COMPARISON OF SEA SURFACE HEIGHT FREQUENCY SPECTRA IN TIDE GAUGES AND HIGH-RESOLUTION OCEAN SIMULATIONS WITH EMBEDDED TIDES

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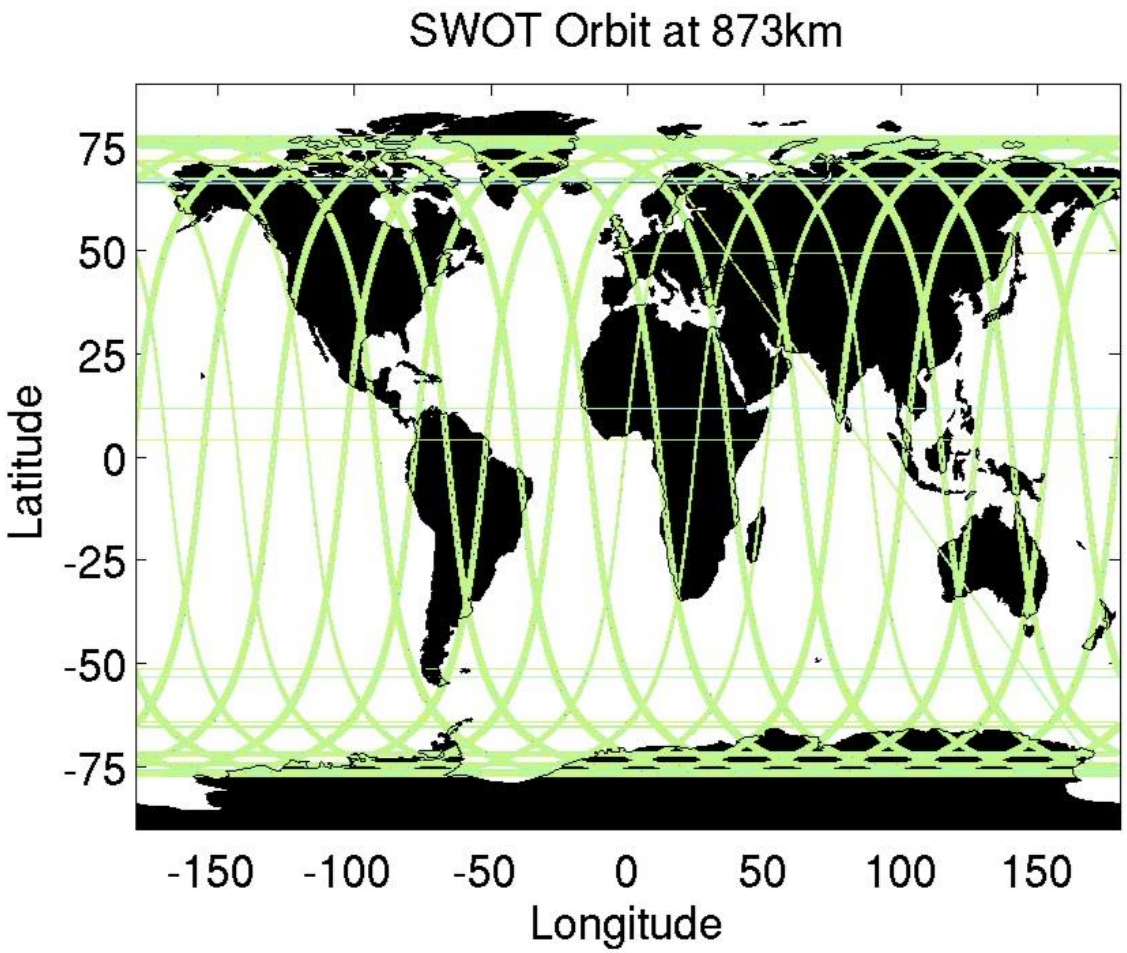
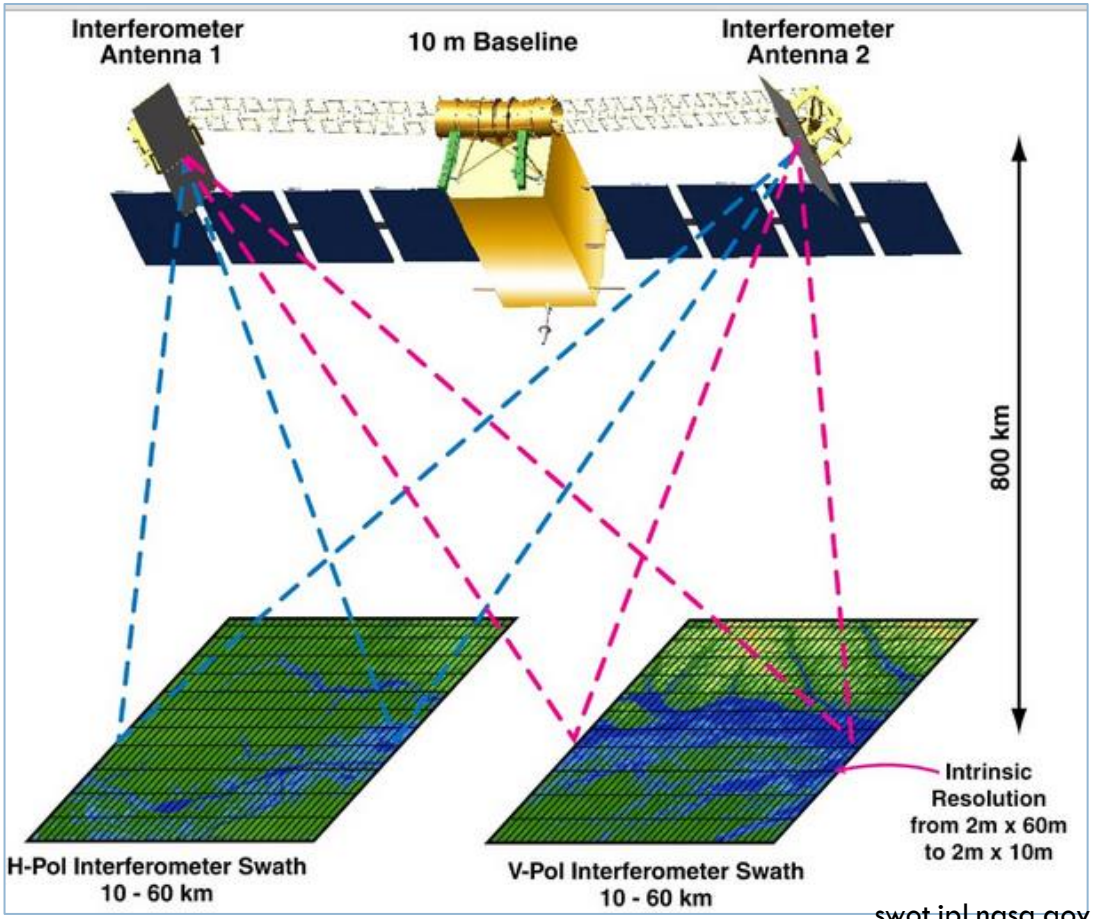
Motivation: altimeters

- Global tracking-- good spatial resolution
- Tracks hit same location once every ten days-- poor temporal resolution
- Aliasing issues at high frequencies

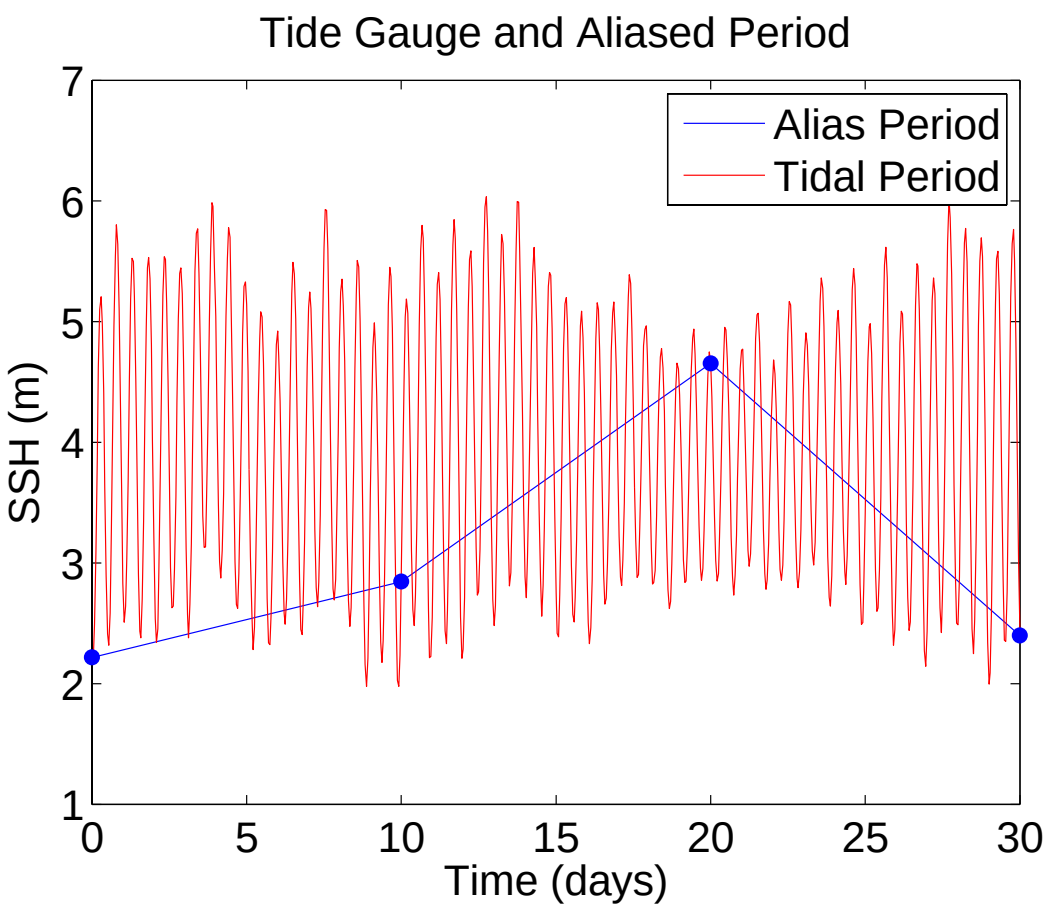


Altimeters cont.

- HYCOM and SWOT
- NASA project: Surface Water Ocean Topography
- Resolves rivers and lakes
- Include higher latitudes for glacial lakes
- Look at aliasing issues of wide-swath altimeters



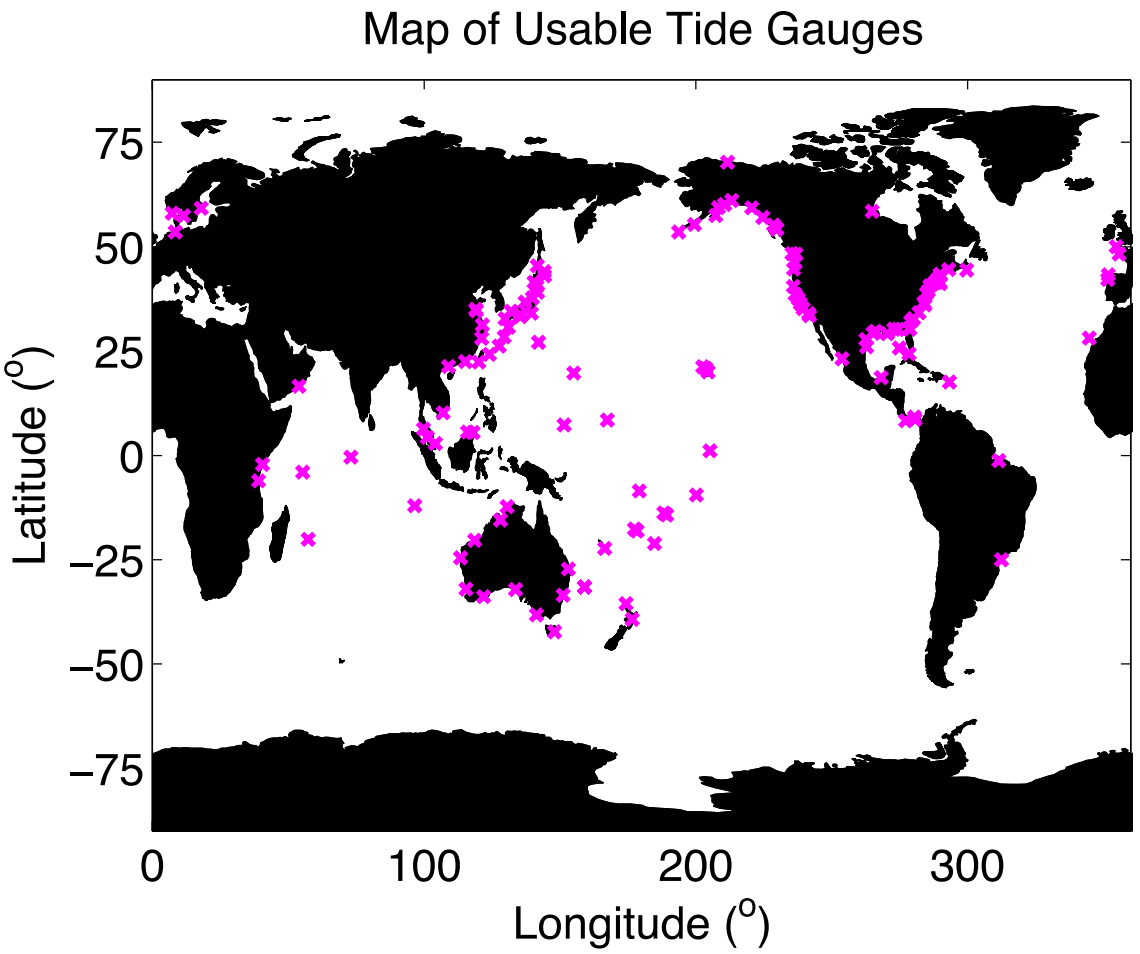
Aliasing



- Problem due to sampling at lower frequency than signal being studied
- Alias frequency determined by repeat period of instrument and period of signal
- Problematic when alias periods coincide with periods of other natural phenomena

Motivation: tide gauges

- Hourly measurements--excellent temporal resolution
- Few locations -- poor spatial resolution
- Even fewer locations that satisfy necessary qualifications



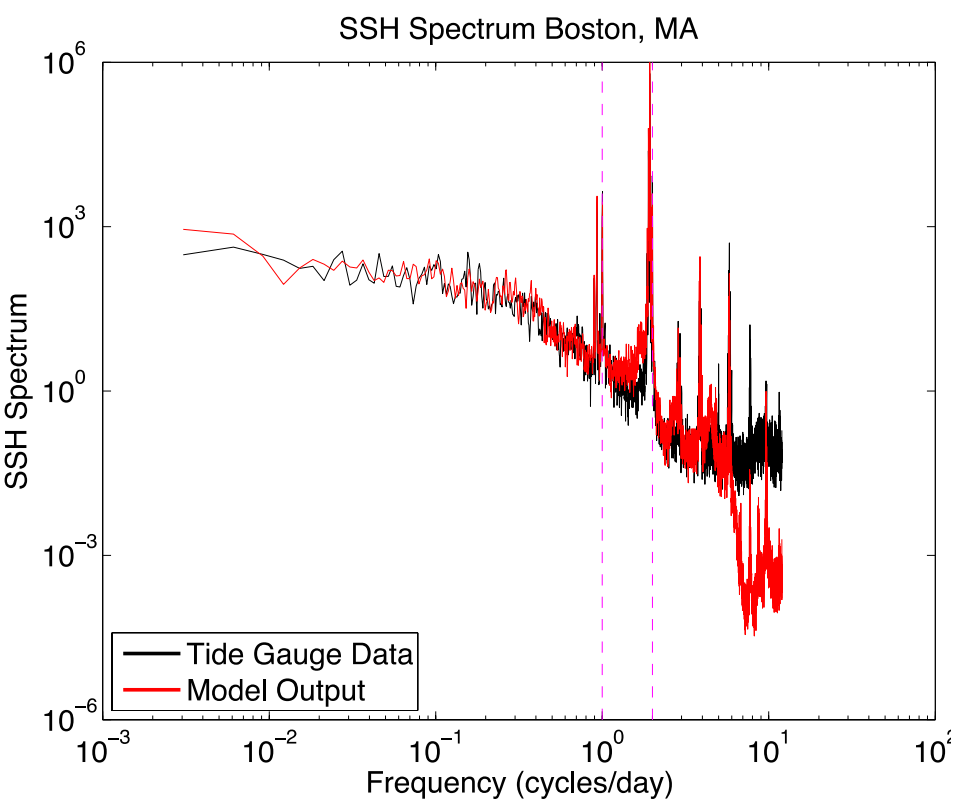
Fourier Transforms

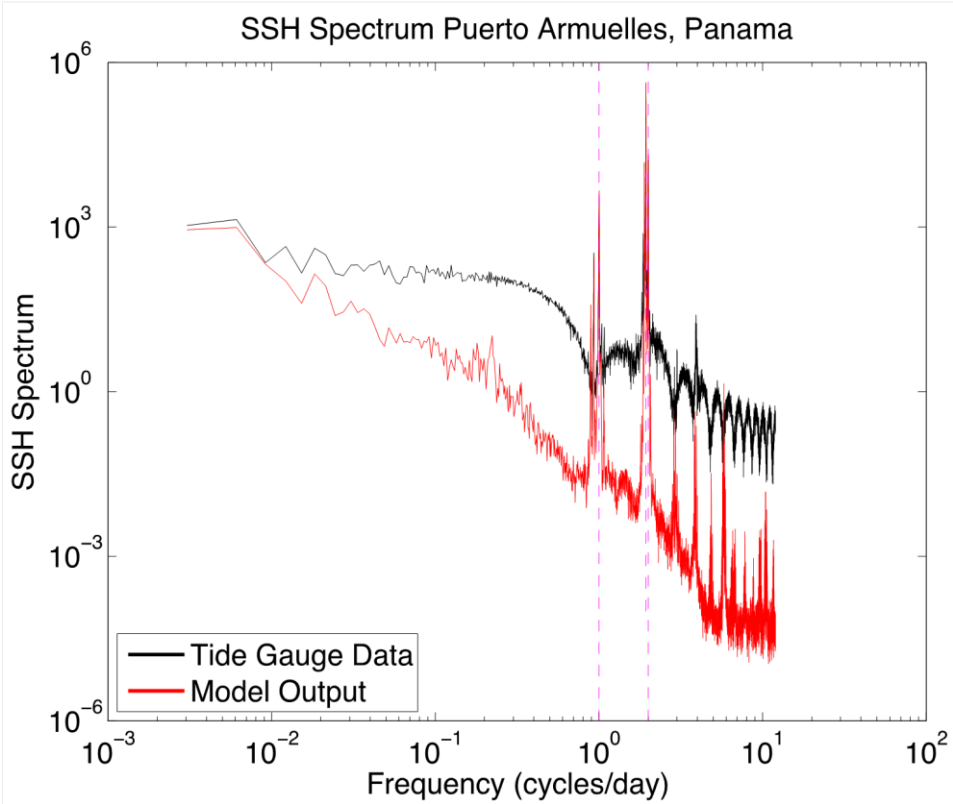
- $\widehat{SSH}(\omega) = \int SSH(t)e^{-i\omega t}dt$

- Gives us information about the energy of each frequency of oceanic motion

- Frequency spectrum averaged over seven overlapping one-year periods within four year window

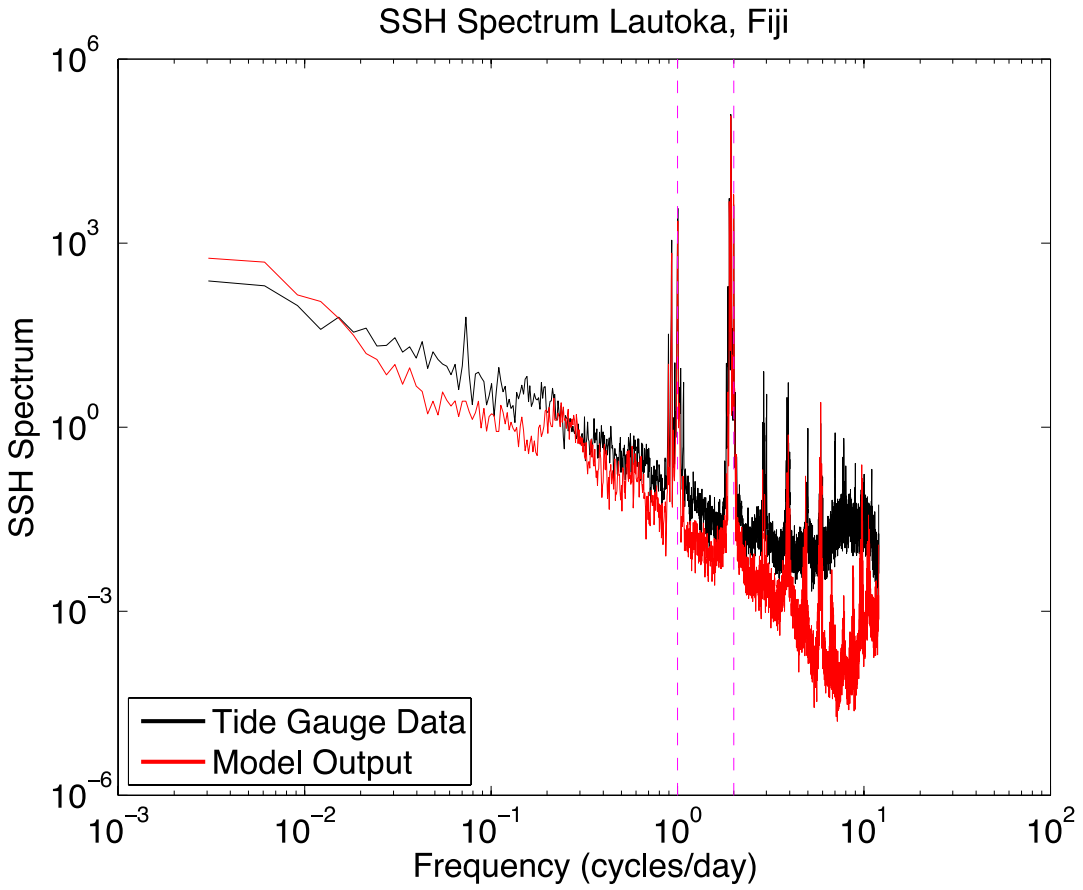
Total Frequency Spectra



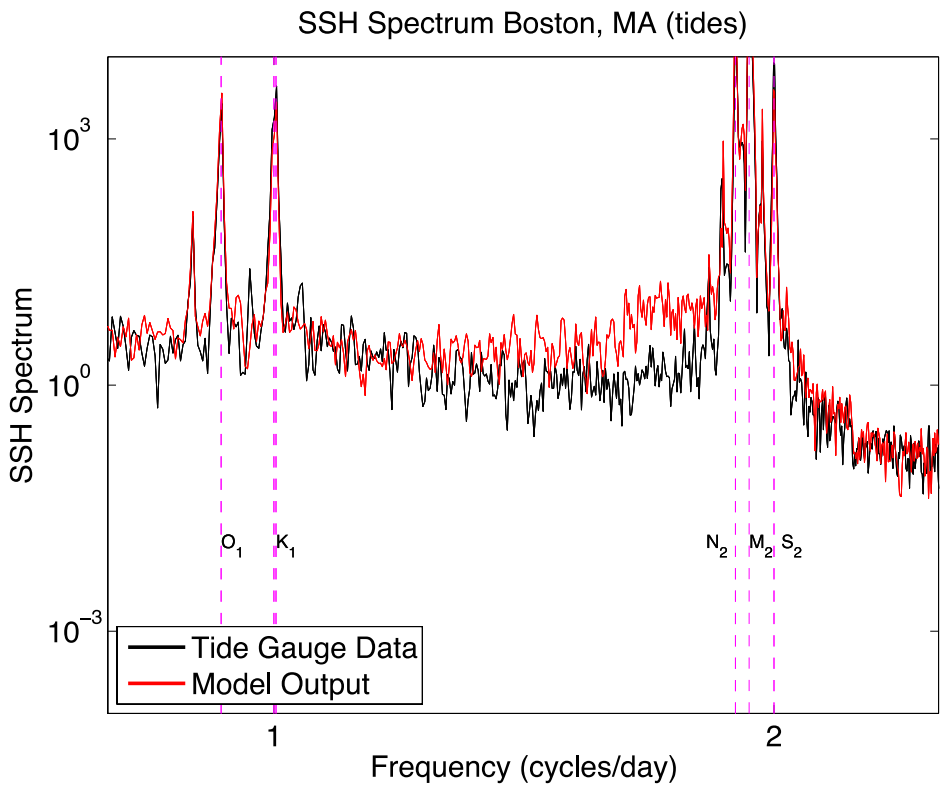


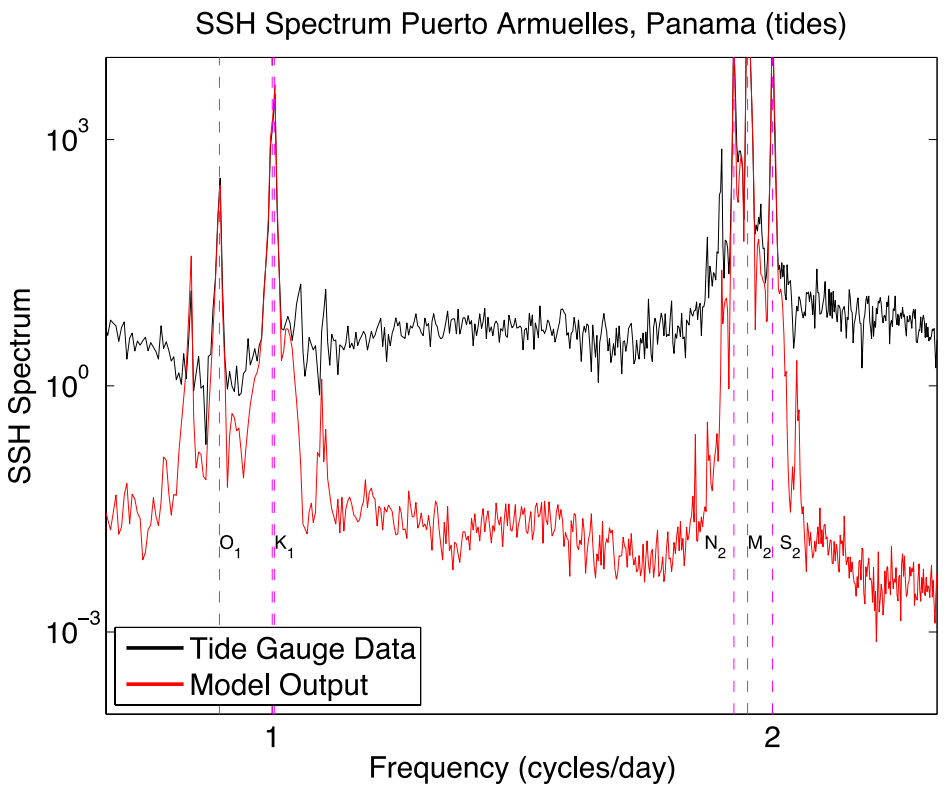
Total Frequency Spectra cont.

- High correlation for coastal regions and estimates for open ocean
- Diurnal and semidiurnal tides clearly indicated in frequency spectra
- High correlation at low frequencies, where model has been compared to altimeter data



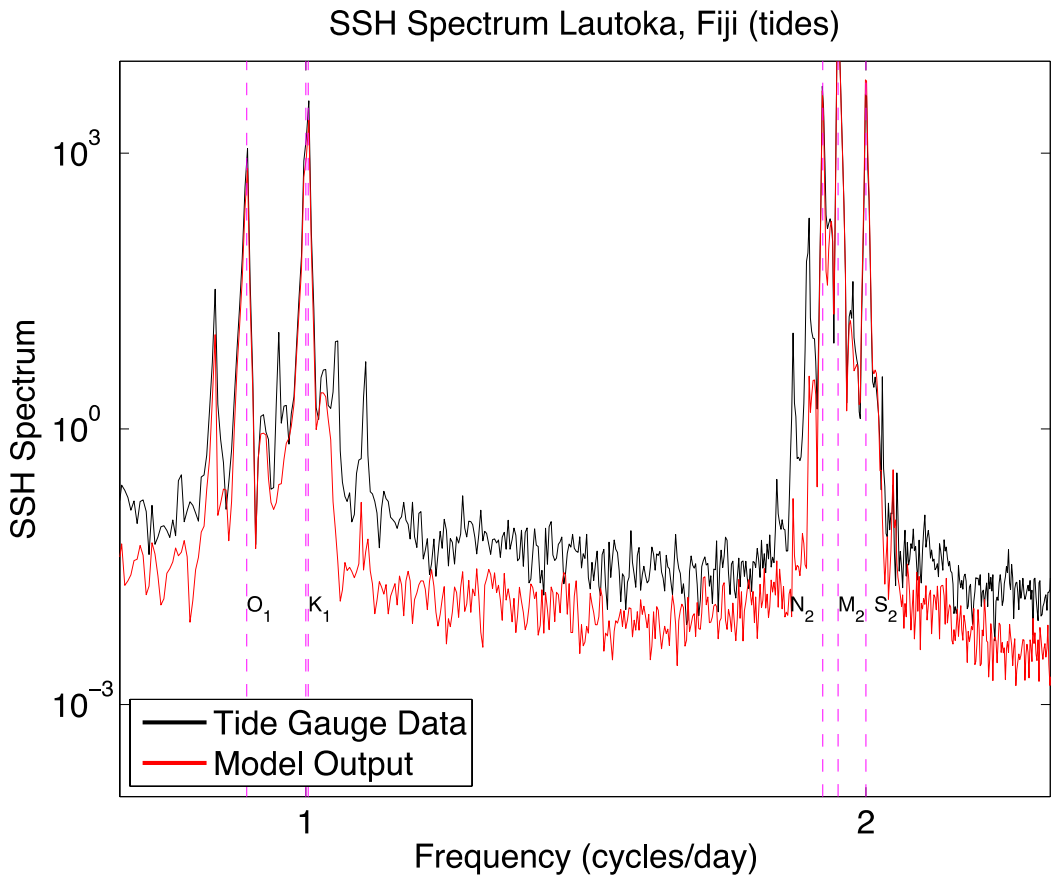
Frequency Spectra at Tidal Bands





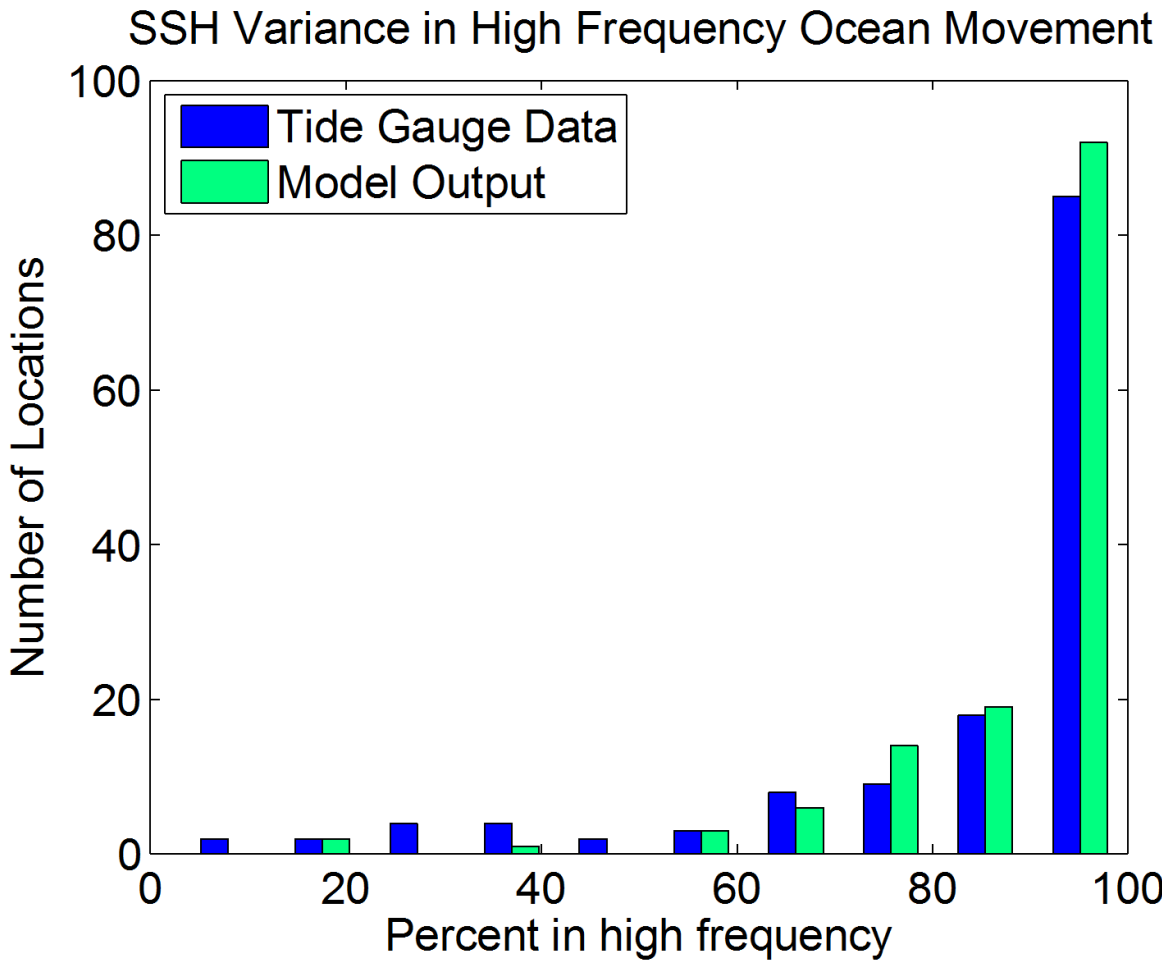
Frequency Spectra at Tidal Bands cont.

- Accuracy in location of tidal peaks
- Error in size of tidal peaks
- Tide bands -- high correlation regions
- Tide bands -- high energy regions

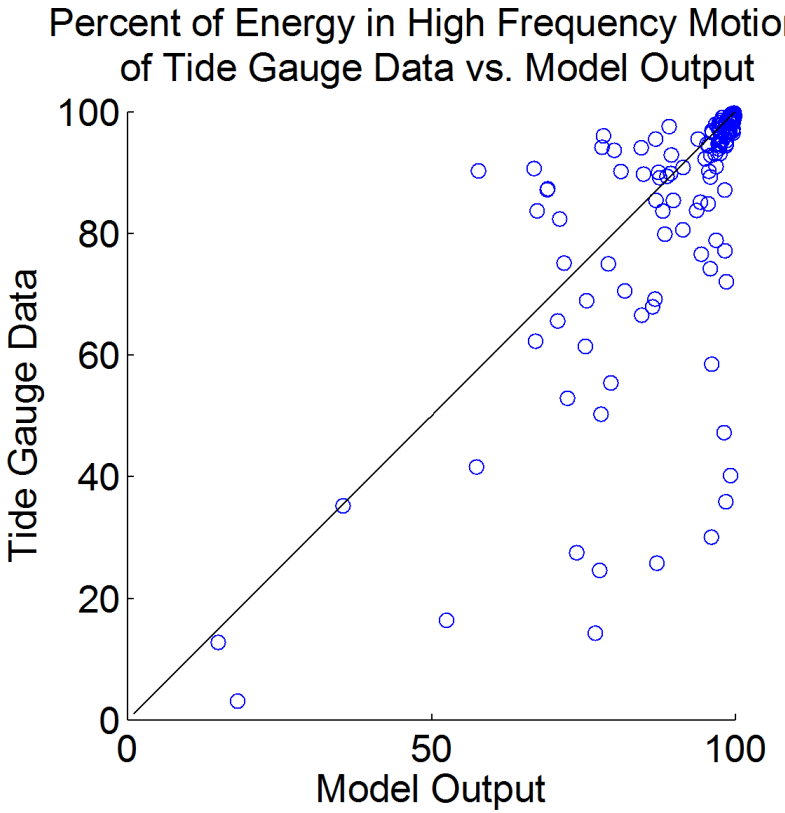


SSH Variance in High Frequency Motions

- Percent of total energy in high frequency motions
- High-frequency oceanic motions -- high energy oceanic motions
- Current altimeter technology aliases >90% energy in some locations

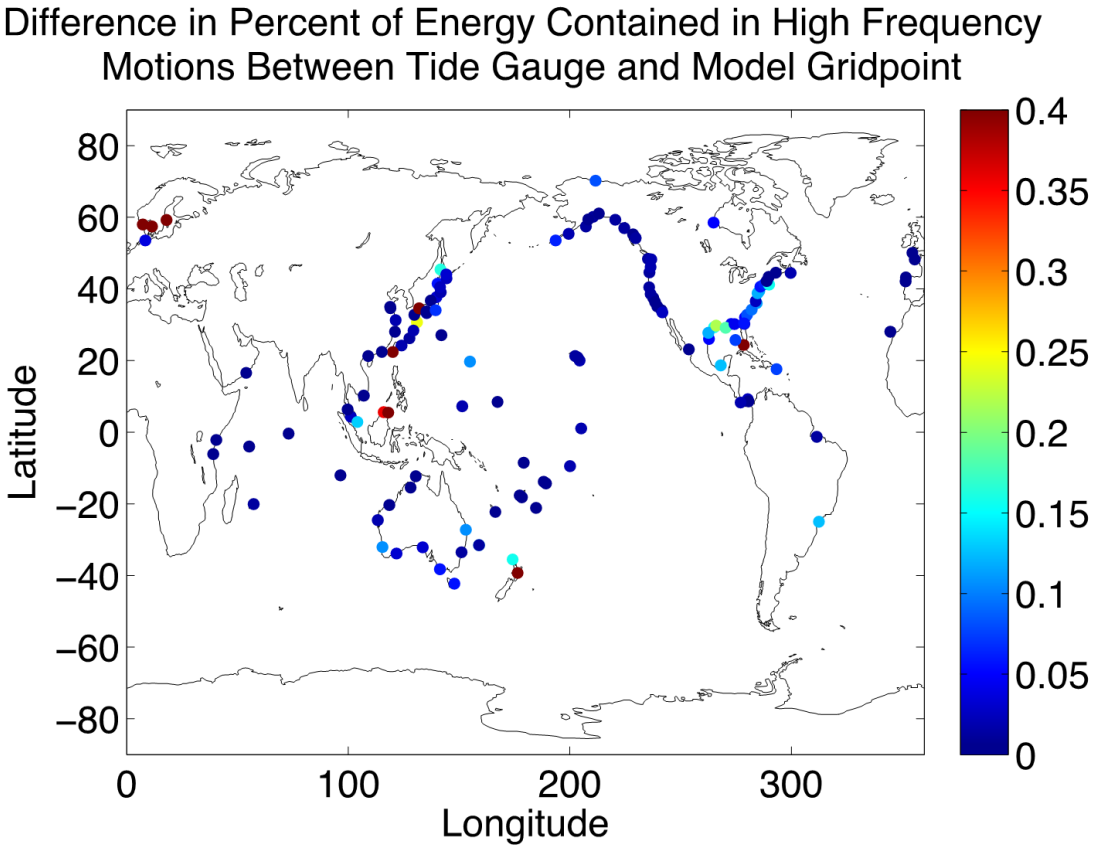


SSH Variance in High Frequency Motions (cont.)



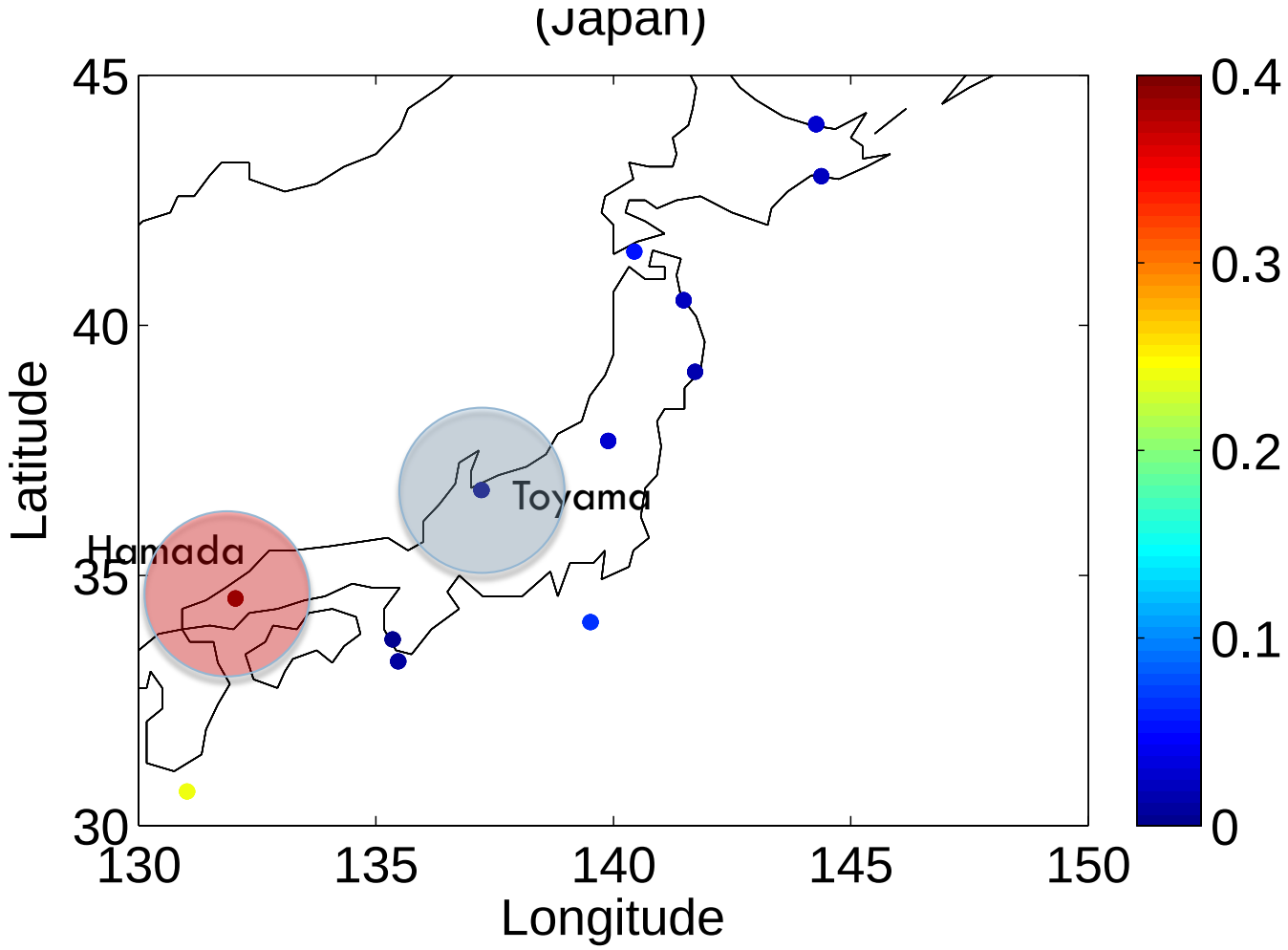
Most locations show small difference between percent of energy in tide gauge data and HYCOM output

Model has good approximation of number of tide gauges with high energy contained in high frequency motion

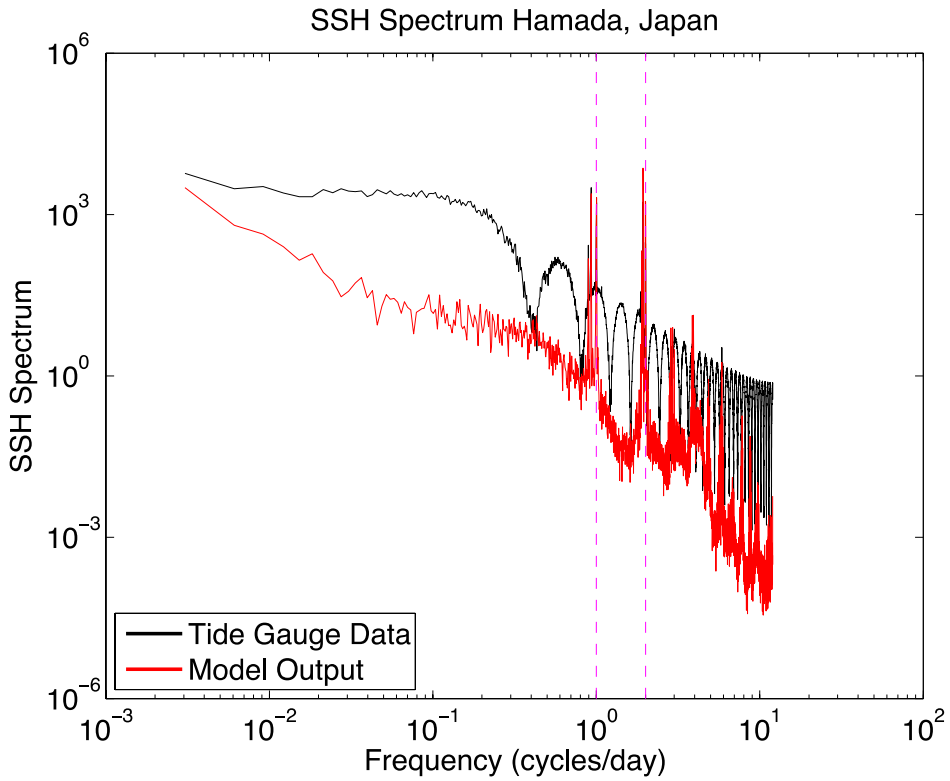


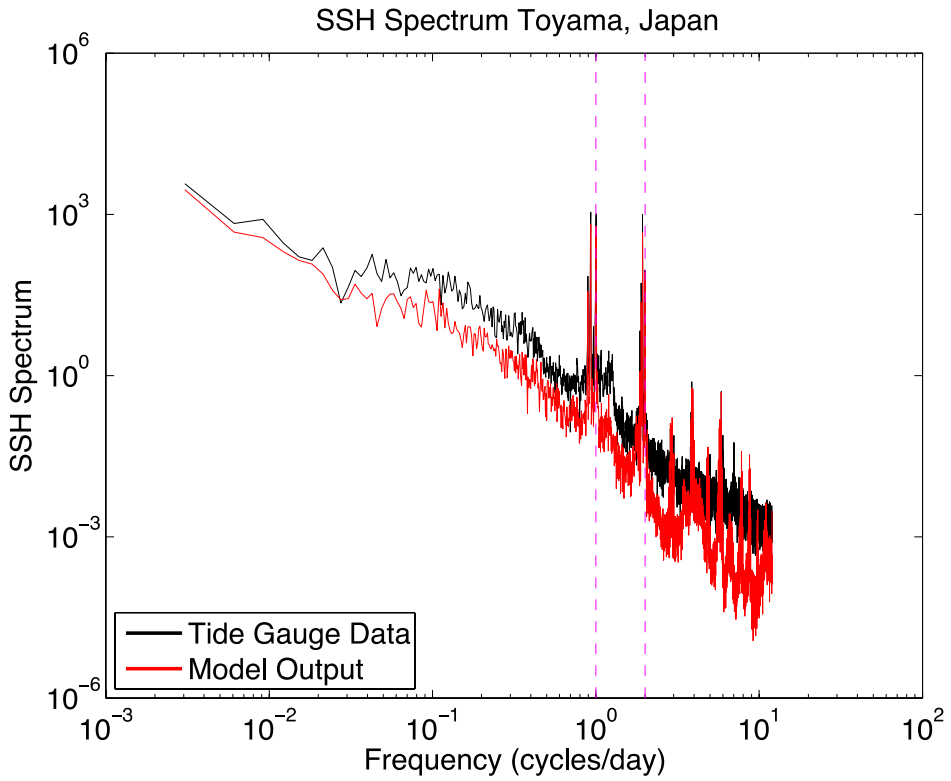
High Frequency Discrepancies

Determine whether discrepancies are in model or tide gauges

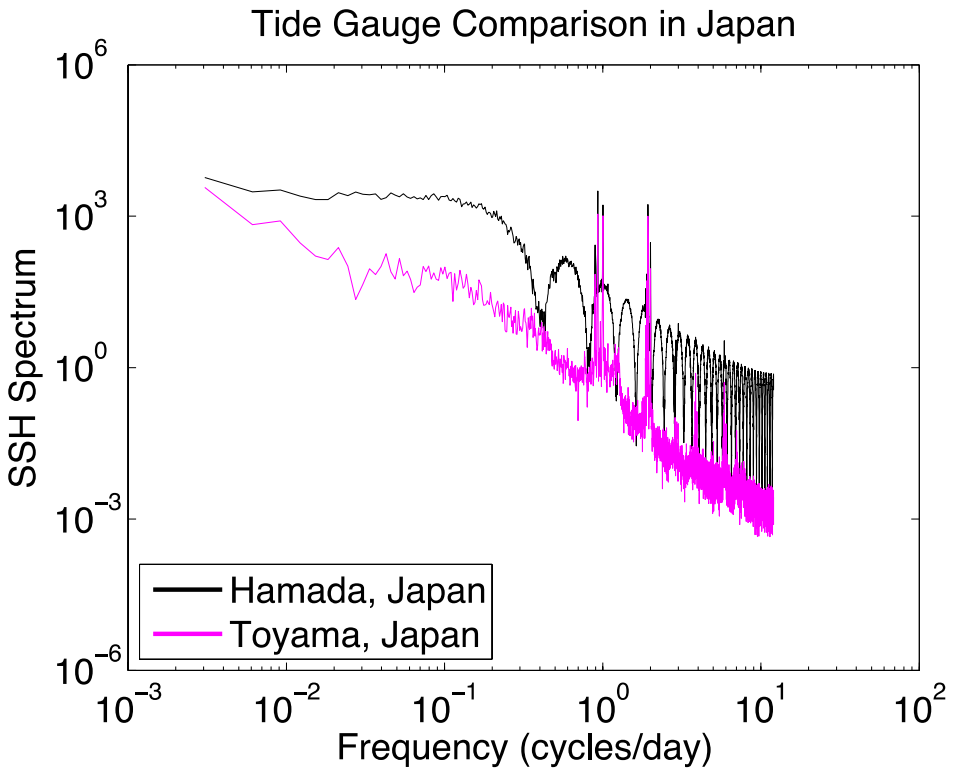


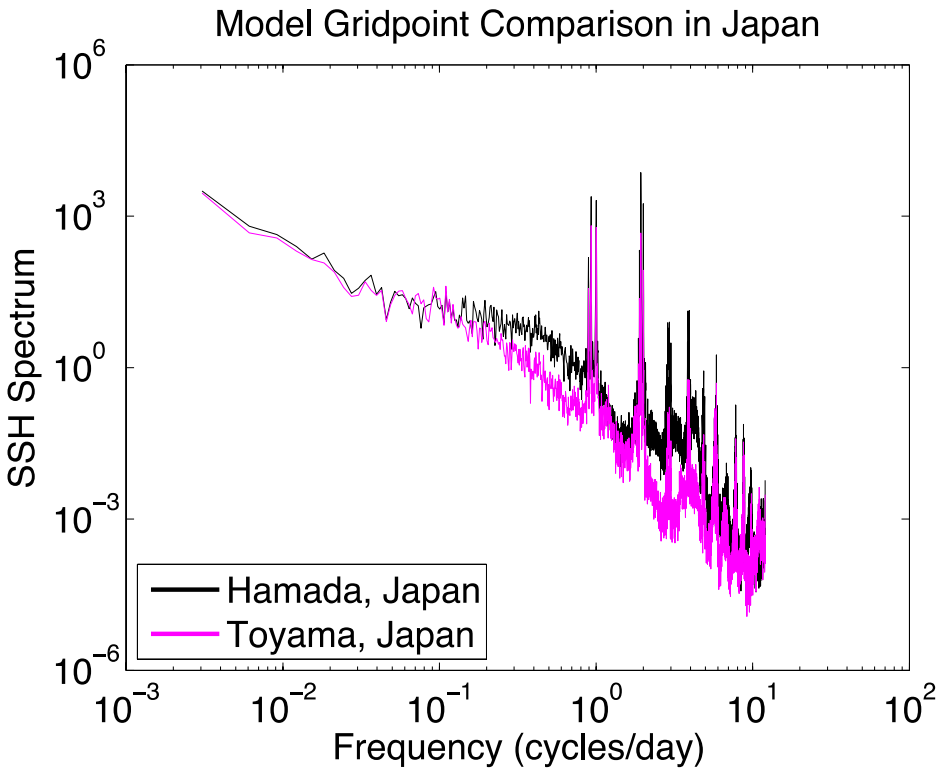
Close Location Comparison (Japan)



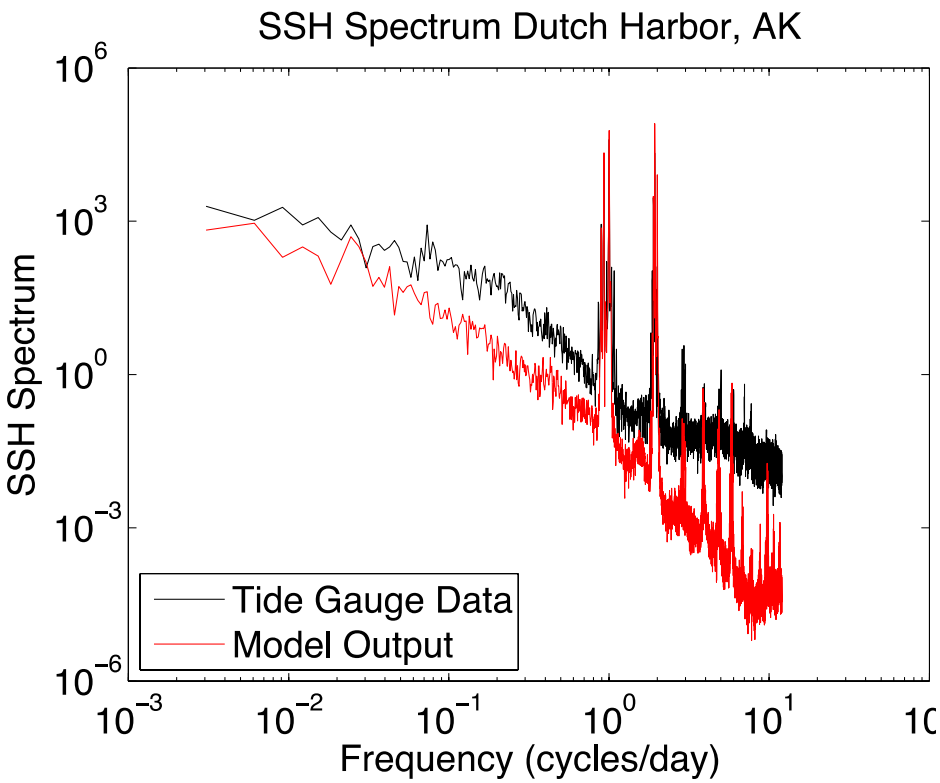


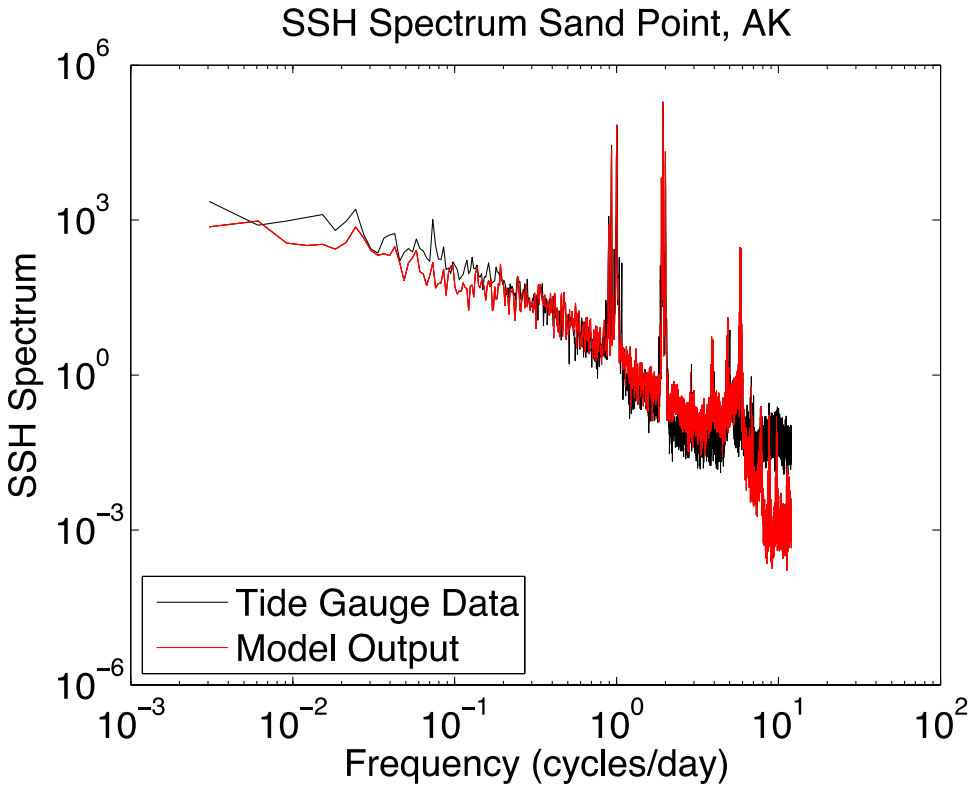
Close Location Comparison (cont.)



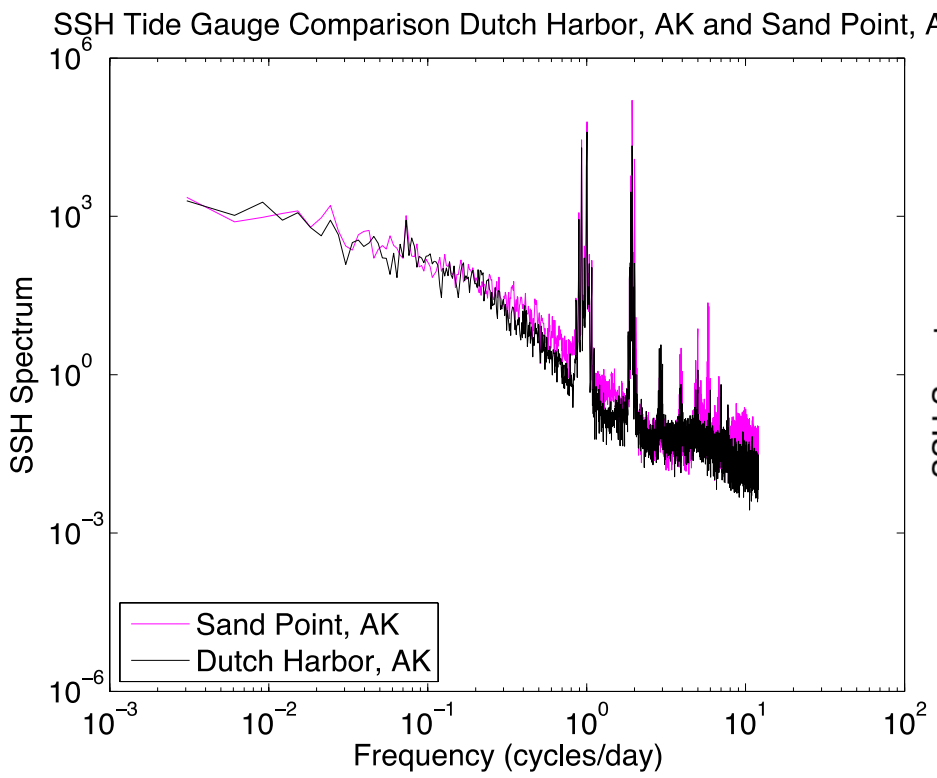


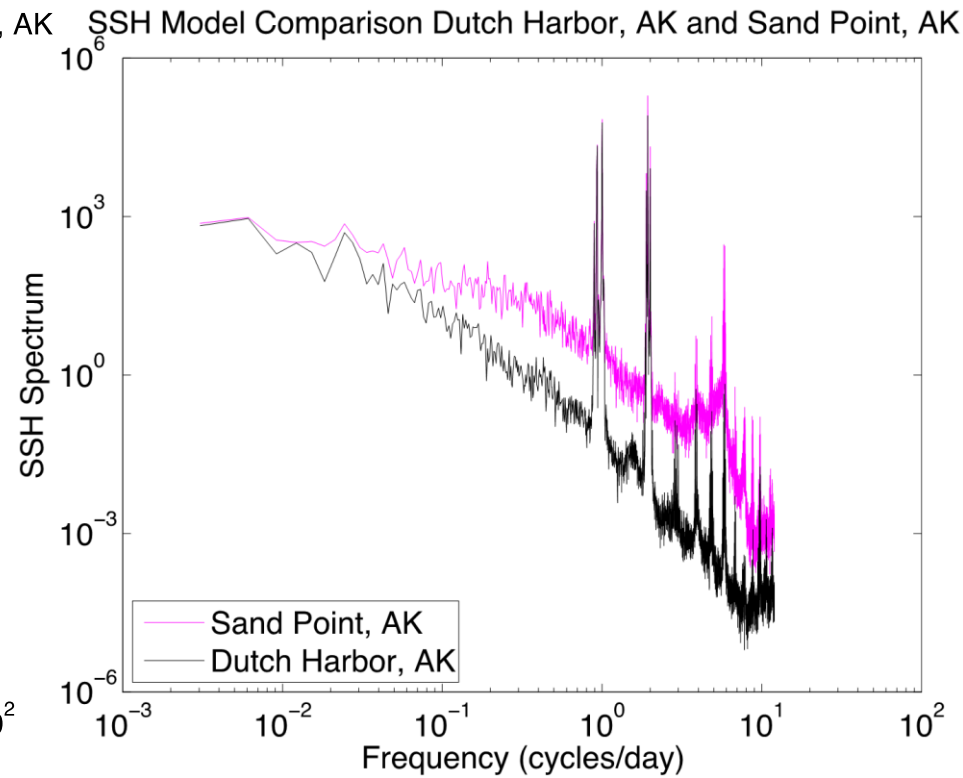
What's missing?



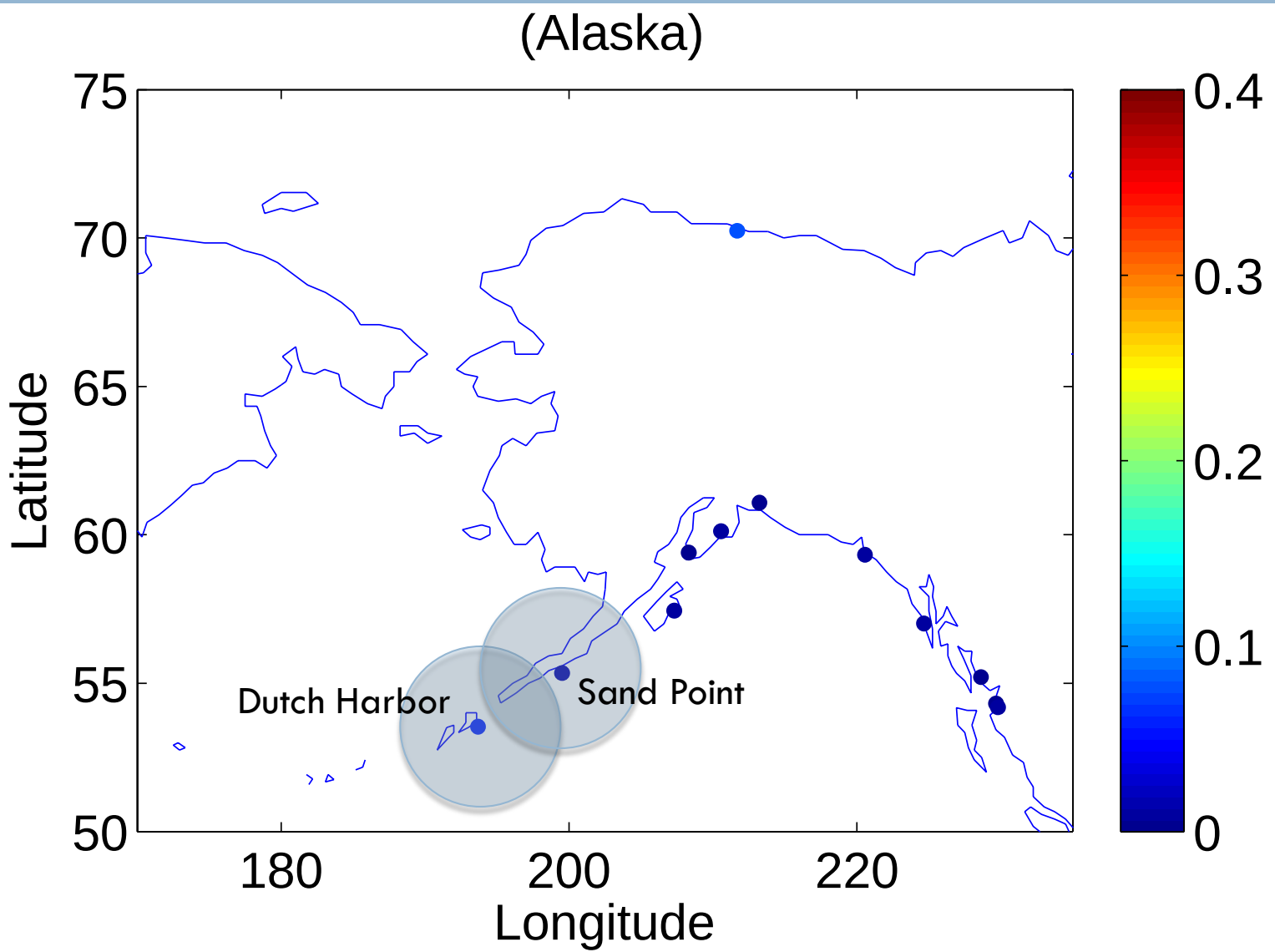


…suspense…


SSH Tide Gauge Comparison Dutch Harbor, AK and Sand Point, AK
SSH Spectrum
Frequency (cycles/day)
Sand Point, AK
Dutch Harbor, AK

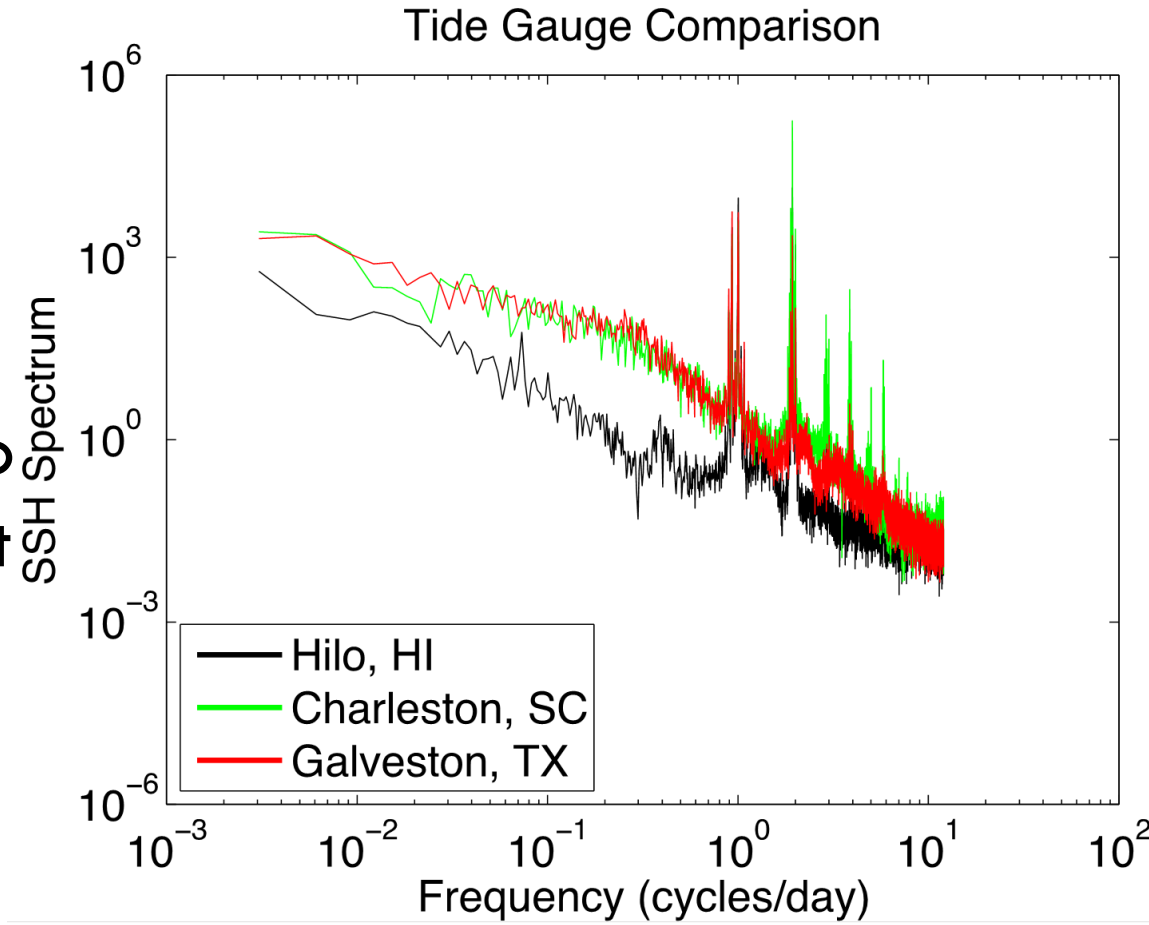

SSH Model Comparison Dutch Harbor, AK and Sand Point, AK
SSH Spectrum
Frequency (cycles/day)
Sand Point, AK
Dutch Harbor, AK

Total Spectrum Integration



Noise

- Tide gauge frequency spectra flatten at high frequencies
- May be related to noise of instrument
- Needs further investigation



What's Next?

- Noise floor
- Why are some locations not as good as other nearby locations?
- Look at locations with larger discrepancies to determine cause
- Frequency spectra comparison with altimeter data
- Wavenumber and wavenumber frequency spectra comparison between HYCOM output and altimeter data
- Study aliasing issues associated with a SWOT

References

- Special thanks to Jim Richman and Jay Shriver

- Arbic, B.K., A.J. Wallcraft, and E.J. Metzger, 2010: Concurrent simulation of the eddying general circulation and tides in a global ocean model, Ocean Modelling 32, 175-187, doi:10.1016/j.ocemod.2010.01.007.

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- Shriver, J.F., B.K. Arbic, J.G. Richman, R.D. Ray, E.J. Metzger, A.J. Wallcraft, and P.G. Timko, 2012: An evaluation of the barotropic and internal tides in a high resolution global ocean circulation model. Journal of Geophysical Research 117, C10024, doi: 10.1029/1012JC008170.

Questions?