AMV RESEARCH USING SIMULATED DATASETS

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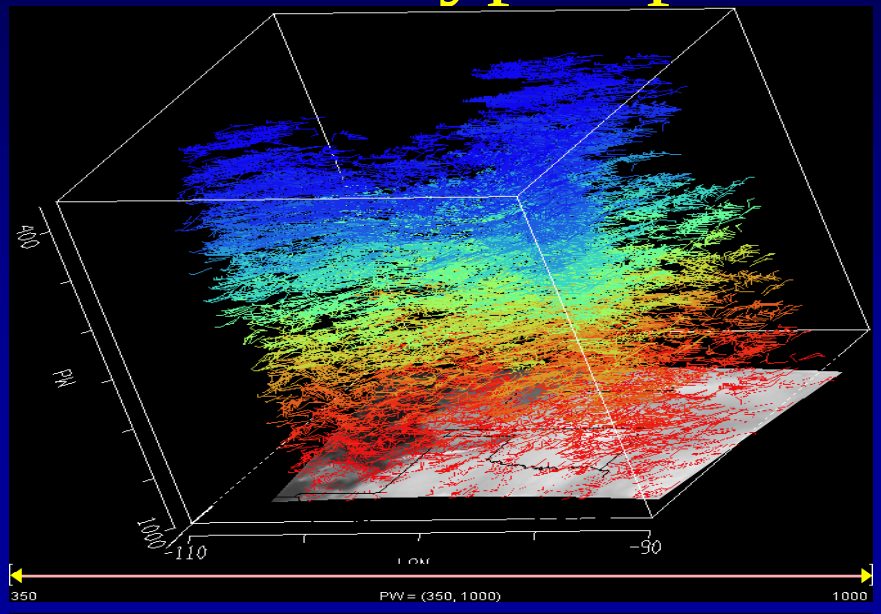
Study Content

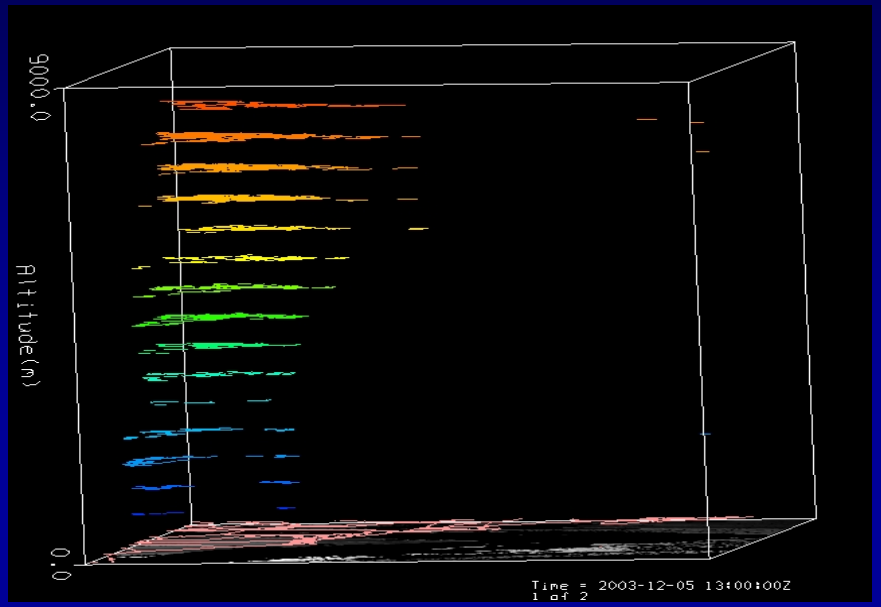
- Motivation
- Review of simulated hyperspectral sounder retrieval AMVs
- Simulated GOES-R ABI AMVs
- Simulated Meteosat-8 AMVs (w/ ECMWF)
- Future Work

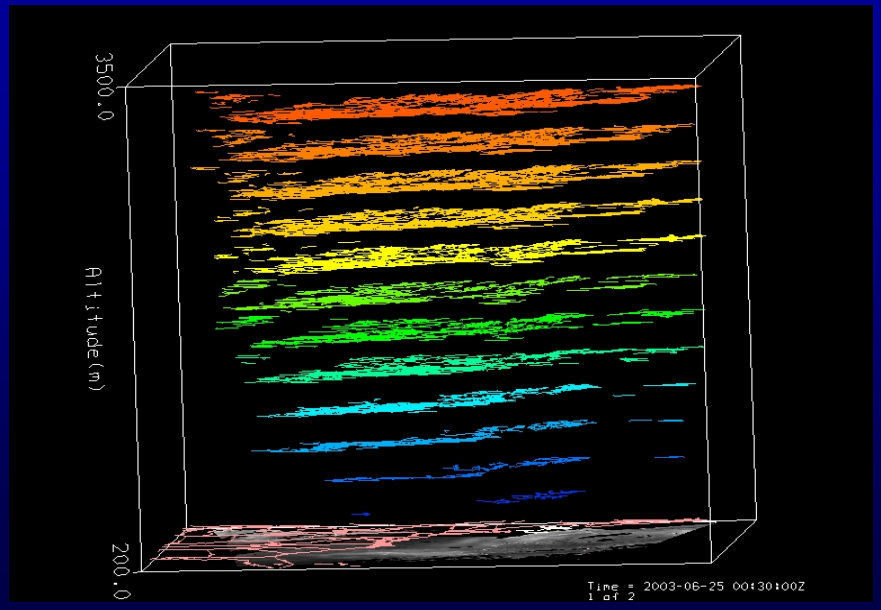
Motivation

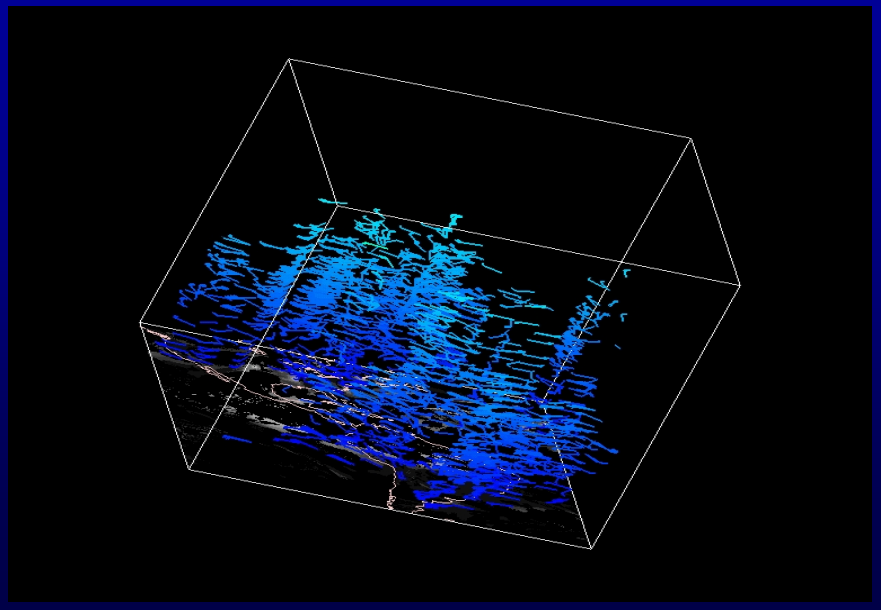
- The NOAA/NESDIS GOES-R Risk Reduction effort, and the accompanying Algorithm Working Group (AWG), was established to manage and coordinate the development of GOES-R products and validation activities that will support readiness for GOES-R implementation and operations (~ 2016).
- Proxy datasets, including simulated data, are necessary for pre-launch studies.
- 15 AWG Teams – Winds group is one.

AMVs from simulated hyperspectral sounder data





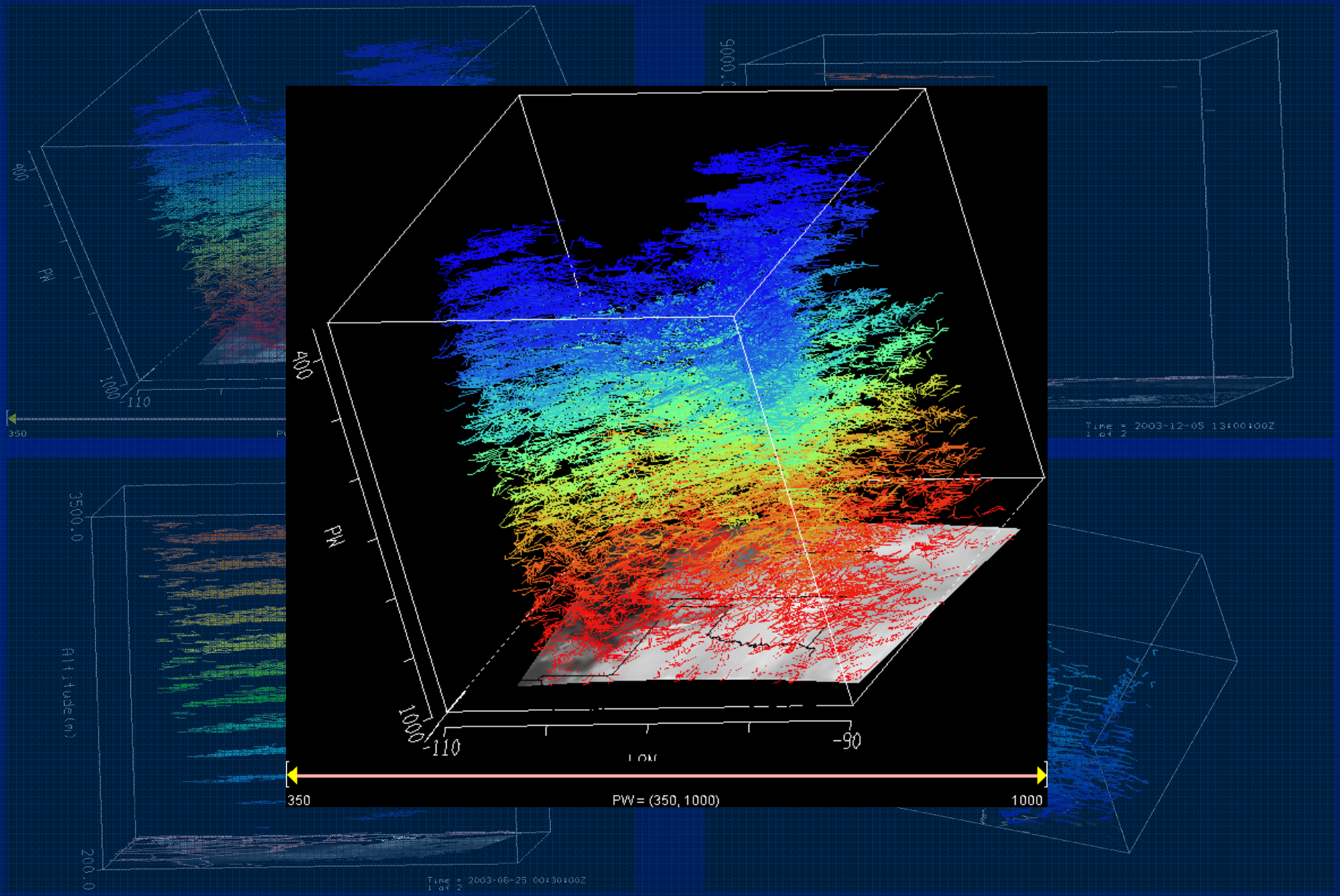




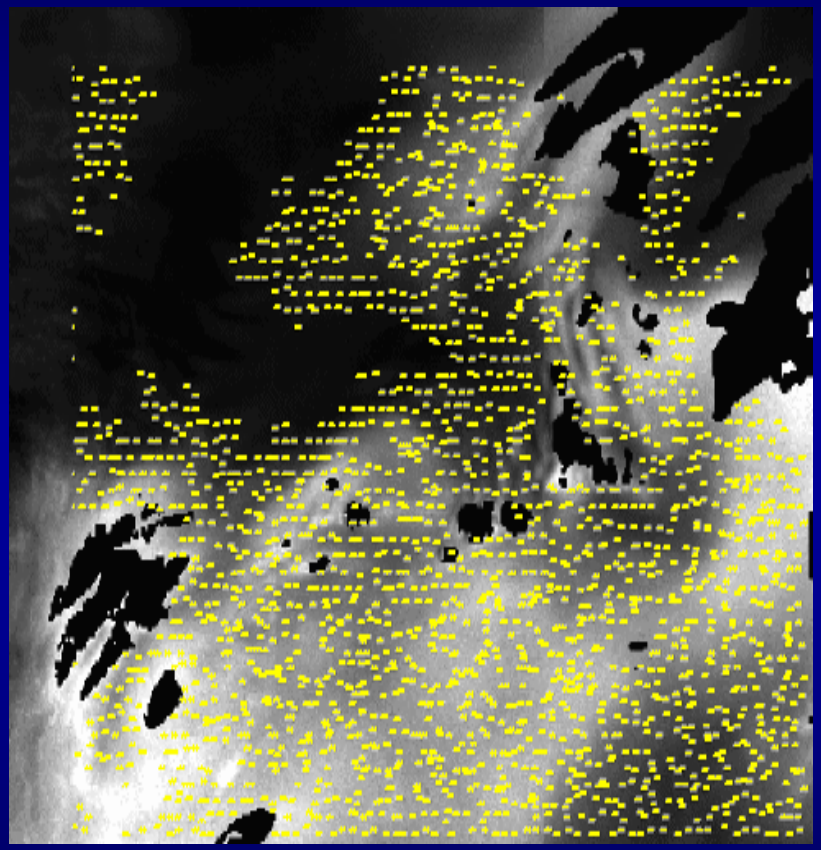
Methodology

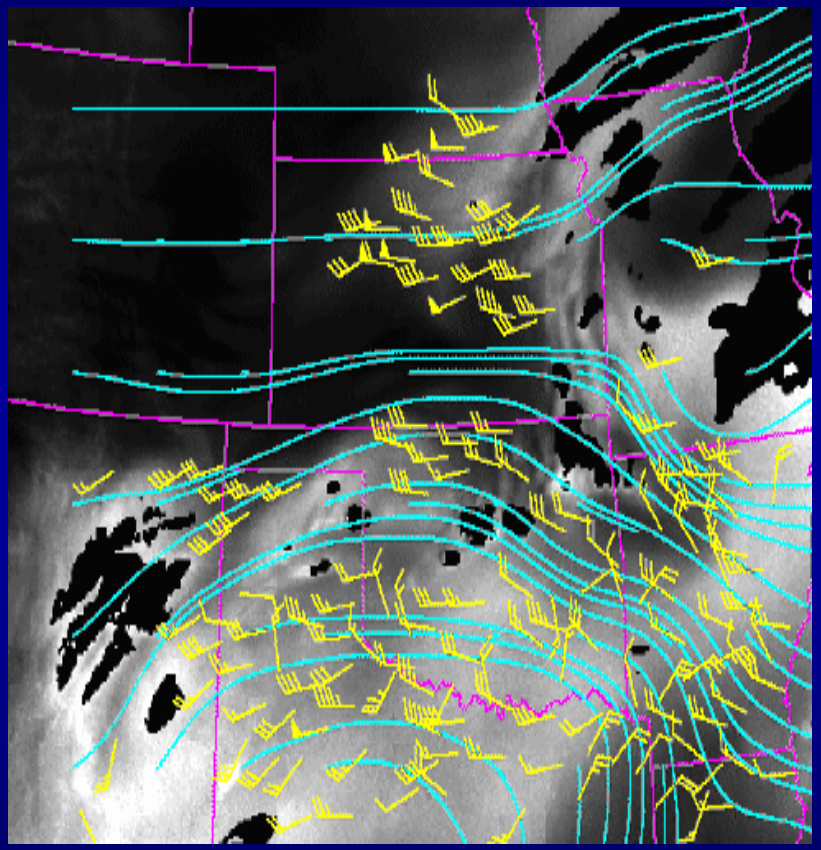
- Employ high resolution mesoscale models to generate simulated atmospheres.
- Calculate Top of Atmosphere (TOA) radiances from the mesoscale model simulations using the GIFTS forward radiative transfer model.
- Generate single-field-of view water vapor retrievals (vertical profiles) from the TOA radiances.
- Target and track clear-sky Atmospheric Motion Vectors (AMV) using constant-pressure (altitude) analyses derived from the water vapor retrievals and model mixing ratios.

Simulated hyperspectral sounder AMVs



First attempt at AMVs from simulated hyperspectral sounder data – central US (Velden – IWW6 & 7)



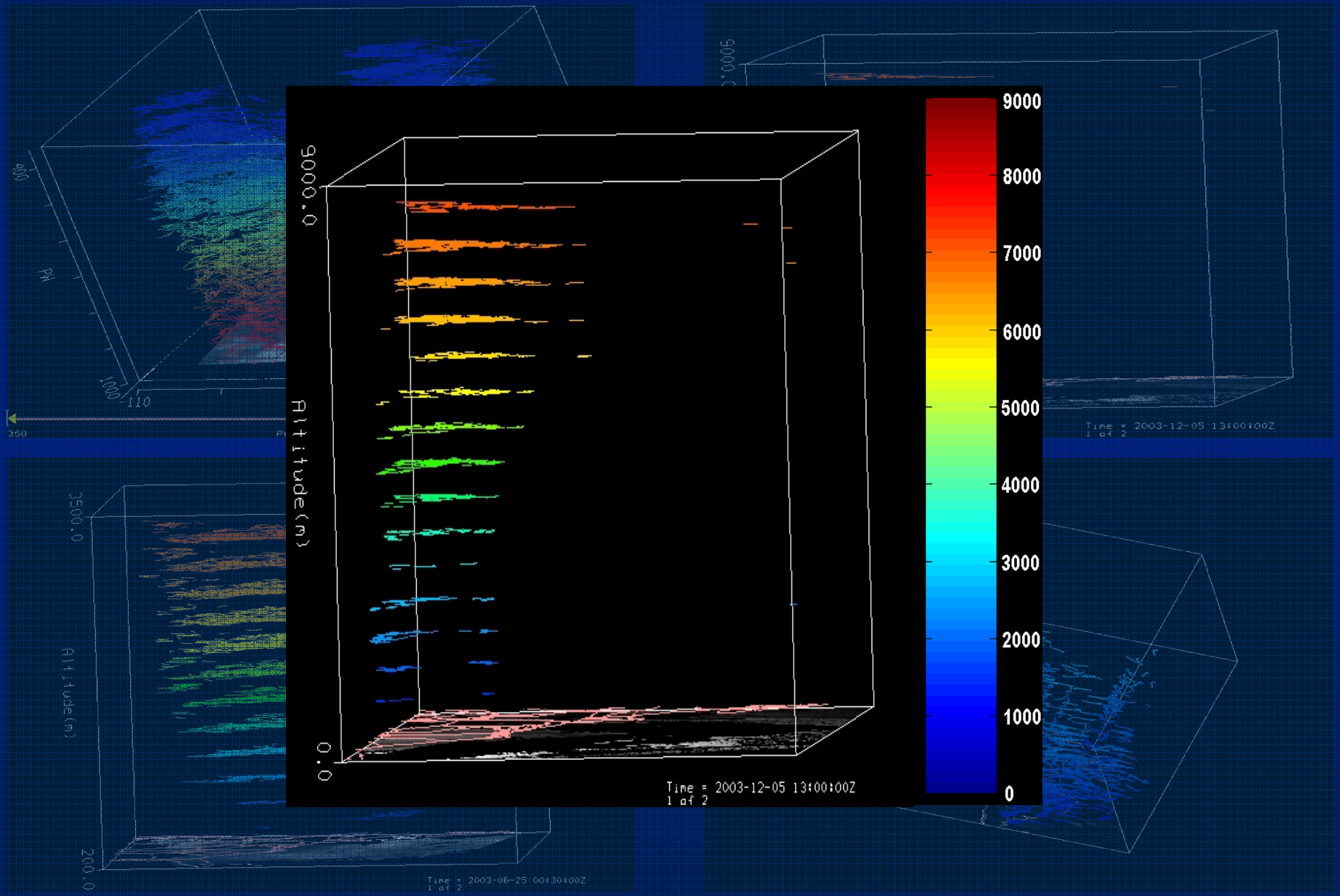


Noise Filtered Retrievals targets

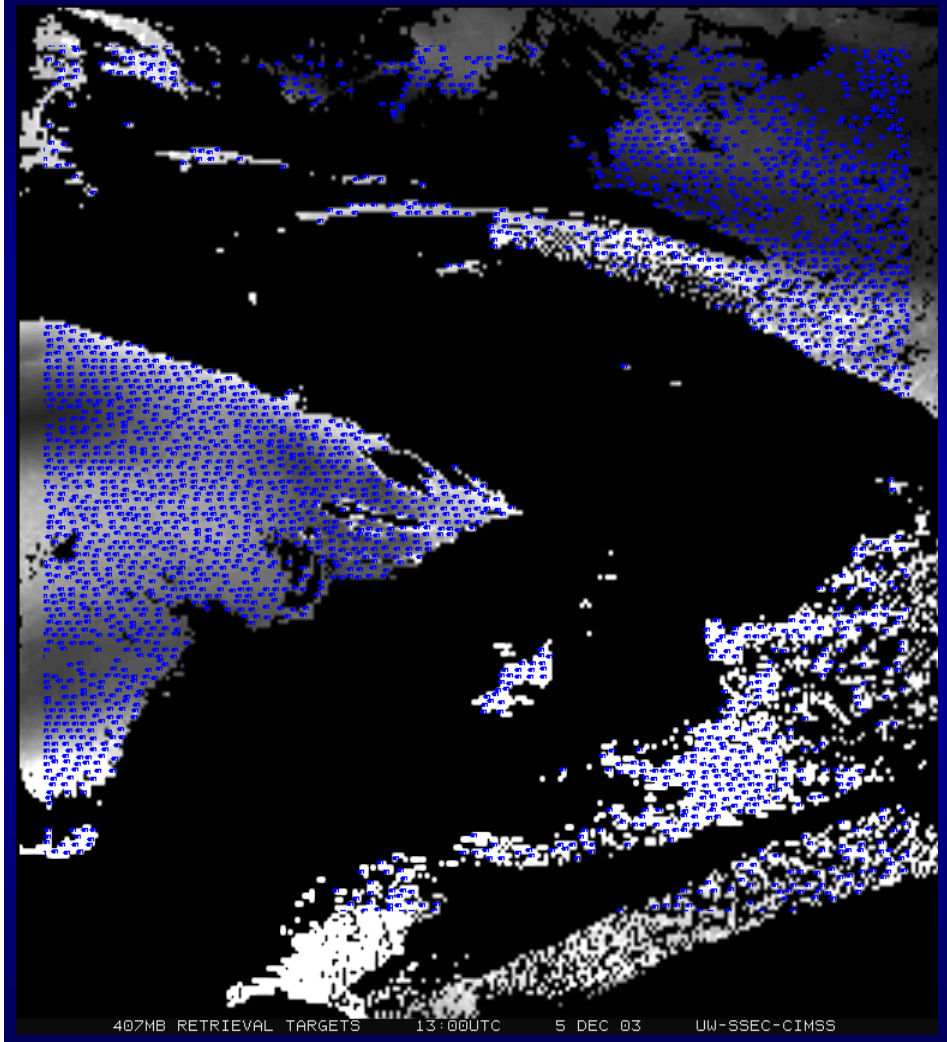
500 mb

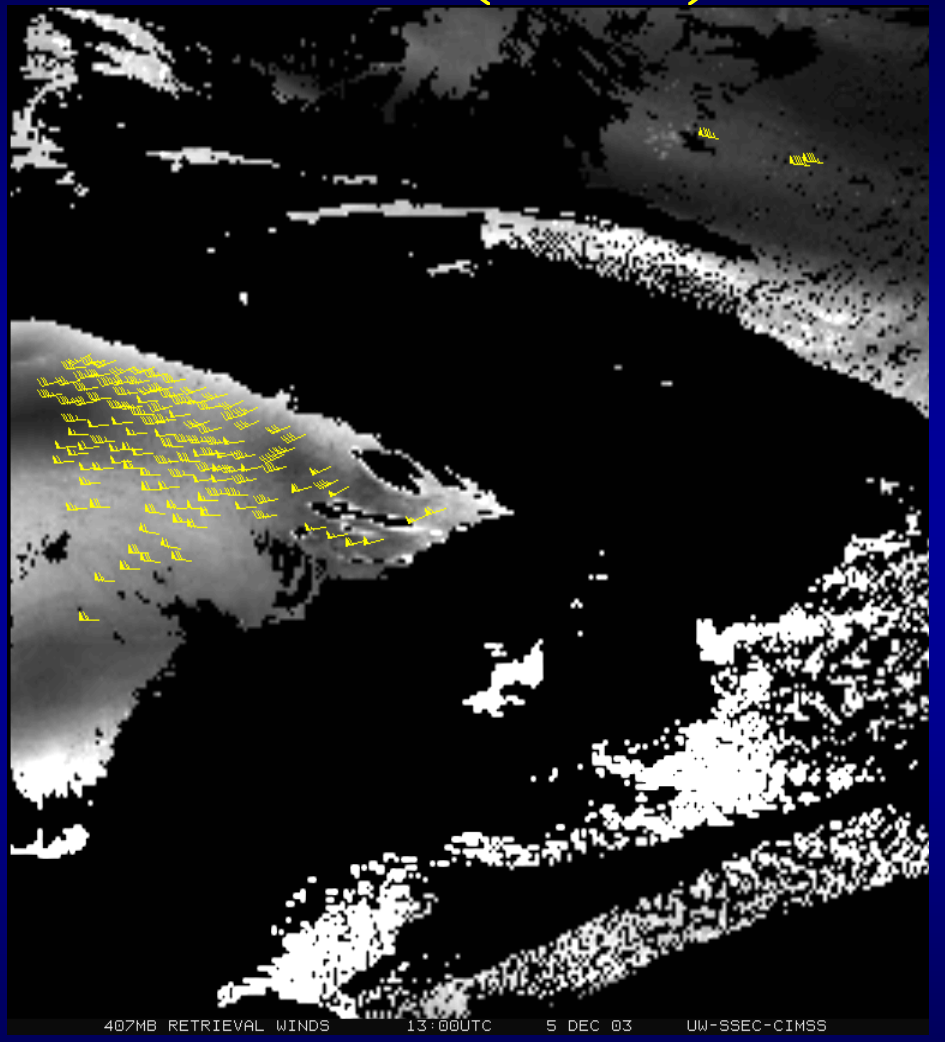
Noise Filtered Retrievals wind vectors (no QI)

Simulated hyperspectral Sounder AMVs



AMVs from simulated hyperspectral sounder data – ATREC case (2003)



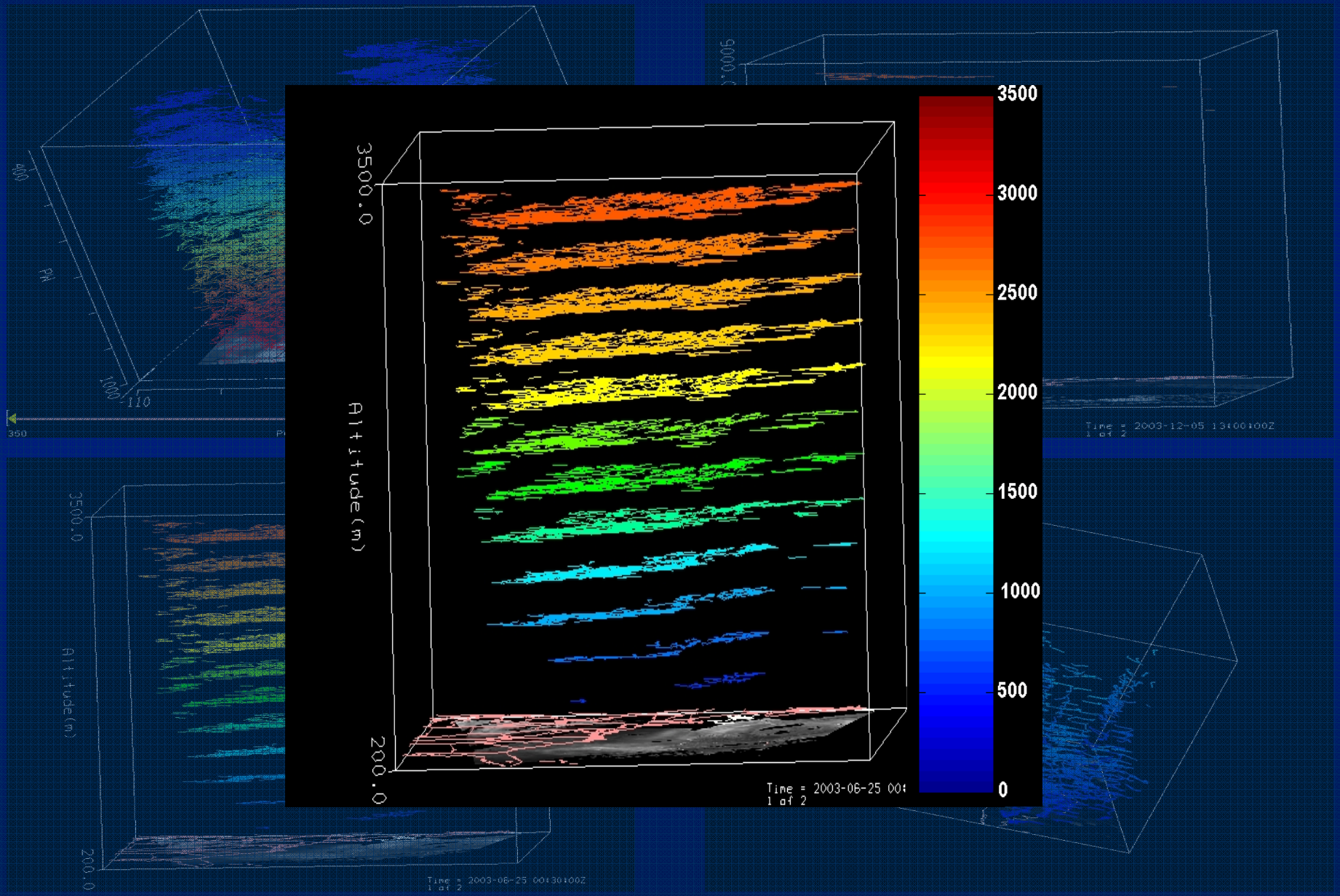


Noise Filtered Retrievals targets

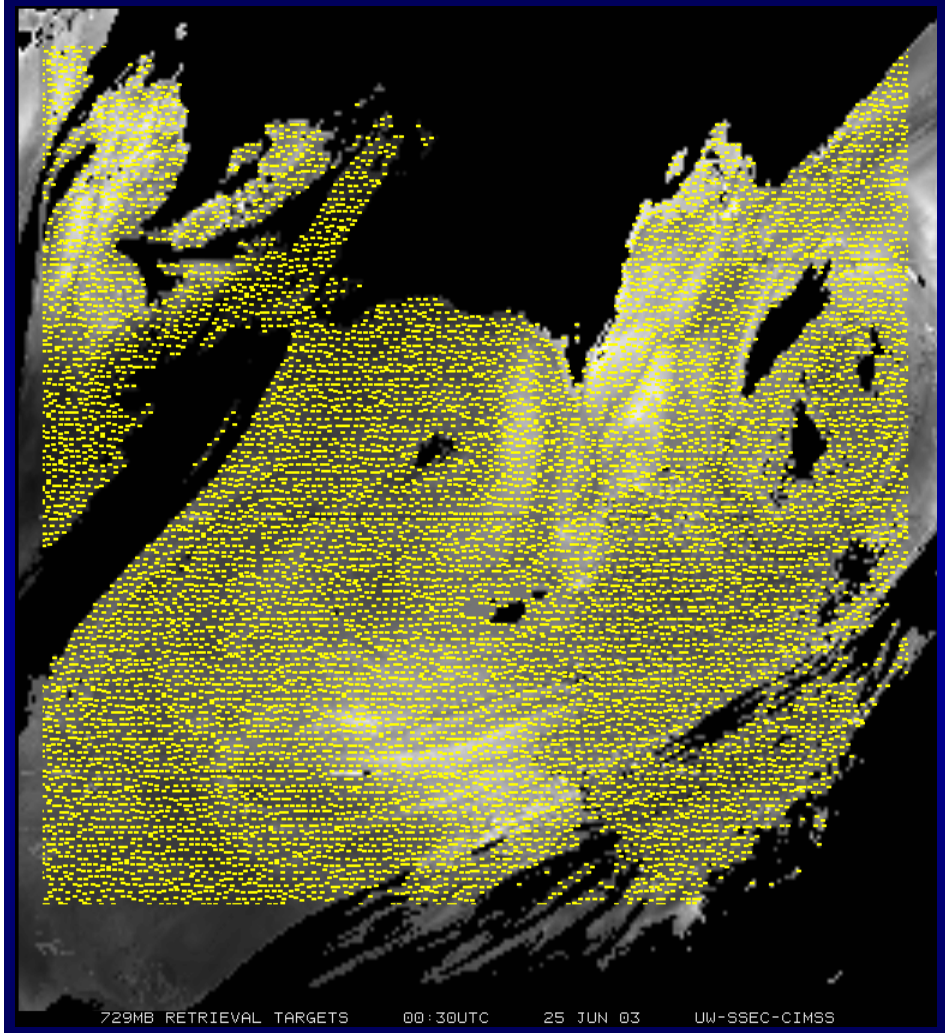
407 mb

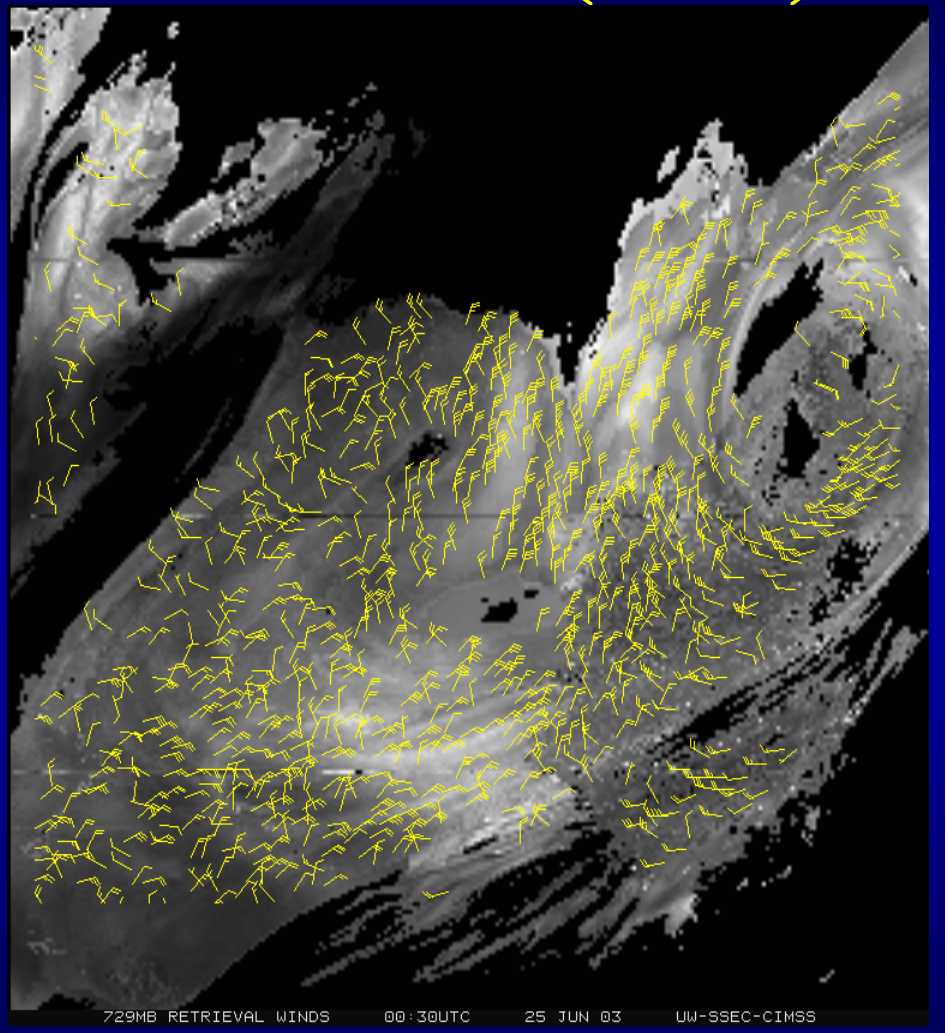
Noise Filtered Retrievals vectors (QI>60)

Simulated hyperspectral sounder AMVs



AMVs from simulated hyperspectral sounder data – Ocean Winds case (2003)



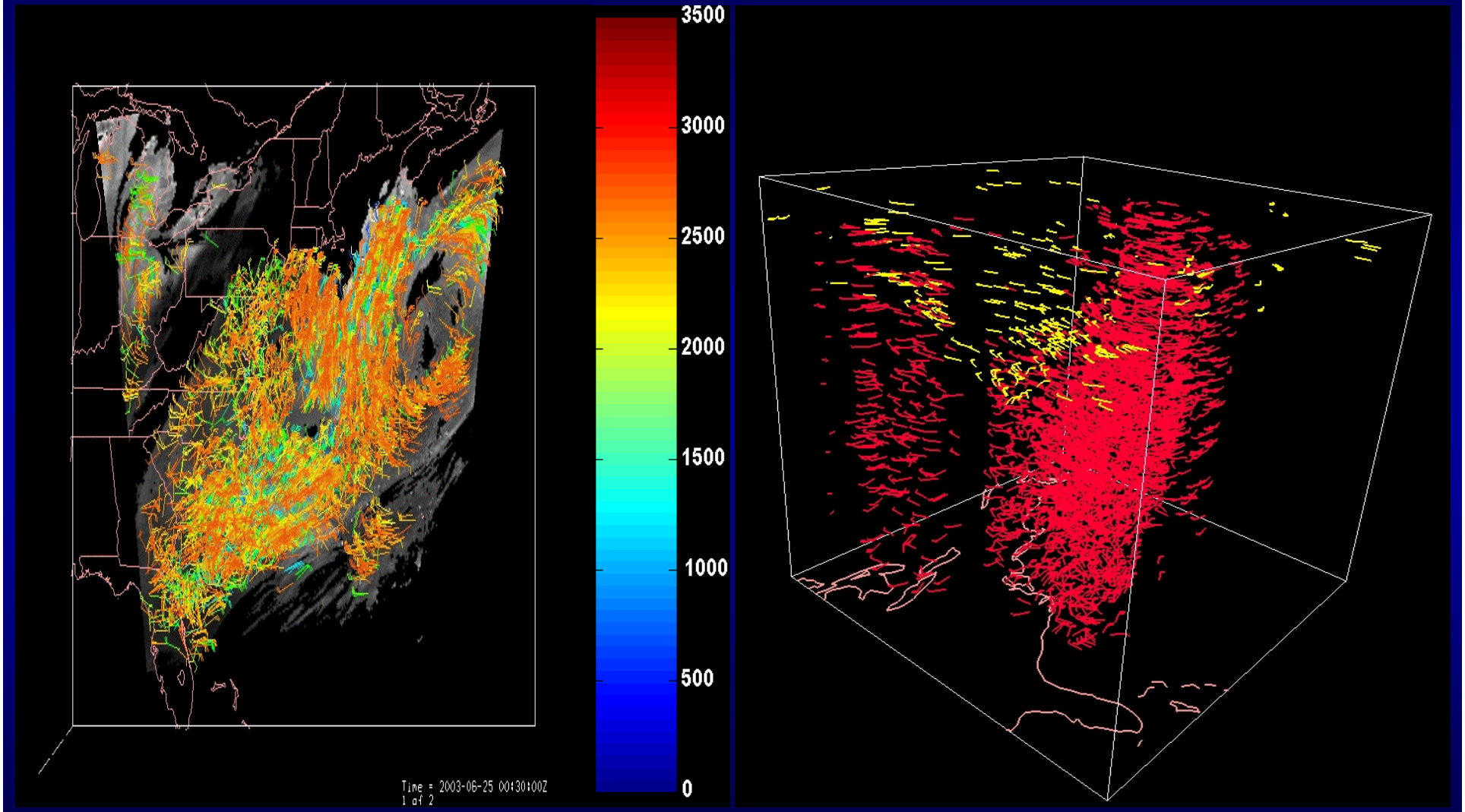


Noise Filtered Retrievals targets

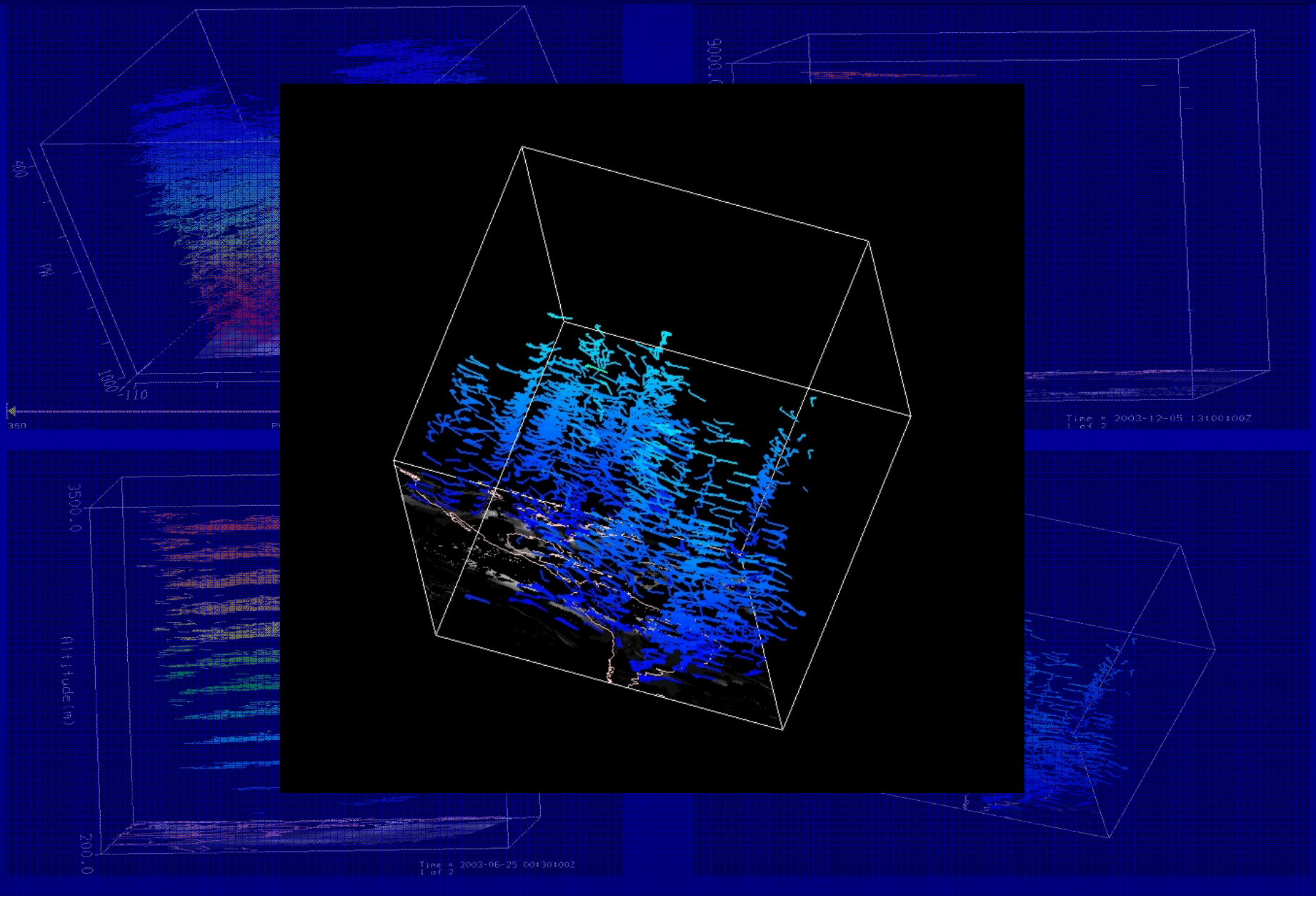
729 mb

Noise Filtered Retrievals vectors (QI > 60)

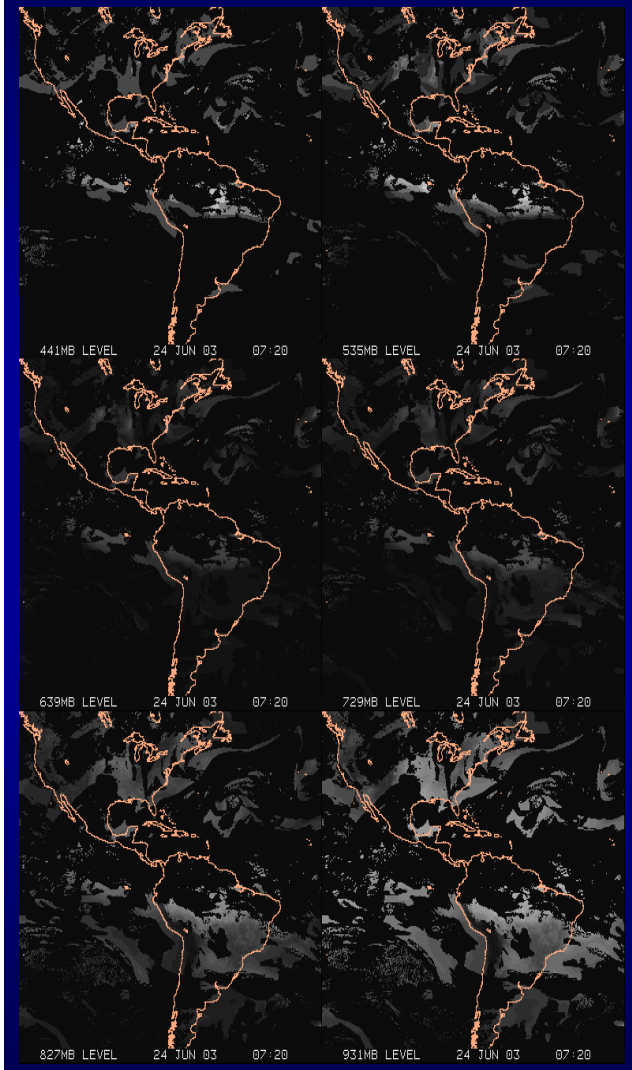
AMVs from simulated hyperspectral sounder data – Ocean Winds case

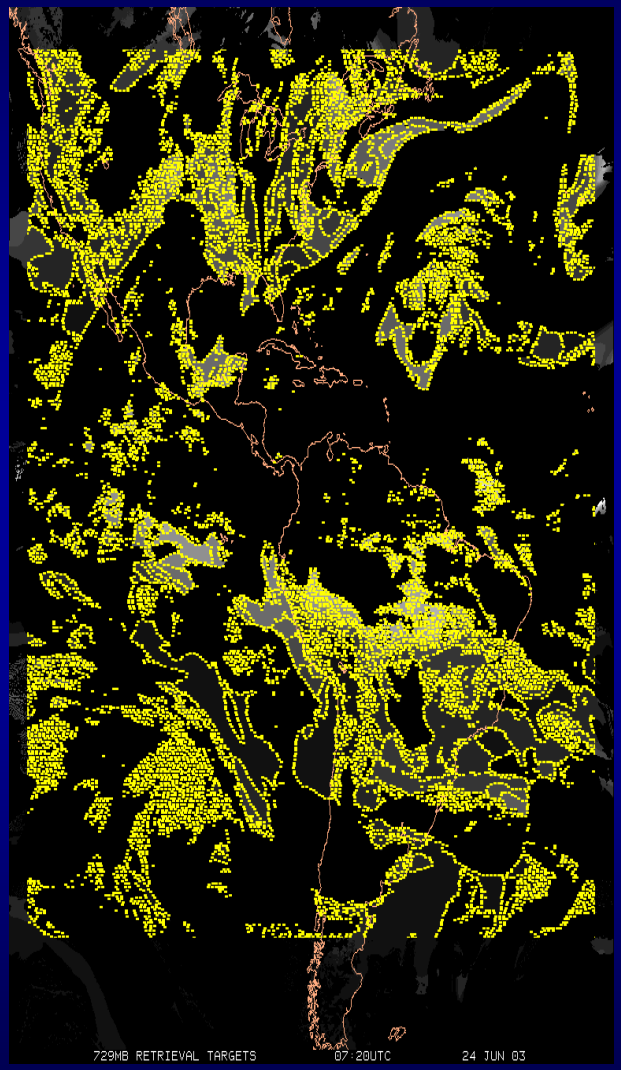


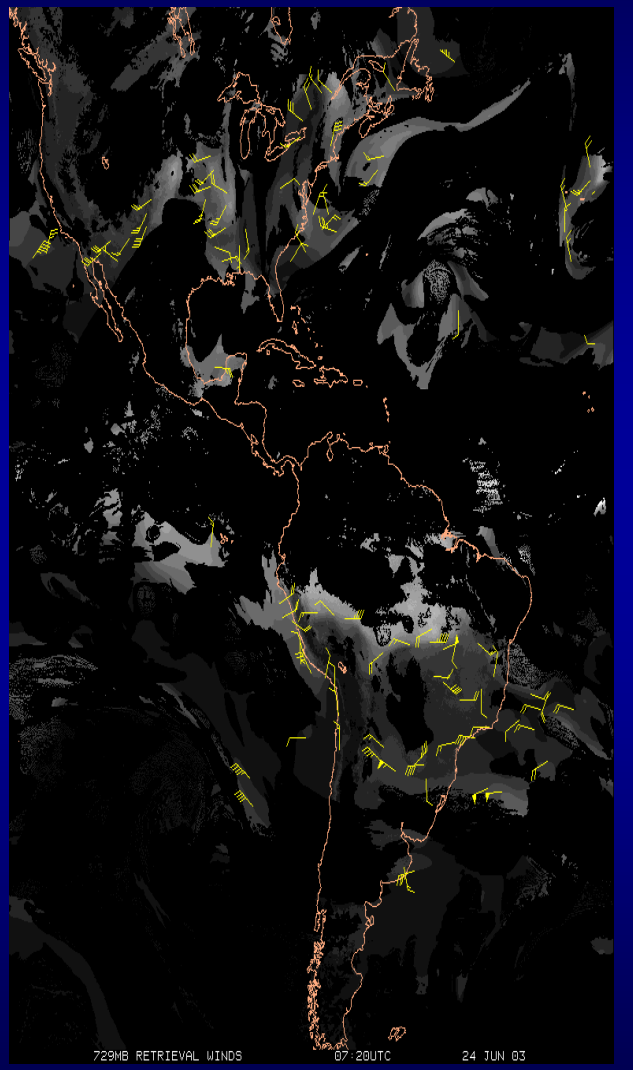
Simulated hyperspectral sounder AMVs



AMVs from simulated hyperspectral sounder data - Full disk case (2003)







GOES-R Advanced Baseline Imager (ABI) Simulations

- GOES-R AMV readiness support
- Thursday morning talk by Jaime Daniels:
  - ***ALGORITHM AND SOFTWARE DEVELOPMENT OF ATMOSPHERIC MOTION VECTOR PRODUCTS FOR THE FUTURE GOES-R ADVANCED BASELINE IMAGER (ABI)***
- Brief description of the ABI
- Simulated ABI data set examples

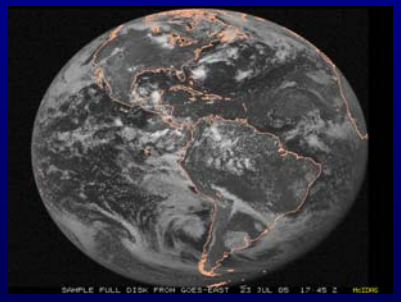
GOES-R ABI Upgrades

	ABI	Current
Spectral Coverage		
	16 bands	5 bands
Spatial resolution		
0.64 μm Visible	0.5 km	Approx. 1 km
Other Visible/near-I	1.0 km	n/a
Bands (>2 μm)	2 km	Approx. 4 km
Spatial coverage		
Full disk	4 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

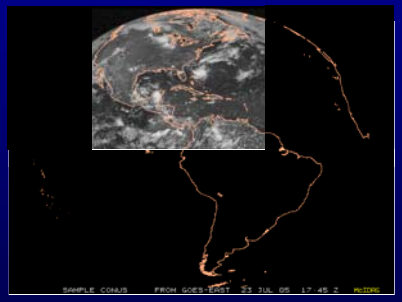
GOES-R ABI Upgrades

Number of images in 30 minutes of scan coverage

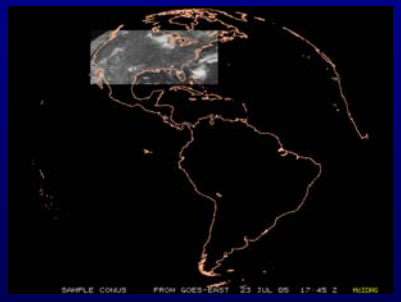
	Current Imager (Rapid Scan mode)	**ABI** ("Flex" mode)
Full Disk	0	2
North Hemisphere	1	-
CONUS	3	6
Mesoscale	0	60



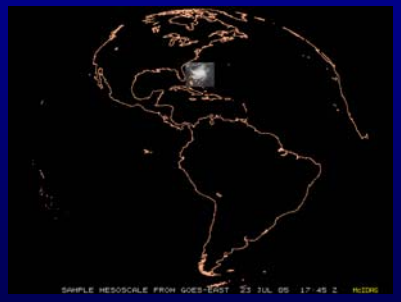
Full Disk



N. Hemisphere



CONUS



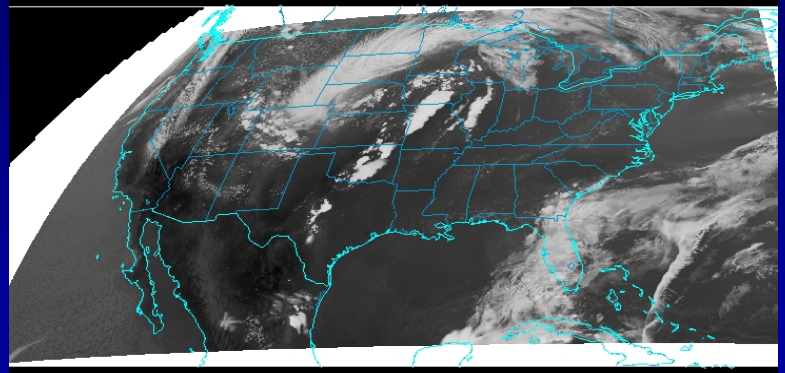
Mesoscale

ABI Simulations - Methodology

- Employ high resolution mesoscale models to generate simulated atmospheres.
- Calculate Top of Atmosphere (TOA) infrared radiances from the mesoscale model simulations using CRTM and SOI. ABI bands 7-16.
- Calculate TOA reflectances from the mesoscale model simulations using CRTM and SOI. ABI bands 1-6.

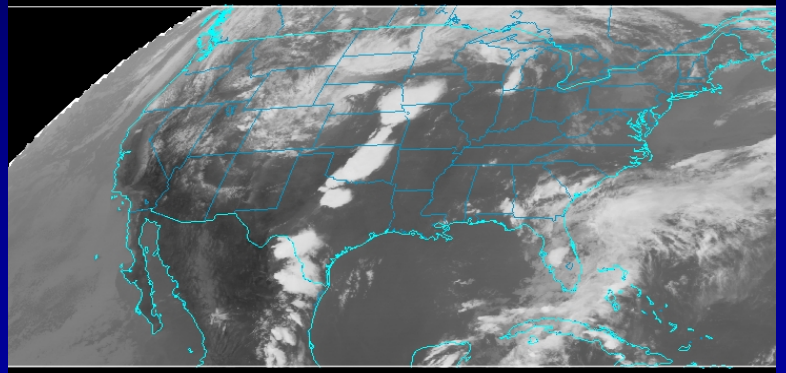
GOES-R ABI – CONUS Coverage

Simulated GOES-R ABI



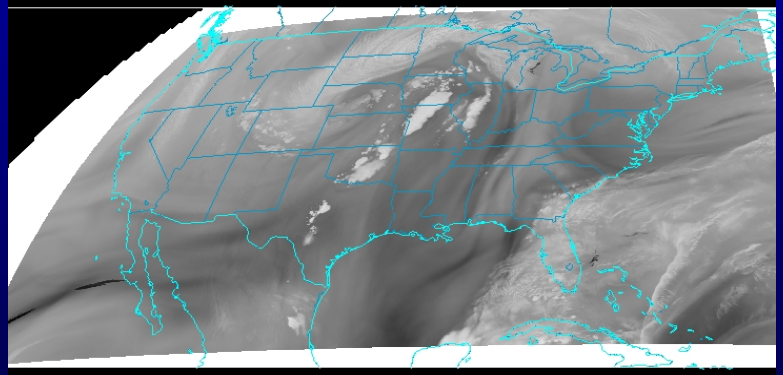
Band 14: 11.2 µm

GOES-12 Imager



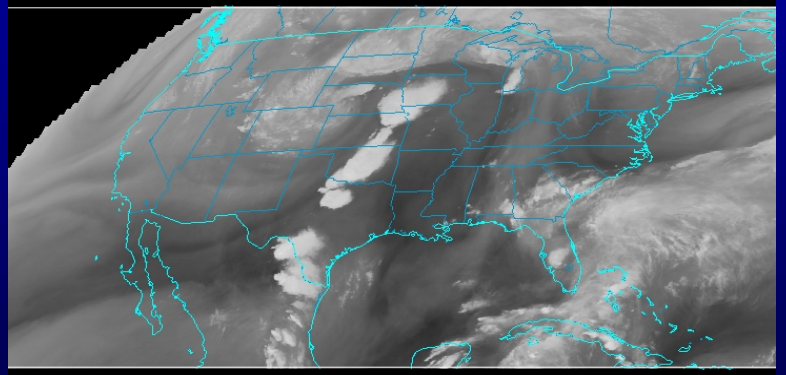
Band 04: 10.7 µm

Simulated GOES-R ABI



Band 08: 6.19 µm

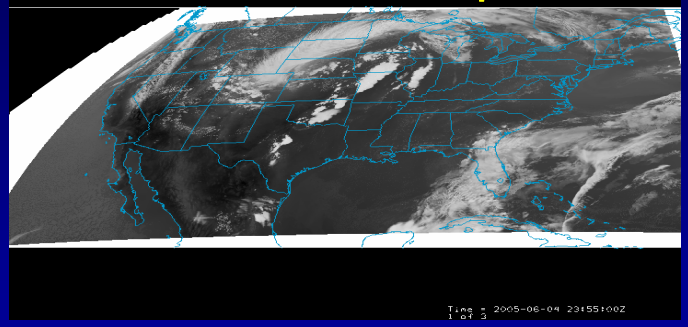
GOES-12 Imager



Band 03: 6.5 µm

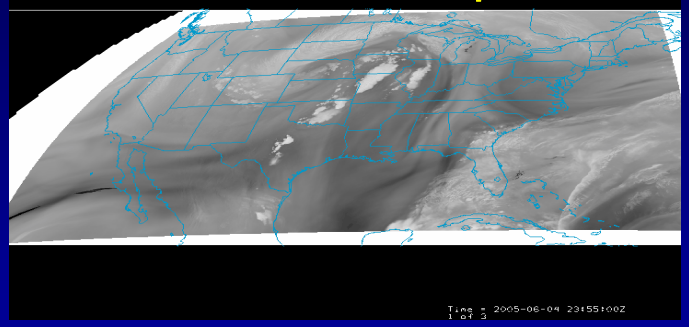
GOES-R ABI Image Sampling

Band 14: 11.2 µm

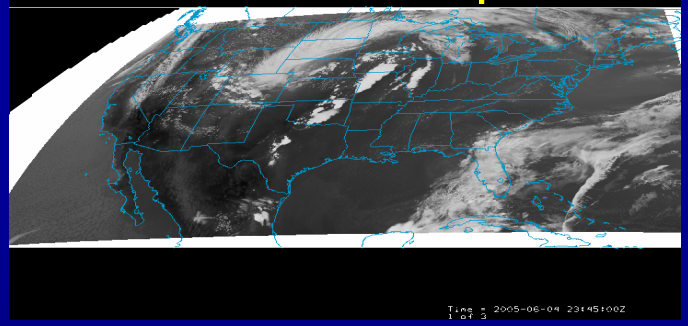


5 minute time step

Band 08: 6.19 µm

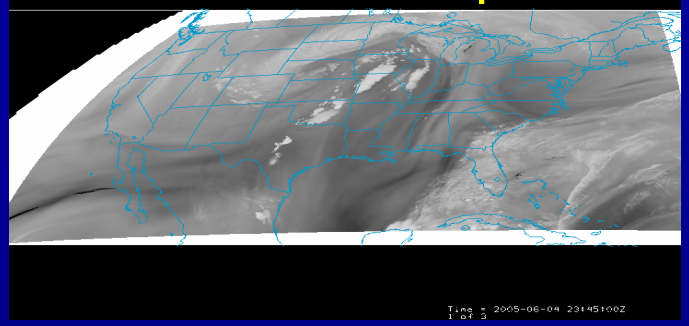


Band 14: 11.2 µm

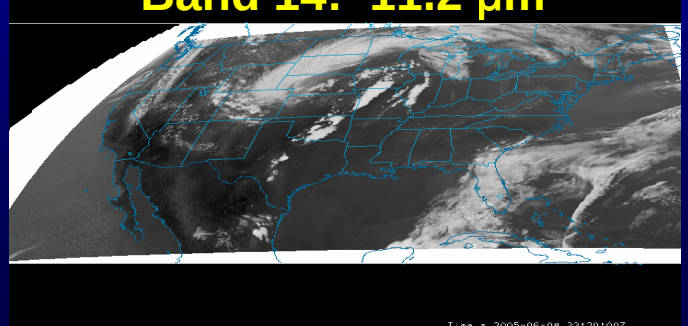


15 minute time step

Band 08: 6.19 µm

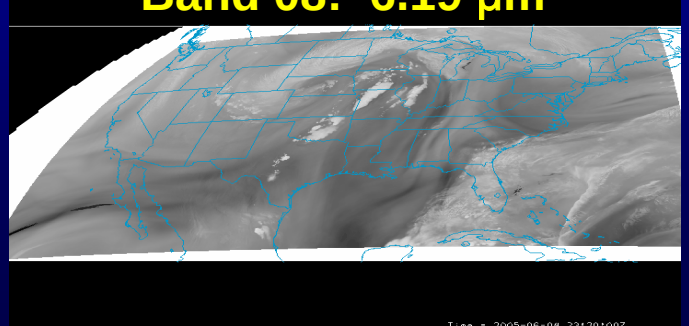


Band 14: 11.2 µm

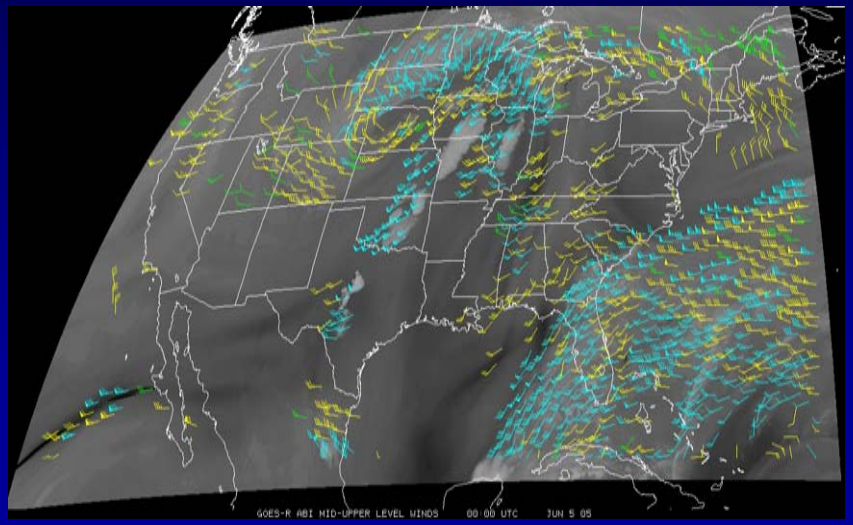


30 minute time step

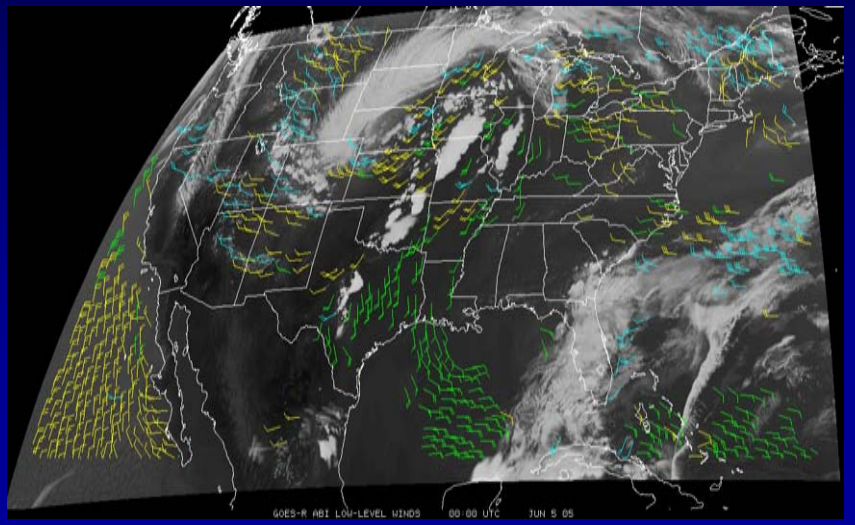
Band 08: 6.19 µm



GOES-R ABI Simulations - AMVs



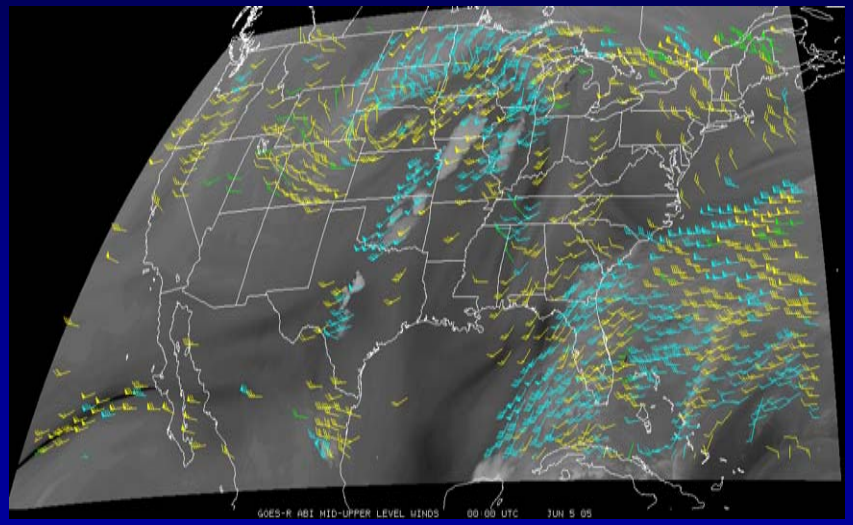
Mid to Upper Level IR and WV AMVs
Cyan 100-250mb, Yellow 251-350mb, Green 351-500mb



Mid to Low Level IR AMVs
Cyan 400-599mb, Yellow 600-799mb, Green 800-950mb

-Heritage Retrieval Algorithm
-5 minute time step
-2km image resolution
-Tracking images: 6.19µm and 11.2µm
-Height Assignment: 6.19µm, 11.2µm and 13.3µm

GOES-R ABI Simulations - AMVs



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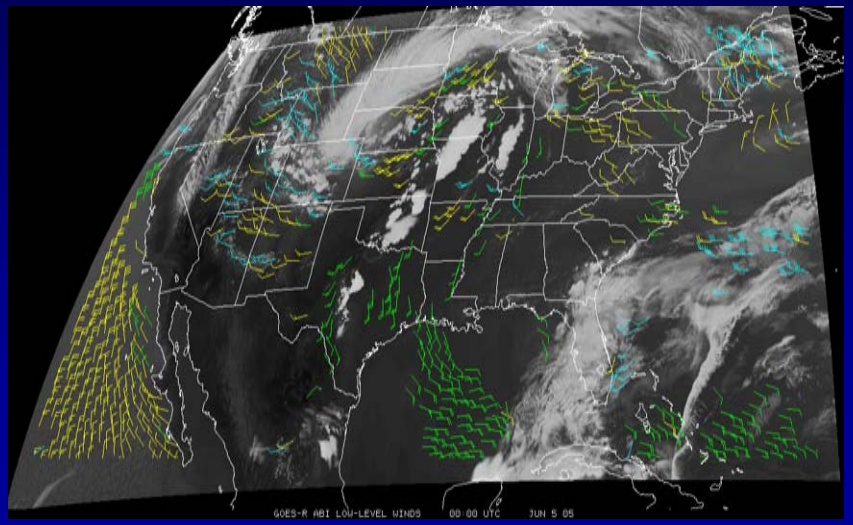

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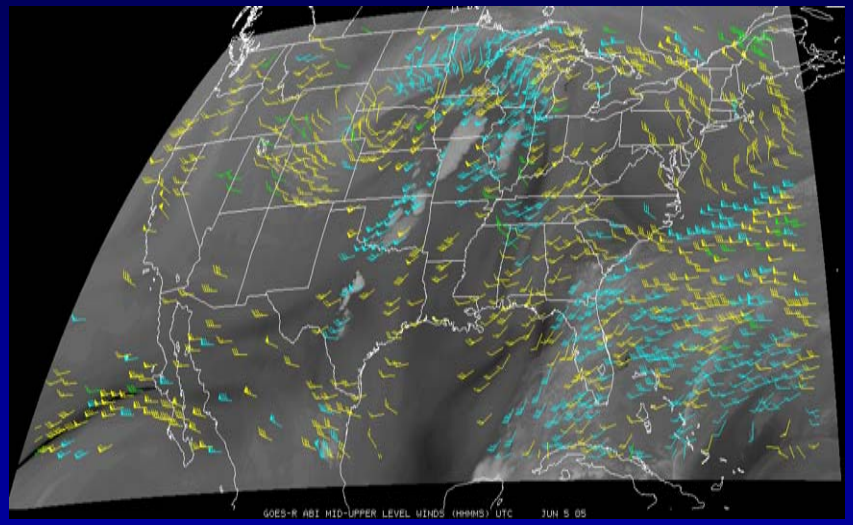
GOES-R ABI Simulations - AMVs



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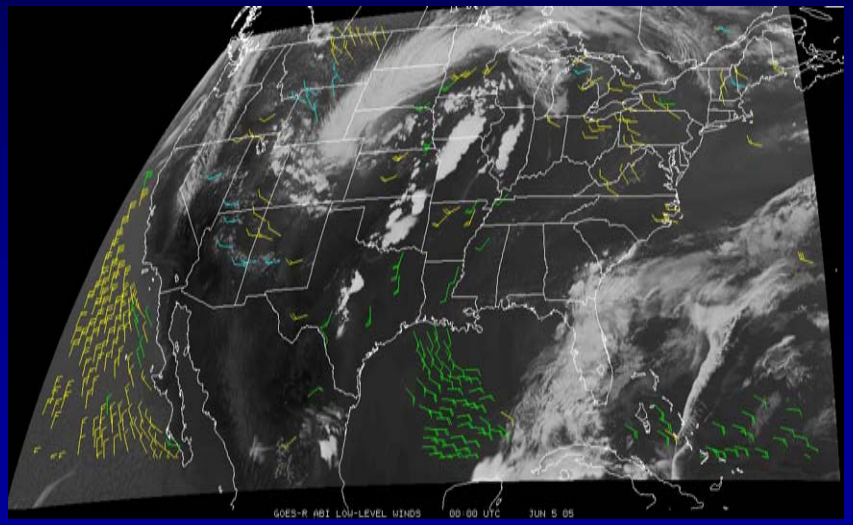

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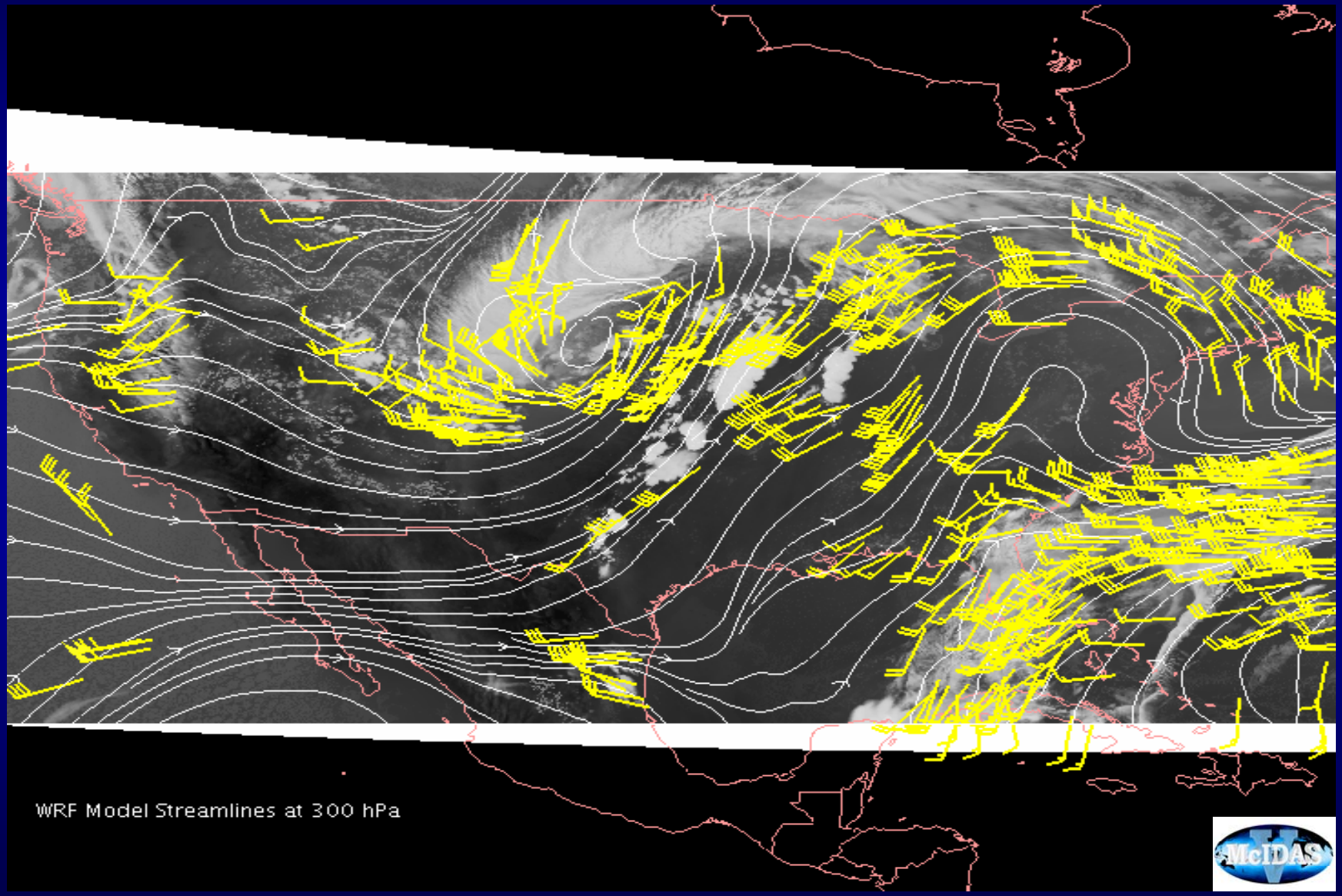
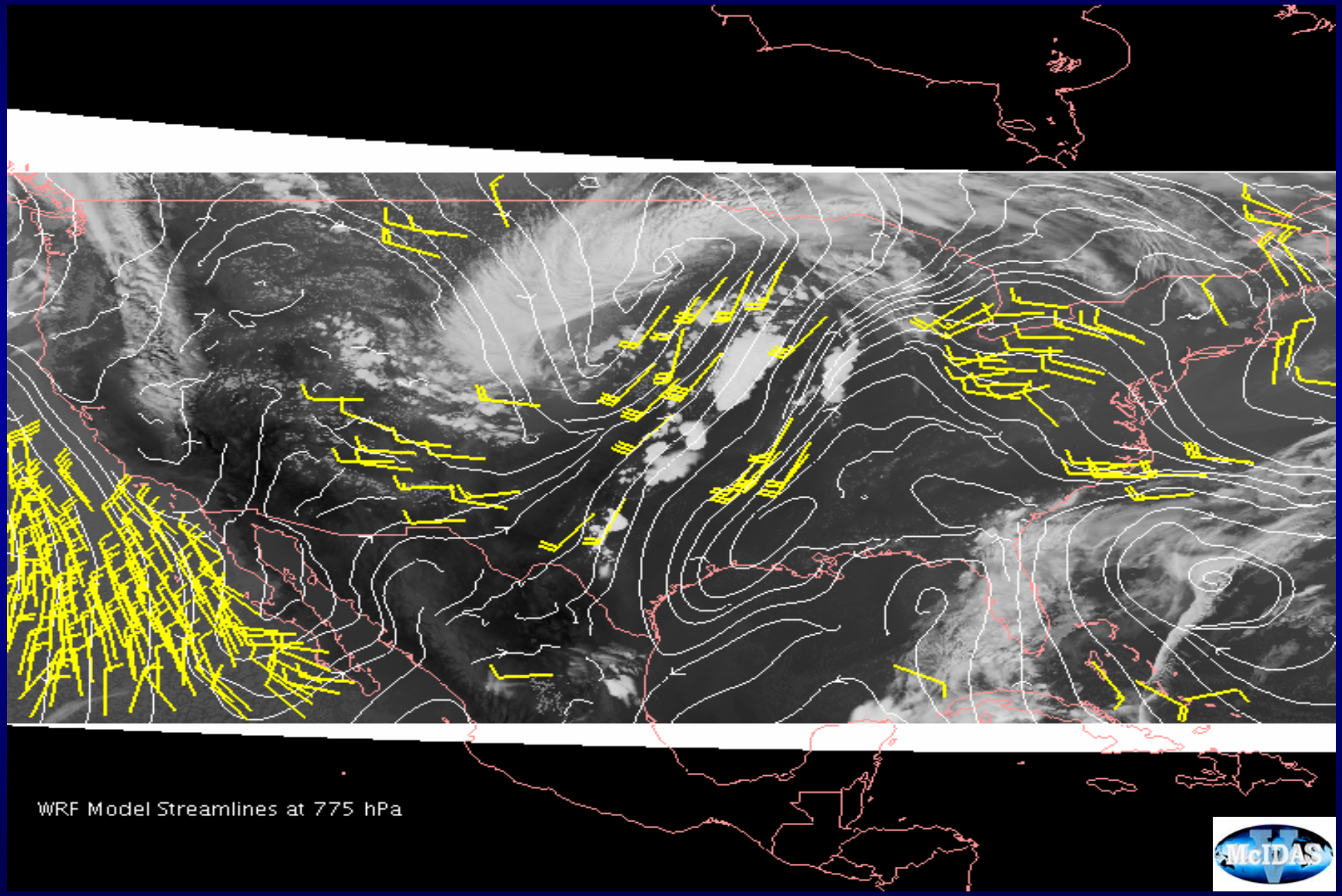
GOES-R ABI Simulations - AMVs



GOES-R ABI Simulations - AMVs



GOES-R ABI Simulations - AMVs

Water Vapor (WV) Atmospheric Motion Vectors (Clear Sky and Cloudy WV AMVs)			
Image Interval (Minutes)	# Matches	Speed Bias (AMV – WRF)	V_{RMS} (AMV – WRF)
5	3041	-0.06	5.15
15	2693	0.06	4.70
30	2124	0.07	5.00

Infrared (IR) Atmospheric Motion Vectors			
Image Interval (Minutes)	# Matches	Speed Bias (AMV – WRF)	V_{RMS} (AMV – WRF)
5	4157	-0.36	4.45
15	3754	-0.56	4.01
30	2484	0.50	4.02

GRAFIIR Sample Results

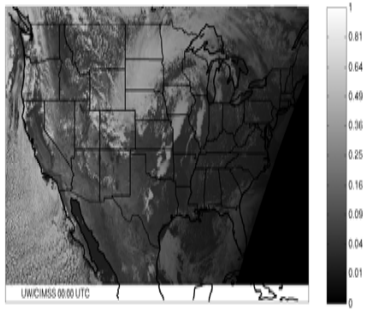
-GOES-R Analysis Facility for Instrument Impacts on Requirements
-Facility to assess instrument impacts on TOA radiances
-Effects include noise, calibration, striping, navigation…
-Effects can be double, tripled, and used in combination

Water Vapor (WV) Atmospheric Motion Vectors

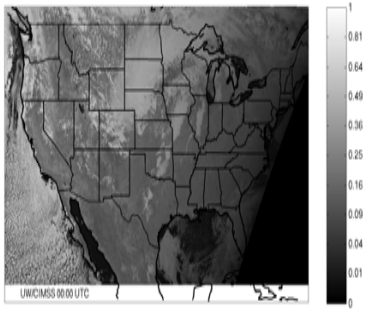
Image Interval (Minutes)	# Matches		Speed Bias (AMV-WRF)		V_{rms} (AMV Vs WRF)	
	Pure	3X AIE	Pure	3X AIE	Pure	3X AIE
5	3041	534	-0.06	1.66	5.15	6.11
15	2693	1189	0.05	1.68	4.70	5.29
30	2124	1217	0.07	1.40	5.00	4.84

GOES-R ABI Simulations

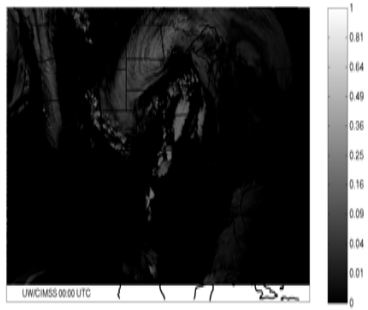
ABI band 2 (0.64 μm)



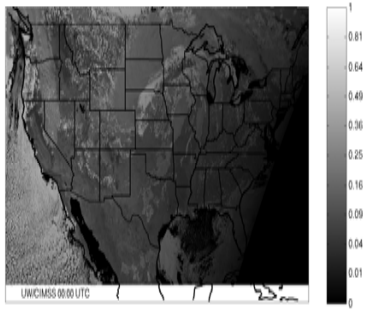
ABI band 3 (0.87 μm)



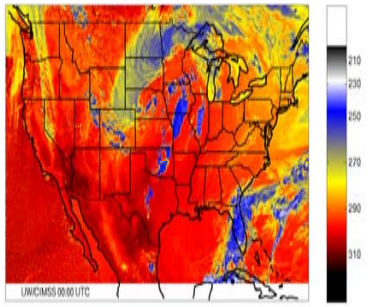
ABI band 4 (1.38 μm)



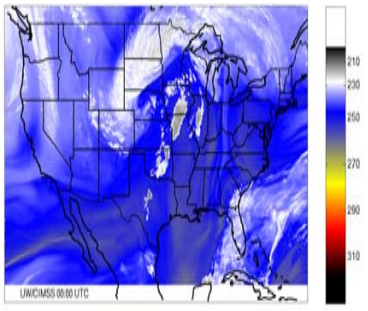
ABI band 5 (1.61 μm)



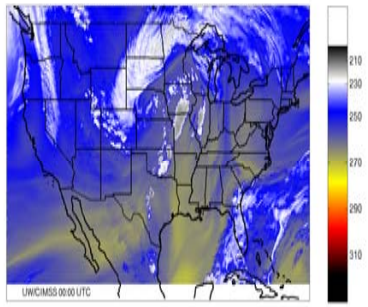
ABI band 7 (3.90 μm)



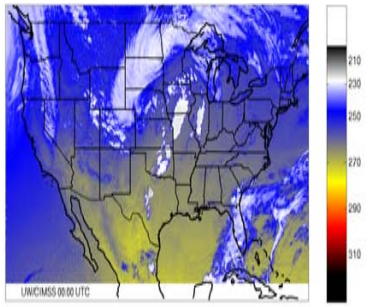
ABI band 9 (6.95 μm)



ABI band 10 (7.34 μm)

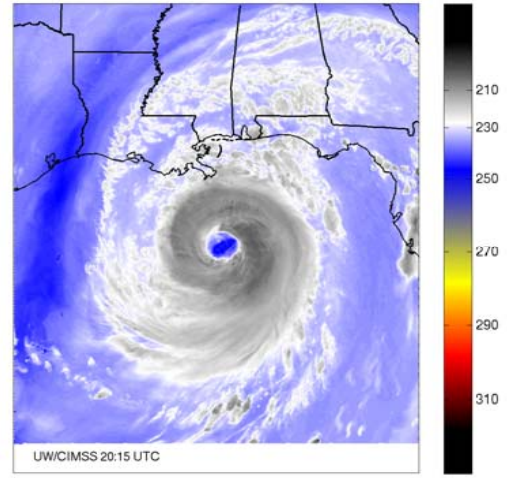


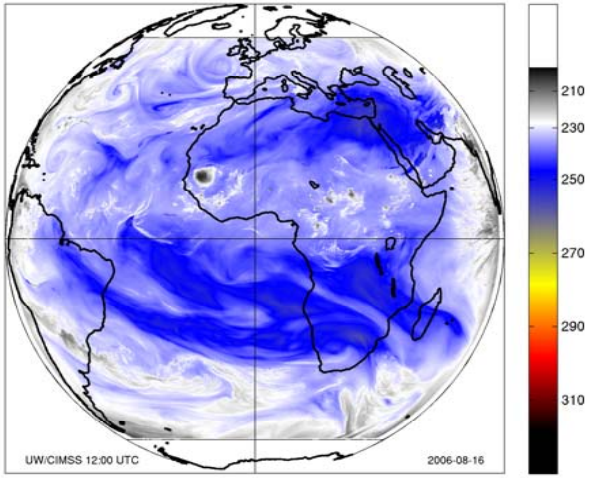
ABI band 12 (6.61 μm)

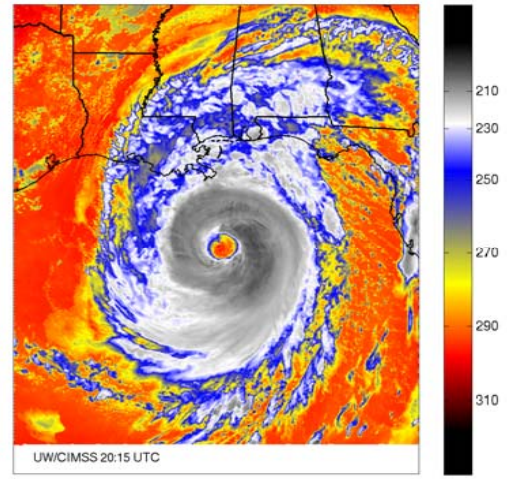


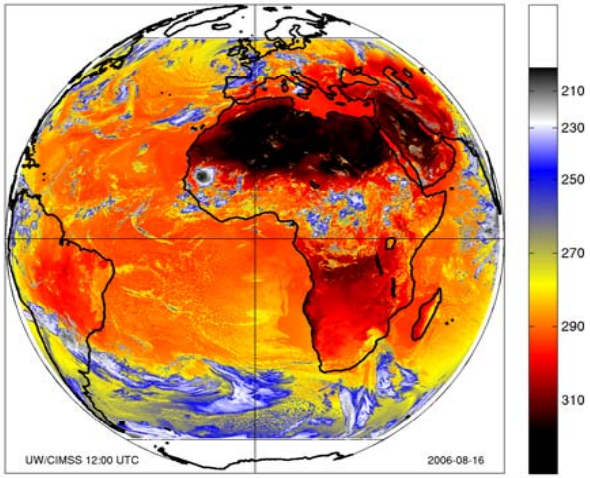
Future work: Explore “Non-Heritage” ABI bands for potential AMVs

Future Simulations







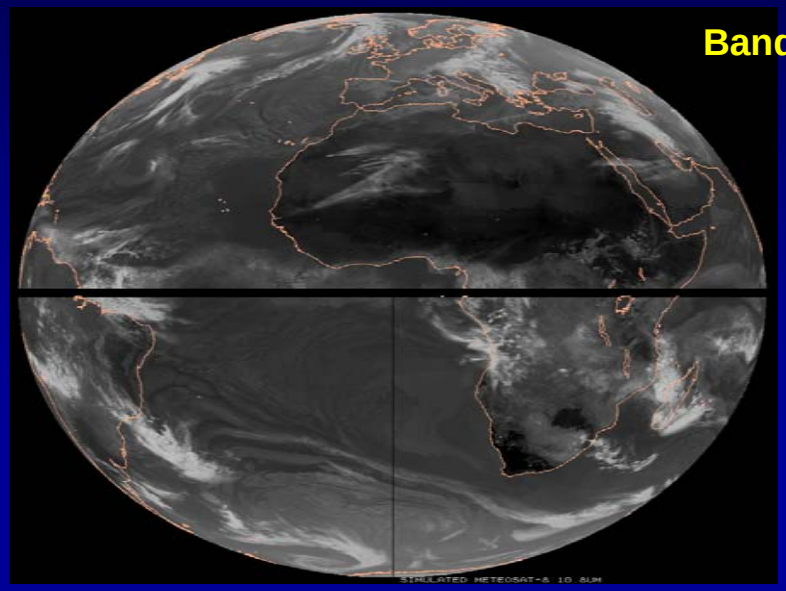


Simulated AMVs -ECMWF Collaboration

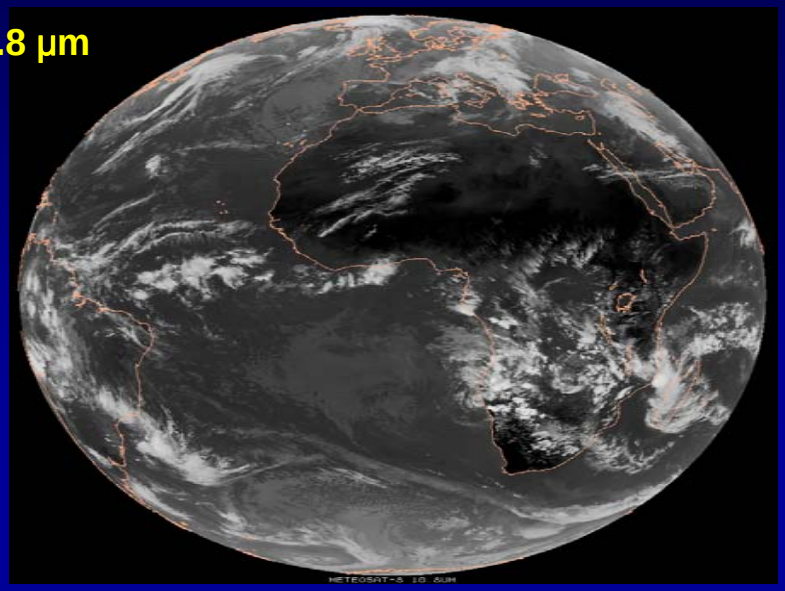
- Simulated Meteosat-8 images were derived from a high resolution version of the ECMWF global model.
- From these images, CIMSS produced AMVs.
- More details to follow next in:
  - ***"EVALUATION OF AMVs DERIVED FROM ECMWF MODEL SIMULATIONS" by Leuder von Bremen, et al.***

Simulated AMVs - ECMWF Collaboration

Band 9: 10.8 µm

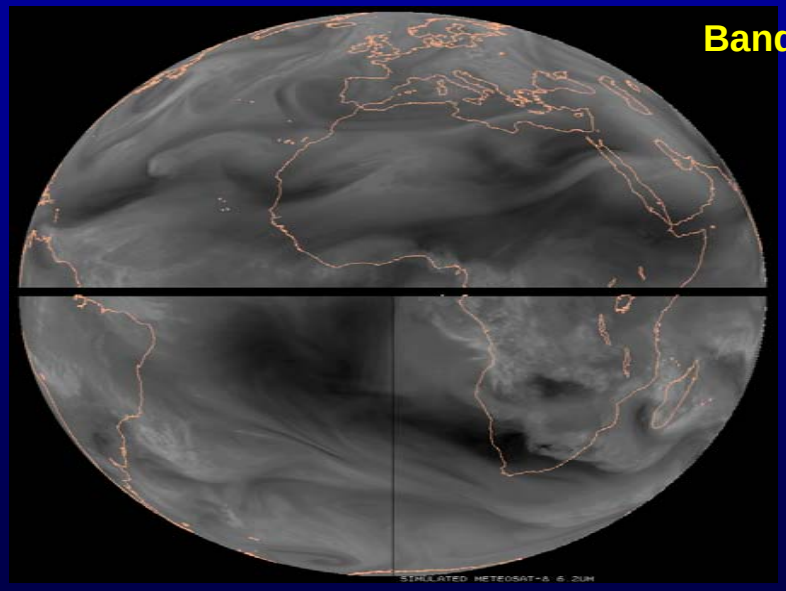


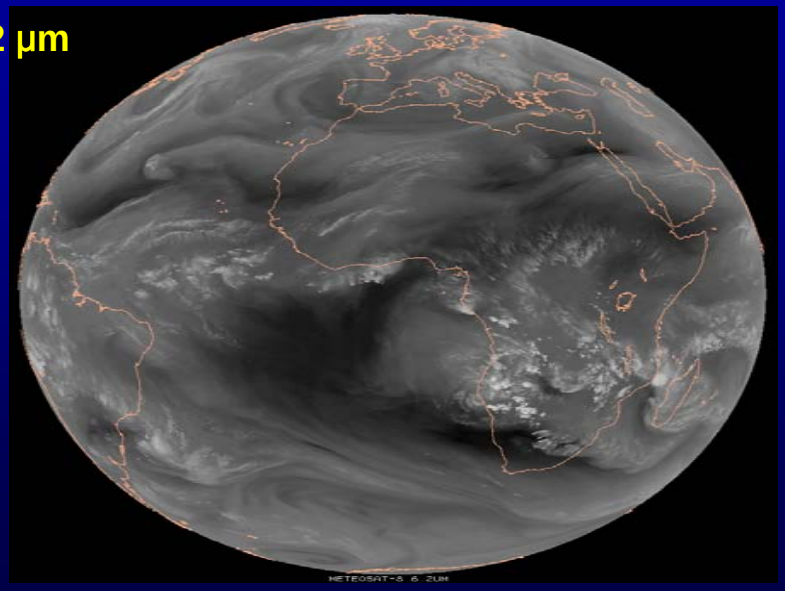
Simulated Meteosat-8



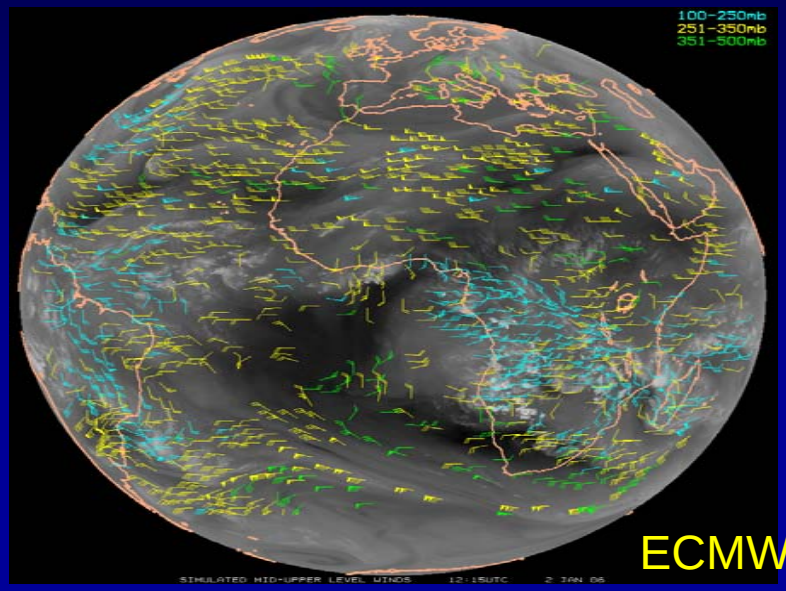
Real Meteosat-8

Band 5: 6.2 µm

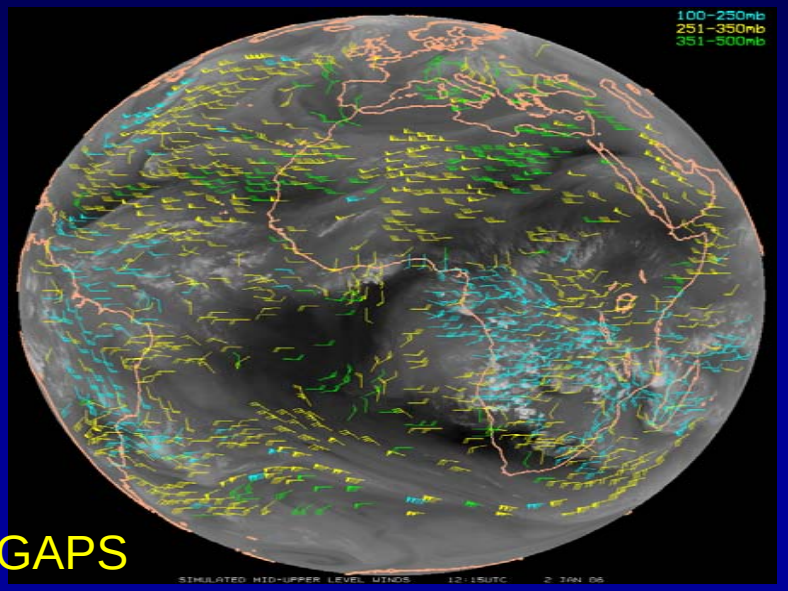




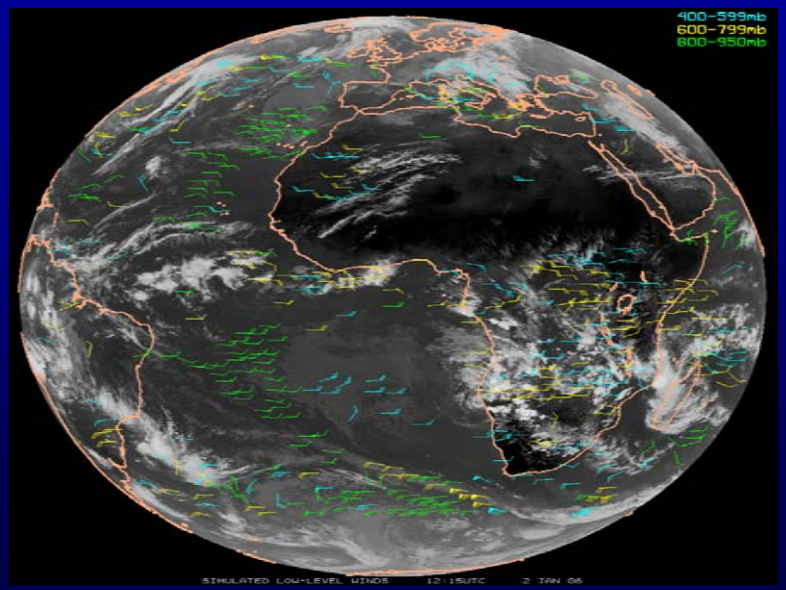
Simulated AMVs -ECMWF Collaboration

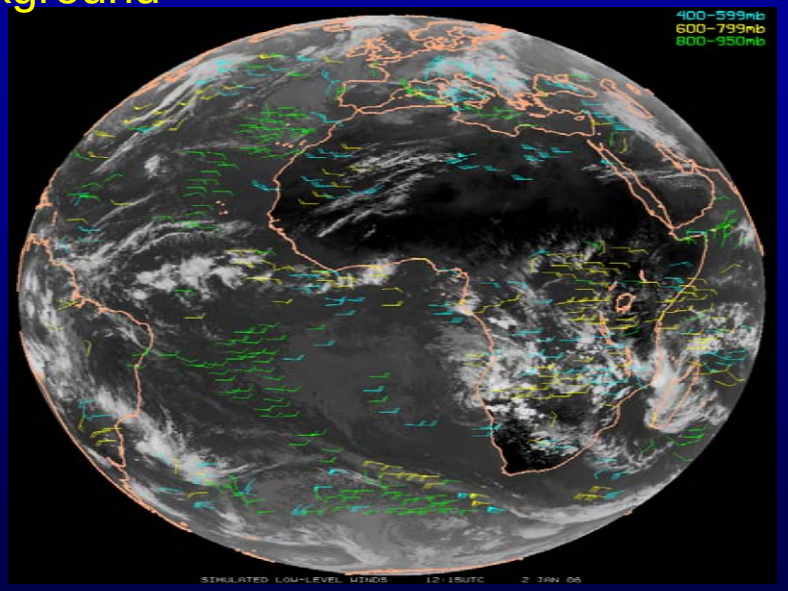


ECMWF Background



NOGAPS Background





Summary

- To prepare for the GOES-R era, simulated datasets are being employed to ready the NESDIS AMV algorithms
- Results from several cases indicate the simulated proxy (GOES-R) datasets can provide a good framework for advancing algorithm development
- The proxy datasets can also be used to better understand the AMV algorithm behavior when conditions are changed

Thank You

Questions?

Backups

GOES-R Analysis Facility for Instrument Impacts on Requirements (GRAFIIR)

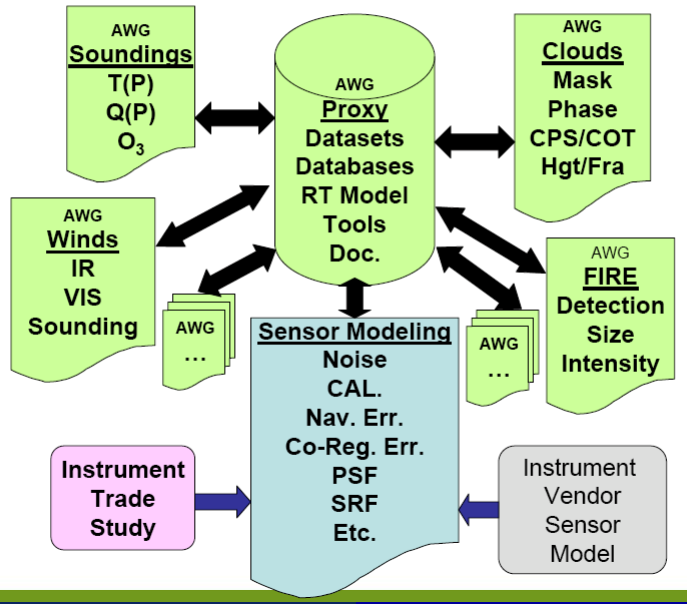
GRAFIIR is a facility established to leverage existing capabilities and those under development for both current GOES and its successor in data processing and product evaluation to support GOES-R analysis of instruments impacts on meeting user and product requirements.

GRAFIIR is for "connecting the dots", the components that have been built and/or are under development, to provide a flexible frame work to effectively adopt component algorithms toward analyzing the sensor measurements with different elements of sensor characteristic (i.e. noise, navigation, band to band co-registration, diffraction, etc.) and its impact on products.

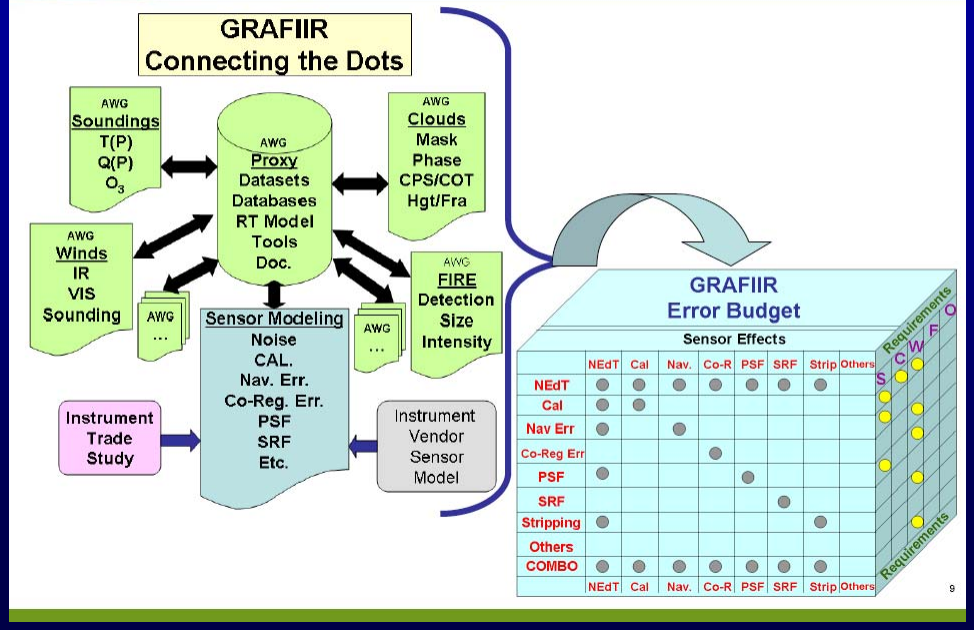
GRAFIIR is to assess and evaluate many of the GOES-R data and products (i.e. imagery, clouds, derived products, soundings, winds, etc.) in a consistent way to ensure the instrument effects on the products can be fully accounted for, characterized and product performance could be optimized.

GRAFIIR is a coordinated team effort from GOES-R Risk Reduction and Algorithm Working Group and other related projects. It will not independently develop any new algorithms or processing that are available or already under developed.

GRAFIIR Connecting the Dots



GRAFIIR Error Budget



Approximate number of ABI pixels

Input Information			0.5 km	1 km	2 km	
Full disk diameter	17.76	deg	22141	11070	5535	pixels
CONUS height	4.8129	deg	6000	3000	1500	pixels
CONUS width	8.0215	deg	10000	5000	2500	pixels
Meso height/width	1.6043	deg	2000	1000	500	pixels

Current GOES is approximately 2705 x 5209 for the FD IR

Water Vapor (WV) Atmospheric Motion Vectors

Image Interval (Minutes)	# Matches		Speed Bias (AMV-WRF)		V_{rms} (AMV Vs WRF)	
	Pure	3X AIE	Pure	3X AIE	Pure	3X AIE
5	3041	534	-0.064	1.6648	5.1523	6.1122
15	2693	1189	0.0554	1.6774	4.7039	5.2942
30	2124	1217	0.0698	1.4038	5.0002	4.8443

Infrared (IR) Atmospheric Motion Vectors

Image Interval (Minutes)	# Matches		Speed Bias (AMV-WRF)		V_{rms} (AMV Vs WRF)	
	Pure	3X AIE	Pure	3X AIE	Pure	3X AIE
5	4157	1615	-0.355	0.1657	4.449	4.7329
15	3754	2825	-0.564	0.7658	4.0065	3.8399
30	2484	1890	0.5022	0.7612	4.0185	3.4238

All (IR & WV) Atmospheric Motion Vectors

Image Interval (Minutes)	# Matches		Speed Bias (AMV-WRF)		V_{rms} (AMV Vs WRF)	
	Pure	3X AIE	Pure	3X AIE	Pure	3X AIE
5	7198	2149	-0.232	0.5382	4.7588	5.1105
15	6447	4014	0.0971	1.0358	4.3116	4.322
30	4608	3128	0.3029	1.0129	4.4977	4.6402