Incorporating New Satellite Data Improves Marine Gravity Field

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Summary

Adding recent satellite data has significantly improved the marine gravity field

For GEBCO purposes, we want to exploit the correlations between satellite gravity and bathymetry

The portion of the gravity field that is correlated with bathymetry improved the most in areas having smooth seafloor and subdued gravity anomalies

Gravity anomalies arising from small seafloor features are:
- more accurately located
- better resolved
- abyssal hill trends are emerging

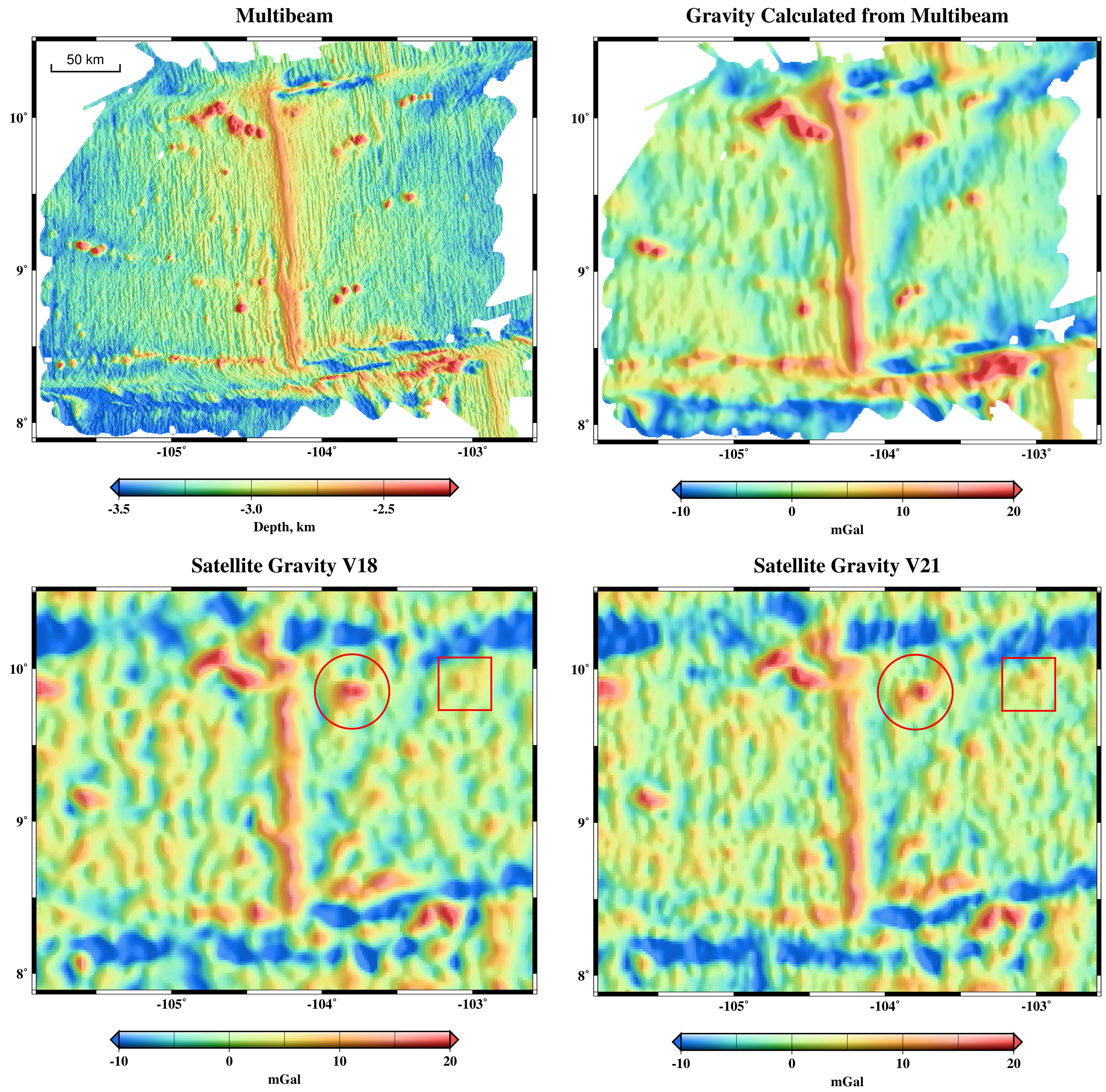
Future bathymetric models should improve with better marine gravity fields

We examined 25 study areas throughout the world's oceans. Each study area is covered by a regional multibeam survey that we used as "ground truth" to compare to satellite gravity anomalies that are correlated with seafloor topography. Below we show one of the study areas, the Clipperton Fracture Zone, to demonstrate how adding recent satellite data to gravity V21 significantly improves it.

The manuscript "Significant improvements in marine gravity from ongoing satellite missions" by Marks, Smith, and Sandwell has been published in Marine Geophysical Research, doi:10.1007/s11001-013-9190-8. A copy is available at http://www.star.nesdis.noaa.gov/star/Marks_K.php.

Clipperton Fracture Zone Study Area

- Multibeam data collected as part of NSF Ridge 2000 Program
- Swath surveys gridded at 300 m spacing
- Fine-scale seafloor features such as spreading ridge axes, seamounts, abyssal hills, and fracture zones are mapped in detail



- Gravity calculated from multibeam gives "ideal" anomalies at the sea surface
- These "ideal" gravity anomalies:
  - are due only to seafloor topography
  - are degraded by ocean depths of about 3 km
  - cannot resolve the smallest features due to the laws of physics
- Abyssal hill fabric (elongated north-south trending anomalies flanking the spreading ridge) is detected in "ideal" gravity anomalies

- "Real" gravity anomalies derived from satellite data include signal from seafloor topography and contaminating signal from sub-seafloor sources
- V18 gravity does a good job mapping fine-scale seafloor features, but V21 does even better.
- In V18:
  - westernmost seamount peak lies due west of adjacent peak (circle)
  - smaller seamounts not as well resolved (square)
  - north-south trending abyssal hill fabric is hinted at

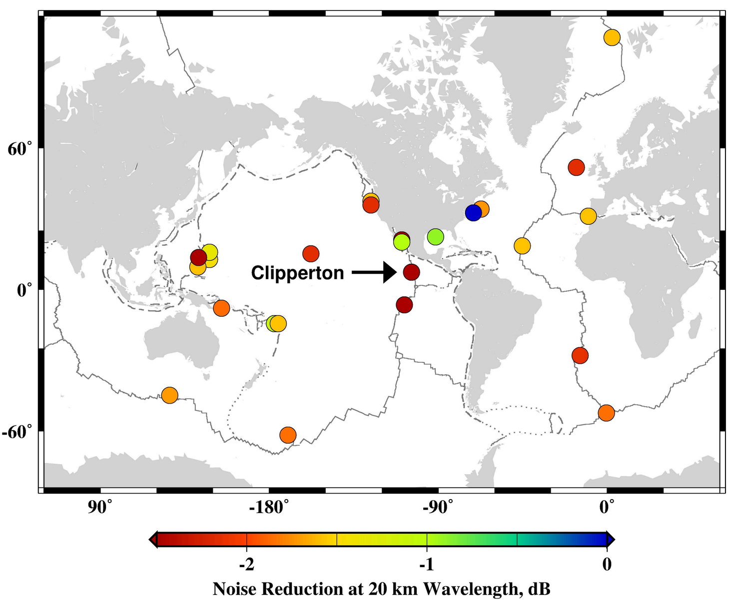
- V21 satellite gravity includes recent Jason-1, CryoSat-2, and Envisat data not in V18
- In V21:
  - westernmost seamount peak lies southwest of adjacent one (circle), matching configuration in multibeam map
  - smaller seamounts are better resolved (square)
  - north-south trending abyssal hill fabric is emerging

25 Study Areas

- Study areas are located over a variety of tectonic settings
- Improvements in mean coherence vary with setting type
- In our study, noise includes errors and gravity signal that is not correlated with bathymetry

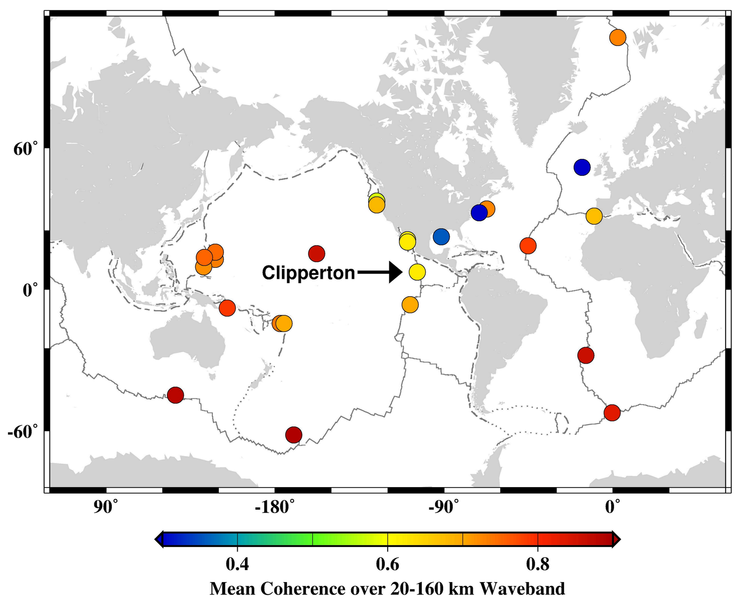
Noise Reduction

- Noise is reduced in V21 compared to V18
- Noise is reduced most over areas with smooth seafloor and subdued gravity anomalies, such as fast spreading ridges
- Signals emerge when the noise level is lowered



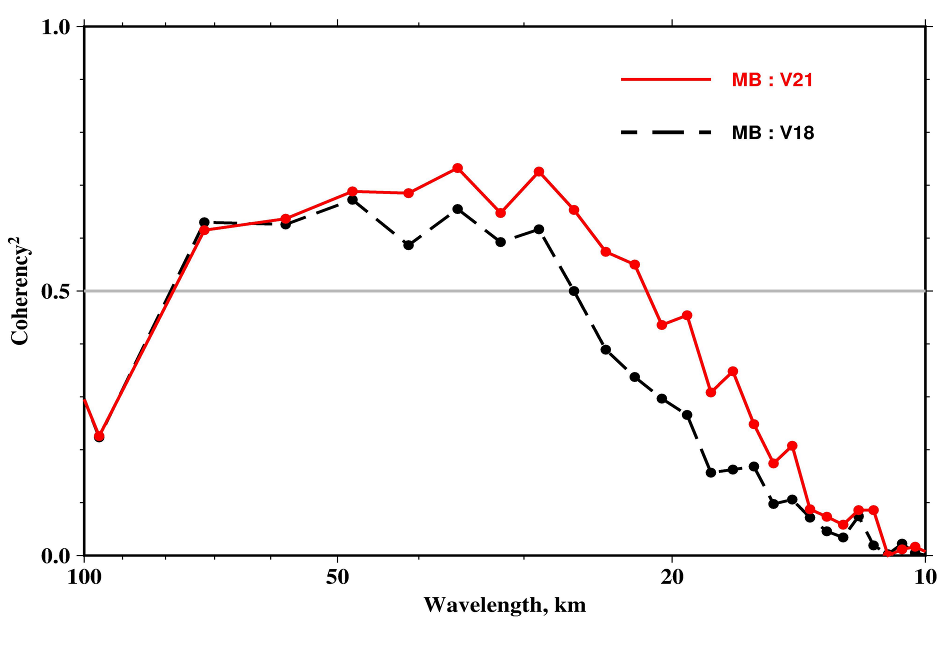
Coherence

- Overall mean coherence is improved using V21 instead of V18; biggest improvement is over fast spreading ridges
- Shorter wavelengths are better resolved in V21



Coherence over Clipperton FZ area

- In V21, gravity and multibeam bathymetry are coherent (> 0.5) to shorter wavelengths
- New satellite data improve coherence



Noise Reduction as Function of Wavelength

- New satellite data fill in existing coverage
- Noise is reduced more at shorter wavelengths due to increased data density
- Newer more precise data reduce noise at all wavelengths