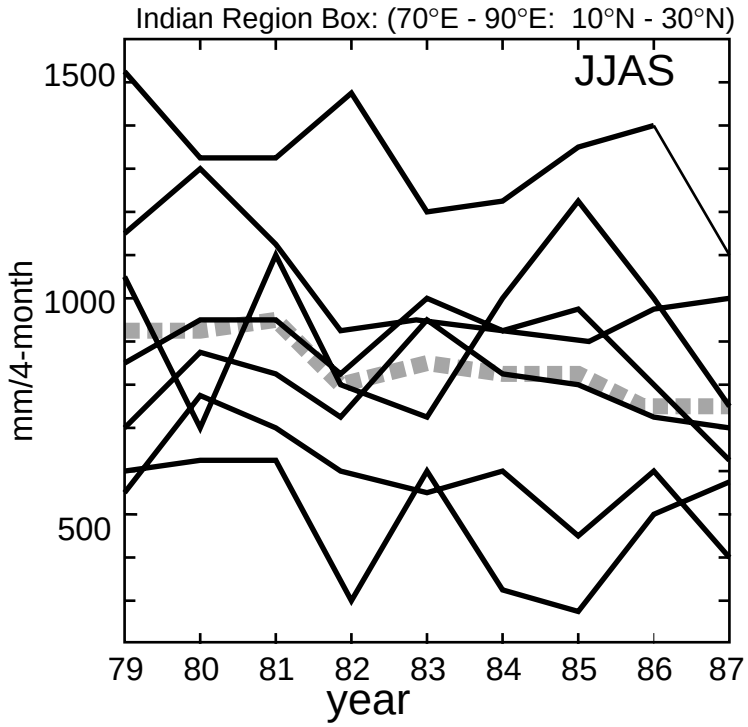
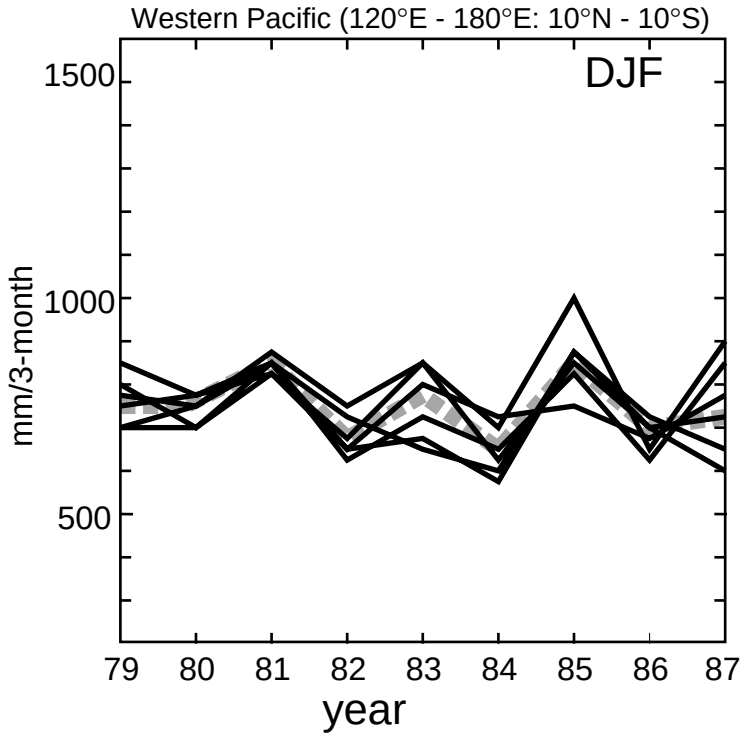
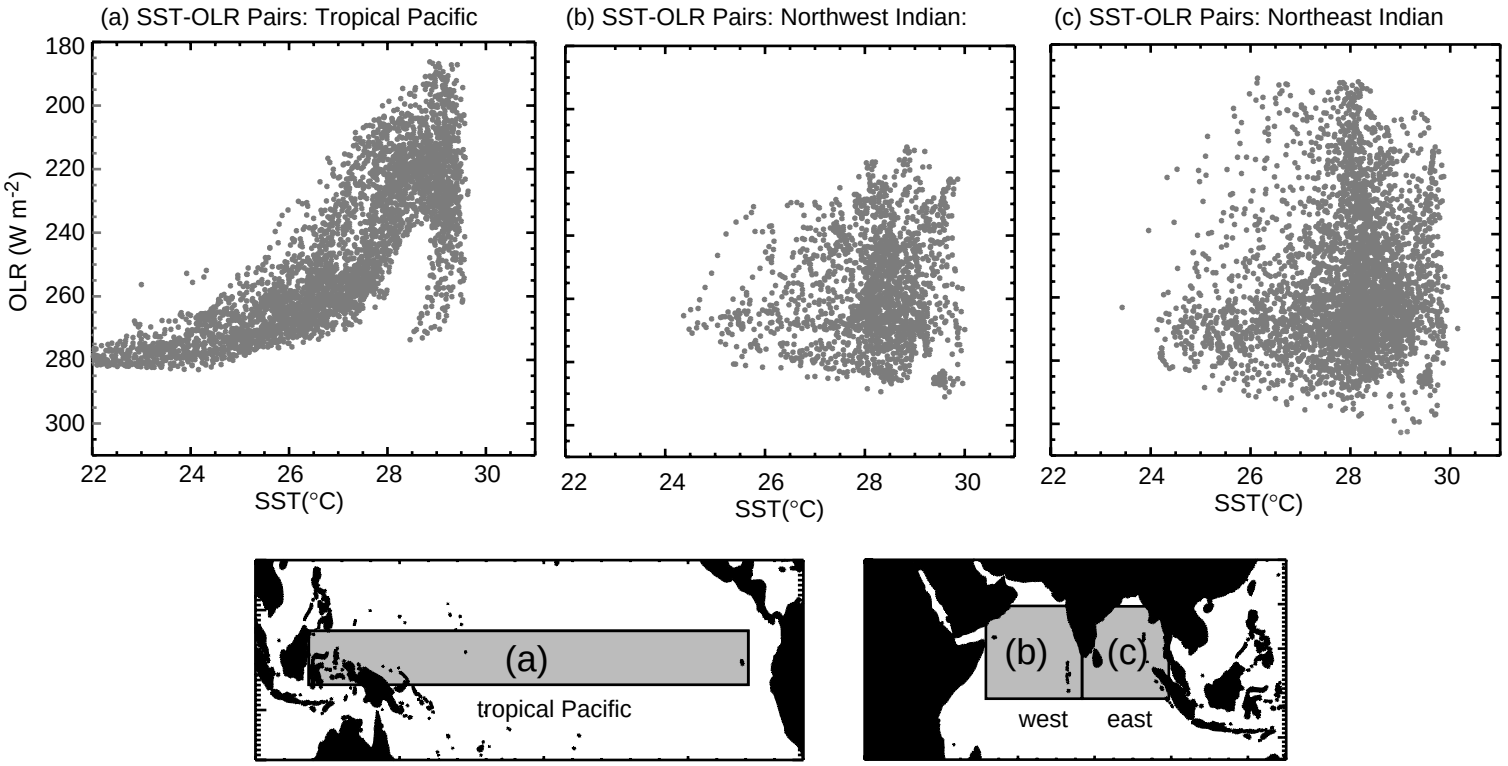
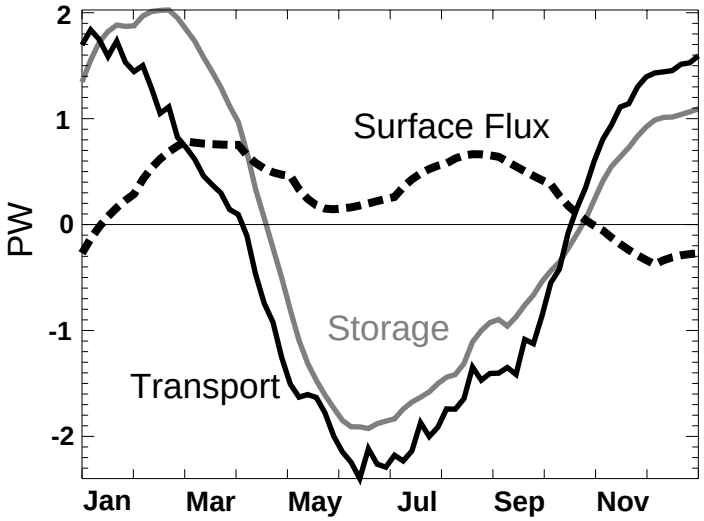

Indian Region Box: (70°E - 90°E: 10°N - 30°N)
JJAS
1500
1000
500
mm/4-month
79
80
81
82
83
84
85
86
87
year

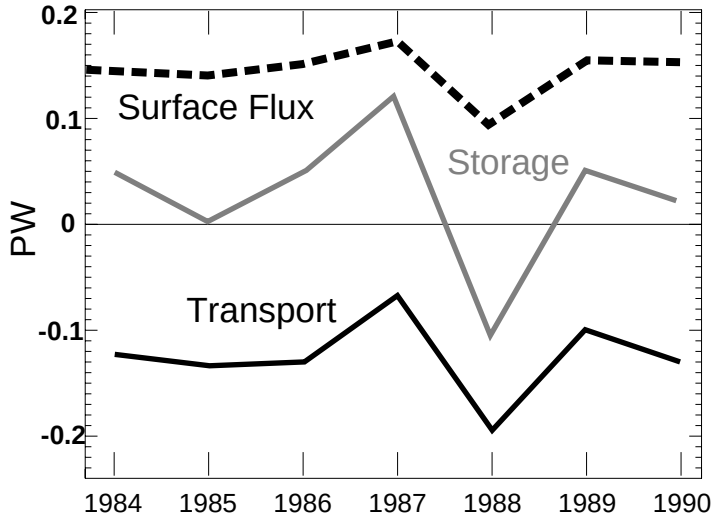

Western Pacific (120°E - 180°E: 10°N - 10°S)
DJF
1500
1000
500
mm/3-month
79
80
81
82
83
84
85
86
87
year


(a) SST-OLR Pairs: Tropical Pacific
(b) SST-OLR Pairs: Northwest Indian:
(c) SST-OLR Pairs: Northeast Indian
OLR (W m-2)
180
200
220
240
260
280
300
22
24
26
28
30
SST(°C)
(a)
tropical Pacific
(b)
(c)
west
east

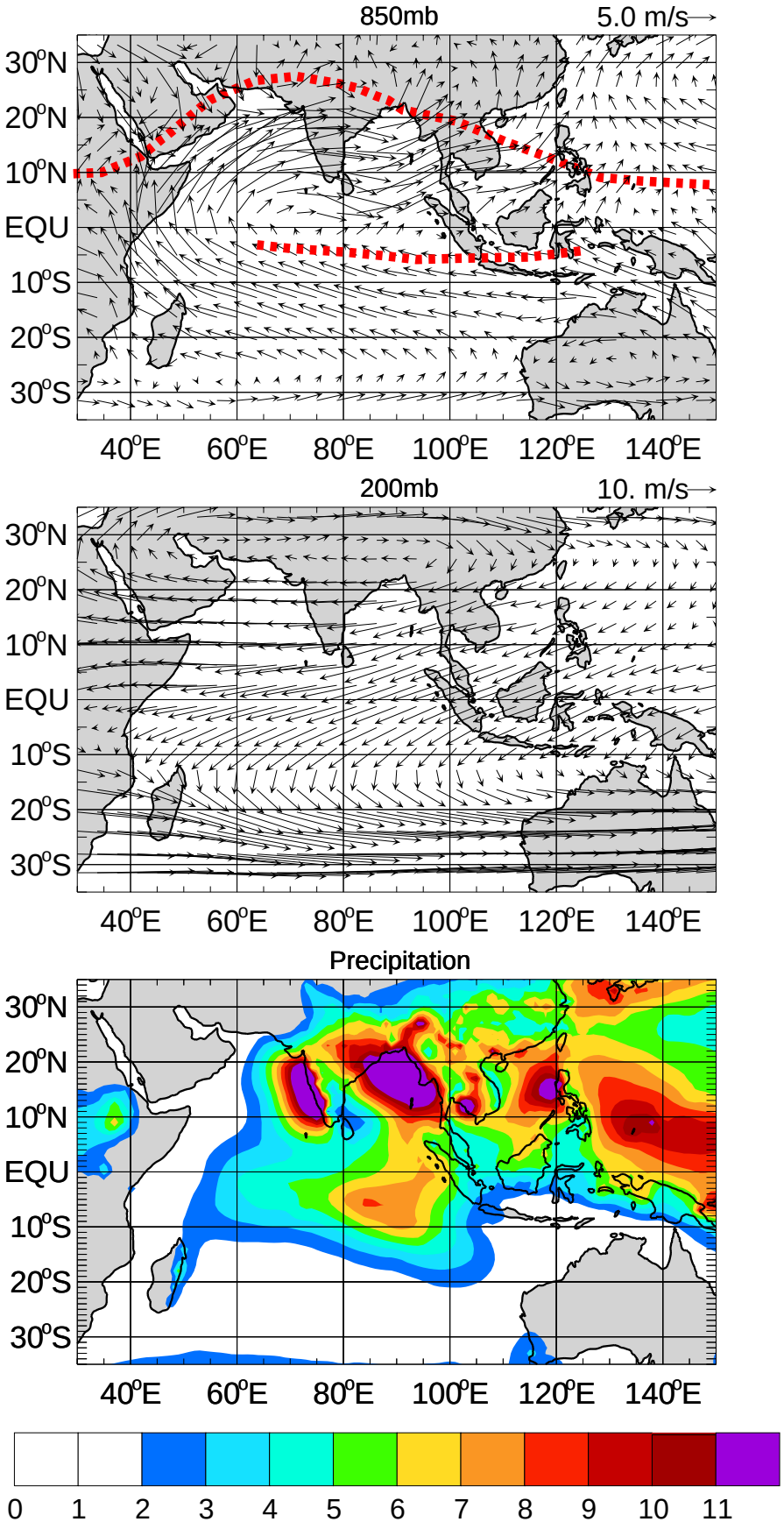
(a) Mean Annual Cycle of Heat Budget of NIO



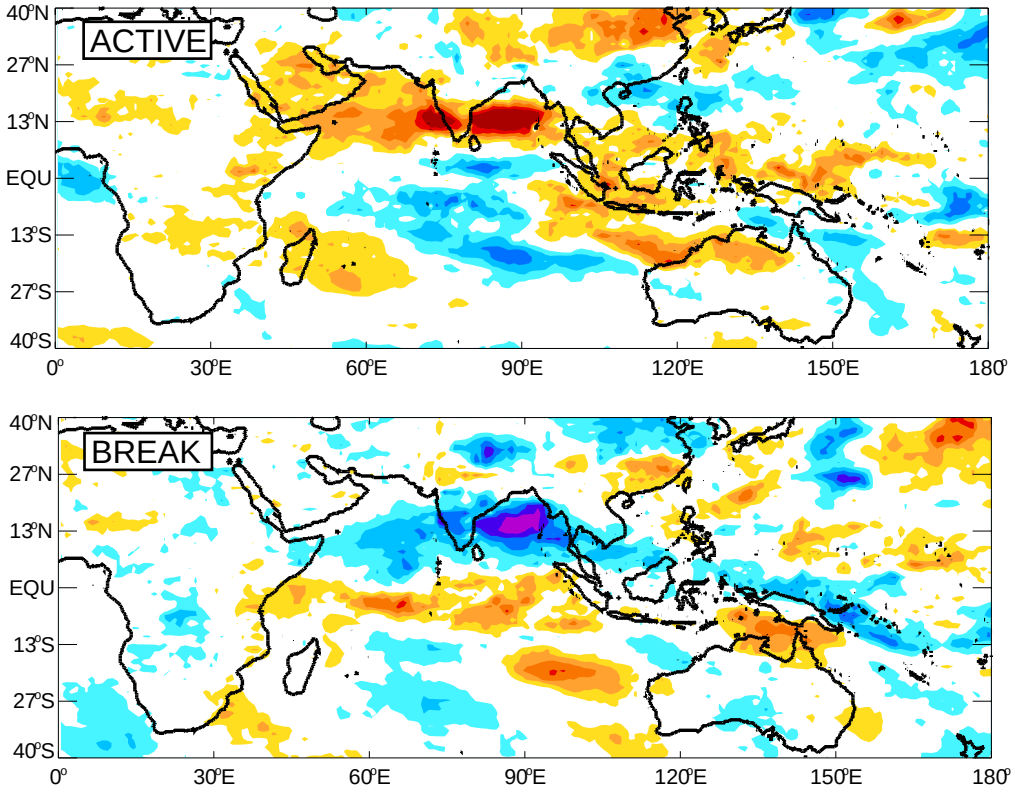
(b) Annual Variation of heat Balance of NIO



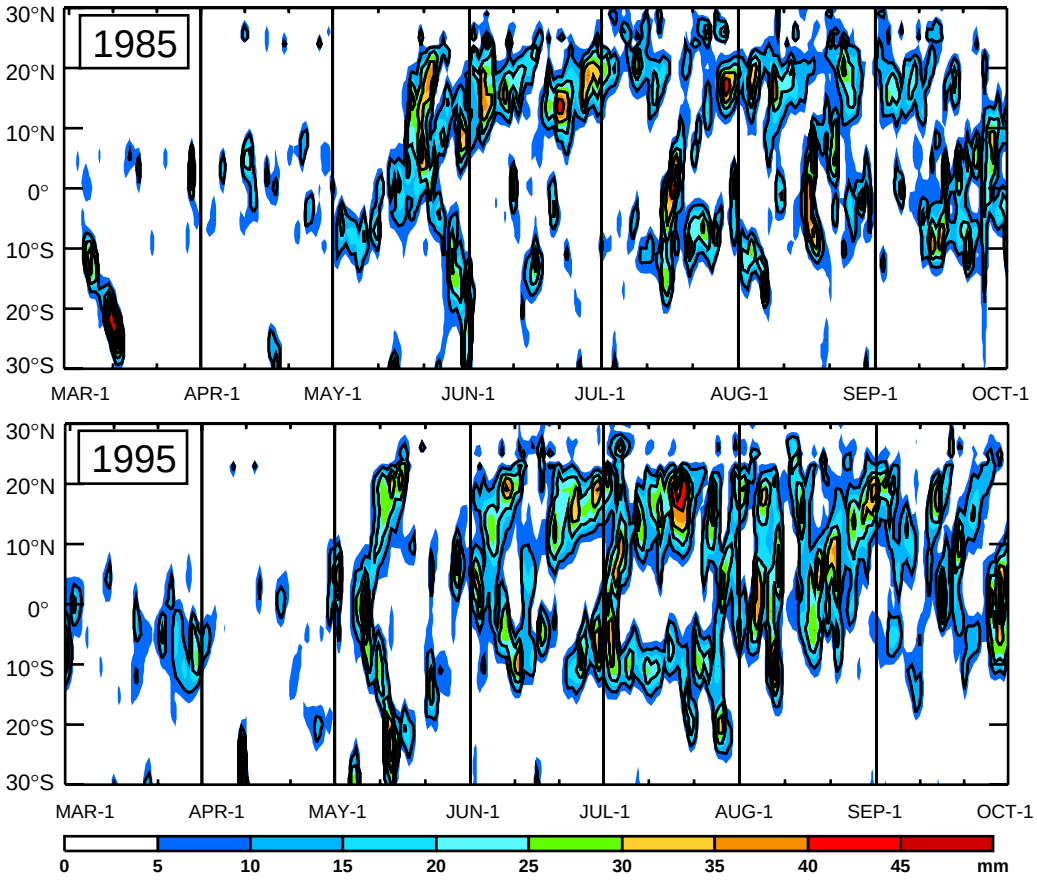
June-August ECMWF Mean Wind
MSU Precipitation (1979-93)

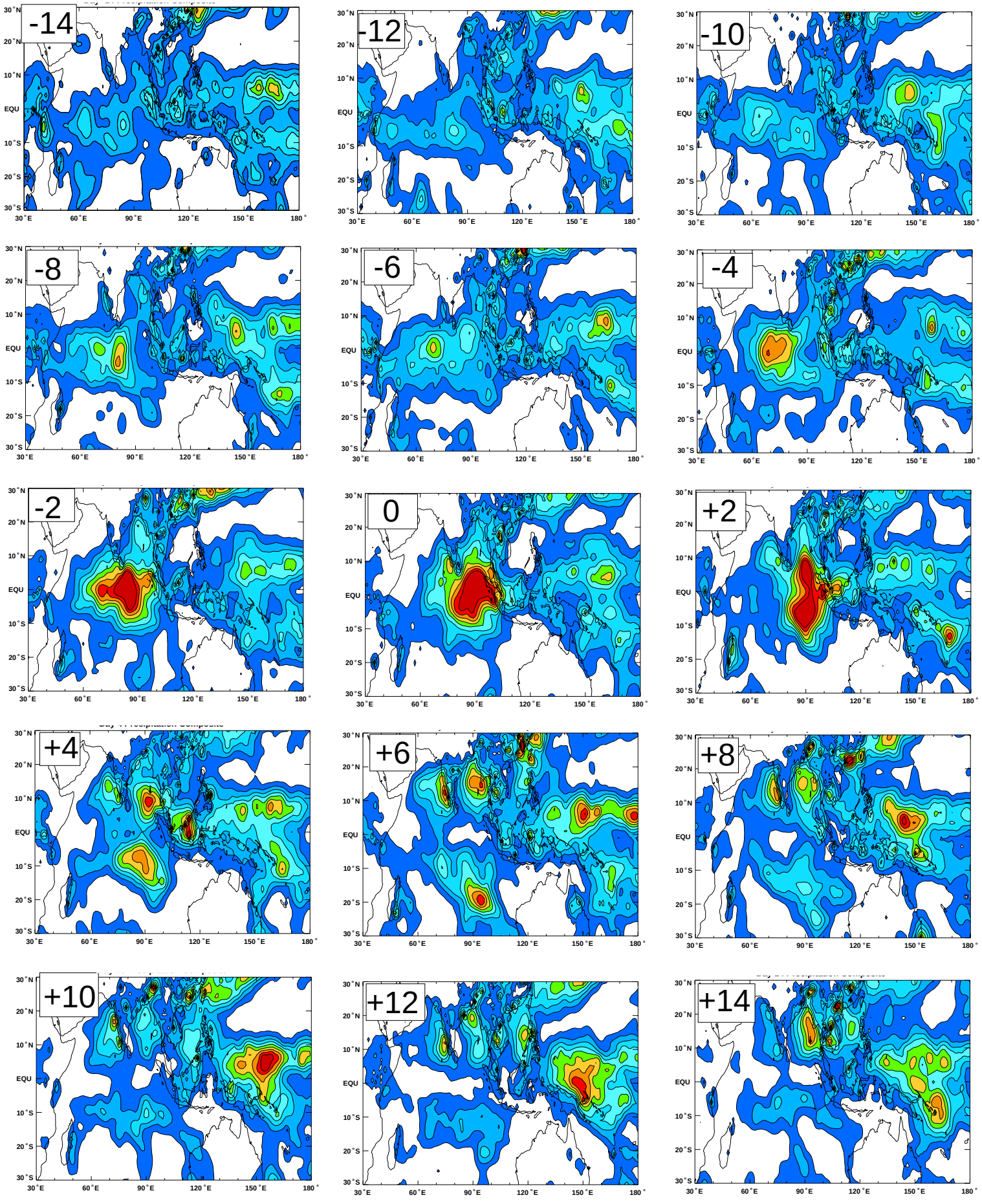


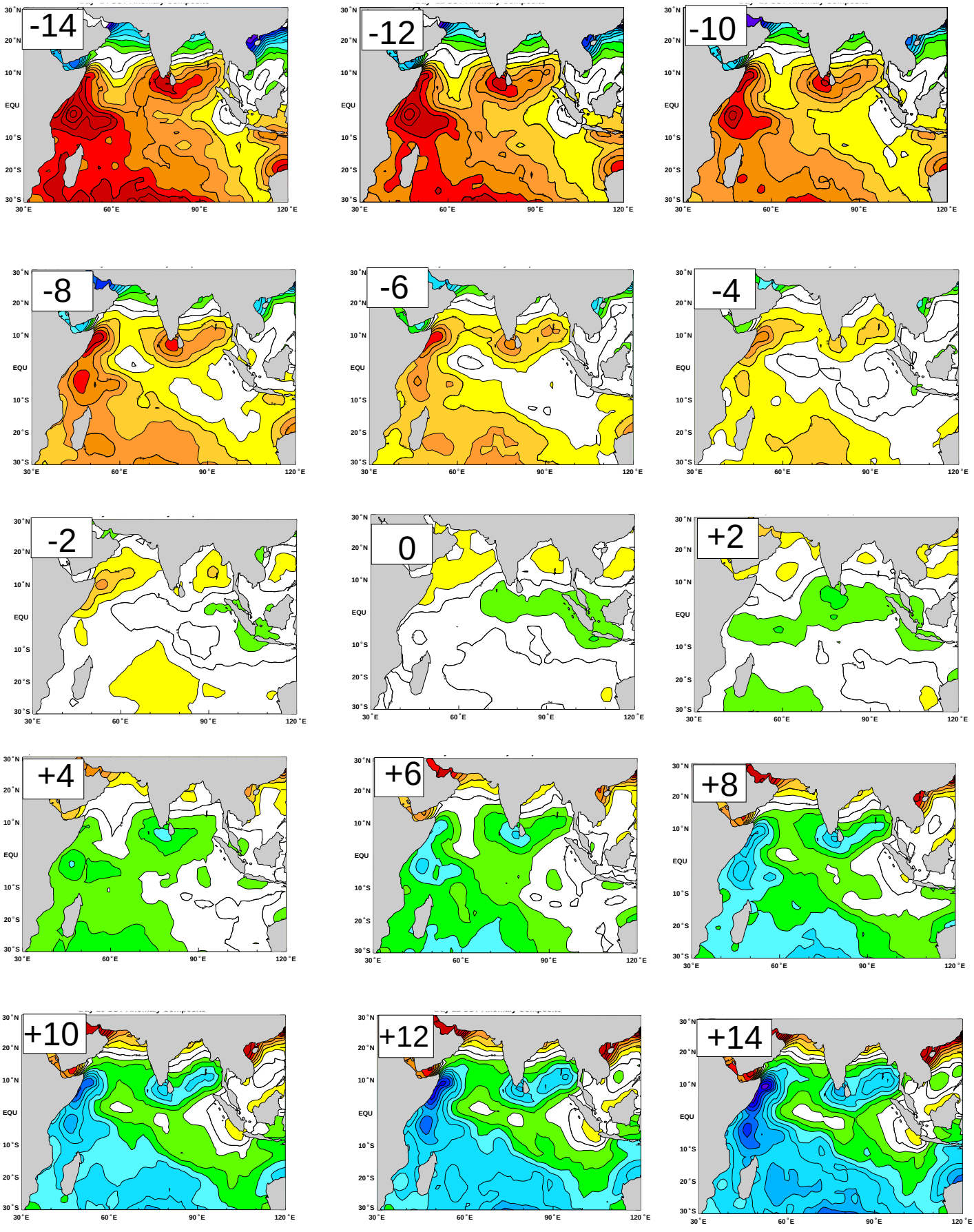
(a) COMPOSITE PRECIPITABLE PWC ANOMALIES (mm)



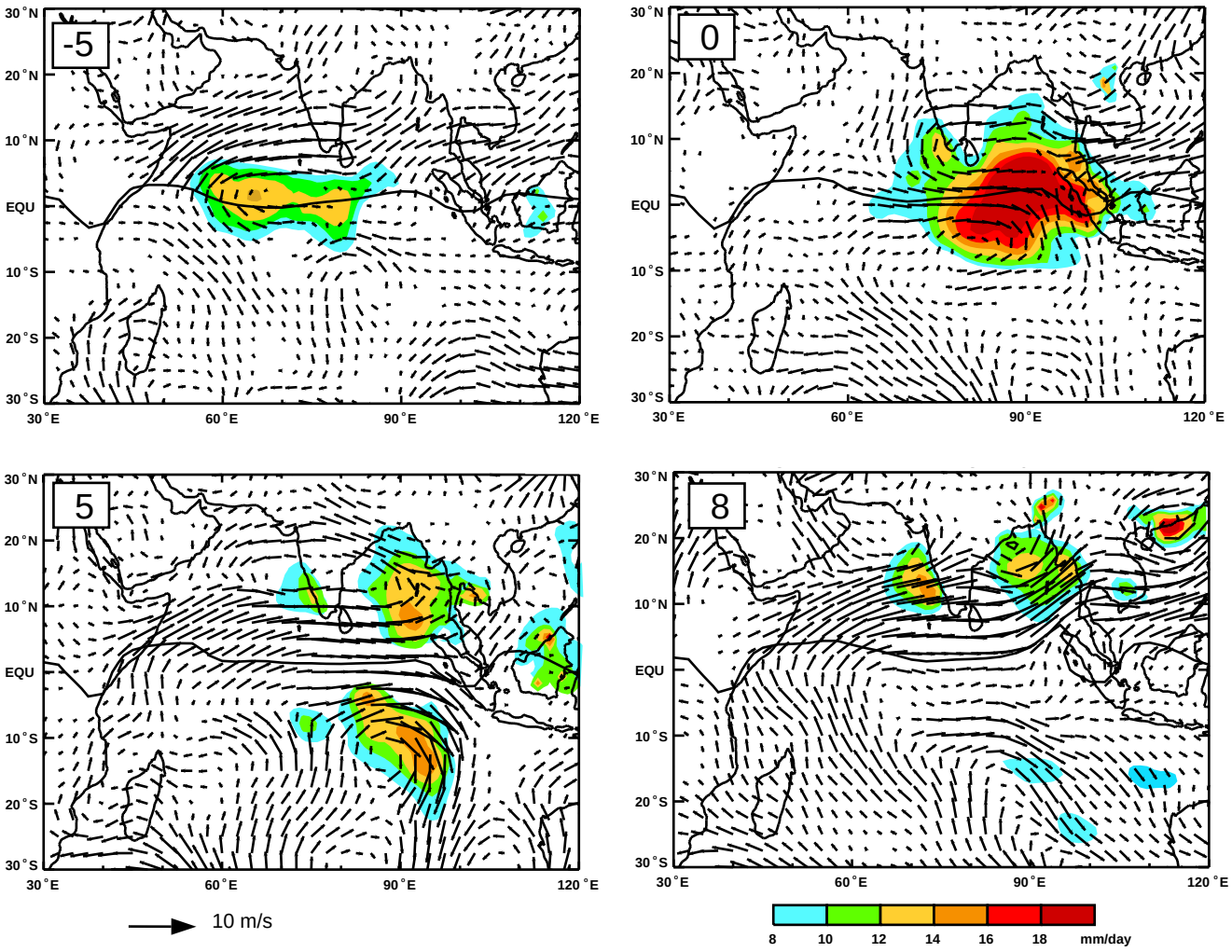
(b) MSU PRECIPTATION RATE ALONG 90°E (mm/day)



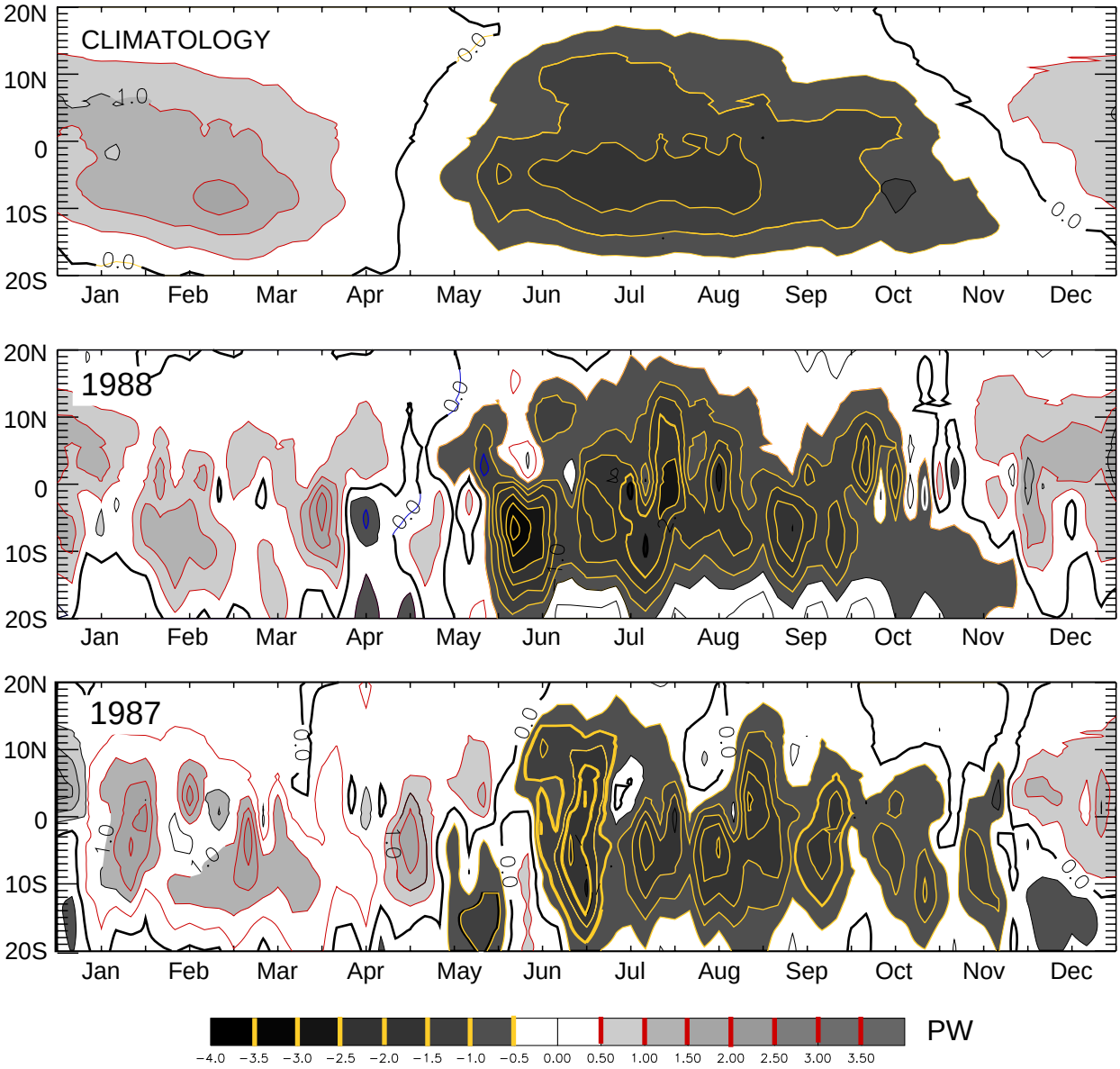

-14
-12
-10
-8
-6
-4
-2
0
+2
+4
+6
+8
+10
+12
+14
30°N
20°N
10°N
EQU
10°S
20°S
30°S
30°E
60°E
90°E
120°E
150°E
180°
0
2
4
6
8
10
12
14
16
18
mm

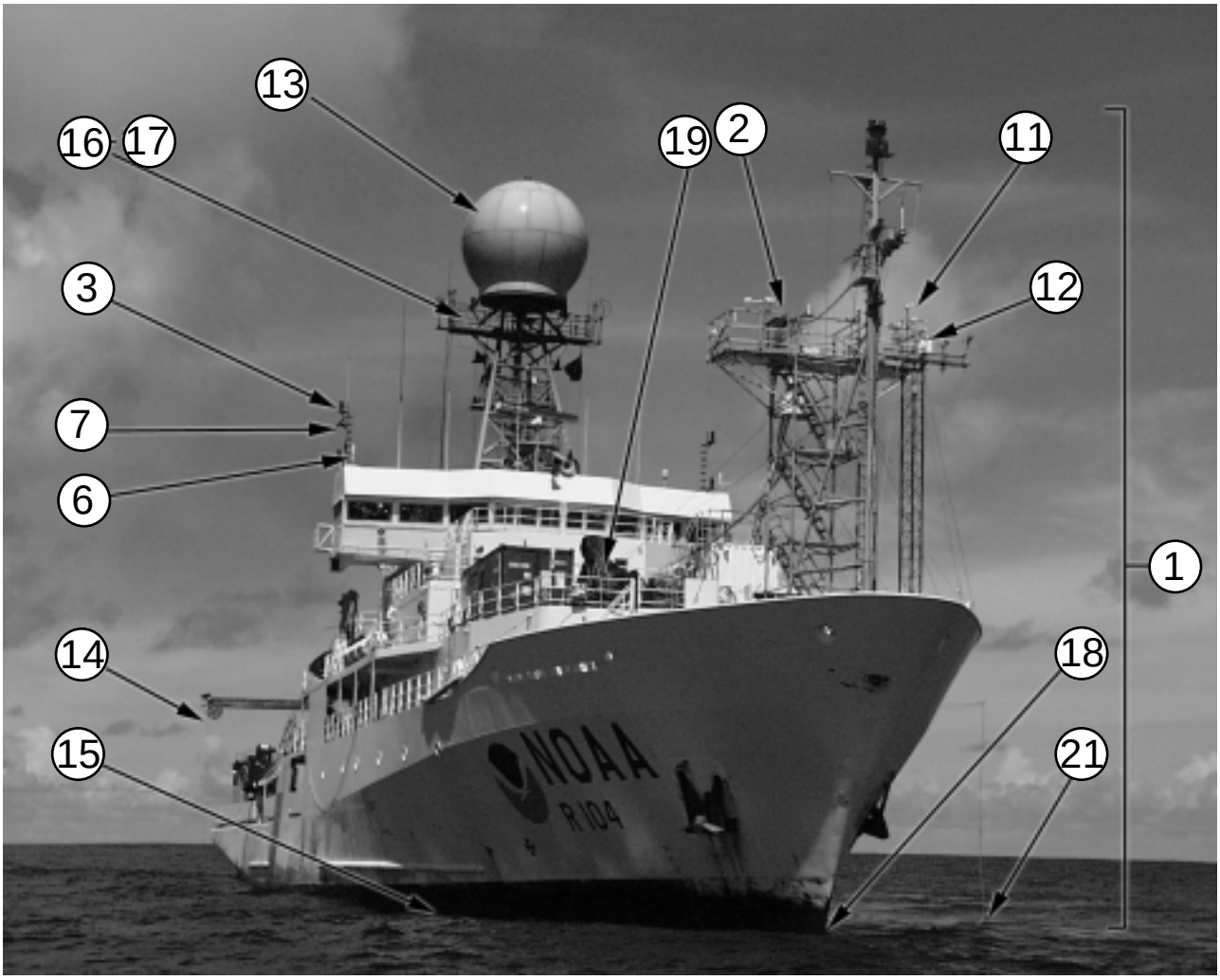

-14
-12
-10
-8
-6
-4
-2
0
+2
+4
+6
+8
+10
+12
+14
30°N
20°N
10°N
EQU
10°S
20°S
30°S
30°E
60°E
90°E
120°E
-1.1
-0.9
-0.7
-0.5
-0.3
-0.1
0.1
0.3
0.5
°C

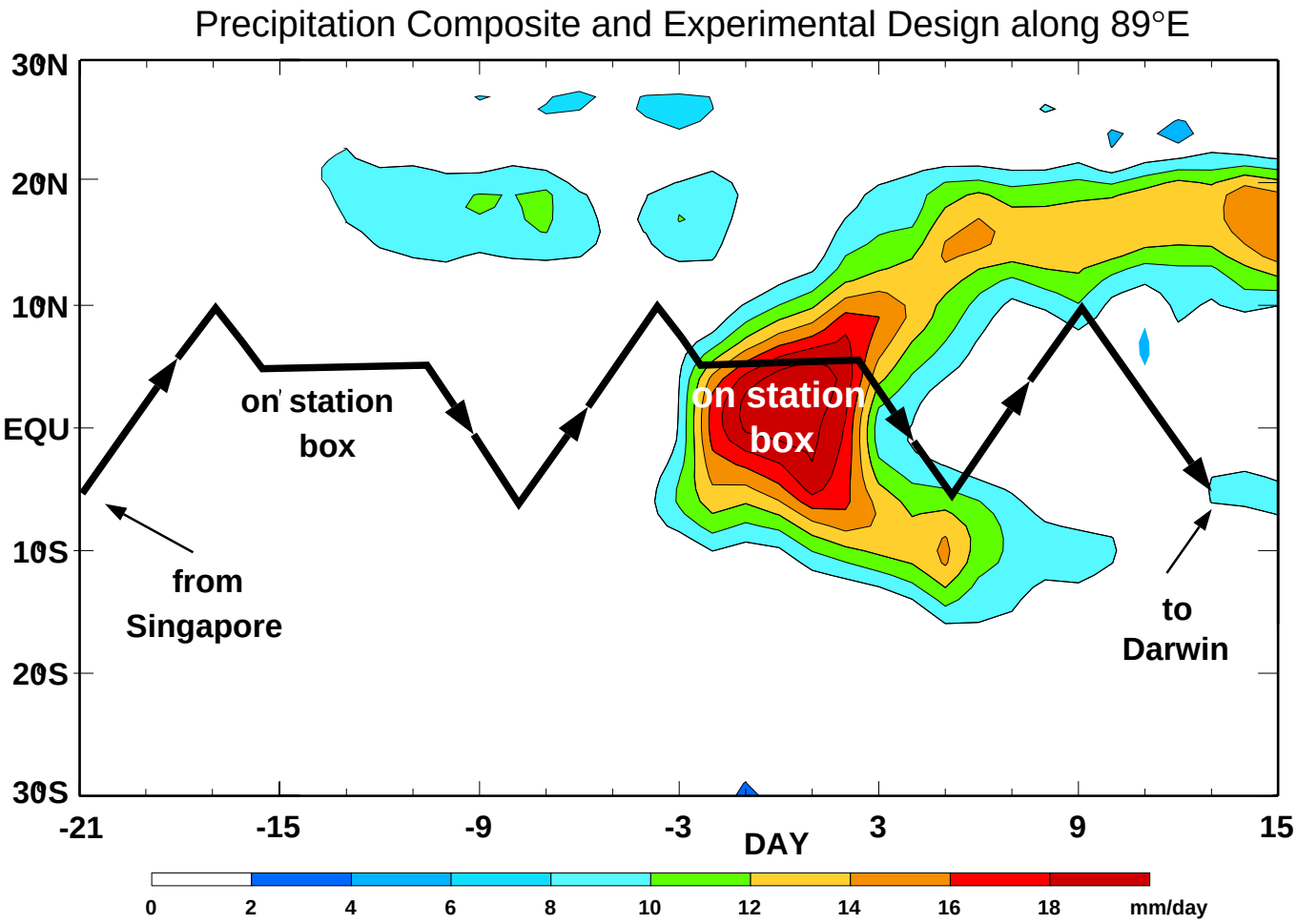
Composite 925 mb wind vectors and precipitation (>8mm/day)

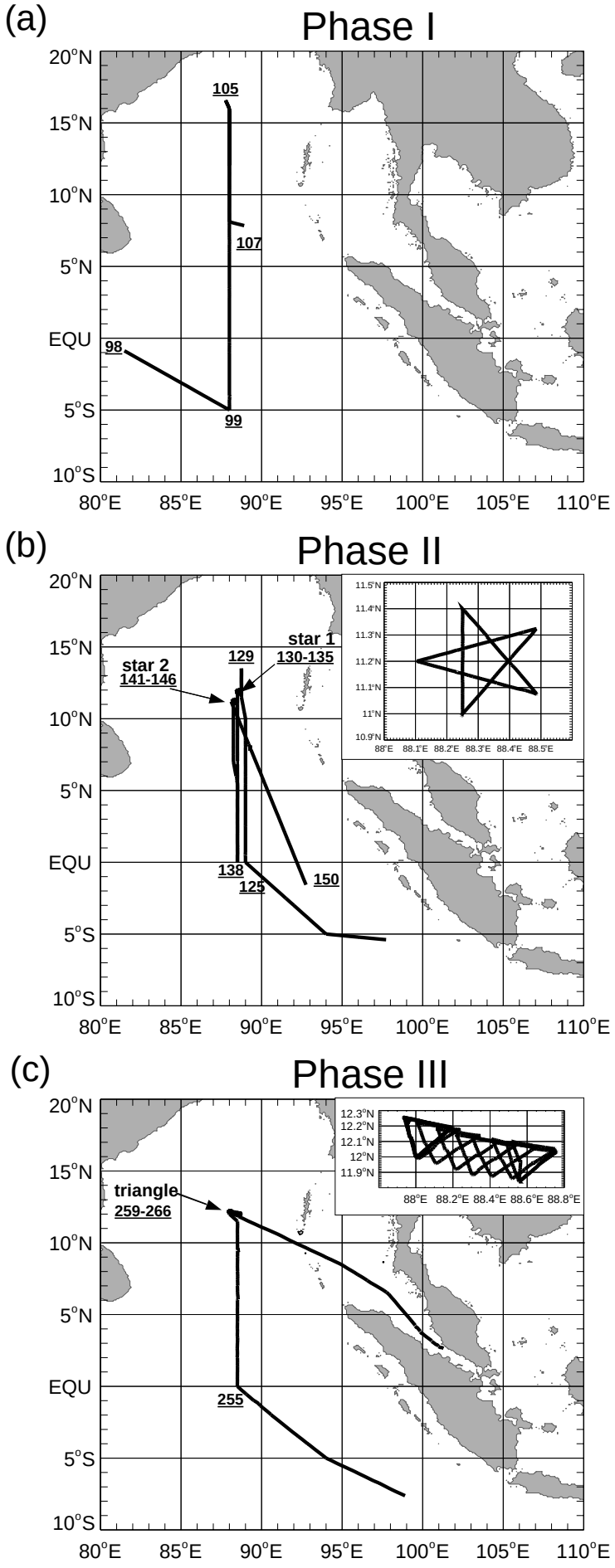


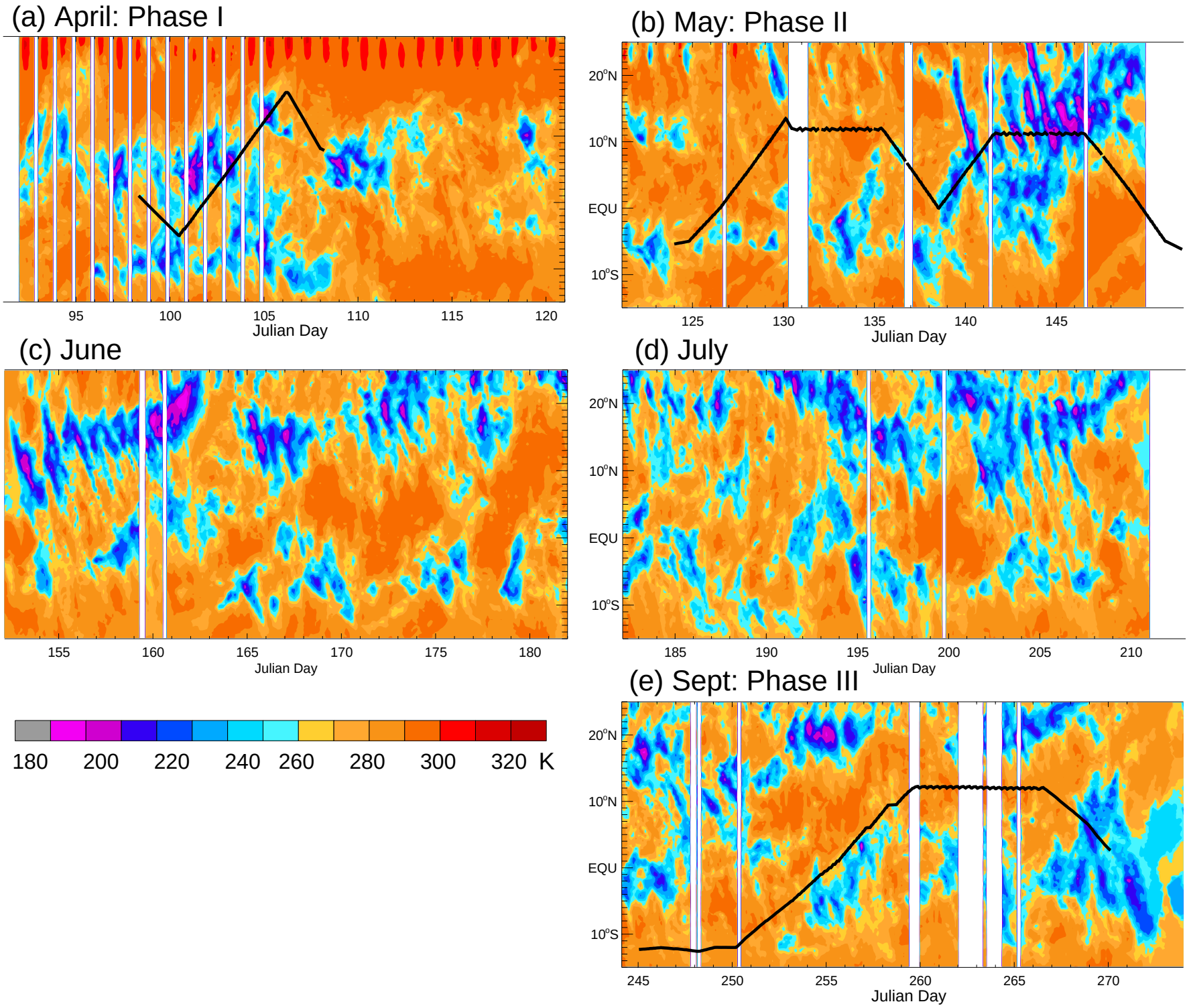
Zonally intergrated ocean heat flux (PW)

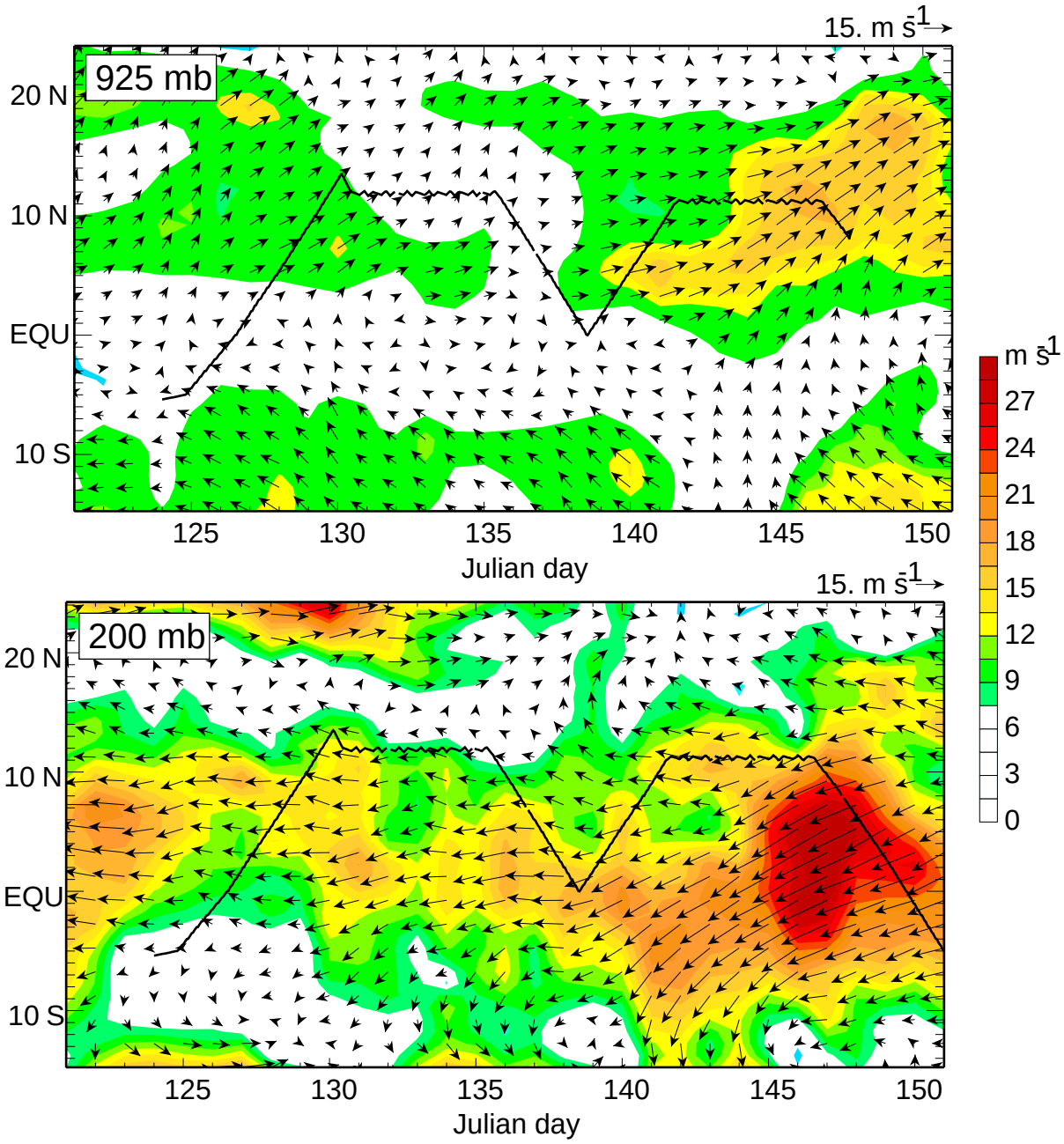



13
16
17
19
2
11
3
12
7
6
1
14
18
15
21
NOAA
R104

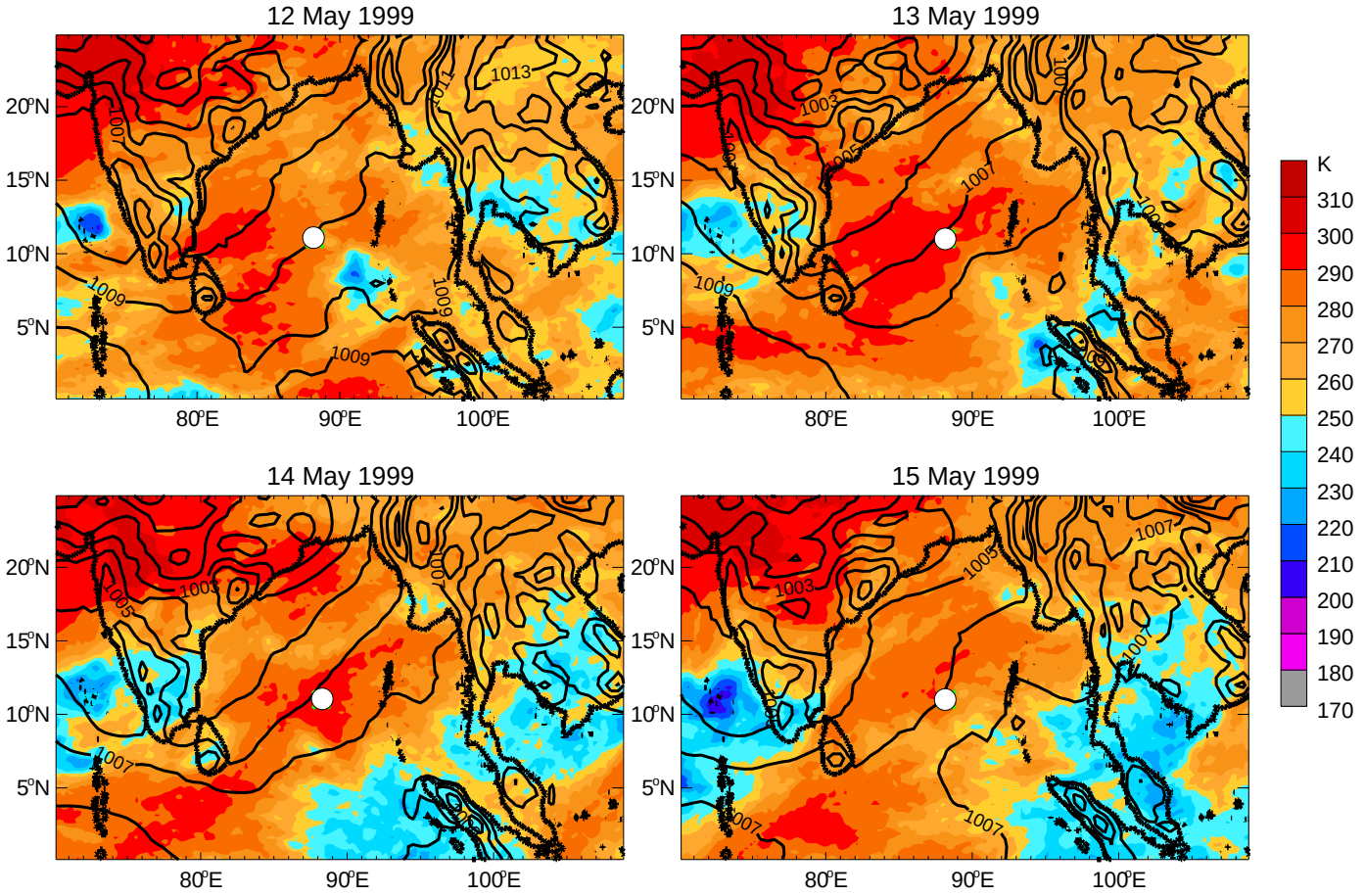

Precipitation Composite and Experimental Design along 89°E
30N
20N
10N
EQU
10S
20S
30S
-21
-15
-9
-3
3
9
15
DAY
on station box
on station box
from Singapore
to Darwin
0
2
4
6
8
10
12
14
16
18
mm/day


(a)
Phase I
105
107
98
99
(b)
Phase II
star 1
130-135
star 2
141-146
129
138
125
150
(c)
Phase III
triangle
259-266
255
20°N
15°N
10°N
5°N
EQU
5°S
10°S
80°E
85°E
90°E
95°E
100°E
105°E
110°E

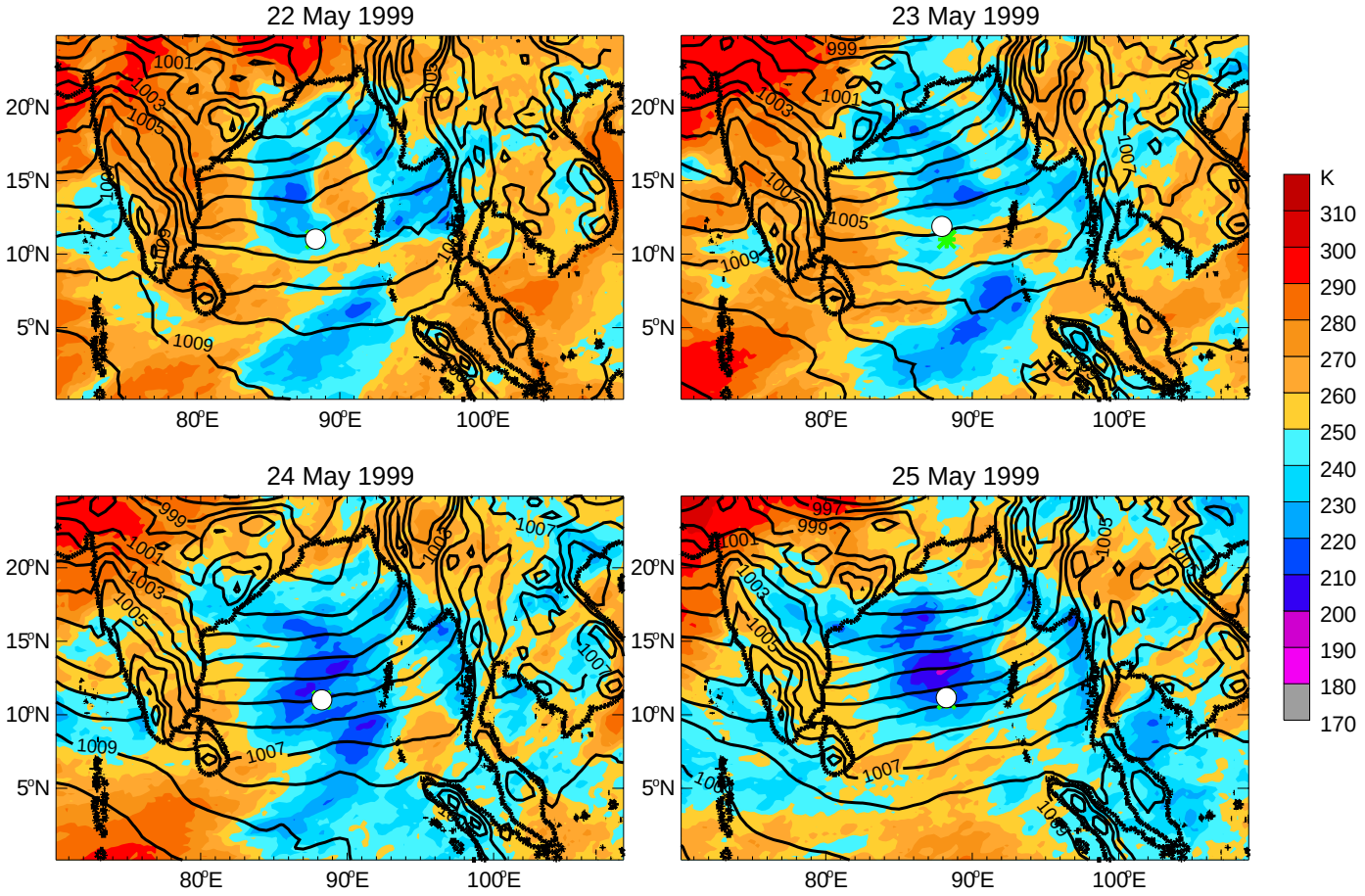

(a) April: Phase I
95
100
105
110
115
120
Julian Day
(b) May: Phase II
20°N
10°N
EQU
10°S
125
130
135
140
145
Julian Day
(c) June
155
160
165
170
175
180
Julian Day
(d) July
20°N
10°N
EQU
10°S
185
190
195
200
205
210
Julian Day
(e) Sept: Phase III
20°N
10°N
EQU
10°S
245
250
255
260
265
270
Julian Day
180
200
220
240
260
280
300
320
K

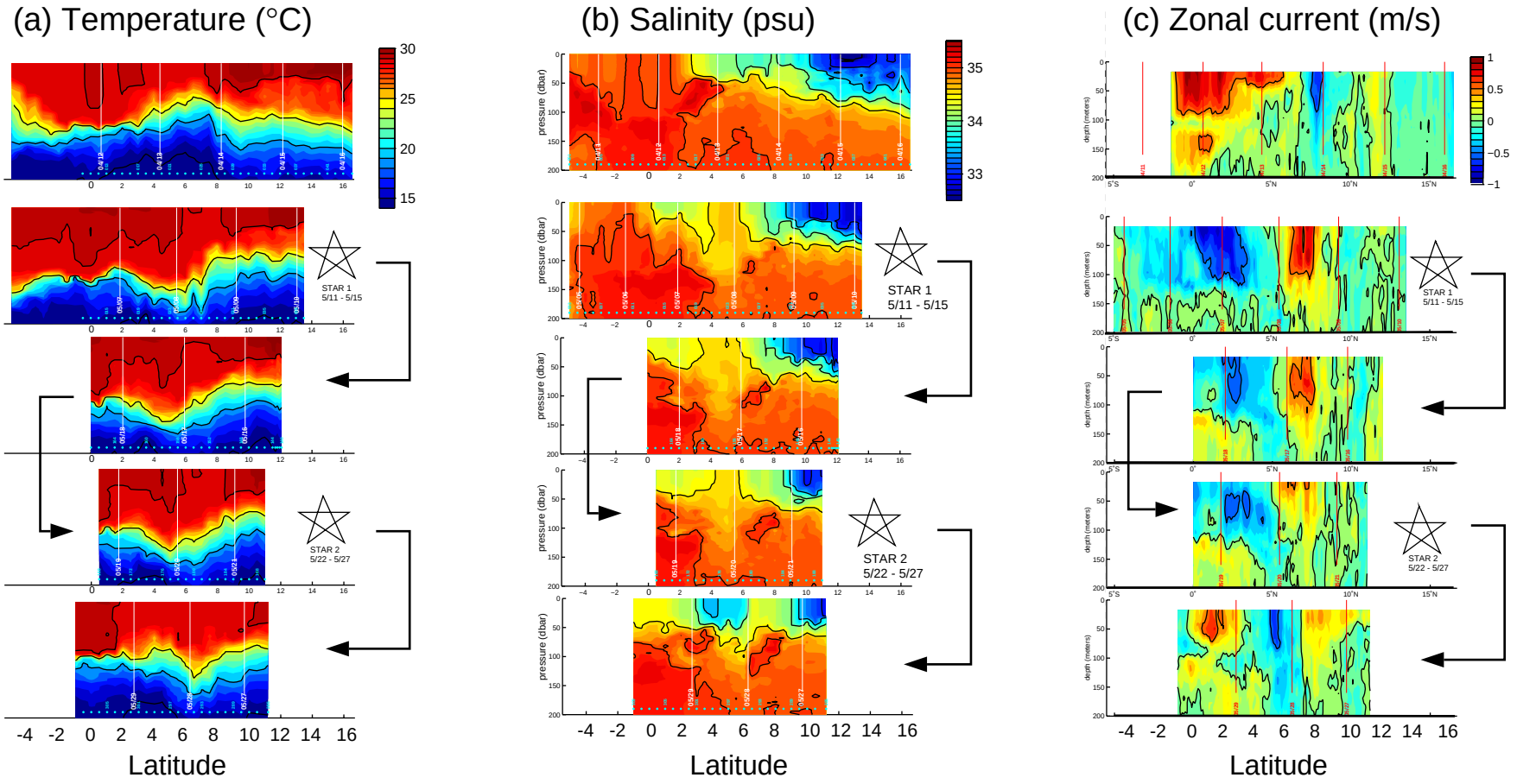

15. m s-1
925 mb
20 N
10 N
EQU
10 S
125
130
135
140
145
150
Julian day
15. m s-1
200 mb
20 N
10 N
EQU
10 S
125
130
135
140
145
150
Julian day
m s-1
27
24
21
18
15
12
9
6
3
0

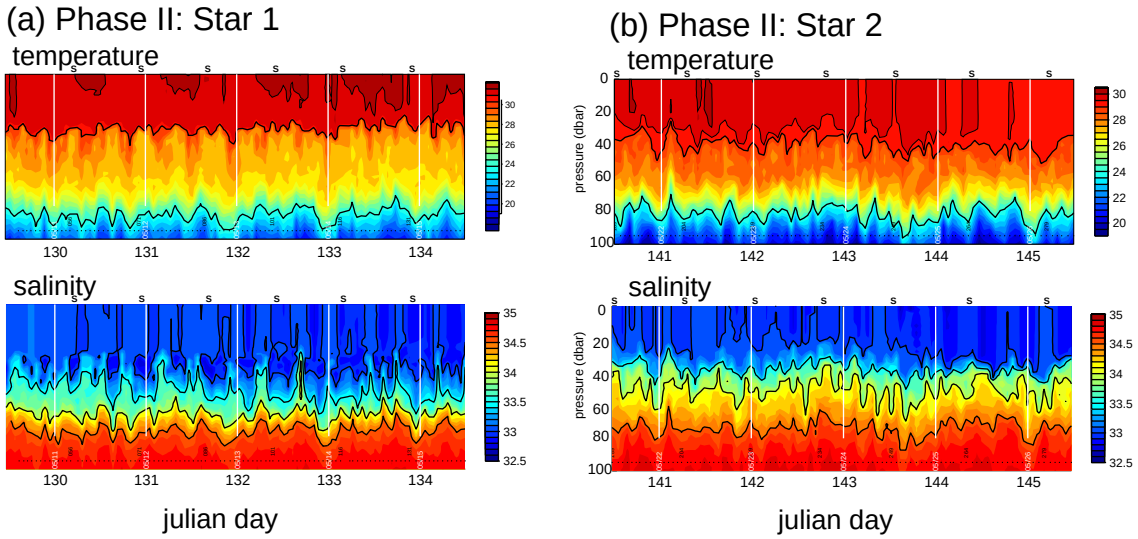
(a) Star 1: Brightness Temperature and SLP

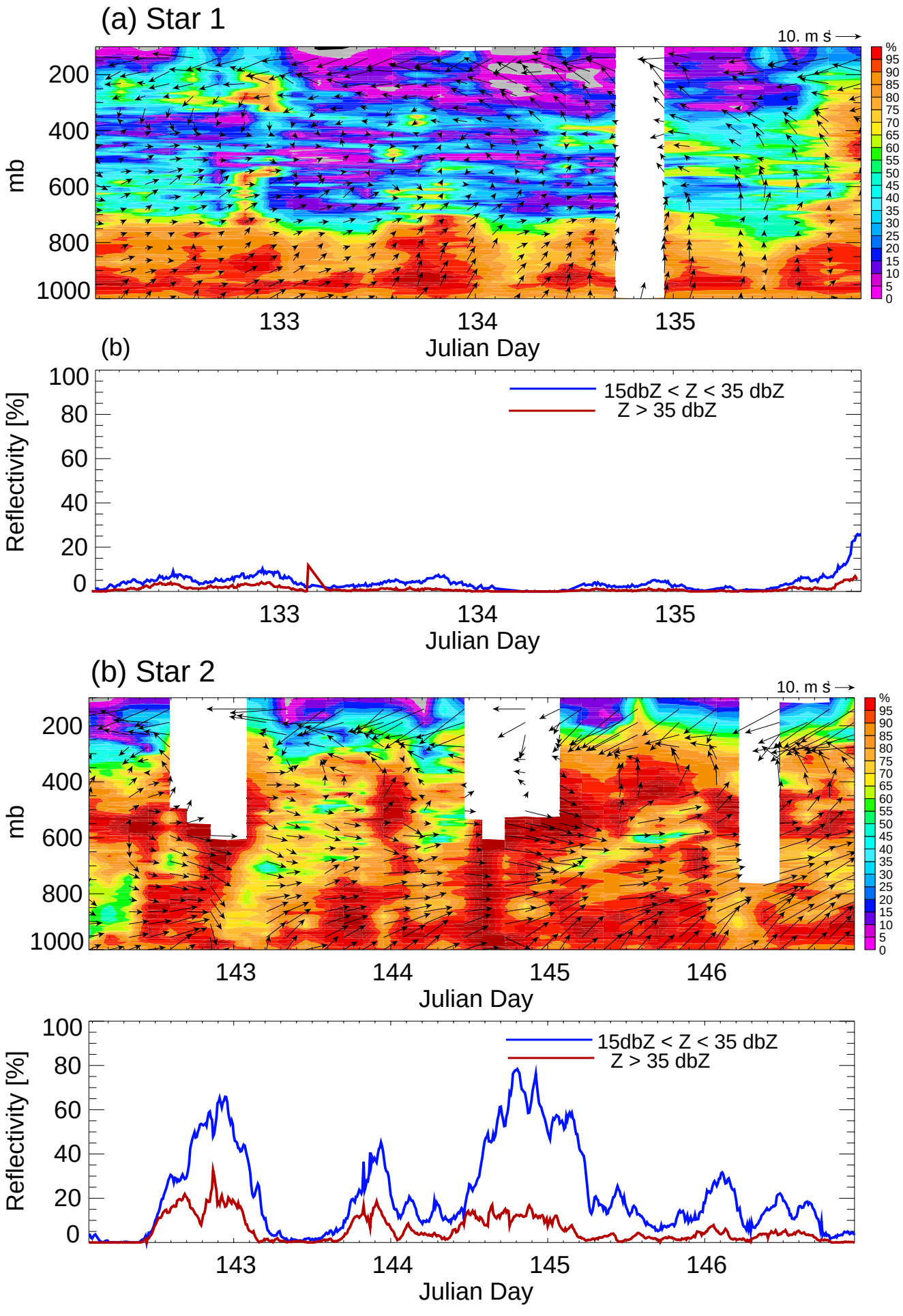


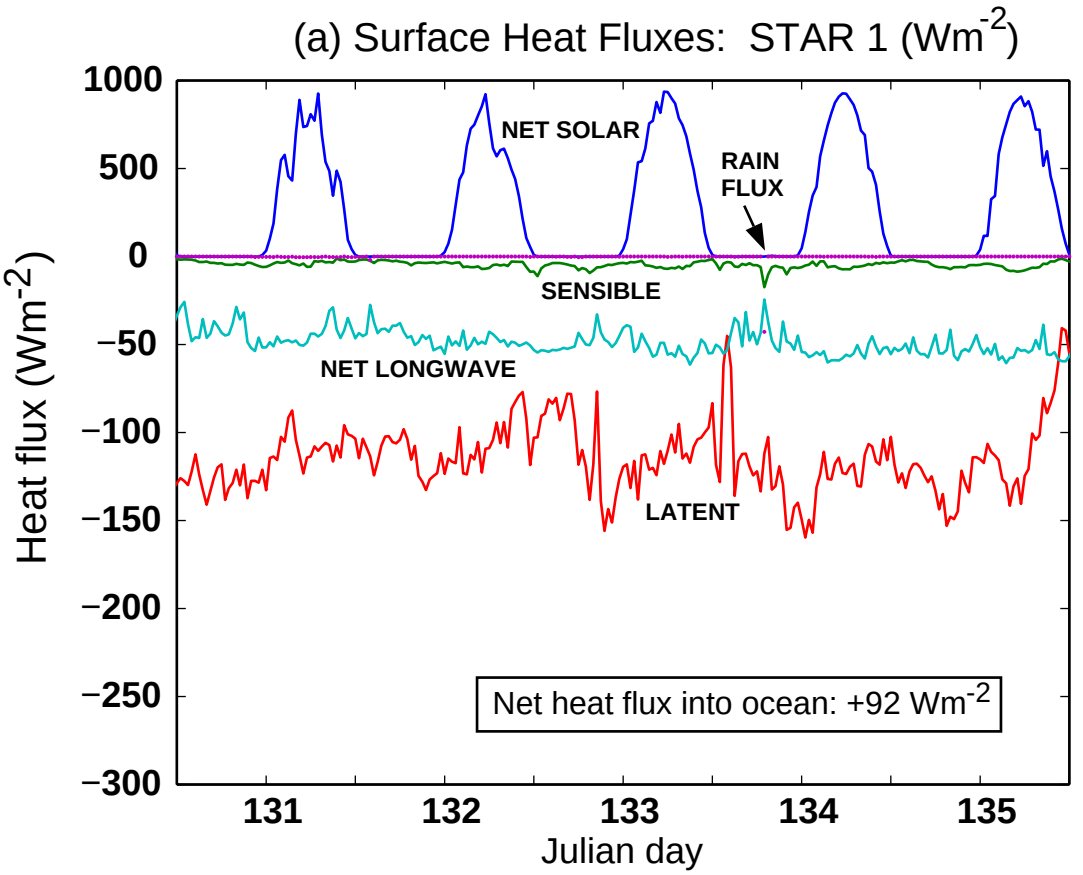
(b) Star 2: Brightness Temperature and SLP

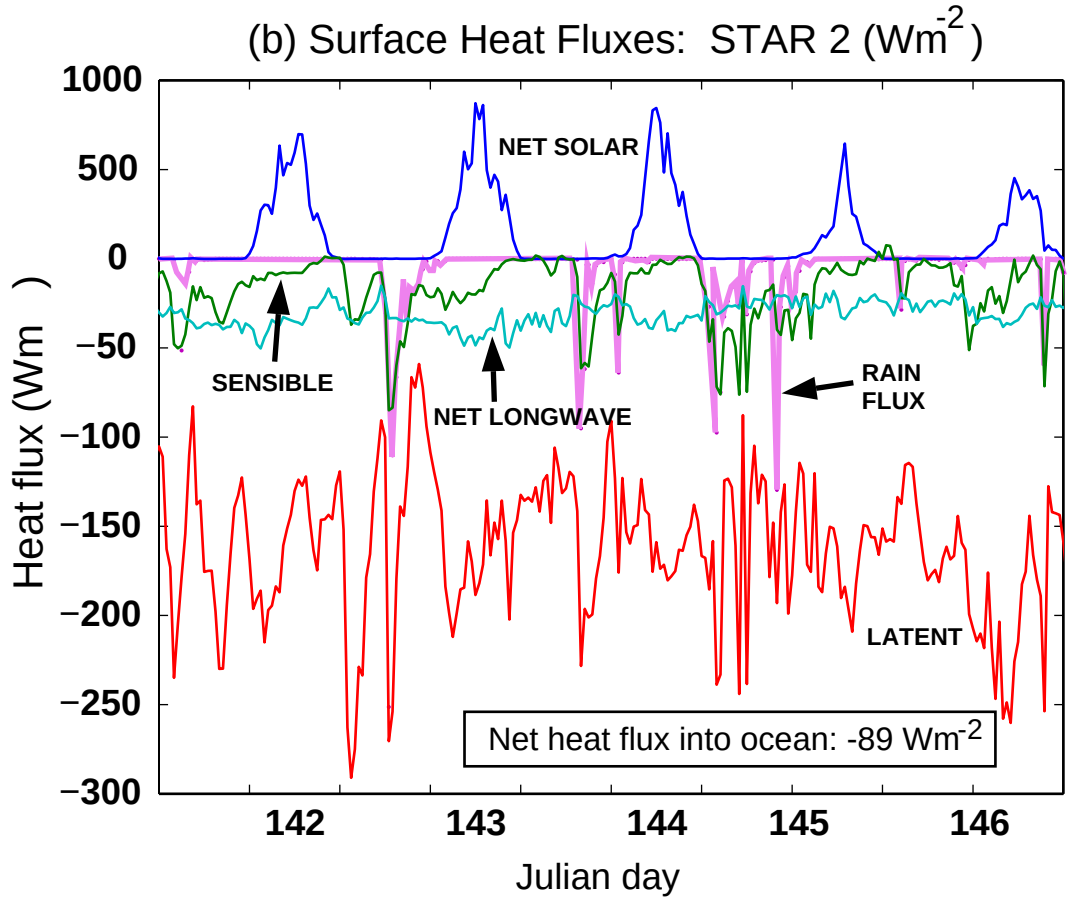


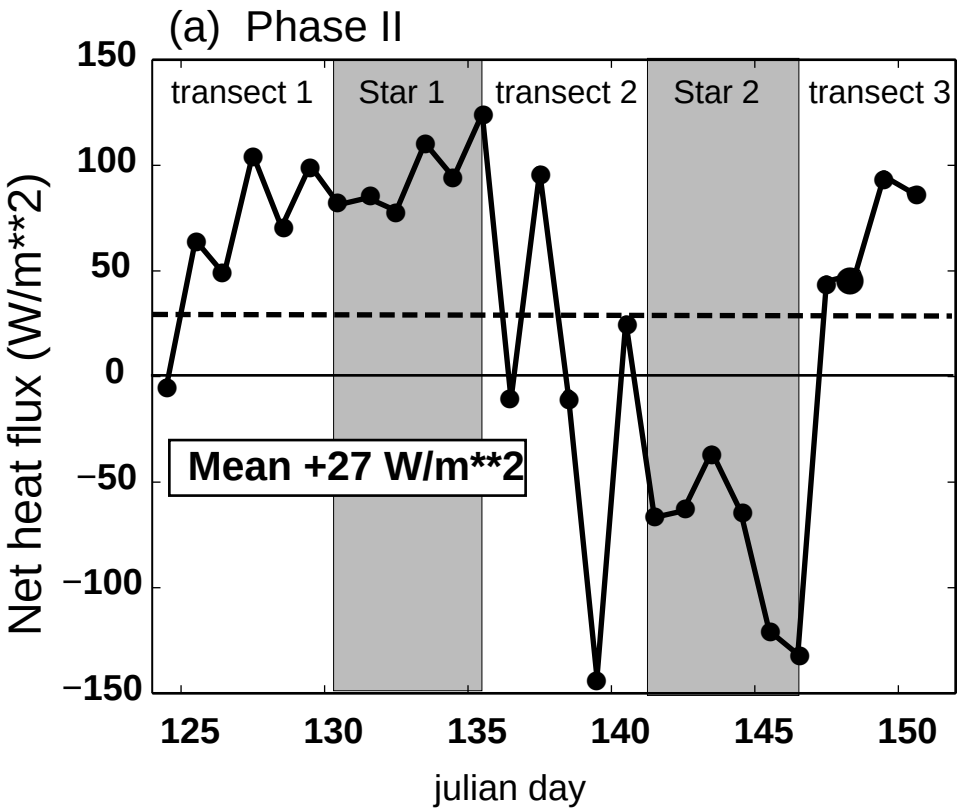

(a) Temperature (°C)
(b) Salinity (psu)
(c) Zonal current (m/s)
STAR 1
5/11 - 5/15
STAR 2
5/22 - 5/27
pressure (dbar)
depth (meters)
Latitude

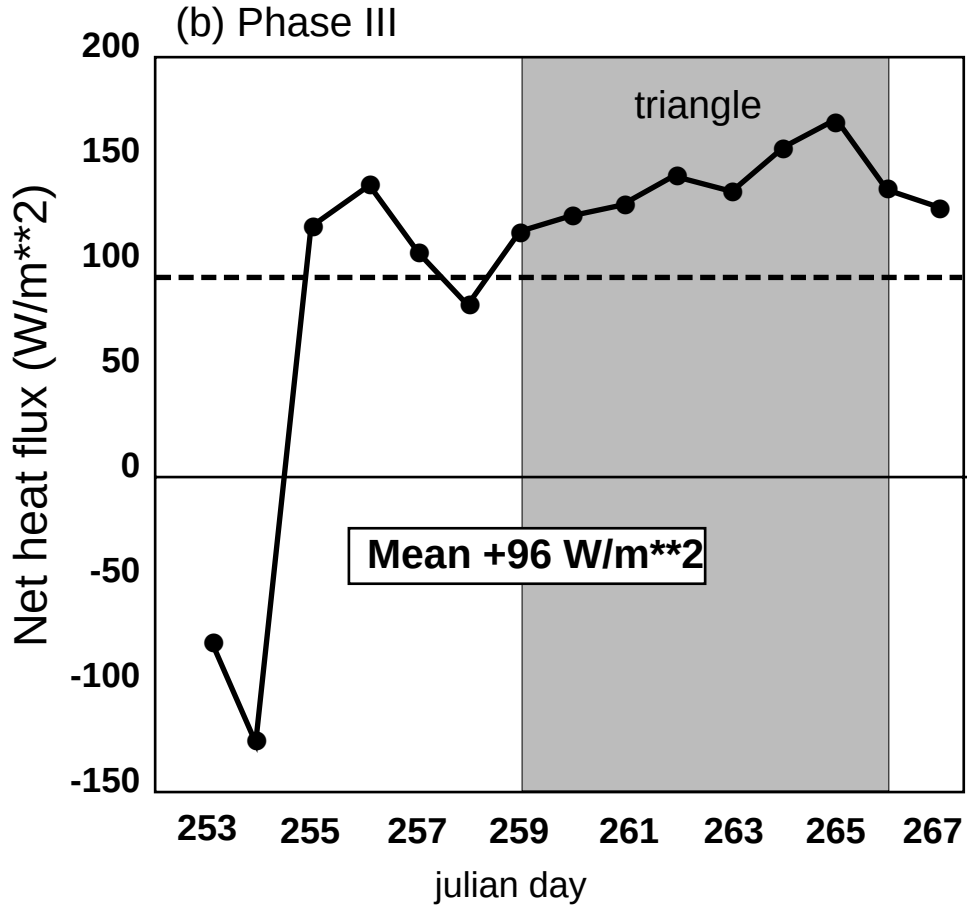

(a) Phase II: Star 1
temperature
salinity
julian day
(b) Phase II: Star 2
temperature
salinity
pressure (dbar)
julian day
(c) Phase III: Triangle
temperature
salinity
Depth (m)
julian day

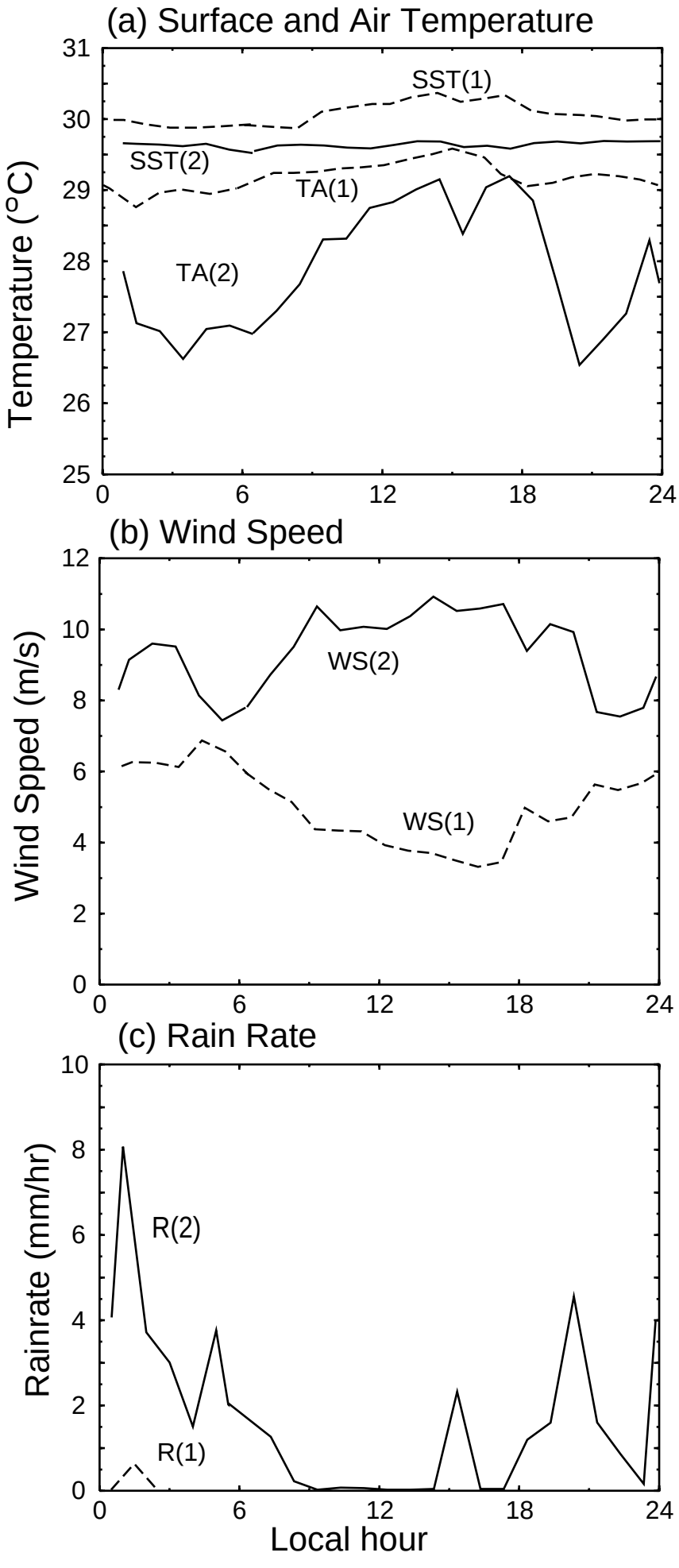

(a) Star 1
10. m s⁻¹
mb
200
400
600
800
1000
%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
133
134
135
Julian Day
(b)
Reflectivity [%]
100
80
60
40
20
0
15dbZ < Z < 35 dbZ
Z > 35 dbZ
133
134
135
Julian Day
(b) Star 2
10. m s⁻¹
mb
200
400
600
800
1000
143
144
145
146
Julian Day
Reflectivity [%]
100
80
60
40
20
0
15dbZ < Z < 35 dbZ
Z > 35 dbZ
143
144
145
146
Julian Day

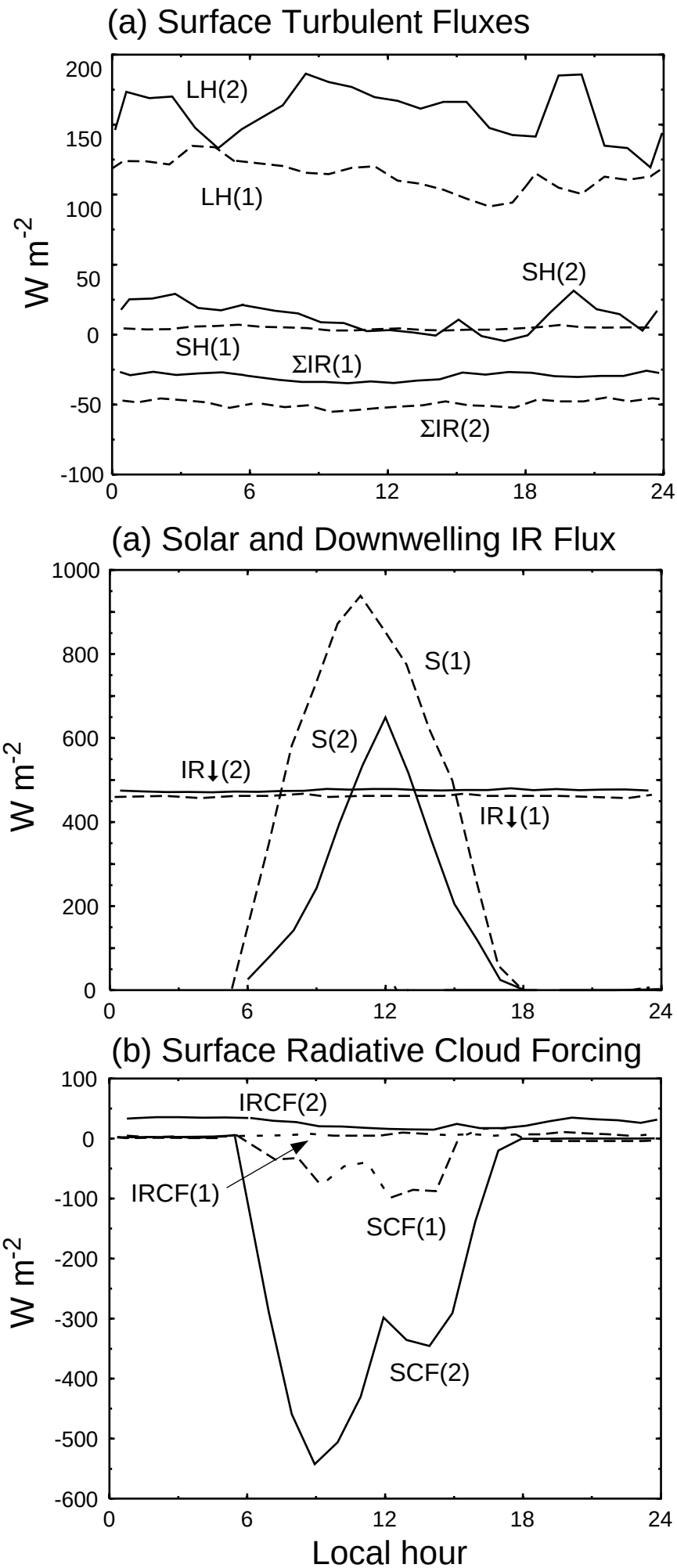

(a) Surface Heat Fluxes: STAR 1 (Wm-2)
Heat flux (Wm-2)
1000
500
0
−50
−100
−150
−200
−250
−300
NET SOLAR
RAIN FLUX
SENSIBLE
NET LONGWAVE
LATENT
Net heat flux into ocean: +92 Wm-2
131
132
133
134
135
Julian day


(b) Surface Heat Fluxes: STAR 2 (Wm-2)
Heat flux (Wm-2)
1000
500
0
−50
−100
−150
−200
−250
−300
NET SOLAR
SENSIBLE
NET LONGWAVE
RAIN FLUX
LATENT
Net heat flux into ocean: -89 Wm-2
142
143
144
145
146
Julian day


(a) Phase II
transect 1
Star 1
transect 2
Star 2
transect 3
Mean +27 W/m**2
Net heat flux (W/m**2)
julian day
150
100
50
0
−50
−100
−150
125
130
135
140
145
150

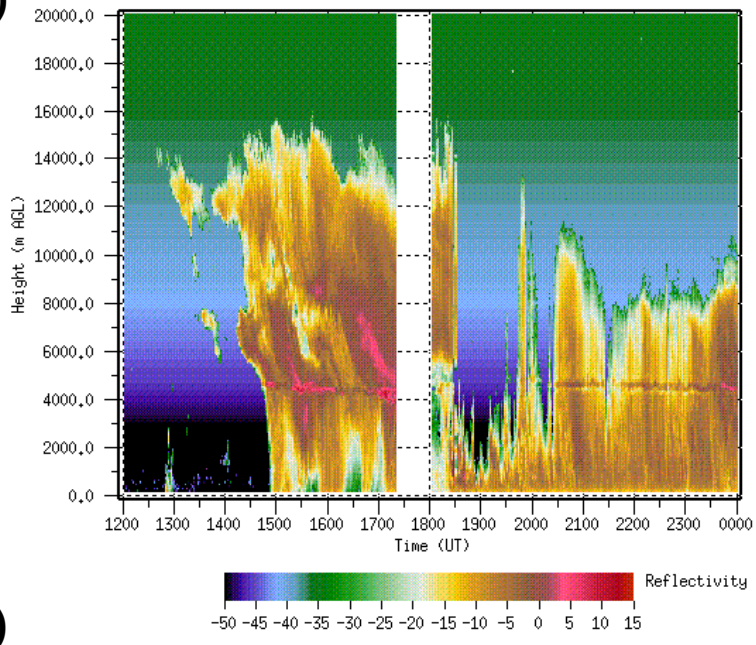

(b) Phase III
triangle
Mean +96 W/m**2
Net heat flux (W/m**2)
julian day
200
150
100
50
0
-50
-100
-150
253
255
257
259
261
263
265
267


(a) Surface and Air Temperature
Temperature (°C)
SST(1)
SST(2)
TA(1)
TA(2)
(b) Wind Speed
Wind Spped (m/s)
WS(2)
WS(1)
(c) Rain Rate
Rainrate (mm/hr)
R(2)
R(1)
Local hour

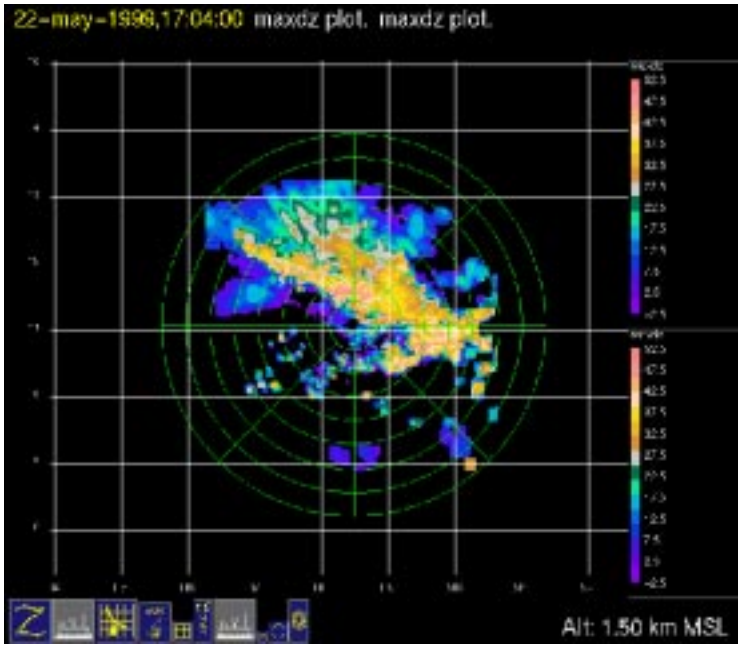

(a) Surface Turbulent Fluxes
W m-2
LH(2)
LH(1)
SH(2)
SH(1)
ΣIR(1)
ΣIR(2)
(a) Solar and Downwelling IR Flux
W m-2
S(1)
S(2)
IR↓(2)
IR↓(1)
(b) Surface Radiative Cloud Forcing
W m-2
IRCF(2)
IRCF(1)
SCF(1)
SCF(2)
Local hour

12-24 UTC 22 May 1999

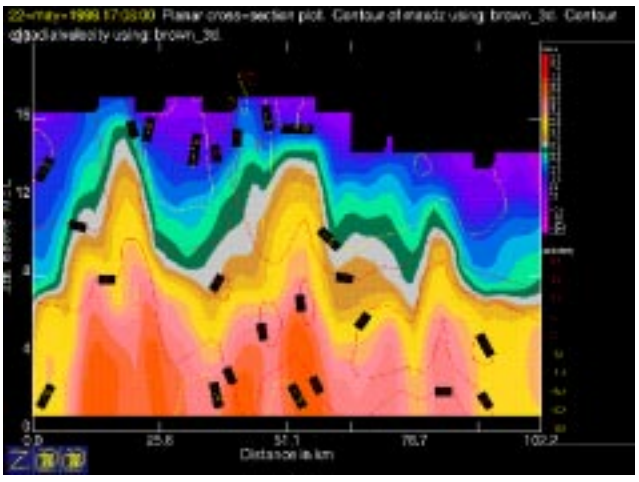
(a)



(b)



(c)



PHASE	SECTION	DATES	WAY POINTS
PHASE I: MALE-SINGAPORE April 7-22 *Ronald H. Brown*	transect 1	4-10 ==>4-16	4.8°S-88.0°E, 16.3°N-88.0°E
	transect 2	4-16 ==>4-18	15.7°N-88.0°E, 8.0°N-88.0°E
PHASE II: SINGAPORE-DARWIN May 1-June 8, 1999 *Ronald H. Brown*	transect 1	5-5 ==>5-10	0°N-89.0°E, 13.5°N-88.8°E
	star 1	5-10 ==>5-15	11.9°N-88.6°E
	transect 2	5-15 ==> 5-18	11.6°N-88.5°E, 0°N-86.5°E
	transect 3	5-18 ==> 5-21	0°N-88.5°E, 11°N-88.2°E
	star 2	5-21 ==> 5-26	11.2°N-89.3°E
	transect 4	5-26 ==> 5-30	11.2°N-88.1°E, 4°6-93.6°E
PHASE III: DARWIN-SINGAPORE Sept. 2-28 *R/V Franklin*	transect 1	9-12 ==> 9-16	0.5°S-88.5°E, 11.5°N-88.5°E
	triangle	9-16 ==> 9-23	11.7°N-88.7°E, 11.2°N-89.8°E
	transect 2	9-23 ==>	

	SYSTEM	MEASUREMENT
1	Air-sea flux system	Motion corrected turbulent fluxes
2	Pyranometer & Pyrgeometer	Downward solar radiative, IR flux
3	Bulk meteorology	SST, Tair, RH, wind speed & direction
4	Ceilometer	Cloud-base height
5	0.92 & 3 GHz Doppler radar profiler	Wind & Precipitation Profiles
6	Raingauges	Rainrate
7	Rawinsonde	Wind, temperature, humidity prof.
8	35 GHz Doppler cloud radar	Cloud microphysical properties
9	20, 31 GHz wave radiometer	Integrated cloud liquid water, total vapor
10	WHOI LICOR 6262 system	Fast CO_2 air concentrations
11	Upward pointed IR thermometer	Cloud-base radiative temperature
12	BNL Portable Radiation	Direct/diffuse solar, IR fluxes
13	Scanning C-band Doppler radar	Precipitation 3-D structure, wind
14	CTD	Ocean T, S profiles
15	ADCP	Ocean current profiles
16	Satellite/SCS	NOAA, GMS data
17	Navigation/SCS	Position, course, speed, heading, etc
18	Thermosalinograph	Near-surface T, S
19	AOML underway CO2 system	Water-air CO_2 concentrations
20	Autosal	Water salinity calibrations
21	Floating thermistor	Near-surface (1 cm) sea temperature

PHASE	SECTION	SONDEs	CTDs
PHASE I:	transect 1,2	23	44
PHASE II:	transect 1,2,3,4	108 (at 6/day)	124
	star 1,2	85 (at 8/day)	103, 97
PHASE III:	transect 1,2	32 (1/day for 8 days and 4/day for 6 days	20 CTD plus 22 XBTs
	triangle	28 (4/day)	126

EXPERIMENT	SOLAR	LW	SEN	LH	RAIN	NET
PACIFIC						
TOGA-COARE PIlot	+197	-43	-12	-116	-3	+22
TIWE	+219	-51	-4	-101	-0	+61
TC-period 1	+222	-58	-7	-89	-1	+65
TC-period 2	+166	-46	-11	-117	-4	-12
TC-period 3	+190	-51	-10	-112	-3	+13
CSP	+225	-48	-6	-109	-2	+59
Nauru-99	+216	-54	-5	-123	-1	+33
Average TOGA COARE	**+205**	**-50**	**-8**	**-110**	**-2**	**+34**
Average Pacific	**+176**	**-52**	**-9**	**-106**	**-2**	**+22**
Average TC satellite	**+226**	**-66**	**-6**	**-110**	**-2**	**+41**
INDIAN						
JASMINE Phase II	+205	-43	-9	-125	-2	+27
Phase II: Satr 1	+260	-49	-5	-115	-0	+92
Phase II: Satr 2	+162	-31	-17	-162	-7	-89
JASMINE Phase III	+229	-38	-3	-92	-1	+96
Average JASMINE (II+III)	**+217**	**-42**	**-6**	**-109**	**-2**	**+62**