JAPAN — PHYSICAL (EXCL. SIMULATION)

GO-SHIP hydrography (JMA, JAMSTEC)

Deep Argo (JAMSTEC)

Pacific hydrography & moorings (AORI)

Antarctic shelf processes (TUMSAT, Hokkaido U.)

Japan Sea hydrography (Kyusyu U.)

Kuroshio current, turbulence (Kagoshima U.)

ITF, Southern Ocean, Pacific turbulence (U. Tokyo)
TURBULENCE IN DEEP OCEAN

Katsuro Katsumata (JAMSTEC)
MIXING TURBULENCE IN DEEP OCEAN

Katsuro Katsumata (JAMSTEC)

Horizontal — isopycnal

Vertical — diapycnal
ISOPYCNAL MIXING

Stirring → (molecular) mixing — scale dependent

Tracer dispersion — industrial & biological applications

Water mass transport — mode & intermediate waters

Difficult to measure, but doable at large scales

Eckart (1948)

Cole et al. (2015)
DIAPYCNAL MIXING — MOC

Diabatic diffusion by wind & tides (and ?…)

Adiabatic upwelling

Munk & Wunsch (1986)
VMP-X

Expendable, (relatively) cheap
Down to bottom
Time efficient (semi-automatic)
CHOKING POINTS

Kawabe and Fujio (2010)

Alford et al. (2013)
Summarise state of knowledge

What are key phenomenon, key space & time scales? Where?

Major gaps/needs for sustained observation

Relevant platforms, sensors, networks — existing & future needs

Draw connection to the other topics on the agenda

Offer up ≥ one recommendation for DOOS
State of knowledge

Isopycnal mixing after stirring — important for tracer dispersion but difficult to measure directly.

Diapycnal mixing driven by wind & tides, enhanced near bottom. Daily and longer periods, but strongly intermittent.

Still insufficient in quality/quantity to close MOC budget.

Direct measurements are accurate but costly. PARAMETERISATION!

GO-SHIP, biogenic turbulence, tracer dispersion.

Spatial coverage with Deep Argo, hydrography, etc. Temporal coverage at choke points.
“Interdisciplinary research often consists of individual disciplinarians standing in a circle, holding hands for mutual comfort, while the problem of interest slips through the middle.”

— S. Beer (1980)
R = 162 km (Purkey & Johnson, 2010)

All WOCE & GO-SHIP CTD’s from CCHDO

9.6\times10^{13} \text{ m}^2 / 3.6\times10^{14} \text{ m}^2 = 26\%
MOC AND MIXING

Nonlinearity in EOS (e.g. Oliver and Tailleux, 2013)

Mixing efficiency (Arneborg, 2011, Bluteau et al., 2013, de Lavergne et al., 2016)

Geothermal heat, biogenic turbulence...
BOTTOM LANDER FOR LONG TERM UNDERWATER SENSING (LOTUS)

Royal Institute of Technology (Sweden)

https://www.ave.kth.se/se/avd/ naval/cute

Study area and PAFOS float trajectories
Study area and RAFOS float trajectories at the LSW level in the western North Atlantic.