

Groundbased Atmospheric Monitoring Update: Why is the Atmosphere so Stable?

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Observations

TEXES, IRTF

R=60,000

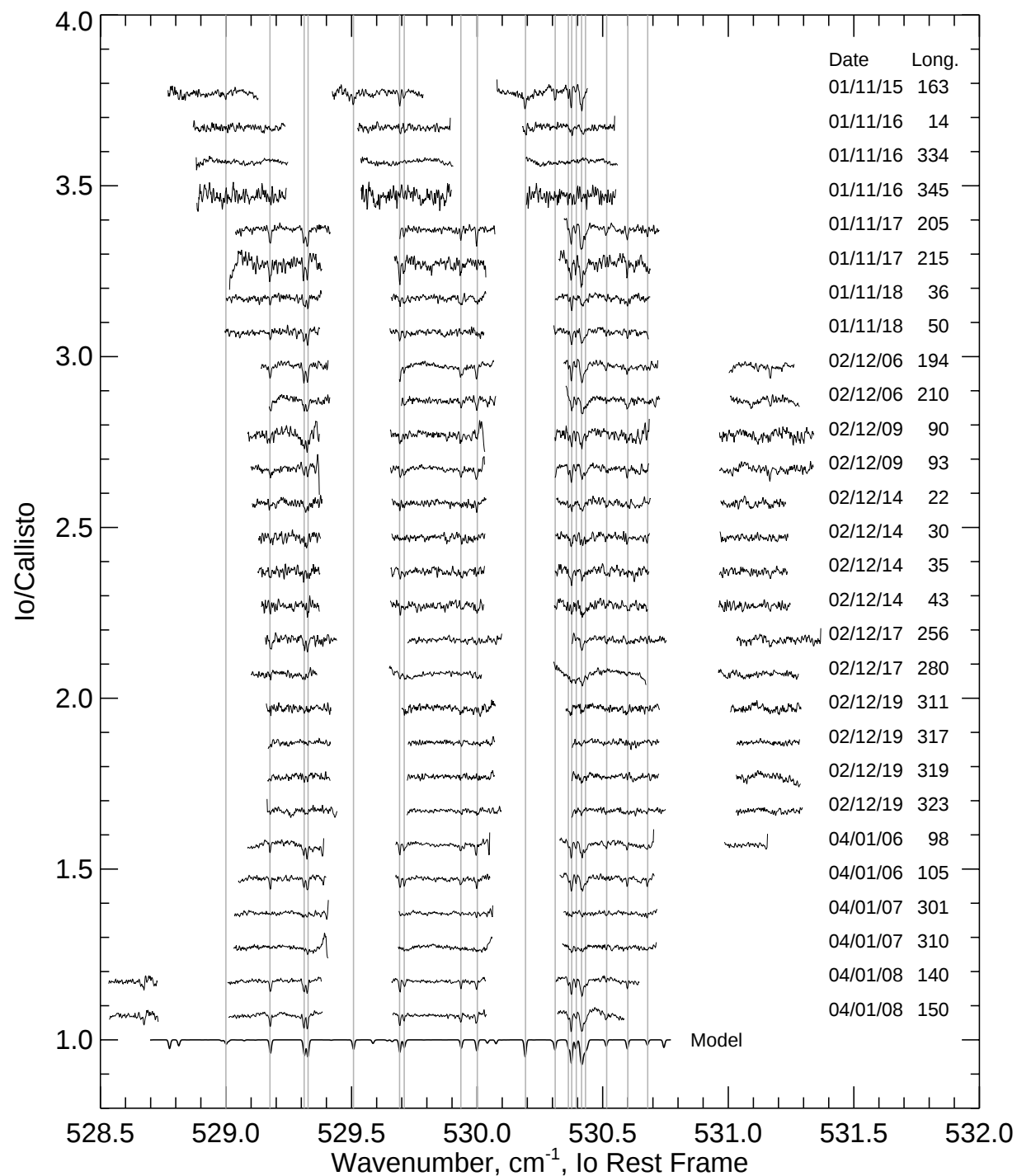
19 microns

SO₂ ν_2 band

~15 lines visible

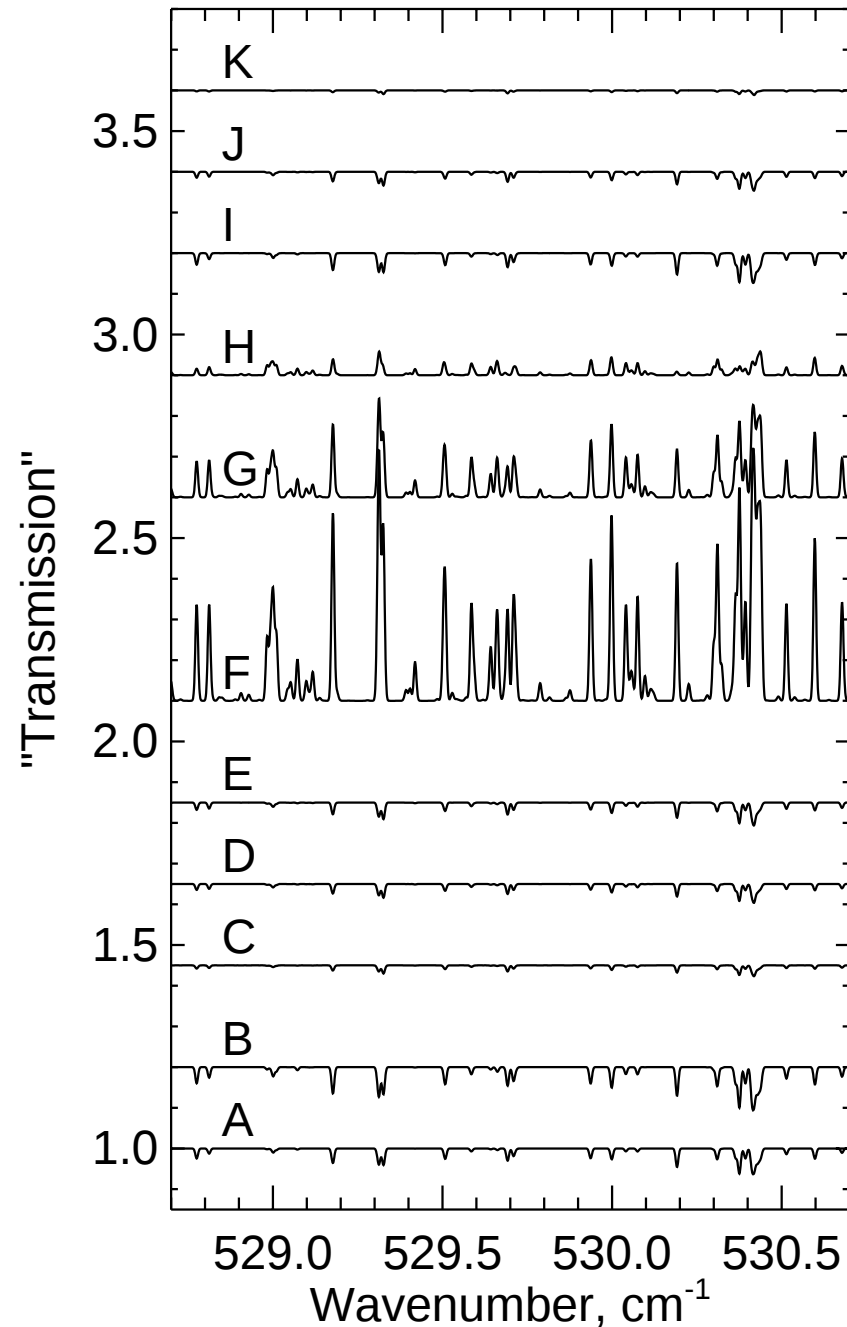
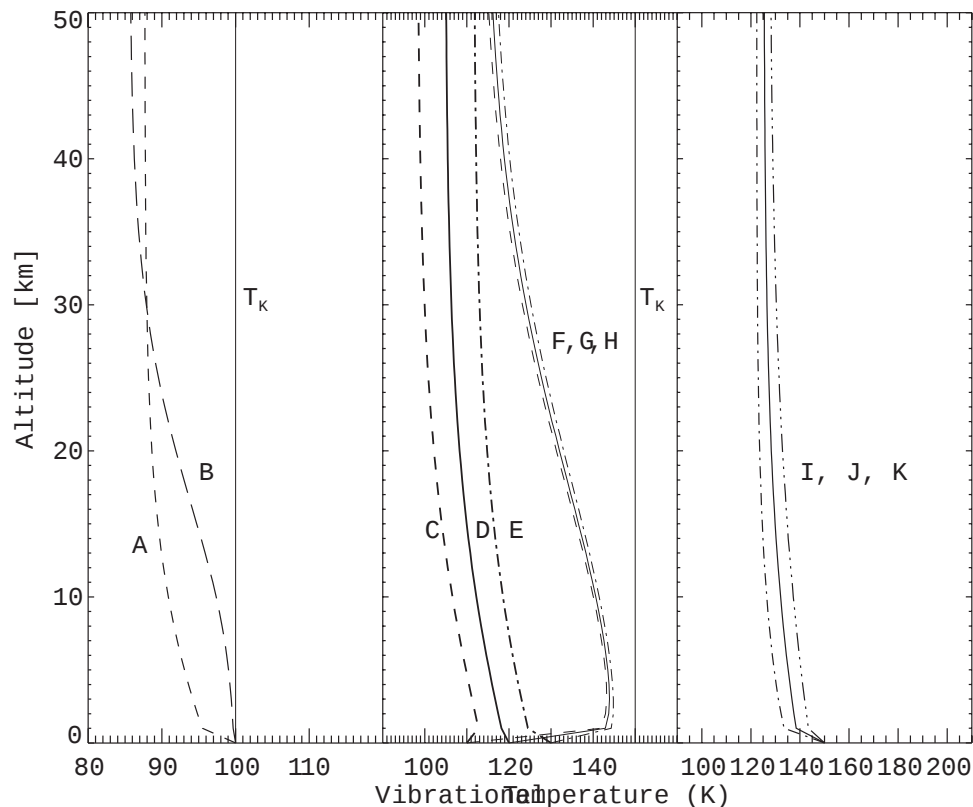
3 years of
observations:

2001, 2002,
2004



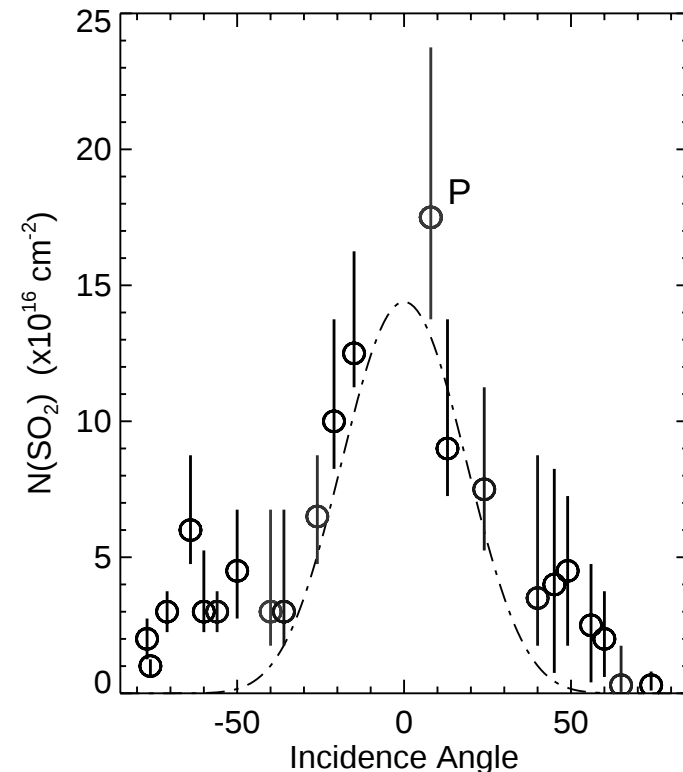
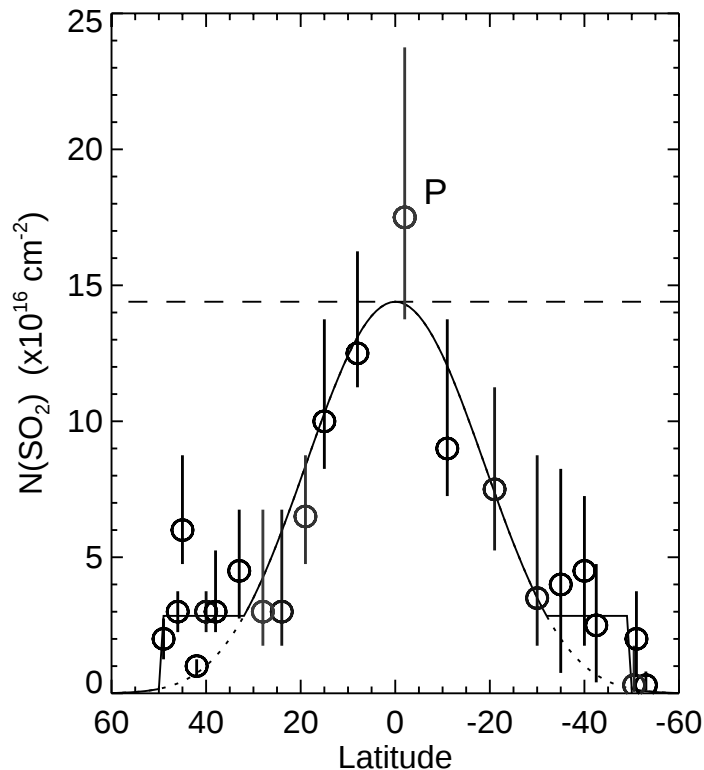
Modeling

Line strength depends on
surface, atmosphere T
Non-LTE effects are important



Atmospheric Model

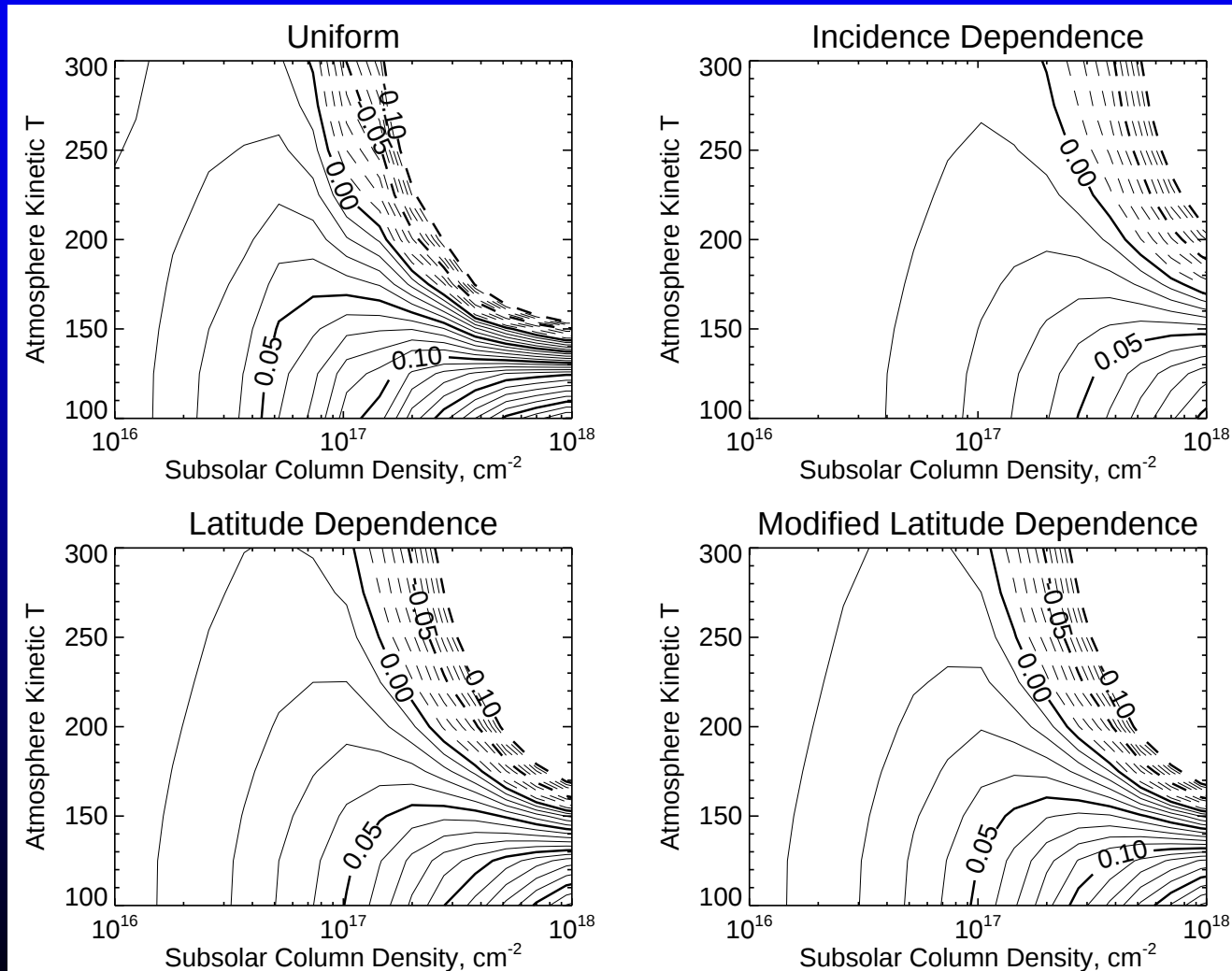
- Isothermal with variable T
- Several models of spatial distribution:
 - Uniform
 - Solar incidence dependent
 - Latitude dependent
 - Latitude dependent with increased mid-latitude abundance



Model Results

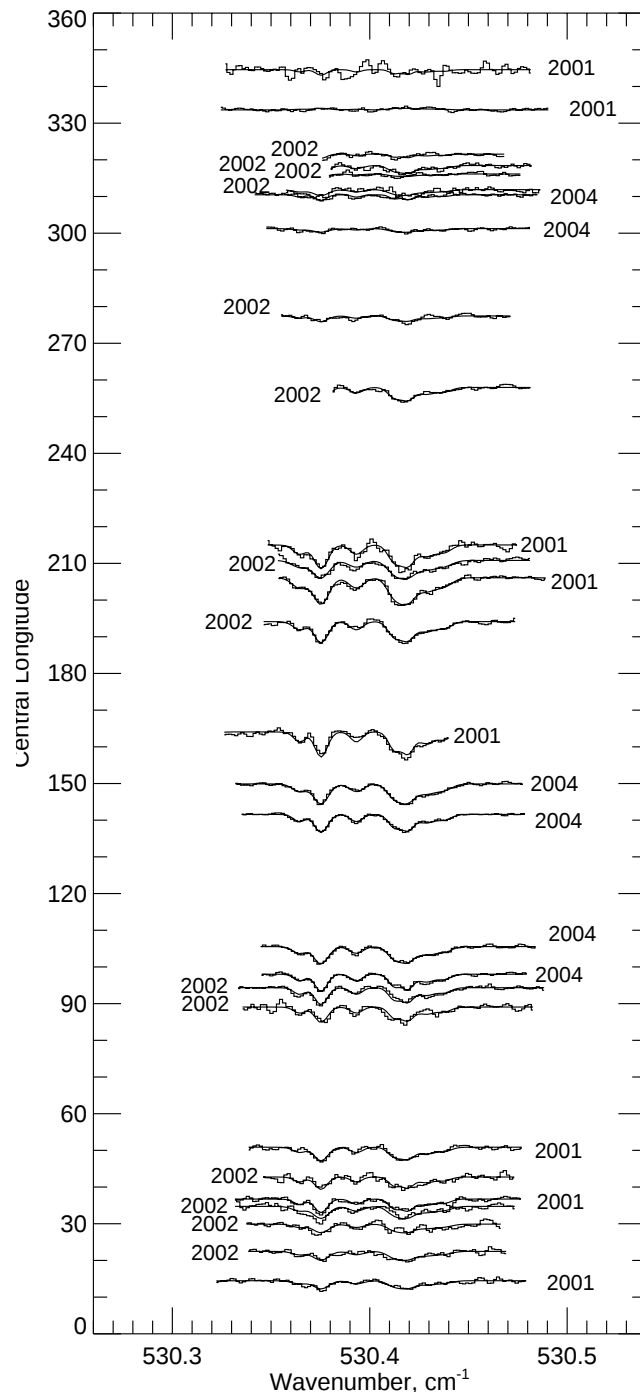
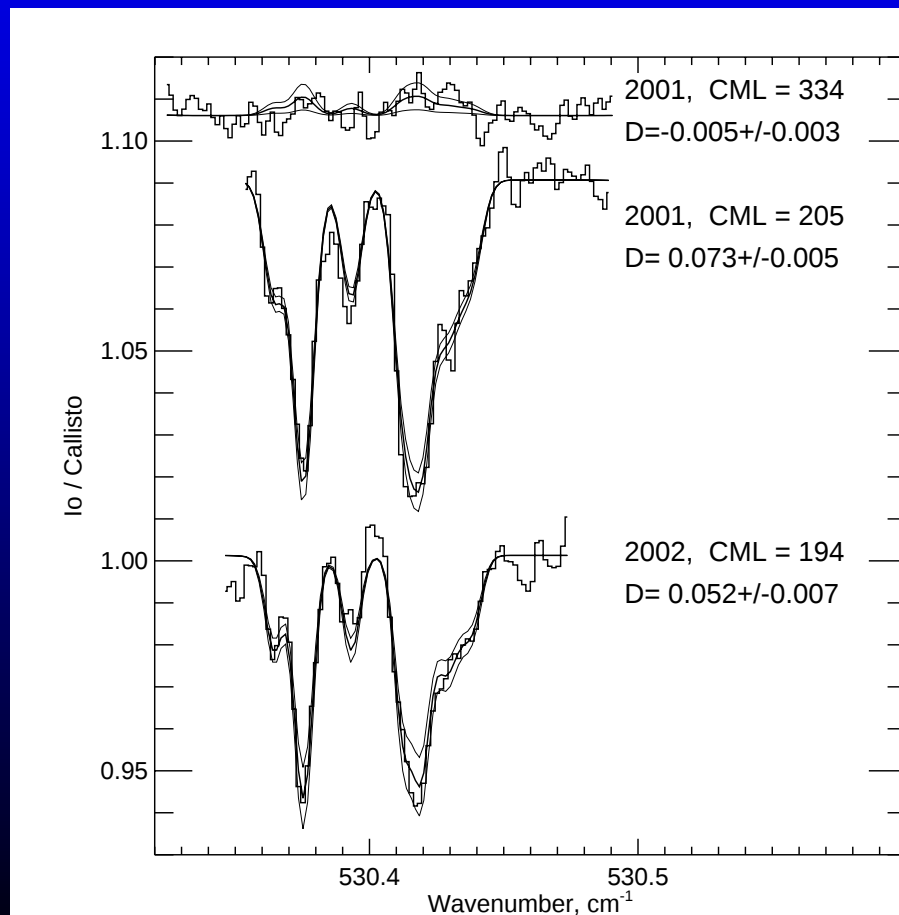
Band strength vs. subsolar column density, atmospheric T, for each atmospheric model:

Data can also be fit by a model that assumes all the atmosphere is above low-T (150 – 200 K) hotspots, but this is unlikely on other grounds



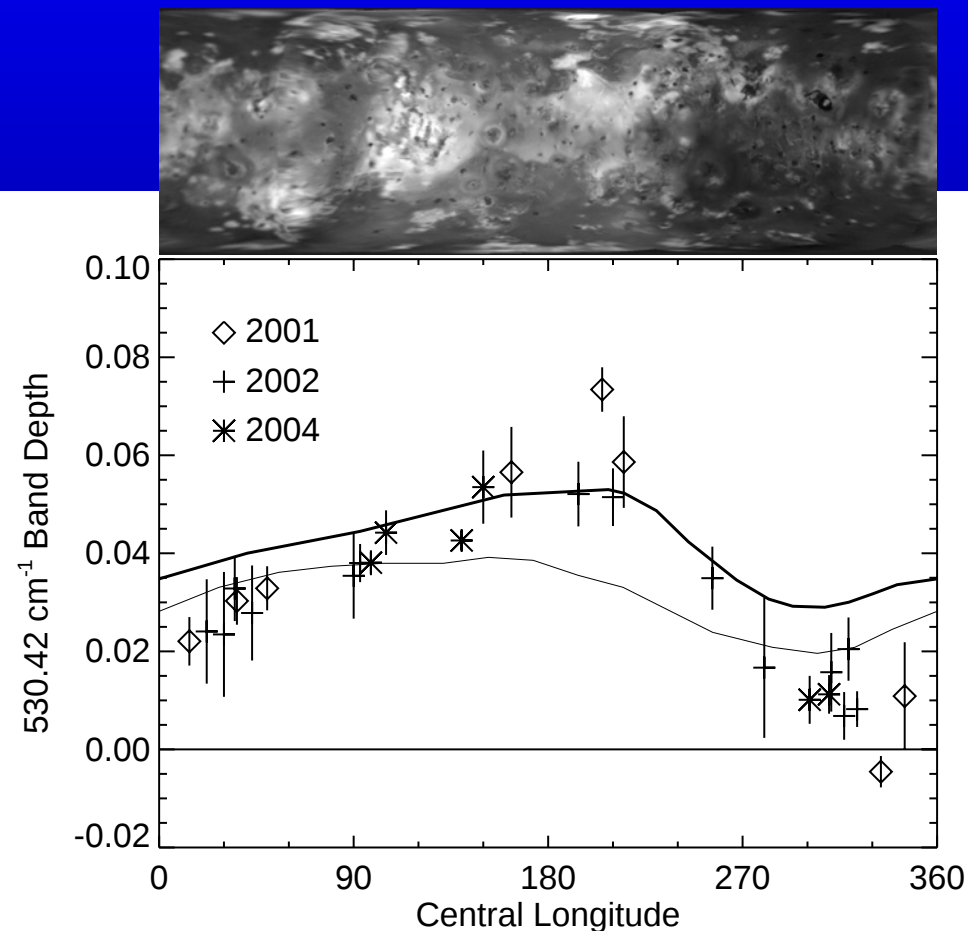
Spectrum fitting

- Model fits to spectra, sorted by longitude



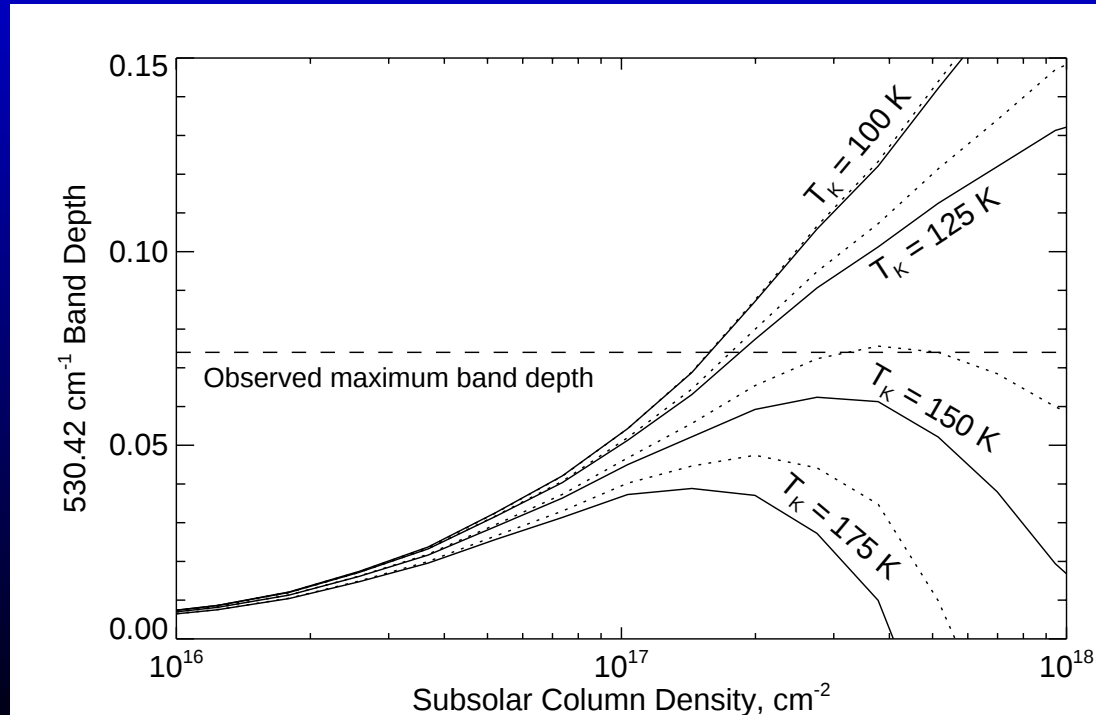
Band strength vs. longitude

- Large longitudinal variations
- Stable over 3 years
(including January 2005 data, not shown)
- Correlate (sort of) with Io's 3500/5500 Å color and distribution of optically thick SO₂ frost (McEwen 1988)



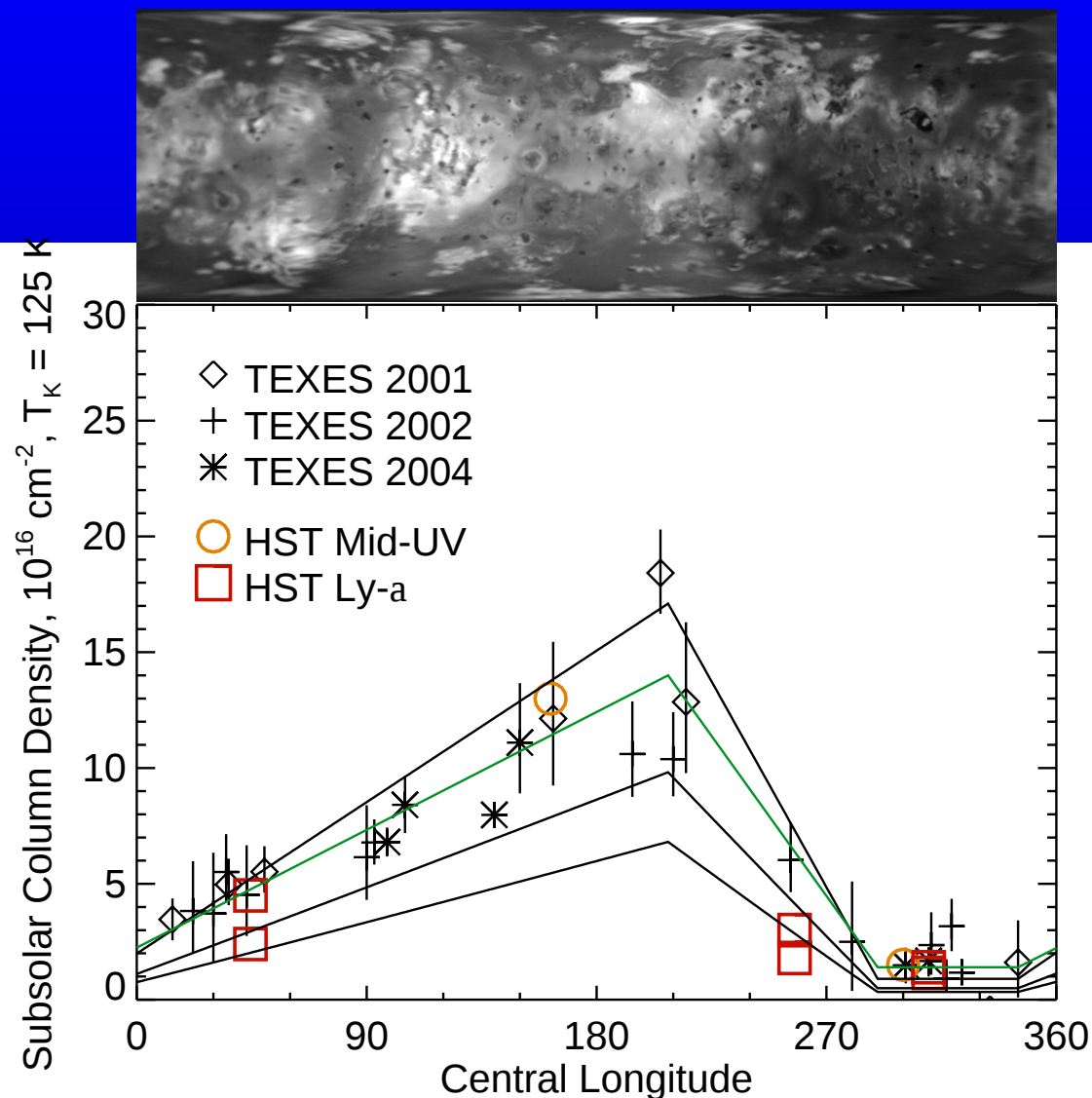
Band depth interpretation

- Used modified-latitude atmospheric model: most consistent with other data
- Observed maximum band depth $\sim 7\%$
 - Sets upper limit to atmospheric temperature: ~ 140 K (surprisingly low)
 - Sets lower limit to subsolar column density: $\sim 10^{17}$ cm $^{-2}$ on anti-Jupiter side

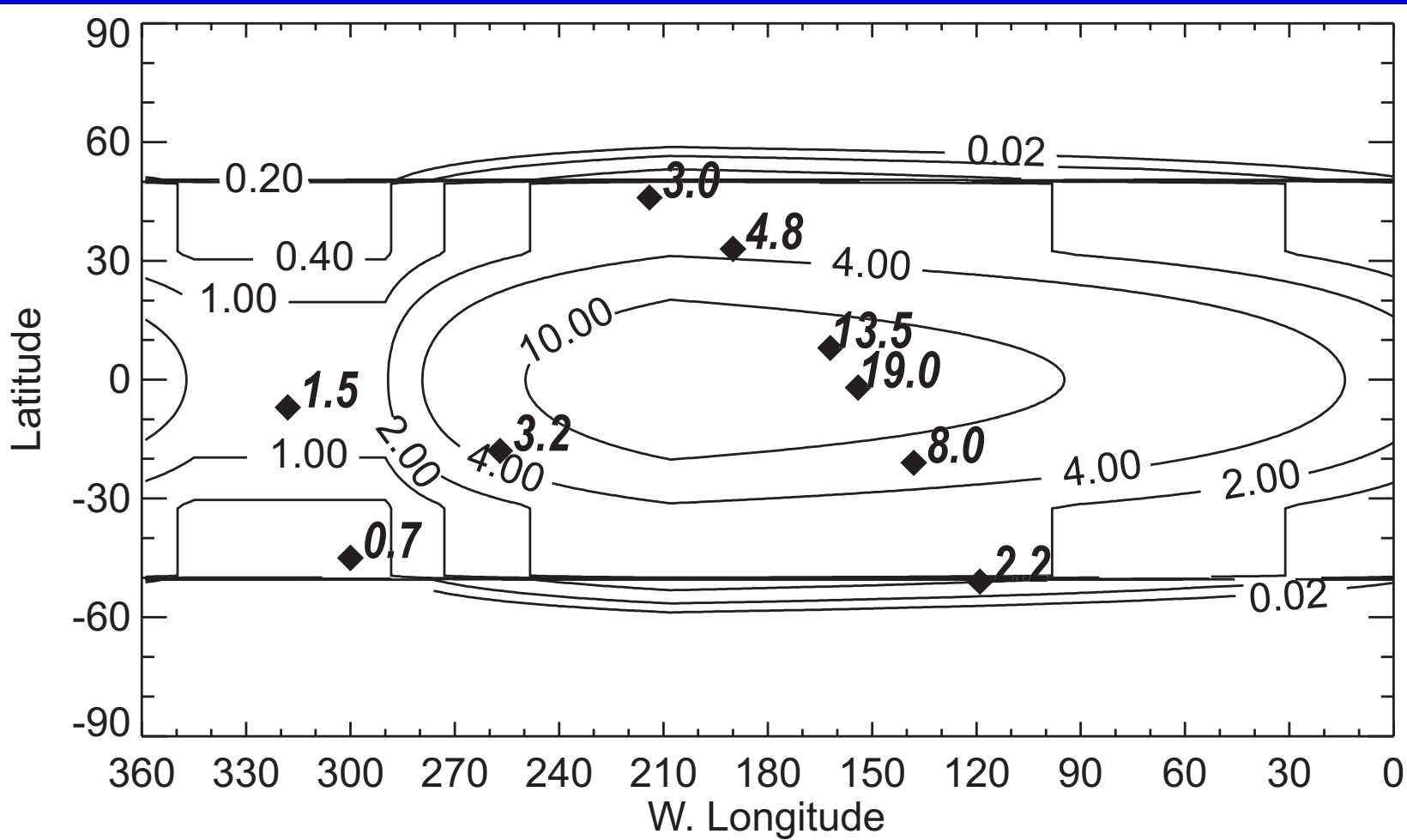


Longitudinal atmospheric distribution

- Use $T = 125$ K to match band depths
- Matches UV observations (though inferred density tends to be higher than Ly-alpha results (Feaga et al. 2004, DPS poster))
- No obvious heliocentric variation (except maybe 2001 – 2002 anti-Jupiter side)



Global Atmospheric Model

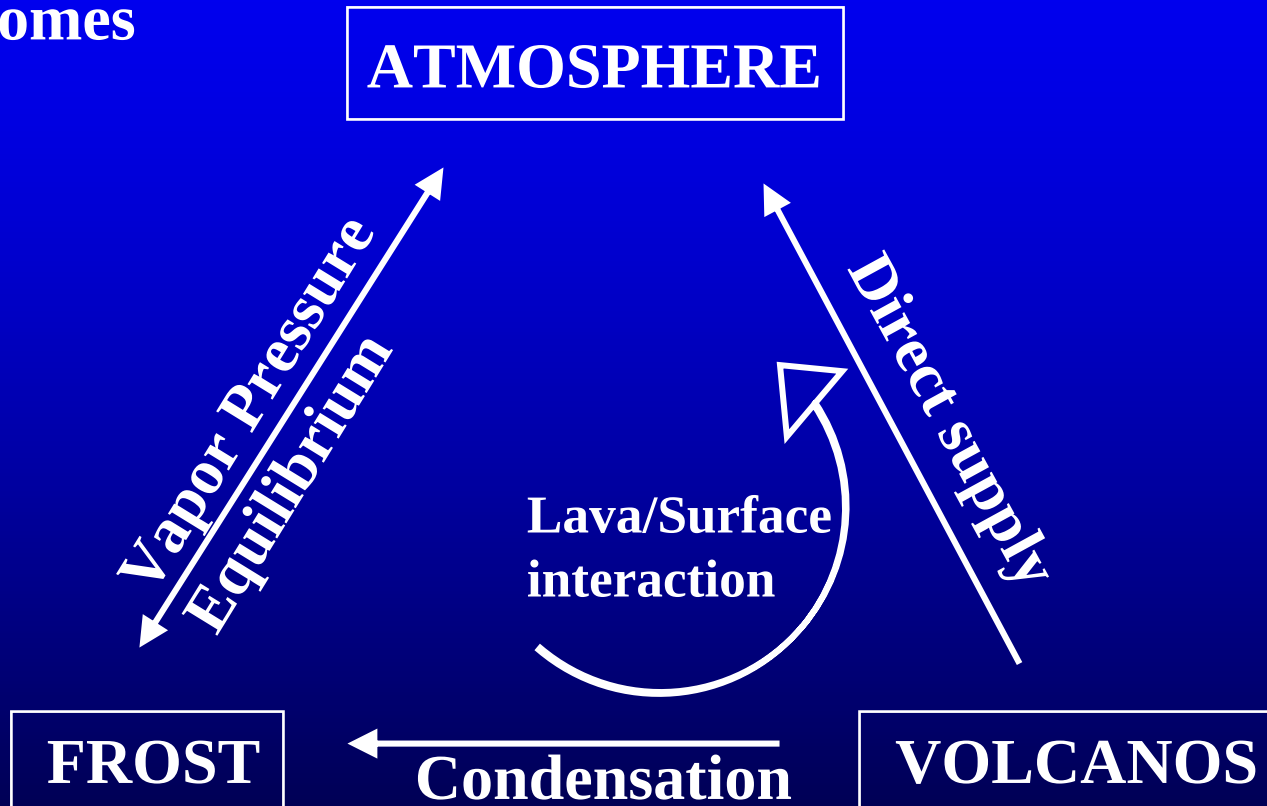


Publication

Spencer et al. 2005, *Icarus*, in press. See
<http://www.boulder.swri.edu/~spencer/publications.html> for a
preprint

Frost/Atmosphere Correlation

Which comes first?



Why is the Atmosphere so Stable?

Band strengths on the leading/anti-Jupiter side

- Sublimation atmosphere should have collapsed in the last 3 years as Io and Jupiter reached aphelion
 - Simple sublimation models predict a 2-3 fold drop in atmospheric pressure from 2001 - 2005
- Volcanic atmosphere should show variations in response to variations in volcanic activity
 - One possible example- drop in SO₂ band strength on the anti-Jupiter side between 2001 and 2002
- Mm-wave (Lellouch 1996) and mid-UV (Jessup et al. 2005) observations in the 1990s showed significant variations from year to year, unlike the mid-IR
 - Do the mm-wave, mid-UV, and mid-IR observations sense different parts of the atmosphere?
 - Or has the atmosphere simply been more stable lately?