SWOT Wetlands HYdrological Monitoring (SWHYM)

Investigators involved

The team is composed of members of five French laboratories: ESPACE-DEV, GET, ISPA, LEGOS, LERMA. For this project, the SWOT Science Team members are: Drs. Marie-Bonnet (ESPACE-DEV), Frédéric Frappart (LEGOS, PI), and Catherine Prigent (LERMA).

General objectives

The SWOT Wetlands HYdrological Monitoring (SWHYM) project has four main objectives that will contribute to better understand the SWOT measurements over wetlands and are necessary for the calibration and validation of the SWOT data. These main objectives of the project are the followings:

- Analysis of the Ka-band backscattering response of wetlands at several incidences
- Generation of surface water storage datasets
- Groundwater anomalies estimates
- Analysis of surface water storage from SWOT in large wetlands

Approach

i) Analysis of the Ka-band backscattering response of wetlands at several incidences

The backscattering coefficients at Ka-band from several wetlands under different climate conditions and vegetation cover will be analyzed. We will use acquisitions from the missions currently operating at Ka-band, i.e., SARAL (02/2013-07/2016 on its nominal orbit and after July 2016 on a drifting orbit) at nadir incidence (see the average amplitude of backscattering from SARAL between 02/2013 and 07/2016 on Figure 1) and GPM (since 02/2014) with an angular range between 0° and 9°, covering the maximum angular range of SWOT (0.5° – 4.5°).

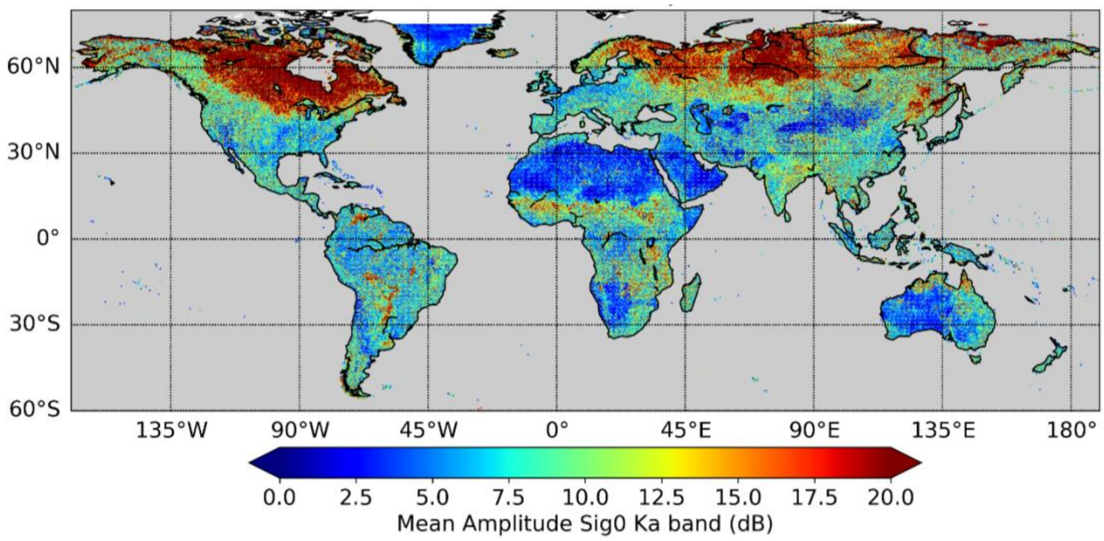

Figure 1: Map of along-track annual amplitude of backscattering using the OCOG retracker (Wingham et al., 1986) at Ka-band from SARAL between 02/2013 and 07/2016. Source: Frappart et al. (2020).

Our goal is to define criteria to discriminate between water and land based on the backscattering at Ka-band. The chosen study areas will encompass a wide range of climate conditions and vegetation cover in equatorial areas covered with forests (in the Amazon and Congo Basins), tropical areas covered with forests and crops (in the La Plata and Mekong Basins), semi-arid areas (Chad Lake and Inner Niger Delta), mid-latitude areas (in the Mississippi and the Danube Basins) and boreal areas (McKenzie Delta and Ob' Basin).

ii) Generation of surface water storage datasets

Water level maps will be obtained interpolating time series of water levels from radar altimetry over inundation extent derived from satellite products. The former ones will include data from Topex-Poseidon to Sentinel-6 satellite altimetry missions and the latter ones will include water extent products from different sources such as GIEMS (Prigent et al., 2020) and derived from multi-spectral and SAR images. The study areas will be the same as for i).

iii) Groundwater anomalies estimates

Groundwater anomalies will be estimated removing surface water storage and soil moisture to the terrestrial water storage derived from the Gravimetry Recovery And Climate Experiment (GRACE), in orbit from 2002 to 2017 (Tapley et al., 2004), and GRACE Follow-On (GRACE-FO), in orbit since 2018, data. Groundwater anomalies will be retrieved in the hydrological basins mentioned above (see the average and associated standard deviation estimated in the Amazon Basin between 2003 and 2010 using GRACE data in Figure 2). Surface water storage will first come from the combination of satellite images and radar altimetry data and then from SWOT. Soil moisture will come from either from hydrological model outputs or from satellite data as the Soil Moisture and Ocean Salinity (SMOS) (Kerr et al., 2001) or the Soil Moisture Active Passive (SMAP) (Chan et al., 2016) missions.

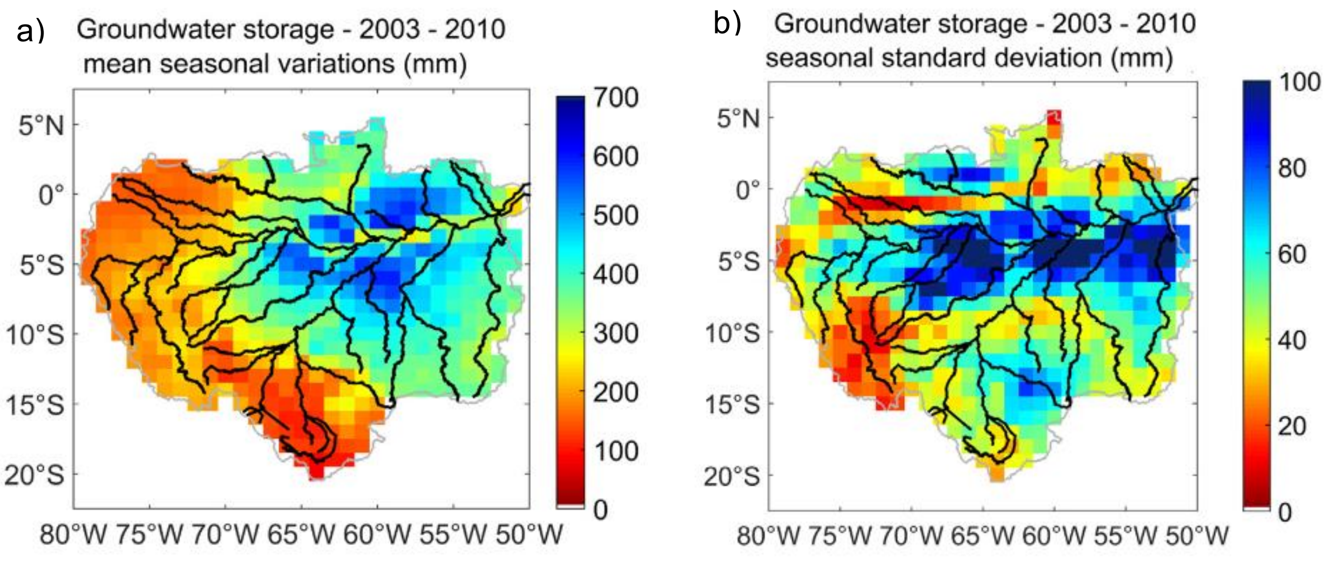

Figure 2: Mean annual changes in groundwater (a) and associated standard deviations (b) over 2003–2010. Source: Frappart et al. (2019).

iv) Analysis of surface water storage from SWOT in large wetlands

Once the SWOT data will be available, we will perform comparisons of surface water extent, level and storage against the products mentioned above and in situ data (Mississippi, Amazon, La Plata, McKenzie, and Inner Niger Delta).

Expected results

- Definition of criteria to discriminate between water and land based on the backscattering at Ka-band,
- Surface water storage maps in several river basins with extensive floodplains and wetlands based on the combination of inundation extent from satellite images and water stages from radar altimetry
- Groundwater maps obtained removing surface water storage and soil moisture to the terrestrial water storage derived from GRACE and GRACE-FO.
- Comparison SWOt surface water storage and multi-satellite surface water storage

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