SWOT River Model Inter-Comparison

CaMa-Flood Results

- Mississippi River -

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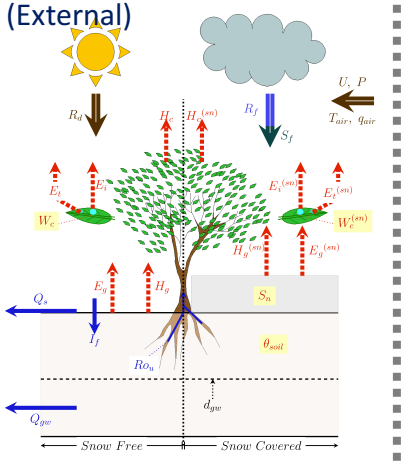
JAMSTEC – Japan Agency for Marine-Earth Science and Technology

7 Nov 2016 @ SWOT-ST Tele-Con

CaMa-Flood Framework

Forcing Data (External)

Land Hydrology (External)



Catchment/Hillslope Routine (External or Neglected)

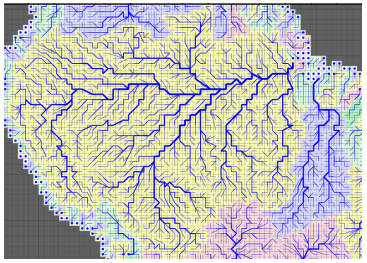
No hillslope process & no groundwater delay in CaMa simulations for SWOT MIP

NLDAS was used for SWOT MIP

Total Runoff

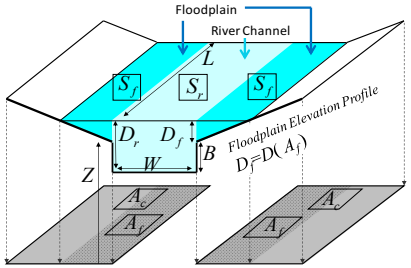
CaMa-Flood (Yamazaki et al., 2011, 2012, 2013, WRR; 2014 GRL)

River/Floodplain Routine



1D river network (default)
Local Inertial Flow Equation

- Backwater effect represented
- Both channel and floodplain flows
- No lake or reservoir routine



Sub-grid flood inundation

- No depression in floodplain (no levee)
- Same water elevation between river channel and floodplains
- No 2D floodplain flow

River network map + Sub-grid toporaphy

Topography (External, with some modifications)

Flow Direction (HydroSHEDS 15sec DIR)

Elevation (HydroSHEDS 15sec DEM)
+ hydrological adjustment (Yamazaki et al., 2012, JoH)

Channel Geometry (W and B from Kostas)

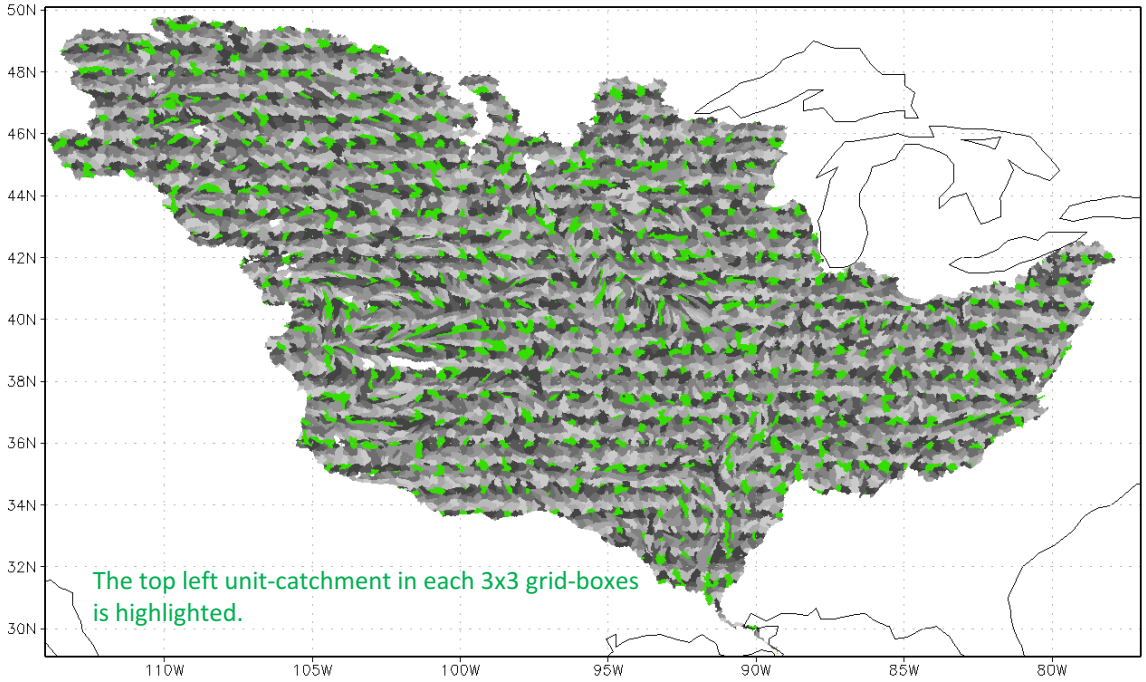
Above were used for SWOT MIP

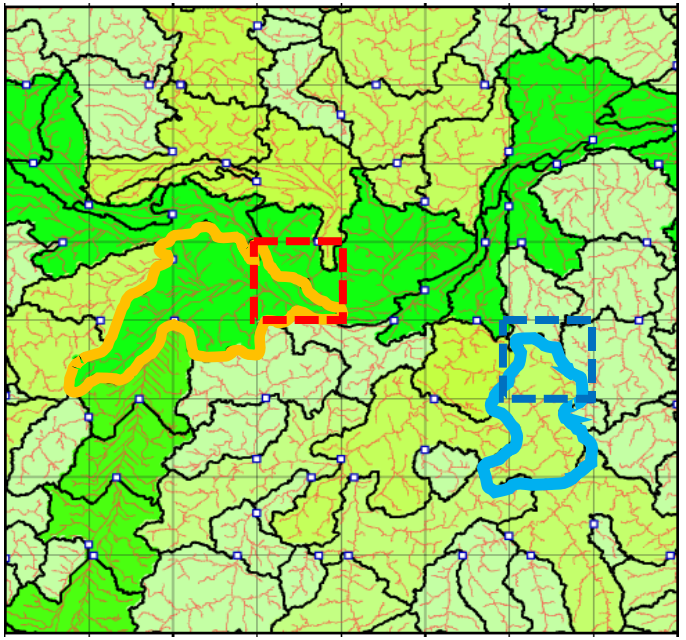
CaMa is almost same as MGB-IPH by Rodrigo, but it only solves river/floodplain routine.

Land hydrology and catchment/hillslope routine should be calculated by external models.

CaMa-Flood characteristics 1

Quasi-2D Catchment Discretization



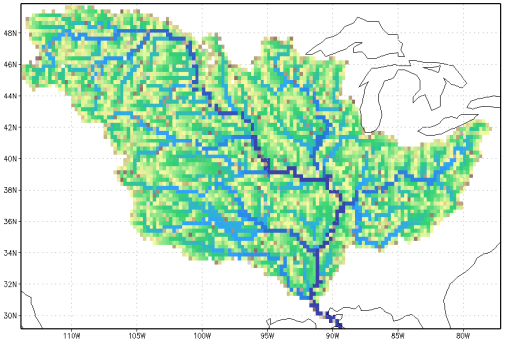


One unit-catchment is defined for one coarse-resolution grid box. (e.g. 0.25deg in the above figure)

- The average size of unit-catchments is similar to that of coarse-resolution grid-box.
- The actual size of each unit-catchment varies.

Irregular-shape catchments allocated on a regular lon-lat grid system.

- The maps and output of CaMa-Flood are in a lon-lat gridded format.
- Very easy to analyze.

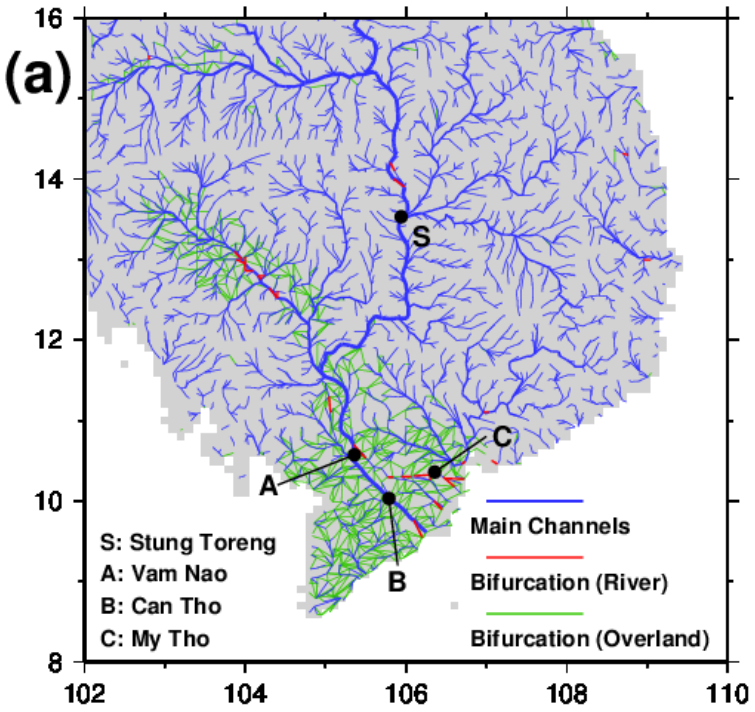


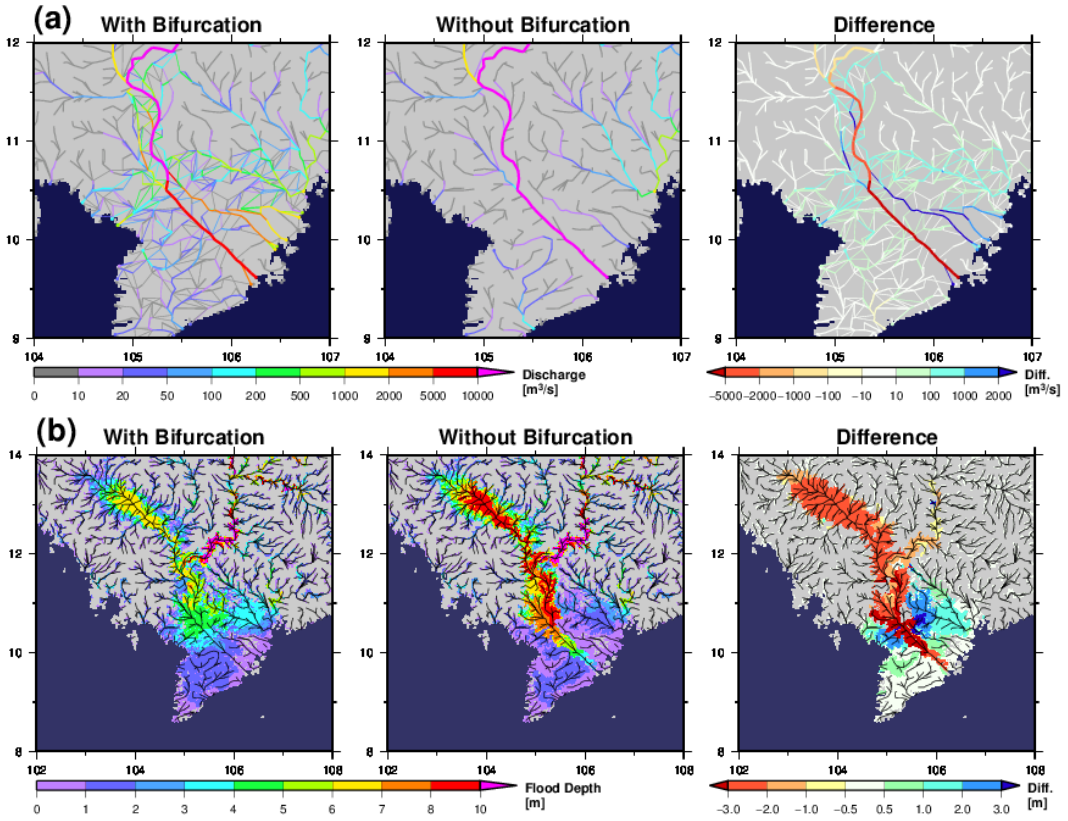
CaMa-Flood river network @0.25 deg

(Yamazaki et al., 2009 HESS; 2011 WRR)

CaMa-Flood characteristics 2

Quasi-2D River Network (Channel Bifurcation)





Bifurcation channels can be added by analyzing 3sec topography data (optional).

- Channel bifurcation in a delta region, quasi-2D flow in floodplains can be simulated.

This option was not used in Mississippi simulations for SWOT-MIP

(Yamazaki et al., 2014 GRL)

CaMa-Flood simulations

Hydrodynamic simulation for the Mississippi River using NLDAS runoff

Date: 01 Jan 2000 – 31 DEC 2010 (+1year spin-up using year 2000 runoff)

Resolution: 0.1 deg / 0.25 deg
Time Step: Automatically adjusted following CFL

Topography: Default SWOT-MIP setting
(but DEM was adjusted due to CaMa-Flood requirement)

Required wall-clock time:

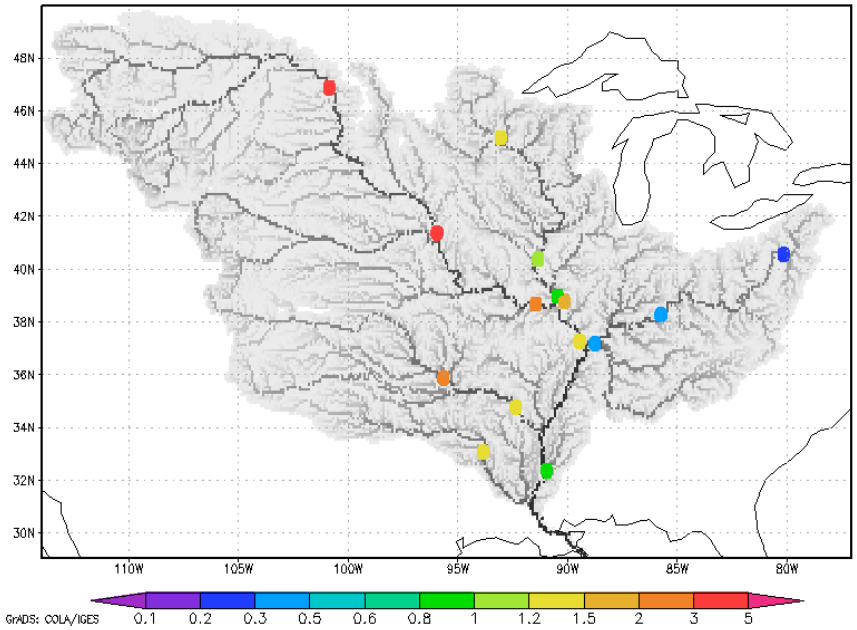
1 model-year simulation takes ~2min at 0.1deg resolution
~15sec at 0.25deg resolution

Using Intel Fortran + OpenMP on 3.0-GHz 8-core Intel Xeon on Apple MacPro-2013

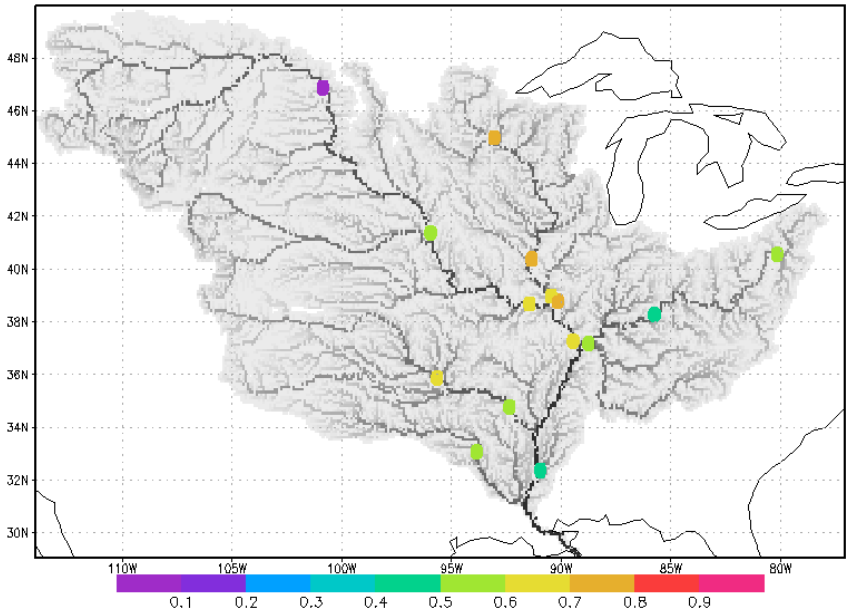
CaMa-Flood simulations results

Hydrodynamic simulation for the Mississippi River using NLDAS runoff

Relative Bias (Qsim / Qobs)



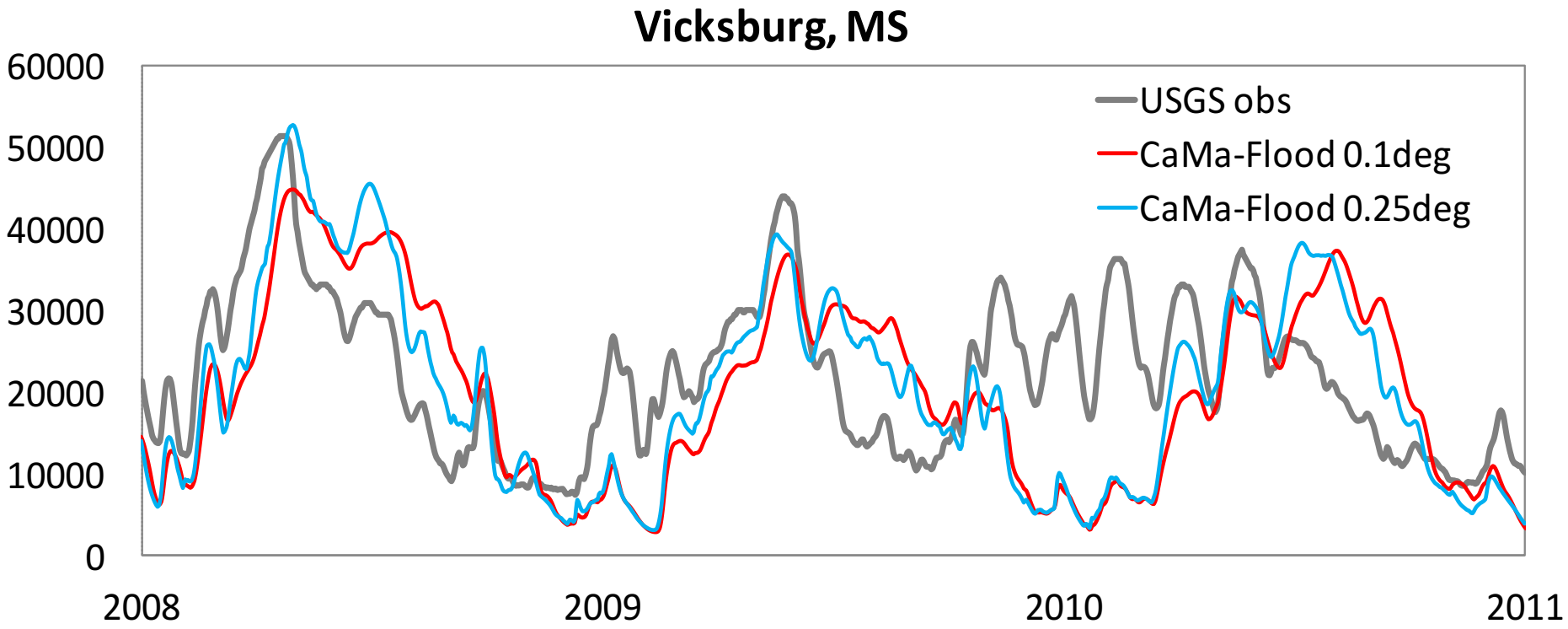
Correlation (Qsim & Qobs)



Selection of USGS gauges were same as HRR presentation by Ed

CaMa-Flood simulations results

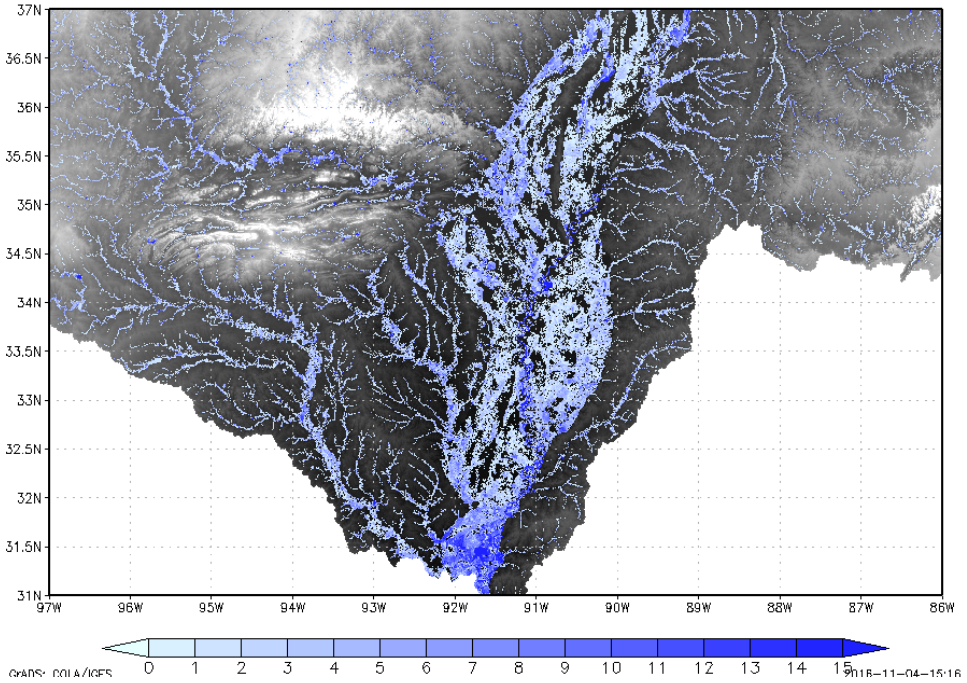
Hydrodynamic simulation for the Mississippi River using NLDAS runoff



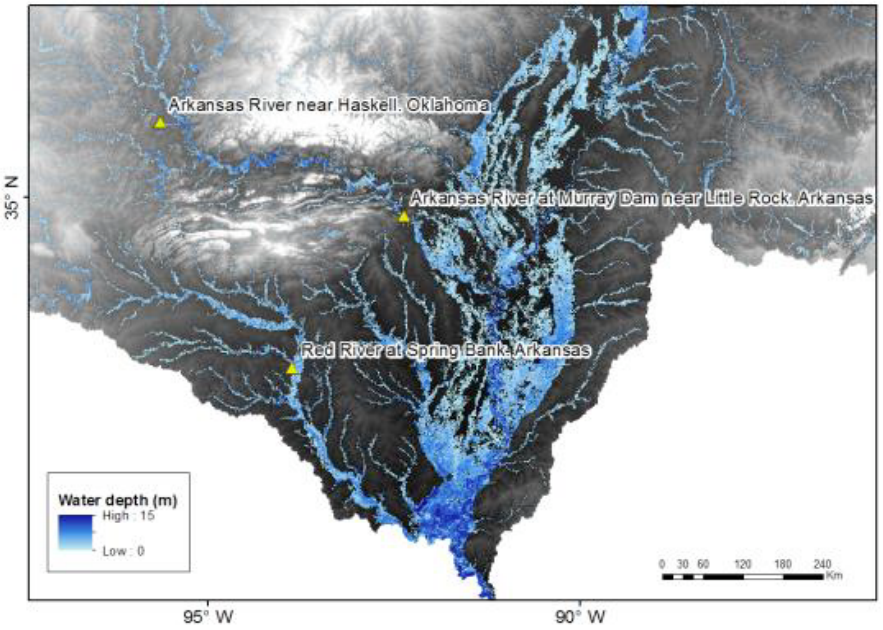
CaMa-Flood simulations results

Hydrodynamic simulation for the Mississippi River using NLDAS runoff

Max Flood Depth (CaMa-Flood)



Max Flood Depth (MGP-IPH)

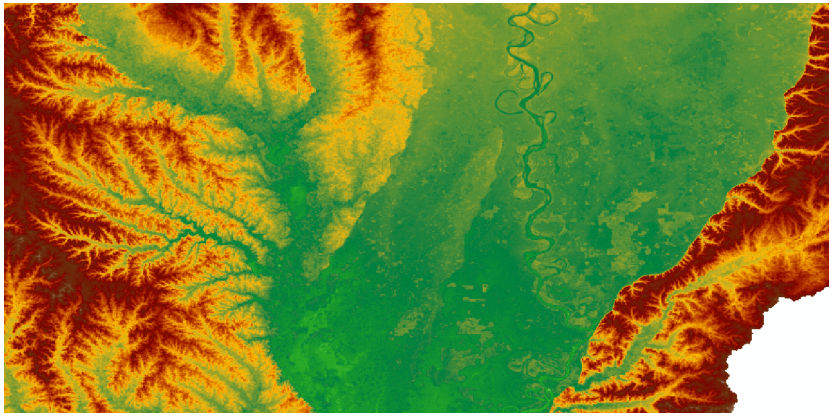


From Rodrigo's Slide

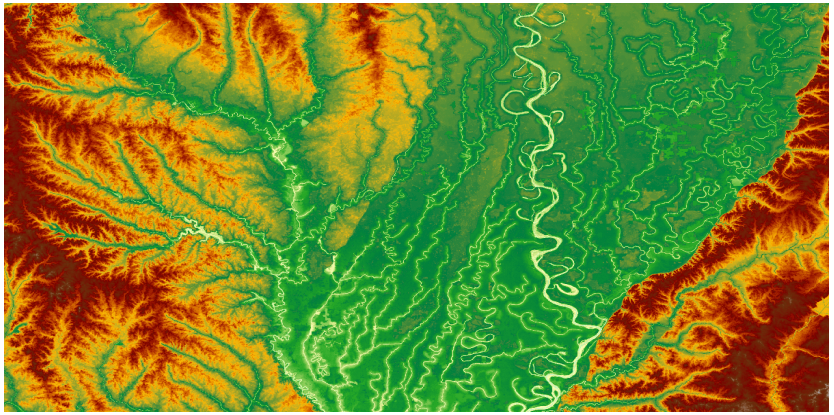
Some discussions on DEMs

After last tele-con, we found “HydroSHEDS 15sec DEM” was actually not conditioned.

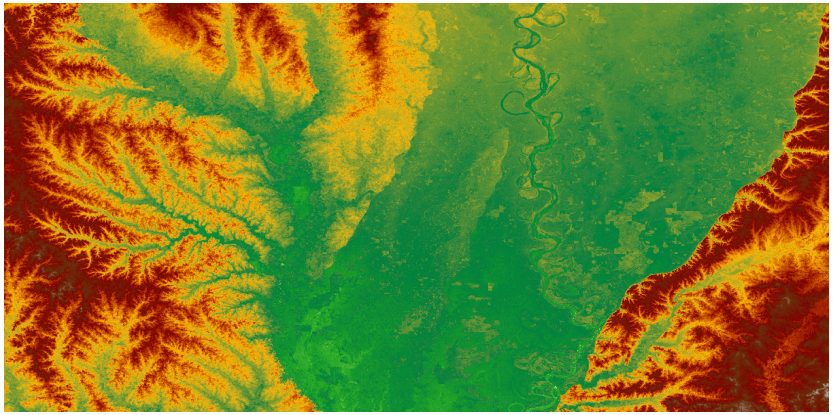
Void Filled 3sec DEM:



Conditioned 3sec CON:



Conditioned 15sec CON:



→Though the file name is “CON”,
the 15sec DEM on the webpage was not conditioned
The elevations were similar to 3sec Void-filled DEM.
Some negative slopes were found along river networks.

Because CaMa-Flood requires conditioned DEM,
I adjusted DEMs to remove negative slopes.
(Adjusted DEM was accessed from Cedric’s Project webpage)

Other models smoothed DEMs (MGB / LISFLOOD-FP),
or assumed minimum slope (Kinematic type).

Figures generated by Rodrigo, thanks.

Some Questions about MIP framework

[1] How do we submit the results to Cedric?

e.g. Discharge data in an Excel file?

If a sample output data format is available, we can just follow it.

[2] Should we keep consistently on DEM modification?

Following e-mail discussions after the last phone-call, we found that:

- Some models perform “DEM conditioning” internally (i.e. New DEM was not generated)
- CaMa-Flood needs to generate a conditioned DEM.

(The generated new DEM was put on the project web).

Probably, we can do simulations with two DEMs (original and conditioned).

[3] Hillslope/catchment routine (before river/floodplain routine)

Given that these routines are independent from river/floodplain routine,
should we also assess the uncertainties due to these scheme?

Some additional news from Tokyo

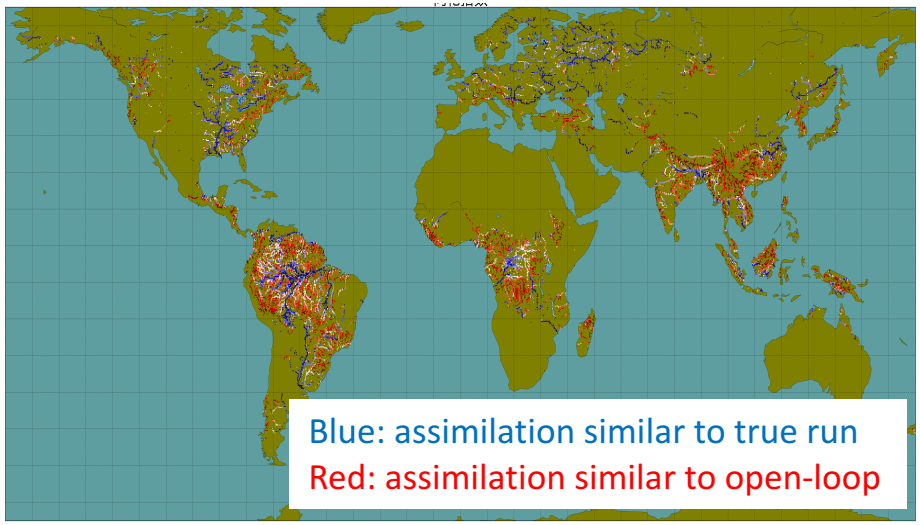
[1] We developed ”SWOT GLOBAL river assimilation” framework.

Poster at AGU (just beside Cedric’s poster)

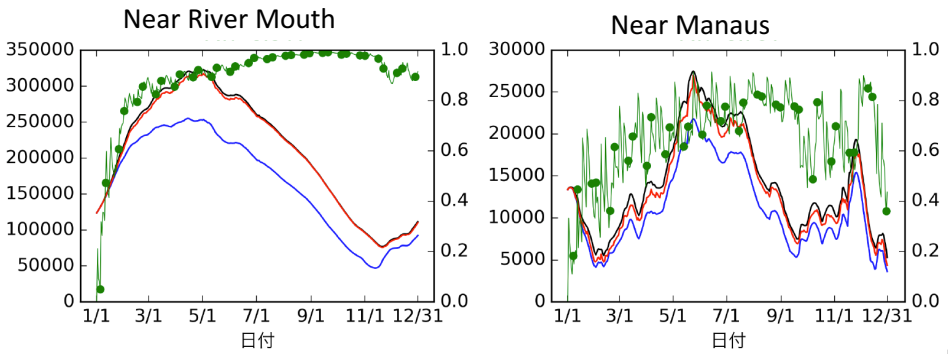
Virtual SWOT twin experiment, using CaMa-Flood as a dynamical core.
- Assume model and topography are true (no uncertainty).
- Assume SWOT can observe CaMa-Flood’s water level with 10cm accuracy.
- Only uncertainty is in runoff forcing. (-25% bias, following [Andreadis, 2007, GRL])

We assimilated SWOT observed water level, with daily interval, using LETKF
(Local Ensemble Transform Kalman Filter).

Similarity between assimilated and true runs



Amazon Mainstem Discharge

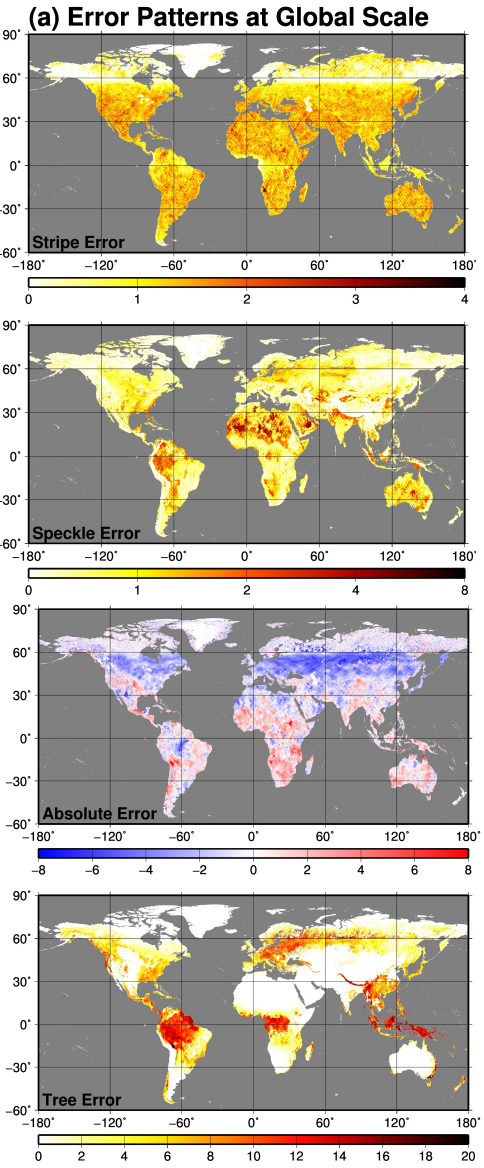


Blue: Open-loop, Black: true run, Red: Assimilation run

Green: (true – assimilation) / (true – open-loop)

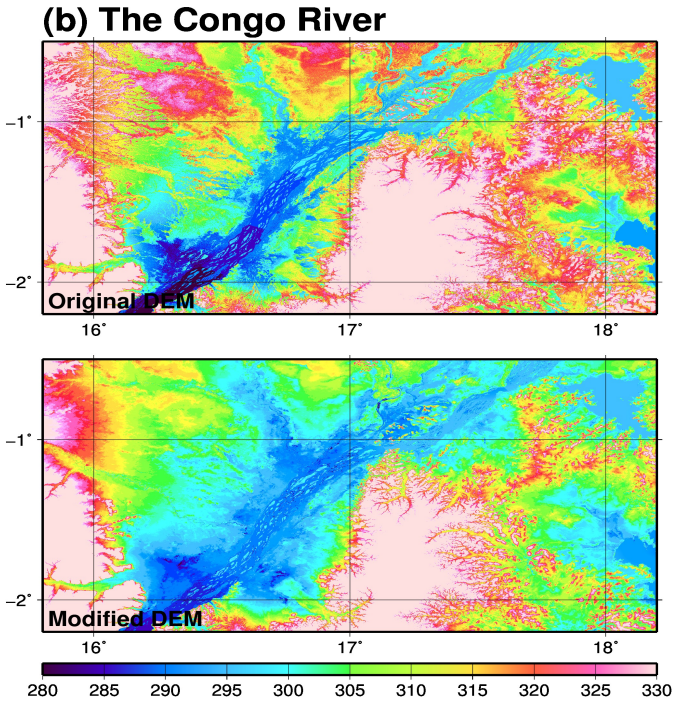
Some additional news from Tokyo

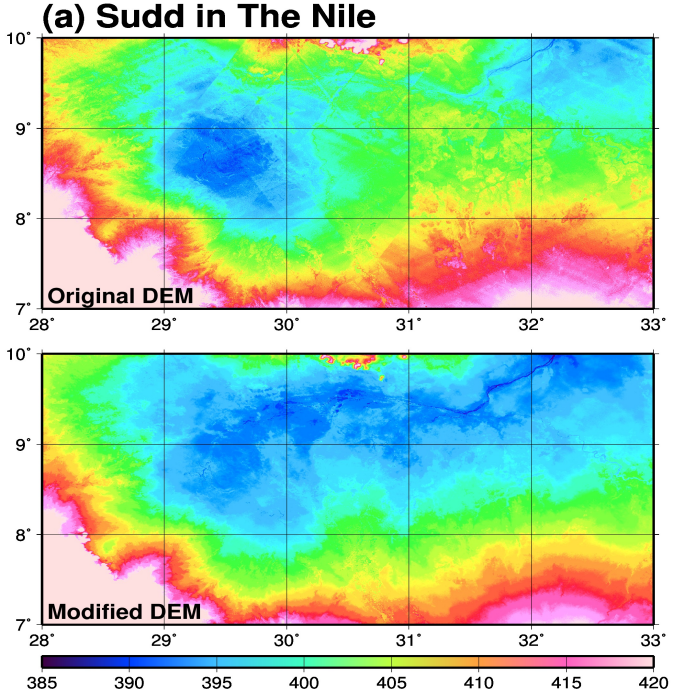
[2] A new and better global DEM. Talk at AGU (Friday Morning)



We removed major errors from SRTM and AW3D DEMs.
(Stripe noise, Absolute bias, Tree bias, & Speckle noise)

We performed >2m correction for 37% of all land pixels.
In the new DEM, 58% of pixels have errors <2m.
and 90% of pixels have errors <5m (except mountainous region).





A description paper is in prep., the data will be available soon.