Ocean Mixing

Gordon Research Seminar
Graduate Research **June 4-5, 2022**

Gordon Research Conference
Frontiers of Science **June 5-10, 2022**

The Impact of Ocean Mixing on the Earth, Ocean and Atmosphere Systems, Climate and Society

- Cutting edge research
- 2:1 format for talks and discussion
- Dedicated free time for networking and community-building

Application Deadlines

- GRS Oral Presentations: **MARCH 4**
- GRC & GRS Attendance: **MAY 7**

Questions: mixing.grc@gmail.com

Topics of Interest

1. Certainties, Uncertainties and Impacts of Ocean Mixing
2. Mixing in Ice-Influenced Oceans
3. Mixing Beneath Ice Shelves, in Fjords and Near Sea Ice
4. Mixing in the Interior: Internal Waves and the Next Generation of Parameterizations
5. Upper-Ocean Mixing and Impacts on Biogeochemistry
6. Mesoscale and Submesoscale Processes: Eddies, Eddy-Wave Interactions and Nonlinear Coupling
7. Mixing and Its Role in Climate Dynamics
8. Mixing at the Bottom
9. Pathways to Reducing Uncertainty

Mount Holyoke College, South Hadley, MA, US
https://www.grc.org/ocean-mixing-conference/2022/
https://www.grc.org/ocean-mixing-grs-conference/2022/

GRC Chairs: Jonathan Nash & Kurt Polzin
GRC Vice Chairs: Sonya Legg & Alberto Naveira Garabato
GRS Chairs: Marion Alberty & Sjoerd Groeskamp

6151 - Estimates of stratification and turbulent dissipation from the High Resolution Profiler during the first Boundary Layer Turbulence - Recipes field program

NOCS
Alberto Naveira Garabato
Eleanor Frajka-Williams
Alex Forryan
Carl Spingys
Bieito Fernandez-Castro
PS01-03

WHOI
Kurt Polzin PS04-03
Jim Ledwell PL01-01

UCSD
Matthew Alford PS01-01
Gunnar Voet
Nicole Cuoto
Arnaud Le Boyer
Bethan Wynne-cattanach PL05-01

MIT
Raffaele Ferrari
Henri Drake PL05-01
Xiaozhou Ruan PL05-01

U. Exeter
Marie-Jose Messias PL01-01
Jack Hughes
Kaylim Reddy

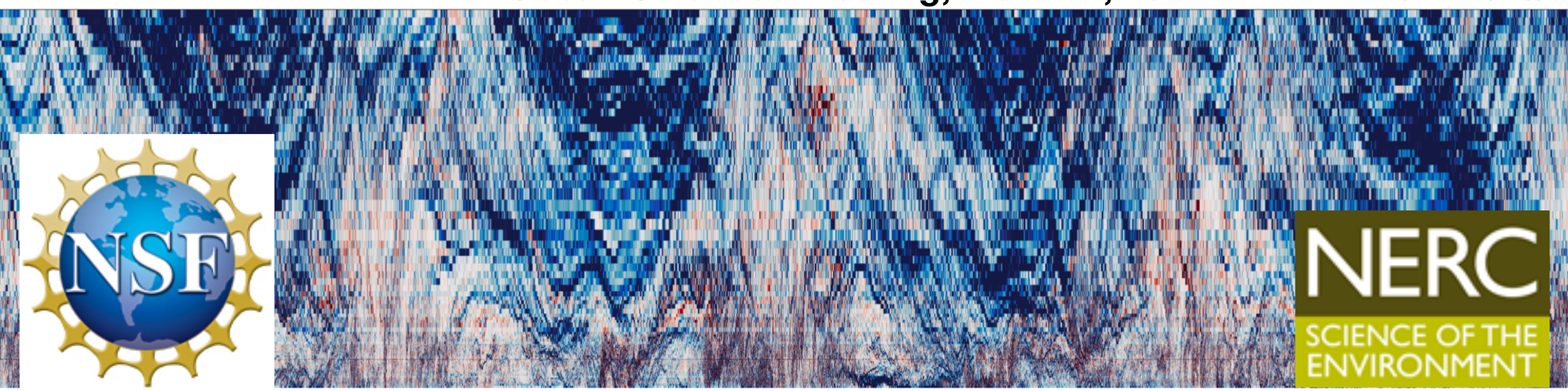
Western U.
Kelly Ogden PL01-01

IFREMER
Herle Mercier
Catherine Kermabon

Vertical profiling - Moorings - Dye - Tracer - Models

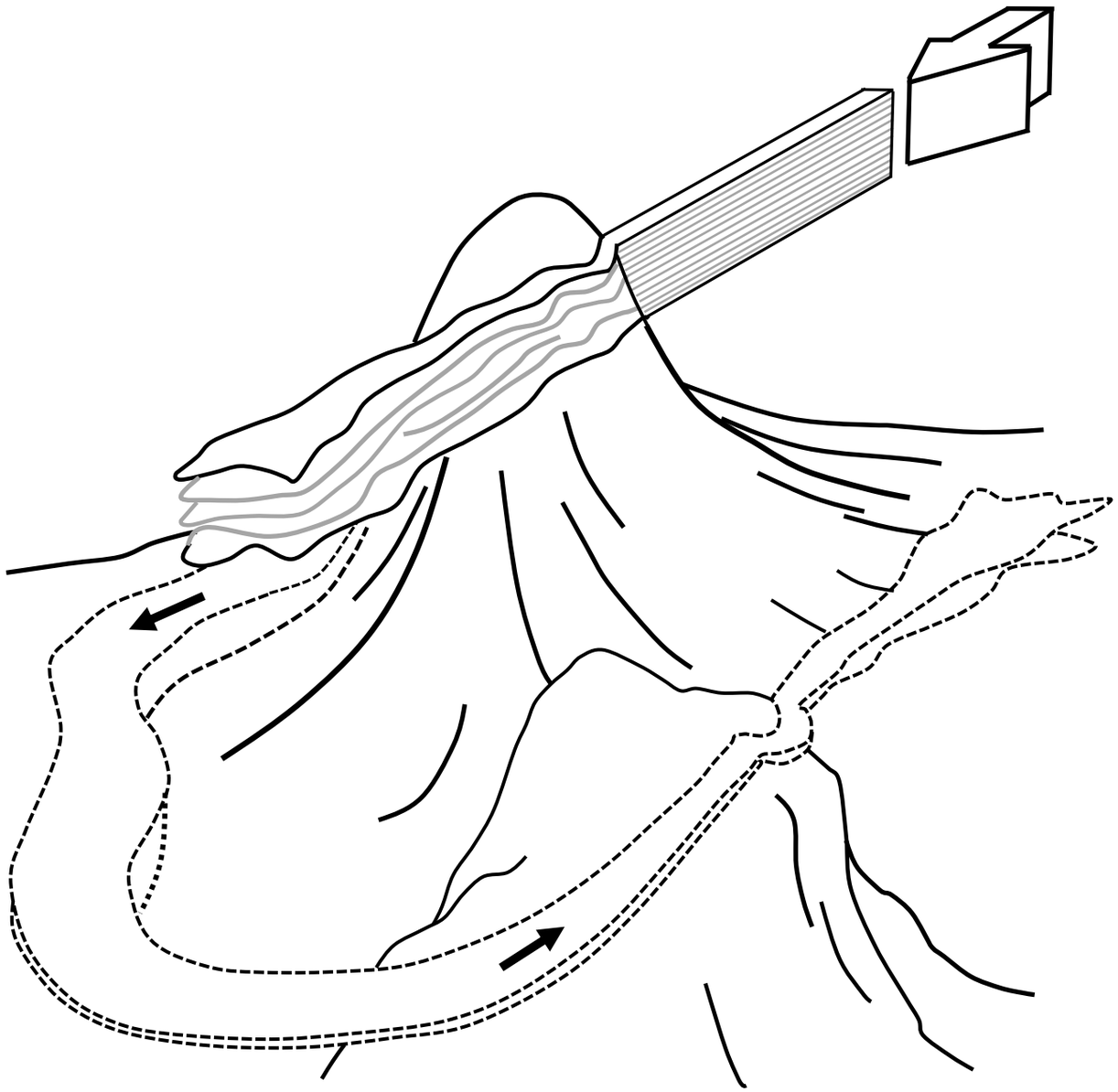
Ocean Sciences Meeting, March 1, 2022

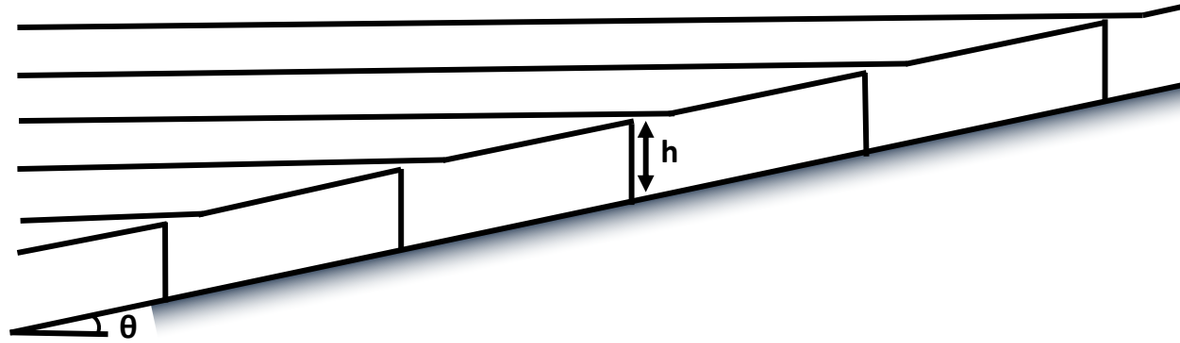
Courtesy Carl Spingys



PS01-03: Inter-scale connections and transfers in mesoscale, submesoscale, and boundary layer turbulence

Armi v. Garrett, circa 1979





Using Phillips 1970 and Wunsch 1970 as a starting point, this picture gets developed into “the one-dimensional model …

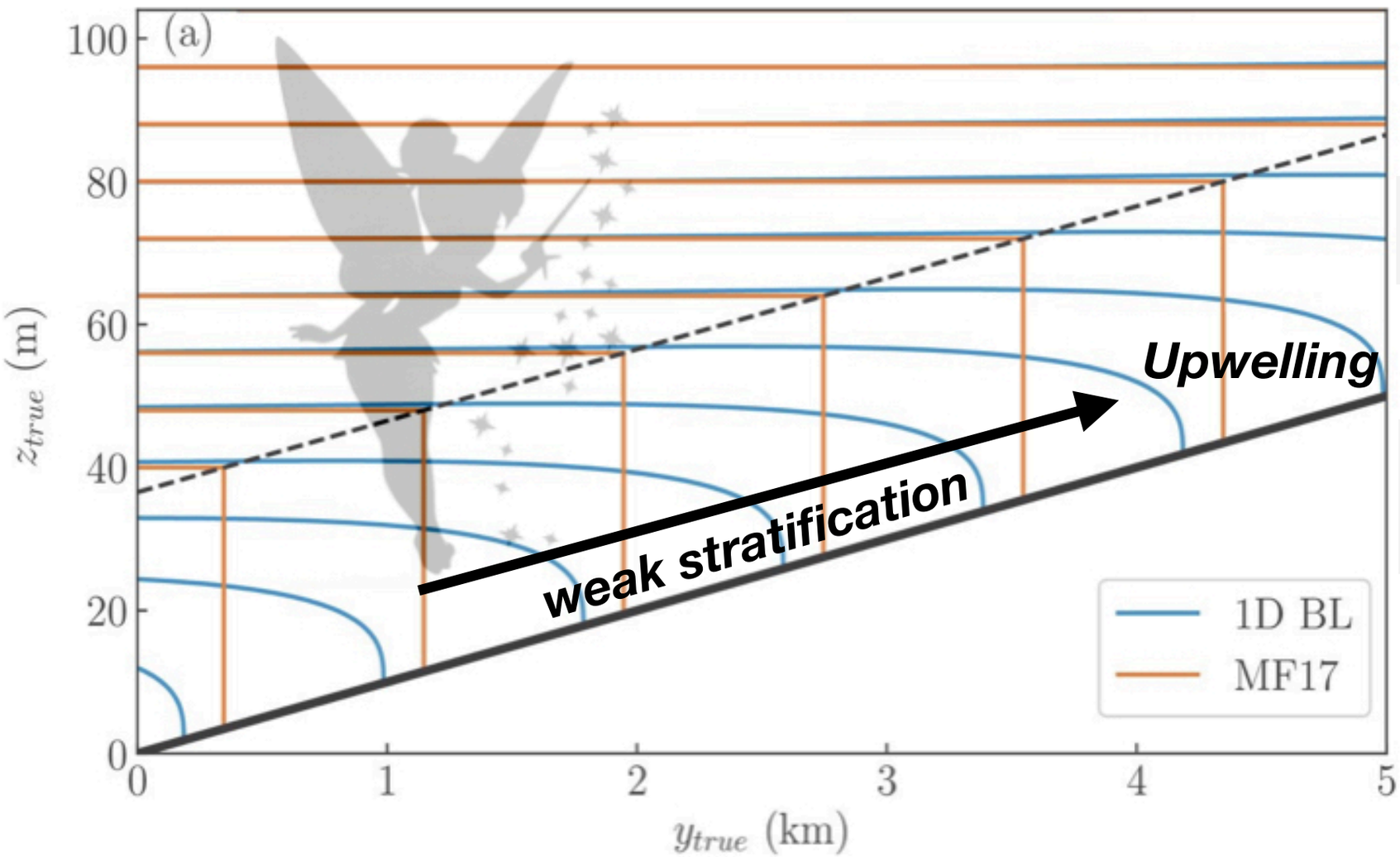
The "one-dimensional" model

See Polzin and McDougall (2021)

Assumptions

- **Subinertial ……..**
- **Isotropic mixing ……**
- **Flux-gradient relation for buoyancy …**
- **No-normal flux bbc dominates …….**

- **Discards coupling of BBL with IW field**
- **Not true for Internal waves**
- **Not true for Convection**
- ***BBC for viscous and form drag dominate***



$$\text{If} \langle w'b' \rangle = \Gamma\epsilon, \Gamma = 0$$

↑

Requires
$$\langle w'b' \rangle|_{\text{bottom}} = 0$$

Given a K(z) profile, or a <w'b'> profile, can solve the entire problem:

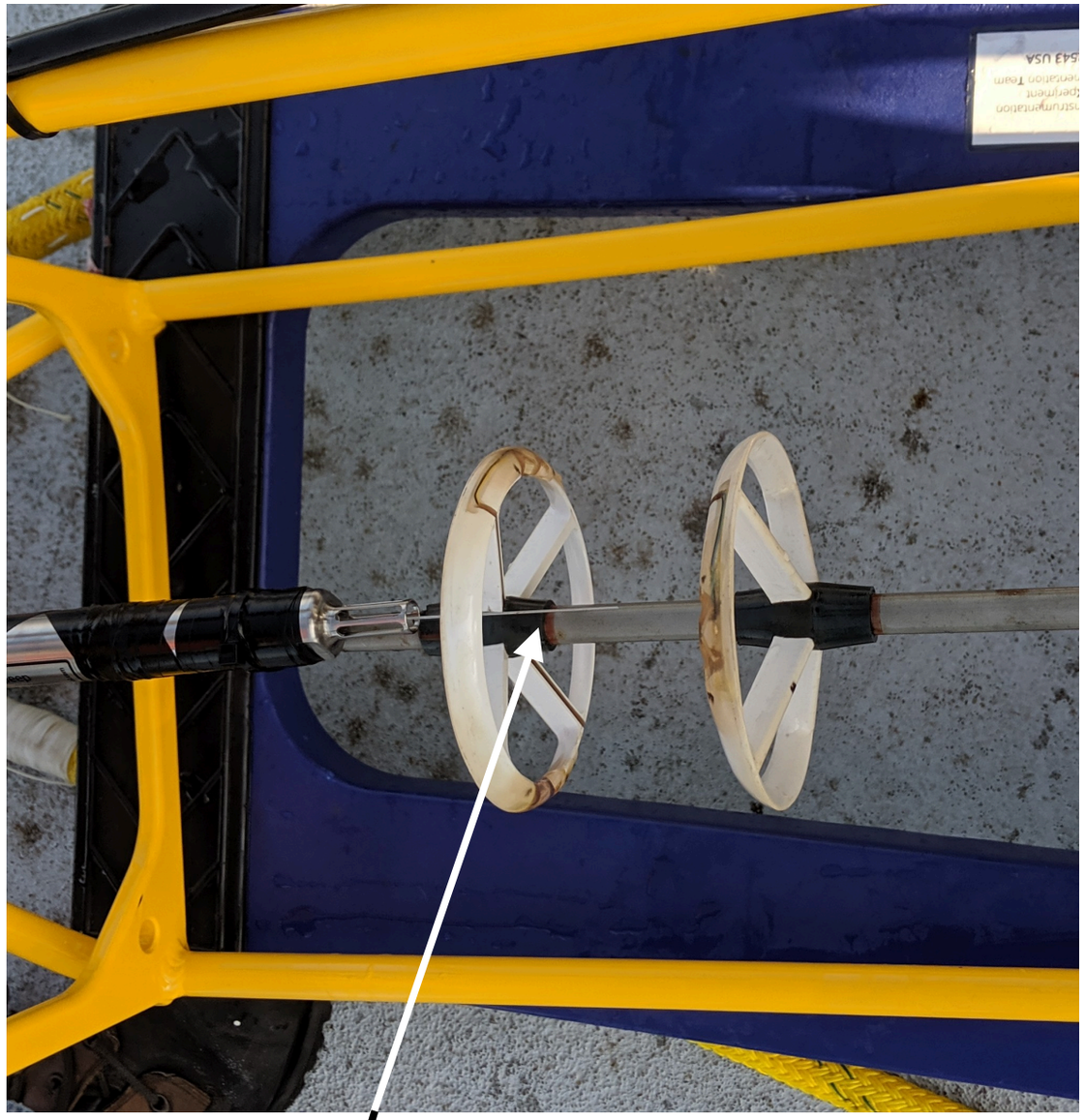
- **Buoyancy field**
- **Residual circulation (aka upwelling)**

Expectations:
buoyancy anomaly
Upwelling as flux -> 0

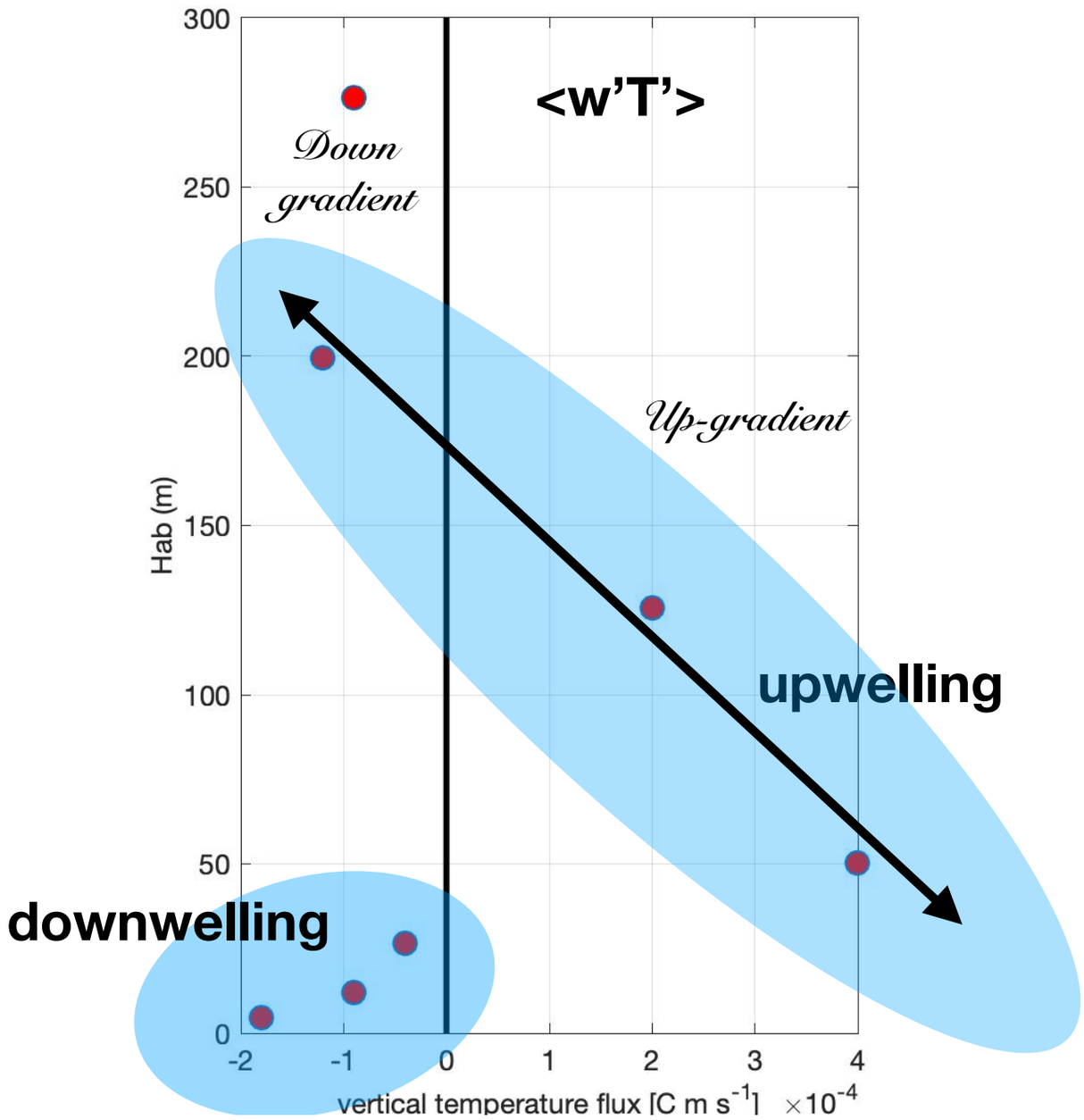
MAVS

Power for 5Hz sampling over 72 days

- **Signal to noise optimization**
- **Convergence of statistics**



fast-T in sampling volume of velocity
fast-T on same time base



Vertical profile <w'T'>

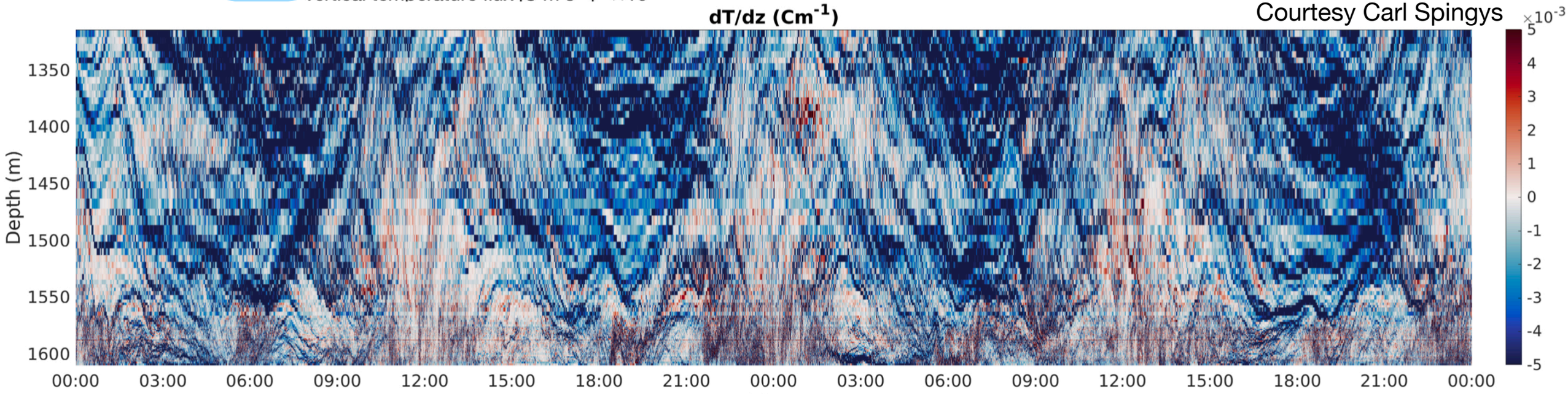
Parsing this as a mixture of convection (flood phase) and shear (ebb phase)

$$w^* = \frac{\partial \langle w'T' \rangle}{\partial z} / \langle \theta_z \rangle$$

$$\frac{5 \times 10^{-4} \mathrm{C\ m\ s^{-1}}}{150\ \mathrm{m}} \frac{1}{4 \times 10^{-3} \mathrm{C\ m^{-1}}} = 8 \times 10^{-4}\ \mathrm{m\ s^{-1}}$$

$$\text{dye}: \ 1.2 \times 10^{-3}\ \mathrm{m\ s^{-1}}$$

Courtesy Carl Spingys



Summary

Upwelling is related to an episodic convection process.

Differential advection of buoyancy initiated by drag

Its not sprinkling mixing on a slope and asking how the buoyancy field adjusts

No-flux condition on buoyancy