Status of MISR Stereo Motion Vectors

and

Assessment using MODIS, MSG, & CATS lidar

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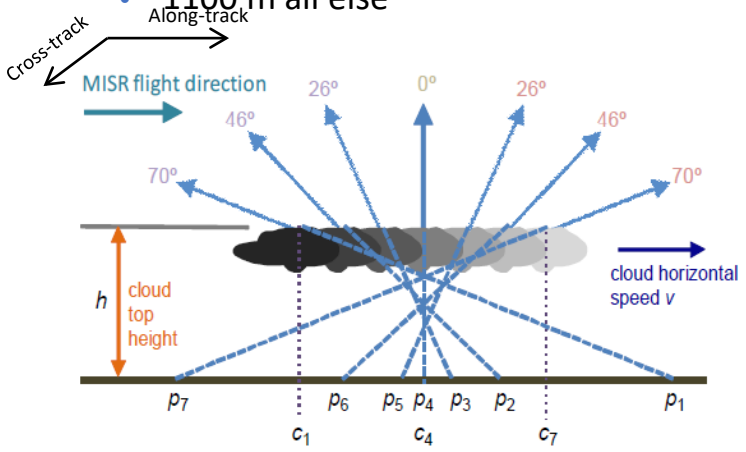
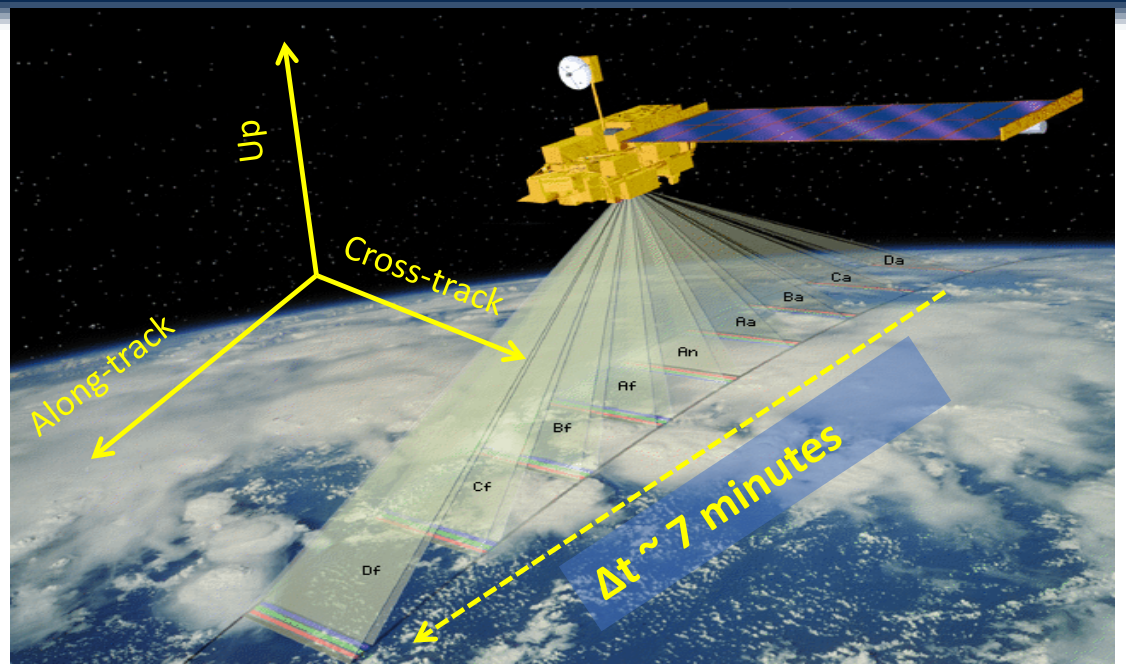
Multi-angle Imaging SpectroRadiometer

MISR instrument

- **Mission Lifetime**
  - **1999 -> ~~2018+~~ 2026**
  - **Orbit change in 2022**
- Swath Width ~ 380 km
- 9 Camera View Angles
  - 0º (Nadir)
  - ±26.1º, ± 45.6º
  - ±60.0º, ± 70.5º
  - 7 minute overpass
- B, G, R, & NIR Bands
- Spatial Resolution
  - **275 m for Nadir and Red Band**
  - 1100 m all else



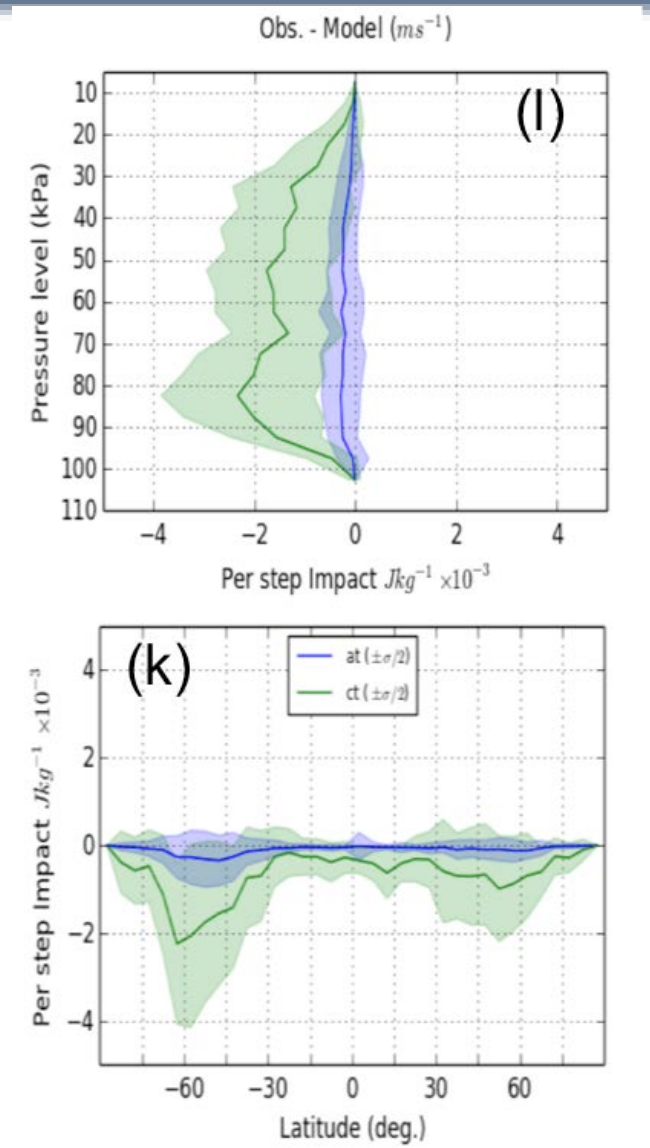


MISR Wind Products

- Stereo Motion Vectors (SMV)
  - **Geometric height obtained from parallax**
  - Retrieved from redundant forward and aft camera triplets
  - Time interval **Δt = 200 seconds**
  - Gridded resolution **Δx = 17.6 km**
- Height-resolved cross-track cloud motions:
  - **Geometric height obtained from parallax**
  - Retrieved from redundant forward and aft camera pairs
  - Time interval **Δt = 46 seconds**
  - Gridded resolution **Δx = 1.1 km**

MISR Stereo Motion Vectors status

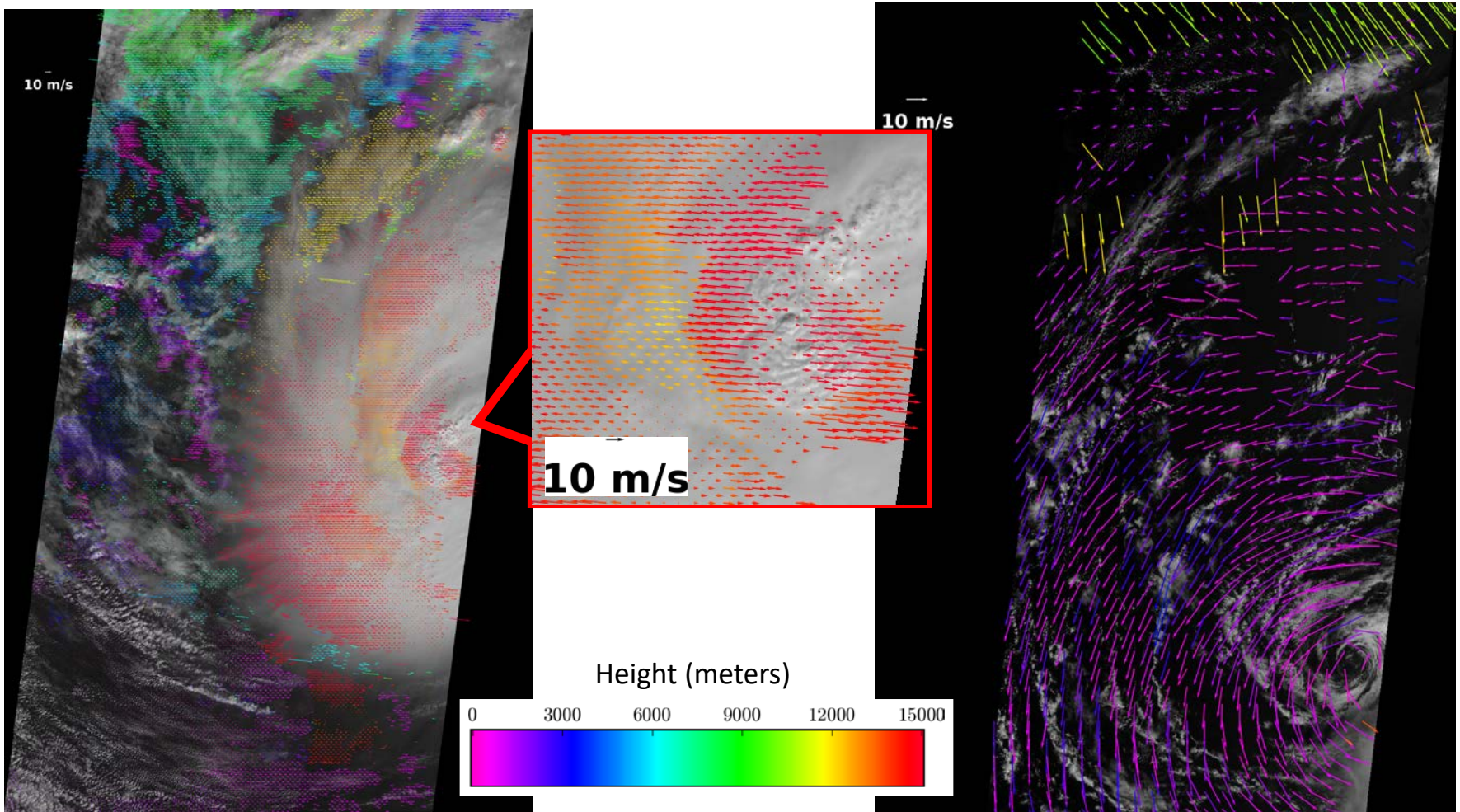
- Forecast benefit in GMAO GEOS-5 model shown
  - Mueller et al. 2017, MWR
  - GMAO following up by incorporating code into operational GEOS5-FP
    - Testing in progress after updating code from paper to current GEOS5 revision
- Two years of NWPSAF monitoring show well constrained error
  - NWPSAF AMV Analysis reports show 2 caveats:
    - occasional orbits with poor georegistration have systematic bias and degraded forecast benefit
- MISR SMV will benefit from major upstream revisions to Level 1 software
  - New DEM and revised camera model will benefit georegistration
  - MISR SMV are highly sensitive to georegistration- see above



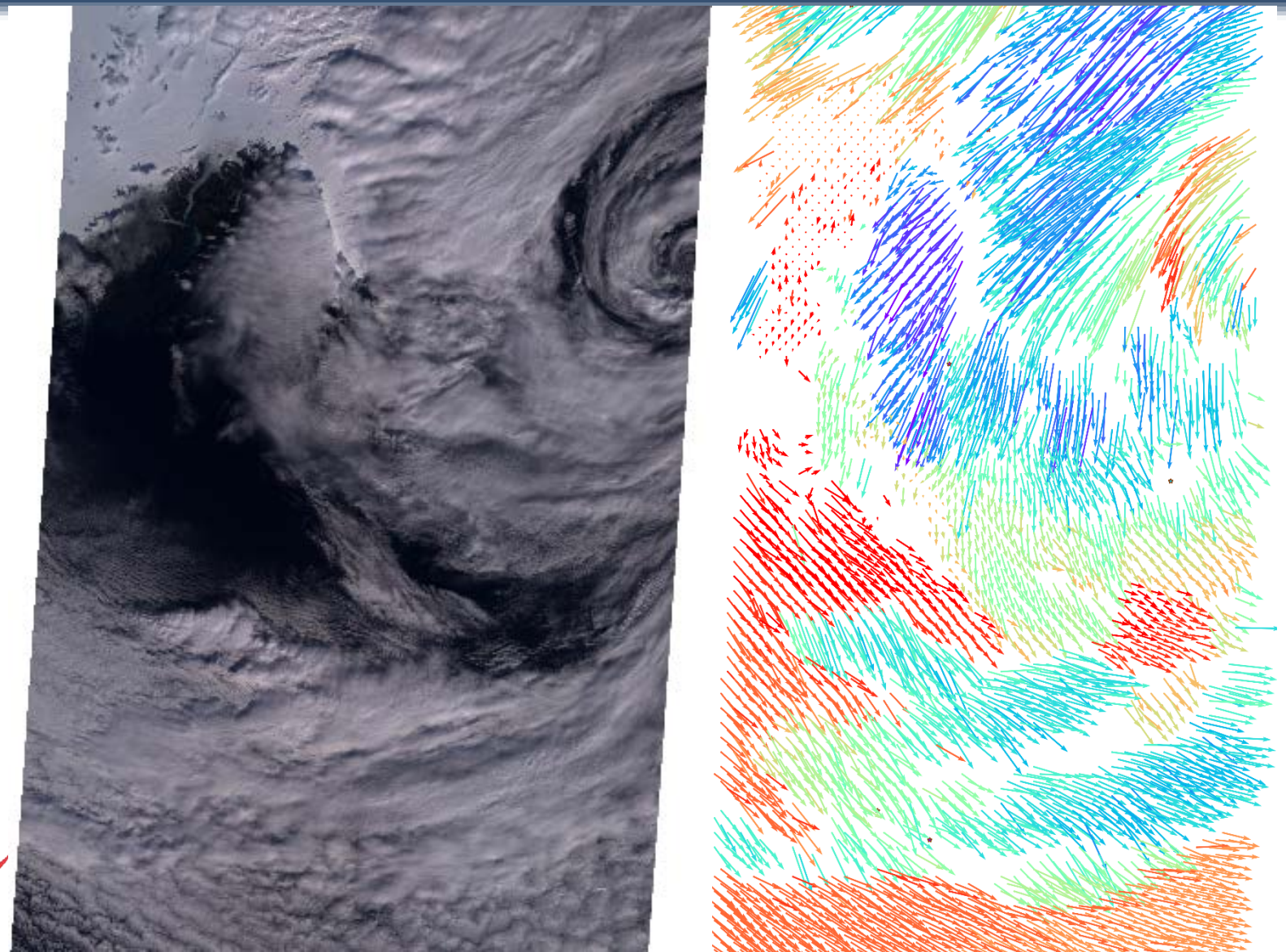
Example MISR Wind Product Retrievals

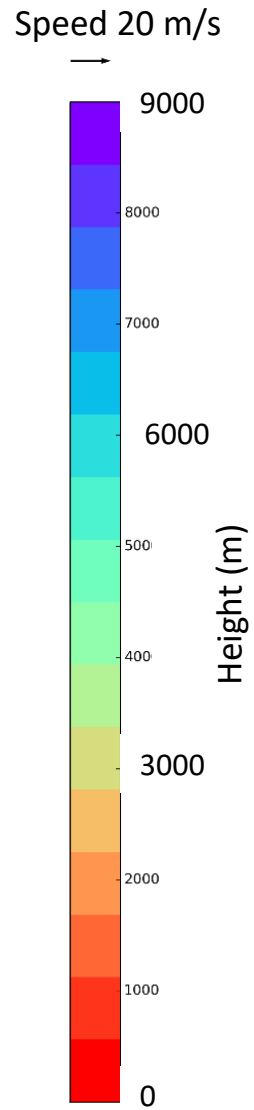
Height resolved cross-track cloud motion (1.1 km resolution)
(Hurricane Ida)

Height resolved cloud motion vectors (17.6 km resolution)
(Hurricane Francis)

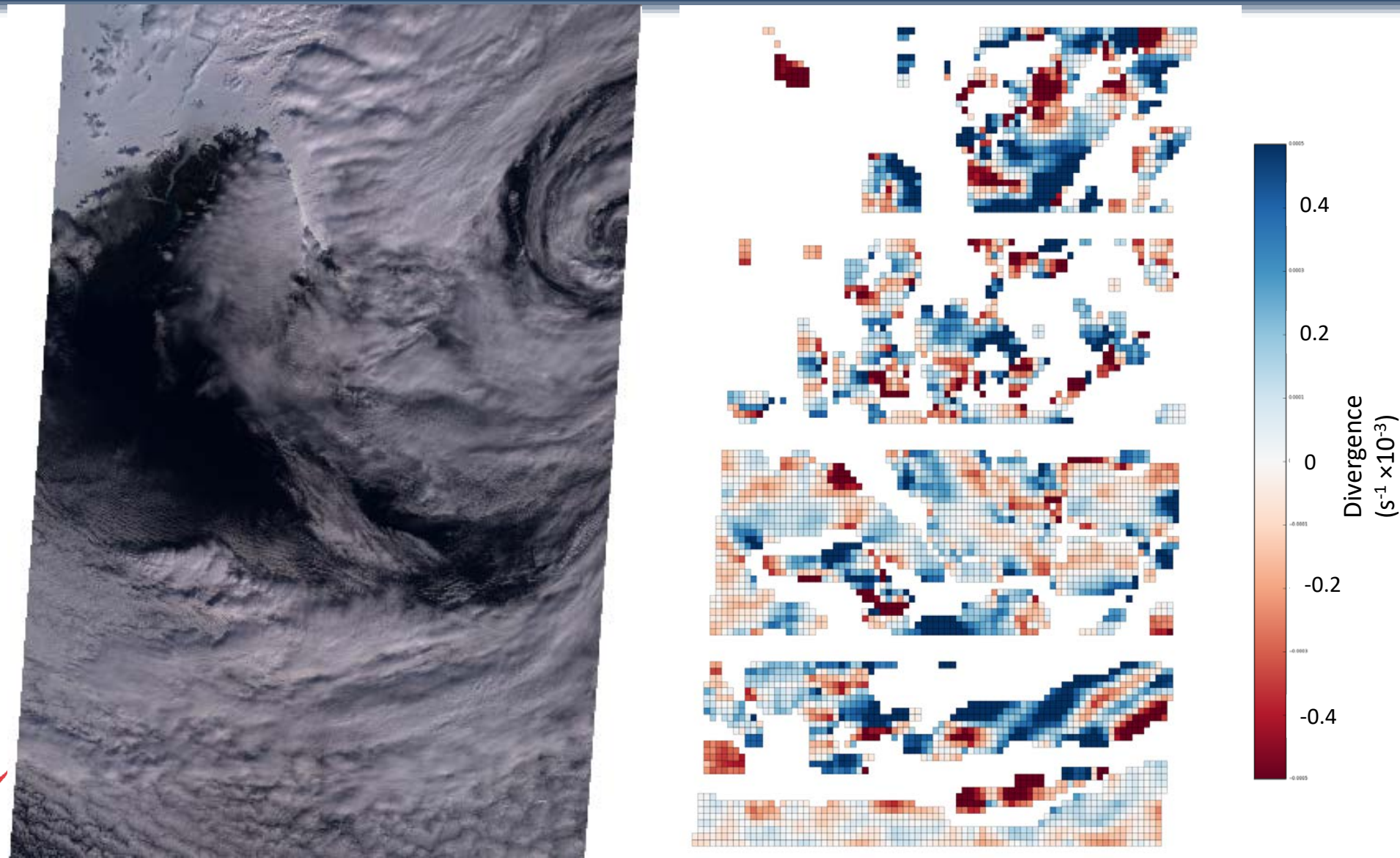


Research retrieval: 4.4 km resolution



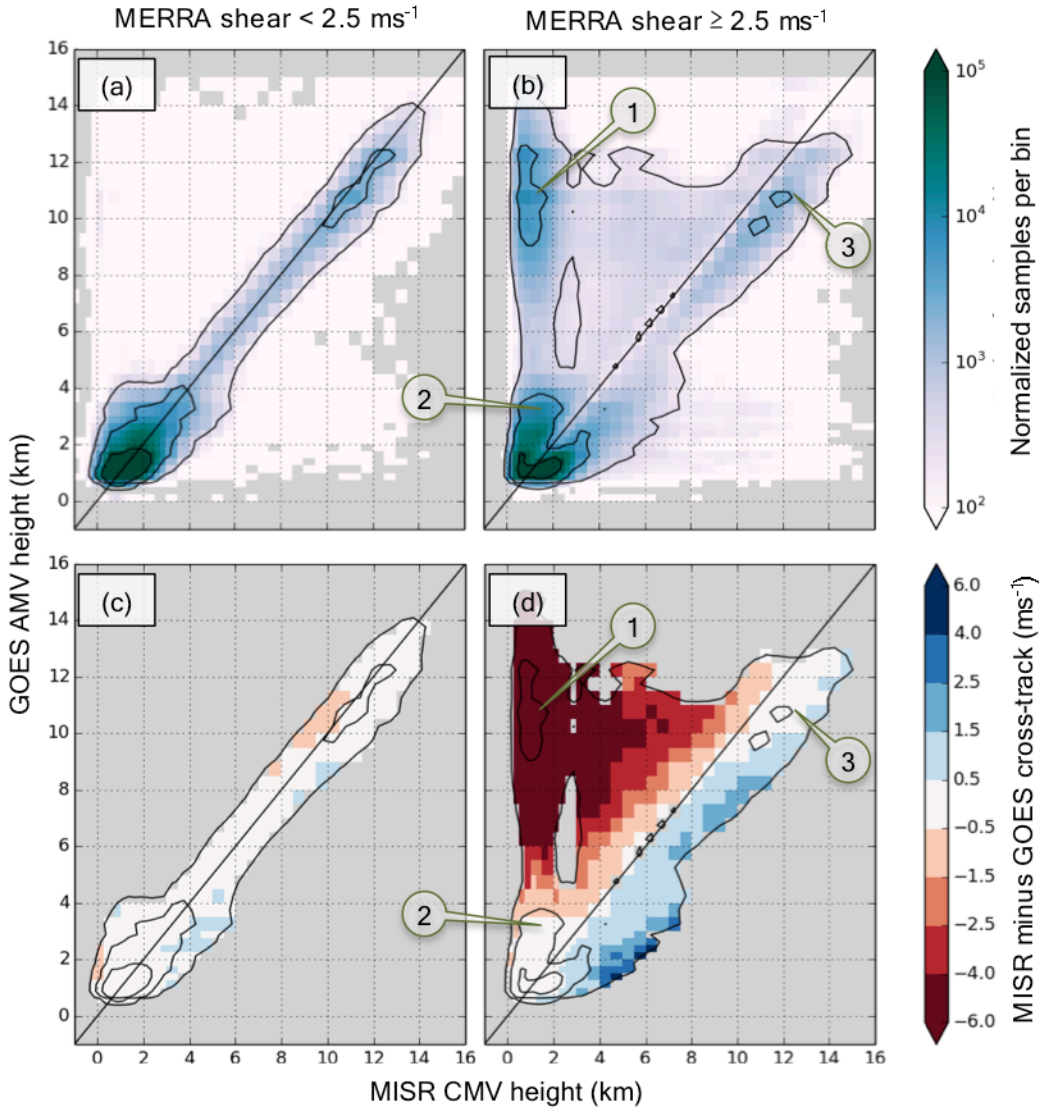


Prototype: divergence @ 4.4 km



Questions from past SMV assessment

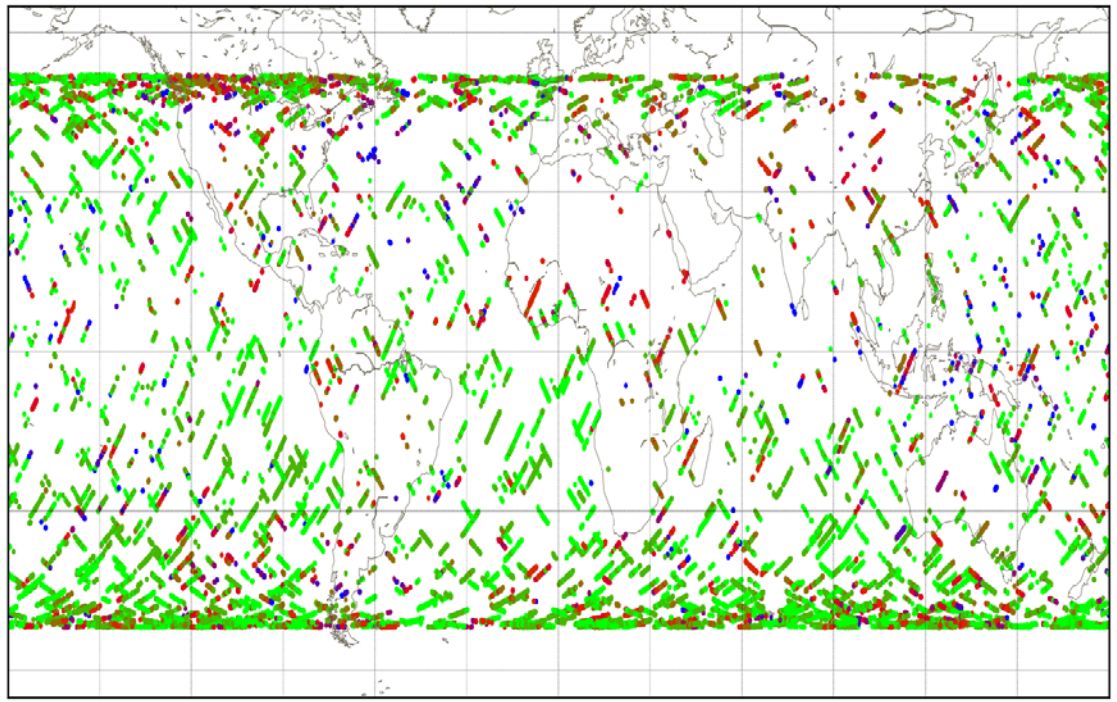
- Comparison of MISR with GOES AMV (2003-2008)
  - Mueller et al., 2017 JAMC
  - MISR and GOES wind tracking agree well
    - 3.2 m s^{-1} VRMS (VIS channel)
    - 1.6 m s^{-1} RMS cross-track
  - Except for…
    - (2) Low heights (< 4 km):
      - Heights uncorrelated
      - MISR often 2 km below GOES
    - (3) High heights (> 8 km)
      - MISR often 1 km above GOES
- Can analysis be corroborated / expanded with “truth” data for heights?

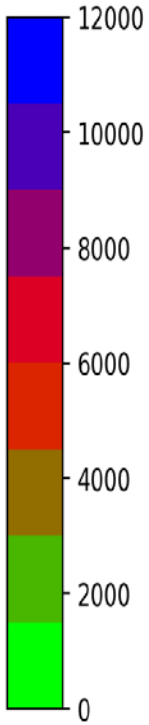


MISR SMV height validation with CATS

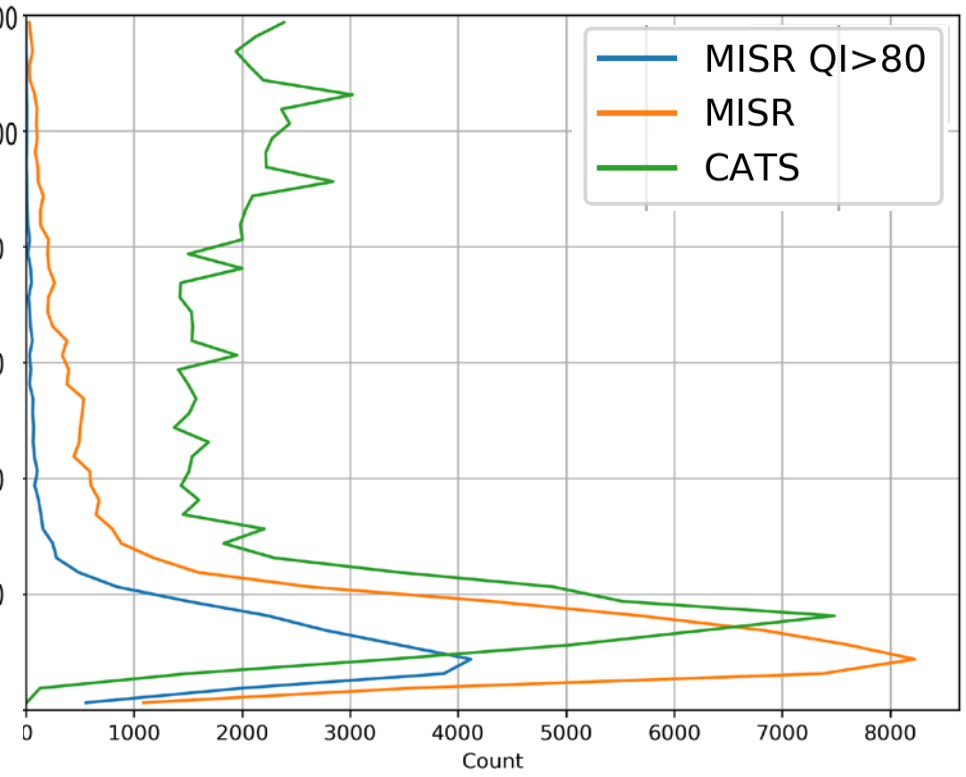
- 10s of thousands of well distributed spatial coincidences within 5 minutes, 2015-2017
- Latitude range 52° S. to 52° N
- Coincidences with poor MISR orbit registration have been excluded

Locations and heights (m) of coincidences



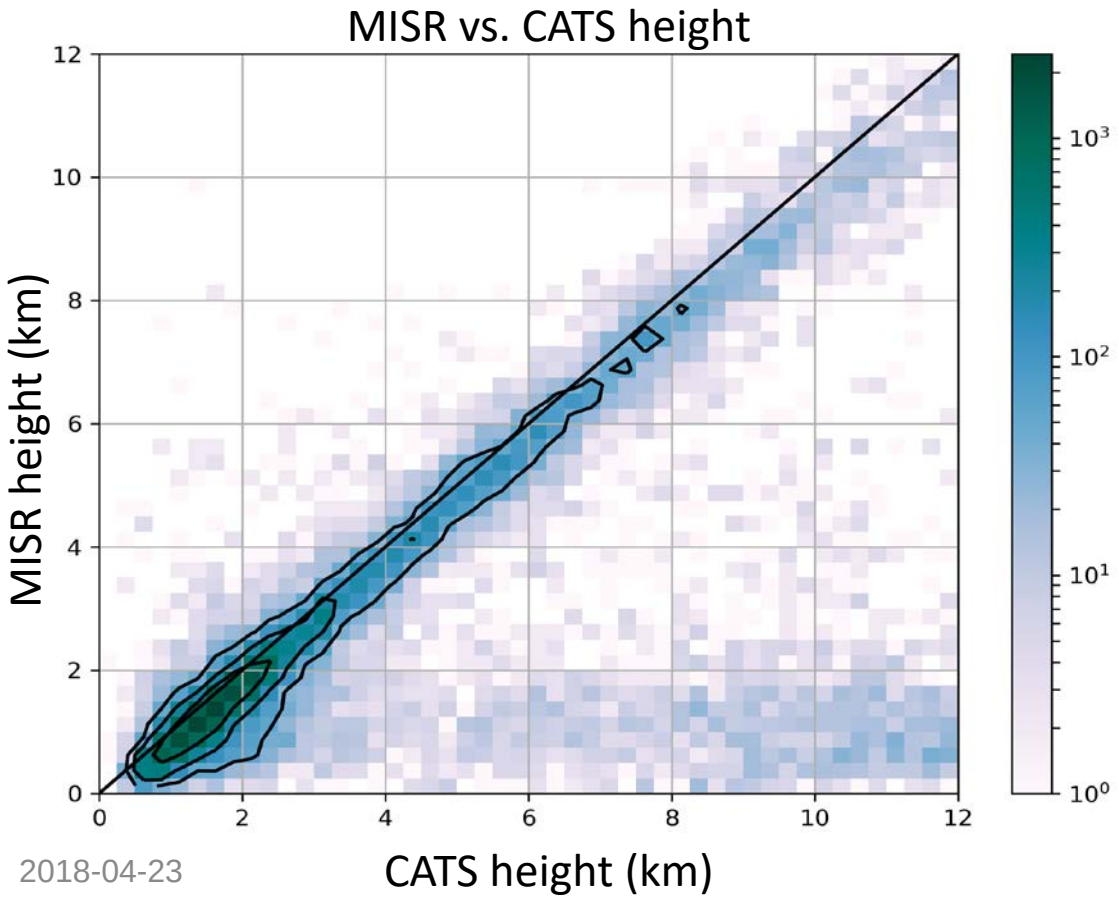


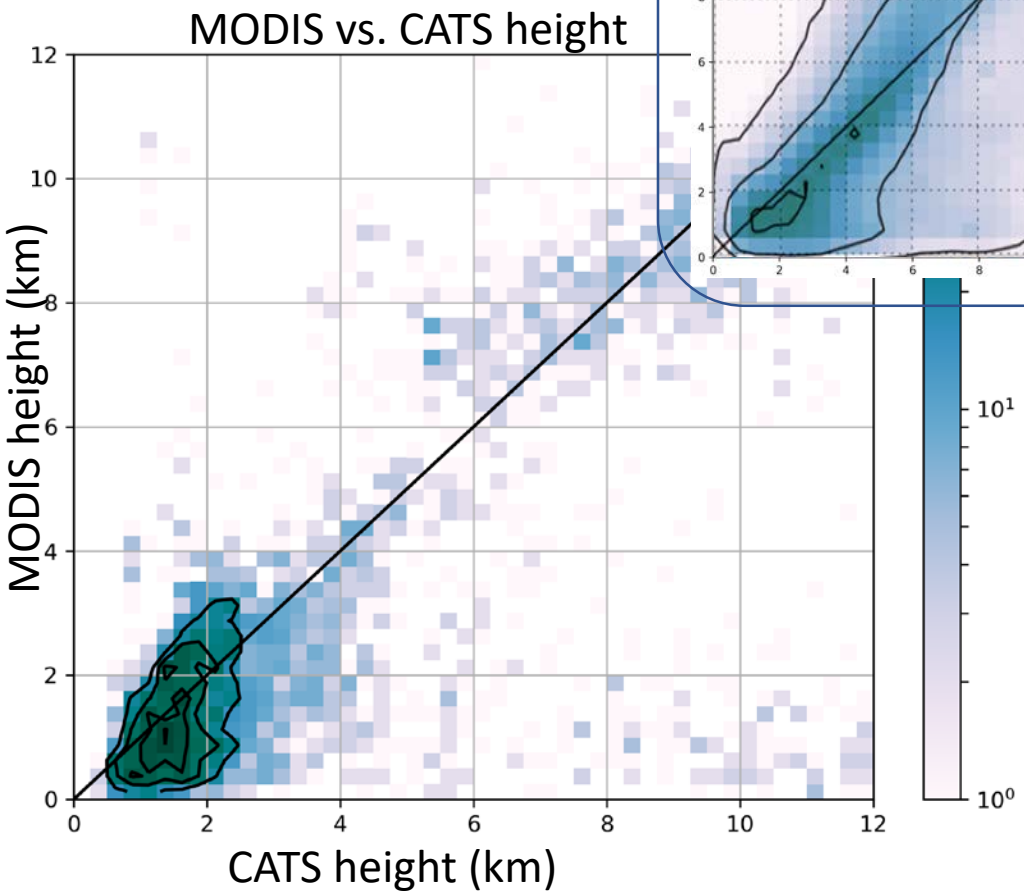
Height distribution of collocations

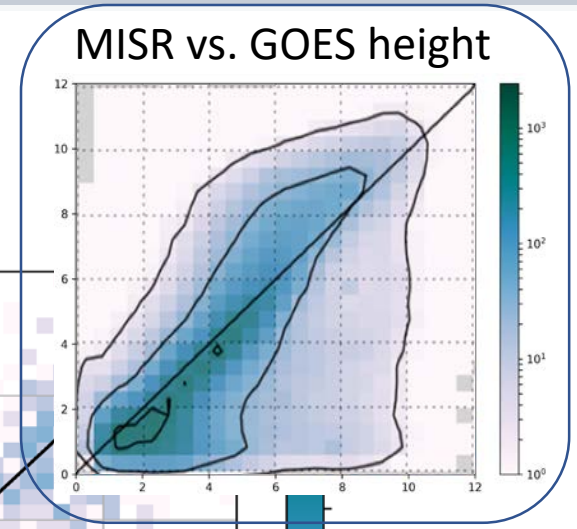


Lidar heights compare favorably with SMV heights

- Directly comparable measurements yield low noise
  - RMS 300 m



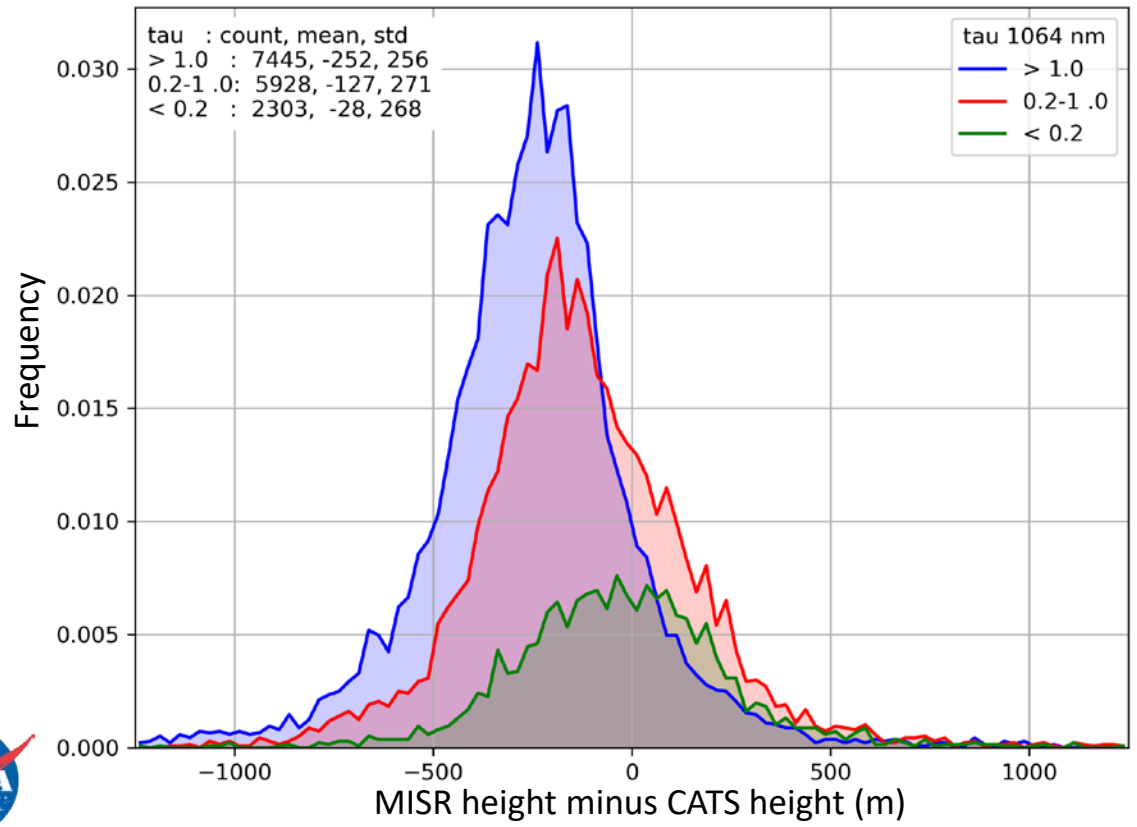




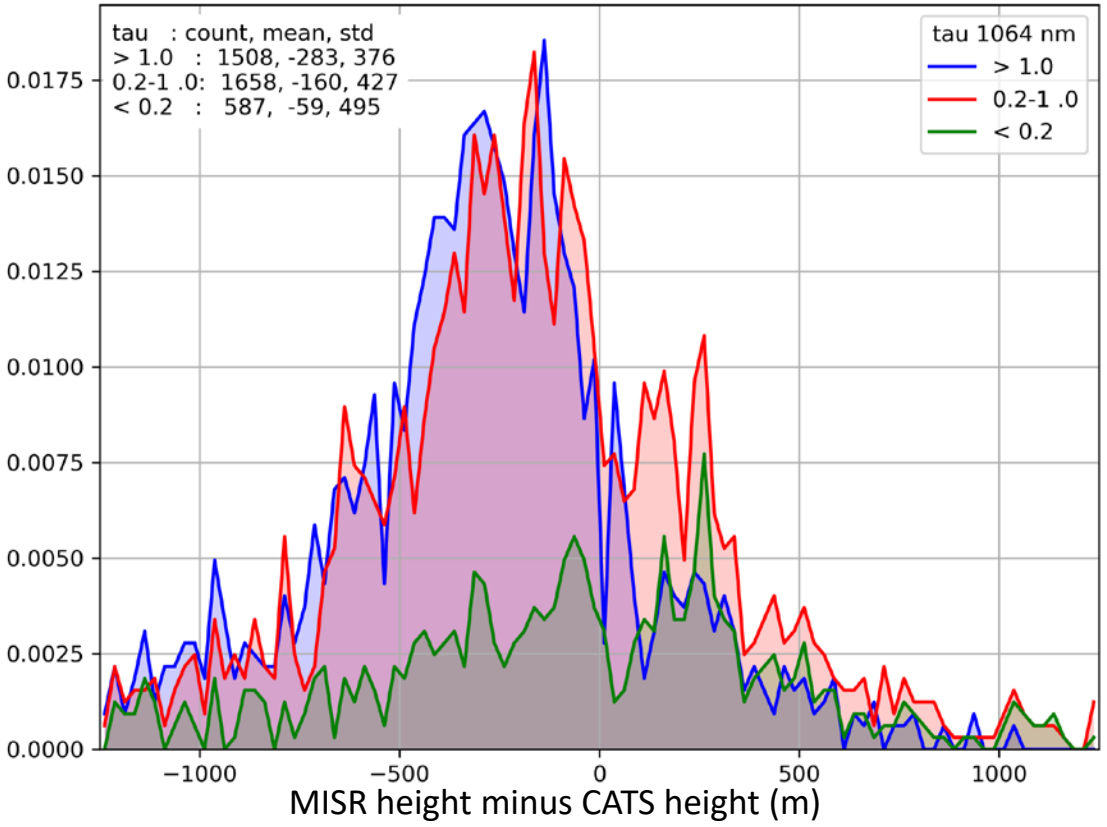
MISR stereo prefers optically thick, water clouds (possible bias in other clouds)

- Ice and unkown phase clouds have double the height variance relative to CATS
  - Liquid phase σ = 260 m, ice & unknown phase σ = 500 m
- With decreasing optical depth, height “bias” relative to CATS increases from -250 m to -30 m
- Would these patterns hold for along-track variance and bias?

Liquid phase, bias as function of tau (at 1064 nm)

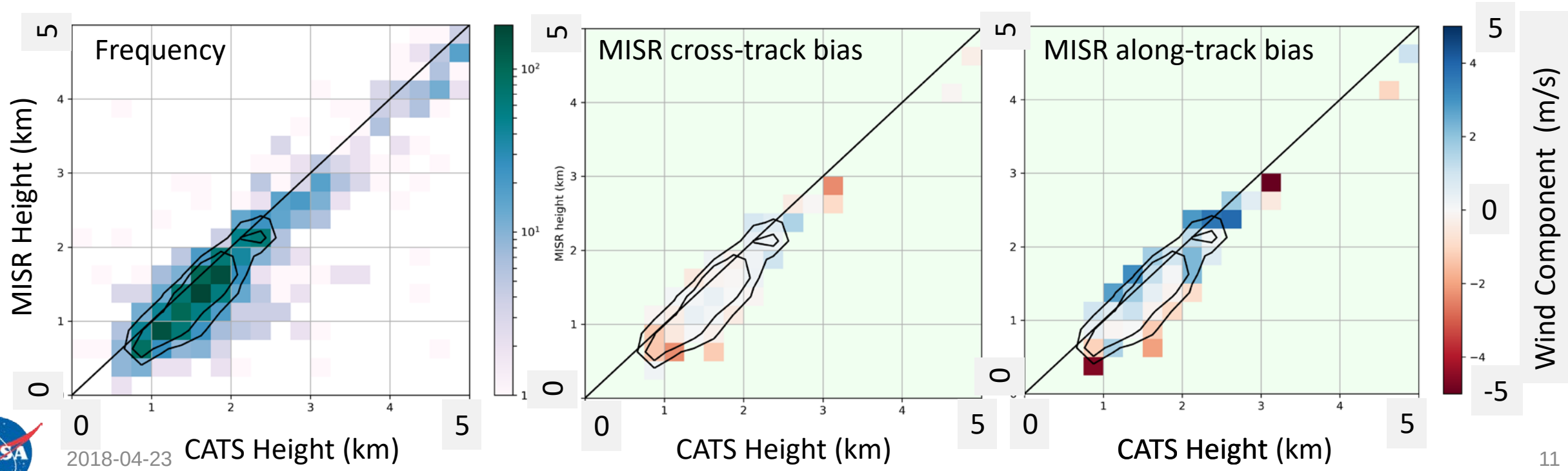


Ice & unknown phase, bias as function of tau



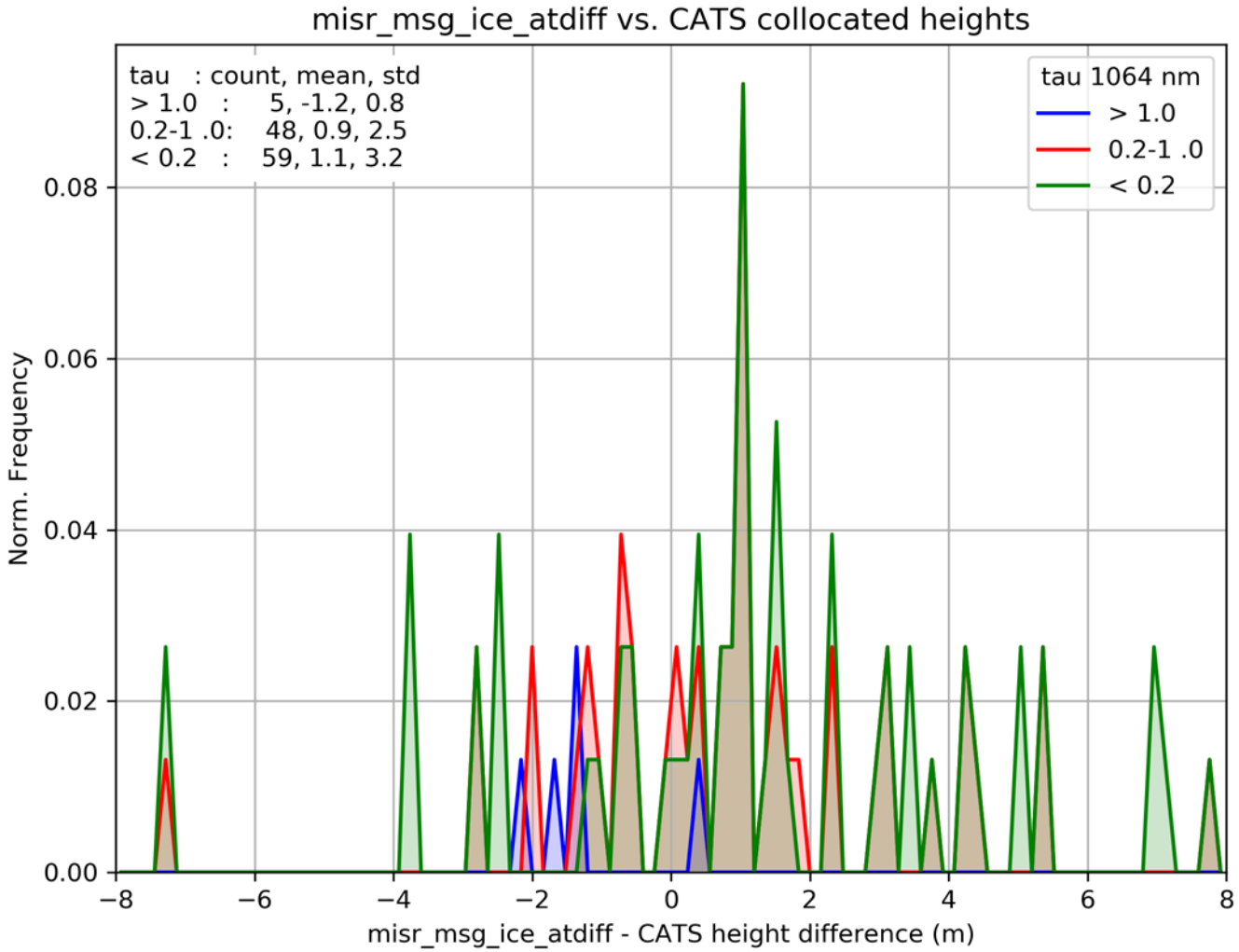
Additionally collocated MSG AMV shows SMV along-track bias may follows height bias

- Pattern of SMV along-track bias vs. MSG AMV follows that of SMV vs. CATS height
  - Positive/negative along-track bias at positive/negative fringes of height distribution which
- For low clouds:
  - height σ=600 m, along-track σ=3.5 m/s, cross-track σ=2.5 m/s



Low optical depth ice clouds (cirrus?) produce along-track biased retrievals

- The fringes of the prior distribution show the source of bias to be ice in prior distribution



Conclusions and follow up work

- Ice clouds are a source of positive along-track bias in MISR SMVs, and may be the dominant source
- Can a scheme for flagging ice clouds be used to improve robustness of MISR SMVs