Baroclinic transport across Drake Passage from the cDrake array

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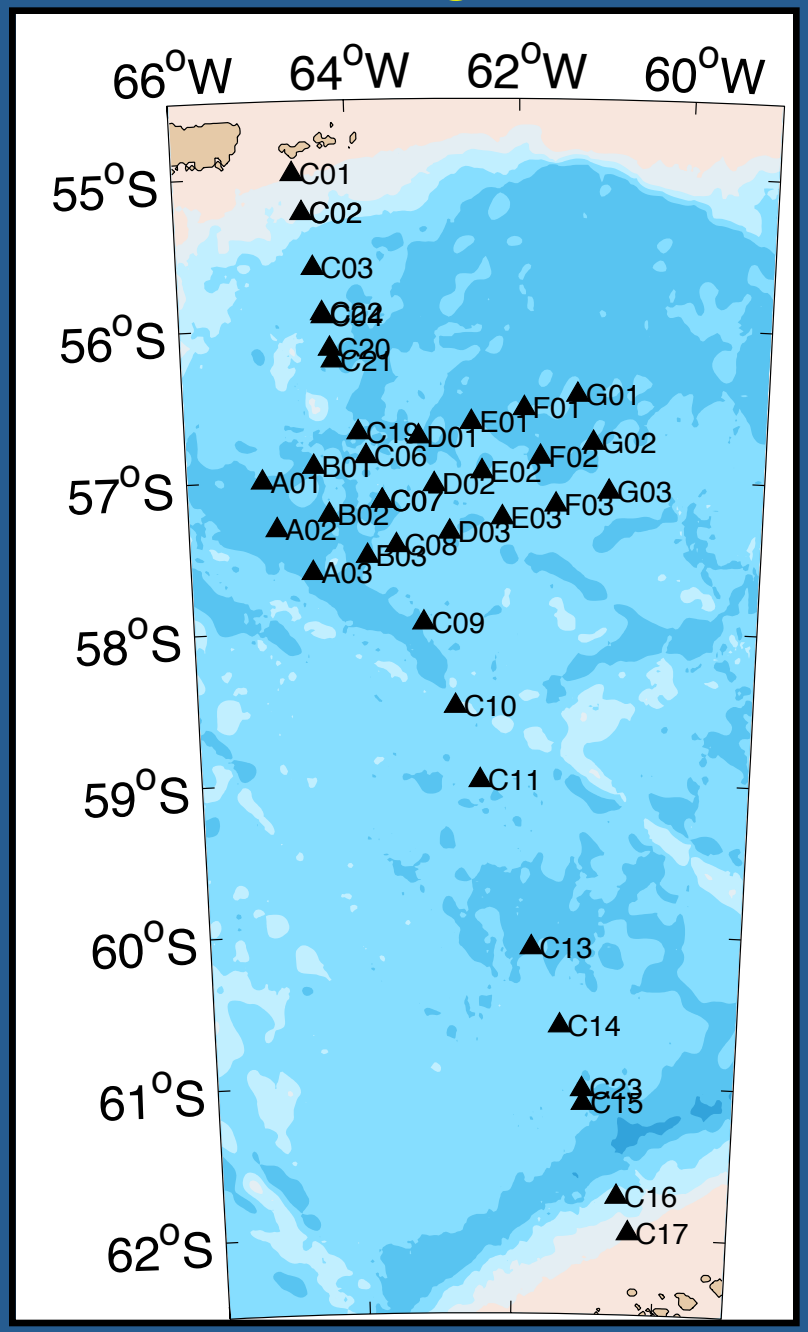
Introduction & Motivation

- ACC transport is a key component of the global ocean circulation.
- Observations to quantify average ACC transport, its temporal variability, and vertical structure are sparse.
- cDrake array: unprecedented temporal and spatial resolution.
- Here: multi-year long time series of baroclinic transport through Drake Passage with the cDrake array.

cDrake array



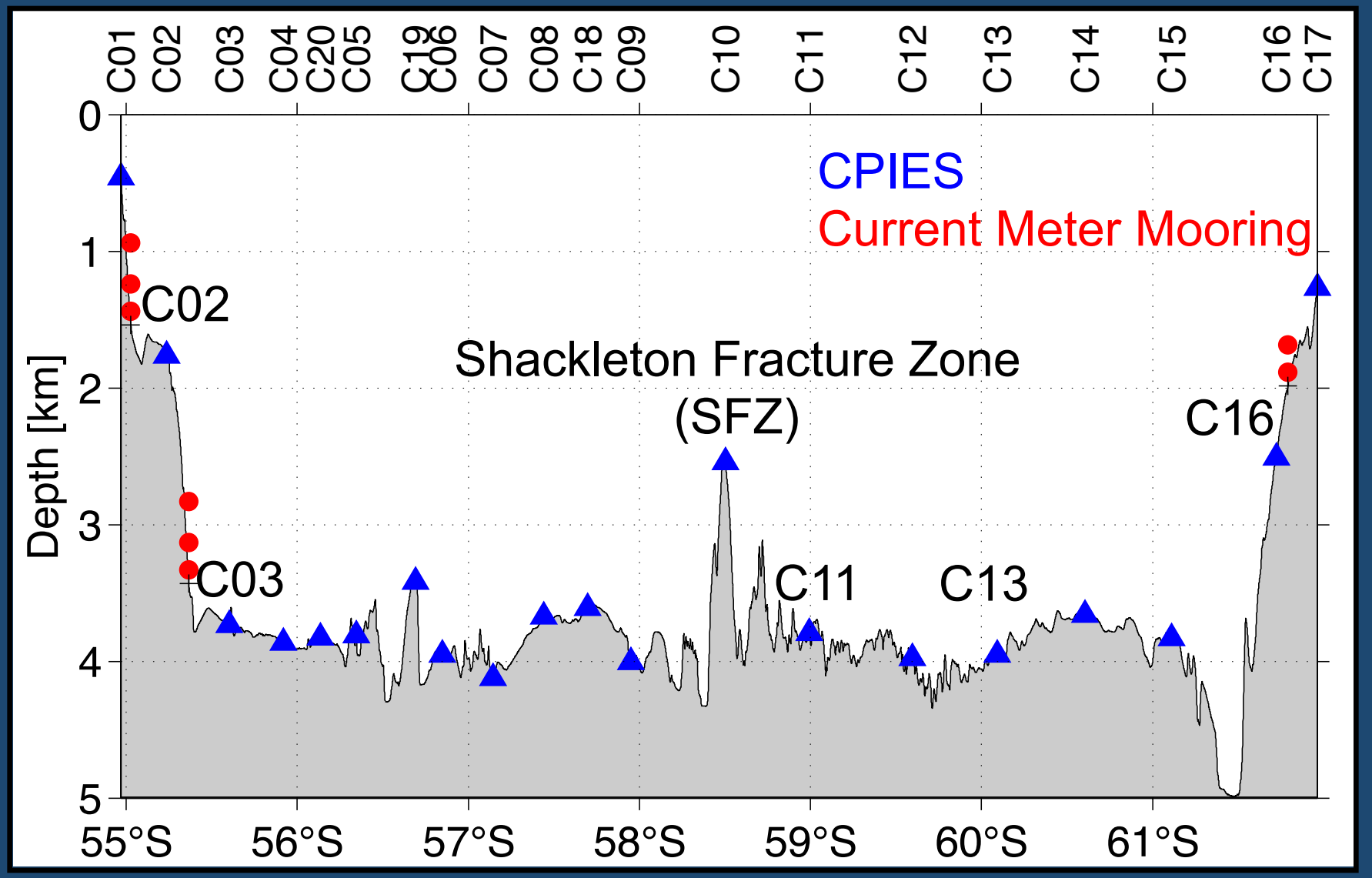
Transport line: Determine horizontal and vertical structure of the time varying transport.

20 CPIES:

- τ-- round trip travel times of acoustic pulses to sea surface and back -> proxy for dynamic height.
- bottom pressure.
- bottom temperature.
- currents 50 m above the seafloor.

Nov. 2007 – Nov. 2011

cDrake array – bathymetry transport line



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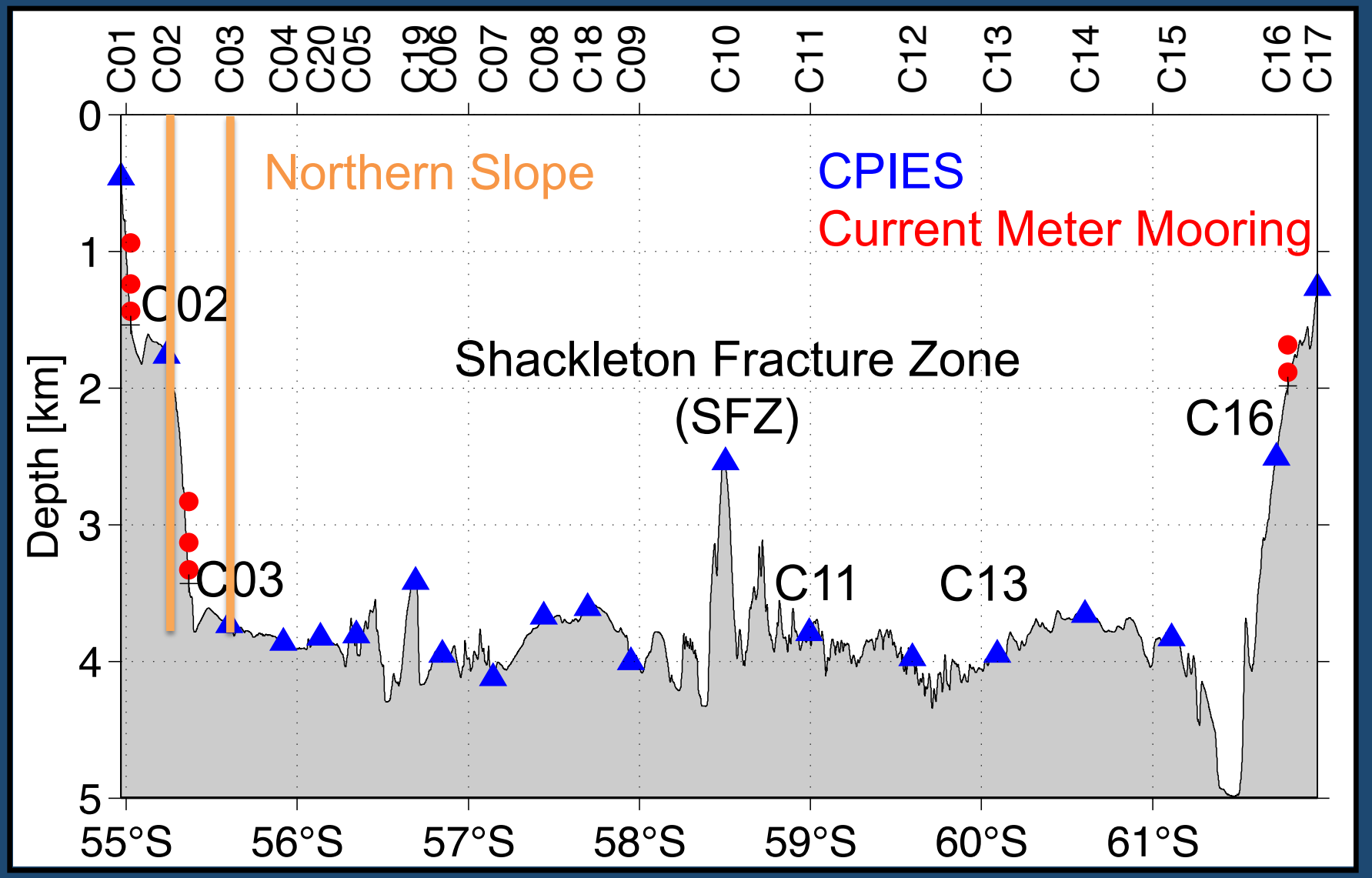
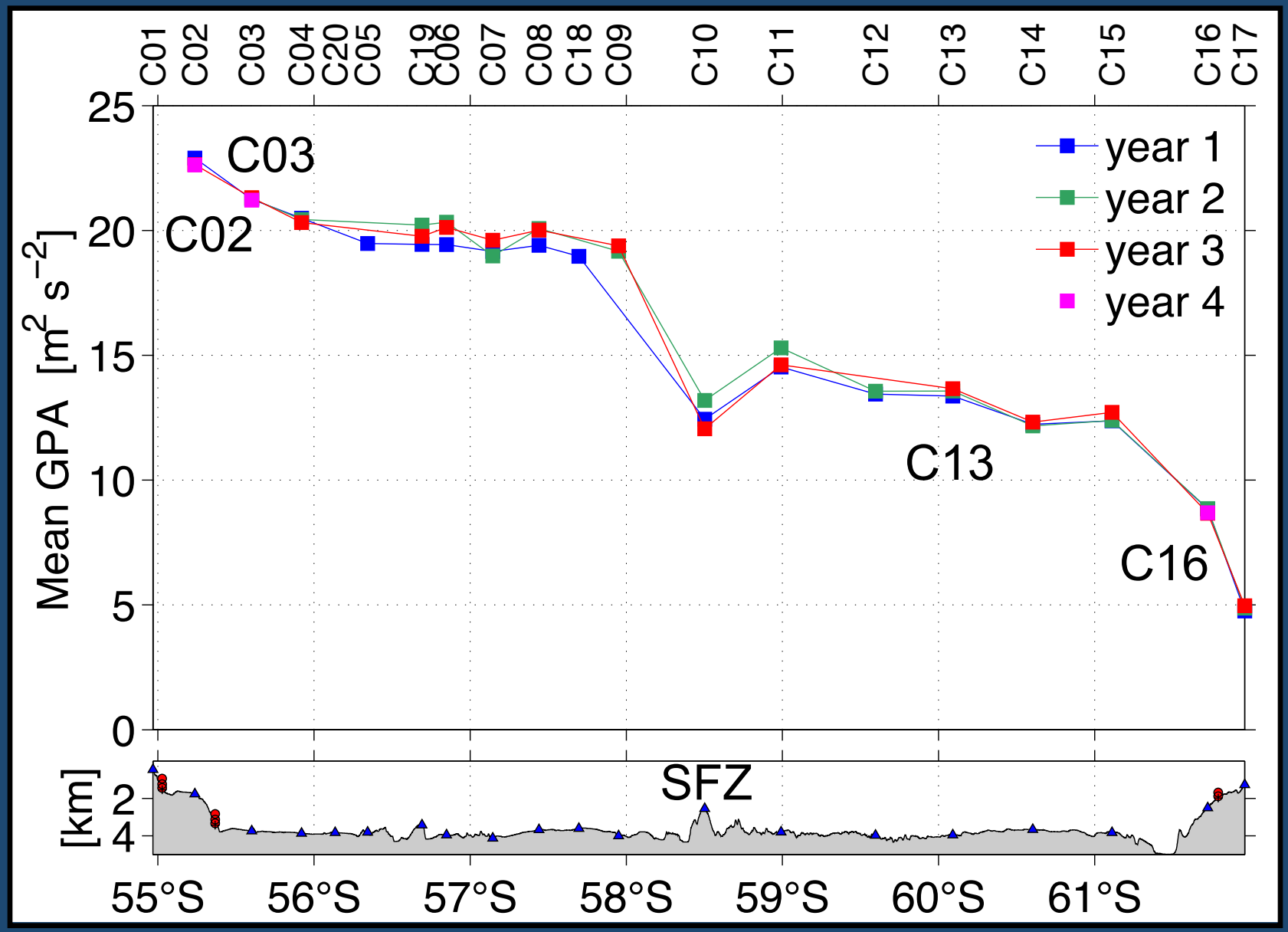


Mean Geopotential Anomaly from cDrake



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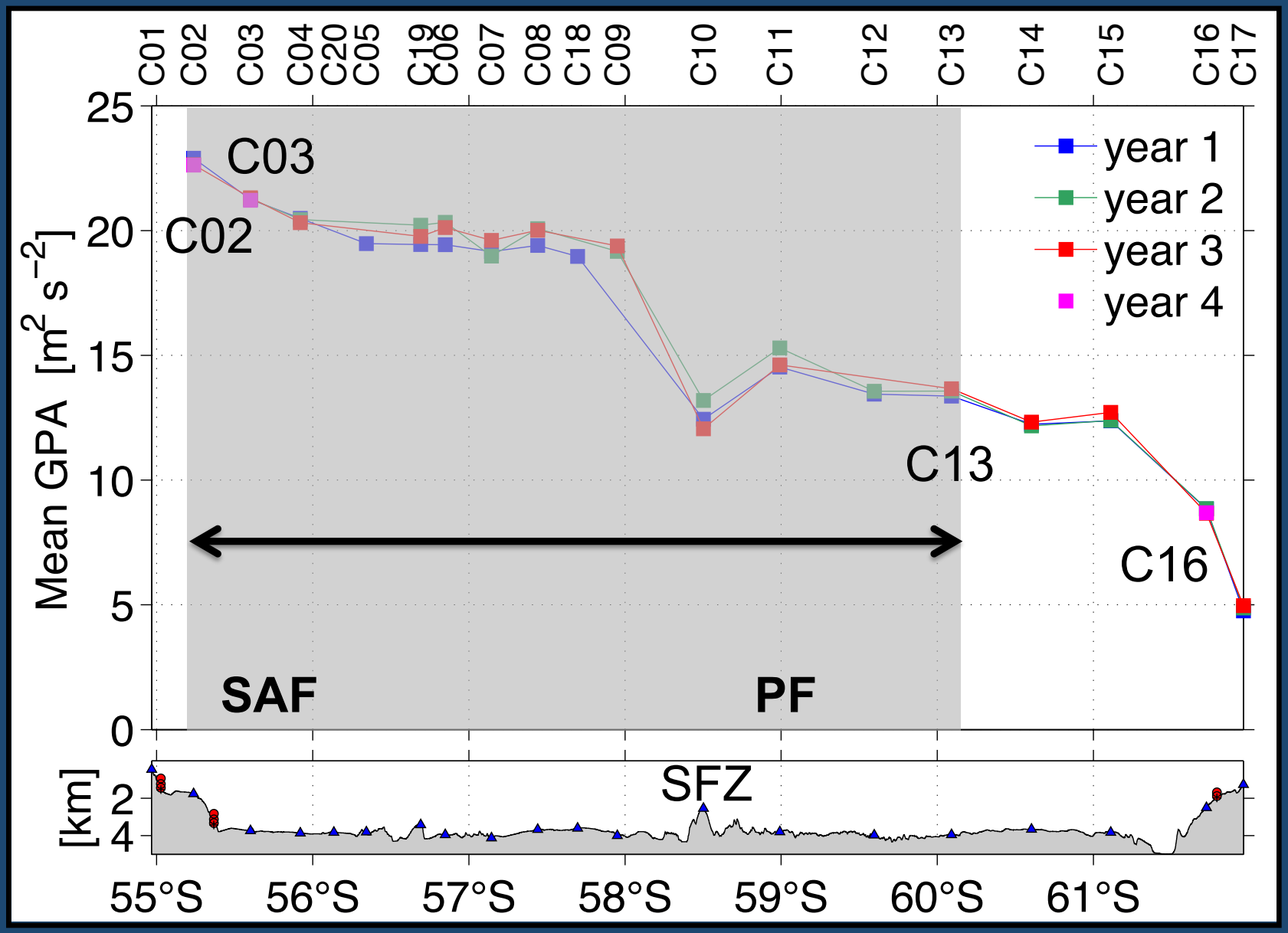
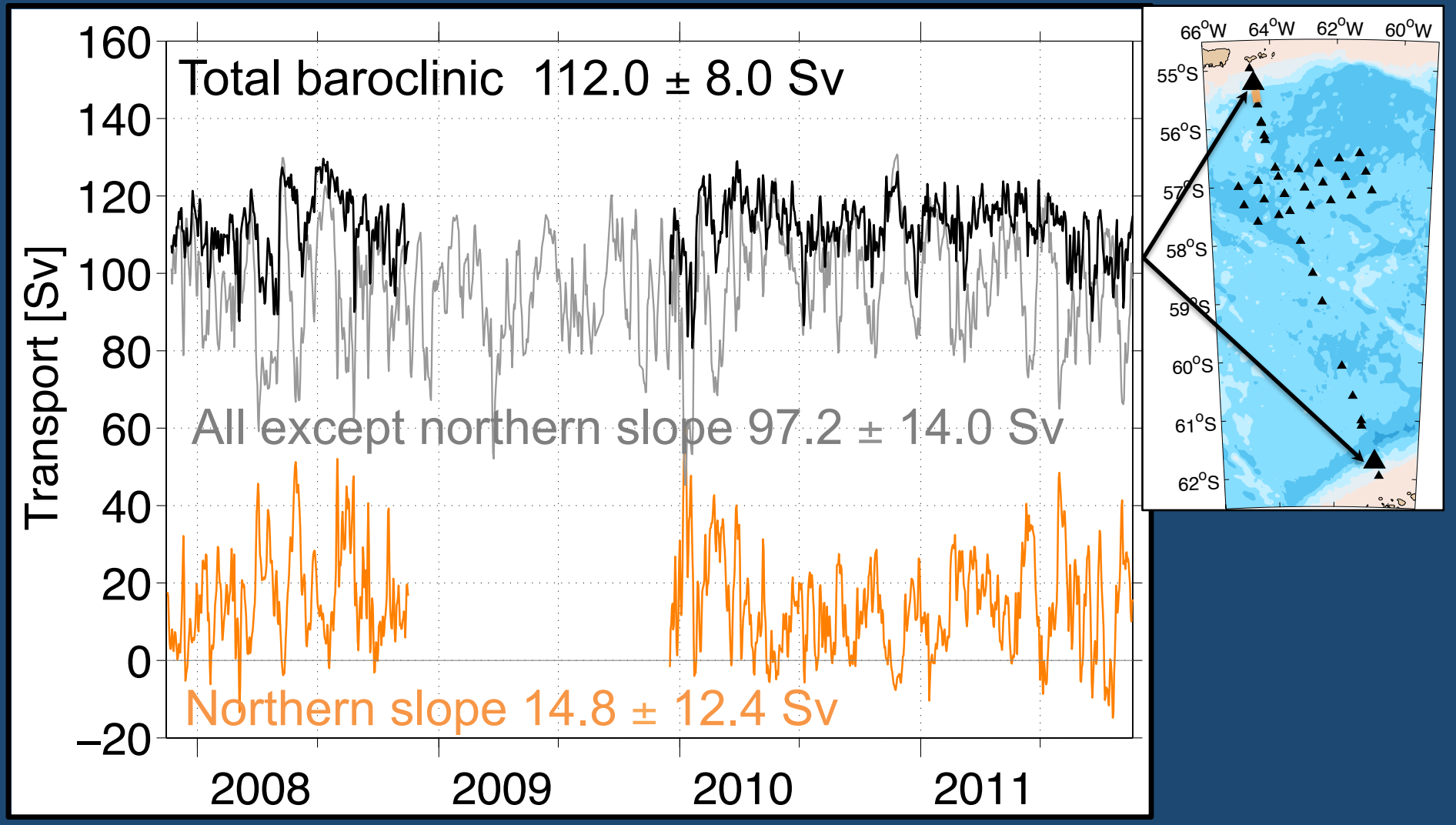


Baroclinic transport relative to and above 3500 m across Drake passage



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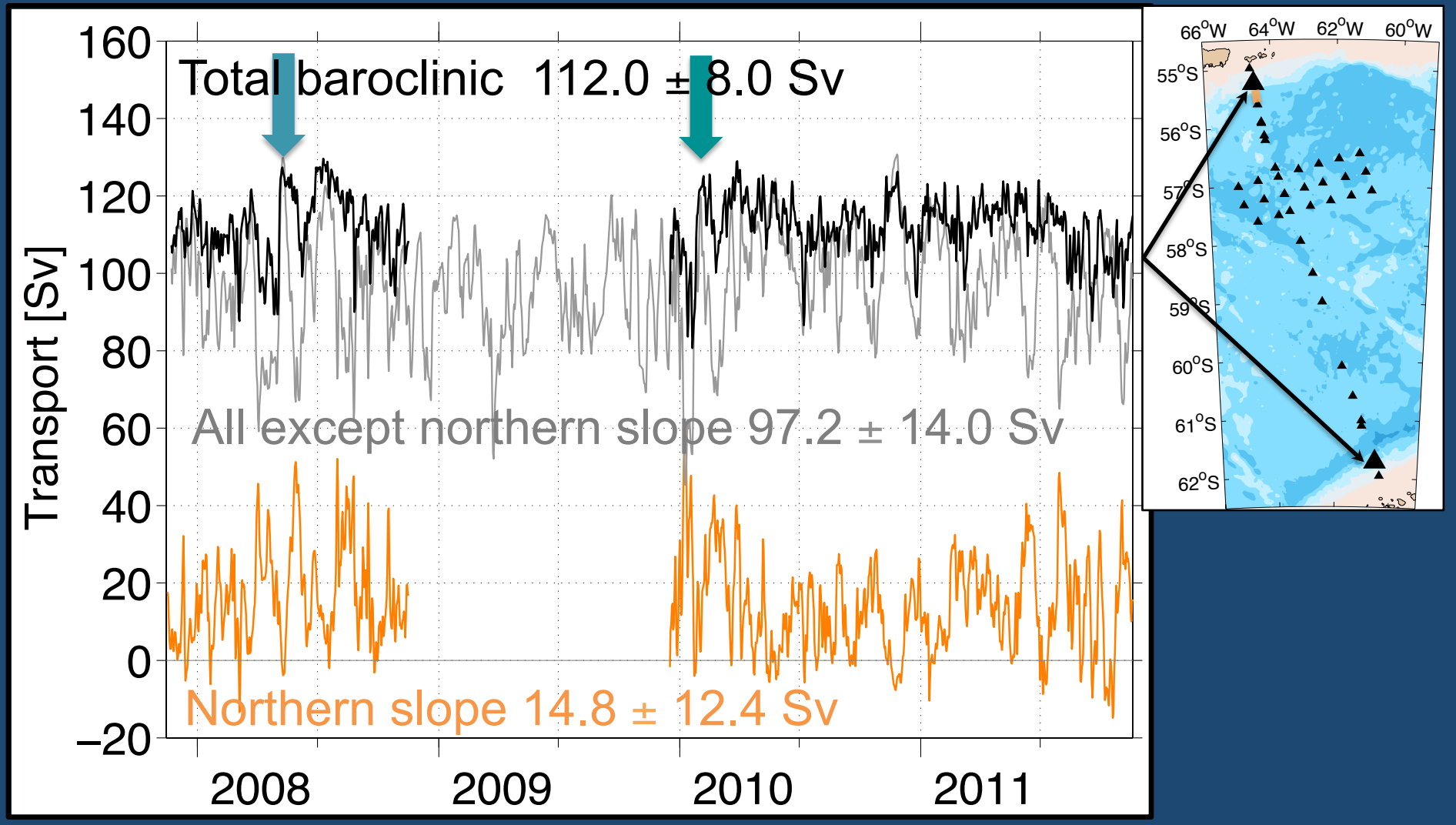
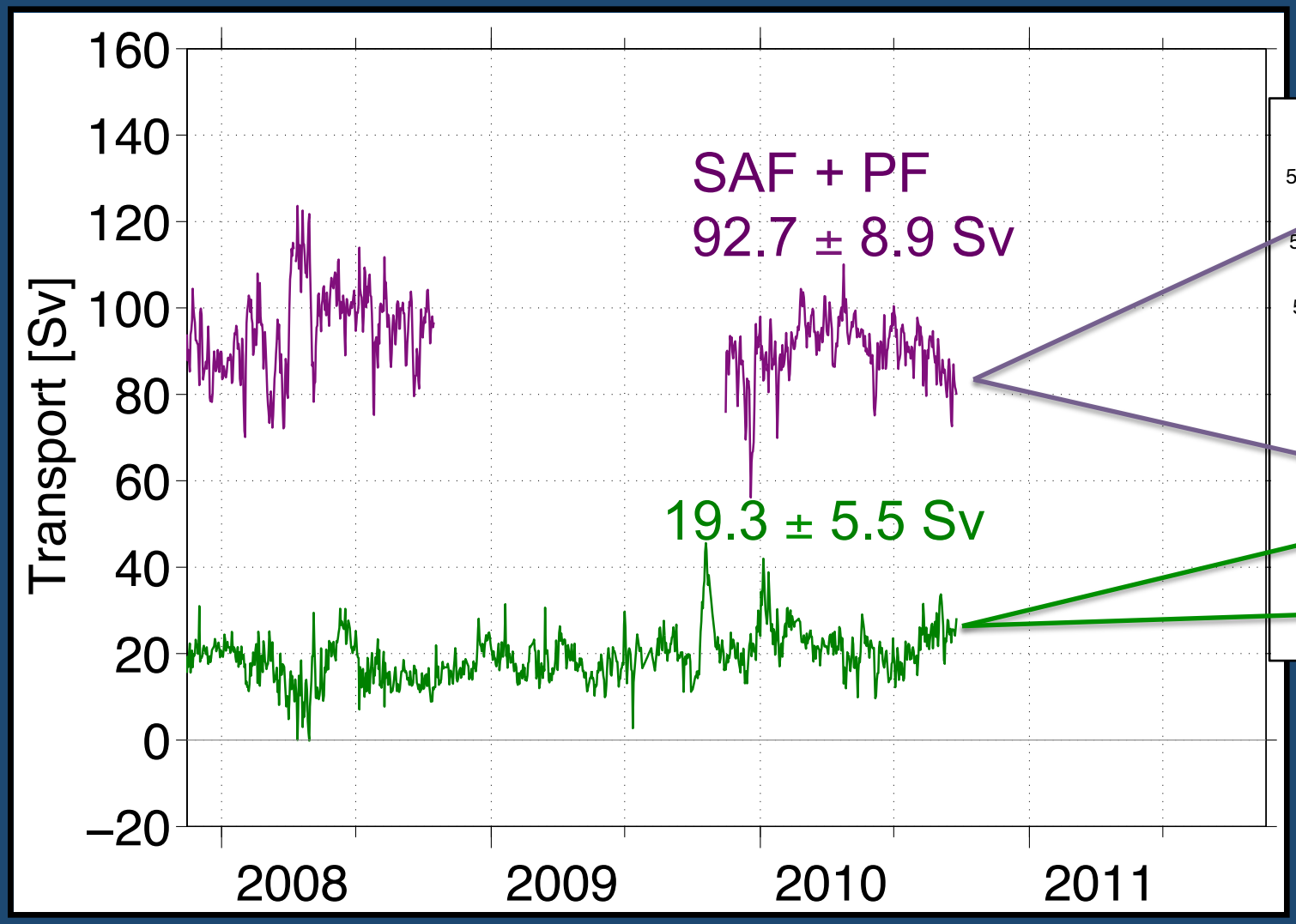
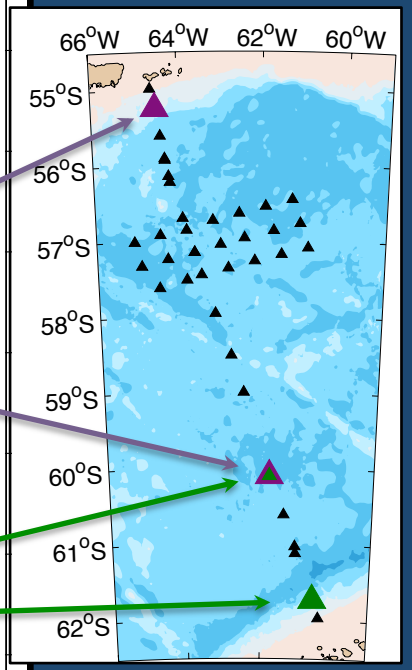


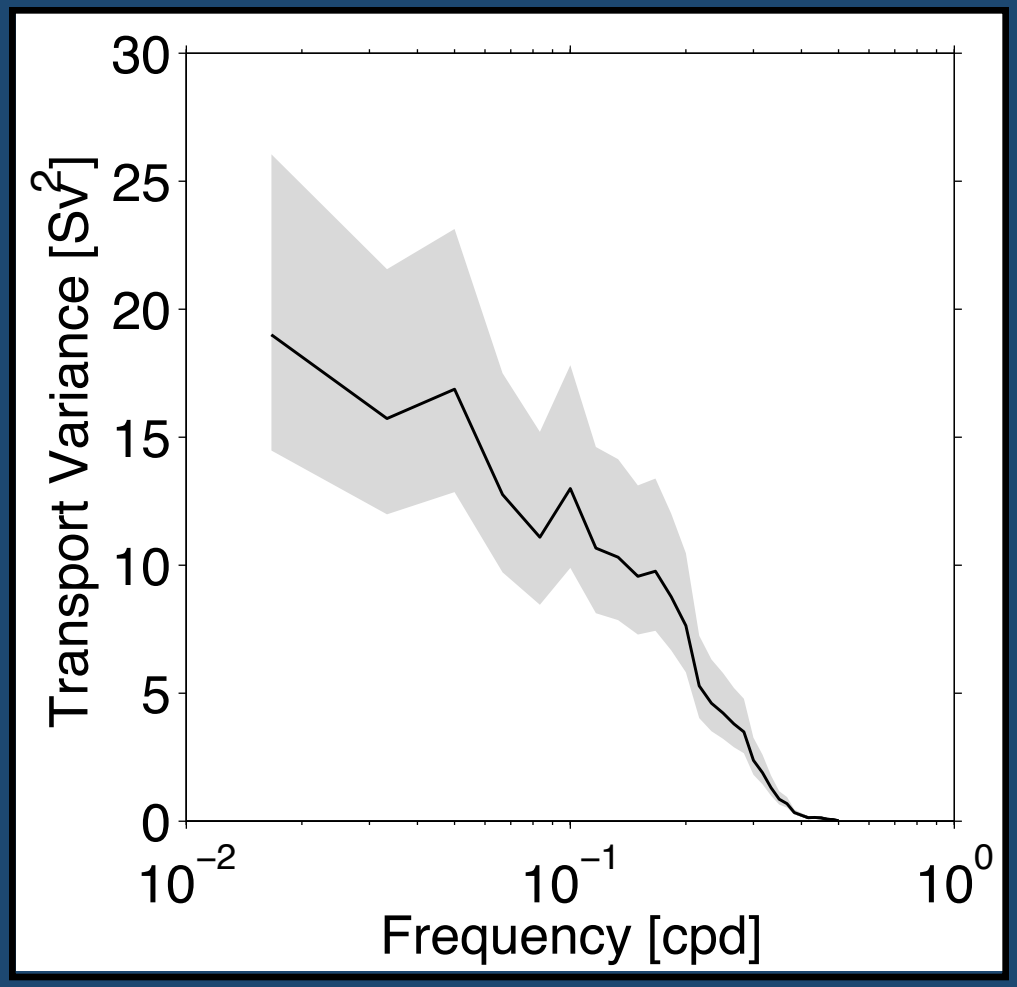
Baroclinic transport carried by SAF and PF

- About 82 % of the total baroclinic transport is carried by the SAF and the PF.





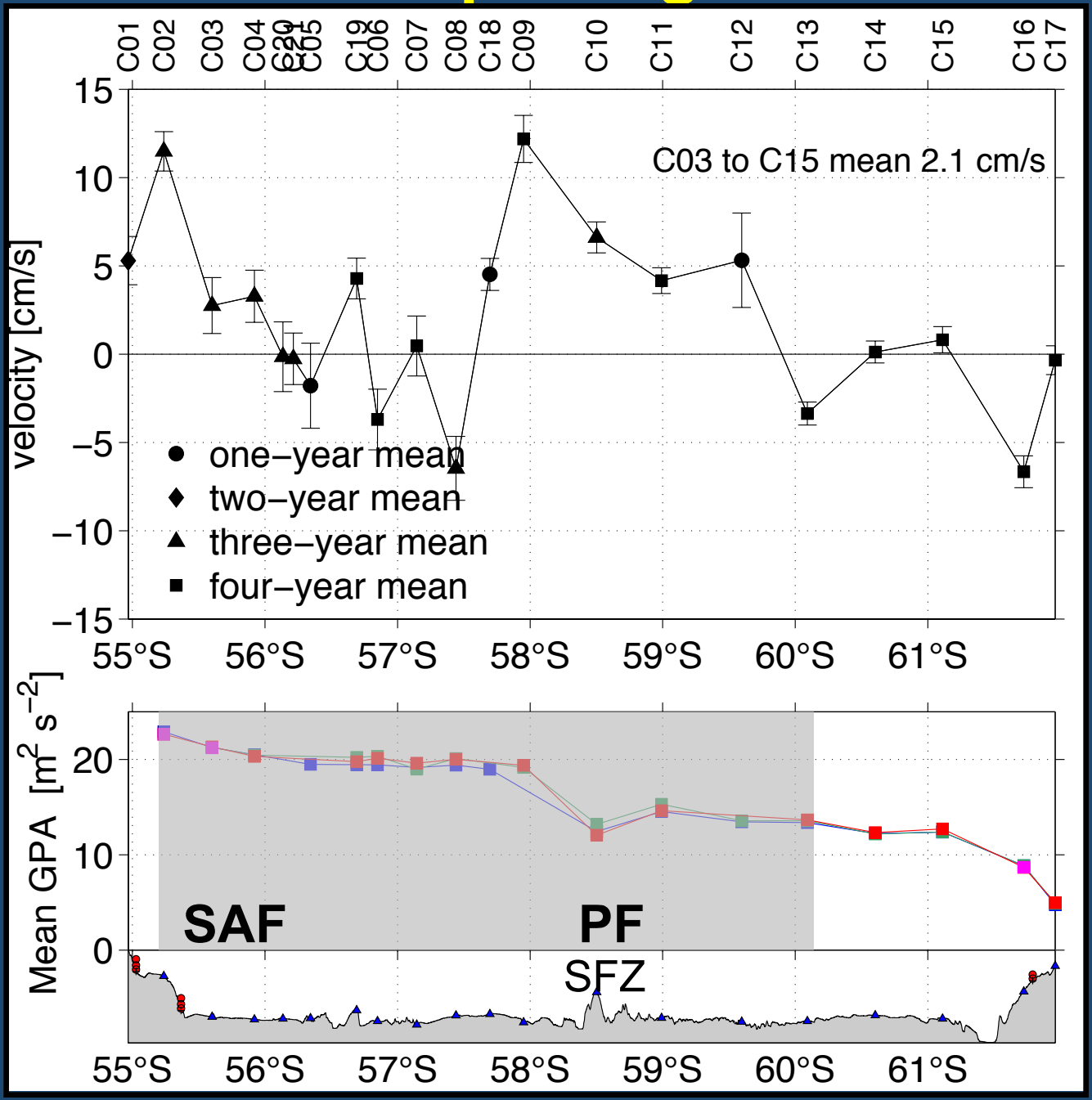
Spectrum of three years of baroclinic transport across Drake passage



- Approximately half of the variance at periods shorter than 30 days.

- Mean baroclinic transport is 112.0 Sv
- How large is the barotropic contribution?

Mean across-passage bottom velocity



- Mean bottom velocity of 2.1 cm/s: ~ 50 Sv through the passage.
- Bottom velocity is eastward and strong beneath the fronts.
- Bottom velocity is weak in the transition between fronts.

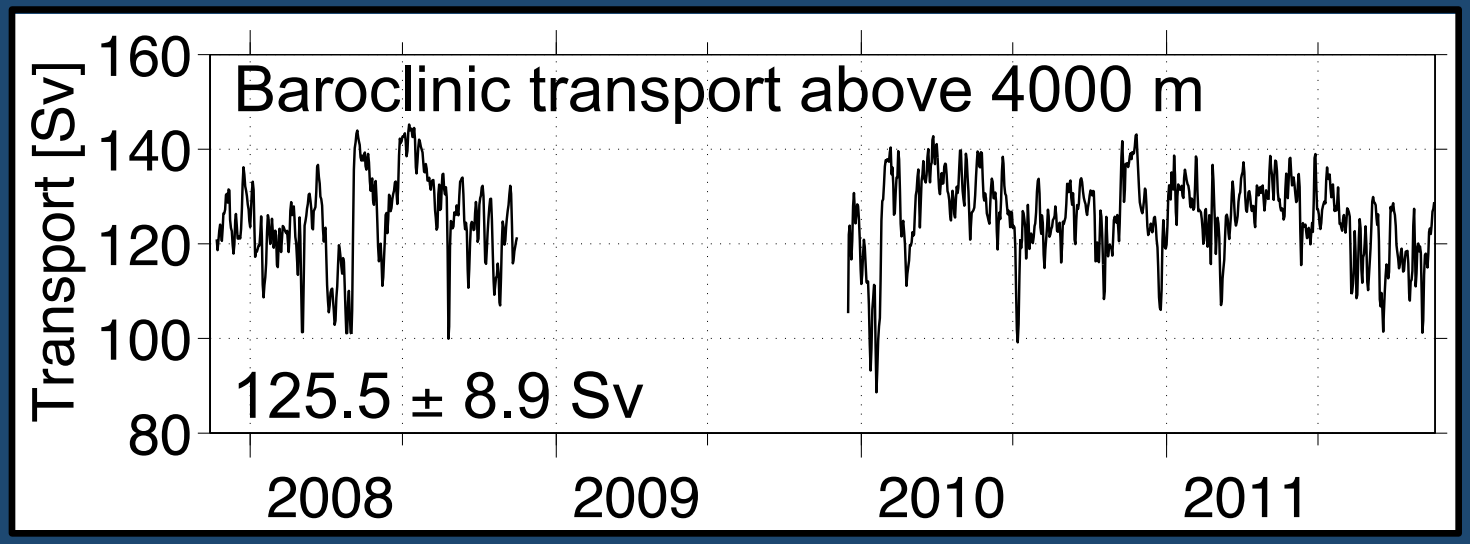
Comparison with previous transport estimates – ISOS

Total transport above 3500 m:

- **cDrake**: 112.0 Sv (Baroclinic) + 50.0 Sv (Barotropic) = 162.0 Sv
- ISOS: 133.8 ± 11.2 Sv (January 1979 - February 1980) Whitworth and Peterson, 1984.
- Average of three years of total transport from cDrake is larger by 28 Sv than ISOS estimate.

Comparison with previous transport estimates – Snapshots from hydrography

Baroclinic relative to DCL:



- **cDrake**: 125.5 ± 8.9 Sv / range: 88.6 Sv – 145.2 Sv

- SR1b, hydrography: 136 ± 7.8 Sv / range: 123.1 Sv – 143.8 Sv (e.g. Cunningham et al., 2003; Renault et al., 2011)

- Average of three years of baroclinic transport from cDrake agrees with SR1b estimates.

Conclusions

- ACC baroclinic transport above 3500 m from a three-year time series is 112.0 ± 8.0 Sv.
- Mean annual baroclinic transports: 111.9 Sv, 112.4 Sv, 111.7 Sv are remarkably steady.
- Adding the contribution of 50 Sv from the mean bottom velocity gives a total transport of 162 Sv.
- Our net transport estimate is 28 Sv larger than previous estimate from ISOS (experimental design or change in wind forcing?).