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Branch – 02 Physics

The Changes of Meteorological and Physical Quantities during Annular and Total Solar Eclipse

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Annotation

The subject of this work is a study of the changes of meteorological and physical quantities during annular and total solar eclipse. Its content is founded on the measurements of the quantities that were implemented during annular solar eclipse in Spain in 2005 and total solar eclipse in 2006 in Turkey.

There are an experiment and measuring devices used for measurements described in the first part of the work. There is also short reference of project's history.

Main principles for successful performance of measurement and description of data processing are stated in the methodics.

The content of the next part is mainly about the characteristics of the solar eclipse during which the measurements were made. In this part the reader can even get to know about the state of the observation sites.

The concise characteristic of measured quantities is stated in the fourth part the work.

The largest part of the work is set of descriptions of changes meteorological and physical quantities during annular and total solar eclipse. A reader can find graphic and numerical data processing here.

There are the main differences in progressions of the changes meteorological and physical quantities during annular and total solar eclipse mentioned in the conclusion of the work, and even the assessment of the project and recommendations for eventual other measurements are not missing in this part.

There are also the appendixes included in the work, which inlude all graphs in high resolution, photos of measuring devices and the recordings of meteorological situation.

The photos created by satellite MSG-1 for area of solar eclipses and all graphs of progressions measured quantities can be found an CD enclosed.

Affirmation

I proclaim, that I have worked out this project for the contest Secondary Scholarly Activity independently with the help of consultants chosen by me and I have properly mentioned all used resources in the chapter Used Resources.

In Cheb on the 12th March in 2007 …………………………..

Acknowledgement

I would like to thank the director of the Observatory and Planetarium in Plzen Lumir Honzik, Mr. Vaclav Svab and Professor Mgr. Karel Martinek for their valuable guidance to this project. I would also like to thank RNDr. Martin Setvak, CSc. and Mr. Jan Charvat from the Satellite Department CHMI for rendering satellite shots from Meteosat Second Generation 1. My thanks also belong to my parents for their financial support during my Solar Eclipse Expedition to Turkey in 2006. I would also like to express my thanks to Ing. Dalibor Boubin, Mr. Zbysek Ouhleda, Miss Maria Nam and Mr. Matej Kucera for their corrections of the English version of this work.

Contents

1 Introduction

Solar electromagnetic radiation is the only essential energy source for the actions on the Earth.

The solar electromagnetic radiation is transformed into other kinds of energy during the passage throughout the Earth's atmosphere and after fall on the Earth's surface *(e.g. thermal energy, energy of highwawe radiation etc.)*. The marked decrease in the intensity of the solar radiation occurs during solar eclipses *(especially during annular and total solar eclipse)*. It is displayed in changes of standard meteorological and physical quantities. Recent meteorology does not deal with these problems in much detail. Although the decrease of the intensity of the electromagnetic radiation is a unique natural event *(according to the attributes mentioned below)*.

a) Speed and amount of the decrease. There is a marked decrease of the intensity of the solar radiation during very short time interval.

b) The decrease of the intensity of solar radiation is caused by non-atmospheric object – by the Moon crossing the Sun.

Some foreign astronomical expeditions were concerned with the changes of standard meteorological quantities during solar eclipse in the past *(e.g.: Andrew White and Stephen McCann – Zambia 2001, Francis Massen – Luxemburg 1999, Institut für Bioklimatologie – Germany 1999, Laboratory Optical Radiometry – Institute of Electronics „Academican Emil Djakov" – Bulgaria 1999)*. Czech expeditions are mentioned in the section 2.2 History. The scale of measured quantities was very small. The expeditions were usually carried out only measurement of the intensity the incident's radiation and air temperature at the bottom layer of the atmosphere. Measurements of the other meteorological and physical quantities were not common in the past.

The measured devices had other flaws *(e.g.: low sensitivity, low resolution, and low speed of indication and high inaccuracy of measurement)*. Some of the measurements were carried out by common thermometers for home use and a record was usually carried out by the observer. A lot of the measurements miss a reference measurement, and because of this it is not possible to compare between the day of eclipse of the Sun and the day of standard progression of the meteorological and physical quantities. Published results have been from the measurements during total solar eclipses *(not annular solar eclipses)*.

The measurements of the intensity of the solar radiation and the air temperature at the bottom layer of the atmosphere displayed the decrease of these physical quantities during total solar eclipse, but because of the low sensitivity of the measured sensors, it was not possible to determinate the minimal value of the intensity of the solar radiation during the total solar eclipse. The measurements showed time delay between the minimal value of the air temperature and the minimal value of the intensity of the solar radiation too. But the low speed of the indication and the low resolution of the measurement disallowed to determinate the time difference.

The measurement of the air relative humidity implemented by Andrew White in 2001 in Africa refer to the rising character the quantity in the short time after the total phase of the total eclipse of the Sun. [16]

Measurement of the colour of solar radiation was carried out by Bulgarian expedition *Laboratory Optical Radiometry – Institute of Electronics* **„***Academican Emil Djakov“* in 1999. It shows that the colour during total phase of total solar eclipse is different in comparison to before sunrise / after sunset. [7]

Francis Massen *(Luxemburg)* measured the speed of wind during total solar eclipse on 11-th August 1999. The data indicate the decrease of quantity during total phase of total solar eclipse. [6]

The purpose of this work is to implement the first detailed description and comparison of the changes of meteorological and physical quantities during annular solar eclipse and total solar eclipse. The contents of the work are based on the data from expedition to Spain for annular solar eclipse *(on the 3-rd October 2005)* and expedition to Turkey in 2006 for total solar eclipse *(on the 29-th March 2006).*

Author of the work was a member of expedition to Turkey for observing of the total solar eclipse in 2006. In Turkey he operated the meteorological device and he took photos of the total solar eclipse. After ending of the expeditions he did process of measured data by devices of the 3-rd generation of project SEMM.

2 Experiment SEMM

2.1 Description of the Experiment

The experiment called SEMM ensued for accurate measurement of the changes meteorological and physical quantities during solar eclipse.

The biggest decrease of the incident solar radiation occurs in particular during total solar eclipses and annular solar eclipses. Places where is possible to observe total *(annular)* solar eclipses named Total Solar Eclipse Paths *(Annular Solar Eclipse Paths)*. Its width is 100 – 200 km. Imaginary line in the middle of total *(annular)* solar eclipse path is called central line. The longest duration of total *(annular)* phase of solar eclipse is in a place in central line. Considering small frequency of annular and total solar eclipse *(1-2 eclipses per year)* and small width of solar eclipse paths the probability, that a stationary weather station will be in central line, is very low.

Considering the characteristics of the solar eclipse mentioned above, the measuring instruments for the experiment SEMM were built with emphasis on the following requirements:

1) High speed of measurement – The duration of the total phase of a solar eclipse is a few of the minutes and the changes of the incident radiation occurred in a few seconds, the value of the period of the measurement must be in seconds too. Professional weather stations usually save the measured values every 15 minutes.

2) High sensitivity and resolution of the measurement - The amount of the intensity of the global solar radiation is about 4-5 orders during a solar eclipses. The professional stations are not able to measure this scale.

3) The choice of measured quantities – The professional weather stations measure the meteorological and the climatic quantities, but they do not measure special quantities, which are useful during the solar eclipses. A few of weather stations are equipped by sensors for measurement of the intensity of the solar radiation or sensors for measurement of the radiation's colour.

4) The mobility and impendent from electricity – With regard to narrow width of the path of the solar eclipse it is possible that the central line passes over a lifeless areas, where is not source of electricity too. The weather station must be feed from the accumulator with capacity c. 50h that is sufficient for the realisation of the referential measurements and the measurement on the day of the solar eclipse. It is requisite for realization most of the measurement.

5) Automatic operation – The observers must carry out a lot of the astronomical tasks, who are connected with recording of the solar eclipse *(e.g.: photography and shooting)* and they can not operate the weather station.

6) Comparability of the data – The comparing with the professional weather stations is important for the measured data evaluation. During construction of the weather stations of the experiment SEMM the references by WMO were taken in addition, which help to achieved required comparability.

It was processed in accordance with [11], [12].

2.2 History

The plan for compilation of the measuring devices, that would record the changes of the air temperature and the illumination intensity during total solar eclipse *(the 11-th August 1999)*, ensued in The West Branch of CAS in 1998.

The central line of this eclipse of the Sun passed near the border of the Czech Republic. So it was possible to organize large observation program. 9 astronomical groups were created; they were situated in France, Germany, Austria, Hungary, Romania and Bulgaria. The target of the observational action that was organized by Observatory and Planetarium in Plzen, Observatory in Rokycany and The West Branch of CAS was carrying out astronomical observations and compare the results from different places in paths of total solar eclipse. Between astronomical experiments there was inserted a meteorological experiment: measurement of the air temperature and the illumination intensity during the total solar eclipse Three identical measuring modules were constructed by Vaclav Svab and Bc. Jiri Hofman for that occasion. The measurements were parts of the observational programs of groups in Austria, Hungary and Romania.

The air temperature was measured by the resistance sensor Pt 100, it was in tubular tunnel of measuring module with a ventilator, which secured the air streaming around the sensor of the air temperature. The illumination was measured by 2 silicon photodiodes, the first one measured the whole spectrum of the solar radiation within the frame of its spectral scale and the second one measured only infra-red part of the solar radiation. The difference of signals was recorded from the photodiodes, the difference referred to with intensity of the illumination in visible part of the spectrum. Measuring modules were constructed for the simplest servicing and for the automatic operation. [14]

The second generation of 2 measuring devices was lent to the expeditions for the total solar eclipse to Angola and Zambia by Observatory and Planetarium in Plzen in 2001. The expeditions were organised by Observatory in Upice and FEE CUT. Scale of measured quantities was the same as the modules of the previous generation. The calibration of the measuring sensors was implemented more precisely than in the second generation. [13]

Process of the data of expeditions mentioned above brought an interesting results and it was decided to continue in experiment SEMM. Three identical weather stations of the third generation were constructed by Vaclav Svab and Bc. Jiri Hofman in term of years 2001 – 2005. Producing of the weather stations was methodically and financially delivered by Observatory and Planetarium in Plzen. The scale of the measured physical and meteorological quantities was extended during the construction of modules of the third generation; accuracy and resolution of measurement were improved too.

Construction of 3 identical weather stations was finished at the beginning of the year 2005, where they were devolved upon Observatory and Planetarium in Plzen, that is the owner and user of them. The first measuring was accomplished at the beginning of October in 2005 during the expedition for the annular solar eclipse to Spain. The expedition was organised by Observatory and Planetarium in Plzen, The Western Branches of CAS and Observatory in Rokycany. The experiment was a part of the scientific program of an expedition to Turkey for observing total solar eclipse in March 2006, the expedition were jointly prepared by organisations mentioned above.

2.3 The Devices of the Third Generation of the Project SEMM

A weather station of the third generations is consisted of the 5 modules:

DAM – Data Acquisition Module

The module is basic part of the device, there are accumulators, and these are needful for feeding of the device *(capacity c. 50h)*. There are a master component of the system and a high-capacity memory FLASH for the collecting of the measured data too. Even a RTC and interface RS232/USB is not missing here, the interface is indented for a communication between module DAM and PC. A measurement is not possible to carry out without connection of the module.

THM – air Temperature and Humidity measuring Module

The module is indented for measuring of the temperature and humidity of the air at 2 m above the ground. Measuring of the temperature is provided by the resistance sensor Pt 1000. A capacitive sensor with an integrated converter the capacity – the voltage was used for determination of the humidity. A ventilator is located within the module, which secured constant streaming of the air around the sensors. The module is equipped with the white radiating shield that absorbed a minimal value of the solar radiation.

The calibration of the sensors mentioned above was carried out in the calibrating laboratory of CHMI in Prague – Libus. The determination of the calibrating constants for every module THM was the result of the calibrations.

Quantity	Label	Measuring Range	Unit	Uncertainty of Measuremeent ($c_e = 2$)
Air Temperature at 2 m	t_{a2m}	- 40 ÷ 60	°C	0.5 °C
Relative Humidity at 2 m	RH	0 ÷ 100	%	3 %

Table no. 1: The View of the Measured Quantities by the Module THM

TTM – air Temperature and ground Temperature measuring Module

The target of the module is measuring of the air temperature at 5 cm above the ground and the soil temperature at 5 cm under the ground. The sensors Pt 1000 secured the determination of the temperatures. The air sensor is equipped with the radiating shield with louvers. The underground sensor is located within the metal probe.

The calibration of the sensors was carried out in the calibrating laboratory of CHMI in Prague – Libus with module THM.

Quantity	Label	Measuring Range	Unit	Uncertainty of Measuremeent ($c_e = 2$)
Air Temperature at 0.05 m	t_{a5cm}	- 40 ÷ 60	°C	0.5 °C
Soil's Temperature at – 0.05 m	t_s	- 40 ÷ 60	°C	0.5 °C

Table no. 2: The View of the Measured Quantities by the Module TTM

WAM – Wind Anemometer Module

The module is indented for measuring of the speed and the direction of wind. It is consisted of the cup anemometer and the wind vane. The indicator of the wind is equipped with the air vane, which is connected with a potentiometer. The direction of wind is possible to determinate from the aberration of the potentiometer.

The measuring of the speed and the direction of wind is carried out at 2 m above the ground, it is not standard height of the measurement of the wind attributes by WMO. The height was chosen from practical reason, because the transport and the hoisting of 10-meter column are not possible.

Quantity	Label	Measuring Range	Unit	Uncertainty of Measuremeent ($c_e = 2$)
Wind Speed[1]	v	0 ÷ 30	$m.s^{-1}$	below 5 $m.s^{-1}$ 0.5 $m.s^{-1}$, above 5 $m.s^{-1}$ 10%
Wind Direction [1] [2]	d	0 ÷ 360	°	5°

Table no. 3: The View of the Measured Quantities by the Module WAM

SPM – Solar Pyranometr Module

The module operate at 2 meters above the ground, it consist of the sensors for the determination of the intensity of the global solar radiation, of the reflected solar radiation from the Earth's surface and sensor of the radiation's colour *(RGB colorimeter).*

Sensing of the global solar radiation is carried out by a silicon photodiodes, who are in casings. The casings secured the cosine correction of the sensors with the filters. The sensor of the colour of the incident radiation is consisted of a integrated sensor with 3 photodiodes, who have got the R, G, B filters. The value of the range of vision of the both sensors is 180°.

Sensor of the reflected solar radiation from the Earth's surface is the same as the sensor for sensing of the global solar radiation, but the value of the range of vision is 160°, because the sensor must not influenced by solar radiation about the time of sunrise or sunset.

[1] The module WAM measures only the horizontal element of the wind
[2] Wind direction recording has been run a wind speed of more than 1.5 $m*s^{-1}$ during both of the expeditions.

The recommended spectral scale of the sensors of the solar radiation by WMO *(0.3 – 3 μm)* was not adhered. Sensors with the narrow scale and the non-uniform spectral characteristic were used. A high sensitivity, common application during meteorological measurements and existence of the mathematical models, who specify the measurement by the sensors, were reasons for their usage.

The measurement of the intensity of the global solar radiation were calibrating in Laboratory for Solar and Ozone Research of CHMI in Hradec Kralove during 2 days. The calibration of the colorimetric sensor was carried out in the Department of Radiometry and Photometry of CMI.

In addition to the quantities mentioned above the module SPM counts the other quantities after transferring of data to PC.

Quantity	**Label**	**Measuring Range**	**Unit**	**Uncertainty of Measuremeent ($c_e = 2$)**
Intensity of the Global Solar Radiation	I	0 ÷ 1550	$W*m^{-2}$	3 % from daylong sum
Intensity of the Reflected Solar Radiation from the Earth's Surface	I_r	0 ÷ 1550	$W*m^{-2}$	3 % from daylong sum
Albedo of the Earth's Surface[3]	α	0 ÷ 100	%	
Correlated Colour Temperature of the Solar Radiation[3]	T_c	1000 ÷ 500 000	K	
Colour of the Light in sRGB[3]	sRGB	0 ÷ 1	-	
Chromaticity Coordinates of the Light[3]	CIE xy	0 ÷ 1	-	
Intensity of the Illumination[3]	E	0 ÷ 250 000	lx	

Table no. 4: The View of the Measured Quantities by the Module SPM

It was processed in accordance with [11].

The photos of the measuring devices are parts of the appendixes.

[3] The quantity is counted. Record is counted only in case if the intensity of the global solar radiation crosses a considerable countable limit.

2.4 The Length and the Periodicity of the Measurement

The recommended length of the measurement was designed so that it covers the whole progression of a solar eclipse. The duration of the total *(annular)* phase of a solar eclipse and the velocity of changes in progression of the meteorological quantities during the phase were taken into account most during the choice of right measurement's period.

The duration of the measurement is 10 h, the measurement is dived into 3 parts, who tie together, but the period of the second part is different:

1) At the time 5 h before T_{max} the weather station starts the measurement. The periodicity of a record of the measured values is 10 s, the duration of the phase is 4h 45 min. [4]

2) 15 minutes before T_{max} the phase of measurement starts, which has got the value of the periodicity of the record 1 s. The duration of the phase is 30 min.

3) The weather station automatically over passed to the other mode after ending of the measurement's part mentioned above. The periodicity and the duration of the mode are the same as the mode at the second part. The measurement will be finished at the time 5 h after T_{max}.

The times these determinate launching of the measurement's parts are fixed by the servicing software before departure to an expedition. The times T_1, T_2, T_3 a T_4 of an solar eclipse are the input values for counting of the launching times of the measurement.

It was processed in accordance with [12].

[4] Before the start of the measurement the compensational mode runs, its length is 20 min. The record of the measured values does not carry out during this phase.

3 Methodics

3.1 Measurement

The recommendations mentioned below are had to take into account for right implementations of the meteorological measurements.

The same configurations of the measured quantities are desirable to use for all weather stations during the solar eclipse.

The recommended locating of the measuring devices:

1) The weather stations are placed in a central line of a solar eclipse's path, the distance between the devices is a few of hundred of kilometres. The way of lay-out of the meteorological devices is suitable for comparing of the changes of the meteorological quantities during the solar eclipse from different places.

2) The weather stations are placed at different places in the solar eclipse's path and they are in the line, which is upright to the central line. This way of lay-out of the meteorological devices is possible to use for comparing of the changes of the meteorological quantities from different places in the path of the solar eclipse.

In addition to measurement on the day of solar eclipse the 2 referential measurements must be carried out, if the meteorological conditions allow so: on the day before and after the day of solar eclipse A referential measurement must have the same time interval, period of the measurement and the scale of the measured quantities as a measurement on the eclipse's day.

It was processed in accordance with [11], [12].

3.2 Data Processing

Process of the measured data, which was acquired by devices of the third generation of project SEMM, has not carried out up to now. It was required to create the consecution of data's processing that will be applied for the other measurements.

All quantities were not processed in the reference of the work's target. The quantities mentioned above were eliminated; they were acquired by the module SPM. These quantities are counted after transferring to the PC; their progressions depend on the other quantities, which are mentioned below.

- the albedo of the Earth's surface
- chromaticity coordinates of the light
- the intensity of the illumination

The rounding of the quantities' values was done before the numerical and the graphical data's processing, it consist in the technical attributes of a sensor and the amount of the measured noise. The resolution of the measured and the calculated quantities, which is mentioned in the work, is stated in the table no. 5.

The numerical and the graphical process of the data were done in the computer program Microsoft® Excel 2003.

Quantity	**Accuracy**	**Unit**
Intensity of the Global Solar Radiation	$1*10^{-3}$	$W*m^{-2}$
Intensity of the Reflected Solar Radiation from the Earth’s Surface	$1*10^{-3}$	$W*m^{-2}$
Temperature of the Air at 2 m above the Ground	$1*10^{-2}$	°C
Temperature of the Air at 5 cm above the Ground	$1*10^{-2}$	°C
Temperature of the Soil at 5 cm under the Ground	$1*10^{-2}$	°C
Relative Humidity of the Air at 2 m above the Ground	$1*10^{-2}$	%
Colour of the Light in Colour Space sRGB	$1*10^{-11}$	-
Correlated Colour Temperature of the Solar Radiation	1	K
Speed of the Wind	$1*10^{-1}$	$m*s^{-1}$
Direction of the Wind	10	°

Table no. 5: Denoted Accuracy of the Quantities

The values in the interval of time <T_{1min}[5]-2 min;T_{1min} [5]) were chosen for the calculation of an average value before the start of solar eclipse. The soil temperature is the exception from the others, the time T_{1min}[5] was stated considering the start of the quantity’s decreasing *(no considering the time T_1 of solar eclipse).*

The searching of the minimal *(maximal)* values of the measured quantities that were caused by solar eclipse was proceeding by this way: Firstly the interval of time, where was the searched minimal value, was chosen from the graph. The function MINIMUM *(MAXIUMUM)* by Microsoft® Excel 2003 was used for the accurate determination the minimal or maximal value of the quantity.

The minimal *(maximal)* values of the quantities, which were caused by eclipse of the Sun, the values of the reference measurement with the same the time as the found minimal *(maximal)* values were chosen for the comparison between the reference day and the day of solar eclipse. [6]

The decrease or the proportion of the quantity’s value during eclipse day was determined by the relevant mathematical operation between the average value before the beginning of the eclipse and the minimal value during the solar eclipse.

The decrease or the proportion of the quantity’s value was determined by the relevant mathematical operation between the minimal *(maximal)* value during the time of solar eclipse and the value from the reference day with the same time as the searched minimal *(maximal)* value. [6]

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[5] T_{1min} is the time of the beginning of the last minute before the time T_1.
[6] If the value of the periodicity of the record was higher than the periodicity of the record from the day of solar eclipse, the value with the most similar times toward the times of the minimal respectively maximal values were chosen.

Before the graphical processing the graphs were smoothed by the trend lines of the moving average with the period. This step was used for simplification of the descriptions of the graphs. But the mentioned times of important time instants *(the minimal and maximal values)* were subtracted from the original curve of graph.

The resolution of the description of the time intervals consists in the speed of quantity's change *(viz. table no. 6)*. The exception can be the time of sunrise, which is mentioned with the accuracy of the informational source.

Quantity	**Resolution of the time interval**
Intensity of the Global Solar Radiation	1 s [7]
Intensity of the Reflected Solar Radiation from the Earth's Surface	1 s [7]
Temperature of the Air at 2 m above the Ground	1 min
Temperature of the Air at 5 cm above the Ground	1 min
Temperature of the Soil at 5 cm under the Ground	1 min
Relative Humidity of the Air at 2 m above the Ground	1 min
Colour of the Light in Colour Space sRGB	1 s [7]
Correlated Colour Temperature of the Solar Radiation	1 s [7]
Speed of the Wind	1 min
Direction of the Wind	1 min

Table no. 6: Denoted Resolution of the Time Intervals

Every word description is replenished with small graph for better orientation. All graphs described in the part no. 6 are components of appendixes.

[7] The resolution of the time interval depends on the periodicity of the record.

4 Characteristics of the Solar Eclipses

4.1 Annular Solar Eclipse on the 3rd October 2005

On the 3-rd October 2005 the eclipse of the Sun occurred, it was visible as the annular solar eclipse from some Earth's places. The annular solar eclipse path started in the northern part of the Atlantic Ocean, it continued in the ESE direction, and then it turned toward to the south-east direction and it passed though Spain. It continued over the Mediterranean Sea to Africa. From there, he crossed from Algeria to Lybia and Sudan. The duration of the eclipse's annular phase was 4 min 31.6 s. It then continued across Ethiopia, Kenya and Somalia to western part of the Indian Ocean and ended up on the Coconut Islands. [9]

The global map of visibility of the solar eclipse is a part of the appendixes.

The target of the expedition was comparing of the meteorological changes in different places in the path of solar eclipse. 3 weather stations of experiment SEMM were used for the measurement. The long-term weather forecast by Fred Espenak *(NASA)* and Jay Anderson *(NASA)*, accessibility of the site and financial possibilities of the members of expedition were taken into account during the choice of the suitable observational site.

The places along the eastern coast of Spain were chosen as possibility observational sites. They are located near Alicane, the probability of clean sky on the day of annular eclipse was about 60%. The weather station no.0 was located in 90% of depth of the path of annular eclipse. Its co-ordinates are: φ = 38° 36' 20.4'' N; λ = 00° 02 '28.2'' W; altitude:0 m The weather station no.1 was located in 60% of depth of the path of annular eclipse. Its co-ordinates are: φ = 38° 36' 20.4'' N; λ = 00° 18 ' 31.8'' W; altitude: 40 m The weather station no.2 was located on the edge of path of annular solar eclipse. Its co-ordinates are: φ = 38° 07' 40.2'' N; λ = 00° 38' 24.6'' W; altitude: 5 m

Considering orientation of the work here is used only the values measured by weather station no.0, which was located the nearest toward the central line of the annular path. The service of the weather station was created by Petr Masek and Jan Vit. The service did not accomplish records about meteorological situation at the place. The photos of the area by satelit MSG-1 in spectral channel IR 10.8 are in CD.

Due to the lack of time the 1st referential measurement on October 2, 2005 was not accomplished. On the day of annular eclipse *(October 3rd, 2005)* the measurement was launched at 05:00:00 UTC; it was ended at 14:17:00 UTC. The Sun rose after the start of measurement *(at 05:57 UTC)* and it set after the ending of measurement *(at 17:41 UTC)* on the day.

T_1	07:42:24 UTC
T_2	09:00:23 UTC
T_{max}	09:02:01.6 UTC
T_3	09:04:37 UTC
T_4	10:31:04 UTC
Magnitude of the Eclipse	95.170 %

Table no. 7: The Elements of the Annular Solar Eclipse *(on the 3rd October 2005)*

It was counted by [1].

On the 4-th October 2005 the second reference measurement was started at 05:00:00 UTC, it was ended at 14:17:00 UTC. The Sun rose after the start of measurement *(at 05:58 UTC)* too and it set after the ending of measurement *(at 17:39 UTC)* on the day.

4.2 Total Solar Eclipse on the 29th March 2006

On the 29-th March the eclipse of the Sun occurred, it was visible as the total solar eclipse from some Earth's places. The total solar eclipse path started in the eastern part of Brazil; it continued in E up to NE direction though the Atlantic Ocean to Africa. Here, it went across the land of Ghana, Toga, Benin, Nigeria, Niger, Chad, and Lybia – near the Chad/Lybian border the total path was reaching its maximum width of (183.5 km). The duration of the eclipse's annular phase was 4 min 31.6 s. The maximal duration was 4 min 06 s. The last state in Africa, where was possible to observe the total solar eclipse, was Egypt. Then the total eclipse path continued over the Mediterranean Sea to Turkey, the Black Sea, Geogria and Russian Federation Caucasus. From there it continued into the northern part of the Caspian sea, crossed the land of Kazachstan and returned to Russia, as people in Mongolia were able to observe this total eclipse where the total path has ended [10]

The global map of visibility of the solar eclipse is a part of the appendixes.

The long-term weather forecast by Fred Espenak *(NASA)* and Jay Anderson *(NASA)*, the weather statistics by RNDr. Martin Setvak, CSc. *(CHMI)* and financial possibilities of the members of expedition were taken into account during the choice of the observational site.

Town Side was chosen as suitable observational site, it is located on the southern edge of coast of the Turkish Republic. The central line of the eclipse passed 4 km from the observational site and the probability of the clean sky was 50-55% on the day of eclipse. Co-ordinates of the place are: φ = 36° 46‘ 48.2‘‘ N; λ = 31° 23‘ 20.8‘‘ E; altitude: 2 m. Service of the weather station no.2 was consisted of Martin Adamovský, Lumir Honzik, Miloslav Machon and Ondrej Trnka. The records about weather situation, whose were doing during the measurements, are the parts of the appendixes. The photos of the area by satelit MSG-1 in spectral channel IR 10.8 are in CD.

The first reference measurement was started on the 28.3.2006, but an unexpected problem with servicing of the weather station caused that the measurement started 12 min later than was expected and the period of the measurement was manually set on 10 s for all duration of the measurement. The Sun rose before the start of the measurement *(at 03:46 UTC)* and it set after the ending of the measurement *(at 16:12 UTC)* on the day.

On the day of the total solar eclipse *(29.3.2006)* no problems occurred during the start of the measurement, it was automatically start at 5:57:00 UTC. The measurement was automatically ended too *(at 15:57:00 UTC)*. The Sun rose before the start of the measurement *(at 03:45 UTC)* and it set after the ending of the measurement *(at 16:15 UTC)* on the day.

T_1	09:38:23 UTC
T_2	10:55:00 UTC
T_{max}	10:56:52.5 UTC
T_3	10:58:45 UTC
T_4	12:13:34 UTC
Magnitude of the Eclipse	105.015 %

Table no. 8: The Elements of the Total Solar Eclipse *(on the 29th March 2006)*

It was counted by [1].

The changes of the weather situation caused by a warm front that the second reference measurement was not launched on the 30.3.2006.

5 Characteristics of the Measured Quantities

5.1 Intensity of the Global Solar Radiation

The intensity of the global solar radiation is a physical quantity that is defined as the sum of the intensity of the diffusion and the direct solar radiation that strike upon the horizontal surface. Its amount and the abundance of each item of the solar radiation are changed in dependence on the height of the Sun below the horizon, amount of the cloud cover and air pollution. The main unit of the physical quantity is $W*m^{-2}$.

The global solar radiation is consisted of the only diffused solar radiation during cloudy days, before a sunrise and after a sunset. The direct solar radiation is the major part of the intensity of solar radiation during clear days and after sunrise. The intensity of the direct solar radiation grows up with the height of the Sun below the horizon. [5]

The amount of the quantity would grow up or decrease with the size non-covered part of the solar disc during the solar eclipse.

5.2 Intensity of the Reflected Solar Radiation from the Earth's Surface

The intensity of the reflected solar radiation from the Earth's surface is a physical quantity that determinate the amount of the reflected solar radiation from the Earth's surface. The main unit of the physical quantity is $W*m^{-2}$. The changes of the quantity's amount that are observed during the day are caused by the changes of the intensity of global solar radiation in particular. [5]

The amount of the quantity would grow up or decrease with the intensity of the global solar radiation during the solar eclipse.

5.3 Temperature of the Air at 2 m above the Ground

The air temperature at 2 m above the ground is a physical quantity and a standard meteorological element that determinate the thermal state of the air at the bottom layer of the atmosphere, it is the ability of the air to transfer or receive the heat energy. Quantity's unit is °C in this work. The change of the quantity depends on the change of the soil temperature. [5]

During the solar eclipse the temperature of the air 2 m above the earth should increase respectively decrease with a certain delay toward the increase respectively decrease of size of the uncovered part of the solar disc.

5.4 Temperature of the Air at 5 cm above the Ground

The air temperature at 5 cm above the ground is a physical quantity and a standard meteorological element that determinate the thermal state of the air at the bottom layer of the atmosphere, it is the ability of the air to transfer or receive the heat energy. Quantity's unit is °C in this work. The change of the quantity depends on the change of the soil temperature.

The measurement of the quantity makes possible the thermal state of the air at the atmosphere's bottom layer.

During the solar eclipse the temperature of the atmospheric ground layer should increase respectively decrease with a certain delay toward the increase respectively decrease of intensity value of the global solar radiance.

5.5 Temperature of the Soil at 5 cm under the Ground

The soil's temperature at 5 cm under the ground is a physical quantity and a standard meteorological element that determinate the thermal state of the soil at the depth 5 cm of the soil, it is the ability of the soil to transfer or receive the heat energy. Quantity's unit is °C in this work. The change of the quantity depends on the change of the intensity of the global solar radiation and the thermal capacity of the soil.

The measurement of the quantity makes possible to determinate the thermal state of the soil.

During the solar eclipse the temperature of the soil should increase respectively decrease with a certain delay toward the increase respectively decrease of intensity value of the global solar radiance.

5.6 Time Comparison of the Minimal Values of the Temperature and Global Solar Radiation

The time comparison between the temperatures mentioned below and the intensity of the global solar radiation was inserted in to the work too, because it enabled to demonstrate the model of the transfer of the thermal energy between the soil and the air layers.

During the solar eclipse the time retardation of the temperature minimal values toward the minimal value of the intensity of the global solar radiation would display. The soil temperature at 5 cm under the ground would have the highest value of the retardation; it would be cause by the thermal capacity of the soil. The air retardations would have smaller values, rather the retardation of the air temperature at 5 cm would have smaller value of the because of the convective exchange of the energy between the atmosphere's layers than the retardation of the air temperature at 2 m above the ground.

5.7 Relative Humidity of the Air at 2 m above the Ground

The relative humidity of the air at 2 m above the ground is a physical quantity and a metrological element too that indicates the degree of the air saturation by water. It is defined as the ratio between the actual pressures of water vapour and saturated water vapour at a given temperature or the radio between the actual absolute humidity of the air and the absolute humidity at a given temperature in the saturated air. The quantity assumes values from 0 % to 100 % in according to the definition. [5]

If the constant amount of water vapour will be in the air, the quantity's value would grow during solar eclipse because the temperature would decrease.

5.8 Colour of the Light in Colour Space sRGB

One of the possible ways how express the colour of the light is via using the co-ordinates in a colour space. During construction of the weather stations the colour space named sRGB *(standard RGB Colour Space)* was chosen.

The colour space was defined by Hewlett-Packard and Microsoft and then it became the most expanded colour space. The sRGB triangle of the noticed colours was defined into the gamut of the human eye. If the noticed colour was not into the triangle, it was re-counted for the most conformable colour on a side of the triangle *(viz. picture 1)*. [8]

It was taken from [8].

Picture no. 1: Colour Space sRGB

In the light of physics the quantity is dimensionless, it is only proportional abundance of the single parts of the colour *(red, green and blue)*, and the addition of colour's part is always 1.

The colour of solar radiation is influenced by the diffusion of solar rays in the atmosphere. We differ the 2 kinds of diffusions: molecular and aerosol

The molecular *(Rayleigh's)* diffusion occurs on molecules of gas *(e.g.: the air)*. The kind of diffusion of the light is mostly influenced the short-wave light *(e.g.: violet and blue light)*, at least the diffusion is effected the long-wave light *(e.g.: red light)*.[5]

The aerosol diffusion occurs on the aerosols *(e.g.: water and salt)*. The king of light's diffusion is mostly influenced the long-wave light but the least the short-wave light. During the diffusion the radiation is absorbed and then it is emitted in the form of the calorific *(infra-red)* radiation.

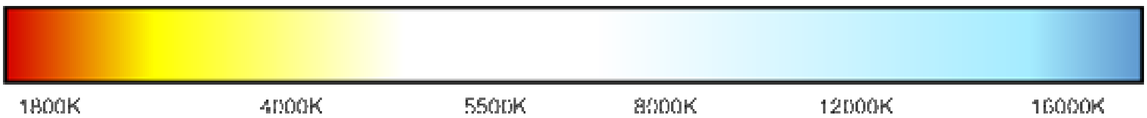
In addition to the kinds of scatterings mentioned above the colour of solar radiation is influenced by phenomenon limb darkening.

Colour of the solar limb is more dark then the centre of solar photosphere. The phenomenon is caused by a inclined viewing angle. The absorption caused, that we have an eye to lower depth of the photosphere. The temperature on the limb is colder than in the centre of photosphere, because the temperature grows with the depth in solar photosphere. The long-waved photons arrived to us from the solar limb. [4]

5.9 Correlated Colour Temperature of the Solar Radiation

The next way how express the colour of the light is via the colour temperature of radiation. The physical quantity determinate what temperature has got the black body, if its radiation evokes the same coloured sensation in human eye as the measured radiation. Quantity's unit is K in this work.

If the shape of a spectral curve of an emitting body is different from the spectral curve of the black body, the expression "the correlated colour temperature" was used. The physical quantity is defined as the temperature of the black body, which has got an approximately similar progression of the spectral curve in the researched spectral domain as the shape of the spectral curve of the black body. Quantity unit is K as well.



It was taken from [15].

Picture no. 2: The Colour of the Visible Light Couched in the Colour Temperature

5.10 Direction and Speed of the Wind

Wind is a basic meteorological element that characterizes the streaming of the air in a determinate place in the Earth's atmosphere in a certain instant of time considering Earth's surface.[5]

In the light of physics the wind is a vector quantity that is possible to disarticulate to the horizontal and the vertical component, but the measuring sensors of WAM module measured the only horizontal component of the wind.

The wind is possible to describe by the 2 quantities: the speed and the direction of the wind

The wind direction is the direction from where the wind blows. It usually indicates in the angular digresses or in decades of angular angles of geographical azimuth, if necessary in 8, 16 or 32 segmented scale with the help of international abbreviations issuing from the English terms of individual cardinal points from where the wind blows.

The speed of the wind is a distance, which a movement matter of the air travel per unit of the time. The value of the quantity is mentioned in $m*s^{-1}$.

In general the formation of the wind is conditioned by the non-uniform heating of the single places on the Earth. In consequence of the phenomenon the different values of temperature *(or atmospheric pressure)* rise above the places and it is the reason of the formation of the wind.

The formation of a local wind is conditioned by the non-uniform heating of the land and the sea, it induce the wind. Breeze is a typical wind for these areas.

The breeze is possible to divided into two basic kinds: the sea breeze and the land breeze

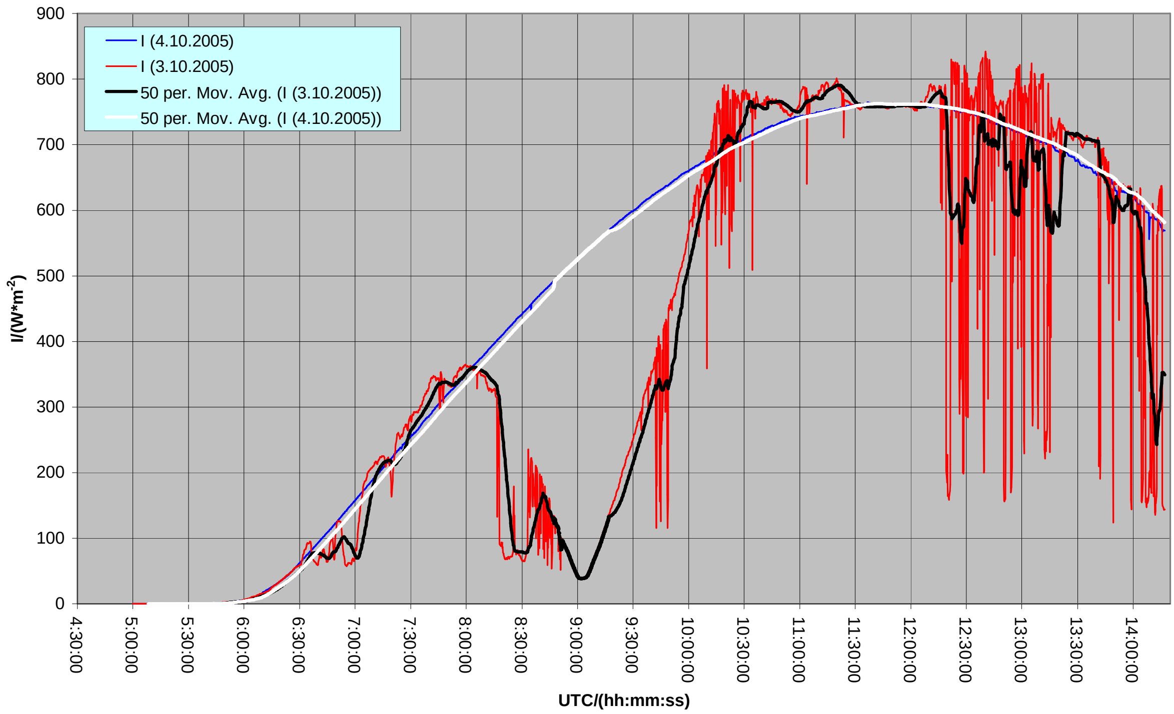
The sea breeze is a local wind, which blows from the sea. If the air temperature above the sea is lower than the air temperature above the land, the wind ensued. The temperature's difference caused the formation of the high-level pressure area above the sea compared with the value of the atmospheric pressure above the land.

The land breeze is a local wind, which blows from the land. If the air temperature above the land is lower than the air temperature above the sea, the wind ensued. The temperature's difference caused the formation of the high-level pressure area above the land compared with the value of the atmospheric pressure above the sea.

6 Measured Quantities

6.1 Intensity of the Global Solar Radiation

6.1.1 Annular Solar Eclipse – Spain 2005



Graph no. 1: Progression of the Intensity of the Global Solar Radiation – Spain 2005

The progression of the intensity of the global solar radiation is possible to see in graph no. 1. The blue curve represents the referential measurement from the 4-th October 2005 and the red curve illustrates the measurement during the day of the annular solar eclipse *(on October 3rd, 2005)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 1 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 4.

The Referential Measurement

The white trend line of the moving average with the period of 50 values from the day of the referential measurement *(October 4th, 2005)* is mostly concave throughout the whole running. The character of the curve is stagnant to slightly increasing too in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:58 UTC), which was caused by the decreasing depth of the Sun below the horizon. The value of the intensity of the global solar radiation is close to 0 W*m^{-2} particularly in the first half of the time interval. In the time interval <05:58 UTC; 11:52:10 UTC) the character of the curve is increasing; that was caused by the increasing height of the Sun above the horizon. The value measured at 09:01:50 UTC was chosen for to determine the quotient of the intensity of the global solar radiation between the referential day and the day of the annular solar eclipse, and which is 531.226 W*m^{-2}. The decrease of the Sun's height above the horizon caused that the curve has got a decreasing character in the time interval <11:52:10 UTC; 14:17:00 UTC).

The Measurement on the Eclipse Day

The black trend line illustrating the moving average with the period of 50 values from the day of the annual solar eclipse has got a stagnant to slightly increasing character in the time interval from the beginning of the measurement to the time of sunrise <05:00:00 UTC; 05:57 UTC), which was caused by the decrease of the Sun’s depth below the horizon. The intensity value of the global solar radiation is close to 0 W*m^{-2} particularly in the first half of the time interval. The increasing character of the curve was inflicted by the increasing height of the Sun above the horizon in the time interval <05:57 UTC; 06:36:40 UTC). The noticeable variations that are noticeable in the time interval <06:36:40 UTC; 07:00:00 UTC) were caused by the transition of the Sc cloudiness over the Sun. The increasing character of the curve was again caused by the increasing height of the Sun above the horizon too in the time interval <07:00:00 UTC; 08:03:20 UTC). The variations in the time interval mentioned above were caused by the transition of cloudiness over the Sun. The values in the time interval <07:37:00 UTC; 07:40:00 UTC) were chosen to determine of the average value of the intensity of the solar radiation before the start of the solar eclipse, their arithmetic mean is 322.851 W*m^{-2}. The decreasing character of the curve in the time interval <08:03:20 UTC; 08:15:30 UTC) is caused by the gradual shading of the Sun by the Moon. The steeper decreasing character in the time interval <08:15:30 UTC; 08:28:20 UTC) and the stagnant character of the curve in the time interval <08:28:20 UTC; 08:32:50 UTC) were caused by the cloudiness and the Moon covering the Sun. The change of the character from a stagnant to an increasing character was caused by the cloudiness uncovering the Sun in the time interval <08:32:50 UTC; 08:42:00 UTC). The decreasing character of the curve was caused by the shading the Sun by the Moon in the time interval <08:42:00 UTC; 09:01:51 UTC). The lowest value of the intensity of the global solar radiation is at the time 09:01:50 UTC, and it is 38.260 W*m^{-2}. The increasing character that is noticeable in the time interval <09:01:50 UTC; 10:33:20 UTC) was caused by the growth of the height of the Sun above the horizon and tge uncovering of the Sun by the Moon. The curve has got more moderate increasing character in the time interval <10:33:20 UTC; 11:58:50 UTC), its cause is the increasing height of the Sun above the horizon. The variations noticeable in the ascending part in graph no. 1 were caused by the transition of the cloudiness though the Sun. The declension of the Sun’s height below the horizon caused that the curve has got a decreasing character in the time interval <11:58:50 UTC; 14:17:00 UTC).

The important values are summarized in the tables mentioned below.

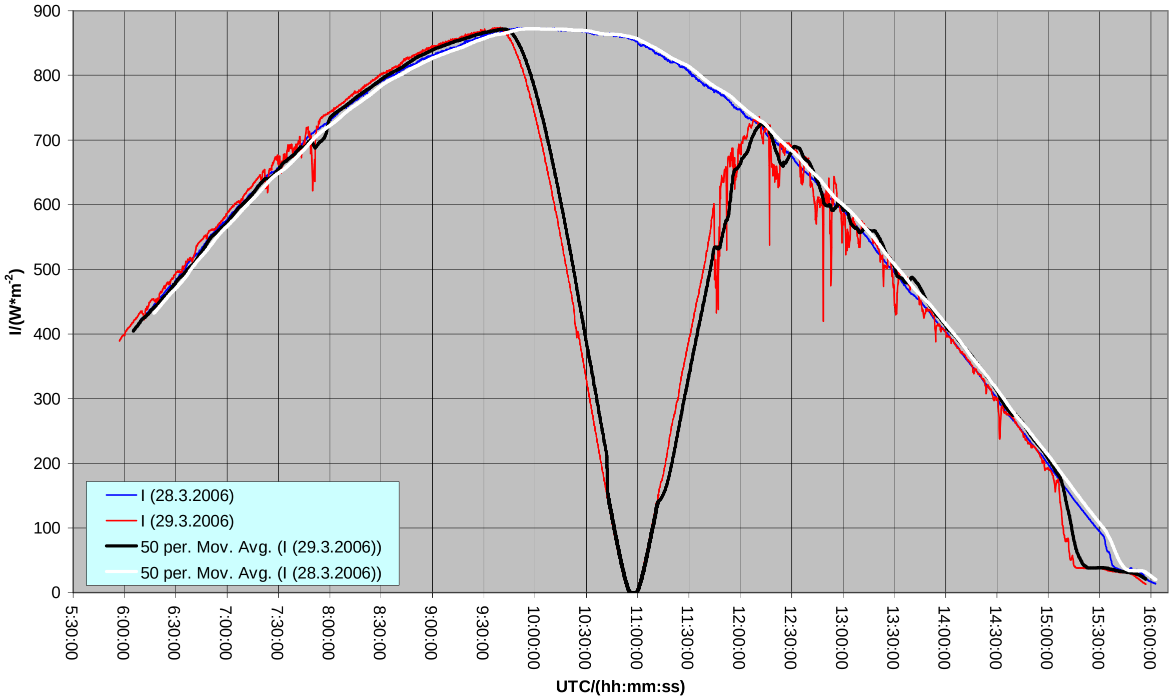
	Value	**Time / (hh:mm:ss)**
Average Value before T_1	322.851 W*m^{-2}	<07:37:00 UTC; 07:40:00 UTC)
Minimum during the Eclipse	38.260 W*m^{-2}	09:01:50 UTC
Referential Measurement	531.226 W*m^{-2}	09:01:50 UTC

Table no. 9: The Intensity of the Global Solar Radiation – Spain 2005: The View of the Important Values

Quotient during the Eclipse Day	8.438 times
Quotient between 3. and 4. 10. 2005	13.885 times

Table no. 10: The Intensity of the Global Solar Radiation – Spain 2005: The Quotients of the Important Values

6.1.2 Total Solar Eclipse – Turkey 2006



Graph no. 2: Progression of the Intensity of the Global Solar Radiation – Turkey 2006

The progression of the intensity of the global solar radiation is possible to see in graph no. 2. The blue curve represents the referential measurement from the 28-th March 2006 and the red curve illustrates the measurement during the day of the total solar eclipse *(on March 29th, 2006)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 2 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 5.

The Referential Measurement

The white trend line of the moving average with the period of 50 values from the day of the referential measurement (March 28th, 2006) is mostly concave throughout the whole running. The increasing character was caused by the increasing height of the Sun above the horizon in the time interval <05:57:00 UTC; 10:05:00 UTC). The decreasing character of the curve is possible to see in the time interval <10:05:00 UTC; 15:57:00 UTC), it was caused by the decreasing height of the Sun above the horizon. The value measured at 10:56:50 UTC was chosen to determine the quotient of the intensity of the global solar radiation between the referential day and the day of the annular solar eclipse, and which is 855.564 W*m-2. The steeper decreasing character of the curve was caused by the shading of measuring sensors in the time interval <15:33:00 UTC; 15:37:00 UTC). The covering of the Sun by the Ac cloudiness caused that information on the intensity of the global solar radiation was distorted in the time interval <15:37:00 UTC; 16:02:40 UTC).

The Measurement on Eclipse Day

The black trend line illustrating the moving average with the period 50 values from the day of the total solar eclipse has got an increasing character in the time interval <05:57:00 UTC; 09:40:30 UTC), that was caused by the increasing height of the Sun below the horizon. The values in the time interval <09:34:00 UTC; 09:37:00 UTC) were chosen to determine the average value of the intensity of the global solar radiation before the start of the partial phase of the solar eclipse, their arithmetic mean is 871.629 W*m^{-2}. The decreasing character of the curve is possible to see in the graph no. 2 in the time interval <09:40:30 UTC; 10:56:48), which was caused by the gradual shading of the Sun by the Moon. The lowest value of the intensity of the solar radiation is at 10:56:47 UTC, and it is 0.021 W*m^{-2}. The curve has got the increasing character in the time interval <10:56:48 UTC; 12:12:10 UTC). It was caused by the gradual uncovering of the Sun by the Moon. The decreasing character of the curve was caused by the decreasing height of the Sun above the horizon in the time interval <12:12:10 UTC; 15:57:00 UTC). The variations of the intensity of the global solar radiation in the time intervals mentioned below were caused by the transition of cloudiness over the Sun. The steep decreasing character was caused by the shading of the Sun by the Ac cloudiness in the time interval <15:06:30 UTC; 15:22:00 UTC). The sequential moderate decrease was caused by the shading of the Sun by the As cloudiness in the time interval <15:22:00 UTC; 15:57:00 UTC).

The important values are summarized in the tables mentioned below.

	Value	**Time / (hh:mm:ss)**
Average Value before T_1	871.629 W*m^{-2}	<09:34:00 UTC; 09:37:00 UTC)
Minimum during the Eclipse	0.021 W*m^{-2}	10:56:47 UTC
Referential Measurement	855.564 W*m^{-2}	10:56:50 UTC

Table no. 11: The Intensity of the Global Solar Radiation – Turkey 2006: The View of the Important Values

Quotient during the Eclipse Day	41506.143 times
Quotient between 28. and 29. 3. 2006	40741.143 times

Table no. 12: The Intensity of the Global Solar Radiation – Turkey 2006: The Quotients of the Important Values

6.1.3 Evaluation

The fact that the quantity decreased about 88.1 % from the original value during the day of the annular solar eclipse in Spain in 2005 flows from the processing of the intensity of the global solar radiation. The value of this decrease noticed during the total solar eclipse was 99.998 % in Turkey in 2006.

These numbers confirmed that the value of the decrease of the global solar radiation decrease respectively increase with the value of the eclipse magnitude.

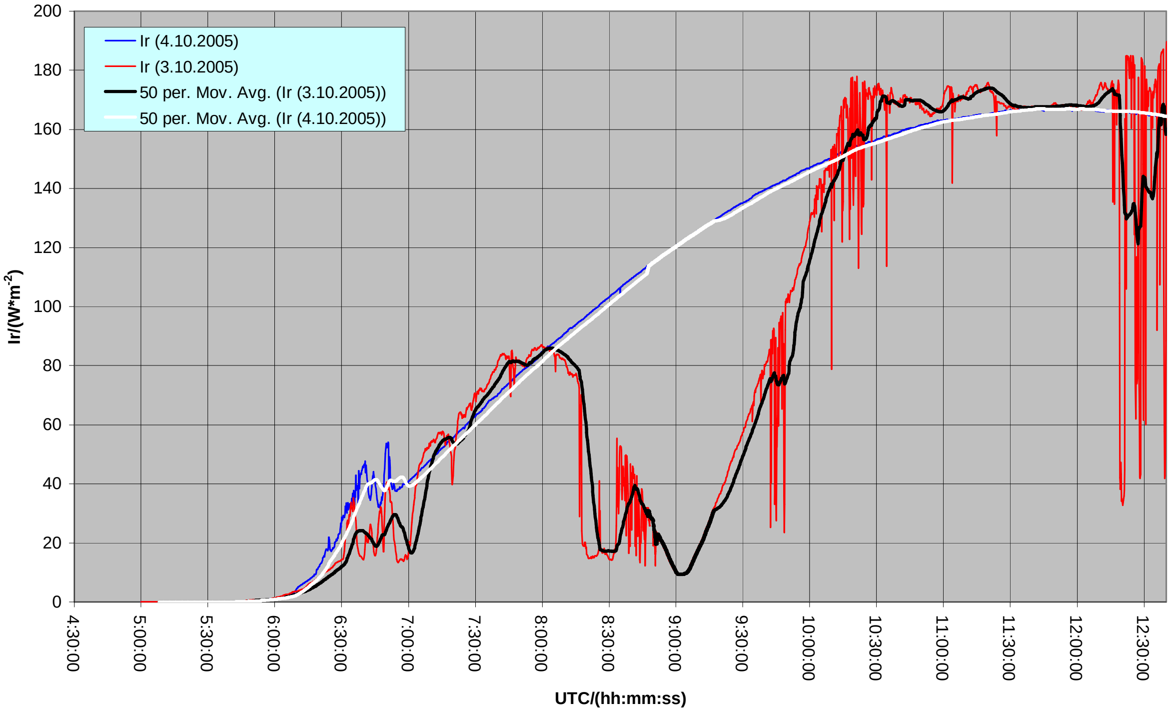
The difference between the measured time of the minimal value of the intensity of the global solar radiation during the annular solar eclipse and the time T_{max} of the eclipse from the prediction *(viz. table no. 7)* was founded. It is 48.6 s.

The difference between the measured time of the minimal value of the intensity of the global solar radiation during the total solar eclipse and the time T_{max} of the eclipse from the prediction *(viz. table no. 8)* was founded. It is 5.5 s.

The differences mentioned above were probably caused by the inaccuracy of the entry parameters of the prediction.

6.2 Intensity of the Reflected Radiation from the Earth's Surface

6.2.1 Annular Solar Eclipse – Spain 2005



Graph no. 3: Progression of the Intensity of the Reflected Radiation from the Earth's Surface – Spain 2005

The progression of the intensity of the reflected radiation from the Earth's surface is possible to see in graph no. 3. The blue curve represents the referential measurement from the 4-th October 2005 and the red curve illustrates the measurement during the day of the annular solar eclipse *(on October 3rd, 2005)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 4 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 6.

The Referential Measurement

The white trend line of the moving average with the period of 50 values from the day of the referential measurement *(October 4th, 2005)* is mostly concave throughout the whole running. The character of the curve is stagnant to slightly increasing in the interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:58 UTC), which was caused by the increasing of the incident solar radiation on the Earth's surface. The value of the intensity of the reflected radiation from the Earth's surface is close to 0 $W*m^{-2}$ particularly in the first half of the time interval. The character of the curve is increasing in the time interval <05:58 UTC; 11:52:40 UTC) too, it was caused by the increasing height of the Sun above the horizon. The causes of the variations that are noticeable in the time interval <06:25:30 UTC; 06:56:40 UTC) are not possible find, because the observers did not make the records. The value measured at 09:01:13 UTC was chosen to determine the quotient between the referential day and the day of the annular solar eclipse, and it is 121.529 $W*m^{-2}$. The declension of the Sun's height above the horizon caused that the curve has got the decreasing character in the time interval <11:52:40 UTC; 14:17:00 UTC).

The Measurement on the Eclipse Day

The black trend line illustrating the movement average with the period of 50 values from the day of the annular solar eclipse has got a stagnant to slightly increasing character in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:57 UTC); it was caused by the decreasing of the Sun depth below the horizon. The value of the intensity of the reflected solar radiation from the Earth's surface is close to 0 W*m^{-2} particularly in the first part of the time interval. The increasing character of the curve in the time interval <05:57 UTC; 06:36:40 UTC) was caused by the increasing Sun's height above the horizon. The variations that are noticeable in the time interval <06:36:40 UTC; 07:00:00 UTC) were caused by the transition of the low Sc cloudiness over the Sun. The increasing in the time interval <07:00:00 UTC; 08:03:20 UTC) was caused by the increasing of the Sun's height above the horizon. The variations in the time interval mentioned above were caused by the transition of the cloudiness over the Sun. The values in the time interval <07:37:00 UTC; 07:40:00 UTC) were chosen to determine the average value before the start of the solar eclipse, their arithmetic mean is 78.422 W*m^{-2}.

The cause of the decreasing character of the curve in the time interval <08:03:20 UTC; 08:15:30 UTC) is the gradual shading of the Sun by the Moon. The steeper decreasing character in the time interval <08:15:30 UTC; 08:27:40 UTC) and the stagnant character of the curve in the time interval <08:27:40 UTC; 08:32:50 UTC) are consequences the shading of the Sun by the cloudiness and the Moon. The change of the curve's character from a stagnant to an increasing was caused by the uncovering of the Sun by cloudiness. The decreasing character of the curve was caused by the other gradual shading of the Sun by the Moon. The lowest value of the intensity of the reflected radiation from the Earth's surface is at 09:01:13 UTC, and it is 9.304 W*m^{-2}. The steep increasing character of the curve that is noticeable in the time interval <09:01:14 UTC; 10:33:20 UTC) was caused by the growth of Sun's height above horizon and the gradual uncovering of the Sun by the Moon. The change of the curve's character from a steep increasing to a less moderate that is noticeable in the time interval <10:33:20 UTC; 11:58:50 UTC) was caused by the end of the partial phase of the solar eclipse. The variations that are noticeable in the ascending part in the graph no. 3 were caused by the transition of the cloudiness over the Sun. The decreasing character of the curve in the time interval <11:58:50 UTC; 14:17:00 UTC) was caused by the decrease of the Sun's height above the horizon.

The important values are summarized in the tables mentioned below.

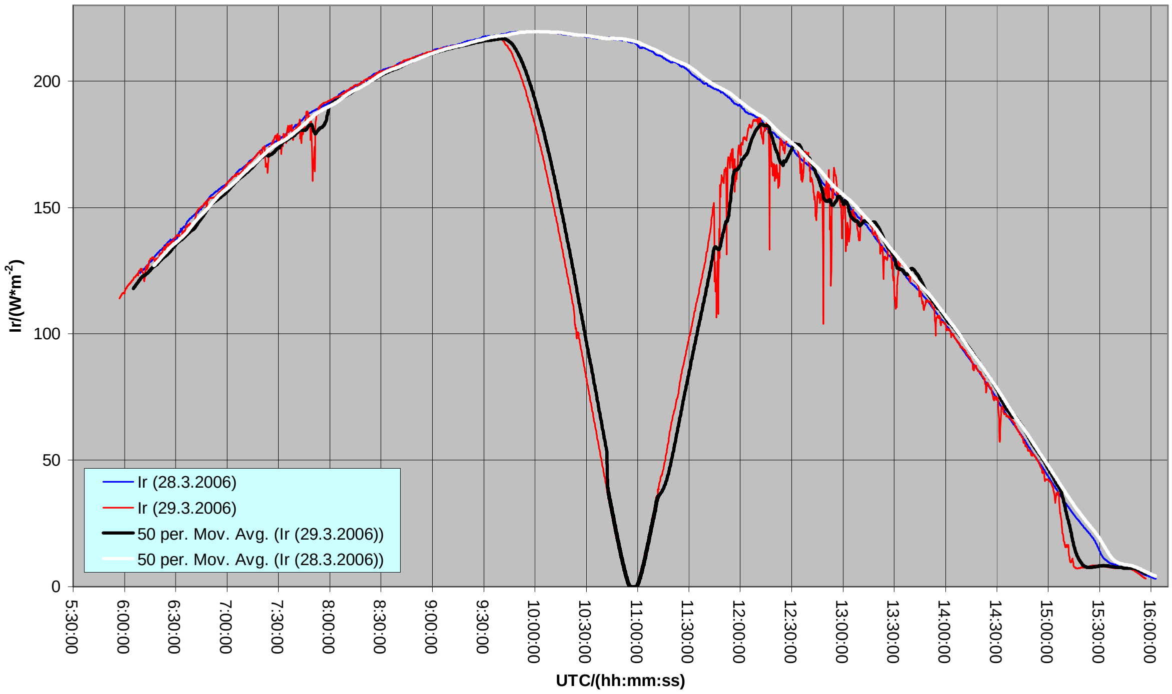
	Value	**Time / (hh:mm:ss)**
Average Value before T_1	78.422 W*m^{-2}	<07:37:00 UTC; 07:40:00 UTC)
Minimum during the Eclipse	9.304 W*m^{-2}	09:01:13 UTC
Referential Measurement	121.529 W*m^{-2}	09:01:13 UTC

Table no. 13: The Intensity of the Reflected Radiation from the Earth's Surface – Spain 2005: The View of the Important Values

Quotient during the Eclipse Day	8.429 times
Quotient between 3. a 4. 10. 2005	13.031 times

Table no. 14: The Intensity of the Reflected Radiation from the Earth's Surface – Spain 2005: The Quotients of the Important Values

6.2.2 Total Solar Eclipse – Turkey 2006



Graph no. 4: Progression of the Intensity of the Reflected Radiation from the Earth's Surface – Turkey 2006

The progression of the intensity of the reflected solar radiation from the Earth's surface is possible to see in graph no. 4. The blue curve represents the referential measurement from the 28-th March 2006 and the red curve illustrates the measurement during the day of the total solar eclipse *(on March 29th, 2006)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 4 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 7.

The Referential Measurement

The white trend line illustrating the moving average with the period of 50 values from the day of the referential measurement *(March 28th, 2006)* has got mostly concave shape throughout the whole running. The increasing character of the curve was caused by the increasing Sun's height above the horizon in the time interval <05:57:00 UTC; 10:05:00 UTC). The value measured at 10:56:50 UTC was chosen to determine the quotient of the intensity of the reflected radiation from the Earth's surface between the referential day and the day of the annular solar eclipse, and it is 215.146 W*m^{-2}. The decreasing character of the curve is possible to see in the time interval <10:56:50 UTC; 15:57:00 UTC), it was caused by the decreasing Sun's height above the horizon. The steeper decreasing character of the curve in the time interval <15:33:00 UTC; 15:37:00 UTC) was caused by the shading of the Earth's surface under the measuring sensors. The covering of the Sun by the Ac cloudiness caused that information on the intensity of the global solar radiation was distorted in the time interval <15:37:00 UTC; 16:02:40 UTC).

The Measurement on the Eclipse Day

The black trend line illustrating the movement average with the period of 50 values from the day of the total solar eclipse has got the increasing character in the time interval <05:57:00 UTC; 09:40:30 UTC) that was caused by the increasing Sun's height above the horizon. The values measured in the time interval <09:34:00 UTC; 09:37:00 UTC) were chosen to determine the average intensity of the reflected radiation from the Earth's surface before the start of the solar eclipse, their arithmetic mean is 216.792 $W*m^{-2}$. The decreasing character of the curve is possible to see in the graph no. 4 in the time interval <09:40:30 UTC; 10:56:48 UTC) and it was caused by the gradual shading of the Sun by the Moon. The lowest value of the intensity of the reflected radiation from the Earth's surface is at 10:56:47 UTC, it is 0.004 $W*m^{-2}$. The curve has got the increasing character in the time interval <10:56:48 UTC; 12:12:10 UTC). It was caused by the gradual uncovering of the Sun by Moon. The decreasing Sun's height above the horizon caused that the curve has got the decreasing character in the time interval <12:12:10 UTC; 15:57:00 UTC). The variations of the intensity of the reflected solar radiation from the Earth's surface in the time interval mentioned above were caused by the transition of the Ci cloudiness over the Sun. The steep decreasing character in the time interval <15:06:30 UTC; 15:22:00 UTC) was caused by the covering of the Sun by Ac cloudiness. The sequent moderate decrease of the curve in the time interval <15:22:00 UTC; 15:57:00 UTC) was caused by the covering of the Sun by the As cloudiness, its consequence was the decrease of the intensity of the reflected radiation from the Earth's surface.

The important values are summarized in the tables mentioned below.

	Value	**Time / (hh:mm:ss)**
Average Value before T_1	216.792 $W*m^{-2}$	<09:34:00 UTC; 09:37:00 UTC)
Minimum during the Eclipse	0.004 $W*m^{-2}$	10:56:47 UTC
Referential Measurement	215.146 $W*m^{-2}$	10:56:50 UTC

Table no. 15: The Intensity of the Reflected Radiation from the Earth's Surface – Turkey 2006: The View of the Important Values

Quotient during the Eclipse Day	54387.474 times
Quotient between 28. and 29. 3. 2006	53974.591 times

Table no. 16: The Intensity of the Reflected Radiation from the Earth's Surface – Turkey 2006: The Quotients of the Important Values

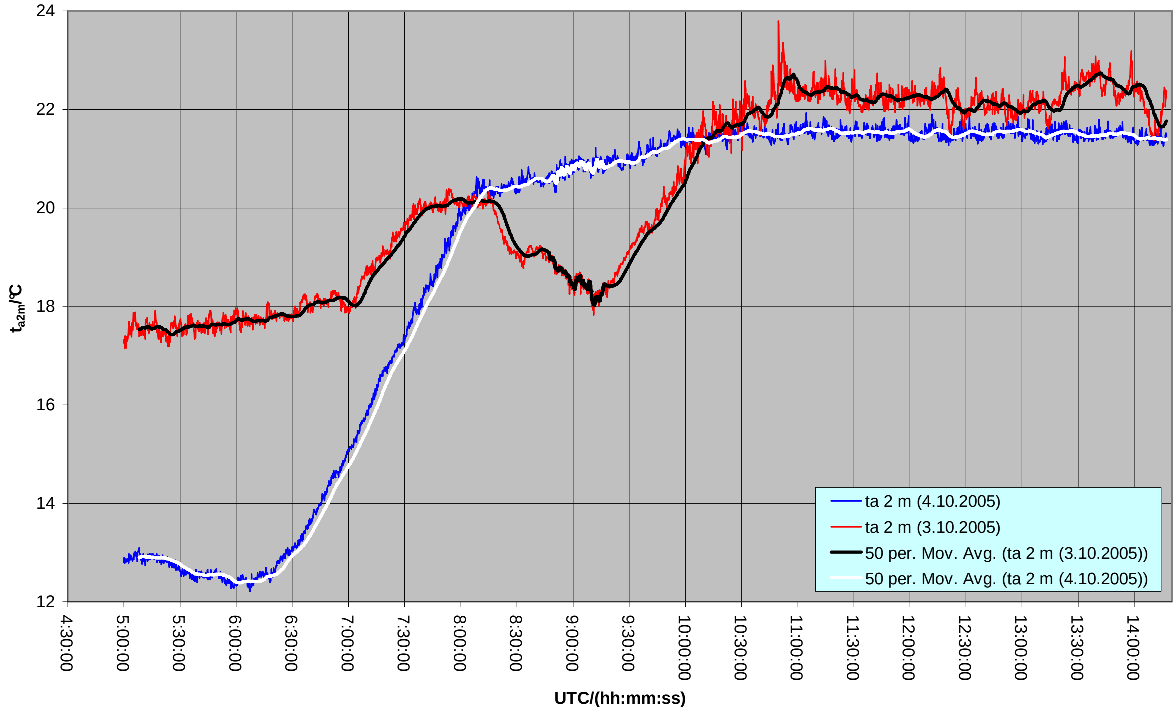
6.2.3 Evaluation

The fact that the quantity decreased about 88.1 % from the original value during the day of the annular solar eclipse in Spain in 2005 flows from the processing of the intensity of the reflected solar radiation from the Earth's surface. The value of this decrease noticed during the total solar eclipse was 99.998 % in Turkey in 2006.

These numbers confirmed that the value of the decrease of the global solar radiation decrease respectively increase with the value of the eclipse magnitude.

6.3 Temperature of the Air at 2 m above the Ground

6.3.1 Annular Solar Eclipse – Spain 2005



Graph no. 5: Progression of the Temperature of the Air at 2 m above the Ground – Spain 2005

The progression of the air temperature at 2 m above the ground is possible to see in graph no. 5. The blue curve represents the referential measurement from the 4-th October 2005 and the red curve illustrates the measurement during the day of the annular solar eclipse *(on October 3rd, 2005)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 5 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 8.

The Referential Measurement

The white trend line of the moving average with the period 50 values illustrating the referential measurement from the day the 4-th October 2005 has got the decreasing character in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:58 UTC) that was caused by the meteorological situation above the observational site. The sky was clear; the heat energy was radiate in the form of the infra-red radiation from the Earth's surface. The decreasing character of the curve is well-marked in the time interval after the sunrise <05:58 UTC; 06:07 UTC), because the air temperature at the bottom layers of the atmosphere start to increase after a certain time after sunrise, that was mostly caused by the caloric capacity of the Earth's surface. The curve has got the increasing character in the time interval <06:07 UTC; 08:10 UTC) it was caused by the increasing height of the Sun above the horizon. The moderate character of the curve is possible to see in the time interval <08:10 UTC; 10:36 UTC) too, it was caused by the increasing of the wind speed that blew from the sea *(SE)* and the sea's temperature was probably lower than the temperature of the land at the moment. The value measured at 09:11:03 UTC was chosen to determine the difference between the referential day and the day of solar eclipse, it is 20.83 °C. The character of the curve is stagnant to moderately decreasing in the time interval <10:36 UTC; 114:17:00 UTC); it was caused by the decreasing height of the Sun above the horizon and the relatively high caloric capacity of the land, which obviated of the steeper decrease of the air temperature.

The Measurement on Eclipse Day

The black trend line representing the movement average with the period of 50 values from the day of the annular solar eclipse has got the moderately increasing character in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:57 UTC); it was caused by the presence of the cloudiness above the observational site that blocks the dissipation of the heat energy in the form of the infra-red radiation. The curve has got this character also after sunrise in the time interval <05:57 UTC; 07:01 UTC), and it was caused by the presence of the cloudiness above the observational site too. The curve's character in the time interval <07:01 UTC; 07:40 UTC) is increasing and its causes are the decay of cloudiness above the sea and the consecutive increase of feeding of the heat energy that come in the form of the solar radiation. The increasing height of the Sun influenced the increasing character of the curve too. The change of the character of the curve from stagnant to moderate increasing was caused also by the presence of the low cloudiness above the observational site and the gradual shading of the Sun by the Moon in the time interval <07:40 UTC; 08:15 UTC). The values in the time interval <07:37:00 UTC; 07:40:00) were chosen to determine the average value of the air temperature at 2 m above the ground before the start of the eclipse. It is 20.02 °C. The decreasing character of the curve in the time interval <08:15 UTC; 09:11:04 UTC) was caused by the gradual shading of the Sun by the Moon, the variations in the time interval were caused by the transition of the cloudiness over the Sun. The lowest value of the air temperature at 2 m above the ground was at 09:11:03 UTC; it is 17.82 °C. The increasing character of the curve is possible to see in the time interval <09:11:04 UTC; 10:46 UTC) that was caused by the gradual uncovering of the Sun by the Moon. The time of the end of the majority effect the solar eclipse on the progression of the temperature is not possible to determine from the graph no.5 because at the time the cloudiness covers the Sun. The curve has got a moderate decreasing character in the time interval <10:56 UTC; 13:20 UTC) and it was caused by the decreasing height of the Sun above the horizon and the occasional transition of the cloudiness over the Sun, it blocks the heat of the Earth's surface and the atmosphere. The increasing character of the curve in the time interval <13:20 UTC; 13:40 UTC) was caused by the decrease in the amount of the cloudiness transition over the Sun. The curve has got the decreasing character in the time interval <13:40 UTC; 14:17:00 UTC) that was caused by the considerable decrease of the Sun's height above the horizon.

The important values are summarized in the tables mentioned below.

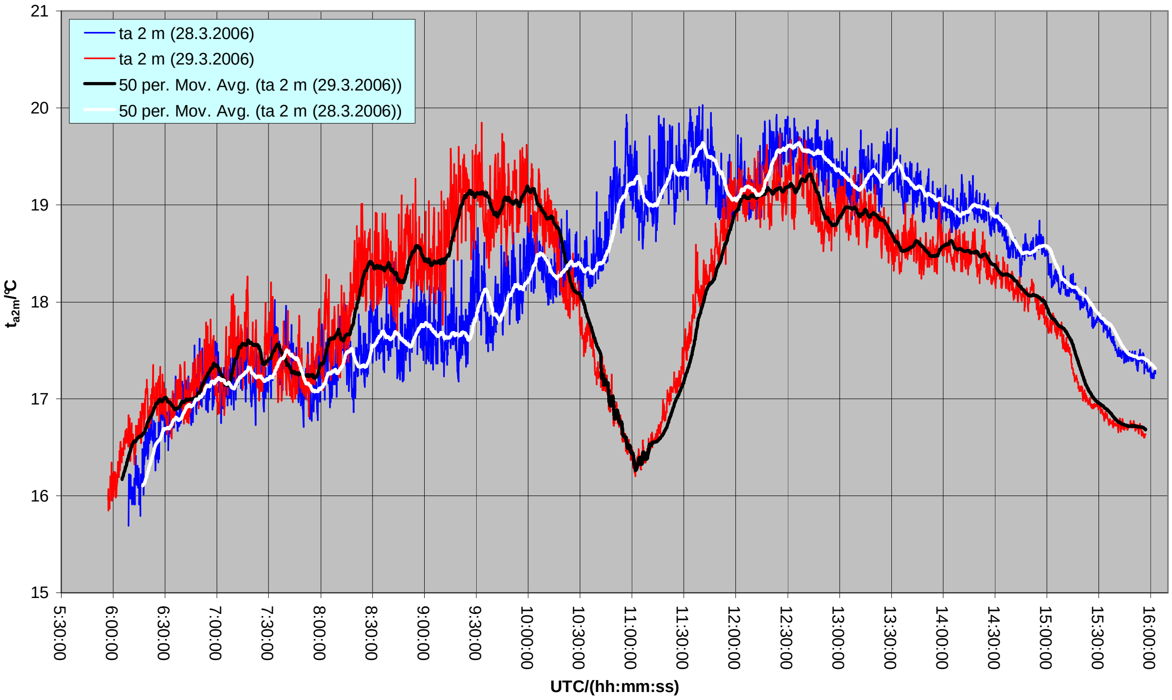
	Value	Time / (hh:mm:ss)
Average Value before T_1	20.02 °C	<07:37:00 UTC; 07:40:00 UTC)
Minimum during the Eclipse	17.82 °C	09:11:03 UTC
Referential Measurement	20.83 °C	09:11:03 UTC

Table no. 17: The Temperature of the Air at 2 m above the Ground – Spain 2005: The View of the Important Values

Decrease during the Eclipse Day	2.20 °C
Difference between 3. and 4. 10. 2005	3.01 °C

Table no. 18: The Temperature of the Air at 2 m above the Ground – Spain 2005: The Differences of the Important Values

6.3.2 Total Solar Eclipse – Turkey 2006



Graph no. 6: Progression of the Temperature of the Air at 2 m above the Ground – Turkey 2006

The progression of the air temperature at 2 m above the ground is possible to see in graph no. 6. The blue curve represents the referential measurement from the 28-th March 2006 and the red curve illustrates the measurement during the day of the total solar eclipse *(on March 29th, 2006)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 6 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 9.

The Referential Measurement

The white trend line representing the movement average with the period of 50 values is mostly concave throughout the whole running and it has got a moderate deformed asymmetric shape. In the time interval <06:09:00 UTC; 11:45 UTC) the character of the curve is a moderate increasing. The value measured at 11:02:00 UTC was chosen to determine the difference between the referential day and the day of the solar eclipse, it is 19.15°C. The decrease of the air temperature at 2 m above the ground in the time interval <11:45 UTC; 12:17 UTC) is consequence of the wind shocks from the sea *(SE)* with the speed 2.8 $m*s^{-1}$, the air temperature above the sea was lower than the air temperature above the land. The cause of the decreasing character of the curve in the time interval <12:17 UTC; 16:02:40 UTC) is the decreasing height of the Sun above the horizon.

The Measurement on Eclipse Day

The black trend line illustrating the movement average with the period of 50 values from the day of the total solar eclipse is mostly increasing character in the time interval <05:57:00 UTC; 09:43 UTC) that was caused by the increasing height of the Sun above the horizon. The values in the time interval <09:34:00 UTC; 09:37 UTC) were chosen to determine the average value before the beginning of the partial part of the solar eclipse, their arithmetic mean is 18.80°C. The curve has got the decreasing character in the time interval <09:43 UTC; 11:01:56 UTC) that was caused by the gradual shading of the Sun by the Moon. The lowest value of the air temperature at 2 m above the ground was at 11:01:55 UTC, it is 16.20°C. The cause of the increasing character of the curve is the increase of the incident solar radiation in the time interval <11:01:56 UTC; 12:17 UTC), it was caused by the gradual uncovering of the Sun by the Moon. The curve is decreasing again in the time interval <12:17 UTC; 15:57:00 UTC) that was caused by the decreasing height of the Sun above the horizon.

The important values are summarized in the tables mentioned below.

	Value	**Time / (hh:mm:ss)**
Average Value before T_1	18.80 °C	<09:34:00 UTC; 09:37:00 UTC)
Minimum during the Eclipse	16.20 °C	11:01:55 UTC
Referential Measurement	19.15 °C	11:02:00 UTC

Table no. 19: The Temperature of the Air at 2 m above the Ground – Turkey 2006: The View of the Important Values

Decrease during the Eclipse Day	2.60 °C
Difference between 28. and 29. 3. 2006	2.95 °C

Table no. 20: The Temperature of the Air at 2 m above the Ground – Turkey 2006: The Differences of the Important Values

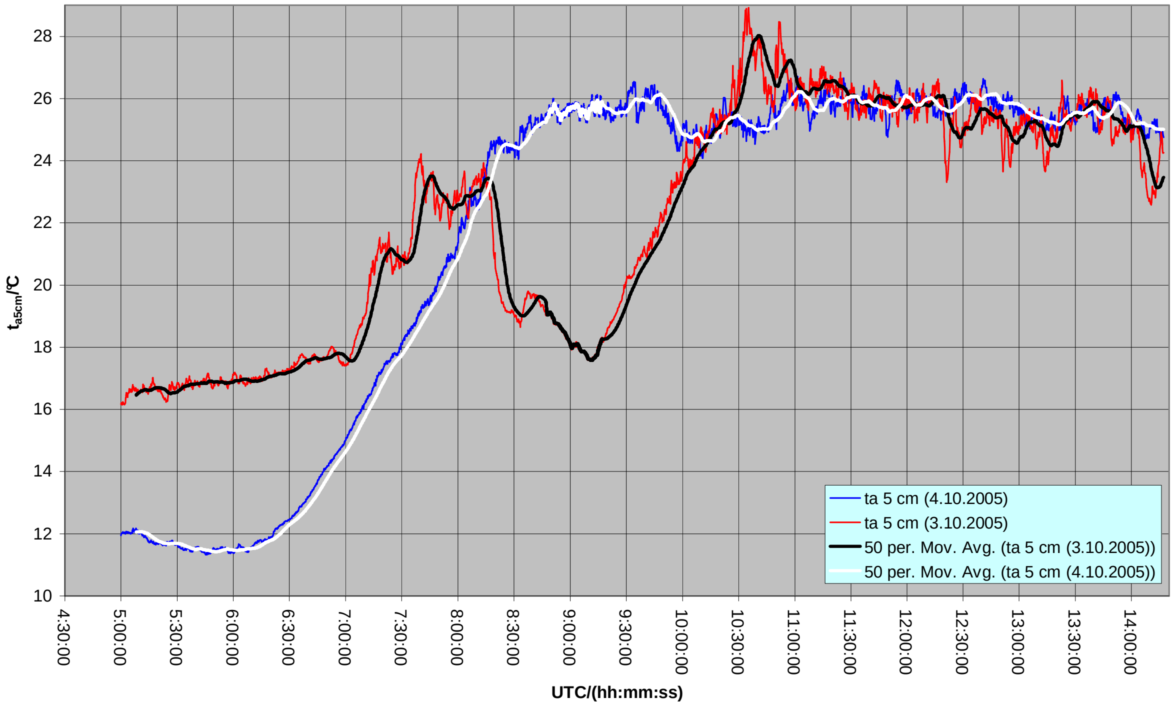
6.3.3 Evaluation

The fact that the quantity decreased about 11.0 % from the original value during the day of the annular solar eclipse in Spain in 2005 flows from the processing of the temperature of the air at 2 m above the ground. The value of this decrease noticed during the total solar eclipse was 28.7 % in Turkey in 2006.

These numbers confirmed that the value of the decrease of the air temperature at 2 m above the ground decrease respectively increase with the value of the eclipse magnitude.

6.4 Temperature of the Air at 5 cm above the Ground

6.4.1 Annular Solar Eclipse – Spain 2005



Graph no. 7: Progression of the Temperature of the Air at 5 cm above the Ground – Spain 2005

The progression of the air temperature at 5 cm above the ground is possible to see in graph no. 7. The blue curve represents the referential measurement from the 4-th October 2005 and the red curve illustrates the measurement during the day of the annular solar eclipse *(on October 3rd, 2005)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 7 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 10.

The Referential Measurement

The white trend line illustrating the movement average with the period of 50 values from the referential measurement *(October 4th, 2005)* has got the decreasing character in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:58 UTC). It was caused by the meteorological situation above the observational site. The sky was clear and the heat energy could leak from the Earth's surface in the form of the infra-red radiation, its consequence was a decrease of the temperature at the bottom layer of the atmosphere. In the time interval <05:58 UTC; 06:02 UTC) the decreasing character of the curve is possible to see, because the value of the air temperature of the bottom layer starts to increase after certain time after sunrise that was caused mainly by the caloric capacity of the Earth's surface and the retardation during the convective heat of the air from the surface. In the time interval <06:02 UTC; 11:03 UTC) the character of the curve is increasing; its cause is the increasing height of the Sun above the horizon. But in the time interval <08:22 UTC; 11:03 UTC) the character of the curve is the moderate increasing that was caused mainly by the increased speed of the wind from the sea *(SE)*, the temperature of the sea was probably lower than the temperature of the land. The value measured at 09:10:43 UTC was chosen to determine the difference between the referential day and the day of the solar eclipse, and it is 25.73°C. The cause of the decreasing character of the curve was the increasing height of the Sun above the horizon in the time interval <11:03 UTC; 14:17:00 UTC).

The Measurement on the Eclipse Day

The black trend line representing the movement average with the period of 50 values from the day of the annular solar eclipse has got a moderate increasing character in he time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:57 UTC) that was caused by the presence of the low cloudiness above the observational site that blocks the steeper decrease of the heat at ground layer of the atmosphere. The curve has got this character after the sunrise in the time interval <05:57 UTC; 07:02 UTC) too and it was also caused by the presence of the low cloudiness above the observational site. In the time interval <07:02 UTC; 07:20 UTC) the curve’s character is increasing; its cause is the decay of the cloudiness above the sea and the increase of the intensity of the incident solar radiation. The increasing height of the Sun above the horizon majority influenced the increasing character of the curve. The cause of the decreasing character of hr curve in the time interval <07:20 UTC; 07:33 UTC) is the transition of the cloudiness that caused the decrease of the intensity of the global solar radiation. The increasing character of the curve is possible to see in the graph no.7 in the time interval <07:33 UTC; 07:46 UTC), it was caused by the uncovering of the Sun by the cloudiness and the increasing height of the Sun above the horizon. The values in the time interval were chosen <07:37:00 UTC; 07:40:00 UTC) were chosen to determine the average value of the air temperature at 5 cm above the ground before the beginning solar eclipse, its arithmetic mean is 23.67°C. The transition of the cloudiness over the Sun caused the decreasing character of the curve in the time interval <07:46 UTC; 07:57 UTC). In the time interval <07:57 UTC; 08:16 UTC) the character of the curve is increasing again, it was caused by the increasing Sun’s height above the horizon again. The decreasing character of the curve in the time interval <08:16 UTC; 08:33 UTC) is caused by the gradual shading of the Sun by the Moon and the cloudiness. The sudden change of the curve’s character from the decreasing to increasing in the time interval <08:33 UTC; 08:40 UTC) was caused by the uncovering of the Sun by cloudiness that enabled the heating of the ground layer of the atmosphere. The lowest value of the air temperature at 5 cm above the ground was at 09:10:43 UTC, it is 17.56°C. The increasing character of the curve in the time interval <09:10:44 UTC; 10:41 UTC) is consequence of the gradual uncovering of the Sun by the Moon and the increasing height of the Sun above the horizon. In the graph no 7 is possible to see that the curve has got the increasing character in the time interval <10:28 UTC; 10:41 UTC), it is caused only by the increasing height of the Sun above the horizon. The decreasing height of the Sun caused that the curve has got the decreasing character in the time interval <10:41 UTC; 14:17:00 UTC). The variations in this time interval were caused by the transition of the cloudiness over the Sun.

The important values are summarized in the tables mentioned below.

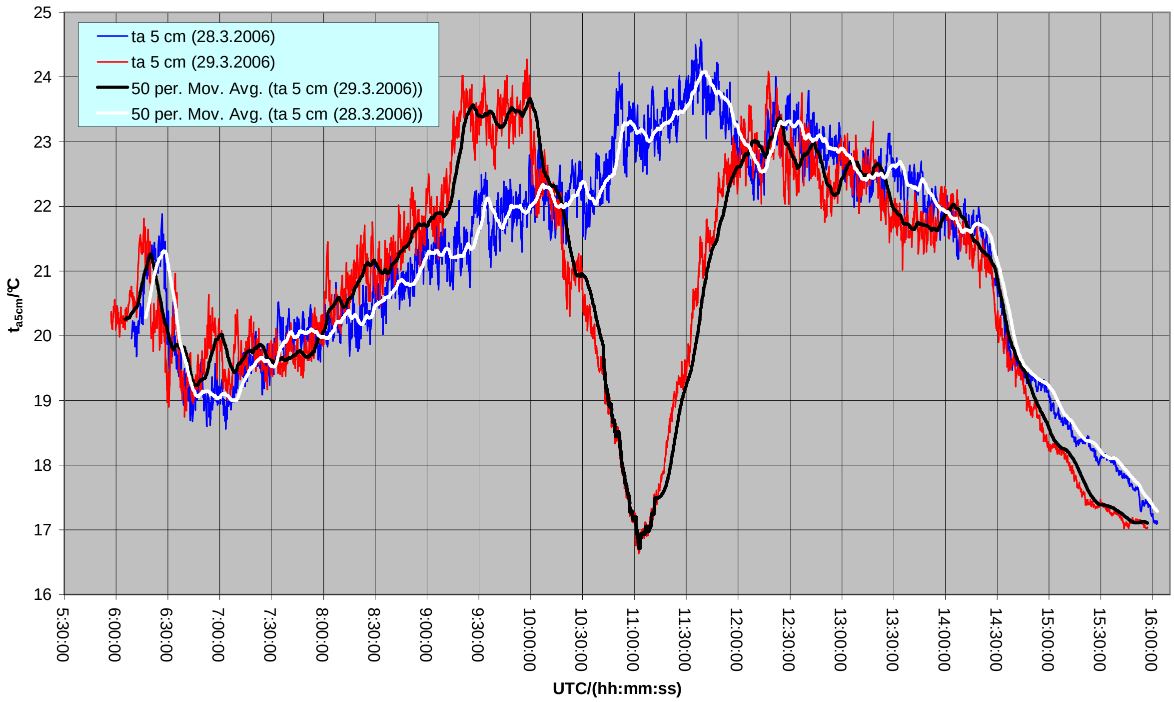
	Value	**Time / (hh:mm:ss)**
Average Value before T_1	23.67 °C	<07:37:00 UTC; 07:40:00 UTC)
Minimum during the Eclipse	17.56 °C	09:10:43 UTC
Referential Measurement	25.73 °C	09:10:43 UTC

Table no. 21: The Temperature of the Air at 5 cm above the Ground – Spain 2005: The View of the Important Values

Decrease during the Eclipse Day	6.11 °C
Difference between 3. and 4. 10. 2005	8.17 °C

Table no. 22: The Temperature of the Air at 5 cm above the Ground – Spain 2005: The Differences of the Important Values

6.4.2 Total Solar Eclipse – Turkey 2006



Graph no. 8: Progression of the Temperature of the Air at 5 cm above the Ground – Turkey 2006

The progression of the air temperature at 5 cm above the ground is possible to see in graph no. 8. The blue curve represents the referential measurement from the 28-th March 2006 and the red curve illustrates the measurement during the day of the annular solar eclipse *(on March 29th, 2006)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 8 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 11.

The Referential Measurement

The white trend line illustrating the movement average with the period of 50 values from the referential measurement *(March 28th, 2006)* has got concave shape throughout the whole running without the beginning. It has got mostly the increasing character in the time interval <06:09:00 UTC; 06:28 UTC) that was caused by the increasing Sun's height above the horizon. The sudden change of the curve's character from the increasing to decreasing in the time interval <06:28 UTC; 07:04 UTC) was probably caused by the increased speed of the cooler wind. In the time interval <07:04 UTC; 11:41 UTC) the curve has got the increasing character that was also caused by the increasing height of the Sun above the horizon. The value measured at 11:02:30 UTC was chosen to determinate the difference between the referential day and the day of the solar eclipse. It is 22.97°C. The steep decrease of this value that is noticeable in the time interval <11:41 UTC; 12:14 UTC) and its increase in the time interval <12:14 UTC; 12:26 UTC) were caused by the wind shocks from the sea *(SW)*, their duration was a few minutes. Average speed of the wind was 2.8 m*m^{-1}. The decreasing character of the curve in the time interval <12:26 UTC; 16:02:40 UTC) was caused by the decreasing height of the Sun above the horizon.

The Measurement on the Eclipse Day

The black trend line representing the movement average with the period of 50 values from the day of the total solar eclipse has got mostly increasing character in the time interval <05:57:00 UTC; 06:17 UTC) that was caused by the increasing Sun's height above the horizon. The sequent decrease of the air temperature at 5 cm above the ground in the time interval <06:17 UTC; 06:46 UTC) was probably caused by the cold wind at the ground layer of the atmosphere. In the time interval <06:17 UTC; 09:59 UTC) the curve has got mostly increasing character, it was caused by the increasing height of the Sun above the horizon and the heating of the air at the ground layer of the atmosphere. The values in the time interval <09:34:00 UTC; 09:37:00 UTC) were chosen to determine the average value before the solar eclipse. The arithmetic mean of the values in this time interval is 23.31°C. The curve has got a decreasing character in the time interval <09:59 UTC; 11:02:31 UTC) that was caused by the decrease in the incident solar radiation; its cause was the gradual shading of the Sun by the Moon. The lowest value of the air temperature at 5 cm above the ground is at 11:02:30 UTC. It is 16.63°C. The cause of the increasing character of the curve in the time interval <11:02:31 UTC; 12:10 UTC) is the increase of the incident solar radiation that was caused by the gradual uncovering of the Sun by the Moon. The decrease of the temperature is in the time interval <12:10 UTC; 15:57:00 UTC) again that was caused by the decreasing height of the Sun above the horizon.

The important values are summarized in the tables mentioned below.

	Value	**Time / (hh:mm:ss)**
Average Value before T_1	23.31 °C	<09:34:00 UTC; 09:37:00 UTC)
Minimum during the Eclipse	16.63 °C	11:02:30 UTC
Referential Measurement	22.97 °C	11:02:30 UTC

Table no. 23: The Temperature of the Air at 5 cm above the Ground – Turkey 2006: The View of the Important Values

Decrease during the Eclipse Day	6.68 °C
Difference between 28. and 29. 3. 2006	6.34 °C

Table no. 24: The Temperature of the Air at 5 cm above the Ground – Turkey 2006: The Differences of the Important Values

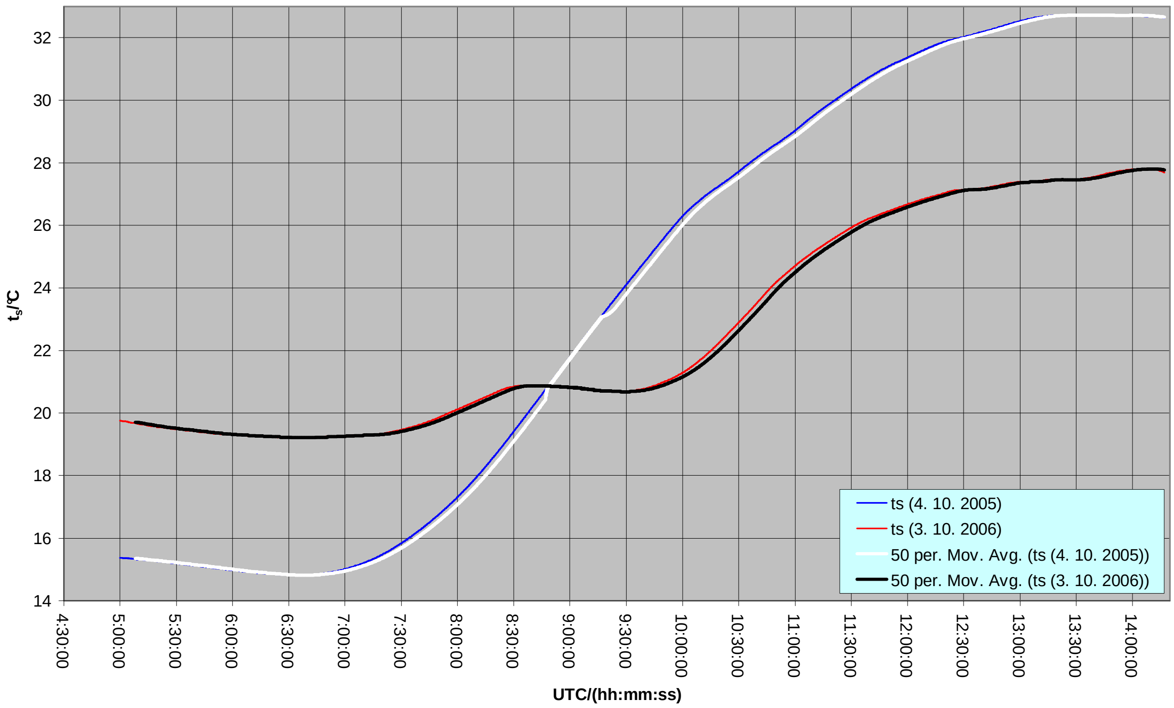
6.4.3 Evaluation

The fact that the quantity decreased about 25.8 % from the original value during the day of the annular solar eclipse in Spain in 2005 flows from the processing of the temperature of the air at 5 cm above the ground. The value of this decrease noticed during the total solar eclipse was 28.7 % in Turkey in 2006.

These numbers confirmed that the value of the decrease of the air temperature at 5 cm above the ground decrease respectively increase with the value of the eclipse magnitude.

6.5 Temperature of the Soil at 5 cm under the Ground

6.5.1 Annular Solar Eclipse – Spain 2005



Graph no. 9: Progression of the Temperature of the Soil at 5 cm under the Ground – Spain 2005

The progression of the soil's temperature at 5 cm under the ground is possible to see in graph no. 9. The blue curve represents the referential measurement from the 4-th October 2005 and the red curve illustrates the measurement during the day of the annular solar eclipse *(on October 3rd, 2005)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 9 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 12.

The Referential Measurement

The white trend line representing the movement average with the period of 50 values from the day of the referential measurement *(October 4th, 2005)* has got the decreasing character in the time interval from the beginning of the measurement to the sunrise <05:00:00 UTC; 05:58 UTC) that was caused by the dissipation of the heat energy in the form infra-red radiation. The value measured at 09:26:00 was chosen to determine the difference between the referential day and the day of the solar eclipse. It is 23.81°C. The sequent change of the curve's character from decreasing to increasing is noticeable in the time interval <09:26:00 UTC; 14:17:00 UTC), its cause is the increasing of the intensity of the global solar radiation. In the conclusion of this time interval the cause of the increasing curve's character is not the varying height of the Sun above the horizon, but it is a high caloric capacity of the soil.

The Measurement on the Eclipse Day

The black trend line representing the movement average with the period of 50 values from the day of the annular solar eclipse has got a decreasing character in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:57 UTC) that was caused by the dissipation of the heat energy in the form the infra-red radiation. The decreasing character of the curve is noticeable in the time interval after the sunrise <05:57 UTC; 06:46 UTC), and it was caused by the high caloric capacity of the soil. In the time interval <06:46 UTC; 08:37 UTC) the curve's character is increasing and it was caused by the increasing height of the Sun above the horizon. Considering the high caloric capacity of the soil the values determining the average value before the beginning of the solar eclipse were chosen in the time interval <08:35:00 UTC; 08:38:00 UTC), but the partial part of the solar eclipse was running in this time interval. The temperature increased before the chosen time interval, it is noticeable in the graph no. 9. Their arithmetic mean is 20.88°C. The decreasing character of the curve is possible to see in the time interval <08:37 UTC; 09:26 UTC), the decrease of the soil's temperature at 5 cm under the ground was caused by the gradual shading of the Sun by the Moon. The lowest value of the soil's temperature at 5 cm under the ground is at 09:26:00 UTC, it is c. 24 min after the maximal phase of the annular solar eclipse. It is 20.68°C. The character of the curve is increasing in the time interval <09:26 UTC; 14:17:00 UTC) that was caused by the gradual uncovering of the Sun by the Moon and the increasing height of the Sun above the horizon.

The important values are summarized in the tables mentioned below.

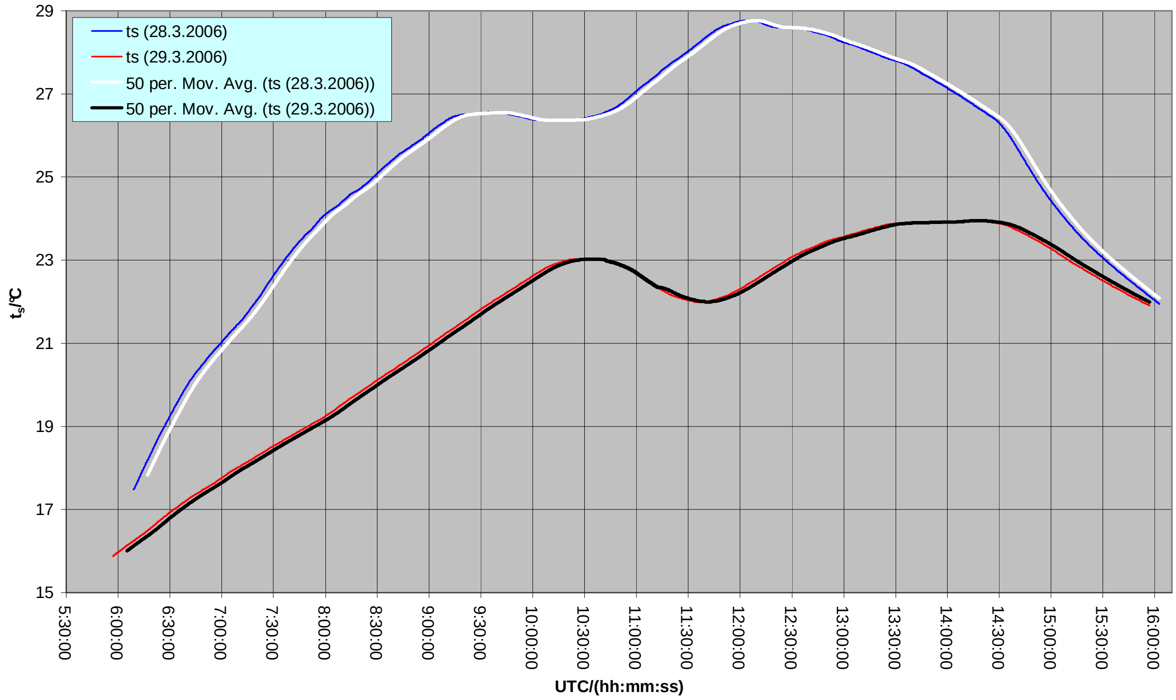
	Value	**Time / (hh:mm:ss)**
Average Value before T_1	20.88 °C	<08:35:00 UTC; 08:38:00 UTC)
Minimum during the Eclipse	20.68 °C	09:26:00 UTC
Referential Measurement	23.81 °C	09:26:00 UTC

Table no. 25: The Temperature of the Soil at 5 cm under the Ground – Spain 2005: The View of the Important Values

Decrease during the Eclipse Day	0.20 °C
Difference between 3. and 4. 10. 2005	3.13 °C

Table no. 26: The Temperature of the Soil at 5 cm under the Ground – Spain 2005: The Differences of the Important Values

6.5.2 Total Solar Eclipse – Turkey 2006



Graph no. 10: Progression of the Temperature of the Soil at 5 cm under the Ground – Turkey 2006

The progression of the soil's temperature at 5 cm under the ground is possible to see in graph no. 10. The blue curve represents the referential measurement from the 28-th March 2006 and the red curve illustrates the measurement during the day of the total solar eclipse *(on March 29th, 2006)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 10 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 13.

The Referential Measurement

The white trend line representing the movement average with the period of 50 values from the day of the referential measurement *(March 28th, 2006)* has got a increasing character in the time interval <06:09:40 UTC; 09:38 UTC) that was caused by the increase of the amount of the heat energy under the ground, its cause is the increase of the intensity of the global solar radiation. The shadow's transition above the measuring sensor caused the decreasing and the increasing of the soil's temperature in the time interval <09:38 UTC; 10:05 UTC). The increasing character of the soil's temperature was caused by the increasing height of the Sun above the horizon in the time interval <10:05 UTC; 12:08 UTC). The value measured at 11:38:50 UTC was chosen to determine the difference between the referential day and the day of the solar eclipse, and it is 28.32°C. The cause of the sequential change of the curve's character from increasing to decreasing in the timer interval <12:08 UTC; 16:02:40 UTC) is the decrease of the intensity of the incident solar radiation caused by the decreasing height of the Sun above the horizon.

The Measurement on the Eclipse Day

The black trend line illustrating the movement average with the period of 50 values from the measurement of the day of the total solar eclipse has got the increasing character in the time interval <05:57:00 UTC; 10:34 UTC); it was caused by the increasing the intensity of the incident solar radiation on Earth's surface. Considering the high caloric capacity of the soil the values determining the average value before the beginning of the solar eclipse were chosen in the time interval <10:30:00 UTC; 10:33:00 UTC), but the partial part of the solar eclipse was running in this time interval. Their arithmetic mean is 23.02°C. The decreasing character of the soil's temperature is noticeable in the graph no. 10 in the time interval <10:33 UTC; 11:38:51 UTC), and it was caused by the decrease of the incident solar radiation, its cause was the gradual uncovering of the Sun by the Moon. The lowest value of the soil's temperature at 5 cm under the ground is at 11:38:50 UTC, and it is 21.99°C. The curve's character is increasing in the time interval <11:38:51 UTC; 14:27 UTC) again that was caused by the gradual uncovering of the Sun by the Moon. The case of the decreasing character of the curve is the decrease of the incident solar radiation in the time interval <14:27 UTC; 15:57:00 UTC), it was caused by the decreasing height of the Sun above the horizon.

The important values are summarized in the tables mentioned below.

	Value	**Time / (hh:mm:ss)**
Average Value before T_1	23.02 °C	<10:30:00 UTC; 10:33:00 UTC)
Minimum during the Eclipse	21.99 °C	11:38:50 UTC
Referential Measurement	28.32 °C	11:38:50 UTC

Table no. 27: The Temperature of the Soil under 5 cm under the Ground – Turkey 2006: The View of the Important Values

Decrease during the Eclipse Day	1.03 °C
Difference between 28. and 29. 3. 2006	6.33 °C

Table no. 28: The Temperature of the Soil at 5 cm under the Ground – Turkey 2006: The Differences of the Important Values

6.5.3 Evaluation

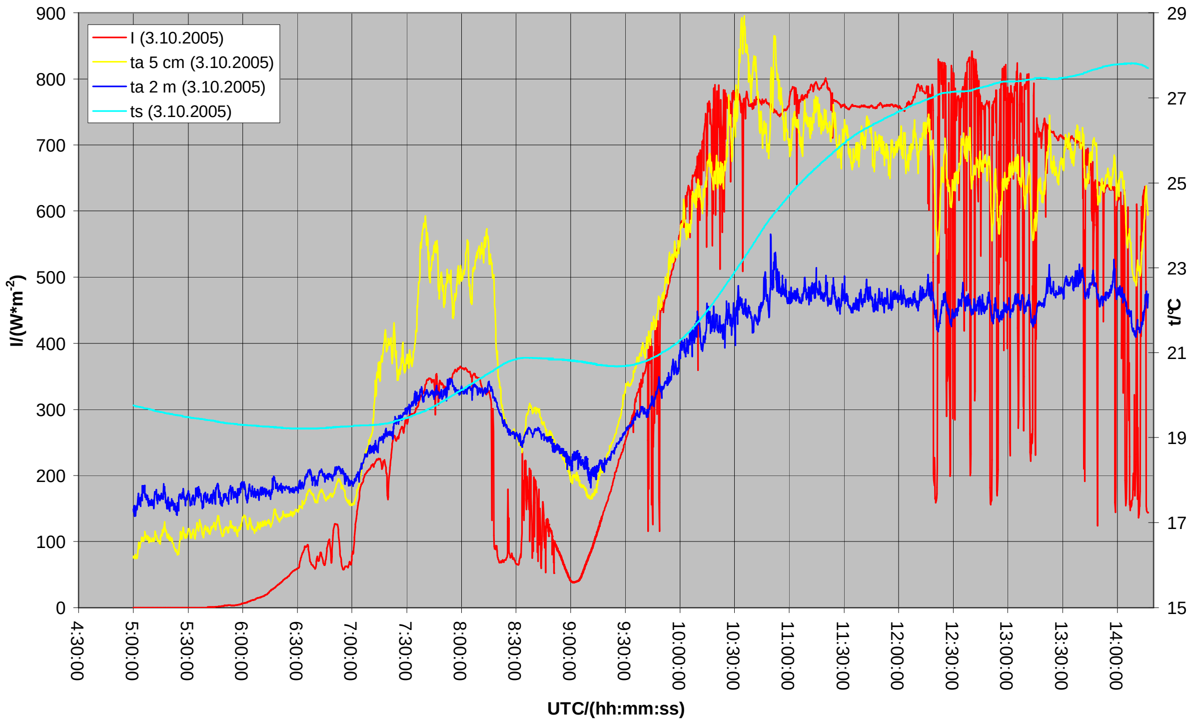
The fact that the quantity decreased about 0.96 % from the original value during the day of the annular solar eclipse in Spain in 2005 flows from the processing of the temperature of the soil at 5 cm under the ground. The value of this decrease noticed during the total solar eclipse is 4.47 % in Turkey in 2006.

These numbers confirmed that the value of the decrease of the temperature of the soil at 5 cm under the ground decrease respectively increase with the value of the eclipse magnitude.

6.6 Time Comparison of the Minimal Values of the Temperature and Global Solar Radiation

6.6.1 Annular Solar Eclipse – Spain 2005

Considering the fact, that on the 4th October 2005 the total solar eclipse did not occur, the processing of the data from this day was not carried out.



Graph no. 11: The Comparasion of the Moments of the Temperature Minimal Values and the Minimal Value of the Global Solar Radiation – Spain 2005

The progression of the intensity of the global solar radiation is possible to see in the graph no. 11 that is illustrating by the red curve, the values of the quantity were applied onto the left axis of the graph. The others three curves represent the progressions of the temperatures, the yellow curve illustrates the progression of the air temperature at 5 cm above the ground, the azure curve represents the progression of the soil's temperature at 5 cm under the ground and the blue curve illustrates the air temperature at 2 m above the ground. Their values were applied onto the right axis of the graph. The curves represent the progressions of the quantities mentioned above from the day of the annular solar eclipse *(October 3rd, 2005)*. A larger sized version of this graph is added in the appendixes as Appendix no. 14.

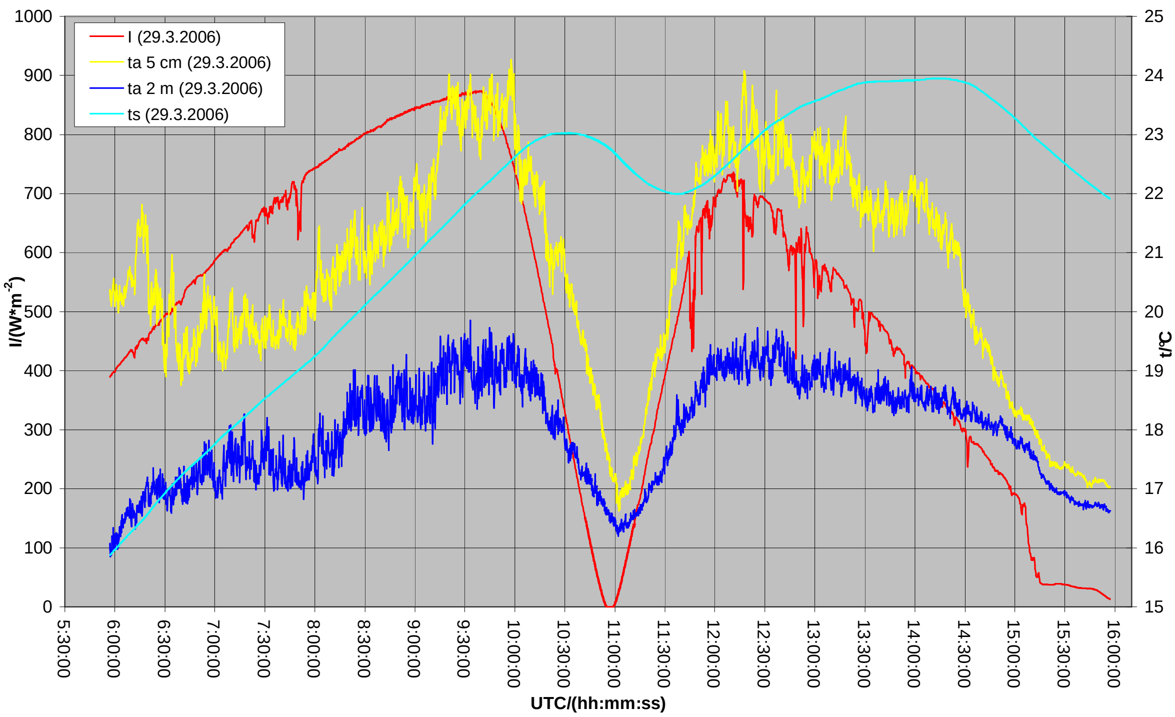
The most interesting points of the curves are the minimums that were caused by the total solar eclipse. In the graph no. 11 a certain time retardation of the temperature minimums toward the minimum of the intensity of the global solar radiation is noticeable. The accurate time differences are mentioned in the table no. 29. The calorimetric capacity of the Earth's surface and the retardation caused by the convective heating of the air by the Earth's surface are causes of the time retardations between the minimums measured temperatures of the air and the minimum of the intensity of the global solar radiation. The relatively high time difference between the minimum of the soil's temperature at 5 cm under the ground and the minimum of the intensity of the global solar radiation was caused by the high calorimetric capacity of the soil.

	Time
Temperature of the Air at 2 m above the Ground	00 h 09 min 13 s
Temperature of the Air at 5 cm above the Ground	00 h 08 min 53 s
Temperature of the Soil at 5 cm under the Ground	00 h 24 min 10 s

Table no. 29: The Retardations of the Temperature Minimal Values toward the Minimal Value of the Global Solar Radiation – Spain 2005

6.6.2 Total Solar Eclipse – Turkey 2006

Considering the fact, that on the 28th March 2006 the total solar eclipse did not occur, the processing of the data from this day was not carried out.



Graph no. 12: The Comparasion of the Moments of the Temperature Minimal Values and the Minimal Value of the Global Solar Radiation – Turkey 2006

The progression of the intensity of the global solar radiation is possible to see in the graph no. 12 that is illustrating by the red curve, the values of the quantity were applied onto the left axis of the graph. The others three curves represent the progressions of the temperatures, the yellow curve illustrates the progression of the air temperature at 5 cm above the ground, the azure curve represents the progression of the soil's temperature at 5 cm under the ground and the blue curve illustrates the air temperature at 2 m above the ground. Their values were applied onto the right axis of the graph. The curves represent the progressions of the quantities mentioned above from the day of the total solar eclipse *(March 29th, 2006).* A larger sized version of this graph is added in the appendixes as Appendix no. 15.

The most interesting points of the curves are the minimums that were caused by the total solar eclipse. In the graph no. 12 a certain time retardation of the temperature minimums toward the minimum of the intensity of the global solar radiation is noticeable. The accurate time differences are mentioned in the table no. 30. The cause of the higher time difference between the minimum of the air temperature at 2 m above the ground and the minimum of the intensity of the global solar radiation than between the minimum of the air temperature at 5 cm above the ground and the intensity of the global solar radiation is probably the higher speed of the wind at the ground layer of the atmosphere

	Time
Temperature of the Air at 2 m above the Ground	00 h 05 min 08 s
Temperature of the Air at 5 cm above the Ground	00 h 05 min 43 s
Temperature of the Soil at 5 cm under the Ground	00 h 42 min 03 s

Table no. 30: The Retardations of the Temperature Minimal Values toward the Minimal Value of the Global Solar Radiation – Turkey 2006

6.6.3 Evaluation

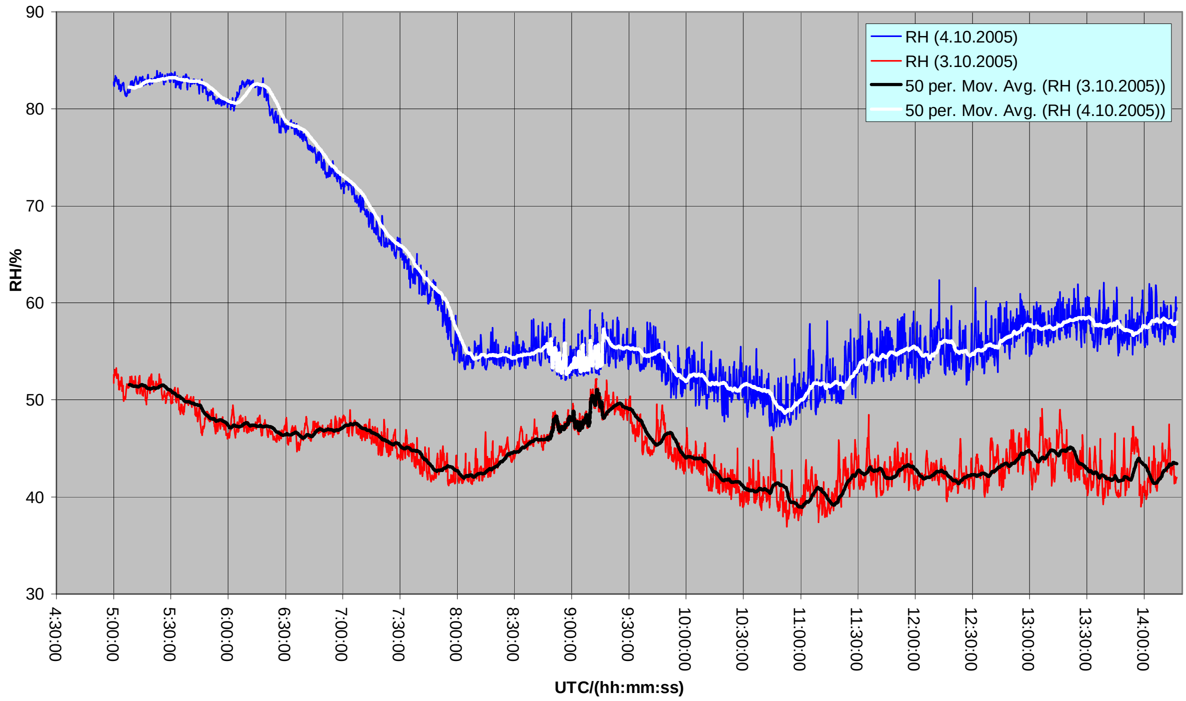
The processing of the data showed that the time retardation of the temperature minims towards the minimum of the global solar radiation occurred during the both of the solar eclipse. The cause of this phenomenon is mostly caloric capacity of the soil and the speed of the atmospheric flowing.

The fact that meteorological conditions were different during total solar eclipse in Turkey in 2006 and during the annular solar eclipse in Spain in 2005 flowed from the comparison of the size of the time retardation between the air temperature at 2 m above the ground and the intensity of the global solar radiation and between the air temperature at 5 cm above the ground and the intensity of the global solar radiation. The different conditions caused the different values and they probably were not connected with the solar eclipses.

This comparison of the soil's temperature at 5 cm under the ground showed the different caloric capacity of the soil in Spain in 2005 and in Turkey in 2006 where the sensors were located.

6.7 Relative Humidity of the Air at 2 m above the Ground

6.7.1 Annular Solar Eclipse – Spain 2005



Graph no. 13: Progression of the Relative Humidity of the Air at 2 m above the Ground – Spain 2005

The progression of the air relative humidity at 2 m above the ground is possible to see in graph no. 13. The blue curve represents the referential measurement from the 4-th October 2005 and the red curve illustrates the measurement during the day of the annular solar eclipse *(on October 3rd, 2005)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 13 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 16.

The Referential Measurement

The white trend line representing the movement average with the period of 50 values from the day of the referential measurement *(October 4th, 2005)* has got the decreasing character in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:58 UTC); it was caused by the feeding of the dry air from the land by the wind *(N)*. The curve has got the steep decreasing character in the time interval after sunrise <05:58 UTC; 08:08 UTC) that was caused by the increasing air temperature. The decreasing character is noticeable in the graph no. 13 in the time interval <08:08 UTC; 10:49 UTC) and it was also caused by the increasing air temperature at 2 m above the ground. The value measured at 09:12:49 UTC was chosen to determine the difference between the day of the referential measurement and the day of the solar eclipse, and it is 53.04 %. But the curve has got the increasing character in the time interval <10:49 UTC; 14:17:00 UTC) that was caused by the decreasing air temperature at 2 m above the ground.

The Measurement on Eclipse Day

The black trend line representing the movement average with the period of 50 values has got the decreasing character in the time interval from the beginning of the measurement to sunrise <05:00:00 UTC; 05:58 UTC) that was caused by the increasing air temperature at 2 m above the ground. This character of the curve is noticeable in the time interval after sunrise <05:58 UTC; 07:58 UTC). The values in the time interval <07:37:00 UTC; 07:39:00 UTC) were chosen to determine the average value of the air humidity at 2 m above the ground before the beginning of the solar eclipse. Their arithmetic mean is 44.06%. The increasing character of the curve in the time interval <07:58 UTC; 09:12:50 UTC) was caused by the decreasing air temperature at 2 m above the ground that was caused by the gradual shading of the Sun by the Moon. The highest value of the air humidity at 2 m above the ground was at 09:12:49 UTC, and it was 52.17%. The decreasing character of the curve in the time interval <09:12:50 UTC; 10:52 UTC) was caused by the increase of the air temperature at 2 m above the ground, that was caused by the gradual uncovering of the Sun by the Moon. The cause of the increasing character of the curve in the time interval <10:52 UTC; 13:22 UTC) was the decreasing air temperature at 2 m above the ground. The change of the curve's character from the increasing to the decreasing was caused by the feeding of air with the low content of the water vapour.

The important values are summarized in the tables mentioned below.

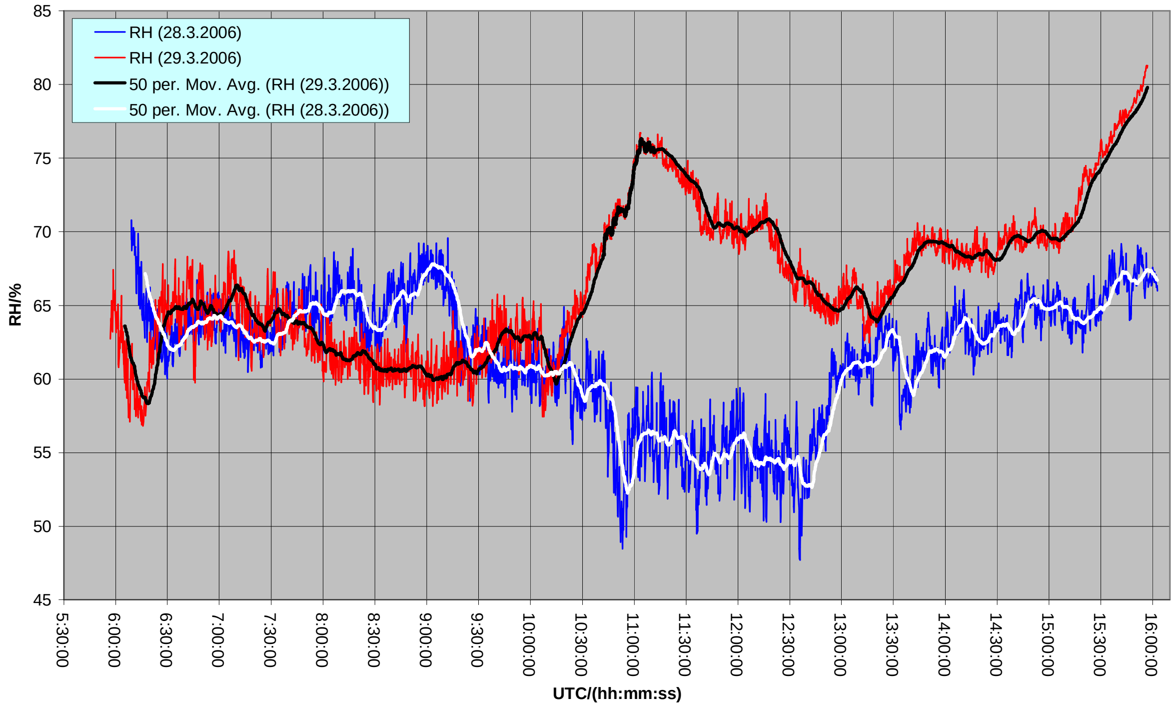
	Value	**Time / (hh:mm:ss)**
Average Value before T_1	44.06 %	<07:37:00 UTC; 07:39:00 UTC)
Maximum during the Eclipse	52.17 %	09:12:49 UTC
Referential Measurement	53.04 %	09:12:49 UTC

Table no. 31: The Relative Humidity of the Air at 2 m above the Ground – Spain 2005: The View of the Important Values

Increase during the Eclipse Day	8.11 %
Increase between 3. and 4. 10. 2005	-0.87 %

Table no. 32: The Relative Humidity of the Air at 2 m above the Ground – Spain 2005: The Differences of the Important Values

6.7.2 Total Solar Eclipse – Turkey 2006



Graph no. 14: Progression of the Relative Humidity of the Air at 2 m above the Ground – Turkey 2006

The progression of the air relative humidity at 2 m above the ground is possible to see in graph no. 14. The blue curve represents the referential measurement from the 28-th March 2006 and the red curve illustrates the measurement during the day of the total solar eclipse *(on March 29th, 2006)*. Both of the curves mentioned above were smoothed by the trend lines of the moving averages with the periods of 50 values, the characteristic of graph no. 13 derives mostly from these trend lines. A larger sized version of this graph is added in the appendixes as Appendix no. 17.

The Referential Measurement

The white trend line representing the movement average with the period of 50 values has got mostly decreasing character in the time interval <06:09:00 UTC; 12:36 UTC) that was caused by the increasing value of the air temperature at 2 m above the ground. But in the time interval <12:03 UTC; 12:36 UTC) the curve's character is influenced by the feeding of the dry air. The value measured at 11:03:30 was chosen to determine the difference between the referential day and the day of the solar eclipse. At this time the value of the air humidity at 2 m above the ground was 55.65 %. The increasing character of the curve in the time interval <12:36 UTC; 16:02:40 UTC) was caused by the decreasing air temperature at 2 m above the ground.

The Measurement on Eclipse Day

The black trend line illustrating the movement average with the period of 50 values has got the decreasing character in the time interval <05:57:00 UTC; 06:17 UTC), but the character of the curve is increasing in the time interval <06:17 UTC; 06:27 UTC). The variation was probably caused by the decrease and the increase of the wind speed that is noticeable in this time interval in the graph no. 14. The decreasing character that is noticeable in the time interval <06:27 UTC; 10:08 UTC) was caused by the increasing temperature of the air at 2 m above the ground. The values in the time interval <09:34:00 UTC; 09:37:00 UTC) were chosen to determine the average value before the start of the solar eclipse. The arithmetic mean is 61.79%. The increasing character of the curve in the time interval <10:08 UTC; 11:03:28 UTC) was caused by the gradual shading of the Sun by the Moon. The lowest value of the air humidity at 2 m above the ground was at 11:03:27 UTC and it was 76.72%. The gradual uncovering of the Sun by the Moon caused that the air temperature at 2 m above the ground increased, its consequence is the decreasing character of the curve in the time interval <11:03:28 UTC; 12:16 UTC). The cause of the decreasing character of the relative humidity of the air at 2 m above the ground is probably the increase of the wind speed of the dry air in the time interval after the ending of the solar eclipse <12:16 UTC; 13:14 UTC). The decrease of the wind speed caused that the increasing air temperature at 2 m above the ground has got the majority influence on the curve's character in the time interval <13:14 UTC; 15:17:00 UTC). The variations that are noticeable on the curve throughout the whole running were caused by the different speed of the wind.

The important values are summarized in the tables mentioned below.

	Value	**Time / (hh:mm:ss)**
Average Value before T_1	61.79 %	<09:34:00 UTC; 09:37:00 UTC)
Maximum during the Eclipse	76.72 %	11:03:27 UTC
Referential Measurement	55.65 %	11:03:30 UTC

Table no. 33: The Relative Humidity of the Air at 2 m above the Ground – Turkey 2006: The View of the Important Values

Increase during the Eclipse Day	14.93 %
Increase between 28. and 29. 3. 2006	21.07 %

Table no. 34: The Relative Humidity of the Air at 2 m above the Ground – Turkey 2006: The Differences of the Important Values

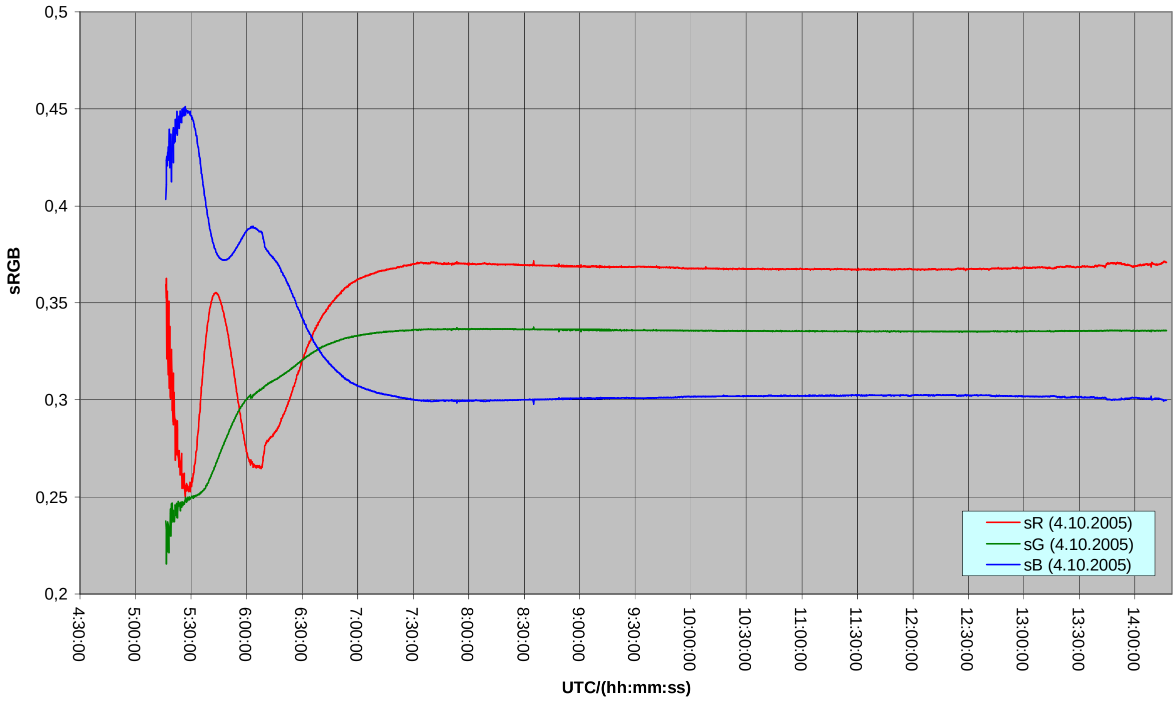
6.7.3 Evaluation

The fact that the quantity increased about 18.41 % from the original value during the day of the annular solar eclipse in Spain in 2005 flows from the processing of the relative humidity of the air at 2 m above the ground. The value of this increase noticed during the total solar eclipse was 24.16 % in Turkey in 2006.

These numbers confirmed that the value of the increase of the air humidity at 2 m above the ground decrease respectively increase with the value of the eclipse magnitude.

6.8 Colour of the Light in the Colour Space sRGB

6.8.1 Annular Solar Eclipse – Spain 2005



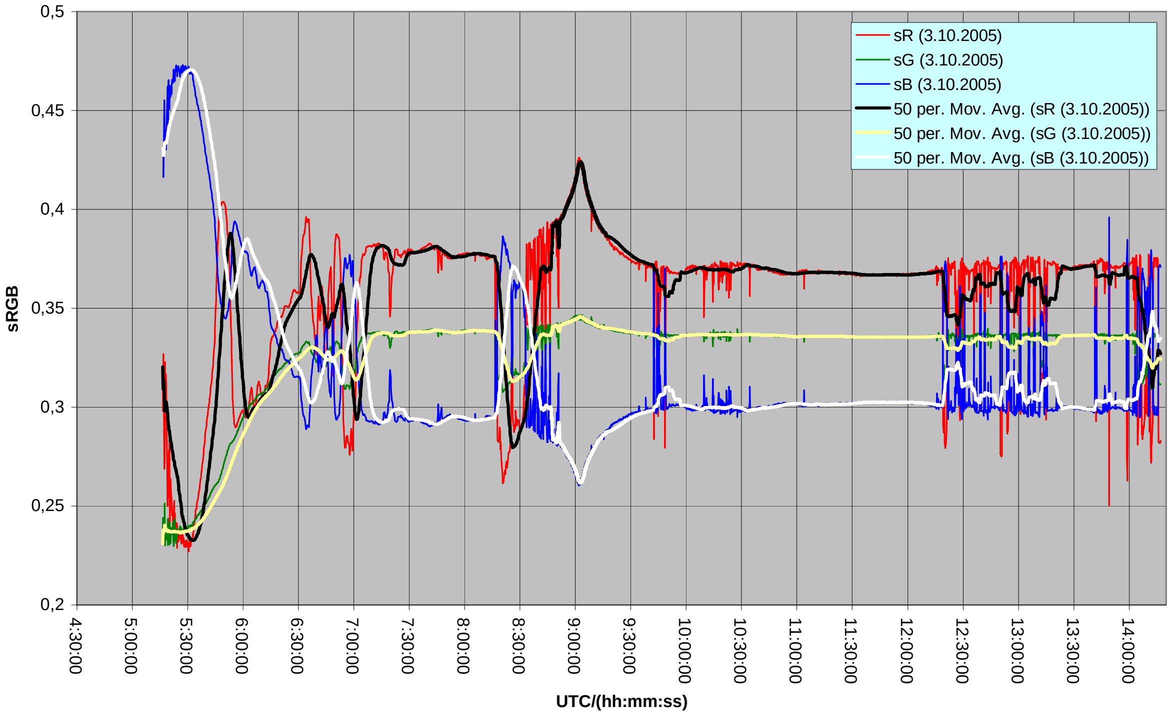
Graph no. 15: Progression of the Colour of the Light in the Colour Space sRGB from the Day of Referential Measurement

The Referential Measurement

The progression of the colour of the light in the standard colour space sRGB from the day of the referential measurement *(October 4th, 2005)* is possible to see in the graph no. 15. The red curve *(sR)* represents the red element of the light. The blue *(sB)* curve illustrates the blue element of the light. The last curve *(sG)* which is green illustrates the green element of the light. A larger sized version of this graph is added in the appendixes as Appendix no. 18.

The curves were not processed in the time interval <05:16:20 UTC; 05:30:50 UTC) by the reason of the high noise. The cause of the curves' characters in the time interval from the beginning of the civil twilight to the time of the appearing of the first part of the Sun above the horizon <05:30:50 UTC; 05:58:50 UTC) is the molecular diffusion of the solar radiation in the atmosphere's layers. At the beginning of the time interval only the diffused solar radiation struck on the measuring sensors of the SPM. The blue photons diffused most on the air molecules, the amount of the green and red diffused photons was minimal. The amount of the solar photons gradually increased at the bottom layer of the atmosphere. The aerosol's diffusion started influenced the ratio of the red, green and blue photons in the reference to probable high amount of the aerosols *(e.g.: dust, salt)* at the bottom layers of the atmosphere. The report from the observers about the observing of the red sky confirmed the increased amount of the red photons. Maximal amount of the red photons is possible to see in the graph no. 15 at 05:45:50 UTC. The depth of the Sun below the horizon decreased and the photons run throughout the atmosphere's layers with the low amount of the dust particle and the water molecules, the influence of the aerosol diffusion decreased. It is possible to see in the time intervals before the sunrise <05:45:50 UTC; 05:58:00 UTC) and after it <05:58:00 UTC; 06:08:40 UTC) too. The characters of the curves in the time interval <06:08:40 UTC; 07:37:50 UTC) were caused by the increasing height of the Sun above the horizon with which the intensity of the direct solar radiation increased. The variations that are noticeable in the time intervals mentioned above were caused by the transition of the cloudiness over the Sun.

The cause of the curves' character in the time interval <07:35:50 UTC; 11:37:50 UTC) is the increasing height of the Sun above the horizon. The Sun was relatively lowly above the horizon, the solar photons run throughout the tight layer of the Earth's atmosphere. The molecular diffusion influenced the colour of the light. So the long-waved photons *(red)* had majority abundance in the direct solar radiation, the curve sR has got the highest value at the beginning of the time interval. The blue photons were diffused most, so their amount at the bottom atmosphere's layer was very low, the curve sB has got the lowest value at the beginning of the time interval. The character of the green curve *(sG)* is constant, because the relative amount of the green photons is constant too. The blue curve character *(sB)* is increasing and the red curve character *(sR)* is decreasing in the whole time interval. Such behaviour is caused by the gradual decrease of the diffusing of the blue photons, which the observer could note more than at the beginning of the time interval. The red photons quantity is also decreased and that is why the influence of the red photons on the colour of the light in the same time is decreased too. The curves' character in the time interval <11:37:30 UTC; 14:17:00 UTC) was caused by the decreasing height of the Sun above the horizon. The solar photons run throughout the denser atmosphere's layer. As a result the photons were more diffused on the air molecules and hence the quantity of the blue photons in the direct solar radiation that arrived at the bottom layer of the atmosphere is decreased and concurrently the red photons quantity is increased at the bottom layer of the atmosphere. Minor variations that are noticeable in the end of the time interval were caused by the slight cloudiness shifting over the Sun.



Graph no. 16: Progression of the Colour of the Light in the Colour Space sRGB from the Day of the Annular Solar Eclipse

The Measurement on the Eclipse Day

The progression of the colour of the light in the standard colour space sRGB during the day of the annular solar eclipse (*October 3rd, 2005)* is possible to see in the graph no. 16. The red curve *(sR)* represents the red element of the light. The blue *(sB)* curve illustrates the blue element of the light. The last curve *(sG)* which is green illustrates the green element of the light. All of the curves were smoothed by the trend lines of the moving averages with the periods of 50 values by the reason of the high variations. The black trend line illustrates the progression of the moving average of the red light's element with the period of 50 values. The light yellow trend line represents the progression of the moving average of the green light's element with the period of 50 values. The white trend line illustrates the progression of the moving average of the blue light's element with the period of 50 values. A larger sized version of this graph is added in the appendixes as Appendix no. 19.

The curves were not proceed in the time interval <05:16:00 UTC; 05:32:00 UTC) by the reason of the high noise. The cause of the curves' characters in the time interval from the beginning of the civil twilight to the time of the appearing of the first part of the Sun above the horizon <05:32:00 UTC; 05:57:00 UTC) is the molecular diffusion of the solar radiation at the atmosphere's layers. At the beginning of the time interval only the diffused solar radiation struck on the measuring sensors of the SPM. The blue photons diffused most on the air molecules, the amount of the green and red diffused photons was minimal. The amount of the solar photons gradually increased at the bottom layer of the atmosphere. The aerosol's diffusion started influenced the ratio of the red, green and blue photons in the reference to probable high amount of the aerosols *(e.g.: dust, salt)* at the bottom layers of the atmosphere. The report from the observers about the observing of the red sky confirmed the increased amount of the red photons. Maximal amount of the red photons is possible to see in the graph no. 16 at 05:50:30 UTC. The depth of the Sun below the horizon decreased and the photons run throughout the atmosphere's layers with the low amount of the dust particle and the water molecules, the influence of the aerosol diffusion decreased. It is possible to see in the time intervals before the sunrise <05:50:30 UTC; 05:57:00 UTC) and after it <05:57:00 UTC; 05:59:30 UTC) too. The characters of the curves in the time interval <05:59:30 UTC; 06:35:50 UTC) were caused by the increasing height of the Sun above the horizon with which the intensity of the direct solar radiation increased. The variations that are noticeable in the time intervals mentioned above were caused by the transition of the cloudiness over the Sun.

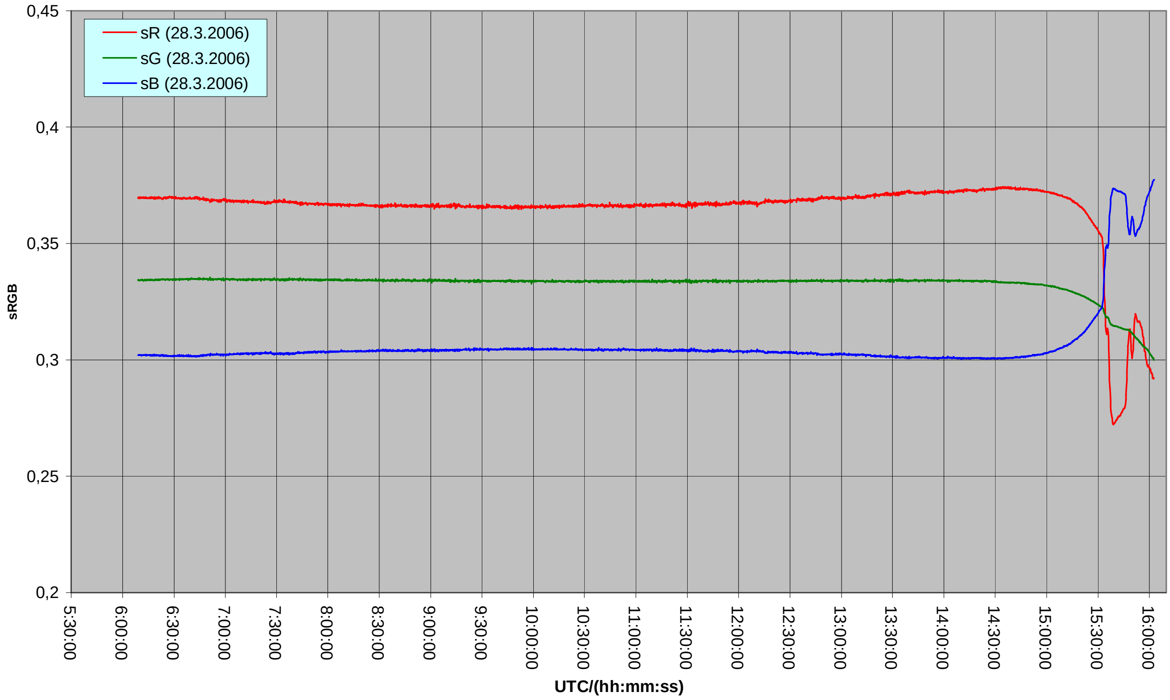
The distinct variations that were caused by the transition of the cloudiness over the Sun are noticeable at the beginning of the time interval <05:59:30 UTC; 07:42:24 UTC) too. If 0 % of cloudiness was in the sky, it is possible to expect that the shape of the curve was the same (in the part of the graph mentioned above - in the time interval <05:57:00 UTC; 07:42:00 UTC)) as on the day of the referential measurement *(October 4th, 2005)* in this time interval.

The gradual shading of the Sun by the Moon influenced the progressions of the colour elements of the solar radiation in the time interval <07:42:24 UTC; 09:01:50 UTC). A phenomenon limb darkening started to show especially in the second half of the time interval. The character of the red curve is sharply increasing, but the blue has got a sharp decreasing character. The variations in this time interval were caused by the transition of the cloudiness over the Sun.

The cause of the steep decreasing character of the red element of the solar radiation, decreasing character of the green element of the solar radiation and the steep increasing character of the blue curve in the time interval <09:01:50 UTC; 10:31:04 UTC) was the gradual uncovering of the Sun by the Moon. The phenomenon of the limb darkening shows in this time interval, the amount of the red and green photons decrease, but the amount of the blue photons increased. The opposite characters of the curves are noticeable in the end of the time interval that was caused by the molecular diffusion which influenced relative amount of the elements of the colour of the light. The variations that are noticeable in this time interval was caused by the transition of the cloudiness over the Sun.

The character of the curves in the time interval <10:31:04 UTC; 14:17:00 UTC) was caused by the decreasing height of the Sun above the horizon. The diffusion of the photons increased. The blue photons had got the large abundance in the direct solar radiation at the bottom layer of the atmosphere in according to Rayleigh diffusion, but the relative amount of the red photons increased and the relative amount of the green photons was constant.

6.8.2 Total Solar Eclipse – Turkey 2006

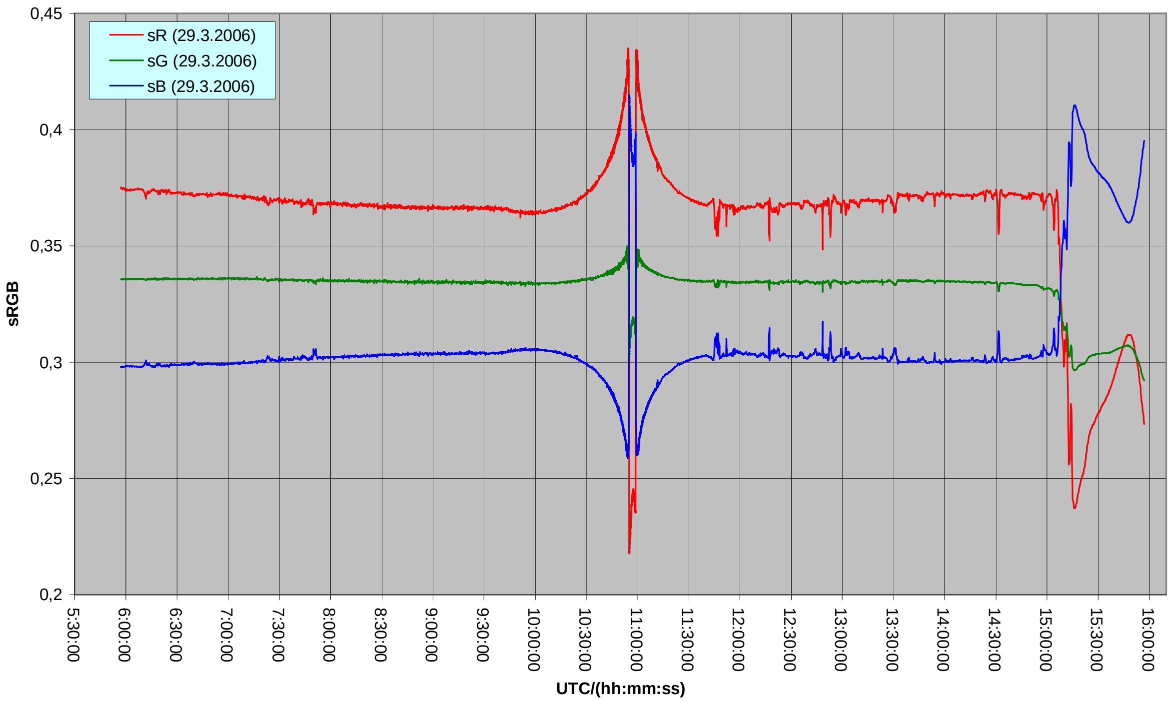


Graph no. 17: Progression of the Colour of the Light in the Colour Space sRGB from the Day of Referential Measurement

The Referential Measurement

The progression of the colour of the light in the standard colour space sRGB during the day of the referential measurement *(March 28th, 2006)* is possible to see in the graph no. 17. The red curve *(sR)* represents the red element of the light. The blue *(sB)* curve illustrates the blue element of the light. The last curve *(sG)* which is green illustrates the green element of the light. A larger sized version of this graph is added in the appendixes as Appendix no. 20.

The cause of the curves' character in the time interval <06:09:00 UTC; 09:54:20 UTC) is the increasing height of the Sun above the horizon. At the beginning of the time interval mentioned above the Sun was low above the horizon. The solar photons run throughout the thick layer of the atmosphere. The molecular diffusion mostly influenced the colour of the light. After transmission of the solar radiation throughout the Earth's atmosphere the long-wave photons *(red)* was the biggest relative amount in the direct solar radiation, and the cure sR has got the maximal value at the begging of the time interval. Blue photons with very short wavelength were insofar diffused that only just few of them reached the low atmosphere layer, so blue sB curve has got the lowest value at the beginning of the time period. Character of the green curve sG is constant in the whole running of the time interval, because the amount of the green photons is constant. The character of the blue curve is moderate increasing in the whole time interval and the character of the red curve is moderate decreasing that was caused by the gradual decrease of the diffusion of the blue photons of which have reached more strongly to the observer in comparison to the beginning of the time interval situation. The character of the curves in the time interval <09:54:20 UTC; 14:45:40 UTC) was caused by the decreasing height of the Sun above the horizon. The solar photons permeated throughout thick layer of the atmosphere with the decreasing height of the Sun above the horizon. As a result, they were more diffused. The amount of the blue photons which arrived at the bottom layer of the atmosphere decreased. But the amount of the red photons increased at this atmosphere's layers. The shading of the measuring sensors in the time interval <14:45:00 UTC; 15:40:00 UTC) blocked the impact of the direct solar radiation and the amount of the incident green and red photons decreased. Only the diffused radiation struck on the measuring sensors, as a result, the relative amount of the blue photons at the bottom layer of the atmosphere increased. The variations that are noticeable in the time interval <15:40:00 UTC; 16:02:40 UTC) were caused by the shading of the Sun by the cloudiness Ac.



Graph no. 18: Progression of the Colour of the Light in the Colour Space sRGB from the Day of the Total Solar Eclipse

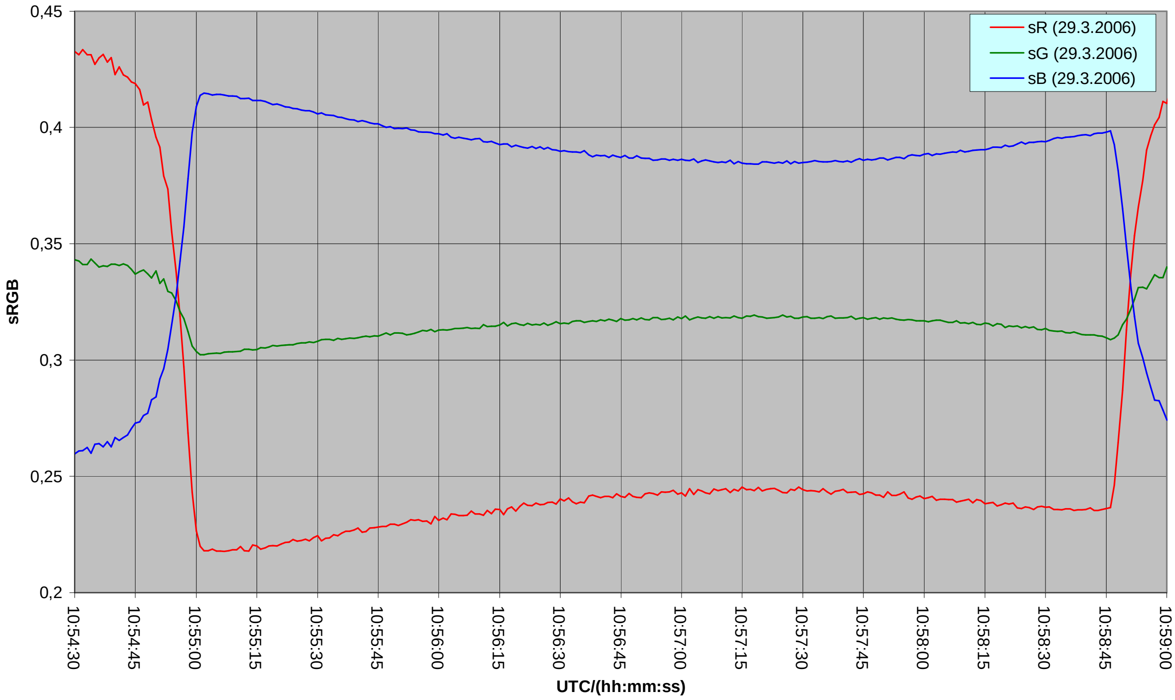
The Measurement on the Eclipse Day

The progression of the colour of the light in the standard colour space sRGB during the day of the total solar eclipse *(March 29th, 2006)* is possible to see in the graph no. 18. The red curve *(sR)* represents the red element of the light. The blue *(sB)* curve illustrates the blue element of the light. The last curve *(sG)* which is green illustrates the green element of the light. A larger sized version of this graph is added in the appendixes as Appendix no. 21.

The cause of the curves' character in the time interval <06:09:00 UTC; 09:54:20 UTC) is the increasing height of the Sun above the horizon. At the beginning of the time interval mentioned above the Sun was low above the horizon. The solar photons permeated throughout the thick layer of the atmosphere. The molecular diffusion mostly influenced the colour of the light. After transmission of the solar radiation throughout the Earth's atmosphere the long-wave photons *(red)* was the biggest relative amount in the direct solar radiation, and the cure sR has got the maximal value at the begging of the time interval. Blue photons with very short wavelength were insofar diffused that only just few of them reached the low atmosphere layer, so blue sB curve has got the lowest value at the beginning of the time period. Character of the green curve sG is constant in the whole running of the time interval, because the amount of the green photons is constant. The variations that are noticeable in the time interval mentioned above were caused by the presence of the cloudiness Ci in the sky.

The different shape of the curves is noticeable in the time interval <09:39:10 UTC; 12:12:05 UTC). It is caused by the solar eclipse. In the time of the partial solar eclipse or in the time interval <09:39:10 UTC; 10:54:35 UTC) the red curve has got the steep increasing character, the green curve has got the increasing character and the character of the blue curve is steep decreasing. It was caused by the gradual covering of the Sun by the Moon rather by the phenomenon of limb darkening.

Considering the short period of the total phase of the solar eclipse is here mentioned detailed view of this quantity during this time interval. A larger sized version of this graph is added in the appendixes as Appendix no. 22.



Graph no. 19: Progression of the Colour of the Light in the Colour Space sRGB during the Total Phase of the Solar Eclipse

The highly sharp characters of the curves are noticeable in the time interval <10:54:35 UTC; 10:55:03 UTC) and they were caused by the total shading of the Sun by the Moon. As a result the direct solar radiation was blocked and only the diffused solar radiation struck on the sensors of the measuring sensors of the SPM that contains the most of the blue photons.

The asymmetric shapes of the curves in the time of the total phase of the eclipse *(in the time interval <10:55:03 UTC; 10:58:46 UTC))* were caused by the location of the weather station near the sea that was 200 m far from the observational site. The cause of the curves' characters at the beginning of the time interval <10:55:03 UTC; 10:57:30 UTC) is the presence of the majority part of the Moon's shadow above the sea. The reflected solar radiation from the land arrived in this time interval and was also diffused by air molecules and the red photons have got the minority relative amount. The intensity of the reflected solar radiation decreased with the gradual shading of the Moon by the Sun.

The cause of the curves' character in the time interval <10:57:30 UTC; 10:58:46 UTC) is the presence of the majority part of the Moon's shadow above the land that enabled input of the reflected solar radiation from the sea level. In consequence of the increased amount of the aerosols *(e.g.: water, salt)* the solar radiation is diffused on the mentioned aerosols and the amount of the green and red photons increases. The steep change of the curves is possible to see in the graph no. 18 in the time interval <10:58:46 UTC; 10:59:19 UTC) and that was caused by the end of total phase of the solar eclipse, after that the limb of solar photosphere appeared.

The roughly parabolic shape of the curves that is noticeable in the time interval <10:55:03 UTC; 10:58:46 UTC) was caused by the almost circular shape of the Moon's shadow and the almost circular shape of the horizon. While the speed of the motion of the shadow on central line is possible to consider being uniform for this short time, the change of the area that was covered by the shadow is non-uniform in consequence of the shape of the Moon's shadow and the horizon.

The cause of the curves' character during the total solar eclipse was probably the different horizon above the inland part and the sea too, and the amount of the reflected photons that was diffused was higher above the ground than above the land.

In consequence of the phenomenon of limb darkening and the Rayleigh's diffusion the amount of the red and green photons decreased and the amount of the blue photons increased in the time interval <10:59:19 UTC; 12:12:05 UTC). The variations that are noticeable on the all 3 curves were caused by the transition of the cloudiness Ci over the Sun. The cause of the curves' character in the time interval <12:12:05 UTC; 15:06:20 UTC) is the decreasing height of the Sun above the horizon. The diffusion of the photons increased, in according to Rayleigh's diffusion the short-waved photons was diffused more than long-waved photons and the blue photons have got minority relative amount in the direct solar radiation at the bottom layer of the atmosphere. The relative amount of the red photons increased and the relative amount of the green photons was constant. The variations that are noticeable in this time interval were caused by the transition of the cloudiness over the Sun. The shading of the Sun by the cloudiness As in the time interval <15:06:20 UTC; 15:57:00 UTC) caused that the relative amount of the red and green photons decreased and the relative amount of the blue photons increased, because only the diffused lateral solar radiation struck on the sensors and according to Rayleigh's diffusion the blue photons diffused the most, because they relative amount was the biggest.

6.8.3 Evaluation

The progression of the colour of the light in the colour space sRGB showed that the progression of the single elements of the radiation was different during the annular and total solar eclipse.

The total blockading of the direct solar radiation did not occur during the annular solar eclipse, the red photons mostly struck on the measuring sensors of the module SPM in consequence of a phenomenon of limb darkening. The amount of the green and blue photons decreased.

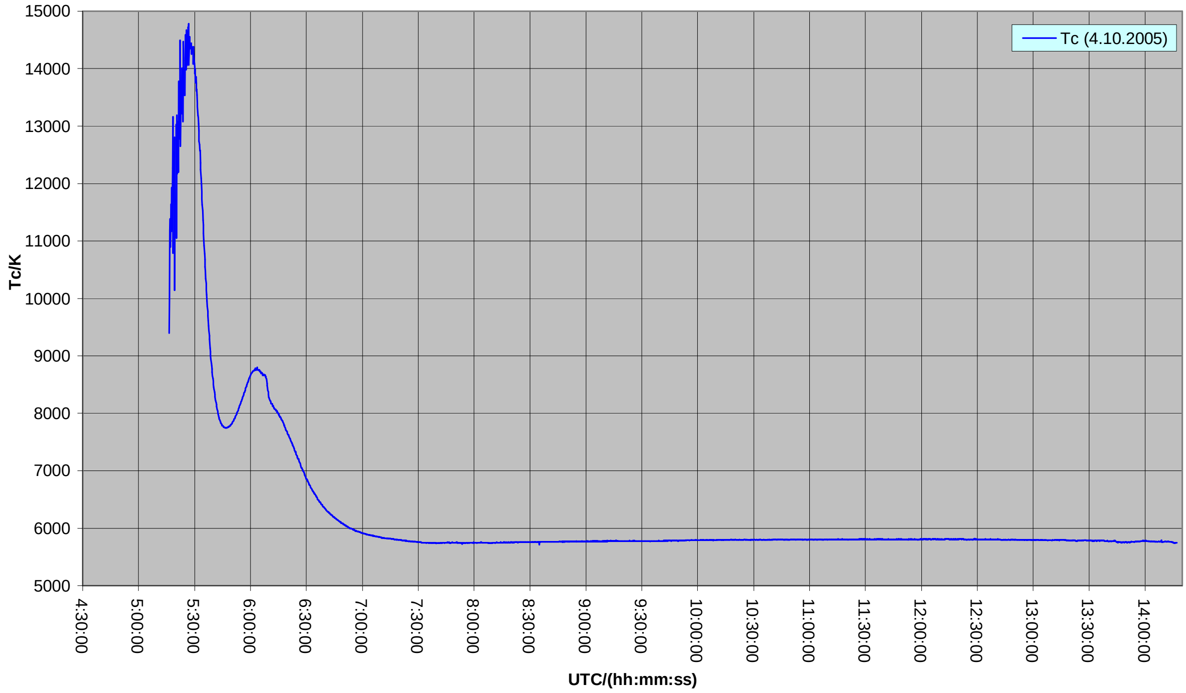
The total blockading occurred during the total solar eclipse. Only the diffused solar radiation struck on the measuring sensors of the module SPM and the blue photons diffused on molecules of the air the most. In addition to the diffused solar radiation the solar radiation which was indented from the land respectively from the sea and then it was diffused in the Earth's atmosphere. The relatively amount of the light's element depended on the shape of the horizon and the composition of the Earth's atmosphere *(e.g.: the presence of the aerosols at the air layers)*. The aerosols caused the aerosols diffusion that influenced more the long-wavelength photons.

The high changes of the character of the curve that are noticeable in the time interval during the total phase of the solar eclipse could to determine the times T_2 an T_3 from the measurement. The values of the start and the end of the total phase are: T_2 = 10:55:03 UTC;
T_3 = 10:58:46 UTC

But it is difference from the prediction *(viz. table no. 8)*. The difference between the predicted and measured T_2 is 3 s and this difference of the T_3 is 1 s. These differences mentioned above were probably caused by the inaccuracy of the entry parameters of the prediction.

6.9 Correlated Colour Temperature of the Solar Radiation

6.9.1 Annular Solar Eclipse – Spain 2005



Graph no. 20: Progression of the Correlated Colour Temperature of the Solar Radiation from the Day of the Referential Measurement

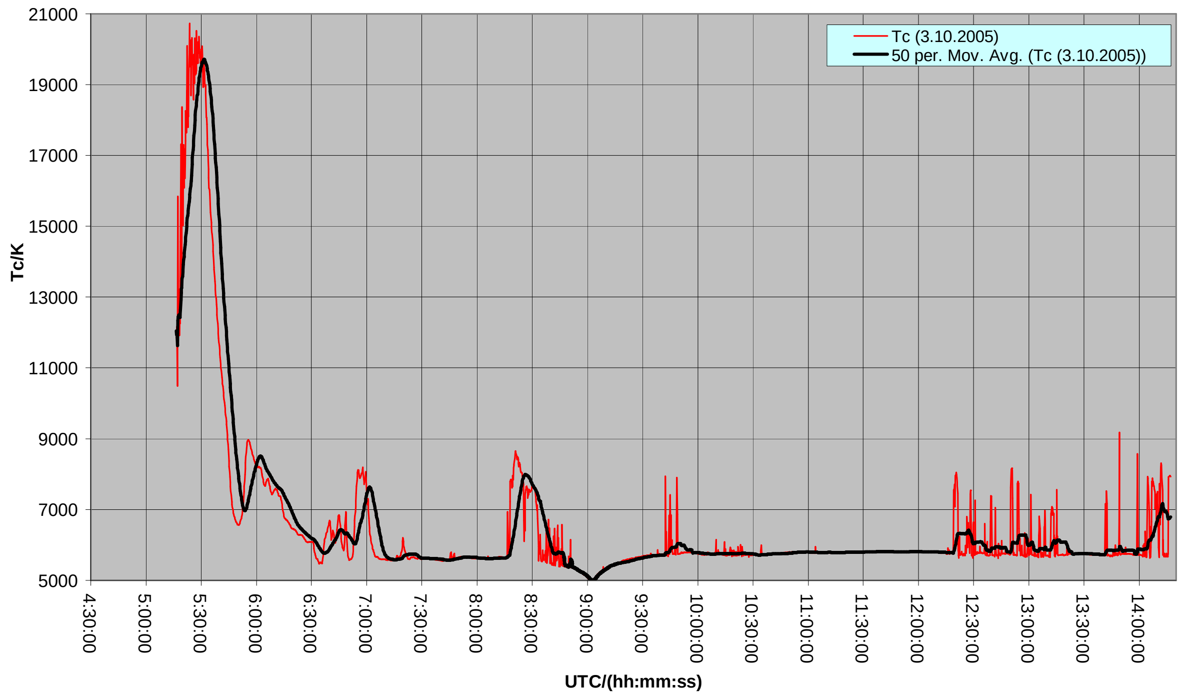
The Referential Measurement

The progression of the correlated colour temperature is possible to see in the graph no. 20. The blue curve represents referential measurement from the 4th October 2005. A larger sized version of this graph is added in the appendixes as Appendix no. 23.

The curve was not proceed in the time interval <05:16:20 UTC; 05:32:50 UTC) by the reason of the high noise. The cause of the curve's character in the time interval from the beginning of the civil twilight to the sunrise of the first part of the Sun <05:30:50 UTC; 05:58:00 UTC) is the diffusion of the solar radiation at atmosphere's layers. At the beginning of the time interval only the diffused solar radiation struck on the measuring sensors of the SPM. The radiation with the higher correlated colour temperature diffused most on the air molecules. In according to molecular *(Rayilegh's)* diffusion the radiation with the higher correlated colour temperature diffused more than the radiation with the lower correlated colour temperature, so the incident solar radiation has got very high correlated temperature at the beginning of the time interval. The value was higher than 20 000 K that corresponds to blue colour. The cause of the steep decreasing character of the curve in the time interval mentioned above was diffusion of aerosols that influenced mostly the light with the lower correlated temperature. The report from the observers about the observing of the red sky confirmed the increased amount of the radiation with the increased correlated colour temperature. Maximal amount of the red photons is possible to see in the graph no. 20 at 05:50:50 UTC. Its value is 7 823 K. The amount of the aerosol diffusion decreased with the decreasing depth of the Sun below the horizon that caused the increase of the correlated colour temperature of the radiation. It is possible to see in the time interval <05:50:50 UTC; 05:58:50 UTC), the maximal value 8 788 K was at 08:02:50 UTC.

The cause of the decreasing character of the curve in the time interval <06:02:50 UTC; 07:37:50 UTC) is the increasing amount of the direct solar radiation.

In the time interval <07:37:00 UTC; 14:17:00 UTC) the correlated temperature is higher than 5 500 K considering the direct solar radiation. This value is very close toward the surface temperature of the Sun (5 570 K). The difference between the correlated colour temperature and the surface temperature off the Sun was caused by the refraction of the light at atmosphere, its amount increase with the height of the Sun above the horizon, and the phenomenon of the limb darkening.



Graph no. 21: Progression of the Correlated Colour Temperature of the Solar Radiation from the Day of the Annular Solar Eclipse

The Measurement on the Eclipse Day

The progression of the correlated colour temperature is possible to see in the graph no. 21. The red curve represents the measurement during the day of the annular solar eclipse *(October 3rd, 2005)*. The curve was smoothed for better lucidity by the black trend line with the period of 50 values. A larger sized version of this graph is added in the appendixes as Appendix no. 24.

The curve was not proceed in the time interval <05:16:30 UTC; 05:32:00 UTC) by the reason of the high noise. The cause of the curve's character in the time interval from the beginning of the civil twilight to the sunrise of the first part of the Sun <05:32:00 UTC; 05:57:00 UTC) is the diffusion of the solar radiation at atmosphere's layers. At the beginning of the time interval only the diffused solar radiation struck on the measuring sensors of the SPM. The radiation with the higher correlated colour temperature diffused most on the air molecules. In according to molecular (Rayilegh's) diffusion the radiation with the higher correlated colour temperature diffused more than the radiation with the lower correlated colour temperature, so the incident solar radiation has got very high correlated temperature at the beginning of the time interval. The value was higher than 20 000 K that corresponds to blue colour. The cause of the steep decreasing character of the curve in the time interval mentioned above was diffusion of aerosols that influenced mostly the light with the lower correlated temperature. The report from the observers about the observing of the red sky confirmed the increased amount of the radiation with the increased correlated colour temperature. Maximal amount of the red photons is possible to see in the graph no. 21 at 05:51:50 UTC. Its value is 7 823 K. The amount of the aerosol diffusion decreased with the decreasing depth of the Sun below the horizon that caused the increase of the correlated colour temperature of the radiation. It is possible to see in the time interval <05:51:50 UTC; 05:57:10 UTC), the maximal value 8 732 K was at 05:57:00 UTC.

The correlated colour temperature decreased in the time interval after the sunrise <05:57:10 UTC; 07:12:40 UTC) in consequence of the increased amount of the direct solar radiation, the amount of the direct solar radiation increased in this time interval. The variations that are noticeable in part of the time interval mentioned above were caused by the transition of the cloudiness over the Sun.

Almost stagnant character of the curve representing of the correlated temperature of the solar radiation in the time interval <07:12:40 UTC; 07:42:24 UTC) was caused by the impact of the direct solar radiation on the sensors of the module SPM.

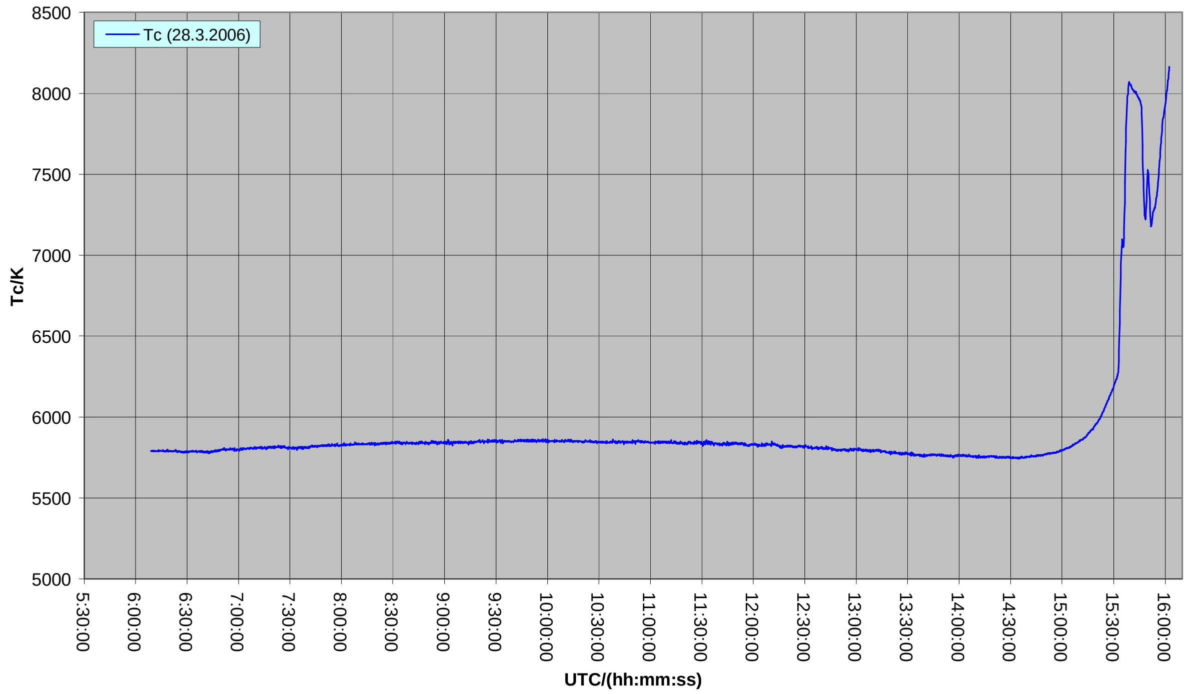
If 0 % of cloudiness was in the sky, it is possible to expect that the shape of the curve was the same (in the part of the graph mentioned above - in the time interval <05:32:00 UTC; 07:42:24 UTC)) as on the day of the referential measurement *(October 4th, 2005)* in this time interval.

The gradual shading of the Sun by the Moon influenced the progression of the correlated colour temperature of the light in the time interval <07:42:24 UTC; 09:01:51 UTC). The decreasing character of the curve is noticeable in this time interval in the graph no. 21 that was caused by the gradual shading of the Sun by the Moon during which a phenomenon of limb darkening showed.

The cause of the increasing character of the curve in the time interval <09:01:51 UTC; 10:31:04 UTC) is the gradual uncovering of the Sun by the Moon. A phenomenon of the limb darkening showed in this time interval again.

The character of the curve in the time interval <10:31:04 UTC; 14:03:30 UTC) is decreasing that was caused by the impact of the direct solar radiation from the Sun that height above the horizon decreased. The variation that is noticeable in the time interval <14:03:30 UTC; 14:17:00 UTC) was caused by the shading of the Sun by the cloudiness.

6.9.2 Total Solar Eclipse – Turkey 2006



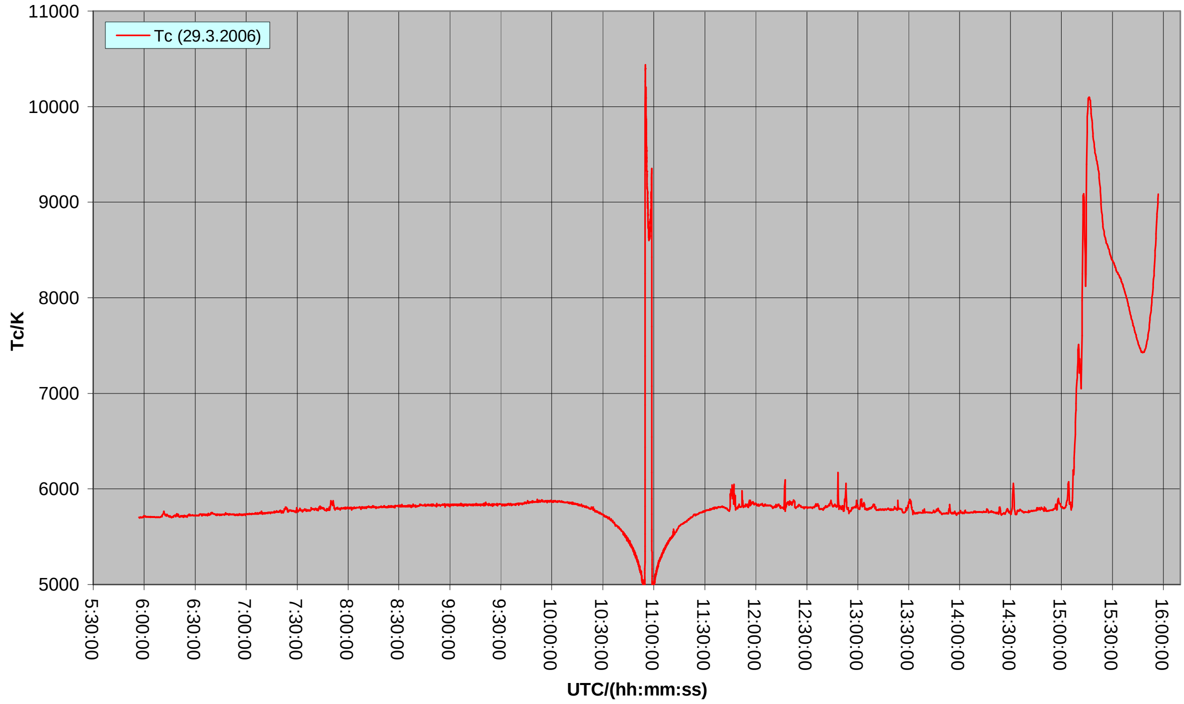
Graph no. 22: Progression of the Correlated Colour Temperature of the Solar Radiation from the Day of the Referential Measurement

The Referential Measurement

The progression of the correlated colour temperature is possible to see in the graph no. 22. The blue curve represents referential measurement from the 28th March 2006. A larger sized version of this graph is added in the appendixes as Appendix no. 25.

In the time interval <06:09:00 UTC; 14:45:40 UTC) the correlated temperature is higher than 5 500 K considering the direct solar radiation. This value is very close toward the surface temperature of the Sun (5 570 K). The difference between the correlated colour temperature and the surface temperature off the Sun was caused by the refraction of the light at atmosphere, its amount increase with the height of the Sun above the horizon, and the phenomenon of the limb darkening.

The shading of the measuring sensors by the shadow in the time interval <14:45:50 UTC; 15:40:00 UTC) blocked the increasing of the direct solar radiation. In this time interval only the diffused solar radiation struck on the measuring sensors of the SPM, the blue spectrum of the light was diffused the most, because the character of the curve is increasing. Maximal value *(8 057 K)* of the correlated colour temperature in the time interval mentioned above was at 15:39:40 UTC. The variations that are noticeable in the time interval <15:40:00 UTC; 16:02:40 UTC) were caused by the covering of the Sun by the Moon.



Graph no. 23: Progression of the Correlated Colour Temperature of the Solar Radiation from the Day of the Total Solar Eclipse

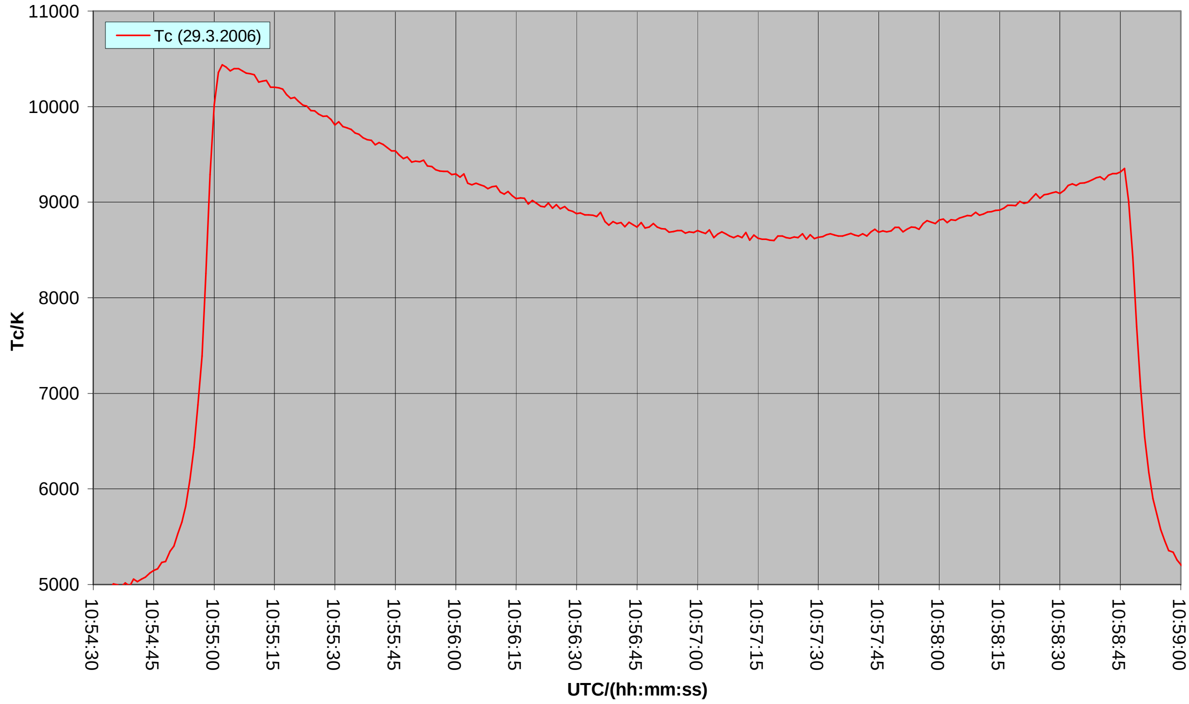
The Measurement on the Eclipse Day

The progression of the correlated colour temperature is possible to see in the graph no. 23. The red curve represents measurement during the day of the total solar eclipse *(March 29th, 2006)*. A larger sized version of this graph is added in the appendixes as Appendix no. 26.

The moderate increase is noticeable in the time interval from the beginning of the measurement to the beginning of the partial phase of the solar eclipse <05:57:00 UTC; 09:39:10 UTC) that was caused by the impact of the direct solar radiation. The value of the correlated colour temperature was more than 5 500 K, the difference between the correlated colour temperature of the light and the surface temperature of the Sun changed depending on the refraction of the light at Earth's atmosphere and a phenomenon of the limb darkening.

The curve has got the decreasing character in the time interval during the partial phase of the eclipse <09:39:10 UTC; 10:54:35 UTC) that was caused by a phenomenon of the limb darkening. The influence of the radiation from the solar limb increased with the gradual shading of the Sun by the Moon.

Considering the short period of the total phase of the solar eclipse is here mentioned detailed view of this quantity during this time interval. A larger sized version of this graph is added in the appendixes as Appendix no. 27



Graph no. 24: Progression of the Correlated Colour Temperature of the Solar Radiation during the Total Phase of the Solar Eclipse

The steep increasing character of the curve is noticeable in the graph no. 24 in the time interval <10:54:35 UTC; 10:55:03 UTC), the maximal value of the correlated colour temperature was at 10:55:02 UTC and it was 10 436 K. The character was caused by the total shading of the Sun by the Moon; the direct solar radiation was blocked in the consequence of the total shading of the Sun by the Moon. The diffused solar radiation had the biggest substitution in the incident radiation, the light with the highest correlated colour temperature is diffused the most.

The roughly parabolic shape of the curves that is noticeable in the time interval <10:55:03 UTC; 10:58:46 UTC) was caused by the almost circular shape of the Moon's shadow and the almost circular shape of the horizon. While the speed of the motion of the shadow on central line is possible to consider being uniform for this short time, the change of the area that was covered by the shadow is non-uniform in consequence of the shape of the Moon's shadow and the horizon.

Asymmetric shape of the curve in the time period of the total phase of the eclipse was caused probably by the different diffusion of the solar radiation above the sea, where was the aerosol diffusion and above the land, where the light was diffused on molecules of the air.

The steep change of the curve is possible to see in the time interval <10:58:46 UTC; 10:59:19 UTC) with maximal value of the correlated colour temperature at 10:58:46 UTC that was caused by the ending of total phase of the solar eclipse, the blockading of the direct solar radiation ended in consequence of this.

The character of the curve is increasing in the time interval <10:59:19 UTC; 12:12:05 UTC) that was caused by a phenomenon of the limb darkening. As s result of the gradual uncovering of thee Sun by the Moon, the light coming from the centre of the Sun has got the majority substitution in the incident radiation.

Almost stagnant character of the curve in the time interval <12:12:05 UTC; 15:06:20 UTC) was caused by the impact of the direct solar radiation. The low variations that are noticeable in the part of the graph no 23 mentioned above were caused by the transition of the thin cloudiness Ci over the Sun.

The covering of the Sun by the cloudiness As in the time interval <15:06:20 UTC; 15:57:00 UTC) caused the blockade of impact of the direct solar radiation, only diffused solar radiation struck on the measuring sensors of the module SPM. The light with the highest correlated colour temperature diffused the most in consequence of the Rayleigh’s diffusion.

6.9.3 Evaluation

The progression of the correlated colour temperature showed that its progression was different during the annular and total solar eclipse.

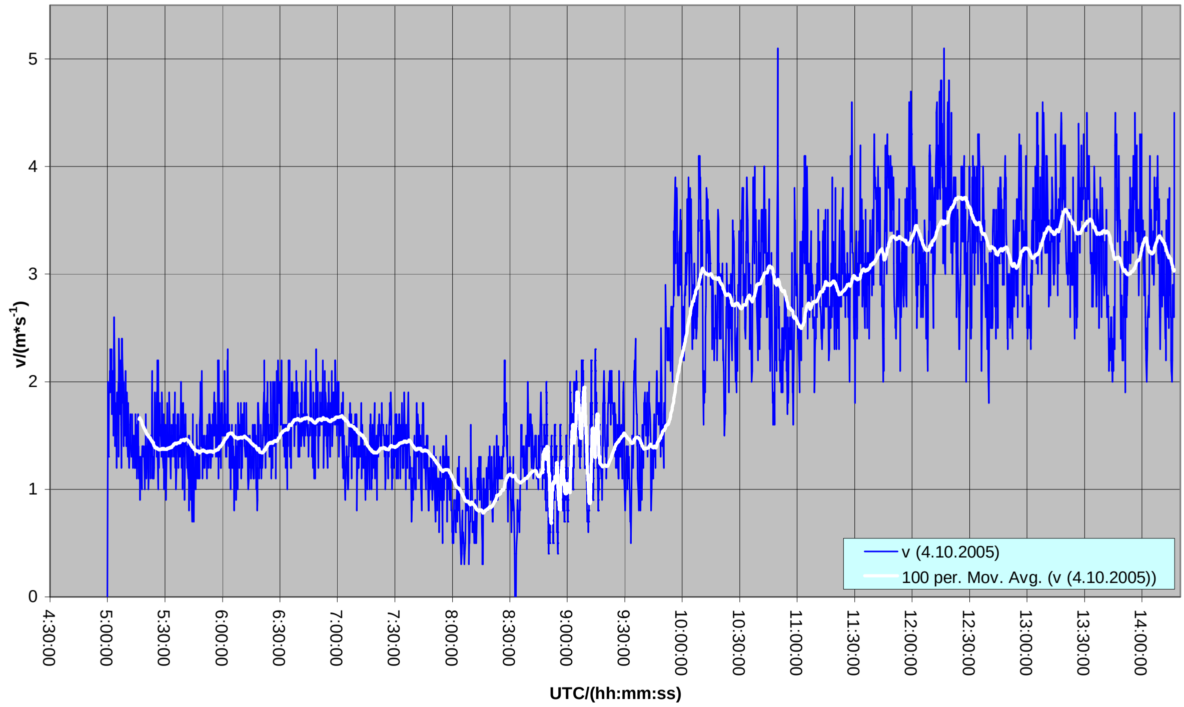
The total blockading of the direct solar radiation did not occur during the annular solar eclipse, the radiation with the lower correlated colour temperature mostly struck on the measuring sensors of the module SPM in consequence of a phenomenon of limb darkening.

The total blockading occurred during the total solar eclipse. Only the diffused solar radiation struck on the measuring sensors of the module SPM and the radiation with the higher correlated colour temperature diffused on molecules of the air the most. In addition to the diffused solar radiation the solar radiation which was indented from the land respectively from the sea and then it was diffused in the Earth's atmosphere. The size of the correlated colour temperature of the light depended on the shape of the horizon and the composition of the Earth's atmosphere *(e.g.: the presence of the aerosols at the air layers).* The aerosols caused the aerosols diffusion that influenced more the light with the lower correlated temperature.

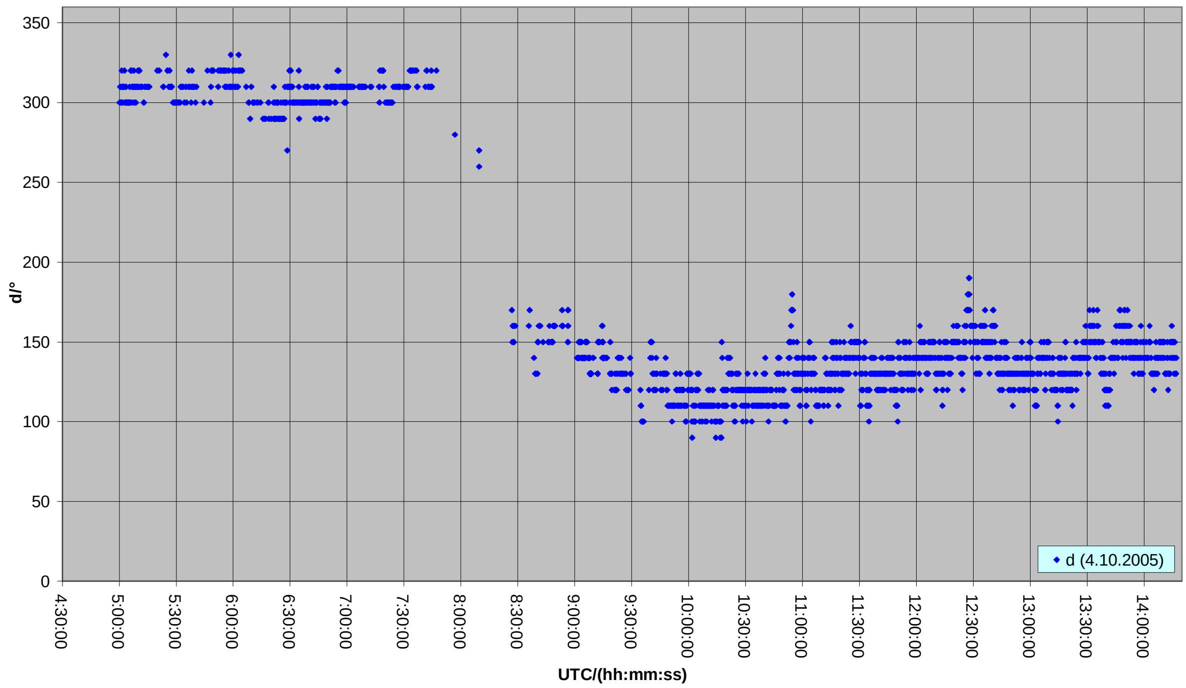
The fact that the coronal light was in minority in comparison with the diffused solar radiation was found after the comparison of the measured correlated temperature and correlated colour temperature that was acquired by the processing of the photos of the total solar eclipse by worker of the Observatory and Planetarium in Plzen Mr. Ing. Jiri Polak. The value of the correlated colour temperature of the solar corona was 4 800 K.

6.10 Wind Direction and Speed

6.10.1 Annular Solar Eclipse – Spain 2005



Graph no. 25: Progression of the Wind Speed (4.10.2005) – Spain 2005



Graph no. 26: Progression of the Wind Direction (4.10.2005) – Spain 2005

The Referential Measurement

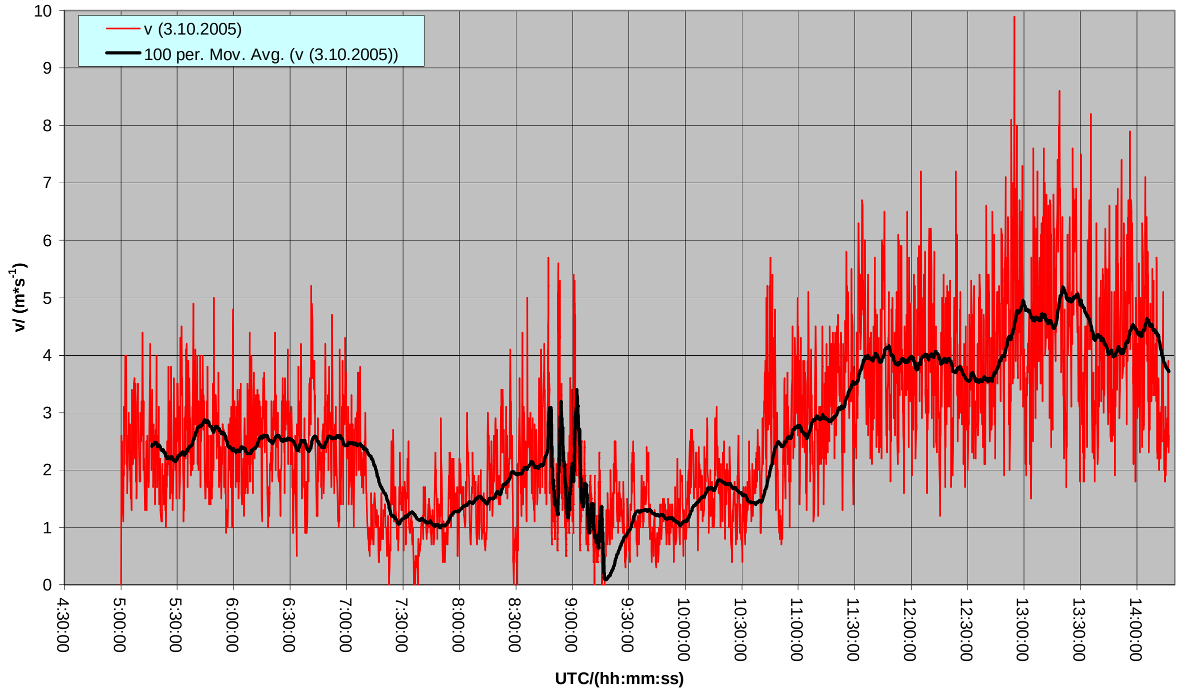
The progressions of the wind speed and direction from the day of the referential measurement *(October 4th, 2005)* are possible to see in the graphs no. 25 and 26. The blue curve represents the running of the wind speed at 2 m above the ground in the graph no. 25; the curve was smoothed for better lucidity by the white trend line with the period of 100 values. The direction of the wind is illustrated by the dark blue points in the graph no. 26; the wind was sensed during the speed more than 1.5 $m*s^{-1}$. Larger sized versions of these graphs are added in the appendixes as Appendixes no. 28 and 29.

The characters of the wind direction and speed were influenced by the presence of the sea throughout the whole running; the sea was c. 120 m far from the observational site. It caused the breeze.

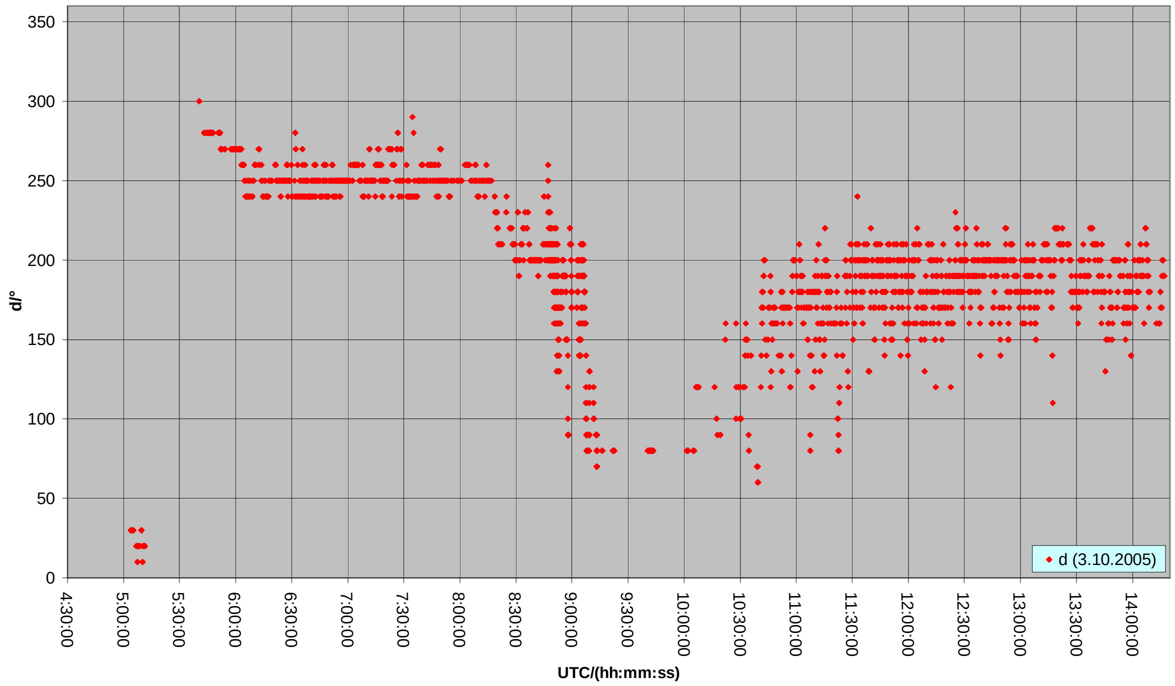
The higher air temperature above the sea and the lower air temperature above the land caused the character of the wind speed and direction in the time interval <05:00:10 UTC; 08:11 UTC). The value of the atmospheric pressure above the sea at the bottom atmosphere's layer was lower then the value of atmospheric pressure above the ground at the same layer of the atmosphere. As a result, the air was flowing from the land (north-west direction). The low speed of the flowing was probably caused by the low difference of air temperature above the sea and the land.

The steep increasing curve's character illustrating the speed of the wind in the time interval <08:11 UTC; 10:06 UTC) and the increasing curve's character in the time interval <10:06 UTC; 12:20 UTC) were probably caused by the increasing height of the Sun above the horizon that probably caused the heating of the air at the bottom layers of the atmosphere. In consequence of the low soil's caloric capacity in comparison with the sea's caloric capacity in this time interval the air temperature above the land has the higher value than the air temperature above the sea. The value of the air pressure at the bottom layer of the atmosphere was lower than the value of the air pressure at the bottom layer above sea. It verifies the direction of the wind too, because it is mostly SE *(the direction from the sea)* in the time intervals <08:11 UTC; 10:06 UTC) and <10:06 UTC; 12:20 UTC).

The moderate decrease of the speed of the wind was caused by the decreasing quantity of the pressure gradient above the land and the sea in the time interval <12:20 UTC; 14:17:00 UTC).



Graph no. 27: Progression of the Wind Speed (3.10.2005) – Spain 2005



Graph no. 28: Progression of the Wind Direction (3.10.2005) – Spain 2005

The Measurement on the Eclipse Day

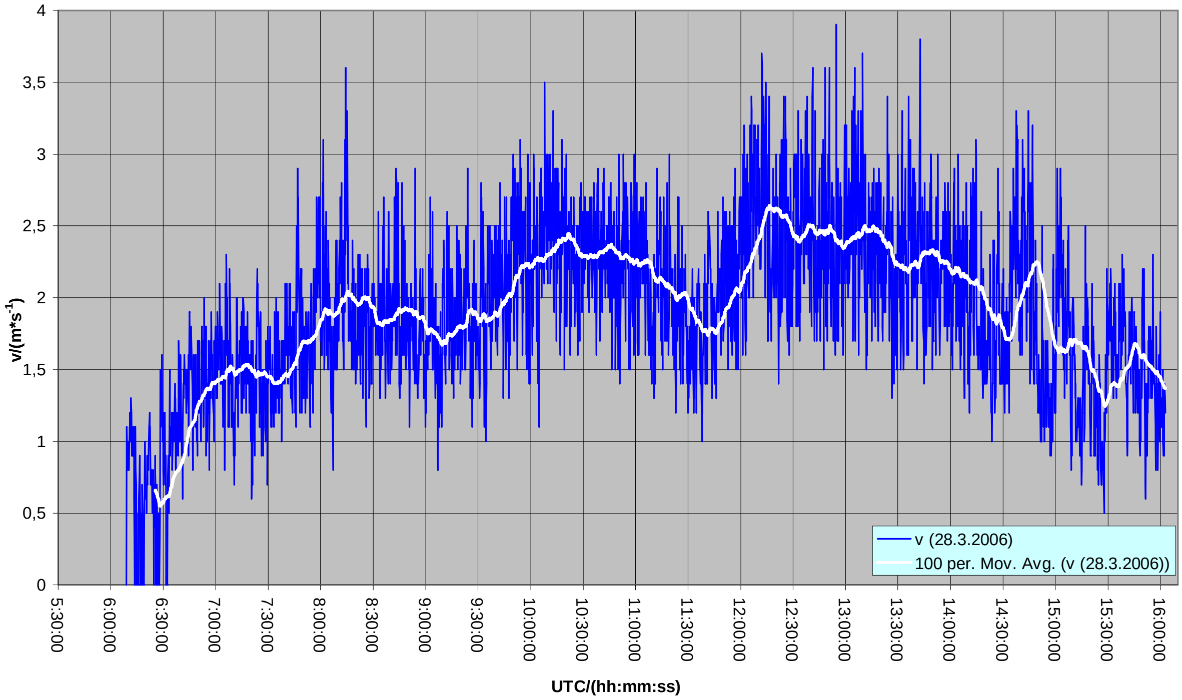
The progressions of the wind speed and direction during the day of the annular solar eclipse *(October 3^{rd}, 2005)* are possible to see in the graphs no. 27 and 28. The red curve represents the running of the wind speed at 2 m above the ground in the graph no. 27; the curve was smoothed for better lucidity by the white trend line with the period of 100 values. The direction of the wind is illustrated by the red blue points in the graph no. 28; the wind was sensed during the speed more than 1.5 $m*s^{-1}$. Larger sized versions of these graphs are added in the appendixes as Appendixes no. 30 and 31.

The characters of the speed and the direction *(NW)* of the wind were caused by the lower air temperature at the bottom layers of the atmosphere above the land than the air temperature at the bottom layers of the atmosphere above the sea in the time interval <05:00:10 UTC; 07:45 UTC).

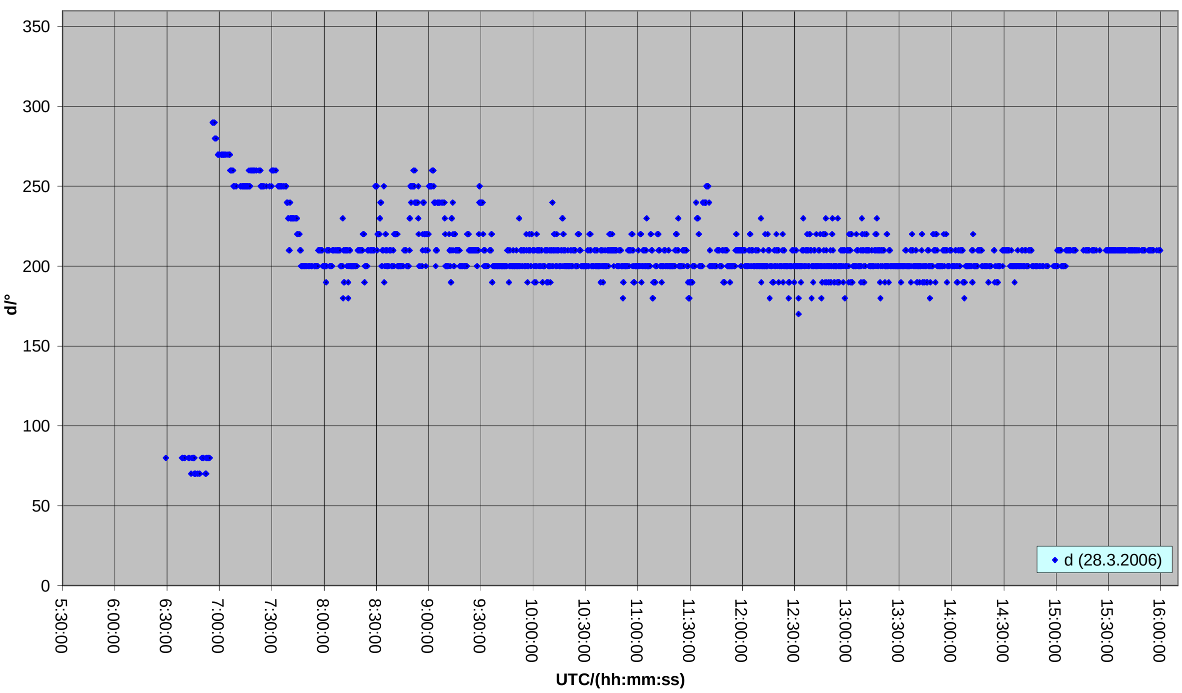
The character of the wind speed and the direction in the time interval <07:45 UTC; 08:47 UTC) was caused by the higher temperature of the air at the bottom layer of the atmosphere above the land compared with the air temperature above the sea.

The gradual shading of the Sun by the Moon caused the decrease of the air temperature at the bottom atmosphere’s layers above the observational site which showed by the marked decrease of the wind speed; it is noticeable in the graph no. 27 in the time interval <08:47 UTC; 09:12 UTC). The consequence of the phenomenon is the decrease of the pressure gradient at the bottom layer of the atmosphere above the sea and the land. The change of the wind direction is possible to see in the graph no. 28 in the time interval <08:47 UTC; 12:54 UTC). Considering long time duration of it the solar eclipse probably did not mostly influence the change, but the cause was probably covering of the sky by the cloudiness that decreased the quantity of the temperature gradient between the sea and the land. The increasing character of the wind speed in the time interval <09:12 UTC; 14:17:00 UTC) was caused by the increasing pressure gradient between the sea and the land. The air flowing in the time interval <12:54 UTC; 14:17:00 UTC) is possible to designate as the sea breeze in according to the direction of the wind.

6.10.2 Total Solar Eclipse – Turkey 2006



Graph no. 29: Progression of the Wind Speed (28.3.2006) – Turkey 2006

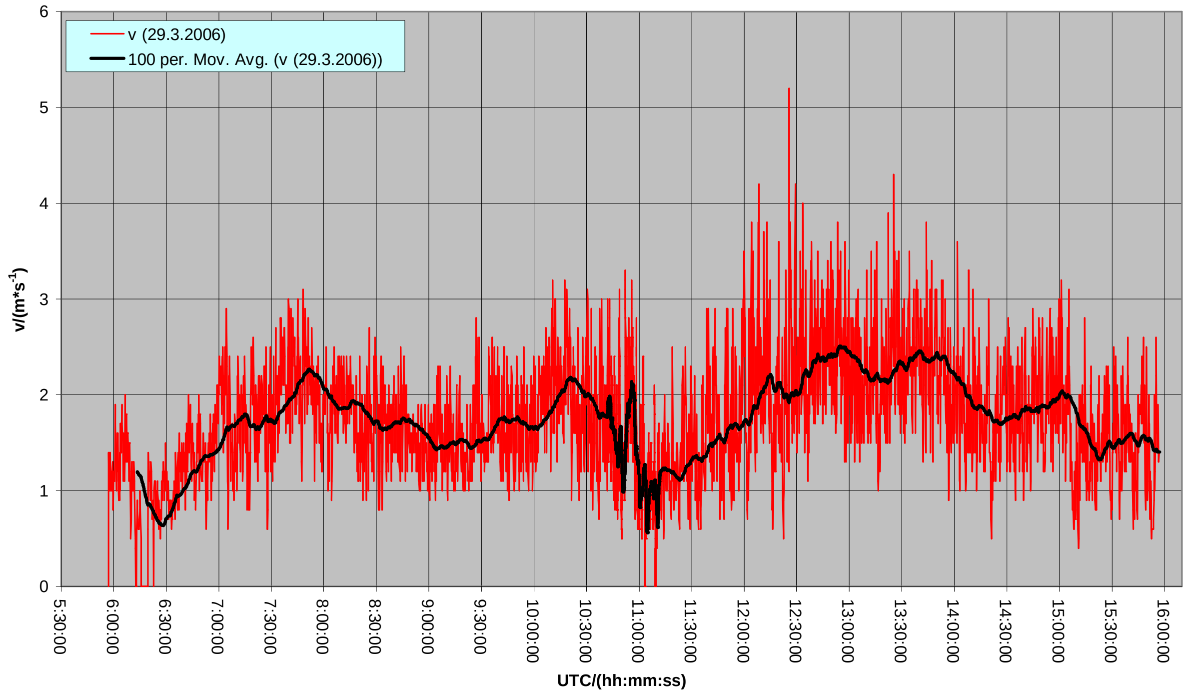


Graph no. 30: Progression of the Wind Direction (29.3.2006) – Turkey 2006

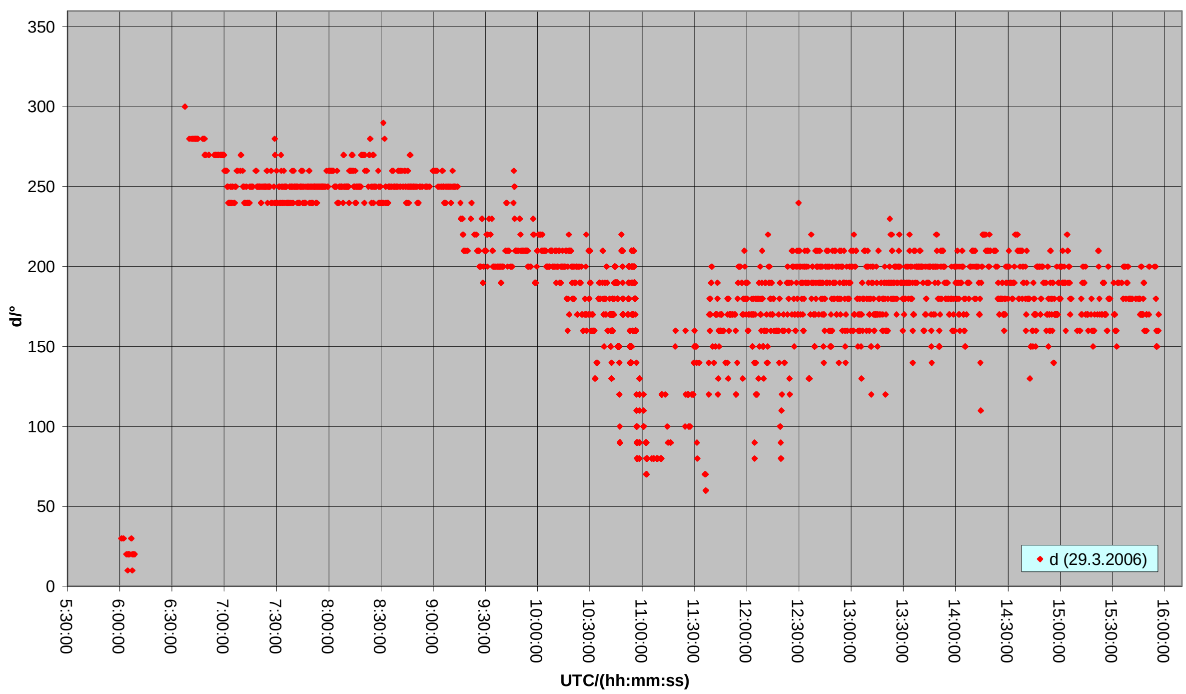
The Referential Measurement

The progressions of the wind speed and direction from the day of the referential measurement *(March 28th, 2006)* are possible to see in the graphs no. 29 and 30. The blue curve represents the running of the wind speed at 2 m above the ground in the graph no. 29; the curve was smoothed for better lucidity by the white trend line with the period of 100 values. The direction of the wind is illustrated by the dark blue points in the graph no. 30 the wind was sensed during the speed more than 1.5 $m*s^{-1}$. Larger sized versions of these graphs are added in the appendixes as Appendixes no. 32 and 33.

Mostly increasing character of the white trend line of the moving average with the period of 50 values in the time interval <06:09:00 UTC; 12:14 UTC) was caused by the unequal heat of the Earth's surface and the sea. As a result, the temperature *(pressure)* gradient between the bottom layers of the atmosphere above the land and the sea occurred. In this time interval the area of the high pressure was above the sea in comparison with the value of the air pressure above the land, it caused the air flowing from the sea to the land *(S direction).* The curve representing the moving average of the wind speed has got mostly decreasing character in the time interval <12:14 UTC; 16:02:40 UTC) which was caused by the decreasing height of the Sun above the horizon, its consequence was the decrease of the quantity of the temperature *(pressure)* gradient between the sea and the land.



Graph no. 31: Progression of the Wind Speed from the Day of the Total Solar Eclipse (29.3.2006)



Graph no. 32: Progression of the Wind Direction from the Day of the Total Solar Eclipse (29.3.2006)

The Measurement on the Eclipse Day

The progressions of the wind speed and direction during the day of the total solar eclipse *(March 29th, 2006)* are possible to see in the graphs no. 31 and 32. The red curve represents the running of the wind speed at 2 m above the ground in the graph no. 31; the curve was smoothed for better lucidity by the white trend line with the period of 100 values. The direction of the wind is illustrated by the dark red points in the graph no. 32; the wind was sensed during the speed more than 1.5 $m*s^{-1}$. Larger sized versions of these graphs are added in the appendixes as Appendixes no. 34 and 35.

Character of the wind speed and the direction *(S)* were caused by the increasing temperature gradient between the bottom layers above the land and the sea in the time interval <05:57:00 UTC; 10:55 UTC). The value of the air pressure above the sea was higher than the pressure above the land in this time interval. The sudden decrease of the wind speed and the sudden change of the direction in the time interval <10:55 UTC; 11:11 UTC) were caused by the total shading of the Sun by the Moon. The value of the air pressure in the place where was possible to see total solar eclipse was probably just a little bit higher than the value of the pressure in the places where was possible to see only the partial solar eclipse. The increasing character of the curve representing the moving average of the wind speed and the S direction of the wind in the time interval <11:11 UTC; 12:48 UTC) was caused by the unequal heating of the land and the sea too that caused the formation of the temperature *(pressure)* gradient at the bottom layers between the sea and the land. The decrease of the incident solar radiation in the time interval <12:48 UTC; 15:57:00 UTC) caused the decreasing of the pressure gradient at the bottom layers of the atmosphere between the sea and the land that showed as the decreasing character of the curve representing the wind speed.

6.10.3 Evaluation

The progression of the wind speed and the direction showed that its progression was partialy different during the annular and total solar eclipse.

The marked decrease of the wind speed occurred during the both of the solar eclipses after the time T_{max} that was caused by the decrease of the amount of the temperature gradient between the sea and the land. The change of the wind direction is noticeable during both of the solar eclipses, but the change of the wind direction was very long during the annular solar eclipse in Spain. Considering the long duration of it the change was caused by the presence of the cloudiness above the observational site. The time interval of the change of the wind direction was shorter during the measurement during the total solar eclipse and 0% of cloud cloudiness. During a complete phase of solar eclipse, a brief high air pressure has probably occured in comparison to places where only a partial solar eclipse was showing. (out of total path)

7 Discusion

A study of changes in meteorological quantity in the process of total eclipse was a part of observational programs of several expeditions in the Czech Republic in the past: Observatory and Planetarium in Plzen *(1999)*, FEE CUT and Observatory in Upice *(2001)*. These abroad expeditions were concerned with these meteorological problems: : Andrew White a Stephen McCann – Zambia 2001, Francis Massen – Lucemburg 1999, Institut für Bioklimatologie – Germany 1999, Laboratory Optical Radiometry – Institute of Electronics „Academican Emil Djakov“ – Bulgaria 1999

The measurements realized by the expeditions mentioned above measured only the intensity of the solar radiation and the temperature of the air. *(The exemption is formed from the Laboratory Optical Radiometry–Institute of Electronics „Academican Emil Djakov“.)*

The facts mentioned below were acquired from the comparison between the measurement of the air temperature and the intensity of the global solar radiation at 2 m above the ground during the total solar eclipse in Turkey in 2006 and the conclusions of the measurements of the expeditions mentioned above.

- The existence of the decrease of the intensity of the global solar radiation *(respectively of the intensity of the luminescence)* and the air temperature during the total solar eclipse. It is accordance.

- The consistent result was found in comparison of the time of the minimum of the air temperature and the intensity of the global solar radiation. The previous measurements showed a certain retardation of minimum of the air temperature towards the minimum of the intensity of the global solar radiation respectively the intensity of the luminescence.

- The decrease of the wind speed was noted by the Francis Massen from Lucemburg during the total solar eclipse in 1999 that is the accordance with results from the measurement during the total solar eclipse in Turkey in 2006.

- The consistent result of the measurement of the relative humidity was noted in comparison with the measurement of this quantity that was carried out by the Adrew White in Africa in 2001.

- The partial consistent result was noted in comparison of the colour of the sky that was measured by the Laboratory Optical Radiometry – Institute of Electronics „Academican Emil Djakov“ in Bulharka in 1999. The colour of the sky during the total solar eclipse in Turkey in 2006 was probably different from the part of the measurement before the sunrise in Spain in 2005. The aerosol diffusion influenced of the colour of the sky before the sunrise and the measured data was not able to compare with the Bulgarian expedition.

Considering the fact that the measurement of the other quantities was not carried out during the total solar eclipse; the carrying out of the other comparison was not possible.

The information about measurement of the meteorological and the physical quantities during the annular solar eclipse has not found.

8 Conclusion

The marked variations in progressions of the meteorological and physical quantities during the annular and the total solar eclipses flowed from the processing of the measured data during the annular solar eclipse in Spain in 2005 and the total solar eclipse in Turkey in 2006.

The amount of the measured increases of the all temperatures was lower during the annular solar eclipse in consequence of the lower increase intensity of the global solar radiation during the annular solar eclipse in compassion with the total solar eclipse.

The different kind of the solar eclipse did not influence the time retardation between the minimal value of the global solar radiation and the minimal value of the air temperature at 5 cm above the ground; the other factors influenced this time delay *(e.g.: the observational site, the actual meteorological situation).*

The marked variation was noted during the progression of the colour of the solar radiation. The phenomenon of the limb darkening influenced the progression of this physical quantity during the annular solar eclipse. While the total blockade occurred during the total solar eclipse and only the diffused solar radiation struck on the measuring sensors that was influenced by the observational site *(e.g.: the distance from the sea and the non-uniformity of the horizon).*

The variation in progression of the speed and the direction of the wind is noticeable too; the wind speed decreased during the both of the solar eclipses. But the change of the wind direction was not proved during the annular solar eclipse but the change of the wind direction in Turkey in 2006 was caused by the astronomical phenomenon that could be concerned with the forming of the higher value of the atmospheric pressure in area of the eclipse shadow in comparison with its neighbourhood.

The insertion of the measurement of the atmospheric pressure to the experiment SEMM would help to confirm respectively refute the theory about the higher value of the atmospheric pressure at the shadow of the total solar eclipse.

The work brought an interesting study about the meteorological phenomenons that occurred before the sunrise in addition to the first detailed description of the changes of the meteorological quantities during the annular and the total solar eclipse.

Because not much attention is recently paid to the topic of changes of meteorological and physical quantities during solar eclipses and because the measurements made so far with the 3-rd generation SEMM project devices have brought in new or refined already known information about the time behaviour of the meteorological quantities, it is desirable to continue this meteorological measurements.

Meanwhile, during future measurements, it would be reasonable to monitor the meteorological station and the sky by cameras with a time base, as it can minimize the risk of not having records on the weather conditions, or other effects that could influence the measurements, available for further data processing.

9 List of the Used Abbrevations

A	Azimuth
Ac	Altocumulus
As	Altostratus
Cb	Cumulonimbus
Cc	Cirrocumulus
c_e	Expansion Coefficient
Ci	Cirrus
Cs	Cirrostratus
Cu	Cumulus
CAS	Czech Astronomical Society
CHMI	Czech Hydrometeorological Institute
CMI	Czech Metrological Institute
d	Direction of the Horizontal Component of a Wind
DAM	Data Acquisition Module
E	East
ESE	East-South-East
FEE CTU	Faculty of Electrical Engineering of the Czech Technical University
I	Intensity of the Global Solar Radiation
Ir	Intensity of the Reflected Radiation from the Earth's Surface
IR 10.8	Infra-Red Spectral Channel of the MSG 1 with Wavelength 10.8 μm
lambda (λ)	Geographical Latitude
MSG 1	Meteosat Second Generation 1
N	North
NASA	National Aeronautics and Space Administration (the United States of America)
NE	North-East
NW	North-West
phi (φ)	Geographical Longtitude
Pt	Platinum
RH	Relative Humidity of the Air at 2 m above the Ground

S	South
sB	Blue Element in the Colour Space sRGB
Sc	Stratocumulus
SE	South-East
SEMM	Solar Eclipse Meteorological Measurement
sG	Green Element in the Colour Space sRGB
SPM	Solar Pyranometr Module
sR	Red Element in the Colour Space sRGB
sRGB	Colour of the Light in the Colour Space sRGB
SW	South-West
T_1	Time Determining the Start of the Partial phase of a solar eclipse
T_2	Time Determining the Start of the Total (Annular) Phase of a Solar Eclipse
T_3	Time Determining the End of the Total (Annular) Phase of a Solar Eclipse
T_4	Time Determining the End of the Partial Phase of a Solar Eclipse
t_{a2m}	Temperature of the Air at 2 m above the Ground
t_{a5cm}	Temperature of the Air at 5 cm above the Ground
Tc	Correlated Colour Temperature of the Solar Radiation
THM	Air Temperature and Humidity Measuring Module
T_{max}	Time Determining the Greatest Magnitude of the Total (Annular) Phase of a Solar Eclipse
t_s	Temperature of the Soil at 5 cm under the Ground
TTM	Air Temperature and Ground Temperature Measuring Module
UTC	Universal Time Co-ordinated
V	Speed of the Horizontal Component of a Wind
W	West
WAM	Wind Anemometer Module
WMO	World Meteorological Organization

10 List of the Graphs

11 List of the Tables

12 Used Resources

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13 Appendixes

List of the Appendixes

Appendix no. 1: Records about Meteorological Situation – Turkey 2006

28. 3. 2006

UTC	Description
5:20	Sun is c. 20° above the horizon; Clear sky; Light wind
6:10	Clear sky, Light wind(S) from the sea
~ 7:30	Noteless Cu is low above the SW horizon
7:50	Clear sky, Light wind, Cu increase above the SW horizon, altitude c. 5°
8:30	Clear sky, Light wind from the S – SW direction, Cu is static above the SW horizon
9:00	Weather is the same: Clear sky, light wind, Cb increase above the horizon A = 340° to 040°; altitude c. 12°
9:40	Weather is the same, Cb increase above the N horizon (alt. c. 15°); cloudiness = 1/10
10:00	Clear sky, cloudiness = 1/10 (A = 340° to 060°; alt. cca 20° to 25°). Increase of the Cb above the N horizon, Cu is static above the SW horizon, Light wind S-SW
10:35	Slightly Clouded Sky, Cloudiness 2/10 (A = NW to NE) alt. c. 20° to 25°; Cu and Cb decay, Ac, Ci – Light wind rom the S direction
11:15	Slightly Clouded Sky Cloudiness 2/10 to 2/10, A = NW to NE alt. c. 20° to 25°, Cb is static above the N horizon, It delays to the zenith, Light wind from the S. Ac delay c. 30° above the horizon
12:00	Slightly Clouded Sky, Cloudiness below 1/10, SW horizion, Cu – low and static; Cu is above the N horizon (Cb delay alt. c. 10° to 12°, a few disintegrating Ac alt. 15° to 20° above the horizion, Light wind;
13:10	The meteorological situation is without a changes.
13:30	The amount of the cloudiness decrease below 1/10, cloudiness above the N horizon decrease (alt. 10° to 12°), Light wind: S to SE
14:40	Clear sky, disintegration of the cloudiness Ac, A man entrances into the area around weather station.
15:05	Clear sky, Disitengration of the rest of Ac, Light wind from the SW
15:30	The shadow trasition over the bottom sensors before 15:30, The top sensors are light illuminated at 15:35, they are at the shadow after 15:37.
16:05	The clouds above the horizon shading the Sun. It cool down. Slightly Clouded Sky, Cloudiness 1/10: Cc, Ci, Ac. Smoke is above the horizon at the atmosphere. Light wind from the S direction.
16:10	End of the measurement

29. 3. 2006

UTC	Description
5:10	Launch of the weather station, the Sun is 18° above the horizon, Ci
5:23	A man entrace toward the weather station *(the weather station does not measure - compensational mode)*
5:47	The sensors are actived, Clear sky, Sun is 28°above the horizon, The shadows leave from the area of the weather station.
5:57	The measurement starts.
7:20	Clear sky (cloudiness 0/10), Light wind from W to NE. Thin Ci cloudiness.
8:00	Clear sky (cloudiness 0/10); Light wind from W to NW. Thin Ci (N and E) – alt. 30°.
8:35	Clear sky, Cs cloudiness A = 0° to 90°, alt. 20°
8:50	Clear sky, cloudiness – less than 0/10, Cu discovers above the NE horizon, A = 0° to 90°, Ci – alt. c. 15° above the horizon, Light wind from SW
9:30	Clear sky, Cloudiness – less than 0/10, Low Cu (N), Cs is noticed suddenly above W horizon. Light wind from the SW
10:05	Speed of the wind increase (S) , Clear sky, Cloudiness 1/10, Cu above the NE horizon, Cs (SW – W) – it moves toward the south.
10:25	Ci cloudiness moved from the W horizon to the zenith, The illuminance decreased. The colour of the light change from 10:10. Noticeable decrease of temperature *(before the eclipse)*.
11:40	After eclipse – intensity and colour of the illuminance increase, The cirrus cloudiness Cs (N) is not at zenith, Cs S-SW, Cloudiness 1/10, Speed of the wind decrease.
12:43	A man entraces into the area aroud the weather station
12:55	Clear sky – Light wind, cloudiness – below 1/10, The cloudiness (Cs, Cc, Ci) trasition.
~ 13:20	The man is on edge of the area around the weather station
14:03	A dog entraces into the area around the weather station.
14:45	Cloudiness Cs arrives from the W
15:03	Ci moved to the zenith, cloudiness 2 or 3/10, Light wind
15:12	The Sun is shadowed by the Ac.
15:25	Cloudiness is from W to the zenith – 5/10 (Cs, As, Ac, Ci) , Light wind, The Sun is covered by the cloudiness, A dog run over the observational site – near the weather station
15:45	Cloudiness 6 or 7/10 – W (As), light wind
15:55	Cloudiness 7/10 – W (As+Ac), light wind
16:10	End of the measurement, Cloudiness 8/10 – 2 layers, Sun is low above the horizon and covered by the clouds

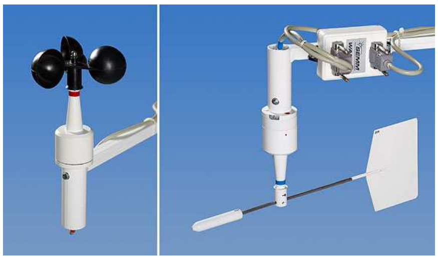
Appendix no. 2: The Weather Station of the 3rd Generation of the SEMM

Photography no. 1: DAM

Photography no. 2: SPM

Photography no. 3: THM

Photography no. 4: TTM

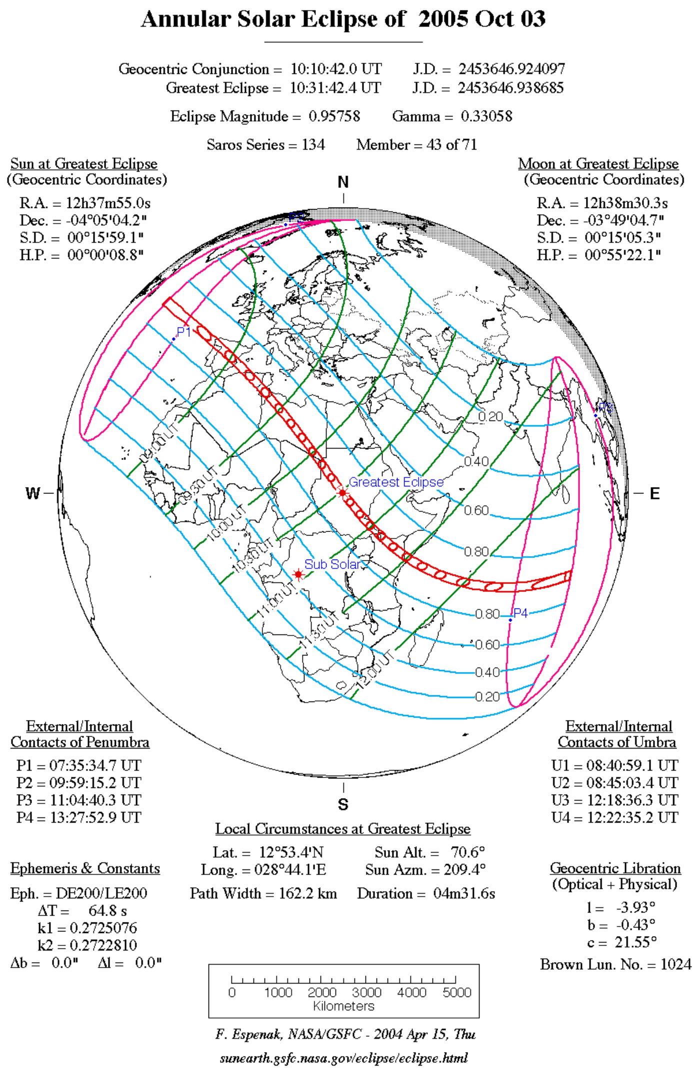


Photography no. 5:WAM

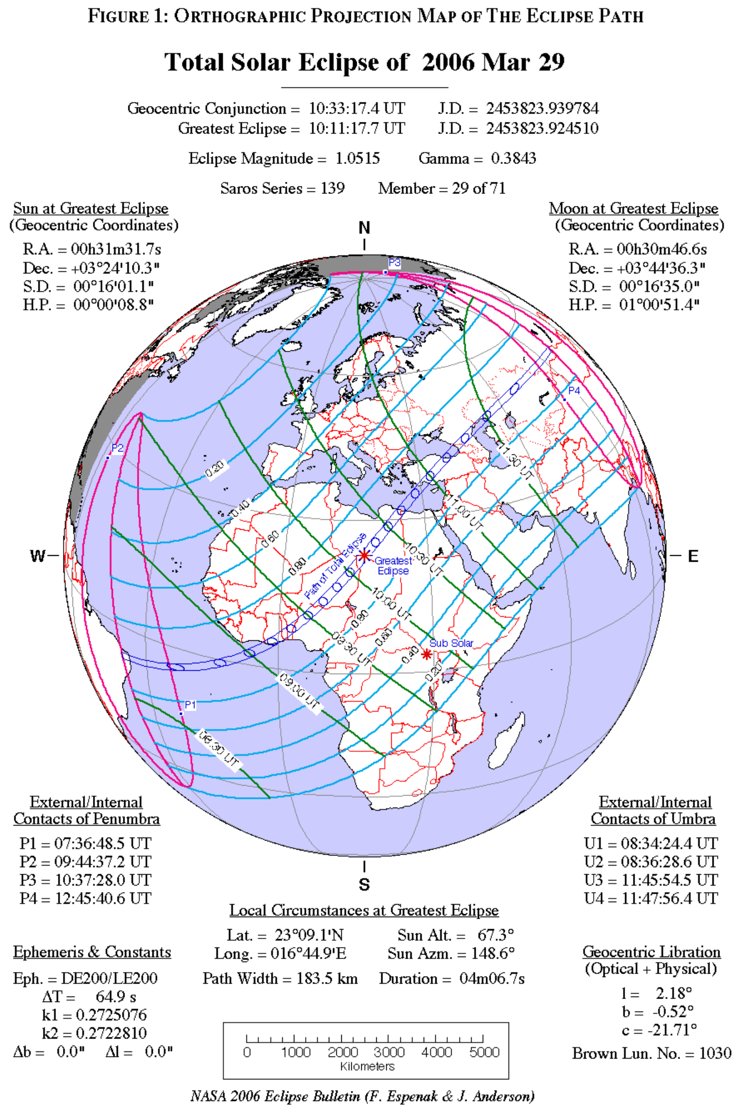
Photos 1,2,3,4,5 were taken from [11].

Photo no. 6: The Weather Station of the 3rd Generation

Appendix no. 3: Global Maps of the Solar Eclipses

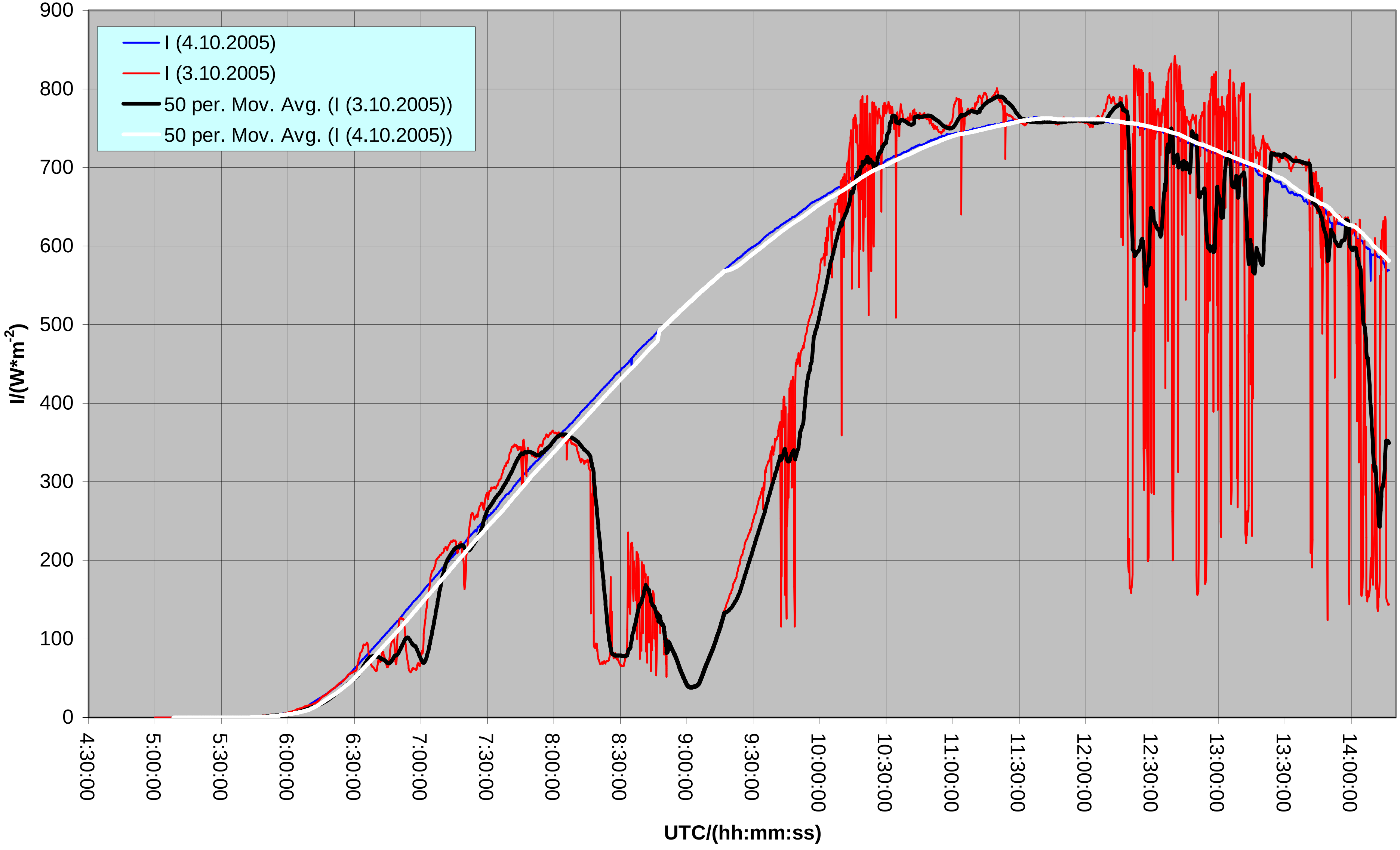


It was taken from: [2].

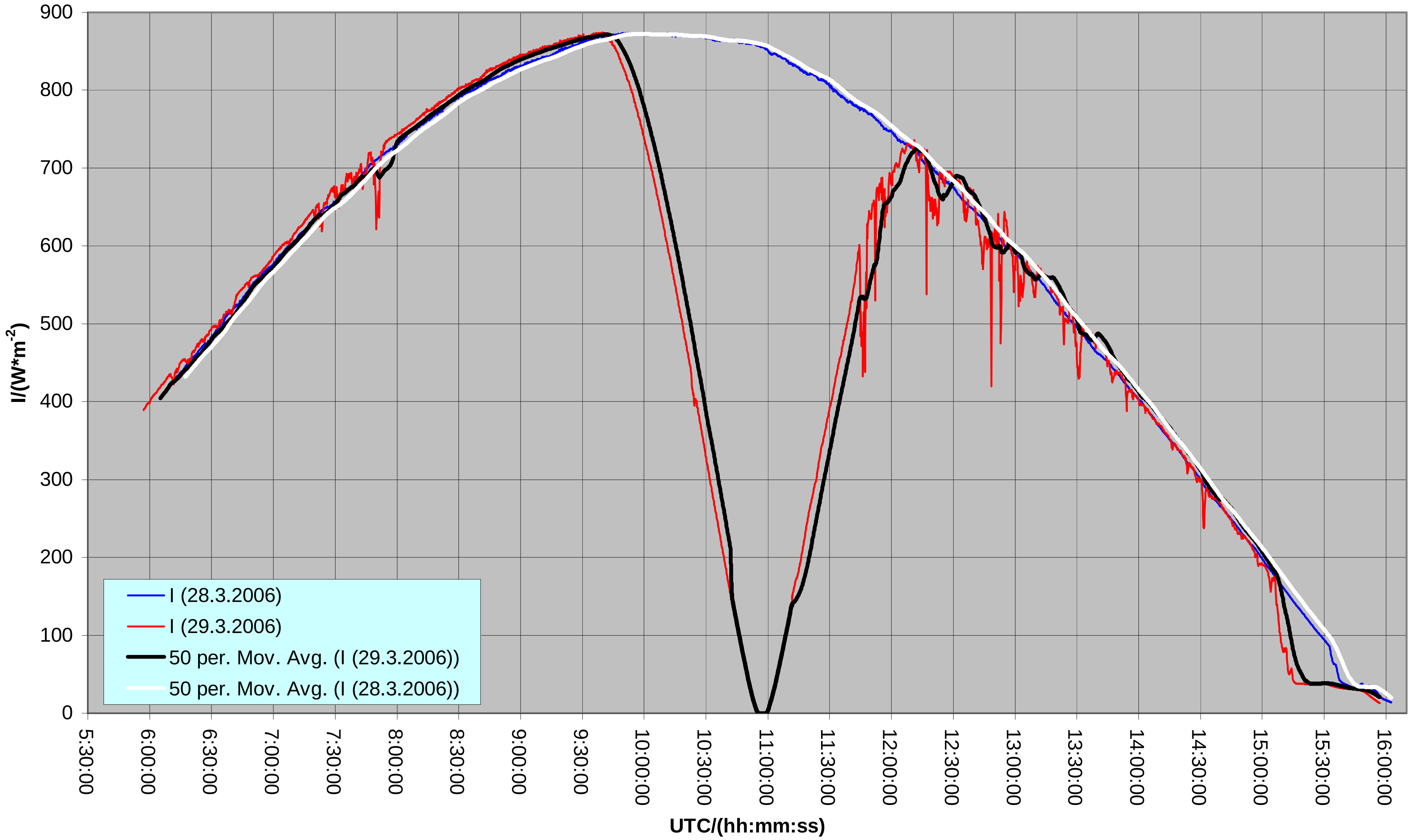


It was taken from: [3]

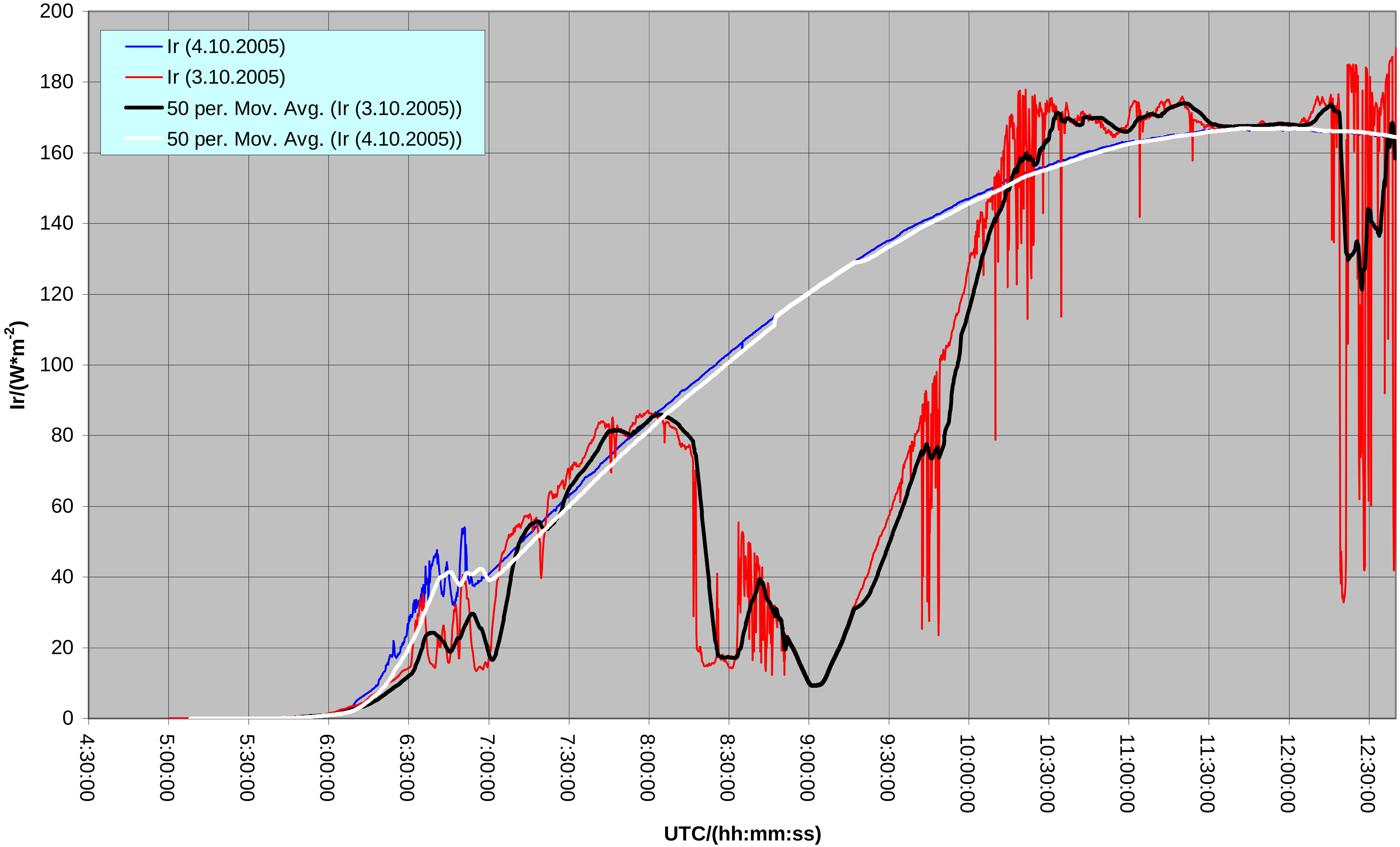
Appendix no. 4: Graph of the Progression of the Intensity of the Global Solar Radiation – Spain 2005



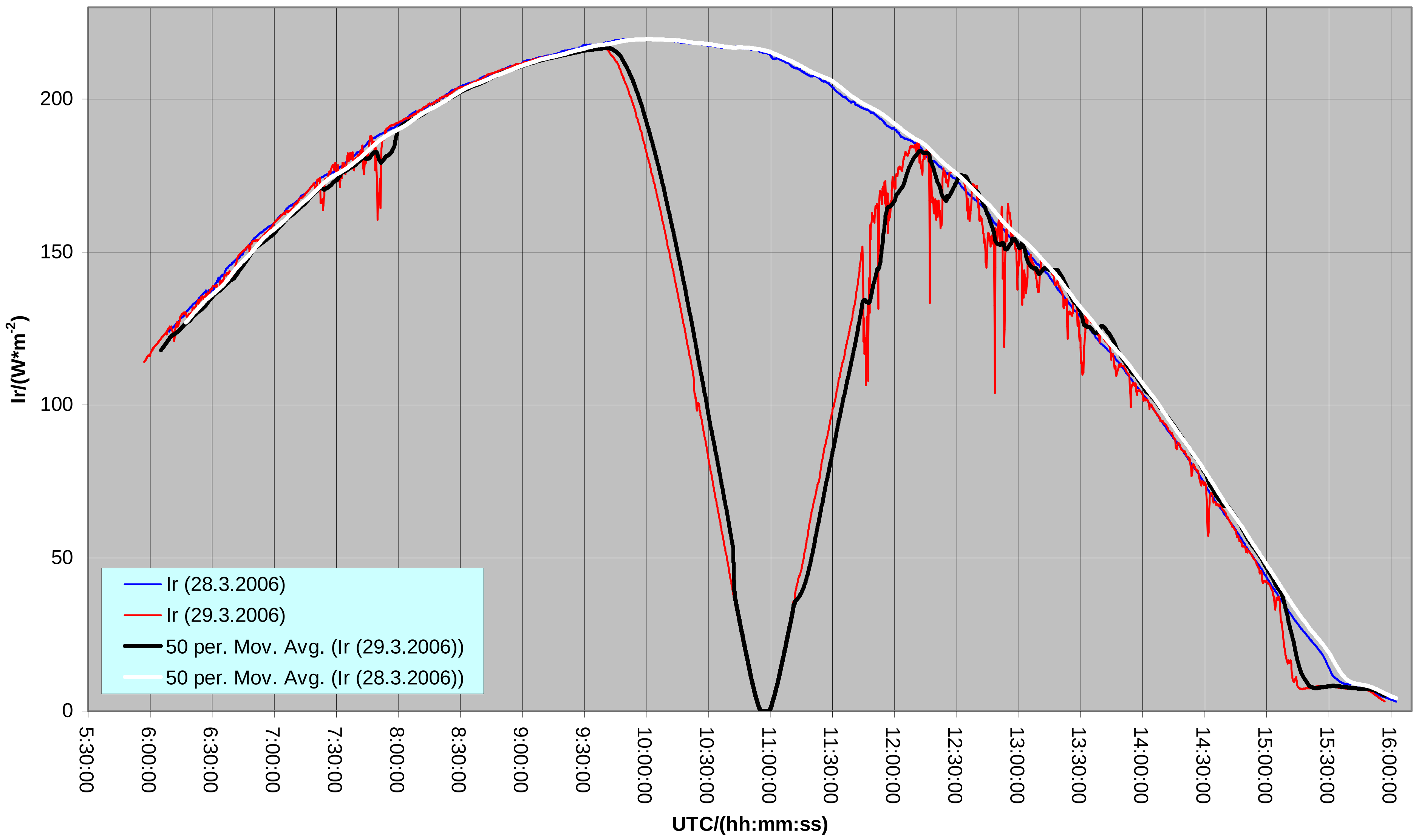
Appendix no. 5: Graph of the Progression of the Intensity of the Global Solar Radiation – Turkey 2006



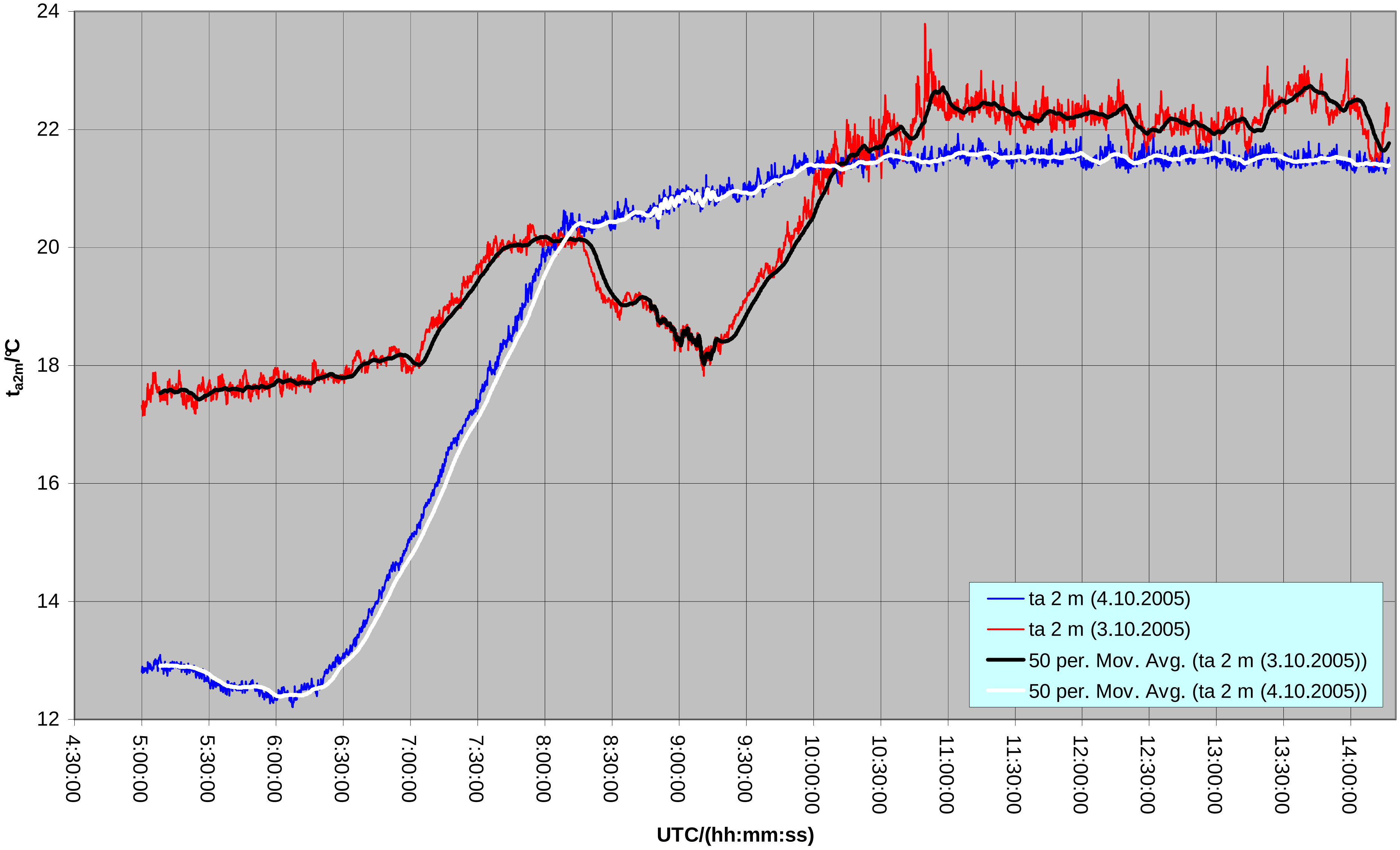
Appendix no. 6: Graph of the Progression of the Intensity of Reflected Solar Radiation from the Earth's Surface – Spain 2005



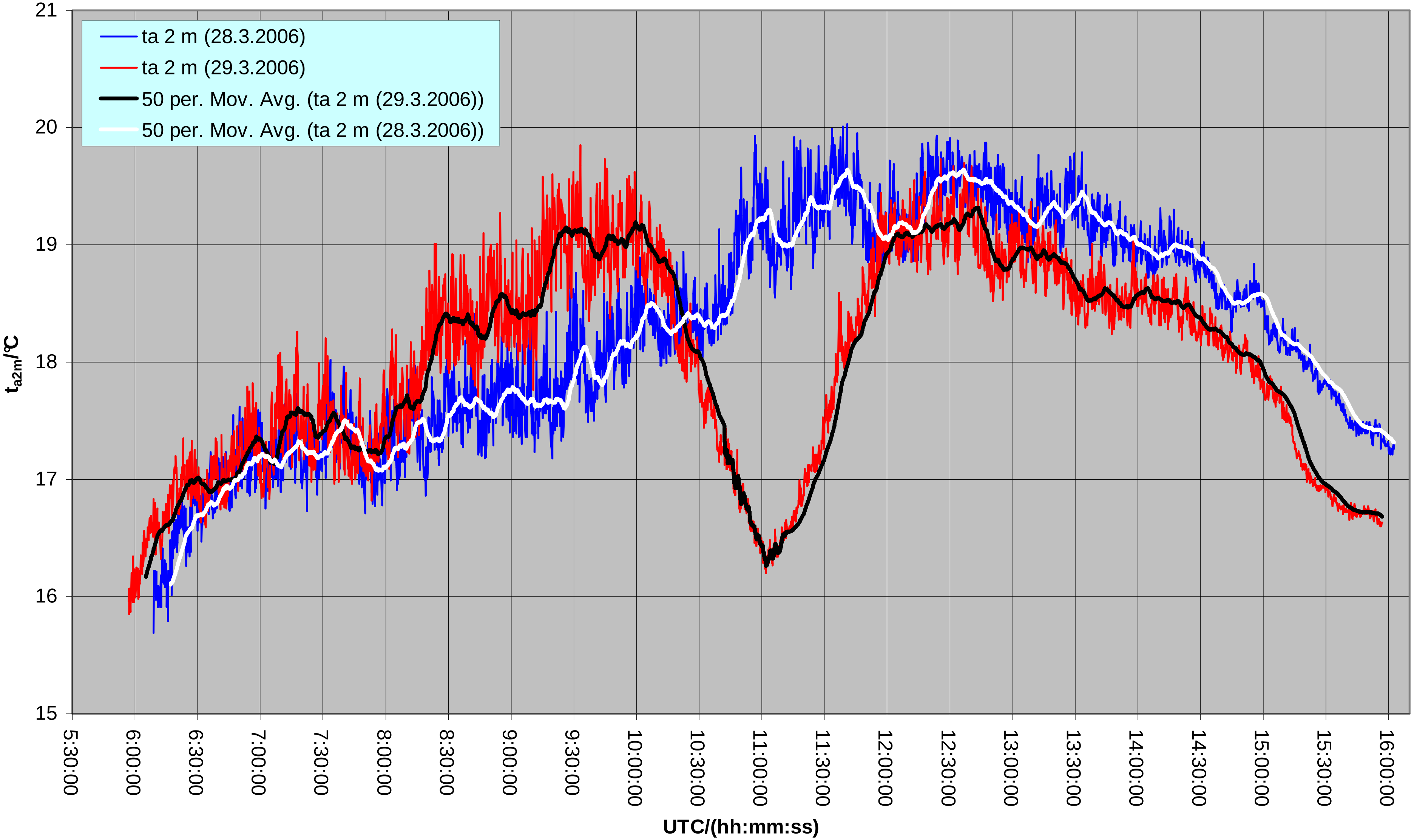
Appendix no. 7: Graph of the Progression of the Intensity of Reflected Solar Radiation from the Earth's Surface – Turkey 2006



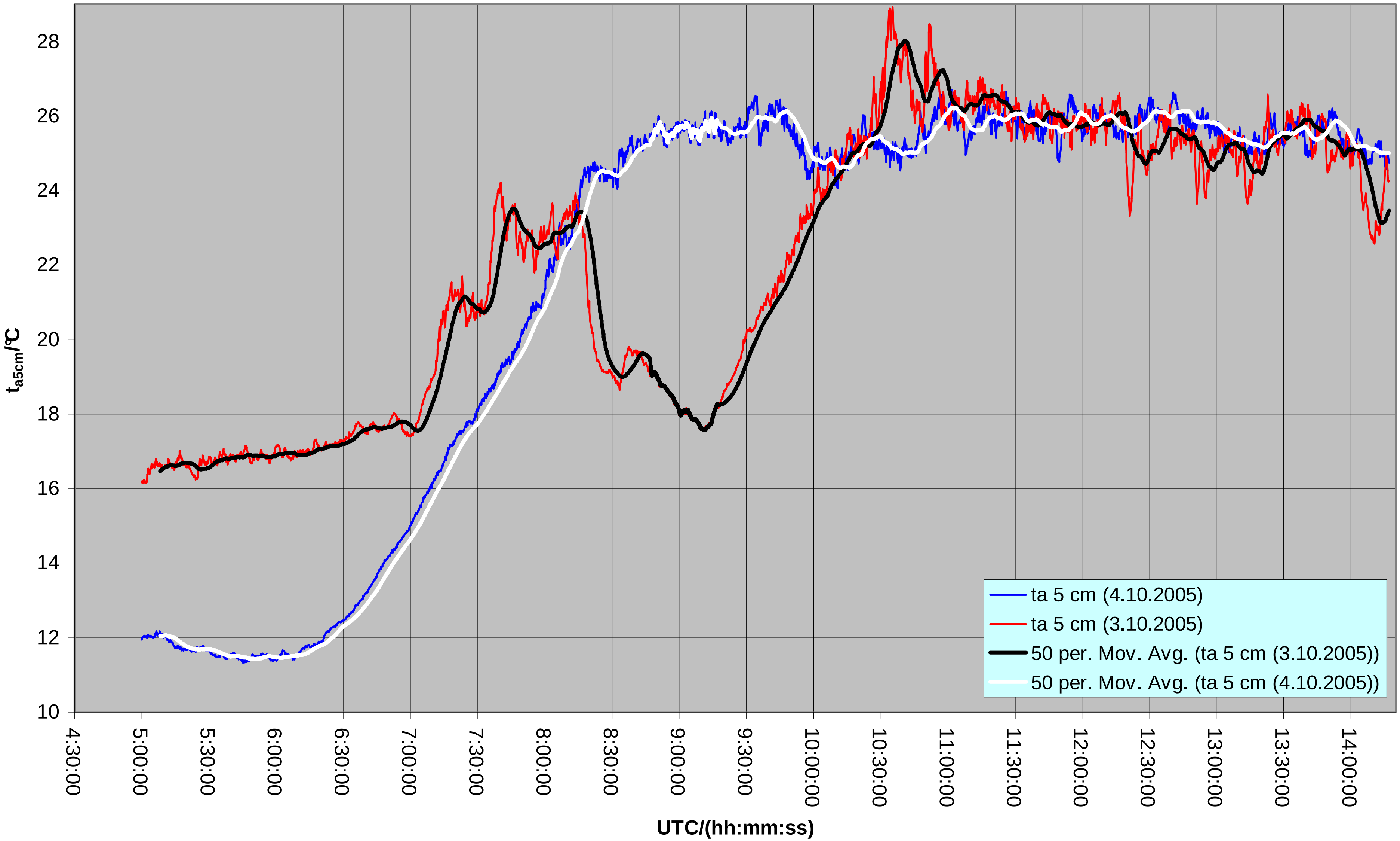
Appendix no. 8: Graph of the Progression of the Air Temperature at 2 m above the Ground – Spain 2005



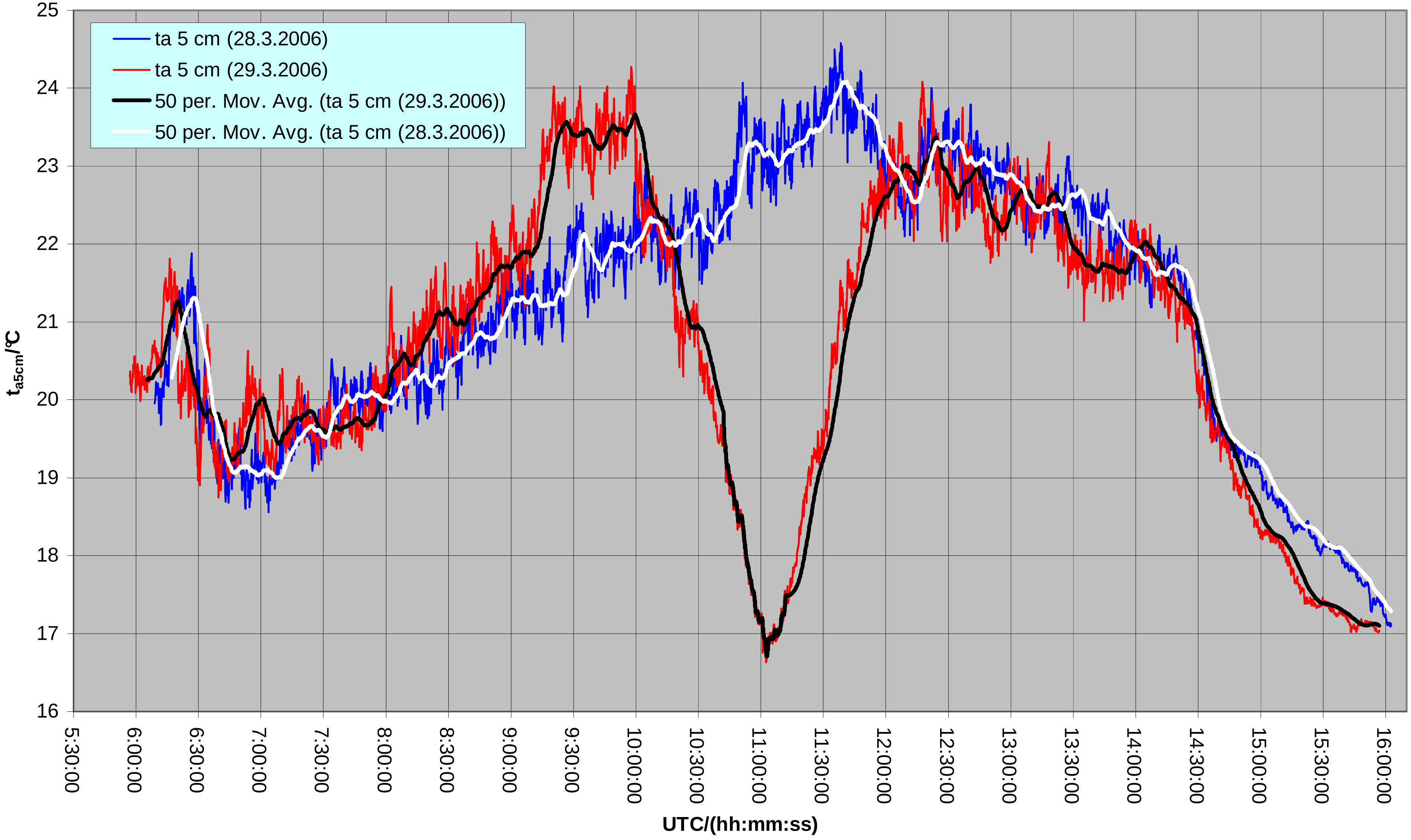
Appendix no. 9: Graph of the Progression of the Air Temperature at 2 m above the Ground – Turkey 2006



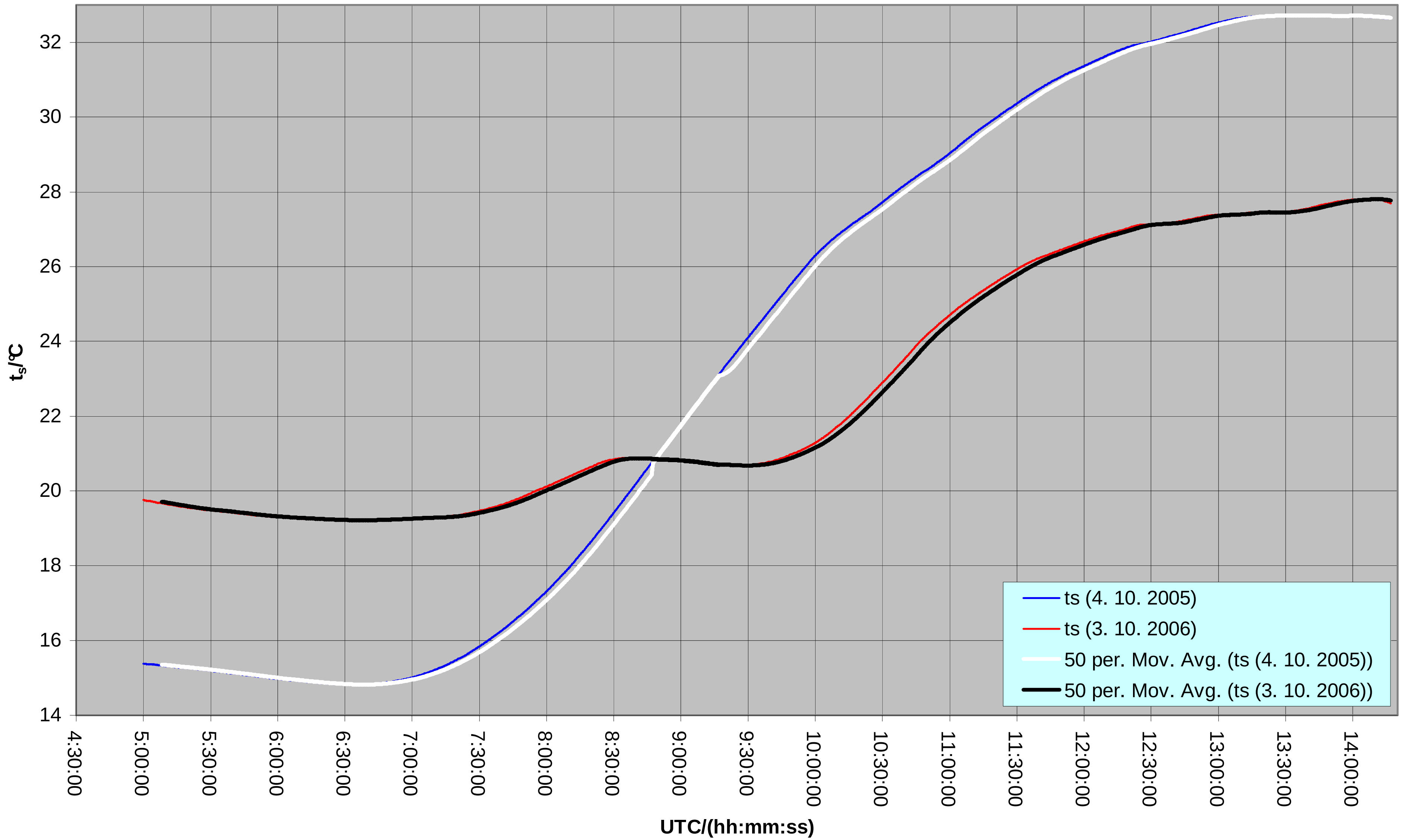
Appendix no. 10: Graph of the Progression of the Air Temperature at 5 cm above the Ground – Spain 2005



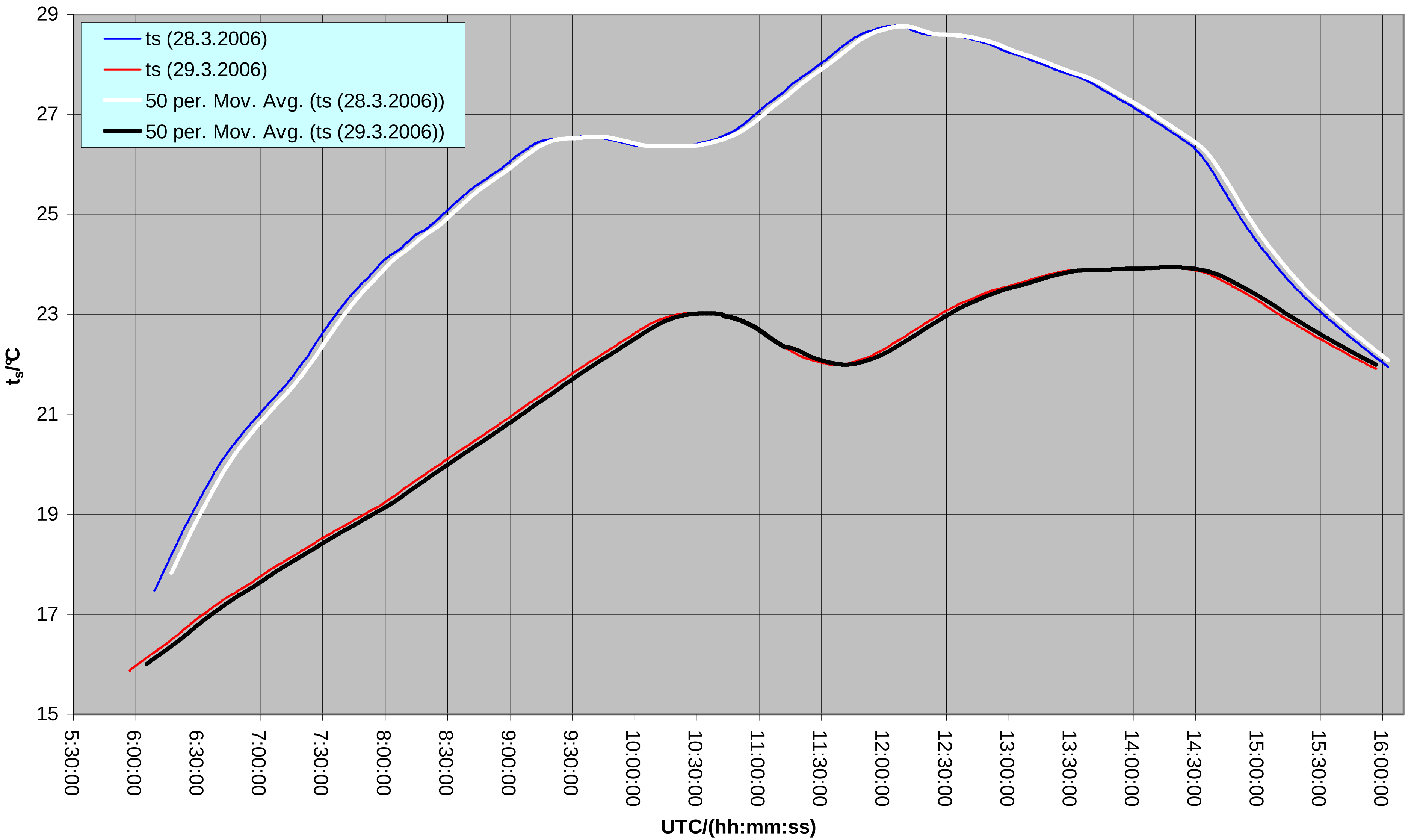
Appendix no. 11: Graph of the Progression of the Air Temperature at 5 cm above the Ground – Turkey 2006



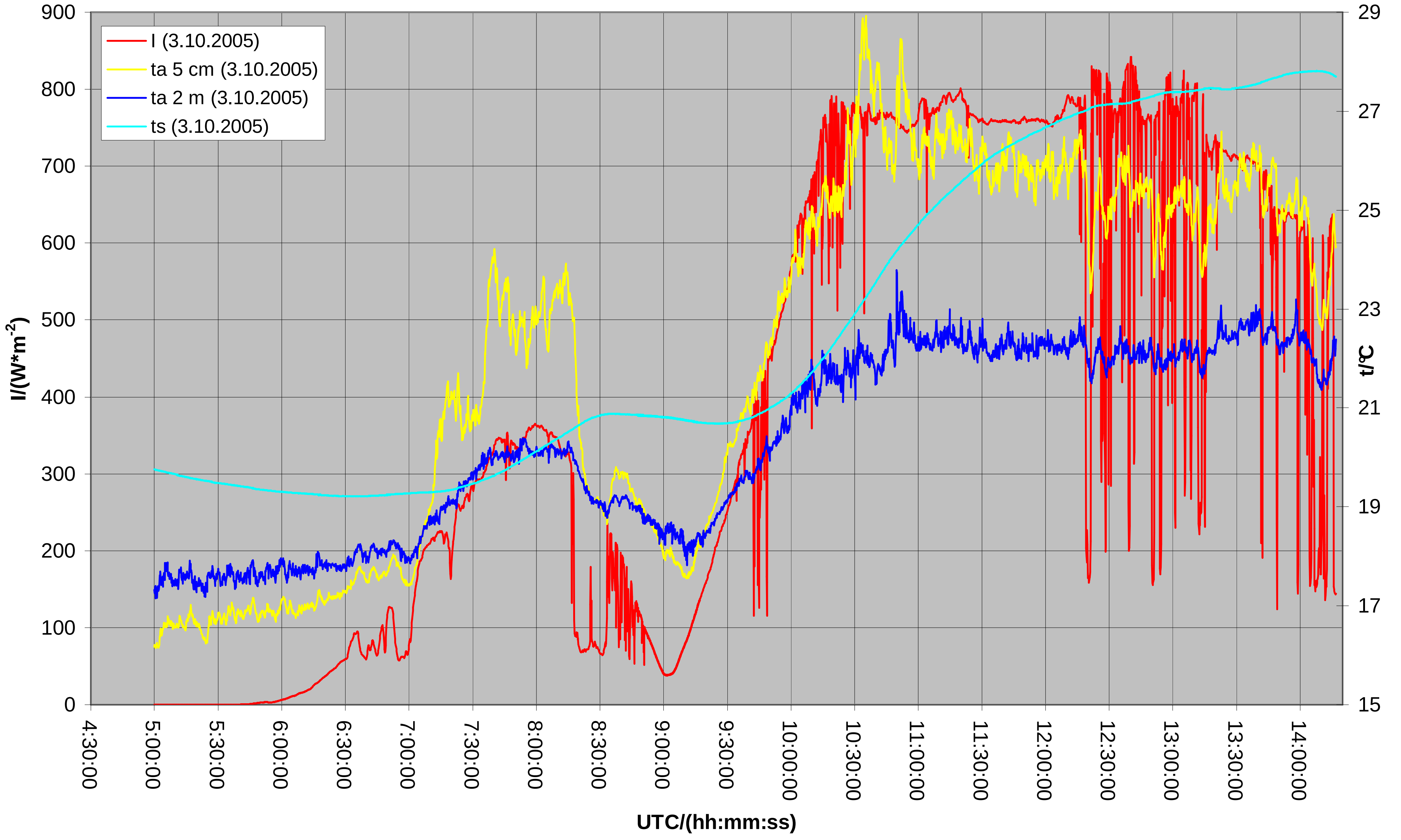
Appendix no. 12: Graph of the Progression of the Soil's Temperature at 5 cm under the Ground – Spain 2005



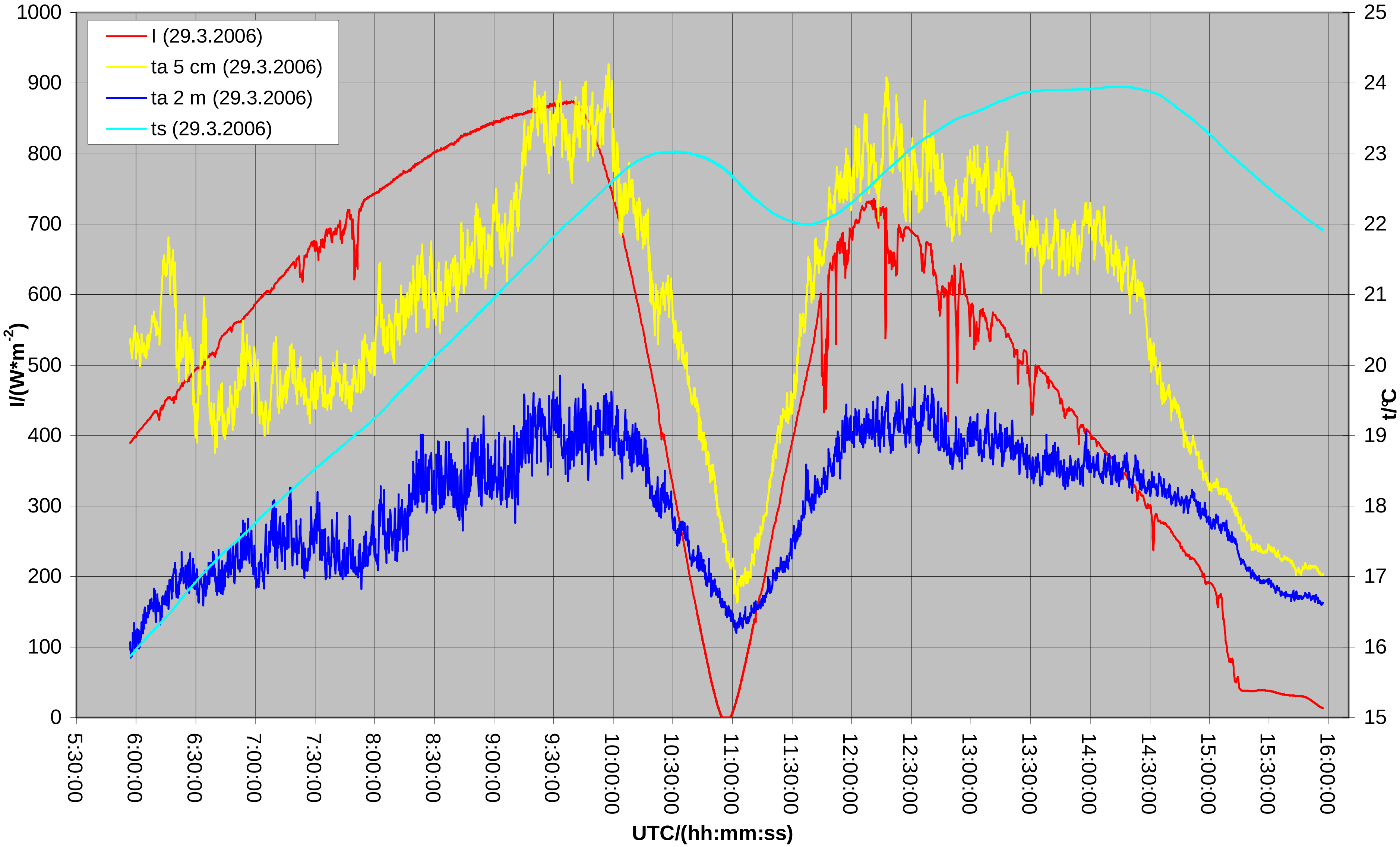
Appendix no. 13: Graph of the Progression of the Soil's Temperature at 5 cm under the Ground – Turkey 2006



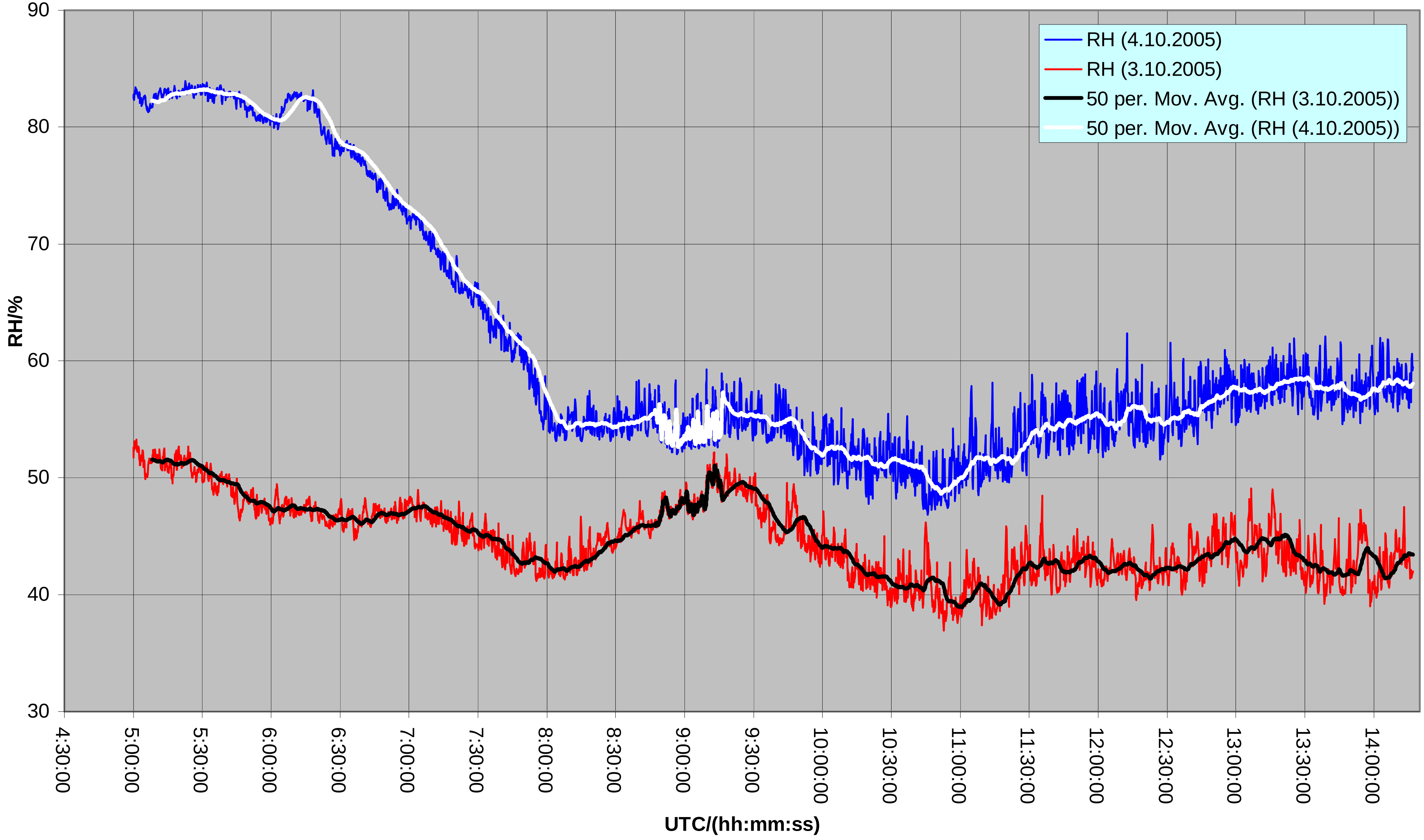
Appendix no. 14: Graph of the Comparision of the Moments of the Minima of the Temperatures and Intensity Global Solar Radiation – Spain 2005



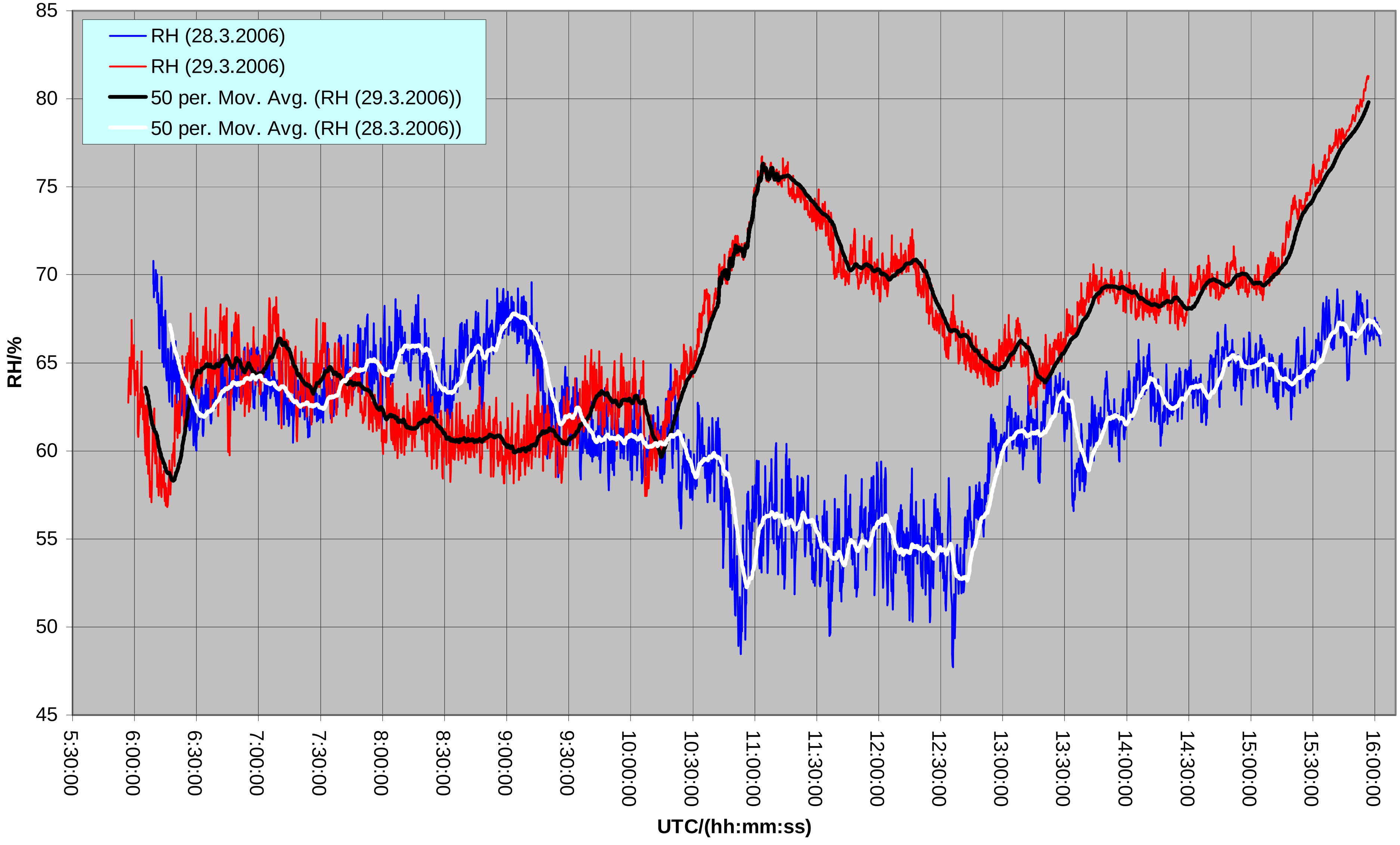
Appendix no. 15: Graph of the Comparision of the Moments of the Minima of the Temperatures and Intensity Global Solar Radiation – Turkey 2006



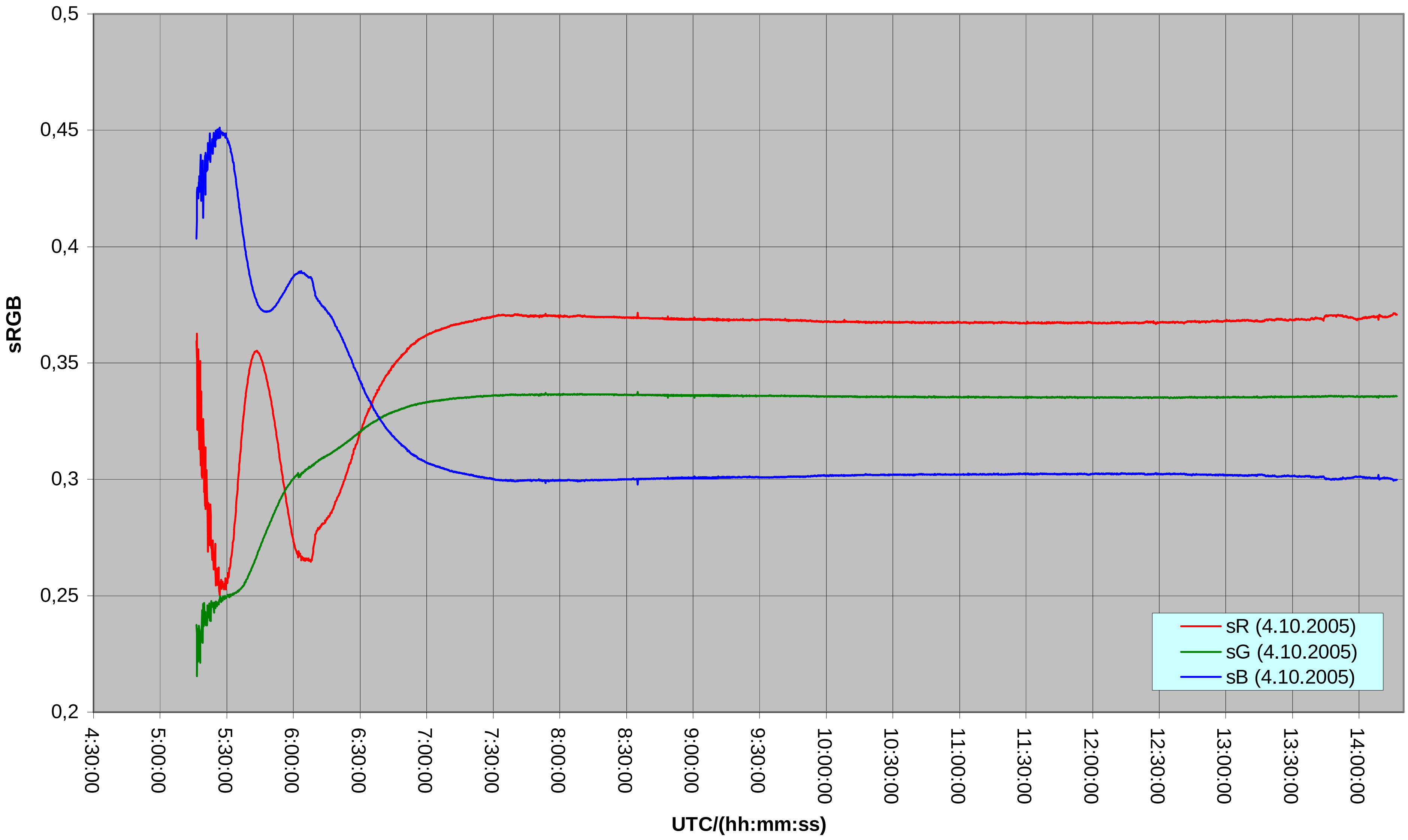
Appendix no. 16: Graph of the Progression of the Air Relative Humidity at 2 m above the Ground – Spain 2005



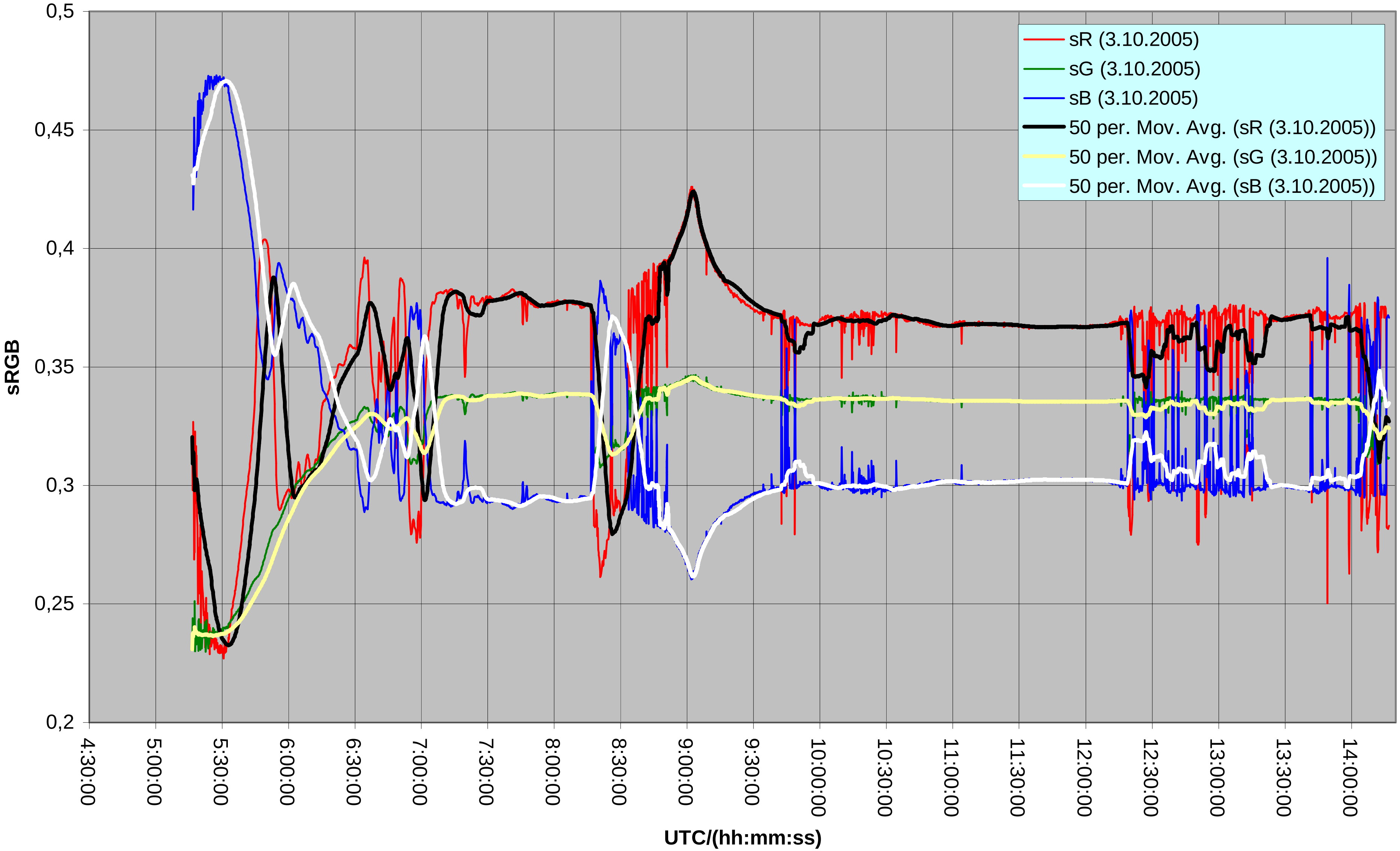
Appendix no. 17: Graph of the Progression of the Air Relative Humidity at 2 m above the Ground – Turkey 2006



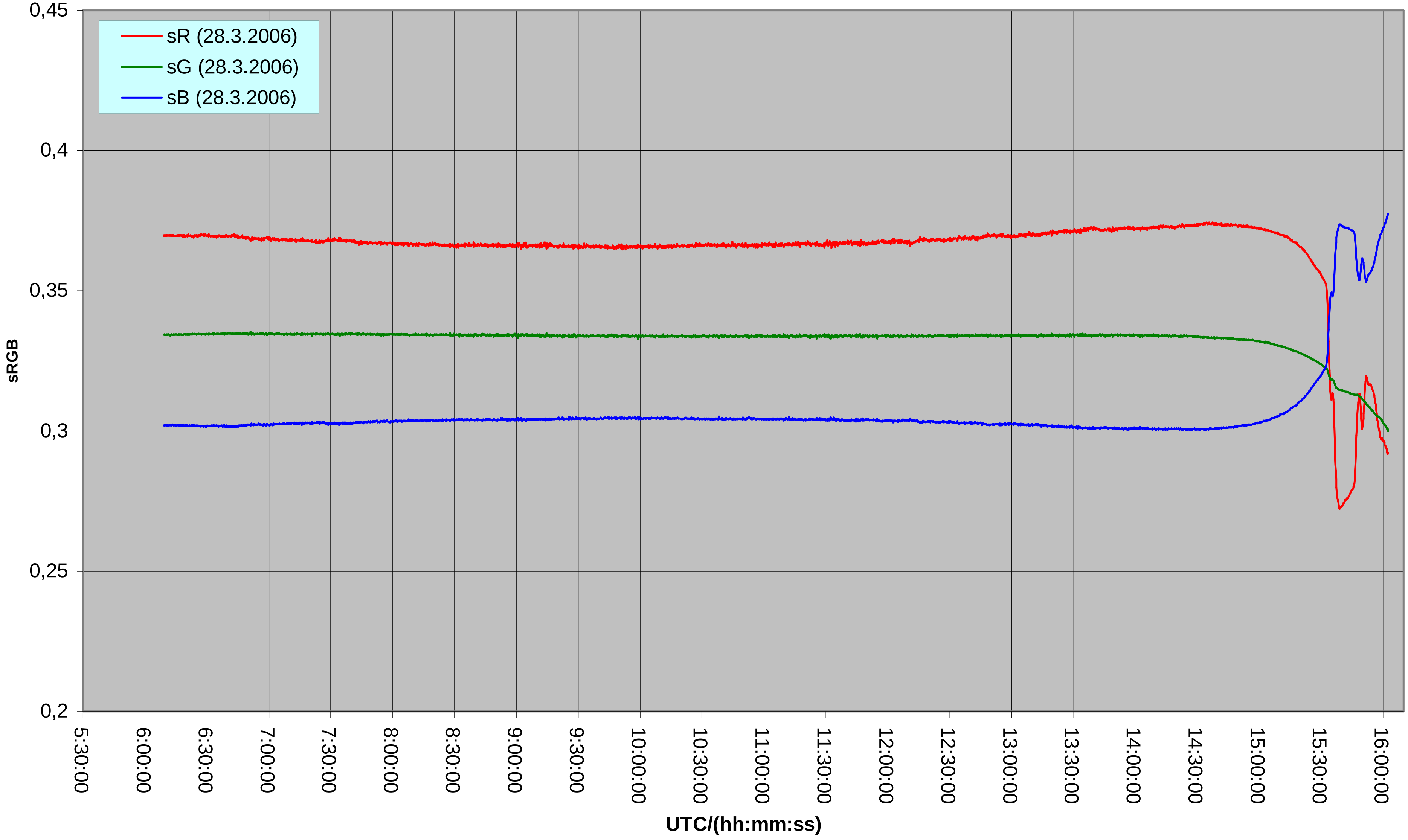
Appendix no. 18: Graph of the Progression of the Colour of the Light in the Colour Space sRGB (4.10.2005) – Spain 2005



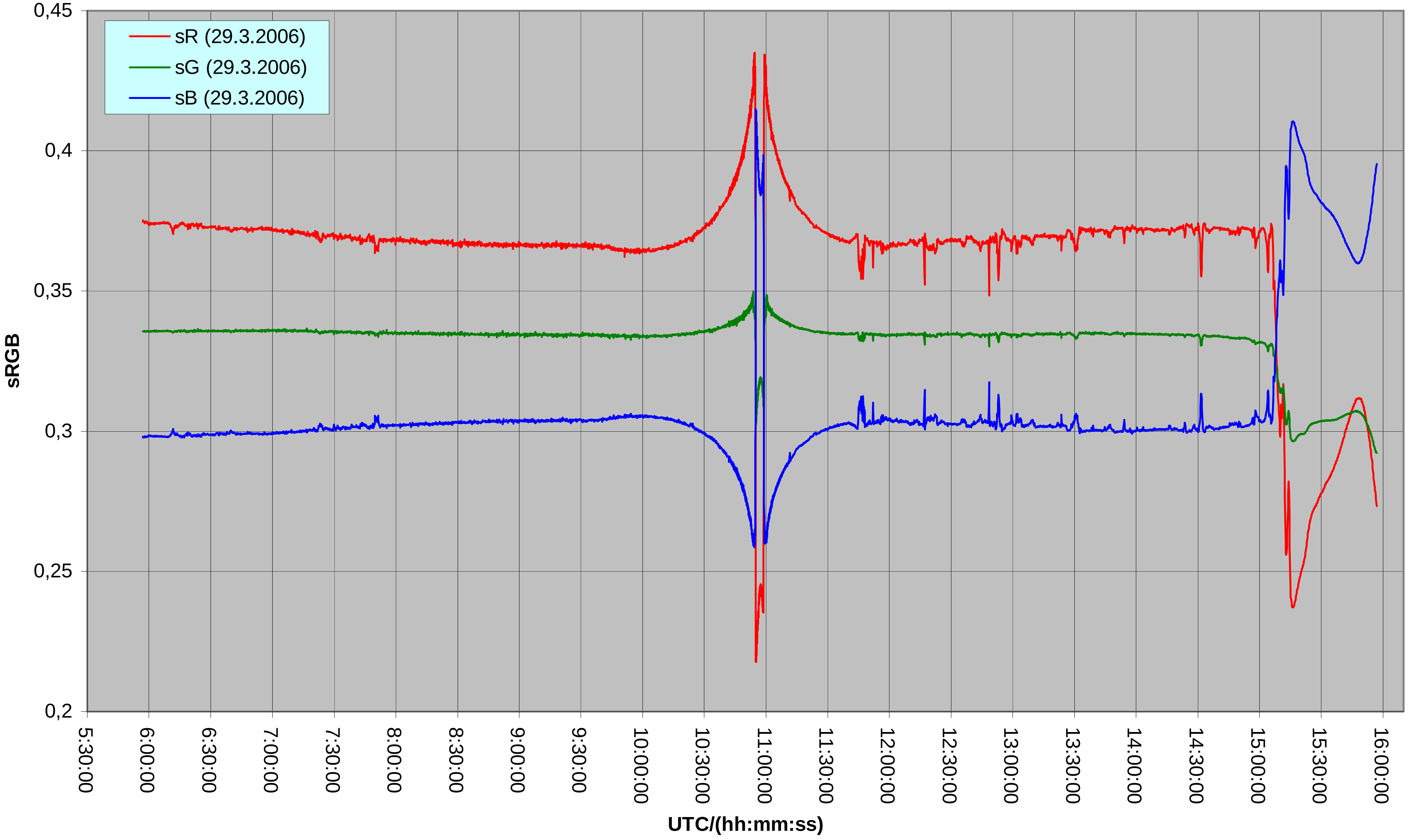
Appendix no. 19: Graph of the Progression of the Colour of the Light in the Colour Space sRGB (3.10.2005) – Spain 2005



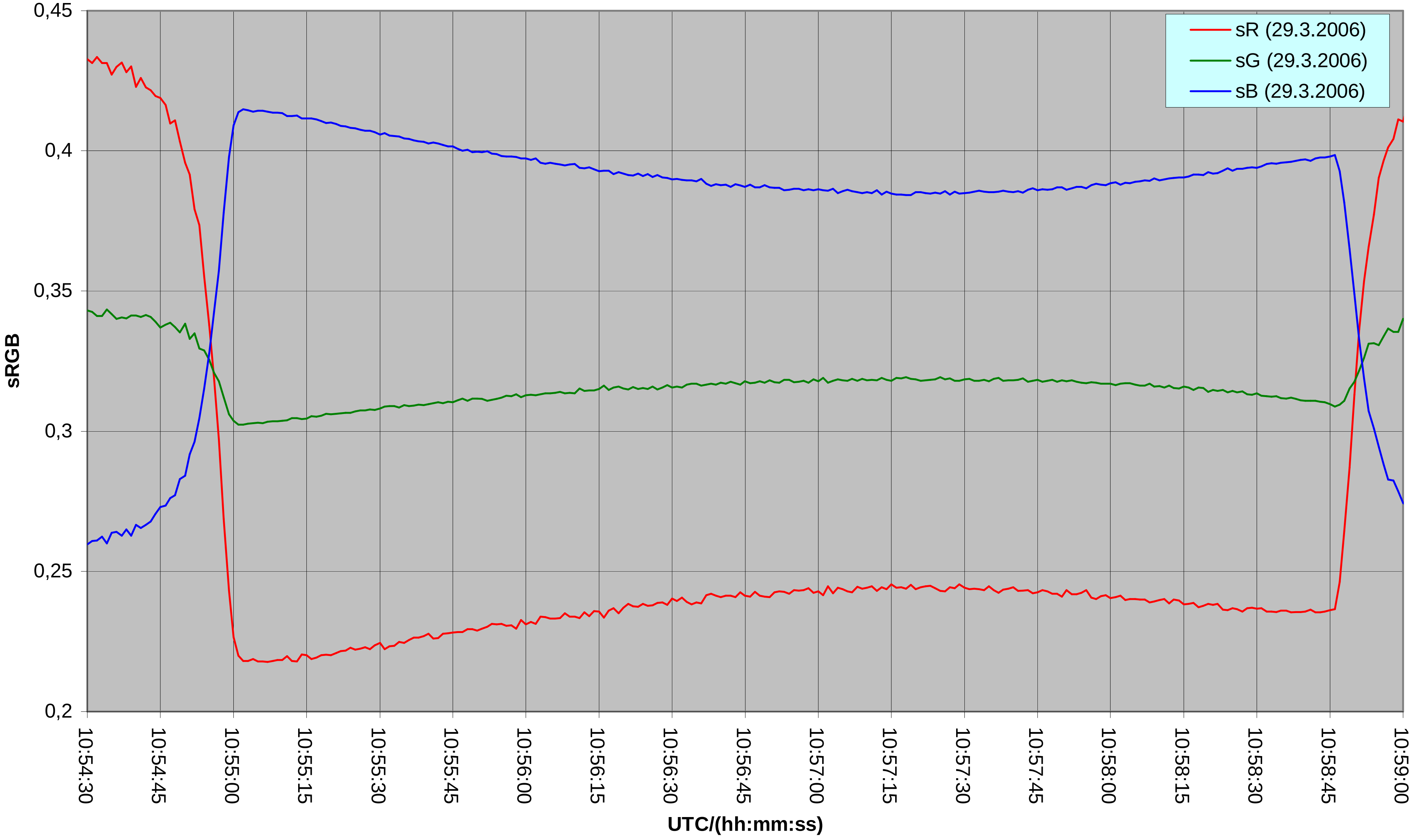
Appendix no. 20: Graph of the Progression of the Colour of the Light in the Colour Space sRGB (28.3.2006) – Turkey 2006



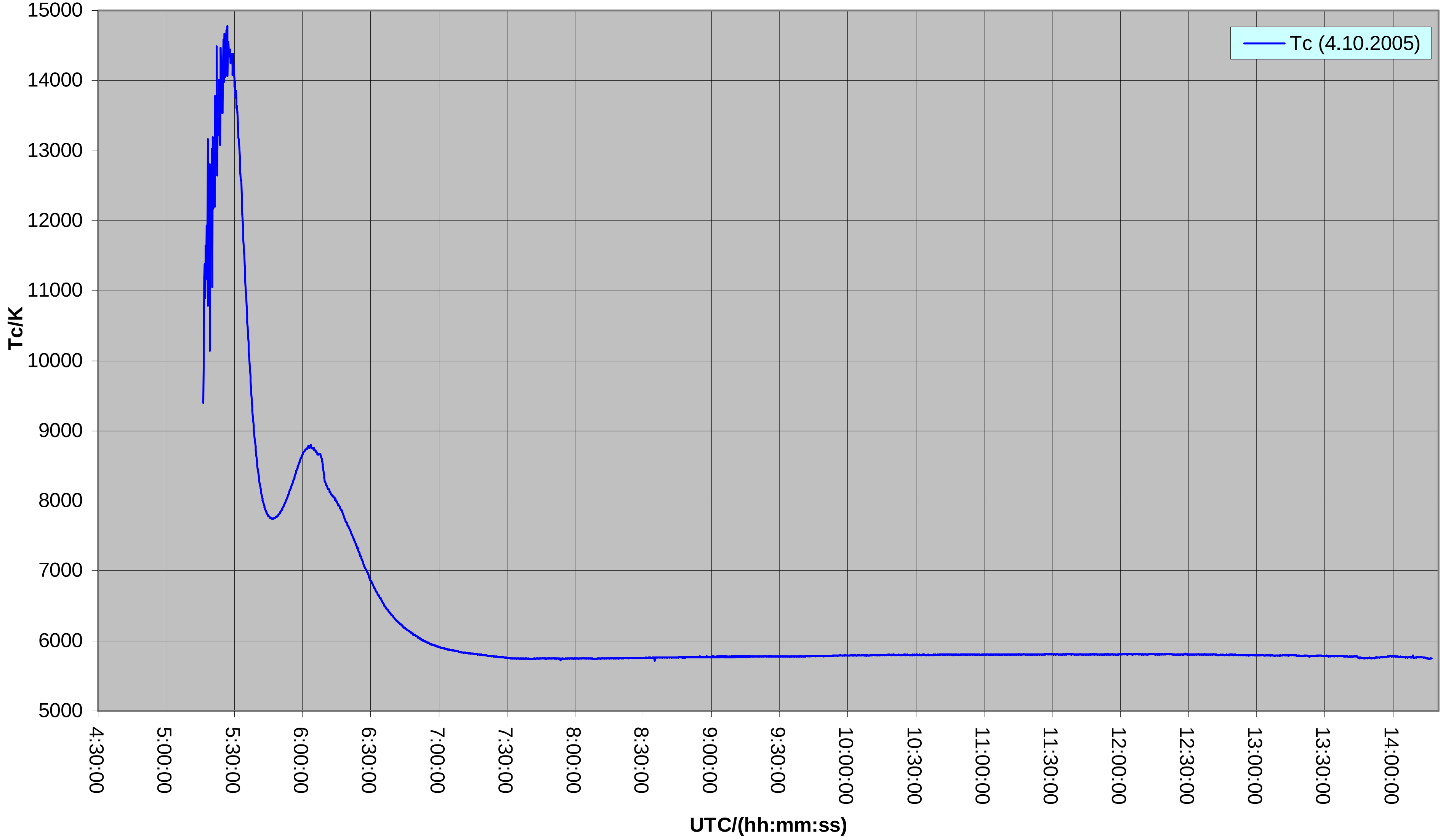
Appendix no. 21: Graph of the Progression of the Colour of the Light in the Colour Space sRGB (29.3.2006) – Turkey 2006



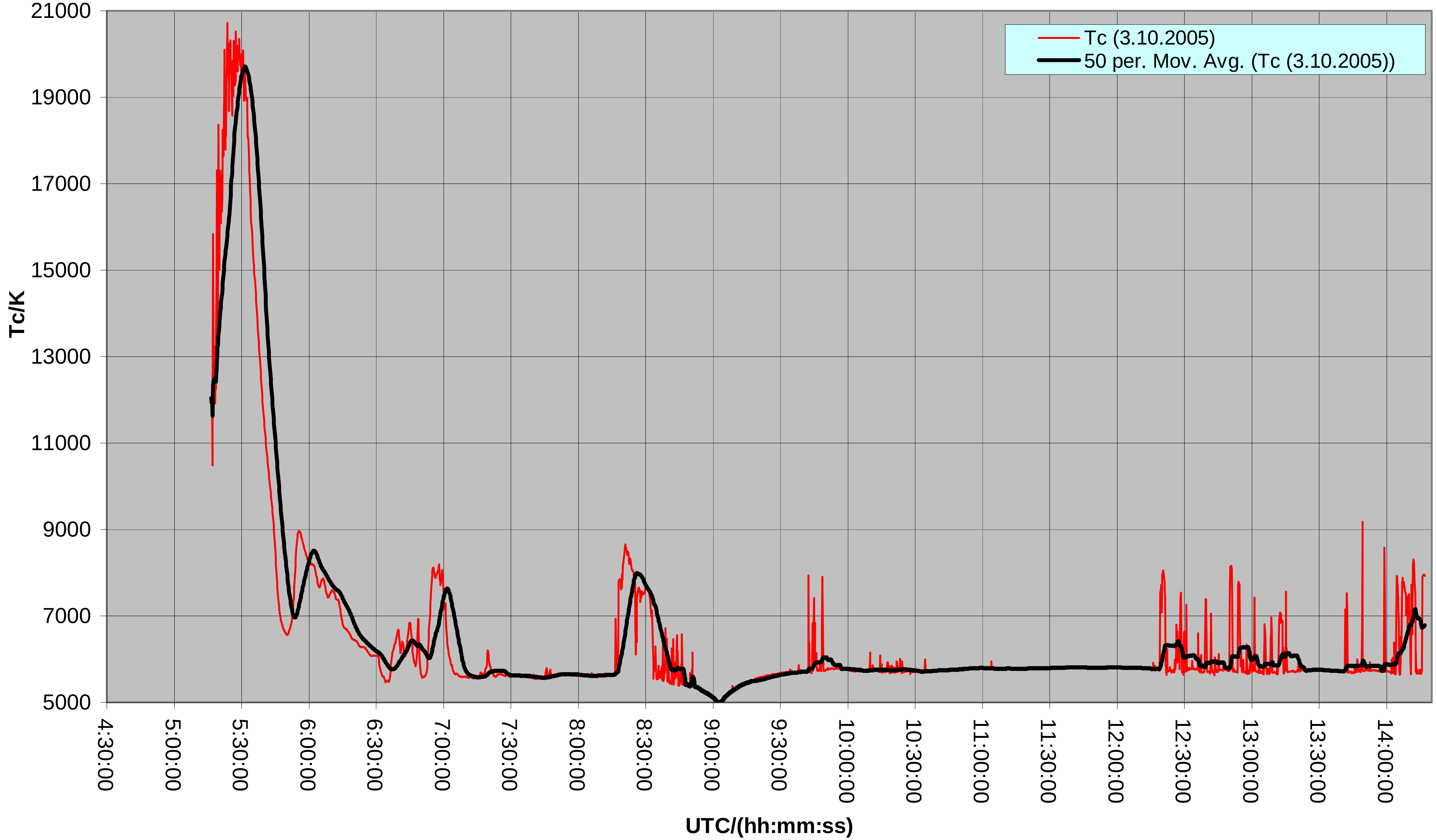
Appendix no. 22: Graph of the Progression of the Colour of the Light in the Colour Space sRGB during Total Phase of the Solar Eclipse



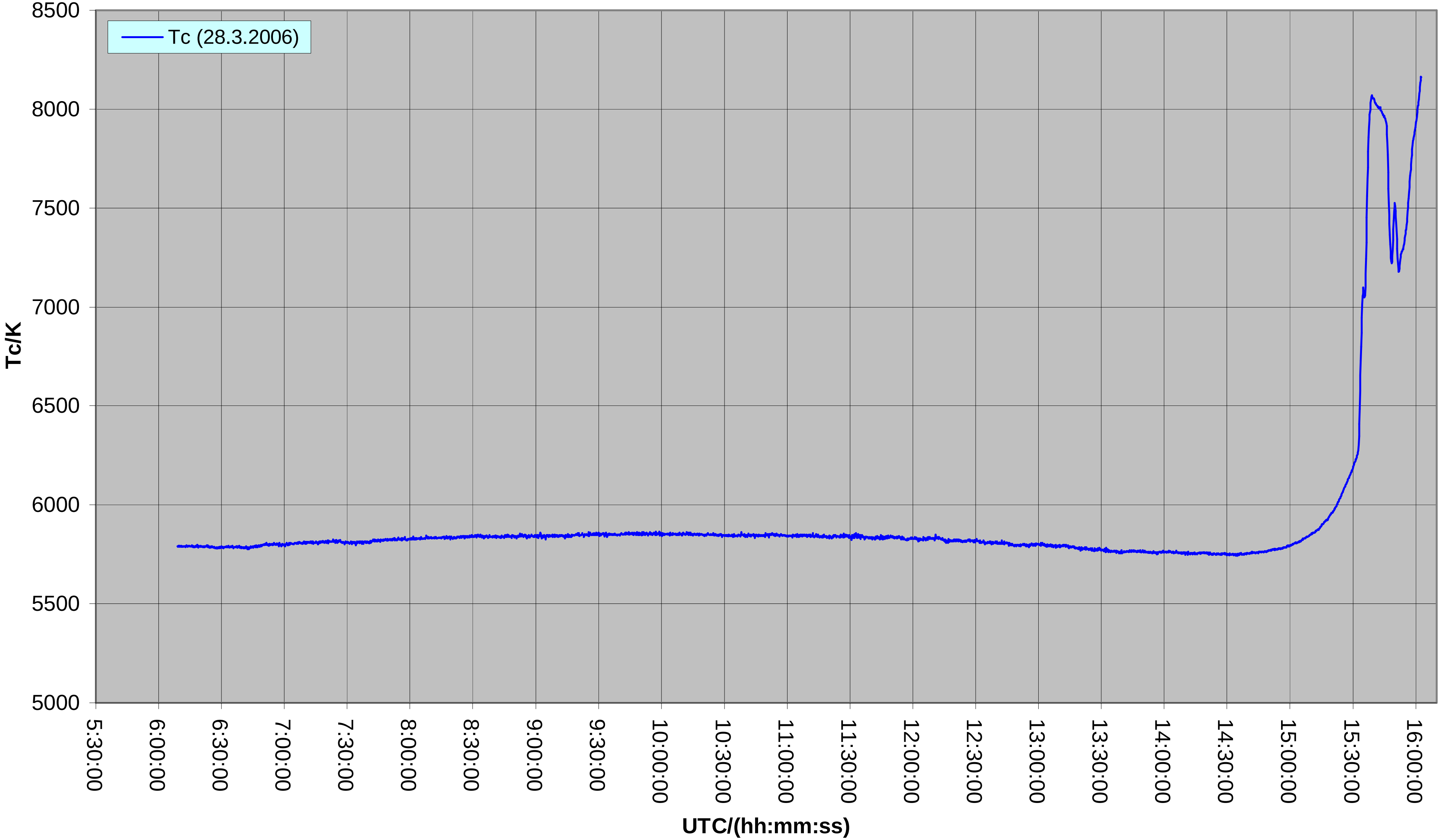
Appendix no. 23: Graph of the Progression of the Correlated Colour Temperature of the Solar Radiation (4.10.2005) – Spain 2005



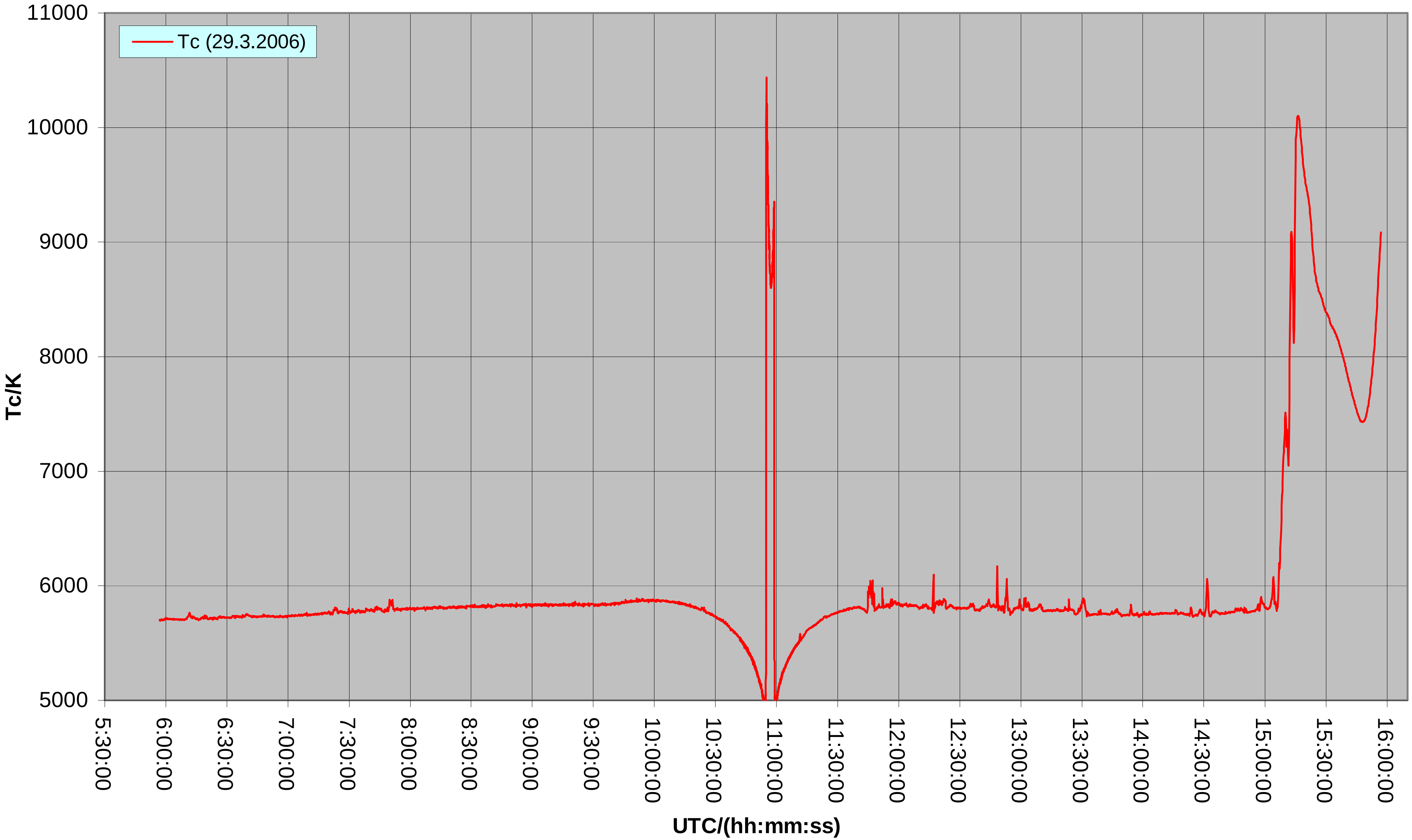
Appendix no. 24: Graph of the Progression of the Correlated Colour Temperature of the Solar Radiation (3.10.2005) – Spain 2005



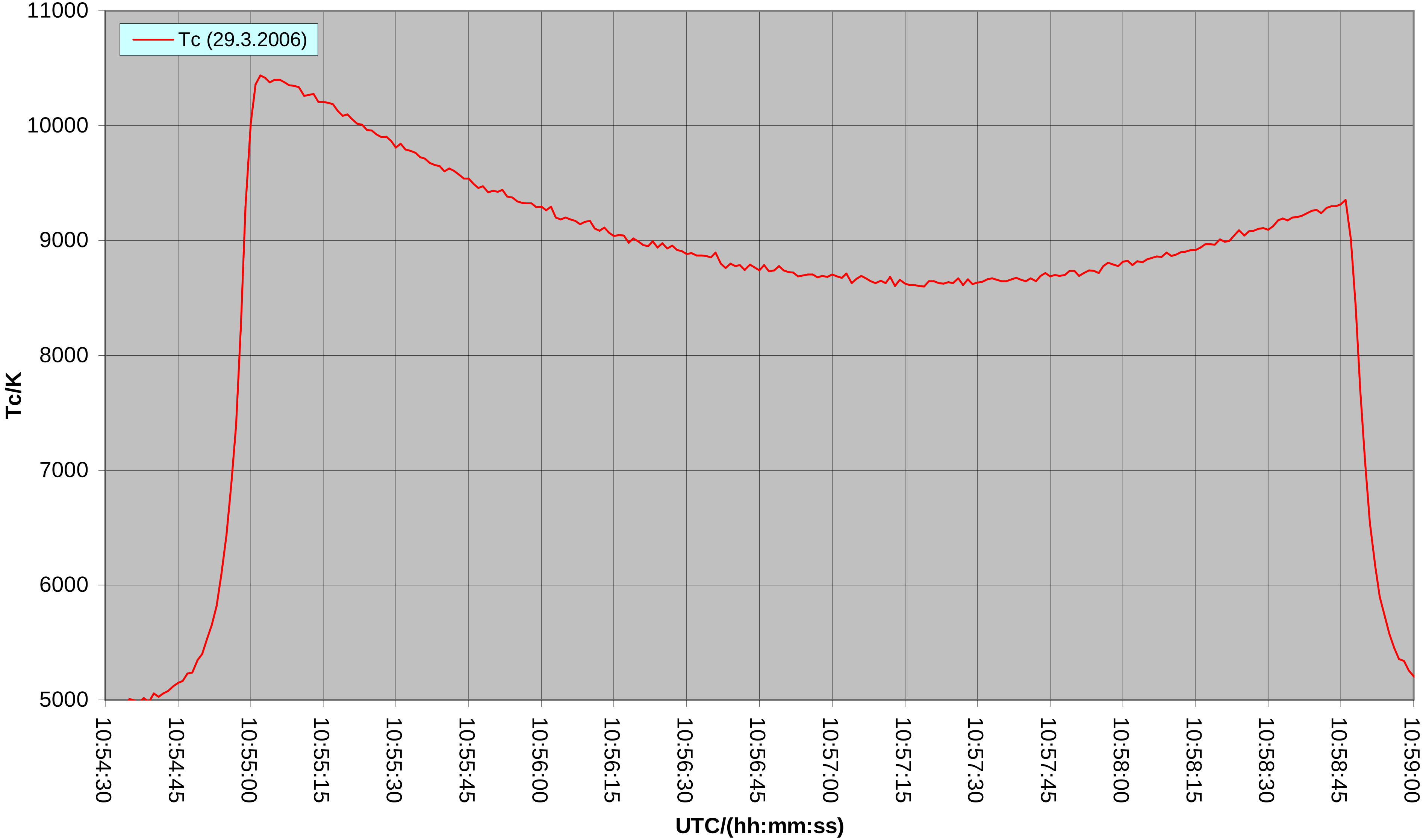
Appendix no. 25: Graph of the Progression of the Correlated Colour Temperature of the Solar Radiation (28.3.2006) – Turkey 2006



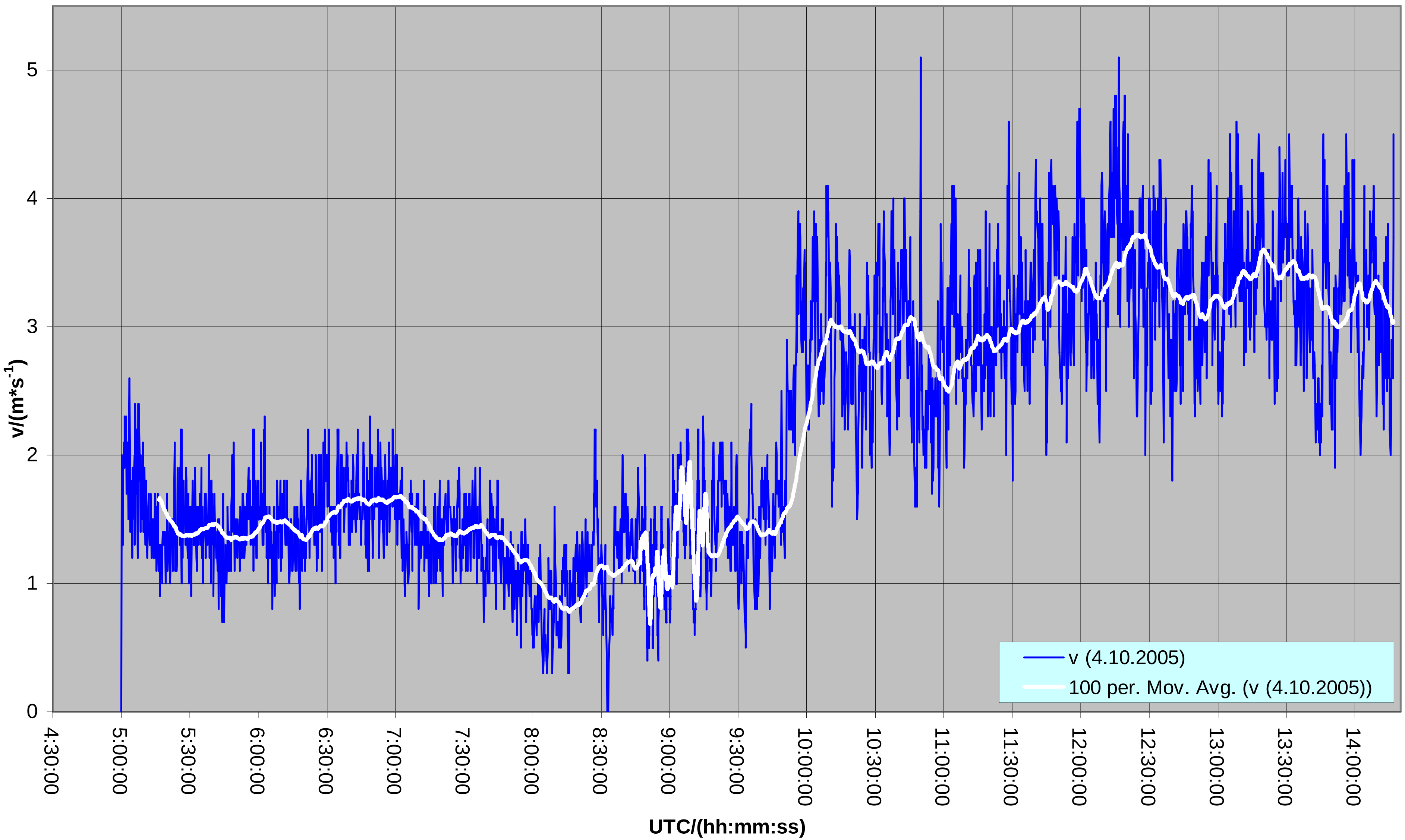
Appendix no. 26: Graph of the Progression of the Correlated Colour Temperature of the Solar Radiation (29.3.2006) – Turkey 2006



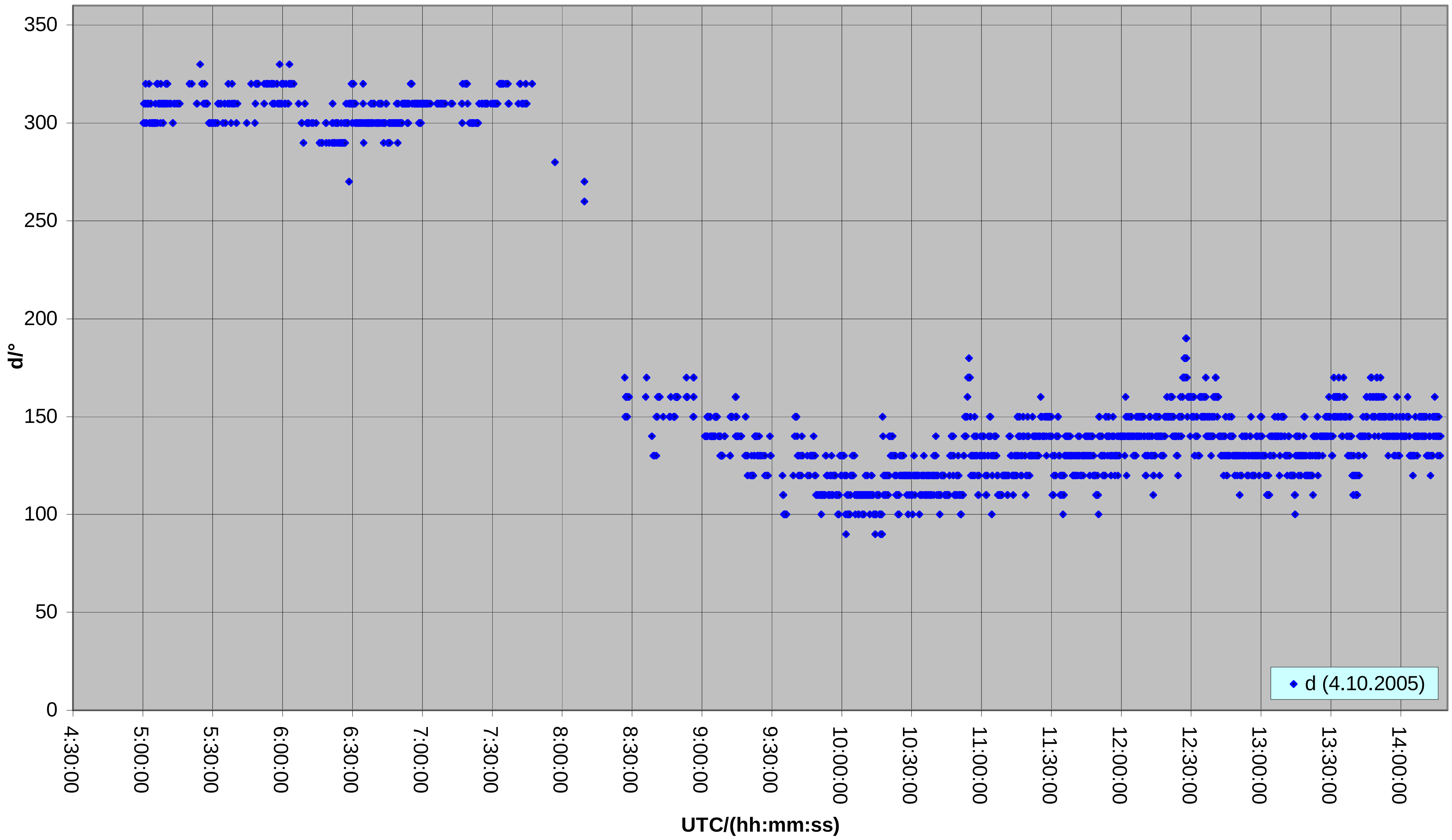
Appendix no. 27: Graph of the Progression of the Correlated Colour Temperature during Total Phase of the Solar Eclipse



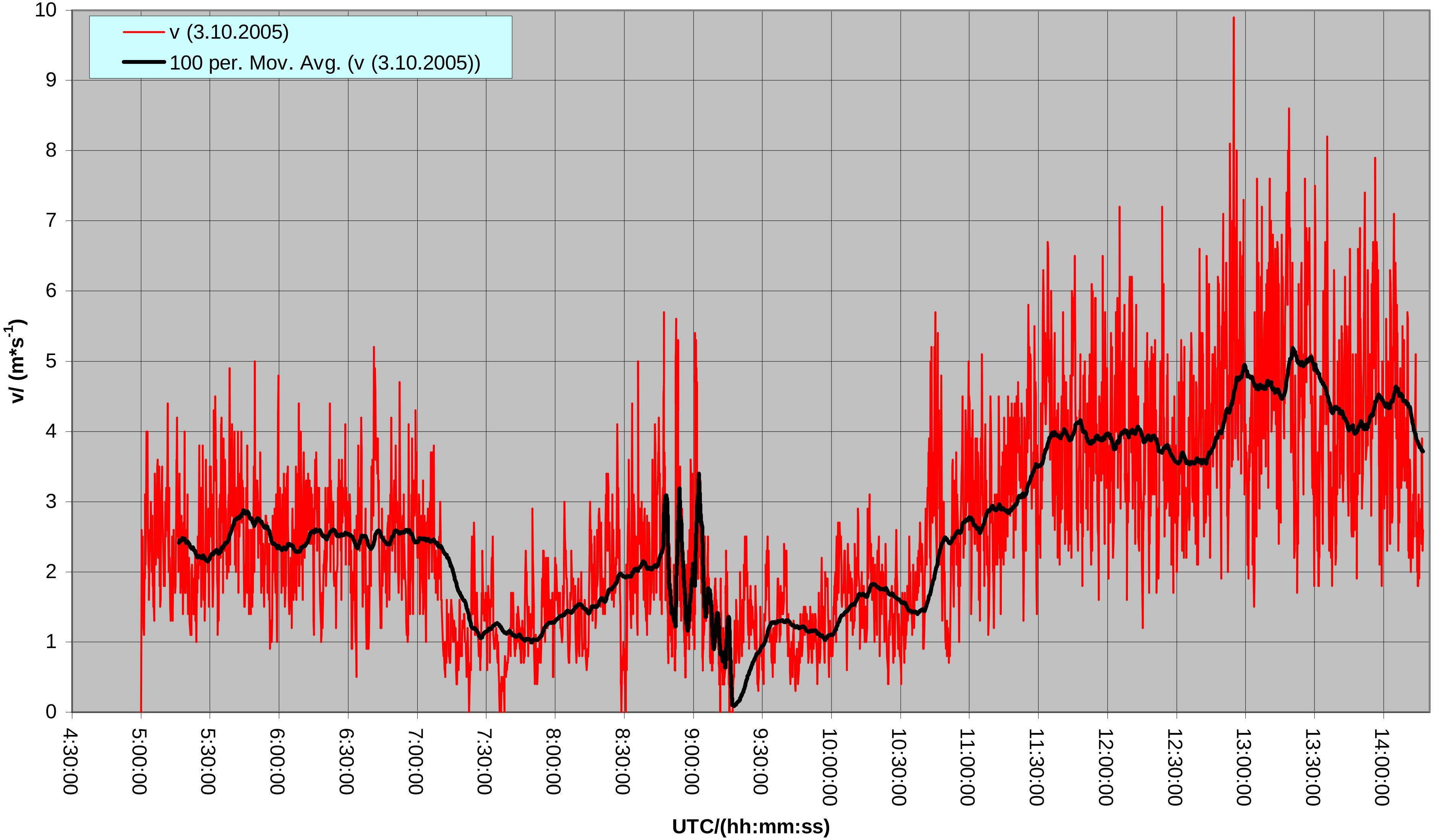
Appendix no. 28: Graph of the Progression of the Wind Speed (4.10.2005) – Spain 2005



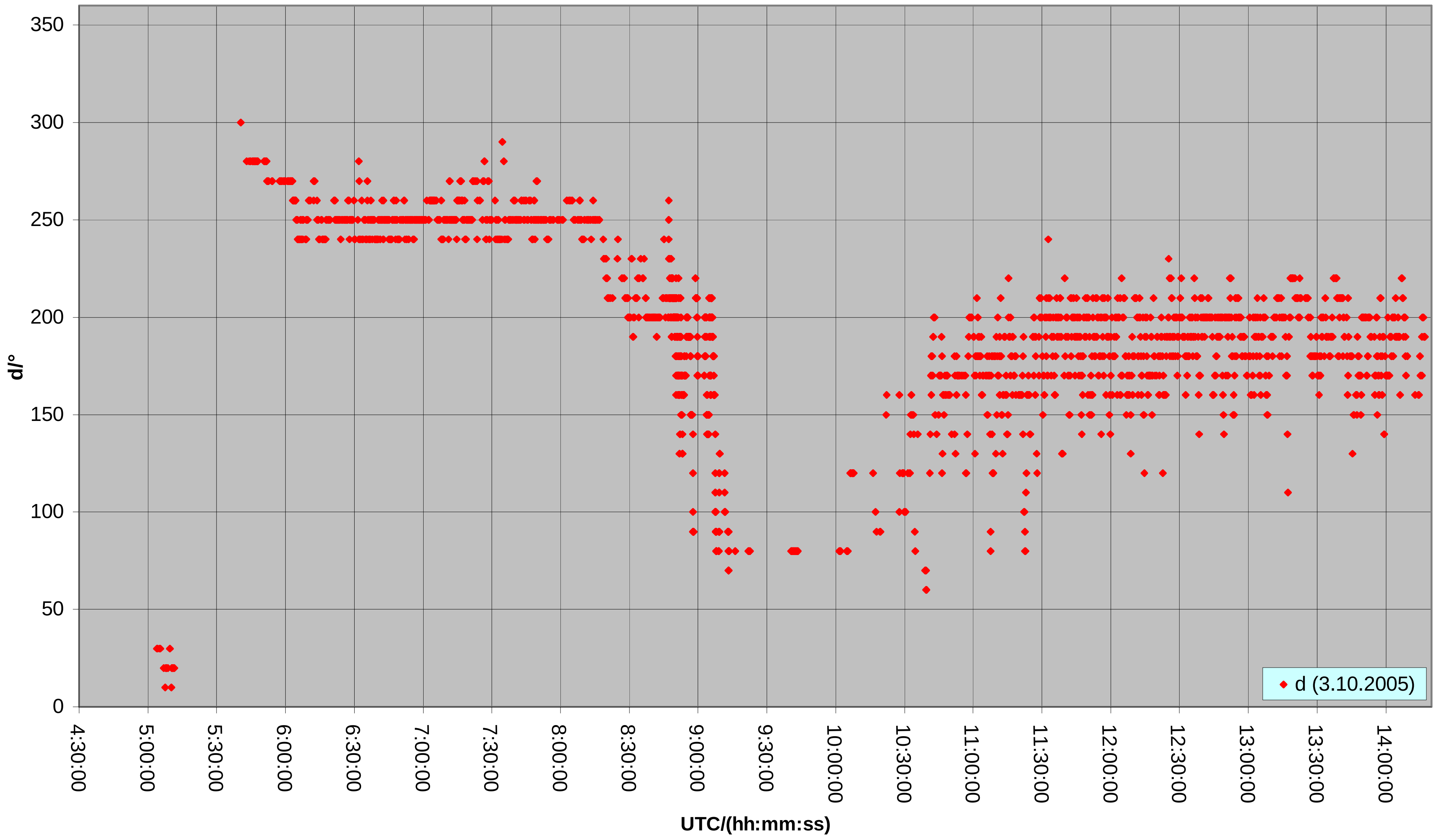
Appendix no. 29: Graph of the Progression of the Wind Direction (4.10.2005) – Spain 2005



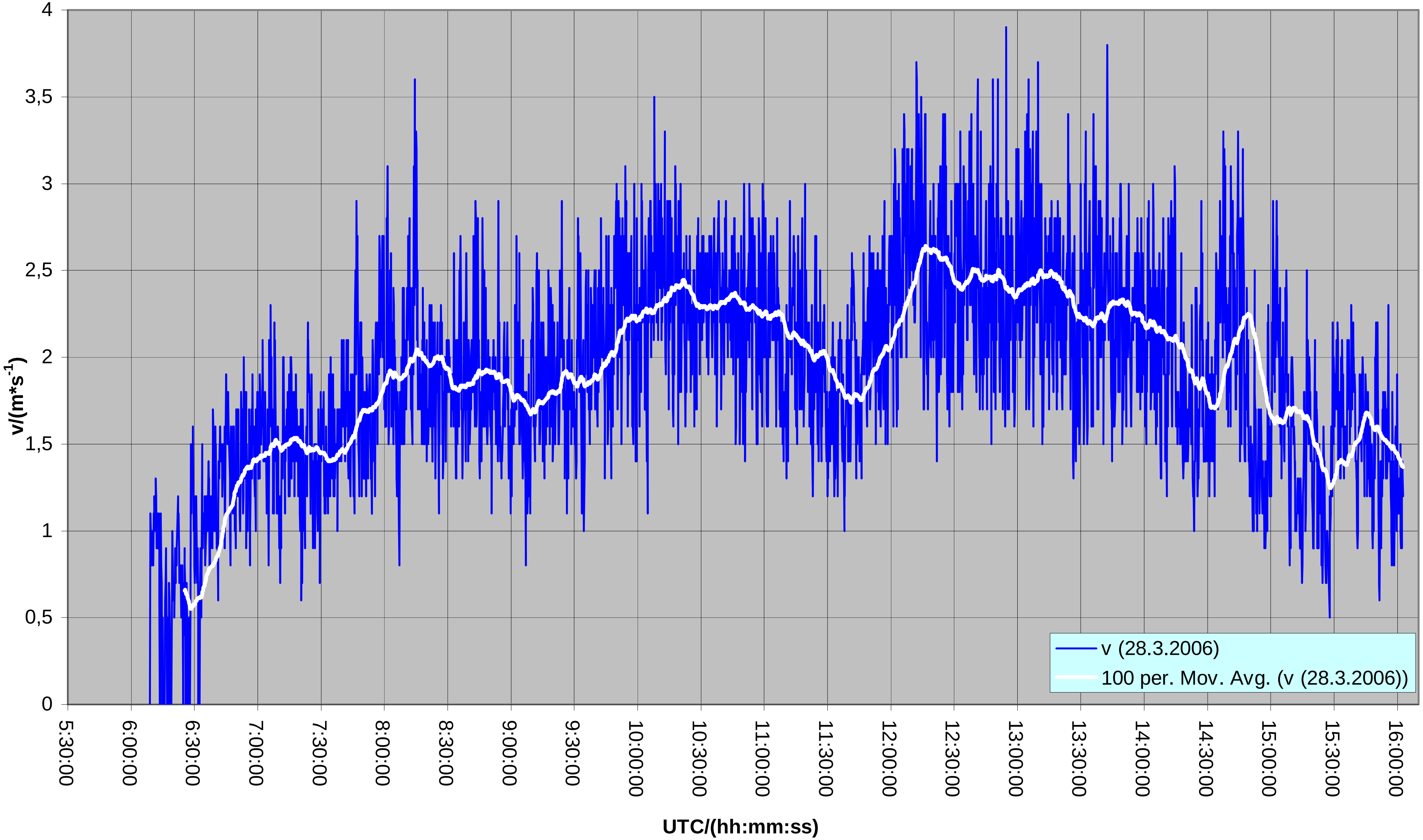
Appendix no. 30: Graph of the Progression of the Wind Speed (3.10.2005) – Spain 2005



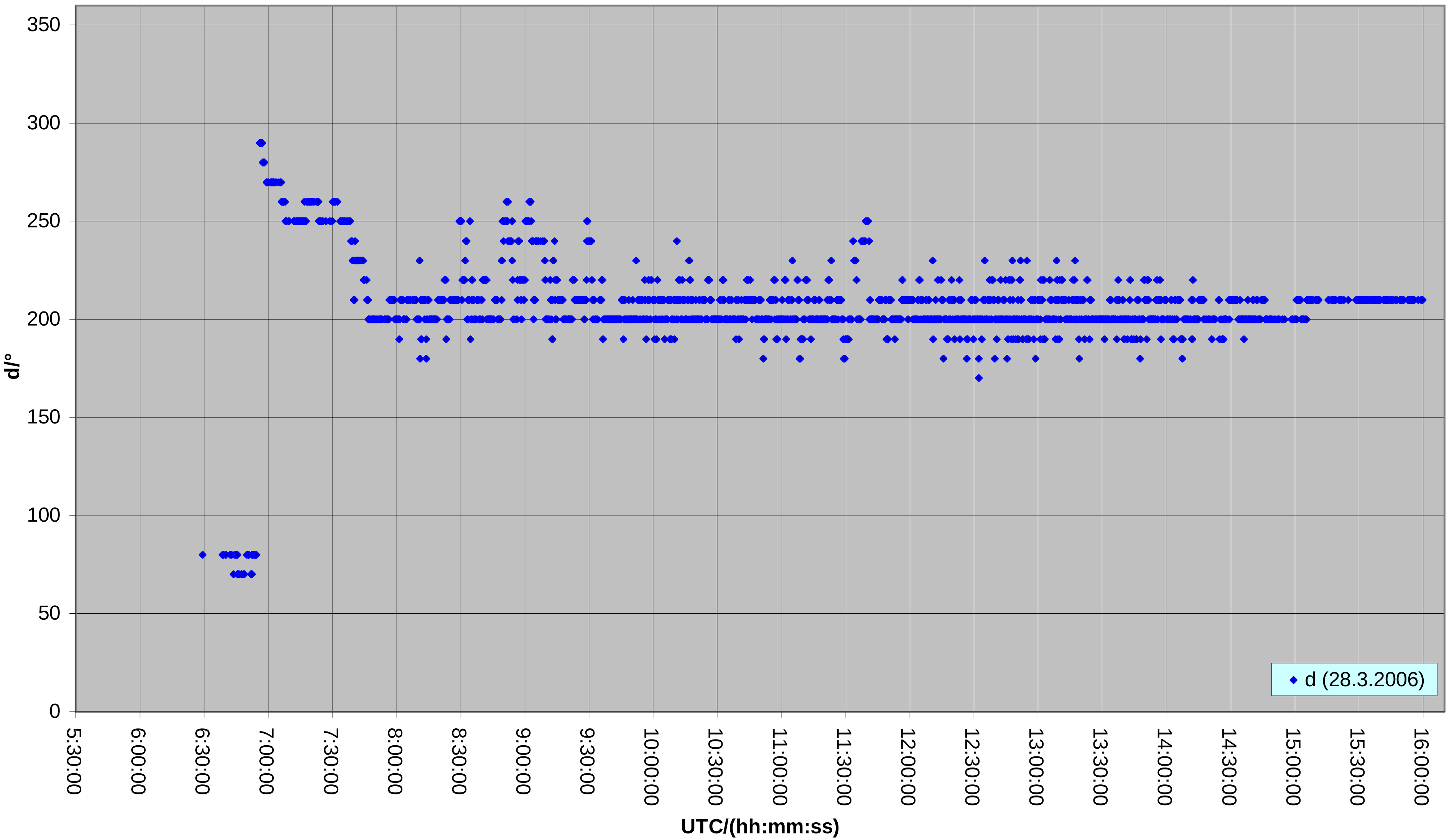
Appendix no. 31: Graph of the Progression of the Wind Direction (3.10.2005) – Spain 2005



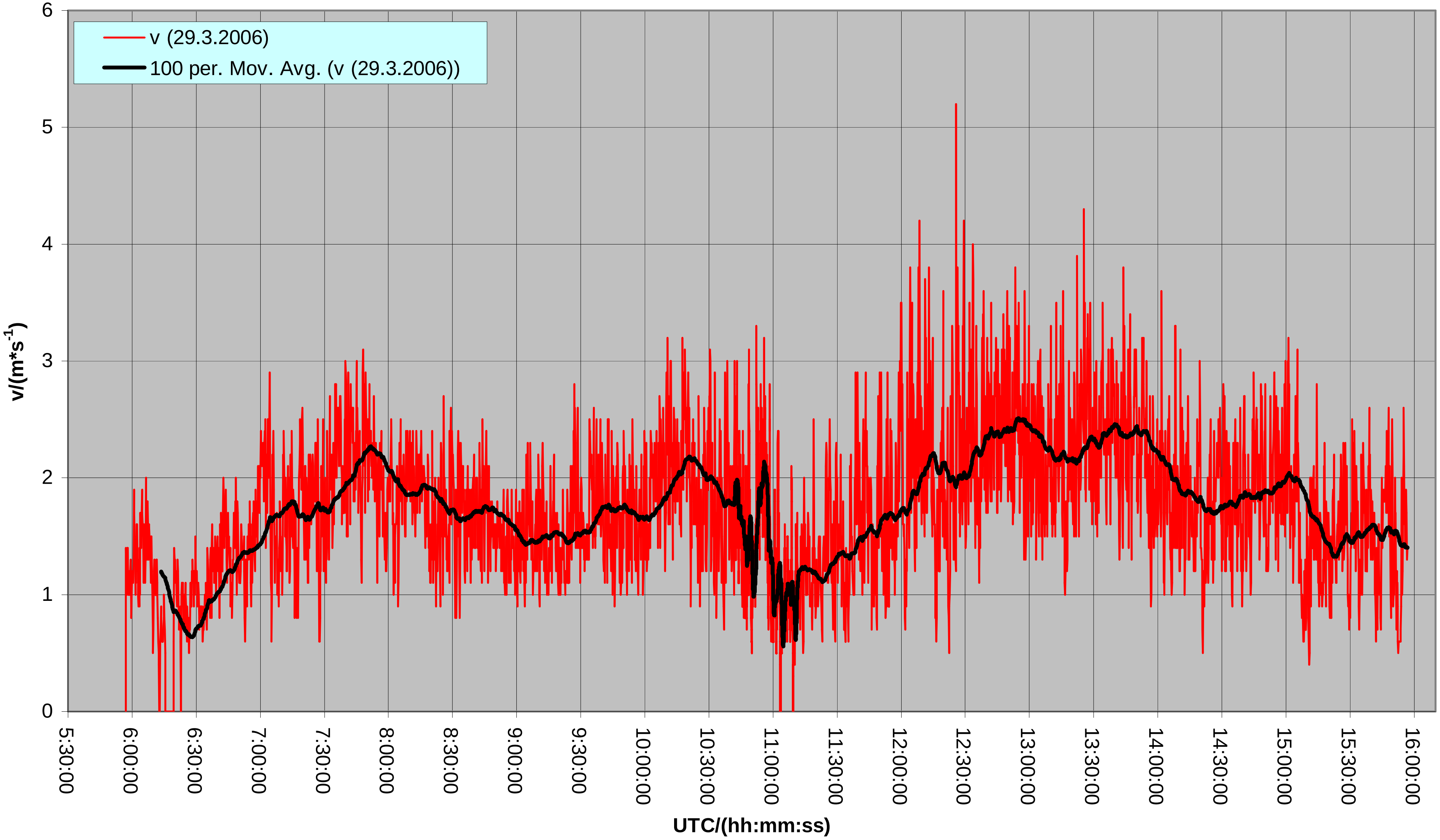
Appendix no. 32: Graph of the Progression of the Wind Speed (28.3.2006) – Turkey 2006



Appendix no. 33: Graph of the Progression of the Wind Direction (28.3.2006) – Turkey 2006



Appendix no. 34: Graph of the Progression of the Wind Speed (29.3.2006) – Turkey 2006



Appendix no. 35: Graph of the Progression of the Wind Direction (29.3.2006) – Turkey 2006