ATMOSPHERIC OVERTURNING, FROM THE CONVECTIVE TO THE PLANETARY SCALES

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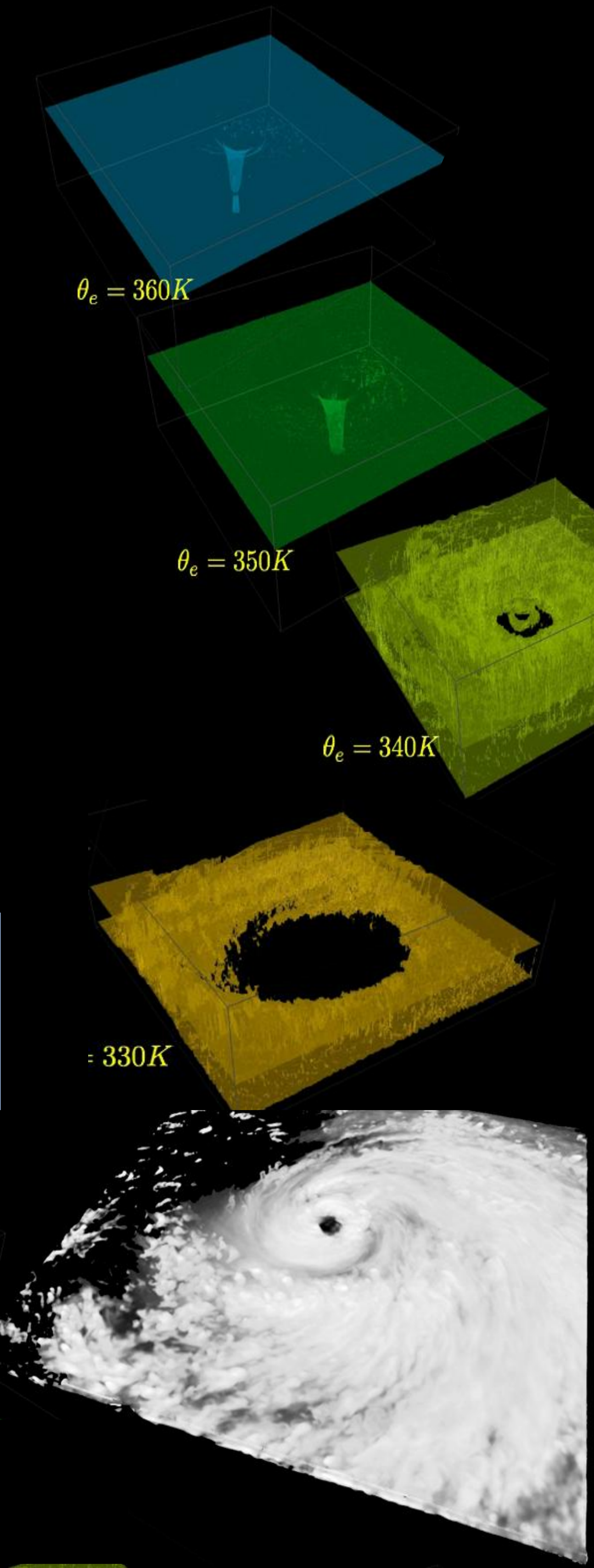

The atmosphere absorbs solar energy mostly at the Earth's surface and in low latitudes, and loses energy by emitting infrared radiation from the troposphere. This differential heating drives an atmospheric circulation that redistributes the energy around the globe. This circulation is an overturning flow characterized by the ascent of warm, moist air balanced by the subsidence of colder, drier air. It also involves a broad range of scales, from the global planetary Hadley cell to individual convective clouds.

In this talk, I will show how atmospheric overturining can be quantified using isentropic analysis. This method relies on separating air parcels through their equivalent potential temperature. The overturning circulation then appears as an upward mass flux of air at a high equivalent potential temperature, balanced by a descending mass flux of air at a low equivalent potential temperature. This method has been successfully applied to identify the overturning in high-resolution simulations of convection, tropical cyclones, and the Indian Summer Monsoon. When applied to a global dataset, one can also determine the contributions of different motion scales to the overturning.

A significant challenge to our understanding of atmospheric overturning is that, to date, no global dataset has fully resolved all the scales involved. However, the emergence of Global Cloud Resolving Models (GCRMs) such as XSHIELD and ICON makes it now possible to investigate the contribution of convective motions to this overturning directly. In particular, because they resolve convective motion, these models produce an overturning circulation that is about twice as strong as that of the previous generation of global models.