Coupled California Reanalysis Downscaling at 10km (CCaRD10)

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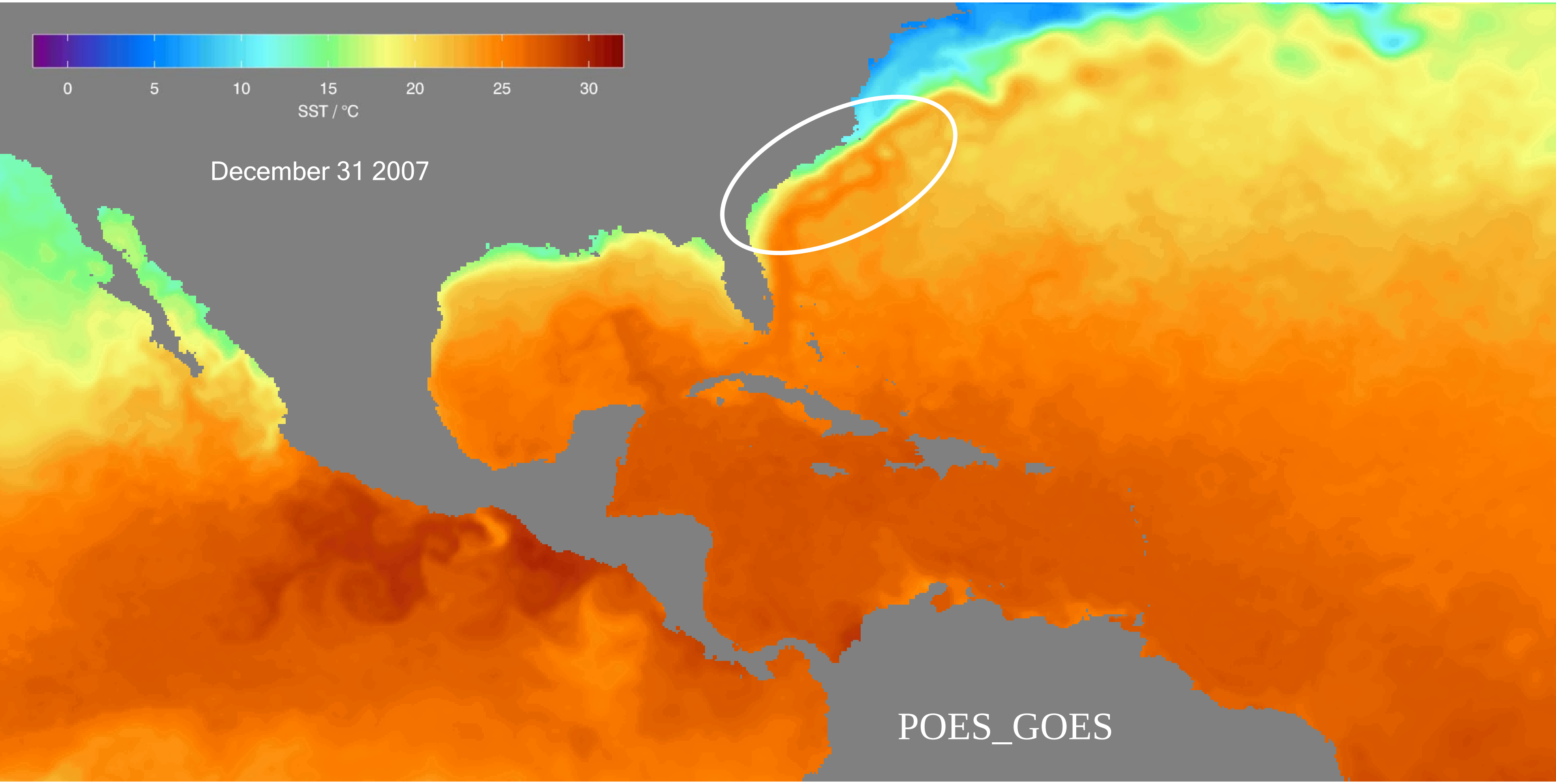
Purpose

- Most of the downscalings made so far utilize SST from large scale analysis.
  - SST analysis is available in 2.0 degree to 0.5 degree resolutions, not sufficiently high enough for high resolution downscaling
  - Although high resolution SST analysis becoming available in recent years (POES-GOES Blended analysis), it is very difficult to obtain very high resolution SST in earlier years.



Point-for-point comparison with RTG_HR shows S.D. of 0.45 K

Comparison with Reynolds ¼° daily OI has S.D. of 0.65 K

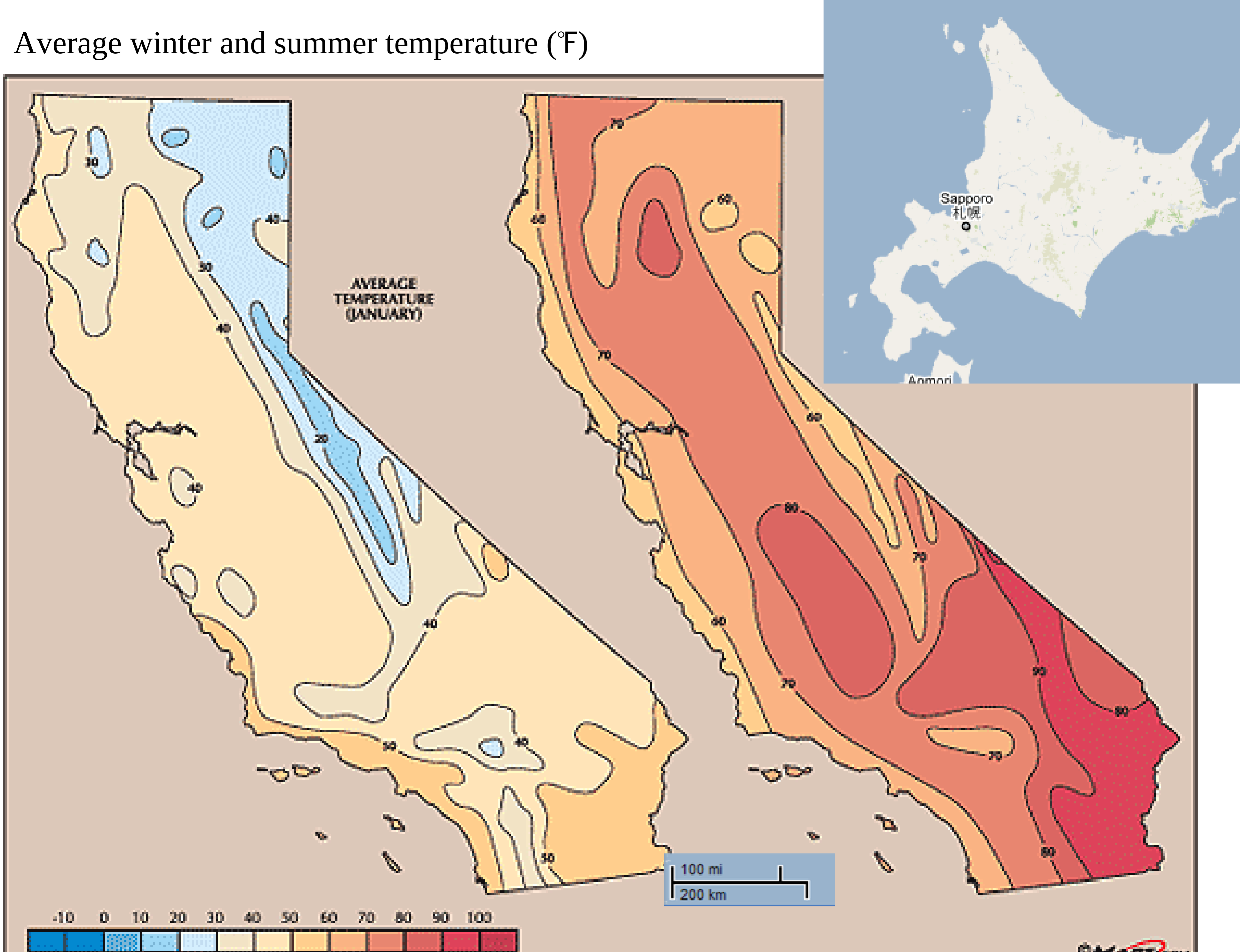
Importance of high resolution coastal SST

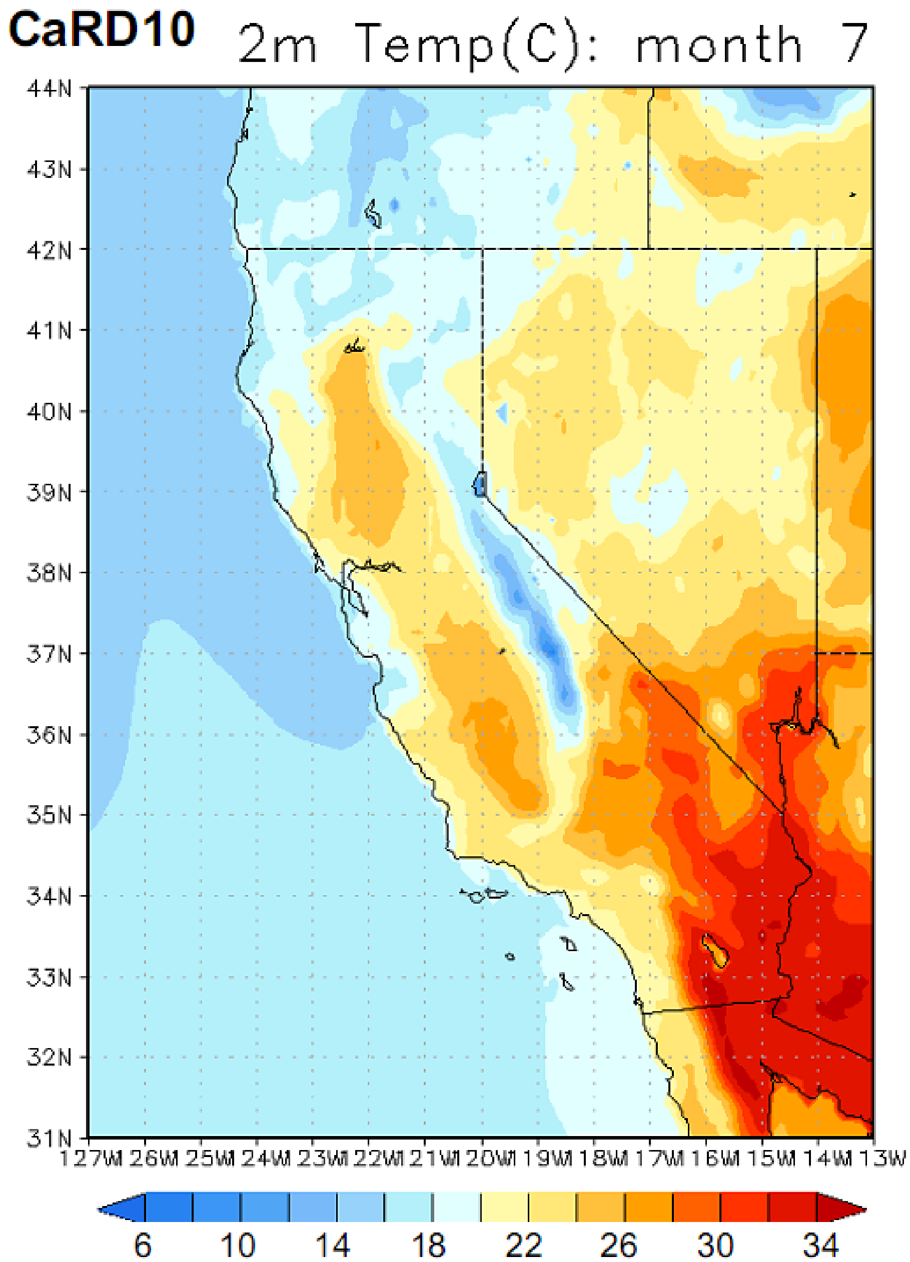
- The understanding of the effect of small scale detail in SST on coastal atmospheric analysis/forecast is still insufficient.
- The small scale ocean analysis, SST, temperature, salinity and currents are important for ecological study as well as for fishery and other applications.

Possible impacts

- Impacts on reanalysis:
  - Near coast temperature, cloudiness, inversion
  - Sea breeze circulation.
  - Precipitation, storm strength
- Impacts of global warming:
  - Global warming leads to intensification of coastal ocean upwelling. (A. Bakun, Science, 1990)
  - Boundary current intensity and meandering.
  - Gulf of California SST and monsoon. Effect of other fine scale gulf (Red sea, Mediterranean sea, Bay of Bengal, etc).

Average winter and summer temperature (℉)





CaRD10
2m Temp(C): month 7
44N
43N
42N
41N
40N
39N
38N
37N
36N
35N
34N
33N
32N
31N
127W 26W 25W 24W 23W 22W 21W 20W 19W 18W 17W 16W 15W 14W 13W
6
10
14
18
22
26
30
34

Possible troubles with coupled integrations

- Stability of ROMS
- How the lateral boundary condition works for ROMS
- Systematic error and flux correction.

Experiments

1. Uncoupled integration with climatological atmospheric forcing.
   a. Importance of initial condition and spin-up
   b. Systematic error
2. Uncoupled integration with RSM forcing
   a. Monthly mean or daily mean
   b. Systematic error and flux correction
3. Coupled integration (with daily coupling)
   a. Systematic error and flux correction
   b. Systematic error in salinity

Initial condition

- Simple Ocean Data Assimilation (SODA) analysis is used (Carton et al. 2000), available from http://www.atmos.umd.edu/~ocean/ .
- 20-levels, 2x2.5 / 0.5x2.5 degree resolution. 1958-2001. ERA-40 wind used.
- No special spin-up required. Accurate horizontal and vertical interpolation is necessary. The ocean initial state near the coast is found to be critical.
- Complex coast line needs to be avoided. At least 5 consecutive straight grid alignment if necessary.
- Small lakes and narrow bays causes instability.

SODA – reanalysis

NCEP – NCEP SST

MQC – monthly mean forcing

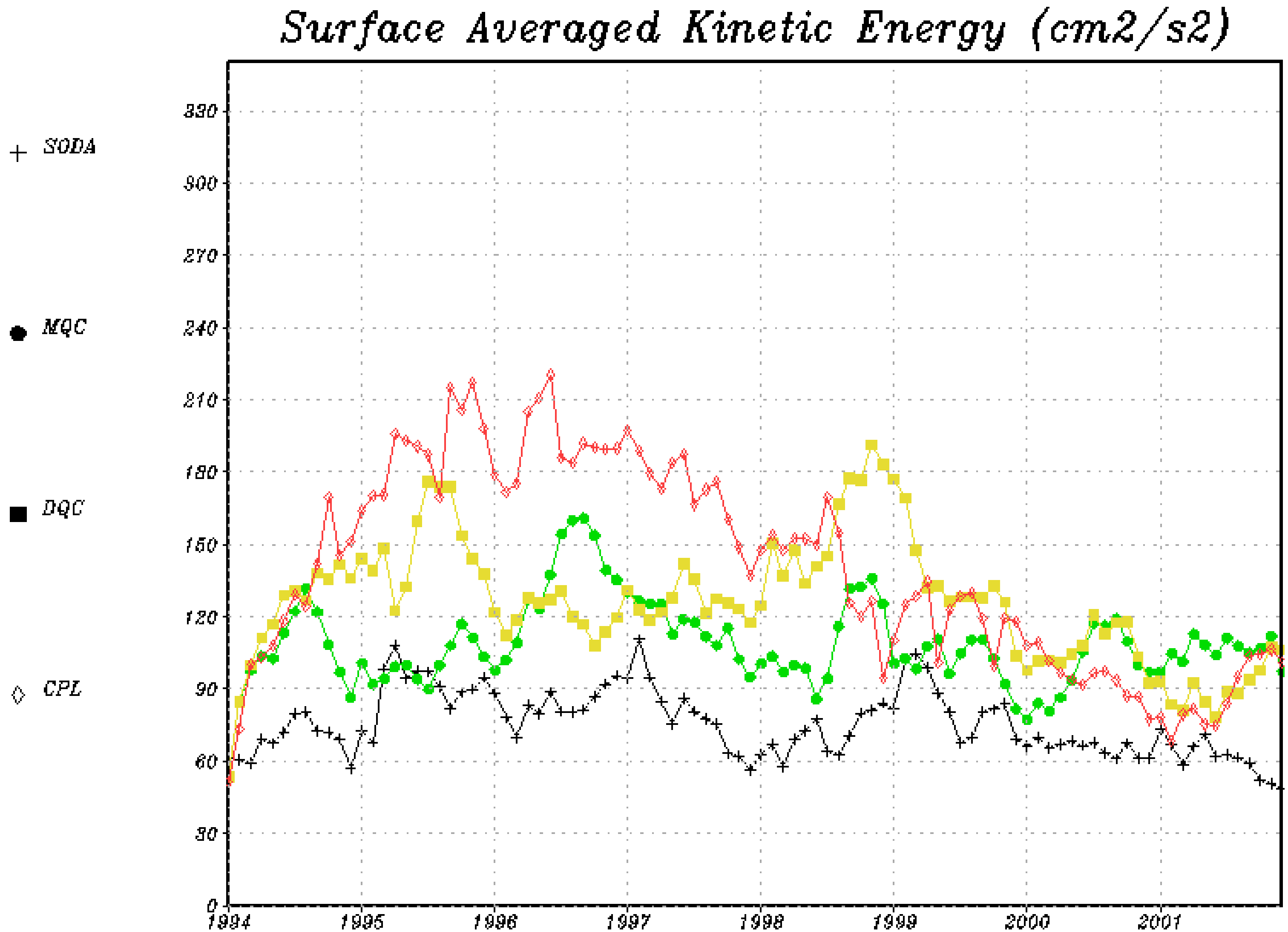
DQC – daily mean forcing

CPL – RSM-ROMS coupled model

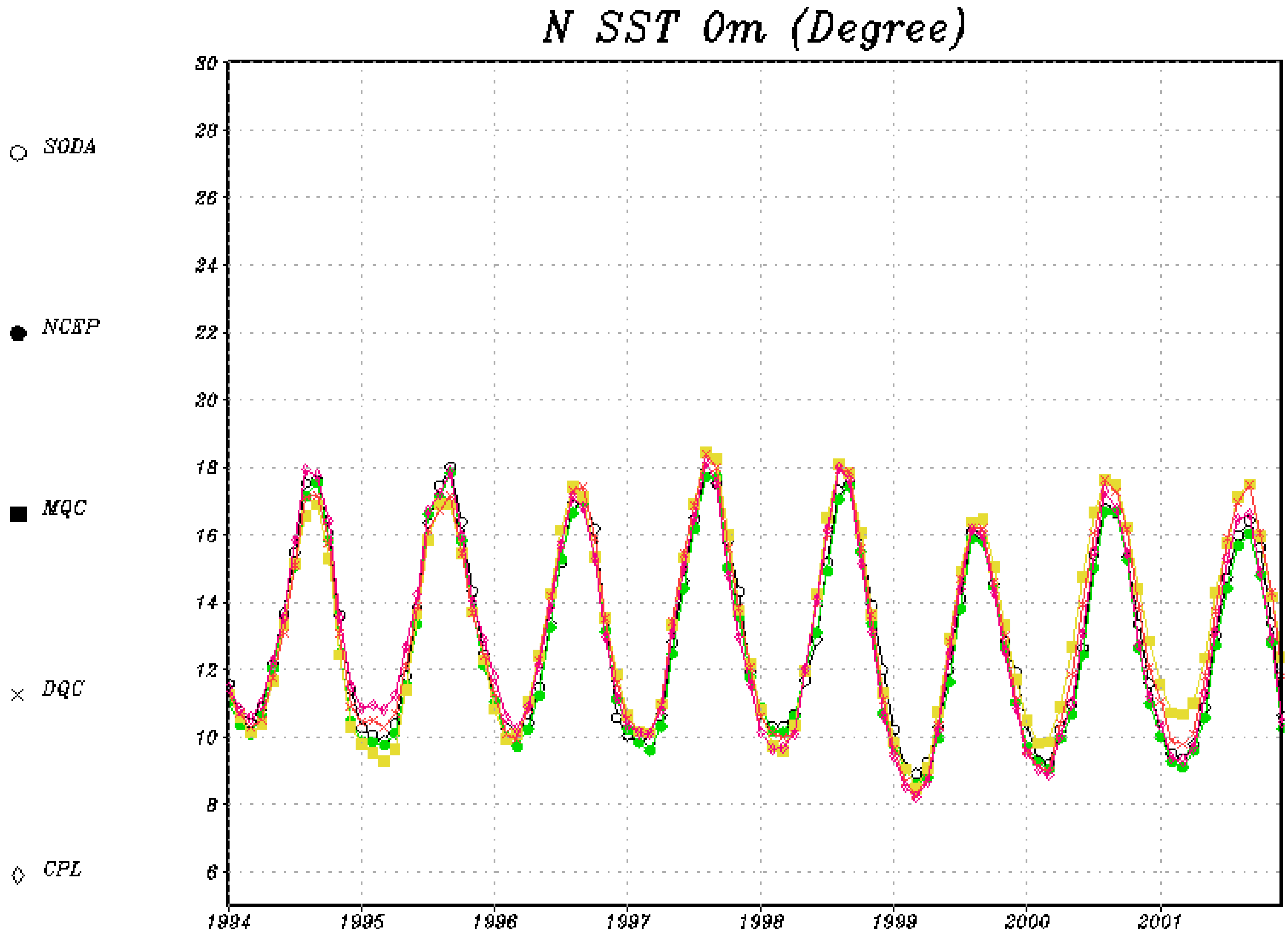
All the result are within 1996 and 2001.

Inner domain (133W-106W, 22N-48N)

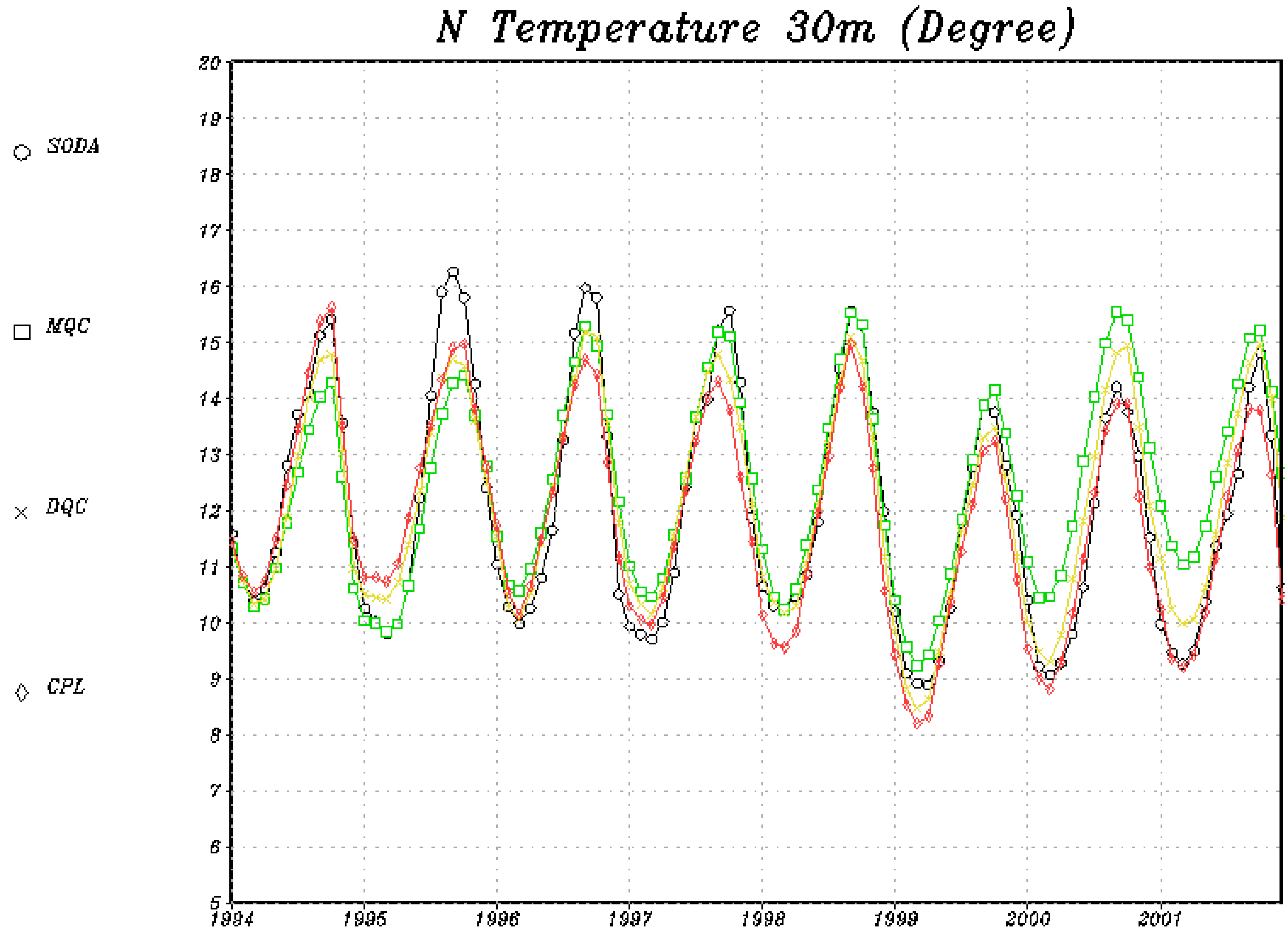
Note: Bugs in the program. These results are tentative.



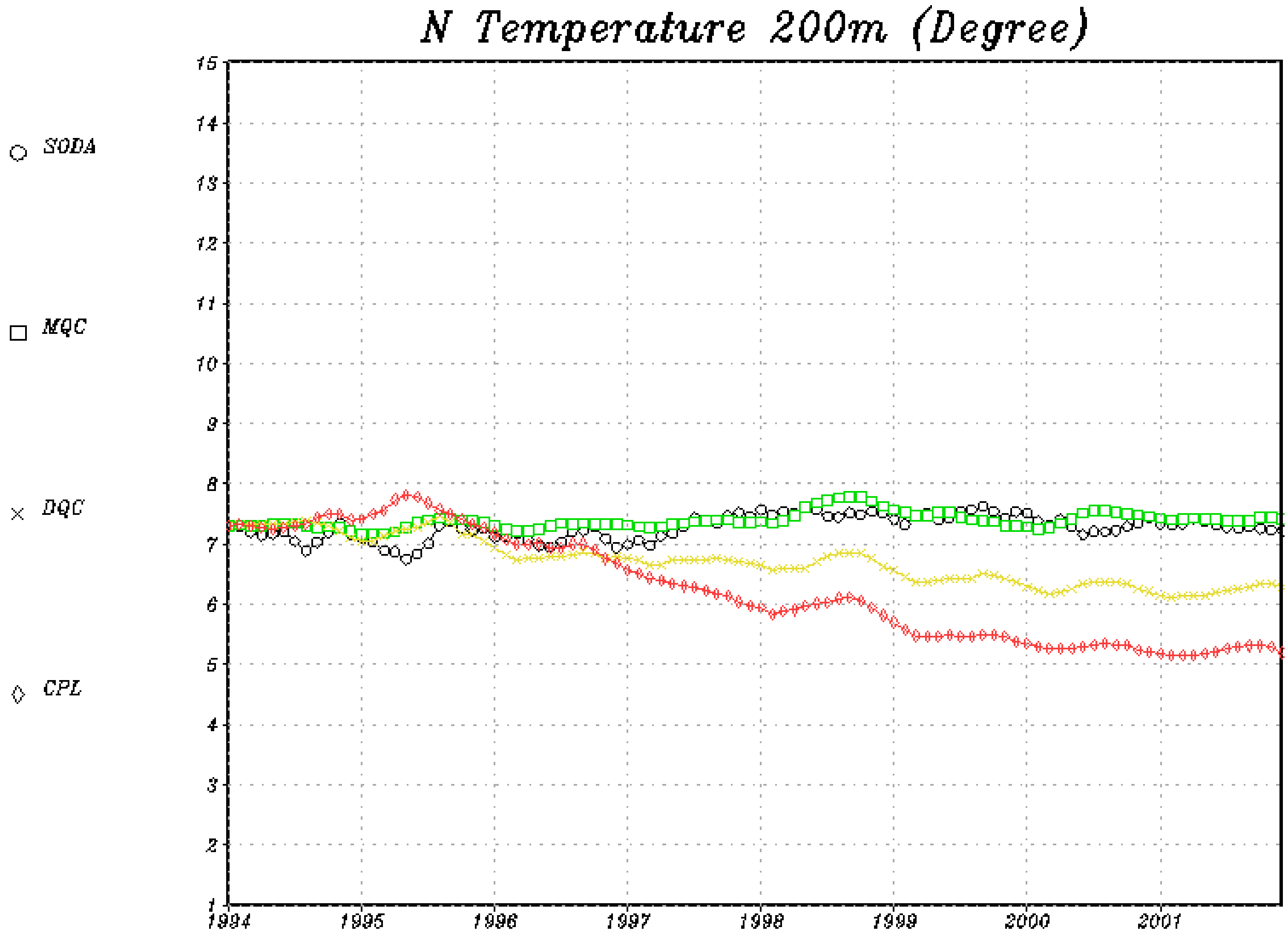
Surface Averaged Kinetic Energy (cm2/s2)
SODA
MQC
DQC
CPL
330
300
270
240
210
180
150
120
90
60
30
0
1994
1995
1996
1997
1998
1999
2000
2001



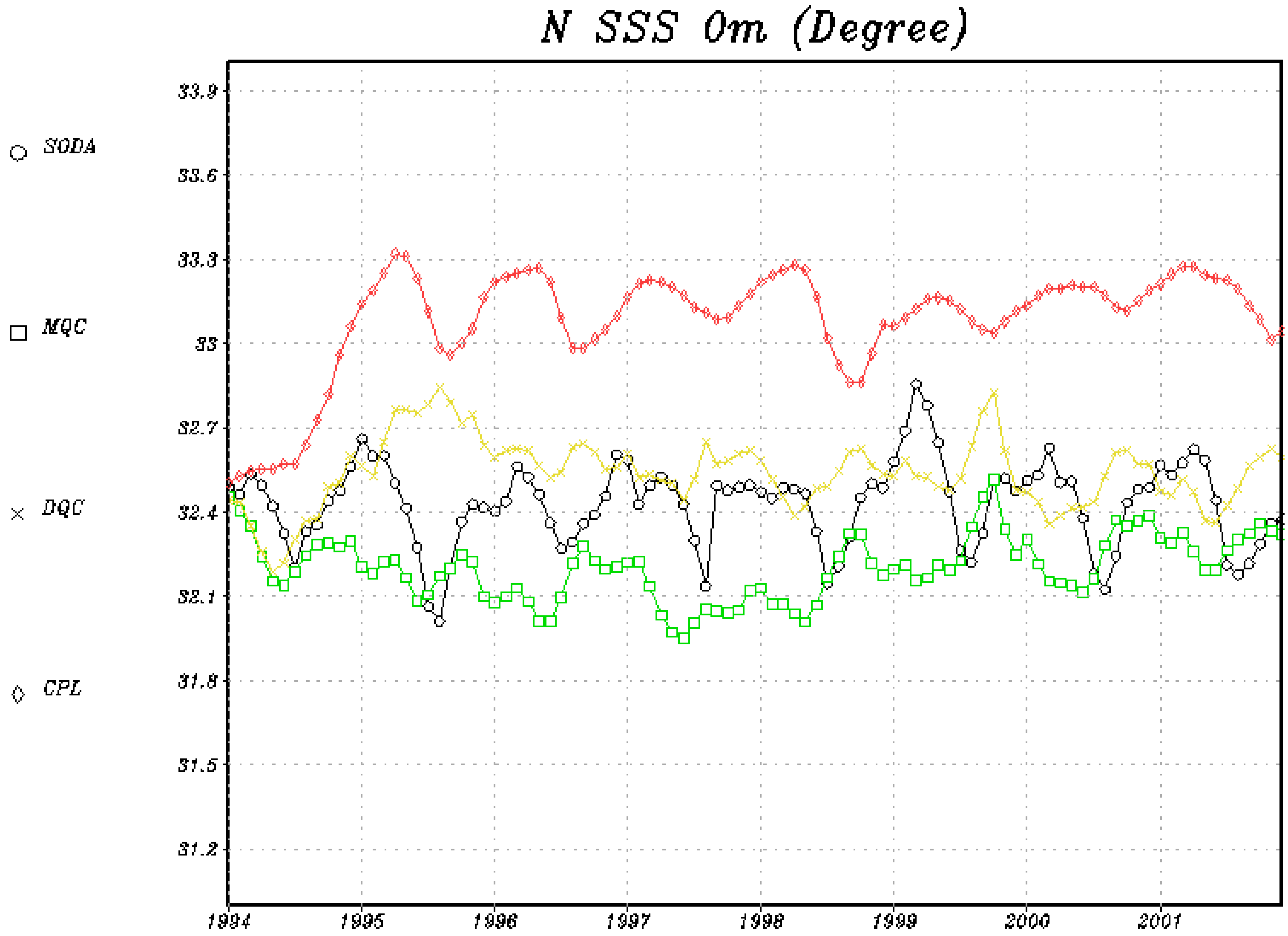
N SST 0m (Degree)
SODA
NCEP
MQC
DQC
CPL
30
28
26
24
22
20
18
16
14
12
10
8
6
1994
1995
1996
1997
1998
1999
2000
2001

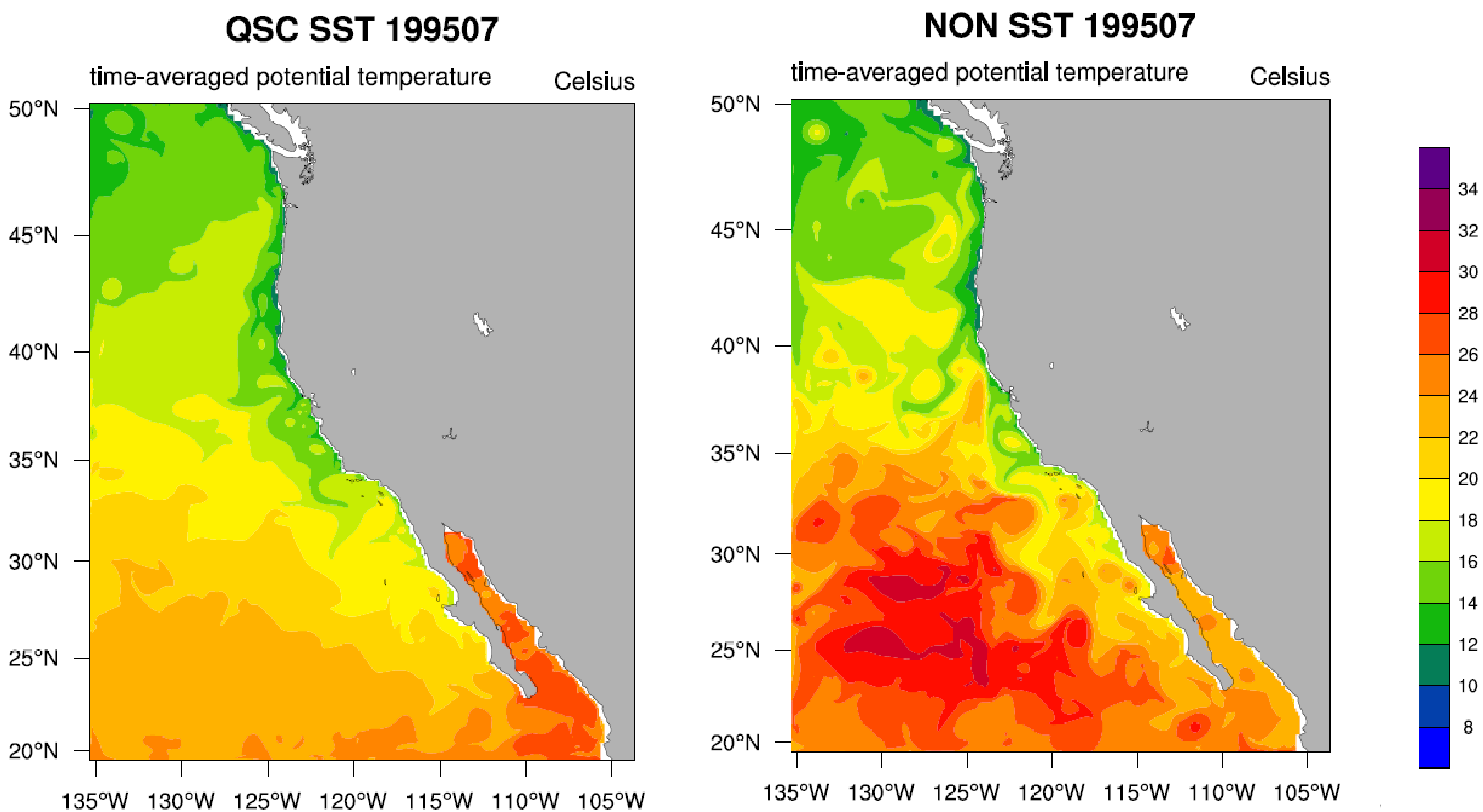


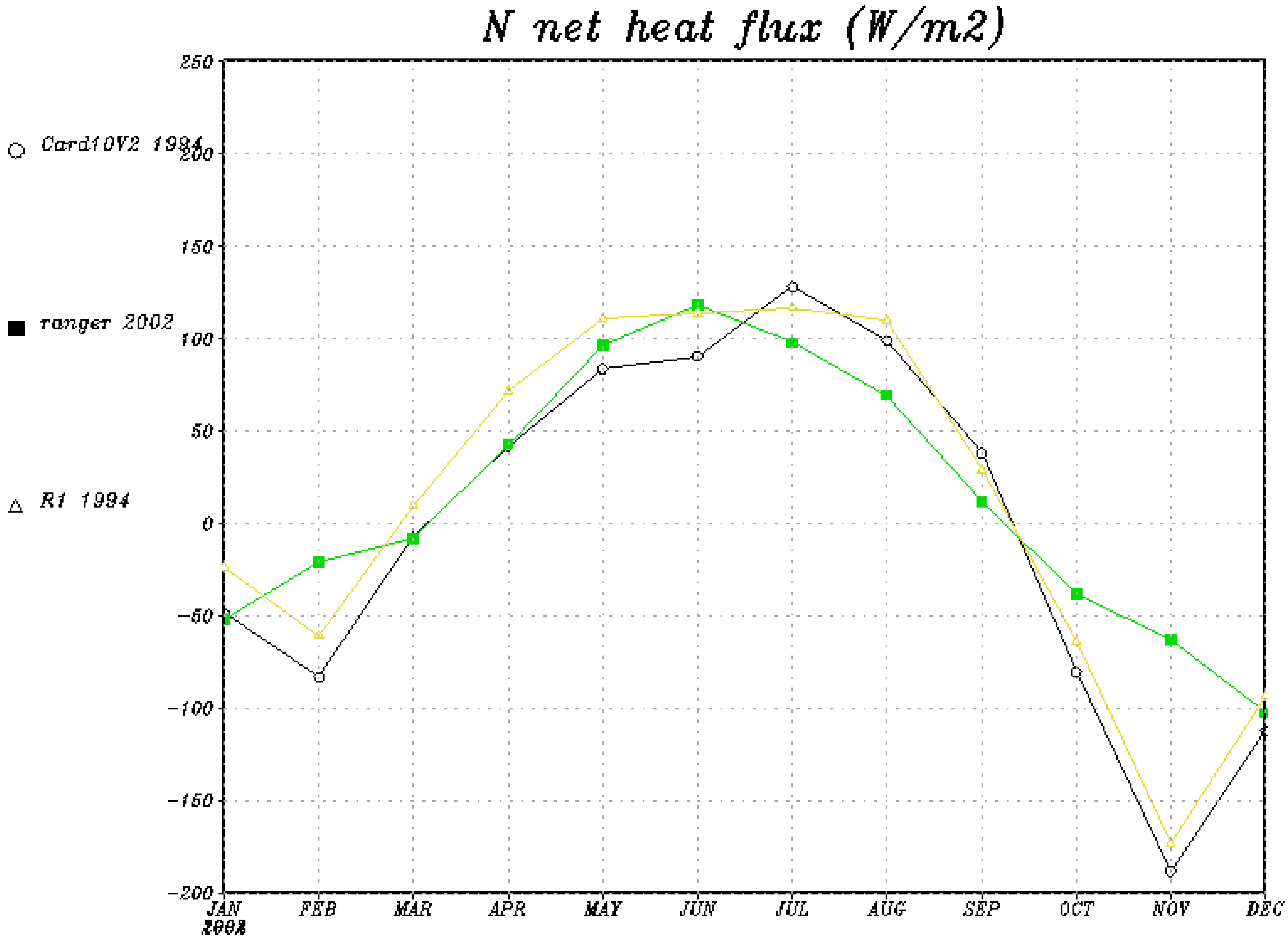
N Temperature 30m (Degree)
SODA
MQC
DQC
CPL
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
1994
1995
1996
1997
1998
1999
2000
2001



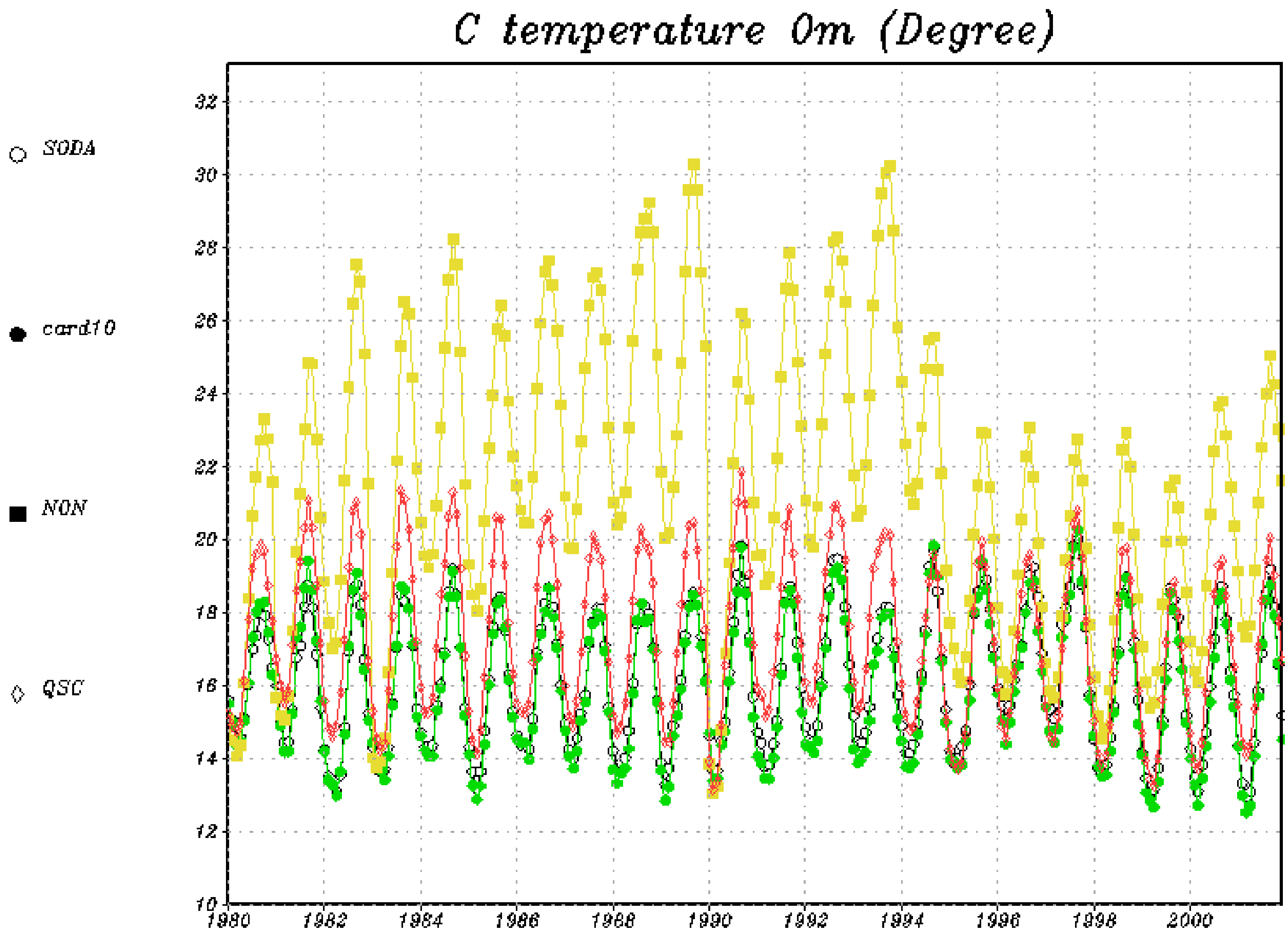
N Temperature 200m (Degree)
SODA
MQC
DQC
CPL
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1994
1995
1996
1997
1998
1999
2000
2001

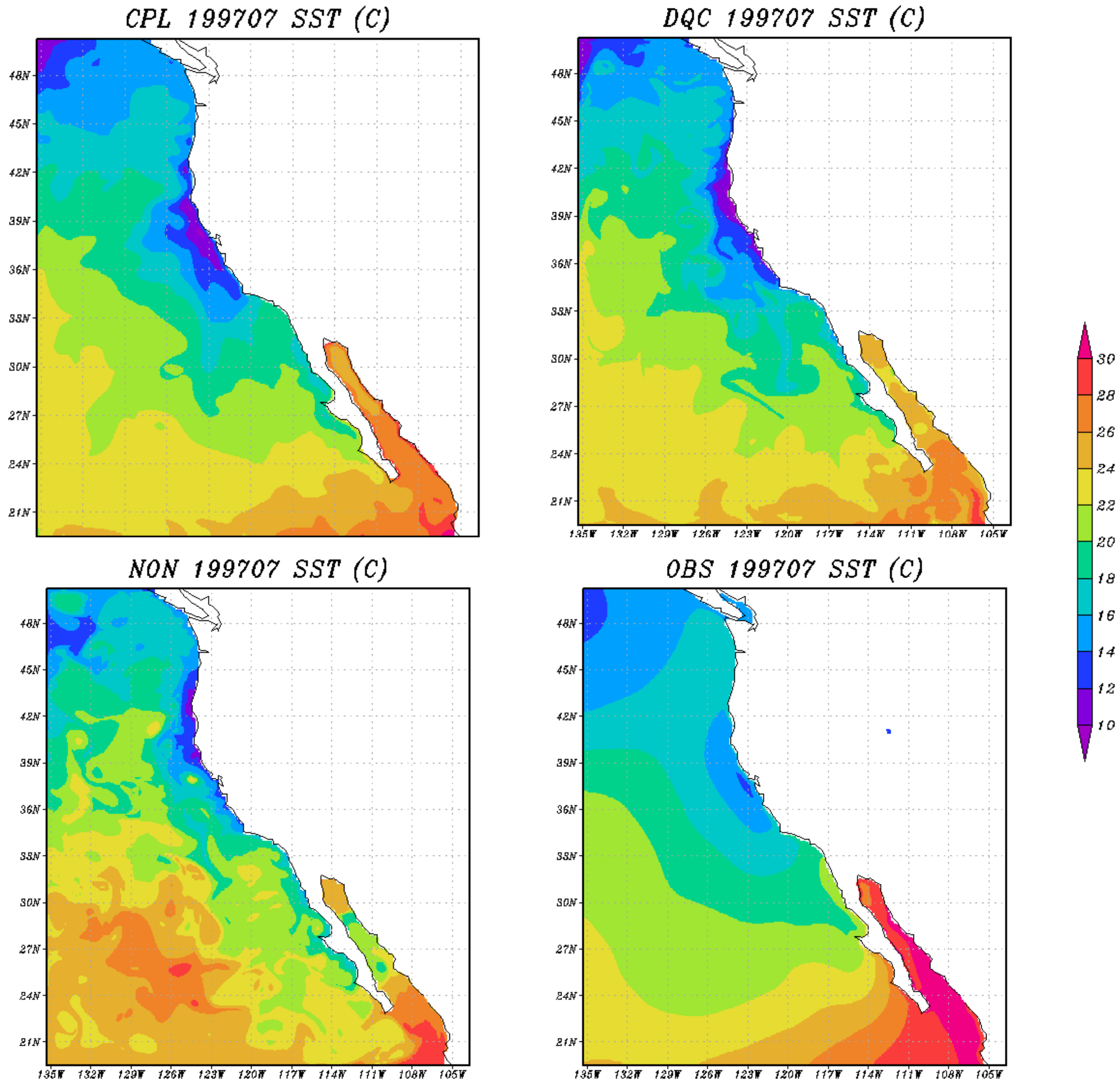

N SSS 0m (Degree)
SODA
MQC
DQC
CPL
33.9
33.6
33.3
33
32.7
32.4
32.1
31.8
31.5
31.2
1994
1995
1996
1997
1998
1999
2000
2001


QSC SST 199507
time-averaged potential temperature
Celsius
50°N
45°N
40°N
35°N
30°N
25°N
20°N
135°W
130°W
125°W
120°W
115°W
110°W
105°W
NON SST 199507
time-averaged potential temperature
Celsius
34
32
30
28
26
24
22
20
18
16
14
12
10
8

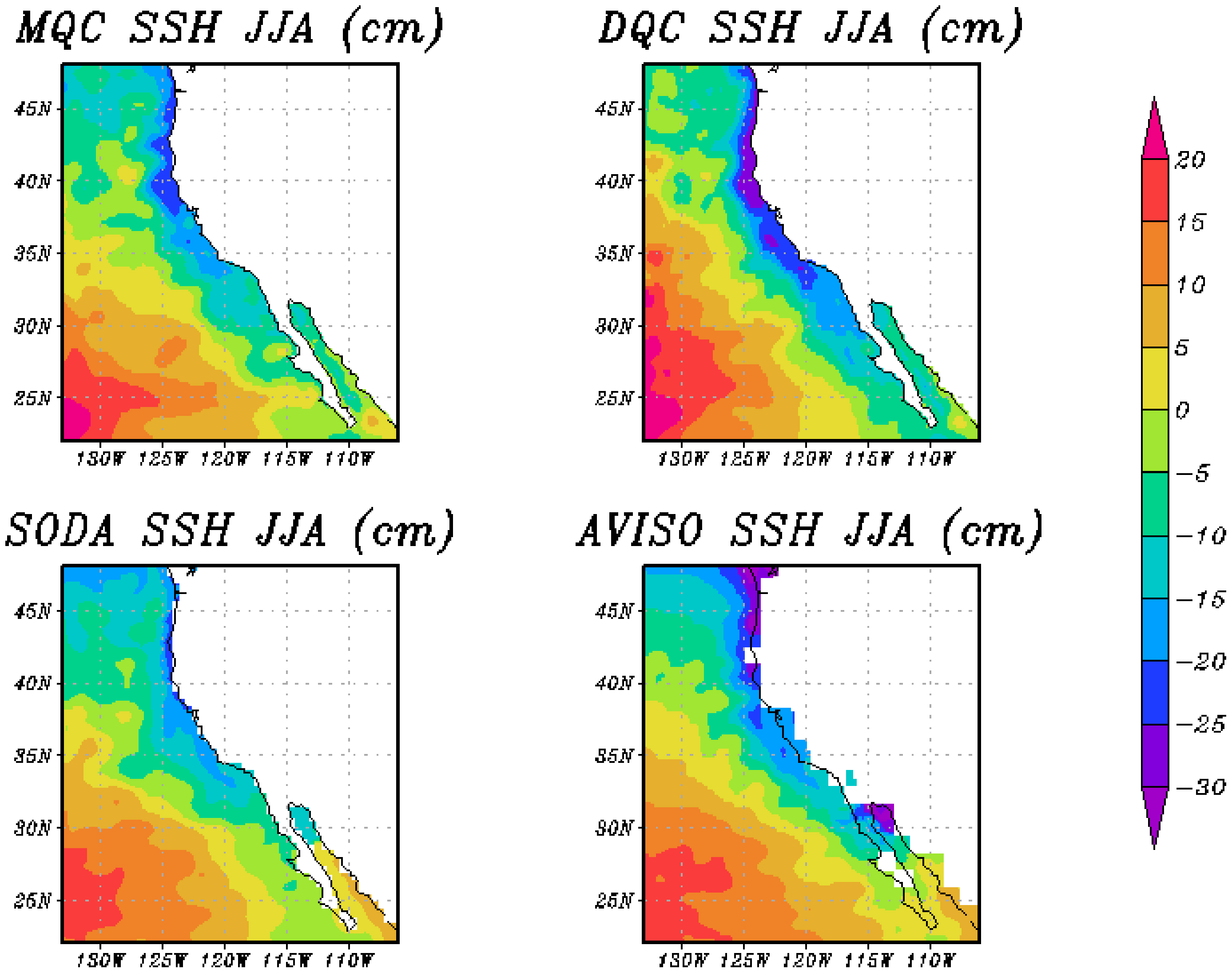


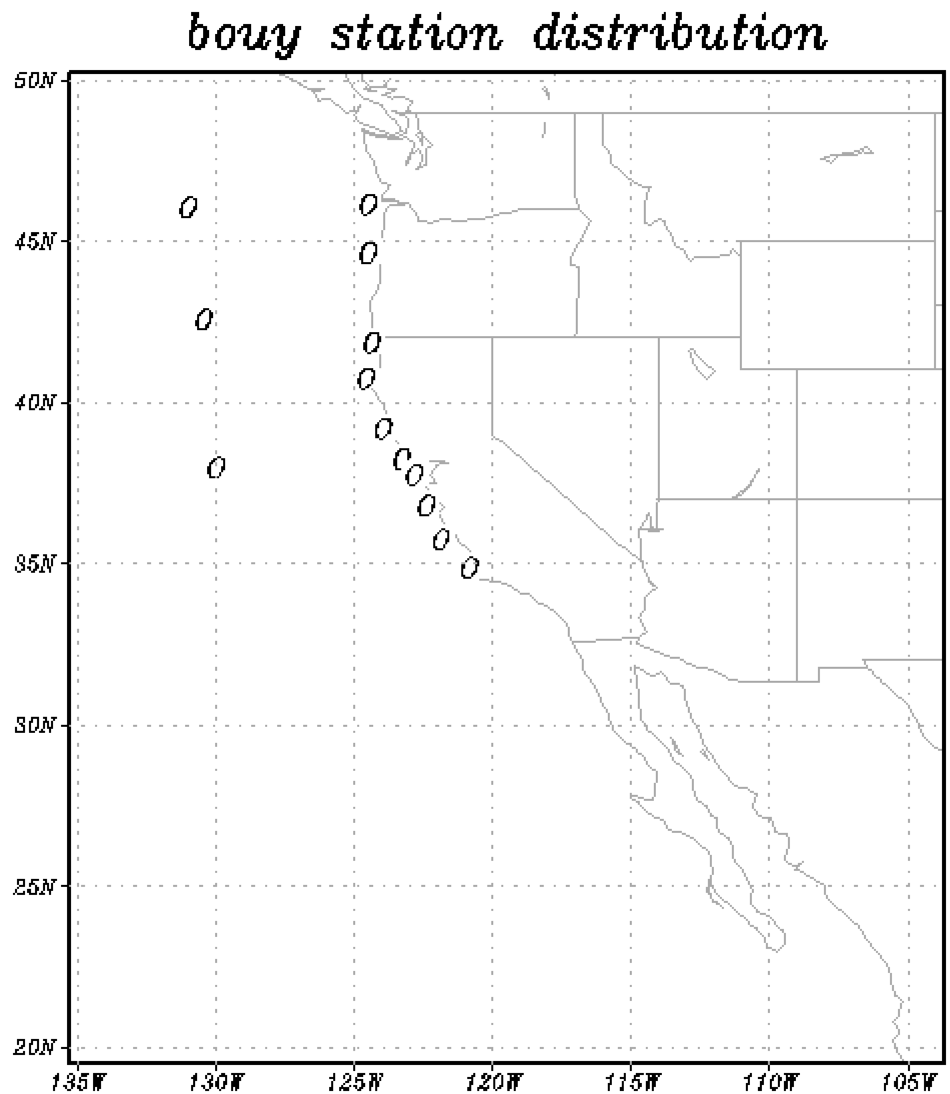
N net heat flux (W/m2)
Card10V2 1994
ranger 2002
R1 1994
250
200
150
100
50
0
−50
−100
−150
−200
JAN
2002
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

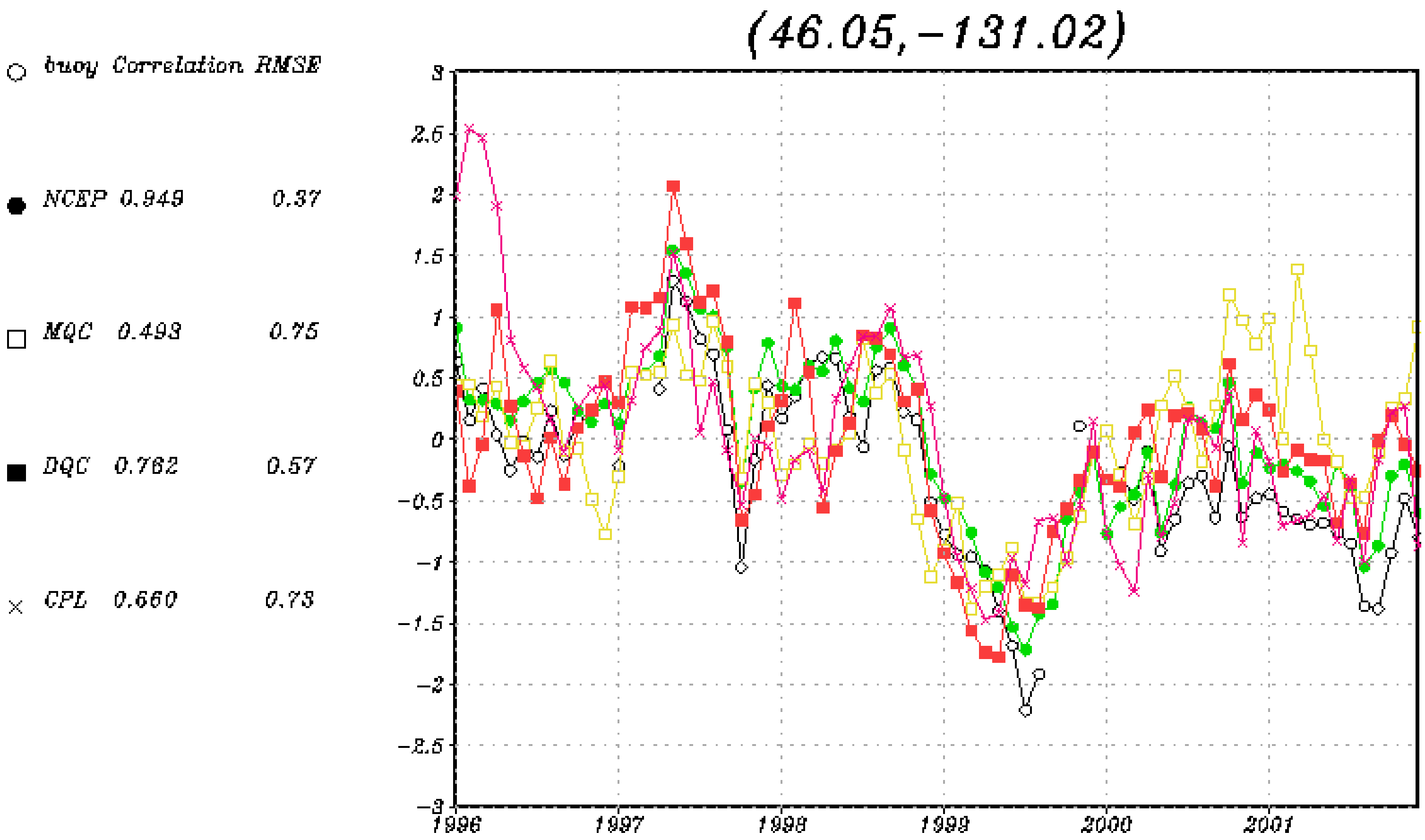

C temperature 0m (Degree)
SODA
card10
NON
QSC
32
30
28
26
24
22
20
18
16
14
12
10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000


CPL 199707 SST (C)
DQC 199707 SST (C)
NON 199707 SST (C)
OBS 199707 SST (C)
48N
45N
42N
39N
36N
33N
30N
27N
24N
21N
135W
132W
129W
126W
123W
120W
117W
114W
111W
108W
105W
30
28
26
24
22
20
18
16
14
12
10

Jun-Jul-Aug SSH



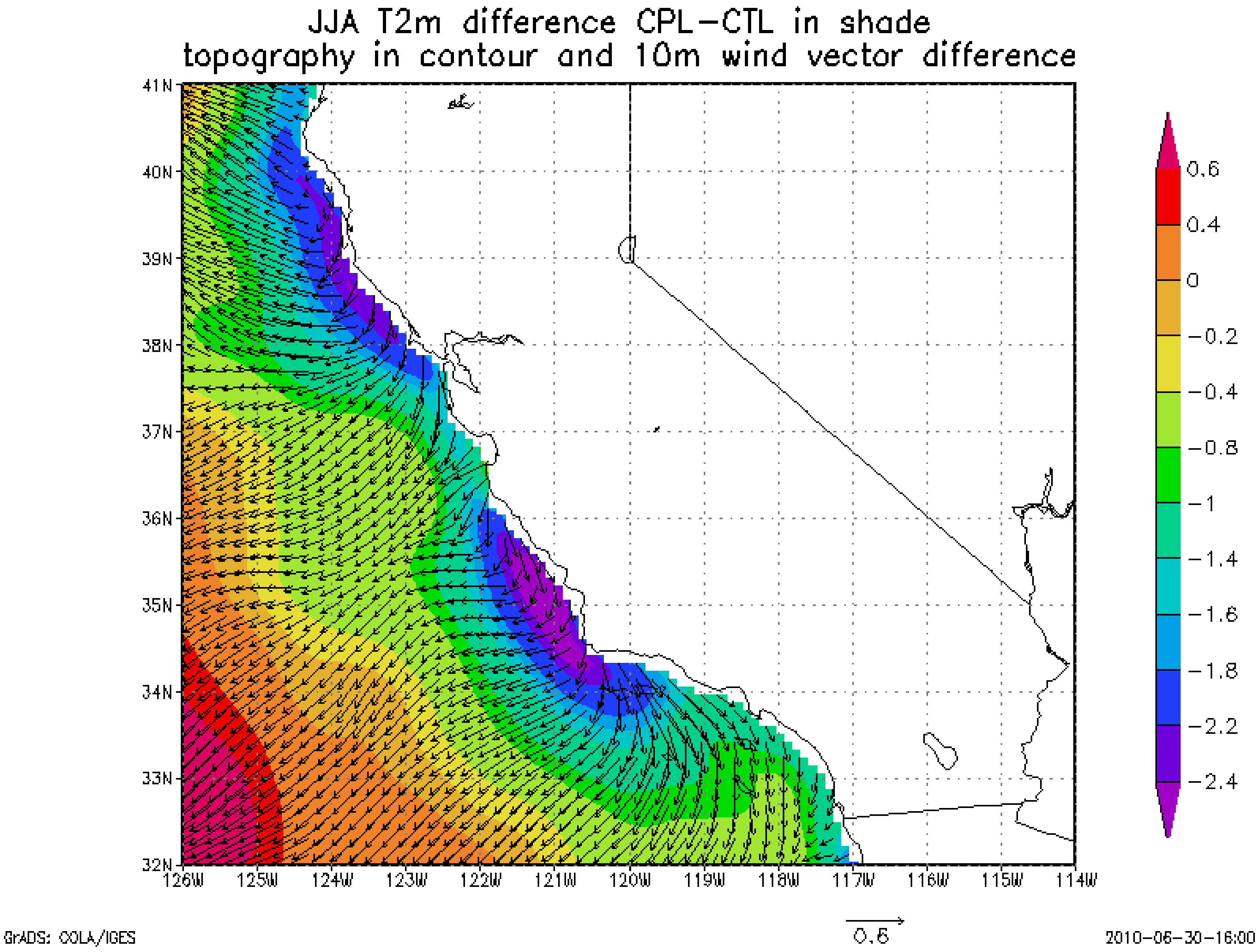

bouy station distribution
50N
45N
40N
35N
30N
25N
20N
135W
130W
125W
120W
115W
110W
105W



(46.05,-131.02)
buoy Correlation RMSE
NCEP 0.949 0.37
MQC 0.493 0.75
DQC 0.762 0.57
CPL 0.660 0.73
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
1996
1997
1998
1999
2000
2001

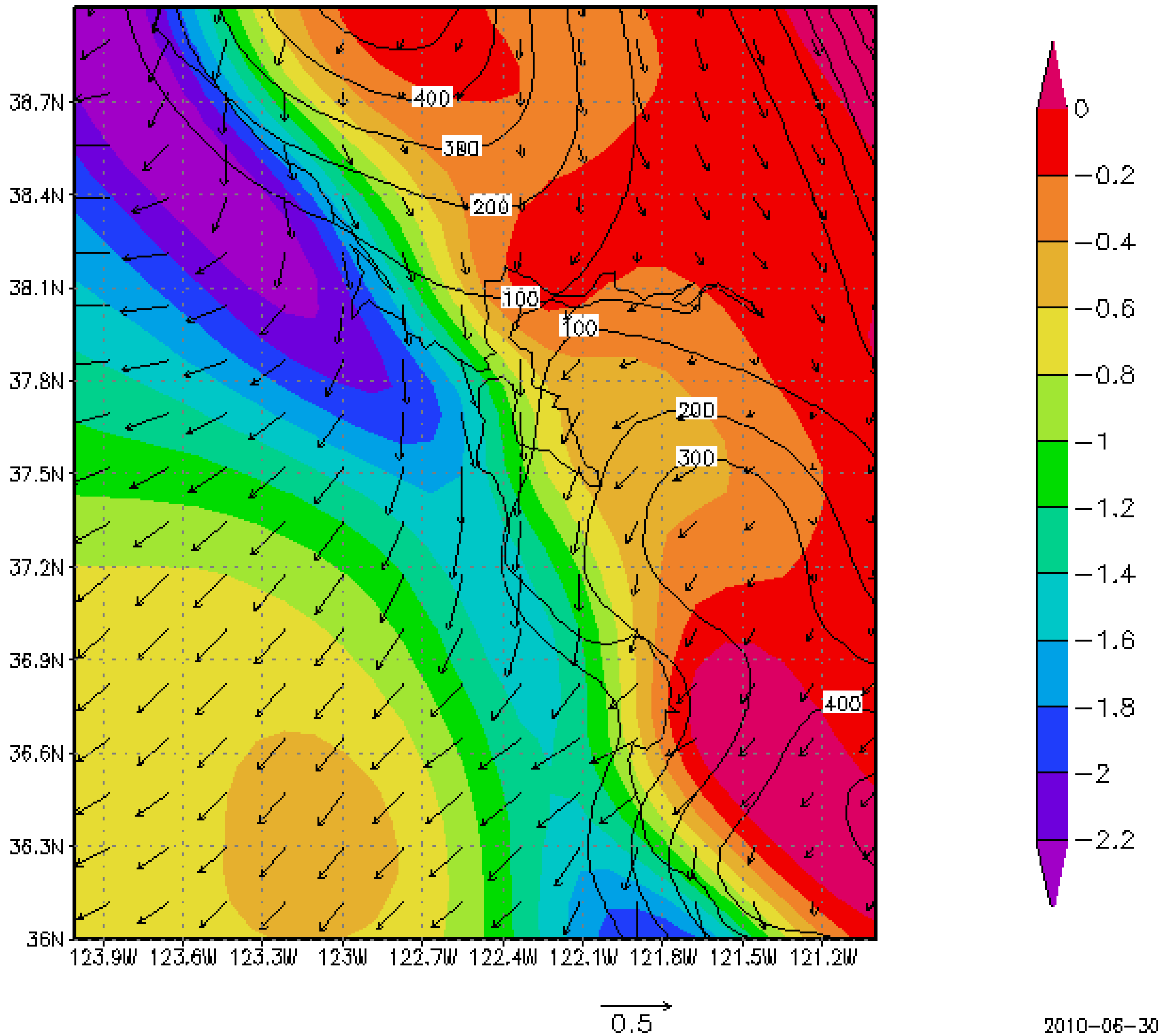
	Correlation	RMSE
NCEP	0.835	0.48
MQC	0.547	0.83
DQC	0.589	0.88
CPL	0.641	0.78

Impact on atmosphere



JJA T2m difference CPL-CTL in shade
topography in contour and 10m wind vector difference
41N
40N
39N
38N
37N
36N
35N
34N
33N
32N
126W
125W
124W
123W
122W
121W
120W
119W
118W
117W
116W
115W
114W
0.6
0.4
0
-0.2
-0.4
-0.8
-1
-1.4
-1.6
-1.8
-2.2
-2.4
0.6
GrADS: COLA/IGES
2010-06-30-16:00

JJA T2m difference CPL-CTL in shade
topography in contour and 10m wind vector difference



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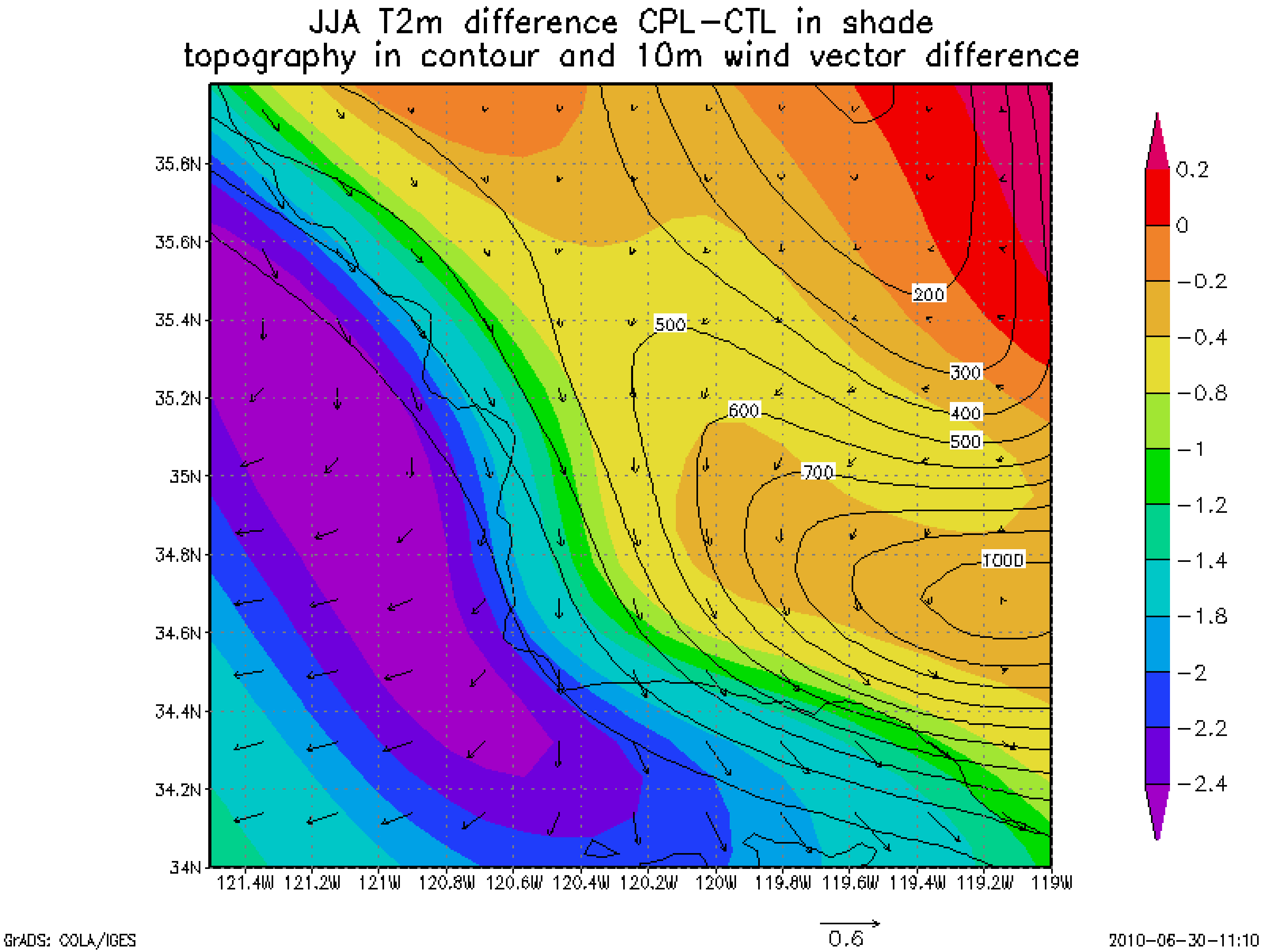
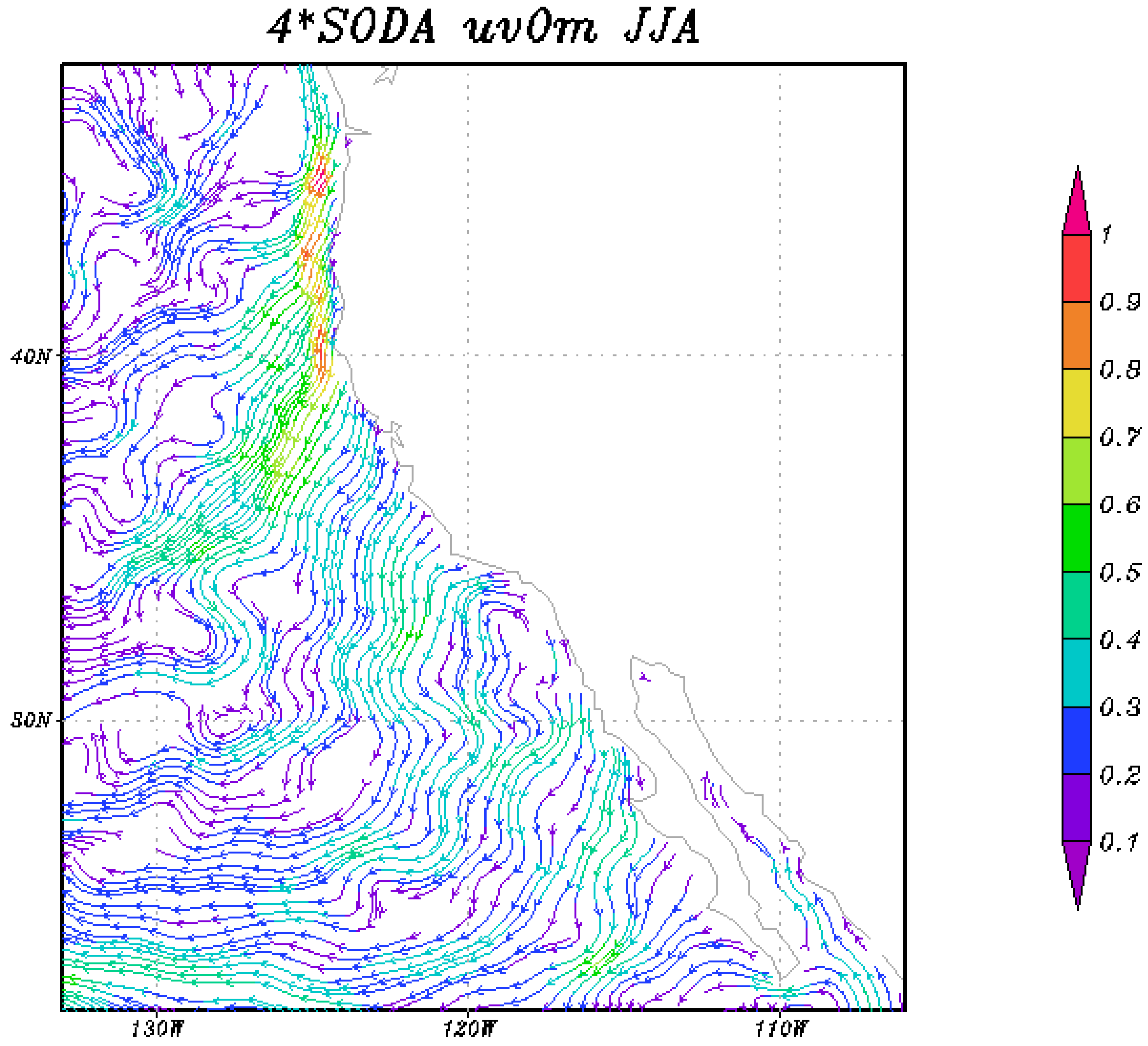

JJA T2m difference CPL−CTL in shade
topography in contour and 10m wind vector difference
35.8N
35.6N
35.4N
35.2N
35N
34.8N
34.6N
34.4N
34.2N
34N
121.4W
121.2W
121W
120.8W
120.6W
120.4W
120.2W
120W
119.8W
119.6W
119.4W
119.2W
119W
200
300
400
500
500
600
700
1000
0.2
0
−0.2
−0.4
−0.8
−1
−1.2
−1.4
−1.8
−2
−2.2
−2.4
0.6
GrADS: COLA/IGES
2010−06−30−11:10

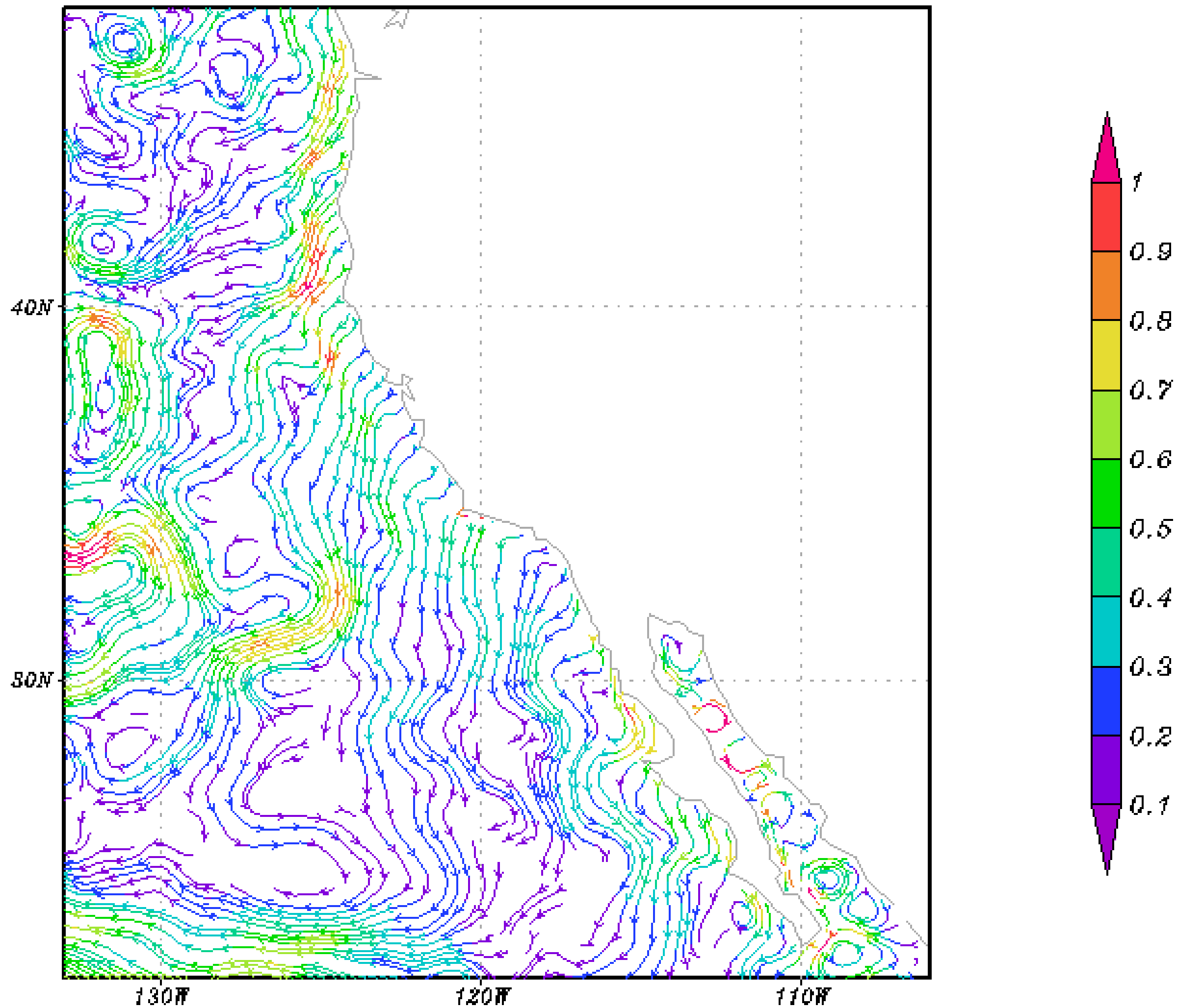
Conclusions

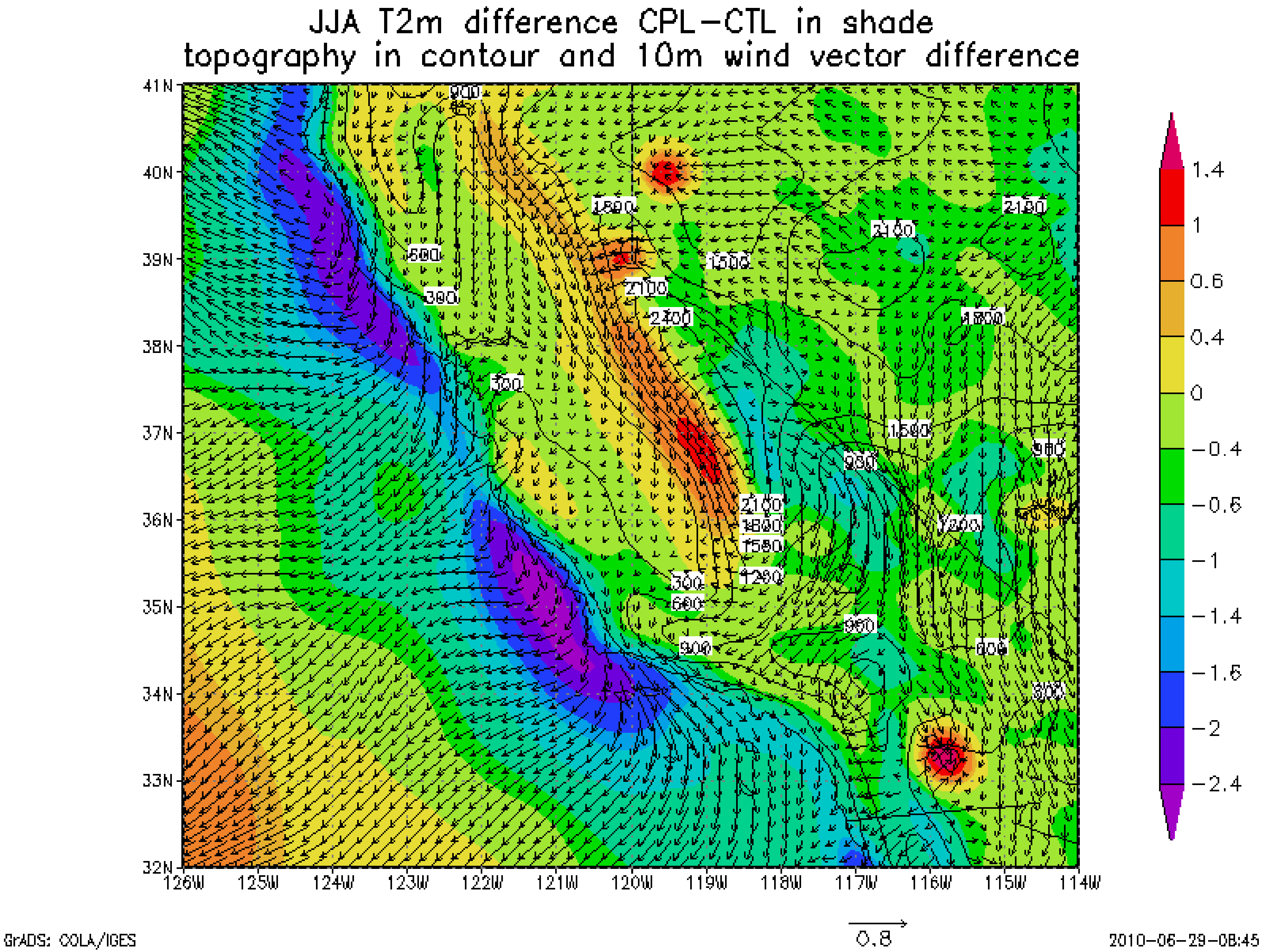
- RSM and ROMS are coupled.
- Parallel coupling is now working, saving wall clock time (but requires more nodes).
- The simulated ocean is reasonable. Analysis is still in progress.
- The impact of coastal SST on atmosphere is significant at some locations.
- We observed a large scale anomalous wind circulation due to much more intense cold SST at the coast, which is caused by the enhanced upwelling.
- More works are needed to examine the impact of coupling on downscaling.

Surface Currents JJA



4*CPL uv0m JJA




JJA T2m difference CPL-CTL in shade
topography in contour and 10m wind vector difference
41N
40N
39N
38N
37N
36N
35N
34N
33N
32N
126W
125W
124W
123W
122W
121W
120W
119W
118W
117W
116W
115W
114W
1.4
1
0.6
0.4
0
-0.4
-0.6
-1
-1.4
-1.6
-2
-2.4
0.8
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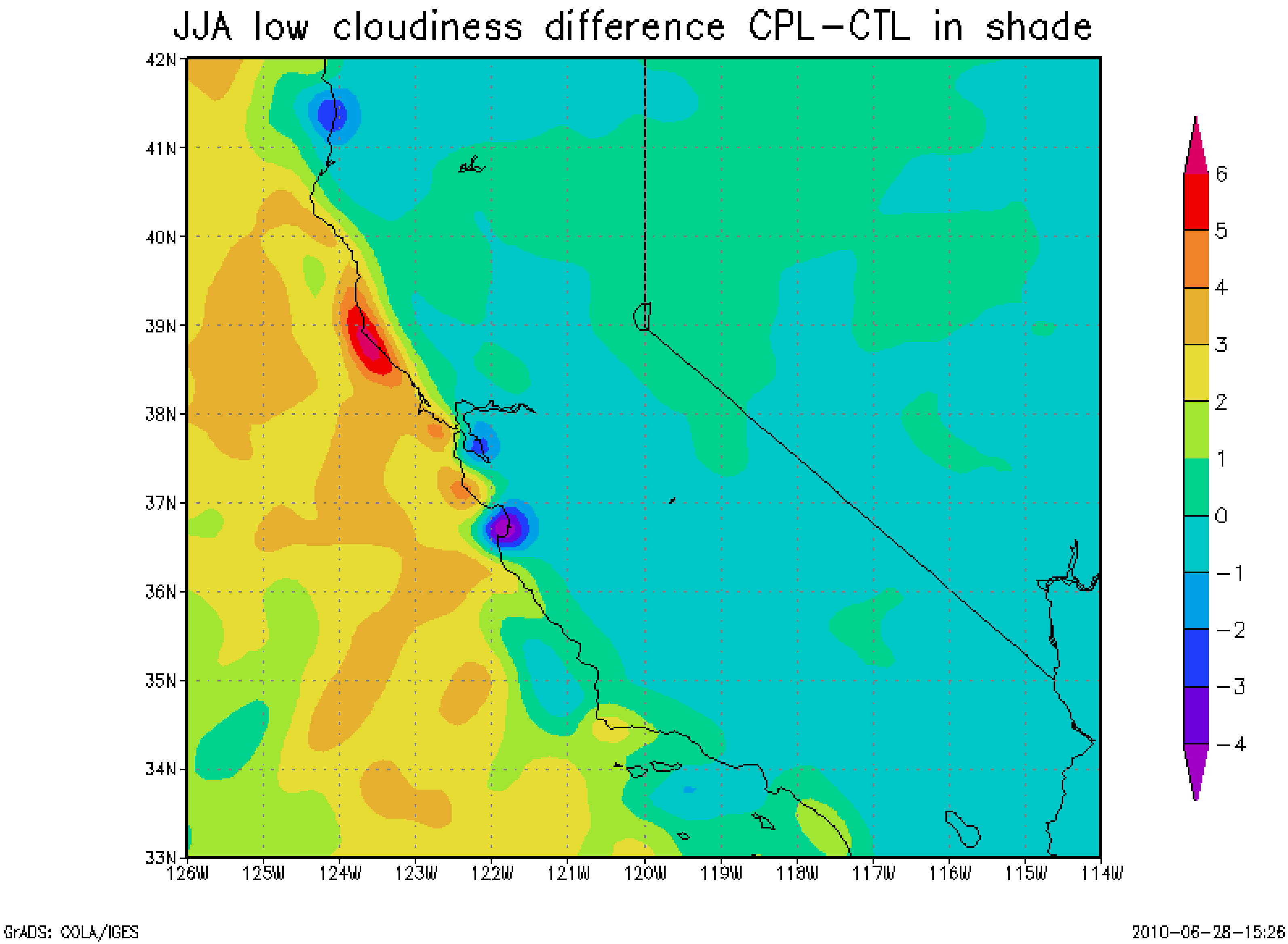
JJA low cloudiness difference CPL-CTL in shade
42N
41N
40N
39N
38N
37N
36N
35N
34N
33N
126W
125W
124W
123W
122W
121W
120W
119W
118W
117W
116W
115W
114W
6
5
4
3
2
1
0
-1
-2
-3
-4
GrADS: COLA/IGES
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