The GOES-R Air Quality Proving Ground: Preparing the Air Quality Community for the Next Generation of NOAA Geostationary Satellites

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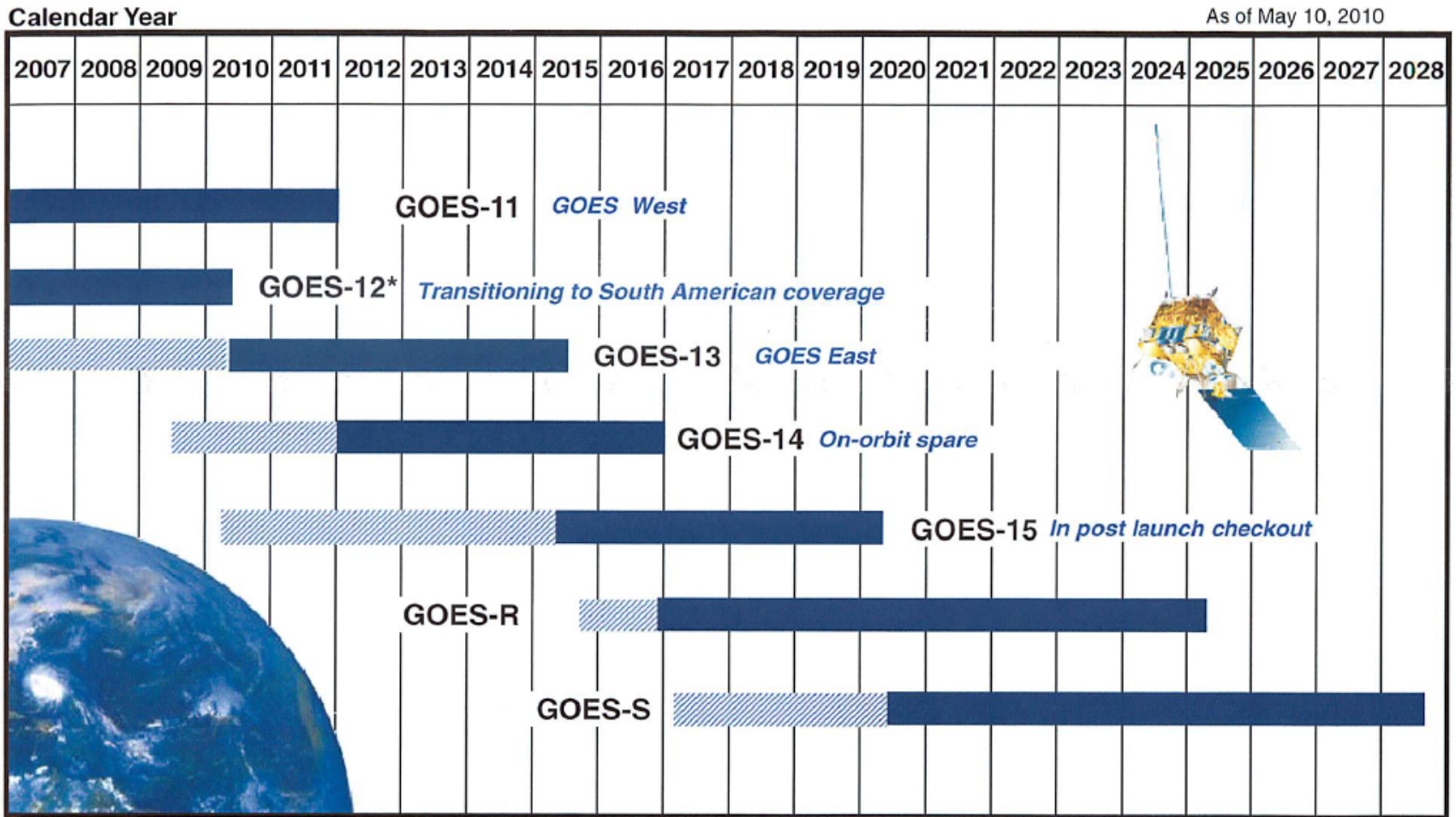
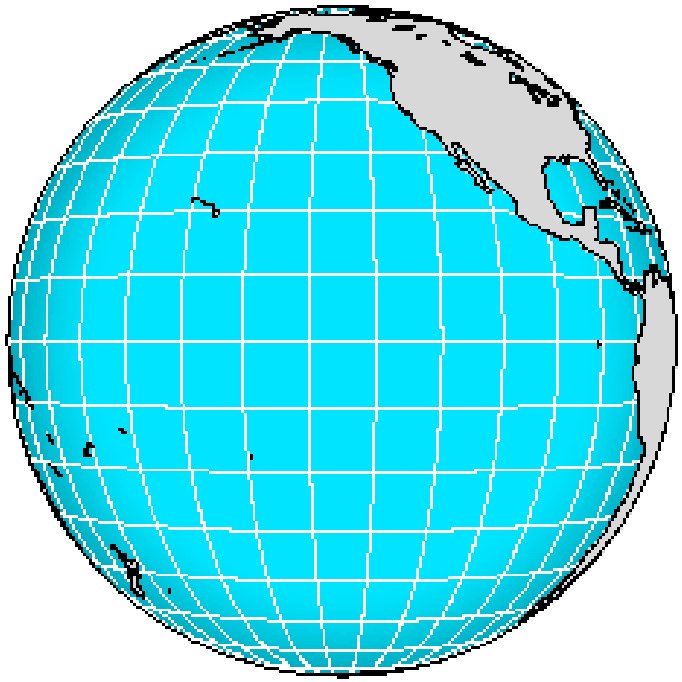
GOES-R Satellite

- 1st in next generation of NOAA geostationary weather satellites, designed to replace current series of GOES
- Launch planned for 2015

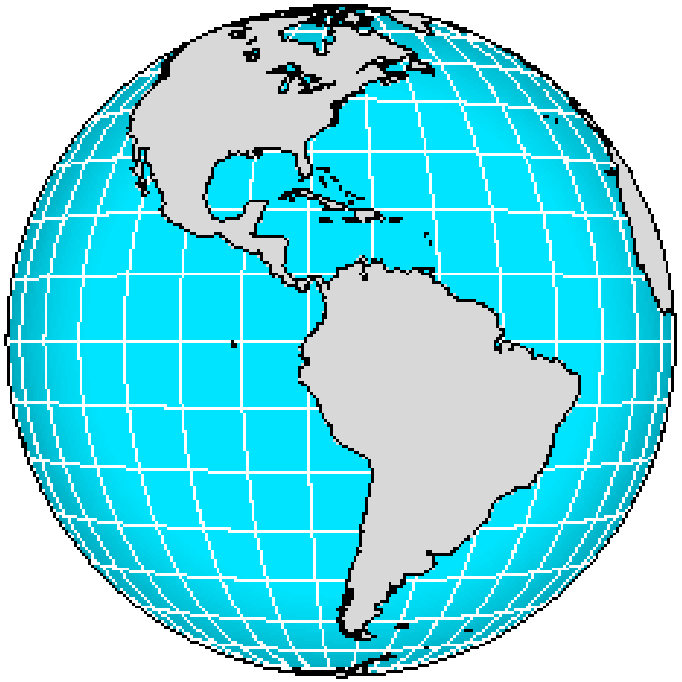


GOES Geographic Coverage

- GOES-R tentative location: 135° W ("GOES-West")



GOES-West (GOES-11)
135° W



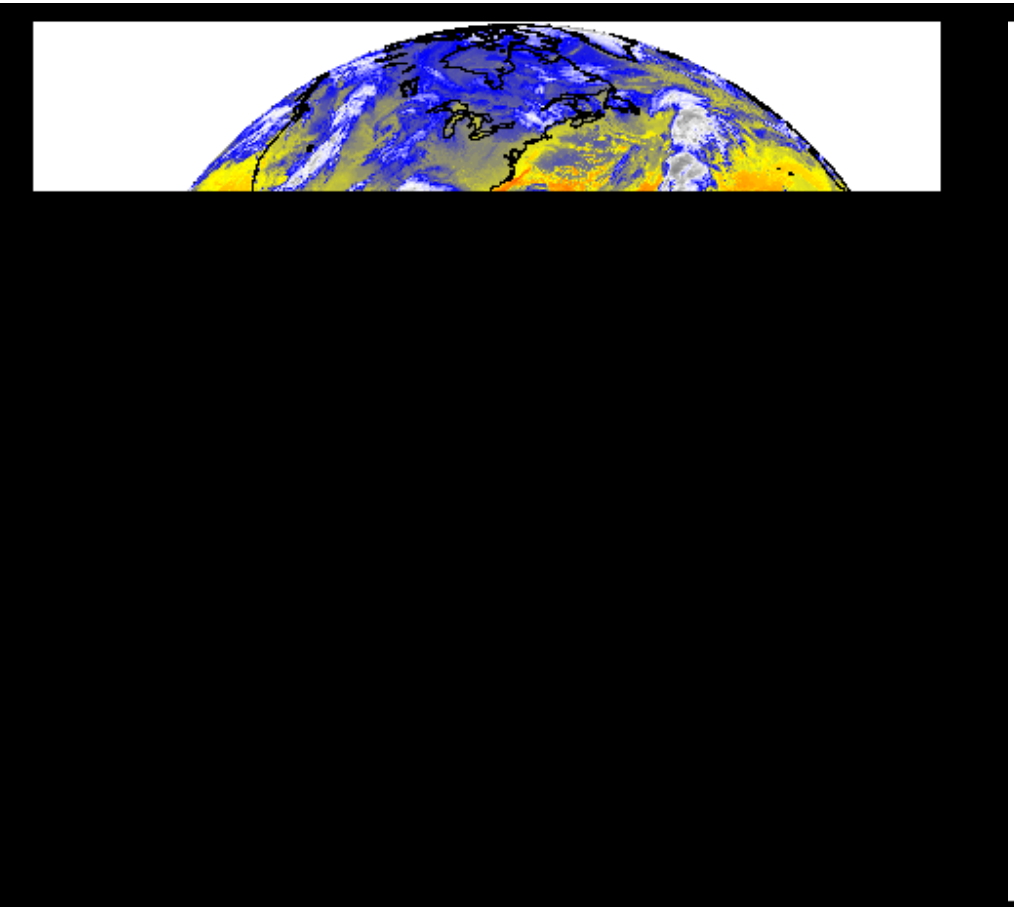
GOES-East (GOES-13)
75° W

Advanced Baseline Imager (ABI)

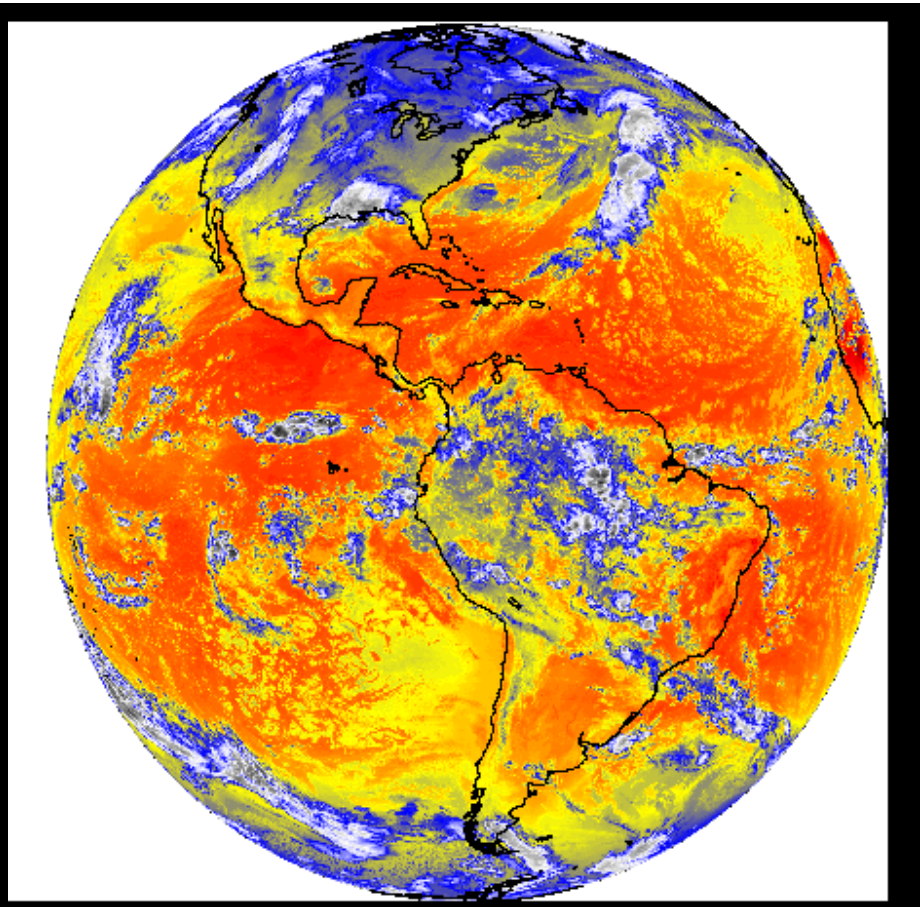
- Key instrument on GOES-R is the Advanced Baseline Imager (ABI):
  - Aerosol optical depth (AOD)
  - Aerosol type information (smoke vs. dust vs. haze)
  - Fire/hot spot characterization
  - Visible, IR, water vapor imagery

		Current GOES Imager	ABI
Spectral Bands (Channels)		5	16
Temporal Resolution	**Full Disk**	3 hr	15 min
	CONUS	15 min	5 min
	Mesoscale	N/A	30 sec
Spatial Resolution	**AOD**	4 km	2 km

Temporal Resolution Comparison

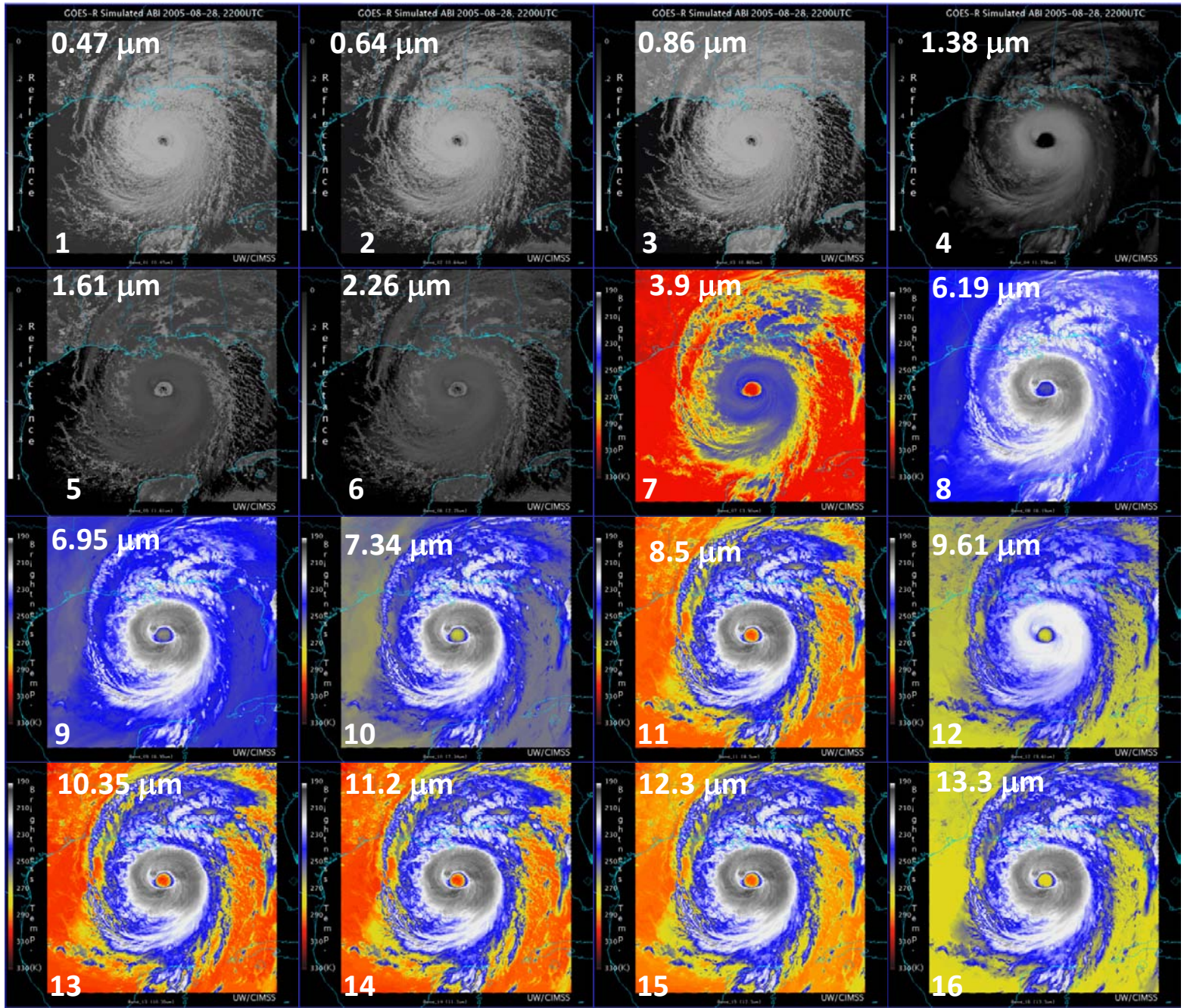


Current GOES imager coverage in 5 min

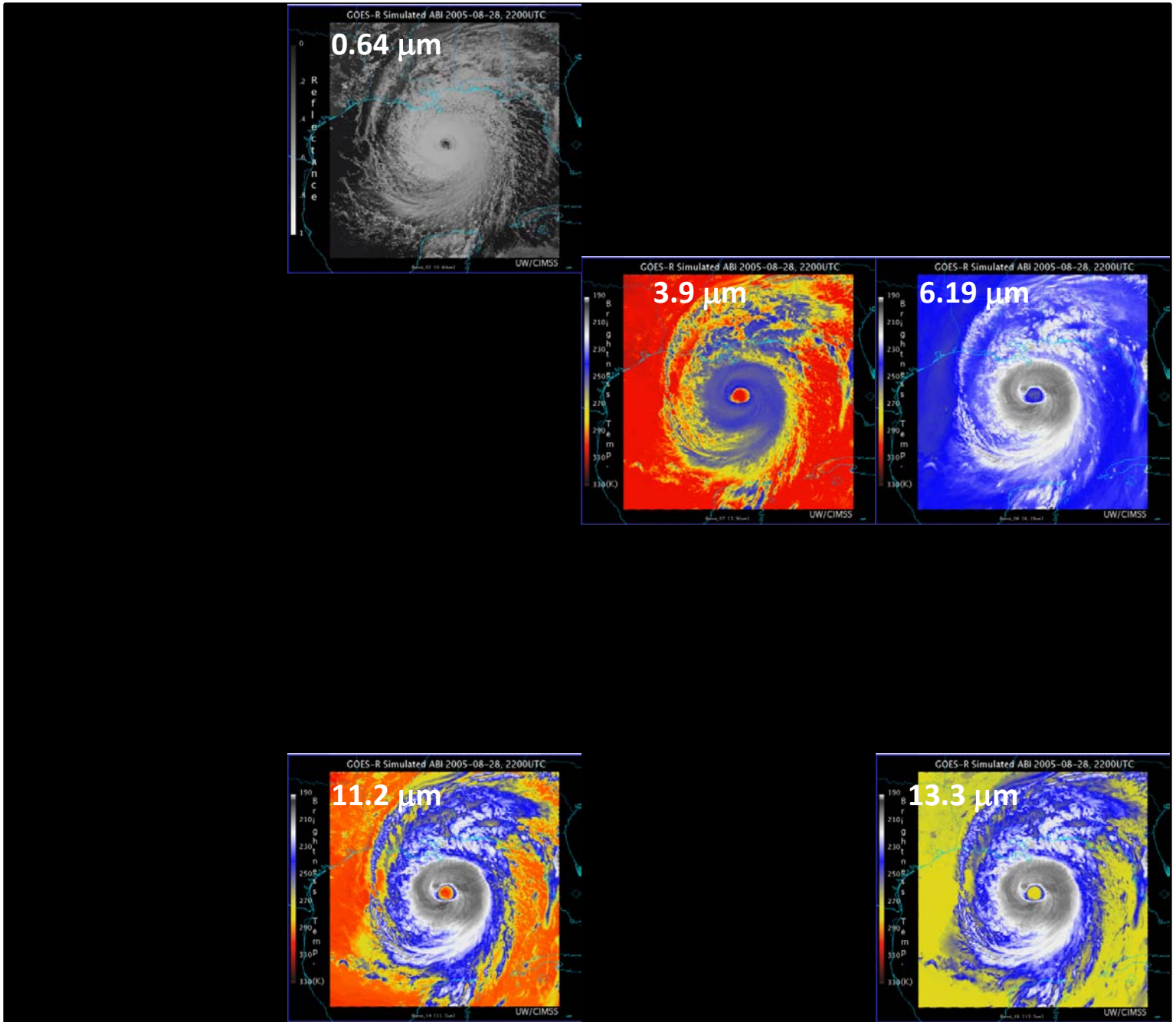


GOES-R ABI coverage in 5 min

ABI (16 Spectral Bands)

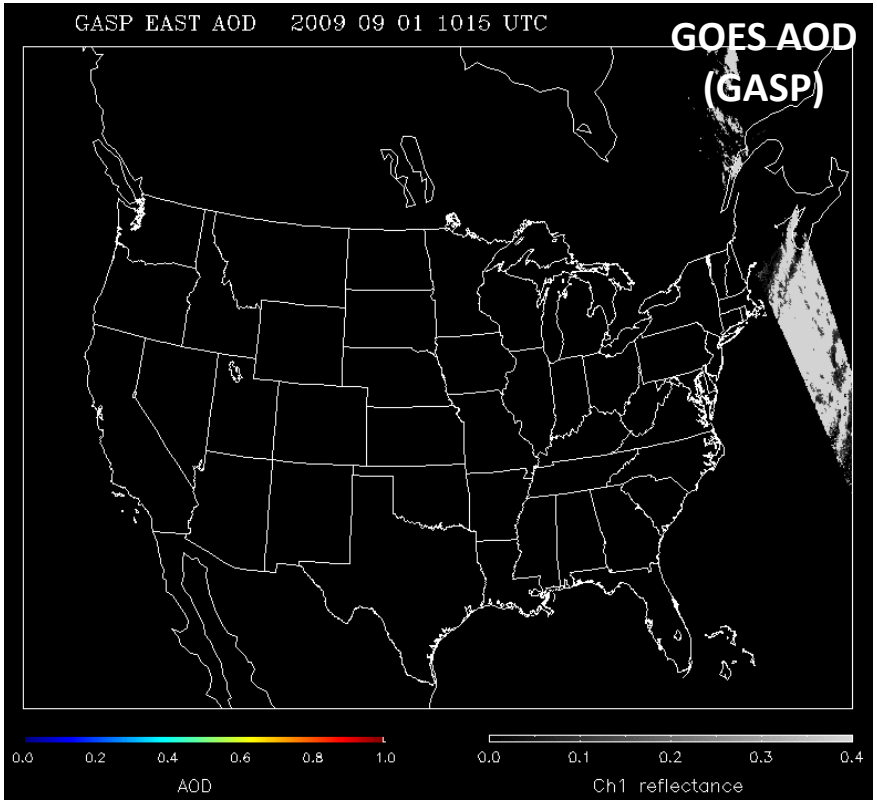


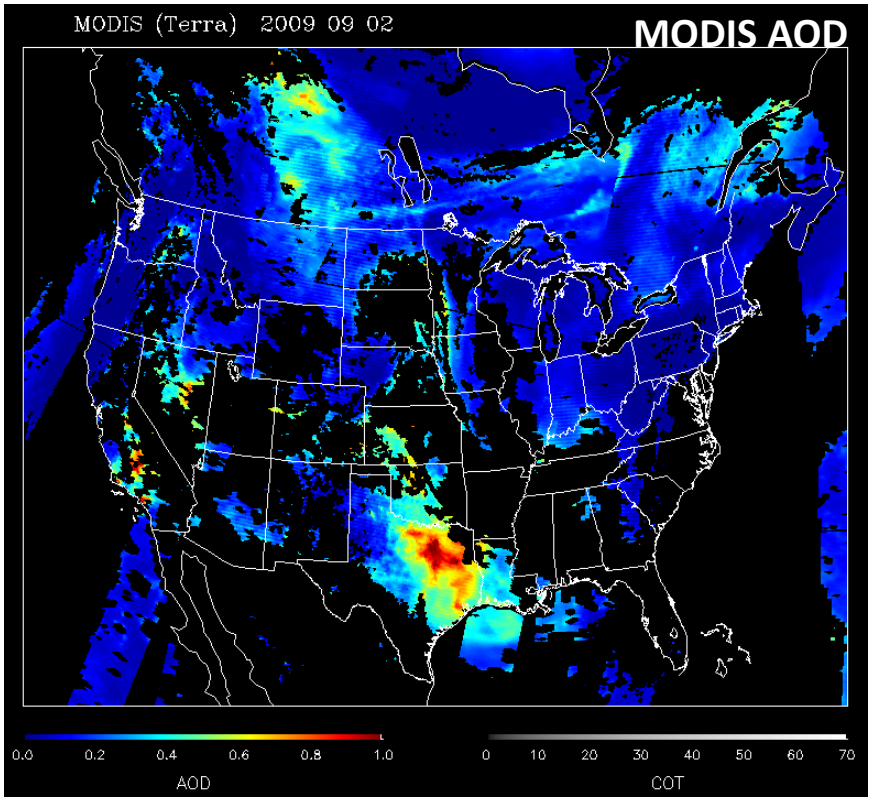
ABI Equivalent Bands on Current GOES Imager



ABI Products: Aerosol Optical Depth (AOD)

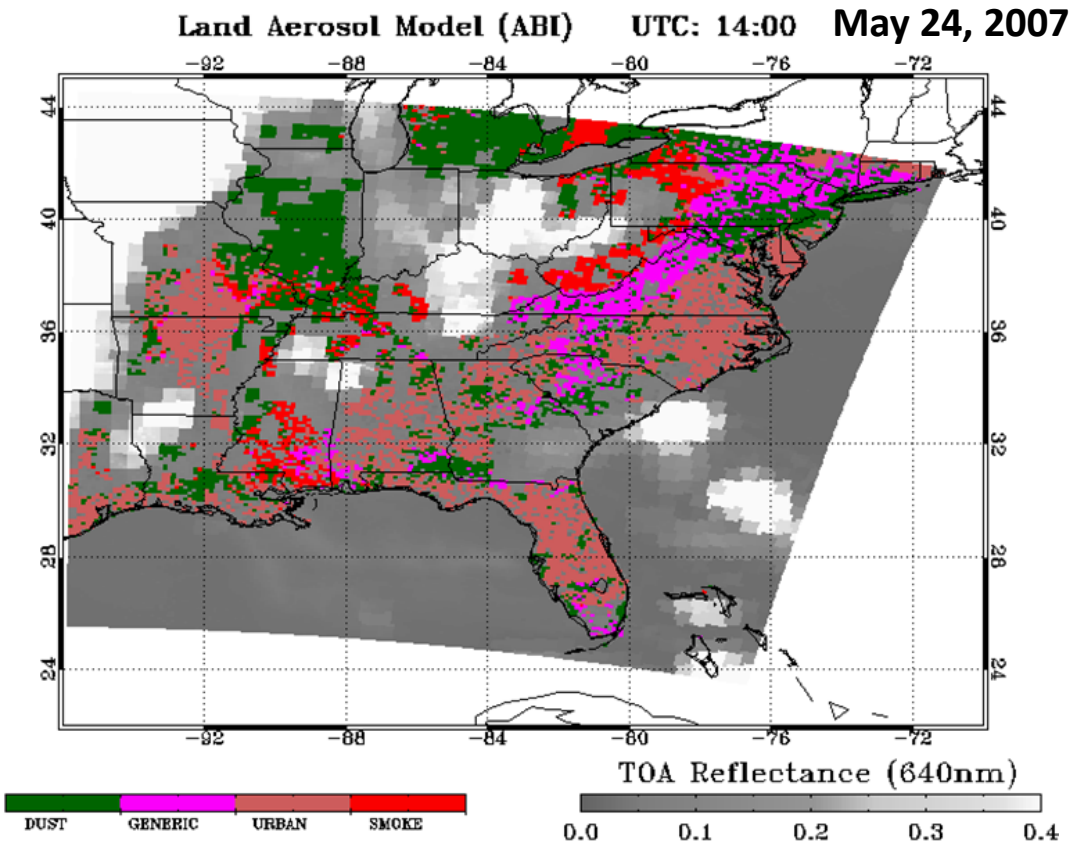
- AOD is a proxy for $PM_{2.5}$ ($\mu g/m^3$) – areas of high AOD correspond to high $PM_{2.5}$
- GOES-R AOD will combine "best of both worlds":
  - High temporal resolution (observations every 15-30 min during daylight) – like current GOES
  - High accuracy (multi-band aerosol retrieval) – like MODIS





ABI Products: Aerosol Type

- Aerosol type is a new GOES-R ABI product – not available currently.
- Qualitative product based on AOD radiances scaled to concentrations of 4 different aerosol types.
- Useful for distinguishing between smoke and dust, but can be noisy, especially at low aerosol concentrations.



ABI Products: False Color Imagery

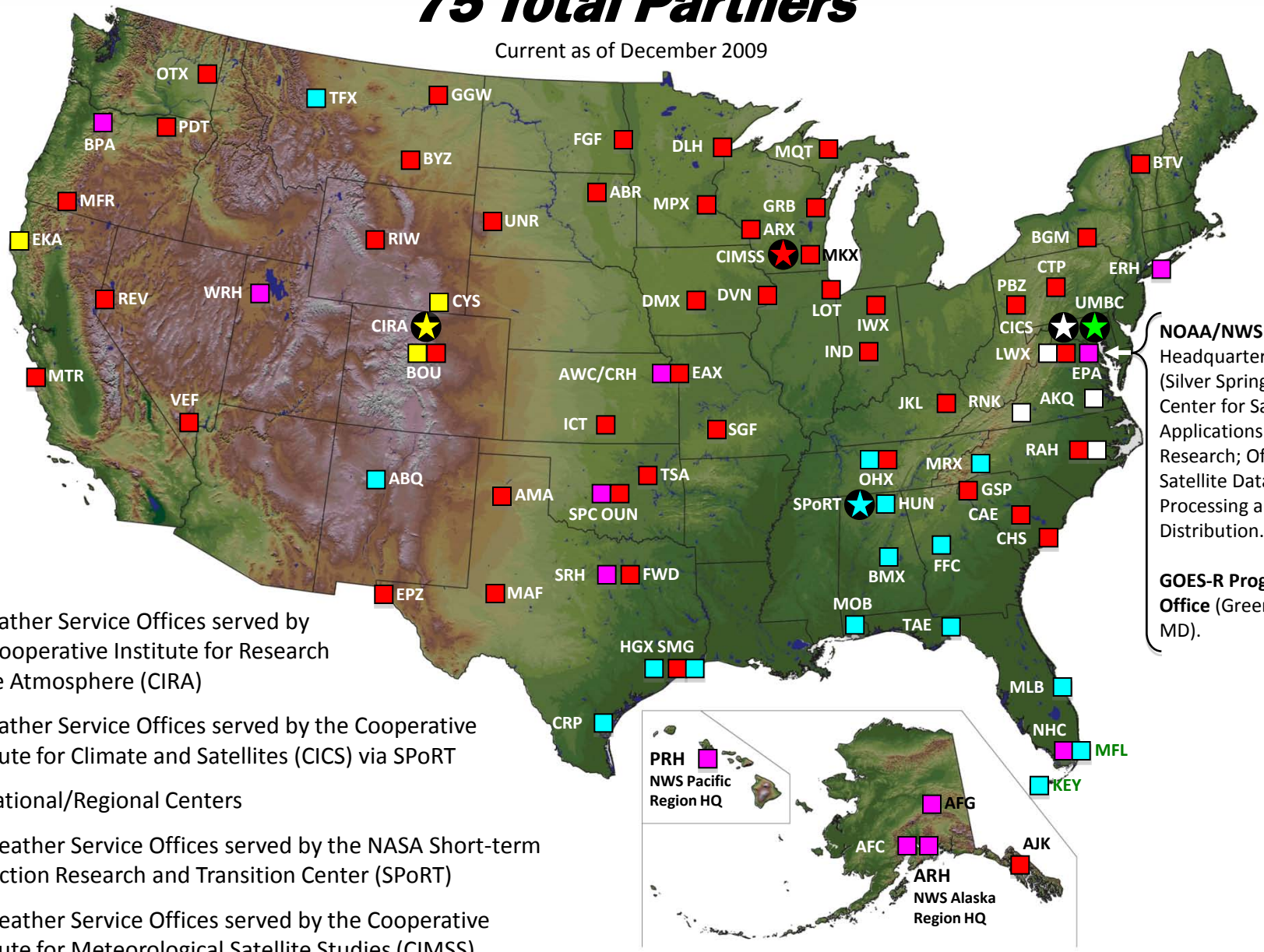
- False color imagery looks like a photograph with unnatural colors; useful for distinguishing surface/atmosphere features.
- The ABI will not have a green band, so true color RGB imagery (like MODIS) will not be available.
- ABI false color imagery will look similar to MODIS false color but will have high temporal resolution (images every 15-30 min).

MODIS Aqua
False Color (7-2-1)
October 24, 2007

GOES-R Proving Ground Partners

75 Total Partners

Current as of December 2009



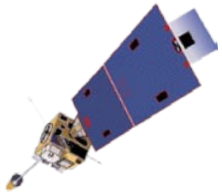
NOAA/NWS Headquarters (Silver Spring, MD); Center for Satellite Applications and Research; Office of Satellite Data Processing and Distribution.

GOES-R Program Office (Greenbelt, MD).

- ***3*** Weather Service Offices served by the Cooperative Institute for Research in the Atmosphere (CIRA)
- ***4*** Weather Service Offices served by the Cooperative Institute for Climate and Satellites (CICS) via SPoRT
- ***11*** National/Regional Centers
- ***15*** Weather Service Offices served by the NASA Short-term Prediction Research and Transition Center (SPoRT)
- ***46*** Weather Service Offices served by the Cooperative Institute for Meteorological Satellite Studies (CIMSS)

Air Quality Proving Ground (AQPG)

http://alg.umbc.edu/aqpg/

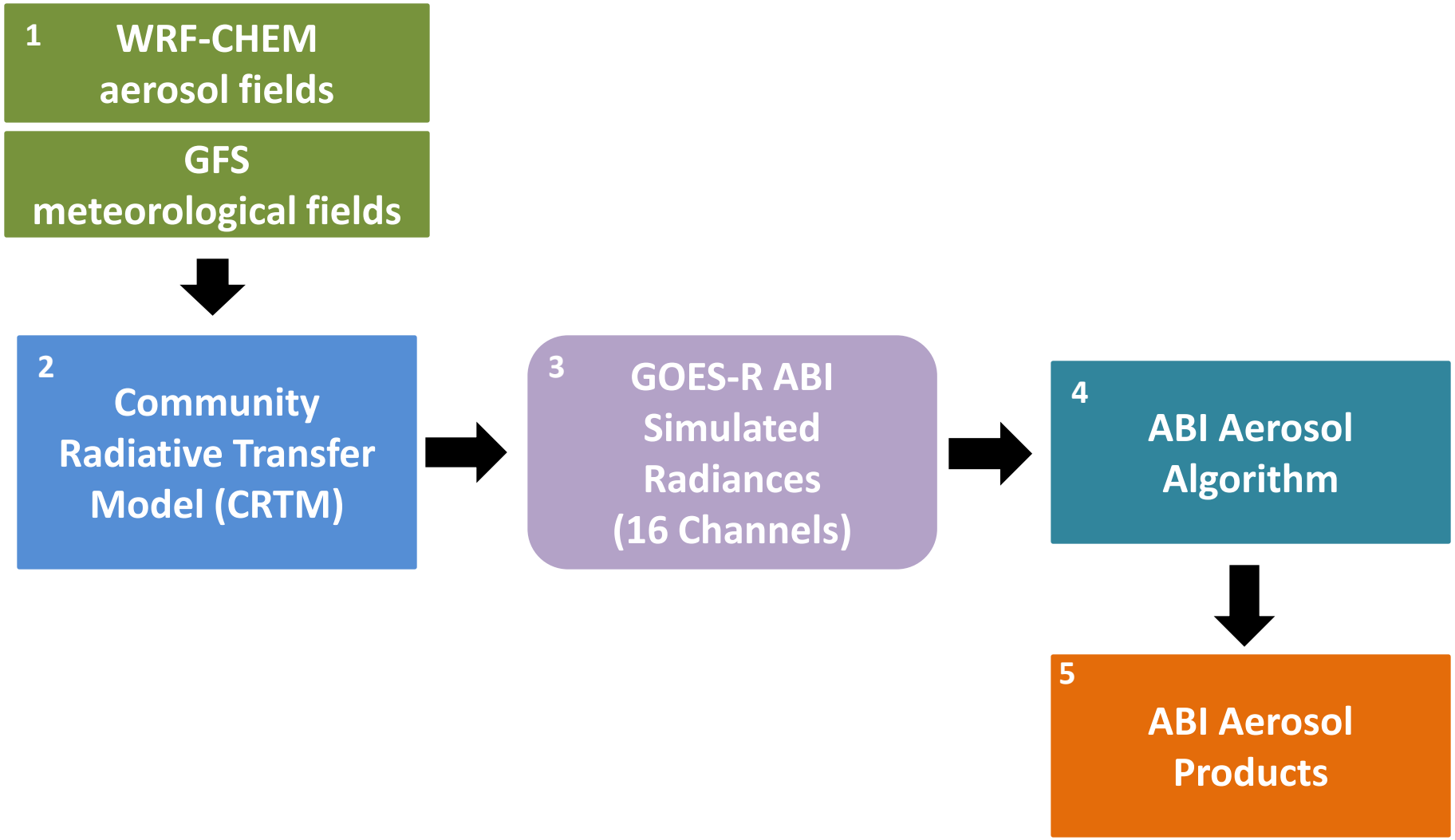


- NOAA has created the AQPG – a subset of the GOES-R Proving Ground – focusing on the aerosol products that will be available from the ABI.
- Goal: build a user community that is ready to use GOES-R air quality products as soon as they become available.
- This distinction is important because the air quality community has very different needs than the majority of NOAA users (NWS meteorologists).
- AQPG is using *simulated GOES-R ABI data* for training and interaction with the user community.

AQPG Activities

- Created an Advisory Group of forecasters, analysts and modelers who are providing feedback on products.
  - User community feedback is critical for improving product quality, usage, and distribution, and for the development of new applications (including specific data formats)
- Working with NOAA to prototype the delivery system for GOES-R air quality products.
- Creating simulated GOES-R ABI products for at least 10 case studies:
  - Past air quality events featuring haze, smoke, and/or dust
  - Range of locations in CONUS
  - 3 case studies already completed (8/24/06, 5/24/07, 7/5/10)

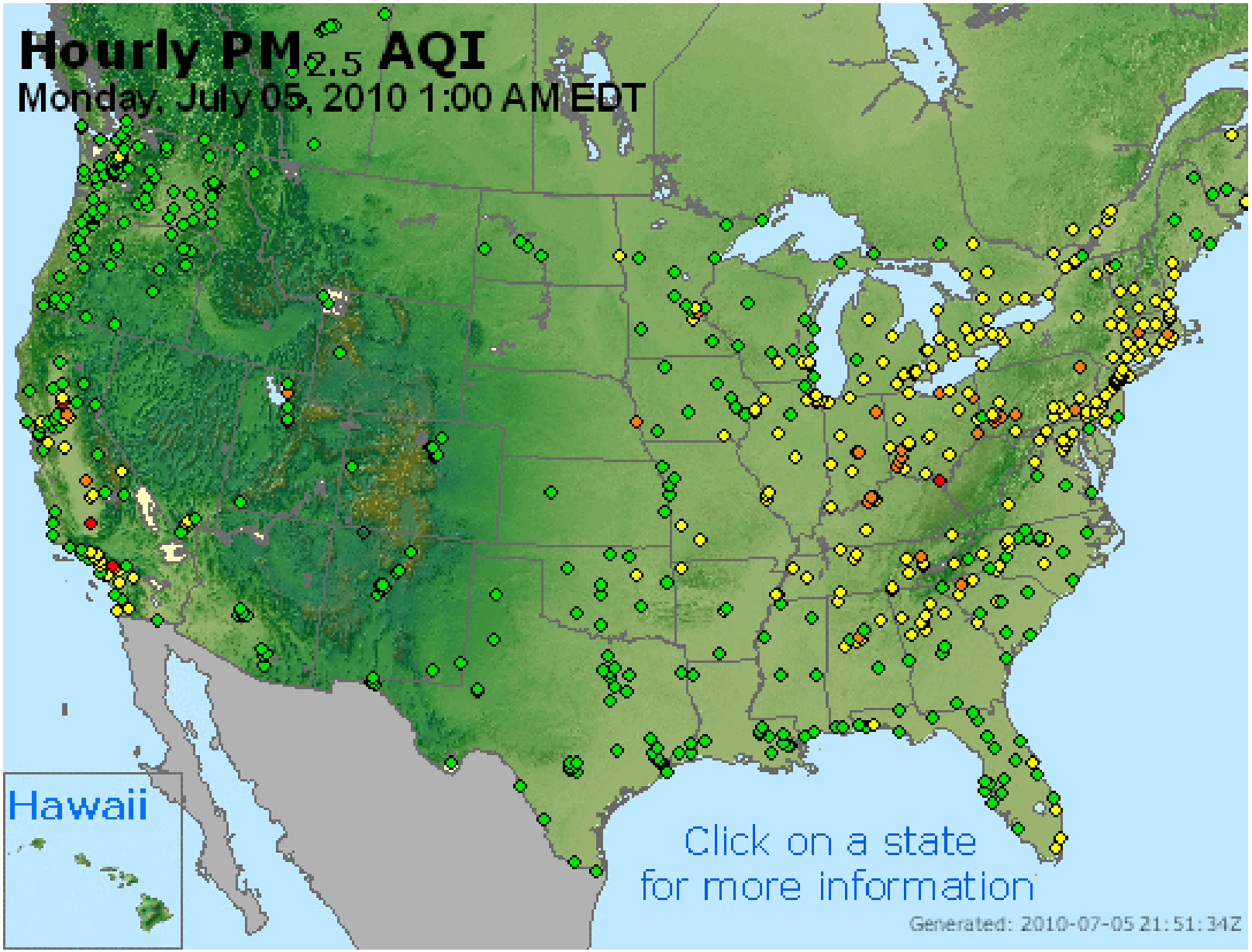
Simulated ABI Data Creation Process



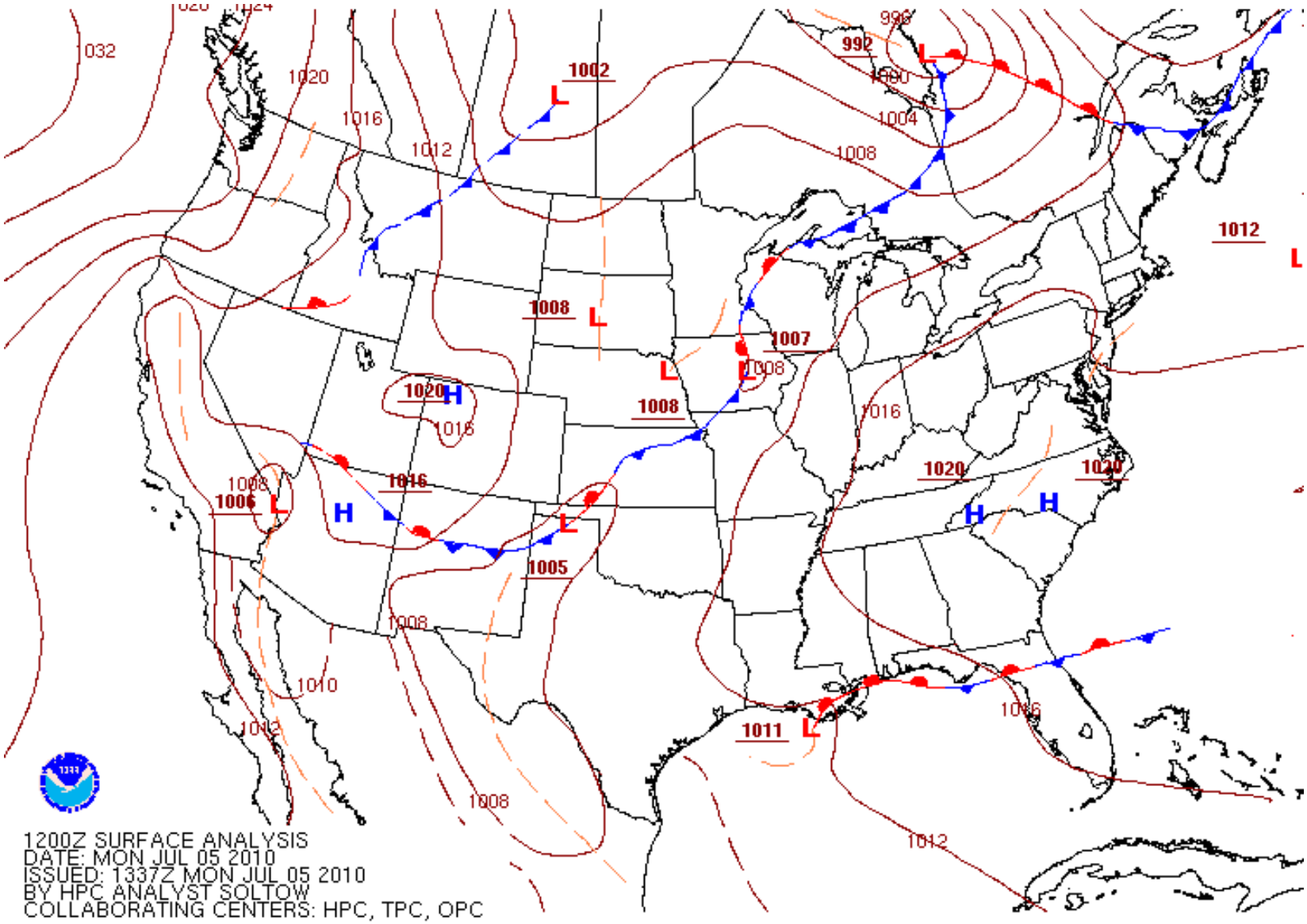
Case Studies of Simulated ABI Data

- Case studies help users to:
  - Envision what actual ABI data will look like
  - Anticipate how to use actual ABI data
- Simulated ABI data are not completely faithful representations of past conditions.
- As the AQPG continues over the next few years, we will have more simulated ABI case study examples, and they will be more faithful representations of past conditions (especially for false color imagery).
- Once GOES-R launches, actual "on-orbit" ABI data will have the accuracy and clarity of operational NOAA products.

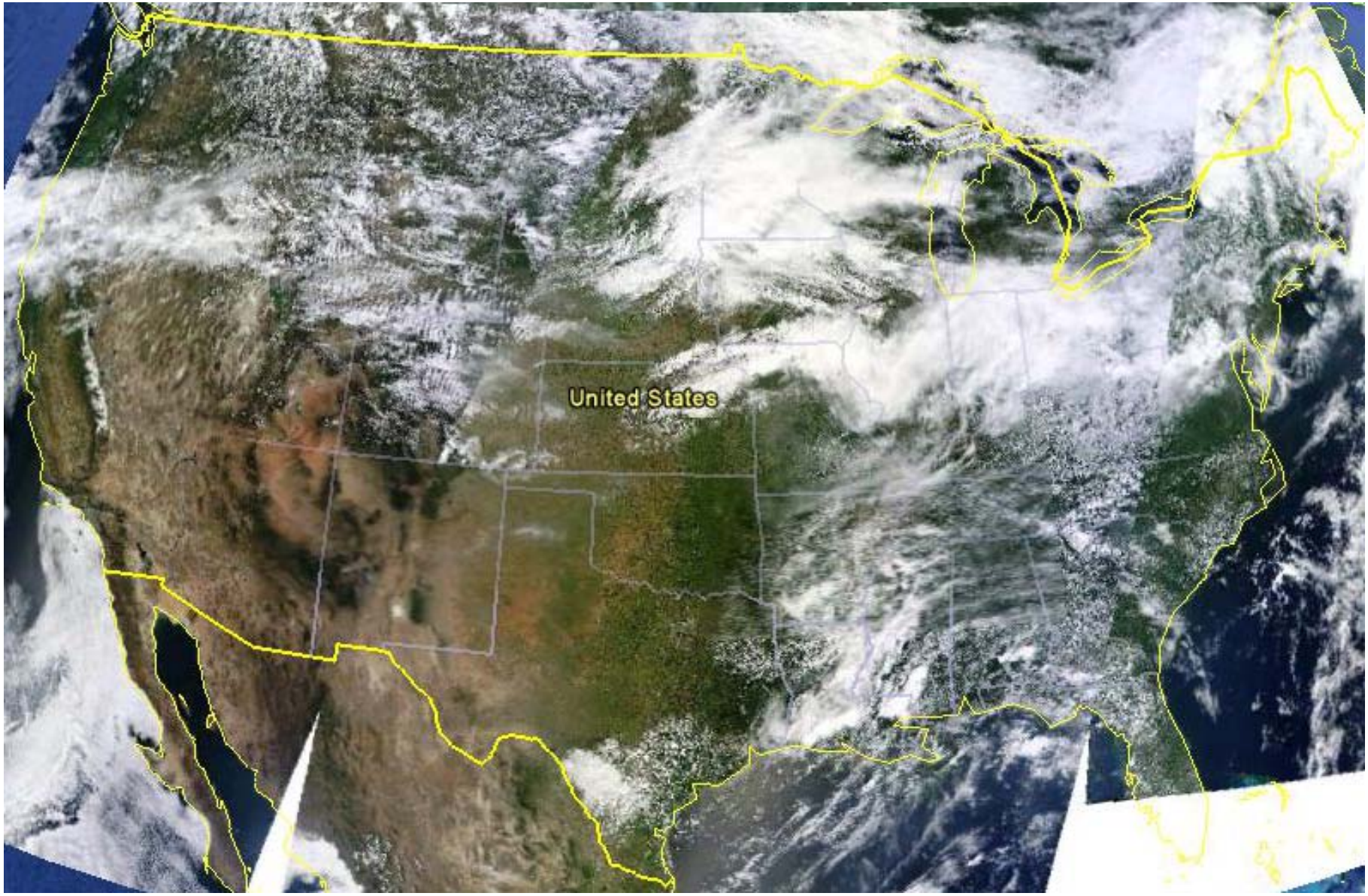
$PM_{2.5}$ AQI Loop for July 5, 2010



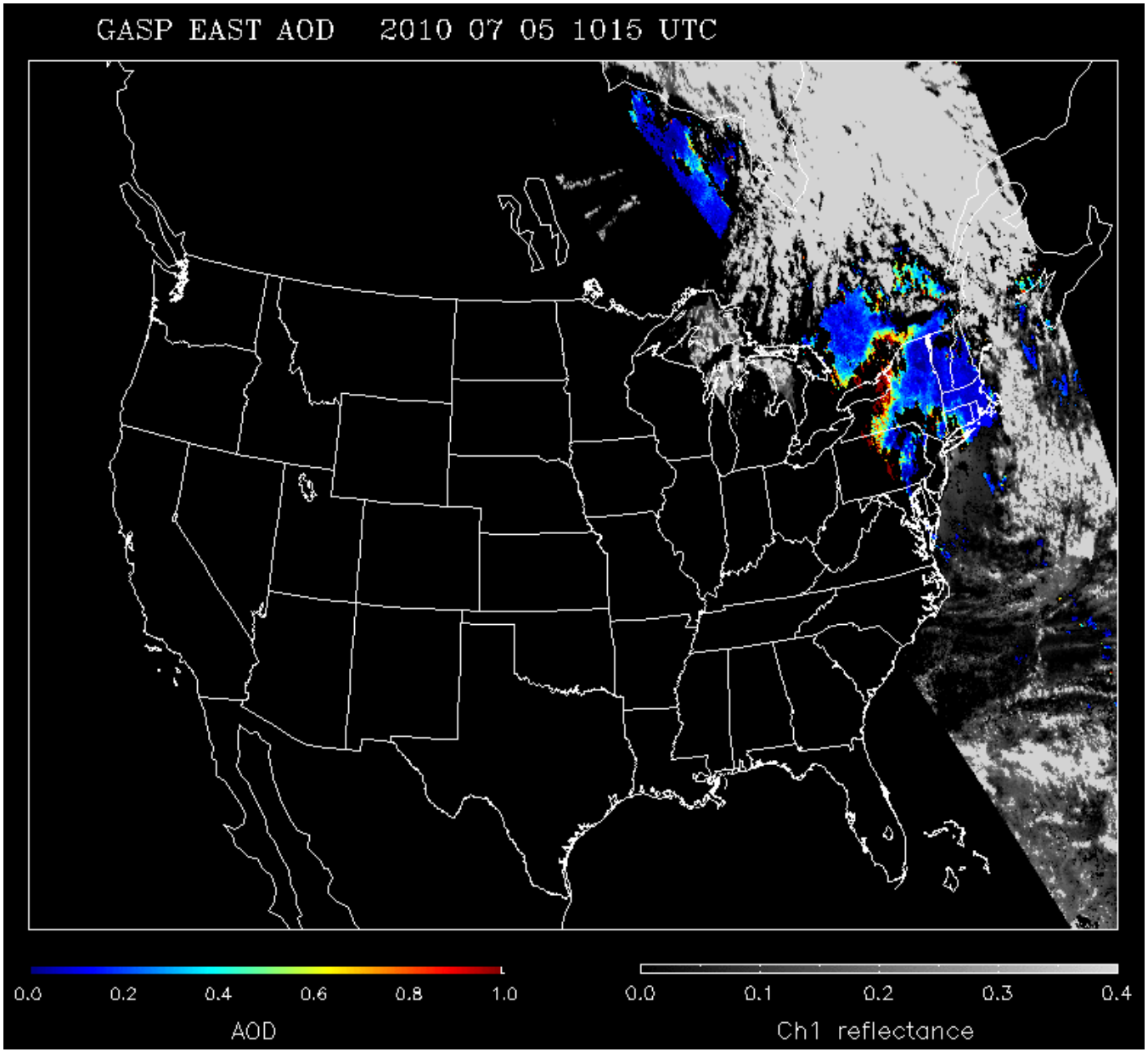
12 UTC Surface Analysis for July 5, 2010



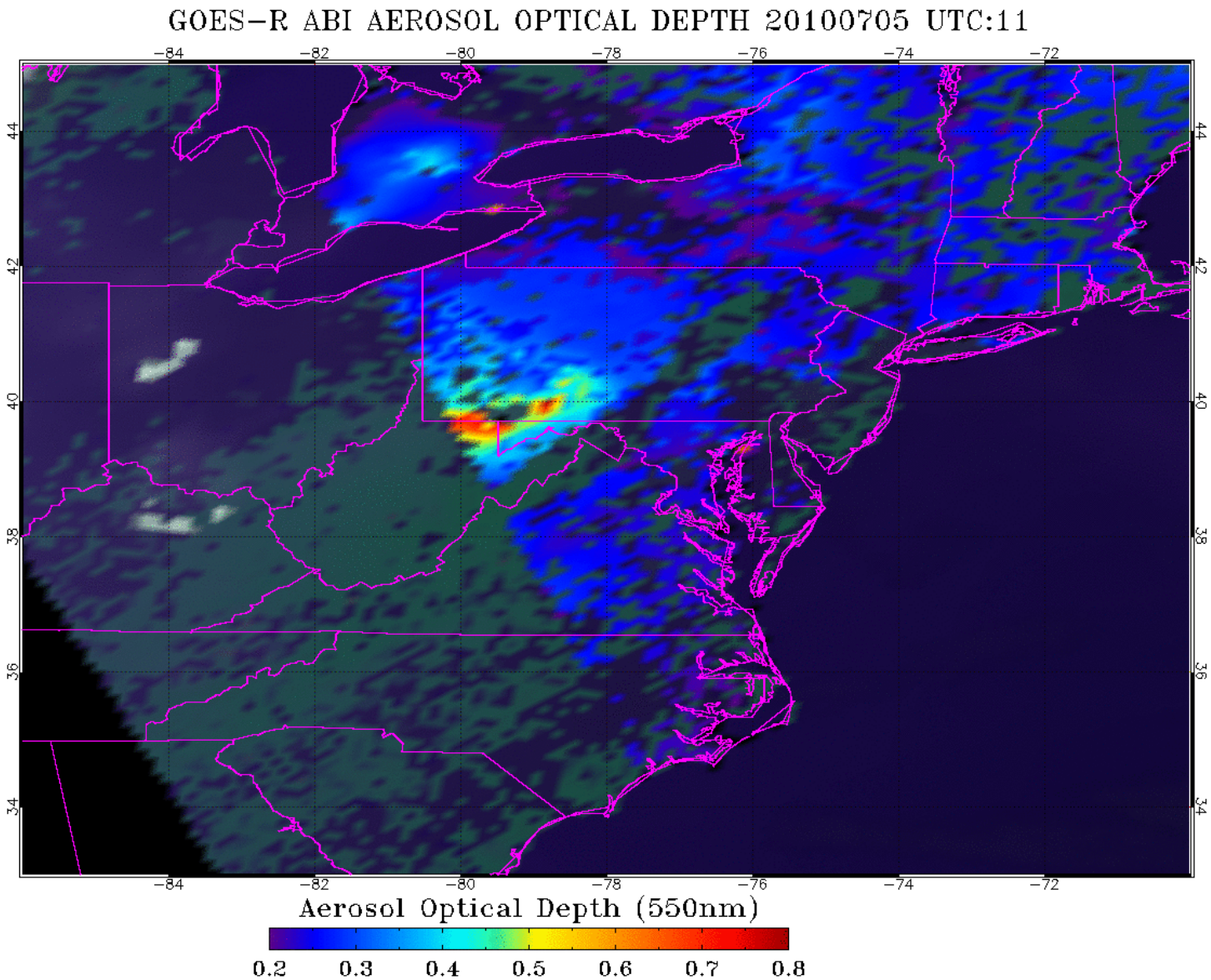
Terra MODIS True Color Image for July 5, 2010



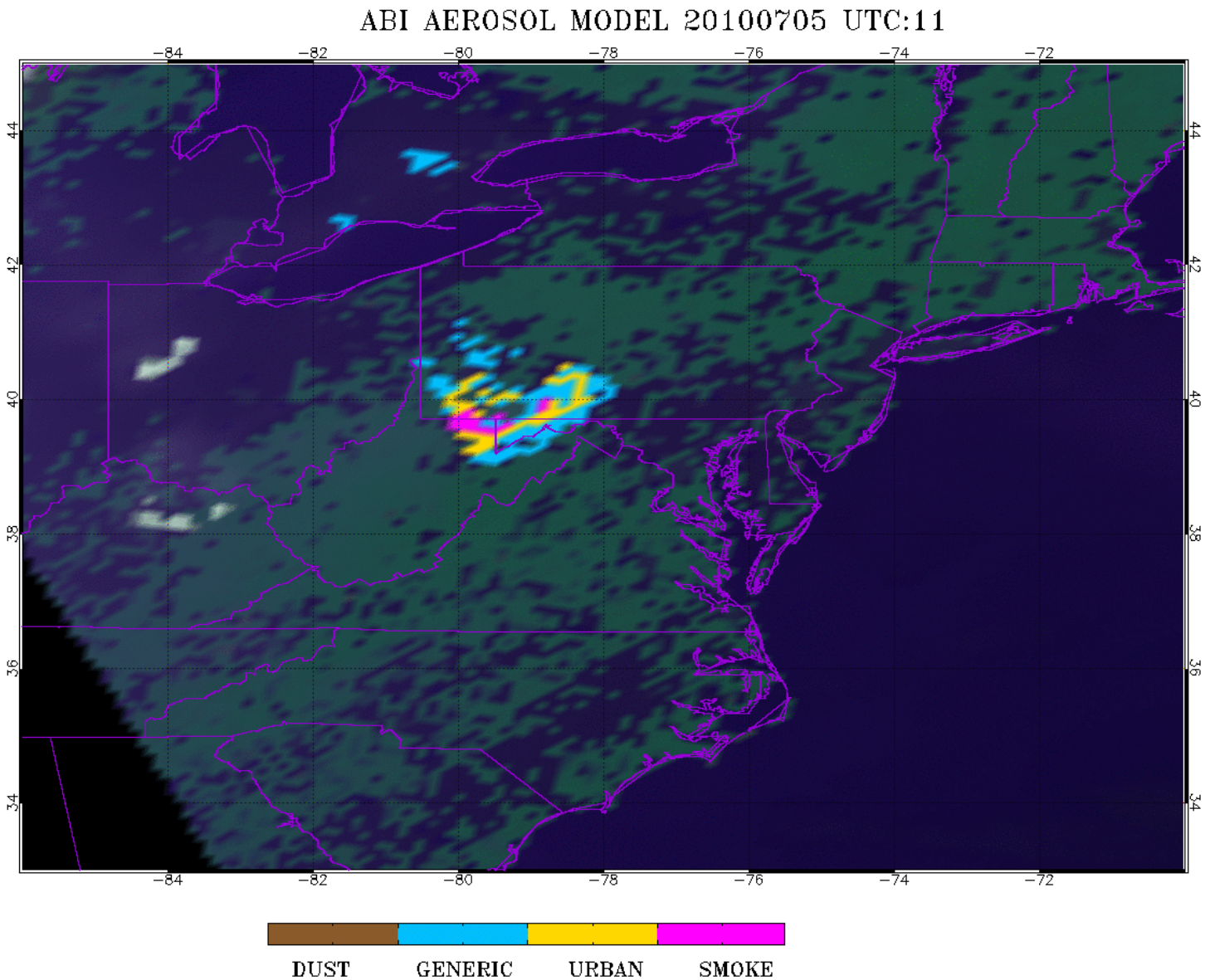
GOES Aerosol Optical Depth (GASP) for July 5, 2010



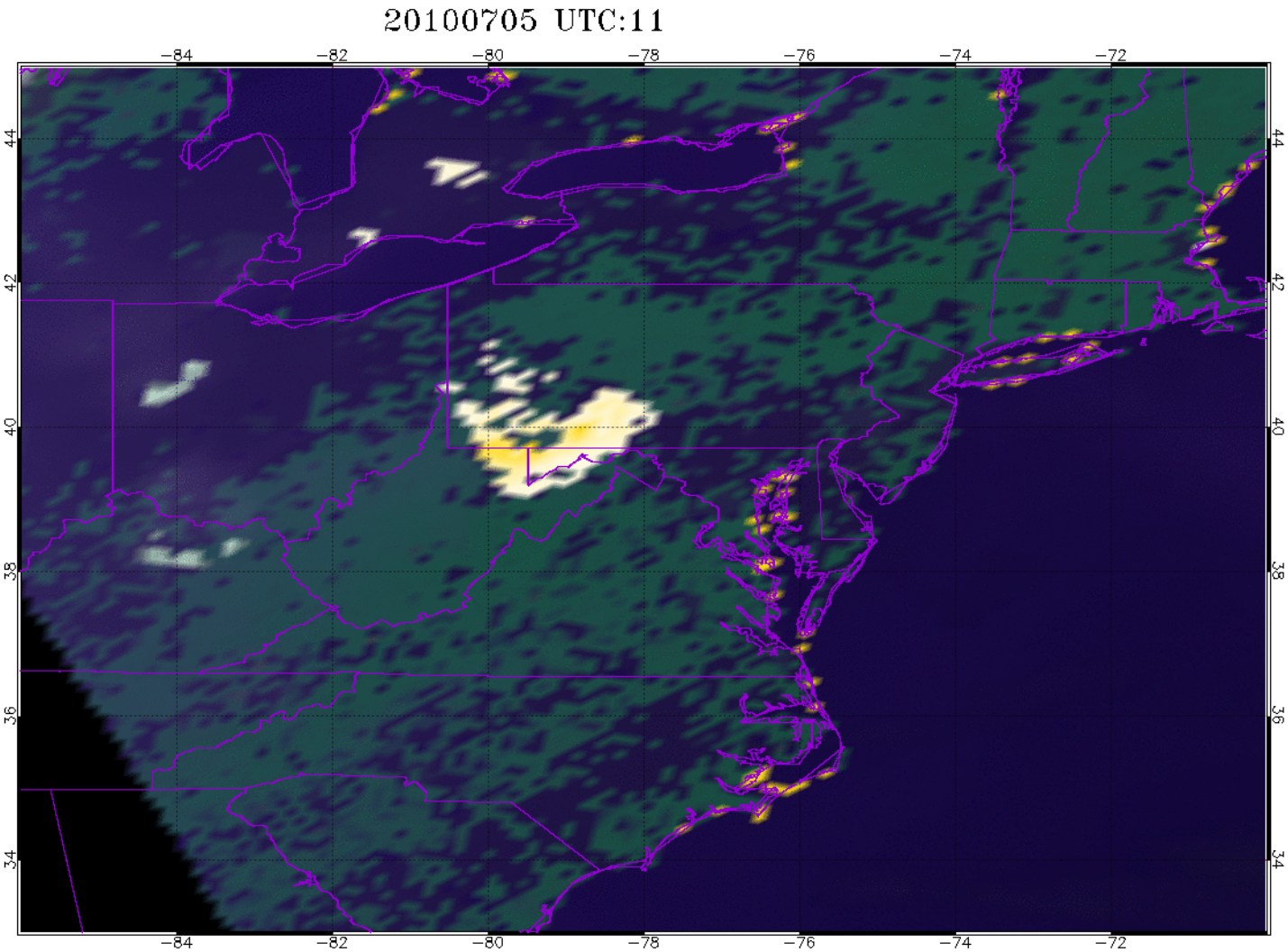
Simulated GOES-R ABI AOD Loop for 11-18 UTC July 5, 2010



Simulated GOES-R ABI Aerosol Type Loop for 11-18 UTC July 5, 2010



Simulated GOES-R ABI False Color Imagery Loop for 11-18 UTC July 5, 2010



Next Steps for the AQPG

- Preparing more case studies.
  - Looking for good events to analyze (especially dust)
  - Send event info to Amy at huffa@battelle.org
- 2nd annual AQPG workshop at UMBC in Oct/Nov.
  - 1-day workshop in Baltimore for Advisory Group members
  - Discuss recent progress in AQPG, review simulated ABI data, get feedback from air quality community
  - Travel funding provided by NOAA
- Developing on-line satellite training modules in conjunction with COMET (http://www.comet.ucar.edu/).
- AQPG will be running a near real-time testbed of simulated ABI aerosol products during DISCOVER-AQ mission in July.

DISCOVER-AQ

Deriving Information on Surface Conditions from Column and VERtically Resolved Observations Relevant to Air Quality

PI: James H. Crawford, NASA LaRC (james.h.crawford@nasa.gov)

NASA Earth Venture campaign to improve the interpretation of satellite observations to diagnose near-surface conditions relating to air quality

Objectives:

1. Relate column observations to surface conditions for aerosols and key trace gases O_3, NO_2, and CH_2O

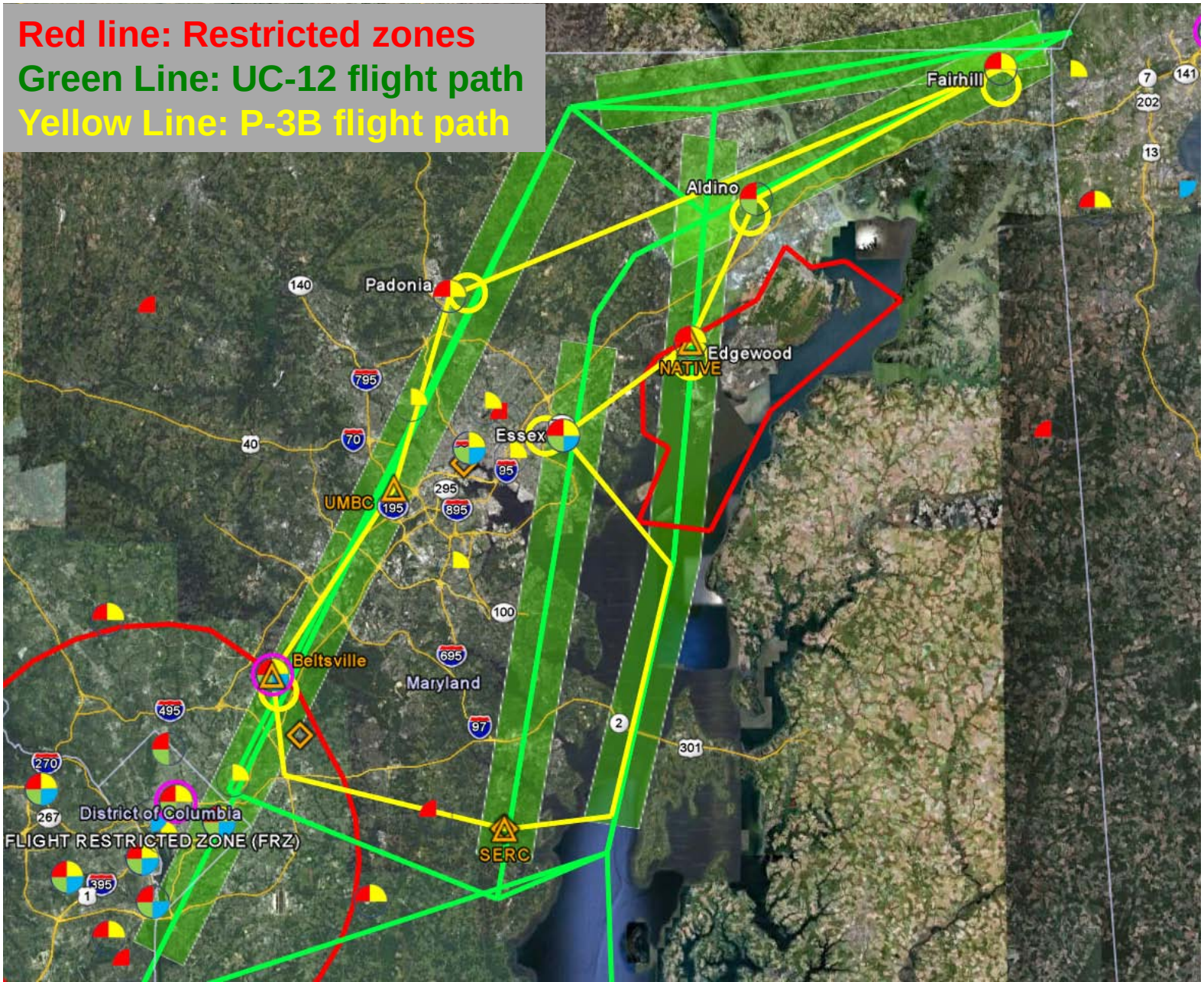
2. Characterize differences in diurnal variation of surface and column observations for key trace gases and aerosols

3. Examine horizontal scales of variability affecting satellites and model calculations

Deployments and key collaborators

Maryland, July 2011 (EPA, MDE, UMd, UMBC, Howard U.)
Texas, September 2013 (EPA, TCEQ, and U. of Houston)
California, January 2014 (EPA and CARB)
TBD, Summer 2014

July DISCOVER-AQ Planned Flight Paths



Simulated ABI Testbed during DISCOVER-AQ

- AQPG near real-time simulated ABI aerosol products:
  - 12 UTC CMAQ 12 km output run through CRTM and ABI algorithm
  - Next-day ABI AOD available ~2-3 PM
  - July 9-30, 2011
  - DISCOVER-AQ region: PHL-BAL-DC corridor
- Looking for volunteers to review the NRT simulated ABI data.
  - Give us feedback on necessary improvements to products
  - Additional dataset for forecasting activities
  - We're still designing the experiment – tell us your requirements for data format, availability time, etc.

Acknowledgements

- Special thanks to Pubu Ciren and Chuanyu Xu (NOAA NESDIS) for preparing the simulated ABI aerosol imagery.
- Shobha Kondragunta (NOAA NESDIS)
- Ray Hoff (UMBC)
- Sundar Christopher (Univ. of Alabama – Huntsville)
- Brad Pierce (NOAA NESDIS)
- Jim Crawford (NASA LaRC)