Thunderstorm influence on upper atmosphere

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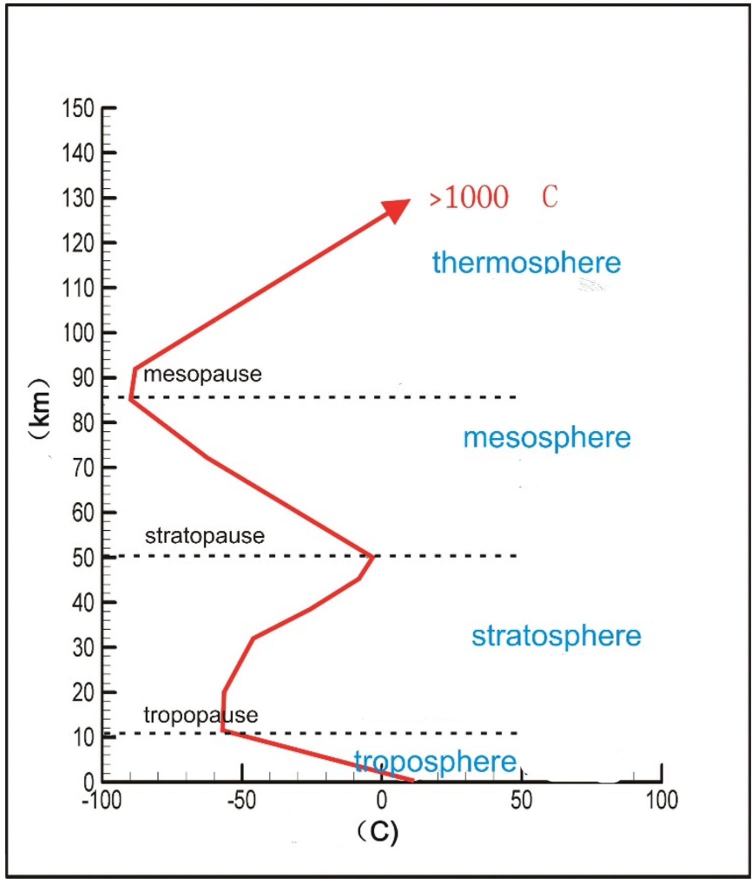
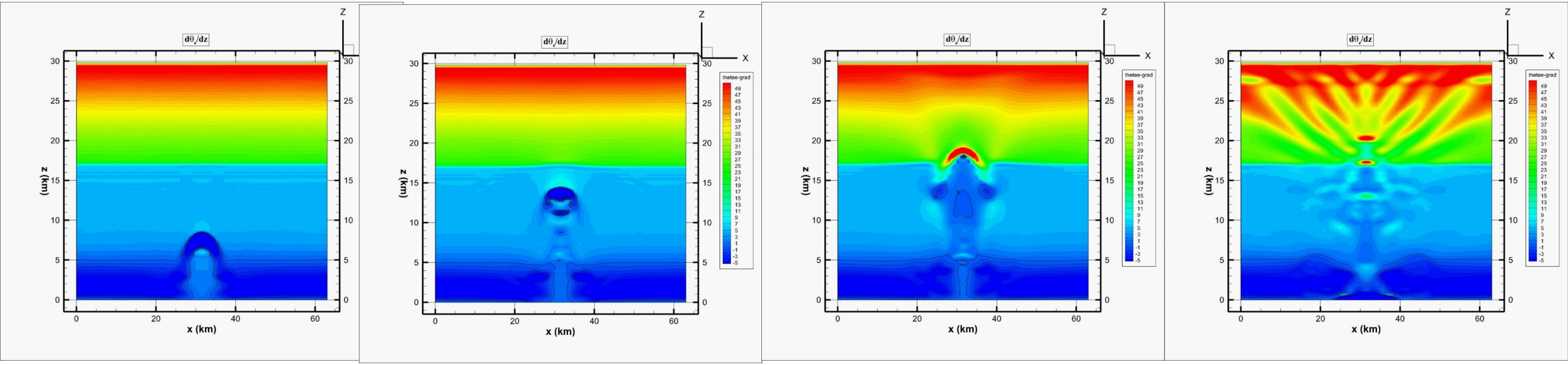
Where is upper atmosphere?

- Conventional meteorological satellites sense *mostly* information related to weather phenomena (e.g., deep convection) in the troposphere
- Some satellites (e.g., UARS or SCIMACHY) work on upper atmosphere such as mesosphere and thermosphere
- It would be of interest to connect what happen in the troposphere to what can be detected in the upper atmosphere
- We are concerned with the **mesosphere** in this presentation



How does the troposphere "tell" the mesosphere that deep convections have occurred?

Storms excites internal gravity waves that propagate upward and reach the mesopause

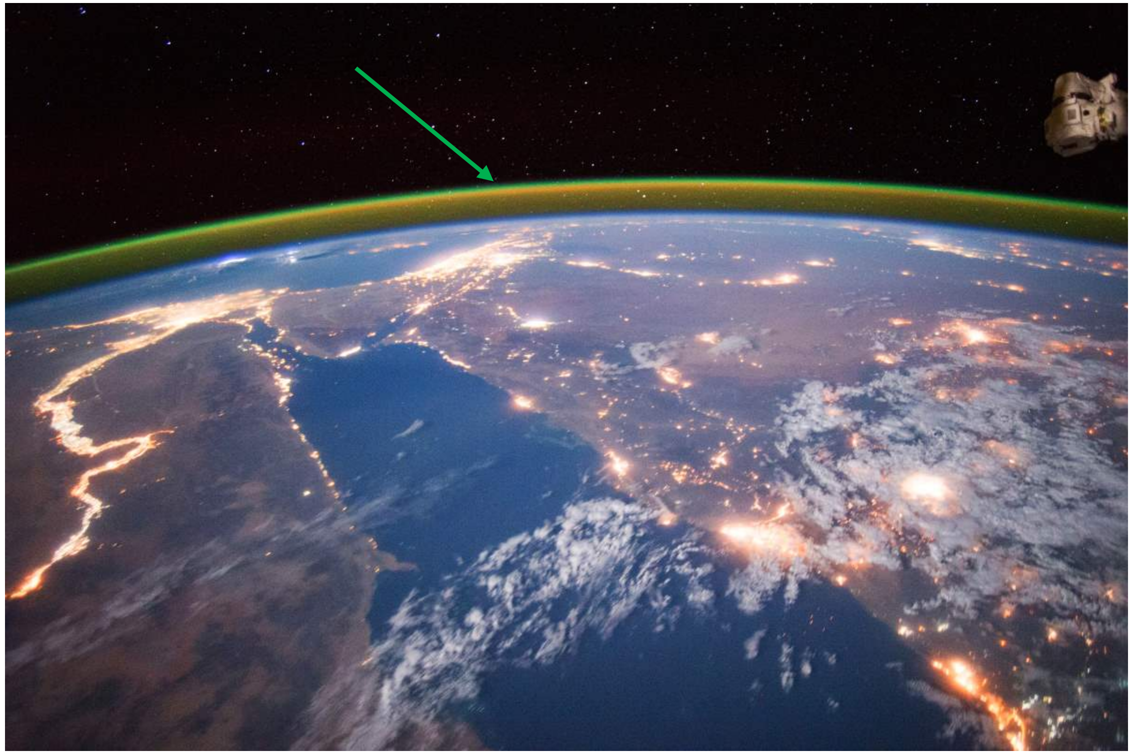


- We can decode this message if we have a code book
- We run a theoretical model to build the code book

What can satellites see in the mesosphere about deep convection events?

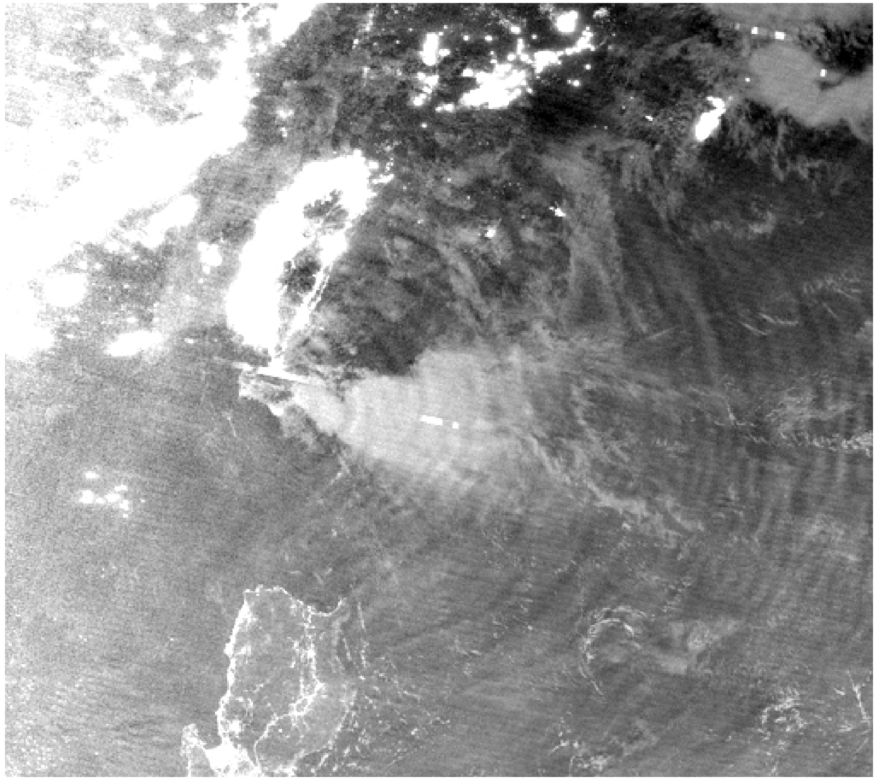
Airglow showing the gravity waves at 85 km

Airglow seen by ISS



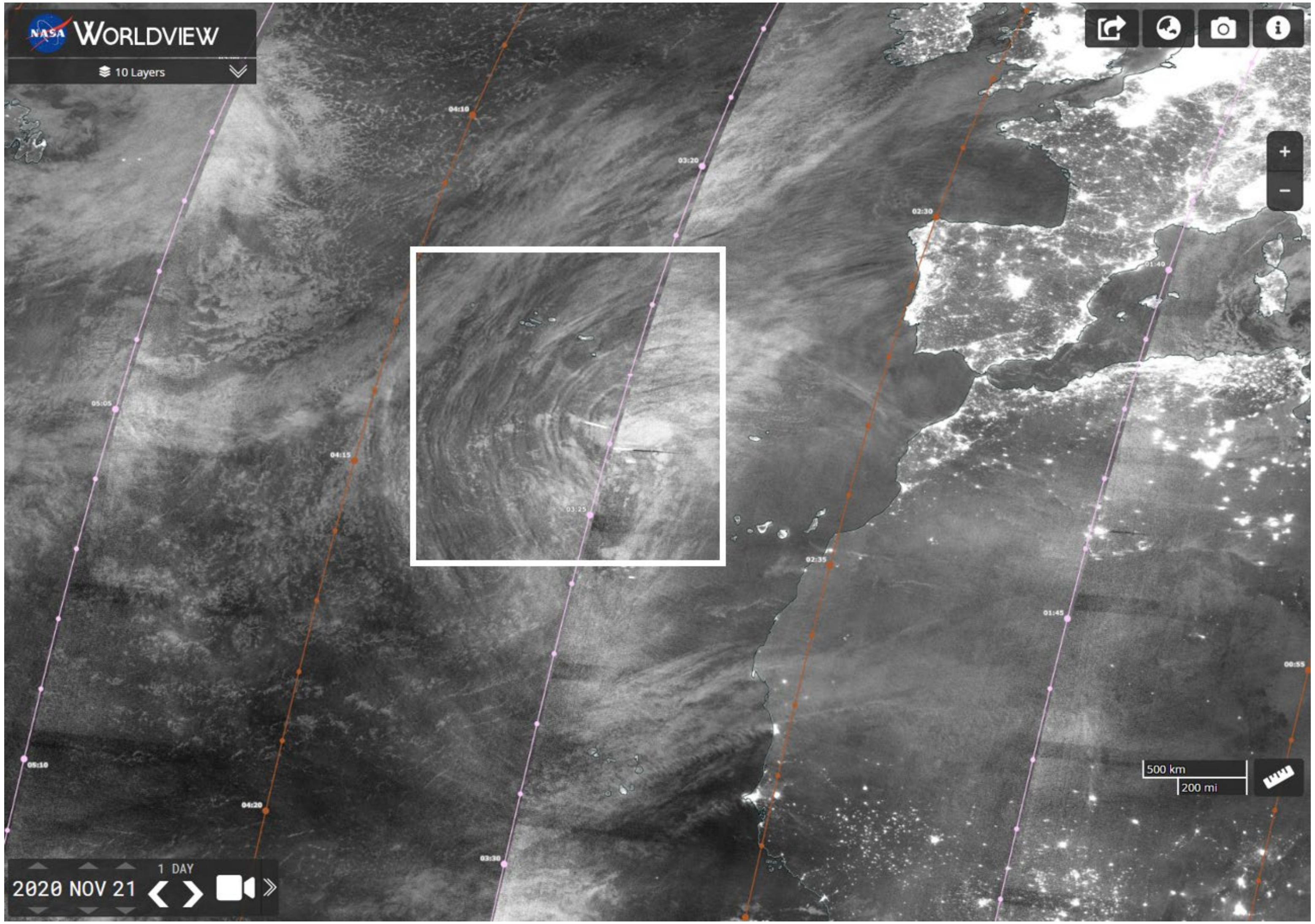
International Space Station

Airglow wave pattern seen by SUOMI/NPP VIIRS DNB



Courtesy of Martin Setvak

Airglow over Eastern Atlantic 0n 2020/11/21



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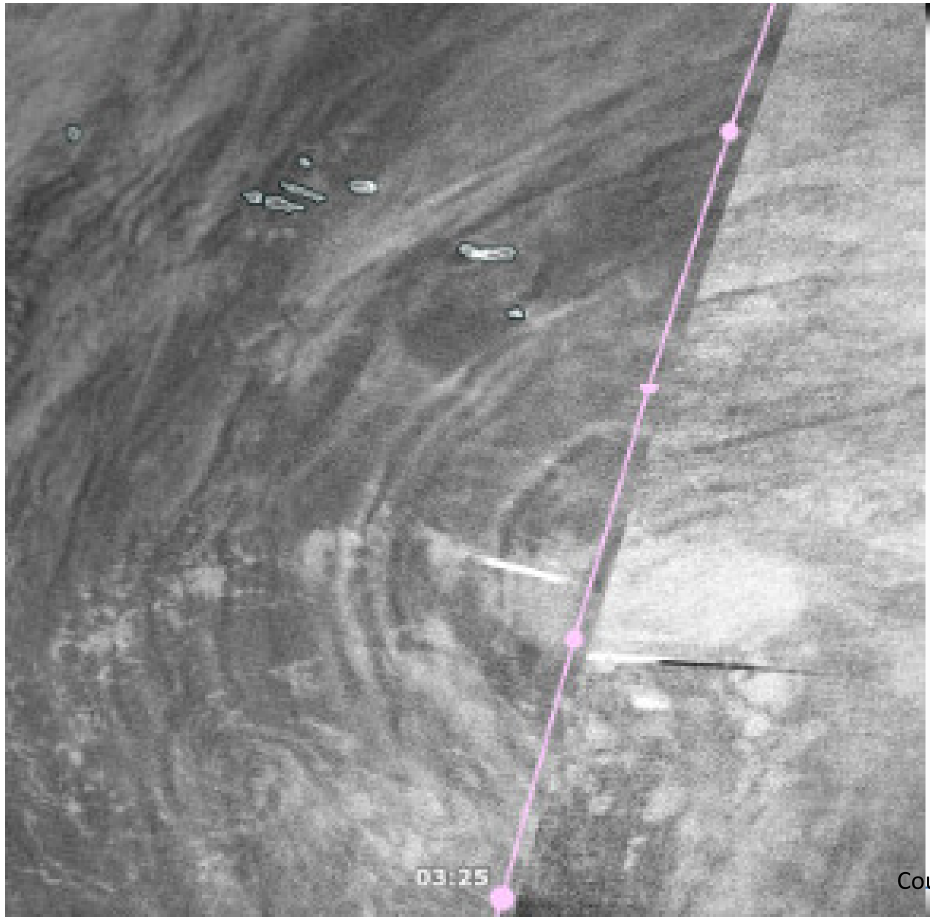
WRF simulation of 2020-11-21 Eastern Atlantic

- Initialization fields are taken from WACCM output
- Model top at z = 110 km
- Video showing the w-field at z = 80 km



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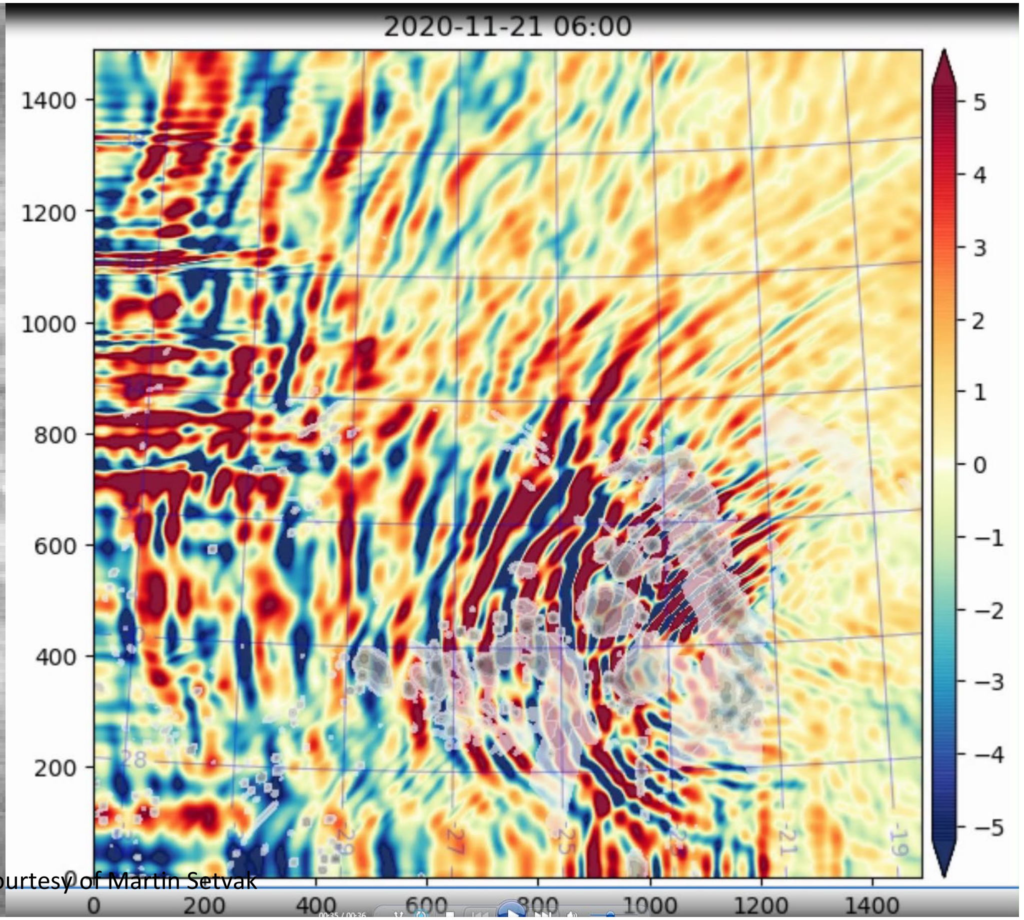
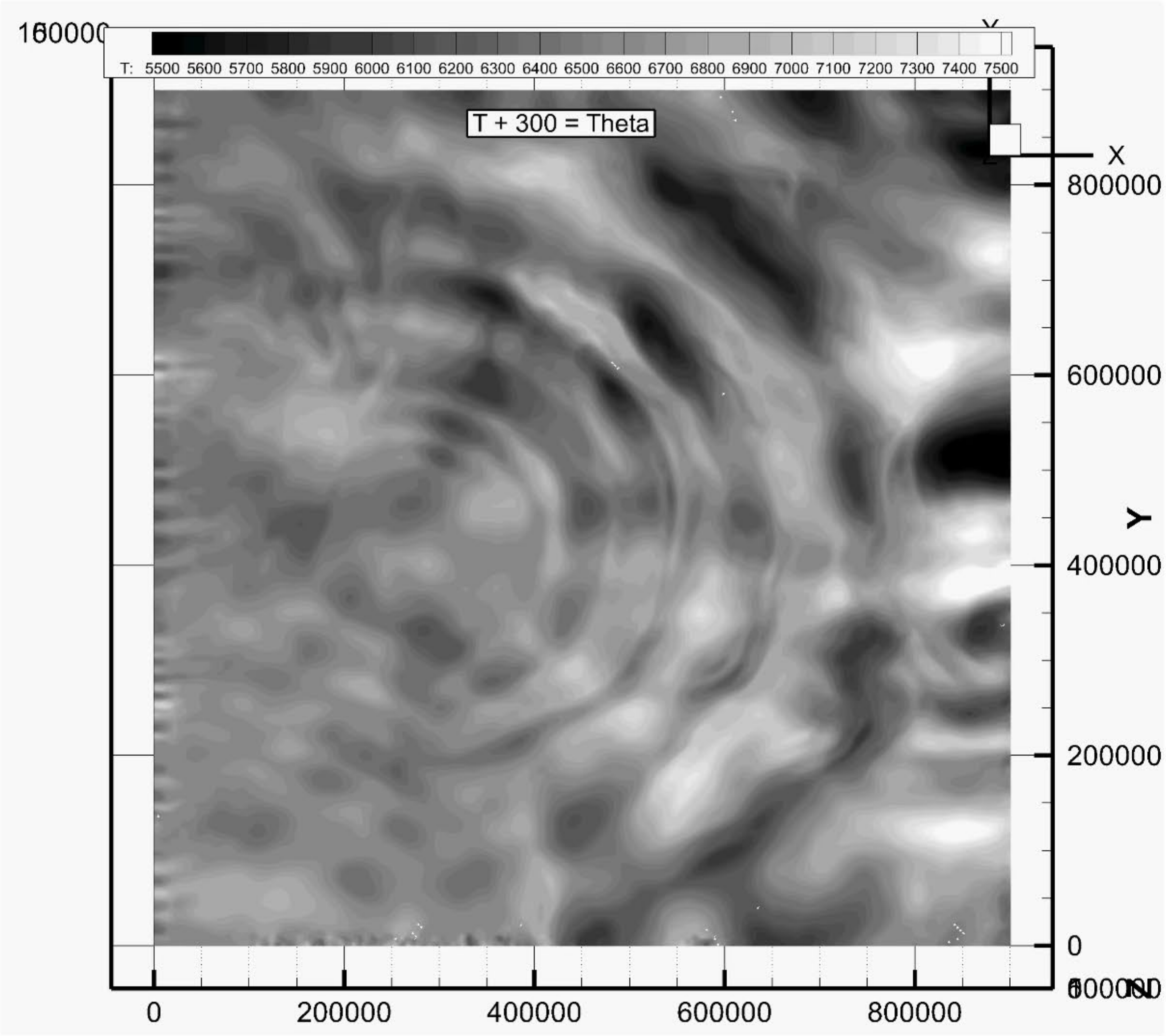


Courtesy of Martin Setvak

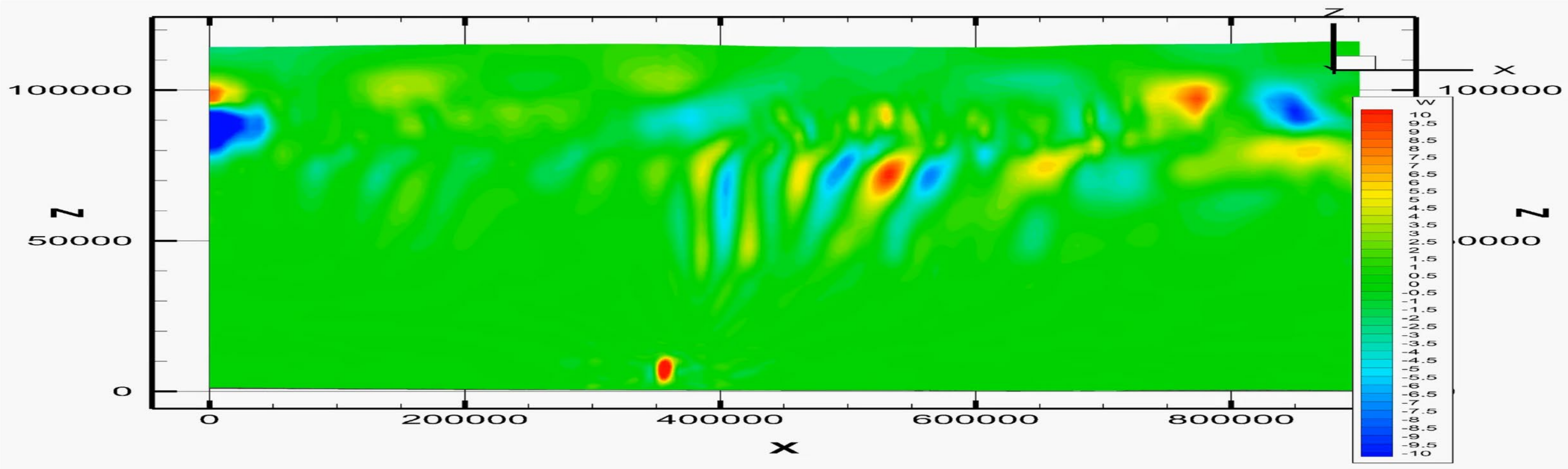
Z = 85 km cross-section of the θ - field of a convective storm event
2019-06-26 N. America – characteristic wavelength 30-40 km



Vertical cross-section of the w-field of a convective storm event

2019-06-26 N. America

we see wave propagation upward and outward to the right (against wind shear). Wave breaking may be occurring at z ~ 80-85 km



Conclusions

- Storm activities in the troposphere generate internal gravity waves that may propagate all the way up to mesopause (~ 85 km)
- Wave may appear in airglow patterns observed by satellites
- WRF model appears to do a reasonable job in reproducing the wave propagation properties in the mesosphere
- Combining satellite data and model interpretation may provide layer information of the mesosphere

— Thank you —