Waves and Mixing Observed During SWAT (2000)

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Introduction

- The SWAT (Shallow Water Acoustic Technology) Fall 2000 experiment in coastal waters off New Jersey was designed to study effects of IW activity on sound propagation in the coastal ocean

- The large density stratifications found in Fall in coastal waters off New Jersey are associated with strong internal wave activity, leading to substantial mixing in the water column

- The strength of this mixing and how it depends on internal wave characteristics (amplitude, shear, stratification) is poorly known, and needs to be better understood

Background

- Numerous studies have documented large-amplitude IW activity in coastal regions throughout the world ocean (e.g., Holloway (1987, 1997), and others)

- Hallock (2004) used the SWAT (2000) ADCP data to quantify directional (shoreward) energy fluxes associated with these internal waves

- Duda (2002, JGR), Rehmann and Duda (2000, JPO) used microstructure data to quantify diffusivities near the SWAT survey region, finding systematic differences for double-diffusively stable/unstable stratifications

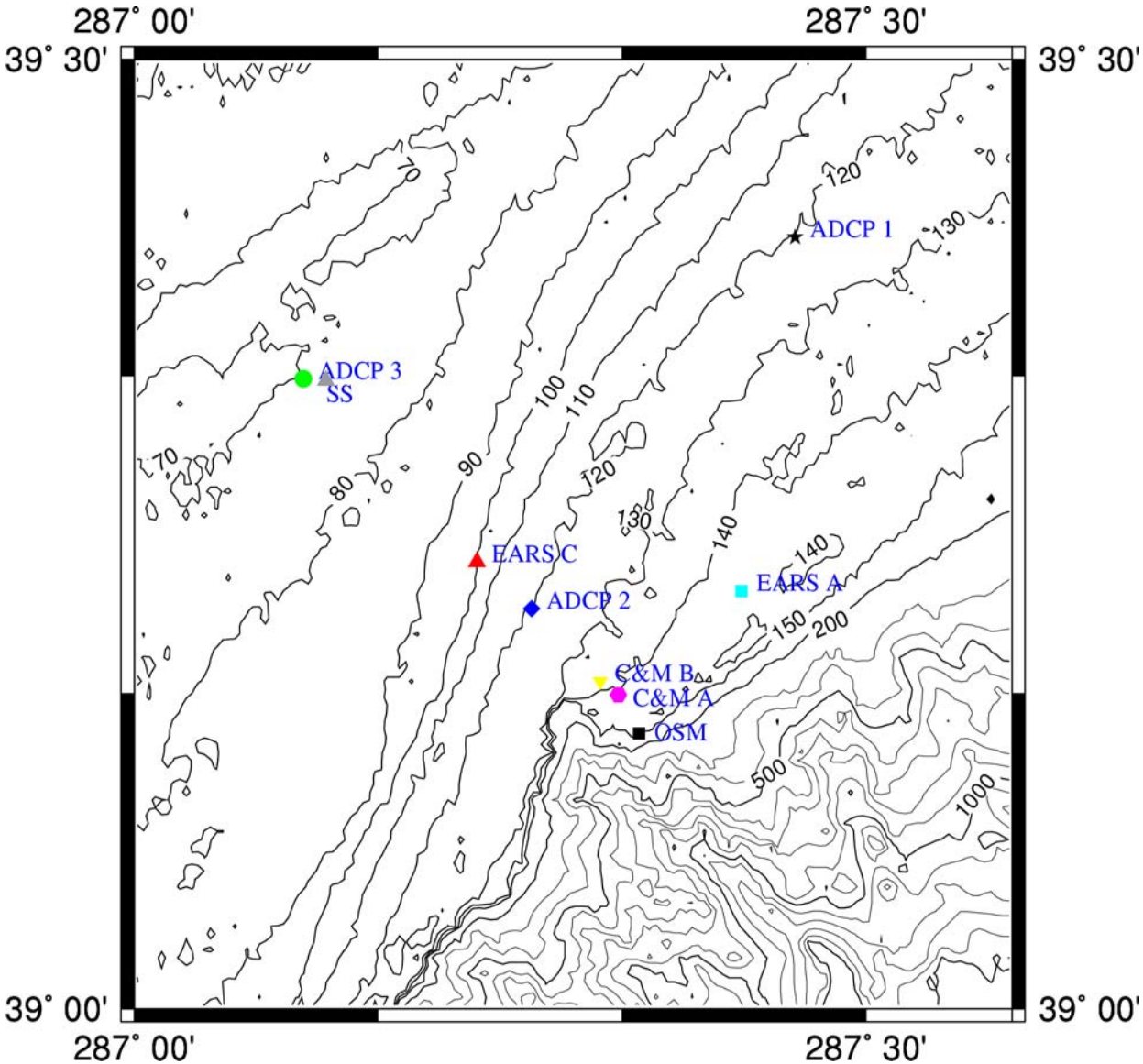
- The Thorpe sorting method (e.g., Thorpe, 1977; Stansfield et al., 2001) allows effective diffusivities to be estimated by 'sorting' high-resolution CTD profiles taken in energetic coastal environments to identify turbulent overturn scales

SWAT Deployments: 3 trawl-resistant ADCPs and 7 C-T chain moorings

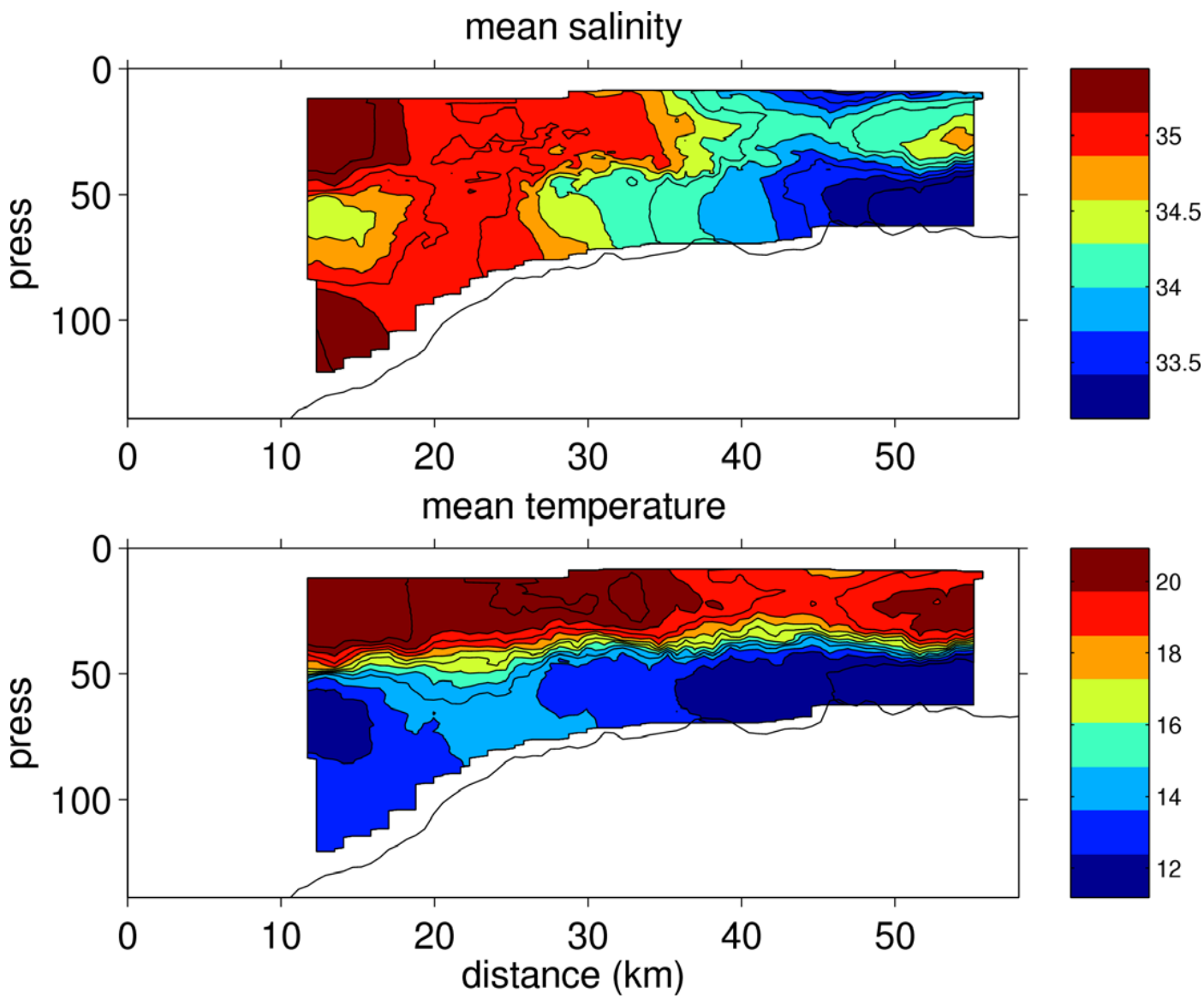
name	location (lon, lat)	depth (m)	dates (year day)	description	CTDs	T sensors
ADCP 1	-72.5486, 39.4068	120	272.90–312.50	ADCP	–	1
ADCP 2	-72.7284, 39.2113	120	272.90–312.50	ADCP	–	1
ADCP 3	-72.8844, 39.3321	70	272.90– 312.50	ADCP	–	1
EARS A	-72.5848, 39.2205	140	272.80–278.50	C-T chain	5	14
EARS C	-72.7658, 39.2360	100	272.57– 278.80	C-T chain	5	13
C & M A	-72.6692, 39.1658	140	274.05– 275.60	C-T chain	5	16
C & M B	-72.6815, 39.1729	140	275.85–278.50	C-T chain	5	16
OSM	-72.6548, 39.1455	150	292.91–306.55	T chain	–	27
SS	-72.8690, 39.3313	70	272.99–278.88	T chain	–	14
SS (leg 3)	-72.8690, 39.3313	70	292.63–306.84	T chain	–	11

Table 1: Summary of the moorings deployed during SWAT

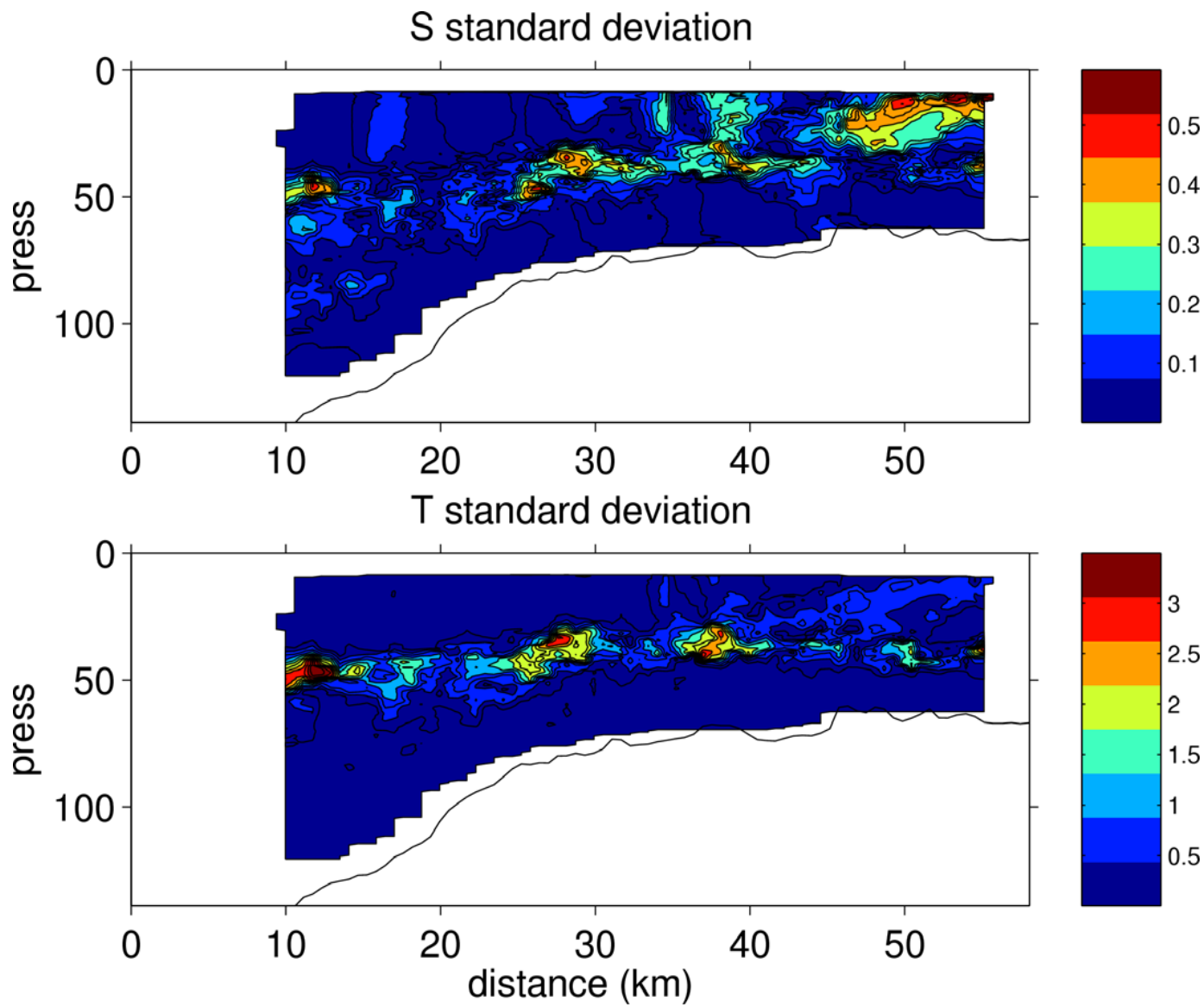
The SWAT (2000) Survey Area



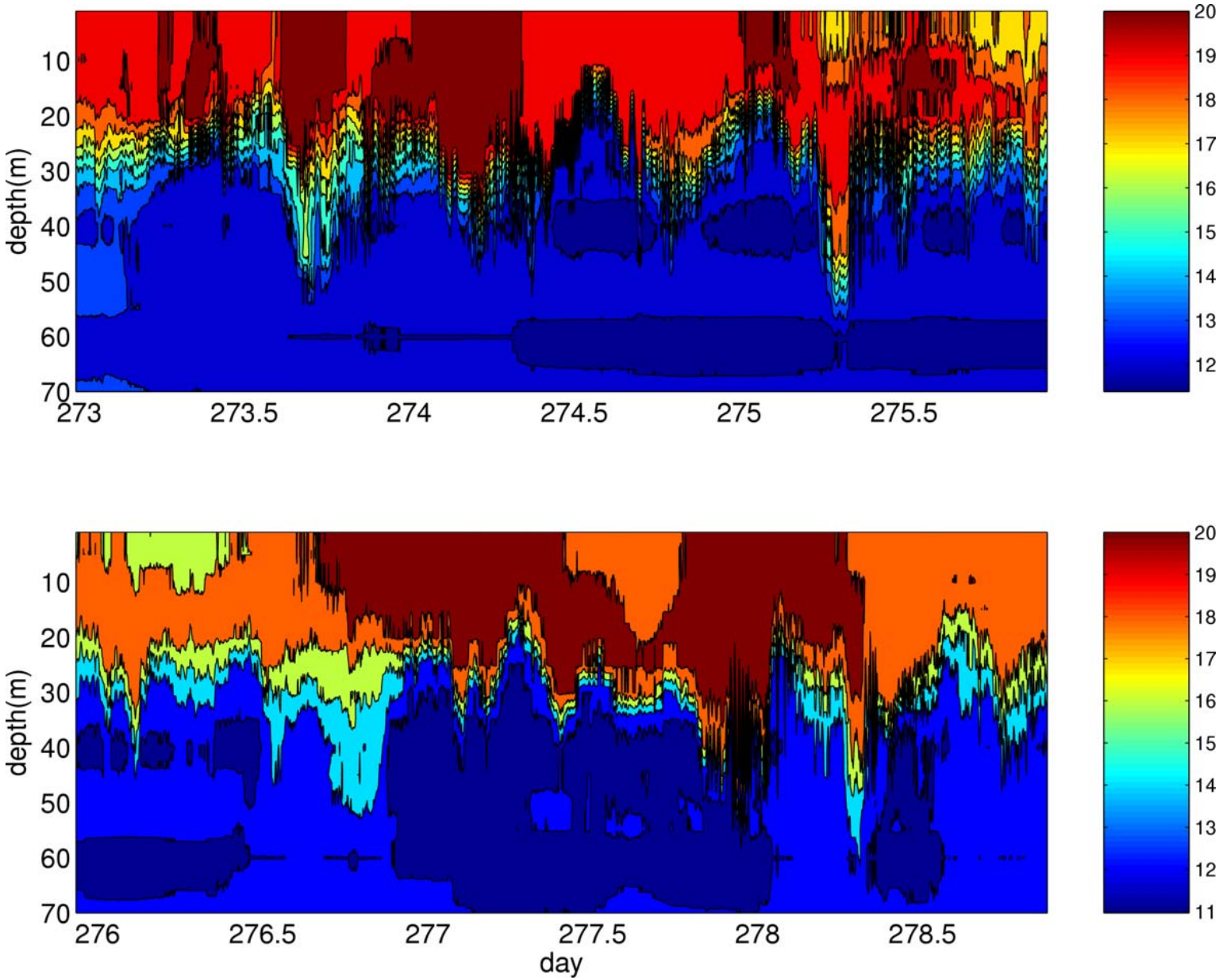
Scanfish-measured mean salinity and temperature along an onshore section



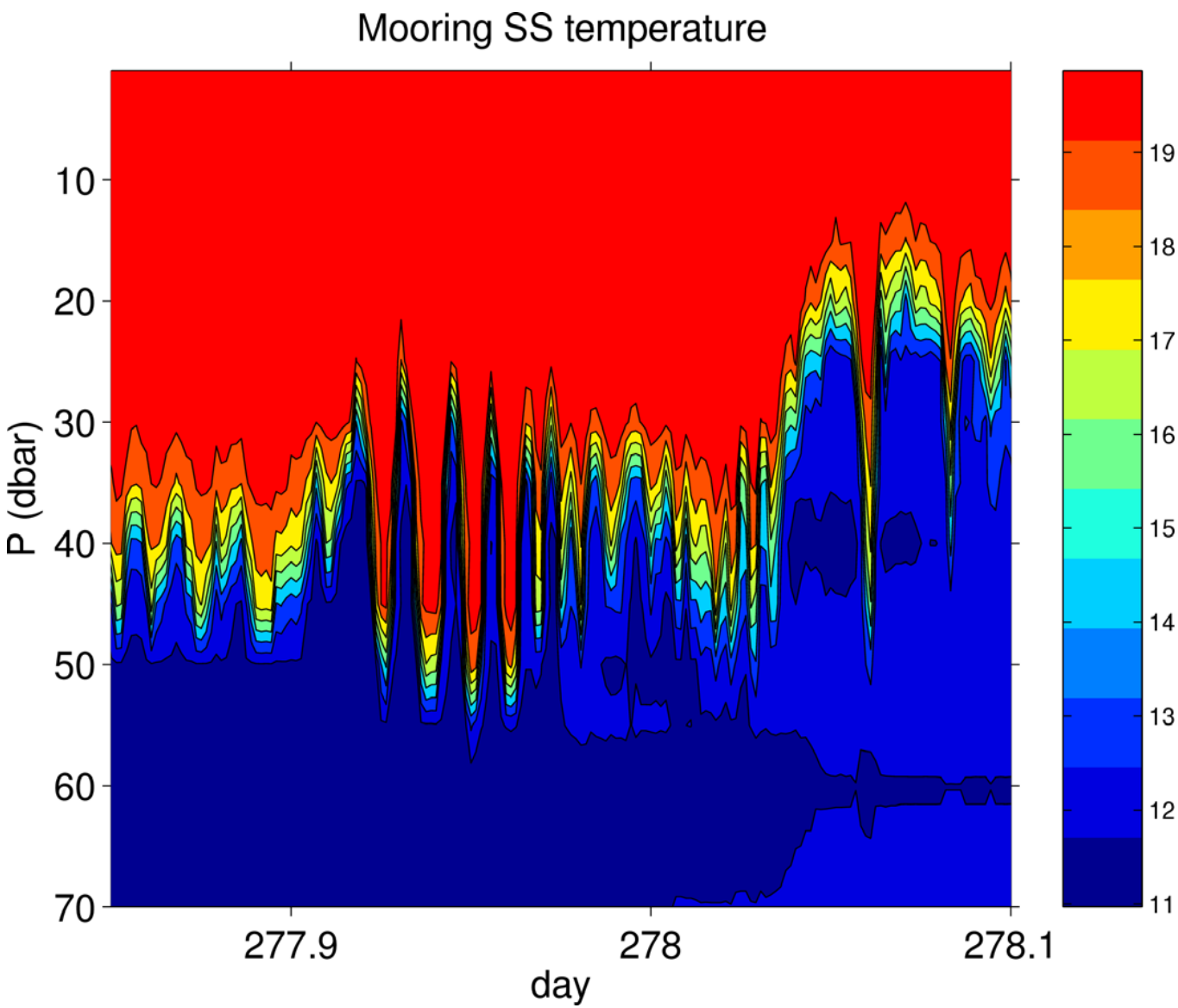
Scanfish-measured standard deviations of S (top and T (bottom)



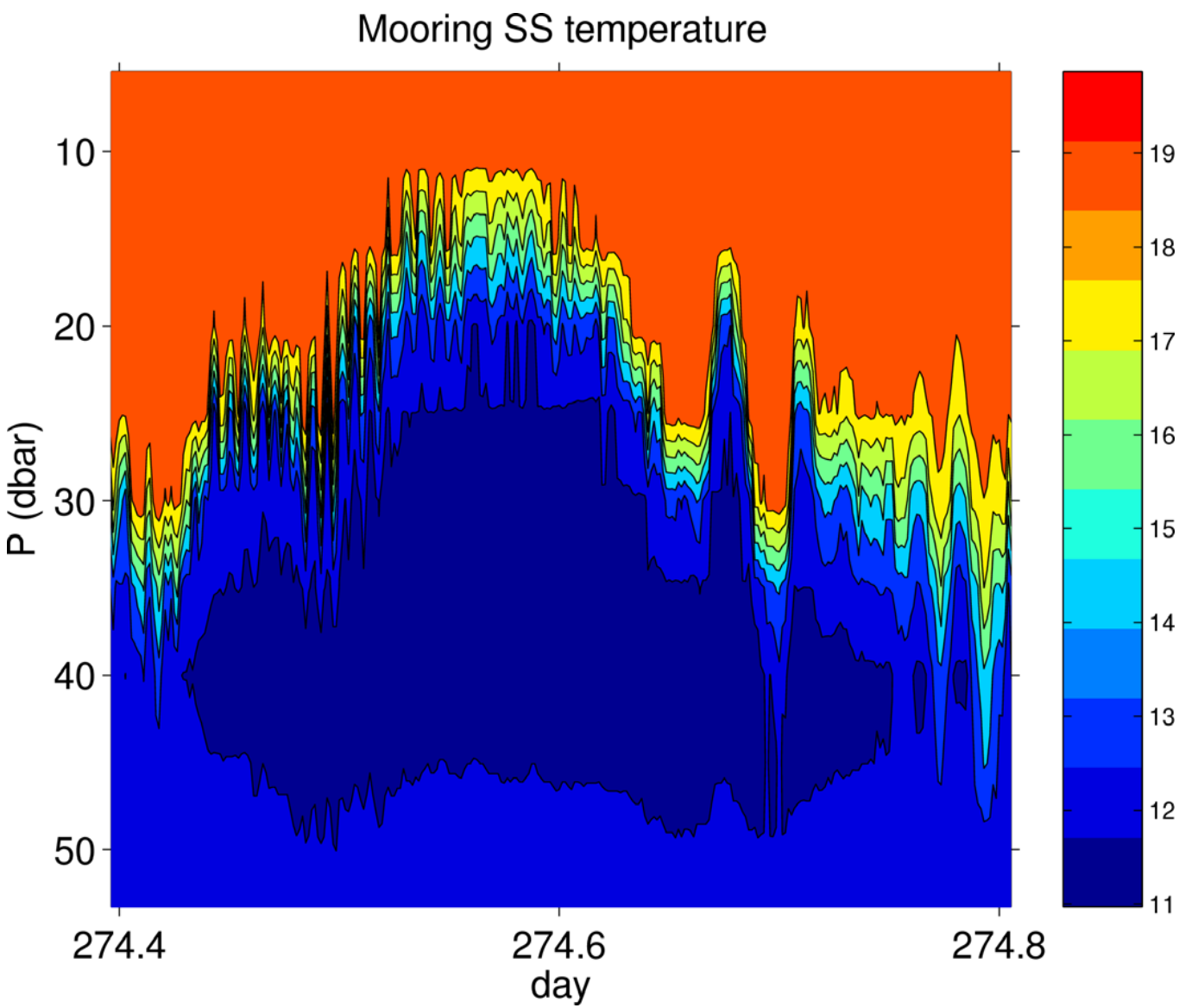
SS mooring temperatures



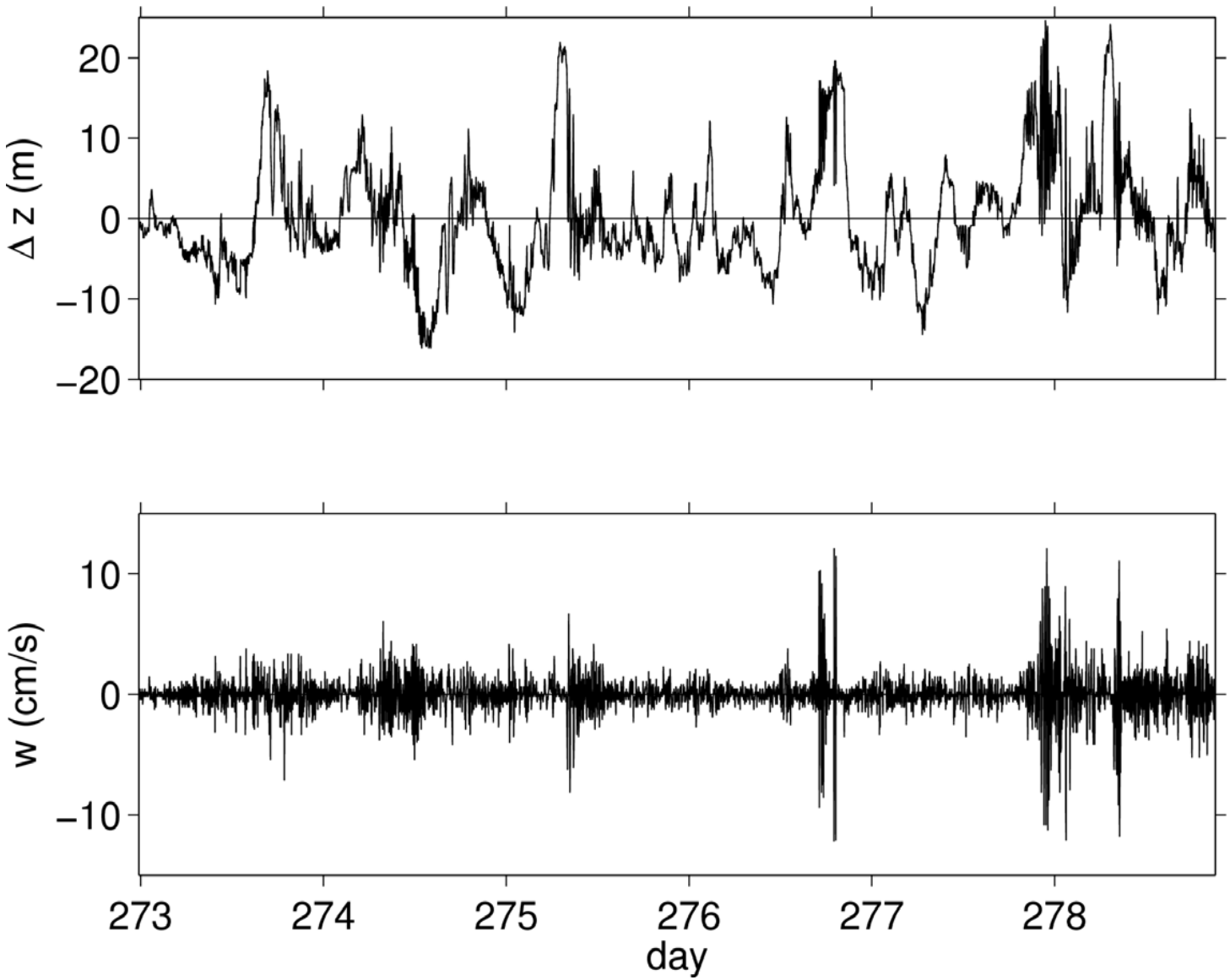
Large-amplitude waves observed by SS mooring:



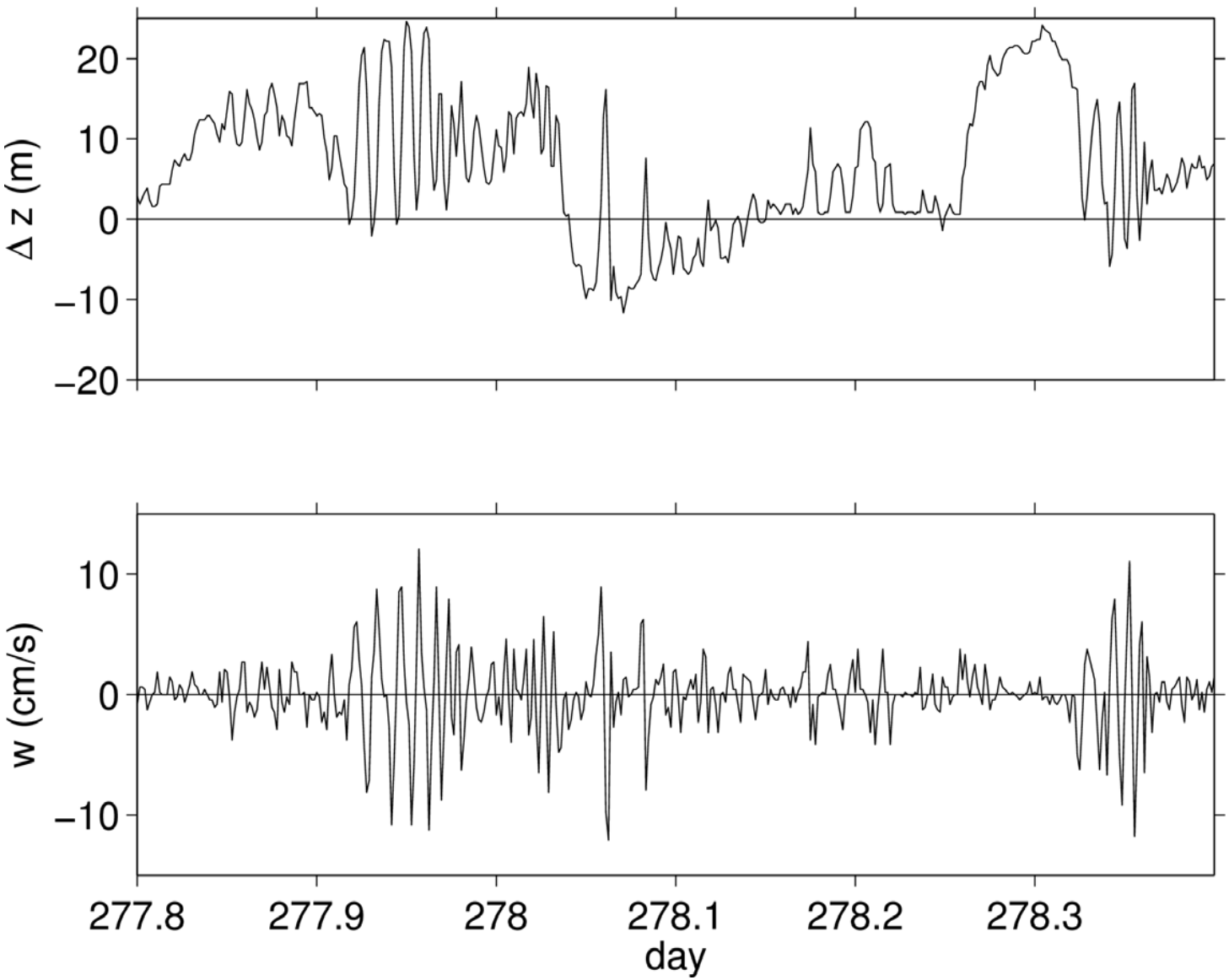
another large-amplitude wave packet...



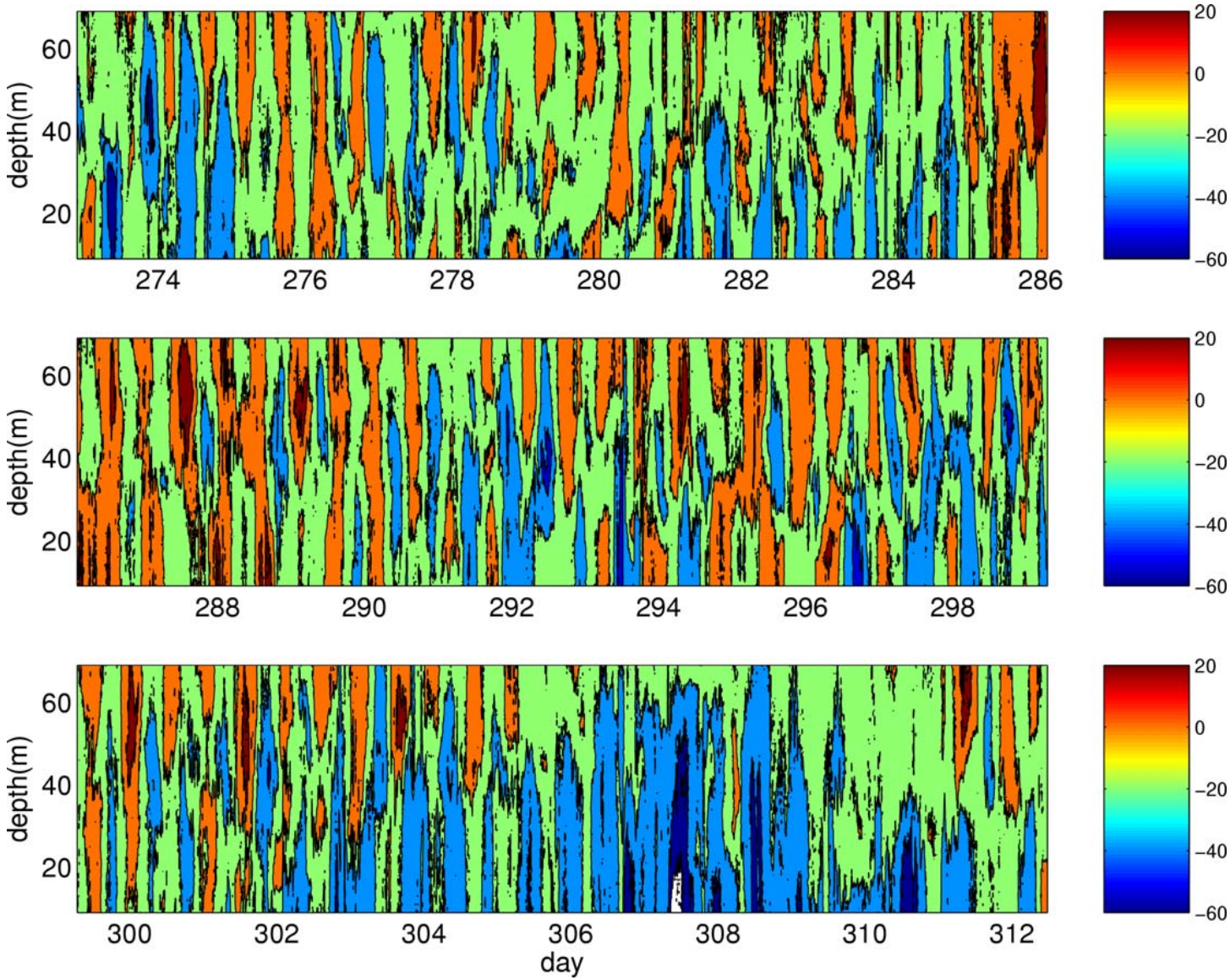
Inferred vertical displacement and vertical velocity



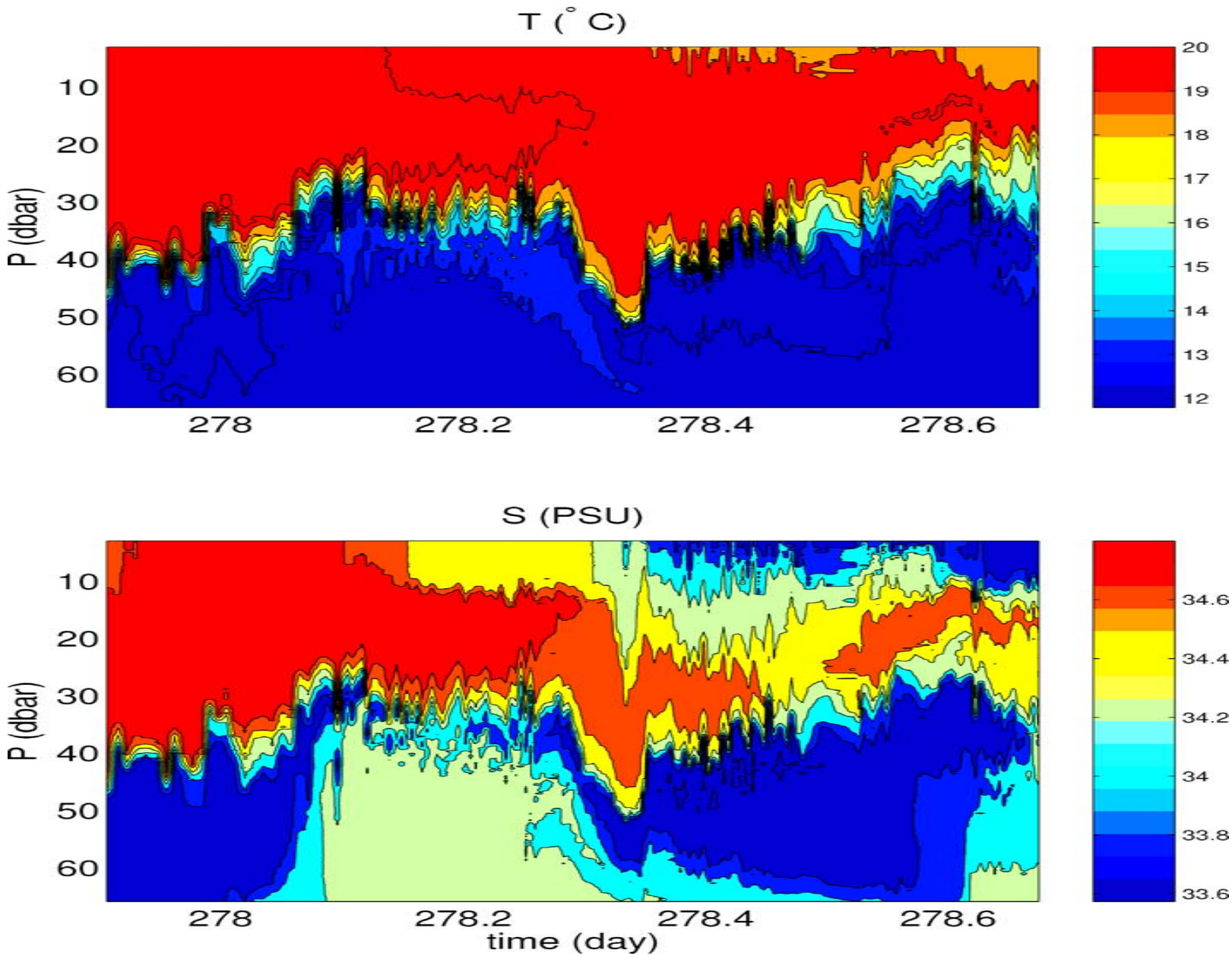
Close-up showing displacement and vertical velocity for prominent wave packet



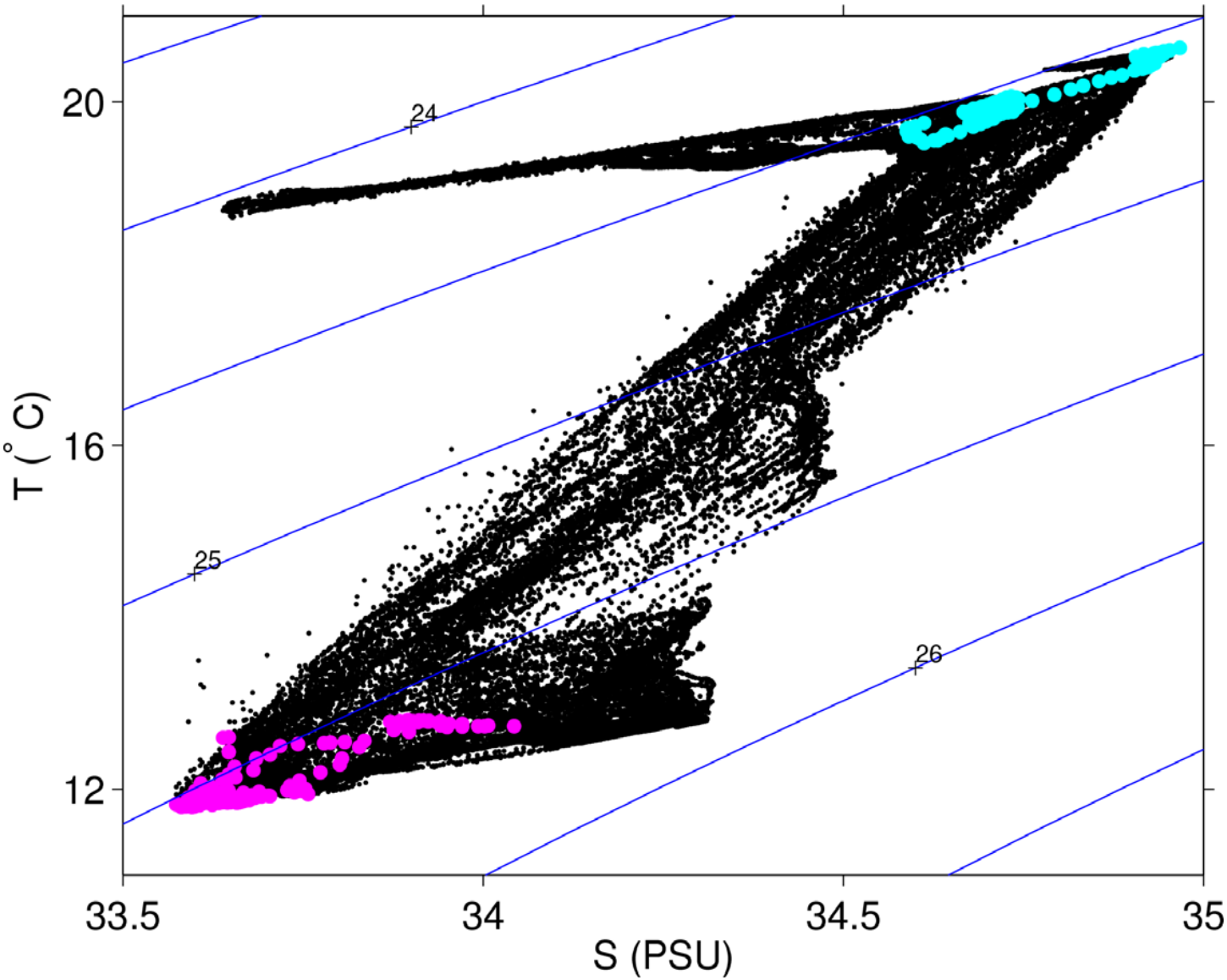
SWAT ADCP#3 u velocity (cm/s)



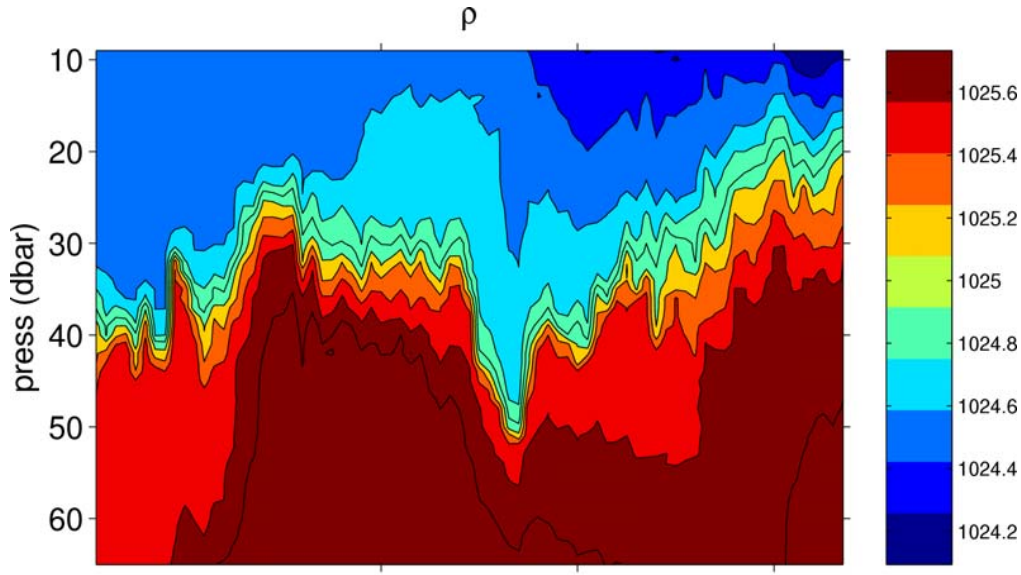
Yo-yo CTD temperature and salinity

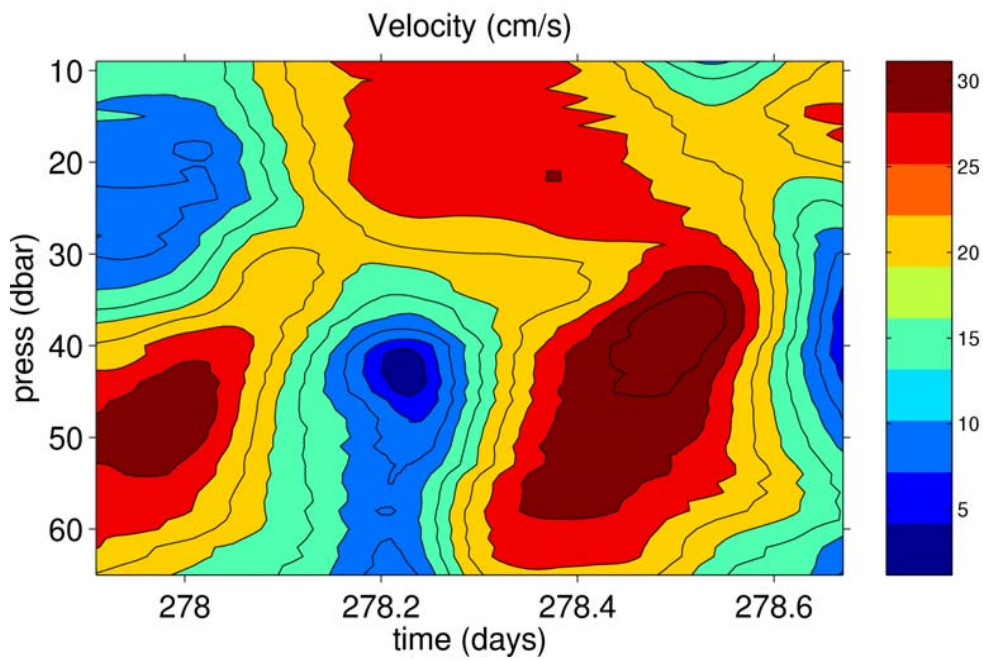


SWAT (2000) yo-yo CTD data

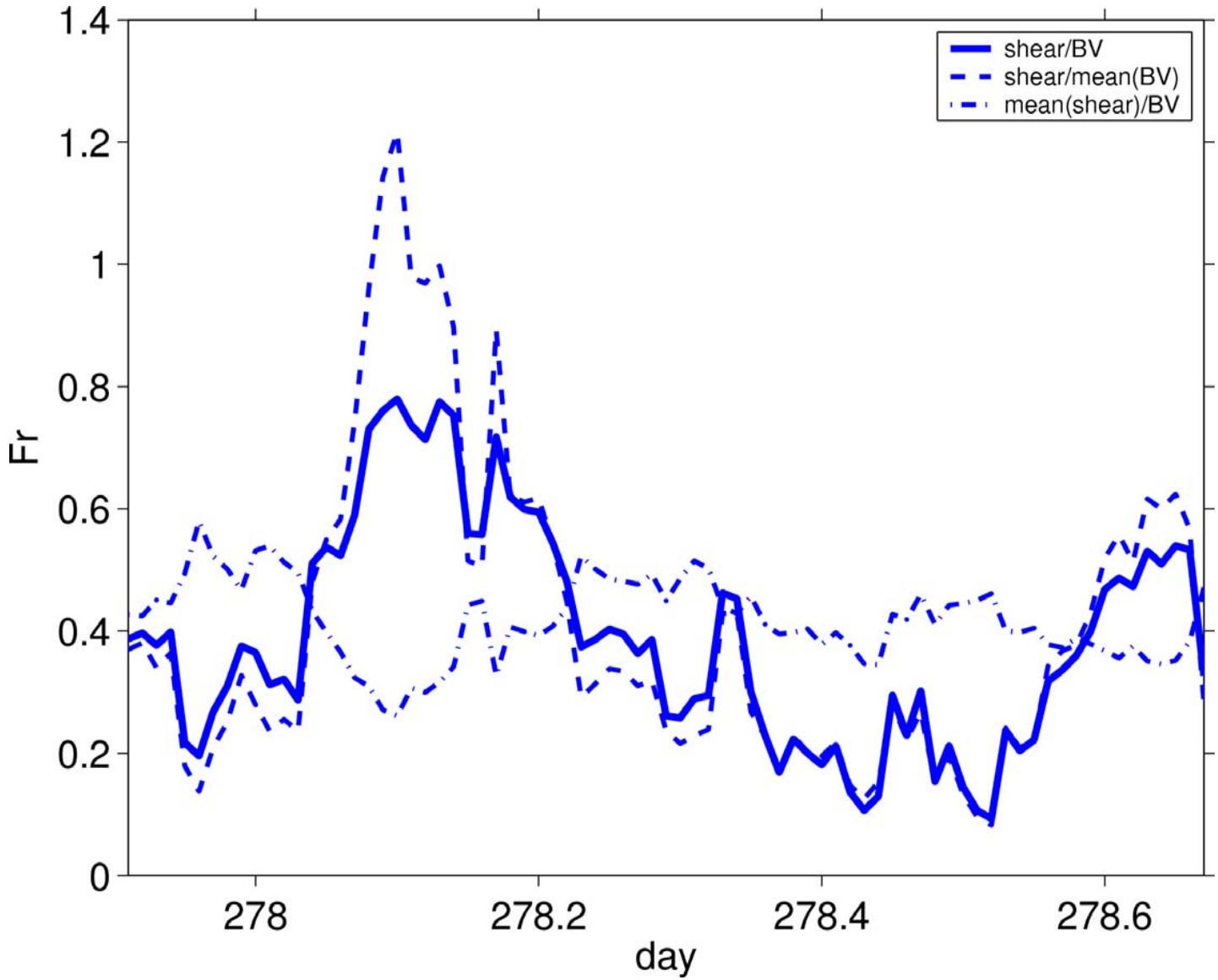


CTD-measured density and coincident ADCP-measured velocities

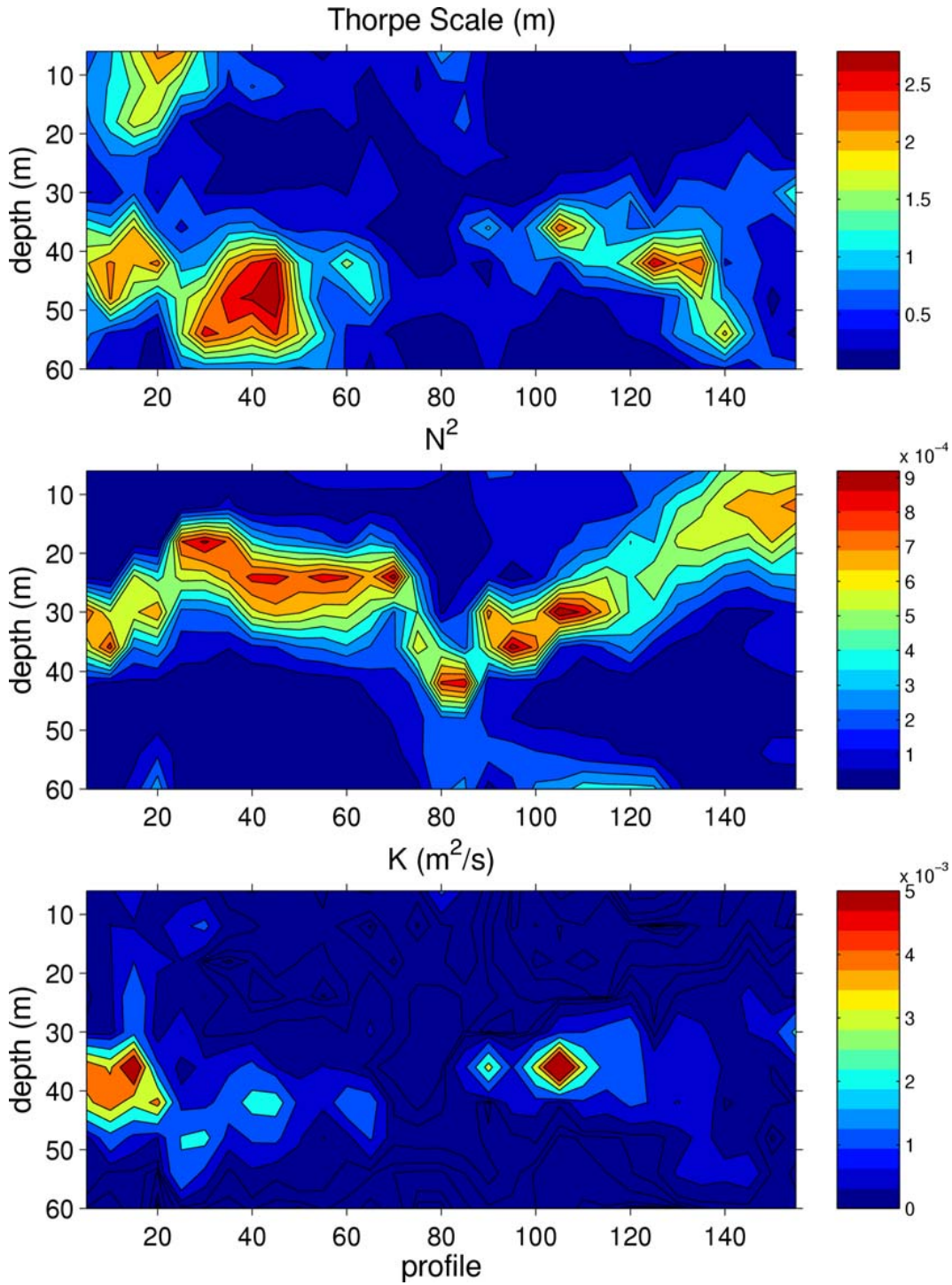




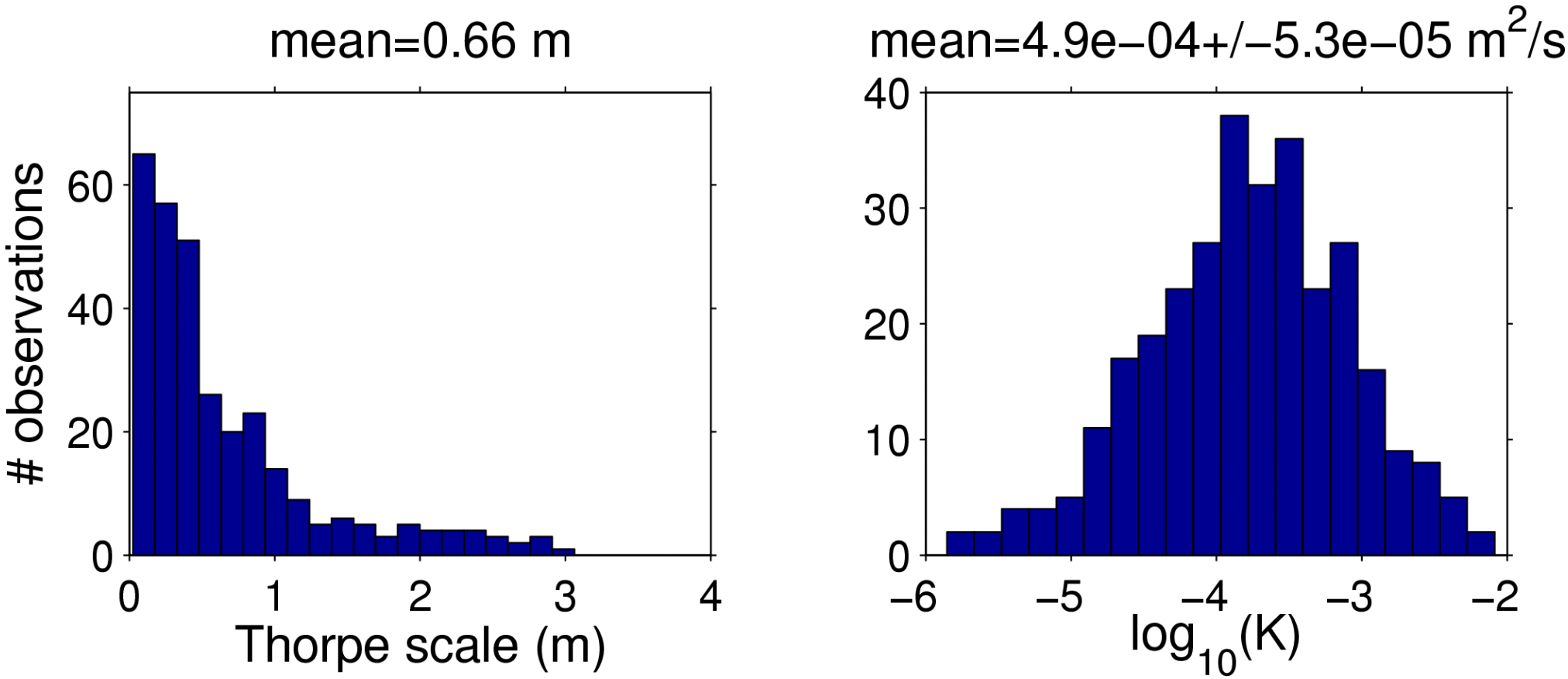
Estimated Bulk Froude number: (du/dz)/N



Thorpe scales (top), buoyancy frequencies (middle), and inferred diffusivities (bottom)



Observed distribution of Thorpe scale and diffusivity



What's next:

- Extend coverage from ~24 hr to ~3 weeks by using data from nearby T-chain mooring together with observed T-S relation pattern

- Try to better quantify the relationship between Froude number, observed Thorpe scale, and associated eddy diffusivity

- Newly available RAGS (2003) data, including microstucture data, should shed new light on waves and small-scale processes occurring in this region

Conclusions

- Strong internal tides and large-amplitude, high-frequency internal waves observed during SWAT have been characterized, showing vertical velocity amplitudes of up to 10 cm/s and vertical displacement amplitudes of up to 20 meters

- Elevated Froude numbers are observed consistent with enhanced mixing early in the observation period

- RMS Thorpe displacements of up to 3m are observed, suggesting a diffusivity K~5e-4 m2/s, consistent with near-bottom diffusivities found by Rehmann and Duda (2000) on the New England shelf