Coastal turbulence

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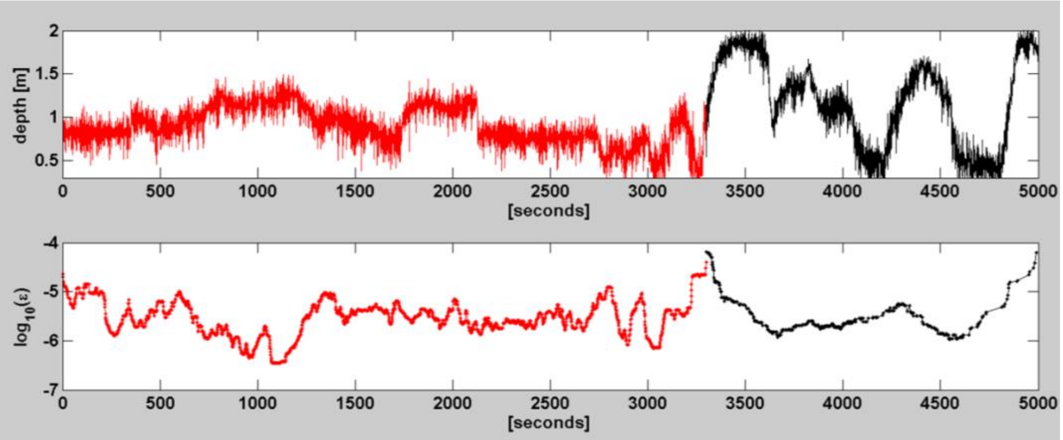
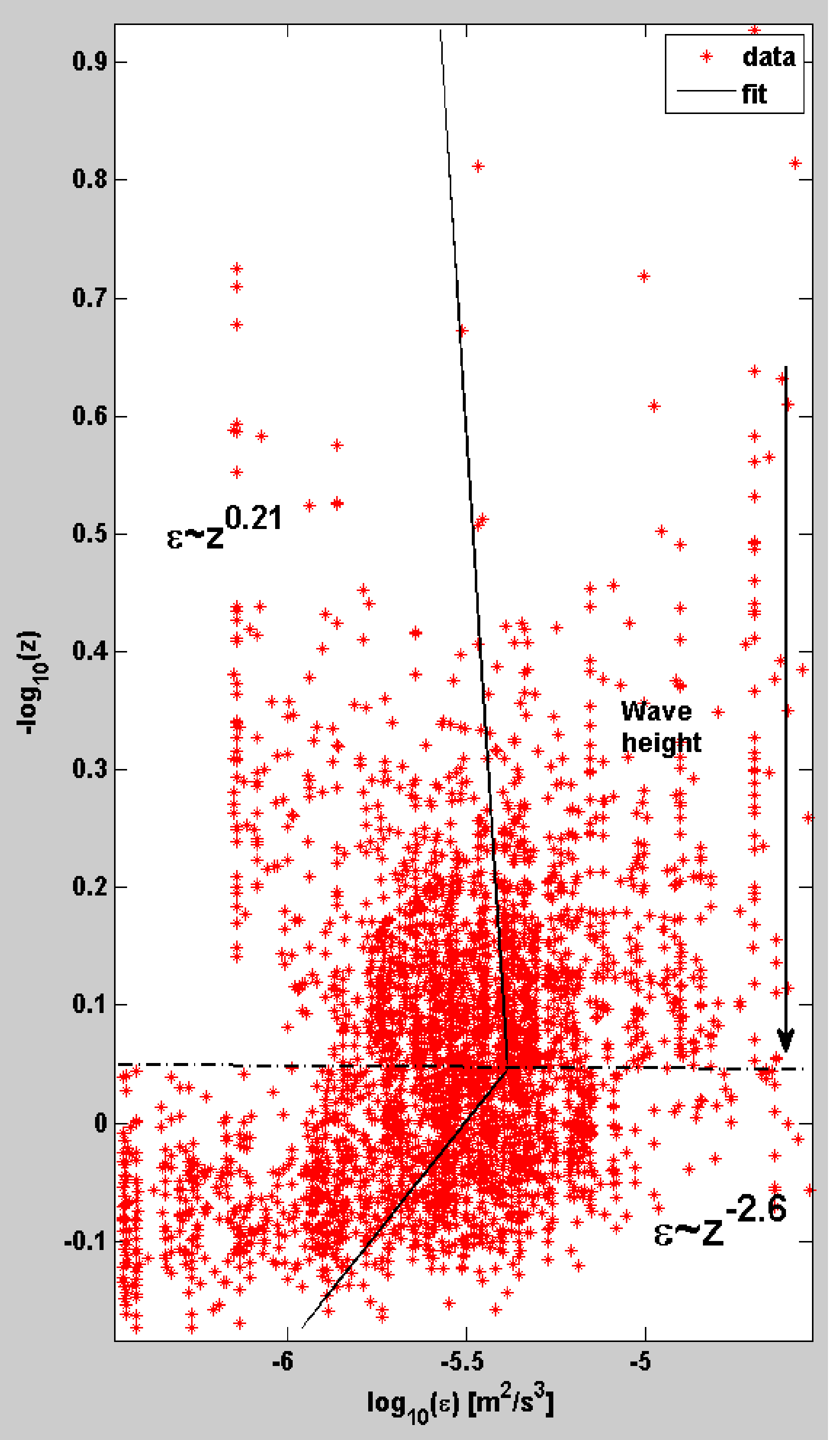
The energy dissipation rate ε within 0-2 m depth



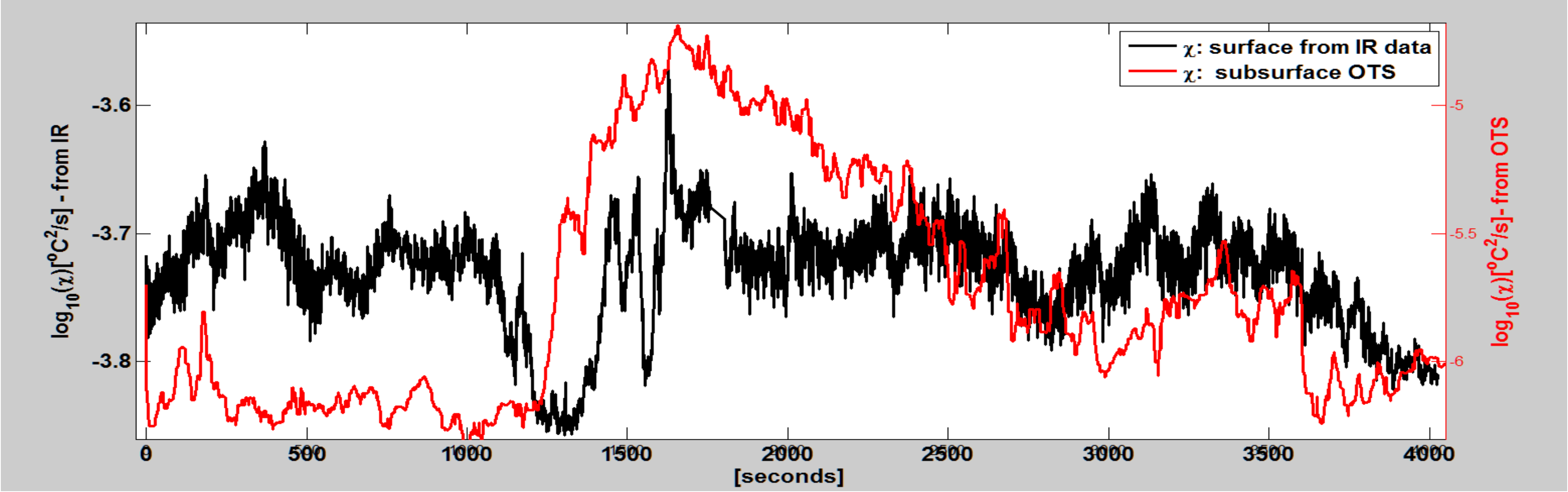
The time series of depth and temperature dissipation
The red denotes the origin of the data in ***ε(z)*** plot.

- Data are from 3250 second long tow at 1m/s

- Within the wave affected water column (0-0.9 m depth) $\varepsilon(z)\sim z^{0.21}$ i.e. weakly depends on depth.
- Below that depth $\varepsilon(z)\sim z^{-2.6}$

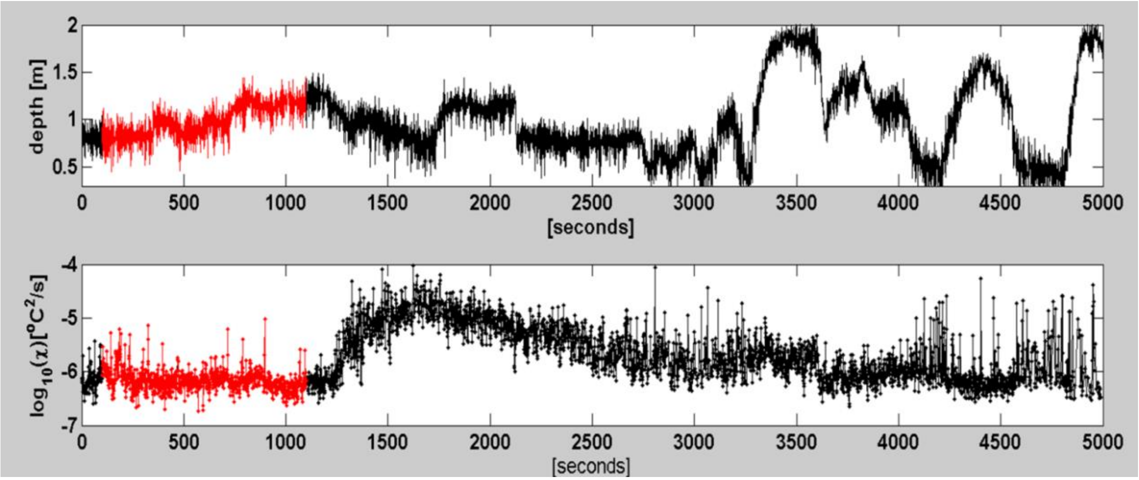


Time series of surface and subsurface temperature dissipation rate



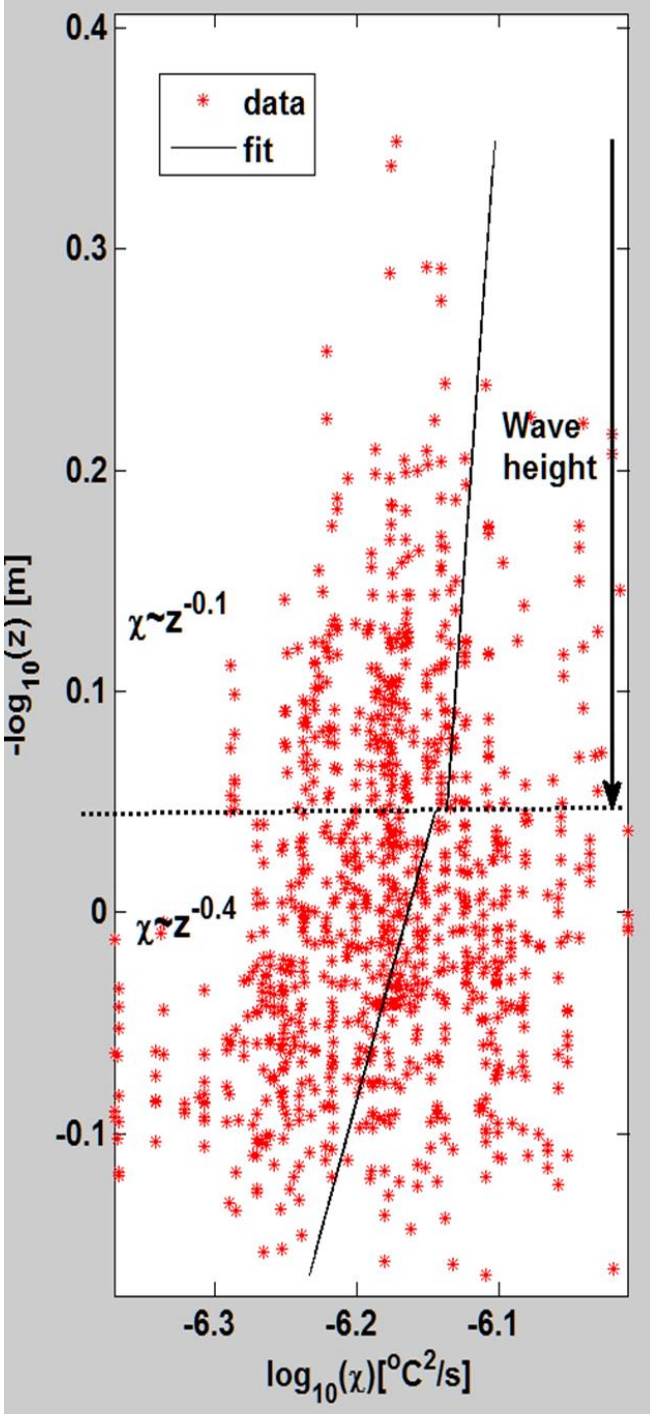
- 4000 seconds of surface and subsurface temperature dissipation rate χ collected during 1m/sec tow.
- **Surface - skin**: for each IR image we calculate $\partial T/\partial x$ and $\partial T/\partial y$ at the dissipation scale length interval – IR 10Hz rate.
- We have estimated the temperature dissipation rate from IR surface data $\chi_{z=0}$ as: $\chi_{z=0} = 2D_T[(\partial T/\partial x)^2 + (\partial T/\partial y)^2 + (\partial T/\partial z)^2] \cong 3D_T[(\partial T/\partial x)^2 + (\partial T/\partial y)^2]$
- **Subsurface (0-2 m)**: OTS temperature dissipation spectra and χ at 5000 spectra/second as 1 second average.

The temperature dissipation rate $\chi(z)$ at 0.5-1.5 m below surface.

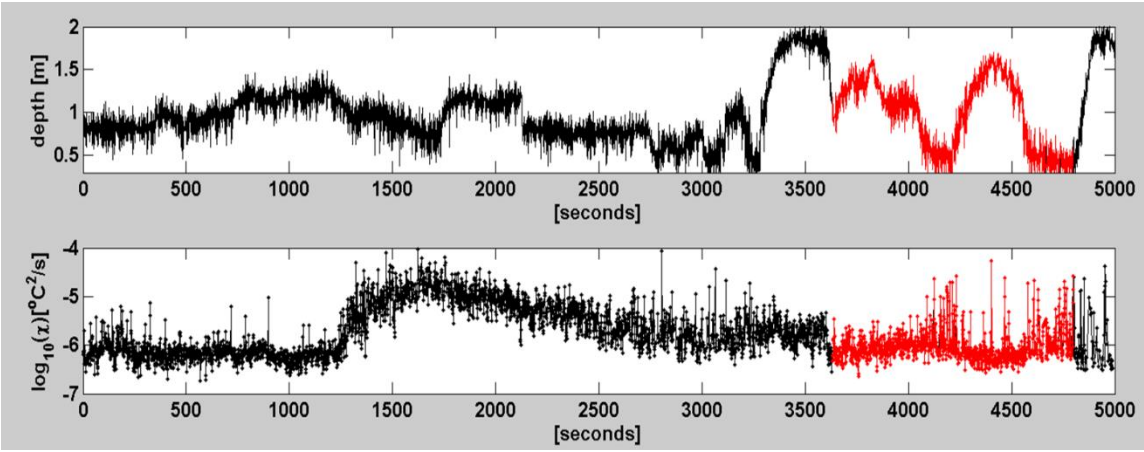


The time series of depth and temperature dissipation
The red denotes the origin of the data in $\chi(z)$ plot.

- The temperature dissipation rate χ as a function of depth (0-2 m) below surface).
- Within the wave affected water column (0-0.9 m depth) $\chi(z)\sim z^{-0.1}$ - weak depth dependence
- Below that depth $\chi(z)\sim z^{-0.4}$



The temperature dissipation rate $\chi(z)$ at 0-1.5 m below surface.

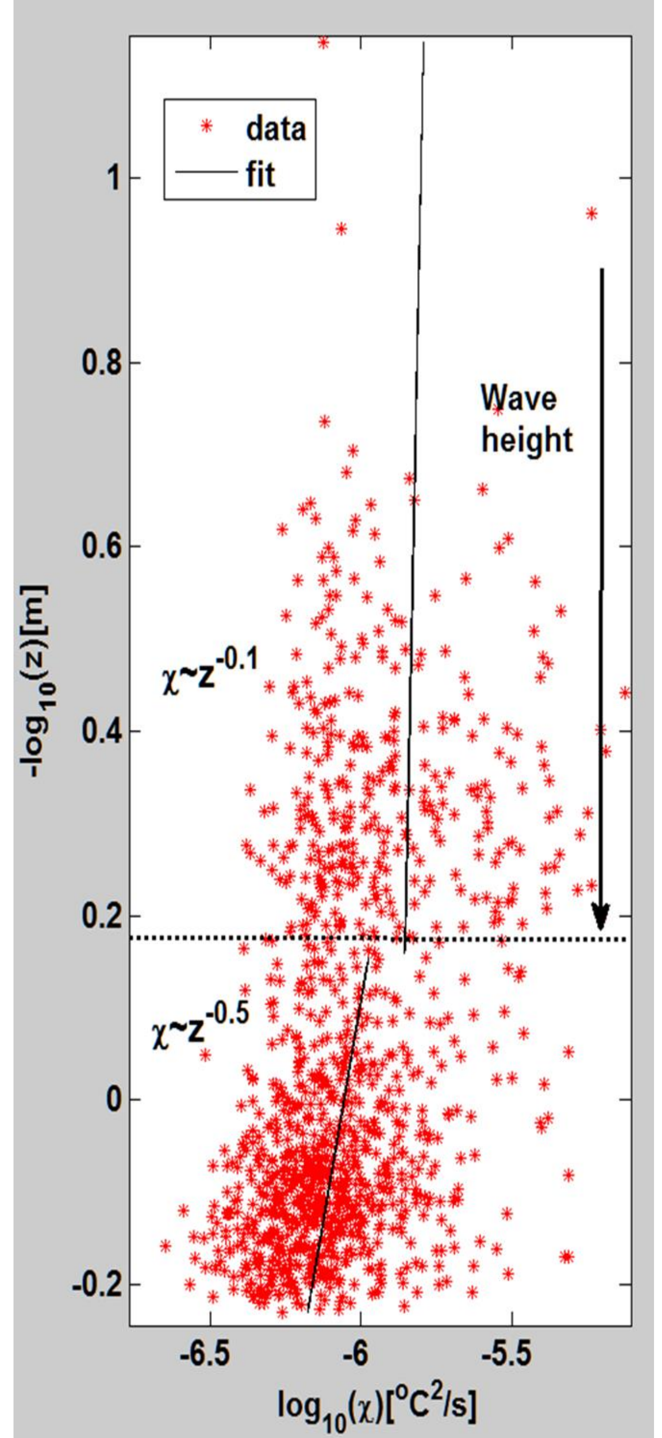


The time series of depth and temperature dissipation
The red denotes the origin of the data in $\chi(z)$ plot.

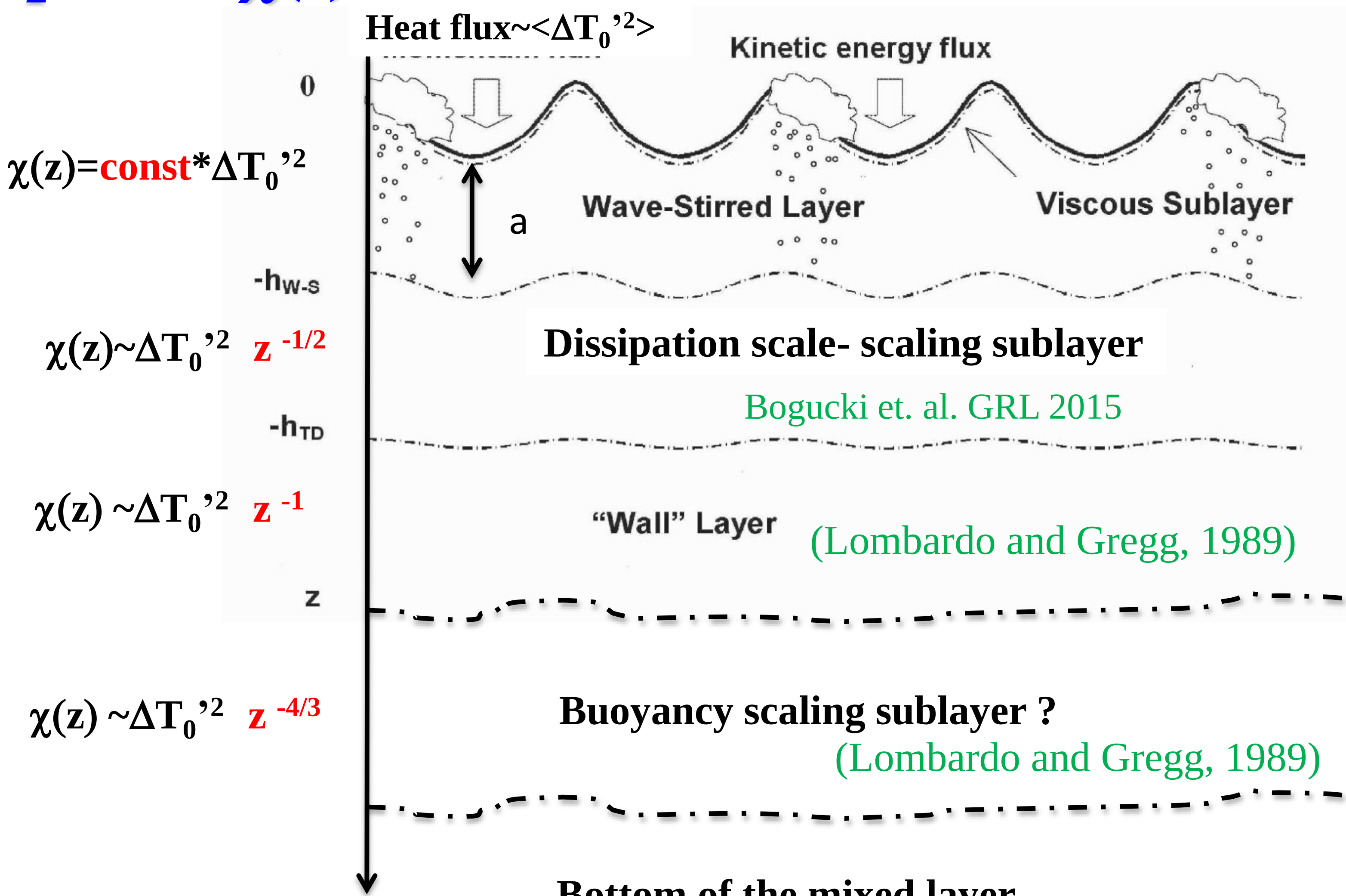
- The temperature dissipation rate χ as a function of depth (0-2 m)below surface.

- Within the wave affected water column (0-0.9 m depth) $\chi(z) \sim z^{-0.1}$ and weakly depends on depth.

- Below that depth $\chi(z) \sim z^{-0.5}$

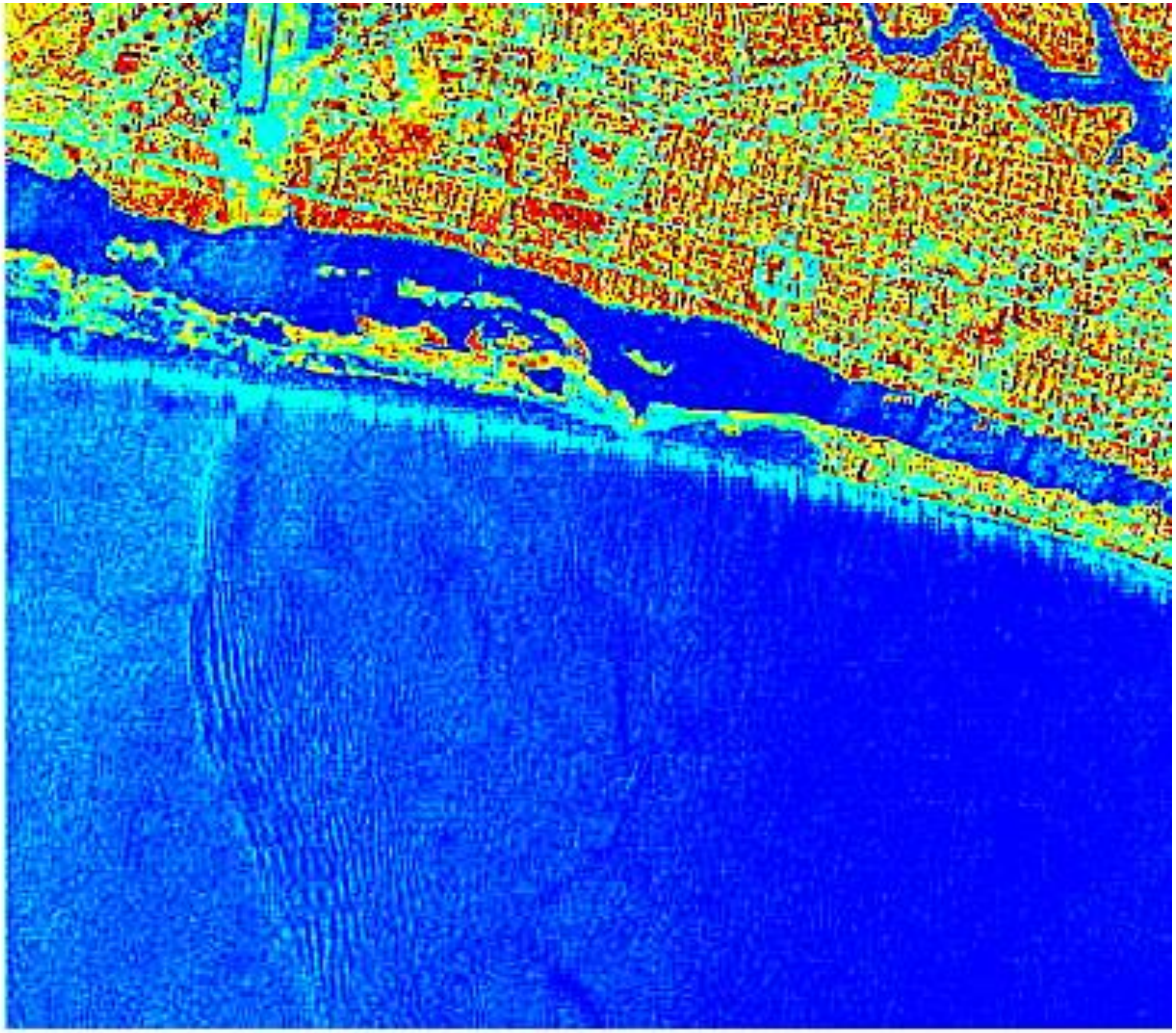


Conclusions: Vertical structure of the temperature dissipation $\chi(z)$



- December 17: No wind small waves
- Rare instance: coastal ocean in the absence of waves and wind

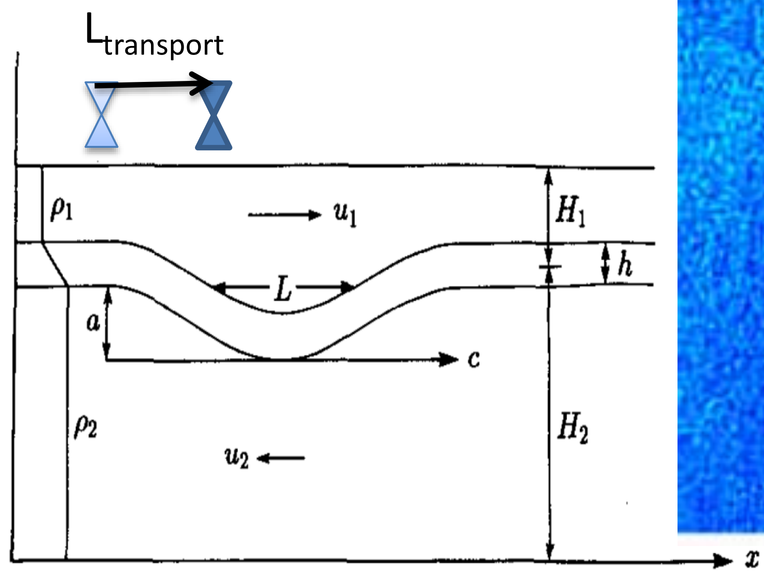
Long internal waves in LASER 2013

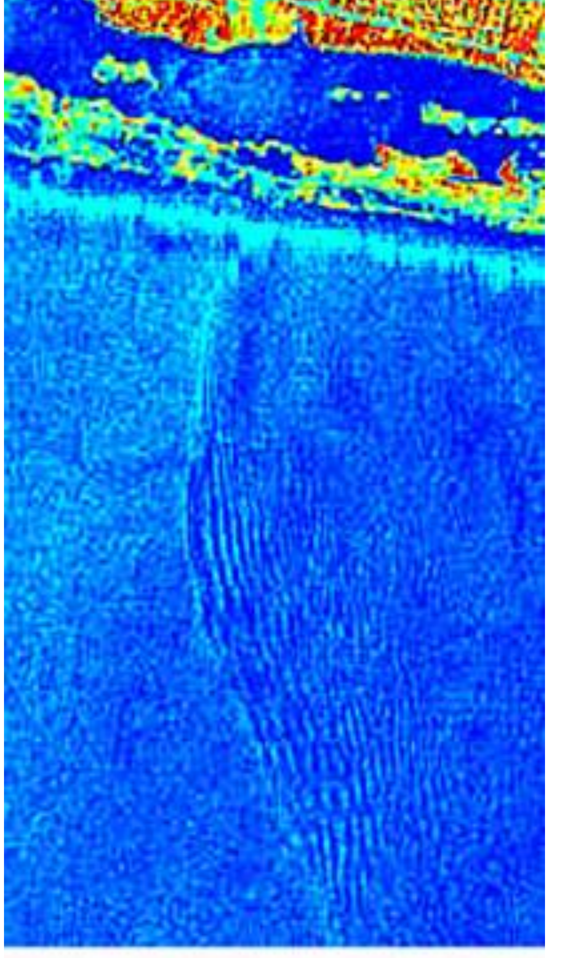


Long internal waves

- For the wave of depression the surface **transport** is in **the direction of the wave propagation**
- Internal wave induced horizontal transport at the surface –$L_{transport}$:

$$L_{transport} = \frac{1}{2}\frac{a}{H_1}L$$





- In LASER 2013: Very thin upper layer: 1 m thick.

- **GLAD values – oil slick stretching/compressing and drifter transport:**

BV max at H_1=7 m, moderate wave amplitude a=3-5 m, L=1km

$L_{transport}$=0.25 -1 km per wave equivalent to stretching/compressing: 1 km to 4 km for each internal *wave packet*.

Long internal waves –LASER 2013

- The properties of long ducted linear internal waves are given by the Taylor-Goldstein equation (Maslowe and Redekopp, 1980) are given by:

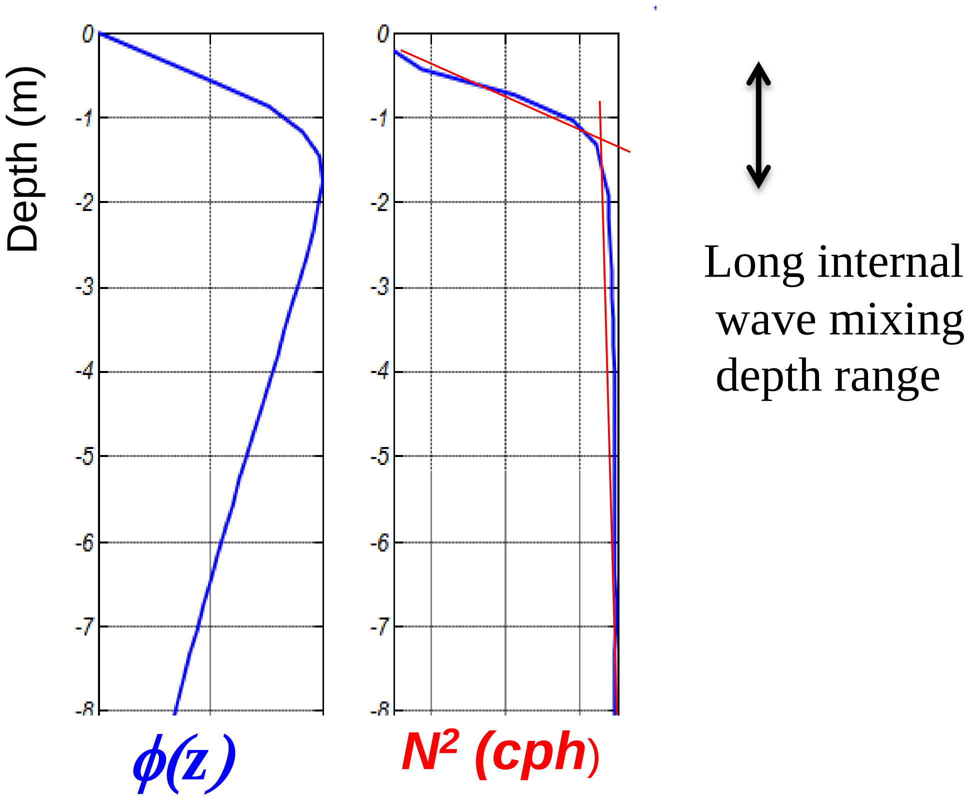
$$\phi'' + \frac{N^2}{(c)^2}\phi = 0$$

$$\phi(0) = \phi(h) = 0$$

- Wave induced *Ri(z)*:

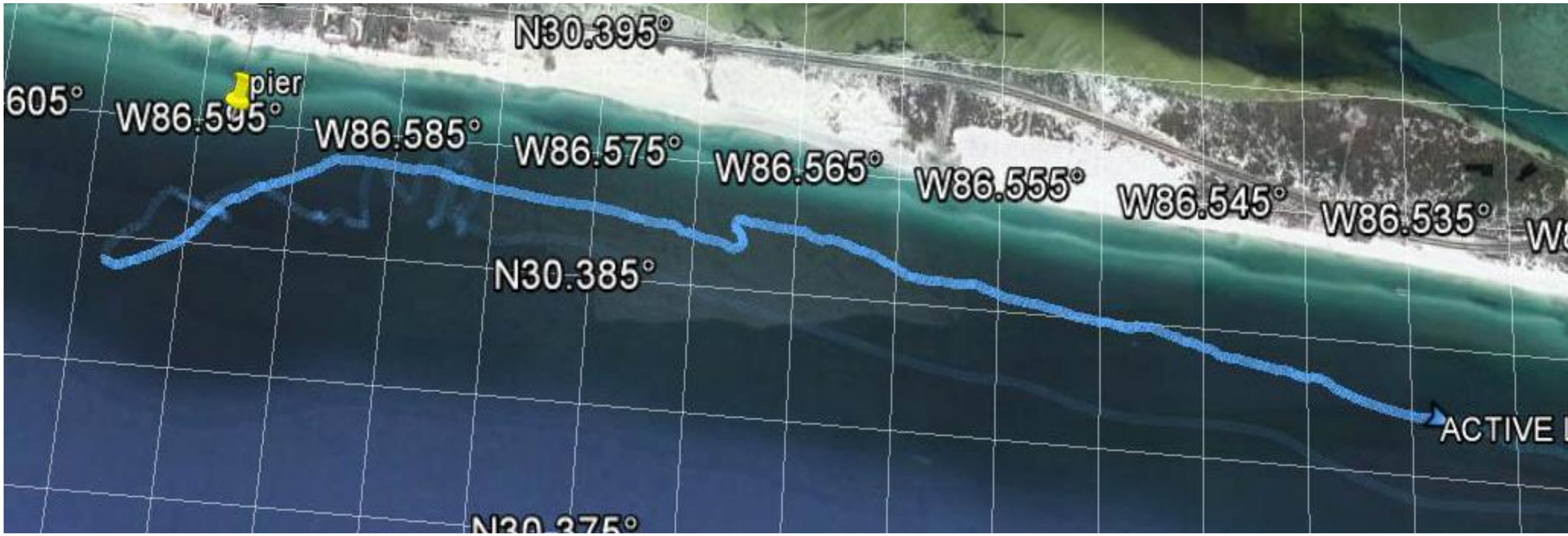
$$\mathrm{Ri}(z') = N^2\left[1 + a\left(\frac{\partial\phi}{\partial z}\right)\right]^5\left[ca\,\frac{\partial^2\phi}{\partial z^2}\right]^{-2}$$

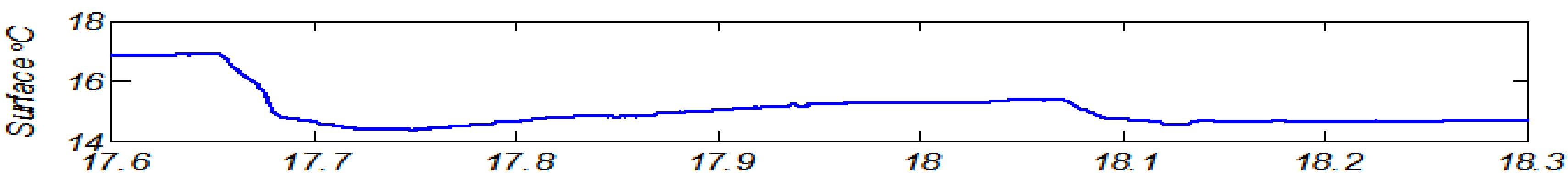
$$= \frac{c_0^4}{c^2}(N^2a^2)^{-2}\left[1 + a\left(\frac{\partial\phi}{\partial z}\right)\right]^5\phi^{-2}$$

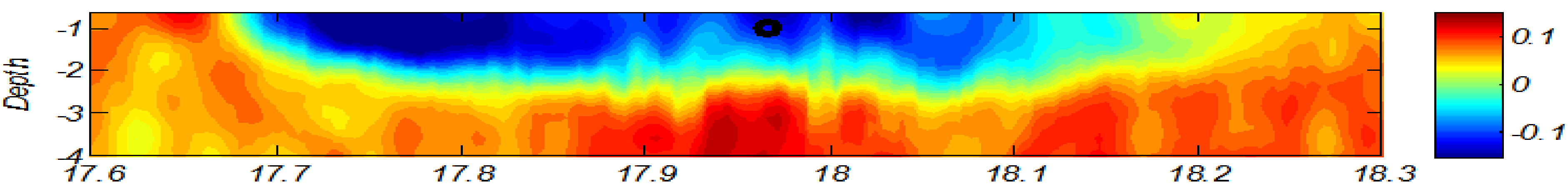


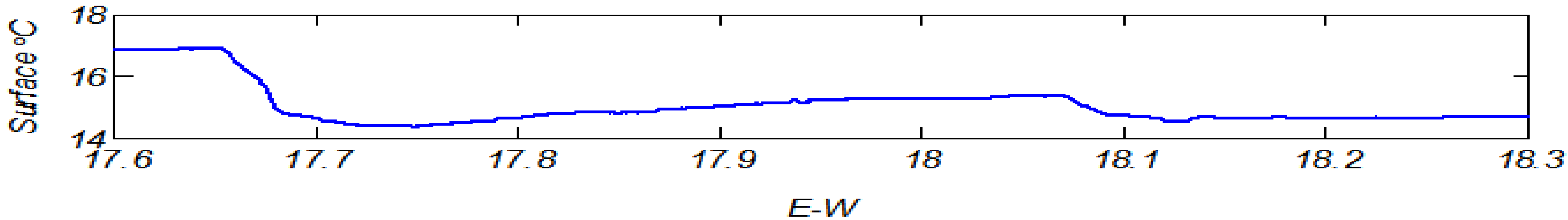
- $\mathrm{Ri}(z) \sim 1/N^2(z)\ \ 1/\phi^2(z)$
- $du/dz(z) \sim 1/\phi(z)$
- The long internal wave mixing most likely at low Ri depth range – i.e. upper 2 m

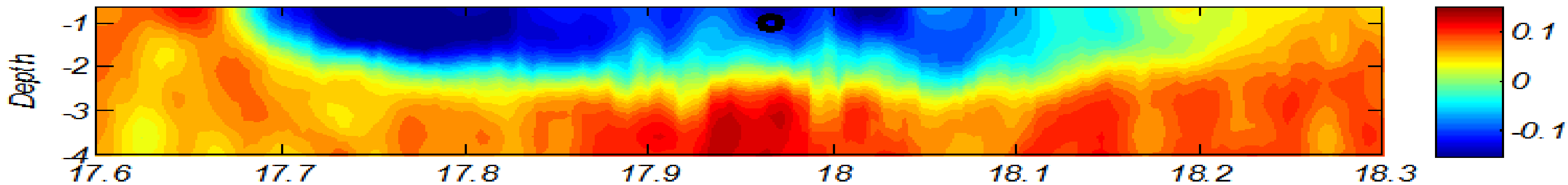
Main Front- December 17, 2013

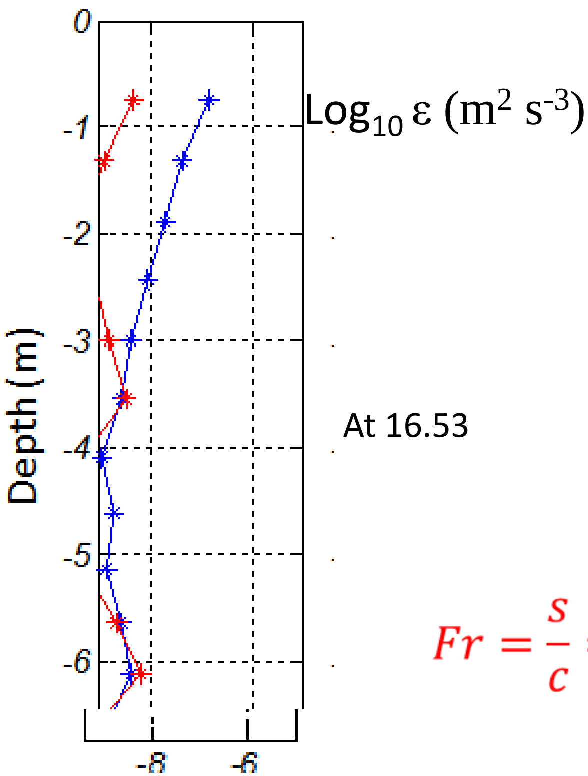




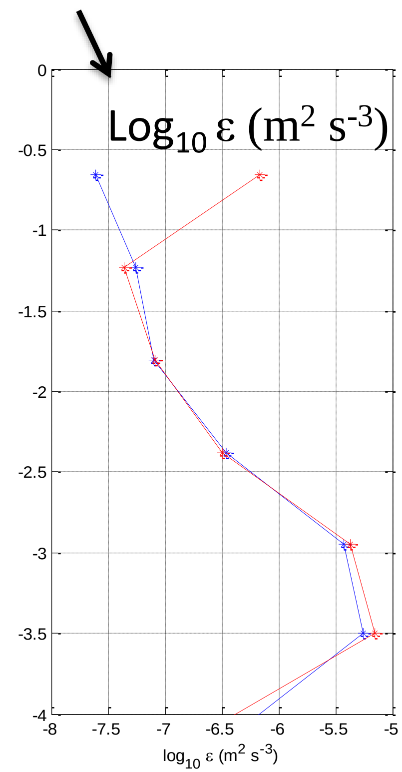


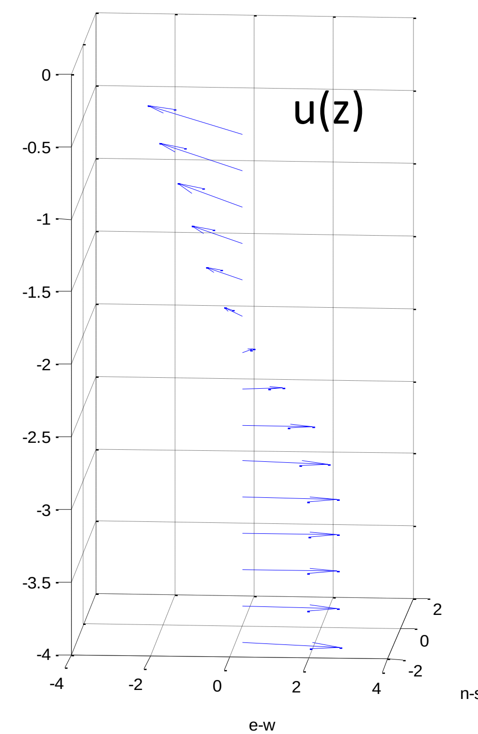




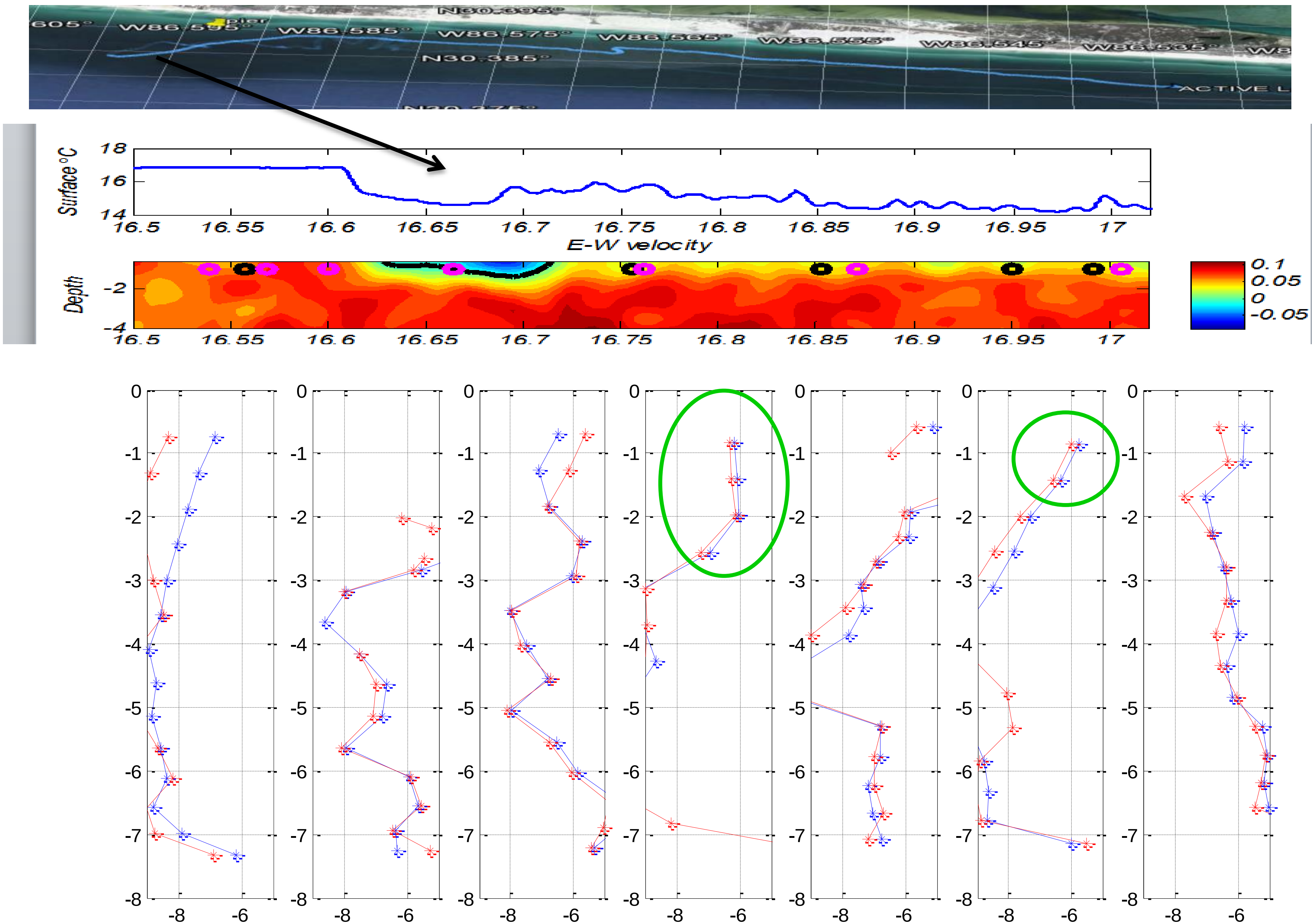


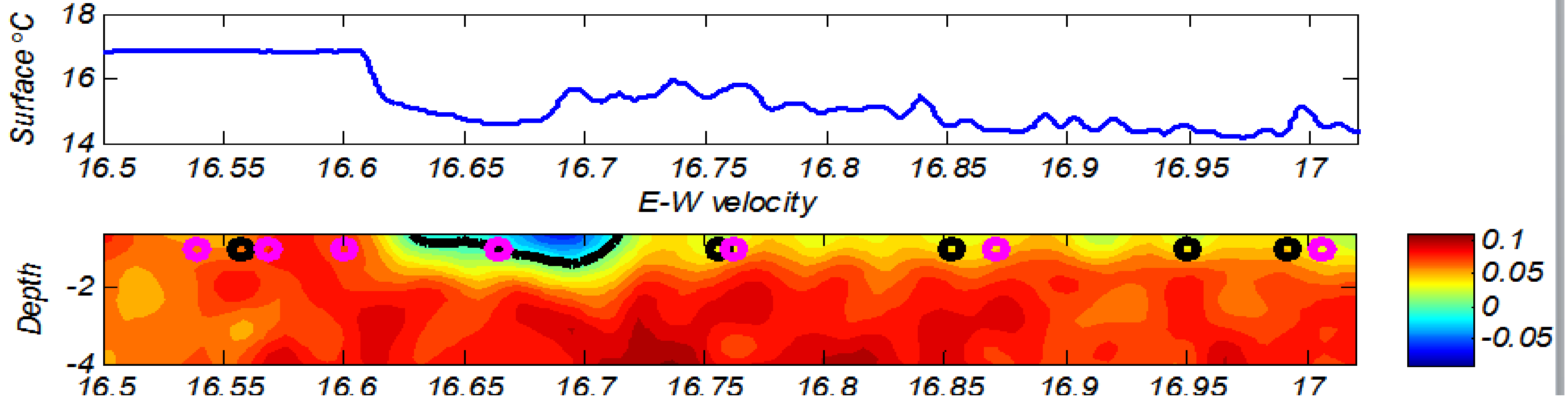
$$Fr = \frac{s}{c} = \frac{.17}{.185} = .92$$





Shear instability





Energy dissipation at 0.9 m