

Oxygen saturation surrounding deep-water formation events in the Labrador Sea from Argo-O₂ data



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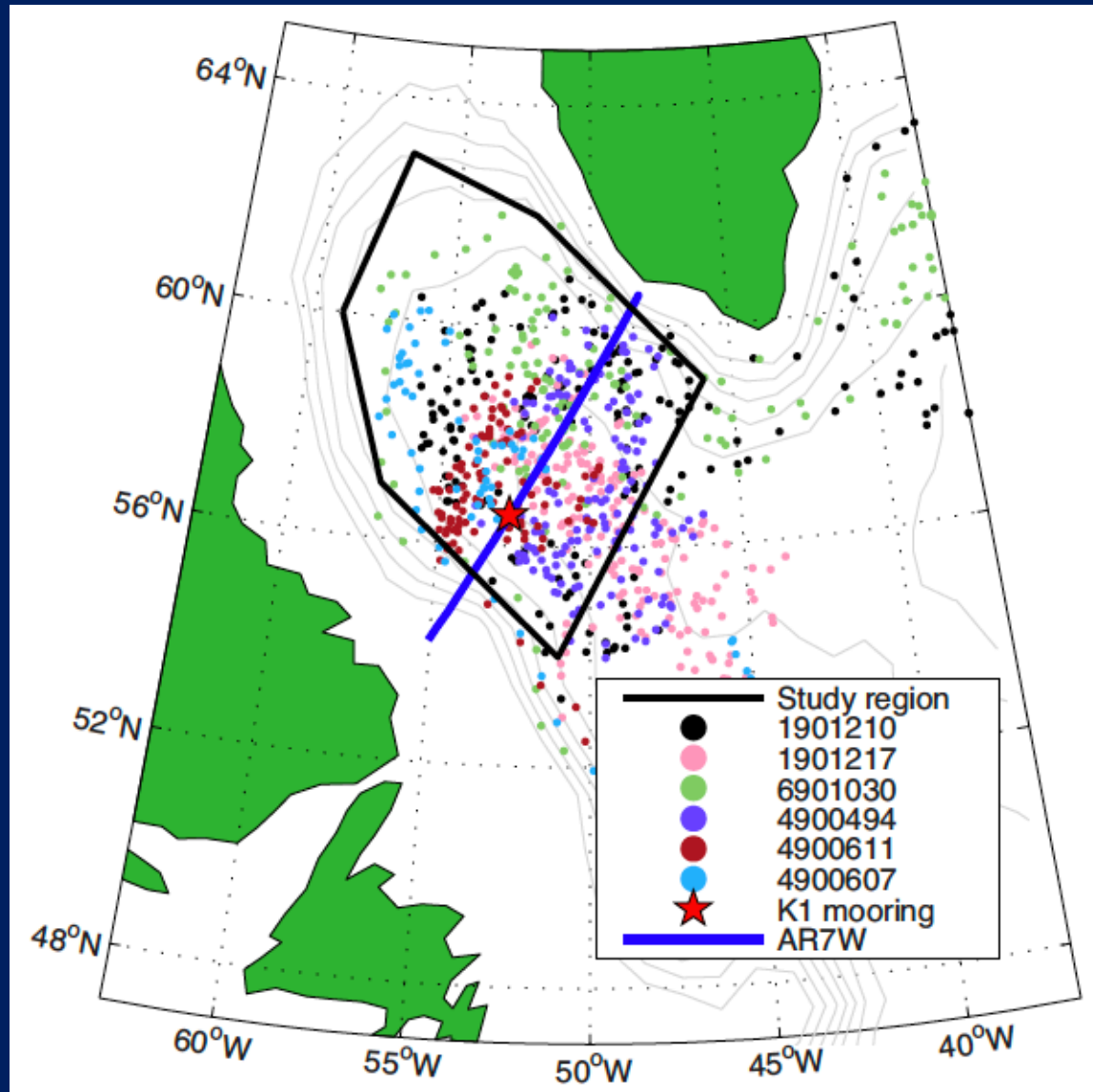


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What is the oxygen content of newly formed deep water?
What factors control its variability?



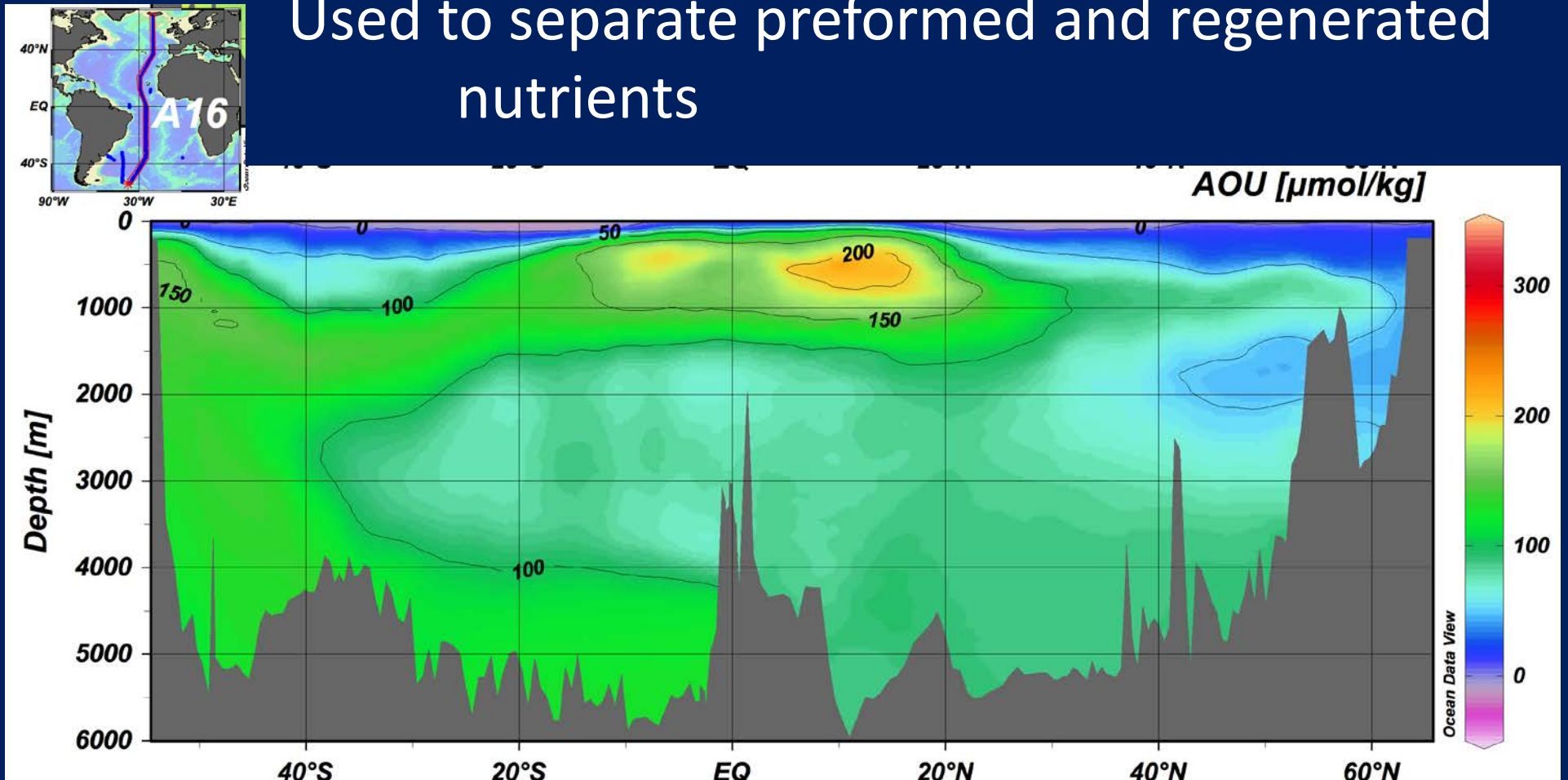
AOU = Apparent Oxygen Utilization = $[O_2]_{\text{equil}} - [O_2]_{\text{meas}}$

Amount of oxygen consumed by biological processes

Used to calculate ocean productivity rates

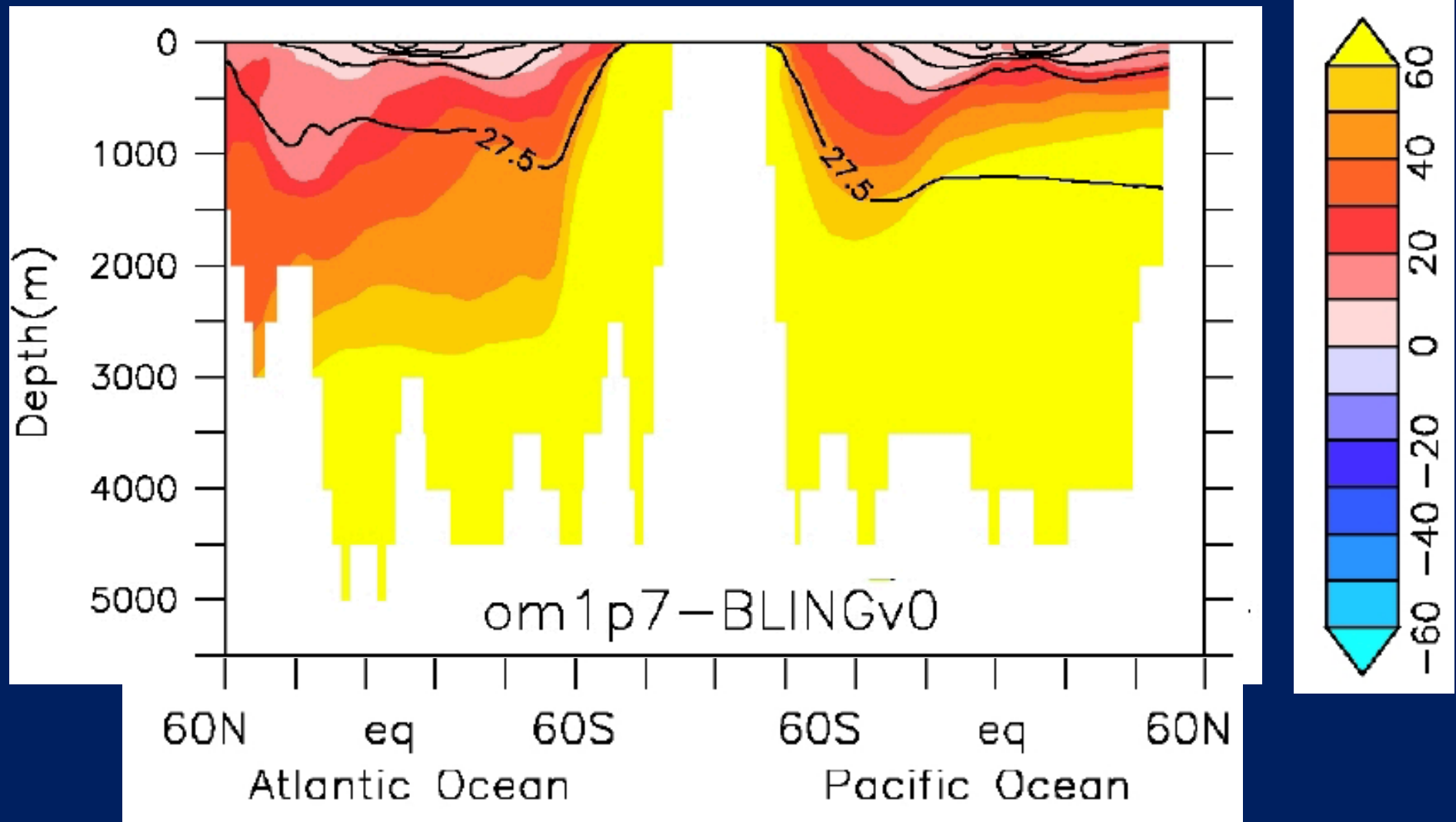
Used to estimate anthropogenic carbon

Used to separate preformed and regenerated nutrients



Substantial error in assuming surface equilibrium

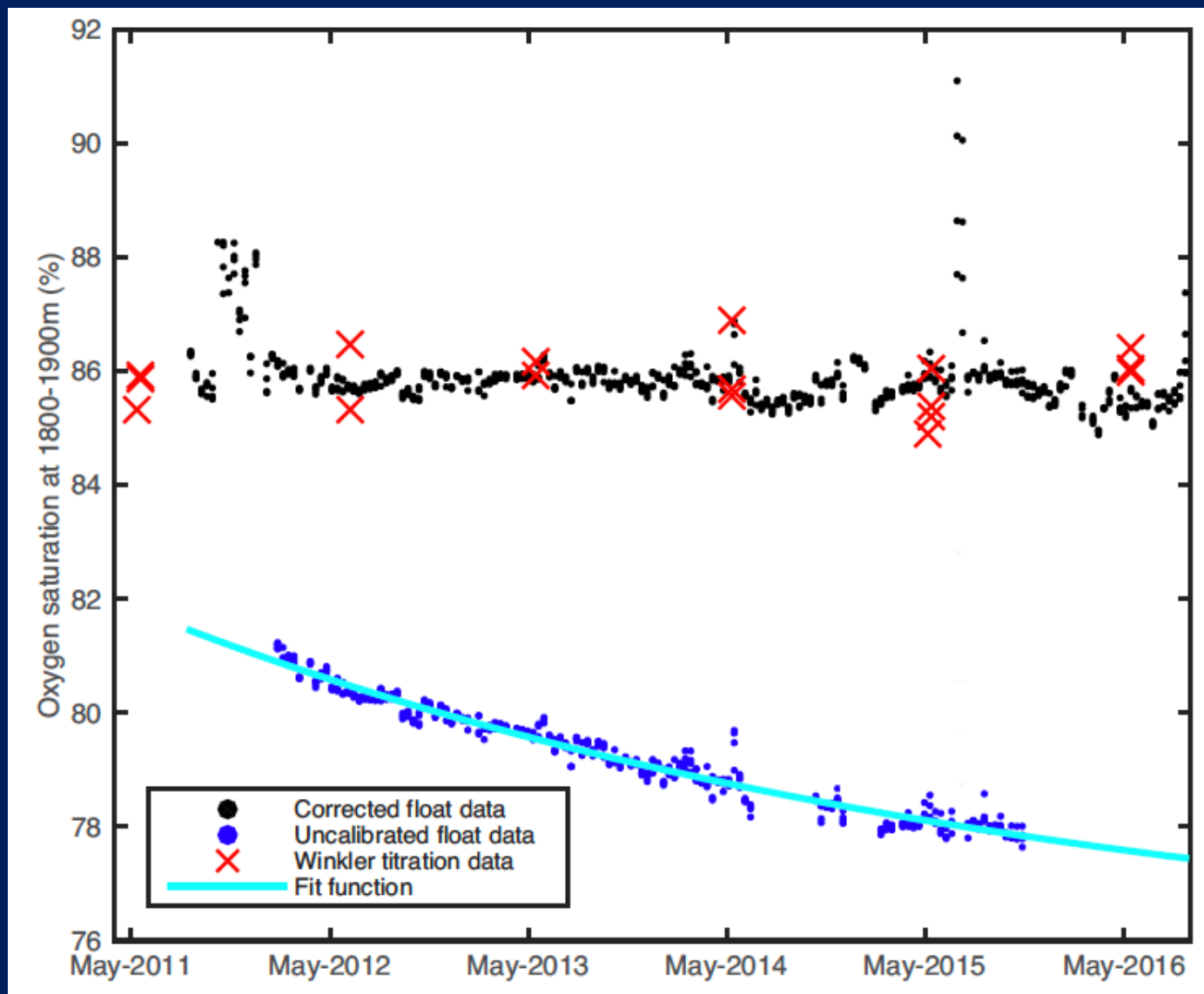
Model estimate of error in AOU from equilibrium assumption



Optode sensors not calibrated well and drifting

In-air measurements available on only one float

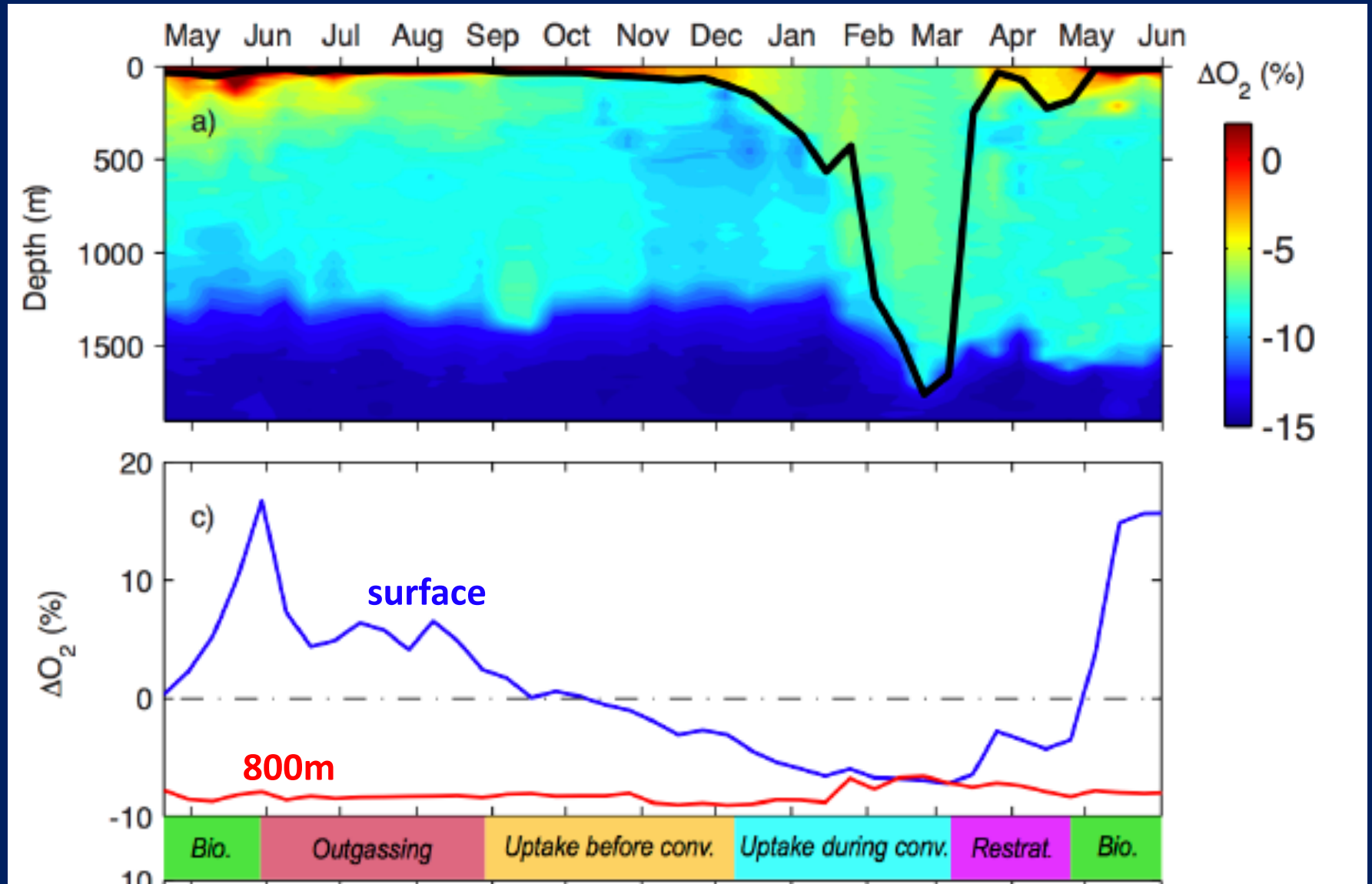
Developed method to correct drift to repeat ship obs.



Typical annual oxygen cycle in Lab Sea

Cooling and convection drive winter undersaturation

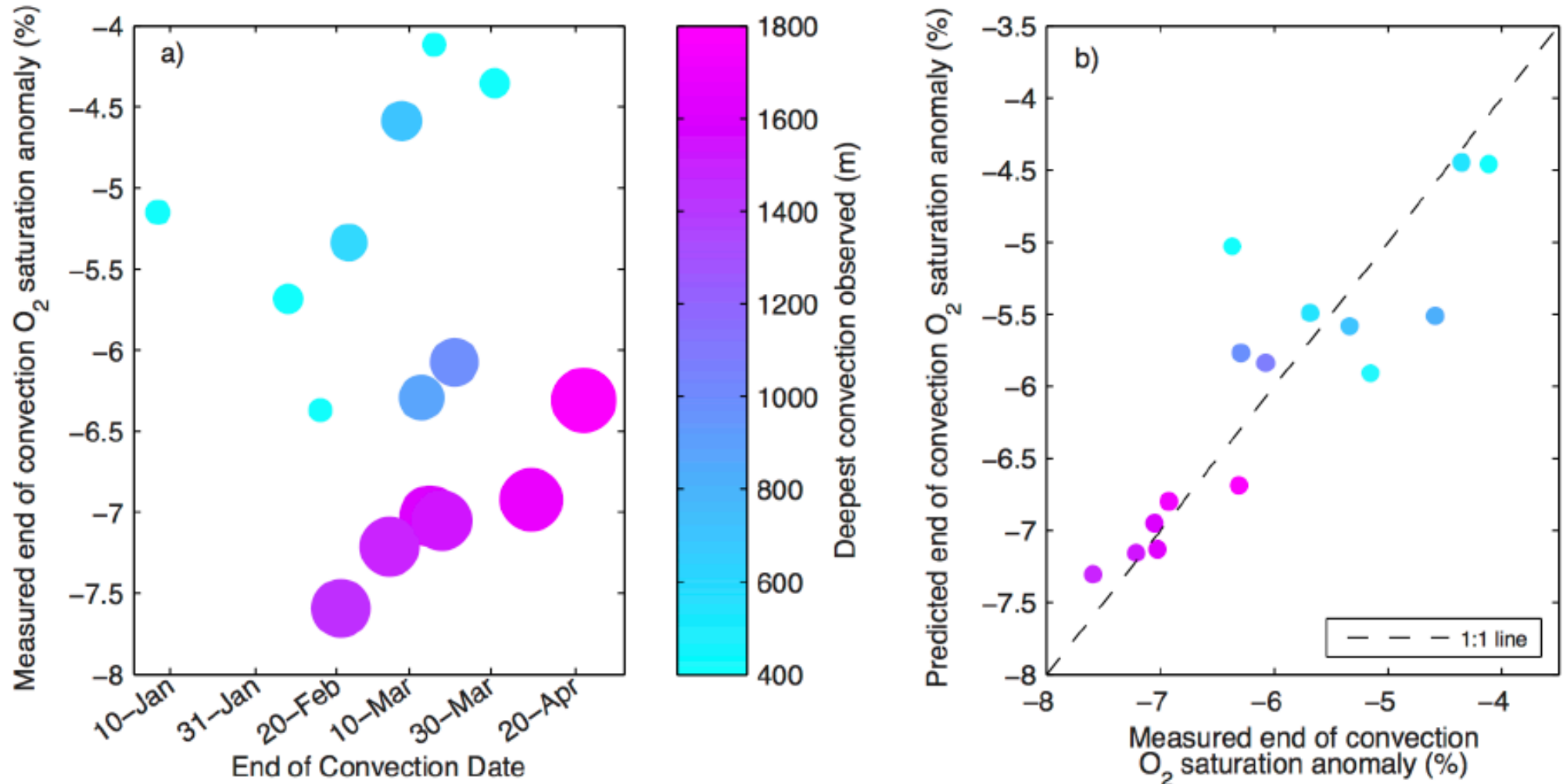
Observe full time series during the worst weather



Convection's end: oxygen consistently undersaturated

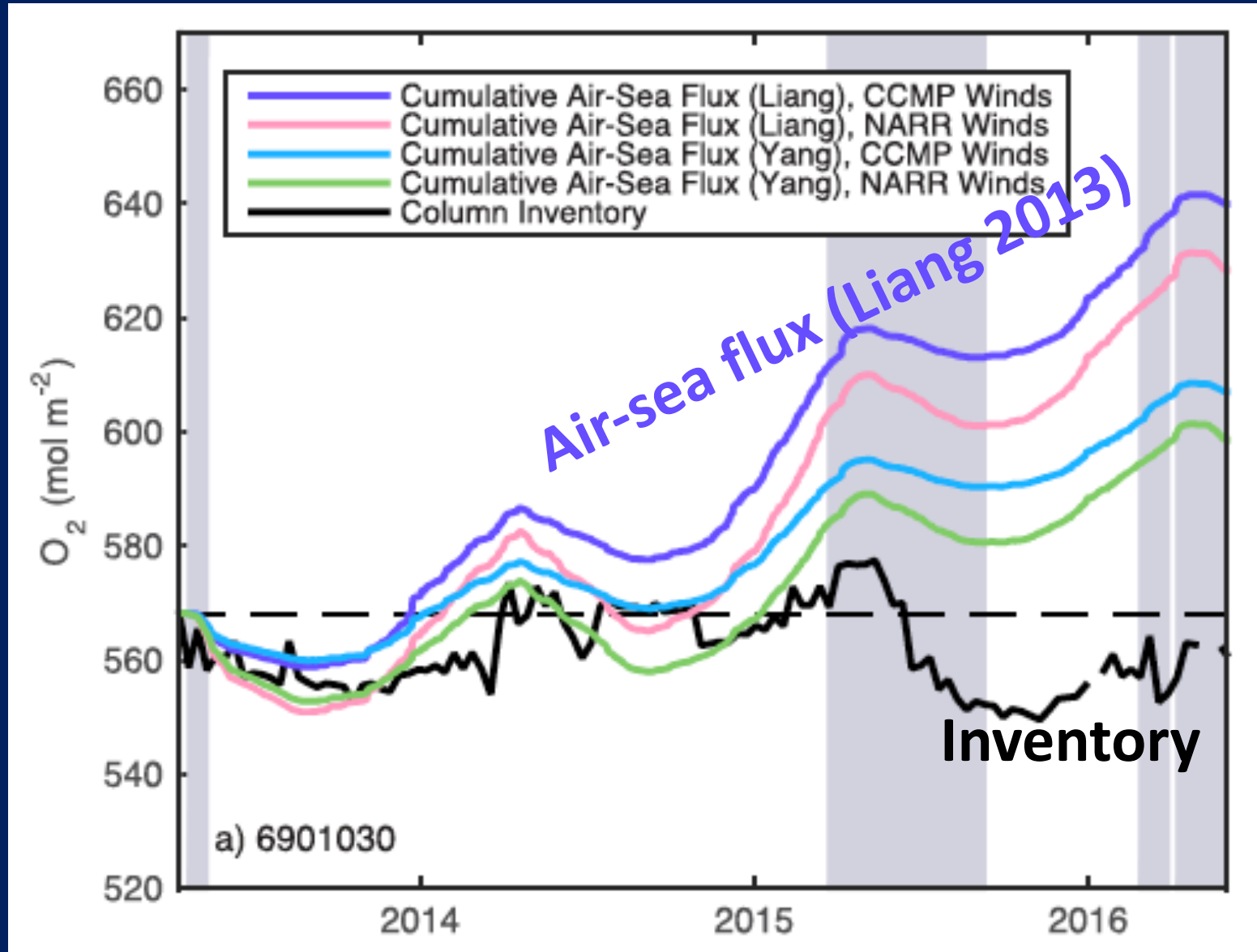
Deeper convection → greater undersaturation

Earlier end to convection → greater undersaturation



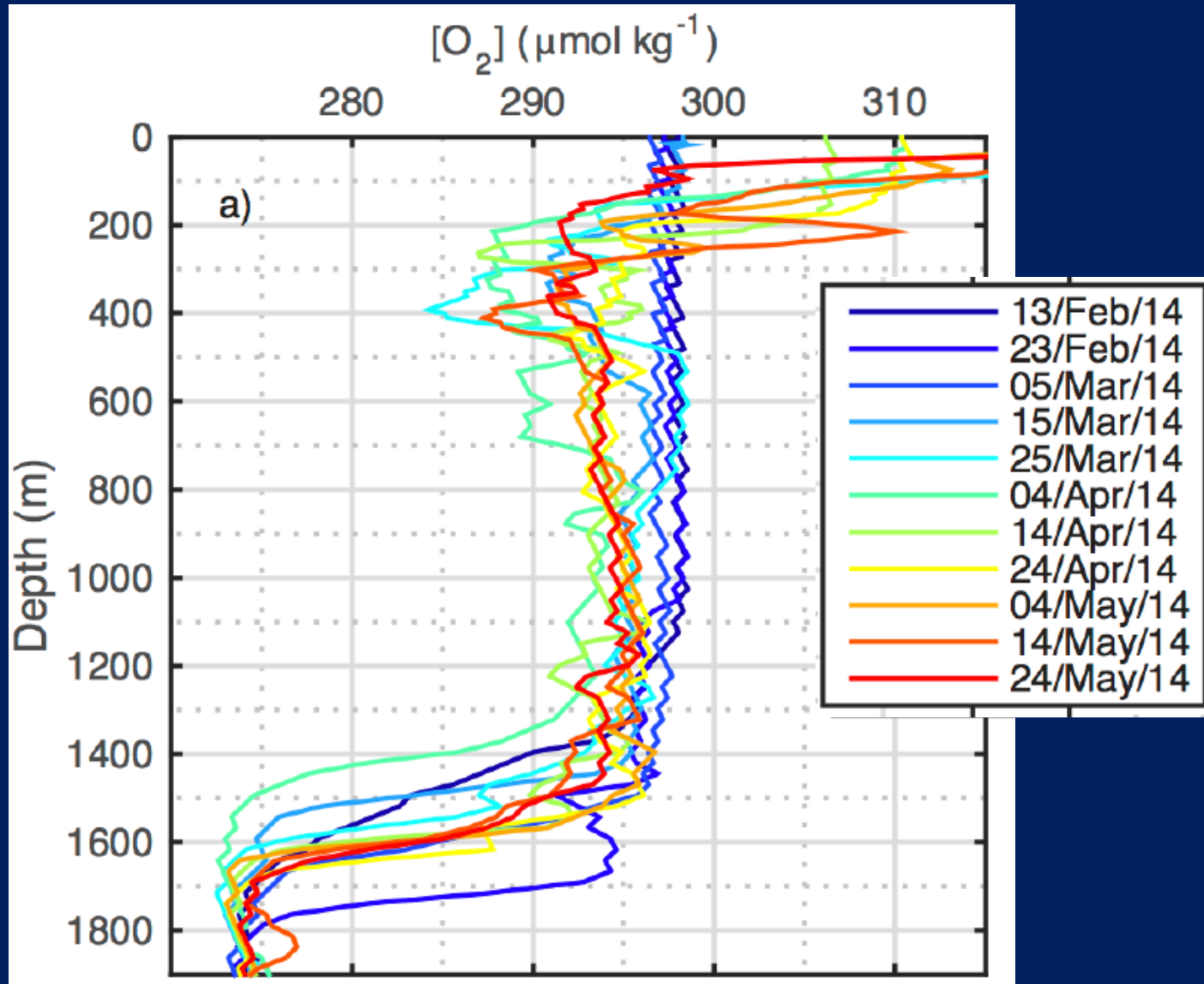
Best estimate: net oxygen uptake in Lab Sea

Gas exchange rates (esp. bubbles) uncertain

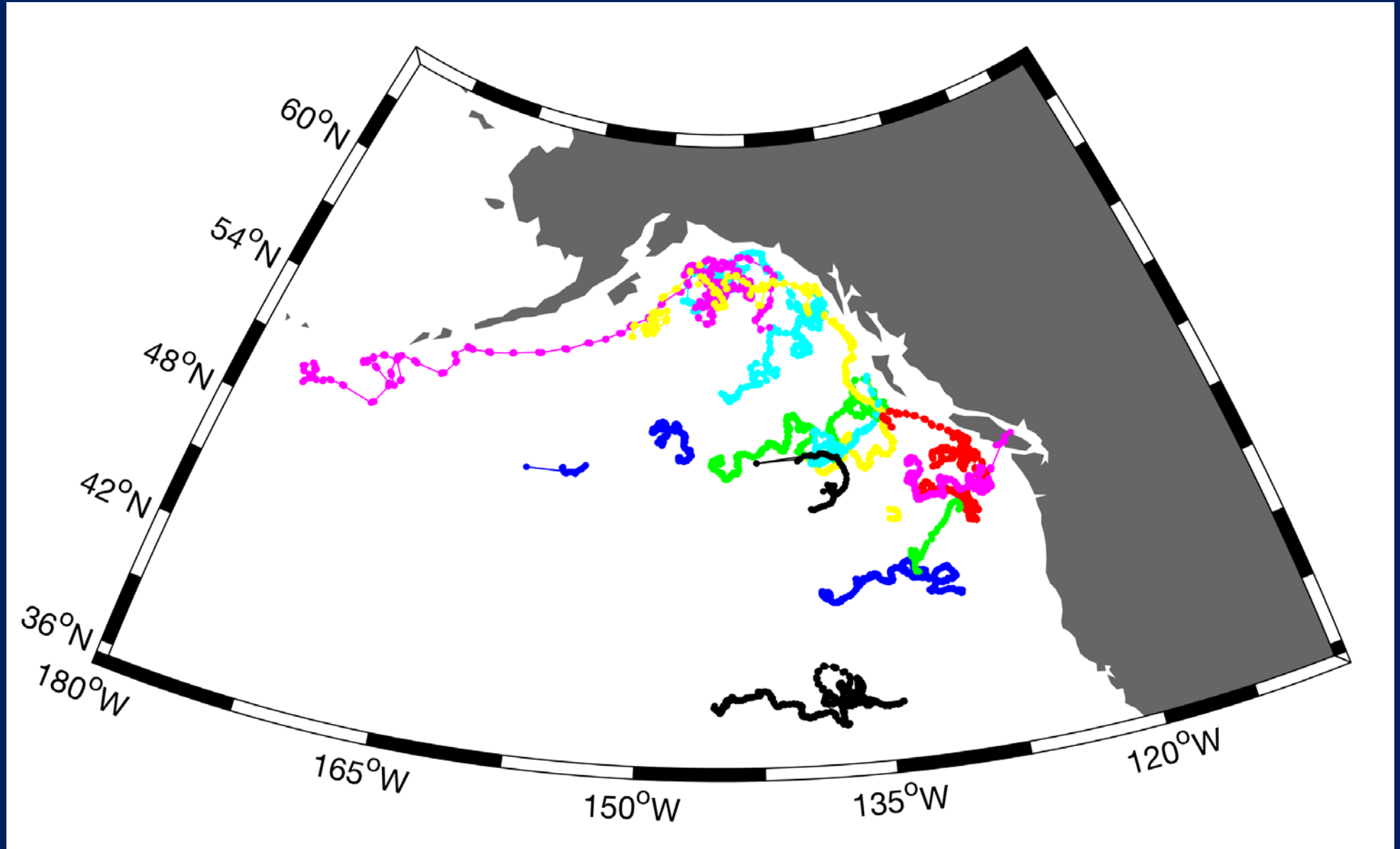


Air-sea oxygen uptake balanced by lateral advection

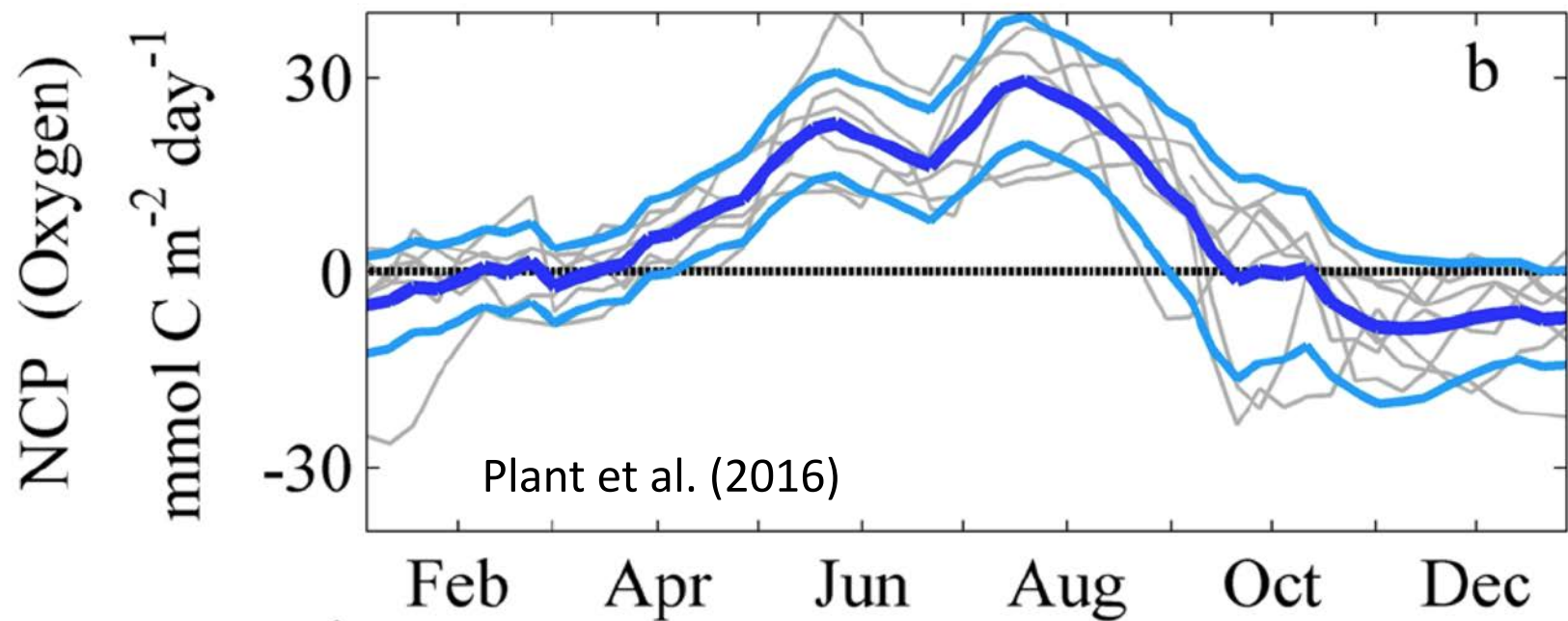
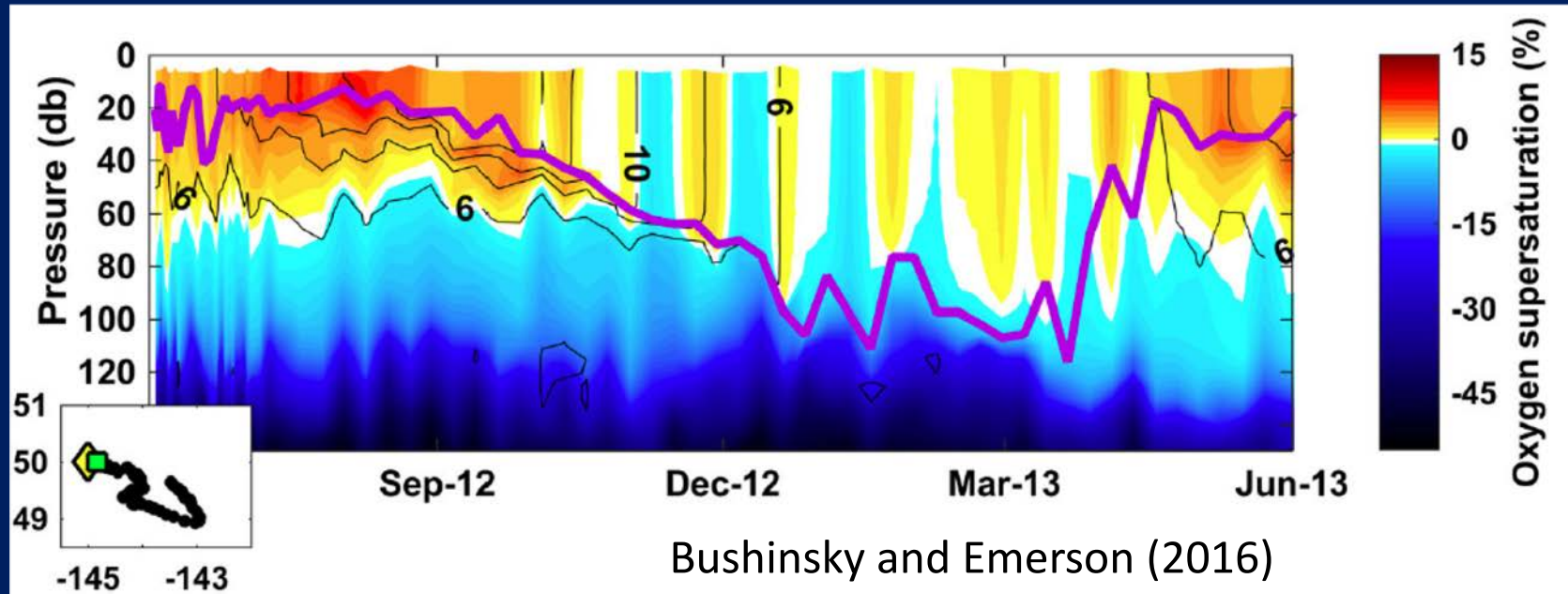
Example of a low oxygen intrusion just after convection ends



Large amount of Argo-O₂ data in North Pacific remains unanalyzed



Examples measuring productivity in NE Pacific

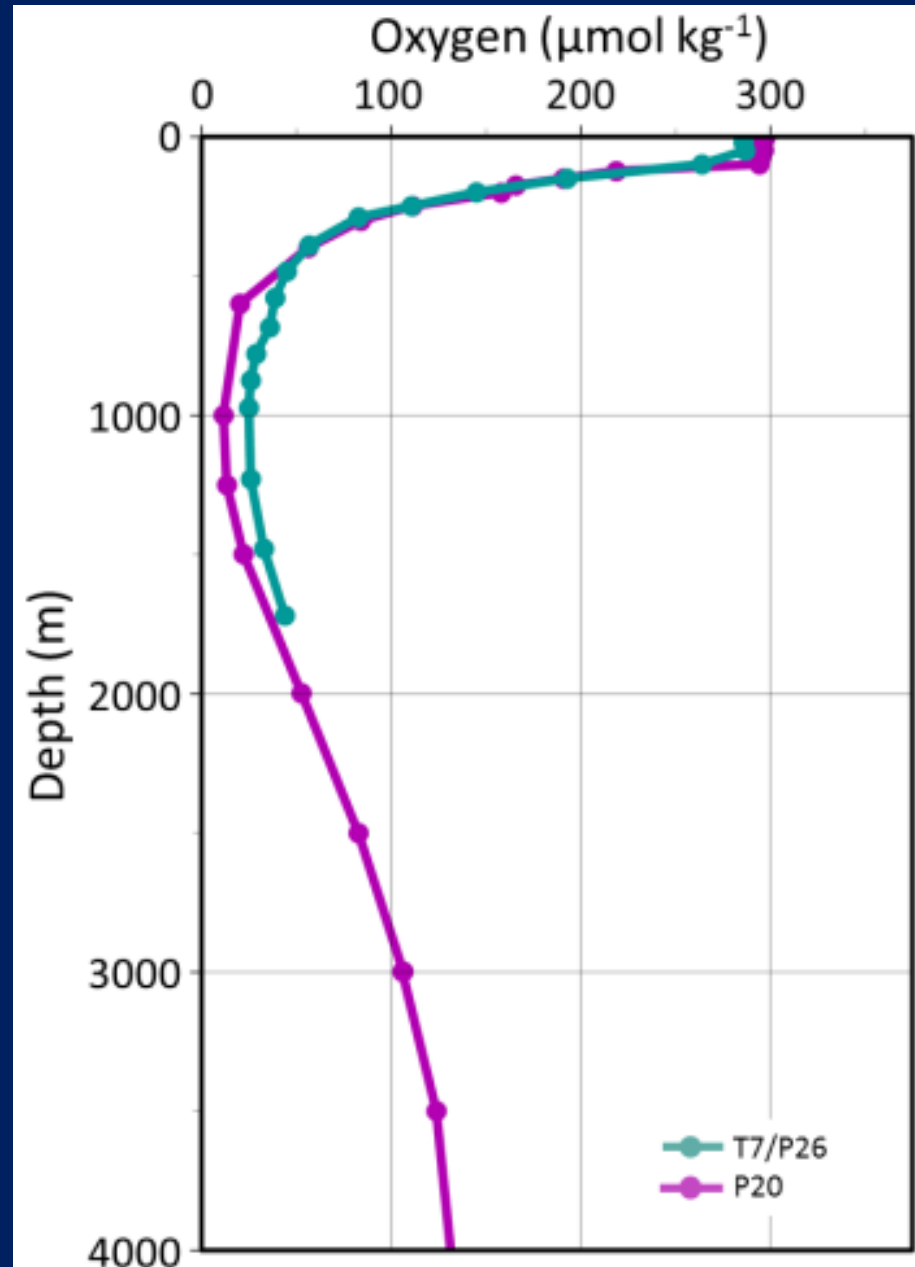


North Pacific – challenging for optode calibration

Deep stable layers have very low oxygen – applying gain to surface questionable

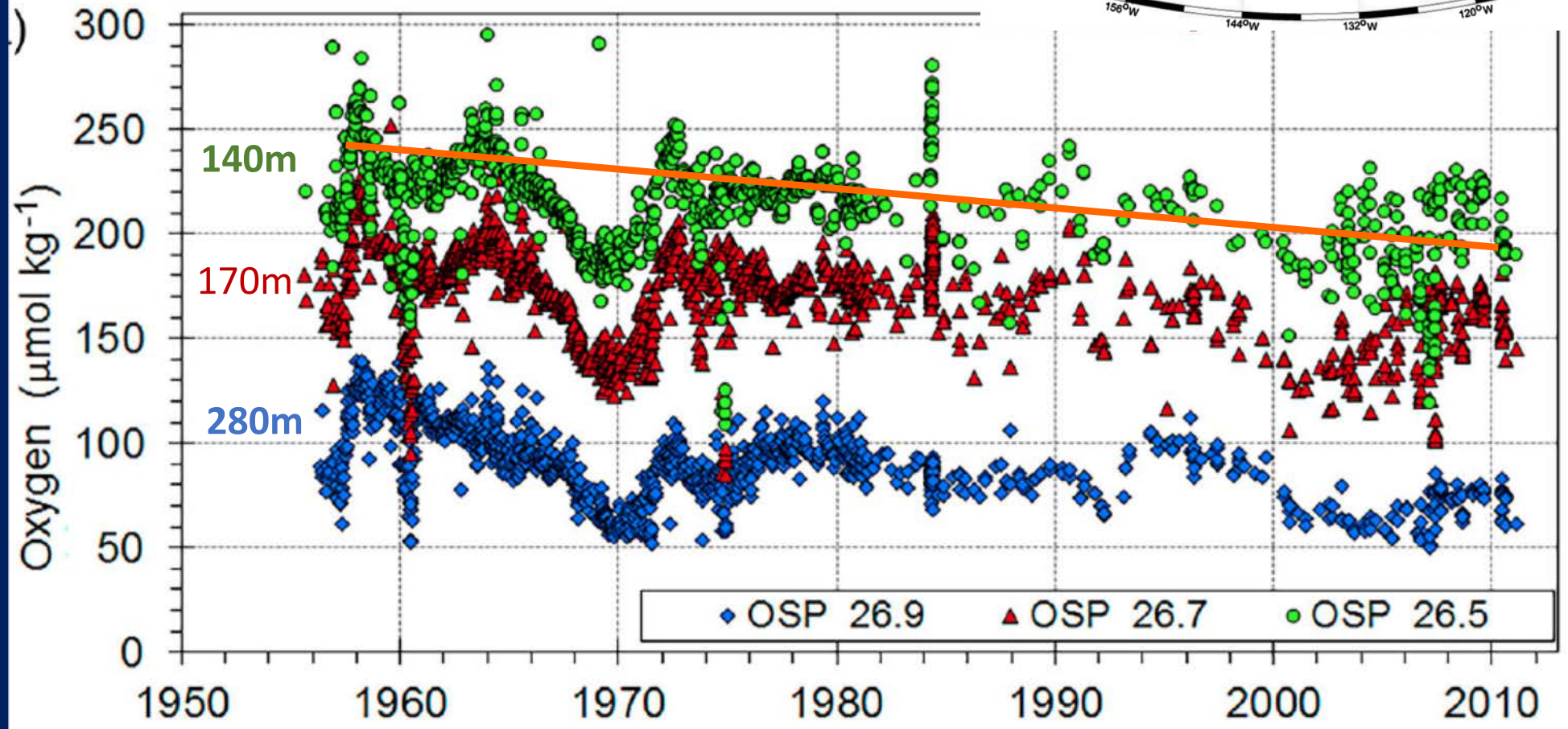
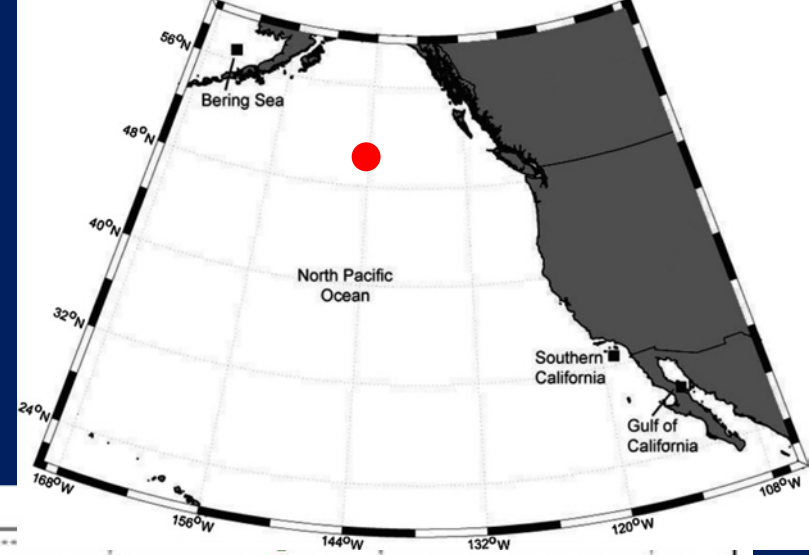
Shallow thermocline waters are changing

Air-calibrated optodes very important



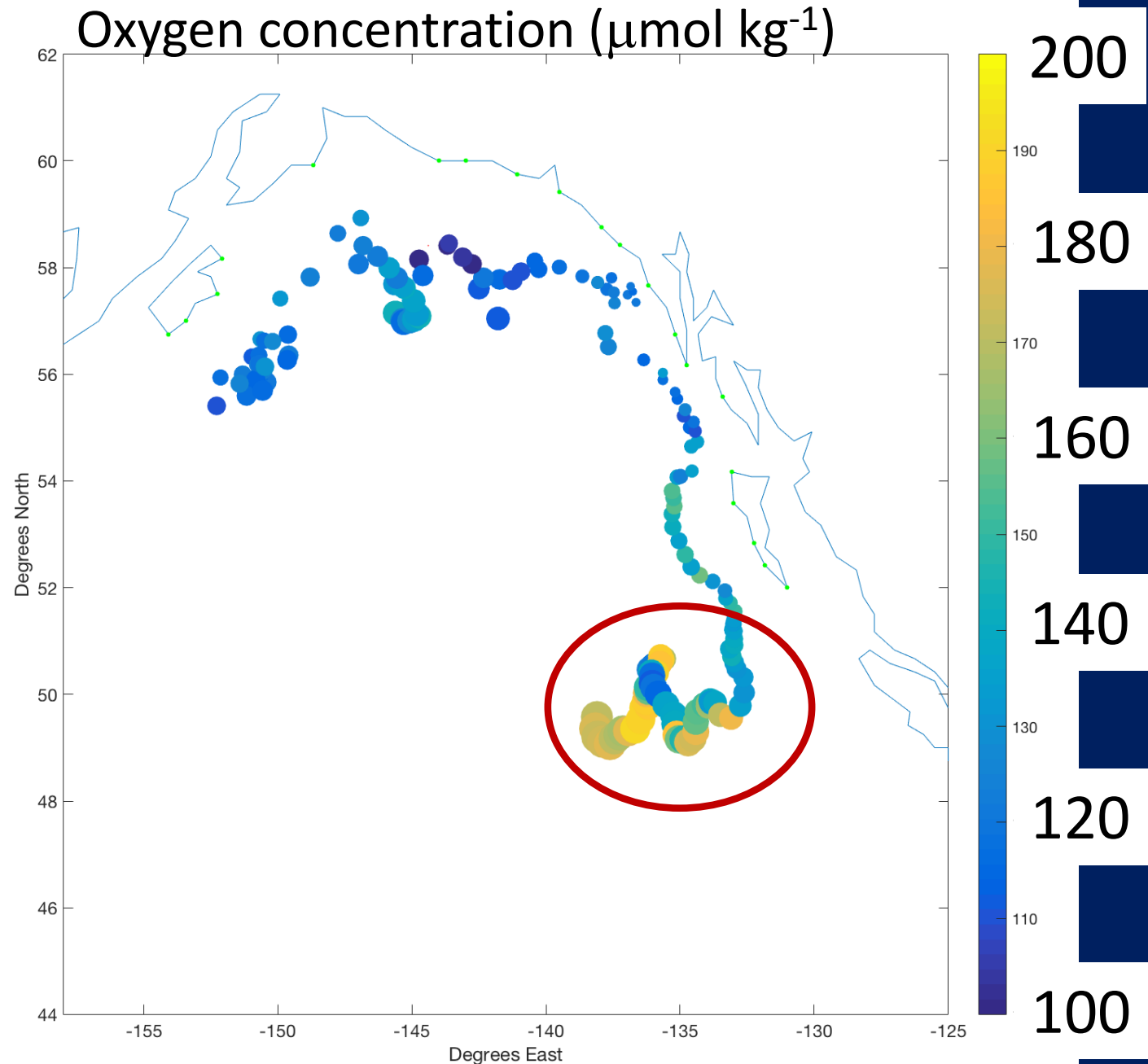
Janssen et al. (2014) PNAS

Long records of declining oxygen show significant undiagnosed variability



Crawford and Pena (2016)

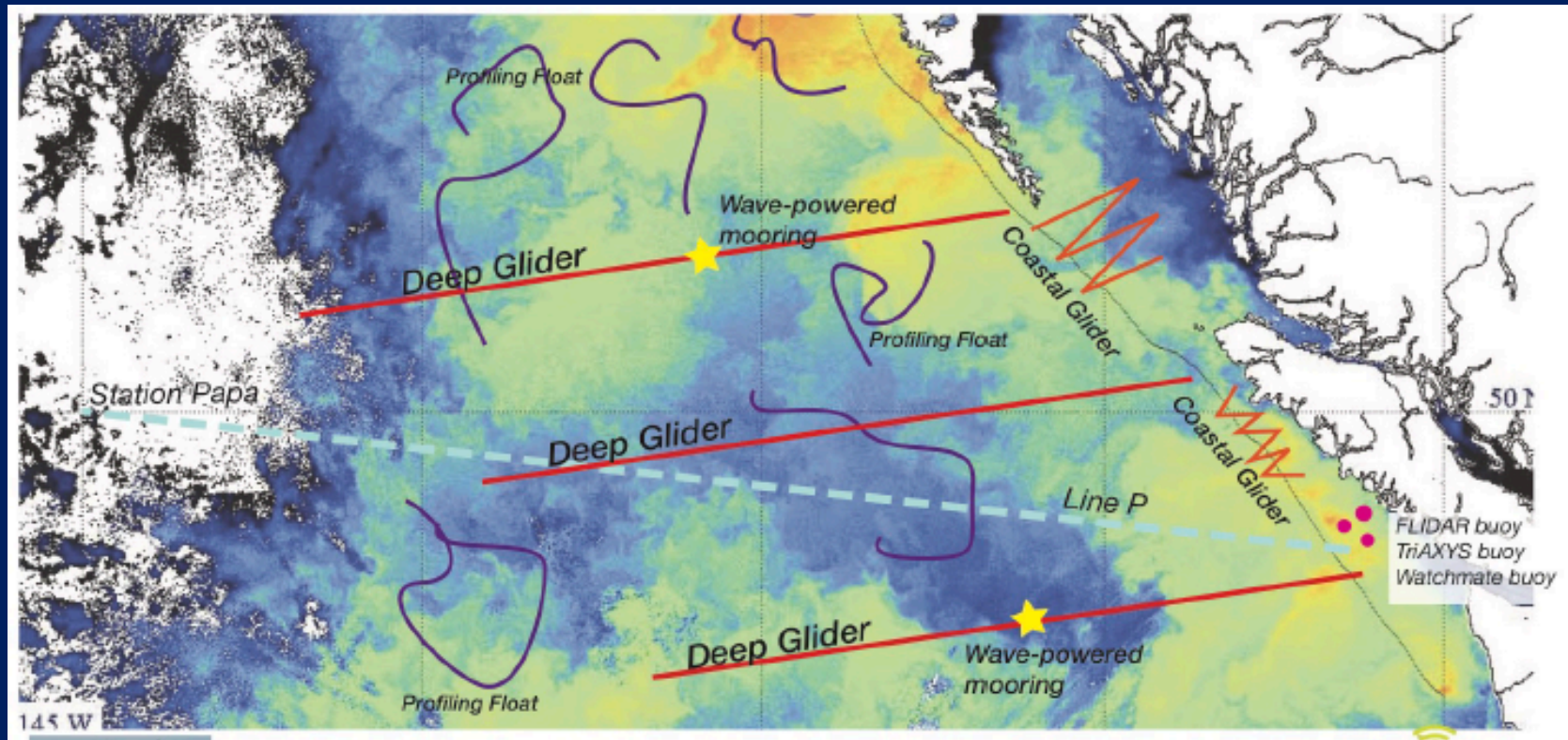
Oxygen on σ_θ 26.5 – Justin Szabo UVic Honours student



C-PROOF:

Canadian Pacific Robotic Ocean Observing Facility

13 Argo-O₂ floats, 6 full BGC-Argo floats, gliders etc...



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Summary

Labrador Sea

Optodes can drift during deployment – calibrate to deep repeat hydrography

Quantified how far oxygen from equilibrium in newly formed waters (up to 7.6% undersaturated)

Lab Sea is likely a region of net oxygen uptake from atmosphere

North Pacific

Use existing Argo-O₂ data

to quantify biological productivity rates

to understand oxygen variability that could bias trends

Deploy new Argo-O₂ and BGC-Argo floats