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Solar radiation and clouds - an overview on processes, interactions and trends

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This talk will provide an overview regarding the many aspects of the solar radiation-cloud interaction. It will address questions of cloud dynamics, the clouds in radiative transfer as well as the important role the cloud-radiation interaction plays in climate. The state of discussion in some disputed fields will be reported.
Before solar radiation reaches the surface of the Earth´s continents and oceans, it has to pass the atmosphere consisting of a multitude of gases, particles, and hydrometeors. The prime regulator of the radiation field in the atmosphere is clouds. Thus the cloud radiation interaction is of utmost importance for climate, climate change and radiation driven processes in the biosphere or in photochemistry.
Solar radiation is strongly steering the lifecycle (generation, maintenance and dissipation) of clouds. Cloud dynamics and the vertical distribution of energy are dependent on the processes involved. Central aspects of the chain of effects will be outlined in this overview.
Clouds reflect and absorb solar radiation, both processes are highly dependent on their radiative properties, thus on the detailed microphysical composition of clouds as well as on their geometrical appearance. The talk will provide an update of the current knowledge and state of discussion with respect to theses properties. Additionally, an actually suggested geo-engineering approach building on the deliberate change of cloud radiative properties will be discussed.
One bulk measure of the impact of clouds on the radiation balance in a climatological sense is the so called ‘cloud radiative forcing’ (CRF). It allows the assessment of the amount by which the presence of clouds alters the top-of-the-atmosphere (TOA) energy budged. CRF is determined by the difference between the cloud-free radiation budget climatology and the average one over all scene types. Estimates from the Earth Radiation budget Experiment (ERBE) and more recent compilations from satellite climatologies show that clouds approximately double the albedo of the Earth from an estimated clear sky value of 0.15 to its average of 0.3. The associated SWCF amounts to about –52 Wm-2 as a global average. Thus, about 50 Wm-2 is reflected by clouds that would not be reflected by the cloud-free planet. Locally and instantaneously, clouds can reduce absorbed shortwave radiation by as much as 700 Wm-2. Current trends and sensitivities in the related quantities will be presented.
It is the SWCF in competition with longwave cloud effects which contributes to the overall cloud feedback in the climate system, a most important but less well treated feedback for climate modelling. In general, the problem of clouds in radiative transfer and interactions involving clouds and solar radiation processes in the atmosphere and in atmospheric modelling are still subject of contemporary research. The state-of-the-art of clouds in climate modelling will be summarized in this overview.