A photograph of a sailboat on a shimmering blue sea under a bright sky. The sun is high in the sky, creating a strong lens flare and illuminating the water with a dense field of bright, sparkling reflections. The sailboat is positioned on the left side of the frame, with its mast and rigging visible against the sky. The overall scene is serene and captures a beautiful moment on the water.

A Comparison of Acoustic Turbulence Profiling Techniques

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What do we measure?

- Turbulent Kinetic Energy
- Reynolds Stress
- Dissipation

What do we measure, and how?

- Turbulent Kinetic Energy
 - Direct velocity (TKE $\sim \overline{u^2}$)
- Reynolds Stress
 - Correlate velocity component pairs (e.g. $\overline{u'w'}$)
- Dissipation
 - Indirectly via cascade theory

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Surface gravity waves can contaminate all

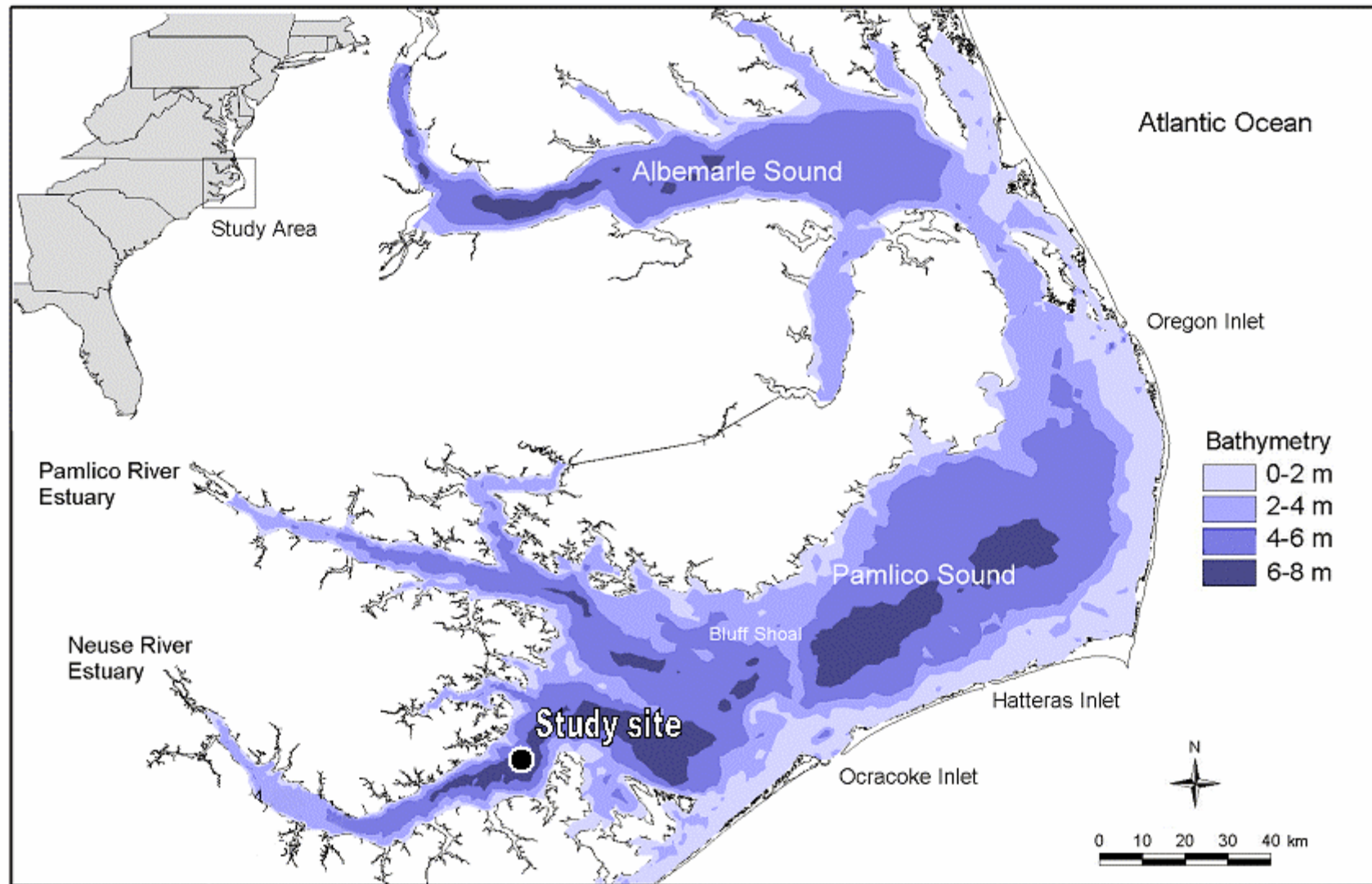
Proposal

- Use vertical beam data on AWAC to directly measure w'
 - Vertical beam gives lower bound to anisotropic turbulence
- Apply procedure to remove surface gravity waves
 - Vertical beam reduces phase offset in wave correction
- Use vertical beam data to measure dissipation
 - Vertical beam eliminates upstream/downstream isotropy problems

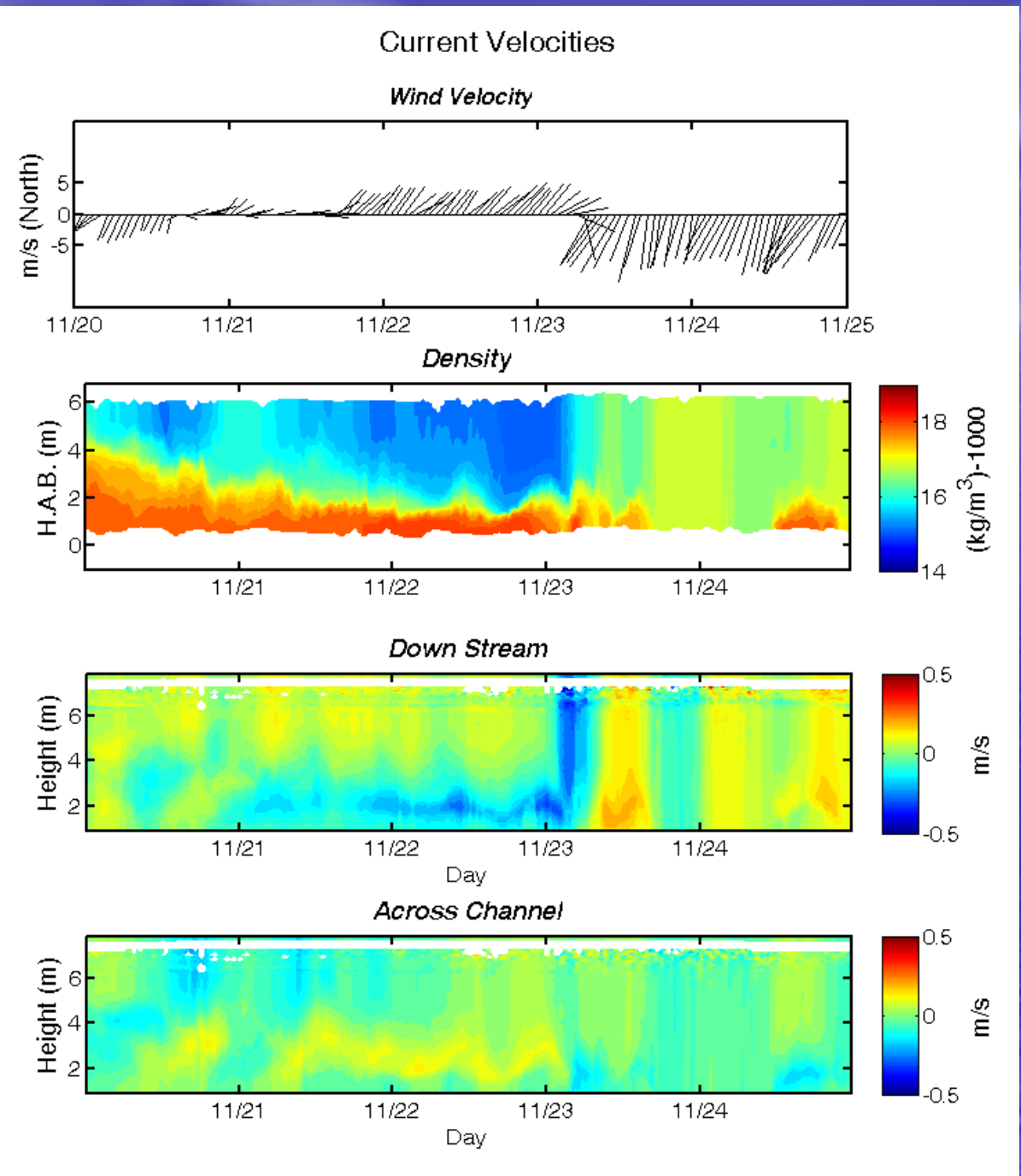
Deployment

- AWAC
 - Programmed to measure velocity profiles along the vertical beam
- Vector
 - Dissipation via spectral analyses
- RDI ADCP
 - Reynolds stress via Variance Technique
- Vertical profiler and anemometer

Location

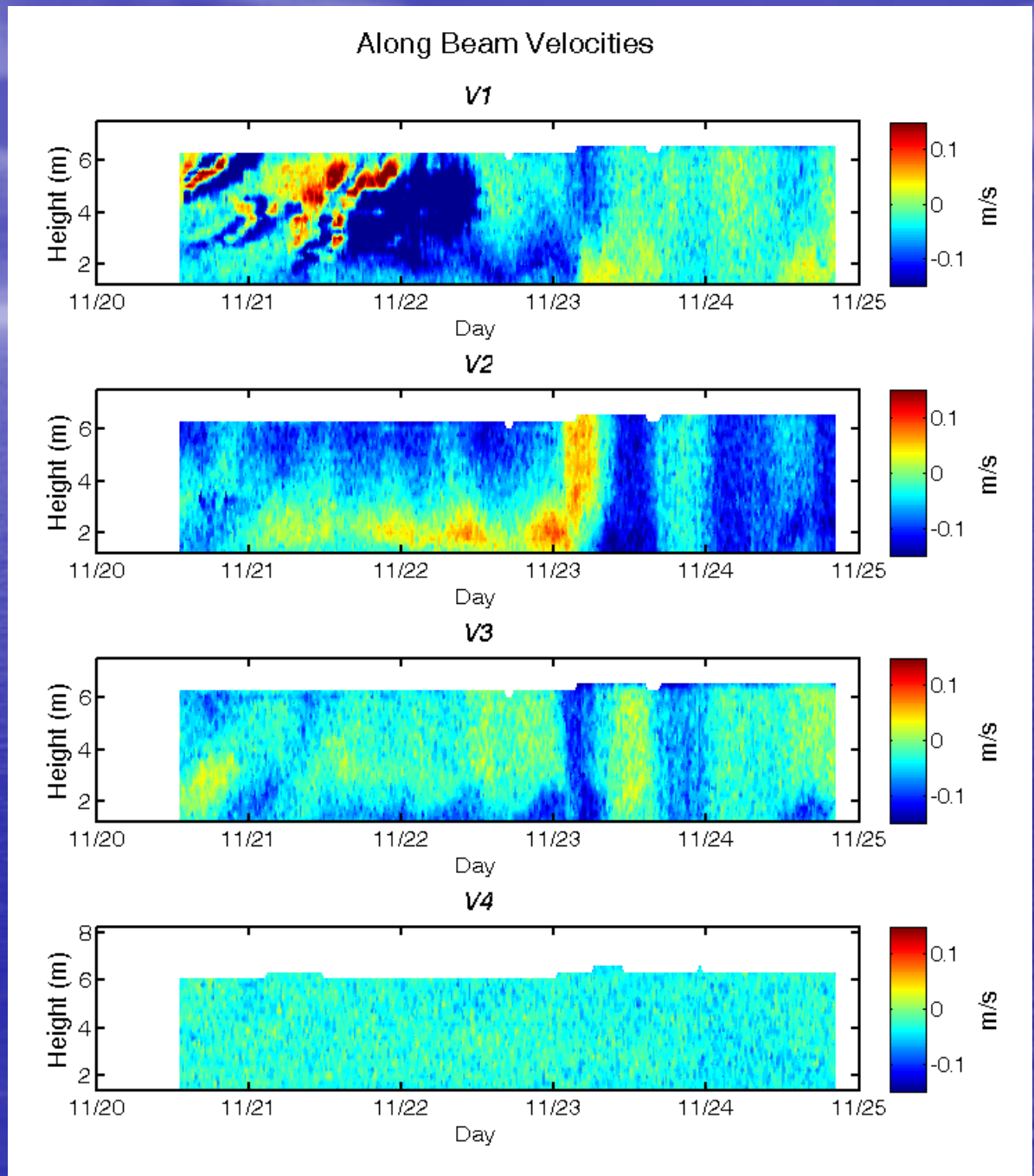


Mean Conditions



AWAC Beam Velocities

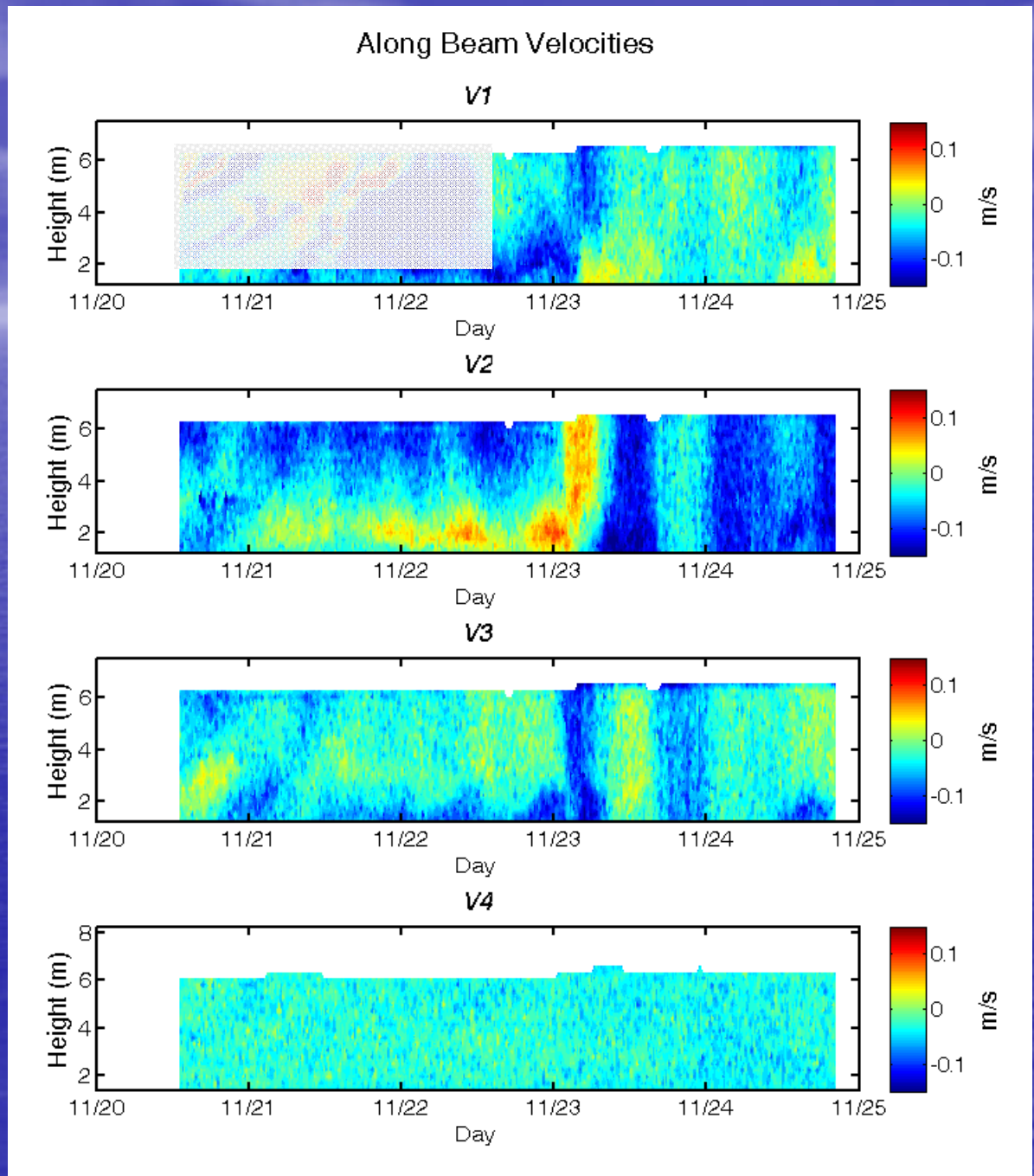
What happened to
beam 1?



AWAC Beam Velocities

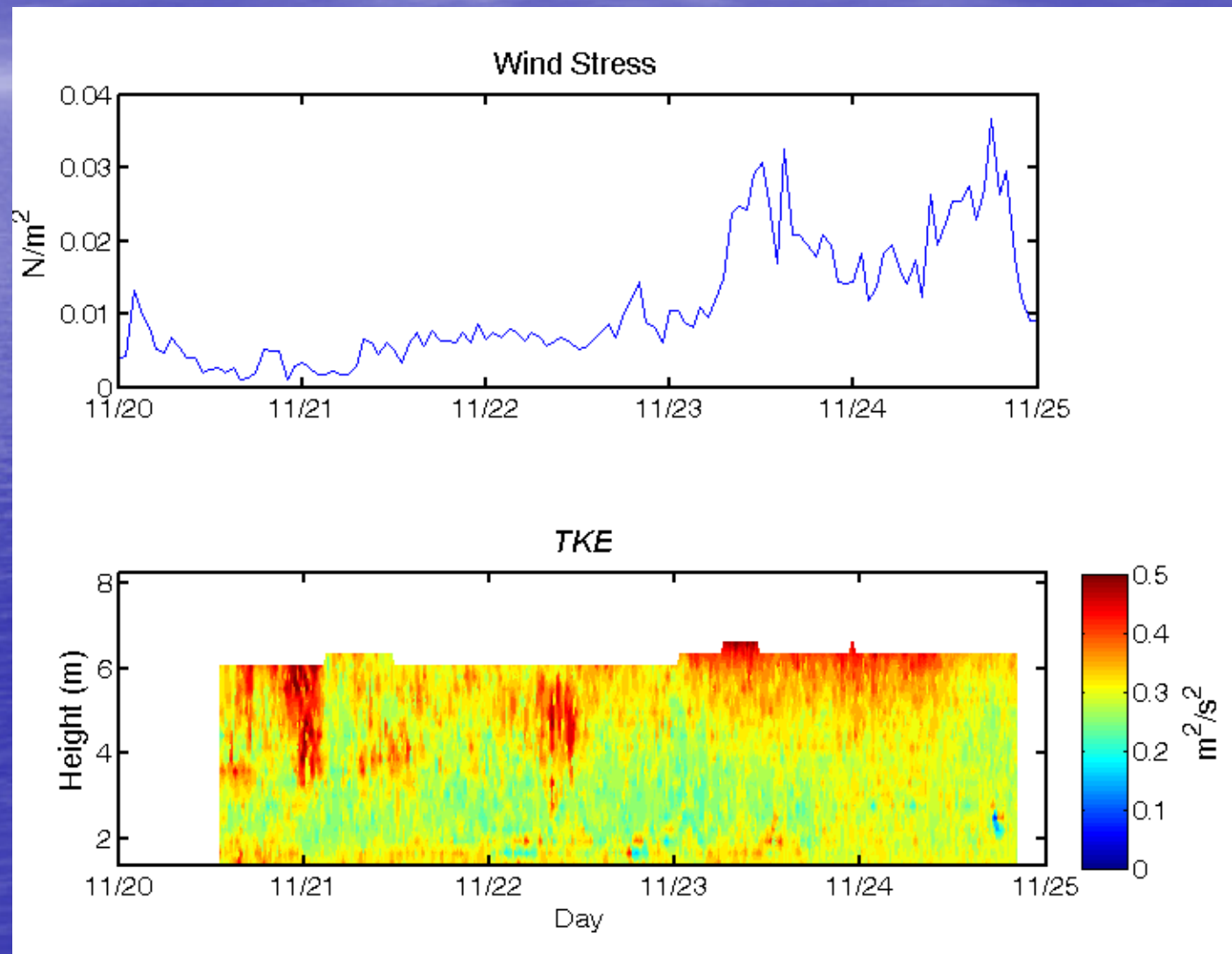
What happened to
beam 1?

Let's ignore that part.

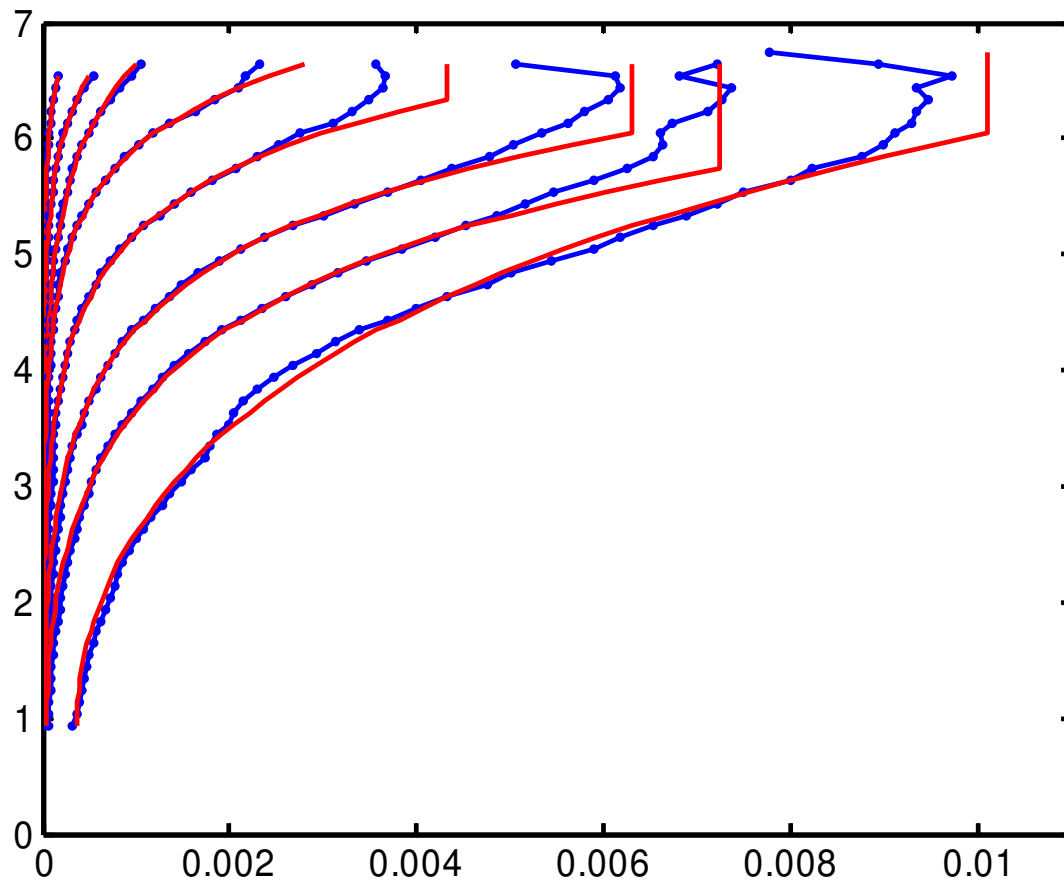


Raw TKE from vertical beam

- Assumes isotropy
- Calculated as $1.5\overline{w^2}$
- Theoretical instrument noise = $0.29 \text{ m}^2/\text{s}^2$
- Includes wave variance



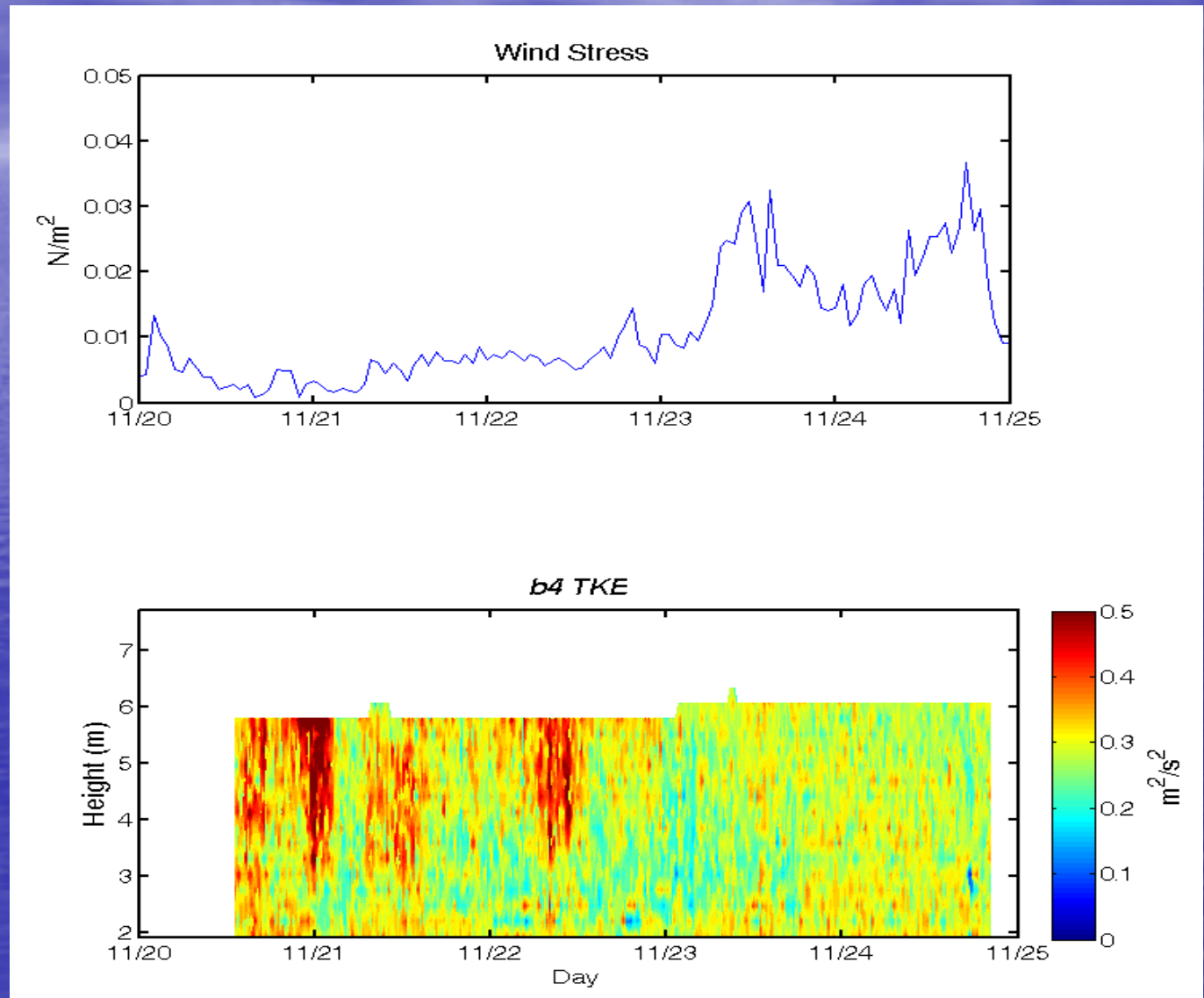
Removing wave variance



- Fit linear wave theory curve (red) to variance data (blue)
- Subtract wave variance using best fit curve

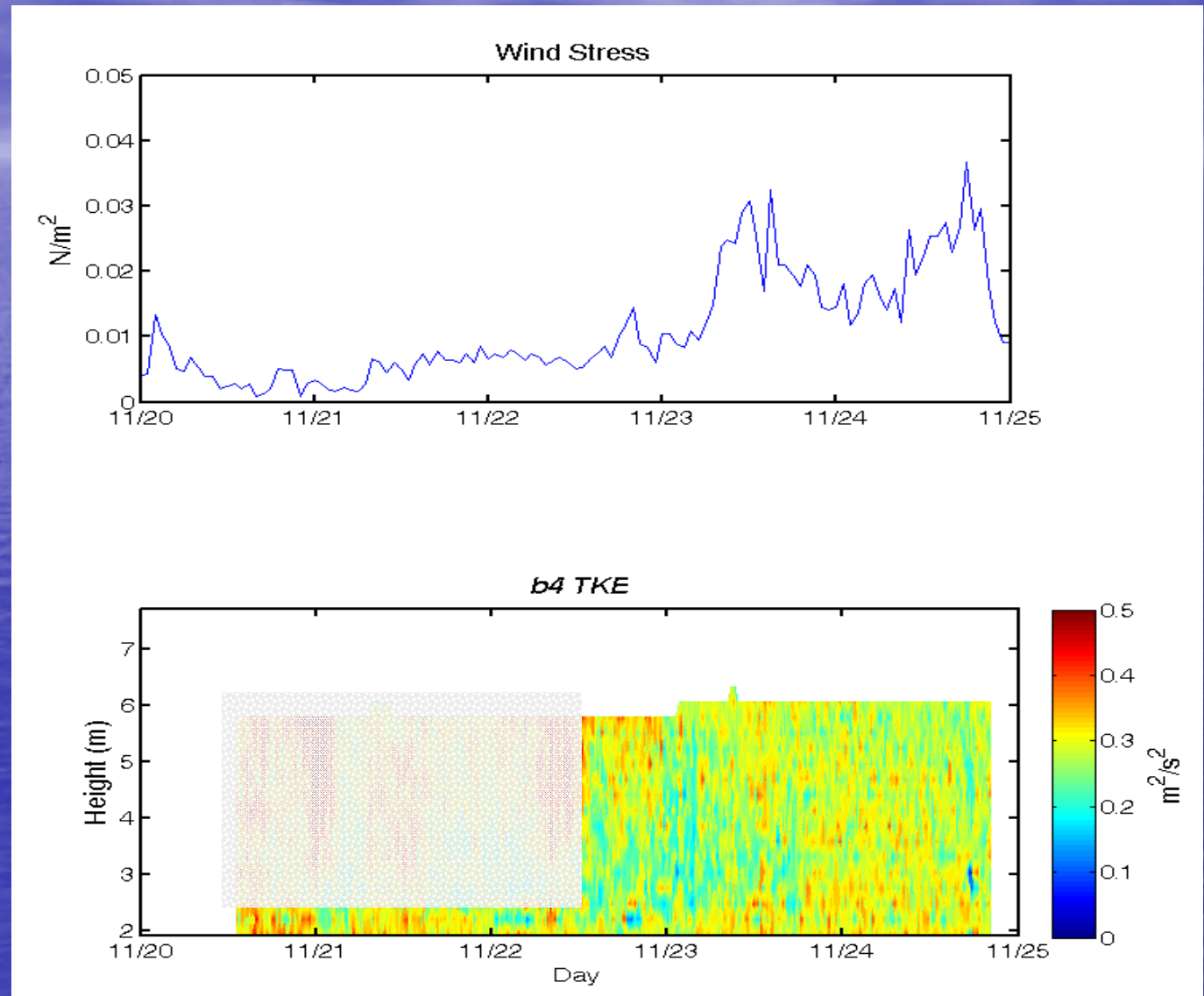
TKE after wave removal

- Assumes isotropy
- Calculated as $1.5w'$
- Theoretical instrument noise = $0.29 \text{ m}^2/\text{s}^2$



TKE after wave removal

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- Calculated as $1.5w'$
- Theoretical instrument noise = $0.29 \text{ m}^2/\text{s}^2$
- Should we ignore this part?

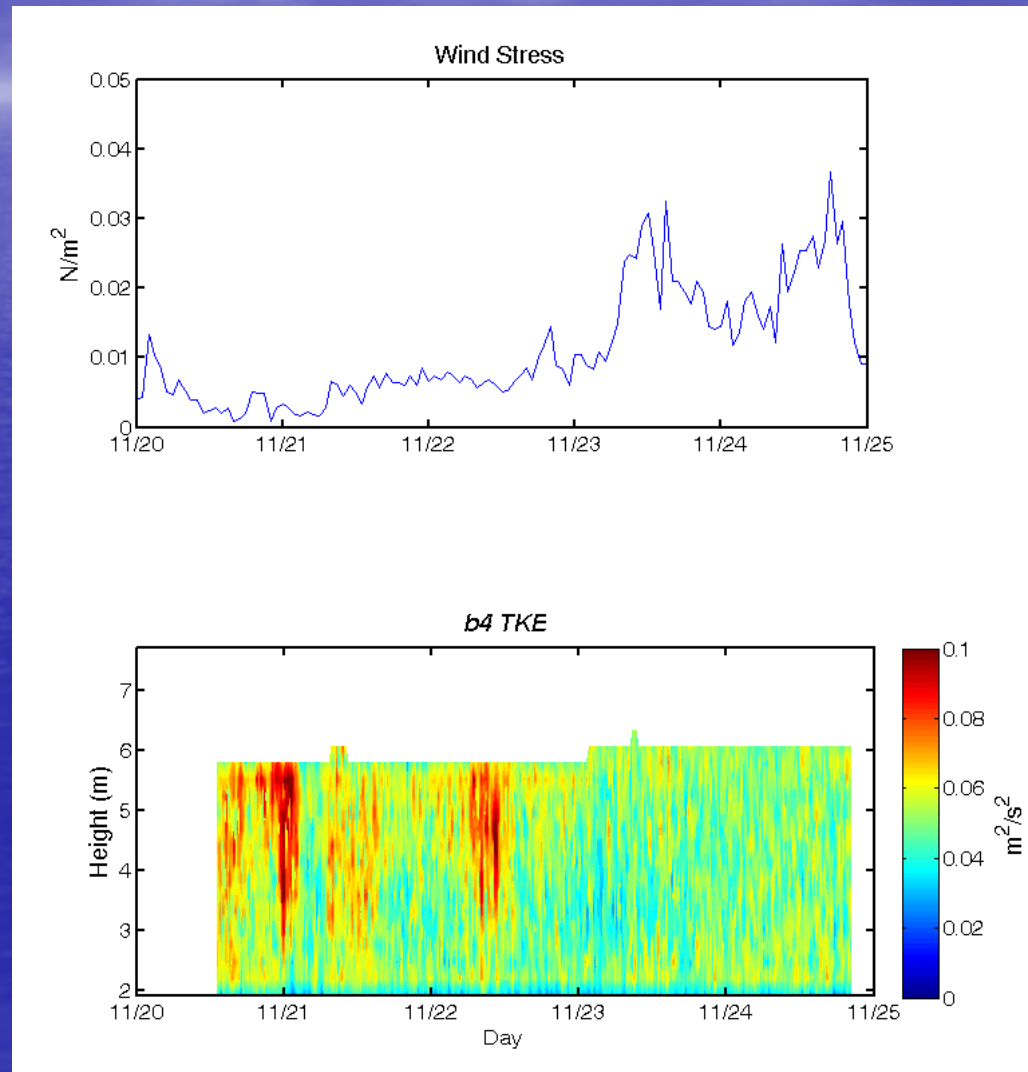


Can we reduce noise by filtering?

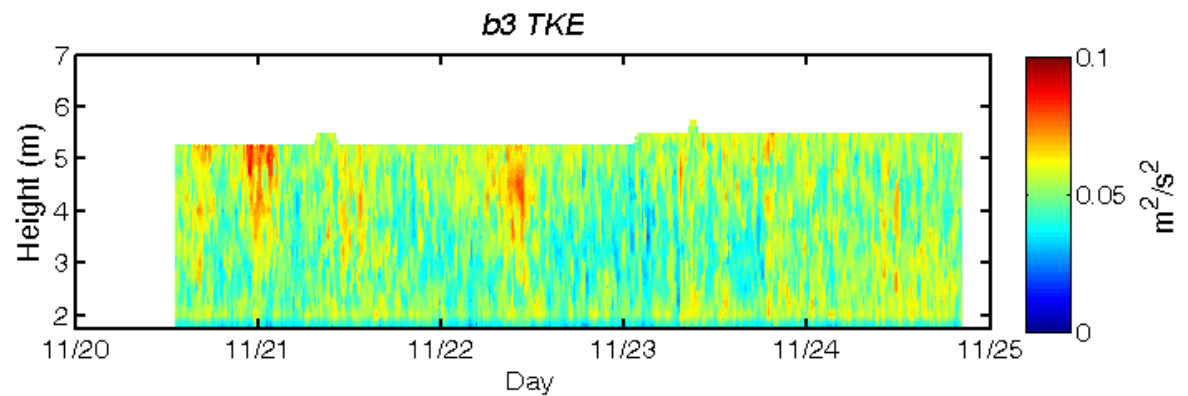
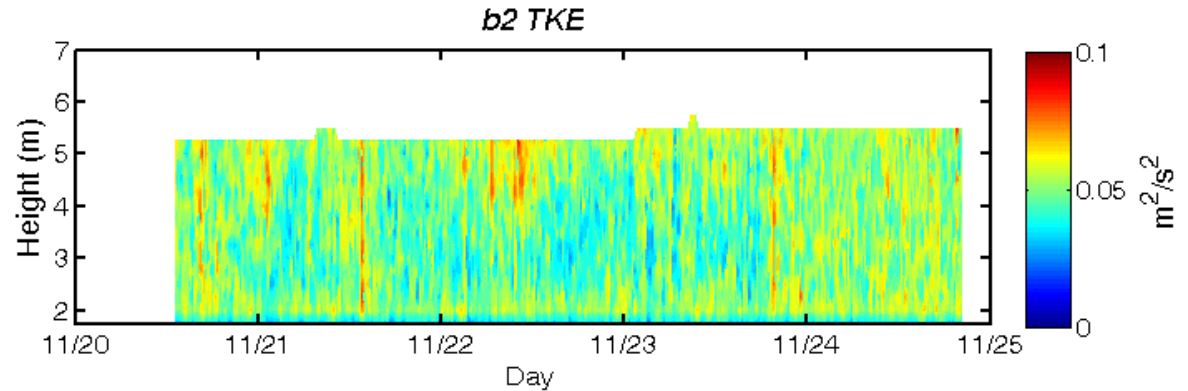
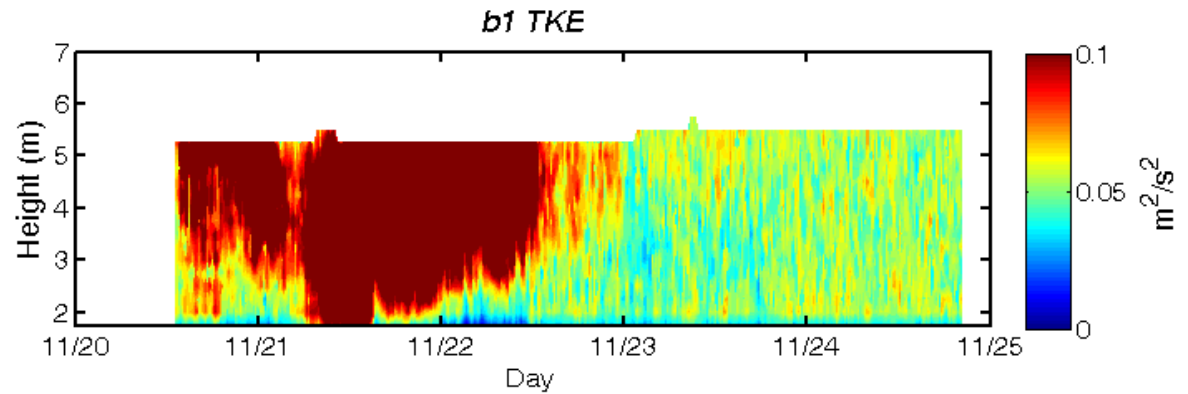
- Deployment used 1 sec samples in 0.25 meter bins
- Filter over 2 sec and 3 bins
- Should reduce noise by a factor of 6

TKE after wave removal and filtering

Expected noise level =
 $0.05 \text{ m}^2/\text{s}^2$

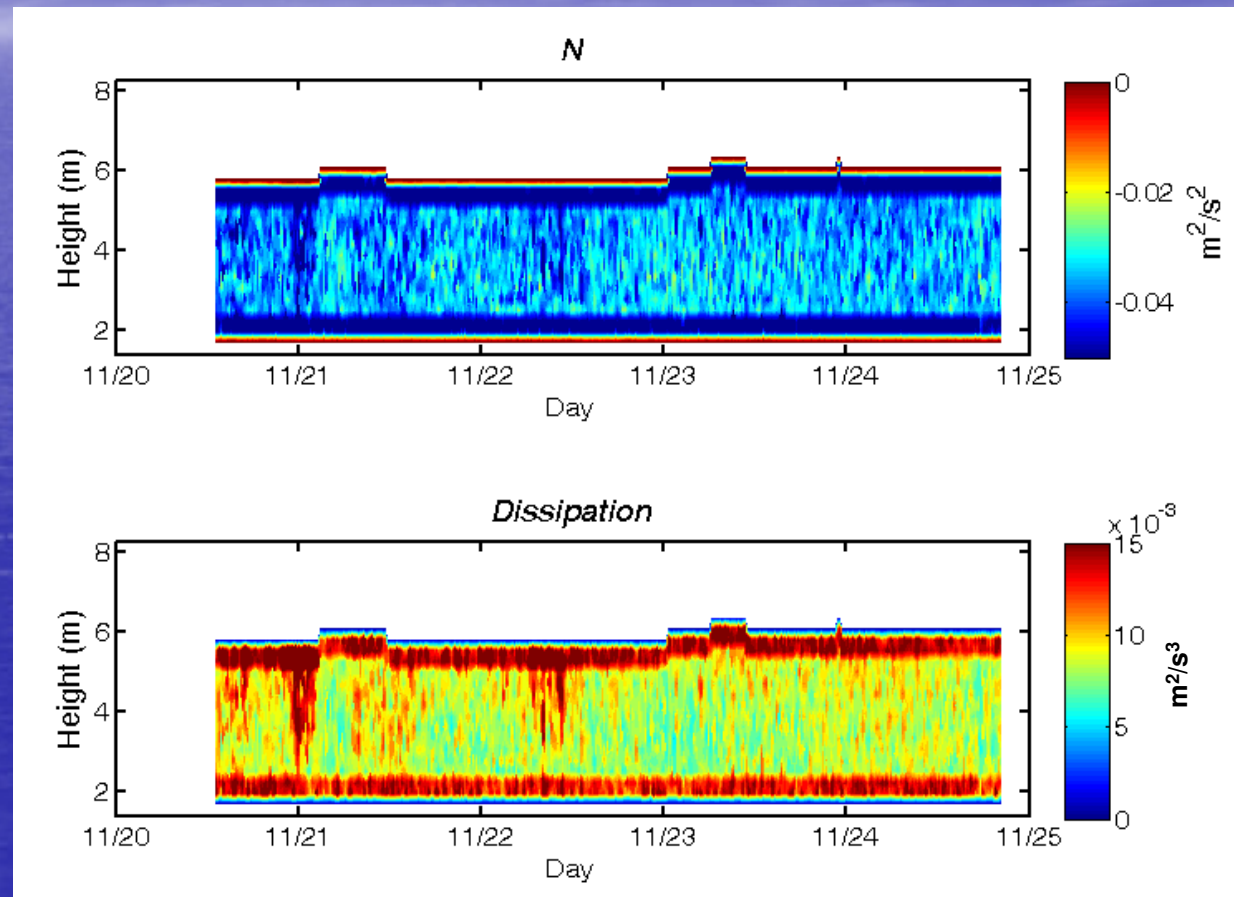


Slant beam TKE



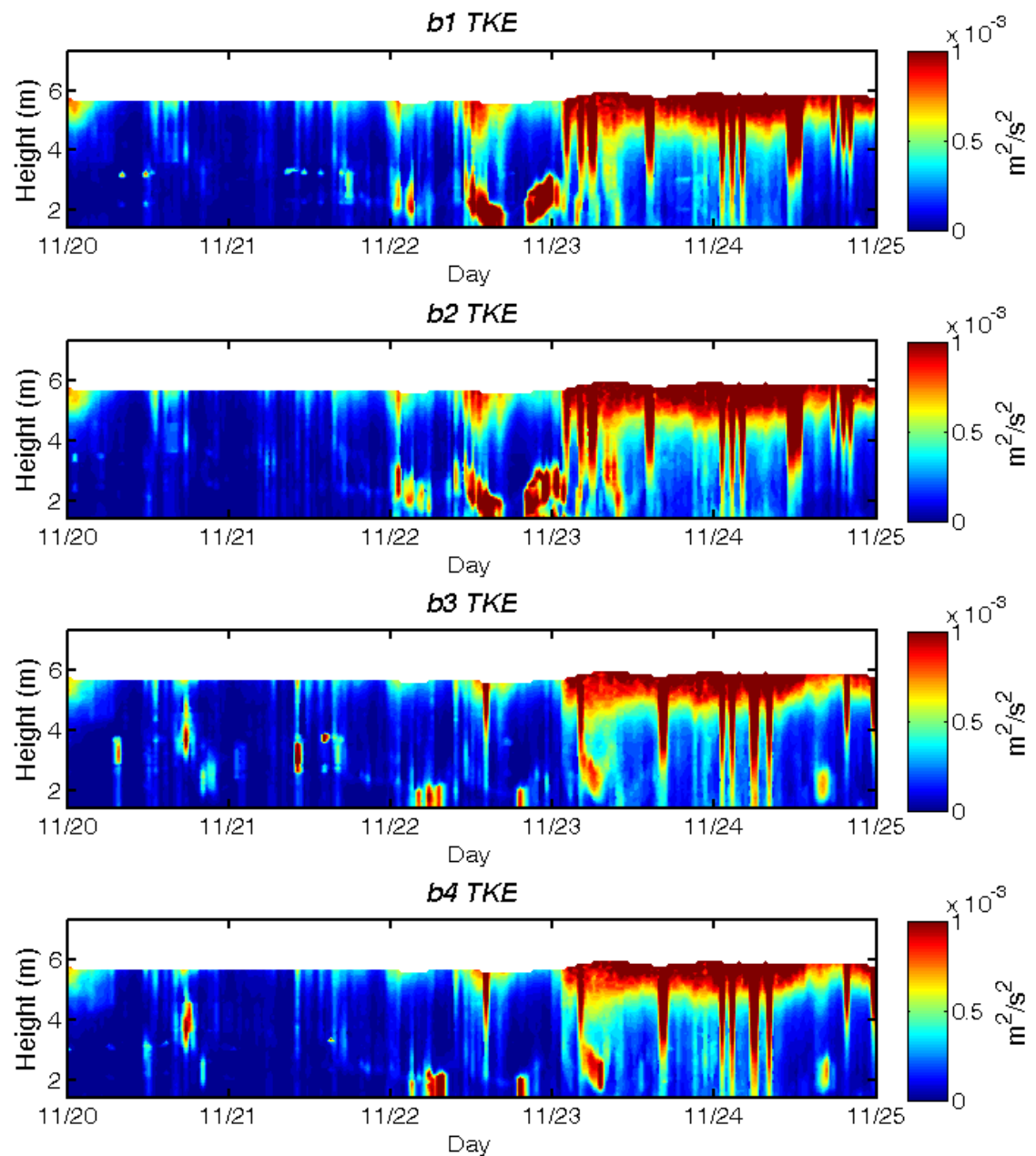
Dissipation via structure function

- Using Taylor's cascade theory squares of velocity differences should follow $2/3$ power law as function of range
- Dissipation calculated based on best fit
- N should be noise parameter estimated as $0.06 \text{ m}^2/\text{s}^2$



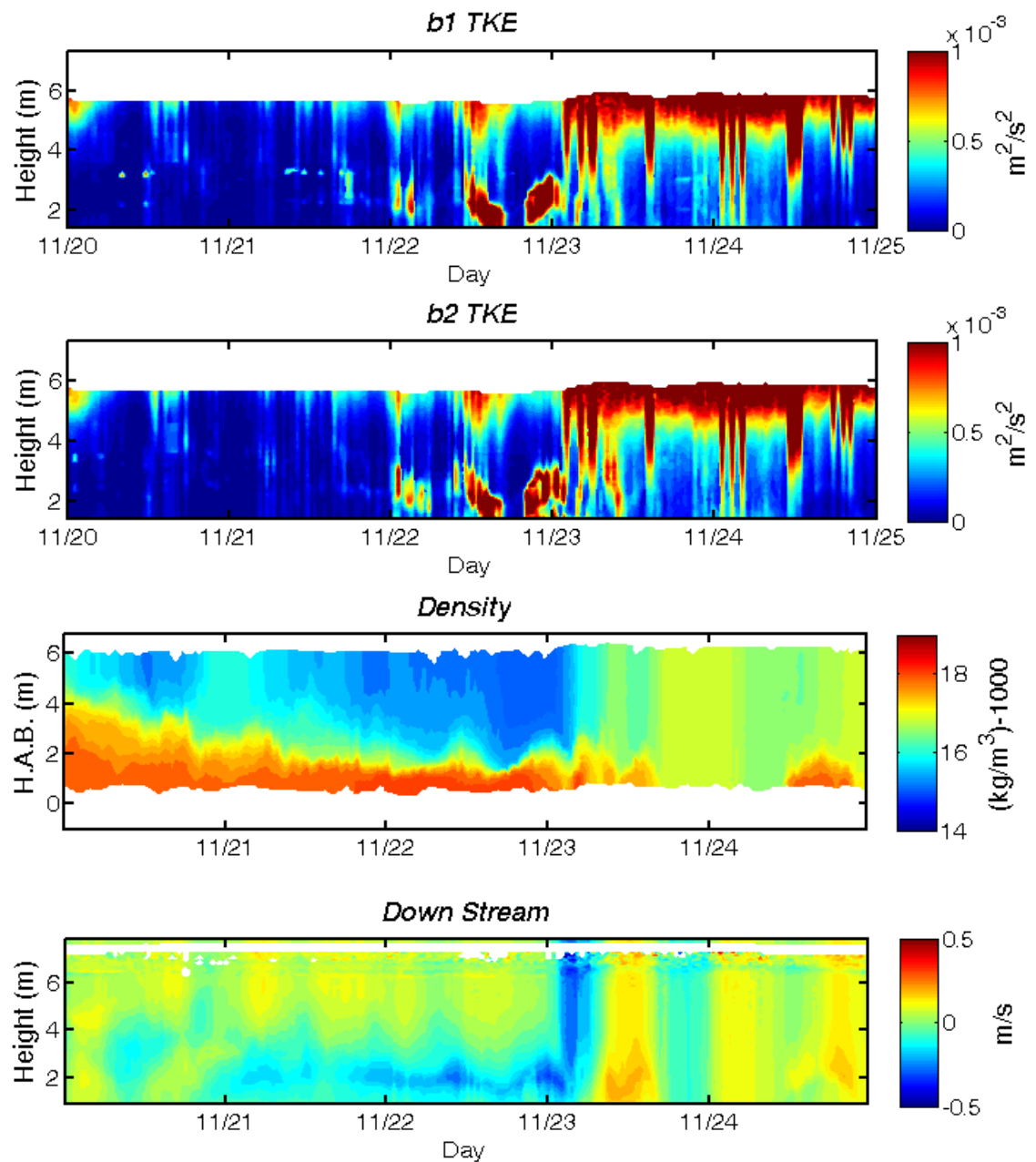
RDI (slant beam) TKE

- Mode 11 has lower standard deviations
- Slant beam data
- Expected noise floor = $0.3e-3$
- Beams 1 and 2 are oriented nearly up and down channel



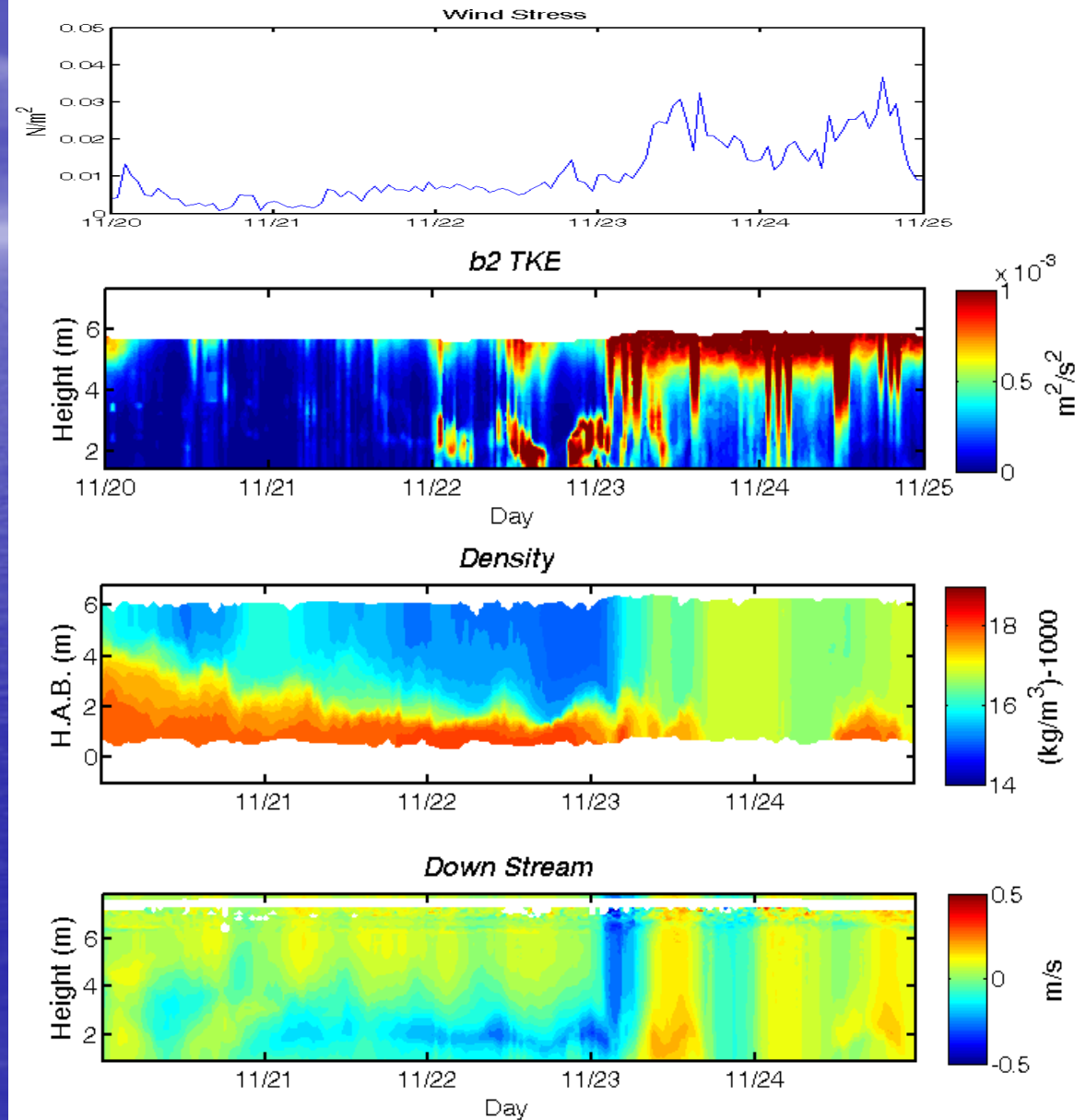
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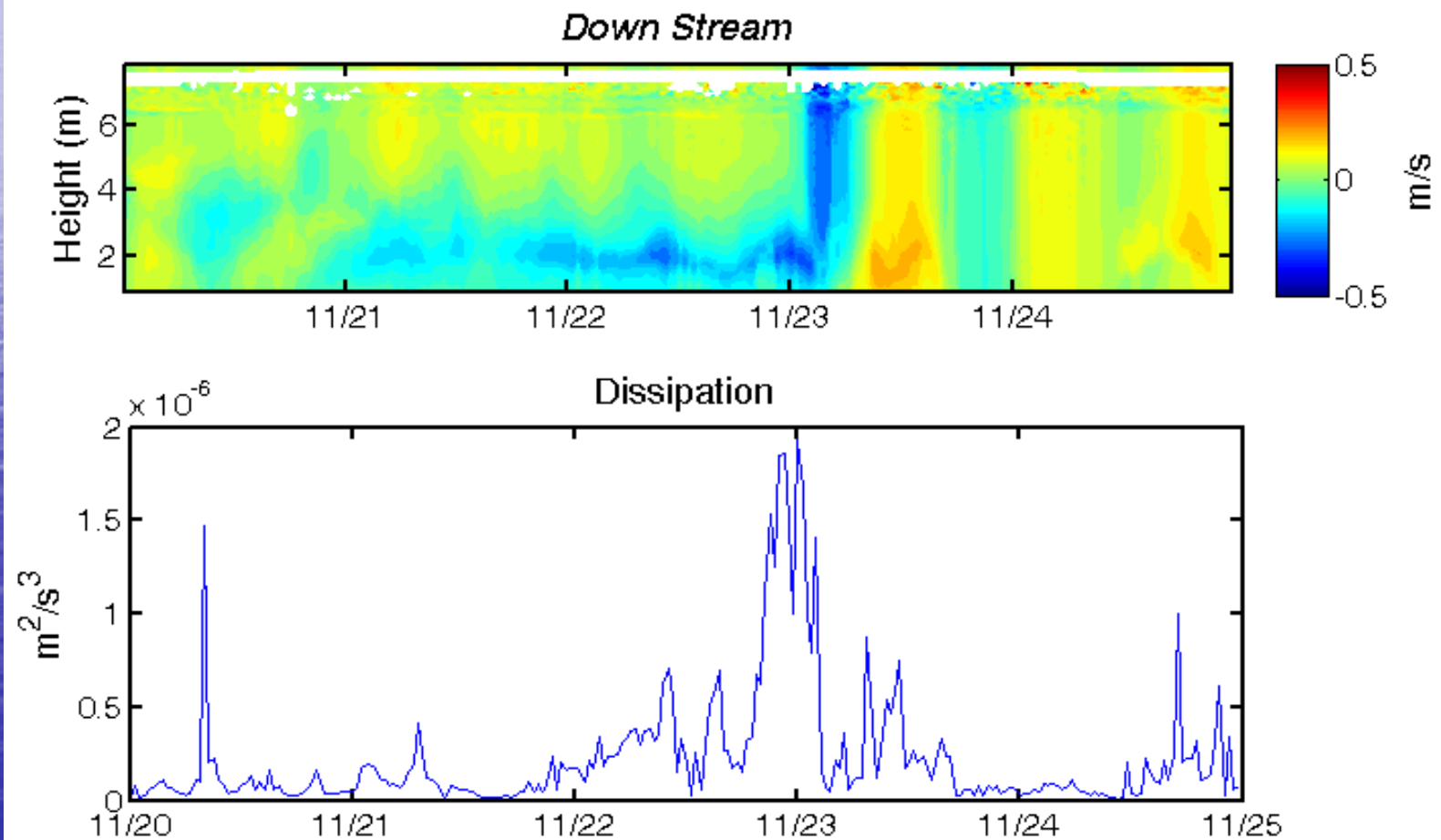
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Dissipation via spectral analysis

- Vertical velocity
- Fit $-5/3$ slope to > 1 Hz frequencies



Summary

- Wave removal cleared up vertical beam TKE
- Vertical beam still holds promise, but
- Need lower noise data
- 0.5 m bins would have dropped noise from 0.19 to 0.05 m^2/s^2 where averaging two 0.25 m bins only drops to 0.10 m^2/s^2