Modelling the SERIES patch:

the important physical terms

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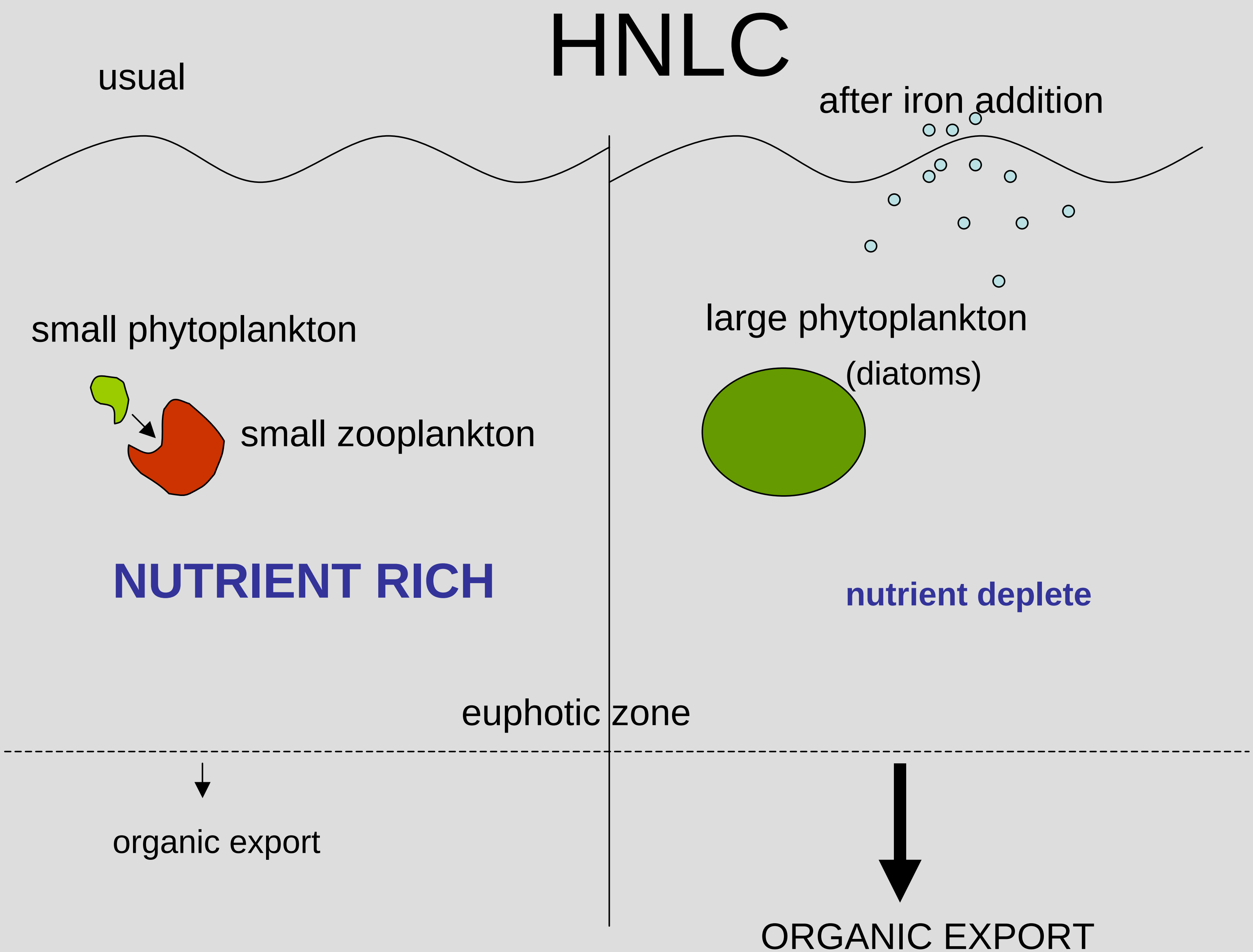

HNLC
usual
after iron addition
small phytoplankton
small zooplankton
large phytoplankton
(diatoms)
NUTRIENT RICH
nutrient deplete
euphotic zone
organic export
ORGANIC EXPORT

Goal of Iron Enrichment Expts

1. mimic natural events that are hard to observe because they occur so infrequently and are hard to predict
2. assess the potential of large scale iron fertilization as a means to sequester anthropogenic CO_2

What happens later?

Our goal

- use the data to *create biochemical models* that "work" and are simple enough to put in larger scale models that run over longer time scales
- ***what happens to the exported carbon?*** where and when does it come back up?
- ***what happens to the ecosystem?*** does silicic acid limit diatom growth?

Model

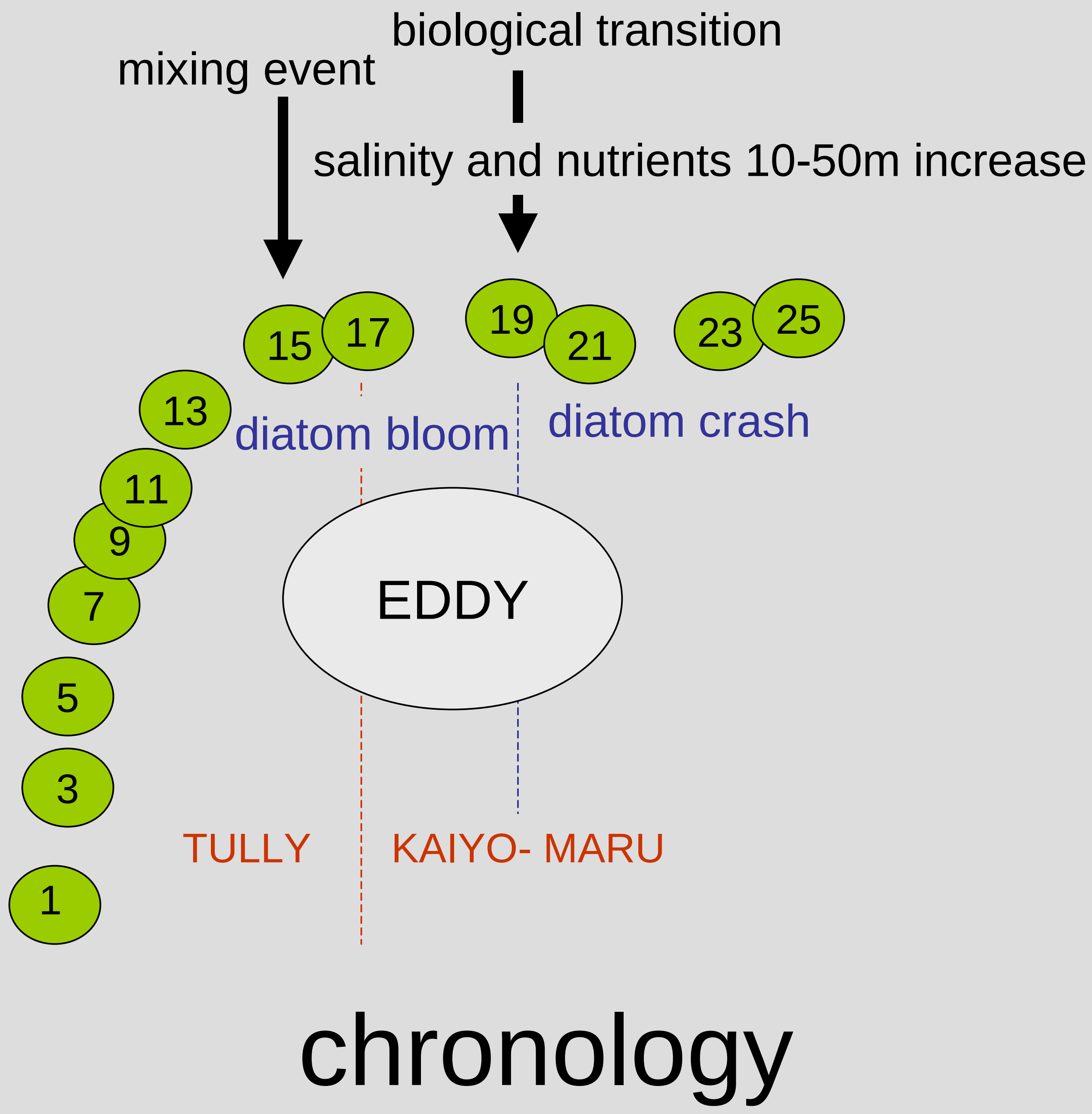
simple physical structure, detailed forcing

↓ Quasi - homogeneous boxes

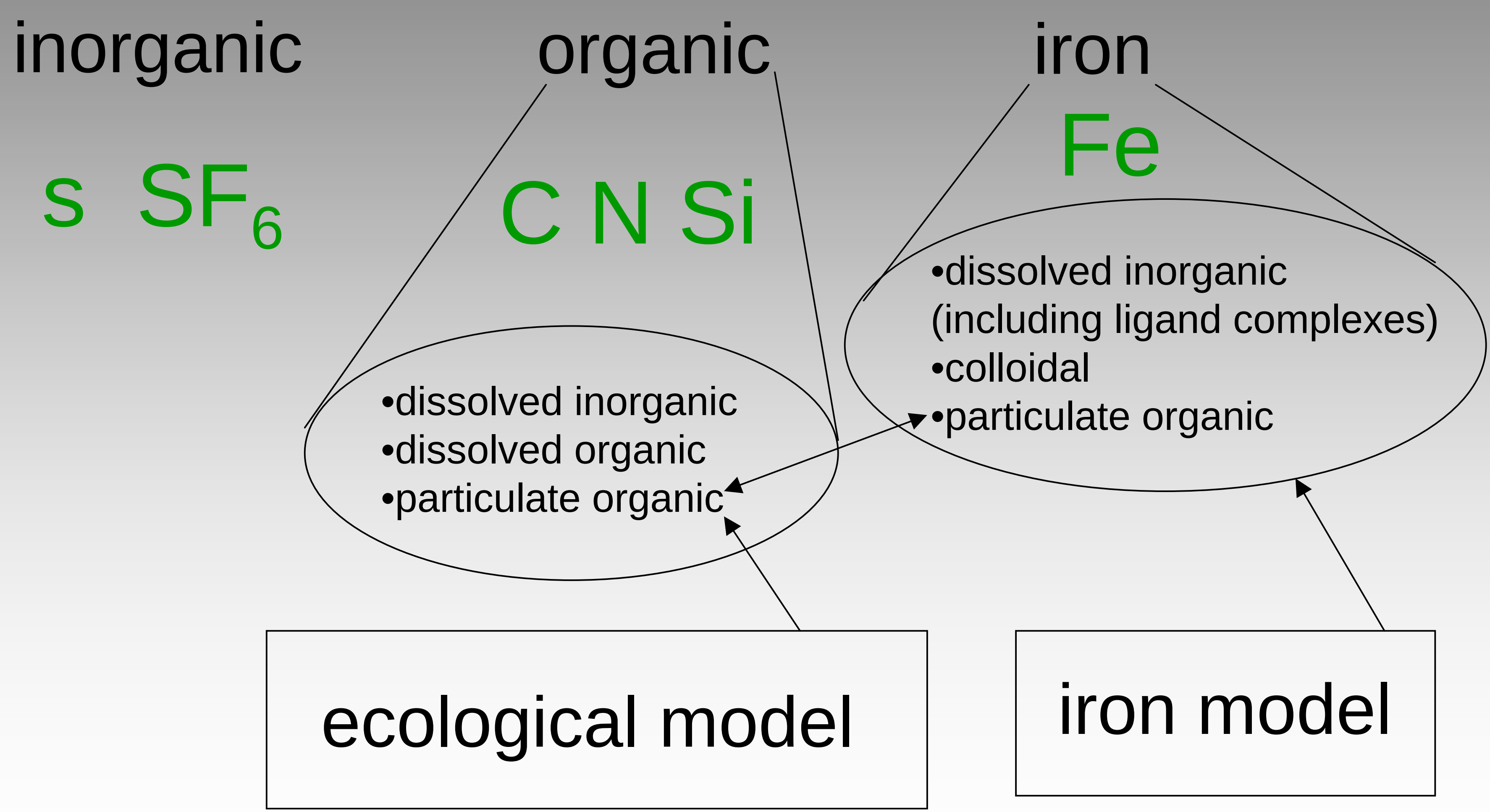
↓ data

Complex iron chemistry, ecology

what fits data?

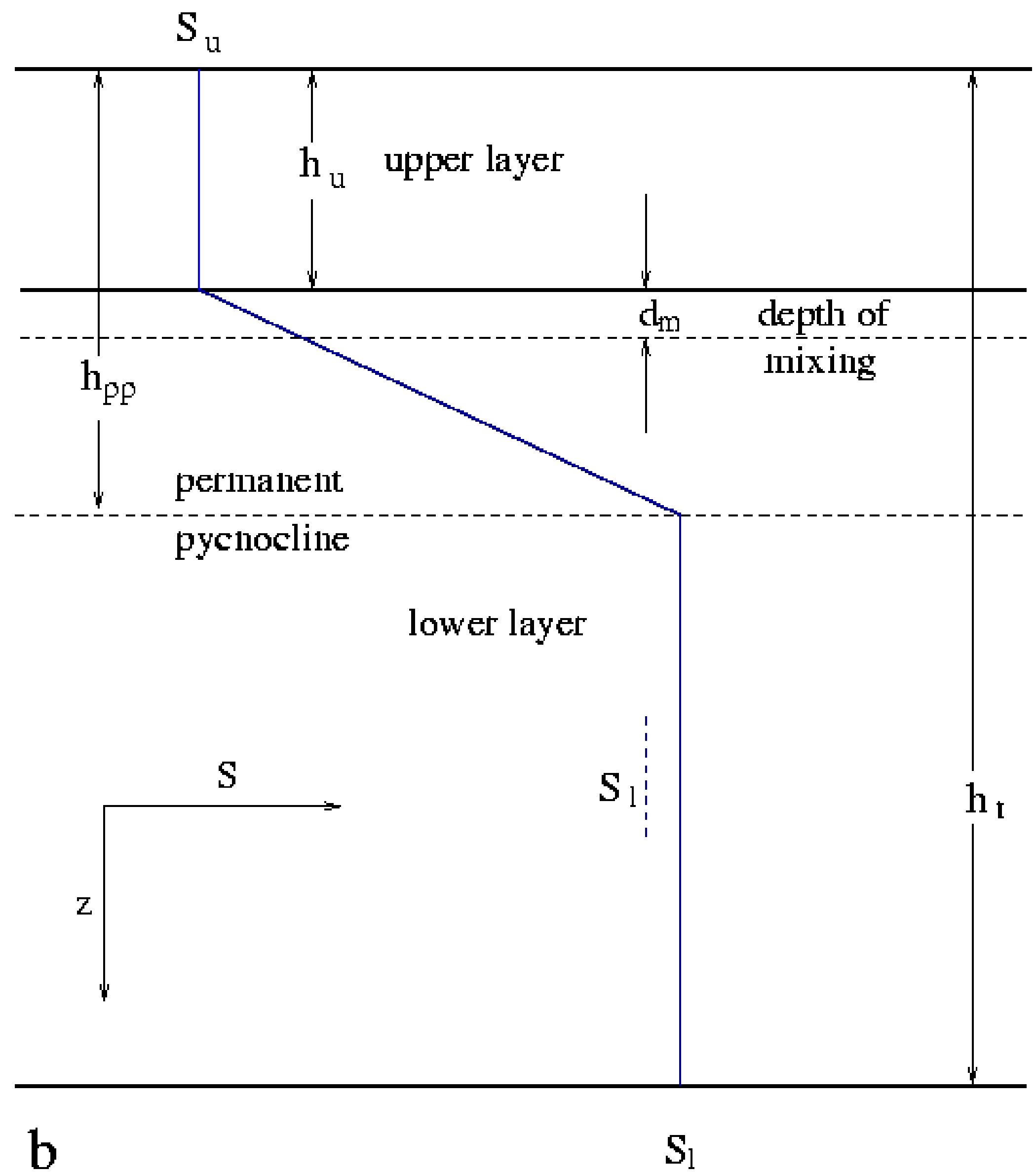

biological transition
mixing event
salinity and nutrients 10-50m increase
15
17
19
21
23
25
13
diatom bloom
diatom crash
11
9
7
EDDY
5
3
TULLY
KAIYO- MARU
1
chronology

state variables

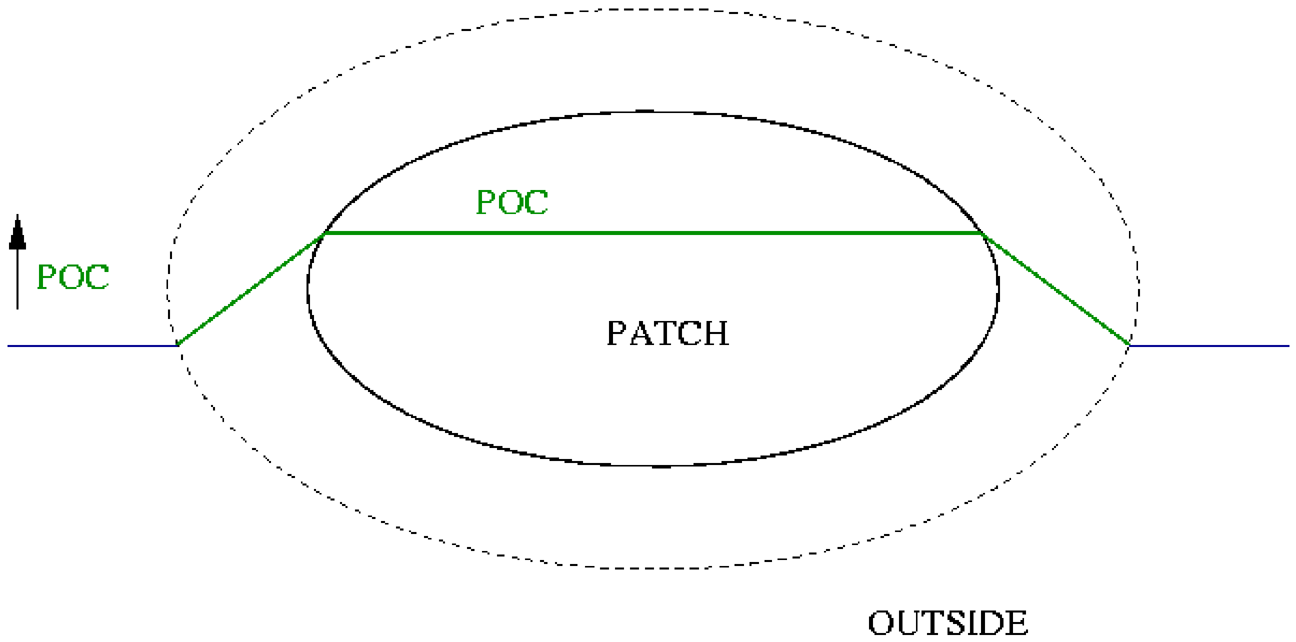


physics (vertical)

- 2 boxes
- quasi-homogeneous
- gradient adds 2 model parameters (h_{pp}, d_m)
- h_u = f(t) from observations



physics (horizontal)

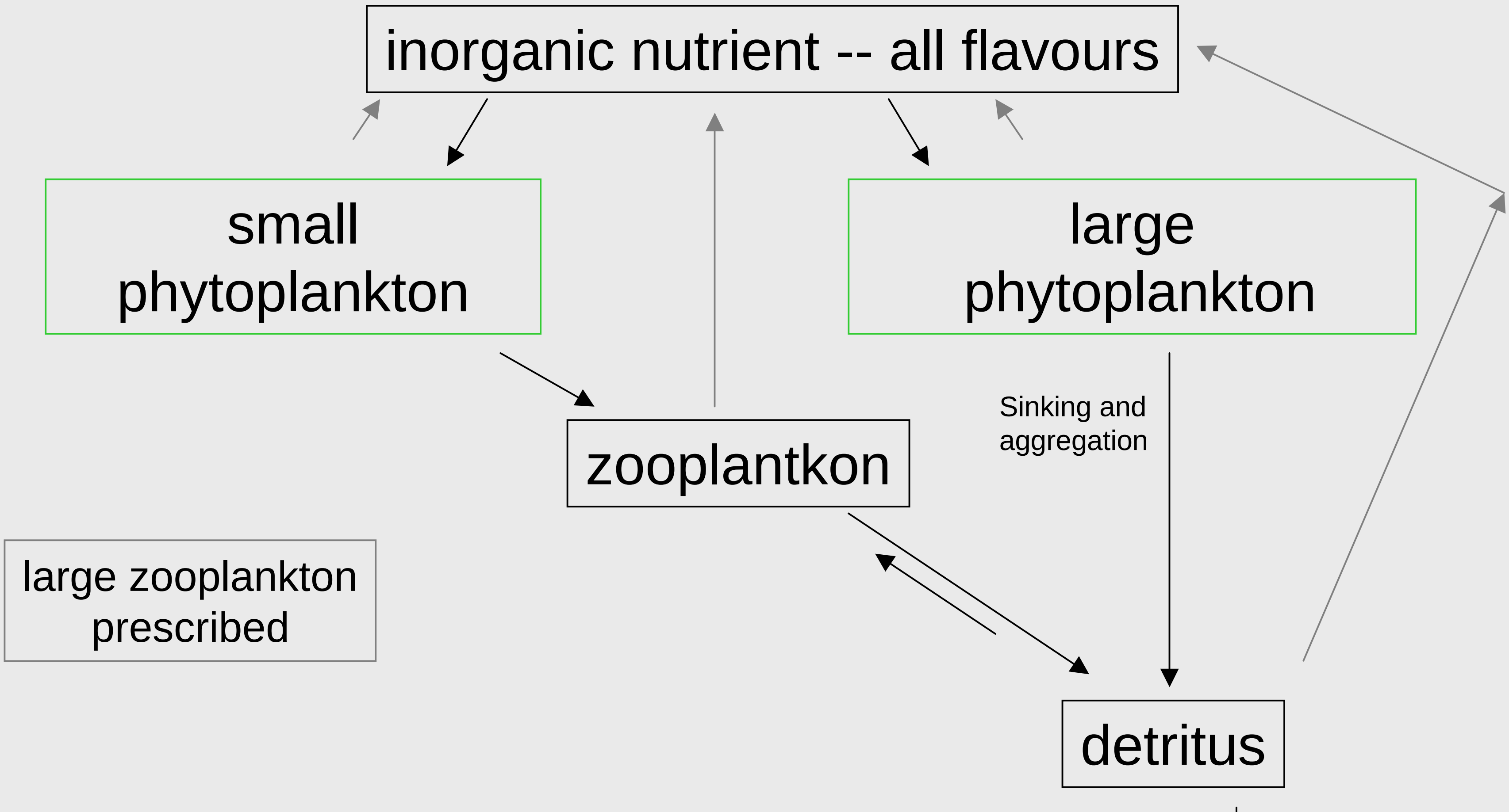


- 2 areas (inside and outside)
- quasi-homogeneous
- need A(area) and p(perimeter) = f(t) from data (Cliff Laws)
- Adding gradient (2 parameters) as in vertical
- Issues: anisotropy (e.g. upwind, downwind)

detailed forcing

- mixed layer depth GOTM (Y. LeClainche, N. Steiner) from data, heavily restored
- patch area (C. Laws), assume circular for perimeter as a first approximation
- mixing/diffusion from theory, scaled to spatial dimensions of problem (steady or tuned to vary with time)

Ecological Model



Denman and Pena (simple version)

ecological model

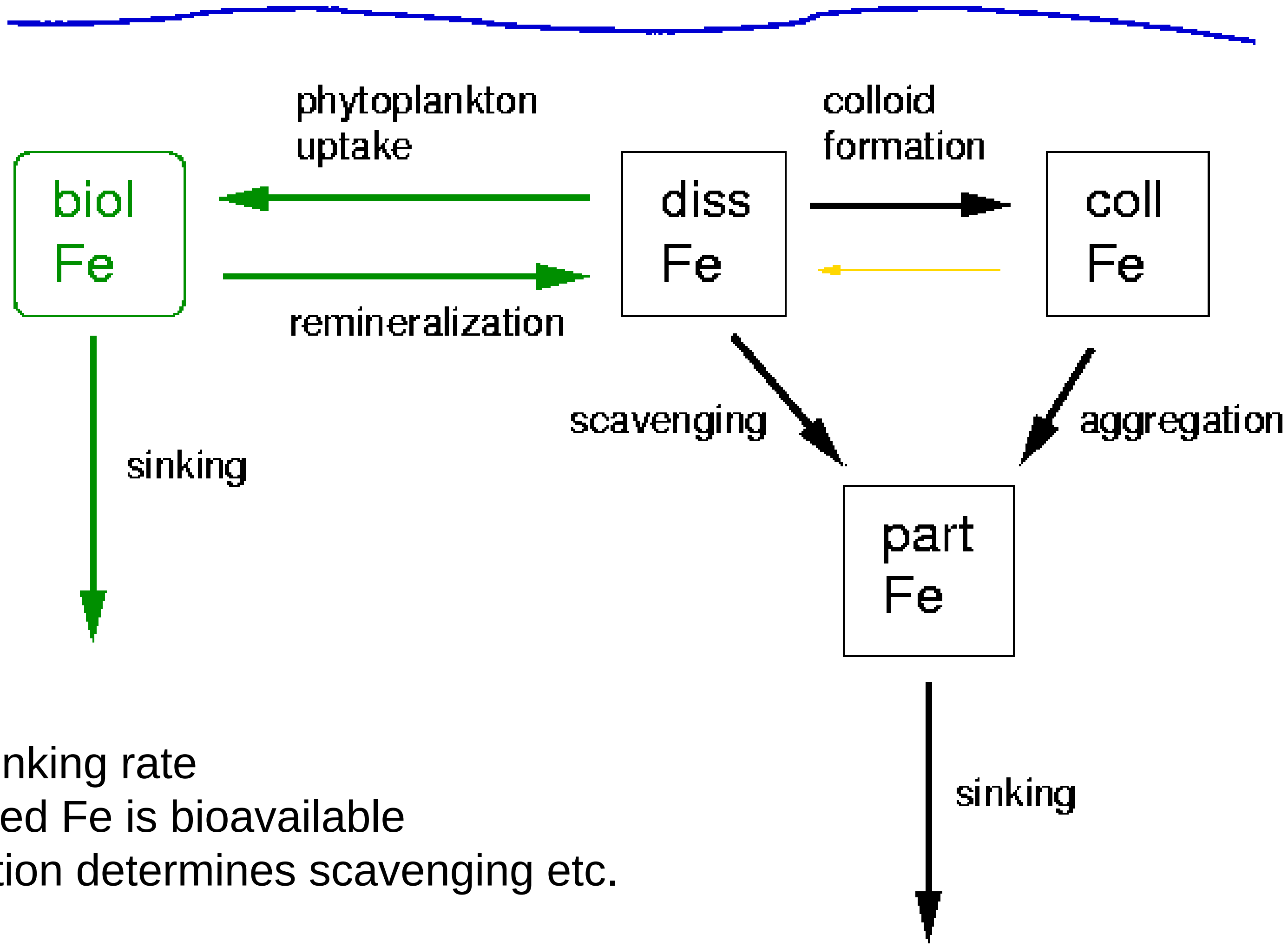
- 2 size classes of phytoplankton (P)
- small P tightly coupled with zooplankton
- large P (diatoms) need silicic acid
- large P sink as single cells and aggregates
- mesozooplankton are imposed based on data, diatom grazers

Fe in ecomodels

- constant limitation in phytoplankton uptake, no explicit iron Denman and Pena
- just like dissolved nutrients (1 pool)
- add scavenging =f(Fe, particle) Watson et al. 2000; Christian et al. 2002
- complex, all reactions known to mankind
  Weber et al.
- diagnose fast reactions in dissolved pool, model non-sinking and sinking Fe (not bioavailable) Voelker et al.

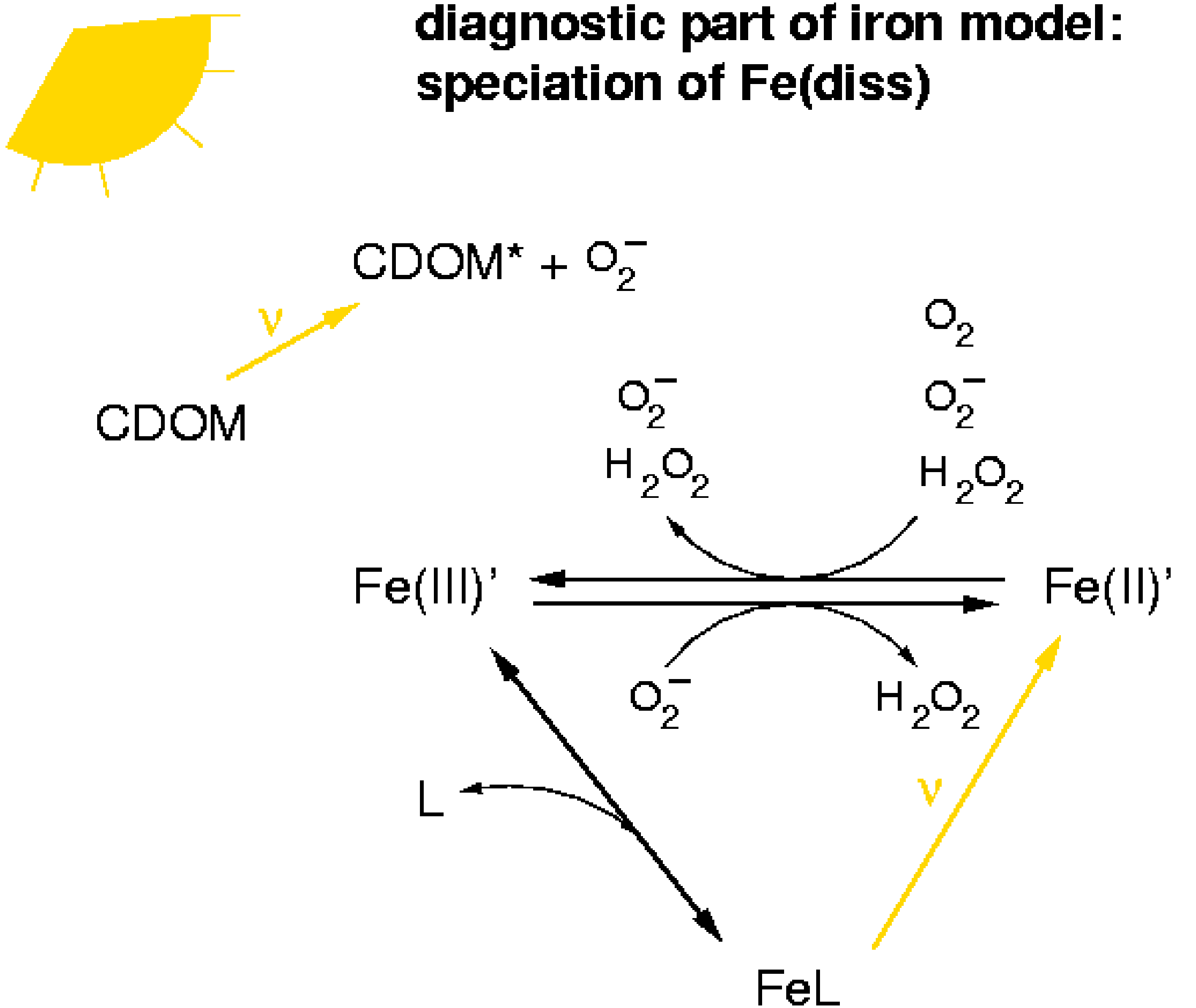
  Parekh and Follows

prognostic part of iron model



- fixed sinking rate
- dissolved Fe is bioavailable
- speciation determines scavenging etc.

diagnostic part of iron model: speciation of Fe(diss)



Speciation =f(irradiance, [Ligand], [H_2O_2])

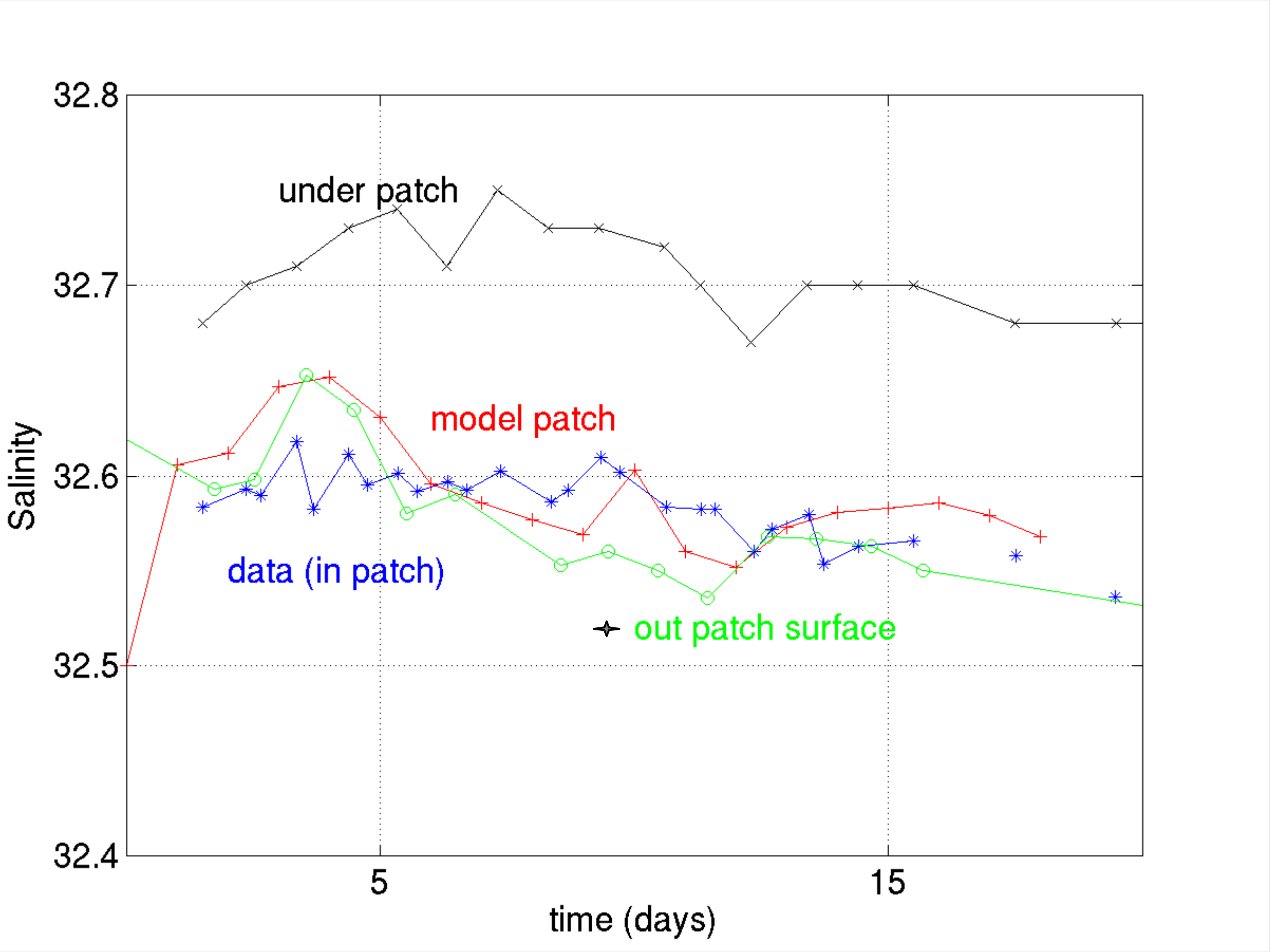
Iron model ideas

- luxury Fe uptake
- simplify – bioavailable Fe made up of ligands and colloids of varying lability (one less Fe pool, combine scavenging and aggregation flux)
- sensitivity to ligand strength?

results (day0-19)

- physical model reasonable without tuning
- eco model is embedded, both inside and outside of patch for comparison
- iron model under construction

Salinity NOT BAD….



MLD – GOTM   patch area (Laws)   mixing/diffusion -- theory

- patch is sitting in a horizontal salinity gradient

physical conclusions

vertical

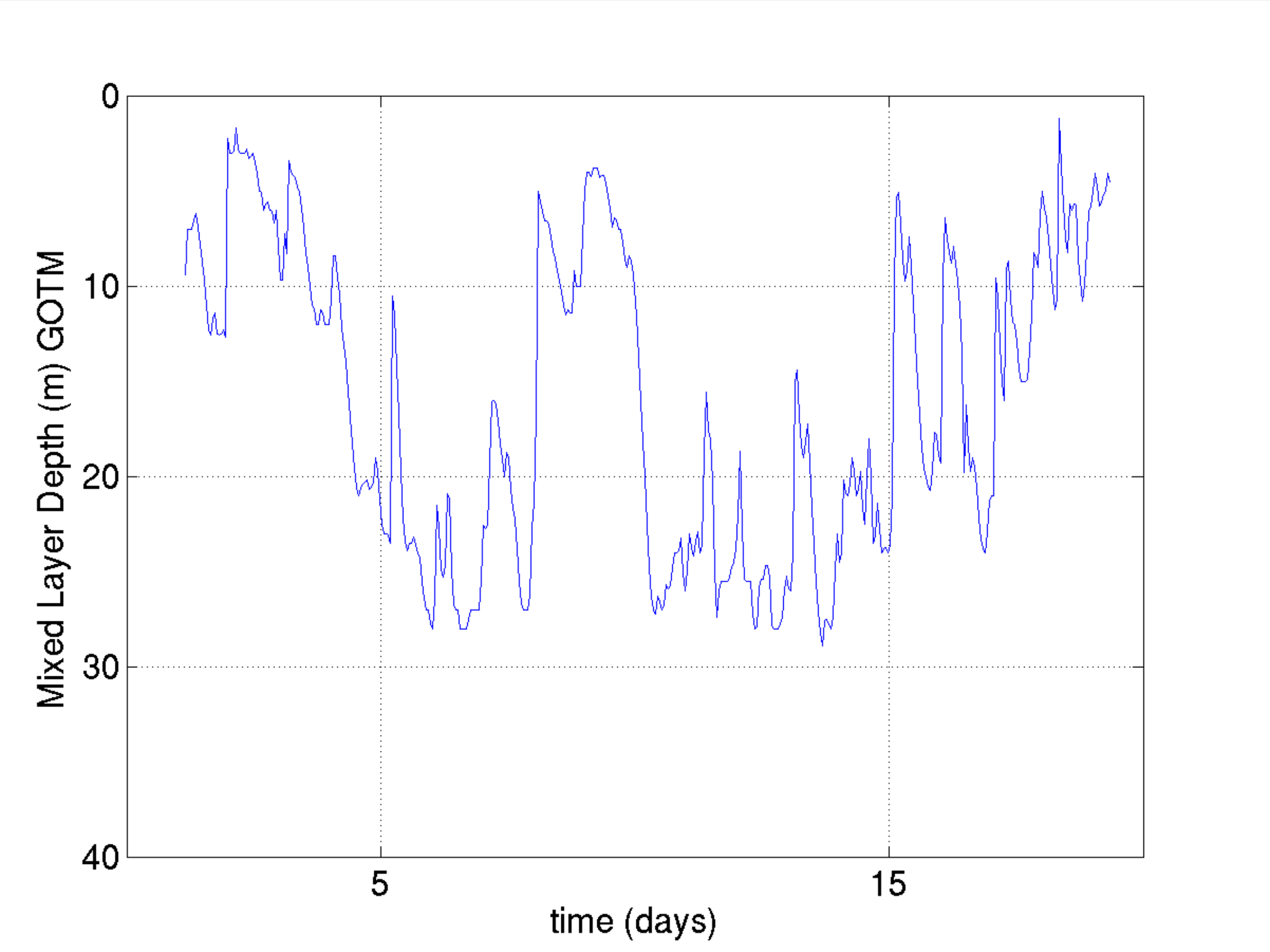
- time-varying mixed layer depth important
- mixing/diffusion same order as entrainment

horizontal

- mixing/diffusion >> entrainment
- changes in patch area with time not important

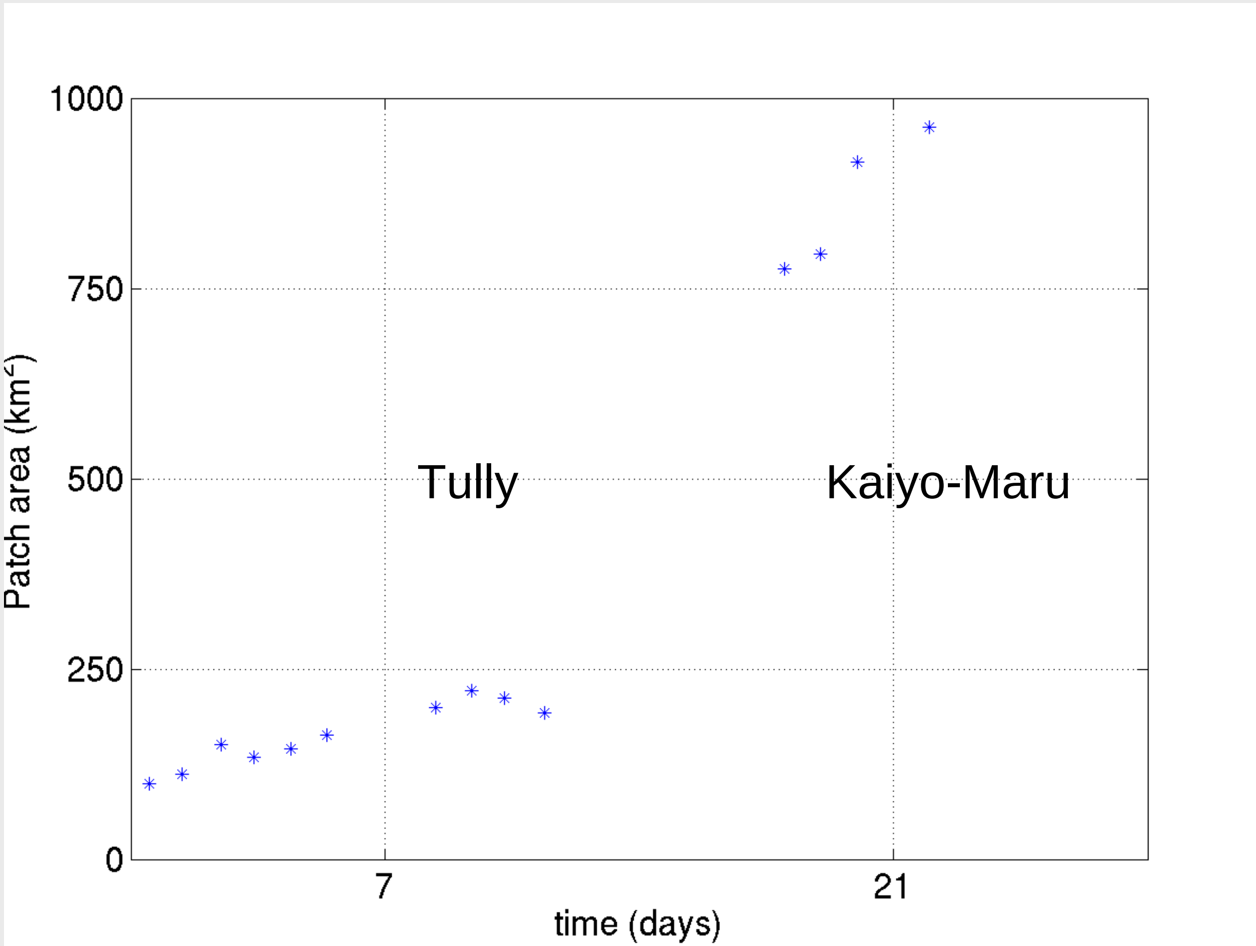
need to get MLD and perimeter right

MLD – GOTM (Y.LeClainche)



MLD appears unrealistically shallow at times
heavily restored (deepens MLD)
Tully data only

patch area (C. Laws)



Questions:

- sensitivity to horizontal gradients, location of outer sampling…. Is it a 2D or 3D problem?
- How to handle transition from Tully to Kaiyo-Maru?   WIND, PATCH AREA
- IRON – what do you know that I should?

Bottom line

- ***need to get MLD right*** for time variation

gee those 1D models look pretty good..

- ***need to get perimeter and horizontal diffusion/mixing coefficient right*** for average values

Patch budgets need to think about the stuff coming out the bottom in their dilution terms