MISSION DESIGN FOR THE "SWOT" MISSION

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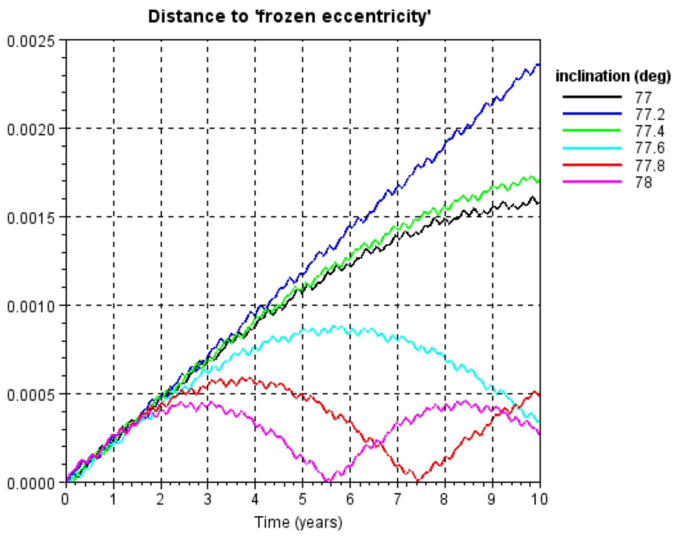
ABSTRACT

SWOT (Surface Water and Ocean Topography) is a joint CNES/NASA mission whose objective is to characterize the ocean mesoscale and sub-mesoscale circulation at spatial resolutions of 15 km and greater, and to provide a global inventory of all terrestrial water bodies whose surface area exceeds 250 m2, and rivers whose width exceeds 100 m.
The SWOT mission is composed of a single spacecraft equipped with a Ka-band SAR interferometer. The satellite will operate in a near-polar Earth orbit for about 3 years from 2020. SWOT extends the series of altimetry mission (Topex-Poseidon, Jason 1/2/3...) with more stringent accuracy requirements and a wider spectrum of scientific objectives.

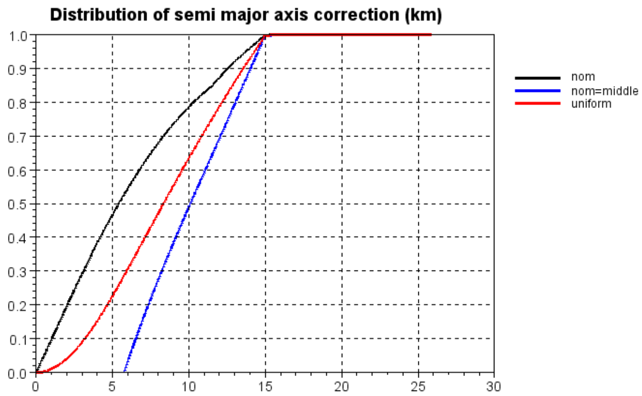
This paper provides an overview of the analyses conducted for the phase A and related to flight dynamics: main results obtained as well as methods used. The main aspects that will be addressed are: orbit selection process, orbit control and change for LEOP, station keeping and at end of life, and also overall system performance (downlink capability).

The first part shows the results and trades of the orbit selection process. The objective was to select an orbit meeting all requirements best: the scientific requirements (relative to coverage, aliasing aspects, high rate data areas on Earth (mask) but also requirements relative to the mission system (maneuvering capability, effect of perturbations), the instrument, etc.... The analysis of all these aspects led to the choice of a science orbit with a 21 (or so) day repeat cycle, an inclination of about 77.6 deg (and an altitude of about 890 km).

Various results related to the effect of perturbations that affect the orbit will be shown. The orbit is for instance subject to a resonance effect due to the coupling between Earth gravity (J2/J3 mainly) and solar radiation pressure. This effect mainly causes eccentricity to undergo large variations as can be seen in the figure below (the results were obtained using "STELA" which is a tool used by CNES for long-term propagation).The paper will detail this resonance effect (which by the way does not exist for the other altimetry missions) and also various impacts as on station keeping: dedicated eccentricity maneuvers are planned to compensate for the effect of eccentricity variations on the ground tracks.



Other aspects of the mission design that will be shown are related to the various maneuver sequences that are necessary at different stages of the mission: after launch, from the intermediate “fast (1-day) repeat orbit” to the mission orbit and at the end of mission. For instance the DV necessary to reach the fast (1-day) repeat orbit after launch depends on the launcher’s trajectory and on the targeted ground track. The method used for the estimation considering injection errors and uncertainties will be detailed. The figure below illustrates for instance how the DV (or equivalently the total change of semi major axis) depends on various hypotheses regarding the launcher’s trajectory.



Other maneuver results will address the end of life: controlled (or maybe uncontrolled) reentry in order to comply with the French Space Operations Act.

Another aspect that will be developed concerns the downlink margin: how much margin there is to download all the data recorded by the on-board instruments, depending on station selection strategy, high rate areas (as defined by the scientific team) and other constraints.