National Aeronautics and Space Administration

Postdoc Research

Comparison of SWOT sea surface height and NCOM steric height at the SWOT oceanography CalVal site

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Introduction

✓ **The Surface Water Ocean Topography (SWOT)**, launched in December 2022, represents a significant breakthrough in the measurement of sea surface height (SSH) in two-dimension and will fill the observation gap in conventional satellites altimetry by providing near-global coverage of SSH at a spatial scale resolution of 15 km.

✓ **Navy Coastal Ocean Model-standard (NCOM-standard)** has been running in a real-time since March 2023 for assessing the performance of the SWOT satellite during the CalVal (Calibration/Validation) phase of the satellite orbit.

✓ **In this study, we present a comparative analysis between model steric height and SWOT KaRIn SSH**

NCOM model setup

- **NCOM-standard** is the operational configuration which assimilate all the routine data together with most of the post-launch in-situ data collected since march 2023 in the SWOT CalVal site.

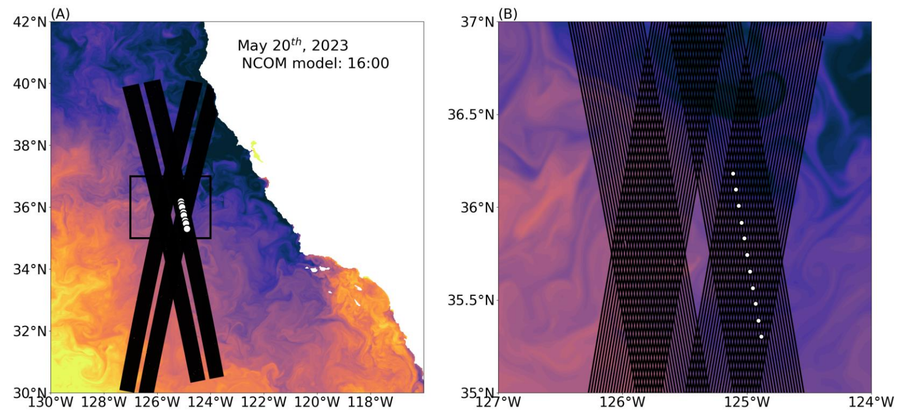


Figure1: An overview of the California Current system and layout of the SWOT CalVal site: (A) Sea Surface Temperature (SST) on May 20th, 2023 at 16:00 from NCOM model. The enclosed black box on the Figure 1A shows the study region. (B) Zoomed-in NCOM SST in the SWOT CalVal region superimposed with SWOT swaths and CalVal field campaign moorings (white circles).

Analysis Method

➢ The SWOT data used in this study were processed and detrended in both along and cross swath using a third degree polynomial at JPL

To compare NCOM to SWOT data, these steps were followed:

➢ We computed NCOM steric height based on this formulation:

$$h = -\int_{-H}^{0} \frac{\rho'}{\rho_0} dz$$

H = 1000-m is the chosen depth
0 is the ocean surface,
ρ' is ocean density anomaly
ρ_0 = 1027.5 kg/m^3 is the mean reference density.

➢ We interpolated NCOM steric height on SWOT swath grid

➢ We detrended NCOM olongtrack

➢ The period of study is April 1st to July 10

Results

Snapshot of SWOT SSH vs NCOM steric height

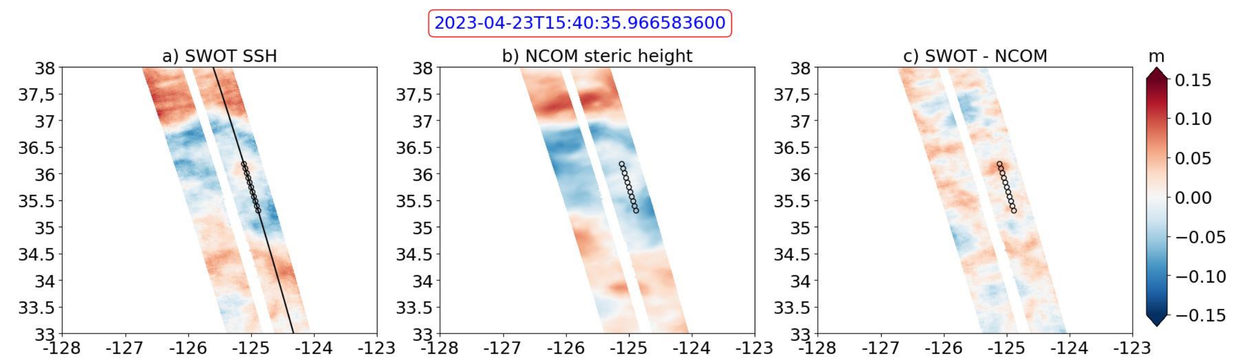


Figure 2: SWOT SSH (a), NCOM steric height (b) and difference between SWOT and NCOM (c) for the date of April 24 2023 at 15:40:36. On the top of each plot are superimpose the post-launch moorings location (black circle). NCOM is qualitatively comparable to SWOT. The difference between SWOT and NCOM is lower than the signal in most of the places and at the moorings location the difference is small.

Standard statistical analysis

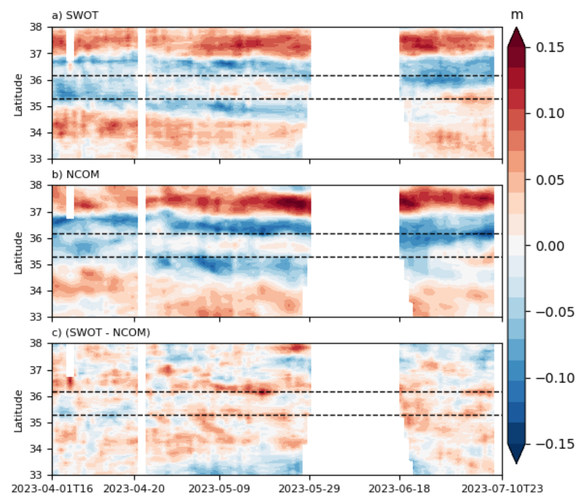
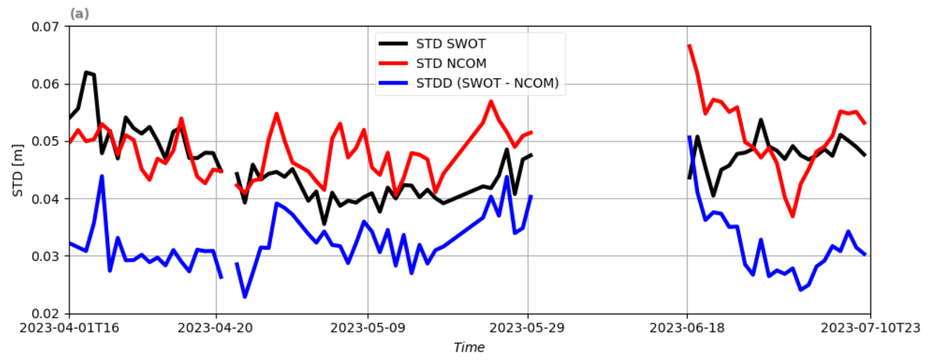


Figure 3: Latitude-time distribution of SWOT SSH (a), NCOM steric height (b) and difference between SWOT and NCOM (c) for the cross-track (num_pixels) number 17 where the post-launch moorings are located (see black line on top of Figure 2a). The black dash horizontal lines are the delimitation of the moorings location. NCOM is qualitatively comparable to SWOT and can represent the mesoscales observe in SWOT data. The difference between SWOT and NCOM appears particularly at the small scales.

Figure 4: Standard deviation computed over along and cross track of SWOT SSH (black line), NCOM steric height (red line) and difference between SWOT and NCOM (blue line). The standard deviation of the difference shows an error smaller than the two signals over the entire time and oscillate around 3 cm.



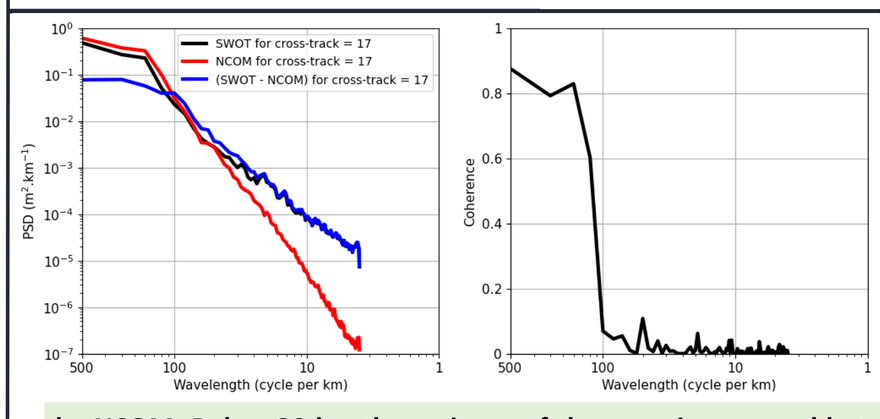


Figure 4: (left) power spectral density (PSD) of SWOT SSH (black line), NCOM steric height (red line) and SWOT – NCOM (blue line) along the cross-track (num_pixels) number 17. Between 500 and ~120-km, the variance of the error is below the observed variance ➔ these scales are constrained by NCOM. Between ~120 and ~20-km the variance of the error is above the observed variance ➔ these scales are unconstrained by NCOM. Below 20-km the variance of the error is comparable to the observed variance ➔ these scales are not represented by NCOM. These results are clearly seen in the coherence between SWOT and NCOM (right).

Summary

➢ Overall, NCOM steric height compare well with SWOT SSH at the meso-scales (>~120-km). This comparison is important along the post-launch mooring location which the data were partially assimilated in NCOM.

➢ The model together with observations can be used to understand the dynamics of the ocean by the SWOT CalVal site.

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