Oceanic Feedback and Acceleration of Climate Variability

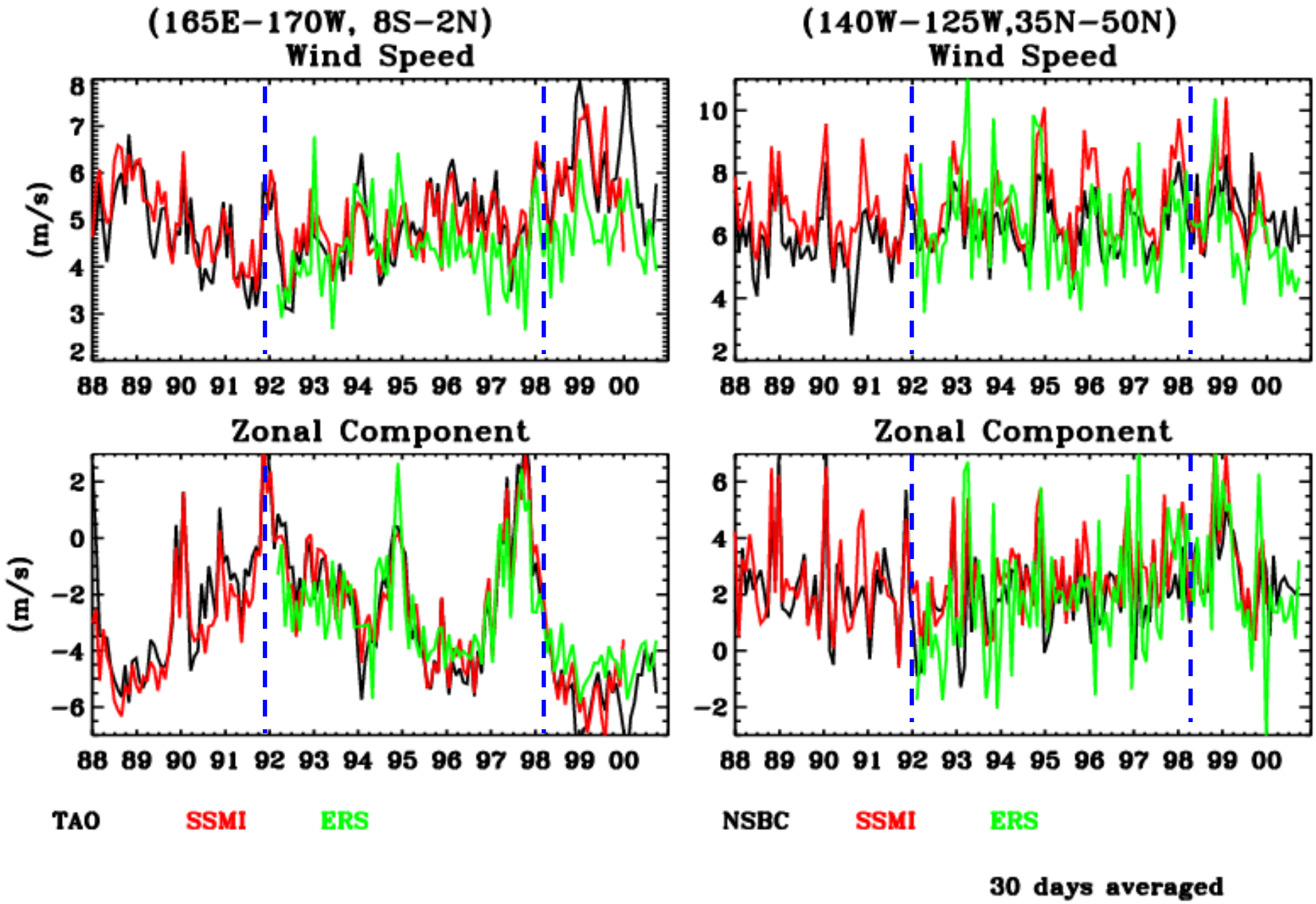
P. I.: W. Timothy Liu
Co-I: Xiaosu Xie and Wenqing Tang

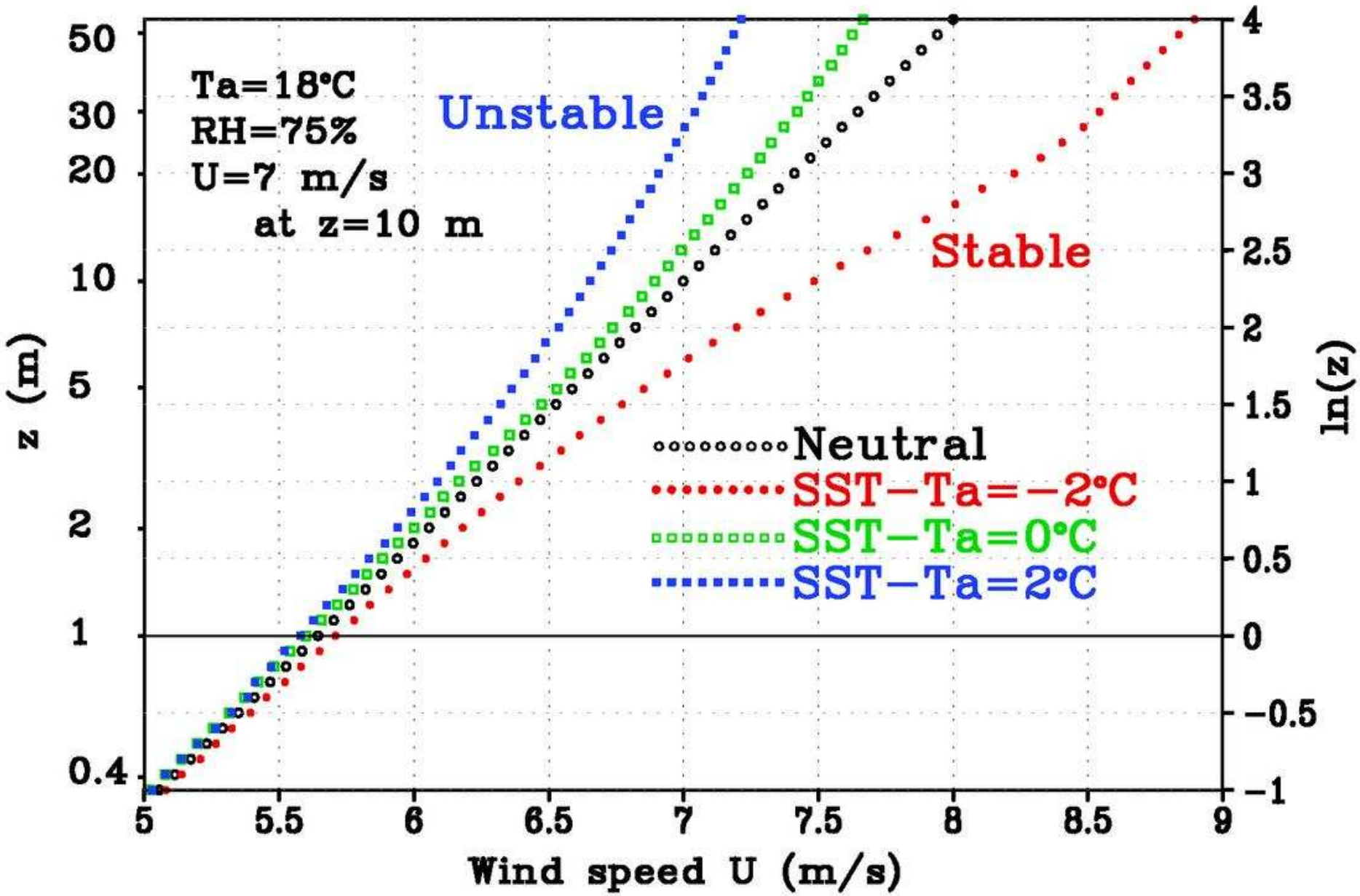
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA

Objectives:

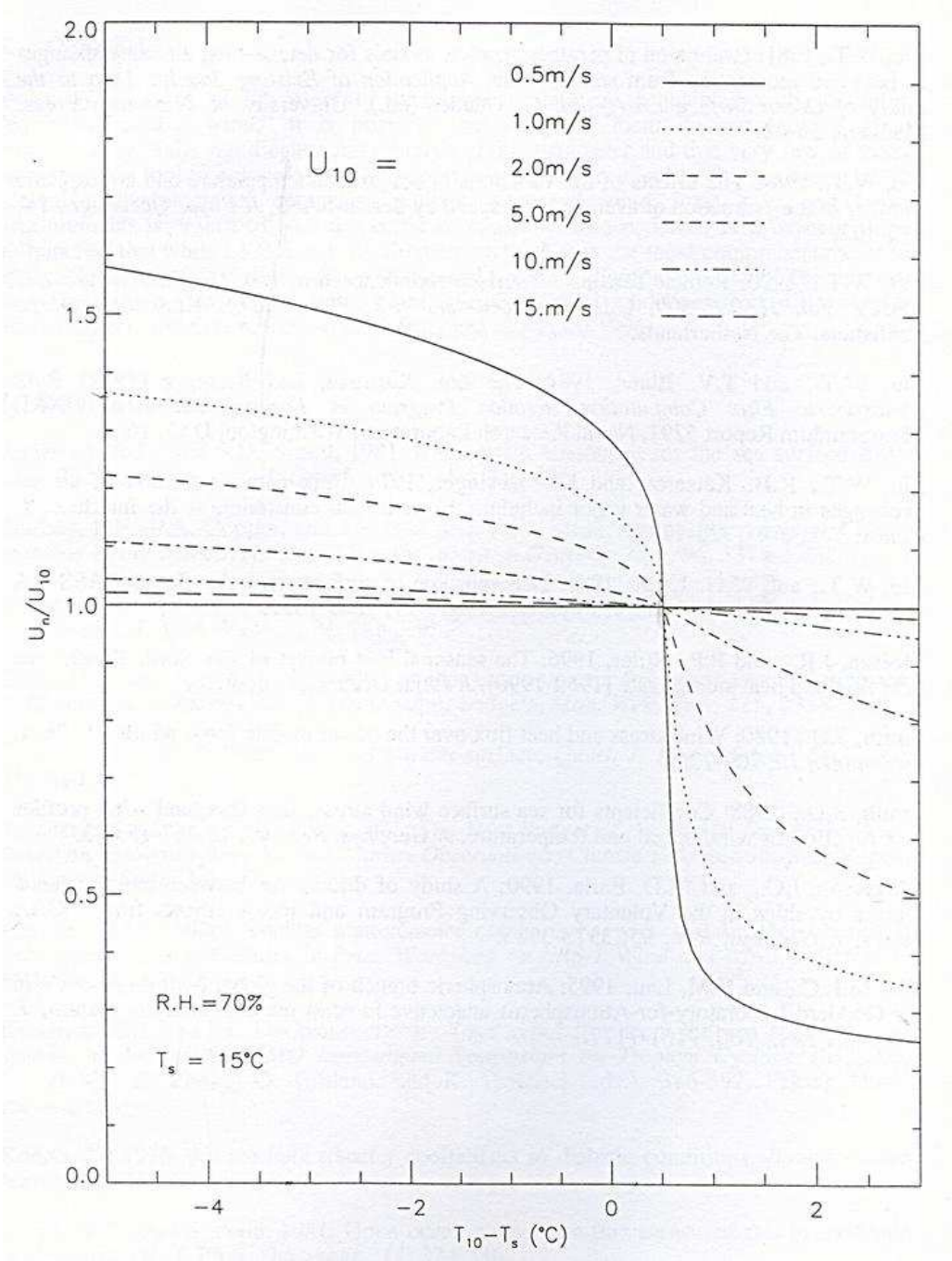
Use long time series of wind/stress by QuikSCAT

1. **to link regional climate changes into a global scenario**
2. **to study persistent atmospheric imprints by the ocean across ocean fronts**
3. **to study oceanic influence on global energy and water cycles**

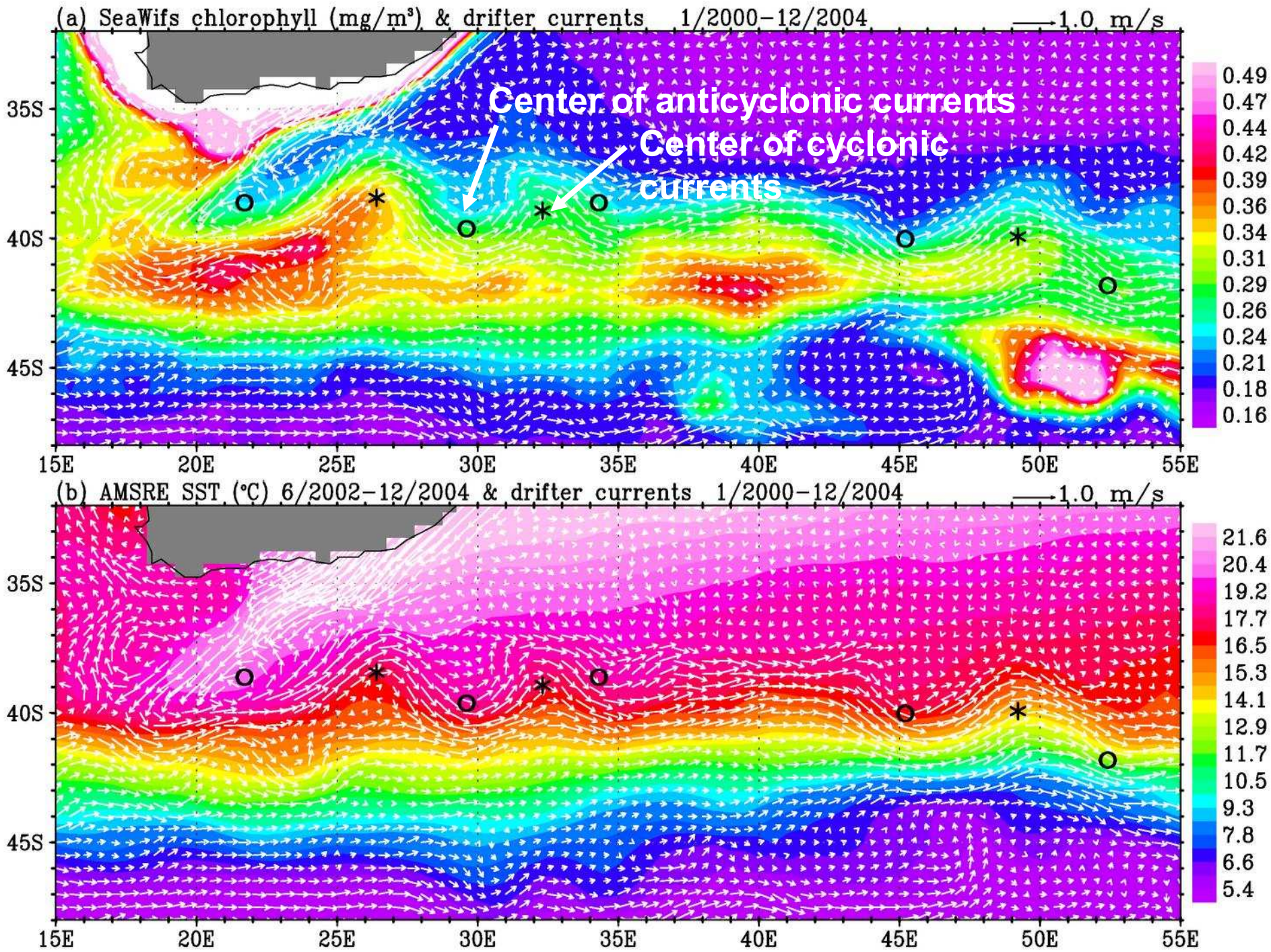

(165E−170W, 8S−2N)
Wind Speed
(m/s)
8
7
6
5
4
3
2
88 89 90 91 92 93 94 95 96 97 98 99 00
(140W−125W,35N−50N)
Wind Speed
10
8
6
4
2
88 89 90 91 92 93 94 95 96 97 98 99 00
Zonal Component
(m/s)
2
0
−2
−4
−6
88 89 90 91 92 93 94 95 96 97 98 99 00
Zonal Component
6
4
2
0
−2
88 89 90 91 92 93 94 95 96 97 98 99 00
TAO SSMI ERS
NSBC SSMI ERS
30 days averaged

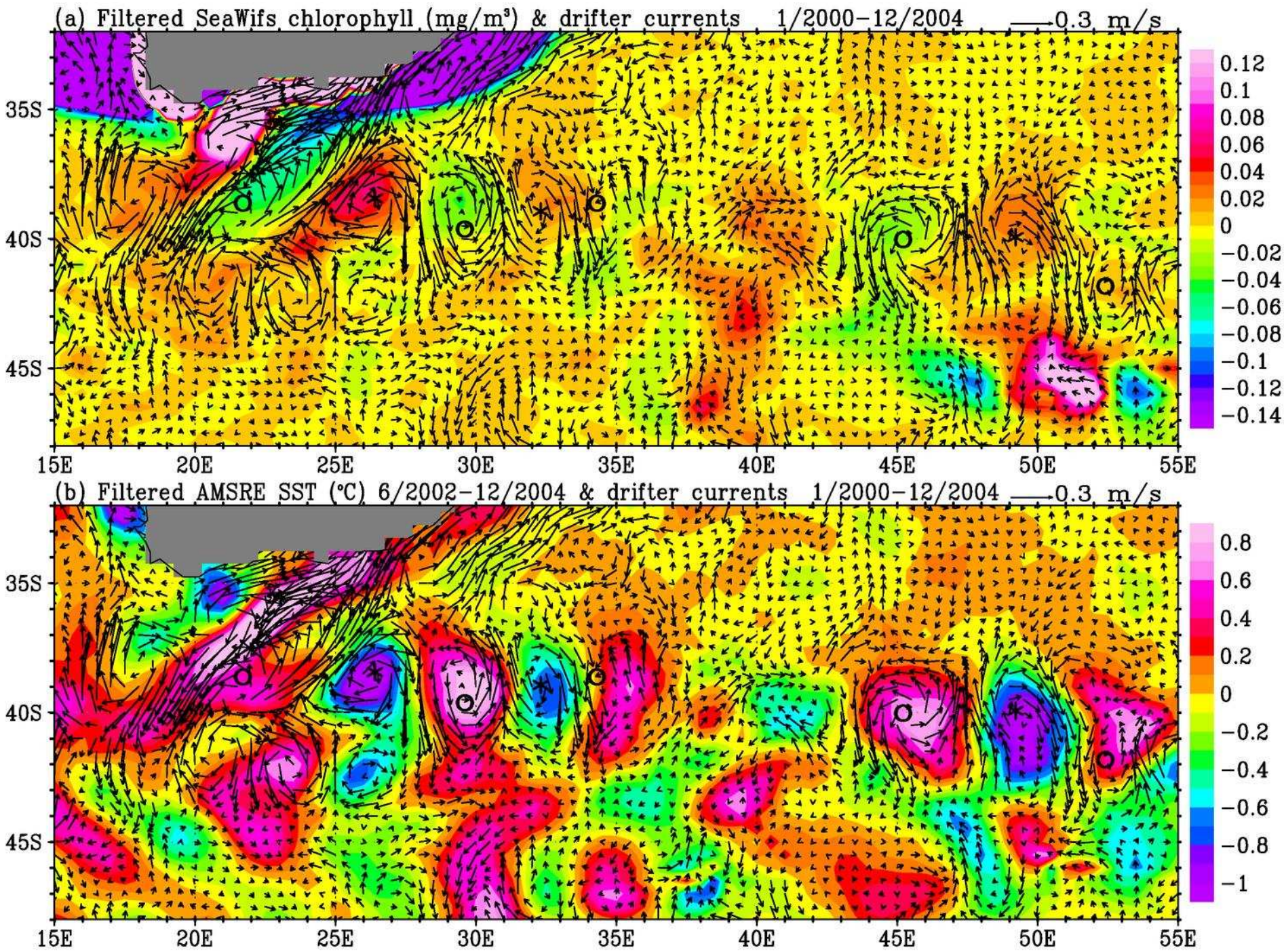


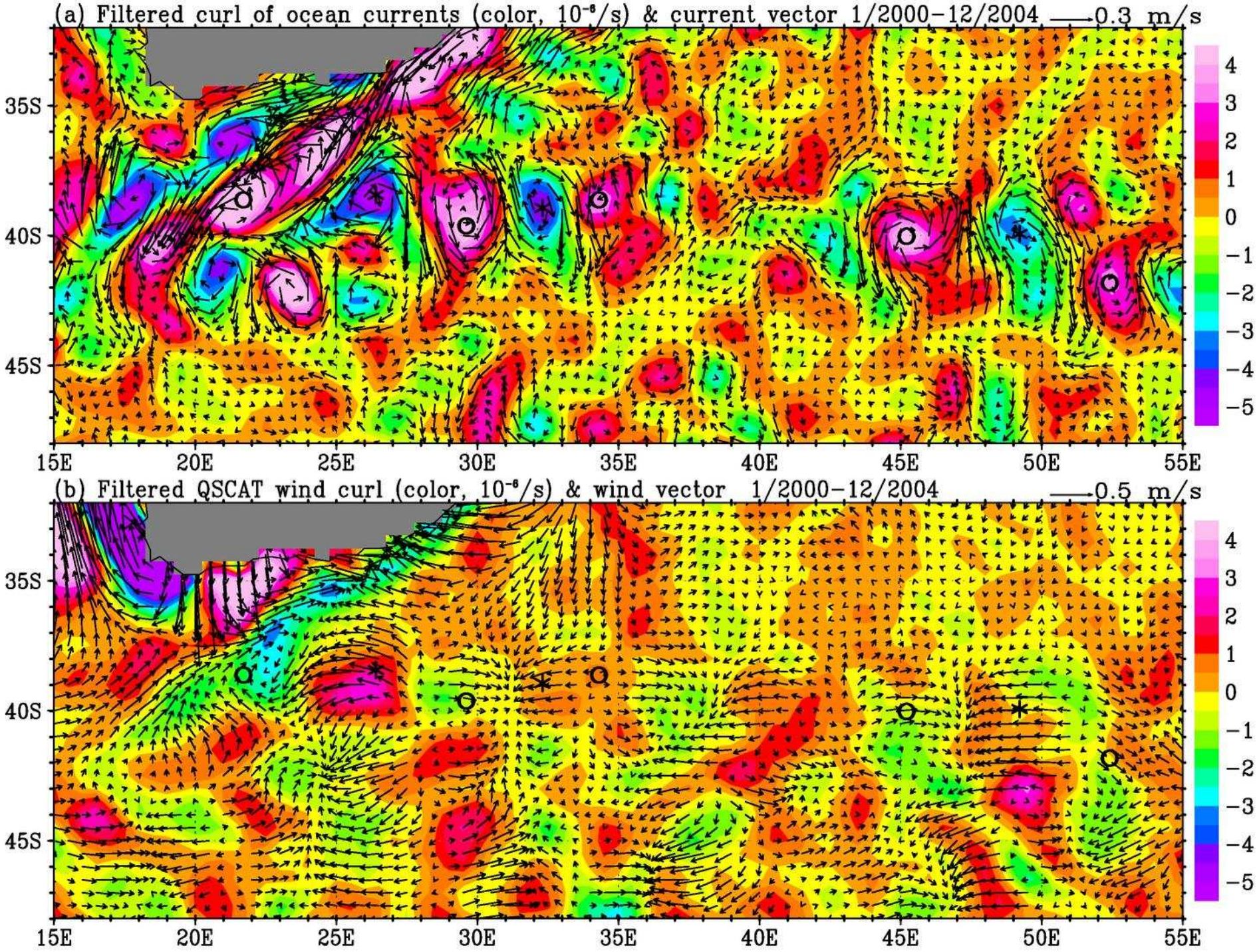
$$\frac{u-u_s}{u_*} = 2.5(\ln\frac{z}{z_0} - \psi_u) = \frac{1}{\sqrt{C_D}}$$

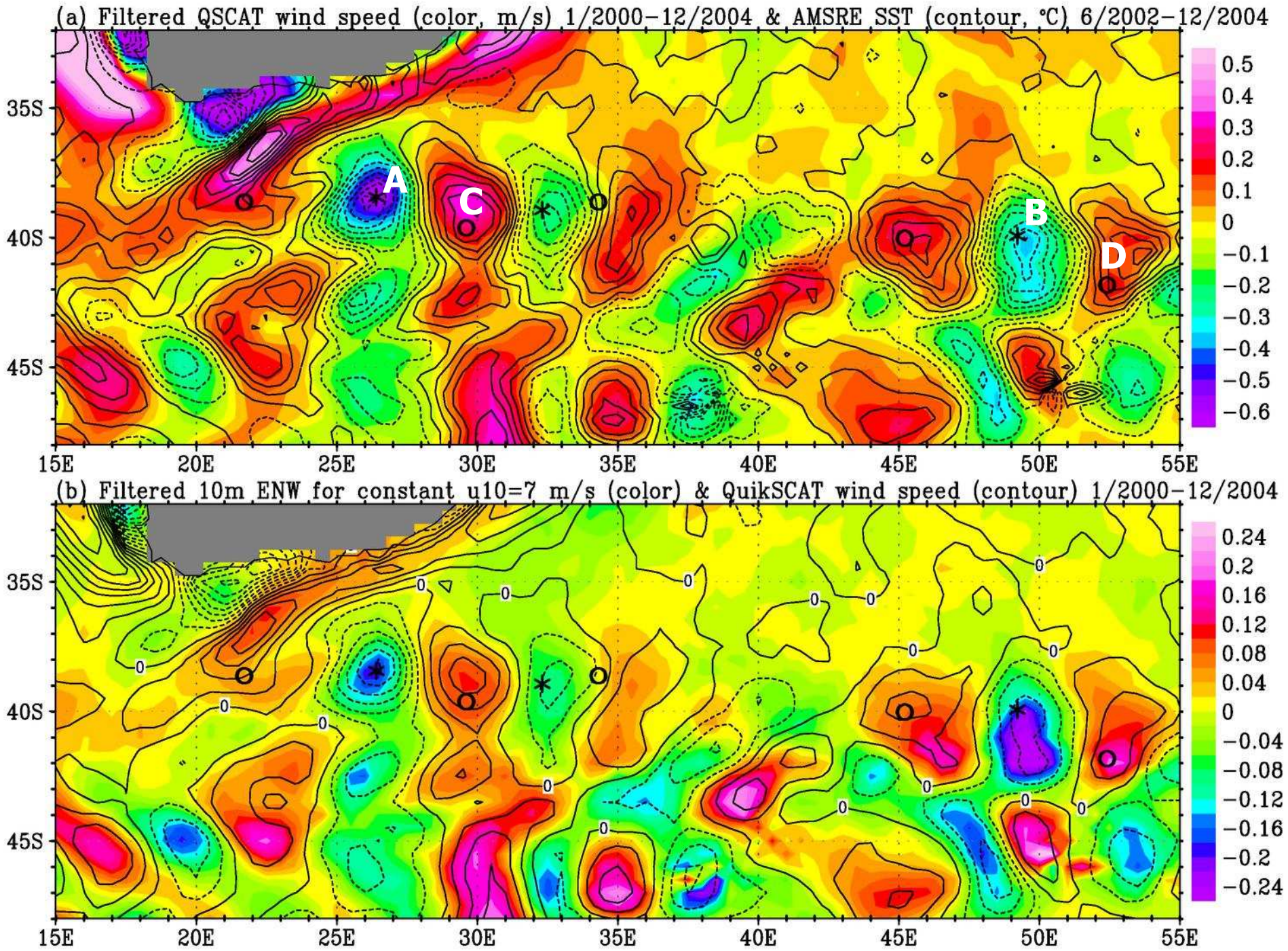


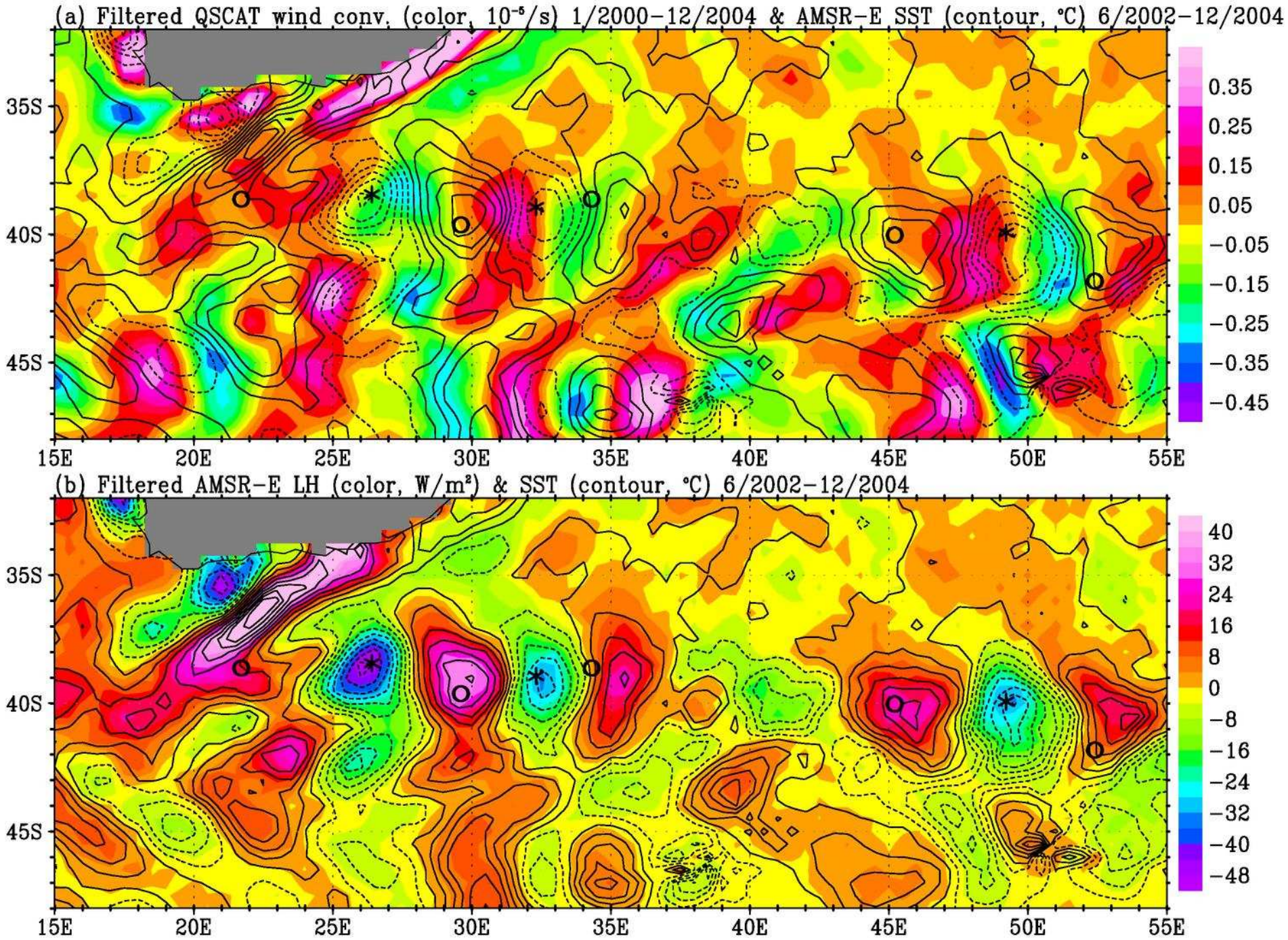
Liu and Tang, 1996: Equivalent neutral wind. JPL Publication 96-17.

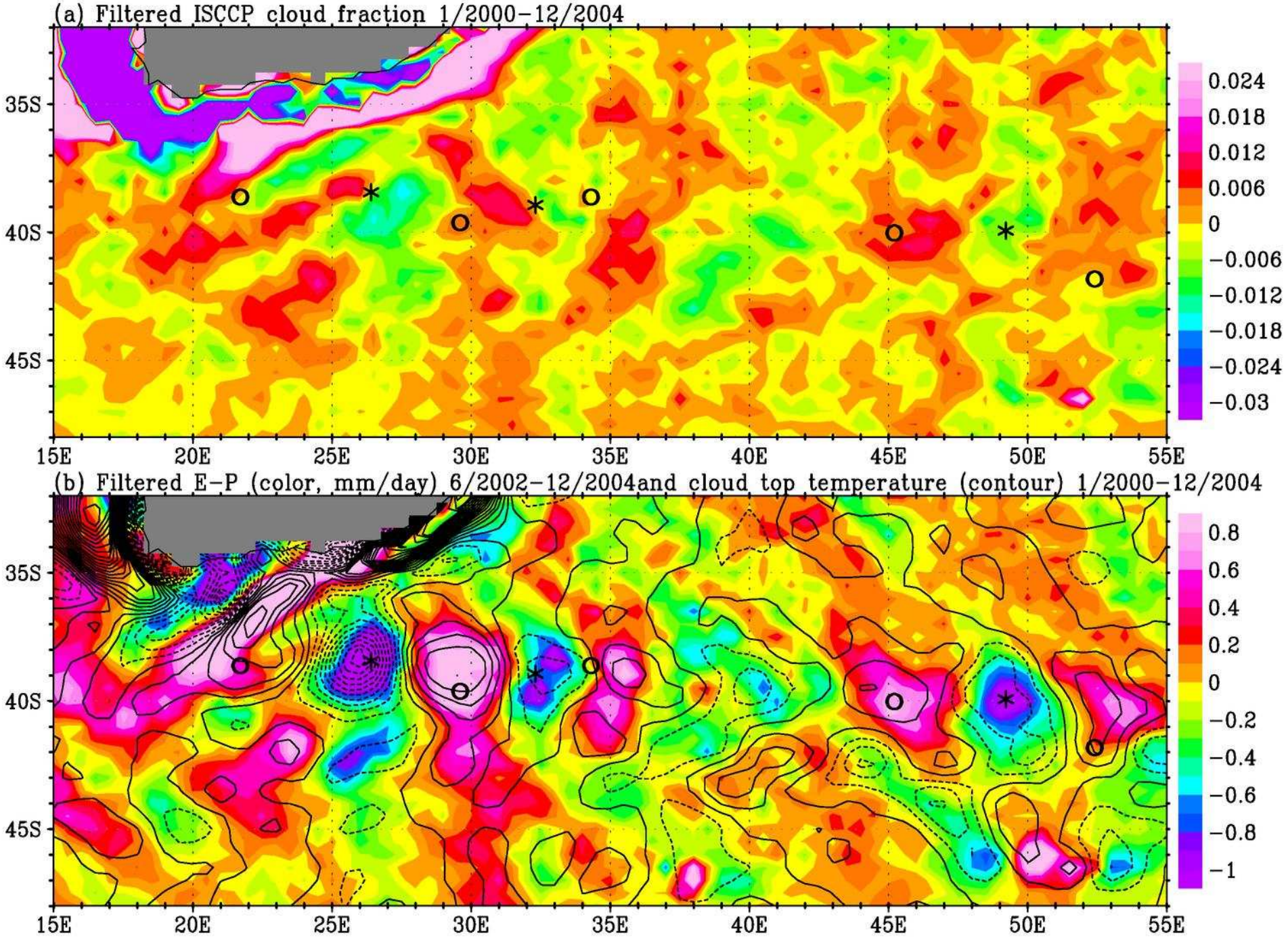

(a) SeaWifs chlorophyll (mg/m³) & drifter currents 1/2000-12/2004
1.0 m/s
Center of anticyclonic currents
Center of cyclonic currents
0.49
0.47
0.44
0.42
0.39
0.36
0.34
0.31
0.29
0.26
0.24
0.21
0.18
0.16
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
(b) AMSRE SST (°C) 6/2002-12/2004 & drifter currents 1/2000-12/2004
1.0 m/s
21.6
20.4
19.2
17.7
16.5
15.3
14.1
12.9
11.7
10.5
9.3
7.8
6.6
5.4
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E


(a) Filtered SeaWifs chlorophyll (mg/m³) & drifter currents 1/2000–12/2004
0.3 m/s
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
0.12
0.1
0.08
0.06
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
−0.1
−0.12
−0.14
(b) Filtered AMSRE SST (°C) 6/2002–12/2004 & drifter currents 1/2000–12/2004
0.3 m/s
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1


(a) Filtered curl of ocean currents (color, 10⁻⁶/s) & current vector 1/2000–12/2004
0.3 m/s
(b) Filtered QSCAT wind curl (color, 10⁻⁶/s) & wind vector 1/2000–12/2004
0.5 m/s
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
4
3
2
1
0
−1
−2
−3
−4
−5

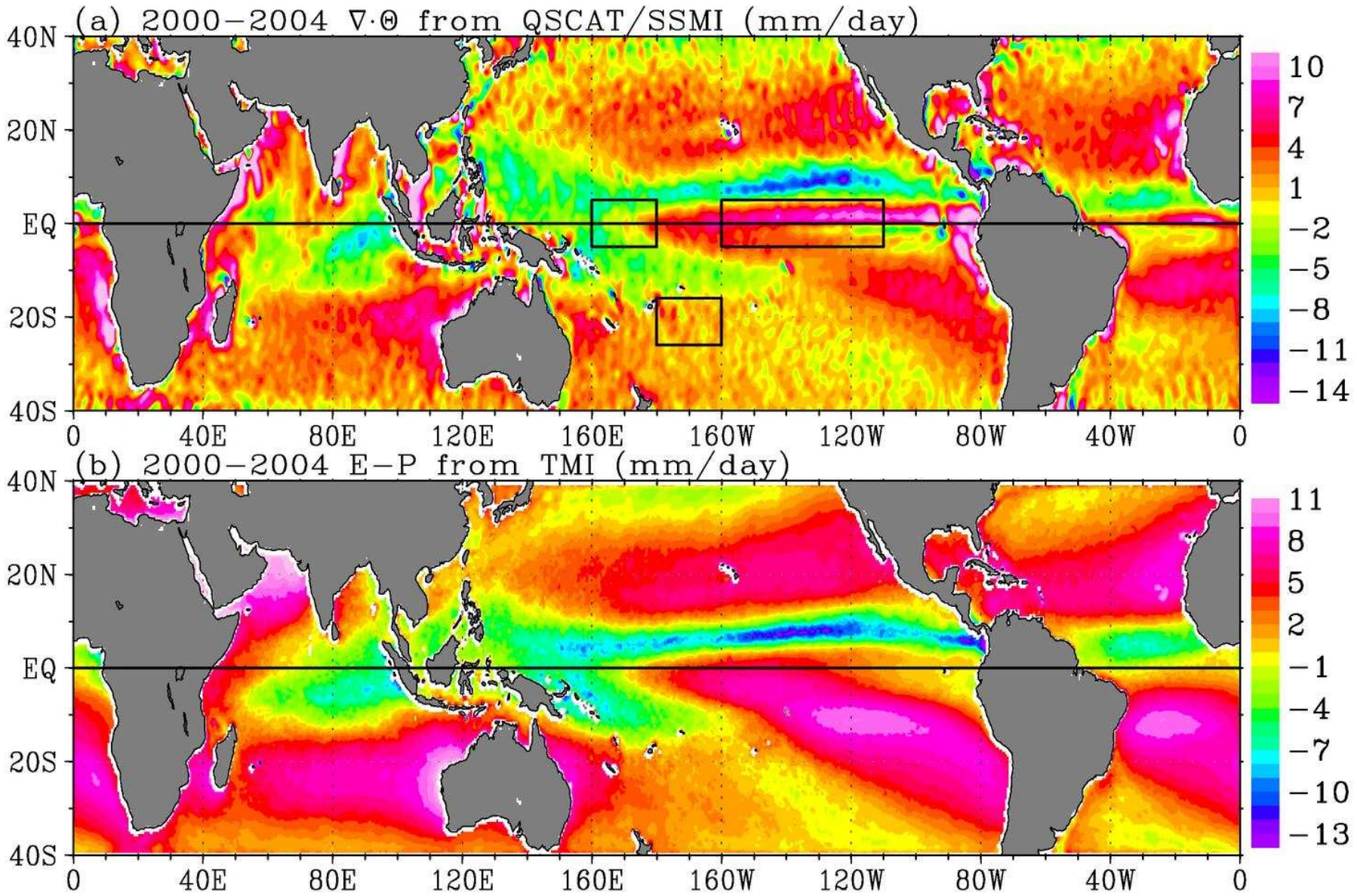

(a) Filtered QSCAT wind speed (color, m/s) 1/2000–12/2004 & AMSRE SST (contour, °C) 6/2002–12/2004
A
C
B
D
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
(b) Filtered 10m ENW for constant u10=7 m/s (color) & QuikSCAT wind speed (contour) 1/2000–12/2004
0.24
0.2
0.16
0.12
0.08
0.04
0
−0.04
−0.08
−0.12
−0.16
−0.2
−0.24


(a) Filtered QSCAT wind conv. (color, 10⁻⁵/s) 1/2000–12/2004 & AMSR-E SST (contour, ℃) 6/2002–12/2004
0.35
0.25
0.15
0.05
−0.05
−0.15
−0.25
−0.35
−0.45
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
(b) Filtered AMSR-E LH (color, W/m²) & SST (contour, ℃) 6/2002–12/2004
40
32
24
16
8
0
−8
−16
−24
−32
−40
−48
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E

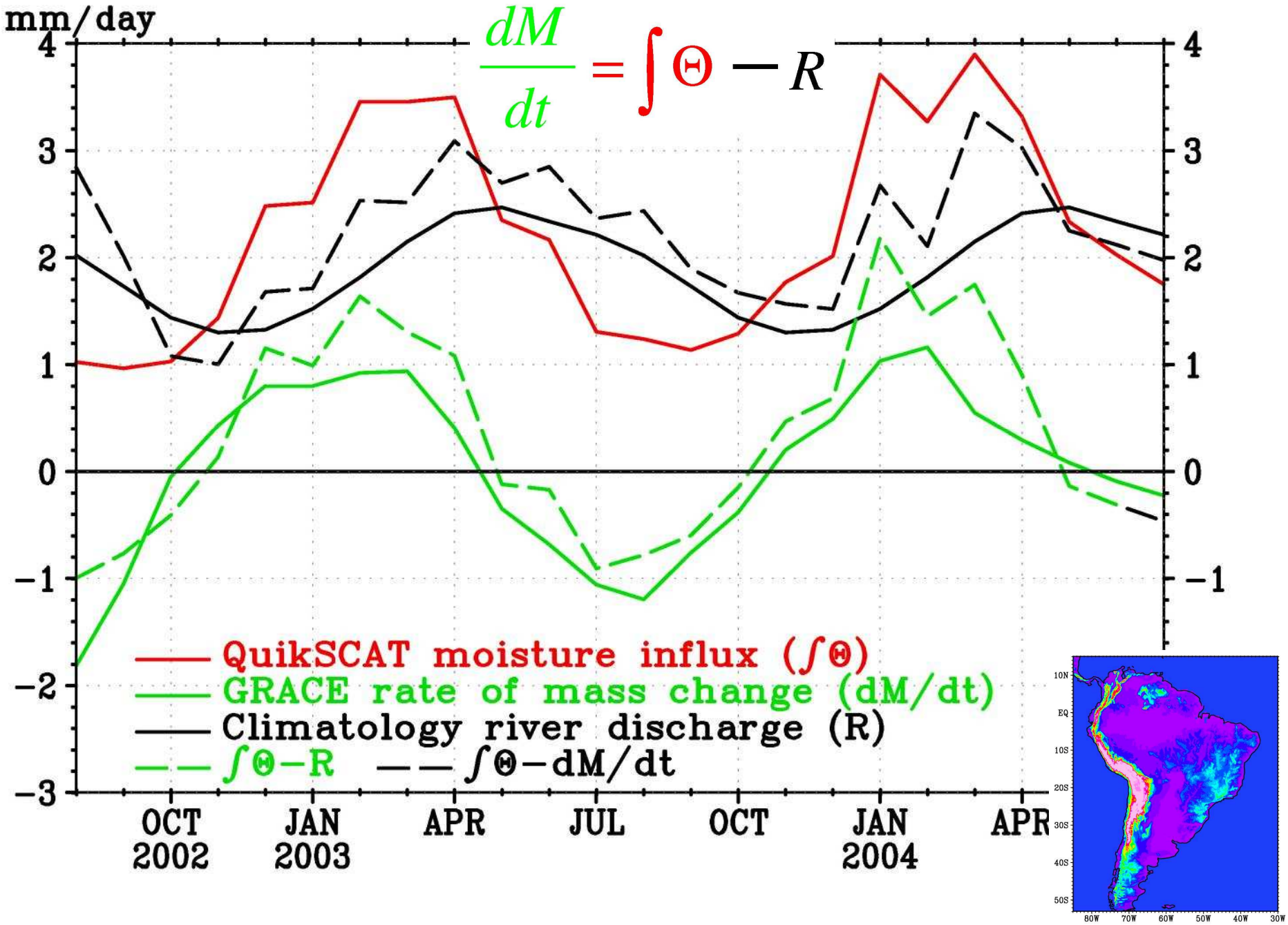

(a) Filtered ISCCP cloud fraction 1/2000–12/2004
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
0.024
0.018
0.012
0.006
0
−0.006
−0.012
−0.018
−0.024
−0.03
(b) Filtered E−P (color, mm/day) 6/2002–12/2004and cloud top temperature (contour) 1/2000–12/2004
35S
40S
45S
15E
20E
25E
30E
35E
40E
45E
50E
55E
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1

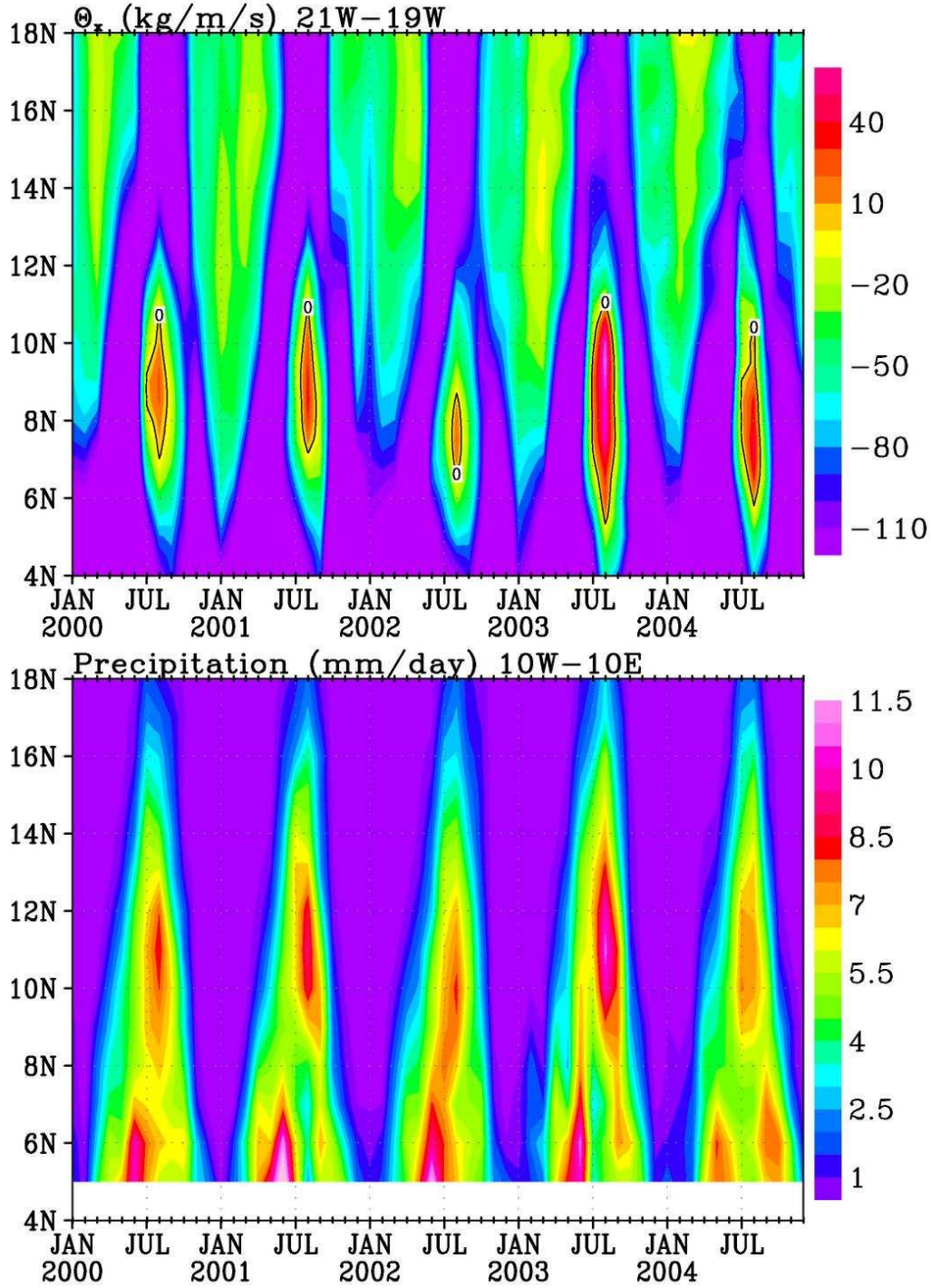
Evaporation (E), precipitation (P), and moisture advection (Θ) over ocean were independently derived from space.

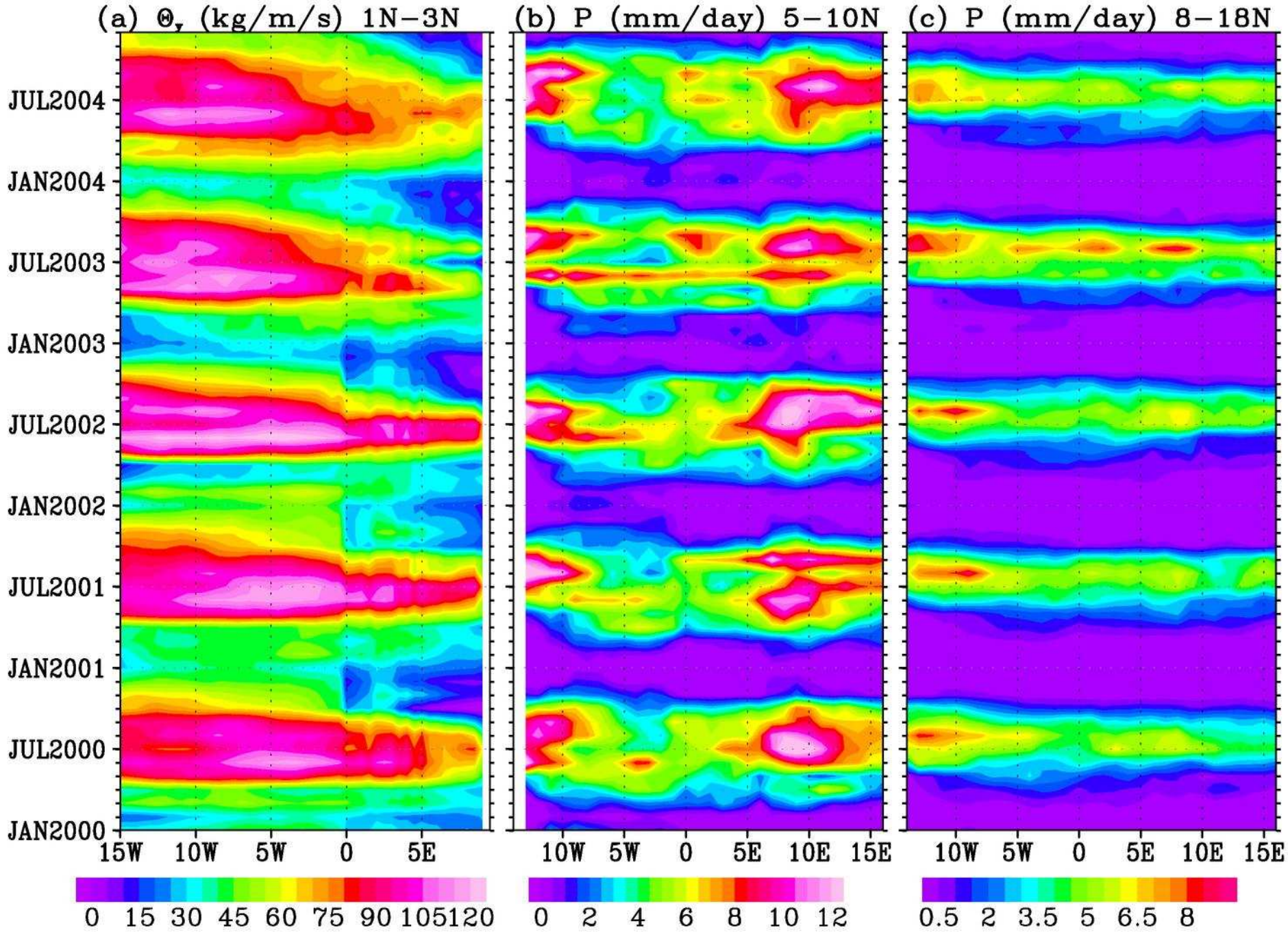
E-P and∇·Θ show similar geographic patterns

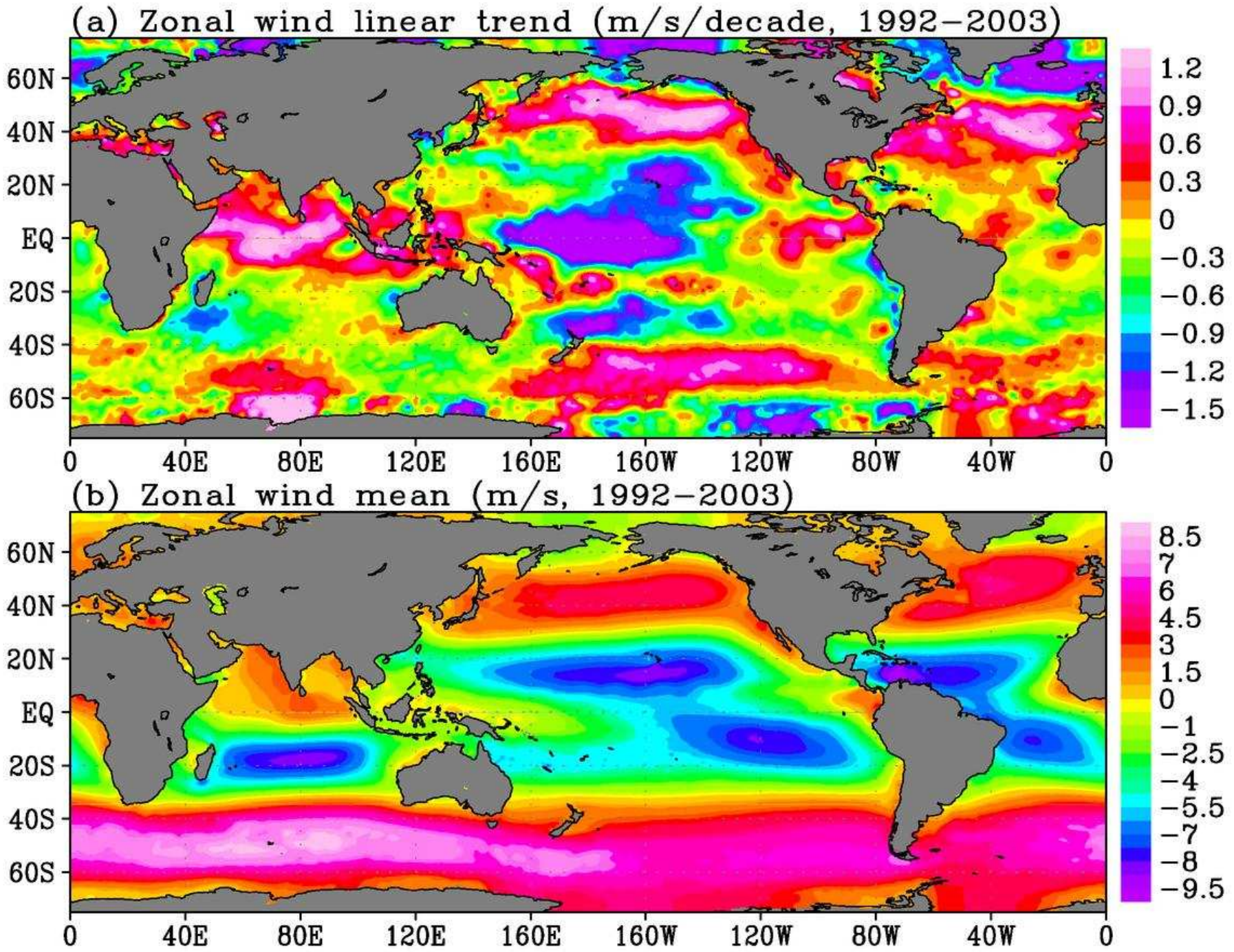


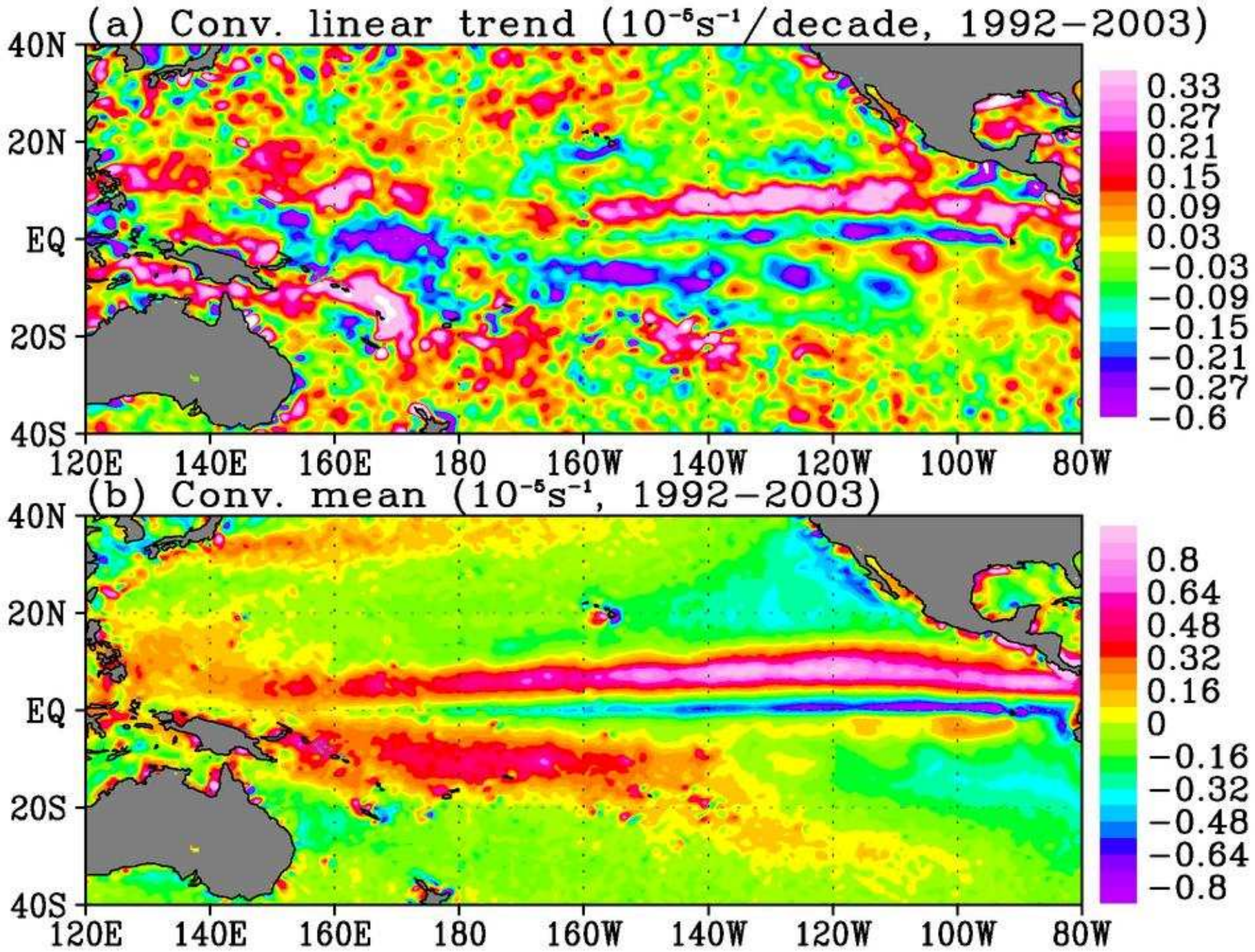
Ocean's Influence on Water Balance of South America




Θ, (kg/m/s) 21W–19W
18N
16N
14N
12N
10N
8N
6N
4N
0
0
0
0
0
40
10
−20
−50
−80
−110
JAN 2000
JUL
JAN 2001
JUL
JAN 2002
JUL
JAN 2003
JUL
JAN 2004
JUL
Precipitation (mm/day) 10W–10E
18N
16N
14N
12N
10N
8N
6N
4N
11.5
10
8.5
7
5.5
4
2.5
1
JAN 2000
JUL
JAN 2001
JUL
JAN 2002
JUL
JAN 2003
JUL
JAN 2004
JUL


(a) Θy (kg/m/s) 1N−3N
(b) P (mm/day) 5−10N
(c) P (mm/day) 8−18N
JUL2004
JAN2004
JUL2003
JAN2003
JUL2002
JAN2002
JUL2001
JAN2001
JUL2000
JAN2000
15W 10W 5W 0 5E
10W 5W 0 5E 10E 15E
10W 5W 0 5E 10E 15E
0 15 30 45 60 75 90 105120
0 2 4 6 8 10 12
0.5 2 3.5 5 6.5 8


(a) Zonal wind linear trend (m/s/decade, 1992–2003)
60N
40N
20N
EQ
20S
40S
60S
0
40E
80E
120E
160E
160W
120W
80W
40W
0
1.2
0.9
0.6
0.3
0
−0.3
−0.6
−0.9
−1.2
−1.5
(b) Zonal wind mean (m/s, 1992–2003)
60N
40N
20N
EQ
20S
40S
60S
0
40E
80E
120E
160E
160W
120W
80W
40W
0
8.5
7
6
4.5
3
1.5
0
−1
−2.5
−4
−5.5
−7
−8
−9.5


(a) Conv. linear trend ($10^{-5}s^{-1}$/decade, 1992–2003)
40N
20N
EQ
20S
40S
120E
140E
160E
180
160W
140W
120W
100W
80W
0.33
0.27
0.21
0.15
0.09
0.03
−0.03
−0.09
−0.15
−0.21
−0.27
−0.6
(b) Conv. mean ($10^{-5}s^{-1}$, 1992–2003)
40N
20N
EQ
20S
40S
120E
140E
160E
180
160W
140W
120W
100W
80W
0.8
0.64
0.48
0.32
0.16
0
−0.16
−0.32
−0.48
−0.64
−0.8