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What can we learn from energy transports in the atmosphere?

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The atmosphere and the ocean play a critical role in the Earth energy balance by transporting energy from the equator to the poles. In the atmosphere, this net meridional energy transport is the sum of many atmospheric processes occurring on very different scales in space and time: in the tropics most of the energy is transported poleward by the Hadley circulation, whereas eddies become the principal agency of heat transport in mid and higher latitudes. However these synoptic-scale weather systems also feed back onto the larger scale flow, interacting in a quite complex manner with the Hadley circulation. These interactions are believed to be essential in ensuring an overall ‘seamless’ transfer of energy in the atmosphere.

The aim of this work is to gain new insight into the behaviour of global atmospheric circulations by exploring these within an energy (rather than a mass) framework. Using 6-hourly outputs from state-of-the-art reanalyses (e.g. ERA-Interim and JRA55), we provide a new estimate of energy transports over the 1979-2015 period and determine the relative role of large-scale and synoptic atmospheric circulations in the global energy redistribution. To do this, we first examine the spatial contrasts in the transport of sensible heat, latent heat, potential and kinetic energy fields, and diagnose how these may have been changing on seasonal to inter-annual timescales. These contributions are further partitioned into mean meridional circulations and (stationary and transient) eddy activities, to explore the complementary variations occurring between high latitude synoptic systems and mean tropical cells. This diagnostic energetic framework allows us to study tropical-extratropical teleconnection patterns through a new perspective, and improve our understanding of the underlying dynamical processes by taking into account the links between different atmospheric scales. Finally, by applying these diagnostics to historical and future (RCP8.5) CMIP5 model simulations, we are able to compare atmospheric teleconnections in the present climate and under a global warming scenario.