SWOT Hydrologic Modeling Activities: A Large Scale Niger Application and towards a global Hydrodynamic-Hydrological system

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Collaborations with: LEGOS (N. Mognard, J.-F. Cretaux, S. Biancamaria), LMTG (M.-P. Bonnet, S. Calmant), LERMA (C. Prigent), LTHE (L. Descroix, T. Vischel), CNRM (B. Decharme), IPH

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ISBA/TRIP modeling of the Niger basin

Thesis: Preparation for the Surface Water Ocean Topography mission: The use of wide-swath altimetry for modeling hydrological and hydrodynamic processes in West Africa as a part of the AMMA Project

Vanessa Pedinotti: Thesis directors: A. Boone (CNRM-GAME, Météo-France) and N. Mognard (CNES/LEGOS)

Collaborations: Bertrand Decharme (CNRM-GAME), Luc Descroix (LTHE), Jean-François Cretaux (CNES/LEGOS), C. Prigent (LERMA), T. Vischel (LTHE)

Resumé 2010:
• Set up SURFEX model configuration (using ISBA and TRIP) over the Niger basin
• Evaluation of different forcing inputs (rainfall: TRMM, CMORPH, PERSIANN), evaluation of simulated flood extent using satellite data, discharge evaluation…
• Use TRIP-Offline (classic configuration) to simulate discharge from ALMIP (10 LSM models)
• Simulations and sensitivity tests using fully coupled floodplain and simple aquifer representation
• Results presented at the AGU of the Americas, Foz, Brazil, July, 2010
ISBA/TRIP modeling of the Niger basin

0.5 deg resolution, 2002-2007

ISBA/TRIP (Oki et al., 1999)

Niamey, Niger

ISBA/TRIP coupling: Decharme et al., 2007

ISBA/TRIP modeling of the Niger basin

Satellite Product: Flooded Zones (from J.-F. Cretaux, LEGOS)

Water extent developed from a classification based on MODIS data: fraction represent coverage over delta region
ISBA/TRIP modeling of the Niger basin

- Using TRIP alone (offline) with LSM runoff: overestimate of discharge, rapid recession
- Coupled system: better timing and volume

**Perspectives 2011:**
- Use GRACE to better estimate/constrain water budget components, and additional water fractional coverage product (Prigent)
- Perform more sensitivity tests towards parameter estimation optimization
- Use MGB simulation by Jhan-Carlo as « SWOT observation » to develop assimilation
Previous Work discharge, water level and flood inundation in Solimões River simulation results from MGB-IPH hydrodynamic model:

- Full Saint Venant equations
- Simple storage model for flood inundation
MGB-IPH hydrological and hydrodynamic simulation on Purus river basin

1) Synthetic SWOT data using the calibrated MGB-IPH model

2) Automatic calibration of MGB-IPH model using the previously simulated SWOT data

Estimation of discharge: 2004-2005

Compute discharge using Manning equation:

\[ Q = \frac{1}{\eta} B (z(0) - z_0)^{0.667} S_{swot}^{0.5} \]

*SWOT – MGB-IPH
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Hydrodynamic simulation of Niger River using MGB-HD model

Preparation of forcing and physiographic parameters

Segmentation: HRUs

River Network

Vegetation and Soils from ECOCLIMAP

Niger River: 4,180 km

MGB-HD Pre-processing is now completed
First test of MGB-IPH
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**Goal:**
Develop a simple routing scheme for the mesoscale which can be used to transfer LSM runoff through a river network.

Used to evaluate and intercompare hydrology from multiple LSMs (Météo-France, NCEP, ECMWF, UKmetOff etc…) and compare to « pure » hydrological models (e.g. TOP-AMMA etc.)

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*GEWEX News, November, 19(4), 2009*
Discharge simulated by ISBA 2005-2008 at Beterou, Benin
After calibration of 3 MC parameters

Perspectives for SWOT:
- Use the same model towards a global scale approach (post-doc 2010-2011, CNES)
- Designed to be rapid, automatic (as possible) determination of river network
  (see next talk)
**Perspectives:**

1) **Finalize large scale modeling of the Niger using ISBA-TRIP**
   - Improve simple aquifer representation, use GRACE to try to better quantify large scale storage
   - Evaluate flooded fraction of delta region with additional datatset (Prigent)
   - Perform a parameter optimization (using discharge): try to obtain more discharge data
   - Examine impact of improved vegetation datatbase (including annual cycle)
   - Test uncertainties related to meteoroloigcal forcing: notably precipitation: TRMM, PERSIANN, CMORPH

2) **Begin optimization/assimilation work ➔ SWOT preparation**
   - Inter-Compare ISBA-TRIP results with more detailed approach using MGB (Jhan Carlo, Marie-Paul Bonnet, Stéphane Calmant)
   - Develop assimilation scheme/strategy (first test, use MGB simulation as « SWOT measurement »)

3) **Begin working on global methodology for SWOT (see next talk)**