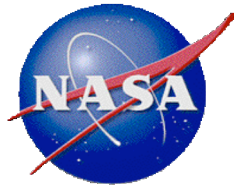

Flooding Estimates from Aqua Microwave Observations

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This work was carried out at the Jet Propulsion Laboratory, California Institute of Technology
under a contract with the National Aeronautics and Space Administration

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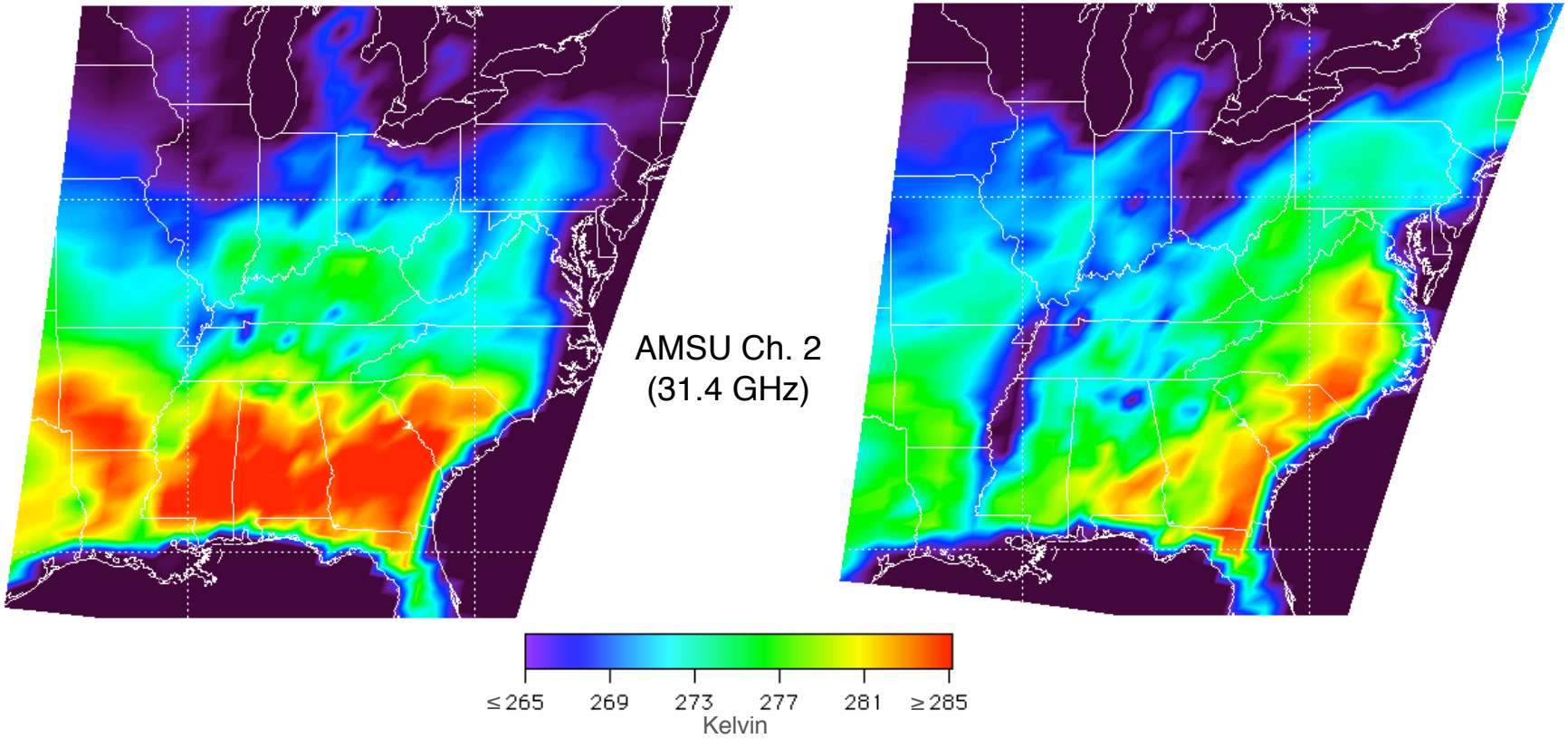
Example Observation

Tropical Storm Isidore

12 days before landfall: 9/12/02

2 days after landfall: 9/28/02



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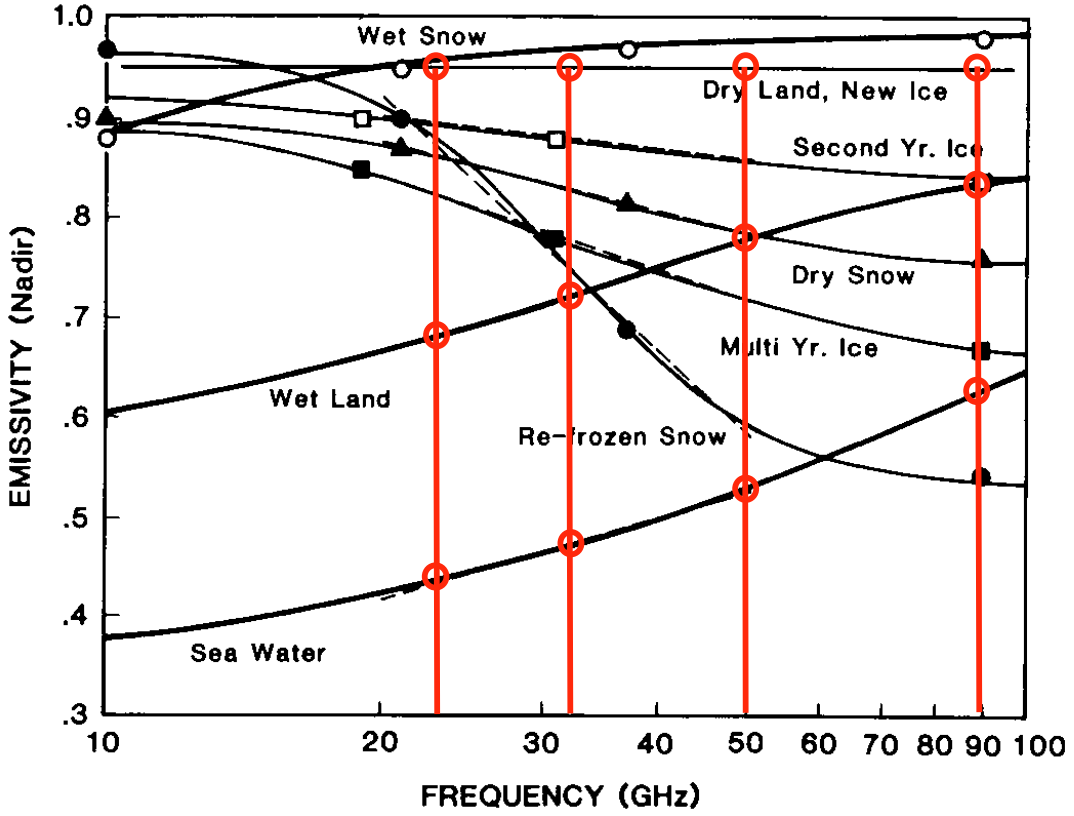
Microwave Emissivity

Physical basis for method

Red: AMSU window channels



Grody, TGRS **26** (6), 850-859, 1988

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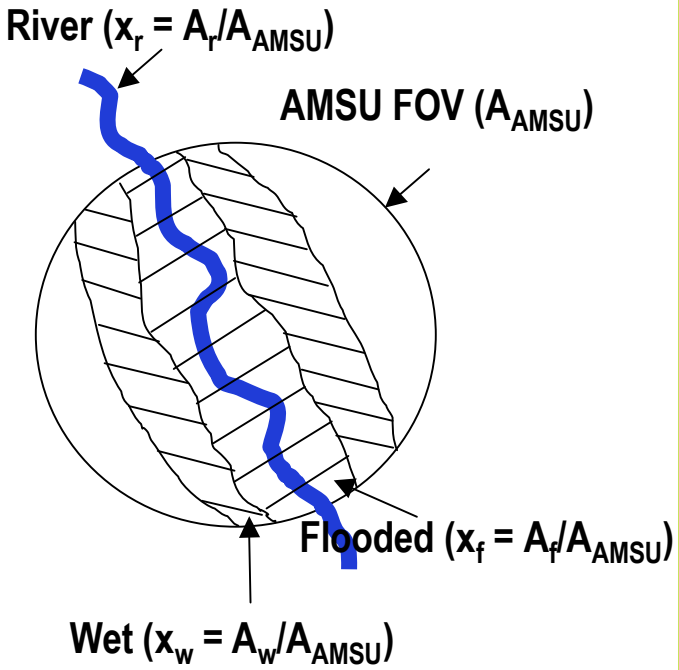
Methodology



$Tb = \{\varepsilon T_s + (1-\varepsilon)Tb^d\}e^{-\tau} + Tb^u \approx \varepsilon T_s + \tau Tb$
(τTb is small and can be estimated from AIRS/forecast)

$\varepsilon \approx x_d * \varepsilon_d + x_w * \varepsilon_w + (x_r + x_f)\,\varepsilon$
For AMSU channel 1-2 (3 & 15 also usable):
- $\varepsilon_d \approx 0.95$ Also vegetation (~ same emissivity)
- $\varepsilon_w \approx 0.70$ Wide range vs. moisture content
- $\varepsilon_d \approx 0.45$ Narrow range, but pol. dependent

Use map (DEM) to estimate x_r
Use prior (unflooded) observations to verify

Method 1: Bounding cases
- a) Take $x_f = 0$, solve for x_w
- b) Take $x_w = 0$, solve for x_f

Method 2: Solve for linear combination
$(\varepsilon_d - \varepsilon_w)x_w + (\varepsilon_d - \varepsilon_f)x_f = (Tb/T_s)^{prior} - (Tb/T_s)^{now}$

Method 3: Use 2 channels, solve for x_w and x_f

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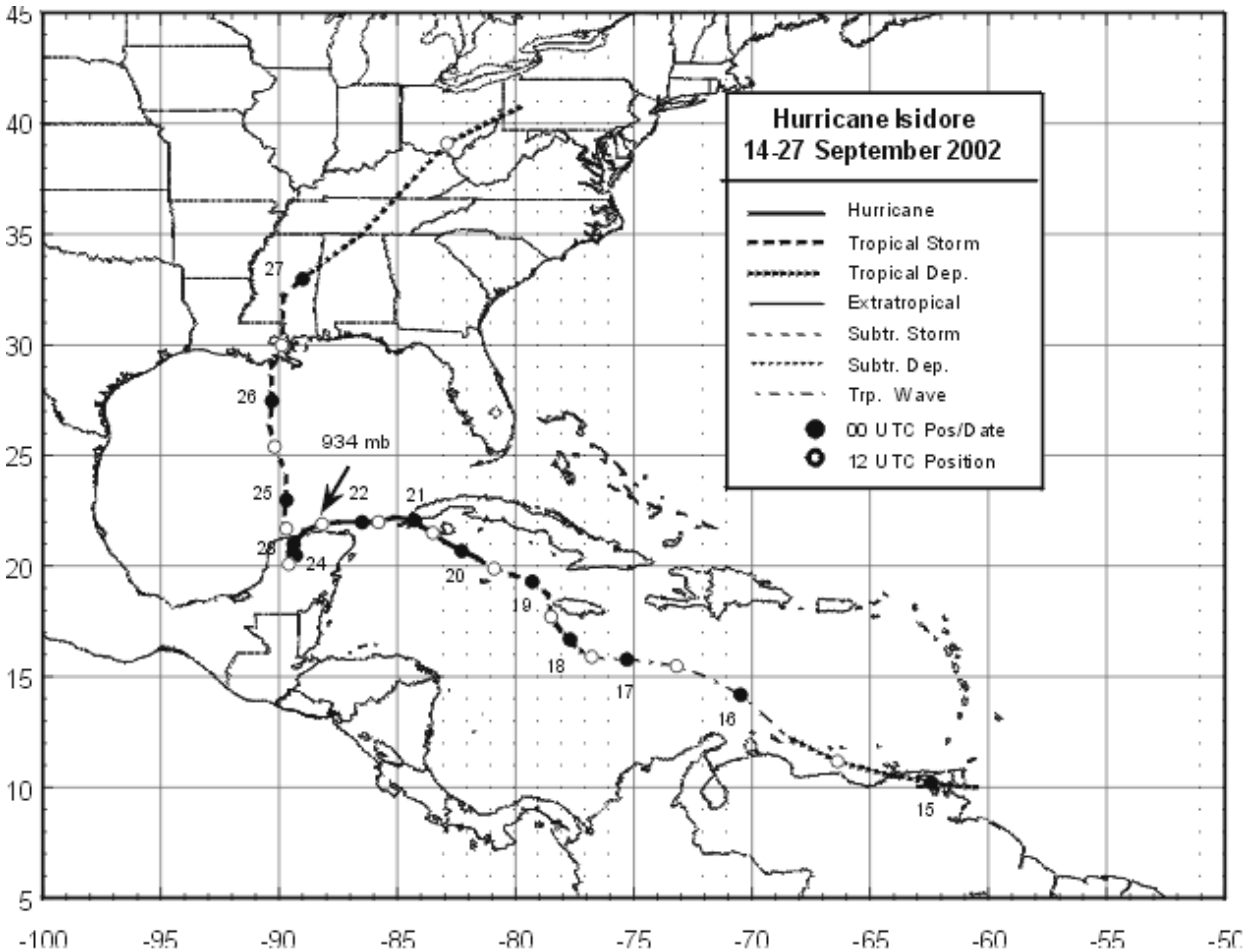
Isidore's Path



NHC [http://www.nhc.noaa.gov/2002isidore.shtml]

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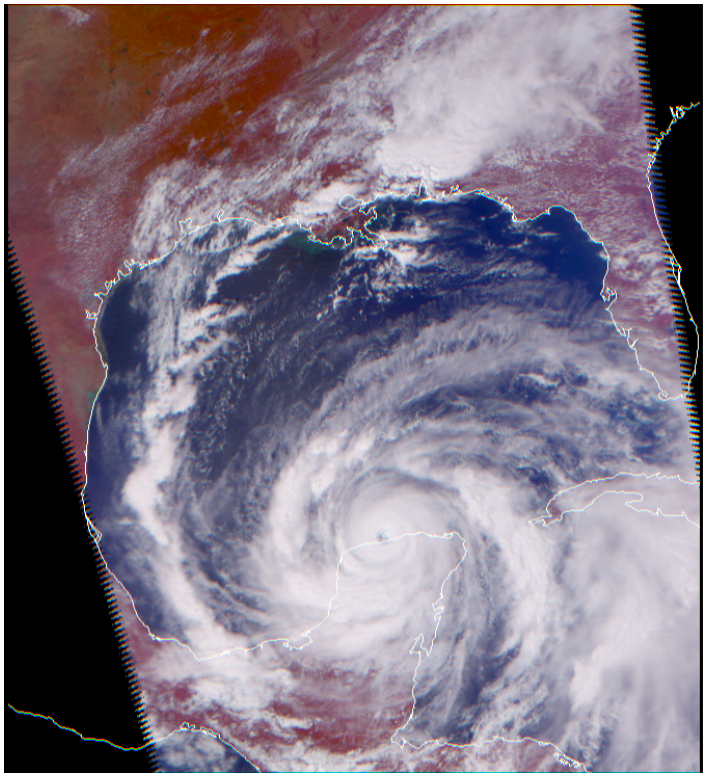
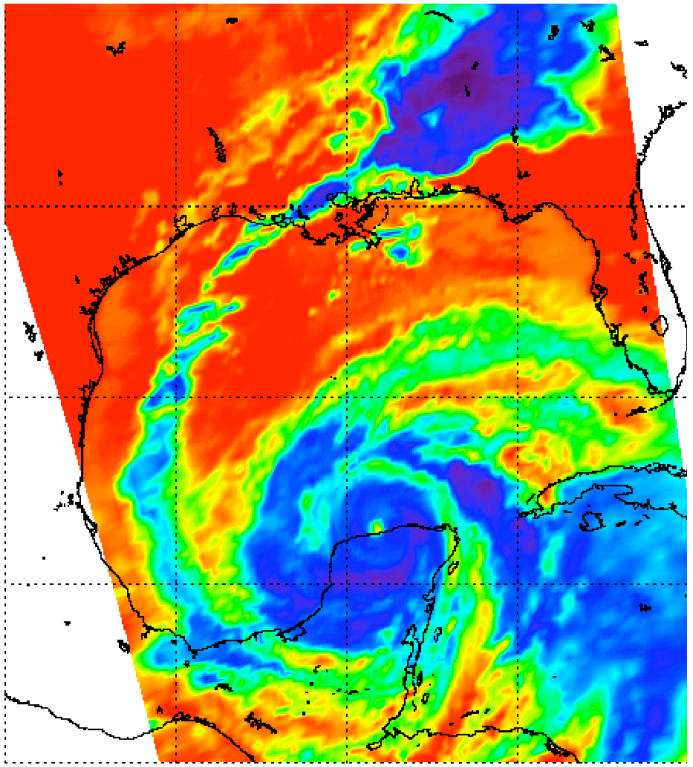
AIRS View of Isidore

September 22

Vis/NIR composite



AIRS 2616 cm^{-1}



JPL [http://www.jpl.nasa.gov/airs/images_data/image_releases/2002/hurricane_isidore.html]

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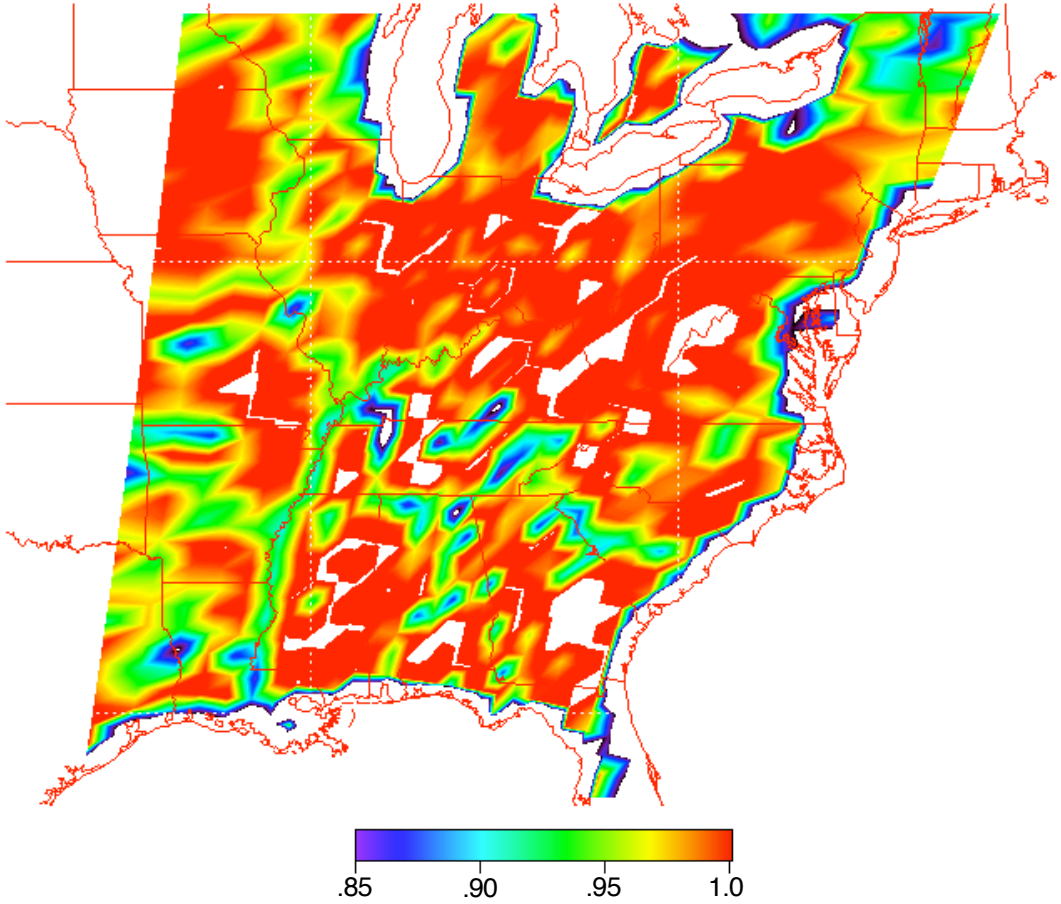
Land Fraction

(30-arcsec DEM surface type convolved with AMSU antenna function)



- Typical land fraction is ~0.93 along large rivers
- This corresponds to 7% water in an AMSU FOV
- AMSU FOV has ~20 km radius @ nadir
- AMSU area is ~1250 km^2
- 7% of that is ~80 km^2
- Equivalent to a ~2 km wide strip of water
- These numbers are not unreasonable

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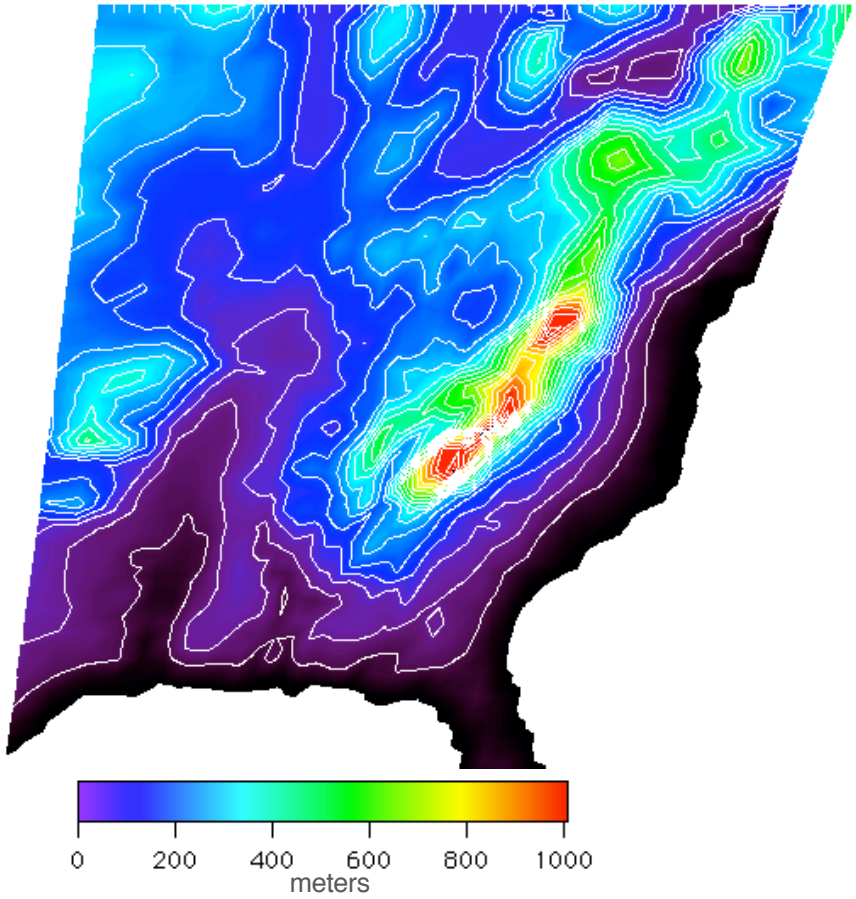
Topography

(30-arcsec DEM elevation convolved with AMSU antenna function)



- This map illustrates how low lying the land in the lower Mississippi Valley is
- That makes the region prone to flooding

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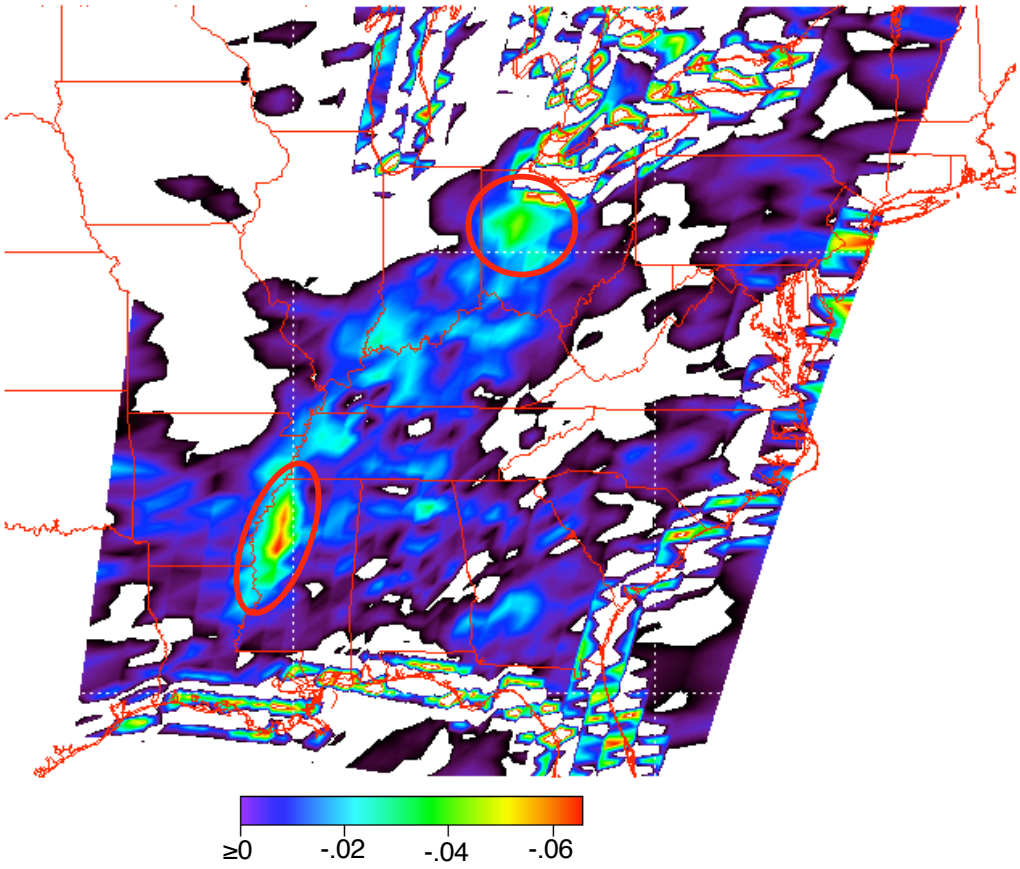
Emissivity Changes

From September 12 to September 28

(Exact-repeat descending passes at 0740 UT over south-central US)

Based on AIRS retrieved MW emissivities



- Only emissivity decrease is shown
- Increases are minor and due to retrieval errors
- Maximum change is 0.065
- Area between Memphis and Vicksburg is severely flooded
- Region around Dayton also appears flooded
- If we attribute all changes to flooding, the fractional area affected is ~0.15 at the max.
- This is ~200 km^2 per FOV ≈ a 5 km wide strip
- The area estimate will be increased by taking into account the vegetation cover

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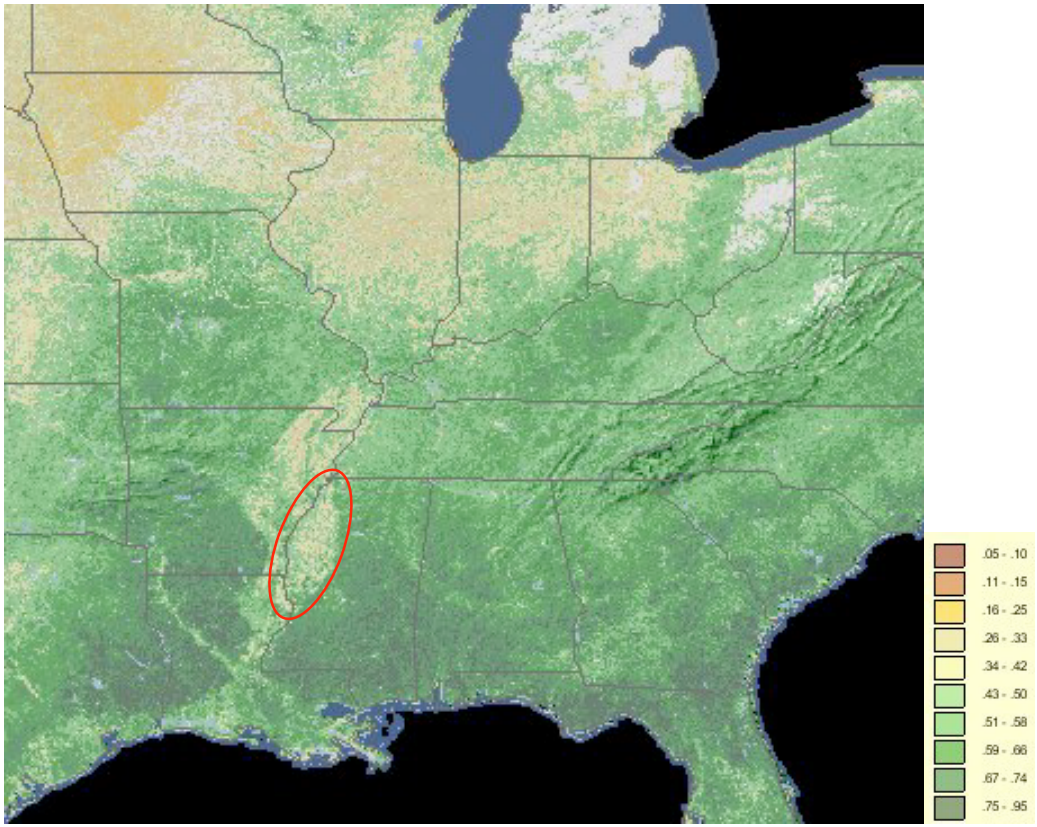
Vegetation Cover



USGS [http://gisdata.usgs.net/website/ivm/viewer.asp]

- This map shows vegetation cover
- The region between Memphis and Vicksburg is mainly cropland and agricultural fields
- Cropland will not mask flooding (forest land will)
- Also, vegetation coverage is less than 0.5
- This “amplifies” the estimated area of flooding by a factor of 2+

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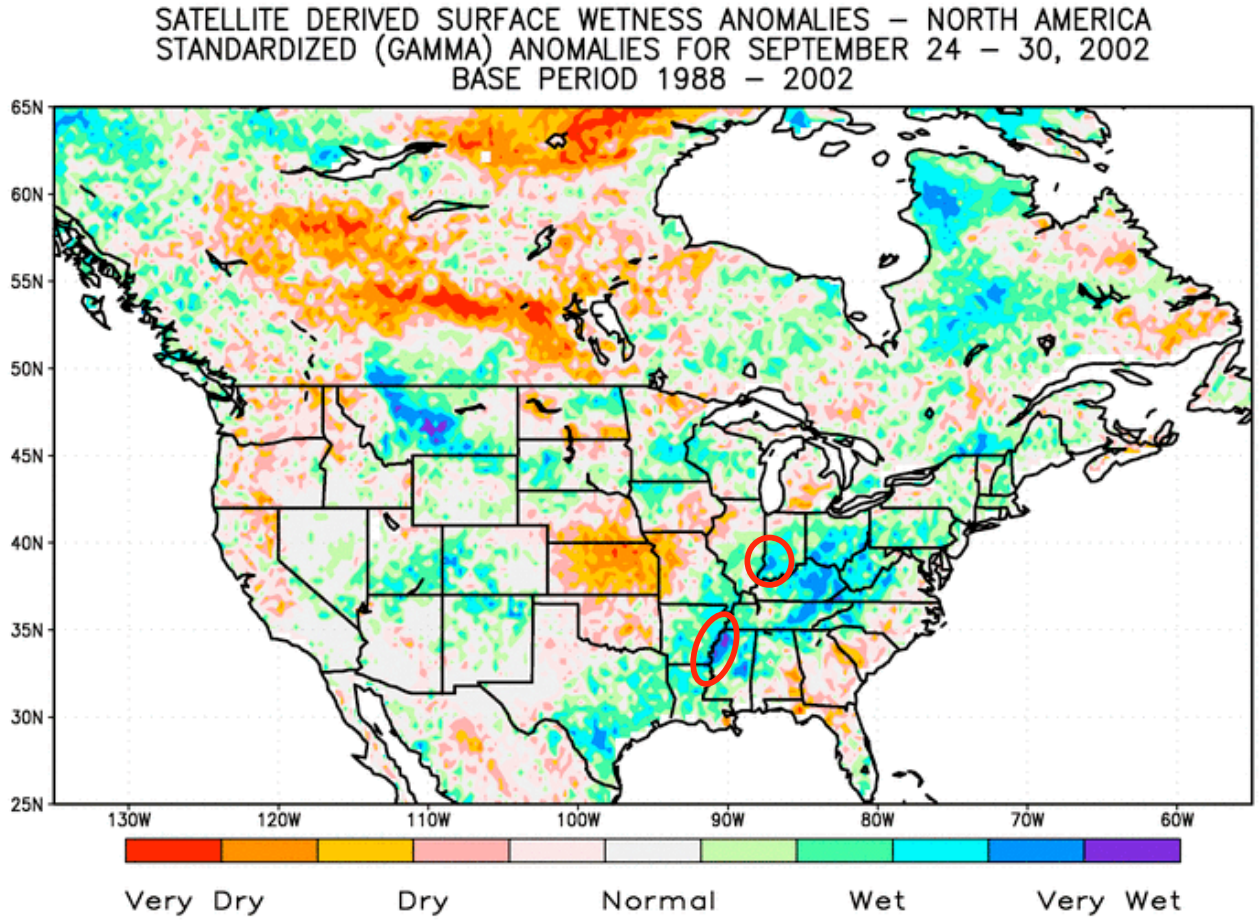
Soil Wetness - 1st Week



NCDC [http://lwf.ncdc.noaa.gov/servlets/SSMIBrowser]

- The period covered by this map spans Isidore's passage through the region
- Soil wetness distribution differs from the distribution of total rainfall (next)

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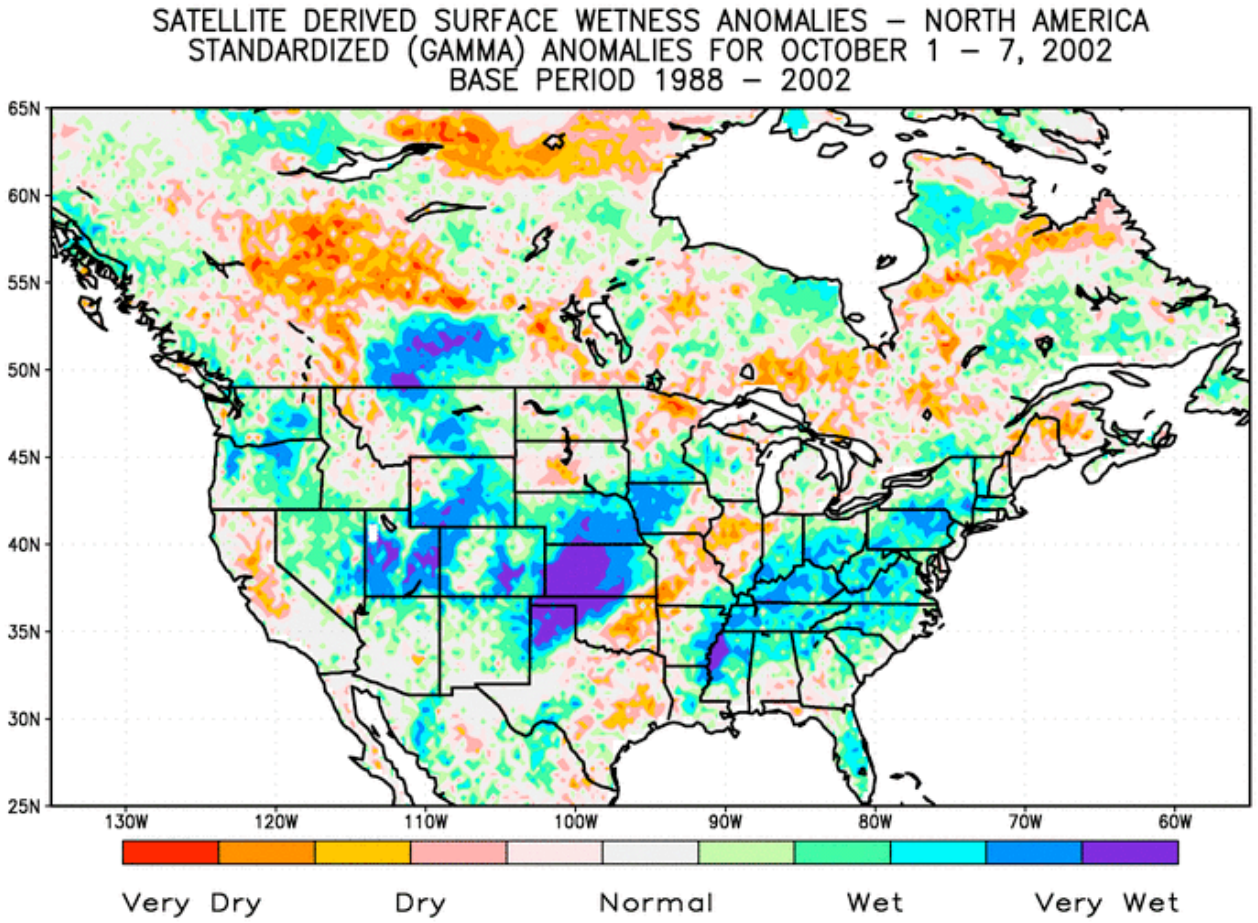
Soil Wetness - 2nd Week



NCDC [http://lwf.ncdc.noaa.gov/servlets/SSMIBrowser]

- The period covered by this map spans Lili's passage through the region
- It followed a path nearly identical to Isidore's

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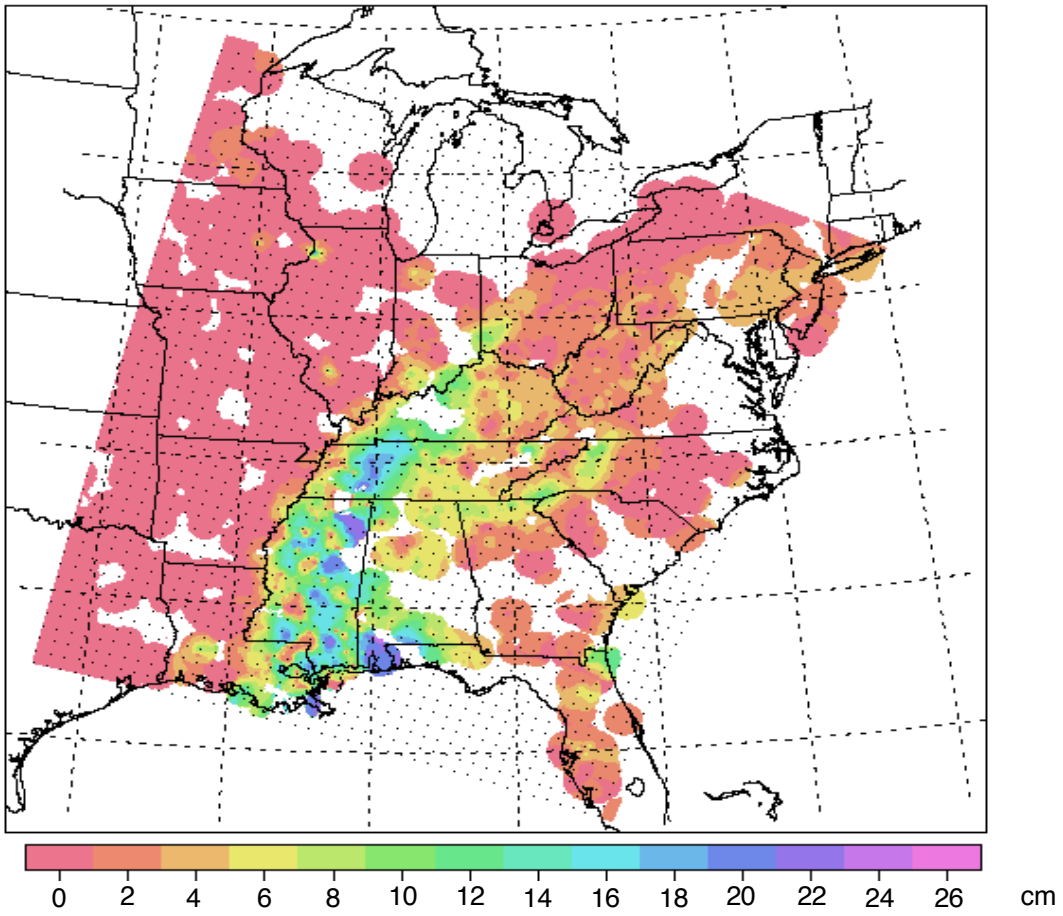
Total Rainfall

September 24-27



NCEP/UCAR [http://www.joss.ucar.edu/cgi-bin//codiac/dss?21.006]

- This map shows observations with rain gauges only
- Most of the precipitation was east of the Mississippi
- It correlates well with the path of Isidore
- Soil wetness and flooding, on the other hand, are concentrated in the low lying drainage basins

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Conclusion

- **The method is promising**
  - Preliminary results show strong correlation with ground truth
  - Accuracy can be improved substantially
  - Can be applied in near real time using direct broadcast data
- **Next steps**
  - Use vegetation index to refine areal fraction estimates
  - Derive emissivity independently from observations
    - Atmospheric corrections from forecast or retrieved fields
    - Surface temperature from forecast or retrievals
  - Use AMSR-E and SSM/I observations
    - Dual polarizations: easier to distinguish between wet soil and floodwater
    - Higher spatial resolution