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A Century of Atmospheric Transmission over Davos, Switzerland

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Solar radiation and atmospheric transmission have been of increasing interest in climate research in the past decades. In this context, recent studies have observed decadal trends in solar radiation received at the Earth's surface. They claim a decrease of solar radiation starting from the 1950s to the end of the 1980s followed by an increase from the 1990s to present. These periods are referred to as Global Dimming and Global Brightening (1), respectively. Trends in cloud coverage and atmospheric transmission are prime focal points in the quest for possible causes of this variability.

Pyrheliometric measurements have been carried out at the PMOD/WRC from 1909 until present which results in the longest stationary direct irradiance record. A variety of radiometers and changing measurement scales had to be adjusted to the World Radiometric Reference (WRR).

The measurement time is converted to airmasses and the entire data set was screened using upper and lower irradiance boundaries which are simulated by the SMARTS2-model (2). Following the Ratioing Technique used by Hoyt and Fröhlich (3), apparent atmospheric transmission is obtained by calculating the ratio of irradiances, interpolated at two fixed airmasses from a fit through observations. Suitable criteria for the selection of raw data as well as the adequacy of the chosen fitting function are crucial for the quality of the resulting transmission time-series.

In the 1970s, apparent atmospheric transmission over Davos shows a slight transition from Dimming to Brightening which is more pronounced if favourable seasonal subsets are analyzed. Atmospheric transmission over Davos is subject to a strong annual cycle, due to increased transmission values during the comparatively clear winter months when advection of pollution is restrained by an inversion layer at lower altitudes in contrast to the summer season when local and regional aerosol sources take full effect.

In order to determine the relative contribution of aerosols on atmospheric transmission, Broadband Aerosol Optical Depth (BAOD) is obtained applying the Gueymard's method (4). This implies factorization of transmission into Rayleigh scattering and water vapour absorption, and interpreting the residual as BAOD. Therefore, Integrated atmospheric Water Vapour (IWV) had to be reconstructed by estimating its value from specific humidity and 2m-temperature measurements. Comparisons of the estimated IWV and modern-day measurements carried out by GPS show good agreement.

The resulting BAOD time-series shows a clearer signal of Global Dimming and Global Brightening as the other factors show no significant decadal trends. Based on the facts that the PMOD/WRC is located upwind of Davos and anthropogenic pollution is marginal, the influence of local aerosol sources are negligible. The detected trend in BAOD over Davos primary reflects a larger-scale aerosol background.

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