



Greenhouse warming - solar brightening and climate sensitivity in and around the Alps

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In central Europe temperature increased about 1.3°C since 1981. In the Alps however, the temperature rise over the same period is less than 1°C, even though greenhouse warming is expected to show larger climate forcing at high elevations. Detailed investigations of temperature, humidity and the radiation budget at lowland and alpine climate stations now show that despite the lower temperature rise, the greenhouse effect in fact increased more in the Alps. In the lowland total net radiation and absolute humidity both show a Clausius-Clapeyron conform 6% K⁻¹ increase, demonstrating sufficient water and soil moisture available during the rapid warming. Climate sensitivity values under climate forcings are similar to sensitivities determined from altitude dependence. In the Alps however, total net radiation and humidity increased considerably more leading to very large water vapour feedback greenhouse warming. The analysis also shows that the important decline of anthropogenic aerosols in Europe since the 1980s led to solar brightening at low elevations, whereas the inherent low aerosol concentrations in the Alps had little effect on solar irradiance. Hence, while solar brightening produced important additional warming in central Europe, temperature in the Alps increased almost exclusively due to strong water vapour enhanced greenhouse warming.