Proxy relationships for carbonate chemistry: applications in Washington State marine waters

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PMEL CARBON PROGRAM

With thanks to Richard Feely, Andrea Fassbender, Adrienne Sutton, Jan Newton, Christopher Krembs, John Mickett, and other partners

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NOAA OCEAN ACIDIFICATION PROGRAM

PMEL

UCAR

Washington OA Center

CLIMATE PROGRAM OFFICE
Advancing scientific understanding of climate, improving society's ability to plan and respond

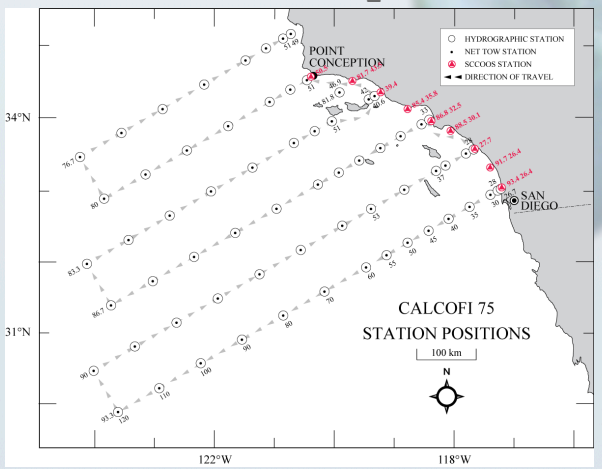
What do we want?

Biogeochemical metrics reflecting exposure of marine organisms to OA **– pH or $\Omega_{aragonite}$ are often preferred**

What do we have?

Ideally direct measurements of carbonate chemistry, but these measurements are still expensive and difficult to make well.

CalCOFI since 1949
(T, S, O_2)



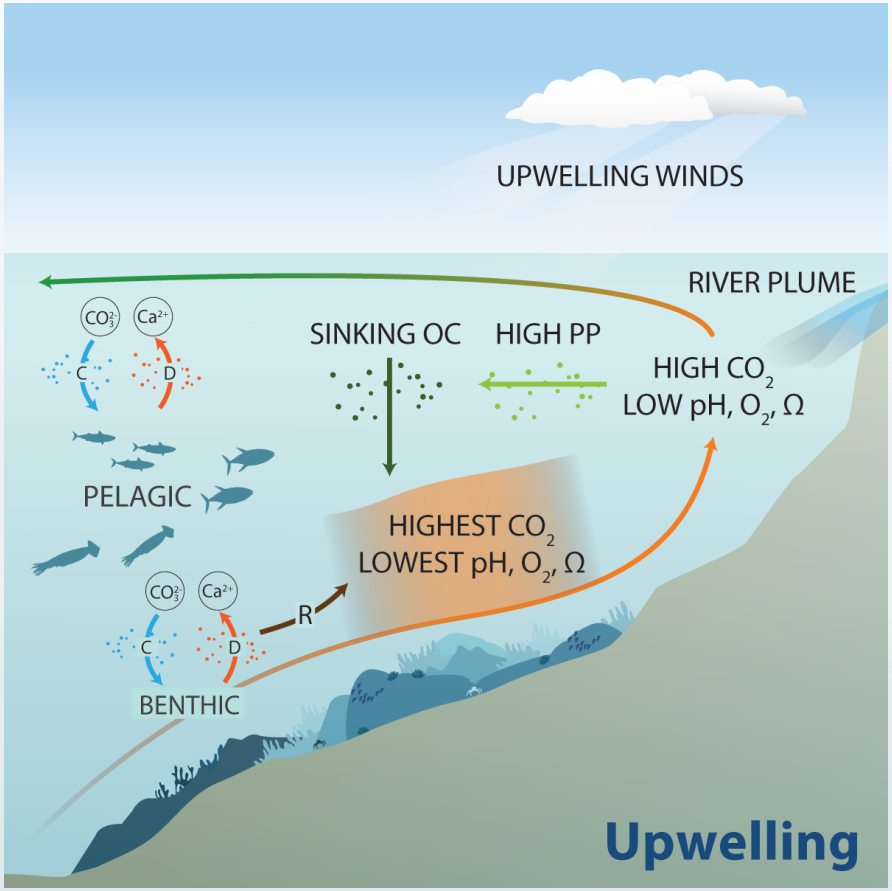
Race Rocks (BC) since 1930s (T, S)

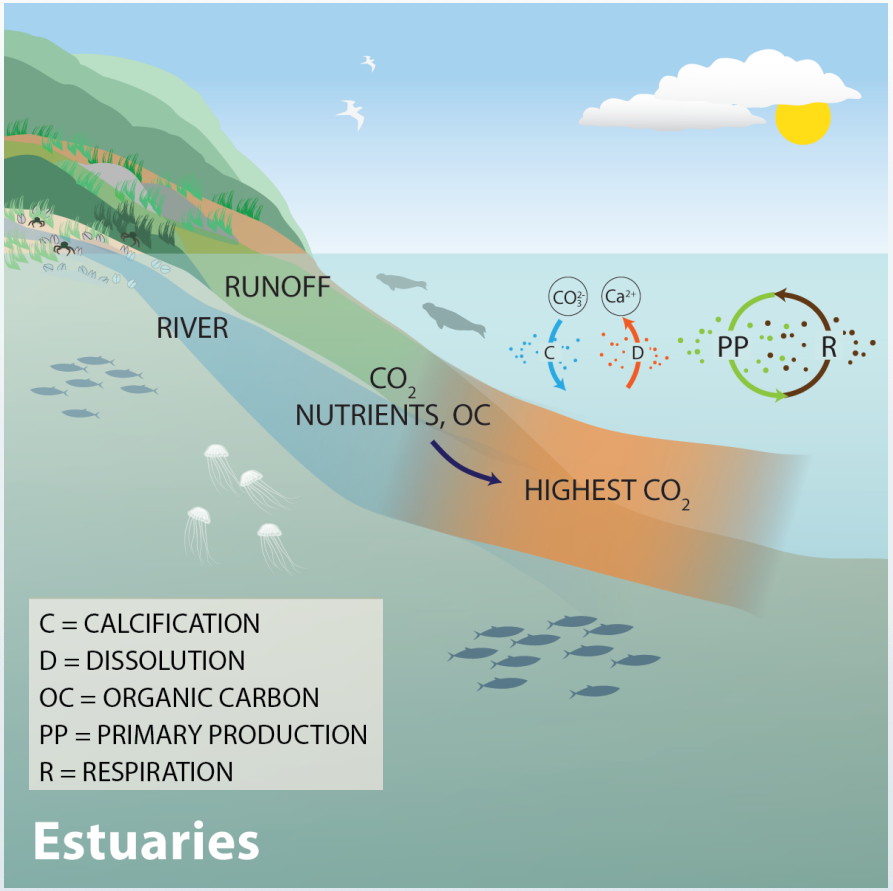
Photo: Russ Hopcroft

Considerations in developing proxies

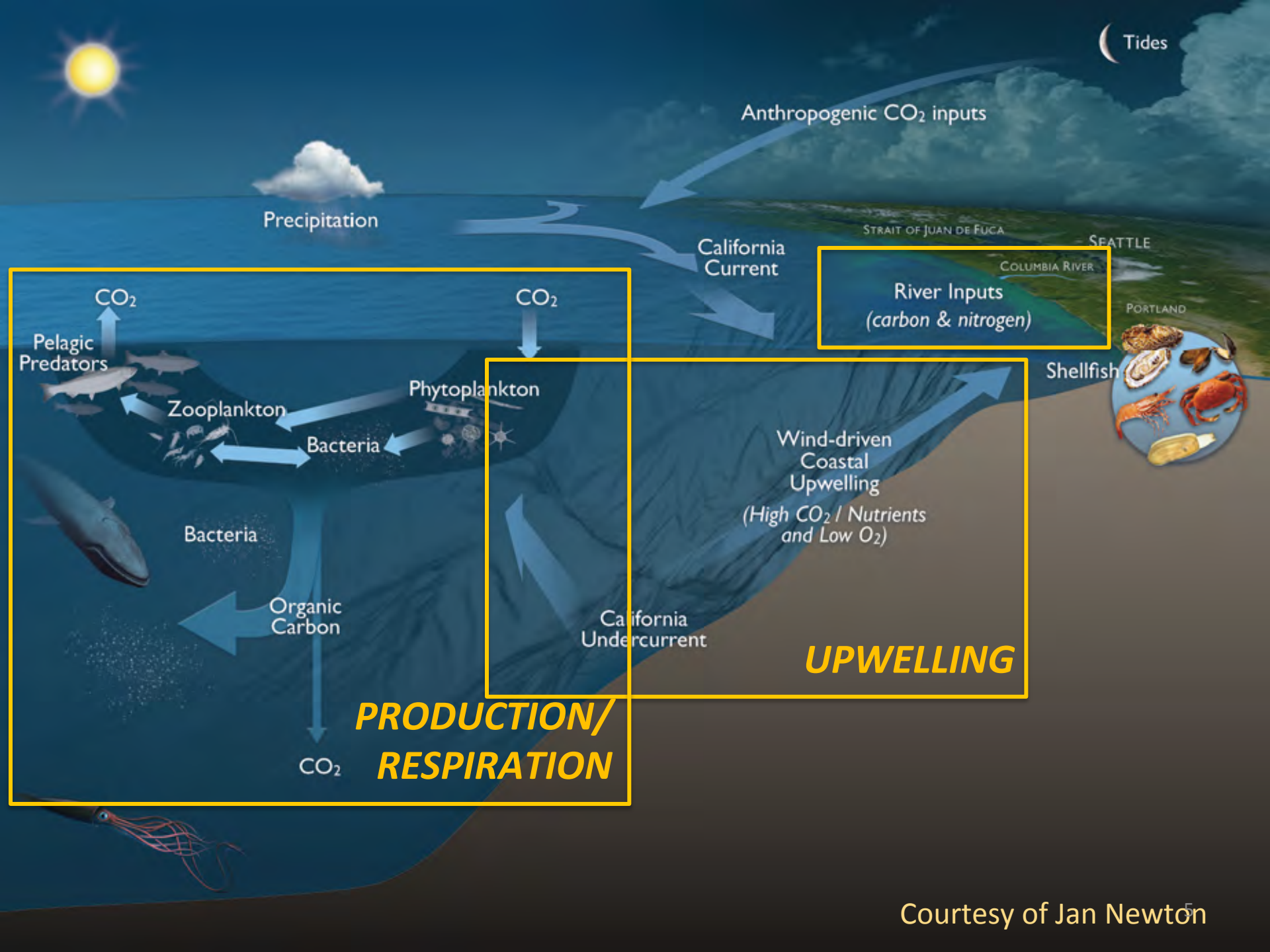
- *What data are available (and quality of data)?*
- *Application (e.g., spatial or temporal coverage)?*
- *Tradeoff between breadth of applicability and uncertainty of estimates*

California Current System ecosystem types





Figures by Amanda Dillon in Alin et al., *Oceanography*, in press



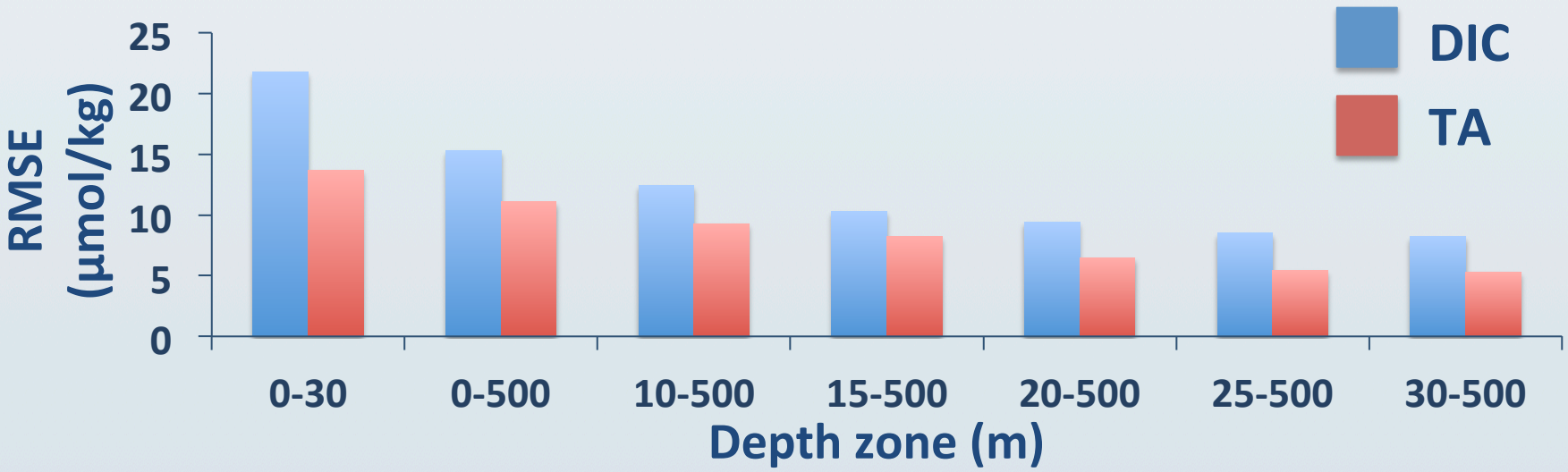
Courtesy of Jan Newton

Many ways to predict each parameter

depending on available data…

Temperature, salinity, oxygen or nitrate concentration, density (e.g., σ_θ) from West Coast OA cruises

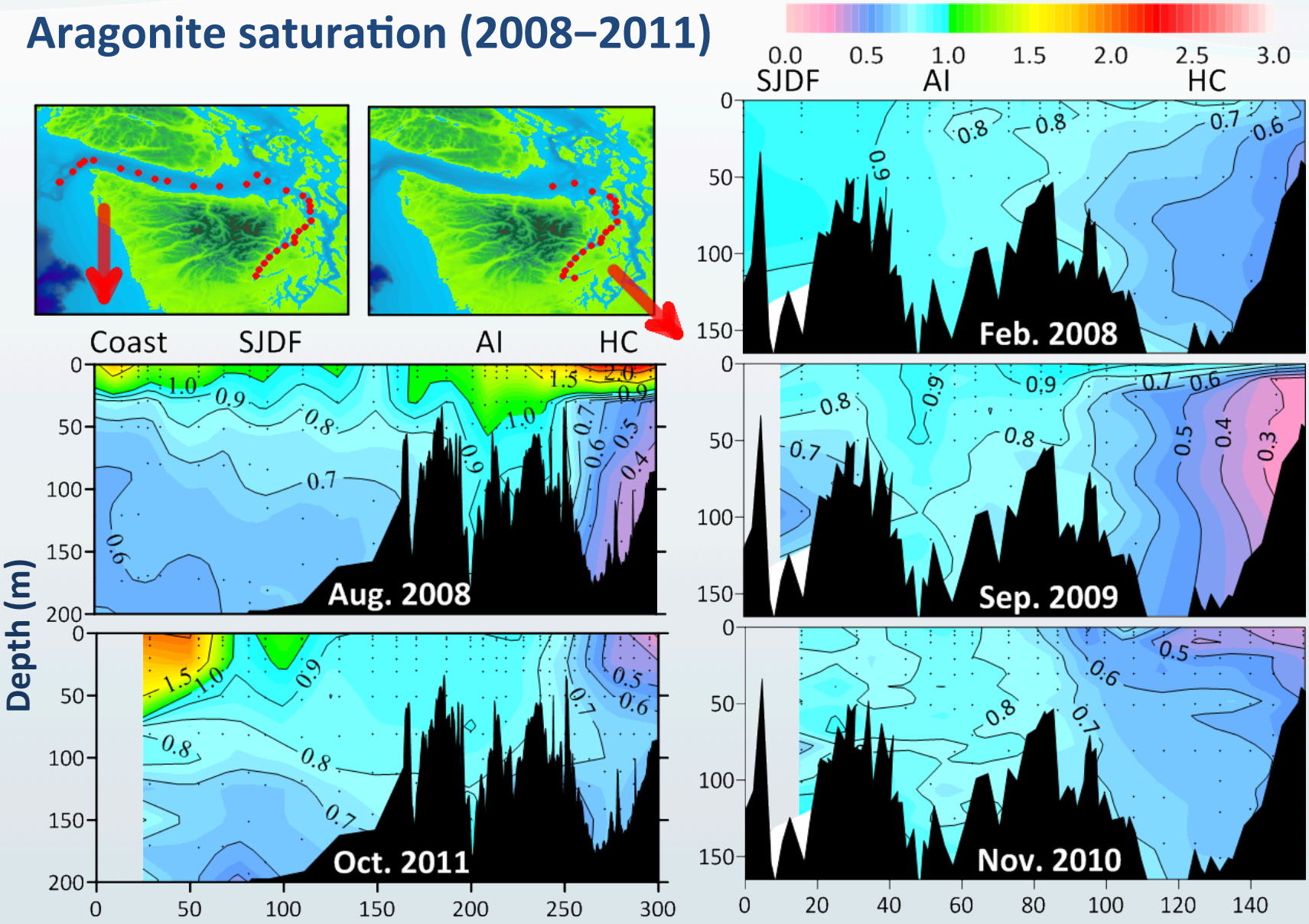
Best fits in northern CCS (20–500 m)	RMSEs
DIC ~ f (O_2 (or NO_3), σ_θ)	9.4 µmol/kg
TA ~ f (S, T, 1/T)	6.5 µmol/kg
Ω_{arag} ~ f (O_2, T)	0.06
pH ~ f (O_2)	0.03
pCO_2 ~ f (O_2, T)	74 µatm



Attribution of corrosive bottom-water conditions in Puget Sound: *incoming marine waters*

Corrosive conditions in Hood Canal

Aragonite saturation (2008–2011)



Alin et al. in prep,
Feely et al. 2010

Closing thoughts

- Proxy relationships can yield very robust estimates of inorganic carbon chemistry.
- However, must consider end goal and errors carefully in determining how best to get there.
- Opens the door to tracking OA evolution in longstanding time-series with biological measurements.