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General circulation modeling of the Jupiter stratosphere

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Abstract

The stratosphere of Jupiter extends for more than 350 km above the cloud top. It is driven almost equally by the radiative heating and cooling within the atmosphere, and by heat from below. We present first results of simulations with the newly developed general circulation model (GCM).

1. Model description

A general circulation model is based on the finite-difference (grid) dynamical core, which was extensively used in the Martian GCM [2,4]. It solves the primitive equations of hydrodynamics on a sphere under the hydrostatic approximation. The model domain extends from 1 bar to approximately 1 μbar. The model physics includes the molecular viscosity and thermal conduction, Richardson-based turbulent diffusion, and radiative forcing in the form of the Newtonian cooling. The latter is soon to be replaced by parameterizations of radiative heating and cooling due to C_2H_6, C_2H_2, and CH_4 (see presentation of Kuroda et al., this session). The influence of the interior is accounted for at the lower boundary through nudging the zonal component of the wind to observed values [3].

2. Results

Simulations for high (360 x 180 grid points in longitude and latitude) and low (64 x 72) resolutions reveal rather zonally symmetric circulation in the stratosphere. Zonal disturbances develop in the lower atmosphere, but their size is much smaller than the Jupiter radius. The disturbances remain shallow, and do not penetrate above. The strength of the simulated circulation is sensitive to the dissipation, but the structure is not. It represents a set of meridional cells induced by alternating jets at the lower boundary, which extend higher, and decay with height.

Figure 1 compares the simulated temperature with the measurements acquired by Composite Infrared Spectrometer onboard the Cassini spacecraft [1].

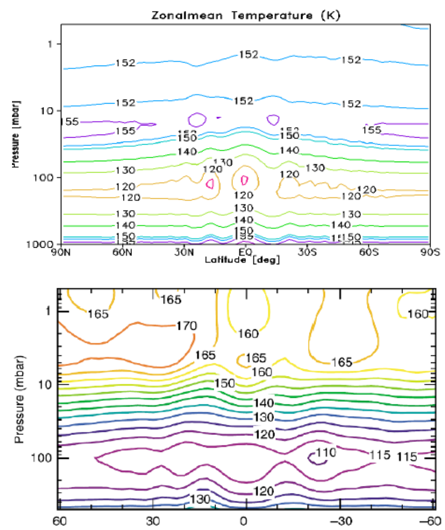

Figure 1: Zonal mean temperature simulated with the GCM (upper panel), and the observed from Cassini [1] (lower panel)

Latitudinal variations of temperature are caused by adiabatic heating and cooling associated with downward and upward branches of the meridional cells.

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