



The Vorticity Experiment 2022

VortEx – an update

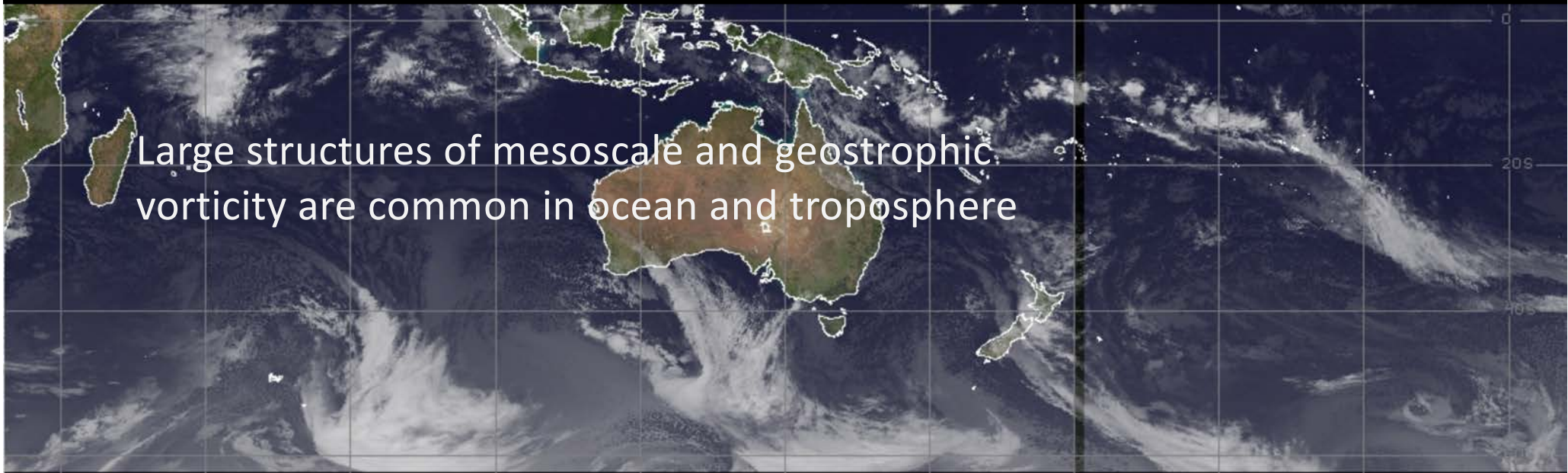
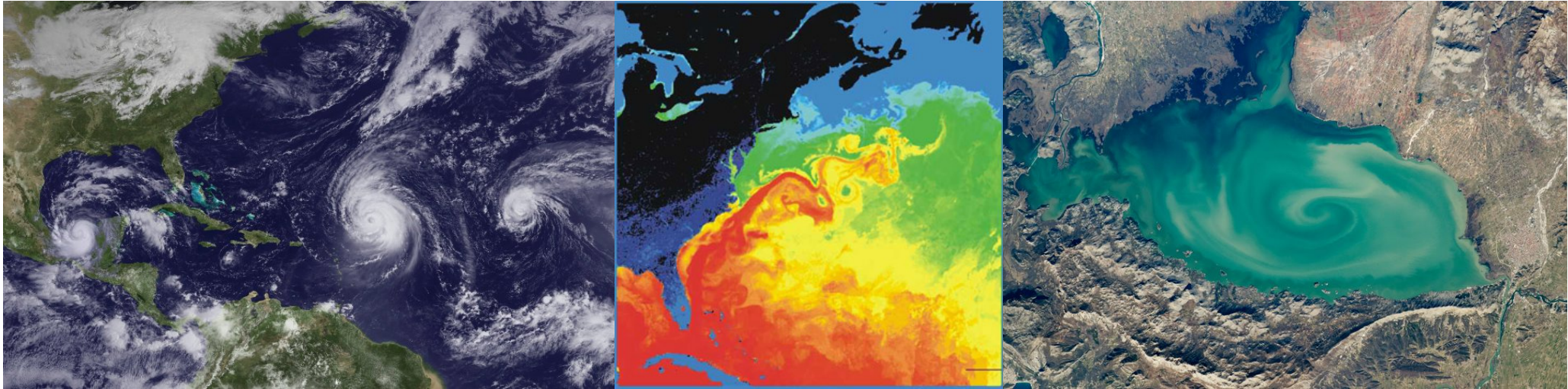
Gerald Lehmacher, Miguel Larsen (Clemson University)

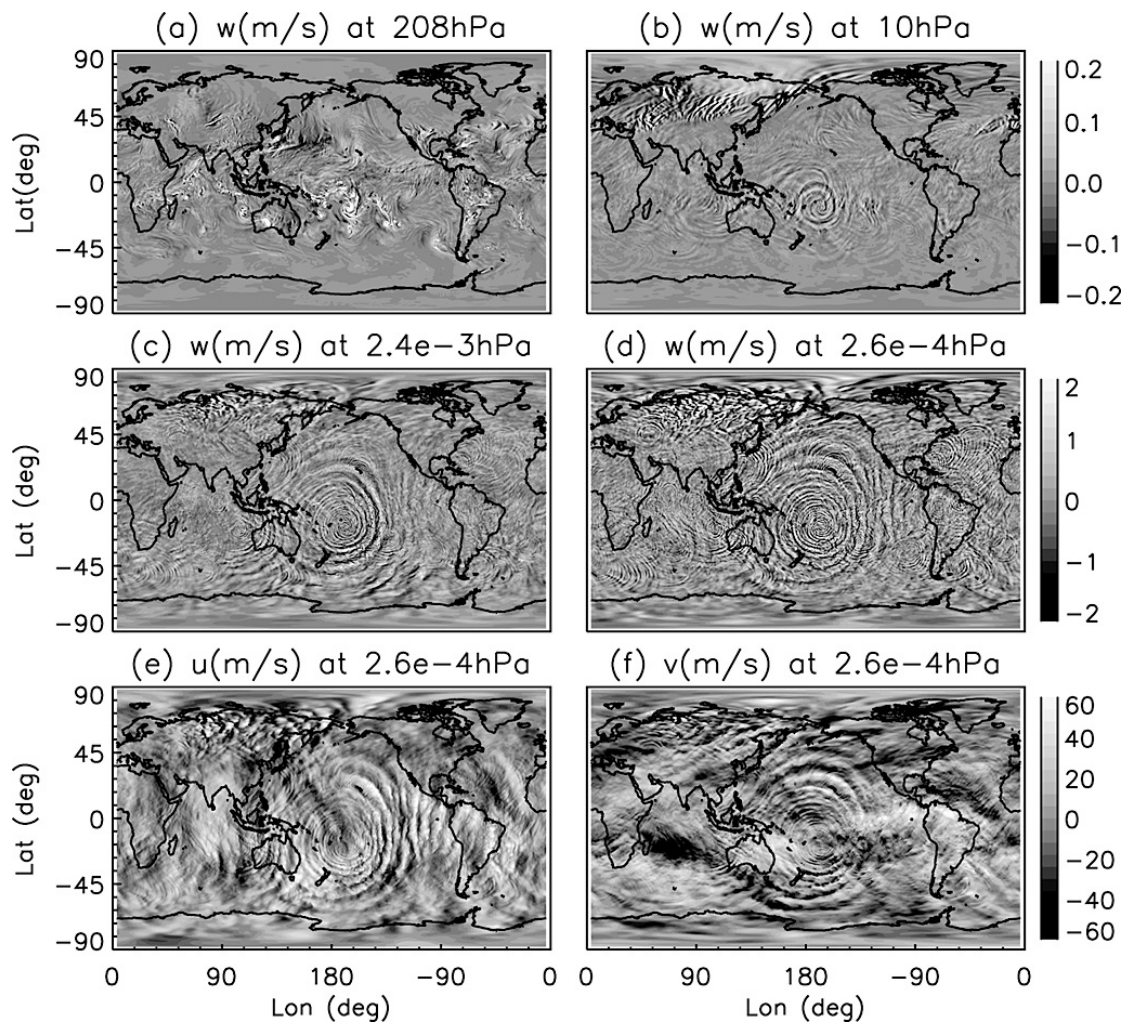
Jonathan Snively, Aroh Barjatya (Embry-Riddle
Aeronautical University)



Michael Taylor, D. Pautet, Y. Zhao (Utah State University)

Jorge Chau, Ralph Latteck, Gerd Baumgarten, Franz-Josef
Lübken (Leibniz-Institute for Atmospheric Physics)





WACCM GW: Liu et al., 2014

CEDAR 2020, Cyberspace, Earth

What is the importance of vorticity (ω_z or ζ) and the spectral characteristics of mesoscale stratified turbulence (ST) in the M/LT?

What is the relative role of gravity waves and ST?

Is there a reverse energy cascade (from smaller to larger scales) and mean-flow acceleration (as for tropical cyclones, e.g., Rhines, 1971)

Importance of GW forcing has been explained in Hanli Liu's Daedalus talk on 3/8/2020:

https://youtu.be/Df_Ewp5I5wE

Gravity Wave Perturbations

- Cause large wind shears in the mesosphere and lower thermosphere, which may drive ionospheric sporadic E layers.
- Primary and/or secondary gravity waves can force large thermospheric and ionospheric disturbances (traveling atmospheric/ionosphere disturbances, TADs/TIDs), which may trigger ionospheric irregularities.
- These effects cannot be parameterized.

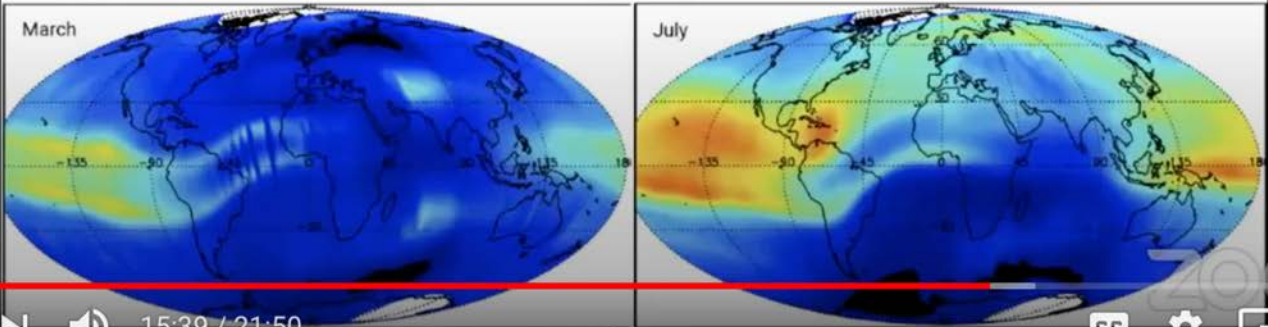
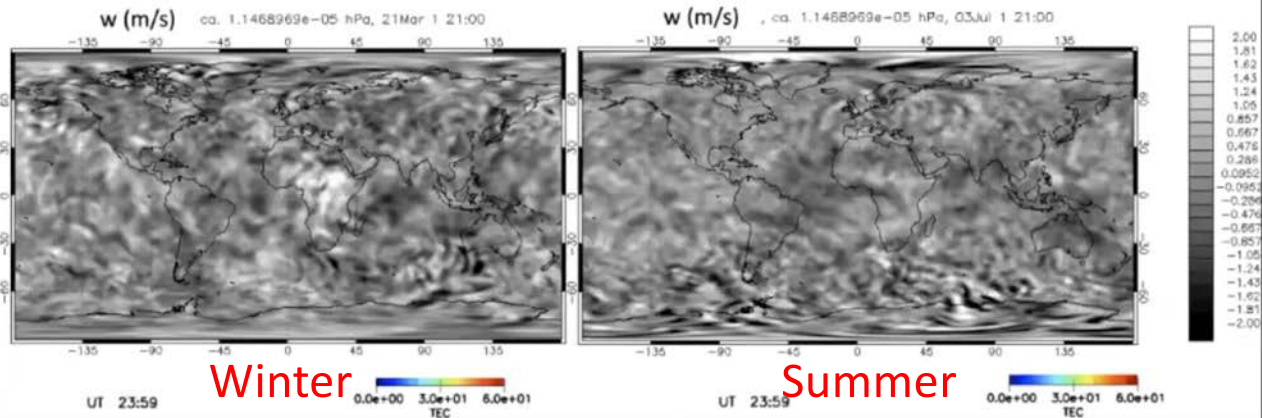


12:00 / 21:50



zoom

Thermosphere Vertical Wind at E-region Height (~130km): WACCM-X (~60km resolution)



15:39 / 21:50 SAMI3/WACCM-X Huba and Liu, Submitted GRL

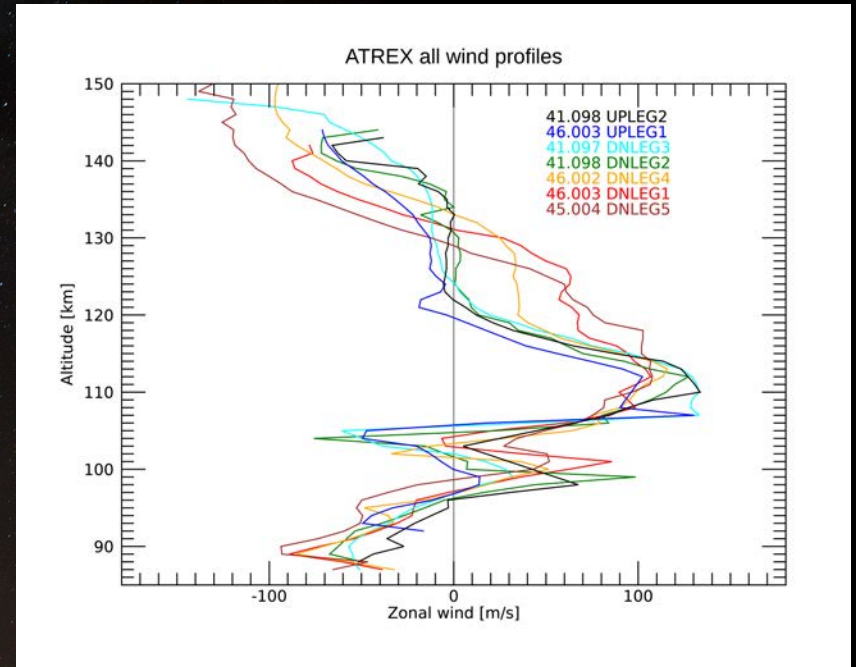
Anomalous Transport Experiment (ATREX)

27 March 2012, Wallops Island

Seven simultaneous TMA wind profiles spaced horizontally ~100-600 km

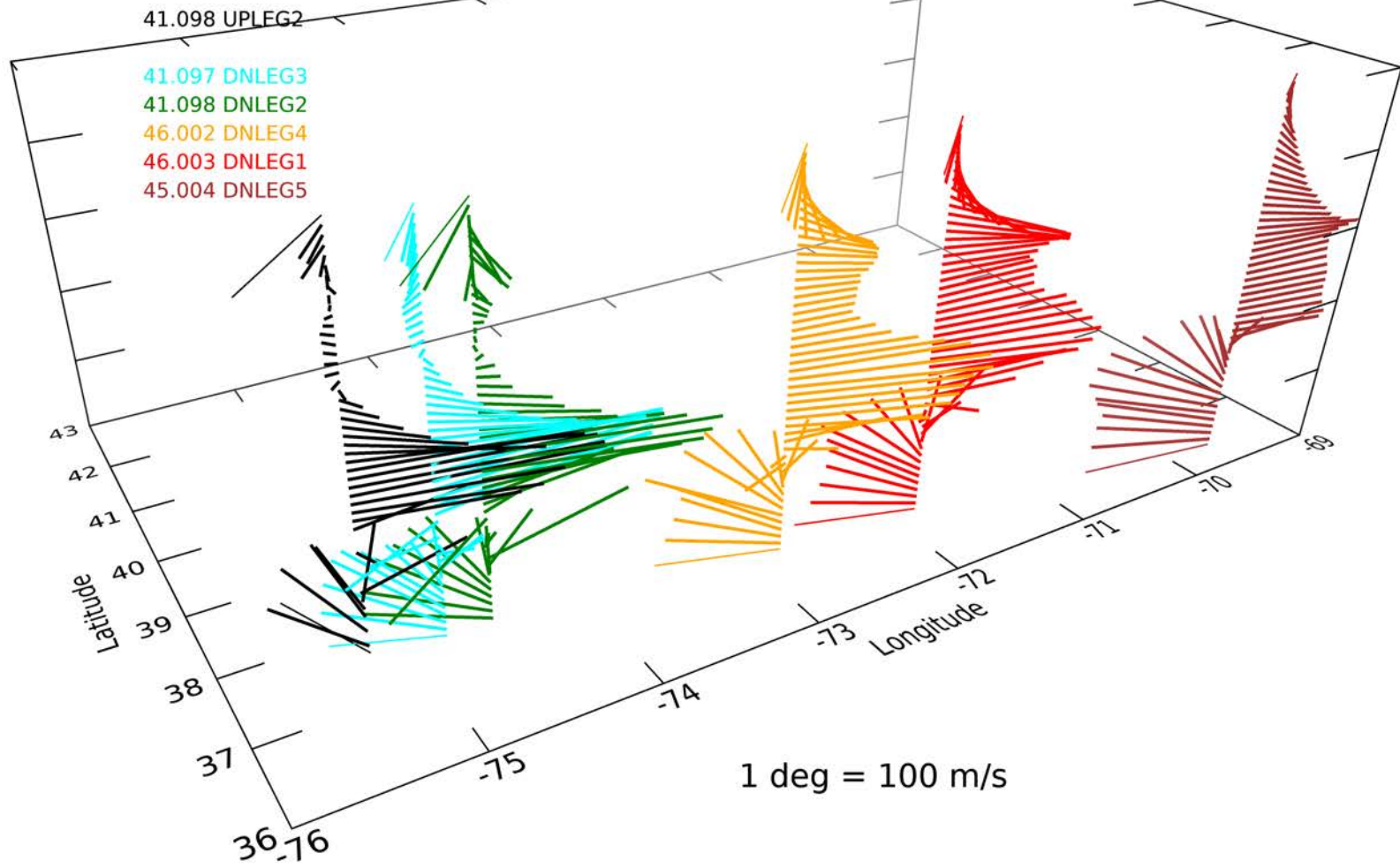
TMA structure function analysis shows evidence for universal transition from 3-D to quasi 2-D stratified macro-turbulence for horizontal scales of 100-200 km

Roberts and Larsen (2015)



Wind profiles show coherent wave structures, but also randomness, structure function analysis forthcoming

ATREX simultaneous wind profiles 90-140 km



VortEx

Ground-based and
rocket
observations

MR TX Andenes

MR TX Ramfjordmoen

MR TX Straumen

Google Earth

Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO

200 mi



VortEx

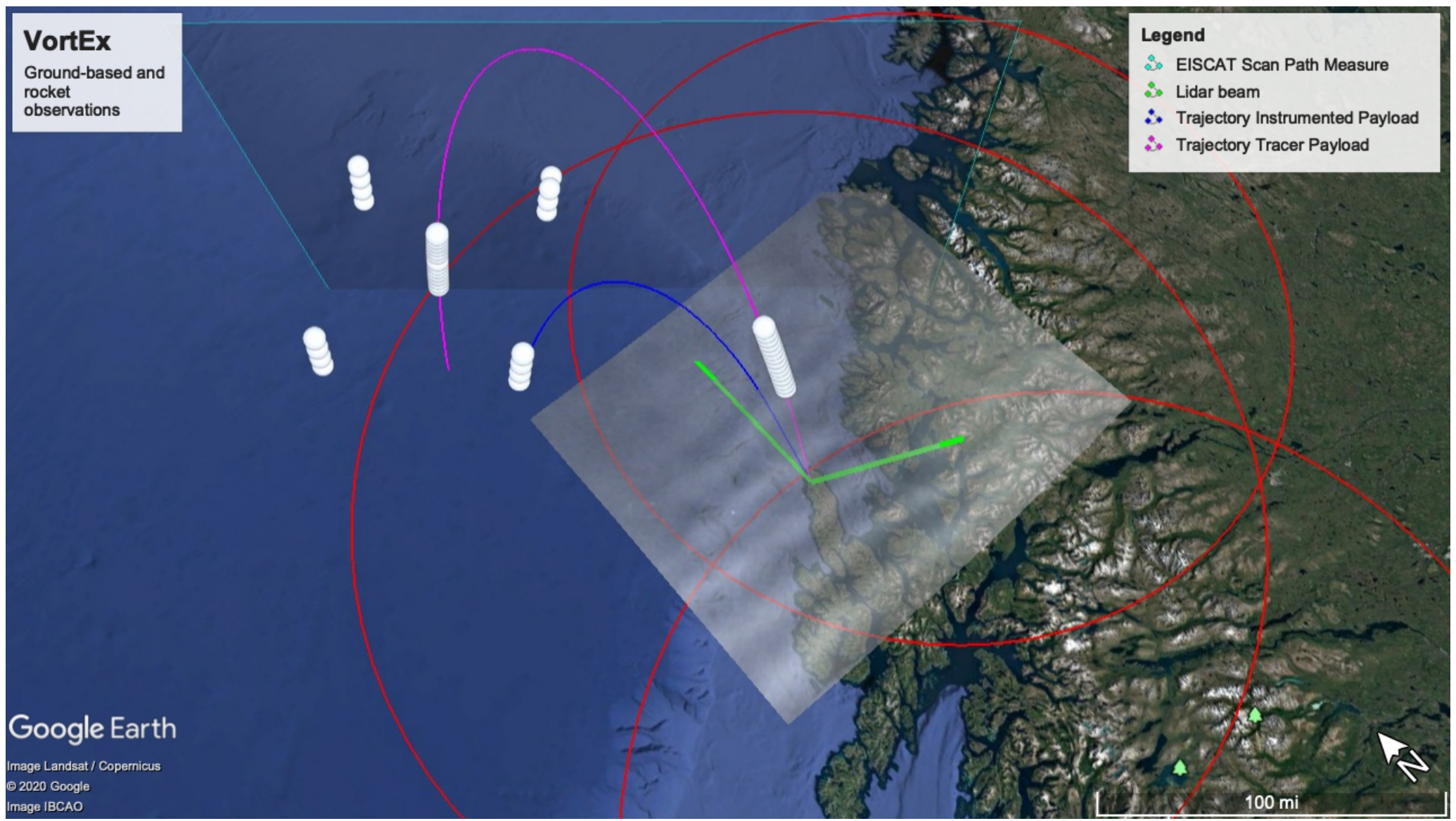
Ground-based and rocket observations

Legend

- EISCAT Scan Path Measure
- Lidar beam
- Trajectory Instrumented Payload
- Trajectory Tracer Payload

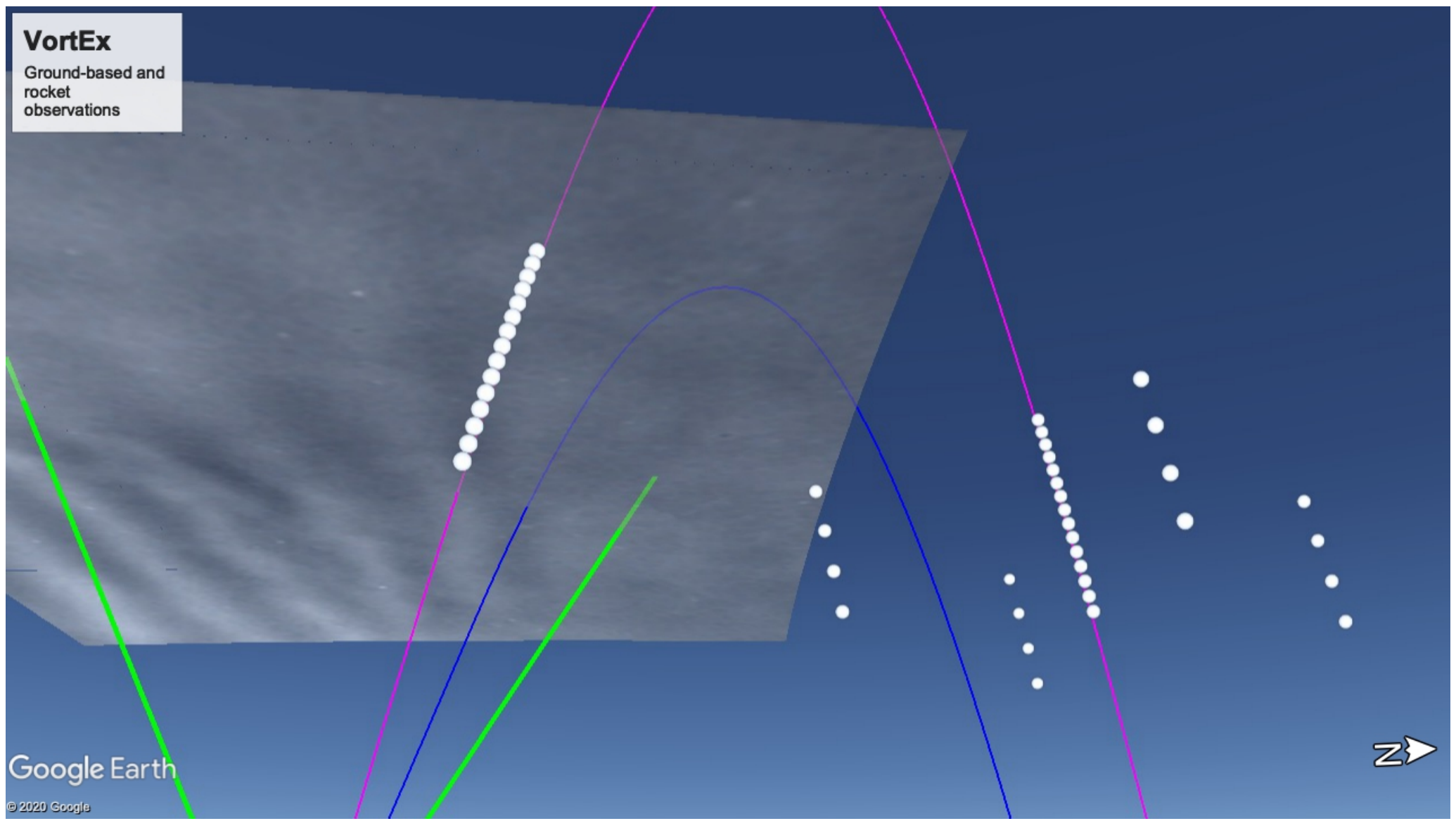
Google Earth

Image Landsat / Copernicus
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Image IBCAO



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Ground-based and
rocket
observations



Google Earth

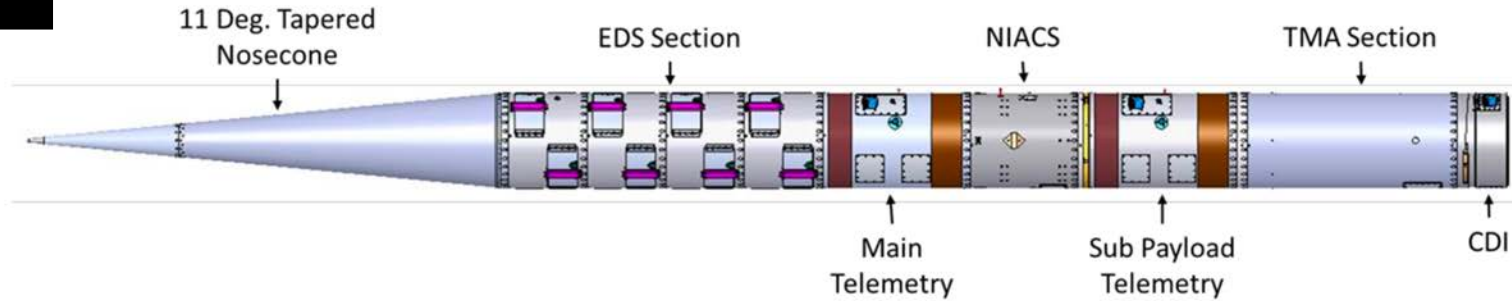
© 2020 Google



Two x
two-rocket
salvoes

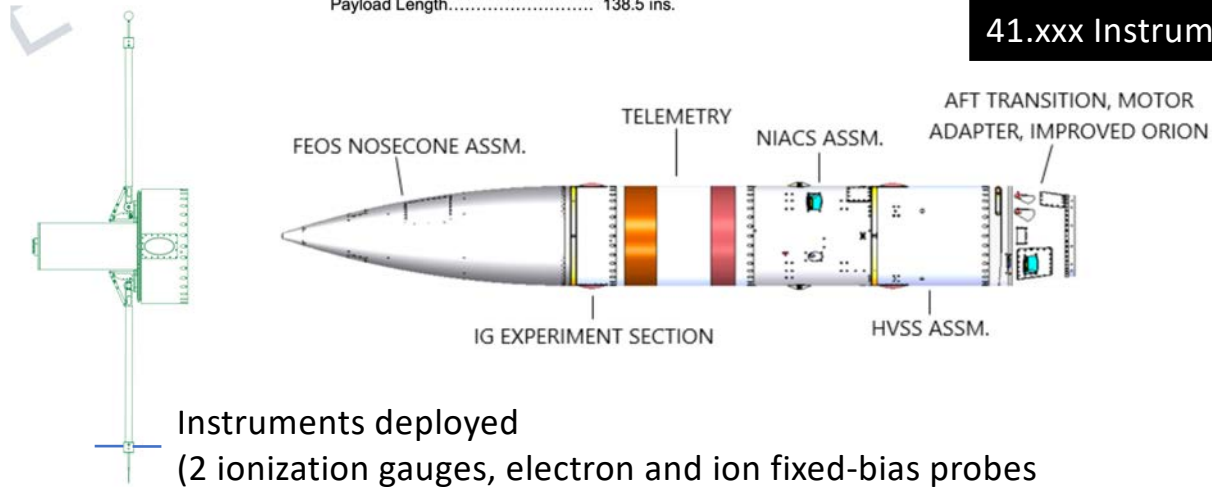
Payload Weight (Launch)..... 938.5 lbs.
Payload Length..... 271.3 ins.

36.xxx Chemicals, Elev. 84°, Apogee 281 km




Payload Weight (Launch)..... 412.0 lbs.
Payload Length..... 138.5 ins.

41.xxx Instrumented, Elev. 80°, Apogee 150 km

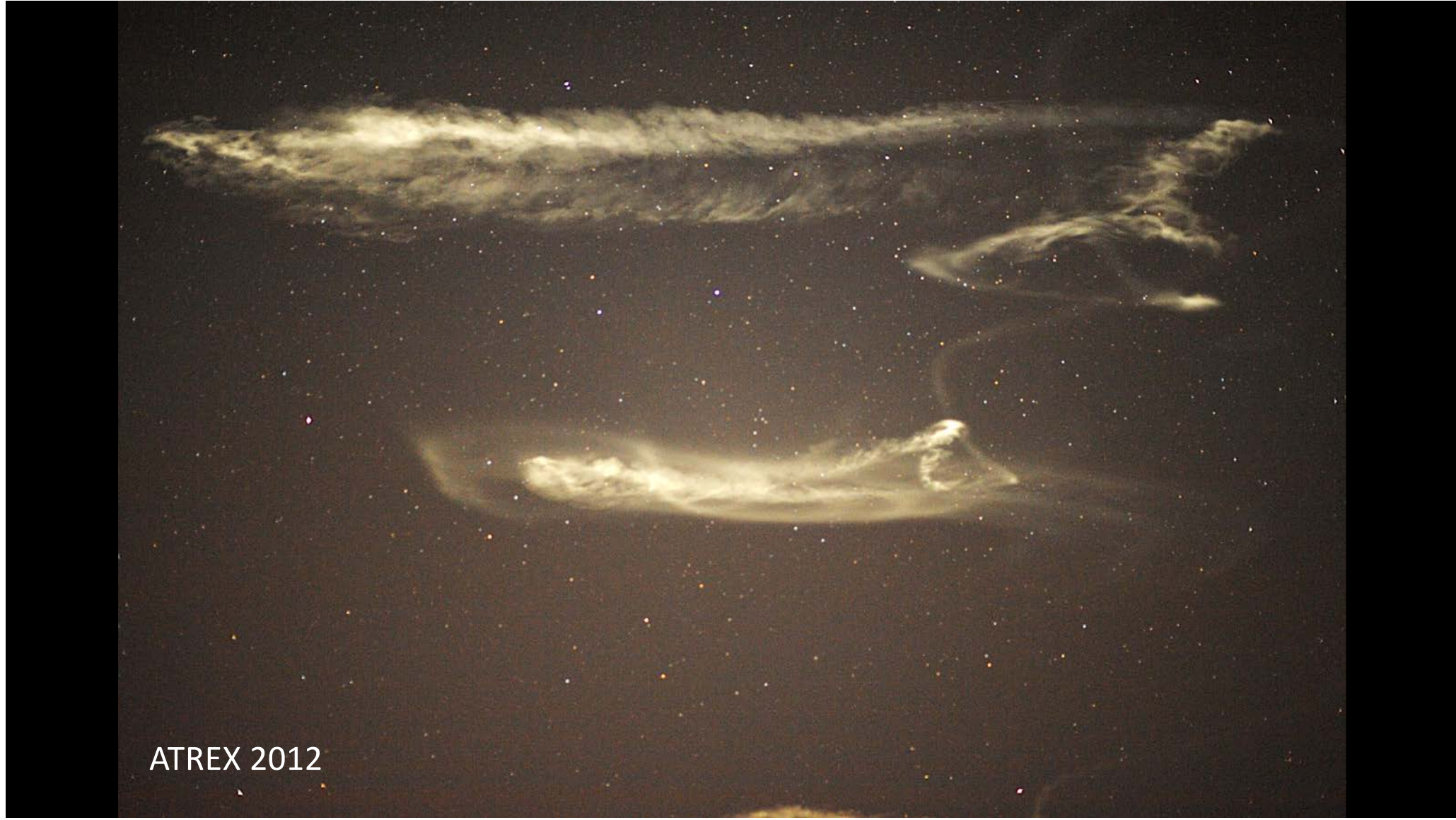


Instruments deployed
(2 ionization gauges, electron and ion fixed-bias probes)

An astronomical image showing a complex, glowing nebula against a dark starry background. The nebula features a prominent ring-like structure on the left side, with a central bright spot. Several elongated, filamentary structures extend from the ring towards the right. The overall appearance is that of a star-forming region or a remnant of a stellar outflow. The colors are primarily yellowish-white, with some blue highlights from the stars in the background.

ATREX 2012

100 m – 1 km rather isotropic

The image displays two prominent, glowing, horizontal structures against a dark, star-filled background. These structures appear as elongated, filamentary clouds or nebulae, possibly composed of dust and gas. The upper structure is more diffuse and extends across most of the frame, while the lower structure is more compact and concentrated in the center. The overall appearance is that of a complex interstellar environment. The text 'ATREX 2012' is located in the bottom-left corner of the image.

ATREX 2012



some Clemson instrument parts (Michael Denz, Lamar Durham)

Milestones (planned)

8/6/2020 Design Review

9/6/2021 Integration
and Testing

1/20/2022 – 2/9/2022
Moon down launch
window

(early morning
preferred, e.g. 0100-
0500)

Additional support
request EISCAT scans

See also

*Lehmacher et al., Proc.
ESA-SP 742, Nov. 2019*