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Mesoscale Circulations over Titan's Lakes

Alejandro Soto and Scot Rafkin
Southwest Research Institute, Planetary Science, Boulder, United States (asoto@boulder.swri.edu)

The formation and duration of the Titan lakes are dependent on the balance of precipitation and evaporation in the Titan climate. It appears that the seasonal variations of insolation combine with the slow planetary rotation rate to generate a climate where the bulk of precipitation is confined to the polar regions and transient storm activity occurs in the equatorial and mid-latitude regions. Numerous studies have already investigated how large-scale atmospheric dynamics contributes to this precipitation and evaporation cycle. Some of these studies used two and three dimensional general circulation models (GCMs) that employed parameterizations to capture the near surface evaporation and convective processes.

The GCM parameterizations of evaporation and convection parameterizations inevitably fail to capture in detail the evaporation and precipitation processes that occur over the hydrocarbon lakes on Titan. To investigate these processes in detail, we used a mesoscale numerical model of the Titan atmosphere in order to assess the evaporation rates and convective activities over the Titan lakes. Our model was developed by modifying the mesoscale version of the Weather Research and Forecasting (WRF) atmospheric dynamics model. WRF has been extensively used to study mesoscale atmospheric dynamics on Earth, including the dynamics that develop over lakes, making it an ideal model for this type of investigation. For our use, Titan parameters were applied to the WRF model, including planetary size and atmospheric composition. Due to the long radiative timescale of the atmosphere of Titan and the length of our simulations, radiative transfer calculations were not included in the simulation. Idealized, two-dimensional simulations of lakes were simulated in order to understand evaporation rates as well as identify the types of circulations generated over the lakes. Here we present the results of this research.