3rd International Conference on Earth System Modelling
Vol. , 3ICESM-265, 2012
3rd International Conference on Earth System Modelling

Compensation of hemispheric albedo differences by tropical clouds

A. Voigt, B. Stevens, J. Bader, and T. Mauritsen
MPI for Meteorology, The Atmosphere in the Earth System, Hamburg, Germany (aiko.voigt@zmaw.de)

Despite a large hemispheric difference in clear-sky planetary albedo caused by the preponderance of continents in the Northern Hemisphere, satellite measurements repeatedly report near-zero hemispheric difference in all-sky planetary albedo. This hemispheric symmetry cannot be explained by the statistical properties of the reflected shortwave radiation, which motivates to search for mechanisms that work in favor of a small hemispheric difference in planetary albedo. Here, we present results from an investigation of the hemispheric distribution of reflected shortwave radiation in climate model simulations of aquaplanets. In these simulations we perturb the surface albedo to study how the atmospheric circulation, and with it clouds, respond to hemispheric surface albedo differences. The surface albedo perturbations are asymmetric with respect to the equator such that their global-mean radiative forcing is zero. We find that the dark-surface hemisphere warms while the bright-surface hemisphere cools. This leads to cross-equatorial energy transport from the dark-surface hemisphere into the bright-surface hemisphere, which is associated with a shift of the inter-tropical convergence zone and deep convective clouds into the dark-surface hemisphere. While details of the response of tropical clouds are sensitive to the parameterization of deep convection and the structure of the inter-tropical convergence zone, the shift of tropical clouds always work against the imposed surface albedo perturbation. In some cases, the shift is strong enough to overcompensate the surface albedo perturbation such that the dark-surface hemisphere has a higher planetary albedo than the bright-surface hemisphere. Overall, our results demonstrate that the shift of the inter-tropical convergence zone and tropical clouds efficiently act to compensate hemispheric albedo differences.