UPPER ATMOSPHERE THERMAL STRUCTURE IN SLOW ROTATOR ATMOSPHERES: VENUS VS. TITAN A. S. Brecht[1], S. W. Bougher[2], and J. M. Bell[3], [1]NASA Ames Research Center (MS 245-3, Moffett Field, CA USA 94035 (amanda.s.brecht@nasa.gov)), [2]University of Michigan (2455 Hayward St., Ann Arbor, MI USA 48109), [3]Southwest Research Institute (P.O. Drawer 28510, San Antonio, TX USA 78228).

Introduction: Venus and Titan are both slow rotating bodies with a thick atmosphere. Venus' rotation is almost an Earth year (1 Venus day = 243 Earth days), while Titan remains phase locked with Saturn and rotates once per orbit (~16 Earth days). The surface of these planets cannot be seen by the naked eye due to H_2SO_4 clouds (Venus) or thick aerosol hazes (Titan). They both have efficient cooling mechanisms; CO_2 on Venus and HCN on Titan. These planets are very similar bodies except for their location. Venus orbits the Sun at 0.72 AU and is exposed to the solar environment (it doesn't have a magnetic field), while Titan is 10 AU from the Sun and orbiting Saturn. Furthermore, Titan is mostly protected from the interplanetary plasma environment by Saturn's magnetic field; it does experience energetic particle bombardment due to Saturn's magnetosphere. Their location thus creates a slightly different environment. So what kind of thermal structure can you expect from these slow rotators?

Venus: Observations of Venus' upper atmosphere thermal structure are being conducted through ground based observatories (e.g. [1], [2]). These temperature measurements, along with those from several instruments onboard the current Venus Express (VEx) mission, are augmenting the previous thermal structure data from past missions (e.g. Veneras', Pioneer Venus Orbiter, Pioneer Venus Probes) (e.g. [3], [4], [5], [6], [7], [8]). These recent ground-based and VEx observations reveal the Venus dayside lower thermosphere to be considerably warmer and dynamically important then previously understood. In addition, the global winds generated by these warm dayside temperatures are shown to give rise to dayside upwelling (divergence) and nightside subsidence (convergence) resulting in nightside warming near the anti-solar point at ~100 km.

In this study, the three dimensional Venus Thermospheric General Circulation Model (VTGCM) (e.g. [9], [10]) is used to provide temperature predictions for comparison to these recent ground based and VEx observations. Such a comparison serves to identify and quantify the underlying thermal processes responsible for the observed dayside and nightside temperature structure. The VTGCM reproduces the dayside temperatures observed near 110 km at noon from 40 deg S to 40 deg N very well [11]. Moreover, the corresponding nightside temperatures near 104 km reach ~198 K, in accord with averaged measurements [10]. See Figure 1.

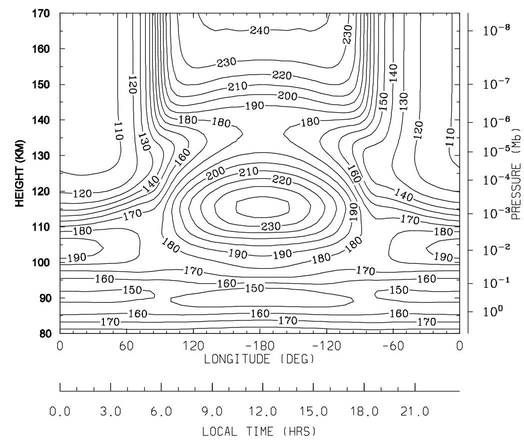

Figure 1: VTGCM temperature (K) for solar minimum conditions; longitude-height cross section at 2.5°N (LT vs. height).

Titan: Observations of Titan's upper atmosphere are fewer than Venus; however the Cassini-Huygens mission is augmenting observations made by Voyager 1 (e.g. [12], [13], [14]).

Numerically, the Titan Global Ionosphere-Thermosphere Model (T-GITM) is utilized to simulate Titan's upper atmosphere thermal structure in this study (e.g. [15]). Above ~900 km, Titan's thermal structure is nearly isothermal. See Figure 2. EUV/UV heating is an important heat source but does not drive large enough pressure gradients to create very strong winds. Previous modeling of the thermosphere by [16], [17], [18] simulates diurnal temperature variation of ~10 to ~20 K at 1300 km with winds of ~30 to 60 m/s, but these simulations show little to no temperature variation below ~1000 km. Near 500 km, the temperatures in the stratosphere are warm, and are apparently driven by a combination of radiative balance and global dynamics [19].

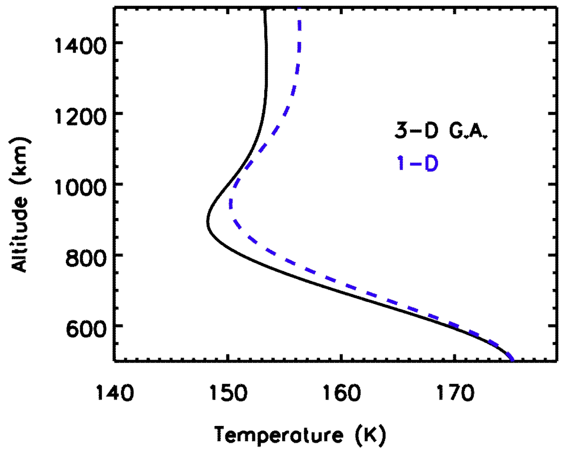

Figure 2: Simulated thermal structures from the T-GITM framework. The solid black line is a global mean temperature from the 3-D T-GITM during the solar minimum conditions of the Cassini Mission. The blue dashed line is a 1-D simulation exposed to magnetospheric heating during the same time period.

Conclusion: This work will compare Venus and Titan's thermal structure and investigate the importance of dynamics in each planets' thermal structures.

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