Eddy diffusivity from microstructure measurements

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Few observational estimates exist

Horizontal mixing in the Southern Ocean from Argo float trajectories

Christopher J. Roach[1], Dhruv Balwada[2], and Kevin Speer[2,3]

Eddy stirring and horizontal diffusivity fr
Argo float observations: Geographic and depth variability

Sylvia T. Cole[1], Cimarron Wortham[2], Eric Kunze[3], and W. Brechner

Global surface eddy diffusivities derived from satellite altimetry

R. P. Abernathey[1,2] and J. Marshall[1]

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2 Microstructure derived estimates

Finescale Structure of the *T–S* Relation in the Eastern North Atlantic

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(Manuscript received 26 April 2004, in final form 10 February 2005)

A Microscale View of Mixing and Overturning across the Antarctic Circumpolar Current

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Microstructure

- ε : rate of dissipation of TKE
  - shear probe
- χ : rate of dissipation of temperature variance
  - fast temperature sensor

Variance pathways

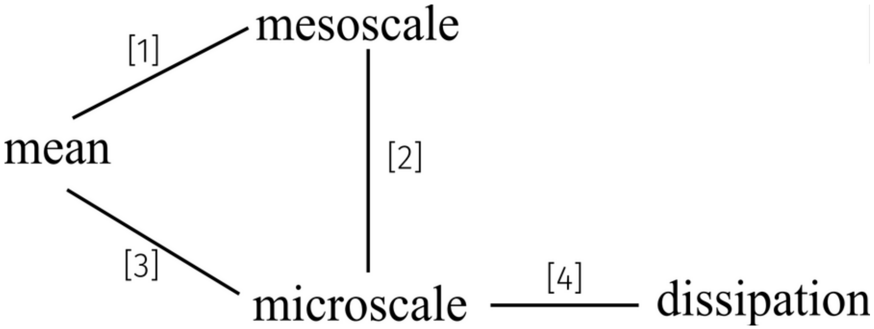
Triple decomposition + ignore 11/16 terms **(!)**

- Davis (1994); Ferrari and Polzin (2005); Garrett (2001),

(**m**ean, basin-scale, 1000km, years)

+ (m**e**soscale, 100km, months)

+ (**t**urbulence, 10m, minutes)



$$\langle \widetilde{u_t\theta_t}\rangle \cdot \nabla\theta_m + \langle u_e\theta_e\rangle \cdot \nabla\theta_m = -\frac{1}{2}\langle\widetilde{\chi}\rangle.$$

dissipation [4]

Turbulent stirring [3]

Mesoscale stirring [1]

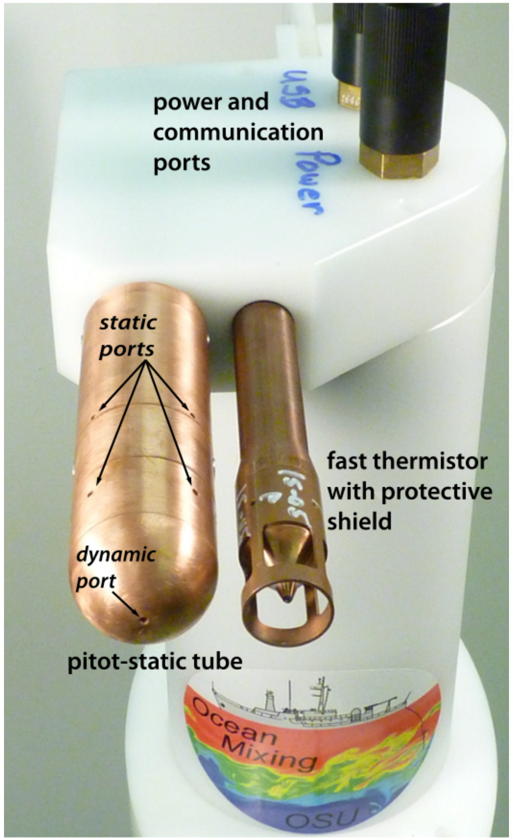
$$\langle \widetilde{u_t \theta_t} \rangle \cdot \nabla \theta_m + \langle u_e \theta_e \rangle \cdot \nabla \theta_m = -\frac{1}{2} \langle \widetilde{\chi} \rangle.$$

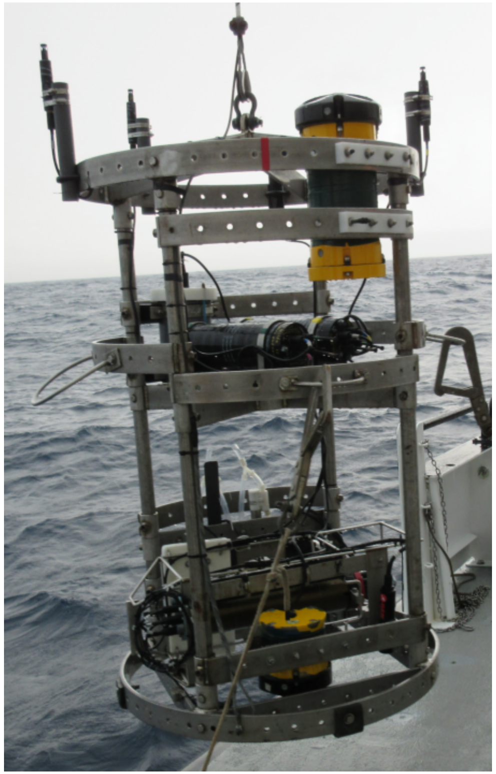
χpod

$$K_e = \frac{\langle \widetilde{\chi} \rangle / 2 - \langle K_T \partial_z \tilde{\theta} \rangle \partial_z \theta_m}{|\nabla \theta_m|^2}.$$

Mean gradients: Argo, ECCO?
Gradient along neutral-surface

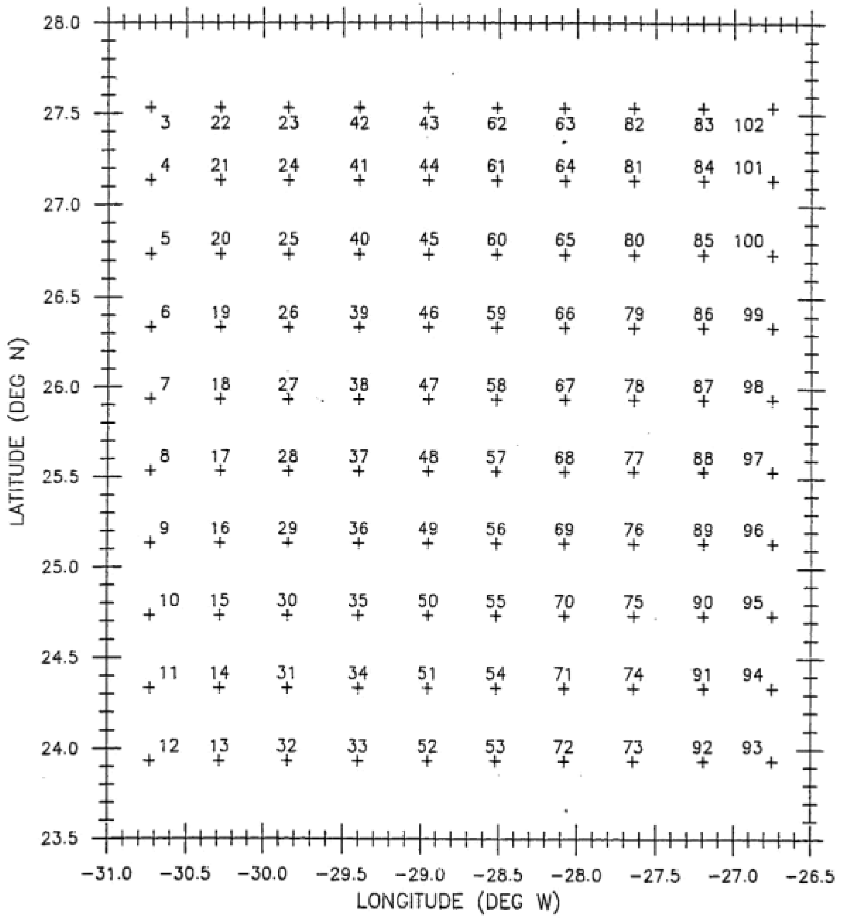
Moored χpod | CTD χpod
(Moum & Nash, 2009) : only fast T sensor!

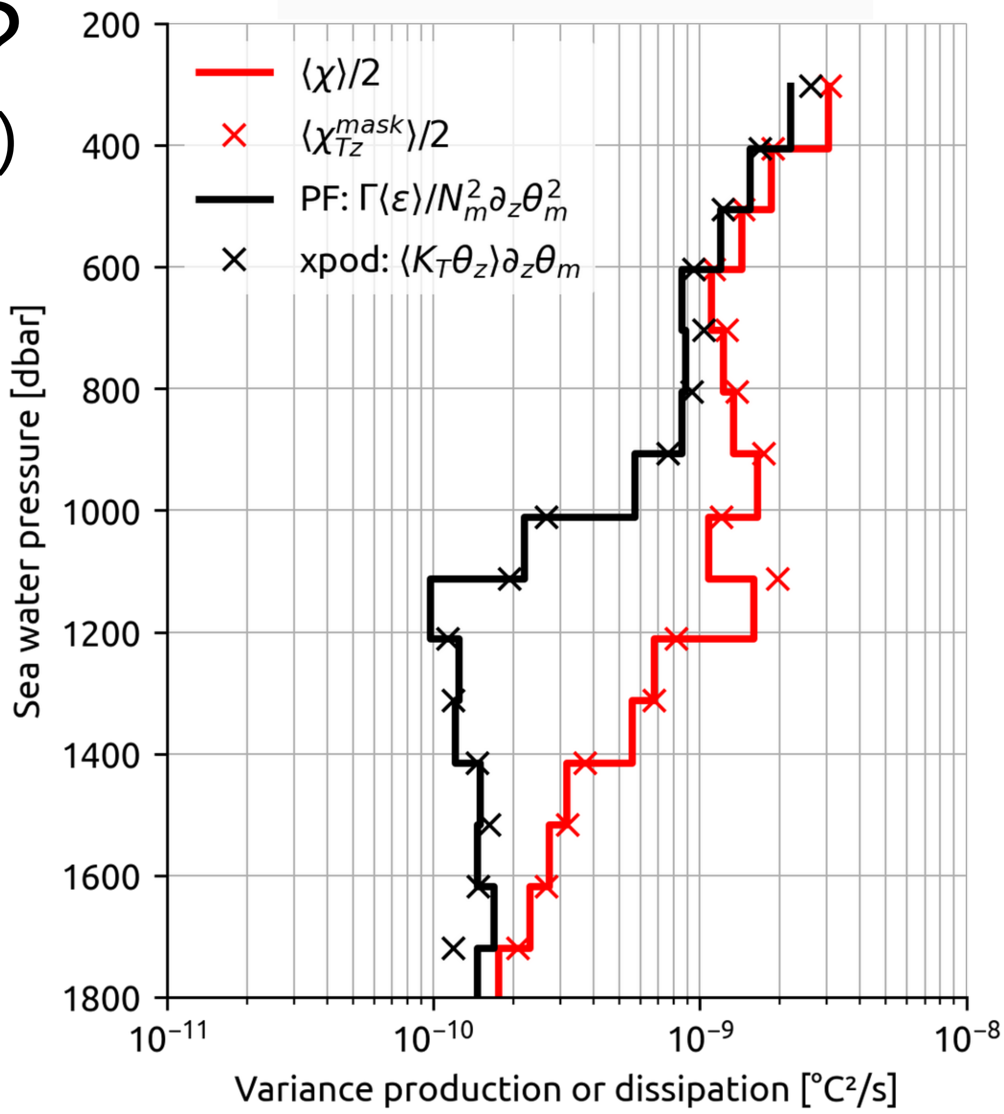




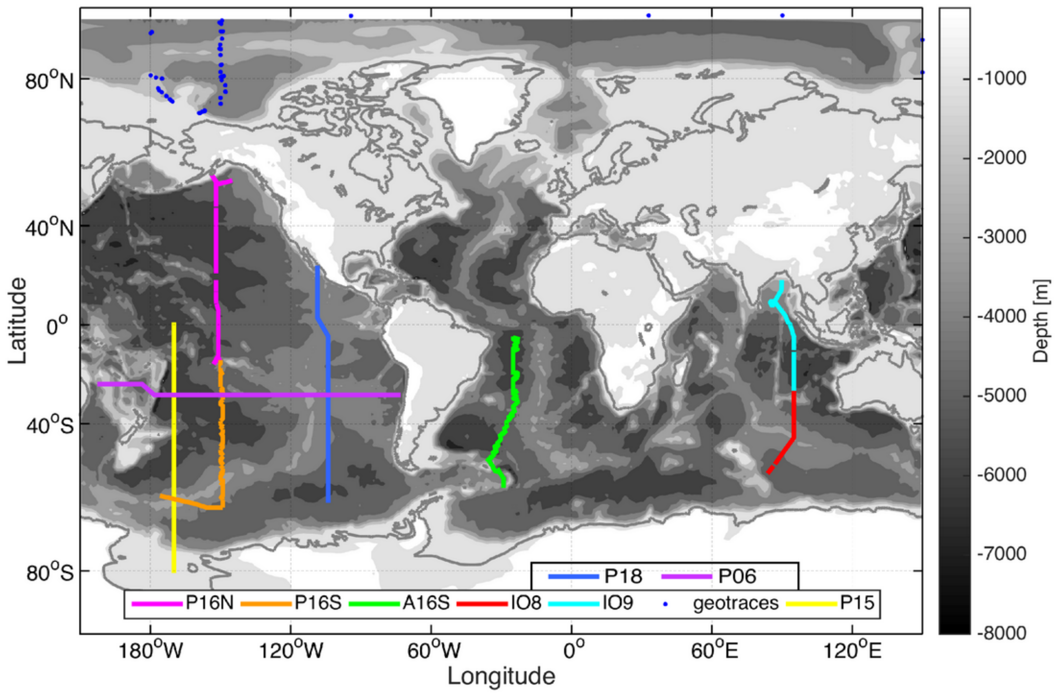
Can this actually work?

Reproduce Ferrari & Polzin (2005)

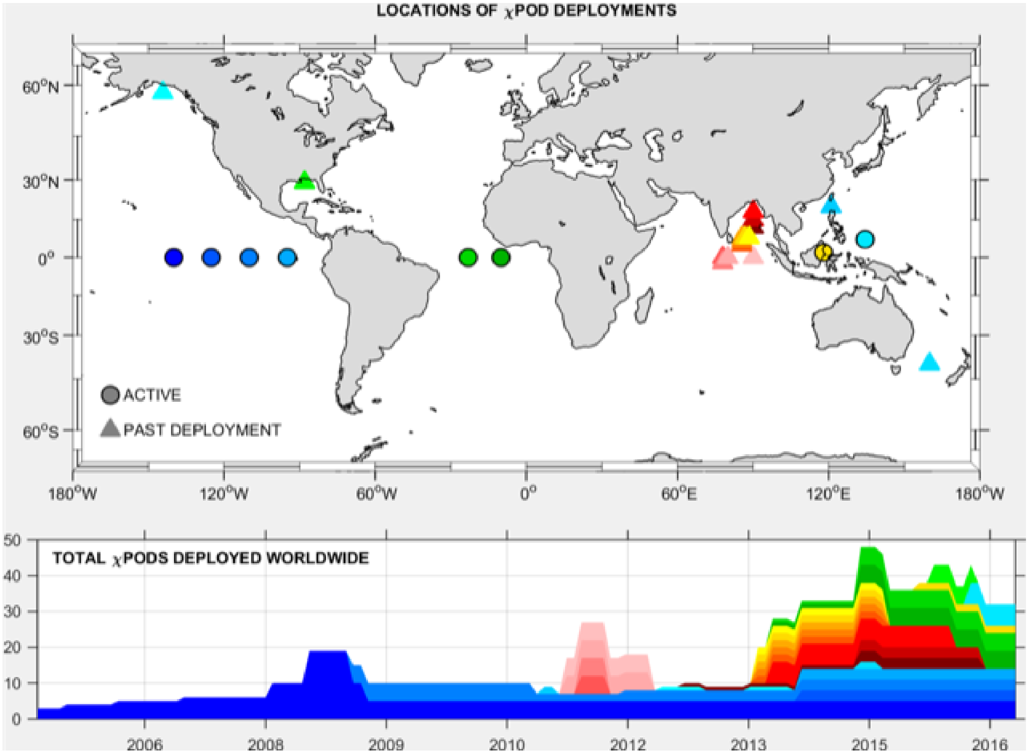




Two datasets

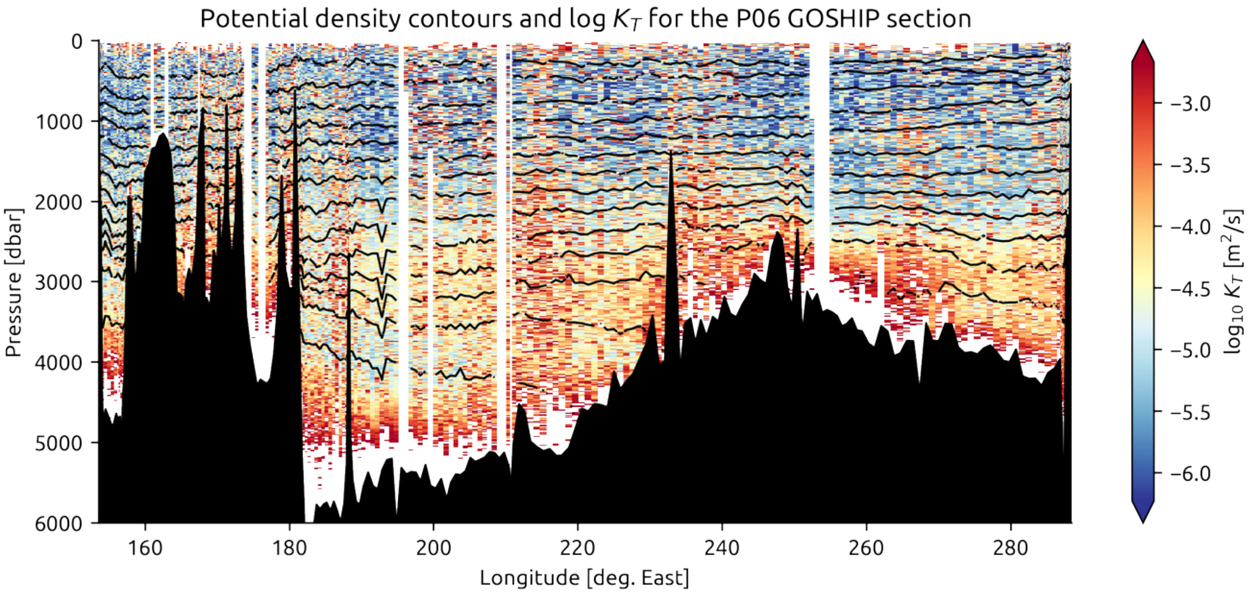


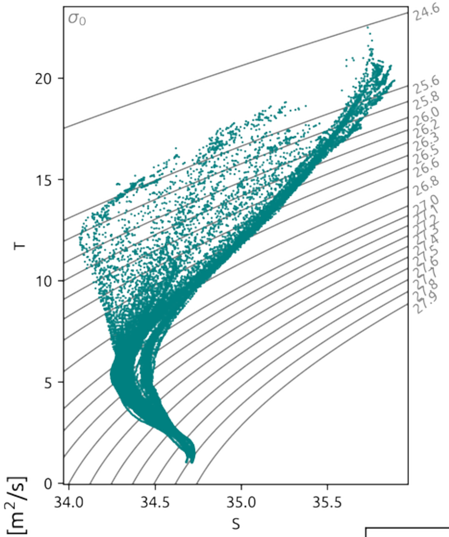
GO-SHIP CTD transects

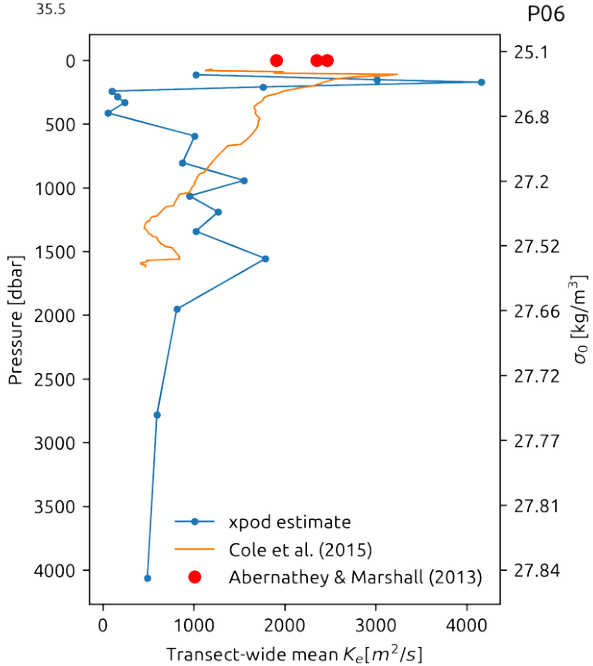


Long term moorings
(Eq. Pac; eq.Atl, Indian Ocean)

Example calculation:
P06, 24S transect across the Pacific
≈ 250 stations







Are there systematic disagreements between finestructure and microstructure estimates?

e.g. Naviera-Garabato et al (2016)

Q: How is this useful for model efforts?

- Best case obs estimates:
  - Profiles of “eddy diffusivity” estimates in a few isopycnal bins
  - Time series at equator
- Variance generated by everything **other** than microscale stirring of mean vertical gradient
- Connect to other estimates (Abernathey et al., Cole et al.)