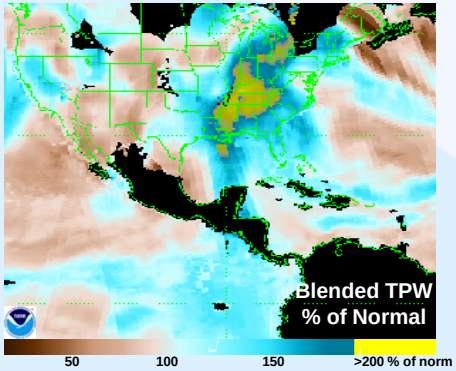
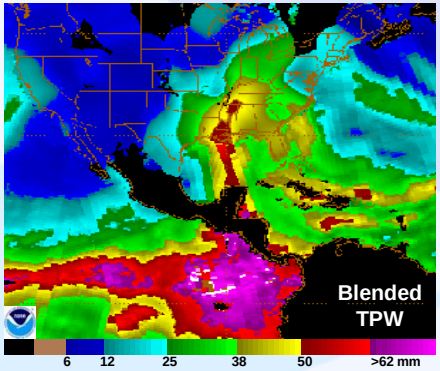
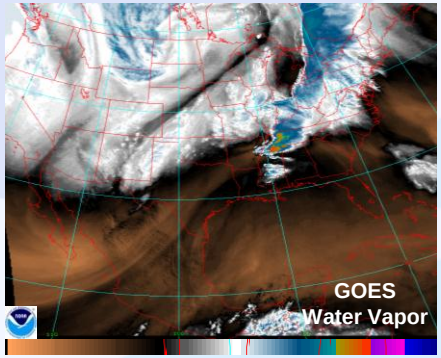
The Tennessee Floods of May 2010: A Satellite Perspective

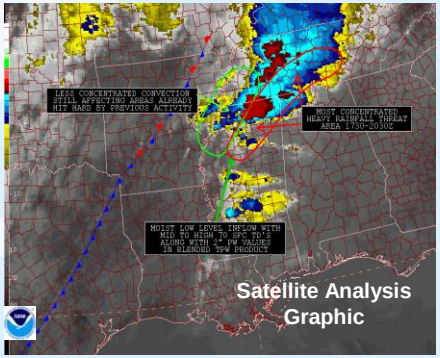
Sheldon Kusselson
NOAA/NESDIS/OSPO/Satellite Products and Services Division
Camp Springs, Maryland

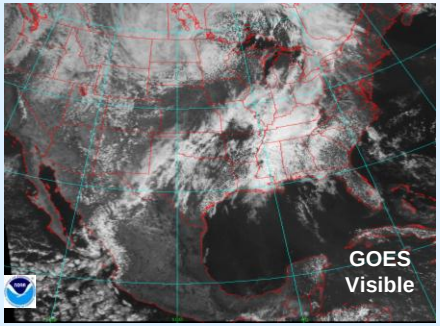
Limin Zhao, Robert Kuligowski, NOAA/NESDIS
Stanley Kidder, John Forsythe, Andrew Jones, CIRA / Colorado State University

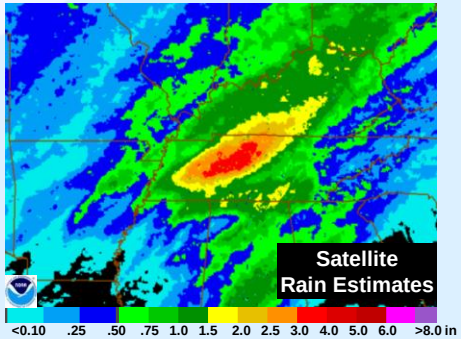












36th National Weather Association Annual Meeting
20 Oct 2011 / Birmingham, Alabama

NOAA Satellite and Information Service
National Environmental Satellite, Data and Information Service (NESDIS)

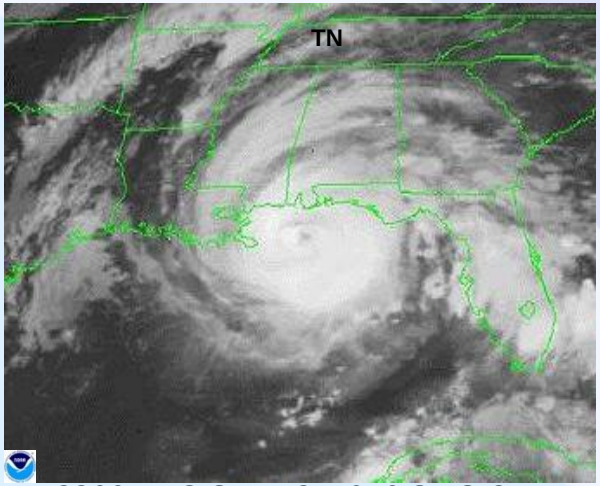
Colorado State University CIRA

ftp://satepsanone.nesdis.noaa.gov/Presentations/Conferences/Kusselson_nwa_gucjointsession_nesdis_spsd.ppt

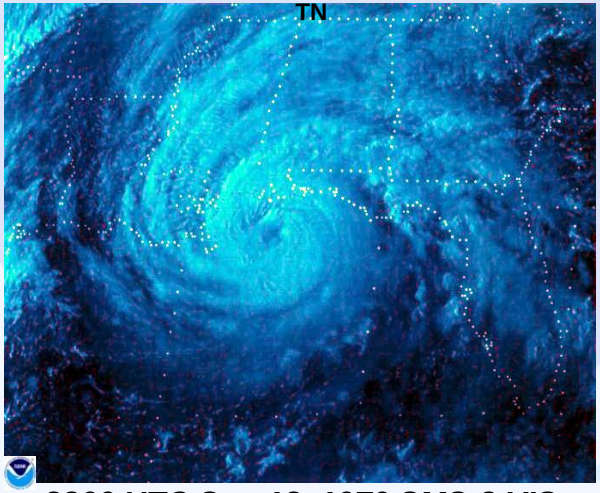
Historical Comparison With Extreme Rainfall Storm of the Past

Before May 1, 2010 for Nashville, Tennessee

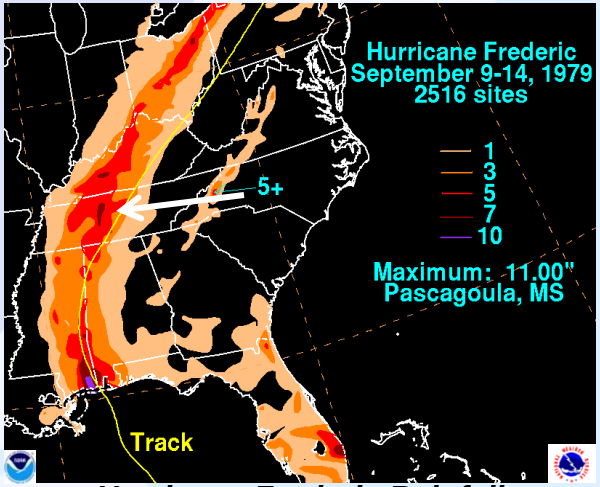
largest calendar day = ***6.60" on Sep 13 1979*** & 2-day total = ***6.68" Sep 13-14, 1979*** with ***Frederic***



2300 UTC Sep 12, 1979 SMS-2 IR



2200 UTC Sep 12, 1979 SMS-2 VIS

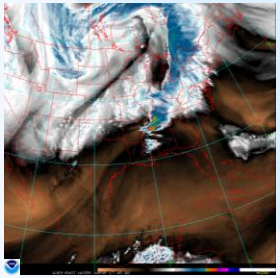


Hurricane Frederic Rainfall

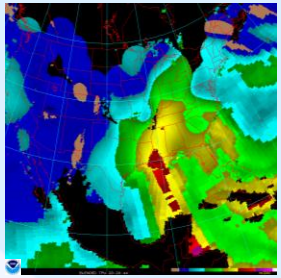
Just after the early May, 2010 extreme heavy rain event ended:

- ***May 2, 2010 now largest calendar day = 7.21"; May 1 was 3rd = 6.32"***
- ***May 1-2 total of 13.53" was double the Frederic total of 6.68"***

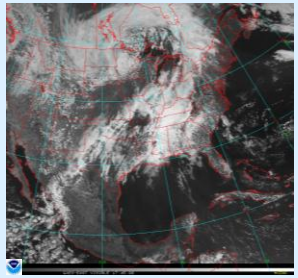
GOES WV



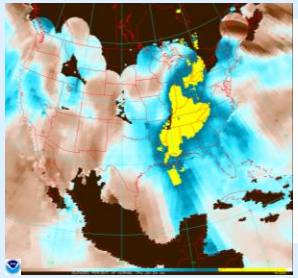
TPW



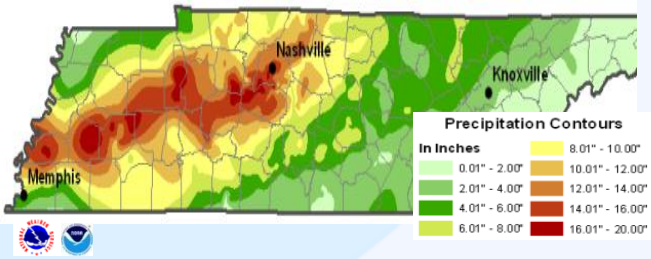
GOES VIS



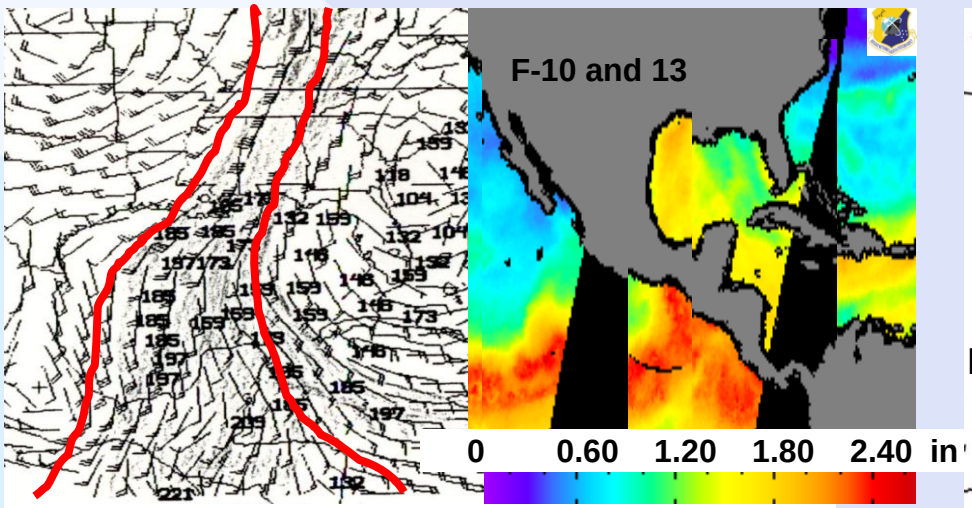
% of normal TPW



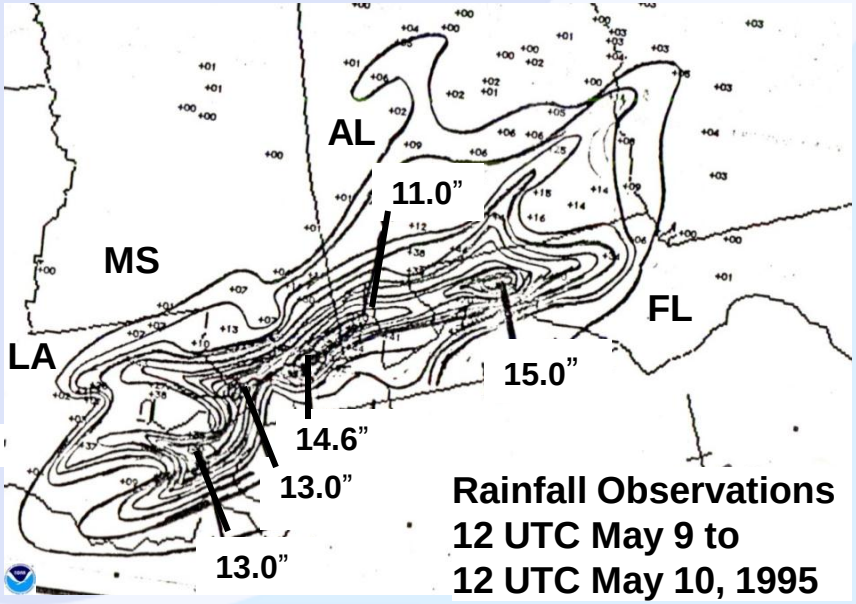
May 1-2, 2010 rainfall totals



Comparison Between May 1995 and May 2010 Total Precipitable Water and their Resultant Heavy Rain / Flash Flood Events



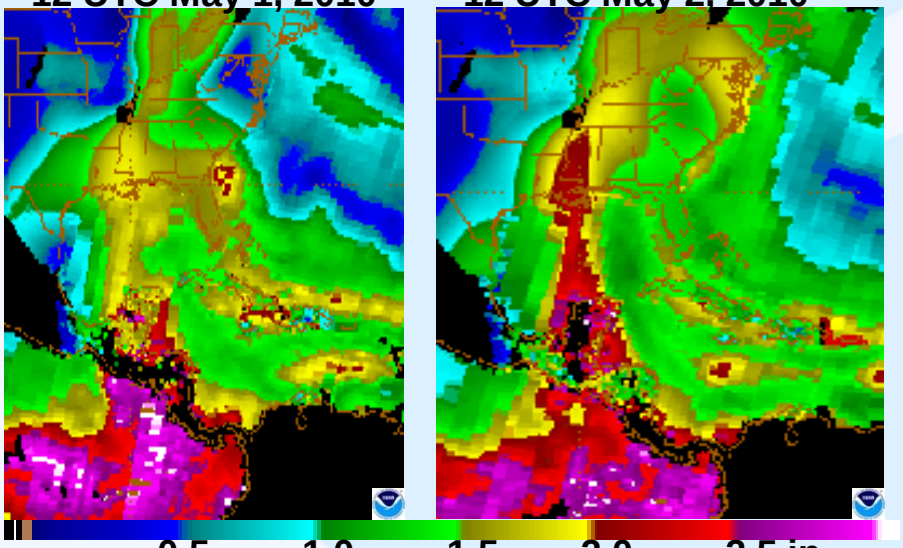
DMSP SSM/I TPW with 850mb Winds for 12 UTC May 9, 1995



Rainfall Observations 12 UTC May 9 to 12 UTC May 10, 1995

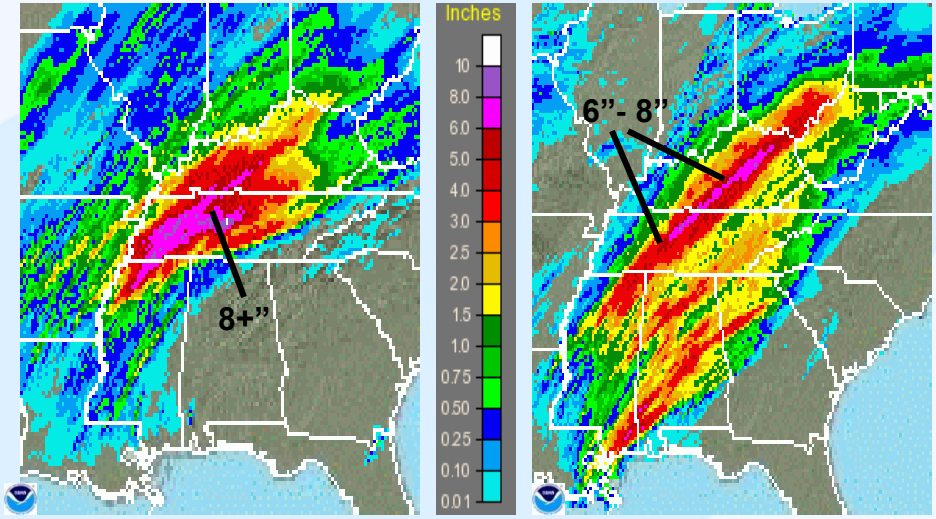
Blended Total Precipitable Water (TPW)

12 UTC May 1, 2010 **12 UTC May 2, 2010**



0.5 1.0 1.5 2.0 2.5 in

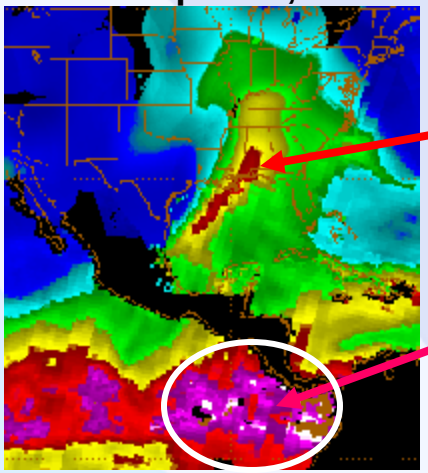
Rainfall Observations



24h ending 12 UTC May 2 **24h ending 12 UTC May 3**

Blended Total Precipitable Water (TPW) images leading to heavy rain event

18 utc April 24, 2010



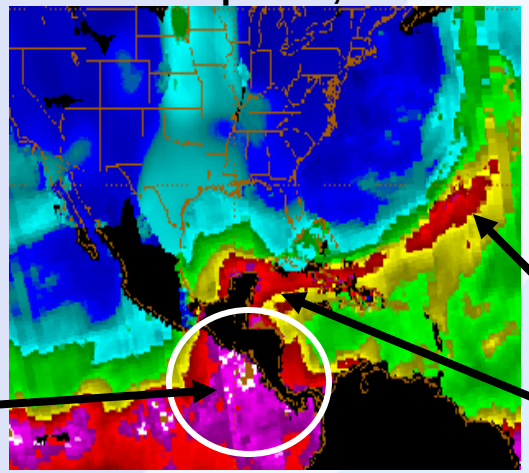
~ one week before

previous weekend's frontal moisture

very high moisture for time of year

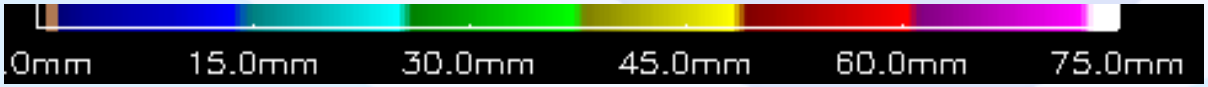
4.5 days later

06 utc April 29, 2010

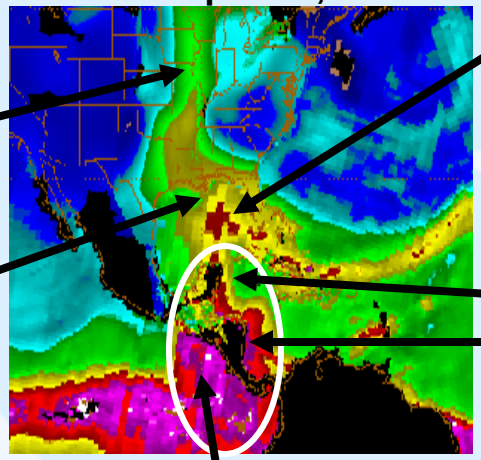


very high moisture for time of year continues

frontal moisture settles east and south



18 utc April 30, 2010



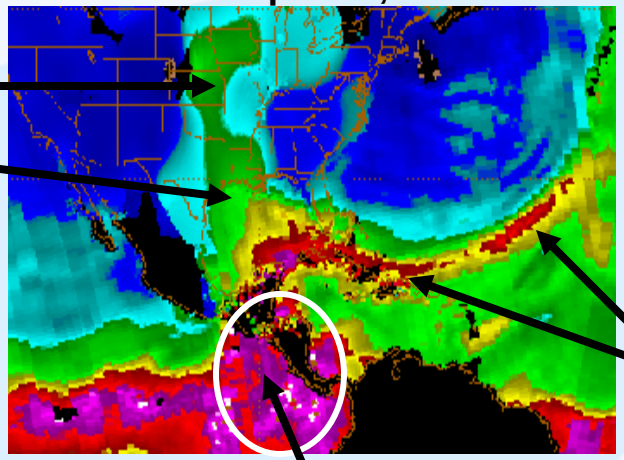
Frontal moisture now well established with return Gulf of Mexico moisture

old frontal moisture lifting north

moisture connection to East Pacific becoming established

very high moisture continues; NESDIS/SAB watching area for weak tropical-like disturbance

06 utc April 30, 2010



frontal moisture from west with return Gulf of Mexico moisture

~ one day before

remains of old frontal moisture

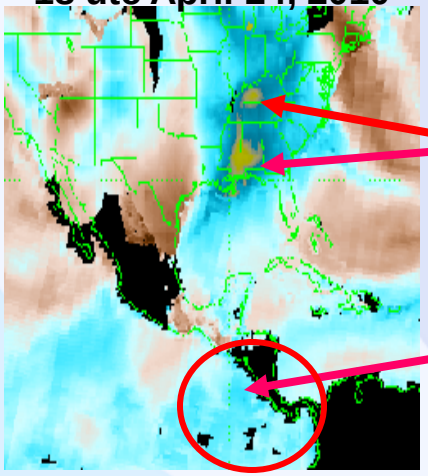
continuing very high moisture

http://www.osdpd.noaa.gov/bTPW

NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)

Blended TPW Percent of Normal images leading to heavy rain event

18 utc April 24, 2010



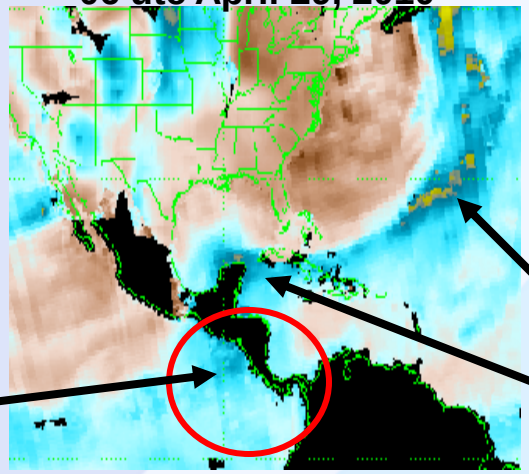
~ one week before

Previous weekend's above normal frontal moisture

above normal moisture for time of year

4.5 days later

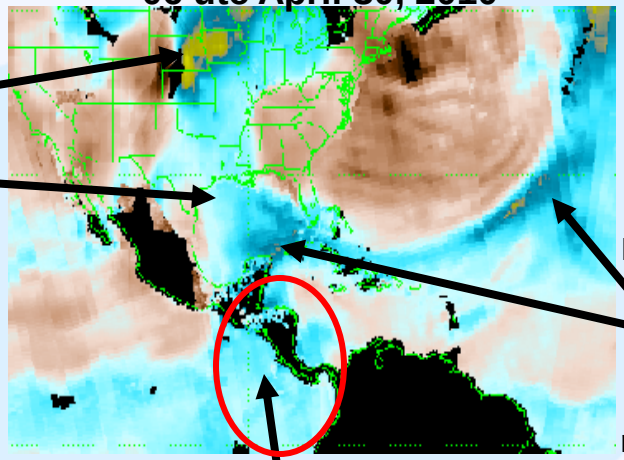
06 utc April 29, 2010



above normal moisture for time of year continues

above normal frontal moisture settles east and south

06 utc April 30, 2010



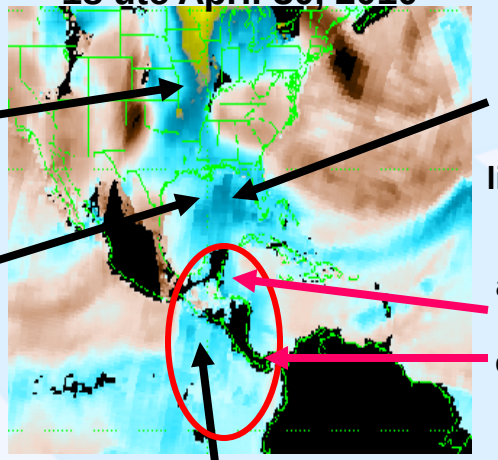
~ one day before

above normal frontal moisture from west with return Gulf of Mexico moisture

Remains of old above normal frontal moisture

continuing above normal moisture

18 utc April 30, 2010



above normal frontal moisture now well established with return Gulf of Mexico moisture

old above normal frontal moisture lifting north

above normal moisture connection to East Pacific

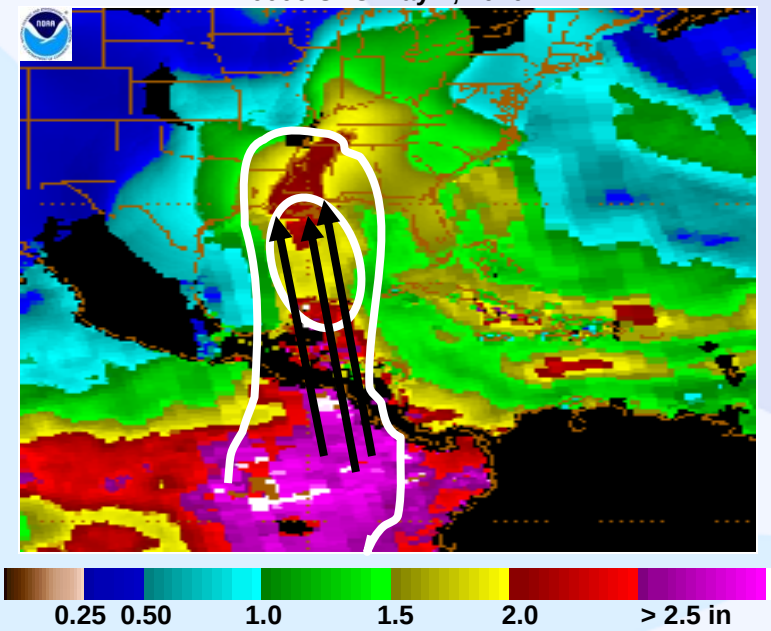
above normal moisture continues; NESDIS/SAB watching area for weak tropical-like disturbance

http://www.osdpd.noaa.gov/bTPW

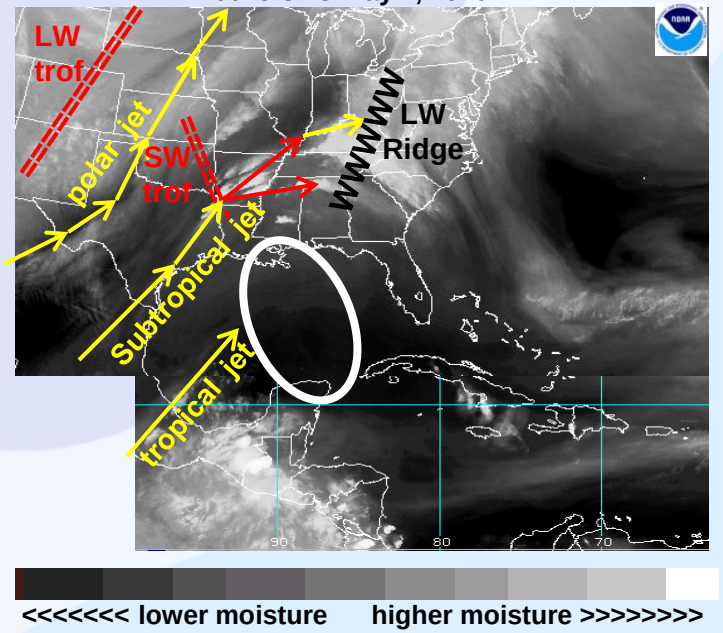
Blended Total Precipitable Water (TPW) and Geostationary 6.7μ Water Vapor (WV)

Compare and Contrast; Complement and Supplement

0000 UTC May 2, 2010



0015 UTC May 2, 2010



Total Precipitable Water

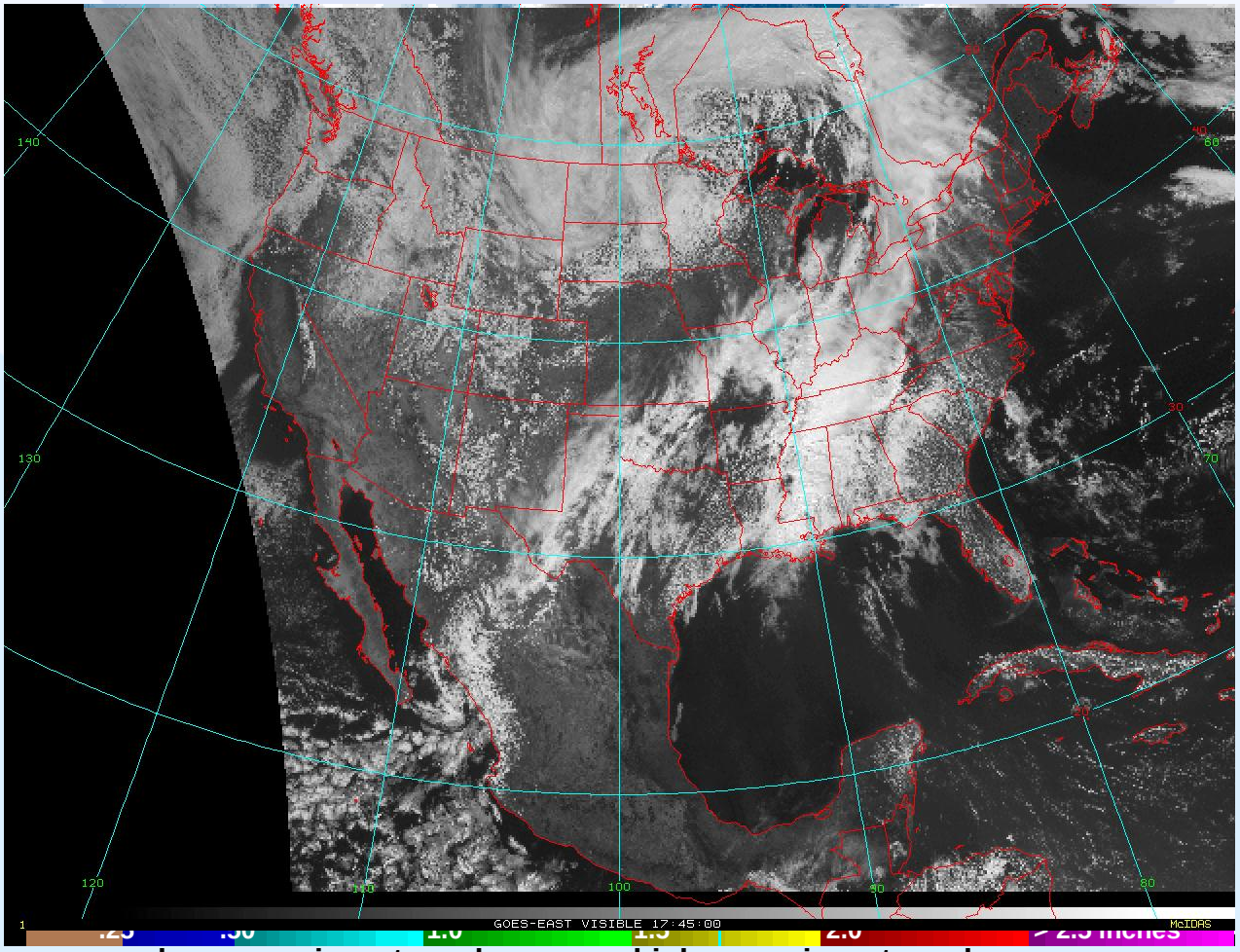
- **Total moisture**
- **Senses low level moisture**
- **Identifying moisture plumes**
- **Low level moisture transport**

Geostationary 6.7μ WV

- Moisture 12000-25000 ft
- Senses mid/high level moisture
- Identifying jets, trofs, short waves, diffluence
- Mid to high level moisture transport

Analysing different types of satellite data and products

GOES visible ***GOES GPW water vapor*** ***midday of May 1, 2010***

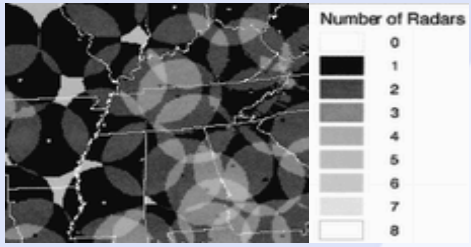


<<<<<<<lower precip water values higher precip water values>>>>>>>>>>

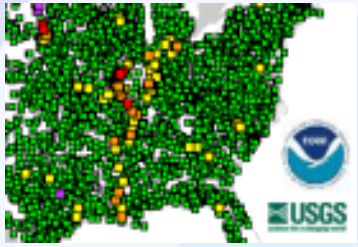
providing information to forecasters to help in the heavy precipitation/flash flood decision process

Satellite Rainfall Estimates

+ *Supplement rain gauge and radar observations*
+ *Inclusion in multi-sensor precip estimate product*
+ *Help in areas of radar outages*
+ *Help in areas on the edge of radar*
+ *Help in mountainous/sparse observation areas*
+ *Help in areas of radar algorithm difficulties*

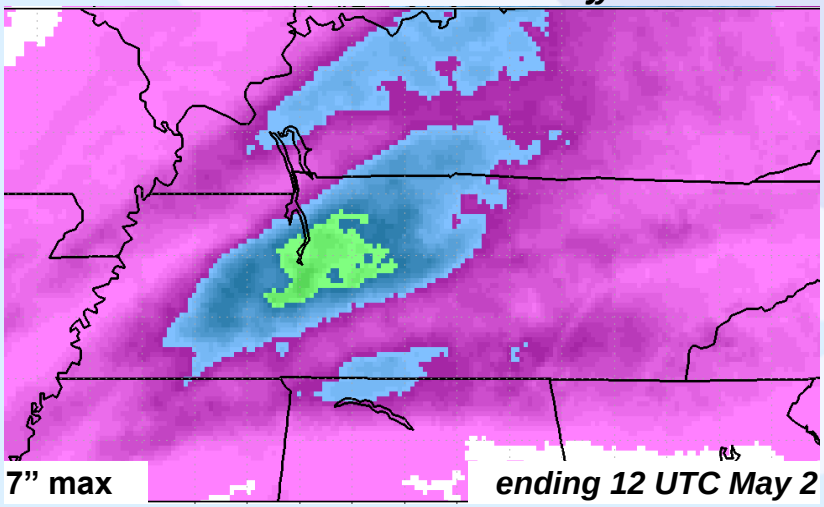


Radar coverage
3km abv ground



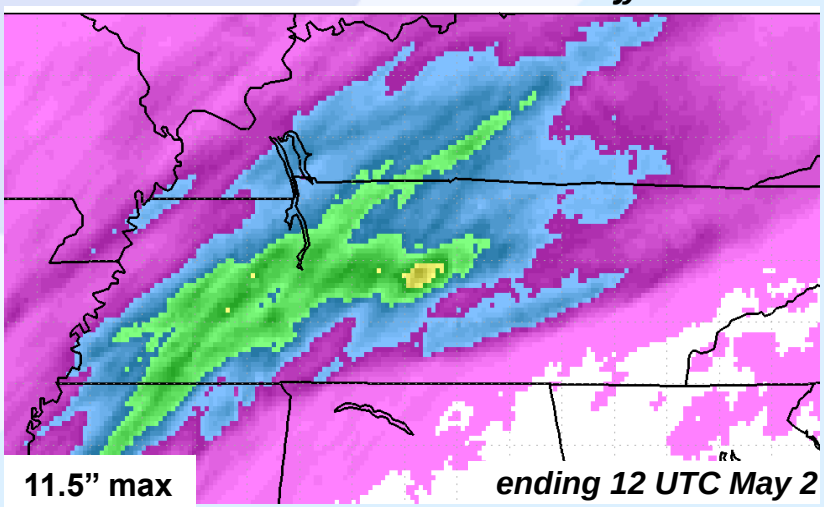
Rain guage coverage

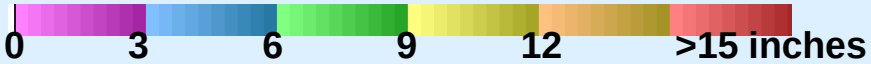
Satellite Rain Estimates -- 2 day totals



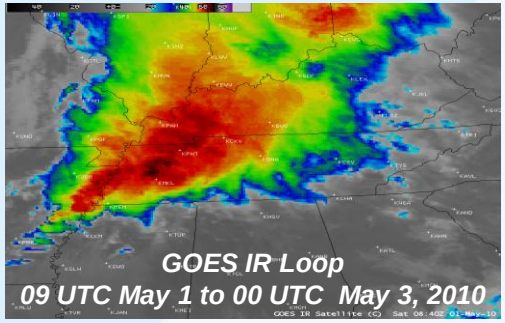
Google: osdpd rain estimates

Multi-sensor Rain Amounts -- 2 day totals





Satellite Rain Estimates were too low,
BUT were better with the locations of the max amounts

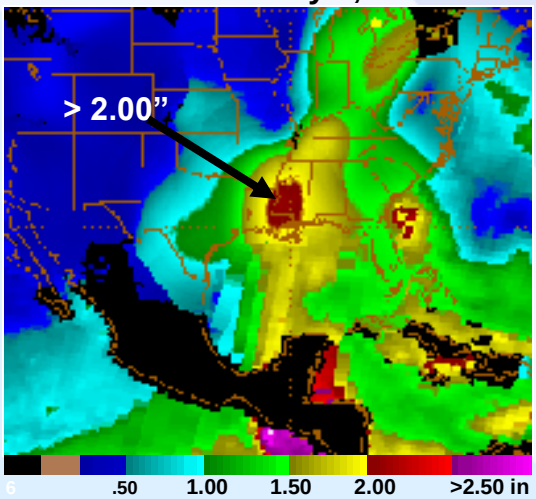


Satellite Imagery to Complement / Supplement NCEP Real-time Standardized Anomalies

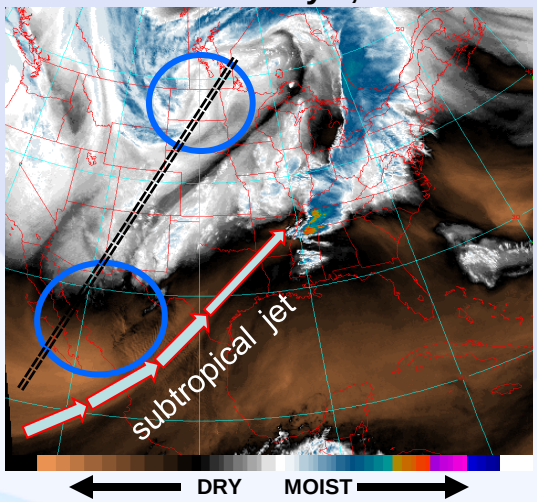
Google: ***OSDPD Satellite Imagery***

Google: HPC ***Anomalies***

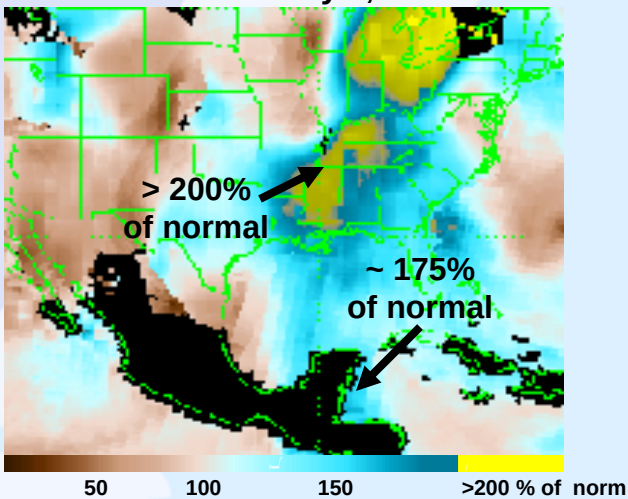
Blended Total Precip Water (TPW)
1215 UTC May 1, 2010

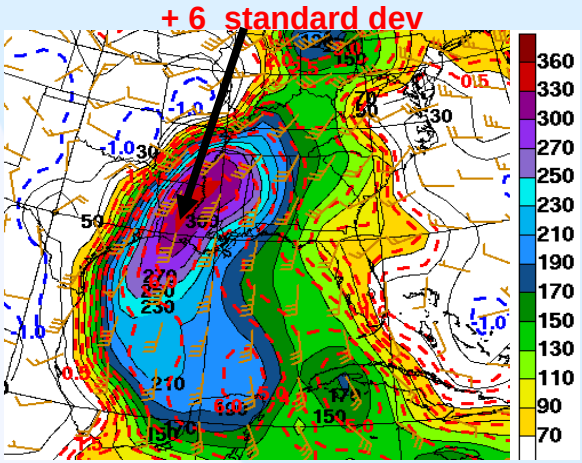


GOES Water Vapor
1215 UTC May 1, 2010

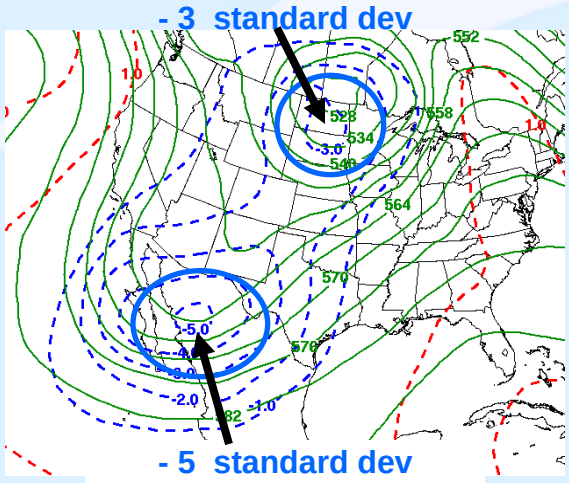


Blended TPW Percent of Normal
1215 UTC May 1, 2010

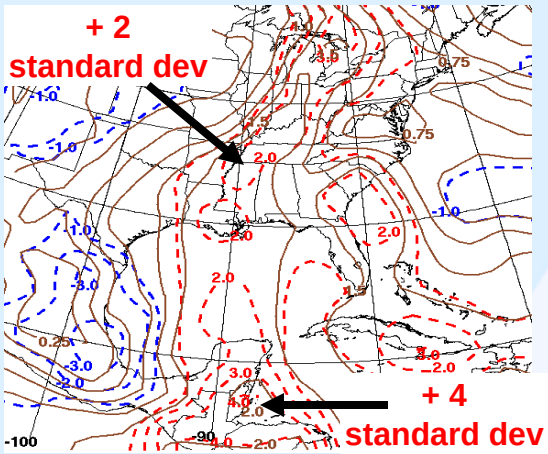




GFS 850mb Moist Flux Anomalies
Initial Vt 12 UTC May 1, 2010



GFS 500mb Height Anomalies
Initial Vt 12 UTC May 1, 2010



GFS Precip Water Anomalies
Initial Vt 12 UTC May 1, 2010

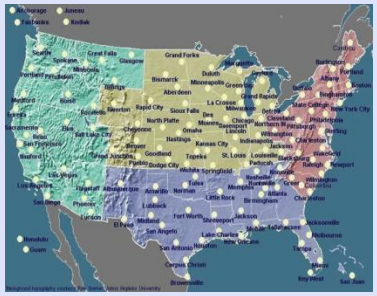
NOAA's Satellite Precipitation Program

Google:SSD Precip

24/7/365 monitoring of precipitation with emphasis on satellite analysis and short term trends

Supporting NWS WFOs/RFCs

- **up to 6h before heavy rainfall / flash flooding expected**
- **every 3 hours during heavy rain and flooding events**

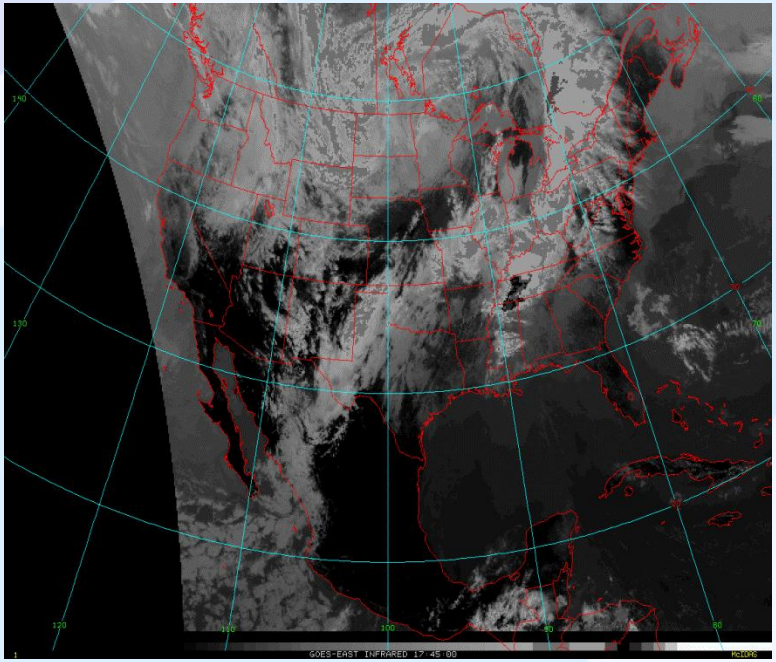


satellite discussion messages	**18**	IM chat messages
Satellite graphical analysis	**22**	satellite rainfall estimates

Satellite Discussion Messages (SPENES)

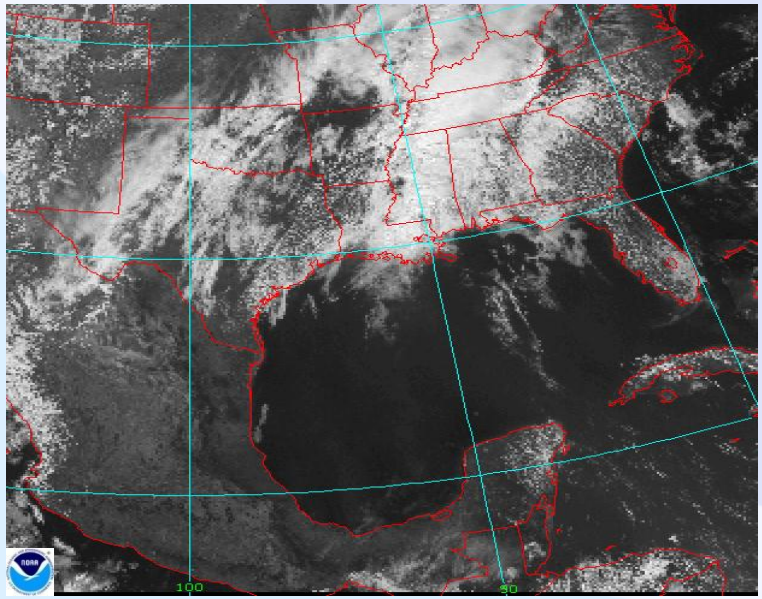
SATELLITE ANALYSIS BRANCH/NESDIS---NPPU---TEL 301-763-8678
LATEST DATA USED: GOES-EAST: 1745Z JS
VISIBLE IMAGERY ALONG WITH SFC AND PROFILER DATA SHOW
THAT IT IS LIKELY THAT MORE ACTIVITY WILL DEVELOP FARTHER
TO THE WEST ACROSS PORTIONS OF ARKANSAS AND WESTERN
MISSISSIPPI LATER THIS AFTERNOON/EVENING WHICH WILL IN
TURN MOVE BACK OVER SPOTS OF E AR/N MS/W TN WHICH HAVE
ALREADY BEEN WITH THE MOST INTENSE CELLS WITHIN
THIS AREA. MANUAL ADJUSTMENT TO AUTOMATED
STREAMING NORTHWARD AHEAD OF WELL DEFINED SFC
BOUNDARY ESTIMATED LOCATION SEEN ACROSS THE MORE
IMMEDIATE SHORT TERM (NEXT 1-2 HOURS). SFC/PROFILER DATA
SHOWS S AND SW LOW LEVEL INFLOW CONTINUING TO OVERRIDE
STRETCHING FROM E AR OVER N MS TO W TN WHICH WILL LEAD
TO A CONTINUATION OF NEW CELL DEVELOPMENT AND TRAINING
ACROSS PARTS OF E AR/N MS/W AND CENT TN WITH FLOOD THREAT
ALSO EXPANDING EASTWARD TO INCLUDE CENT TN.

Satellite Analysis Graphic

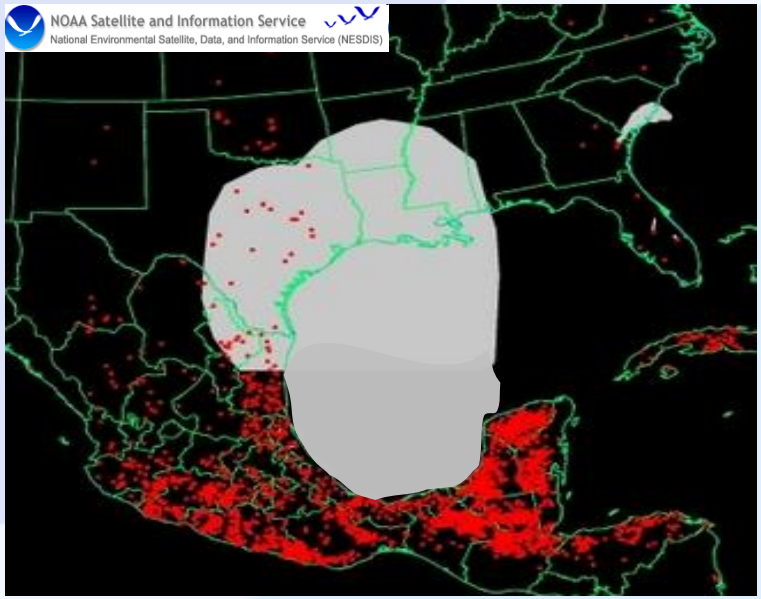


Smoke as an inhibitor of Heavy Rainfall?

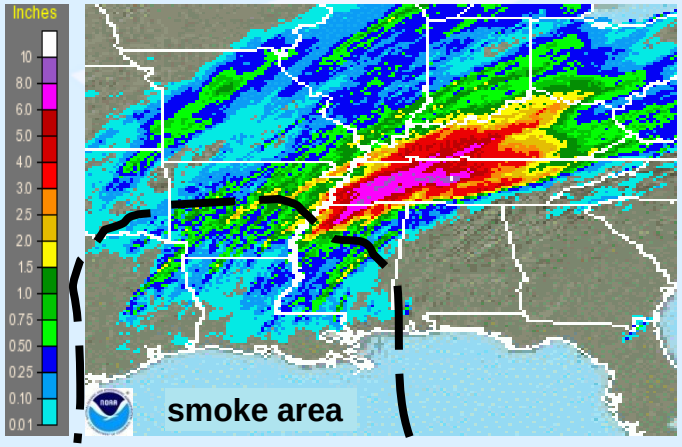
GOES Visible Image at 1745 UTC May 1, 2010



Daily NOAA/NESDIS Fire and Smoke Product for May 1, 2010



Google: NESDIS Fire and Smoke

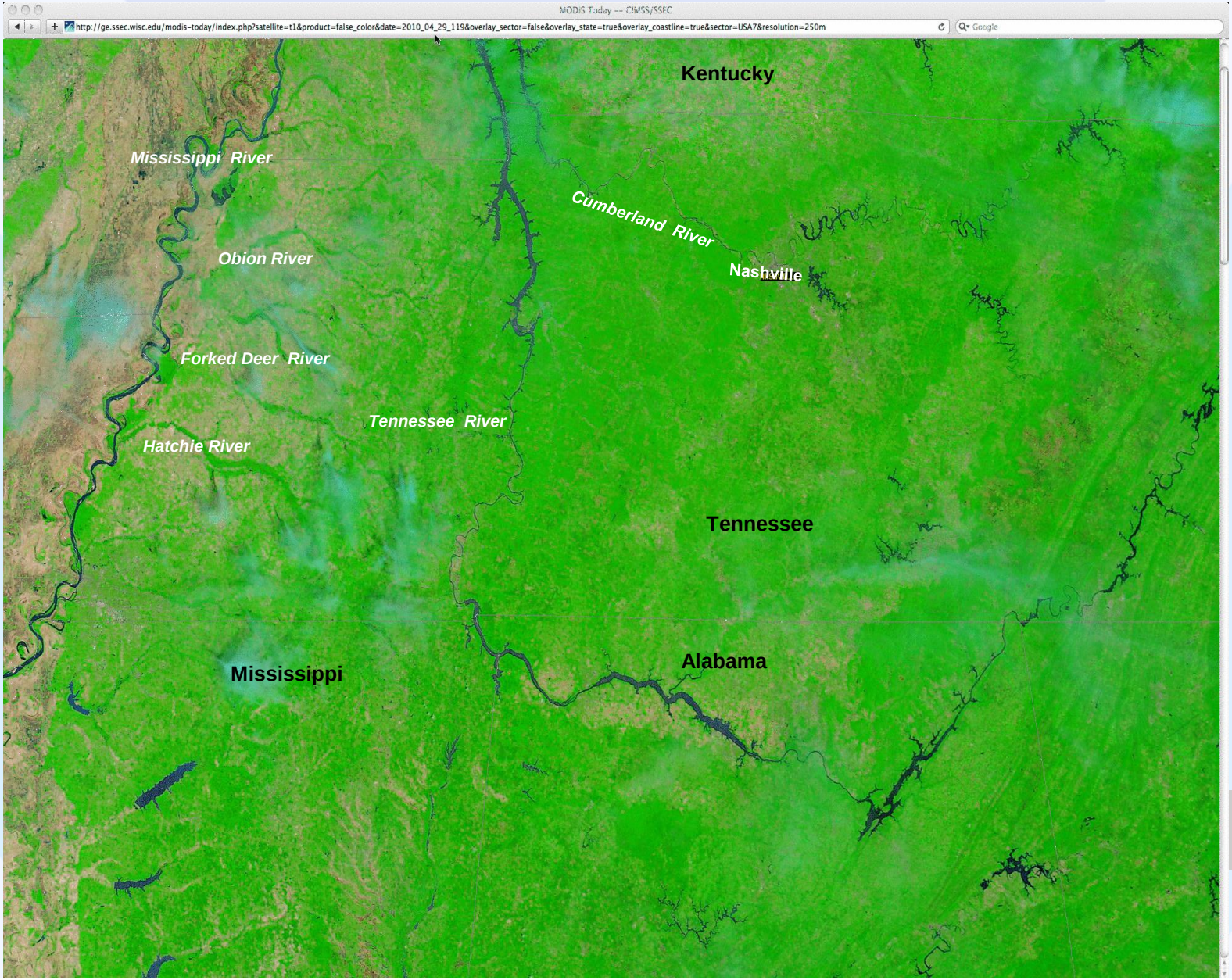


Observed rainfall 12utc May 1 to 12utc May 2, 2010

"...heavy smoke inhibits cloud formation and reduces rainfall."

- Dr. Daniel Rosenfeld and NASA 1999

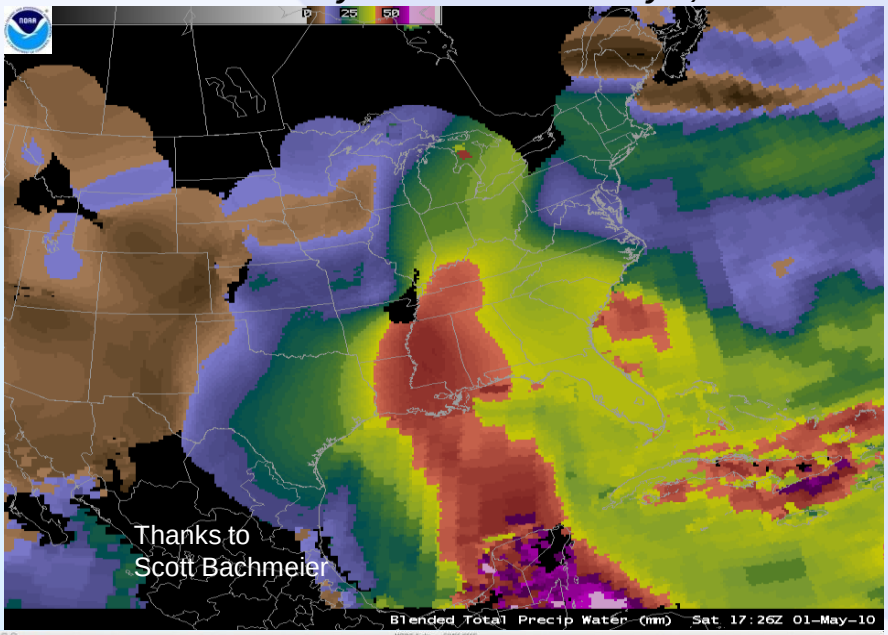
Dramatic Changes in some small rivers from the High Resolution MODIS Imagery



MODIS 250-Meter Resolution False Color Image Comparison of Before (April 29) and After (May 3, 2010)

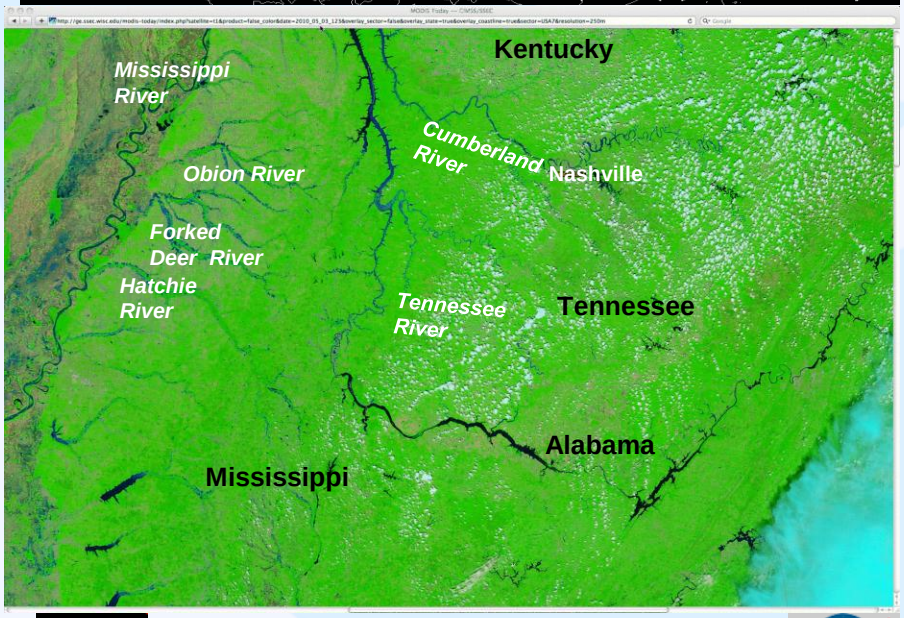
contact: Sheldon.Kusselson@noaa.gov

Blended TPW loop
1726 UTC May 1 to 0049 UTC May 3, 2010

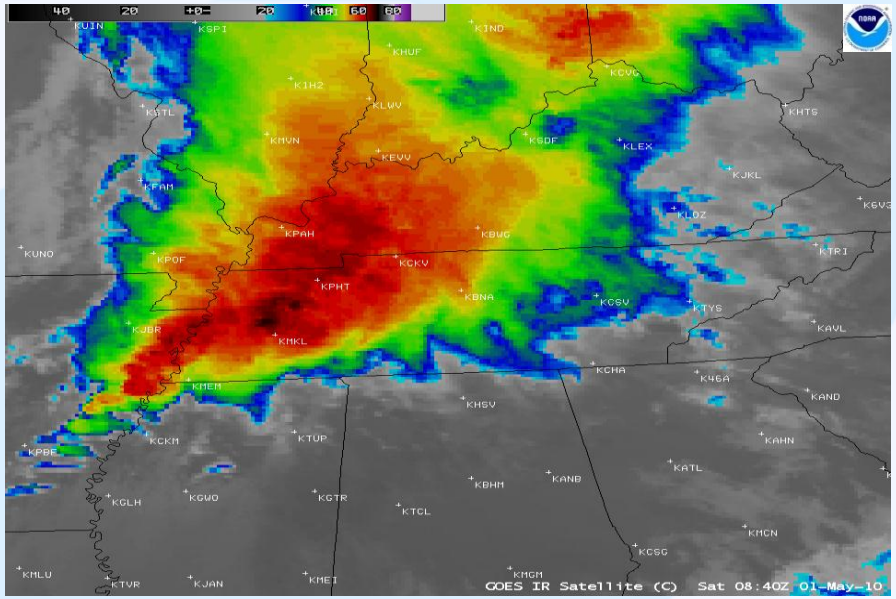


Thank you for your attention

Any questions?



MODIS May 3, 2010



GOES IR
09 utc May 1 to 00 utc May 3, 2010