MISR Cloud Motion Vectors, ERA-I Reanalysis Winds, and Stereo Heights

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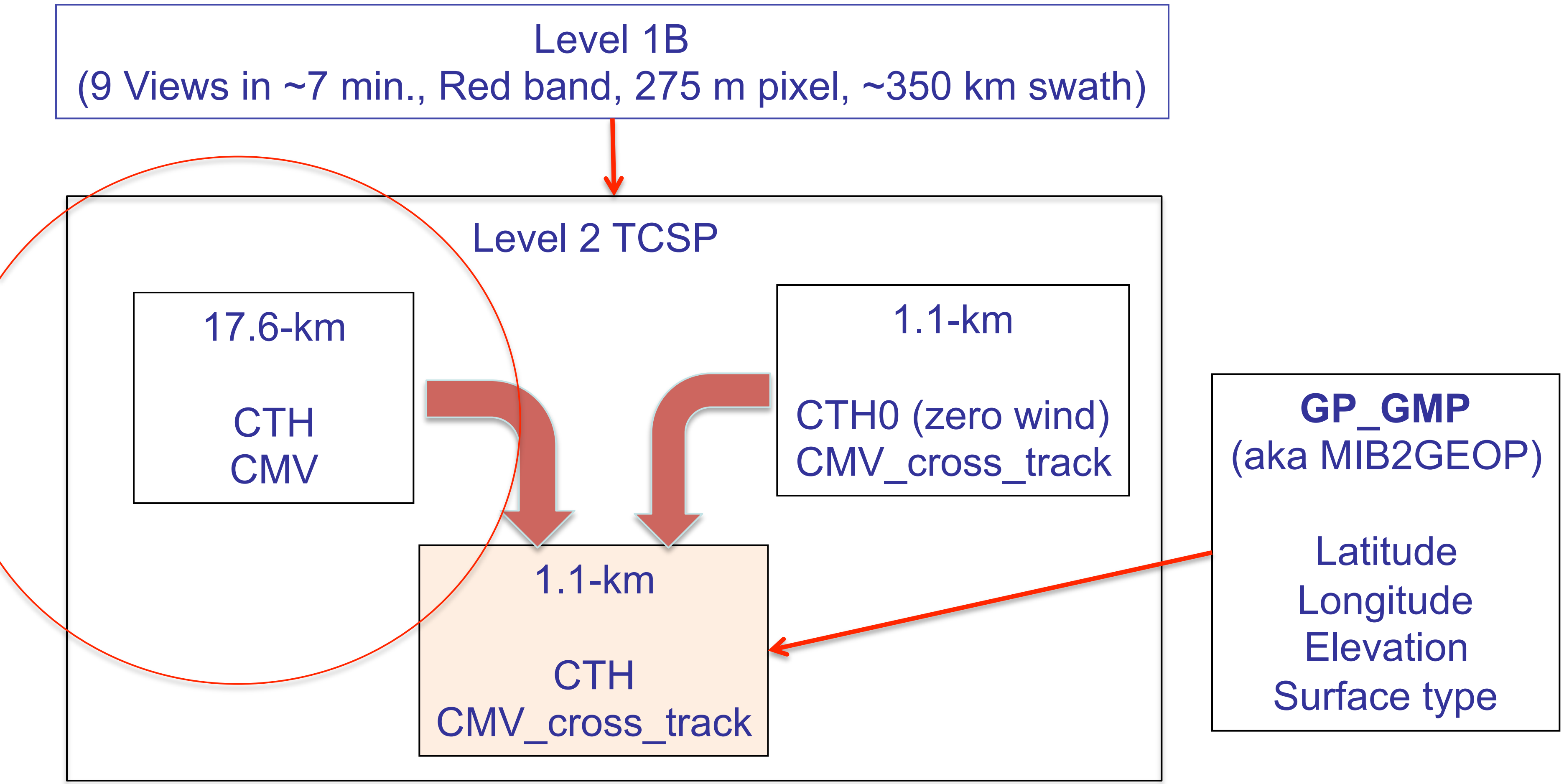
Acknowledgment: MISR science and engineering teams

Outline

- MISR CMV Data
  - Sampling and coverage
  - Geo-registration
- MISR and ERA-Interim Comparison
  - Monthly mean
  - Effects of orographic clouds
- Stereo CMV Techniques from Space
  - Dual-GEO approach
  - Dual-LEO stereoscopic approach

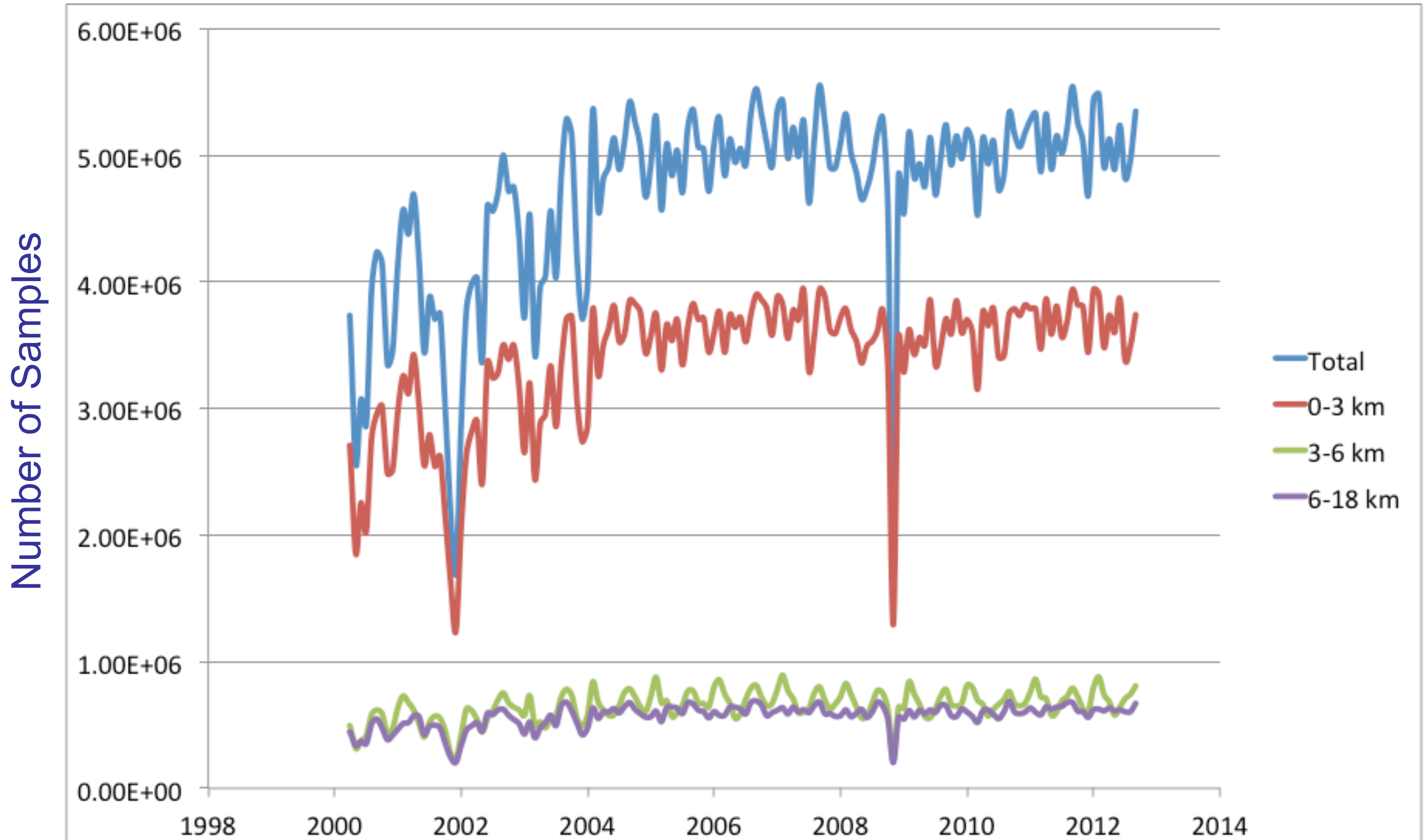
MISR CMV Data



https://eosweb.larc.nasa.gov/project/misr/2tc_table

CTH = Cloud Top Height, CMV = Cloud Motion Vector

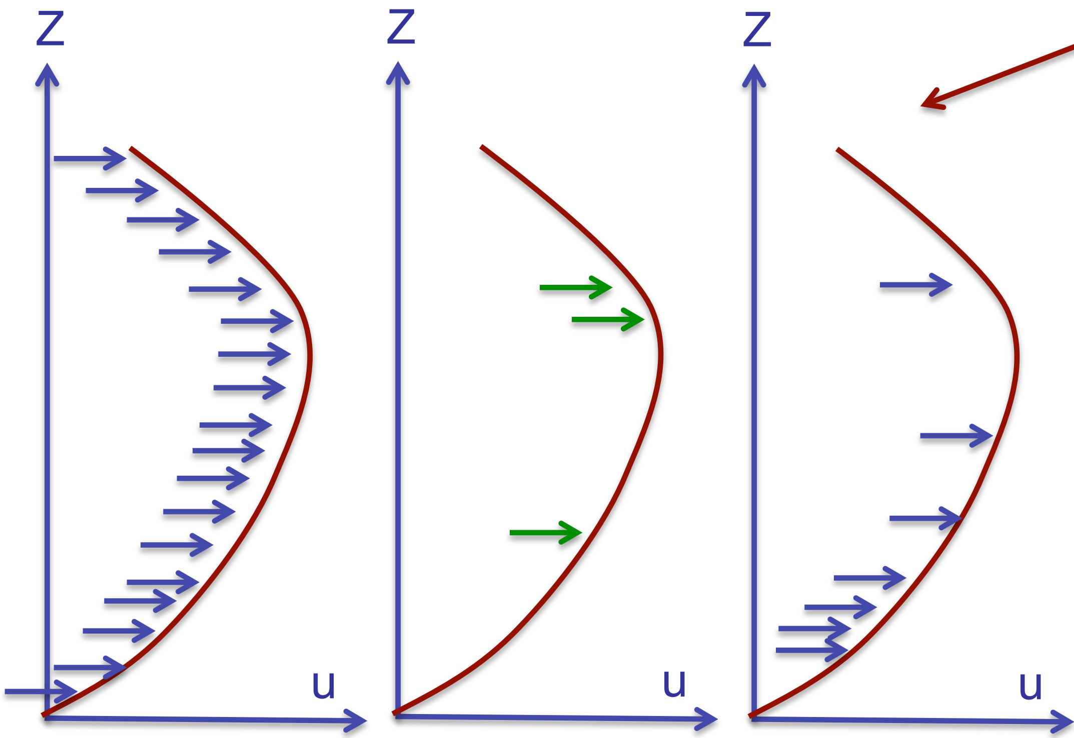
MISR Monthly Data Statistics



Past Present Future

MISR CMV: 70.4 km → 17.6 km → 4.4 km

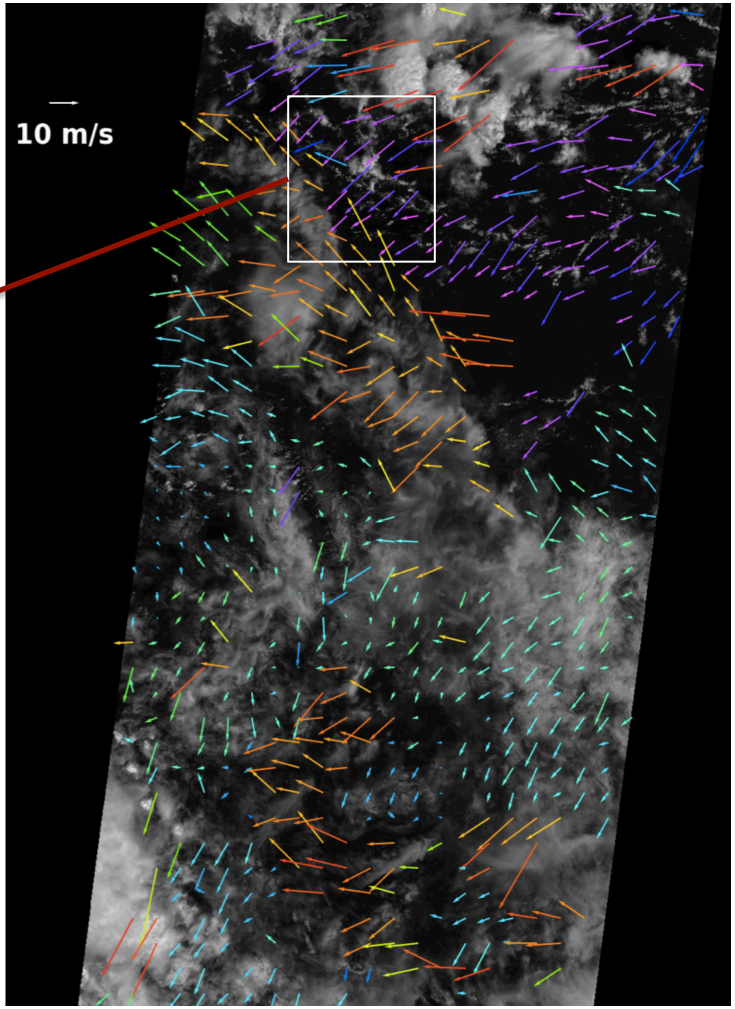
CMV height assignment



ERA-I Wind
0.75° x 0.75°

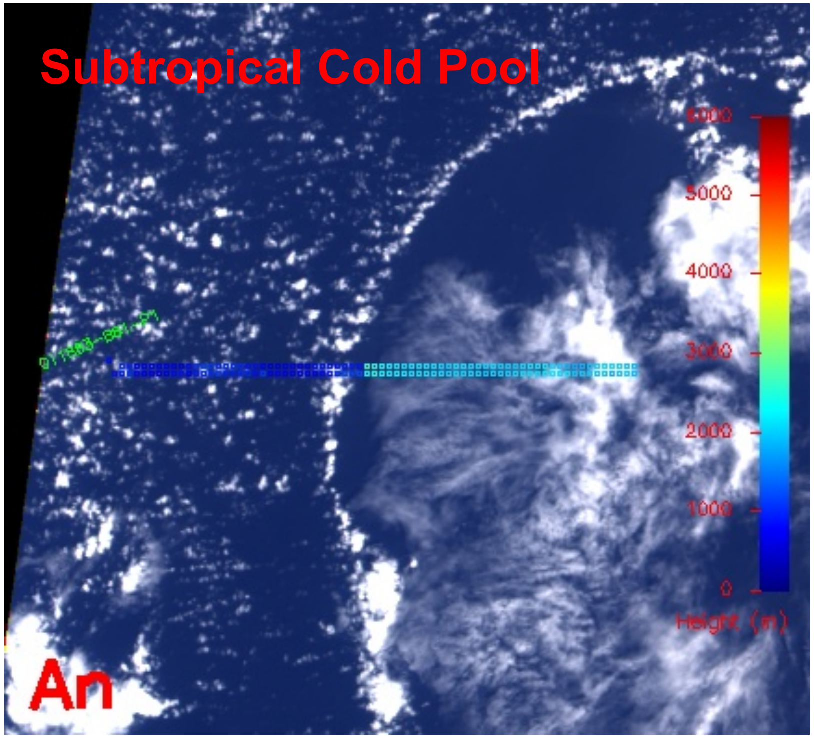
IR Wind

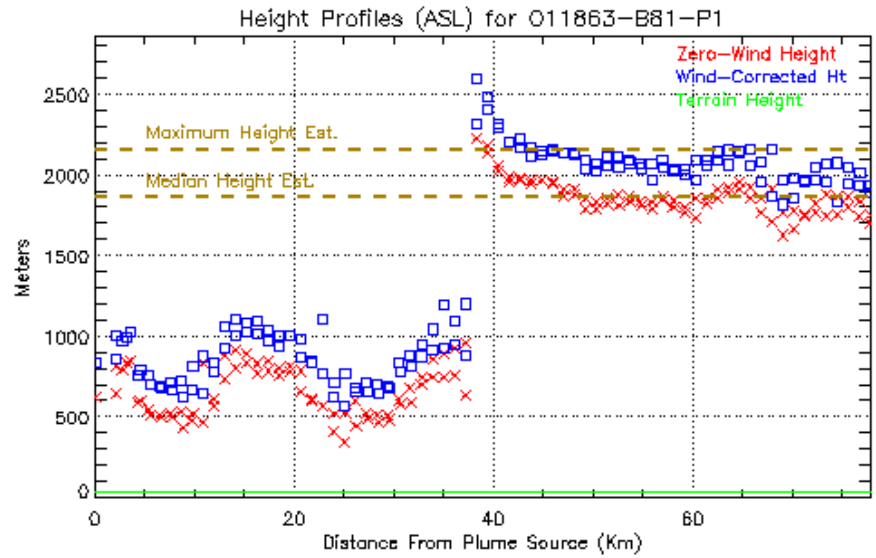
MISR Wind
17.6 km

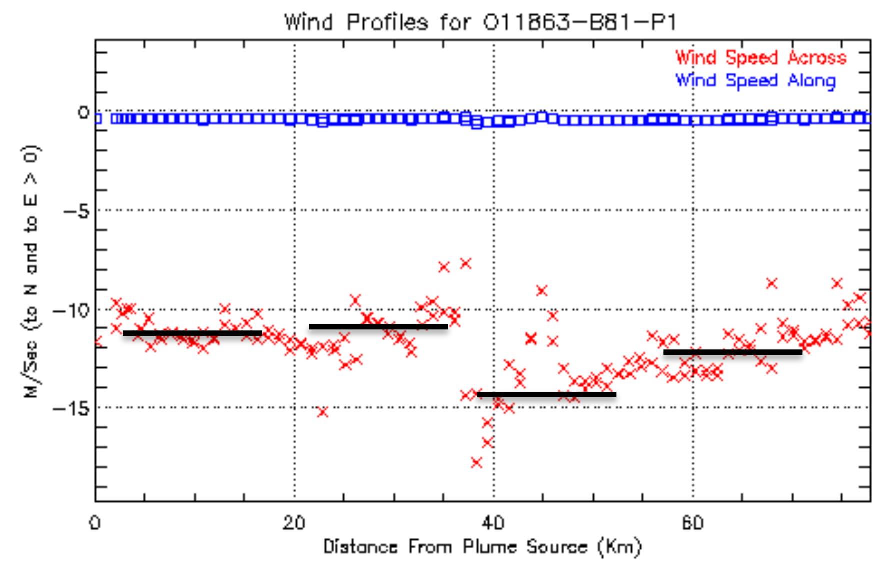


MISR 17.6 km CMV
(courtesy of K. Mueller)

PBL Dynamics and Processes







Resolution: 1.1 km

Precision:

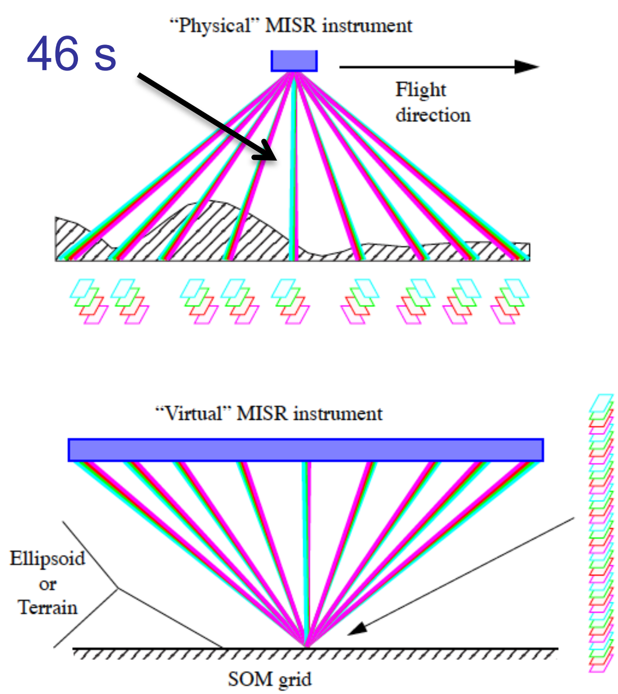
height: ~100 m

wind: ~0.3-1 m/s

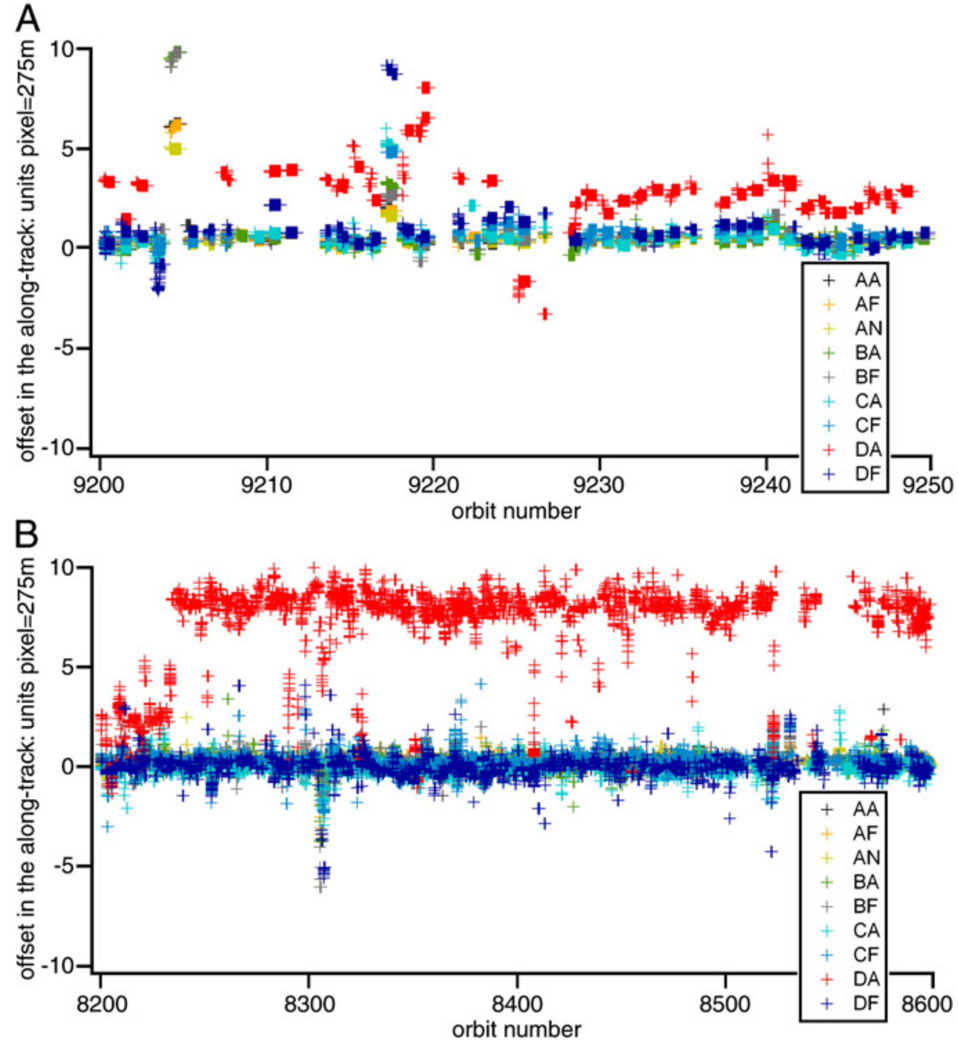
Terra/MISR Geo-Registration

- Orbit-to-orbit variations of a few pixel size
- DA camera (70° aft) worst
- 1 pixel (275m) ≈ 6 m/s

MISR ATBD
[JPL D-11532, Jovanovic et al., 1999]



Jovanovic et al. [2007]

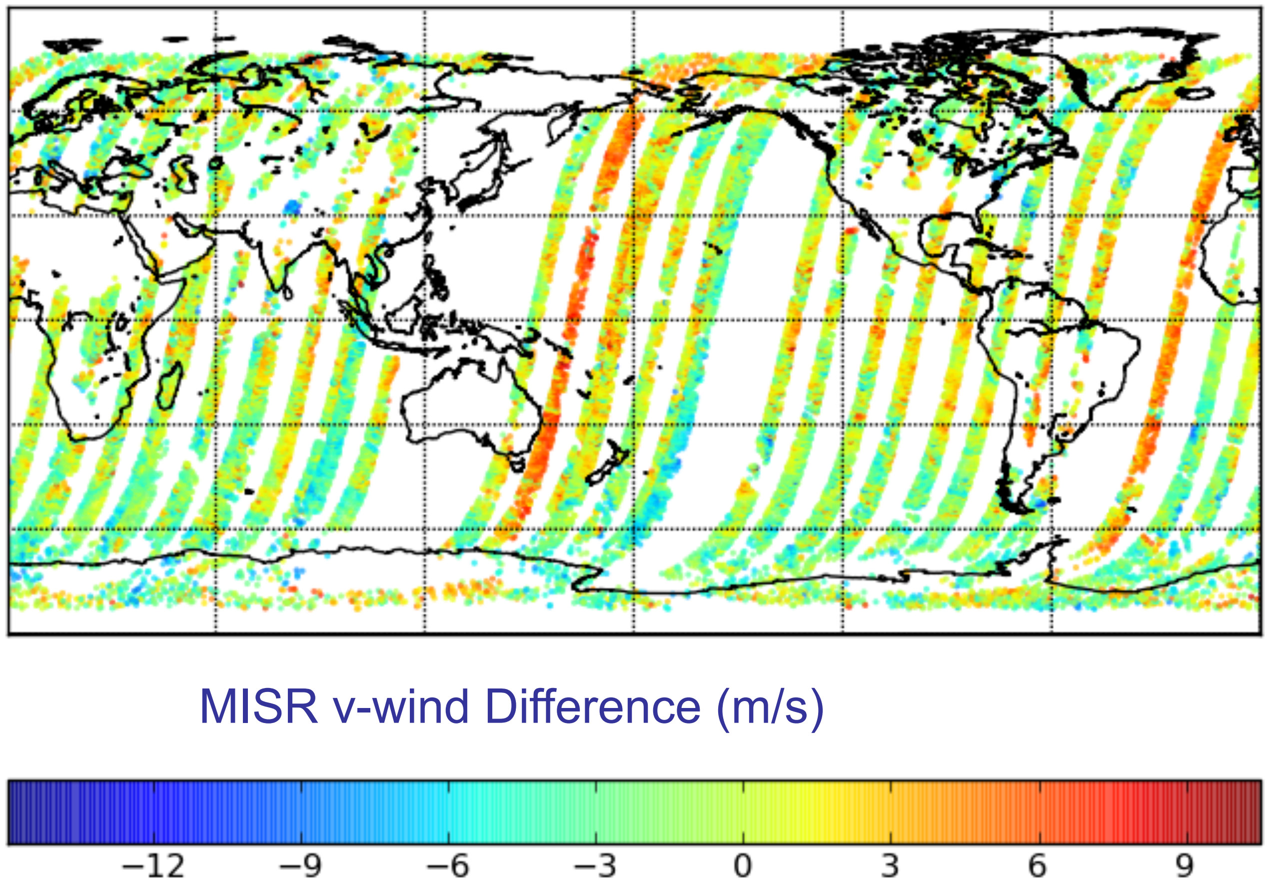


Terra/MISR Geo-Registration (2)

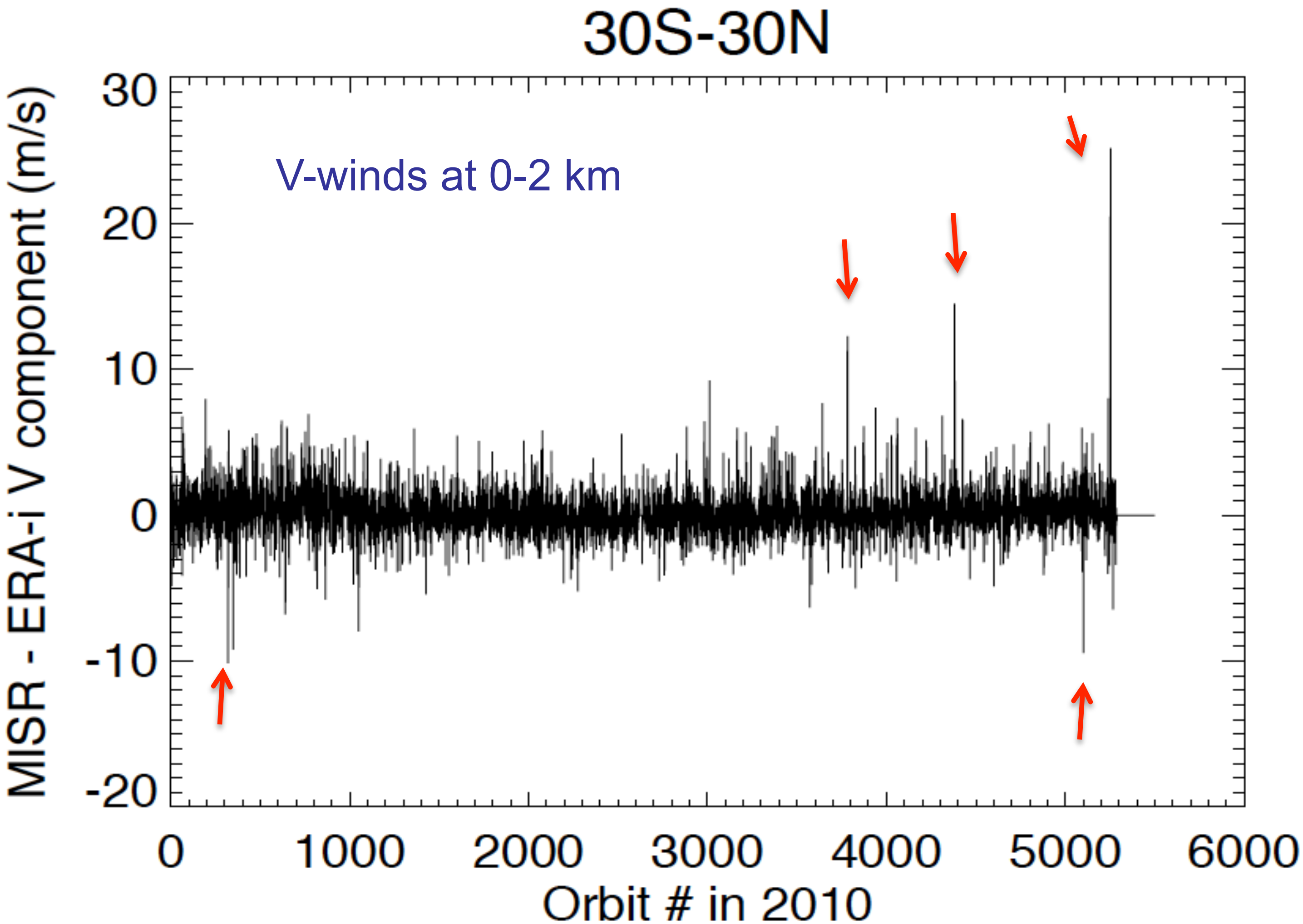
Courtesy of Nancy Baker (Presentation in the 2nd **JCSDA Symposium)**

- Occasional large geo-registration error
- Entire orbit of MISR meridional winds affected
- Evident in MISR-GRL analysis V-wind differences

MISR v-wind innovation
2012.10.27.00 – 2012.10.29.06



Large Offsets Likely due to Geo-Registration Error



Recommendations:

- Near-real time O-B check for rejecting the bad MISR orbits.
- Investigation and development of more robust MISR geo-registration.

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  - Geo-registration

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  - Monthly mean
  - Effects of orographic clouds

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  - Dual-GEO approach
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Zonal Mean Differences

January (2001-2012)

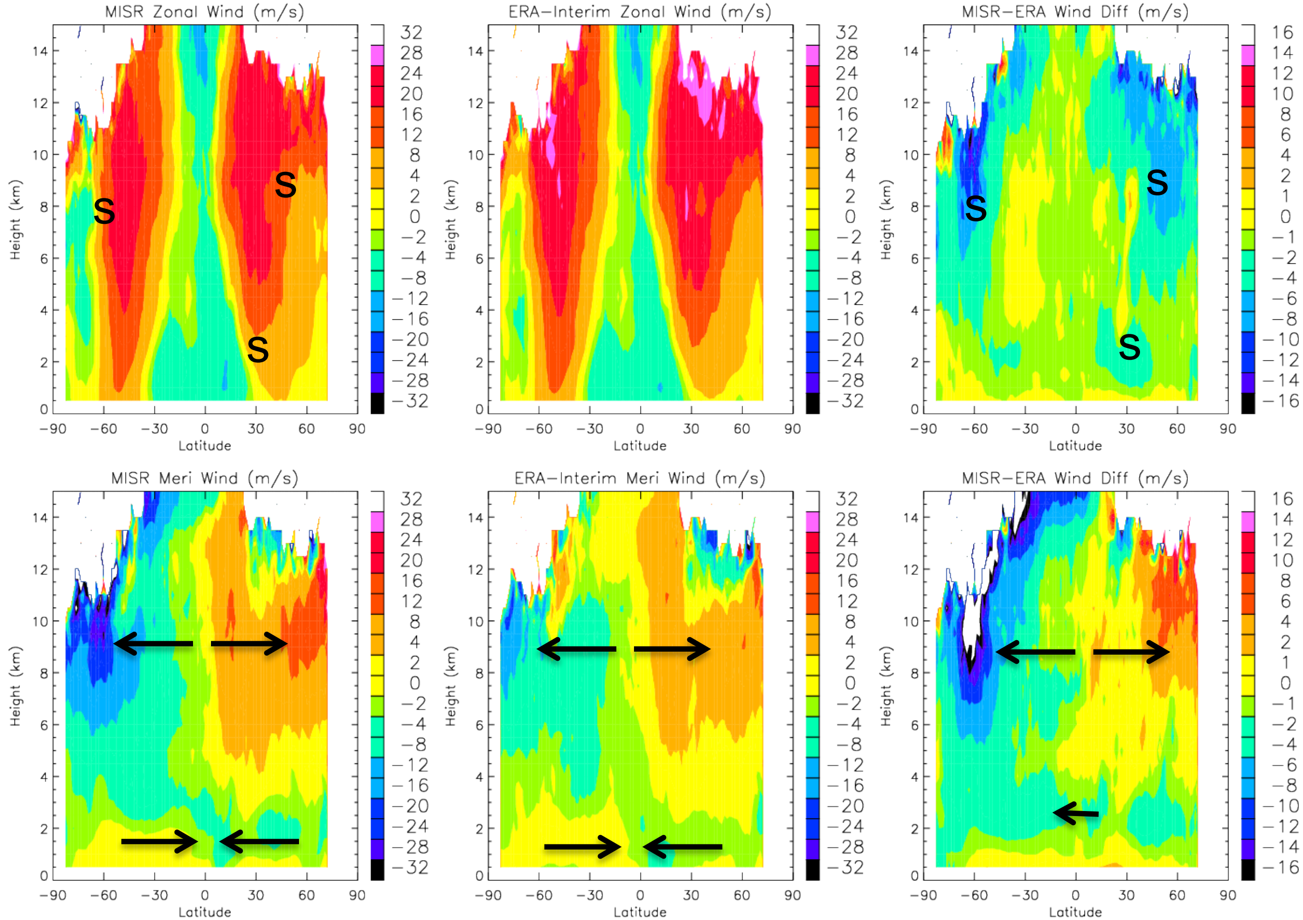
MISR | ERA-I | Diff

Zonal (U)

- Slower MISR winds in the poleward side of jets

Meridional (V)

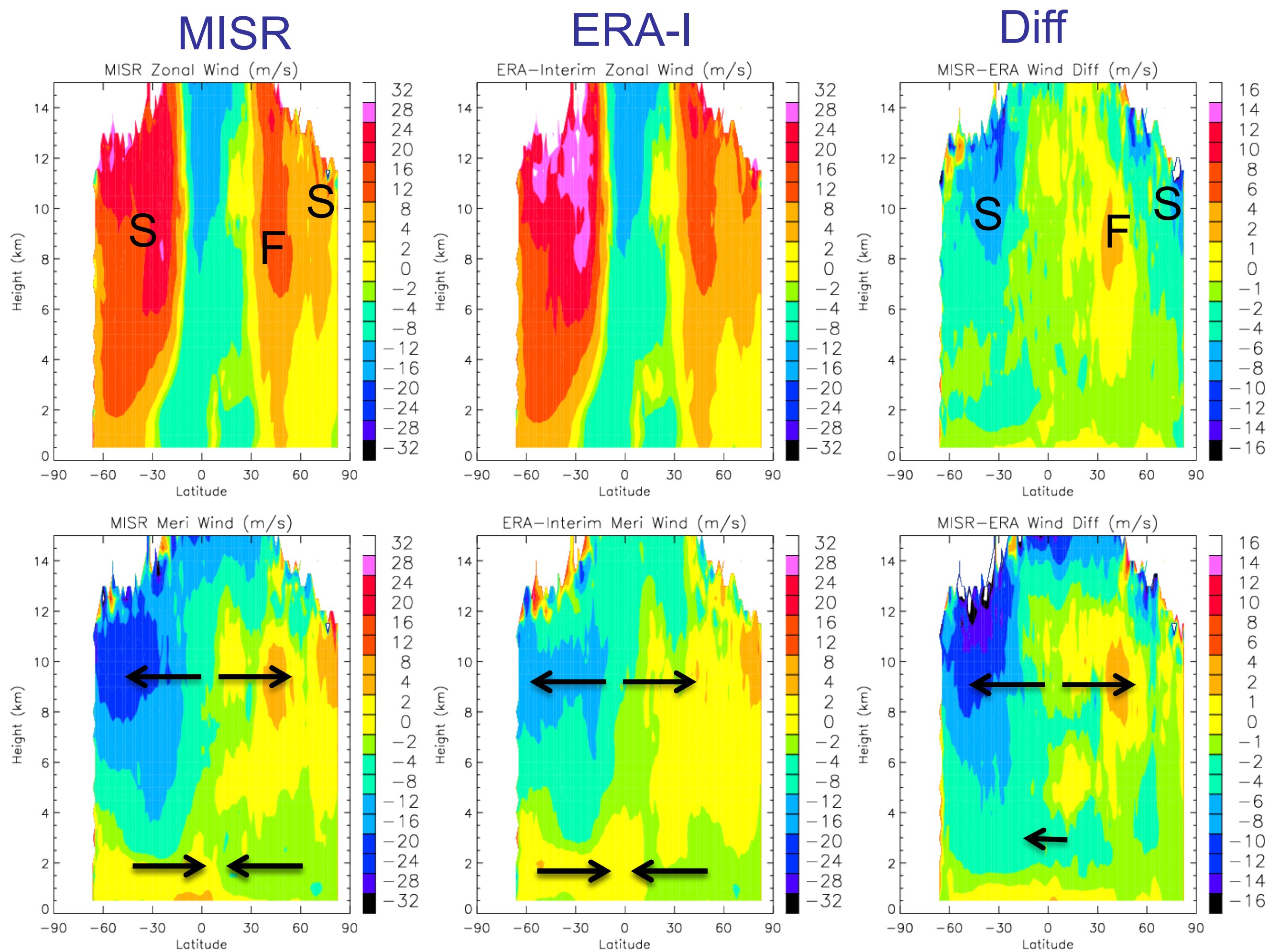
- Stronger poleward MISR winds in the upper trop
- Slightly southward bias in the lower trop



ERA-I winds are too zonal at the tropical jets

Zonal Mean Differences (2)

July (2001-2012)



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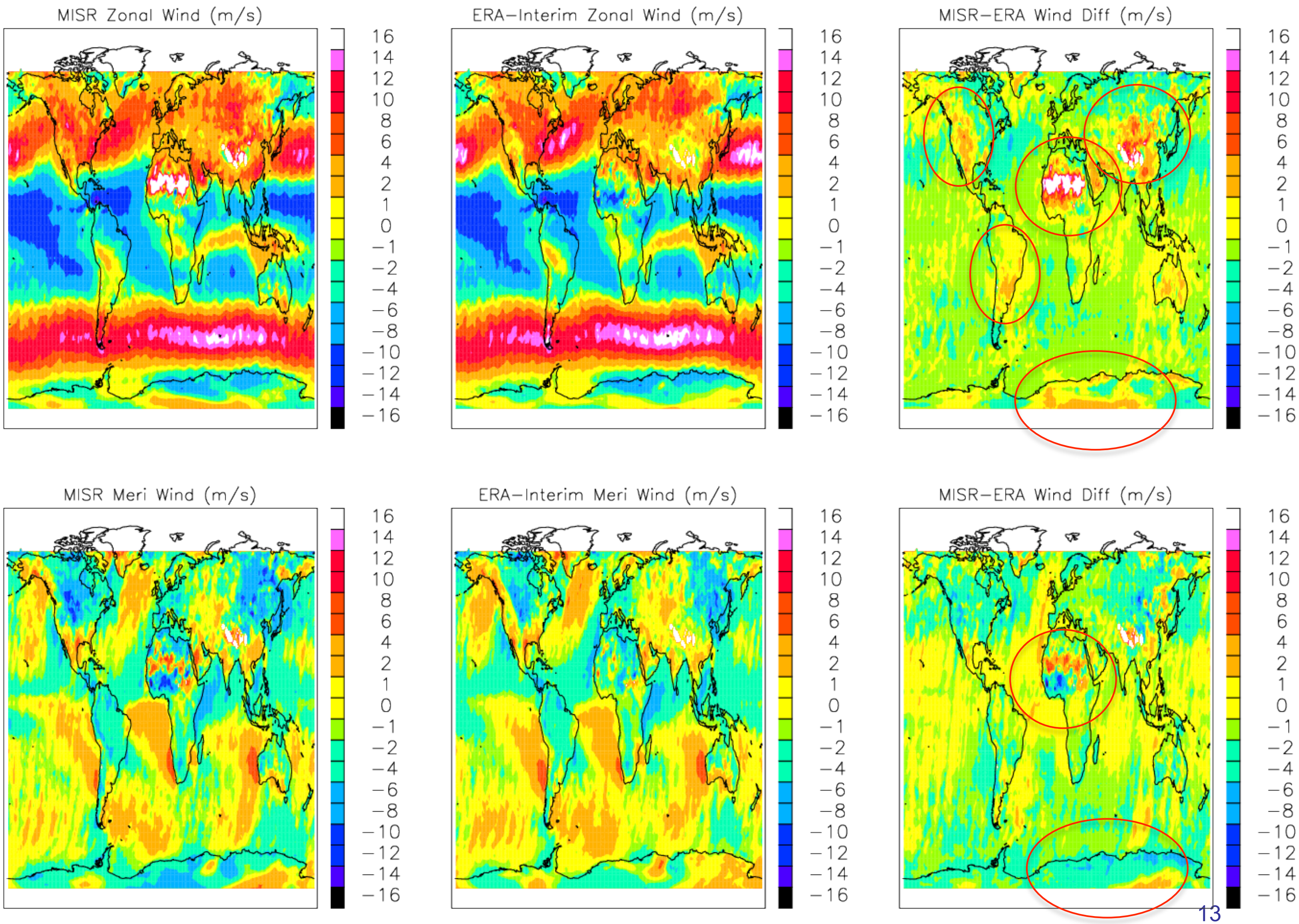
Lower Tropospheric Winds

January, z=0-5km

U

V

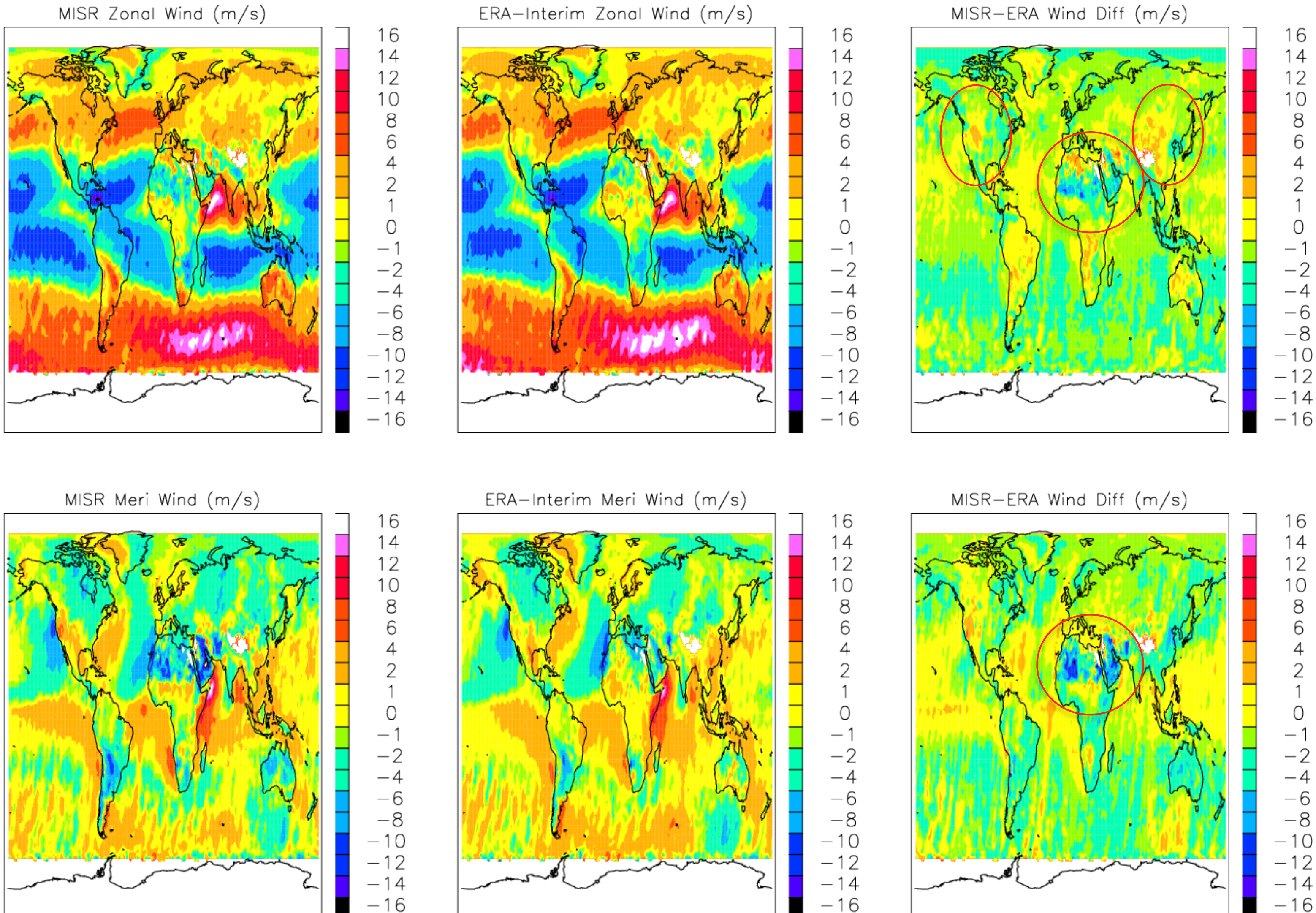


Lower Tropospheric Winds (2)

July, z=0-5km

U

V

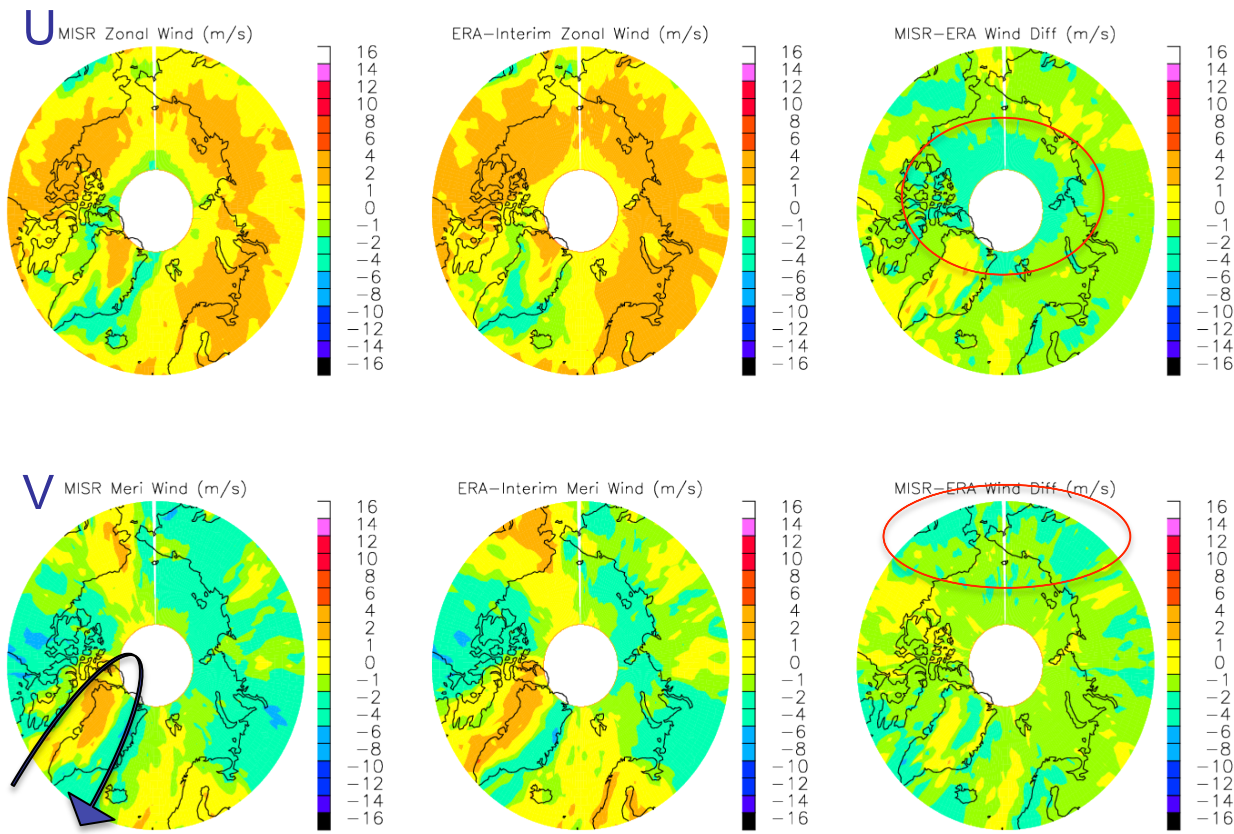


Arctic Region

July winds at 0-5km

Lower Troposphere (MISR-ERA):

- MISR U wind slower over the Arctic Ocean.
- MISR V wind less poleward over landmasses.
- MISR weaker Greenland gyro.

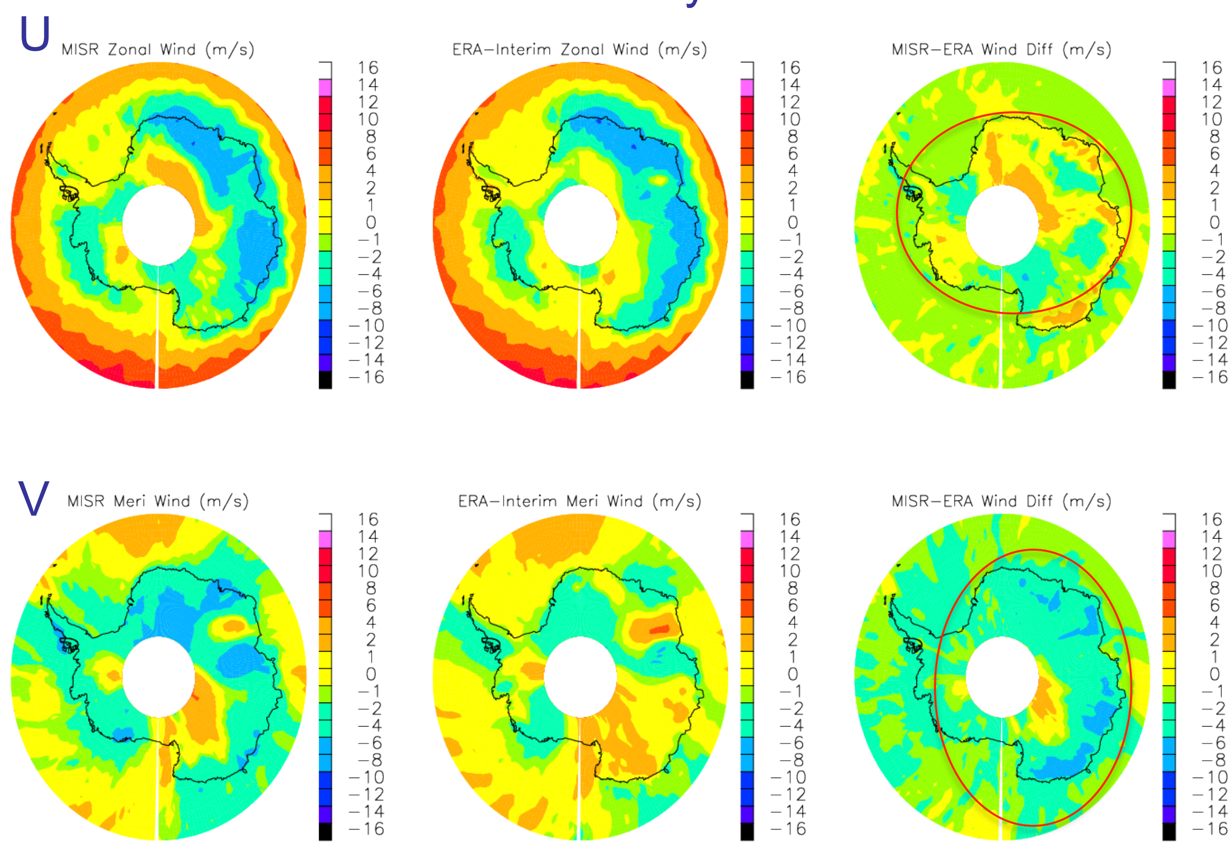


Antarctic Region

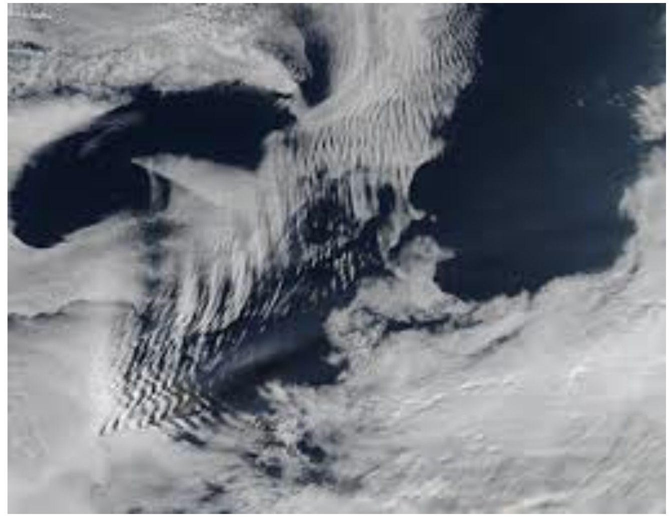
Lower Troposphere (MISR-ERA):

- MISR-ERA biases correlated strongly to topography
- MISR v-wind more poleward

January winds at 0-5km

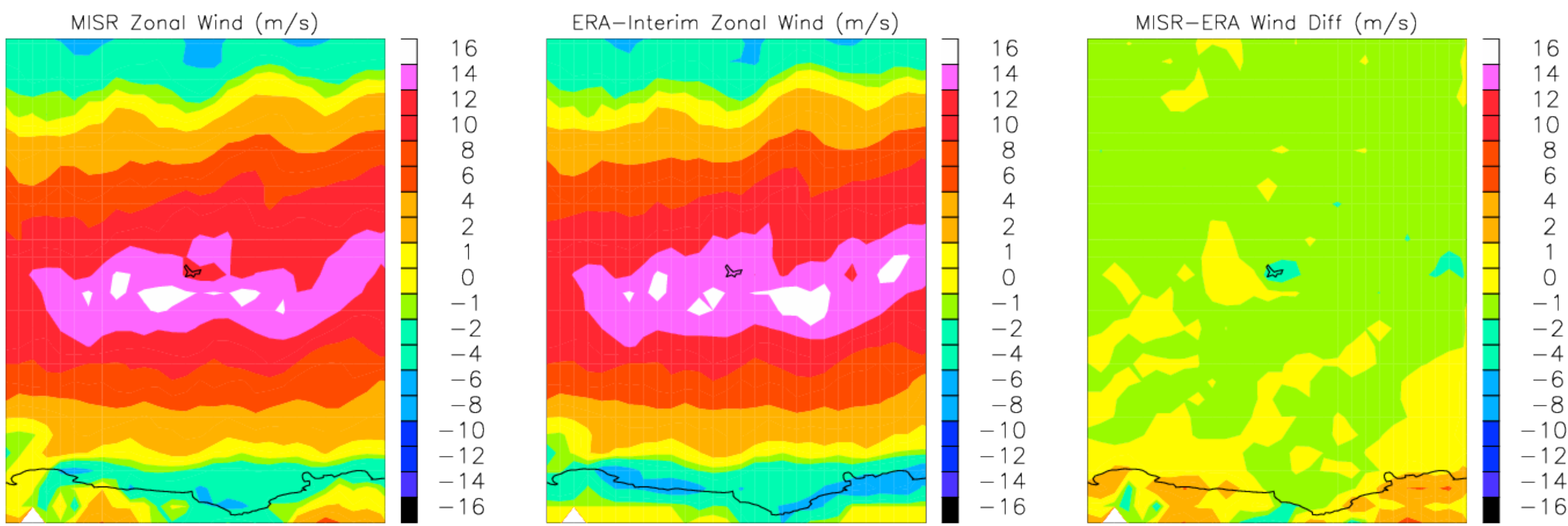


Effects of Topography



Kerguelen Islands
~80 x 90 km

January   U at <5km

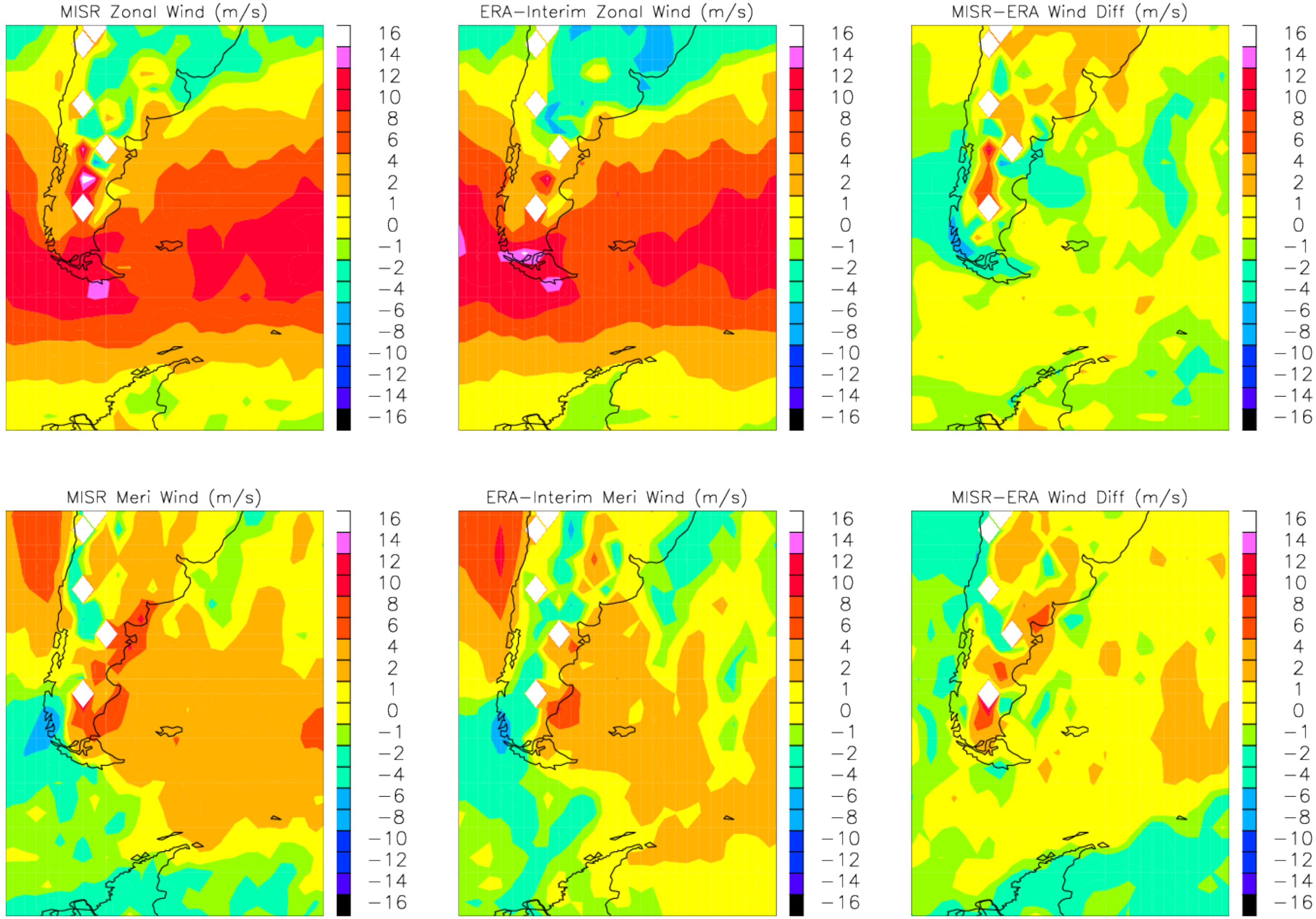


Effects of Topography (2)

Argentine Patagonia January mean winds at 0-5km

U

V



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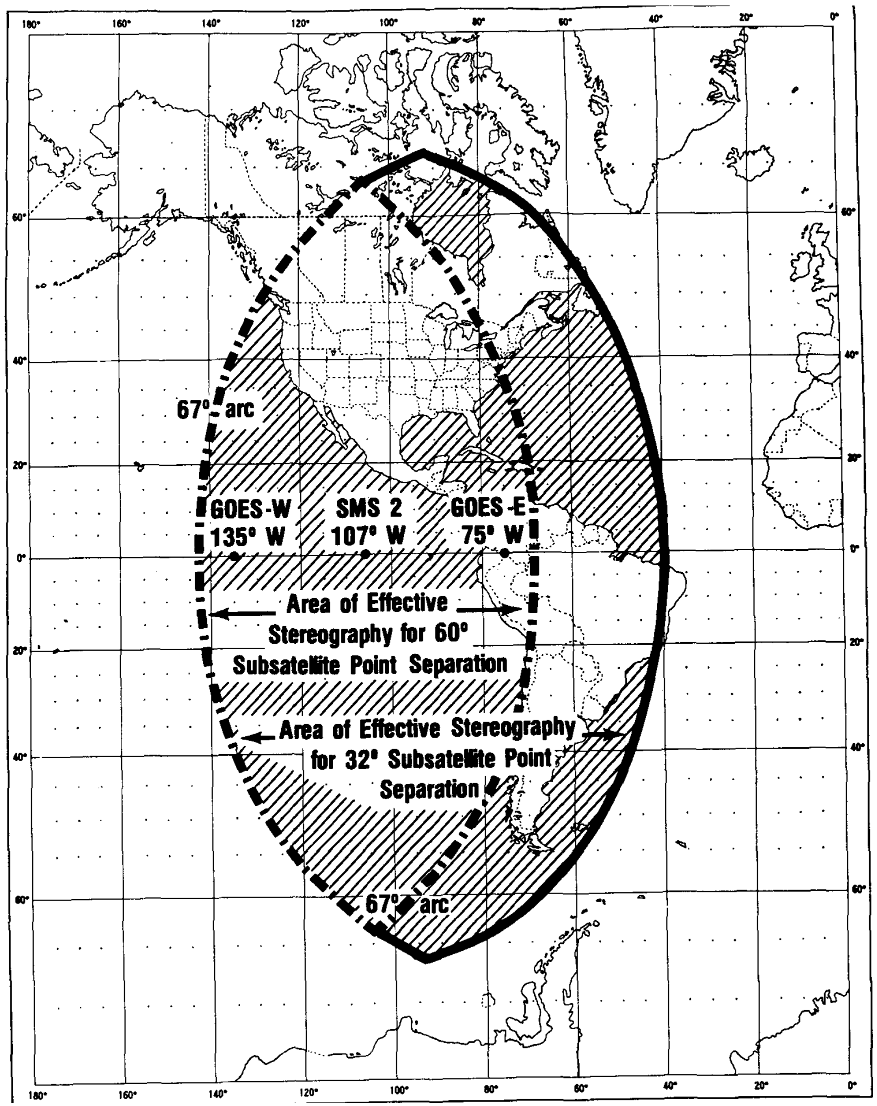
Lidar/Radar Winds, AMVs and Stereo Height

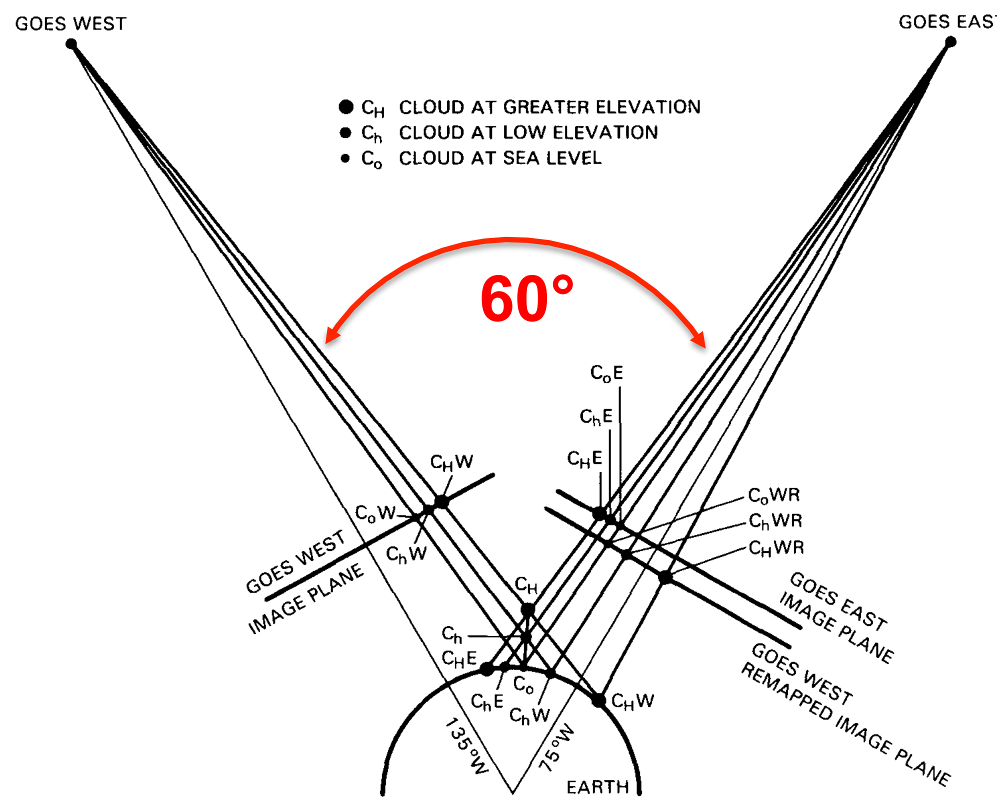
Radar (2D Wind)	LIDAR (2D Wind)	Single Satellite (3D Wind)		Dual and Multi Satellites (3D Wind)		
		LEO	GEO	LEO	GEO Stereo	LEO Stereo
• NASA/NScat	ESA/Aeolus (2015/16)	• MISR[1]	• GOES	• MetOp A/B	• GOES-E/W • Meteo-7/10 • FY2-FY2 • GEO/LEO …	• AATSR/ ATSR-2 • MetOp-SG • Proposals
• NASA/QScat • ESA/AScat • ISRO/OScat • CMA/HY1-2 … • NASA/RScat • NASA/ CYGNSS	NASA/3D-WIND[1] (2025+)	• AASTR	• MeteoSat 7-10 • MTSAT • FY2 …	• MODIS/ VIIRS • N18-20 …		
Swath	Curtain	Swath	Disk	Swath	Partial Disk	Swath
Sea surf wind	Wind profiles	Cloud-top, thick-aerosol, water vapor winds				
Δx =12-50 km Δu <2 m/s	Δz =1-3 km Δy =50 km? Δu =1-3 m/s	Δz =0.5-1 km Δx =1-20 km Δu =1-3 m/s	Δz =1-3 km Δx =10-40 km Δu =1-3 m/s		???	Δz =200 m Δx = 1-5 km Δu < 1 m/s Δw = ? m/s

[1] CGMS-41 NASA whitepaper (NASA WP-5) [D. Wu and M. Kavaya]

2-GOES Concept:
pointing knowledge and time-sync are critical

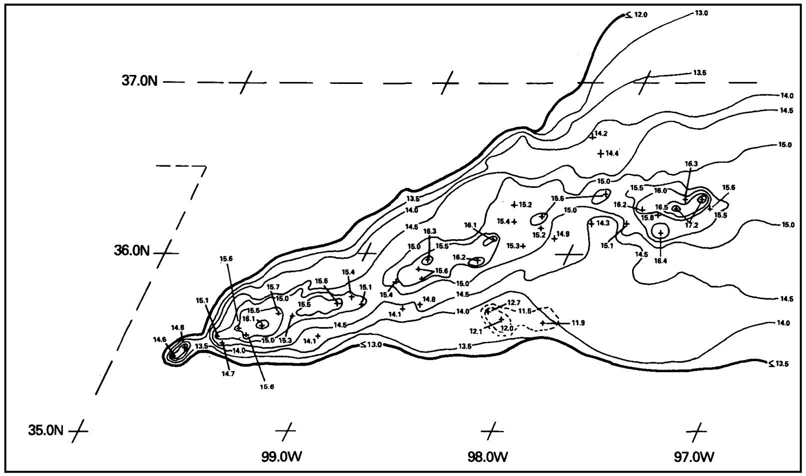


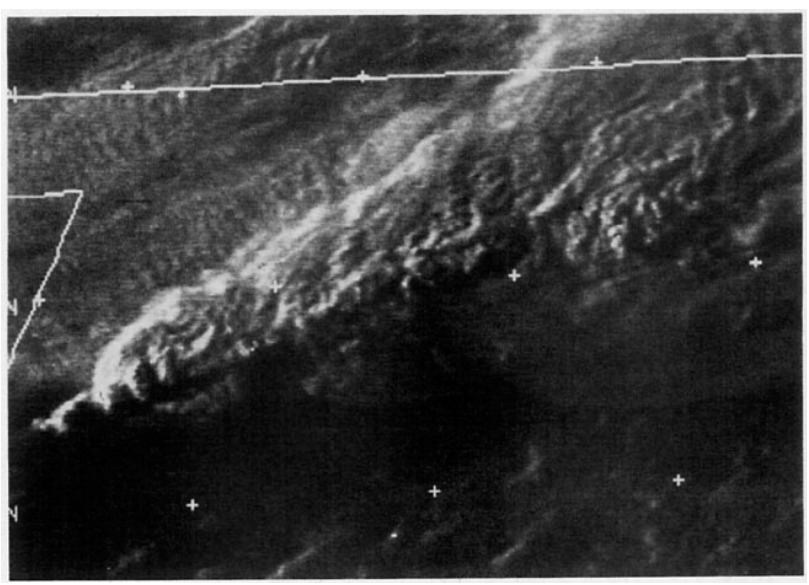
Shenk (1971) Apollo-6
Hasler (1981)
Black (1982)
Fujita and Dodge (1982)



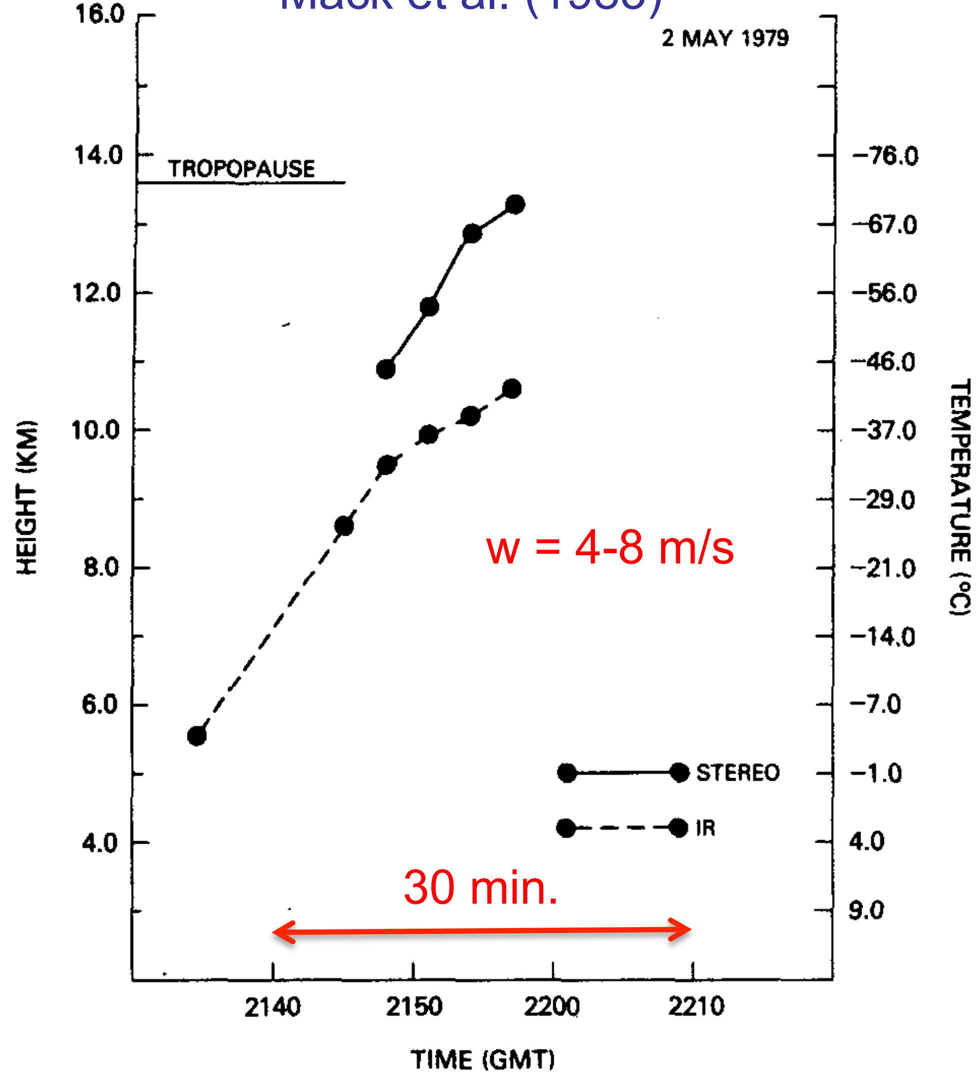
IR vs Stereo Height: 2-GOES Measurements

Importance of Vertical Motion



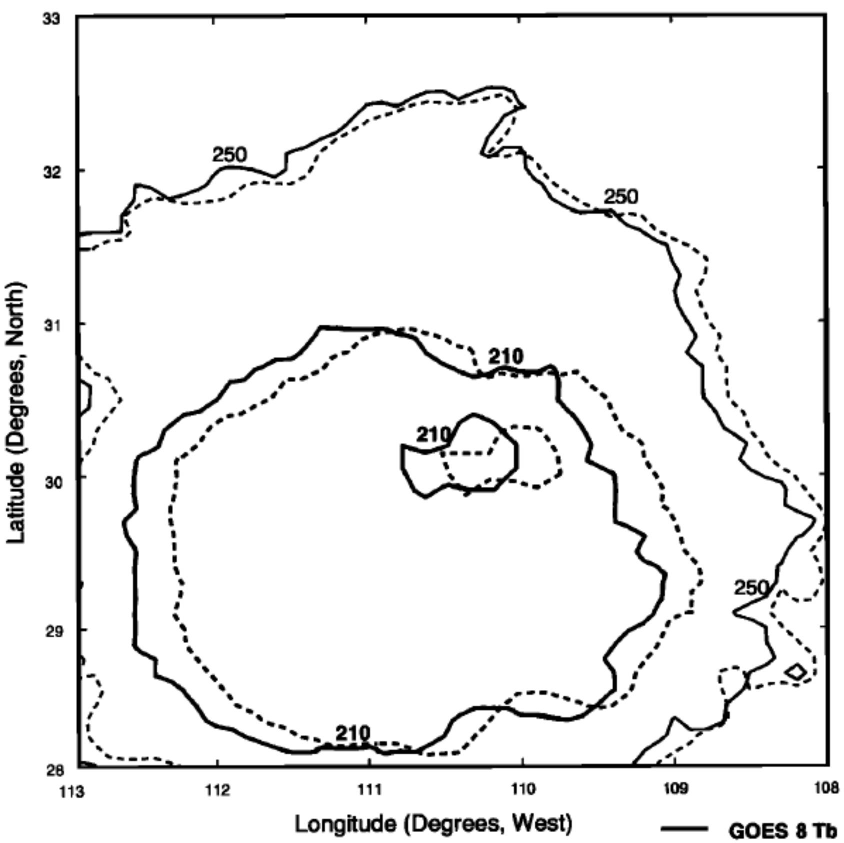


Mack et al. (1983)

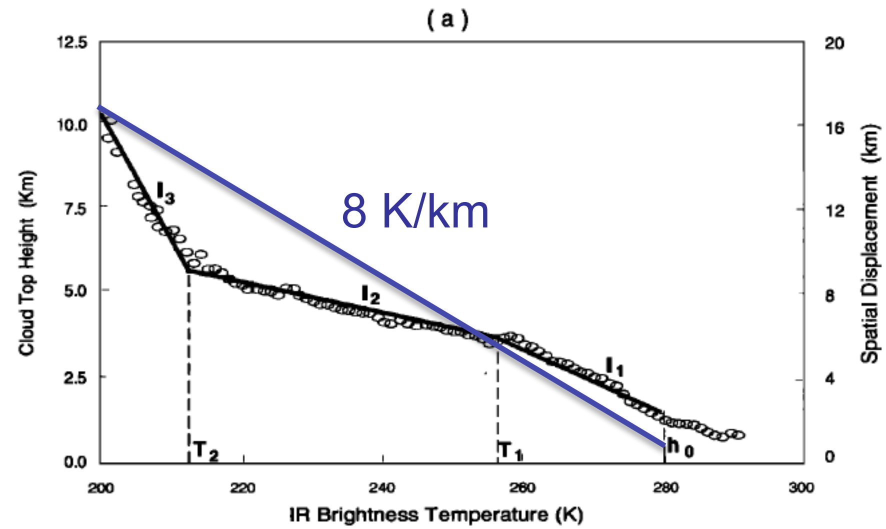


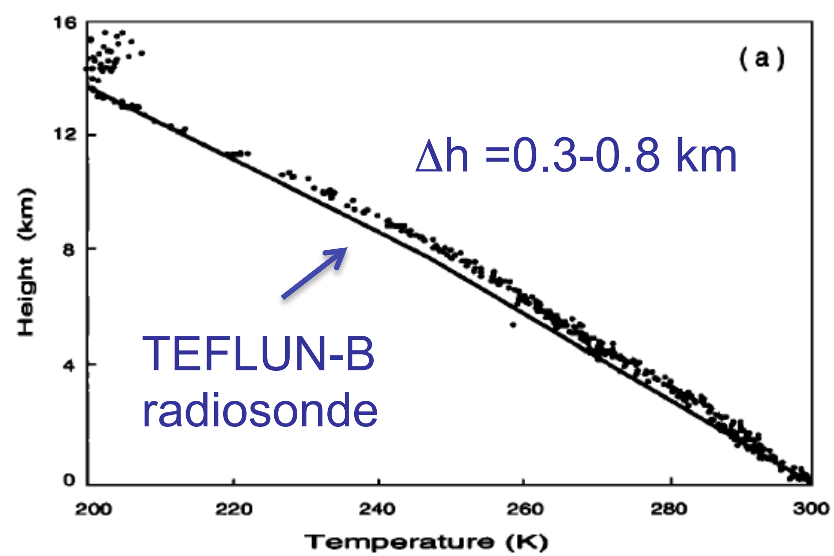
IR vs. Stereo Height: A Pattern Height

Mahani et al., (2000)



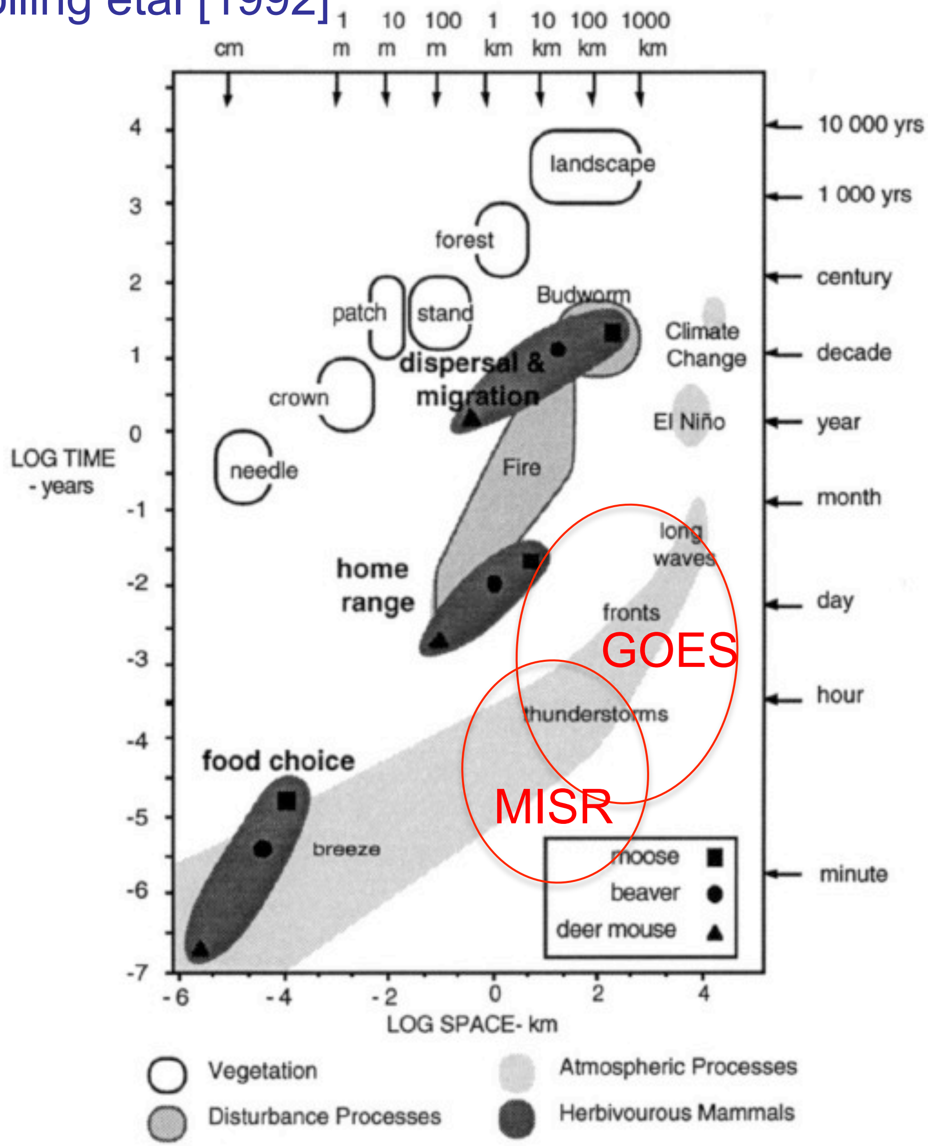
Baja Peninsula (July 12, 1998)



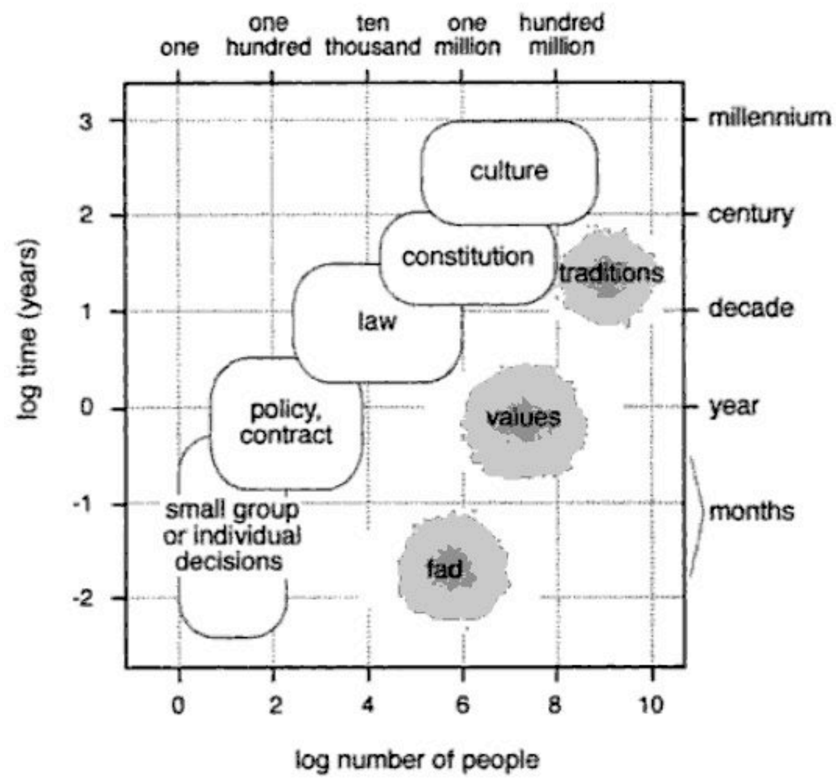


Pattern Matching: Spatial vs Temporal Variabilities

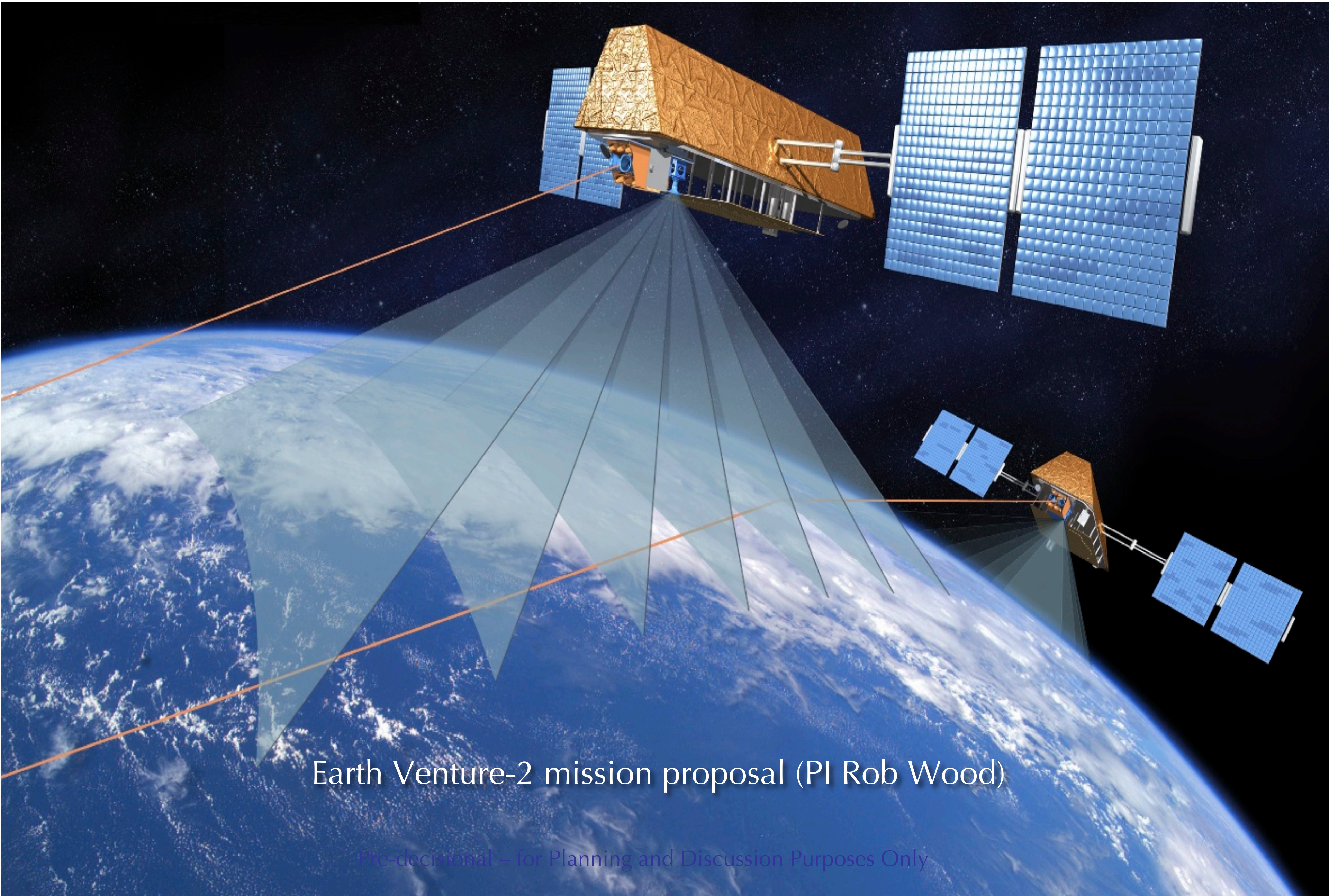
Holling etal [1992]



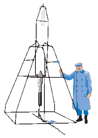
Westley et al. [2002]



Spaceborne Atmospheric Boundary Layer Explorer (SABLE)



Summary



- MISR zonal winds are slower than ERA-I in the January upper trop (UT) where the latitudinal gradient of polar jets is large.
- MISR meridional winds show a stronger poleward flow in the UT, compared to ERA-I
- MISR CMVs have occasionally large bias due to geo-registration problems, mainly affecting the meridional wind.
- Topography seems to produce slower lee-side wind speed in MISR than in ERA-I, but is small compared to other factors.
- Lidar/Radar winds and CMVs are complementary. Overlapped samples provide valuable cross-calibration globally. The CMV technique from space, providing a much wider swath (or coverage), is 5x-10x cheaper than wind-lidars (still technically challenging from space).