DIMES* Shearmeter Overview

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WHOI
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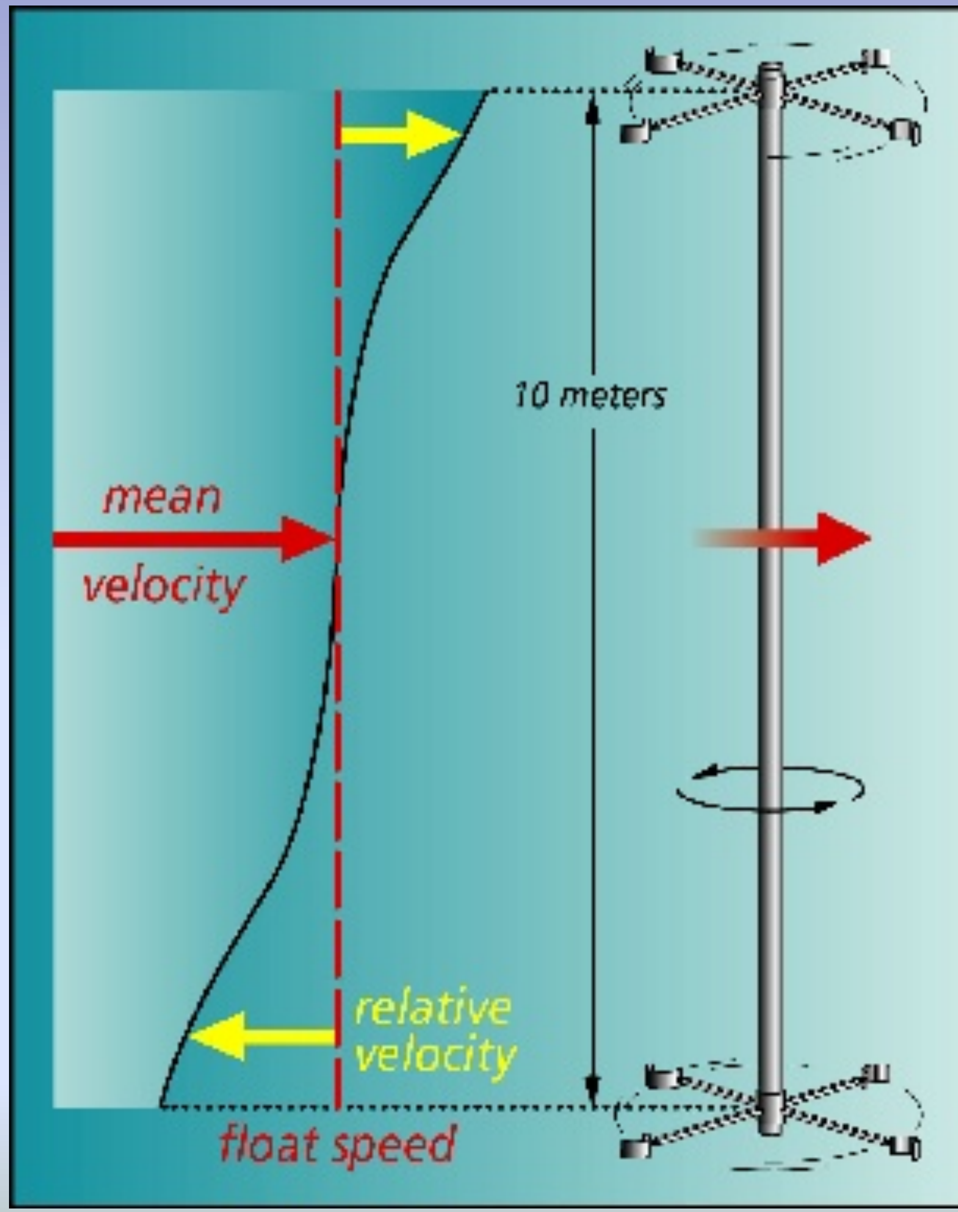
* Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean
USA (NSF) and UK sponsorship

Mission

- Drift on or near isopycnals in the tracer patch and measure continuous Lagrangian time series of internal waves and finestructure in the patch.
- Measure
  - Time series of shear,T, S, N (B.V. freq.), gradient Ri #
- Compute
  - One-year mean values of each
  - Statistics and nature of spatial/temporal variability.



10 meters
mean
velocity
relative
velocity
float speed

DIMES Shearmeter Specs

- **Protocol**
  - Isopycnal drift, continuous sampling
  - RAFOS localized
  - Data retrieval via Iridium
- **Measurements**
  - Shear via rotation (7.3 m vertical separation)
  - CTD upper end
  - T lower end
  - GPS
- **Derived**
  - Gradient Richardson number
  - Vertical Strain
  - Trajectory
- **Sampling**
  - 6 to 10 per hour

DIMES Shearmeter Components

- **Measurement**
  - 36-inch shearmeter vanes each end
  - PNI 3-axis attitude
  - Seabird SBE41CP CTD (Coriolis model)
  - Seabird SBE38 OEM T
  - Garmin GPS
  - Seascan Inc. RAFOS receiver
- **Control**
  - WHOI AEL Shearmeter/VBFC * board set (Persistor PC)
  - Webb Research APEX screw-jack buoyancy changer
  - Galvanic ballast release
- **Communication**
  - Iridium modem
  - Webb Research dual GPS/Comm antenna
  - PC control port / multiple sensor serial ports
- **Power**
  - Alkaline batteries, 6 strings of 10 D cells.

* Variable buoyancy float controller

DIMES Shearmeter Mechanical

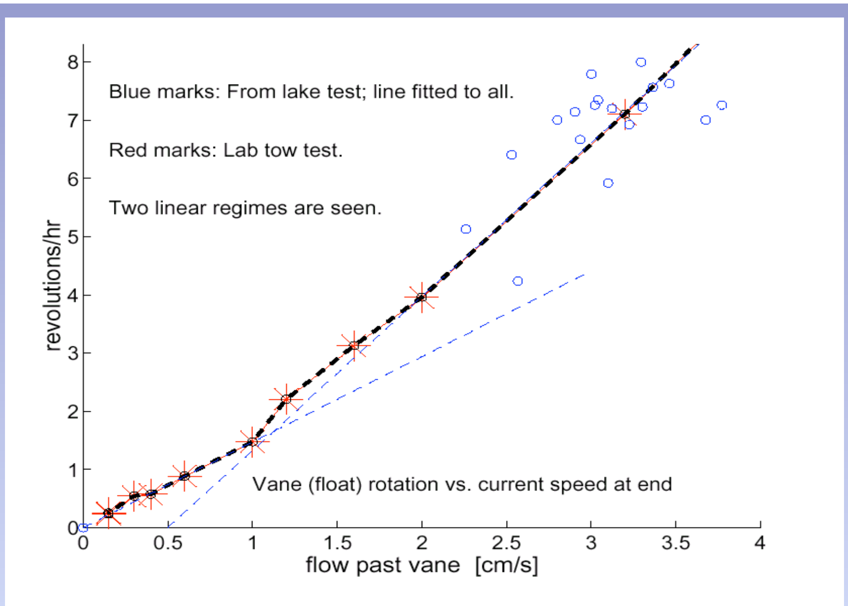
- 24-foot by 4.5-inch OD pressure case
  - ¼-inch wall
  - 6061-T6 alloy
  - Not anodized
  - 1800 m operating depth
- Hard-coated 6061 end assemblies
- Estimated mass 80 kg (tube displacement 77)
- Estimated payload 30 kg
- Dual drop weights
- 230 ml volume (buoyancy) adjustment

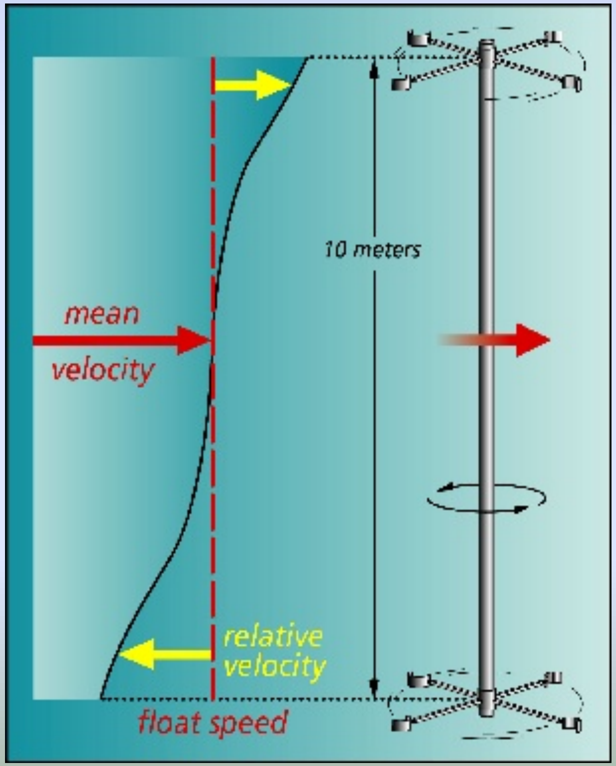
DIMES Shearmeter Version 2

2nd deployment will have a float with a sensitive tilt sensor to provide shear direction θ ($\mathbf{S} = S\ exp(i\theta)$)

A system to move an internal mass is needed to de-stabilize the float to allow tilt from the very low torques expected from shear. A feed-back control system is needed to find the balance point and then move the center of mass downward o(2 cm).

Shear Measurement Calibration





$$\frac{C_{DF}}{C_{DR}} = \frac{(U+\Delta u)^2}{(U-\Delta u)^2} \cong 1 + 4\left(\Delta u/U\right) + 8\left(\Delta u/U\right)^2$$

High speed:

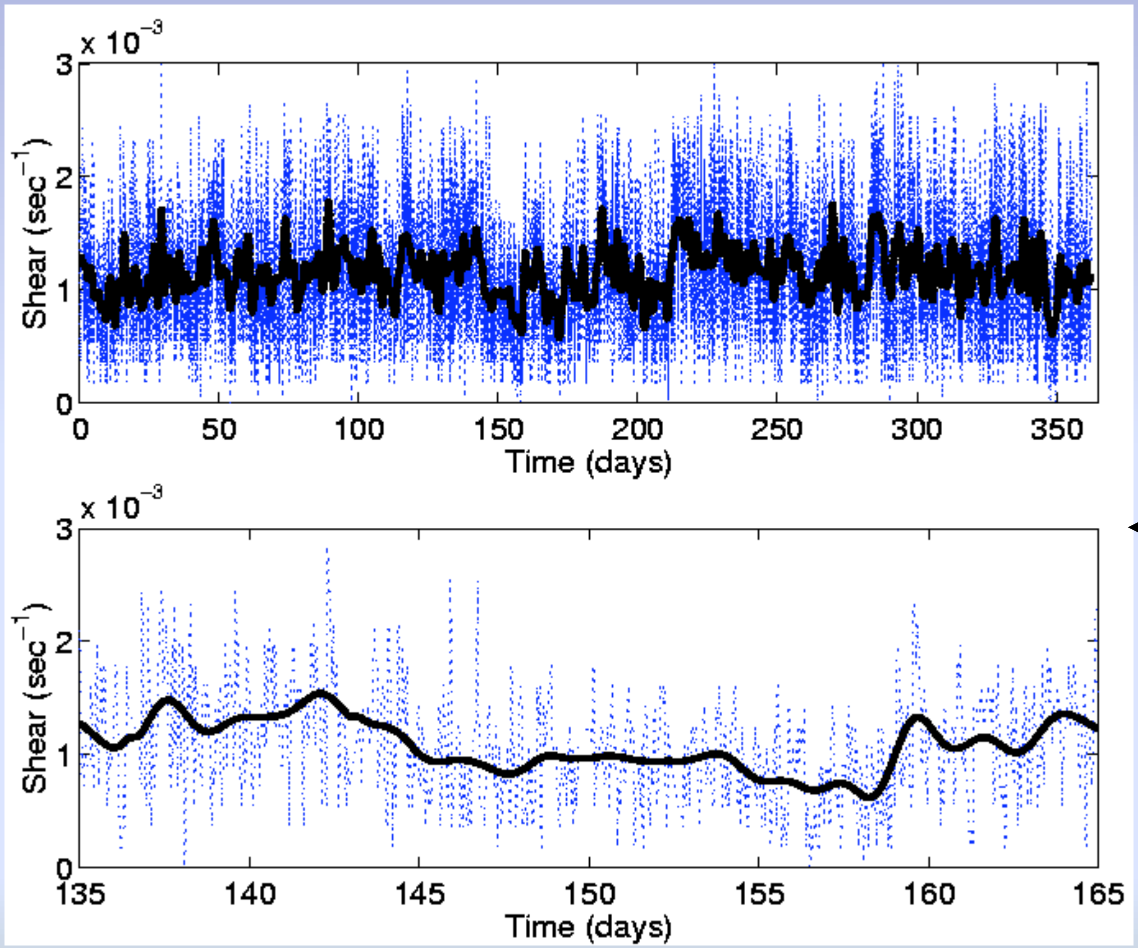
$\Delta u/U = 0.18$; $C_{DF}/C_{DR} = 2.0$

Low speed:

$\Delta u/U = 0.10$; $C_{DF}/C_{DR} = 1.5$;

Minimum $Re = 120$

Example data : Hourly |Shear|, BBTRE

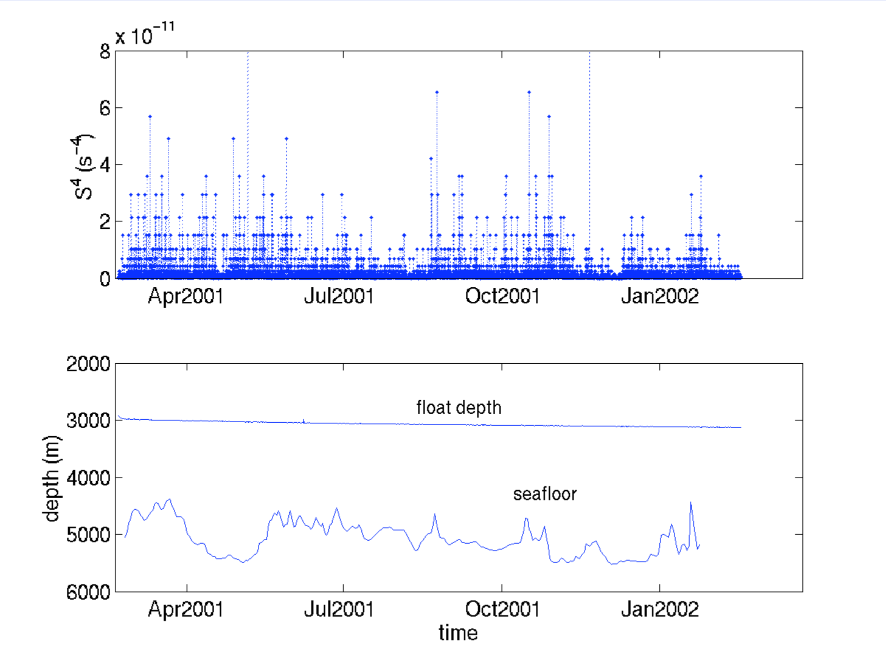


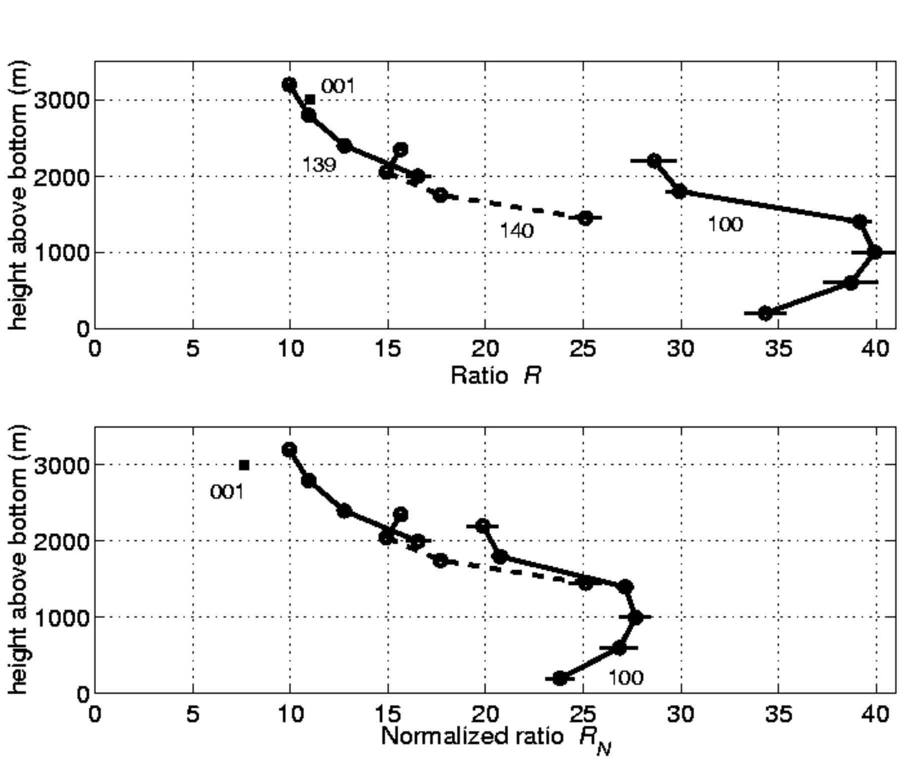
3 cm/s current difference at delta-z = 10 m

GAGE and BBTRE Atlantic results. Four floats.

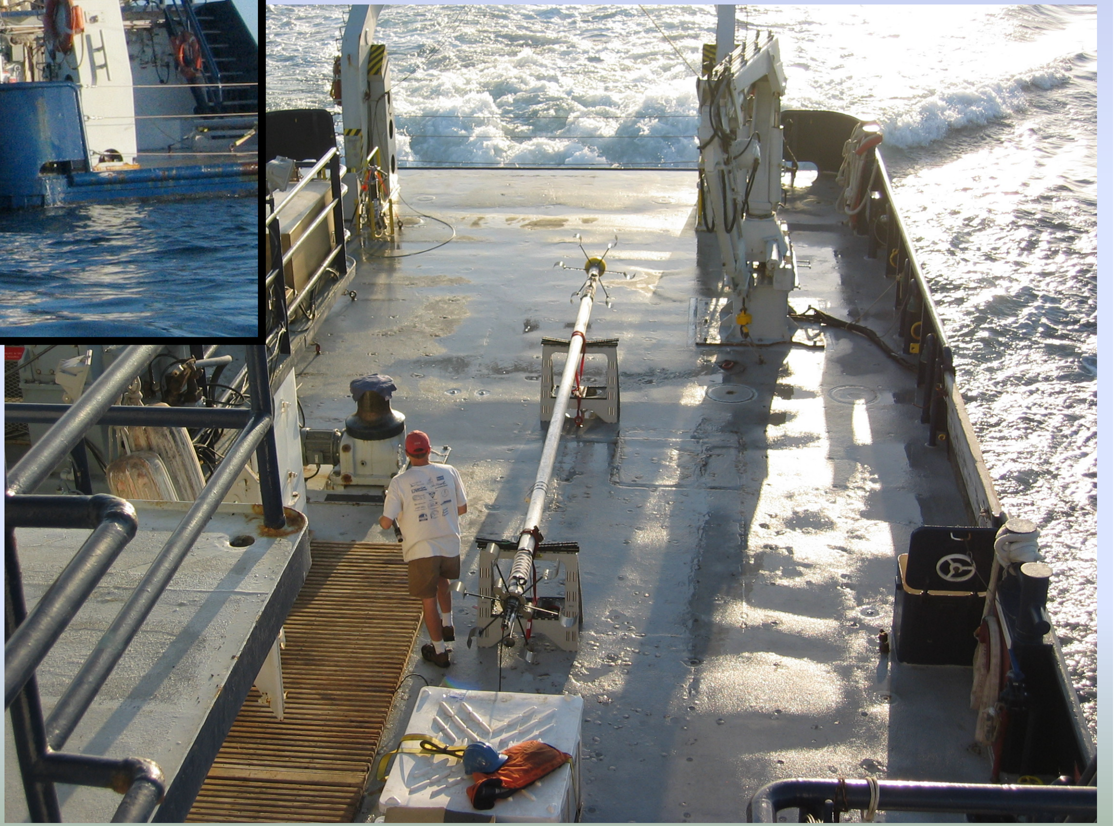
Shear to the 4th power, normalized using the Garrett-Munk model level, plotted as a function of height above bottom (right, upper). Also, further Normalized to take into account differing seafloor roughness and rms tidal velocity in the two areas, North and South Atlantic (right, lower).

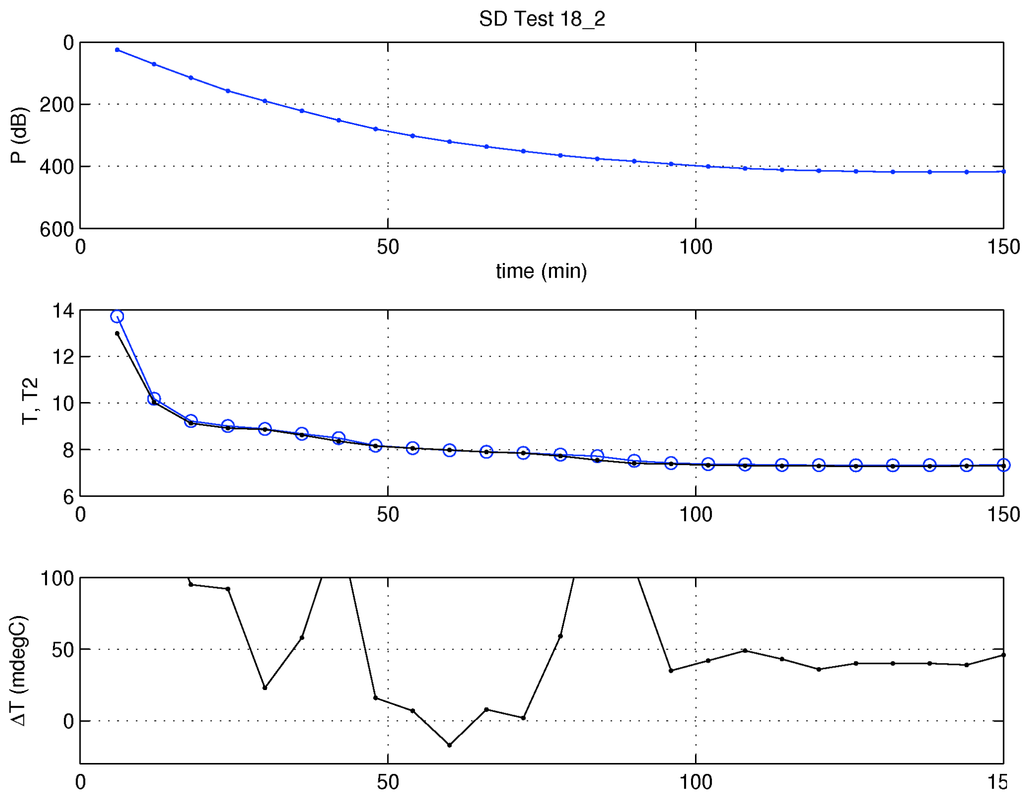
These *R* (normalized shear^4 values) are proportional to *K* using Henyey/Wright/Flatte'/Gregg/Polzin/Toole/Schmitt internal-wave dissipation scaling

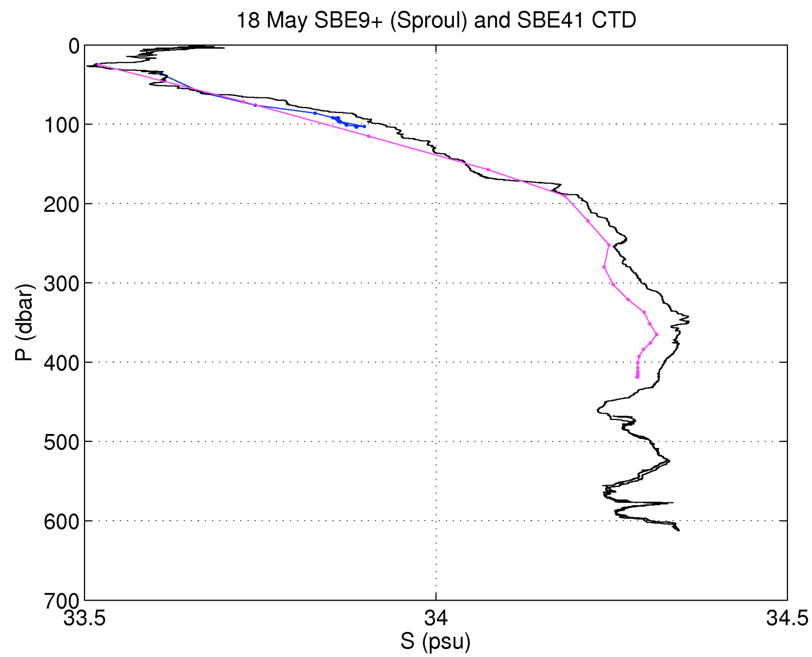




DIMES Shearmeter tests.
San Diego CA, May 2008.



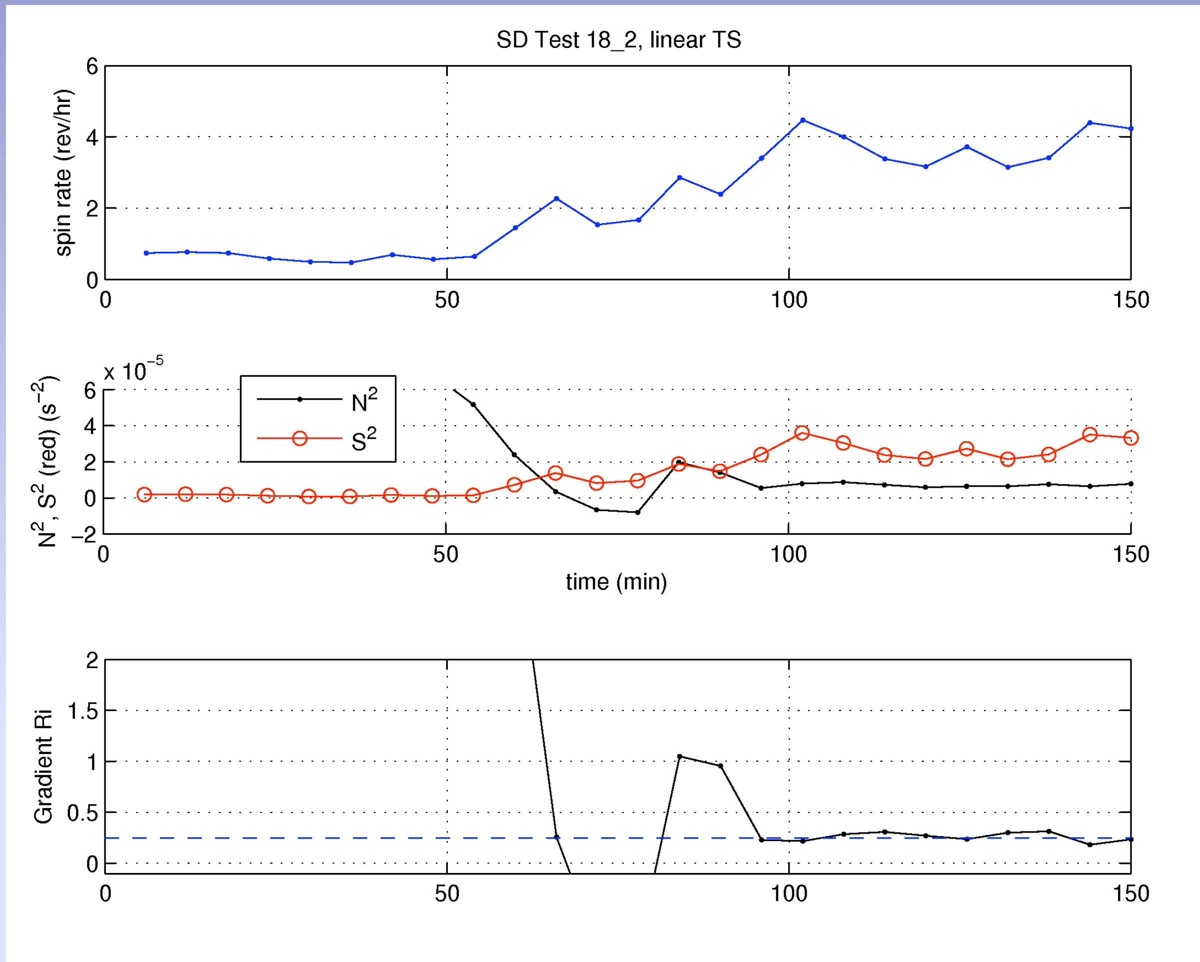




San Diego tests, final day, 18 May 2008.

Above: Pressure, upper/lower temperatures, and temperature difference, test 18_2.

Right: Salinity profiles from Shearmeter CTD (18_1 and 18_2) and ship CTD.



Shearmeter shear and Richardson number results. Linear TS fit to upper TS data used to compute density at lower end.

Test 18_2, 18 May 2008, near San Diego. Float spins up as settling depth is reached (100 min). Ri near ¼ (!!) High shear and rapid drift, 0.5 m/s northward just W of Coronado Escarpment.

- Left: Float density vs. depth at fixed buoyancy, controlled by float compressibility. 2.0e-6, 2.36e-6 and 2.6e-6 fractional volume change per decibar shown, each with +/- nominal density error (50 gram equiv.)
- Right: Float depth versus buoyancy adjuster position. Analysis shows that we will be able to adjust to drift at tracer (target) depth for each of the nine scenarios.