AFFECTS OF CONDENSATION AND RADIATION ON EDDIES IN THE MARTIAN ATMOSPHERE.

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We use a simplified GCM to examine affects of condensation and radiation on Martian atmospheric dynamics. The model has a simplified surface friction and a diabatic heating, calculated by a gray-gas model of IR radiation. There are no surface latent heat fluxes and there are no convection or boundary layer parameterizations in the model. The radiative model has a parameter (α) which determines the ratio of scale heights of the main atmospheric component to the main IR absorber. The large-scale condensation parameterization prohibits the temperature from falling below CO_2 saturation but does not account for pressure alterations. This is similar to large-scale condensation of water vapor in Earth GCM's.

We find that the eddy dynamics display two distinct regimes in the radiative parameter α: 1) low α - with features seen on present Mars, and 2) high α - qualitatively resembling the Earth. In particular, we find deep (equivalent barotropic), highly regular eddies with large zonal scale in the low α case. This behavior is typical of present Mars but we find it even when Earth-like parameters (such as the planet's radius and gravity and $\frac{R}{c_p}$) are used as long as we are in the low α regime. As α is increased we find a shift in the typical zonal scale of eddies toward shorter waves. The waves also become shallower and more irregular, as is typical of eddies on Earth. The transition between these regimes can be predicted from the radiation model. We claim that the value of α for which the radiative equilibrium temperature becomes unstable is critical.

We also use the GCM to study the effects of condensation on eddies in a thick CO_2 atmosphere, as might have been on early Mars. Using a quasi-linear QG model, we show that, with a warm surface the condensation occurs at high altitudes and has little affect on the growth rates. However, if the surface was cool then the QG model predicts changes to the growth rates and structures of the normal modes. We test these ideas in the nonlinear regime with the simplified GCM including large-scale condensation.