

# Along-track Marine Geoid Resolution Enhancement with SWOT

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## 1. Introduction

Altimetry-derived geoid and gravity anomaly models are typically released with a 1'×1' gridding interval. However, their actual spatial resolution is far lower than the nominal ~ 2 km level. Therefore, analyzing the marine geoid resolution capability from satellite altimetry observations is crucial for marine gravity recovery studies. Here, we present the analysis results of marine geoid resolution capability for both typical conventional nadir altimeters and the SWOT Ka-band radar interferometer (KaRIn) in 2°×2° bins worldwide between 60°N-60°S. We demonstrate the potential of SWOT KaRIn to capture along-track short-wavelength signals below 10 km and analyze the bin-based statistics of key marine geophysical factors correlated with this marine geoid resolution capability.

## 2. Spectral analysis method

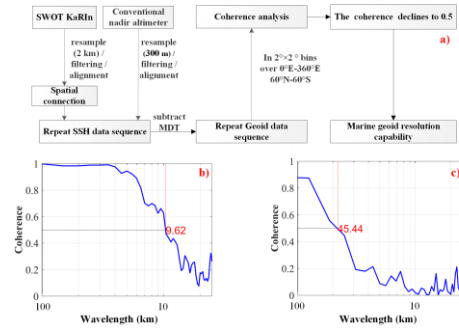


**Figure 1.** Spectral analysis method (a: Flowchart; b: Coherence declines to 0.5 at a wavelength of 9.62 km, where SWOT KaRIn exhibits better marine geoid resolution capability; c: Coherence declines to 0.5 at a wavelength of 45.44 km, where SWOT KaRIn exhibits poorer marine geoid resolution capability).

## 3. Data

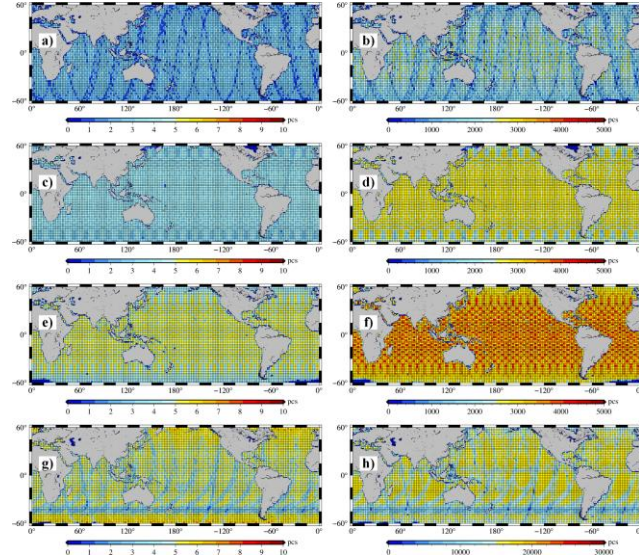


**Figure 2.** Statistical map of the number of passes and the amount of data in each 2°×2° bin for different altimetry missions (a, c, e, and g respectively represent the number of passes in each 2°×2° bin for SWOT Nadir Ku, Sentinel-3B SAR Ku, SARAL/AltiKa Ka, and SWOT KaRIn; b, d, f, and h respectively represent the number of observations in each 2°×2° bin for SWOT Nadir Ku, Sentinel-3B SAR Ku, SARAL/AltiKa Ka, and SWOT KaRIn).

## 4. Resolution capability

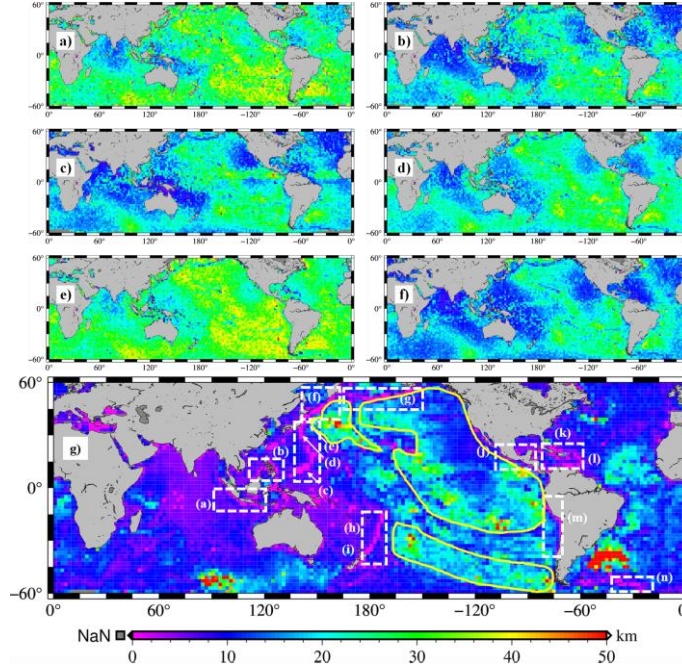


**Figure 3.** Marine geoid resolution capability of different satellites and bands (a: SWOT LRM C-Band; b: SWOT LRM Ku-Band; c: SARAL/AltiKa Ka-Band; d: Sentinel-3B PLMR Ku-Band; e: Sentinel-3B SAR C-Band; f: Sentinel-3B SAR Ku-Band; g: SWOT KaRIn).

## 5. Resolution capability in seamount areas and trench areas

- We identify worldwide major trenches in Figure 3(g) and use yellow irregular curves in both Figure 3(g) and Figure 4 to highlight three regions in the Pacific Ocean where relatively fewer seamounts exceed 1 km.
- SWOT KaRIn exhibits better marine geoid resolution capability over bins with large-scale seamounts or trenches.

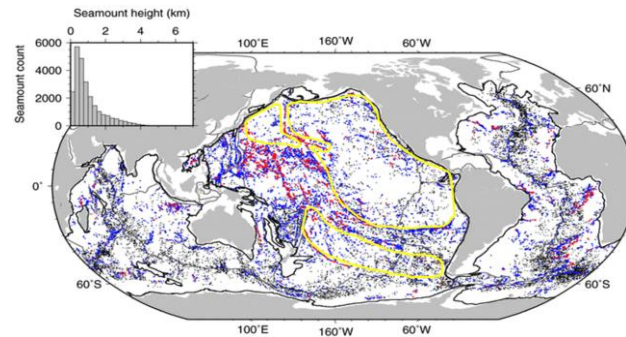


**Figure 4.** Global distribution of 24643 potential seamounts identified by Kim et al. (2011). Black dots for 0.1 ≤ height < 1 km (n = 16185), blue dots for 1 ≤ height < 3 km (n = 7514), and red dots for height ≥ 3 km (n = 944). The plate boundaries are shown as grey lines and the Seamount Exclusion Zones (SEZs) defined by the 2000 m isobaths are drawn as black lines. Inset shows histogram of height distribution of potential seamounts. The yellow circle shows the area in the Pacific Ocean where there are relatively few above 1 km seamounts.

## 6. Marine geophysical parameters correlated with resolution capability

- The investigated marine geoid resolution capability is evidently correlated with marine geophysical parameters.

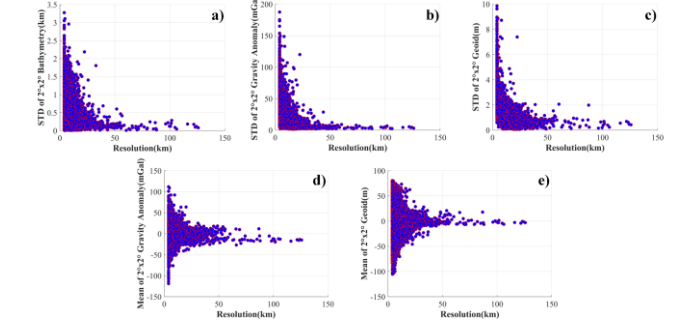


**Figure 5.** Scatter plots of the statistical values of marine geophysical parameters and the marine geoid resolution capability of SWOT KaRIn (a: STD of bathymetry from GEBCO2024 with KaRIn results; b: STD of gravity anomaly from V32.1 with KaRIn results; c: STD of geoid undulation from EGM2008 with KaRIn results; d: Mean values of gravity anomaly from V32.1 with KaRIn results; e: Mean values of geoid undulation from EGM2008 with KaRIn results).

## 7. Evaluation of short-wavelength detection in SWOT KaRIn

- Short-wavelength geoid signals are more susceptible to ocean currents, as they may be masked by these dynamic ocean signals.

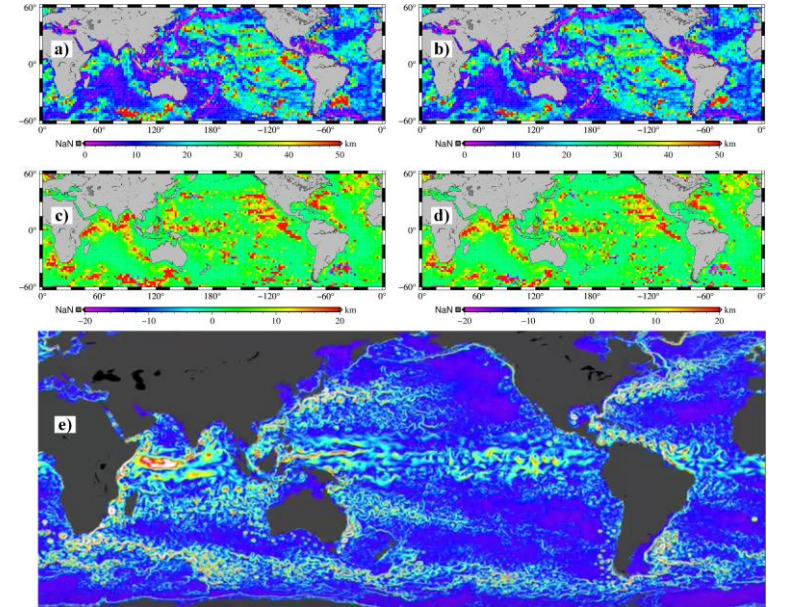


**Figure 6.** Marine geoid resolution capability of SWOT KaRIn (a: resolution capability of the slopes; b: resolution capability of high-pass filtered geoid; c: difference in resolution capability between slopes and original geoid; d: difference in resolution capability between high-pass filtered geoid and original geoid; e: ocean current motion at 0.05° under SWOT observations, produced by JPL (JPL, 2014)).