Proudman Oceanographic Laboratory
NATURAL ENVIRONMENT RESEARCH COUNCIL

Altimetry and Dynamics of the Southern Ocean

Arles, Nov. 2003

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Teresa Chereskin

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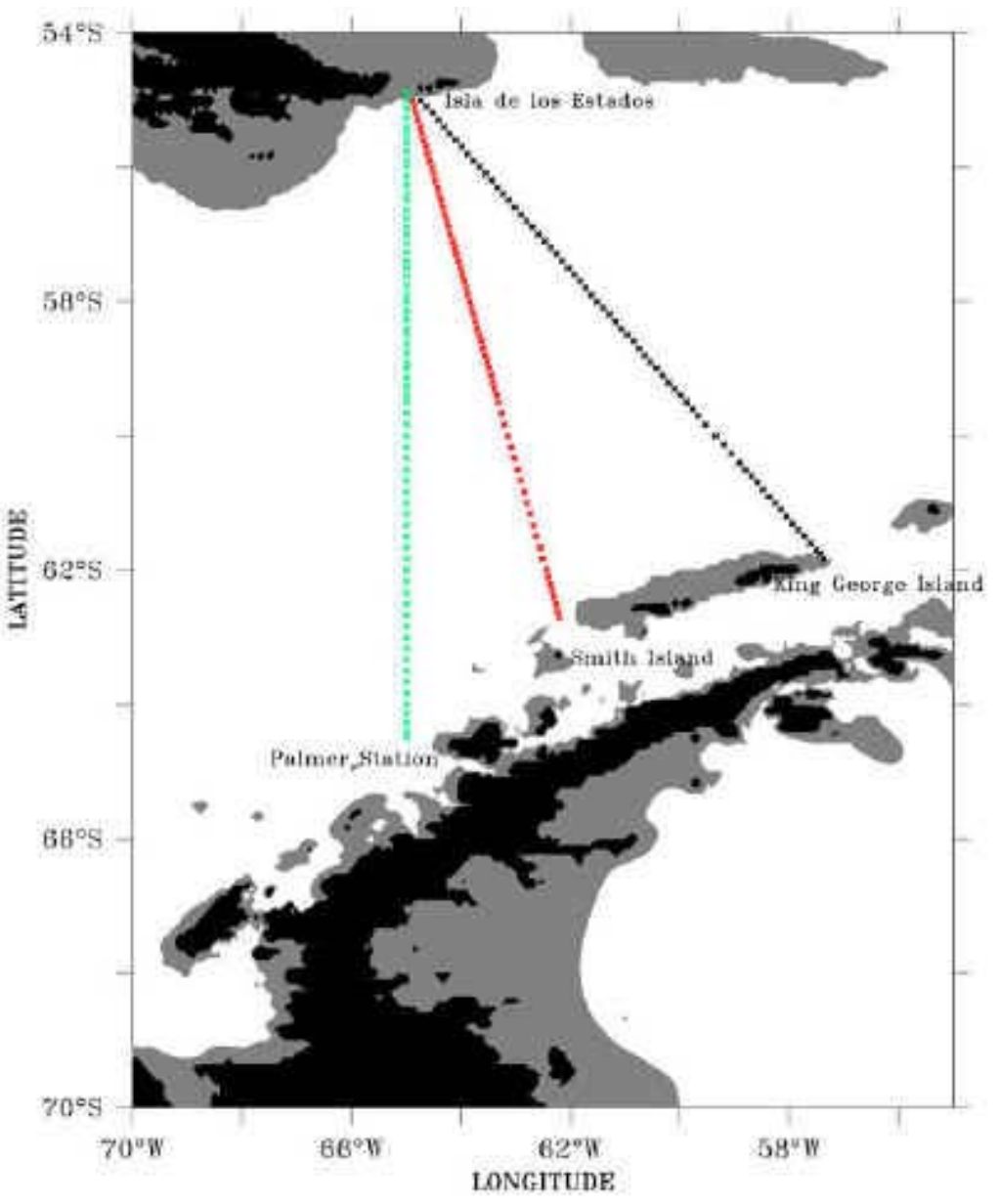
See also:

Cunningham, King et al. (SOC)

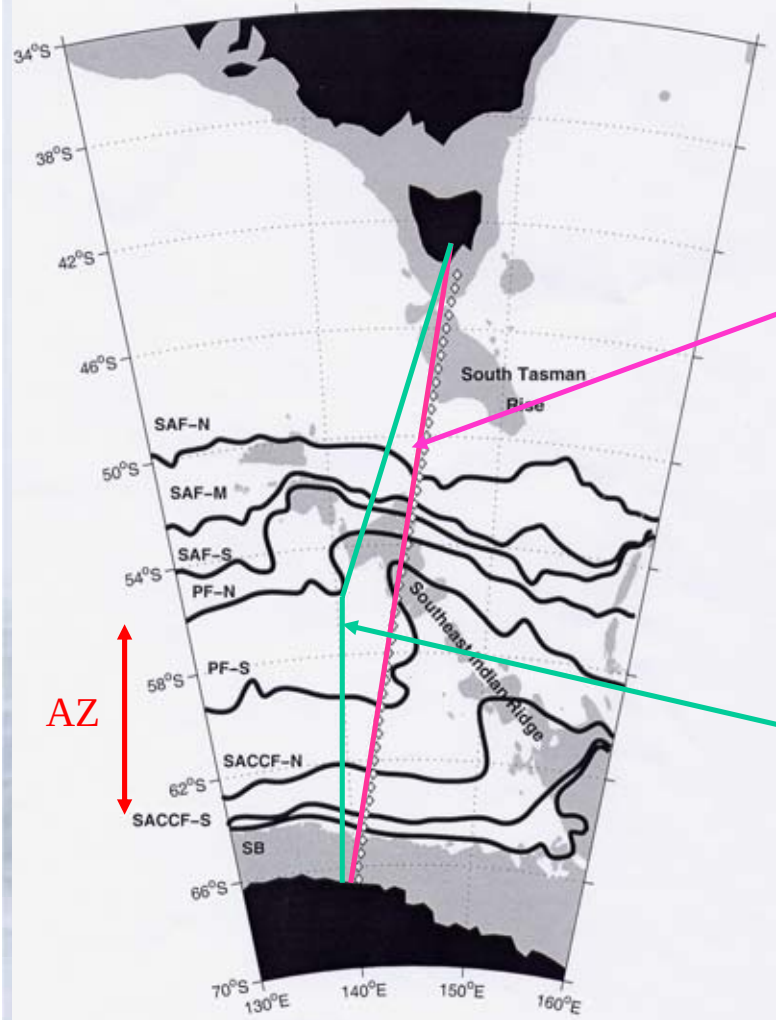
Provost et al. (poster)



SURVOSTRAL and WOCE/SR3 Study zone

Courtesy Rosemary Morrow

Sokolov and Rintoul, 2003



SURVOSTRAL:

Project started in 1992 by France, Australia and USA.

5 rotations each austral summer (October-March)
3 with high density XBTs (volunteer onboard):

TSG: ~1.85km

XBTs: ~40km and 20km in frontal zone over 0-800m depth..

WOCE/SR3:

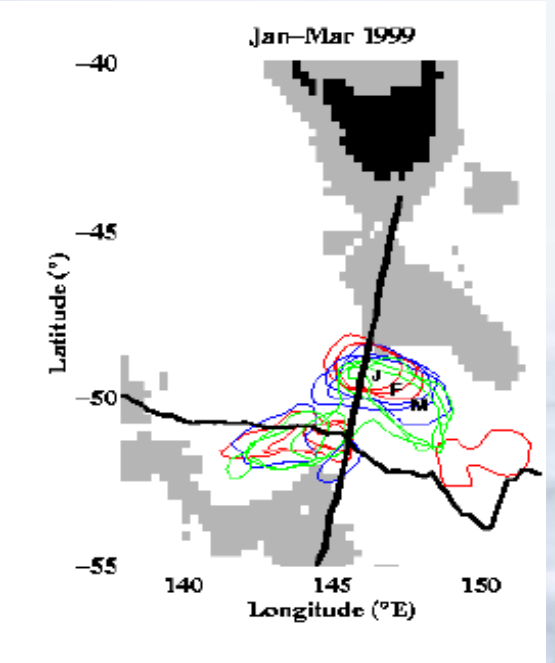
7 CTD sections during different seasons between 1991 and 2001 (Oct., Mar, Jan., Jul., Sept., Nov.) with a horizontal resolution of ~50 km

Cold-core rings transporting heat across SAF

Altimetry is used to track the circulation pathways and decay of cold-core rings drifting north of the SAF

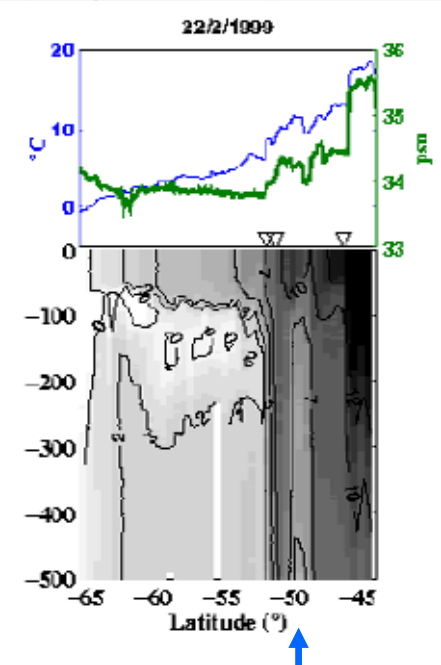
SURVOSTRAL XBTs and TSGs provide their heat anomalies and SSS anomalies

SLA < 10 cm in **Jan**, **Feb**, **Mar** '99



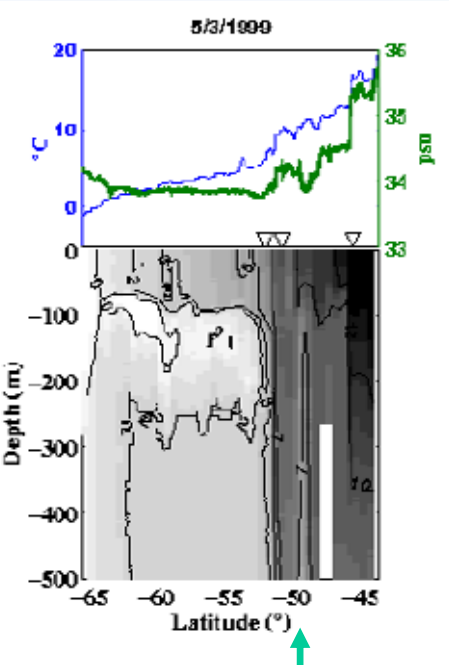
Morrow et al, DSR, (submitted).

XBT and SSS data in **Feb** '99

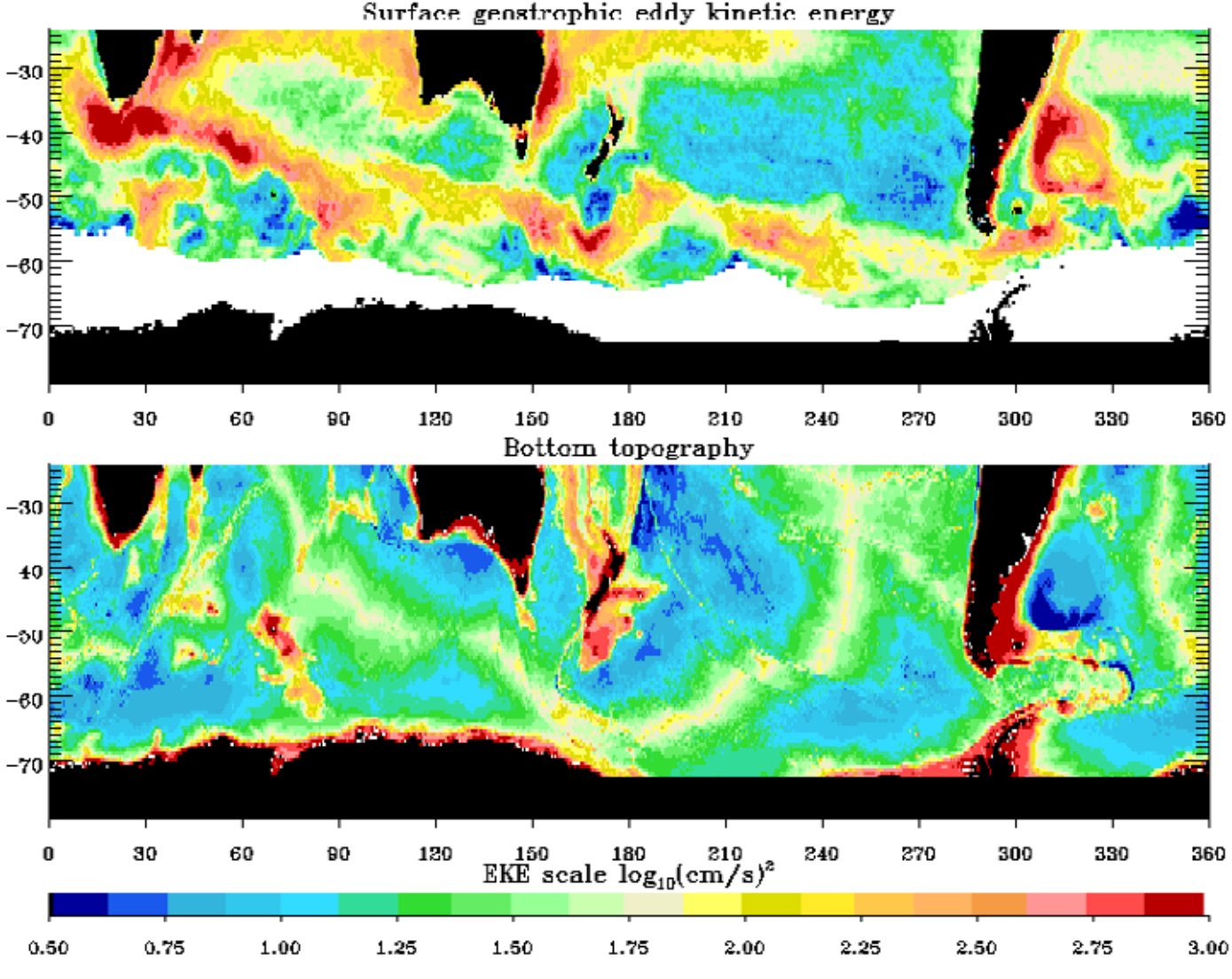


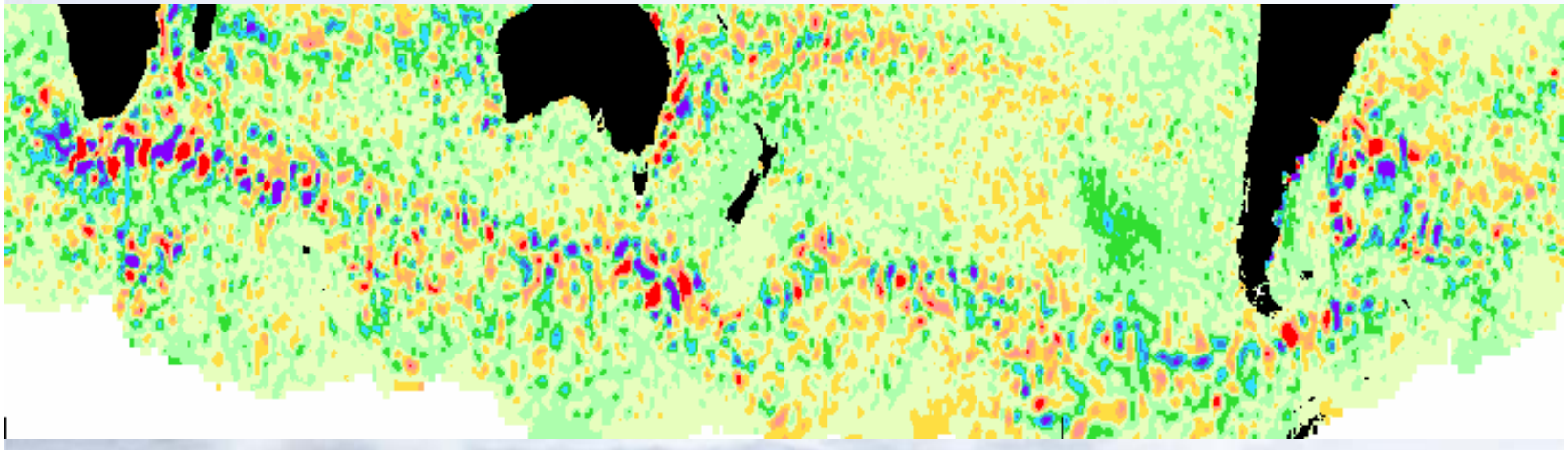
Eddy

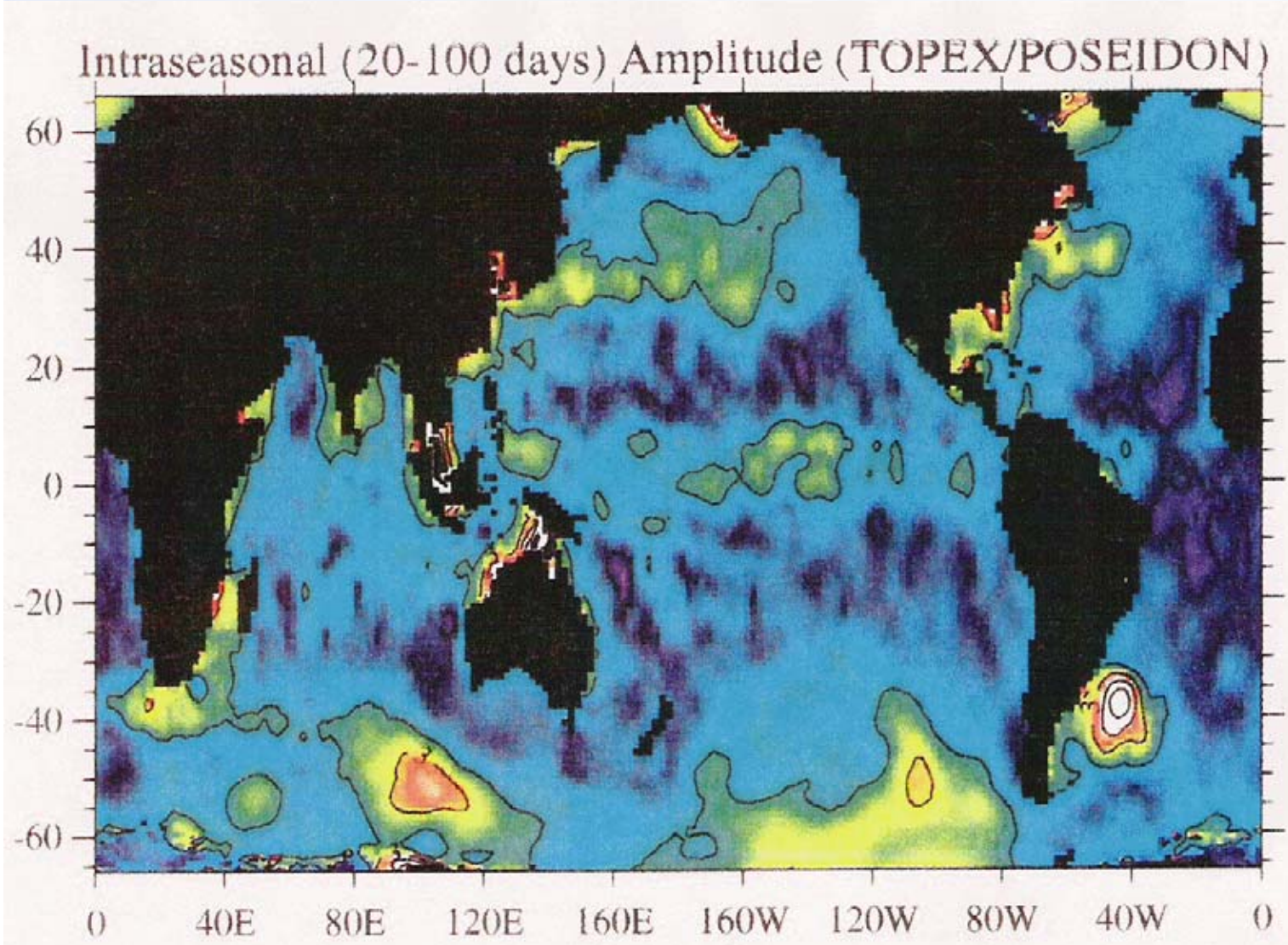
Mar '99



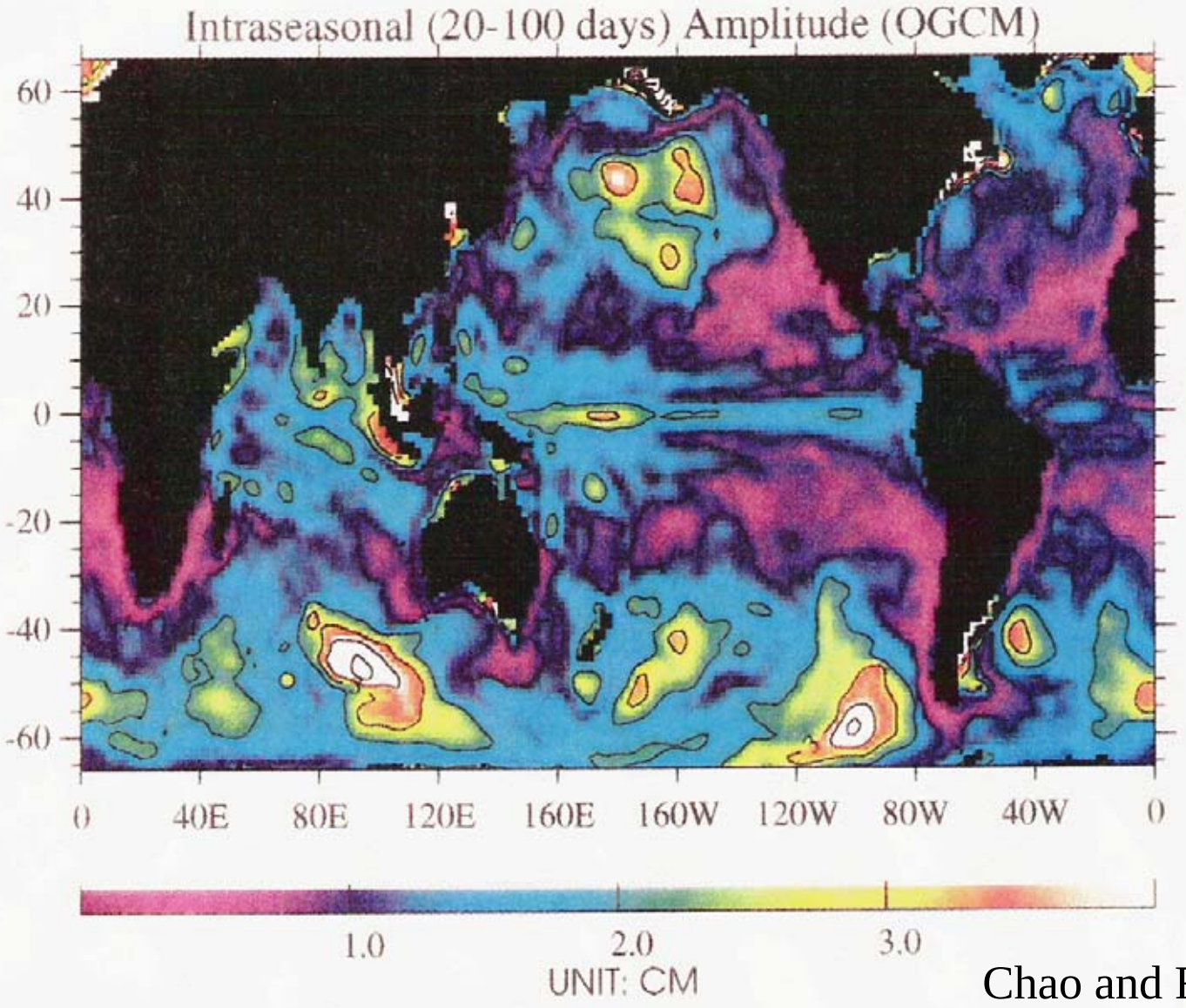
Eddy


Surface geostrophic eddy kinetic energy
-30
-40
-50
-60
-70
0
30
60
90
120
150
180
210
240
270
300
330
360
Bottom topography
-30
40
-50
-60
-70
0
30
60
90
120
150
180
210
240
270
300
330
360
EKE scale log10(cm/s)2
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00



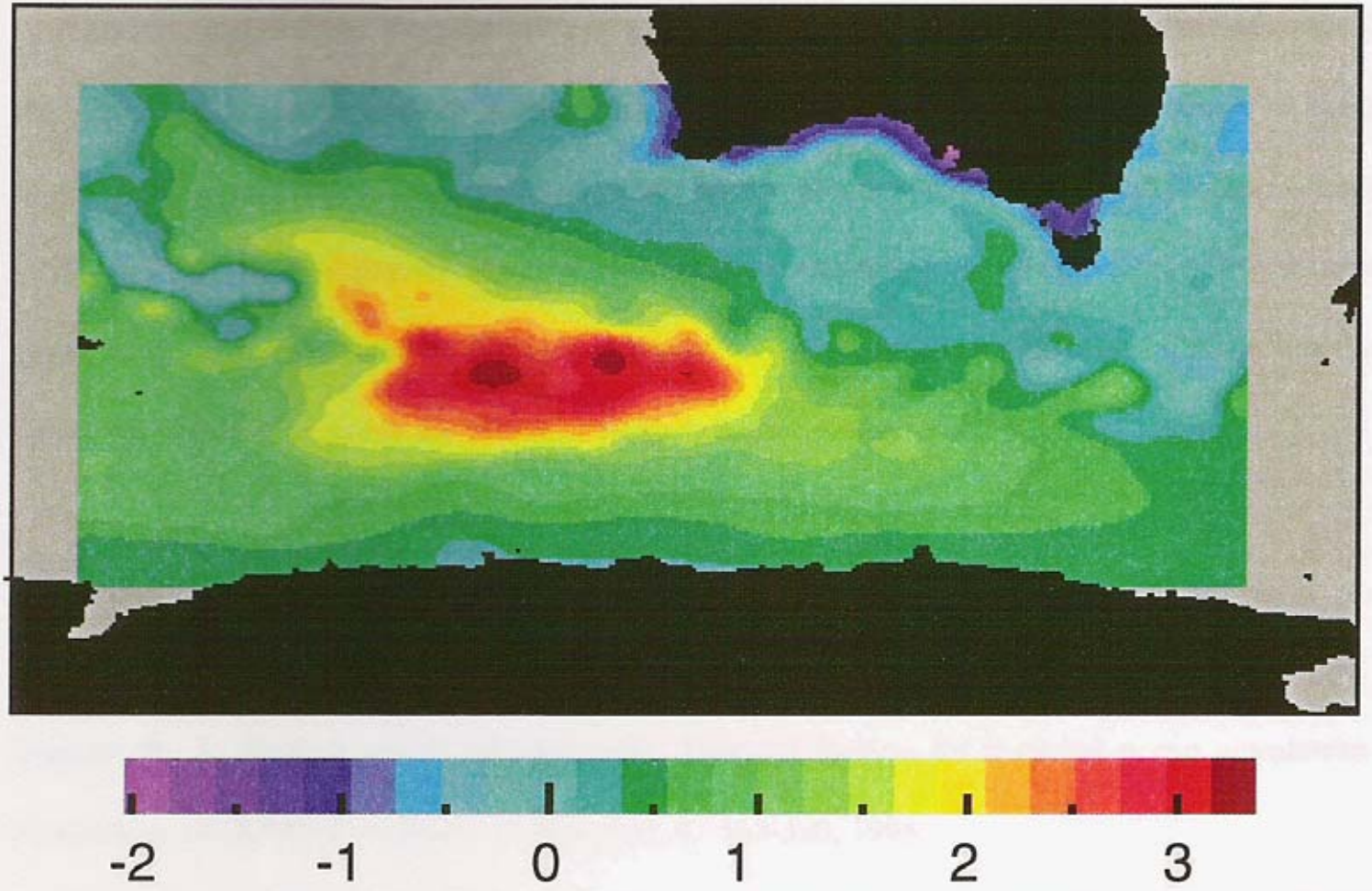


Chao and Fu 1995

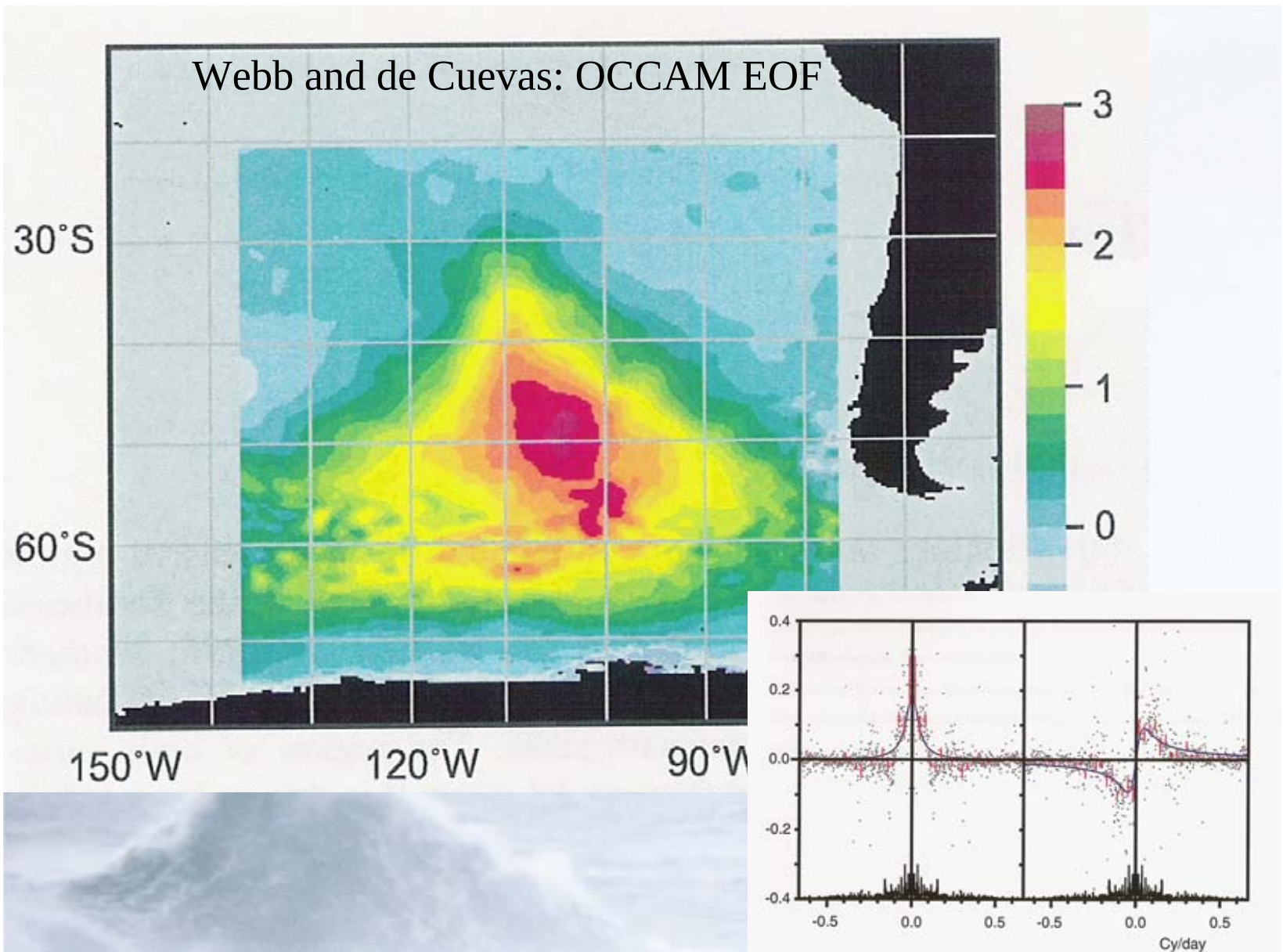


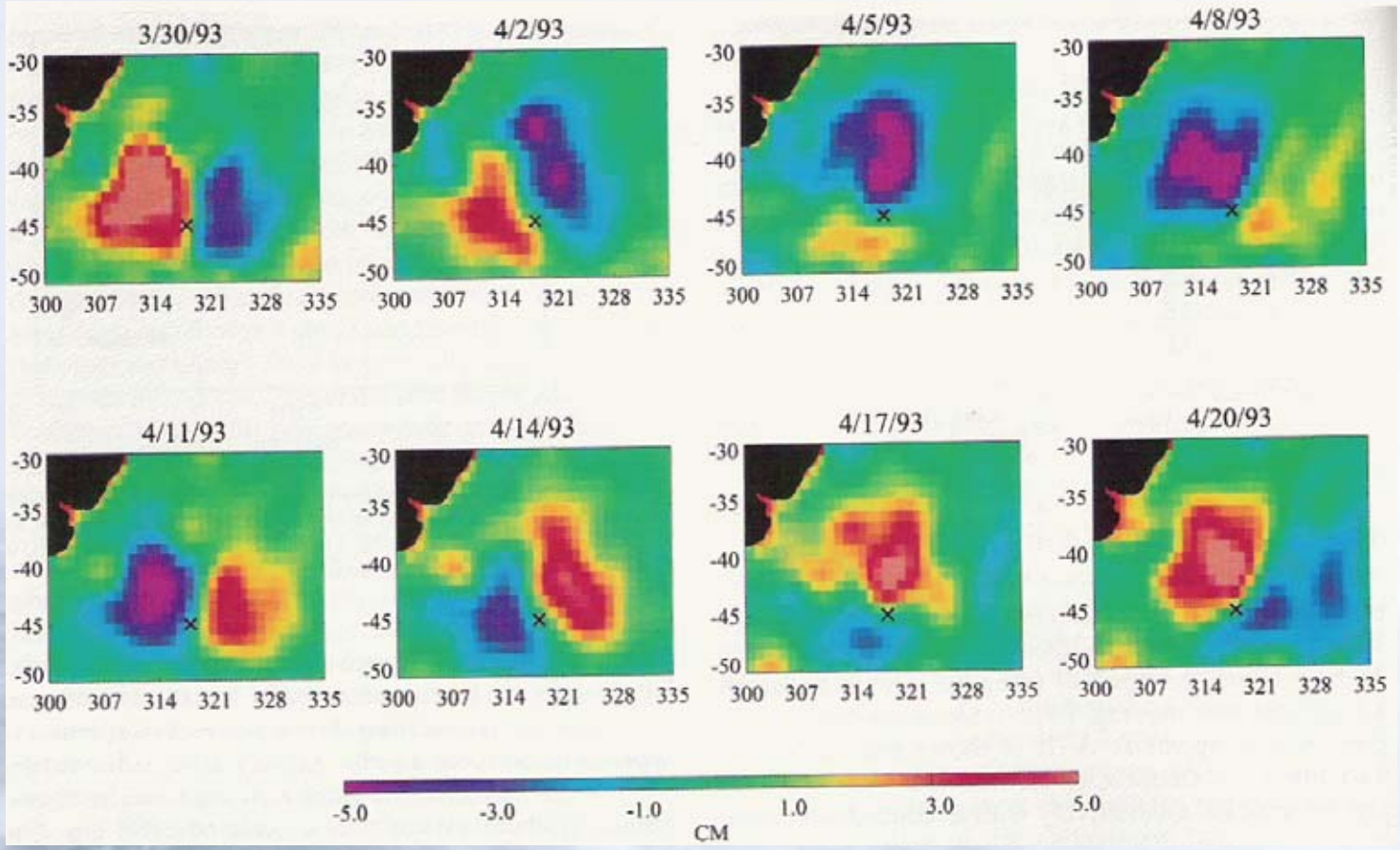
Chao and Fu 1995

Webb and de Cuevas: OCCAM EOF

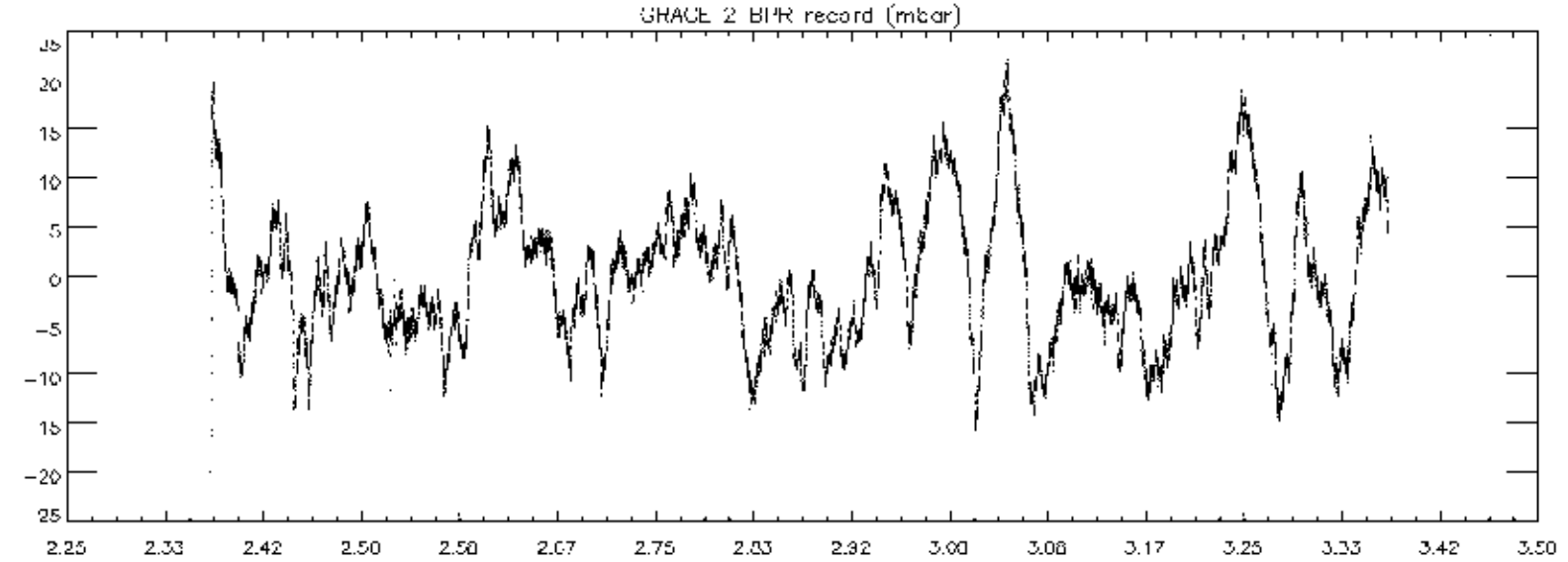


Webb and de Cuevas: OCCAM EOF

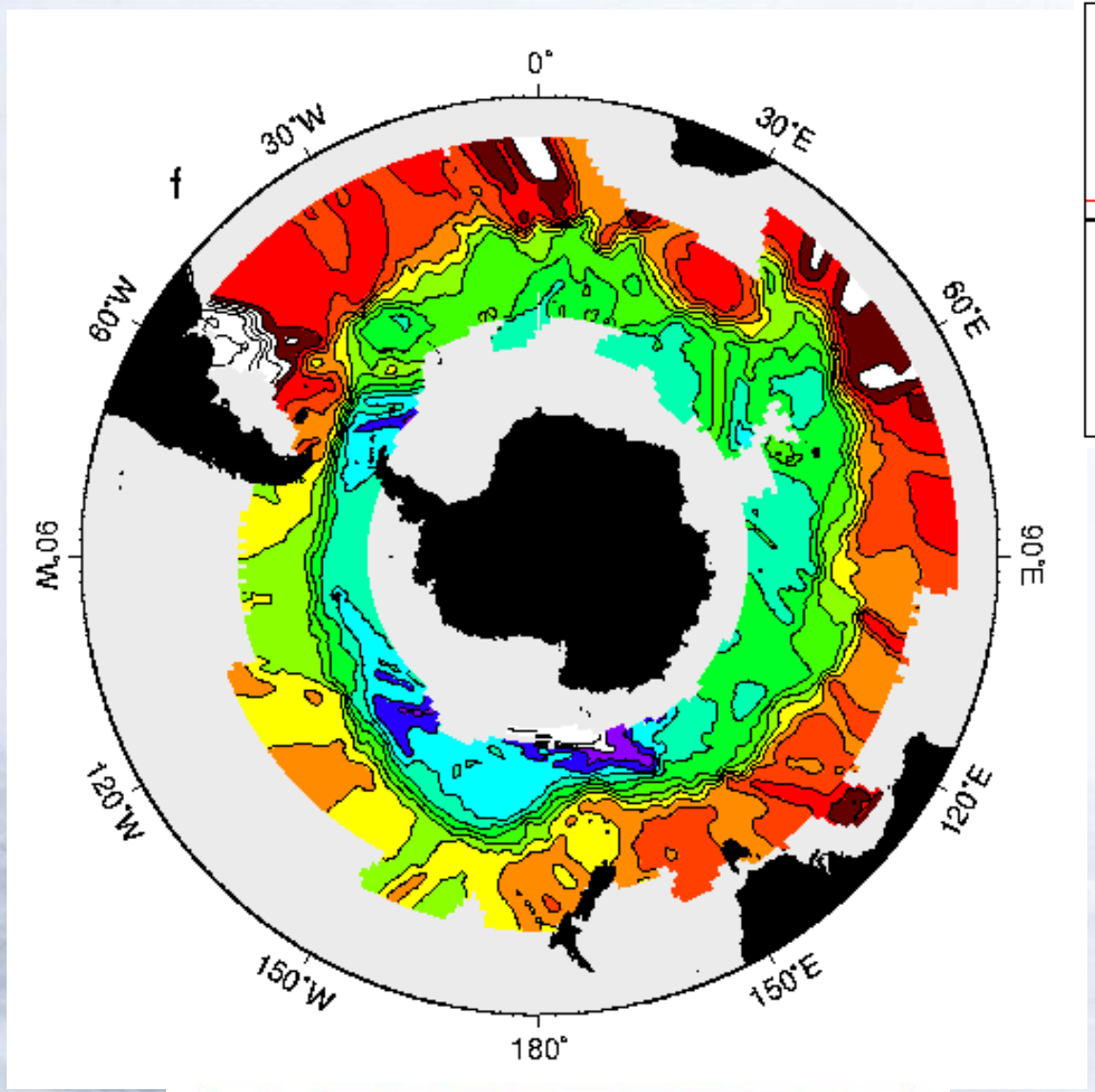


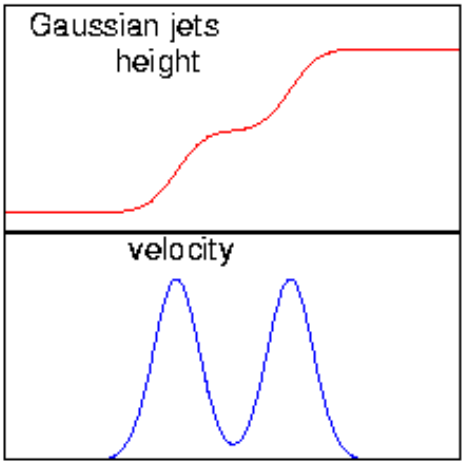

3/30/93
4/2/93
4/5/93
4/8/93
4/11/93
4/14/93
4/17/93
4/20/93
-30
-35
-40
-45
-50
300 307 314 321 328 335
-5.0 -3.0 -1.0 1.0 3.0 5.0
CM

2002 POL Bottom Pressure measurements: Argentine Basin



Cf. Lee Fu Altimetry



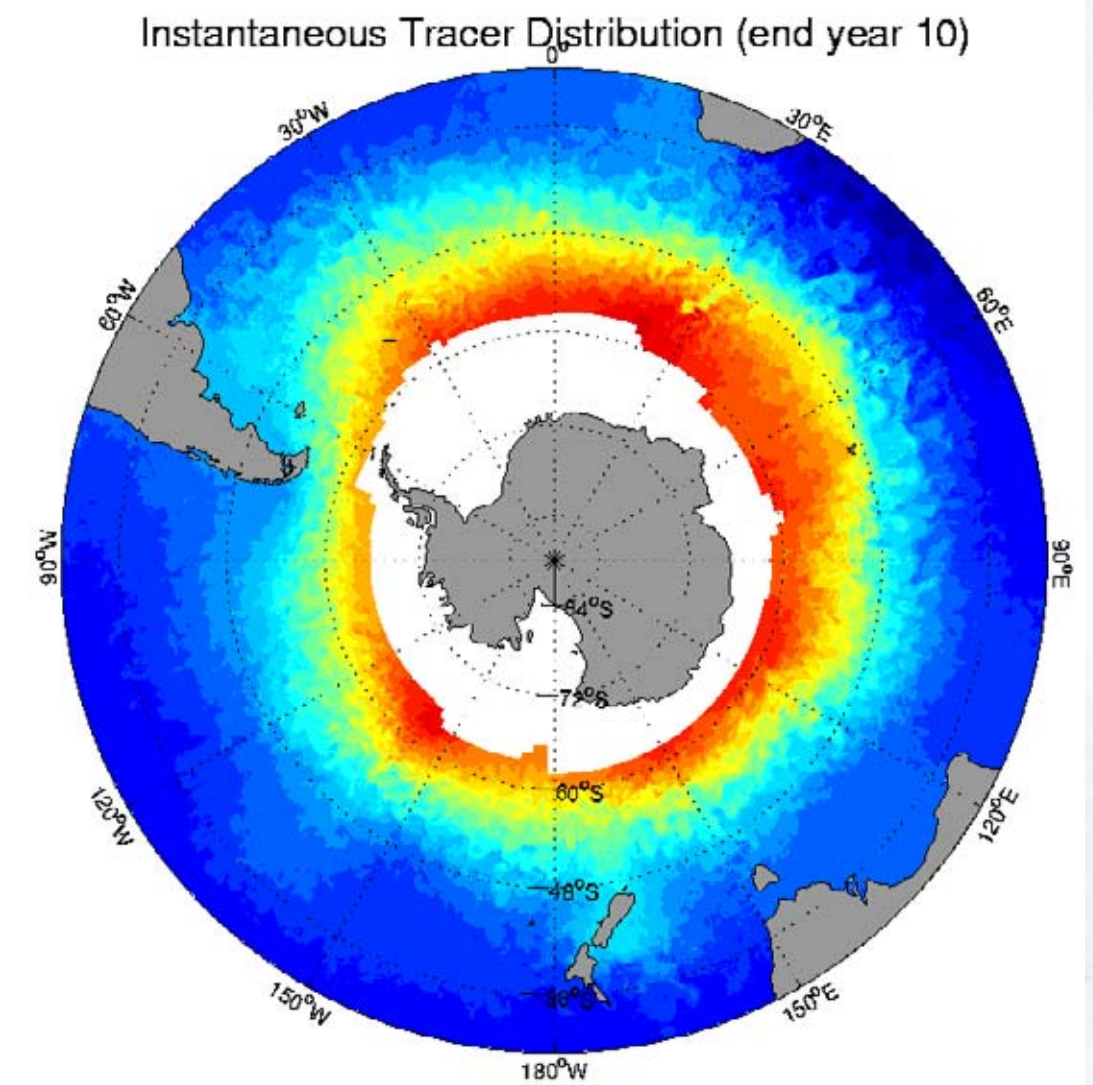


Sarah Gille:

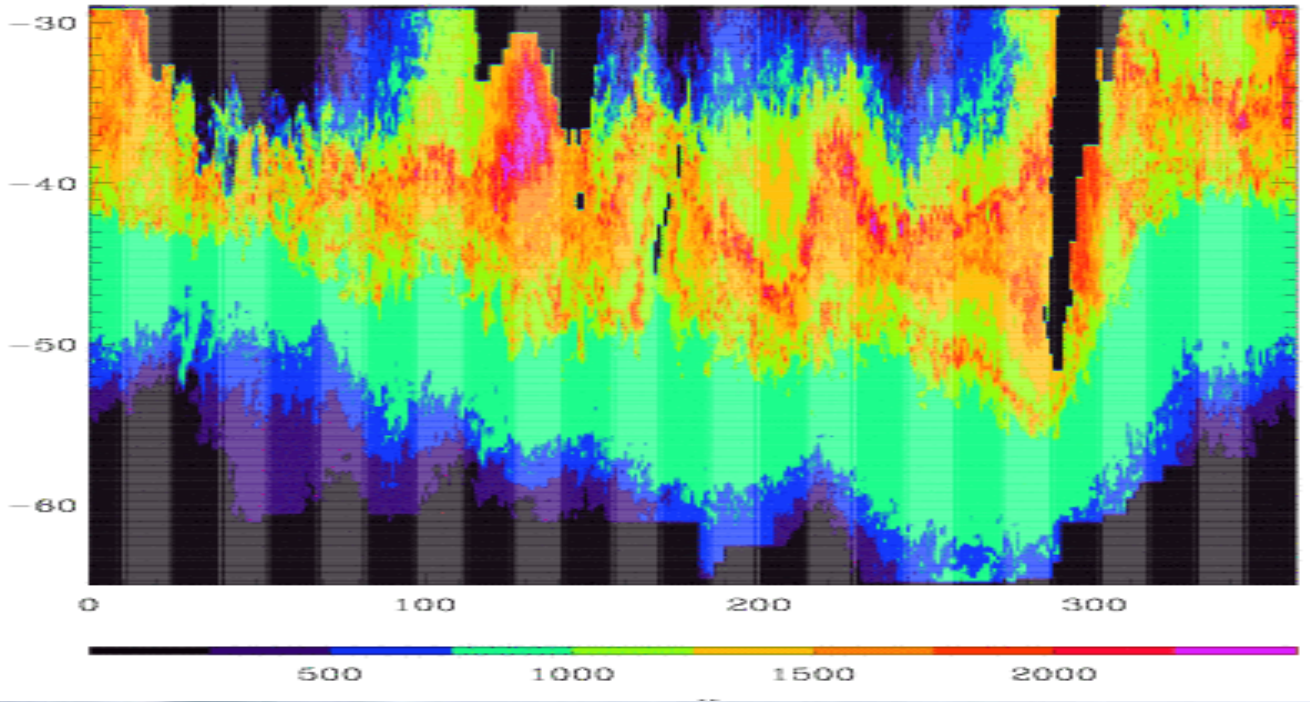
Model variability as meandering Gaussian jet

(Shane Elipot and Sarah Gille poster about drifters)

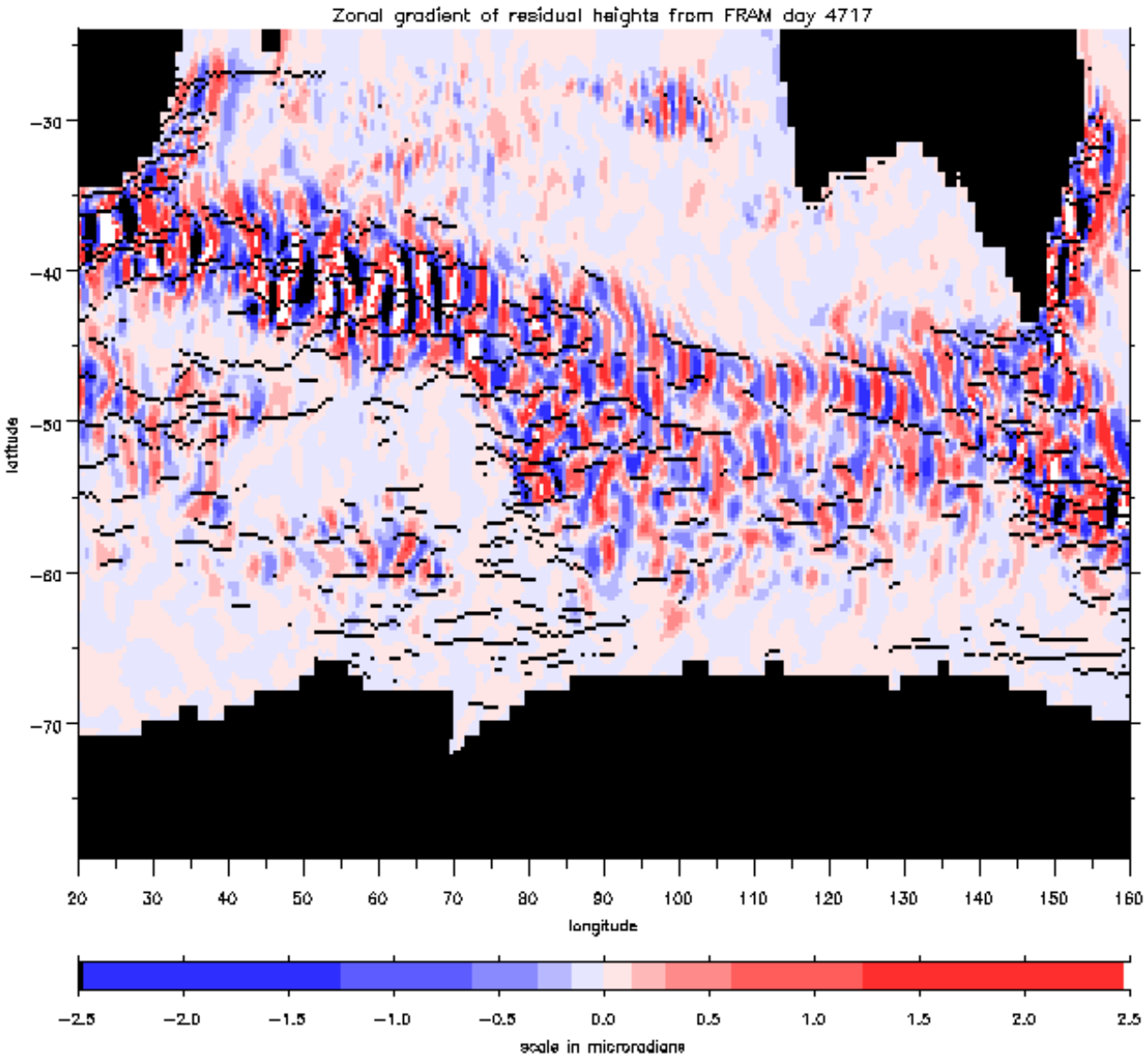
John Marshall, Helen Hill, Emily Shuckburgh

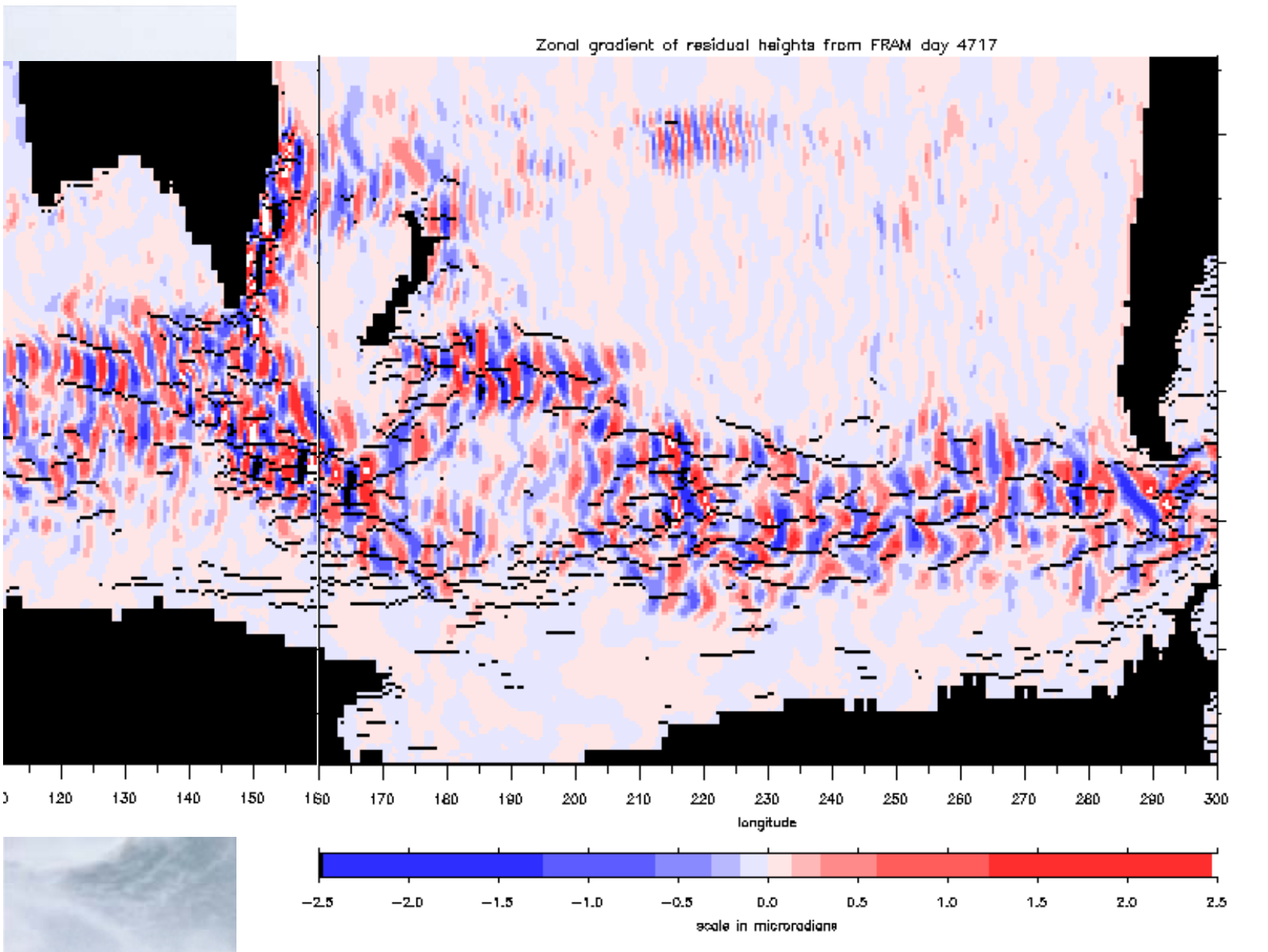


Effective diffusivity

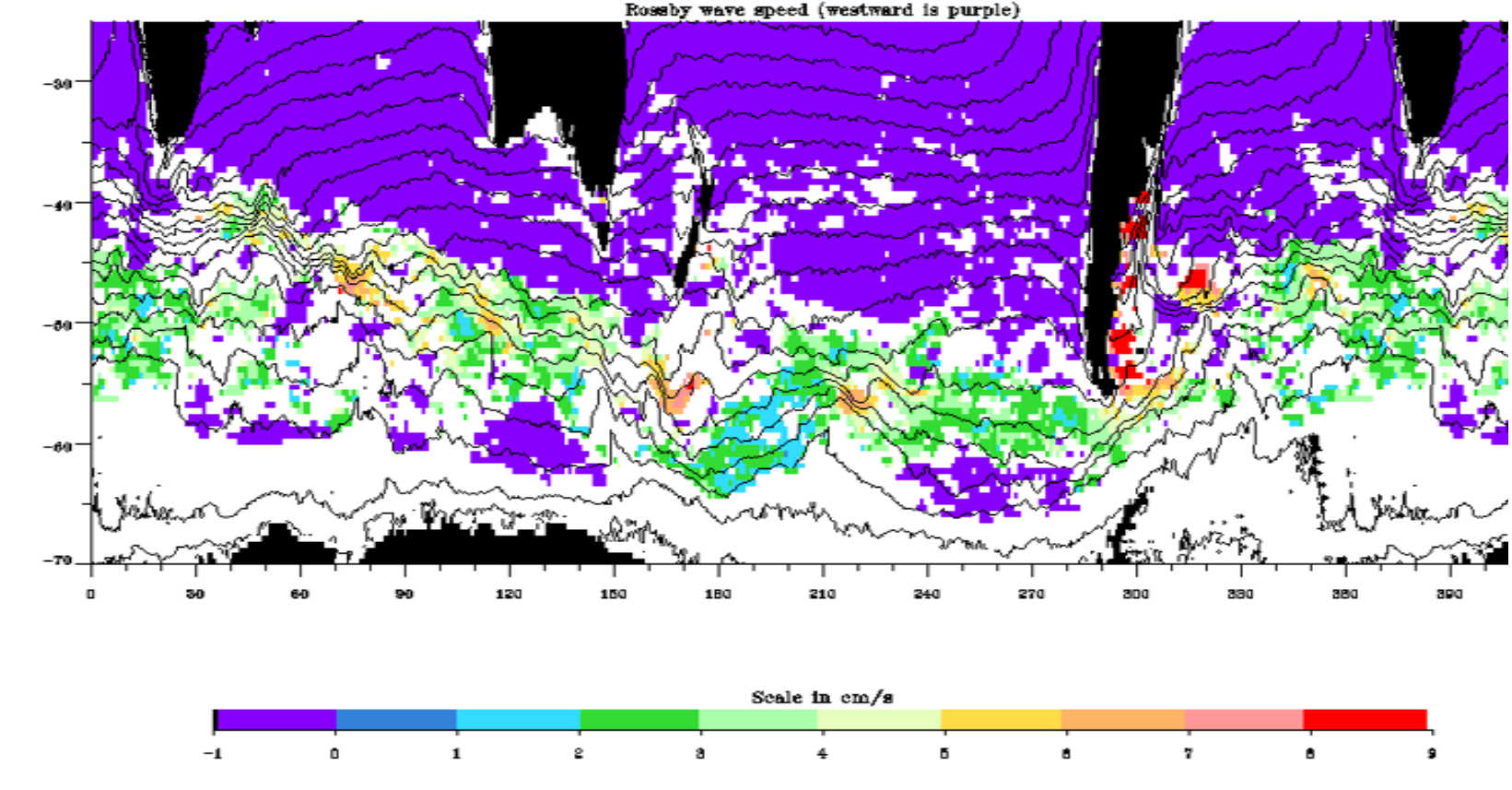


Wave-mean flow interactions in FRAM

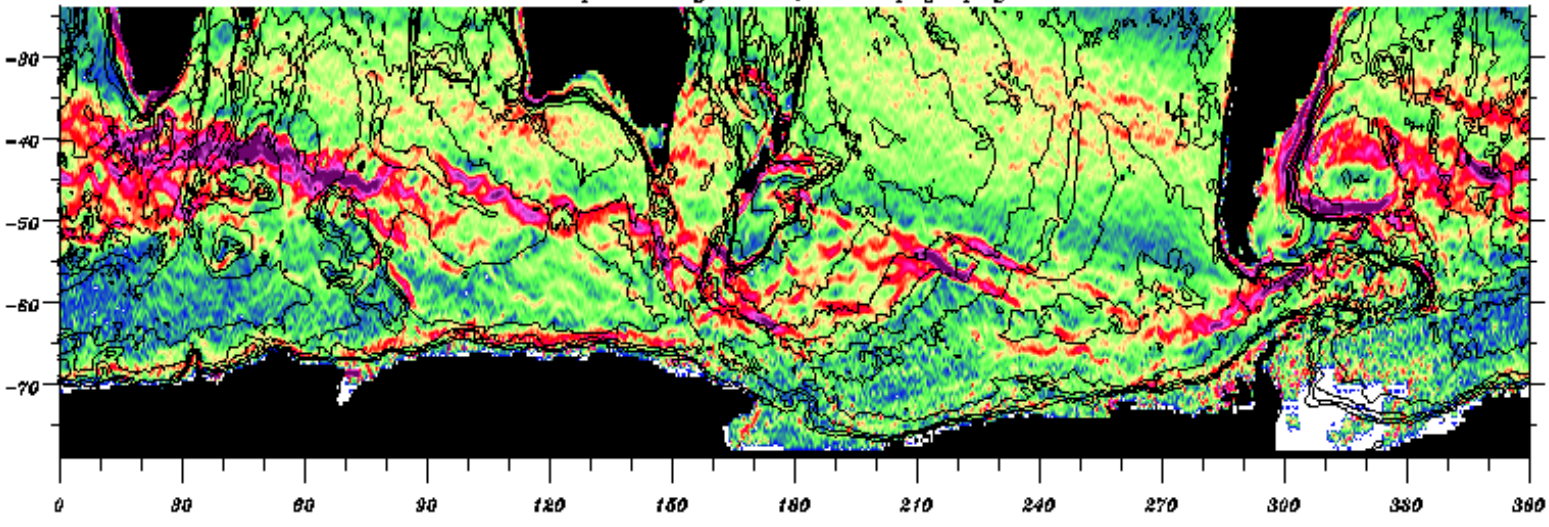



Zonal gradient of residual heights from FRAM day 4717
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
longitude
−2.5
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
scale in microradians

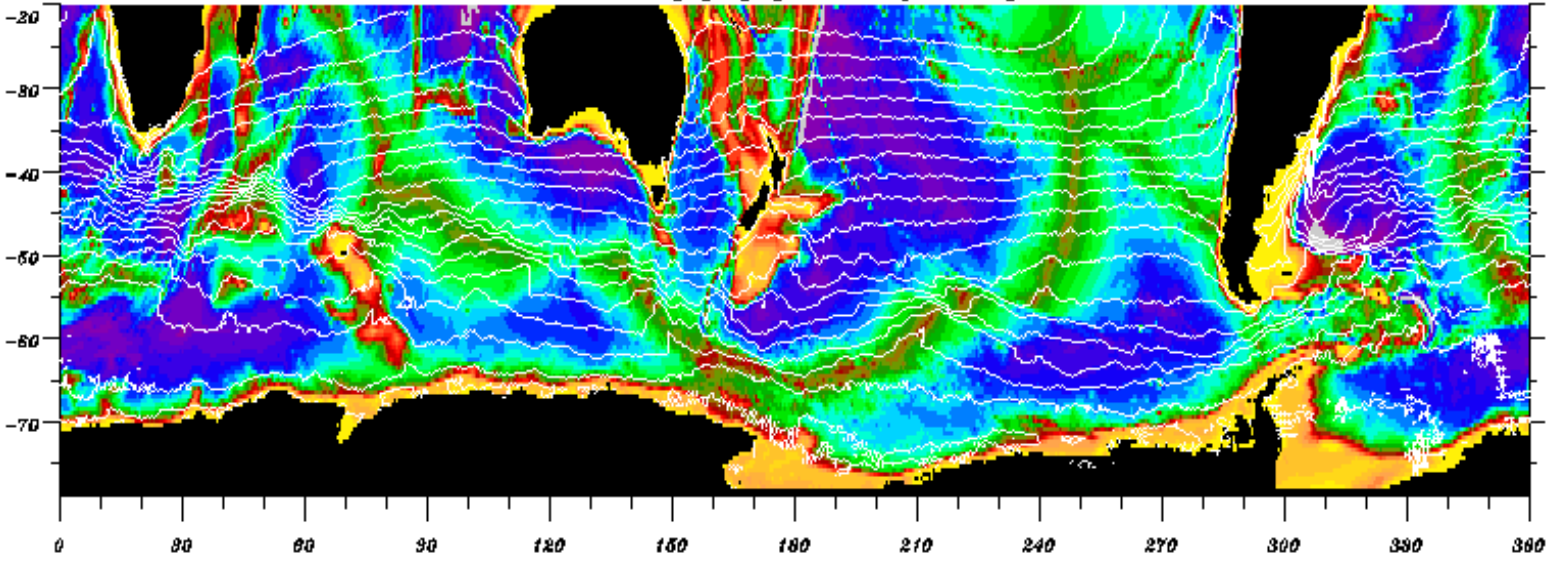
Wave/eddy/meander propagation speed

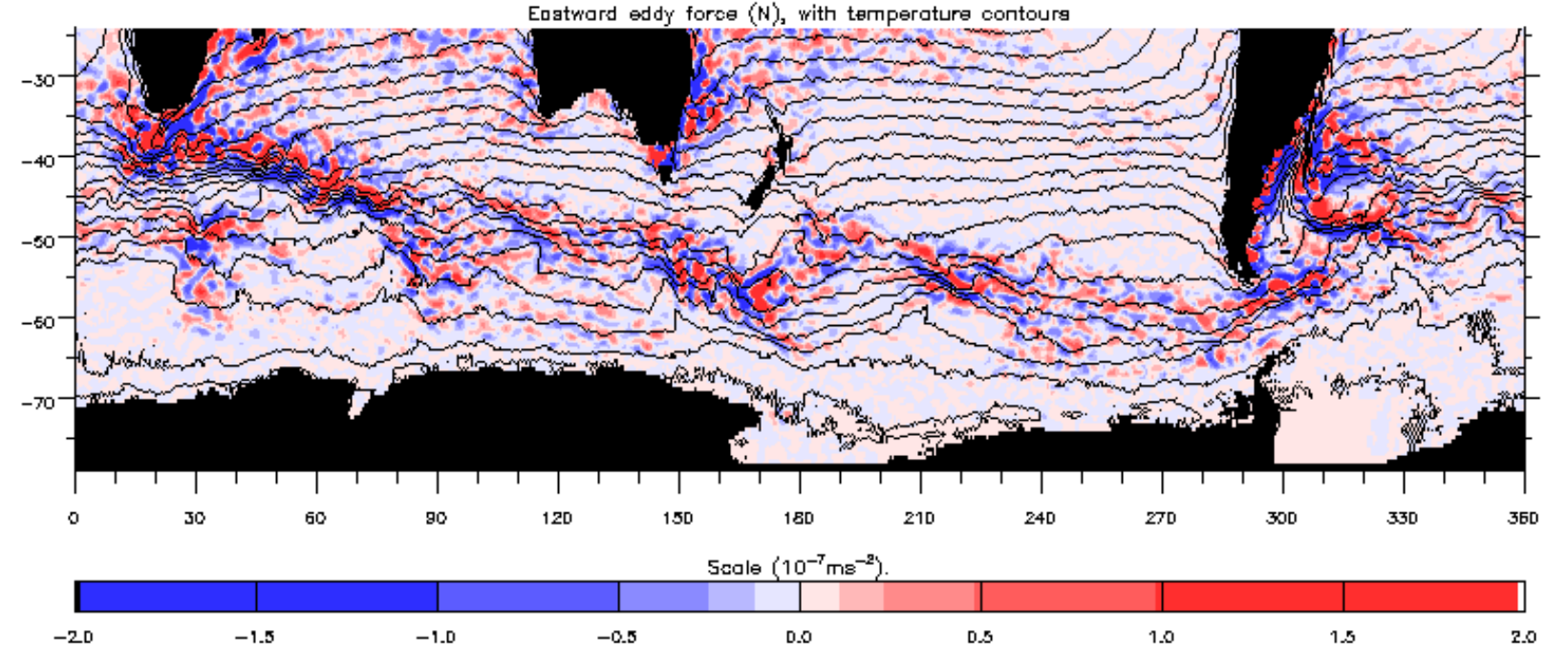


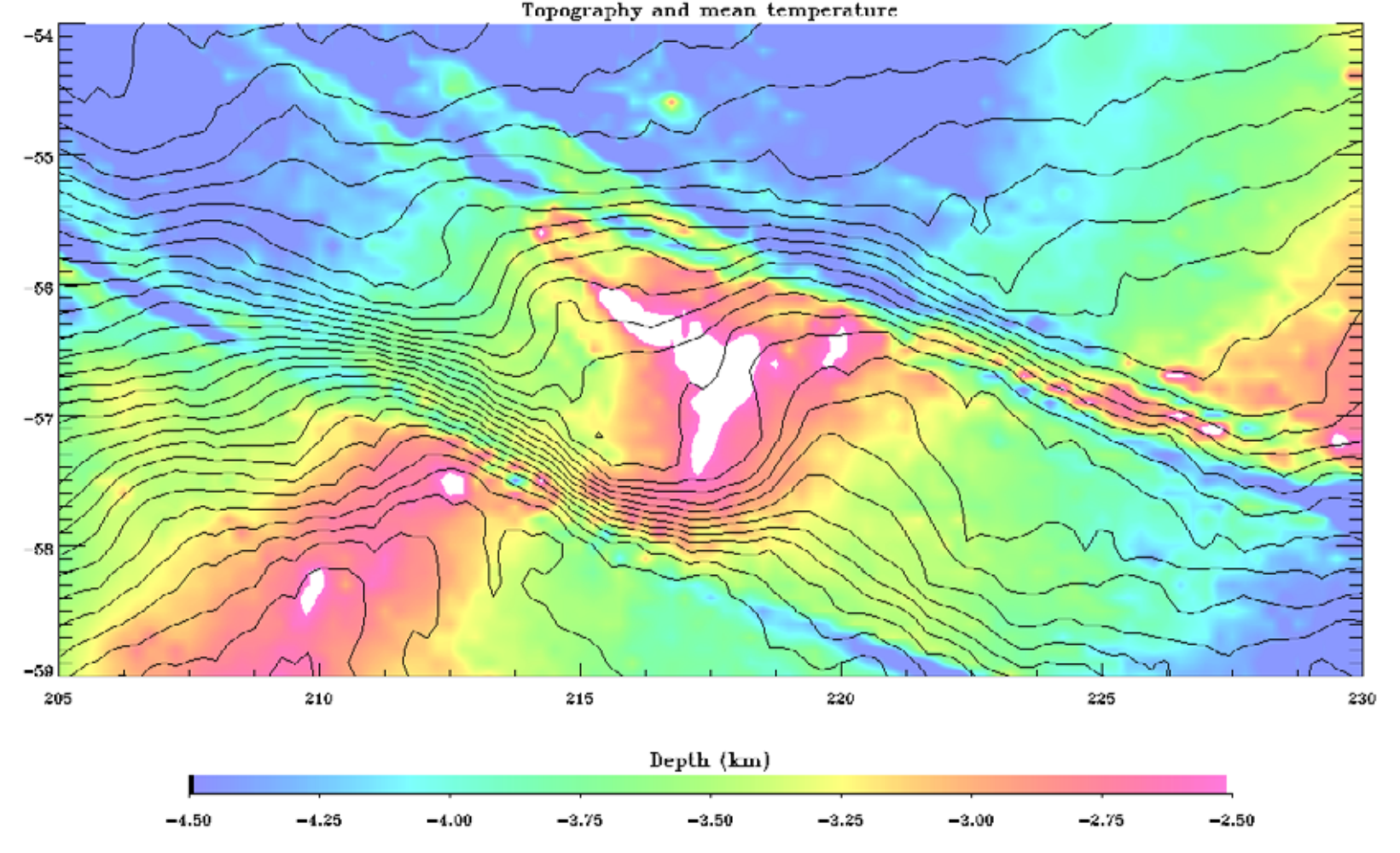
Mean temperature gradient, with topography contours

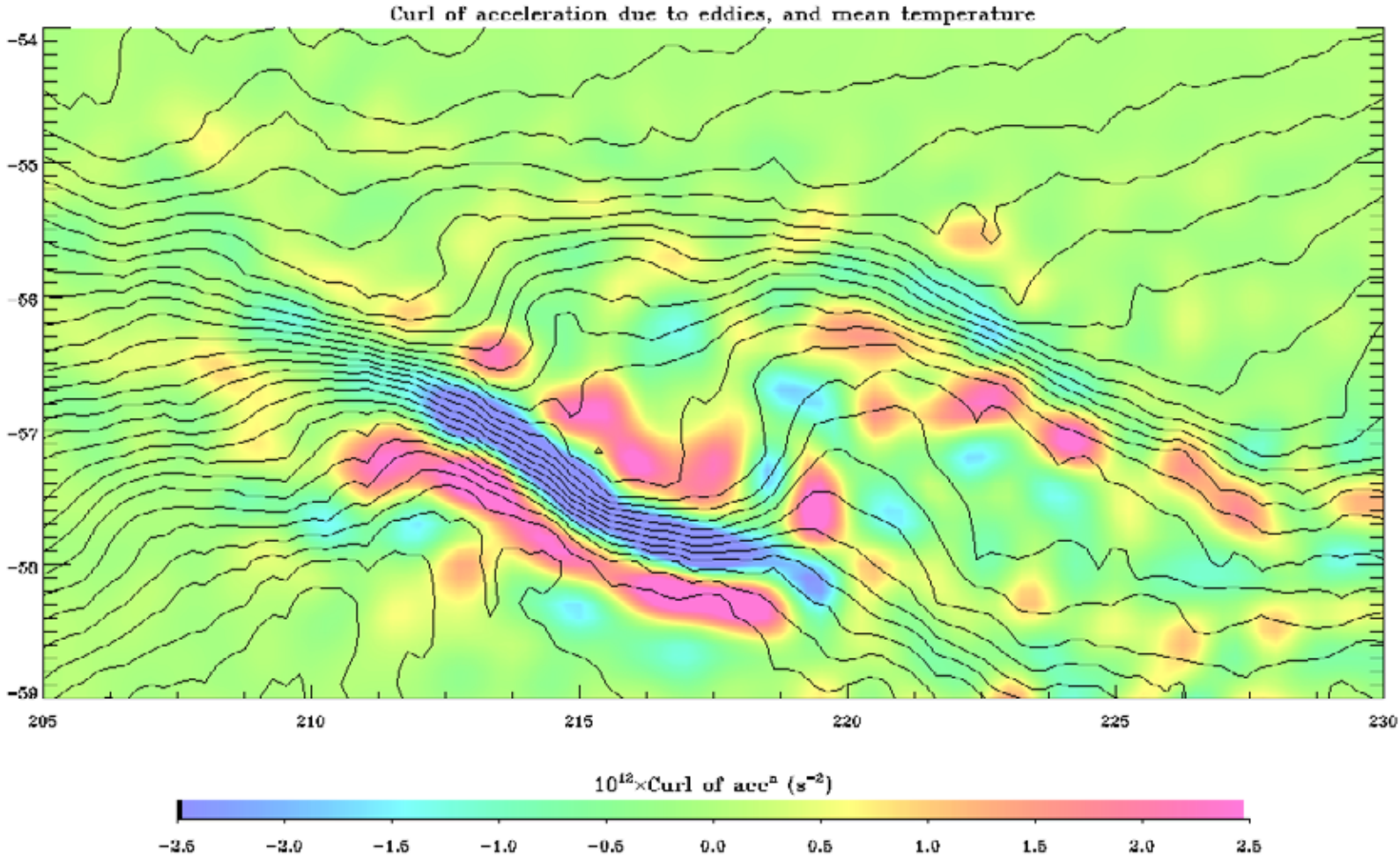


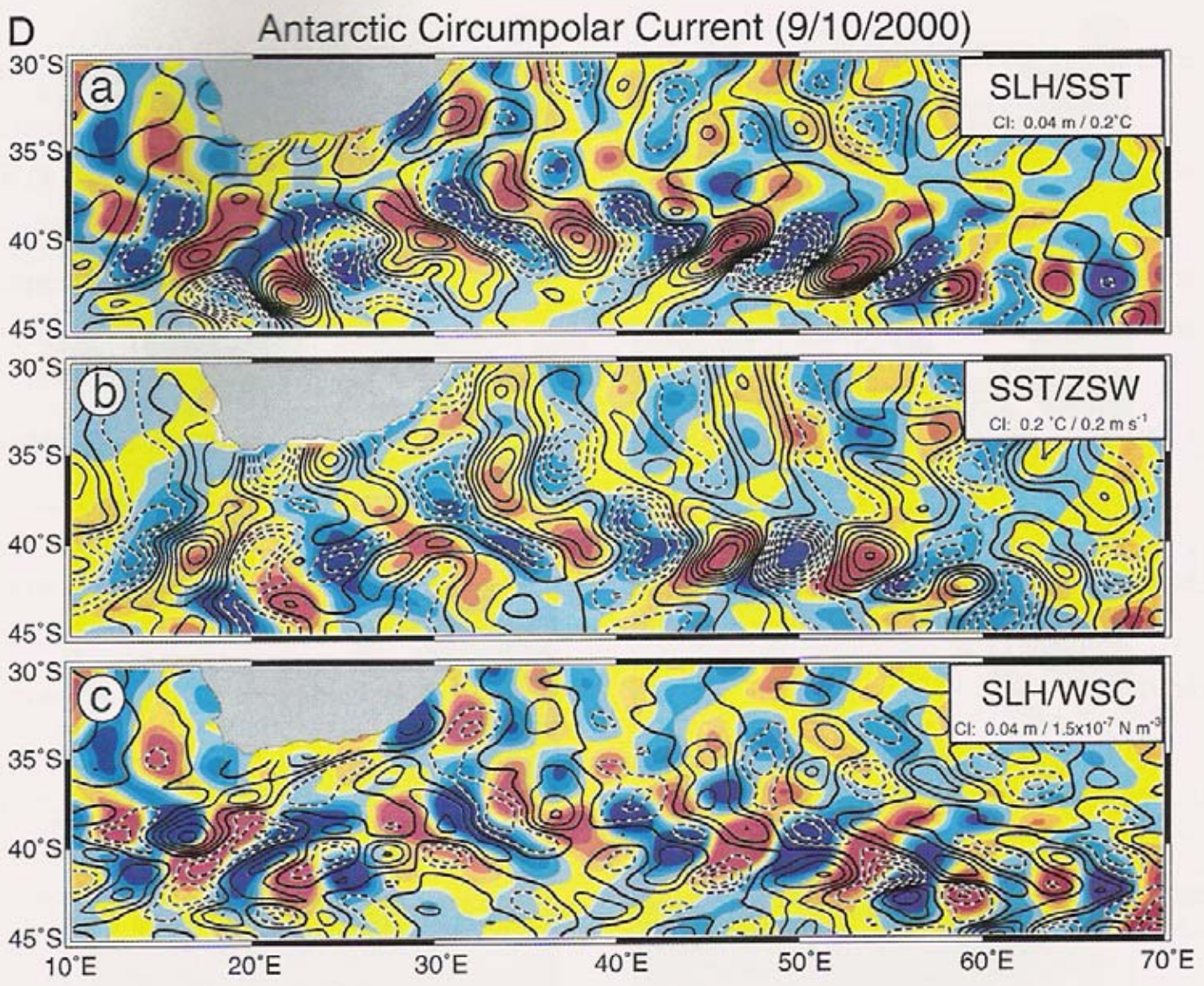
Southern Ocean bottom topography, with surface temperature contours




Eastward eddy force (N), with temperature contours
-30
-40
-50
-60
-70
0
30
60
90
120
150
180
210
240
270
300
330
360
Scale ($10^{-7}ms^{-2}$).
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0


Topography and mean temperature
-54
-55
-56
-57
-58
-59
205
210
215
220
225
230
Depth (km)
-4.50
-4.25
-4.00
-3.75
-3.50
-3.25
-3.00
-2.75
-2.50


Curl of acceleration due to eddies, and mean temperature
-54
-55
-56
-57
-58
-59
205
210
215
220
225
230
10^12×Curl of acc^n (s^-2)
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5


D
Antarctic Circumpolar Current (9/10/2000)
a
SLH/SST
CI: 0.04 m / 0.2°C
b
SST/ZSW
CI: 0.2 °C / 0.2 m s-1
c
SLH/WSC
CI: 0.04 m / 1.5x10-7 N m-3
30°S
35°S
40°S
45°S
10°E
20°E
30°E
40°E
50°E
60°E
70°E

White and Annis: Wind stress curl

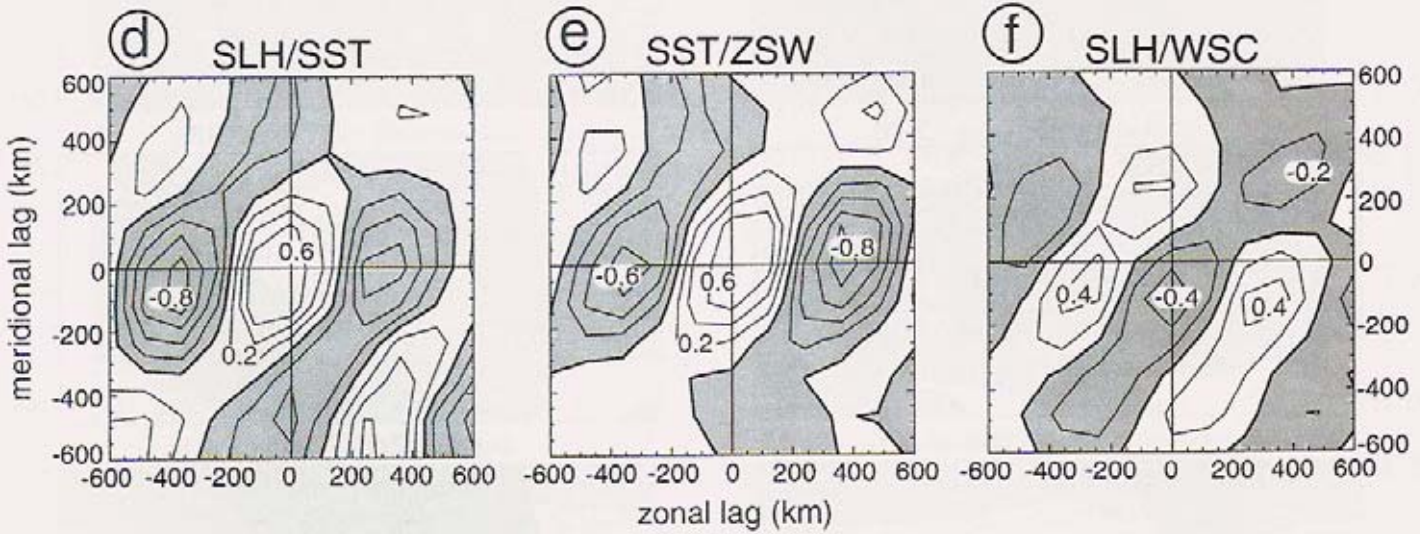
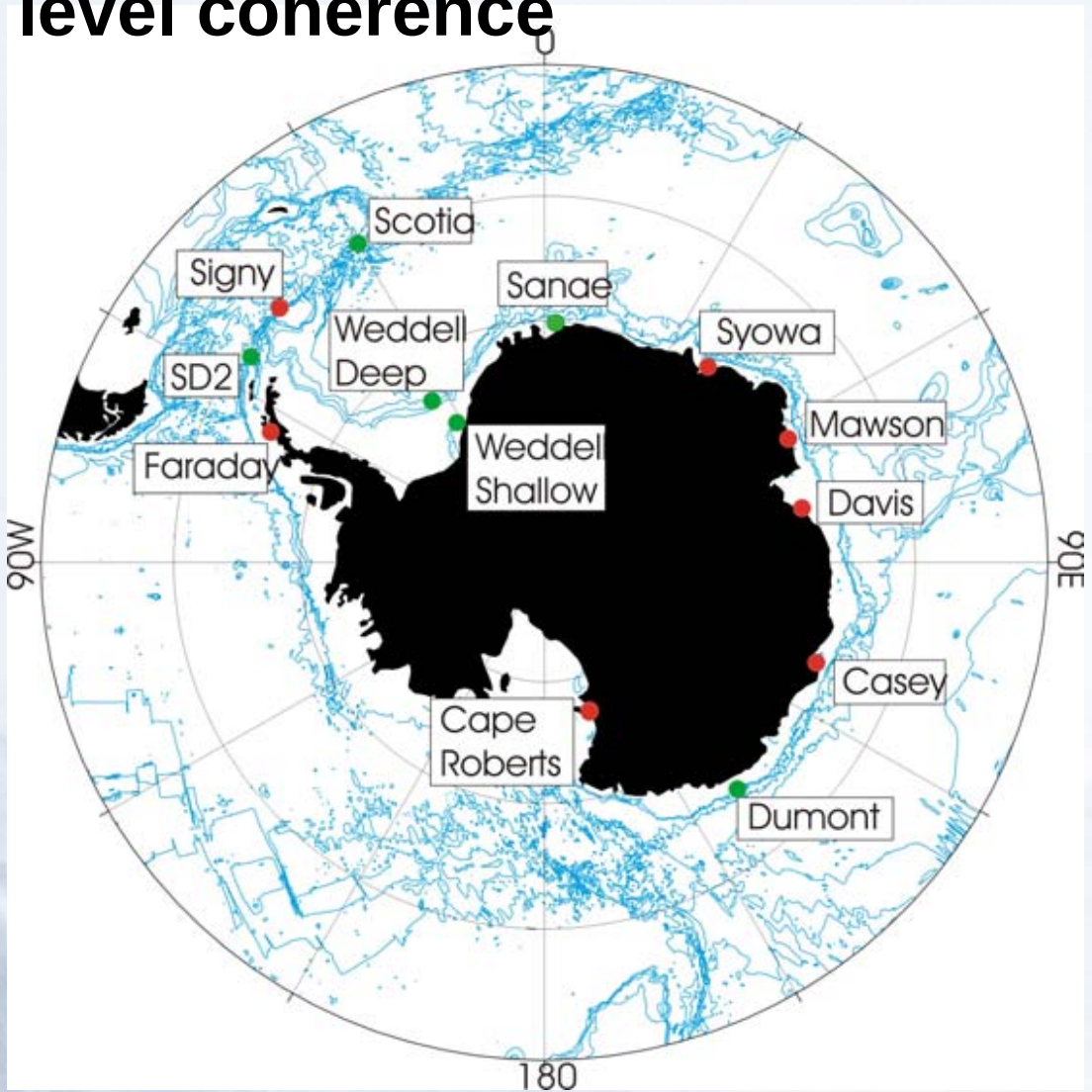
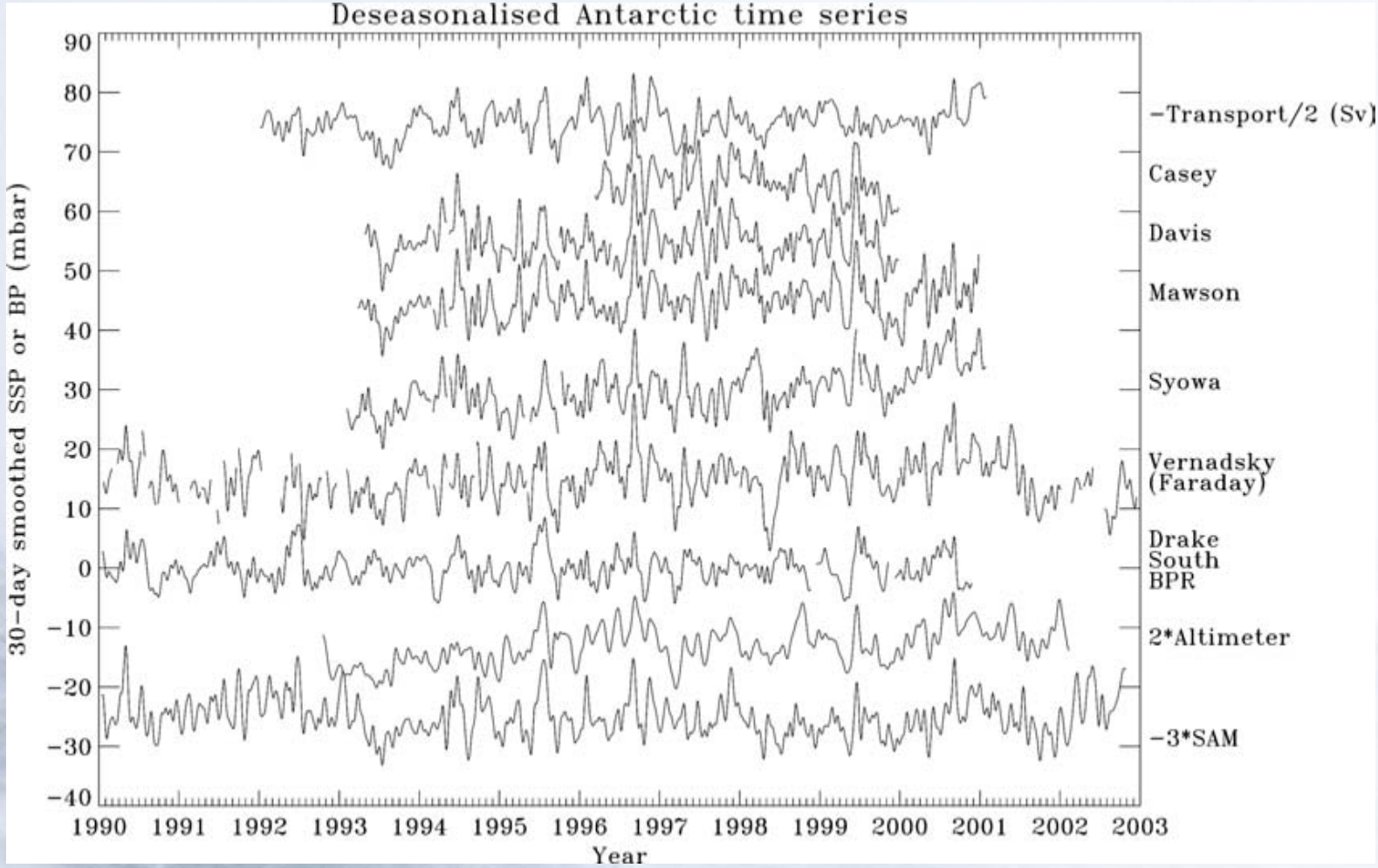


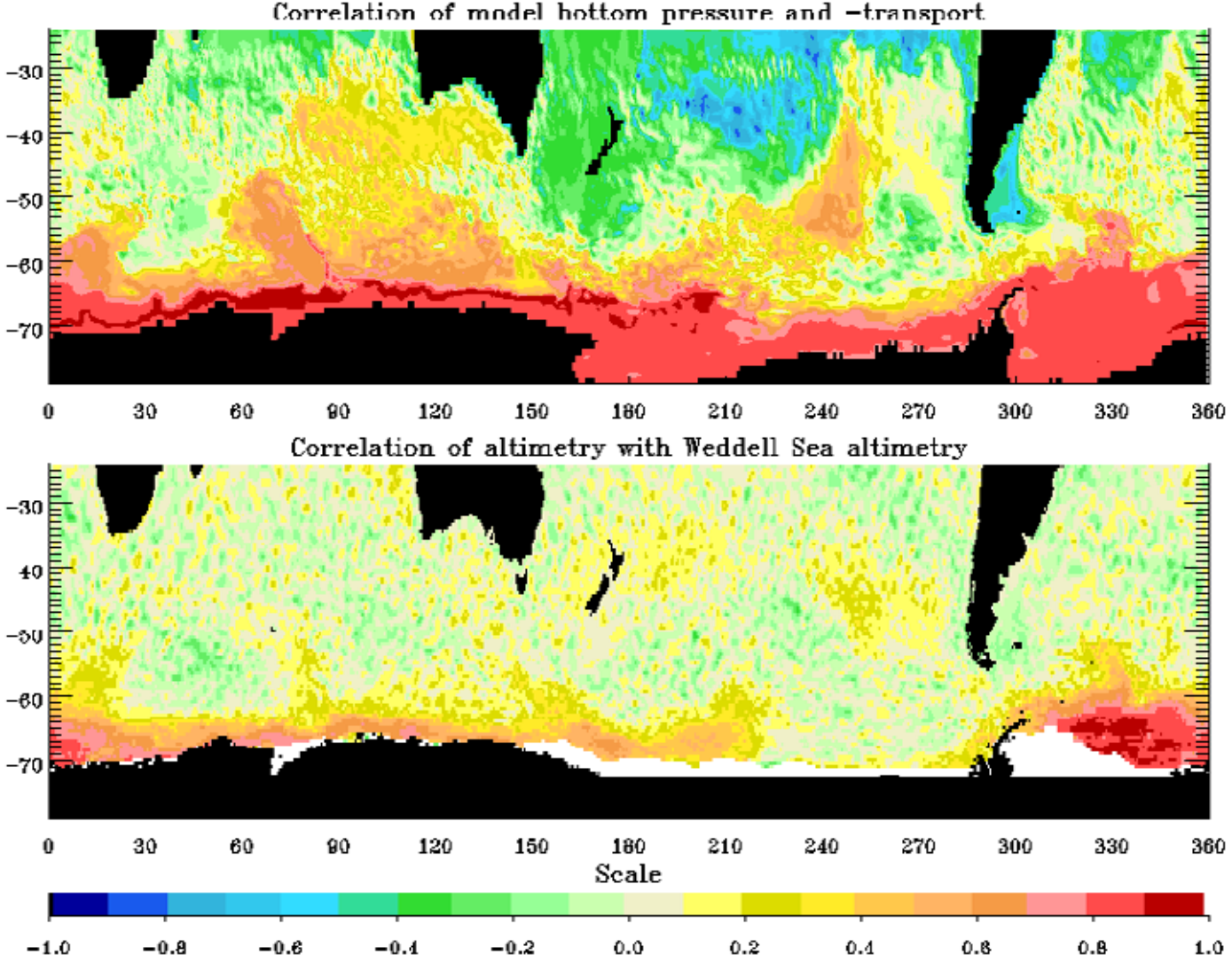
FIG. 2d. As in Fig. 2a but for the ACC as it traverses south of Africa from 30° to 45°S and 10° to 70°E for the 10-day period bracketing 10 Sep 2000, during late winter when the westerly winds are strong near the current (see Fig. 3c).

Antarctic sea level coherence



Antarctic sea level coherence

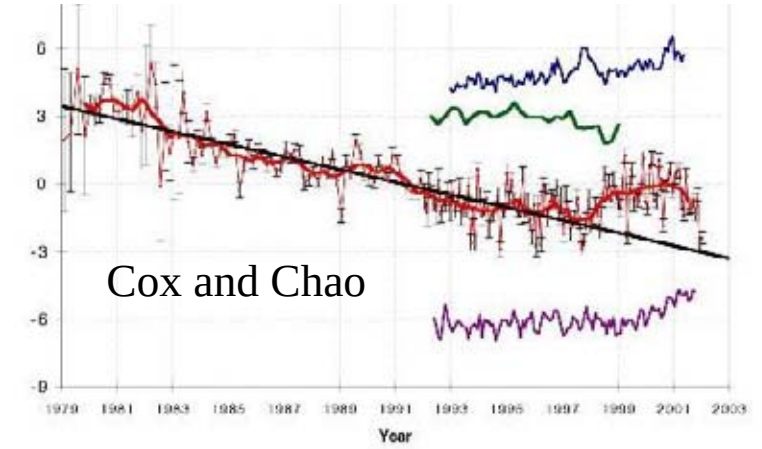


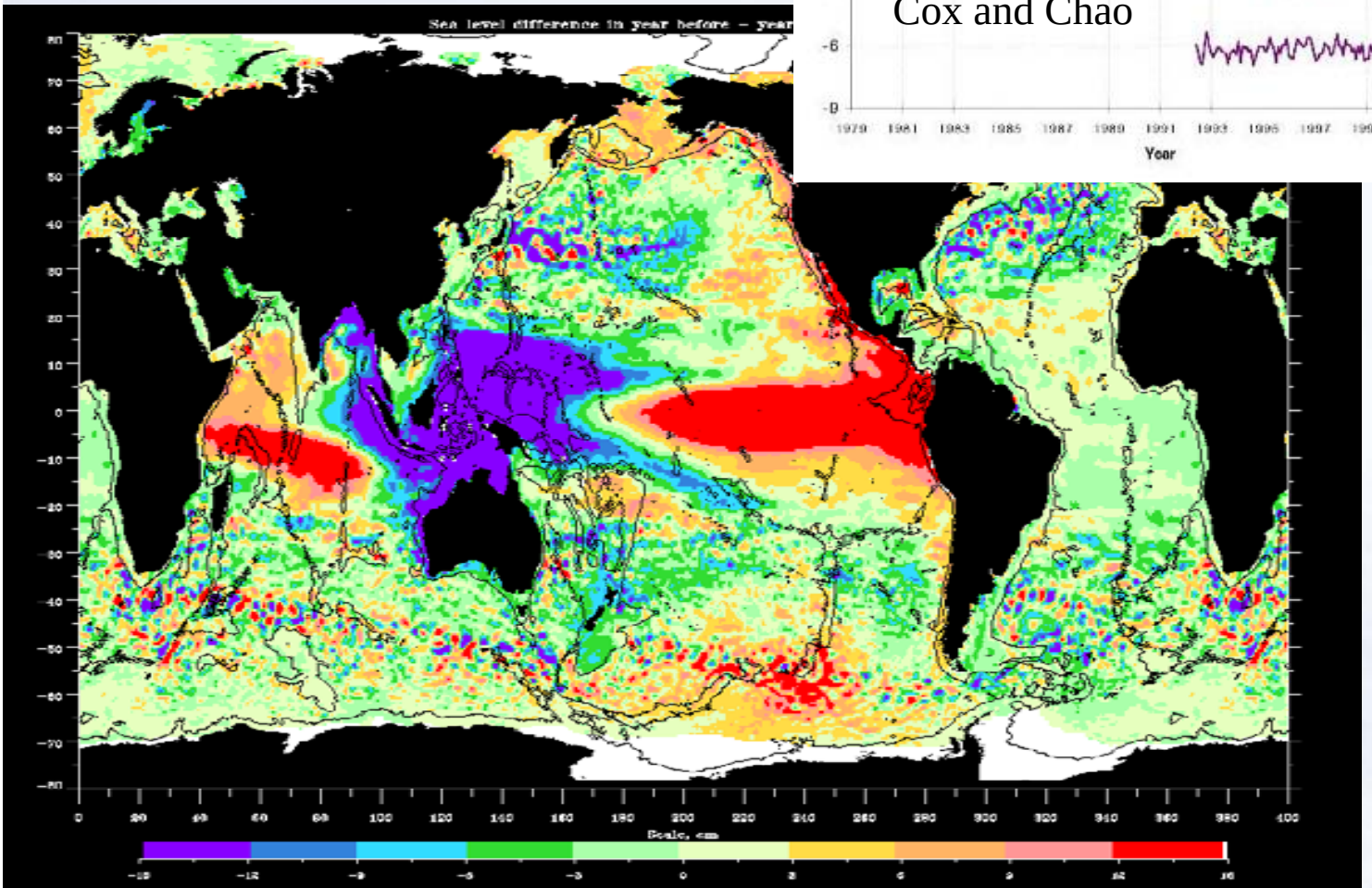

Correlation of model bottom pressure and −transport
−30
−40
−50
−60
−70
0
30
60
90
120
150
180
210
240
270
300
330
360
Correlation of altimetry with Weddell Sea altimetry
−30
40
−50
−60
−70
0
30
60
90
120
150
180
210
240
270
300
330
360
Scale
−1.0
−0.8
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
1.0

Future

- Objective mean surface flow from GRACE, then GOCE, permits better eddy-mean interaction and diffusivity calculations
- Interannual variability in ACC strength becoming measurable
- Combination/swath altimetry pushes down measurable length and time scales
- Long time series : reliable statistics : detailed interpretation of dynamics and interaction with steep topography
- Increased importance of Sea State Correction, especially for mean flow, given large mean waves in Southern Ocean
- GRACE time dependent bottom pressure …

Sea level before - after





Sea level before - after