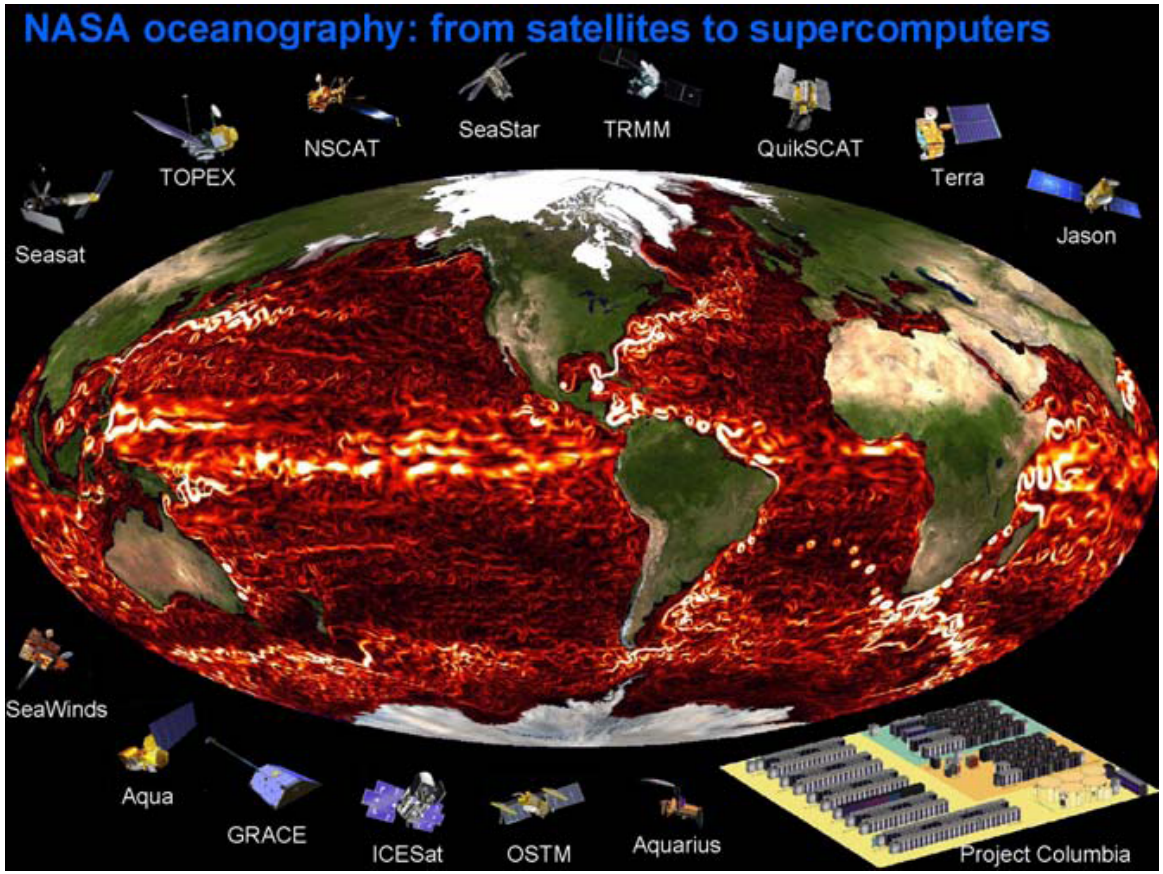
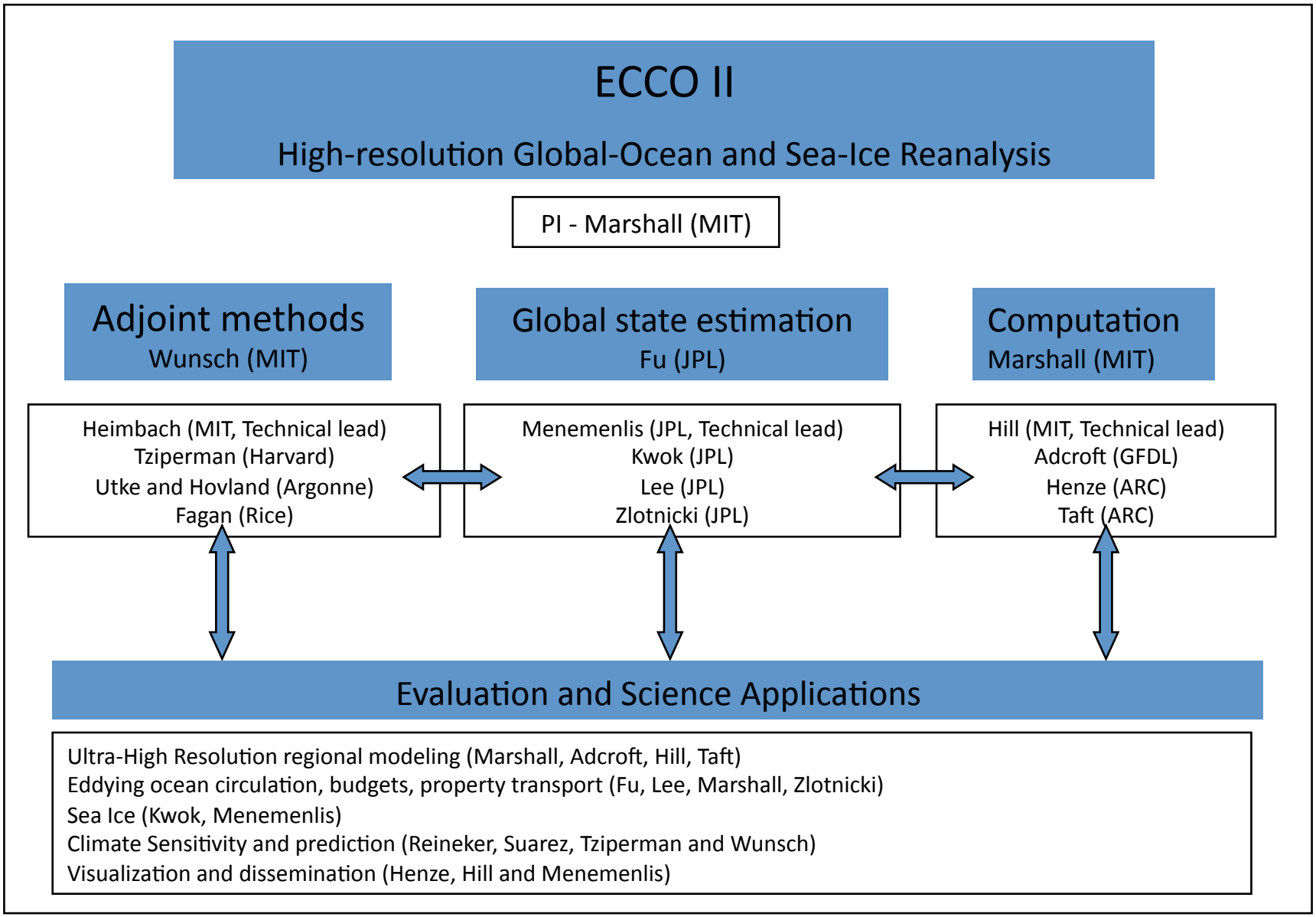
ECCO2 meeting
MIT, September 2008

Ocean state estimation in the presence of eddies and ice

Supported by NASA



Modeled Instantaneous current speed at a depth of 15 m


ECCO II
High-resolution Global-Ocean and Sea-Ice Reanalysis
PI - Marshall (MIT)
Adjoint methods
Wunsch (MIT)
Global state estimation
Fu (JPL)
Computation
Marshall (MIT)
Heimbach (MIT, Technical lead)
Tziperman (Harvard)
Utke and Hovland (Argonne)
Fagan (Rice)
Menemenlis (JPL, Technical lead)
Kwok (JPL)
Lee (JPL)
Zlotnicki (JPL)
Hill (MIT, Technical lead)
Adcroft (GFDL)
Henze (ARC)
Taft (ARC)
Evaluation and Science Applications
Ultra-High Resolution regional modeling (Marshall, Adcroft, Hill, Taft)
Eddying ocean circulation, budgets, property transport (Fu, Lee, Marshall, Zlotnicki)
Sea Ice (Kwok, Menemenlis)
Climate Sensitivity and prediction (Reineker, Suarez, Tziperman and Wunsch)
Visualization and dissemination (Henze, Hill and Menemenlis)

Beginning year 3 of a 5 year project

First 2 years we have been exploring state estimation approaches in the presence of eddies and ice

Today – review where we are
Tomorrow – discuss future strategy

- We have been exploring two interrelated strategies to minimize misfit between model and data

  1. Greens functions applied to global problem - JPL
  2. Adjoint methods in embedded models - MIT

- Science applications

  Global, regional

  Arctic,
  Weddell
  Southern Ocean

- Wider impacts

  1. Ecosystem modeling
  2. Collaboration with WHOI in support of field experiments and Arctic research
  3. A + O coupling

- Ocean model development
  Coupling

  O ⟹ A
  O ⟹ I
  O ⟹ Biogeo

Tuesday

Morning

Review of Greens Function global calculations and associated science

Afternoon

Model development

4.30 Vizwall in the Stata Center:

Evening
Jean-Michel leading foray to local sites and dinner venues.

Wednesday

Morning

Plans for next phase of ECCO2

(I) CS510 adjoint eddying solution

(II) Pushing resolution and embedding models

(III) Coupling of models

Finish by 1.00pm

Engaging physical oceanographers in ECCO

Give three examples:

CLIMODE	Subtropical mode water
KESS	
DIMES	mixing in the southern ocean

Using state estimates produced by Gael Forget at MIT.

Gael deployed ECCO adjoint technology to fit a coarse resolution ocean model to Argo data and altimetry etc etc, to produce an 'atlas' that's been given the name OCCA.

OCCA was then used by Matt Mazloff and Patrick Heimbach to initialize an eddying model of the southern ocean and constrain that model with Argo.

Propose a way forward for the next phase of ECCO2

Atlantic mode water

CLIMODE

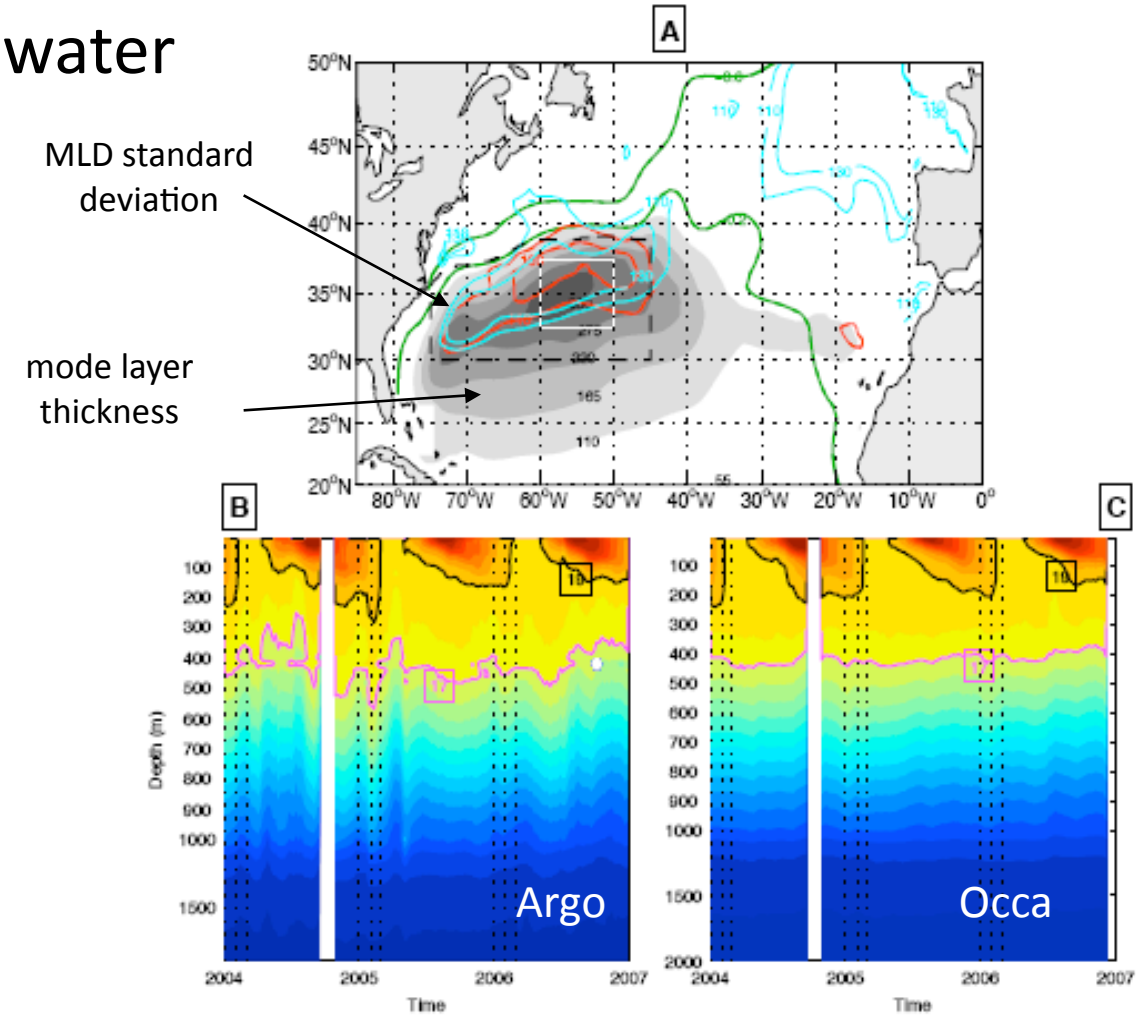
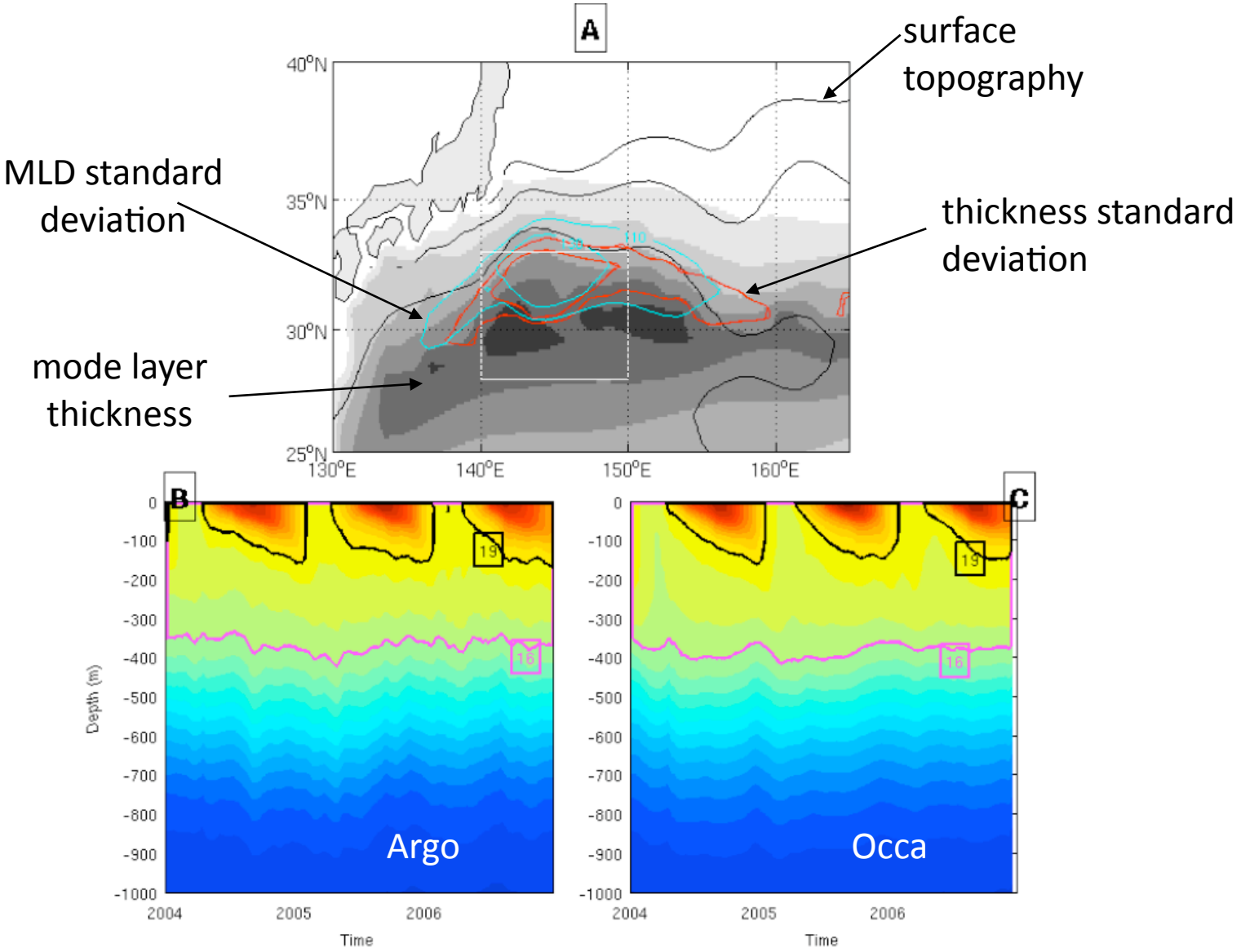
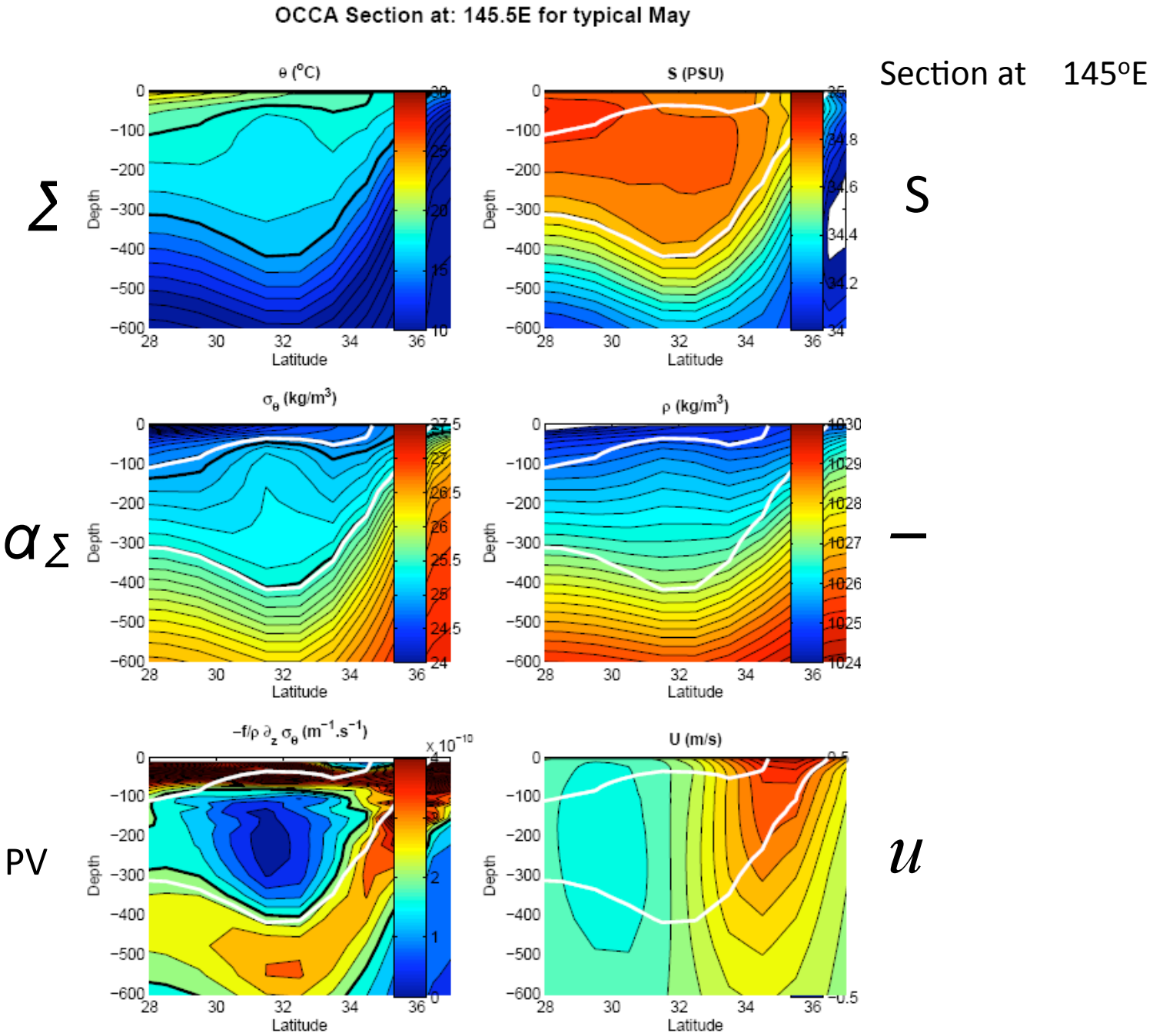


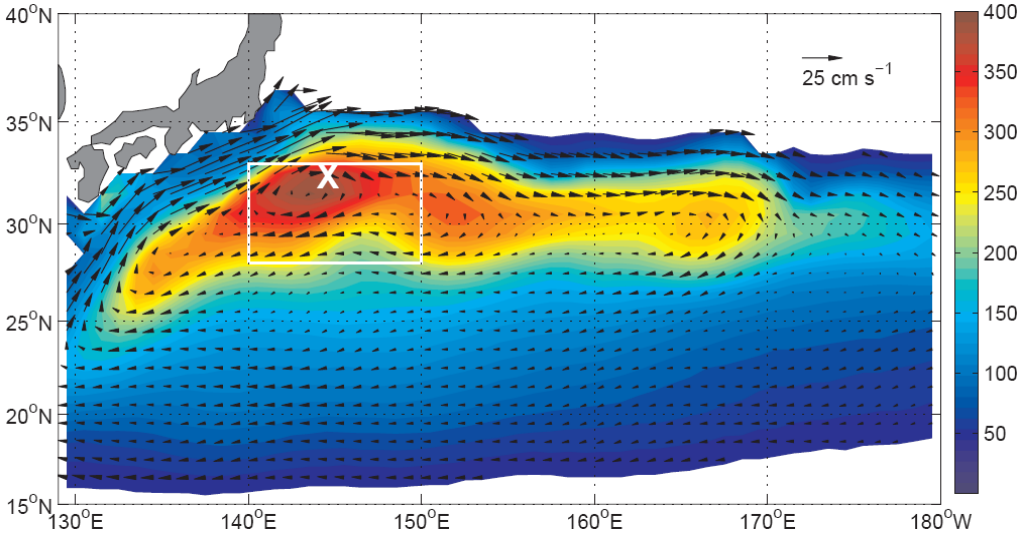
Figure 1: Panel A: Observed three years (2004-2006) mean characteristics of the $18 \pm 1°C$ layer in the OCCA dataset. Mean thickness (shaded gray), monthly thickness standard deviation (red contours) and mixed layer depth standard deviation (blue contours). The two thick green contours are mean SSH (-0.2m;-0.6m), chosen to mark the arc of the subtropical and subpolar gyre. The box marked by the black dashed line encloses the main formation area of NASTMW (see section d). In Panel B: Every Argo profile within the $10° \times 5°$ white box centered on 35N/55W shown in panel A, is plotted as a function of time, beginning in January 2004 and ending in December 2006. The white bar indicates a period of time when there were no profiles. The $19°C$ and $17°C$ isotherms, enhanced in black and magenta, are plotted. The first day of January, February and March in each of the years is indicated by the vertical dotted lines. Panel C: As in Panel B but sampling the OCCA data set to mimic Argo profiles.

Pacific mode water

KESS

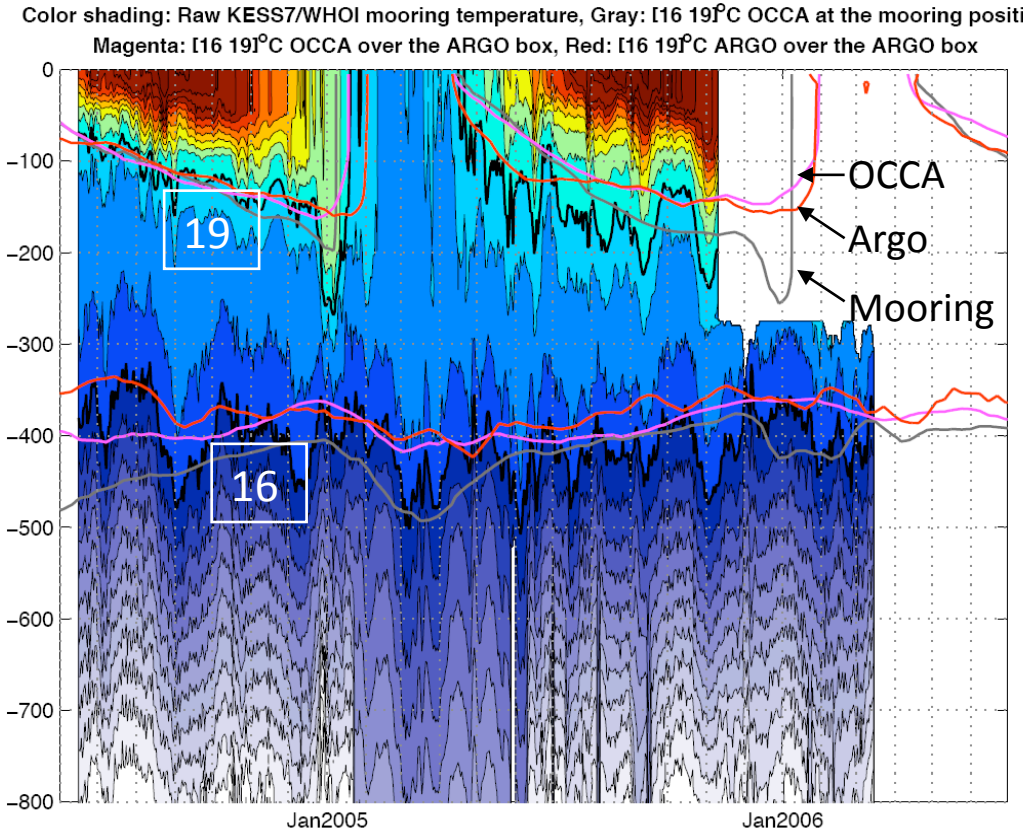



OCCA Section at: 145.5E for typical May
θ (°C)
S (PSU)
σθ (kg/m3)
ρ (kg/m3)
−f/ρ ∂z σθ (m−1.s−1)
U (m/s)
Depth
Latitude
Section at 145°E
Σ
S
αΣ
−
PV
u



thickness of mode water layer

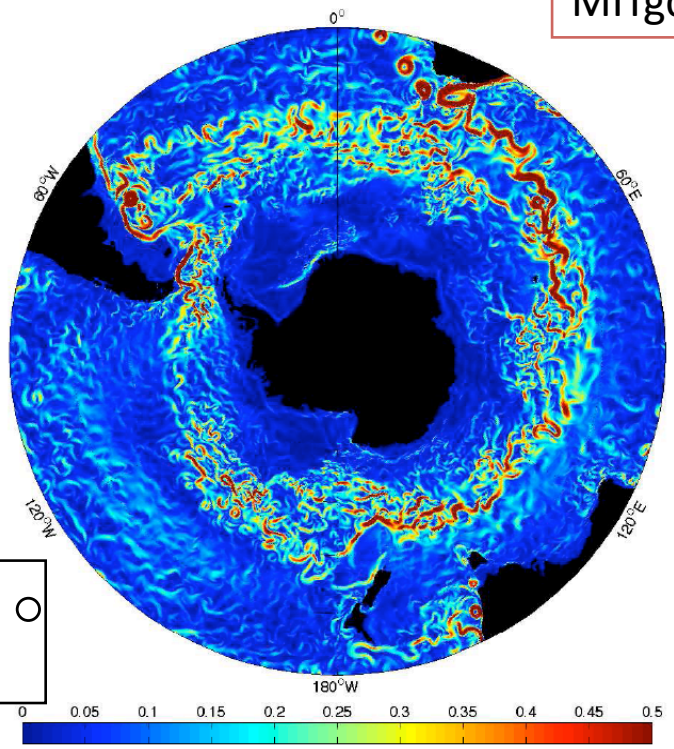
Kess mooring



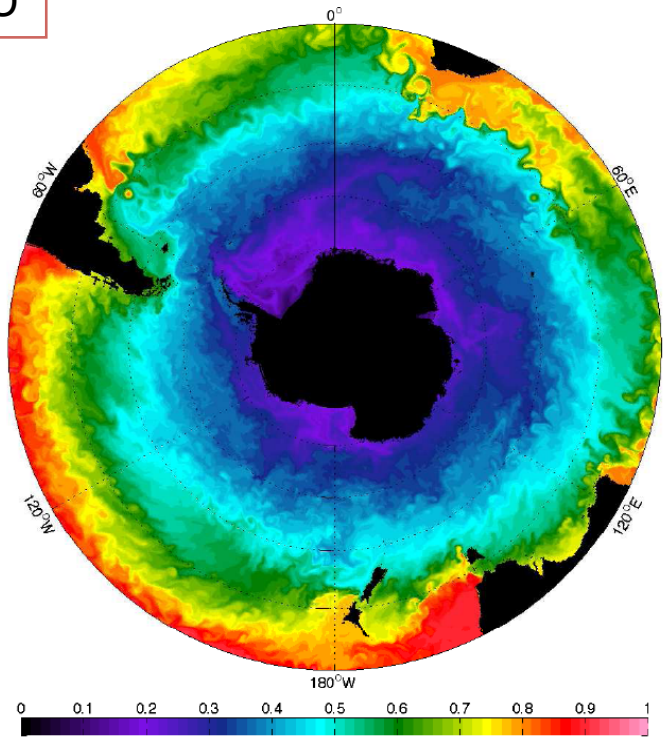
Effective diffusivities estimated from an eddy resolving model constrained by observations

MITgcm + ECCO

$\frac{1}{6}^{\circ} \times \frac{1}{6}^{\circ}$



Surface current speed



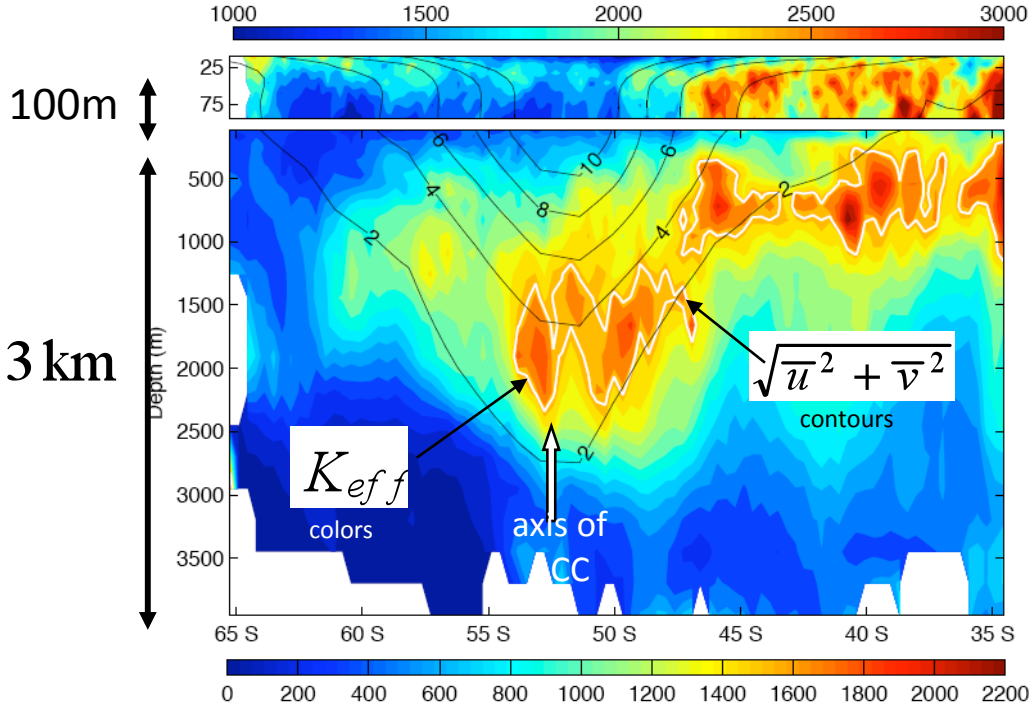
Surface tracer distribution

$$\frac{/q}{/t} + \mathbf{v}\,64q = k4^2 q$$

carry out calculation in 3-dimensions

Ryan Abernathey
Matt Mazloff
Patrick Heimbach

Ryan Abernathey



In next phase of ECCO2 propose that we do this globally:

1. Take JPL CS510 configuration, tuned using Greens Functions
2. Initialize with OCCA
3. Minimize cost function, heavily weighting Argo data and altimetry, using adjoint machinery
4. Proceed year by year, laying down an estimate that is close to data: 2004 to present
5. Tune model mixing schemes to reduce systemic drift
6. Return to the decadal problem later