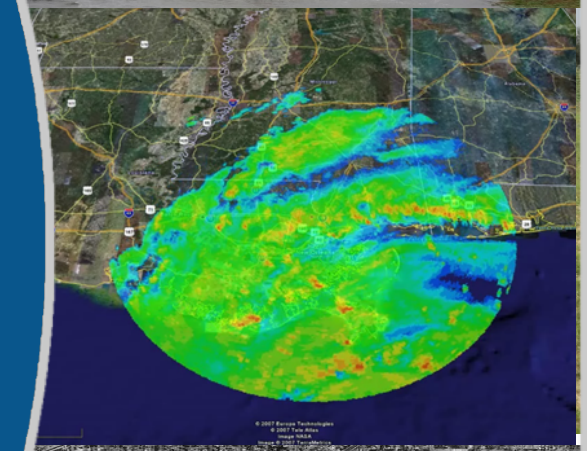
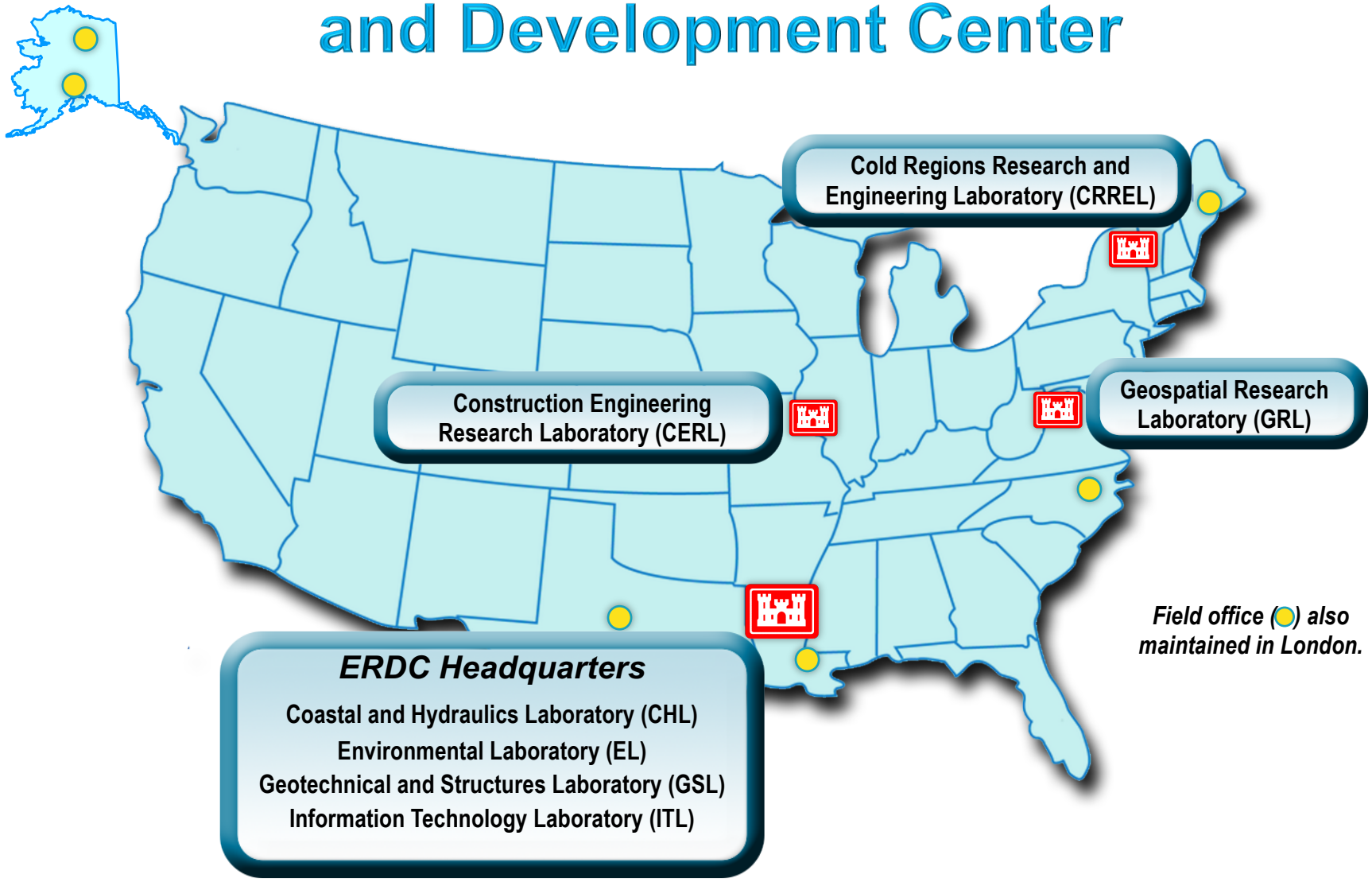
Enabling the U.S. Army Streamflow Prediction Tool to use GPM products

2019 PMM Science Team Meeting
November 4 – 8, 2019
Indianapolis, IN



USACE-ERDC
Ahmad A. Tavakoly; Mark D. Wahl
UMD-ESSIC
Robert Adler, Guojun Gu
University of Arizona
Ali Behrangi

U.S. Army Engineer Research and Development Center

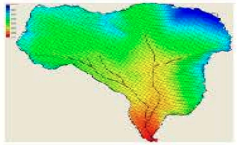


Coastal and Hydraulics Laboratory

Problem Solver

CHL solves complex problems in the following areas:

- Inland and coastal navigation
- Force projection
- Hydropower
- Flood and storm risk reduction
- Dredging
- Waterway restoration
- Hydro-environmental modeling
- Water and land management

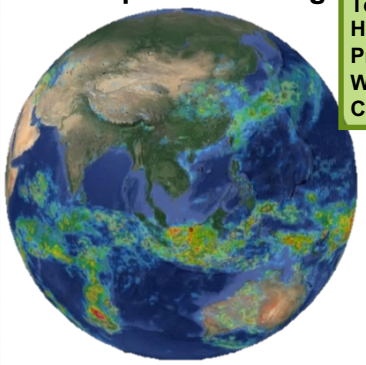


Main Goal

Integrate NASA GPM IMERG-based information into DoD Army Corp A-SPT system to improve accuracy and delivery of analyses and forecasts of streamflow and other critical information

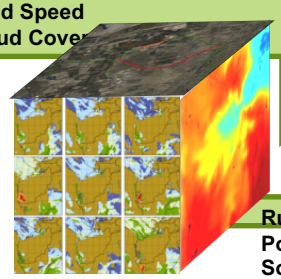
Conceptual Framework

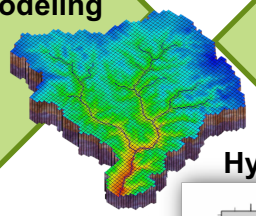
Atmospheric Forcing



Precipitation
Temperature
Humidity
Pressure
Wind Speed
Cloud Cover

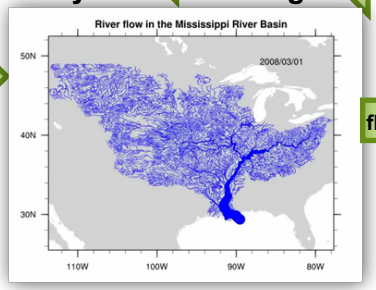
Terrestrial Modeling



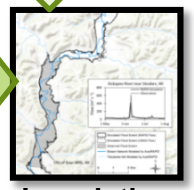


Runoff
Potential ET
Soil Moisture
Snow Water Equiv.

Hydraulic Routing

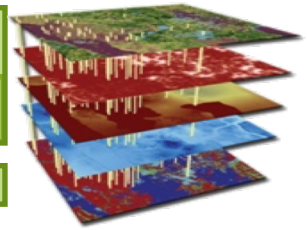


flow



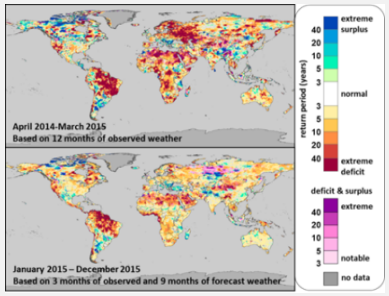
Inundation Mapping

Physical Geography

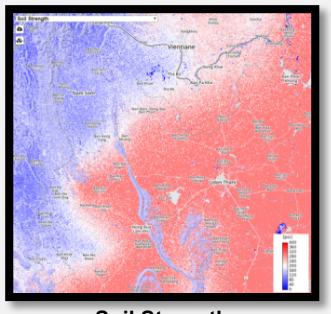


Soil
Geology
Land Cover
Terrain
Hydrography

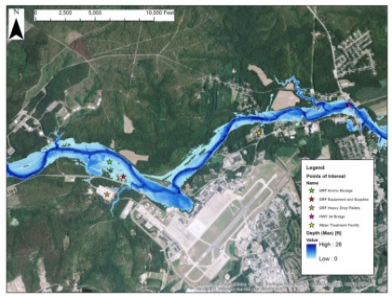
Spatiotemporal Products



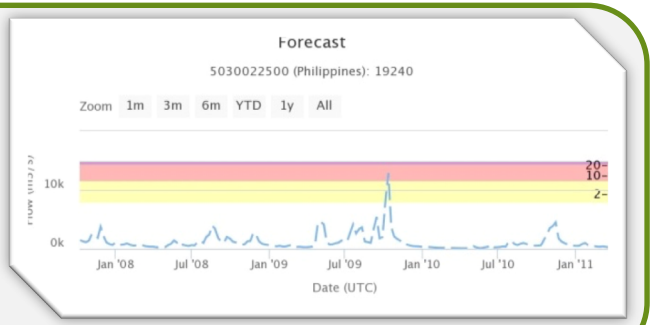
Water Security Indicators



Soil Strength



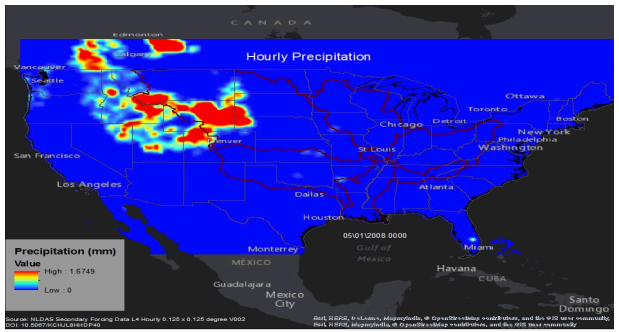
Flood Extents



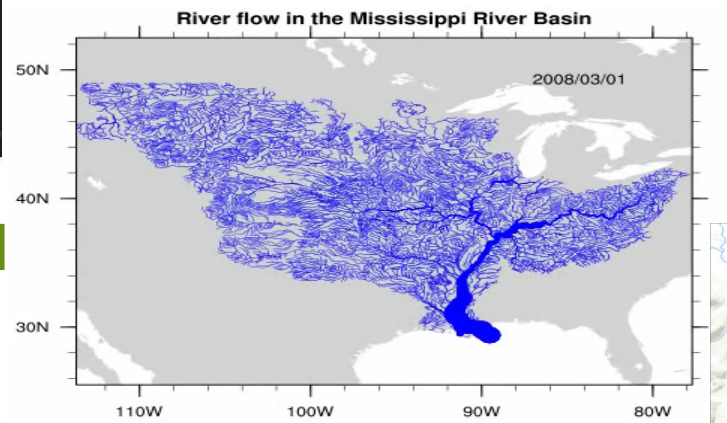
Streamflow

Weather Informed Hydrology: Integrated Approach

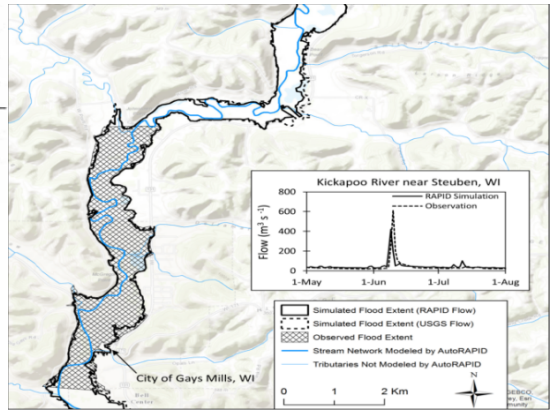
Weather



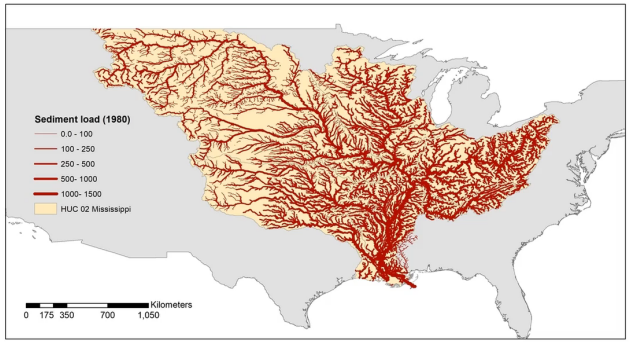
Streamflow

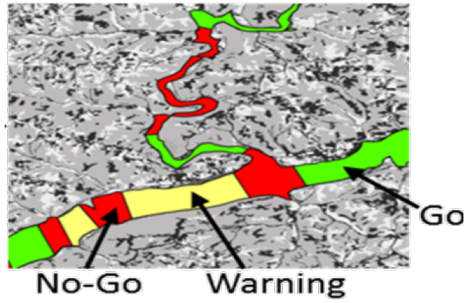


Flood Impact



Sediment Yield



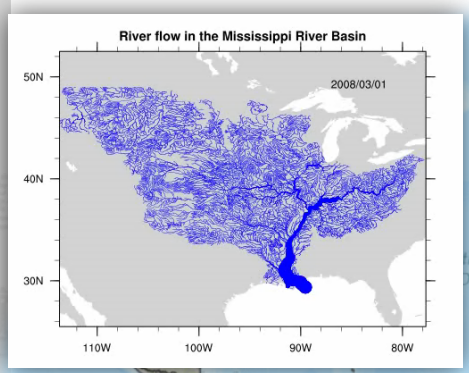


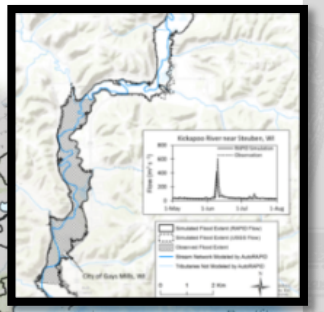
Gap-Crossing Maps

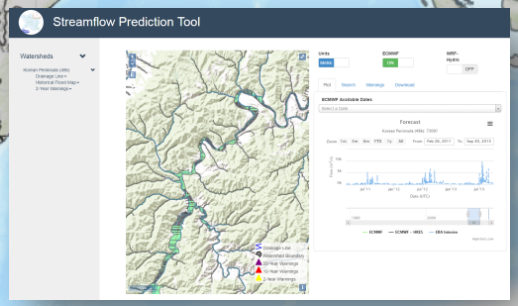
Hydrologic Awareness through Real-time Estimates of Streamflow and Inundation Mapping

Providing hydrologic information that is globally aware and locally precise

U.S. Army ERDC, along with university partners, developed a method for forecasting streamflow and mapping inundation by routing globally available runoff estimates over continental-scale stream networks. This is a first-order approach for estimating streamflow in ungauged basins. The tool provides a15-day hydrologic forecast in the context of a 35 year hindcast.

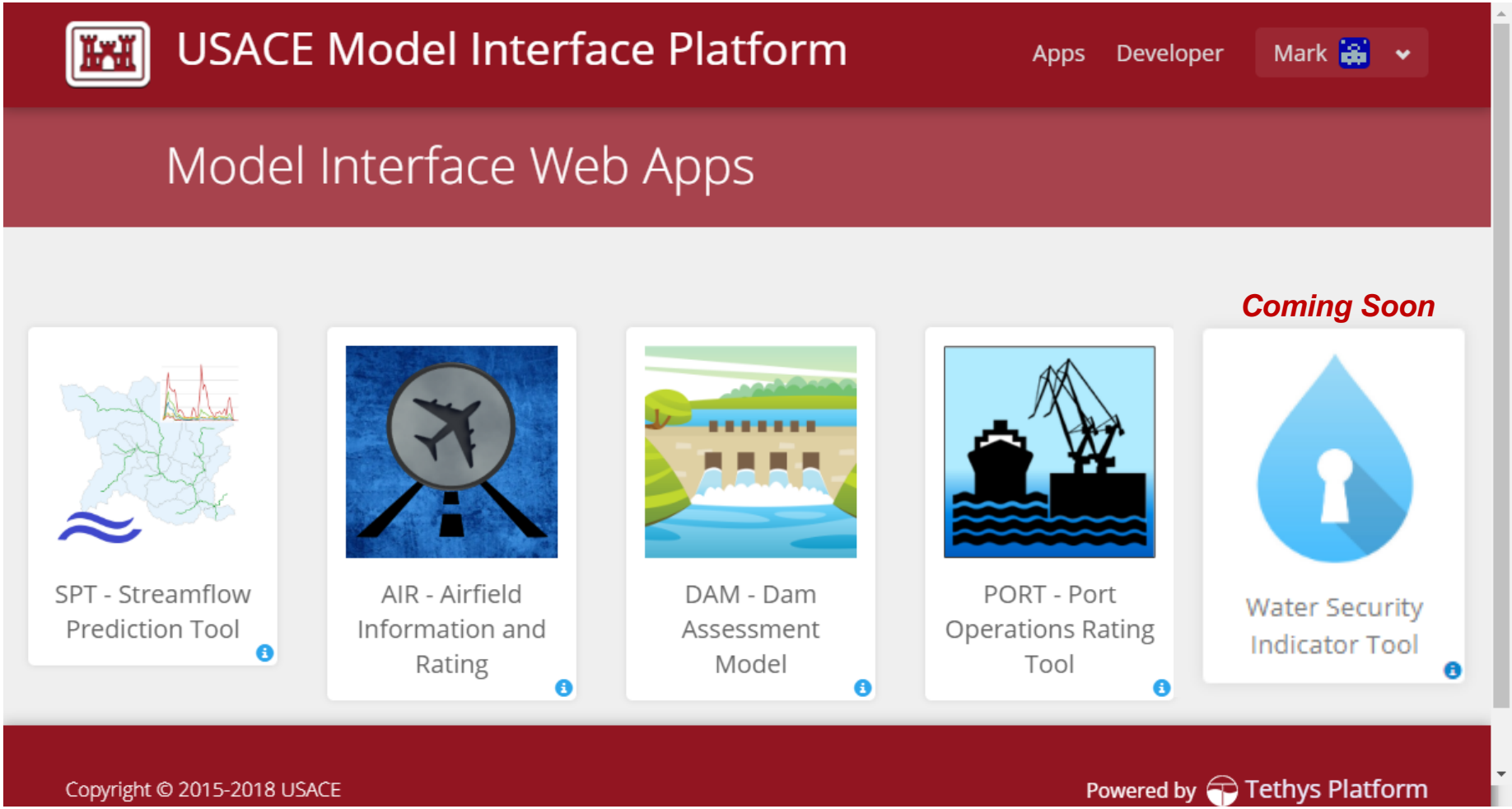






AutoRAPID is running operationally in several regions around the world after being tested and in the United States. This approach provides estimates of flow and inundation at each stream reach.

US Army Corps of Engineers • Engineer Research and Development Center



https://umip.erdc.dren.mil/apps/

Web-based Graphical User Interface

Making hydrologic information accessible and comprehensible

Operational application

European Centre for Medium-Range Weather Forecasts (ECMWF)

- The ECMWF global runoff ensemble provides 52 separate predictions every 12 hours
- Estimate cumulative runoff depths.
- The first 51 predictions represent an ensemble of equally probable conditions and are created at a lower resolution on a ~0.28-degree grid cell (up to day 10, ~0.56-degree grid cell thereafter)
- 6 hour accumulated runoff time step and a 15-day lead time.
- The 52nd forecast is a higher resolution with a ~0.14-degree grid cell
- varying time step of accumulated runoff with a 10-day lead time.

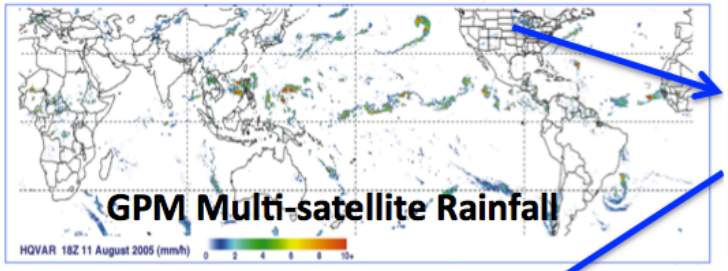
Hindcast Simulations

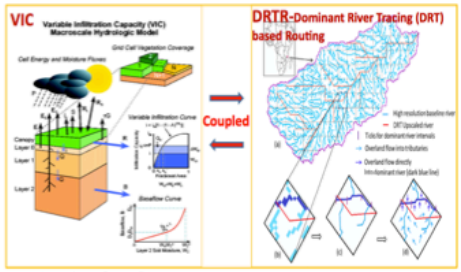
- **Operational application:** The ERA-Interim dataset (HTESSEL LSM)
  Global application, (~39 km grid cell), has a 3-hourly time step, and spans the years 1980-2014 (soon to be through 2018)
- **North American Land Data Assimilation Dataset: VIC LSM**
- **NOAH and JULES LSMs**

Global Flood Monitoring System (GFMS)

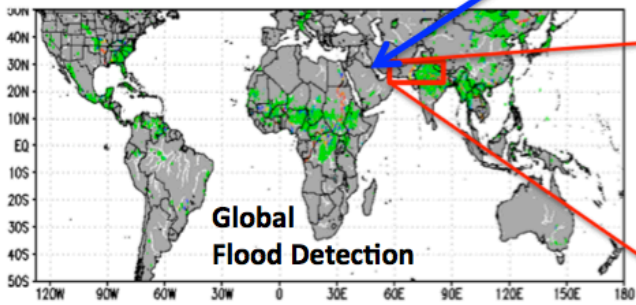
Global Flood Monitoring System (GFMS) http://flood.umd.edu/

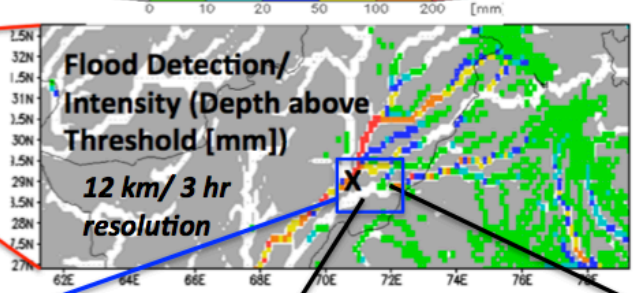
Global Real-time Flood Calculations Using Satellite Rainfall and Hydrological Model



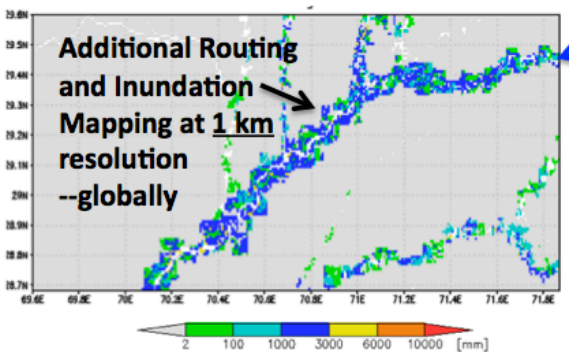


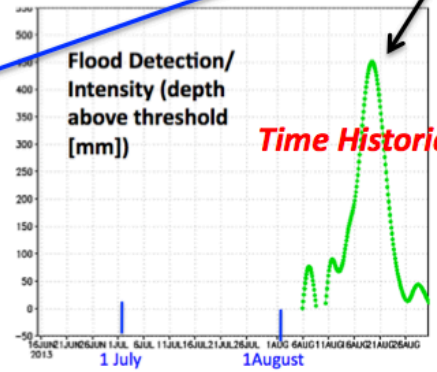
TRMM/GPM rainfall into land surface and routing models for water depth and stream flow calculations compared to flood thresholds

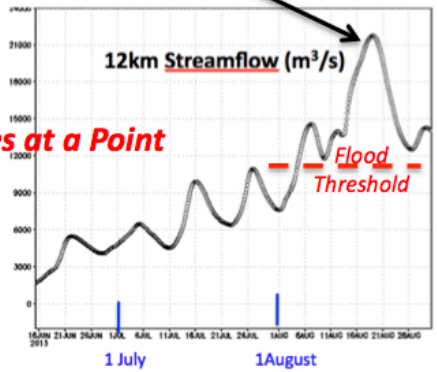




Indus River basin







Precipitation information is the key input into the GFMS

Global Flood Monitoring System (GFMS)

- Uses the NASA multi-satellite precipitation estimates, along with other satellite and conventional information
  - GPM IMERG (Integrated Multi-satellitE Retrievals for GPM (IMERG) is the primary precipitation product used in the GFMS
- Includes VIC land-surface and routing models
- The GFMS products provide real-time estimates of flood occurrence, intensity, and streamflow at 12 km resolution currently over areas 50N-50S, every three hours
  - Additional product: High-resolution (1 km) streamflow and inundation estimates

Precipitation information is the key input into the GFMS

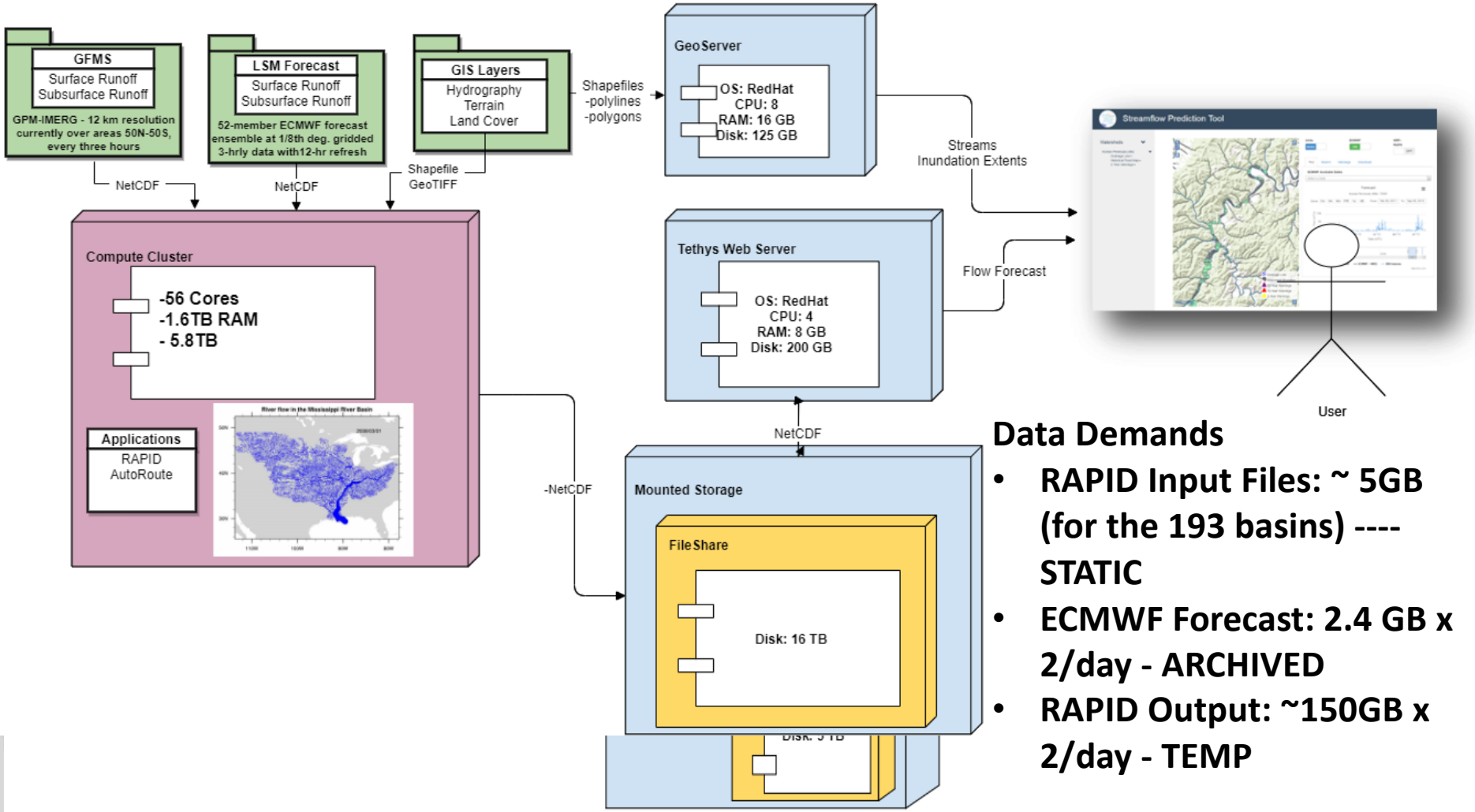
SPT Improvement

- Currently SPT uses ECMWF runoff as inputs to the river routing component of SPT
- Reanalysis may not be accurate in tropical and midlatitude regions where convective precipitation is the main sources of flood
- Reanalysis may not capture the correct location and timing of the storms
- Critical to generate a reliable flood maps especially in small and mid-size basins
- GPM IMERG providing near real-time maps of 0.1x0.1 precipitation estimates every ½ hour
- Need to revisit SPT and modify the framework so SPT can utilize the latest advancement in remote sensing of precipitation made available through IMERG
- SPT will use the functioning GFMS LSM output (using IMERG as input) to initialize the SPT calculations for forecasting as well real-time streamflow simulation

Revisit SPT to utilize the latest advancement in remote sensing of precipitation made available through IMERG

Existing SPT Architecture

Existing Framework



Data Demands

- **RAPID Input Files: ~ 5GB (for the 193 basins) ---- STATIC**
- **ECMWF Forecast: 2.4 GB x 2/day - ARCHIVED**
- **RAPID Output: ~150GB x 2/day - TEMP**

Research Objectives

- How well the IMERG based system is performed compared to the existing one that is based on runoff from ECMWF (impact assessment)?
- In which climate region and/or season improvement is achieved when IMERG is utilized?
- What causes such differences?

SPT Improvement

- Evaluate and compare SPT flood and streamflow results with GFMS and validation data as part of a hydrological evaluation of IMERG
- Revise the SPT framework to enable the use of GPM IMERG.
- Modify the existing web interface, so ERDC can also access the new maps based on IMERG to distribute to its wide users

References

SPT

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