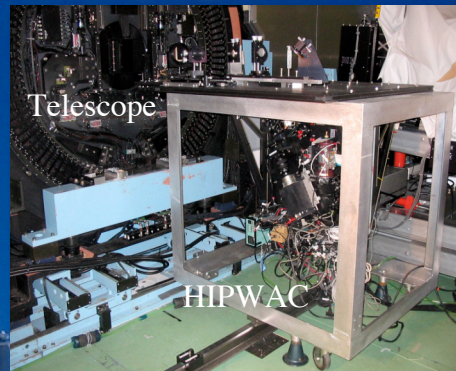


Stratospheric Global Winds on Titan at the Time of Huygens Descent



HIPWAC
at Subaru Nasmyth
Focus
Jan. 14-15, 2005



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Goals of HIPWAC Investigations on Subaru

Primary Goals on Titan:

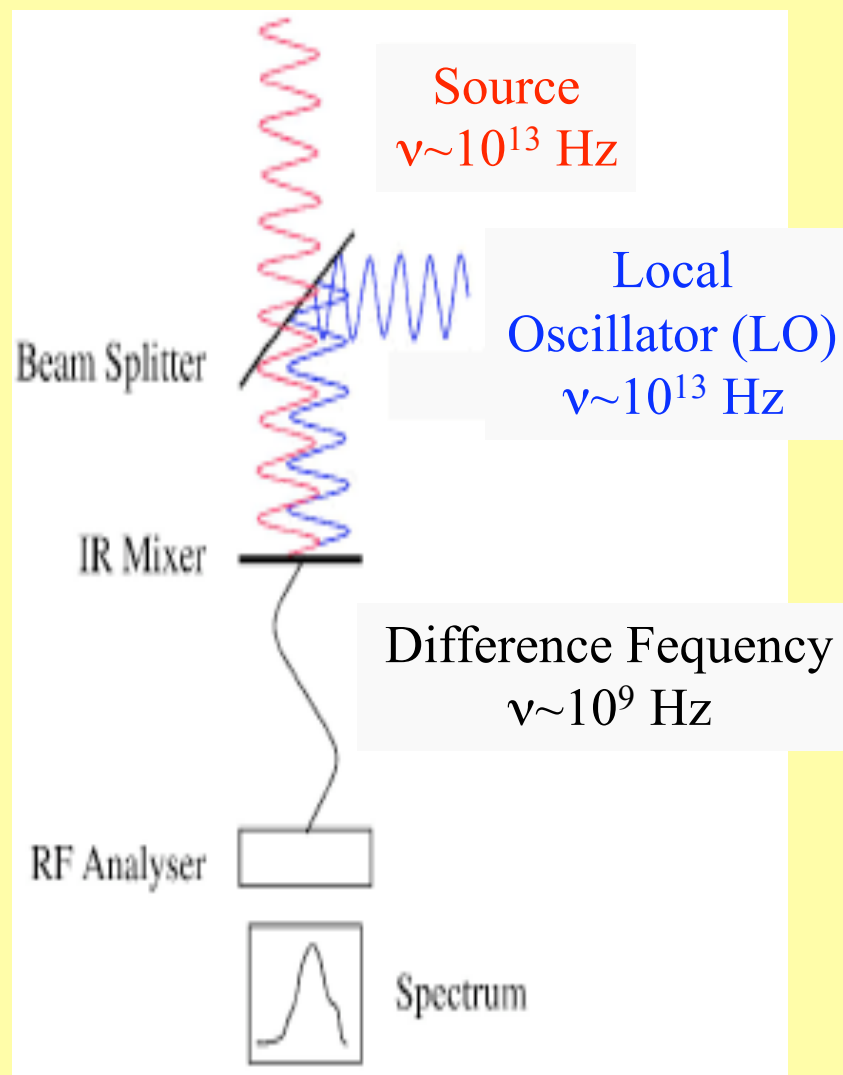
- Directly measure *Wind Direction* and *Magnitude*
- Study atmospheric dynamics of slowly rotating bodies
- Measure atmospheric ethane (C_2H_6) abundance
- Constrain Stratospheric Temperature
- Support the Cassini-Huygens Mission
- Coordinate with other observers during Huygens descent into Titan

Discover and Investigate Any Unexpected Phenomena

IR Heterodyne Spectroscopy

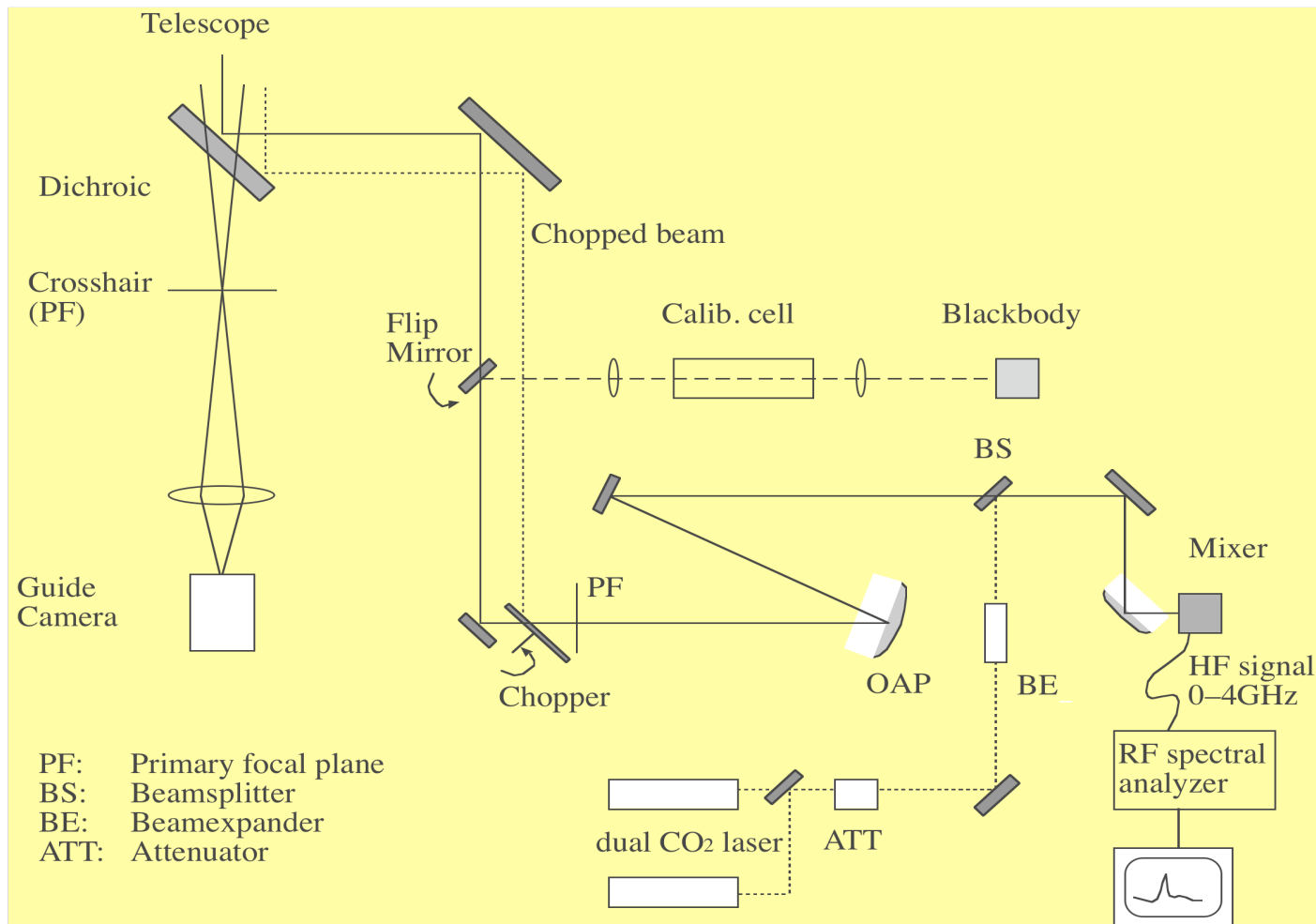
Performance Parameters

- $S/N = 2 \sqrt{B\tau} / \Delta(e^{h\nu/kT} - 1)$
- $\lambda/\Delta\lambda > 10^7$
- 9–12 μm CO₂ laser LO
- ± 3 GHz for HgCdTe mixer
- $1:10^8$ Frequency Determination
- $\theta \sim \lambda/D$ (Diffraction Limited)
- MEASURES TRUE LINE SHAPES
- VELOCITY TO ~ 1 m/s

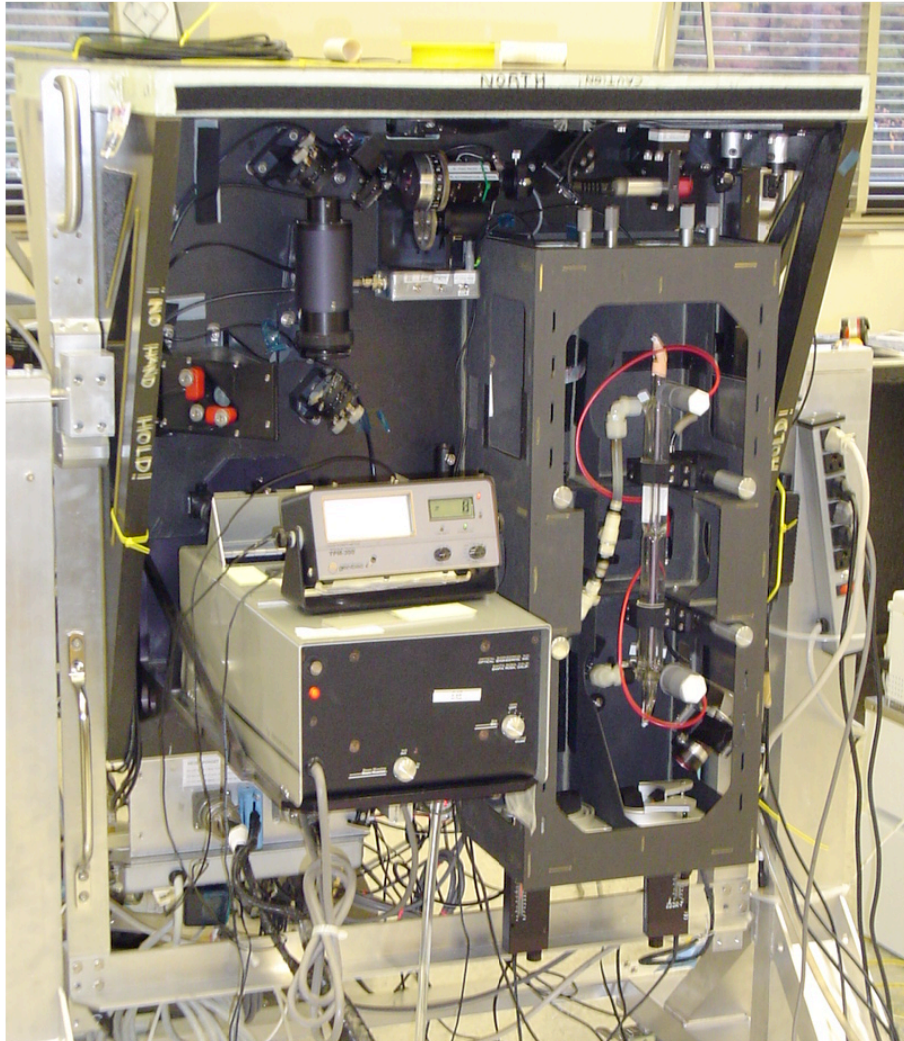


HIPWAC

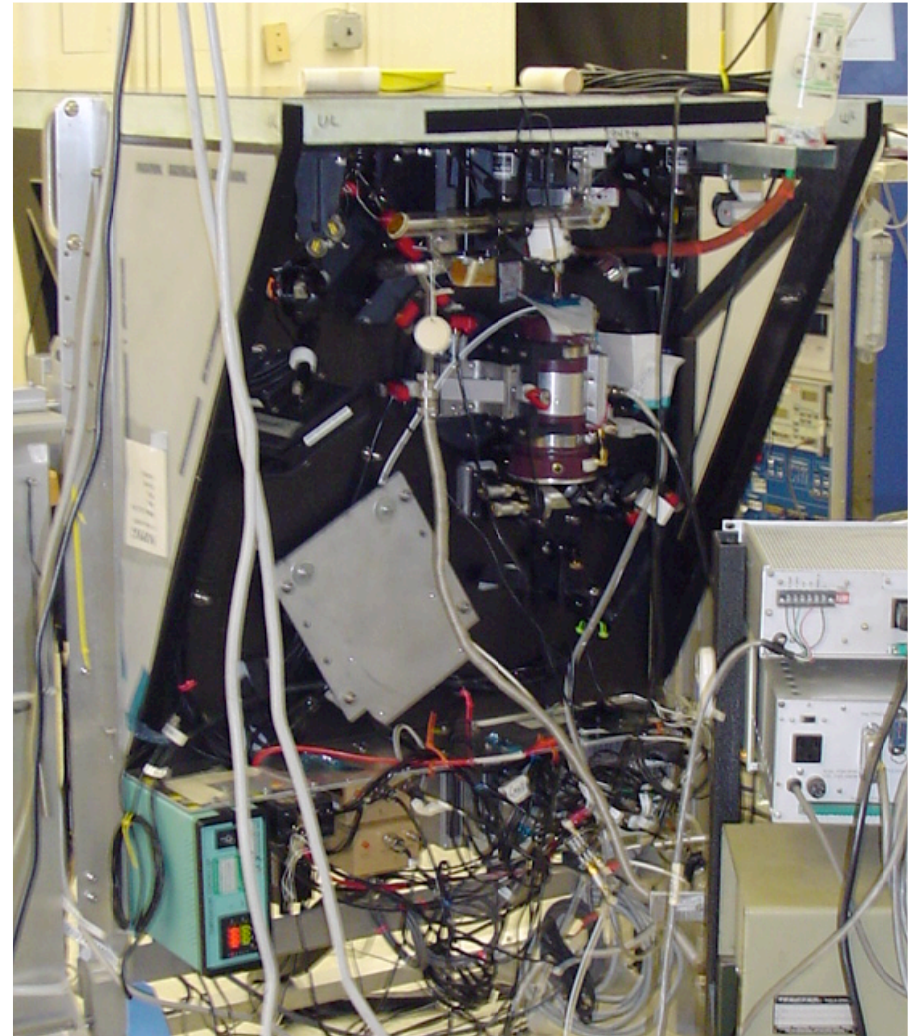
Heterodyne Instrument for Planetary Wind And Composition



Heterodyne Instrument for Planetary Wind And Composition



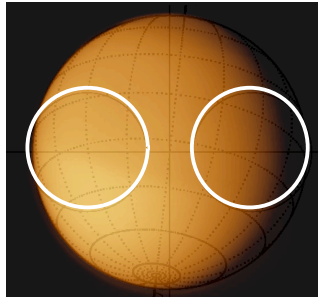
Laser Side



Mixer Side

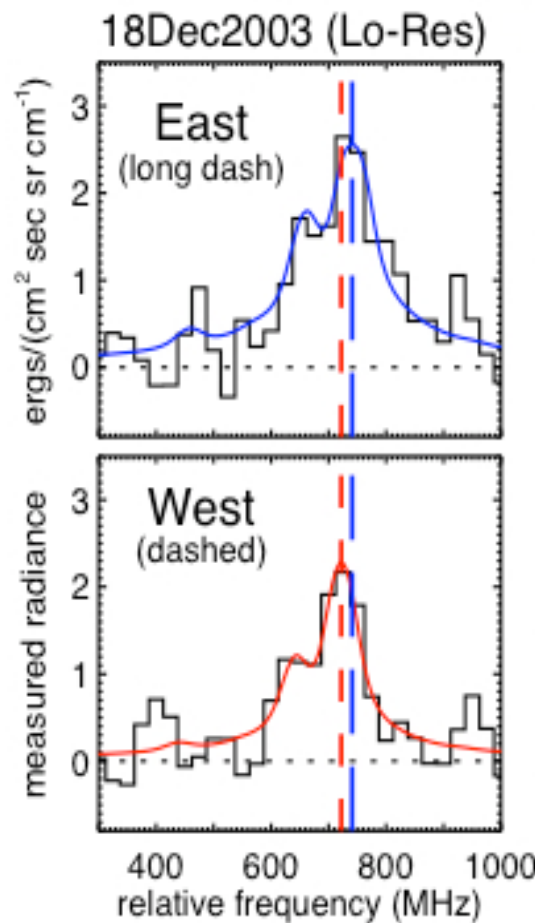
HIPWAC/Subaru Wind Measurements on Titan

Ethane (C_2H_6) Emission Near $11.74 \mu m$

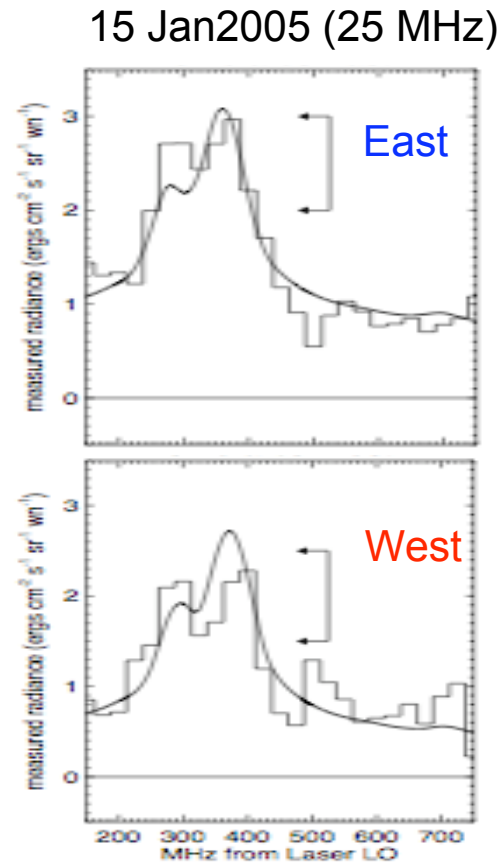


Titan 0.89 arcs
IR FOV ~ 0.4 arcs

Kostiuk *et al.*
J. Geophys. Res. Lett.,
32 (2005)

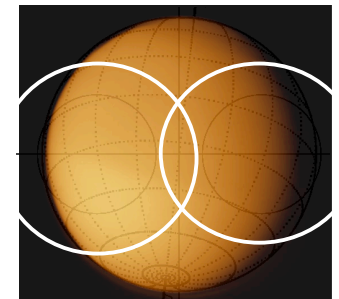


Wind Prograde 190 ± 90 m/s;
 $h \sim 230$ km



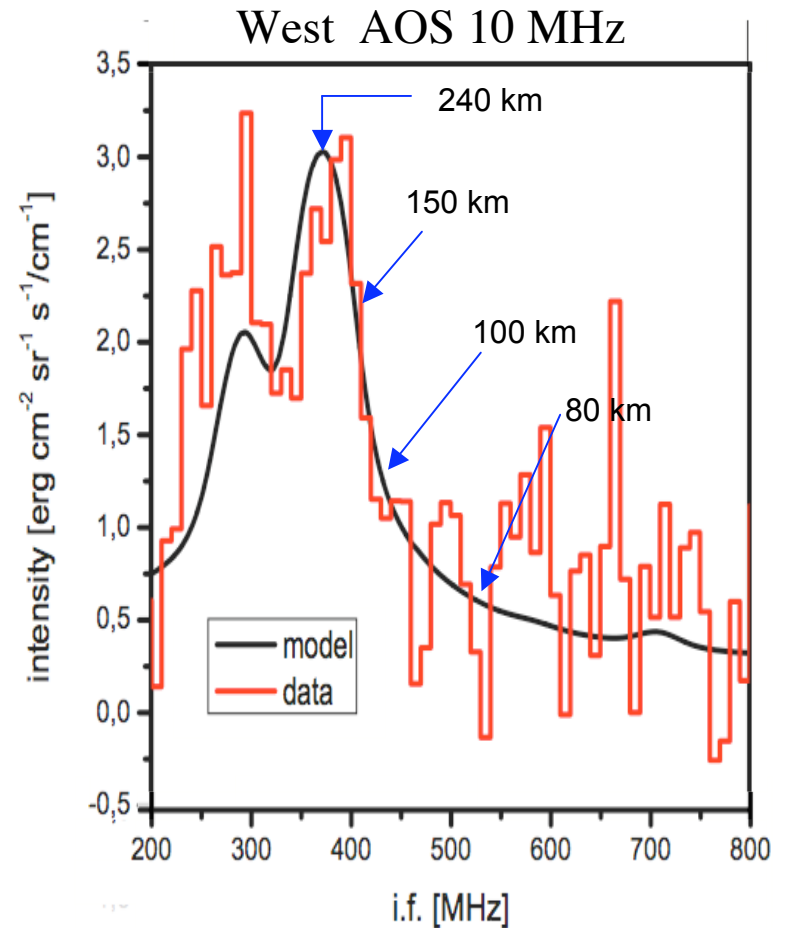
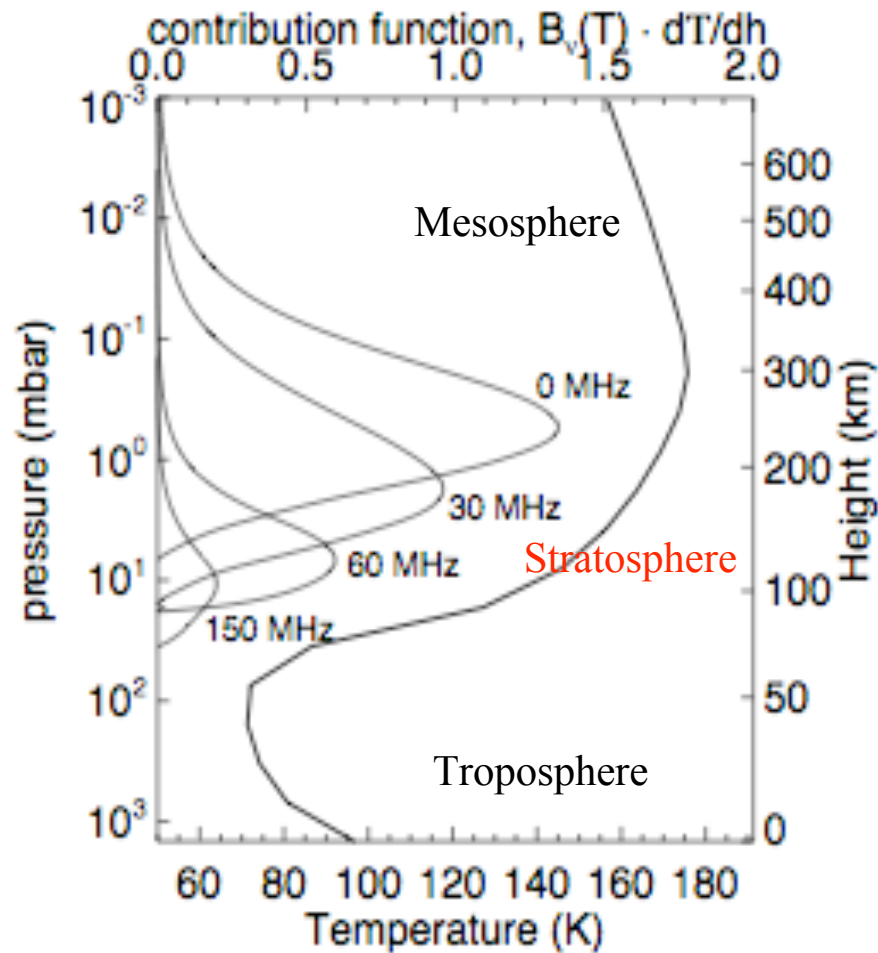
?

Kostiuk *et al.*
J. Geophys. Res.
(2006)



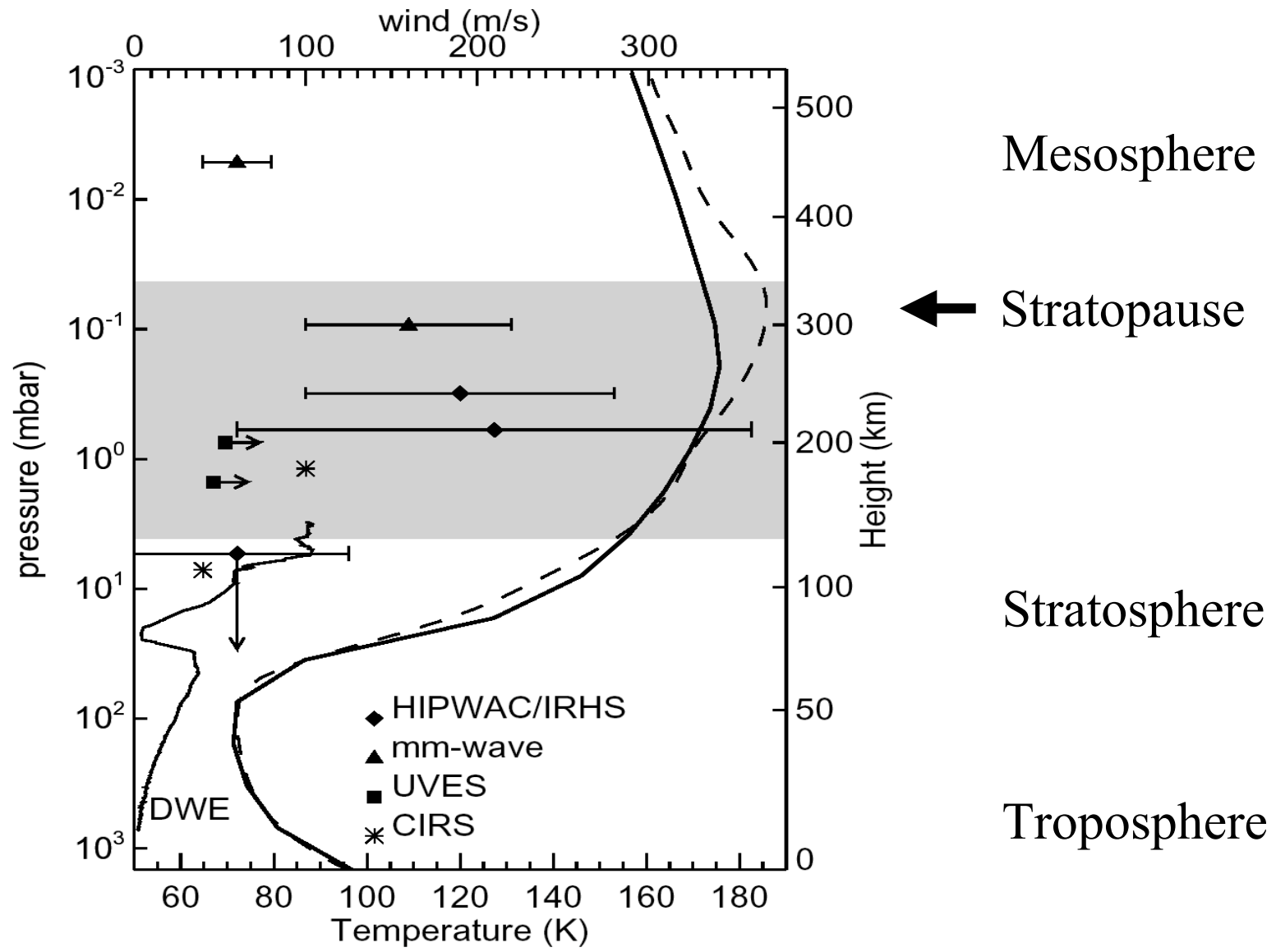
IR FOV ~ 0.6 arcs

Altitudes Probed by Ethane Line Profile



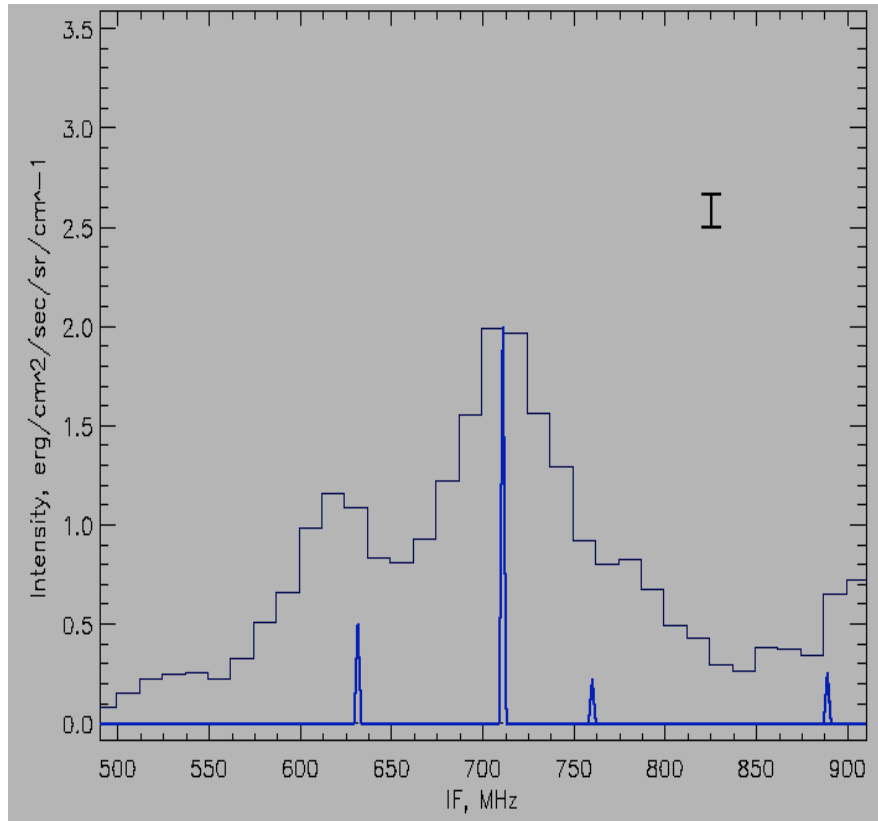
No Wind Information Can Be Retrieved Above ~120 km Altitude
Below 120 km best retrieved Winds are prograde $\sim 60 \pm 65$ m/s

Wind Altitude Profile on Titan

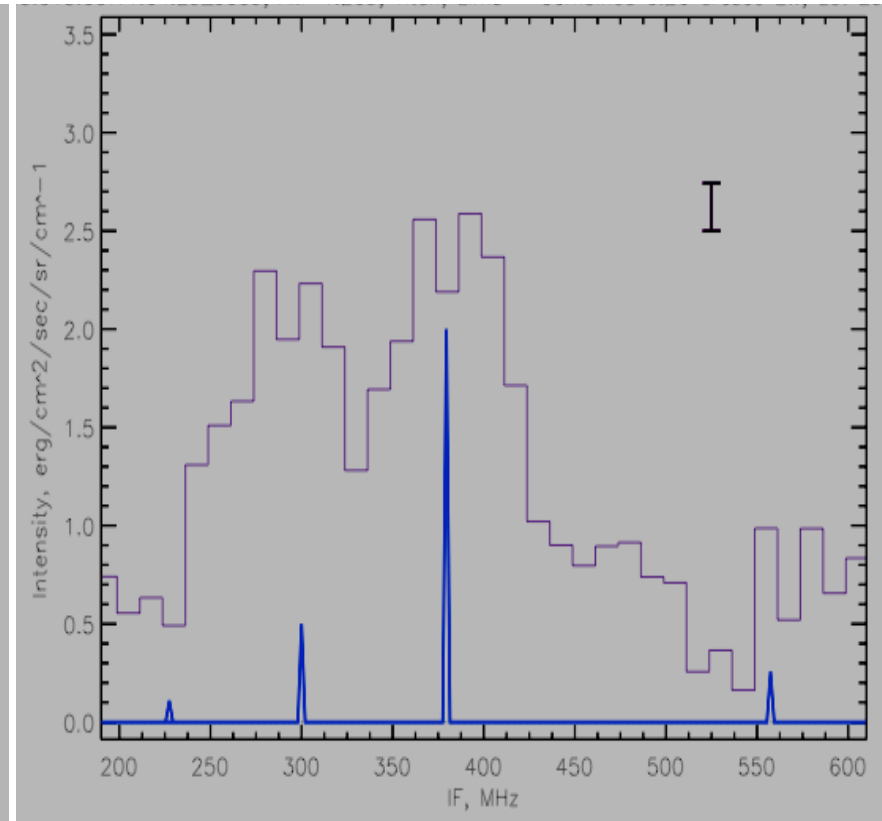


Difference Between Titan Spectra from 2003 and 2005

Dec. 18, 2003 E-W Average

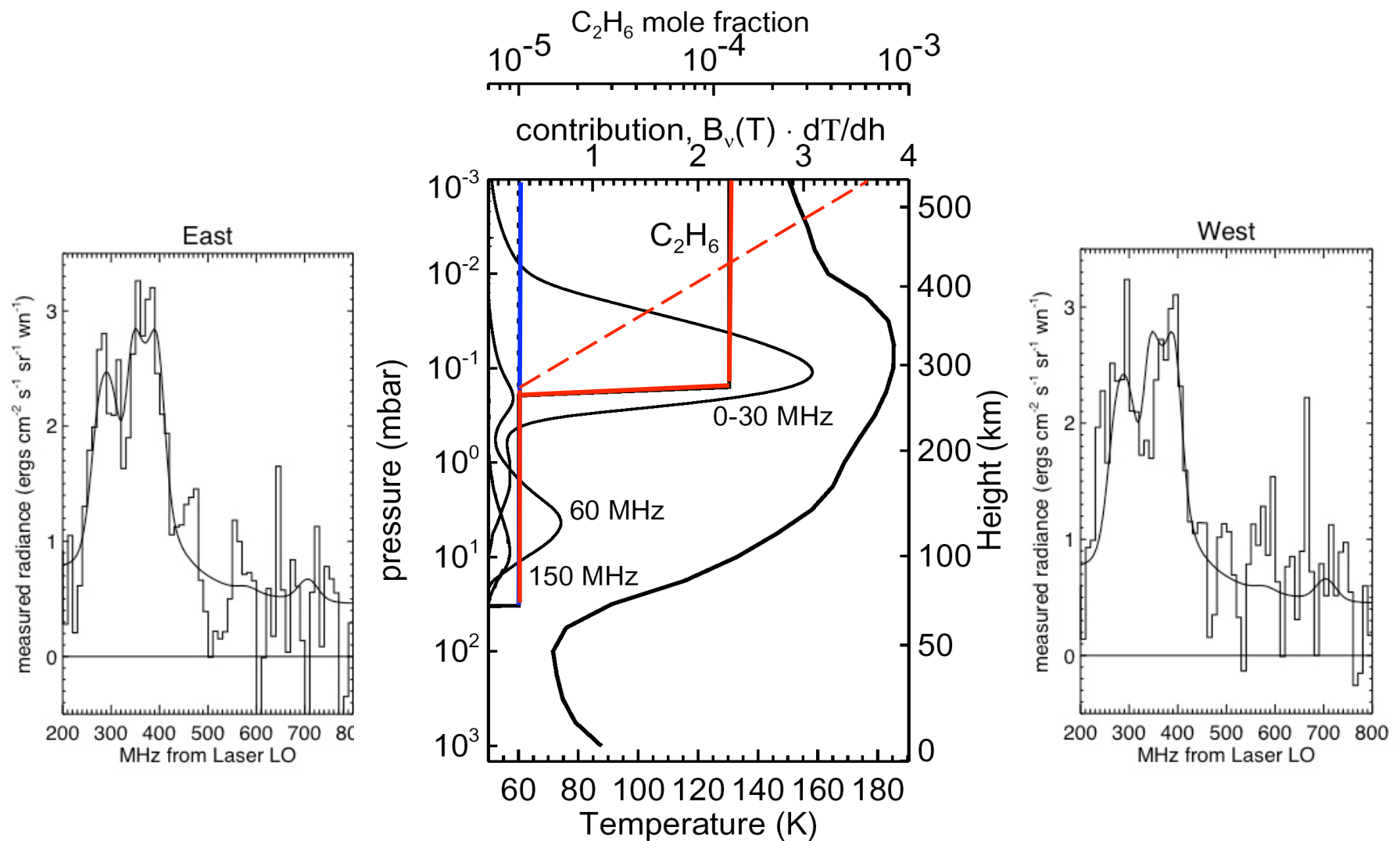


Jan. 15, 2005 E-W Average



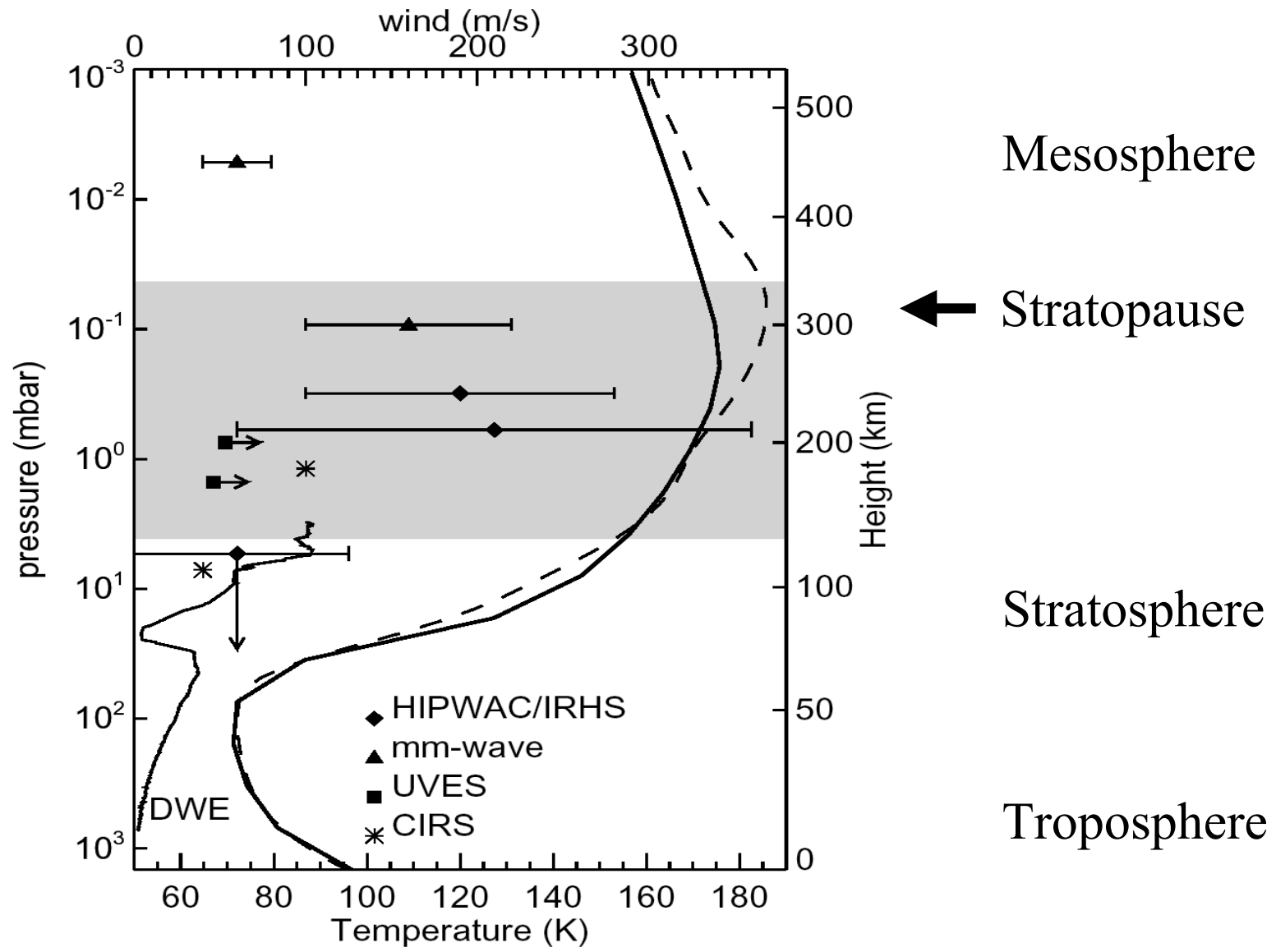
Different *Line Shapes* of C_2H_6 (851.5051 cm^{-1}) lines suggests change in Titan's atmosphere

Evidence of Mesosphere and Large C_2H_6 Abundance

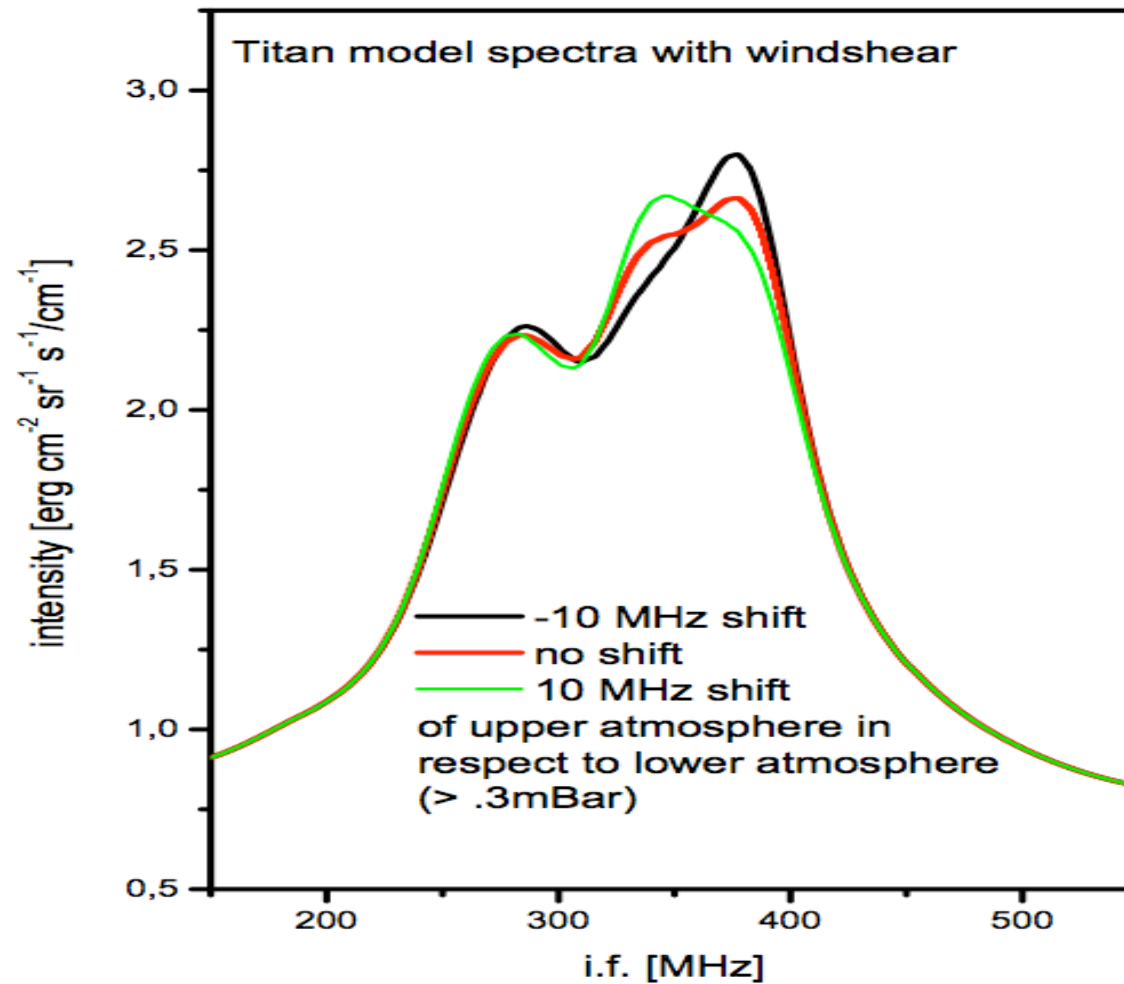


C_2H_6 Abundance Above 300 km is 10 times higher ($Q \sim 1.5 \times 10^{-4}$)

Wind Altitude Profile on Titan



Possible Wind Shear



Differences in Wind Velocity Change the measured Line Shape
(~100 m/s change stratosphere vs. mesosphere shown)

Conclusions

- Helped generate the first *Wind Altitude Profile* on Titan
- E – W spectra imply high ethane mole fraction above stratopause (~10 x) - *Not Expected*
- Spectral changes and wind retrievals both suggest *Variability* in Titan's atmosphere - *Not Expected*
- Detected evidence of Titan's Mesosphere
- Possible detection of Wind Shear near stratopause
- HIPWAC Results are Complementary to Cassini/Huygens Investigations

(Kostiuk et al., *Geophys. Res. Lett.* **32**, 2005; Kostiuk et al. *J. Geophys. Res.*, 2006; Livengood et al. *J. Geophys. Res.*, 2006; Witasse et al. *J. Geophys. Res.*, 2006)

Possible Future HIPWAC Observations

- Titan's Mesosphere, positive Measure Wind Shear, detection of minor constituents (e.g. C_3H_4) and spatial and temporal Variability
- Envelopes of Infrared Stars their composition and their velocity structure

We welcome future collaborations from the entire
astronomy community

We thank Dr. H. Karoji and the Subaru staff for their excellent support of our investigation and wish them all a happy holiday and a successful New Year

Happy New Year from NASA Goddard Space Flight Center HIPWAC Team at Subaru



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D. Buhl, P. Rozmarynowski, T. Hewagama, J. Delgado (UMD),

END