



## **Aerosol- cloud- and greenhouse- surface forcing and the rapid warming since the 1980s**

**R. Philipona** (1) and C. Ruckstuhl (2)

(1) Federal Office of Meteorology and Climatology MeteoSwiss, Aerological Station, Payerne, Switzerland, (2) Institute for Atmospheric and Climate Science, Swiss Federal Institute of Technology (ETH), Zürich, Switzerland (rolf.philipona@meteoswiss.ch)

The rapid temperature increase of 1°C over mainland Europe since 1980 is considerably larger than expected from anthropogenic greenhouse warming. Measurements of aerosol optical depth from six specific locations and surface irradiance measurements from a large number of radiation sites in Northern Germany and Switzerland show a substantial decline in aerosol concentration over Europe, which has led to a statistically significant increase of solar irradiance under cloud-free skies. The measurements explain solar brightening and show that the direct aerosol effect has about a five times larger climate forcing impact on the observed warming than the indirect aerosol and other cloud effects have. The surface forcing due to the direct aerosol- and the cloud effect combined are more than twice as large as the expected forcing due to anthropogenic greenhouse gases. The measurements therefore indicate that the aerosol decline over Europe likely produced more than half of the rapid warming since the 1980s.