



## **Greenhouse warming and solar brightening in and around the Alps**

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At low elevations (500 m a.s.l.) central Europe's surface temperature increased about 1.3°C since 1981. Interestingly, at high elevations (2200 m a.s.l.) in the Alps, temperature rose less than 1°C over the same period. Detailed investigations of temperature, humidity and the radiation budget at lowland and alpine climate stations now show that the difference is likely related to unequal solar- and greenhouse warming. The analysis shows that the important decline of anthropogenic aerosols in Europe since the mid 1980s led to solar brightening at low elevations, whereas inherent low aerosol concentrations at high elevations had little effect on solar irradiance. Large water vapor increases however, show larger greenhouse warming in the Alps than in the Lowland. Absolute humidity and interestingly, also total net radiation show a Clausius-Clapeyron conform 6-7% per Kelvin altitude dependence in central Europe. At Lowlands rising temperatures since the 1980s, led to similar increase of absolute humidity (5.9% K<sup>-1</sup>) and total net radiation (5.1% K<sup>-1</sup>). In the Alps however, humidity and radiation increased more than twice as much leading to very large greenhouse warming. Hence, while solar brightening produced important additional warming at low elevations in Europe, temperature in the Alps increased less but almost exclusively due to strong water vapour enhanced greenhouse warming.