# Use of GOES-R Advanced Baseline Imager (ABI) Proxy Data to Assess the Performance of the GOES-R Winds Algorithm

**Jaime Daniels**

NOAA/NESDIS, Center for Satellite Applications and Research

**Wayne Bresky, Andrew Bailey, Americo Allegrino**

IM Systems Group (IMSG)

**Steve Wanzong & Chris Velden**

Cooperative Institute for Meteorological Satellite Studies (CIMSS)

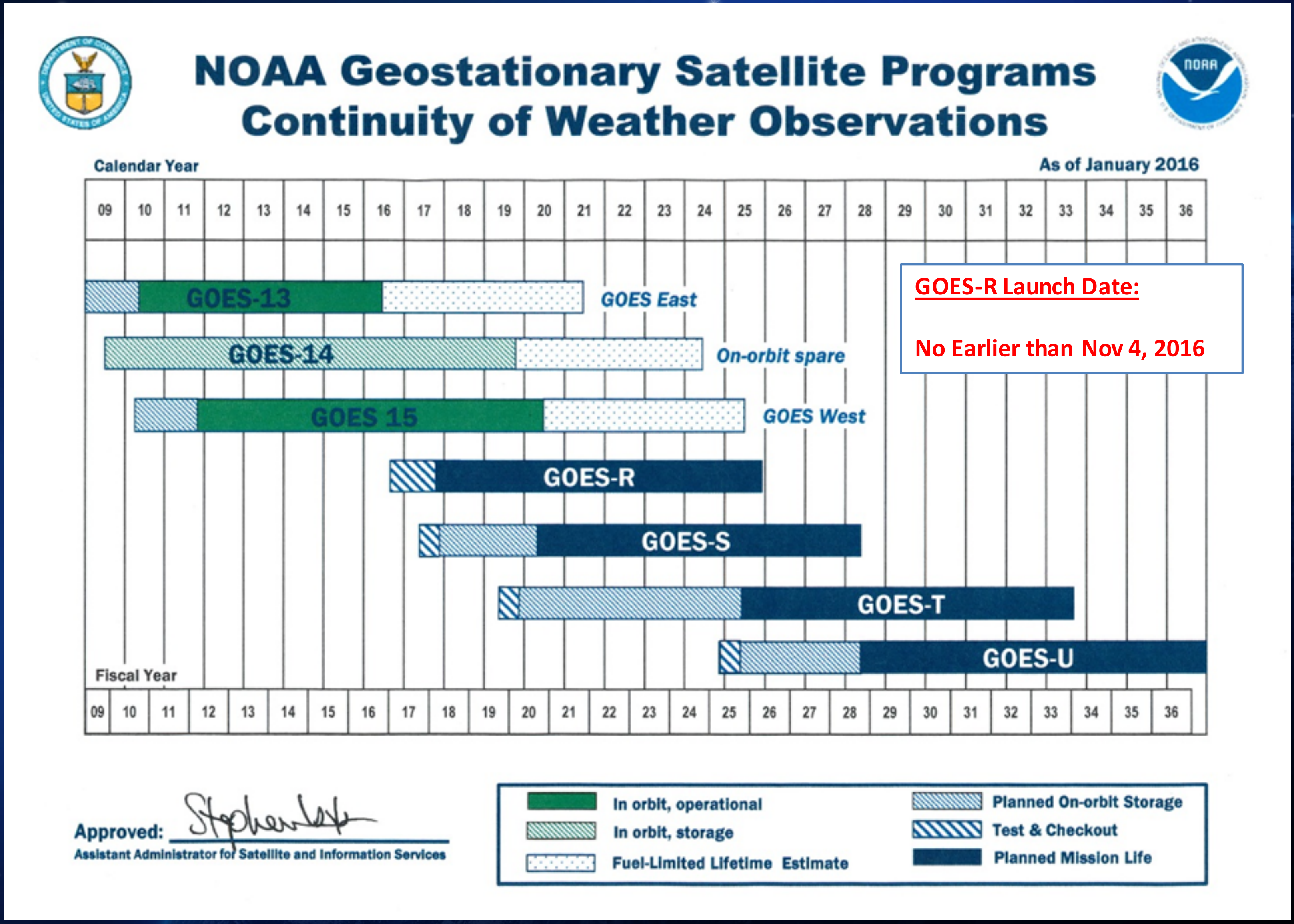
# Outline

- Latest on GOES-R
- Review of the GOES-R Winds Algorithm
- Examples and Lessons Learned Using Available ABI Proxy Data
- Summary

# Outline

- Latest on GOES-R
- Review of the GOES-R Winds Algorithm
- Examples and Lessons Learned Using Available ABI Proxy Data
- Summary

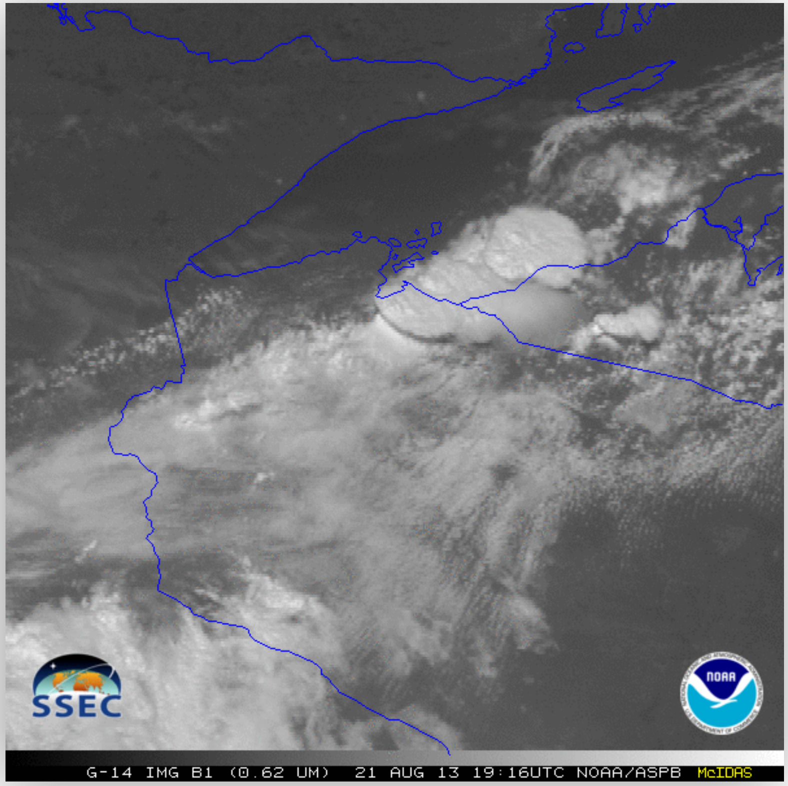
# GOES-R Series Maintains Continuity of NOAA's GOES Program



# GOES-R ABI Enhanced Capabilities Expected to Bring Improved Level-2 products

- **Higher Spectral Resolution**
  - Can see and retrieve new phenomena
- **Higher Spatial Resolution**
  - Higher fidelity imagery and L2 products; information at smaller scales now observed
- **Higher Temporal Resolution**
  - Physical and dynamical processes are now captured; new information to exploit and be used by user community
- **Improved Radiometrics**
  - Translate to more accurate products
- **Improved Navigation and Registration**
  - More accurate products and improved utilization of them

All of these things contribute to one being able to observe and retrieve phenomenon not previously observed before

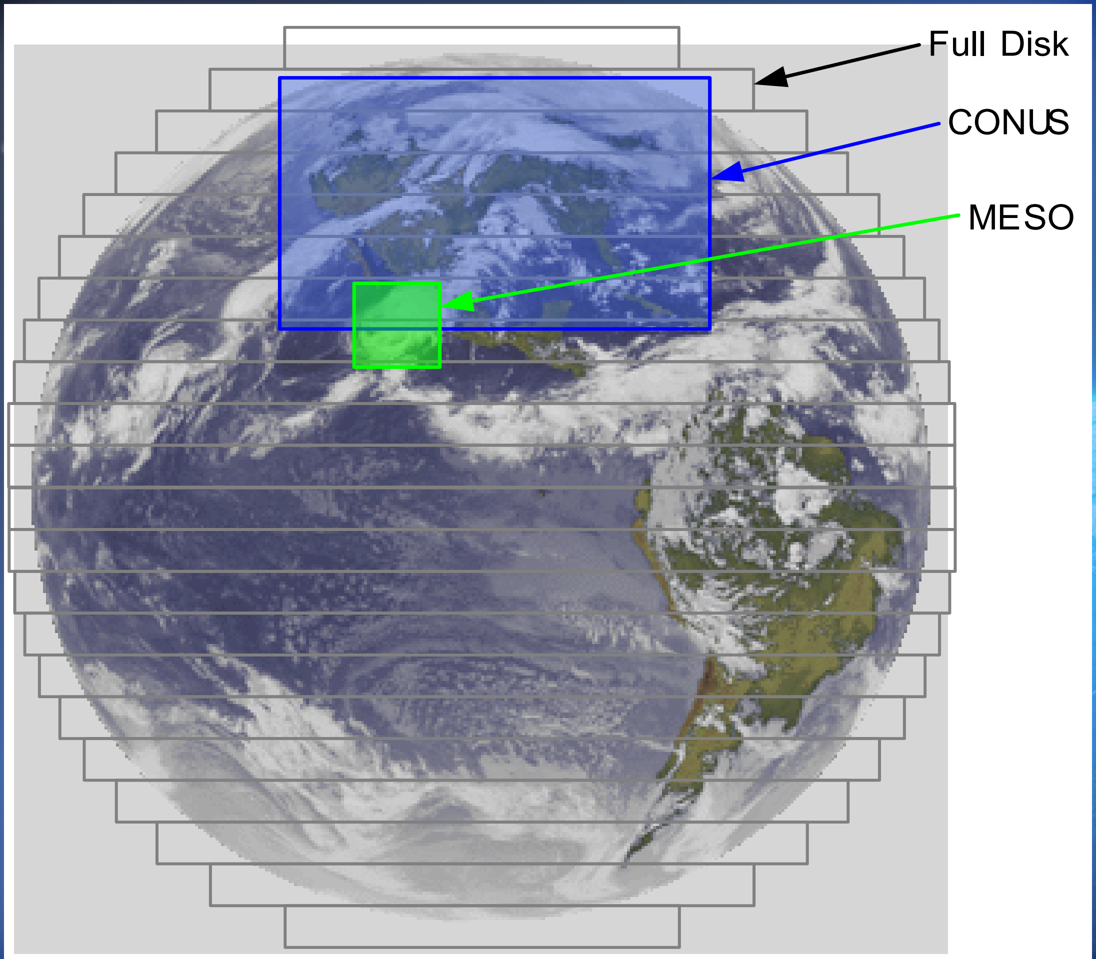



GOES-14 provided very unique information and offers a glimpse into the possibilities that will be provided by the ABI on GOES-R.

# The Advanced Baseline Imager

| | ABI | | Current GOES Imager |
|---|---|---|---|
| **Spectral Coverage** | 16 bands | | 5 bands |
| **Spatial resolution** | | | |
| 0.64 μm Visible | 0.5 km | | Approx. 1 km |
| Other Visible/near-IR | 1.0 km | | n/a |
| Bands (>2 μm) | 2 km | | Approx. 4 km |
| **Spatial coverage** | **Scan Mode 3** | **Scan Mode** | |
| Full disk | 4 per hour | 12 per hour | Scheduled (3 hrly) |
| CONUS | 12 per hour | | ~4 per hour |
| Mesoscale | Every 30 sec | | n/a |
| **Visible (reflective bands)** | | | |
| On-orbit calibration | Yes | | No |

# Advanced Baseline Imager (ABI)




## Scan modes for the ABI:

**Mode 3:**

Full disk images every 15 minutes
CONUS images every 5 minutes
Mesoscale images (2) every 1 minute

**Mode 4:**

Full disk images every 5 mins

## AMV Product Refresh Rate:

Full Disk: Hourly
CONUS: 15 minutes
Meso: 5 minutes

There is an approved ABI scan mode 6 which will provide 10-min FD scans. Implementation some time after checkout period.

# ABI Visible/Near-IR Bands

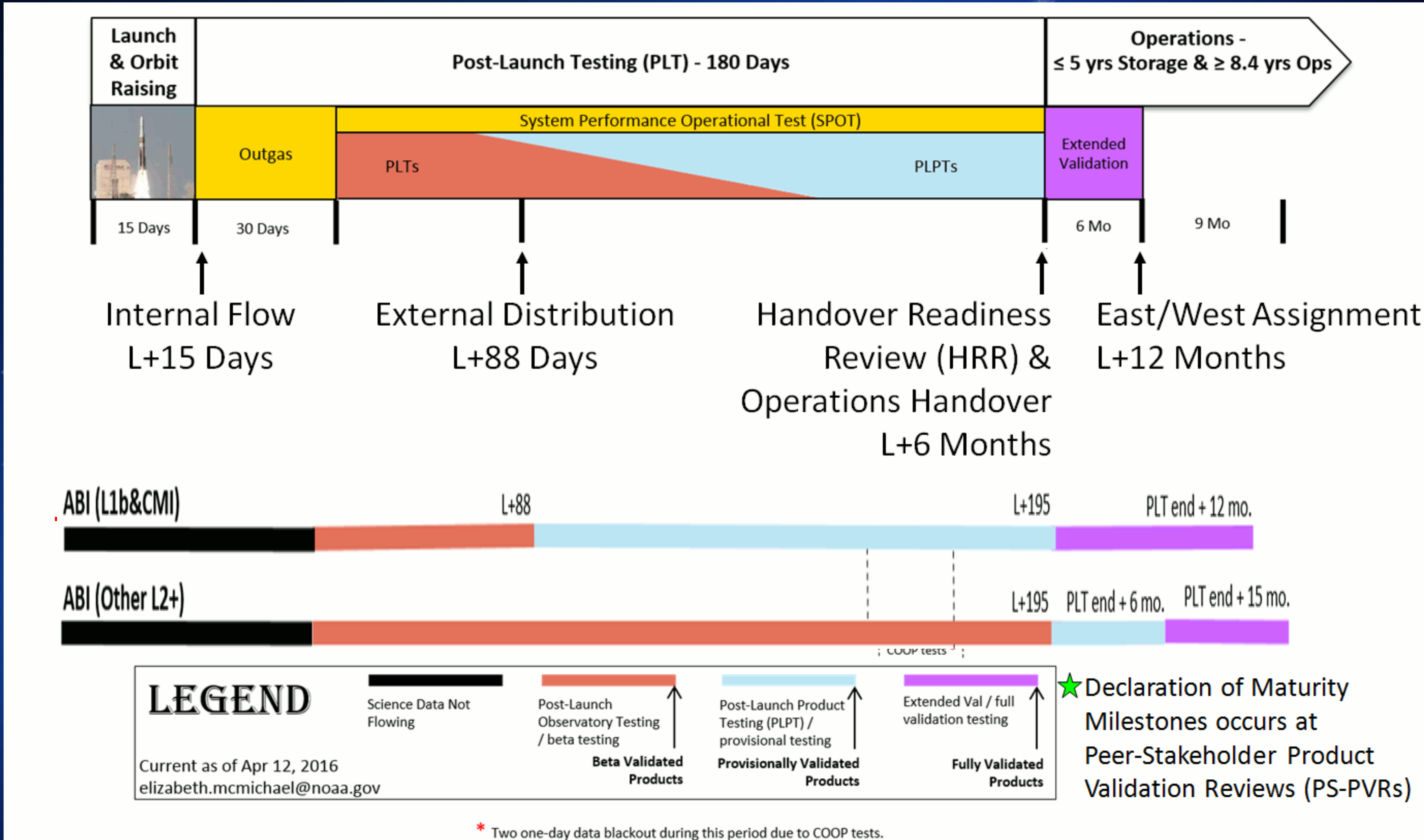
| Future GOES imager (ABI) band | Wavelength range (μm) | Central wavelength (μm) | Nominal subsatellite IGFOV (km) | Sample use |
|---|---|---|---|---|
| 1 | 0.45–0.49 | 0.47 | 1 | Daytime aerosol over land, coastal water mapping |
| 2 | 0.59–0.69 | 0.64 | 0.5 | Daytime clouds fog, insolation, winds |
| 3 | 0.846–0.885 | 0.865 | 1 | Daytime vegetation/burn scar and aerosol over water, winds |
| 4 | 1.371–1.386 | 1.378 | 2 | Daytime cirrus cloud |
| 5 | 1.58–1.64 | 1.61 | 1 | Daytime cloud-top phase and particle size, snow |
| 6 | 2.225–2.275 | 2.25 | 2 | Daytime land/cloud properties, particle size, vegetation, snow |

Schmit, T. J., M. M. Gunshor, W. P. Menzel, J. J. Gurka, J. Li, and A. S. Bachmeier, 2005: Introducing the next-generation Advanced Baseline Imager on GOES-R. Bull. Amer. Meteor. Soc., **86**, 1079-1096.

# ABI IR Bands

| Future GOES imager (ABI) band | Wavelength range (µm) | Central wavelength (µm) | Nominal subsatellite IGFOV (km) | Sample use |
|---|---|---|---|---|
| 7 | 3.80–4.00 | 3.90 | 2 | Surface and cloud, fog at night, fire, winds |
| 8 | 5.77–6.6 | 6.19 | 2 | High-level atmospheric water vapor, winds, rainfall |
| 9 | 6.75–7.15 | 6.95 | 2 | Midlevel atmospheric water vapor, winds, rainfall |
| 10 | 7.24–7.44 | 7.34 | 2 | Lower-level water vapor, winds, and $SO_2$ |
| 11 | 8.3–8.7 | 8.5 | 2 | Total water for stability, cloud phase, dust, $SO_2$ rainfall |
| 12 | 9.42–9.8 | 9.61 | 2 | Total ozone, turbulence, and winds |
| 13 | 10.1–10.6 | 10.35 | 2 | Surface and cloud |
| 14 | 10.8–11.6 | 11.2 | 2 | Imagery, SST, clouds, rainfall |
| 15 | 11.8–12.8 | 12.3 | 2 | Total water, ash, and SST |
| 16 | 13.0–13.6 | 13.3 | 2 | Air temperature, cloud heights and amounts |

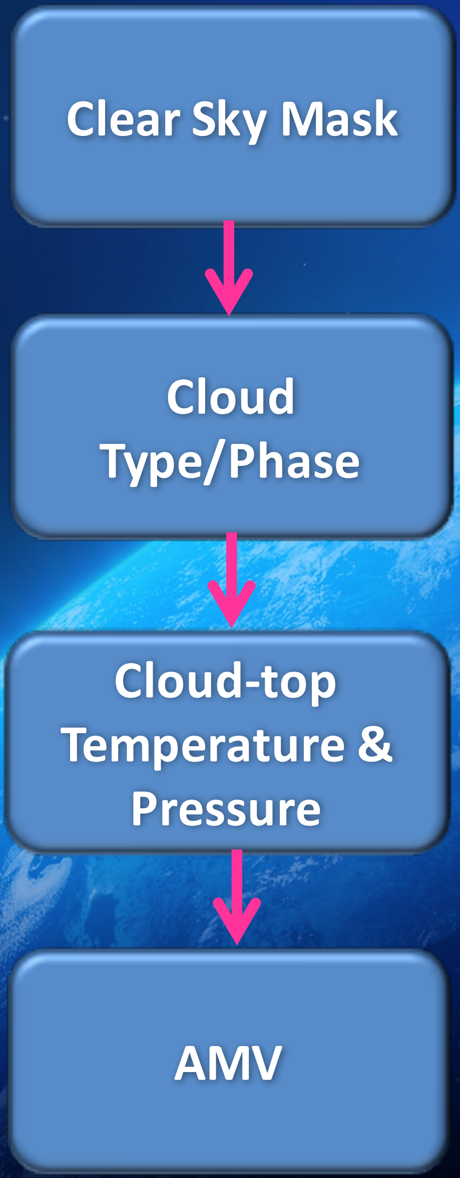
# Data Release Strategy



# Outline

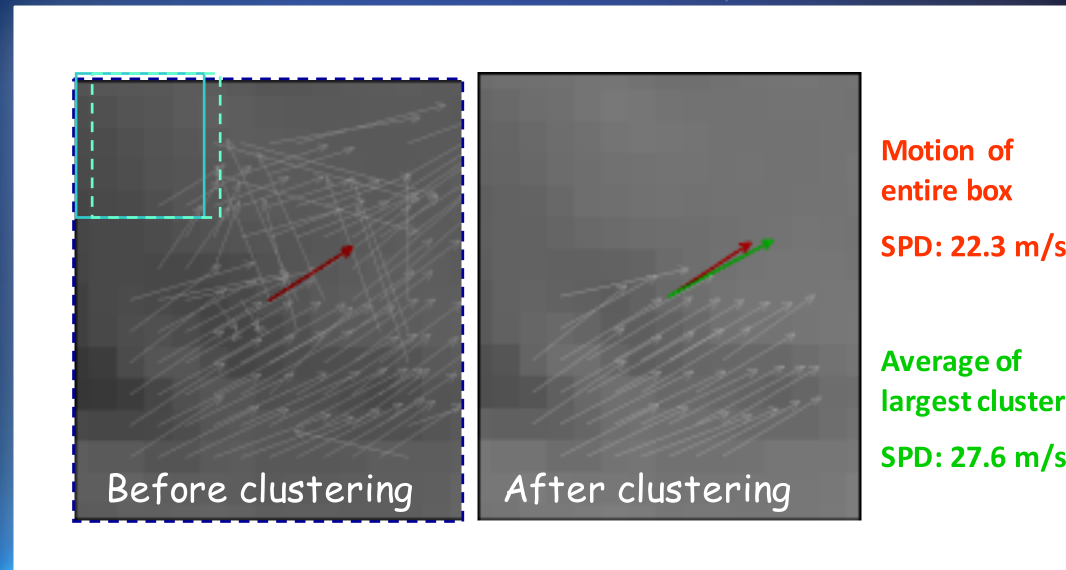
- Latest on GOES-R
- Review of the GOES-R Winds Algorithm
- Examples and Lessons Learned Using Available ABI Proxy Data
- Summary

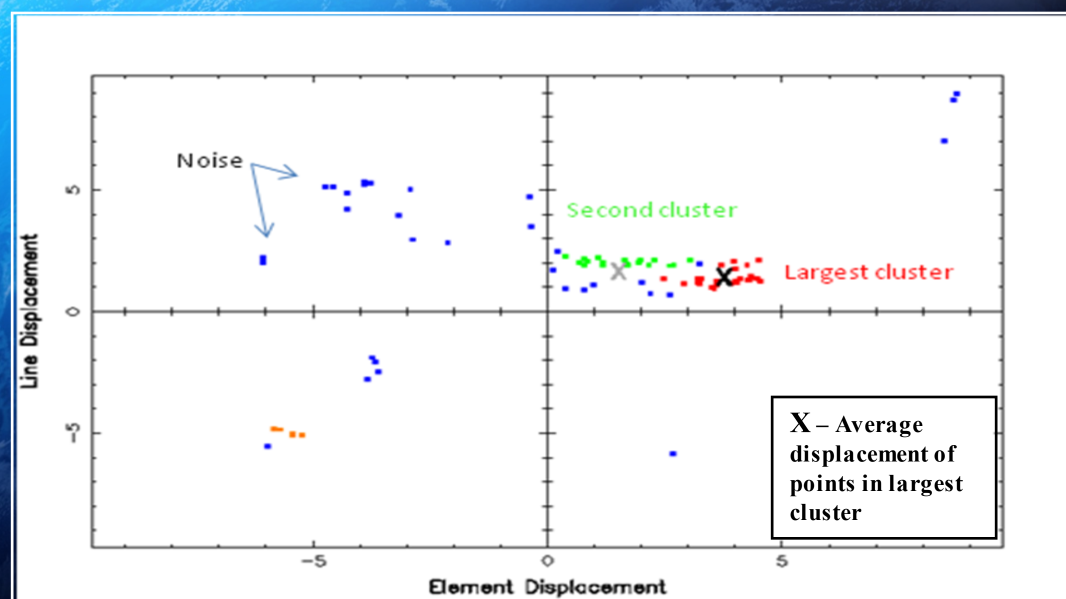
# GOES-R AMV Product Precedence Chain



# Nested Tracking Approach

- Computes local motions (nested) within a larger target scene, together with a clustering algorithm, to extract motion solution(s)
- Perform cluster analysis of line and element displacements
- Cloud heights at pixels belonging to the largest cluster are used to assign a representative height ***(*Median)** to the derived motion wind
- Potential for determination of motion at different levels and/or different scales




**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

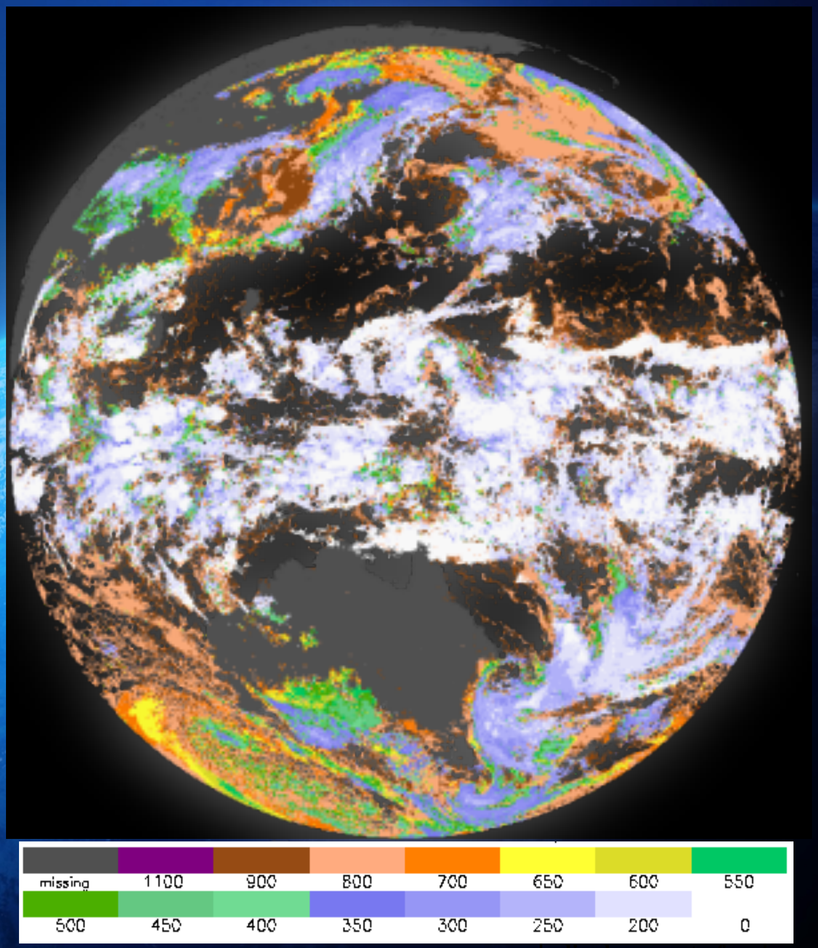
# Cloud Top Pressure Product

- **Cloud Height Algorithm Highlights**
  - Algorithm uses the 11, 12 and 13.3mm channels to retrieve cloud-top temperature. Cloud emissivity and a cloud microphysics are retrieved as well.
  - Algorithm uses an optimal estimation approach (Rogers, 1976) that provides error estimates (Tc).
  - NWP forecast temperature profiles used to compute cloud-top pressure and height.
  - For pixels typed as containing multi-layer clouds, a multi-layer solution is performed.
  - Special processing occurs in the presence of low level temperature inversions.

- **References**

  - Heidinger, A., 2010: GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Cloud Mask, GOES-R Program Office, www.goes-r.gov.
  - Rodgers, C.D., 1976: Retrieval of atmospheric temperature and composition from remote measurements of thermal radiation. Rev. Geophys. Space Phys., 60, 609-624.


**H-8/AHI Cloud-top Pressure (hPa)**




**Steve Wanzong will talk more about the GOES-R cloud height algorithm tomorrow**

# Outline

- Latest on GOES-R
- Review of the GOES-R Winds Algorithm
- Examples and Lessons Learned Using Available ABI Proxy Data
- Summary

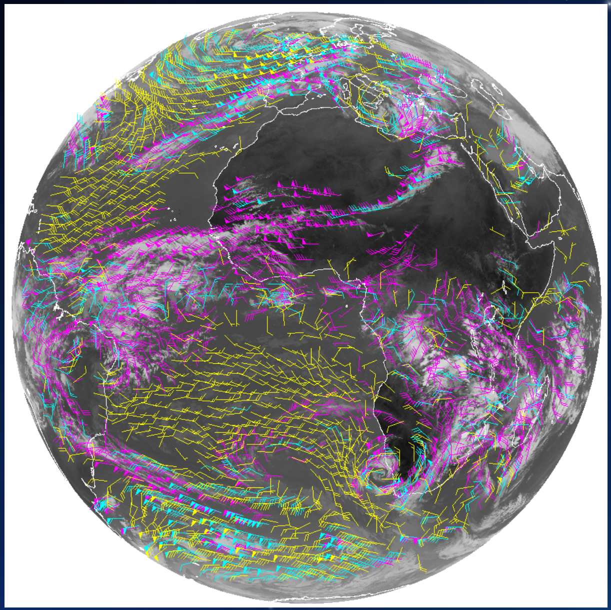
# Proxy Data Applied to the GOES-R Algorithms

| Satellite/Sensor | Notes |
|---|---|
| **Meteosat-8/9/10 - SEVIRI** | Most of our development work done with these sensors |
| **GOES-13/15** | Operational target date: Spring 2017 |
| **GOES-14** | Super Rapid Scans for GOES-R Readiness |
| **Himawari-8/AHI** | Ideal ABI proxy data source; recent work focused on these data |
| **NOAA-15/18/19 – AVHRR** | Operational target date: June 2017 |
| **METOP-A/B - AVHRR** | Operational target date: June 2017 |
| **Terra/Aqua-MODIS** | Operational target date: June 2017 |
| **Suomi NPP/VIIRS** | Operational (May 2014) |

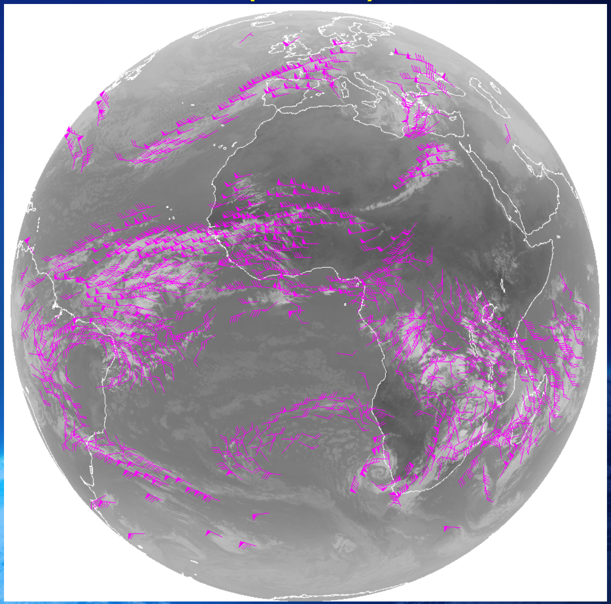
# Meteosat-10/SEVIRI FD Winds

January 6, 2013

LWIR (10.8um)



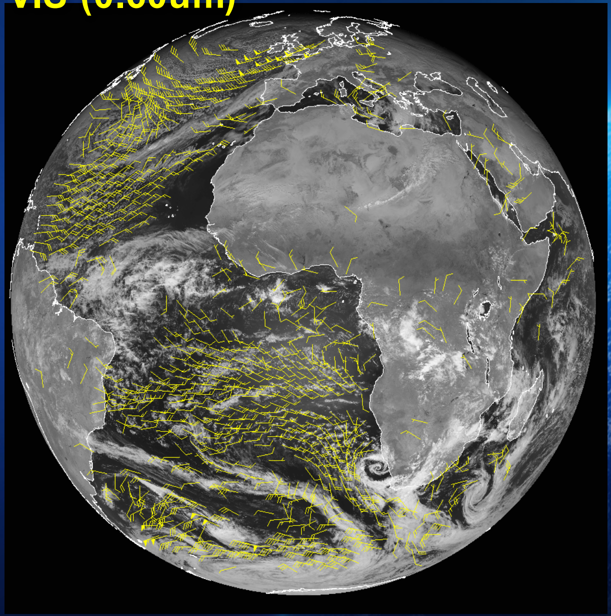
WVCT (6.2um)



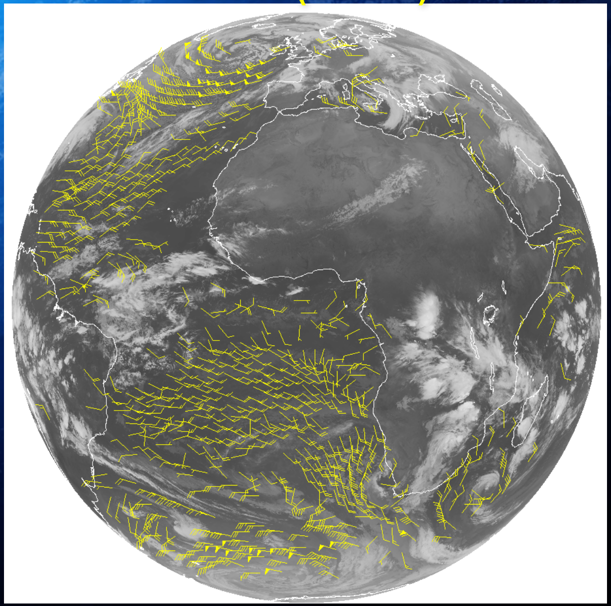
We did a lot of our initial development of the GOES-R algorithms using SEVIRI data.

High-Level 100-400 mb | Mid-Level 400-700 mb | Low-Level >700 mb

VIS (0.60um)

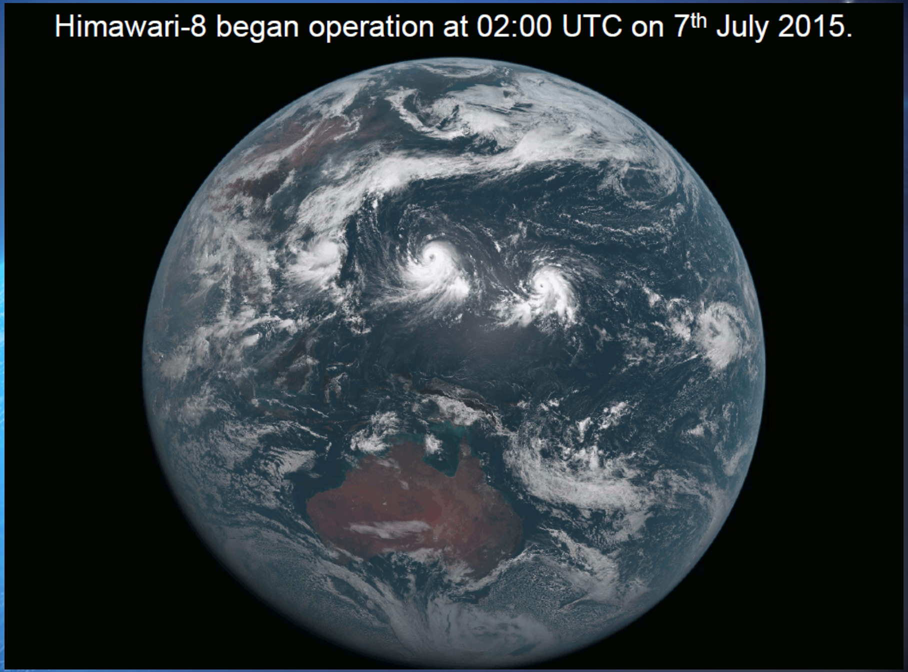


SWIR (3.9um)



# Leveraging Himawari-8/AHI for GOES-R Readiness

- Himawari-8 was successfully launched October 7, 2014 and carries the AHI which is an almost identical instrument to the ABI
- Availability of AHI datasets brings an unprecedented opportunity to exercise the Level-2 algorithm developed for GOES-R
- NESDIS/STAR is routinely pulling AHI data from JMA's Cloud Service
- GOES-R Algorithm Working Group (AWG) teams are working to test their product algorithms with AHI data
- Special thanks to JMA for sharing data and collaborating with NOAA and NASA during their post launch checkout



# Comparison of Spectral Bands

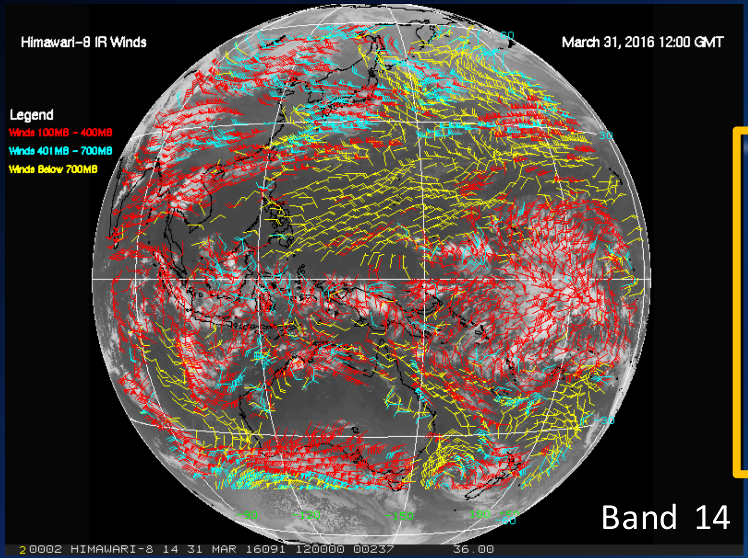
| Approx. Central Wavelength (µm) | Band Explanation | GOES-R ABI | Himawari AHI | GK-2 AMI | MTG FCI | FY-4 AGRI |
|---|---|---|---|---|---|---|
| | | Central Wavelength (µm) [Band Number] | | | | |
| 0.47 | Visible/reflective | 0.47 [1] | 0.47 [1] | 0.46 [1] | 0.44 [1] | 0.47 [1] |
| 0.51 | | None | 0.51 [2] | 0.51 [2] | 0.51 [2] | None |
| 0.64 | | 0.64 [2] | 0.64 [3] | 0.64 [3] | 0.64 [3] | 0.65 [2] |
| 0.865 | Reflective | 0.865 [3] | 0.86 [4] | 0.86 [4] | 0.865 [4] | 0.825 [3] |
| 0.91 | | None | None | None | 0.914 [5] | None |
| 1.378 | Cirrus | 1.378 [4] | None | 1.38 [5] | 1.38 [6] | 1.375 [4] |
| 1.61 | Snow/Ice | 1.61 [5] | 1.61 [5] | 1.61 [6] | 1.61 [7] | 1.61 [5] |
| 2.25 | Particle size | 2.25 [6] | 2.25 [6] | None | 2.25 [8] | 2.25 [6] |
| 3.90 | Shortwave IR | 3.90 [7] | 3.9 [7] | 3.85 [7] | 3.8 [9] | 3.75[2] [7,8] |
| 6.19 | Water vapor | 6.19 [8] | 6.2 [8] | 6.24 [8] | 6.3 [10] | 6.25 [9] |
| 6.95 | | 6.95 [9] | 6.9 [9] | 6.95 [9] | None | 7.1 [10] |
| 7.34 | | 7.34 [10] | 7.3 [10] | 7.35 [10] | 7.35 [11] | None |
| 8.5 | Water vapor, $SO_2$ | 8.5 [11] | 8.6 [11] | 8.6 [11] | 8.7 [12] | 8.5 [11] |
| 9.61 | Ozone | 9.61 [12] | 9.6 [12] | 9.63 [12] | 9.66 [13] | None |
| 10.35 | Longwave IR | 10.4 [13] | 10.4 [13] | 10.43 [13] | 10.5 [14] | 10.7 [12] |
| 11.2 | | 11.2 [14] | 11.2 [14] | 11.2 [14] | None | None |
| 12.3 | | 12.3 [15] | 12.3 [15] | 12.3 [15] | 12.3 [15] | 12.0 [13] |
| 13.3 | | 13.3 [16] | 13.3 [16] | 13.3 [16] | 13.3 [16] | 13.5 [14] |

**True-color component bands are highlighted in red, green, and blue.**

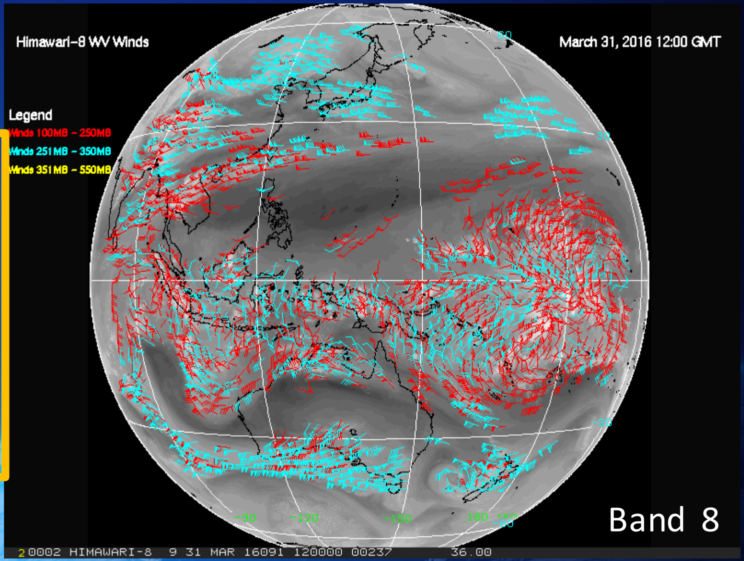
# Himawari-8/AHI Winds

March 31, 2016

## LWIR (11.2um)




## WVCT (6.2um)

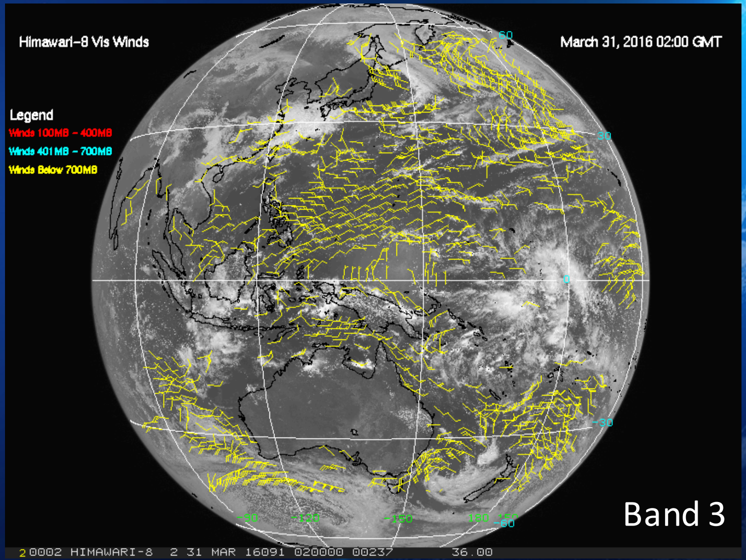



We are routinely processing all wind types once an hour.

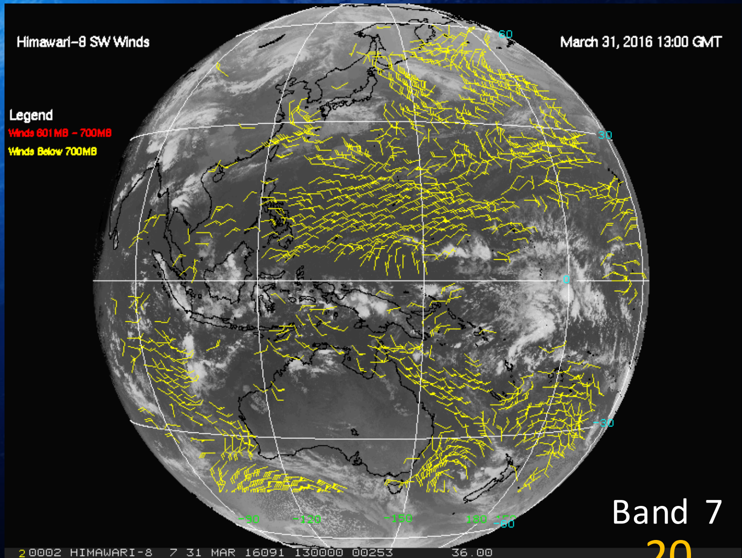
We continue to focus on these data for GOES-R readiness, continued algorithm development, etc.

High-Level 100-400 mb | Mid-Level 400-700 mb | Low-Level >700 mb

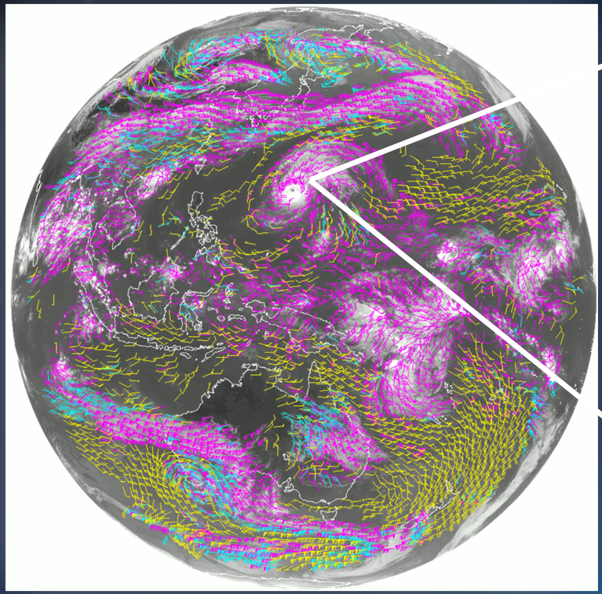
## VIS (0.64um)



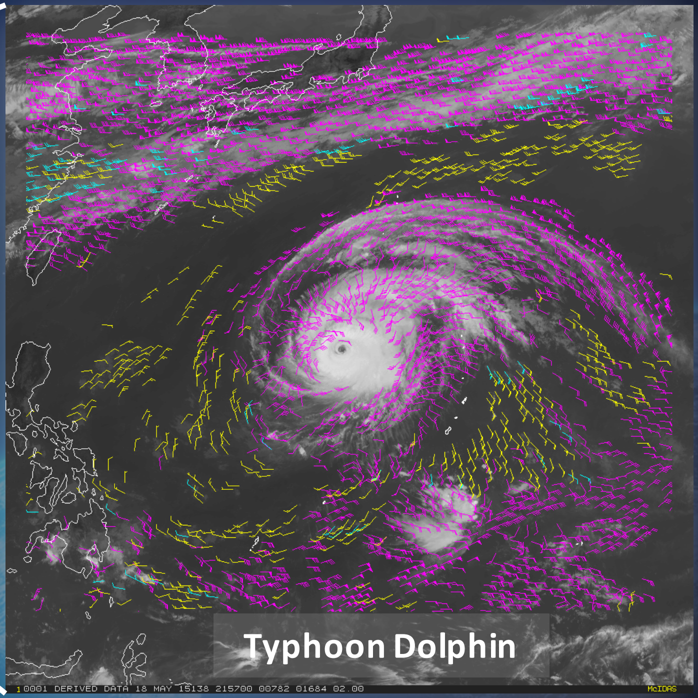

## SWIR (3.9um)



# Himawari-8 AHI as a Proxy for the GOES-R ABI – Derived Motion Winds

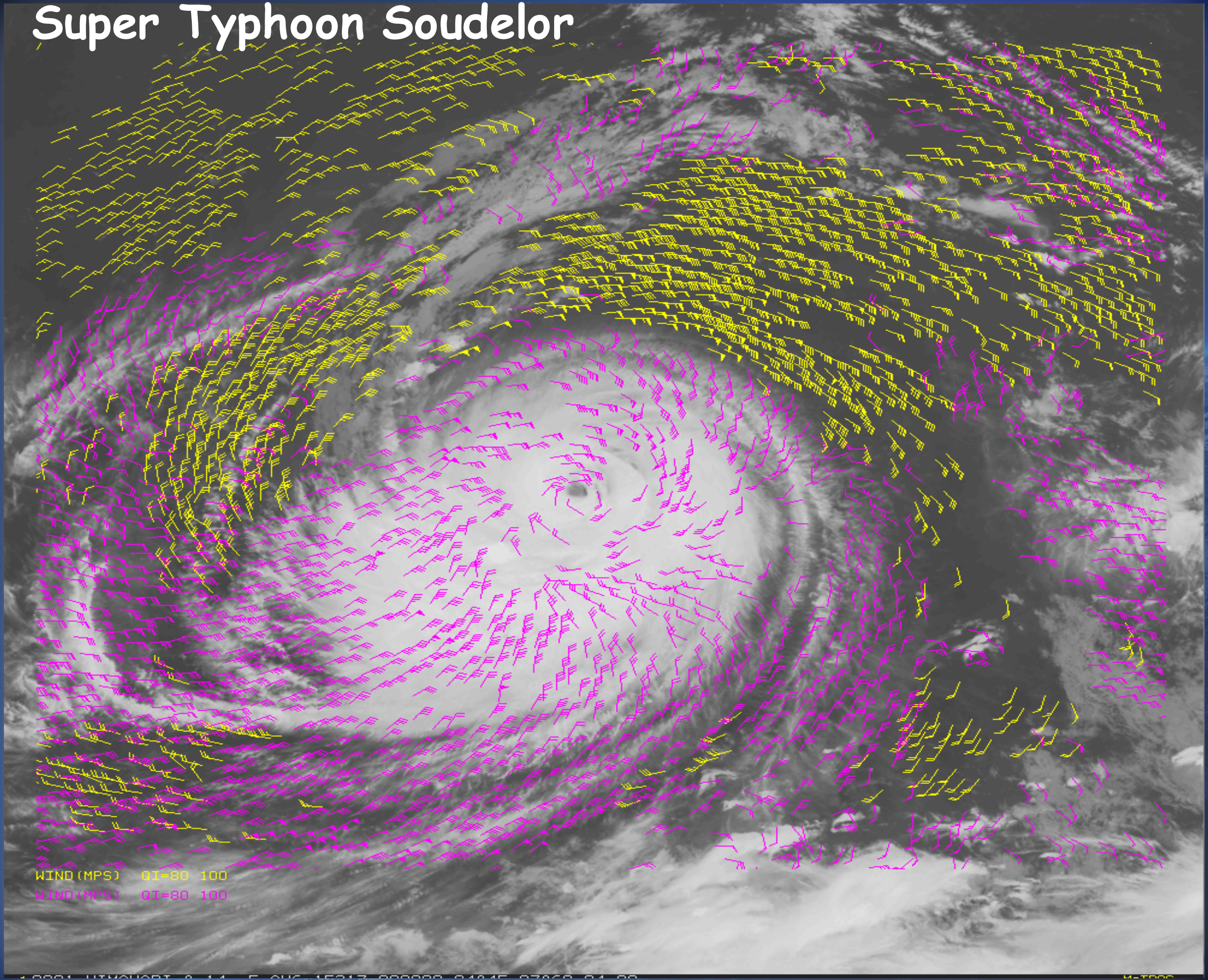


High-Level 100-400 mb Mid-Level 400-700 mb Low-Level >700 mb




- AHI data is the ideal ABI proxy data to perform pre-launch L2 algorithm testing and to assess L2 algorithm performance
- The AWG winds team began near real-time processing of H-8 AMVs on 8/12/2015 along with routine collocations with radiosonde observations. Work is ongoing to initiate routine collocations with aircraft wind observations .
- Exercised steps to read in L1b data for algorithm execution
- Exercised DMW validation tools
  - Visualization of DMW product over imagery
  - Collocation of DMW vs reference/ground truth wind observations (radiosondes, aircraft)
  - Computation of comparison statistics

# Himawari-8/AHI Winds




**Nice example of the complimentary coverage provided by the visible (generated using full res 0.5km imagery) and the WV cloud top winds.**

# Lessons Learned

- **Significantly more data to process with H-8/AHI**
- **Significant increase in AMV counts over AMV counts generated from current GOES/N/O/P series**

| Wind Type | Approx. Number of Good Winds over FD | Acceptable Vertical Coverage (hPa) |
|---|---|---|
| Visible (Band 3; 0.64um) | 100,000* | Below 700 |
| SWIR (Band 7; 3.9um) | 20,000 | Below 700 |
| WV Cloud-top (Band8; 6.2um) | 30,000 | Above 350 |
| WV Clr-sky (Band 8; 6.2um) | 5,000 | 100 –1000 |
| WV Clr-sky (Band 9; 7.0um) | 5,000 | 100 –1000 |
| Wv Clr-sky (Band 10; 7.3 um) | 1,000 | 450-700 |
| LWIR (Band 14; 11um) | 50,000 | 100-1000 |

*** $10^6$ targets!**

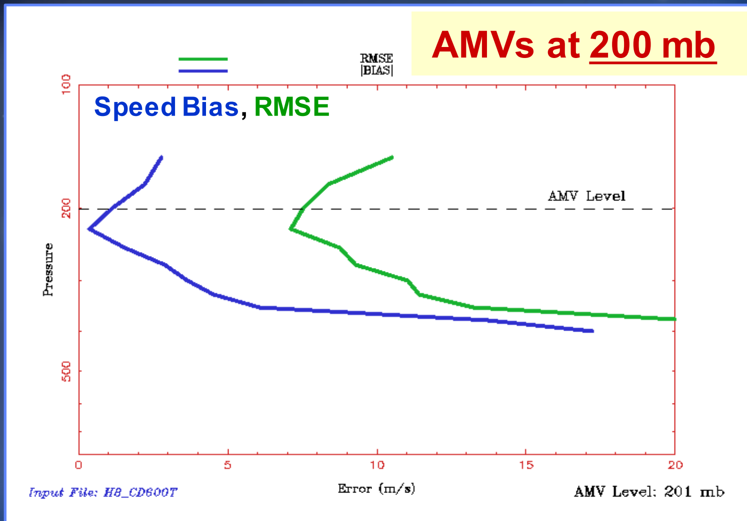
# Himawari-8 Winds vs Radiosondes

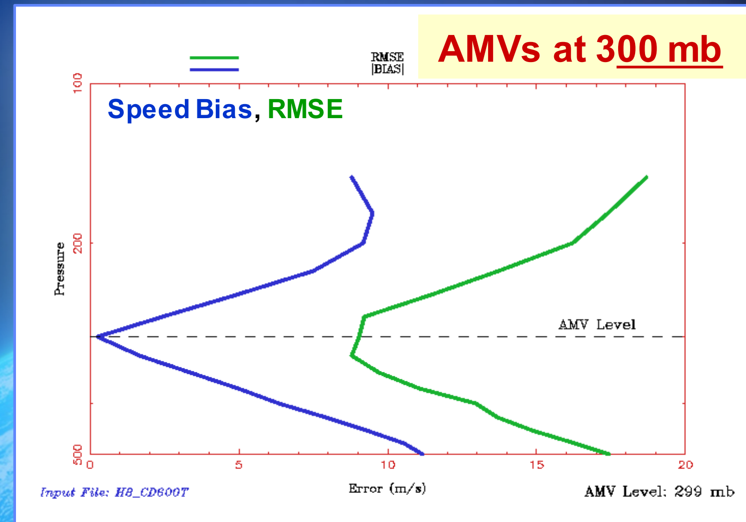
| All Levels (100-1000 hPa) | 12/22/15 – 1/4/16 | 10/29/15 – 1/4/16 | 8/13/15 – 1/4/16 | 8/13/15 – 1/4/16 |
|---|---|---|---|---|
| | LWIR | WVCT | VIS | SWIR |
| **MVD** *(m/s)* | **5.71** | **5.57** | **3.21** | 3.22 |
| **St. Deviation** *(m/s)* | 4.76 | 4.43 | 2.16 | 2.21 |
| **Speed bias** *(m/s)* | **-0.97** | **-0.09** | **0.05** | **-0.19** |
| **Speed** *(m/s)* | 19.28 | 23.66 | 8.88 | 8.99 |
| **Sample** | 24004 | 169943 | 16420 | 34719 |
| **High Level (100-400 hPa)** | LWIR | WVCT | | |
| **MVD** *(m/s)* | **6.16** | **5.57** | | |
| **St. Deviation** *(m/s)* | 4.96 | 4.43 | | |
| **Speed bias** *(m/s)* | **-0.65** | **-0.09** | | |
| **Speed** *(m/s)* | 24.31 | 23.66 | | |
| **Sample** | 11637 | 169943 | | |
| **Mid Level (400-700 hPa)** | LWIR | | | |
| **MVD** *(m/s)* | **7.39** | | | |
| **Precision** *(m/s)* | **5.48** | | | |
| **Speed bias *(m/s)*** | **-1.93** | | | |
| **Speed** *(m/s)* | 20.28 | | | |
| **Sample** | 5689 | | | |
| **Low Level (700-1000 hPa)** | LWIR | | VIS | SWIR |
| **MVD** *(m/s)* | **3.51** | | **3.21** | **3.22** |
| St. Deviation *(m/s)* | 2.28 | | 2.16 | 2.21 |
| **Speed bias *(m/s)*** | **-0.72** | | **0.05** | **-0.19** |
| **Speed** *(m/s)* | 9.66 | | 8.88 | 8.99 |
| **Sample** | 6678 | | 16420 | 34719 |

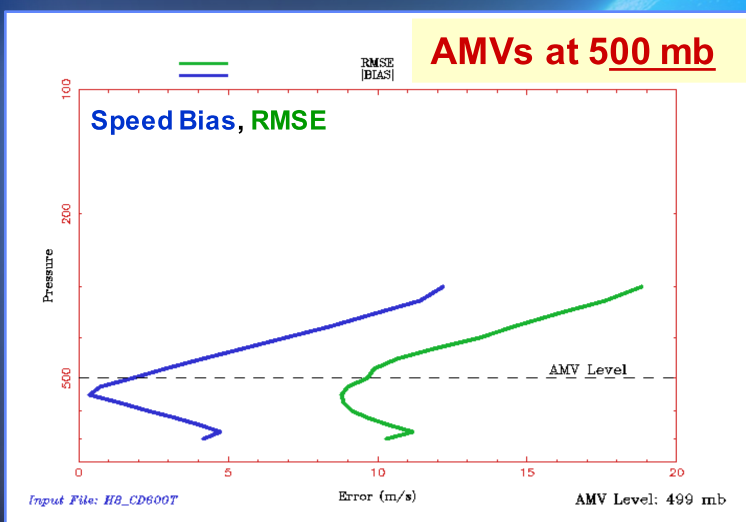
# AMV Height Assignment

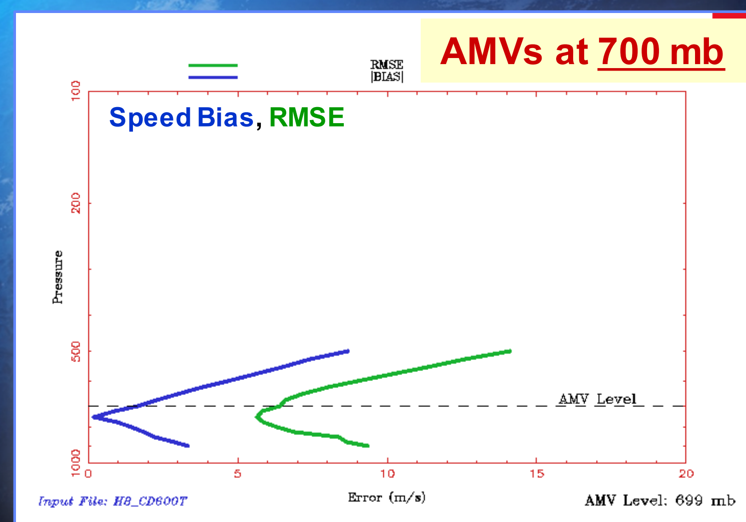
*Level-of-Best-Fit vs Radiosondes*

**Himawari-8/AHI (11.2um) AMVs (09 February 2016 – 15 June 2016)**



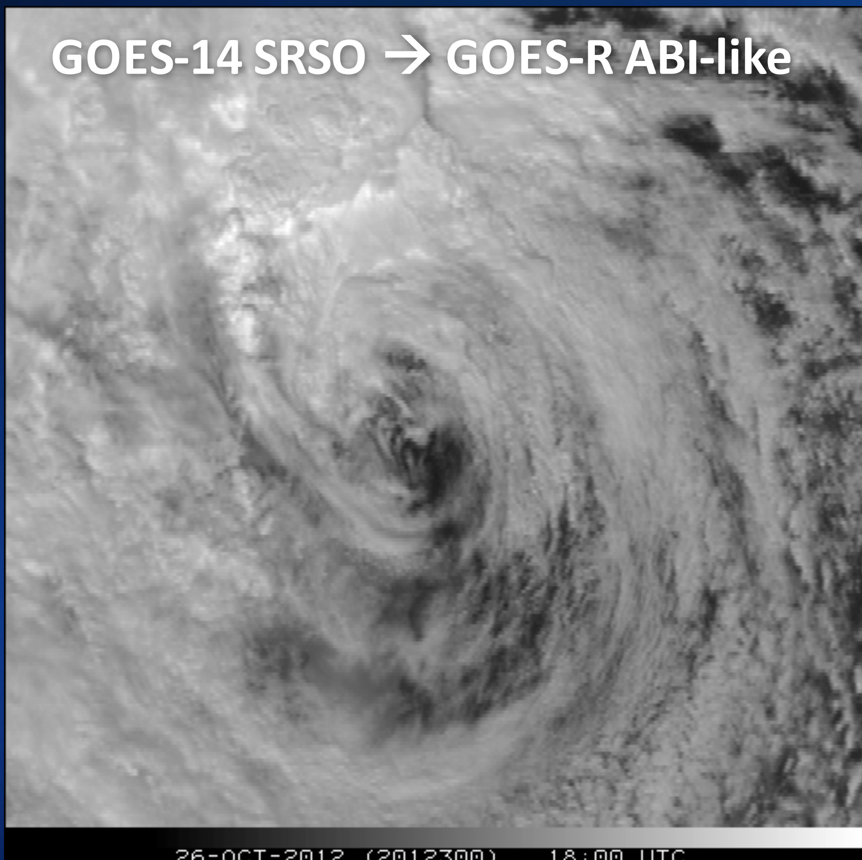



# Status and Lessons Learned Using ABI proxy Data

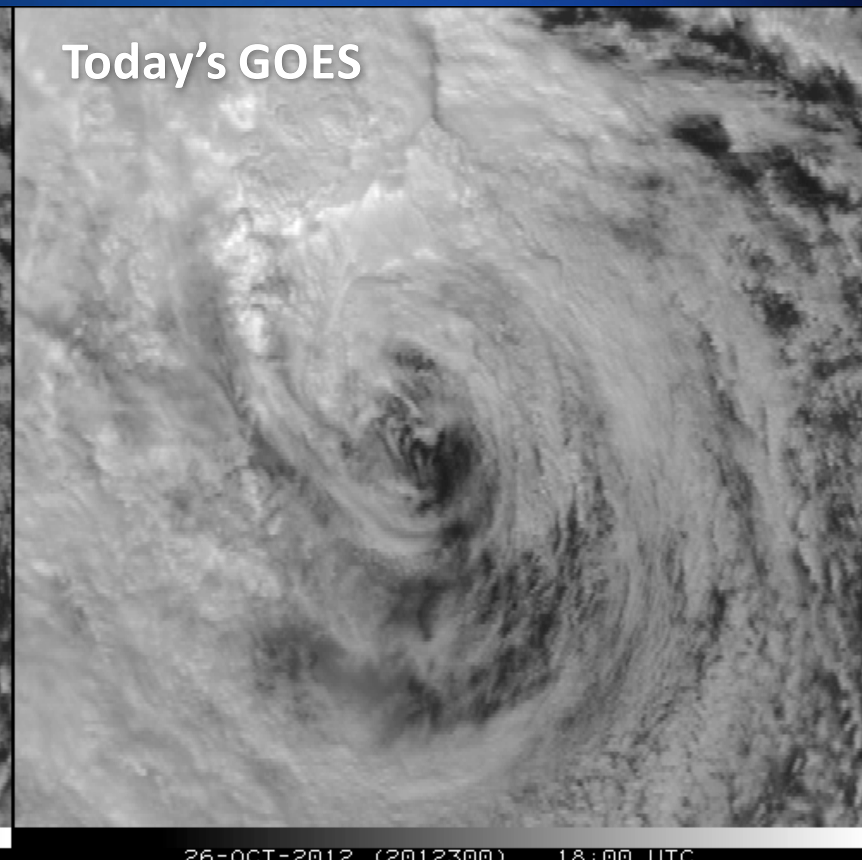
- Recently, we have focused on and have done a lot of GOES-R algorithm testing with
  - GOES-14 SRSOR imagery
  - Himawari-8 AHI Imagery
- Focus areas:
  - Heights assigned to the winds
  - Optimizing the geographic coverage of the winds product
  - Use of the full resolution (0.5km) 0.64um visible channel
  - Optimizing the use of temporal imagery
  - Optimizing the target scene size and spacing
  - Quality control

# Hurricane Sandy from GOES-14 at Two Temporal Resolutions

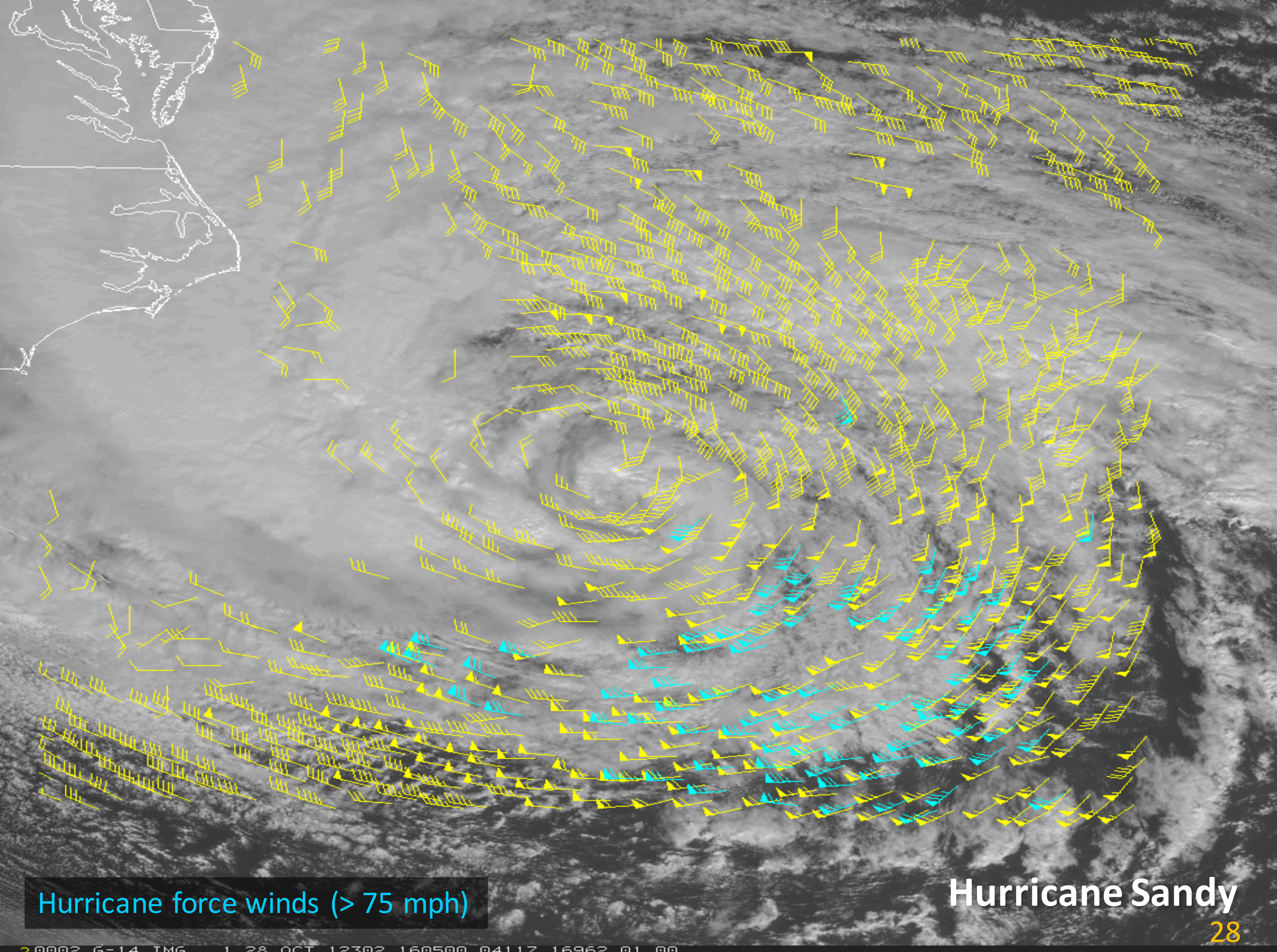
**Δt = 1 minute**




**Δt = 30 minutes**




GOES-14 in super rapid scan mode collecting images every minute


Hurricane force winds (> 75 mph)
Hurricane Sandy
2 0002 G-14 IMG 1 28 OCT 12302 160500 04117 16962 01.00

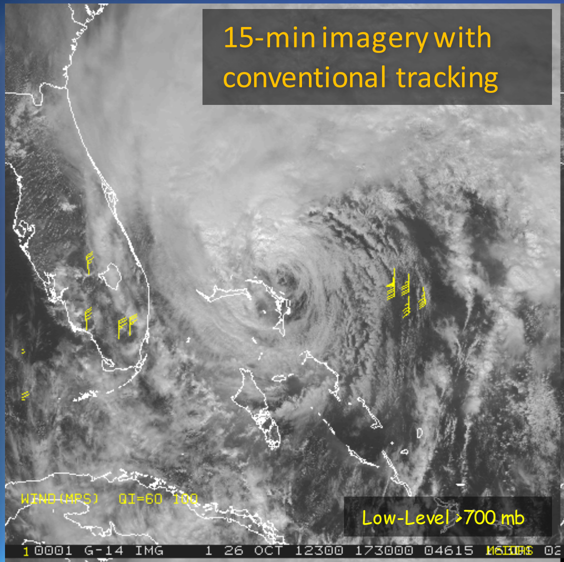
# Lessons Learned Using ABI proxy Data

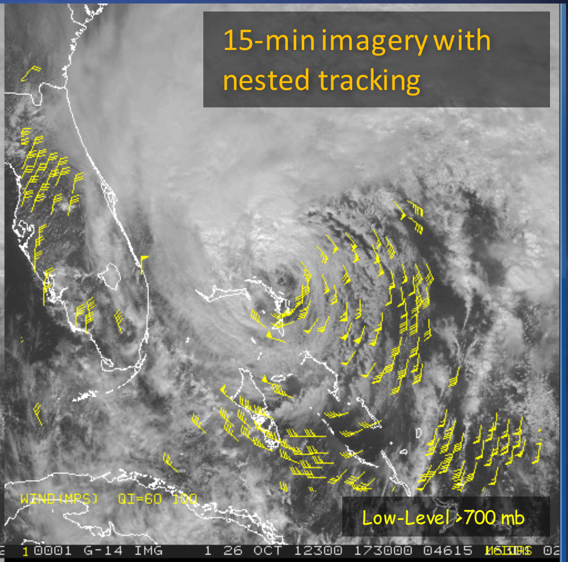
## Visible AMVs from GOES-14 SRSOR rapid-scans during Hurricane Sandy

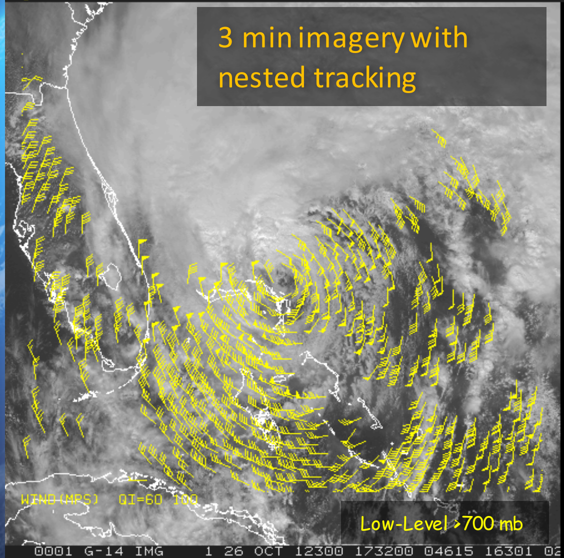
Given a set of imagery, what is the optimal configuration to use to generate AMVs in a TC environment?

- ➢ Image spatial resolution
- ➢ Image temporal resolution
- ➢ Target scene size
- ➢ Target spacing
- ➢ Image resolution
- ➢ AMC QC thresholds

What winds scale(s) are trying to be captured?

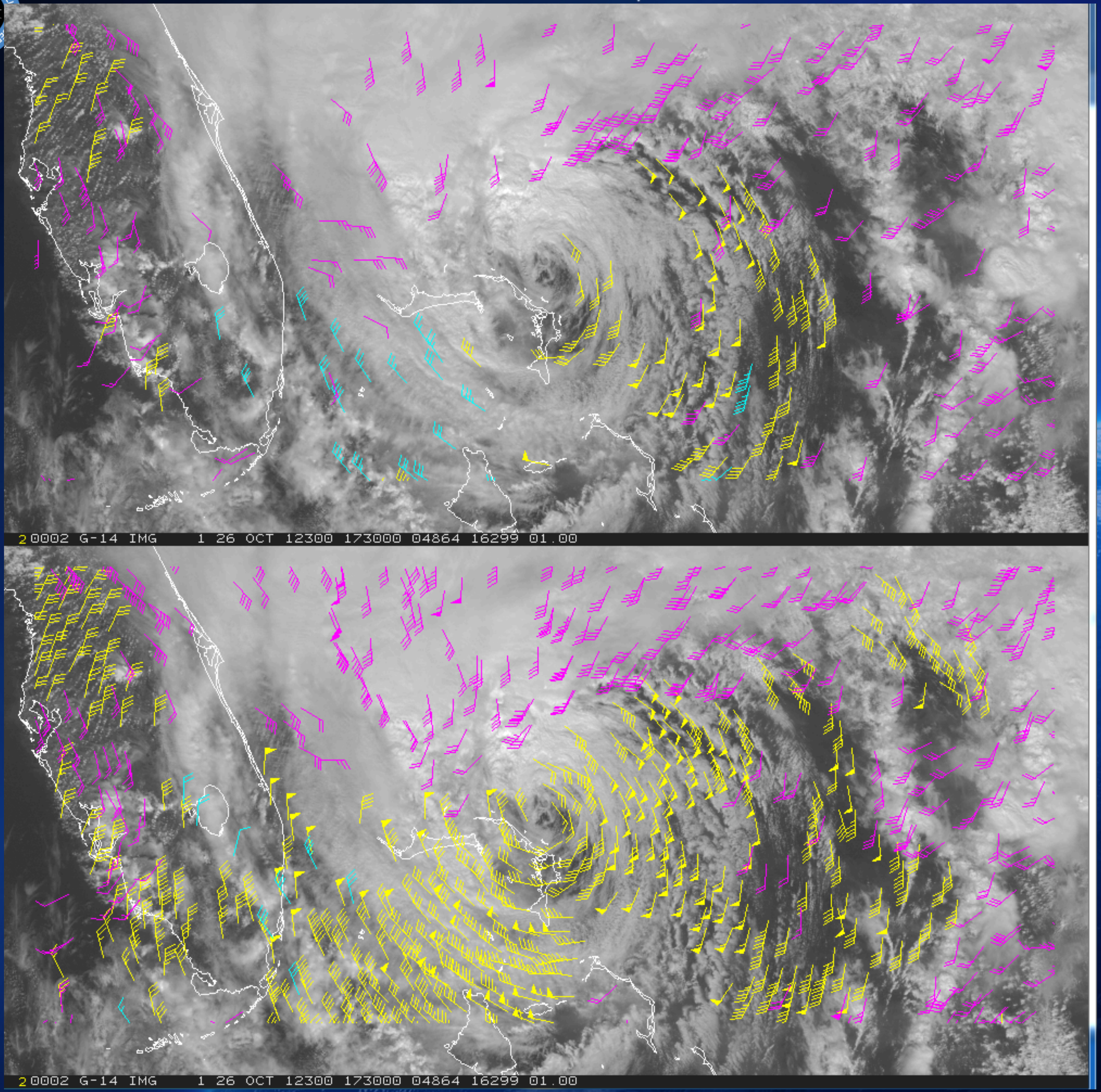


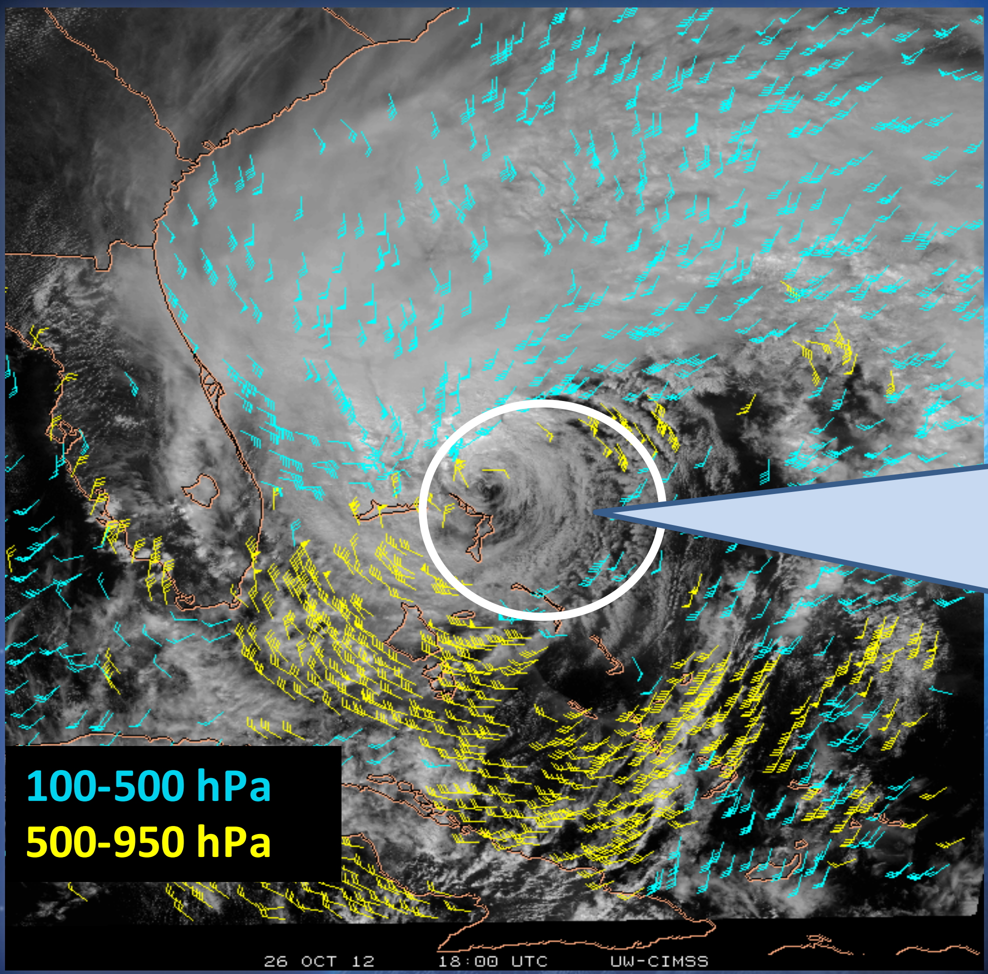

### Goals

- Good geographic coverage
- 
- Improved wind analyses
- Improved NWP forecasts
- Improved utilization and impact of the AMV product in the end-to-end forecast process


2 0002 G-14 IMG 1 26 OCT 12300 173000 04864 16299 01.00
2 0002 G-14 IMG 1 26 OCT 12300 173000 04864 16299 01.00

# Lessons Learned Using ABI proxy Data

## Visible AMVs from GOES-14 SRSOR rapid-scans during Hurricane Sandy




Large gaps in the low level visible winds coverage. Winds were flagged by QC check which verifies if derived winds fall within expected pressure range.

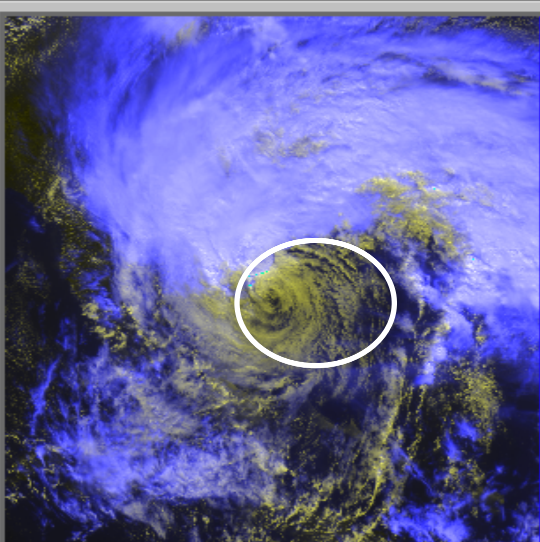
We discovered that retrieved cloud-top pressures in this area were in the 200-400mb range.

However, we knew we were tracking low level clouds.

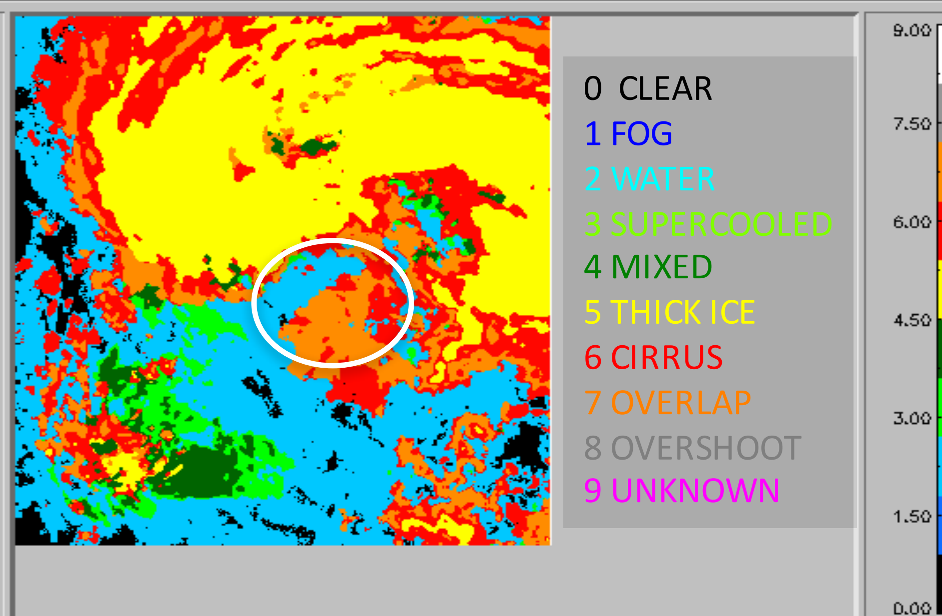
iView V0.1

Show Full Area

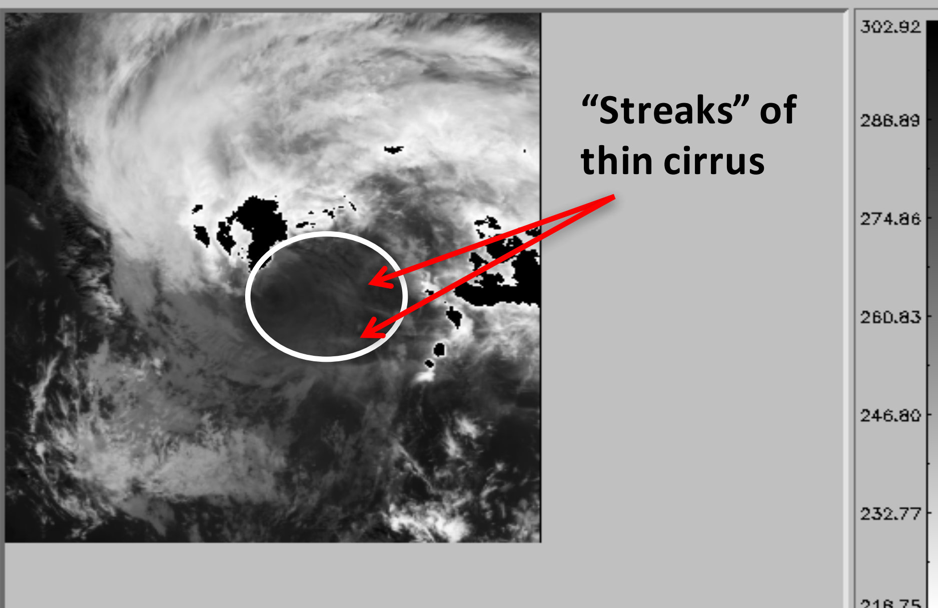
## 0.65, 0.65, 11 um RGB)



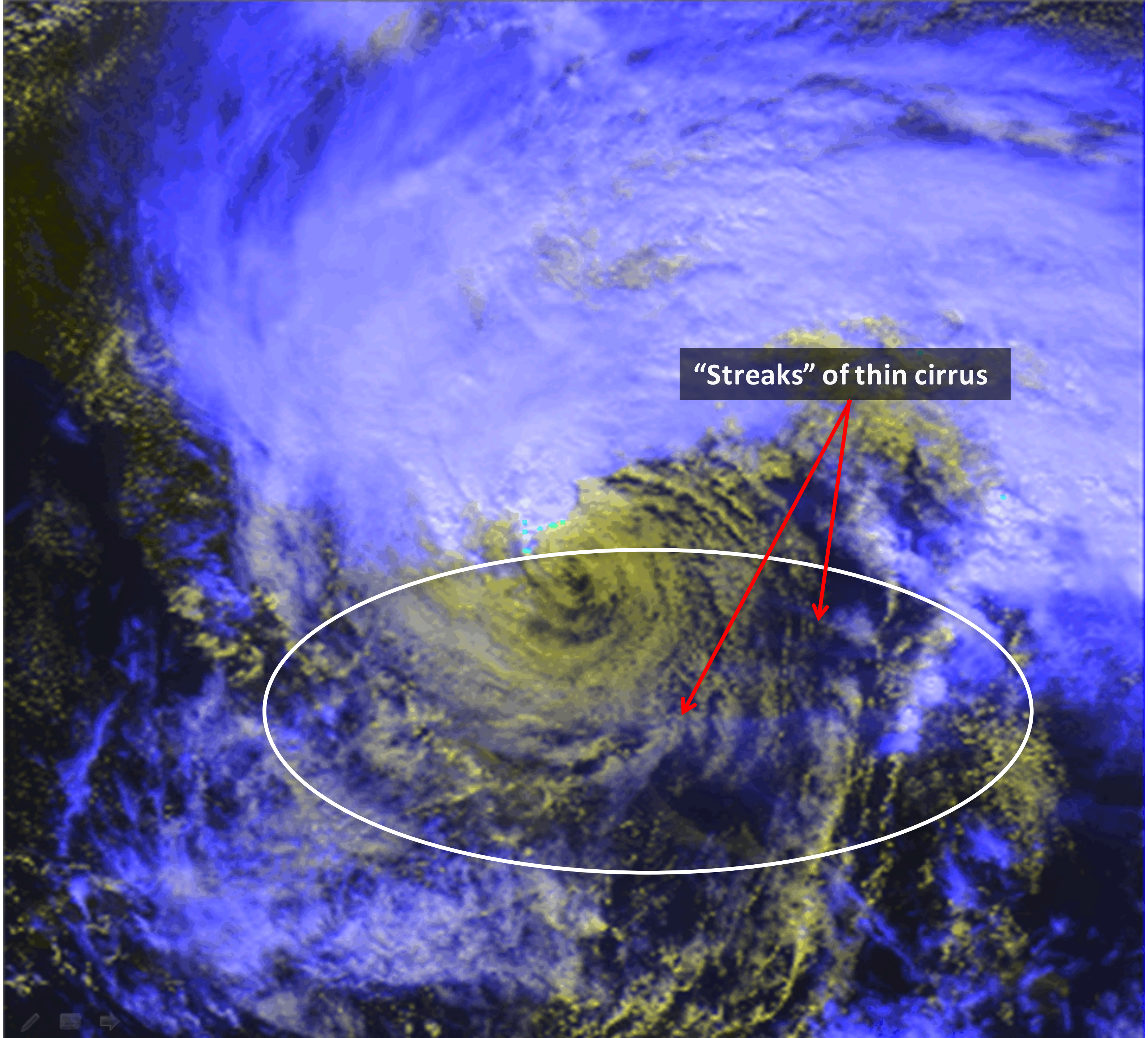
## Cloud Type




## 11 um Image

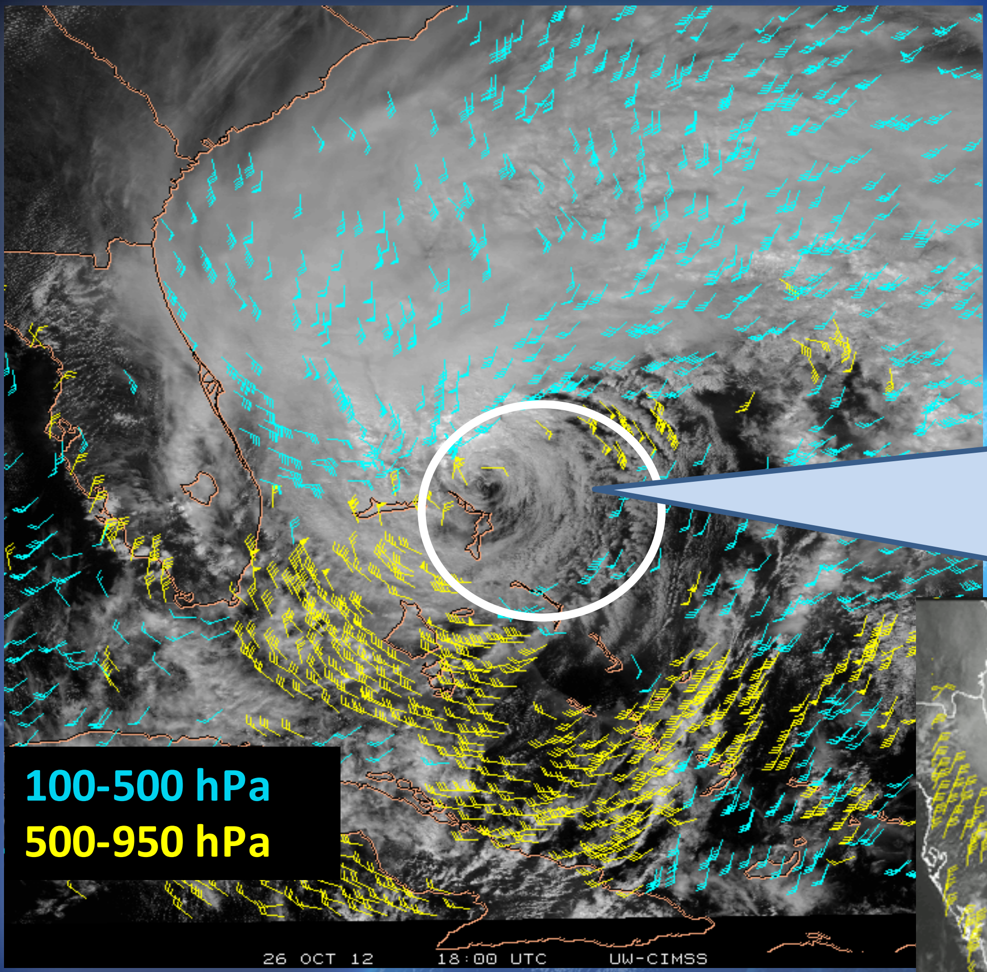



- Thin cirrus are generally present in multi-spectral and IR window imagery where the **cloud type indicates overlapping cirrus and cirrus (orange and red in cloud type image).**
- The thin cirrus that overlap the lower level clouds cannot be identified in visible imagery alone (IR channels are needed)


"Streaks" of thin cirrus

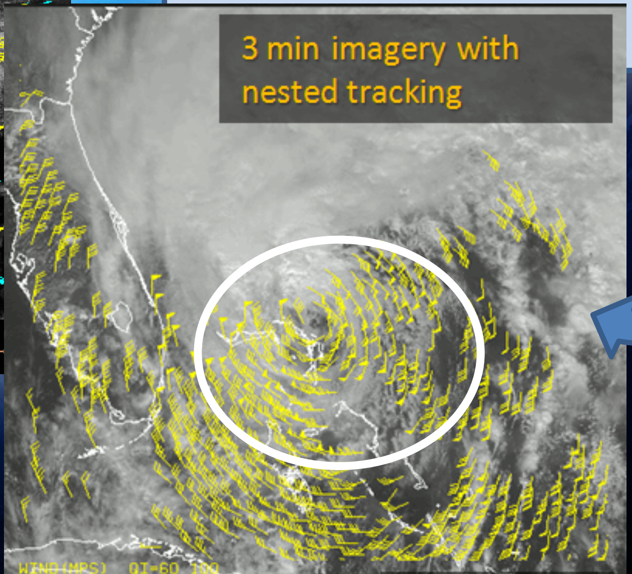
# Lessons Learned Using ABI proxy Data

## Visible AMVs from GOES-14 SRSOR rapid-scans during Hurricane Sandy




**To resolve this problem, we developed and tested a AMV algorithm update that takes advantage of:**

- OVERLAP cloud type designation
- Estimated cloud emissivity
- Opaque cloud height estimate provided by the cloud height algorithm.



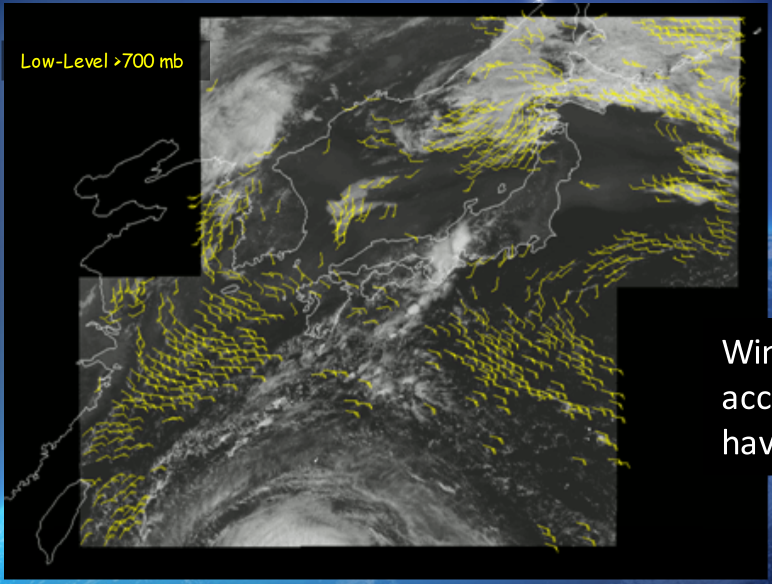
# Lessons Learned Using ABI proxy Data

**Visible winds derived from Himawar-8/AHI 2.5 min, 0.5km visible imagery in the vicinity of Super Typhoon Soudelor.**

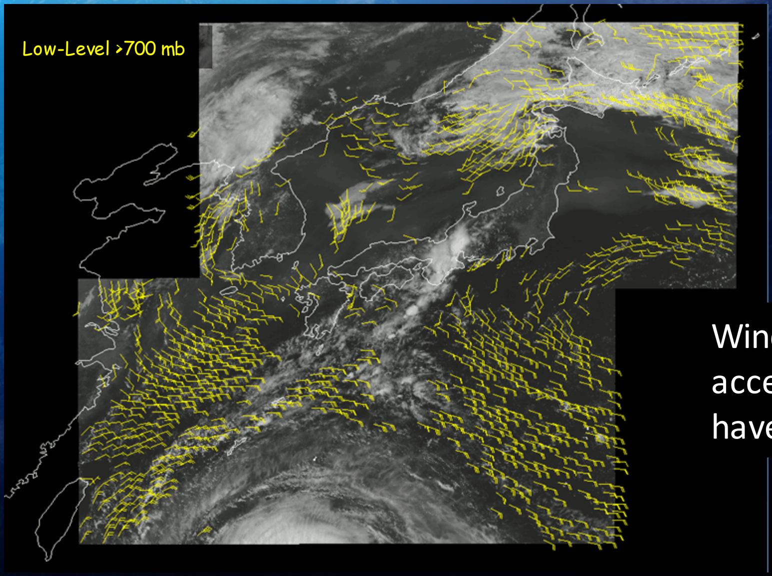
Given a set of imagery, what is the optimal configuration to use to generate AMVs in a TC environment?

- Image spatial resolution
- Image temporal resolution
- Target scene size
- Target spacing
- Image resolution
- AMC QC thresholds

What winds scale(s) are trying to be captured?



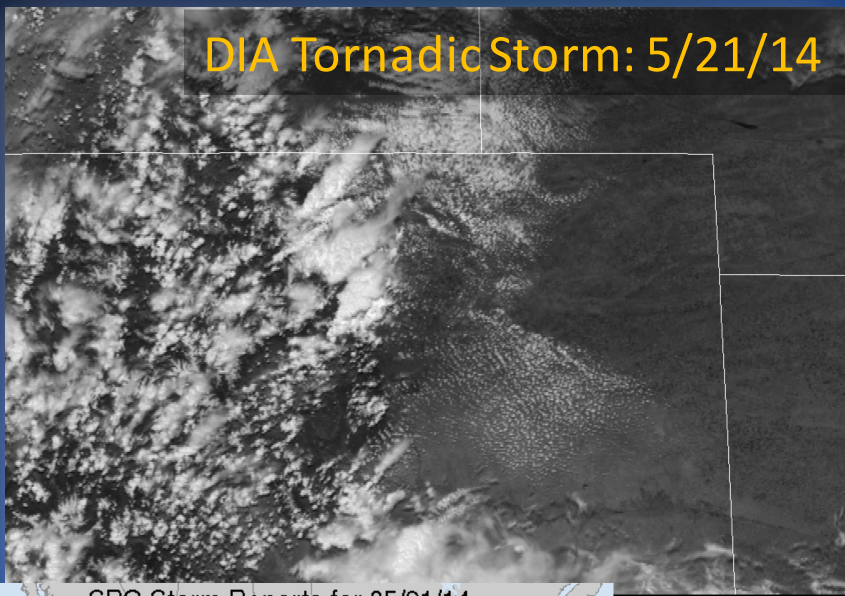

Winds exhibiting an acceleration > 5 m/s have been removed.

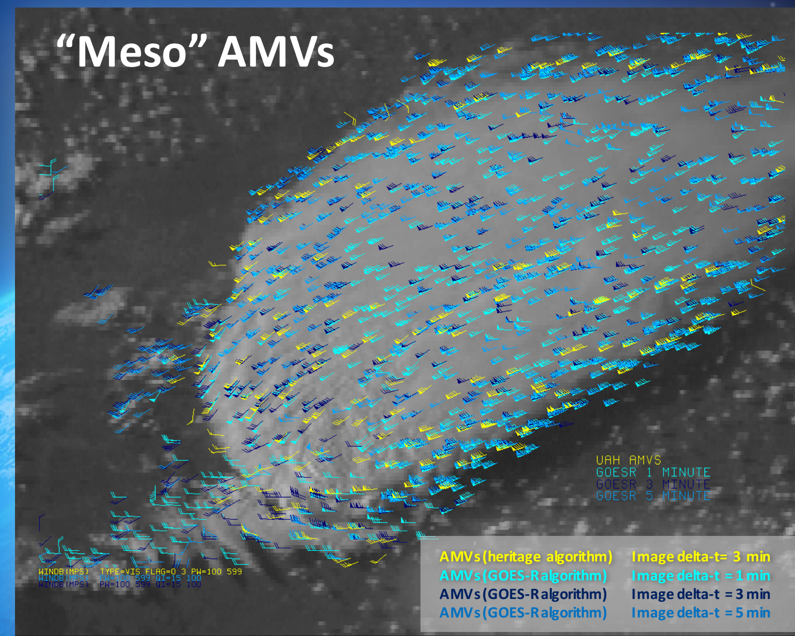


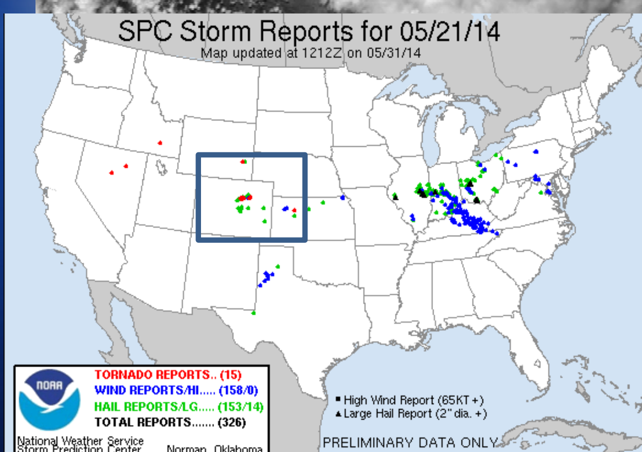

Winds exhibiting an acceleration > 7.5 m/s have been removed.

# Lessons Learned Using ABI proxy Data

GOES-14 SRSO provided *one minute mesoscale imagery* and offered a glimpse into the possibilities that will be provided by the ABI on GOES-R in one minute mesoscale imagery



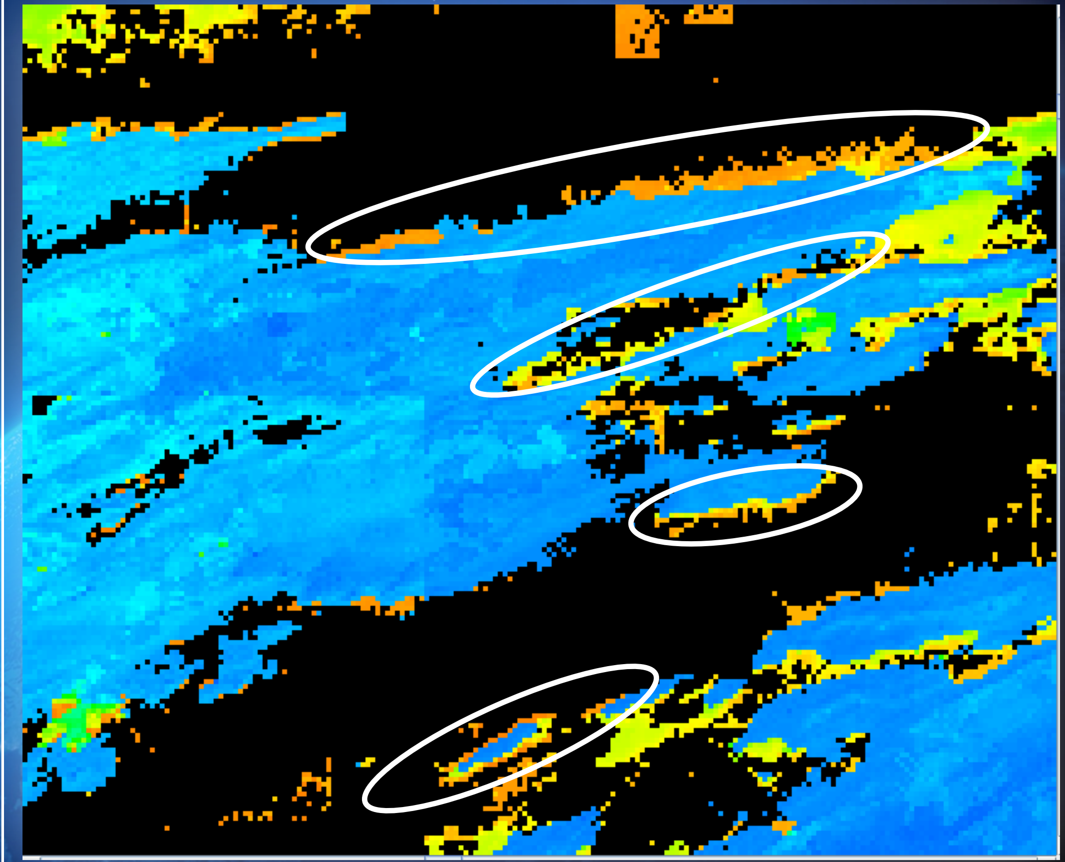




Dave Stettner will discuss this case and "meso" AMVs more in his talk on Wednesday

# Another Lesson Learned Using Externally Generated Cloud Products

- Cloud product retrievals at cloud edges can be challenging
- Can be problematic for AMV height assignments
- We've updated our GOES-R AMV algorithm to interrogate the cloud phase for pixels in the largest cluster and determine the dominant (ie., mode) cloud phase
  - Use pixels whose phase matches the dominant phase to compute the median CTP
  - This approach minimizes, but does not totally eliminate this problem

**H-8/AHI Retrieved Cloud Top Pressure**



**IWWG** ⟲ **ICWG**

# **Still Learning:** The Value of Cloud Information Associated with AMV Target Scenes

- Cloud Information *(beyond CTP/CTT)*
  - Cloud Optical Depth, Cloud type/phase
  - Estimates of retrieval error (CTP, CTT, OE Cost)

- What is the value of this information in terms of Quality Control ?

**IWWG** **ICWG**

# Himawari-8 LWIR *(11.2um)* Winds vs. Radiosondes

## 2/9/2016 – 6/21/2016 (60 <QI < 100)

| All Levels (100-1000 hPa) | Estimate of Cloud Top Pressure Error | | | |
|---|---|---|---|---|
| | 0 – 50mb | 50 – 100mb | 100 – 200mb | > 200mb |
| **MVD** *(m/s)* | 5.62 | 6.51 | 8.78 | 7.91 |
| **St. Deviation** *(m/s)* | 4.31 | 5.08 | 6.70 | 6.74 |
| **Speed bias** *(m/s)* | -1.18 | 0.18 | 1.77 | -2.23 |
| **Speed** *(m/s)* | 19.95 | 21.28 | 25.21 | 15.59 |
| **Sample** | 291251 | 119936 | 55262 | 3565 |
| **High Level (100-400 hPa)** | | | | |
| **MVD** *(m/s)* | **6.06** | **6.54** | **8.78** | **14.40** |
| **St. Deviation** *(m/s)* | **4.46** | **5.05** | **6.43** | **8.13** |
| **Speed bias** *(m/s)* | **-1.31** | **0.49** | **2.19** | **0.09** |
| **Speed** *(m/s)* | 24.63 | 22.41 | 28.53 | 42.88 |
| **Sample** | 180355 | 101809 | 35240 | 217 |
| **Mid Level (400-700 hPa)** | | | | |
| **MVD** *(m/s)* | **5.78** | **7.12** | **9.17** | **8.29** |
| **St. Deviation** *(m/s)* | **4.69** | **5.66** | **7.28** | **6.87** |
| **Speed bias** *(m/s)* | **-1.77** | **-2.03** | **1.21** | **-2.63** |
| **Speed** *(m/s)* | 15.62 | 17.24 | 20.36 | 15.38 |
| **Sample** | 57248 | 13232 | 18402 | 2624 |
| **Low Level (700-1000 hPa)** | | | | |
| **MVD** *(m/s)* | 3.96 | 4.26 | 4.23 | 4.56 |
| **St. Deviation** *(m/s)* | 2.73 | 3.03 | 2.80 | 2.98 |
| **Speed bias** *(m/s)* | -0.13 | -0.34 | -0.94 | -1.45 |
| **Speed** *(m/s)* | 8.88 | 8.76 | 8.15 | 8.19 |
| **Sample** | 53646 | 4895 | 1620 | 724 |

# Himawari-8 LWIR Winds vs Radiosonde

## (2/9/2016 – 6/21/2016; 60 < QI < 100)

| All Levels (100-1000 hPa) | Estimate of Cloud Top Temperature Error | | | |
|---|---|---|---|---|
| | 0 – 5K | 5– 10K | 10 – 20K | > 20K |
| MVD *(m/s)* | 5.60 | 6.11 | 7.32 | 8.49 |
| St. Deviation *(m/s)* | 4.34 | 4.70 | 5.83 | 6.21 |
| Speed bias *(m/s)* | -1.33 | -1.05 | 1.11 | 1.74 |
| Speed *(m/s)* | 19.09 | 22.22 | 22.98 | 29.16 |
| Sample | 236062 | 85530 | 146366 | 201 |
| High Level (100-400 hPa) | | | | |
| MVD *(m/s)* | **6.30** | **6.00** | **7.02** | **8.63** |
| St. Deviation *(m/s)* | **4.58** | **4.58** | **5.49** | **6.23** |
| Speed bias *(m/s)* | **-1.69** | **-0.77** | **1.12** | **1.76** |
| Speed *(m/s)* | 25.88 | 23.42 | 23.46 | 29.34 |
| Sample | 120416 | 70336 | 125027 | 196 |
| Mid Level (400-700 hPa) | | | | |
| MVD *(m/s)* | **5.82** | **6.69** | **9.14** | **3.04** |
| St. Deviation *(m/s)* | **4.73** | **5.23** | **7.31** | **1.00** |
| Speed bias *(m/s)* | **-1.84** | **-2.29** | **1.14** | **0.97** |
| Speed *(m/s)* | 15.45 | 16.95 | 20.28 | 22.18 |
| Sample | 55788 | 14651 | 21092 | 5 |
| Low Level (700-1000 hPa) | | | | |
| MVD *(m/s)* | 3.97 | 5.93 | 6.44 | NA |
| St. Deviation *(m/s)* | 2.74 | 3.46 | 3.67 | NA |
| Speed bias *(m/s)* | -0.13 | -4.00 | -4.84 | NA |
| Speed *(m/s)* | 8.84 | 9.36 | 8.10 | NA |
| Sample | 59856 | 543 | 247 | NA |

# Himawari-8 LWIR Winds vs Radiosonde
## (2/9/2016 – 6/21/2016; 60 < QI < 100)

| All Levels (100-1000 hPa) | Cloud Optical Depth | | |
|---|---|---|---|
| | **0 – 1.0** | **1.0 – 10** | **10 - 20** |
| **MVD** *(m/s)* | 7.37 | 5.65 | 7.67 |
| **St. Deviation** *(m/s)* | 5.81 | 4.39 | 5.87 |
| **Speed bias** *(m/s)* | 0.70 | -1.09 | -2.73 |
| **Speed** *(m/s)* | 22.68 | 20.04 | 20.18 |
| **Sample** | 152549 | 306134 | 4121 |
| **High Level (100-400 hPa)** | | | |
| **MVD** *(m/s)* | **7.14** | **6.12** | **6.41** |
| **St. Deviation** *(m/s)* | **5.54** | **4.54** | **4.30** |
| **Speed bias** *(m/s)* | **0.87** | **-1.19** | **-1.27** |
| **Speed** *(m/s)* | 23.64 | 25.04 | 24.02 |
| **Sample** | 124314 | 184580 | 2021 |
| **Mid Level (400-700 hPa)** | | | |
| **MVD** ***(m/s)*** | **8.40** | **5.91** | **9.42** |
| **St. Deviation** ***(m/s)*** | **6.86** | **4.80** | **7.14** |
| **Speed bias** ***(m/s)*** | **0.02** | **-1.70** | **-4.87** |
| **Speed** *(m/s)* | 18.63 | 15.94 | 17.67 |
| **Sample** | 27796 | 61613 | 1764 |
| **Low Level (700-1000 hPa)** | | | |
| **MVD** *(m/s)* | 6.09 | 3.97 | 6.08 |
| **St. Deviation** *(m/s)* | 3.53 | 2.74 | 3.87 |
| **Speed bias** *(m/s)* | -4.27 | -0.15 | -0.34 |
| **Speed** *(m/s)* | 8.34 | 8.84 | 10.27 |
| **Sample** | 439 | 59939 | 336 |

# Himawari-8 LWIR Winds vs Radiosonde
## (2/9/2016 – 6/21/2016; 60 < QI < 100)

| **All Levels** (100-1000 hPa) | **OE Cost** | | |
|---|---|---|---|
| | **0 – 1** | **1 – 5** | **5 - 18** |
| **MVD** *(m/s)* | 6.10 | 9.12 | 10.08 |
| **St. Deviation** *(m/s)* | 4.77 | 6.71 | 6.94 |
| **Speed bias** *(m/s)* | -0.13 | 1.61 | 4.60 |
| **Speed** *(m/s)* | 21.02 | 22.52 | 20.43 |
| **Sample** | 278072 | 3859 | 234 |
| **High Level** (100-400 hPa) | | | |
| **MVD** *(m/s)* | **6.31** | **8.65** | **8.63** |
| **St. Deviation** *(m/s)* | **4.78** | **6.24** | **5.83** |
| **Speed bias** *(m/s)* | **-0.14** | **0.76** | **2.44** |
| **Speed** *(m/s)* | 23.38 | 22.66 | 18.94 |
| **Sample** | 215814 | 3163 | 155 |
| **Mid Level** (400-700 hPa) | | | |
| **MVD** *(m/s)* | **6.04** | **11.85** | **15.02** |
| **St. Deviation** *(m/s)* | **5.24** | **8.30** | **8.07** |
| **Speed bias** *(m/s)* | **-0.27** | **6.05** | **10.46** |
| **Speed** *(m/s)* | 14.94 | 23.25 | 27.72 |
| **Sample** | 41873 | 631 | 59 |
| **Low Level** (700-1000 hPa) | | | |
| **MVD** *(m/s)* | 4.01 | 5.31 | 6.76 |
| **St. Deviation** *(m/s)* | 2.83 | 3.22 | 3.00 |
| **Speed bias** *(m/s)* | 0.26 | -0.13 | 4.15 |
| **Speed** *(m/s)* | 8.60 | 8.58 | 10.40 |
| **Sample** | 20385 | 65 | 20 |

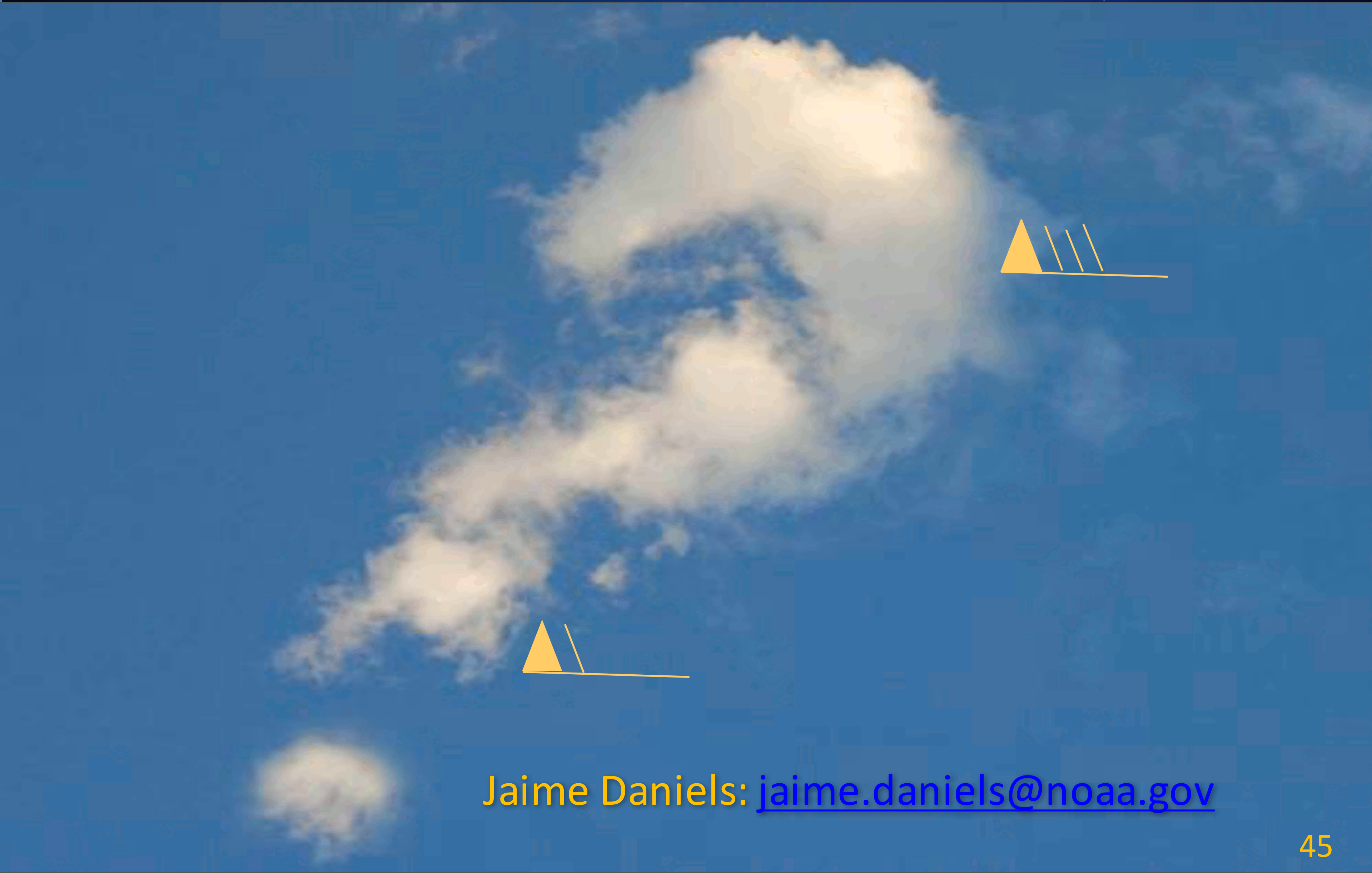
# Outline

- Latest on GOES-R
- Review of the GOES-R Winds Algorithm
- Examples and Lessons Learned Using Available ABI Proxy Data
- Summary

# Summary

- GOES-R Launch Date: No earlier than 4 November 2016
- GOES-R winds algorithm has been run and tested on numerous ABI proxy datasets.
- Focused recent testing and analysis on GOES-14 super rapid scan and Himawari-8/AHI to optimize AMV algorithm configurations and quality control
- We are still learning the value of cloud information associated with AMV target scenes. Active topic for collaboration between the IWWG and ICWG.

# Questions



Jaime Daniels: jaime.daniels@noaa.gov

# BACKUP SLIDES

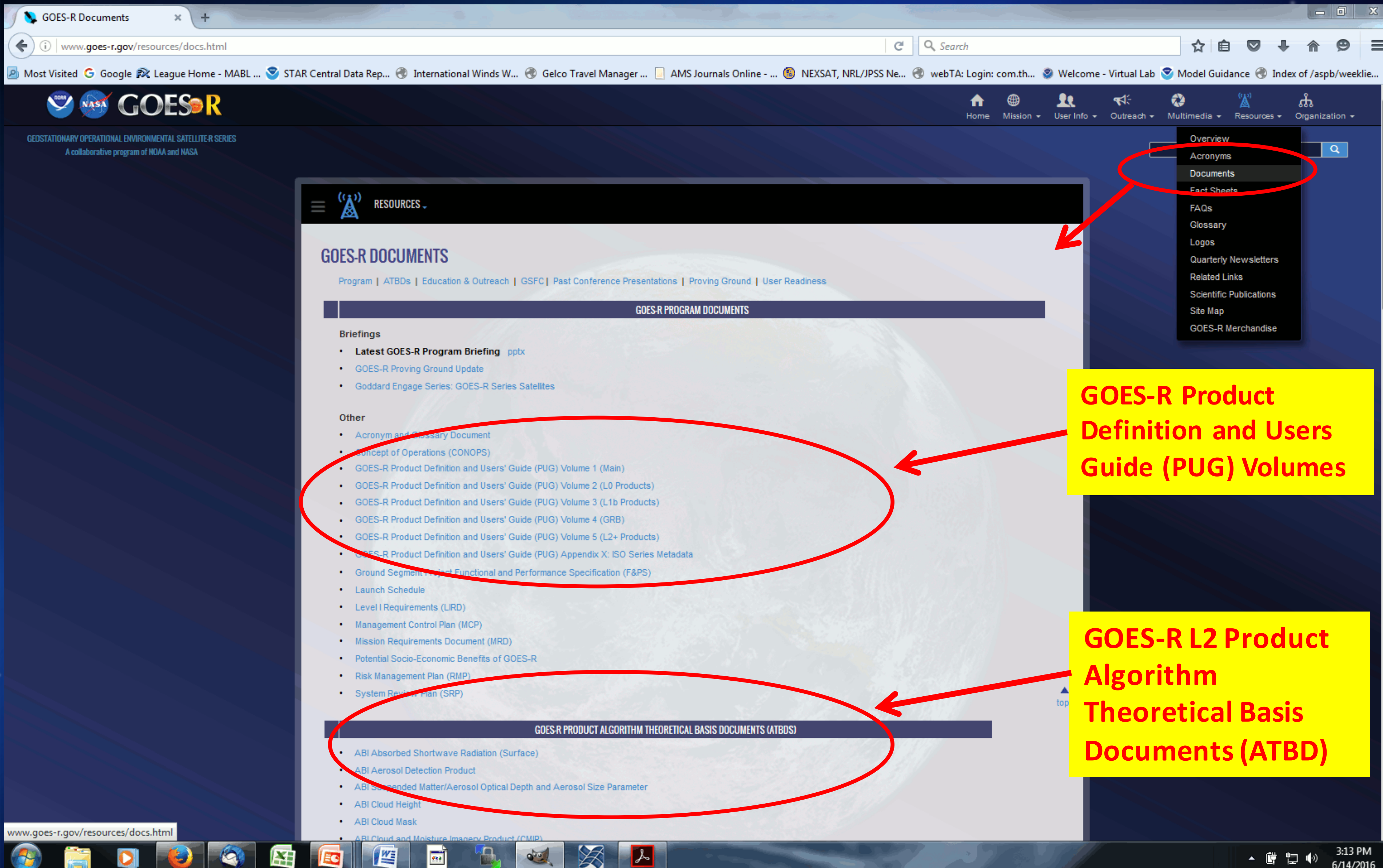
# Nested Tracking & Clustering Details

- **Size of outer target scene is 19x19 pixels**
  - 2-pixel offset is used that yields a maximum of 225 possible local motion estimates derived from nested 5x5 target scenes

- **An initial sample of local motion vectors is filtered by imposing a 0.8 correlation threshold**

- **Clustering (via DBSCAN)**
  - *Specification of two parameters to start*
    - Minimum number of points in a cluster (4)
    - Radius about each point to search for neighboring points (1/2 pixel)
  - *Each point (ie., displacement) is processed and given a classification based on nearby points*
    - <u>"Core" cluster point:</u> Has at least 4 points in neighborhood (radius)
    - <u>"Boundary" point:</u> Has fewer than 4 neighbors, but connected to neighborhood by at least one other point
    - <u>"Noise":</u> Point does not belong to any cluster

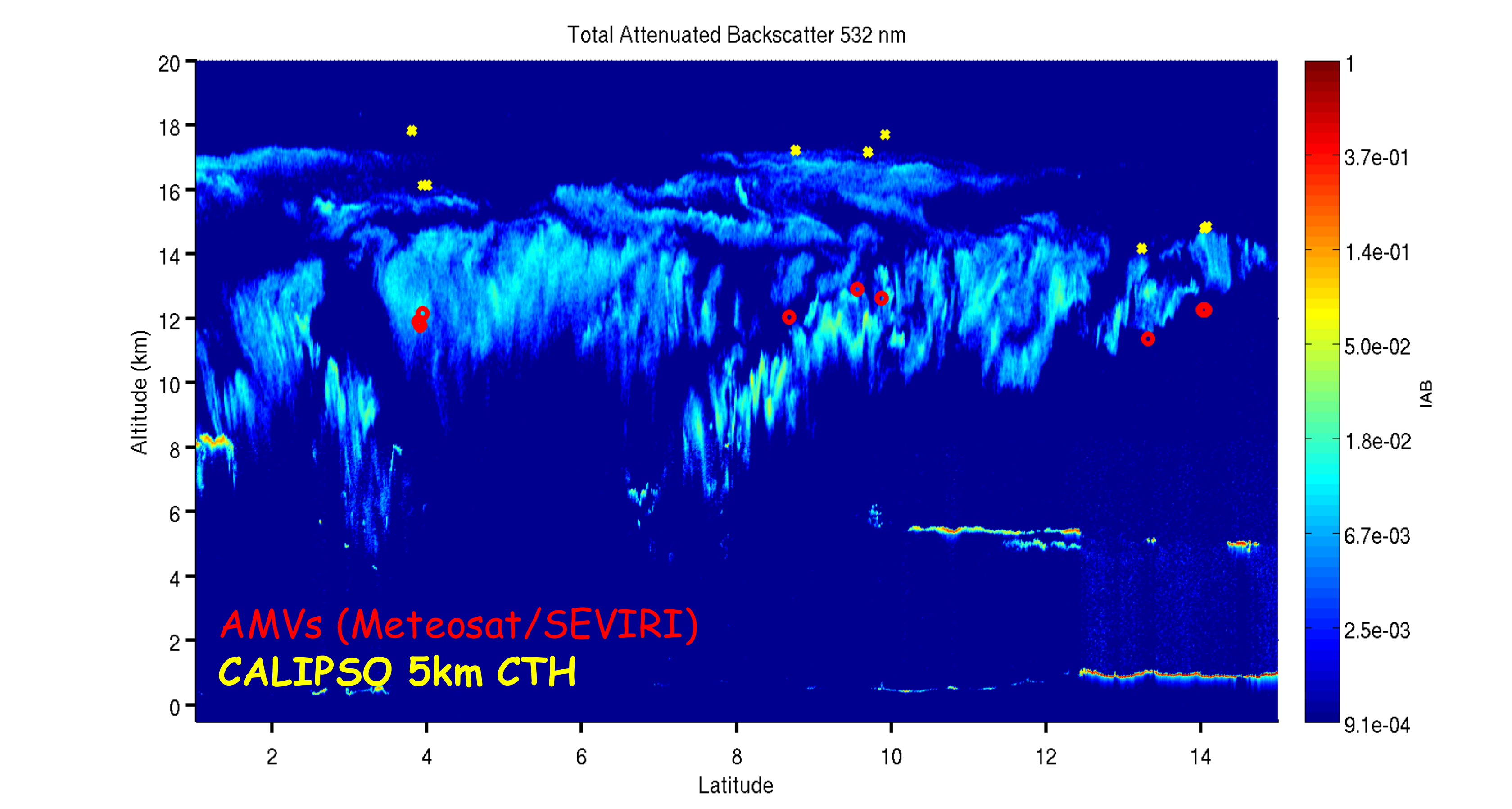
# http://www.goes-r.gov/




GOES-R Product Definition and Users Guide (PUG) Volumes

GOES-R L2 Product Algorithm Theoretical Basis Documents (ATBD)

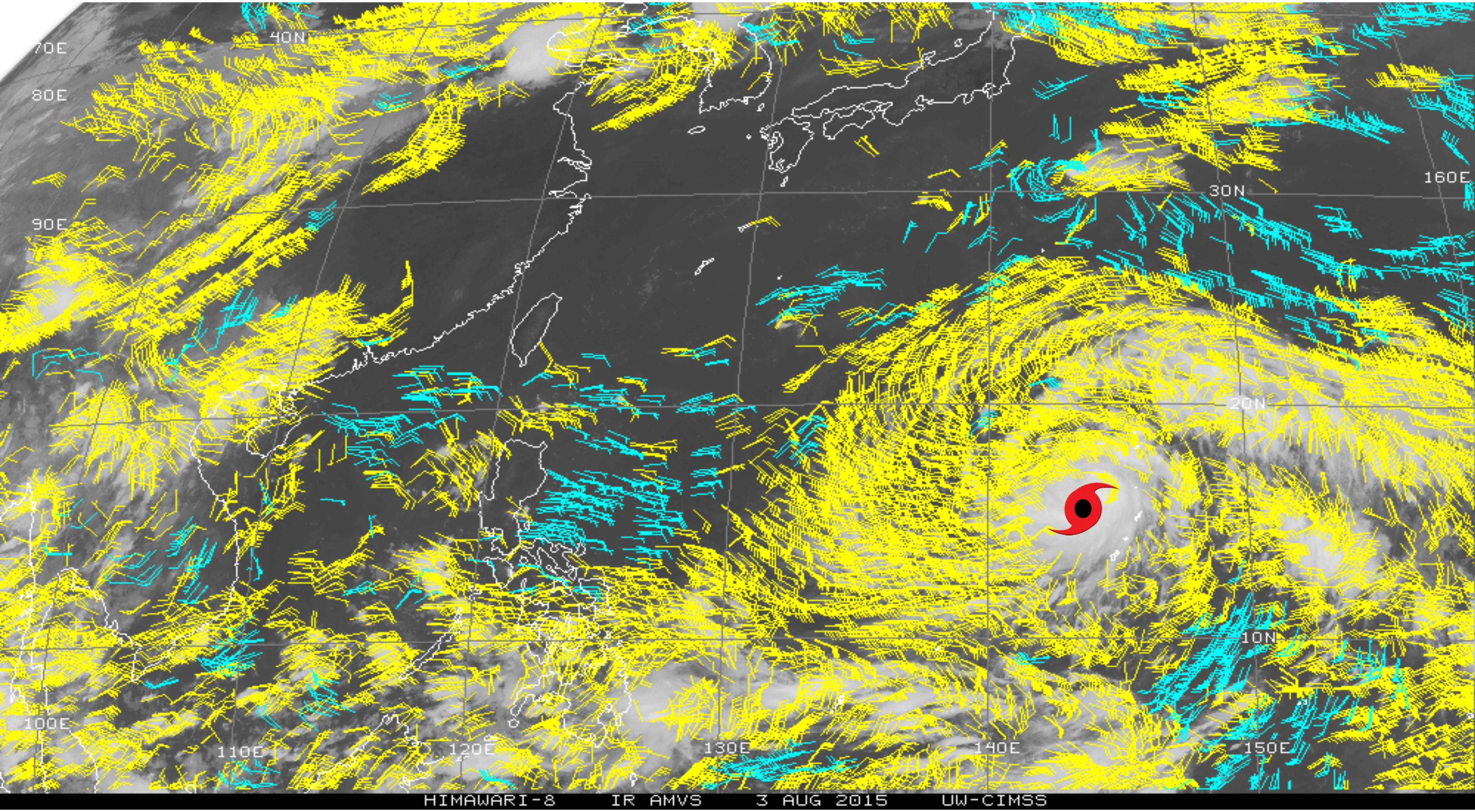
# Example Deep Dive Validation: CALIPSO Cloud-Top Heights vs. DMW Height Assignments




**Instruments "see" different things, but comparisons are still useful**


Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin - Madison

# Himawari-8 AHI Data and Assimilation for Typhoon Soudelor (2015)




GOES-R AWG algorithm Atmospheric Motion Vectors -- 100-500hPa (yellow) 500-950hPa (blue)