GOES-R Readiness: Atmospheric Motion Vectors (AMVs) Validation Activities

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Cooperative Institute for Meteorological Satellite Studies
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Outline

- Project Overview and Motivation
- Validation Strategies
- "Deep-Dive" Validation Tools
- Summary

Project Overview/Motivation

- New AMV derivation software being developed for GOES-R represents a major change to the current GOES operational software.

- Pre-launch proxy datasets are used to test, demo and verify that future AMVs derived from the GOES-R Advanced Baseline Imager (ABI, set for launch in ~2016) will be as good/better than the current product

-- Proxy data sets include imagery obtained from model-simulated GOES-R ABI, Meteosat SEVIRI, and current GOES.

Validation Strategies

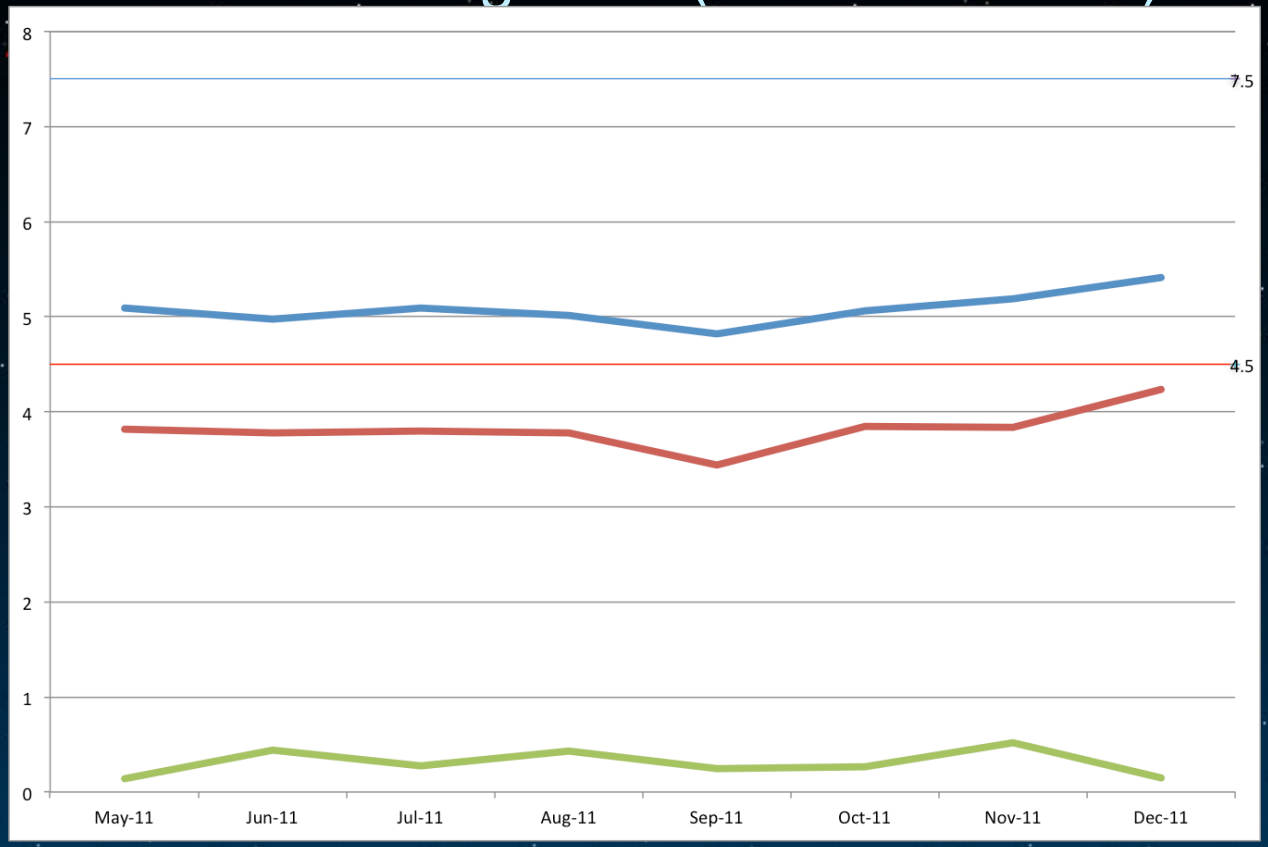
- Routinely generate AMVs in near real-time using available proxy data
  - Meteosat-9, existing GOES satellites
- Collect "truth" data and collocate with AMVs
  - Rawinsondes, GFS analyses, CALIPSO
- Produce graphics and statistics
- Interrogate AMVs using available and customized tools
  - McIDAS-X, Matlab, McIDAS-V

Traditional Approach: Comparison Statistics
Meteosat-9 AMVs with GOES-R Algorithm (All Bands/Levels) vs RAOBS

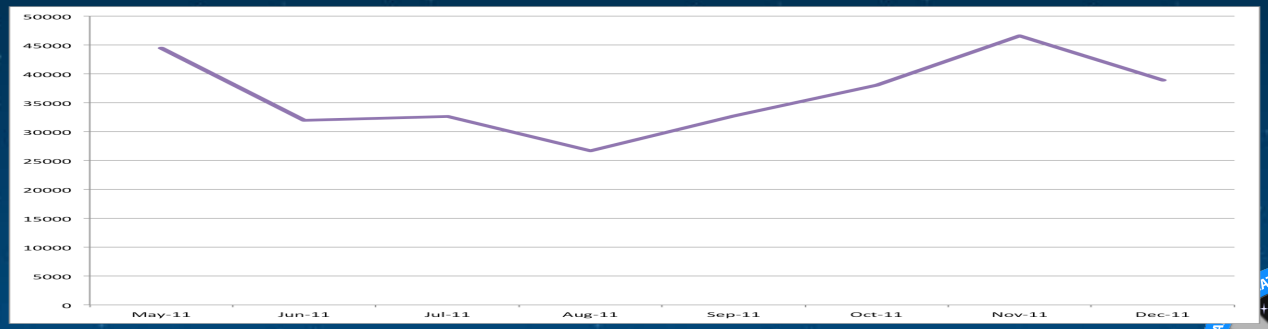
GOES-R Accuracy Requirement

GOES-R Precision Requirement

Accuracy (m/s)
Precision (m/s)
Speed Bias (m/s)



Match Count



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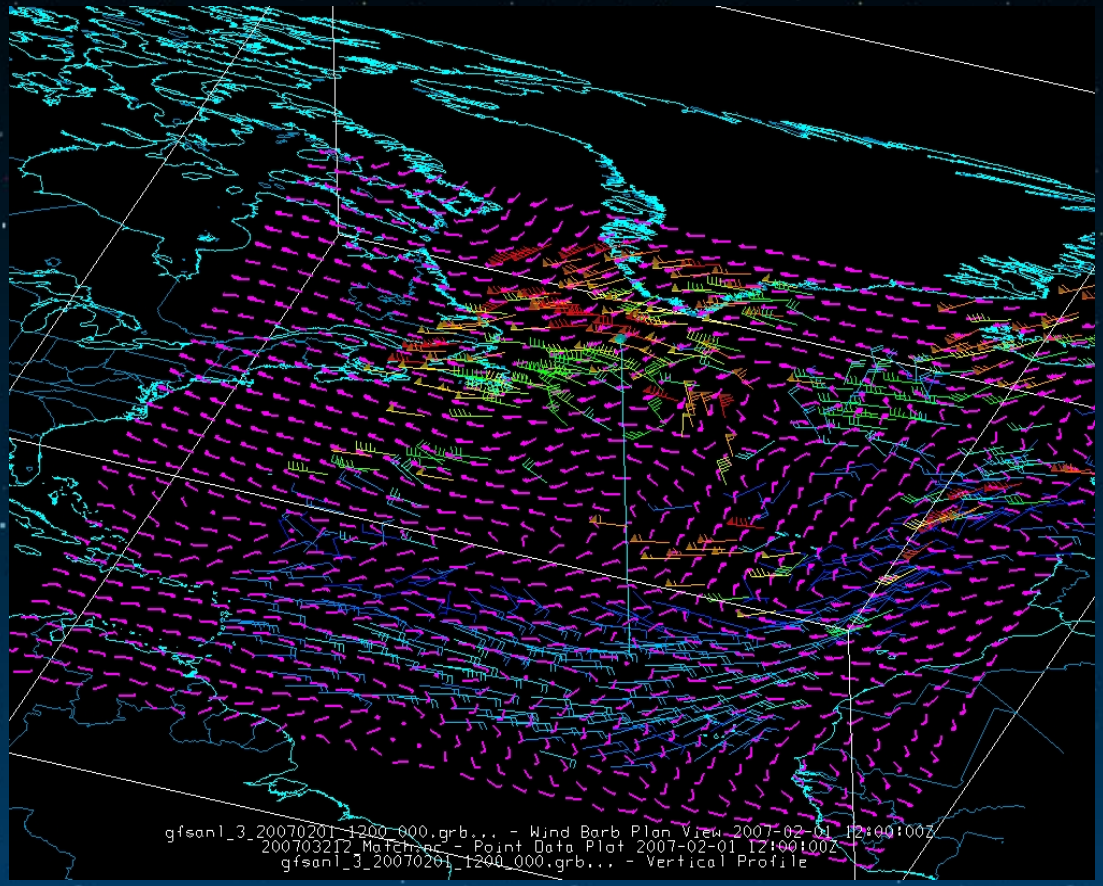
"Deep-Dive" Validation Tools

- Routine validation approaches can lead us to suspect areas to focus on for "deep-dive" inspection
- Analyze and visualize data using custom tools
  - i.e. McIDAS-V, Matlab
- Allows us to carefully diagnose AMV performance to better understand errors/tendencies
- Feedback for improving algorithm development

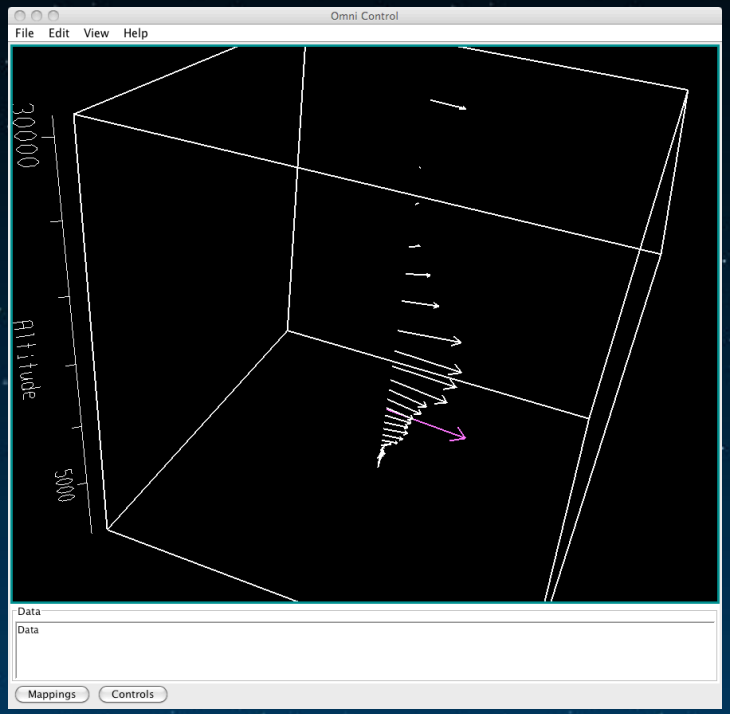
Deep Dive Validation Tool – McIDAS-V Utilities Under Development

Interrogation of vertical structure of surrounding reference winds from model analysis and/or in-situ obs near location of selected AMV allows for easier visualization in error diagnosis.

Slide courtesy of Tom Rink, UW-Madison/SSEC/CIMSS



Plot of low-level AMVs color scaled by wind speed, with nearest-level GFS gridded wind field in magenta.



Profile of GFS winds (white) at selected AMV (magenta) location

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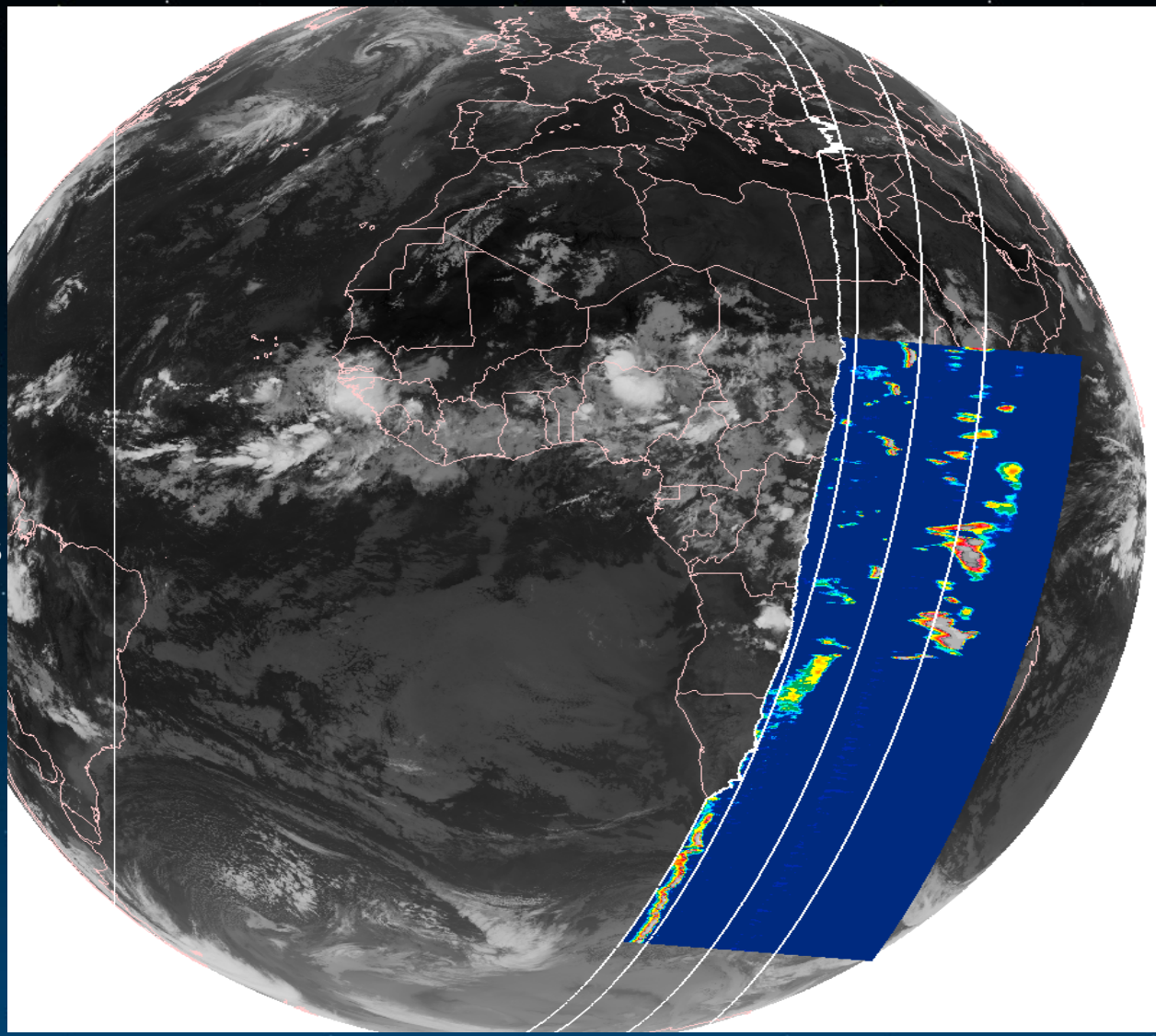
Another Example of Deep Dive Validation – Meteosat-9 AMVs vs CALIPSO

September 15, 2011, 00 UTC

Preliminary use of CALIPSO to assess AMV height assignments

Piece of CALIPSO transect showing cross-section of backscatter signal from clouds



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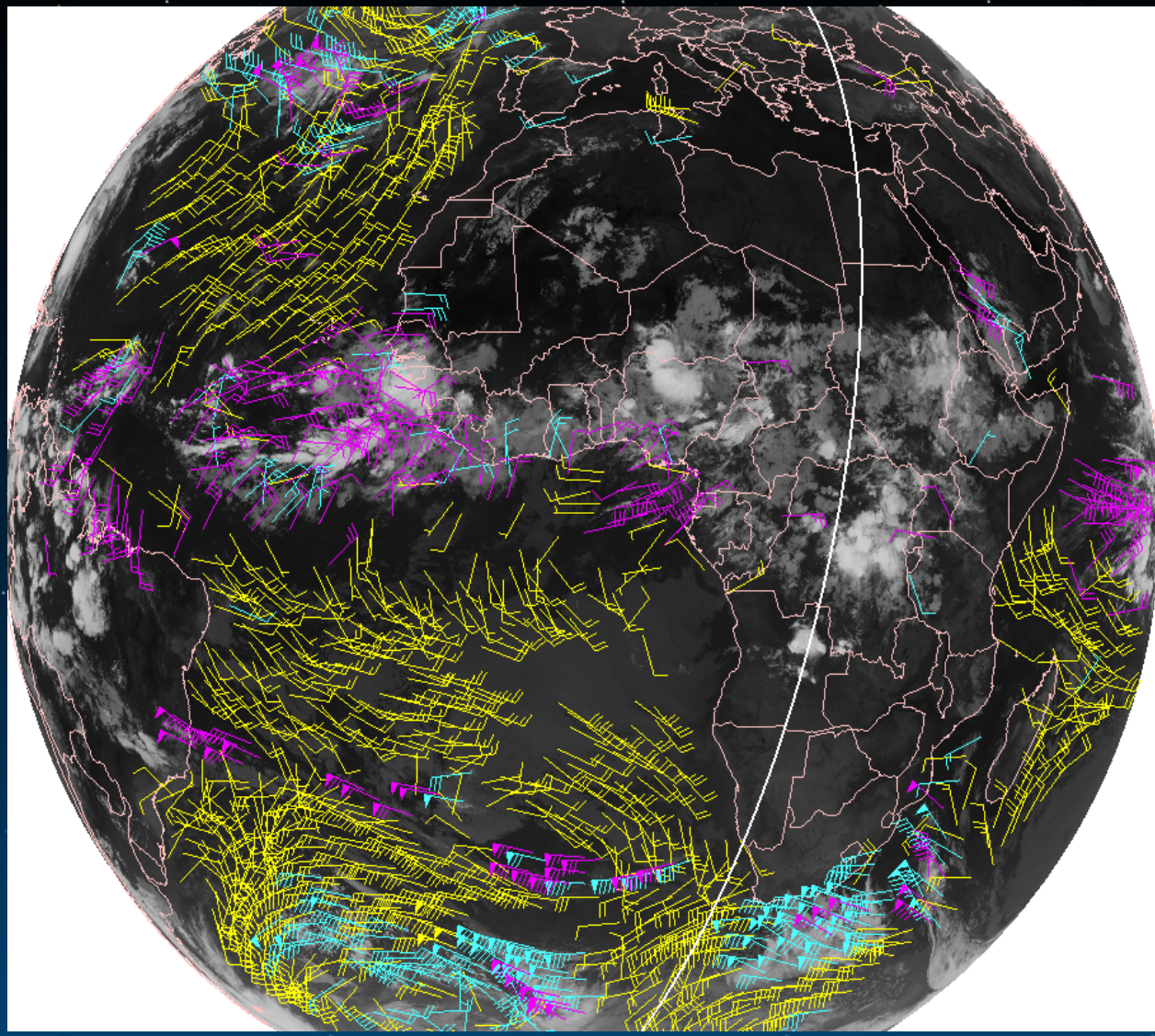
Example Deep Dive Validation – Meteosat-9 AMVs vs CALIPSO

September 15, 2011, 00 UTC

Plot of GOES-R proxy AMVs using Meteosat-9 along with track of CALIPSO pass near the time of the dataset



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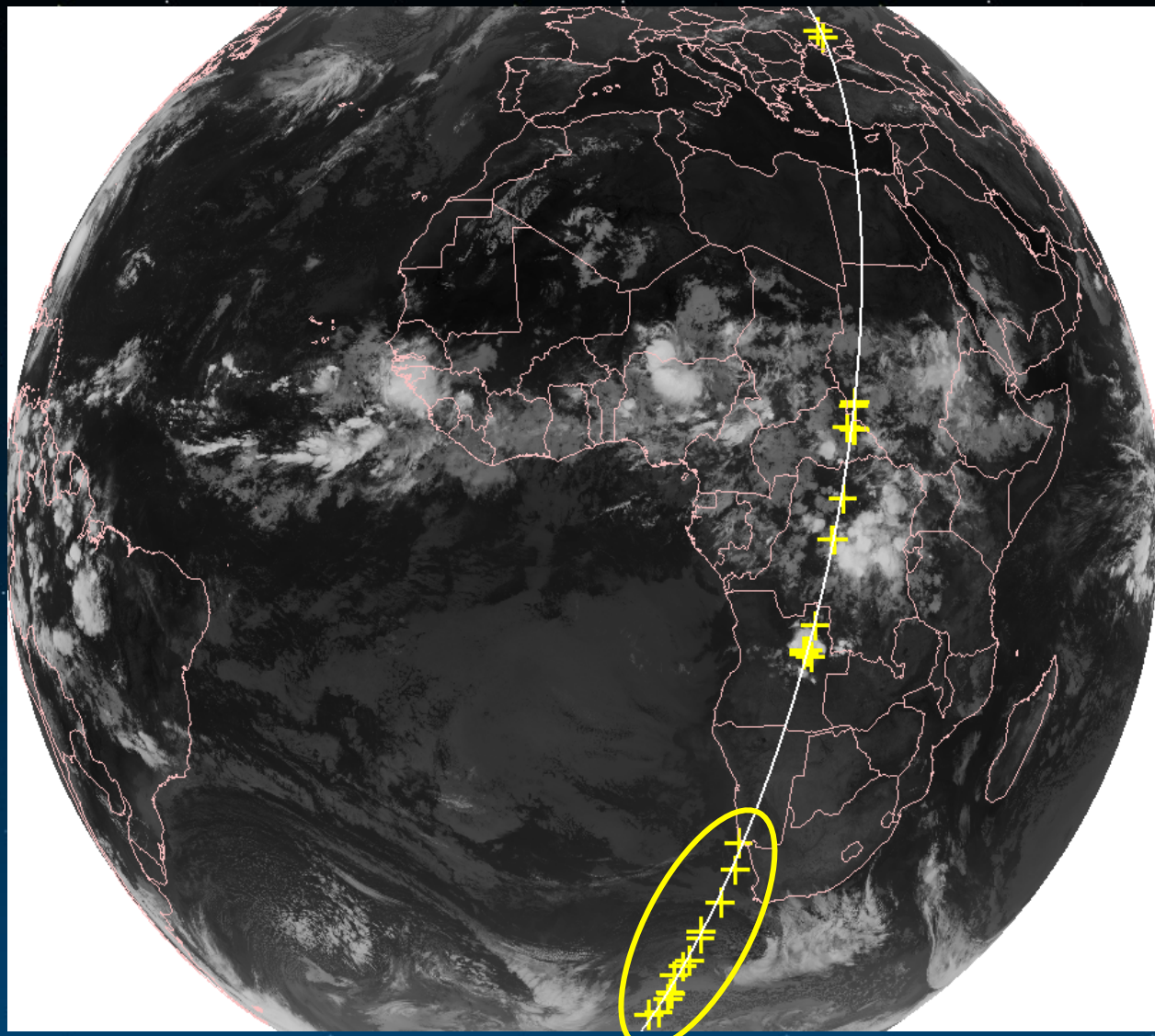
Example Deep Dive Validation – Meteosat-9 AMVs vs CALIPSO

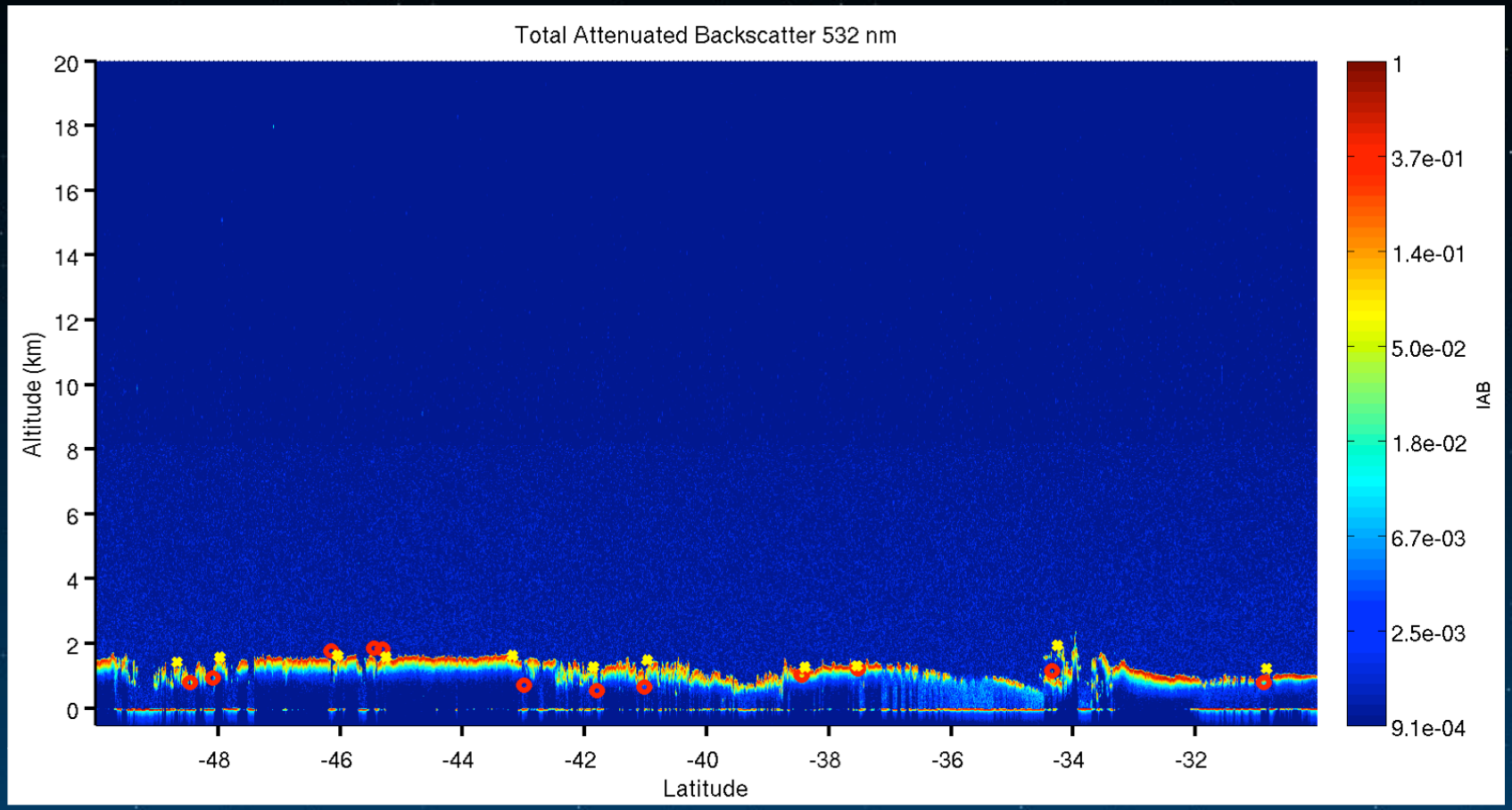
September 15, 2011, 00 UTC

In this case we identify 29 AMVs with CALIPSO collocation criteria of 50 km and 30 minutes (yellow tick marks).

The matches circled in yellow are examined in the next slide.



Example Deep Dive Validation: CALIPSO Cloud-Top Heights vs. AMV Height Assignments



Low-level AMVs plotted as red circles. CALIPSO 5km CTH plotted in yellow. AMV height assignment shows pretty good agreement over low-level water clouds.

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Example Deep Dive Validation – Meteosat-9 AMVs vs CALIPSO

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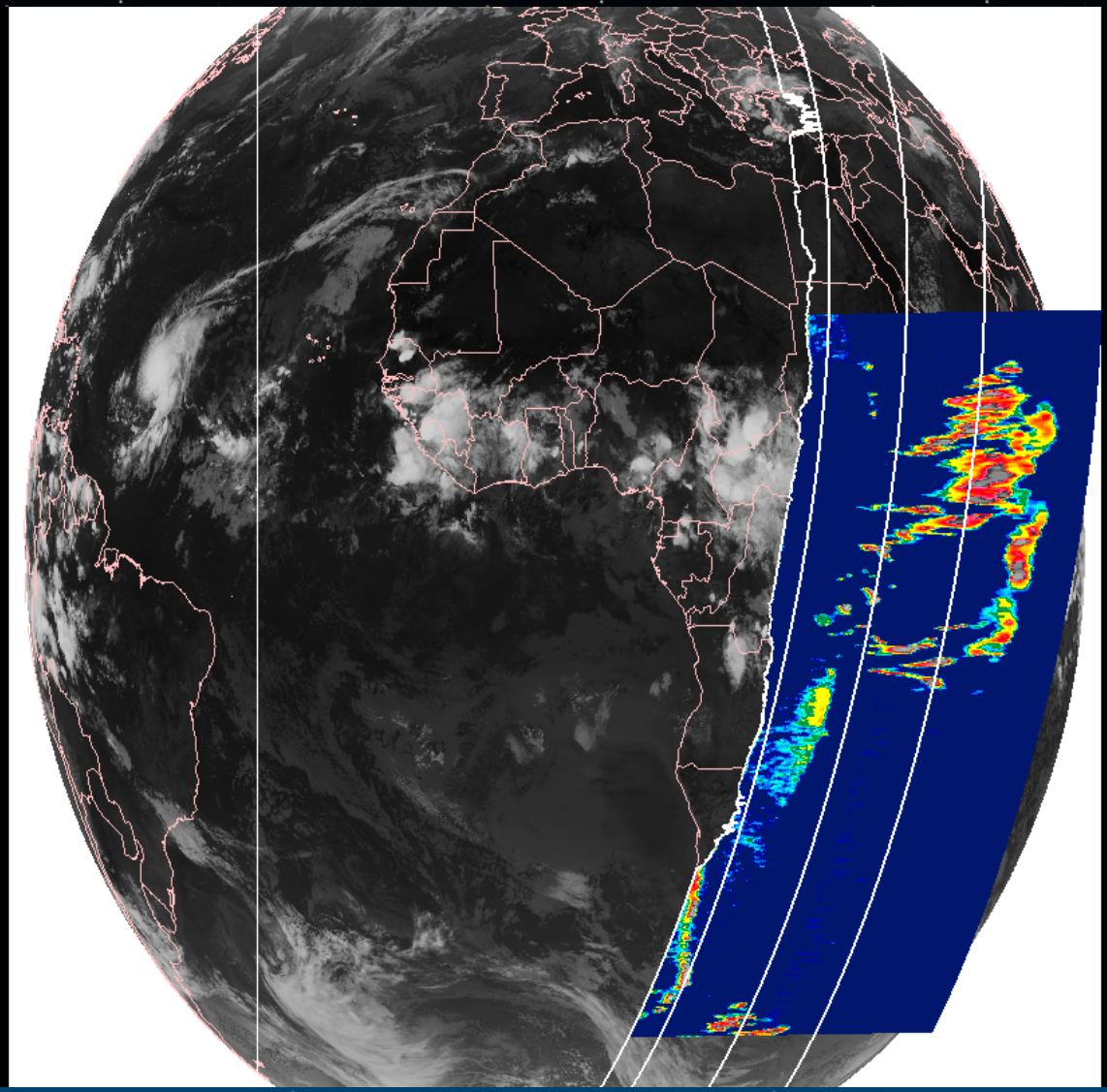

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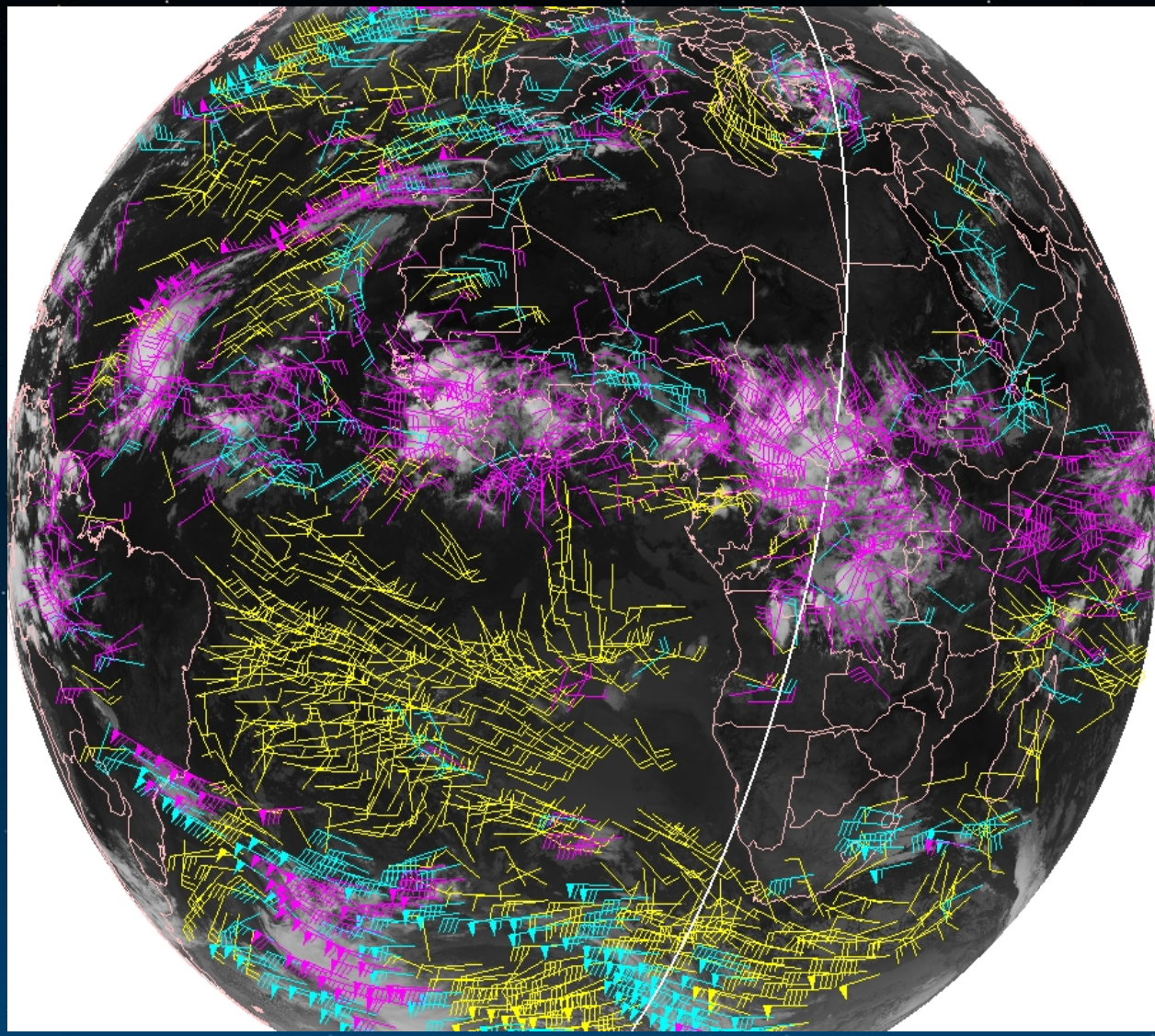
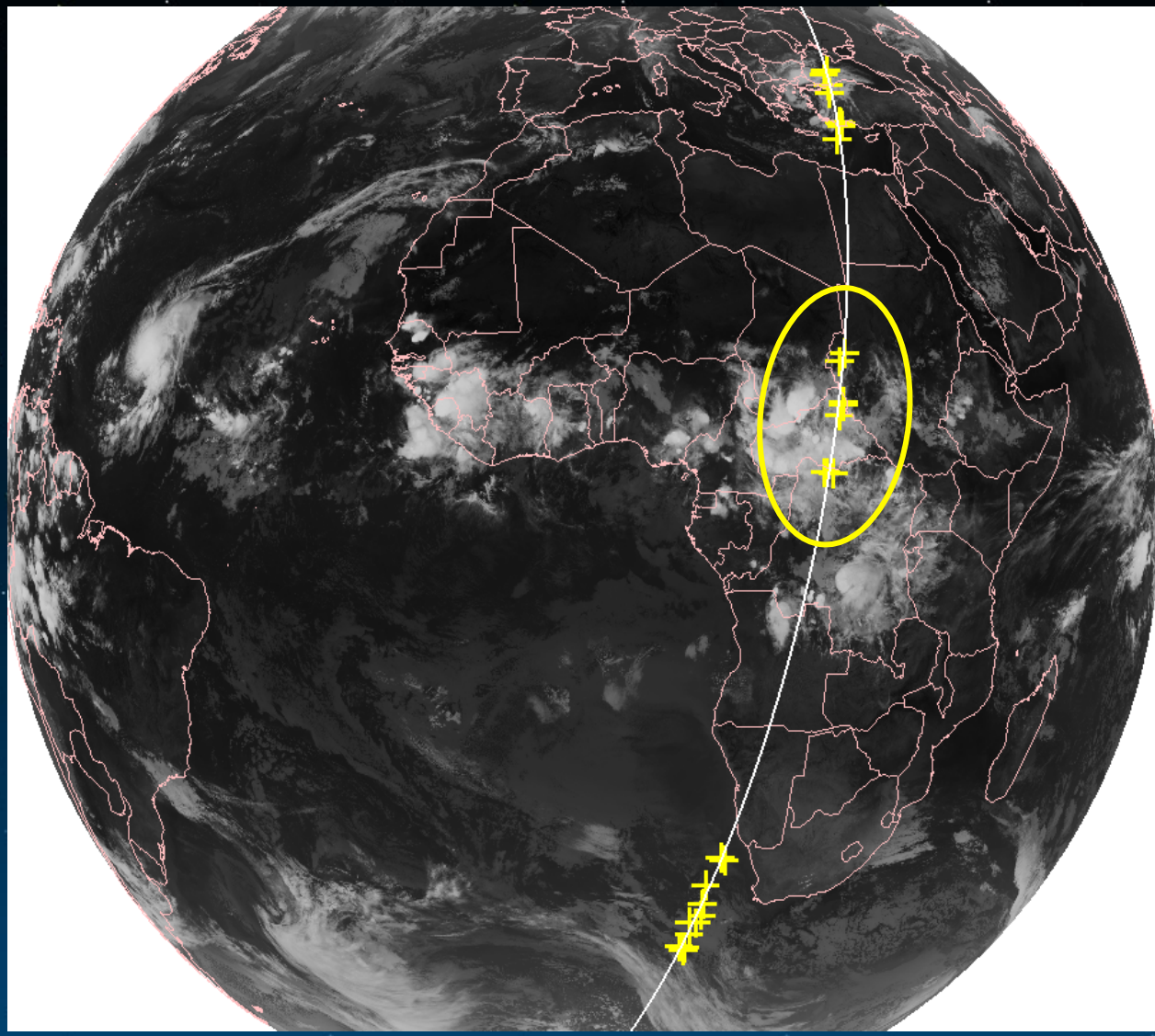


Example Deep Dive Validation – Meteosat-9 AMVs vs CALIPSO

September 22, 2011, 00 UTC

In this case we identify 30 AMVs with CALIPSO collocation criteria of 50 km and 30 minutes (yellow tick marks).

The matches circled in yellow are examined in the next slide.



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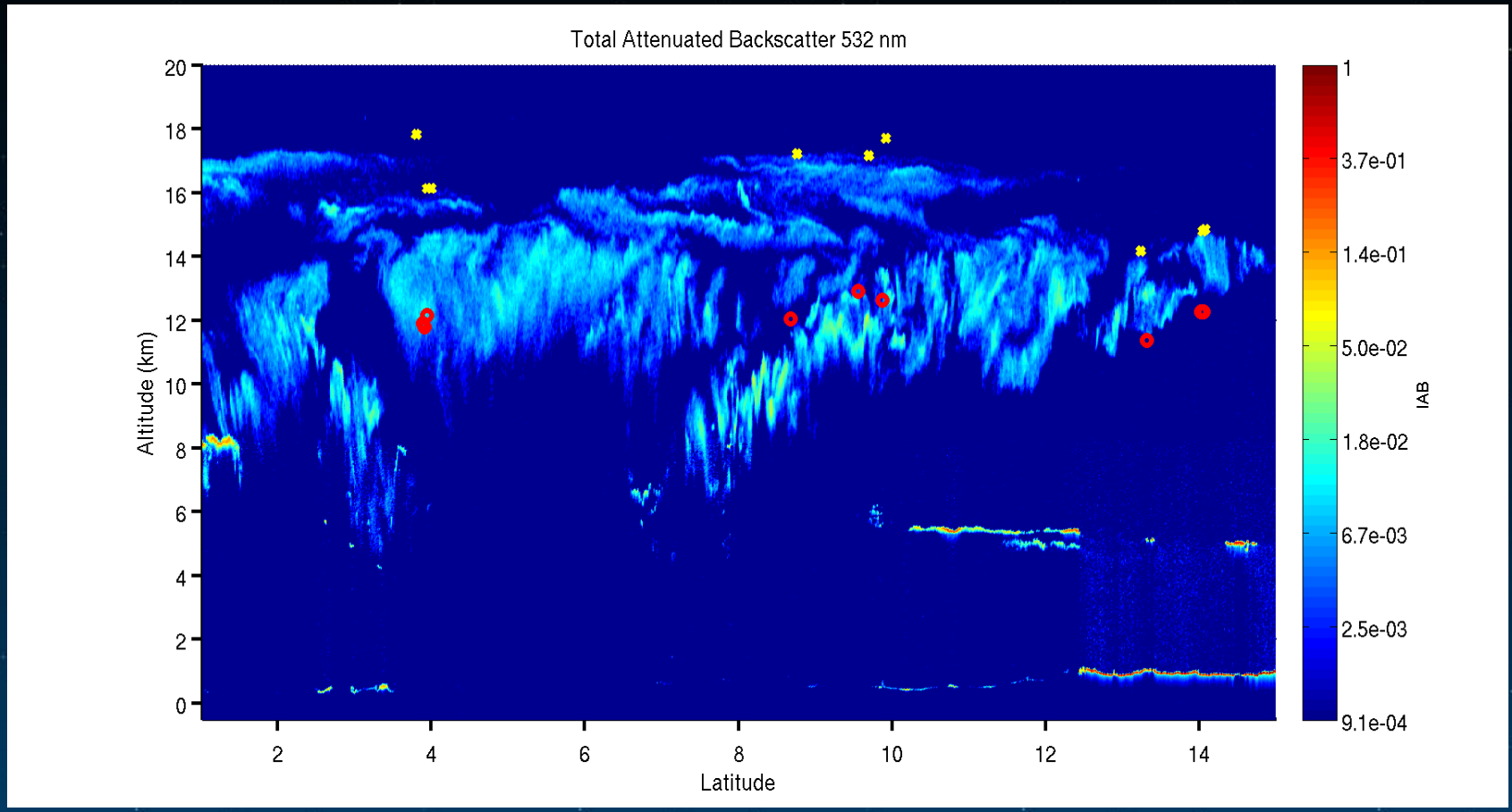

Upper-level AMVs plotted as red circles. CALIPSO 5km CTH plotted in yellow. Now we see very large differences in the AMV HA vs CALIPSO CTH values.

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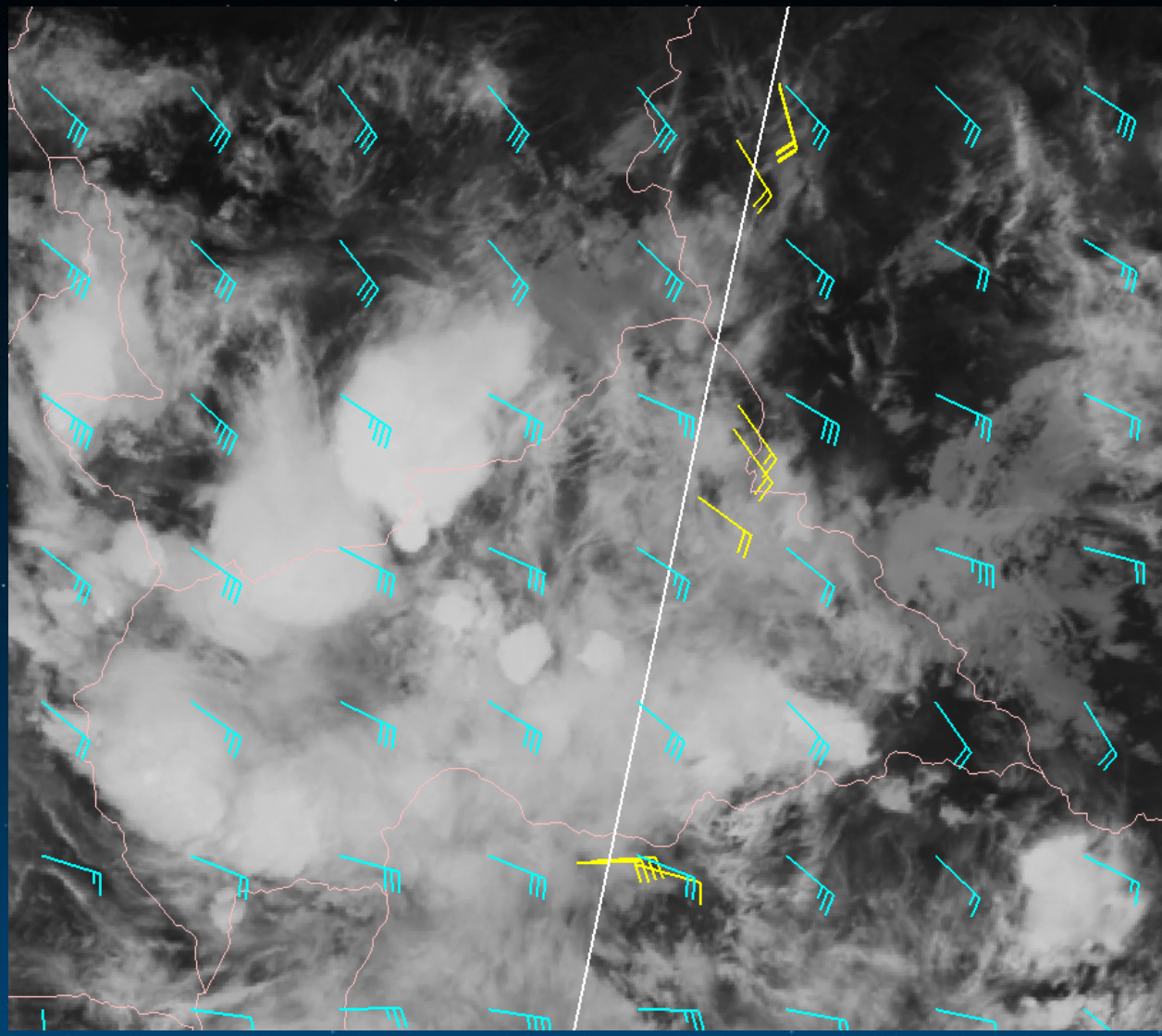
Example Deep Dive Validation – Meteosat-9 AMVs vs GFS Analysis

September 22, 2011, 00 UTC

No RAOBS nearby, so we first look at model analyses for verification clues.

AMVs with height (yellow) assignments near 200 hPa plotted with 150 hPa GFS Analysis winds (cyan). Both plotted in kts. CALIPSO transect location is the white line.



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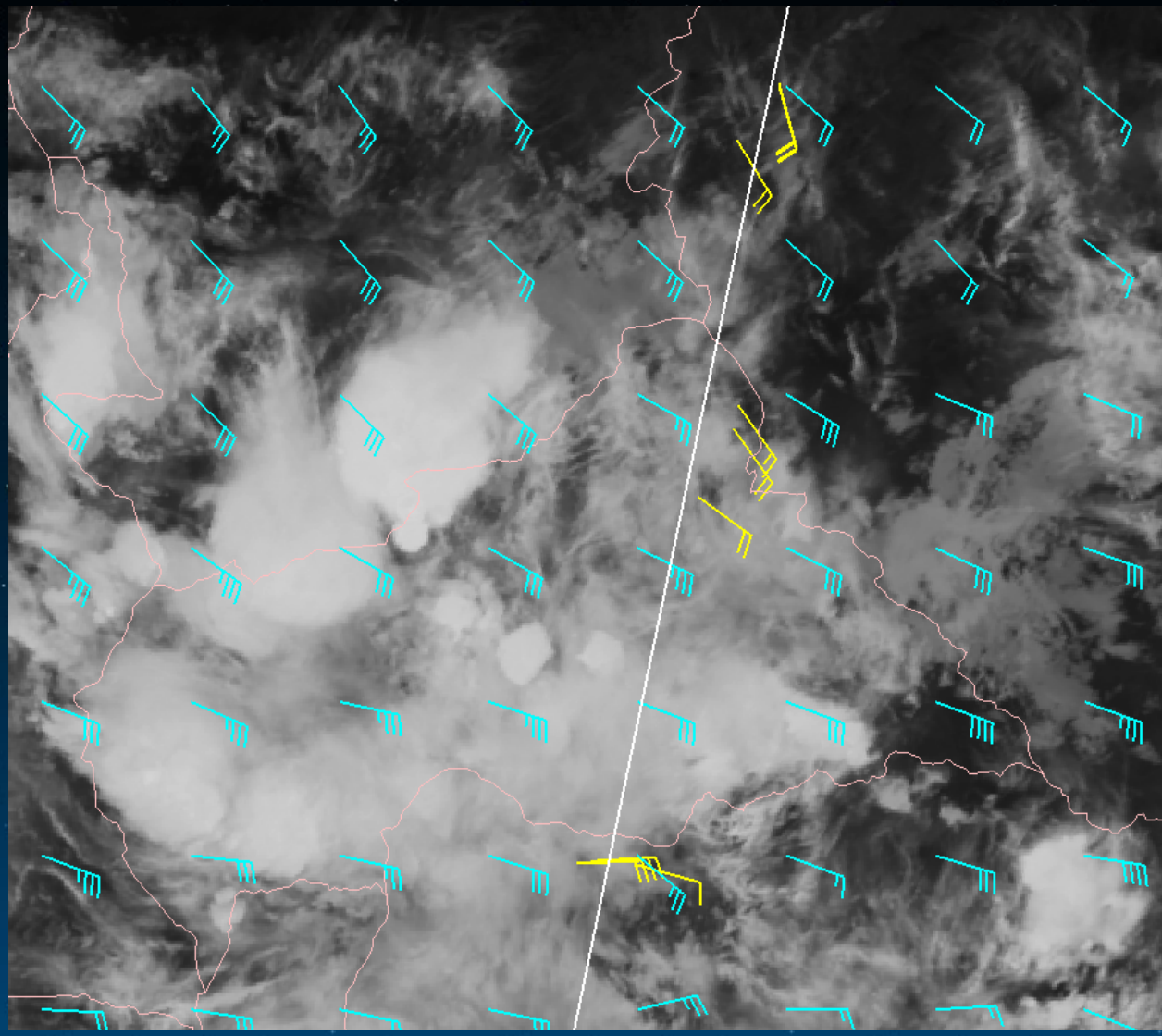
Example Deep Dive Validation – Meteosat-9 AMVs vs GFS Analysis

September 22, 2011, 00 UTC

AMVs with height (yellow) assignments near 200 hPa plotted with 200 hPa GFS Analysis winds (cyan). Both plotted in kts. CALIPSO transect location is the white line.



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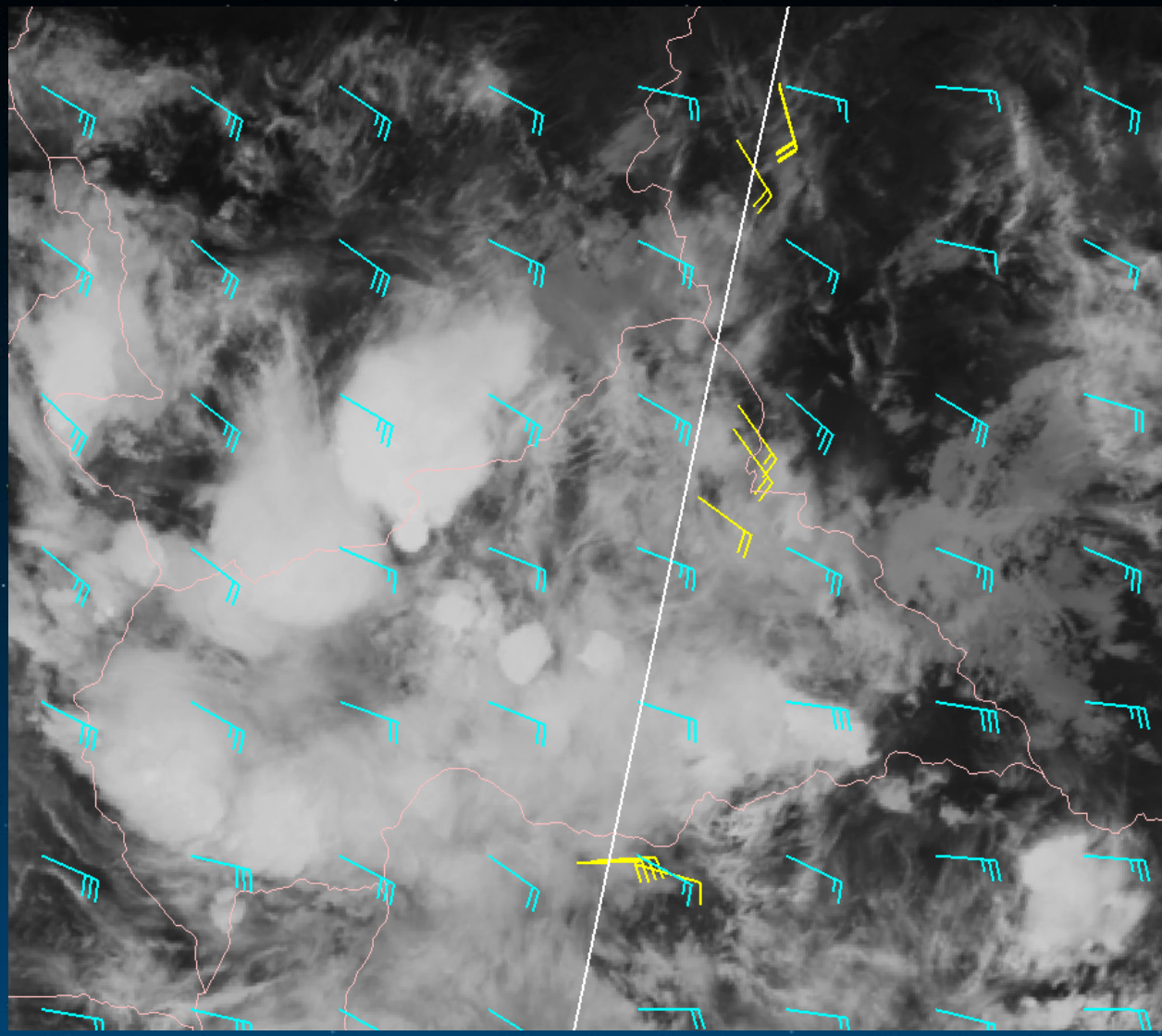
Example Deep Dive Validation – Meteosat-9 AMVs vs GFS Analysis

September 22, 2011, 00 UTC

AMVs with height (yellow) assignments near 200 hPa plotted with 250 hPa GFS Analysis winds (cyan). Both plotted in kts. CALIPSO transect location is the white line.

Conclusion: Since there is nearly laminar flow depicted by the GFS, a diagnosis of the AMV HA precision is difficult.



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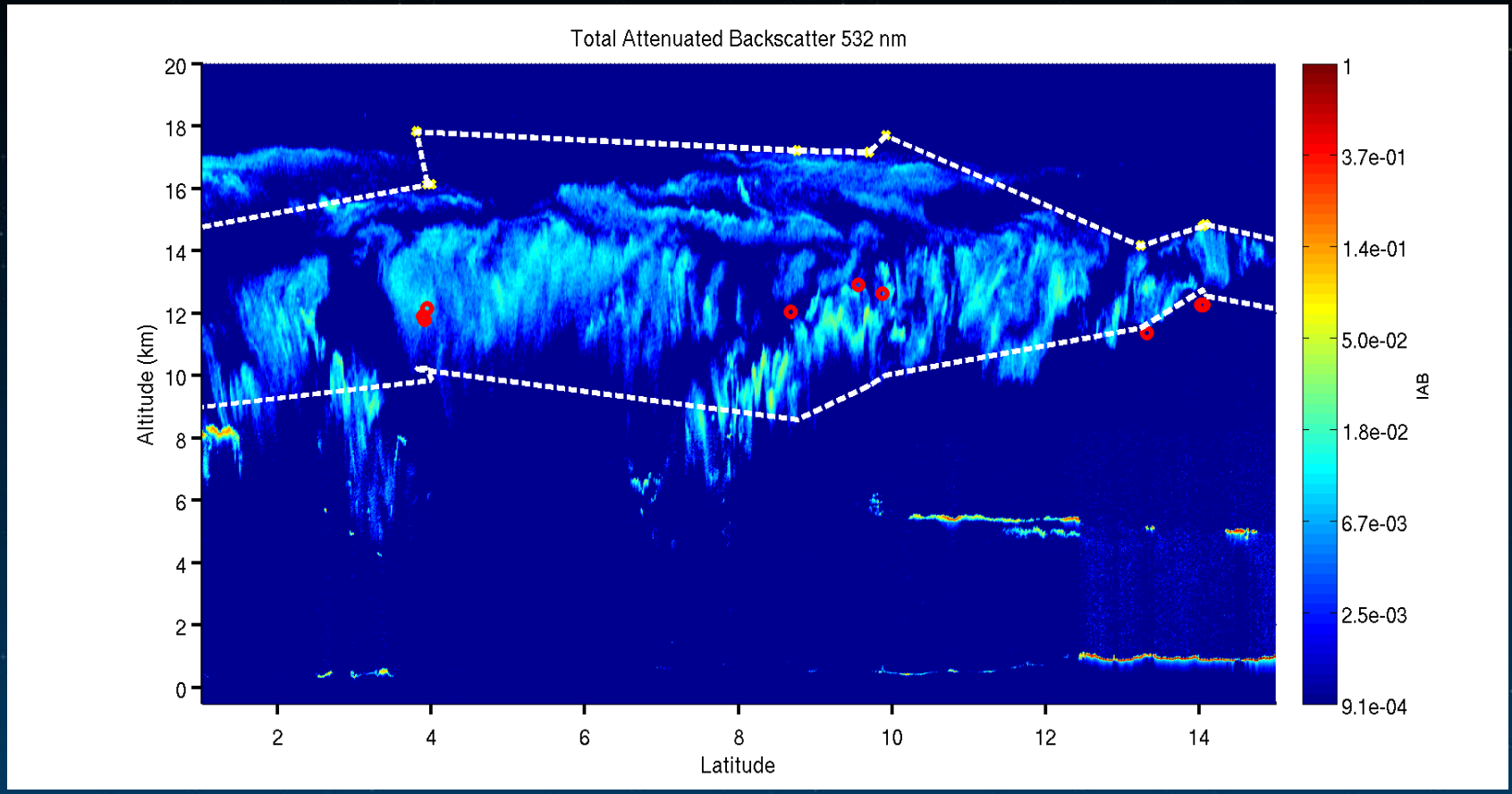

Instead of using CALIPSO CTH as a metric, are there other diagnostics that can be used to better compare and validate AMV HA? Example above shows CALIPSO “first layer” cloud top and bottom altitudes used in the layer optical depth (OD) calculation.

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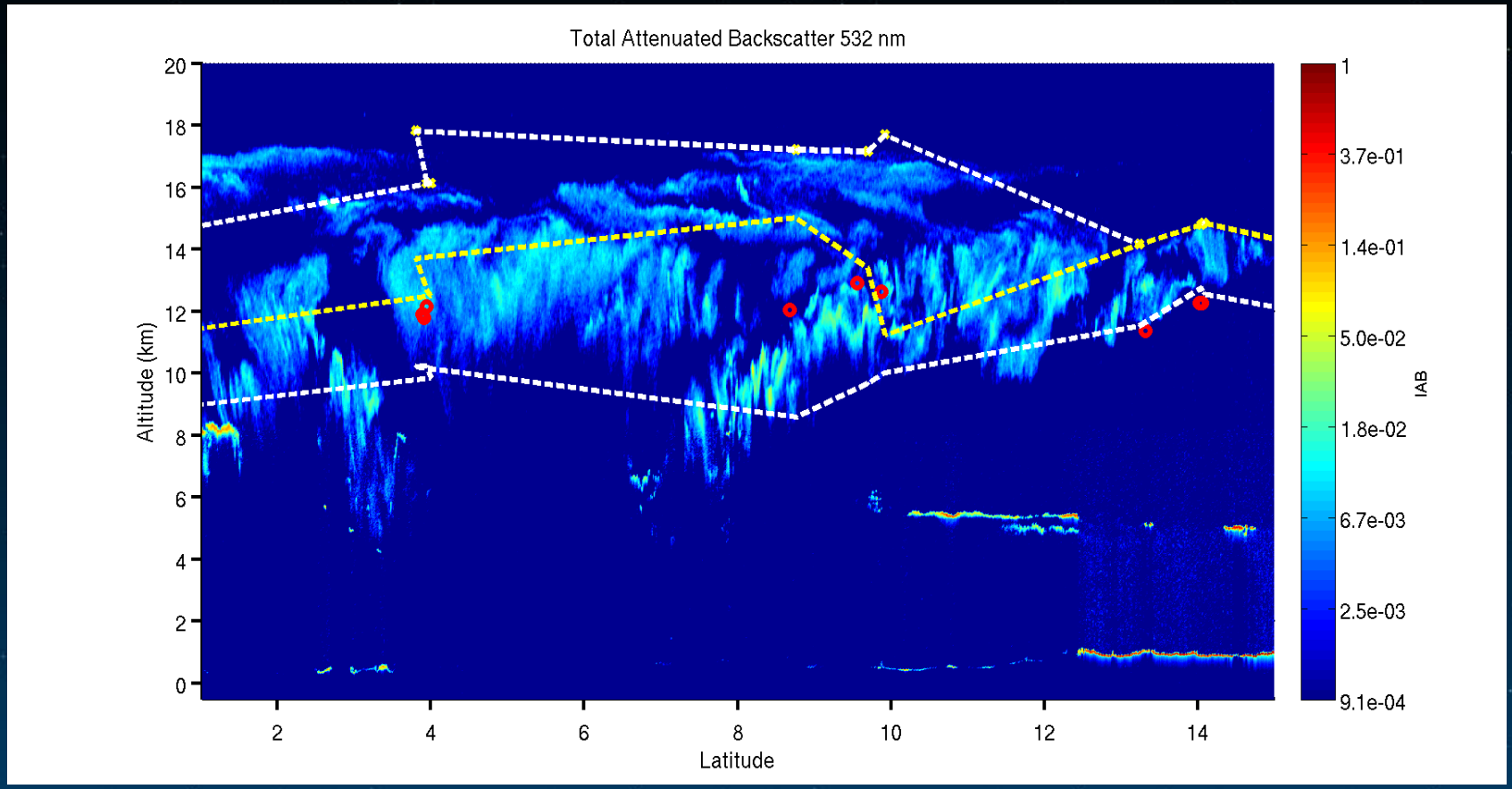

Looking at clouds with OD>=1 only, we linearly spread the OD over the depth of the layer. Through radiative transfer principles, it is estimated that Meteosat-9 can only "see" to an OD of 1 in the CALIPSO signal. We then adjust the CALIPSO CTH to an altitude where its OD=1 (yellow line).

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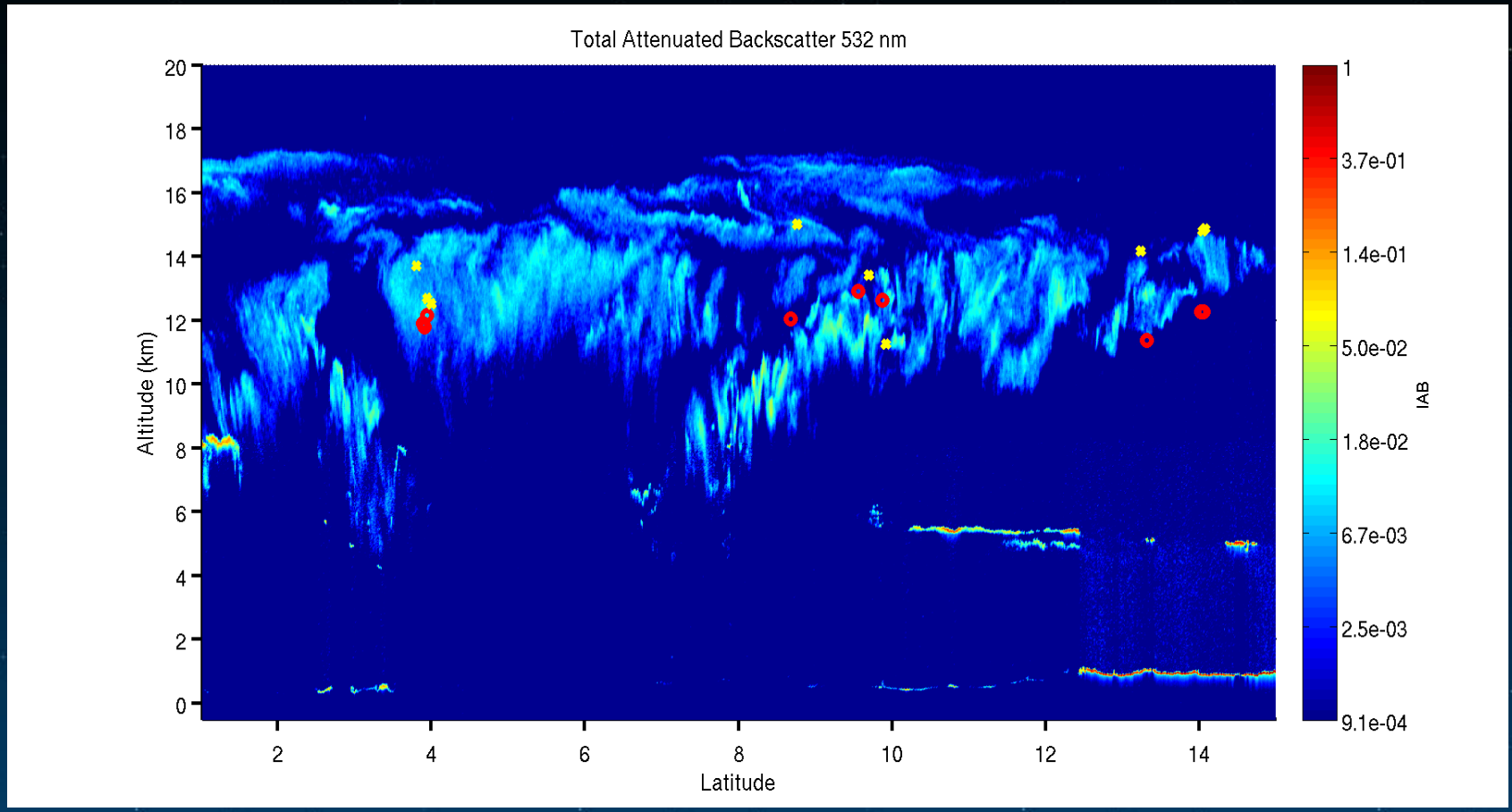

Upper-level AMVs plotted as red circles. "Adjusted" CALIPSO CTH plotted in yellow. Is this a better comparison metric than the unadjusted single layer CALIPSO CTH?

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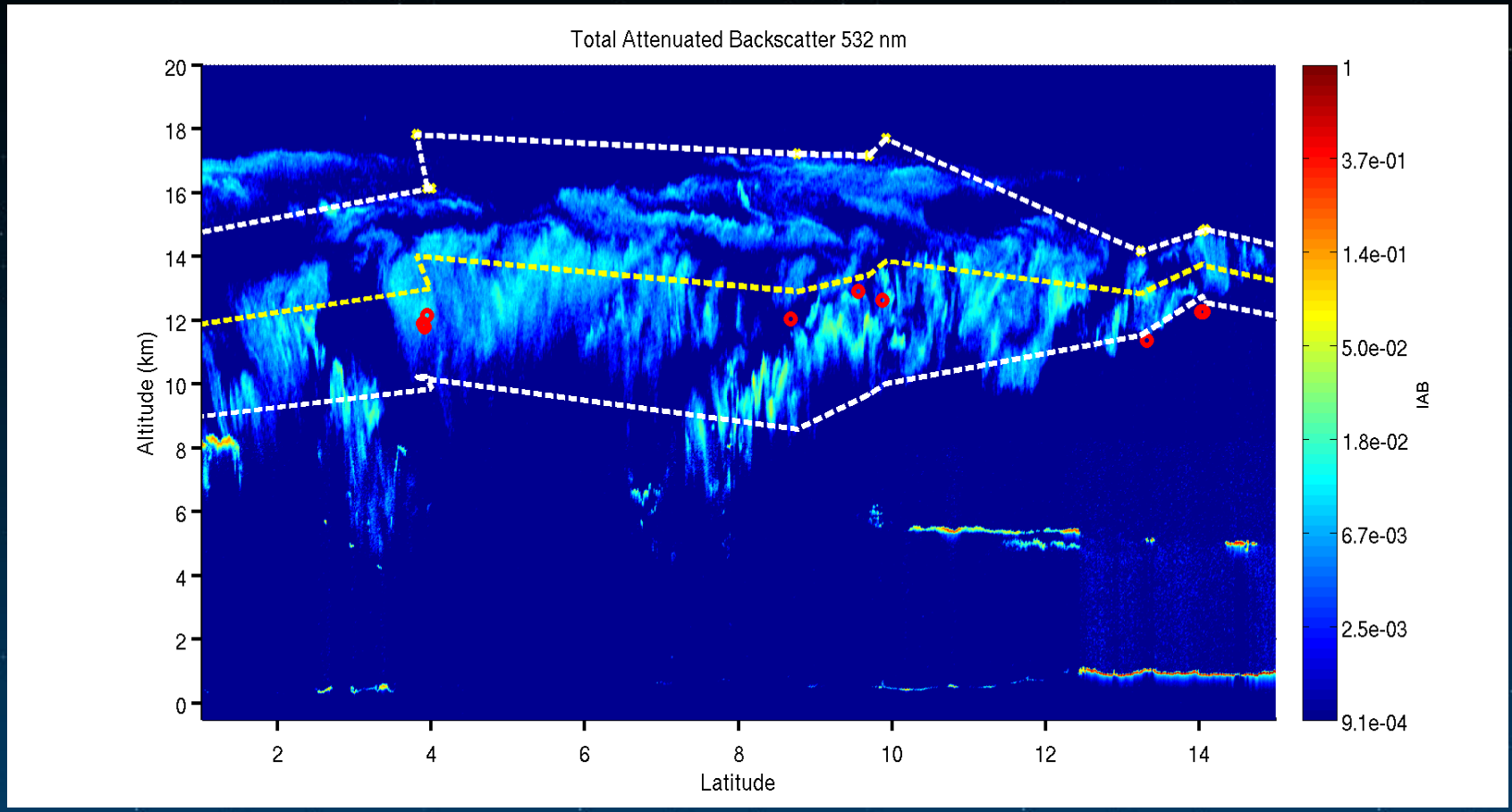
Example Deep Dive Validation: CALIPSO Cloud-Top Heights vs. AMV Height Assignments



Another potential approach: Adjust the CALIPSO CTH using the midpoint of the estimated cloud layer (yellow line). Note the better fit in thin cloud (OD<1) at the right.

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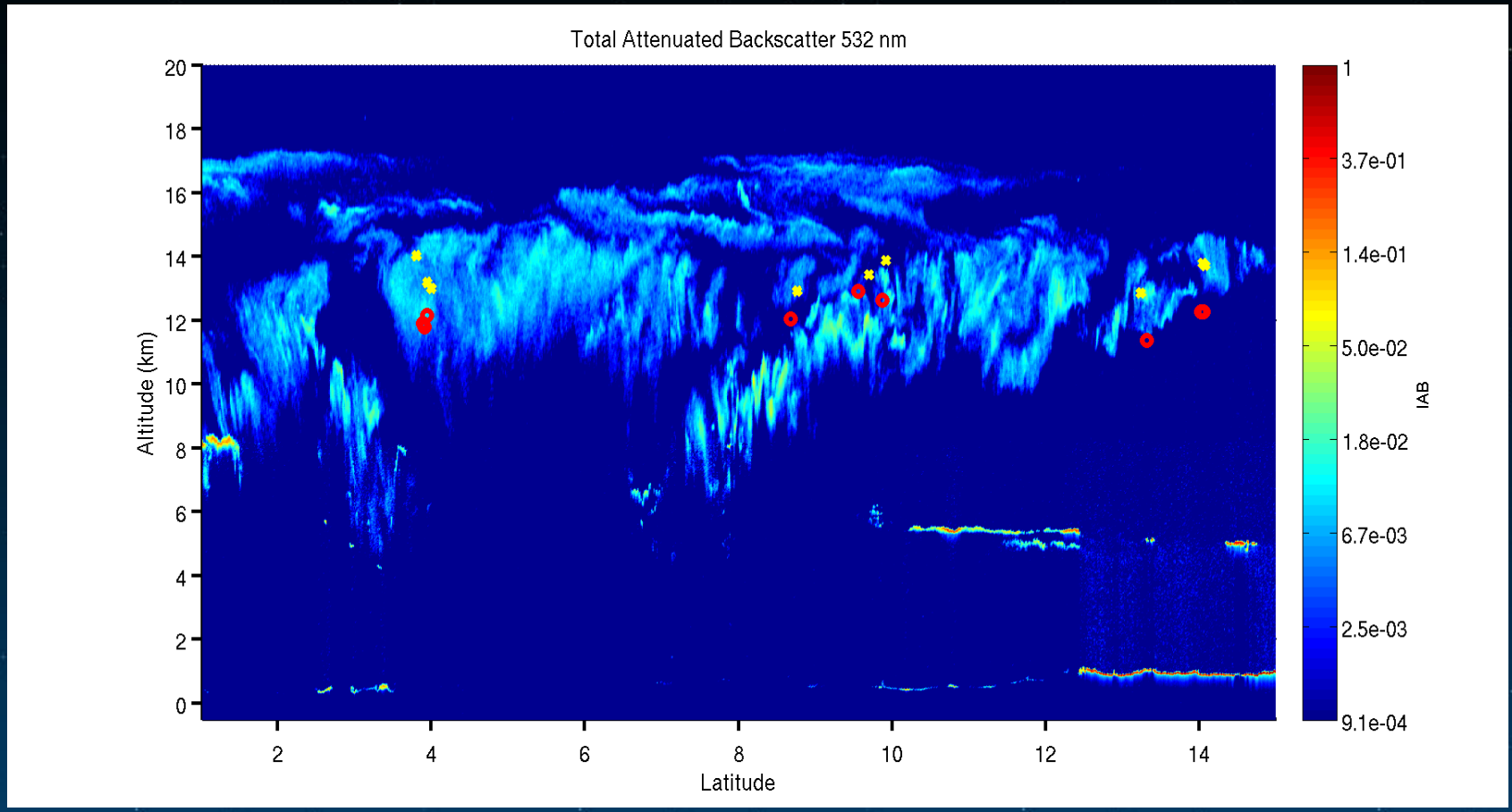
Example Deep Dive Validation: CALIPSO Cloud-Top Heights vs. AMV Height Assignments



Upper-level AMVs plotted as red circles. "Adjusted" CALIPSO CTH plotted in yellow. Is this a better comparison metric than the OD adjusted CALIPSO CTH?

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Summary

- Overall, the GOES-R AMV product, using pre-launch proxy datasets, is meeting required specifications.
- However, suspect AMVs exist and are being interrogated using "deep dive" validation and analysis approaches.
- Tools such as McIDAS-V and CALIPSO comparisons can be used to diagnose potential problems.