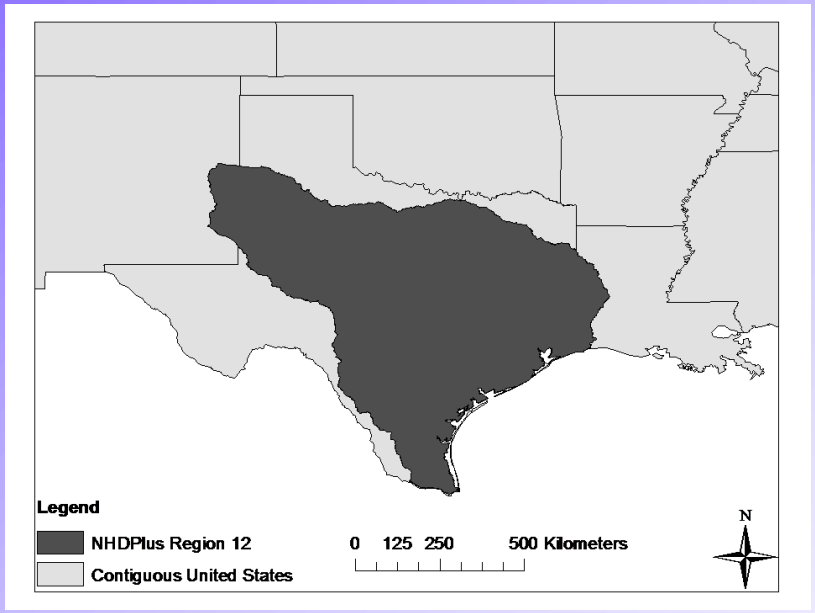
River Modeling as Big as Texas

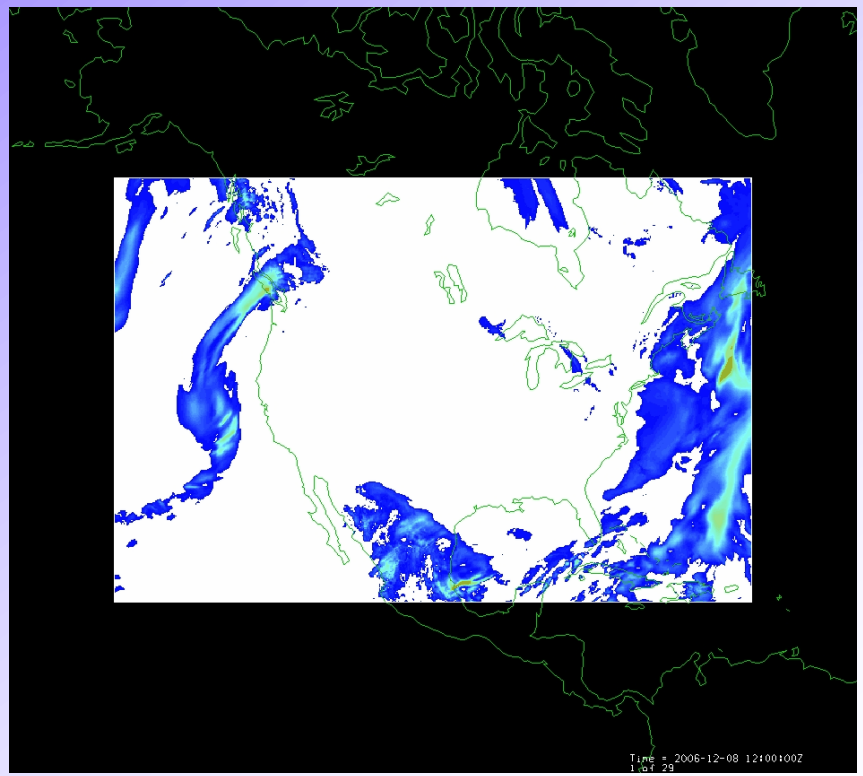


Cédric H. David
David R. Maidment, Zong-Liang Yang

First Water Forum
Austin, TX
13 February 2012

Atmospheric modeling

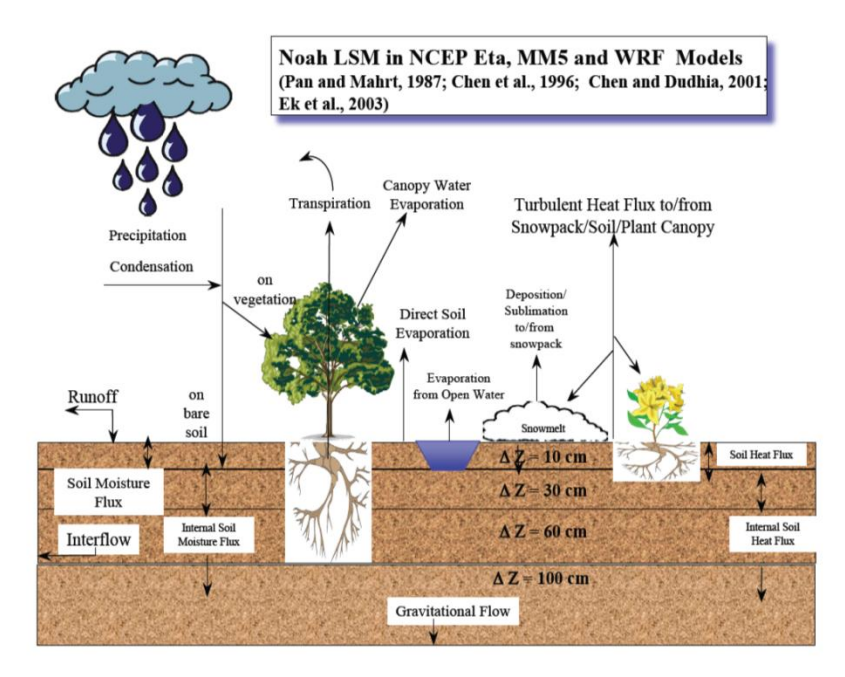
- Equations of fluid mechanics and thermodynamics of the atmosphere commonly solved everyday by computer models
- Temperature, pressure, winds, precipitation, etc. are available
- For past, present and future
- Dynamic maps



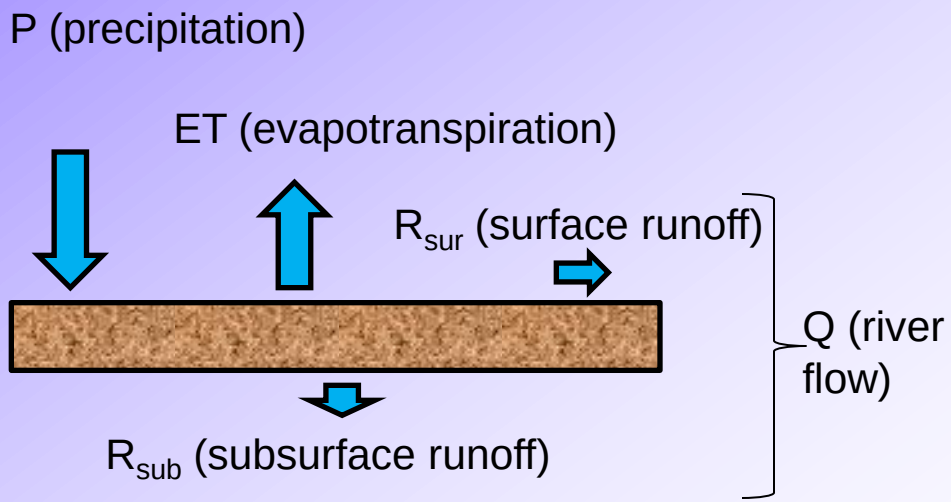
Animation of precipitation over the U.S.

Models and datasets available cover the entire U.S.

Land surface modeling



Noah land surface model (first version in 1999), serves as the land model for operational weather prediction in North America



Bottom boundary conditions for atmospheric models
Models and datasets also cover the entire U.S.

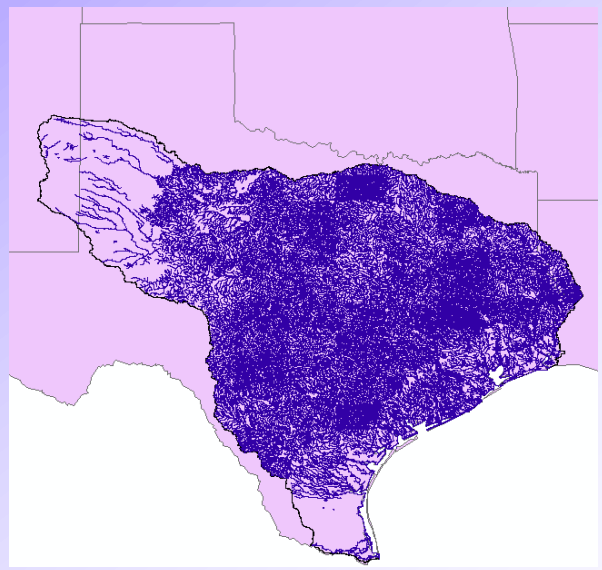
NHDPlus – River and Catchment Network for the Nation

Entire dataset

3 million river reaches

Connectivity information

Region 12 = Texas Gulf Coast Hydrologic Region



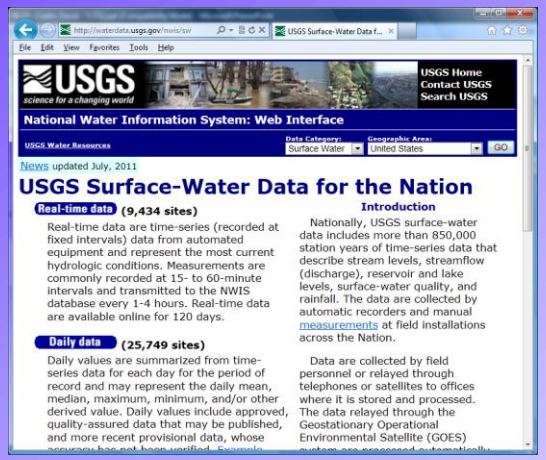
68,143 river reaches
465,000 km^2

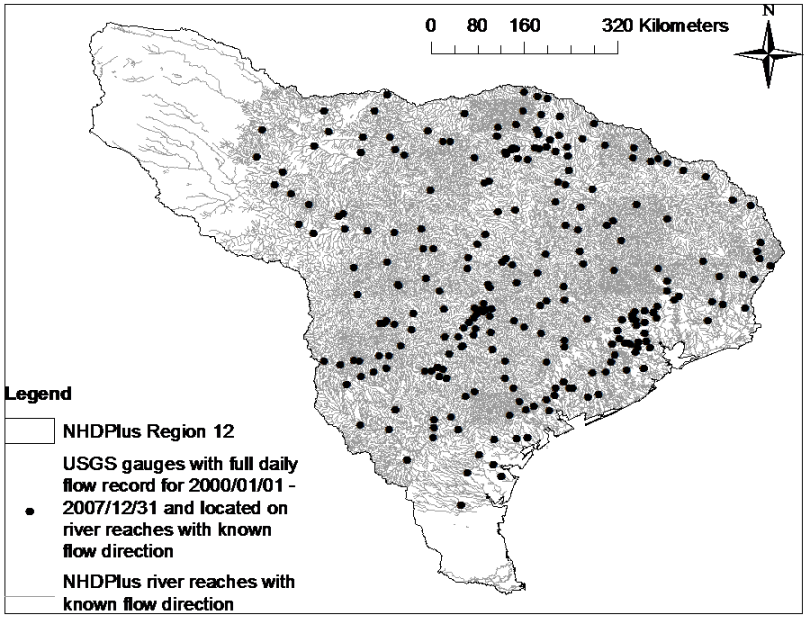
Integration of the National Hydrography Dataset, National Elevation Dataset and National Land Cover Dataset completed by EPA in 2006

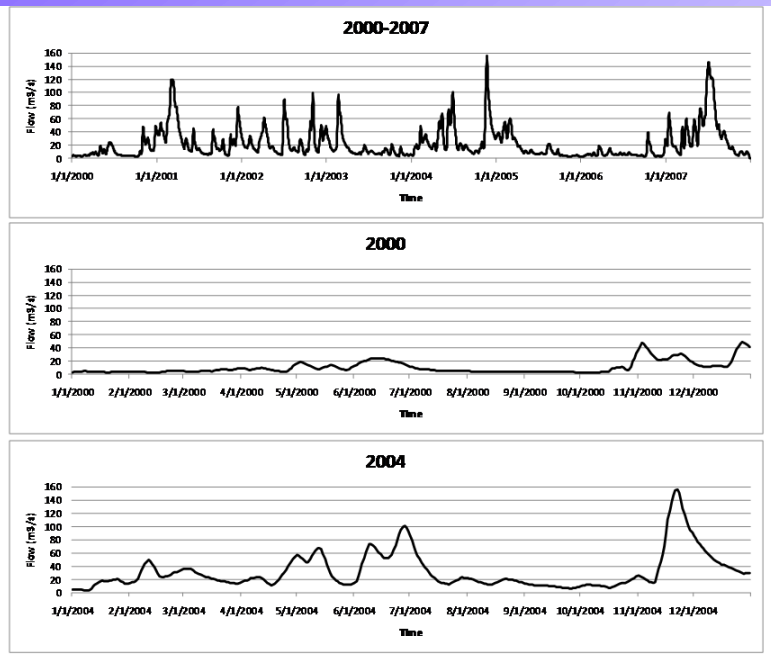
"Blue line" rivers available for the entire U.S.

USGS National Water Information System

20,000+ gauges available for the United States



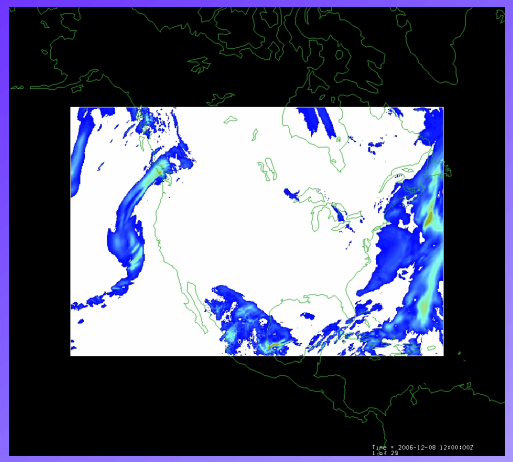




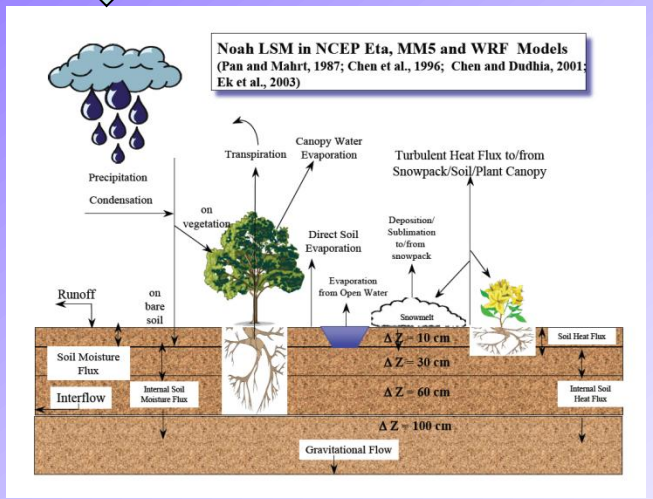
Spatial average

773 gages total in Region 12
248 with full daily data for 2000/01/01 – 2007/12/31 and on reaches with known direction

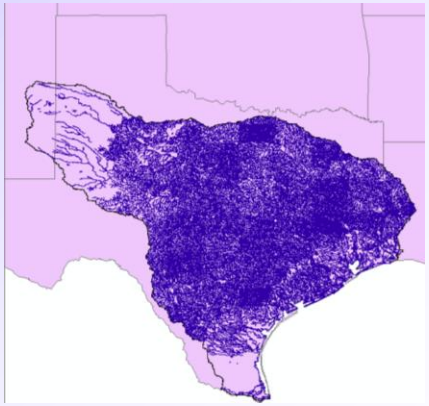
Integrated River Modeling



Atmospheric Model or Dataset



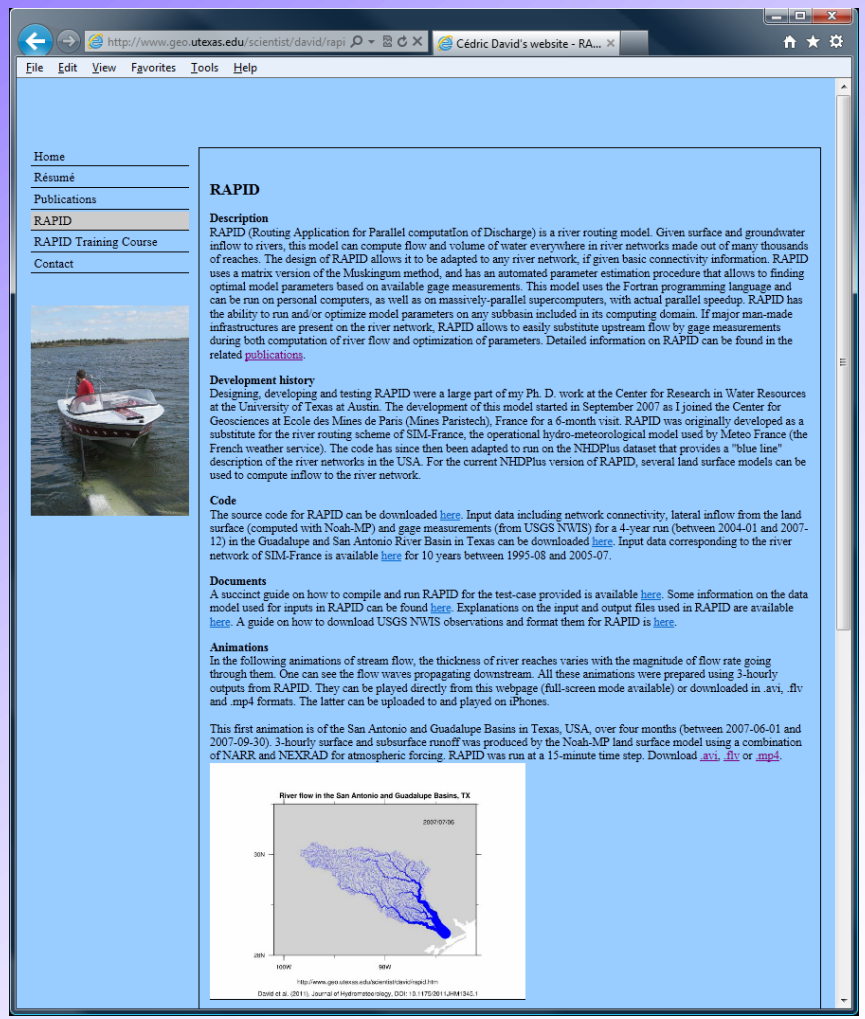
Land Surface Model



“Blue Line” River Network - High-Performance Computing River Network Model

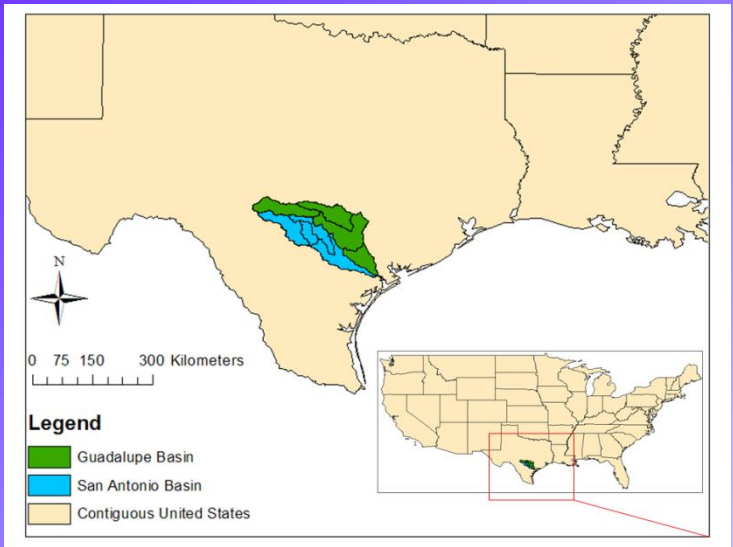
River model

- **RAPID** (Routing Application for Parallel computatIon of Discharge)
- Computes flow and optimizes model parameters
- Model code, input data and animations are available online
- Can run on supercomputers

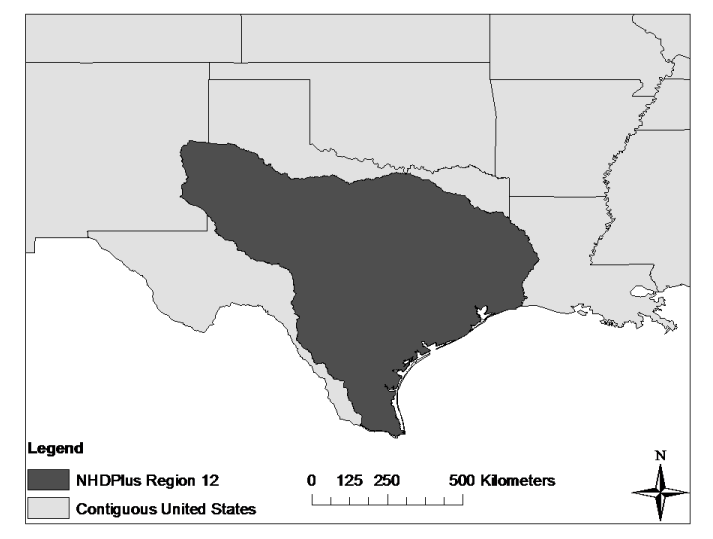


http://www.geo.utexas.edu/scientist/david/rapid.htm

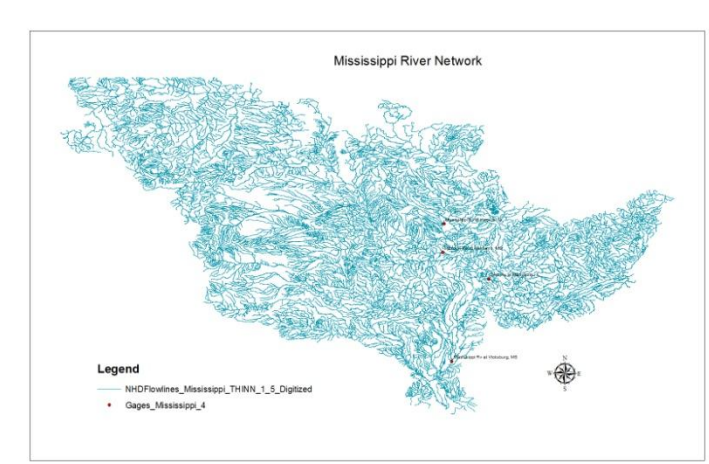
Existing RAPID applications



David et al. (2011a), Journal of Hydrometeorology

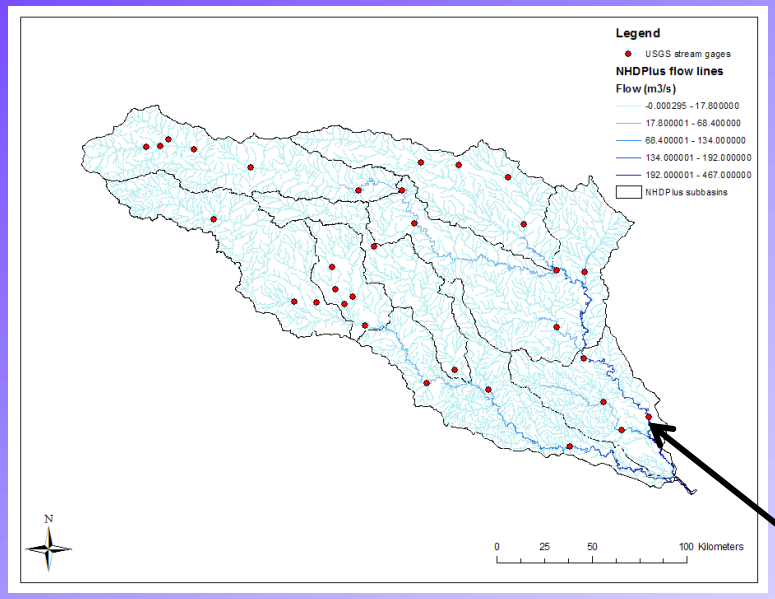


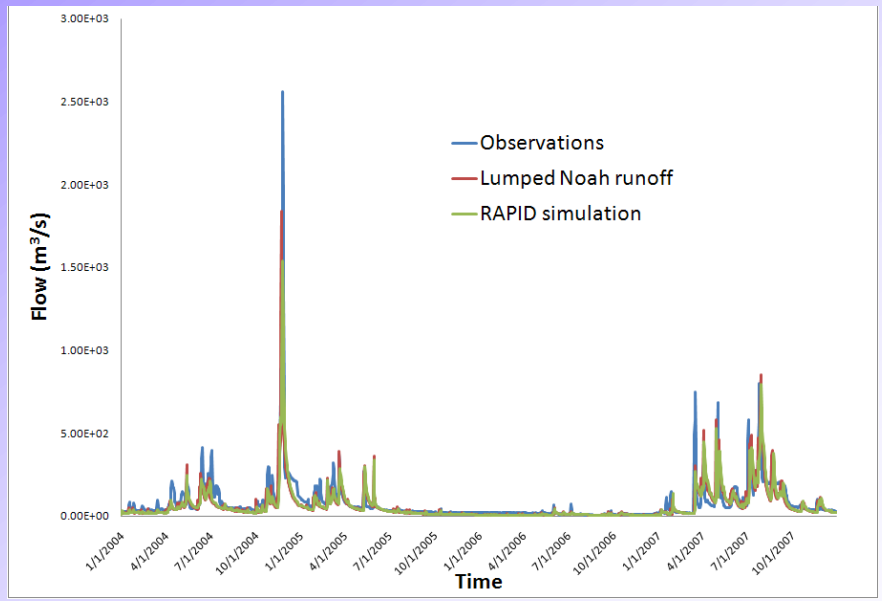
David et al., in preparation



Tavakoly et al., in preparation

Guadalupe – San Antonio Streamflow map

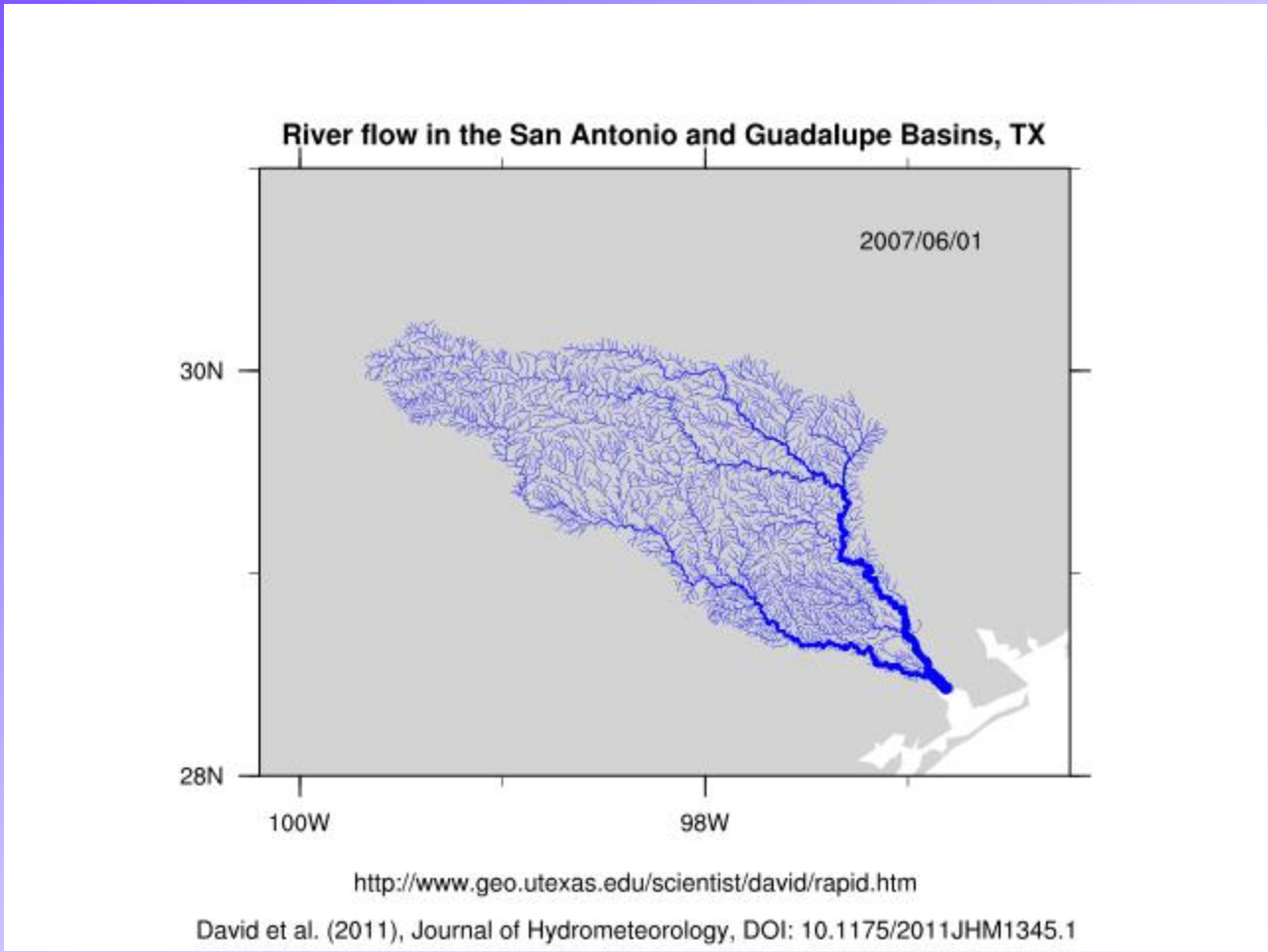




Flow calculated everywhere

Guadalupe River at Victoria

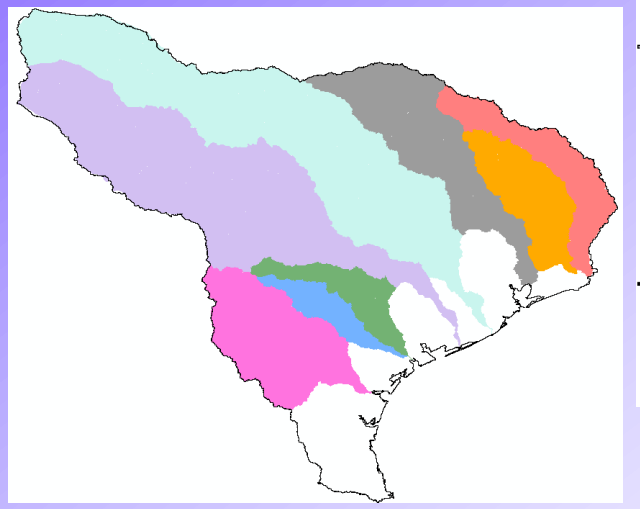
Guadalupe – San Antonio Animation

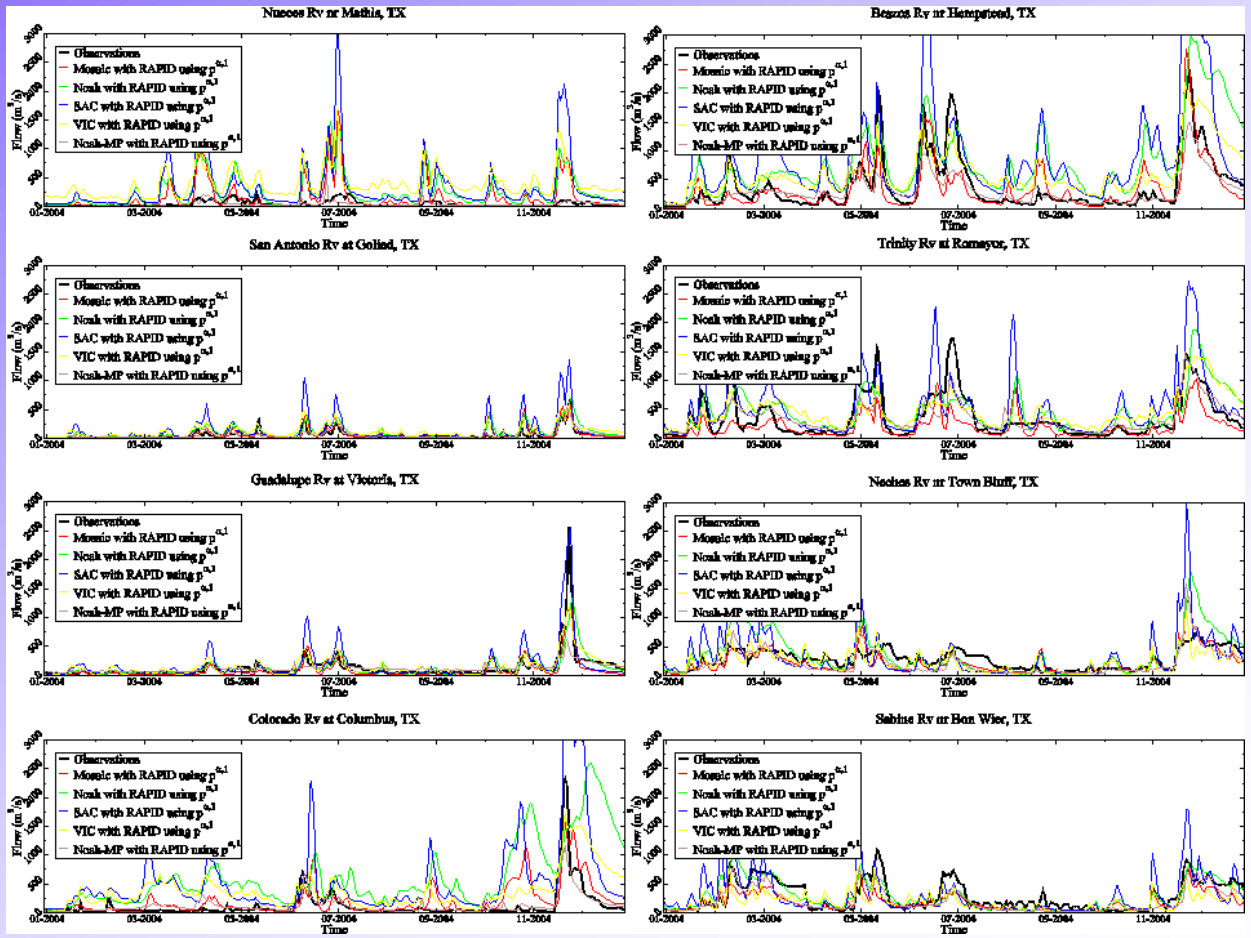


NHDPlus rivers, Noah-MP land surface model, atmospheric forcing from NEXRAD and North American Regional Reanalysis

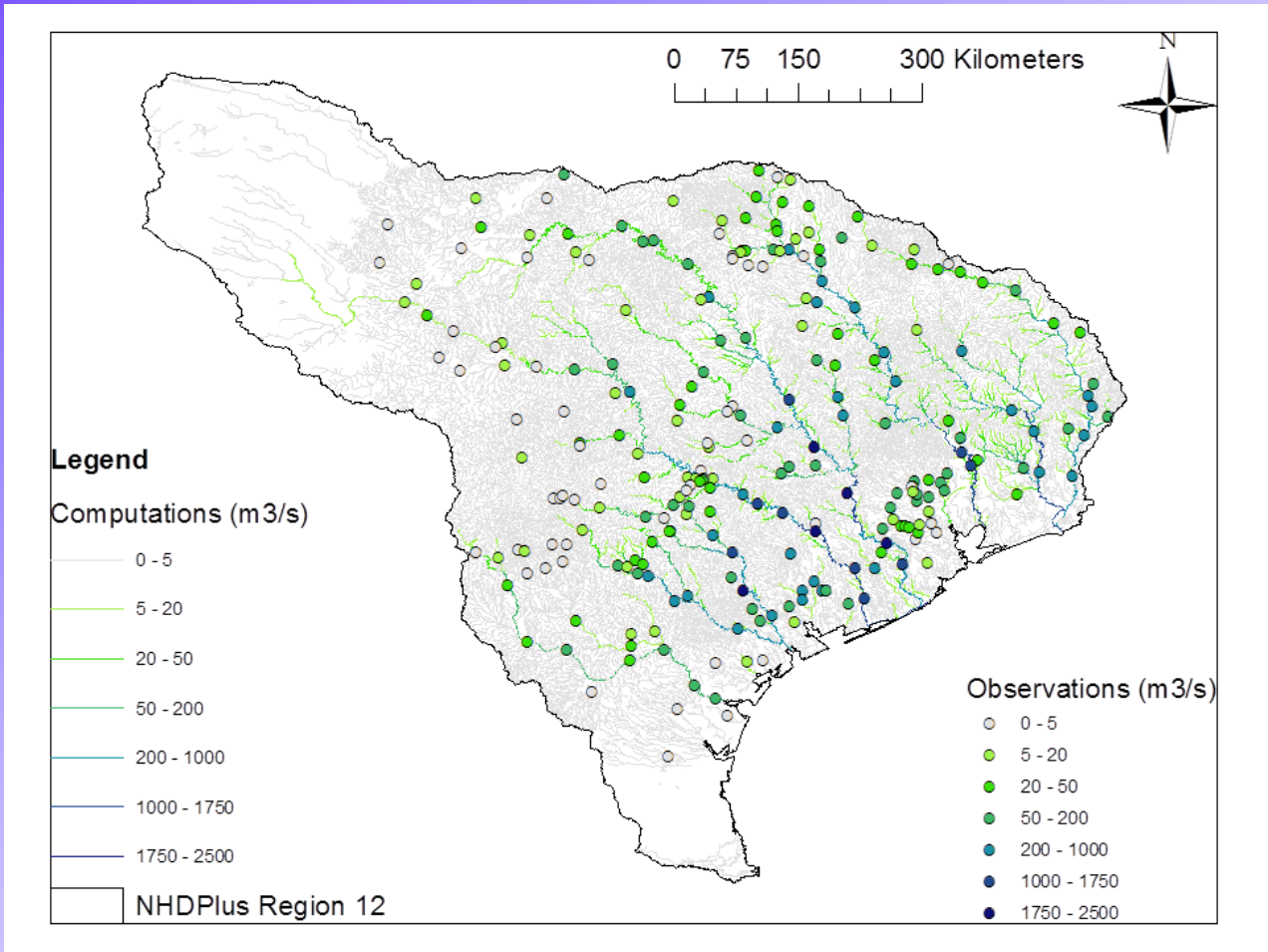
Texas Gulf Hydrologic Region River flow in 8 major Rivers

River flow produced using 5 different runoff datasets into RAPID



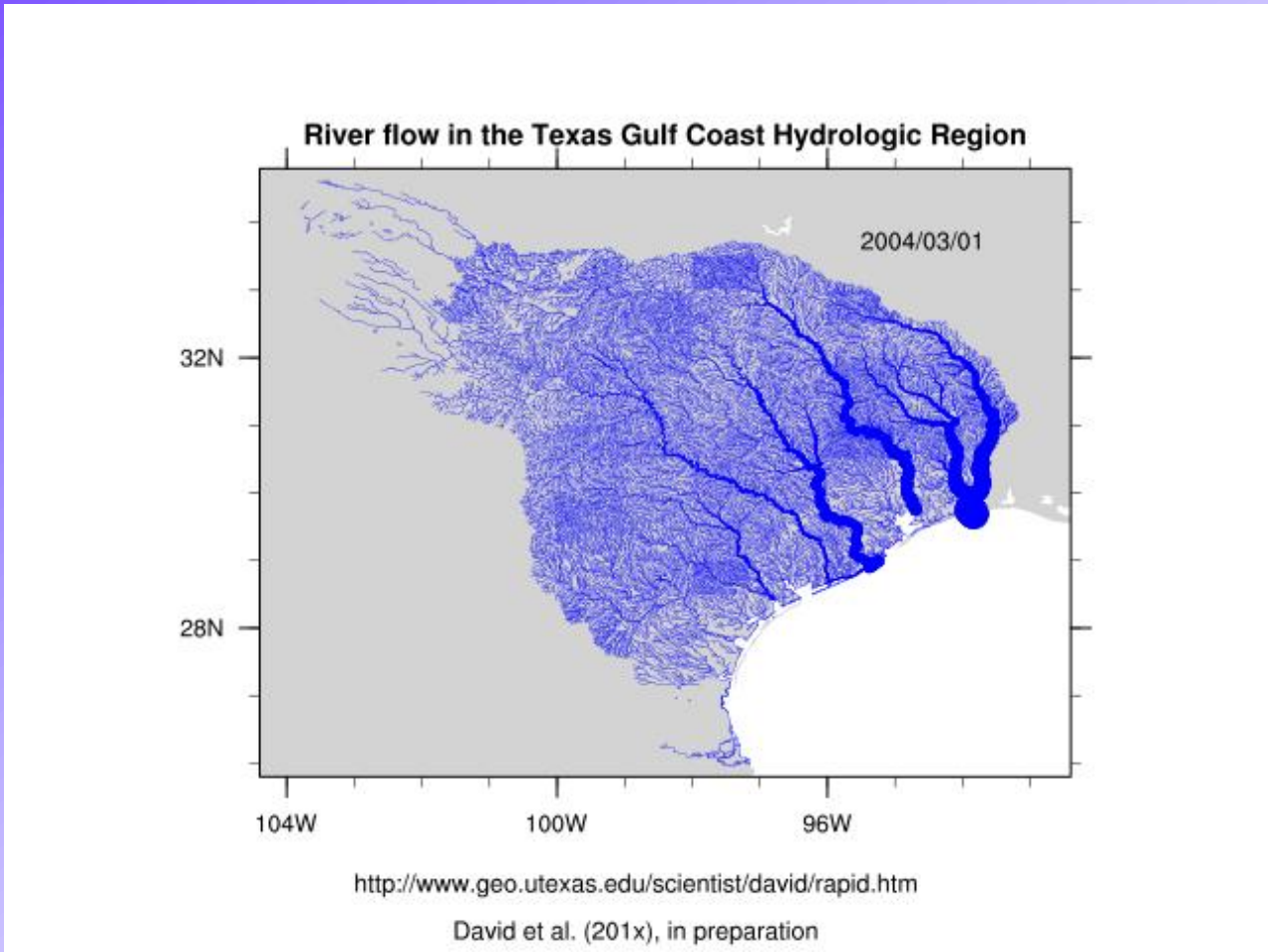


Texas Gulf Hydrologic Region Synoptic hydrology



River flow computations and observations plotted together (24 November 2004)

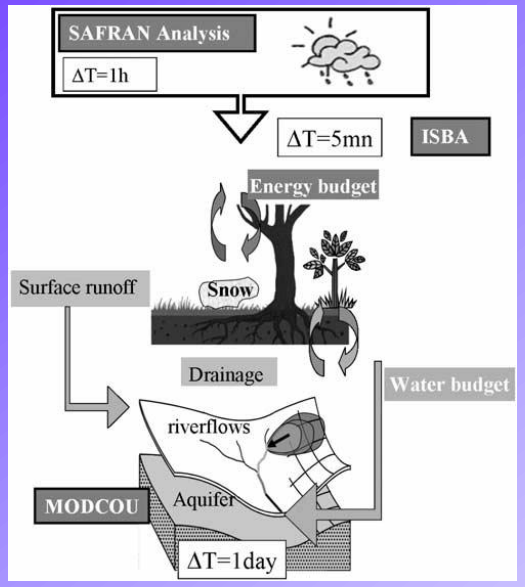
Texas Gulf Hydrologic Region Animation



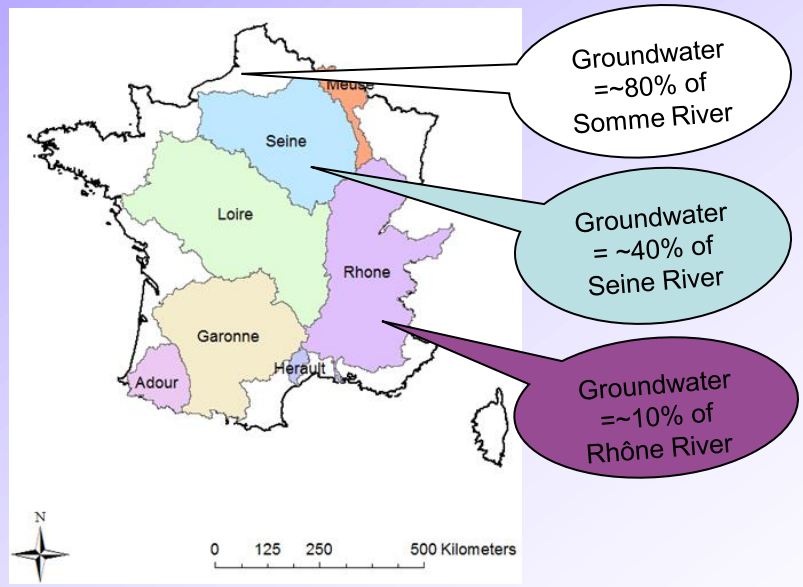
NHDPlus rivers, Noah-MP land surface model, atmospheric forcing from North American Land Data Assimilation Sytem

RAPID in France

Habets et al. (2008)



David et al. (2011b)

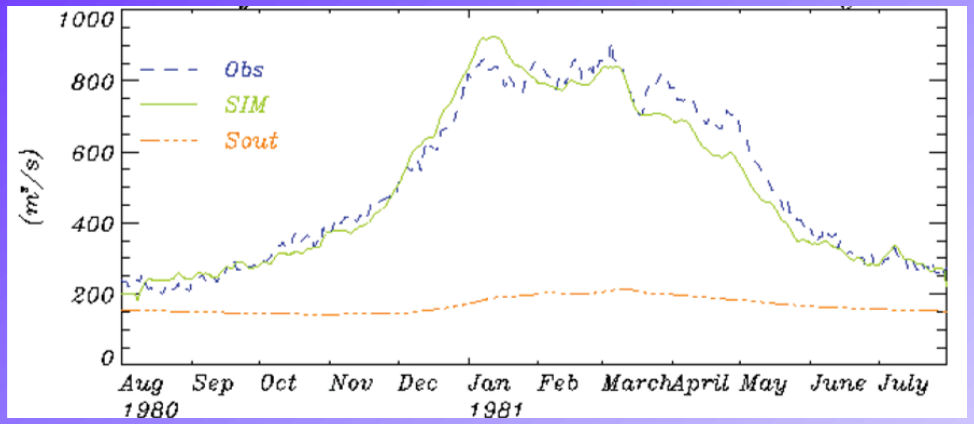


Operational System: Runs every day at the French Weather Service (Meteo France)

Includes Groundwater Modeling

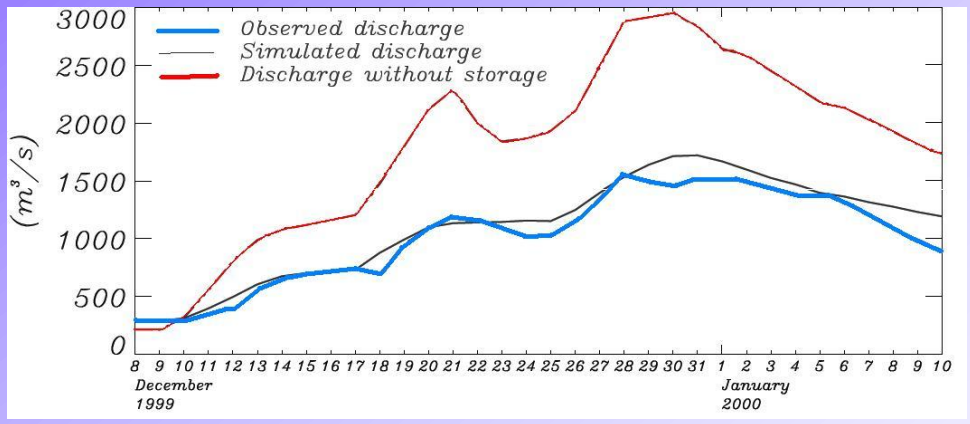
Groundwater influence varies with time and space

Seine River at Poses (near Rouen)



- 80% of flow is from groundwater at low flow, 25 % at high flow

Seine River at Paris



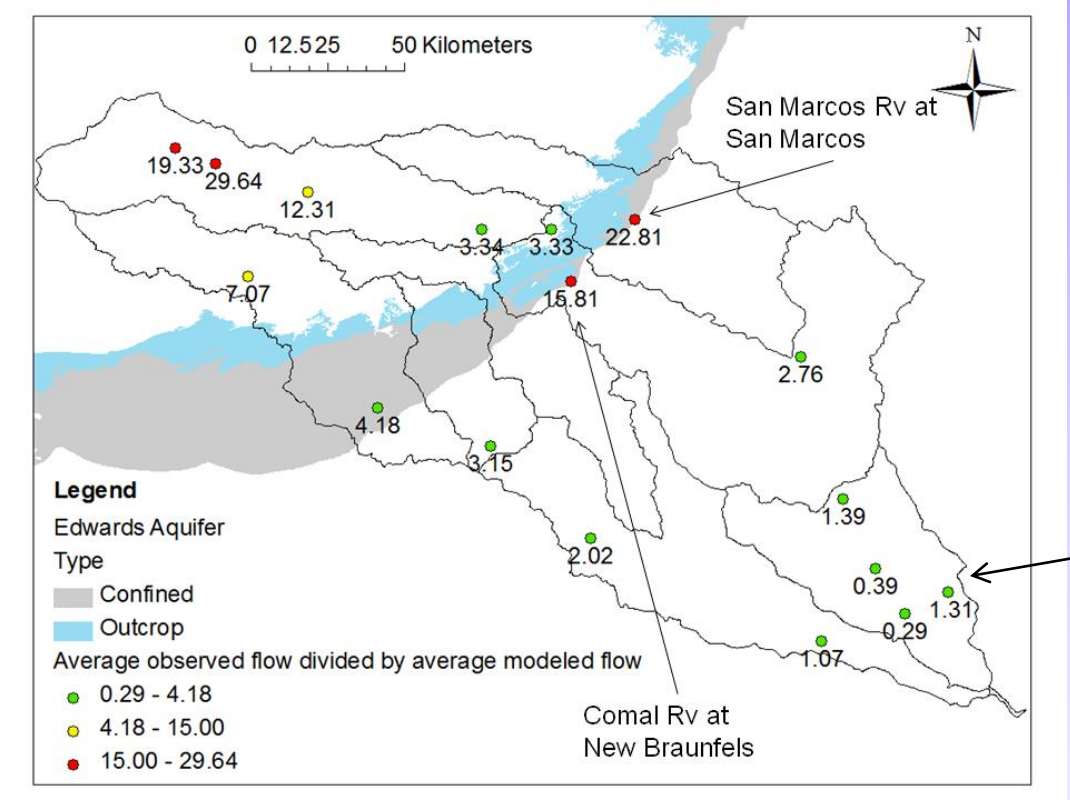
- Infiltration from rivers to aquifers is important as well

Rousset et al., 2007

Courtesy of Florence Habets

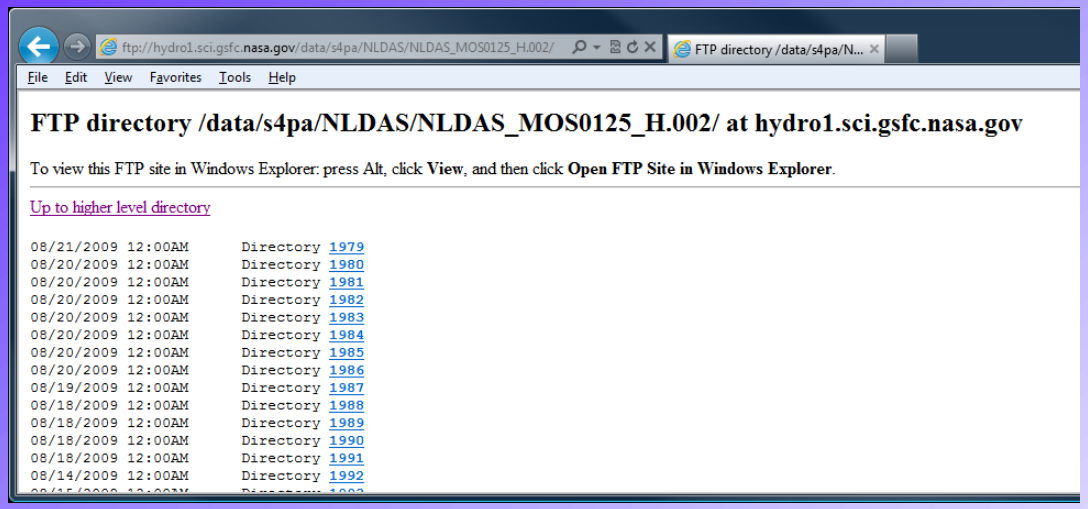
Real-time integrated atmosphere/surface/groundwater modeling is great but…

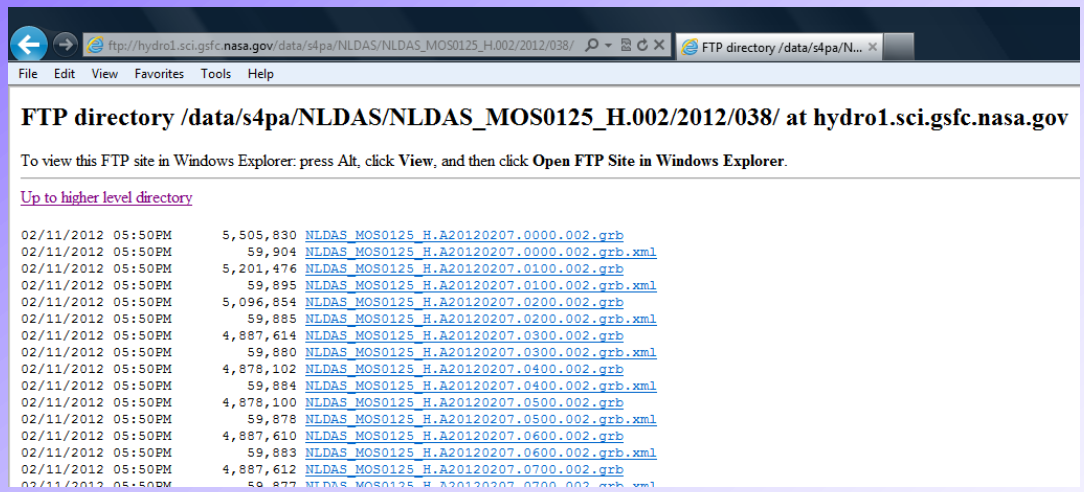
Groundwater is important in Texas too!



San Marcos and Comal Springs alone are 17% of flow at Victoria

Near real-time river flow is doable in Texas as well





Runoff from the North American Land Data Assimilation System (NLDAS) is available in near real-time

February 7th data available on February 11th (~4-day lag)

ftp://hydro1.sci.gsfc.nasa.gov/data/s4pa/NLDAS/NLDAS_MOS0125_H.002/

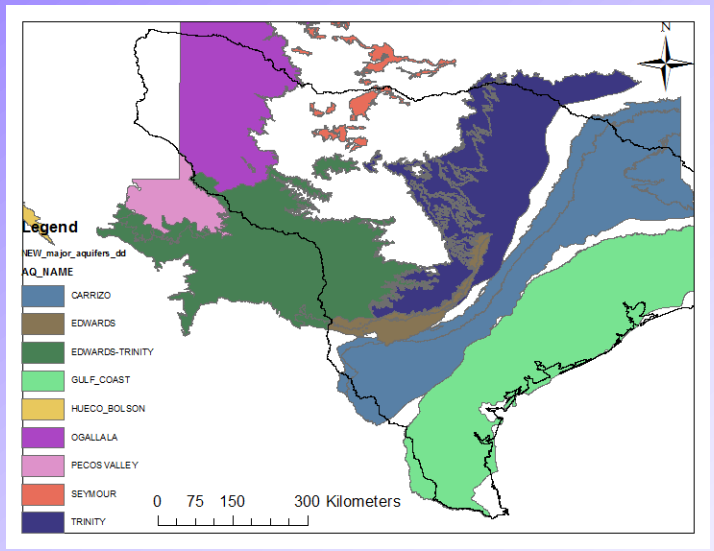
Summary

- Today's models of the atmosphere, land surface and rivers can be integrated into Texas-scale river modeling

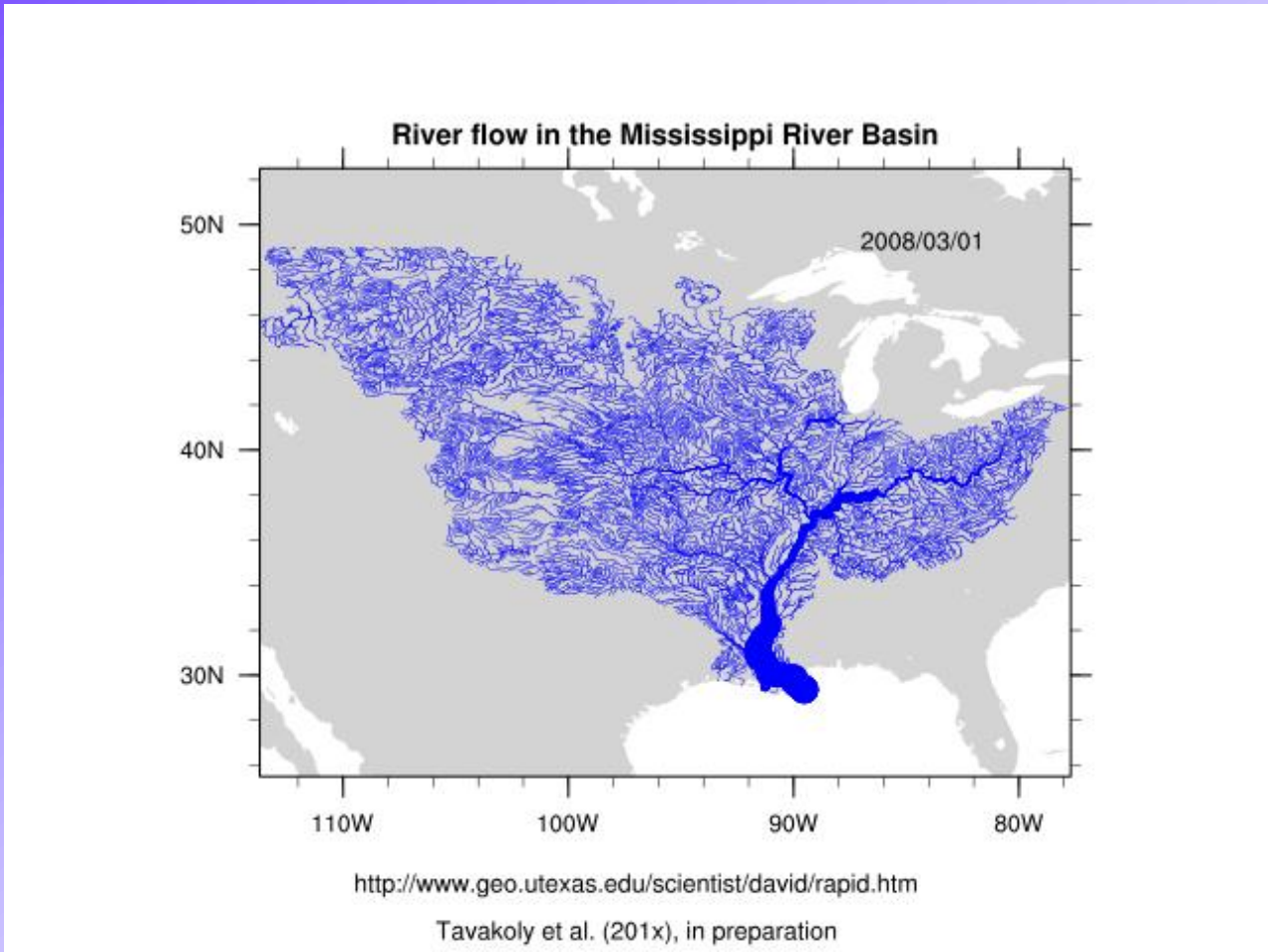
- This can be made into a near real-time tool
- Some modeling of aquifers would be beneficial

What's next?

- Texas groundwater?
- Real-time RAPID
- Dam treatment
- Divergence data
- Suggestions?



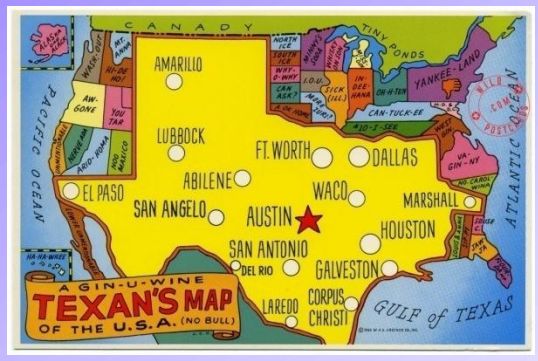
Mississippi Animation



RAPID run by Ahmad Tavakoly

Thank you!

Questions?



Area of Texas: 261,231.71 mi^2 (i.e. 261,231.71 x 1.609344^2 = **676,587.02 km^2**)
(from http://quickfacts.census.gov/qfd/states/48000.html)

Area of France: 643,801 km^2
(from https://www.cia.gov/library/publications/the-world-factbook/geos/fr.html)

Difference: 1 - 643,801 / 676,587.02 = 0.048 = **4.8%**