



Relationships between trends of daily temperature range, cloudiness, and sunshine in Europe

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We study links between trends of maximum and minimum temperature (TX and TN), daily temperature range (DTR), cloud cover, and sunshine duration at European stations in the period 1961–2010. For this purpose the method of “moving trends” is applied, thus trend magnitudes are estimated for “sliding seasons” lasting 30 days, moving during the year with a daily step. This approach enables us to identify short-scale intraannual variations in trends that cannot be uncovered by the standard monthly or seasonal trends.

During the course of the year, moving trends of DTR are mostly closely related to those of cloudiness and sunshine (e. g. decreasing cloudiness forces sunshine to increase, which raises TX more than TN, thus raising DTR) except for Spain where the connection is looser, and Alpine mountain summits where cloudiness and sunshine do not affect the trends of DTR.

The “autumn warming hole” (lack of warming, or even cooling) previously discovered over Central and South-eastern Europe in the last four decades of the 20th century had two phases: a September-October decrease in temperature, DTR, and sunshine with a concomitant increase in cloudiness, and a November cooling that was not accompanied by changes in cloudiness and sunshine. In data extended to 2010 the November cooling is no longer present.

To look for “solar dimming” and “solar brightening” (i.e. changes in solar radiation caused first by increasing, then decreasing emissions of anthropogenic aerosols), we have divided the study period into two halves: 1961–1985 and 1986–2010, and estimated trends therein. Interestingly, sunshine trends have recovered from dimming to brightening irrespective of trends in cloud cover only in the Alps (in May, June, and at the turn of August/September) where many of the previous dimming-brightening studies took place. In Spain, a notable brightening in the warm half-year is most often connected to decreasing cloud cover.