1_Rockall_Trough_glider_HEOF_2020_2023

November 29, 2023

1 Rockall Trough glider section - HEOF analysis

1.1 Output praemble

1.2 Input Praemble

1.3 Parameter Praemble

2 Functions

2.1 Load data

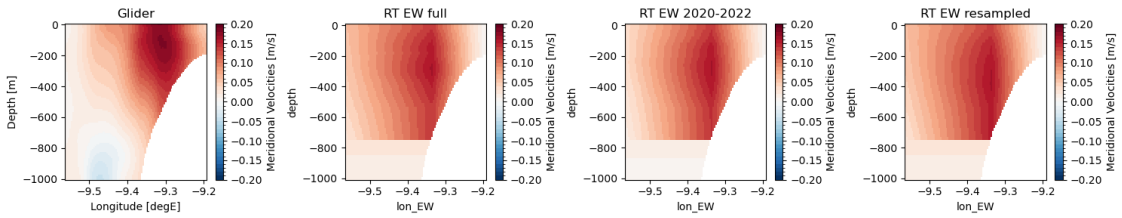
3 Analysis

- Glider - velocity from glider sections May 2020- Feb 2023
- RT EW full - full data set (Jul 2014- Jul 2022) - velocity section from eastern wedge transport reconstruction (Fraser et al., 2022)

- RT EW 2020-2022 - data from period Jan 2020- Jul 2022 - velocity section from eastern wedge transport reconstruction (Fraser et al., 2022)

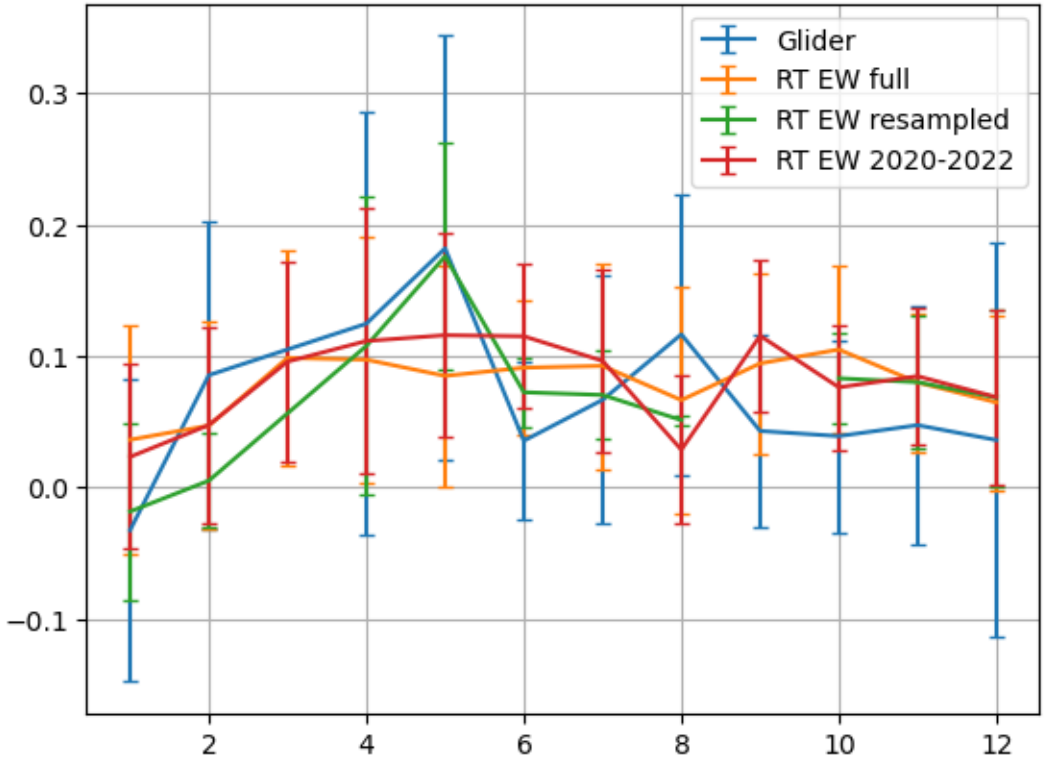
- RT EW resampled - data interpolated on Glider time stamp (May 20-Jul 23) -velocity section from eastern wedge transport reconstruction (Fraser et al., 2022) !NOTE: RT EW time series ends in July 2022 and does not cover full glider timeseries!

3.1 Mean velocity section



We are missing the undercurrent in ER EW reconstruction.

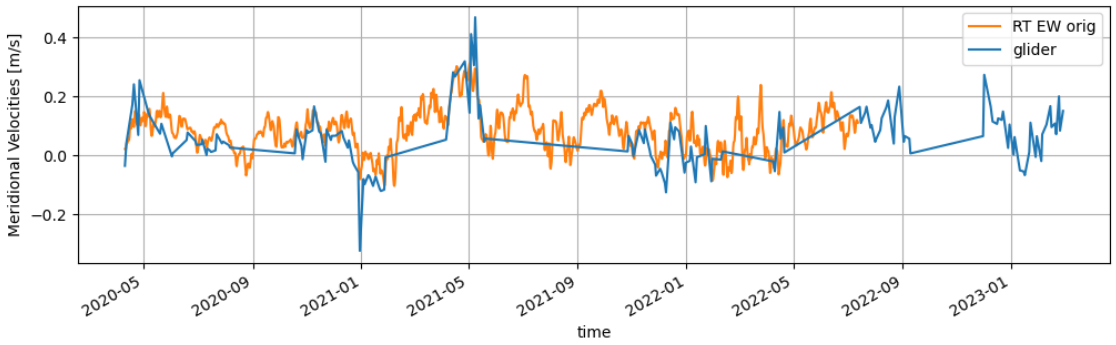
3.2 Seasonal Cycle - spatially averaged velocity



When resampled on the same time stamp, the glider and the RT EW reconstruction are quite silimar. However, when compared to the full time series it is clear that the seasonal cycle reconstructed from the glider still suffers from aliasing.

August high velocities in glider section dominated by values observed in August 2022 (see figure below). Unfortunatly the moored transport time series ends in July 2022!

3.3 Time series in original resolution 2020-2022 - spatially averaged velocity

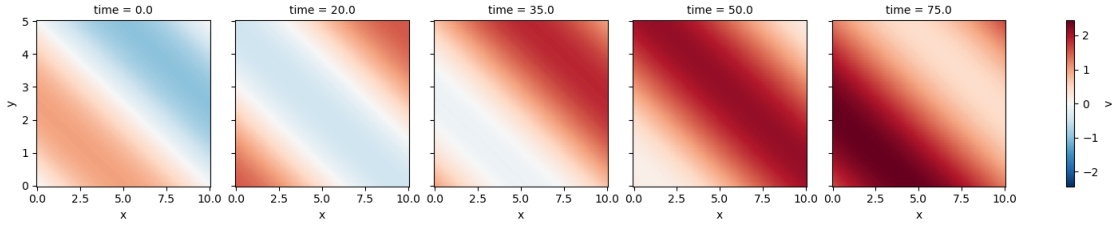


4 HEOF

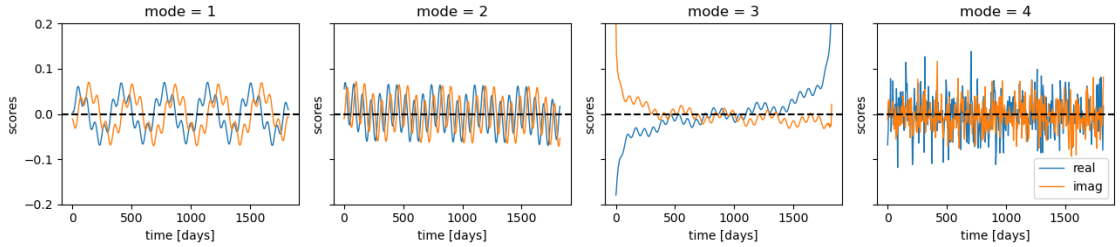
4.0.1 Idealized dataset

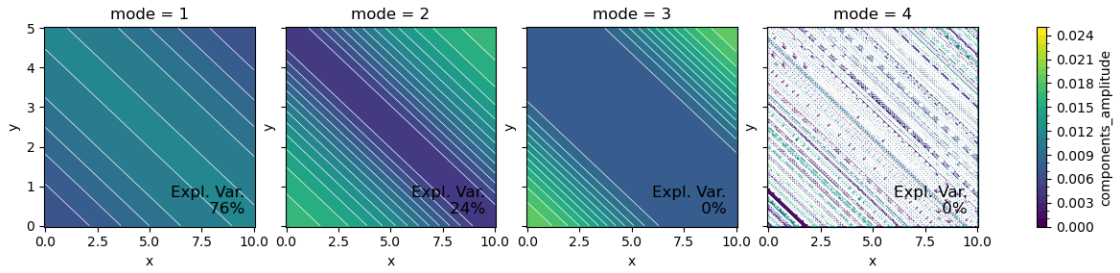
- Barotropic signal varying only in time with a period of T=365 days + Travelling wave with a period of T=73 days
- Amplitude of annual signal is 1.5 higher than travelling wave

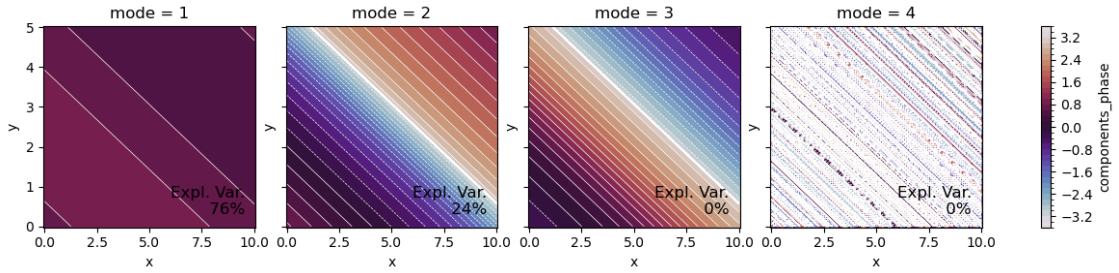
Snapshots of idealiezed dataset for different time periods



Results of the HEOF analysis of the idealized dataset





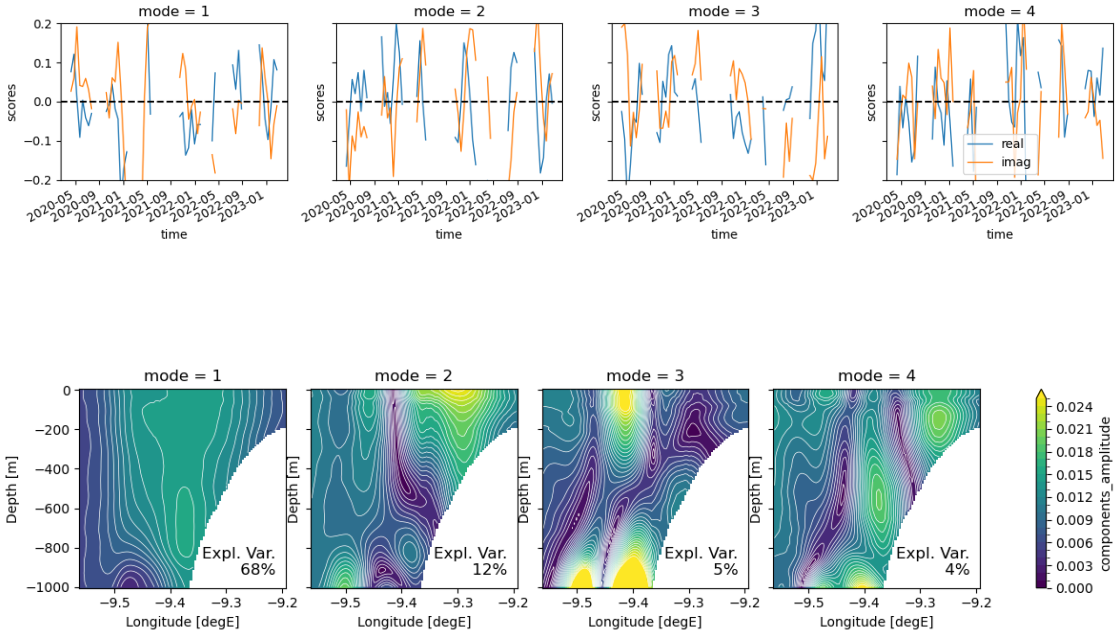


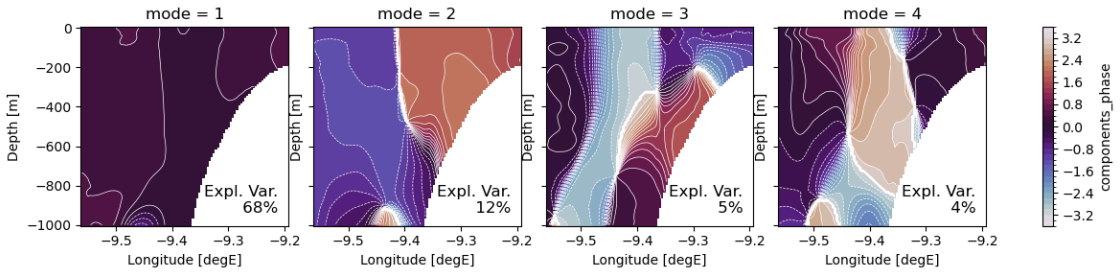
This is a demonstration how to interprete the figures below. The HEOF scores show the temporal evolution of the pattern (components_amplitude and components_phase). A homogenous phase indicates that the signal does not travel spatially. In this case mode 1 shows a the spatially homogenous anual strengthening and weakening, while mode 2 show the semi-annual signal wich is propageting through the domain (as presented by the phase). Mode 3 and 4 are noise and irrelavant (explained variance is closed to zero).

In the following I applied the same method to the glider and ET EW velocity sections

4.0.2 Glider data

Resampled to 15 days and mean removed





The first HEOF seems to display a strengthing/weakening of the velocity field in time (homogenous phase) in the entire domain explaining 68% of the variance in the glider section. This agrees well with the phase and explained variance of HEOF 1 of the reconstructed velocity section using EB1 and GLORYS12v2 output at the ADCP position following Fraser et al. (2022). Here the temporal strengthening/weakening explains up to 83% (see figures below for different time periods). However, comparing the amplitudes between glider and reconstructed velocities the later are dominated by velocities at EB1 while the glider section show highest amplitudes between EB1 and the ADCP.

Undercurrent in glider HEOF 1 is visible with low amplitudes and a up to ~90 degree phase shift (dark red to dark blue ~90)

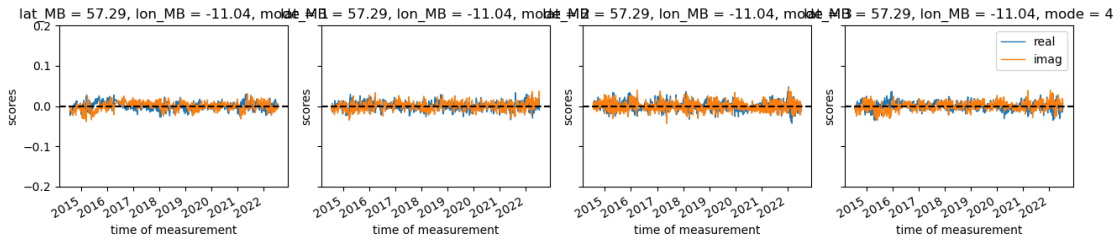
The second HEOF I would interprete a zonal shift of the slope current with negative velocity to the west of the slope current when the slope current sits shallow in the east onto the shelf and vice versa. Again, HEOF2 from the reconstructed velocity field (Fraser et al., 2022) agrees well with the glider results. The zero crossing in the reconstructed velocity fields seems to be too far west compared to glider sections.

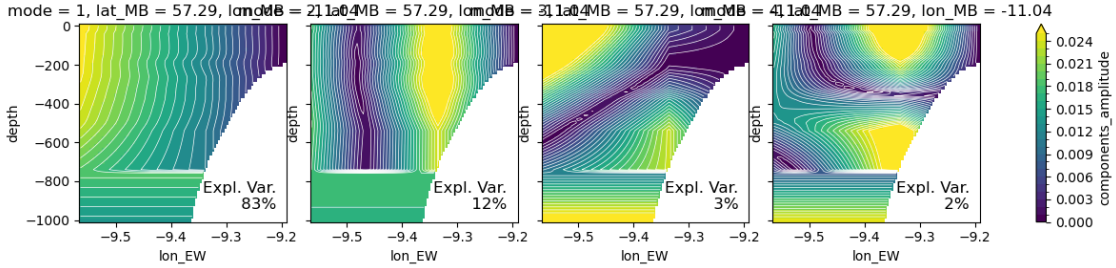
Again, undercurrent in glider HEOF 2 visible with low amplitudes/high east/west of its core in HEOF1. Phase shift of ~180 degree between the high/low amplitudes –> zonally migration? –> see if present in ship ladcp?

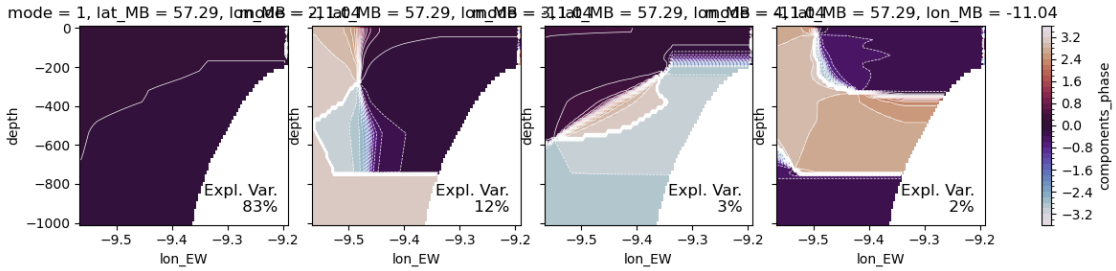
HEOF 3&4 from the glider sections are quite similar and more difficult to interprete. Together they explain up to 9%. I am wondering whether this depicts the vertical migration of the under current or some kind of recirculation between EB1 and the ADCP position? This feature is not visible in the velocity reconstruction from the moored observation (Fraser et al., 2022) which make sense as we do not have any information what happens between EB1 and the ADCP.

4.0.3 Rockall EW reconstruction

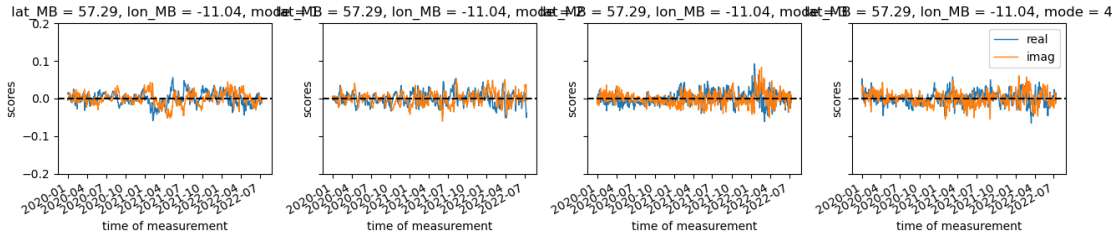
Full timeseries (2014-2022) original resolution, mean removed

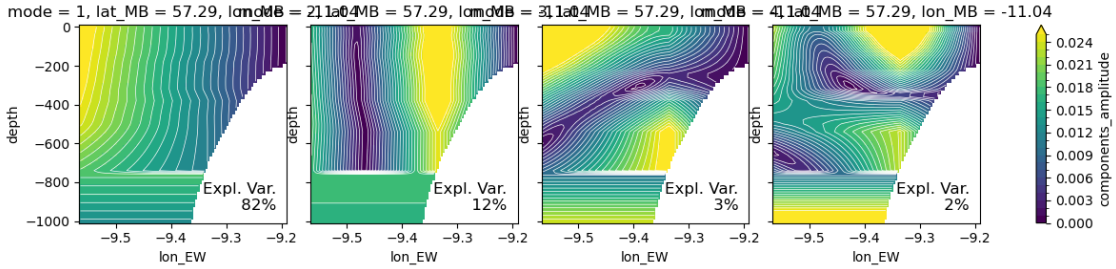


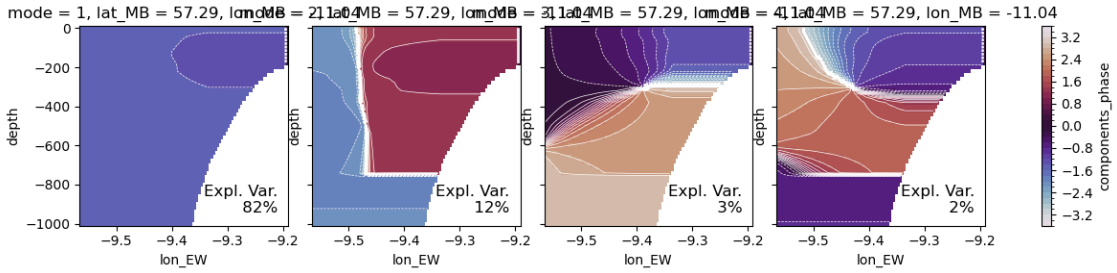




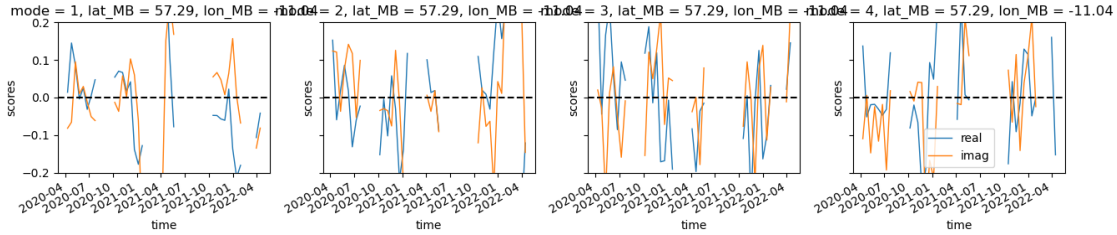
2020-2022 original resolution - mean removed

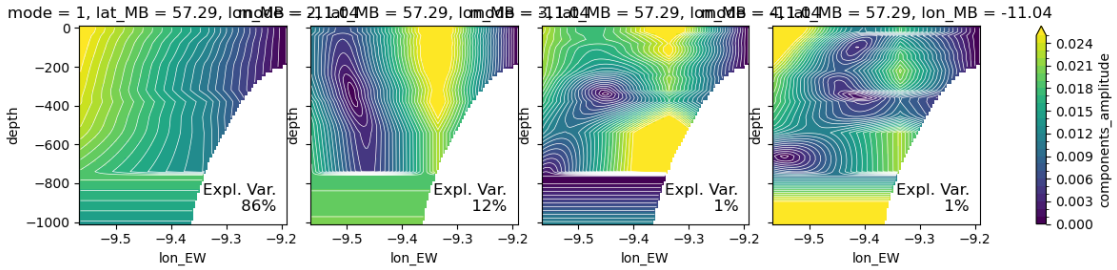


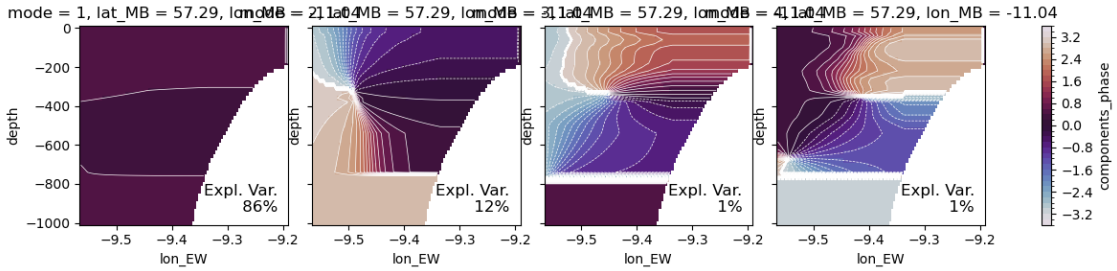




Interp on glider time stamps 15D averaged and mean removed







5 Reconstruction

Idea: Use the spatial pattern from the HEOF (X) reproduce velocity section (y) for the eastern wedge:

$$X\alpha = y$$

Therefore we first need to find alpha. We know y at certain locations: the meridional velocities from RTEB1 and GLORYS2v12-ADCP. We can stack them together to get y_{loc}, use the HEOF at the mooring positions (X_{loc}) and find alpha by solving:

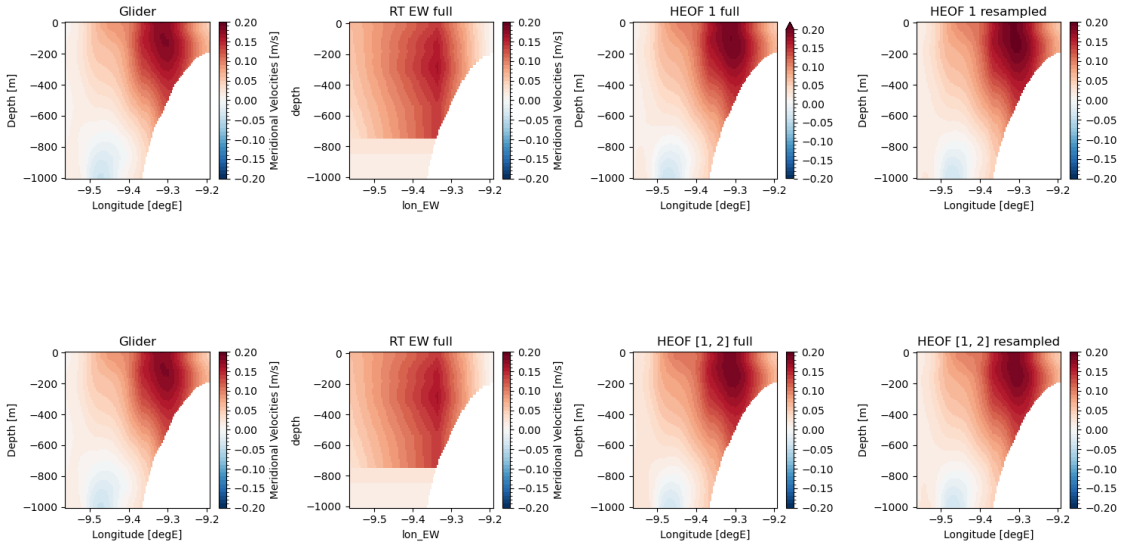
$$X_{loc}^T X_{loc}\alpha = X_{loc}^T y_{loc}$$
$$\alpha = (X_{loc}^T X_{loc})^{-1} X_{loc}^T y_{loc}$$

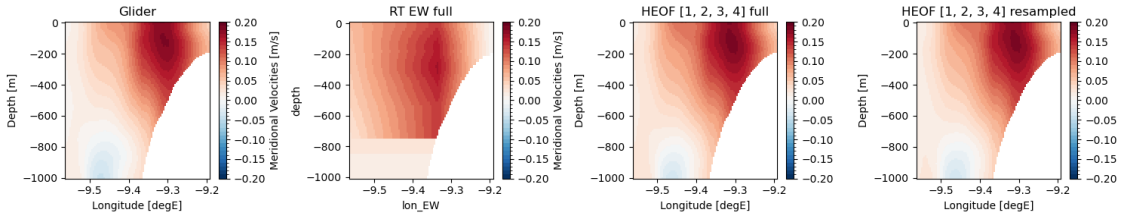
5.1 Recreate sections from moorings

5.2 Mean section of glider, RT EW full and HEOF-reconstructions

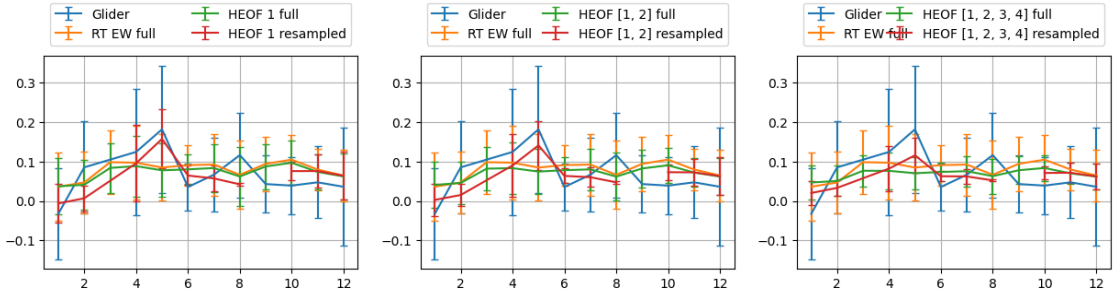
- Glider - velocity from glider sections May 2020- Feb 2023
- RT EW full - full data set (Jul 2014- Jul 2022) - velocity section from eastern wedge transport reconstruction (Fraser et al., 2022)

- HEOF [X] full - HEOF reconstruction averaging over [X] modes for the full mooring time period (Jul 2014- Jul 2022)
- HEOF [X] resampled - data interpolated on Glider time stamp (May 20-Jul 23) using HEOF reconstruction averaged over [X] modes !NOTE: mooring time series ends in July 2022 and does not cover full glider timeseries!

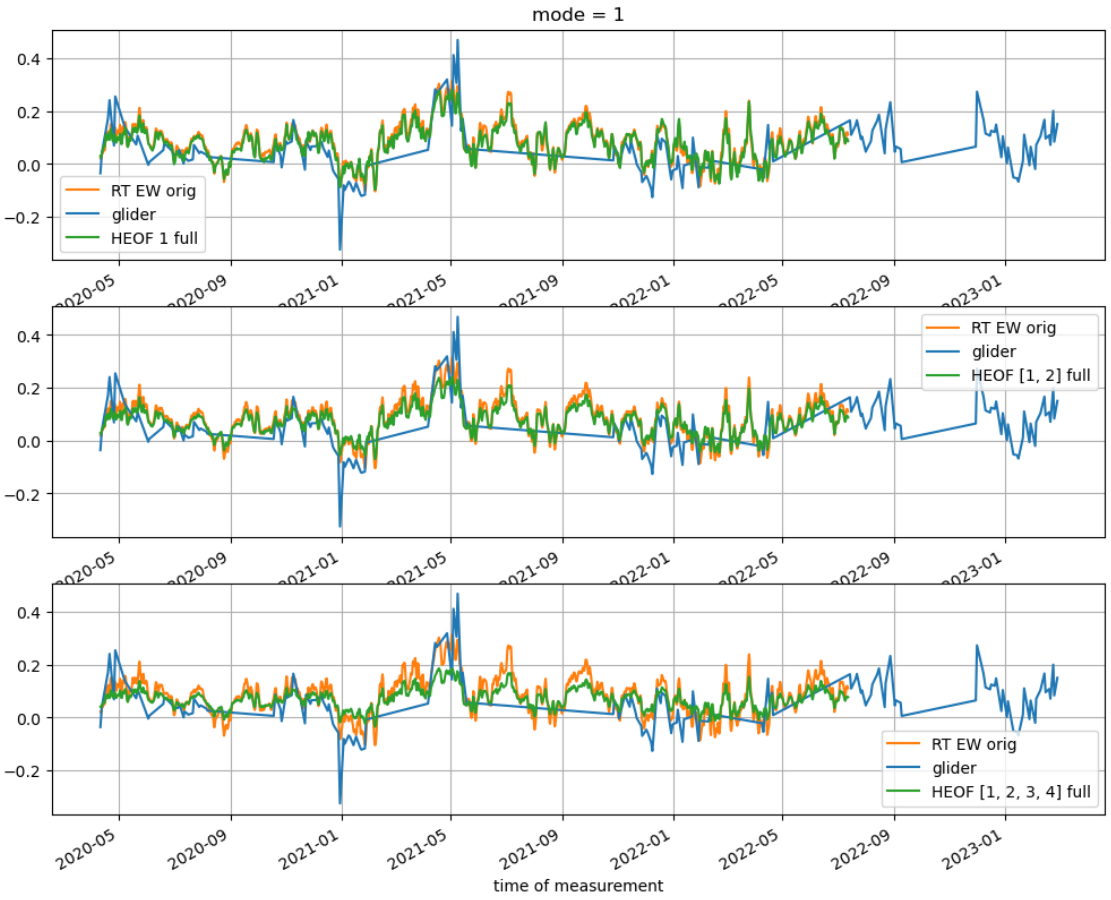




5.3 Seasonal Cycle



5.4 Time series in original resolution 2020-2022 - spatially averaged velocity



HEOF mode 1 and 2 looks like a good combination to reconstruct the slope current tranports