Title: **Atmospheric Motion Vectors Derived from the Future GOES-R Advanced Baseline Imager (ABI): Methods and Error Characteristics**

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Topics: Numerical Weather Prediction, Non-Convective Forecasts

Program: AWG, GOES-R3

2. Introduction

- Need existed to address the long standing issue of slow derived motion winds at upper levels *(Schmetz et al.1993, Bormann et al. 2002; von Bremen et al. 2008)*

- The AWG winds team developed a new derived motion winds algorithm for GOES-R ABI that **minimizes the slow speed bias** without increasing the noise of the retrieved winds *(Bresky et al, 2012)*

- **Brings new exploitation opportunities to NWP centers** to use these AMV products and impact NWP forecasts in a positive way.

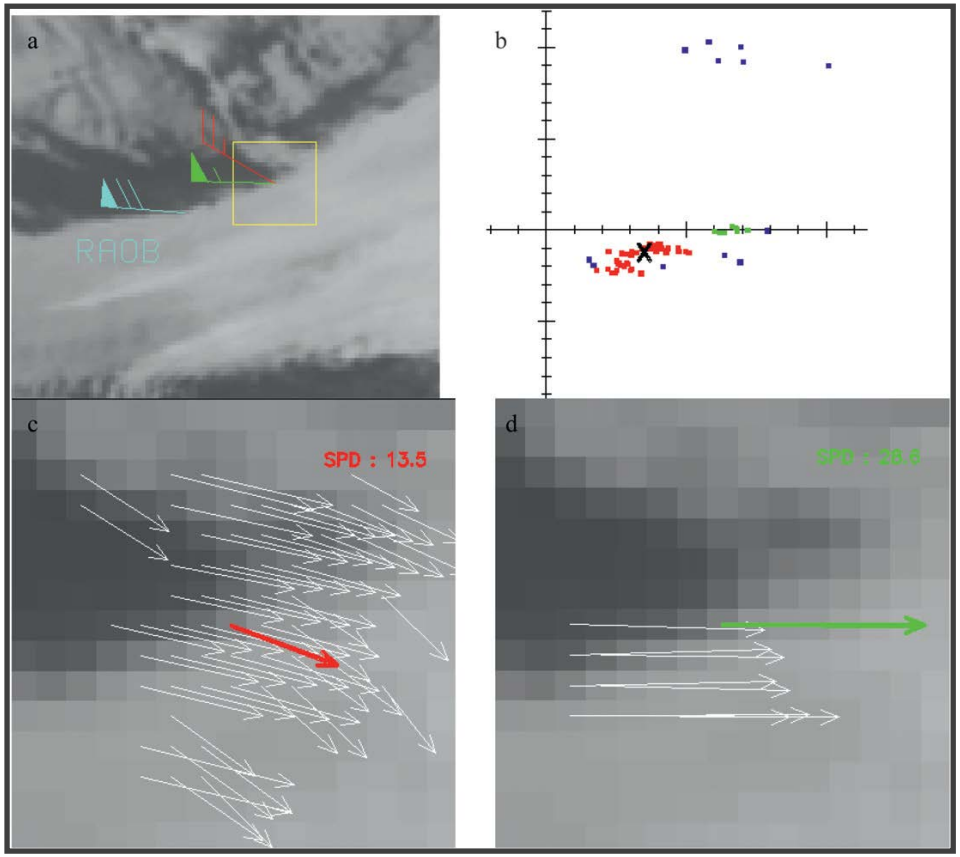
- The AWG winds team continues to pursue more complete validation of the GOES-R derived motion winds algorithm **using Meteosat/SEVIRI and GOES imagery as proxy data for GOES-R ABI**.

- A companion GOES-R3 project is assessing the **impact of winds derived from the new GOES-R ABI algorithm on GFS forecasts**

3. Methodology/Expected Outcomes

- By using small subregions (5x5 pixels) ***nested*** within a conventional target window (19x19 pixels), the algorithm produces a set of **local motion vectors** for each cloud scene.
- A **clustering** algorithm (DBSCAN) is used to analyze the displacements and **isolate distinct motion clusters**
- Cloud heights at pixels **belonging to the largest cluster** are used to assign the height of the derived wind vector
- Derived winds are validated and characterized using reference/"ground truth" observations from other observing systems (e.g., rawinsondes, CALIPSO) as well as NCEP/GFS analysis winds

Cluster Analysis of Local Motion Near a Frontal Zone

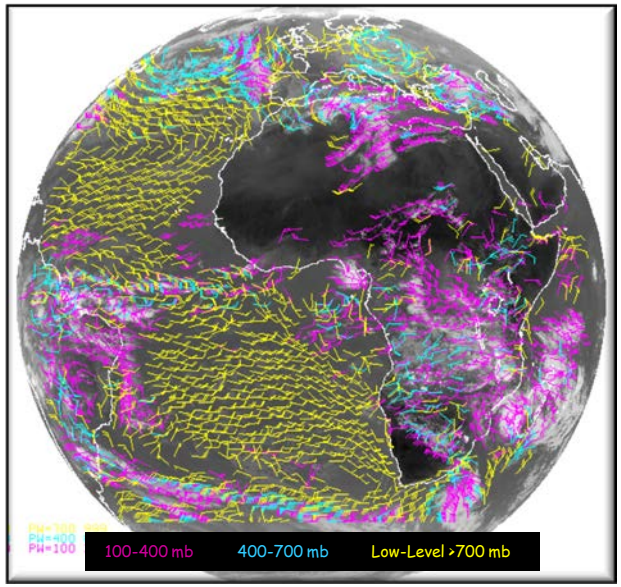


a) Meteosat-8 Image 12 UTC 1 Feb 2007; Target box , AMV from largest cluster, AMV from second largest cluster, Raob wind at 500 hPa,
b) Clusters found. Based on analysis of displacements
c) Average motion of vectors in largest cluster (13.5 m/s)
d) Average motion of second largest cluster (28.6 m/s); Better agreement with collocated radiosonde

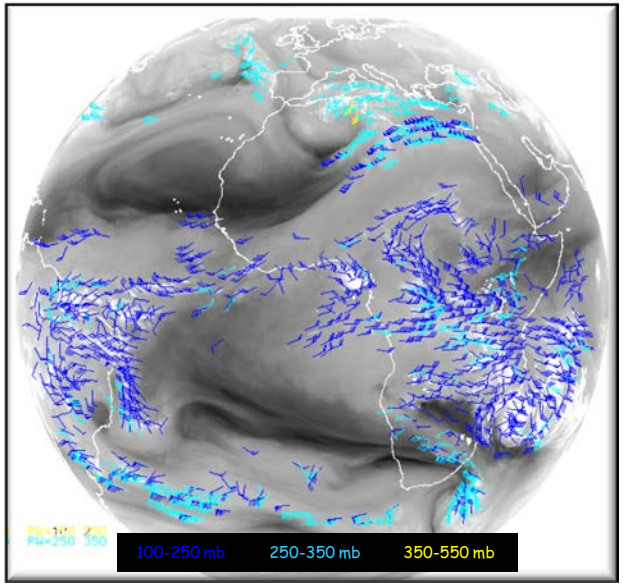
Example Atmospheric Motion Vector Products

Generated from Meteosat-10/SEVIRI (ABI Proxy Data)…

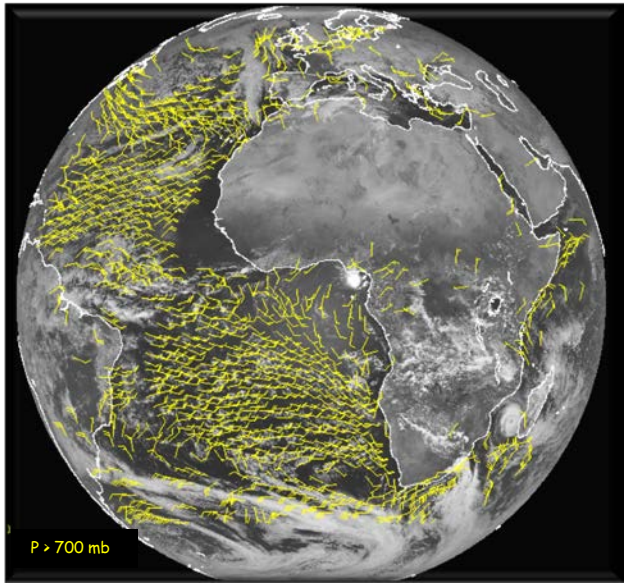
LWIR (10.8um) Winds



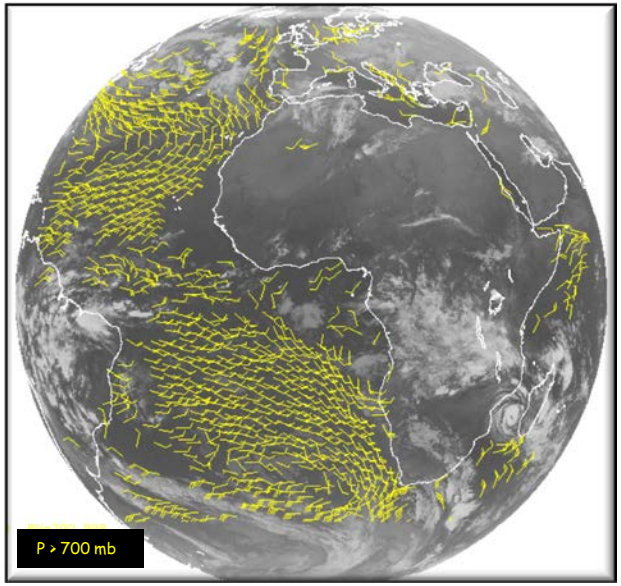
Cloud-top WV (6.2um) Winds



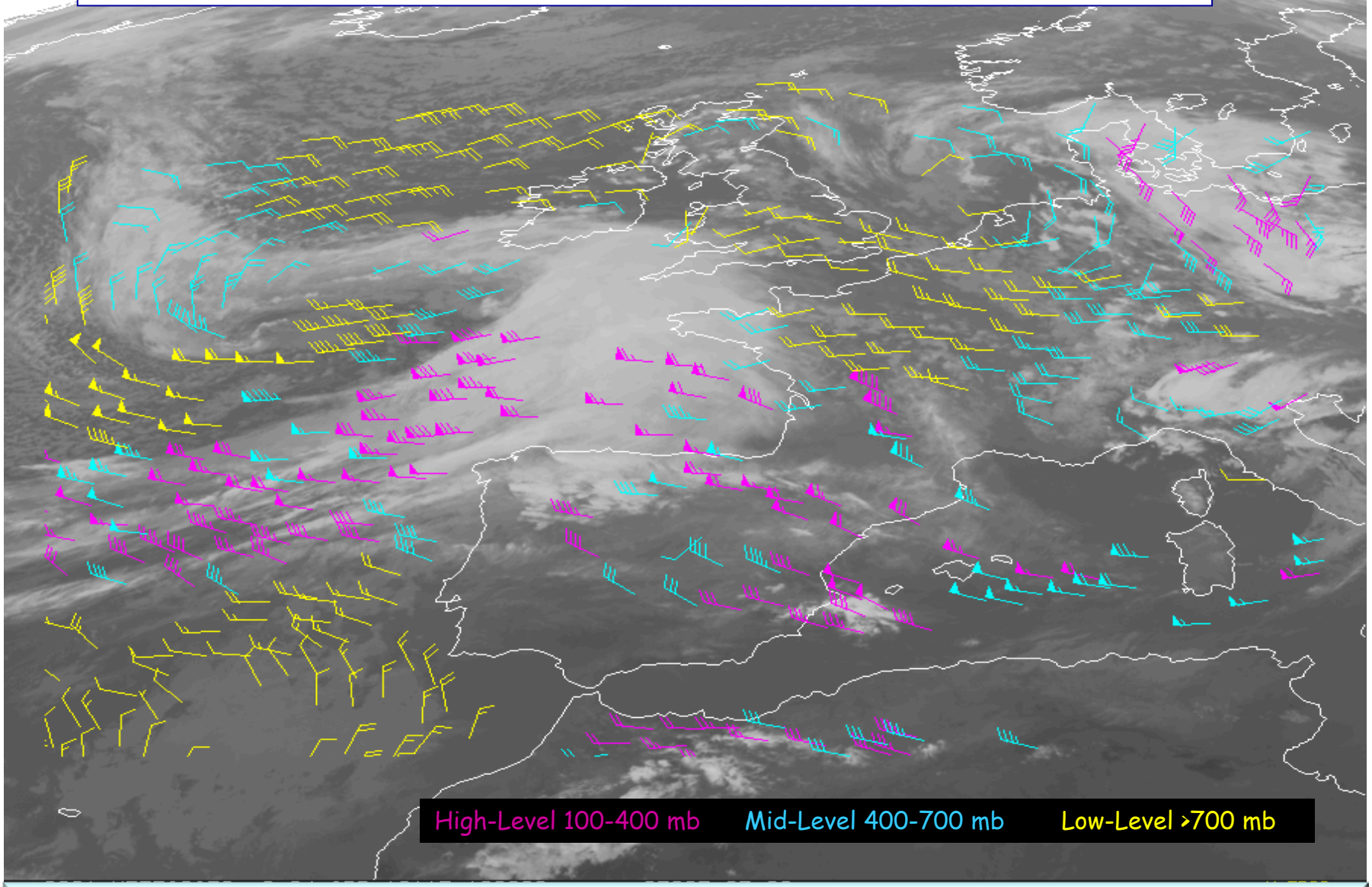
Visible (0.64um) Winds



SWIR (3.9um) Winds



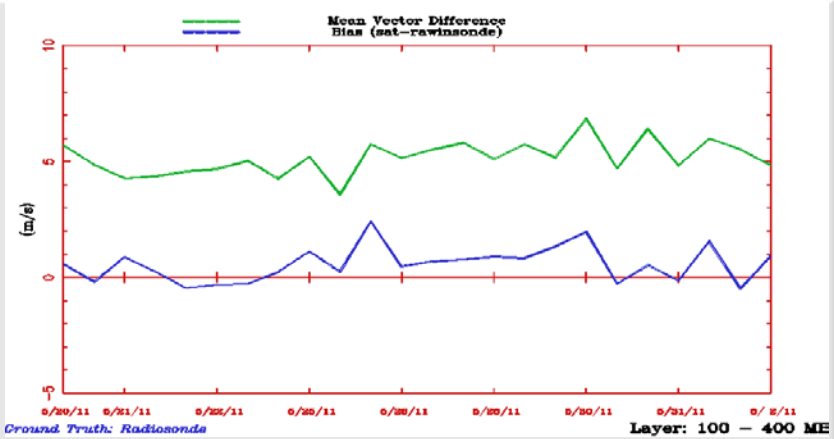
Loop of winds derived from hourly Full Disk Meteosat-9 SEVERI 10.8 μm imagery (22 UTC Apr 24 – 08 UTC Apr 25, 2012



Since February 2011, NESDIS/STAR has been routinely generating experimental winds from Meteosat-9/SEVIRI using the GOES-R winds algorithm (ie., nested tracking)

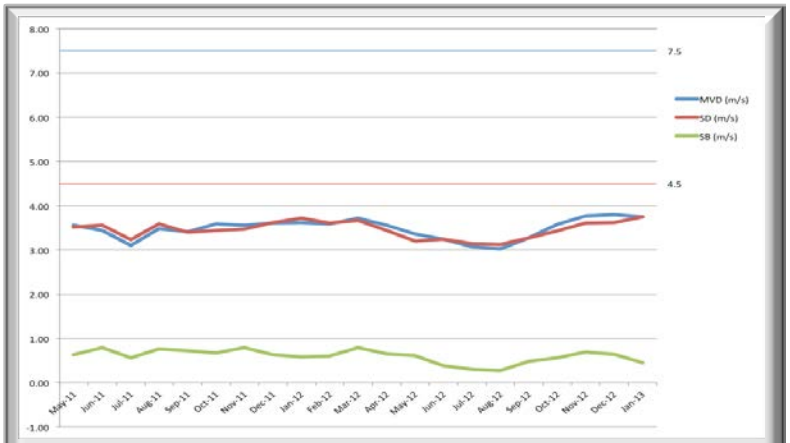
Comparisons to "Ground Truth"/ Reference Data

Radiosondes

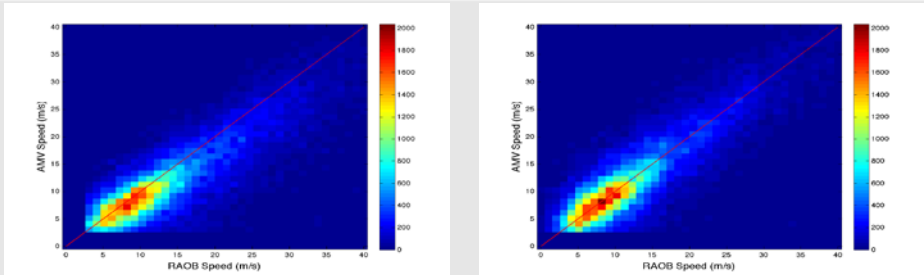


Mean vector difference and **speed bias** (**satellite – rawinsonde)** for Meteosat-9 upper-level (100-400 hPa) IR cloud-drift winds for the period 20 May 2011 to 2 June 2011.

GFS Analysis

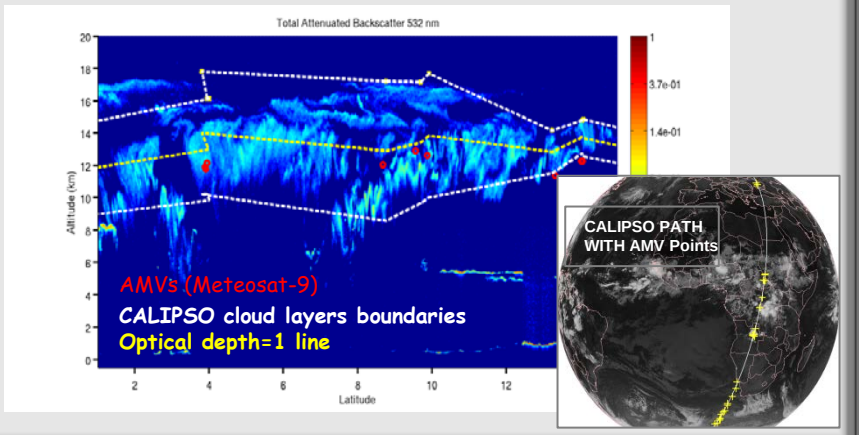


Mean vector difference, Std. Dev., and **Speed Bias** (**satellite – analysis)** for Meteosat-9 winds (all types, all levels) for the period 1 May 2011 to 31 January 2013.



Density plots of AMV speed against RAOB speed for Aug 2006 and Feb 2007 for **traditional tracking (left)** and **nested tracking (right).**

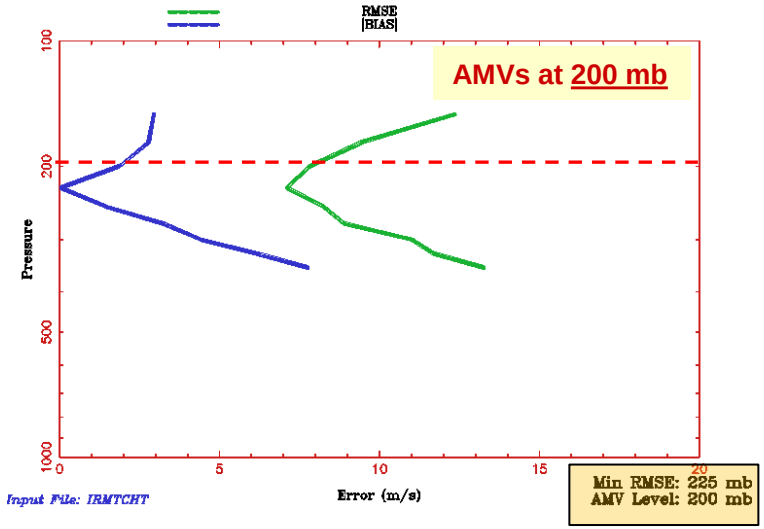
CALIPSO

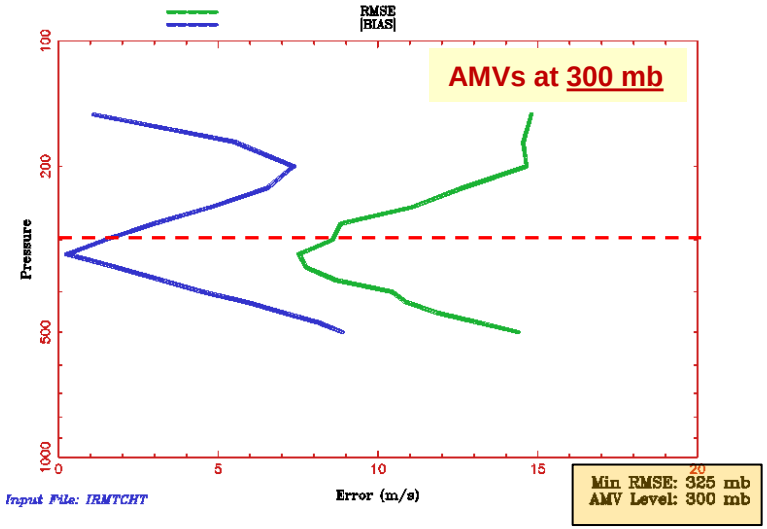


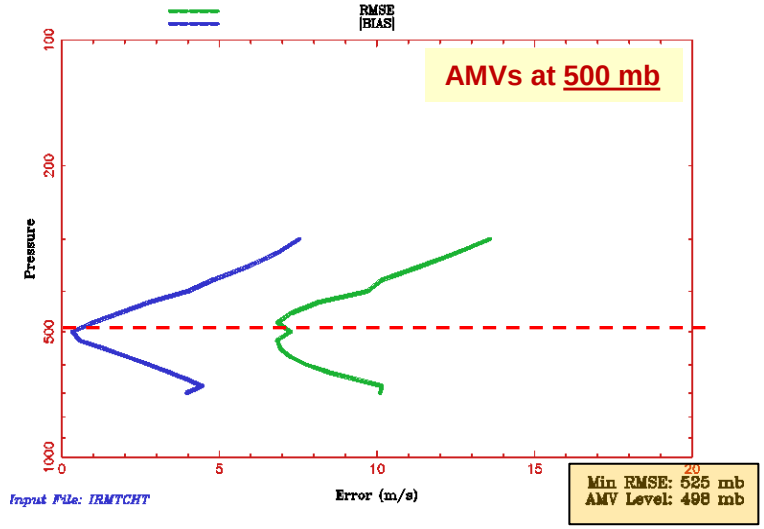
Validation of AMV Height Assignment

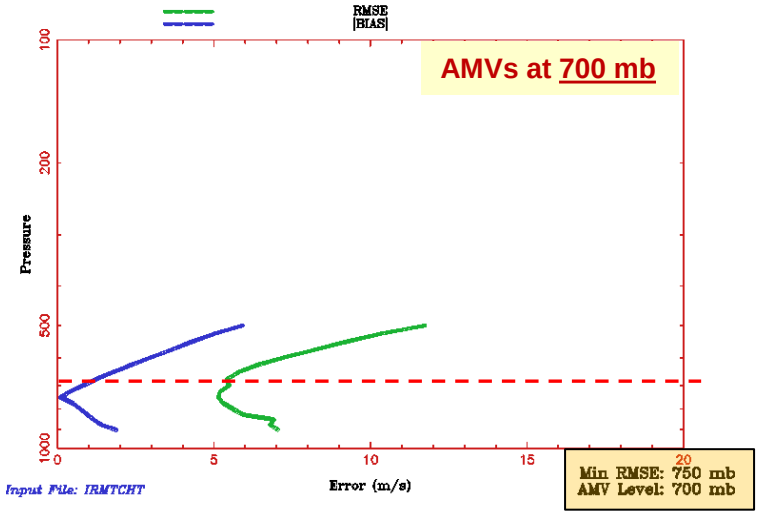
Finding the "Level-of-Best-Fit" using Radiosondes…

Meteosat-9/SEVIRI (10.8um) AMVs (28 Nov 2011 – 06 Feb 2012)



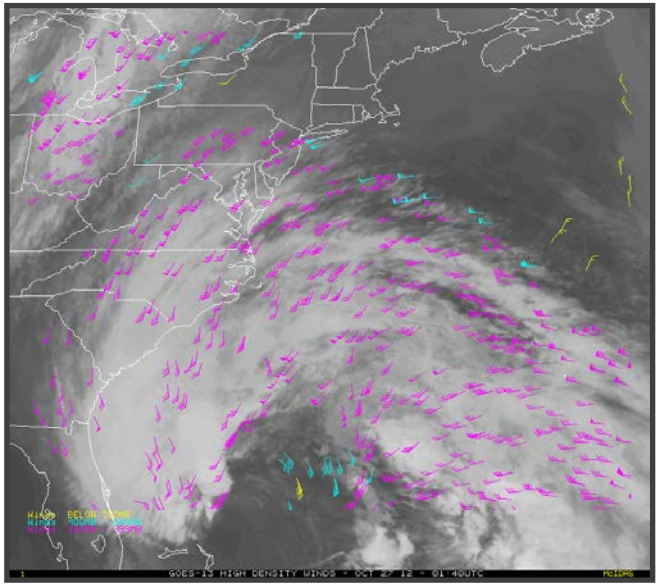




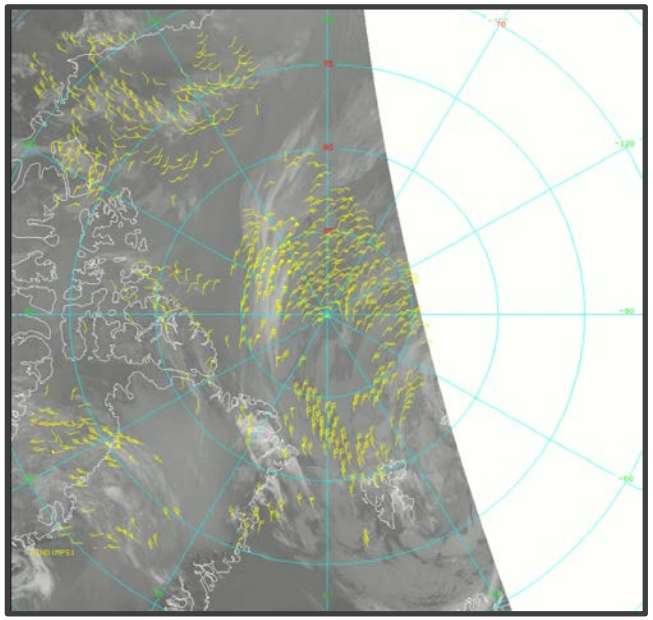


5. Possible Path to Operations

- GOES-R Ground Segment (October 2015)
- Internal NESDIS Projects underway for early transition of the GOES-R nested tracking approach into NESDIS operations for to generate GEO and LEO winds
  - *GOES/NOP (July 2013)*
  - *NPP/VIIRS (June 2013)*



Cloud-drift winds derived from 15-min GOES-13 11um imagery over **Hurricane Sandy** over the period October 27 (0140 UTC) through October 30 (1240 UTC) , 2012



Cloud-drift winds derived from NPP VIIRS Imagery over the Arctic at 1220 UTC on 12 May 2012

6. Future Plans

- Continue to support Harris' implementation of the GOES-R winds algorithm in the GOES-R ground segment.
- We are in the process of applying the GOES-R derived motion winds algorithm on simulated GOES-R ABI data
- Continue validation efforts to further characterize and document the performance and error characteristics of winds derived from the GOES-R winds algorithm
- Work to transition the GOES-R winds algorithm ("nested tracking") into NESDIS operations (GOES, NPP/VIIRS)
- Continue assessing the impact of Nested Tracking Winds in NCEP's NCEP GFS Hybrid Ensemble Kalman Filter Data Assimilation System *(GOES-R3 Project; See Nebuda et al poster)*
- Support efforts to help ensure NCEP is prepared to use winds derived from the new GOES-R winds algorithm in their data assimilation/forecast systems.

7. Publication List

- **References**
  - Bormann, N., G. Kelly, and J.-N. The´paut, 2002: Characterising and correcting speed biases in atmospheric motion vectors within the ECMWF system. *Proc. Sixth Int. Winds Workshop*, Madison, WI, EUMETSAT, 113–120.
  - Bresky, W., J. Daniels, A. Bailey, and S. Wanzong, 2012: New Methods Towards Minimizing the Slow Speed Bias Associated With Atmospheric Motion Vectors (AMVs). *J. Appl. Meteor. Climatol*., 51, 2137-2151
  - Schmetz, J., K. Holmlund, J. Hoffman, B. Strauss, B. Mason,V. Gaertner, A. Koch, and L. Van De Berg, 1993: Operational cloud-motion winds from Meteosat infrared images*. J. Appl. Meteor*., 32, 1206–1225.
  - Von Bremen, L., N. Bormann, S.Wanzong,M.Hortal, D. Salmond, J.-N. Thepaut, and P. Bauer, 2008: Evaluation of AMVs derived from ECMWF model simulations. *Proc. Ninth Int. Winds Workshop*, Annapolis, MD, EUMETSAT, 8 pp.
- **Project Publications**
  - Daniels, J., W. Bresky, S. Wanzong, C. Velden, and H. Berger, 2010: GOES-R Advanced Baseline Imager (ABI) algorithm theoretical basis document for derivedmotion winds. GOES-R Program Office, 96 pp. [Available online at http://www.goes-r. gov/products/ATBDs/baseline/Winds_DMW_v2.0_no_color.pdf.]