# How well can we estimate high frequency non-tidal ocean variability for de-aliasing purposes?

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## Introduction

Reducing aliasing in altimetry missions requires accurate estimates of rapid sea level variability (periods <20 days for Jason). We assess how well we know rapid, non-tidal ocean bottom pressure (OBP) signals by analyzing in-situ bottom pressure recorder (BPR) data and available OBP estimates from different ocean models. OBP can be considered equivalent to sea level if we assume mostly barotropic variability at high frequencies. Previous theoretical and model-based studies suggest the existence of a barotropic regime at mid to high latitudes for periods <20 days. We use 7-day GRACE solutions and equivalent satellite altimetry maps to provide direct evidence of barotropic behavior at mid and high latitudes. The correspondence between GRACE and altimetry at rapid timescales could be useful for de-aliasing altimetry observations.

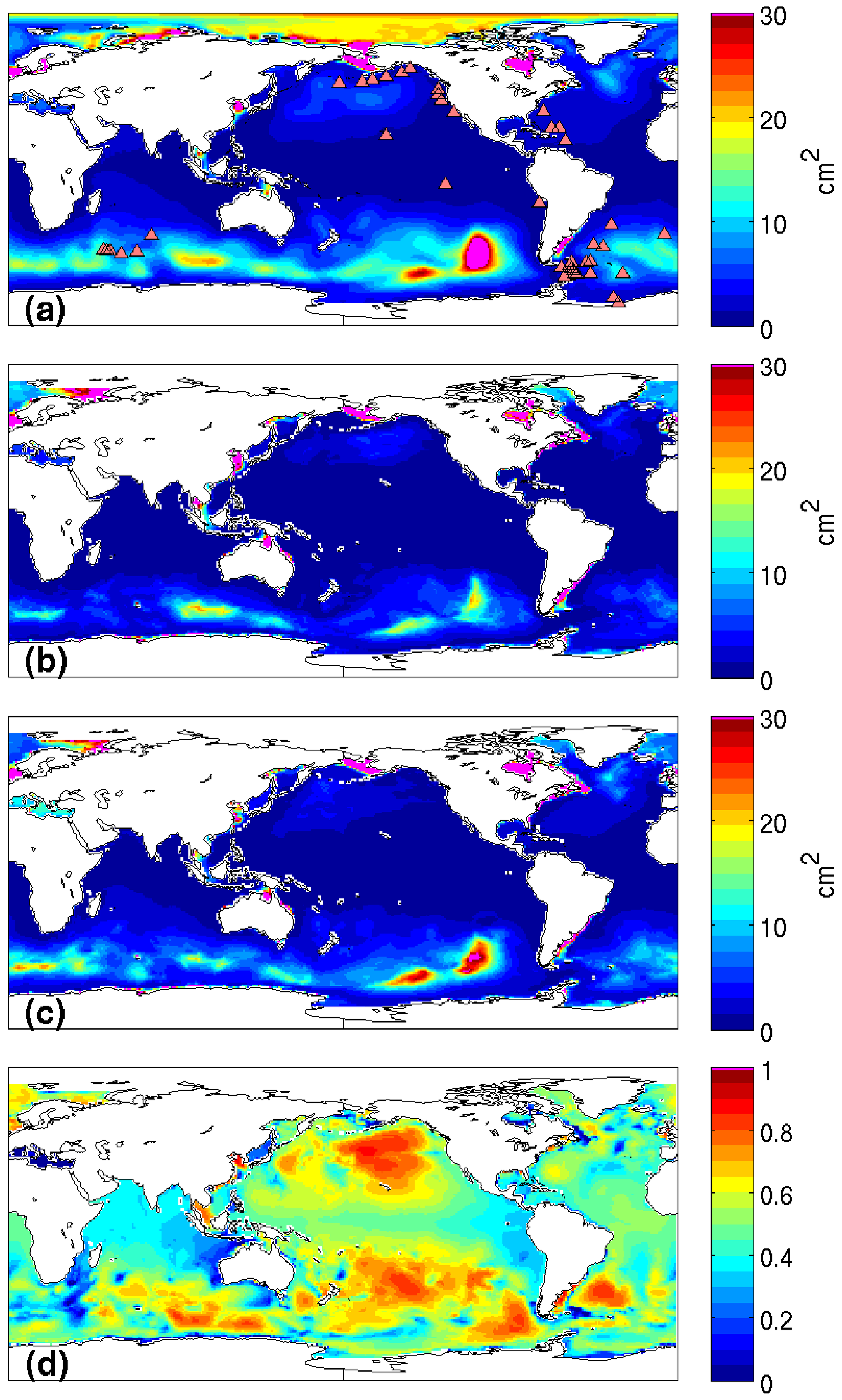


**Figure 1.** Variance of OBP series for (a) OMCT, (b) ECCO, and (c) OMCT–ECCO. (d) Correlations between OMCT and ECCO series. All calculations are done for series from 1992–2006 containing only periods <20 days. Triangles denote the locations of the BPR stations.

### Model Variance, Correlations, and Comparisons to BPRs

- Models and data used (all filtered to contain only periods <20 days):
  - ECCO and OMCT (MOG2D planned for future work)
  - Bottom Pressure Recorders (best observations but sparse)
- OMCT and ECCO have same basic spatial patterns (Fig 1a,b)
- OMCT and ECCO correlations positive but spatially variable and weak over extensive regions (Fig 1d)
- OMCT–ECCO variance (Fig 1c) ≈sum of error variances **if** errors uncorrelated
  - same order of magnitude as signals => low signal to noise ratio
- BPR variance tends to be higher c.f. OMCT and ECCO (Fig 2a)
- Residual BPR variance still high (Fig 2b) => this will be aliased if BPR "truth"
  - correlated over hundreds kilometers (not shown)
- OMCT–ECCO variance tends to be much smaller than BPR–OMCT or BPR–ECCO (Fig 2b)
  - models underestimate high freq variance => model error correlated
- OMCT-ECCO error estimates **too low**

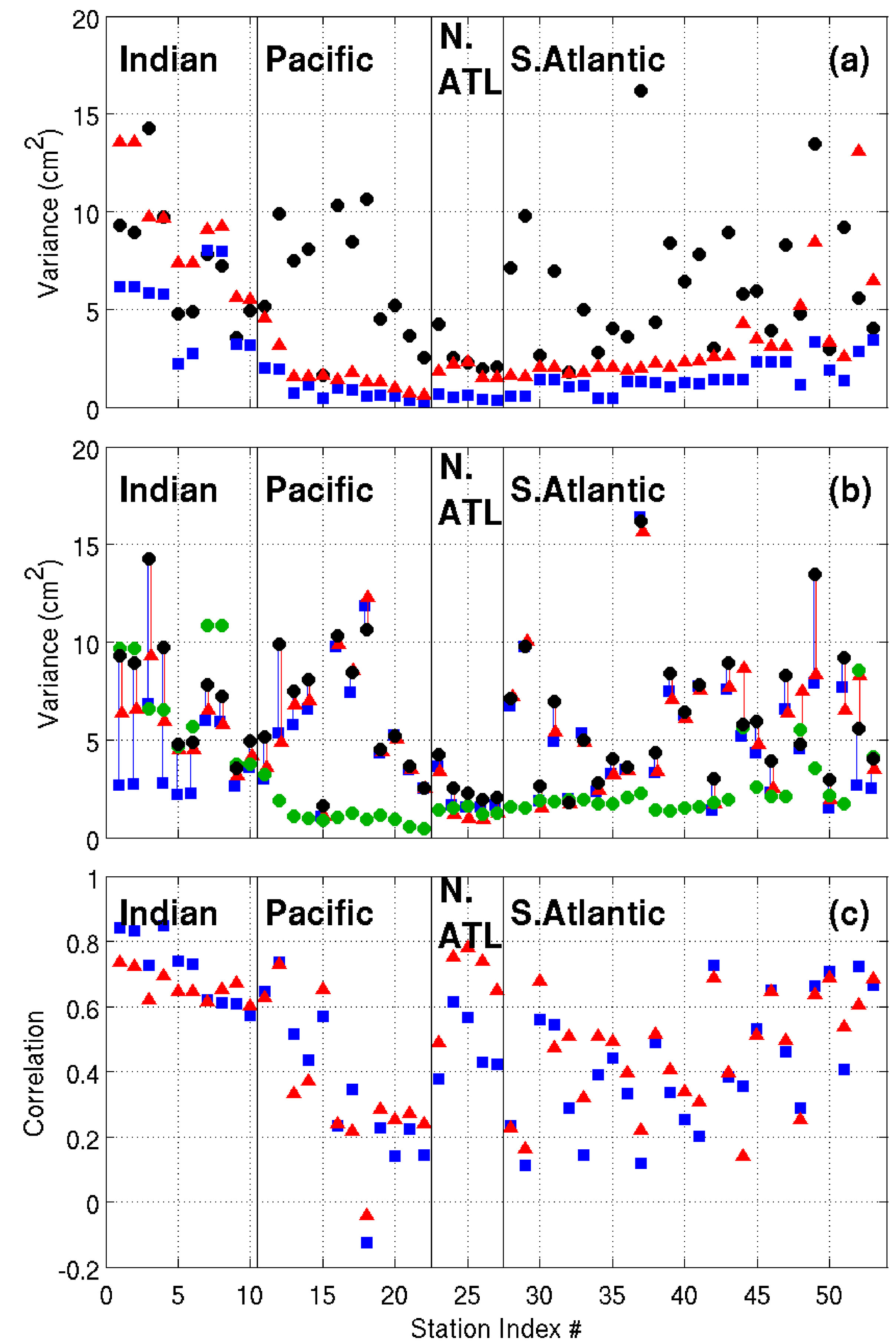


**Figure 2.** (a) Variance of OBP series for BPR (black circles), OMCT (red triangles), and ECCO (blue squares). (b) As in (a) but for BPR (black circles), BPR–OMCT (red triangles), BPR–ECCO (blue squares), and OMCT–ECCO (green circles). (c) Correlations of BPR series with OMCT (red triangles) and ECCO (blue squares). All results are based on high-pass filtered series (cutoff period of 20 days) over the time range of the BPR data.

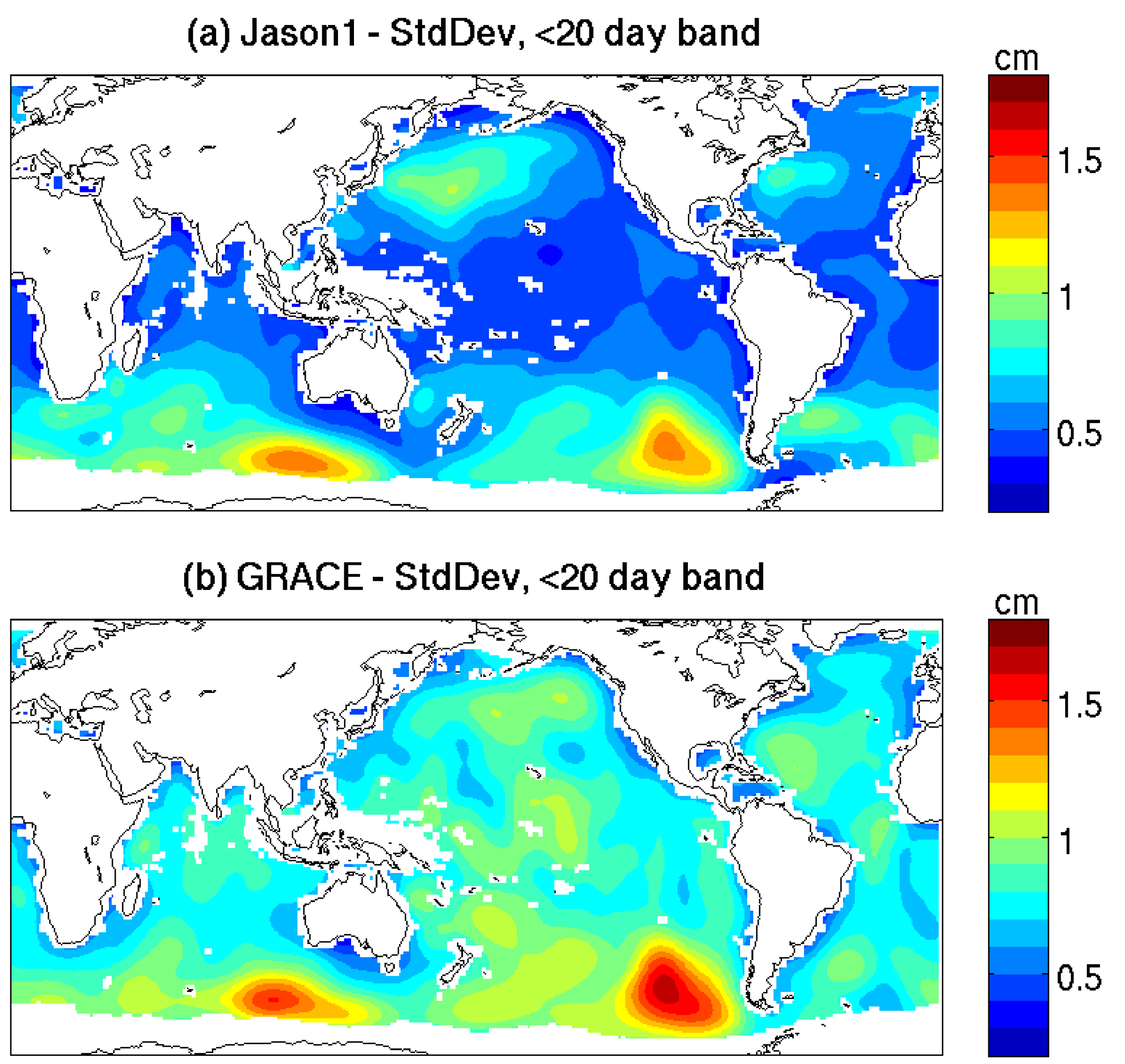


**Figure 3.** Standard deviations in units of cm of water for (a) Jason-1 sea level and (b) GRACE bottom pressure series filtered to show variability at periods of 14-20 days. Data range from 2003 to 2010 and are smoothed to 750km. Values are only shown where there is available Jason-1 data over the entire data range.

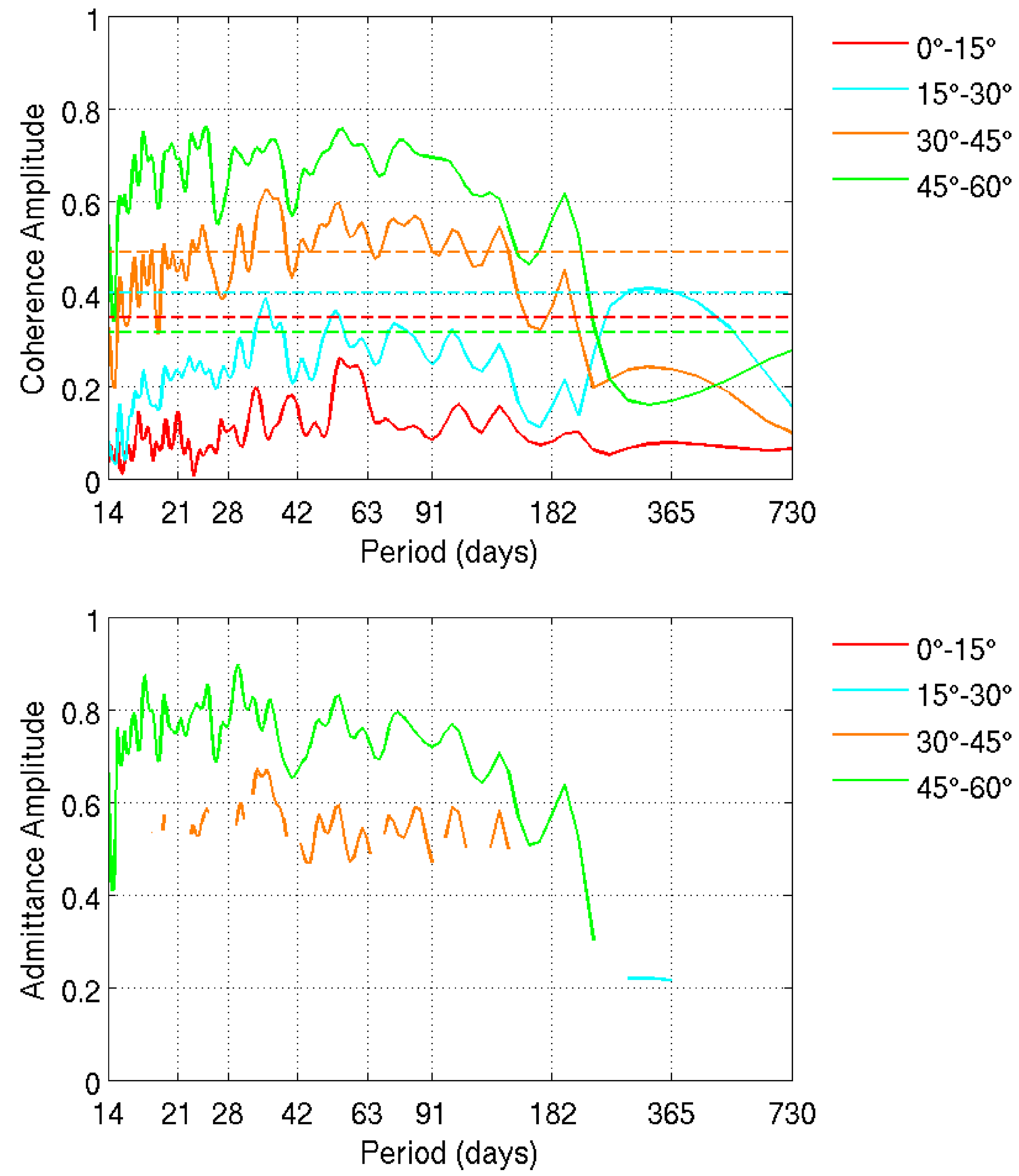


**Figure 4.** Coherence (top) and admittance (bottom) over various latitude bands. The 95% significant coherence levels are shown by the dashed lines. Admittance values are only shown for frequencies with significant coherence.

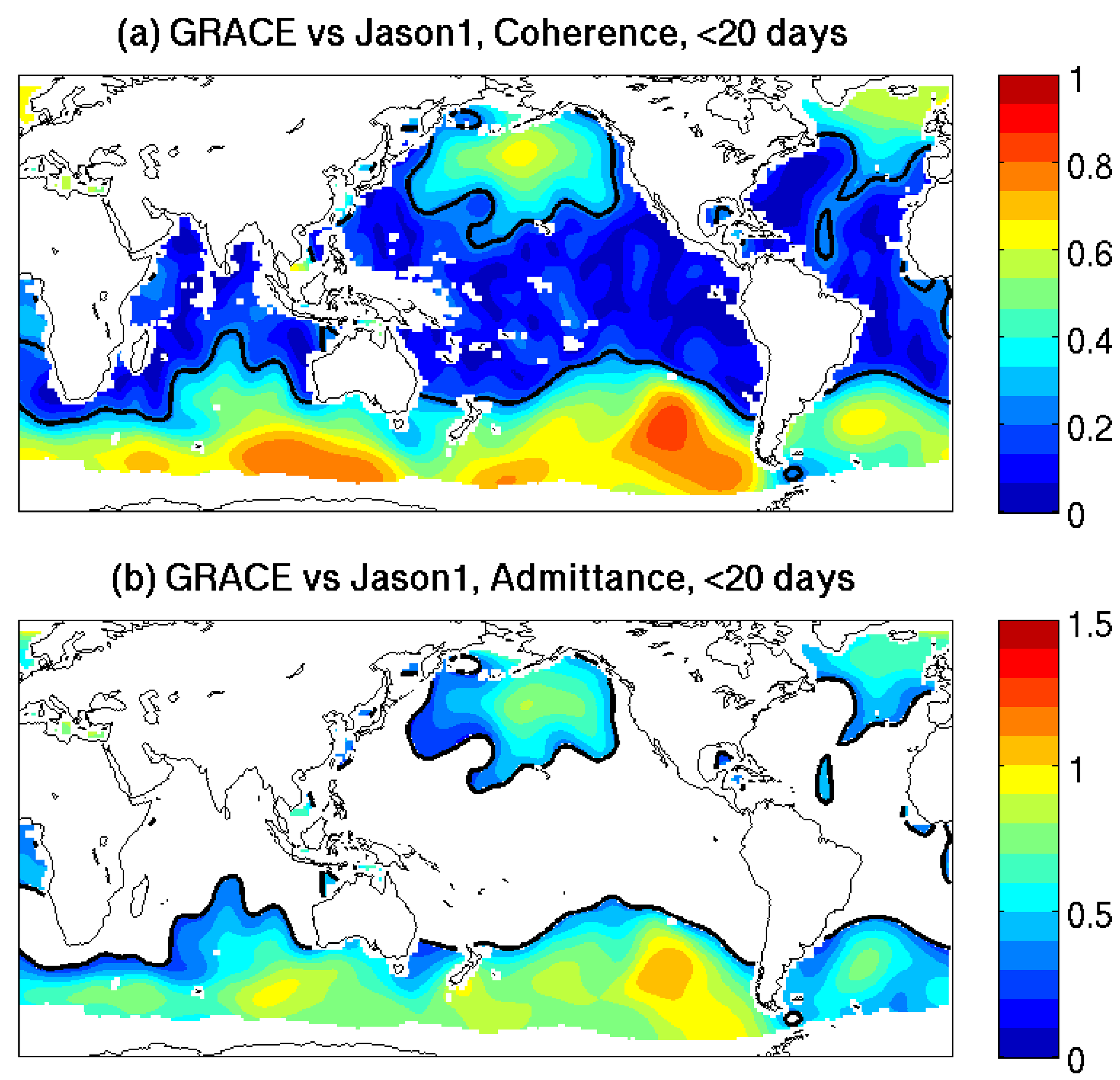


**Figure 5.** (a) Coherence and (b) admittance amplitudes over the 14—20 day band. Dark contour indicates the 95% significant coherence level; admittance is only shown in regions withsignificant coherence.

### Observed High Freq Barotropic Behavior Between Jason-1 and GRACE

- Jason-1 and GRACE have very similar patterns of variability in the Southern Ocean and North Pacific (Fig 3)
  - regions noted to have previous modeling studies as having enhanced barotropic high frequency variability
- OBP and sea level variability barotropic if:
  - significant coherence
  - admittance amplitude ~1 with ~zero phase
- Jason-1 and GRACE observations suggest the presence of barotropic regimes:
  - on large spatial scales
  - at high latitudes over broad band of sub-annual periods (Fig 4)
  - in Southern Ocean, N. Pacific and N. Atlantic for 14-20 day band (Fig 5)
- Correspondence of Jason-1 and GRACE can provide cross-check of the accuracy of each dataset

### Summary

The difficulty in estimating high frequency OBP fields is apparent in the relatively poor agreement found in the OMCT and ECCO solutions. The model estimates of OBP variance are generally lower than that measured by BPRs, suggesting the presence of correlated model errors, thus errors derived simply from model differences will be underestimated. Removing estimated series from BPR data tends to reduce the variance but residuals are not negligible relative to expected variance in climate OBP signals. The residual OBP variability can be correlated over hundreds of kilometers. To the extent that OBP and sea level are expected to behave very similarly in barotropic regimes, GRACE fields can offer a good check on altimetry and may be useful for de-aliasing. Results indicate the need to continue to improve estimates of rapid oceanic variability in order to minimize aliasing noise in the altimeter records.

**References**

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