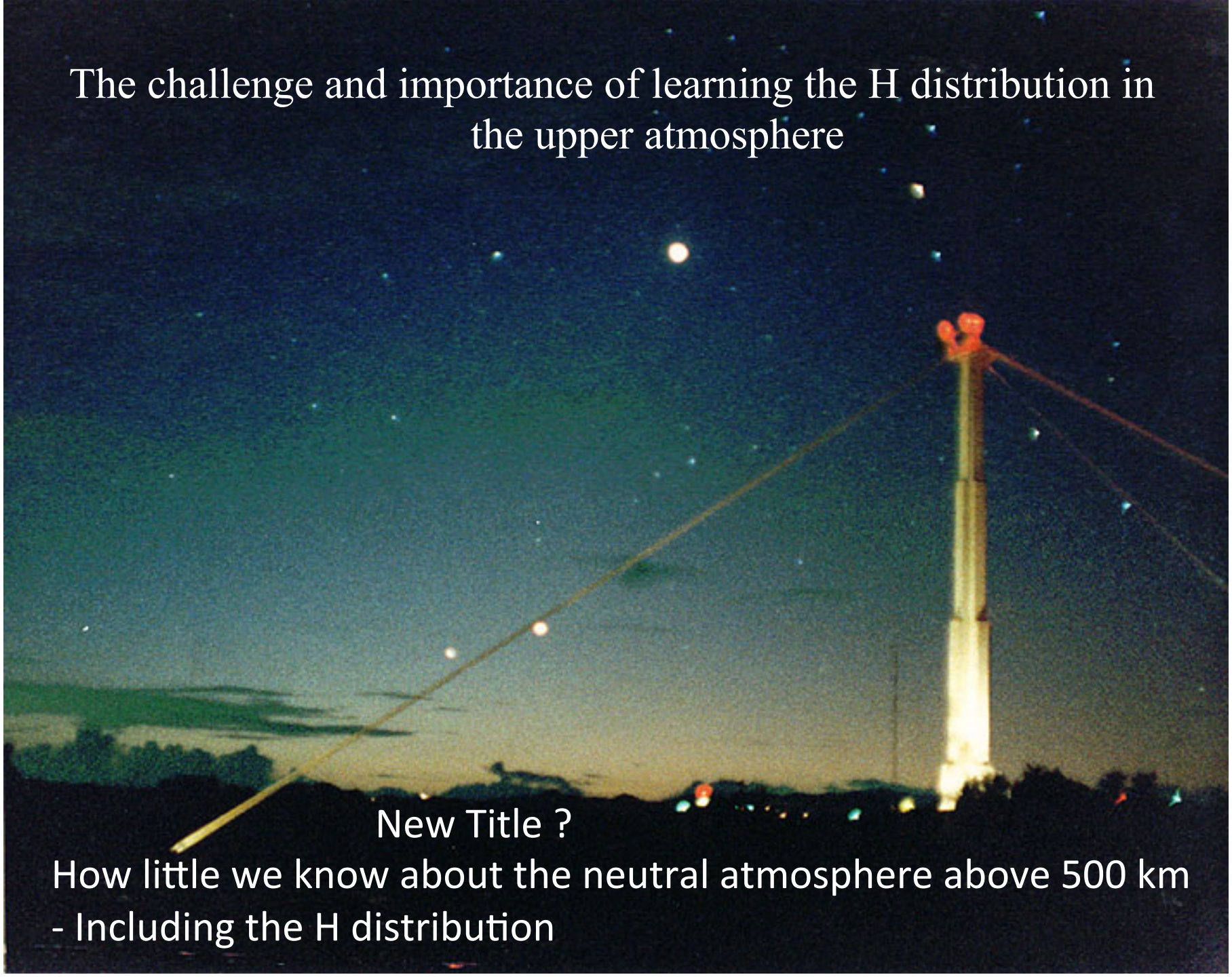
The challenge and importance of learning the H distribution in the upper atmosphere



New Title ?

How little we know about the neutral atmosphere above 500 km

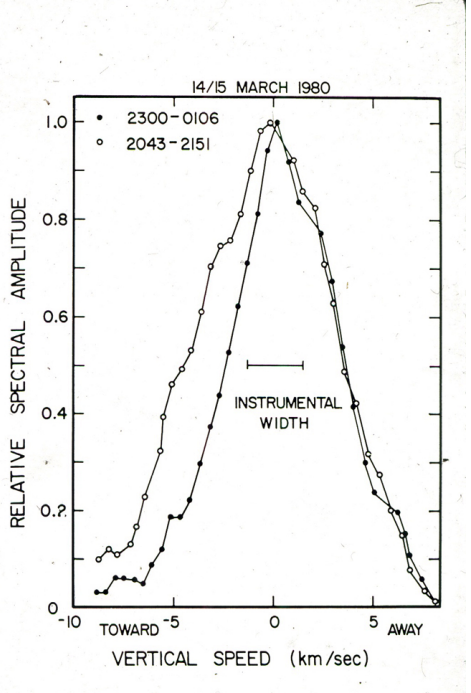
- Including the H distribution

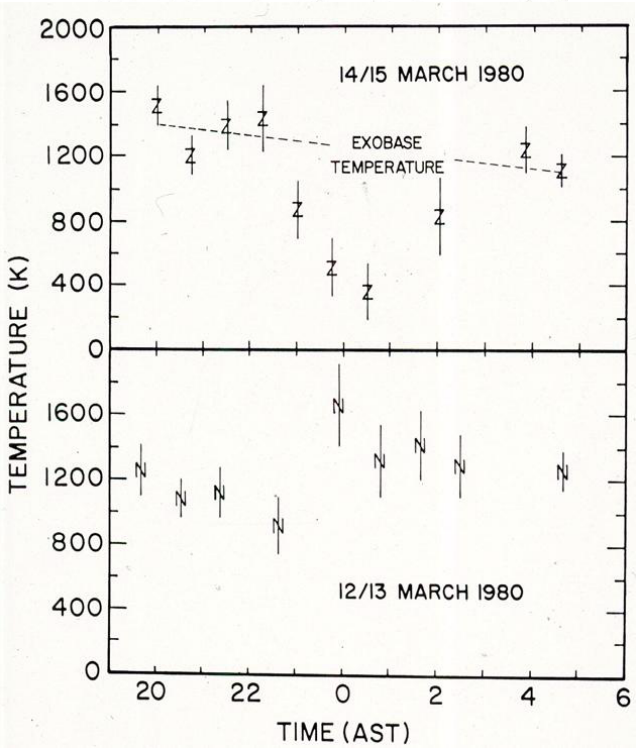
- We do not know, or model well, the NEUTRAL TEMPERATURE (Not only where the atomic velocity distributions are still nearly Maxwellian, but even if we erroneously assume they are Maxwellian)

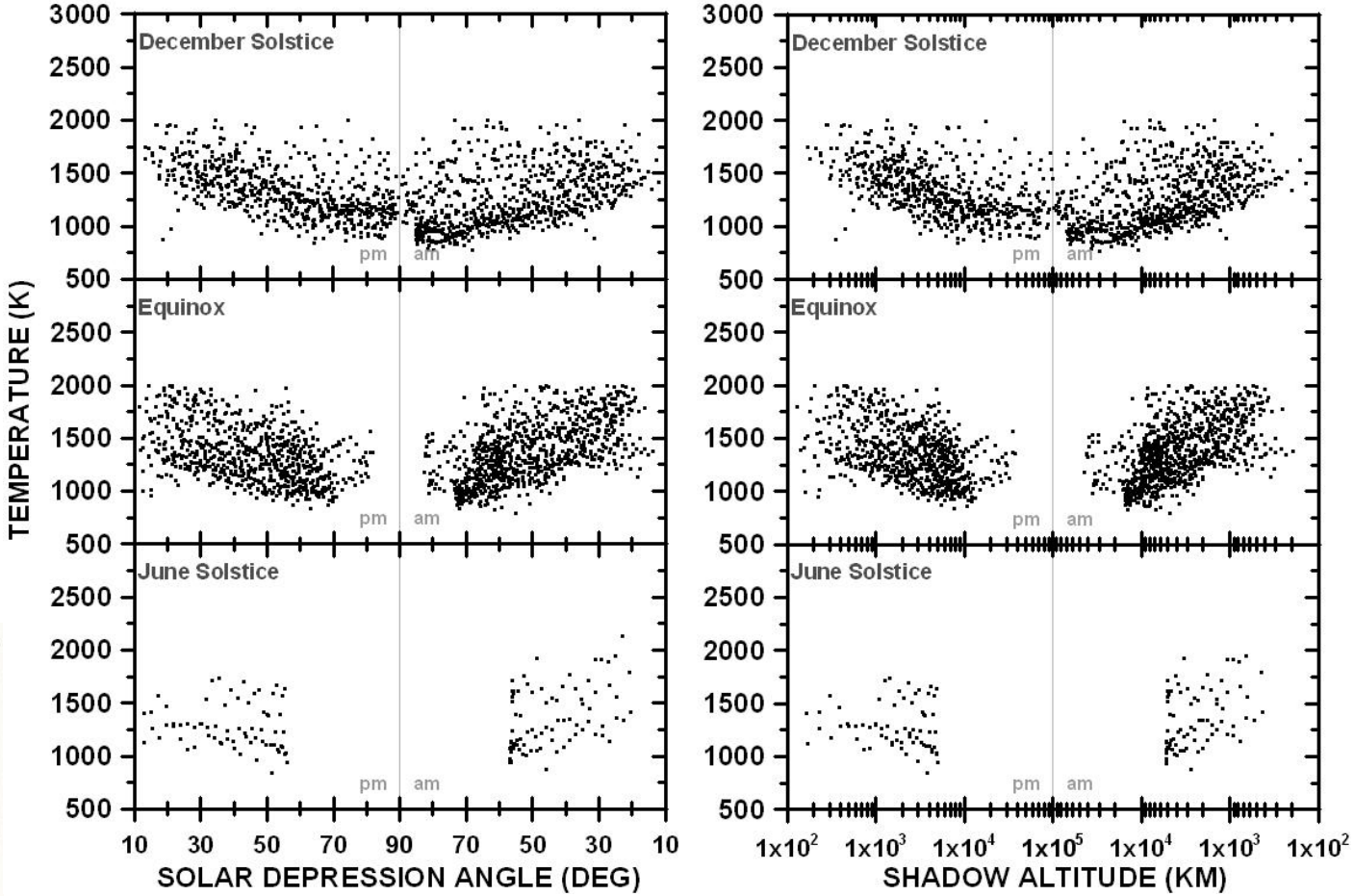
- We do not know the [H](z) profile well at all, or model it very well. We especially do not know the how that altitude profile varies by location, or during magnetic storms.

- We do not know the neutral wind field anywhere above the F2 peak.

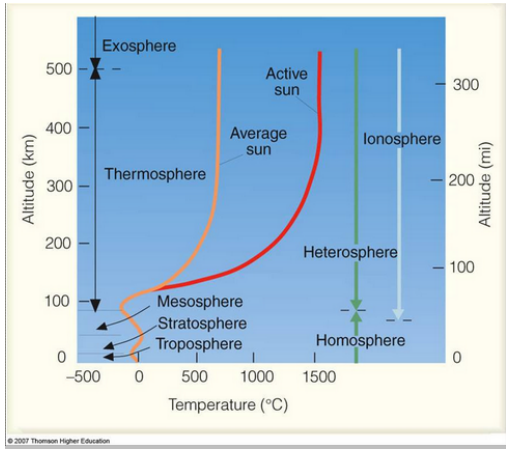
We know virtually nothing about the transport of neutrals in the topside ionosphere or exosphere.







Scatter plots of Effective Tn, from H-alpha line widths sampled in 2007 & 2008 at Arecibo. DT/Dz is evidently negative, generally – due to gravitational cooling.



← ???

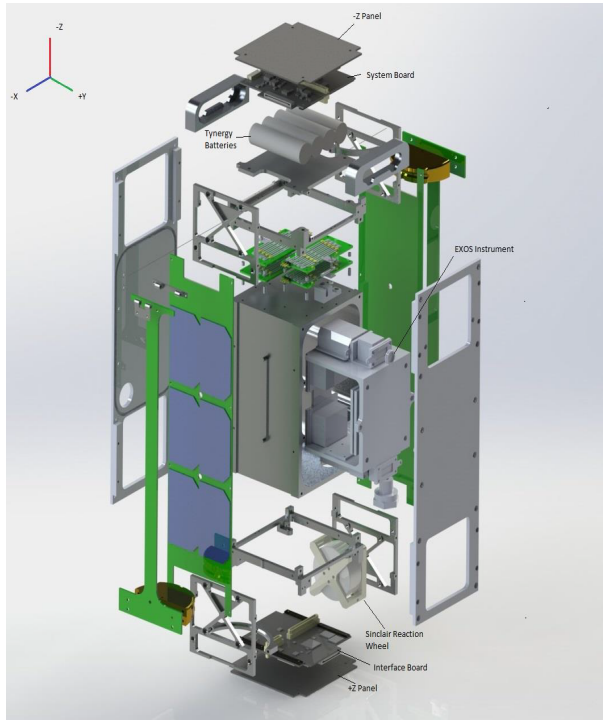
Most texts and models (?) still show an isothermal Temperature profile in the exosphere – or even a positive lapse rate, even though we've had Strong indications otherwise, since the pioneering Work of JWM Jr., in 1981.

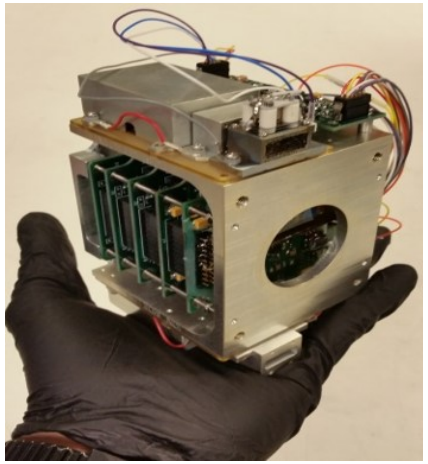
Light species densities are necessary for

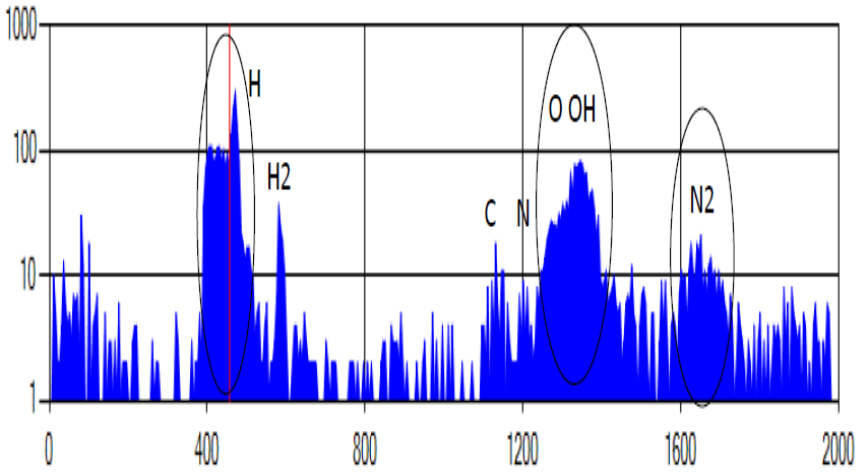
- Physics based modeling of TEC
- Quantification of parameters in the Flux Equation, the Energy Equation, Charge-Exchange equilibrium

Calculations, quantification of the H escape flux and its physical mechanisms (thermal, charge-exchange, Polar Wind) – and more. The density of all hydrogenous species near the turbopause is also needed to Quantify the canonical "Limiting Escape Flux"

Enter EXOCUBE, EXOCUBE II, and ExoDyn – the 1st mass specs measuring light neutral and ions in the Upper atmosphere since the DE era, and the 1st mass specs sampling atomic mass 1. No in-situ measurements of [H] have been made near 500 km, before.

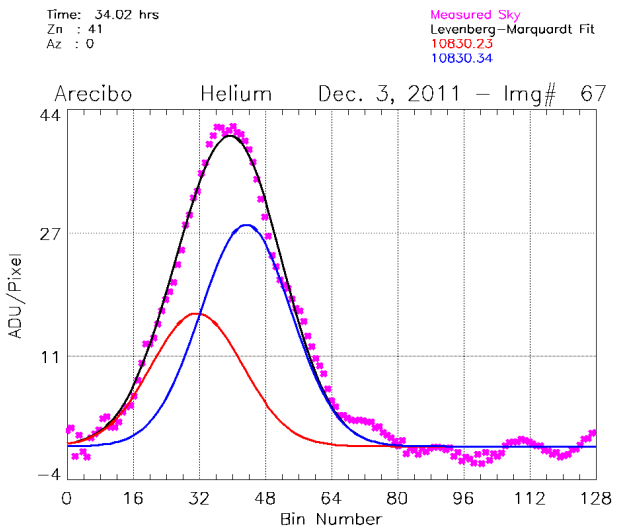






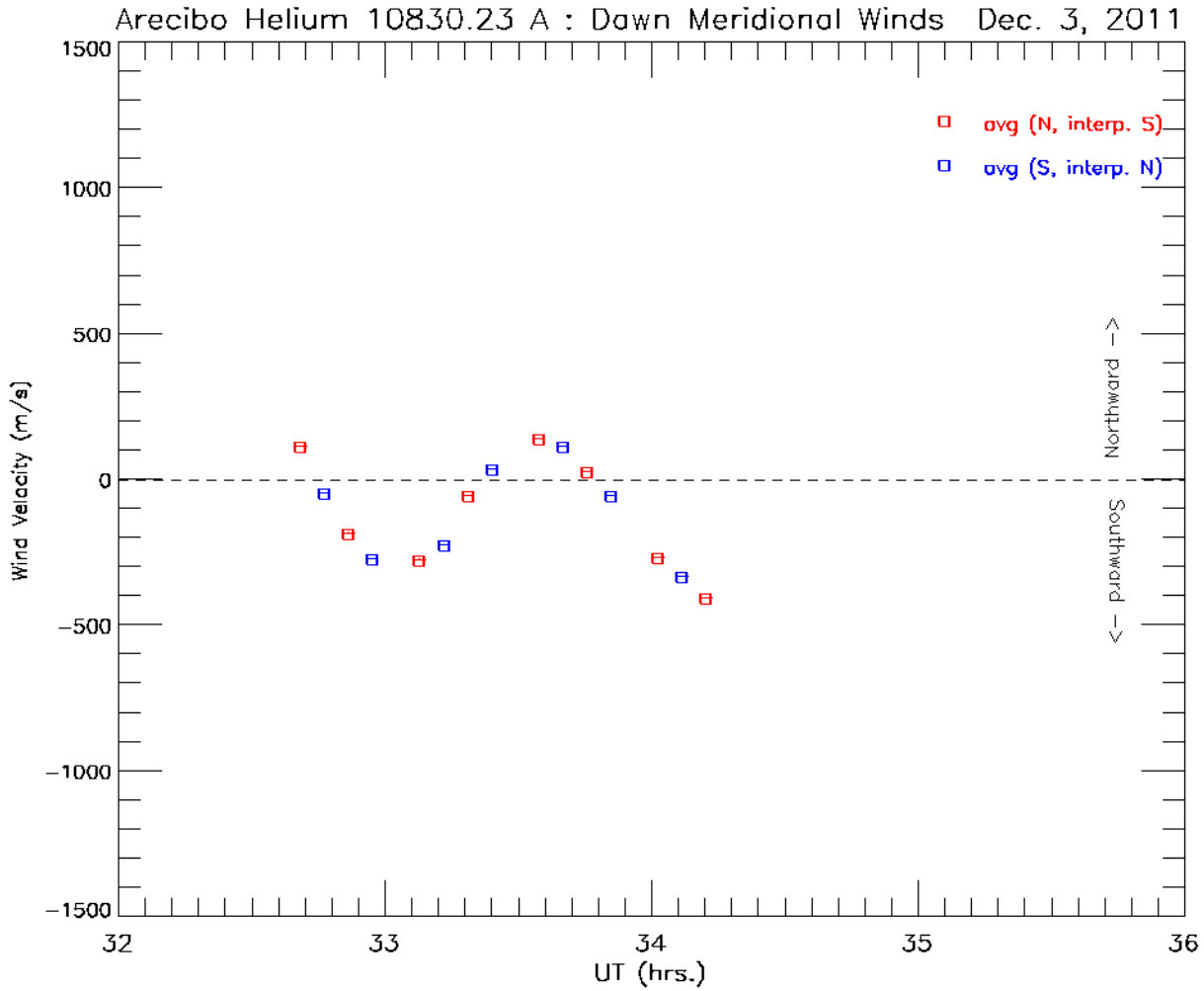
On-orbit INMS neutral spectrum – of outgassing From the instrument, only. Ram direction atmospheric sampling will produce signals 10^5 times greater.

TRANSPORT in the Exosphere



Metastable helium forms in a layer, near 700 km, due to the photolytic creation rate profile by photelectrons, and quenching at lower altitudes. (see Waldrop, et al.)

That layer creates a great opportunity to measure winds near 700 km, IF you can sample the 1083 nm He emission. We have been trying that, for some time – using a deep-depleted CCD, and measured QE of 1.5% at 1083 nm. Sometimes, we have Enough signal to derive meridional winds, for about 2 hours in the Twilight. Here is one very nice example – wind velocity error bars are Included here – they are smaller than the data point size.



These initial measurements of neutral winds Near 700 km indicate they generally have A much greater magnitude, and temporal variability than F-region winds. **The winds at 700 km have Little resemblance to the winds at 300 km.**