



Old and cold contributions to the Oxygen Minimum Zones

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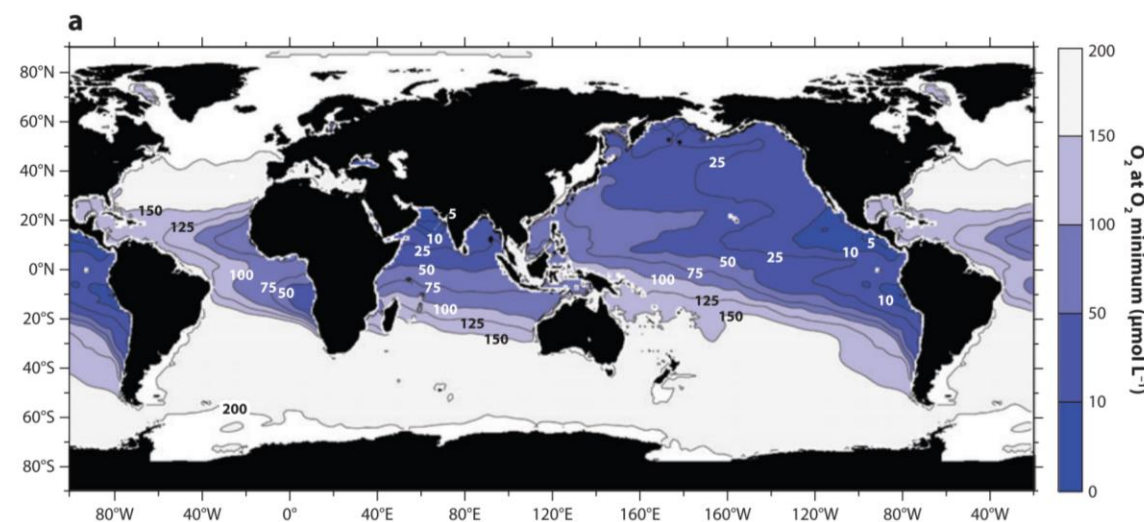
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Oxygen Minimum Zones

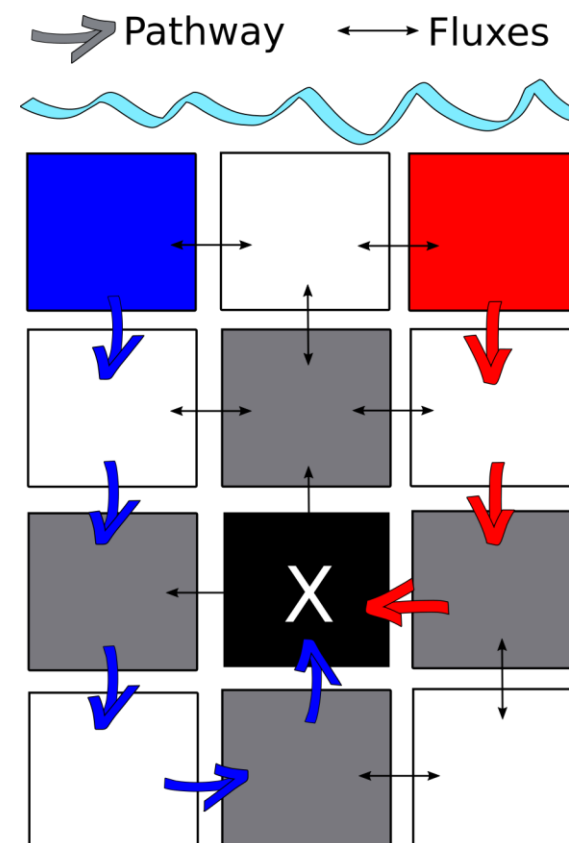
- › Oxygen Minimum Zones (OMZs) are oxygen deficient layers in the water column.
 - Sluggish circulation.
 - Oxygen consumption.
- › The OMZs are expanding.
- › Here we decompose the OMZ into **water masses** to understand how they are formed.



Keeling et al. (2010)

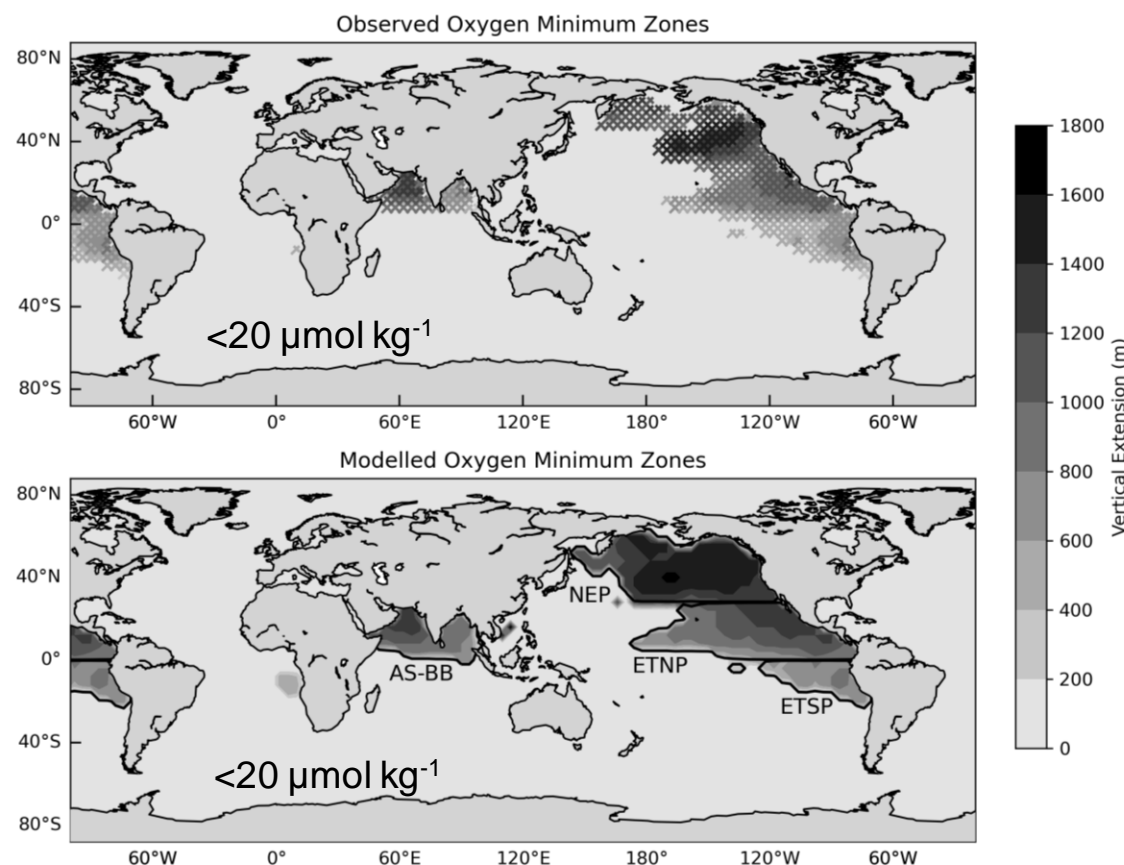
Transport Matrix Intercomparison (TMI)

- › TMI is an inverse circulation model developed by Gebbie & Huybers (2012).
- › Constrained using observations of ocean tracers:
 - Temperature, Salinity, **Nutrients, Oxygen and Radiocarbons**.
- › In addition to circulation TMI gives estimates of:
 - **Preformed O_2**
 - **O_2 consumption**
 - **Mean Age**



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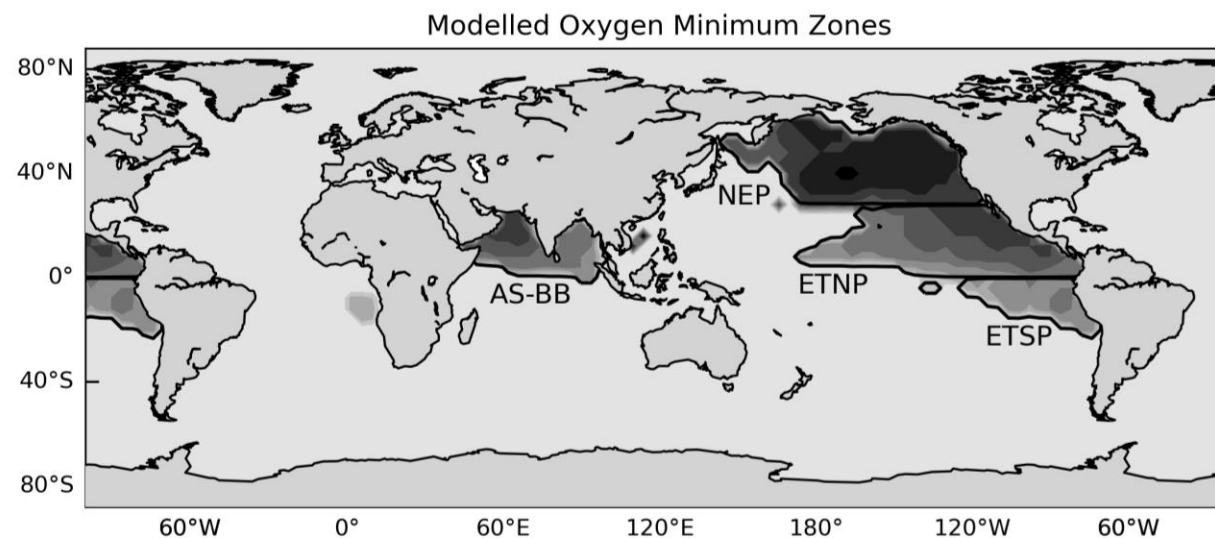
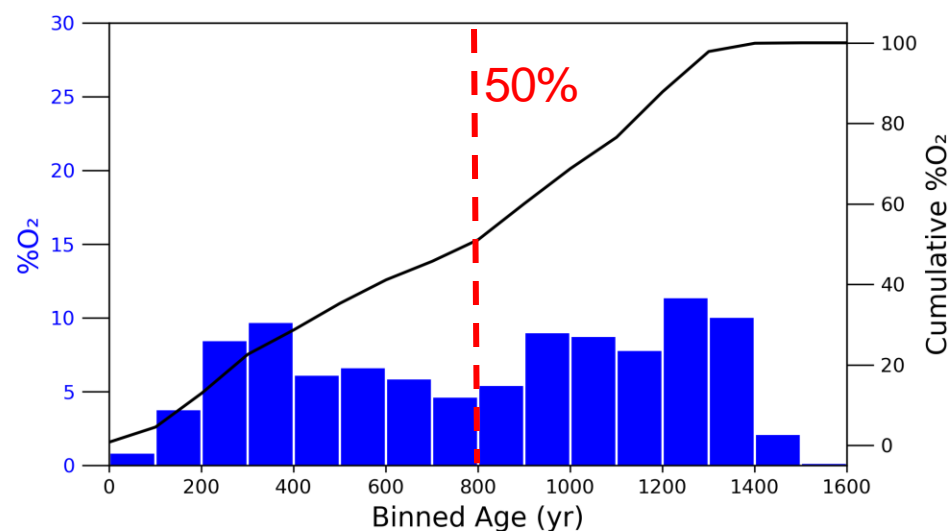
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Old... and Cold

Old...

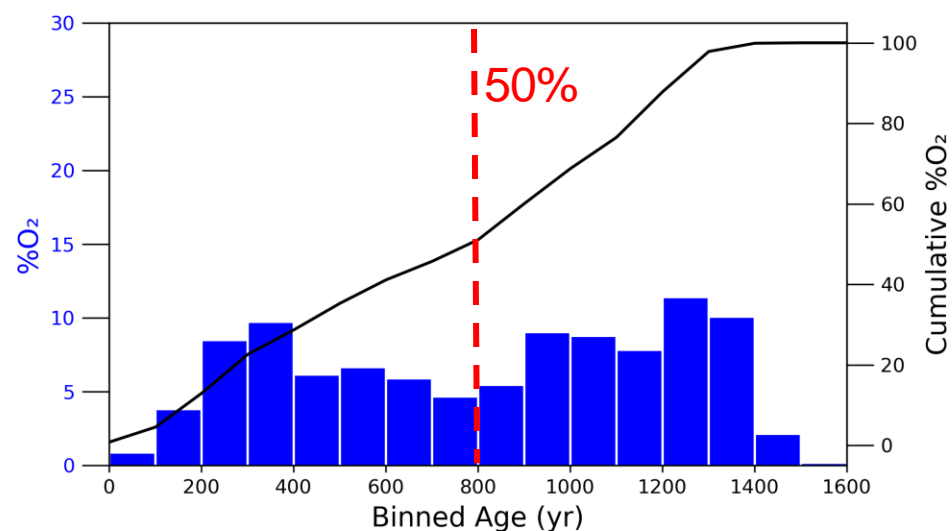
- › The oxygen-age distribution shows that 50% is older than ~800 years.



Old... and Cold

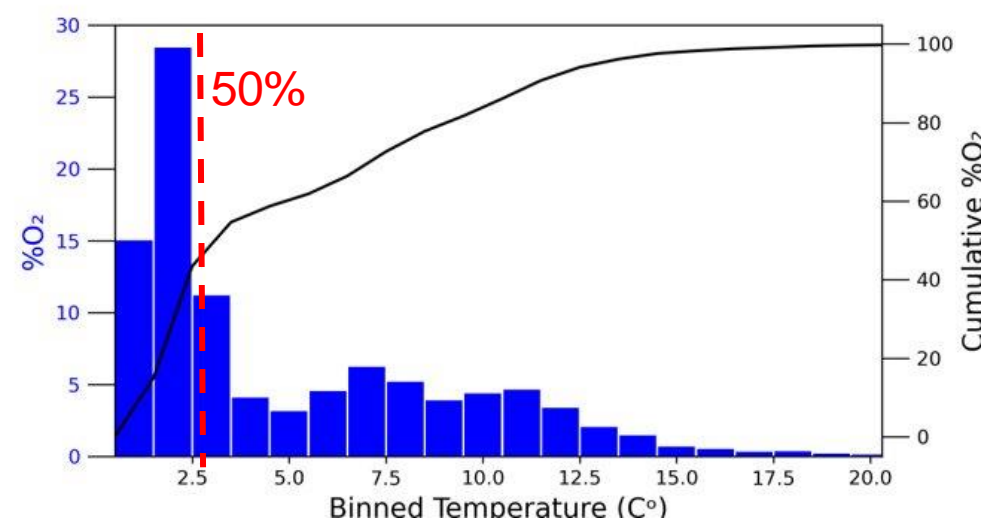
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...and Cold

- › 50% of the oxygen is present in waters colder than ~2.5 °C.



Old... and Cold

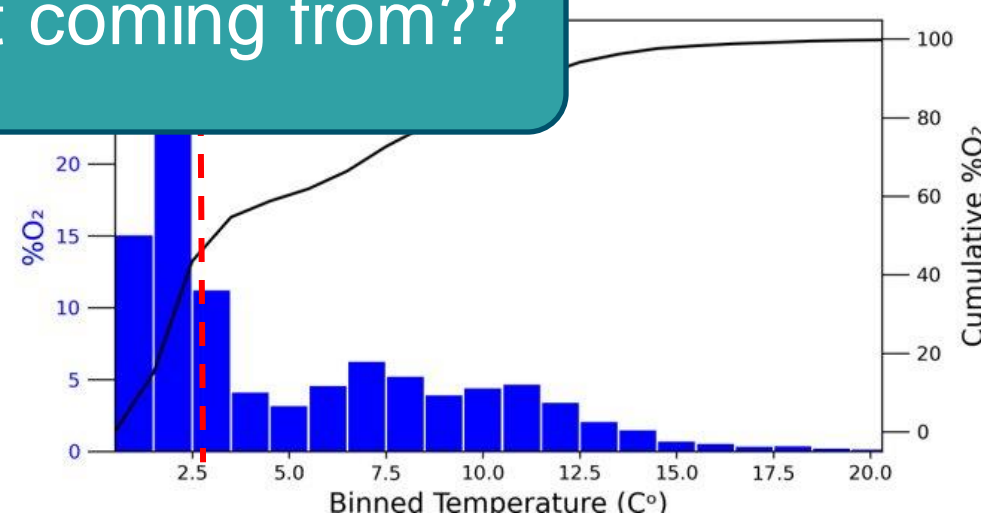
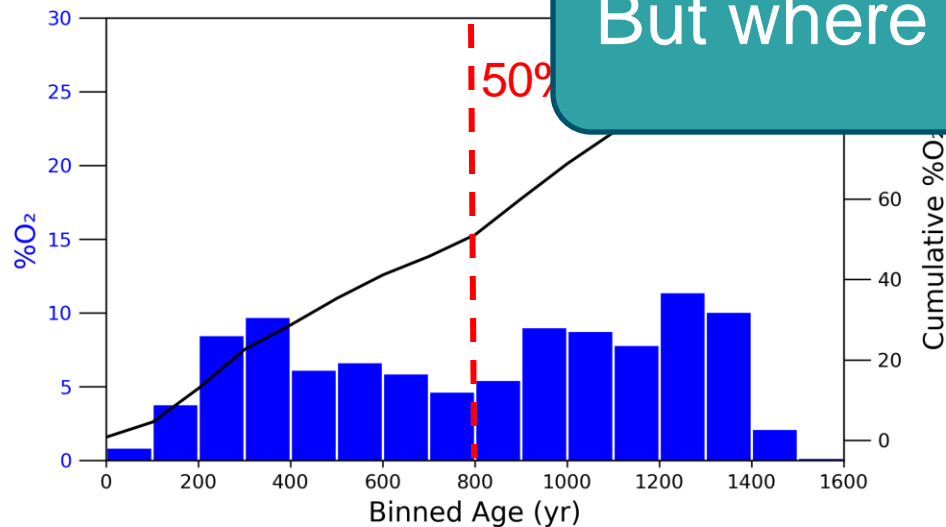
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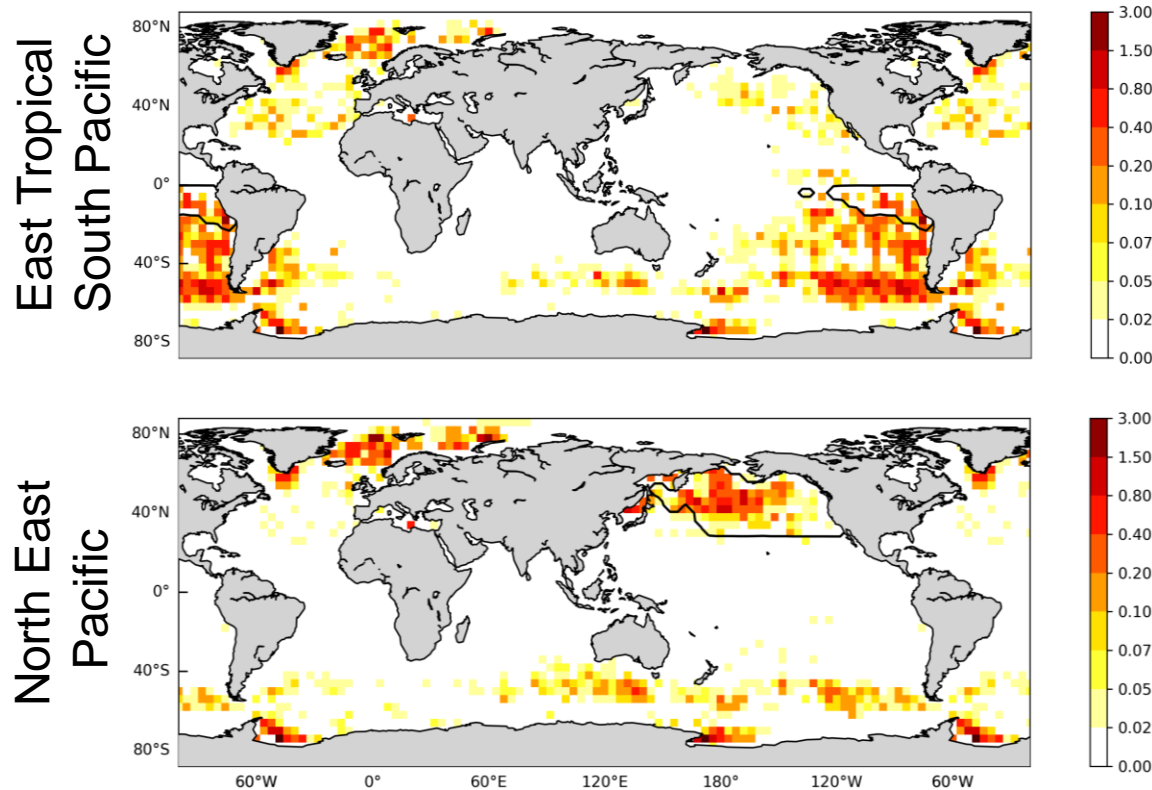
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But where is it coming from??



Surface Origin and Timescales

% Volume



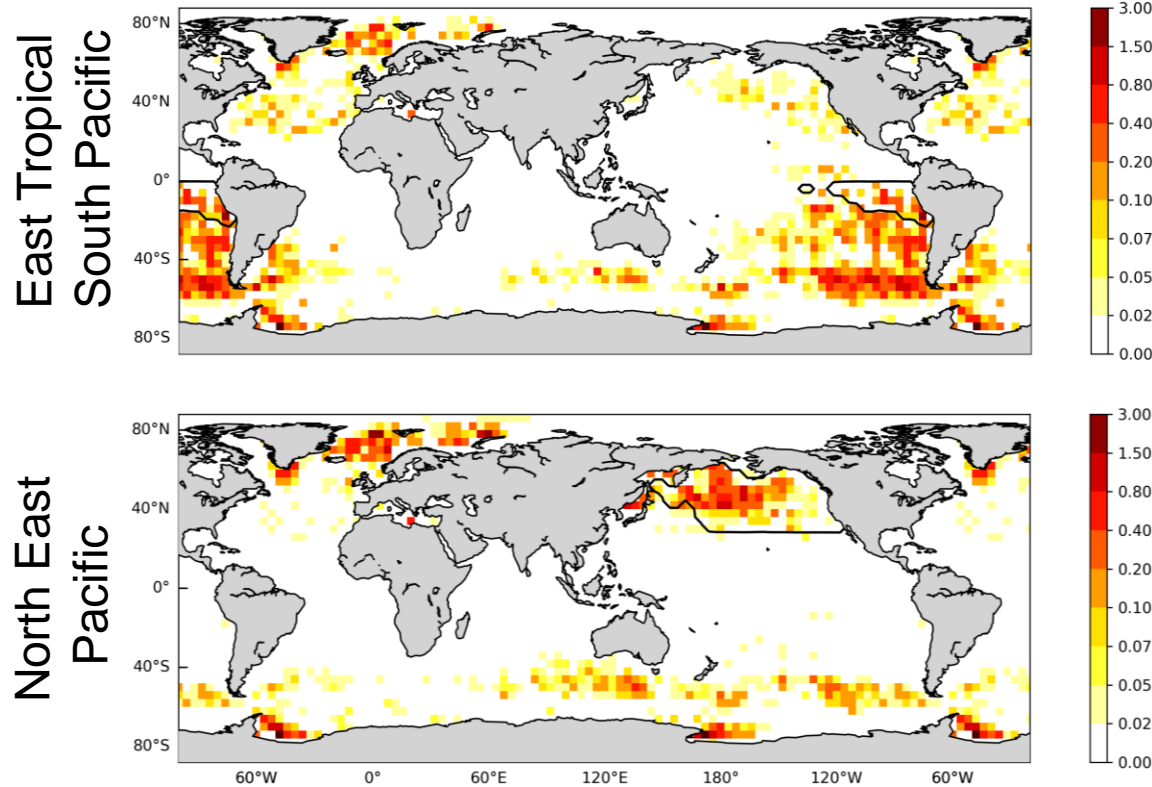
ETSP	Vol %	O ₂ %
(Sub)tropical	24 %	30 %
Subantarctic Mode Water	46 %	56 %
Antarctic Bottom Water	17 %	7 %

NEP	Vol %	O ₂ %
North Pacific	17%	41 %
Subantarctic Mode Water	15 %	0 %
Antarctic Bottom Water	31%	17 %



Surface Origin and Timescales

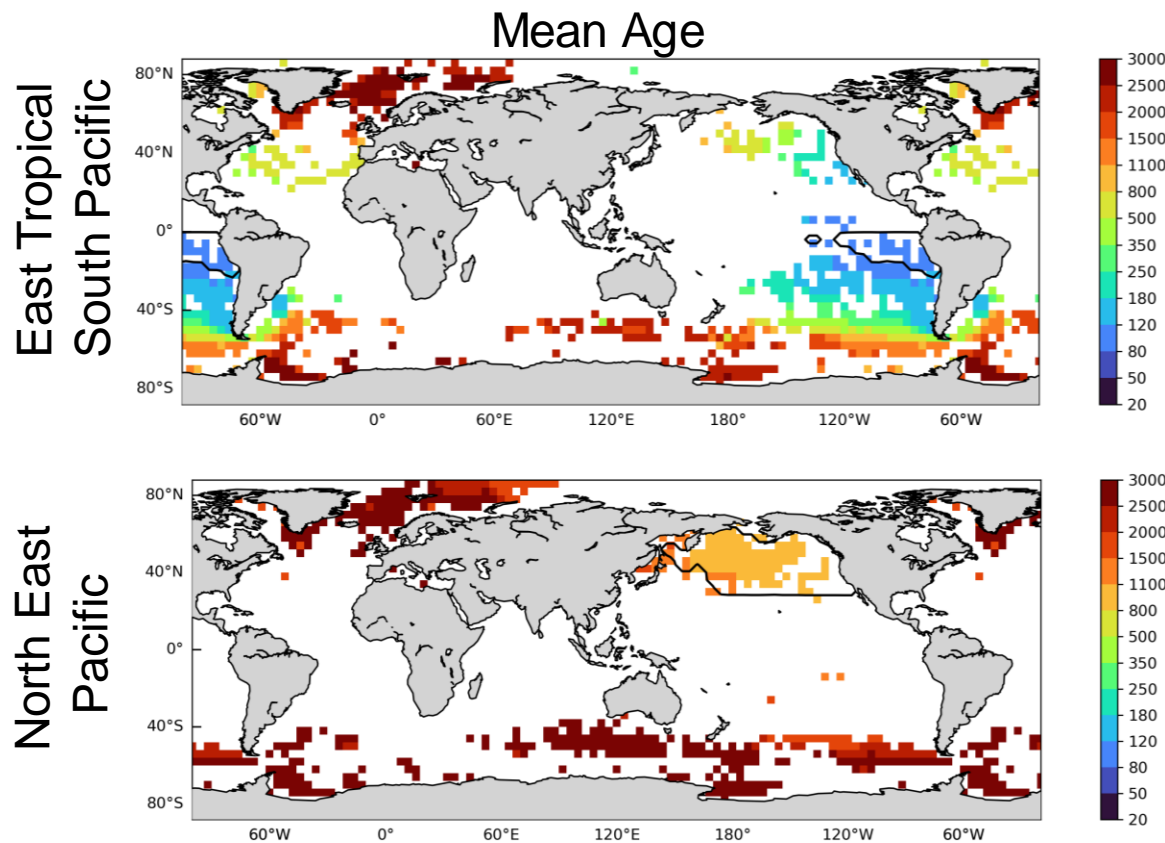
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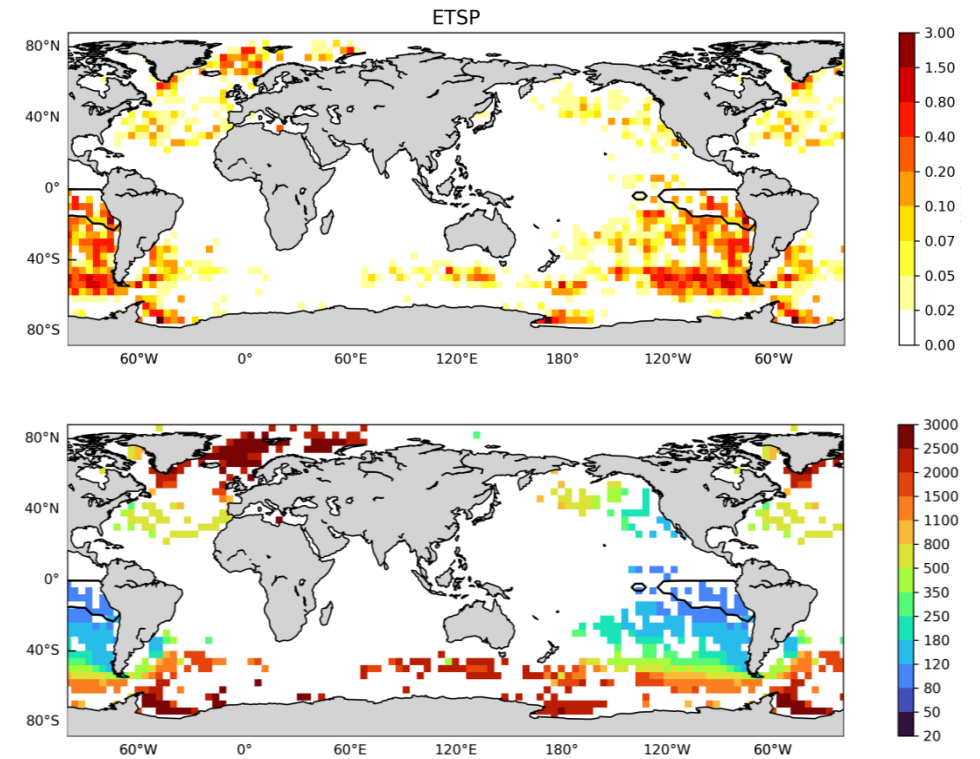


Summary

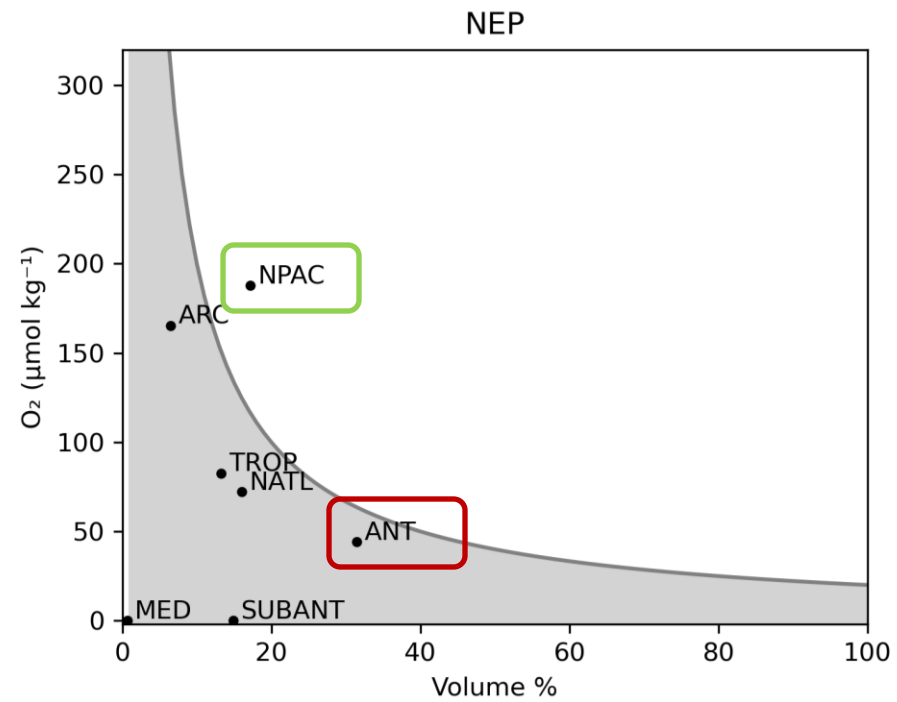
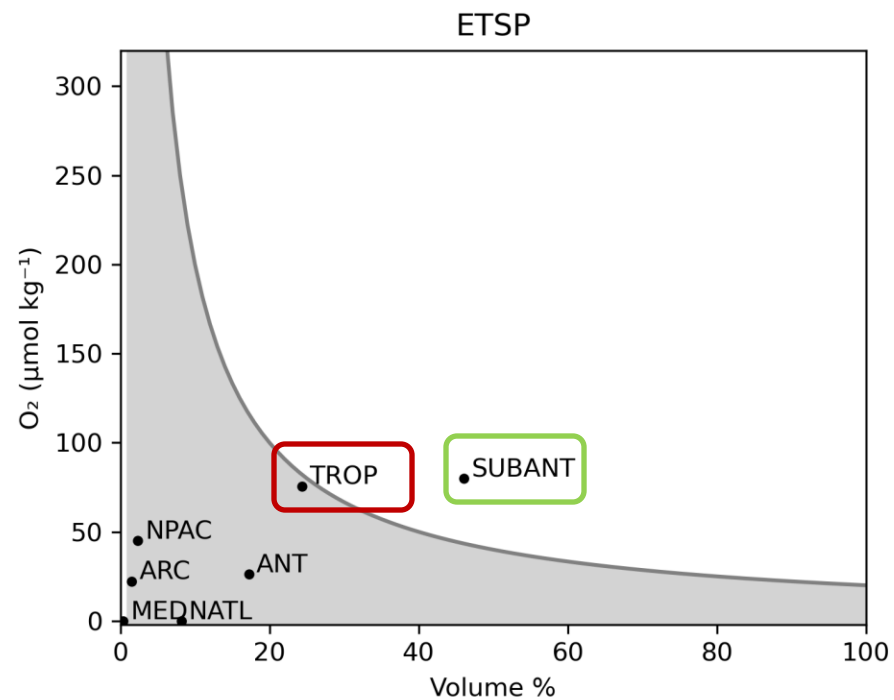
- › **OMZs are largely sensitive to mode and deep waters.**
- › Large amount of old and cold waters contribute with low oxygen content are transported into the OMZs.
- › Adjacent regions with short transit times are the main oxygen source for the OMZs.

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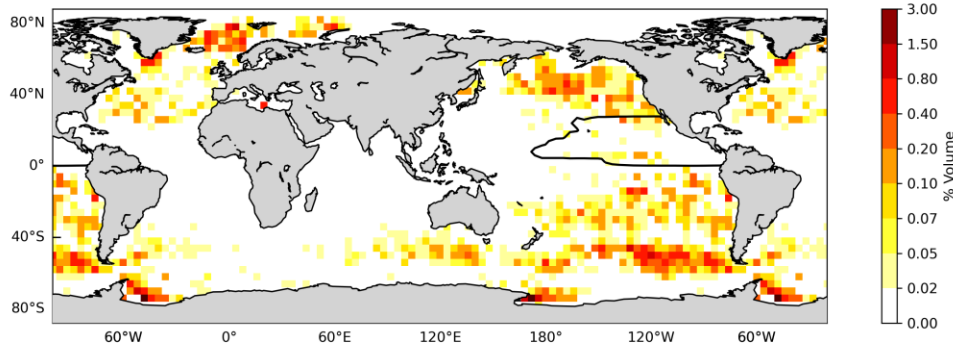
Volume or Concentration?



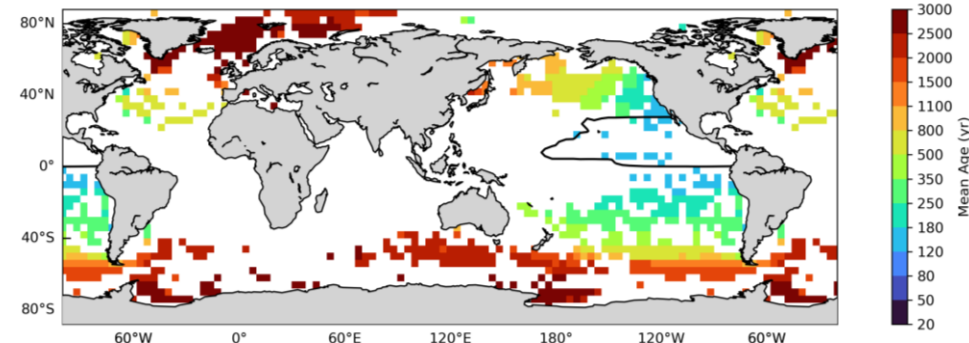
Surface Origin and Timescales

East Tropical
North Pacific

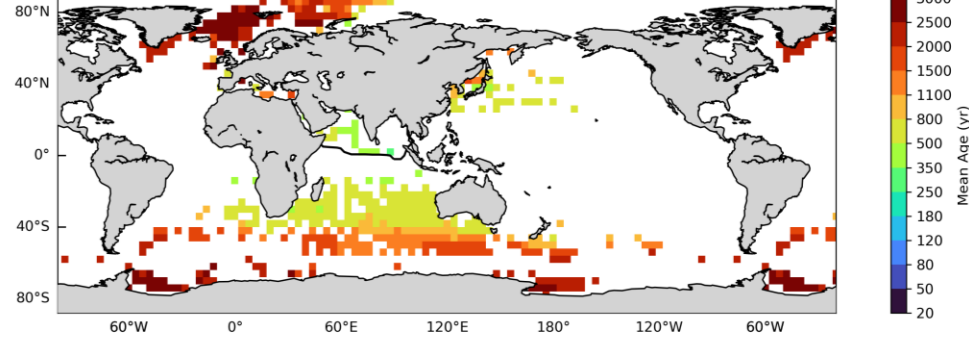
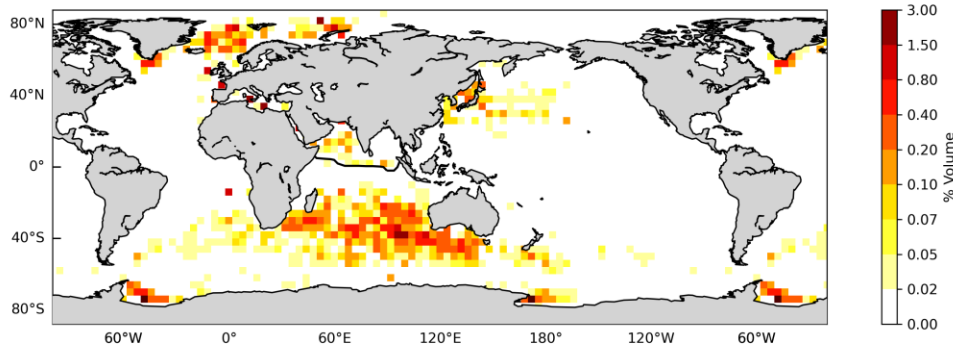
% Volume



Mean Age



Arabian Sea –
Bay of Bengal





TMI could also be used to investigate similar biogeochemical problems.

We recently used the TMI to constrain the Anthropogenic Carbon fluxes across the mixed layer:

"How is the ocean anthropogenic carbon reservoir filled?"

