

# **Fitting Observations from Drake Passage to the Southern Ocean State Estimate (SOSE)**

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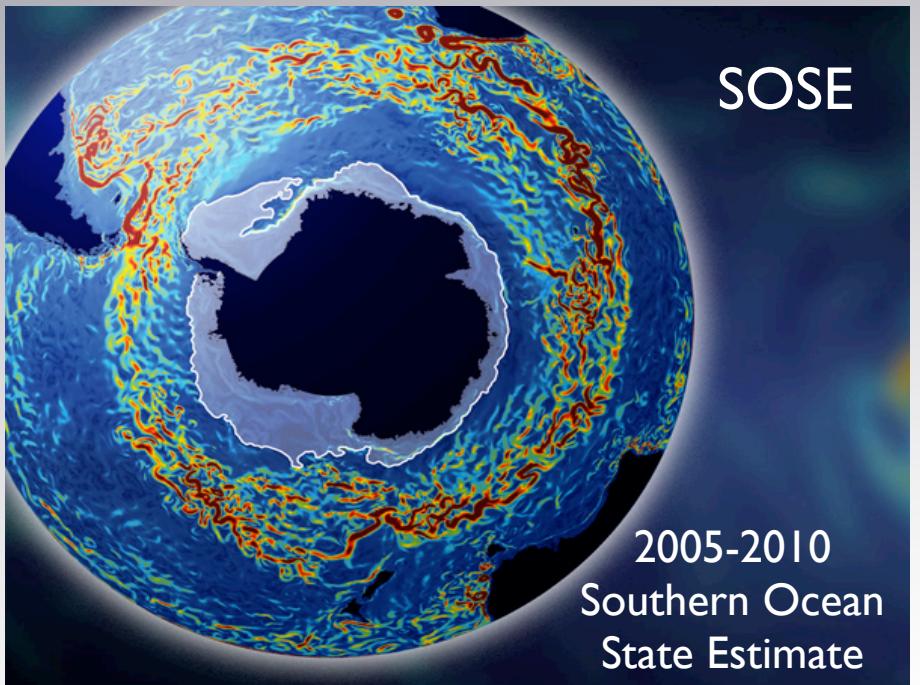
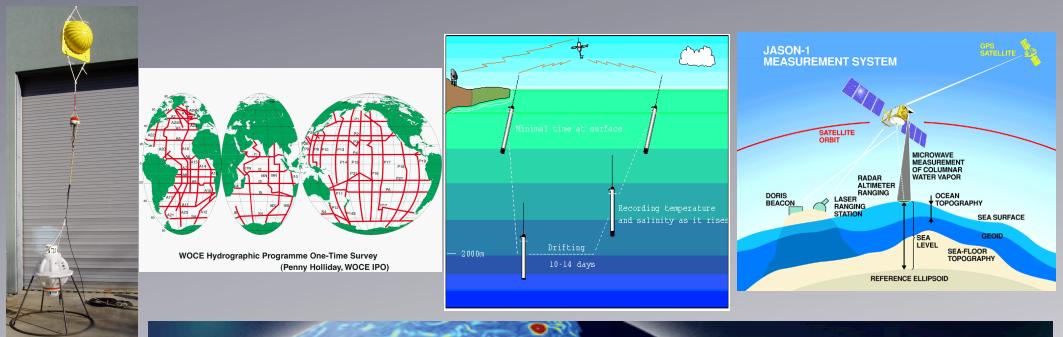
Scripps  
Institution of  
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National  
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IAPSO 2013  
Gothenburg  
Sweden

# Southern Ocean State Configuration

- MITgcm-ECCO
- Adjoint method optimization
- True to physics - no nudging
- Eddy permitting ( $1/6^\circ$ )
- 42 depth levels
- Open northern ( $24.7^\circ\text{S}$ ) BC from  $1^\circ$  OCCA
- full sea-ice model
- Minimize  $J = (\text{obs} - \text{model})^2 \sigma^{-2}$  by solving BC, IC, & atm. state
- Currently optimizing 2008-2010



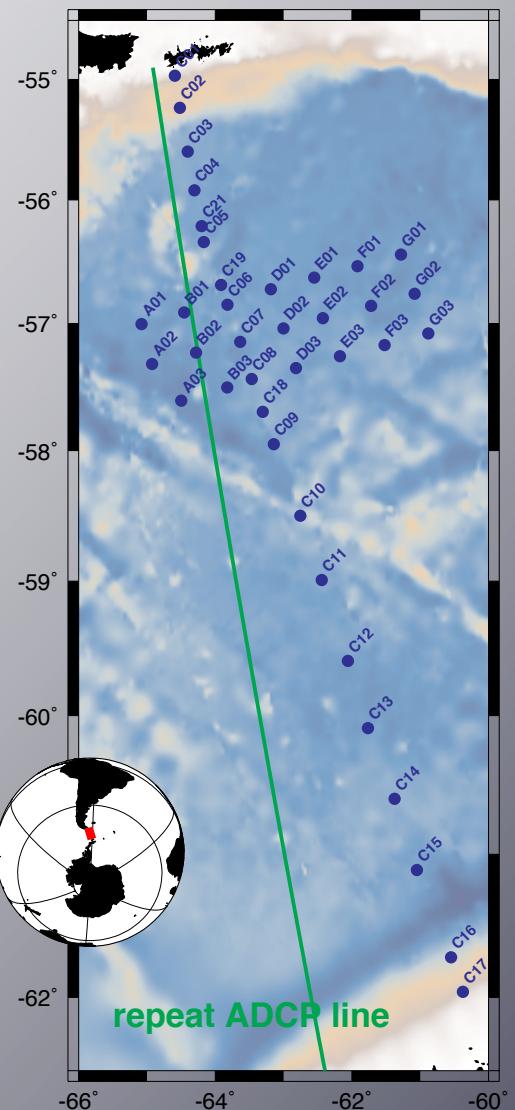
# Observations

## shipboard ADCP

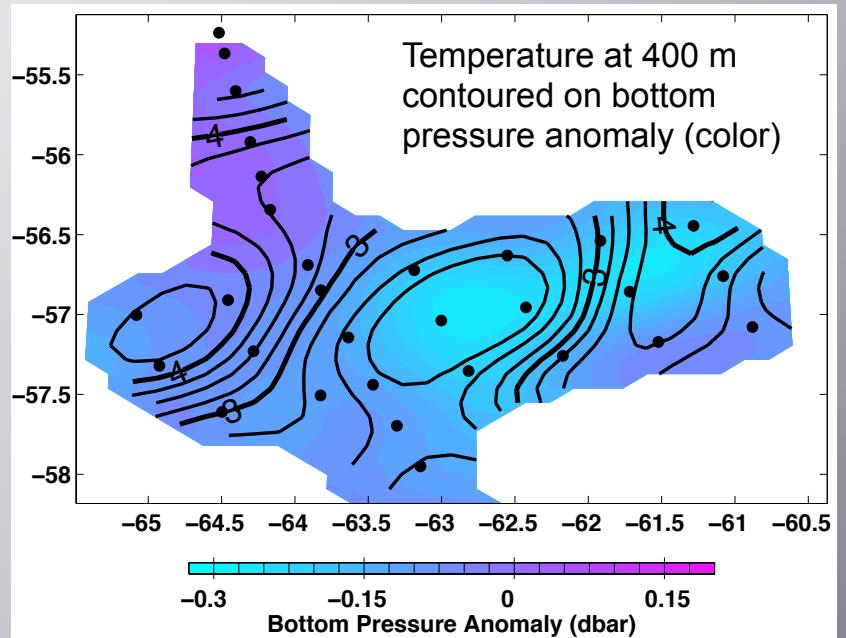
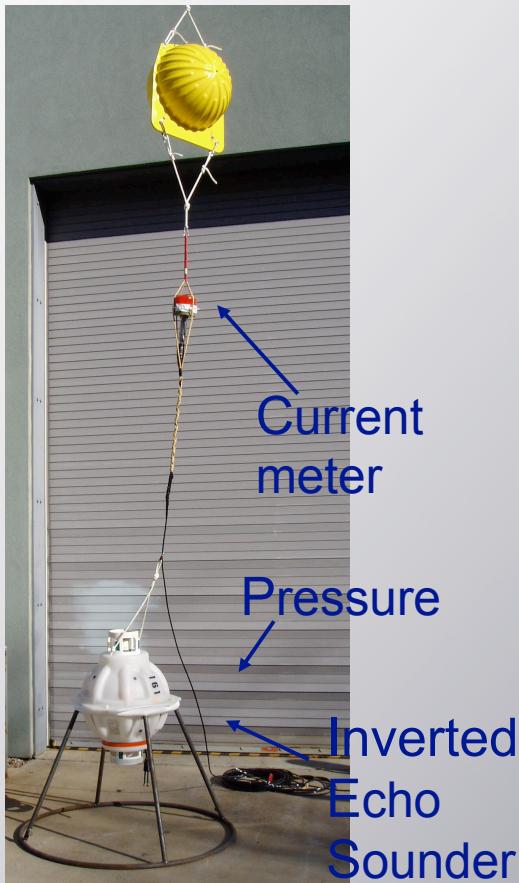
- 2005-2009 (51 transects)
- Direct velocity observations
- 1000 m range

## cDrake

- 2007-2011
- Current and Pressure Recording Inverted Echo Sounders (CPIES)
- transport line
- eddy resolving local dynamics array (LDA)

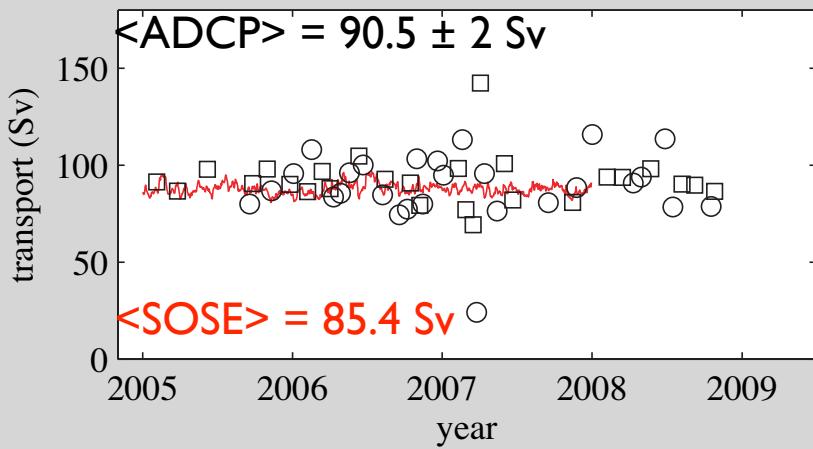
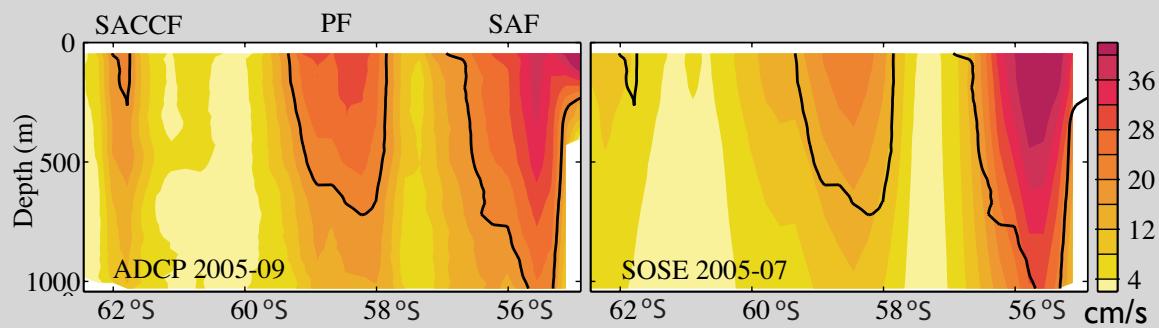
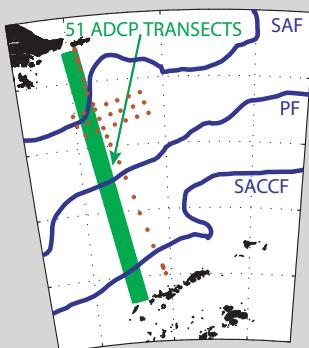


# CPIES Observations



- Look-up tables interpret acoustic travel times as hydrographic profiles  $T(z)$ ,  $S(z)$
- 2-D arrays of CPIES used to calculate geostrophic shear (0 rel 4000 m)
- Measured bottom pressure and bottom currents provide deep reference (4000 m)

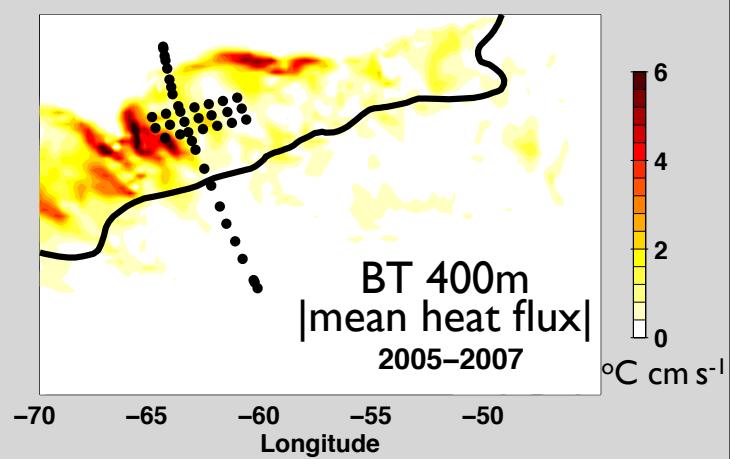
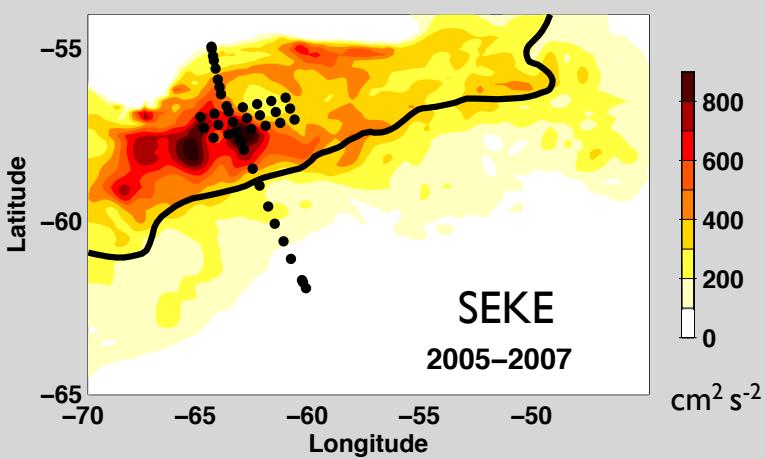
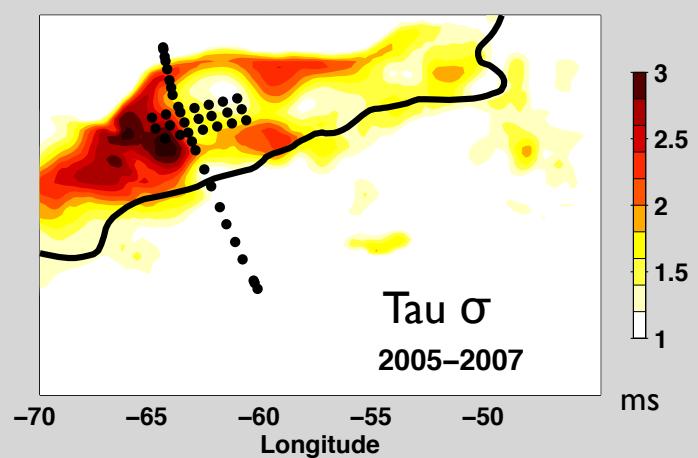
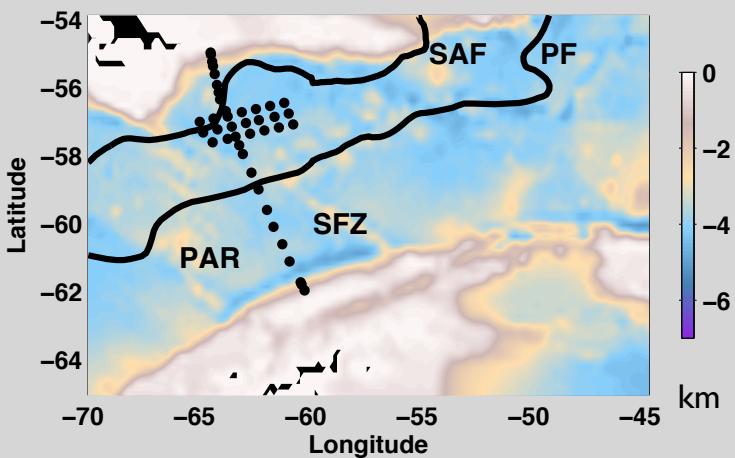
## SOSE/ADCP current speed & transport (0-970m)



(Firing et al., JGR 2011)

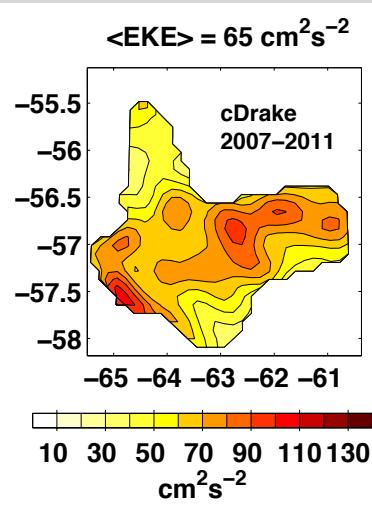
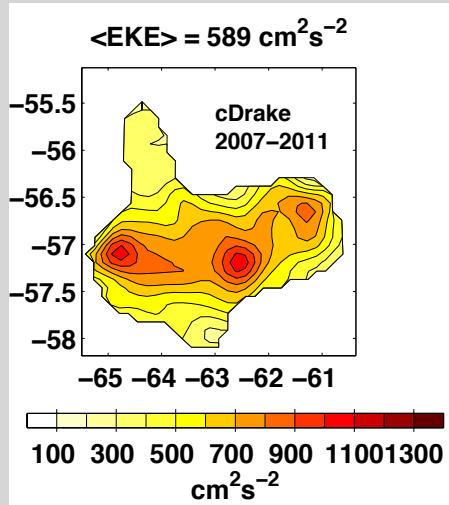
- Locations of SAF and PF agree well between SOSE and observations.
- SOSE SAF stronger than observed SAF; SOSE PF weaker than observed PF.
- SOSE transport in good agreement with observed mean but does not capture observed variability.

# Mean 2005-2007 SOSE fields in Drake Passage

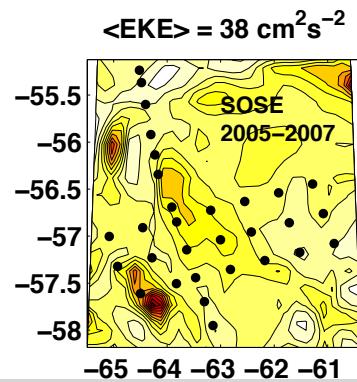
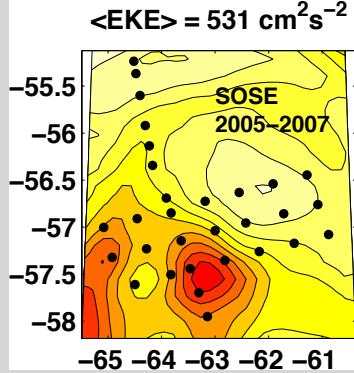


# cDrake/SOSE EKE

cDrake

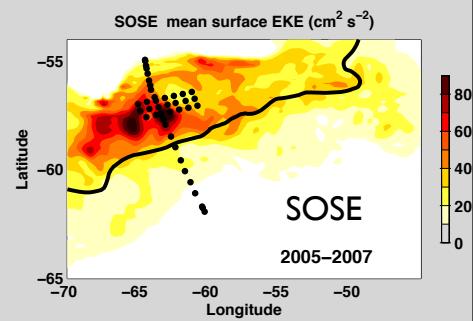


SOSE



Surface

Bottom

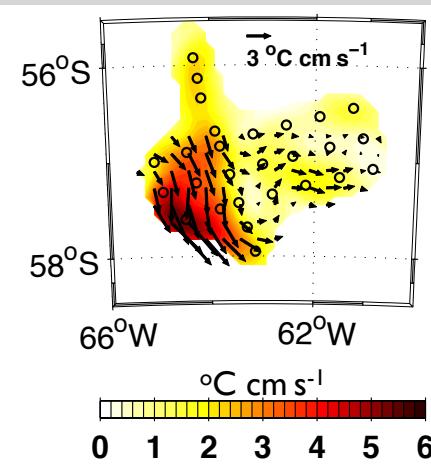


- SOSE surface EKE averaged over cDrake LDA area in good agreement with observations

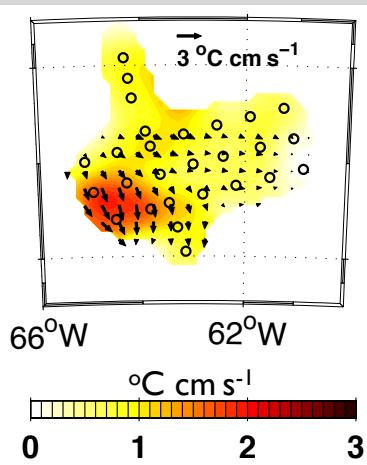
- SOSE bottom EKE averaged over LDA is about 50% weaker than observed.

## cDrake/SOSE eddy heat flux

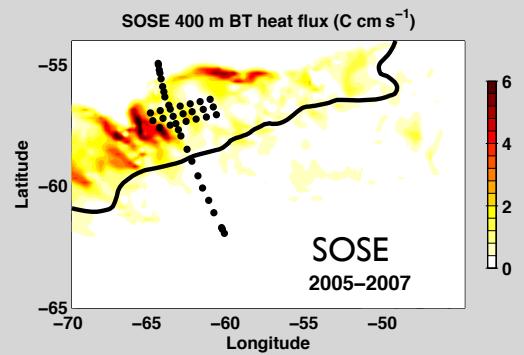
BT HF 400m



DEHF 400m

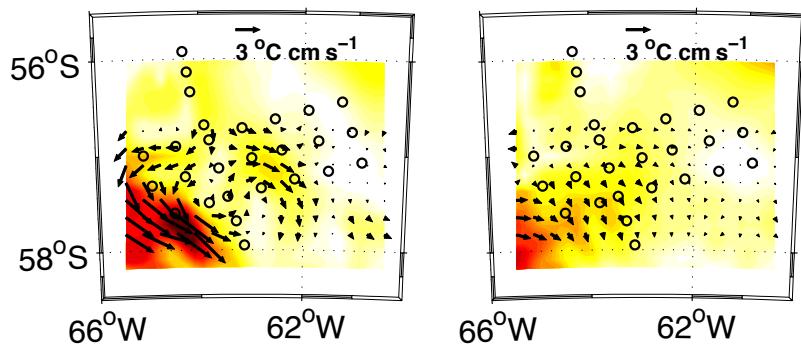


cDrake



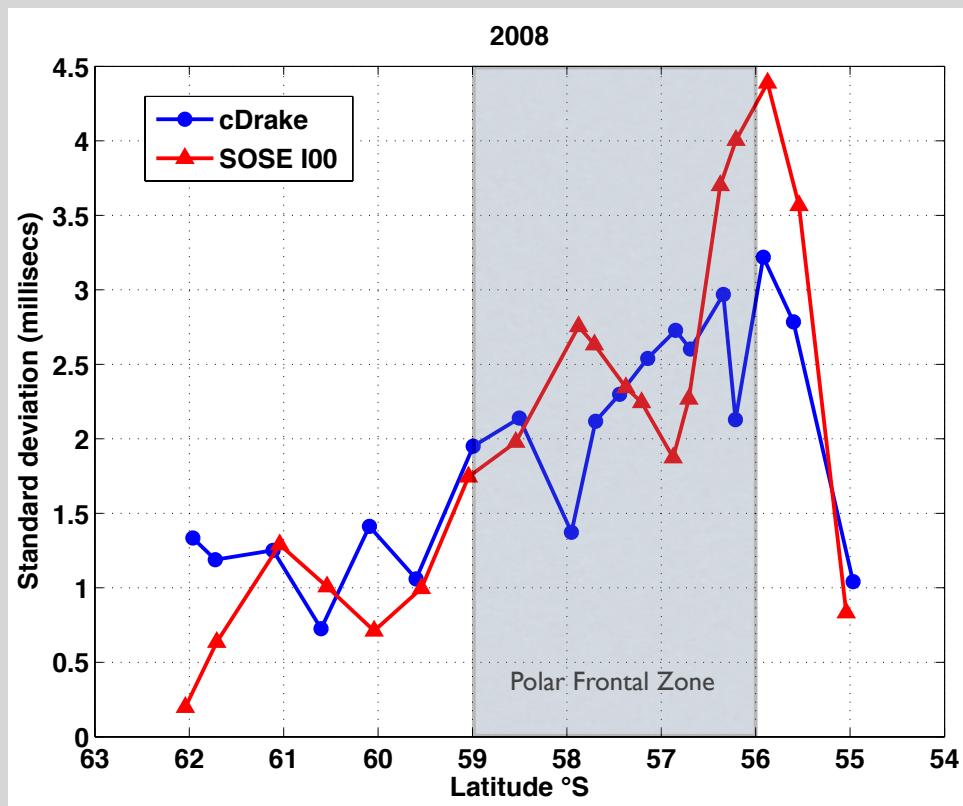
- cDrake peak poleward DEHF is  $1.8\text{ }^{\circ}\text{C cm s}^{-1}$  ( $76\text{ kW m}^{-2}$ )

SOSE



- SOSE peak poleward DEHF is  $1.3\text{ }^{\circ}\text{C cm s}^{-1}$  ( $54\text{ kW m}^{-2}$ )

## SOSE/cDrake C-line comparison: prior to fitting

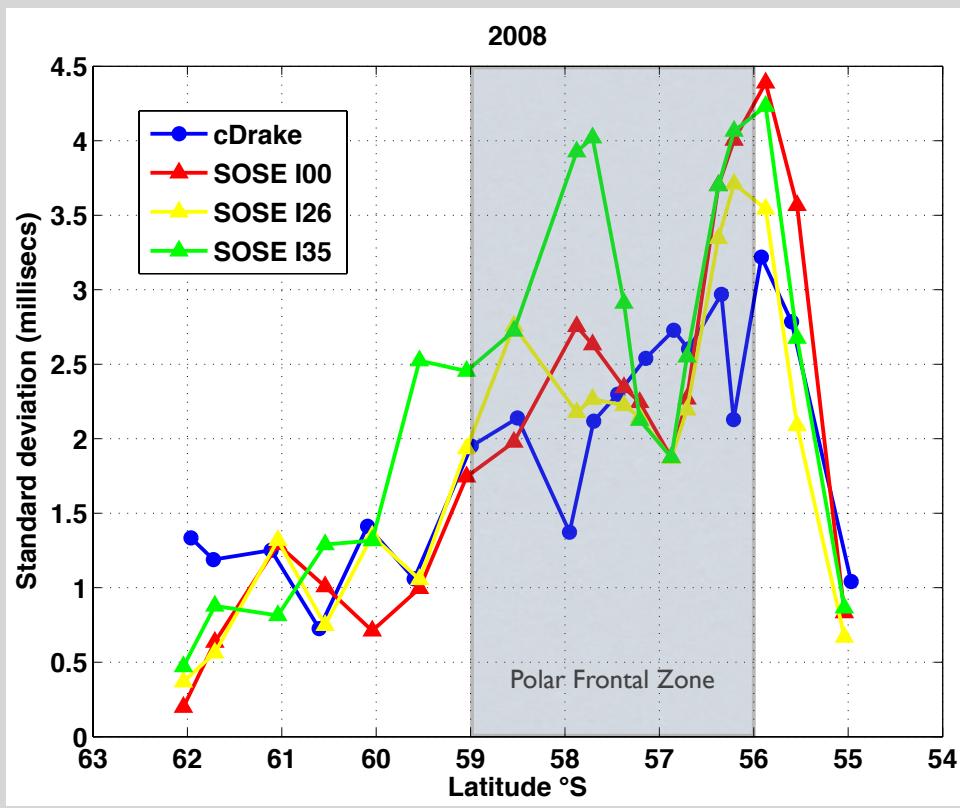


Data used as constraint is the anomaly of round-trip travel time.

Travel-time variability primarily steric, meandering ACC fronts

Overall good agreement in size and spatial distribution

## SOSE/cDrake C-line comparison: prior and post fitting

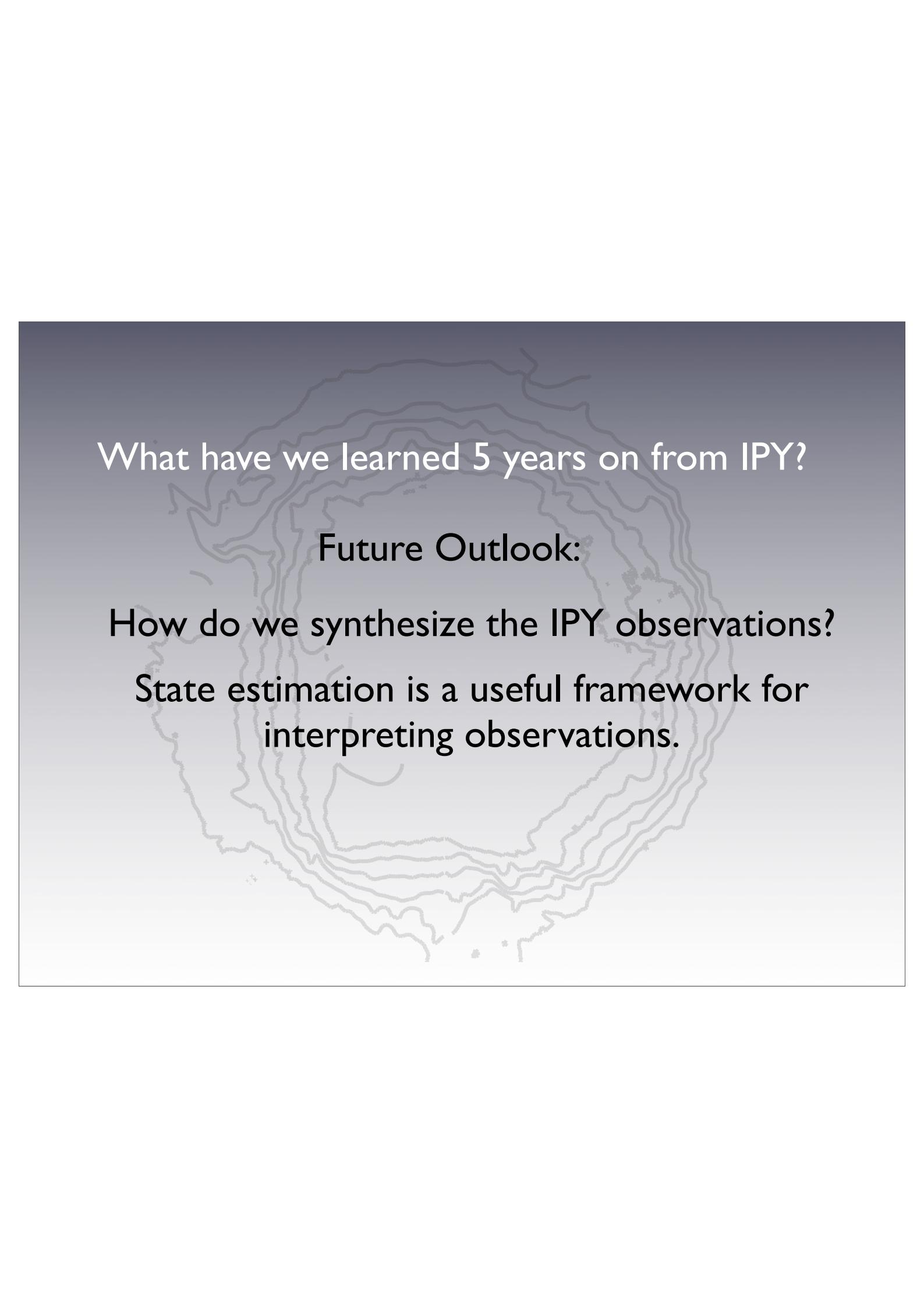


Iterations agree to within  
specified uncertainty  
(about 1 ms)

Overall rms differences  
(not shown), normalized  
by observed standard  
deviations, are decreasing

# Summary

- Comparison with observations vital for improving model realism.
- SOSE compares well with recent observations in Drake Passage using metrics such as speed, transport, EKE, eddy heat flux and travel time anomaly standard deviation.
- “Fitting” to IES data: good prior fit to SOSE; improvement with iteration has been modest.



What have we learned 5 years on from IPY?

## Future Outlook:

How do we synthesize the IPY observations?

State estimation is a useful framework for interpreting observations.