The effect of the annular solar eclipse on 15 January 2010 on meteorological variables in China and Thailand

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Abstract

Integrated atmospheric measurements were made at two sites in China and Thailand, during the annular solar eclipse on 15 January 2010 with clear sky conditions. Sensitive high-resolution meteorological observations revealed dynamical atmospheric effect. Short-term eclipse-related changes dominated over temperature, wind speed and wind directions associated with the synoptic conditions. The Observations showed a dramatic reduction of the incoming global radiation and subsequent, pronounced changes in surface air temperature with the lowest temperature values occurring about 36 min after the annular phase of a solar eclipse. The amplitude of the air temperature drop was not analogous to the obscuration percentage but was principally determined by the surrounding environment (mainly the lake influence) and the background meteorological conditions. Surface wind-speed decreased on both sites as a result of the cooling and stabilization of the atmospheric boundary layer.

Introduction

Solar electromagnetic radiation is an essential energy source for the actions on the earth. The marked decrease in the intensity of the solar radiation occurs during solar eclipse (especially during annular and total solar eclipses). It is displayed in changes of standard meteorological and physical quantities. The event of a solar eclipse has always been very attractive to meteorologists for studying the response of the atmosphere under specific conditions of an abrupt change of the incident solar radiation. Observations of annular and total solar eclipses are valuable to understand the physical processes occurring in the earth's atmosphere.

In order to study the response of the earth's atmosphere during the solar eclipse, measurements of different atmospheric parameters, viz. temperature, pressure, relative humidity, wind speed and sky brightness, etc. have been made earlier by several authors[1-5].

Methodology

Measurement sites

The meteorological data were obtained at two stations. One measurement site was in the region of annularity at Dali in Yunnan territory, China and an other site was in the partial eclipse region at Chiang Mai, Thailand as shown in Fig. 1, where the umbral path is also shown. Table 1 shows information on eclipse circumstances and obscuration at each site.

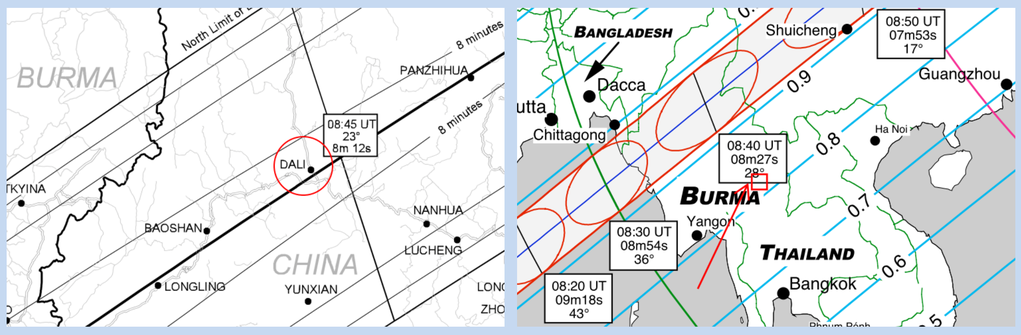

Fig. 1. Map showing location of central line of annularity (left panel). In China, the central line passed close to Dali. The observation site is shown by a red circle. The right panel, shows a measurement site within Thailand (Chiang Mai, in the partiality zone) by a red arrow.

Table 1. Information from each observation sites: Position, Obscuration and Eclipse circumstances.

Eclipse circumstances Time (UT)	Dali (China) 25°42' N 100°15.5' E	Chiang Mai (Thailand) 18°45' N 98°55.5' E
1st contact (I)	07:07	06:59
2nd contact (II)	08:40	-
Mid eclipse (M)	08:44	08:39
Obscuration (%)	(83.06)	(73.77)
3rd contact (III)	08:48	-
4th contact (IV)	10:06	10:03

Note: Universal Time (UT) is the modern counterpart to Greenwich Mean Time (GMT) and is determined from Very Long Baseline Interferometry (VLBI) observations of the diurnal motion of quasars.

Instrumentation

For the measurements of atmospheric parameters, we installed pocket weather stations (Kestrel 4500) with the same manner at both observation sites. There were several sensors integrated on the pocket weather stations to measure ambient atmospheric air temperature, relative humidity, wind speed and wind direction. The pocket weather stations were installed 1.5 m above the ground. Additionally, the lux meters were installed nearby to record the zenith sky brightness, and all data were recorded at every 1 min.

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Conclusions

Meteorological observations in China and Thailand during the solar eclipse on 15 January 2010, showed a strong eclipse-induced changes on many variables. Although some data recorded in this work are fluctuated due to influence of the site environment, this study showed characteristic of the behavior of meteorological parameters which may assist forecasters in predicting the weather in eclipse and non-eclipse regions.

Results and discussion

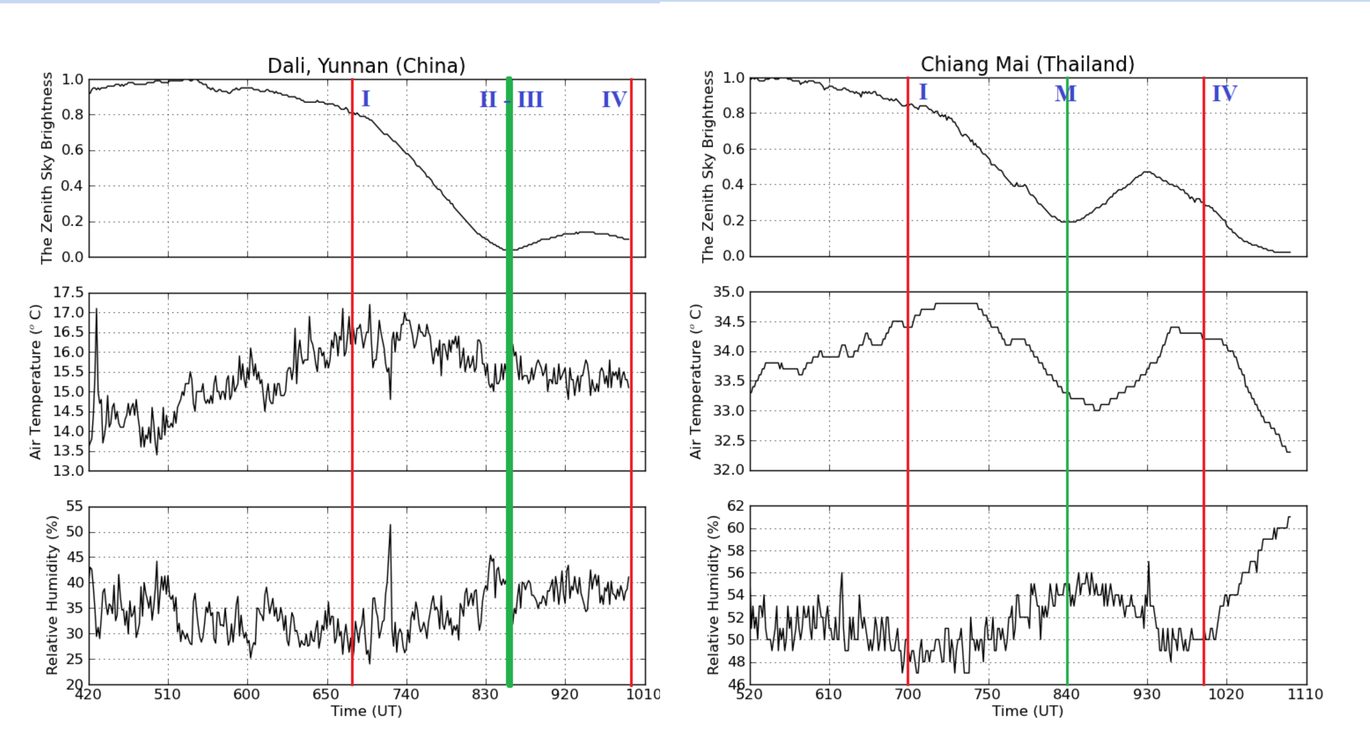

Fig. 2. Plot showing variation of the zenith sky brightness, air temperature and relative humidity from top to bottom, respectively (left, Dali and right, Chiang Mai) during the eclipse day.

Table 2. Surface temperature drop at two sites of different obscuration during the eclipse. The mean rate of temperature drop as well as the time lags from 1st contact and mid-eclipse are also shown.

Station	Temperature drop (°C)	Time lag from 1st contact (min)	Time lag from mid-eclipse (min)	Mean Rate of temperature drop (°C/min)
Dali	1.5	18	36	0.013
Chiang Mai	1.8	41	18	0.023

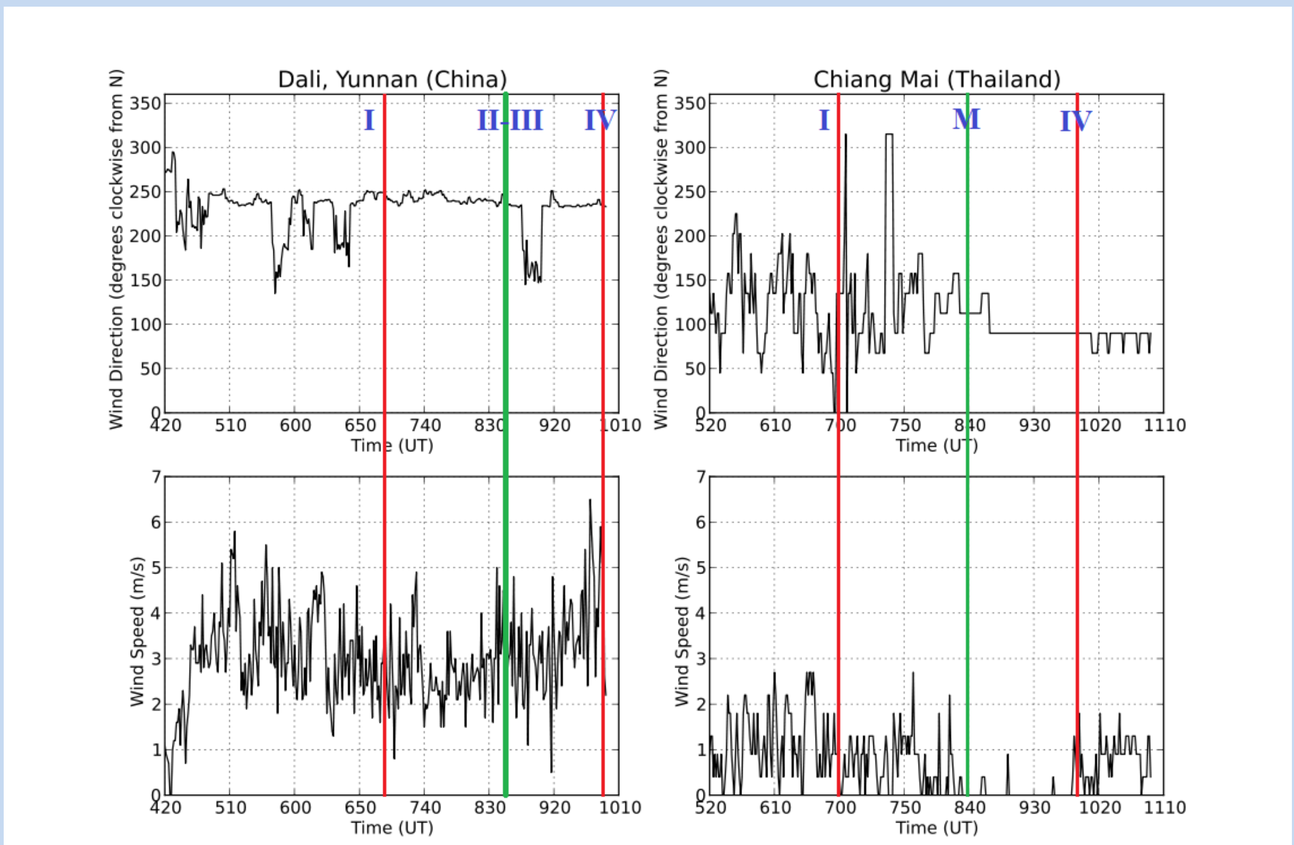

Fig. 3. Wind speed and direction measurements at Dali (left) and Chiang Mai (right) during the eclipse day.

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