

Coupling between the lower and upper atmosphere via the convectively generated gravity waves

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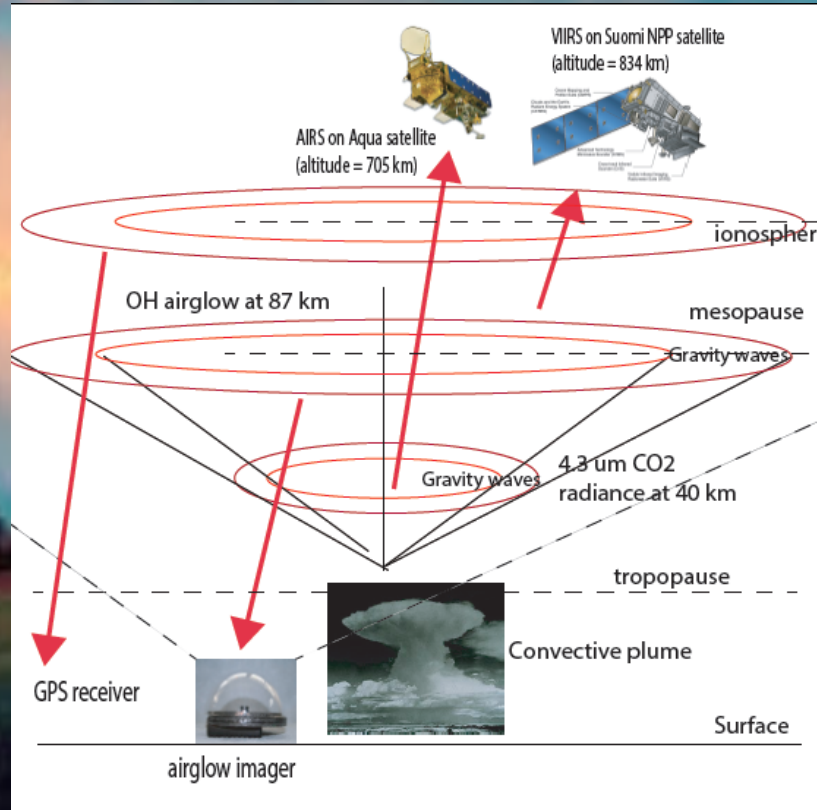


Outline

- Constellation of spaceborne nadir viewing sensors: examples
- Chinese Network of clustered ground imagers: examples
- Examples
- Conclusions

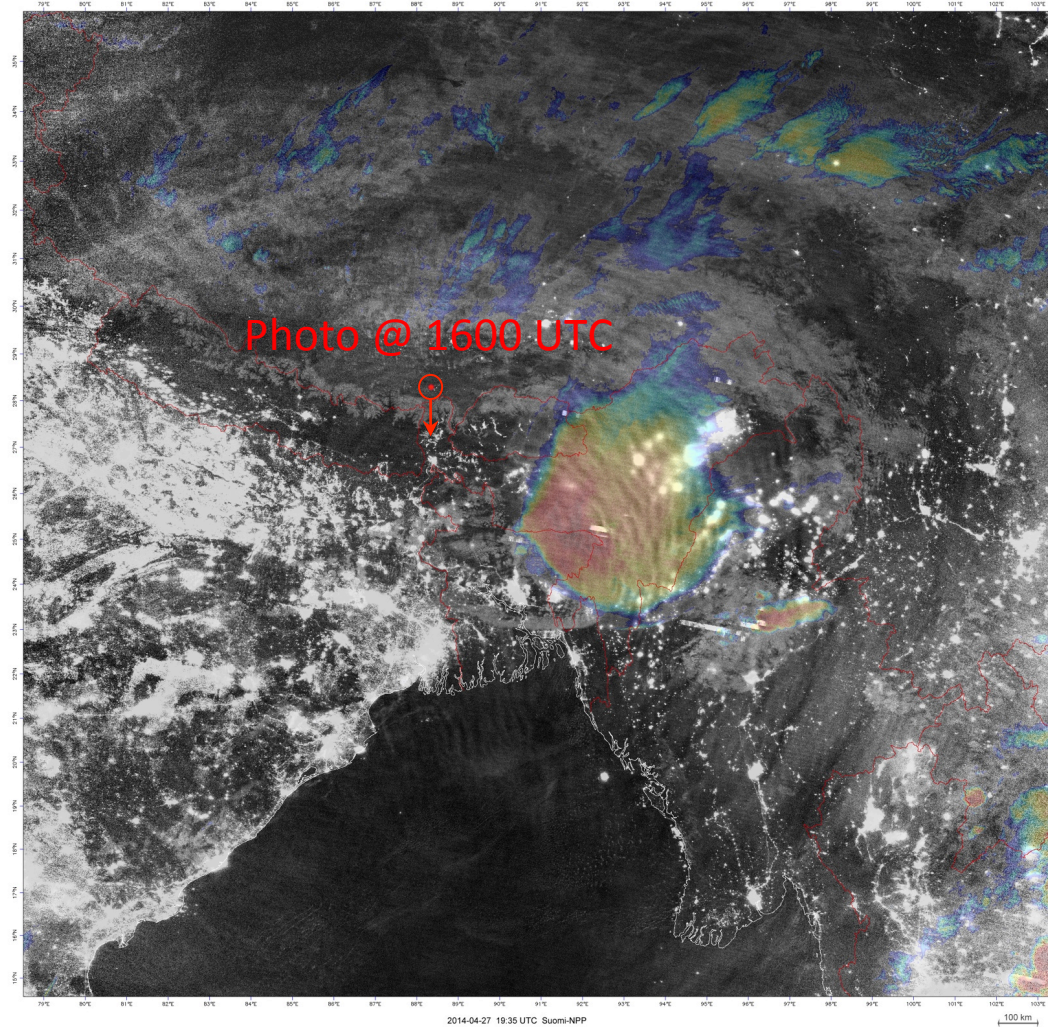
Constellation of nadir viewing sensors in space

NOAA • NESDIS
JPSS
 Joint Polar Satellite System



Bangladesh Thunderstorm (Suomi NPP vs. ground photographer)

4/27/2015 1935 UTC



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PNAS

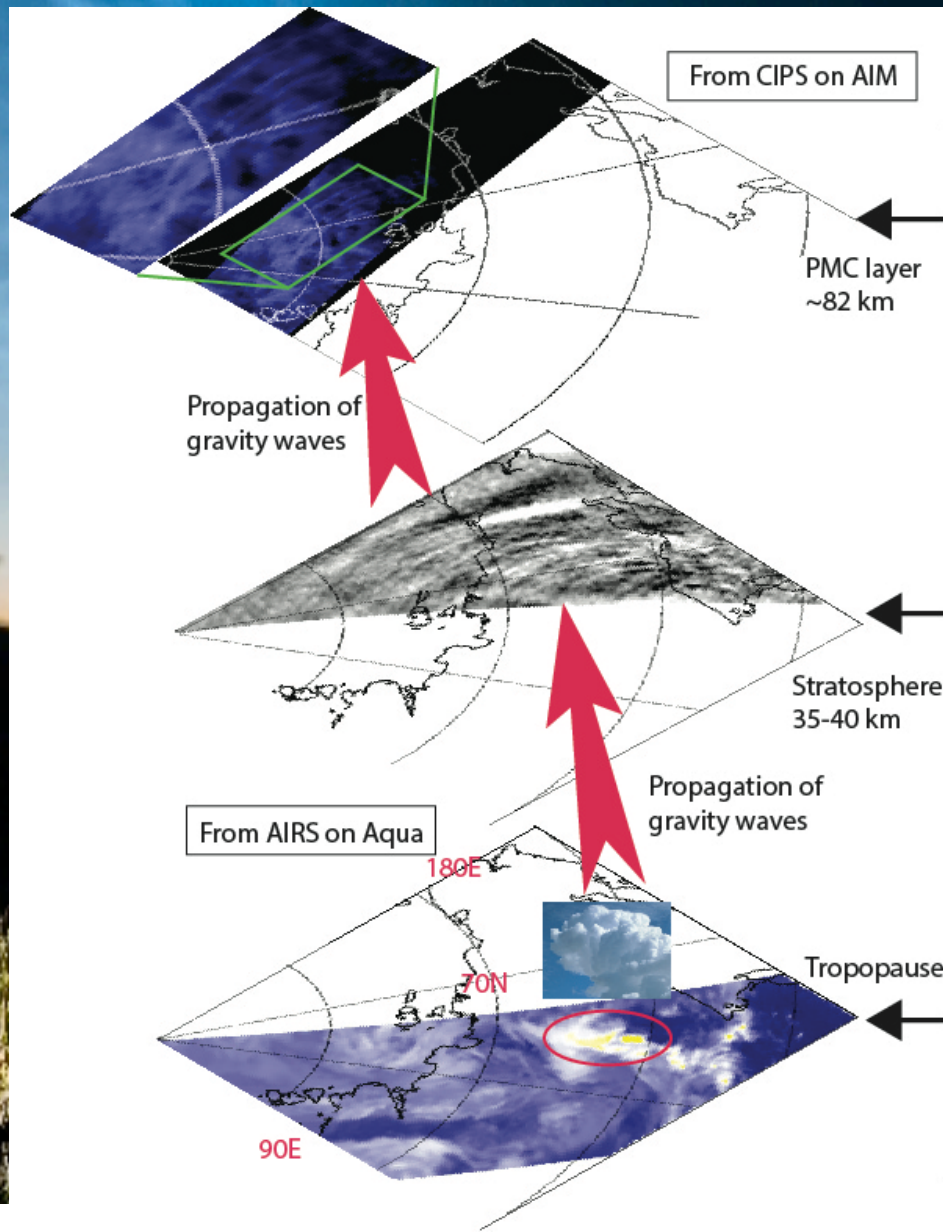
Proceedings of the National Academy of Sciences of the United States of America www.pnas.org

Gravity waves in the upper atmosphere

Middle-age mortality
Reverse transcribed repeats in cancer
History of hepatitis A in mammals
Sensitivity to intracortical electrical stimulation

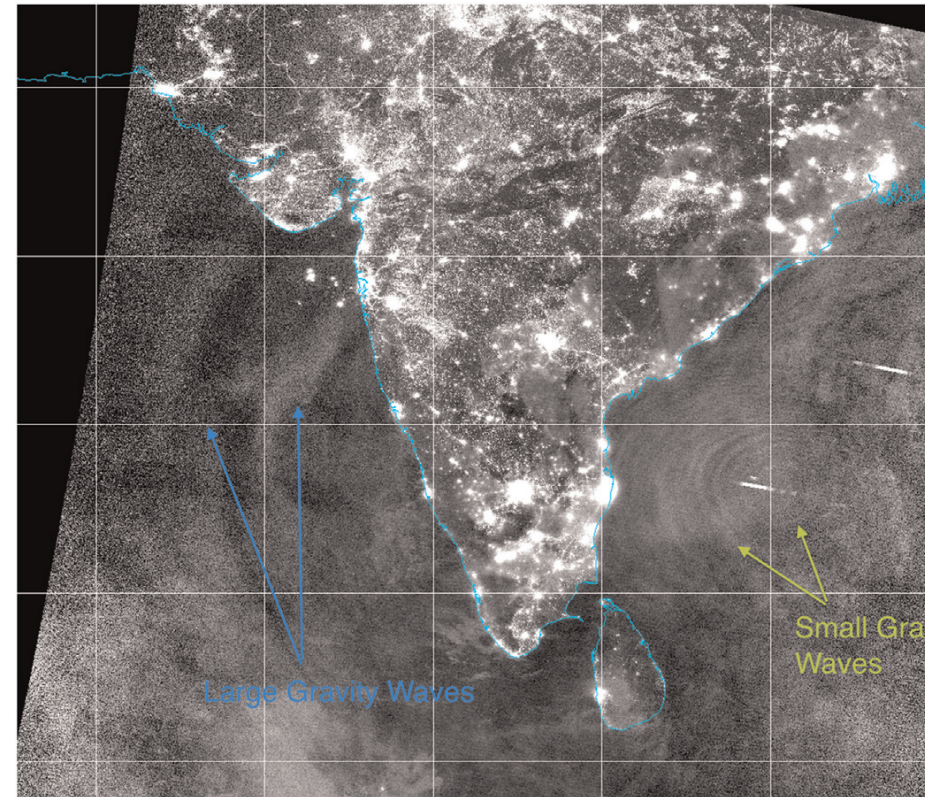
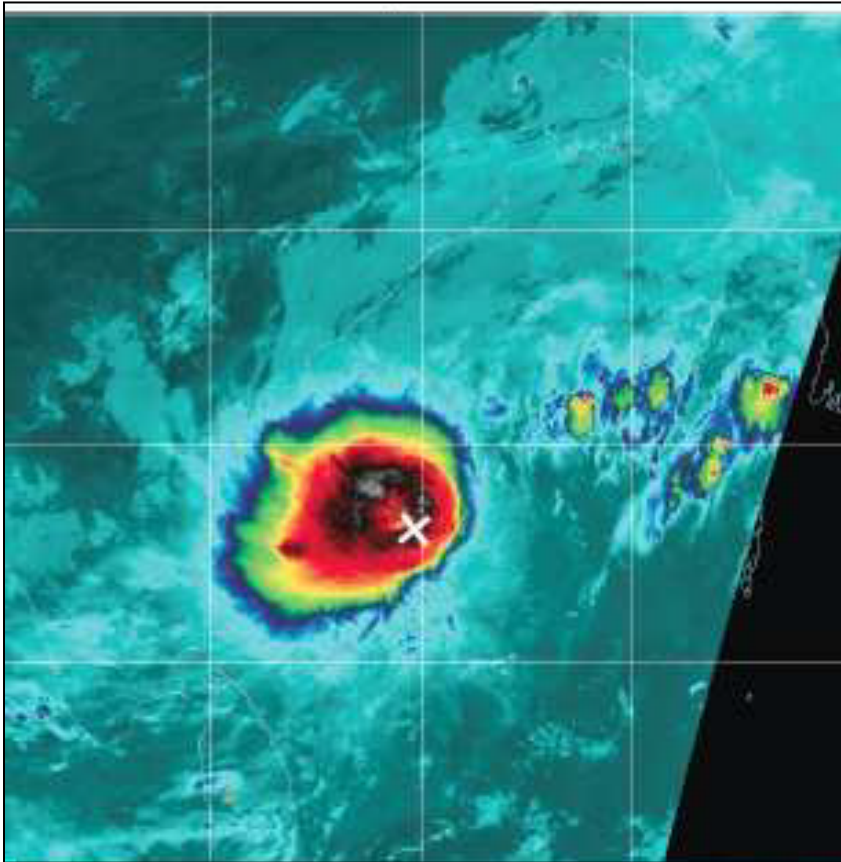
The cover of the PNAS journal features a night sky with a vibrant, multi-colored aurora (green, blue, and orange) over a dark landscape. In the foreground, a person wearing a red, reflective suit is visible, standing in a field. The overall scene is illuminated by the aurora's light.

Joint observations of concentric gravity waves in polar mesospheric clouds from CIPS on AIM and AIRS on Aqua over Siberia on 13 July 2007



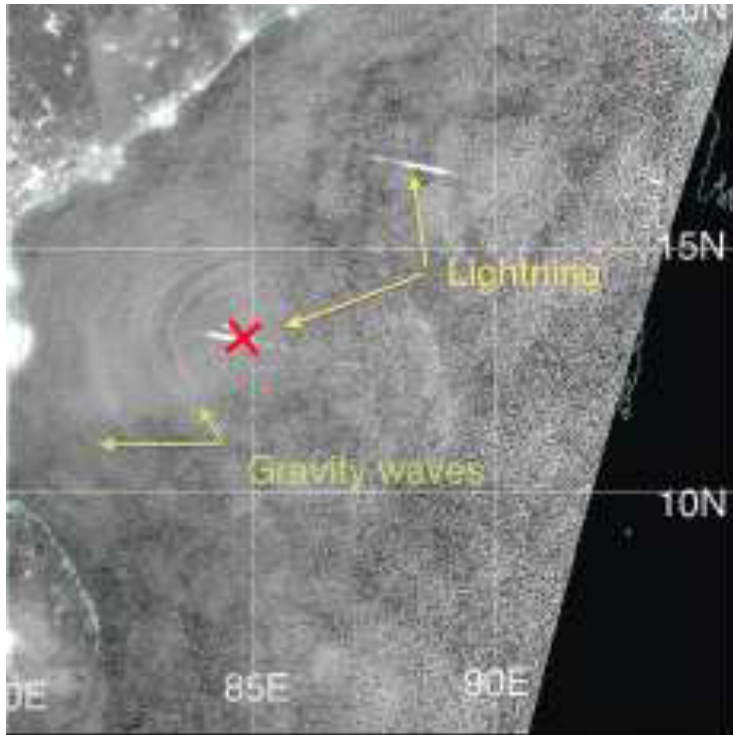
Yue et al., JGR 2014

Tropical Cyclone Mahasen (VIIRS vs. AIRS) 5/13/2013

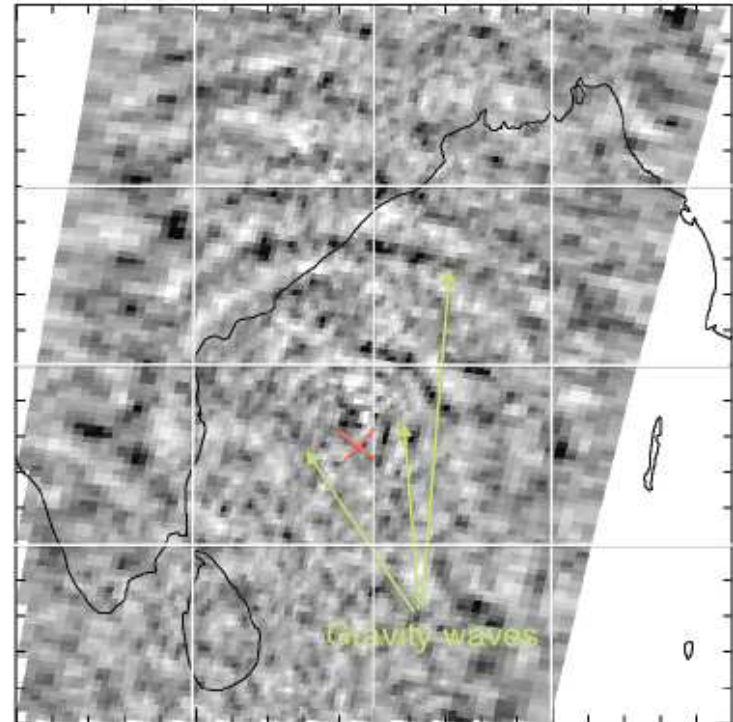


Yue , Miller, Hoffmann, Straka,
JASTP, 2014

Convective Gravity Waves TC Mahasen

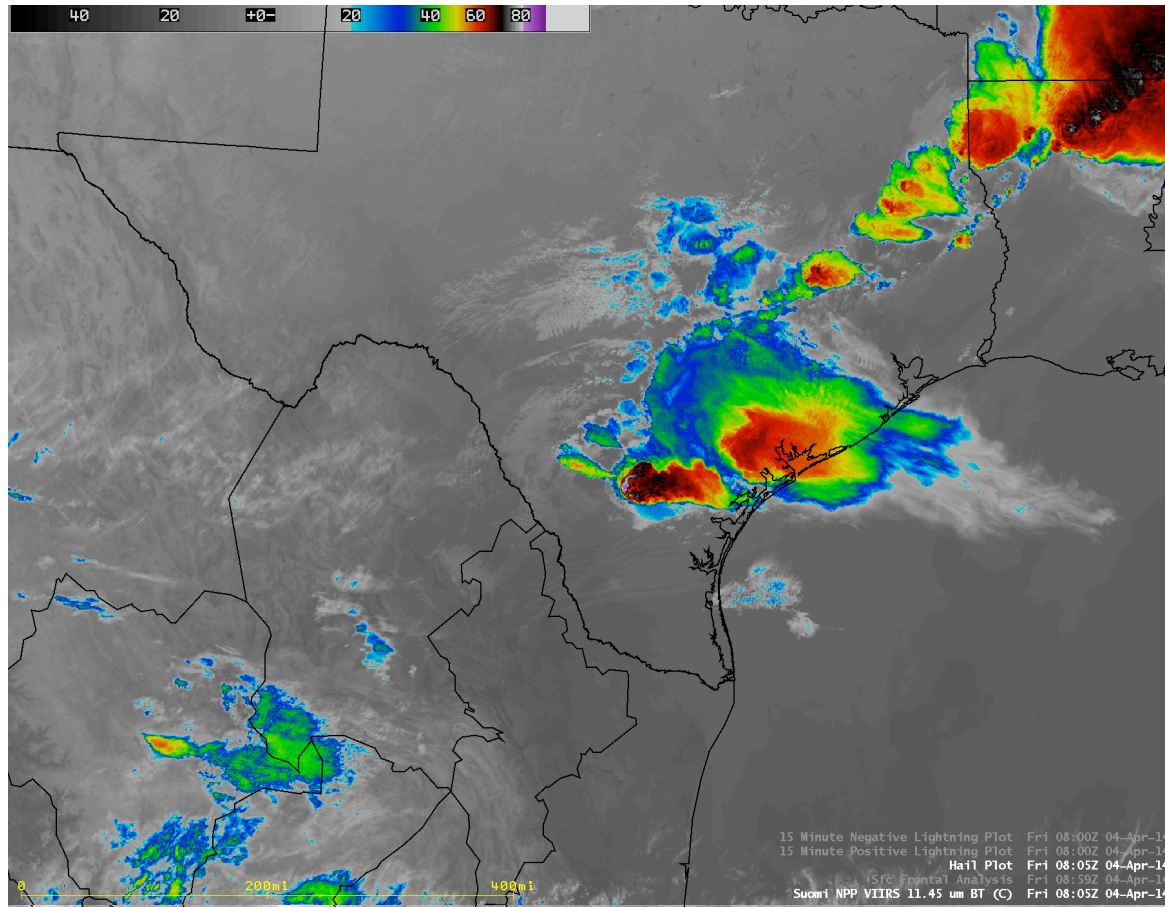


VIIRS DNB and 11 μ m (I05)
imagery on 13 May 2014 at
2015Z



AIRS observations 4.3 μ m
radiance on May 13 2013
around 2010 UT

Gravity wave event reports by The Atlantic reported on the April 4 2014 event



“This is a thin glowing layer of Earth's atmosphere *rippling* in the wake of a huge thunderstorm.” Alexis Madrigal, the deputy editor of TheAtlantic.com

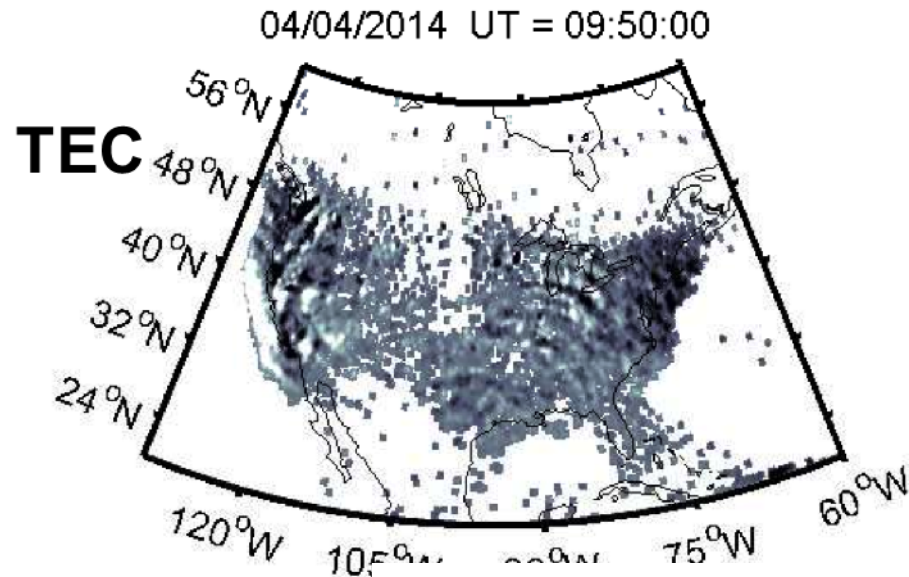
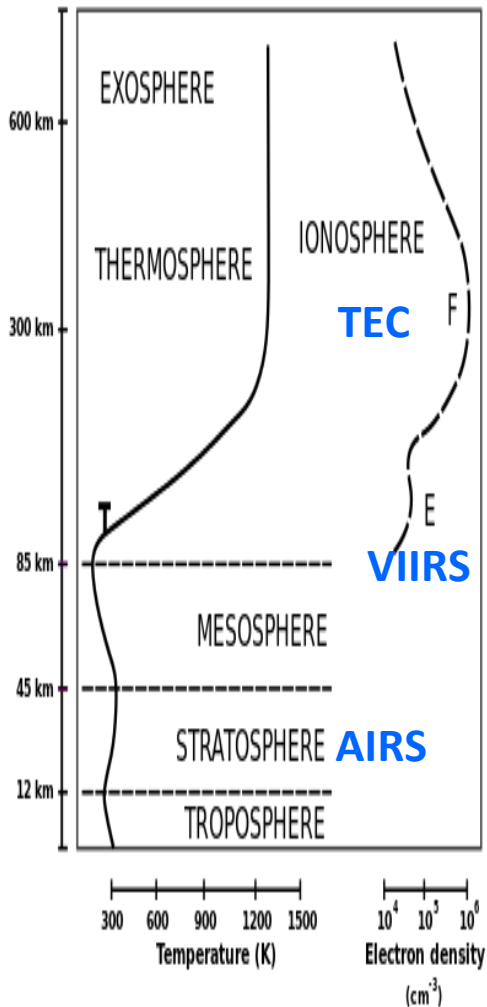
Texas Thunderstorm

Eastward View from Lamy, NM over Texas Panhandle

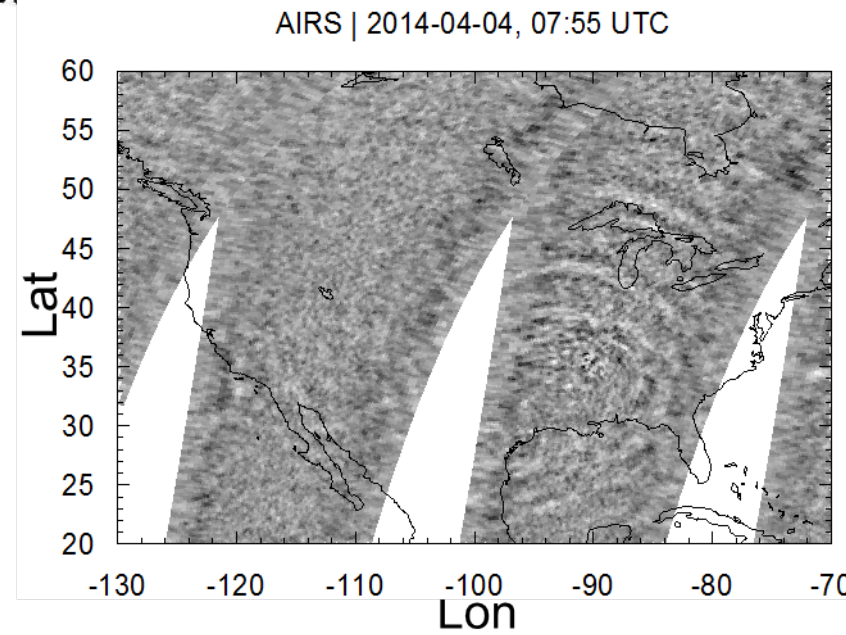


Courtesy: T. Ashcraft and W. Lyons

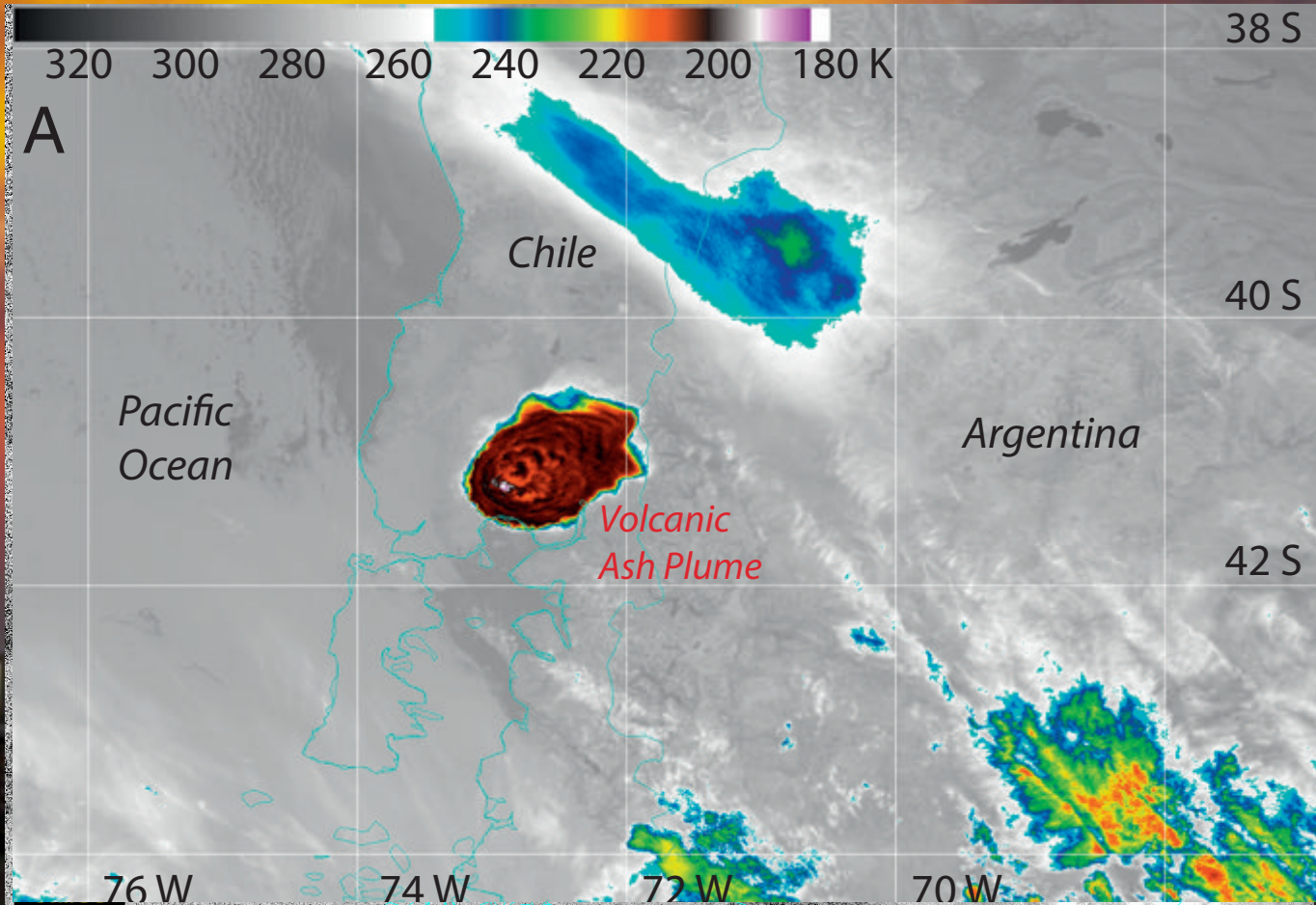
Troposphere to ionosphere connections: Gravity Waves and ion - neutral coupling



AIRS/Aqua



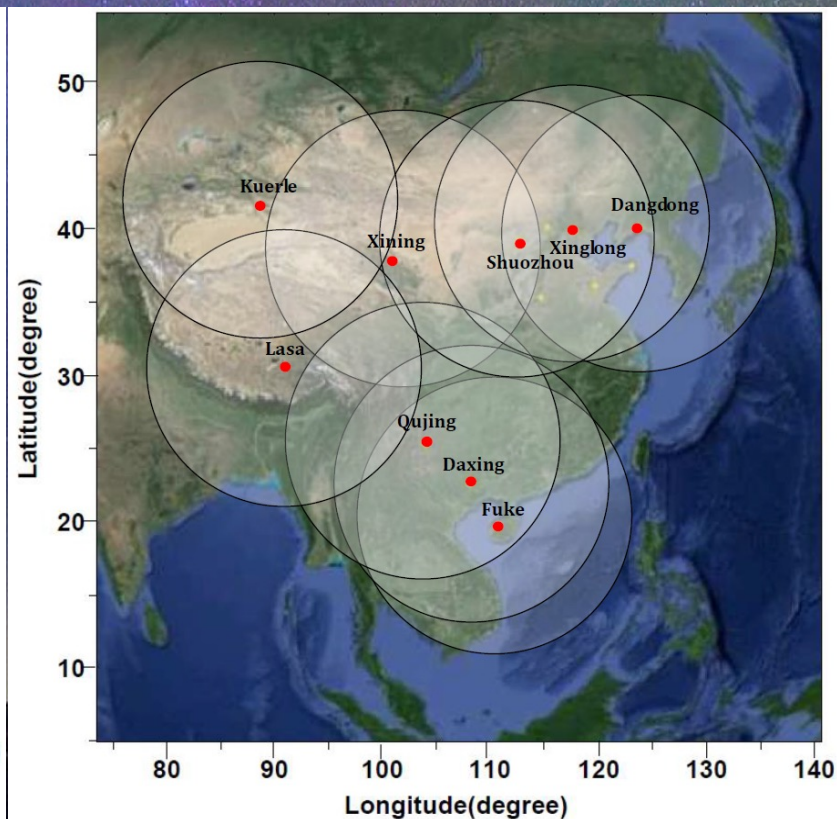
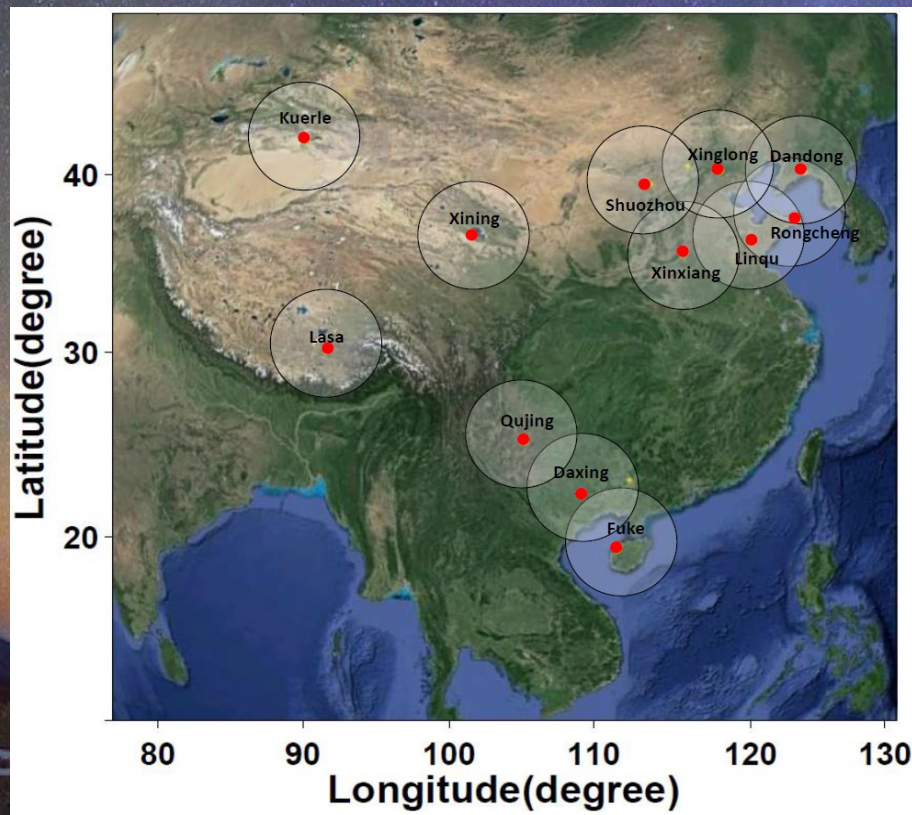
Gravity waves associated with Calbuco Volcanic Eruption on 23 April 2015



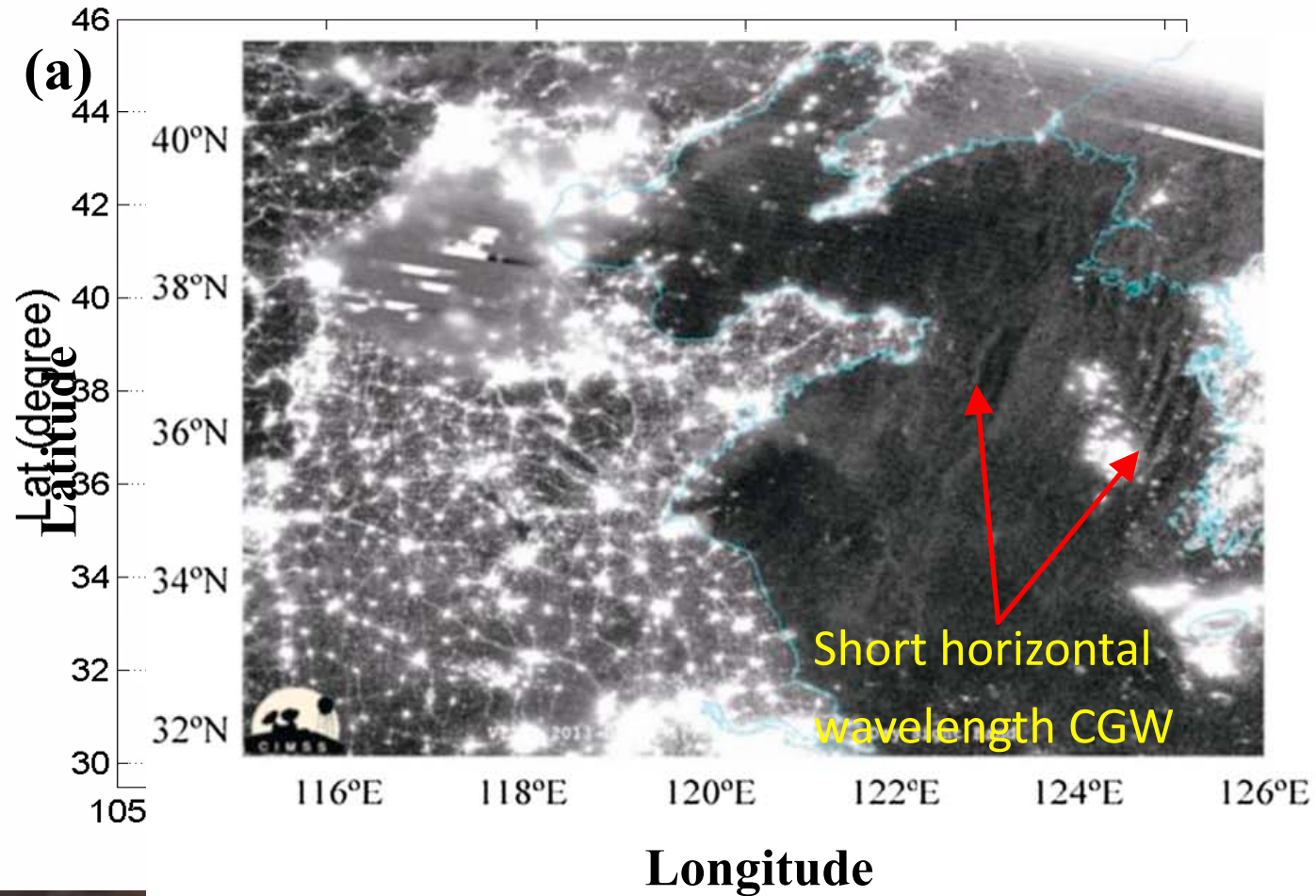
Chinese ground airglow imagers

More being installed (Jiyao Xu)

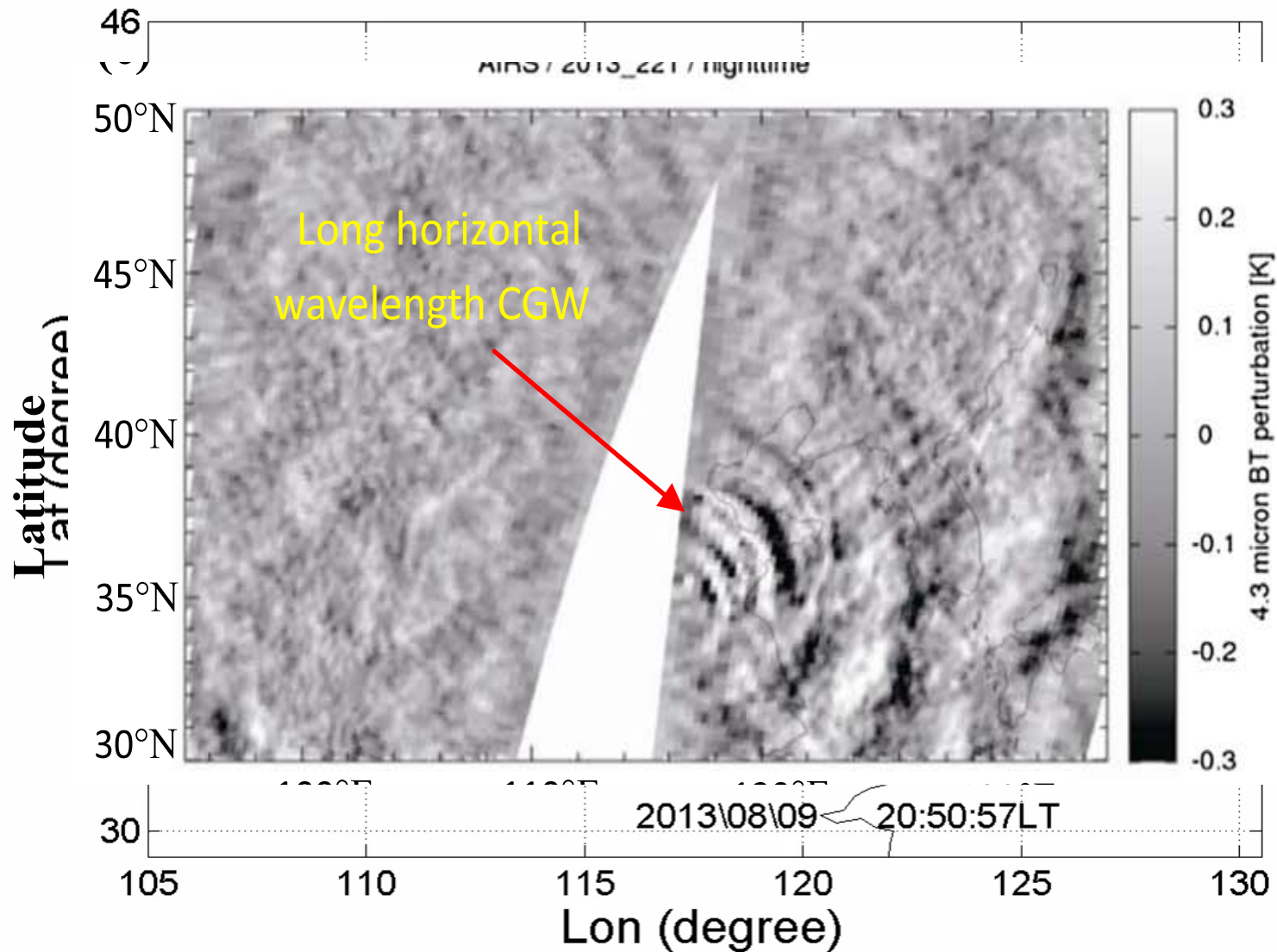
OH airglow network: 87 km altitude, 900 km diameter each
Red line airglow network: 250 km, 2300 km diameter each



Large thunderstorm event 8/13/2013 (ground imager network vs. VIIRS) Xu et al., JGR 2015

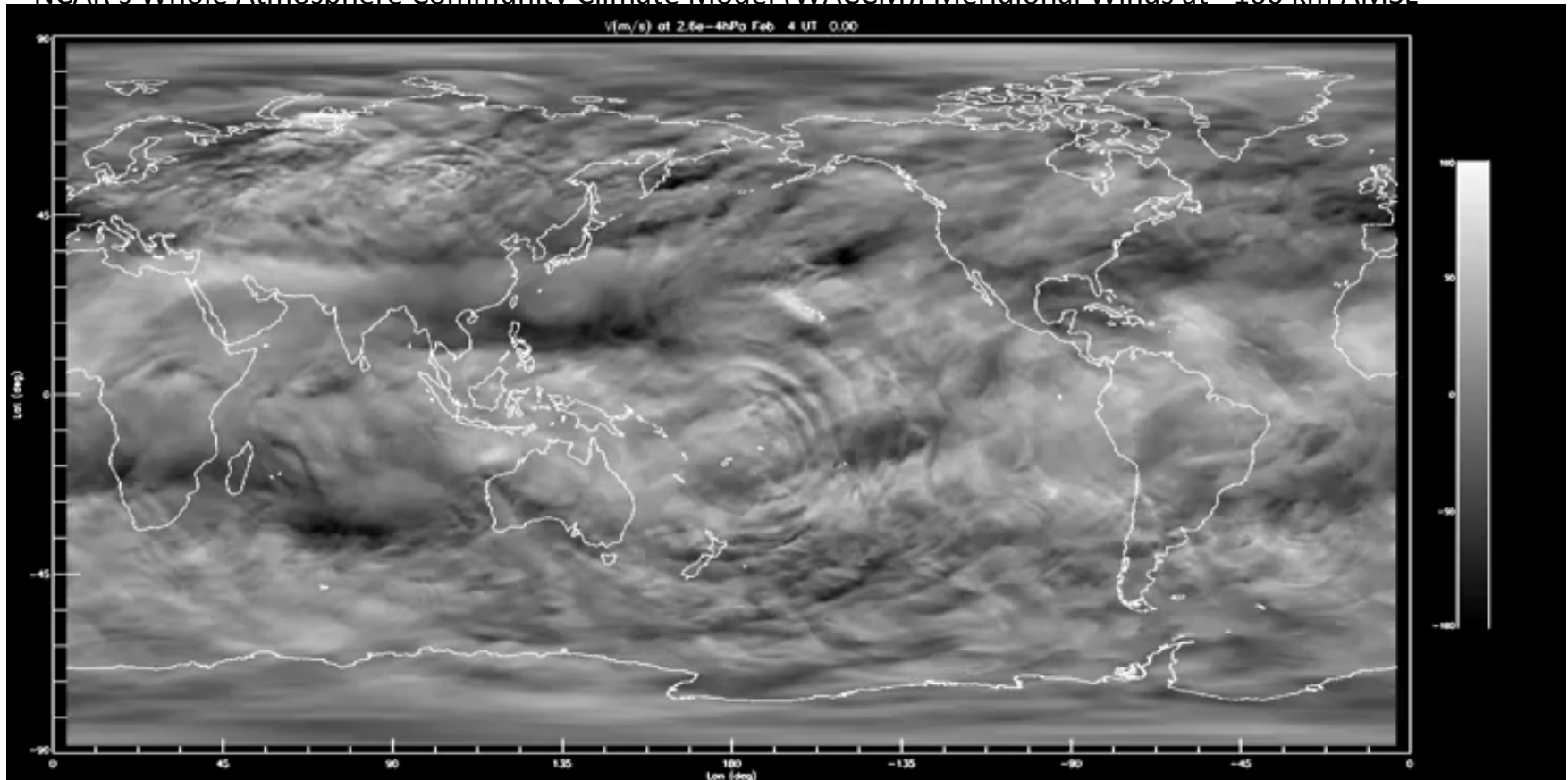


Large thunderstorm event 8/9/2013 (ground imager network vs. AIRS) Xu et al., JGR 2015



Potential Applications: Improved Numerical Modeling

NCAR's Whole Atmosphere Community Climate Model (WACCM); Meridional Winds at ~100 km AMSL



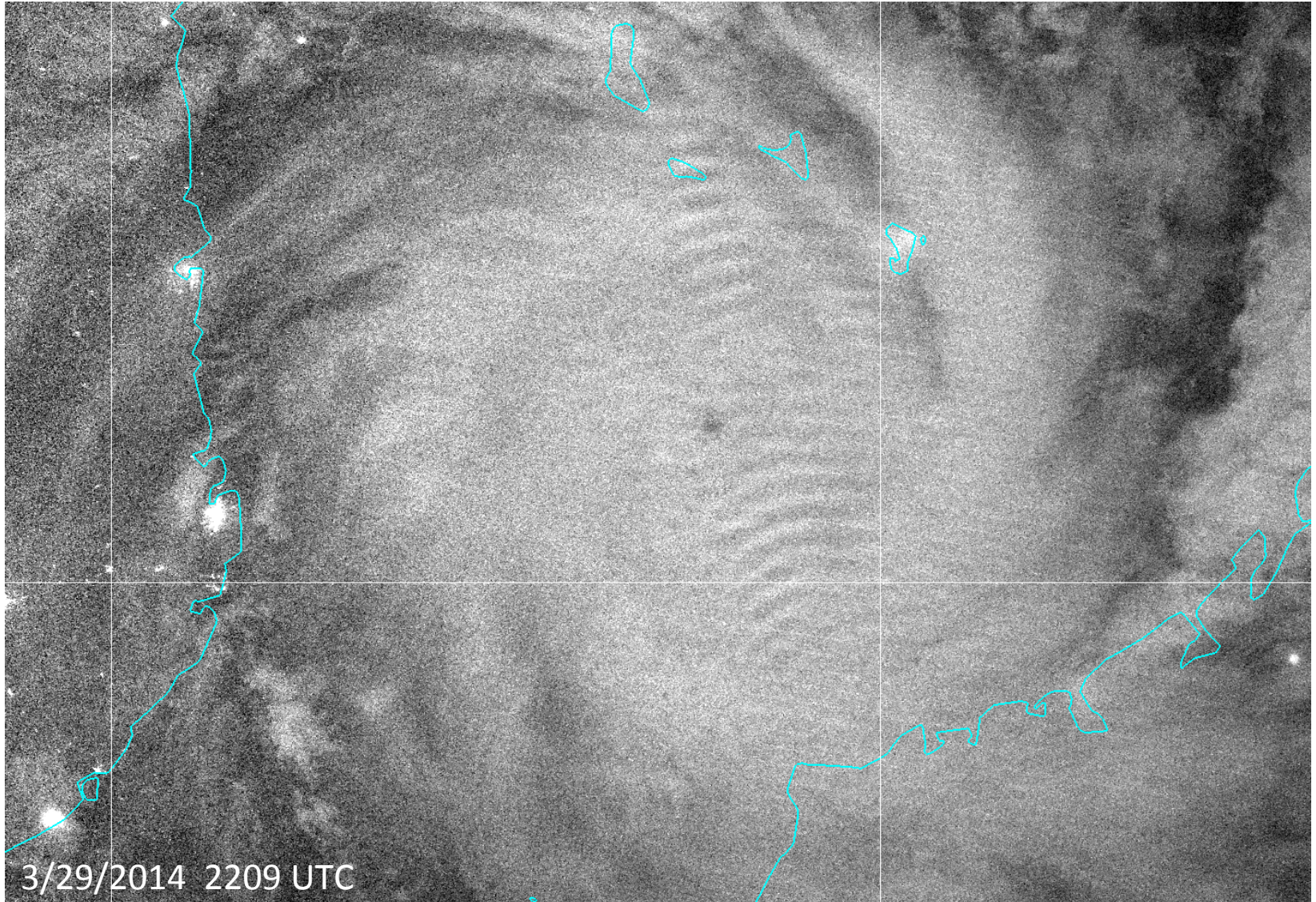
Courtesy: Hanli Liu (NCAR)

- Confronting models with high resolution observations can help to improve model representation of waves, leading to improved momentum flux and circulation processes. Models can help explain DNB-observed structures.

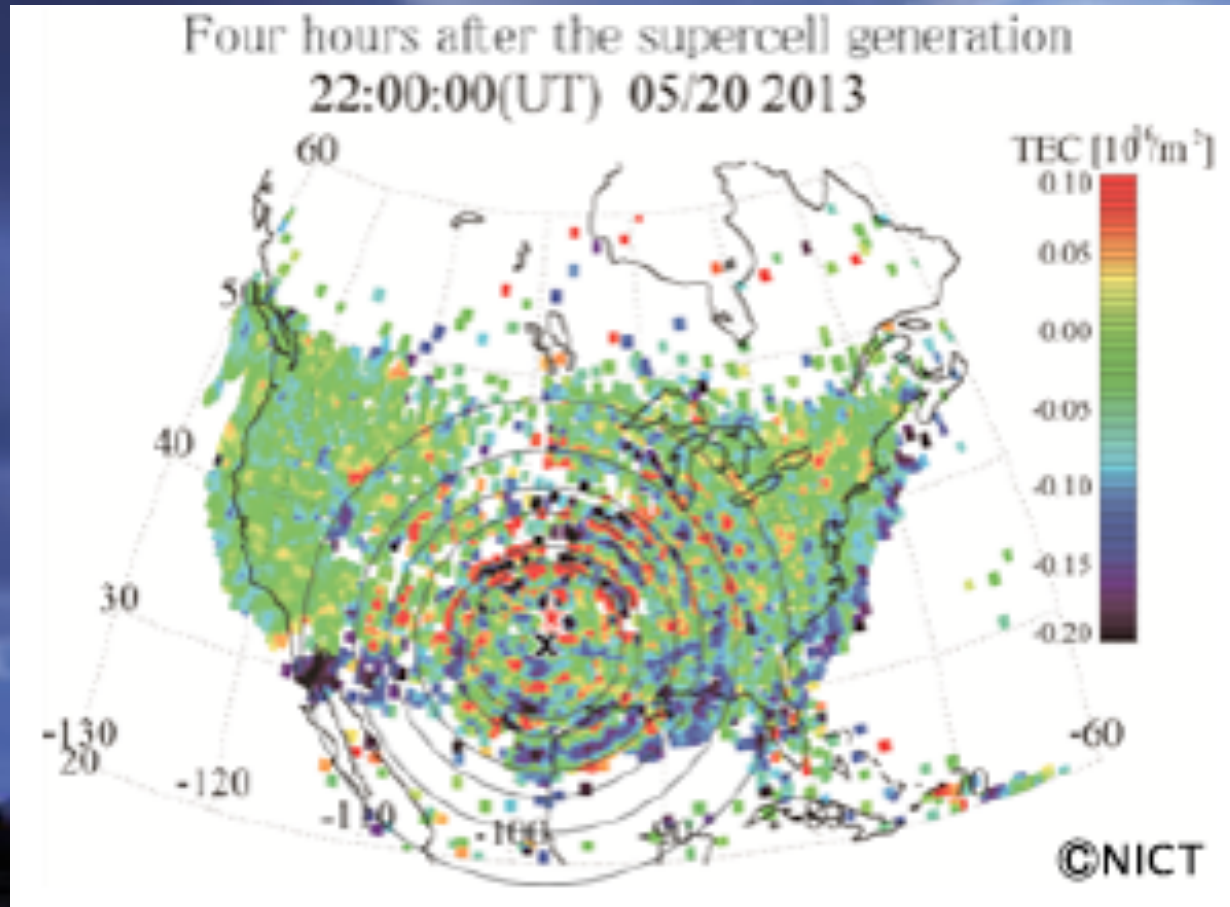
Conclusions

- Large number of gravity waves forced convection can reach the upper atmosphere
- Sets of nadir viewing sensors on satellites provide the 2D view of concentric GWs at different heights, making the correlation study possible
- Airglow imager network covers a much broader area with high resolution measurements.
- These higher frequency waves, which cannot be resolved by conventional limb-sounders, are the main drivers of the upper atmospheric circulation.
- Collaborations between high res models and high res imaging are desired.

Tropical Cyclone Hellen



Ionospheric disturbance after tornados



Waves Launched by Latent Heat

