Investigation of Solar Activity Effect on Surface Air Temperature of Turkey

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Abstract: Here we investigated the effects of solar activity on the surface air temperature of Turkey since 1985. The yearly mean values of temperature of 27 stations over Turkey were compared with large and small sunspot group data sets. In result of comparison we found that;
1. There is no remarkable correlation between temperature and both solar data sets.
2. The yearly mean temperatures of Turkey show a long minimum between 2002 and 2009. This time interval also corresponding to a long solar minimum.
3. During the solar activity maxima the temperature data shows also maximum.

Data, Comparisons and Results: Data sets of (i) monthly and yearly mean surface air temperature data of Turkey and (ii) monthly sunspot classification data are used, as climate parameter and solar activity indicator respectively,. Due to a good monitoring of both data, the time period of this study covers in general the last 27 years (1985–2012). Temperature and altitude data set of Turkey are taken from Turkish State Meteorological Service. Here we used only the data of stations which have not any gap during the investigated time period.

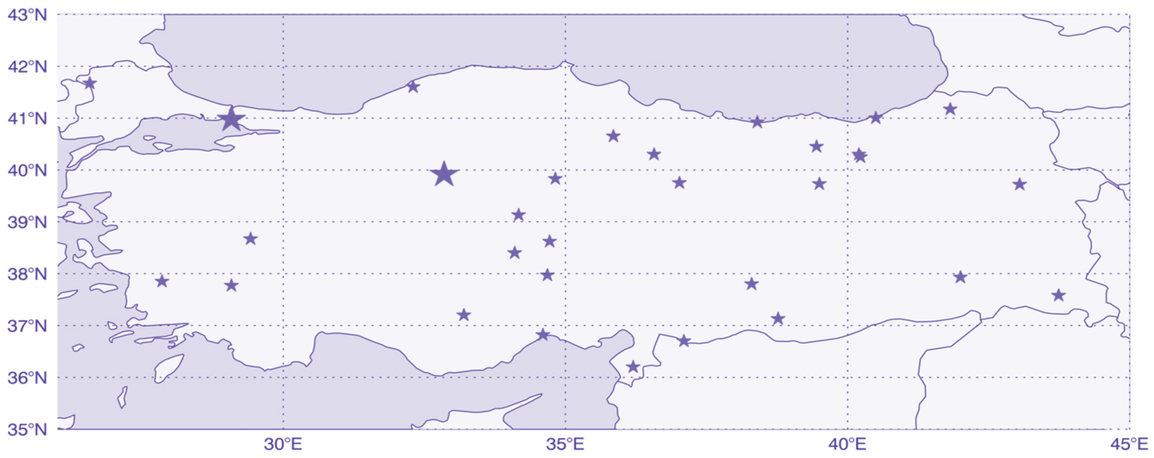

Figure 1: Distribution of temperature stations all over Turkey.

The elevations of these stations vary between 3 and 1727 with average of 765 meters. Note that the continues data came from the less industrialized cities. The most industrialized regions which are located at the West part of Anatolia and we have only four stations (Edirne, Usak, Aydin, & Denizli) data from this region (see Figure 1, Longitude < 30 degree). The large star symbols shows (from left to right) Istanbul and Ankara, their temperature data were not used in this study.

The sunspot group classification data are collected by United States Air Force/Mount Wilson (USAF/MWL) Observatory and are available online at the National Geophysical Data Center (NGDC) Web site http://www.ngdc.noaa.gov/stp/solar/sunspotregionsdata.html. The USAF/MWL database includes measurements of Holloman Solar Observatory (HOLL; 33N, 106W), San Vito Solar Observatory (SVTO; 41N, 18E), Learmonth Solar Observatory (LEAR; 22S, 114E), and the others. We used the LEAR station data as the principal data source. All LEAR data gaps were filled with data from the other stations listed above, so that a nearly continuous time series was produced. Atmospheric transmission of direct solar radiation and CO2 data sets were taken from Mauna Loa observatory web page (http://www.esrl.noaa.gov/gmd/obop/mlo)

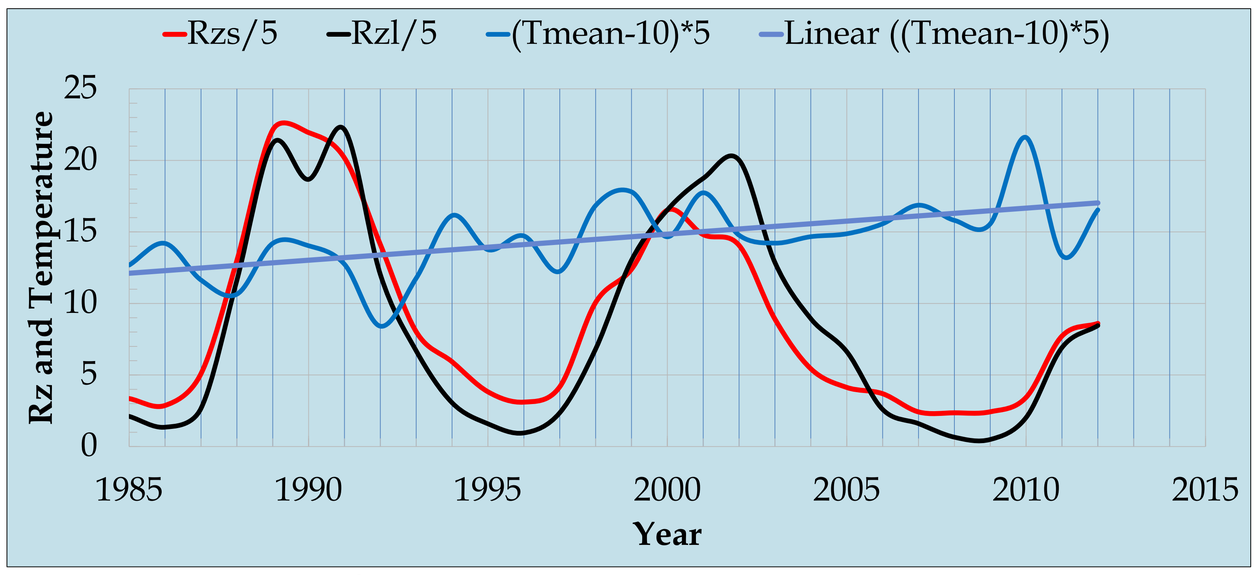

Figure 2. Variations of temperature and sunspot numbers with time.

Here we compared yearly mean temperature (Tmean) and large(Rzl) and small (Rzs) groups sunspot numbers in Figure 2. From this figure;
1. Temperature of Turkey still continue to increase, while the solar activity shows decreasing trend during the investigated time interval.
2. During solar activity maxima the temperature of Turkey was also maximum for solar cycle 22 and 23,
3. After the second maximum of solar cycle 23 (2002) the temperature data show long minimum up to 2009 and starting to fluctuate after that time which corresponds to the solar activity. To note that we calculated the correlation coefficient for all data and cyclic data sets but we couldn`t find any meaningful correlations between solar and temperature data sets; the highest correlation coefficient was obtained for cycle 23 ($r = 0.4$)

Conclusion

Here we compared solar activity and Turkey air surface temperature and found that;
1. There is no remarkable correlation between temperature and both solar data sets.
2. The yearly mean temperatures of Turkey show a long minimum between 2002 and 2009. This time interval also corresponds to long solar minimum.
3. During the solar activity maxima the temperature data shows also maximum.

In spite of we could not find a meaningful correlation between solar and temperature data, during the maxima of solar cycles the mean temperatures are also maximum. This imply that solar cycle variability may play a role on the surface air temperature of Turkey. The other interesting point is that yearly mean temperature of Turkey has a long minimum (2002 – 2009) and we know that this interval starts from descending face of cycle 23 and continue to ascending phase of cycle 24. This long valley (see Figure 2) may be the reason of weak solar activity.

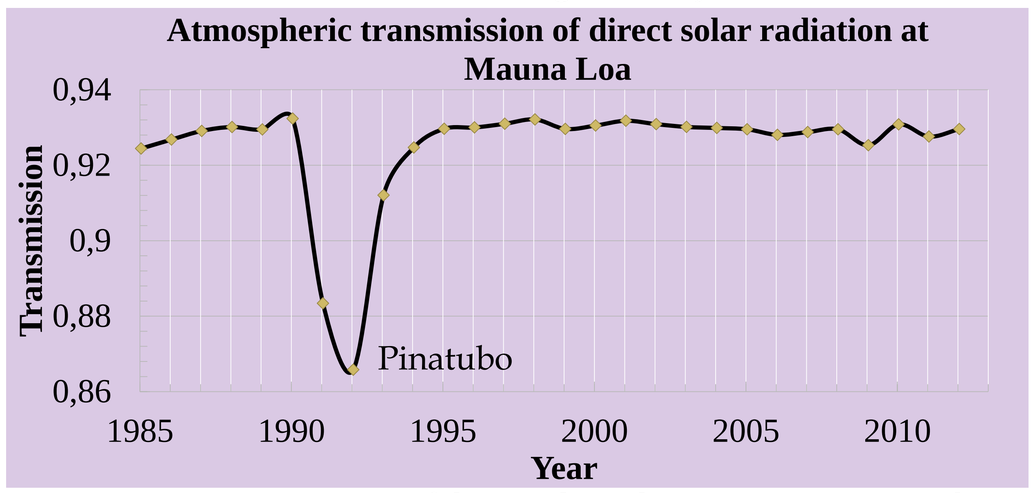

Figure 3. Time variation of direct solar radiation transmission in the atmosphere measured at Mauna Loa Observatory.

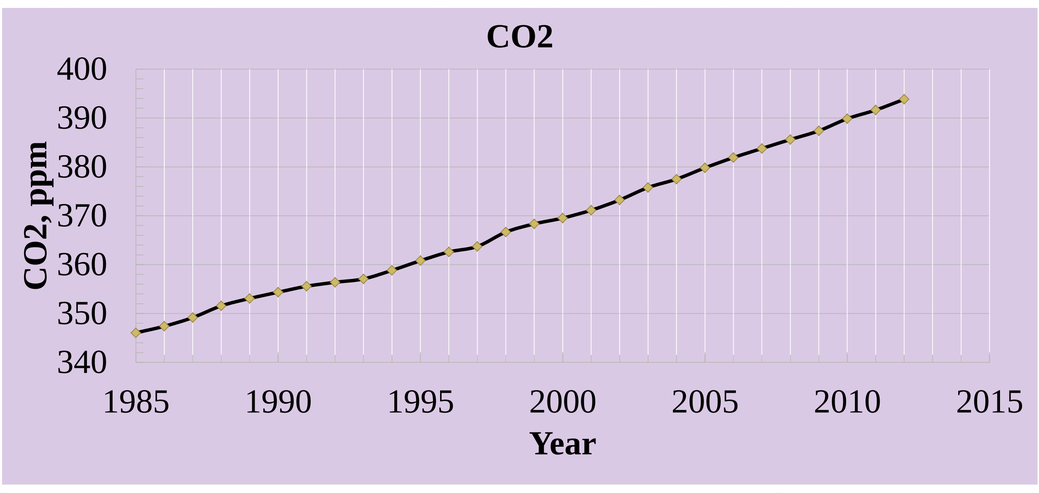

Figure 4. Time variation of atmospheric CO2 emission

A close look on Figure 2 reveals that the temperature anomalies show a deep valley from 1991 to 1994, and this time period is in accordance with a strong volcanic activity (April 2, 1991, Pinatubo; 15.13N, 120.35E). Atmospheric transmission of direct solar radiation measured at Mauna Loa observatory (19.5N, 155.6W) has strong decrease (see Figure 3) at the same time period. Another interesting point in the figure that there is one another deep valley between 2002 and 2009, but there is no such a strong decrease in the time variation of atmospheric transmission of direct solar radiation. The amount of transmitted solar radiation did not change seriously after 1995. Contrary to this the temperature data has long (about seven years) low trend between 2002 and 2009. There were some small fluctuations and decreasing trend in atmospheric transmission data especially after 2001. We think that the combination of low solar activity and decreasing trend of atmospheric transmission may produce such a long low temperature trend. The other interesting point in Figure 2 is that the temperature data has a general increasing trend from 1985 to 2012, correspond to atmospheric CO2 emission. Thus this general increasing trend in air temperature of Turkey may attributed to the increasing CO2 emission.

Acknowledgement
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