Overview of SDT Working group & Science achievements, 2013-2015 (Hydrology)

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SDT, July 7-9, 2015, Toulouse
Local, watershed and continental scales

What do we know today?
What are the key questions and how to adress them?

Perspectives /
Lakes, Rivers and floodplains

Storage changes
Hydrodynamics of rivers

Local, watershed and continental scales

What are the rationales for hydrology?

Scientific objectives / technical performances & requirements?
What are the achievements?
### SDT: French and US contributions

17 SDT projects were funded, spanning a wide range of topics

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- Each theme was addressed by at least 2 different projects under two view angles at minimum.
- The theme of river hydrodynamics was predominant
**River Discharge Algorithm Advances**

**USGS**
Discharge Algorithm Working Group produced the Pepsi challenge/discharge intercomparison study (5 algorithms, 19 rivers). Fourteen of nineteen rivers have best-performing algorithm less than 35% error: median of best performer is 25% error.

**UCLA**

**Ohio St.**

**Garambois/Monnier**
Garonne discharge at Verdun from 09/01/2004

- **Q 1D model (ref)**
- **Q Manning Rh-h(ref)**
- **Obs**
Hydrodynamic Modeling, Assimilation, and Simulator Advances

SWOT-Focused hydrodynamic models of the following rivers:
- Garonne
- Seine
- Niger
- Tanana
- Ganges/Brahmaputra
- Sacramento
- Arkansas

Development of tools in France to make SWOT simulations more user-friendly.

SWOT Hydrology simulations of the following rivers (at least):
- Ohio
- Sacramento
- Garonne
- Seine
- Tanana

Paiva, Durand, and Hossain, *WRR*, 2015: Derived and demonstrated a new framework for interpolating discharge across an entire river network (River Kriging), and for merging in situ discharge with SWOT discharge.
Globally, SWOT will likely improve monitoring of rivers, especially for river basins between 25,000 and 250,000 km².
Assessment of limits and potentials of SWOT data for inland water bodies characterization and monitoring based on simulated data: Application to the lakes and reservoirs of the Yangtze river complex.

Yangtze: various type of water bodies with important inter and intra annual variations.

Pleides VHR DEM
Tandem X Dem
Land Cover
Water masks

CNES JPL Simulator

Lake Poyang water extent from satellite imagery

Courtesy of Hervé Yesou, Sertit
SWOT ability to monitor lakes at global scale

98% of the 3720 lakes > 50km$^2$ could be monitored with a constellation of nadir altimeters: S3-A/B, Saral et JS3
71% of 14,411 lakes > 10km$^2$
⇔ ~40% of total storage change

Main interest is for small lakes and the fact that SWOT will also measure water contours
Improving Water Management Models using SWOT

Schematic of SWOT data assimilation algorithm for operation of Selingue Reservoir

Effect of SWOT data assimilation (of reservoir level and downstream water level) for truth and alternate data assimilation methods (clockwise from upper left)

Water cycle (1/2)

Towards an improved understanding of the water cycle: from regional to global scales using SWOT

**Overall Objective**: Evaluation of SWOT for improved modeling (physics) and monitoring of the global scale freshwater budget

**Lakes contribution**

- **Only big lakes represented**
- **A wider range of lakes represented**

**Objective**: Explore how SWOT can help improve the modeling of the spatial extent and water volumes in lakes/reservoirs on the global scale

**Accomplishments**:
- Improved global lake modeling in preparation for SWOT (comparison with ArcLAKE database for LST)
- Implementation in ARPEGE-Climat (with B Decharme, J Colin) for next IPCC exercise & evaluation

**Prospectives**:
- Develop mass balance in FLAKE for global applications
- Methodology to evaluate the model: goal is to monitor lake extent and volume at global scale with aide of SWOT

Courtesy of CNRM
Water cycle (2/2)

River-focused contributions (CNRM, GET & Mines P-Tech projects)

A Regional scale:

Objective: Test the use of SWOT for regional applications & transerability of methodologies from regional to global scales

Use of GPM constellation to:
- Study the rainfall forcing to hydrological models
- Study of the rainfall uncertainty propagation & Impact of rainfall intensities and space time variability on observed and simulated discharge
- Quantification of the surface–sub surface water exchanges from a physically based distributed model
  => Coupling hydrological and hydrogeological processes at the basin scale

Accomplishments:
- Distributed hydrological model improved over the Garonne for a 10 years period, compared with hydodynamic models: data assimilation methodology developed (to assimilate SWOT data)
- Currently preparing a data assimilation strategy for regional scale hydrometeorological models (using data from SWOT simulator, academic tests)
- Setup of a network of in situ piezometers over the Seine river for survey of the water exchanges and further assimilation into models at basin scale

B Global Scale:

Objective: Explore the possible uses of SWOT data for global scale hydrological modeling

Accomplishments:
- Exhaustive study of Gaussian and Linear approximations (relationship between Manning & river height/discharge)
- Study (using ANOVA technique) of parameter sensitivity in a large scale model for different forcings
- Set up a Kalman filter for multiple (contrastig) large scale basins (thesis of C. Emery, LEGOS)

Prospectives:
- Define a strategy/methodology for assimilating high-resolution synthetic data using simulator (JPL/CNES)
- Extension for several contrastig basins (Niger, Congo, Amazon, Missisipi...cold region basin also), include additiional error sources (precipitation ...
Temporal & spatial variabilities of hydrodynamics by modeling: T-UGOm in the Seine estuary

Preliminary results of SWOT Simulator HR in the Seine estuary
AirSWOT Field Campaigns Supported by the SWOT SDT

Sacramento River 2013: UCLA, UNC, CNES/LEGOS, JPL
First AirSWOT Hydrology data collection

Mono Lake/Lake Tahoe 2014: CNES/LEGOS, UCLA, UNC, JPL
Detection of key features such as variable

Piute Ponds 2014/2015: UCLA, UNC, JPL
Multitemporal measurements of inundation extent, height

Sacramento & Willamette Rivers 2015: UCLA, OSU, UNC, USGS, Oregon
First measurement of flood waves from AirSWOT

Mississippi Delta 2015: JPL, UT Austin, LSU, UNC
AirSWOT measurement of deltas, water under vegetation

Alaska 2015: UNC, UCLA, RSS, IRD, OSU, Bristol, UW, JPL
Multitemporal measurement of complex flow environments
The high-resolution mask working group conducted extensive analysis to determine which parts of the globe were likely to contain SWOT-observable rivers, lakes and wetlands.
Conclusions

1. The SDT has made substantial progress in several areas, most notably in algorithms for estimating river discharge from sWOT, simulation of riverine environments, and assessment of how SWOT will improve on existing hydrologic measurements.

2. A notable strength of the SDT has been the cooperation among members, especially between U.S. and French investigators.

3. The SDT is passing the baton to the new science team, which will have to finalize SWOT hydrology algorithms, determine the best ways to calibrate and validate sWOT science data, and develop robust experiments to address the major SWOT science questions.