Application of a SMAP-based index for flood forecasting in data-poor regions

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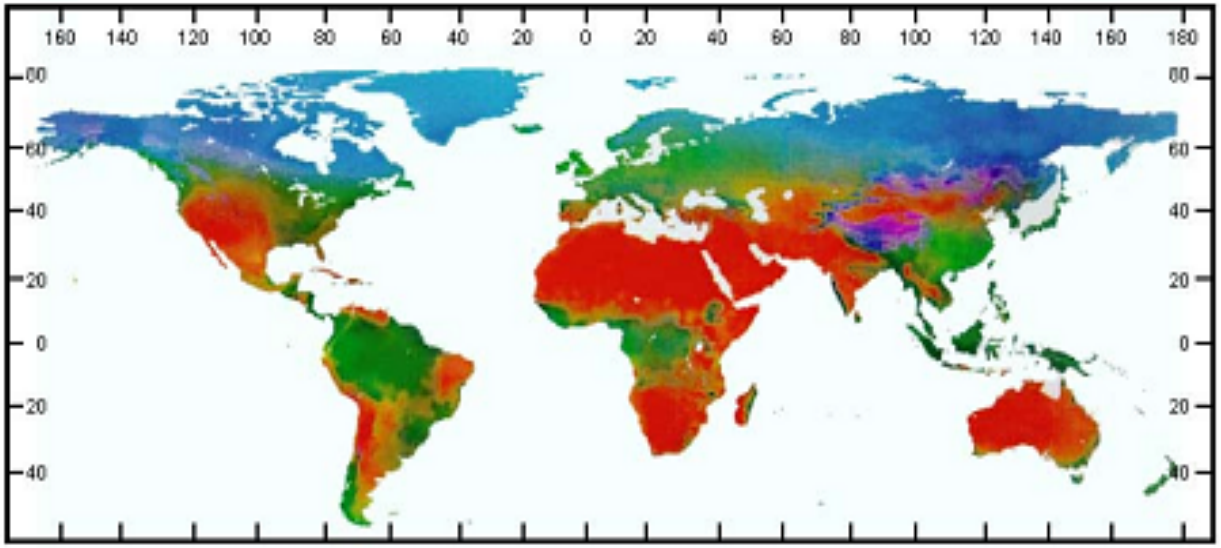
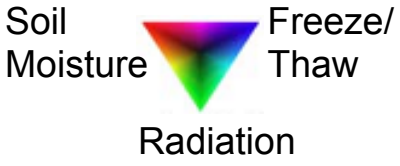
SMAP Mission Science Objectives

- Global mapping of soil moisture and freeze/thaw state to:
  - Understand processes that *link* the terrestrial water, energy and carbon cycles
  - Estimate global water and energy fluxes at the land surface
  - Quantify net carbon flux in boreal landscapes
  - Enhance weather and climate forecast skill
  - Develop improved flood prediction and drought monitoring capability

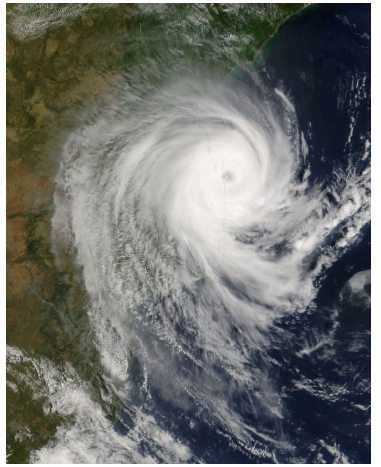


Primary controls on land evaporation and biosphere primary productivity



Motivation & Zambezi Test Case

- UN World Food Programme (WFP): http://www.wfp.org/
- Main objective: After emergencies/disasters, help communities rebuild
- Flooding is one of the most devastating natural disasters
- Floods are regular and devastating in many regions
- Mozambique is known to be a flood-prone country (hotspot region)
- >130,000 people evacuated and >30 people killed (2007 event, modeled here)



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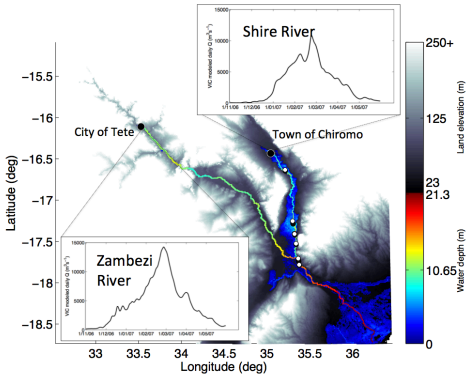
Proposed way forward in terms of science

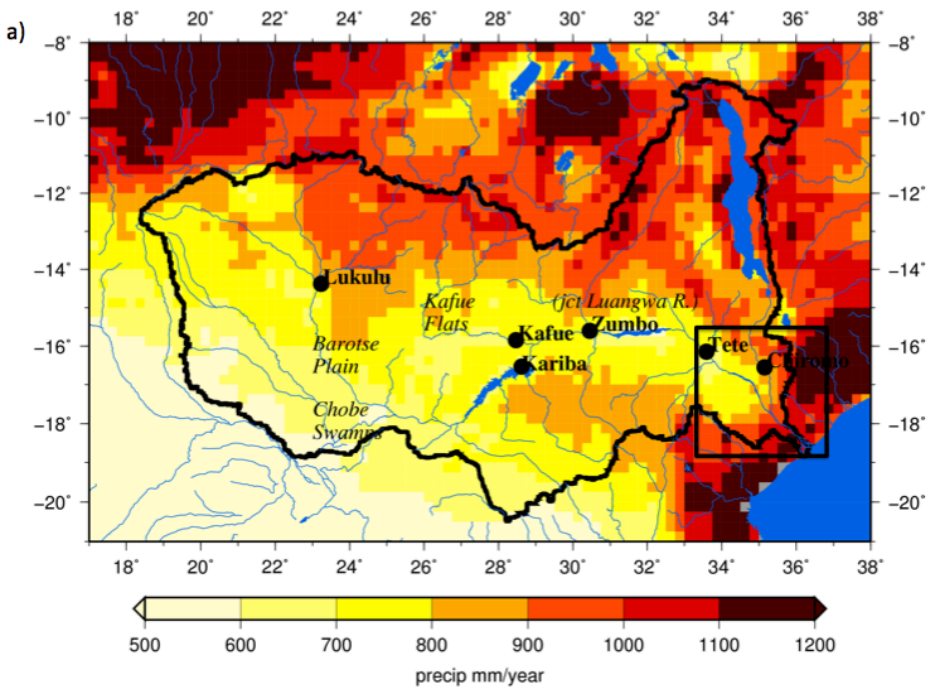
- Short-term flood forecasting in hotspot regions would improve food distribution logistics and operations

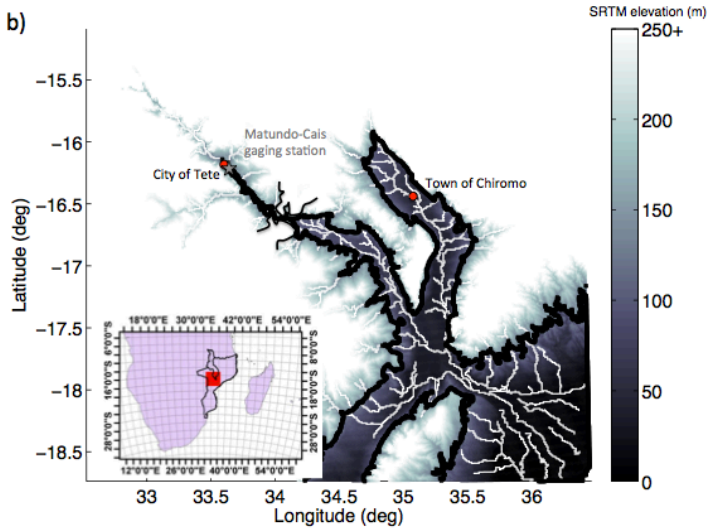
What we have (for the Mozambique Delta)

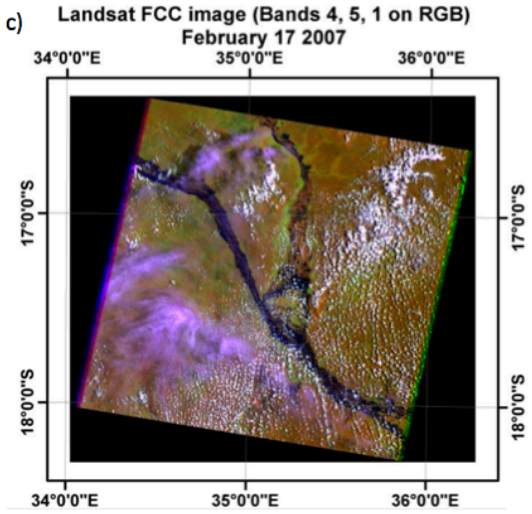
- Designed a flood model for large scale applications to forecast inundation extent, level and wave propagation (utilizes globally available input & boundary data sets; no gauge or any other field data available)
- Calibrated and evaluated on a 700 km stretch of the Zambezi River in SE Africa (Mozambique delta). Cal. against altimetry water level: 27 cm RMSE. Val. against Landsat flood: 0.86



Study Area


a)
Lukulu
Kafue Flats
(jct Luangwa R.)
Kafue
Zumbo
Barotse Plain
Kariba
Tete
Chiromo
Chobe Swamps
precip mm/year

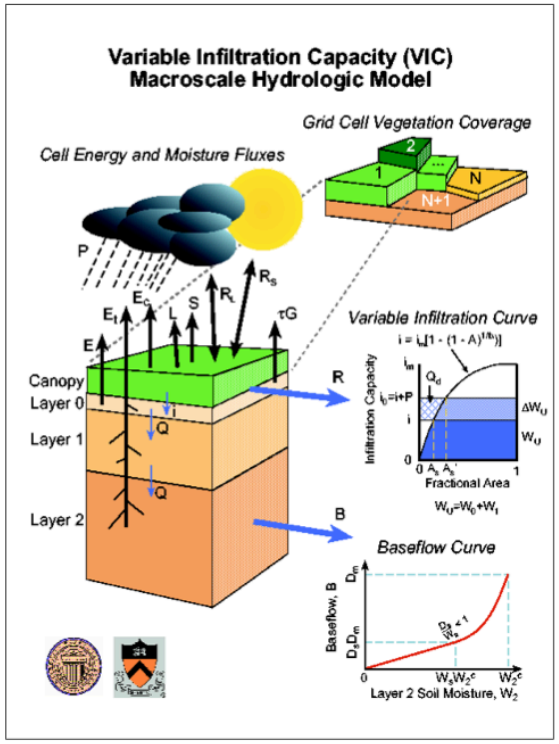

b)
SRTM elevation (m)
Matundo-Cais gaging station
City of Tete
Town of Chiromo
Latitude (deg)
Longitude (deg)


c)
Landsat FCC image (Bands 4, 5, 1 on RGB)
February 17 2007

VIC & LISFLOOD-FP

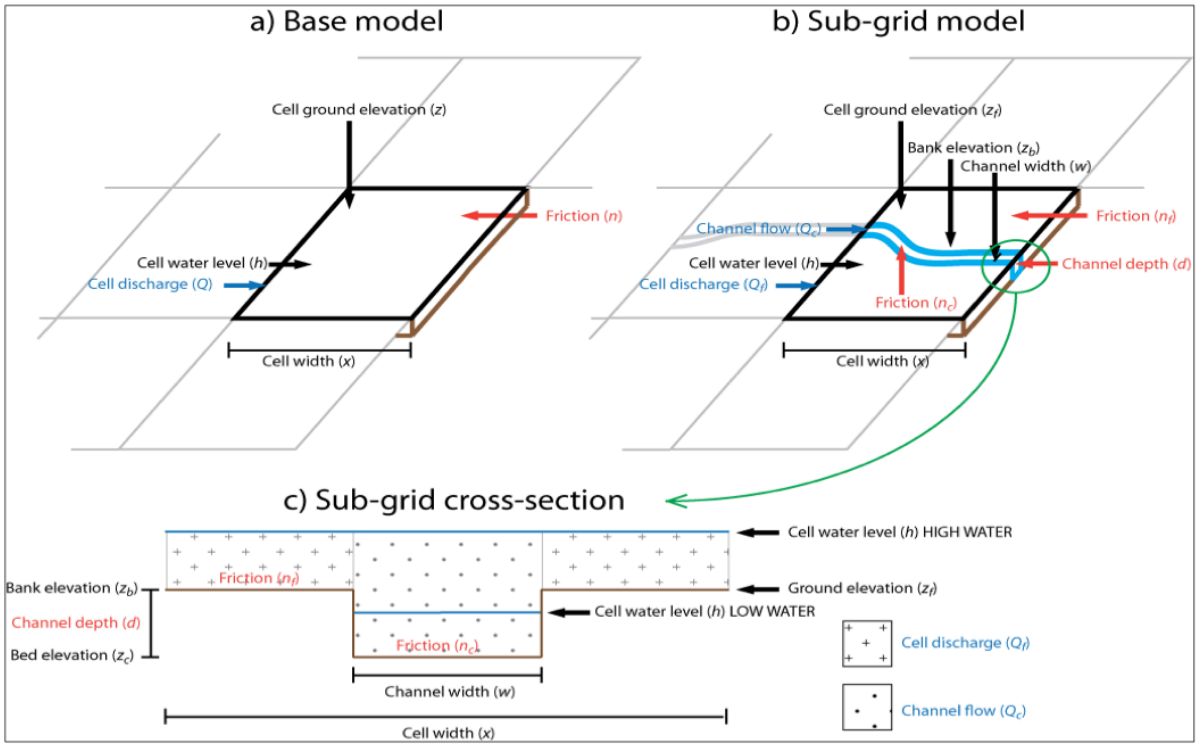
VIC hydrology model

a

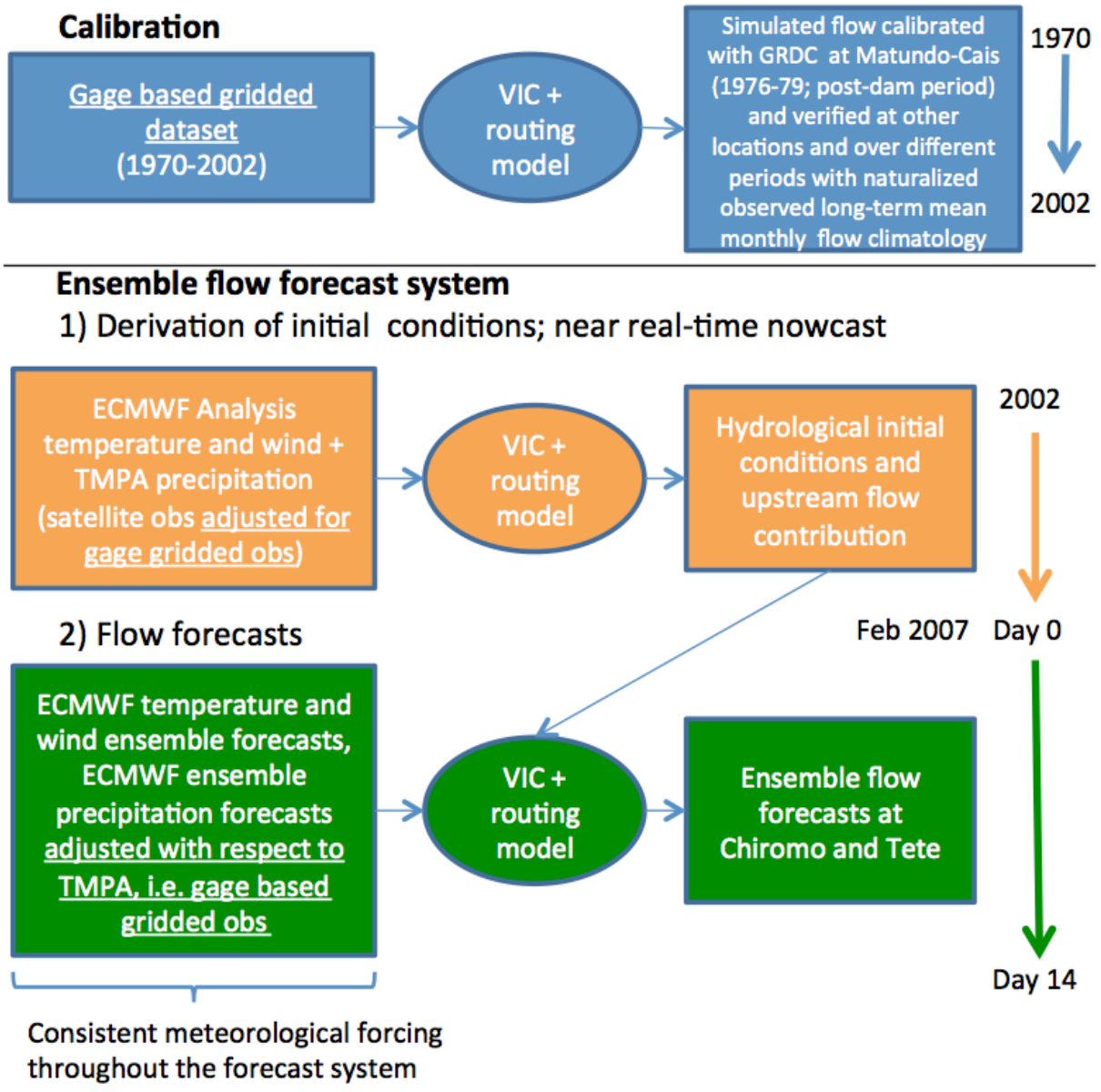


LISFLOOD-FP hydraulic model

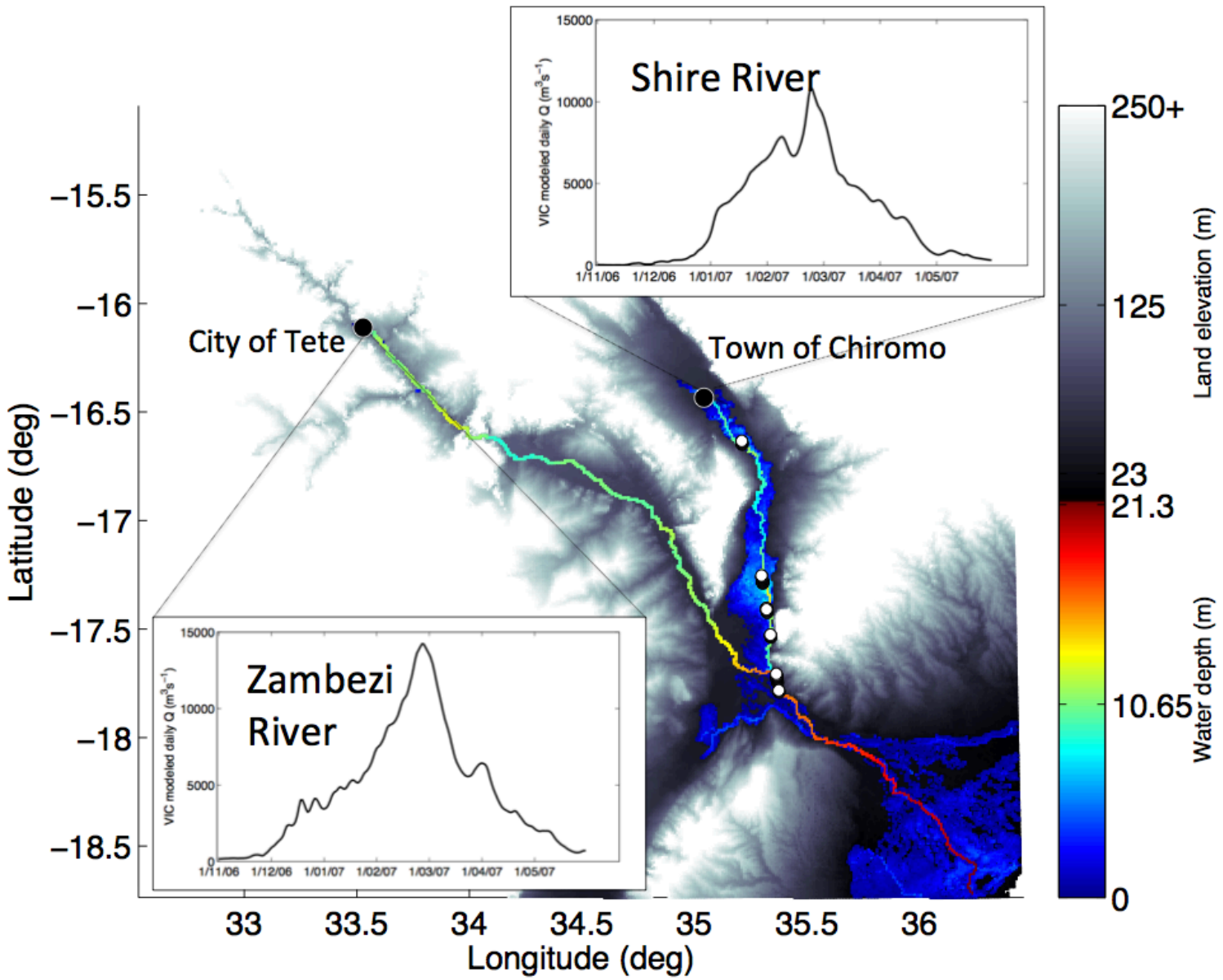
b



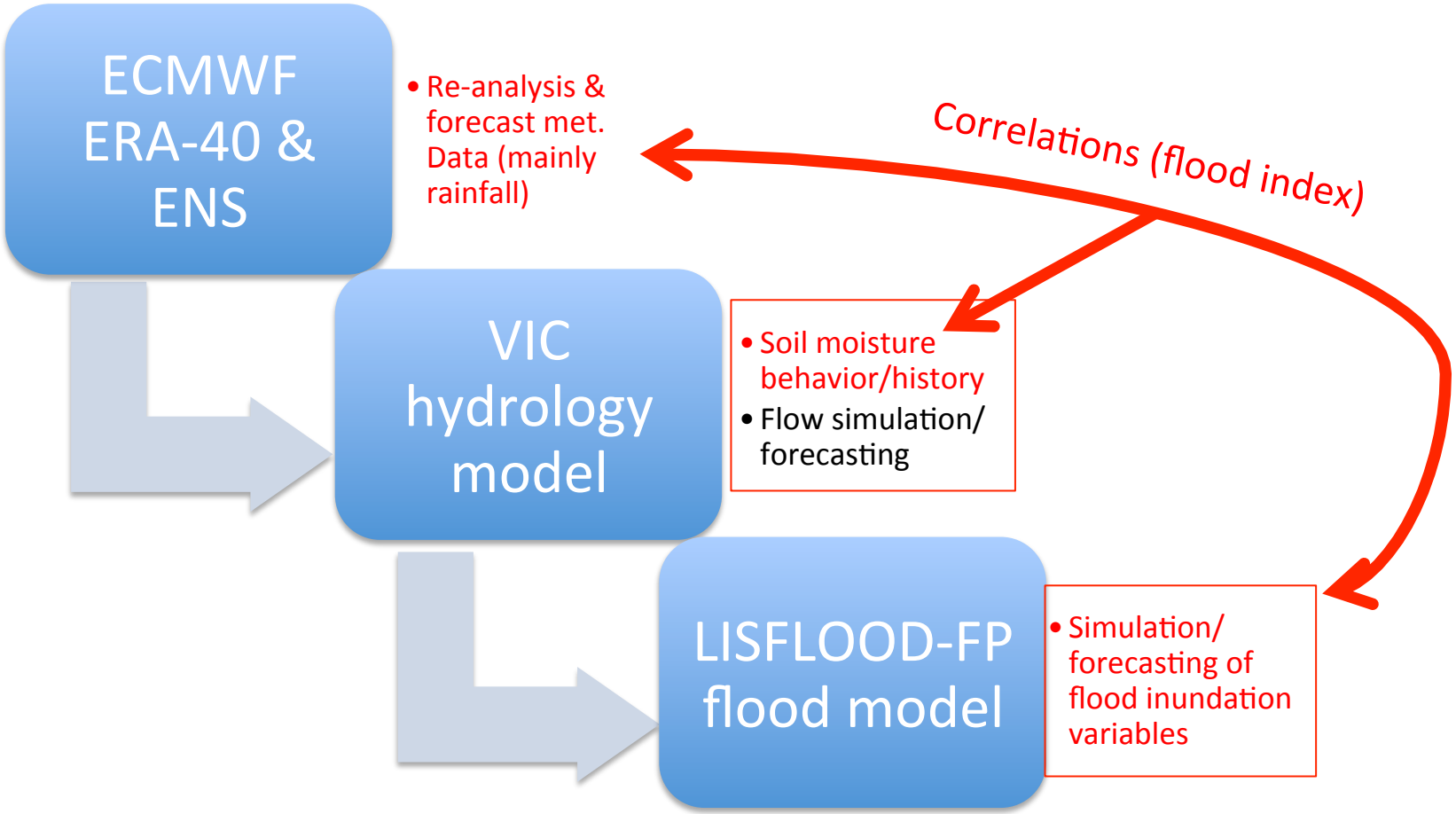
Hydrologic Model (cal/forecast)



Hydraulic model (2007 event)



Modeling Chain (SMAP EA project)

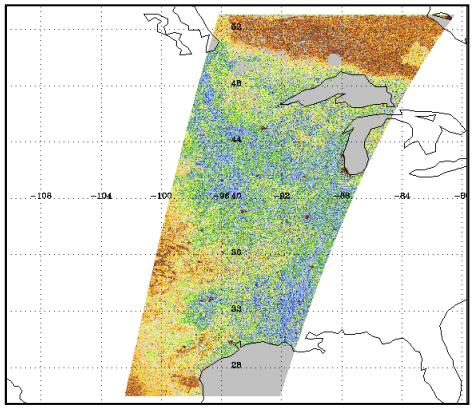


Simple Flood Prediction Index

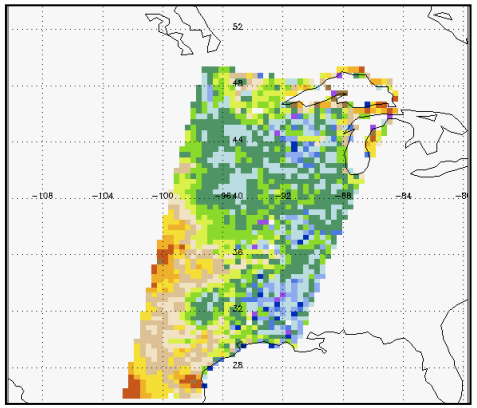
1) Build long database (lookup catalogue) of re-analysis soil moisture, simulated flows and corresponding flood inundation variables (this already exists)
2) Regress these three components to define simple flood index (part of the SMAP EA)
3) Validate flood index on 2007 event (in forecast mode), using ECMWF ENS & VIC soil moisture (try simulated SMAP data to get familiar with the format) (part of the SMAP EA)
4) Eventually use future ECMWF ENS forecast rainfall (already at UN WFP) and SMAP observed SM to predict flood variables (depth, extent, area) with the lookup database and the flood index (No need to run the big models!)

SMAP L2 and L3 Data Products
(Simulations)

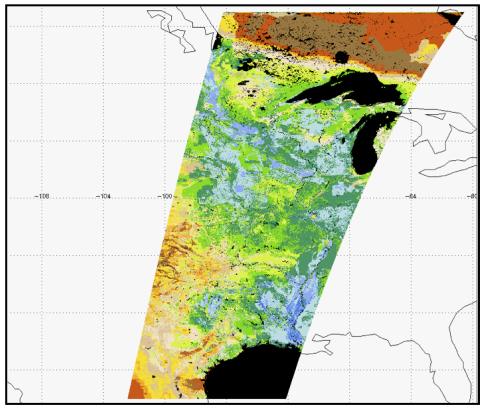
Soil Moisture (Active) (3 km)

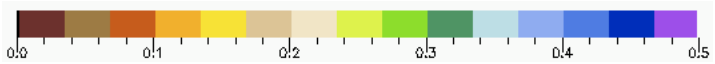


Soil Moisture (Passive) (36 km)



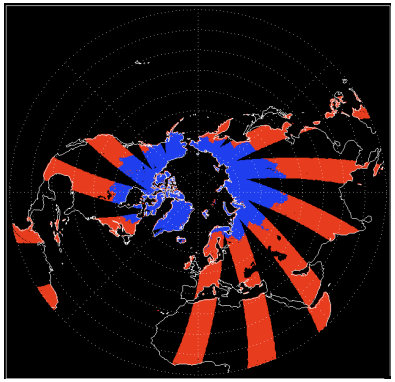
Soil Moisture (Active-Passive) (9 km)

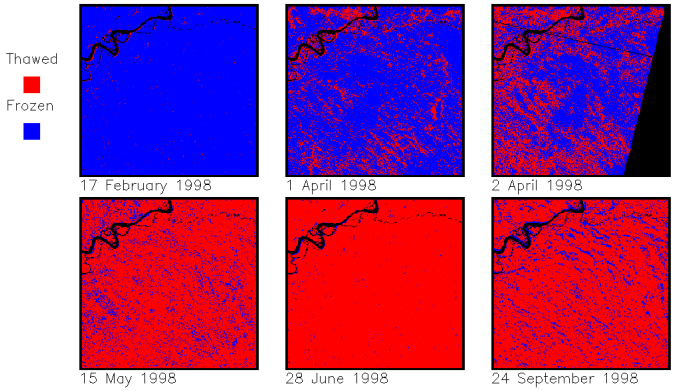




Volumetric Soil Moisture (cm^3/cm^3)

Freeze/Thaw State (Active) (3 km)





Added Value

- First complete modeling system including inundation simulation/ forecasting
- Simple, yet detailed modeling
- Proposed flood prediction index is easily built and applicable to other data sparse areas and large scales (> several 100k km^2 of domain)
- Satellite data add great value (SMAP & SWOT future potential)
- Follow-on work (pending NASA THP – Terrestrial Hydrology Project) will develop a more extensive hydrology model (including dams, reservoirs & wetlands) and also full dynamic coupling between VIC-WRM (water resources model)-LISFLOOD-FP
- We will also use assimilation of existing/future satellite products