Determining aerosol plume height from two GEO imagers: Lessons from MISR and GOES

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Passive Remote Sensing from Space

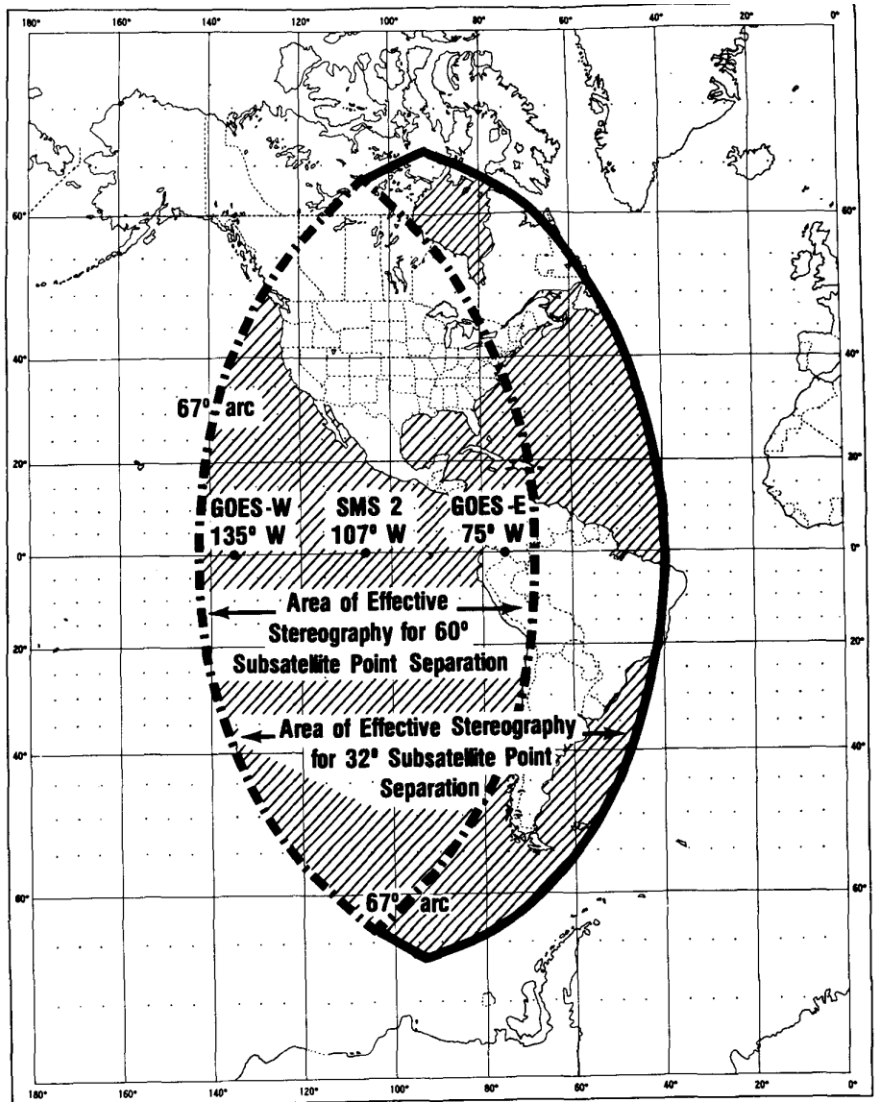
- Spectral information
  - Color, sounding, abundance, Doppler
- Spatial information
  - Shape, size, roughness, inhomogeneity
- Temporal information
  - Earthquake, volcano, fire, flood
- Stereoscopic information
  - 3D

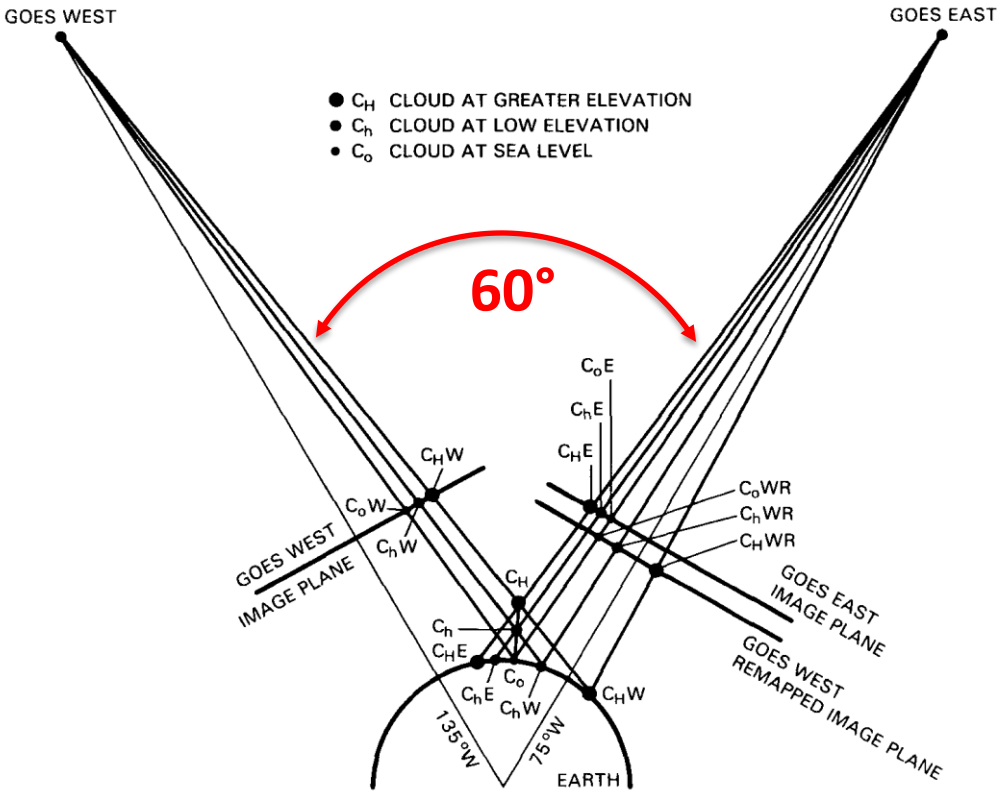
Why aerosol height or layer thickness?

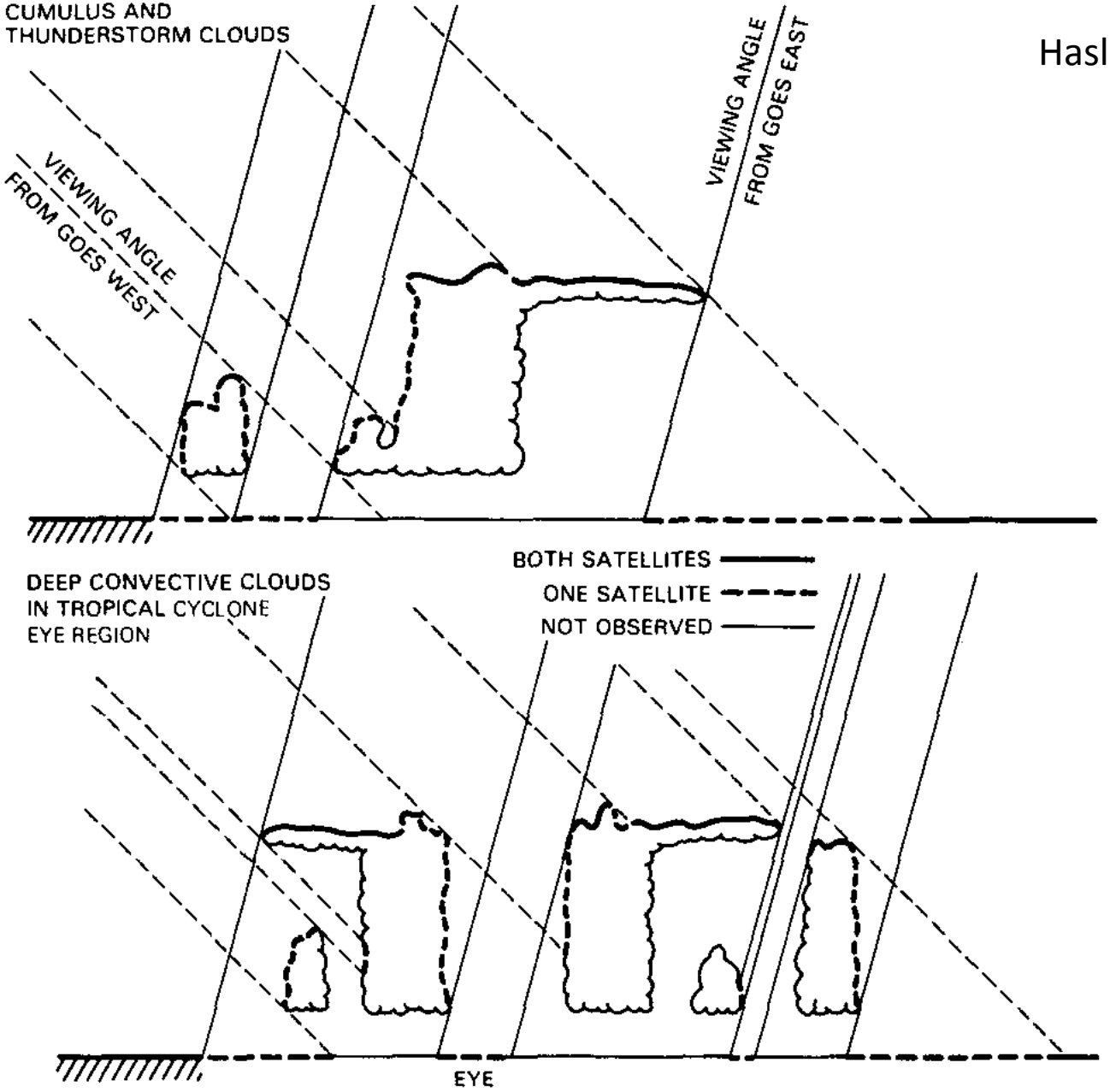
- Transport and lifetime
- Air quality and public health
- Aviation safety

Shenk (1971) Apollo6

Hasler (1981)
Black (1982)
Fujita and Dodge (1982)

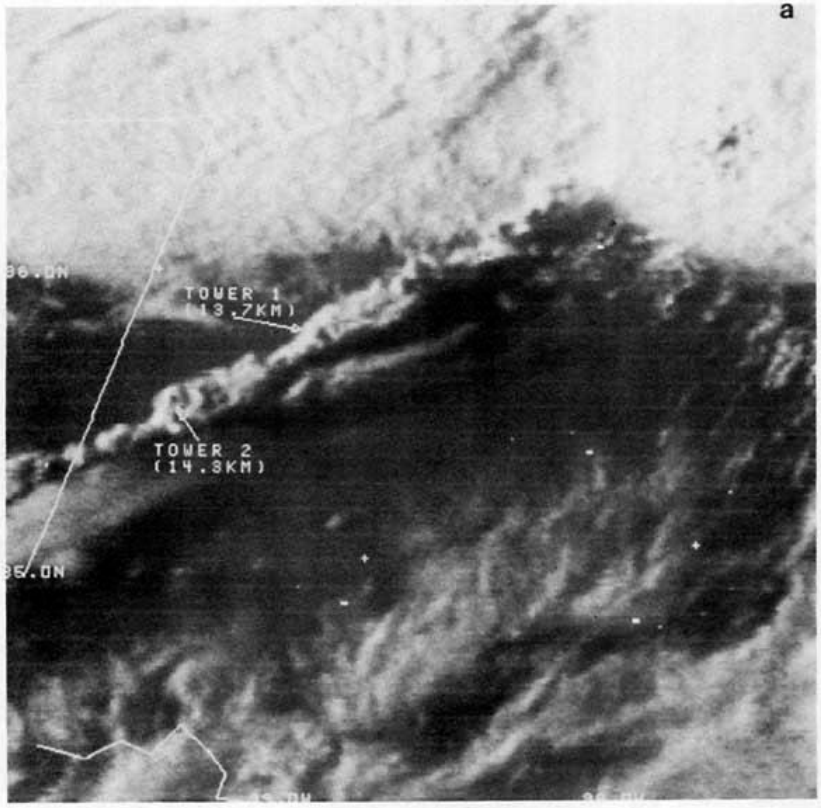


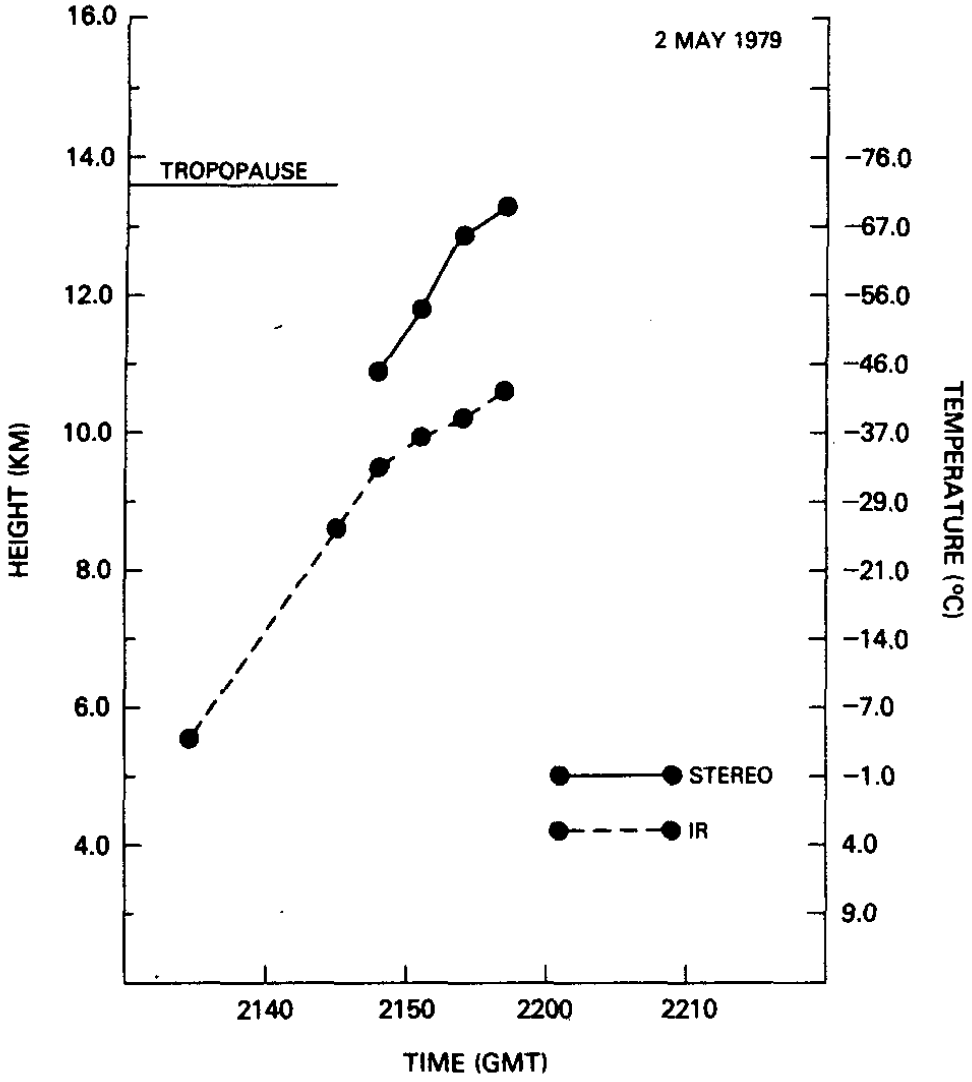



CUMULUS AND
THUNDERSTORM CLOUDS
VIEWING ANGLE
FROM GOES WEST
VIEWING ANGLE
FROM GOES EAST
BOTH SATELLITES
ONE SATELLITE
NOT OBSERVED
DEEP CONVECTIVE CLOUDS
IN TROPICAL CYCLONE
EYE REGION
EYE

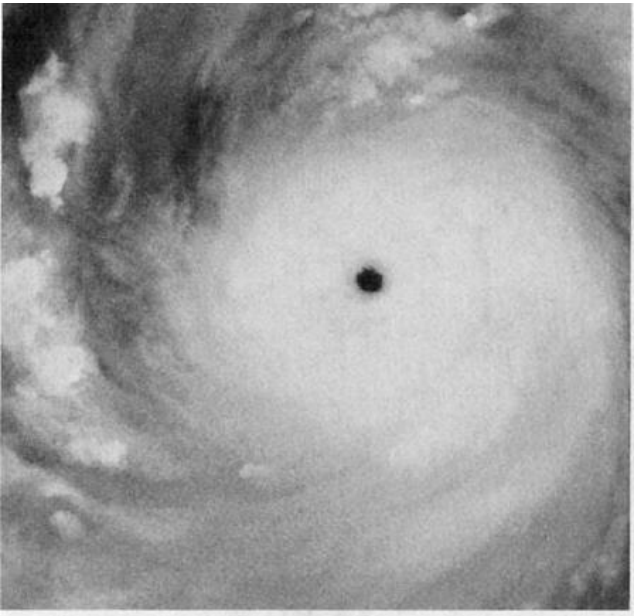
Hasler (1981)

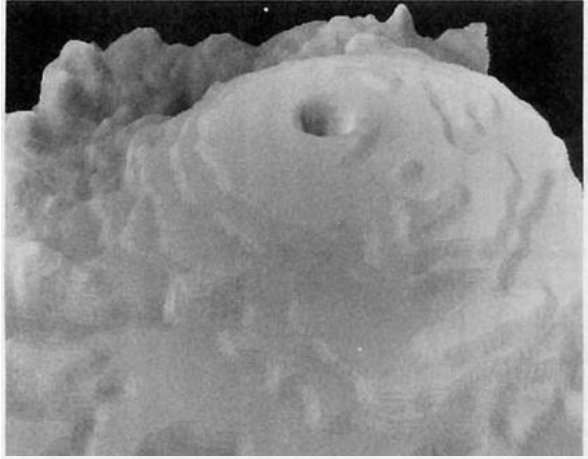
Mack et al. (1983)

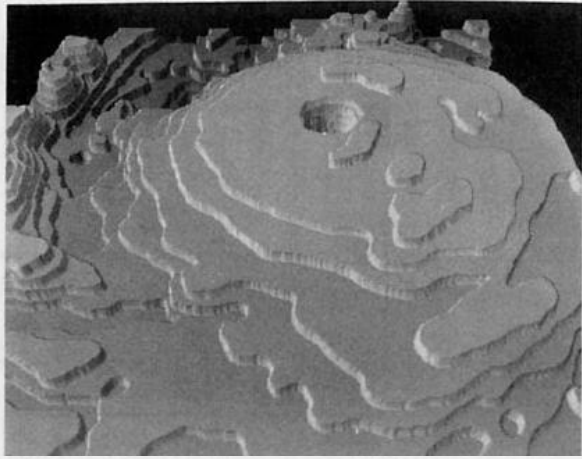


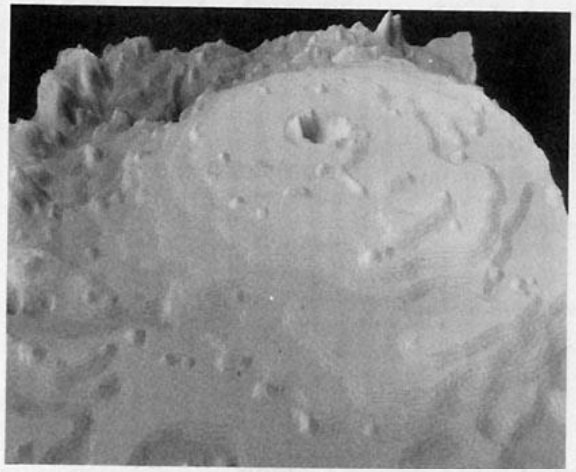


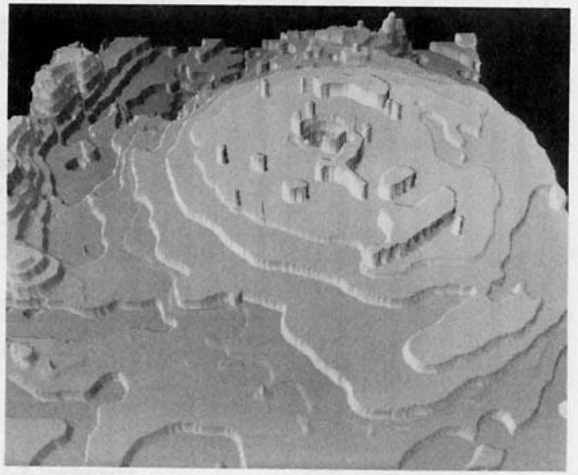
Hasler et al. (1991)

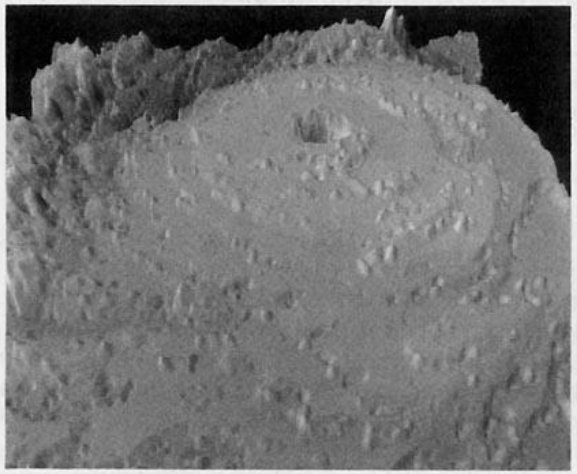


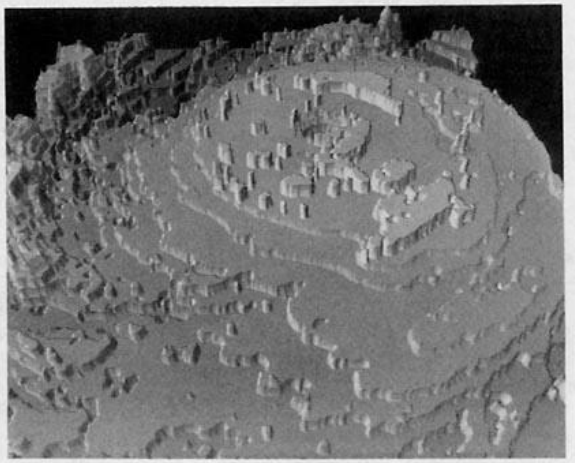


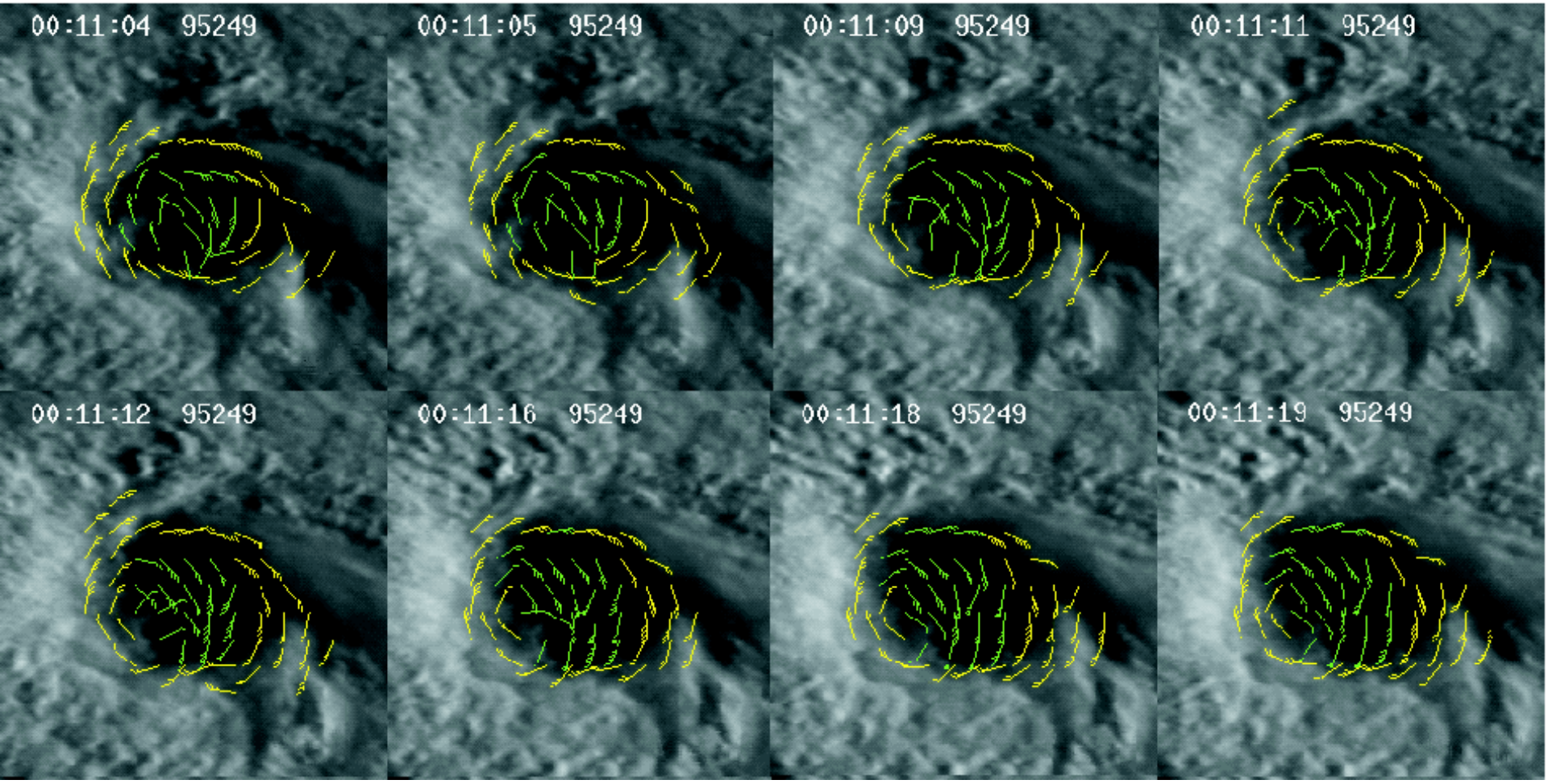






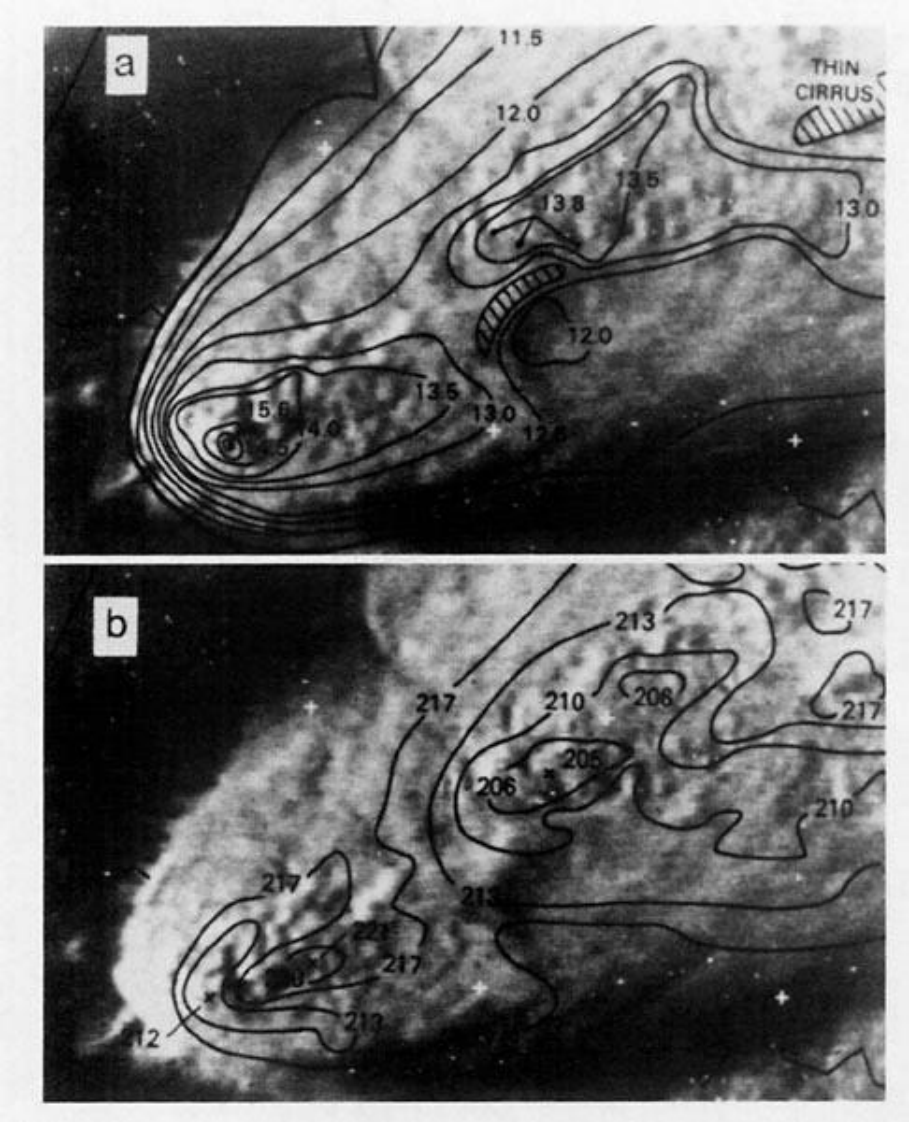


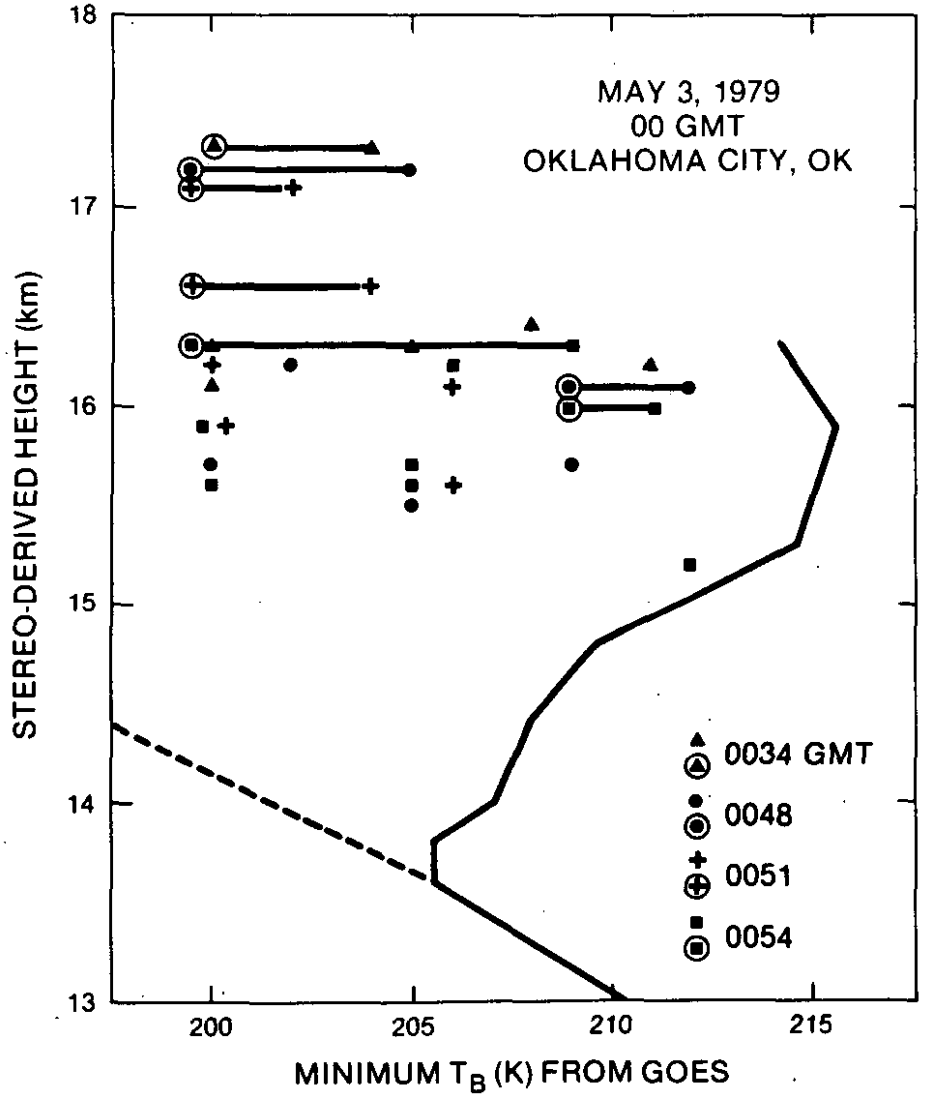




Hasler et al. (1998)

Adler and Mack (1986)

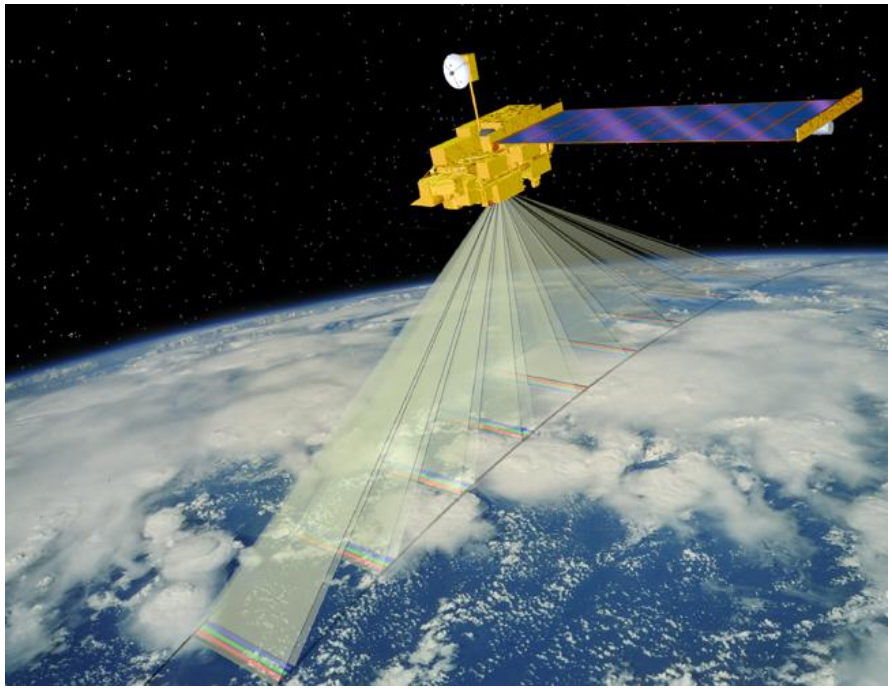




Use of MISR in Aerosol Research

MISR Sciences

- Aerosol and air quality
- Clouds, climate, and weather
- Surfaces
- Advanced concepts for future remote sensing



PI: Dr. David Diner

9 view angles at Earth surface:
Nadir, ±26º, ±46º,±60º, ±70º

4 bands: 446, 558, 672, 866 nm

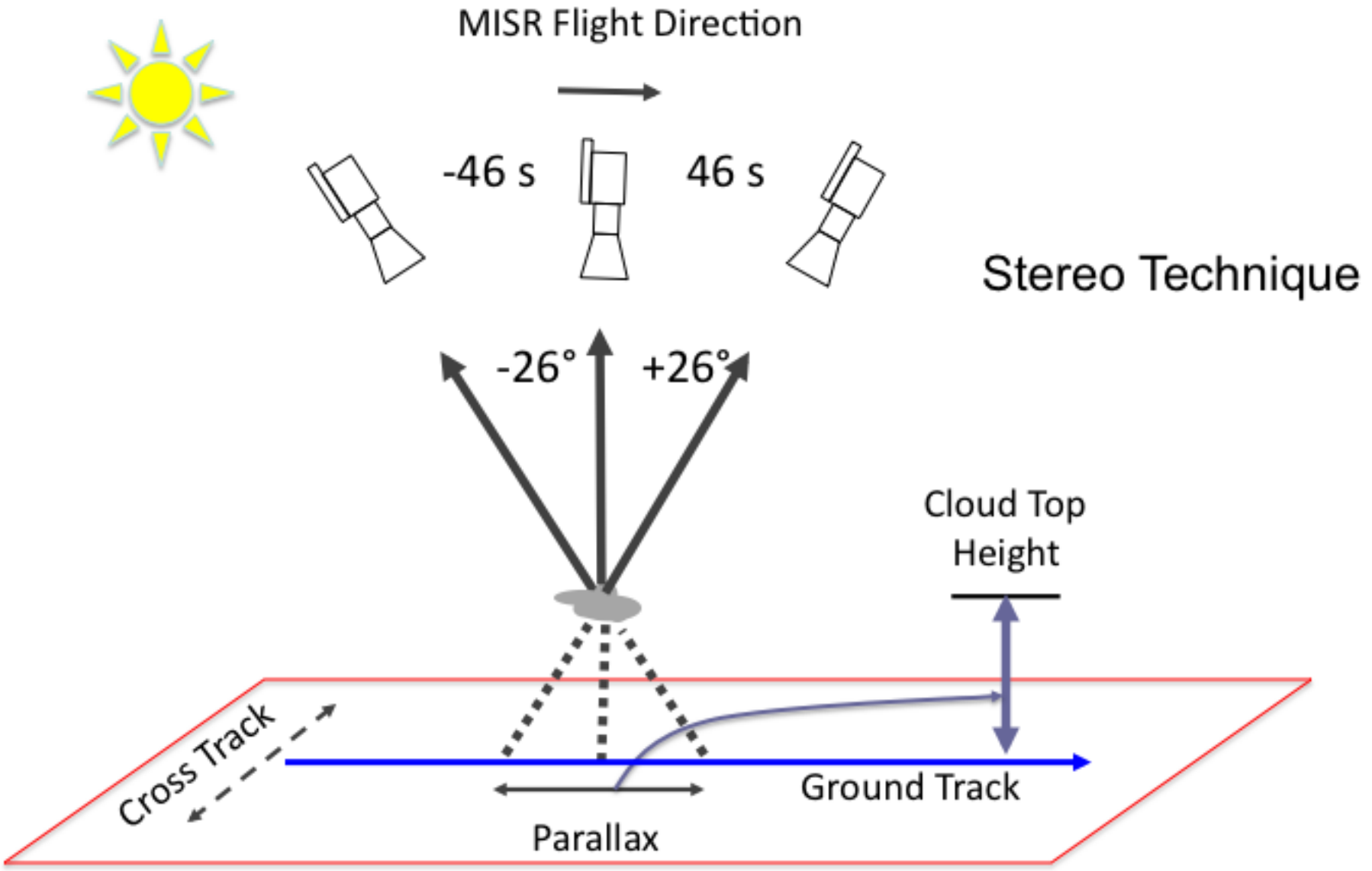
Daylight global coverage: 400-km swath

275 m - 1.1 km resolution

7 minutes for scenes at all 9 angles

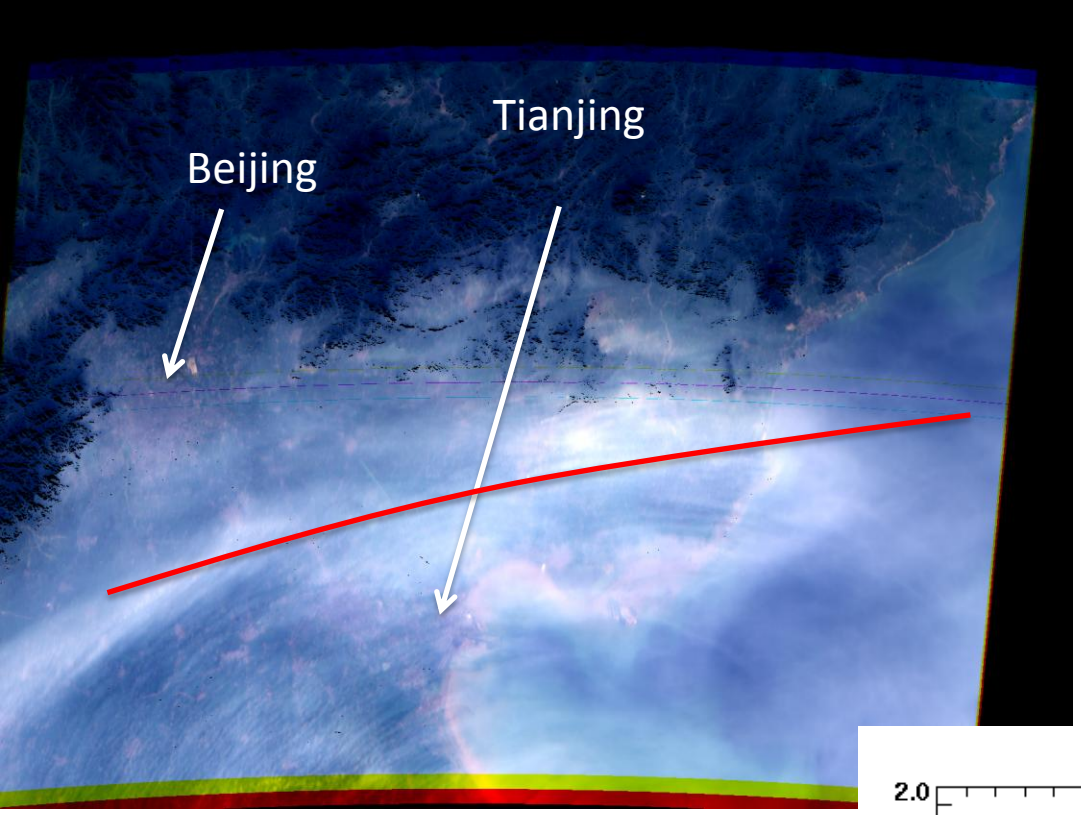
Data since 2000, lifetime projection >2017

MISR High-Resolution Cloud Top Height and Winds



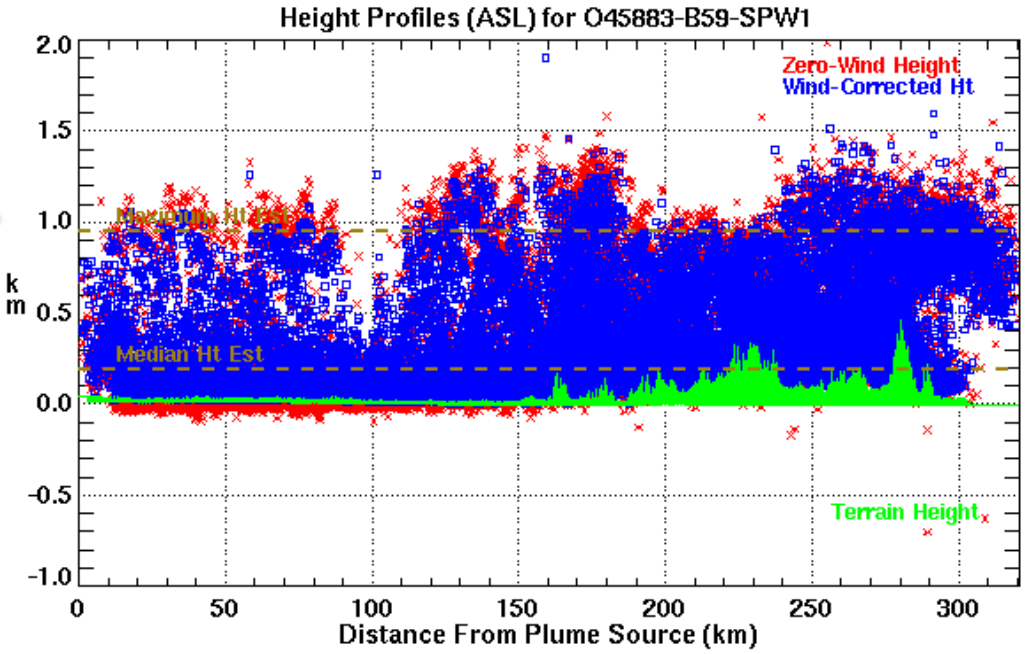
Station Fire (August 31, 2009)

(Courtesy of MISR Team)



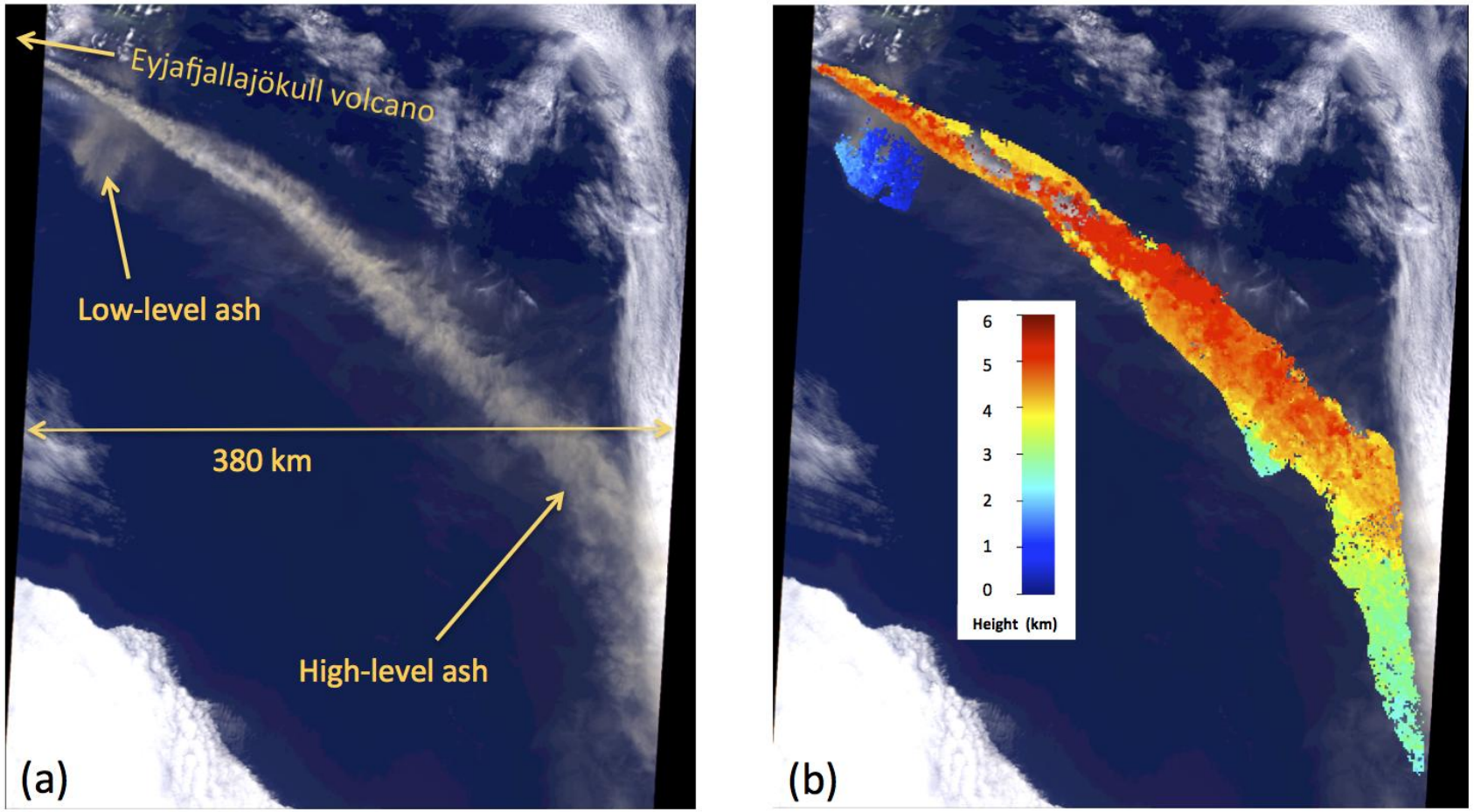
MISR
Aug.3, 2008

1 km →



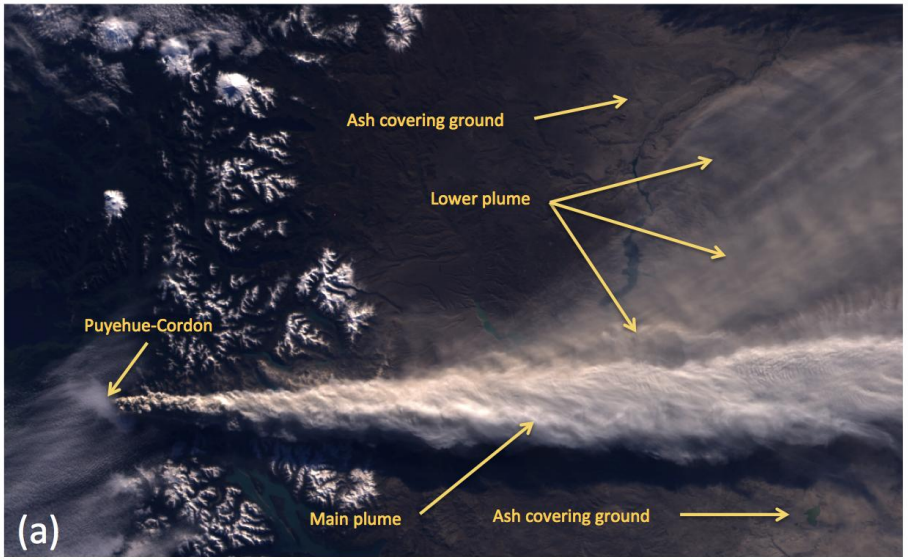
Olympics Games:
8/8/2008 – 8/24/2008
Emission control:
~2 months
Weather modification:
8/8/2008

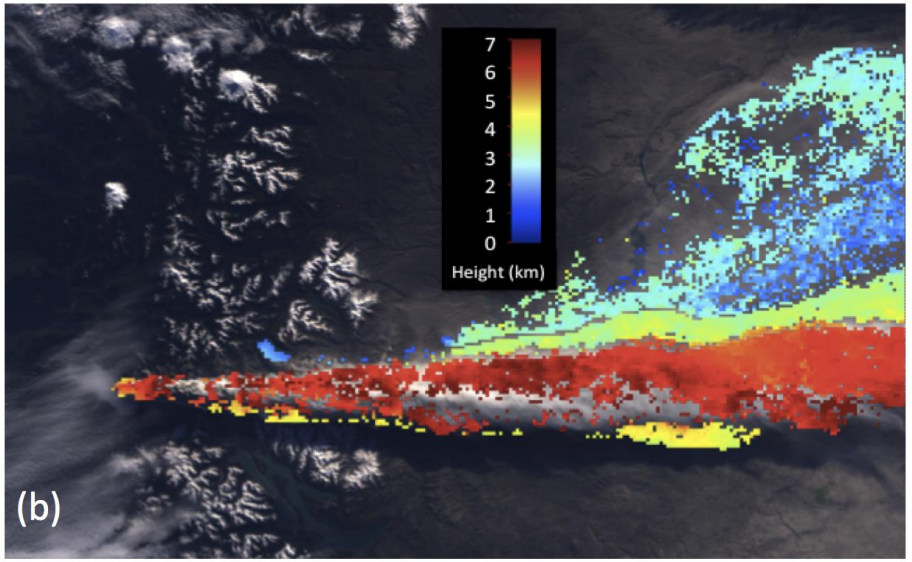
Eyjafjallajökull, Iceland (May, 2010)



Courtesy of David Nelson and MISR team

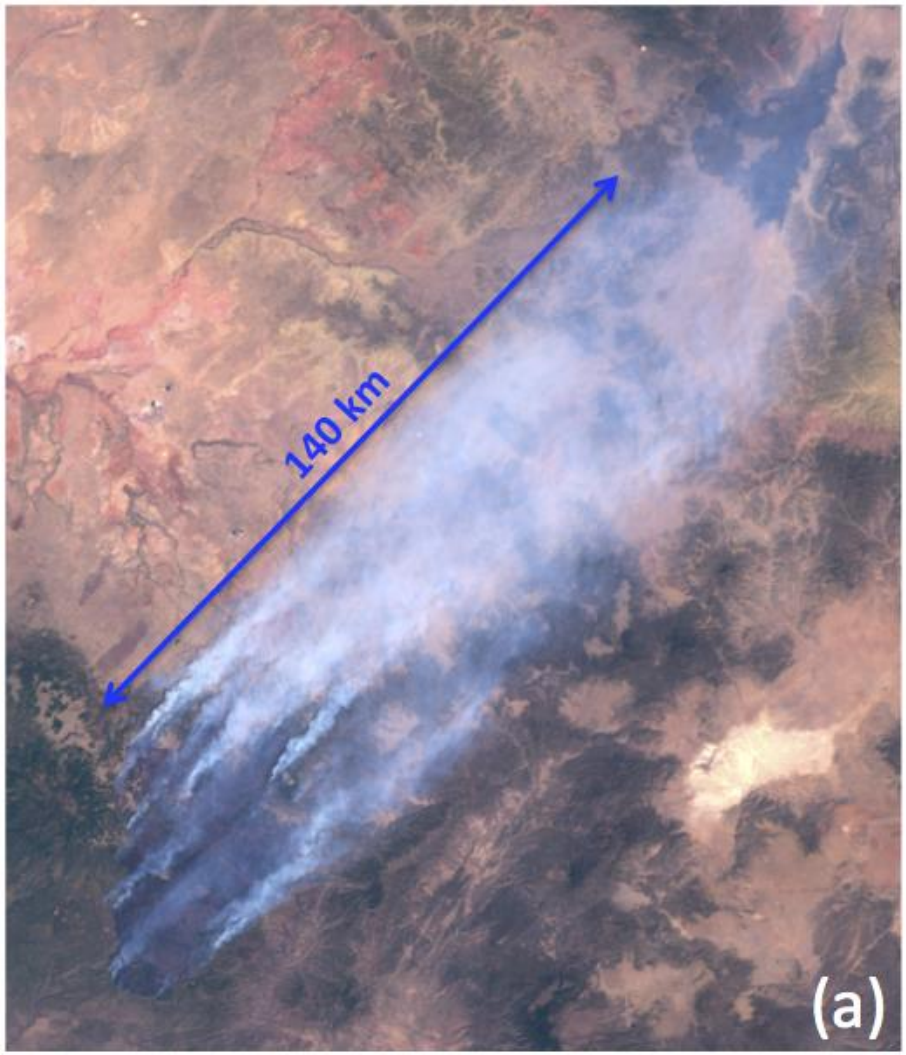
Puyehue-Cordón Caulle, Chile (June, 2011)

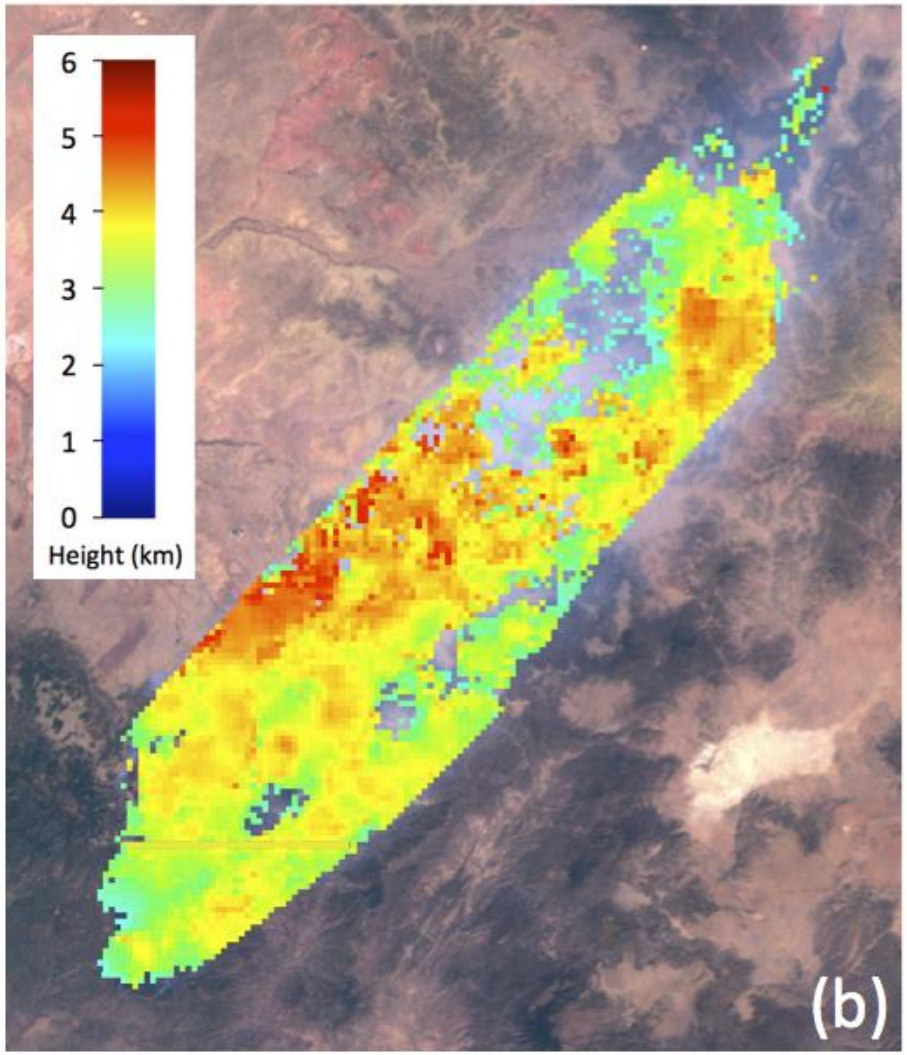




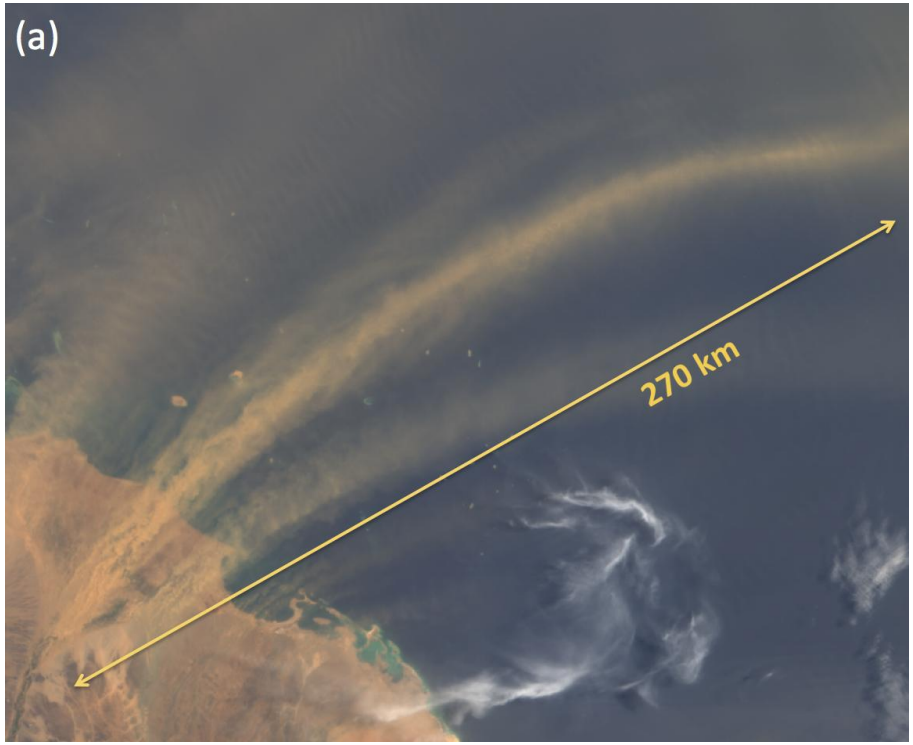
Courtesy of Terra/MISR and Aura/OMI

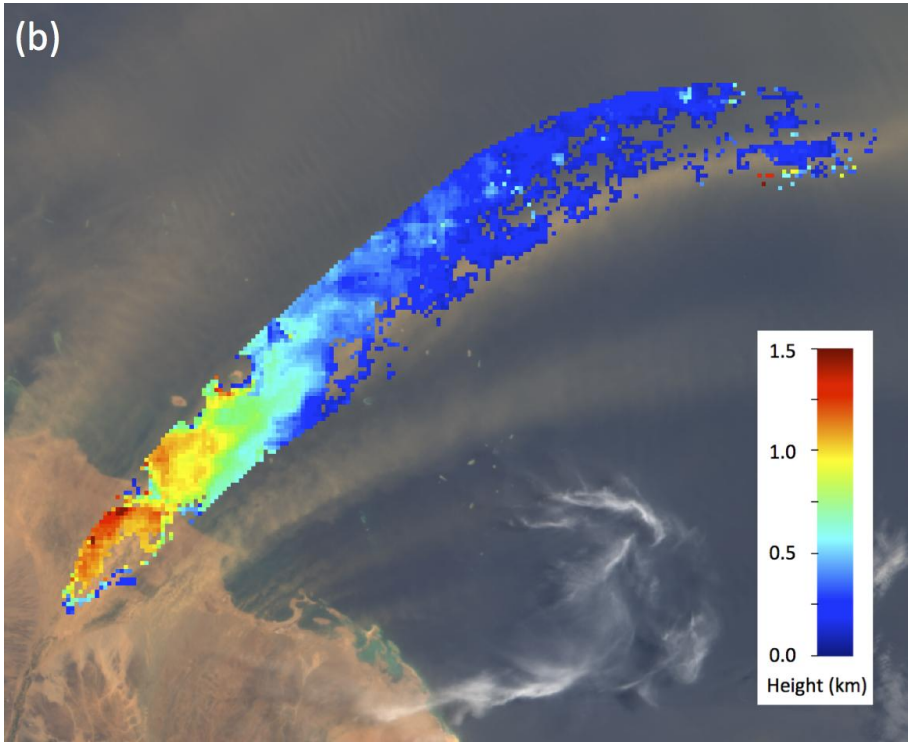
Wallow Fire, Arizona (June 7, 2011)

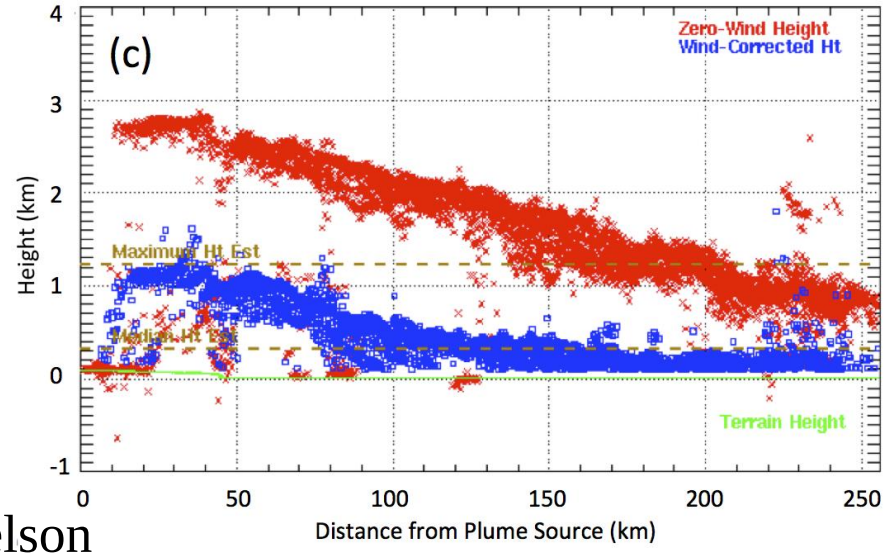




Courtesy of David Nelson and MISR team

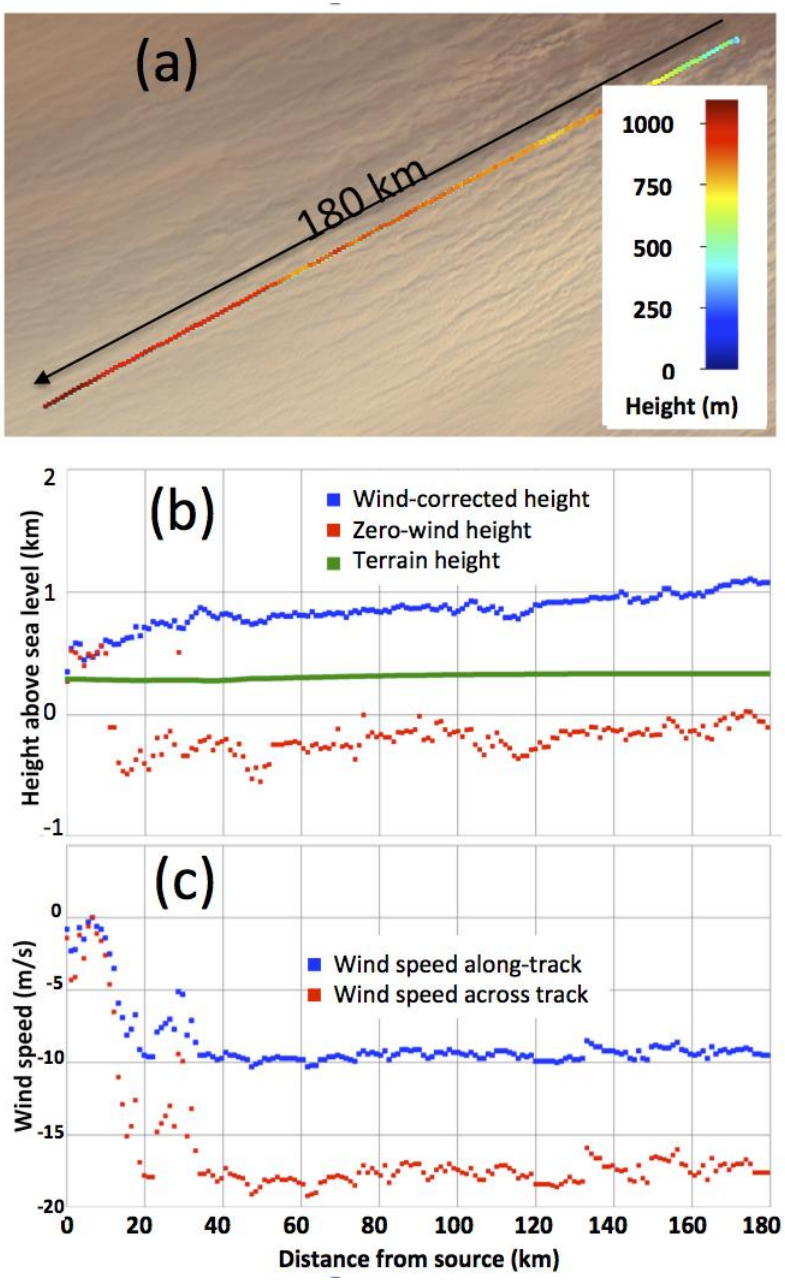






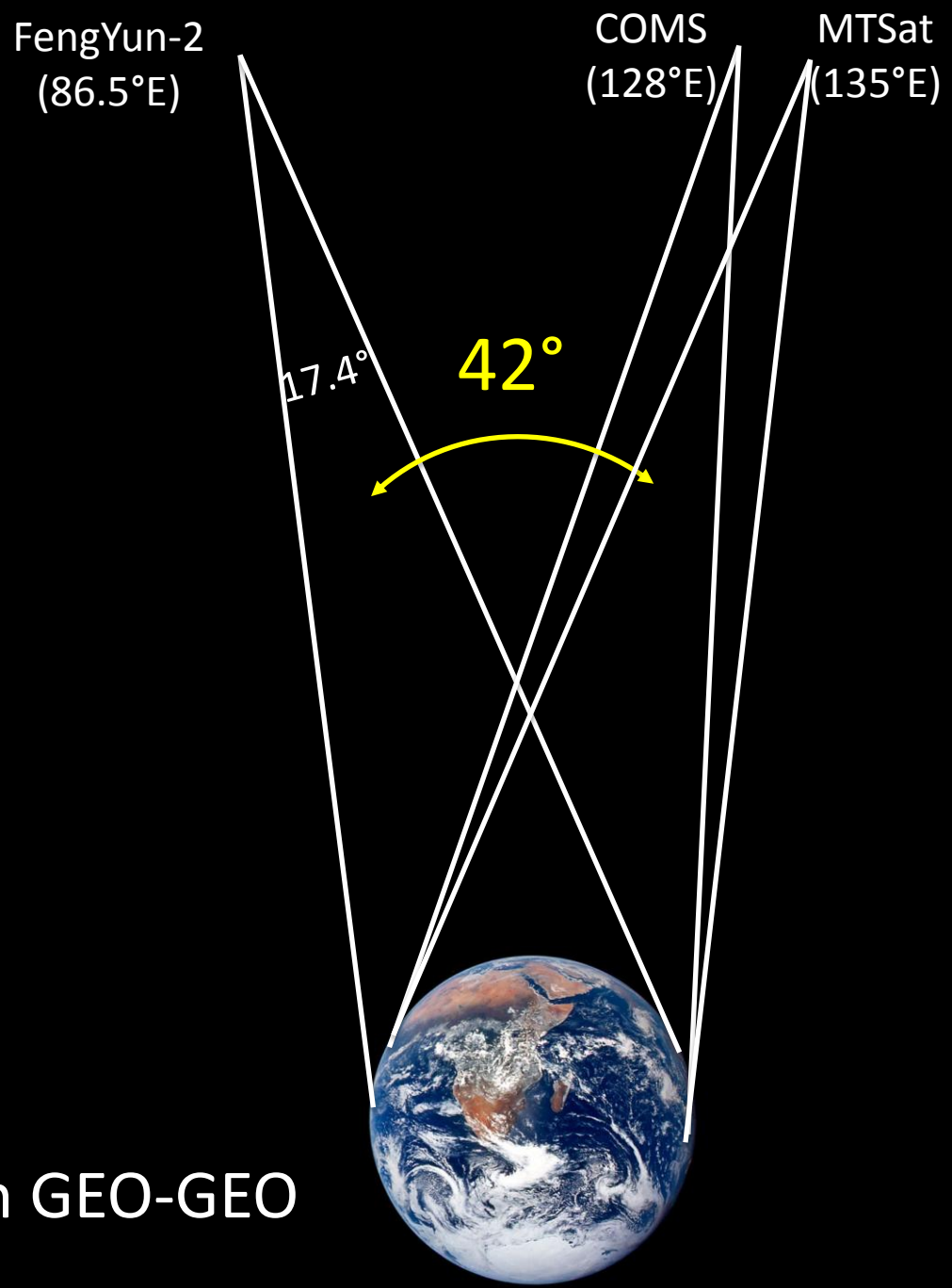
Courtesy of David Nelson

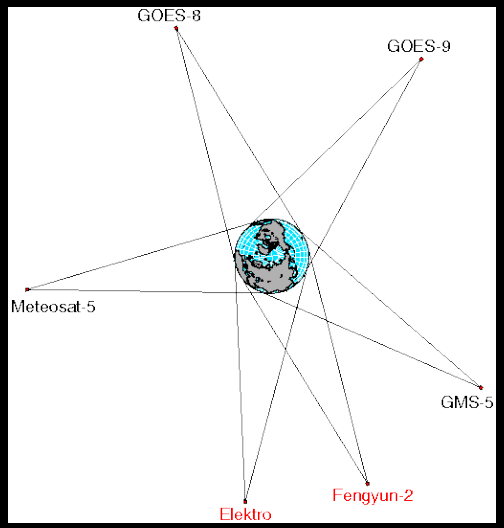
Bodele Depression, Chad (Feb, 2008)



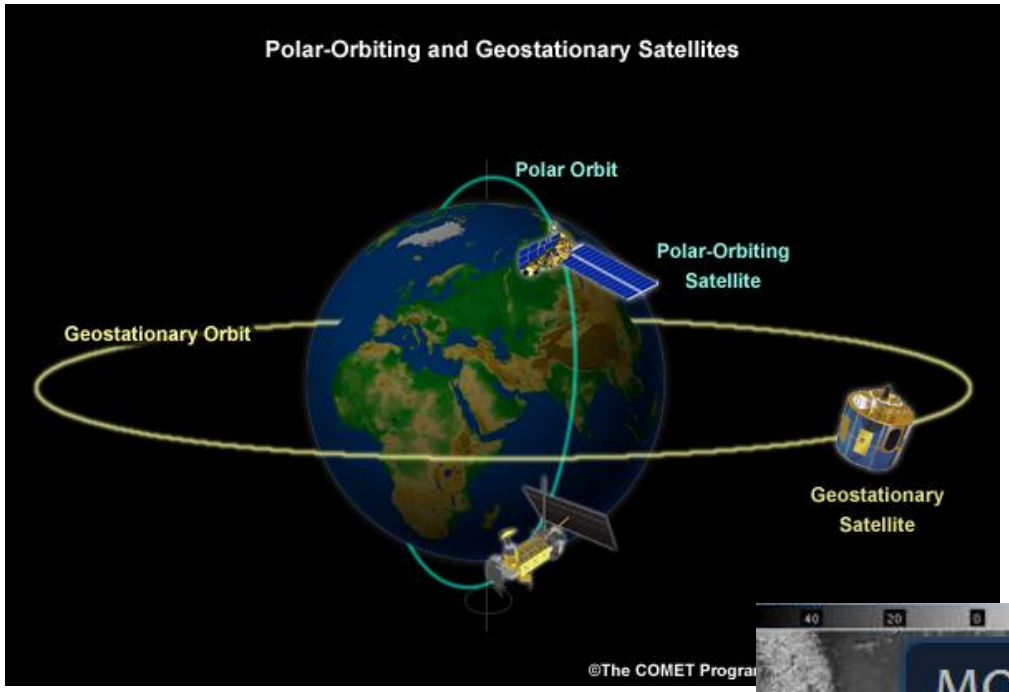
Outlooks of GEO and LEO Stereoscopic Views

- More sensors and frequent coverage that enable GEO-GEO and GEO-LEO stereo
- Better use of solar illumination
- GEO Pointing uncertainty

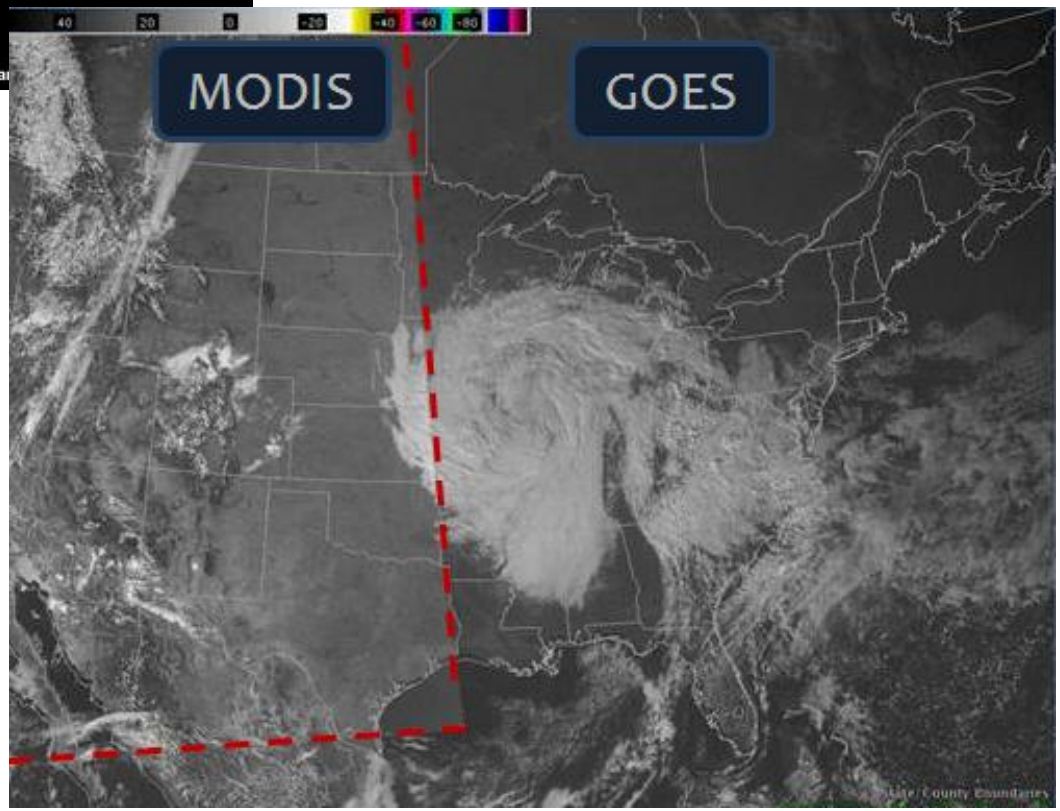




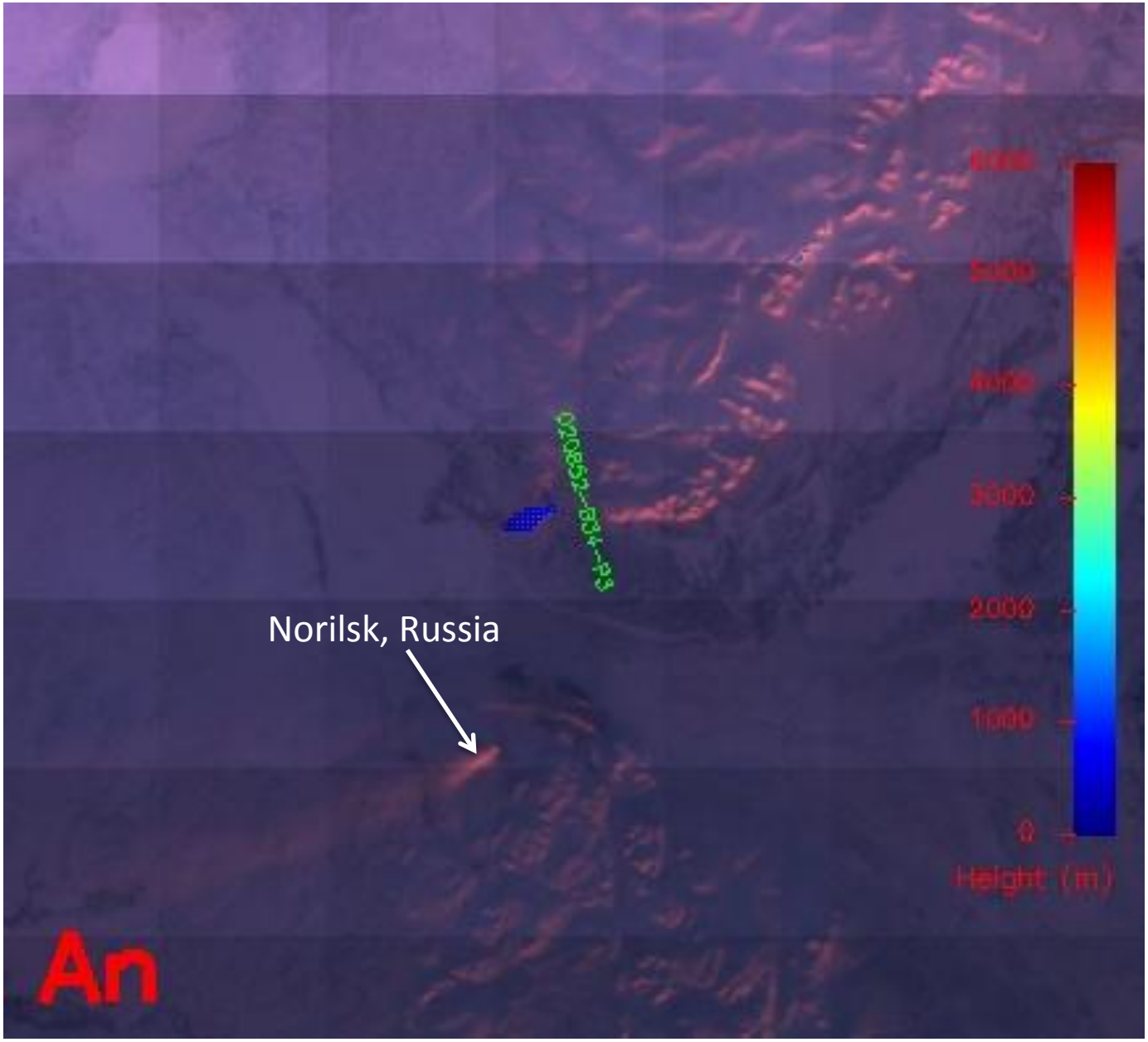
Stereo with GEO-GEO



Potential with GEO-LEO Stereo



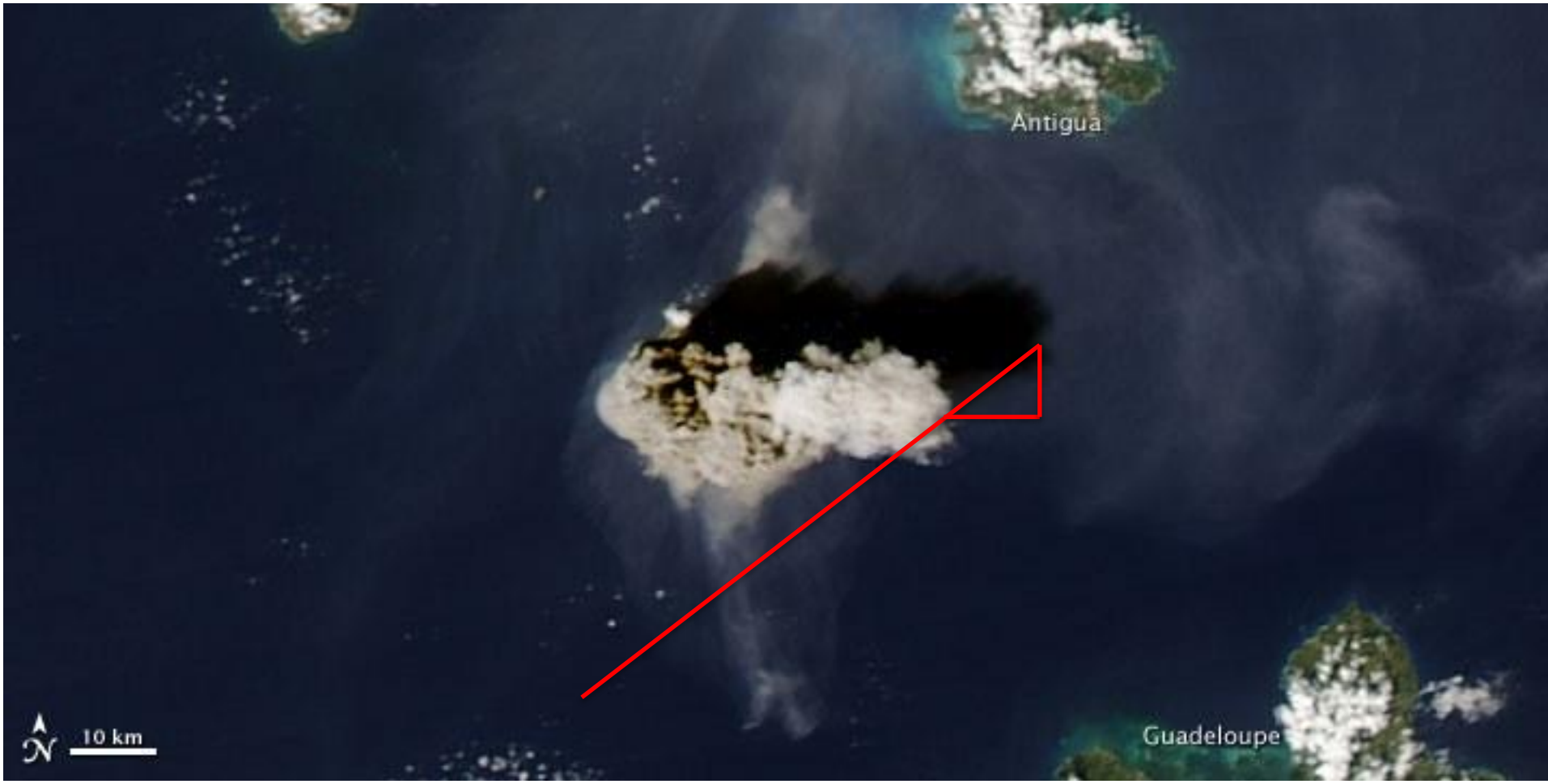
Scattering: Illumination at oblique angles



MISR

Shadow: Illumination from slant angles

MODIS (Soufriere Hills volcano, February 11, 2010)



Summary

- COMS/GEMS and FengYun-2 provide a good GEO-GEO stereo opportunity.
- GEO-LEO stereo need be further explored.
- Key applications of interest for GEMS include heights of dust, volcanic and fire plumes.
- Pointing uncertainty/knowledge issue can be mitigated with more thoughts into designs and observations.
- More information can be derived from slant solar illumination and shadow.