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Hemispheric TOA SW radiation budgets under changed atmospheric radiation conditions

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Under present day conditions the observations approximately show a hemispheric symmetry of the top of atmosphere (TOA) short wave (SW) reflection despite the asymmetry of surface SW reflection. This has been confirmed by climate models. With models in an aqua planet setup, Voigt et al. (2014) found that tropical clouds largely compensate surface SW hemispheric asymmetries, however to a different degree in dependence on the convection scheme.

In this study, we question, whether there is also a hemispheric symmetry of TOA SW radiation under changed atmospheric radiation conditions. For that reason, we analyze experiments performed with a set of fully coupled general circulation models. The experiments were performed with either a) hemispheric asymmetric incoming radiation, b) increased atmospheric CO2 concentrations, c) increased atmospheric CO2 concentrations combined with increased stratospheric aerosol burden, or d) increased atmospheric CO2 concentration in conjunction with increased ocean albedo.

We show that generally, a hemispheric symmetry of TOA SW radiation does not occur. Overall, among the group of models, the hemispheric TOA SW radiation budgets are roughly similar for the distinct experiments, although the models utilyze different convection schemes. We discuss the role of surface and atmospheric feedbacks in the different experiments, especially of tropical and extratropical clouds.

Reference:
Voigt, A., B. Stevens, J. Bader, and T. Mauritsen, 2014: Compensation of Hemispheric Albedo Asymmetries by Shifts of the ITCZ and Tropical Clouds. J. Climate, 27, 1029–1045, https://doi.org/10.1175/JCLI-D-13-00205.1.