

Predicting turbulence generation on a sloping boundary in a lake using and Aquadopp HR Profiler

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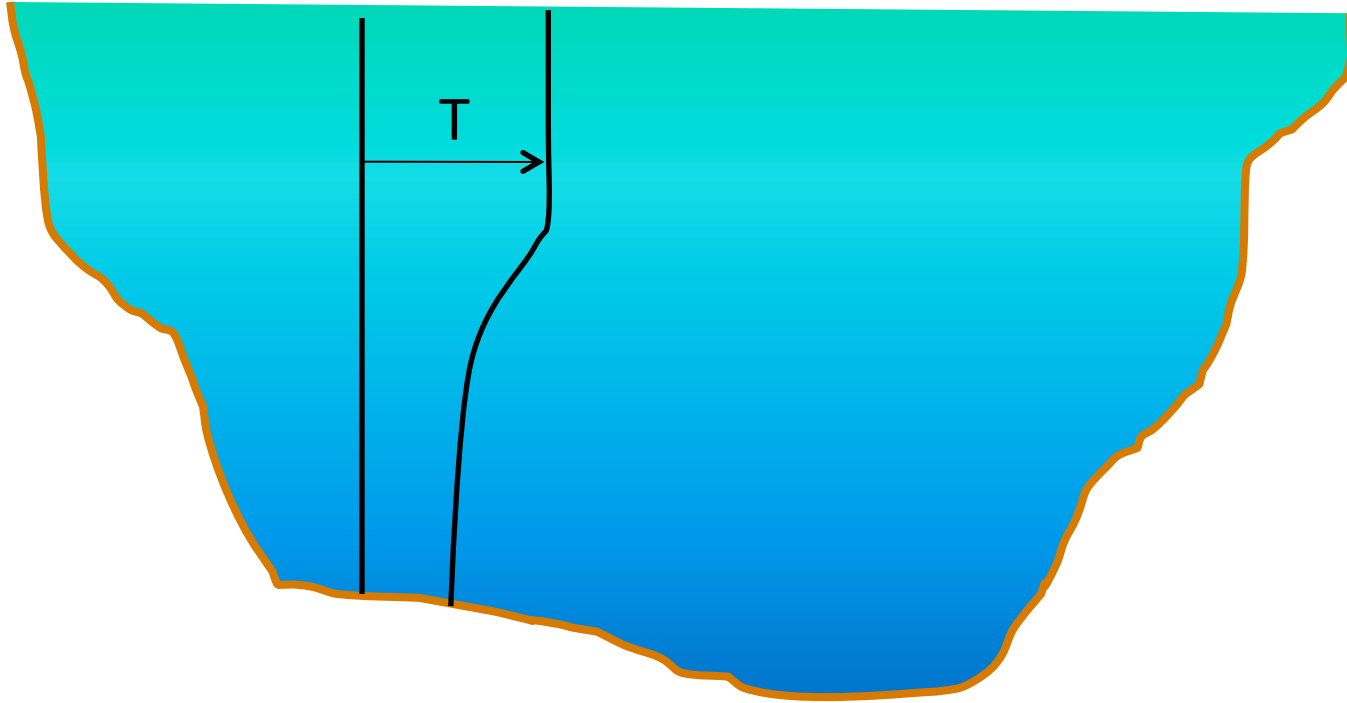
1 June 2015

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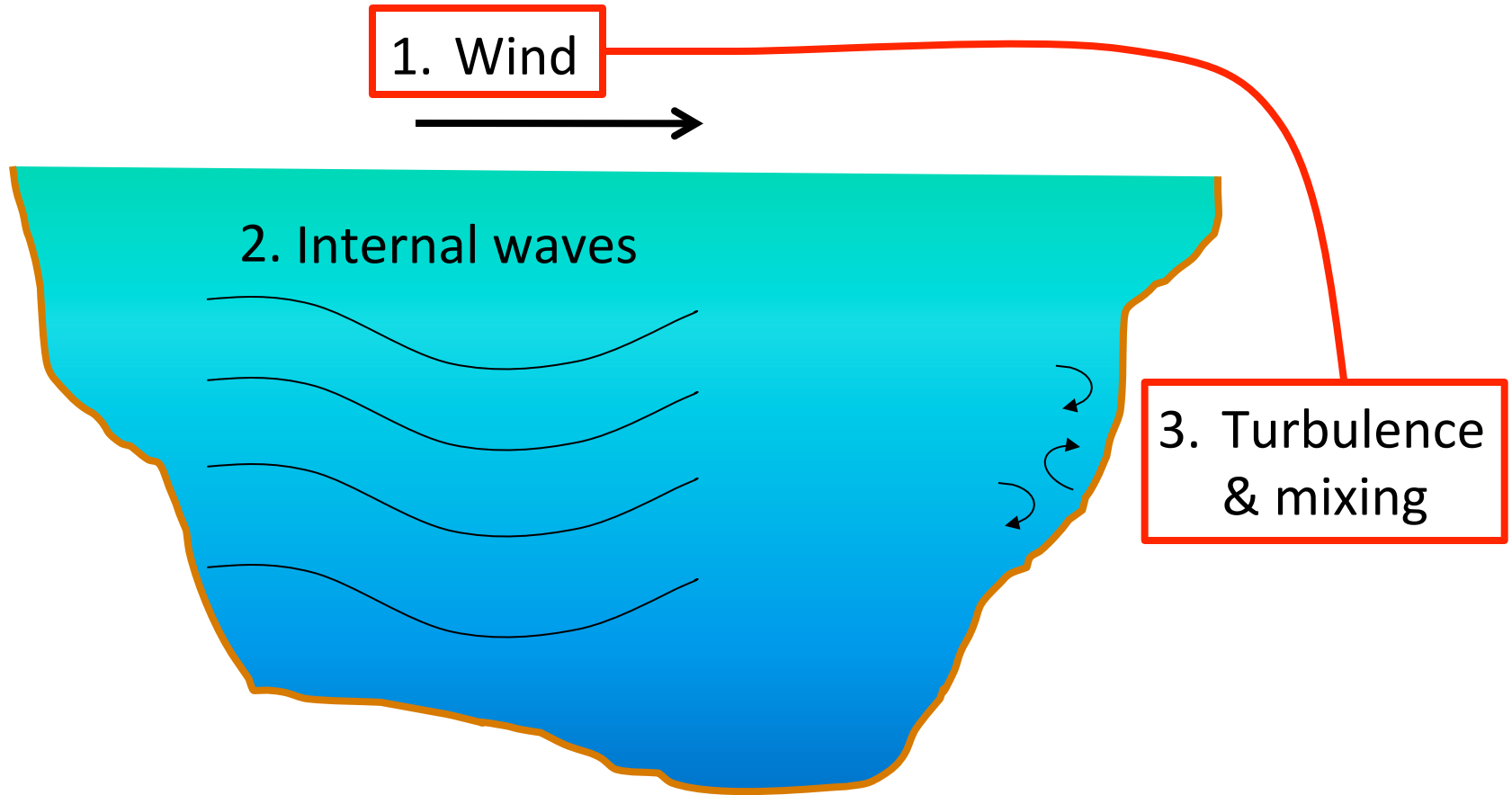


Motivation

1. Wind



Motivation



Can we predict when boundary mixing will occur in lakes?



Lake number

$$S_t = \int_0^{z_S} (z_V - z) \rho(z) A(z) dz,$$

stabilizing forces due to stratification

z_T thermocline height

$$L_N = \frac{g S_t (1 - z_T / z_S)}{\rho_s u_*^2 A_s^{3/2} (1 - z_V / z_S)}$$

z_S surface height

ρ_S surface density

destabilizing forces due to wind

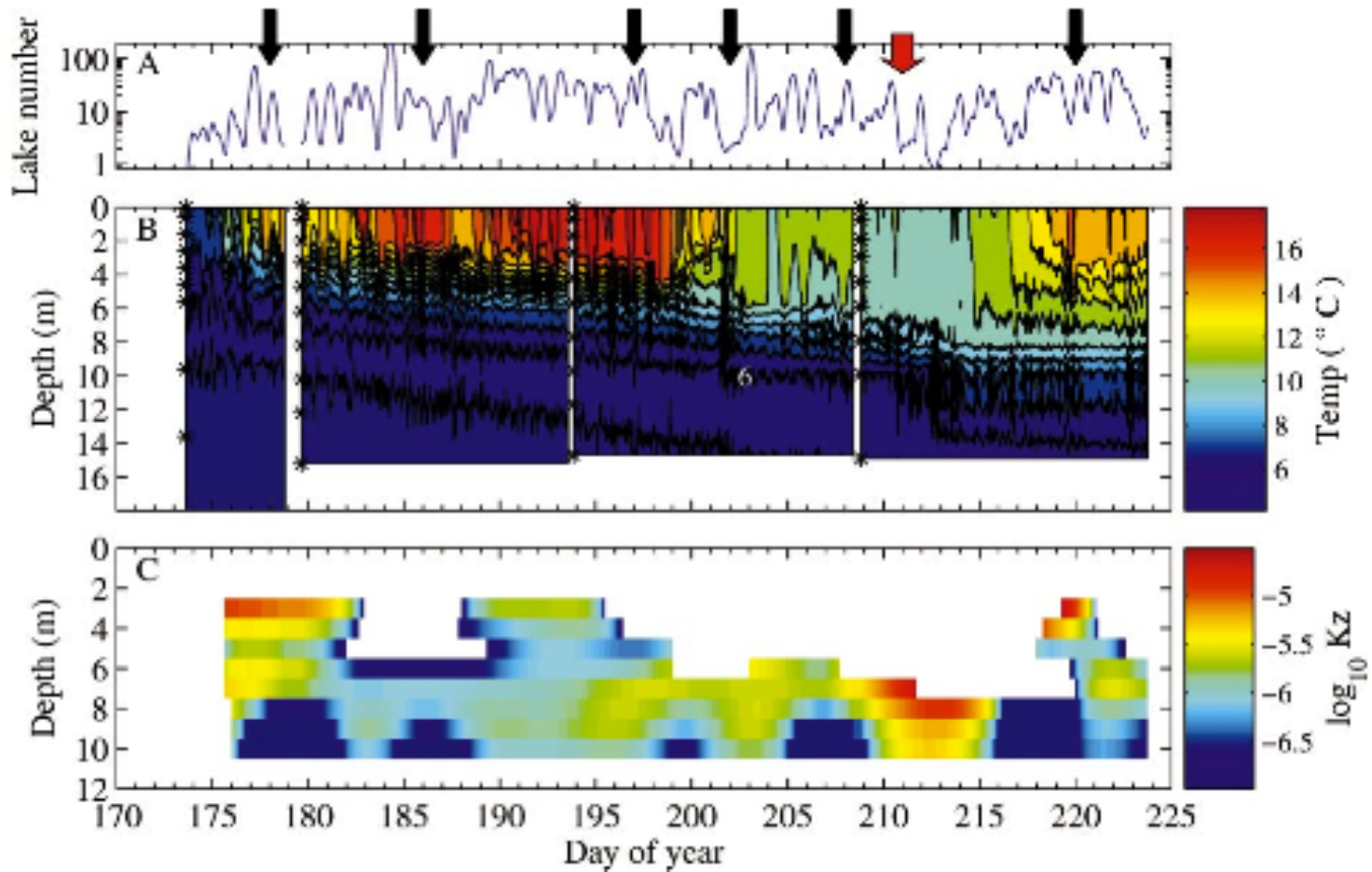
u_* wind shear velocity

A_S surface area

z_V height of center of volume



Lake number and mixing



MacIntyre et al. 2006



Lake number and internal waves

$L_N < 10$ Internal Waves

$L_N < 3$ Nonlinear Motions

$L_N < 1$ Upwelling

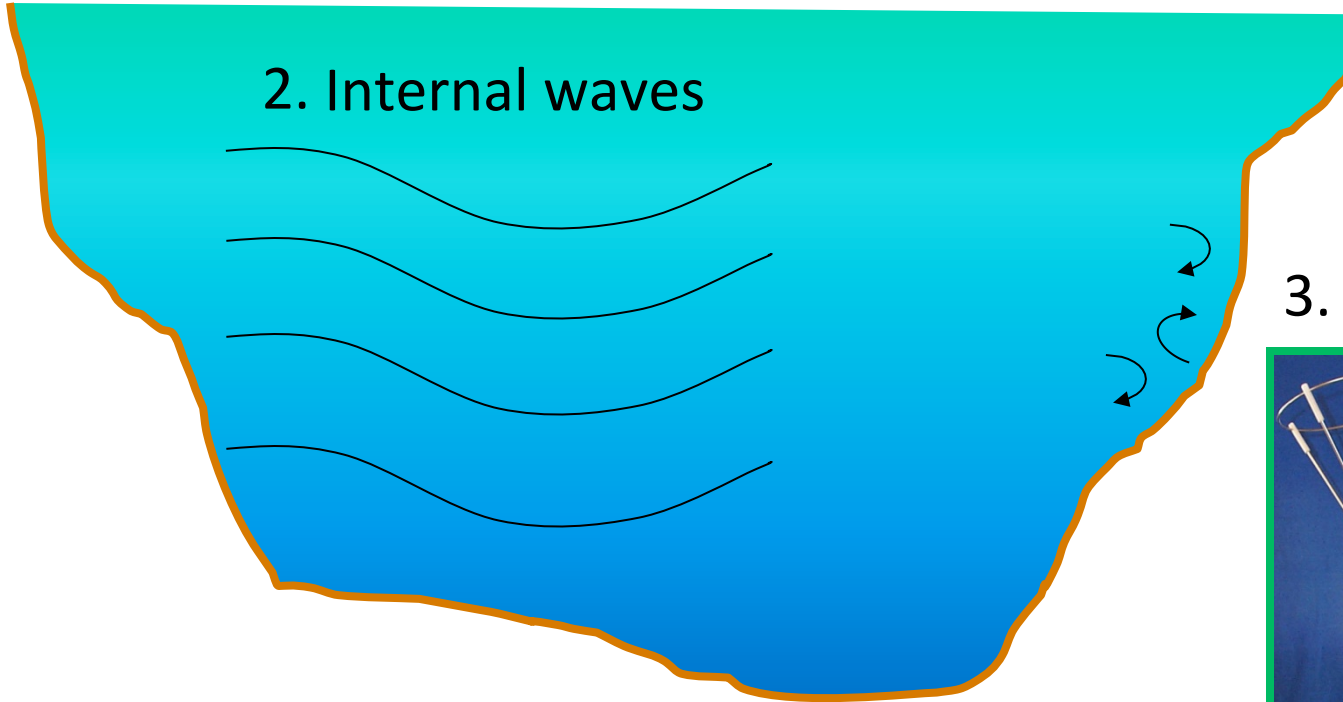


Lake number and mixing

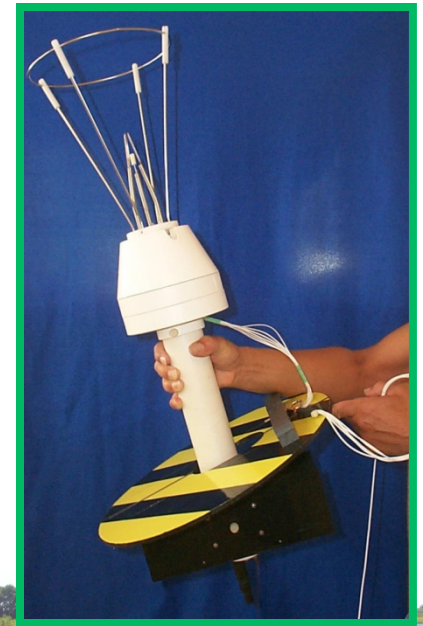
1. Wind



2. Internal waves



3. Turbulence



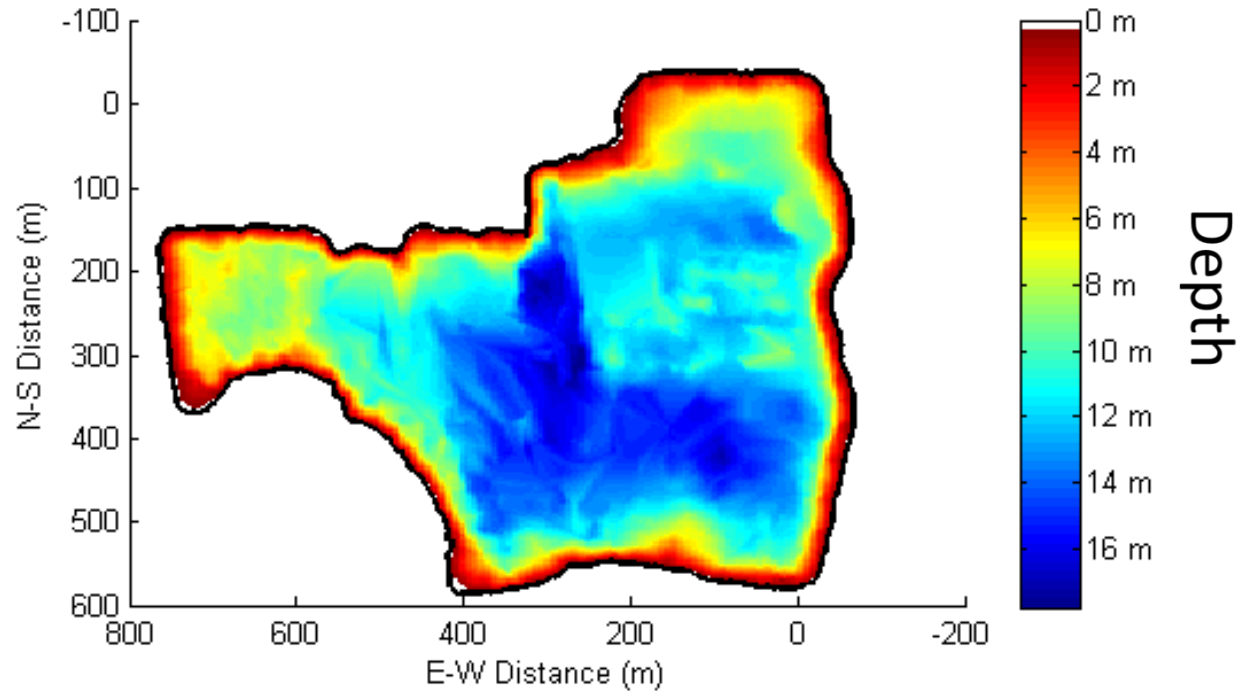
Field site

Ada Hayden Lake

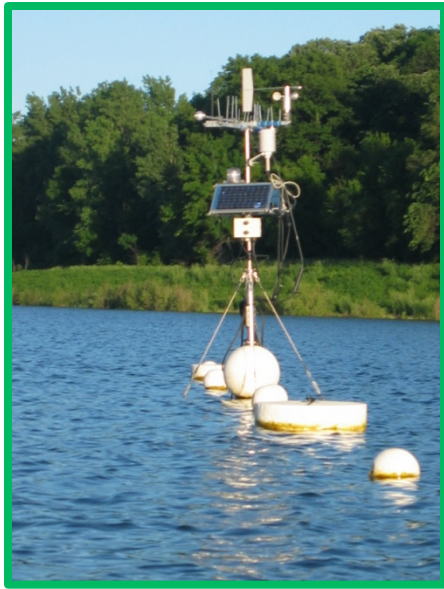


← 750 m →

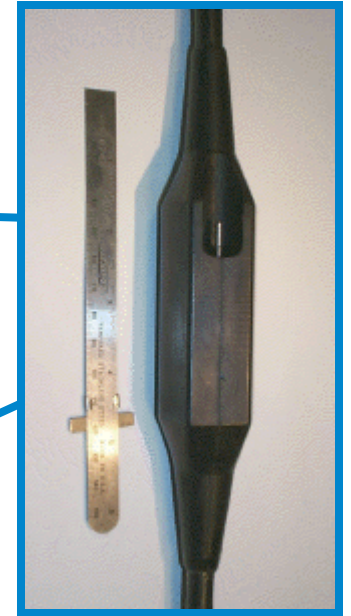
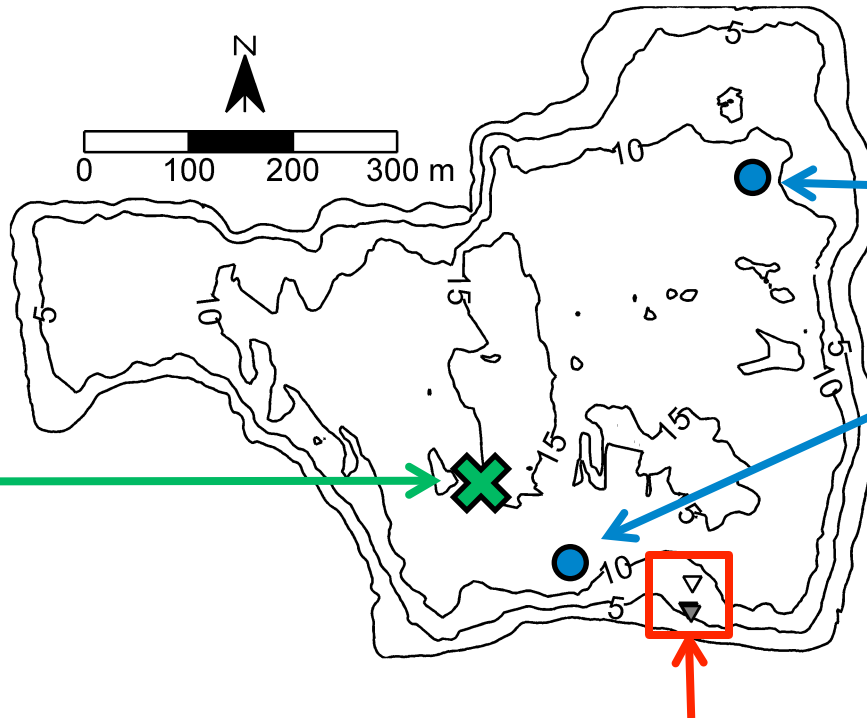
Bathymetry



Measurements



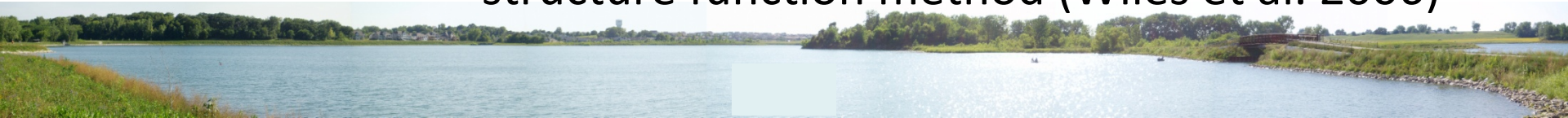
Met station +
thermistor chain



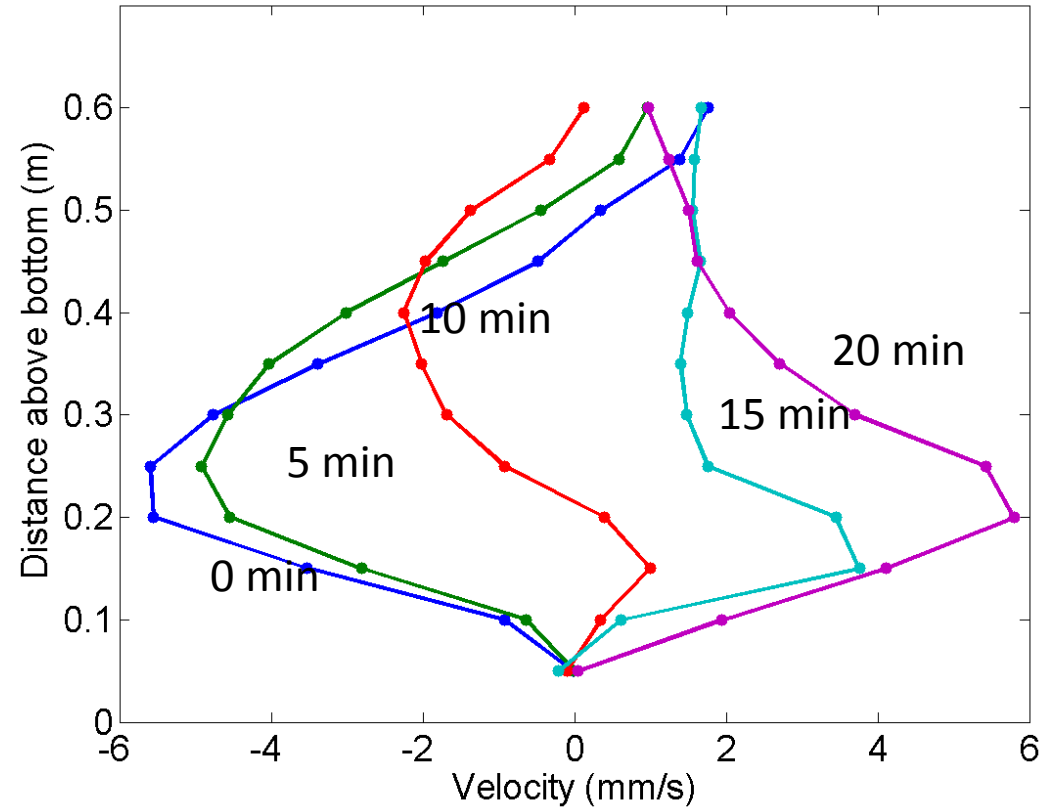
Thermistor chain



Current profiler +
structure function method (Wiles et al. 2006)



First Try



Second Try



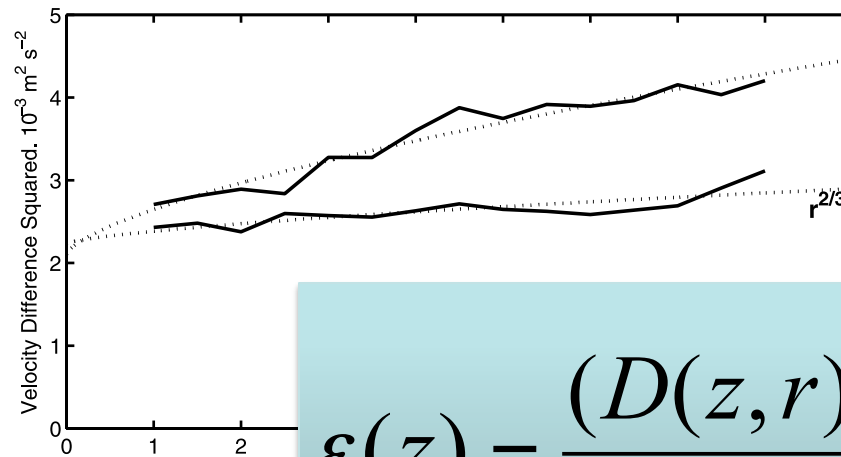
- Measured along beam velocities
- Range ~ 1.5 m
- 5 cm bins
- 8 Hz
- 512 pts/5 min



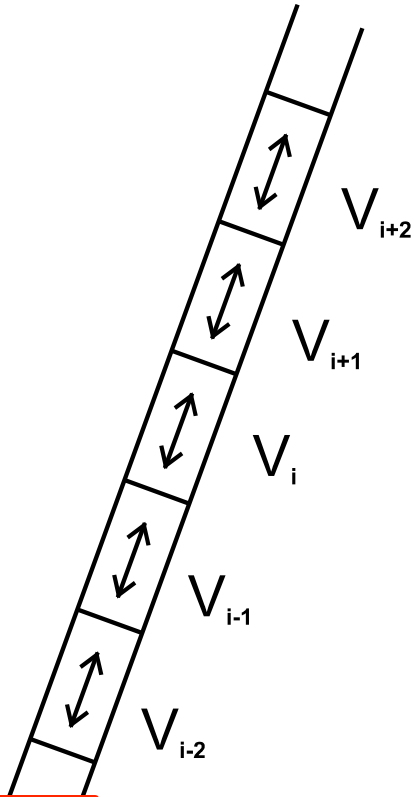
Dissipation of TKE from the Structure Function Method

(Wiles et al. 2006)

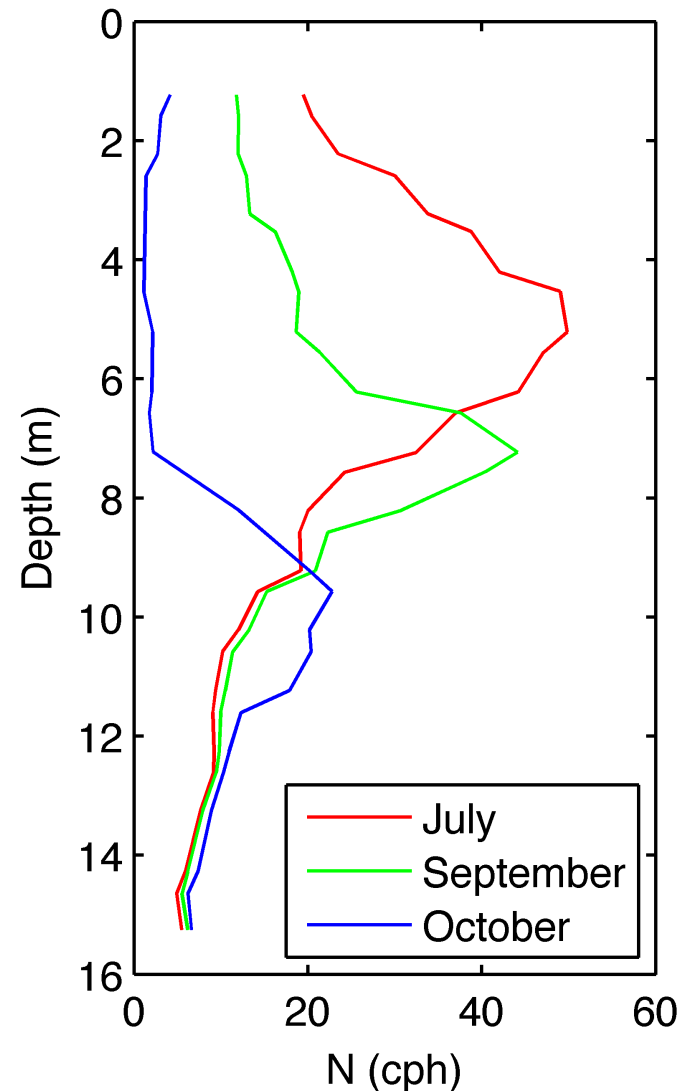
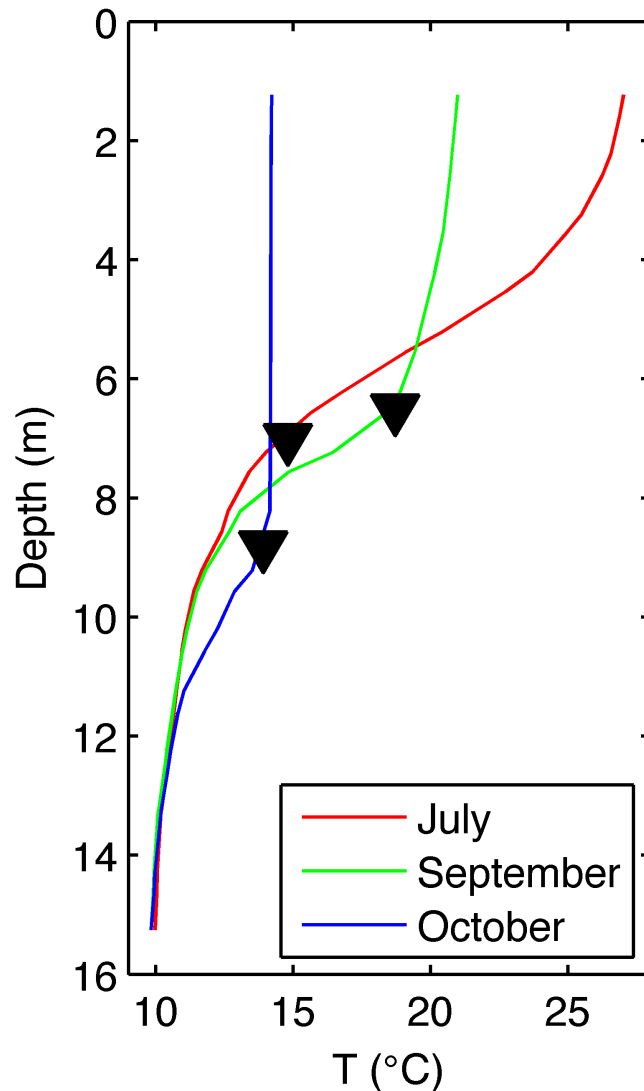
$$D(z, r) = \overline{(v'(z) - v'(z + r))^2}$$



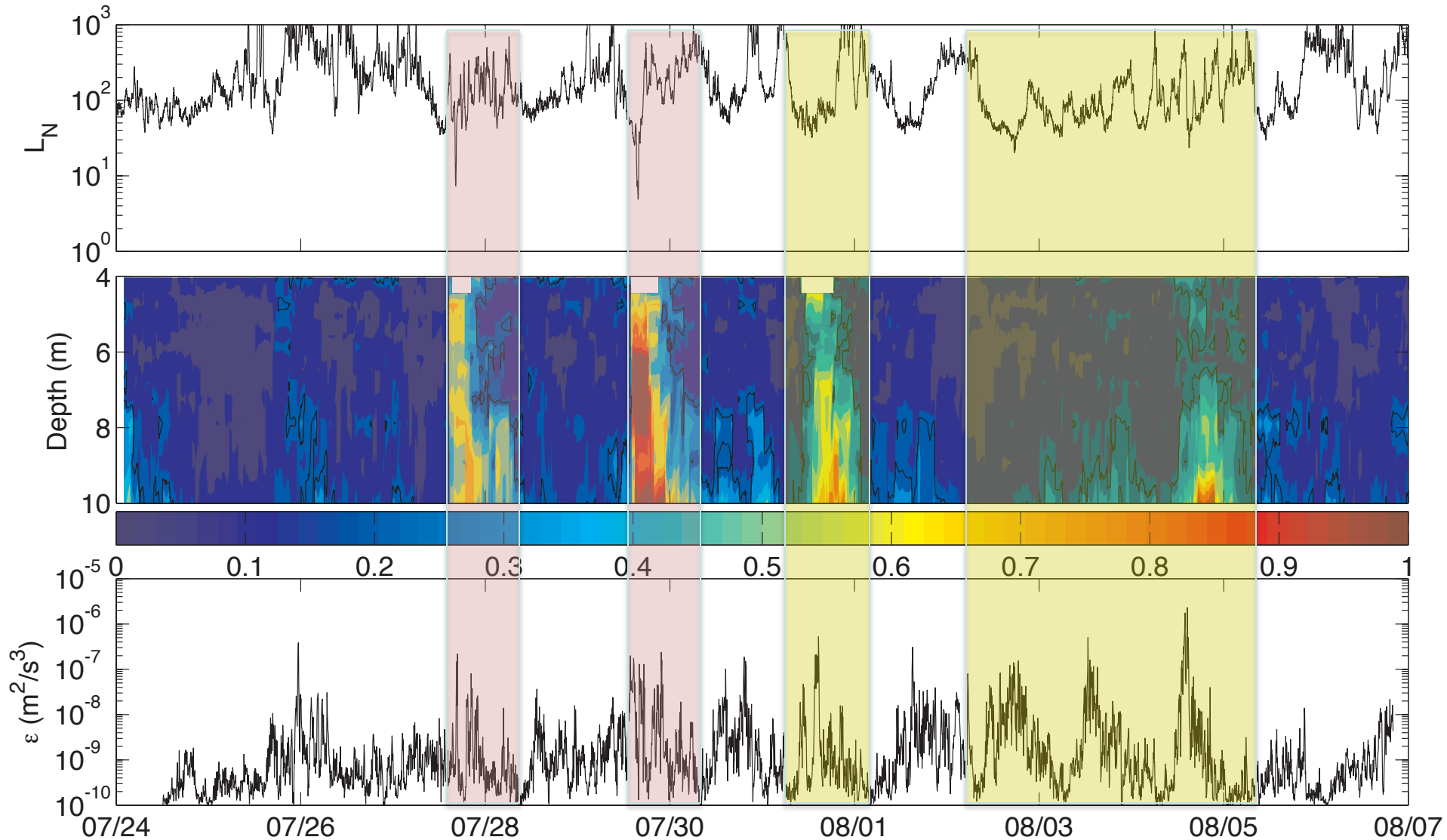
$$\varepsilon(z) = \frac{(D(z, r) - N(z))^{3/2}}{C_v^3 r}$$



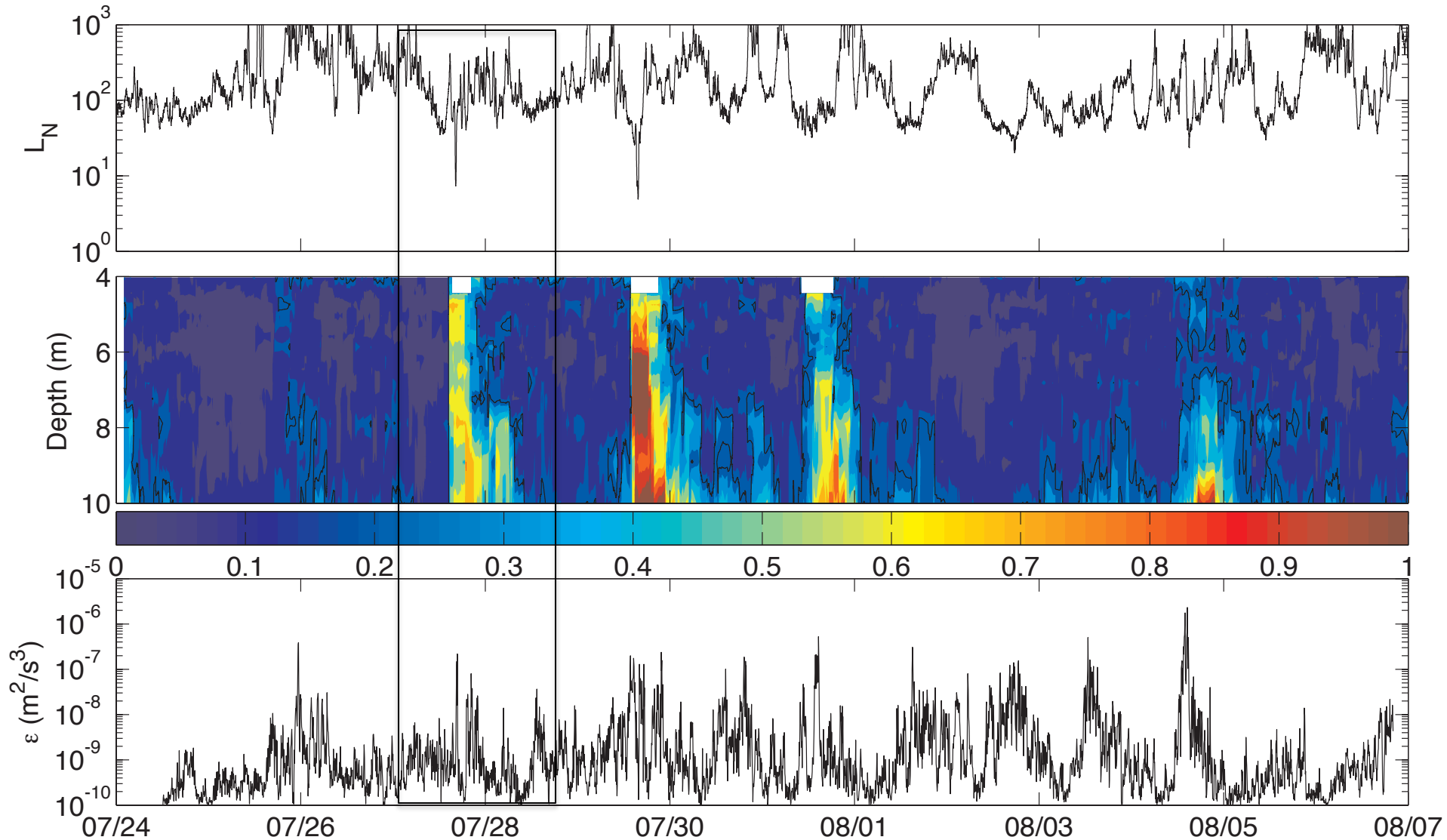
Three deployments with different stratifications



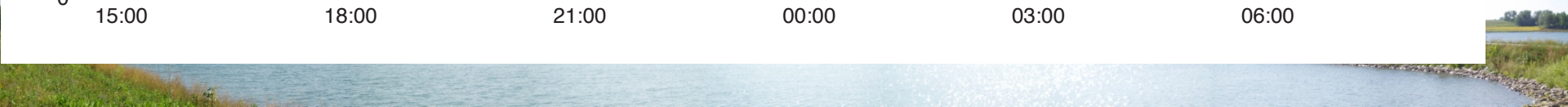
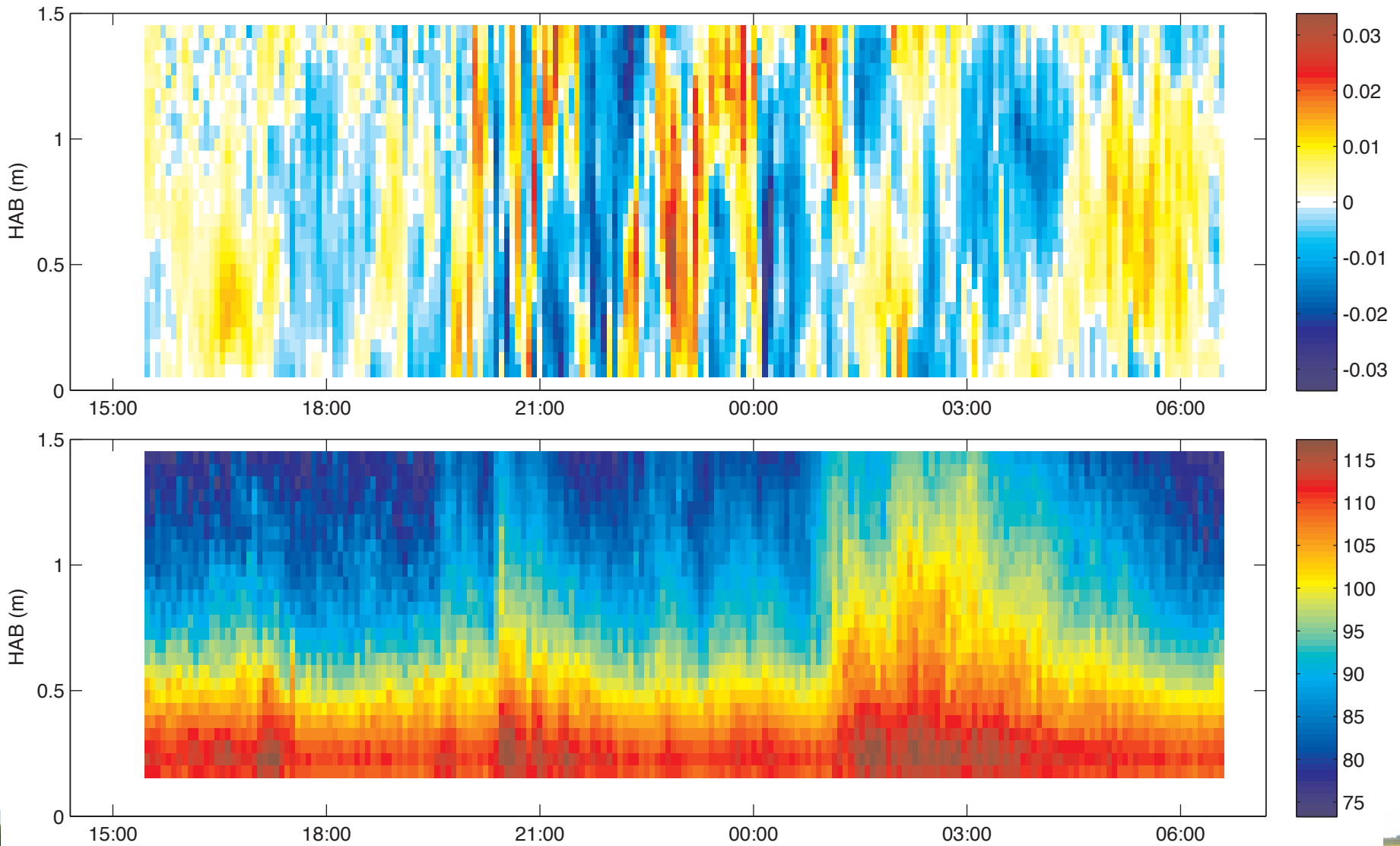
Time Series from July/August



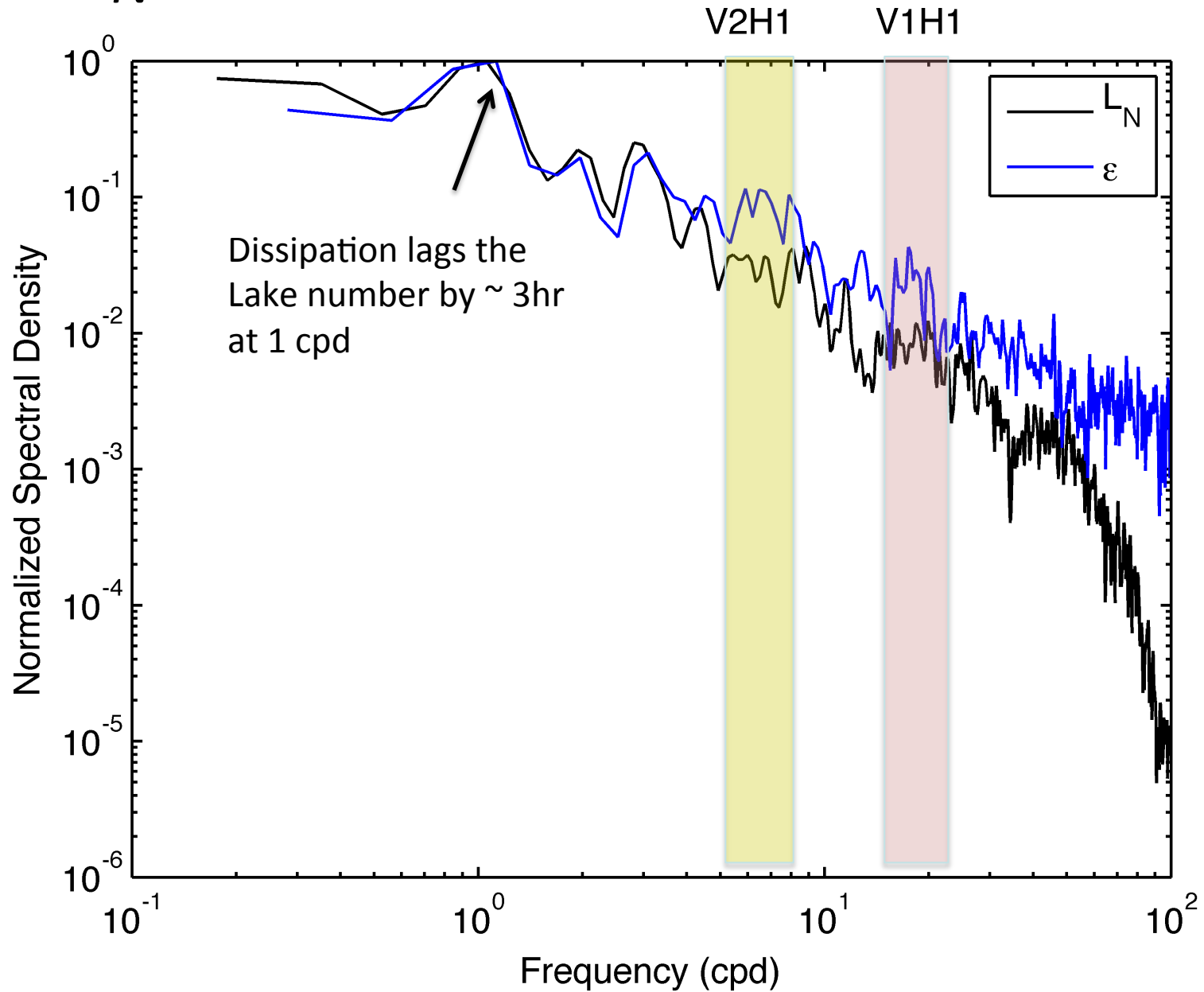
Time Series from July/August



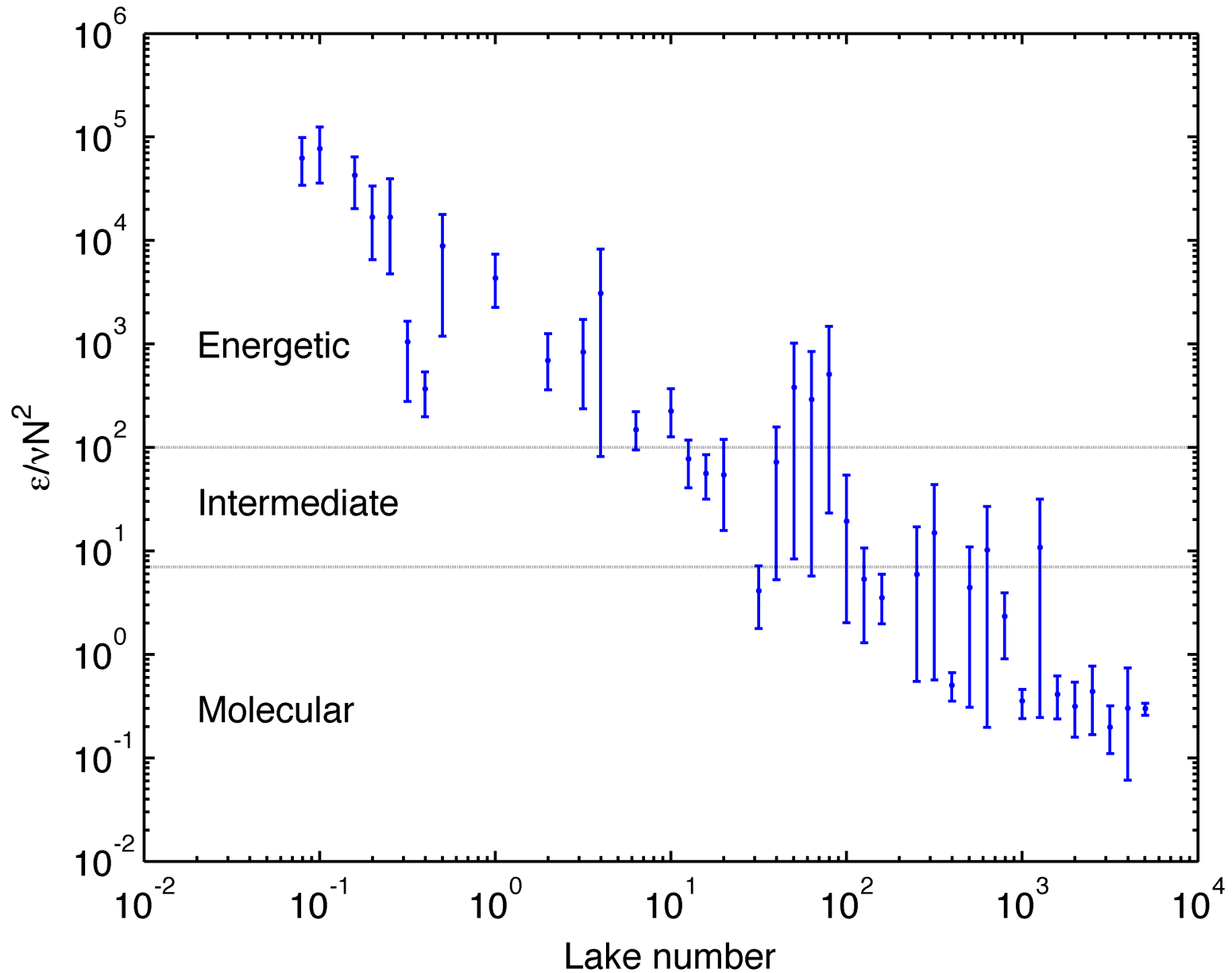
Sample of Data from 7/28-7/29



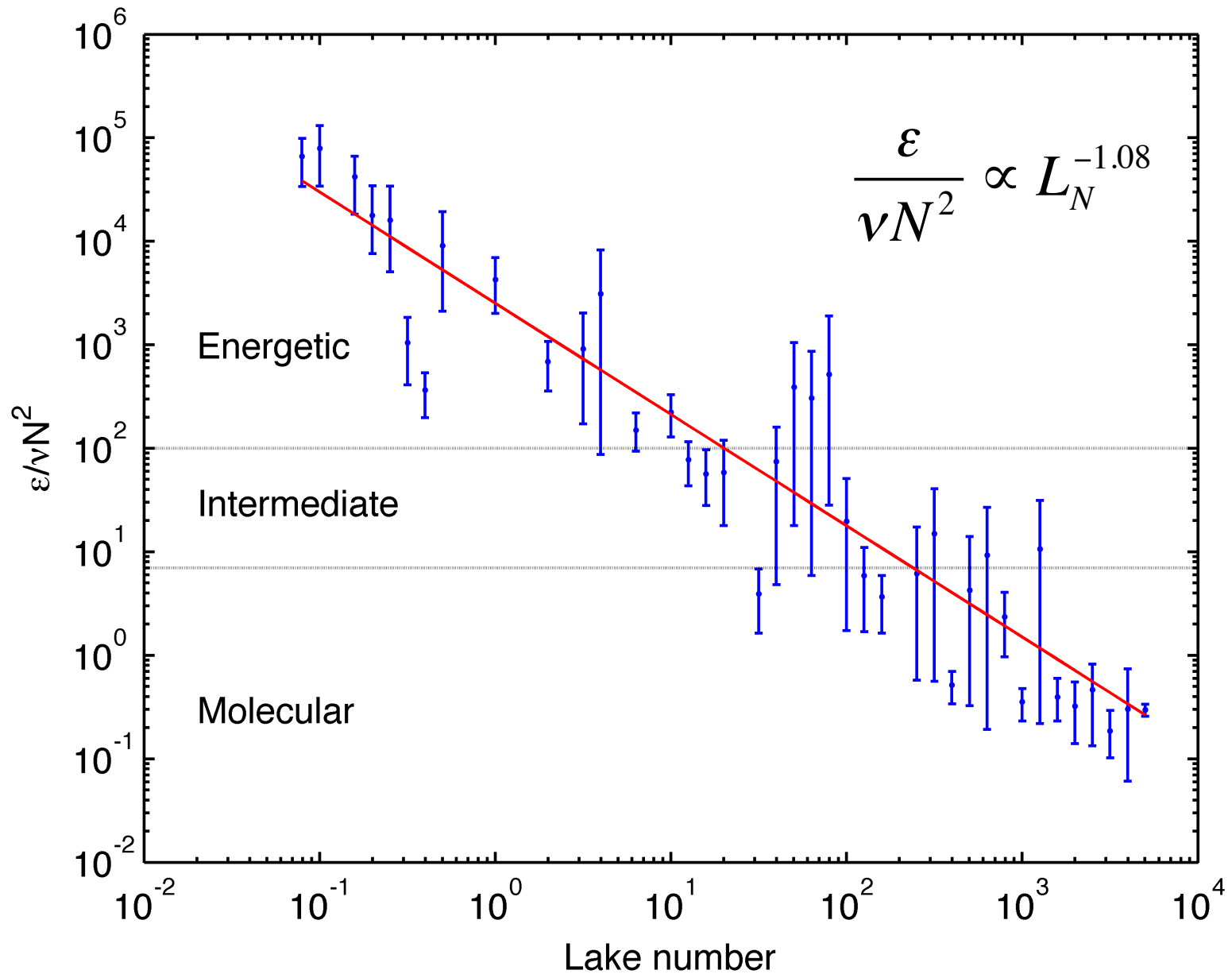
L_N and ε have peaks at 1 cpd.



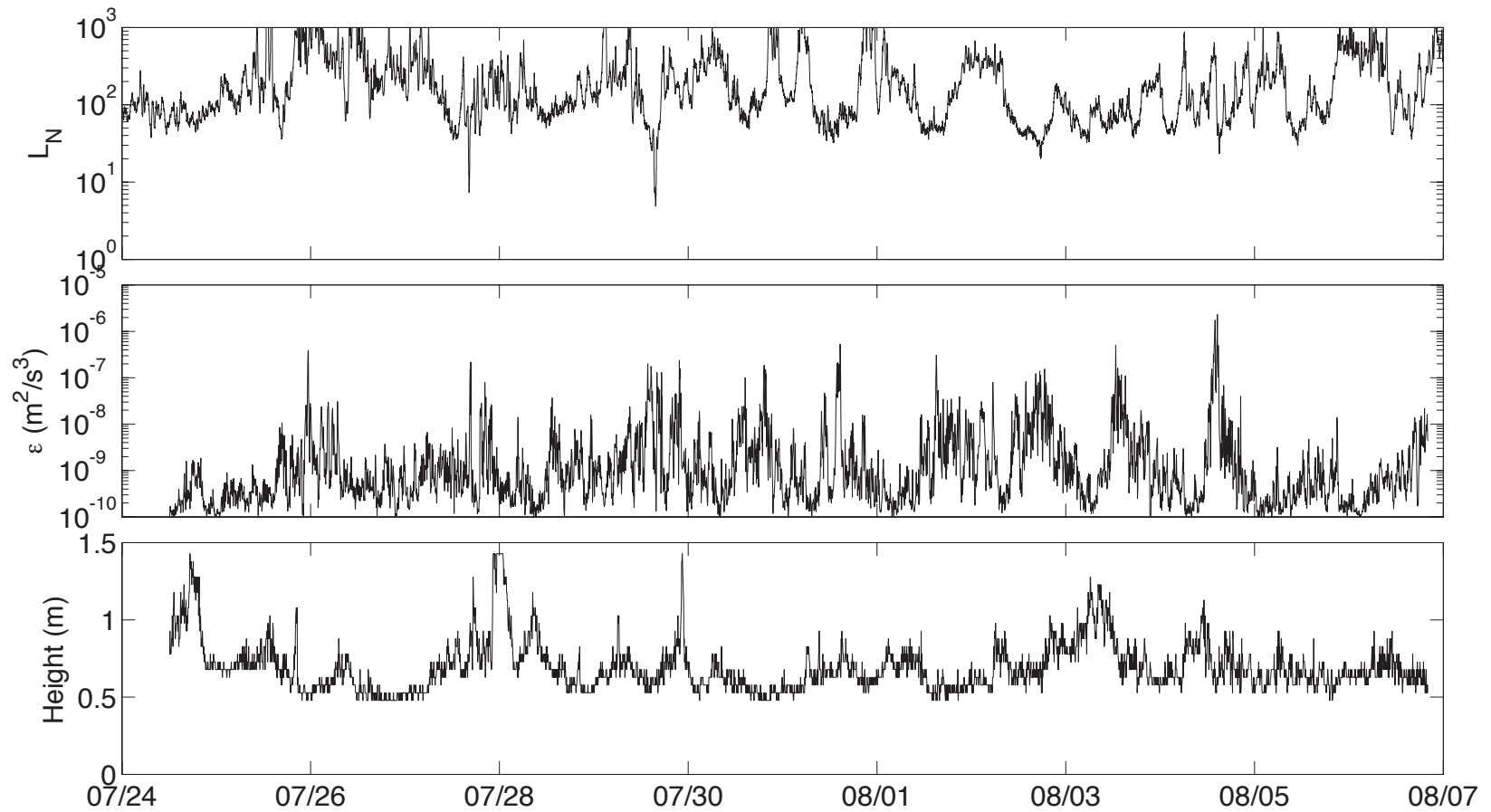
Turbulence increases as L_N decreases.



Turbulence increases as L_N decreases.



Sediment Resuspension?



Summary

- A pulse-coherent acoustic current profiler was deployed under varying stratification conditions in a lake to measure dissipation on the slope.
- The typical values of $\varepsilon / \nu N^2$ increased as the Lake number decreased.



Questions?

