Current Capabilities and Future Needs for the Hazard Mapping System in Support of Air Quality Analysis and Forecasting

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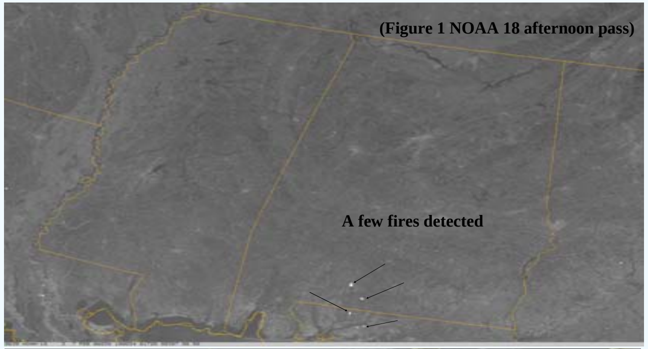
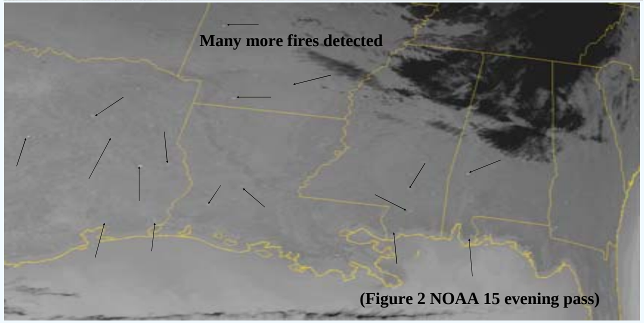
Overview of the HMS and Operations

The Hazard Mapping System (HMS) is an interactive multiplatform remote sensing approach to detecting fires and smoke over the US (including Alaska and Hawaii), Canada, Mexico, and Central America. This system is an integral part of the Satellite Services Division's (SSD) near real time fire and smoke detection and analysis, and is part of the Air Quality forecast initiative of NOAA's National Weather Service. The HMS utilizes NOAA's Geostationary Operational Environmental Satellites (GOES), Polar Operational Environmental Satellites (POES), the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on NASA's Terra and Aqua spacecraft and the Defense Meteorological Satellite Program Operational Linescan System (OLS) sensor (F14 and F15). Automated detection algorithms are employed for each of the satellites (except DMSP OLS). The SSD satellite meteorologist has the capability to delete false detects as well as add points for fires missed by the algorithms.

The satellite meteorologist also outlines areas of smoke and provides locations of significant smoke producing fires as input to the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model which provides a 48 hour forecast of smoke generated from the designated fires (http://www.arl.noaa.gov/smoke/forecast.html). A preprocessor reads this fire position data file and aggregates the locations on a 20 km resolution grid. Each fire location is assumed to represent one sq km and 10% of the area is assumed to be burning. The emission rate of carbon soot varies by land type and uses the rate defined by BlueSky Rains. The total grid cell emission rate and area burning is computed from the sum of the number of fire locations within the aggregation grid cell. It is assumed that the fires are producing emissions for at least a 48 hr period and that each grid cell has the same emission rate regardless of the land type.





Limitations of Current Satellites and the Solutions for Solving these Problems

1. Problem: Many more afternoon polar images compared to the number of morning and evening polar images. The evening passes are able to capture a larger number of fires and associated smoke due to wildfire diurnal characteristics and preferred control burn times. (Figure 1 and 2)

   Solution: Additional polar satellites that have a crossing time near sunrise and sunset. These are better suited for fire and smoke detection
2. Problem: Sensors and algorithms available in near real time have difficulty characterizing aerosol types. For example, on July 4, 2004 the SSD analyst confirmed that smoke from Alaskan fires stretched across most of western and central Canada. The MODIS AOD image in Figure 3 does not show this correlation. Its has smoke in the western portion of the image turning into sulfate in the eastern portion of the image.

   Solution: Sensors/algorithms that can accurately discriminate between aerosol type in near real time for operational applications.
3. Problem: A 4 km nominal spatial resolution is not optimal as smaller and cooler burning fires are at risk of not being detected in satellite imagery.

   Solution: Recommend a higher resolution shortwave IR sensor on the GEO platform for detecting short duration, cooler burning fires or those in a scattered/broken cloud regime.
4. Problem: Navigation issues: A better fire location increases the accuracy of fires for local users as well as for emission modeling since emissions rates are determined by land use maps. For example, if the location is not accurate emission models may interpret the wrong land type. Total emissions could be overestimated or underestimated.

   Solution: Better and consistent navigation (mainly for GEO Spacecraft).
5. Problem: Detection of fires and associated smoke in cloudy areas. For example, a large number of smoke producing fires may be burning in Colorado one day, but the next day clouds have moved into the area. The fires and associated smoke can no longer be seen, but there are reports of these fires still burning.

   Solution: A fire and smoke detection techniques in cloud filled areas.
6. Problem: High surface albedo (ex. Deserts, scrub and grasslands) and dust storms can be difficult regimes in which to accurately identify aerosols (see fig. 4).

   Solution: Further investigate ways to compensate for surface feature contamination.

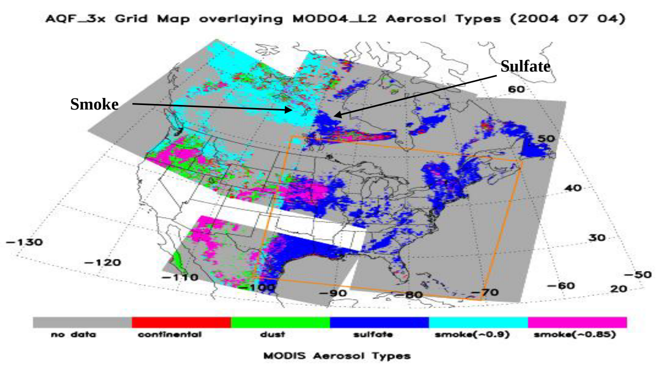


Figure 3 MODIS Aerosol Optical Types image depicting the problem with Aerosol discrimination. West of 100W in Canada smoke is characterized, but to the east the characterization abruptly changes to sulfate.

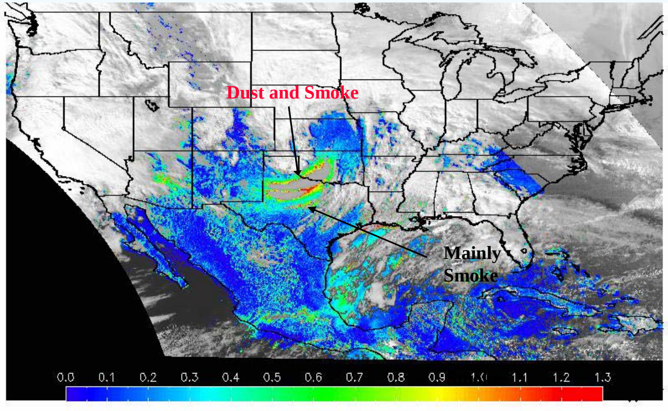


Figure 4 GOES Aerosol Smoke Product (GASP) Aerosol Optical Depth (AOD) for Jan 1, 2006 shows high aerosol optical depth associated with significant area of blowing dust across eastern New Mexico, western and northern Texas, and southern Oklahoma. Smoke from several significant fires was also indicated across central Texas.

7. Problem: Vertical distribution of smoke density is not available. This is needed for accurate long range transport and dispersion modeling.

   Solution: Development of sounding-like retrievals for aerosols.

Product Access

All of the analyzed fire and smoke information is posted to a web page (http://www.ssd.noaa.gov/PS/FIRE/) for viewing in either graphical static jpg format or via a Geographic Information System (GIS) viewer. The GIS page allows for display of multiple layers with roam and zoom capabilities (Figure. 5). There is also an active archive site at www.ngdc.noaa.gov/website/firedetects/viewer.htm.

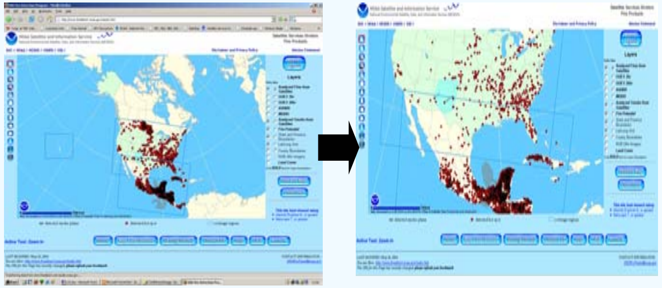


Fig. 5 Full view (left) showing domain of fire/smoke analysis and zoomed in view showing analysis for the southern and central US and Mexico.