Using the Operational and the Experimental NLDAS Monitoring Systems to Investigate the Impact of Hurricane Harvey and Irma on Flooding

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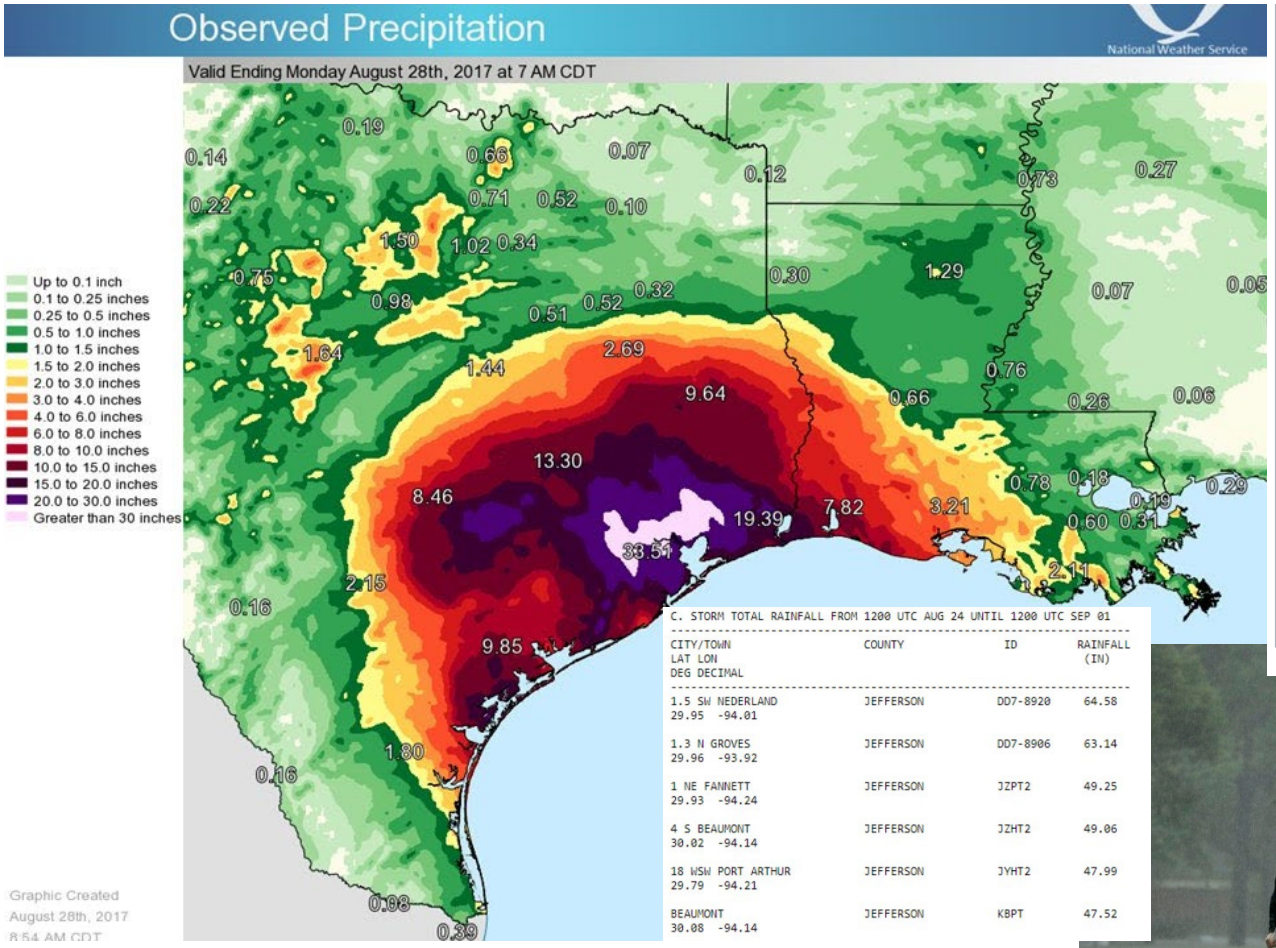
(Allison McLemore)

Hurricane Harvey

https://en.wikipedia.org/wiki/Hurricane_Harvey



Hurricane Harvey at peak intensity, prior to landfall in southern Texas on August 25

Formed	August 17, 2017
Dissipated	September 3, 2017 (Extratropical after September 1)
Highest winds	*1-minute sustained*: 130 mph (215 km/h)
Lowest pressure	938 mbar (hP
Fatalities	83 confirmed
Damage	≥ $70 billion (2017 USD) (Preliminary total; unofficially third-costliest tropical cyclone in U.S. history)
Areas affected	Windward Islands, Suriname, Guyana, Nicaragua, Honduras, Belize, Yucatán Peninsula, Southern and Eastern United States (especially Texas, Louisiana)

Tropical cyclone sc

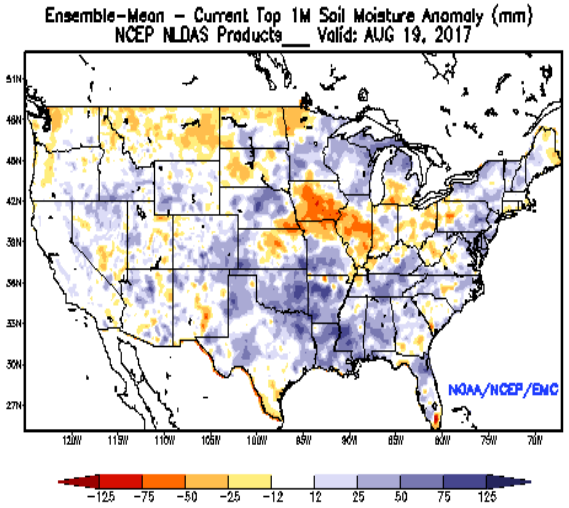
Part of the **2017 Atlantic hurricane season**

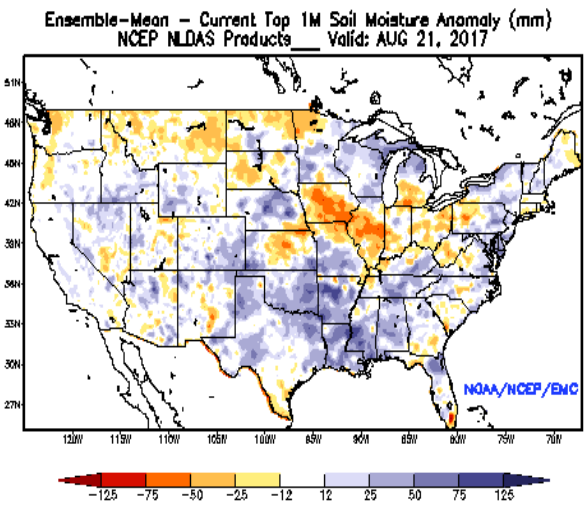
Maximum rainfall for a 4-day period > 1000 mm

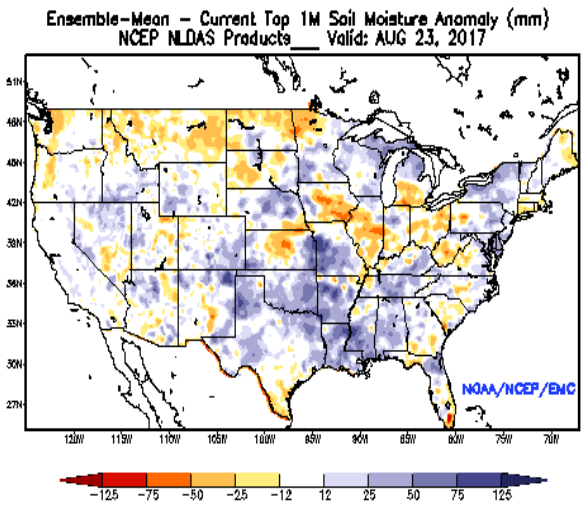
Wettest tropical hurricane brought heavy Rain and caused catastrophic flooding

Soil moisture condition before Harvey landing (operational NLDAS)

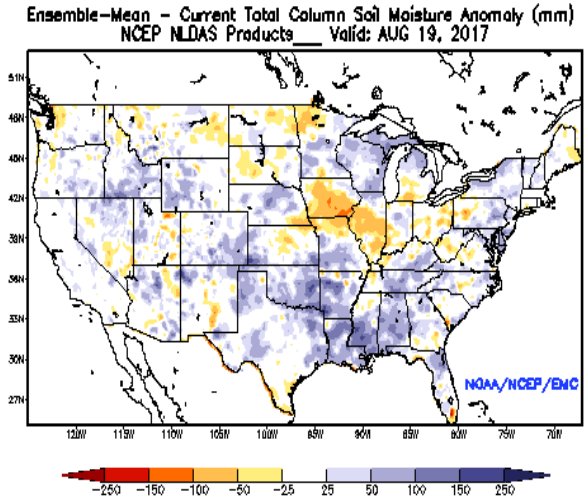
Top 1m soil moisture anomaly

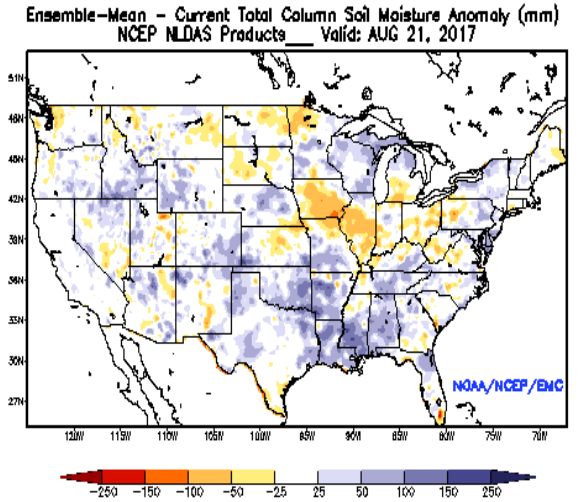


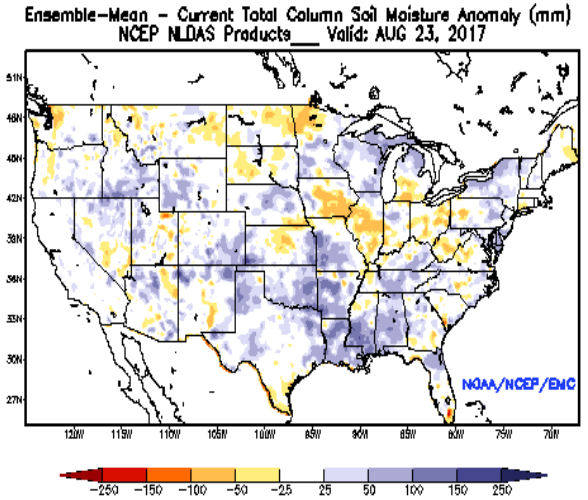




Total column soil moisture anomaly

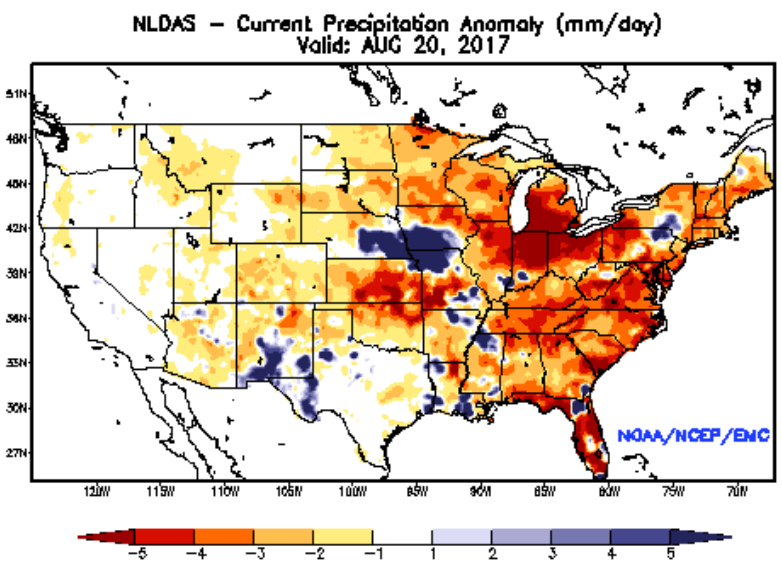




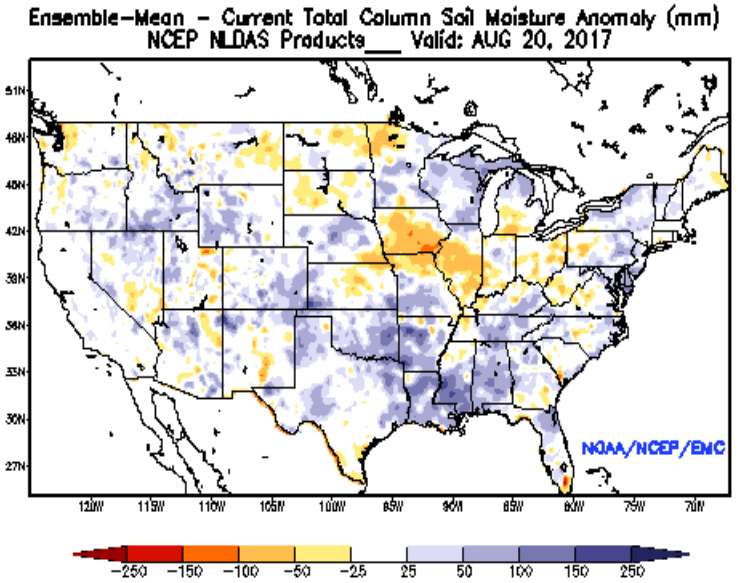


Eastern Texas and Louisiana deep soil is wet and streamflow anomaly is largely positive. If heavy precipitation occurs, flooding will be expected.

(a) Precipitation Anomaly

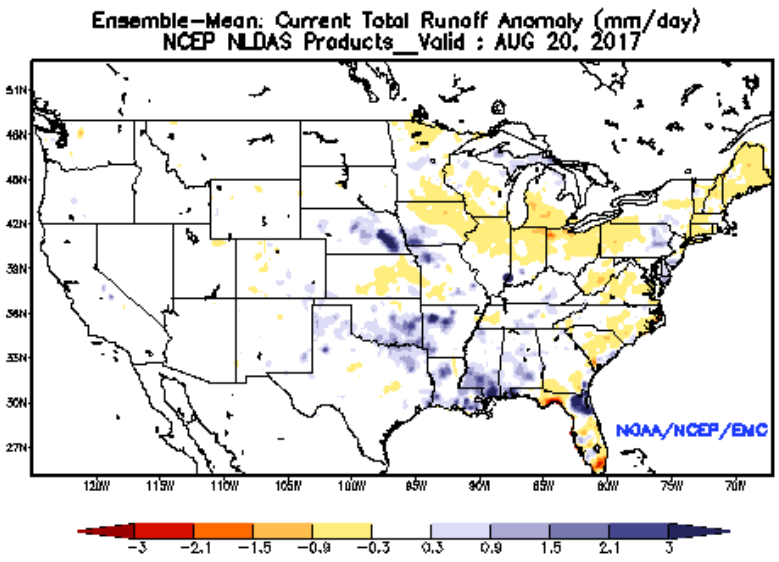


(b) Soil Moisture Anomaly

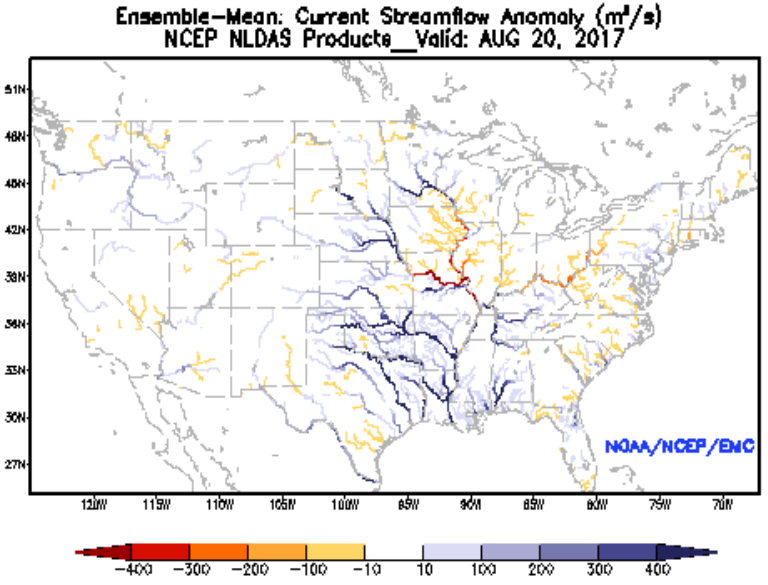


Extremely heavy rainfall and relatively wet soil caused the catastrophic flooding in TX-LA region

(c) Runoff Anomaly

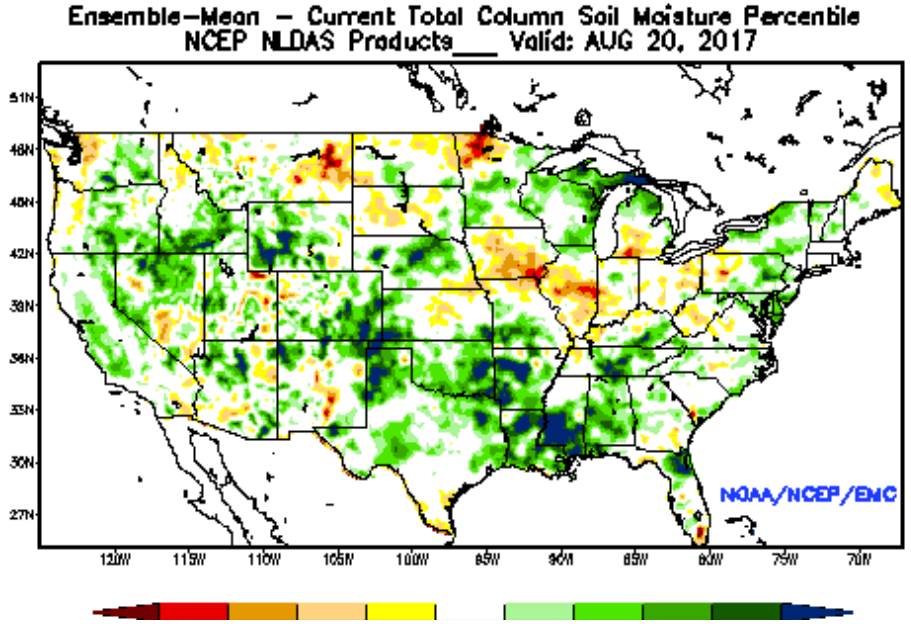


(d) Streamflow Anomaly



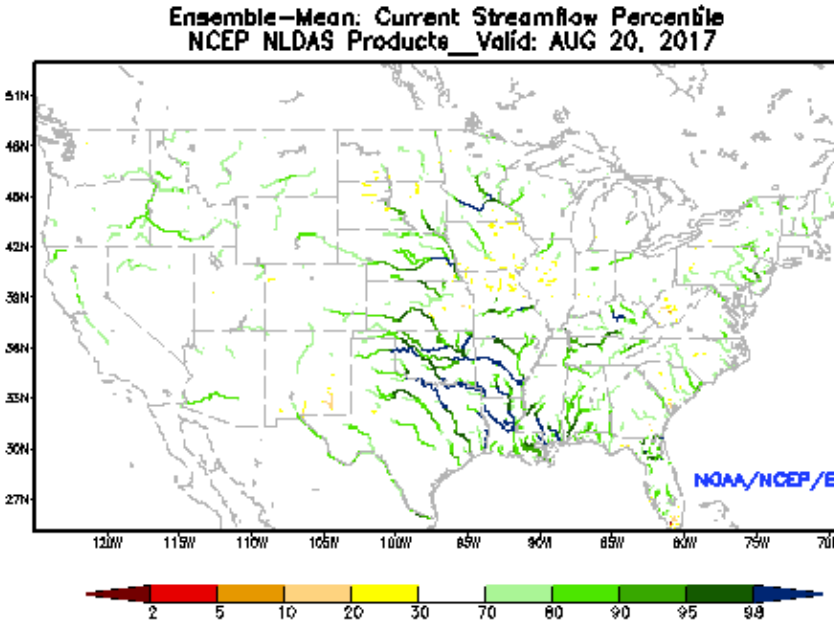
Past Harvey Impact

Soil Moisture Percentiles



Soil wetness will continue 1-2 weeks.

Streamflow Percentiles



Large streamflow percentile will continue about several days.

Experimental realtime NLDAS forcing generation procedure

CPC gauge precipitation, stage II precipitation, NAMv4 forecast precipitation, as well as NAMv4 reanalysis and forecast data (i.e., radiation, air temperature, humidity, wind, surface pressure) are used to extend NARR/RCDAS data to achieve realtime NLDAS system

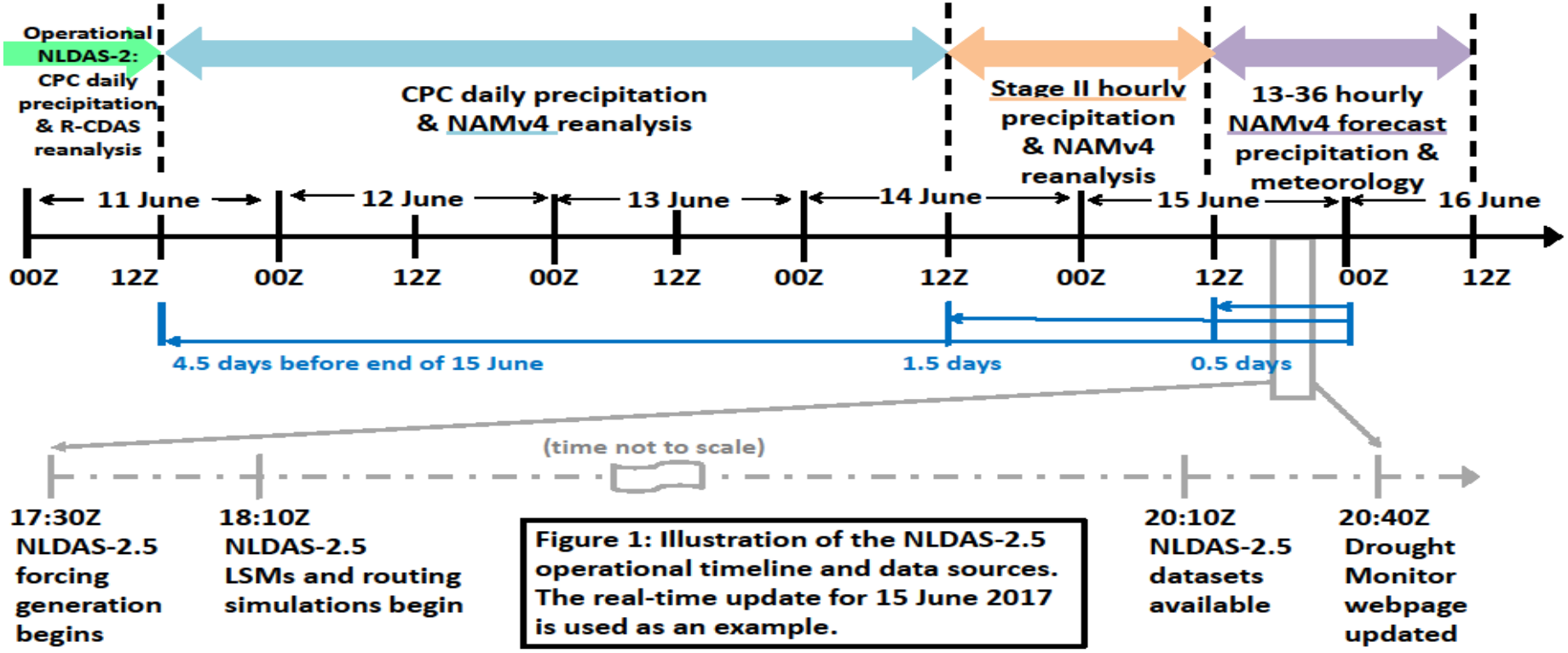


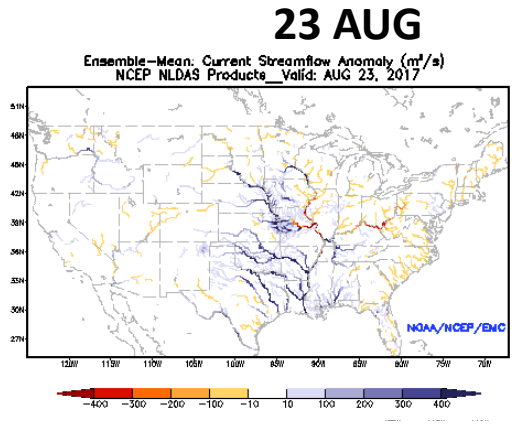
Figure 1: Illustration of the NLDAS-2.5 operational timeline and data sources. The real-time update for 15 June 2017 is used as an example.

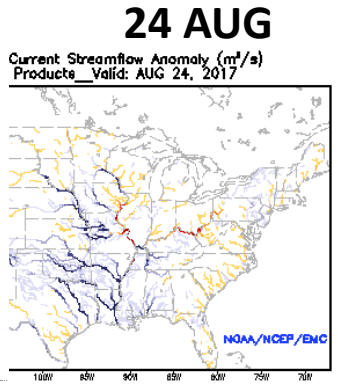
Ek et al, 2017, NCEP LDAS white paper

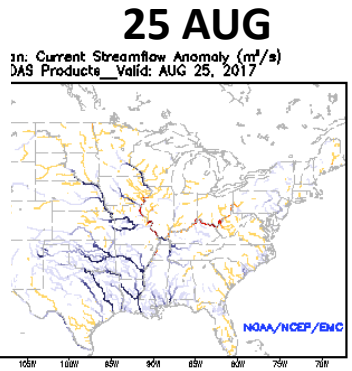
Operational NLDAS2.0 vs Experimental real-time NLDAS2.5

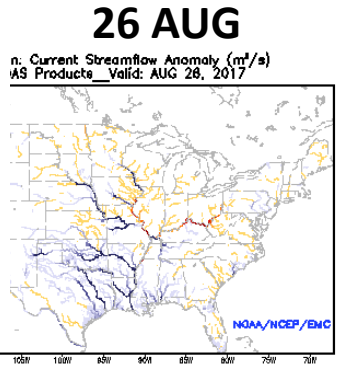
ops NLDAS

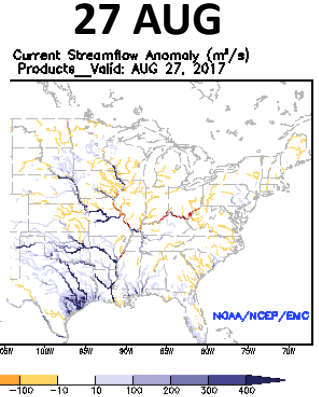
Real-time NLDAS

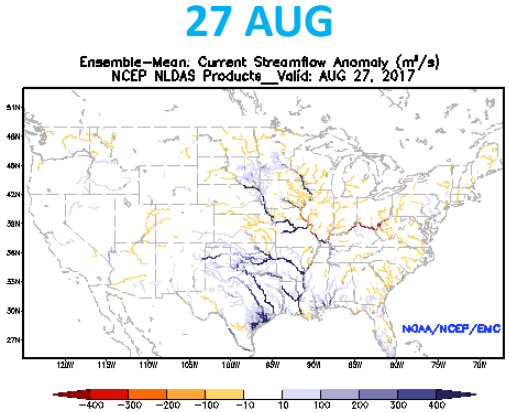


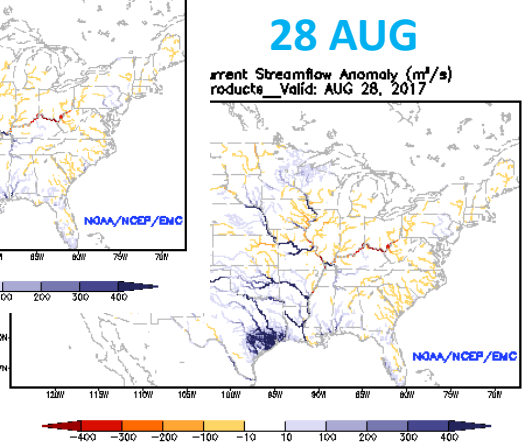


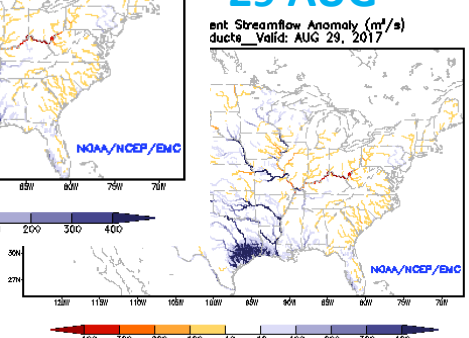


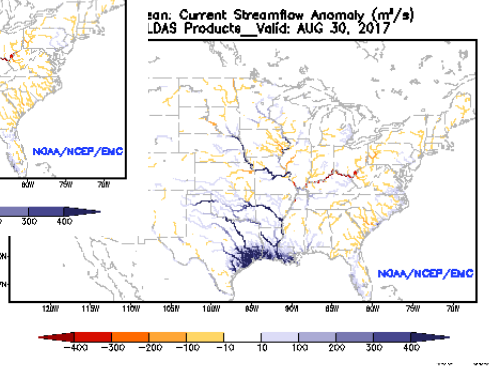


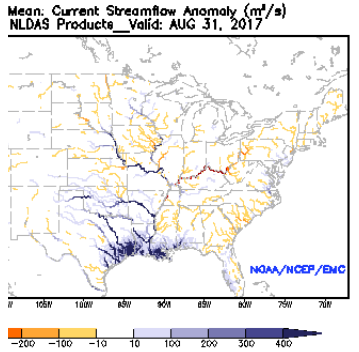










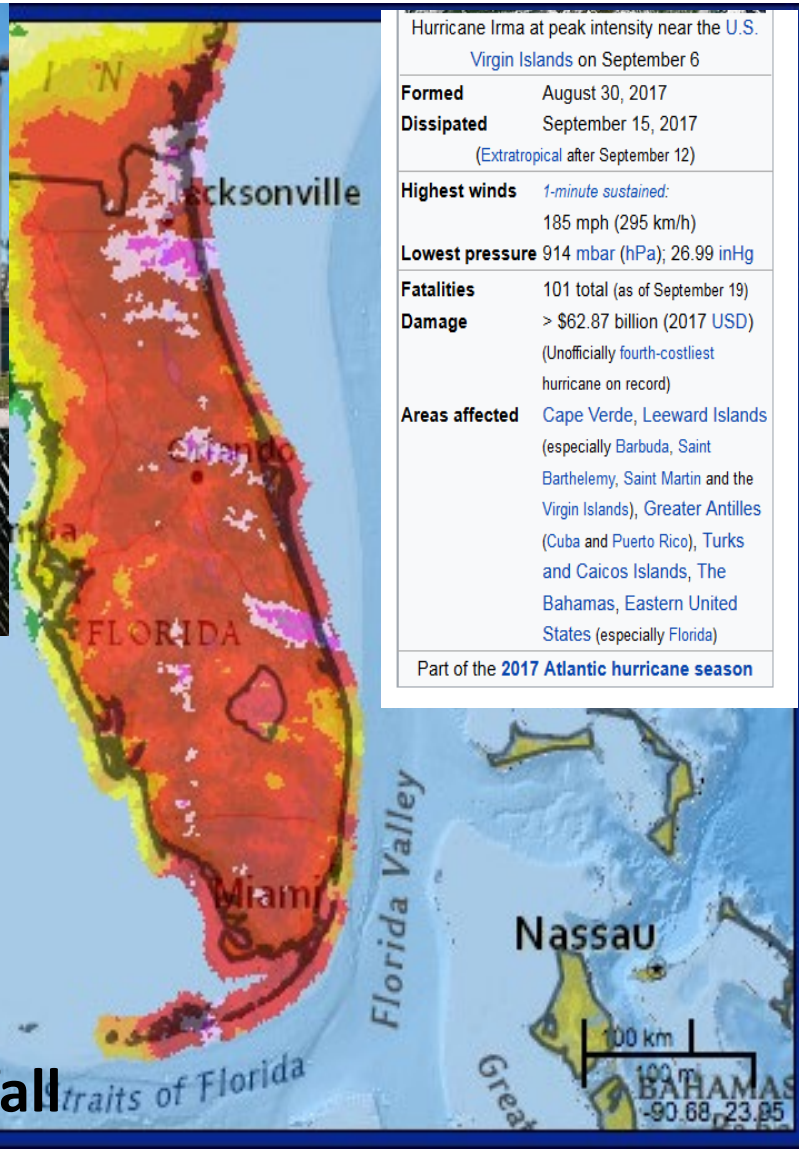


Timing has large impact for monitoring flooding situation

Hurricane Irma

https://en.wikipedia.org/wiki/Hurricane_Irma

https://www.dhs.gov/photo/hurricane-irma-image-2-2



Hurricane Irma at peak intensity near the U.S. Virgin Islands on September 6

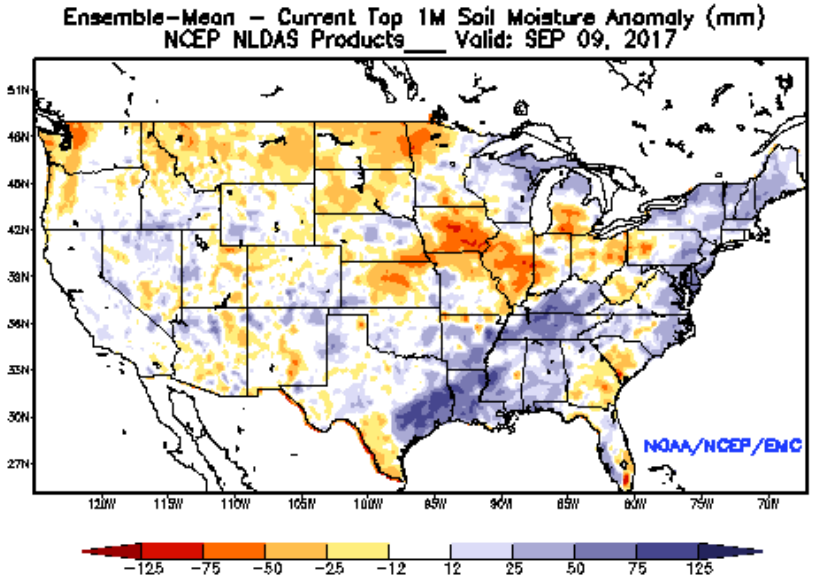
Formed	August 30, 2017
Dissipated	September 15, 2017 (Extratropical after September 12)
Highest winds	*1-minute sustained:* 185 mph (295 km/h)
Lowest pressure	914 mbar (hPa); 26.99 inHg
Fatalities	101 total (as of September 19)
Damage	> $62.87 billion (2017 USD) (Unofficially fourth-costliest hurricane on record)
Areas affected	Cape Verde, Leeward Islands (especially Barbuda, Saint Barthelemy, Saint Martin and the Virgin Islands), Greater Antilles (Cuba and Puerto Rico), Turks and Caicos Islands, The Bahamas, Eastern United States (especially Florida)

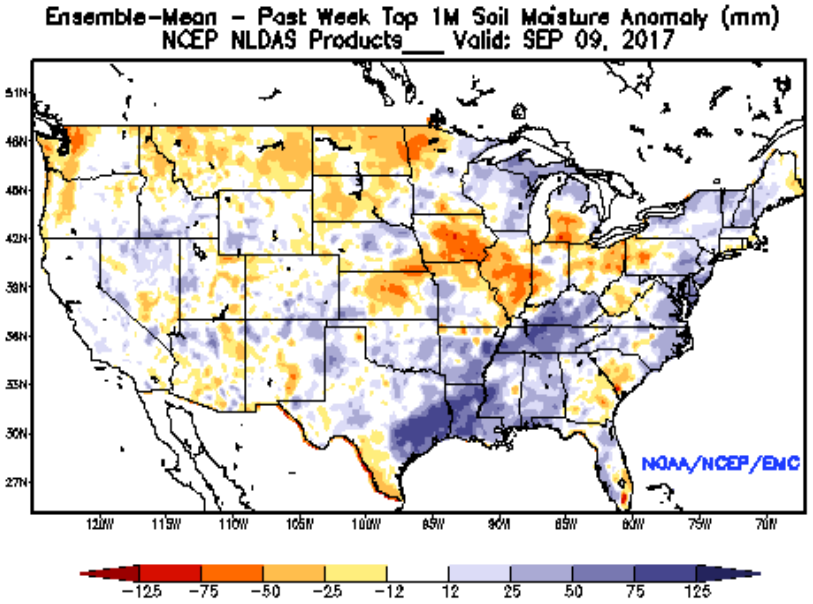
Part of the **2017 Atlantic hurricane season**

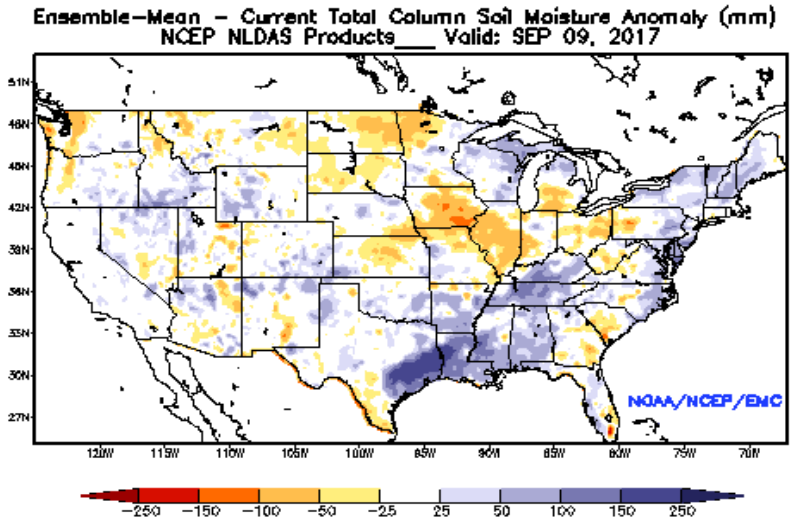
Strong wind and less heavy rainfall

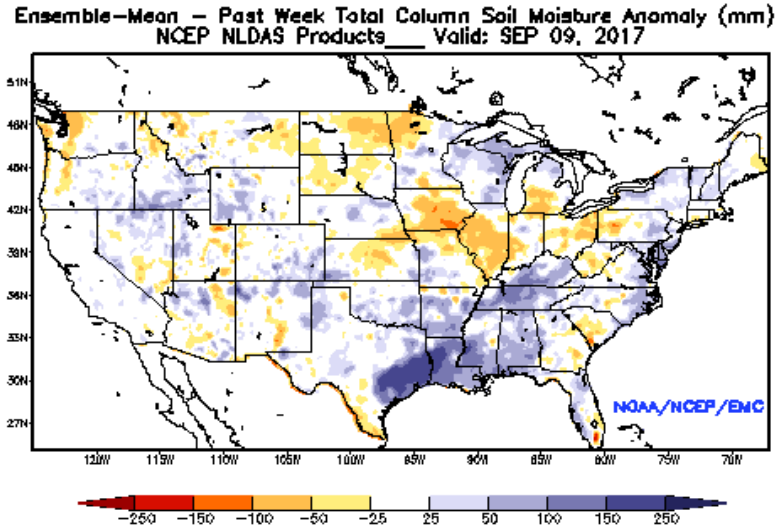
Soil moisture conditions on 09 September 2017

Daily **Top 1m SM anomaly** **Past week**



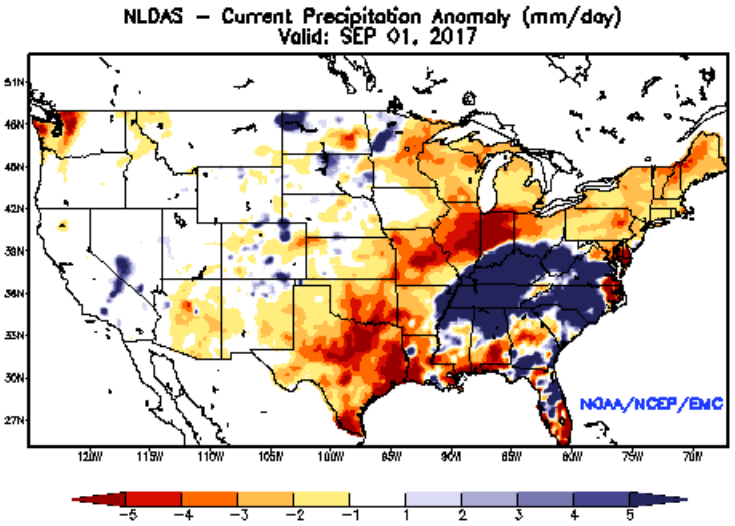




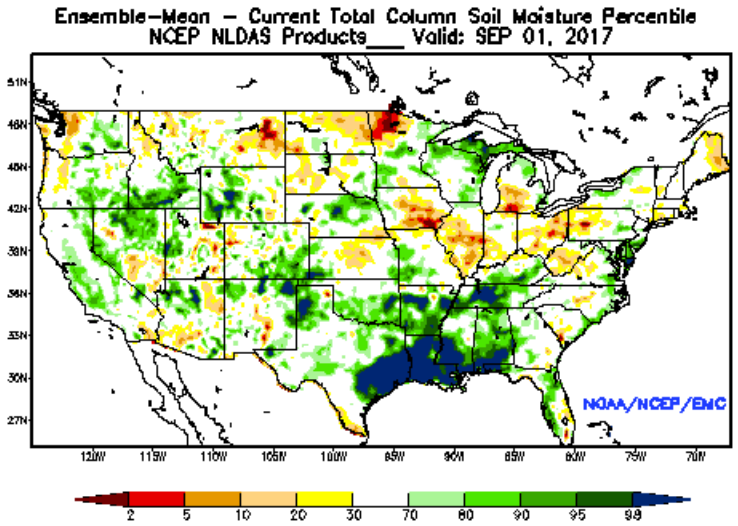


Total Column SM anomaly

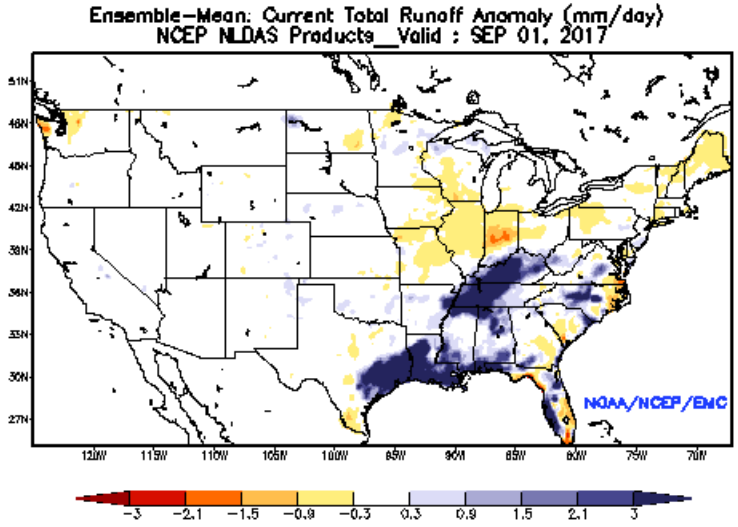
(a) Precipitation anomaly



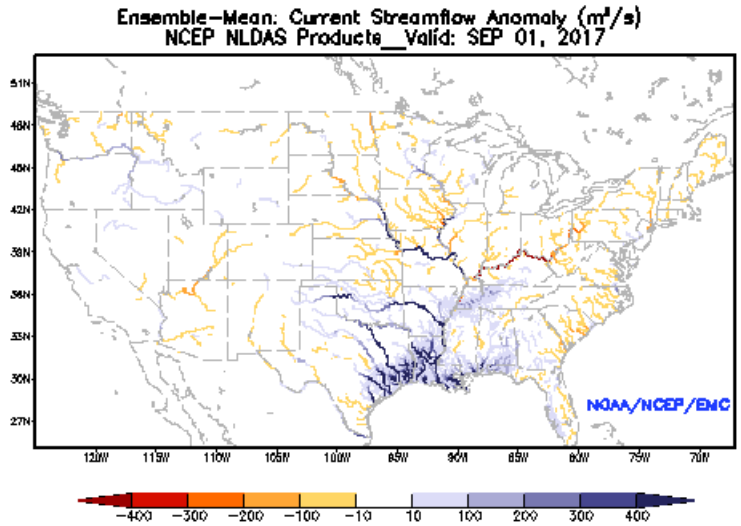
(b) Total column SM percentile



(c) Runoff anomaly



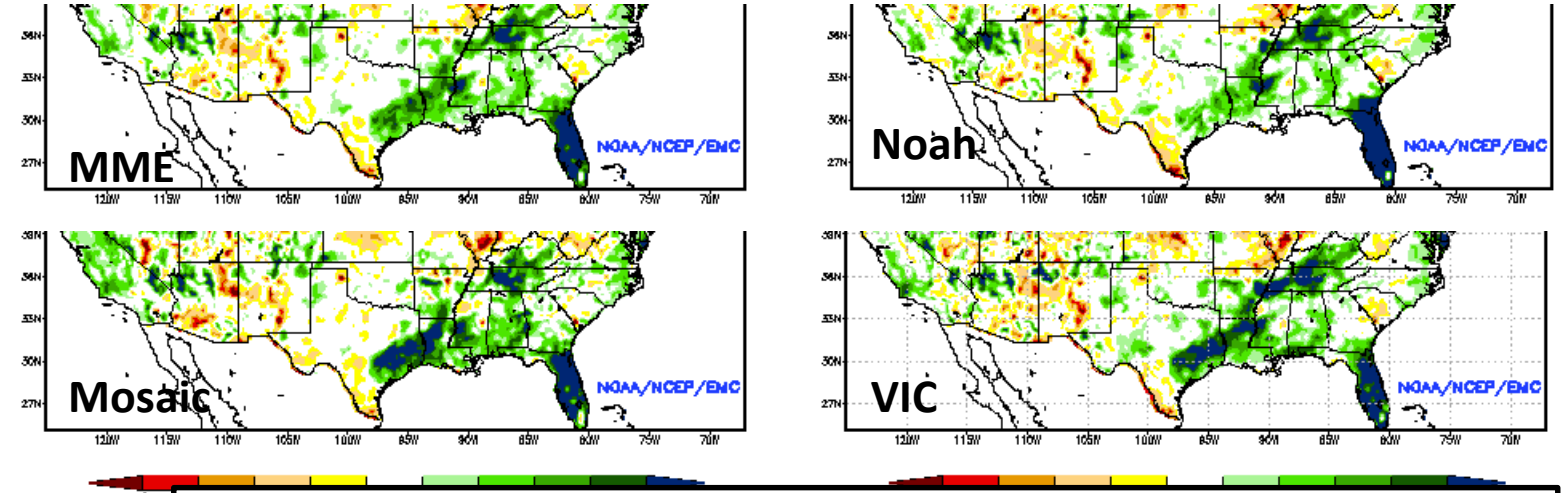
(d) Streamflow anomaly



Relatively less precipitation and dry soil are causing less severe inland flooding in FL, GA, SC when compared with Texas-Louisiana case.

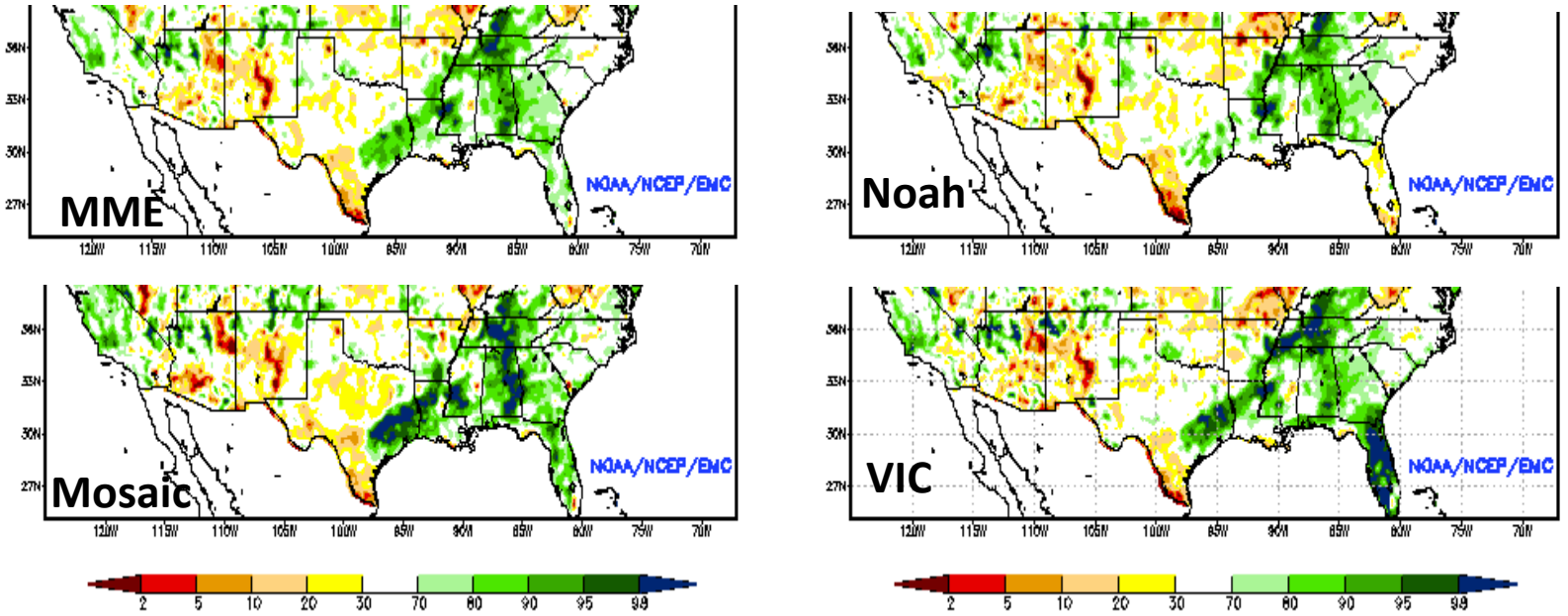
Impact of different soil and hydrology processes on soil moisture (field capacity, hydrological conductivity, root zone depth etc.)

Top 1m Soil Moisture Percentile (11 September 2017)



Different soil wetness duration leads to different flooding duration

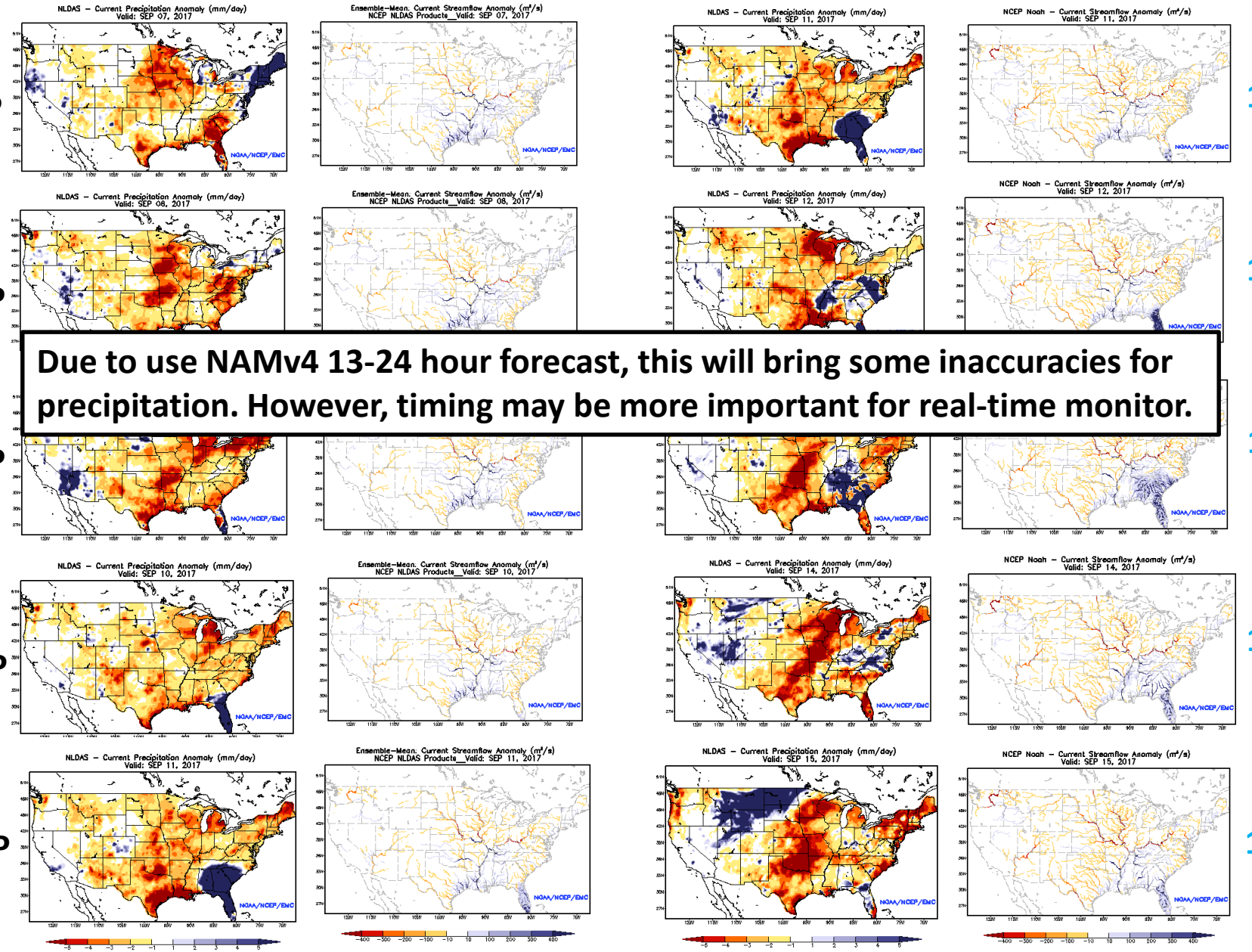
Top 1m Soil Moisture Percentile (26 September 2017)



Operational vs real-time NLDAS

operational precipitation and streamflow Anomaly

real-time precipitation and streamflow Anomaly



Due to use NAMv4 13-24 hour forecast, this will bring some inaccuracies for precipitation. However, timing may be more important for real-time monitor.

NLDAS and NCEP/GLDAS development and future plan – white paper

Next Phase of the NCEP Unified Land Data Assimilation System (NULDAS): Vision, Requirements, and Implementation

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[1]Environmental Modeling Center (EMC), National Centers for Environmental Prediction (NCEP), National Oceanic and Atmospheric Administration (NOAA), College Park, MD, USA

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10 September 2017

Contents

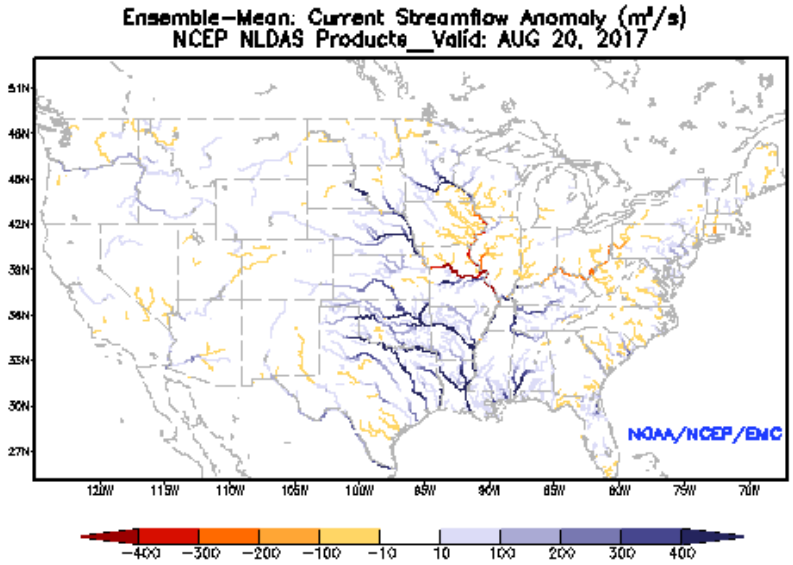
NLDAS development and update will help enhance its capability for both drought and flooding monitoring task.

http://www.emc.ncep.noaa.gov/mmb/nldas/White_Paper_for_Next_Phase_LDAS_final.pdf

Summary and Conclusions

- **NLDAS can monitor many features of the flooding caused by Hurricanes Harvey and Irma, but going to a finer grid-scale than the current 1/8th-degree operational system could provide additional details (e.g., National Water Model).**
- **Harvey brought heavy precipitation over a long duration, over soils in TX and LA that were relatively wet before landfall; these conditions caused catastrophic inland flooding.**
- **Irma had stronger wind over a larger inland area and less precipitation (compared to Harvey), and affected states of FL, GA, and SC had relatively dry soil before landfall, potentially mitigating the level of inland flooding observed.**
- **Real-time NLDAS-2.5 does definitely help monitor the flooding situation when compared to the current operational NLDAS-2 with a 4-day delay.**
- **NLDAS development and upgrades including addition of data assimilation, model physics and parameters upgrades, and increasing fine resolution will further enhance its capability to operationally monitor drought and flood occurrence, duration, and termination. For details, see the recently-released white paper.**

Experimental realtime NLDAS-2.5 products can be downloaded:
ftp://ldas.ncep.noaa.gov/experimental_NLDAS2.5/dev



Any Comments & Questions?

NCEP NLDAS website: http://www.emc.ncep.noaa.gov/mmb/nldas/
NASA NLDAS website: https://ldas.gsfc.nasa.gov/nldas/
NLDAS publications: https://ldas.gsfc.nasa.gov/nldas/NLDASpublications.php