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The climate of a retrograde rotating Earth

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What would the climate of Earth look like if it would rotate in the reversed (retrograde) direction? Which of the characteristic climate patterns in the ocean, atmosphere or land that are observed in a present-day climate are the result of the direction of Earths' rotation? Is, for example, the structure of the oceanic Meridional Overturning Circulation (MOC) a consequence of the interplay of basin location and rotation direction? In experiments with the Max Planck Institute Earth System Model (MPI-ESM), we investigate the effects of a retrograde rotation in all aspects of the climate system.

The expected consequences of a retrograde rotation are reversals of the zonal wind and ocean circulation patterns. These changes are associated with major shifts in the temperature and precipitation patterns. For example, the temperature gradient between Europe and Eastern Siberia is reversed, and the Sahara greens, while large parts of the Americas become deserts. Interestingly, the Intertropical Convergence Zone (ITCZ) shifts southward and the modeled double ITCZ in the Pacific changes to a single ITCZ, a result of zonal asymmetries in the structure of the tropical circulation.

One of the most prominent non-trivial effects of a retrograde rotation is a collapse of the Atlantic MOC, while a strong overturning cell emerges in the Pacific. This clearly shows that the position of the MOC is not controlled by the sizes of the basins, or by mountain chains splitting the continents in unequal runoff basins, but by the location of the basins relative to the dominant wind directions. As a consequence of the changes in the ocean circulation, upwelling of phosphate enriched and nitrate depleted water leads to a dominance of cyanobacteria over bulk phytoplankton in the northern part of the Indian Ocean, a phenomenon not observed in the prograde model.