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Cloud regulation of inter-hemispheric albedo symmetry

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Despite differences in land distribution, and aerosol amount, the Northern and Southern hemispheres have been found to reflect almost exactly the same amount of incoming shortwave radiation. This indicates that clouds compensate for the asymmetry in clear-sky reflection, and make the system maintain an inter-hemispheric albedo symmetry.

In the mean state, retrievals from satellite-borne CERES measurements suggest that mid-latitude clouds are both in amount and reflectivity contributing to this compensation, together with sub-tropical cloud amount, that is also greater in the Northern hemisphere. Composites of instances with high asymmetry in either direction indicate that the variability in albedo symmetry is driven by variation in tropical and subtropical cloudiness, with patterns in agreement with non-neutral phases of ENSO.

CMIP6 models are found to typically overestimate the variability in inter-hemispheric asymmetry, and underestimate the degree of symmetry, compared to observations. The bias in models is largely driven by biases in mid-latitude reflected shortwave radiation. Mid-latitude clouds are also found to play a significant role in model albedo symmetry response to strong forcing: models with large loss of mid- and high-latitude clouds in the Southern hemisphere restore the initial asymmetry, due to relative Northern hemisphere darkening, produced in the models in response to abrupt 4xCO2 forcing and subsequent warming.

Here we discuss albedo distribution and variability in satellite-derived products, and across model generations, pointing at inter-hemispheric symmetry as a useful model diagnostic, and as indicator of cloud feedback mechanisms.