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A data-driven approach to understanding global controls of cloud radiative effects

Hendrik Andersen and Jan Cermak
Karlsruhe Institute of Technology, Karlsruhe, Germany (hendrik.andersen@kit.edu)

In this contribution, statistical and machine learning techniques are applied to quantify the response of clouds to changes in environmental factors.

Clouds play a key role for the Earth's energy balance; however, their response to climatic and anthropogenic aerosol emission changes is not clear, yet. Here, 20 years of satellite cloud observations are analyzed together with reanalysis data sets in multivariate-regression and machine-learning approaches to quantitatively link the variability of observed cloud radiative effects to changes in environmental factors, or cloud-controlling factors (CCFs). In this data-driven approach, a large number of CCFs, including aerosol proxies, are used as predictors at a large spatial and temporal scale typical of CCF analyses. The analysis reveals distinct regional patterns of CCF importance for shortwave and longwave cloud radiative effects. In stratocumulus cloud regions, the main controls of shortwave CRE are the sea surface temperature and the estimated inversion strength, but also zonal winds in the lower free troposphere are relevant controls of CRE. Aerosol proxies are shown to be most important for shortwave CRE in the regions of stratocumulus to cumulus transition. Future analyses of interactions between different CCFs and comparisons to global climate models are outlined.