

Multispectral Satellite Data For Space Shuttle Landing Operations

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Spaceflight Meteorology Group

- Located at Johnson Space Center in Houston, TX
- Part of the National Weather Service
- Primary Functions
 - Site Specific Shuttle *Landing* Forecasts
 - Launch Contingency Abort Sites (RTLS, TAL)
 - On Orbit CONUS Sites
 - End Of Mission Forecast
 - Special Project Support
 - JSC Staff Weather Office



Launch Abort Forecasts

■ Return to Launch Site (RTLS)

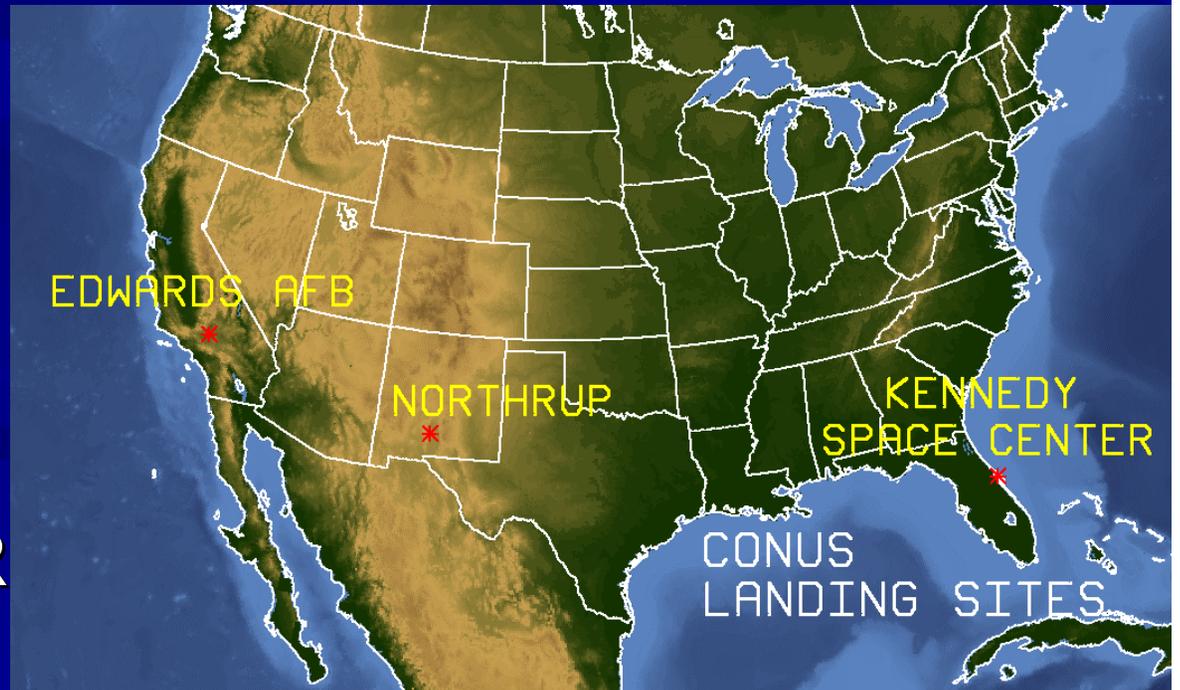
- L + 25 minutes
- KSC only
- Only available between liftoff and 4 min 20 sec
- Failure modes:
 - Main engine failure
 - Orbital Maneuvering System failure
 - Cabin leak
 - Vehicle cooling problem



Launch Aborts cont'd

- Abort Once Around (AOA)
 - L + 105 minutes (one orbit)
 - KSC, EDW, NOR (White Sands)
 - Loss of vehicle performance such that a viable orbit cannot be attained or major system failure

- “First Day” Primary Landing Site (PLS) Abort
 - Orbits 2-6
 - KSC, EDW, NOR



Launch Aborts TAL Sites

- Transoceanic Abort Landing (TAL) Sites
- If main engine failure occurs after last RTLS opportunity or before AOA
- L + 35 minutes



SITE

RUNWAY

Zaragoza, Spain

12,197ft x 197ft

Moron, Spain

11,800ft x 200ft

Istres, France

12,303ft x 197ft

90-Minute End-of-Mission Forecast

- Used to commit to deorbit
- FCT picks the landing opportunity (orbit) and landing site based on the forecast
 - 1st day KSC only
 - 2nd day EDW/NOR added
- Once burn completed, the shuttle must land
 - Can change runway but not landing site



Weather is a Significant Factor in Virtually all Shuttle Missions



■ LANDINGS

- KSC landings save ~ 1 million dollars in ferry costs

■ LAUNCHES

- Avoiding a launch scrub saves 1/2 million to 1 million dollars
- Four missions have been delayed \geq 24 hours in advance based on weather forecasts



Ceiling and Visibility Flight Rules

■ Cloud Ceiling

- 5000 ft RTLS & TAL
- 8000 ft End of Mission

■ Visibility

- 4 miles RTLS, 5 miles TAL, EOM
 - Includes restrictions due to fog/haze/dust
- CIG and VIS rules ensure crew has time to see the runway and landing aids and make navigation adjustments





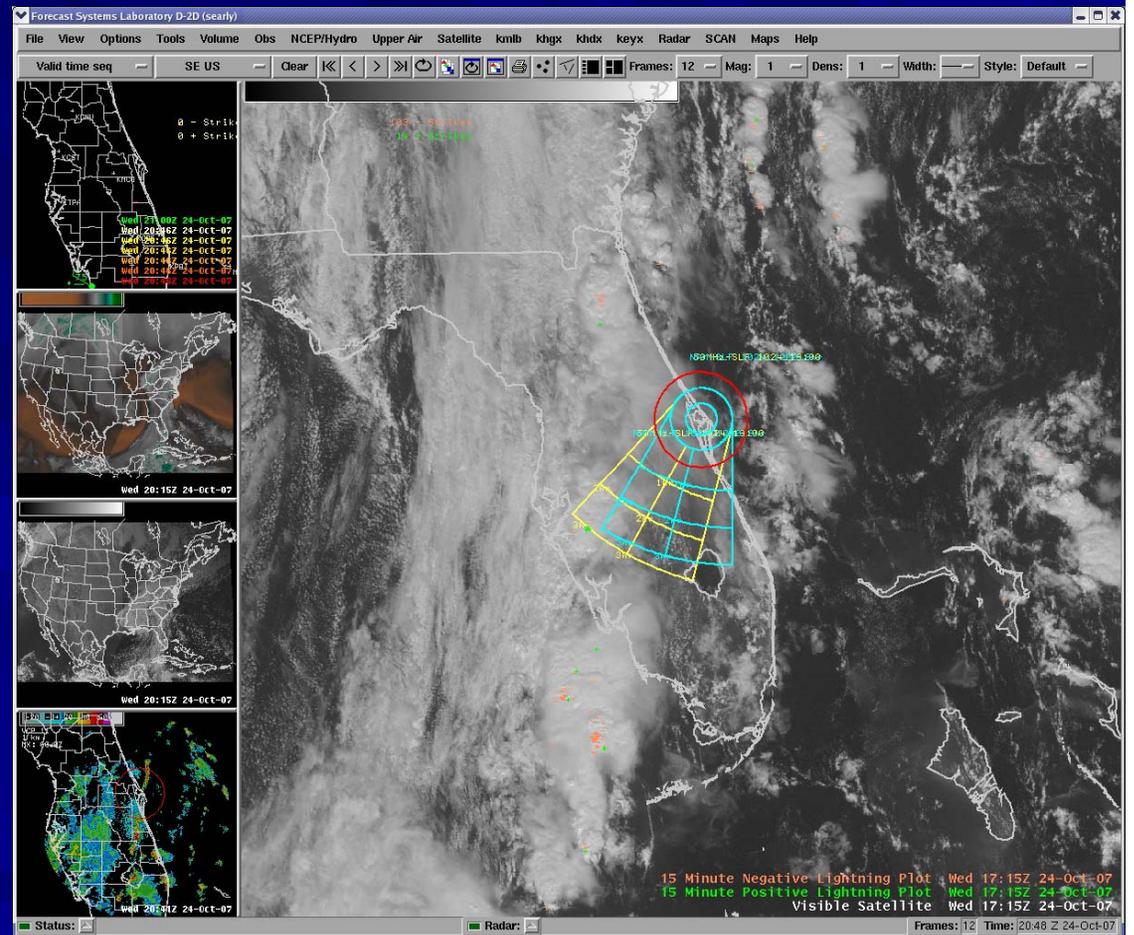
Thunderstorms, Lightning, and Precipitation Rules

- No precipitation or thunderstorms:
 - Within 20 nm of runway for RTLS, TAL
 - Within 30 nm for EOM
- Cannot fly through cumulus clouds from smoke up to 1 hour after detaching
- Impacts: decreased visibility, tile damage, triggered lightning, increased orbiter drag



Thunderstorm Anvils

- No attached active anvils within 20nm RTLS/TAL or 30nm EOM
- No detached opaque anvil < 3 hours old
- Within 15 nm RTLS/TAL or 20nm EOM



SMG Satellite Display Systems



■ McIDAS

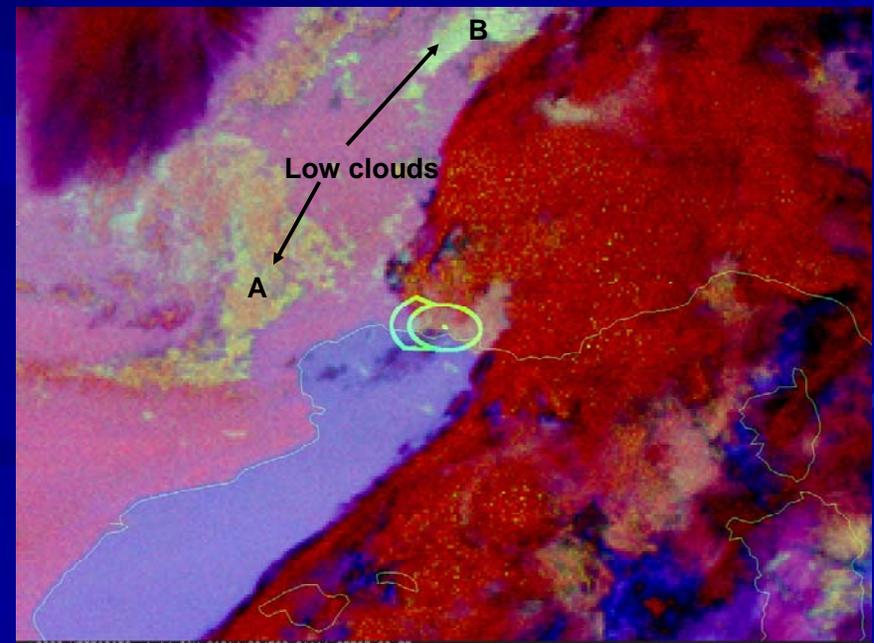
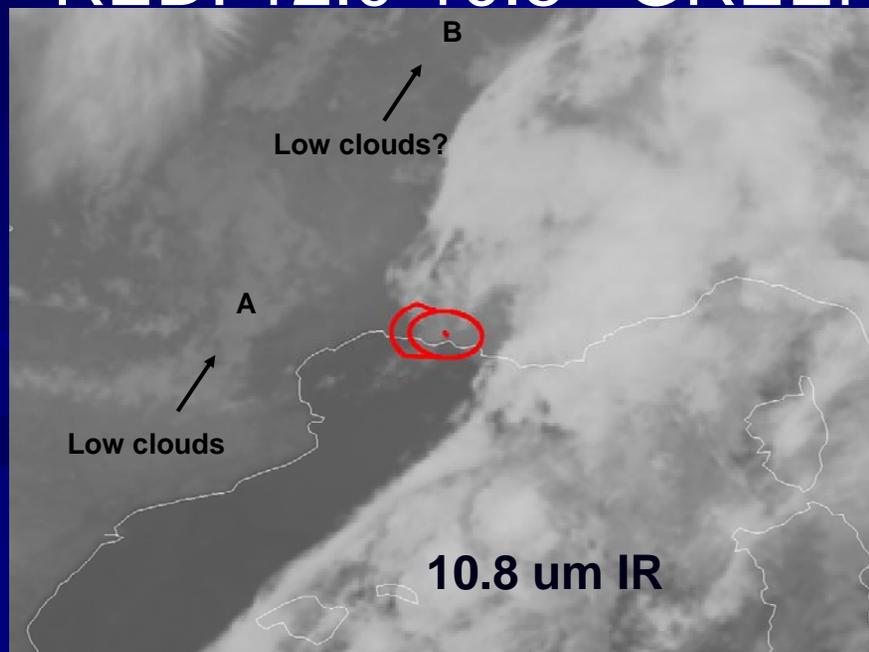
- GOES E real time ingest
- GOES W real time ingest
- Meteosat 9 real time ingest of all 12 channels
- Can create image combinations, differences, etc.
- Access to other McIDAS datasets from NESDIS and NASA

■ AWIPS

- Both GOES E and W turned on for ingest
- Meteosat 9 Vis, IR and WV data sent from McIDAS via LDM
- Use standard available products such as fog, sounder derived products (TPW) and quickSCAT

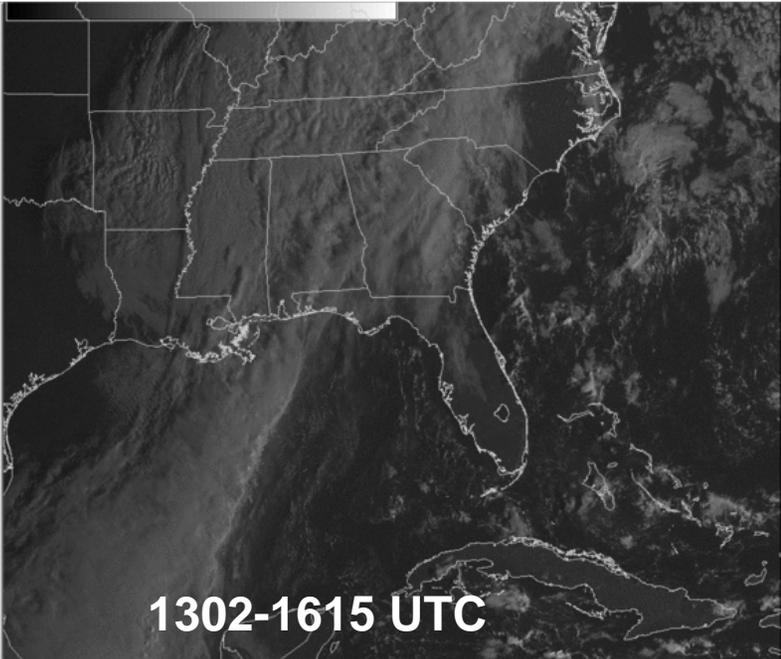
Meteosat RGB Nighttime Microphysics Derived Product Image

- Created from Meteosat 9 imagery on McIDAS
- Procedure described in “Best Practices for RGB Compositing of Multispectral Imagery” by the User Service Division from EUMETSAT’s web site
- RED: 12.0-10.8 GREEN: 10.8-3.9 BLUE: 10.8

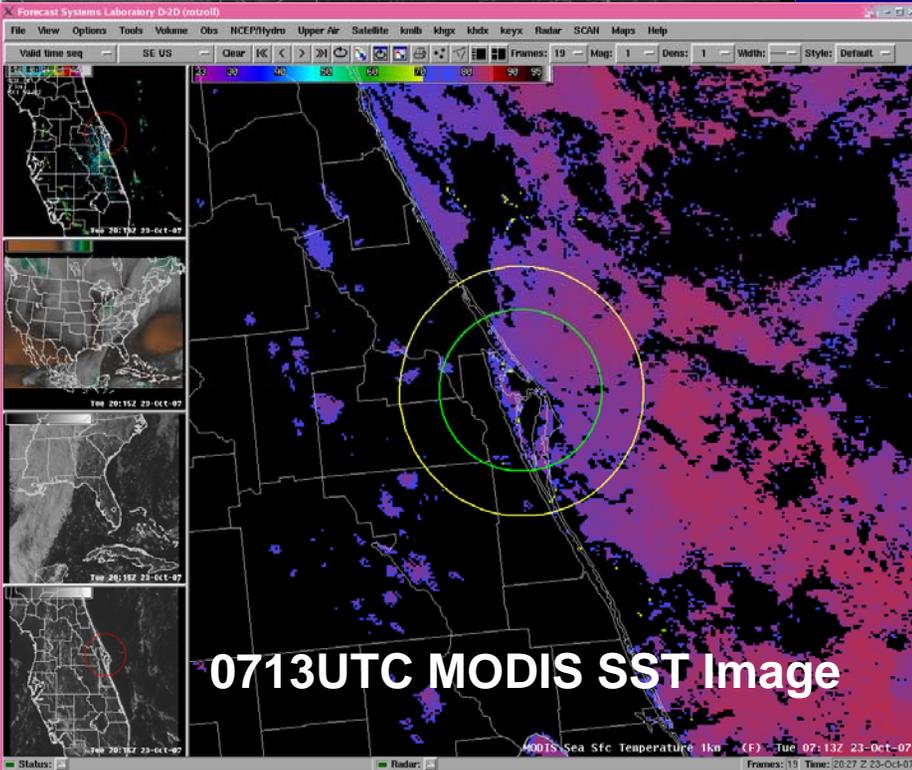


14 January 2008 2045 UTC

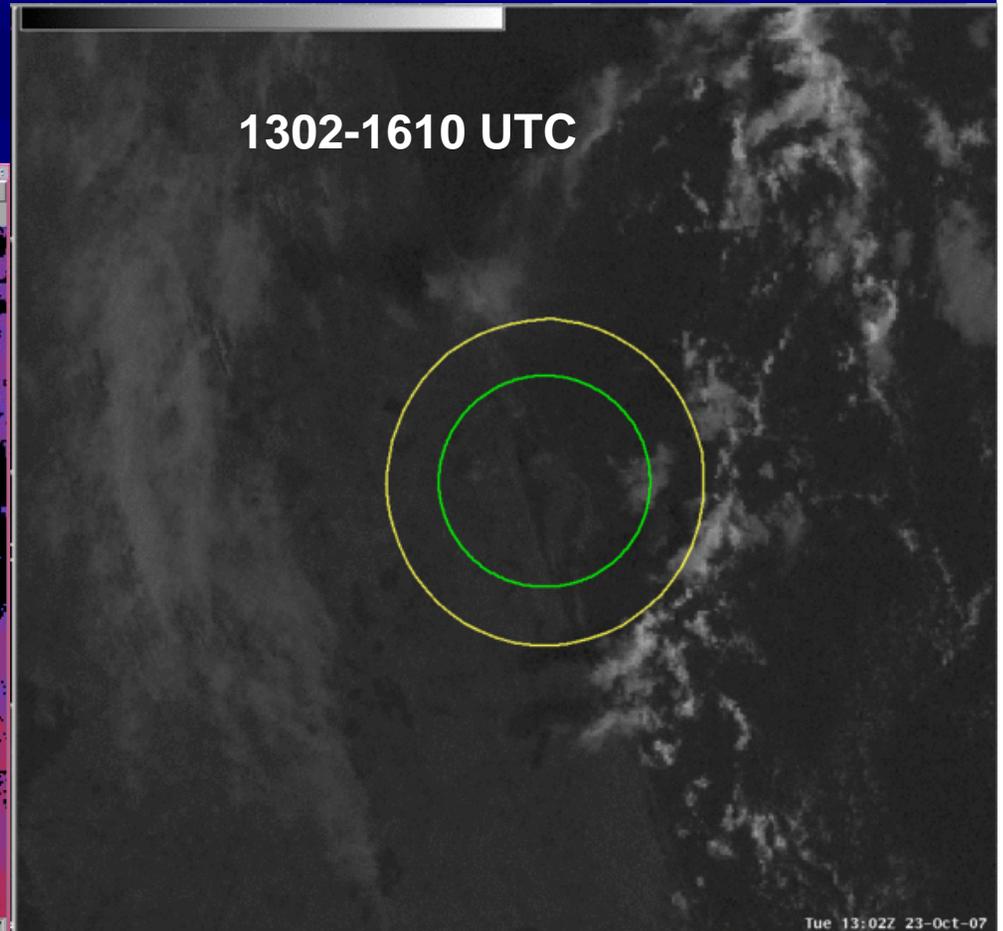
STS 120 Launch Oct 23, 2007 1038 am CDT



1302-1615 UTC



0713UTC MODIS SST Image

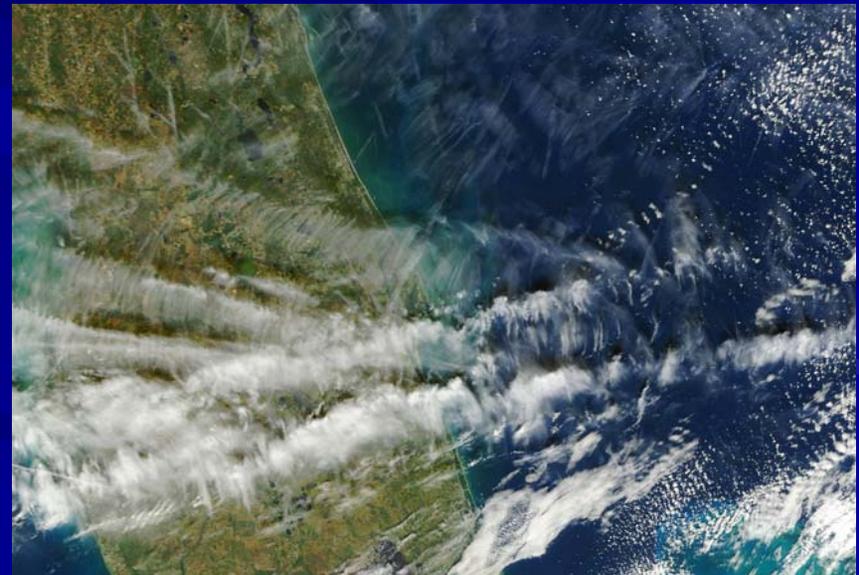


1302-1610 UTC

Tue 13:02Z 23-Oct-07

MODIS 250m True Color Imagery

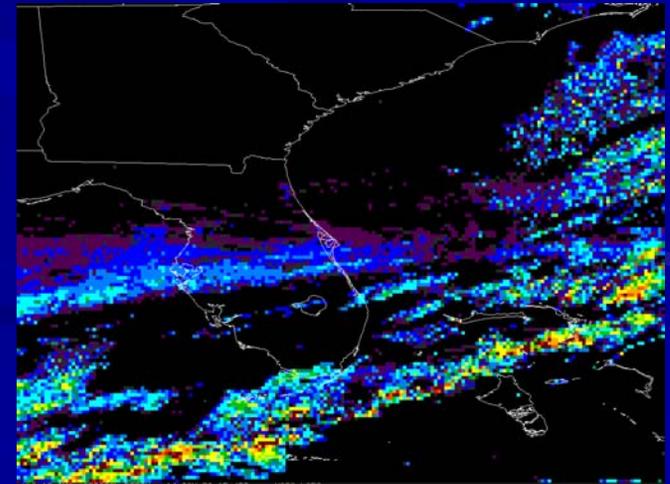
- Sector created for SMG by SSEC over Cape Canaveral Florida
- Received via LDM in compressed jpg format
- Limited display since not in area or netCDF



January 14, 2008 1532 UTC Visible and MODIS True Color Images

GOES Optical Depth Imagery

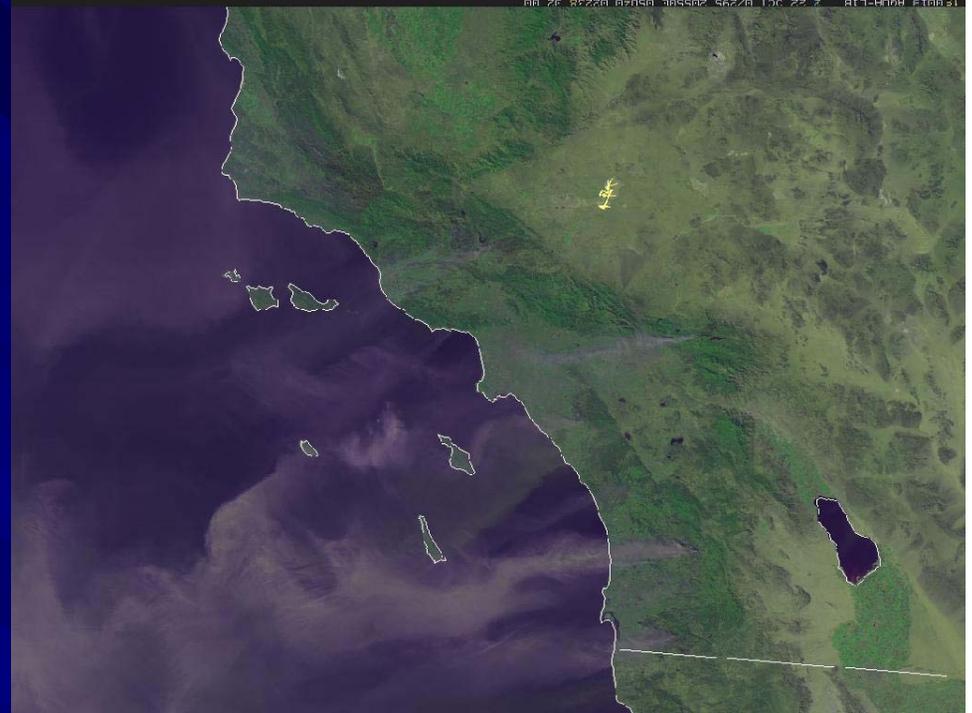
- GOES Optical Depth Imagery is obtained from NASA Langley Cloud and Radiation Research Group server
- Used at SMG to determine transparency of thunderstorm anvils.
- Timeliness and low resolution limits usefulness



January 14, 2008 1532 UTC MODIS True Color Image and 1540 UTC Optical Depth Image

Another MODIS Example

- MODIS picture of California fires on Oct 22, 2007, the day prior to the STS 120 launch.
- Three visible bands retrieved from GSFC EODIS server
- Bands combined on McIDAS to create final image, then overlaid with runway plot.
- Used to brief NASA managers that smoke and electrified cumulus would NOT affect an EDW AFB landing.



Satellite Training at SMG

- Virtual Institute for Satellite Integration Training (VISIT) Teletraining
- COMET on-line training through MetEd
- In-House half day multispectral training for MSG
 - Extensive use of EUMETSAT on-line training materials
- However...
 - Use of complex datasets still limited
 - Ease of access very important in today's data rich environment
 - Must integrate data into tools that the forecasters are comfortable with

Web Pages

<http://www.srh.noaa.gov/smg/>

<http://spaceflight.nasa.gov/shuttle>

