

Thermosphere and Ionosphere Extension of the Whole Atmosphere Community Climate Model

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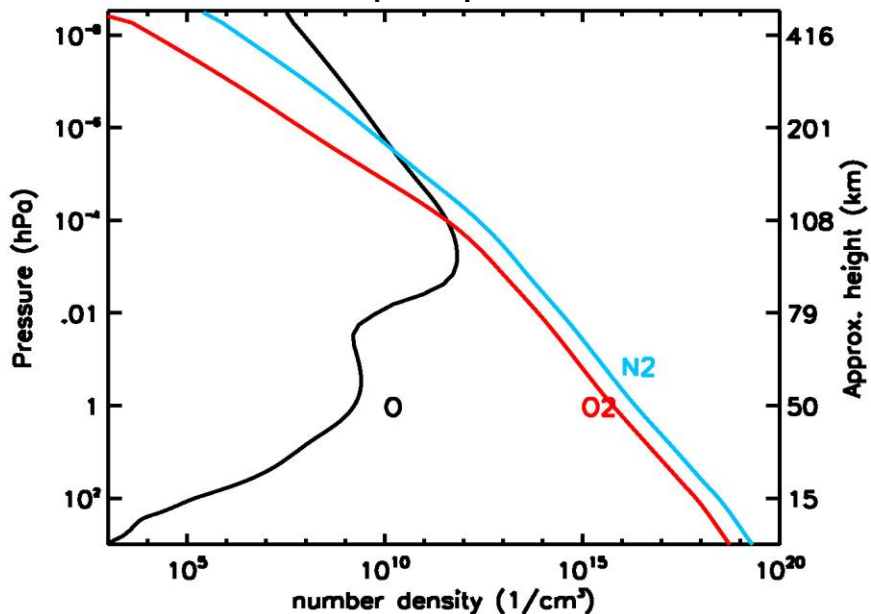


Extension of WACCM to the Thermosphere and Ionosphere

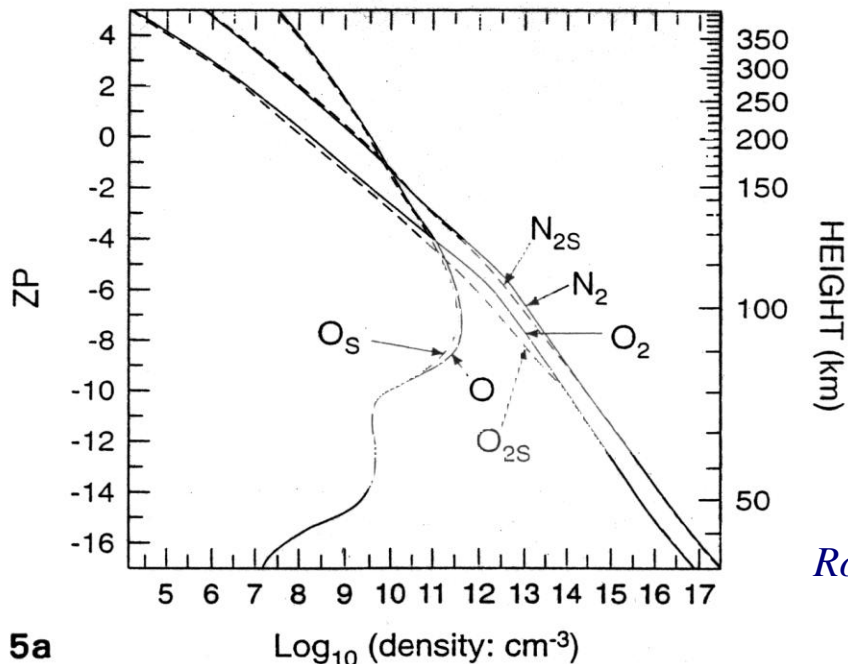
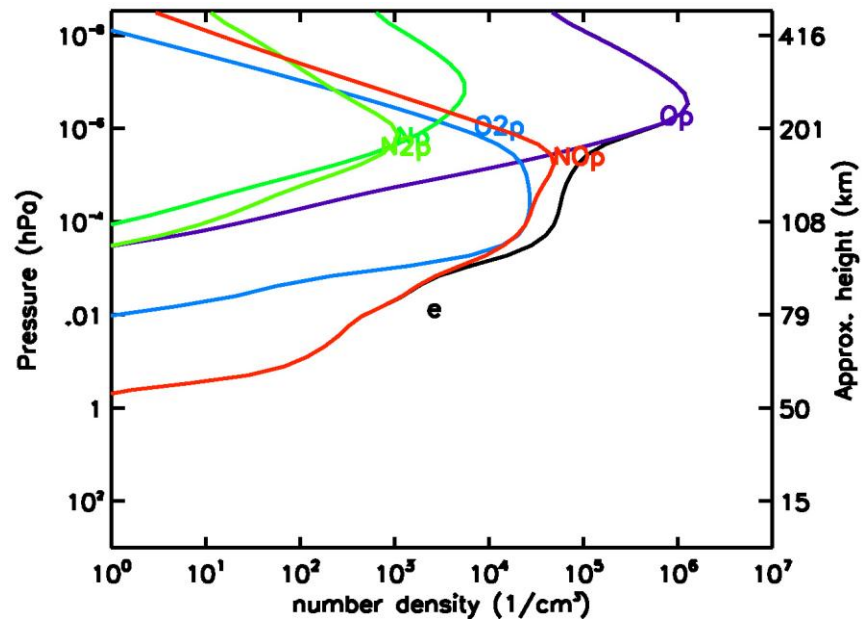
Model Framework	Chemistry	Physics	Physics	Resolution
<p>Extension of the NCAR Community Atmosphere Model V.3 (CAM3)</p> <p>Finite Volume Dynamical Core</p> <p>Green: Thermosphere extension. Red: Ionosphere extension.</p>	<p>MOZART+ Ion Chemistry (52 neutral+5 ions+electron)</p> <p>Fully-interactive with dynamics.</p>	<p>Long wave/short wave/EUV</p> <p>IR cooling (LTE/non-LTE)</p> <p>Major/minor species diffusion</p> <p>Species dependent Cp, R, m.</p> <p>Parameterized electric field at high, mid, low latitudes. IGRF geomagnetic field.</p> <p>Auroral processes, ion drag and Joule heating</p> <p>Parameterized GW (including thermosphere)</p>	<p>Ambipolar diffusion</p> <p>Ion/electron transport due to Lorentz force</p> <p>Ion/electron energy equations</p> <p>Ionospheric dynamo</p> <p>Coupling with plasmasphere/magnetosphere</p>	<p>Horizontal: 1.9° x 2.5° or 4.0° x 5.0° (lat x lon)</p> <p>Vertical: 81 levels 0-~500km</p> <ul style="list-style-type: none">• < 1.0km in Upper Troposphere/ Lower Stratosphere• 1-2 km in strat.• 0.5 scale height in mesosphere/ thermosphere (can be reconfigured as needed)

WACCM: Compositional Structures

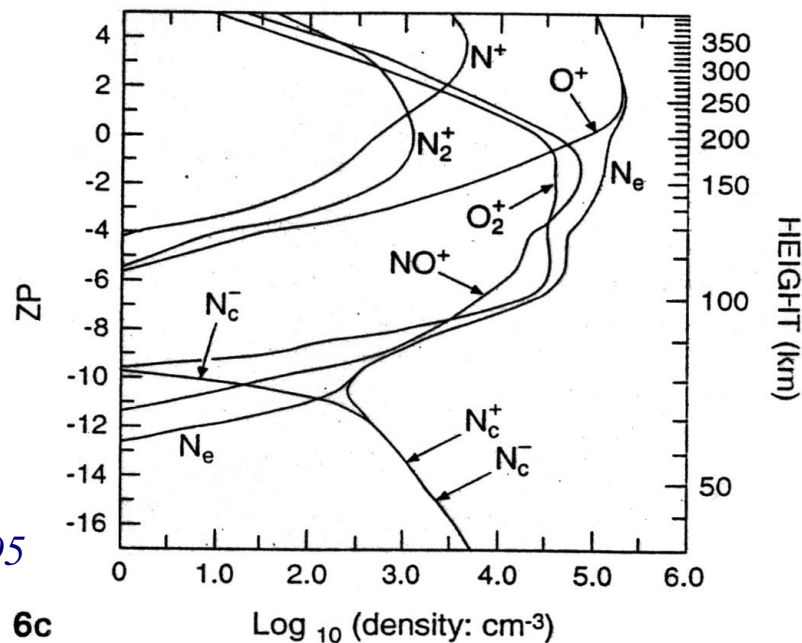
Major Species



Ions and Electrons

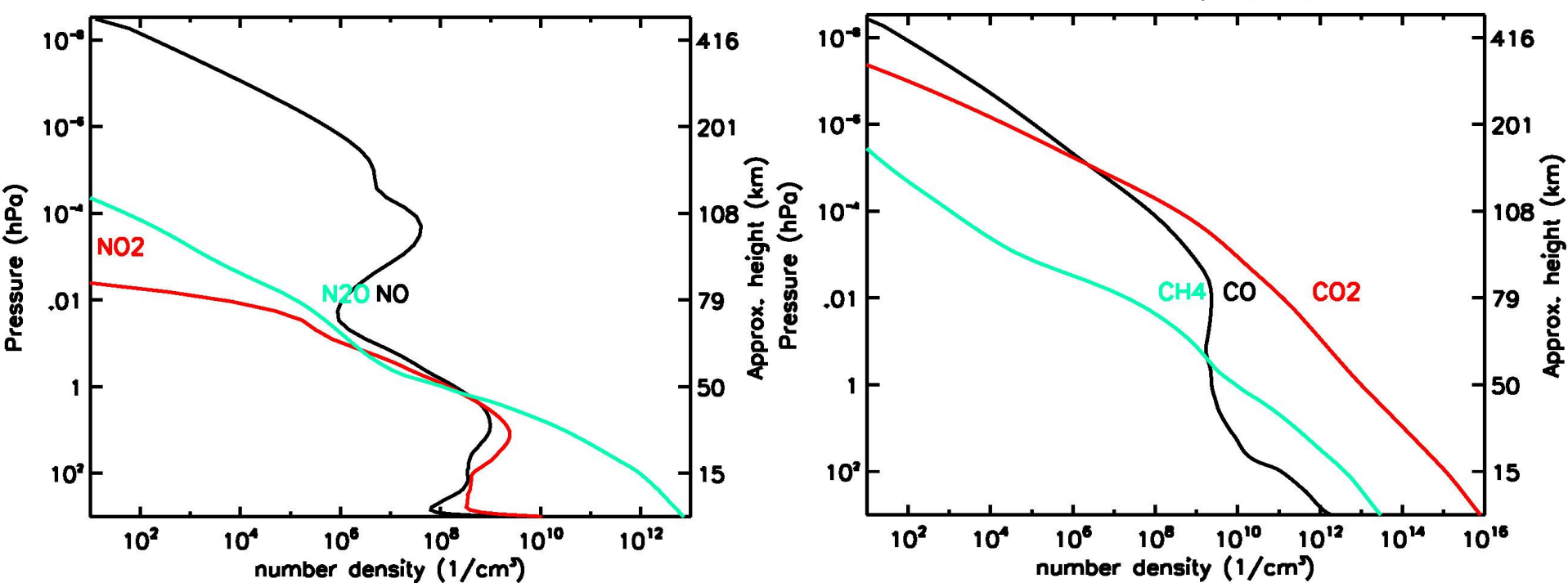
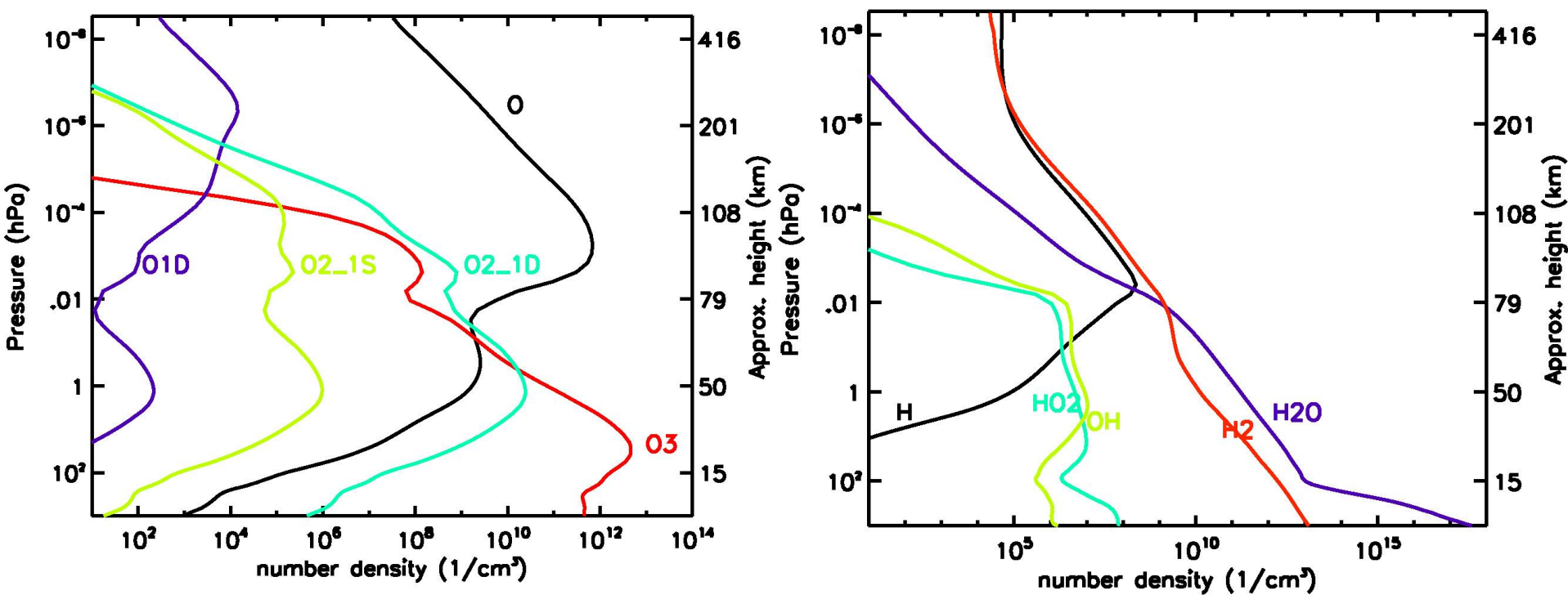


Roble, 1995

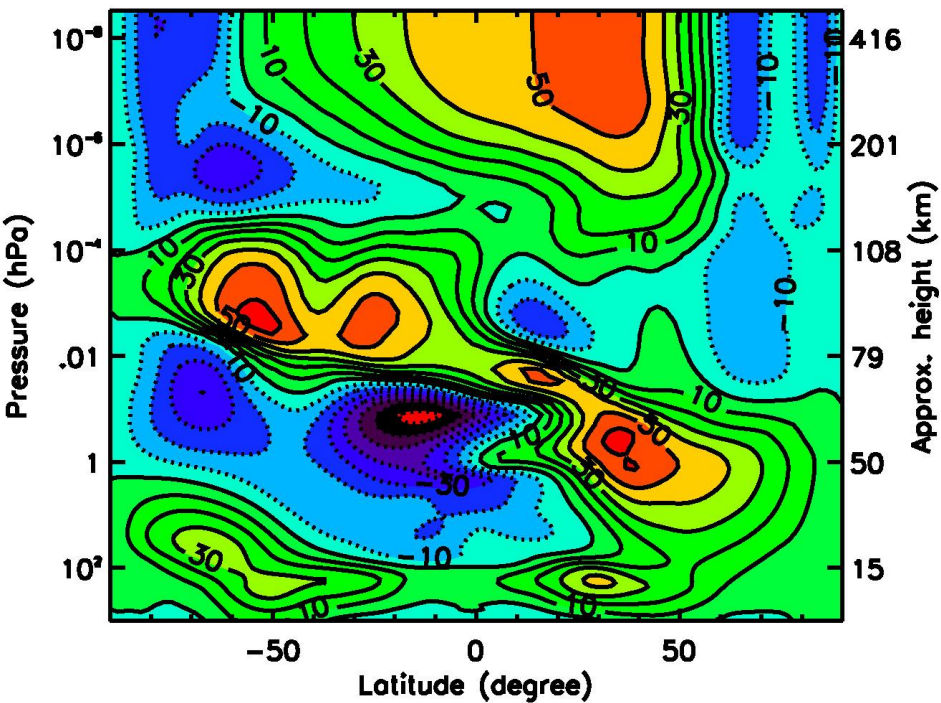


5a

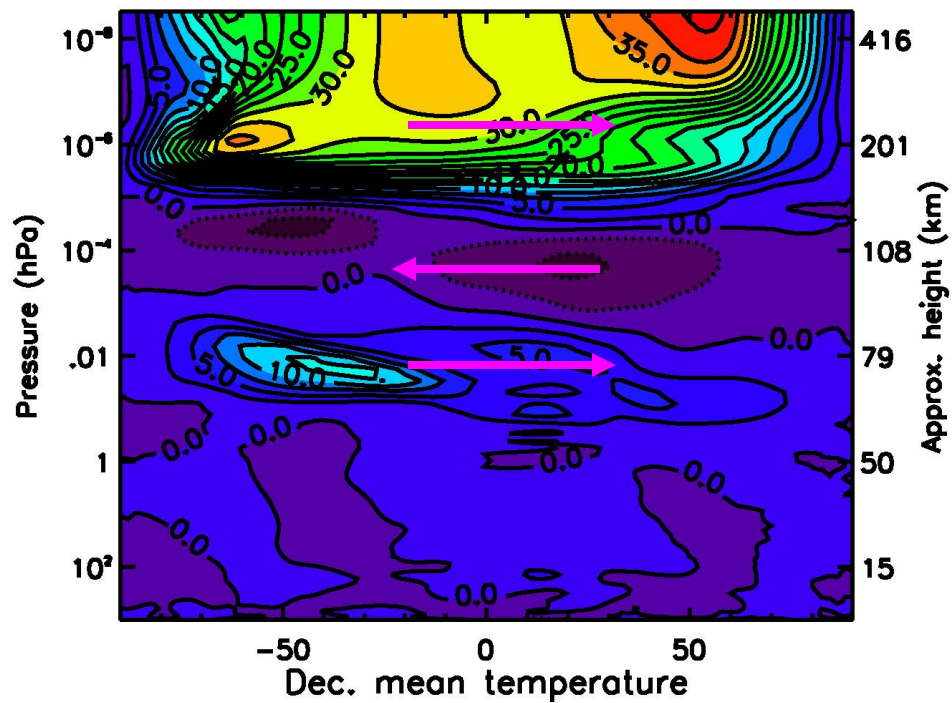
6c



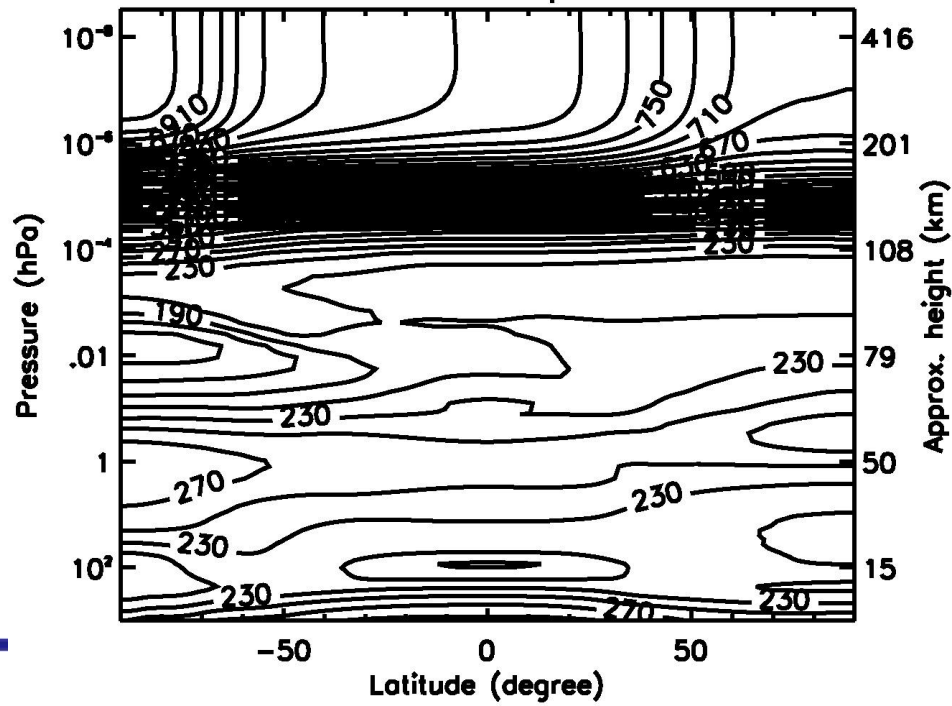
Dec. mean zonal wind



Dec. mean meridional wind

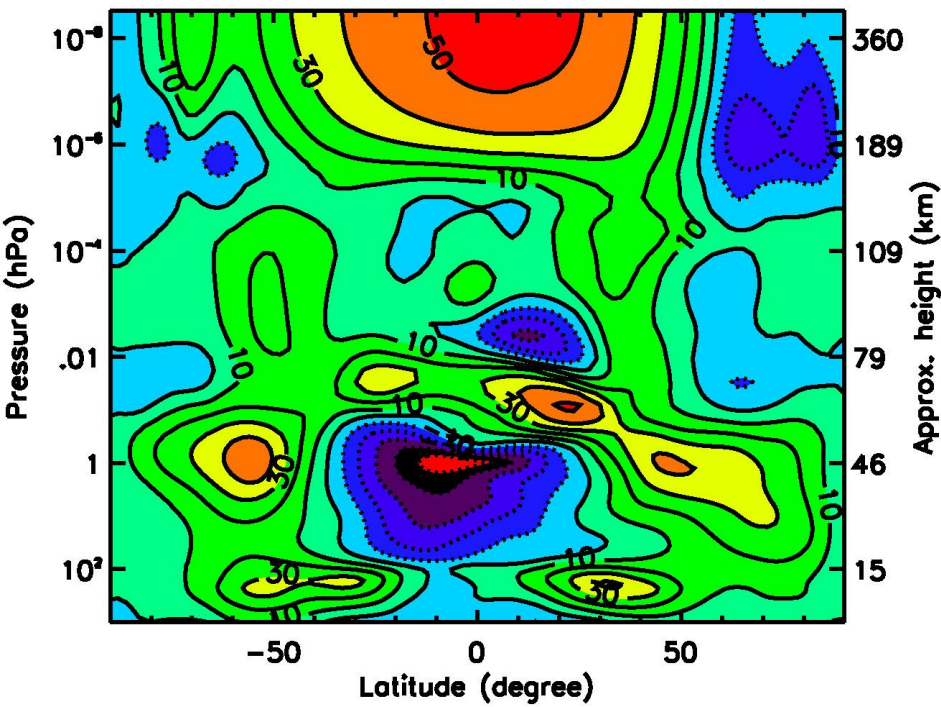


Dec. mean temperature

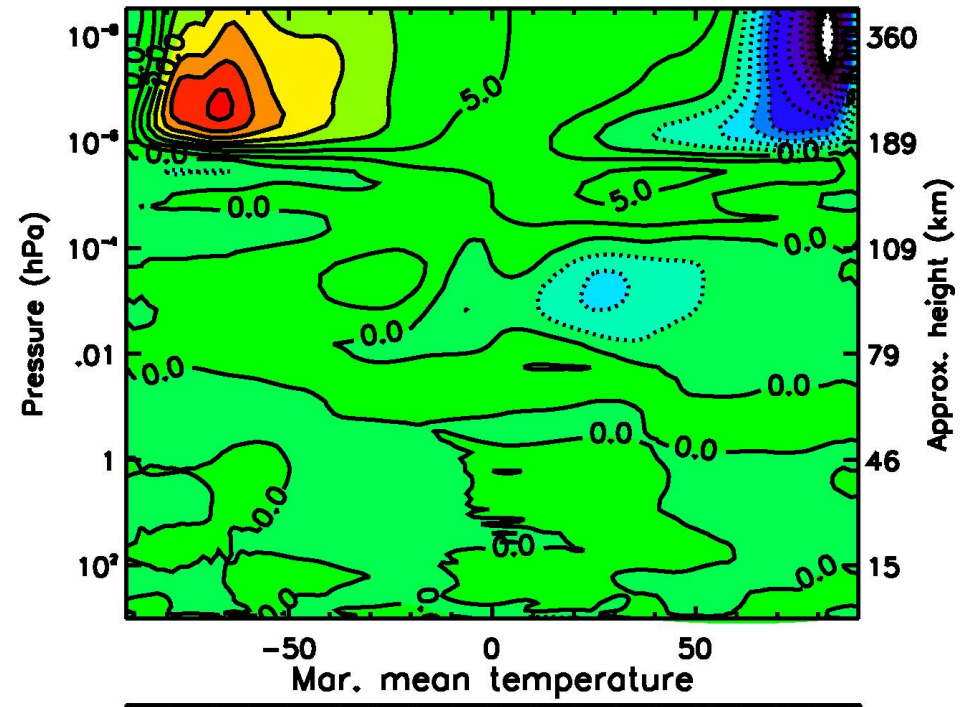


WACCM: Winds and Temperature (December)

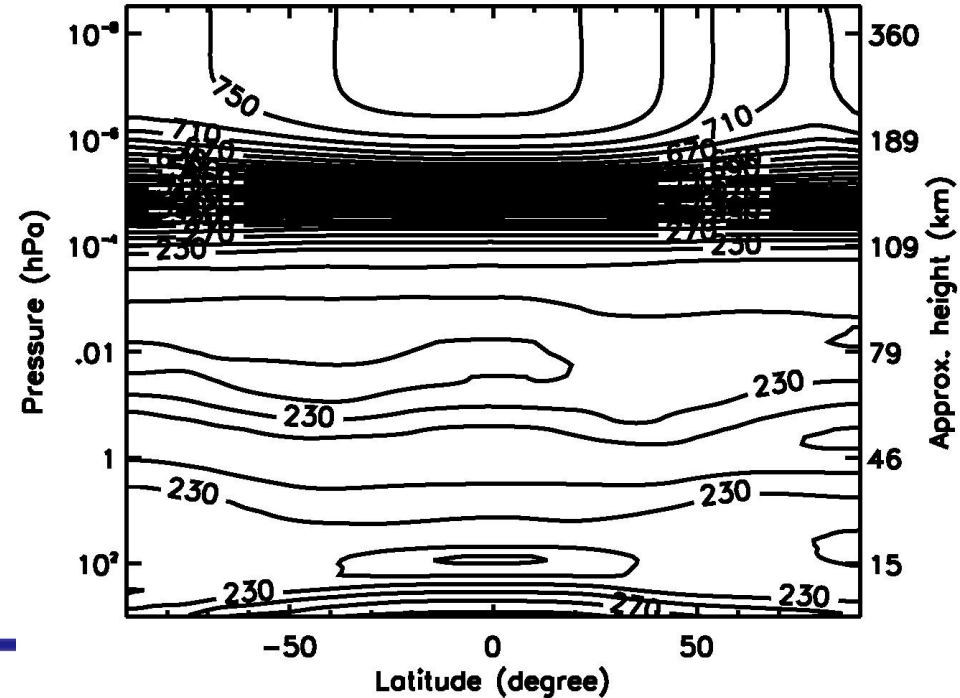
Mar. mean zonal wind



Mar. mean meridional wind



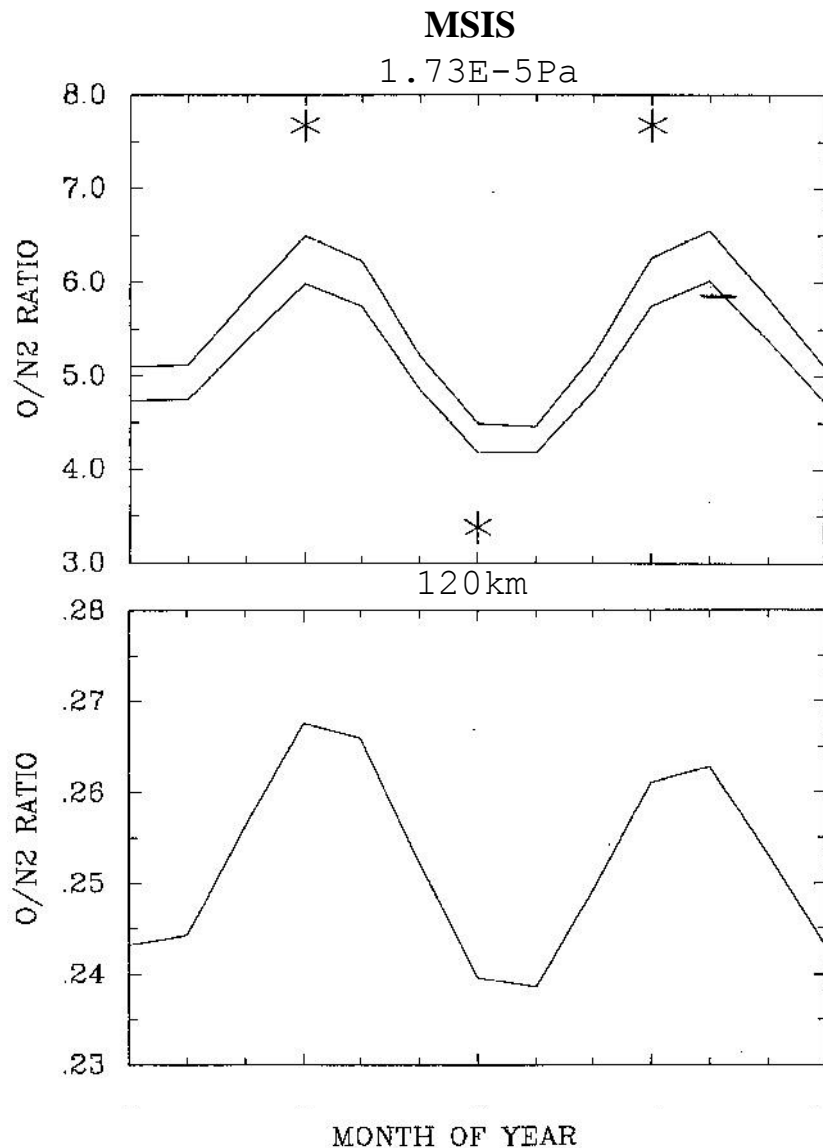
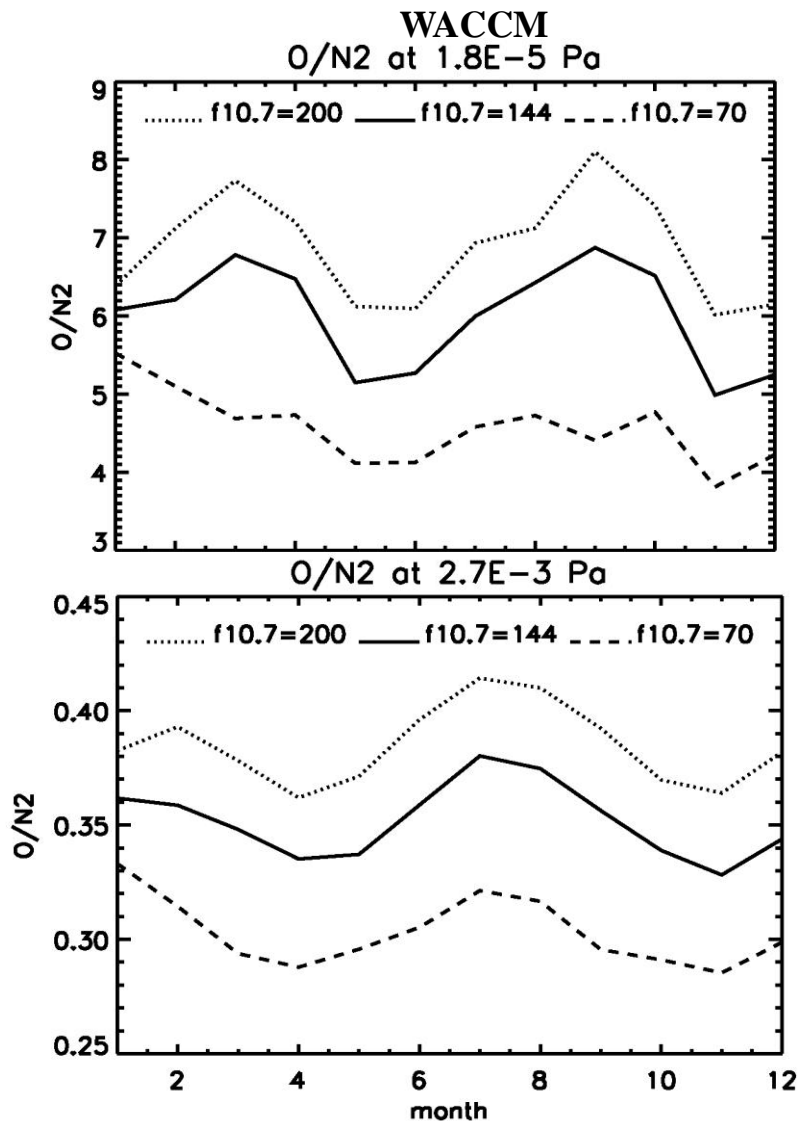
Mar. mean temperature



WACCM: Winds and Temperature (March)



Thermosphere Semi-annual Variation



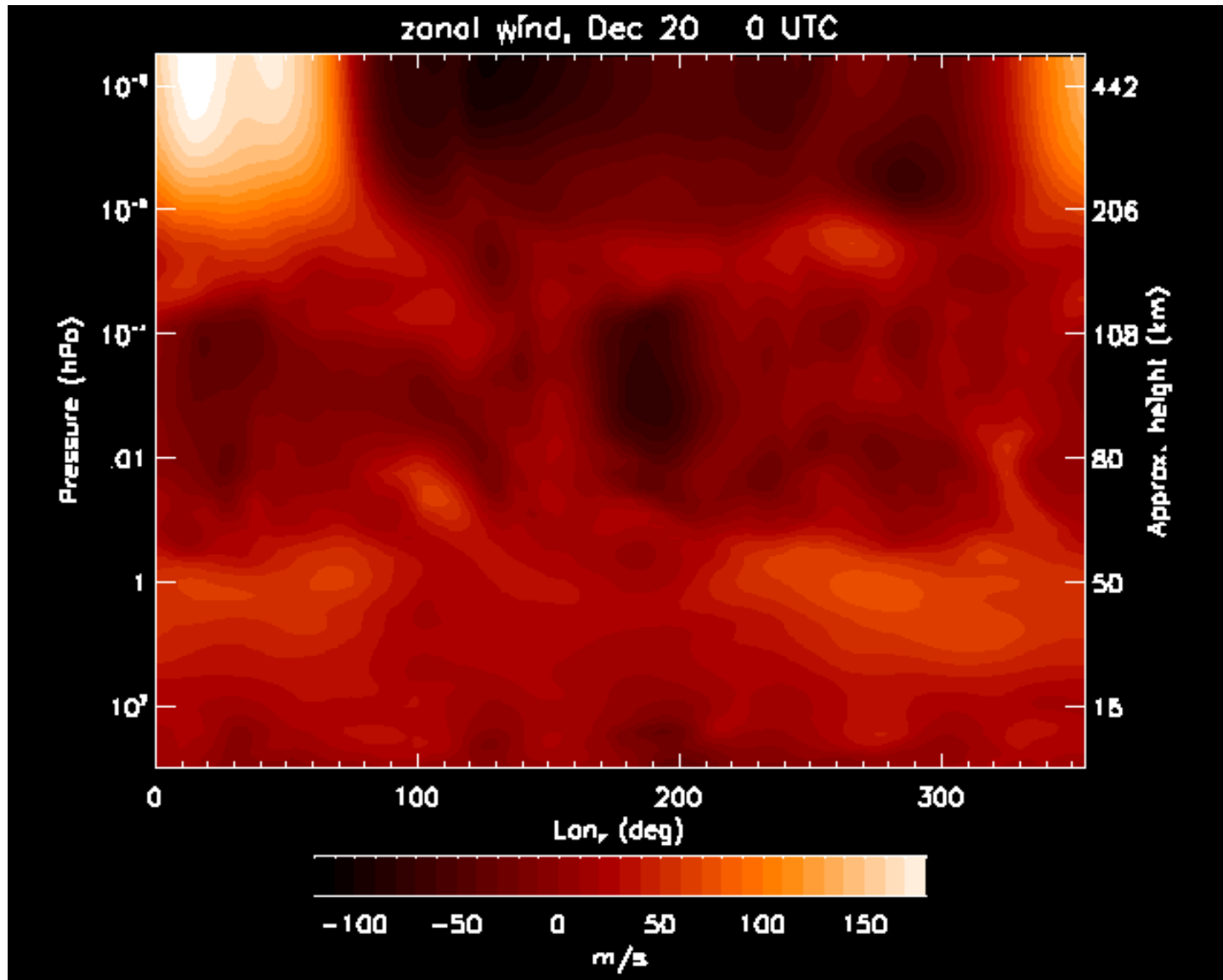
~250 km

120 km

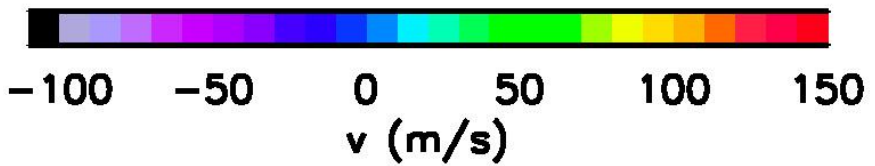
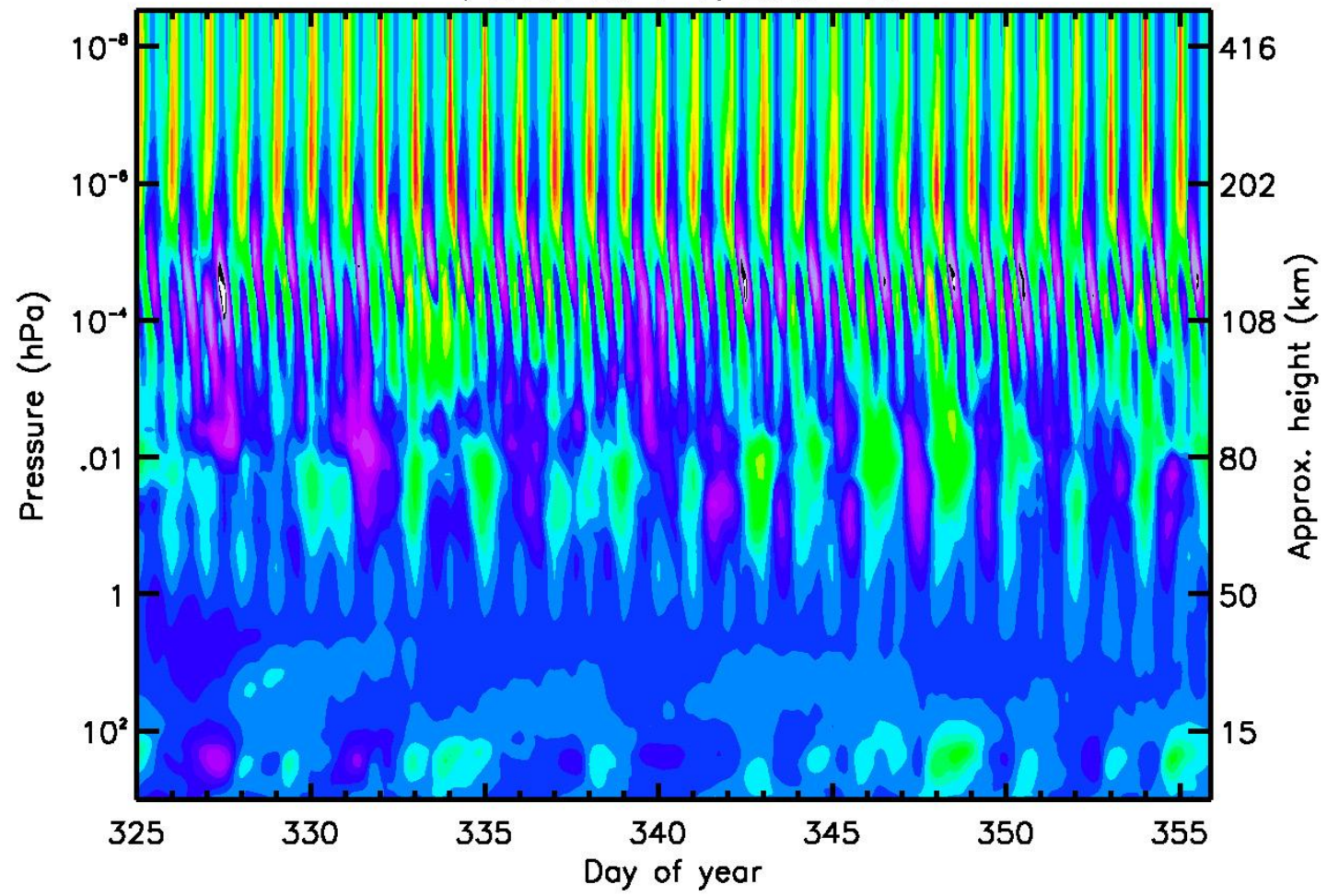
(Courtesy Fuller-Rowell, 1998)



Short-term Variability



V, Dec. Lon. 0, Lat. 46S



Summary and Future Studies

- The extended WACCM reproduces salient features of
 - Atmospheric composition, temperature and wind of the whole atmosphere.
 - Semi-annual variation in the thermosphere.
 - Tides
 - Migrating components: weaker than observed. Test with higher vertical resolution (.25 scale height) yields results in good agreement with observations.
 - E3 diurnal--comparable to observed.
- Further analysis of thermospheric variability as related to the coupling with the lower atmosphere.
- Further development to include ionospheric electrodynamics.