INVESTIGATING UPPER ATMOSPHERIC DYNAMICS FROM NEXT GENERATION SUBORBITAL PLATFORMS:

NOVEL OBSERVATION OPPORTUNITIES AND ACCELERATED DEVELOPMENT OF INNOVATIVE INSTRUMENTATION

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Upper Atmospheric Winds

Mesospheric and thermospheric winds are not routinely measured, but important for our understanding and forecasting of the atmosphere.

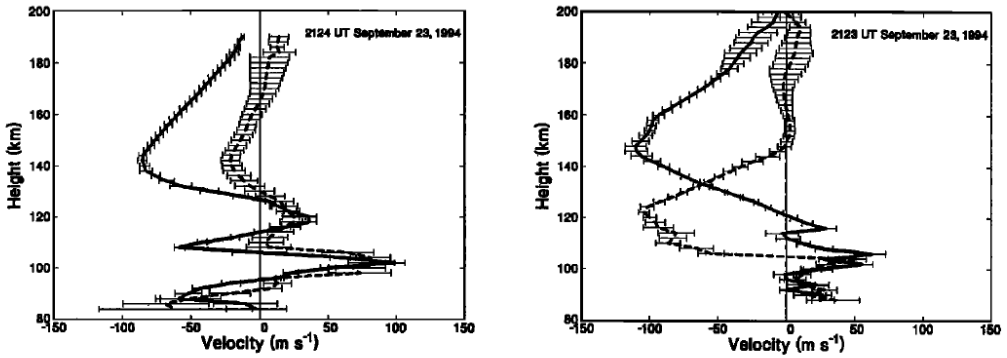
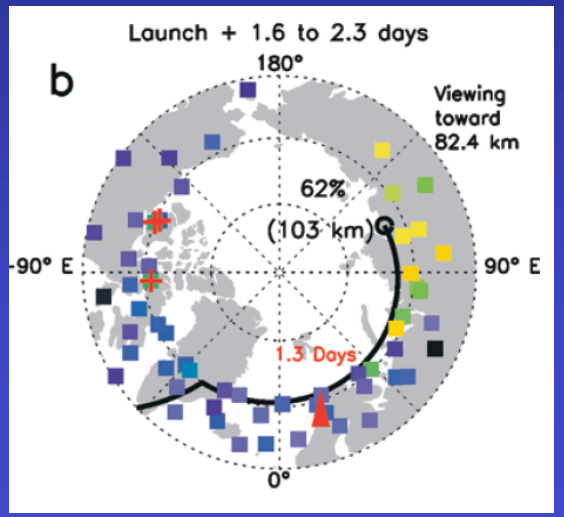


Figure 1. E-region wind profile at the magnetic equator (left-hand panel) and 480 km north along the magnetic meridian (right-hand panel) near sunset on September 23, 1994. The solid line shows the zonal wind component, positive toward east. The dashed line shows the meridional wind component, positive toward north.

[Larsen and Odom, 1997]

Observed large wind shears and strong mean winds are insufficiently explained by model calculations.



[Stevens et al., 2003]

Existing Wind Measurement Concepts From Space Include:

(1) Fabry Perot interferometers:
HRDI on NASA/UARS (mission completed)
TIDI on NASA-TIMED (ongoing mission)

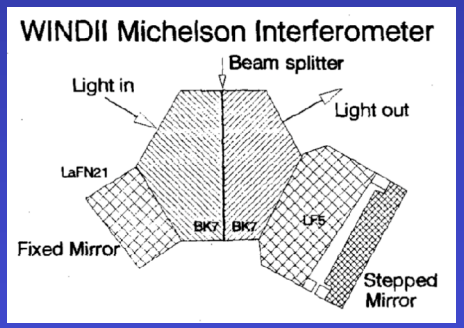
(2) Stepped Fourier Transform Spectrometer
WINDII on NASA/UARS (mission completed)

But currently no mesospheric/thermospheric wind measurements are available that are of high enough quality for assimilative models.

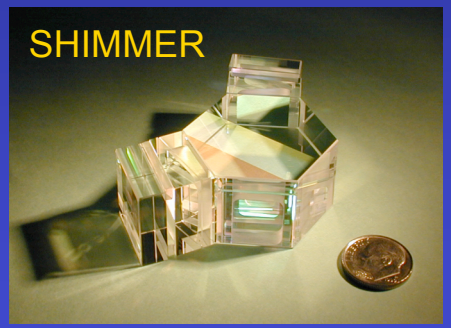
DASH: A New Concept to Measure Winds

Combination of two spectroscopic techniques:

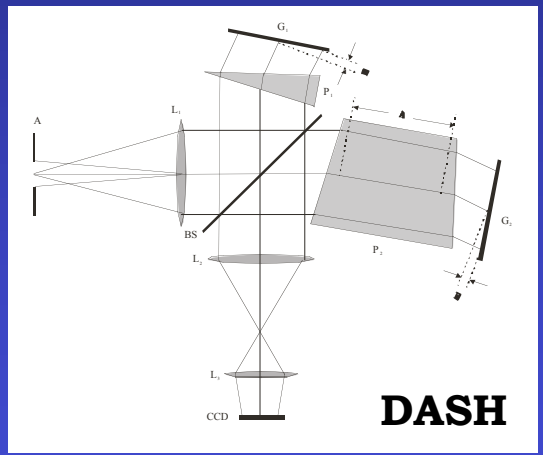
- Stepped Michelson Interferometer (like WINDII on UARS)
- Spatial Heterodyne Spectroscopy (like SHIMMER on STPSat-1)



Asymmetric arms terminated by mirrors. One moving mirror.

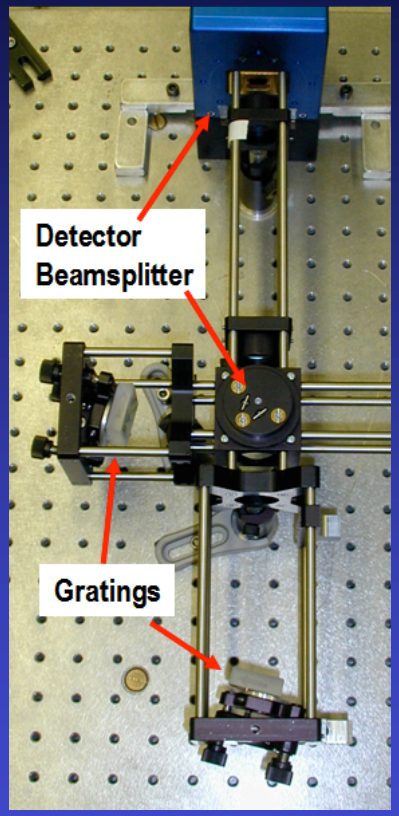


Symmetric arms terminated by fixed gratings.



Asymmetric arms terminated by fixed gratings.

DASH Development is Progressing:

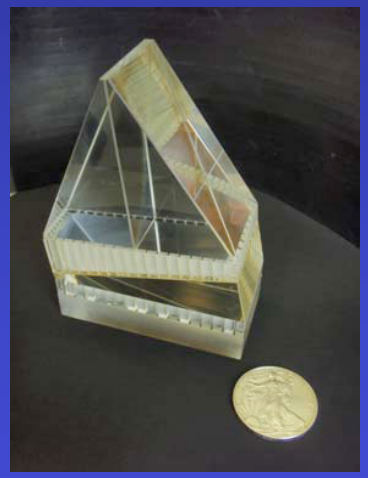


[Englert et al., 2007]

First step: Laboratory Breadboard

Second Step: Monolithic, temperature compensated interferometer for the thermospheric red line

Current TRL: 4-5



[Harlander et al., in prep]

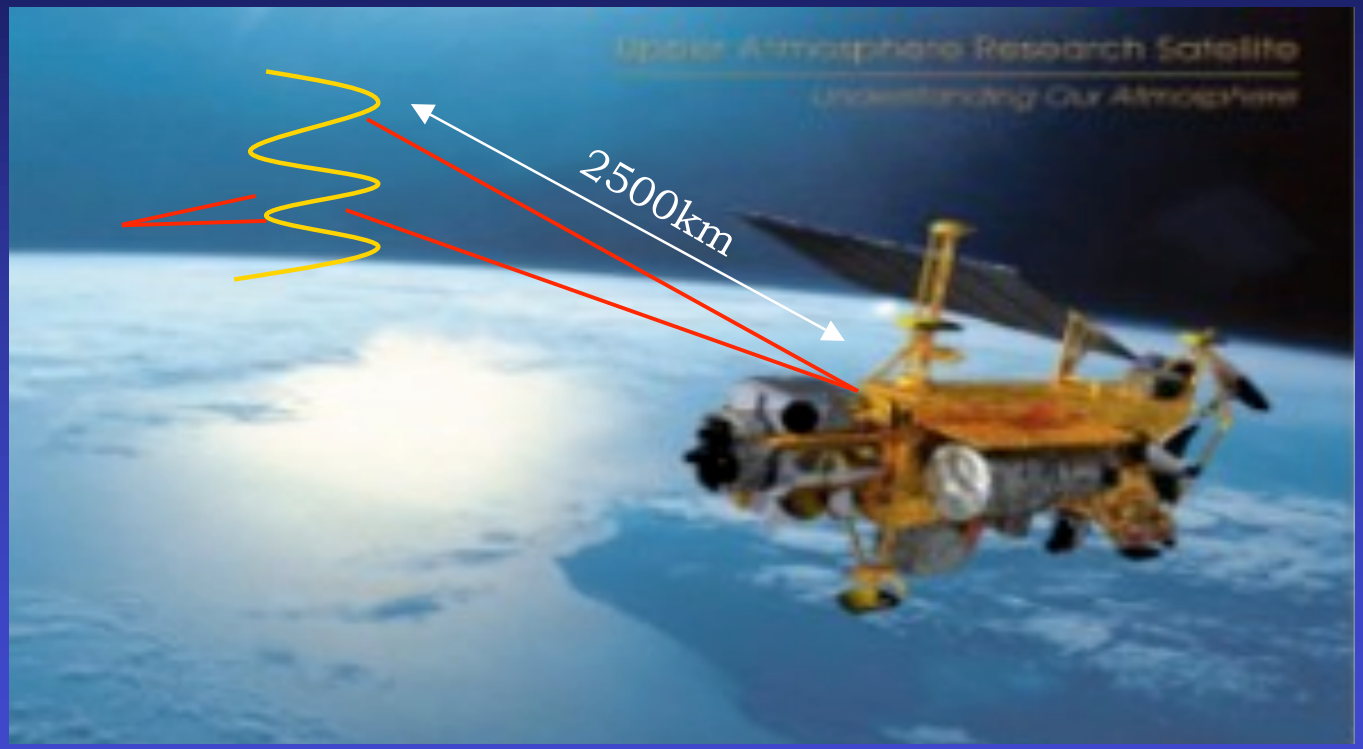
DASH Can Benefit from Suborbital Vehicles in Two Ways

1. Increase DASH TRL by making high vertical resolution wind measurements on the limb in preparation for space flight.
    a) Relatively low cost
    b) No need to automate payload

DASH Can Benefit from Suborbital Vehicles in Two Ways

2. Make repeated, vertically resolved day and nighttime wind measurements, possibly coordinated with other payloads to perform scientific research.
   - The altitude region around 100km is very stable and should support large wind shears. Thus, wind measurements with high vertical resolution are of particular interest.
   - Being at exactly these altitudes, suborbital vehicles enable these very high vertical resolution measurements ($\Delta z < 1$km).

High Vertical Resolution, Remote Wind Observations Enabled by Suborbital Vehicles



Desired Vehicle Resources

1. Window(s):

a) Sized to simultaneously accommodate a 45° and 135° viewing direction of a 5cm diameter beam (preferably relative to the velocity direction)
⇒ Window diameter of 20-30cm …

b) Transparent in the visible (broad band anti-reflection coated), not too parallel (slightly wedged) to avoid fringing within the window(s)

2. Pointing:

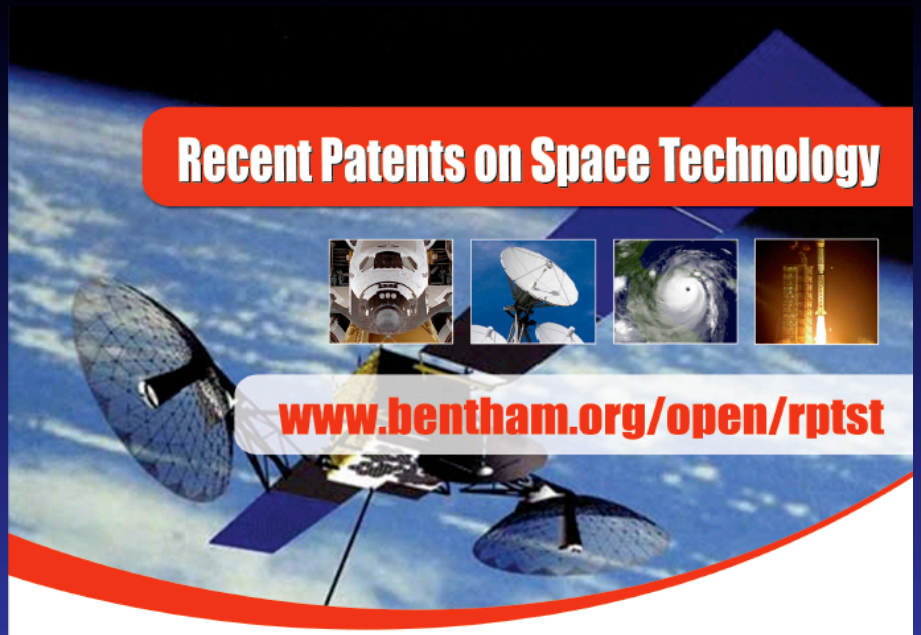
… depends on the vehicle velocity since a vector component of the vehicle speed is included in the wind measurement.

⇒ worst case (from satellite: +/-Roll +/-Pitch +/-Yaw) :

Knowledge:	0.1° / 0.1° / 0.025°
Control:	0.18° / 0.18° / 0.20°
Stability:	0.1°/60sec / 0.1°/60s / 0.025°/60sec

Acknowledgements

The authors would like to thank the Office of Naval Research & NASA for supporting this work



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