3D-AQS: A Three Dimensional Air Quality System

NASA Air Quality Team Meeting
Potomac, MD June 18-20, 2007

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http://alg.umbc.edu; 410-455-1610

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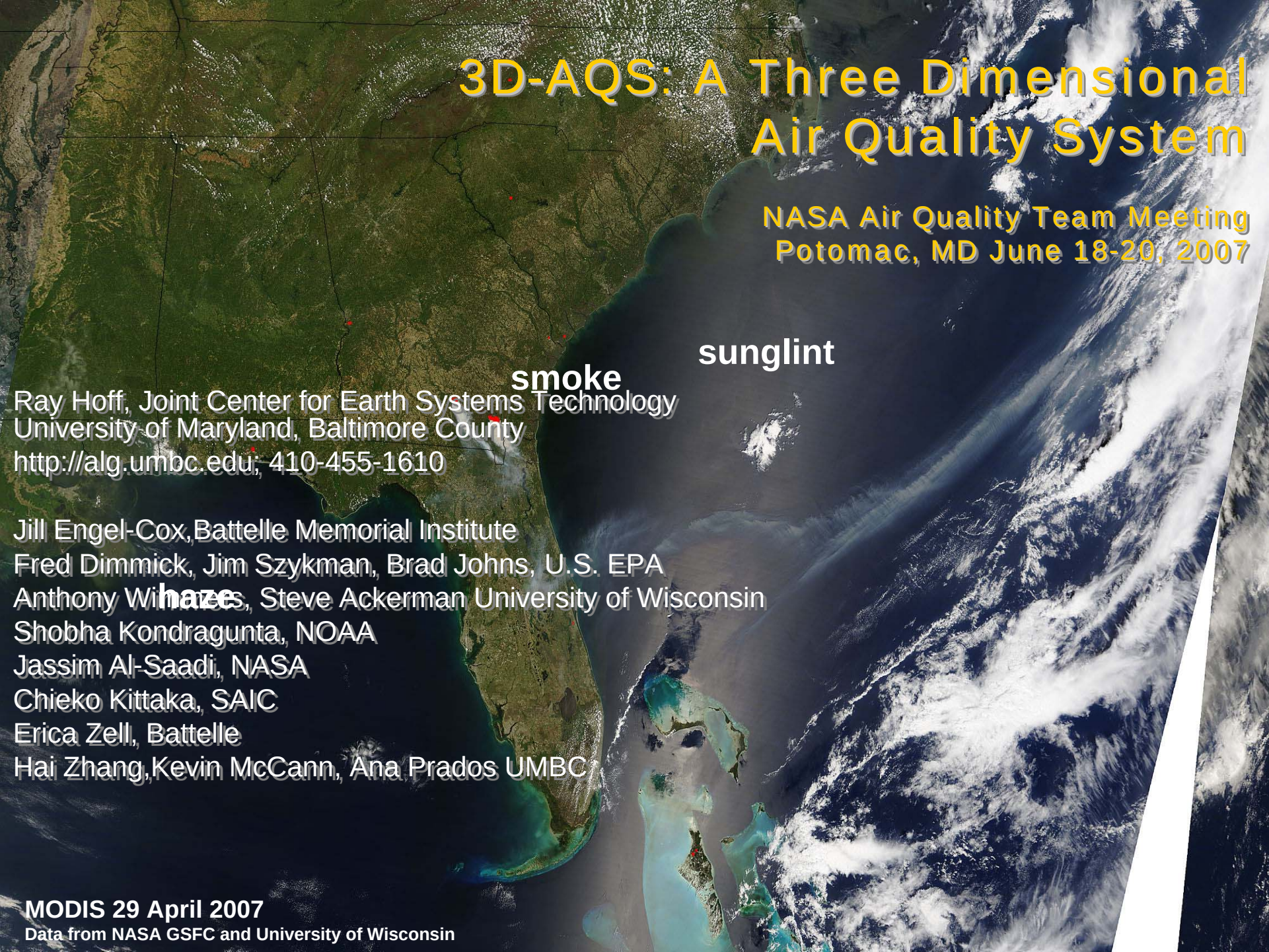
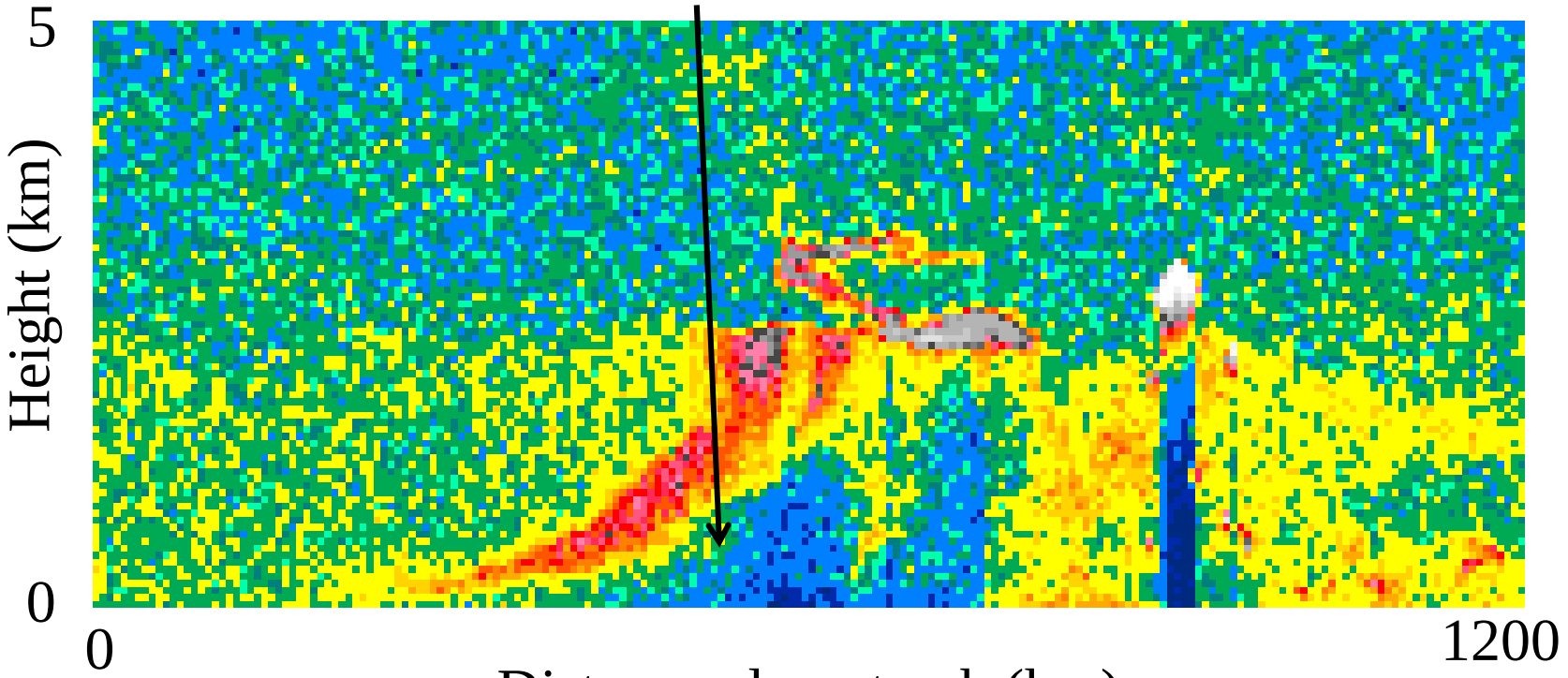
Jassim Al-Saadi, NASA
Chieko Kittaka, SAIC
Erica Zell, Battelle
Hai Zhang,Kevin McCann, Ana Prados UMBC



MODIS 29 April 2007
Data from NASA GSFC and University of Wisconsin

The same plume in the vertical

This is why ground monitors in GA/FLA didn't ring bells



(more on this later…..)

NASA Three-Dimensional Air Quality System (3D-AQS) Project

- Integrate NASA satellite sensor and lidar data into EPA's operational air quality data systems: AQS/AirQuest, AirNow
- Provide greater accessibility and usability of satellite and lidar data to all users of these systems: IDEA, Smog Blog, REALM
- Develop visualization tools in horizontal and vertical dimensions for comparison with CMAQ forecasts and retrospective analysis

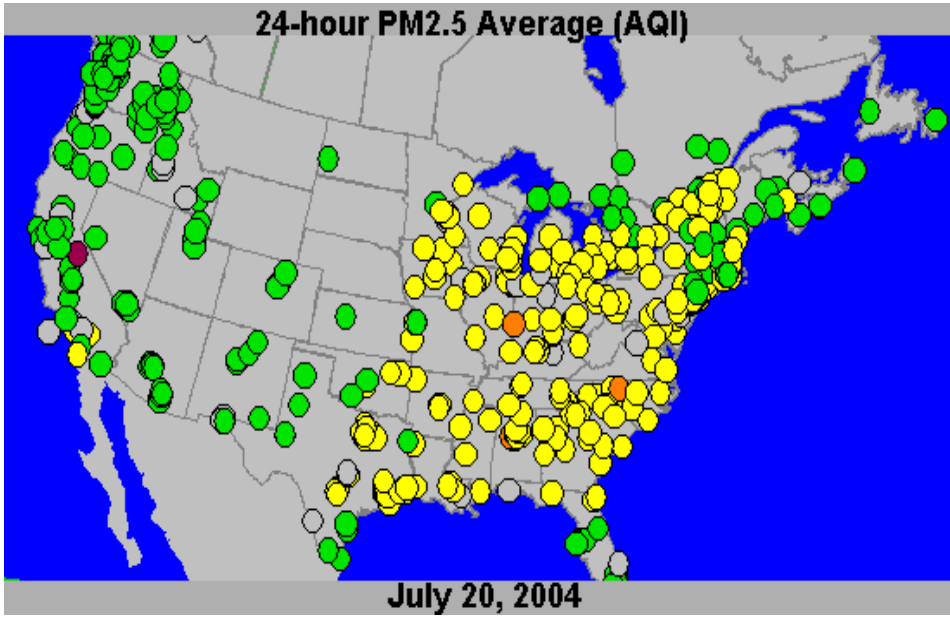
Why are we interested in measuring air quality data in 3D?

- Regional haze and regional scale events
- Long and medium range transport
- Clean Air Interstate Rule
- Improved modeling and validation of models
- Regulatory accountability
- Health endpoints?

Satellite sensors can provide horizontal data coverage, ground and space-based lidar can measure aerosols in the vertical dimension.
"At this point, we are ants on a two dimensional world…."

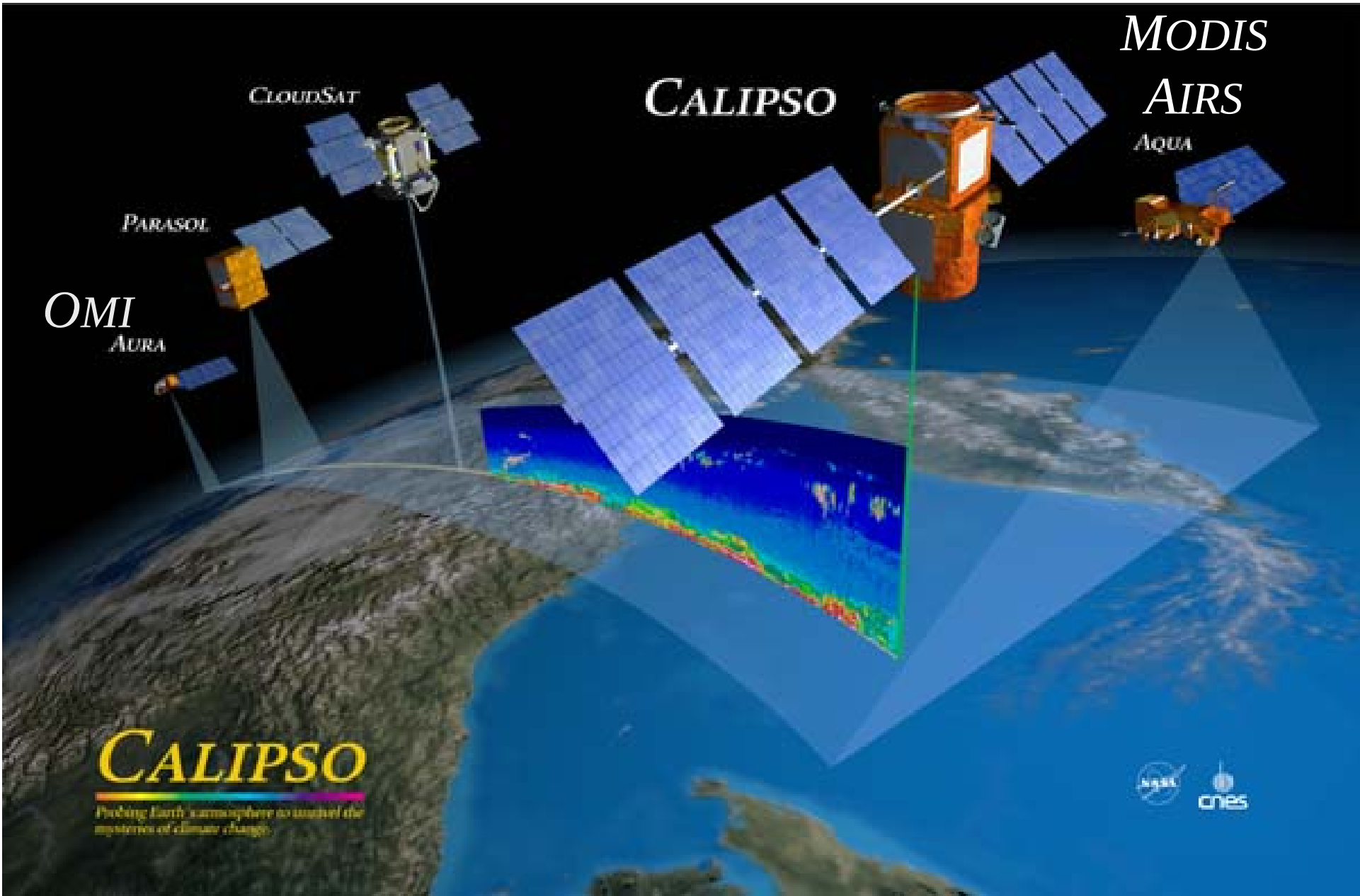
Current Datasets: Ambient Air Monitoring for Aerosols

- "True" measure of air quality
  - → Varying temporal scales (hourly, daily, 1 in 3 days)
  - → Sparse networks spatially
- Ground-based concentration in mass units ($\mu g / m^3$)
- Monitors usually sited in urban or rural areas only, e.g.,
  - → Urban FRM network
  - → IMPROVE in Class I areas



- Used for forecasting and historical analysis (including compliance)
- Decision support systems include:
  - → AQS / AirQuest (http://www.epa.gov/ttn/airs/airsaqs/)
  - → AIRNow (http://www.airnow.gov)

Some key air quality satellite sensors



Integrated System Solutions for 3-D AQS Impacting Air Quality & Public Health

Sun-Earth Observations and Models for Predictions/Assessments/ Forecasts

Observations
Terra/Aqua
MODIS
AIRS
LIDAR
REALM
MPLNet
GOES
GASP
Aura
OMI
CALIOP
CALIPSO
AERONET

Models
NOAA
Hysplit

LaRC
modified
IMPACT
trajectory
model

IDEA

3D-AQS

USAQ Weblog

Partnership Area

Decision-Support Tools
AIRNow/AQS-EPA/NOAA
- Increase synoptic data for $PM_{2.5}$ forecasters

AQS/AIRQuest (EPA)
- Multi-dimensional aerosol related data and analyses:
- Assess general state of air quality and trends
- Assess progress of SIPs and compliance
- Waivers to air standards
- Air quality rule development

NEPHTN-PHASE (CDC)
- Produce better AQ maps through statistical models

Value & Benefits to Citizens & Society

Increase accuracy in AQ forecast: reduce poor air quality health impacts.

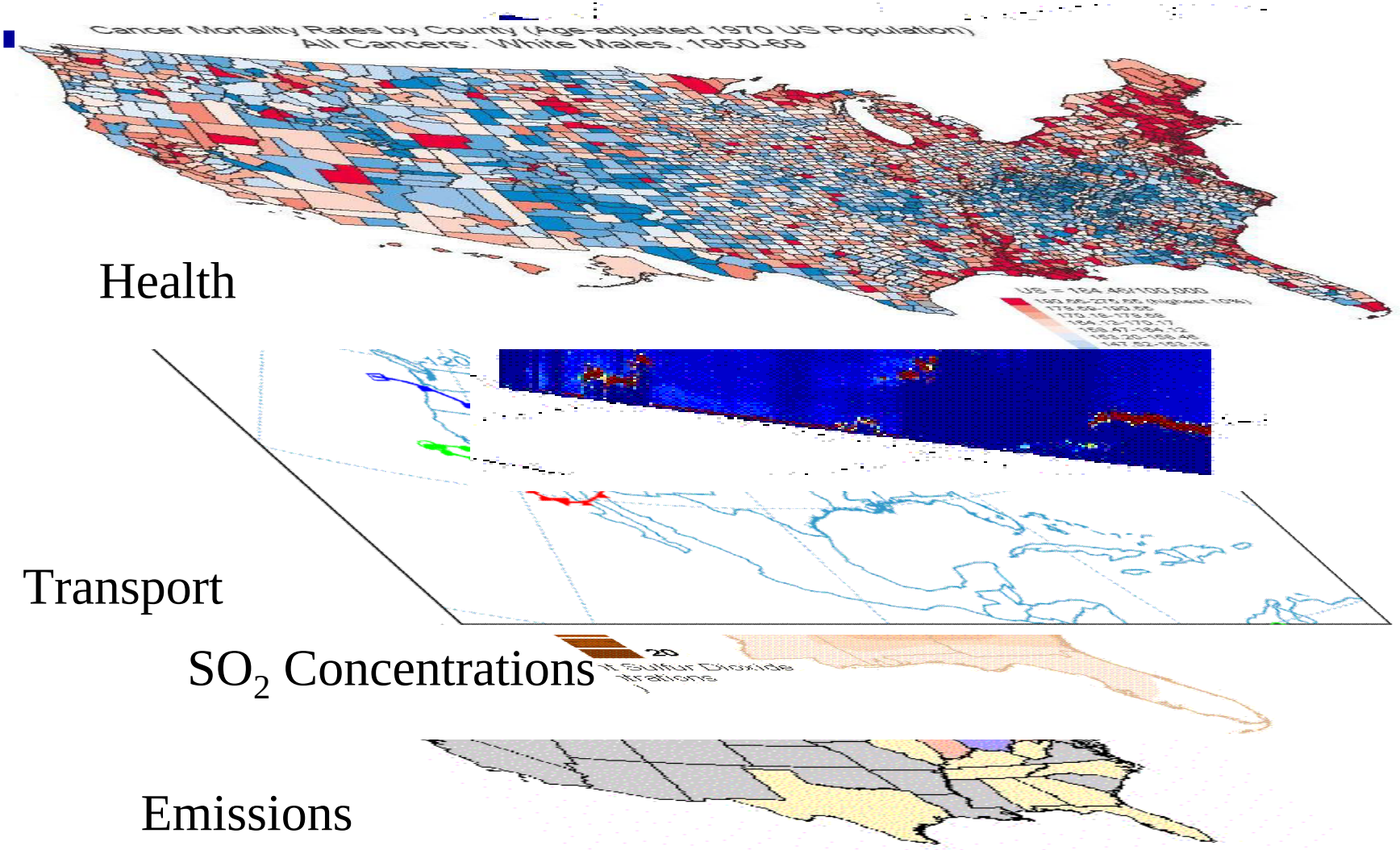
Increase knowledge in causes or poor air quality – leading to improvements in AQ and confidence in government.

Improved prevention initiative targeting.

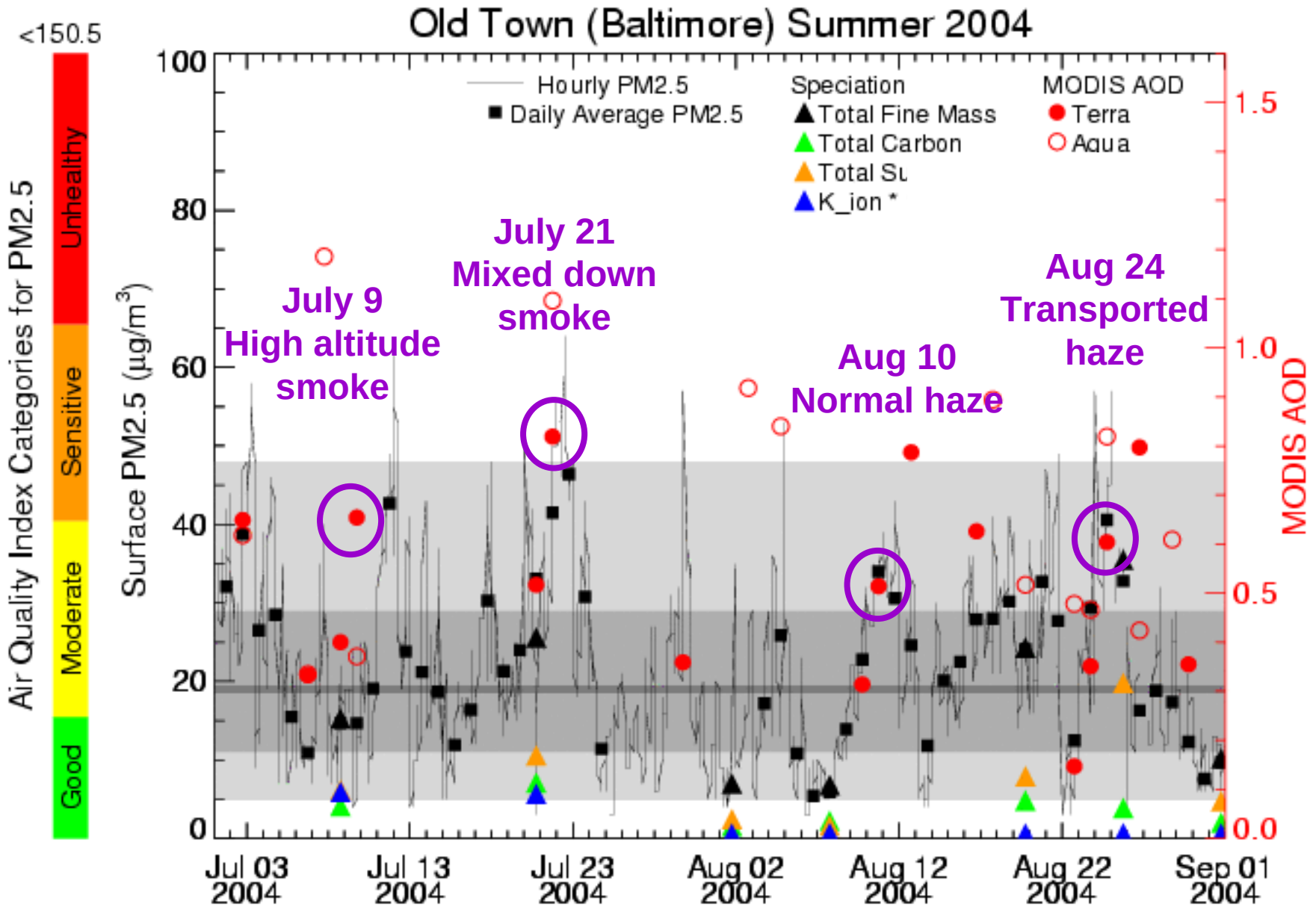
INPUTS | **OUTPUTS** | **OUTCOMES** | **IMPACTS**

NASA/NOAA/EPA/ UMBC/CIMSS/BMI | **EPA/NOAA/CDC**

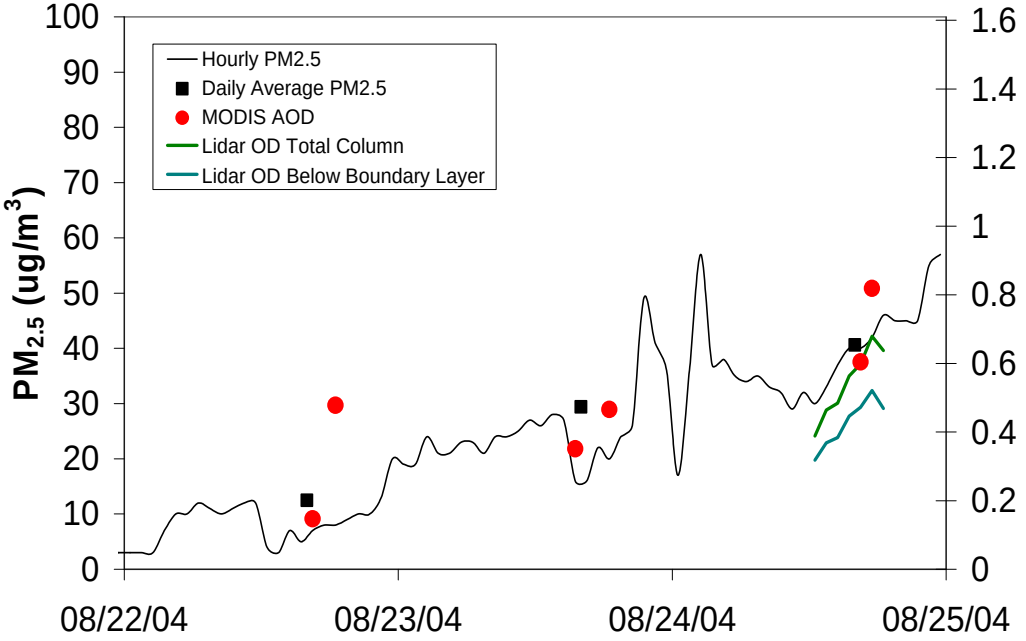
3D-AQS integrates disparate datasets - our vision

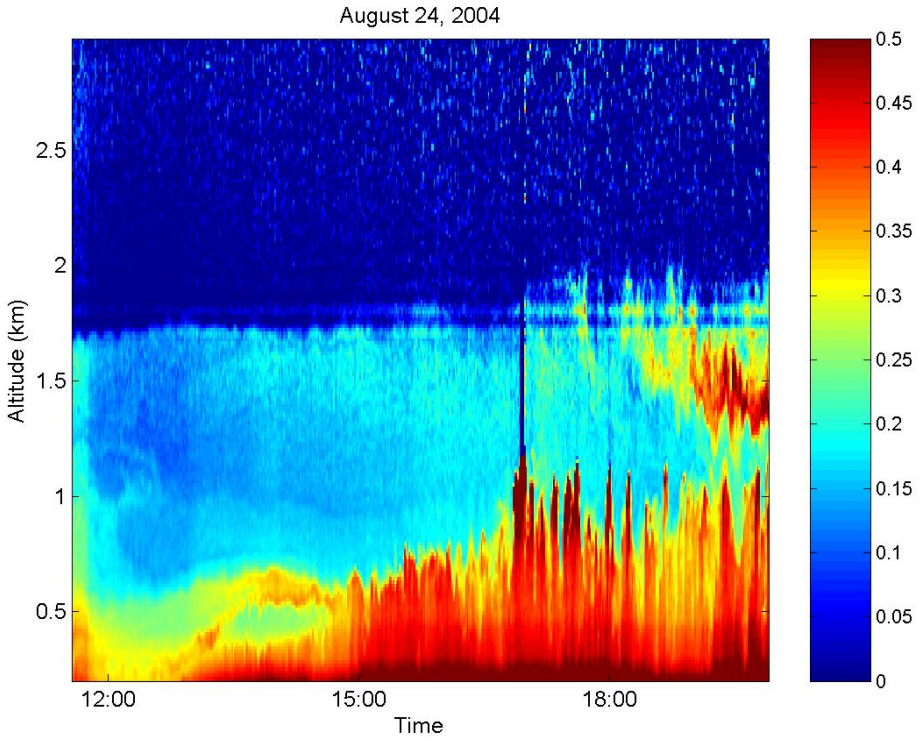


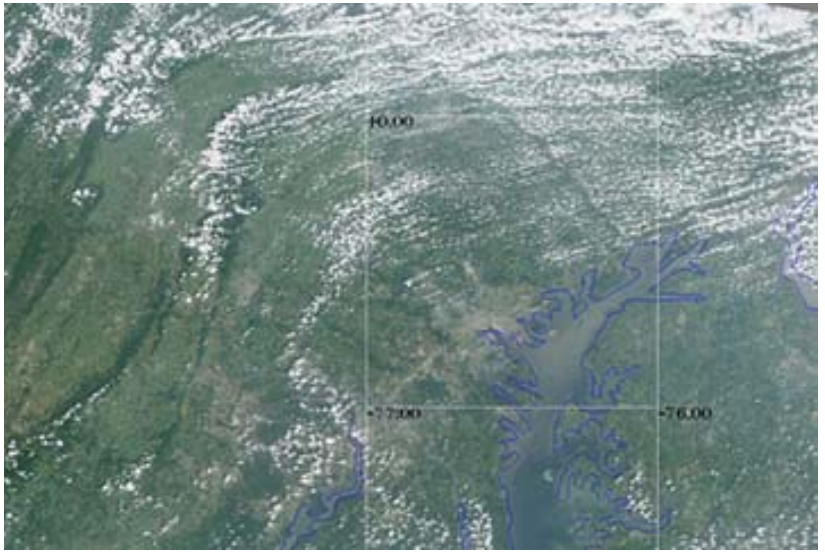
Baltimore, MD Summer 2004



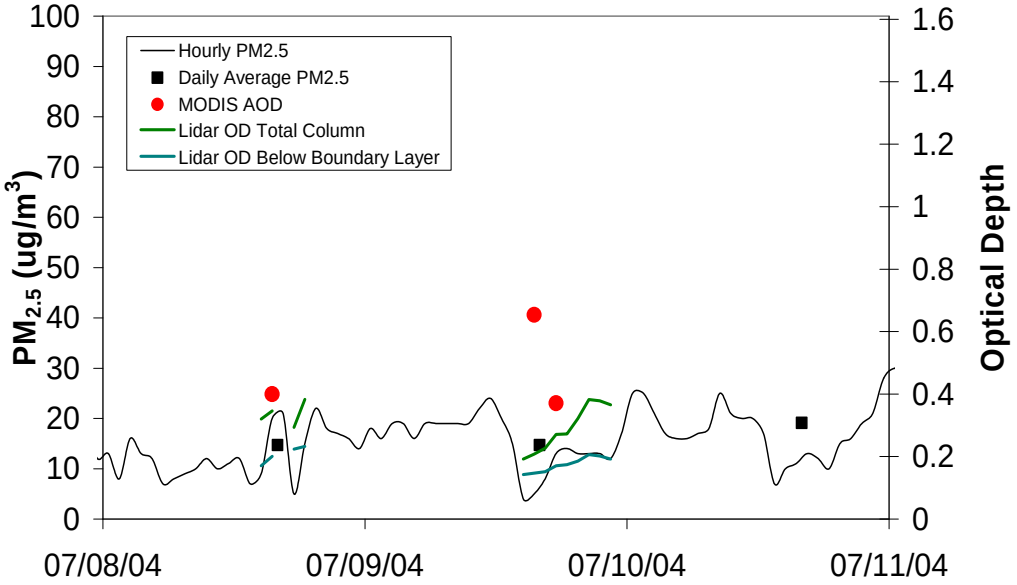
Sulfate transport to Maryland 24 August 2004

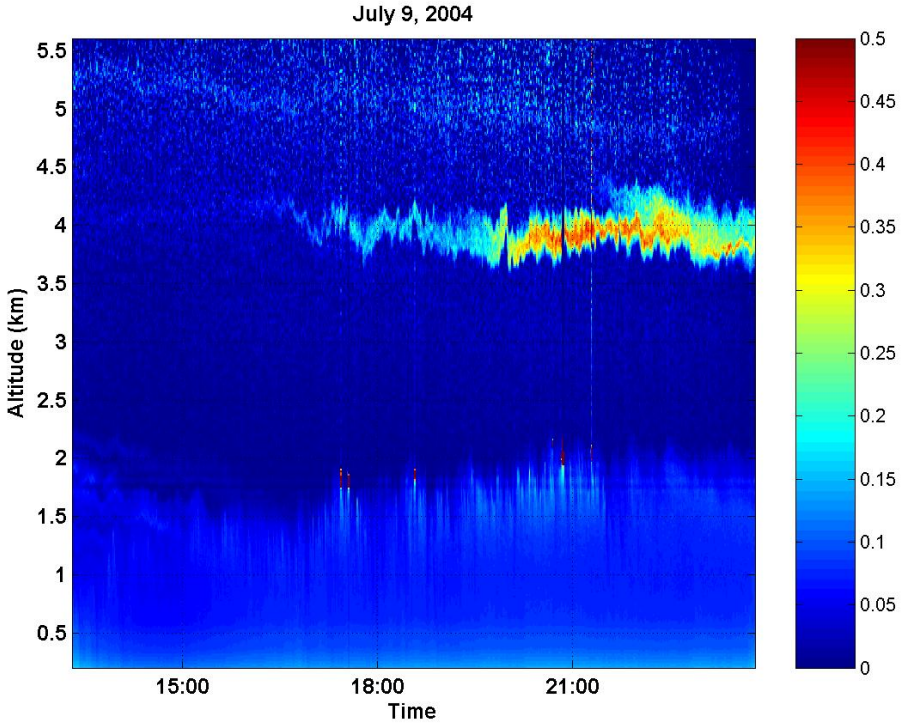


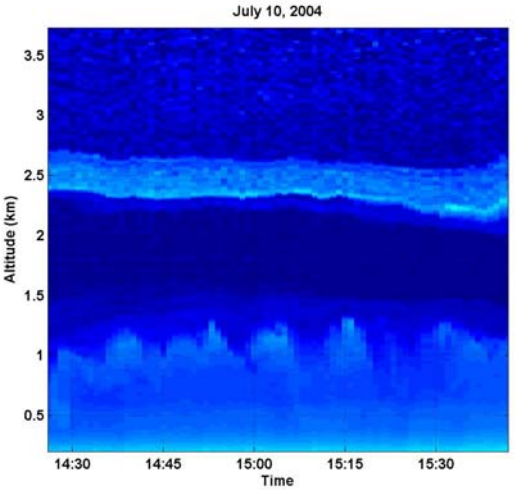




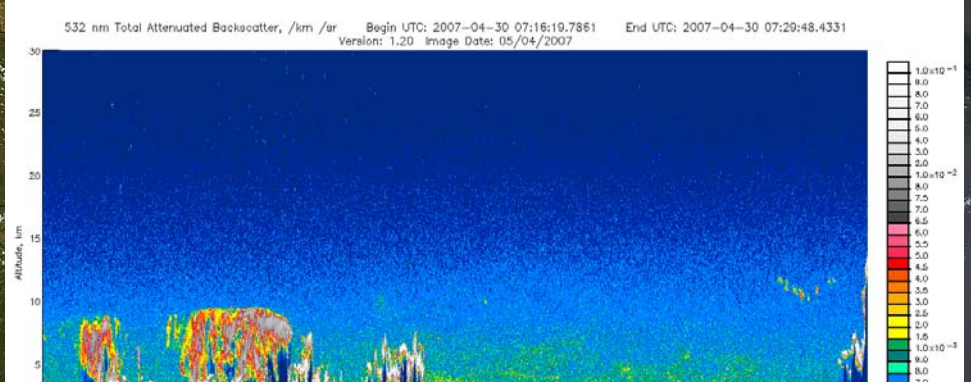
Alaskan Smoke over Maryland 9 July 2004

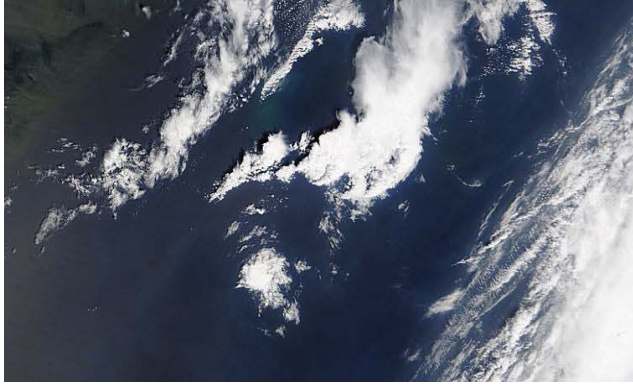






10 July 2004, am





532 nm Total Attenuated Backscatter, /km /sr Begin UTC: 2007-04-30 07:16:19.7861 End UTC: 2007-04-30 07:29:48.4331
Version: 1.20 Image Date: 05/04/2007

(12 hrs later)

Altitude, km

30
25
20
15
10
5
0

63.49 −66.24
57.62 −70.30
51.67 −73.34
45.67 −75.77
39.64 −77.82
33.58 −79.60
27.50 −81.20
21.41 −82.69
15.35 −84.07

1.0×10^{-1} 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0×10^{-2} 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0×10^{-3} 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0×10^{-4}

UMBC data can all be found at http://alg.umbc.edu

U.S. Air Quality (The Smog Blog), http://alg.umbc.edu/usaq

U.S. Air Quality - Mozilla

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U.S. Air Quality
The Smog Blog

UMBC AN HONORS UNIVERSITY IN MARYLAND

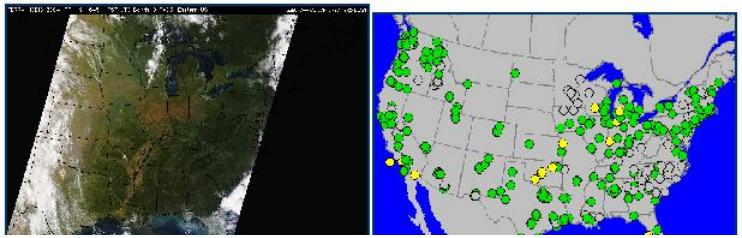
Daily posts

September 19, 2004

CLEAR, LIGHT HAZE, AND CLOUDS

Beautiful clear skies in much of the eastern with a few exceptions in the midwest.

d cloudy in the west. PM2.5 concentrations were similar, mostly good



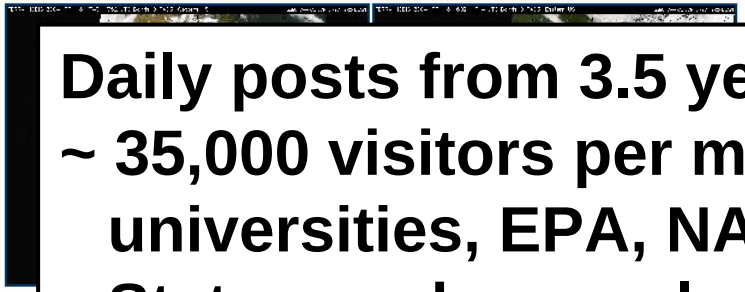
NASA satellite images, EPA data, etc.

Posted by Jill Engel-Cox at 06:30 PM

September 18, 2004

SOUTHCENTRAL HAZE

The remnants of hurricane Ivan continued up the eastern U.S. producing very heavy rain and strong storms. The midwest and west were clear, but some smoky haze has built up in the southcentral region (Texas, Oklahoma, Arkansas, Louisiana).



EPA
(onl

About U.S. Air Quality

USAQ is a daily diary of air quality in the U.S. using information from NASA satellites, ground-based lidar, EPA monitoring networks, and other monitors. Interpretation and analysis is provided by the staff of the University of Maryland, Baltimore County Atmospheric Lidar Group.

Search

Search this site: Search

Recent Entries

- Clear, light haze, and clouds
- Southcentral haze
- Mostly GOOD AQI
- Northeastern haze is out
- Smoke in Arizona and Louisiana while Ivan is approaching
- Northeastern & Midwest Haze
- Haze Remains Over the Plains...and is moving eastward
- Aerosols Aloft in the Morning
- Haze over the plains
- Southern smoky haze

Links

- EPA AirNow
- NASA/EPA/NOAA/UW IDEA
- UW MODIS Direct
- NOAA GOES
- NOAA NESDIS GASP
- A GASP Viewer
- A Hysplit Model
- Monterey Aerosol Page
- M2.5 Forecast
- more-DC Air-Watch.net
- C-ALG Webcam
- C AIRS CO
- R Real-Time Weather
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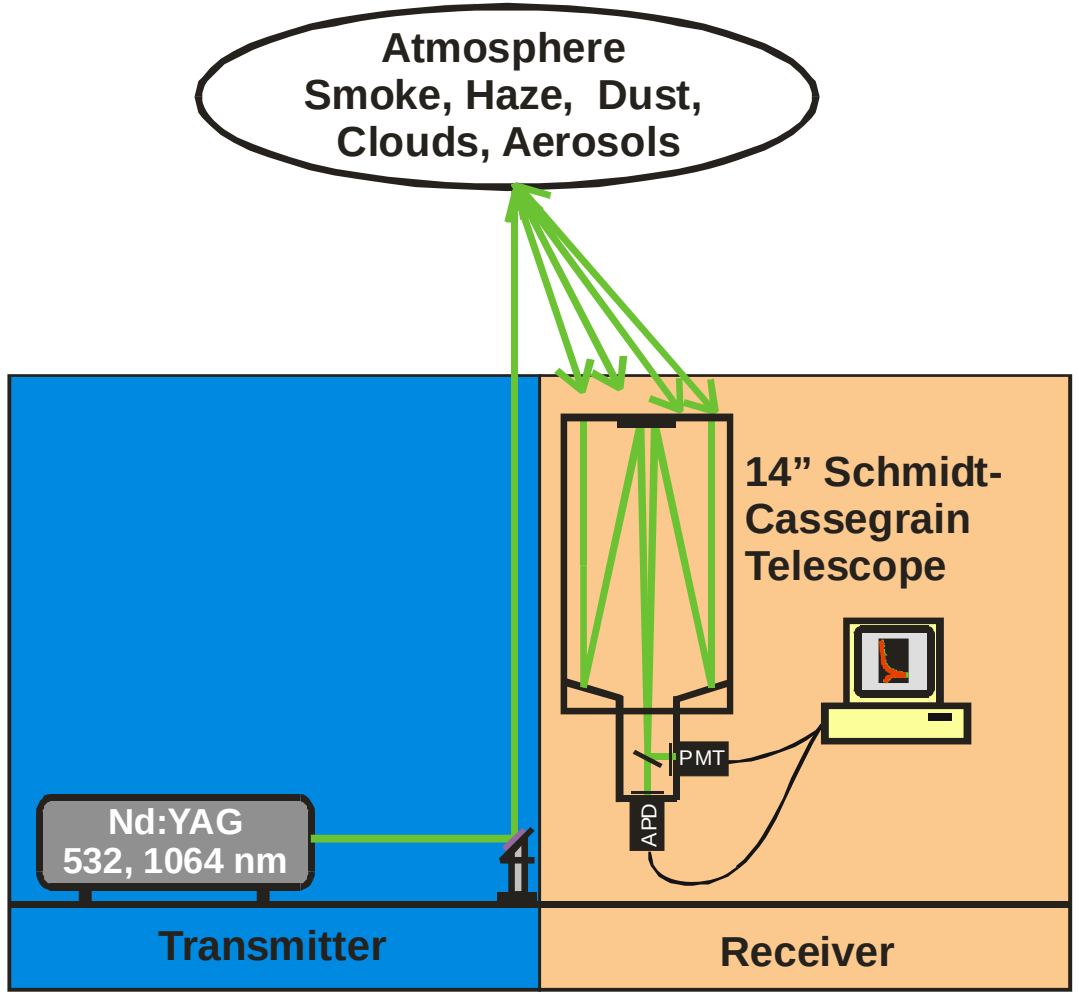
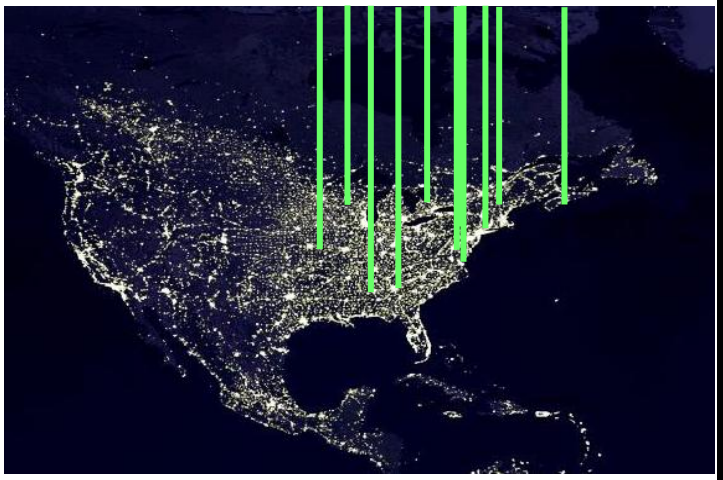
- Note
- Photograph
- SUOMINET

Daily posts from 3.5 years
~ 35,000 visitors per month, including universities, EPA, NASA, NOAA, & States, and general public

Elastic Lidar Facility (ELF)



http://alg.umbc.edu/REALM



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Windows Me... | Welcome to the REALM Data Ce...

January 2007

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December 2006

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31						

November 2006

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OCTOBER 2006

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SEPTEMBER 2006

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AUGUST 2006

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13	14	15	16	17	18	19

RDC:12-04-06

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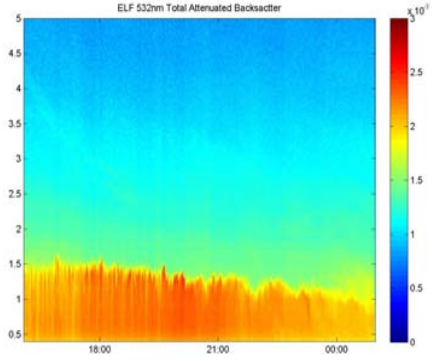
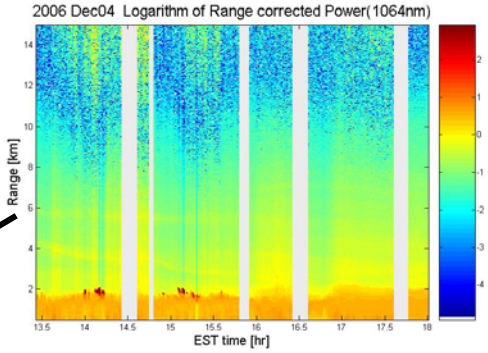
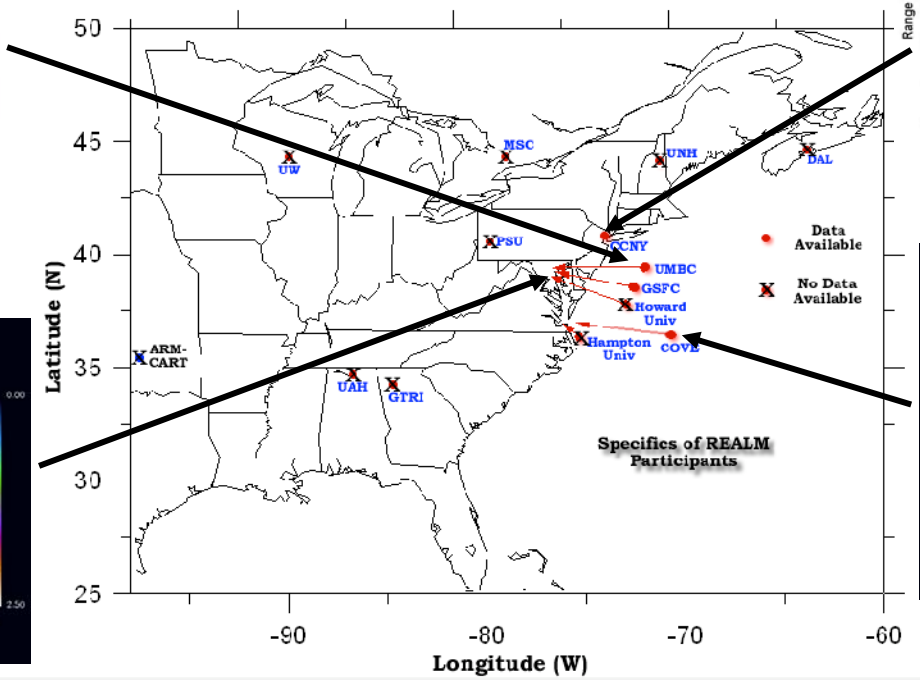
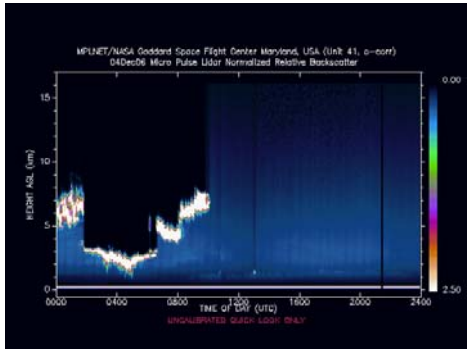
Data for: December 4, 2006

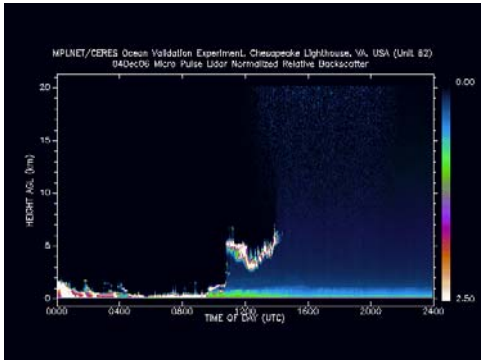
Click on a REALM Participant for their LIDAR data.











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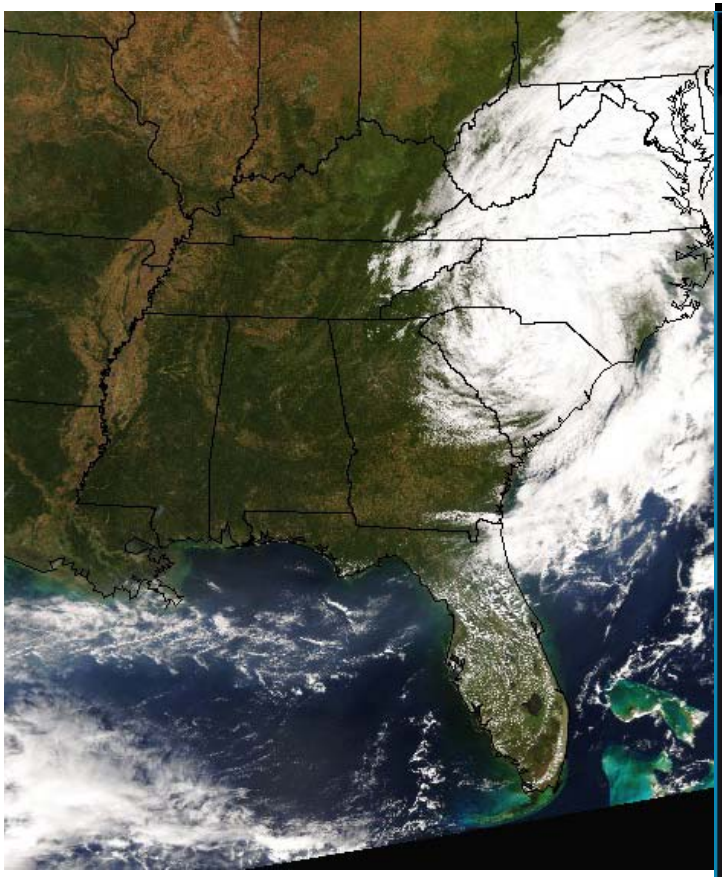
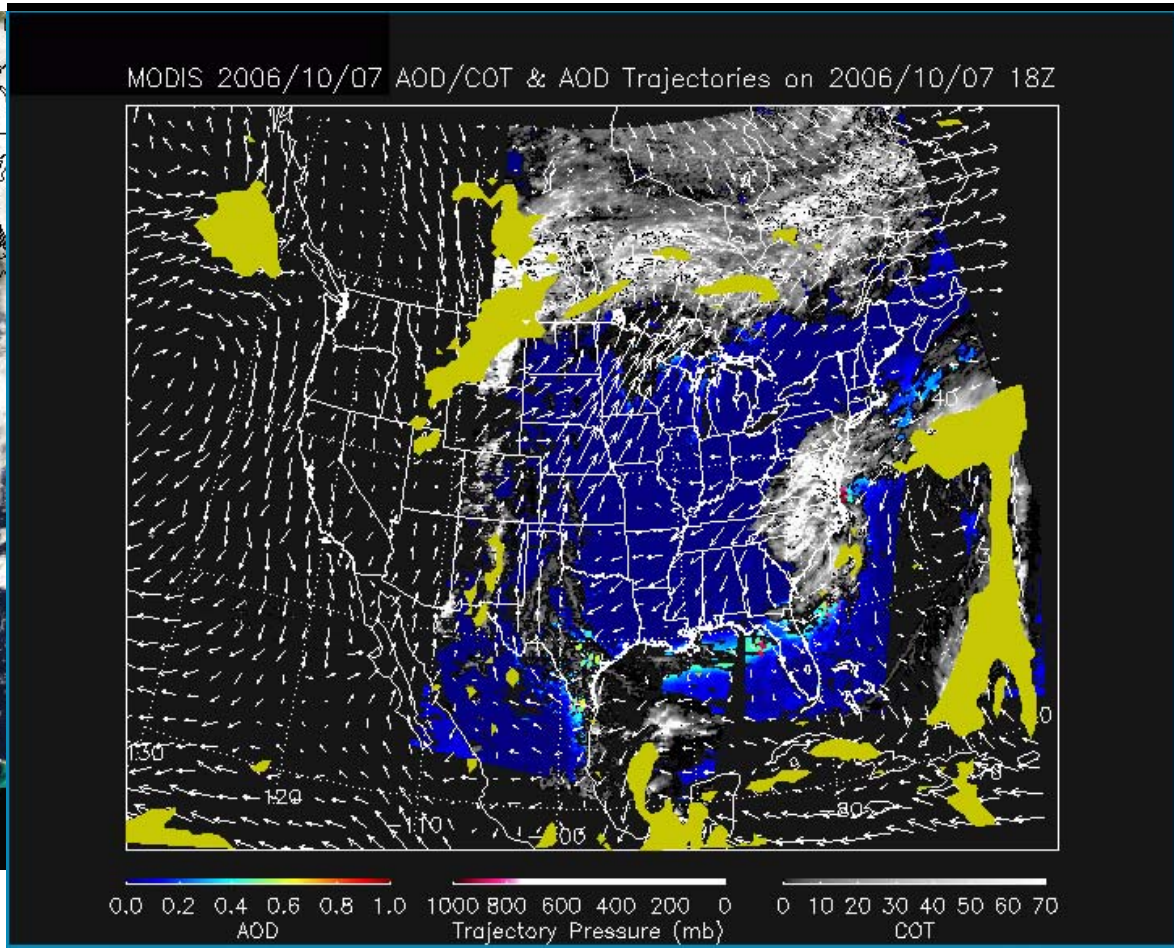
MODIS Direct:

http://eosdb.ssec.wisc.edu/modisdirect/

IDEA: http://idea.ssec.wisc.edu/





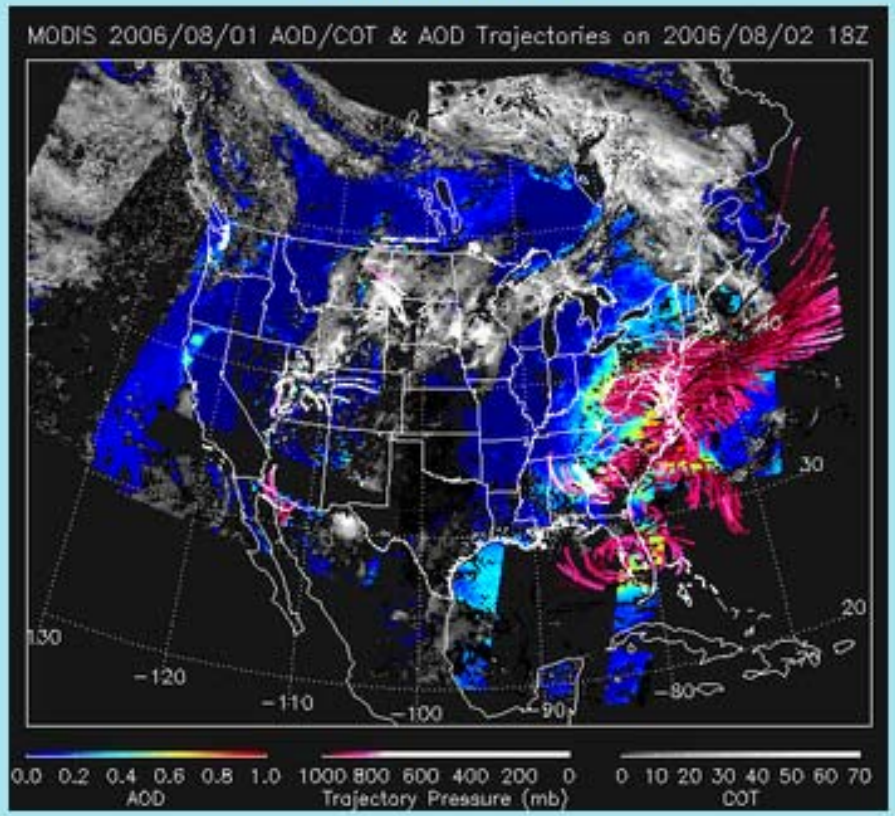
MODIS Terra, October 7, 2006
MODIS Direct and IDEA run by UW-SSEC

IDEA

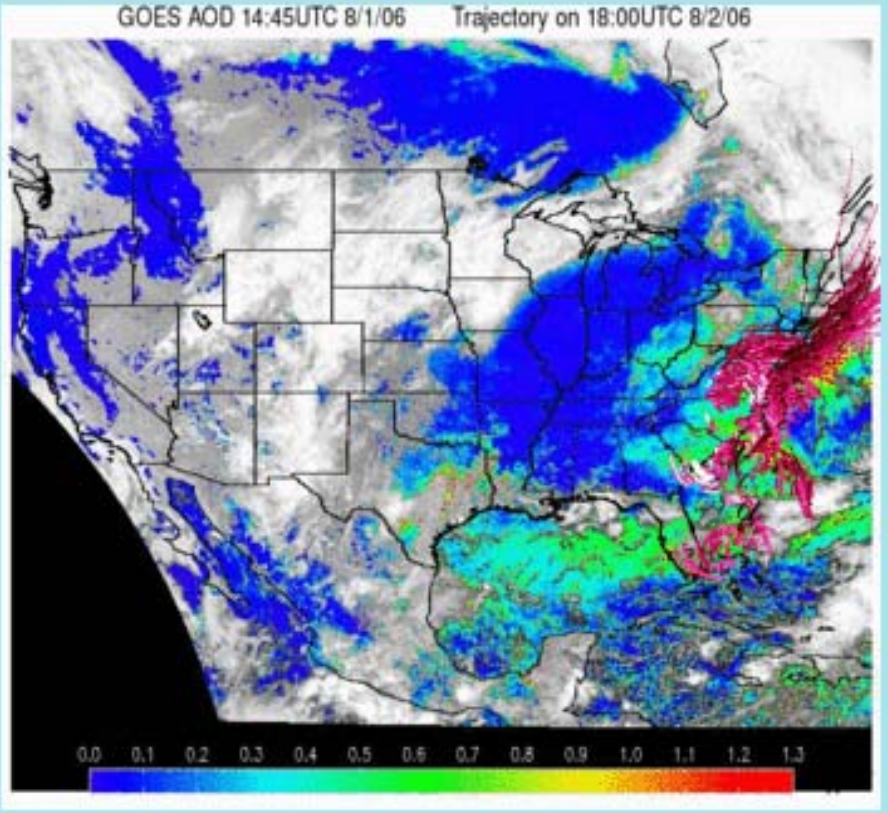
Infusing satellite Data into Environmental Applications

We value your feedback! Please send any comments, problems and suggestions to the IDEA Team.

MODIS aerosol optical depth, with aerosol trajectory forecast

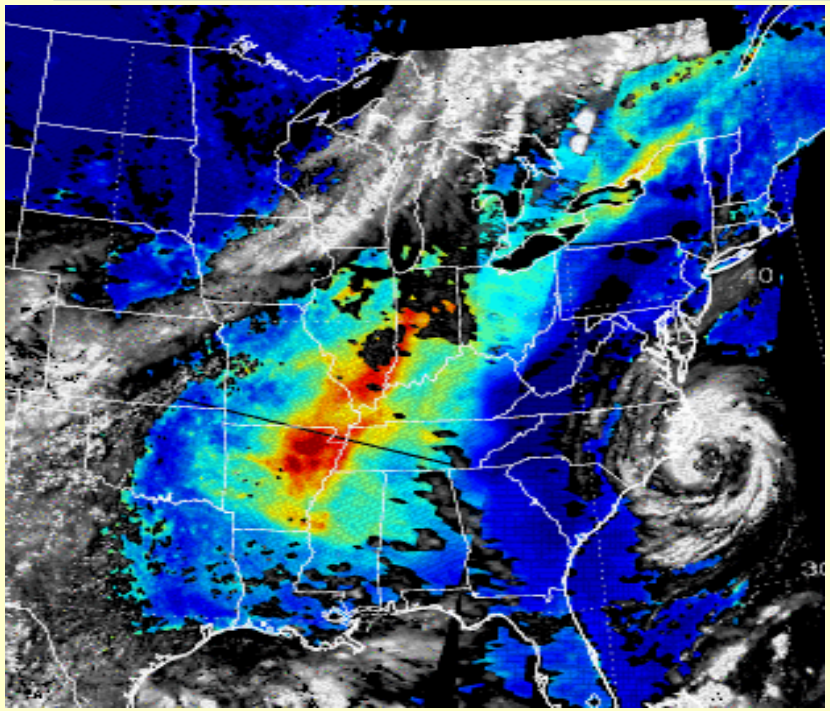


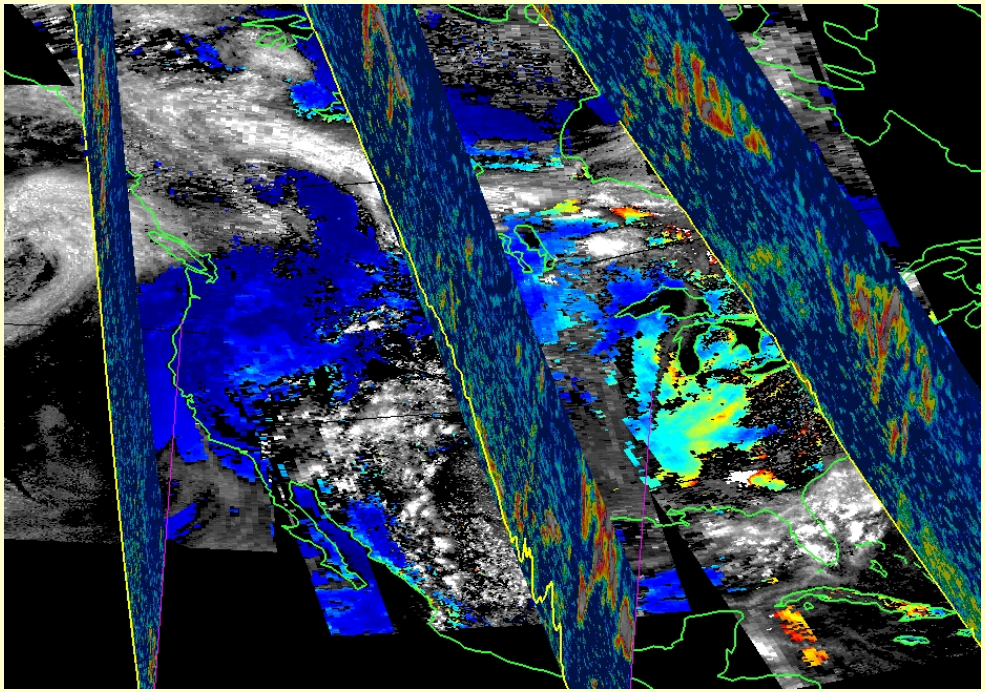
GOES aerosol optical depth, with aerosol trajectory forecast



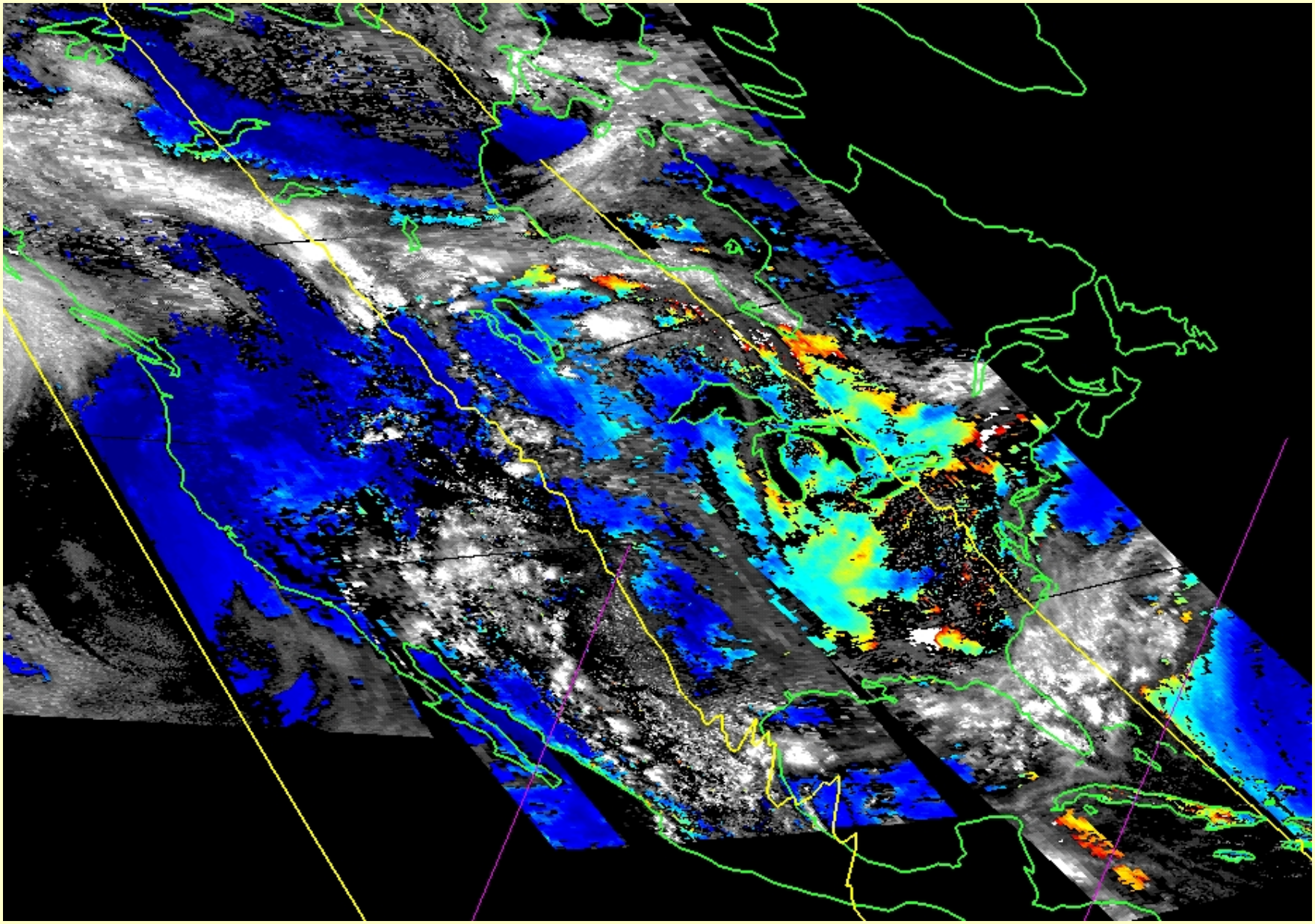
Direction of changes to the website

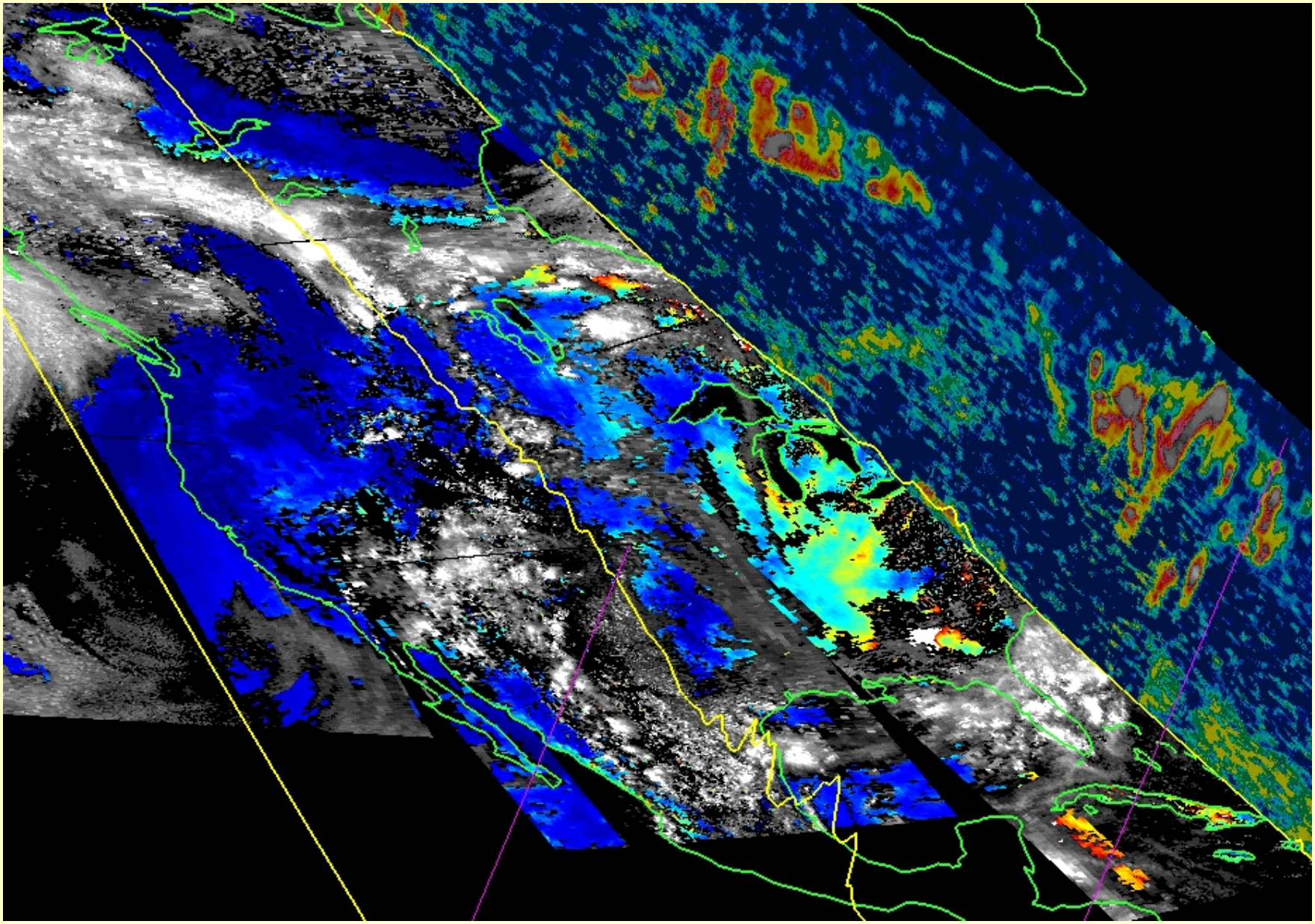
IDEA* ⟶ “3D-IDEA”

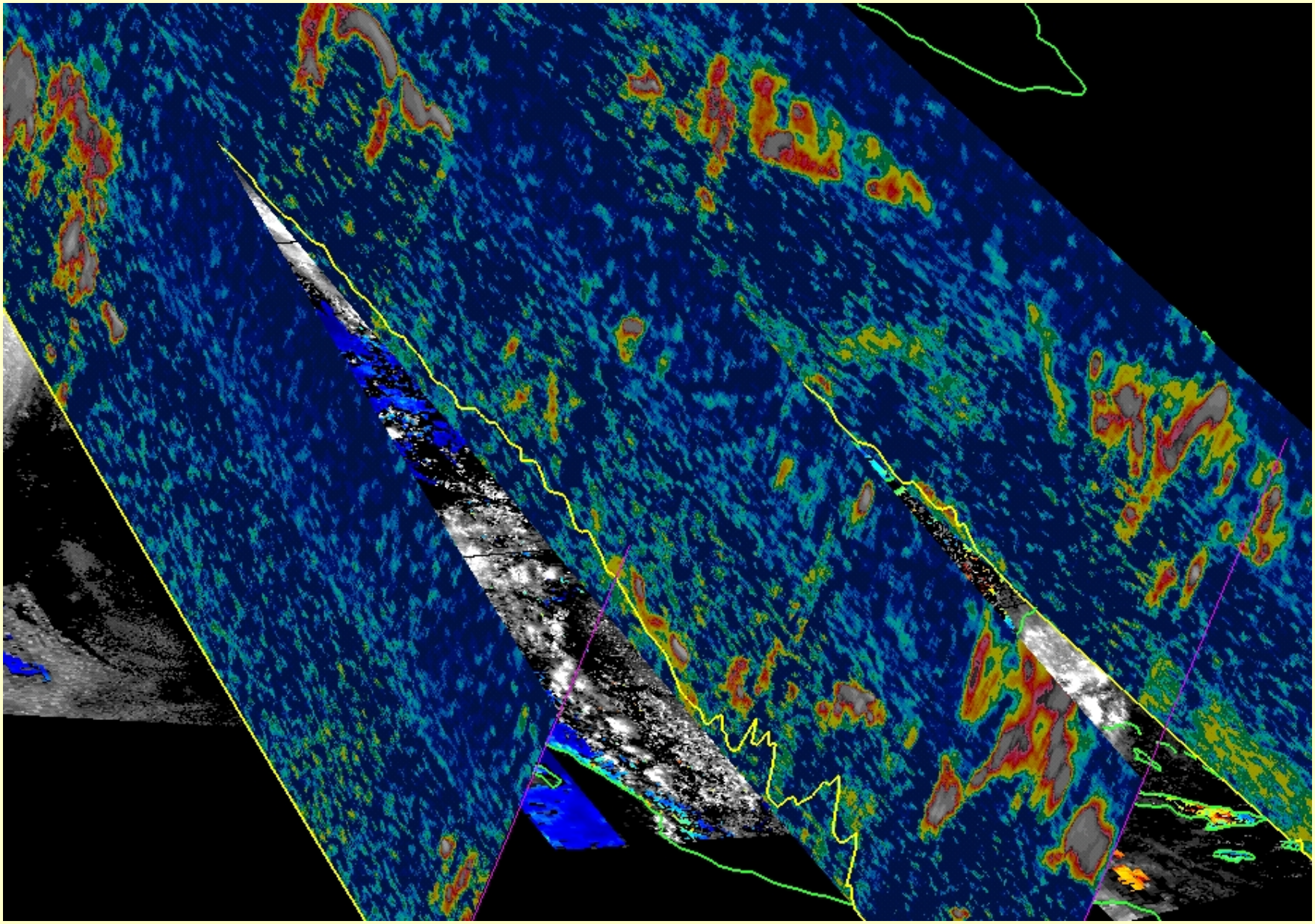




* Infusing satellite Data into Environmental Applications







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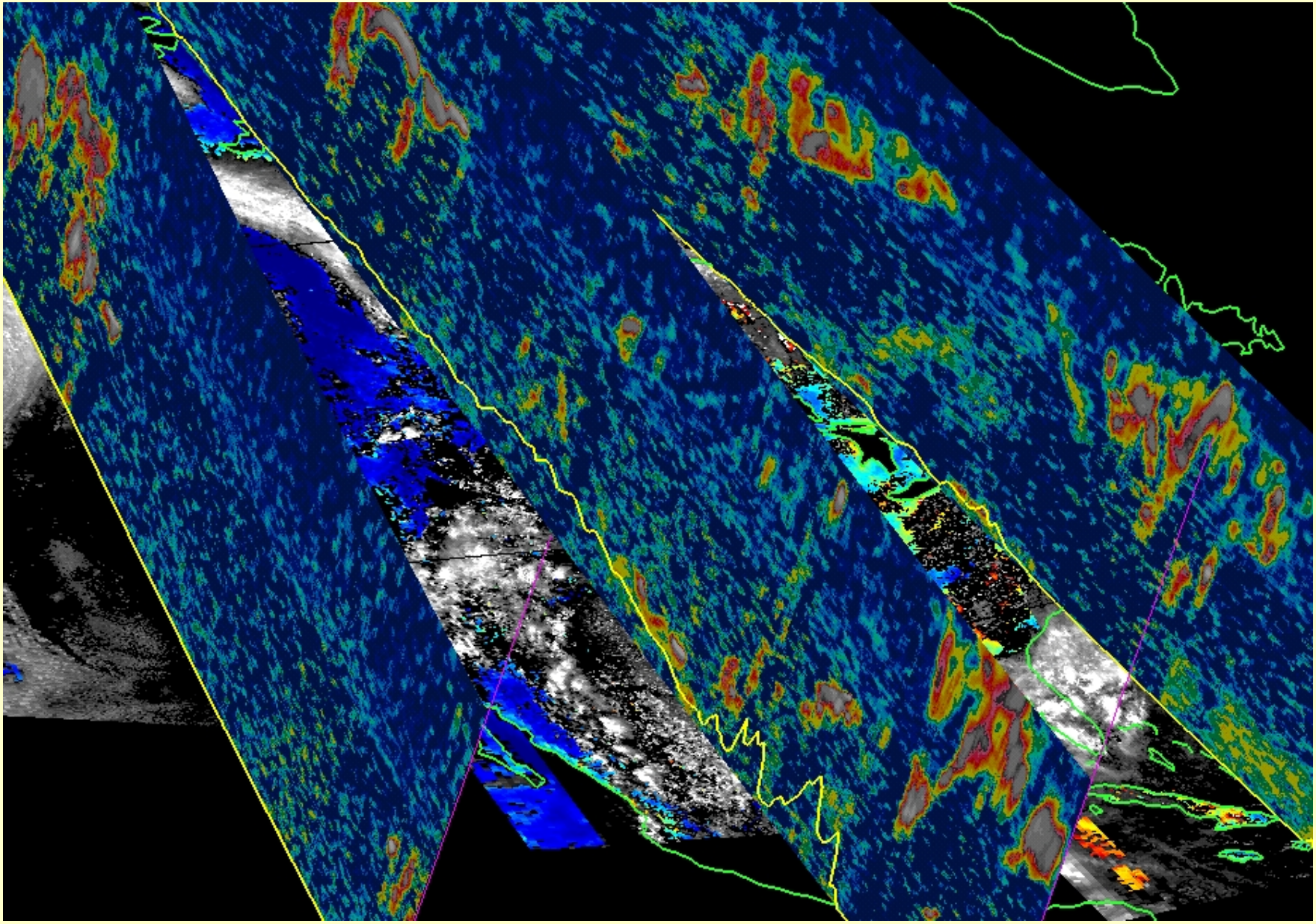

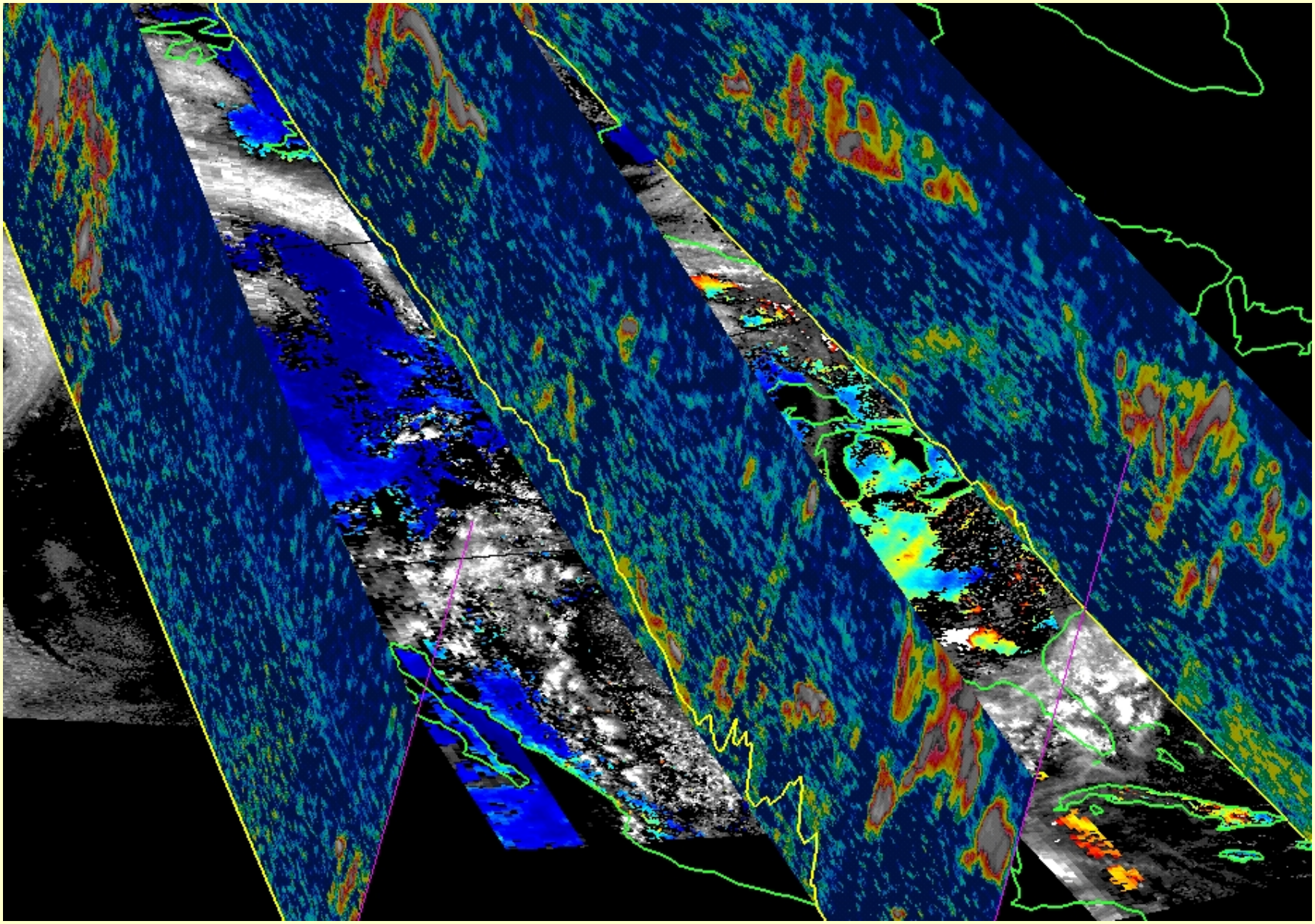

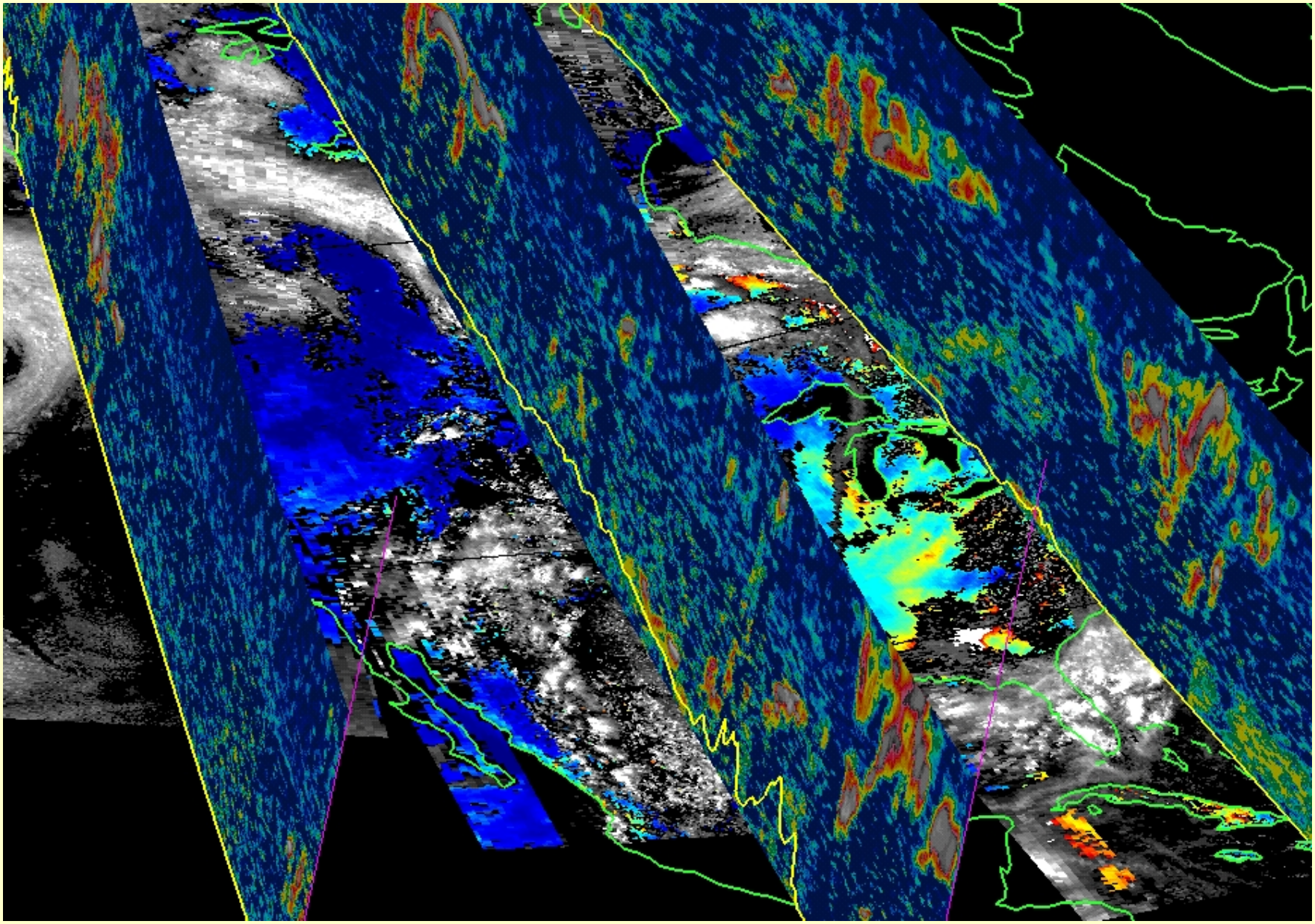

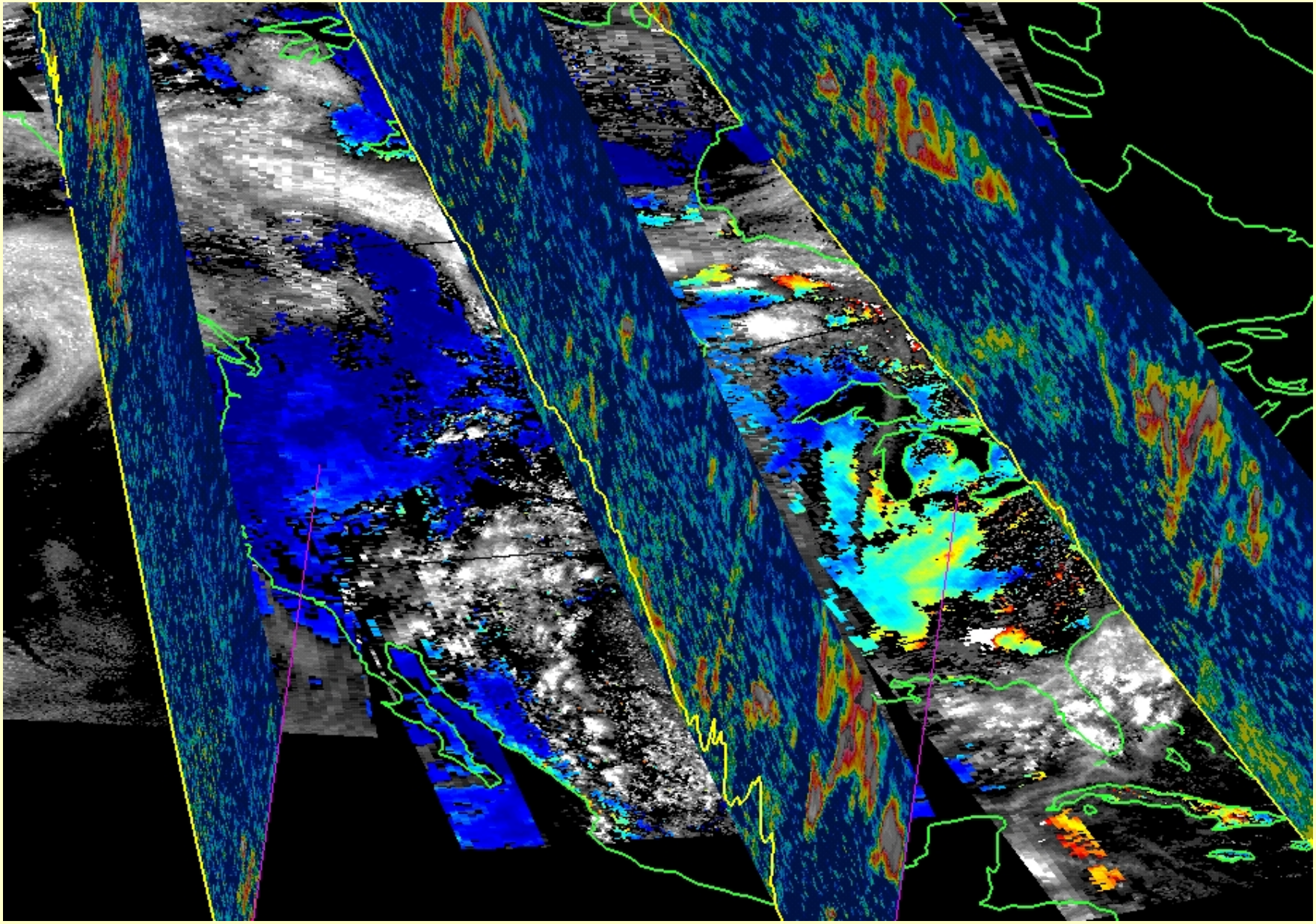

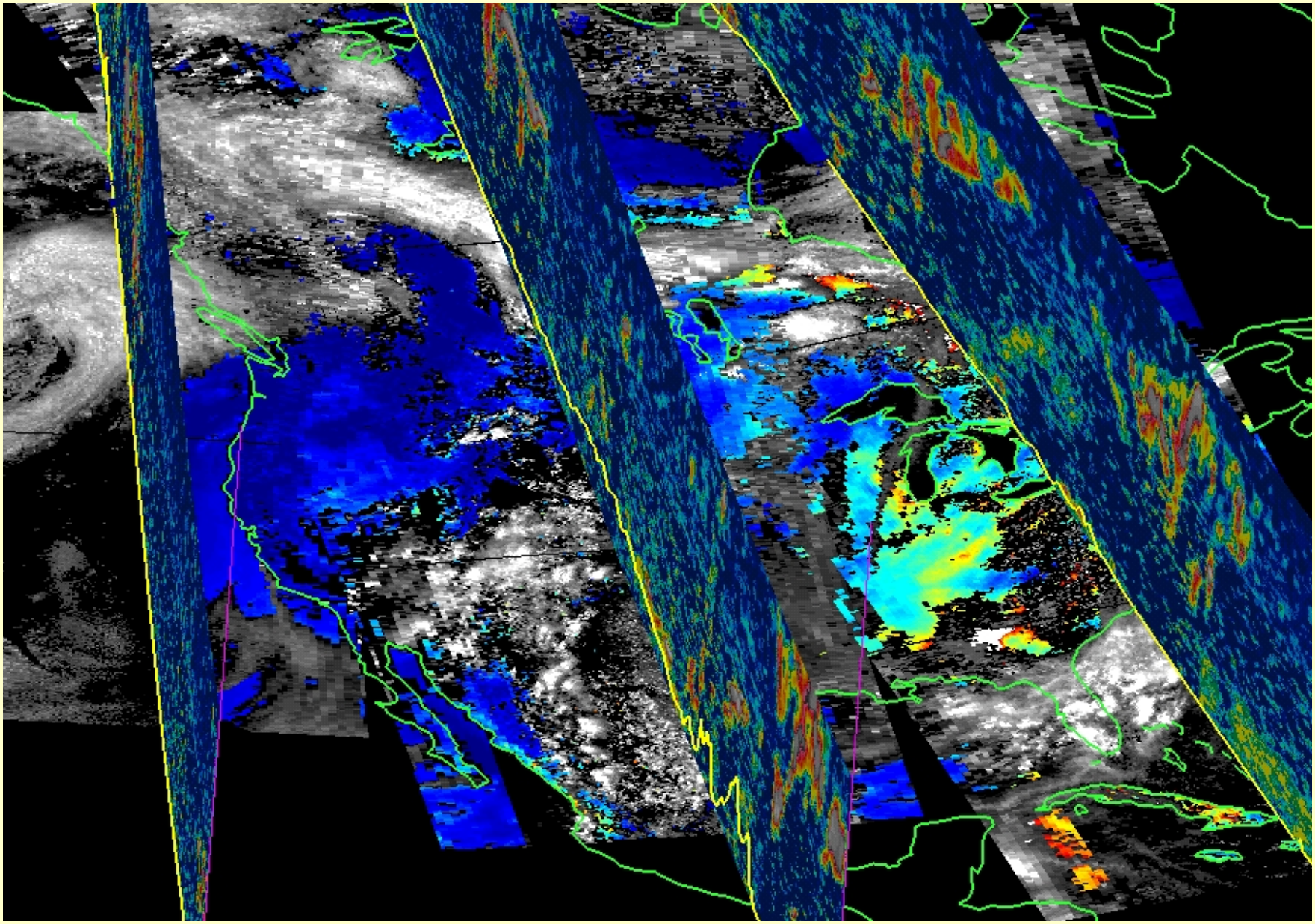

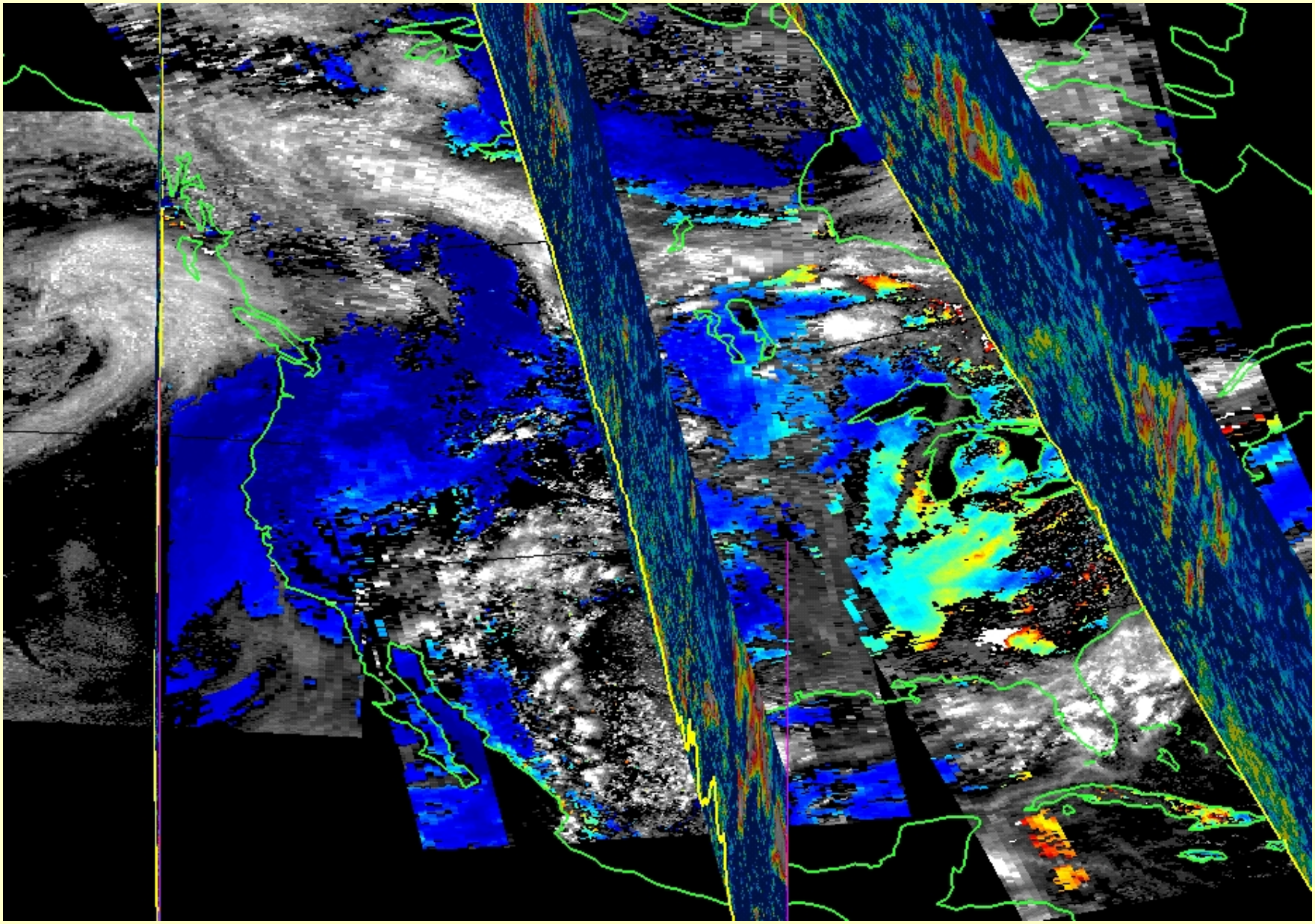

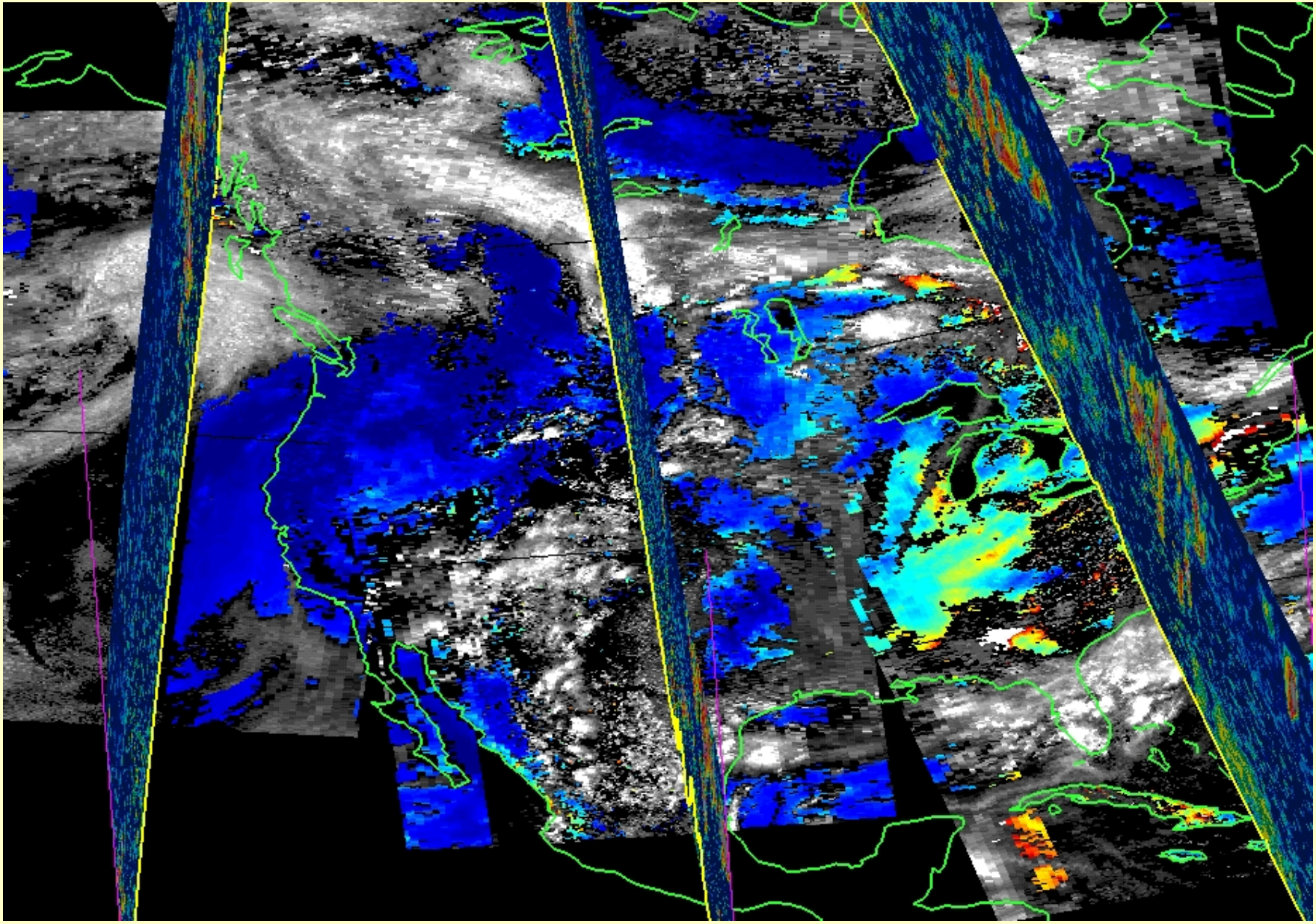

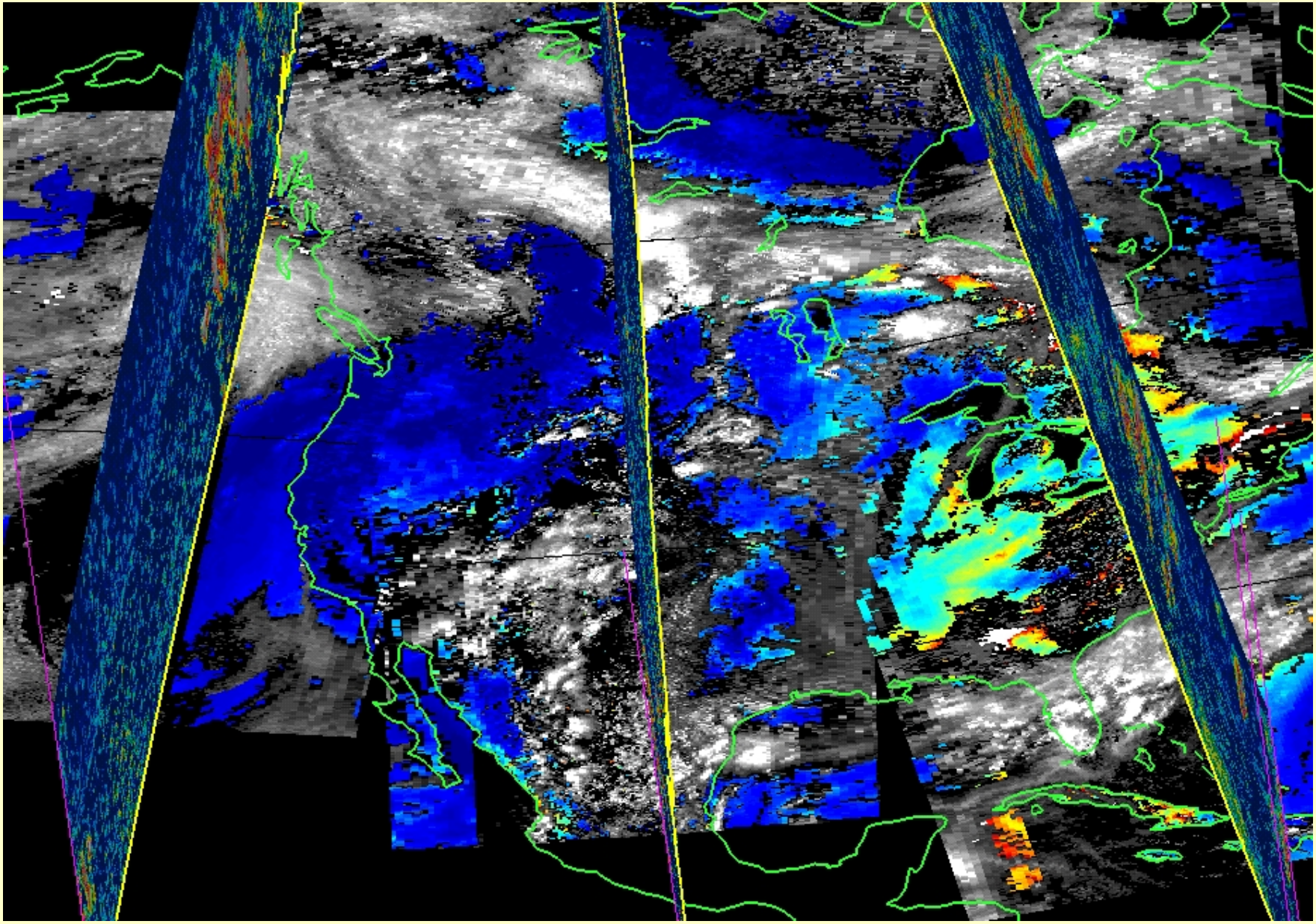

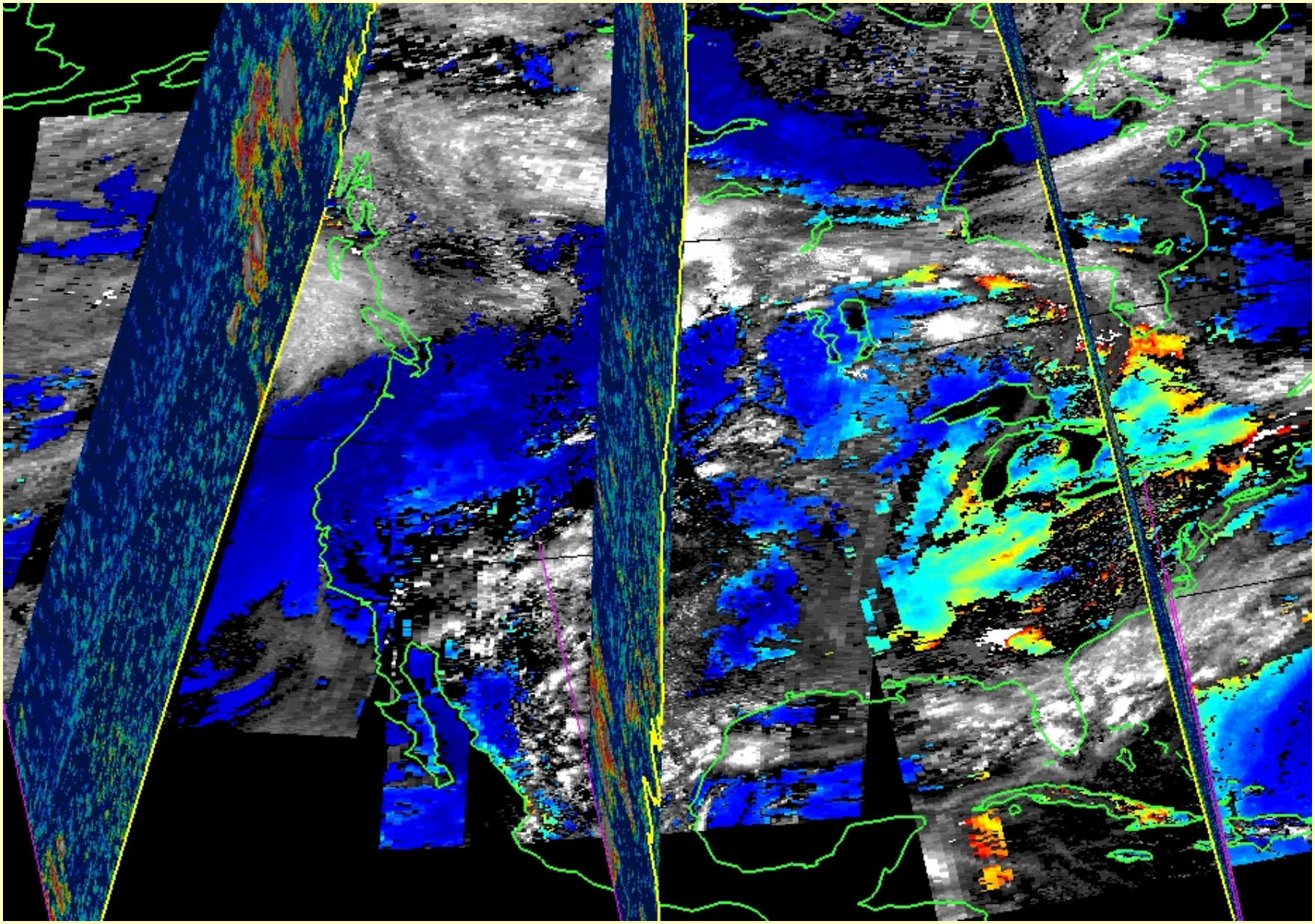

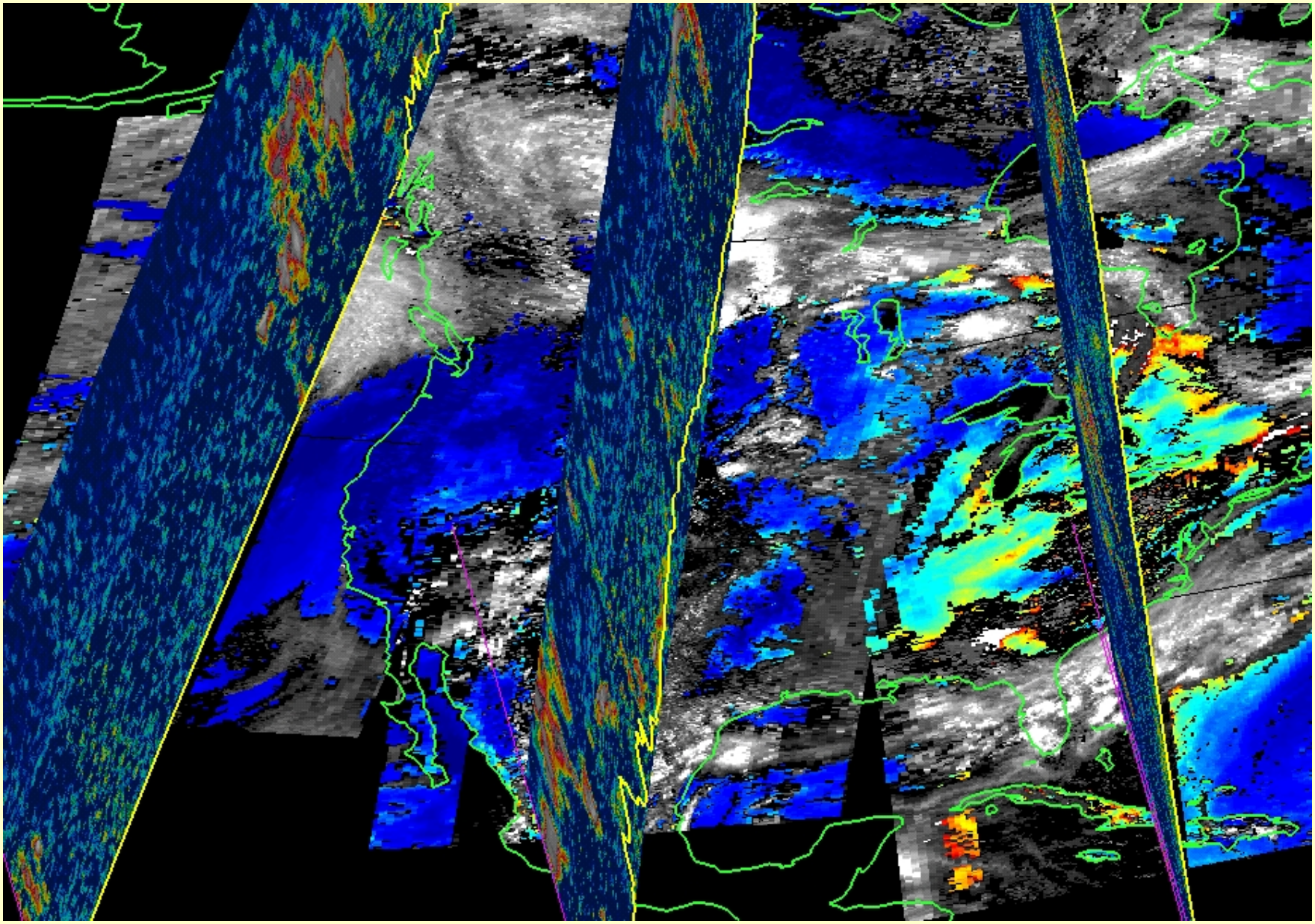

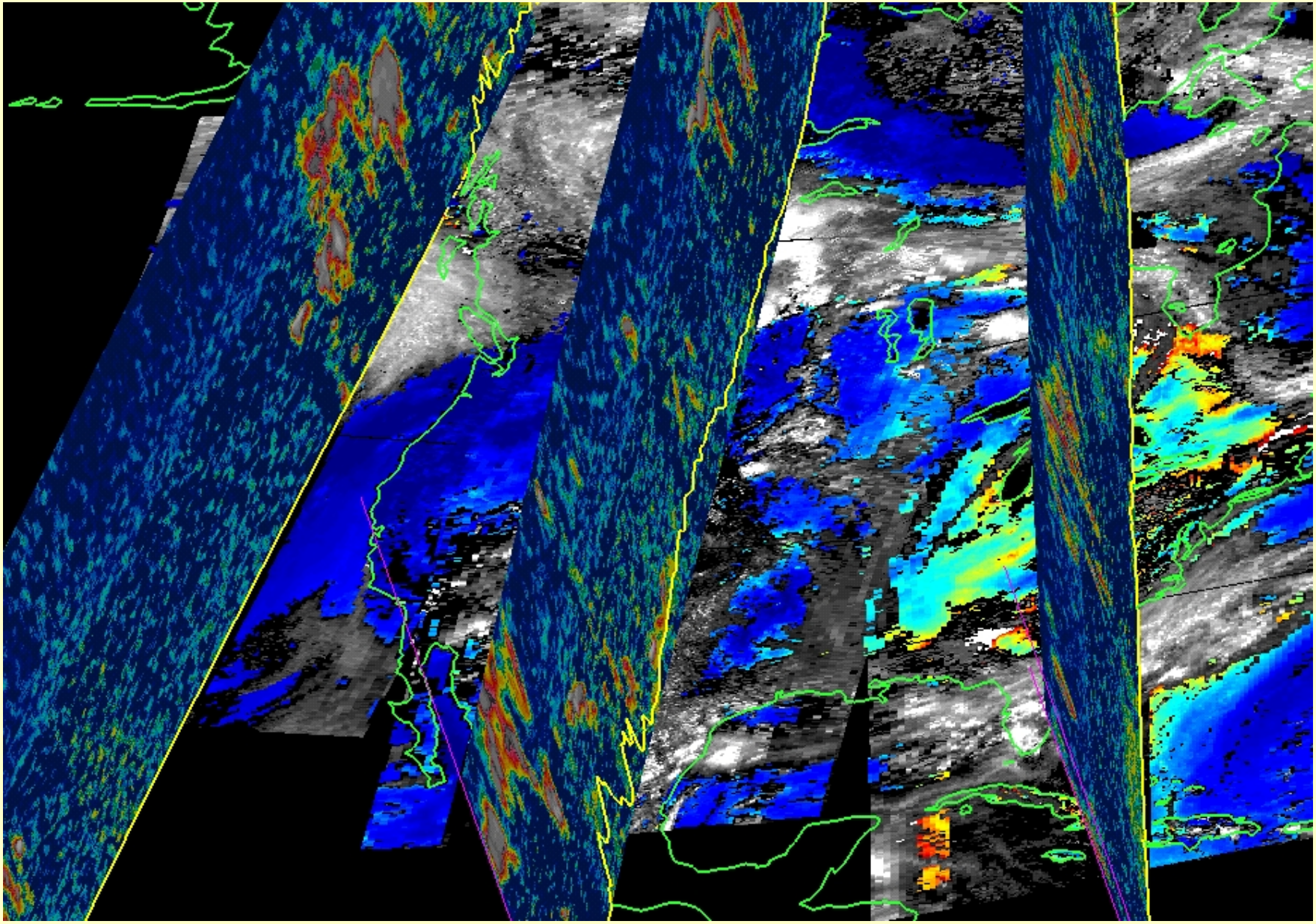

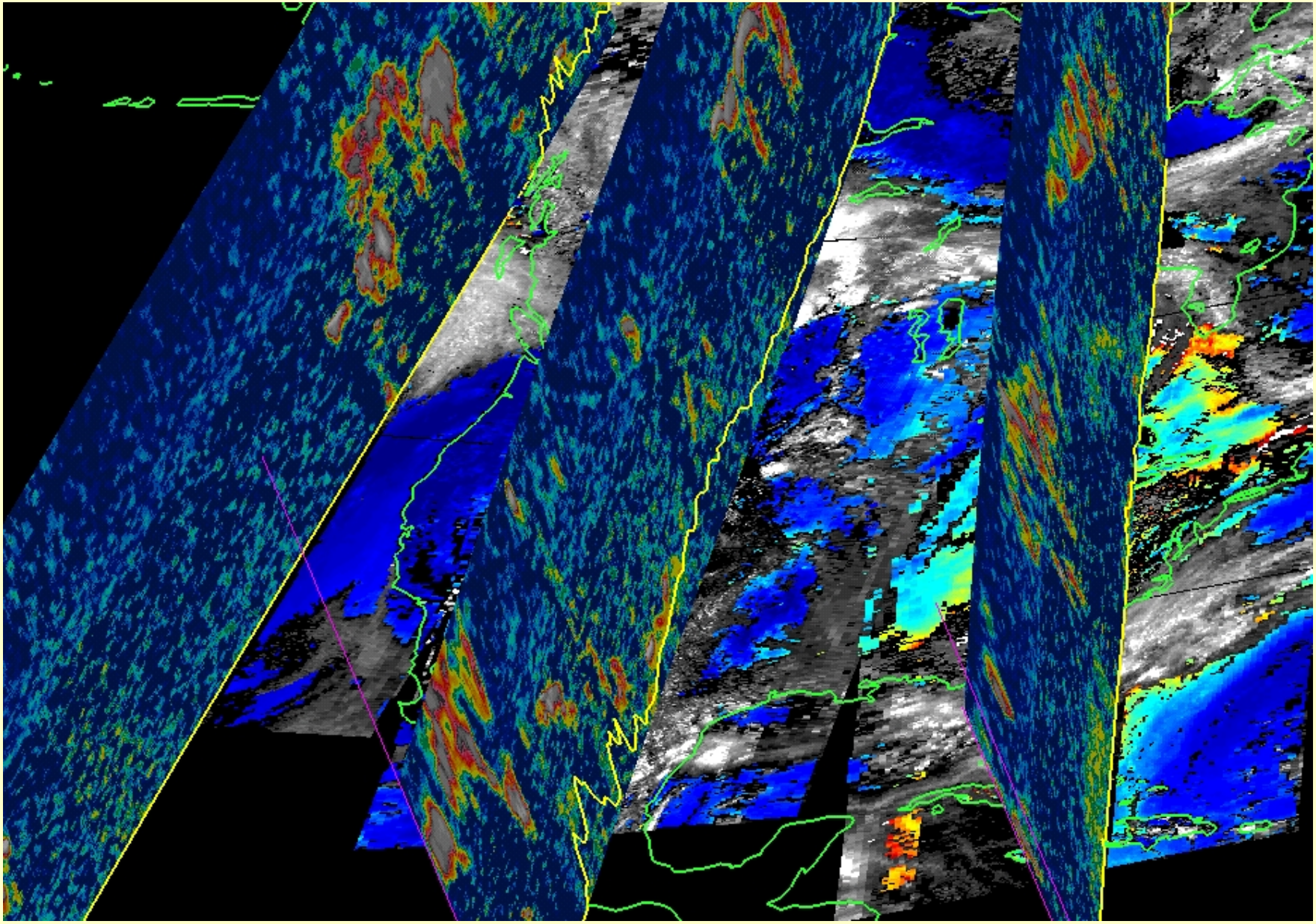

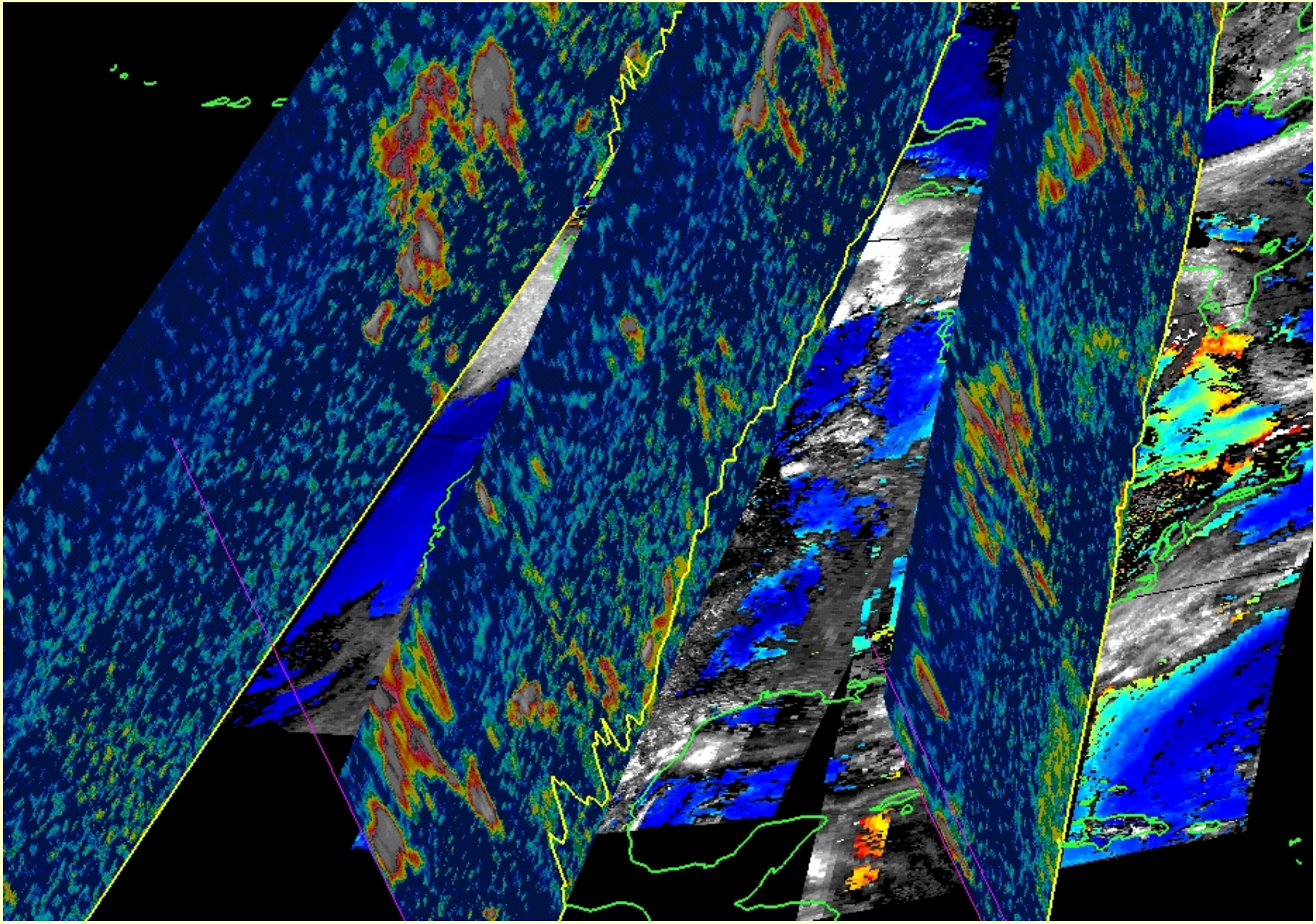

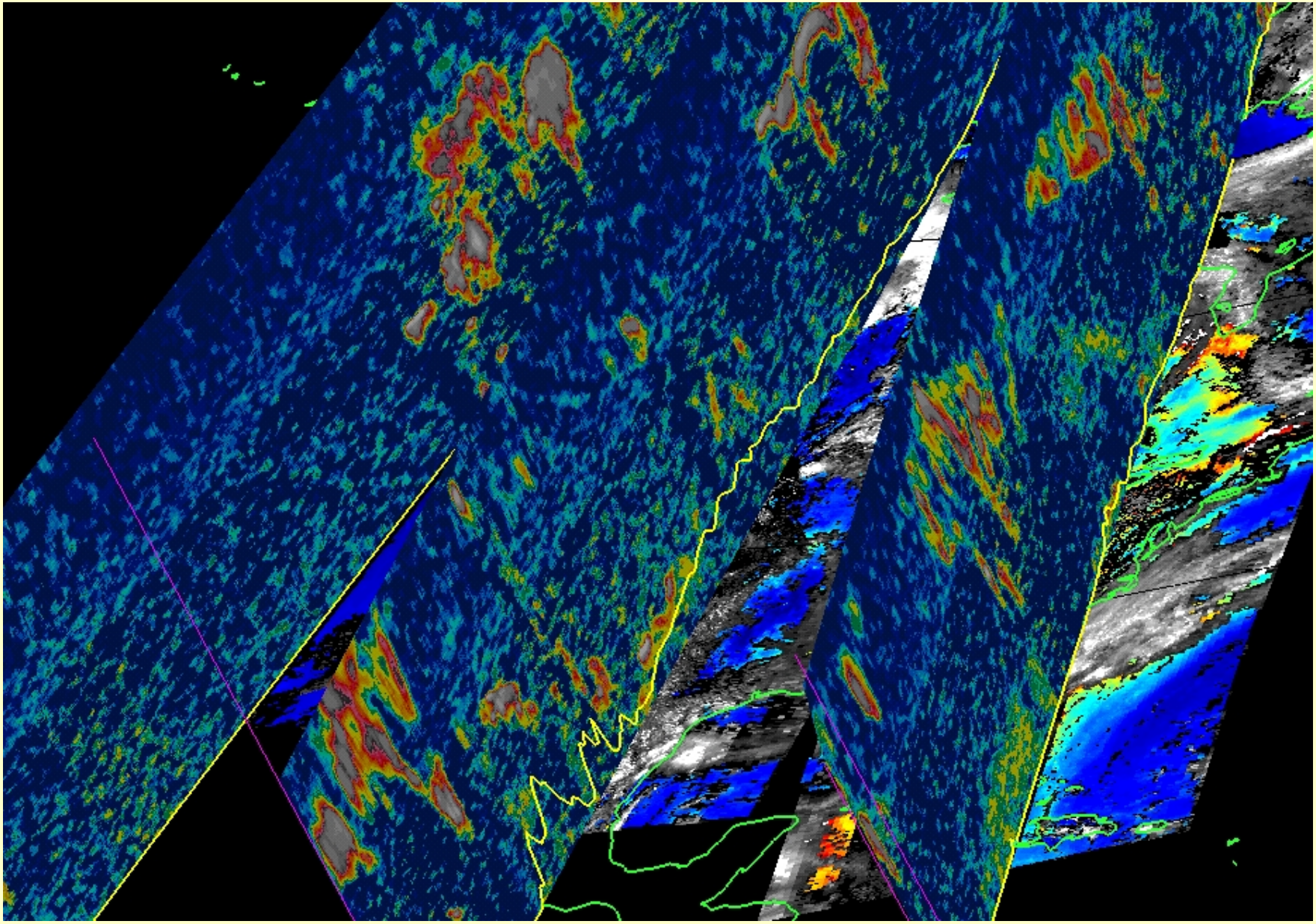

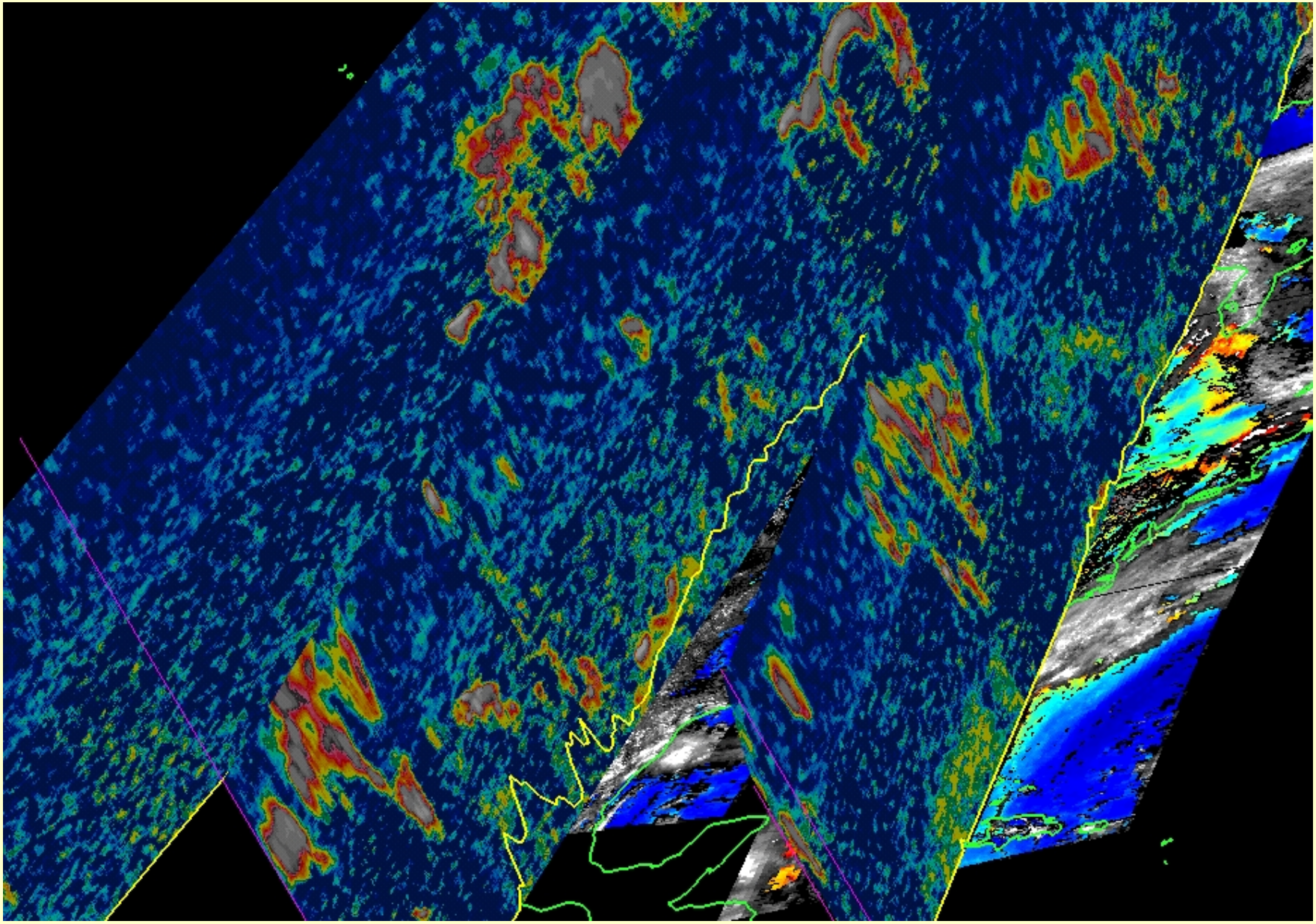

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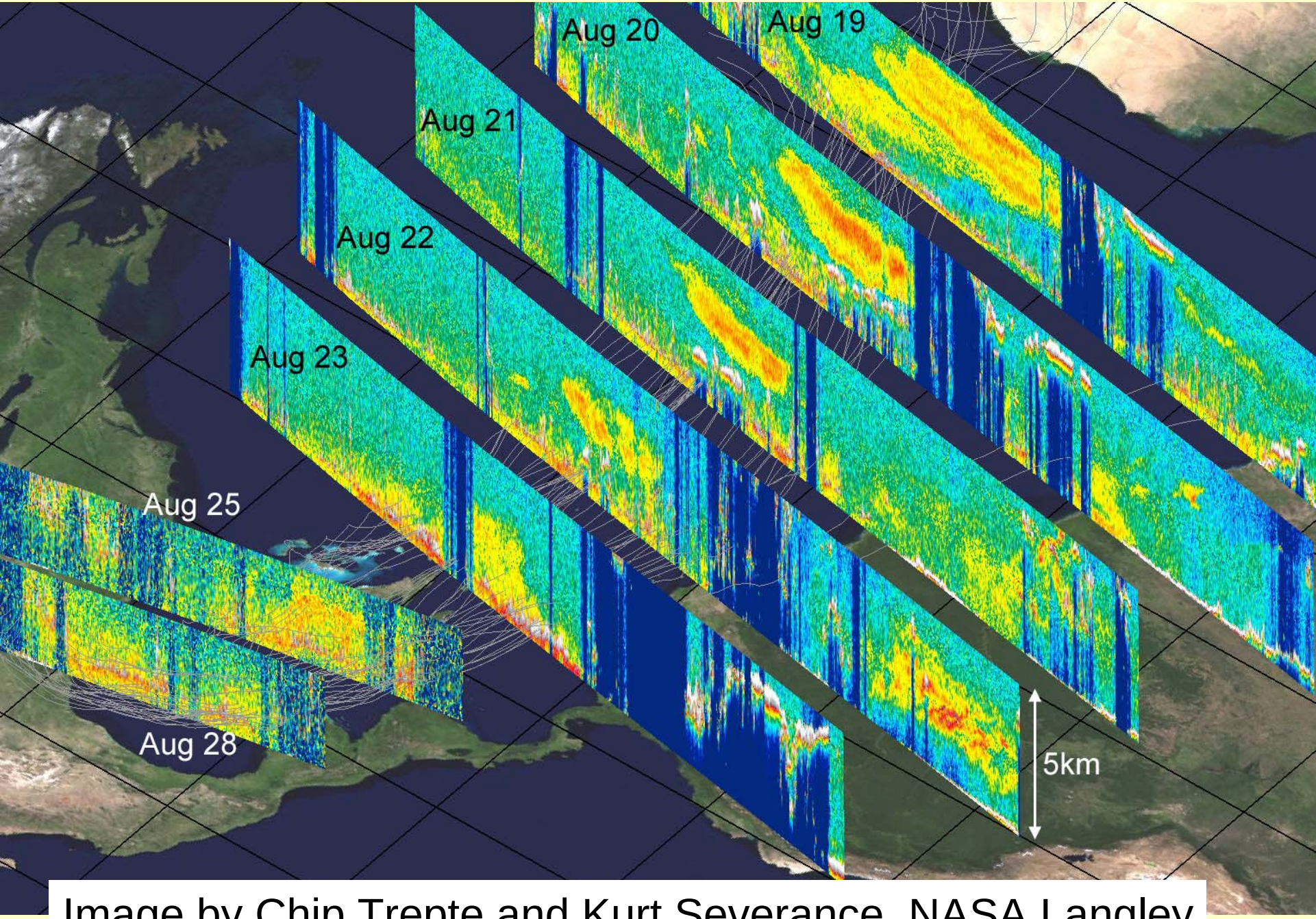
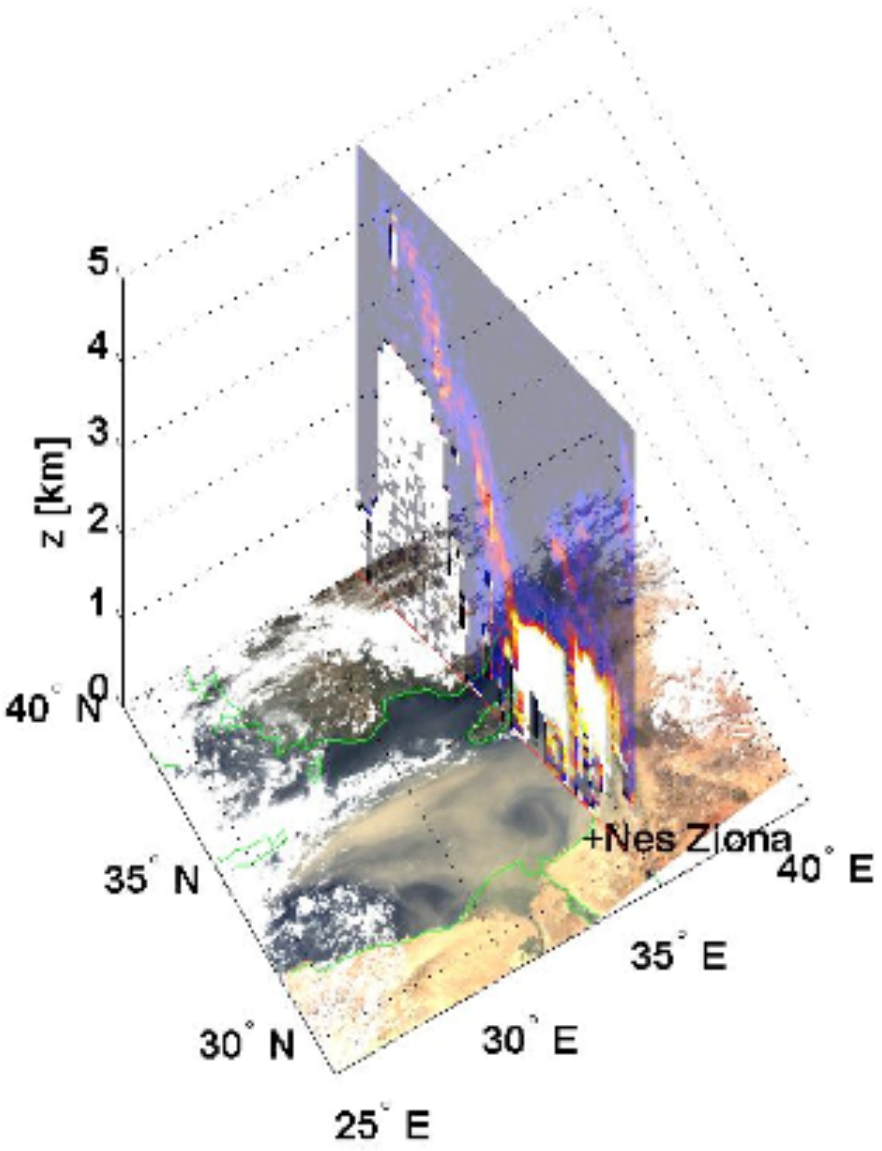
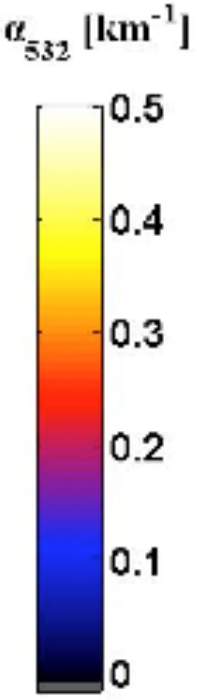


Image by Chip Trepte and Kurt Severance, NASA Langley

Saharan Dust

February 24, 2007





Progress of 3D-AQS Project (6/07)

Progress

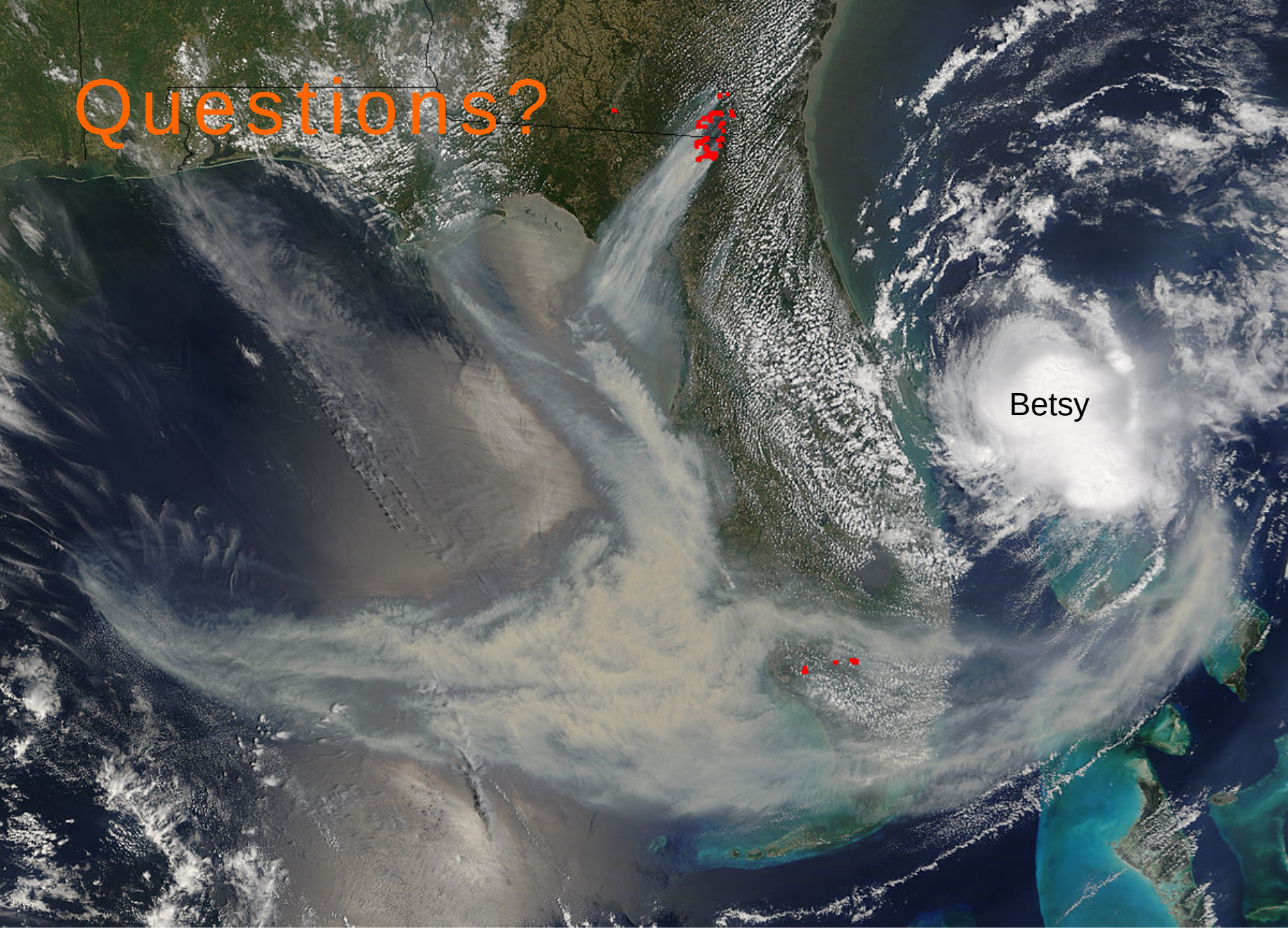
- Determined priority datasets:
  - MODIS AOD and $PM_{2.5}$ monitor matched data
  - GASP AOD, AERONET AOD, LIDAR profiles and AOD
- Ported 2004-2006 MODIS AOD-$PM_{2.5}$ matched station data to AirQuest
- Started development of finer resolution AOD data (5x5km and 2x2 km)
- Started development of 3D visualization methods
- Transferring IDEA to operational NOAA environment - Add GASP
- Formation and interaction with end user committee

Timeline

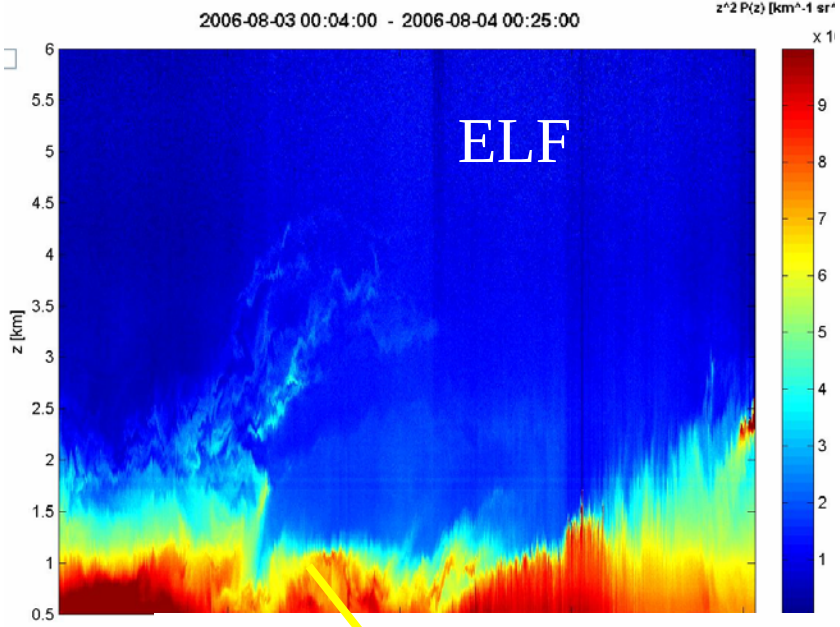
- 2007-08: Evaluation of other sensors (OMI, AIRS) for integration into AirQuest. Implementation of 3D visualization and data output.
- 2008-09: Complete data integration and transition to operations

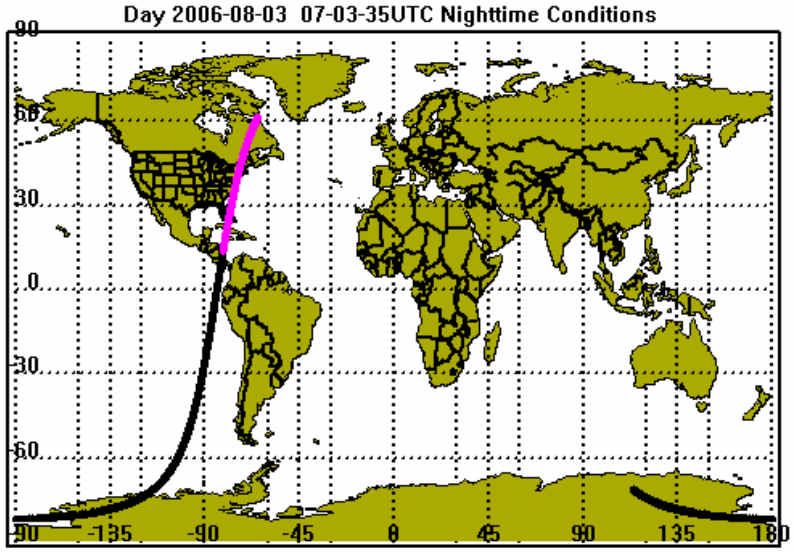
3D-AQS Needs Input

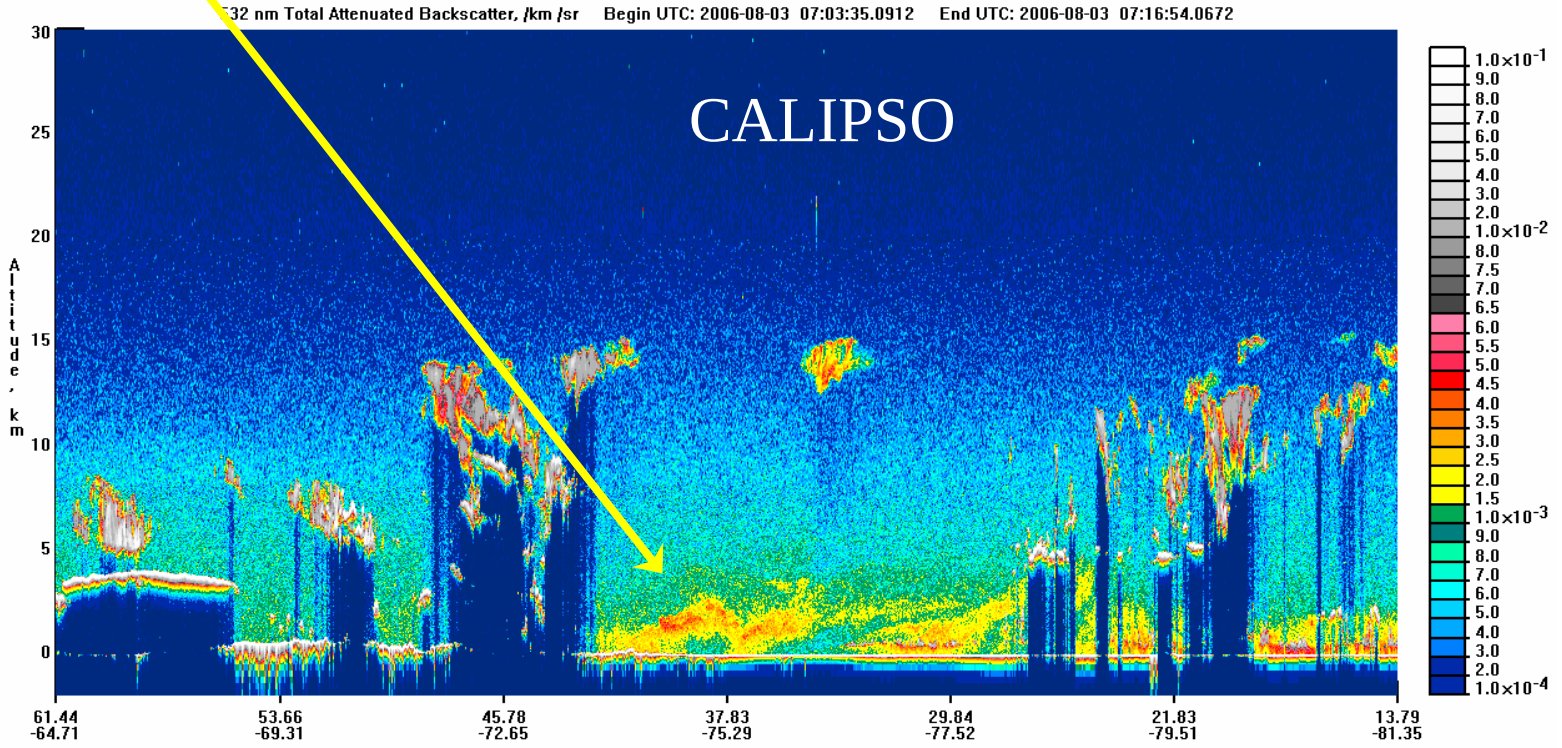
- End user input needed
  - → Input sought through end user committee
  - → Email always welcome: engelcoxj@battelle.org
- Type of input needed
  - → Data types of interest
  - → Level of processing and format required
  - → Type and style of visualization
  - → Temporal and spatial needs
- Better data accessibility = more use and demand for environmental information = greater understanding of our atmosphere

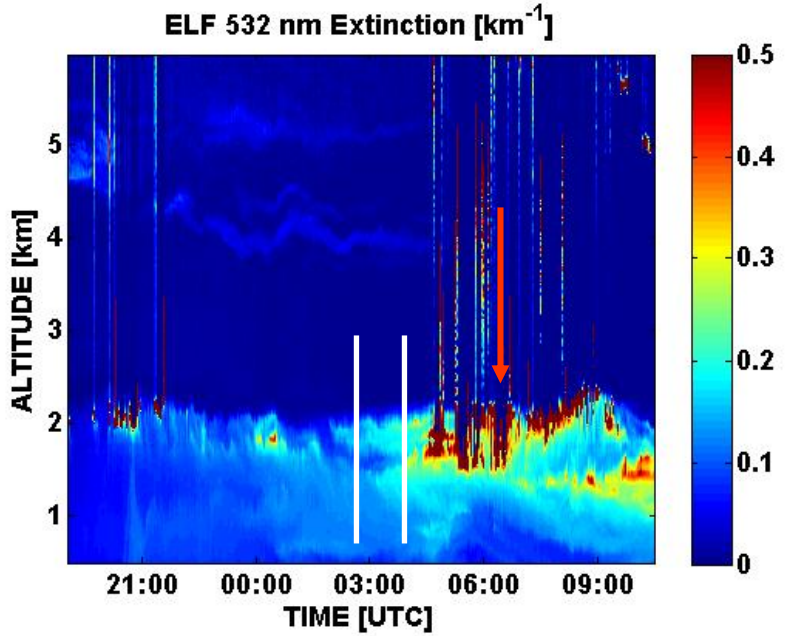

Questions?
Betsy

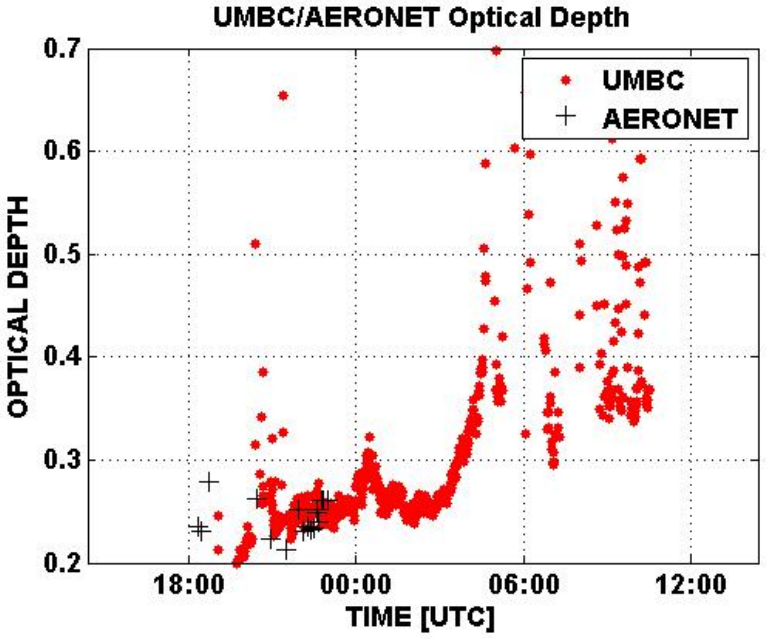
Backup

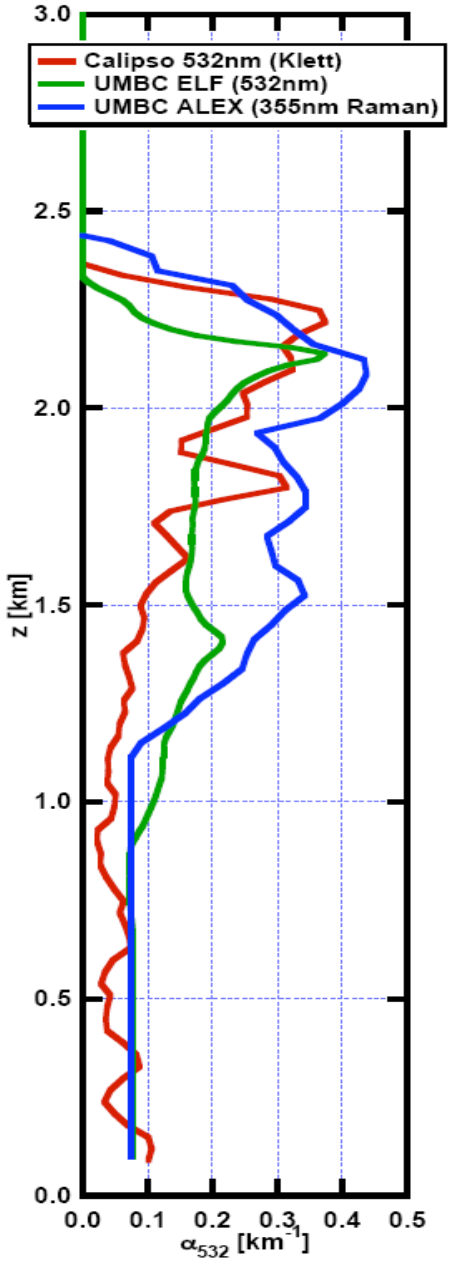

2006-08-03 00:04:00 - 2006-08-04 00:25:00
z^2 P(z) [km^-1 sr^
X 1
ELF
z [km]


Day 2006-08-03 07-03-35UTC Nighttime Conditions

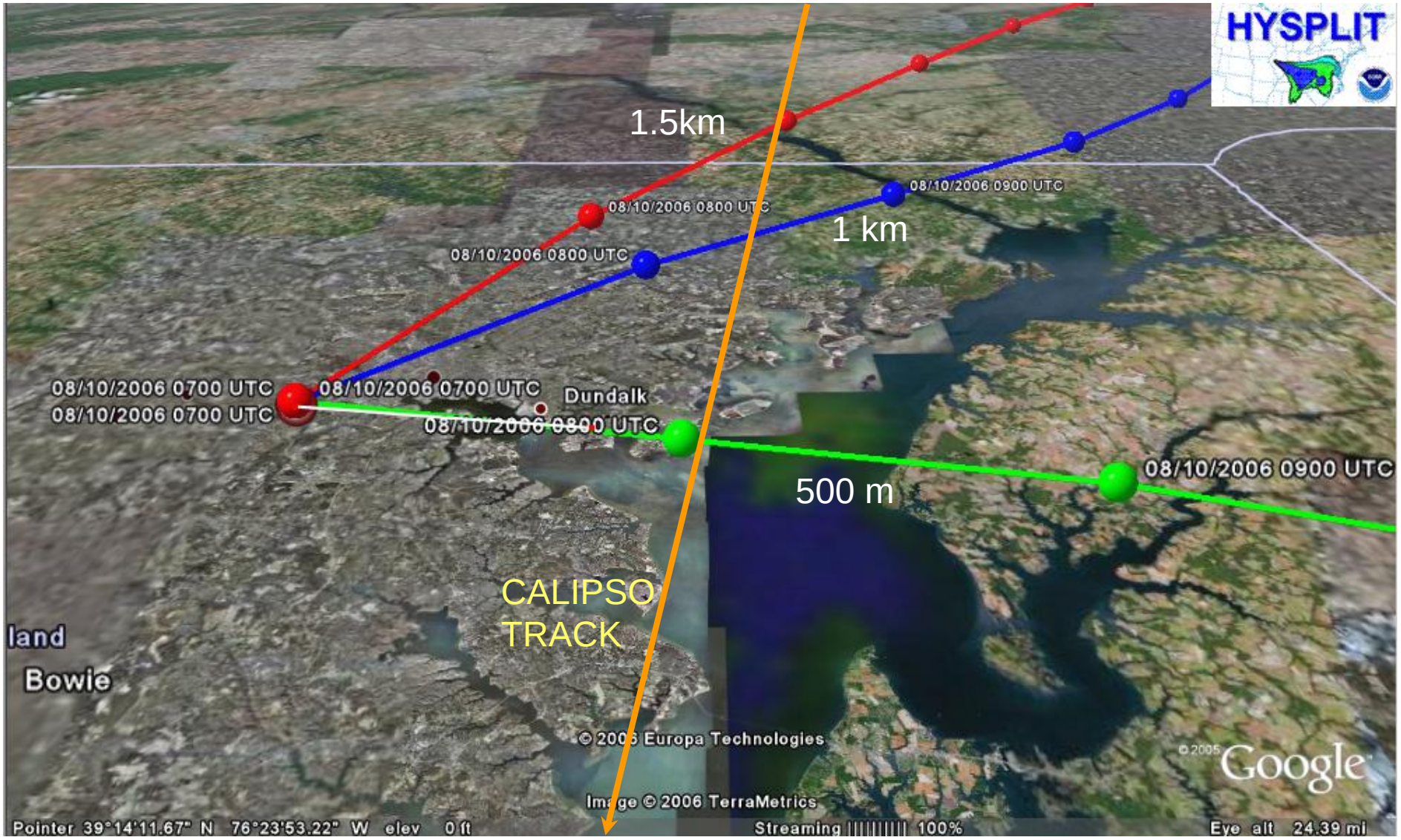

532 nm Total Attenuated Backscatter, /km /sr
Begin UTC: 2006-08-03 07:03:35.0912
End UTC: 2006-08-03 07:16:54.0672
CALIPSO
Altitude, km







August 10, 2006 CALIPSO Validation


HYSPLIT
1.5km
08/10/2006 0900 UTC
08/10/2006 0800 UTC
1 km
08/10/2006 0800 UTC
08/10/2006 0700 UTC
08/10/2006 0700 UTC
Dundalk
08/10/2006 0800 UTC
08/10/2006 0900 UTC
500 m
CALIPSO
TRACK
land
Bowie
© 2006 Europa Technologies
© 2006 Google
Image © 2006 TerraMetrics
Pointer 39°14'11.67" N 76°23'53.22" W elev 0 ft
Streaming 100%
Eye alt 24.39 mi