Development of a Global Fire/Aerosol Operational Product as Part of the CEOS Atmospheric Composition Constellation

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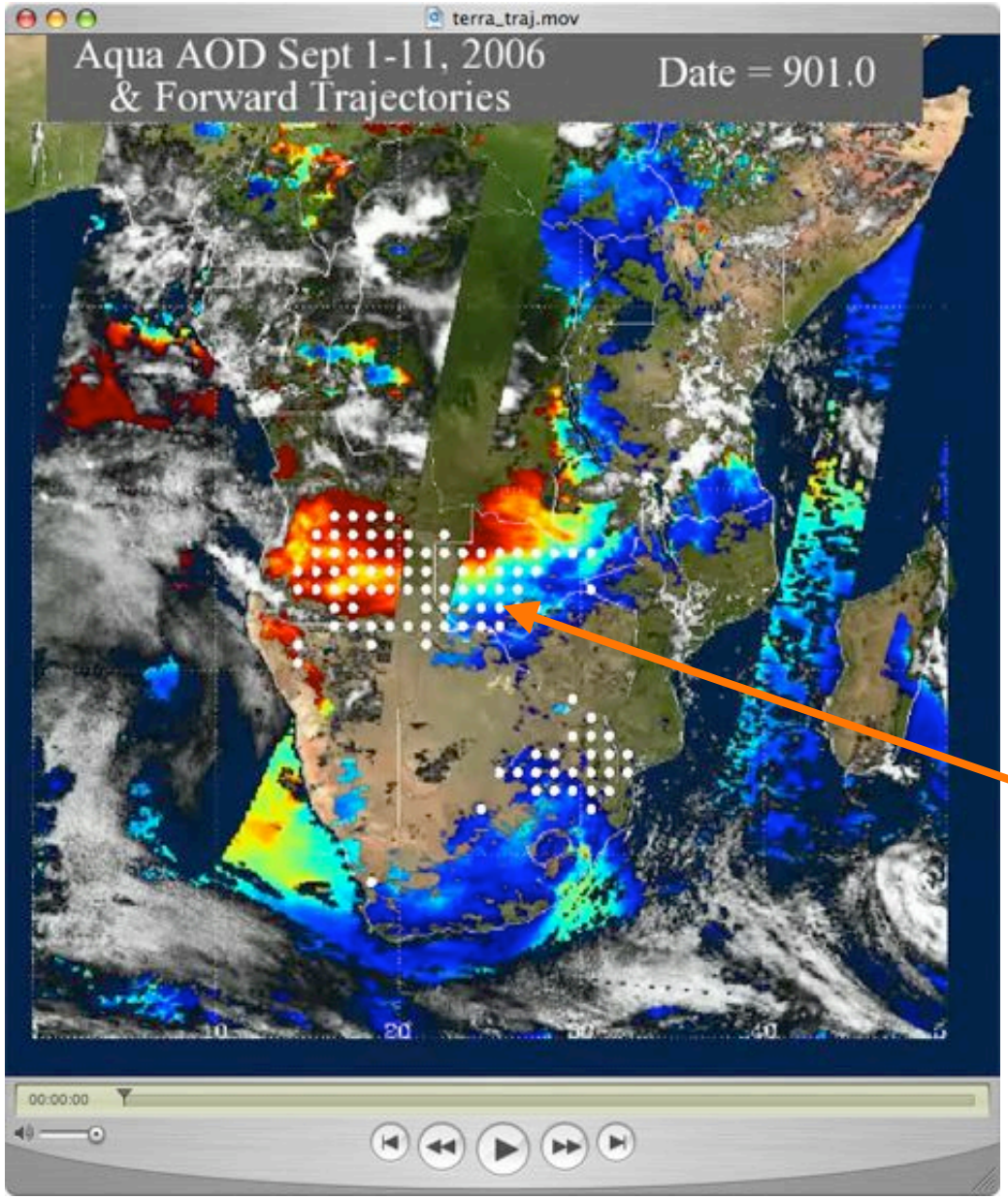
CEOS Virtual Constellations

- Committee on Earth Observation Satellites (CEOS) has agreed to provide the space component for the Global Earth Observation System of Systems (GEOSS), in support of the overall goals of the Group on Earth Observations (GEO).
- The GEO Work Plan calls for ***"Virtual Constellations"*** to provide value-added satellite data products for the Societal Benefit Areas
- The ***Atmospheric Composition Constellation*** (ACC), led by NASA & ESA, is 1 of 4 CEOS Pilot Constellation Projects. Pilots are intended to bring about technical/scientific cooperation and collaboration among space agencies that meet GEO objectives and also support national priorities.
- The ***"Global Fire/Aerosol Product"*** is 1 of 3 ACC Demonstration Projects, supporting Health Societal Benefit Tasks HE-07-02 and HE-07-03

CEOS Pilot Constellation Projects

1) **Atmospheric Composition**
   - I. **Global Fire and Aerosol for Air Quality**
   - II. **Volcanic SO2 & Ash for Aviation**
   - III. **Diurnal NO2 for Air Quality**
2) **Land Surface Characterization**
3) **Precipitation**
4) **Ocean Surface Topography**

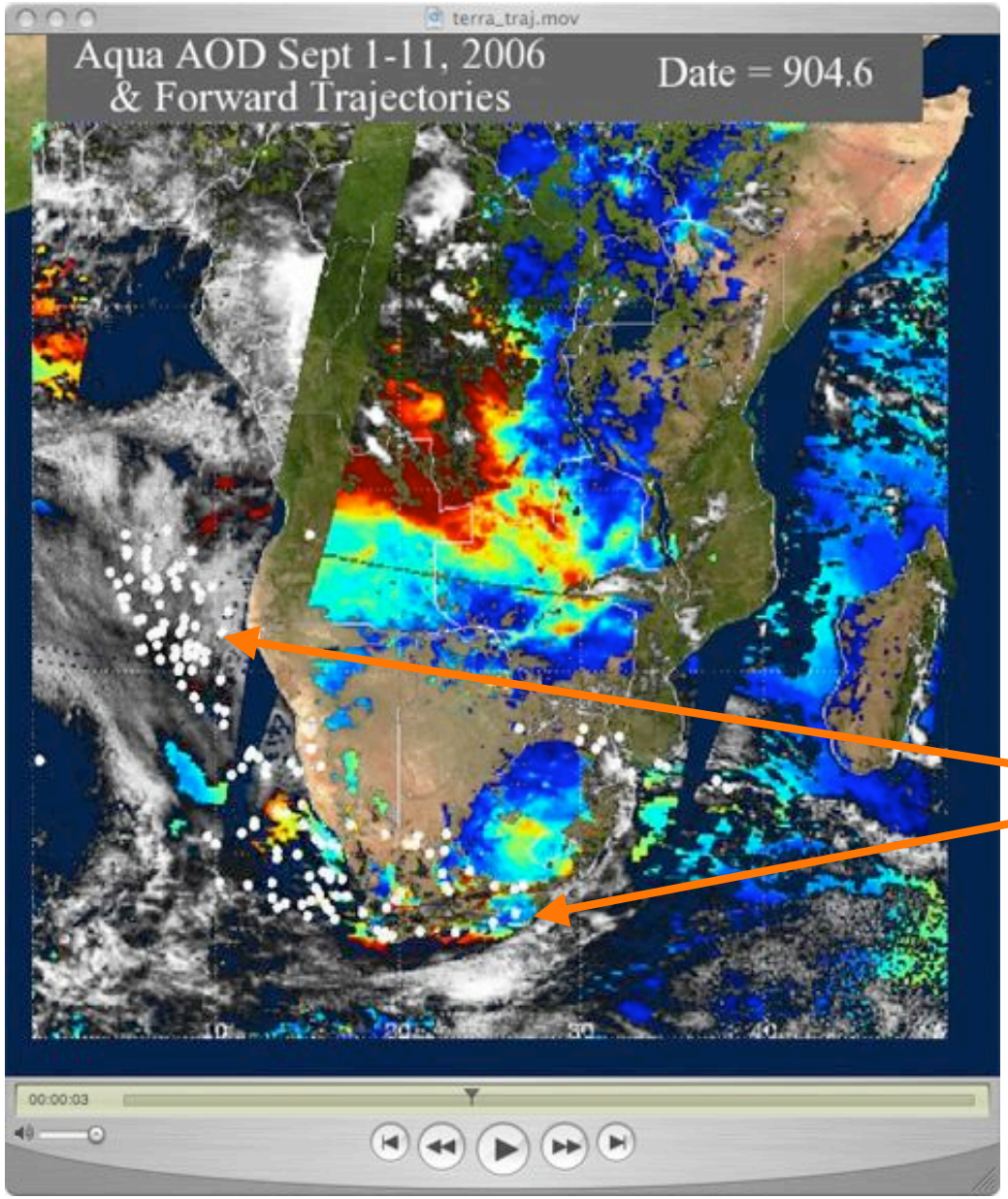
MODIS/Calipso Retrospective Case Study: South African Biomass Burning, early September 2006



September 1, 2006
MODIS AOD (colored)
and clouds

Forward trajectories initialized in global model grid cells containing MODIS active fire detections

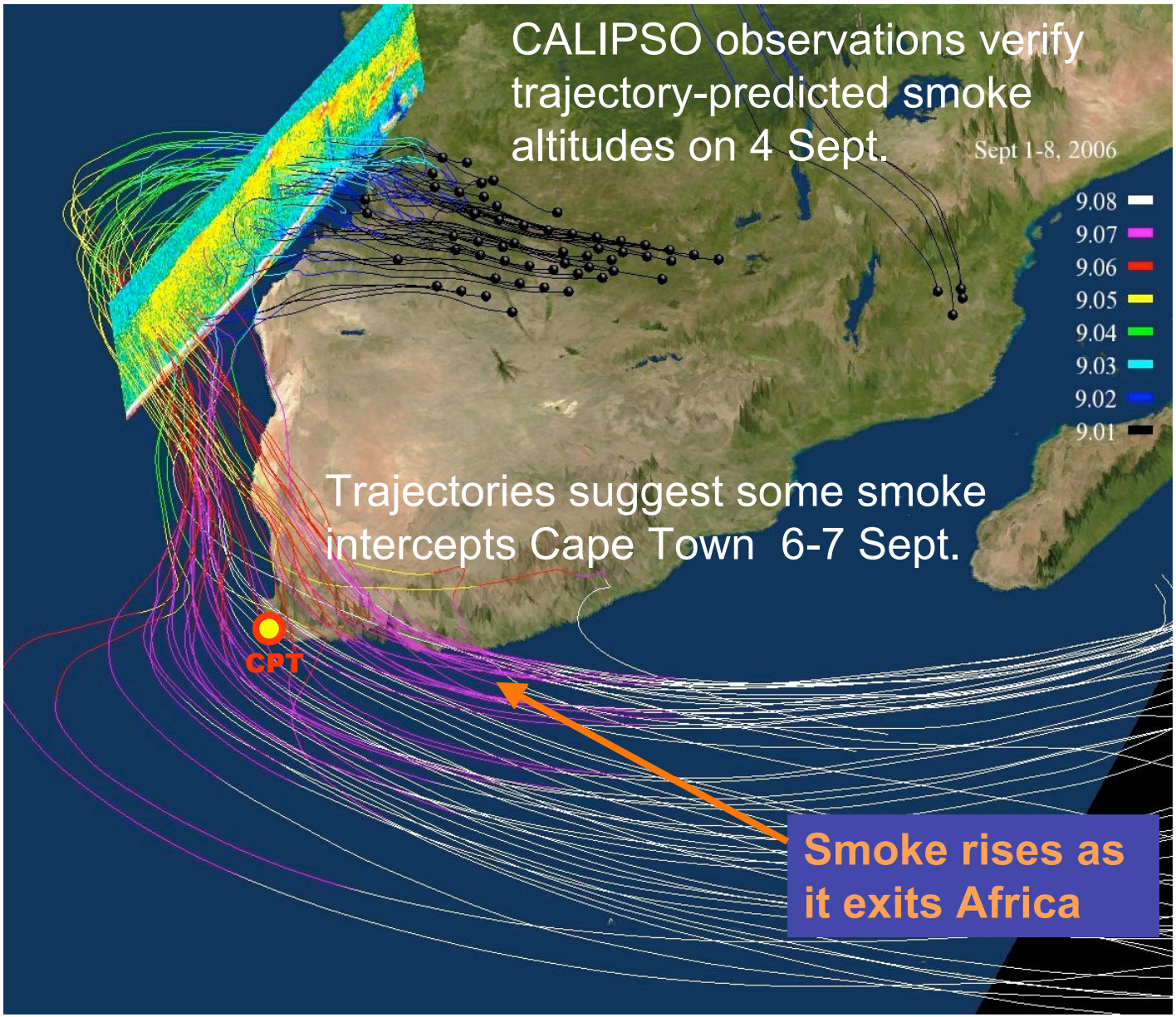
MODIS/Calipso Retrospective Case Study: South African Biomass Burning, early September 2006



September 4, 2006
MODIS AOD (colored)
and clouds

Forward trajectories
initialized from Sep. 1 active
fire detections

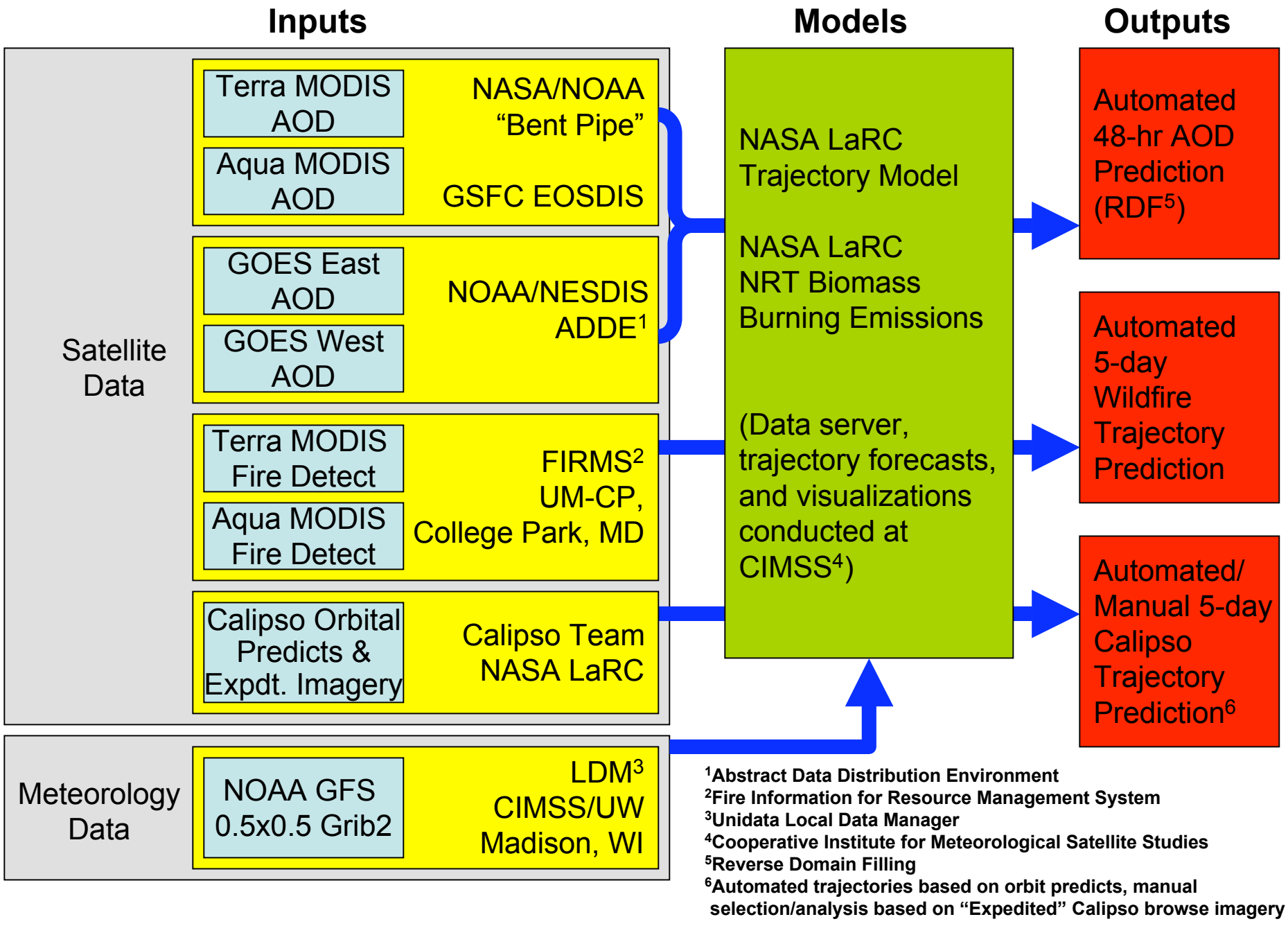
MODIS/Calipso Retrospective Case Study: South African Biomass Burning, early September 2006



Demonstration of Global Fire and Aerosol Product

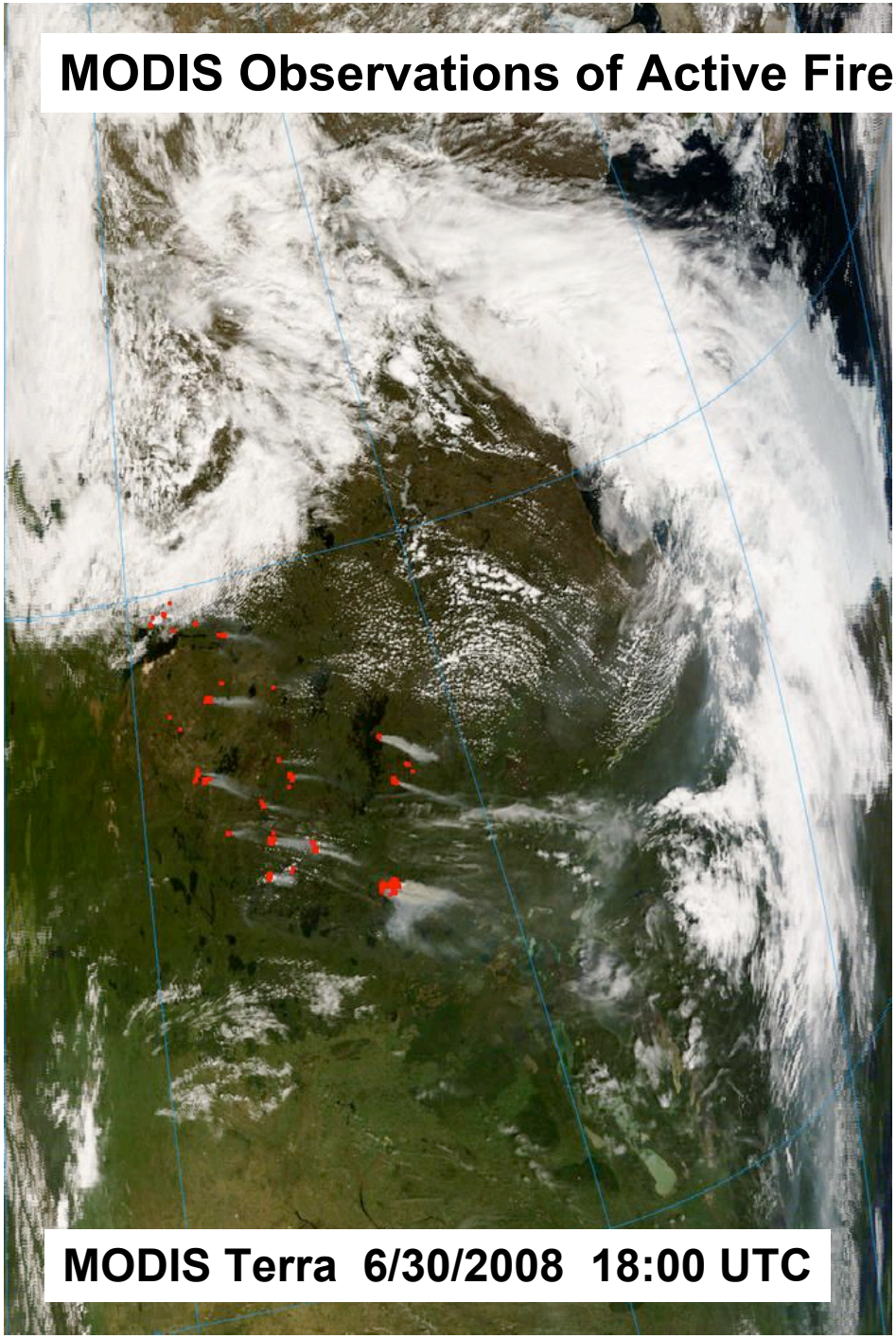
- Use satellite observations of fire and aerosol distributions, in conjunction with trajectory models, to produce air quality guidance related to large-scale aerosol events (e.g., IDEA system, Al-Saadi et al., *BAMS* 2005, http://www.star.nesdis.noaa.gov/smcd/spb/aq/).
  - Develop global warnings on instances of ***potential degradation of air quality due to long-range transport of aerosols*** from widespread burning as well as from naturally occurring dust storms.
  - Initial satellite products include aerosol optical depth and active fire detections from MODIS and GOES, and aerosol height from Calipso
  - Explore international extensions by seeking distribution through existing delivery systems (IMAPP, SERVIR) and by working with international partners to create regional implementations using data from other geostationary satellites (e.g. MSG/SEVIRI, INSAT-3D, etc.).
- Initial demonstration in conjunction with joint NASA (ARCTAS) and NOAA (ARCPAC) field missions during 2008 International Polar Year.
  - Rapid availability of additional satellite products, including Calipso
  - Take advantage of science team focus on identification of wildfire events, particularly during the summer phase of ARCTAS (boreal fire)

Global aerosol/smoke forecast products during 2008 IPY Field Missions

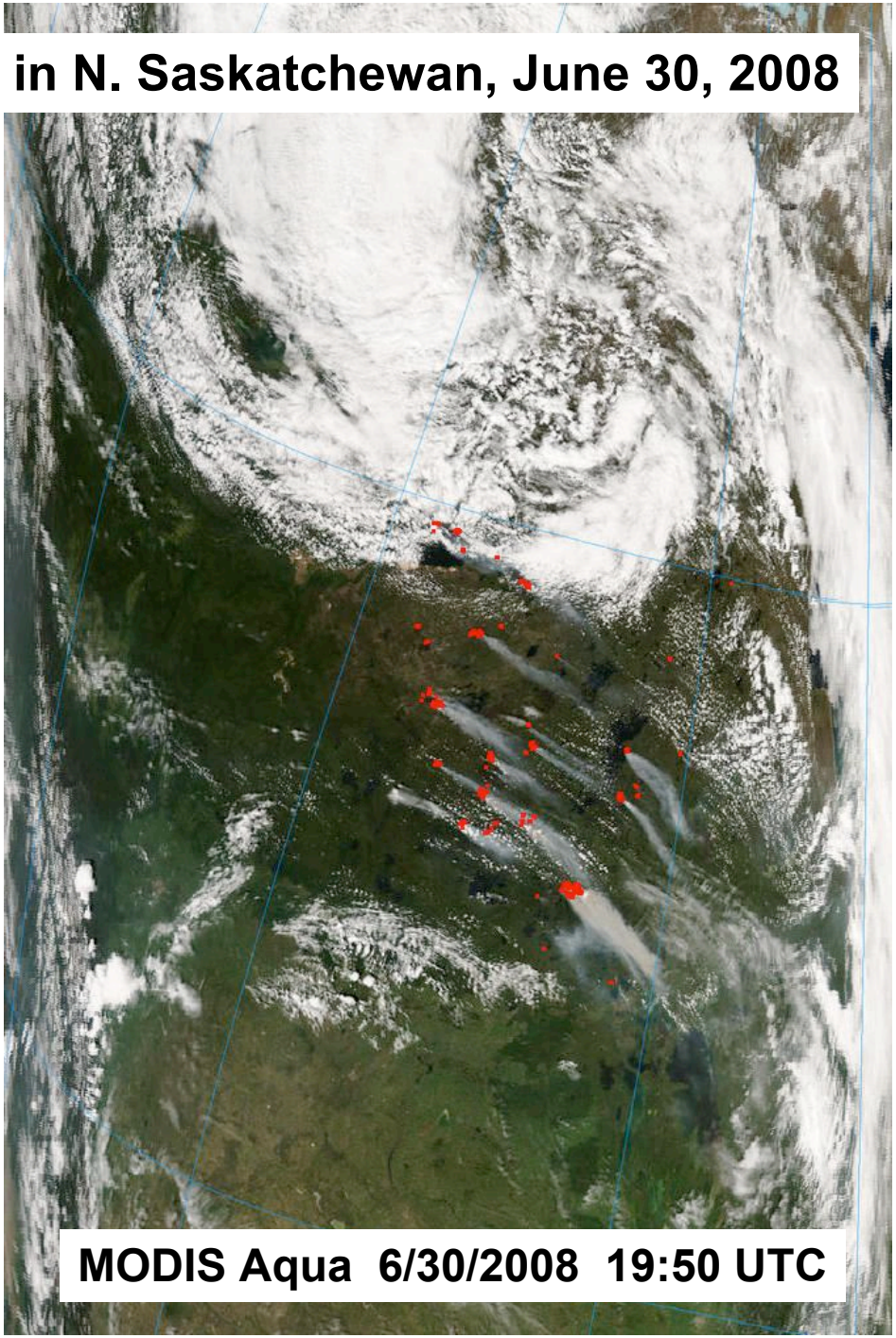


[1]Abstract Data Distribution Environment
[2]Fire Information for Resource Management System
[3]Unidata Local Data Manager
[4]Cooperative Institute for Meteorological Satellite Studies
[5]Reverse Domain Filling
[6]Automated trajectories based on orbit predicts, manual selection/analysis based on "Expedited" Calipso browse imagery

MODIS Observations of Active Fires in N. Saskatchewan, June 30, 2008

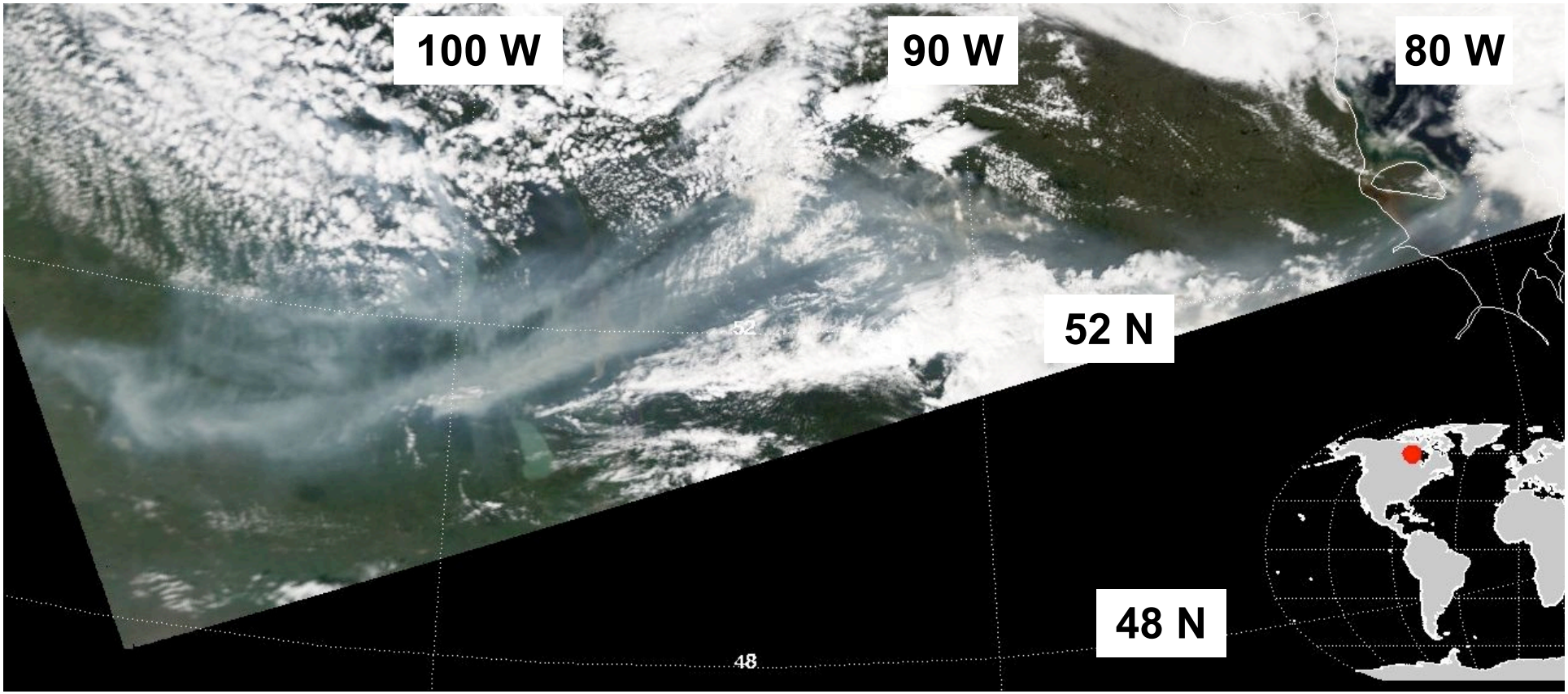


MODIS Terra 6/30/2008 18:00 UTC



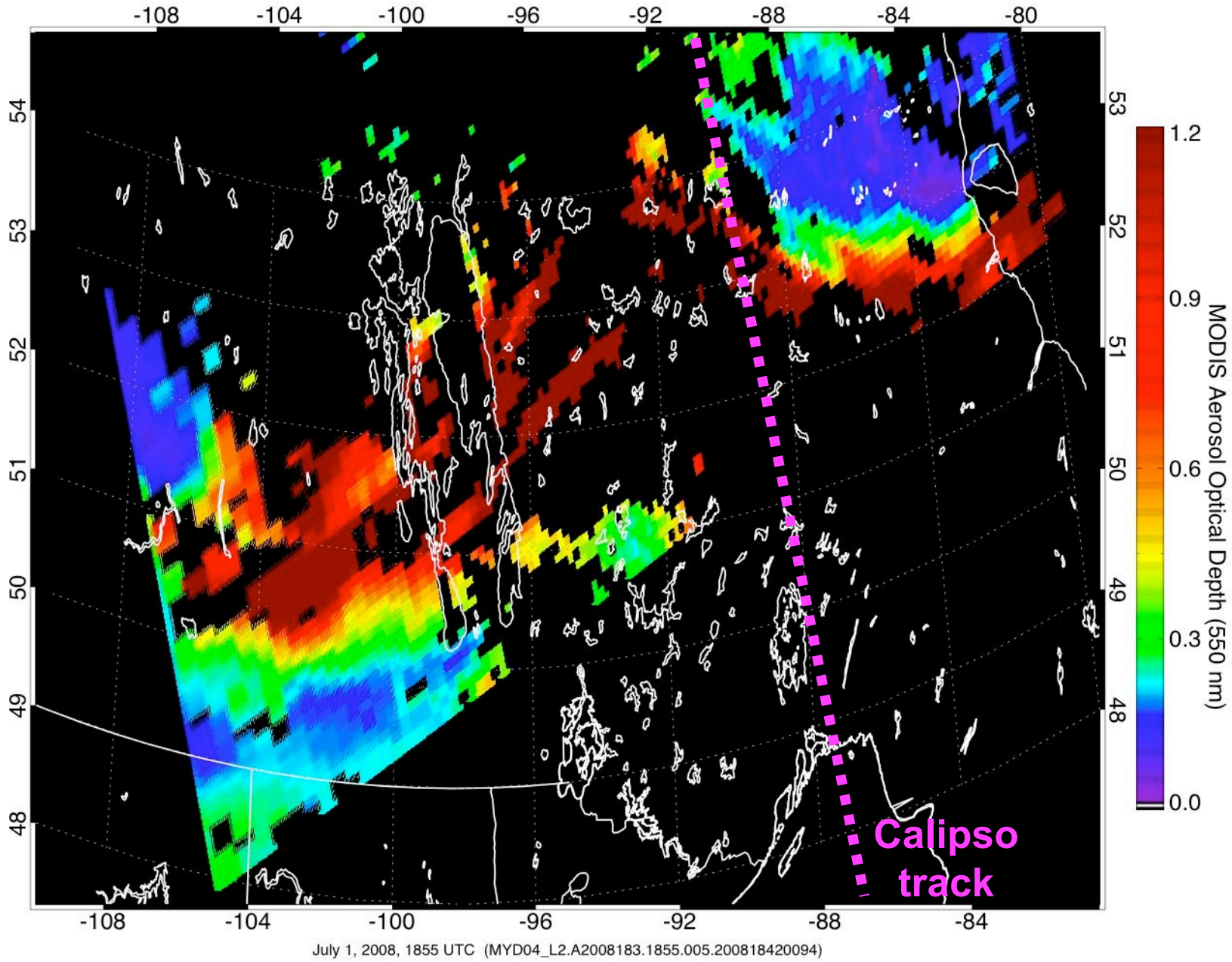
MODIS Aqua 6/30/2008 19:50 UTC

Aqua MODIS RGB July 1, 2008 18:55 UTC

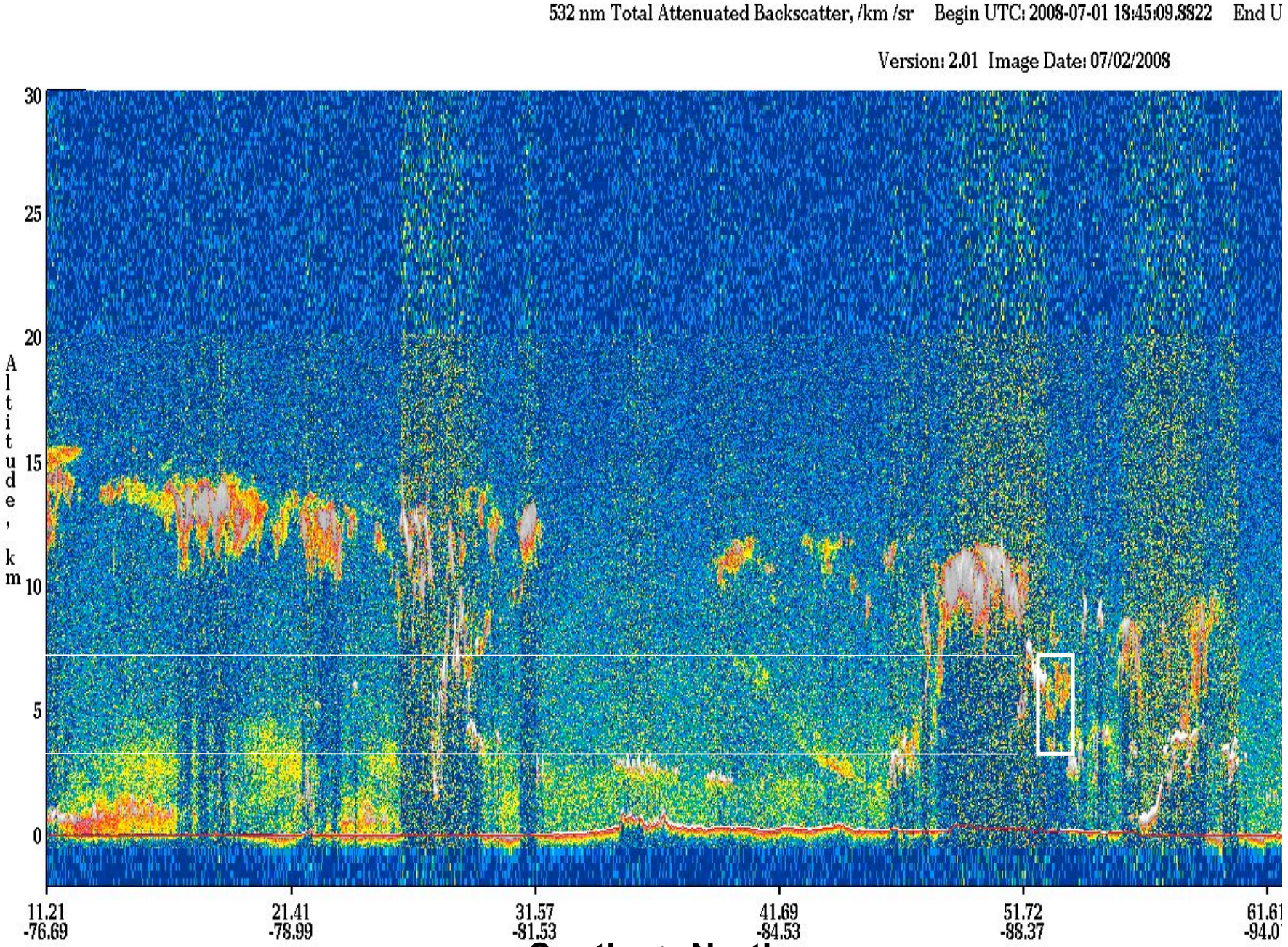


On July 1, visible smoke plume extending over 30 degrees longitude in Southern Canada

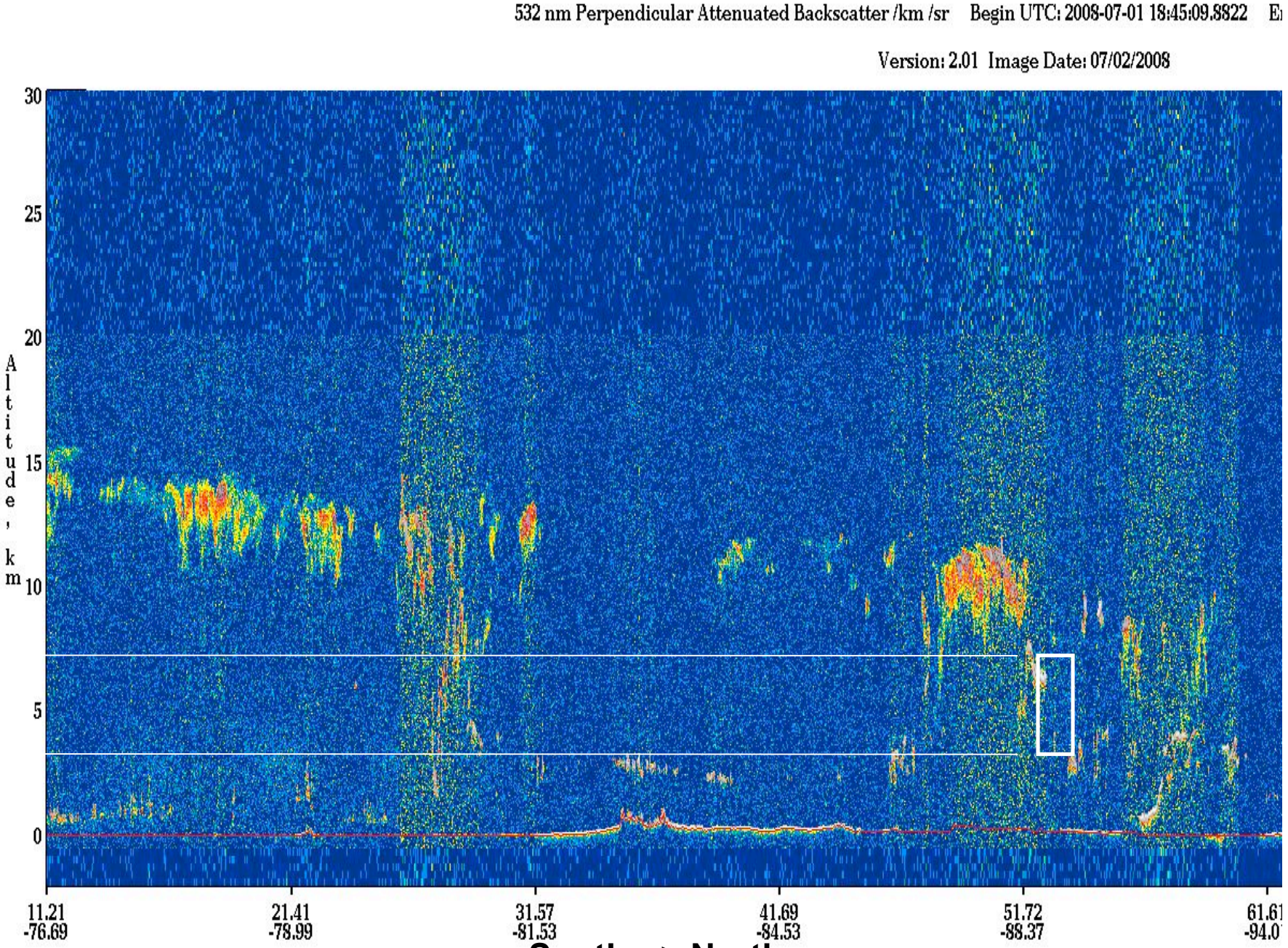
Aqua MODIS AOD July 1, 2008 18:55 UTC



Calipso 532 nm backscatter 07/01 shows features 3.5-7 km

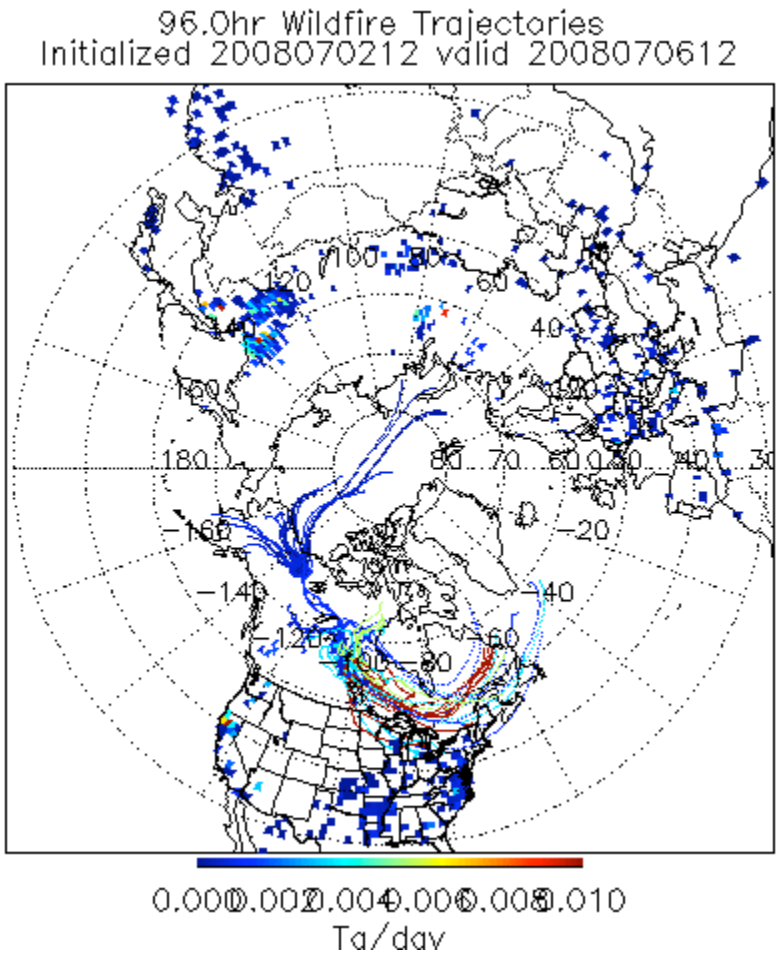


Calipso 532 nm depolarization 07/01 suggests features are aerosol (spherical)

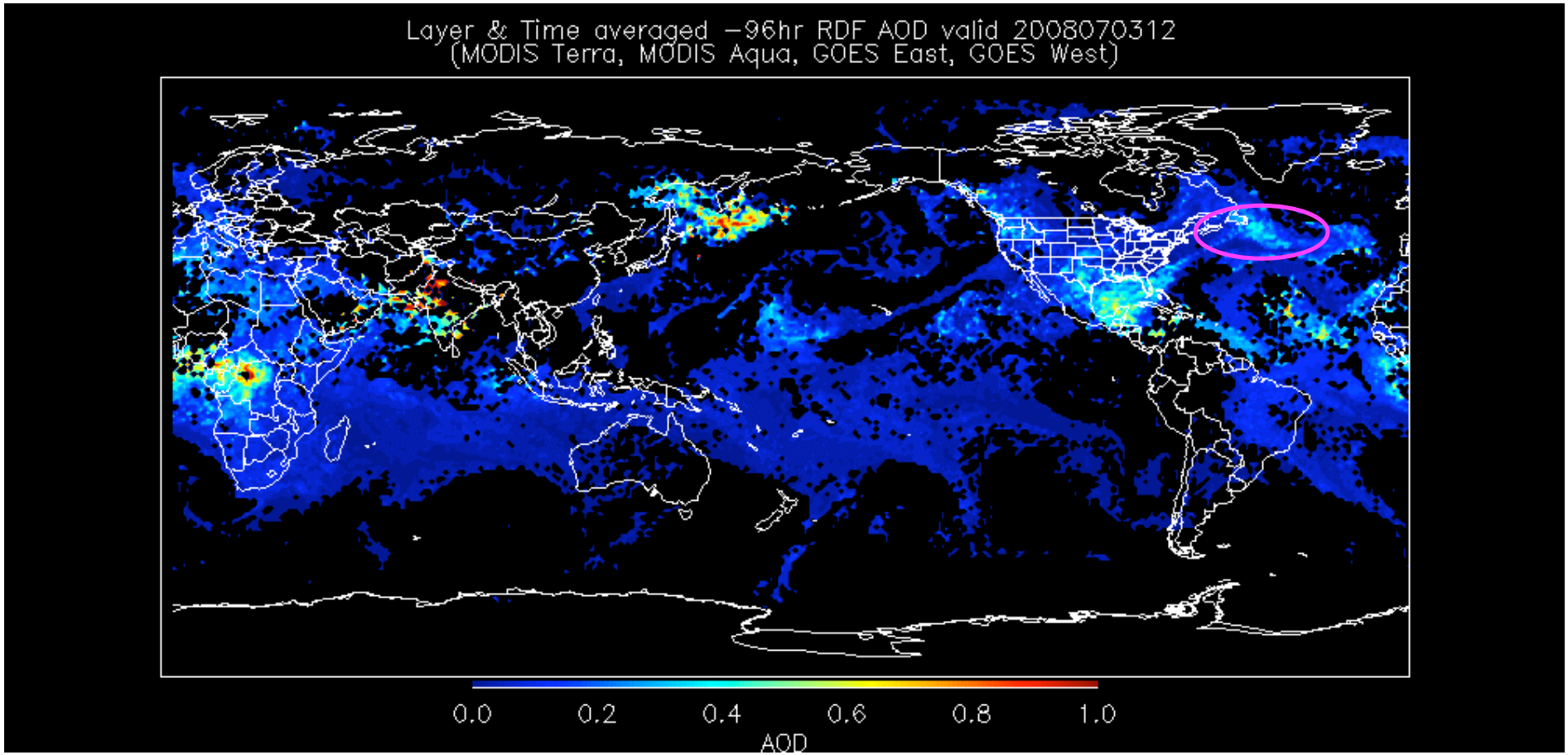


CEOS Automated **Forward trajectories** initialized from MODIS fire detections
Ending 12Z 07/06

Colored by Estimated CO Emission Flux

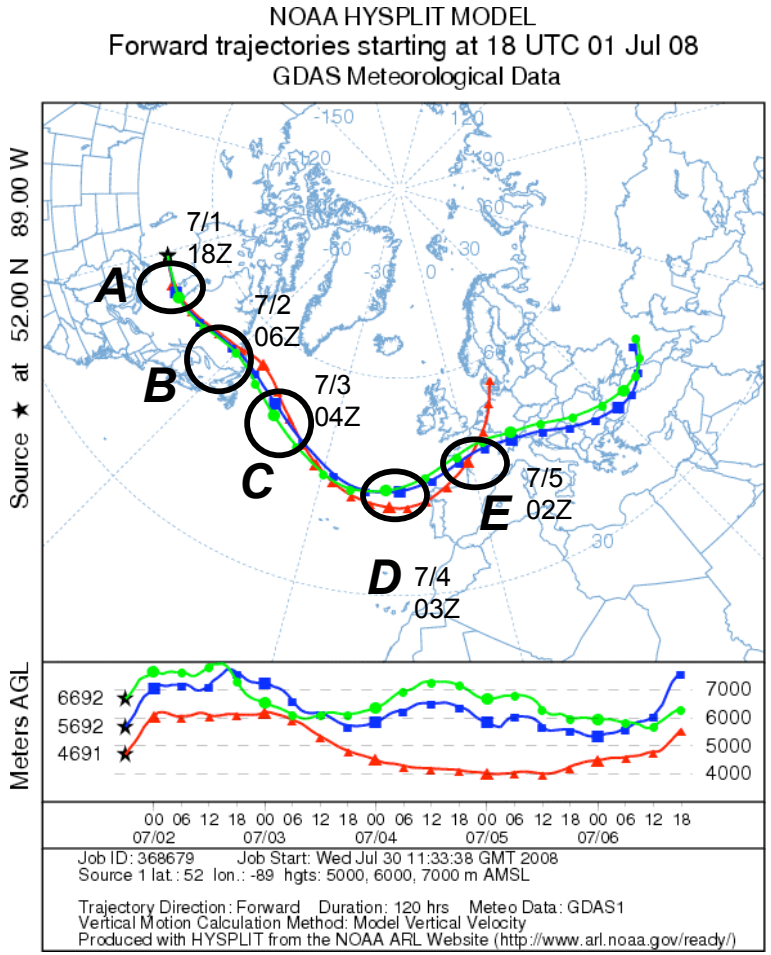


CEOS Automated **Global AOD Prediction**
Reverse Domain Filling (RDF) technique using MODIS and GOES observations
Valid 12Z 07/03



Links between smoke plumes using CALIPSO Observations and Trajectory analysis

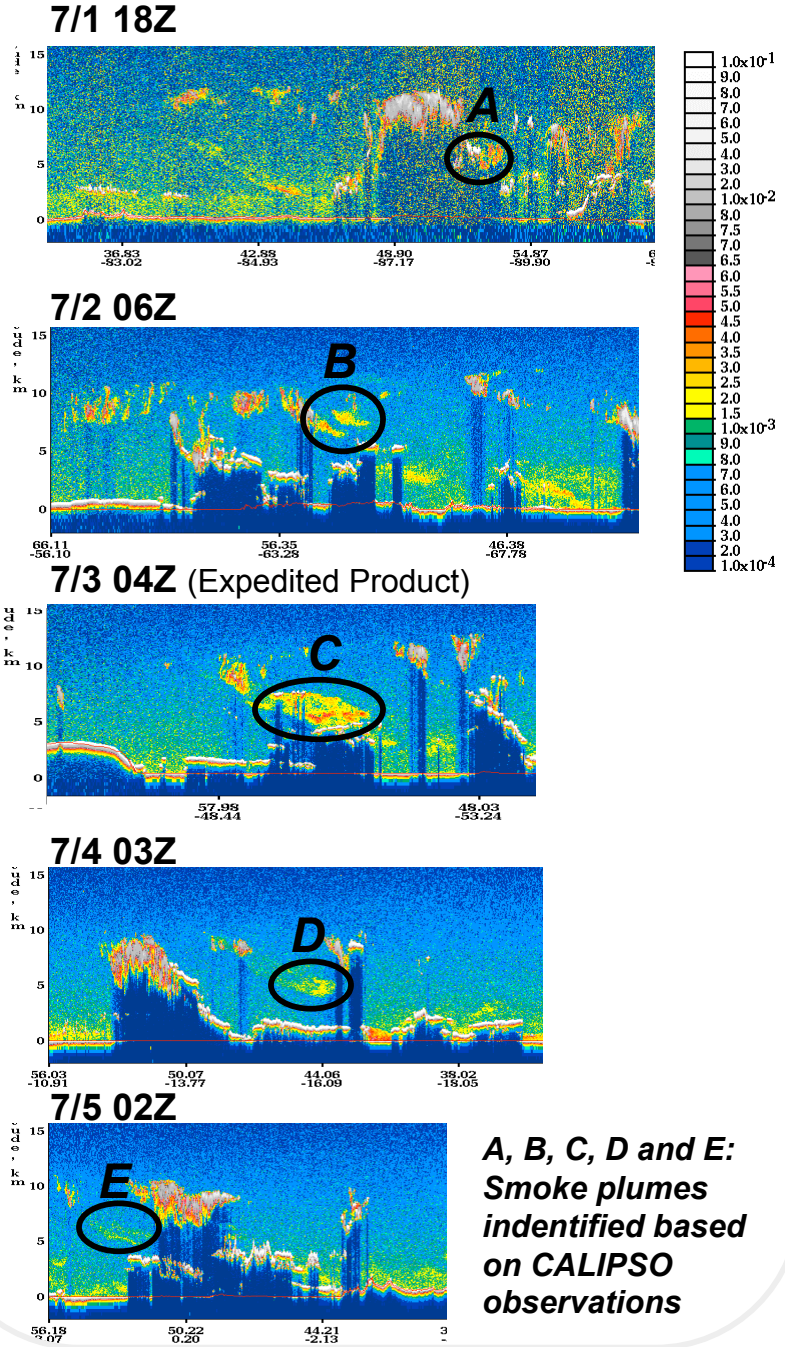
Chieko Kittaka
(chieko.kittaka-1@nasa.gov)



*CALIPSO observations and trajectory analysis suggest that the **smoke plume A** was transported across N. Atlantic Ocean at altitudes between 5 km and 7 km and reached W. Europe on 7/4 (**plume D**). It continued moving eastward (**plume E** on 7/5).*

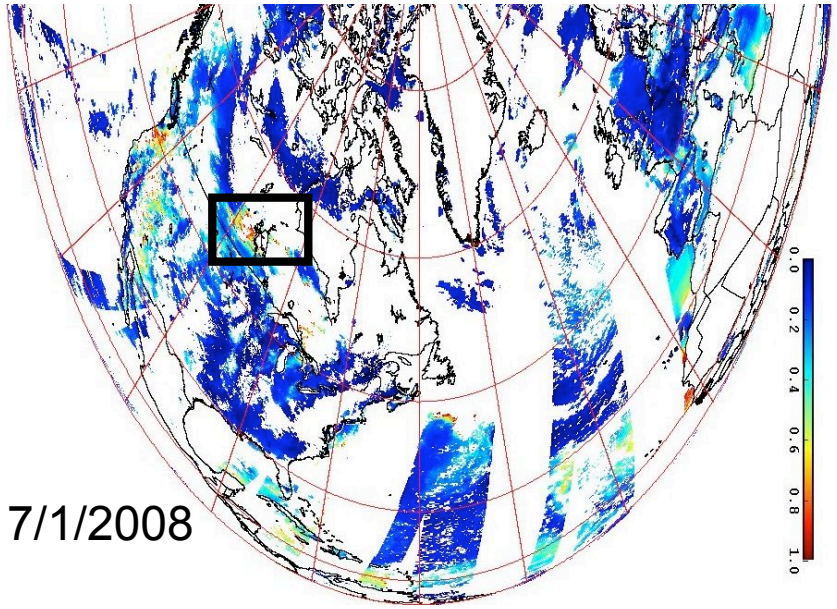
No AQ impact expected on Western Europe during this period.

CALIPSO Attenuated Backscatter

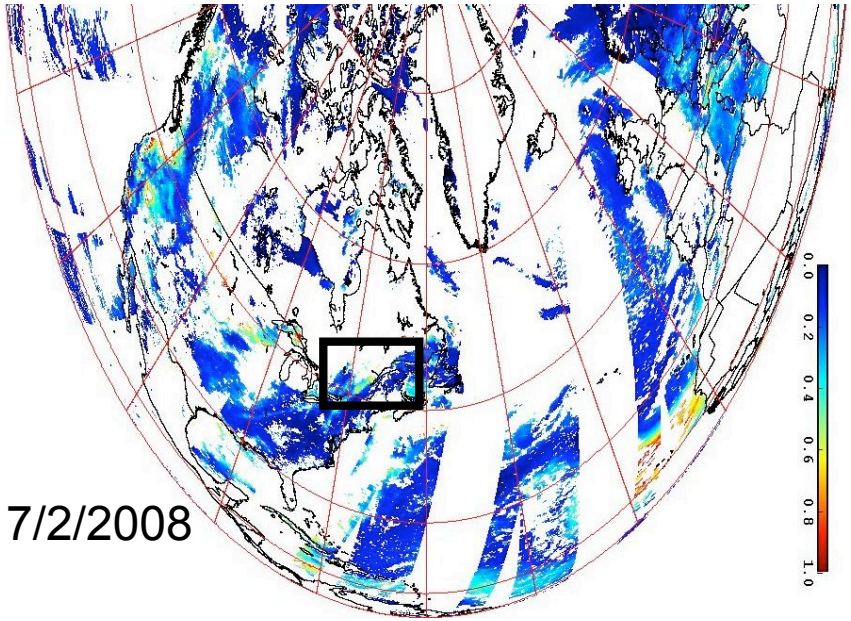


A, B, C, D and E: Smoke plumes indentified based on CALIPSO observations

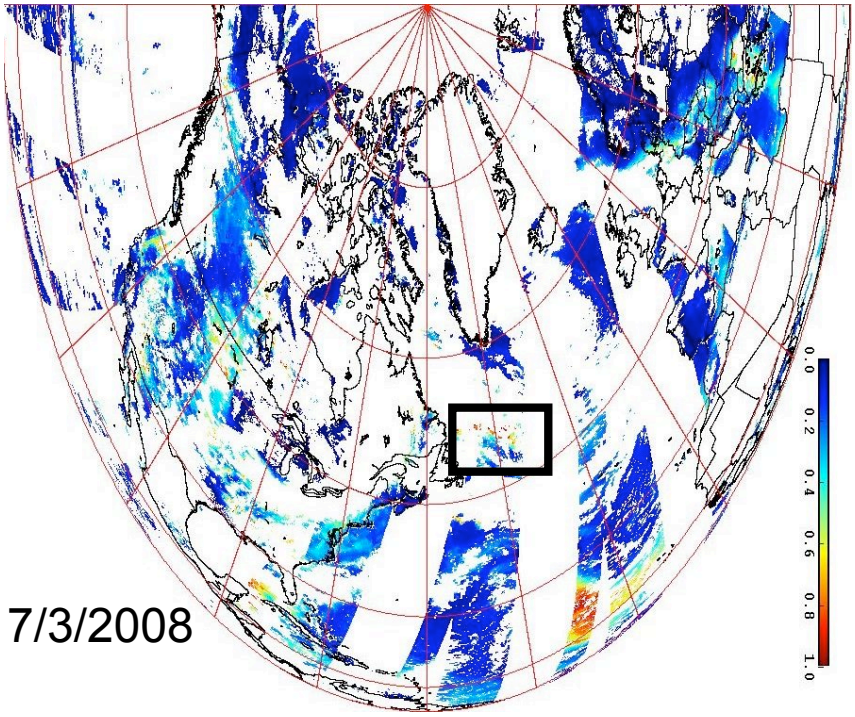
MODIS (Terra) Northern Hemisphere AOD (provided by Allen Chu, UMBC)



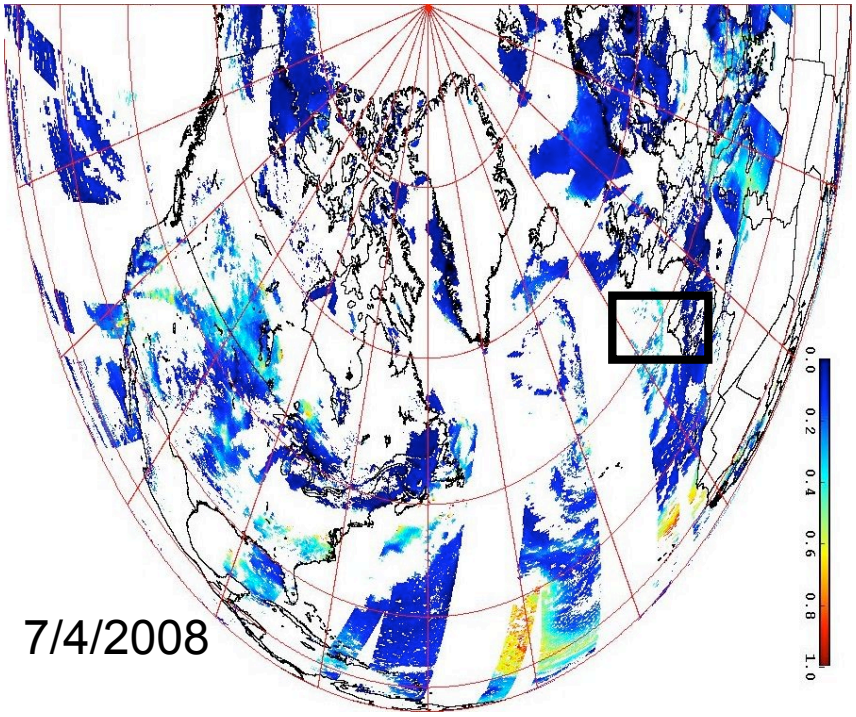
7/1/2008



7/2/2008

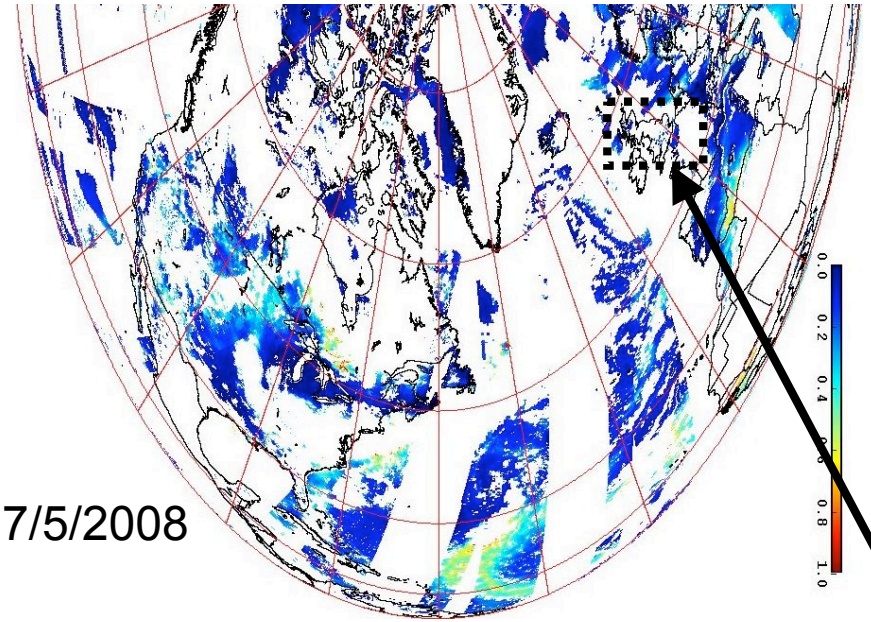


7/3/2008

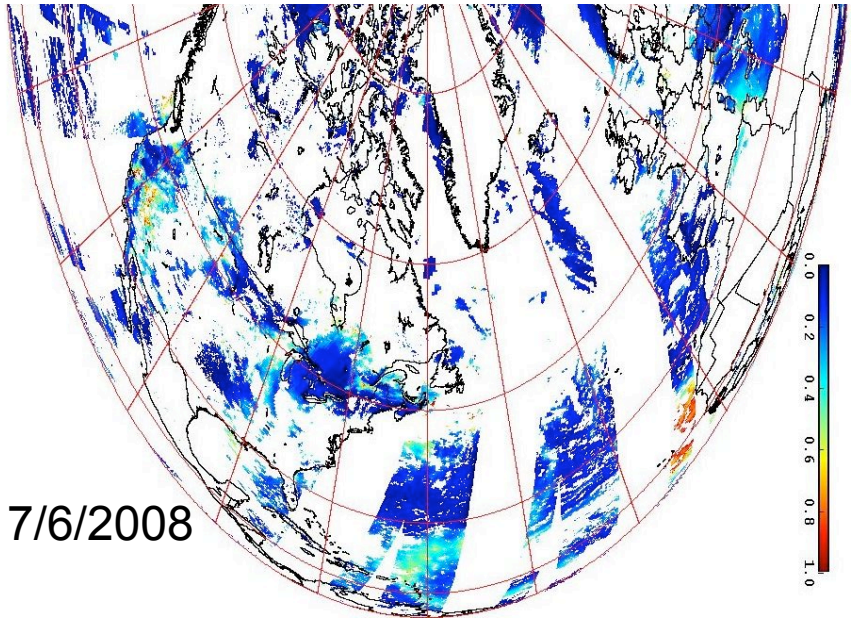


7/4/2008

MODIS (Terra) Northern Hemisphere AOD (provided by Allen Chu, UMBC)

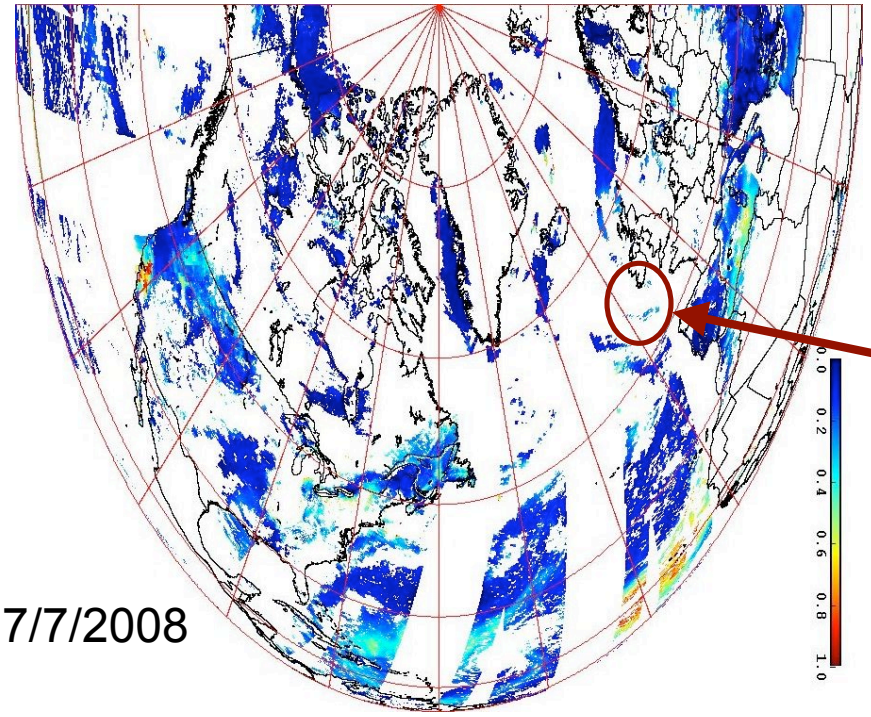


7/5/2008



7/6/2008

Clouds



7/7/2008

Moderate enhancement, possibly from lower altitude SK smoke plume experiencing slower transport

One more case study… with surface data and relation to US operational systems

NOAA's National Weather Service Weather Forecast Office

Chicago, IL

Home Site Map News Organization

Local forecast by "City, St" or Zip

Code City, St

Go

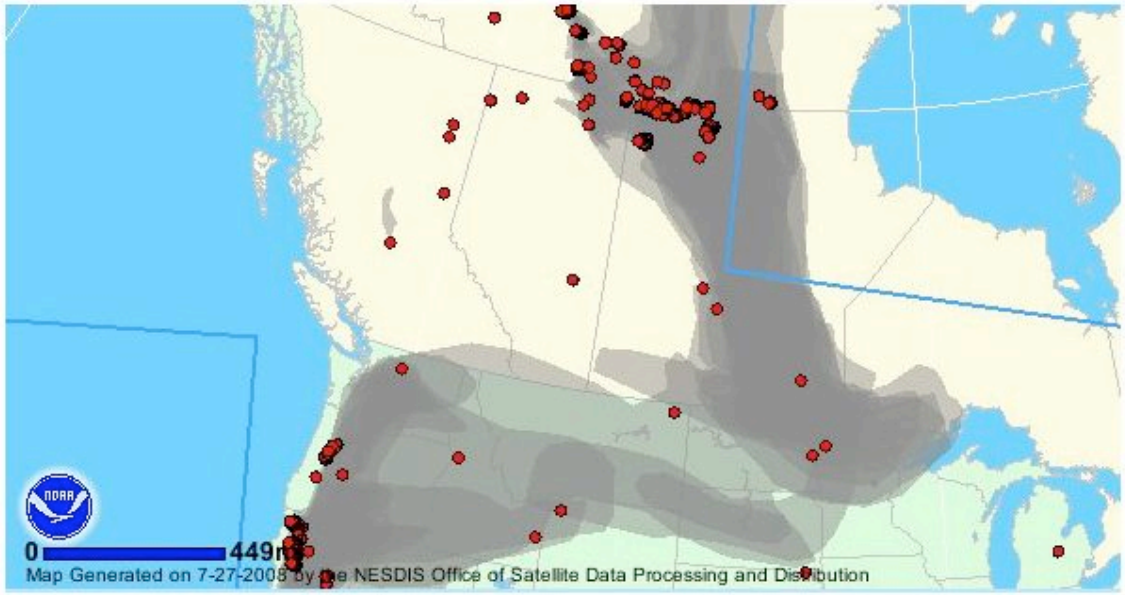
Current Hazards
Watches / Warnings
Outlooks
U.S. Hazards
Hurricane Info
eSpotter
Submit a Report
Storm Data
Local Storm

Smoky Sunset For Southern Wisconsin

Smoky Sunset For Southern Wisconsin

July 26, 2008

NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), has a Fire Detection Program. They monitor most of North America for fires and the resultant smoke plumes. Here is how they analyzed the situation across Canada and the northern United State at around 4AM Saturday morning. The smoke quickly moved southeast across the Badgerland during the day:

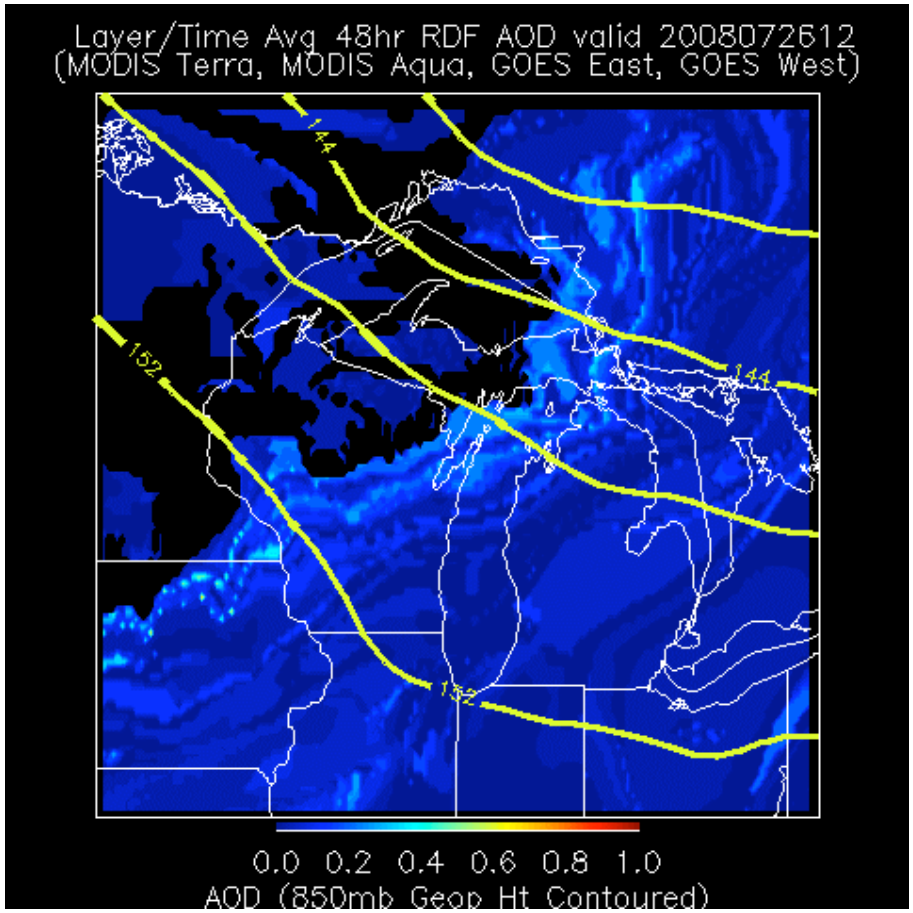


The red cirles are satellite detected hot spots (fires). The gray area is a detected smoke plume.

CEOS Automated **AOD Prediction,** zoom in to US Great Lakes region

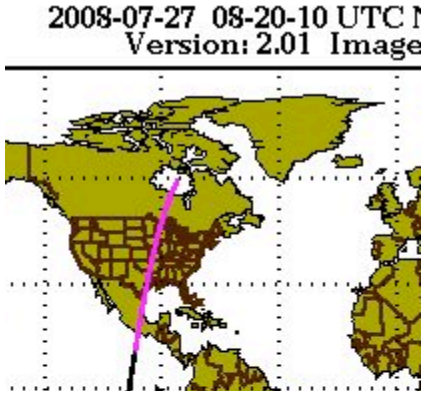
Reverse Domain Filling (RDF) technique using MODIS and GOES observations

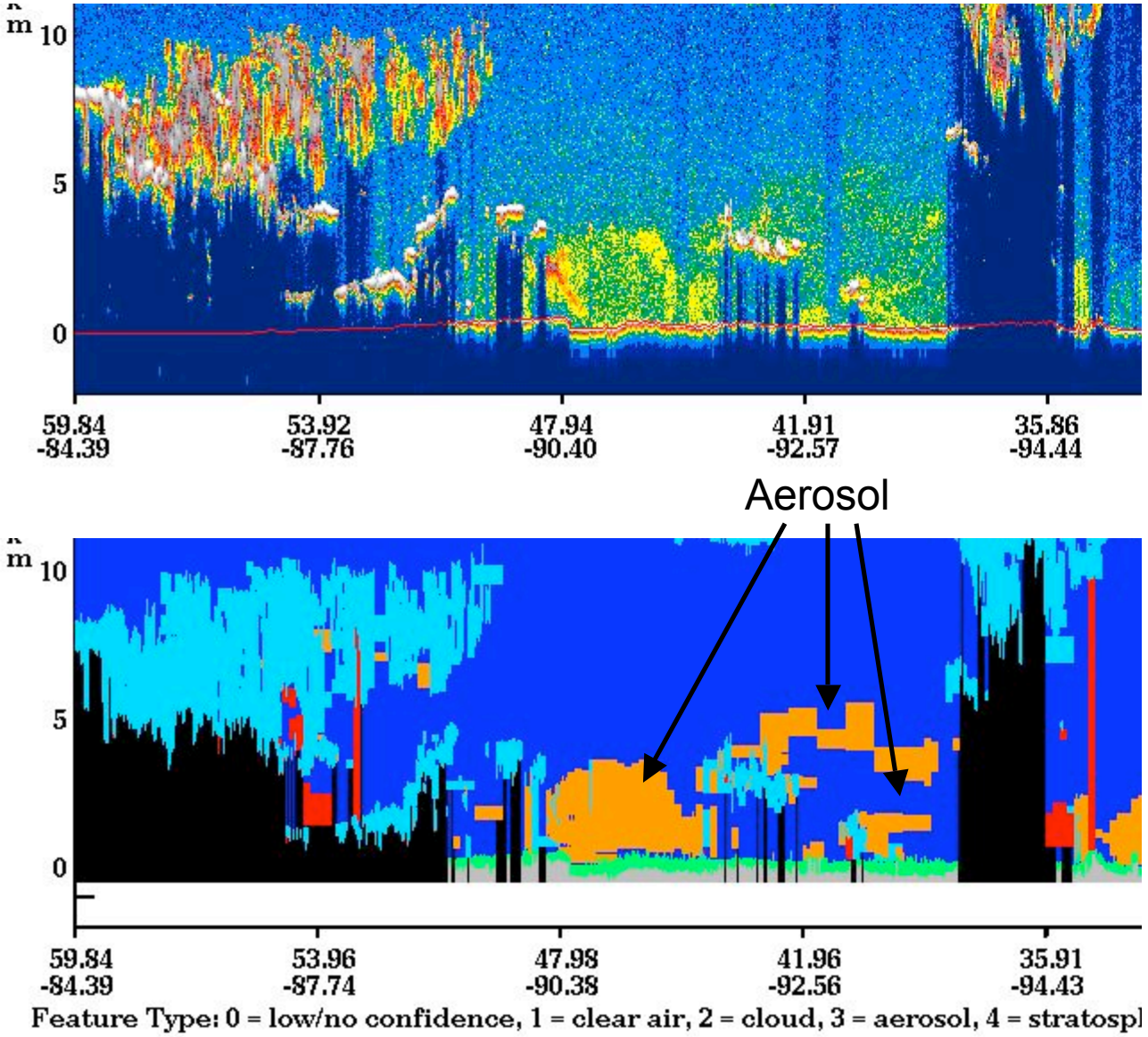
Valid 12Z July 26, 2008



RDF forecast agrees with the smoke plume subsequently detected in the NOAA operational smoke analysis.

CALIPSO Observations July 27 over US Midwest

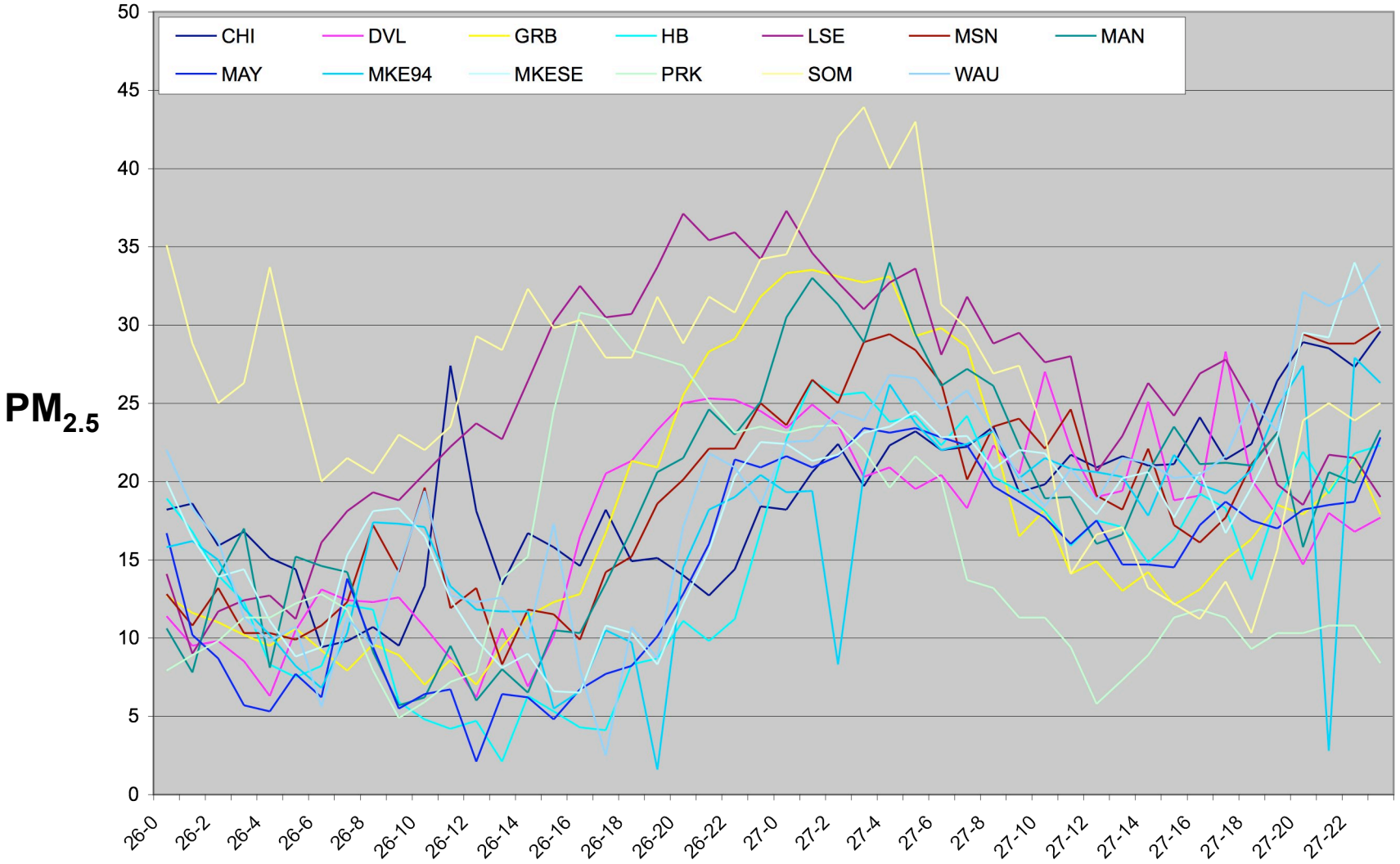




Calipso observations show that aerosol extends from the surface to 3km in the region of the smoke plume. Aerosol layers aloft further to the south.

Regional Surface Fine Particulate Concentration ($PM_{2.5}$) ***July 26-27, 2008 ****

[Provided by Grant Hetherington, Wisconsin Department of Natural Resources]



PM2.5 concentration increases during several hour period at many monitors within the region. Need to look at speciation to verify contribution of smoke.

**Total atmospheric deposition; preliminary/ not quality-assured*

Summary… and plans for moving forward

- Have demonstrated the ***potential*** of combined satellite aerosol observations for informing air quality associated with large-scale transport events
  - Need experienced analysts, familiar with characteristics of each data product
  - Large amount of data to sift through to identify and analyze "relevant" events, particularly with a global focus
- Need for verification of these developmental products
  - Statistical evaluation of forecast products with subsequent satellite observations
  - Broader inclusion of data from surface monitoring networks
- Begin the next phase of the Demonstration Project
  - Identify international partners for infusion of additional ***satellite aerosol and fire products (MSG SEVIRI, MTSAT-1R)*** and ***surface network measurements***
  - Continue to mature enabling science (e.g., Calipso to verify plume height models)
  - Identify appropriate international delivery/distribution mechanism(s)
    - Global vs. regional (e.g., Direct Broadcast/ Direct Readout) analyses
    - Coordination with ongoing Information Systems activities

In summary, the challenge is to continue evolving from individual demonstration projects (labor intensive!) toward routine application of these assets for monitoring and forecasting - particularly within constellations of disparate sensors.

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