Hemispheric Symmetry of Top of the Atmosphere Shortwave Reflection in CERES and CMIP5 Models

Traute Crueger, Hauke Schmidt, and Bjorn Stevens

Introduction

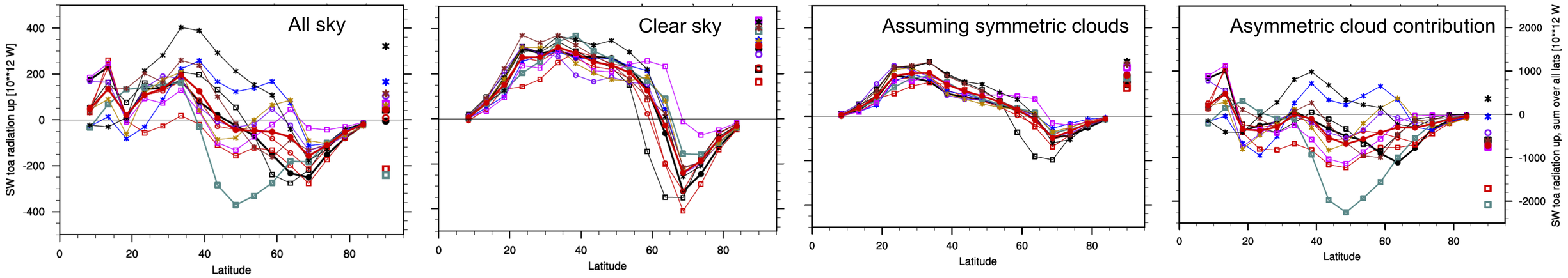
Top of the atmosphere (TOA) short wave (SW) reflection from CERES approximately shows a hemispheric symmetry, although TOA SW clear sky reflection reveals an asymmetry due to a larger land fraction and aerosol burden in the northern hemisphere. Here, we address the following questions: 1.) How is the latitudinal distribution of the (a-)symmetries? 2.) To what extent do symmetric clouds mask the clear sky asymmetry? 3.) How is the amount of compensation by asymmetric clouds? 4.) Do climate models simulate a TOA SW reflection symmetry? 5.) Do clouds play a similar role in models and CERES?

Method

Clouds mask the hemispheric asymmetries of clear-sky reflection. To assess this effect, we calculate a reference reflection by assuming hemispheric symmetric clouds (Voigt et al., 2014). The difference between this reference asymmetry and the all sky asymmetry represents the contribution of asymmetric clouds.

Results

- The (a-)symmetries in CERES are a result of compensation within the equatorial to mid-latitudes and the subpolar to polar areas.
- Symmetric clouds mask CERES clear sky reflection by about one third.
- Compensation of CERES asymmetric clouds is a result of opposite contributions by tropical areas and by areas poleward of the mid latitudes.
- Individual CMIP5 models show a wide spread in all sky (a-)symmetry.
- The All sky model spread mostly reflects the asymmetries of the asymmetric cloud contributions.
- The model mean generally matches the CERES data very well. The bias is about 1 W/m^2.
- The model mean bias of all sky reflection asymmetry is to about 80% due to asymmetry bias of contributions assuming symmetric clouds and to only 20% due to contributions by asymmetric clouds.



Latitudinal distribution of SW radiation hemispheric differences (northern minus southern hemisphere) (for zonal belts of about 5.5º meridional extension). The total sums over all zonal belts are indicated by the marker on the right hand sides. From left to right: all sky, clear sky, assuming symmetric clouds, and contributions by asymmetric clouds (units: 10^{12} W). Left axes refer to the curves, right ones to the marker.

Max-Planck-Institut für Meteorologie

traute.crueger@mpimet.mpg.de

References:

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