



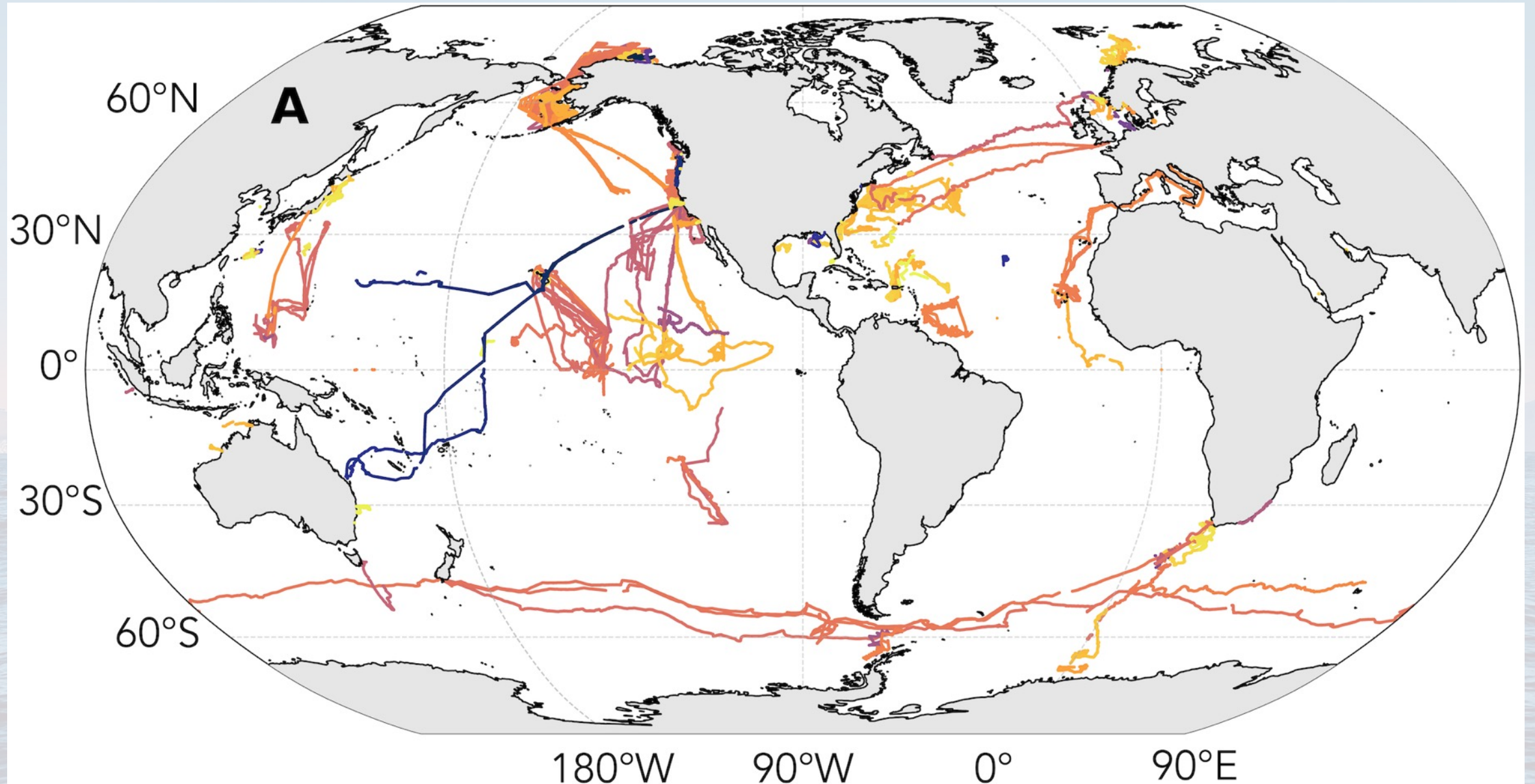
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Air-sea Heat Flux Uncertainties From A Sailing USV

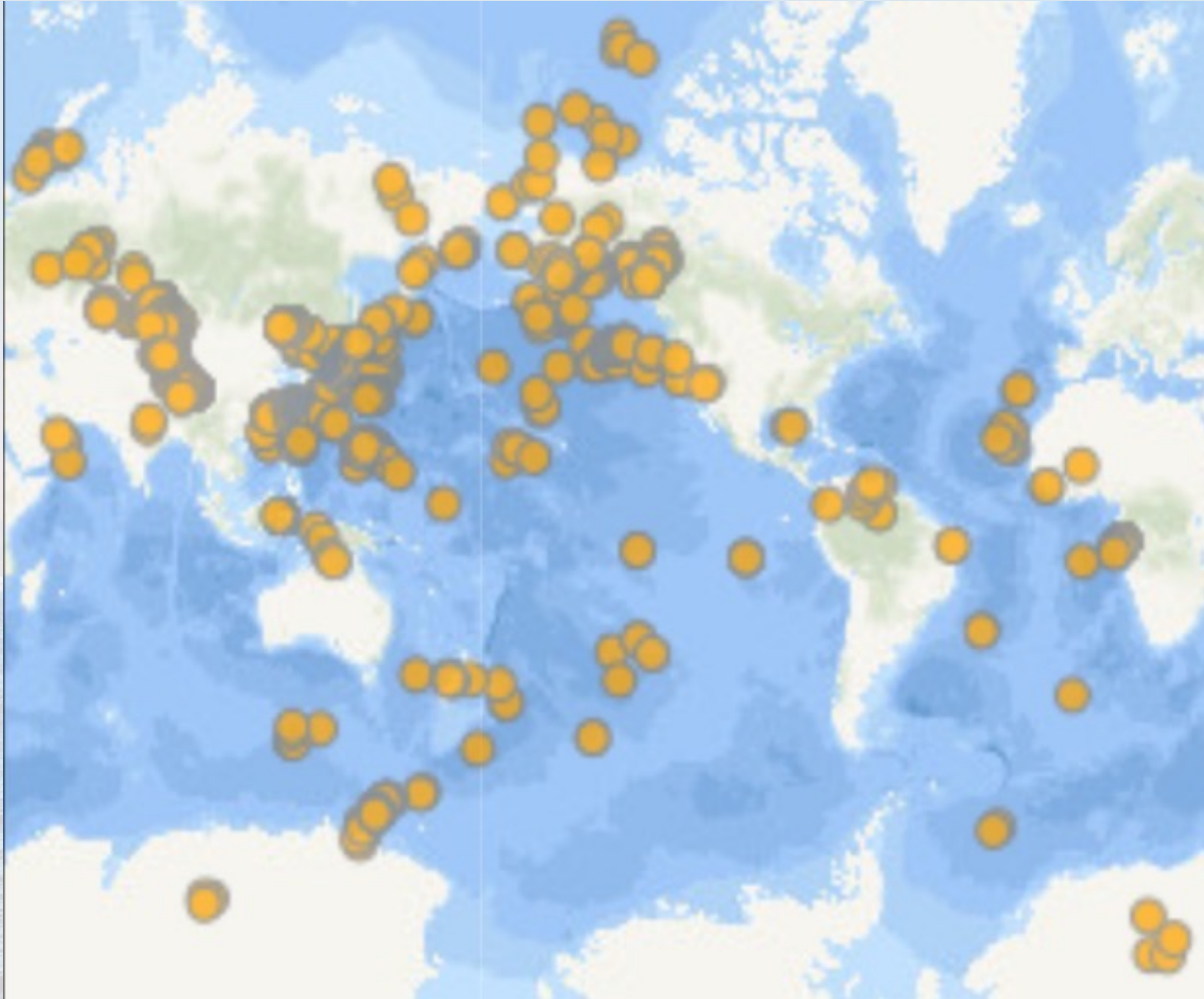


USV deployments 2011-2024



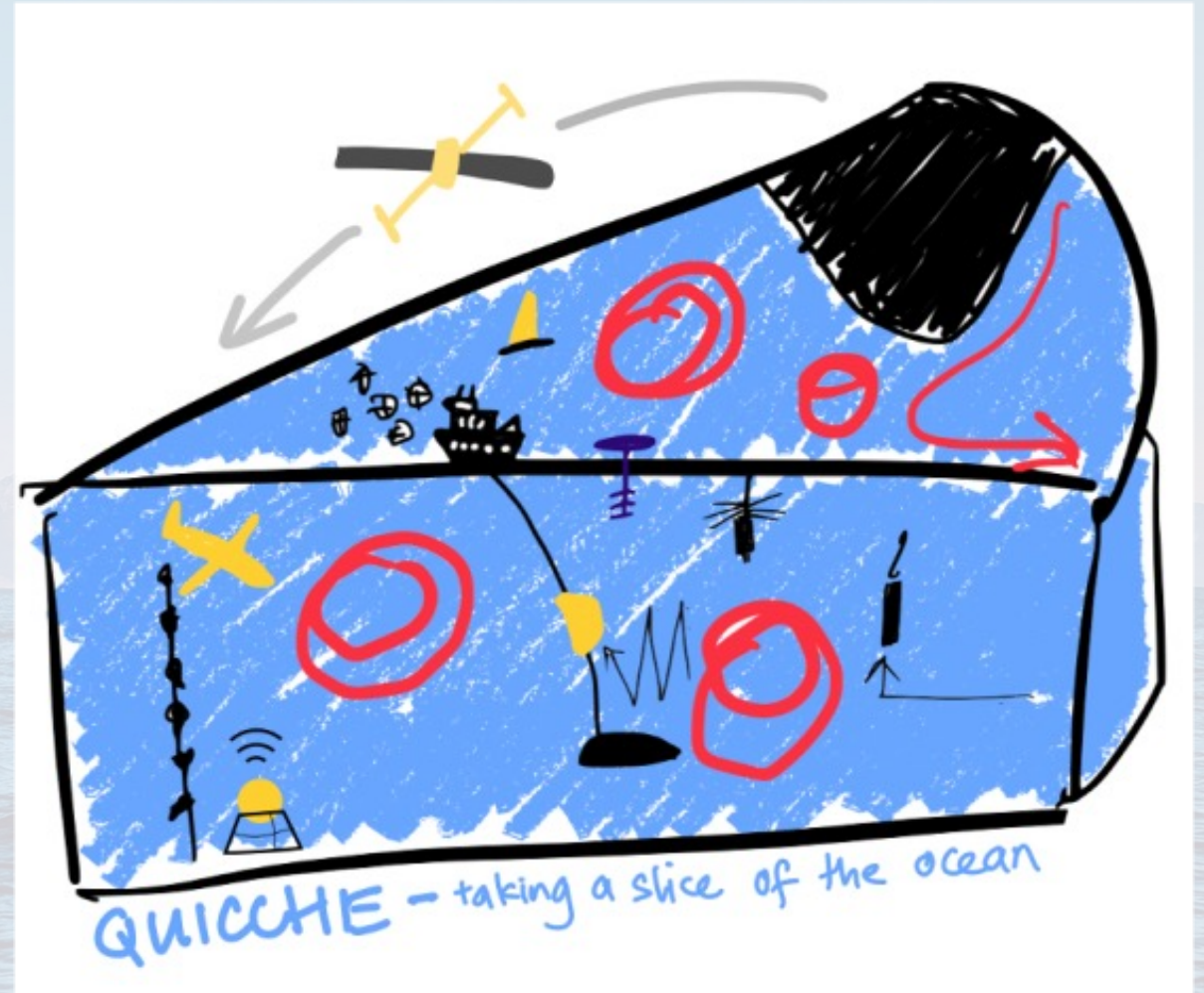
Patterson et al., in prep

Underwater glider deployments



EMODnet, 7 June

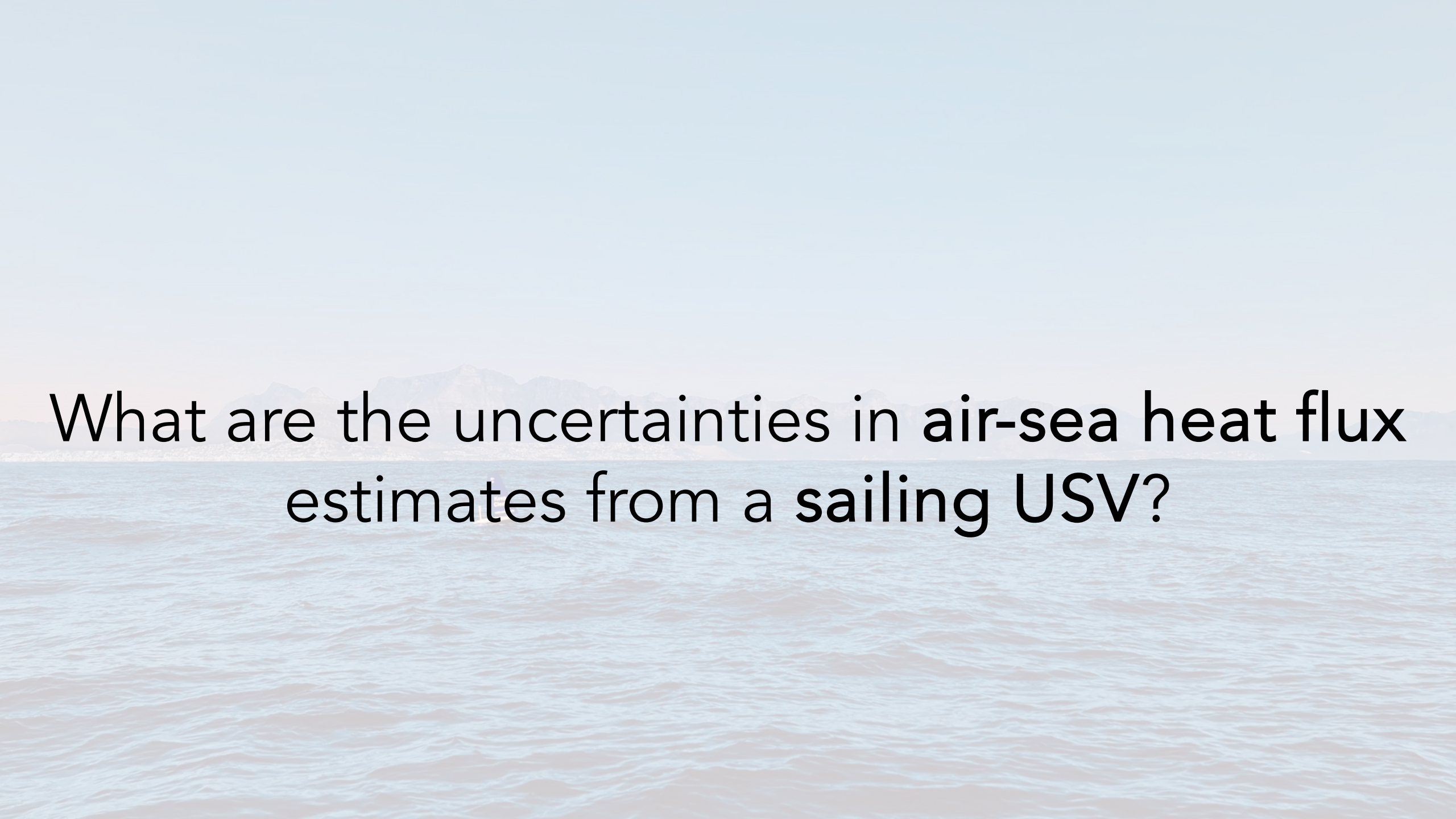
Connecting observations



QUICCHE, NSF project 2023

The air-sea
boundary is a
turbulent place!





What are the uncertainties in air-sea heat flux estimates from a sailing USV?

Air-sea heat flux

$$\frac{Q_{net}}{\text{Total}} = \frac{Q_{SW} + Q_{LW}}{\text{Radiative}} + \frac{Q_{SH} + Q_{LH}}{\text{Turbulent}}$$

Latent

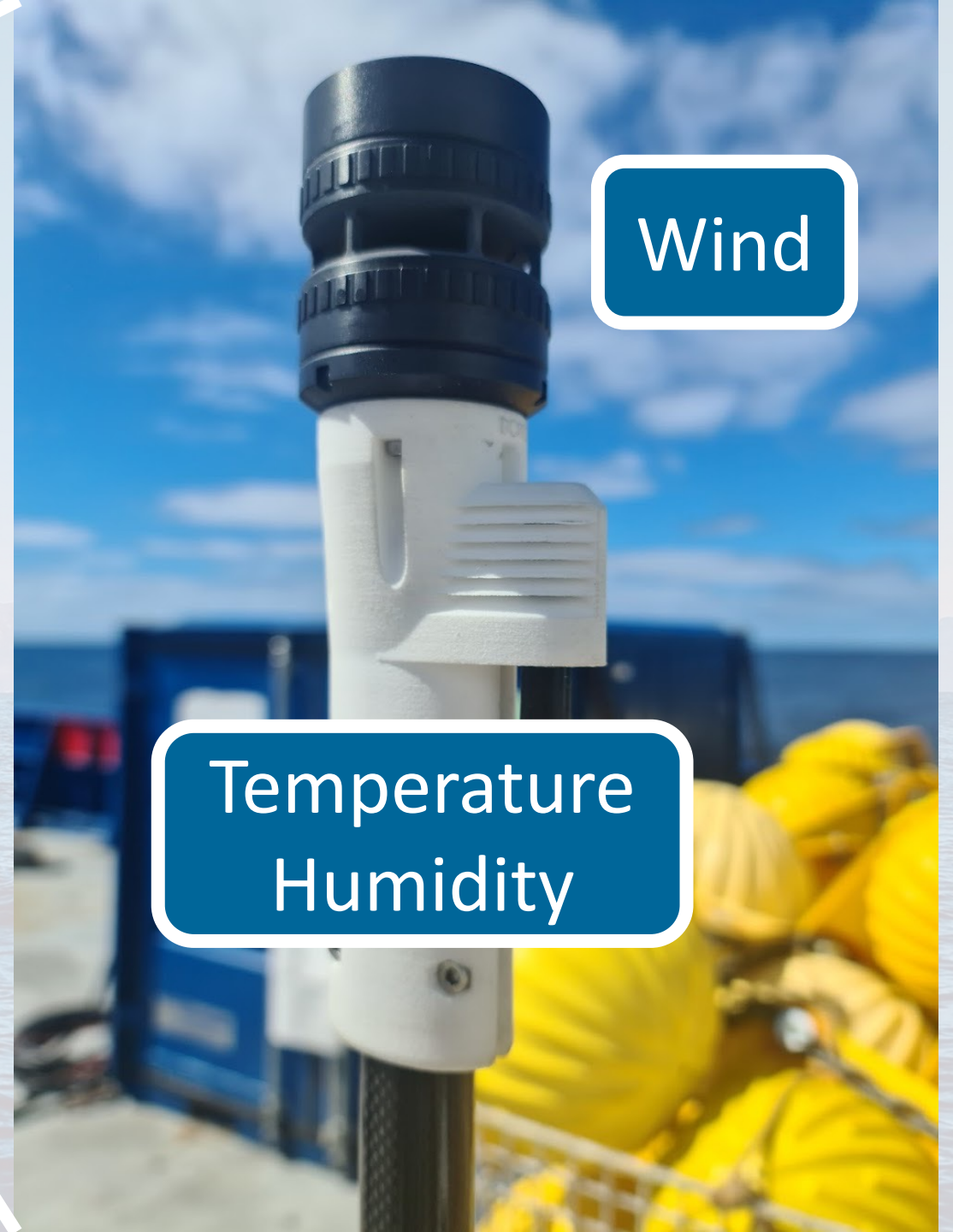
$$Q_{LH} = \rho L_v C_E \mathbf{U} (Q_{air} - Q_{sfc})$$

Sensible

$$Q_{SH} = \rho c_p C_H \mathbf{U} (T_{air} - T_{sfc})$$

What do we need to measure?

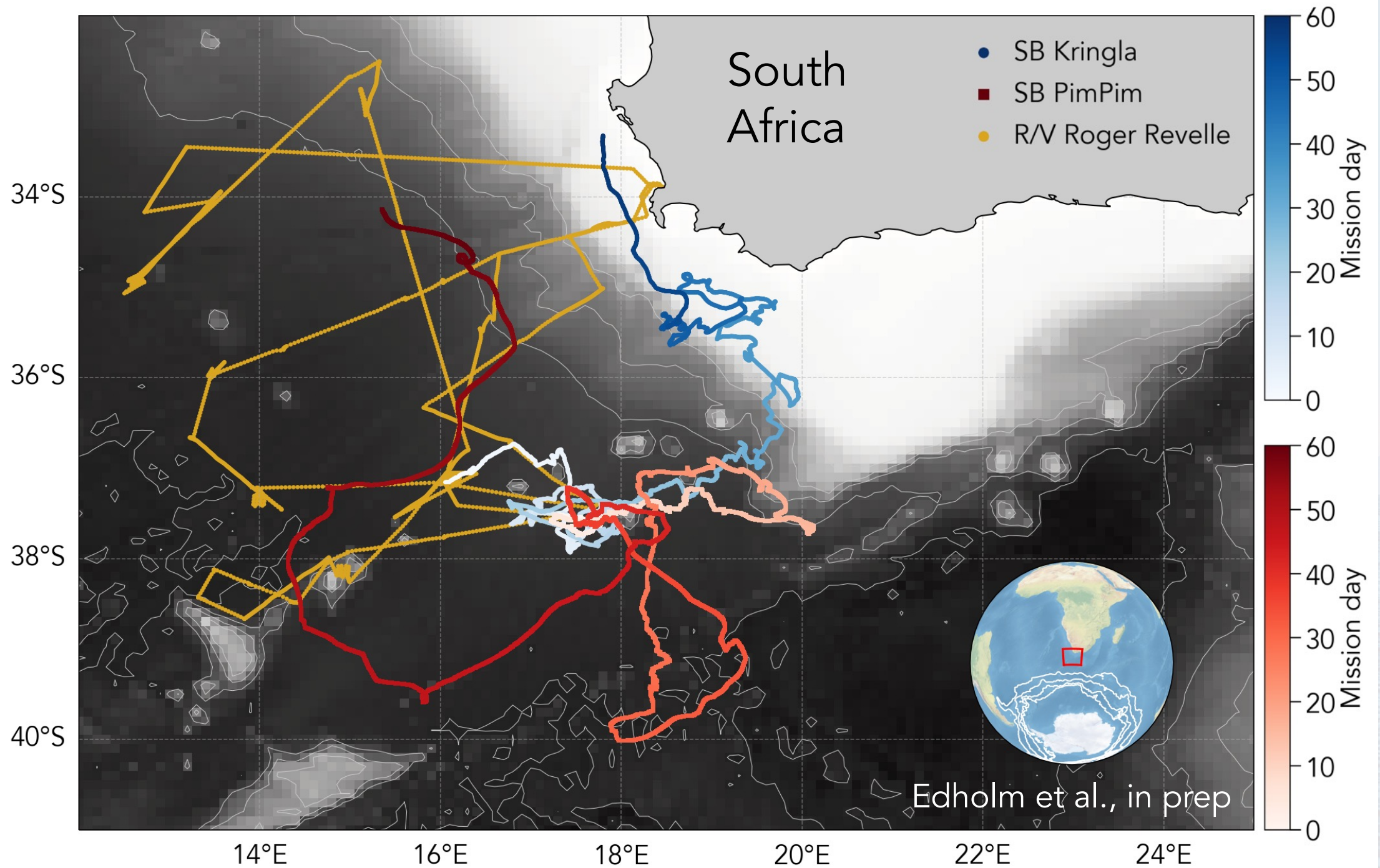
- Winds relative to the ocean
- Air and sea surface temperature
- Humidity

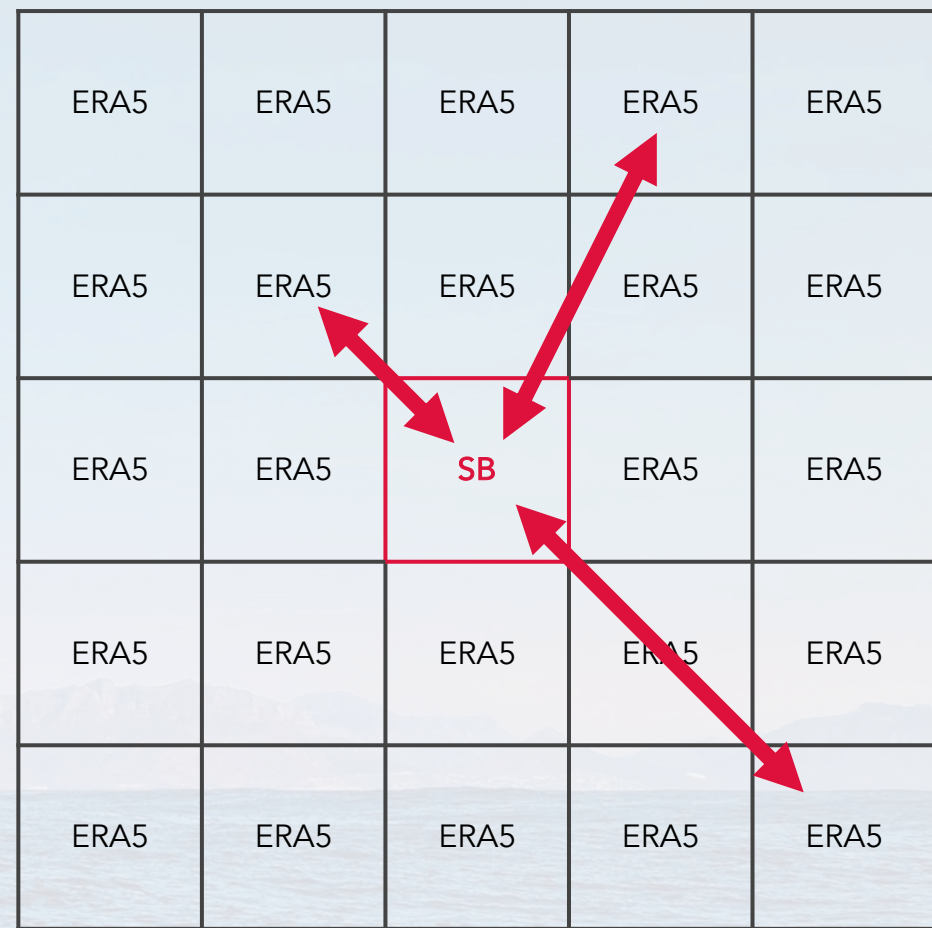
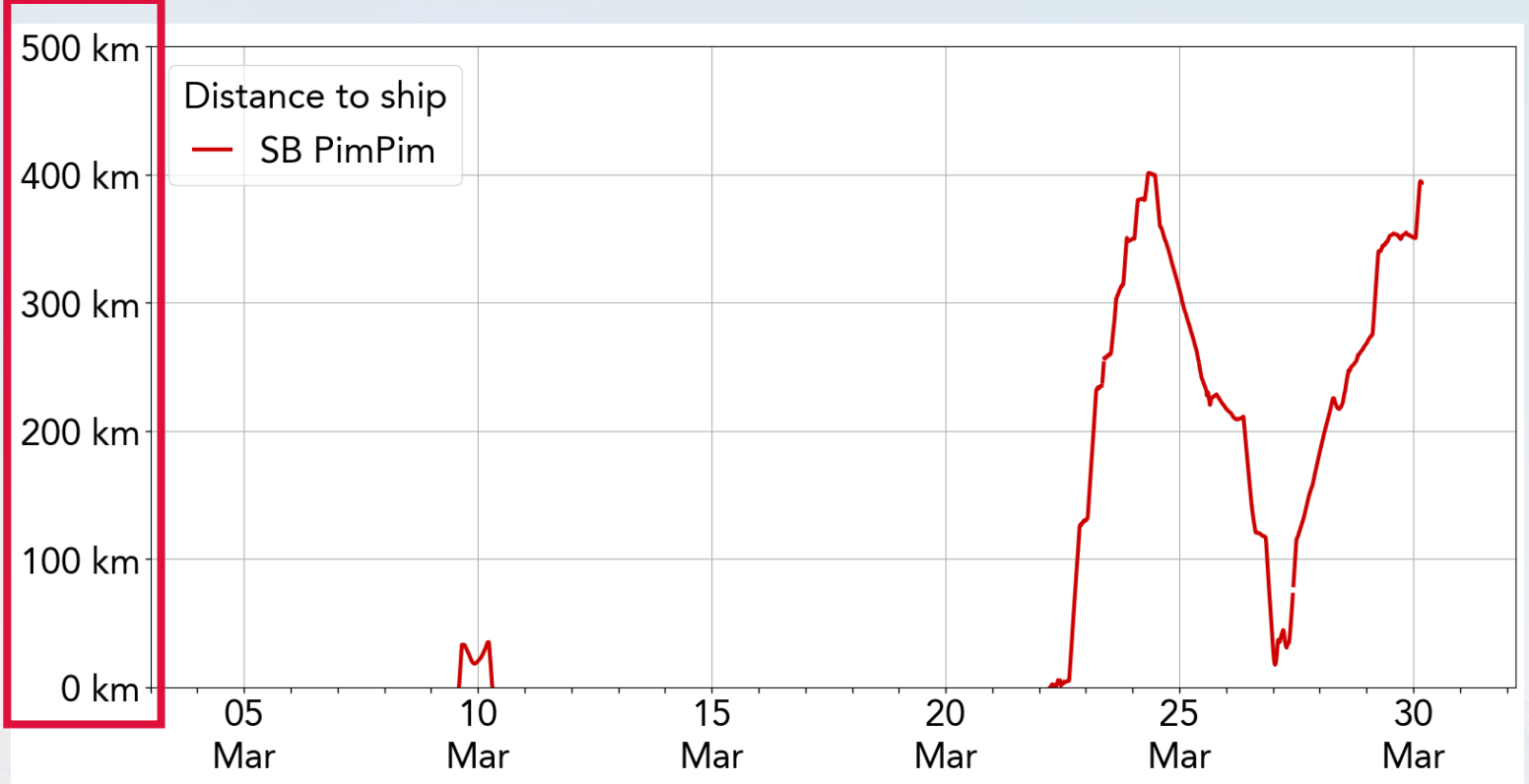


Wind

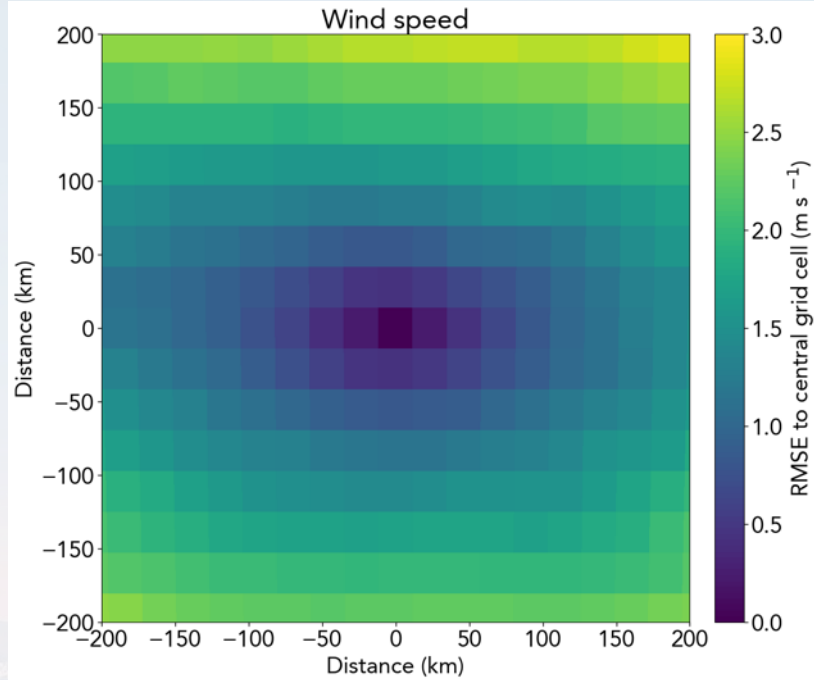
Temperature
Humidity



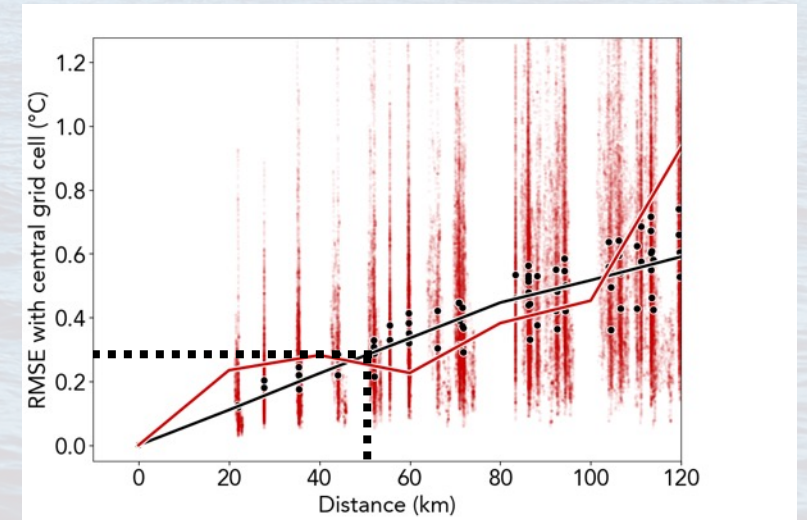
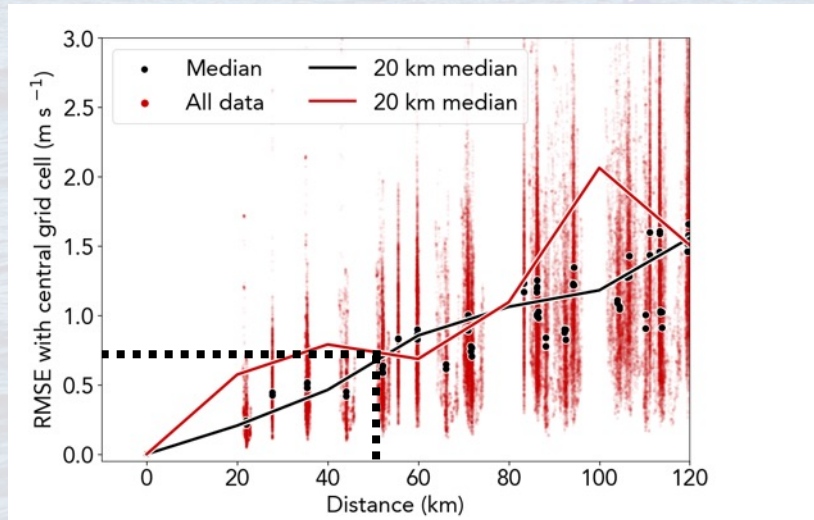
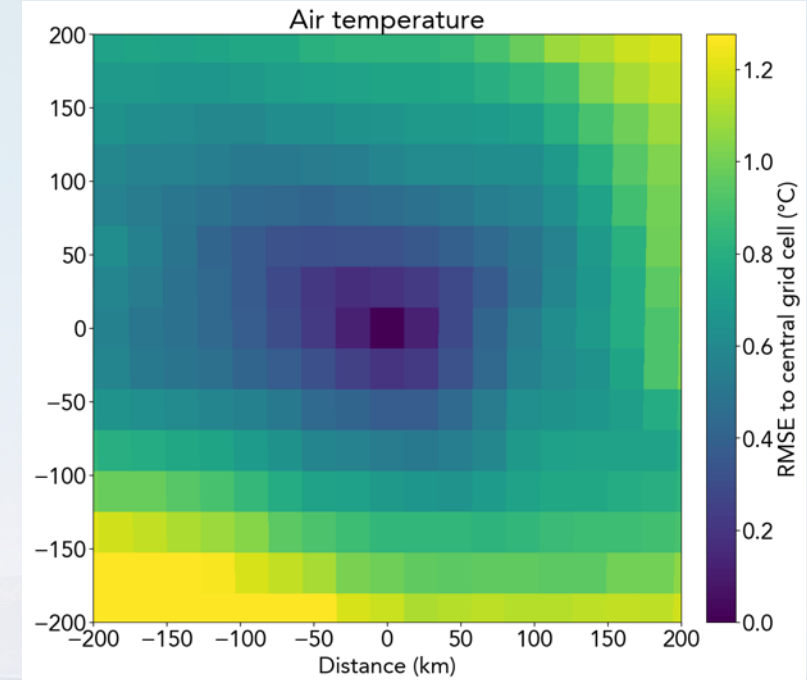




Wind speed

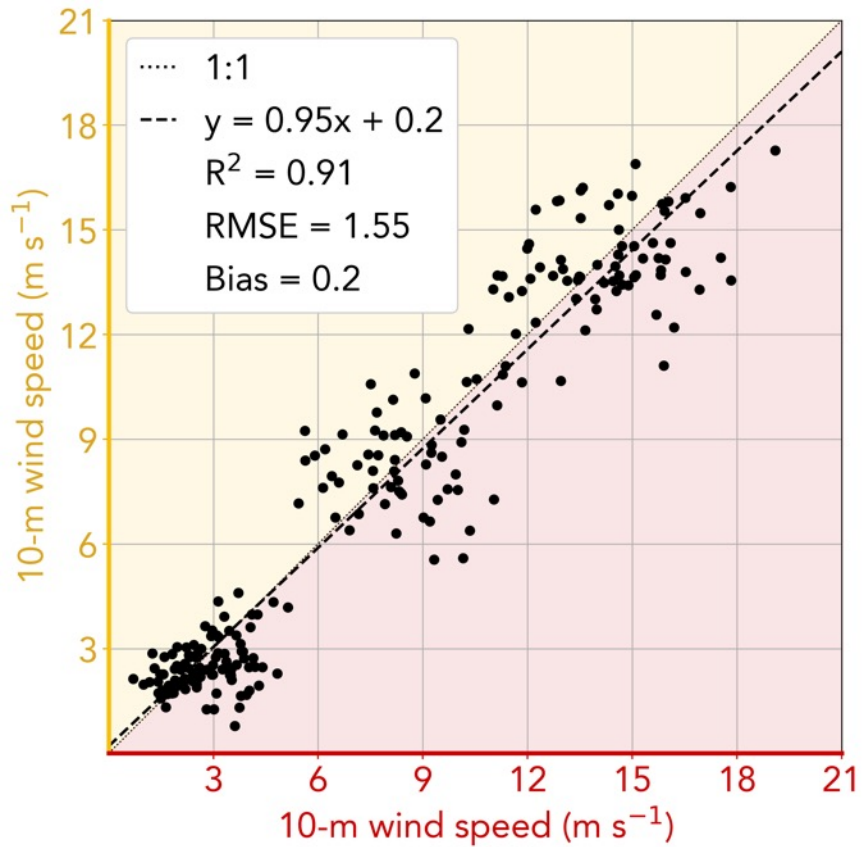


Air temperature

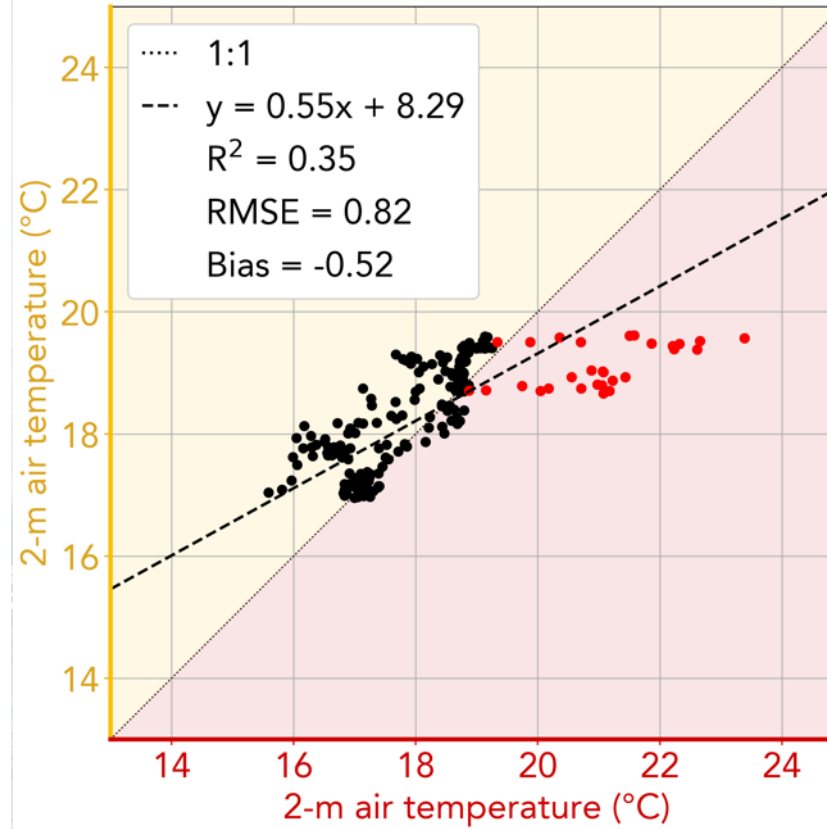


Uncertainties in Q_{net}

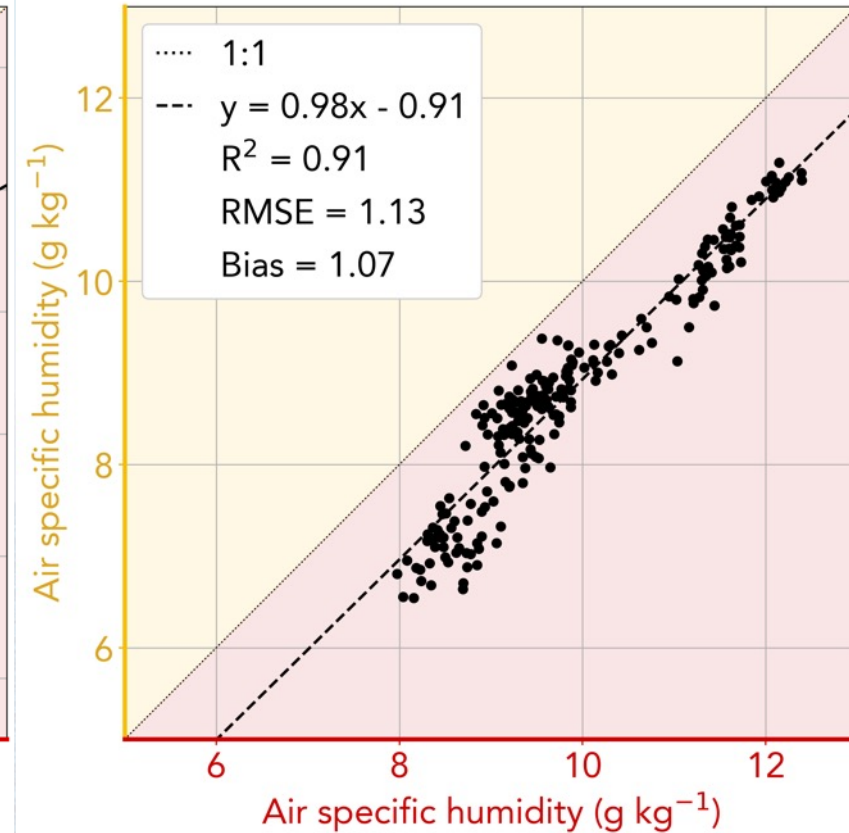
Wind speed



Air temperature



Humidity

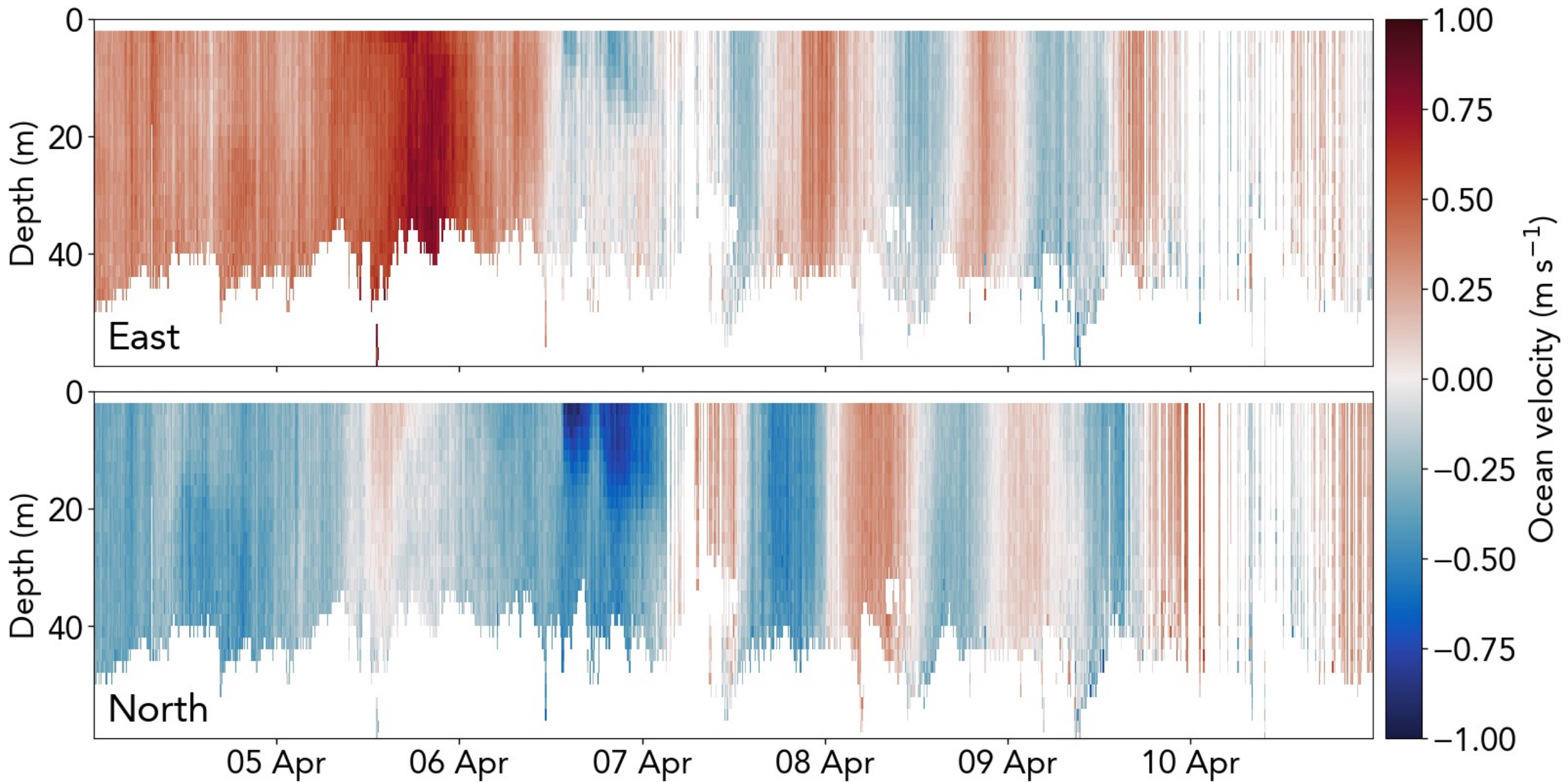


Uncertainties in Q_{net}



	Wind speed	Air temperature	Humidity
Accuracy of the sensors	+5.6	-8.6	-12.2
Uncertainty of the observations	+29.0	-10.9	-12.5
Accuracy of the sensors	+9.3	-19.0	-
Uncertainty of the observations	+39.0	-21.0	-
Accuracy of the sensors	+1.9	-3.4	-7.0

Mixed layer velocities



Conclusions

Uncertainties in air-sea fluxes stem mostly from sensor noise for air temperature and humidity

Wind creates the biggest error in Q_{net} – gustiness and wave sheltering

Reliable observations of humidity at the sea surface

10-minute mixed layer velocities and features improve the relative wind estimate, particularly in high current areas.



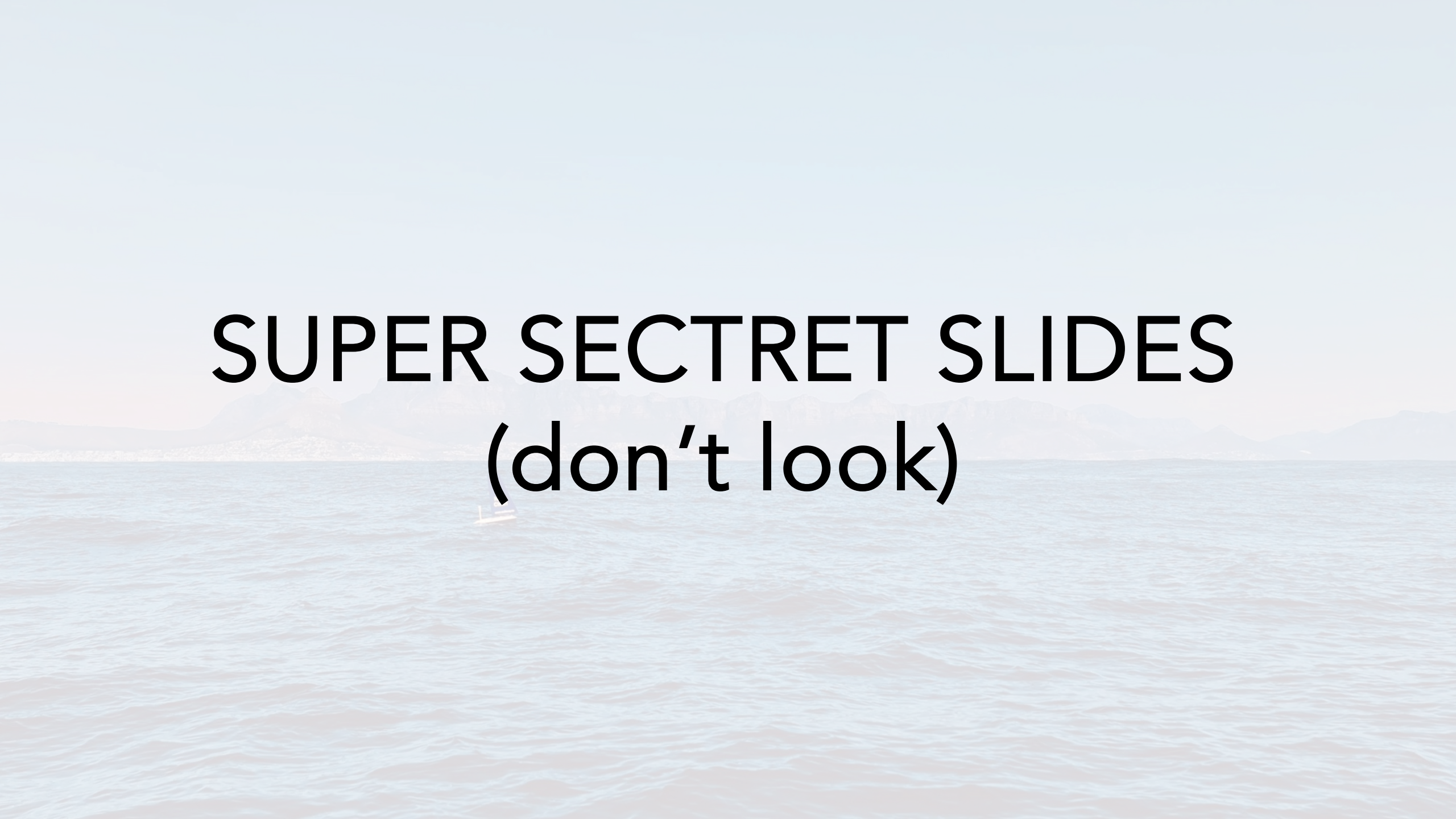
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Thank you!

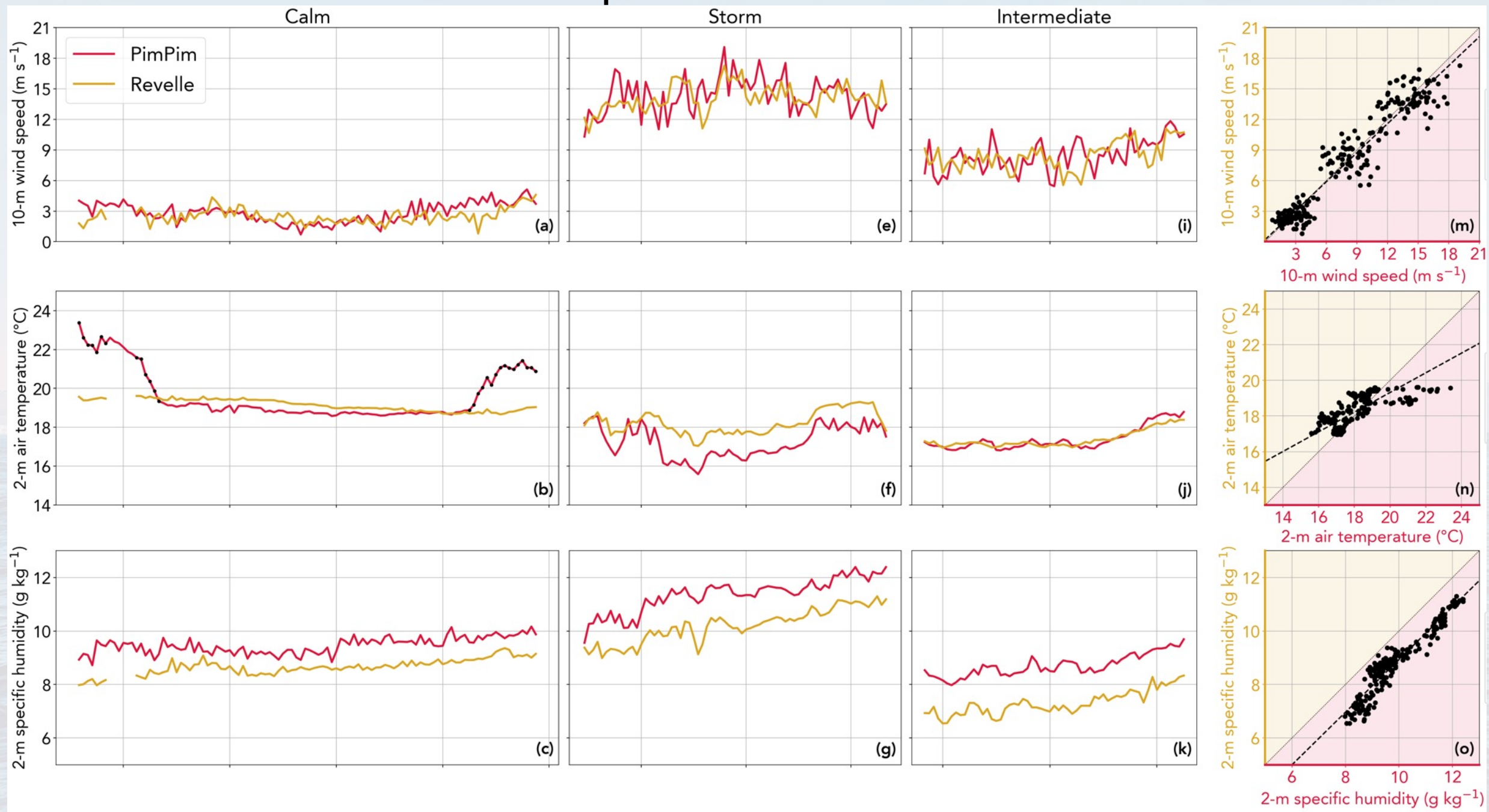
Questions?



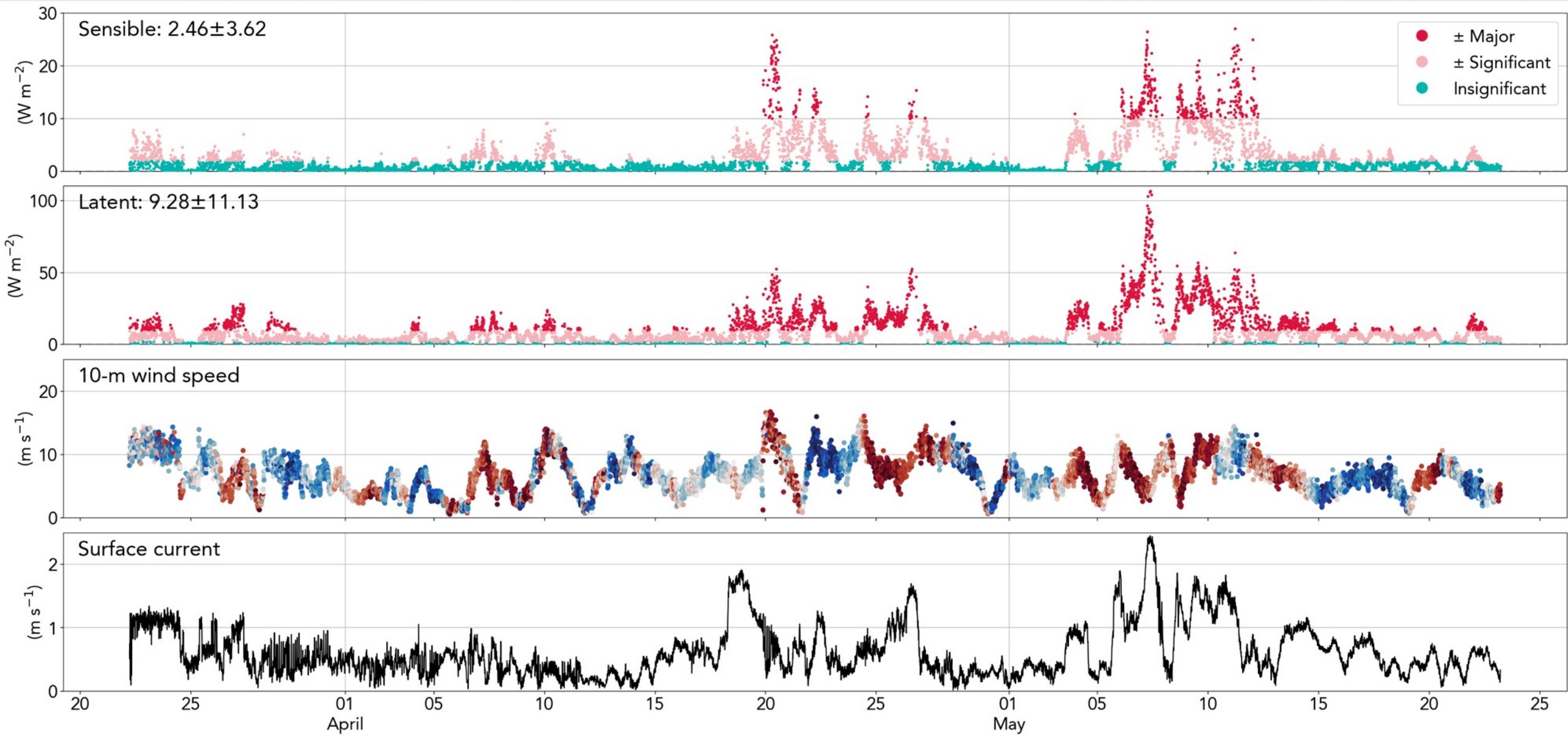


SUPER SECTRET SLIDES
(don't look)

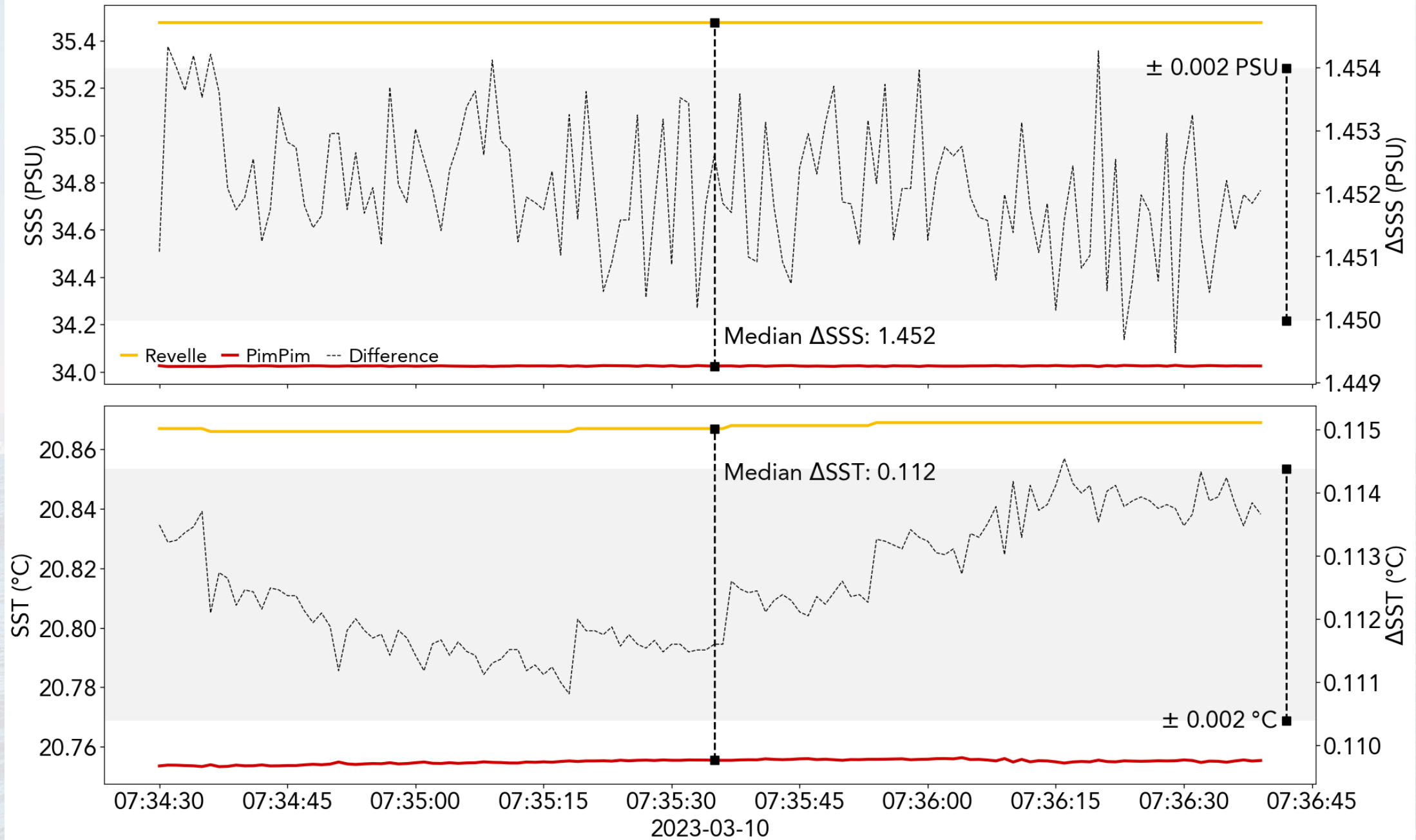
Comparison time series



Current influence on error



SST/SSS Bias



Flow field distortion

