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Impact of SWOT orbit subcycle on river studies

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The future Surface Water and Ocean Topography (SWOT) satellite mission, jointly developed by NASA and CNES, will provide over all continental surface 2D maps of water elevations, providing unprecedented observations of water fluxes over time. The current SWOT orbit has a 78° inclination and a 22 days repeat cycle. Given the 120km total swath of the main satellite payload (a Ka-band SAR Interferometer), every continental surfaces between 78°S and 78°N will be observed between two to seven times (depending of the latitudes) per repeat cycle. However, some variations in the orbit altitudes will not impact the global coverage of the instrument after a repeat period, but will change the way this coverage is done. Especially, different subcycles, i.e. the difference between local times when two adjacent ascending (or descending) tracks crosses the equator during a repeat period, can be considered. In this study, a 3 day subcycle (orbit with a 970km altitude) and a 1 day subcycle (873km and 841km altitude orbits) have selected and their impacts in observing rivers have been assessed, based on in-situ data, hydrology models and hydrodynamic models at global and basin scale.

At a global scale, when considering only error on monthly average due to SWOT temporal sampling, an in-situ based study showed that the 3-day subcycle should have just few percent lower error than 1-day subcycle orbits. When a global hydrology model is used, there is almost no difference between the different subcycles. Besides, these two studies tend to show that 1-day subcycle orbits have lower error for equatorial rivers (<30°N/S), whereas 3-day subcycle orbit has lower error for other rivers.

A regional study for an Arctic river (which will be observed by SWOT between four to seven times per repeat cycle) shows that assimilation with a local Ensemble Kalman Filter of 3-day subcycle orbit SWOT observations is more effective to decrease model error than assimilation of 1-day subcycle orbit SWOT observations. Assimilation with a local Ensemble Kalman Smoother allows a much more important decrease in model error with almost no difference anymore between each orbit. Yet, this result is probably due to the huge size of the river considered (river wider than 2km).

However, assimilation of virtual SWOT observations to correct friction coefficients and water levels from a hydrological modeling of a tropical river (Niger basin, which will be mainly observed only two times per repeat cycle) shows almost no difference between the different subcycles for such low latitude river.