Supplementary Material for
"Ubiquity and seasonality of deep submesoscales in the Southern Ocean revealed by elephant seals"

Siegelman et al.

This PDF file includes:

Figs. S1 to S5.

Figure S1. Vertical sections of the inverse Richardon number (Ri^{-1}, a,d), lateral gradients of buoyancy (b_x, d,e) and the square the Brunt-Väissälä frequency (N^2, c, f) collected by instrumented elephant seals in the East (a-c) and in the South (d-f).

Figure S2. Distribution of the magnitude of lateral gradients of buoyancy $|b_x|$ within the mixed layer (i.e., from the surface to 5 m above the ML, in purple), below the mixed layer (i.e., starting 10 m below the ML, in gray) and at the base of the mixed layer (i.e, between 5m above and 10 m below, in black). The left y-axis shows the histogram (solid lines), whereas the right y-axis shows the cumulative histogram (dotted lines). The strongest lateral gradients of buoyancy are found at the base of the mixed layer, likely due to internal gravity waves.

Figure S3. Regional seasonality of the mixed layer depth (MLD). Histograms of MLD in the a) East, b) South, c) Northwest (NW), d) Southwest (SW) colored by season. The y-axes show the number of occurrences and the dashed lines represent the median MLD depth per season, with their value on top of the y-axis. Note that in b) medians for summer and fall are equal.

Figure S4. Regional seasonality of the inverse Richardson number Ri^{-1}. Histograms of Ri^{-1} in the a) East, b) South, c) Northwest (NW), d) Southwest (SW) colored by season. The y-axes show the number of occurrences and the dashed lines corresponds to $\mathrm{Ri}^{-1} = 1$. $\mathrm{Ri}^{-1} \geq 1$ is indicative of ageostrophic dynamics.

Figure S5. Seasonality of the rms of relative vorticity (ζ, triangle) and b_x at 300 m (diamond) in the East region. ζ is computed from neurOST SSH along the seals' track. 95% confidence interval are indicated by the vertical lines. ζ and b_x have a similar seasonal evolution, suggesting that submesoscale at depth are forced by mesoscale eddies.

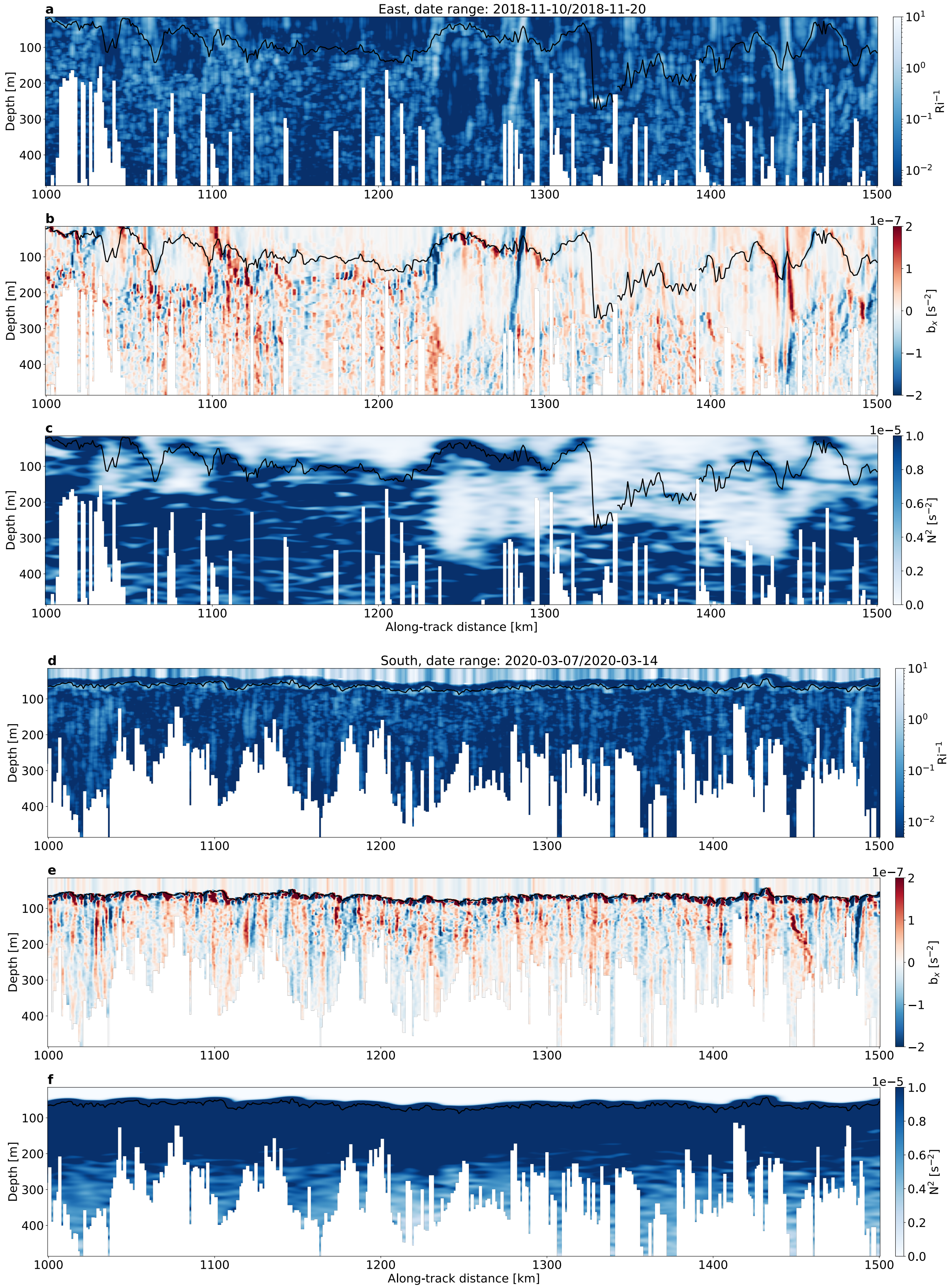

Figure 1: Vertical sections of the inverse Richardon number (Ri^{-1}, a,d), lateral gradients of buoyancy (b_x, d,e) and the square the Brunt-Väissälä frequency (N^2, c, f) collected by instrumented elephant seals in the East (a-c) and in the South (d-f).

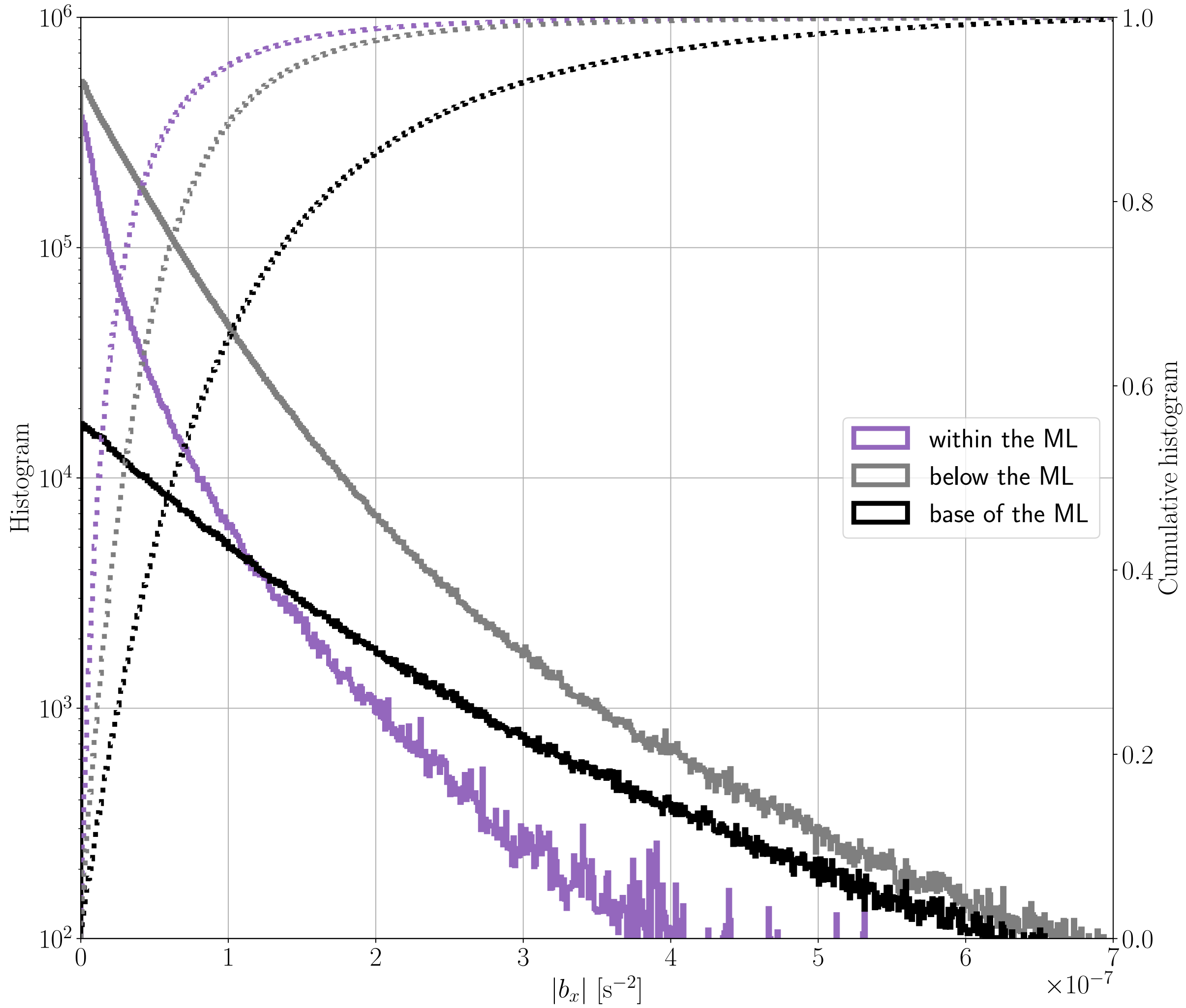

Figure 2: Distribution of the magnitude of lateral gradients of buoyancy $|b_x|$ within the mixed layer (i.e., from the surface to 5 m above the MLD, in purple), below the mixed layer (i.e., starting 10 m below the MLD, in gray) and at the base of the mixed layer (i.e, between 5m above and 10 m below the MLD, in black). The left y-axis shows the histogram (solid lines), whereas the right y-axis shows the cumulative histogram (dotted lines). The strongest lateral gradients of buoyancy are found at the base of the mixed layer, likely due to internal gravity waves.

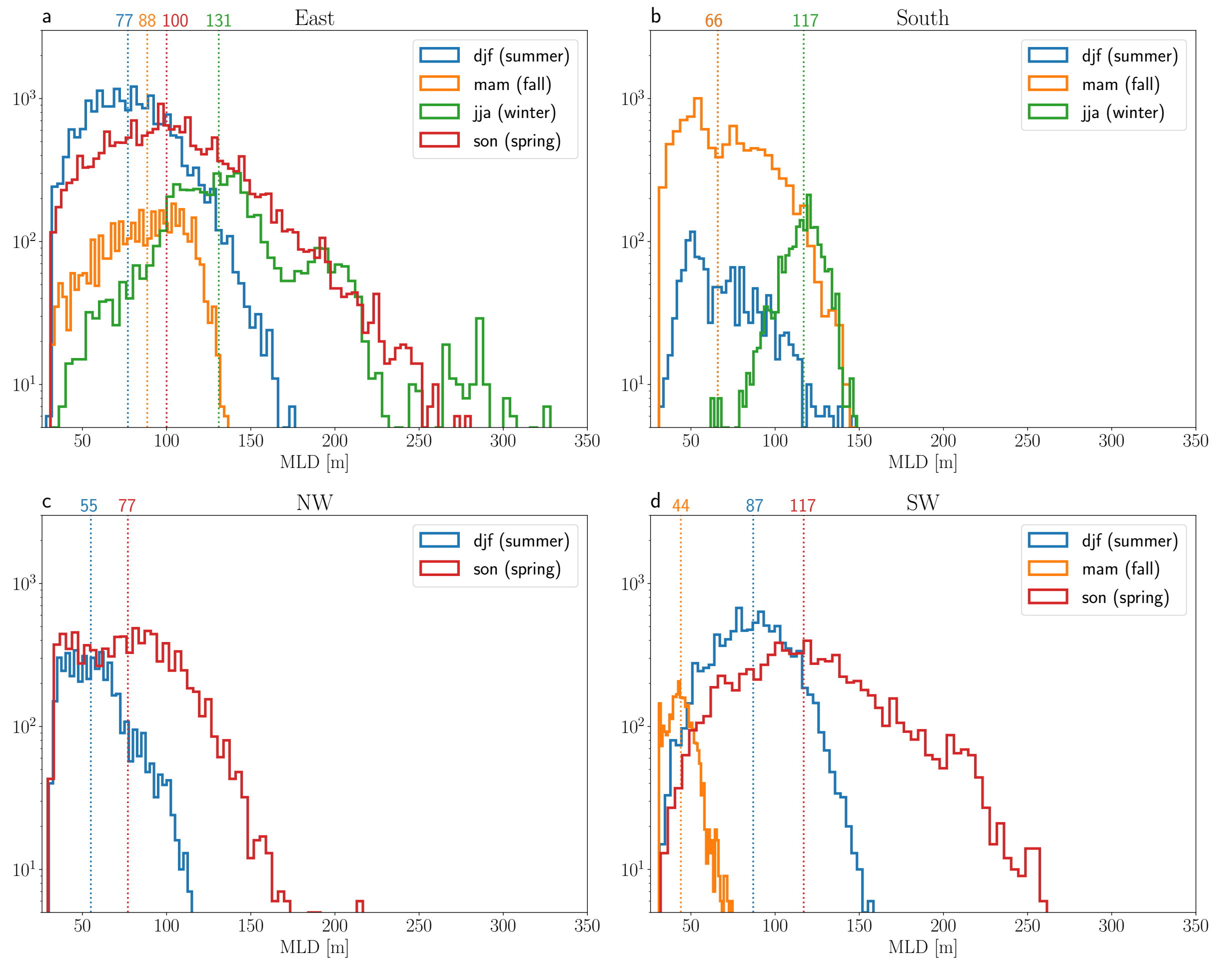

Figure 3: Regional seasonality of the mixed layer depth (MLD). Histograms of MLD in the a) East, b) South, c) Northwest (NW), d) Southwest (SW) colored by season. The y-axes show the number of occurrences and the dashed lines represent the median MLD depth per season, with their value on top of the y-axis. Note that in b) medians for summer and fall are equal.

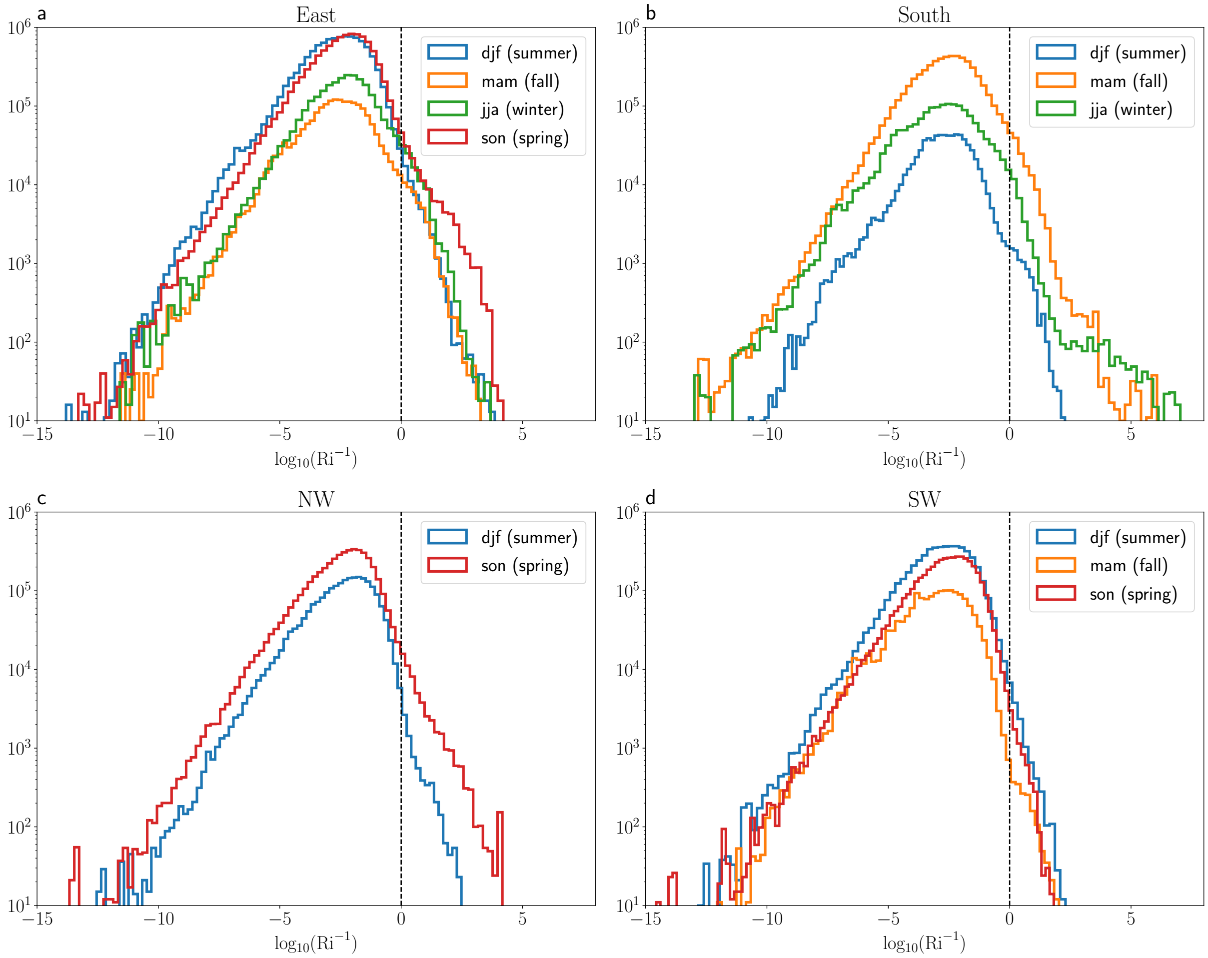

Figure 4: Regional seasonality of the inverse Richardson number Ri^{-1}. Histograms of Ri^{-1} in the a) East, b) South, c) Northwest (NW), d) Southwest (SW) colored by season. The y-axes show the number of occurrences and the dashed lines corresponds to $\mathrm{Ri}^{-1} = 1$. $\mathrm{Ri}^{-1} \geq 1$ is indicative of ageostrophic dynamics.

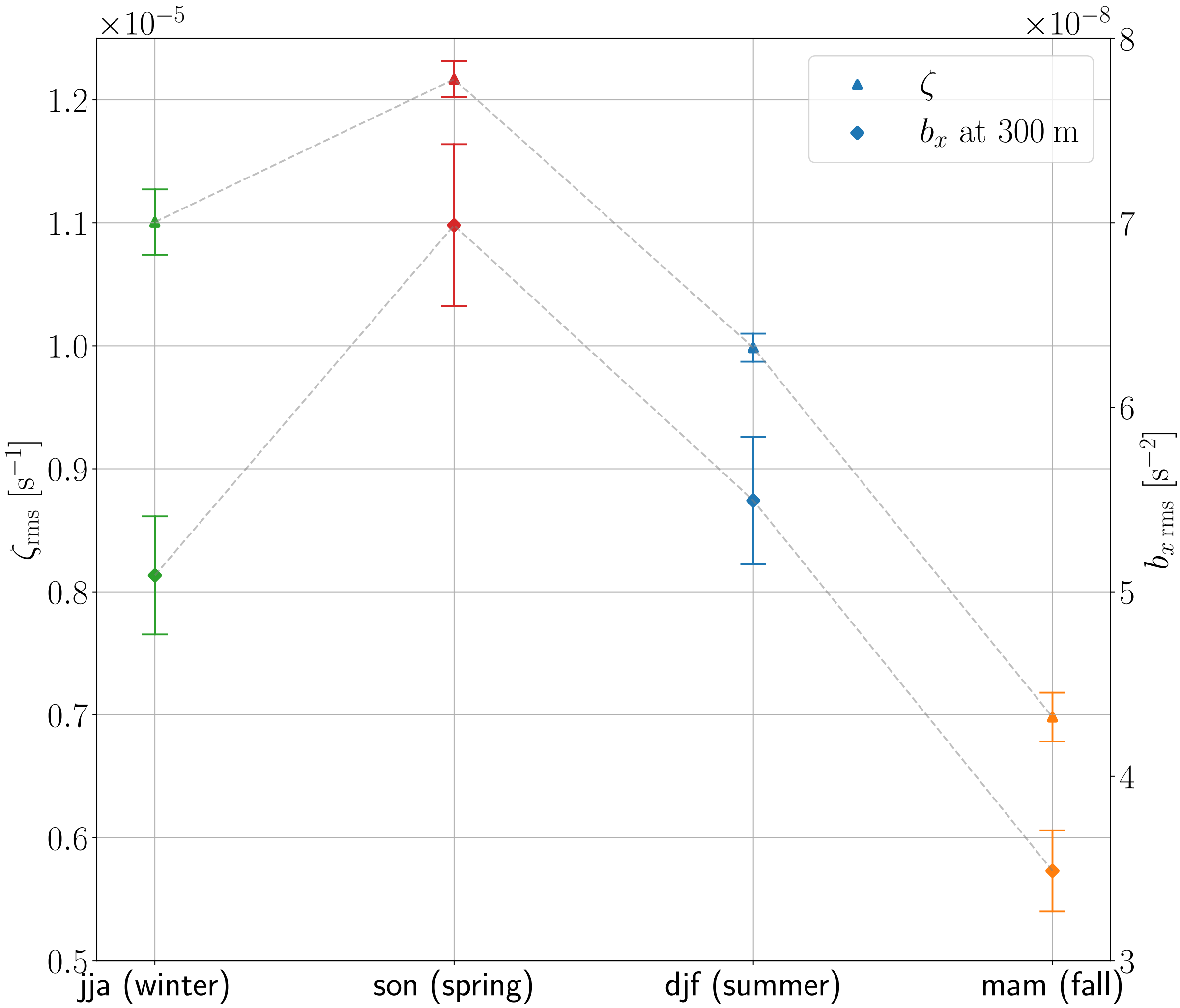

Figure 5: Seasonality of the rms of relative vorticity (ζ, triangle) and b_x at 300 m (diamond) in the East region. ζ is computed from neurOST SSH along the seals' track. 95% confidence interval are indicated by the vertical lines. ζ and b_x have a similar seasonal evolution, suggesting that submesoscale at depth are forced by mesoscale eddies.