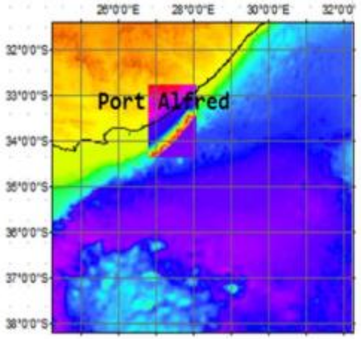
Port Alfred upwelling: A modelling approach



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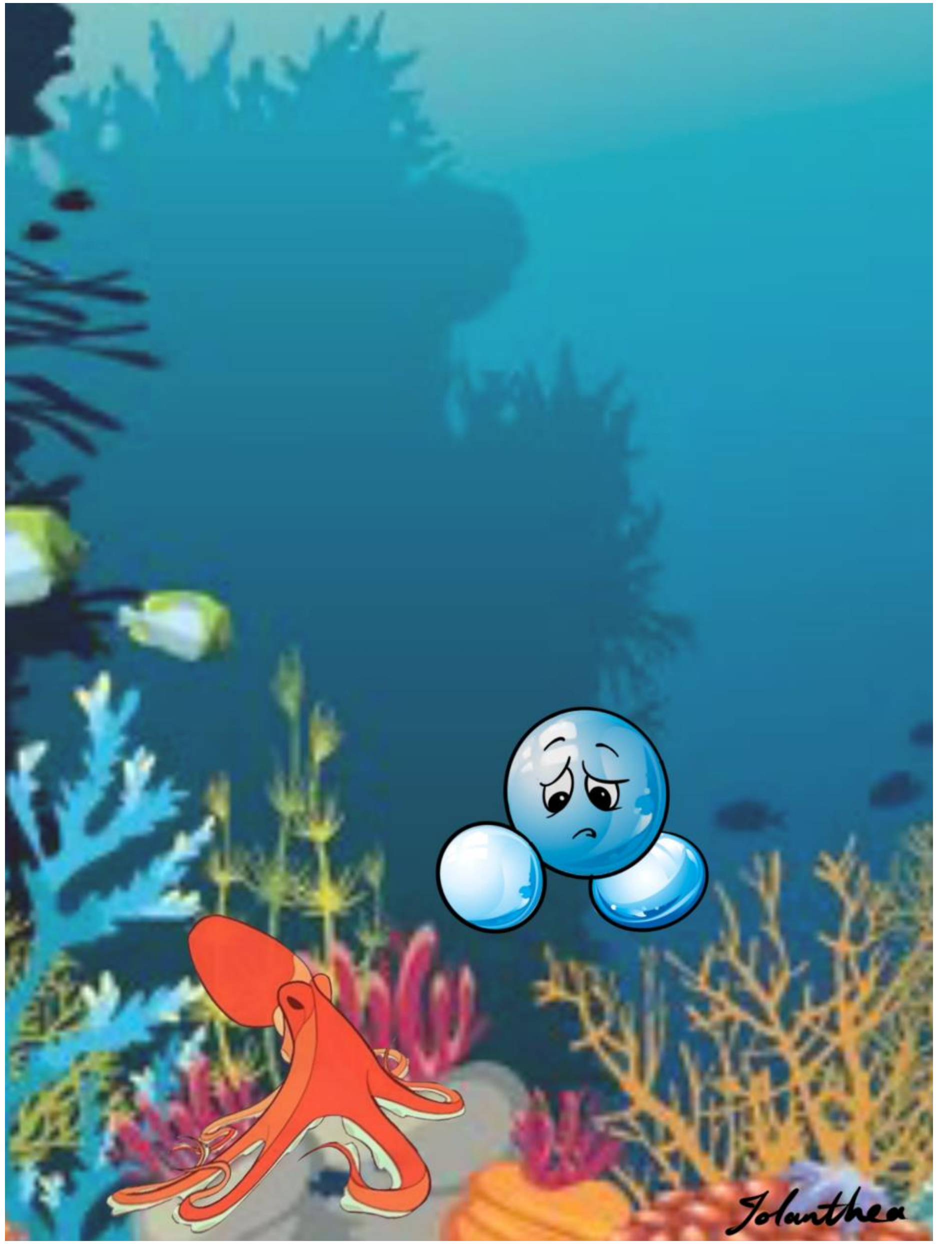

Figure 1: Stressed water molecule at the seafloor in Port Alfred, South Africa

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Port Alfred upwelling

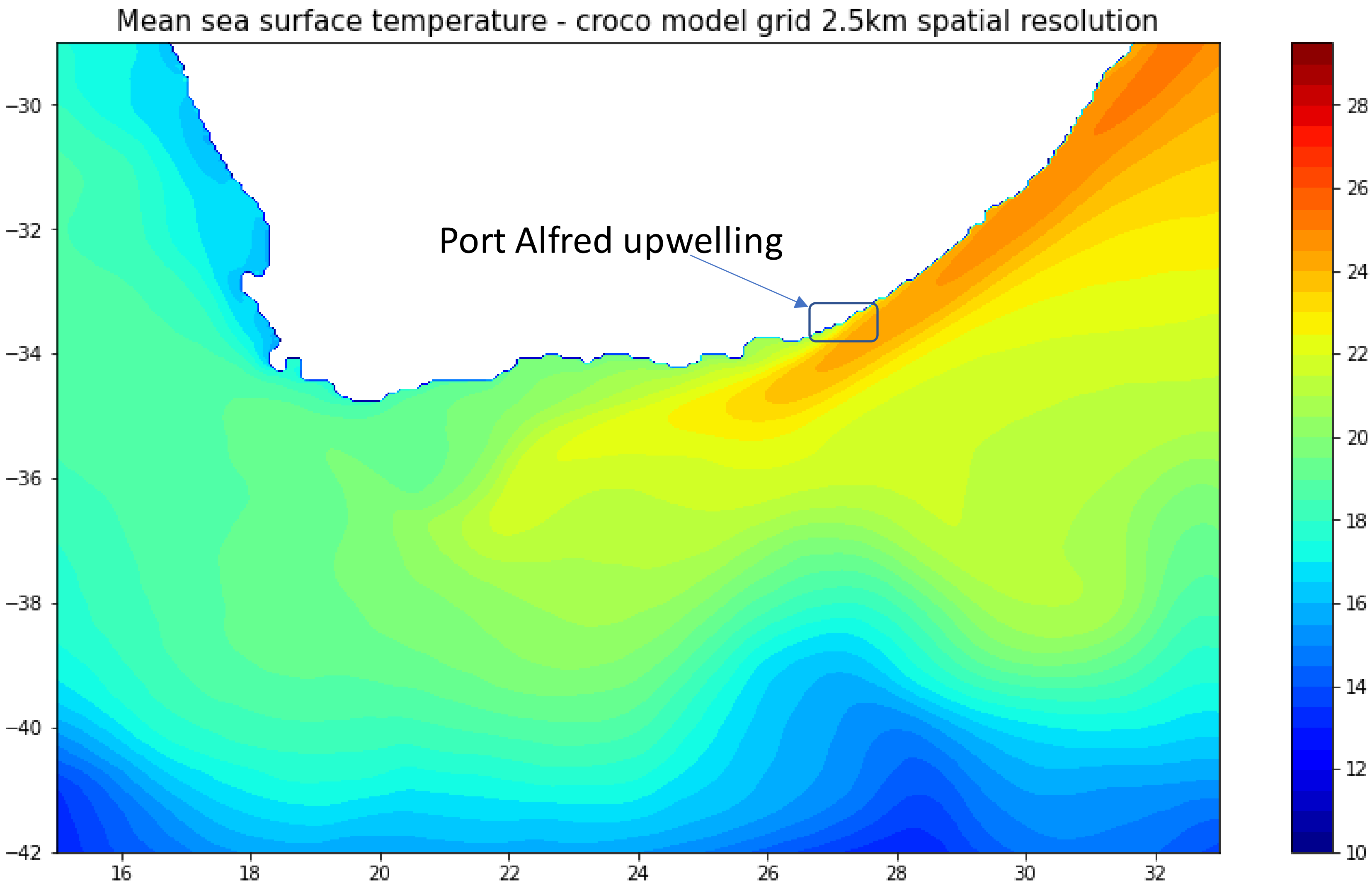

Figure 2: Mean sea surface temperature (1993 – 2014)

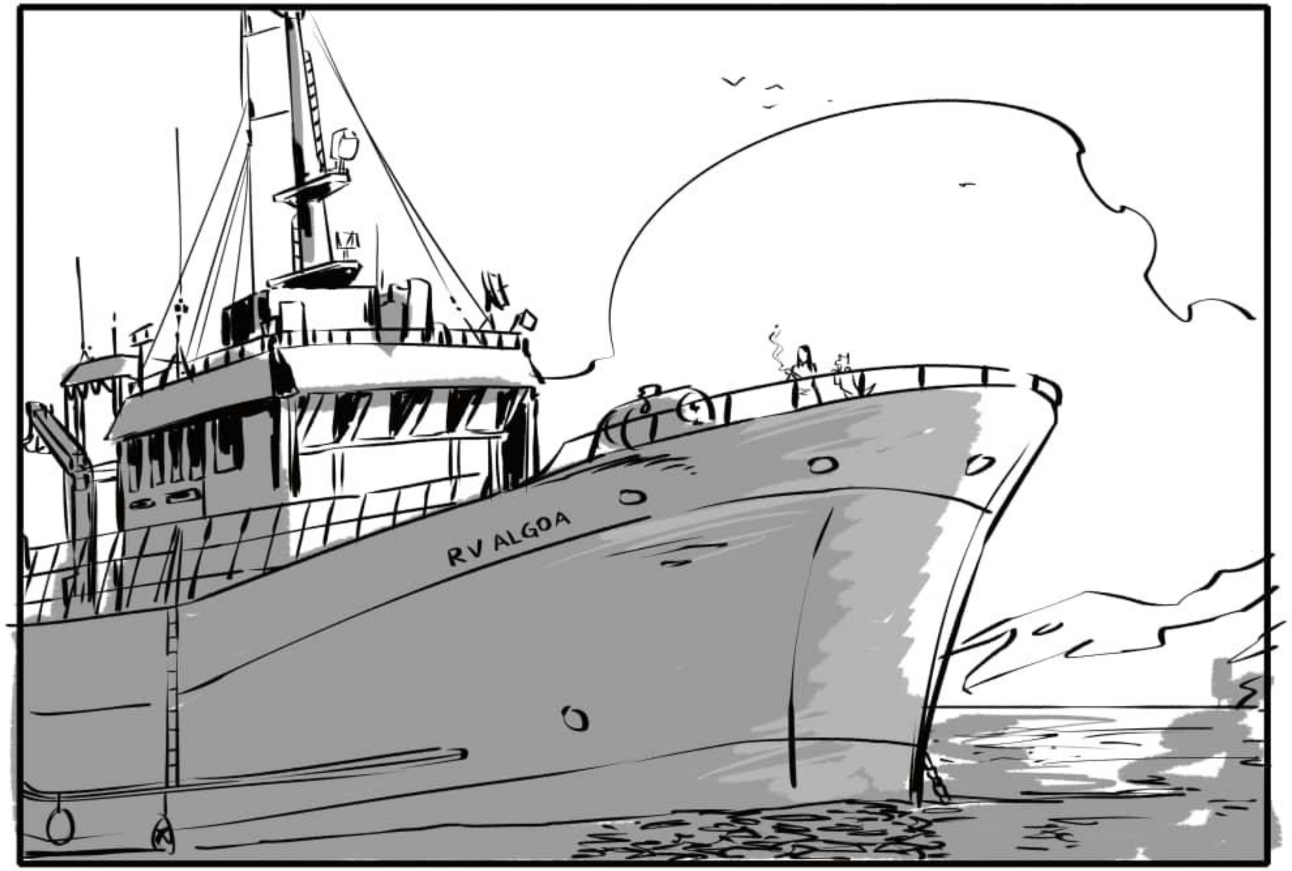

Figure 3: Sherlock Holmes and Dr Watson heading to Port Alfred

Figure 4: Sherlock Holmes and Dr Watson investigating the case

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Port Alfred upwelling

- Study area
- Mesoscale features linked to Port Alfred upwelling
- Atmospheric and oceanic mechanisms possibly triggering Port Alfred upwelling
- Most dominant forcing mechanisms

Figure 5: Sherlock Holmes and Dr Watson analysing croco model outputs

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Upwelling cells on the inshore edge of the Agulhas current

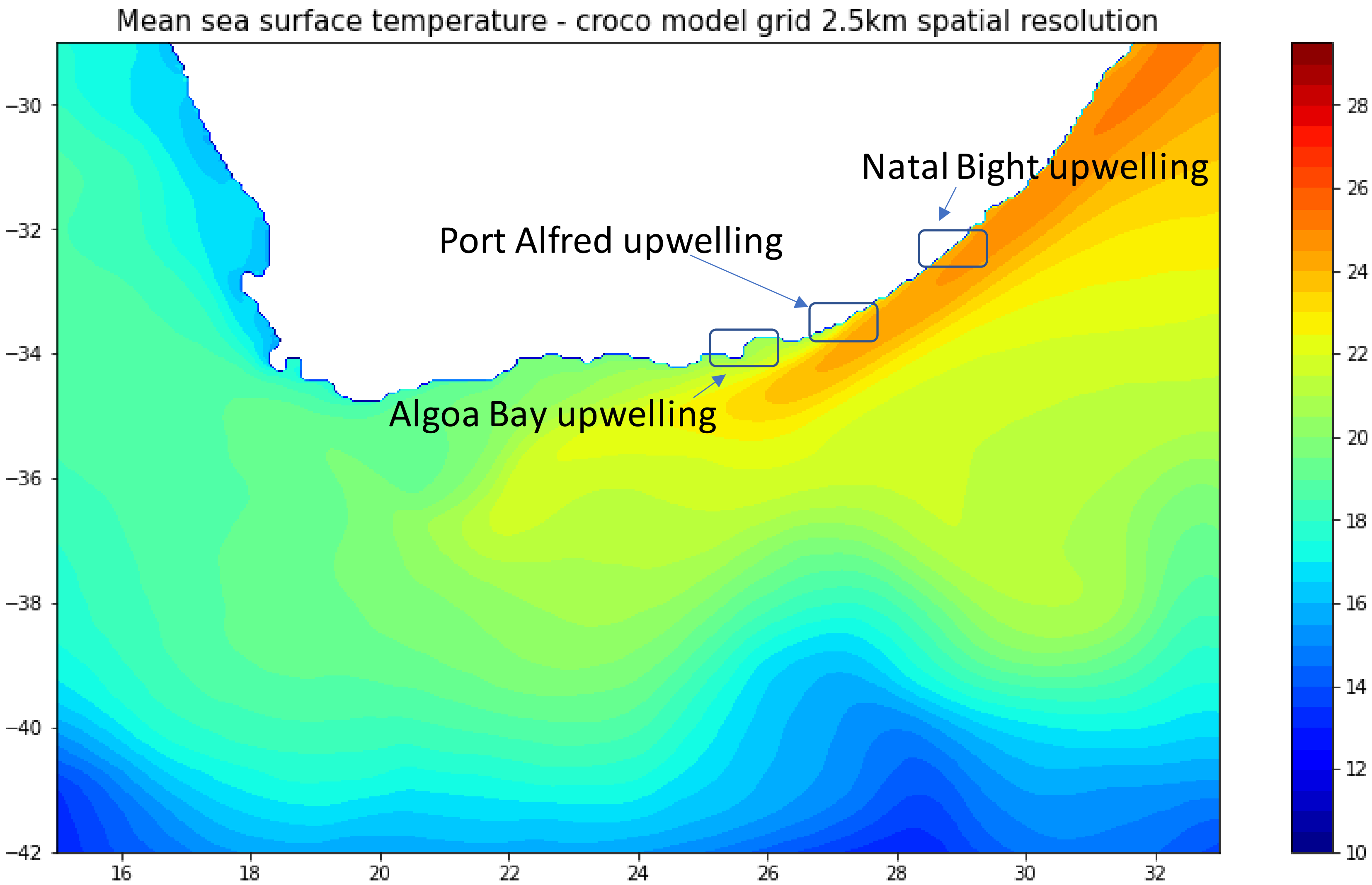

Figure 6: Mean sea surface temperature (1993 – 2014)

Mesoscale features possibly linked to PA upwelling:

The western boundary current, the Agulhas current

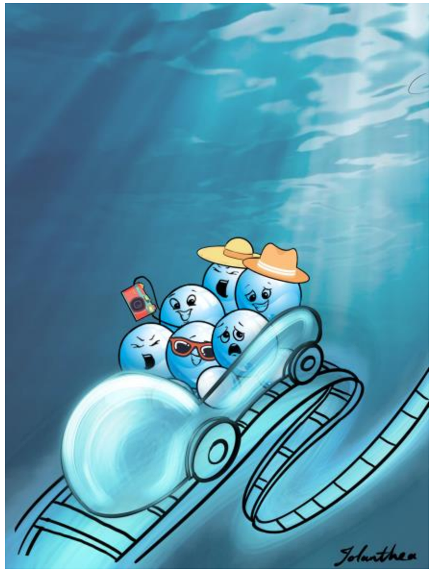

Figure 7: Influx of foreigner molecules

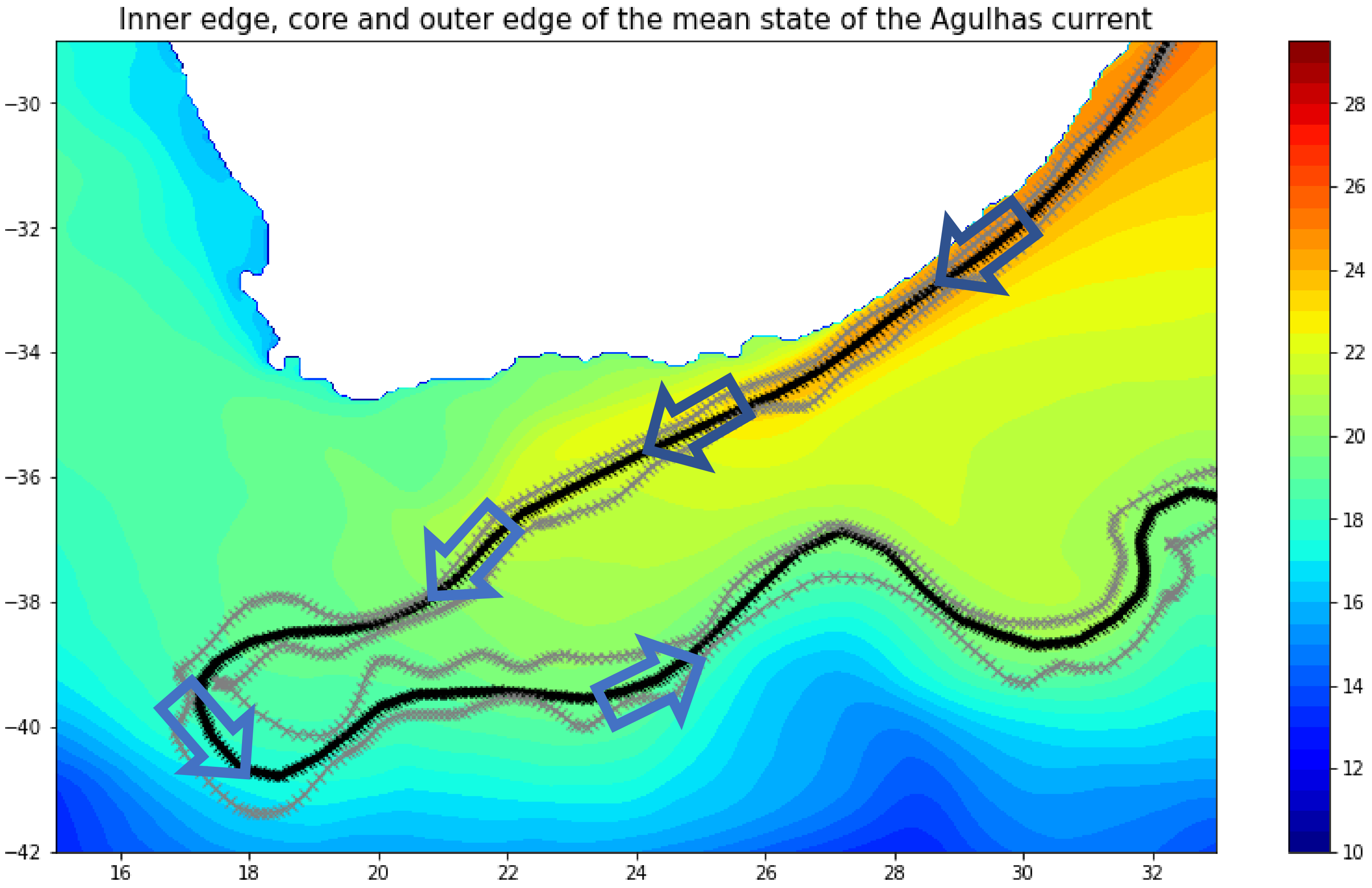

Figure 8: Mean sea surface temperature (1993 – 2014) along with mean position of core of the current

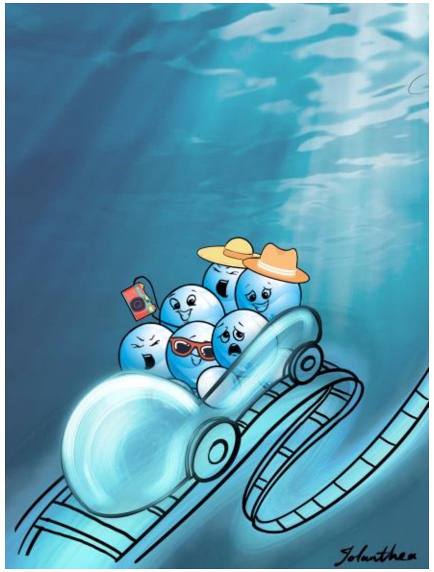

Figure 7: Influx of foreigner molecules

Mesoscale features possibly linked to PA upwelling:

The western boundary current, the Agulhas current

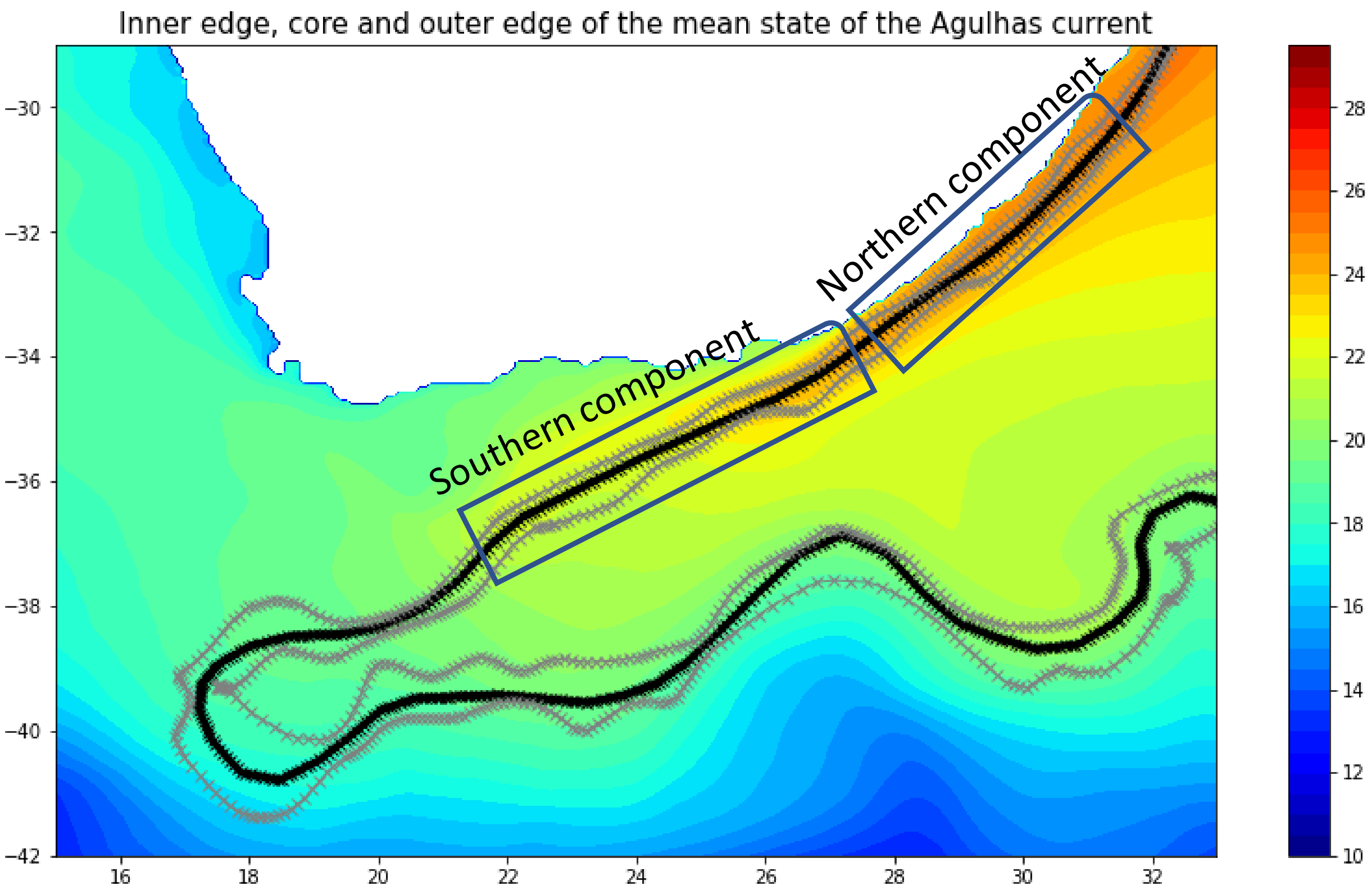

Figure 8: Mean sea surface temperature (1993 – 2014) along with mean position of core of the current

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Mesoscale features possibly linked to PA upwelling:

The cyclonic eddies

Figure 9: Molecules In circular motion party dance mode

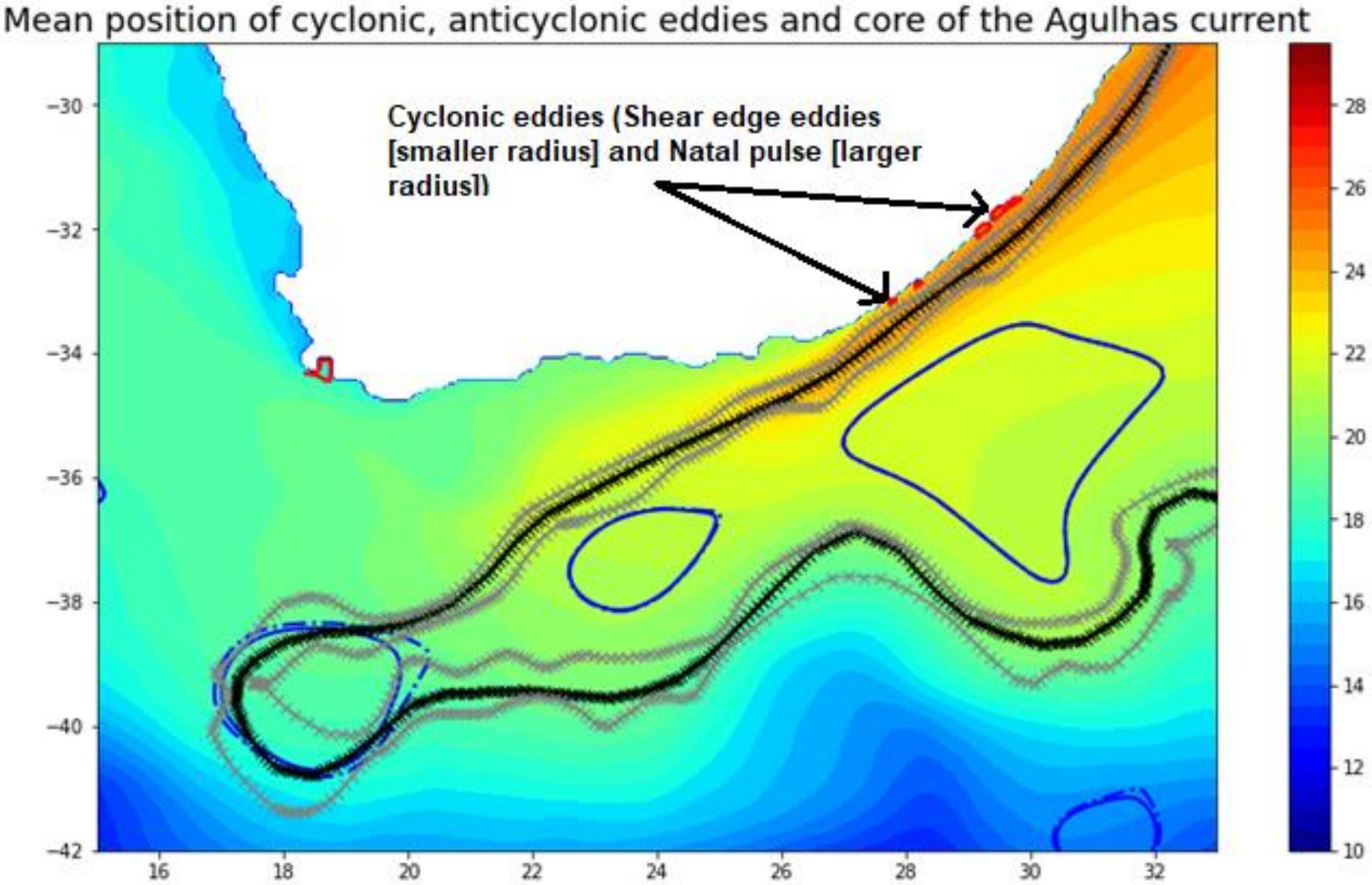

Figure 10: Mean sea surface temperature (1993 – 2014) along with mean position of core of the current and mean position of cyclonic (red) and anticyclonic eddies (blue) derived from eddy tracker algorithm

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Strong northeasterly wind component

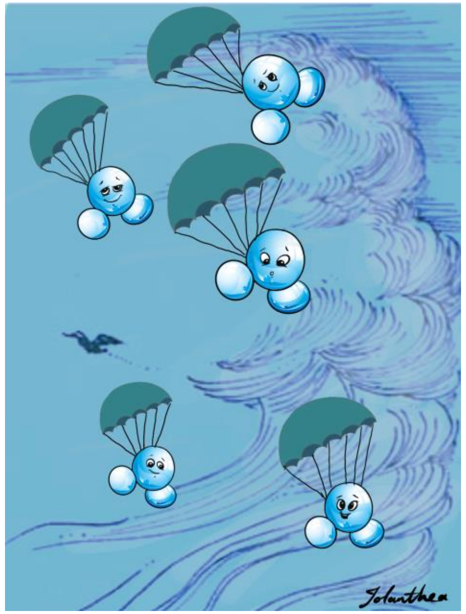

Figure 11: Air molecules also present in Port Alfred

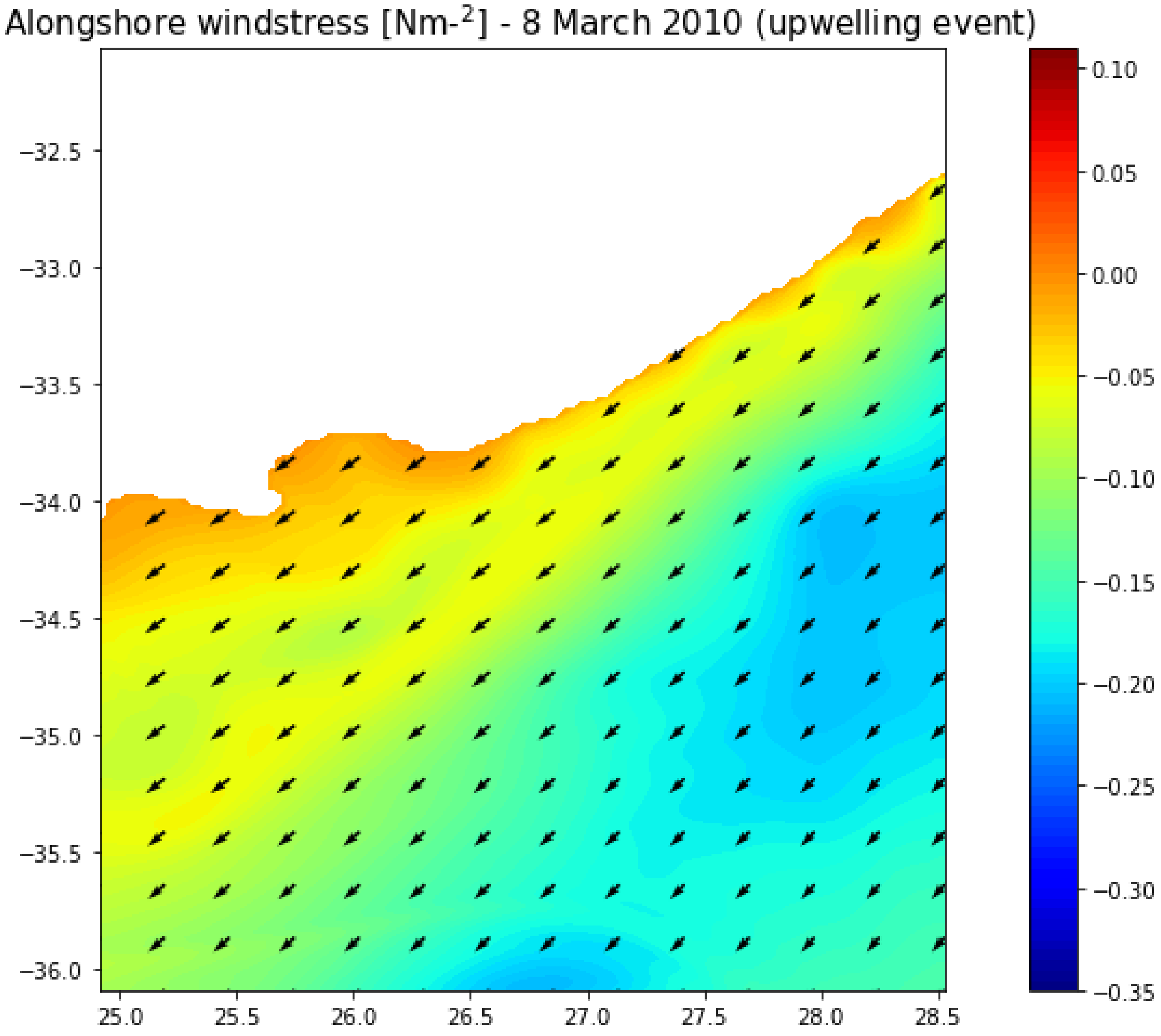

Figure 12: Alongshore windstress in Port Alfred

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Current driven upwelling

Figure 13: Sherlock and Dr Watson wondering about the current

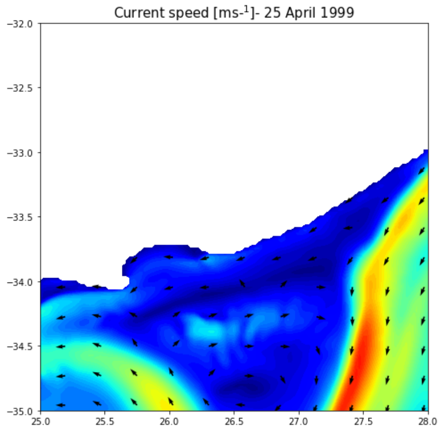

Figure 14: Current speed during an upwelling (presence of meander)

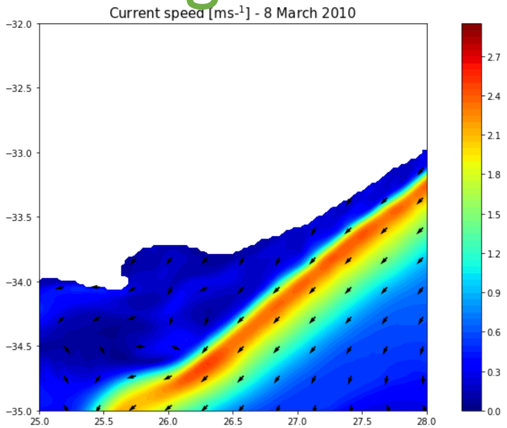

Figure 15: Current speed during an upwelling (presence of strong northeasterly winds)

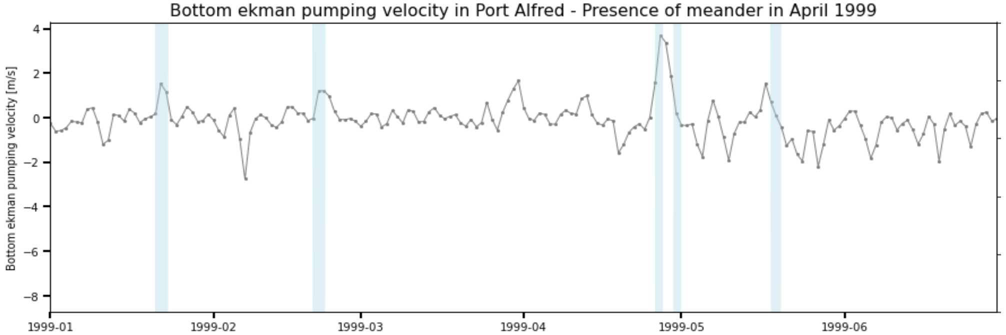

Figure 16: Bottom ekman pumping velocity during an upwelling event

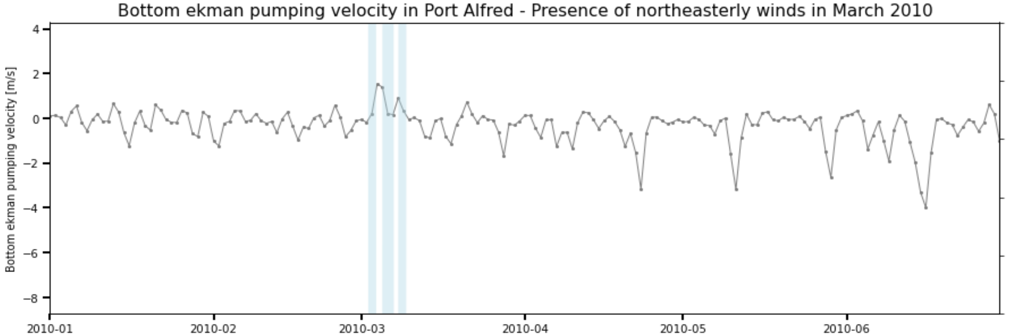

Figure 17: Bottom ekman pumping velocity during an upwelling event

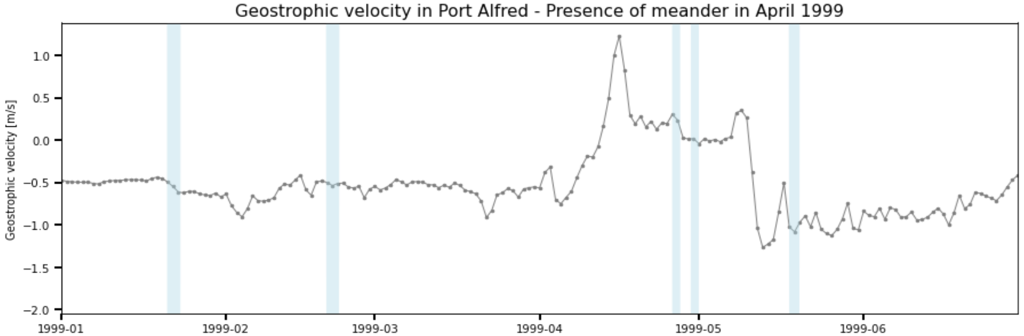

Figure 18: Geostrophic velocity during an upwelling event

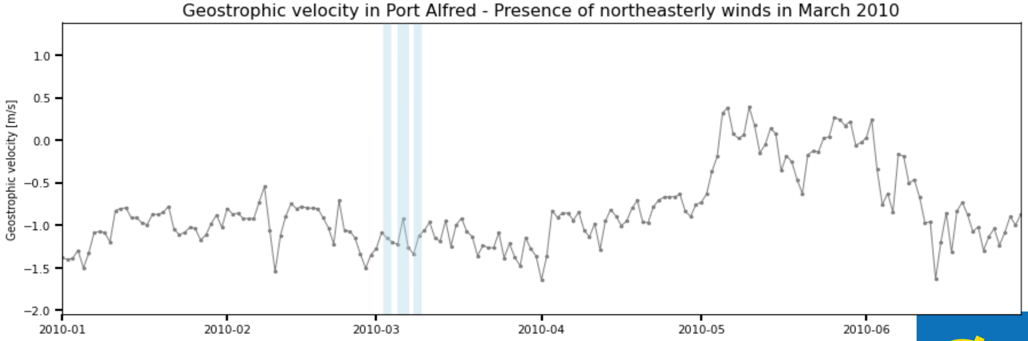

Figure 19: Geostrophic velocity during an upwelling event

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Meander induced upwelling

Figure 20: Sherlock and Dr Watson wondering about the shear edge cyclonic eddies

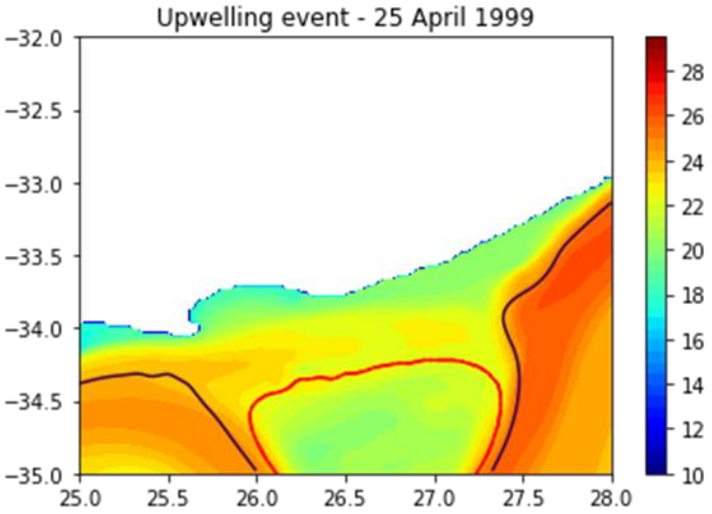

Figure 21: Sea surface temperature with core of the current (black line) and cyclonic eddy (red line) during an upwelling (presence of meander)

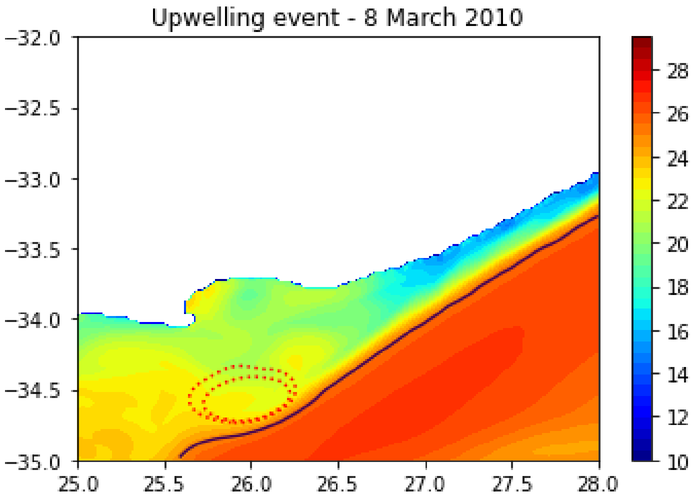

Figure 22: Sea surface temperature with core of the current (black line) and weak cyclonic eddy (red dotted line) during an upwelling (presence of strong winds)

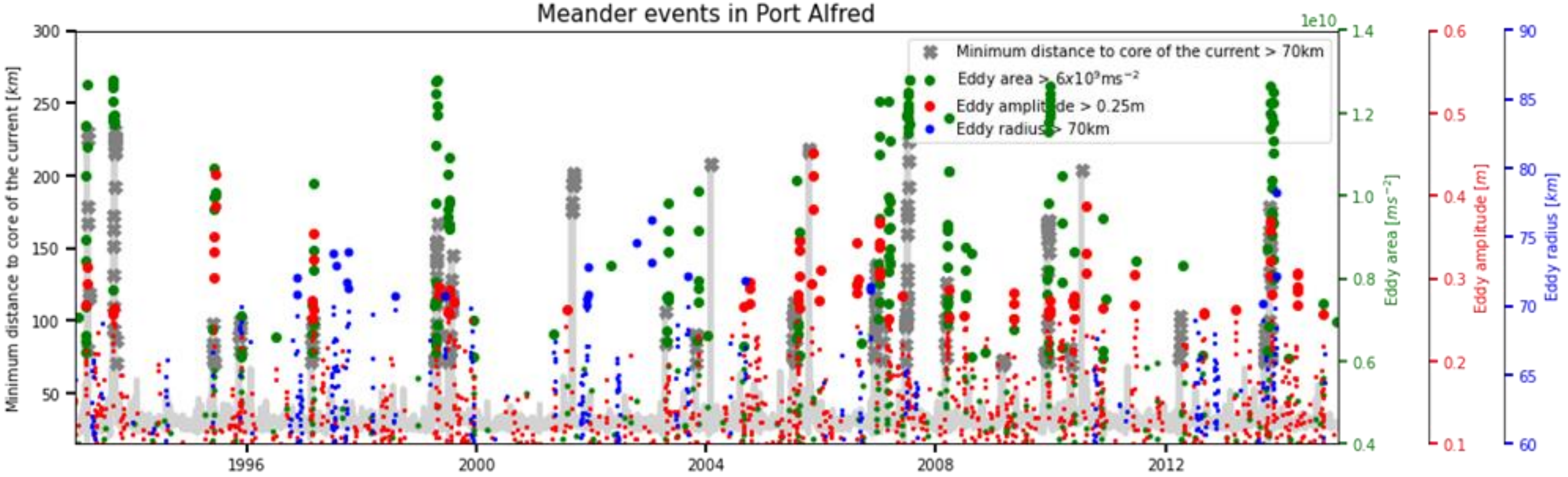

Figure 23: Time series of meander events from minimum distance from core of current to PA upwelling (grey), eddy area (green), eddy amplitude (red), and eddy radius (blue) from 1993 to 2014

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Wind driven upwelling

Figure 24: Sherlock and Dr Watson wondering about the wind

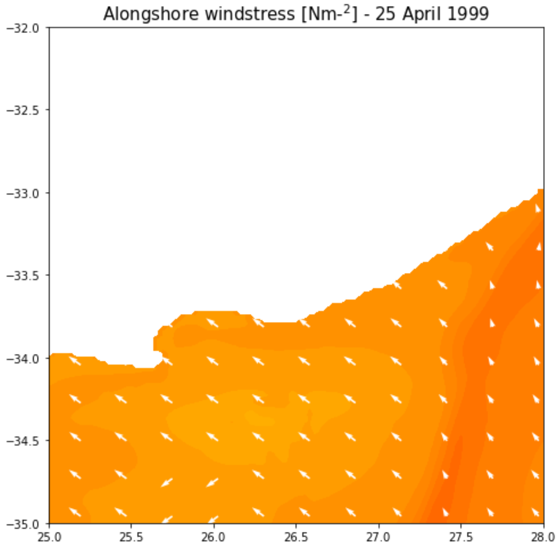


Figure 25: Alongshore windstress during an upwelling (presence of meander)

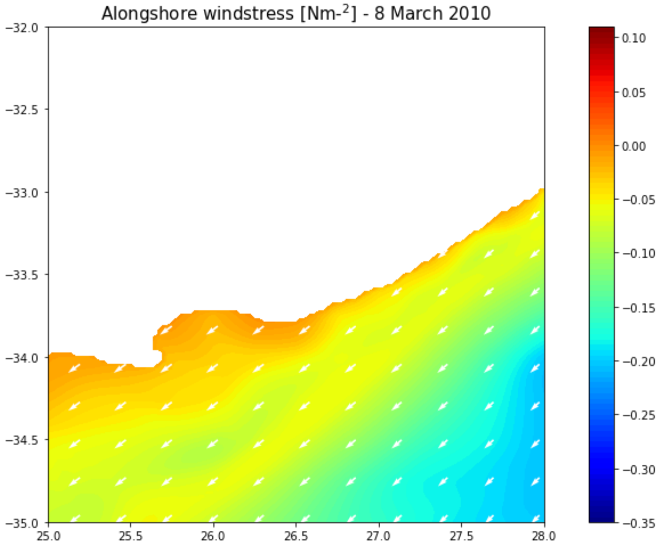


Figure 26: Alongshore windstress during an upwelling (presence of strong northeasterly)

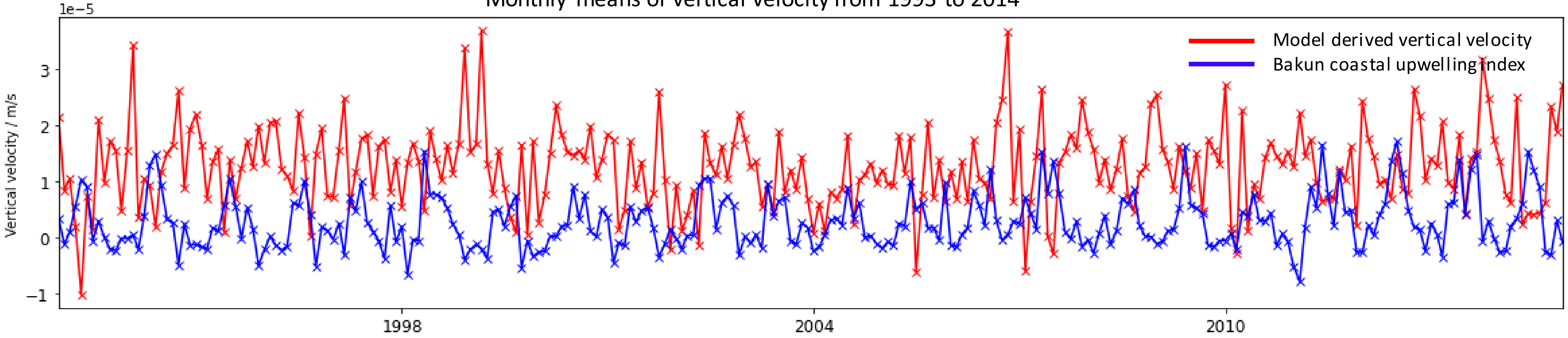


Figure 27: Model derived vertical velocity (red) and Bakun upwelling index (wind driven upwelling index) (blue)

Which forcing mechanism is more dominant? Correlation method

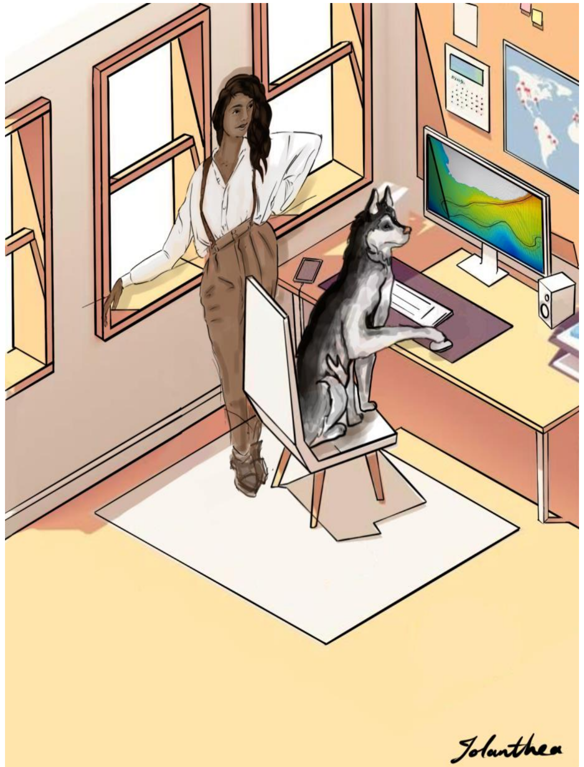


Figure 28: Sherlock and Watson analysing model outputs

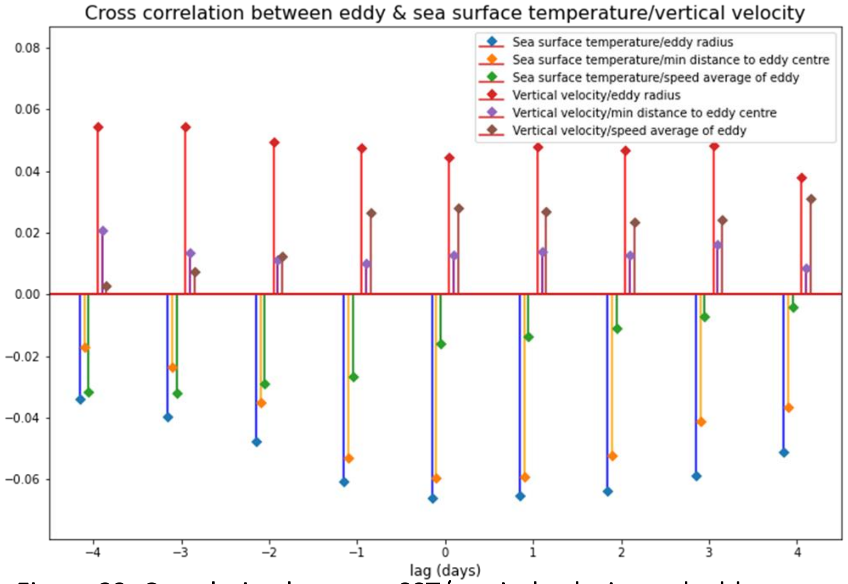


Figure 29: Correlation between SST/vertical velocity and eddy

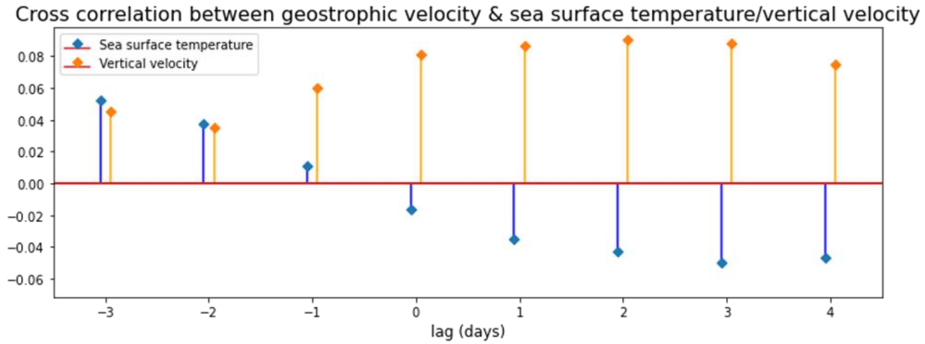


Figure 30: Correlation between SST/vertical velocity and geostrophic current velocity

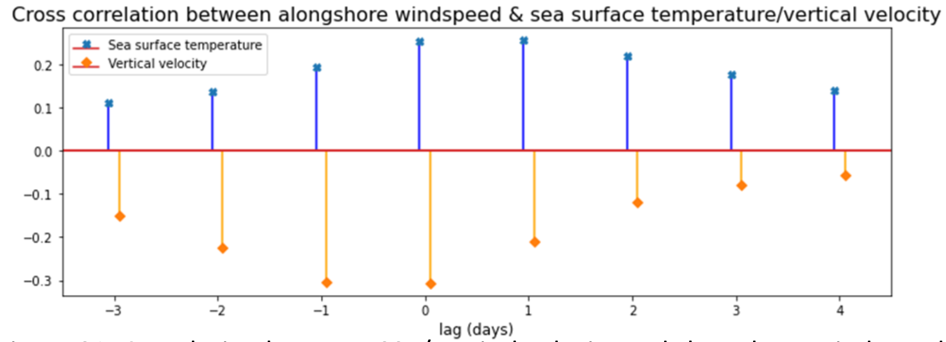
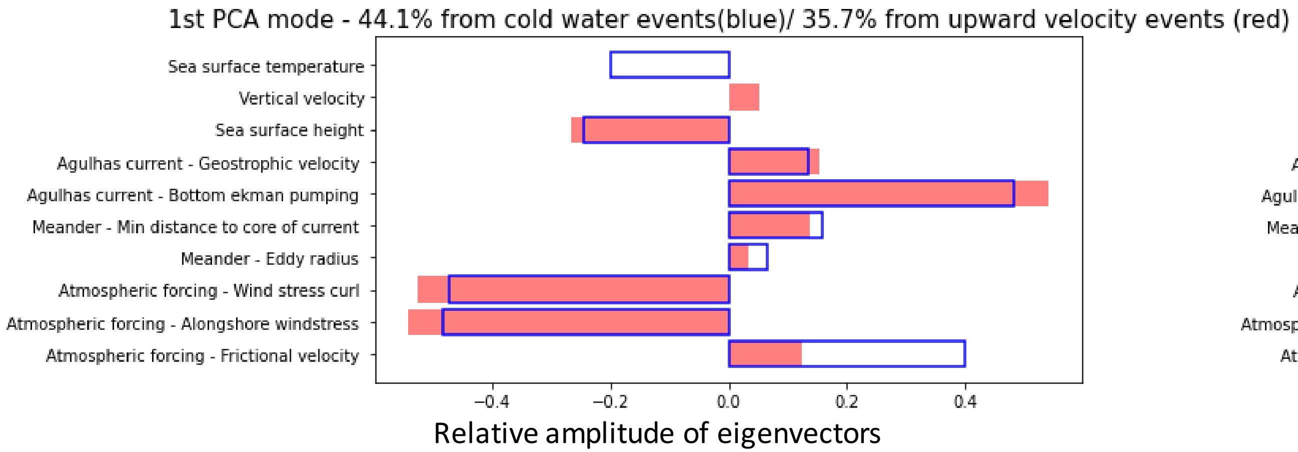


Figure 31: Correlation between SST/vertical velocity and alongshore windspeed

Combined empirical orthogonal function analysis



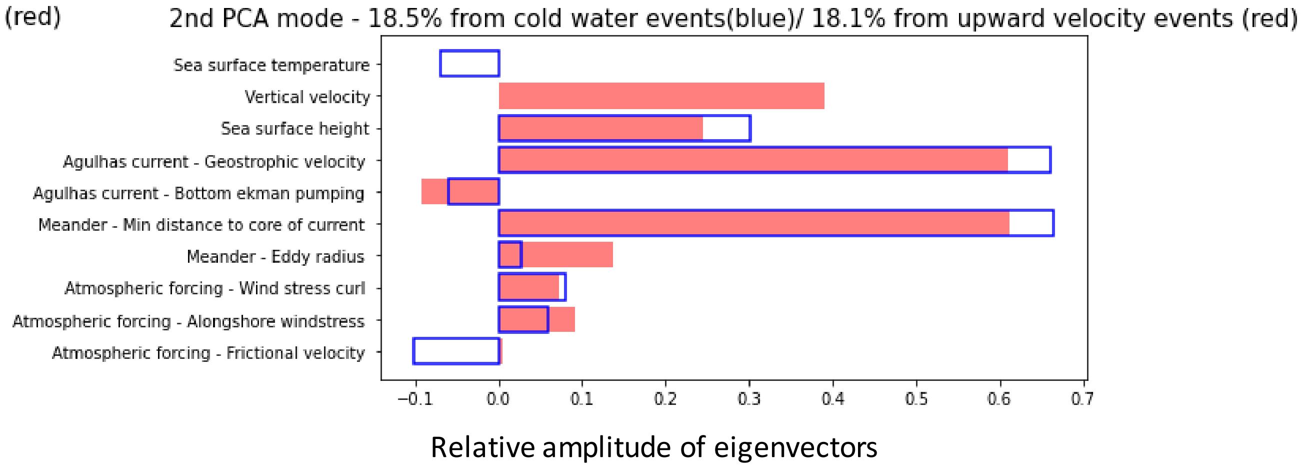


Figure 32: Two panels showing the amplitude of the eigenvectors for the first two modes of a combined EOF analysis of cold events and upward velocity events along with the forcing mechanisms.

Dominating forcing mechanisms
Alongshore windstress, windstress curl [wind] and
bottom stress [friction from current]

Cyclonic eddy – weaker forcing mechanism
Model does not always represent eddy at the exact dates when compared to satellite images.

A combination of wind-driven, meander-induced and current driven upwelling – Strong upwelling events
Individual forcing mechanism can trigger upwelling – Weak upwelling events

Thank you

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