Predictability of Baroclinic Tides in AMSEAS

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Ocean Splinter 3, “tides, internal tides, IGW & DAC”
June 19, 2019
SWOT Science Team Meeting
Bordeaux, France

Big question: Are non-phase-locked (non-stationary) tides predictable with an ocean forecasting system?

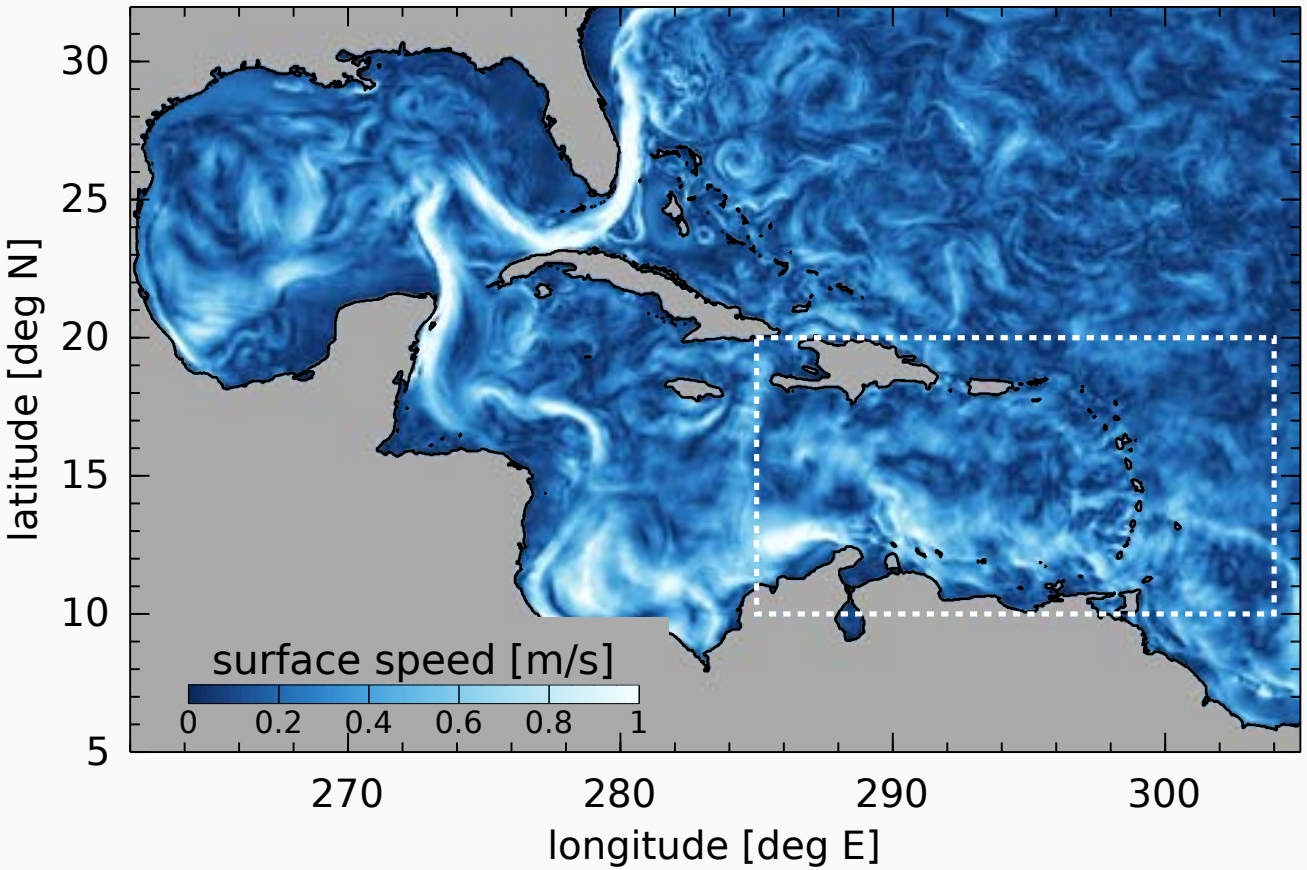
- Address this question with 2 years of AMSEAS output – analyze baroclinic sea level by converting (T, S, p) to steric height anomaly.

- Methodological issues: separating phase-locked and non-phase-locked tides w/in a 4-day window, separating baroclinic vs. barotropic signals in observations, etc.

- Interesting phenomenology: role of shallow seamounts, escarpments, and topography; mode-2 M_2 vs. mode-1 M_4

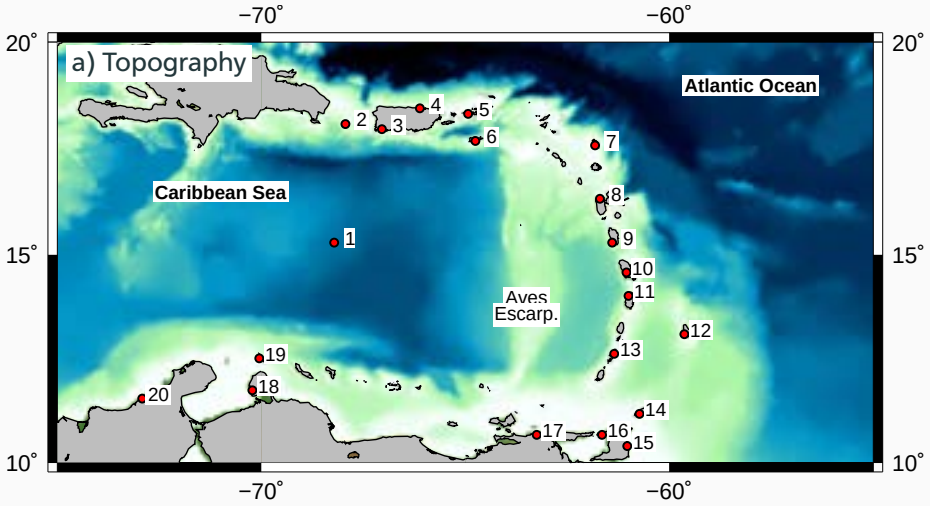
- Main finding: tide prediction error is proportional to mesoscale prediction error.

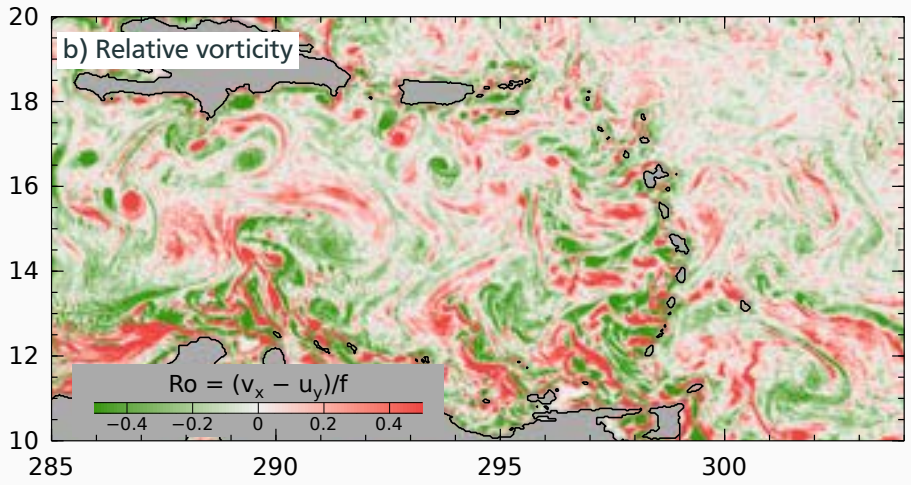
AMSEAS Forecast System

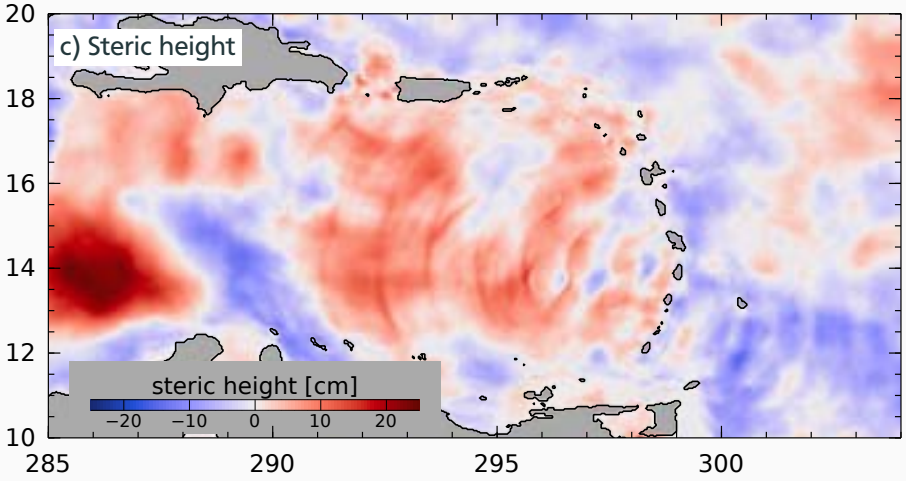


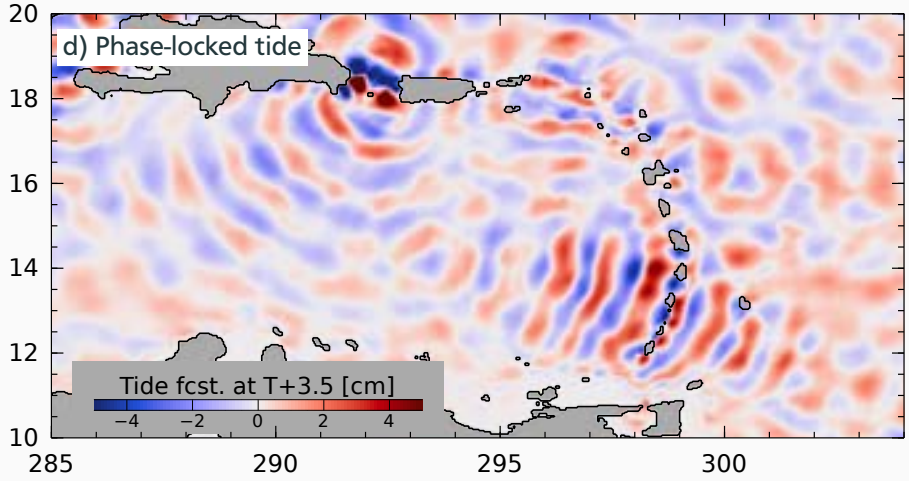
- Based on regional NCOM: 1/30-degree (3.5km), 40 levels.
- Operational since May 2010; major changes in April 2013.
- Assimilates profiles, altimetry, and SST using NCODA.
- 96-hour forecast, reinitialized daily from NCODA analysis.
- Output is archived at 3-hour intervals.

AMSEAS in the Caribbean Sea









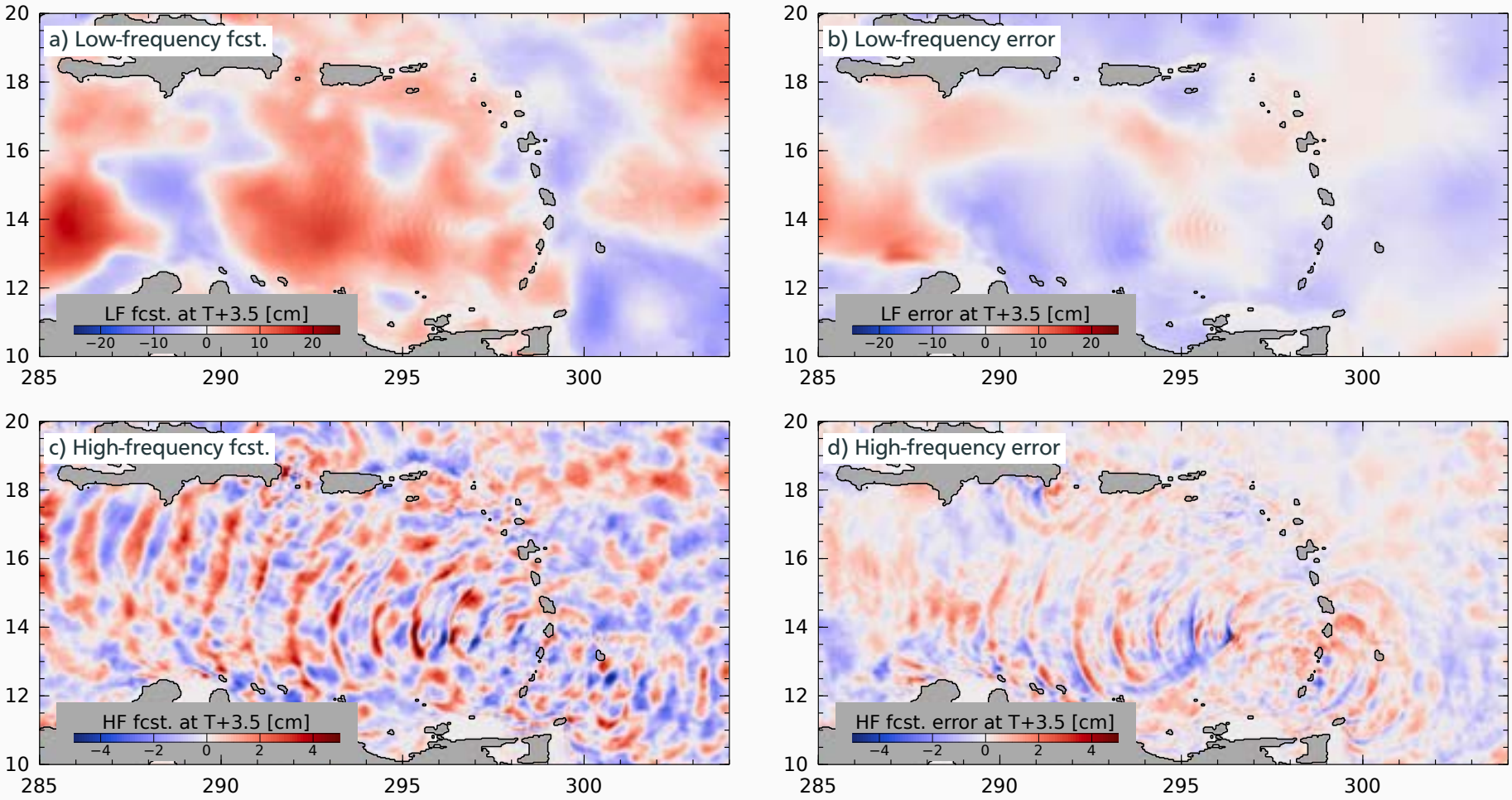
±25cm range

±4cm range

Decomposing SLA: 25-hr mean + Predicted tide + HF residual

The flow decomposition is defined and centered at T + 0.5 day, ..., T + 3.5 day.

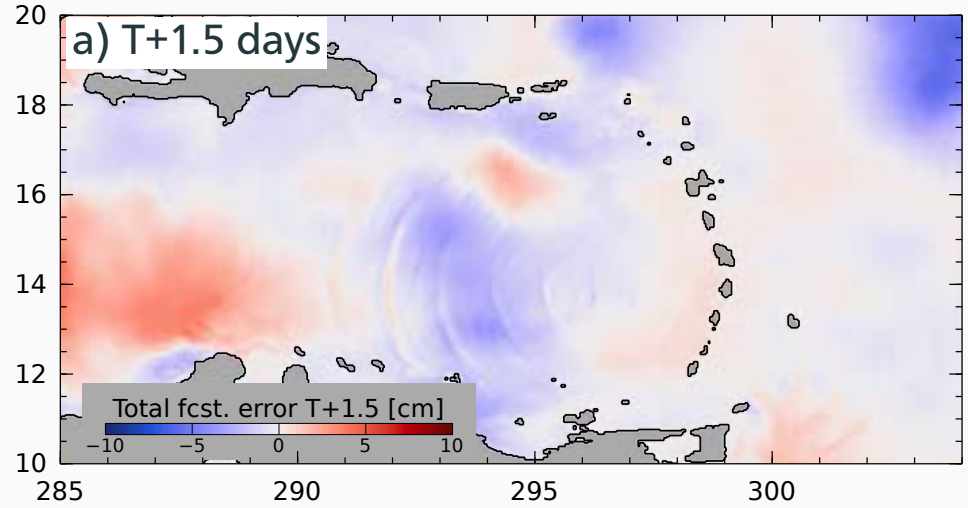
Error is *defined* as forecast minus "nowcast" at T + 0.5 day.

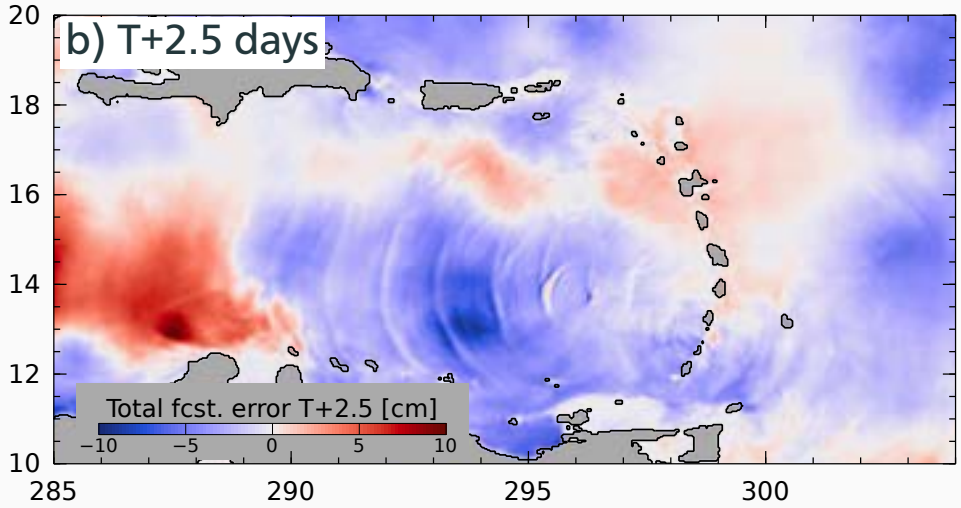


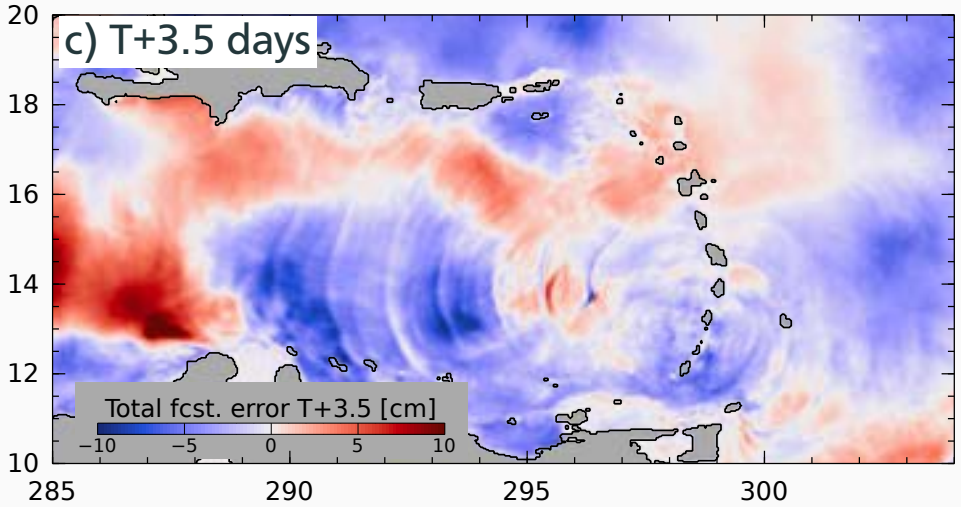
HF residual is dominated by the non-phase-locked baroclinic tide.

Forecast Error Grows in Time (as expected)

Example of SLA forecast error at three different lead-times:



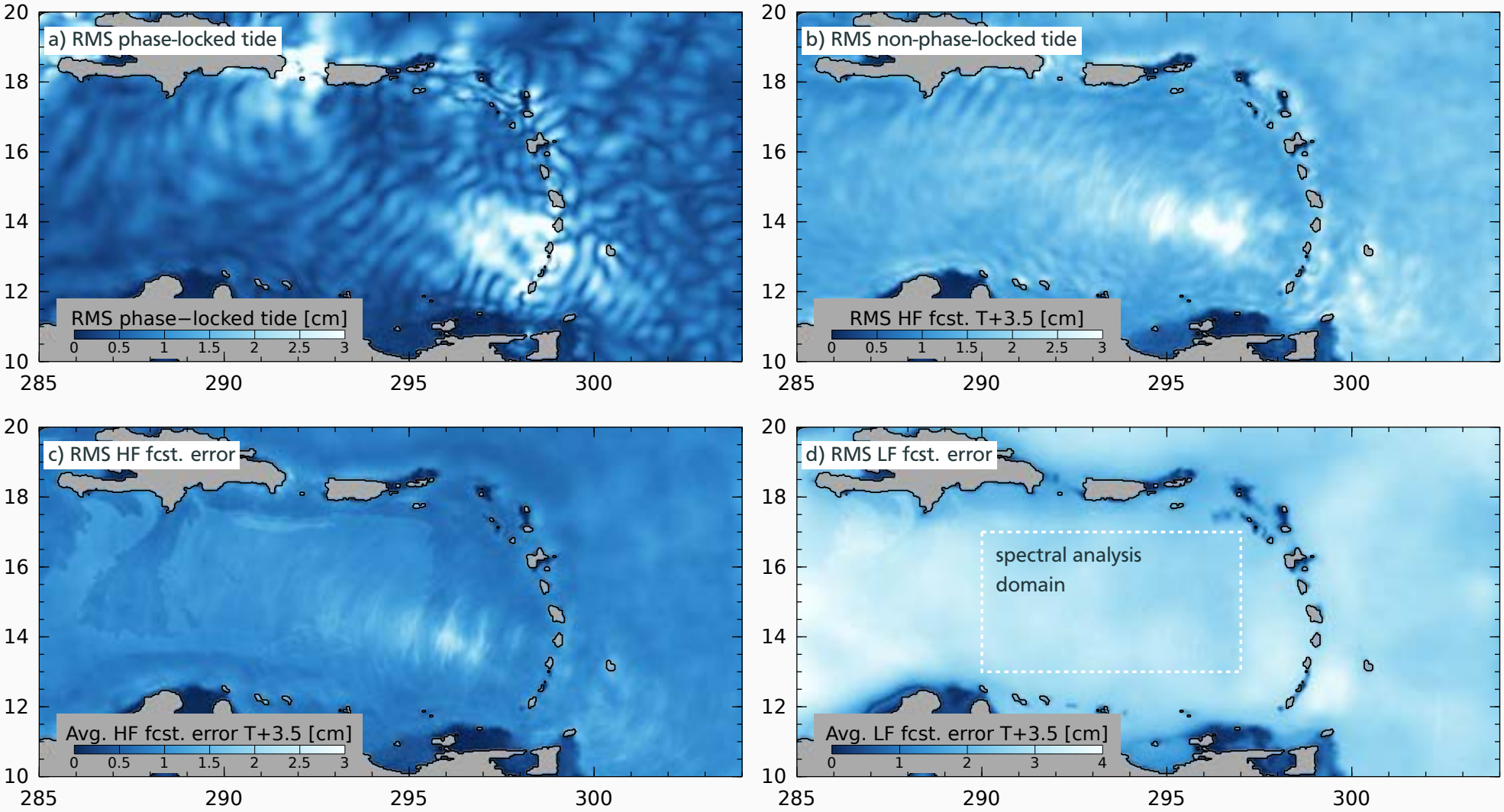




Forecast error is caused by new data arriving via assimilation & by revised atmospheric forcing.

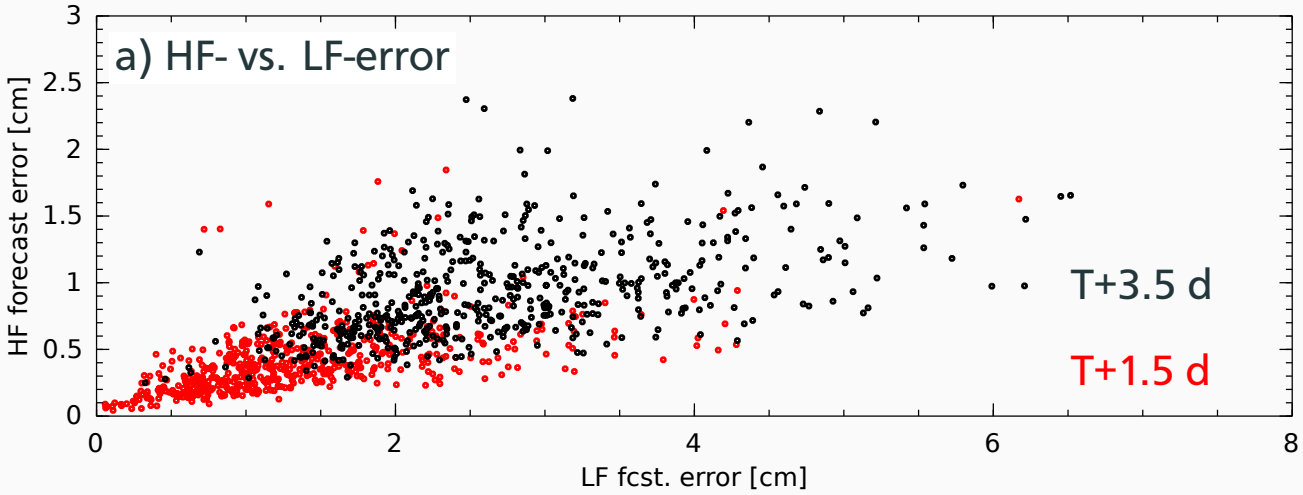
Average Statistics Over the 2 Year Period, 2013–2014

Averaged statistics valid at T + 3.5 days:

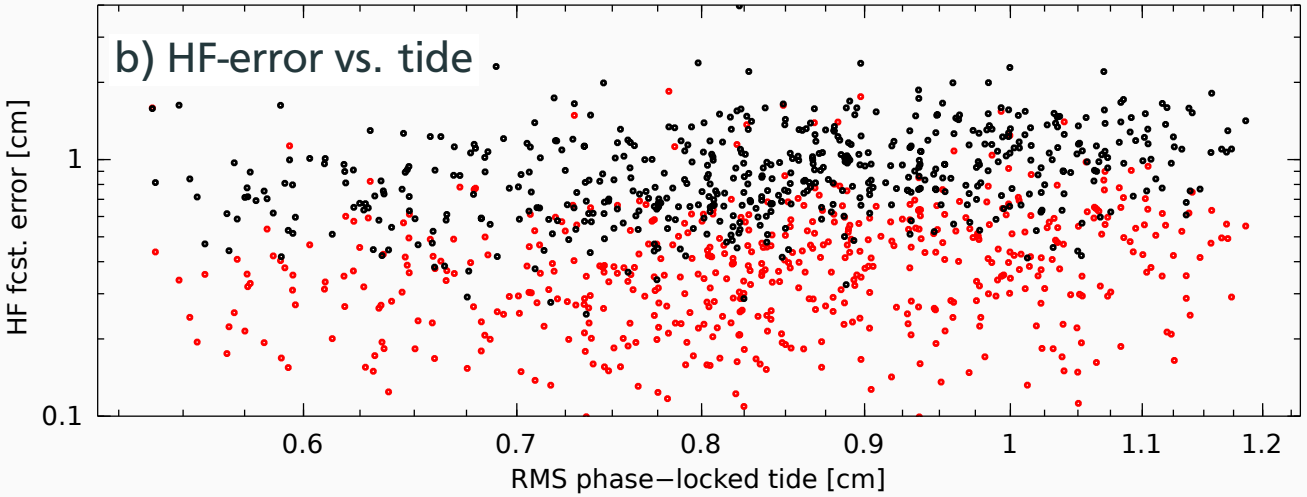


Is HF forecast error related to LF forecast error? – yes

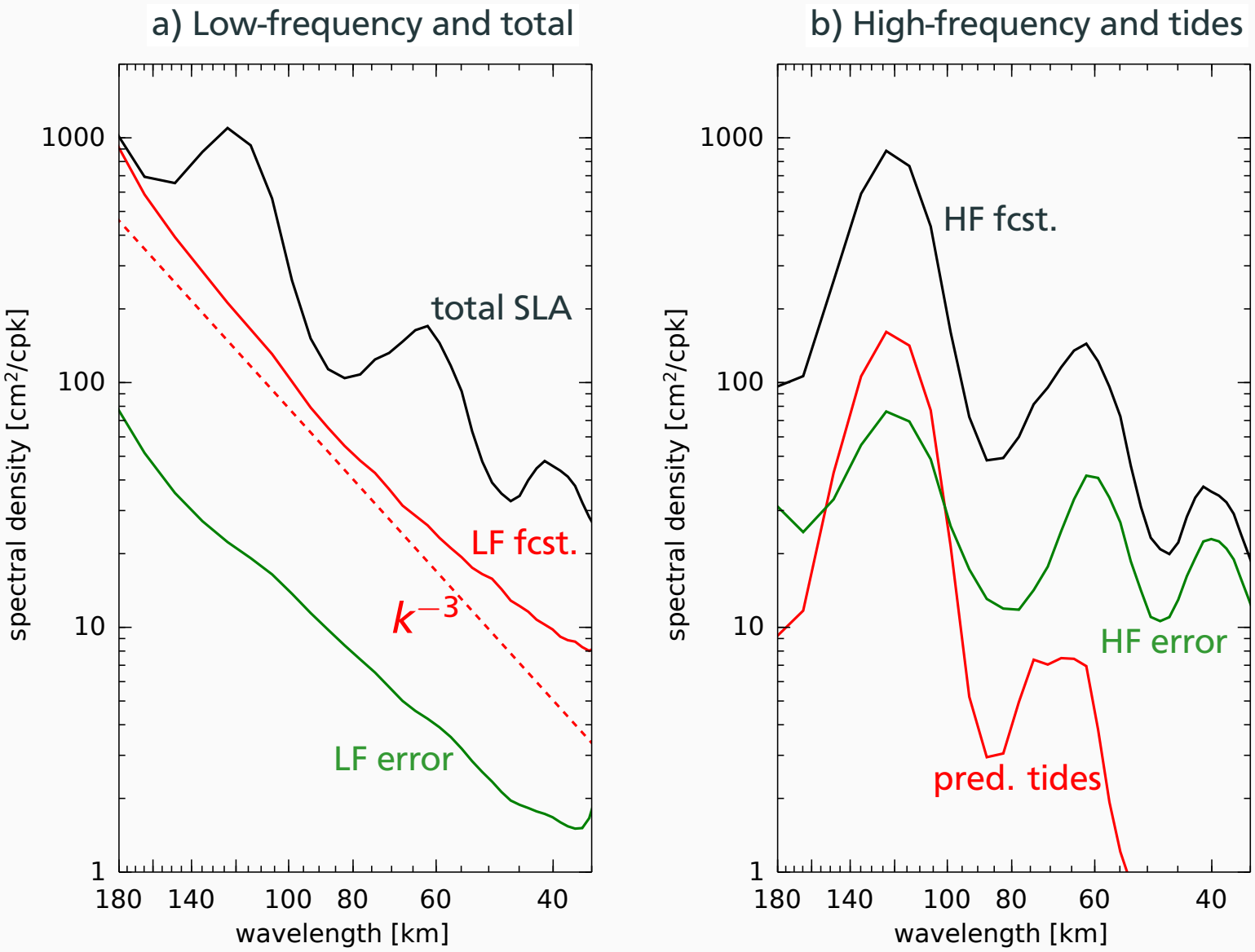
(RMS of spatial average within the spectral analysis domain)



Is HF error related to spring-neap cycle (predicted tide amplitude)? – no



SLA Wavenumber Spectra



(2-dimensional spectrum is azimuthally averaged. *k* is radial wavenumber.)

Conclusions re: AMSEAS forecasts in the Caribbean

- Non-phase-locked baroclinic tides are generally bigger than the phase-locked tides, but they are largely predictable.

- Important caveat – forecast errors were estimated with "self-verifying analyses"; AMSEAS SLA errors in GOMEX associated with the Loop Current are about 6cm rms.

- There are complications with evaluating forecast error using independent altimetry: sparse ground tracks, cannot cleanly separate barotropic and baroclinic SSH, cannot filter in time.

- Interesting dynamics of forecast error are associated with the baroclinic mode-1 M_4 tide (not the mode-2 M_2 tide). Nonlinear waves in the model and observed with sun-glint are generated at Aves Ridge.