

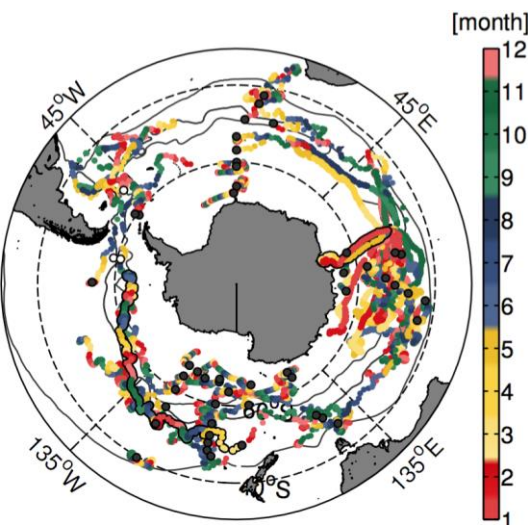
# When Mixed Layers Are Not Mixed: Using Vector Wind Products to Evaluate Storm Recurrence and Upper Ocean Mixing

Magdalena M. Carranza<sup>1</sup>, Sarah Gille<sup>1</sup>, Peter J. S. Franks<sup>1</sup>,  
Kenneth S. Johnson<sup>2</sup>, Robert Pinkel<sup>1</sup>, James B. Girton<sup>3</sup>

<sup>1</sup>Scripps Institution of Oceanography, UC San Diego,

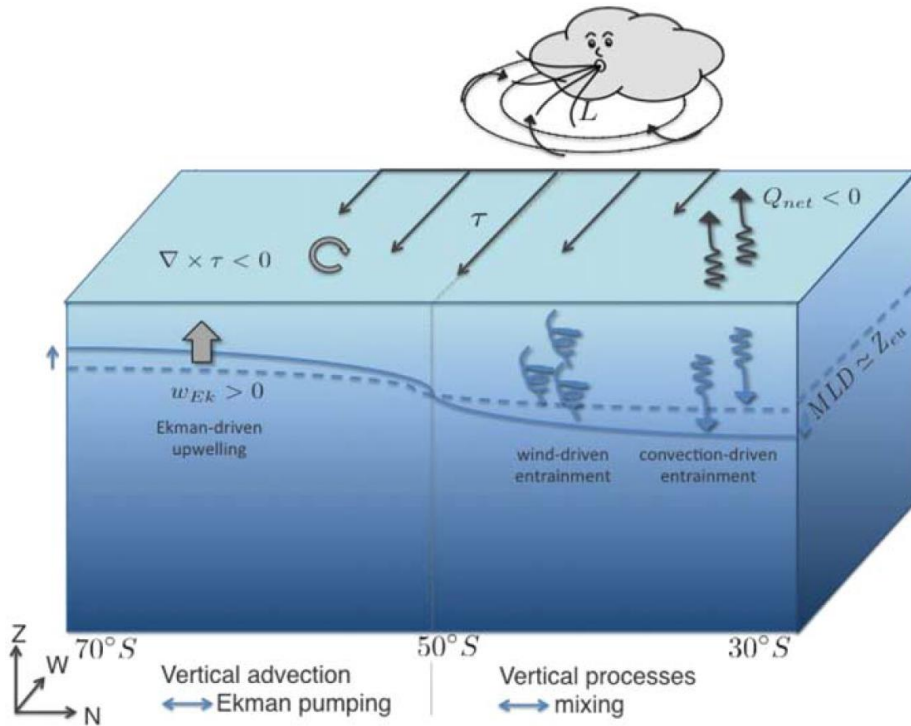
<sup>2</sup>Monterey Bay Aquarium Research Institute,

<sup>3</sup>University of Washington



IOVWST 2018, Barcelona

# Mixed Layers in the Southern Ocean



Mixed layer defined by homogenized density

Deepening of mixed layer brings cold water and nutrients to surface

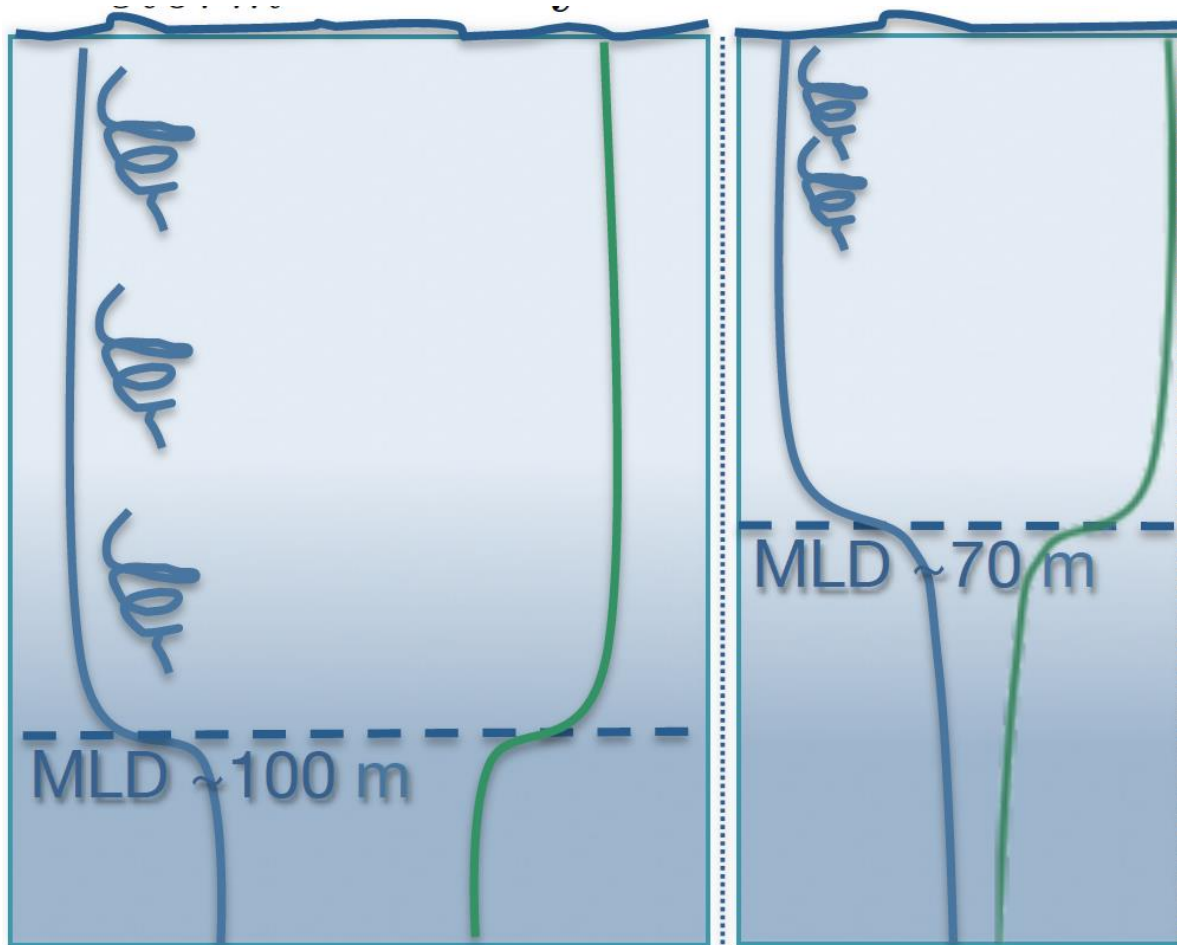
Possible factors:

- Direct wind forcing (21.8% of mixed layer variance)
- Buoyancy forcing (16.7%)
- Ekman pumping (smaller)

(Carranza and Gille, 2014)

# Mixed Layers vs Mixing Layers

**Mixing layer:**  
Actively  
mixing  
*now*



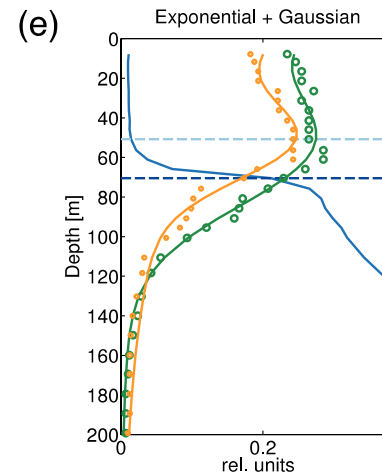
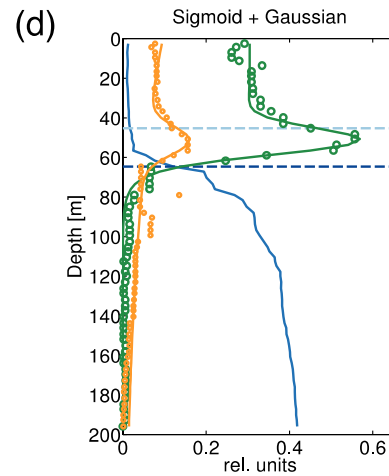
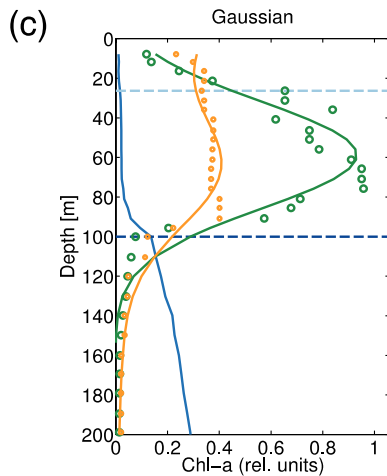
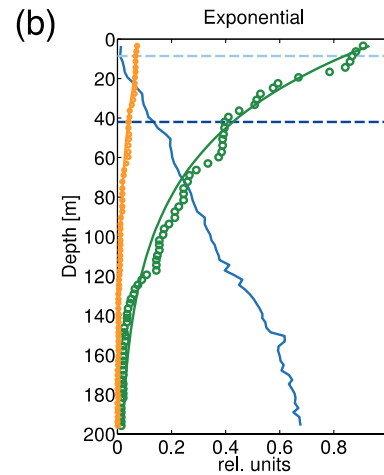
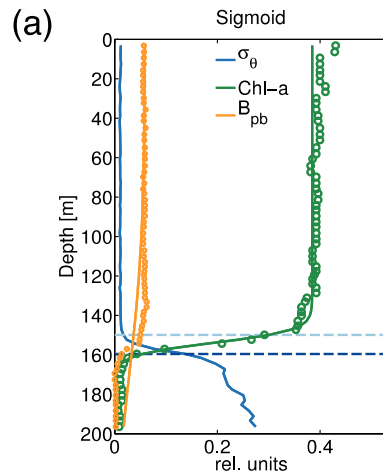
**Mixed layer:**  
Homogenized  
in density

Could be  
remnant of  
previous  
mixing event

Blue line: density

Green line: phytoplankton biomass (represented by fluorescence or backscatter)

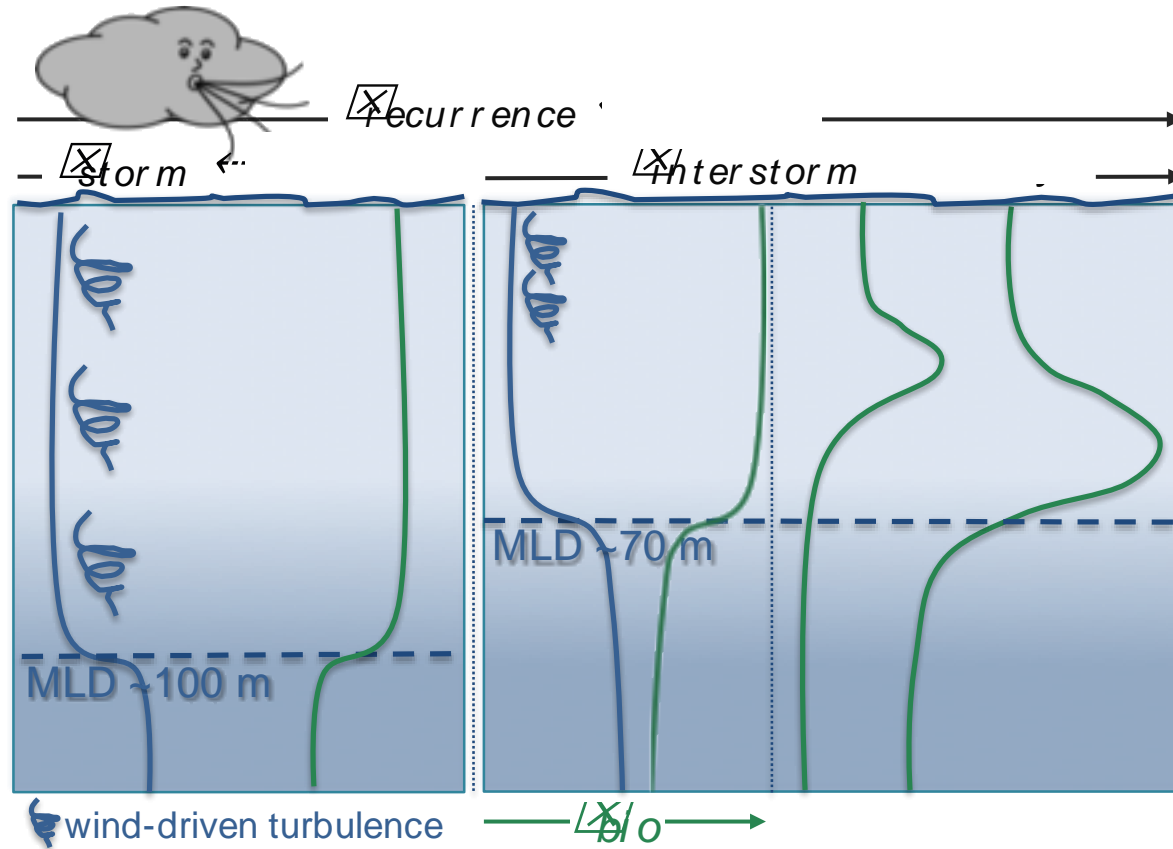
# Observed profiles show Chl-a or backscatter varies within mixed layer



Deep chlorophyll maximum within mixed layer 20-40% of time, depending on season

Deep chlorophyll maxima can also occur below the base of the mixed layer

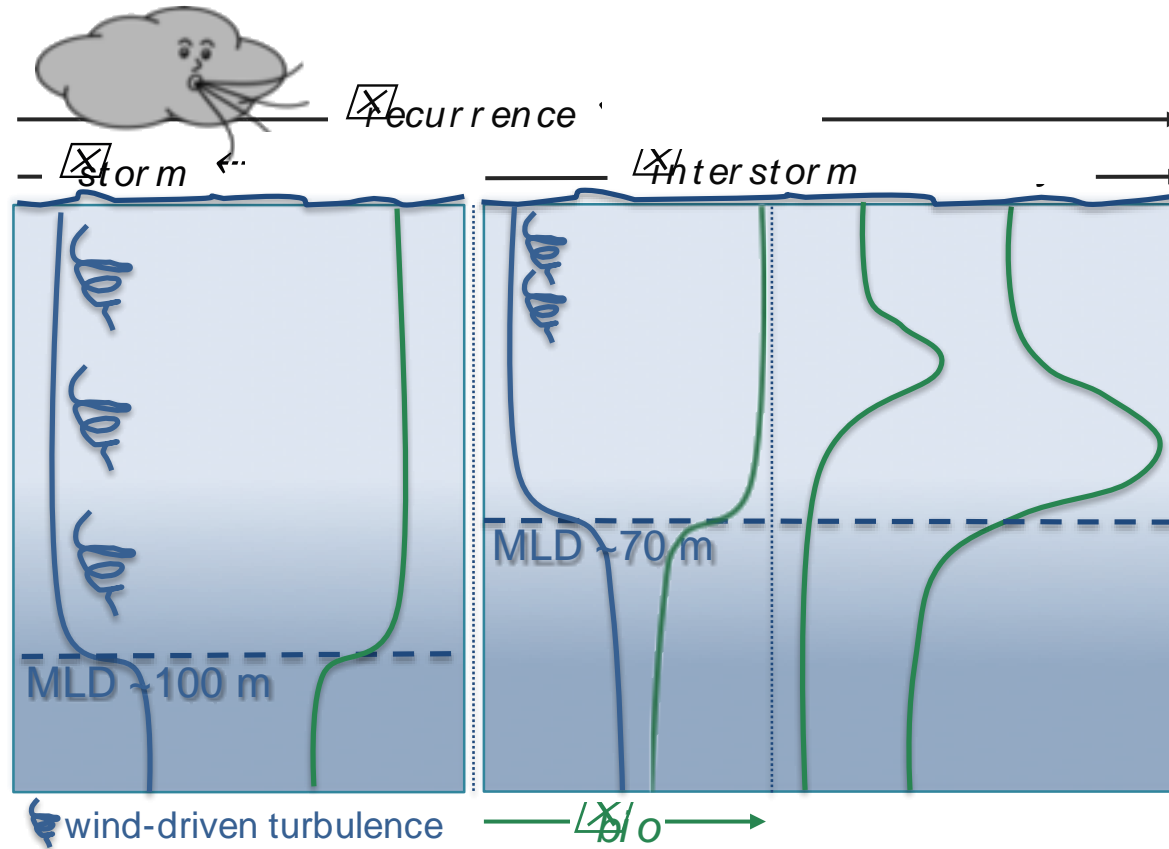
# Schematic framework



Storm events deepen and homogenize mixed layer

When storm ends, density remains mixed and top of mixed layer might continue mixing; phytoplankton grow where mixing is minimal

# Schematic framework



Use CCMP  
winds to  
assign  
timescales

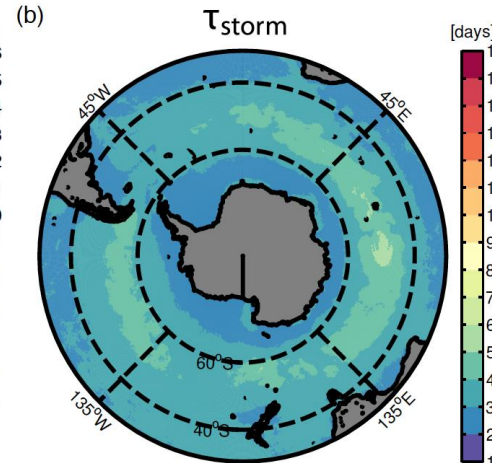
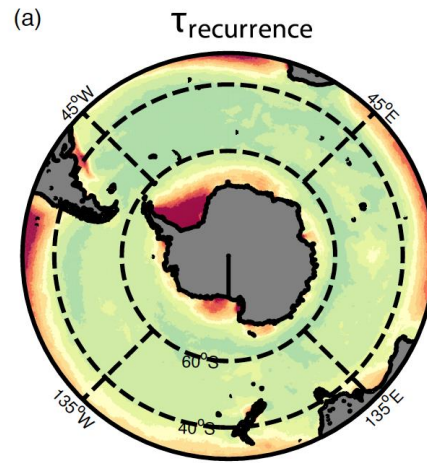
Storms:  
wind speed  
> 10m/s

Storm events deepen and  
homogenize mixed layer

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where mixing is minimal

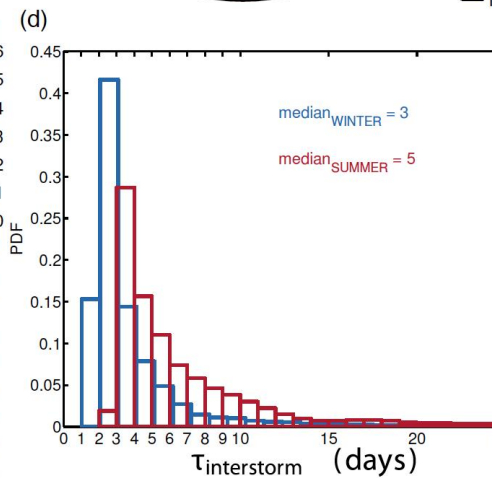
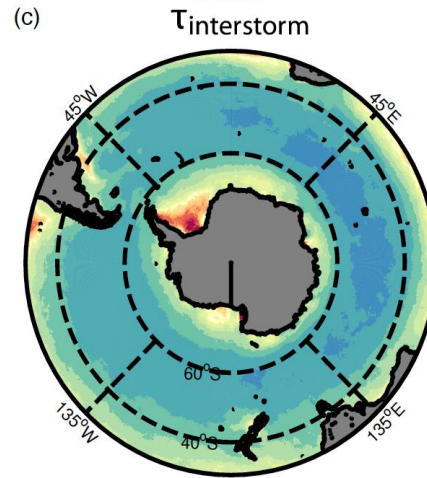
# Storm recurrence timescales

Storm recurrence  
~7 days



Storm duration ~3 days

Time between storms: ~4 days

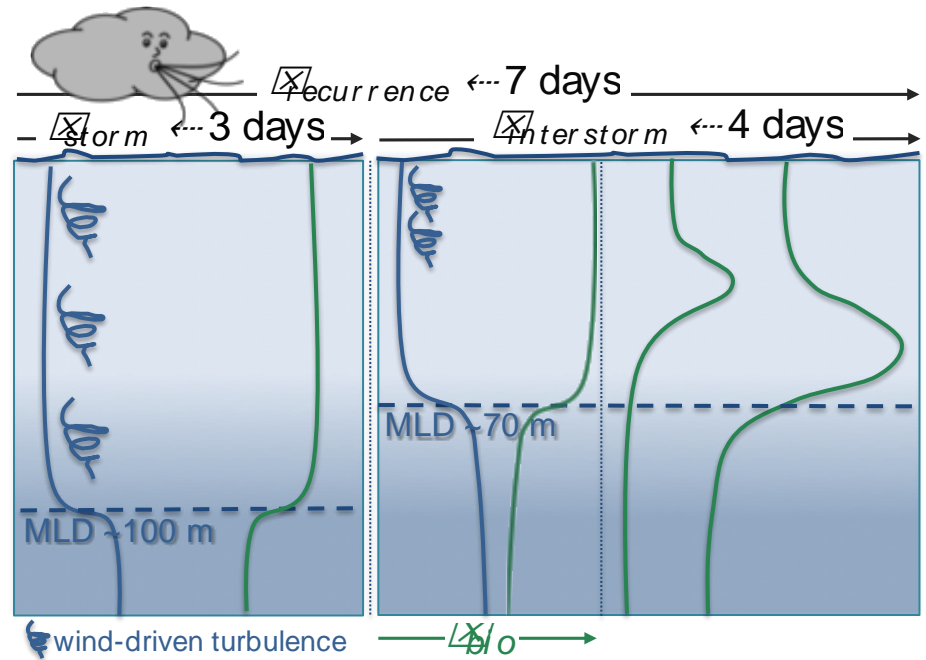


Interstorm period slightly longer in summer

Time scales imply biological restratification occurs within 2 days

# Summary/discussion

- Subsurface backscatter or fluorescence maxima frequently occur within the Southern Ocean mixed layer
- One explanation: storms mix, and between storms phytoplankton preferentially grow at the base of the mixed layer. (Mixing? nutrients?)



*Can we match individual profiles to storms?* Less successful, implying that CCMP mapping does not capture all storms perfectly.

- Southern Ocean OOI mooring (when data went on GTS, ECMWF forecast saw immediate change)
- Ocean waves detected by Ross Ice Shelf seismic stations (~50-60% of wave events detected at ice can be traced to identifiable storms)