35 years in the Vancouver Island Coastal Current

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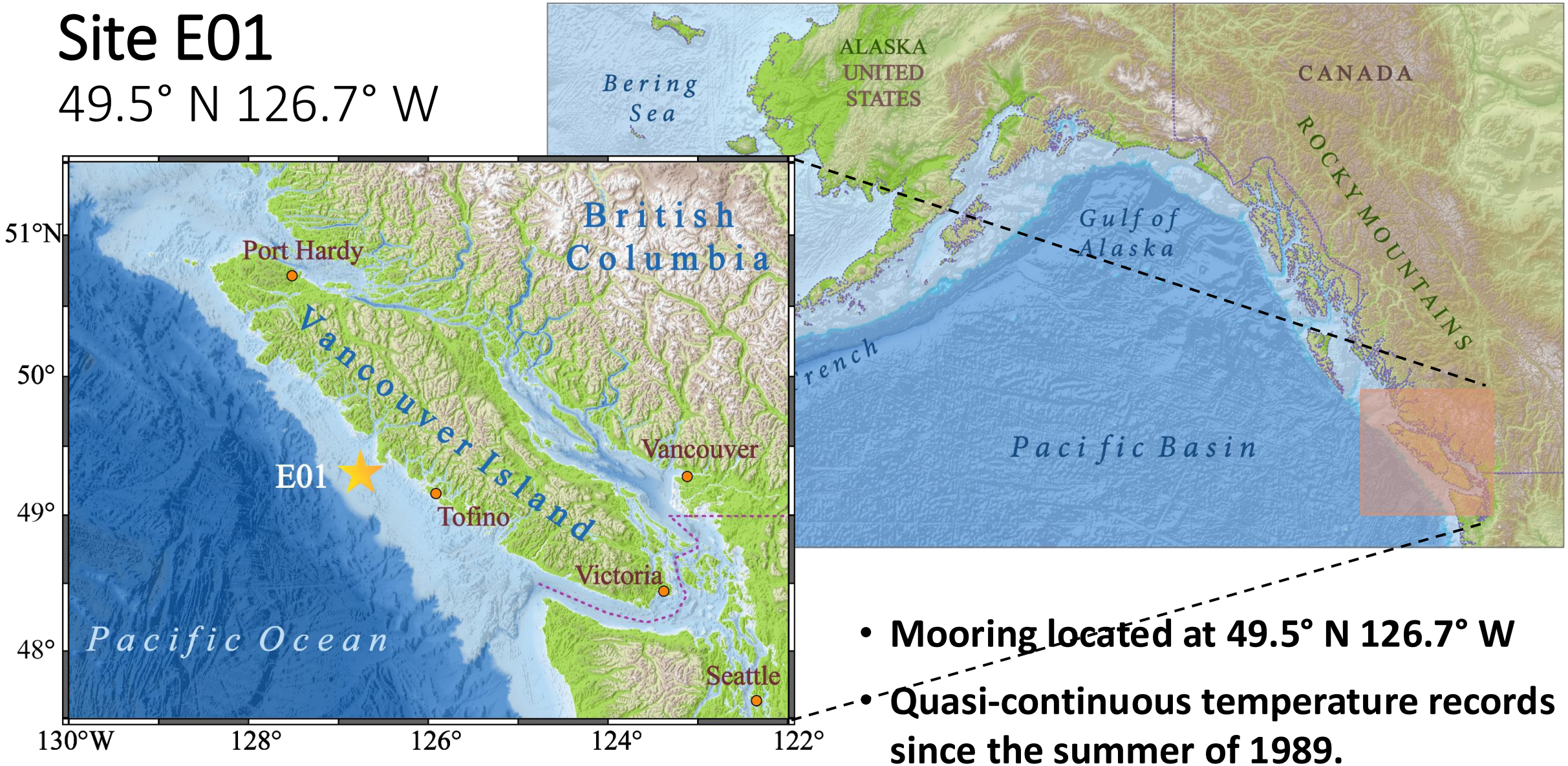
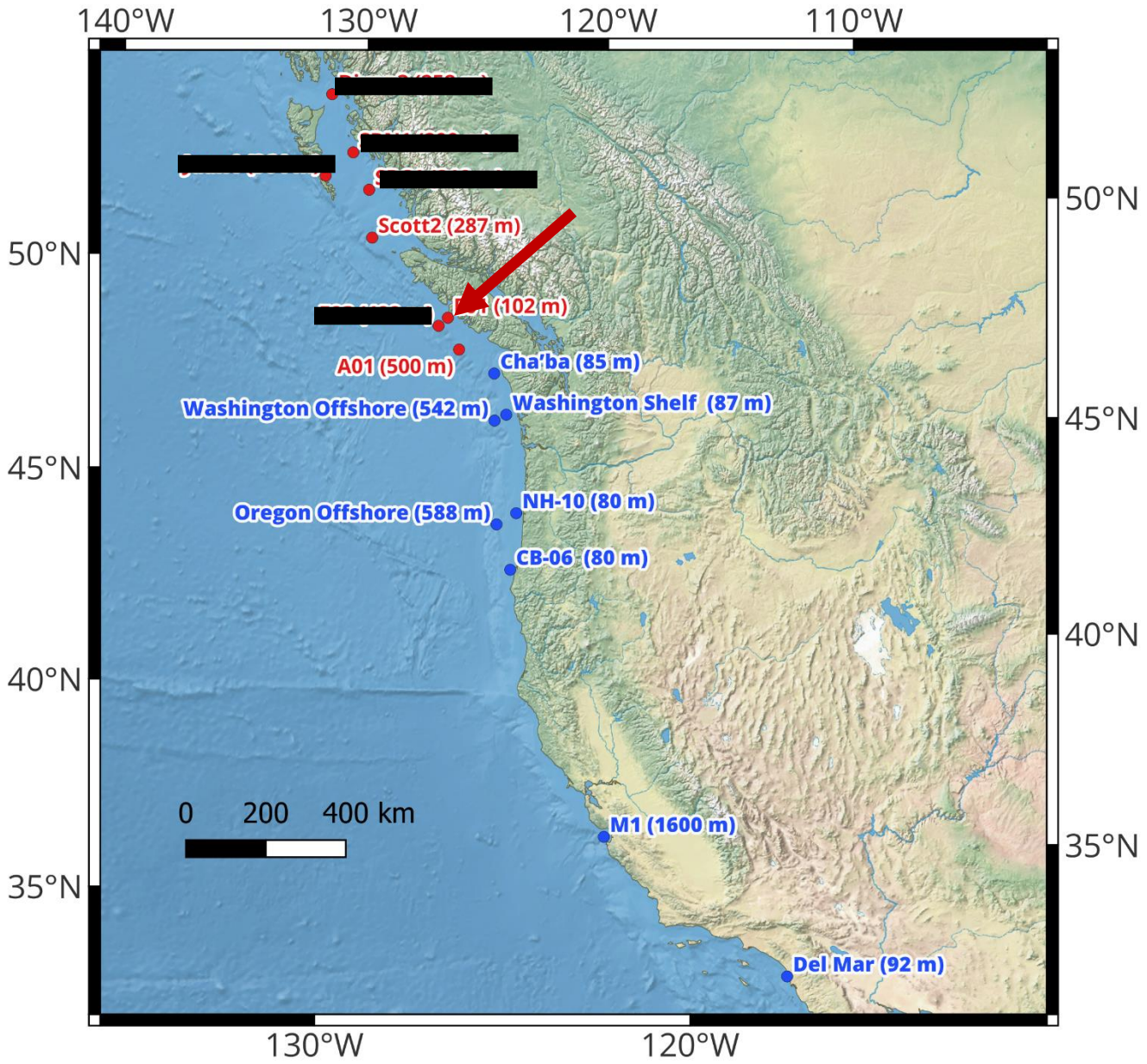
Site E01

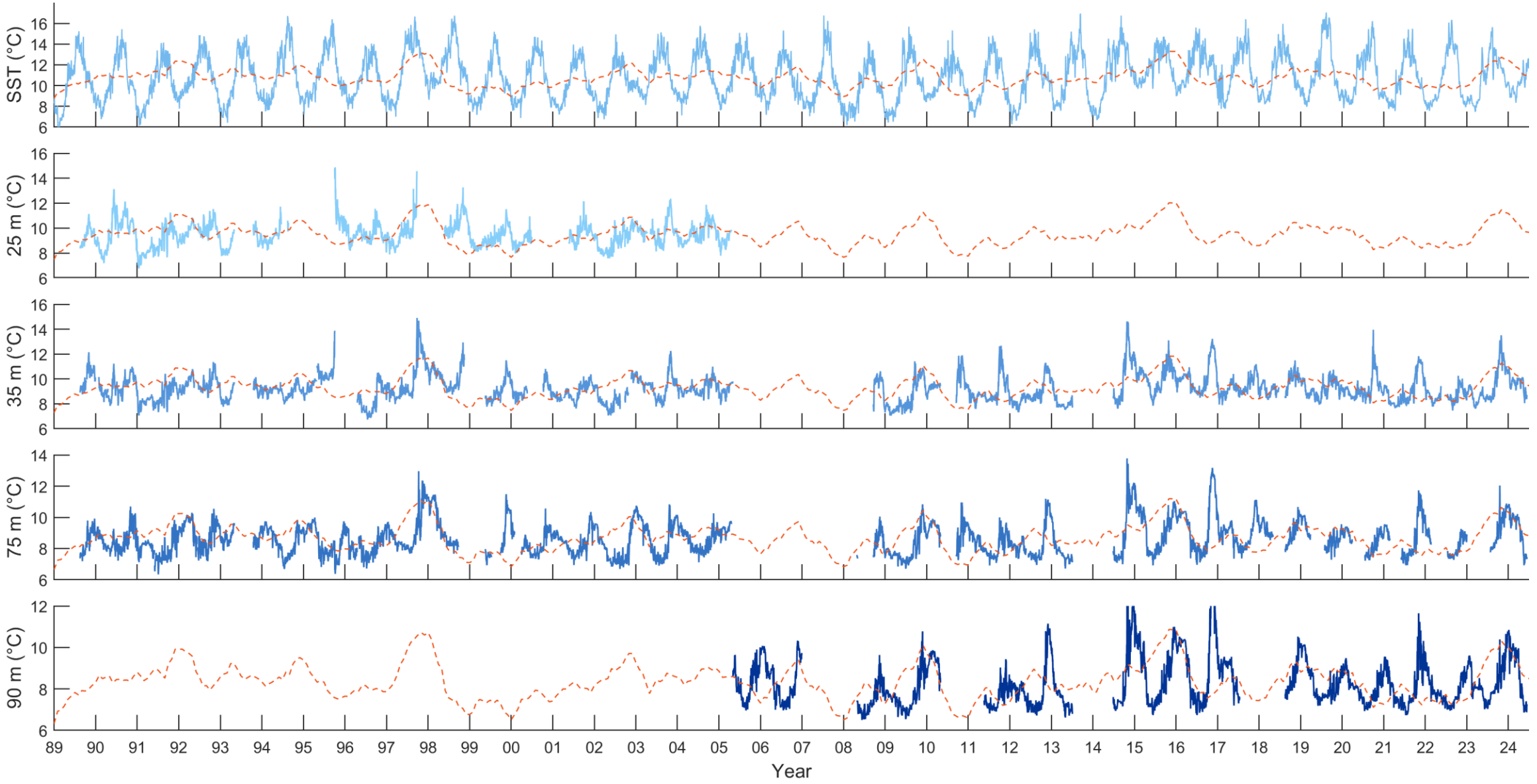
49.5° N 126.7° W



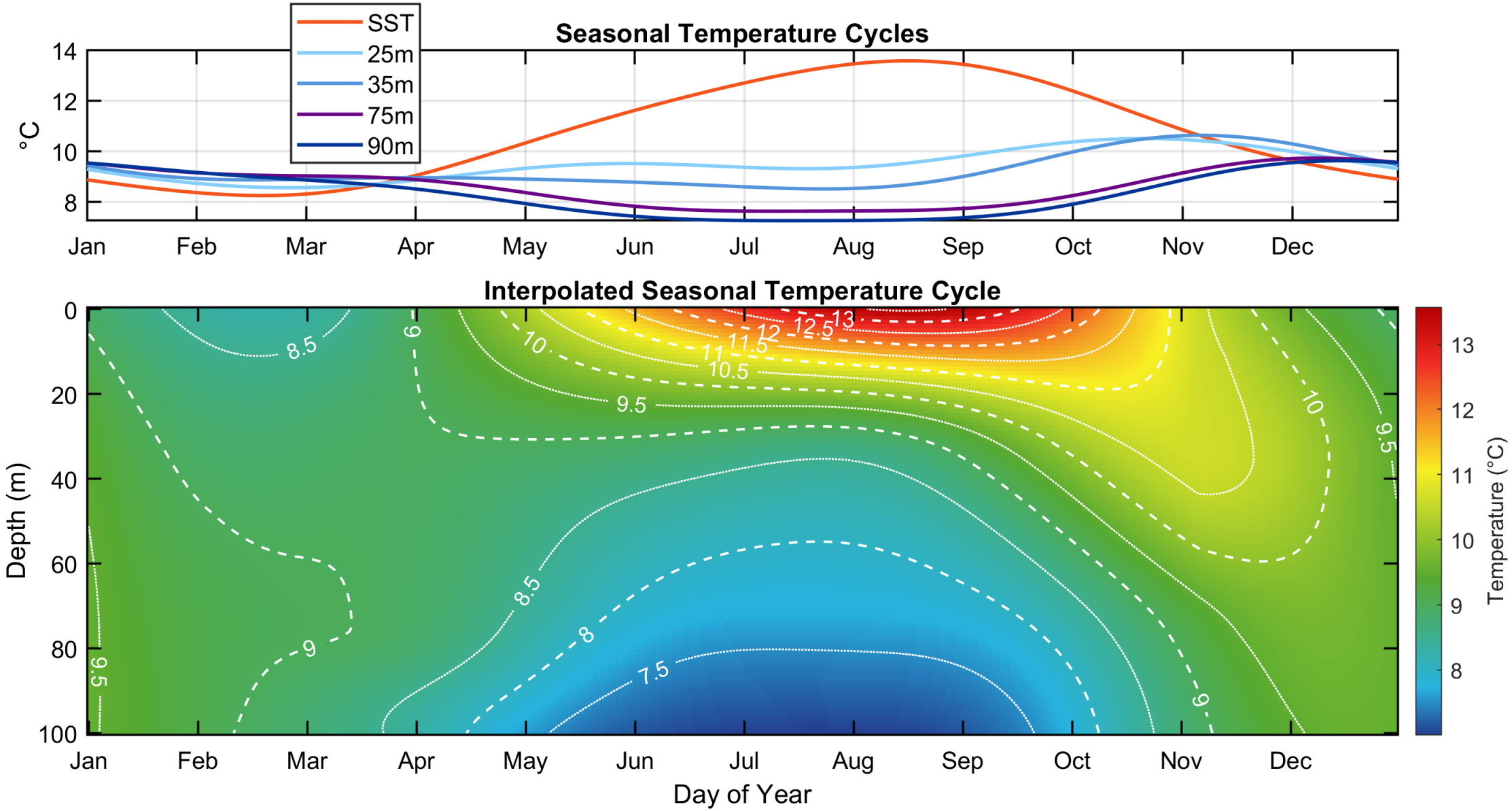
- **Mooring located at 49.5° N 126.7° W**
- **Quasi-continuous temperature records since the summer of 1989.**
- **Depth: 100 m**


140°W
130°W
120°W
110°W
50°N
45°N
40°N
35°N
Scott2 (287 m)
(102 m)
A01 (500 m)
Cha'ba (85 m)
Washington Offshore (542 m)
Washington Shelf (87 m)
Oregon Offshore (588 m)
NH-10 (80 m)
CB-06 (80 m)
0 200 400 km
M1 (1600 m)
Del Mar (92 m)

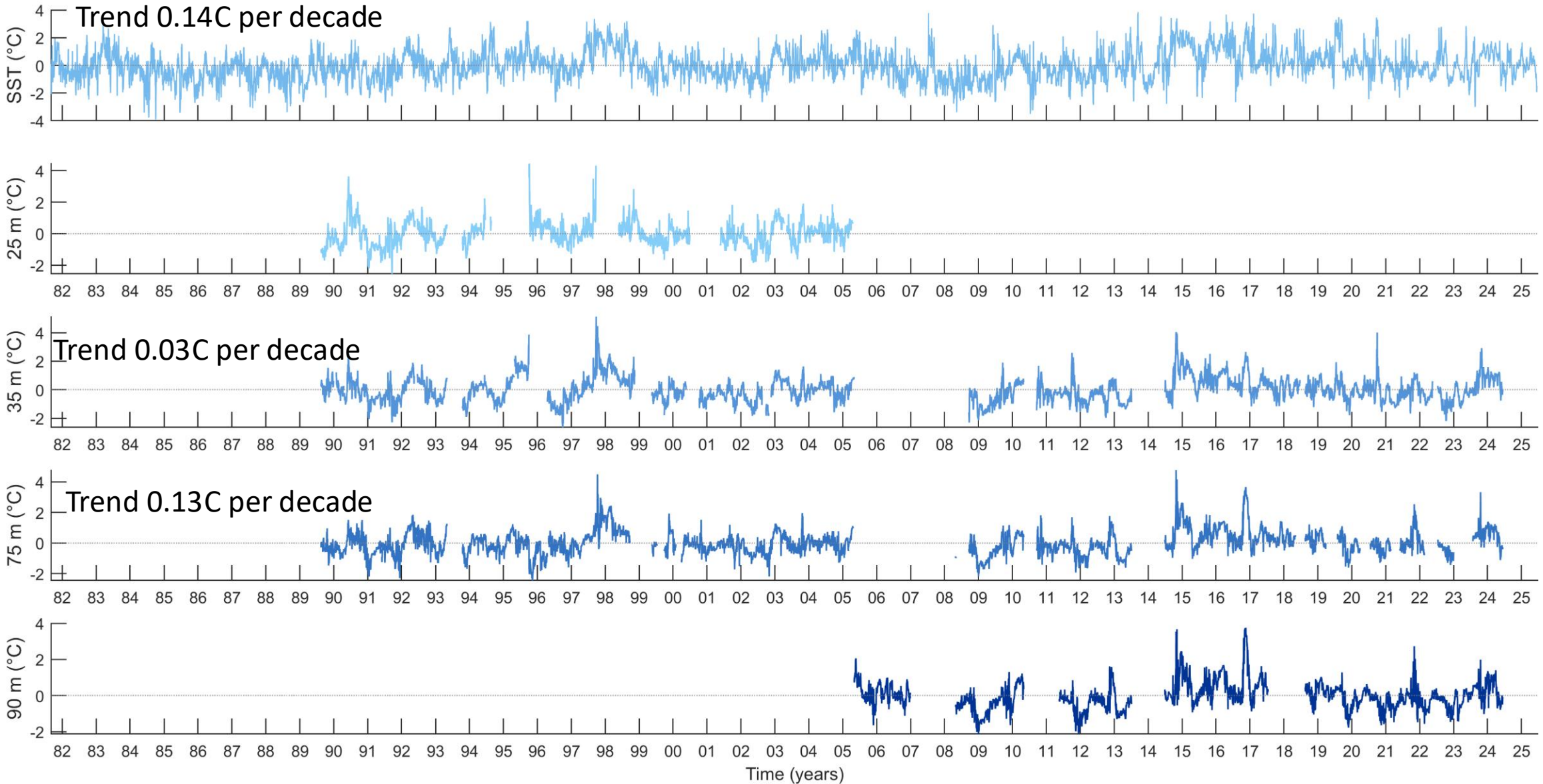
Temperature time series



Seasonal cycle – temperature



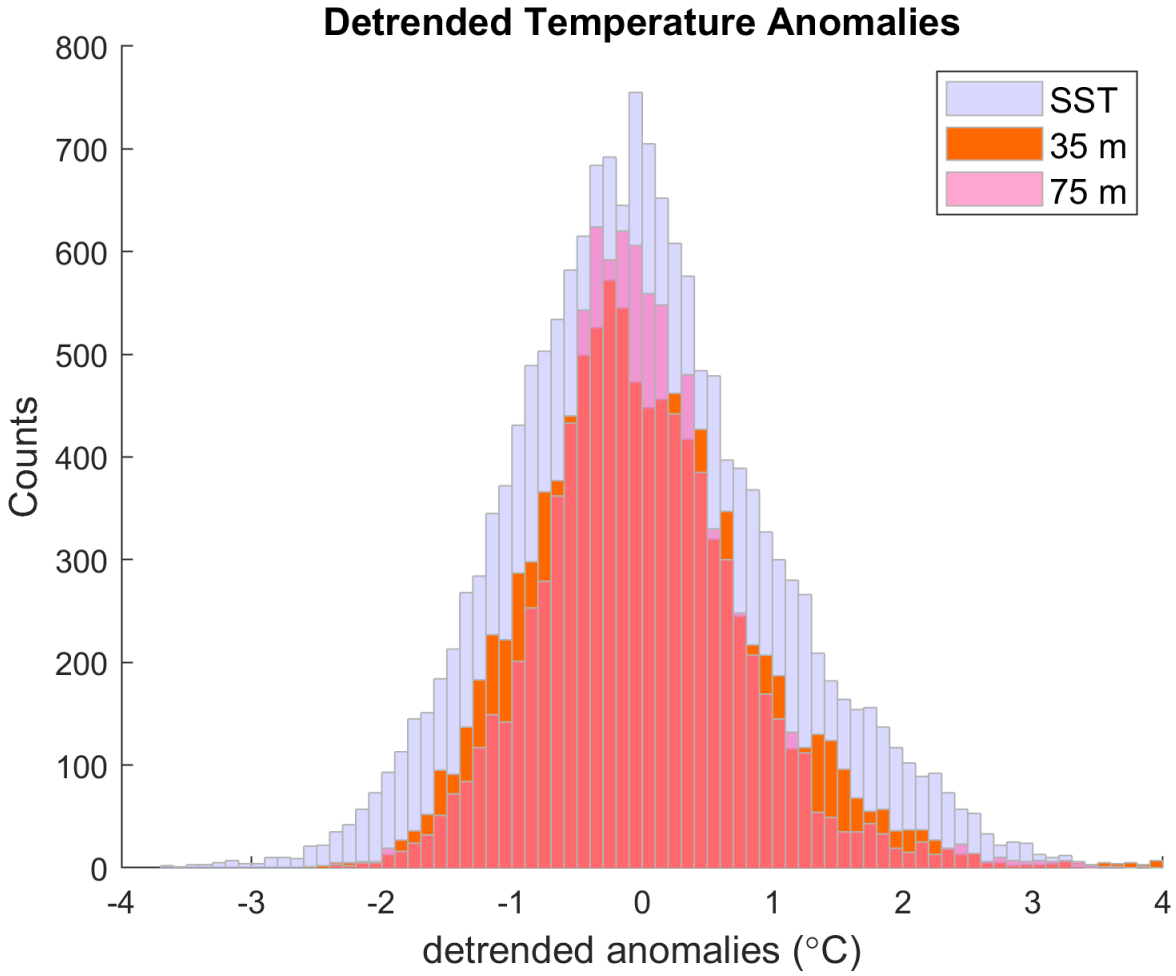
Temperature anomalies relative to seasonal cycle

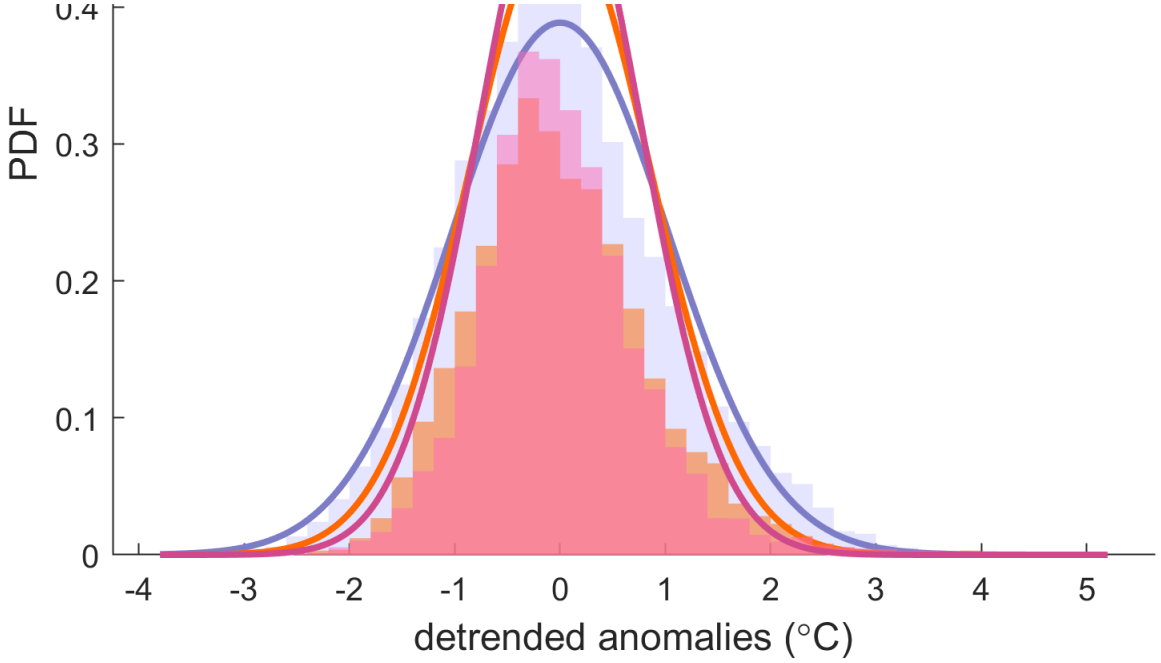


Statistics for sst, 35 m, 75 m
Stand Dev: 1.0, 0.86, 0.76
Skewness: 0.26, 0.63, 0.71
Excess Kurtosis: 0.19, 1.22, 1.98

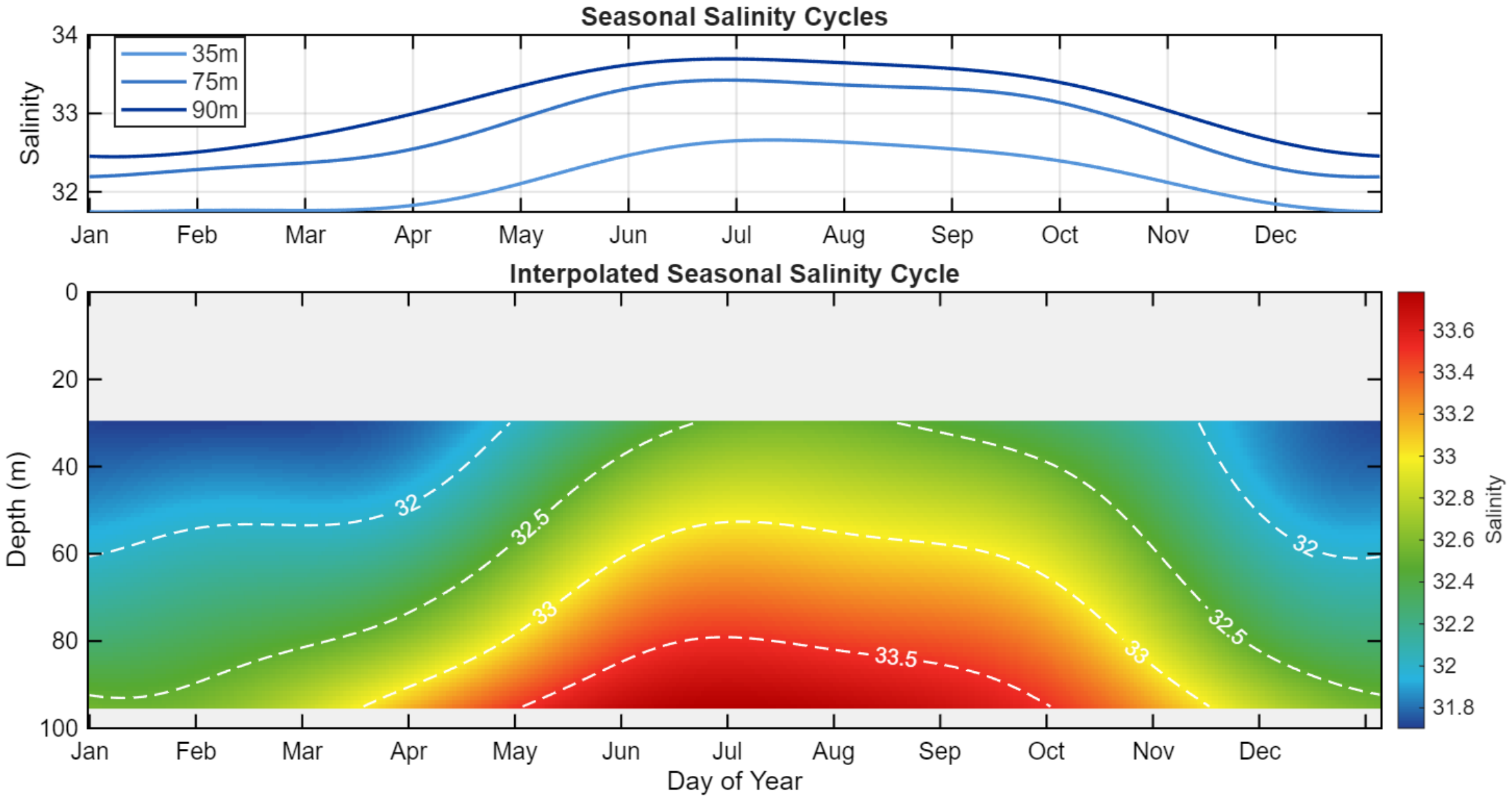
The 35 m and 75 m temperatures are not normal and have larger positive anomalies than negative.

The trend is not the source of the positive tails.

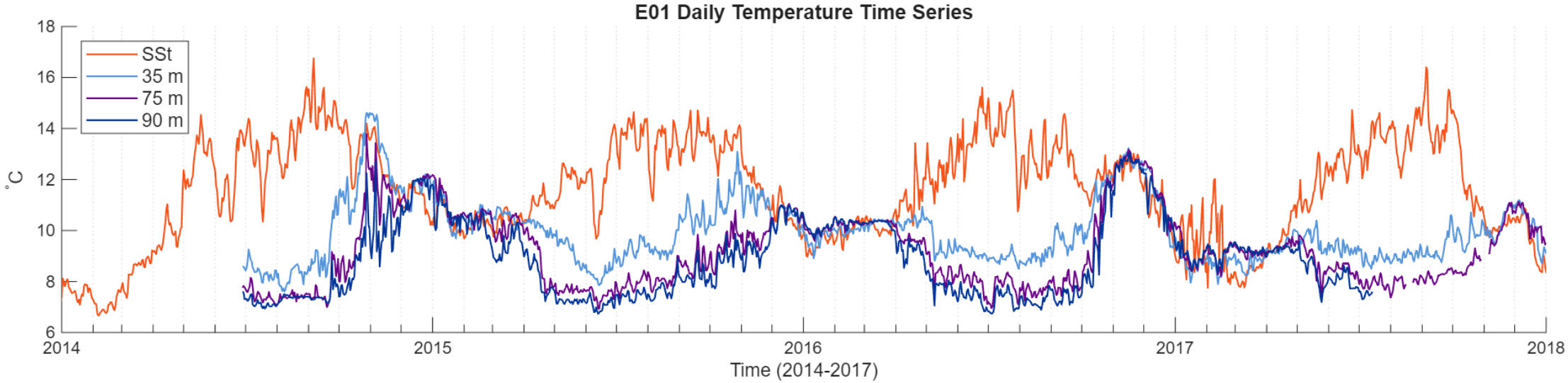


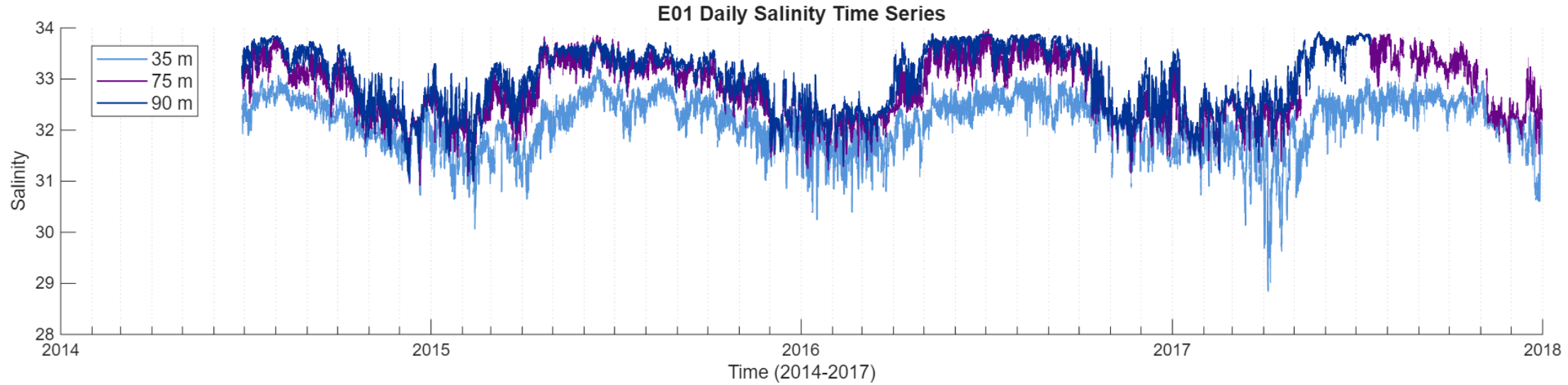


Seasonal Cycles of Salinity

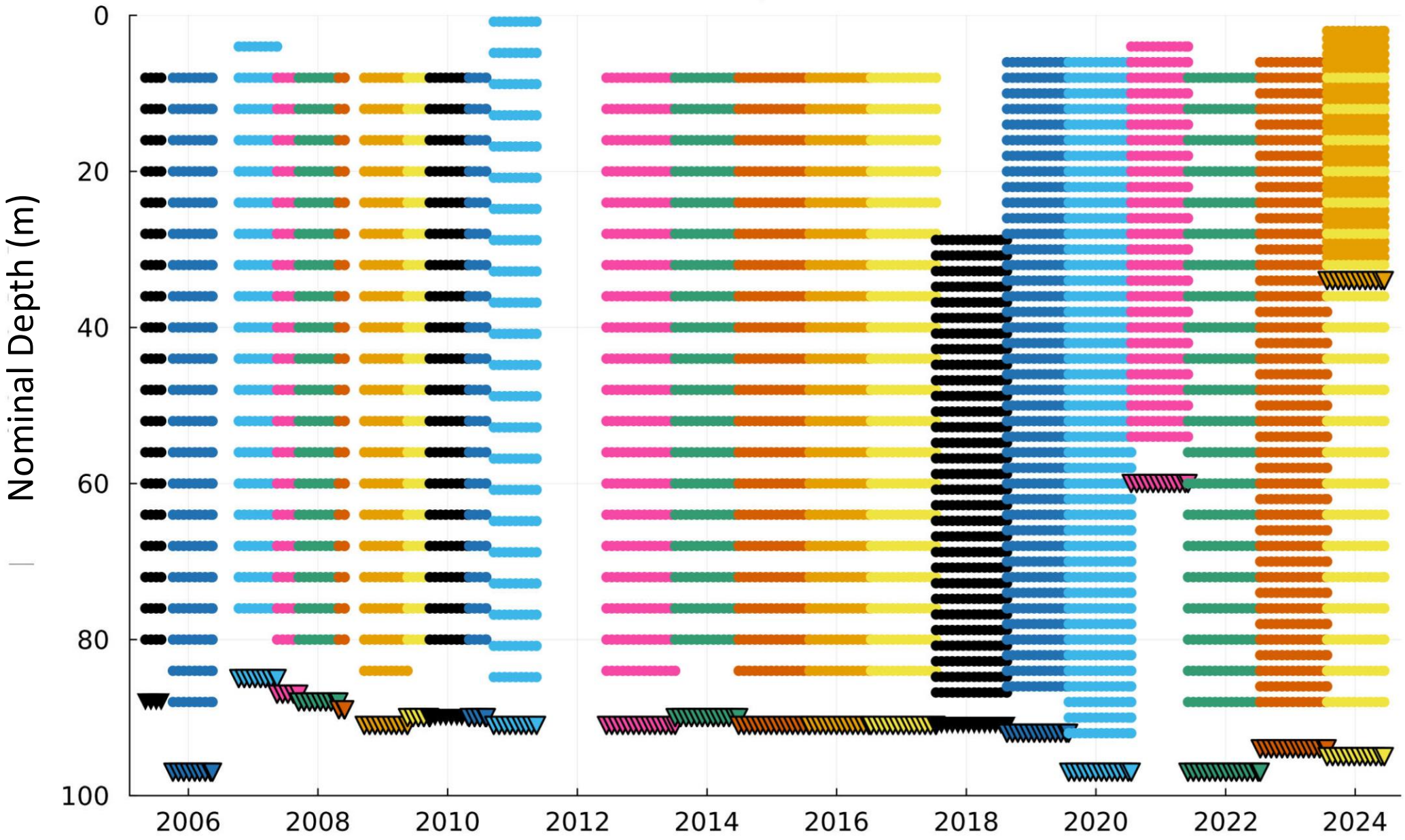


How the fall works

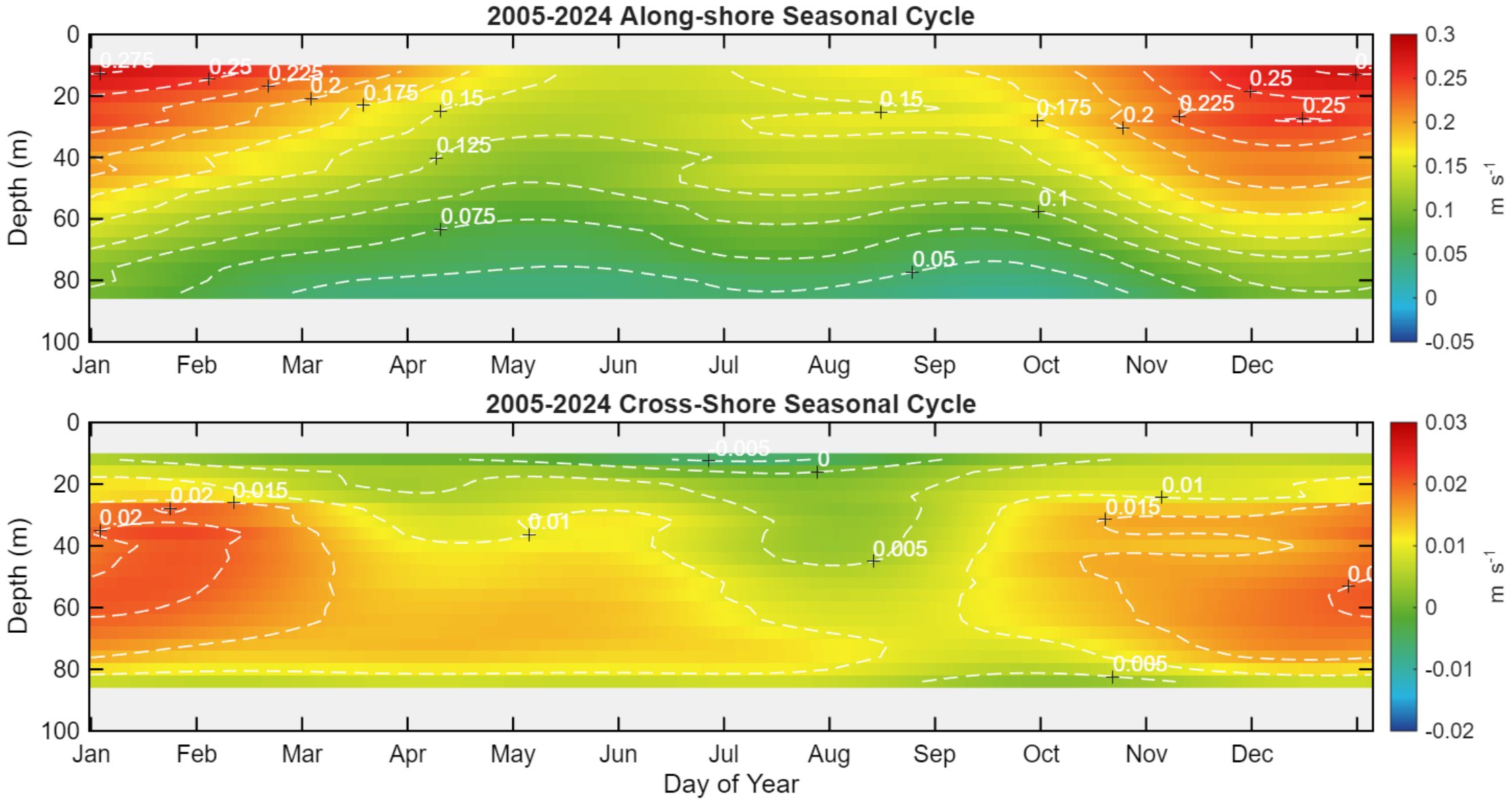




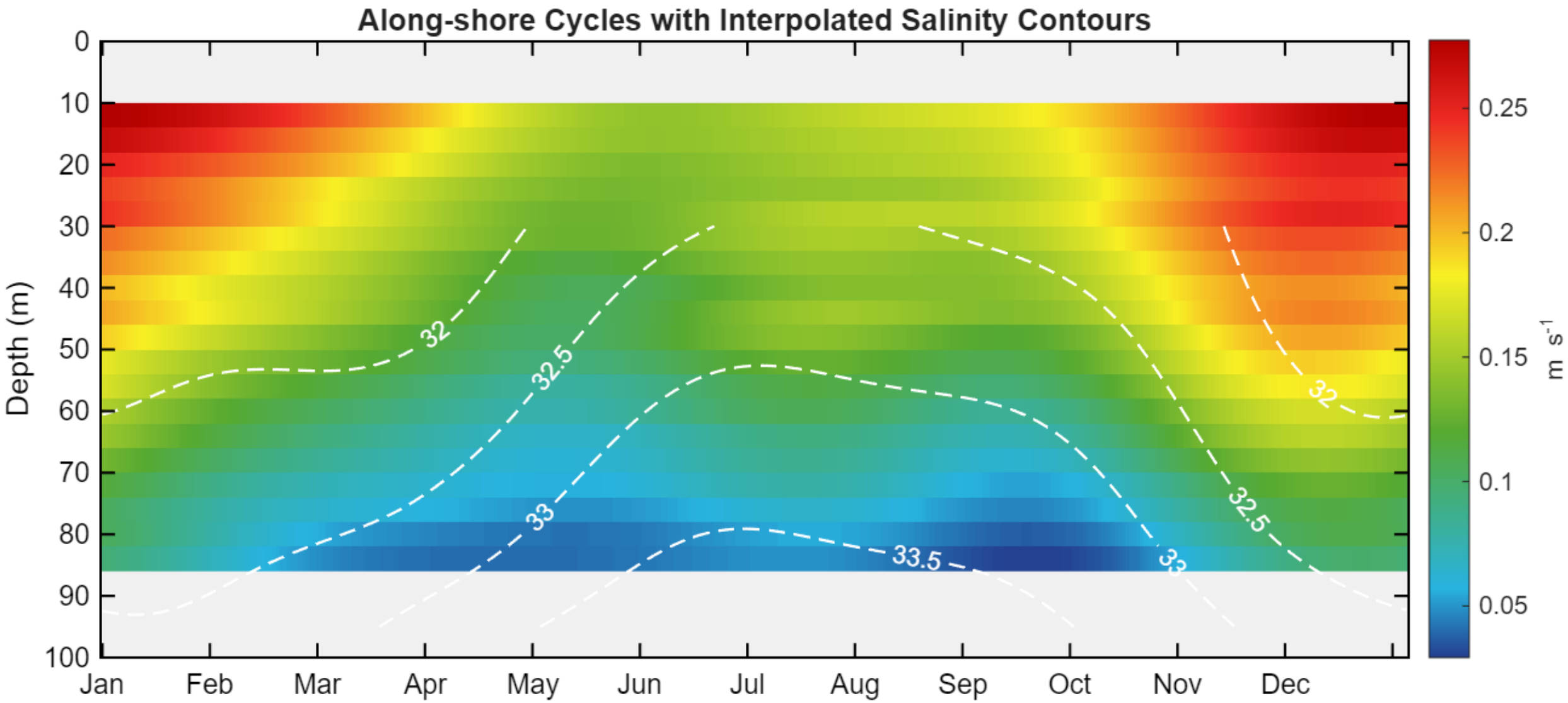
E01 ADCP Coverage



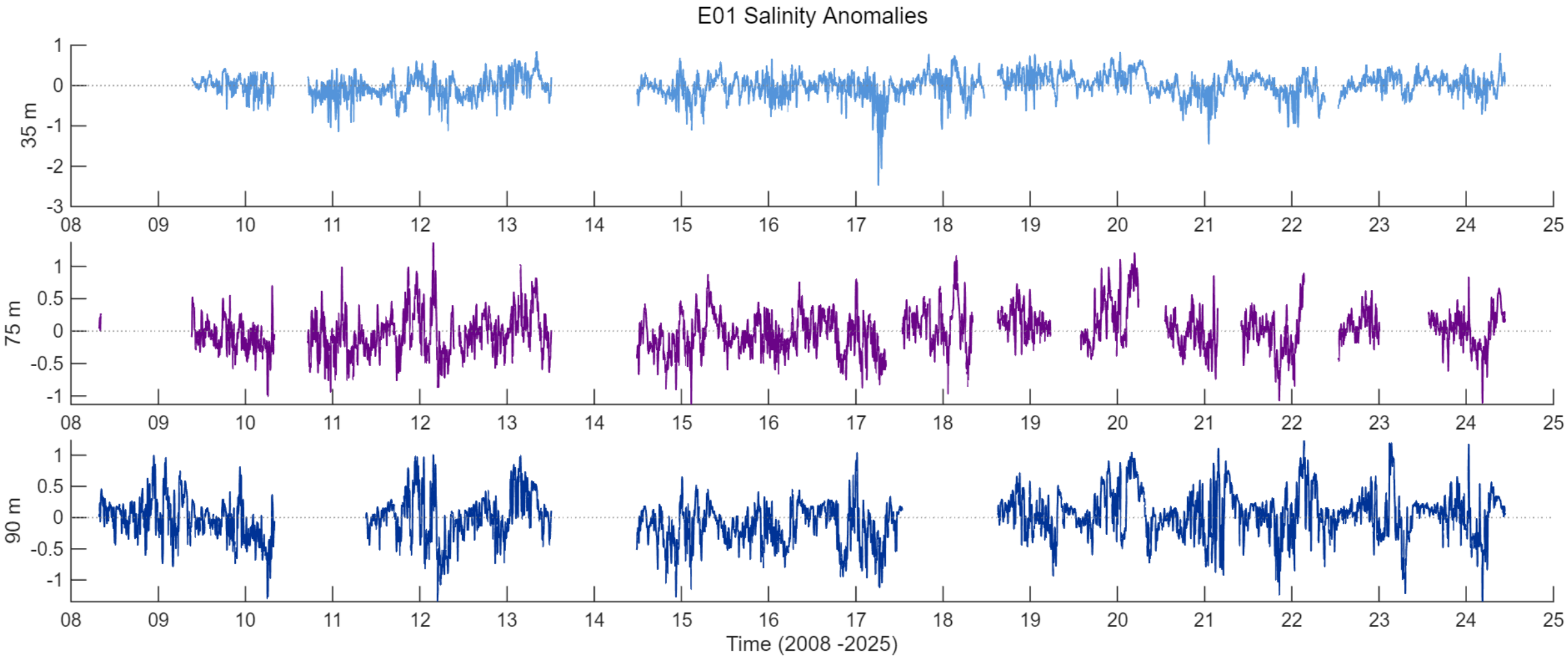
Seasonal Cycles of Velocity



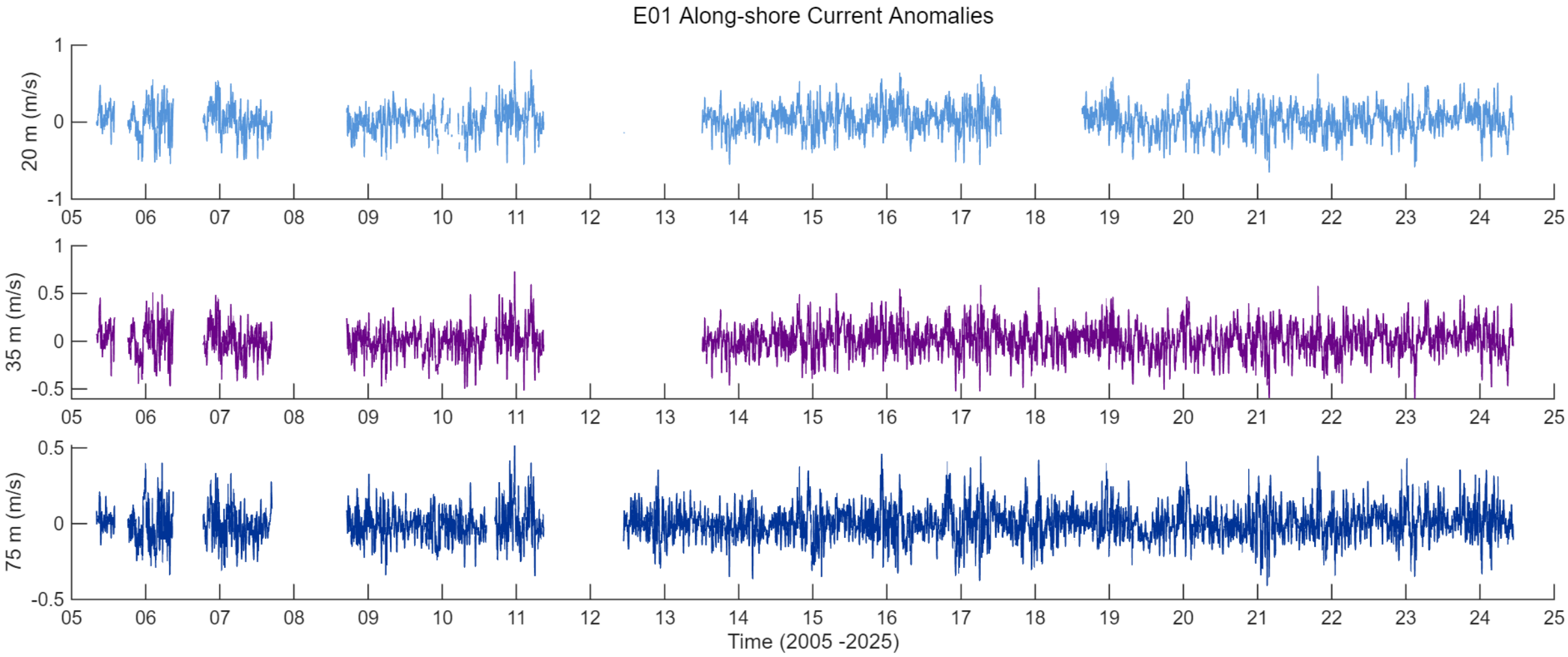
Velocity vs Salinity



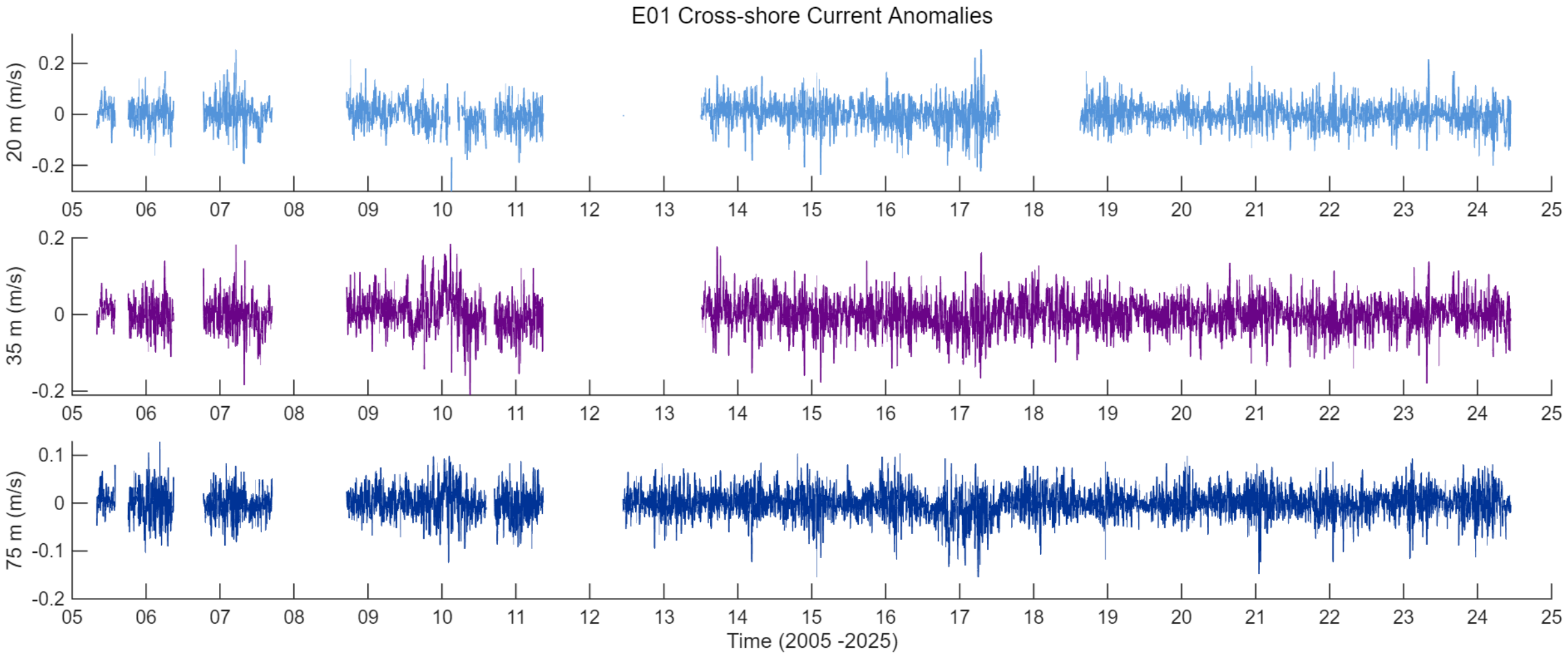
Salinity anomalies



Velocity anomalies



Velocity anomalies



Marine Heatwaves and Extreme Value Theory

- **Analyze Marine Heatwave time series using Extreme Value Theory.**
  - **Characterize the marine heatwaves in terms of Magnitude (the largest temperature) and Duration (number of days)**
  - **Estimate Return Periods.**

- **Return period estimates are a standard tool for planning.**
- **The goal here is to put Marine Heatwaves into the same framework**

For extreme events like maximum sea levels and river flooding a useful tool is the concept of return period.

- **For example, if you are planning dikes and culverts for a city on a river, how big a flood should you expect every 10 years, every 100 years, every 500 years?**
- **If your city is a coastal one, you want to know the sea level heights expected from the 100-year storm.**

Marine Heatwaves

- Anomalies relative to 90th percentile
- SST, 35 m, 75 m, 95 m.
- Add ONI or Nino3.4 time series

- Pull 2 slides from MHW talk.

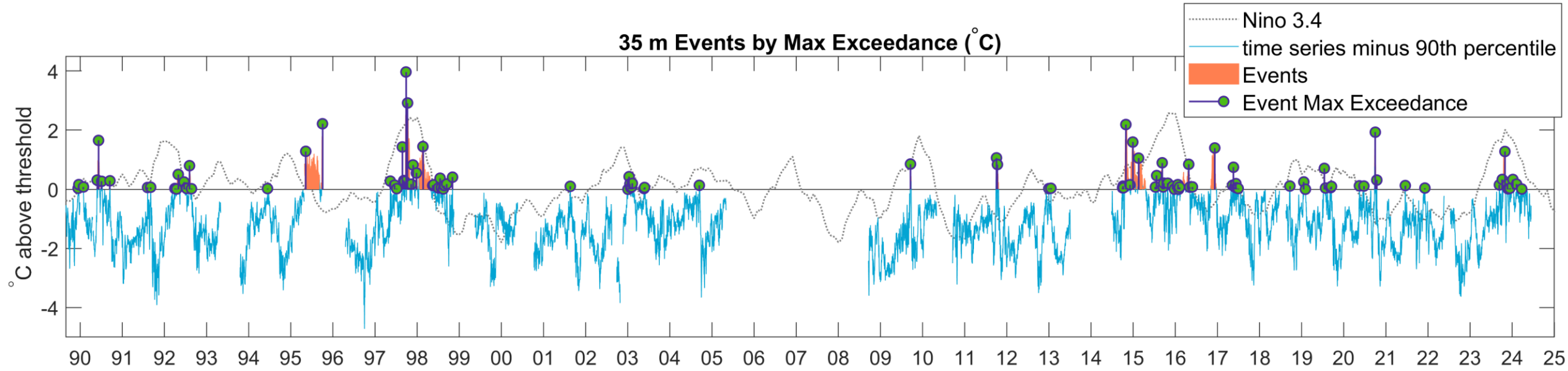
Extreme Value Theory (EVT)

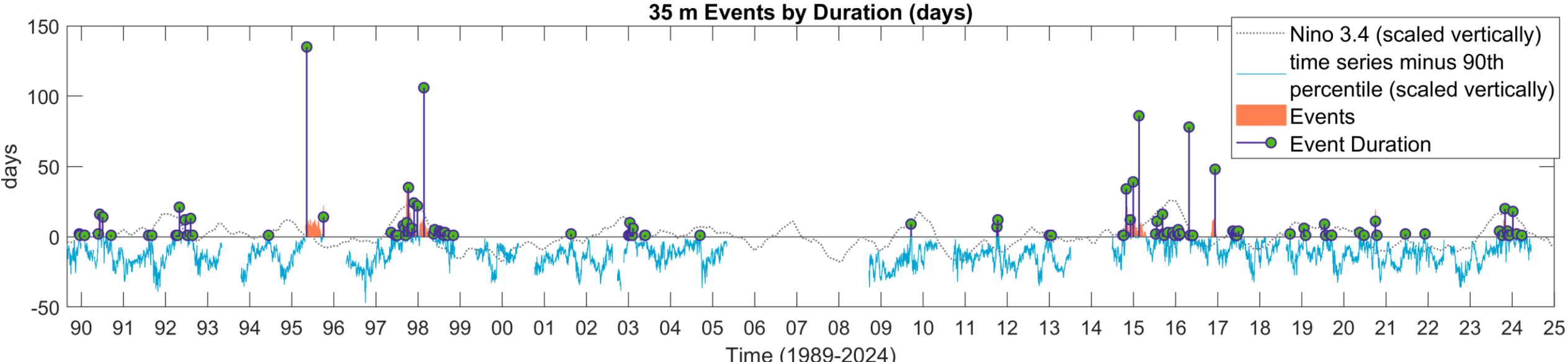
- **Goal: Estimate magnitude of events that have not yet been observed.**
- **For example, estimate the magnitude of the 100 year flood event from 25 year of data.**
- **EVT is a statistical framework for making these types of extrapolations.**

- **Question**: Given a *long enough* sequence of *random* measurements from a sample space, like ocean temperature, what is the likelihood that value ***Z*** is an upper bound on that sequence.
- **Answer**: Under *certain conditions*, such a distribution for ***Z*** *approaches* one of the Gumbel, Weibull and Frechet families (*the GEV family of distributions*).
- The Generalized Pareto Distribution (GPD) is used to model the tail of *another GEV distribution,* with the random variables bigger than a *large* threshold. The extreme end of the extreme values.

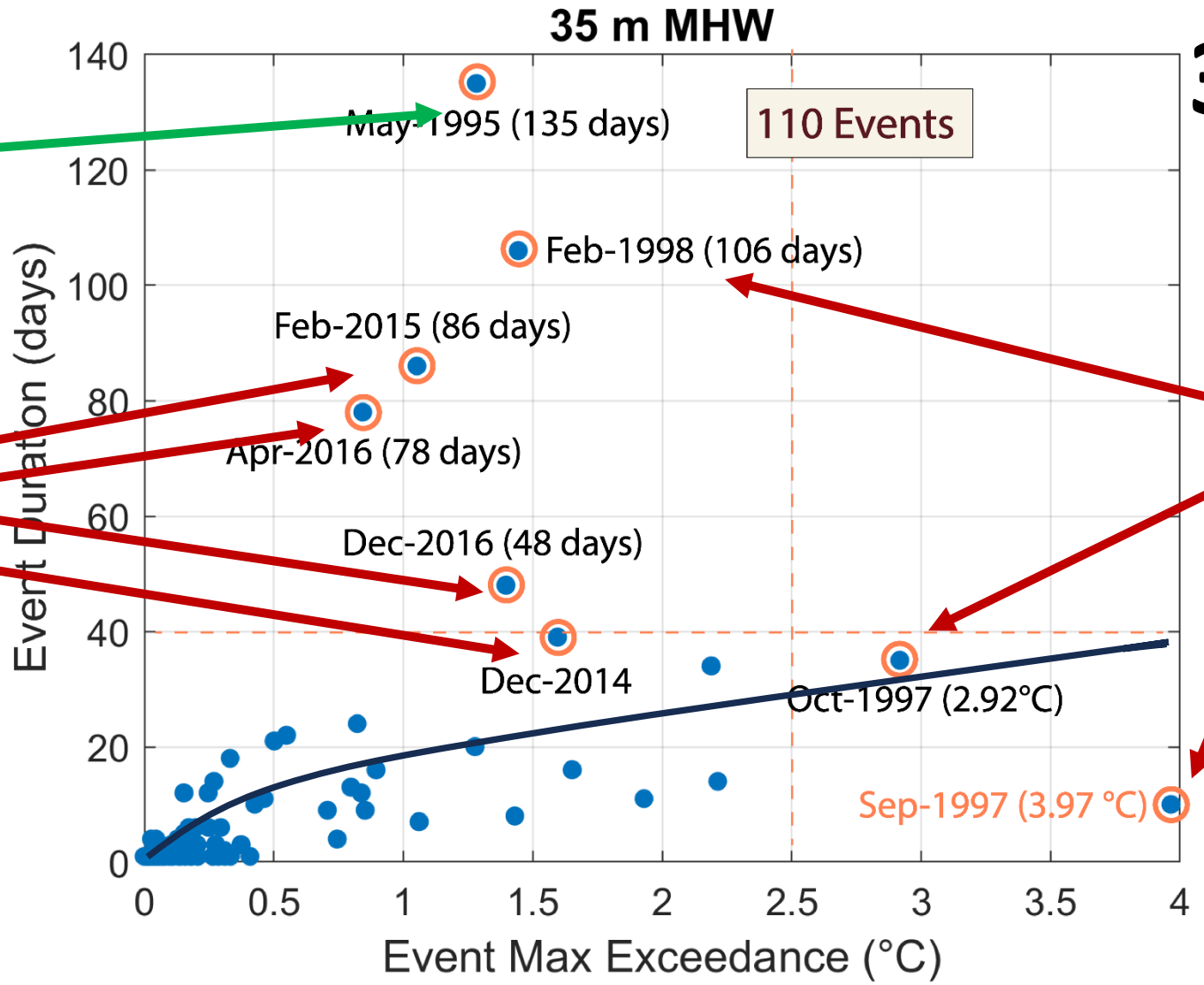
Thomson and Emery. 2024. *Data analysis methods in physical oceanography*.

Marine Heatwaves at 35 m





Distribution of MHW Events: Duration vs Magnitude

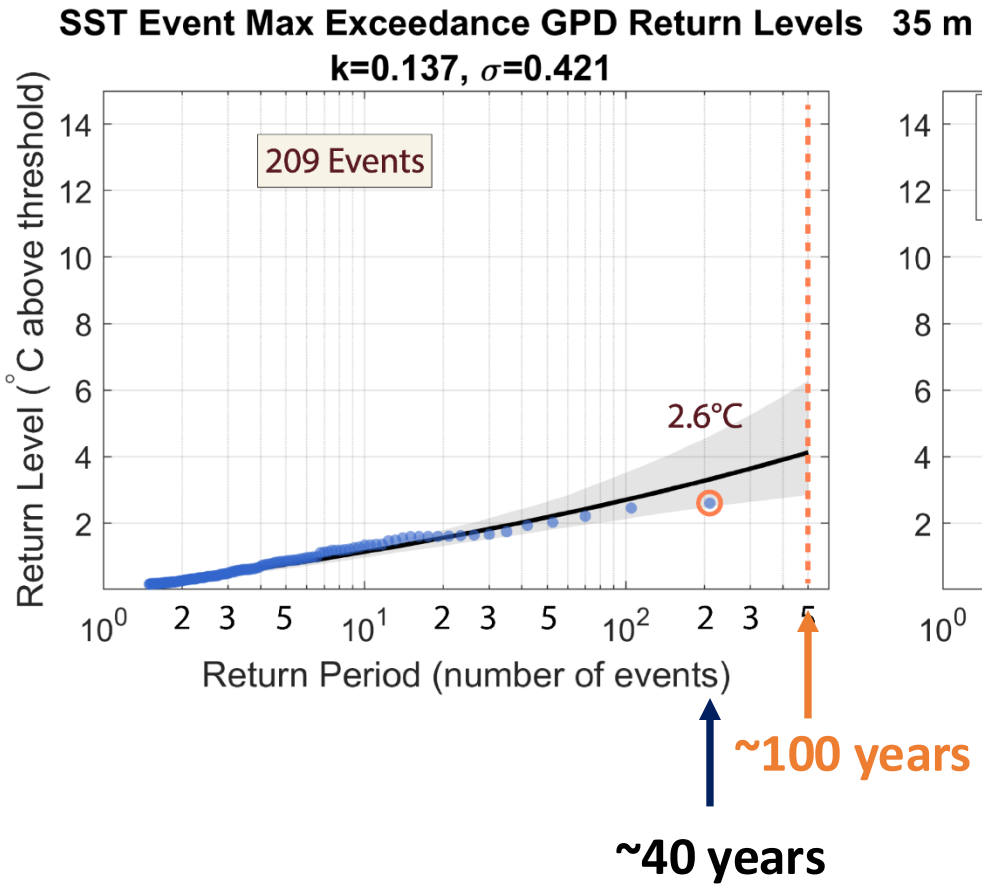


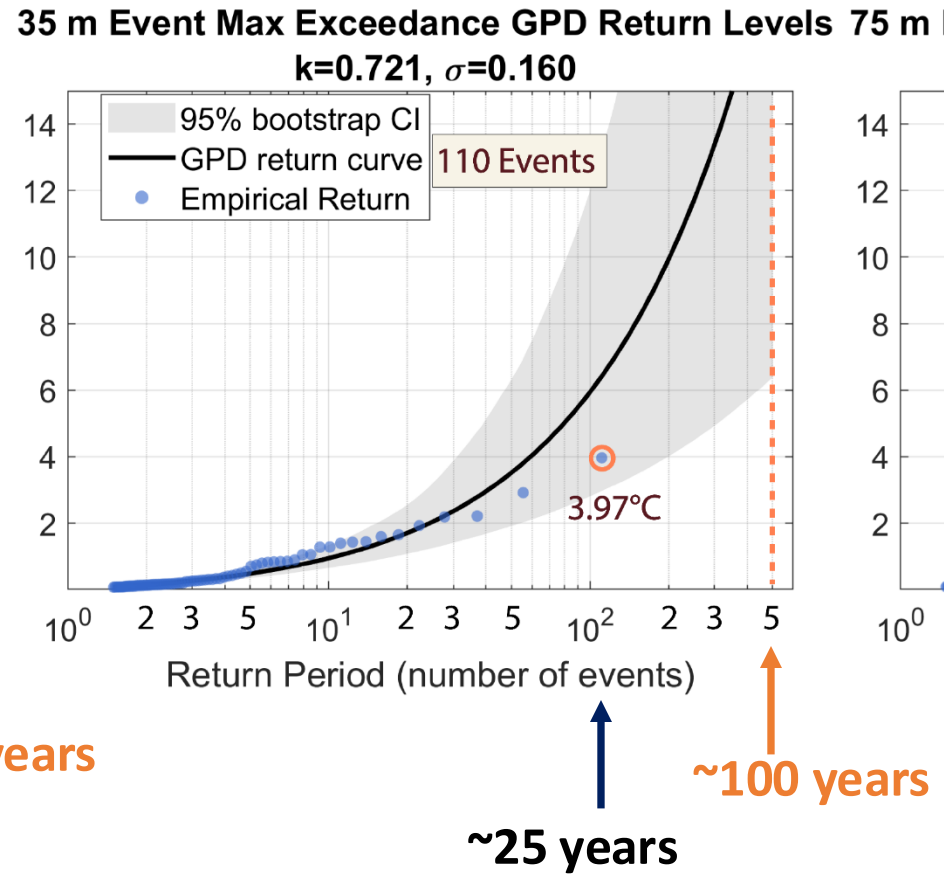
May 1995

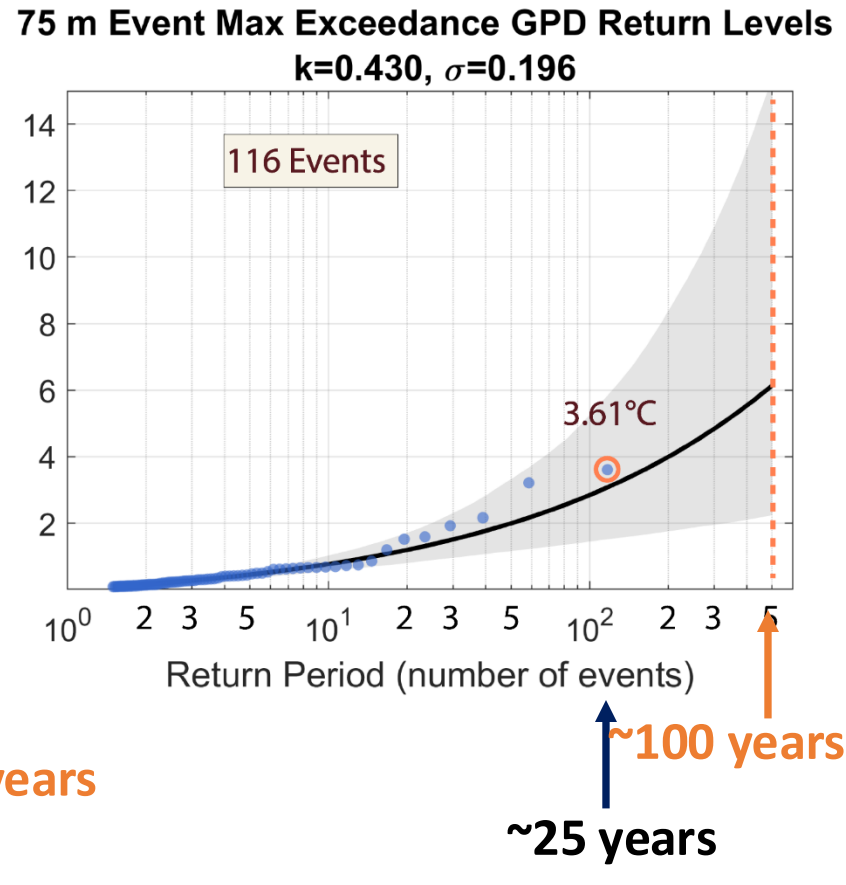
2014-16 Blob and El Niño

1997/98 El Niño

GPD Return Plots for Magntiude

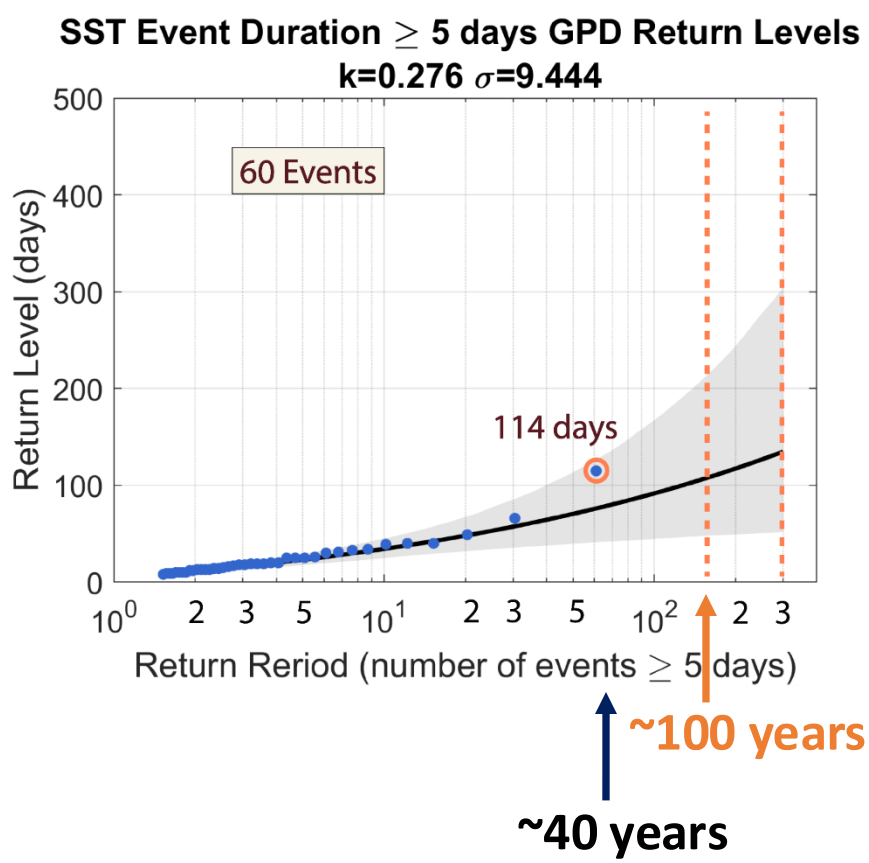


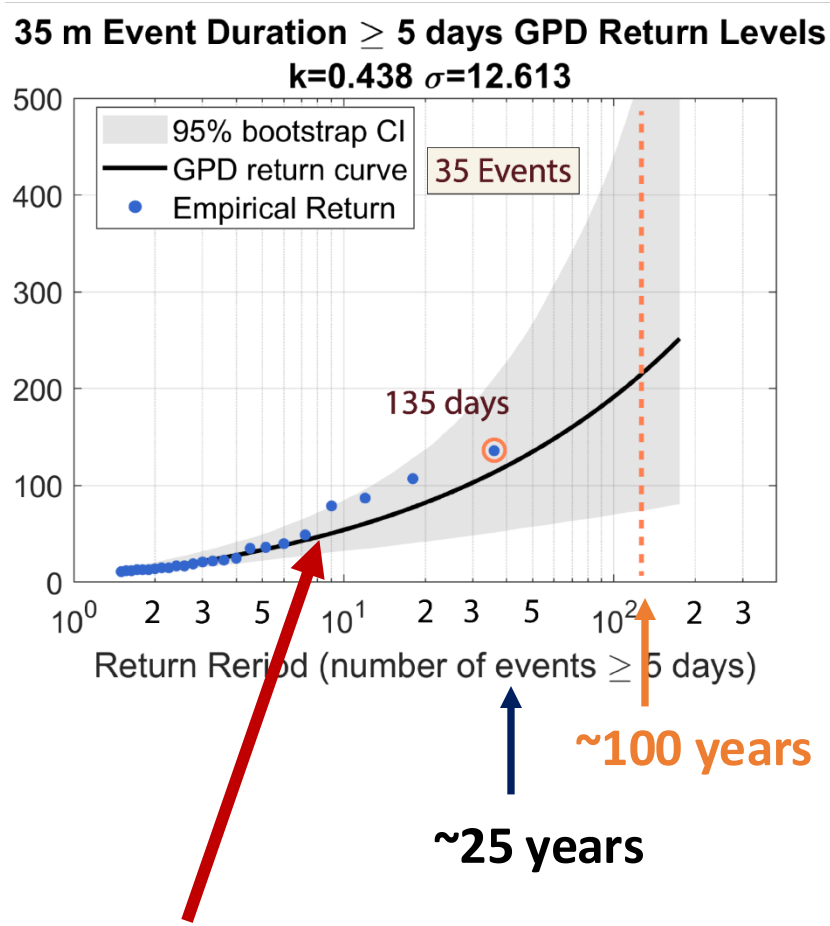


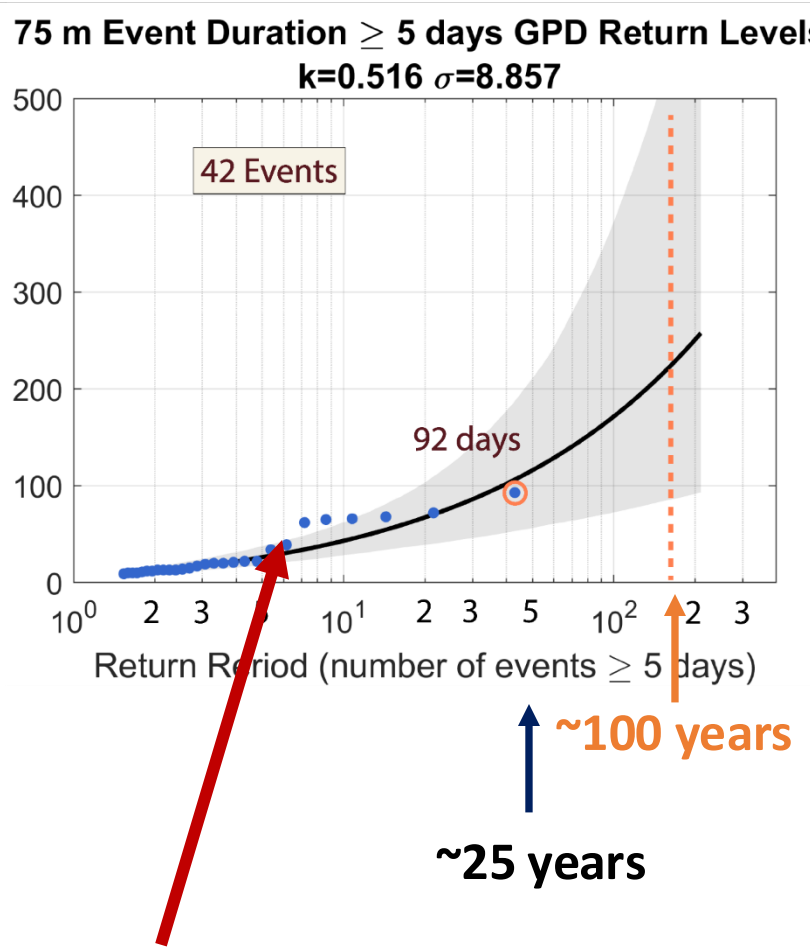


Are the empirical curves flattening out while the GPD curves are increasing?

GPD Return Plots for Event Duration ≥ 5 days







What is happening here? A jump in the empirical return level and then flattening out.

Summary

Thank you.

Thanks to Dr. Rick Thomson for keeping this time series going for 25+ years.

Thanks to Tom Juhasz and Dave Spear for managing the mooring program

T-anom for sst, 35 m, 75 m:
Standard Deviation: 1.0423, 0.85813, 0.7664
Skewness:0.27959, 0.61888, 0.74299
Excess Kurtosis: 0.23312, 1.1913, 2.086

Detrended T-anom
Standard Deviation for sst, 35 m, 75 m: 1.0266, 0.8567, 0.75946
Skewness: 0.2602, .063082, 0.71435
Excess Kurtosis: 0.18879, 1.2221, 1.9831