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Modeling the atmosphere of Venus: influences of large-scale topography

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Several groups internationally are recently developing and running fully 3D global circulation models for the Venus atmosphere. With respect to the planet's highly dynamic superrotation, advances have been forthcoming in simulating aspects of this phenomenon, yet often under inadequate/inappropriate physical assumptions (e.g. the imposition of extremely large diabatic heating rates and/or of near-surface, north-south temperature gradients; the lack of surface-atmosphere interactions arising from the planet's topography; etc). Fully understanding the range of dynamical mechanisms that produce the atmospheric superrotation of Venus (and then realistically modeling such phenomena within 3D climate models of the planet) remains fundamentally a grand challenge in planetary geophysical fluid dynamics. Systematic improvement of Venus GCMs requires a full exploration of "parameter space" to discover how simulations depend on uncertain input assumptions. In this work we assess the importance of surface-atmosphere interactions on the atmosphere's superrotation state within a framework of a simple-physics global circulation model (Venus SGCM). The model incorporates realistic Venus topography obtained from the Magellan mission, in addition to a simplified planetary boundary layer parameterization (i.e., in terms of surface roughness (z_0), drag coefficient (C_D) and boundary layer depth (h)). We investigate the effects of large-scale topography and forced atmospheric waves on the planet's superrotation. The forced, large-scale wave activity is diagnosed in terms of quasi-stationary eddy heat and momentum fluxes, Eliassen-Palm fluxes and its divergence (i.e., wave driving, D_F). Whether the planet's large-scale topography has an important influence on the atmosphere and climate of Venus, let alone, how it may or not play a role in the nature of its superrotation is discussed.