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General Circulation Models and the superrotation question

The superrotation that is observed in the atmosphere of Venus is a specific feature that is not yet fully understood. The bulk of the atmosphere rotates much faster than the solid body of the planet. The maximum zonal wind speed is observed at the top of the dense cloud layer, with winds of more than 100 m/s, while the solid body is slowly rotating at around 2 m/s. The total angular momentum contained in the atmosphere is therefore much larger than what would be contained if the atmosphere was rotating in average as the solid surface (which is the case for the Earth and Mars). To study this outstanding dynamics question (and many other aspects of Venus climate), numerical models are currently developed, similar to the climate models used to study Earth climate. These General Circulation Models simulate the circulation of the atmosphere based on fluid dynamics equations, responding to the solar radiation forcing.

In this presentation, I will present the current state of the art in Venus atmospheric modeling. I will emphasize the main difficulties these models have to face, the dominant parameters and their uncertainties. Venus GCMs are developed in Japan, in France, in the USA and in England. I will show how these models build upon theoretical studies that were proposed in the late 70s and early 80s to understand the superrotation question, and how they bring further explanations on the control mechanisms involved in this dynamical phenomenon. The role of the mean meridional circulation, of the thermal tides, of other planetary waves as well as the potential impact of gravity waves will be illustrated.

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