Mixing and Phytoplankton Dynamics in Antarctica's Coastal Seas

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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:

<table>
<thead>
<tr>
<th>Glider</th>
<th>WP</th>
<th>Amundsen Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLD (m)</td>
<td>7</td>
<td>1.6</td>
</tr>
<tr>
<td>Phytoplankton</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td>Bloom</td>
<td>2</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Physiological Responses Depending on MLD and Water Column Stability**

- Depth-dependent photoacclimation in nutrient replete environment:
- MLD regulates phytoplankton blooms.
- Seasonal/spatial biophysical patterns at Palmer Deep Canyon.
- Physiological responses to physical forcing.

**Max(N²) is Ecologically Relevant MLD Definition Across Antarctica**

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

\[
\text{max}(N^2) = \frac{\text{max}(k_a)}{\sum k_a}
\]

- Quality index (Lorbacher et al., 2006) used to evaluate/filter MLD determined with certainty:
  \[
  QI = 1 - \frac{\text{rmsd}(k_a - \text{MLD})}{\text{rand}(k_a - \text{MLD})}
  \]
- 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.

**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 E₁) 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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