

MIXING AND PHYTOPLANKTON DYNAMICS IN ANTARCTICA'S COASTAL SEAS



check my website!



TELEDYNE MARINE
Everywhere you look



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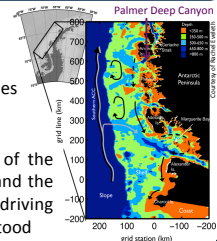
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BACKGROUND

Palmer Deep is considered a biological "hotspot" by providing predictable food resources and driving penguin foraging locations.

Physiology/composition of the phytoplankton blooms and the physical mechanisms driving them aren't well understood



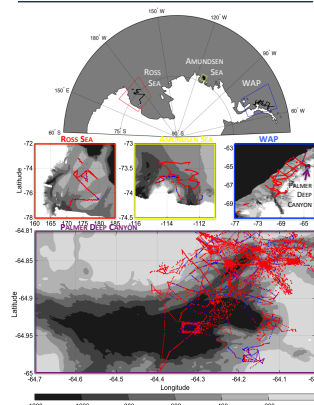
SCIENCE QUESTIONS

- Ecologically relevant mixed layer depth (MLD) definition?
- MLD regulates phytoplankton blooms?
- Seasonal/spatial biophysical patterns at Palmer Deep Canyon?
- Physiological responses to physical forcing?

GLIDER DATASET

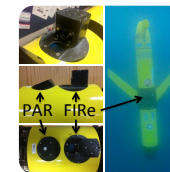
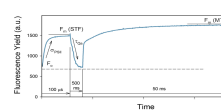
Glider data stats:

	# Profiles	Km flown	# Days
WAP	24 838	8 378	407
Ross Sea	3 476	1 648	67
Amundsen Sea	2 572	682	26



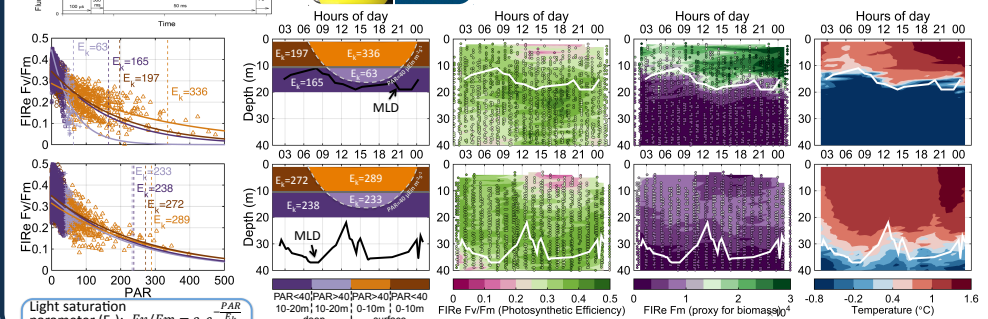
PHYSIOLOGICAL RESPONSES DEPENDENT ON MLD AND WATER COLUMN STABILITY

FIRE glider: comprehensive suite of photosynthetic and photo-physiological characteristics in high temporal/spatial resolution.



Depth-dependent photoacclimation in nutrient replete environment:

MLD (m)	Stratification max(N ²), s ⁻²	Biomass (FIRE Fm)	Layer 0-10m	Layer 10-20m
shallow (average = 16)	High (average = 2x 10 ⁻³)	High	High-light acclimated, higher E _k	low-light acclimated, lower E _k
Deeper (average = 32)	Low (average = 6.7x 10 ⁻⁴)	Low	mid-light (MLD) acclimated, E _k (0-10m) = E _k (10-20m)	



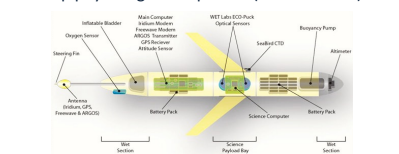
GLIDERS

Stats at Palmer Deep Canyon:

- 14 deployments (2007-2015);
- ~ 3 000 Km flown;
- 15 000 water column profiles (up to 100 m);
- Over 2 million individual CTD measurements;
- High spatial resolution (1 profile every ≈ 250 m);

Goals:

- Map hydrodynamics: focus on canyon head;
- Capture localized regions of high biological activity "hotspots" using chlorophyll as indicator
- Map physiological responses (drift missions)



Sensors on gliders:

- Seabird CTD, Wet Labs Fluorescence and Backscatter Eco Pucks, Satlantic FIRE (Fluorescence Induction and Relaxation).

MAX(N²) IS ECOLOGICALLY RELEVANT MLD DEFINITION ACROSS ANTARCTICA

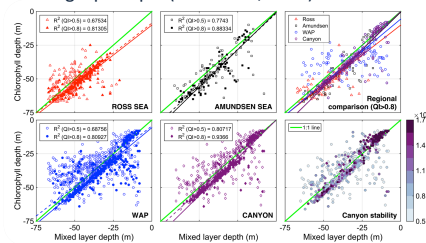
Maximum of Buoyancy Frequency (N²) was the most ecologically relevant MLD definition:

$$\max(N^2) = \max\left[-\frac{g}{\rho} \frac{\partial \rho}{\partial z}\right]$$

- Quality index (Lorbacher *et al.*, 2006) used to evaluate/filter MLD determined with certainty:

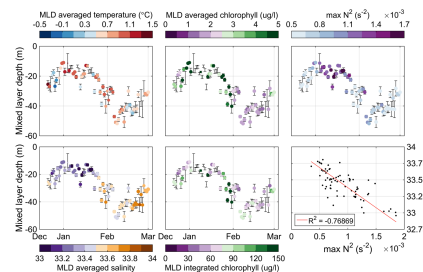
$$QI = 1 - \frac{rmsd(\rho_k - \bar{\rho}_k)(H_1, H_D)}{rmsd(\rho_k - \bar{\rho}_k)(H_1, 1.5 \times H_D)}$$

- Chlorophyll depth adapted from the maximum angle principle (Chu & Fan, 2011).



- All regions: close 1:1 relationship between MLD and depth of lower boundary of chlorophyll.

Climatological analysis (Canyon, 6 years of data):



- Bloom condition: starting January, shallower MLD, colder and fresh water with increased chlorophyll;
- Late January, deepening of MLD, warmer and saltier water with lower chlorophyll/backscatter;
- Late February/early March, shoaling of MLD and consequent increase in chlorophyll.
- Increased chlorophyll in more stratified waters
- Water stability mainly driven by salinity; increased influence of temperature later in the season;

CONCLUSIONS

- Maximum in Buoyancy Frequency (N²) is an ecologically relevant MLD definition;
- Shallower MLD (lower salinity and increased stability) results in increased water column chlorophyll - increased light availability;
- Photoacclimation (evaluated by E_k) is dependent on MLD and water column stability.

FUTURE WORK

- Investigate further the relationship between MLD, water column stability and mixing.
- Understand the temporal and spatial variability of the photophysiological responses to seasonal changes in physical forcing.

ACKNOWLEDGEMENTS

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