Ross Sea Length Scales and Model-Data Comparison

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Outline

- VPR and MVP data overview
- Ross Sea model (1.5 km grid)
- Length scales from correlation
- Wavenumber spectrum
- Model-Data comparison
- Summary

VPR and MVP data overview

- 13 VPR deployments, $\sim$ 1 km spacing,
- 16 MVP deployments, $\sim$ 2 km spacing
- Observations interpolated to 10 m depth intervals
  - 10 to 100 m for VPR
  - 10 to 280 m for MVP

Ross Sea Model

- Based on ROMS
- Model grid has 1.5 km spacing
- Active sea ice and ice shelf
- Model is run with and without tide forcing
- forcing for Sept 15 2010 to Feb 27 2012 (1.5 yr)
- Analyze daily solutions (snapshots) for Dec 30, 2011 to Feb 28 2012.
- More details later by Mike and Stefanie

Length Scale from Correlation

- Analysis from each deployment (section) of MVP and VPR
- Each section is smoothed with boxcar filter to remove long time variations (trends)
- All pairs of points in a section are considered; Direct distance calculated
- Correlation binned by 1 km separations
- Typically 100's to 1000's of estimates in most bins
- Correlations are averaged over depth and sections (ignoring bin counts ??)

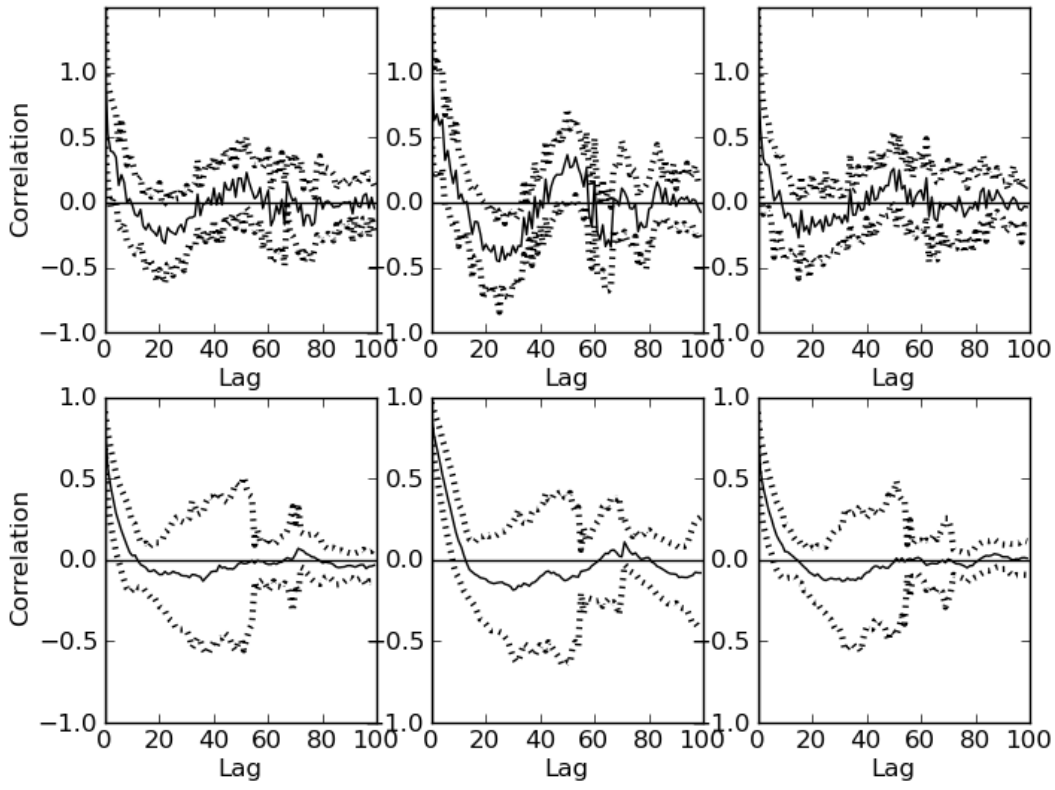
Interpretation of Correlations

Spatial lagged correlations give distance over which obs are not related.
Oscillating correlations indicate structures with alternating character relative to the mean (eddies).

- Exponential decay gives decorrelation distance
- First zero crossing is eddy radius
- First negative correlation max is eddy diameter (distance between opposite eddy centers)
- Second/Third zero crossing is decorrelation distance (??)
- Functional fit can give parameters (not done yet)

$$Cxx(x) = ae^{-bx}(\cos(cx) + (b/c) * \sin(cx))$$

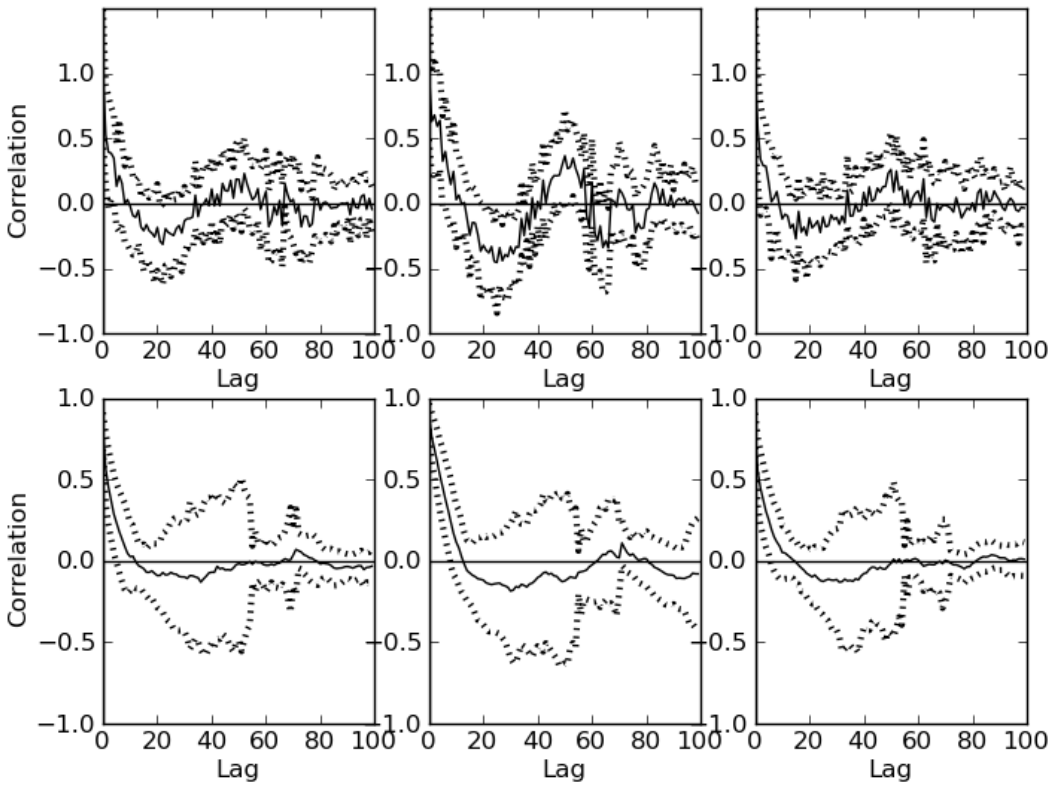
Global Average Correlations



Average correlations for temperature, salinity and fluorescence (left to right) for MVP (top) and VPR (bottom). Dashed lines show standard deviation. Averages over depth and sections.

Correlation Results

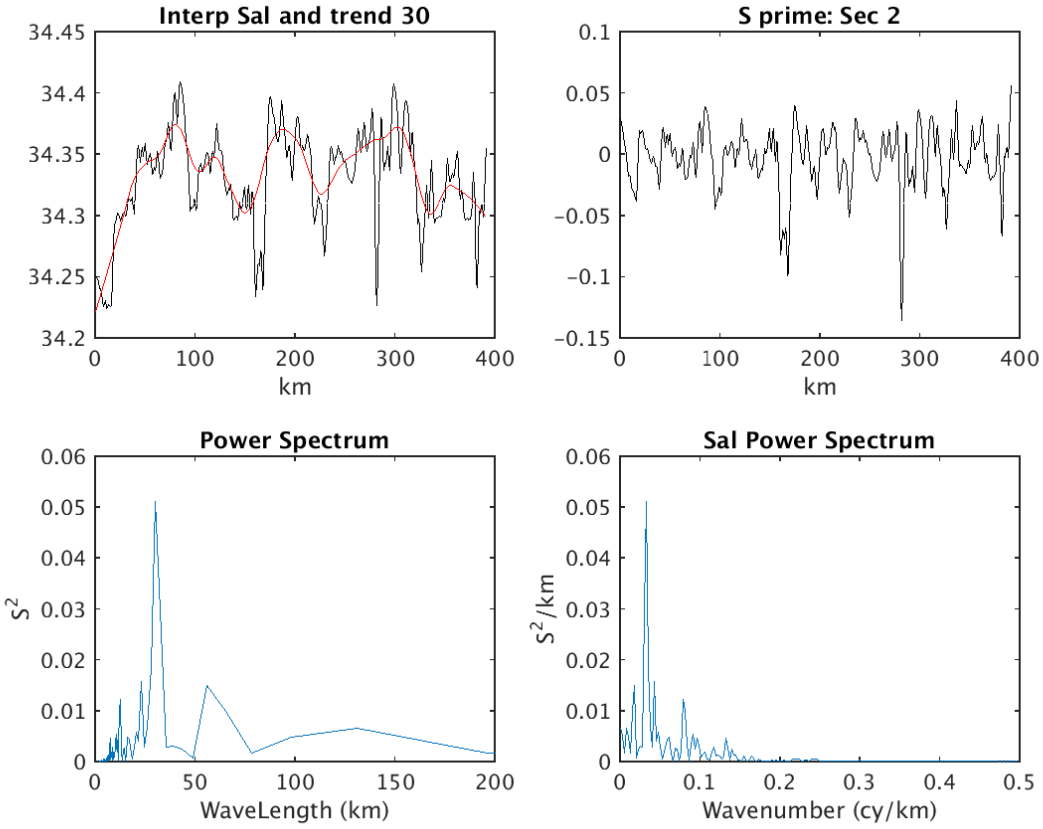
- Zero crossing at 10 km
- Neg Corr at 20 to 30 km
- Decorr at $\sim$ 60 km
- Sal has strongest signal
- Fluorescence has shorter scales
- (Results for other depth intervals available)



Wavenumber Spectra

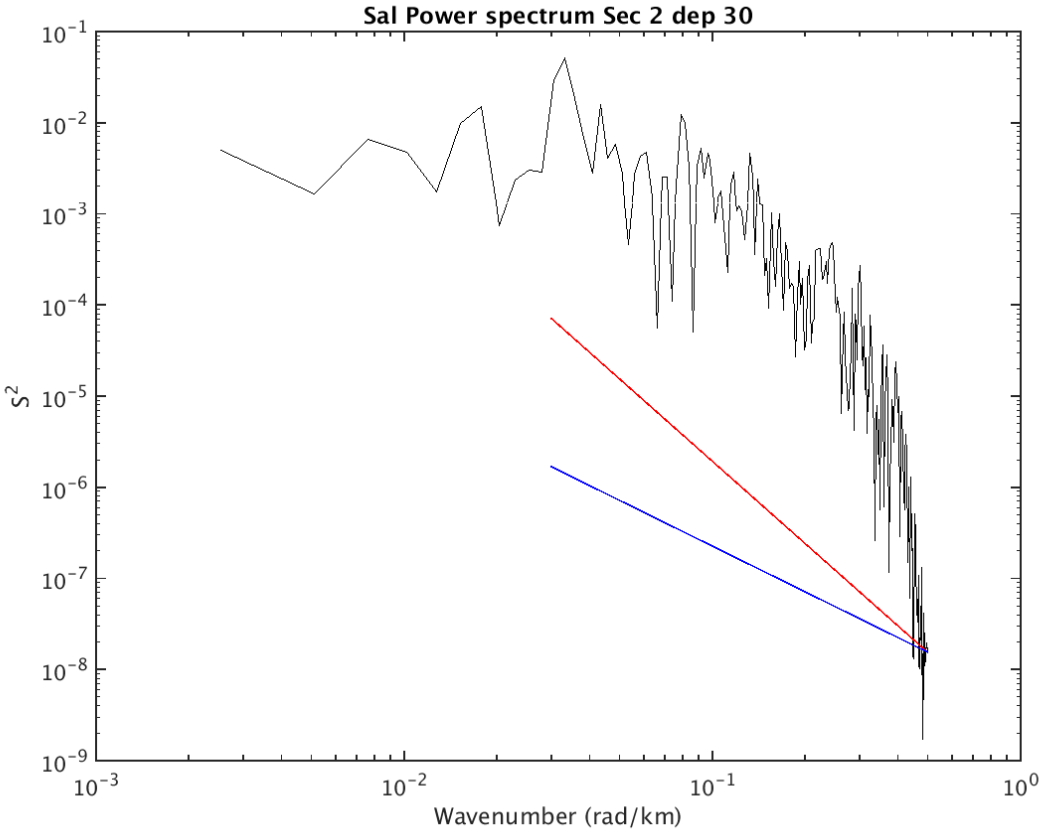
- Variance at different lengths
- Interpolate obs to 1 km uniform spacing, smooth 1-2-1
- Smooth with a 70 point boxcar filter to get trend
- Periodogram with Hamming data window

VPR salinity at 30 m for section 2



Power spectrum shows peak at about 30 km (only 2 df, so precision is not high).

VPR salinity at 30 m for section 2

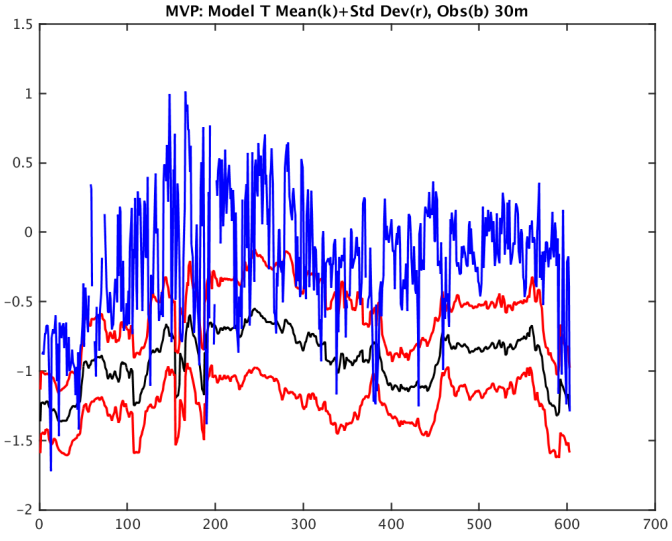


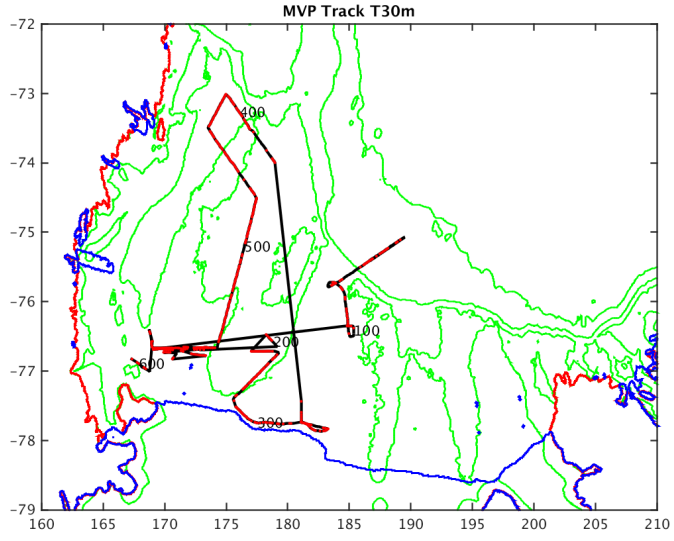
Wavenumber dependence on k. $k^{-5/3}$ indicates dynamic control (internal waves or vorticity dynamics, not turbulence) while k^{-3} indicates turbulent control.

Model-Data comparison

- Use daily model snapshots from Dec 30 to Feb 28 (60 days)
- Interpolate model solution at 10 m depth intervals to location of MVP and VPR observations
- Compare observations to mean and variability of model results over the 60 days
- Sea ice cover and eddies differ between model and obs (needs to be analyzed)

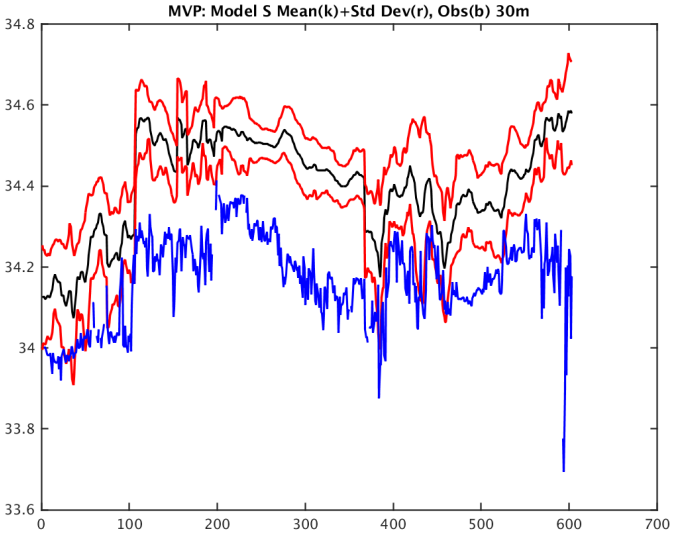
MVP-model temperature comparison at 30 m

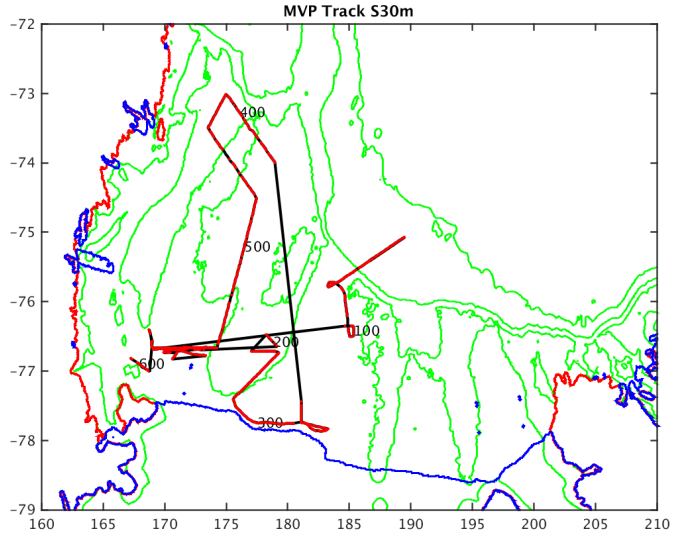




Obs in blue, mean is black, red is std (over 60 days from model).
Red on track is more than 0.5 C different.

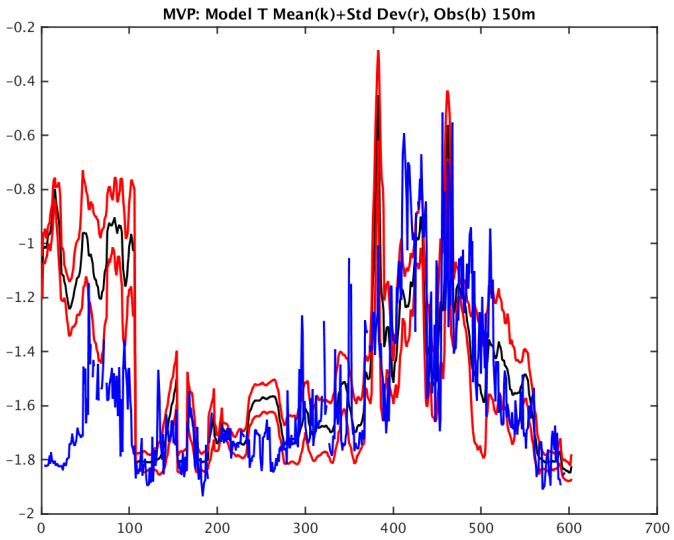
MVP-model salinity comparison at 30 m



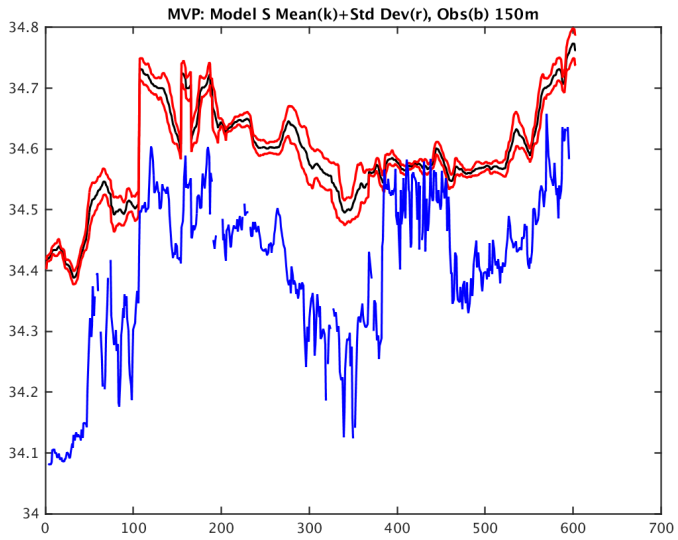


Obs in blue, mean is black, red is std (over 60 days from model).
Red on track is more than 0.1 different.

MVP-model comparison at 150 m

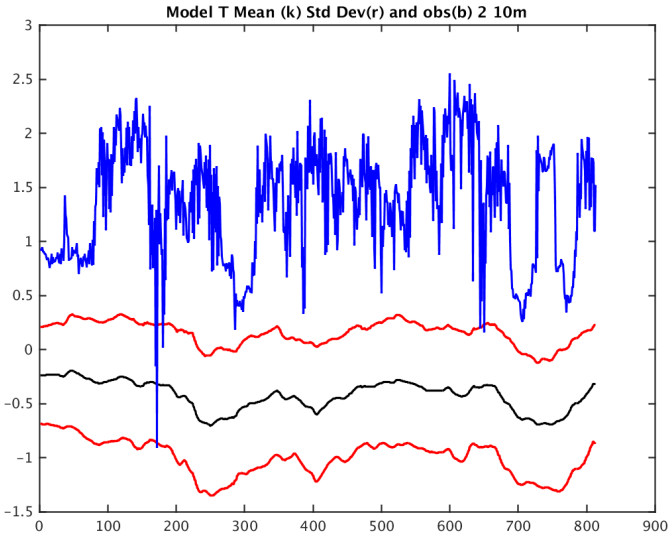


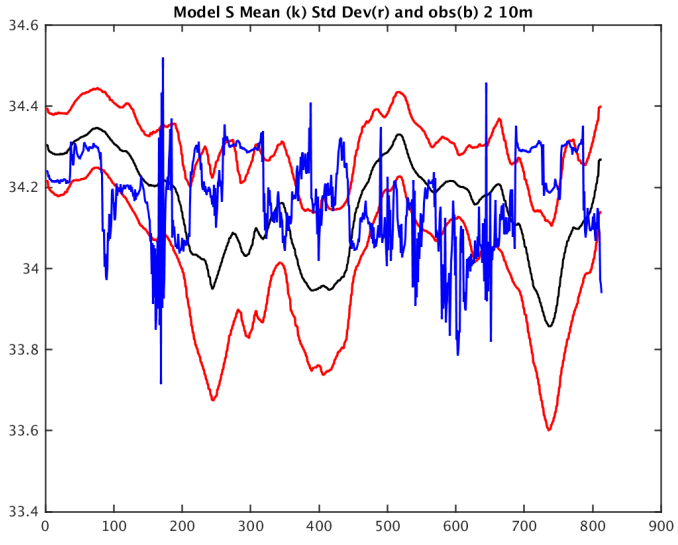
Temperature



Salinity

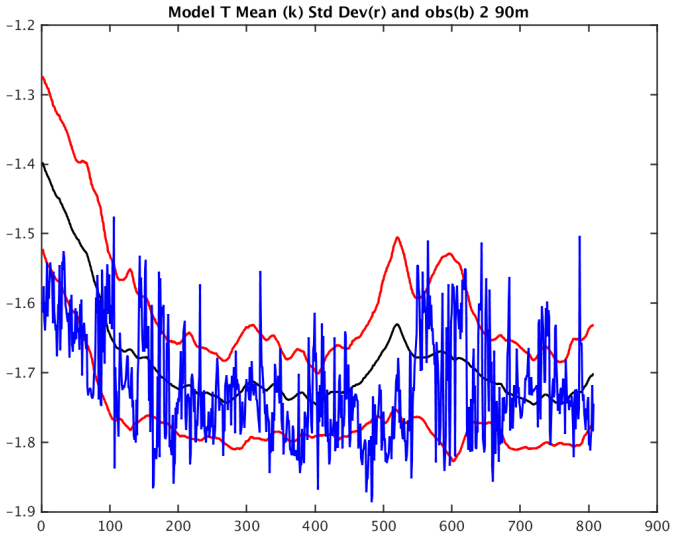
VPR-Model comparison at 10 m for Section 2

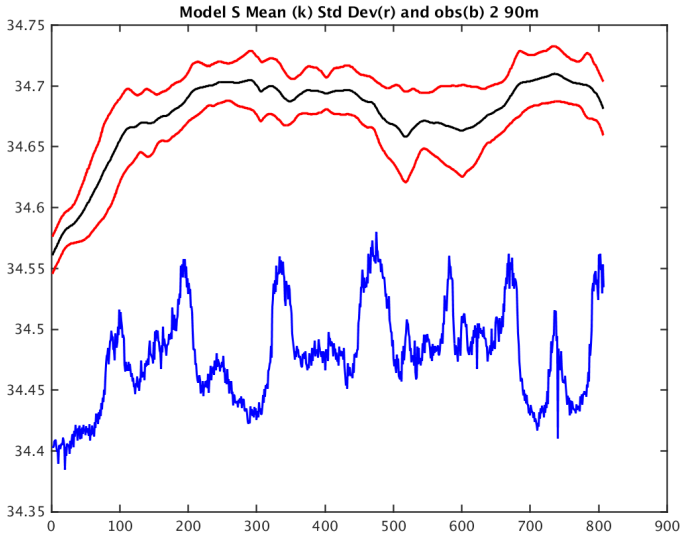




Section 2 is in the Southwest Ross Sea.
Temperature affected by time since sea ice melt.

VPR-Model comparison at 90 m for Section 2





Section 2 is in the Southwest Ross Sea.
Deep salinity difference due to recent convection or vertically displaced salinity.

Summary

- Obs reveal eddy diameter of $\sim$ 30 km
- Model has similar eddy scale
- Eddy scale the same with depth
- Model and obs have similar character
- Model and obs have offsets which are likely due to difference in sea ice timing and winter convection (will be analyzed)

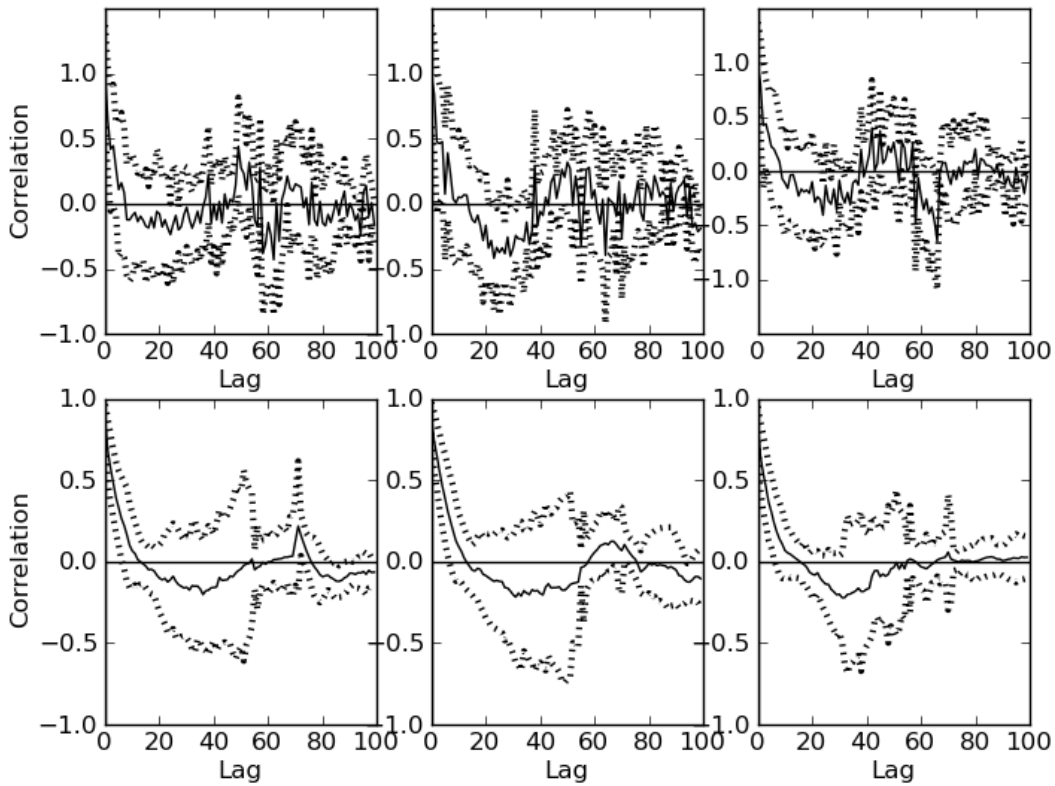
More Work

- Estimate correlations for model results to match MVP, VPR results
- Estimate spectra for model results (compare spectra)
- Extend analysis to alongtrack obs when ship is moving; provides many more variables
- Write the paper!

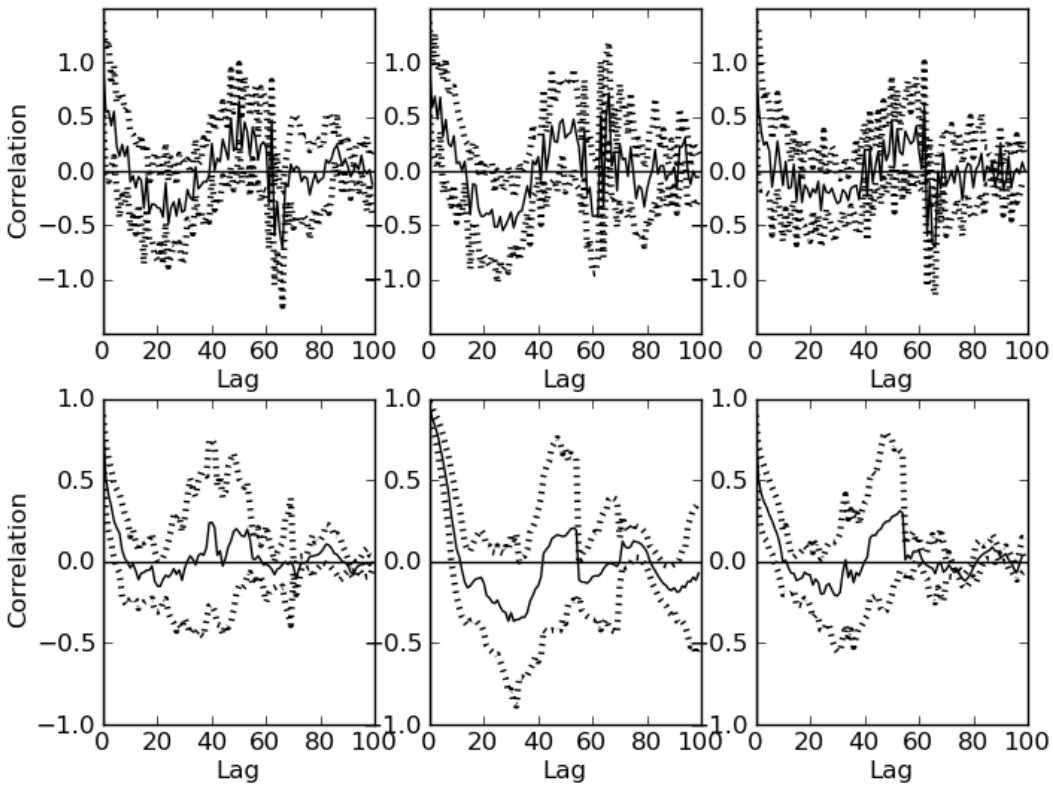
Thanks!

Are there any questions?

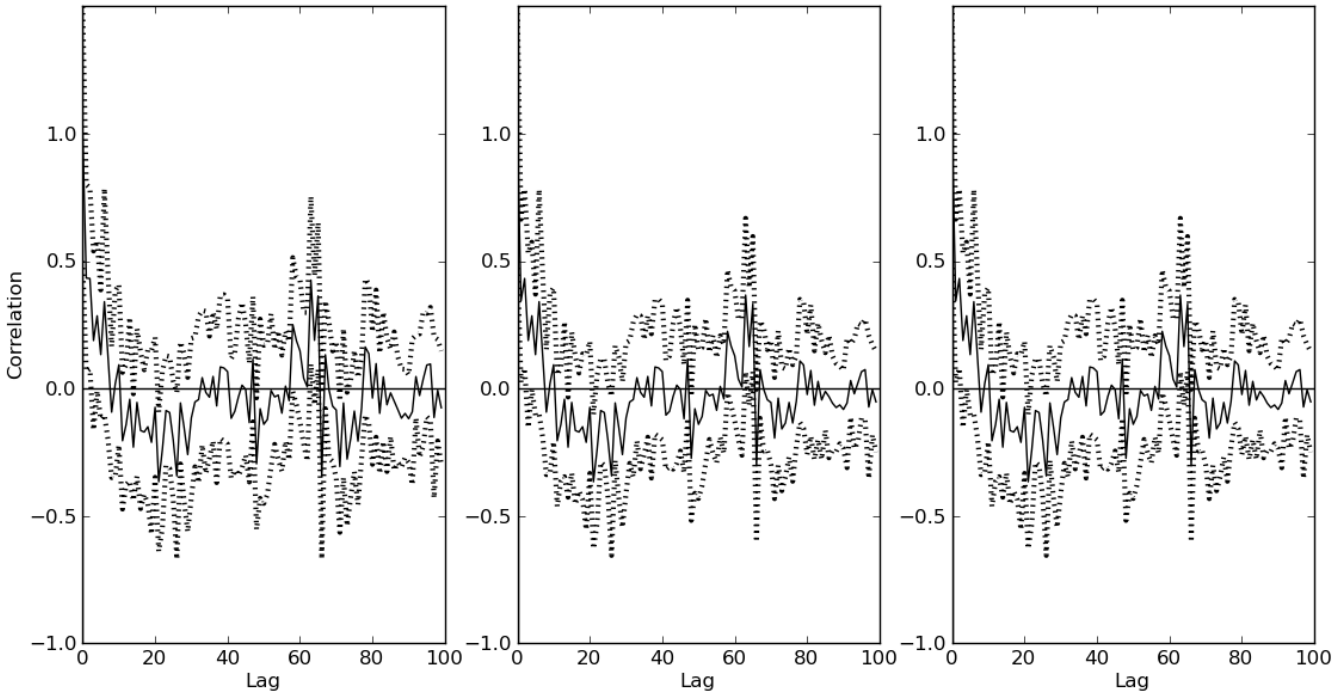
Surface Layer Correlations (10 to 30 m)n



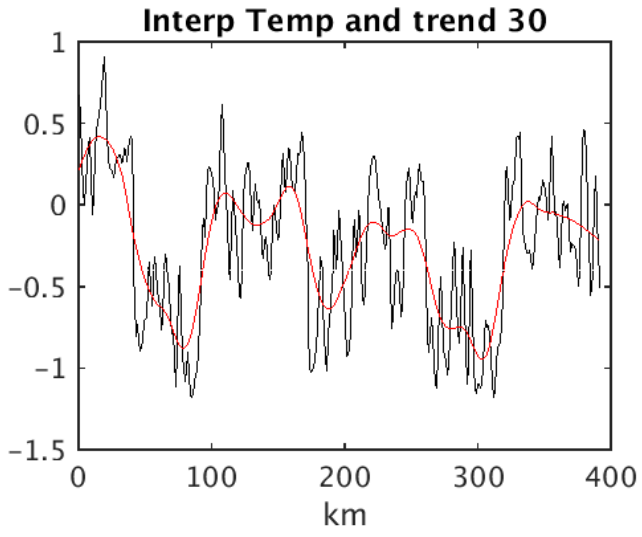
Correlations at 90 to 100 m (Winter Water)

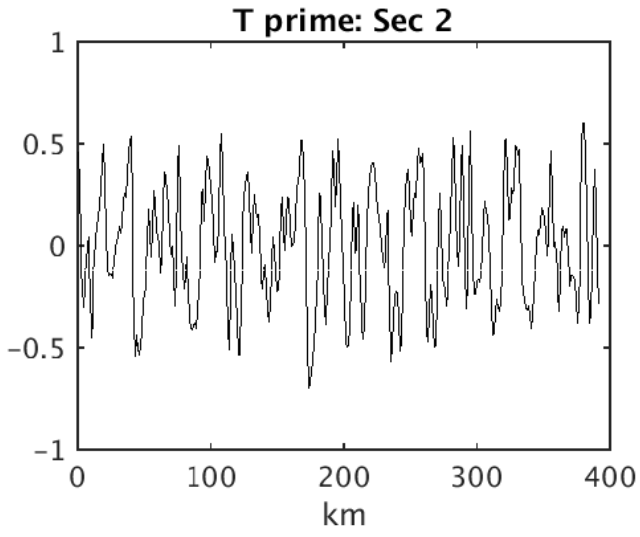


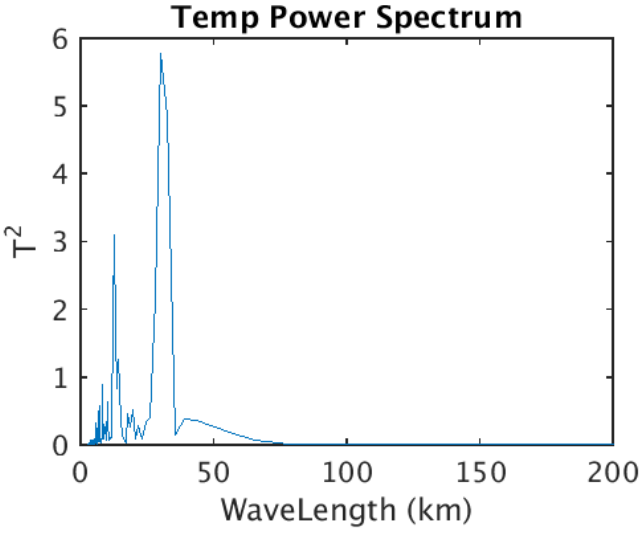
Deep Correlations (200 to 280 m, MVP only)

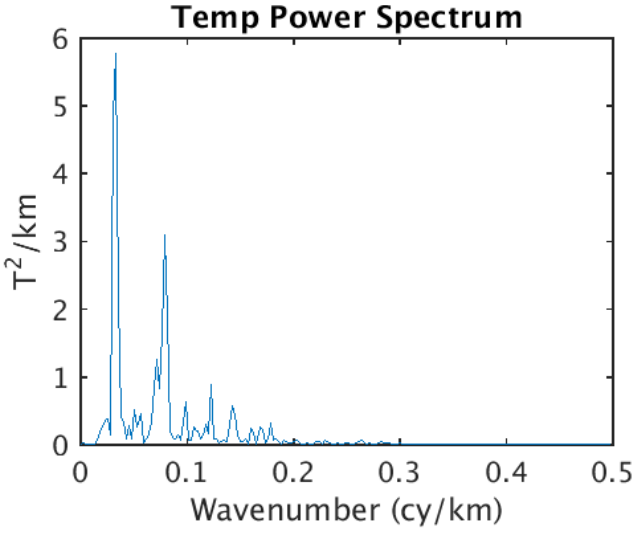


VPR Temperature spectrum for Section 2 at 30 m









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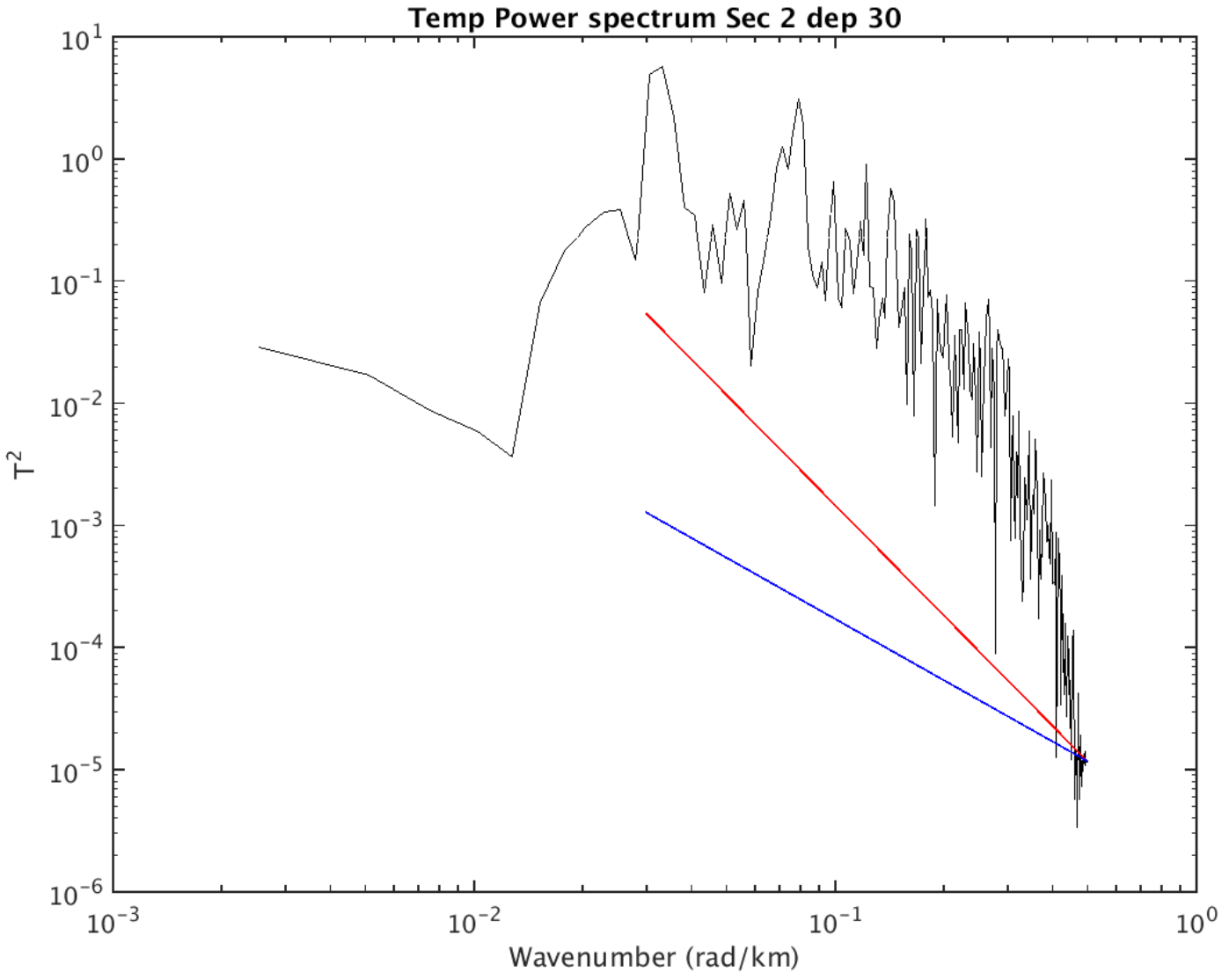
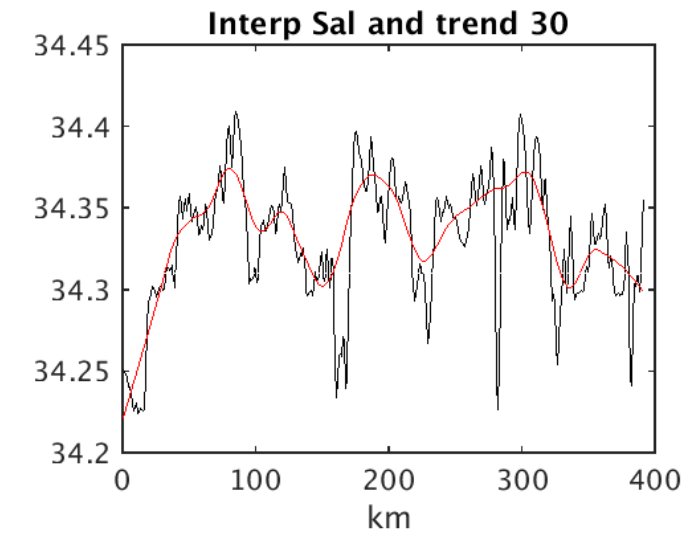
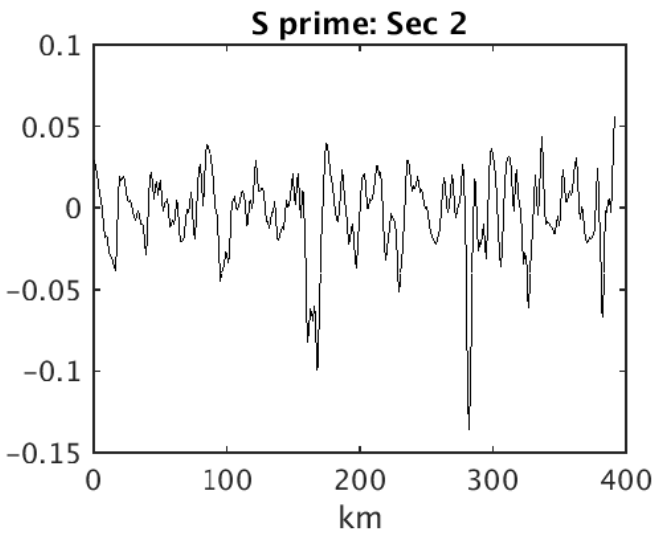
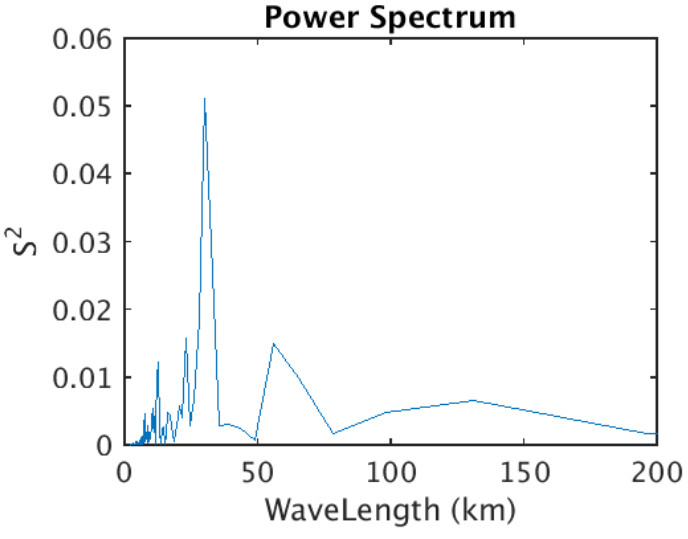
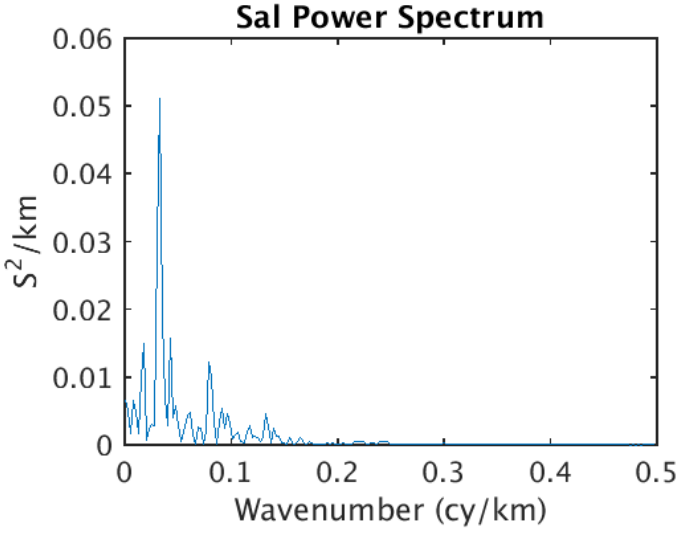


VPR Salinity spectrum for Section 2 at 30 m

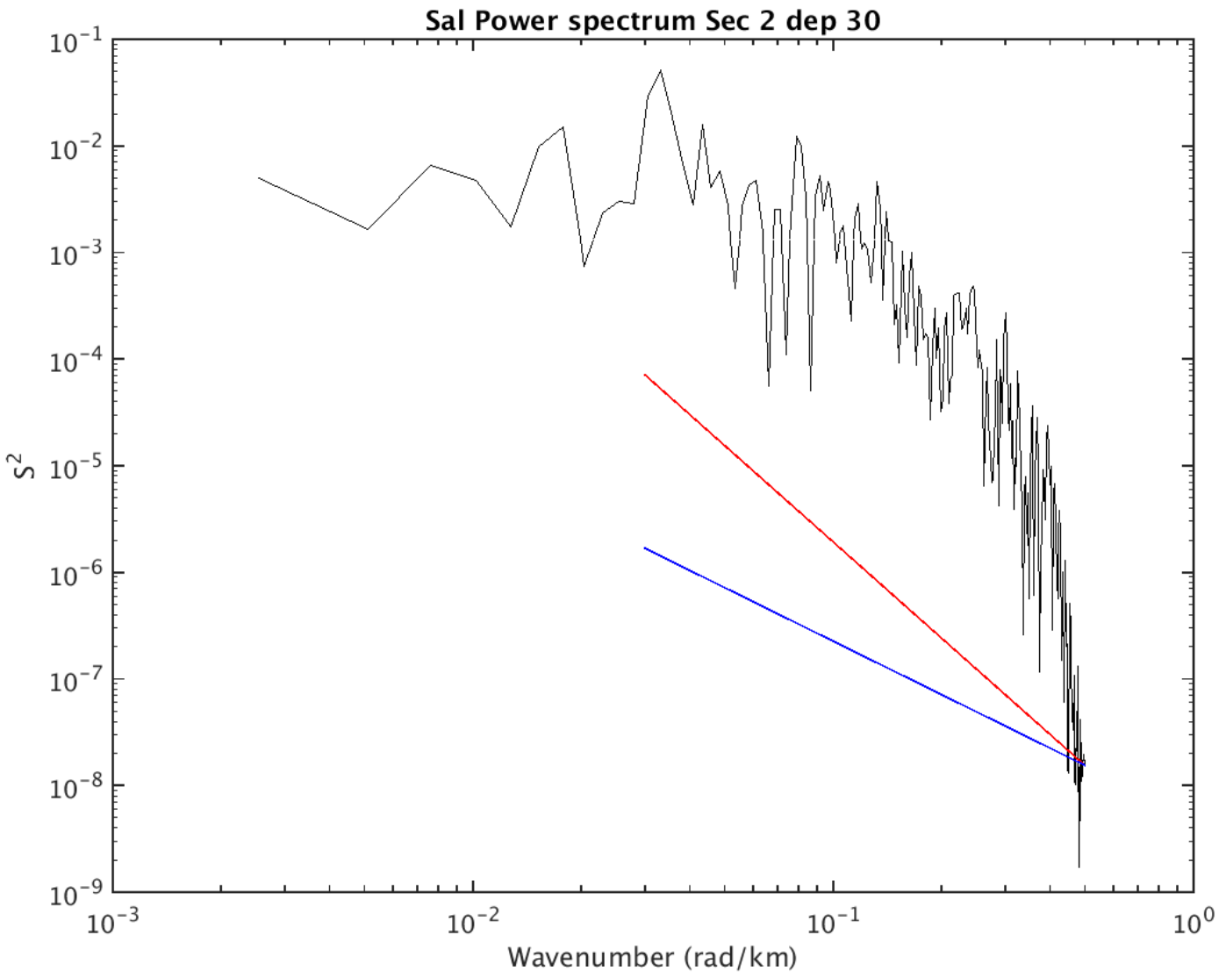




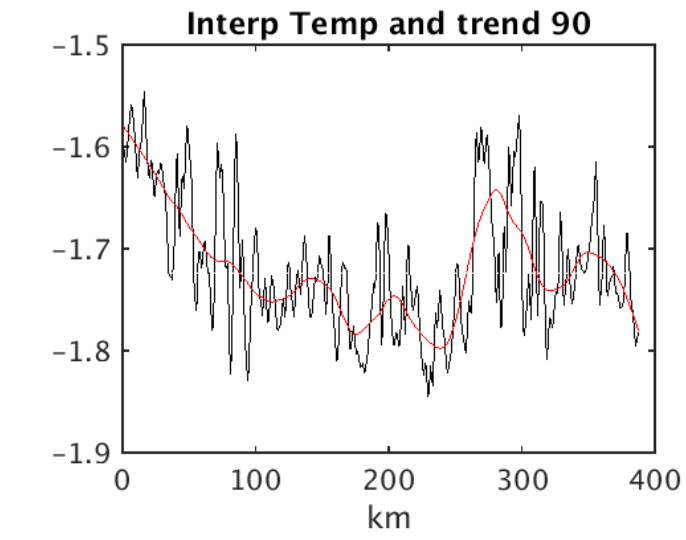


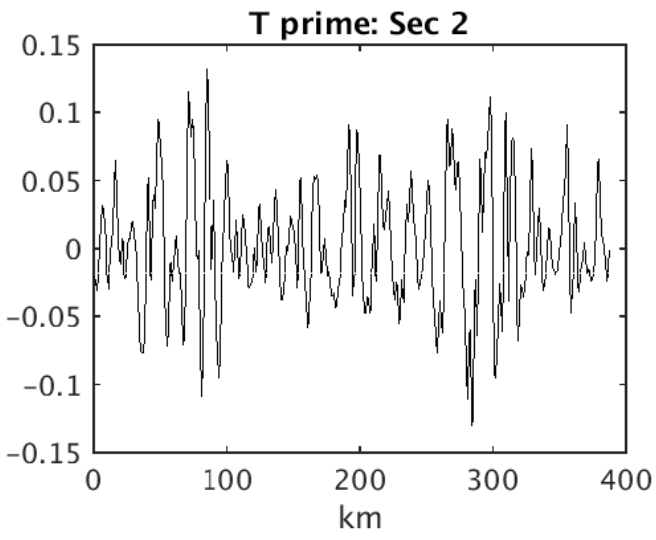


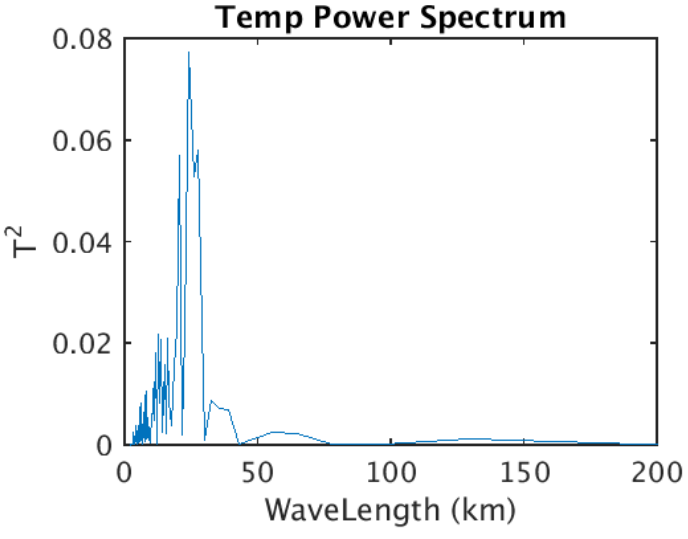
VPR Salinity spectrum for Section 2 at 30 m

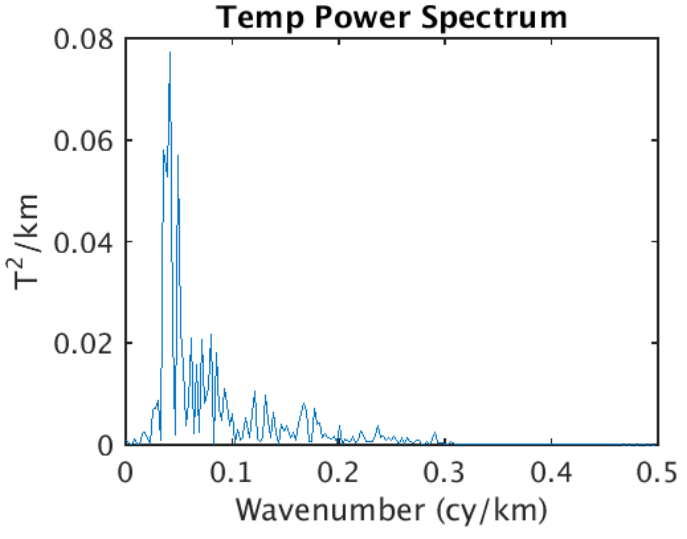


VPR Temperature spectrum for Section 2 at 90 m









VPR Salinity spectrum for Section 2 at 90 m