CLIMATE DIAGNOSTICS BULLETIN

CLIMATE PREDICTION CENTER

AUGUST 2015

NEAR REAL-TIME OCEAN / ATMOSPHERE

Monitoring, Assessments, and Prediction

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

National Centers for Environmental Prediction

CLIMATE DIAGNOSTICS BULLETIN

CLIMATE PREDICTION CENTER
Attn: Climate Diagnostics Bulletin
W/NP52, Room 605, WWBG
Camp Springs, MD 20746-4304

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Tropical Highlights - August 2015

Sea surface temperatures (SSTs) remained above-average across the equatorial Pacific during August 2015 (Fig. T18, Table T2). The latest monthly Niño indices were +2.3°C for the Niño 3 region, +2.1°C for the Niño 3.4 region, and +2.3°C for the Niño 1+2 region (Table T2, Fig. T5). The depth of the oceanic thermocline (measured by the depth of the 20°C isotherm) also remained above-average across the eastern equatorial Pacific (Figs. T15, T16), and the corresponding sub-surface temperatures were 1-6°C above average (Fig. T17).

Also during August, the low-level westerly wind anomalies and upper-level easterly wind anomalies remained strong across the western and central equatorial Pacific (Table T1, Figs. T20, T21). Meanwhile, enhanced convection persisted across the central and eastern equatorial Pacific and suppressed convection was observed across Indonesia and western equatorial Pacific (Figs. T25, E3). Collectively, these oceanic and atmospheric anomalies are consistent with El Niño conditions.

For the latest status of the ENSO cycle see the ENSO Diagnostic Discussion at:
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/index.html

Month	SLP Anomalies		Tahiti minus Darwin SOI	850-hPa Zonal Wind Index			200-hPa Wind Index	OLR Index
	Tahiti	Darwin		5N-5S 135E-180	5N-5S 175W-140W	5N-5S 135W-120W	5N-5S 165W-110W	5N-5S 160E-160W
AUG 15	-1.2	1.4	-1.4	-1.1	-1.3	-0.8	-0.5	-1.4
JUL 15	-0.5	1.6	-1.1	-1.5	-2.2	-2.1	-1.0	-0.3
JUN 15	-0.7	0.4	-0.6	-0.6	-0.6	-0.3	-0.4	-1.4
MAY 15	0.3	1.6	-0.7	-1.2	-1.2	-1.2	-1.5	-1.0
APR 15	0.6	0.6	0.0	-0.6	-0.6	-0.5	-1.0	-1.1
MAR 15	-0.8	0.6	-0.7	-1.8	-0.2	0.5	1.1	-1.9
FEB 15	1.4	1.0	0.2	-0.4	-0.5	-0.4	0.8	-0.2
JAN 15	-1.7	-0.2	-0.8	-0.2	-0.8	-0.4	-0.6	0.2
DEC 14	-0.9	0.1	-0.6	0.9	-0.1	0.1	-0.7	0.3
NOV 14	-0.6	1.0	-0.9	0.8	-0.6	-1.3	-1.3	0.4
OCT 14	-0.3	0.8	-0.6	0.1	-0.3	-0.4	-0.2	-0.1
SEP 14	-0.4	0.9	-0.7	0.1	-0.1	-0.1	0.0	0.2
AUG 14	-0.2	1.1	-0.7	0.1	-0.8	-0.4	-1.1	0.4

TABLE T1 - Atmospheric index values for the most recent 12 months. Indices are standardized by the mean annual standard deviation, except for the Tahiti and Darwin SLP anomalies which are in units of hPa. Positive (negative) values of 200-hPa zonal wind index imply westerly (easterly) anomalies. Positive (negative) values of 850-hPa zonal wind indices imply easterly (westerly) anomalies. Anomalies are departures from the 1981-2010 base period means.

Month	PACIFIC SST								ATLANTIC SST				GLOBAL	
	Niño 1+2 0-10S 90W-80W		Niño 3 5N-5S 150W-90W		Niño 3.4 5N-5S 170W-120W		Niño 4 5N-5S 160E-150W		N.ATL 5N-20N 60W-30W		S. ATL 0-20S 30W-10E		TROPICS 10N-10S 0-360	
AUG 15	2.3	22.9	2.3	27.3	2.1	28.9	1.0	29.7	-0.1	27.7	-0.3	22.8	0.7	27.8
JUL 15	2.9	24.5	2.2	27.8	1.6	28.8	1.0	29.8	-0.3	26.9	-0.2	23.6	0.7	28.1
JUN 15	2.5	25.4	1.7	28.1	1.3	29.0	1.1	29.9	-0.4	26.4	0.0	24.9	0.6	28.6
MAY 15	2.4	26.7	1.2	28.3	1.0	28.9	1.1	29.9	-0.4	26.0	0.5	26.6	0.6	29.1
APR 15	1.4	27.0	0.7	28.2	0.8	28.6	1.2	29.7	-0.3	25.6	0.2	27.3	0.4	29.0
MAR 15	0.1	26.7	0.2	27.3	0.6	27.8	1.1	29.3	-0.2	25.4	0.0	27.2	0.2	28.5
FEB 15	-0.6	25.6	0.2	26.6	0.6	27.3	1.0	29.1	0.3	25.8	0.1	26.7	0.2	28.1
JAN 15	-0.4	24.1	0.4	26.0	0.5	27.1	0.9	29.2	0.1	26.1	0.1	25.7	0.2	27.9
DEC 14	0.1	22.9	0.8	25.9	0.8	27.4	0.9	29.4	0.0	26.8	-0.4	24.4	0.3	28.0
NOV 14	0.7	22.3	0.9	25.9	0.9	27.5	0.9	29.5	0.1	27.7	-0.5	23.5	0.3	28.0
OCT 14	0.8	21.5	0.7	25.6	0.5	27.2	0.6	29.3	0.3	28.4	-0.1	23.3	0.3	27.8
SEP 14	1.0	21.3	0.5	25.3	0.5	27.2	0.7	29.3	0.1	28.2	-0.1	23.0	0.3	27.5
AUG 14	1.3	21.9	0.5	25.5	0.2	27.0	0.5	29.1	-0.2	27.5	0.0	23.1	0.3	27.5

TABLE T2. Mean and anomalous sea surface temperature (°C) for the most recent 12 months. Anomalies are departures from the 1981–2010 adjusted OI climatology (Smith and Reynolds 1998, *J. Climate*, **11**, 3320-3323).

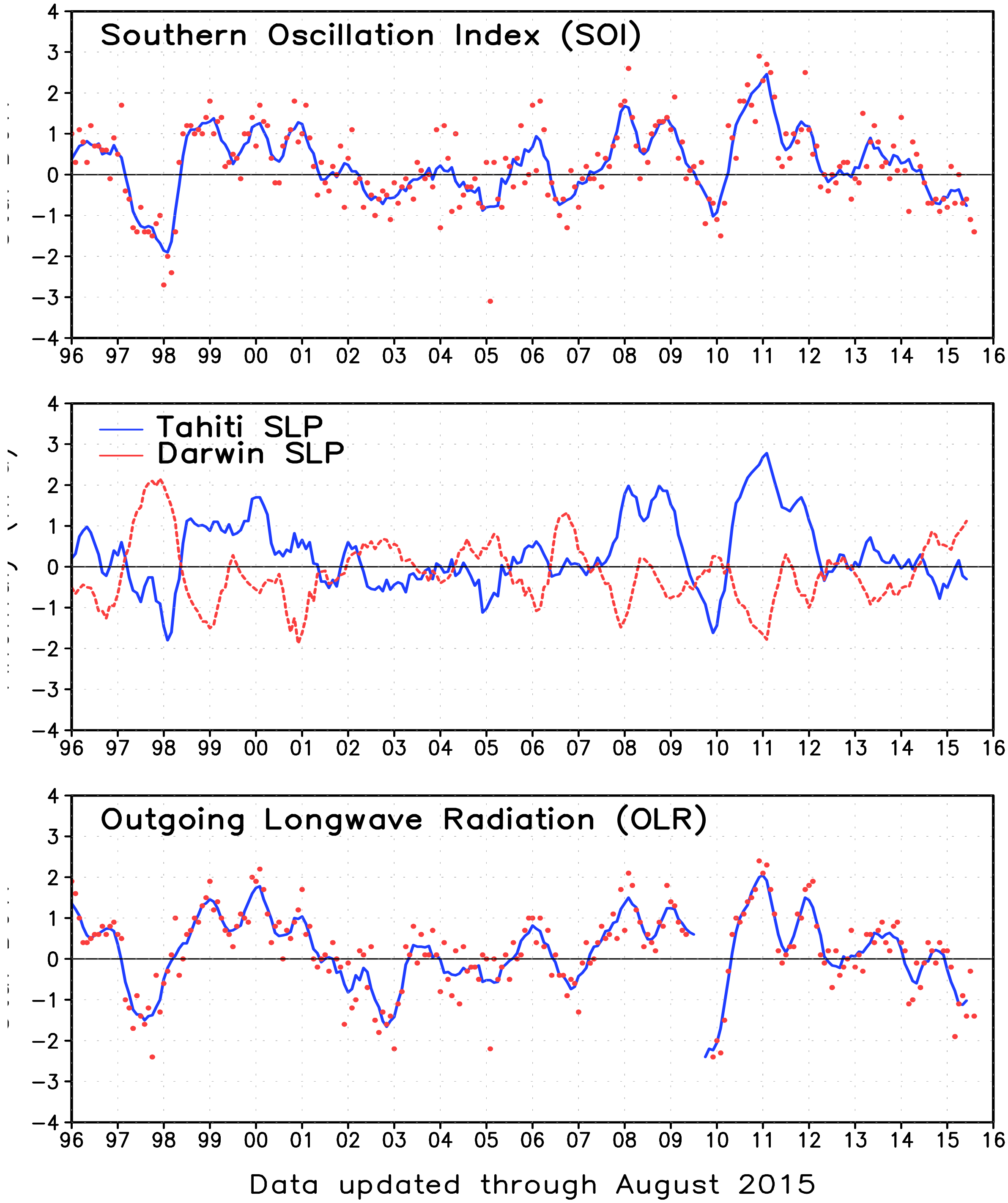


FIGURE T1. Five-month running mean of the Southern Oscillation Index (SOI) (top), sea-level pressure anomaly (hPa) at Darwin and Tahiti (middle), and outgoing longwave radiation anomaly (OLR) averaged over the area 5N-5S, 160E-160W (bottom). Anomalies in the top and middle panels are departures from the 1981-2010 base period means and are normalized by the mean annual standard deviation. Anomalies in the bottom panel are departures from the 1981-2010 base period means. Individual monthly values are indicated by "x"s in the top and bottom panels. The x-axis labels are centered on July.

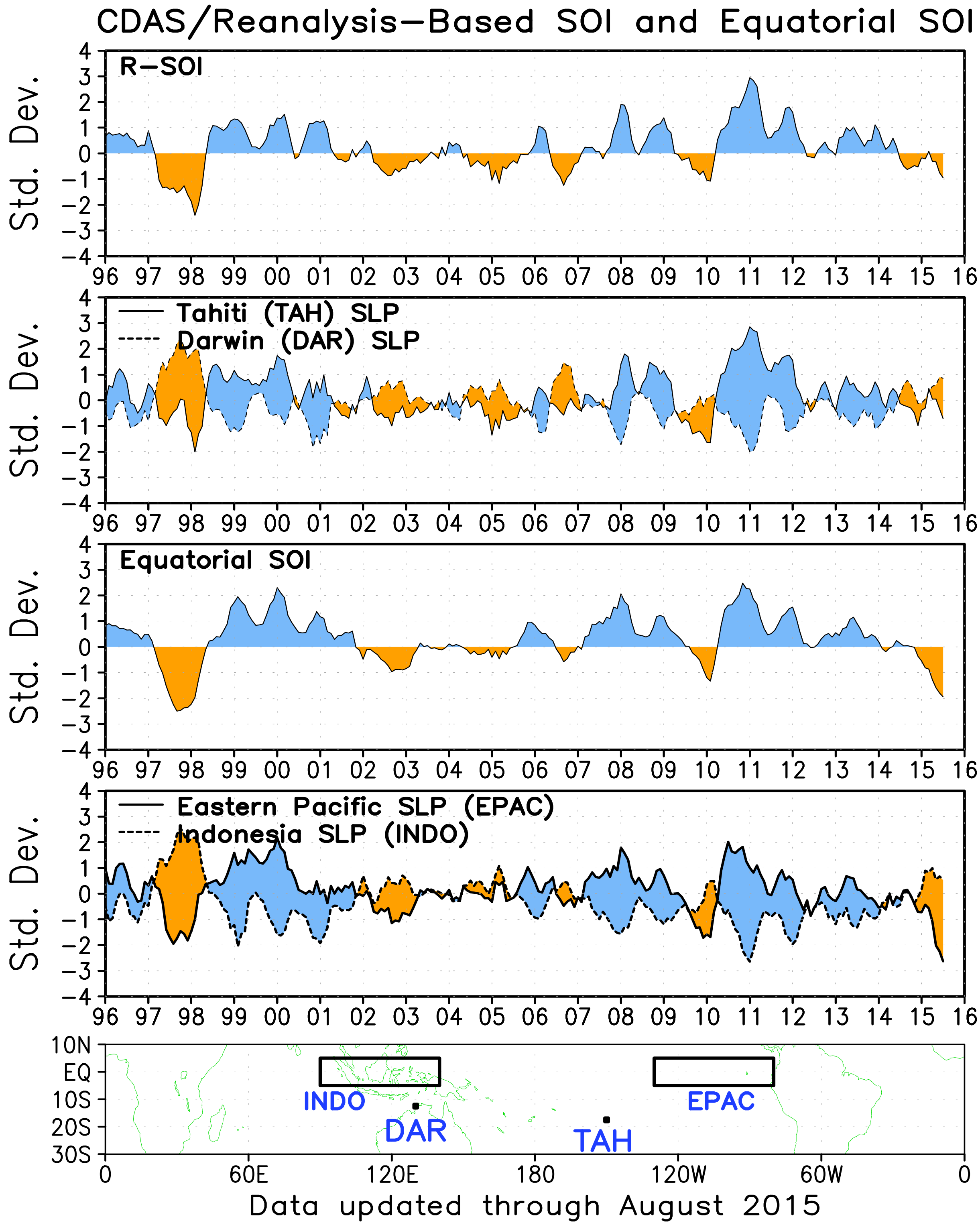


FIGURE T2. Three-month running mean of a CDAS/Reanalysis-derived (a) Southern Oscillation Index (RSOI), (b) standardized pressure anomalies near Tahiti (solid) and Darwin (dashed), (c) an equatorial SOI ([EPAC] - [INDO]), and (d) standardized equatorial pressure anomalies for (EPAC) (solid) and (INDO) (dashed). Anomalies are departures from the 1981-2010 base period means and are normalized by the mean annual standard deviation. The equatorial SOI is calculated as the normalized difference between the standardized anomalies averaged between 5°N–5°S, 80°W–130°W (EPAC) and 5°N–5°S, 90°E–140°E (INDO).

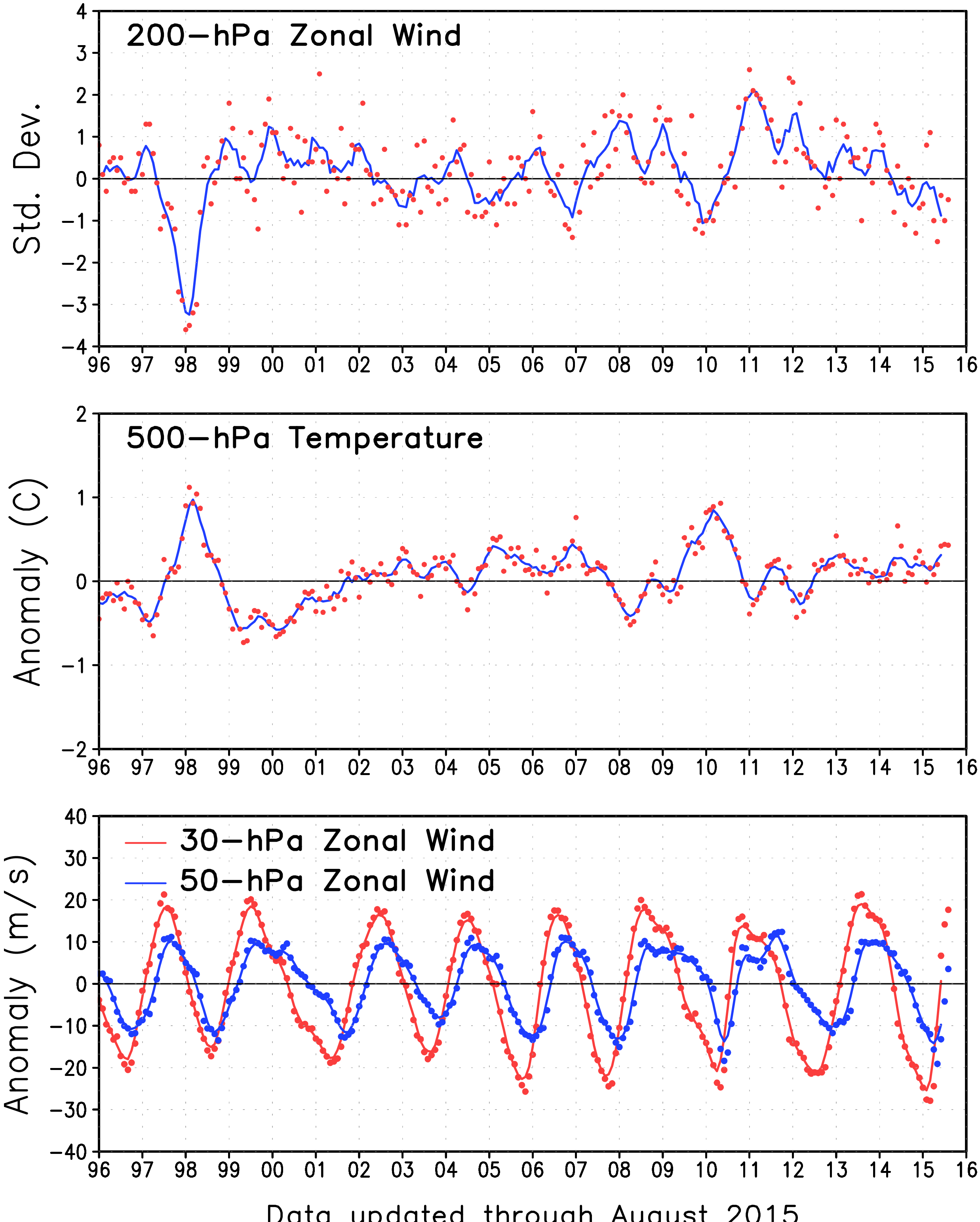


FIGURE T3. Five-month running mean (solid lines) and individual monthly mean (dots) of the 200-hPa zonal wind anomalies averaged over the area 5N-5S, 165W-110W (top), the 500-hPa virtual temperature anomalies averaged over the latitude band 20N-20S (middle), and the equatorial zonally-averaged zonal wind anomalies at 30-hPa (red) and 50-hPa (blue) (bottom). In the top panel, anomalies are normalized by the mean annual standard deviation. Anomalies are departures from the 1981-2010 base period means. The x-axis labels are centered on January.

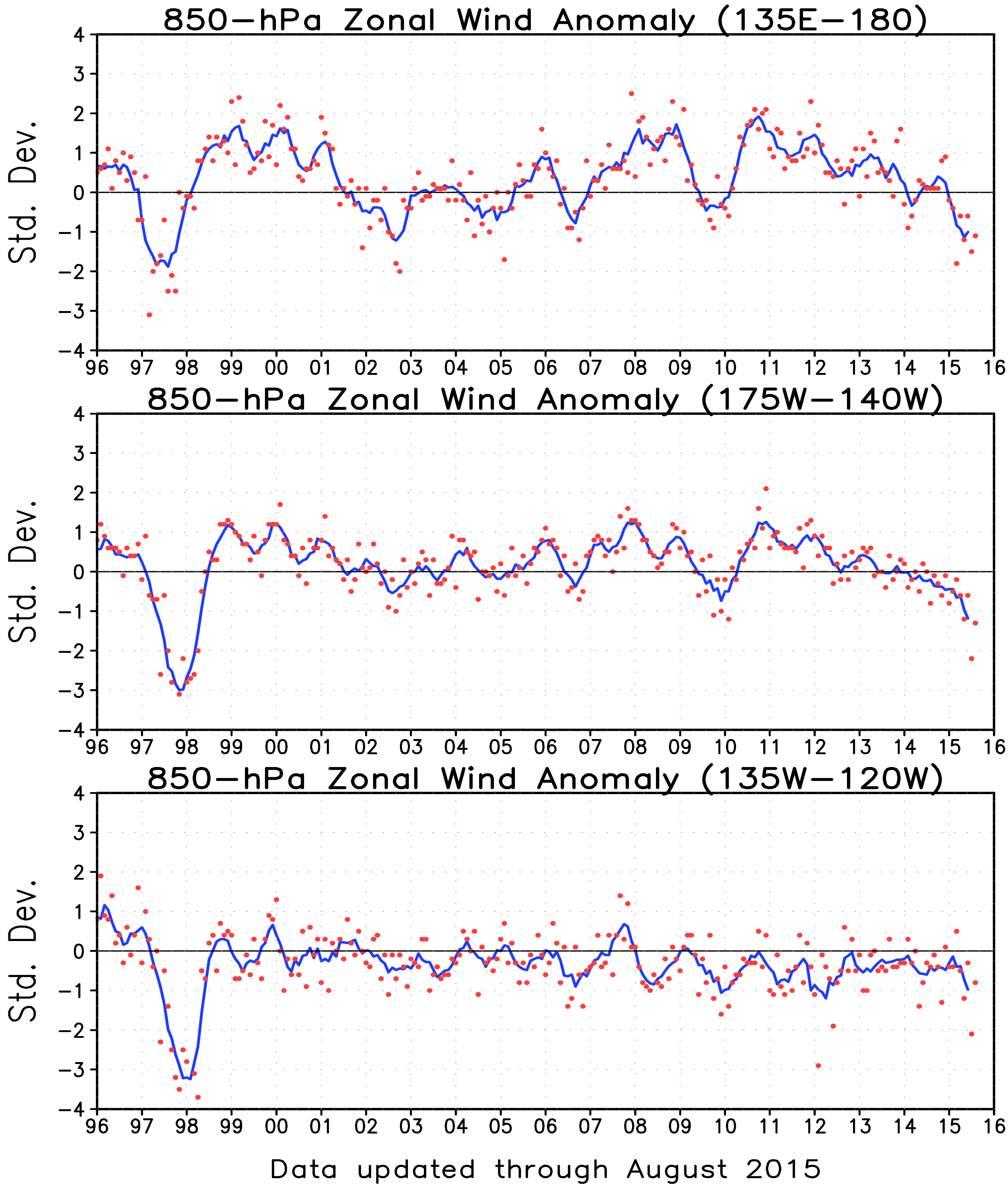


FIGURE T4. Five-month running mean (solid line) and individual monthly mean (dots) of the standardized 850-hPa zonal wind anomaly index in the latitude belt 5N-5S for 135E-180 (top), 175W-140W (middle) and 135W-120W (bottom). Anomalies are departures from the 1981-2010 base period means and are normalized by the mean annual standard deviation.The x-axis labels are centered on January. Positive (negative) values indicate easterly (westerly) anomalies.

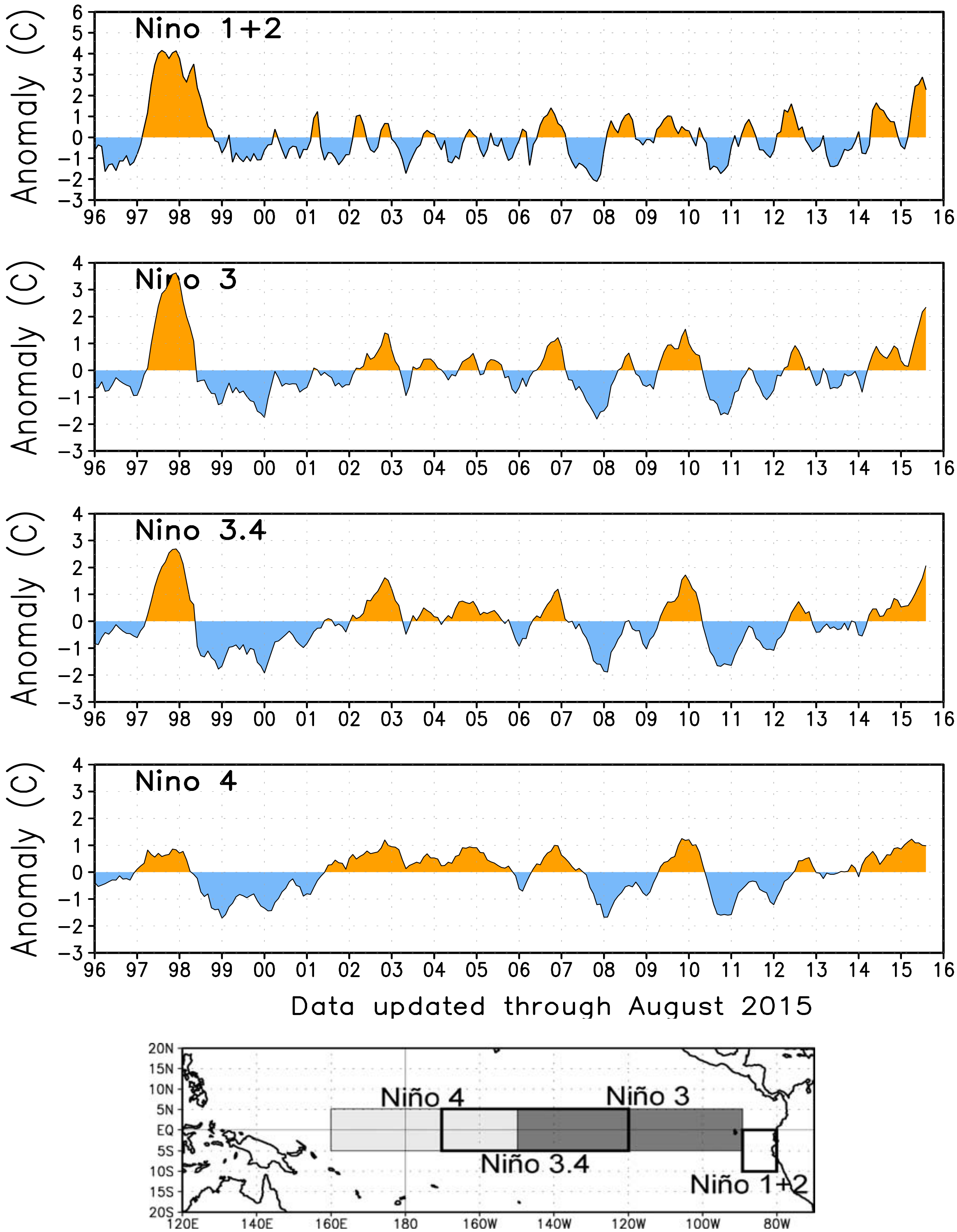


FIGURE T5. Nino region indices, calculated as the area-averaged sea surface temperature anomalies (C) for the specified region. The Nino 1+2 region (top) covers the extreme eastern equatorial Pacific between 0-10S, 90W-80W. The Nino-3 region (2nd from top) spans the eastern equatorial Pacific between 5N-5S, 150W-90W. The Nino 3.4 region 3rd from top) spans the east-central equatorial Pacific between 5N-5S, 170W-120W. The Nino 4 region (bottom) spans the date line and covers the area 5N-5S, 160E-150W. Anomalies are departures from the 1981-2010 base period monthly means *(Smith and Reynolds 1998, J. Climate, 11, 3320-3323)*. Monthly values of each index are also displayed in Table 2.

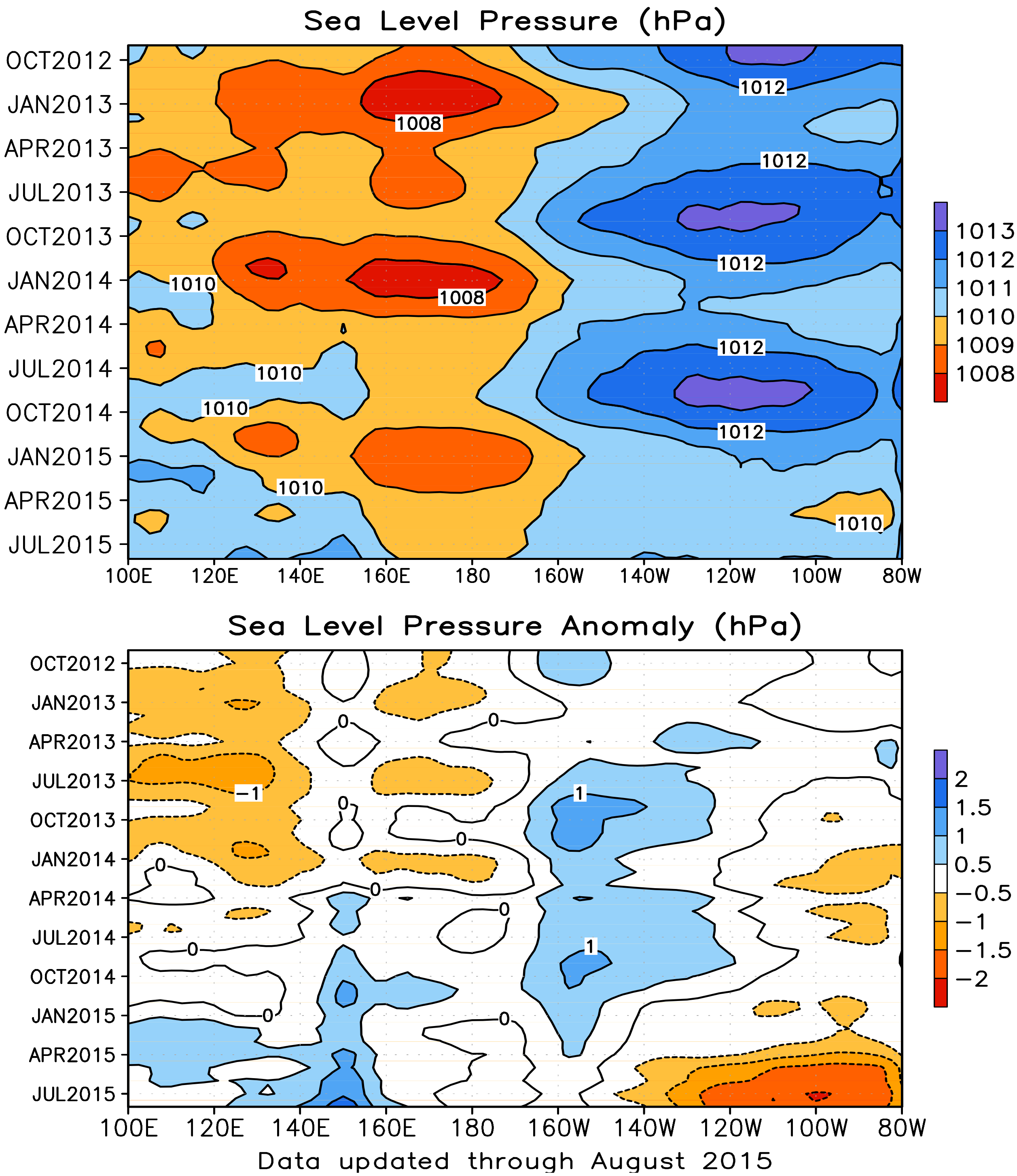


FIGURE T6. Time-longitude section of mean (top) and anomalous (bottom) sea level pressure (SLP) averaged between 5N-5S (CDAS/Reanalysis). Contour interval is 1.0 hPa (top) and 0.5 hPa (bottom). Dashed contours in bottom panel indicate negative anomalies. Anomalies are departures from the 1981-2010 base period monthly means. The data are smoothed temporally using a 3-month running average.

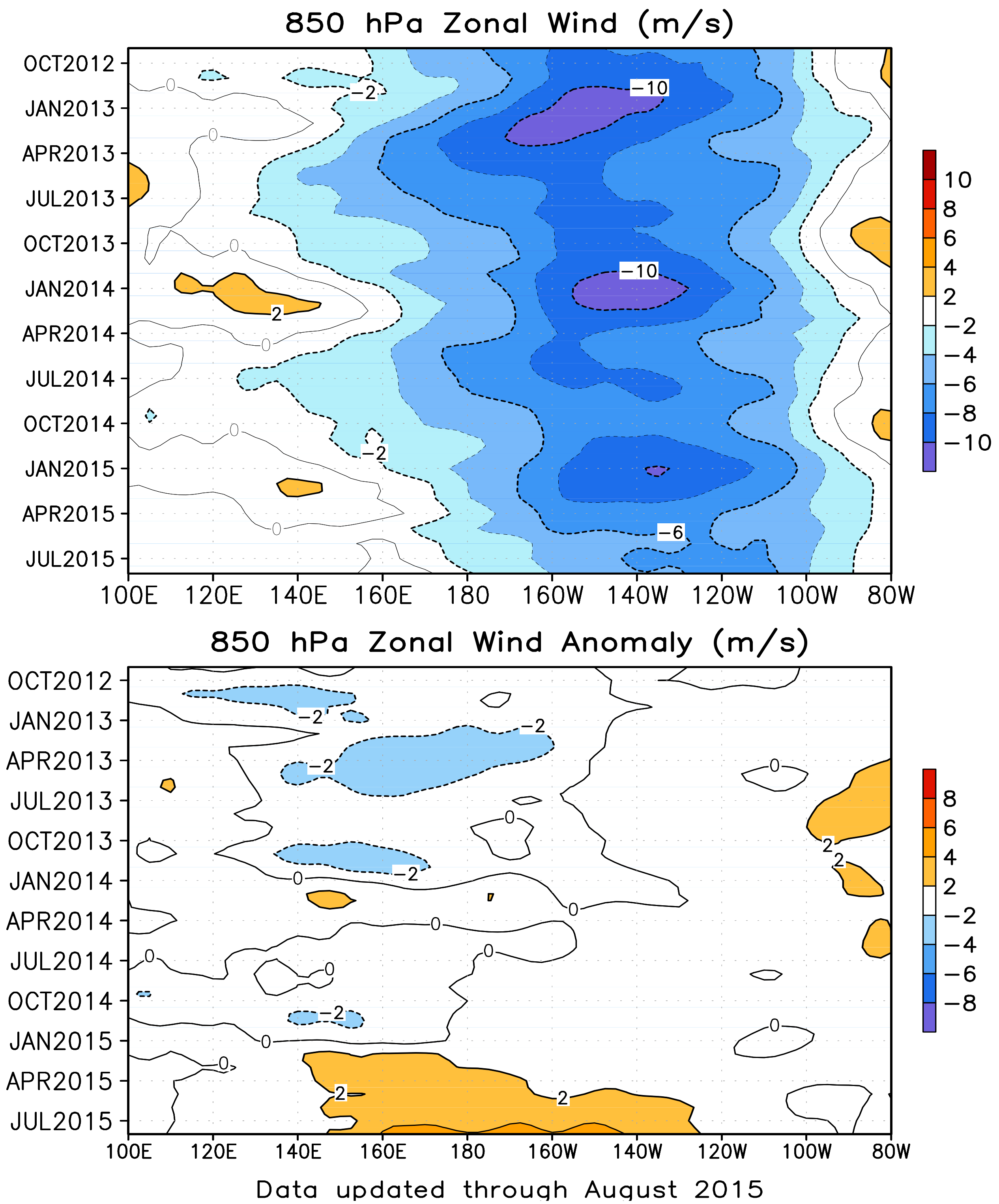


FIGURE T7. Time-longitude section of mean (top) and anomalous (bottom) 850-hPa zonal wind averaged between 5N-5S (CDAS/Reanalysis). Contour interval is 2 ms^{-1}. Blue shading and dashed contours indicate easterlies (top) and easterly anomalies (bottom). Anomalies are departures from the 1981-2010 base period monthly means. The data are smoothed temporally using a 3-month running average.

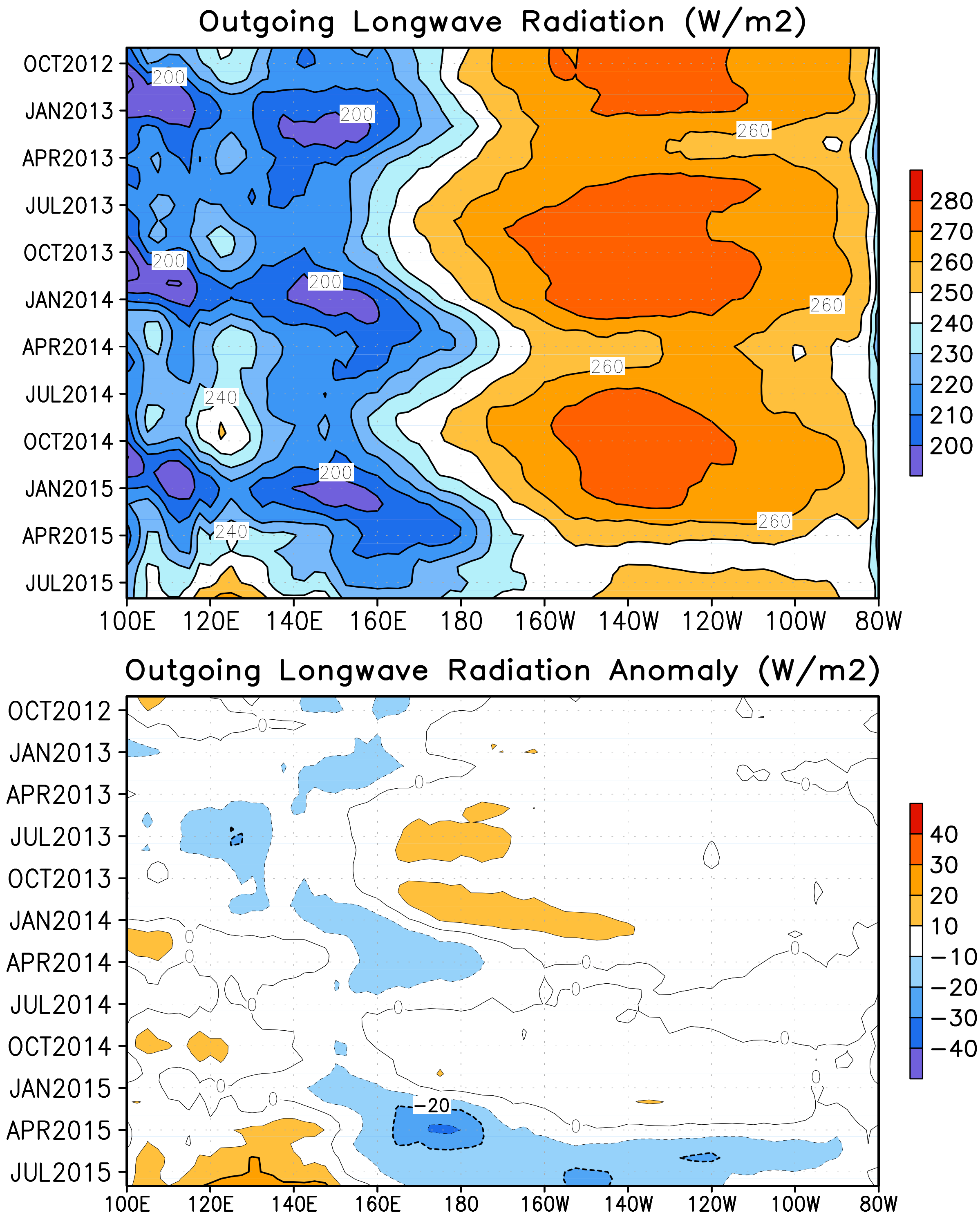


FIGURE T8. Time-longitude section of mean (top) and anomalous (bottom) outgoing longwave radiation (OLR) averaged between 5N-5S. Contour interval is 10 Wm^{-2}. Dashed contours in bottom panel indicate negative OLR anomalies. Anomalies are departures from the 1981-2010 base period monthly means. The data are smoothed temporally using a 3-month running average.

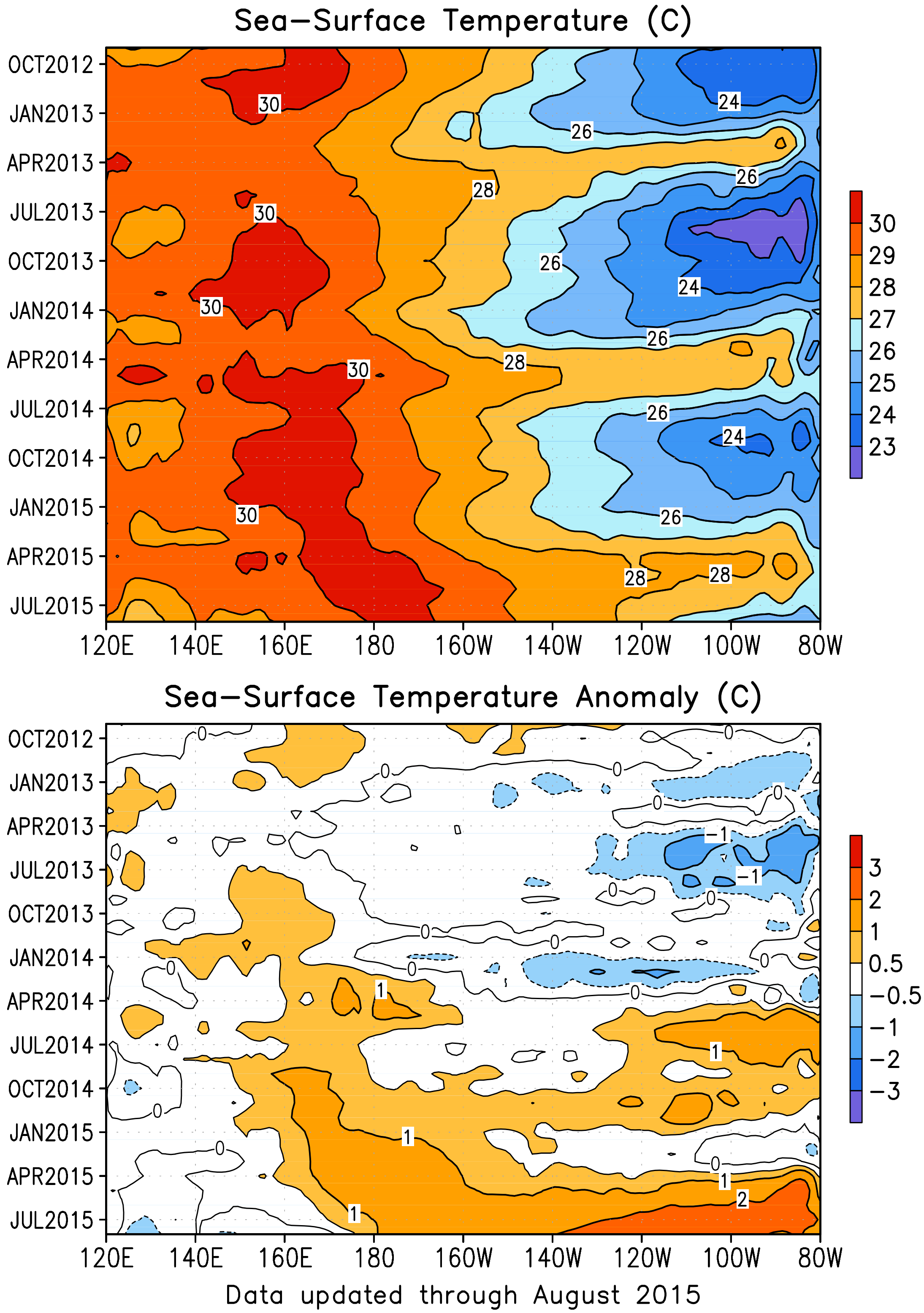


FIGURE T9. Time-longitude section of monthly mean (top) and anomalous (bottom) sea surface temperature (SST) averaged between 5N-5S. Contour interval is 1C (top) and 0.5C (bottom). Dashed contours in bottom panel indicate negative anomalies. Anomalies are departures from the 1981-2010 base period means (Smith and Reynolds 1998, *J. Climate*, **11**, 3320-3323).

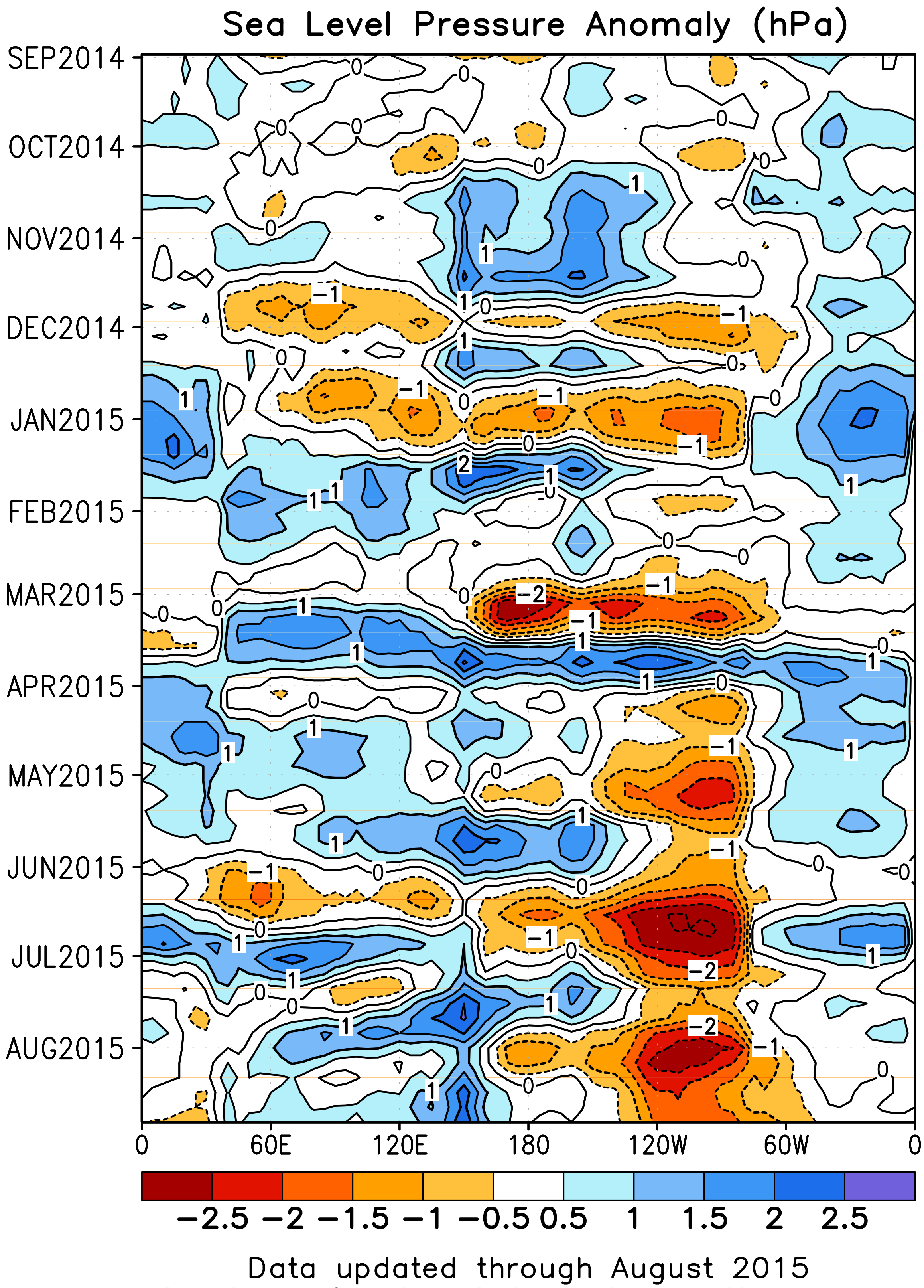


FIGURE T10. Time-longitude section of anomalous sea level pressure (hPa) averaged between 5N-5S (CDAS/Reanaysis). Contour interval is 1 hPa. Dashed contours indicate negative anomalies. Anomalies are departures from the 1981-2010 base period pentad means. The data are smoothed temporally using a 3-point running average.

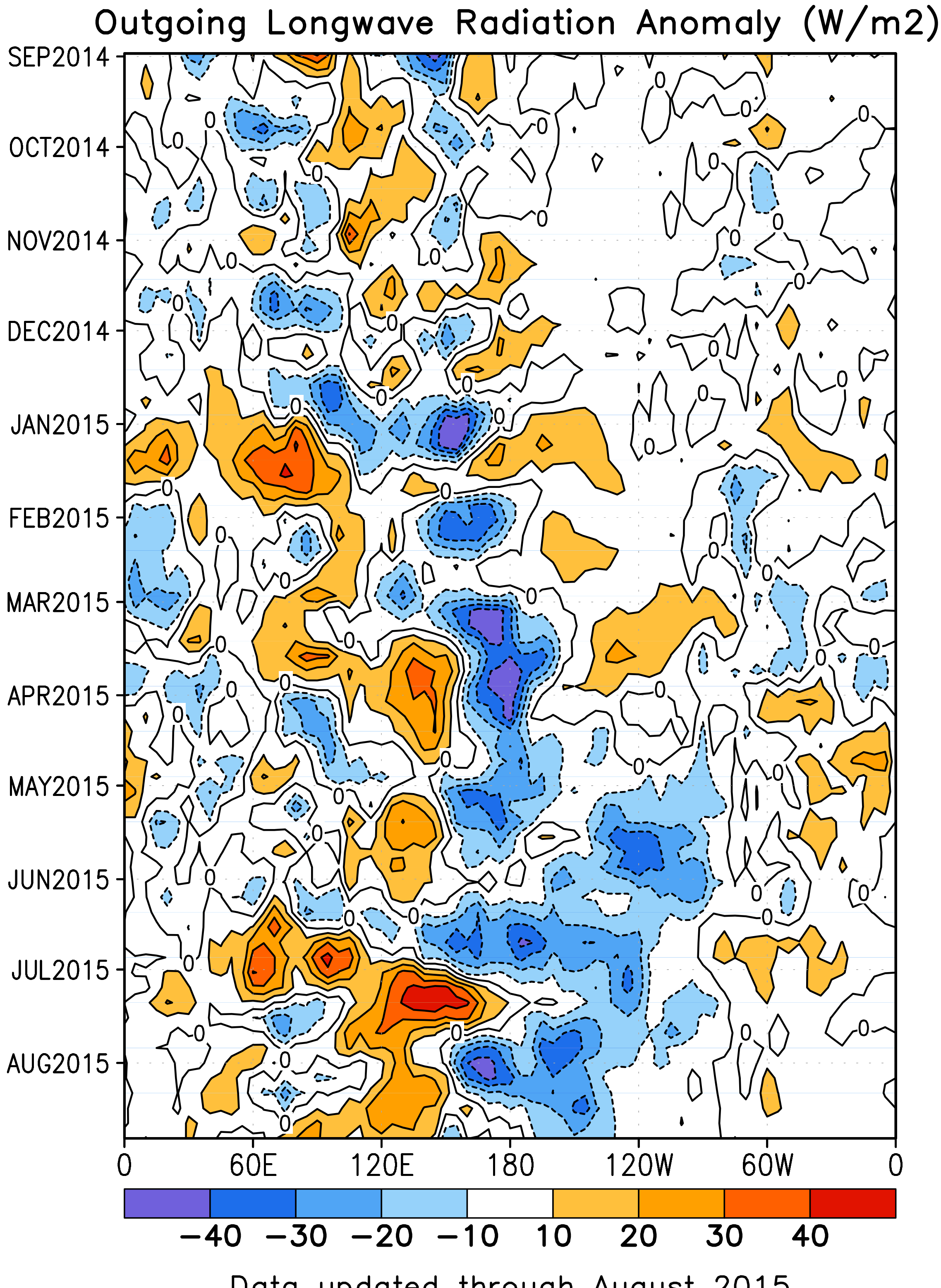


FIGURE T11. Time-longitude section of anomalous outgoing longwave radiation averaged between 5N-5S. Contour interval is 15 Wm^{-2}. Dashed contours indicate negative anomalies. Anomalies are departures from the 1981-2010 base period pentad means. The data are smoothed temporally using a 3-point running average.

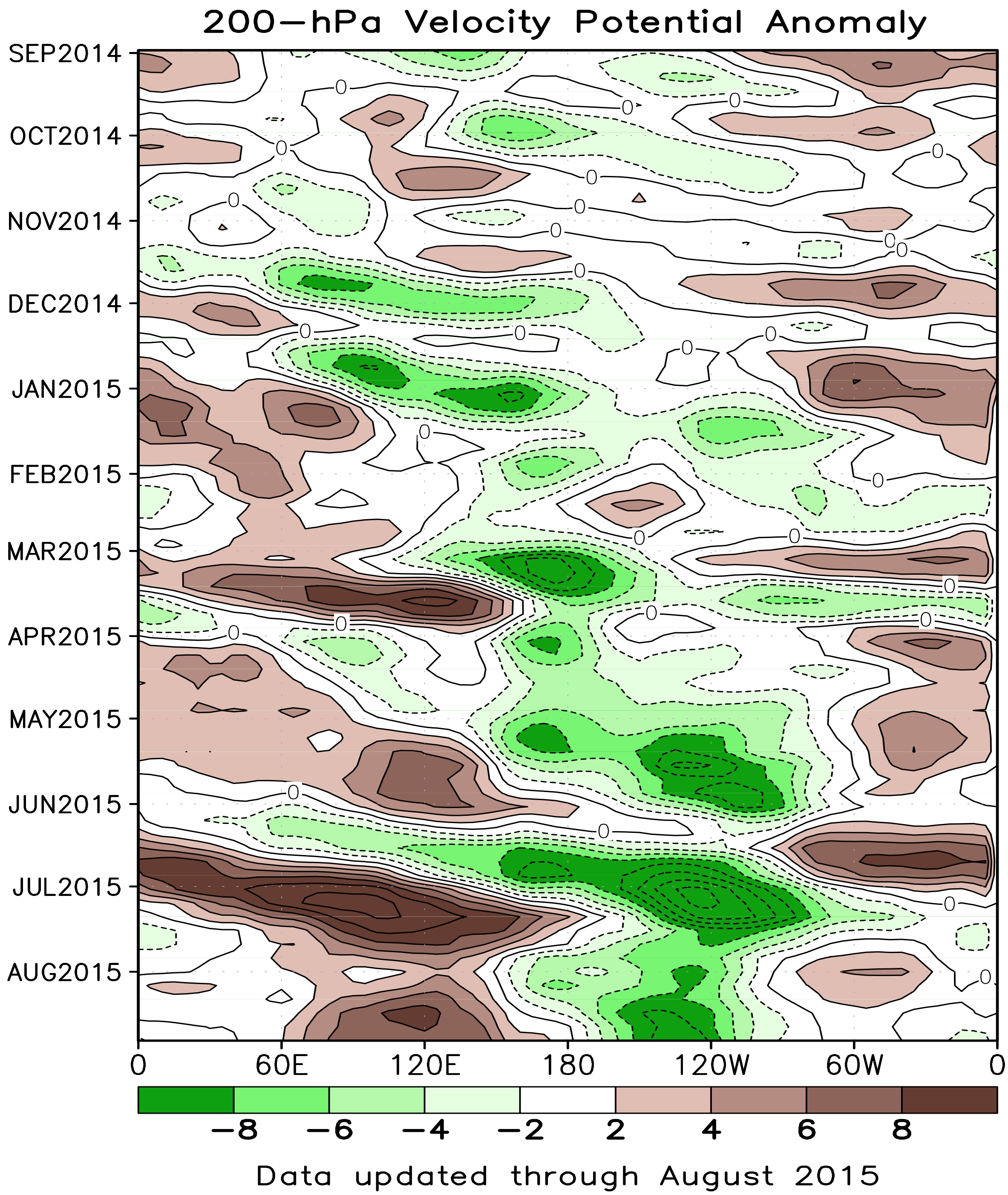


FIGURE T12. Time-longitude section of anomalous 200-hPa velocity potential averaged between 5N-5S (CDAS/Reanalysis). Contour interval is 3 x 10^6 m^2s^{-1}. Dashed contours indicate negative anomalies. Anomalies are departures from the 1981-2010 base period pentad means. The data are smoothed temporally using a 3-point running average.

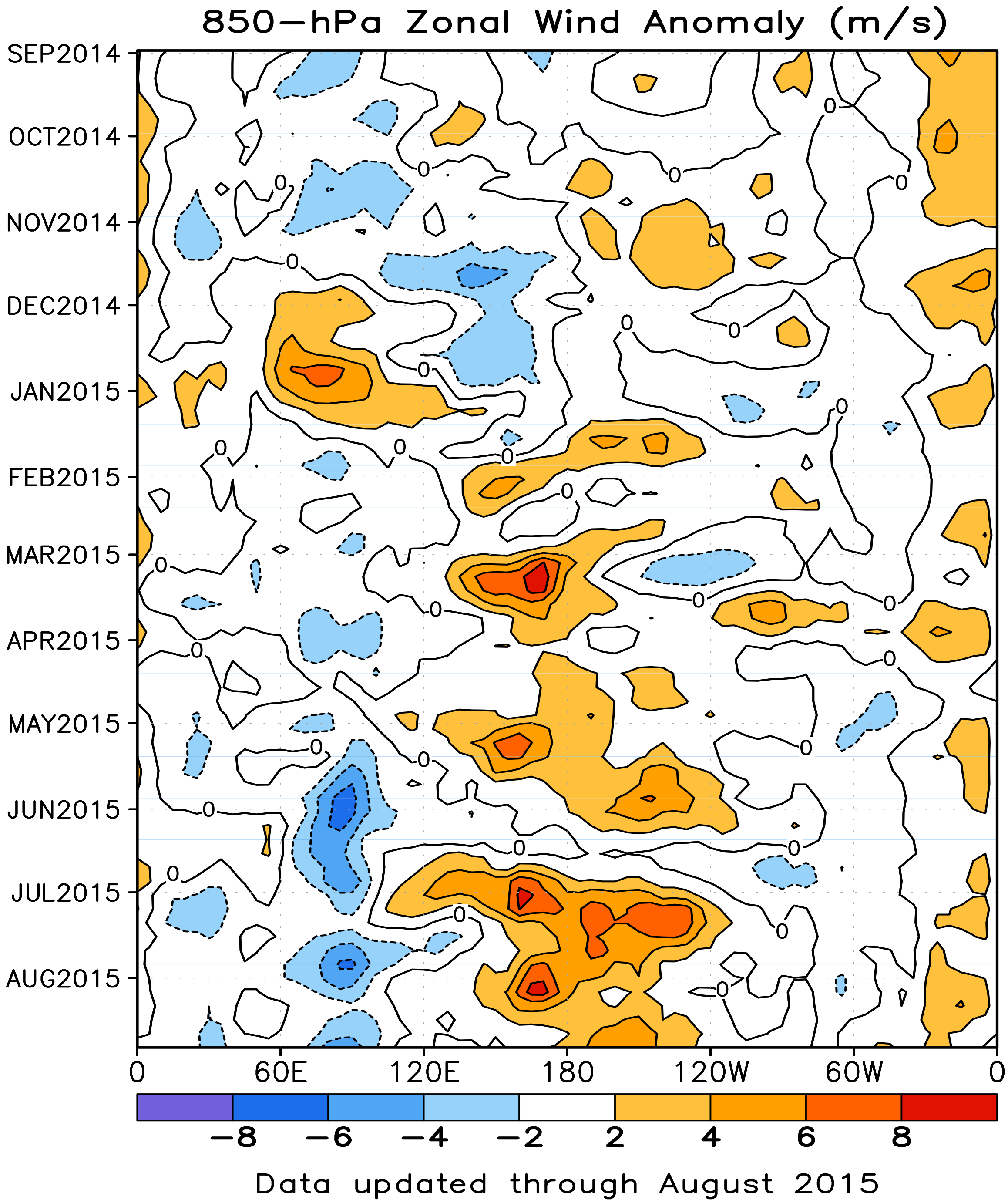


FIGURE T13. Time-longitude section of anomalous 850-hPa zonal wind averaged between 5N-5S (CDAS/Reanalysis). Contour interval is 2 ms^{-1}. Dashed contours indicate negative anomalies. Anomalies are departures from the 1981-2010 base period pentad means. The data are smoothed temporally by using a 3-point running average.

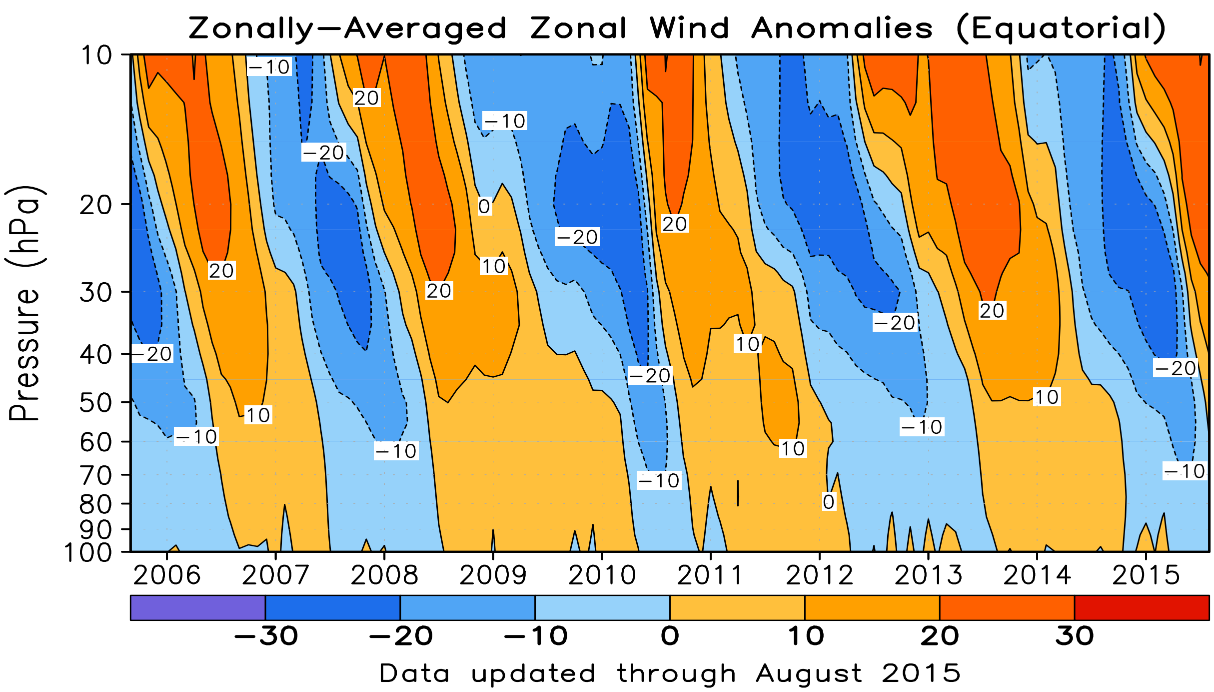


FIGURE T14. Equatorial time-height section of anomalous zonally-averaged zonal wind (m s^{-1}) (CDAS/Reanalysis). Contour interval is 10 ms^{-1}. Anomalies are departures from the 1981-2010 base period monthly means.

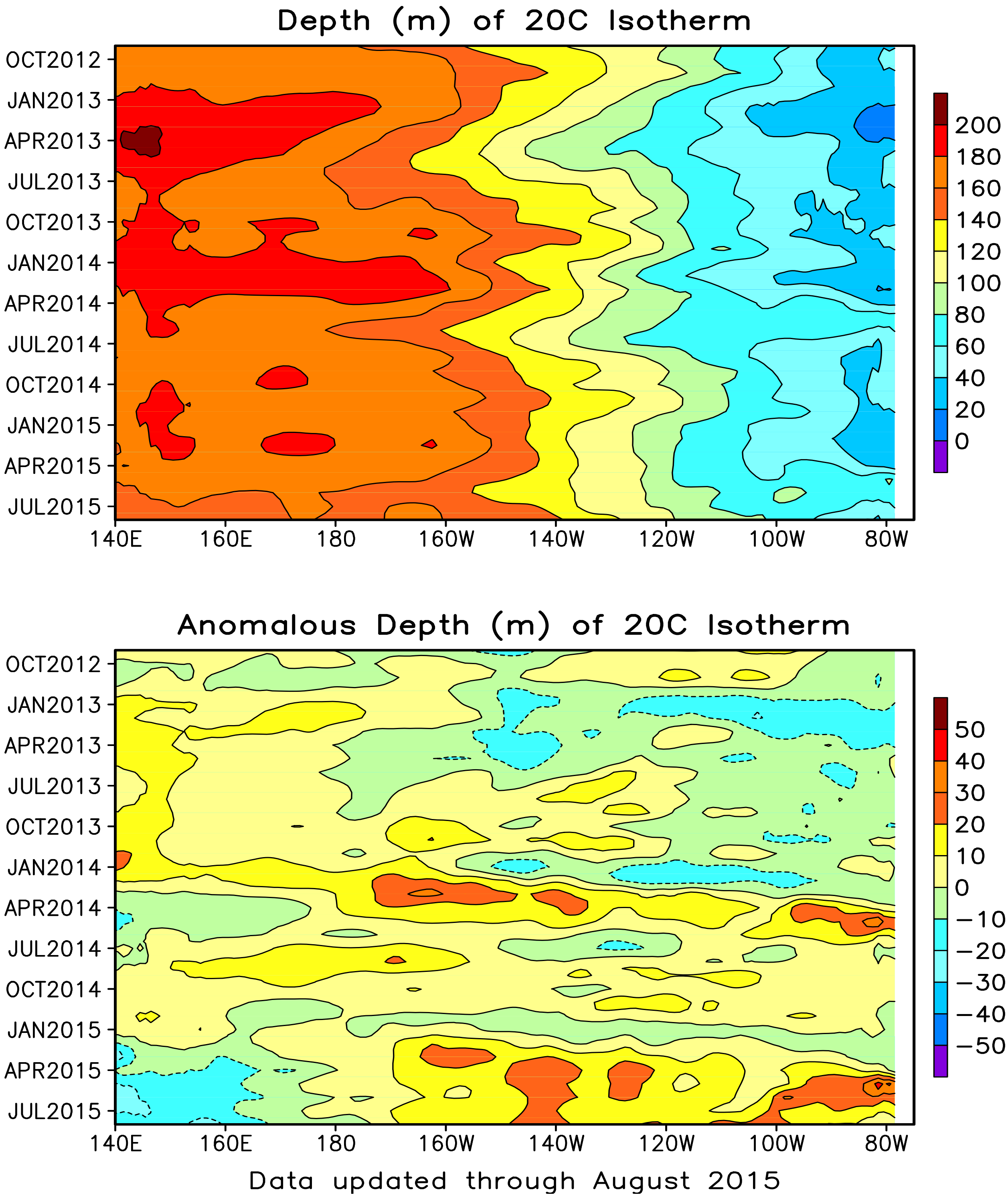


FIGURE T15. Mean (top) and anomalous (bottom) depth of the 20C isotherm averaged between 5N-5S in the Pacific Ocean. Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM (Behringer, D. W., and Y. Xue, 2004: Evaluation of the global ocean data assimilation system at NCEP: The Pacific Ocean. AMS 84th Annual Meeting, Seattle, Washington, 11-15). The contour interval is 10 m. Dashed contours in bottom panel indicate negative anomalies. Anomalies are departures from the 1981-2010 base period means.

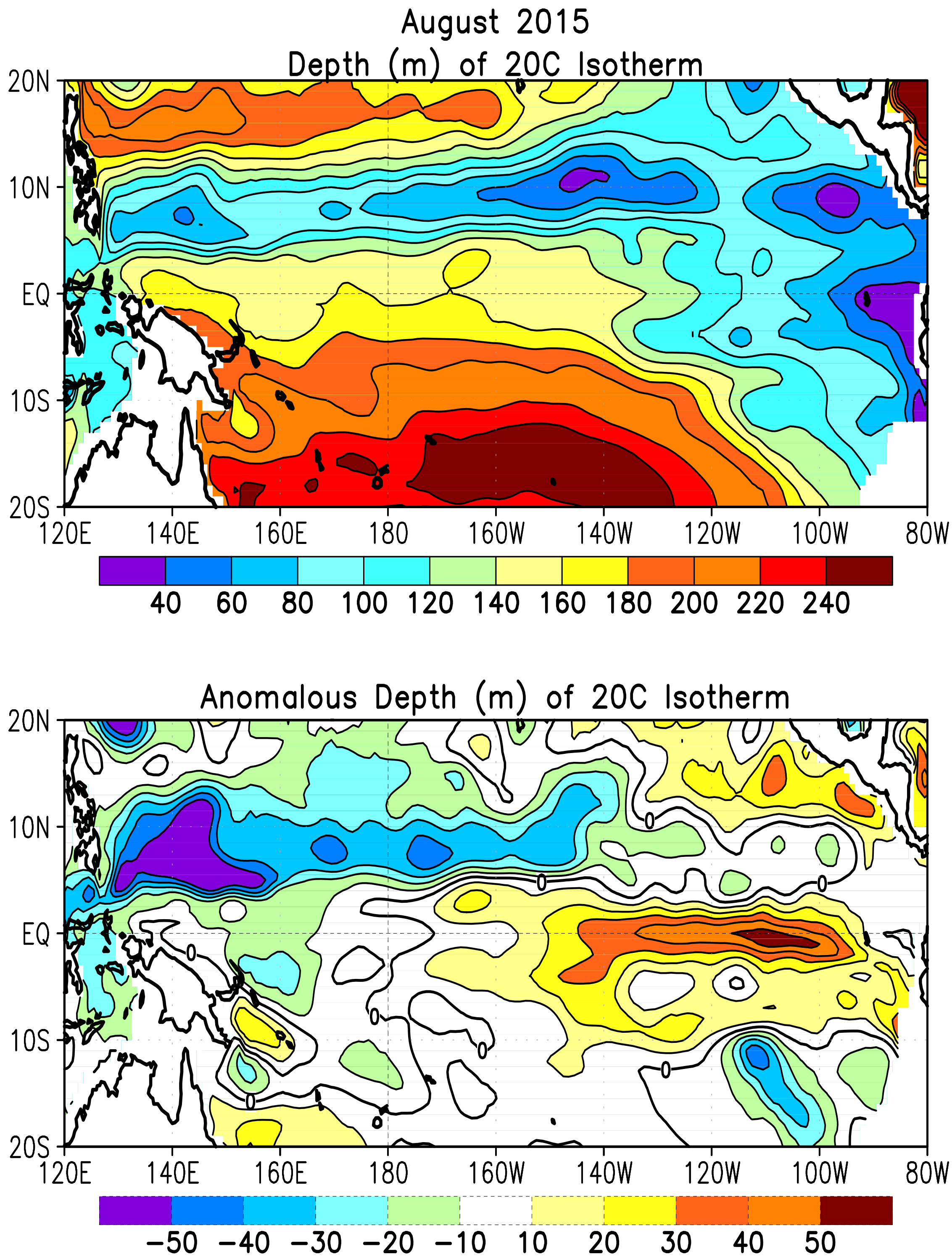
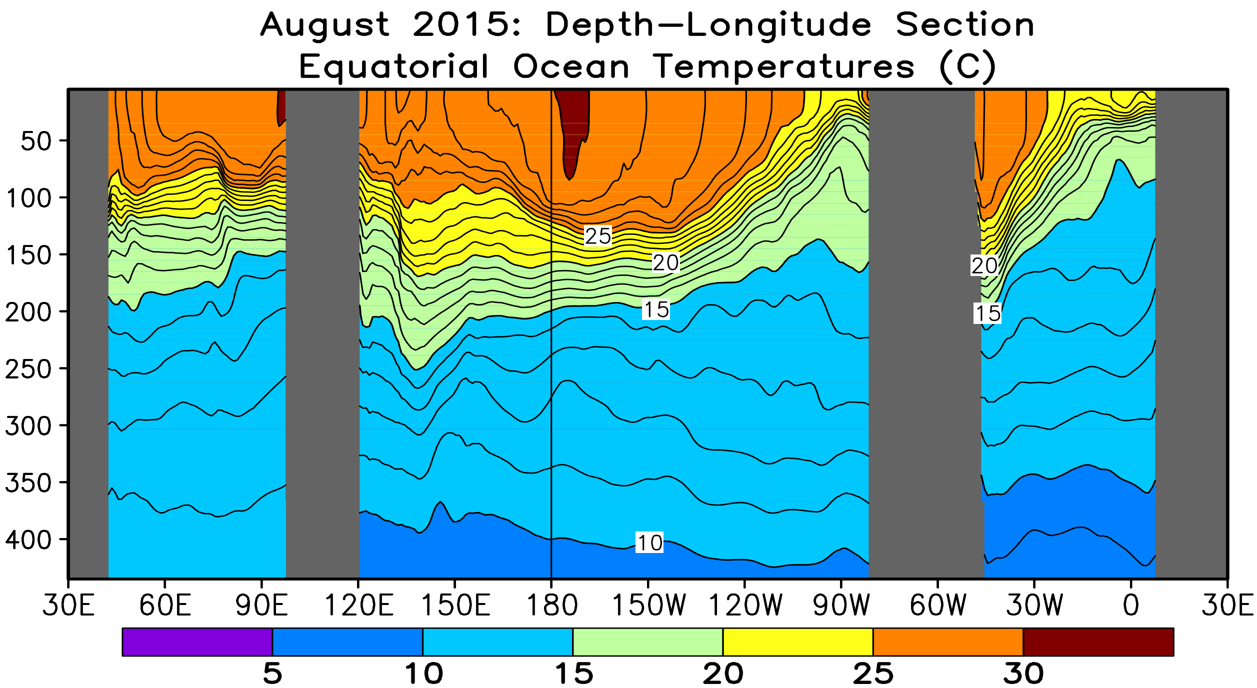


FIGURE T16. Mean (top) and anomalous (bottom) depth of the 20°C isotherm for AUG 2015. Contour interval is 40 m (top) and 10 m (bottom). Dashed contours in bottom panel indicate negative anomalies. Data are derived from the NCEP's global ocean data assimilation system version 2 which assimilates oceanic observations into an oceanic GCM (Xue, Y. and Behringer, D.W., 2006: Operational global ocean data assimilation system at NCEP, to be submitted to BAMS). Anomalies are departures from the 1981–2010 base period means.



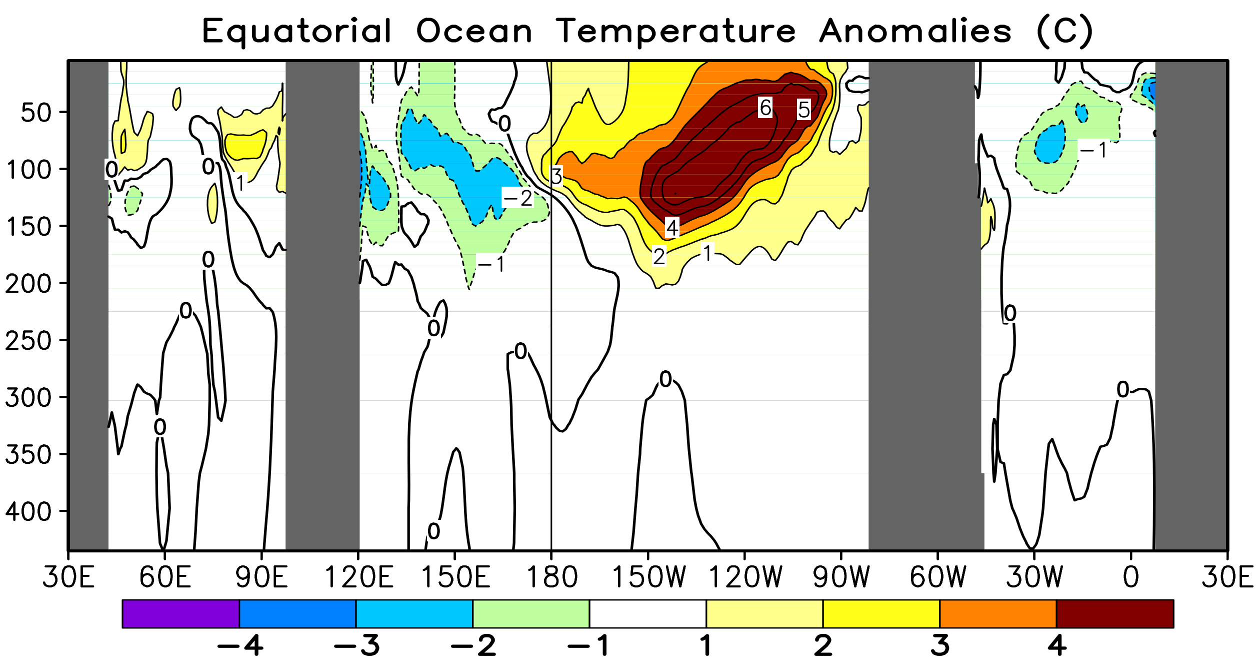


FIGURE T17. Equatorial depth-longitude section of ocean temperature (top) and ocean temperature anomalies (bottom) for AUG 2015. Contour interval is 1°C. Dashed contours in bottom panel indicate negative anomalies. Data are derived from the NCEP's global ocean data assimilation system version 2 which assimilates oceanic observations into an oceanic GCM (Xue, Y. and Behringer, D.W., 2006: Operational global ocean data assimilation system at NCEP, to be submitted to BAMS). Anomalies are departures from the 1981–2010 base period means.

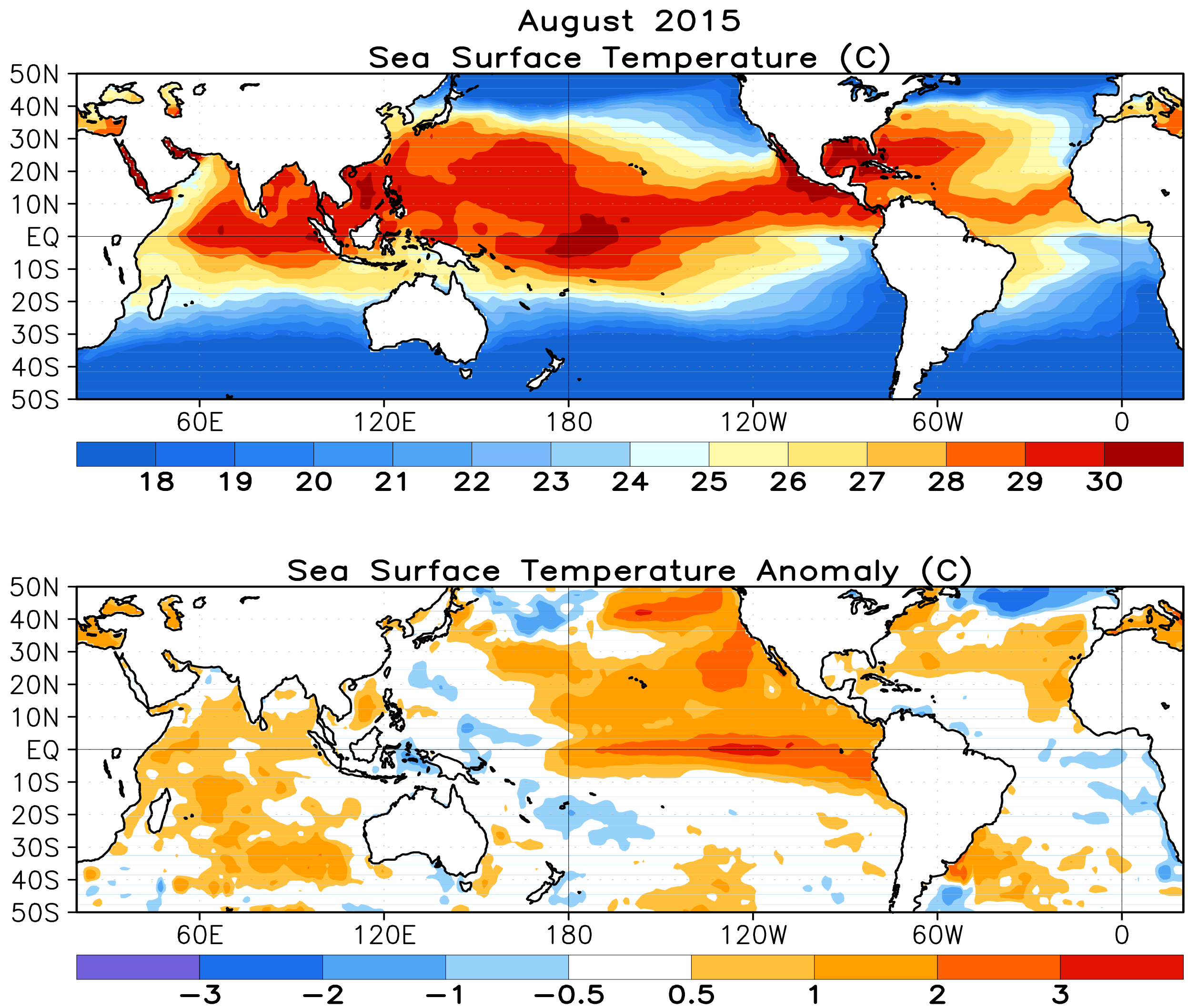


FIGURE T18. Mean (top) and anomalous (bottom) sea surface temperature (SST). Anomalies are departures from the 1981-2010 base period monthly means (Smith and Reynolds 1998, *J. Climate*, **11**, 3320-3323).

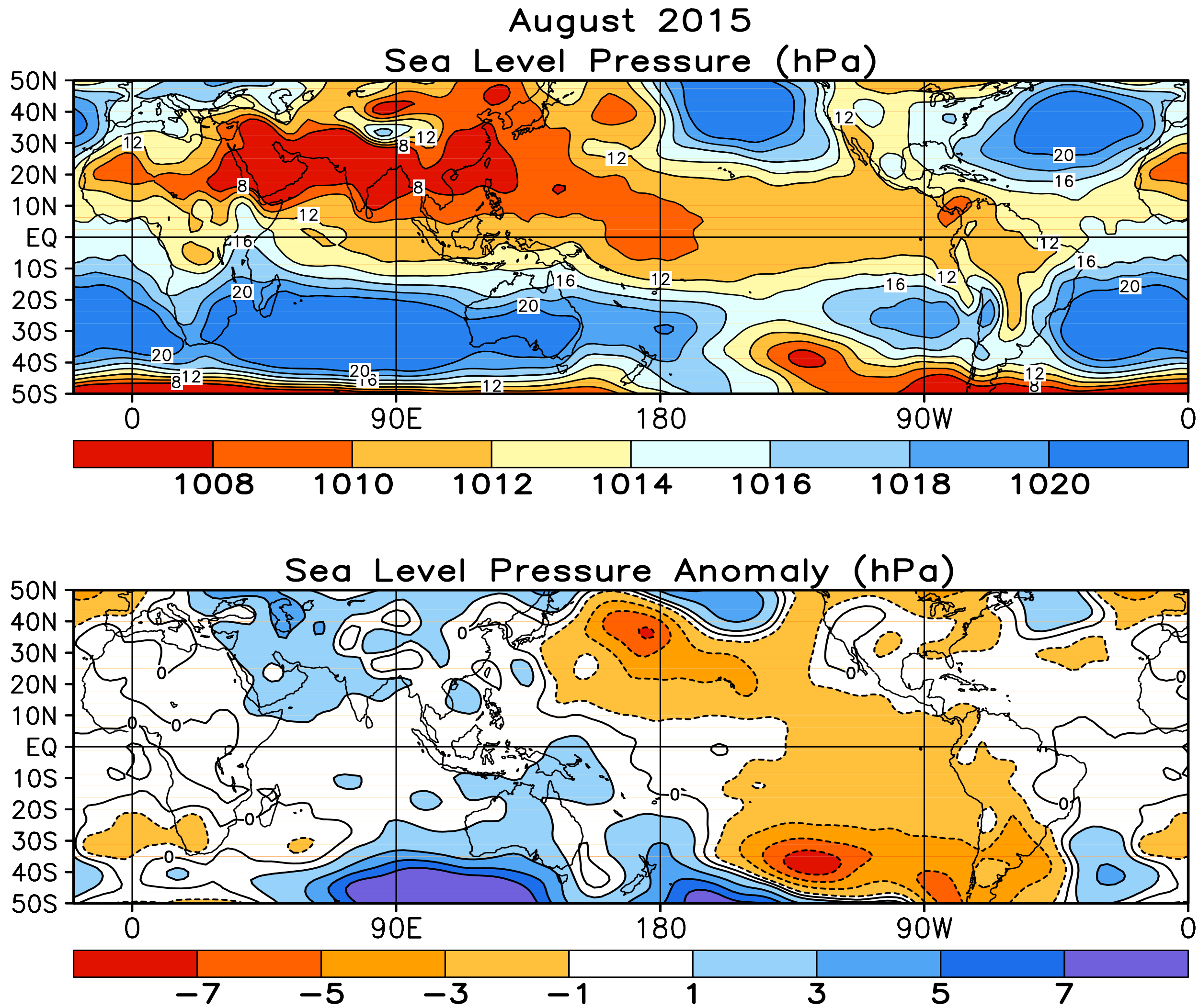
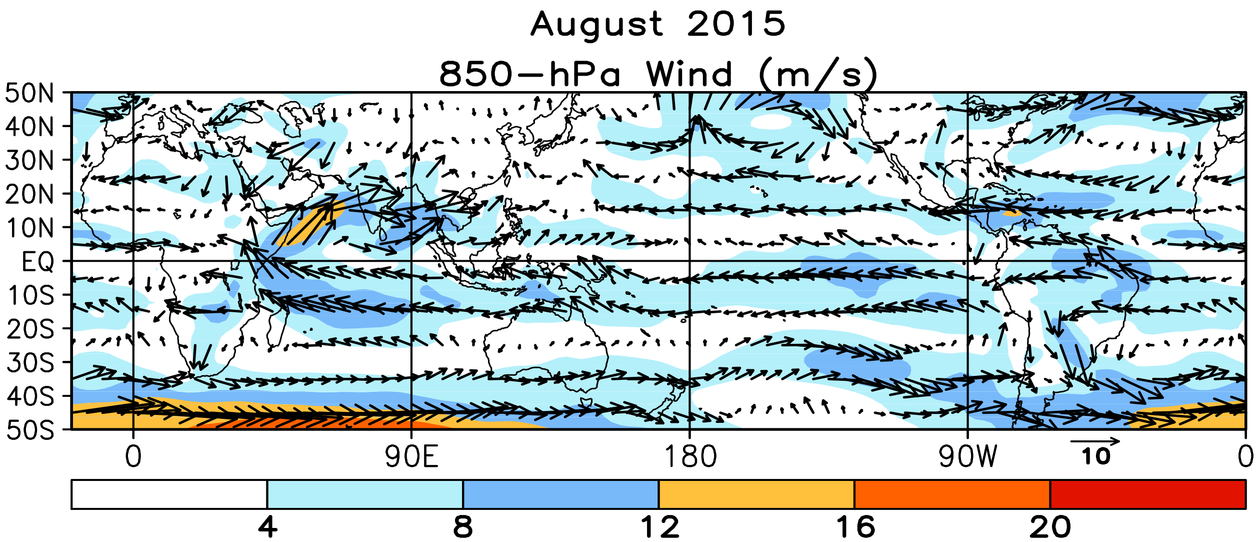


FIGURE T19. Mean (top) and anomalous (bottom) sea level pressure (SLP) (CDAS/Reanalysis). In top panel, 1000 hPa has been subtracted from contour labels, contour interval is 2 hPa, and values below 1000 hPa are indicated by dashed contours. In bottom panel, anomaly contour interval is 1 hPa and negative anomalies are indicated by dashed contours. Anomalies are departures from the 1981-2010 base period monthly means.



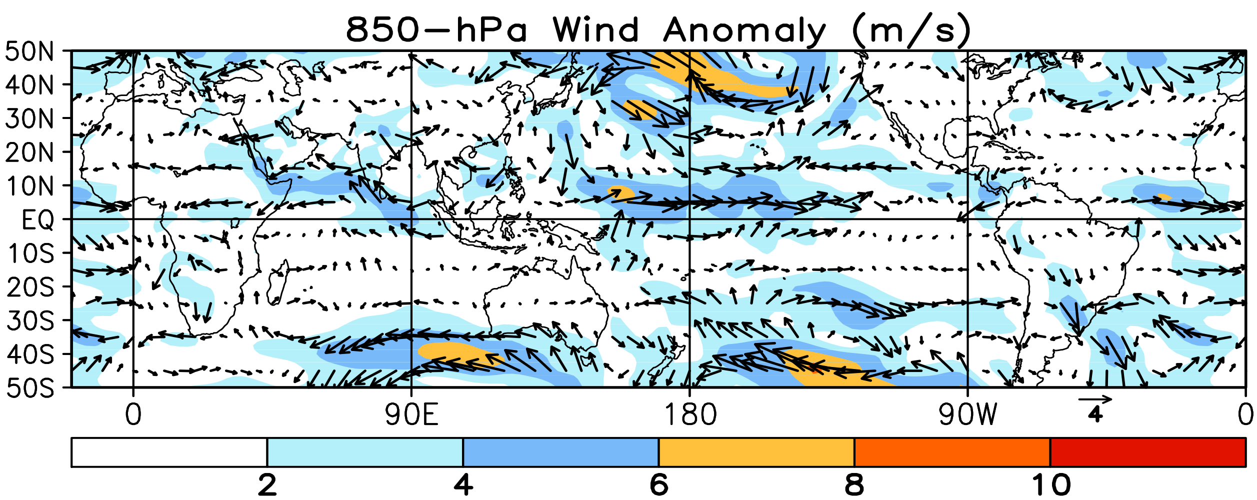


FIGURE T20. Mean (top) and anomalous (bottom) 850-hPa vector wind (CDAS/Reanaysis) for AUG 2015. Contour interval for isotachs is 4 ms^{-1} (top) and 2 ms^{-1} (bottom). Anomalies are departures from the 1981-2010 base period monthly means.

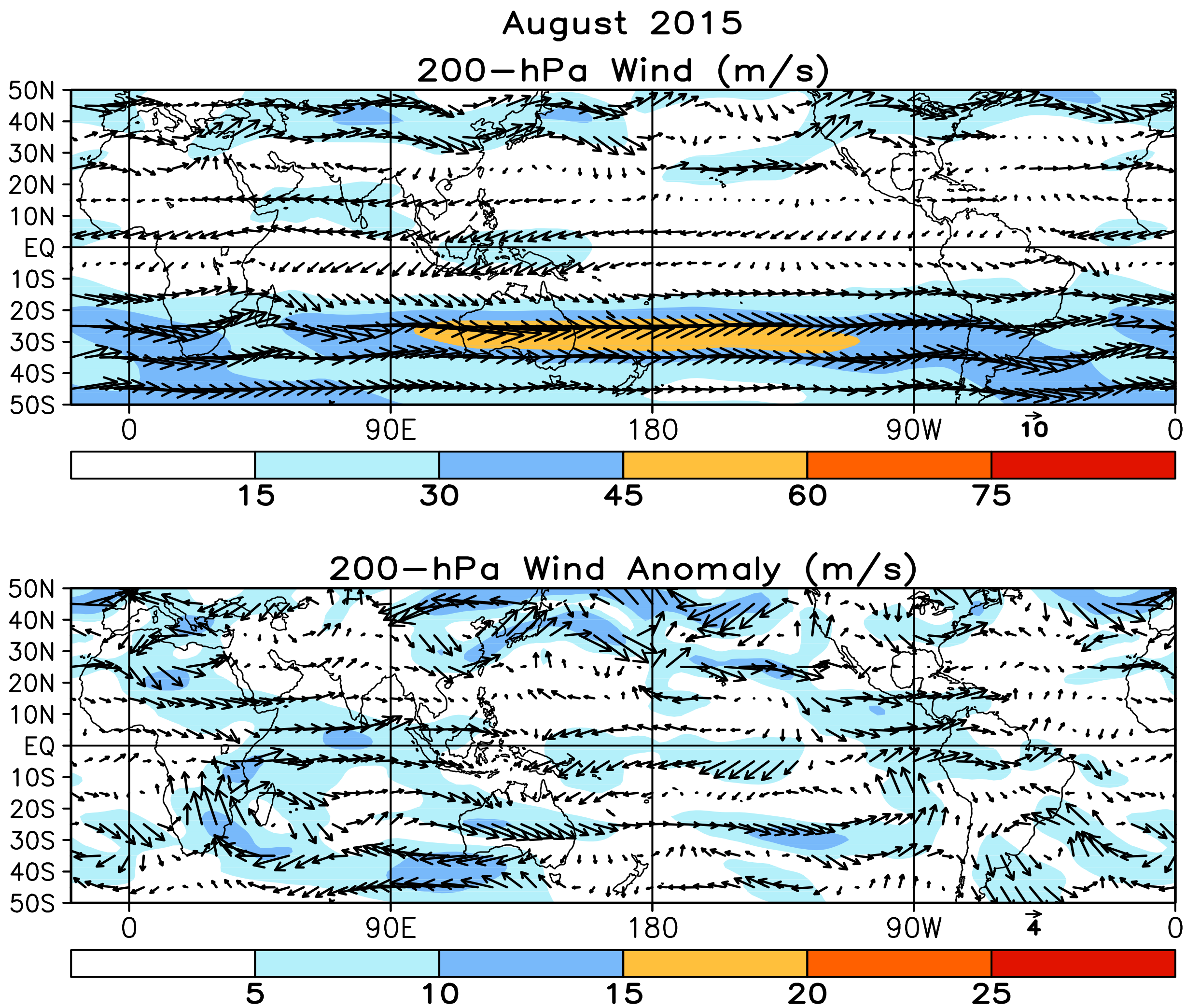


FIGURE T21. Mean (top) and anomalous (bottom) 200-hPa vector wind (CDAS/Reanalysis) for AUG 2015. Contour interval for isotachs is 15 ms^{-1} (top) and 5 ms^{-1} (bottom). Anomalies are departures from 1981-2010 base period monthly means.

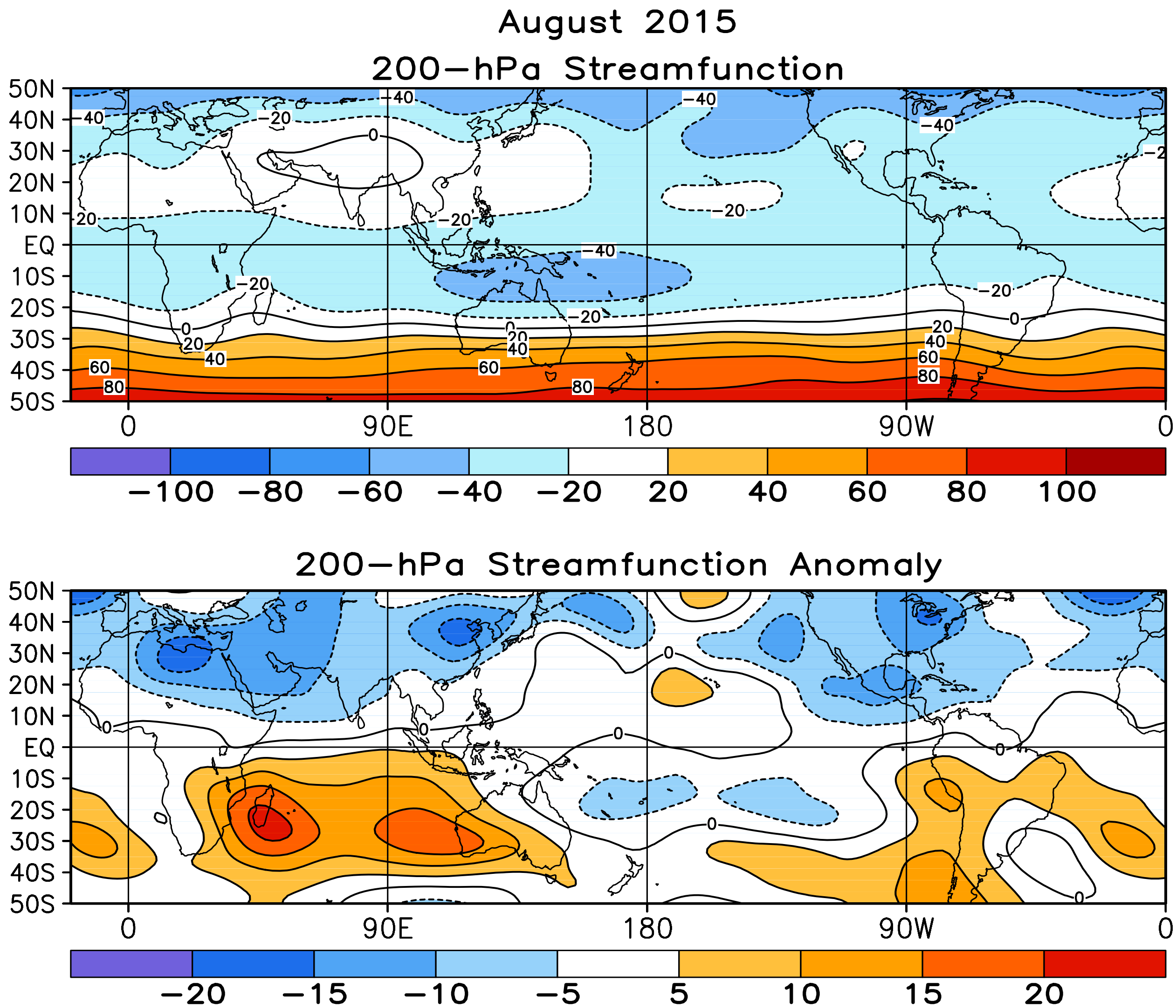


FIGURE T22. Mean (top) and anomalous (bottom) 200-hPa streamfunction (CDAS/Reanalysis). Contour interval is 20 x 10^6 m^2s^{-1} (top) and 5 x 10^6 m^2s^{-1} (bottom). Negative (positive) values are indicated by dashed (solid) lines. The non-divergent component of the flow is directed along the contours with speed proportional to the gradient. Thus, high (low) stream function corresponds to high (low) geopotential height in the Northern Hemisphere and to low (high) geopotential height in the Southern Hemisphere. Anomalies are departures from the 1981-2010 base period monthly means.

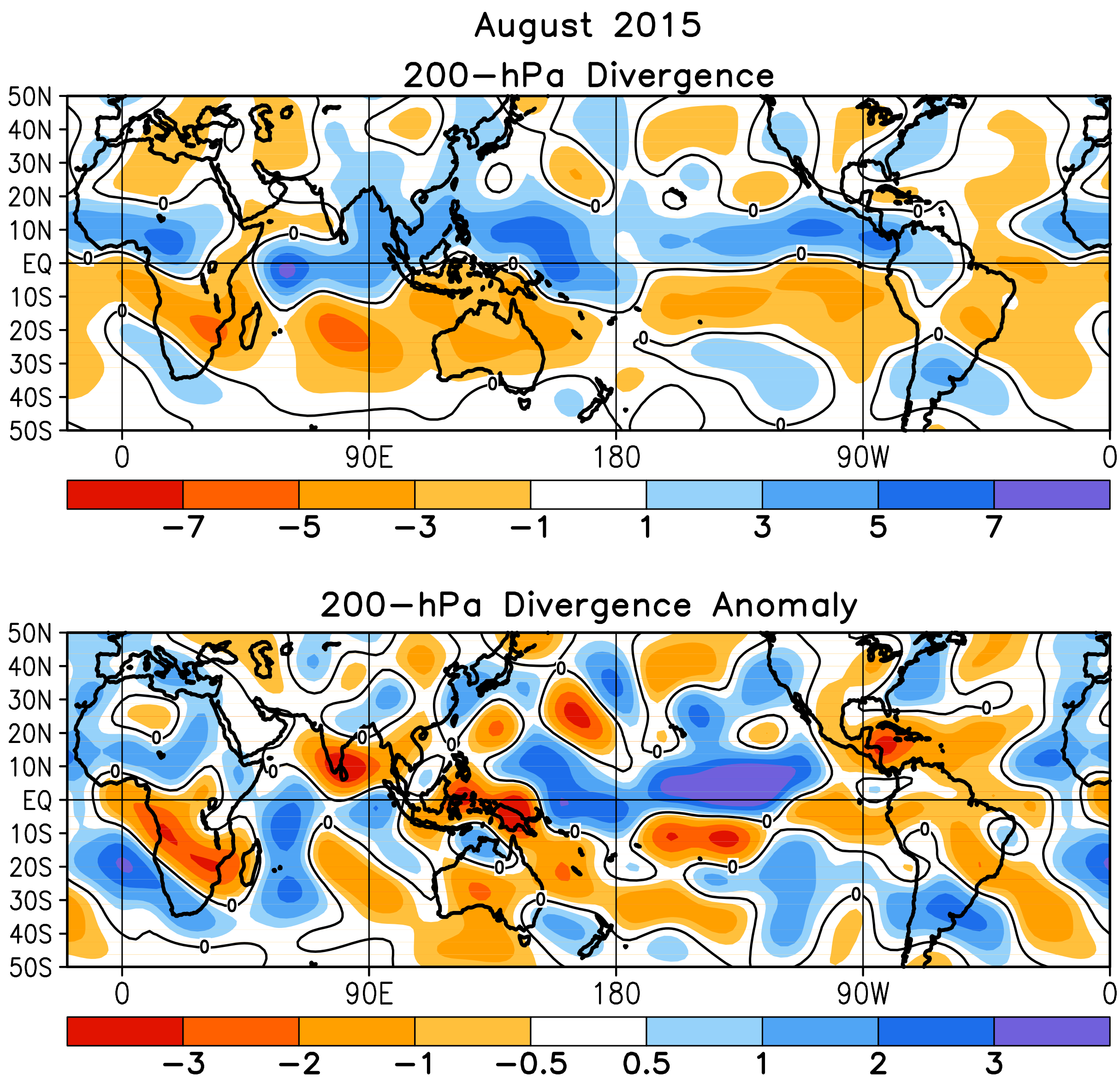


FIGURE T23. Mean (top) and anomalous (bottom) 200-hPa divergence (CDAS/Reanalysis). Divergence and anomalous divergence are shaded blue. Convergence and anomalous convergence are shaded orange. Anomalies are departures from the 1981-2010 base period monthly means.

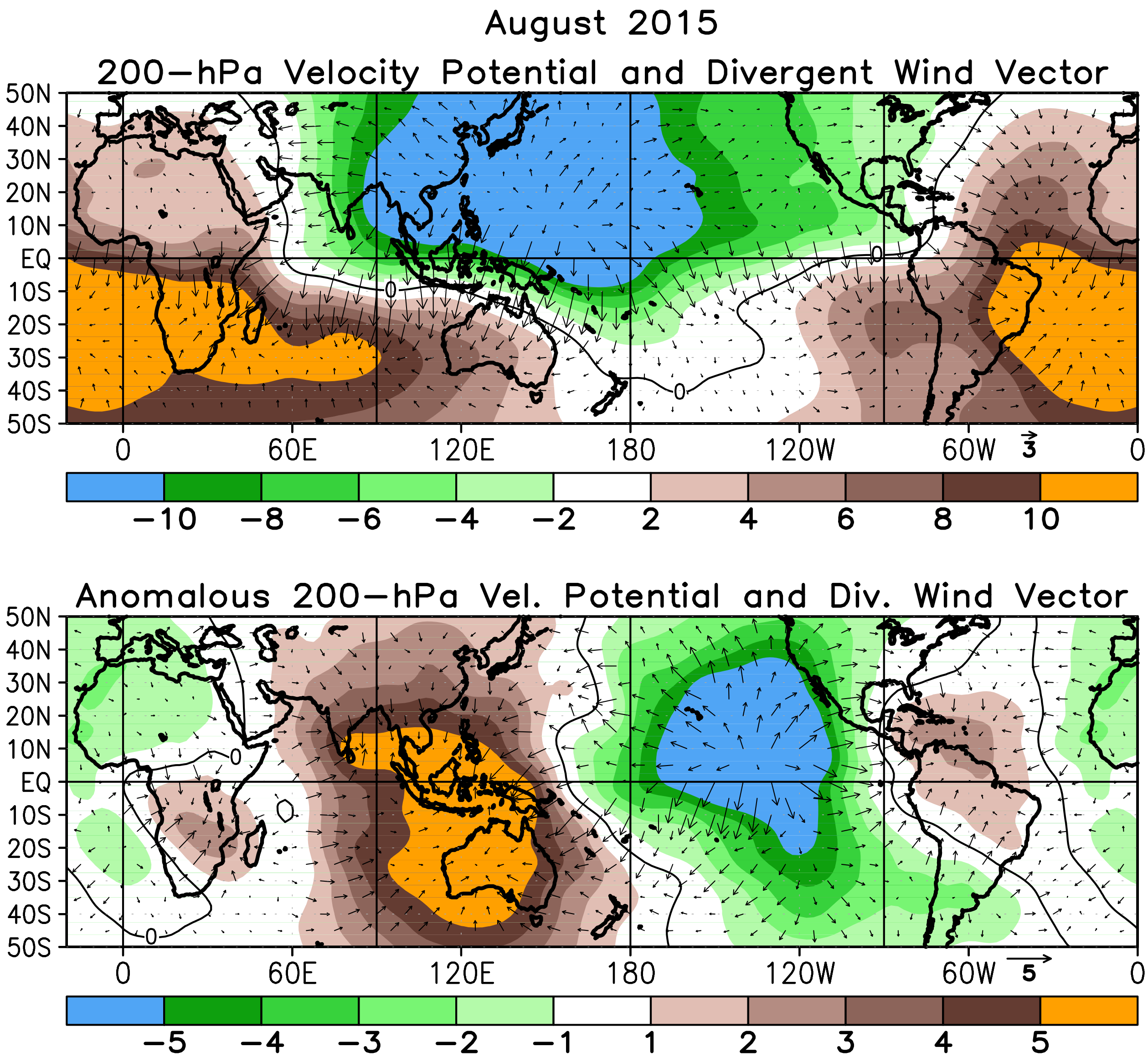


FIGURE T24. Mean (top) and anomalous (bottom) 200-hPa velocity potential ($10^6 m^2 s$) and divergent wind (CDAS/Reanalysis). Anomalies are departures from the 1981-2010 base period monthly means.

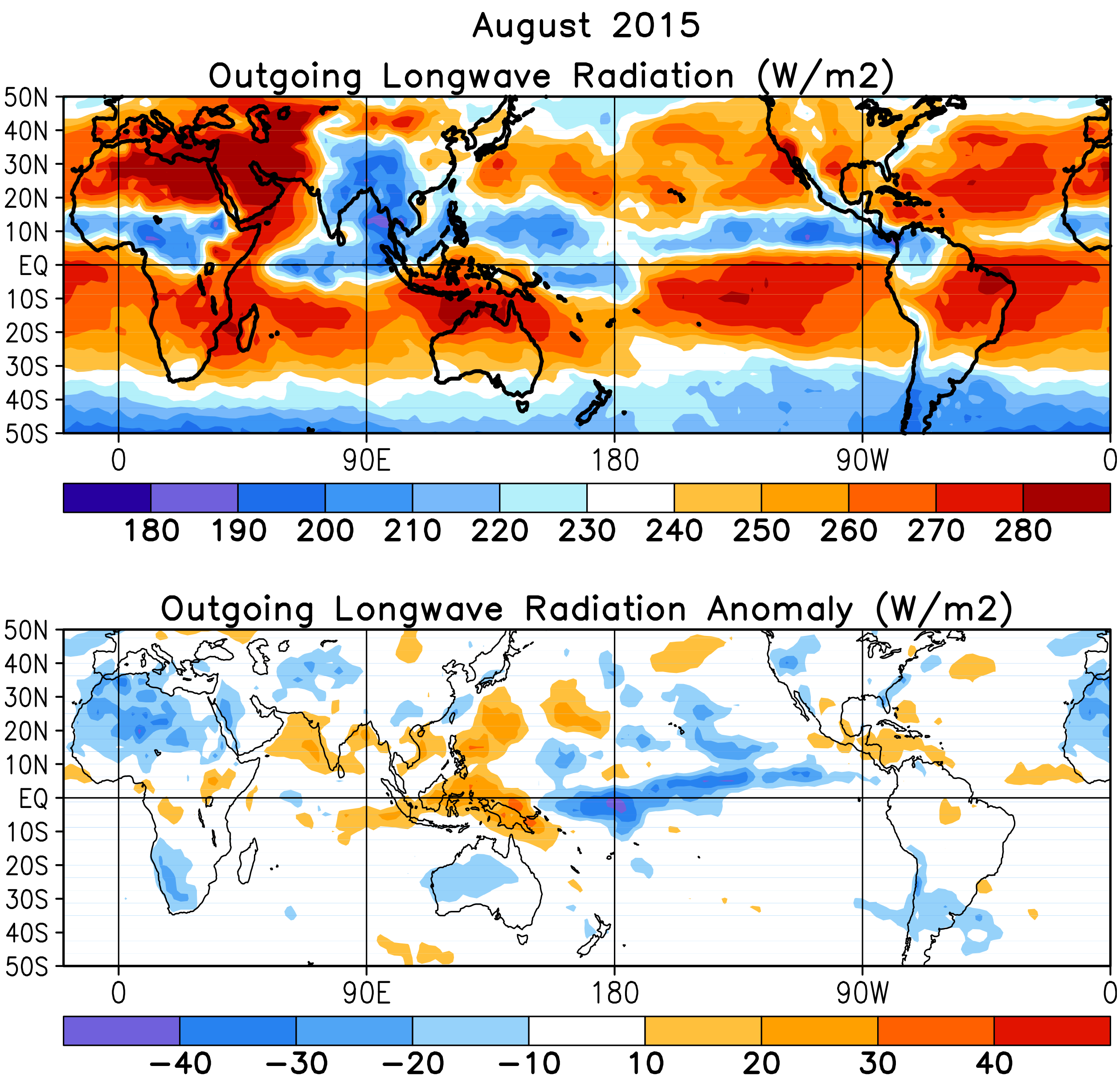


FIGURE T25. Mean (top) and anomalous (bottom) outgoing longwave radiation for AUG 2015 (NOAA 18 AVHRR IR window channel measurements by NESDIS/ORA). OLR contour interval is 20 Wm^{-2} with values greater than 280 Wm^{-2} indicated by dashed contours. Anomaly contour interval is 15 Wm^{-2} with positive values indicated by dashed contours and light shading. Anomalies are departures from the 1981-2010 base period monthly means.

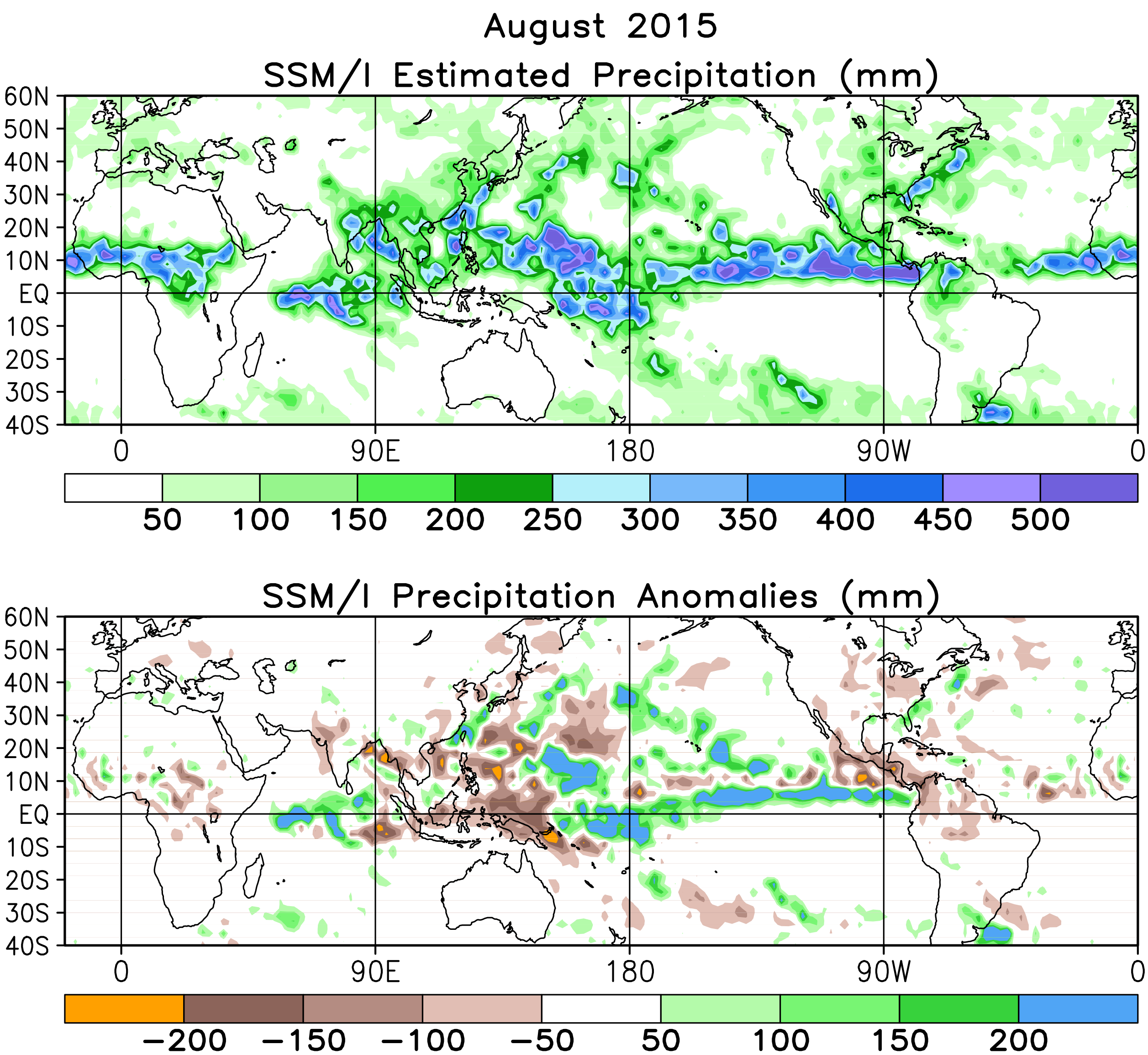


FIGURE T26. Estimated total (top) and anomalous (bottom) rainfall (mm) based on the Special Sensor Microwave/Imager (SSM/S) precipitation index (Ferraro 1997, *J. Geophys. Res.*, **102**, 16715-16735). Anomalies are computed from the SSM/I 1987-2010 base period monthly means. Anomalies have been smoothed for display purposes.

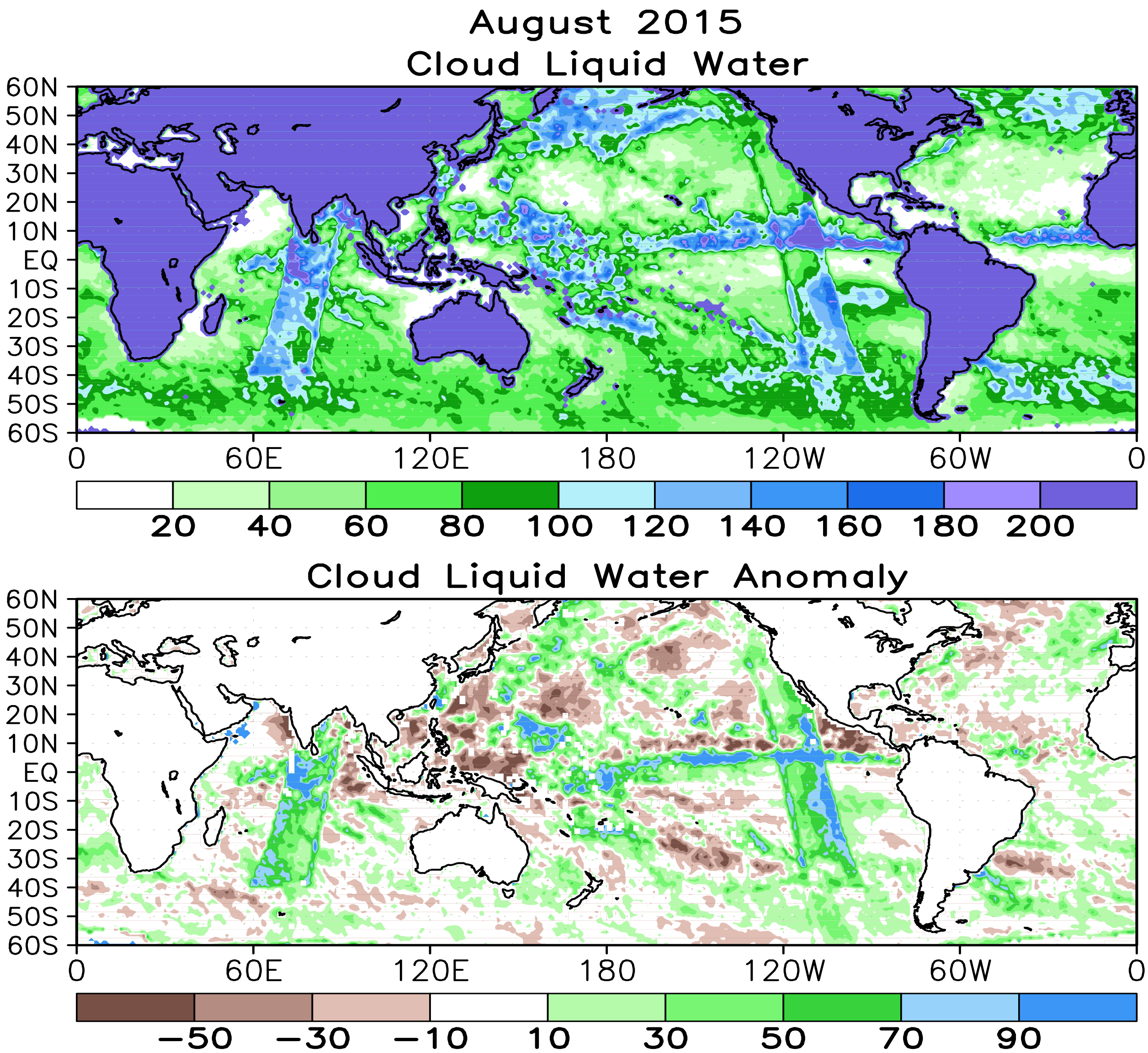


FIGURE T27. Mean (top) and anomalous (bottom) cloud liquid water (g m^{-2}) based on the Special Sensor Microwave/Imager (SSM/I) (Weng et al 1997: *J. Climate*, **10**, 1086-1098). Anomalies are calculated from the 1987-2010 base period means.

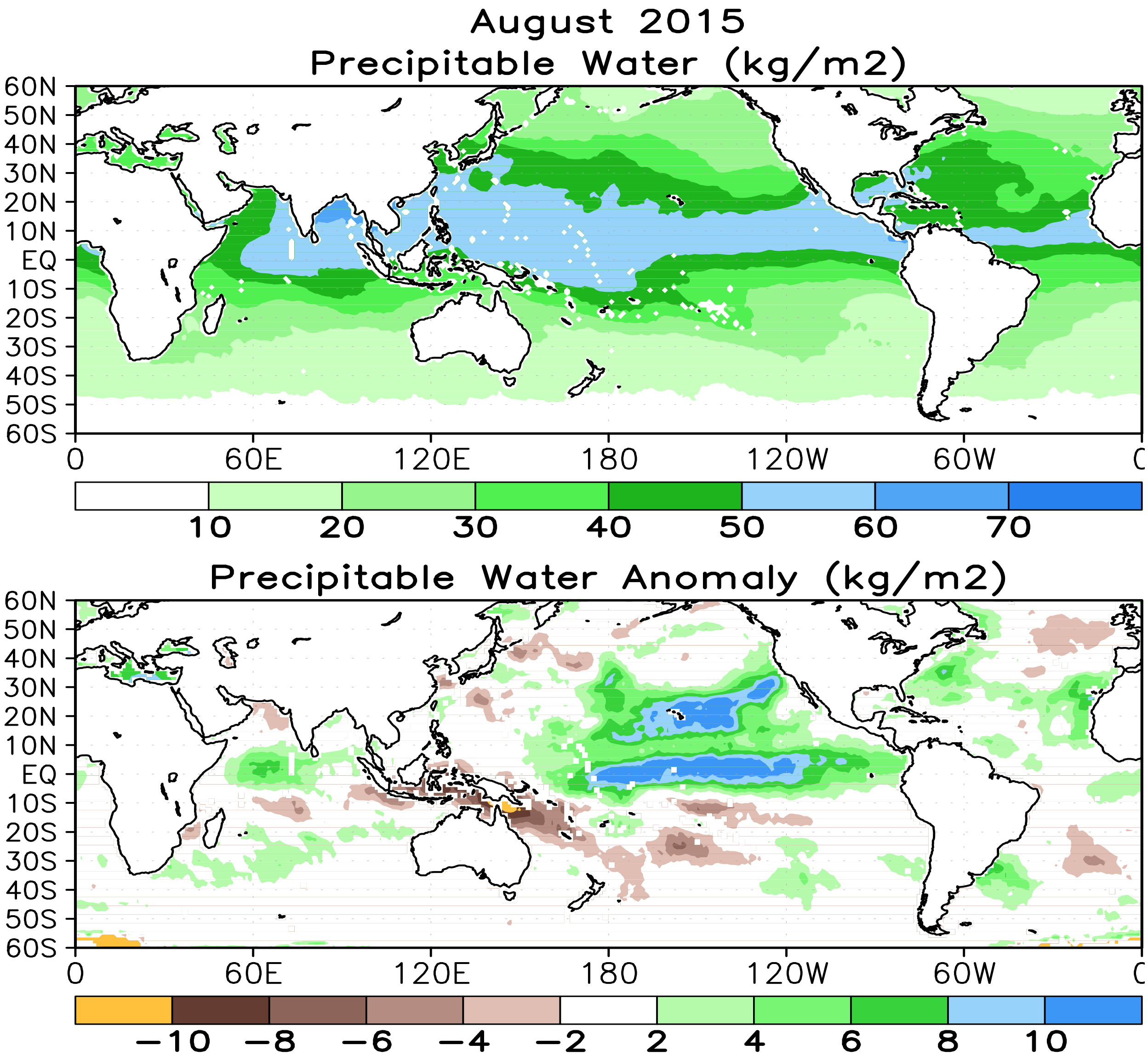


FIGURE T28. Mean (top) and anomalous (bottom) vertically integrated water vapor or precipitable water (kg m^{-2}) based on the Special Sensor Microwave/Imager (SSM/I) (Ferraro et. al, 1996: *Bull. Amer. Meteor. Soc.*, **77**, 891-905). Anomalies are calculated from the 1987-2010 base period means.

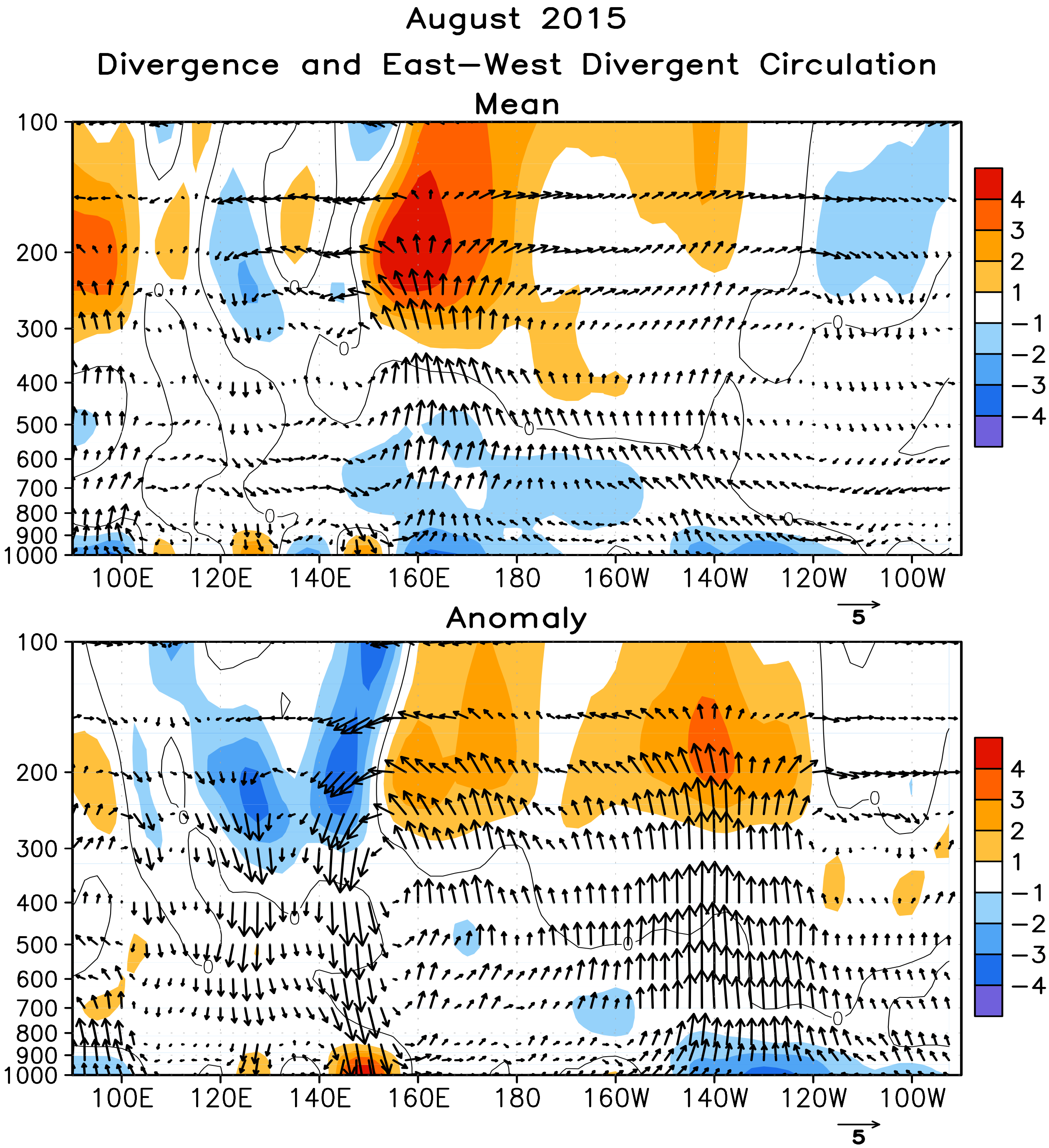


FIGURE T29. Pressure-longitude section (100E-80W) of the mean (top) and anomalous (bottom) divergence (contour interval is 1 x 10^{-6} s^{-1}) and divergent circulation averaged between 5N-5S. The divergent circulation is represented by vectors of combined pressure vertical velocity and the divergent component of the zonal wind. Red shading and solid contours denote divergence (top) and anomalous divergence (bottom). Blue shading and dashed contours denote convergence (top) and anomalous convergence (bottom). Anomalies are departures from the 1981-2010 base period monthly means.

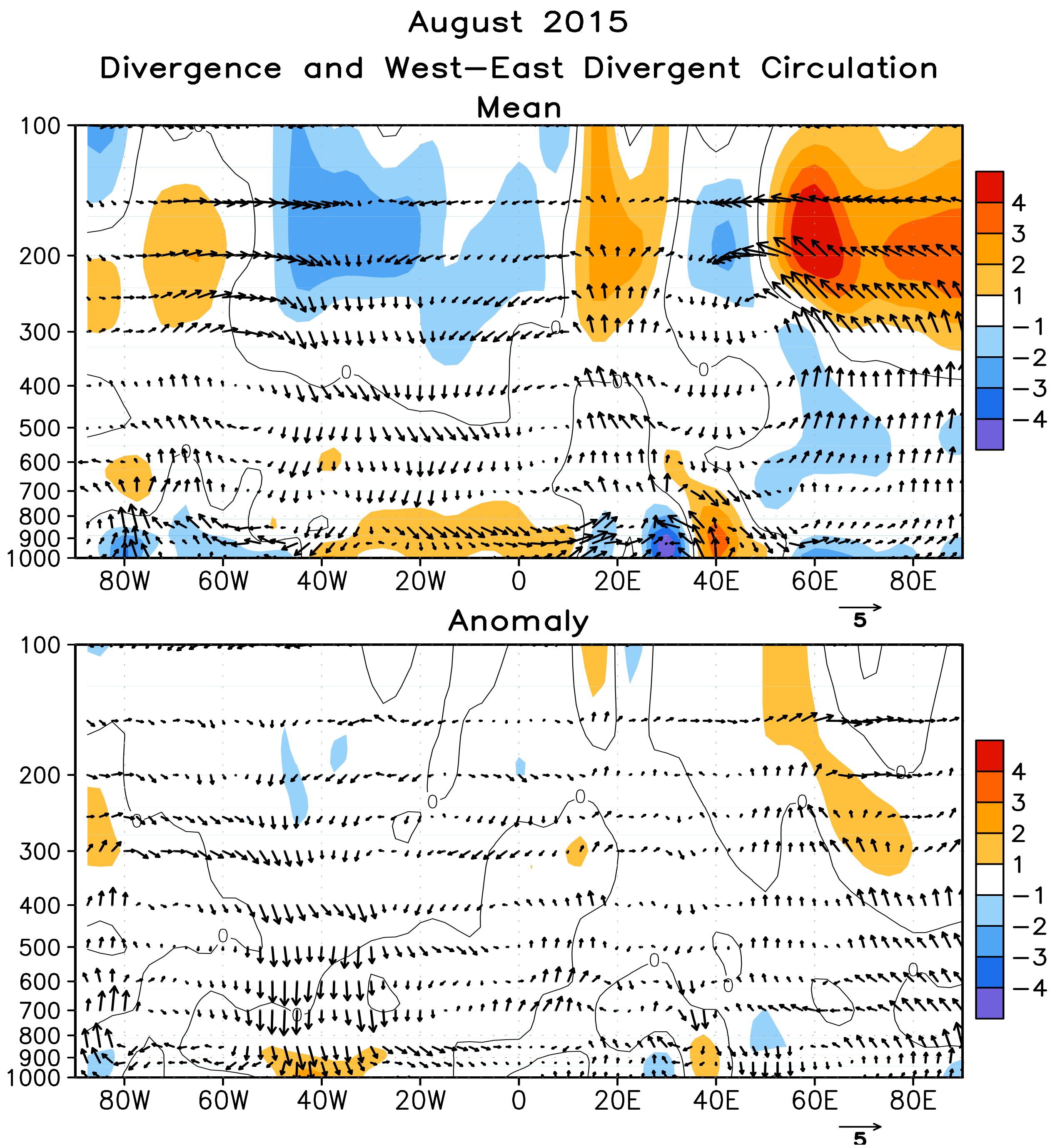


FIGURE T30. Pressure-longitude section (80W-100E) of the mean (top) and anomalous (bottom) divergence (contour interval is 1 x 10^{-6} s^{-1}) and divergent circulation averaged between 5N-5S. The divergent circulation is represented by vectors of combined pressure vertical velocity and the divergent component of the zonal wind. Red shading and solid contours denote divergence (top) and anomalous divergence (bottom). Blue shading and dashed contours denote convergence (top) and anomalous convergence (bottom). Anomalies are departures from the 1981-2010 base period monthly means.

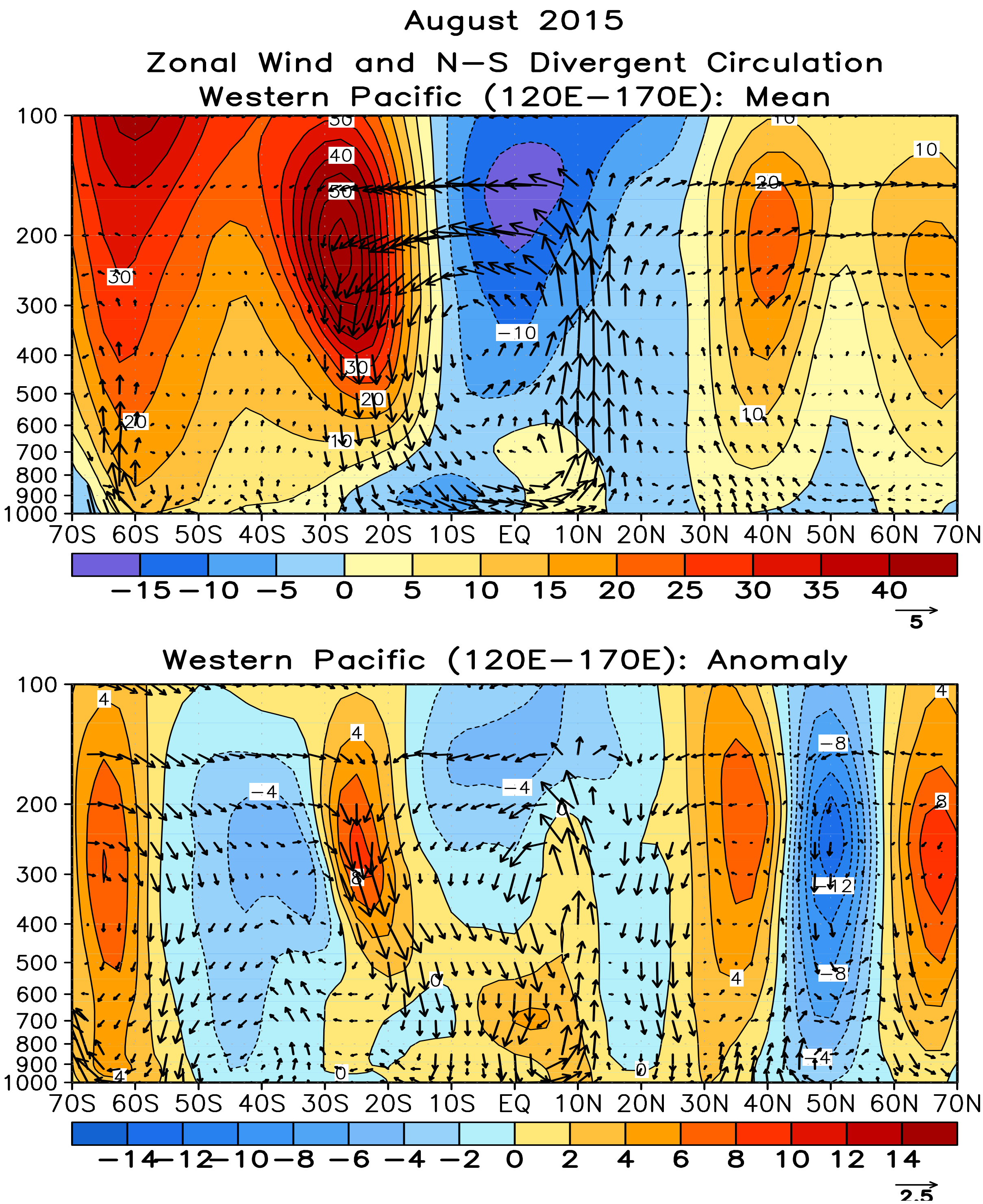


FIGURE T31. Pressure-latitude section of the mean (top) and anomalous (bottom) zonal wind (m s^{-1}) and divergent circulation averaged over the west Pacific sector (120E-170E). The divergent circulation is represented by vectors of combined pressure vertical velocity and the divergent component of the meridional wind. Red shading and solid contours denote a westerly (top) or anomalous westerly (bottom) zonal wind. Blue shading and dashed contours denote an easterly (top) or anomalous easterly (bottom) zonal wind. Anomalies are departures from the 1981-2010 base period monthly means.

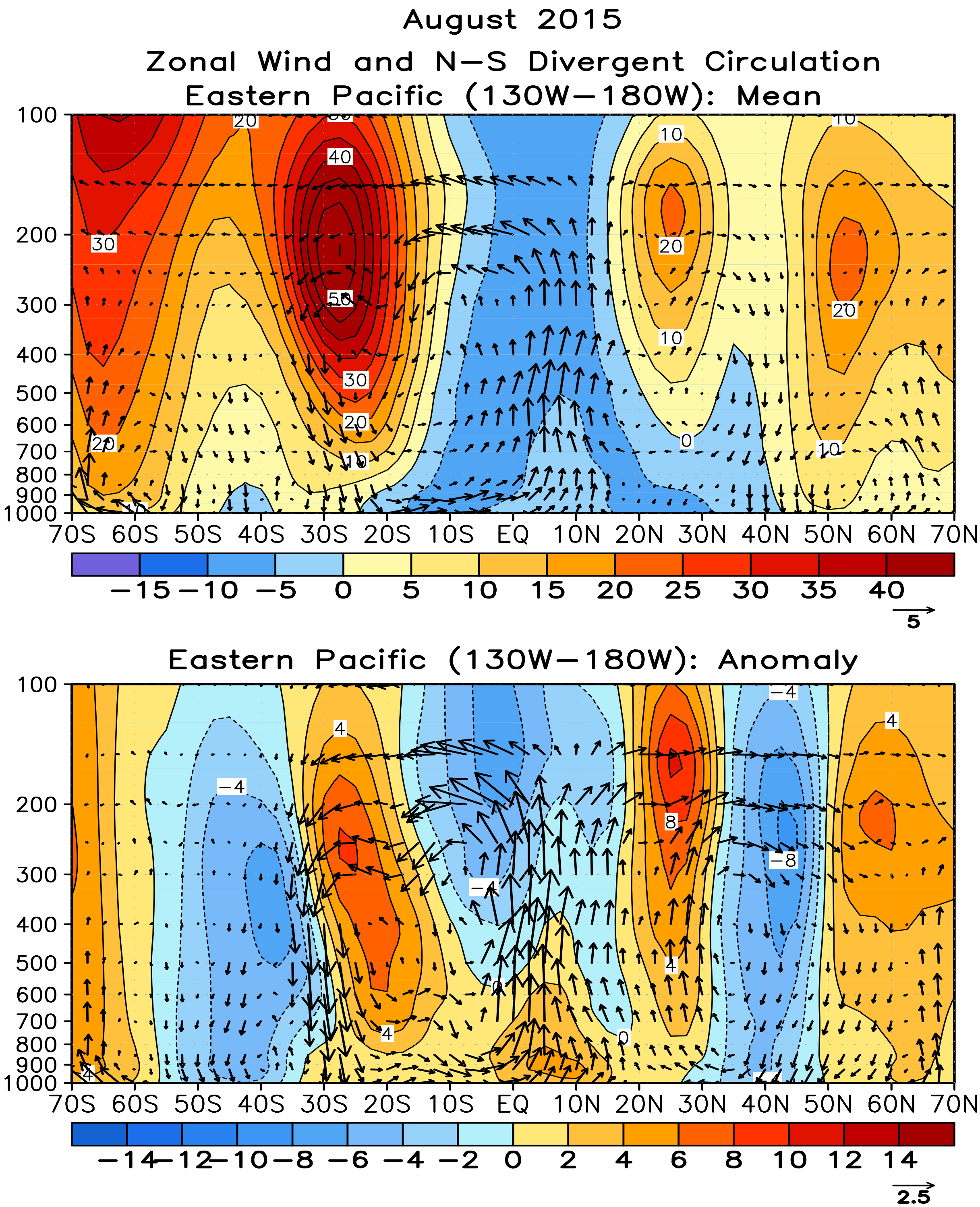


FIGURE T32. Pressure-latitude section of the mean (top) and anomalous (bottom) zonal wind (m s^{-1}) and divergent circulation averaged over the central Pacific sector (130W-180W). The divergent circulation is represented by vectors of combined pressure vertical velocity and the divergent component of the meridional wind. Red shading and solid contours denote a westerly (top) or anomalous westerly (bottom) zonal wind. Blue shading and dashed contours denote an easterly (top) or anomalous easterly (bottom) zonal wind. Anomalies are departures from the 1981-2010 base period monthly means.

Tropical Pacific Drifting Buoys R. Lumpkin/M. Pazos, AOML, Miami

During August 2015, 387 satellite-tracked surface drifting buoys, 70% with subsurface drogues attached for measuring mixed layer currents, were reporting from the tropical Pacific. Across the basin, a number of drifters measured very strong (~75 cm/s on average) eastward anomalies between the equator and 5N. Elsewhere, large-scale currents were close to their climatological August values.

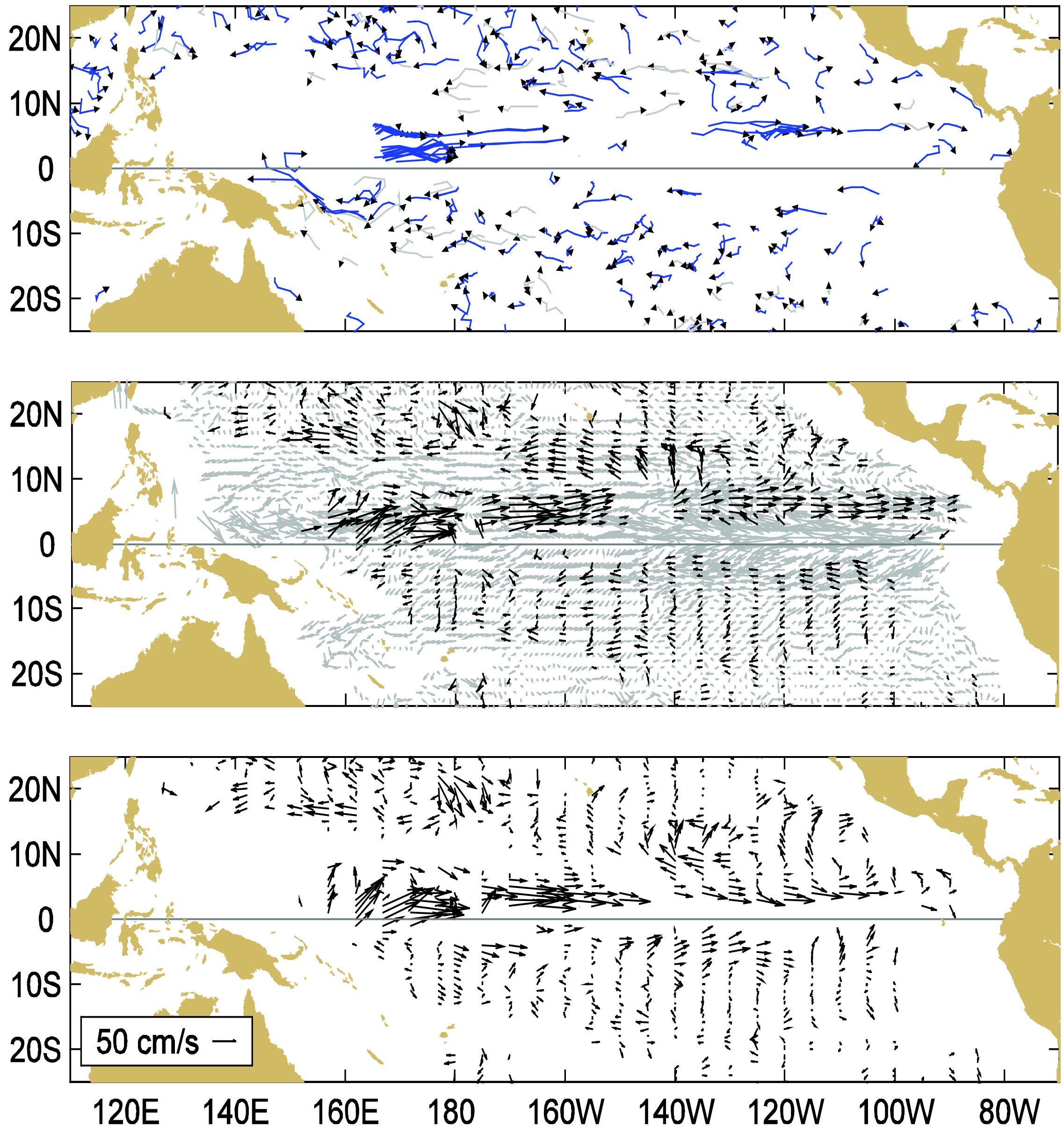


Figure A1.1 Top: Movements of drifting buoys in the tropical Pacific Ocean during August 2015. The linear segments of each trajectory represent a one week displacement. Trajectories of buoys which have lost their subsurface drogues are gray; those with drogues are black.
Middle: Monthly mean currents calculated from all buoys 1993-2002 (gray), and currents measured by the drogued buoys this month (black) smoothed by an optimal filter.
Bottom: Anomalies from the climatological monthly mean currents for this month.

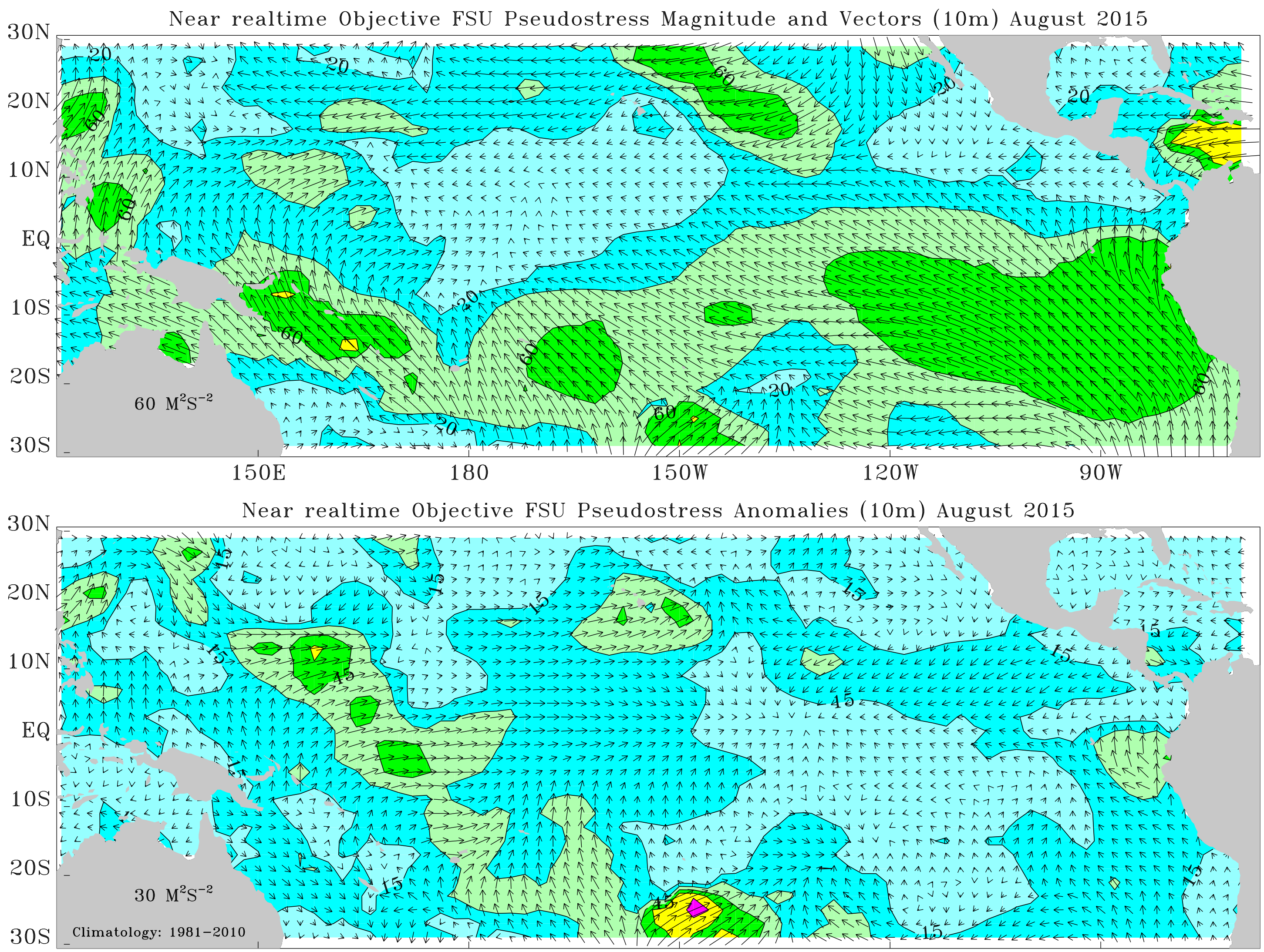


FIGURE A1.2.

FSU SURFACE PSEUDO–STRESS VECTORS AND ANOMALIES: August 2015. Pseudo–stress vectors (top) are objectively analyzed from ship and buoy winds on a 2° grid. Ship and buoy data are independently weighted and the background field is created from the data. Contour interval of the vector magnitudes is 20 M^2S^{-2}. Anomalies (bottom) are departures from 1981–2010 mean. The contour interval is 15 M^2S^{-2}. For more information, please visit our web site at http://www.coaps.fsu.edu/RVSMDC/html/winds.shtml. Produced by Jeremy Rolph, Mark A. Bourassa, and Shawn R. Smith, Center for Ocean–Atmospheric Prediction Studies, Florida State University, Tallahassee, FL 32306–2840, USA.

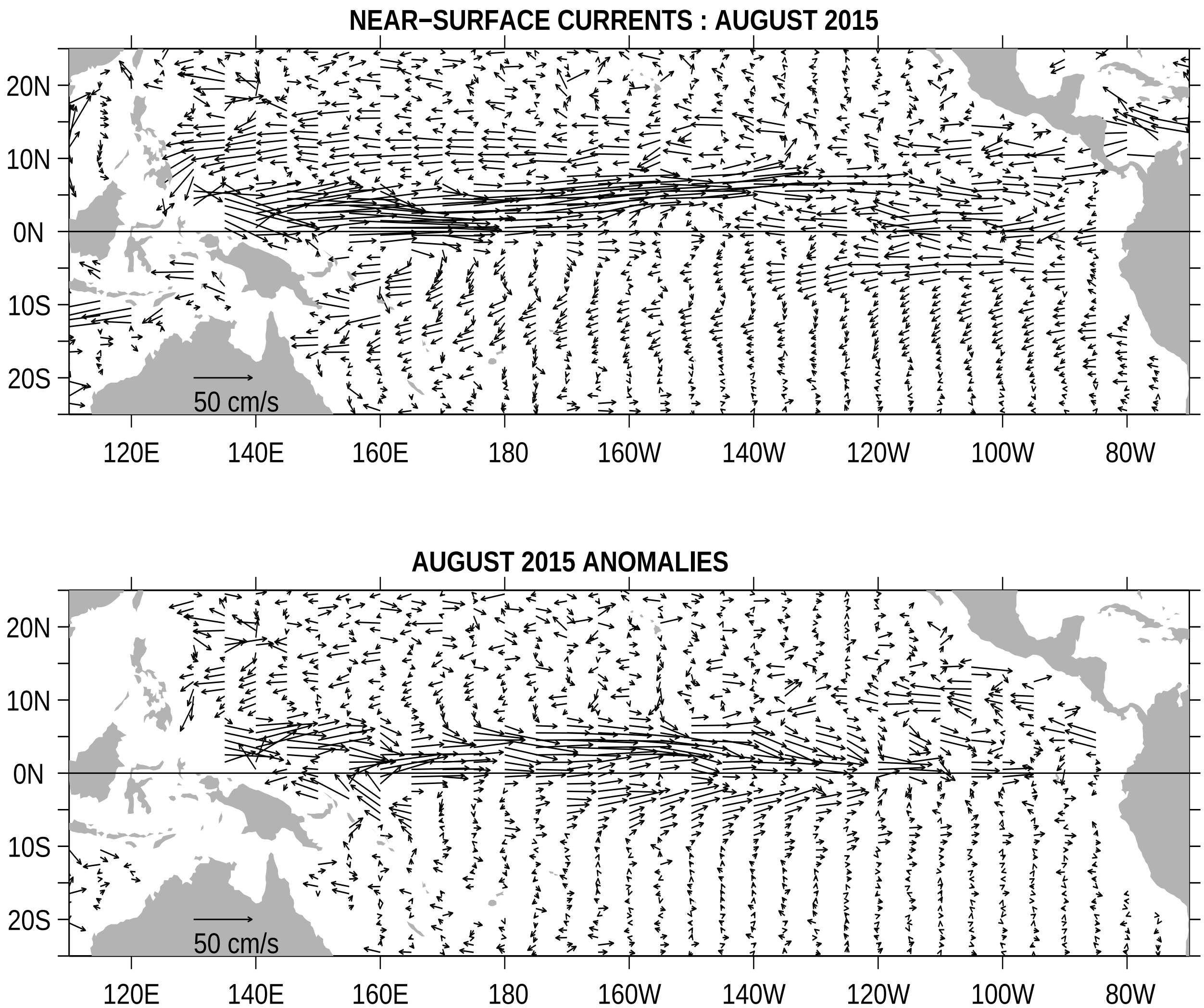


FIGURE A1.3. Ocean Surface Current Analysis-Real-time (OSCAR) for AUG 2015 (Bonjean and Lagerloef 2002, J. Phys. Oceanogr., Vol. 32, No. 10, 2938-2954; Lagerloef et al. 1999, JGR-Oceans, 104, 23313-23326). (top) Total velocity. Surface currents are calculated from satellite data including Jason sea level anomalies and NCEP winds. (bottom) Velocity anomalies. The subtracted climatology was based on SSM/I and QuickScat winds and Topex/Poseidon and Jason from 1993-2003. See also http://www.oscar.noaa.gov.

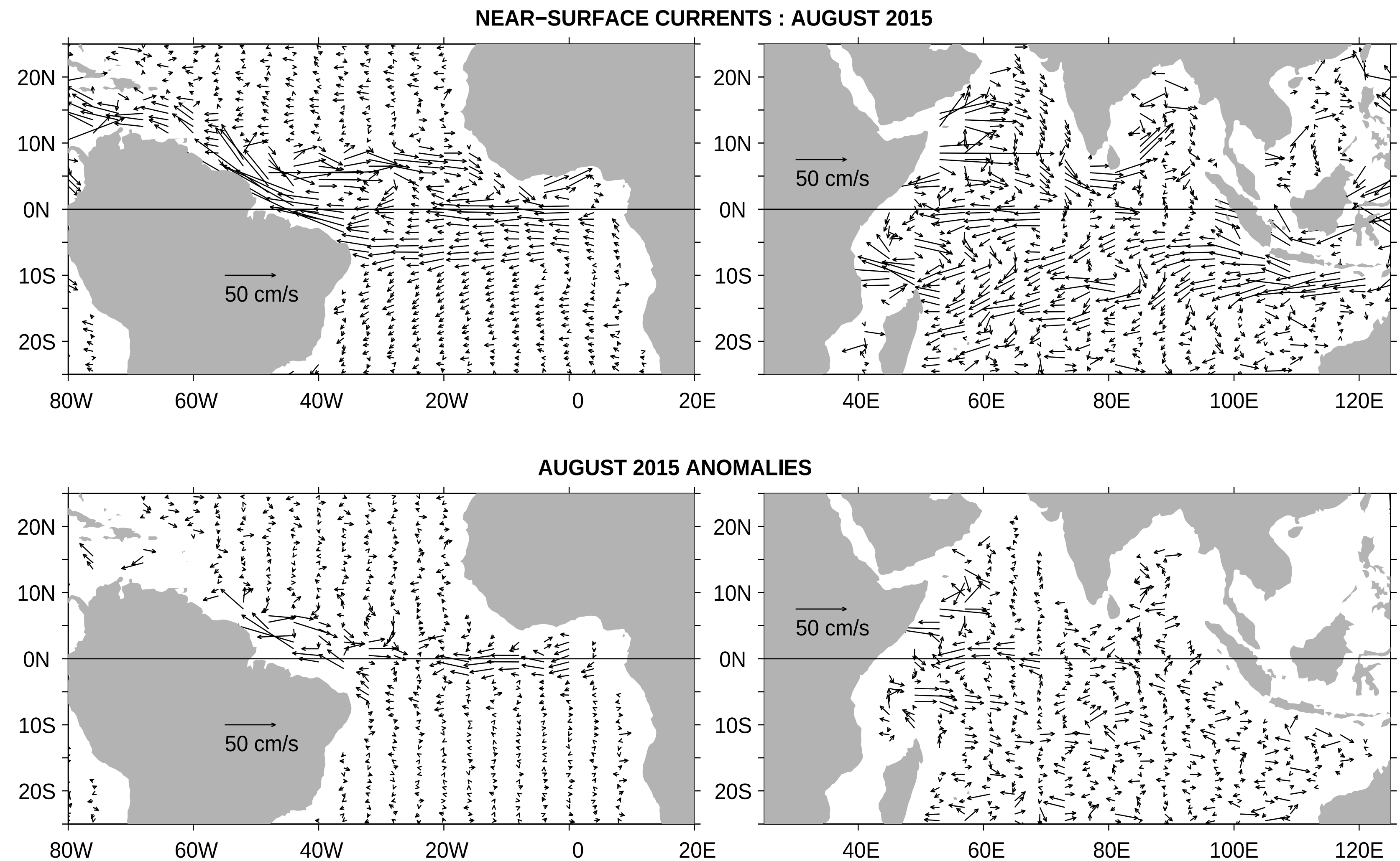


FIGURE A1.4. Ocean Surface Current Analysis-Real-time (OSCAR) for AUG 2015 (Bonjean and Lagerloef 2002, J. Phys. Oceanogr., Vol. 32, No. 10, 2938-2954; Lagerloef et al. 1999, JGR-Oceans, 104, 23313-23326). (top) Total velocity. Surface currents are calculated from satellite data including Jason sea level anomalies and NCEP winds. (bottom) Velocity anomalies. The subtracted climatology was based on SSM/I and QuickScat winds and Topex/Poseidon and Jason from 1993-2003. See also http://www.oscar.noaa.gov.

Forecast Forum

The canonical correlation analysis (CCA) forecast of SST in the central Pacific (Barnett et al. 1988, *Science*, **241**, 192196; Barnston and Ropelewski 1992, *J. Climate*, **5**, 13161345), is shown in **Figs. F1 and F2.** This forecast is produced routinely by the Prediction Branch of the Climate Prediction Center. The predictions from the National Centers for Environmental Prediction (NCEP) Coupled Forecast System Model (CFS03) are presented in **Figs. F3 and F4a, F4b**. Predictions from the Markov model (Xue, et al. 2000: *J. Climate*, **13**, 849871) are shown in **Figs. F5 and F6.** Predictions from the latest version of the LDEO model (Chen et al. 2000: *Geophys. Res. Let.*, **27**, 25852587) are shown in **Figs. F7 and F8**. Predictions using linear inverse modeling (Penland and Magorian 1993: *J. Climate*, **6**, 10671076) are shown in **Figs. F9 and F10.** Predictions from the Scripps / Max Planck Institute (MPI) hybrid coupled model (Barnett et al. 1993: *J. Climate*, **6**, 15451566) are shown in **Fig. F11.** Predictions from the ENSOCLIPER statistical model (Knaff and Landsea 1997, *Wea. Forecasting*, **12**, 633652) are shown in **Fig. F12.** Niño 3.4 predictions are summarized in **Fig. F13**, provided by the Forecasting and Prediction Research Group of the IRI.

The CPC and the contributors to the **Forecast Forum** caution potential users of this predictive information that they can expect only modest skill.

ENSO Alert System Status: El Niño Advisory

Outlook

There is an approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016.

Discussion

During August, sea surface temperature (SST) anomalies were near or greater than +2.0°C across the eastern half of the tropical Pacific (Fig. T18). SST anomalies increased in the Niño-3.4 and Niño 3-regions, were approximately unchanged in the Niño-4 region, and decreased in the Niño-1+2 region (Table T2). Large positive subsurface temperature anomalies persisted in the central and east-central equatorial Pacific during the month, with the largest departures exceeding 6°C (Fig. T17). The atmosphere remained coupled to the anomalous oceanic warmth, with significant low-level westerly wind anomalies and upper-level easterly wind anomalies persisting from the western to east-central tropical Pacific (Figs.T20-T21). Also, the traditional and equatorial Southern Oscillation Index (SOI) were again negative (Table T1 & Fig. T2), consistent with enhanced convection over the central and eastern equatorial Pacific and suppressed convection over Indonesia (Fig.T25). Collectively, these atmospheric and oceanic anomalies reflect a strong El Niño.

All models surveyed predict El Niño to continue into the Northern Hemisphere spring 2016, and all multi-model averages predict a peak in late fall/early winter (3-month values of the Niño-3.4 index of +1.5°C or greater; Figs. F1-F13). The forecaster consensus unanimously favors a strong El Niño, with peak 3-month SST departures in the Nino 3.4 region near or exceeding +2.0°C. Overall, there is an approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016.

Weekly updates of oceanic and atmospheric conditions are available on the Climate Prediction Center homepage (El Niño/La Niña Current Conditions and Expert Discussions).

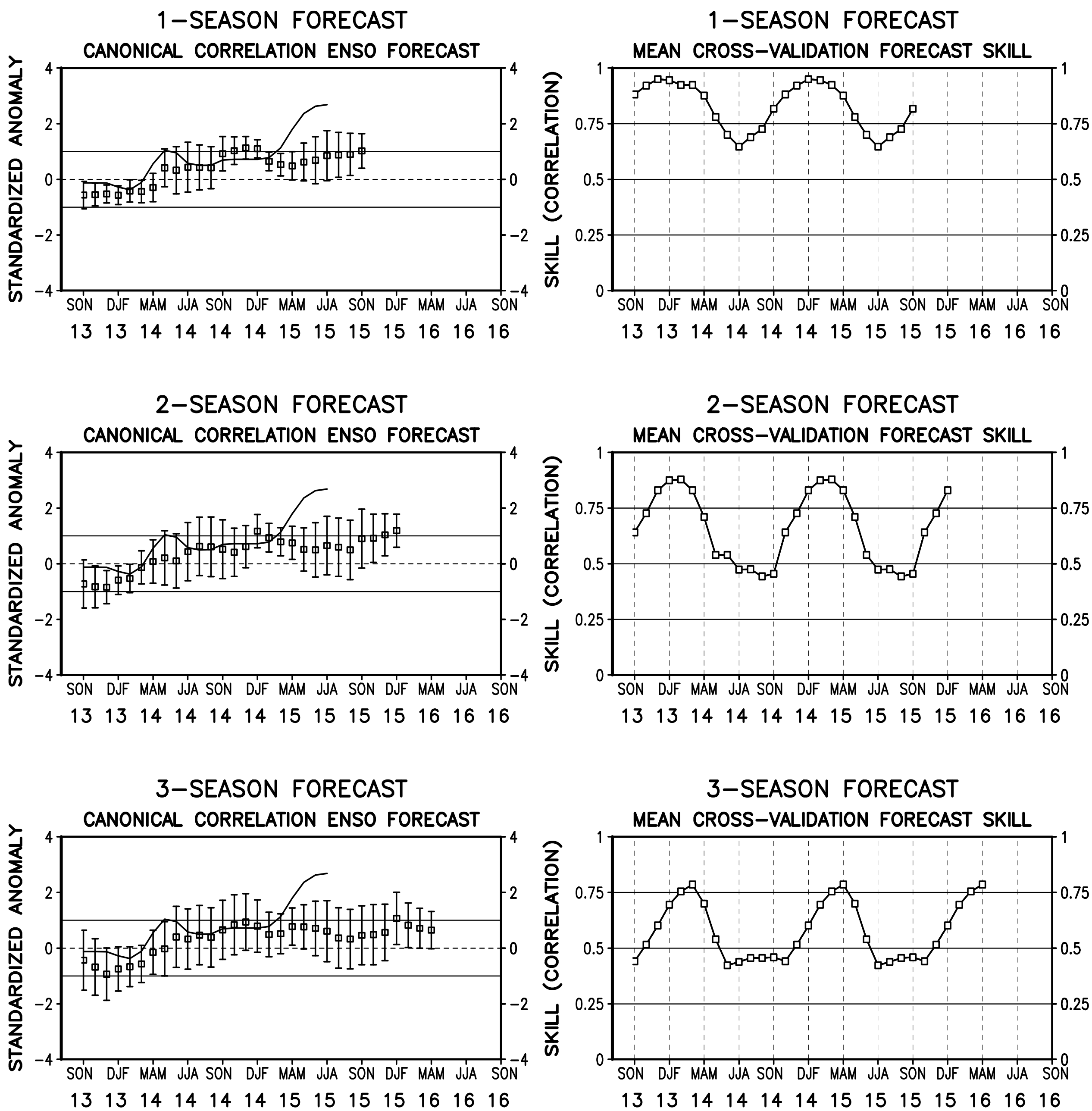


FIGURE F1. Canonical correlation analysis (CCA) sea surface temperature (SST) anomaly prediction for the central Pacific (5˚N to 5˚S, 120˚W to 170˚W (Barnston and Ropelewski, 1992, *J. Climate*, **5**, 1316-1345). The three plots on the left hand side are, from top to bottom, the 1-season, 2-season, and 3-season lead forecasts. The solid line in each forecast represents the observed SST standardized anomaly through the latest month. The small squares at the mid-points of the forecast bars represent the real-time CCA predictions based on the anomalies of quasi-global sea level pressure and on the anomalies of tropical Pacific SST, depth of the 20˚C isotherm and sea level height over the prior four seasons. The vertical lines represent the one standard deviation error bars for the predictions based on past performance. The three plots on the right side are skills, corresponding to the predicted and observed SST. The skills are derived from cross-correlation tests from 1956 to present. These skills show a clear annual cycle and are inversely proportional to the length of the error bars depicted in the forecast time series.

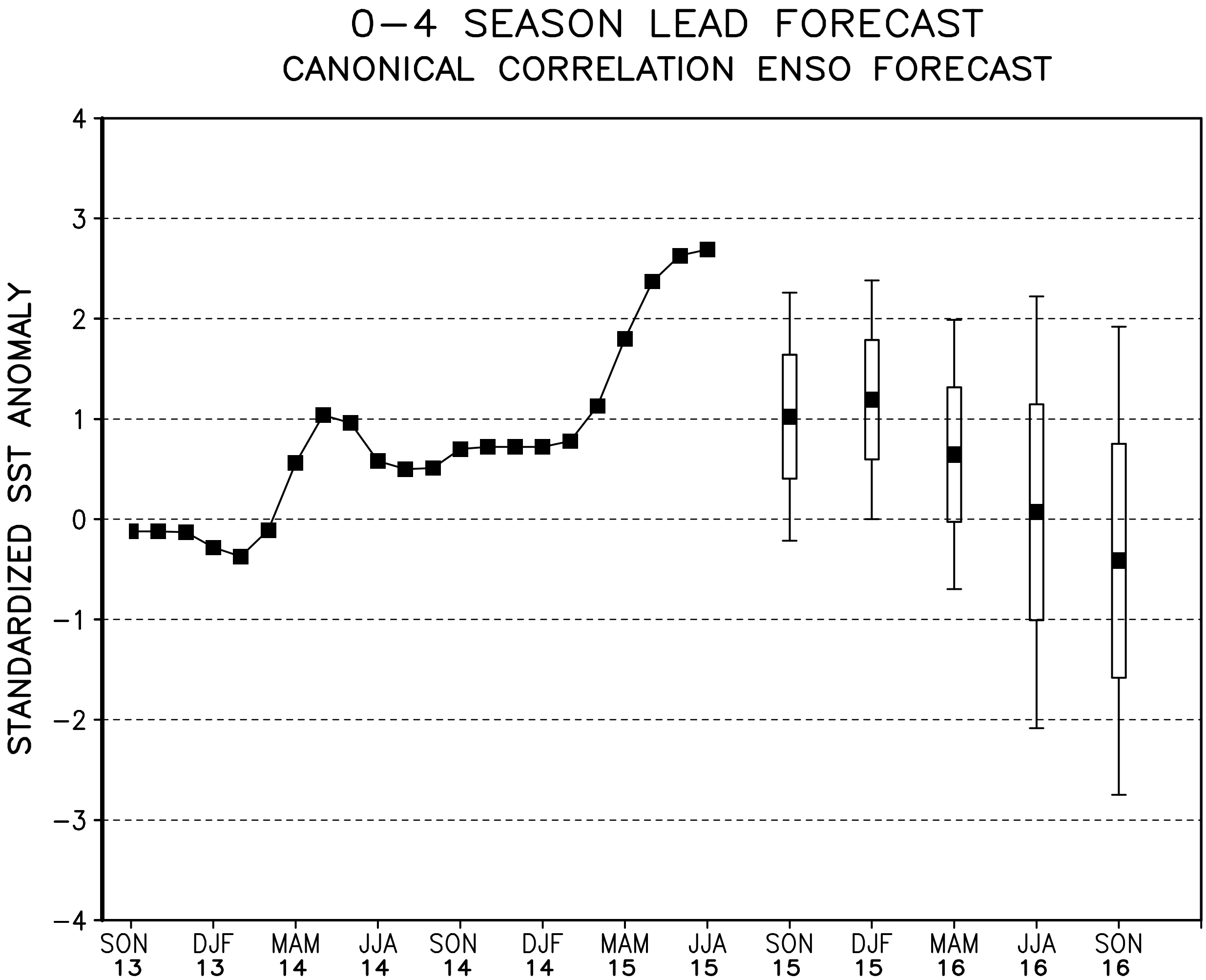


FIGURE F2. Canonical Correlation Analysis (CCA) forecasts of sea-surface temperature anomalies for the Nino 3.4 region (5N-5S, 120W-170W) for the upcoming five consecutive 3-month periods. Forecasts are expressed as standardized SST anomalies. The CCA predictions are based on anomaly patterns of SST, depth of the 20C isotherm, sea level height, and sea level pressure. Small squares at the midpoints of the vertical forecast bars represent the CCA predictions, and the bars show the one (thick) and two (thin) standard deviation errors. The solid continuous line represents the observed standardized three-month mean SST anomaly in the Nino 3.4 region up to the most recently available data.

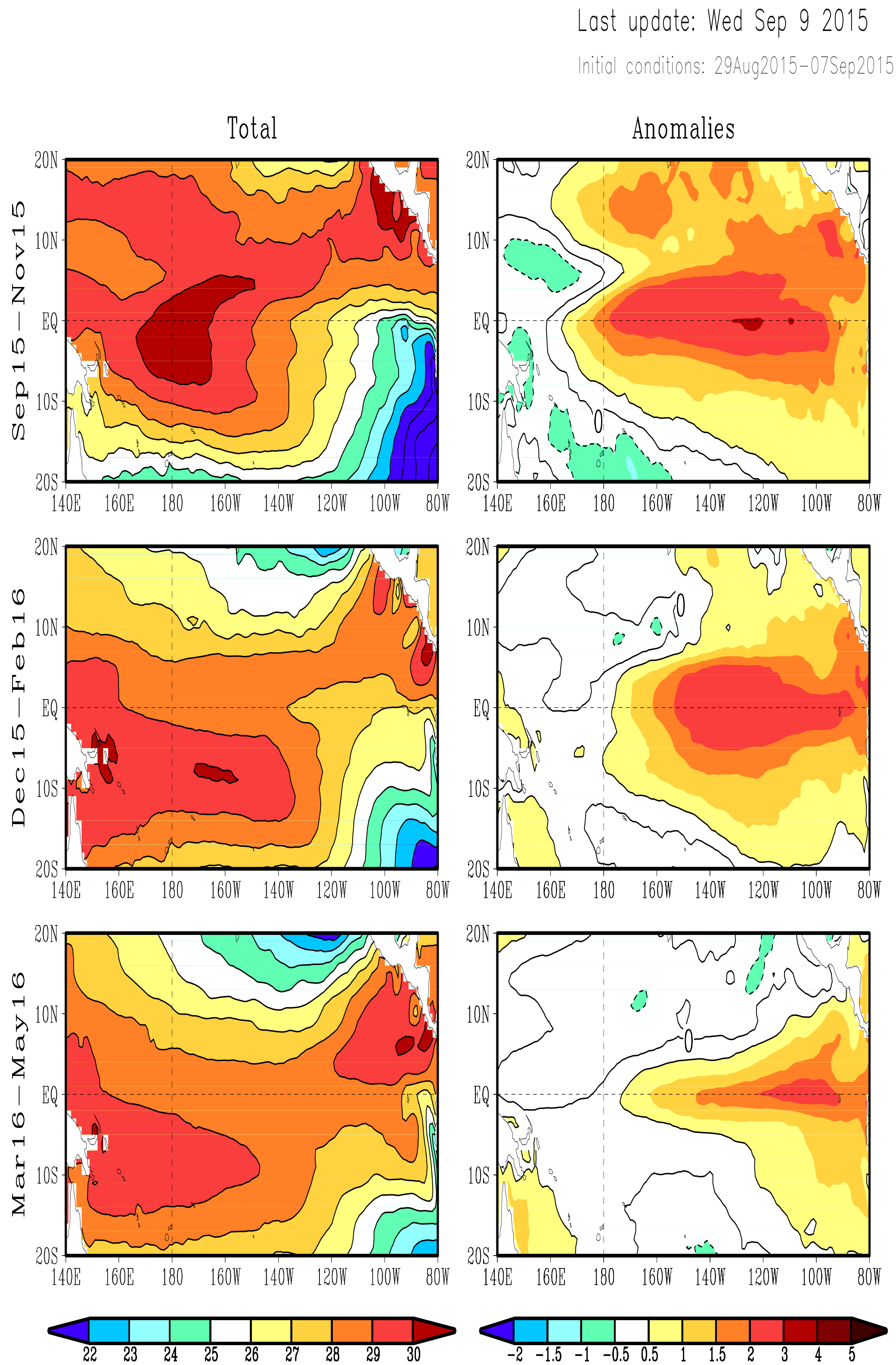


FIGURE F3. Predicted 3-month average sea surface temperature (left) and anomalies (right) from the NCEP Coupled Forecast System Model (CFS03). The forecasts consist of 40 forecast members. Contour interval is 1°C, with additional contours for 0.5°C and -0.5°C. Negative anomalies are indicated by dashed contours.

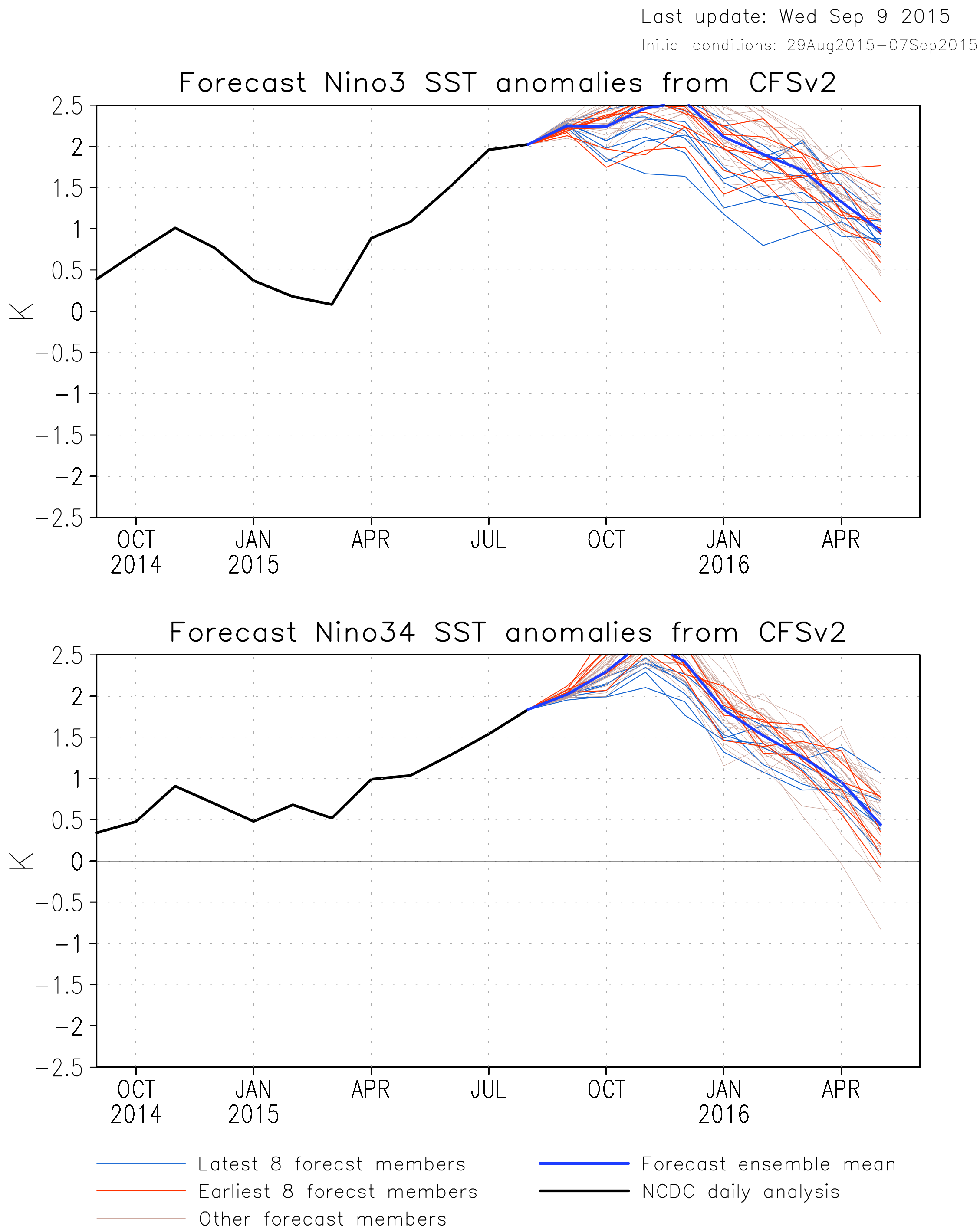


FIGURE F4. Predicted and observed sea surface temperature (SST) anomalies for the Nino 3 (top) and Nino 3.4 (bottom) regions from the NCEP Coupled Forecast System Model (CFS03). The forecasts consist of 40 forecast members. The ensemble mean of all 40 forecast members is shown by the blue line, individual members are shown by thin lines, and the observation is indicated by the black line. The Nino-3 region spans the eastern equatorial Pacific between 5N-5S, 150W-90W. The Nno 3.4 region spans the east-central equatorial Pacific between 5N-5S, 170W-120W.

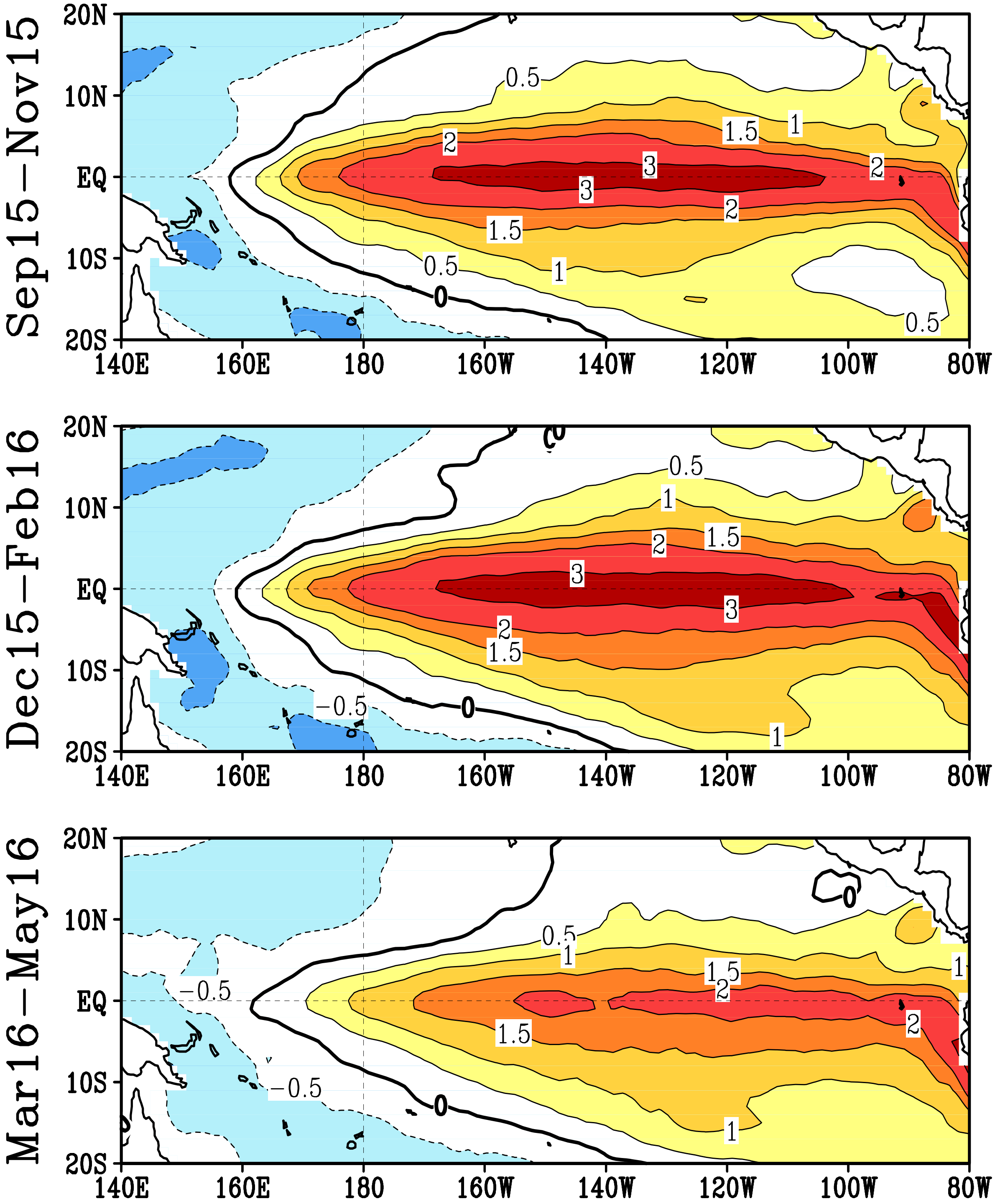


FIGURE F5. Predicted 3-month average sea surface temperature anomalies from the NCEP/CPC Markov model (Xue et al. 2000, *J. Climate*, **13**, 849-871). The forecast is initiated in AUG 2015 . Contour interval is 0.3C and negative anomalies are indicated by dashed contours. Anomalies are calculated relative to the 1971-2000 climatology.

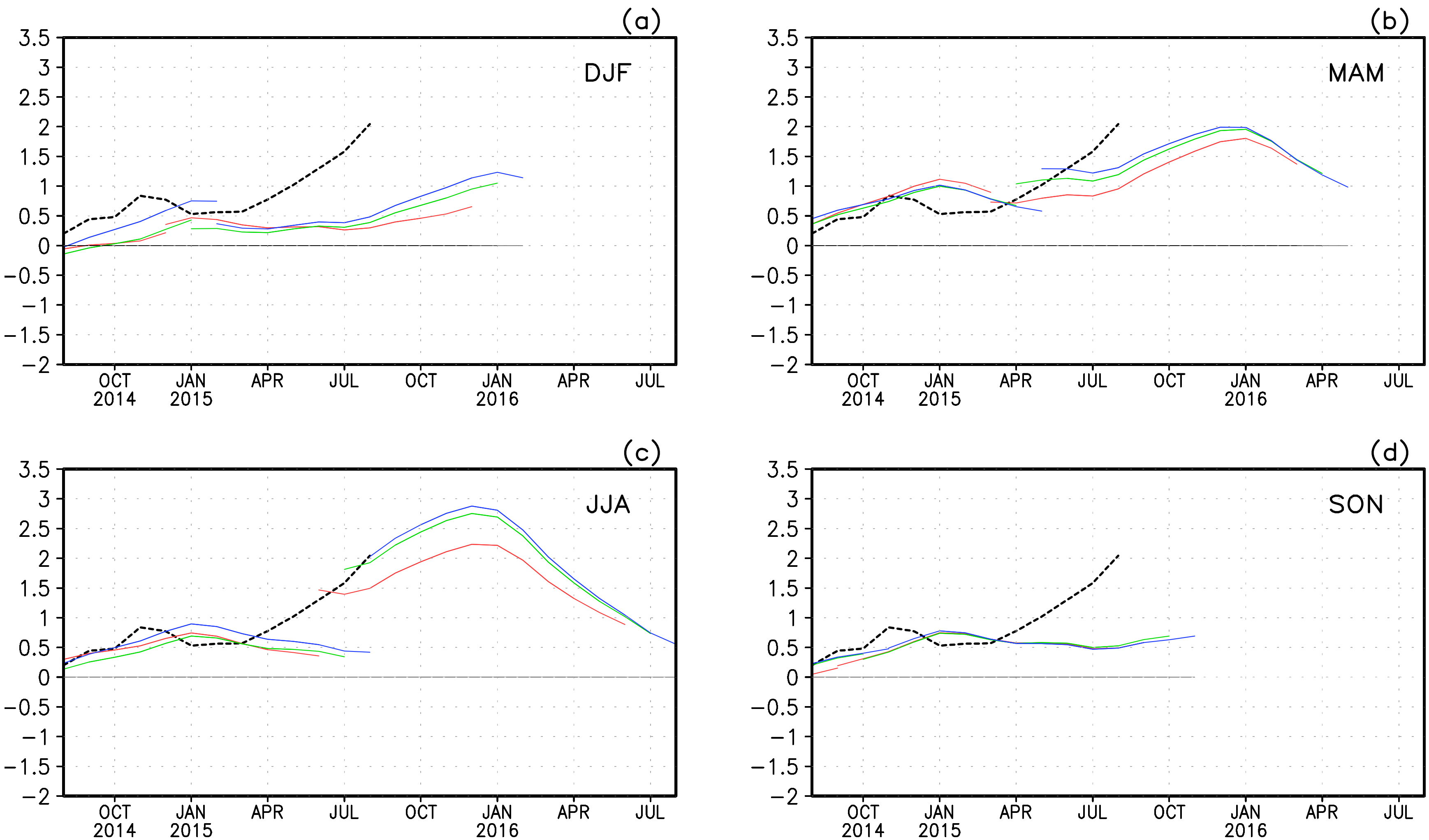


FIGURE F6. Time evolution of observed and predicted SST anomalies in the Nino 3.4 region (up to 12 lead months) by the NCEP/CPC Markov model (Xue et al. 2000, *J. Climate*, **13**, 849-871). Anomalies are calculated relative to the 1971-2000 climatology. Shown in each panel are the forecasts grouped by three consecutive starting months: (a) is for December, January, and February, (b) is for March, April, and May, (c) is for June, July, and August, and (d) is for September, October, and November. The observed Nino 3.4 SST anomalies are indicated by the black dashed lines. The Nino 3.4 region spans the east-central equatorial Pacific between 5N-5S, 170W-120W.

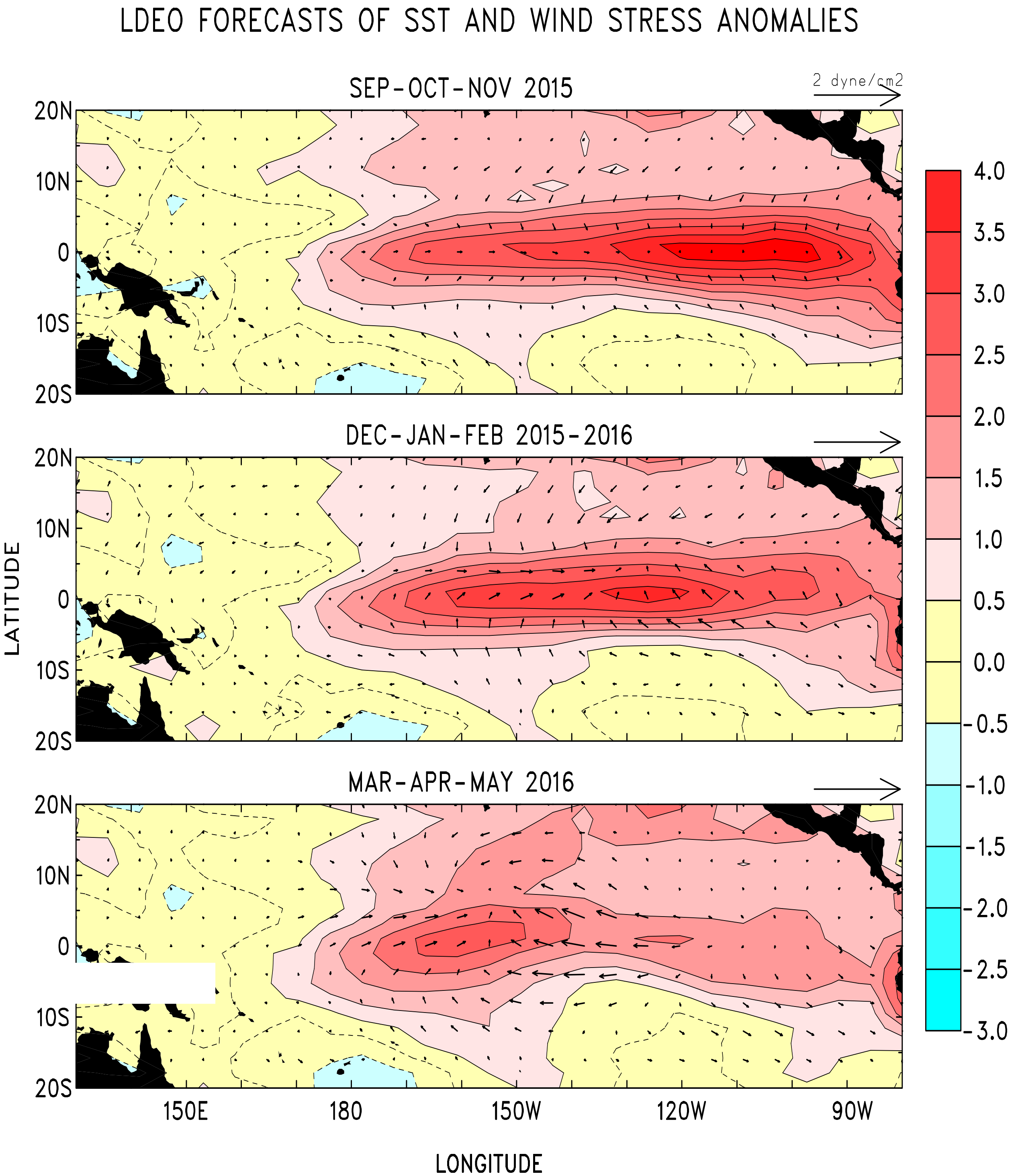


FIGURE F7. Forecasts of the tropical Pacific Predicted SST (shading) and vector wind anomalies for the next 3 seasons based on the LDEO model. Each forecast represents an ensemble average of 3 sets of predictions initialized during the last three consecutive months (see Figure F8).

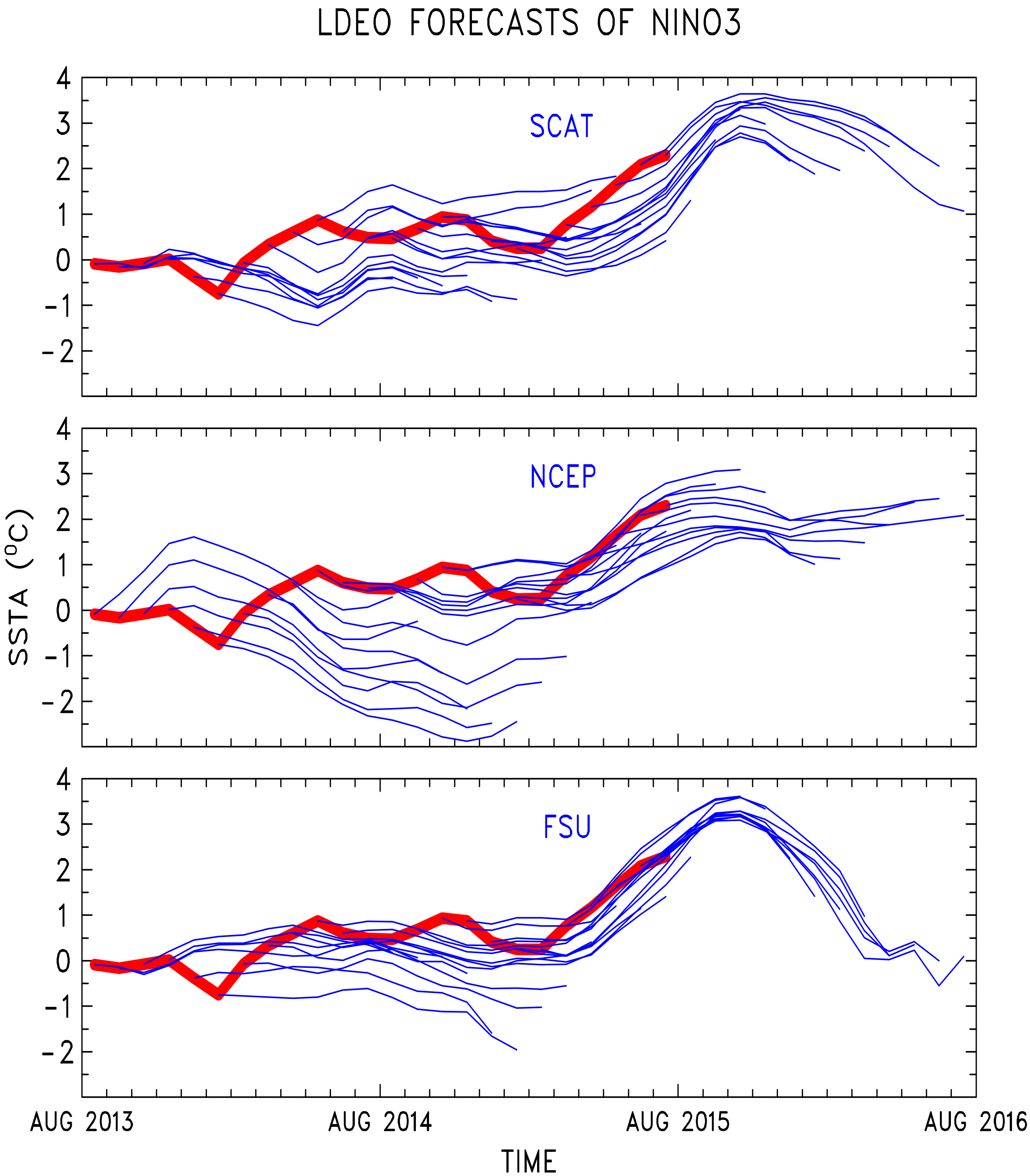


FIGURE F8. LDEO forecasts of SST anomalies for the Nino 3 region using wind stresses obtained from (top) QuikSCAT, (middle) NCEP, and (bottom) Florida State Univ. (FSU), along with SSTs (obtained from NCEP), and sea surface height data (obtained from TOPEX/POSEIDON) data. Each thin blue line represents a 12-month forecast, initialized one month apart for the past 24 months. Observed SST anomalies are indicated by the thick red line. The Nino-3 region spans the eastern equatorial Pacific between 5N-5S, 150W-90W.

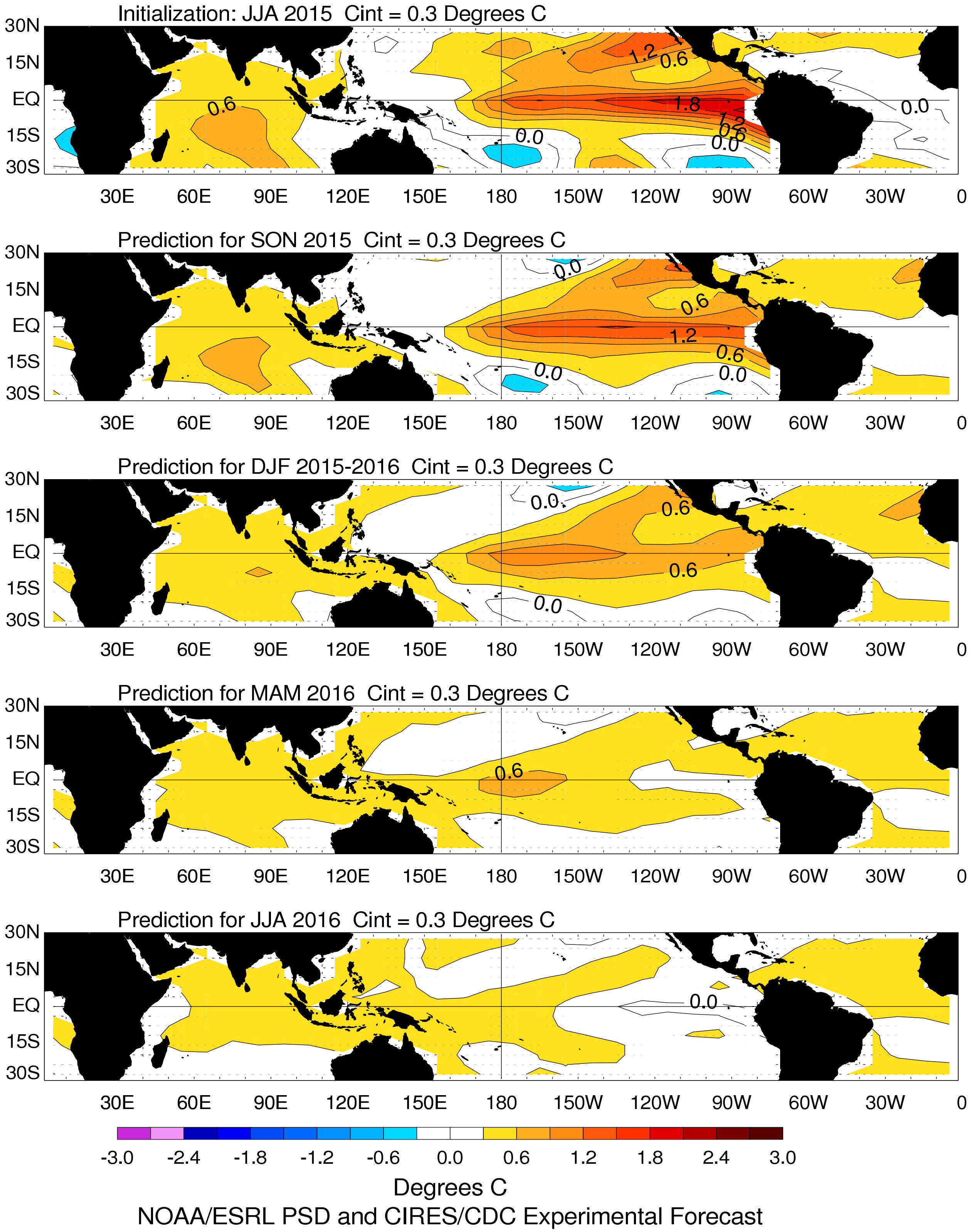


FIGURE F9. Forecast of tropical SST anomalies from the Linear Inverse Modeling technique of Penland and Magorian (1993: *J. Climate*, **6**, 1067-1076). The contour interval is 0.3C. Anomalies are calculated relative to the 1981-2010 climatology and are projected onto 20 leading EOFs.

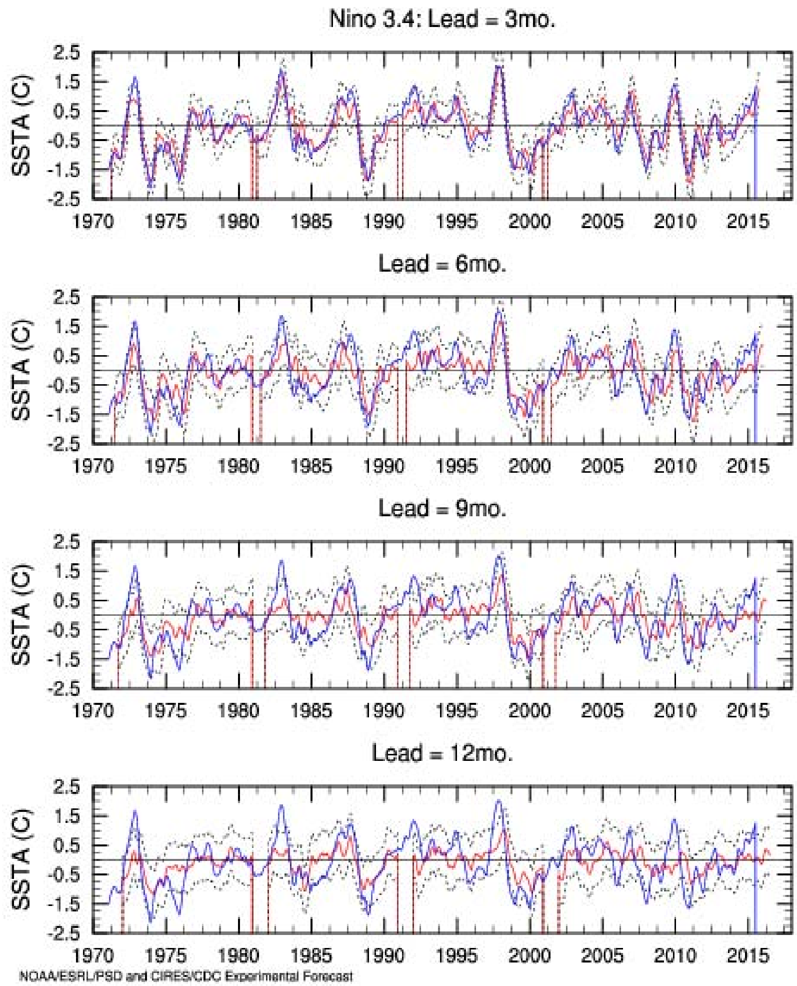


FIGURE F10. Predictions of Niño 3.4 SSTA (blue solid line) and verification (solid red line). The Niño3.4 Index was calculated in the area 6N-6S, 170W-120W. The 1980-2010 climatology was subtracted from ERSST data between 1950 and 2010, after which they were projected onto 20 EOFs containing 90% of thevariance. Significant 1950-2010 trends were subtracted from the corresponding PCs, the forecast was made on the detrended anomalies, after which the trend was added to the forecast. The dotted lines indicate the one standard deviation confidence interval for the forecasts based on a perfect adherence to assumption.

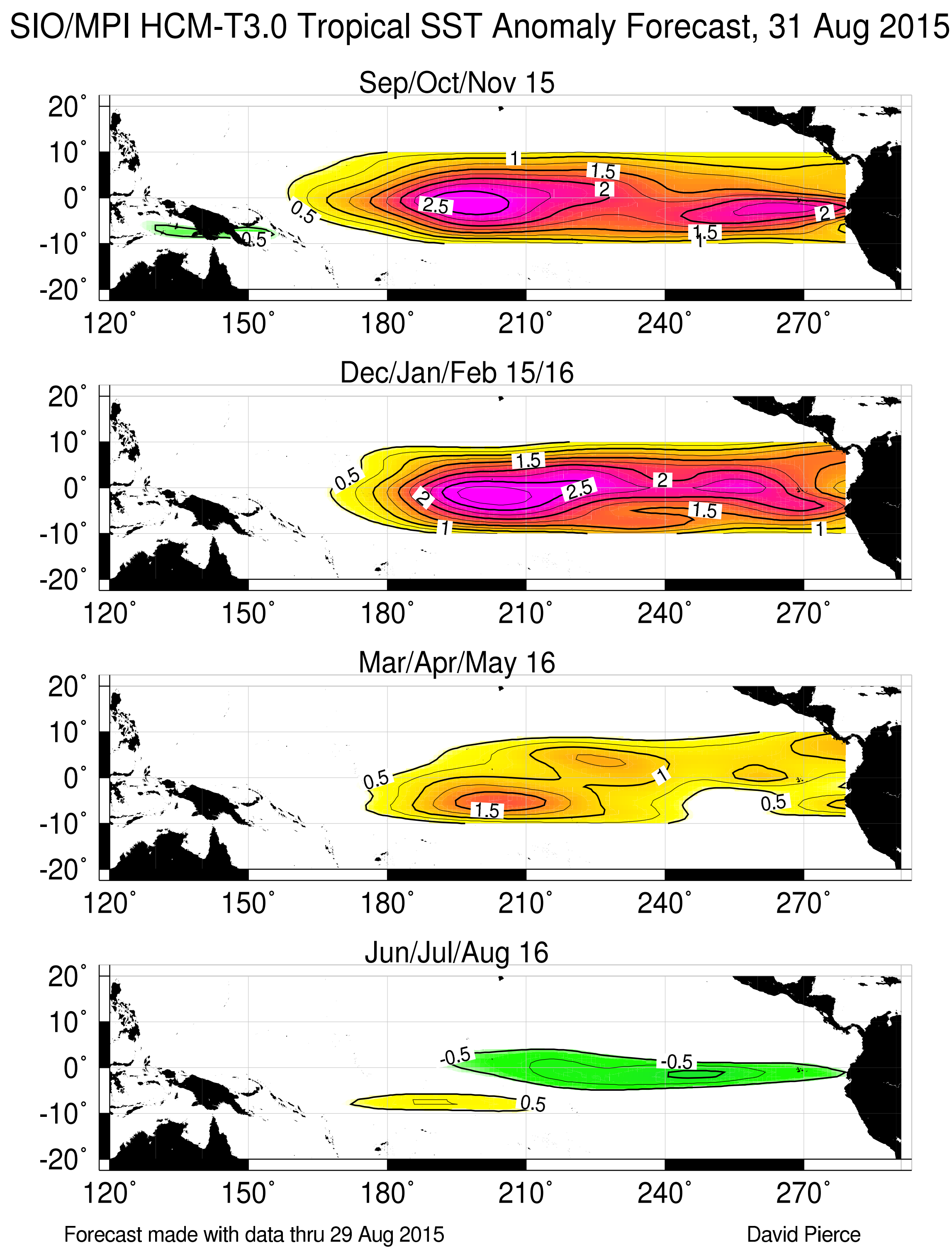


FIGURE F11. SST anomaly forecast for the equatorial Pacific from the Hybrid Coupled Model (HCM) developed by the Scripps Institution of Oceanography and the Max-Plank Institut fuer Meteorlogie.

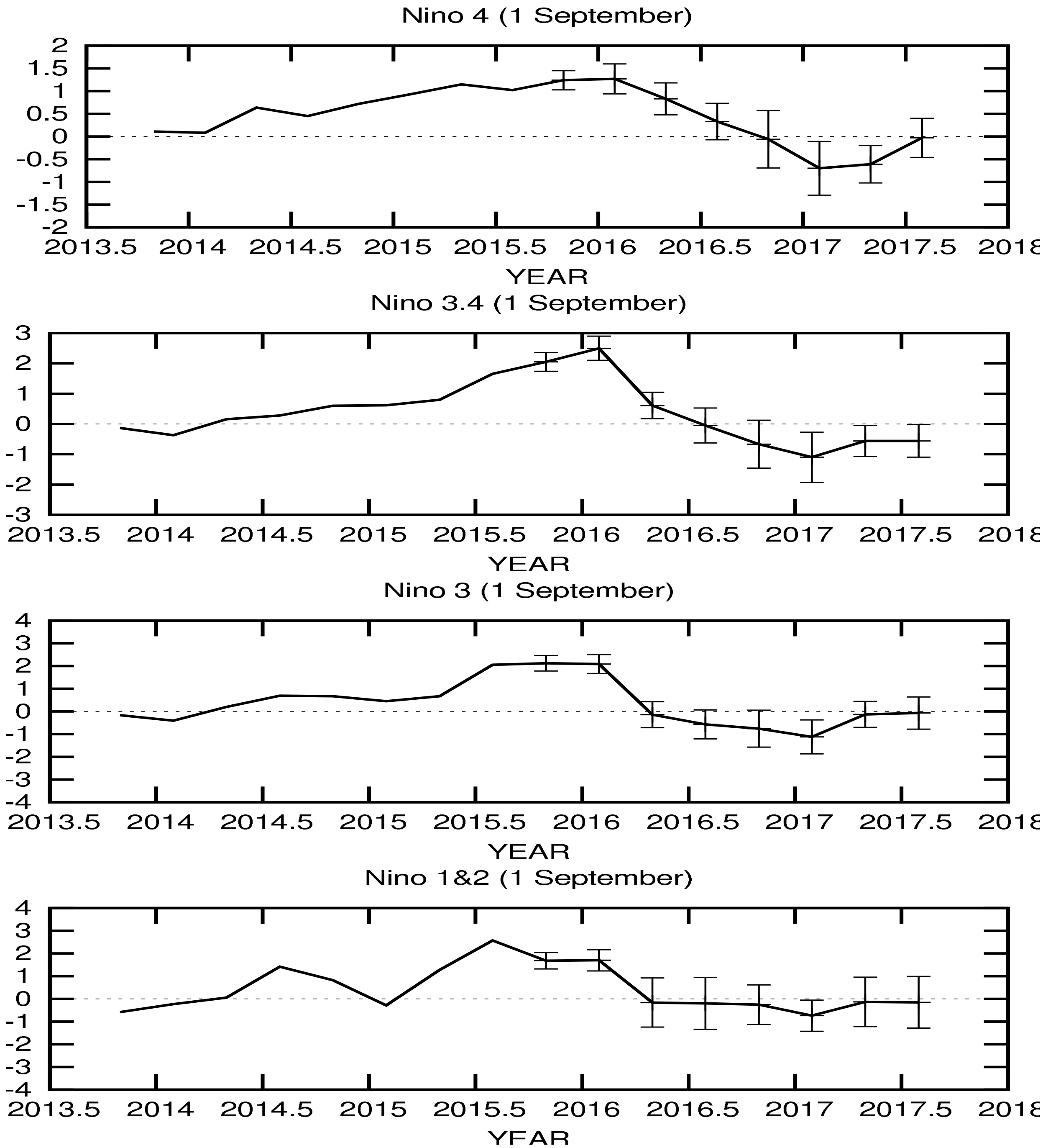


FIGURE F12. ENSO-CLIPER statistical model forecasts of three-month average sea surface temperature anomalies (green lines, deg. C) in (top panel) the Nino 4 region (5N-5S, 160E-150W), (second panel) the Nino 3.4 region (5N-5S, 170W-120W), (third panel) the Nino 3 region (5N-5S, 150W-90W), and (fourth panel) the Nino 1+2 region (0-10S, 90W-80W) (Knaff and Landsea 1997, *Wea. Forecasting*, **12**, 633-652). Bottom panel shows predictions of the three-month standardized Southern Oscillation Index (SOI, green line). Horizontal bars on green line indicate the adjusted root mean square error (RMSE). The Observed three-month average values are indicated by the thick blue line. SST anomalies are departures from the 1981-2010 base period means, and the SOI is calculated from the 1951-1980 base period means.

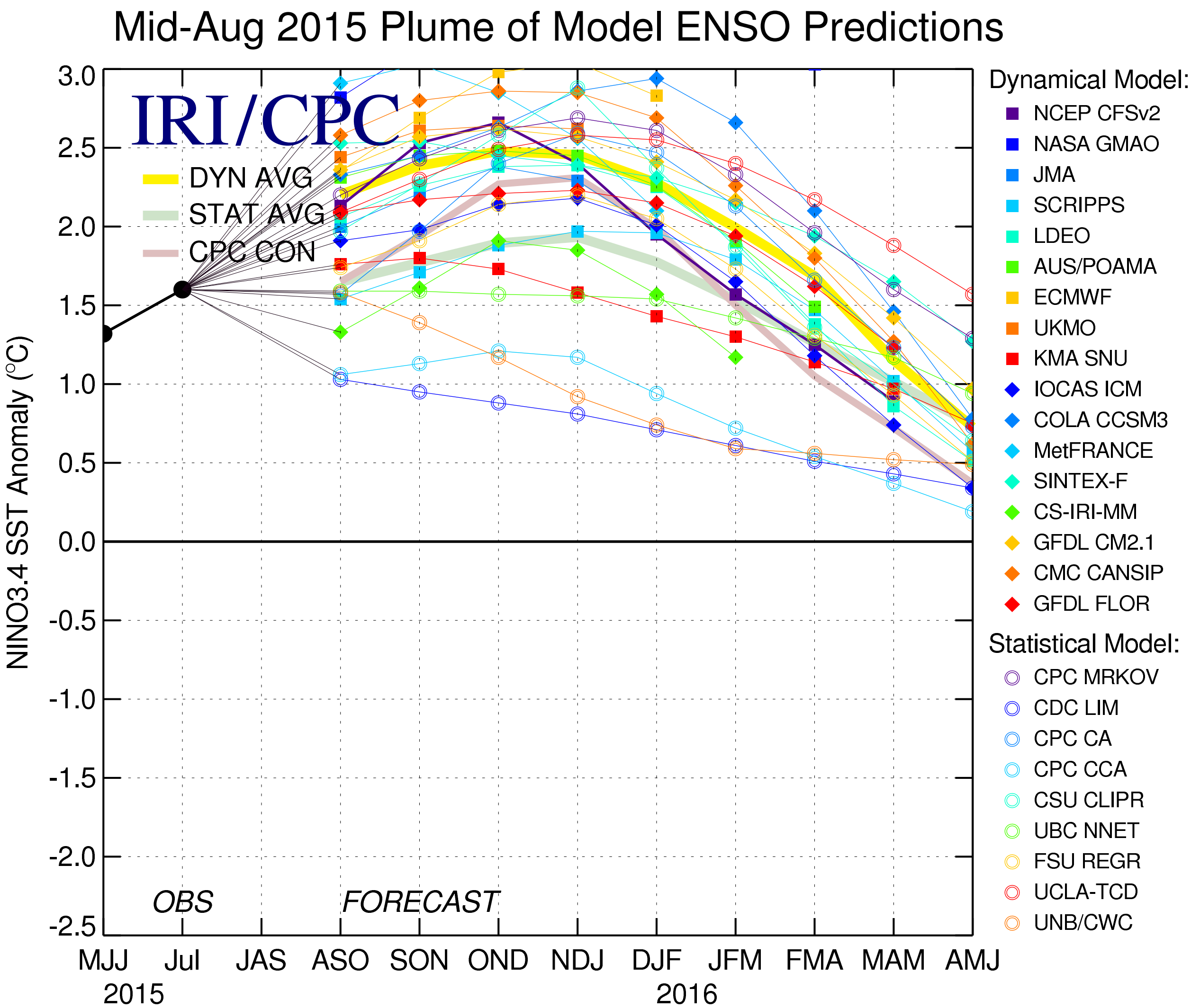


FIGURE F13. Time series of predicted sea surface temperature anomalies for the Nino 3.4 region (deg. C) from various dynamical and statistical models for nine overlapping 3-month periods. The Nino 3.4 region spans the east-central equatorial Pacific between 5N-5S, 170W-120W. Figure provided by the International Research Institute (IRI).

Extratropical Highlights – August 2015

1. Northern Hemisphere

The mean 500-hPa circulation during August featured above-average heights across the high latitudes of the North Pacific, eastern Canada, and Scandinavia, and below-average heights over the eastern North Atlantic Ocean ad central Siberia (Fig. E9).

At 200-hPa, a significant El Niño response was evident in the streamfunction field throughout the global tropics and subtropics. This response featured a zonal wave-1 pattern of streamfunction anomalies in both hemispheres (Fig. T22), with anticyclonic anomalies over the subtropical North and South Pacific straddling the region of enhanced convection (Fig. T25), and cyclonic anomalies extending from the America's to Australasia.

The main land-surface temperature signals during August included above-average temperatures in the western U.S., eastern Canada, most of Europe, and Mongolia (Fig. E1). The main precipitation signals included above-average totals in the northern Europe, and below-average totals in the Pacific northwestern U.S., the northeastern U.S., northwestern Russia, and portions of Scandinavia (Fig. E3).

a. North Pacific/ North America

At 200-hPa, the circulation during August featured a sharper-than-average ridge over the intermountain region of the U.S., and sharper-than-average troughs over the extreme eastern North Pacific and the eastern U.S. (Fig. T21). This pattern contributed to a continuation of exceptionally warm surface temperatures in the western U.S., and also to well above-average temperatures in eastern Canada (Fig. E1). It also contributed to anomalous upper-level convergence and below-average precipitation over the northeastern quadrant of the U.S. (Fig. E3).

According to the U.S. Drought Monitor, severe or extreme drought expanded in Washington, Oregon, Idaho and western Montana. Exceptional drought continued across much of central California and western Nevada. Abnormally dry or moderate drought conditions developed across the U.S. Gulf Coast and in the southeast.

b. North Atlantic

In association with El Niño, the 200-hPa circulation featured cyclonic streamfunction anomalies extending across the tropical and subtropical North Atlantic to southern Asia (Fig. T22). Across the Atlantic hurricane Main Development Region (MDR, which spans the Caribbean Sea and tropical Atlantic Ocean between 9°N-21.5°N), this pattern contributed to an amplification of the Tropical Upper-Tropospheric Trough (TUTT), which now extends well southward into the western MDR.

Over the western MDR, these conditions were associated with above-average westerly winds at 200-hPa (Fig. T21) and enhanced low-level easterly trade winds (Fig. T20). This wind pattern produced enhanced vertical wind shear, and was also associated with anomalous upper-level convergence (Fig. T23) and sinking motion, across large portions of the MDR. This combination of conditions is expected to continue, and to produce a below normal Atlantic hurricane season.

c. Europe

The 500-hPa circulation during August featured above-average heights over Scandinavia, and below-average heights over the eastern North Atlantic (Fig. E9). This pattern contributed to exceptionally warm surface temperatures across Europe and western Russia, with many locations recording departures in the upper 10th percentile of occurrences (Fig. E1). It also contributed to a dipole pattern of precipitation anomalies, with above-average totals in northern Europe and below-average totals in northwestern Russia and portions of Scandinavia.

2. Southern Hemisphere

The mean 500-hPa circulation during August featured an overall zonal wave-1 pattern of height anomalies, with above-average heights in the middle latitudes and below-average heights over Antarctica (Fig. E15). At 200-hPa, a significant El Niño response was evident in the streamfunction field throughout the global tropics and subtropics. This response featured a zonal wave-1 pattern of streamfunction anomalies in both hemispheres (Fig. T22), with anticyclonic anomalies over the subtropical North and South Pacific straddling the region of enhanced convection (Fig. T25), and cyclonic anomalies extending from the America's to Australasia.

The El Niño response also included above-average heights over the high latitudes of the central South Pacific, and below-average heights over both the mid-central South Pacific and the high latitudes of the eastern South Pacific (Figs. E15, T22). The resulting 4-celled anomaly pattern incorporated well-known features of El Niño: namely a strengthening and eastward extension of the South Pacific jet stream to well east of the date line, and an eastward shift of that jet exit region to the area immediately upstream of South America (Fig. T21). This wintertime jet stream pattern represents major dynamical and kinematic changes in the mid- and upper-level circulation during El Niño, and it also represents a fundamental manner in which the El Niño impacts are communicated downstream.

For example, the presence of the amplified trough and jet exit region immediately east of South America contributed to a poleward shift of the mean frontal boundary and to enhanced storminess across central South America, as indicated by exceptionally warm and wet conditions across the region. In many areas, surface temperature anomalies were in the upper 90th percentile of occurrences (Fig. E1) and precipitation totals were above the 70th percentile of occurrences (Fig. E3).

The Antarctic ozone hole typically develops during August and reaches its peak aerial extent in September and October. By the end of August 2015, the ozone hole (Fig. S6) spanned approximately 15 million square kilometers, which is close to the 2005-2014 mean (Fig. S8, top). The aerial coverage of polar stratospheric cloud (Fig. S8, bottom) and the SH polar vortex (Fig. S8, middle) were both slightly above average during August 2015, while polar stratospheric temperatures were below average (Fig. S4).

TELECONNECTION INDICES

Month	North Atlantic			North Pacific			EURASIA		
	NAO	EA	WP	EP-NP	PNA	TNH	EATL/WRUS	SCAND	POLEUR
AUG 15	-1.1	1.1	-1.5	-0.3	0.1	---	-0.4	0.9	0.1
JUL 15	-3.1	0.2	0.8	0.2	0.3	---	2.0	-1.1	0.4
JUN 15	0.2	1.1	0.0	1.7	-0.1	---	-0.8	-1.5	-0.2
MAY 15	0.2	0.7	2.1	0.5	-0.1	---	-1.5	-2.1	0.5
APR 15	0.6	0.9	1.2	-0.4	-0.4	---	1.1	-1.5	-0.9
MAR 15	1.1	1.2	0.4	1.1	-0.5	---	0.3	0.4	0.7
FEB 15	1.1	0.0	-1.4	1.2	0.5	0.7	-0.9	-0.4	2.1
JAN 15	1.6	1.1	-0.2	1.3	0.1	0.4	-0.2	-0.2	0.0
DEC 14	1.6	-0.6	-0.1	---	0.4	-0.2	-0.4	-0.4	-0.9
NOV 14	0.6	0.4	0.1	3.2	0.6	---	1.3	1.8	1.8
OCT 14	-0.9	1.0	-0.3	-0.7	1.1	---	-0.4	1.1	-1.0
SEP 14	1.7	0.2	-1.2	0.2	0.8	---	0.5	1.1	1.1
AUG 14	-2.3	0.8	-0.8	-1.0	1.3	---	-1.7	-0.6	1.6

TABLE E1-Standardized amplitudes of selected Northern Hemisphere teleconnection patterns for the most recent thirteen months (computational procedures are described in Fig. E7). Pattern names and abbreviations are North Atlantic Oscillation (NAO); East Atlantic pattern (EA);West Pacific pattern (WP); East Pacific - North Pacific pattern (EP-NP); Pacific/North American pattern (PNA); Tropical/Northern Hemisphere pattern (TNH);East Atlantic/Western Russia pattern (EATL/WRUS-called Eurasia-2 pattern by Barnston and Livezey, 1987, *Mon. Wea. Rev.*, **115**, 1083-1126); Scandanavia pattern (SCAND-called Eurasia-1 pattern by Barnston and Livezey 1987); and Polar Eurasia pattern (POLEUR). No value is plotted for calendar months in which the pattern does not appear as a leading mode.

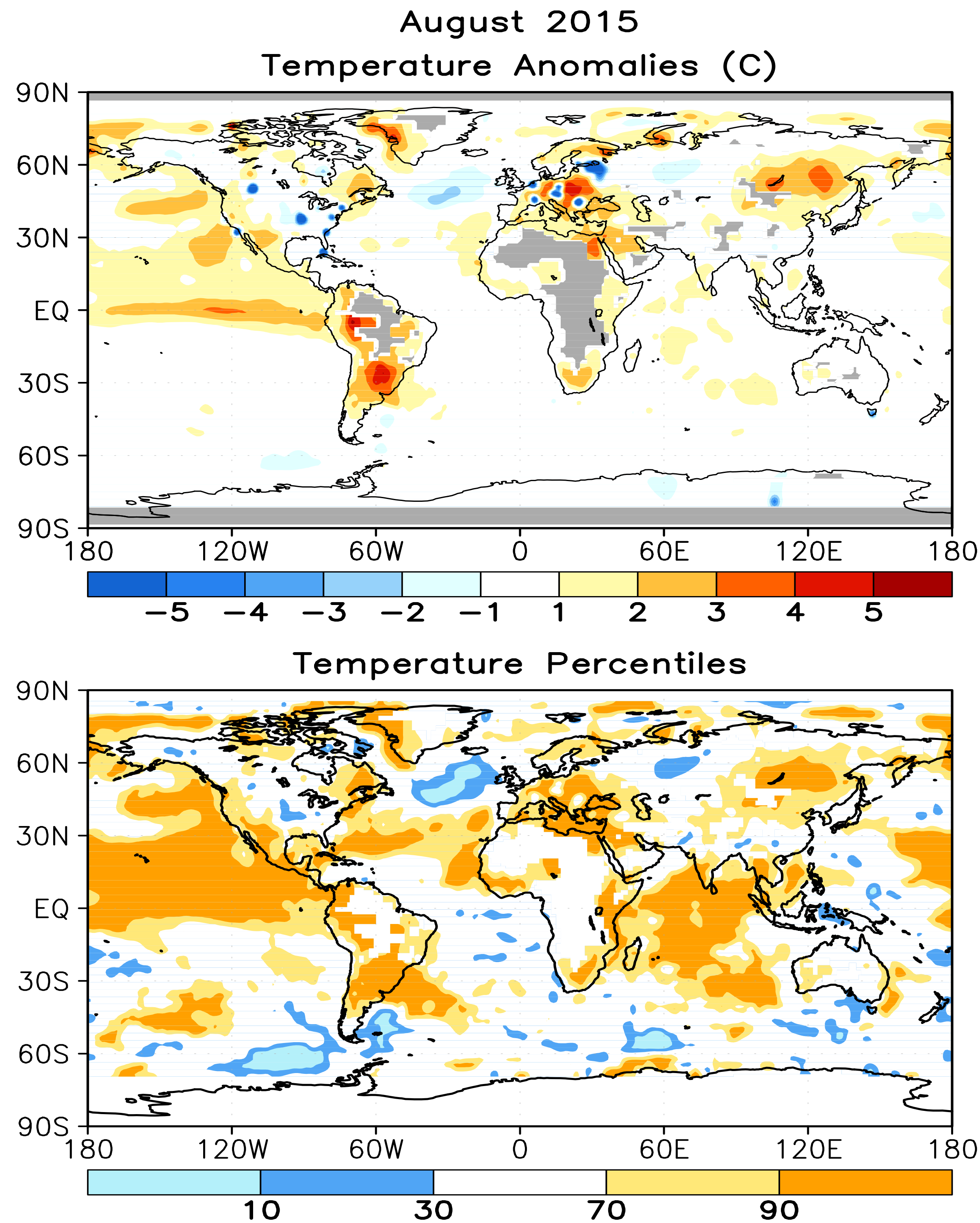


FIGURE E1. Surface temperature anomalies (°C, top) and surface temperature expressed as percentiles of the normal (Gaussian) distribution fit to the 1981–2010 base period data (bottom) for AUG 2015. Analysis is based on station data over land and on SST data over the oceans (top). Anomalies for station data are departures from the 1981–2010 base period means, while SST anomalies are departures from the 1981–2010 adjusted OI climatology. (Smith and Reynolds 1998, *J. Climate*, **11**, 3320-3323). Regions with insufficient data for analysis in both figures are indicated by shading in the top figure only.

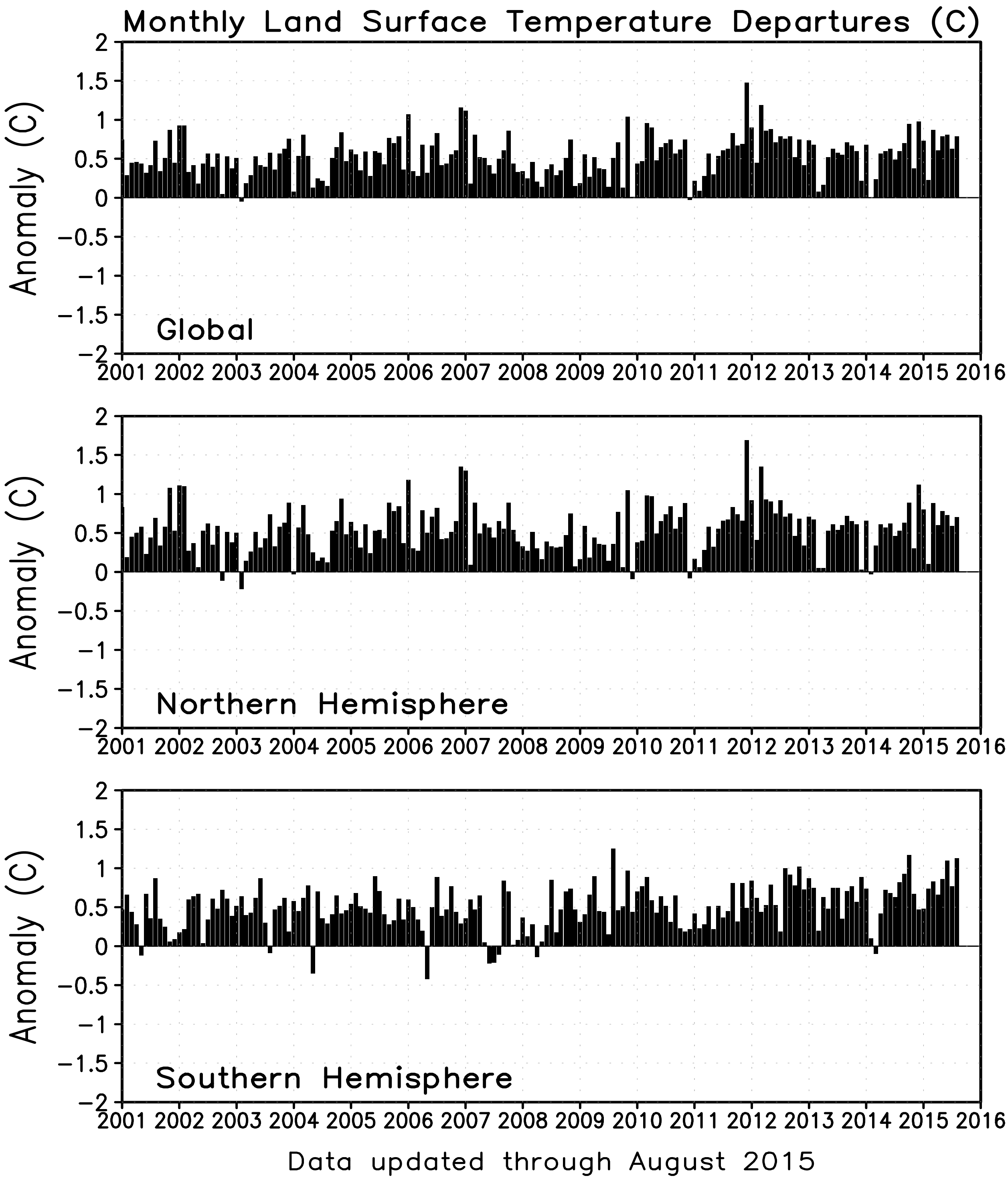


FIGURE E2. Monthly global (top), Northern Hemisphere (middle), and Southern Hemisphere (bottom) surface temperature anomalies (land only, ˚C) from January 1990 - present, computed as departures from the 1981–2010 base period means.

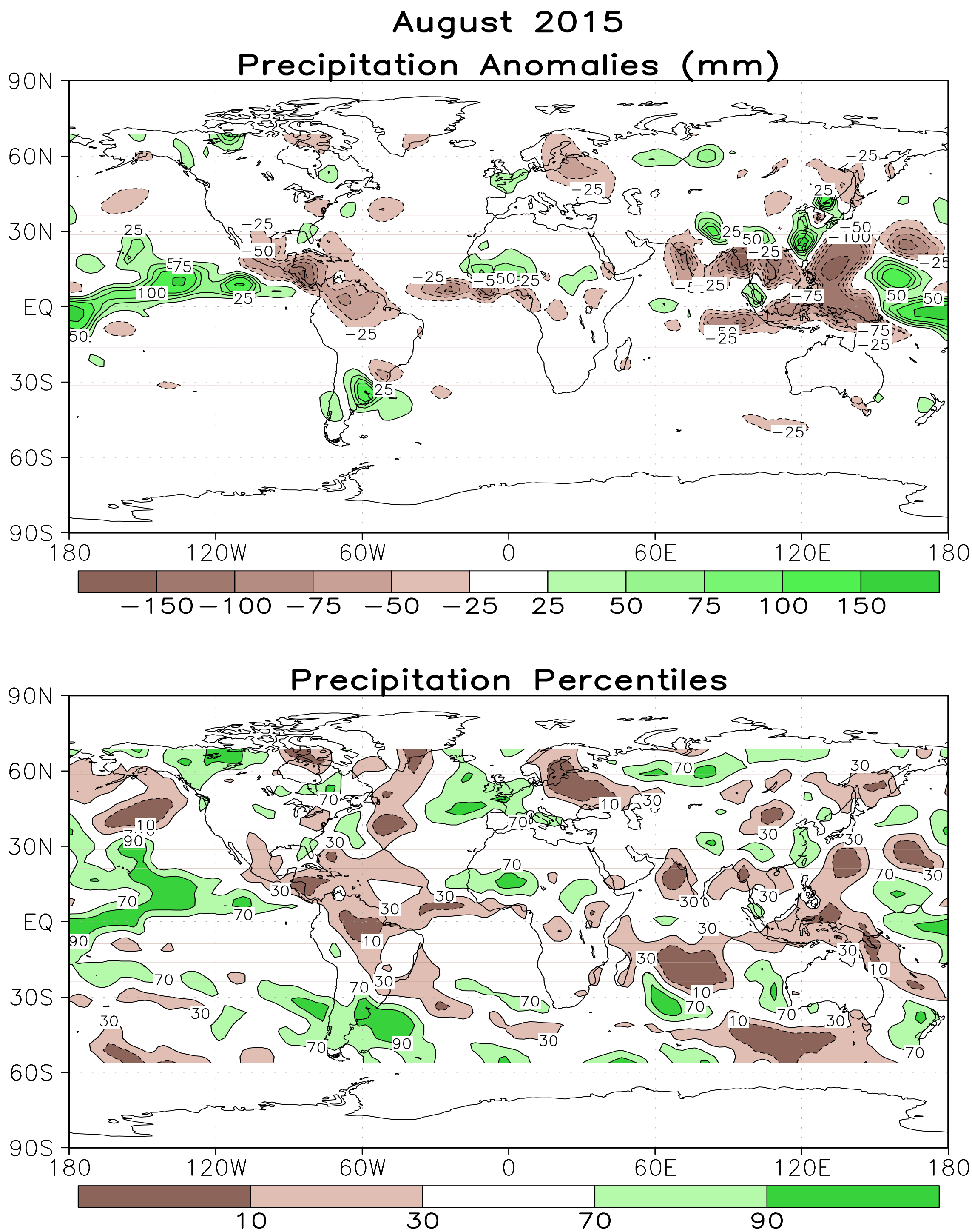


FIGURE E3. Anomalous precipitation (mm, top) and precipitation percentiles based on a Gamma distribution fit to the 1981–2010 base period data (bottom) for AUG 2015. Data are obtained from a merge of raingauge observations and satellite-derived precipitation estimates (Janowiak and Xie 1999, *J. Climate*, **12**, 3335–3342). Contours are drawn at 200, 100, 50, 25, -25, -50, -100, and -200 mm in top panel. Percentiles are not plotted in regions where mean monthly precipitation is <5mm/month.

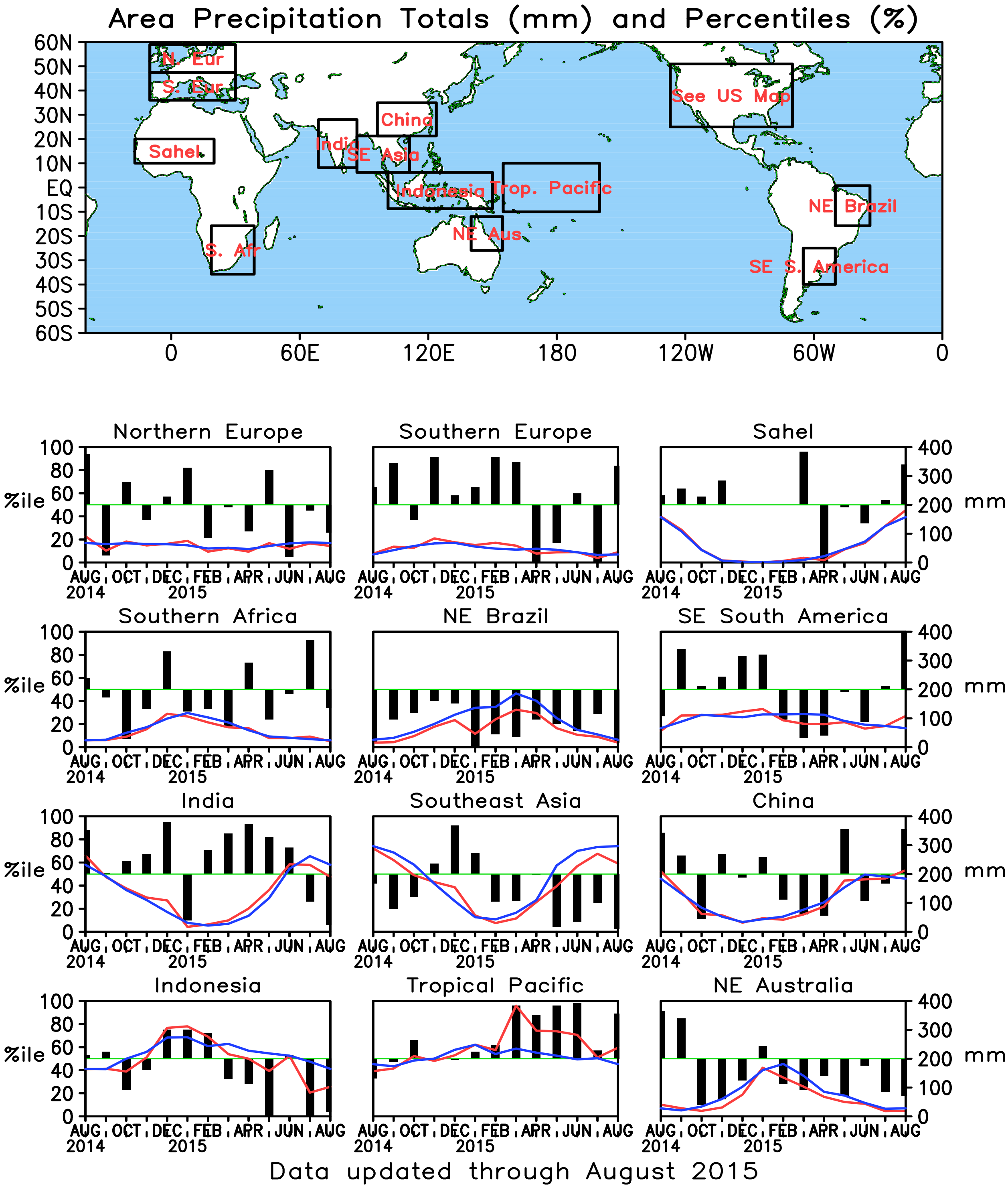


FIGURE E4. Areal estimates of monthly mean precipitation amounts (mm, solid lines) and precipitation percentiles (%, bars) for the most recent 13 months obtained from a merge of raingauge observations and satellite-derived precipitation estimates (Janowiak and Xie 1999, *J. Climate*, **12**, 3335–3342). The monthly precipitation climatology (mm, dashed lines) is from the 1981–2010 base period monthly means. Monthly percentiles are not shown if the monthly mean is less than 5 mm.

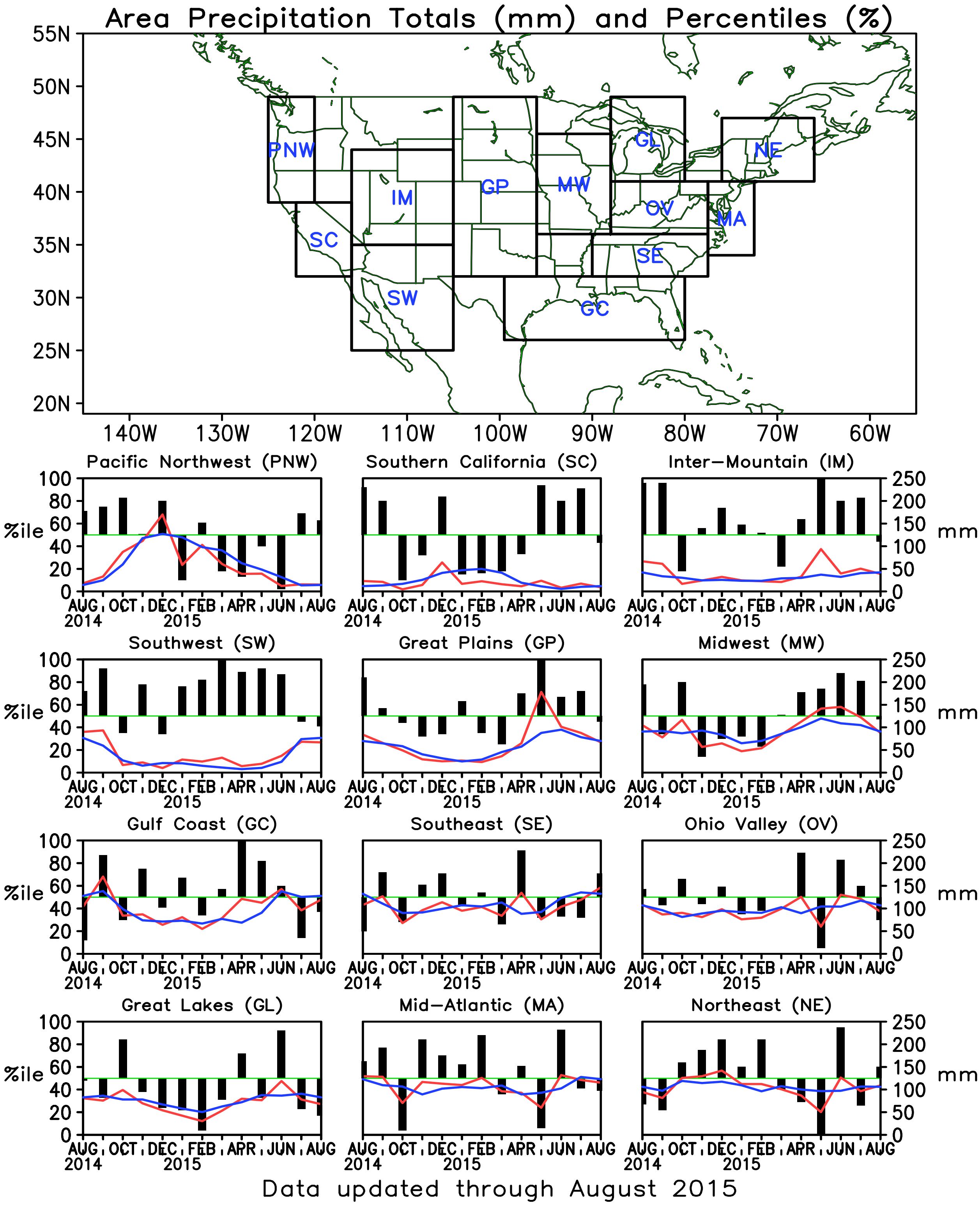


FIGURE E5. Areal estimates of monthly mean precipitation amounts (mm, solid lines) and precipitation percentiles (%, bars) for the most recent 13 months obtained from a merge of raingauge observations and satellite-derived precipitation estimates (Janowiak and Xie 1999, *J. Climate*, **12**, 3335–3342). The monthly precipitation climatology (mm, dashed lines) is from the 1981–2010 base period monthly means. Monthly percentiles are not shown if the monthly mean is less than 5 mm.

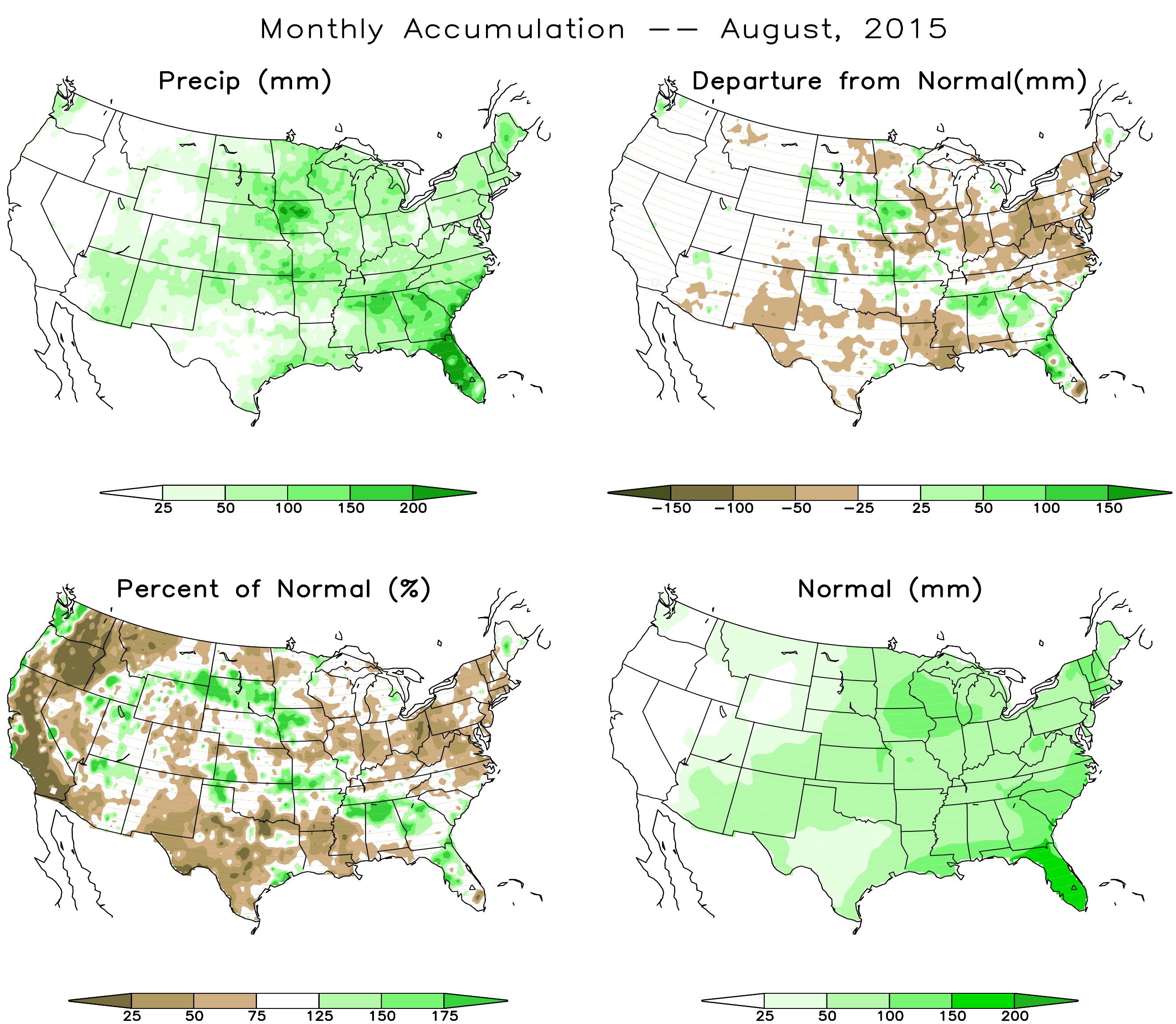


FIGURE E6. Observed precipitation (upper left), departure from average (upper right), percent of average (lower left), and average precipitation (lower right) for AUG 2015. The units are given on each panel. Base period for averages is 1981–2010. Results are based on CPC's U. S. daily precipitation analysis, which is available at http://www.cpc.ncep.noaa.gov/prodcuts/precip/realtime.

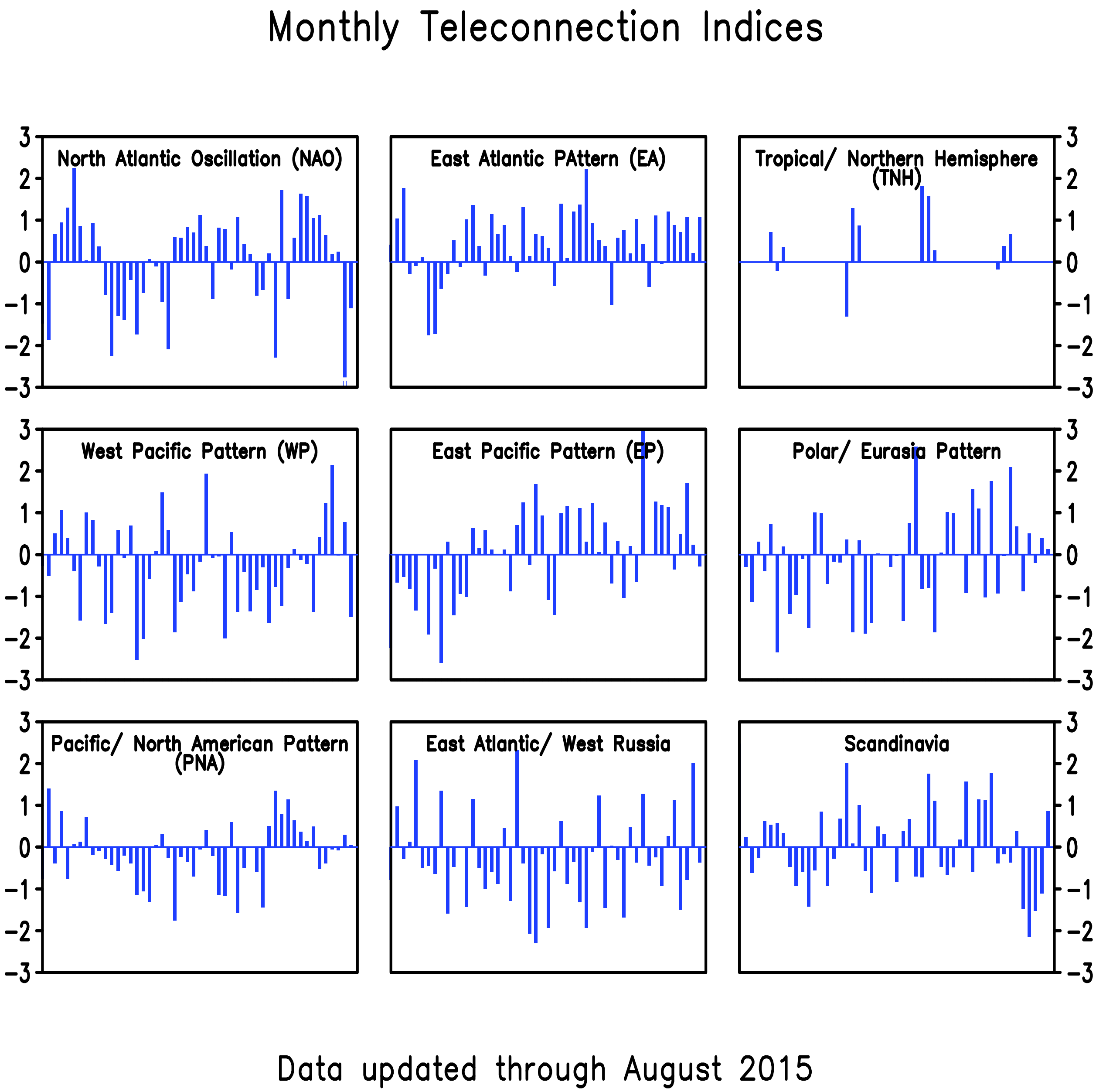


FIGURE E7. Standardized monthly Northern Hemisphere teleconnection indices. The teleconnection patterns are calculated from a Rotated Principal Component Analysis (RPCA) applied to monthly standardized 500-hPa height anomalies during the 1981-2010 base period. To obtain these patterns, ten leading un-rotated modes are first calculated for each calendar month by using the monthly height anomaly fields for the three-month period centered on that month: [i.e., The July modes are calculated from the June, July, and August standardized monthly anomalies]. A Varimax spatial rotation of the ten leading un-rotated modes for each calendar month results in 120 rotated modes (12 months x 10 modes per month) that yield ten primary teleconnection patterns.The teleconnection indices are calculated by first projecting the standardized monthly anomalies onto the teleconnection patterns corresponding to that month (eight or nine teleconnection patterns are seen in each calendar month). The indices are then solved for simultaneously using a Least-Squares approach. In this approach, the indices are the solution to the Least-Squares system of equations which explains the maximum spatial structure of the observed height anomaly field during the month. The indices are then standardized for each pattern and calendar month independently. No index value exists when the teleconnection pattern does not appear as one of the ten leading rotated EOF's valid for that month.

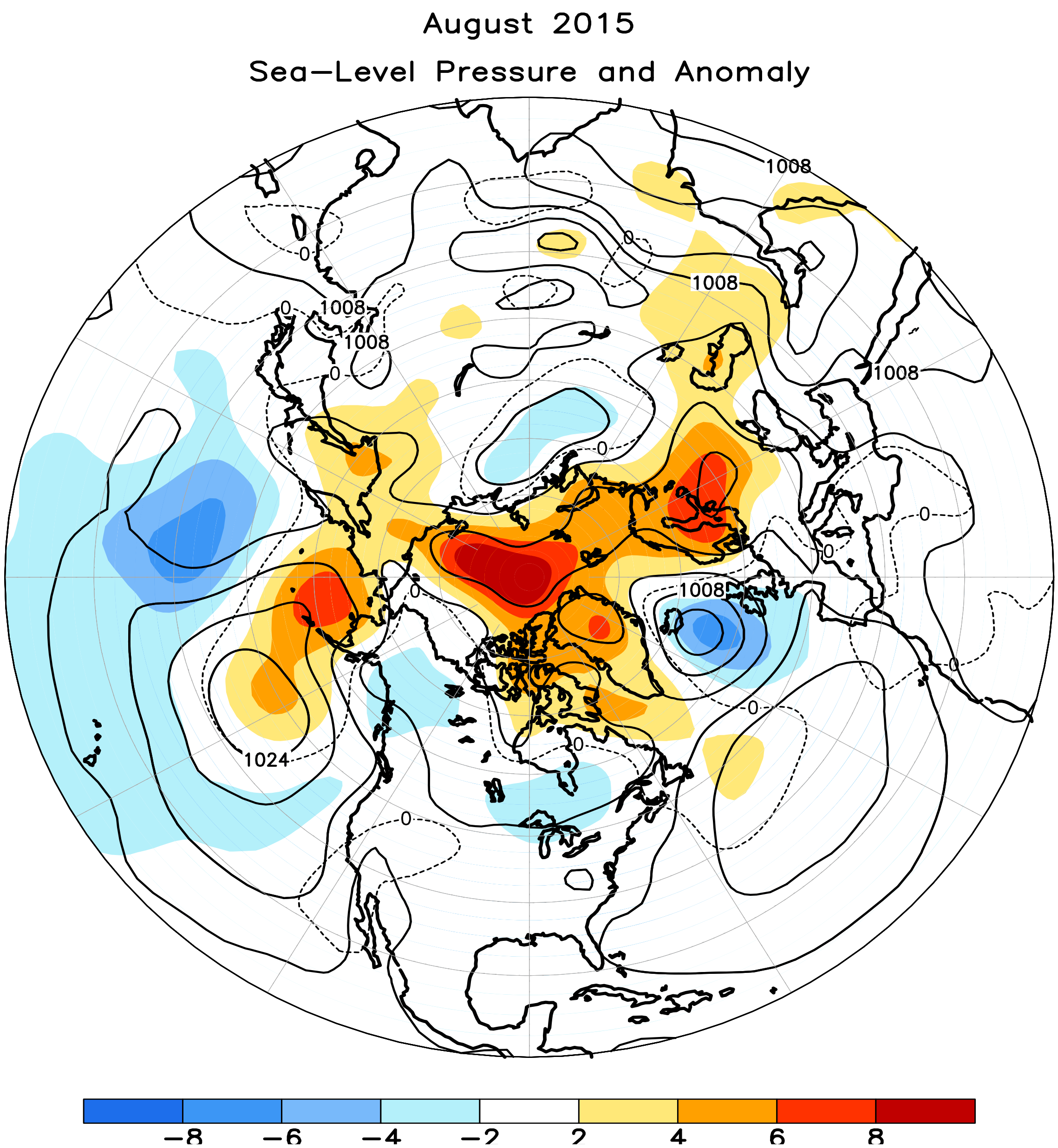


FIGURE E8. Northern Hemisphere mean and anomalous sea level pressure (CDAS/Reanalysis) for AUG 2015. Mean values are denoted by solid contours drawn at an interval of 4 hPa. Anomaly contour interval is 2 hPa with values less (greater) than -2 hPa (2 hPa) indicated by dark (light) shading. Anomalies are calculated as departures from the 1981-2010 base period monthly means.

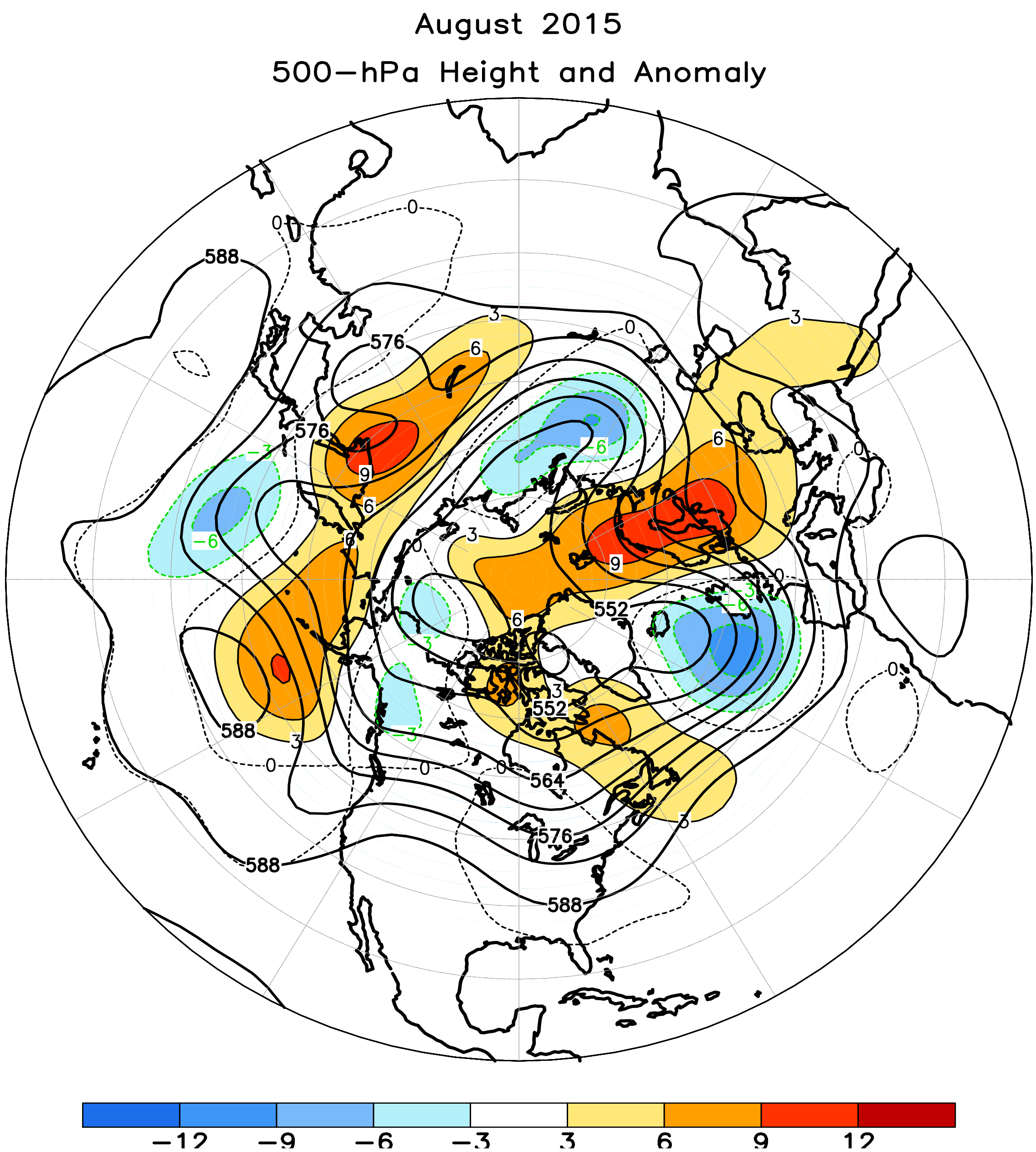
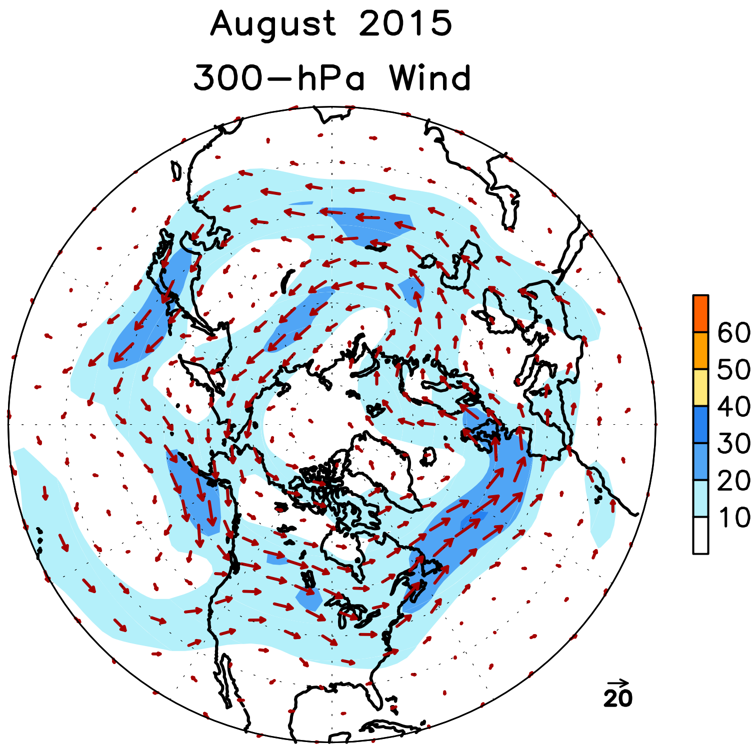


FIGURE E9. Northern Hemisphere mean and anomalous 500-hPa geopotential height (CDAS/Reanalysis) for AUG 2015. Mean heights are denoted by solid contours drawn at an interval of 6 dam. Anomaly contour interval is 3 dam with values less (greater) than -3 dam (3 dam) indicated by dark (light) shading. Anomalies are calculated as departures from the 1981-2010 base period monthly means.



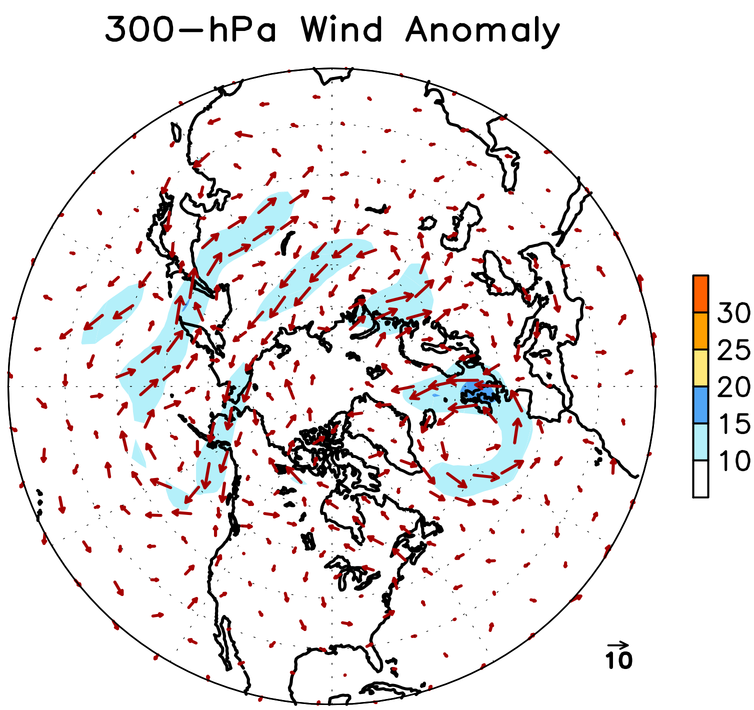


FIGURE E10. Northern Hemisphere mean (left) and anomalous (right) 300-hPa vector wind (CDAS/Reanalysis) for AUG 2015. Mean (anomaly) isotach contour interval is 10 (5) ms^{-1}. Values greater than 30 ms^{-1} (left) and 10 ms^{-1} (rights) are shaded. Anomalies are departures from the 1981-2010 base period monthly means.

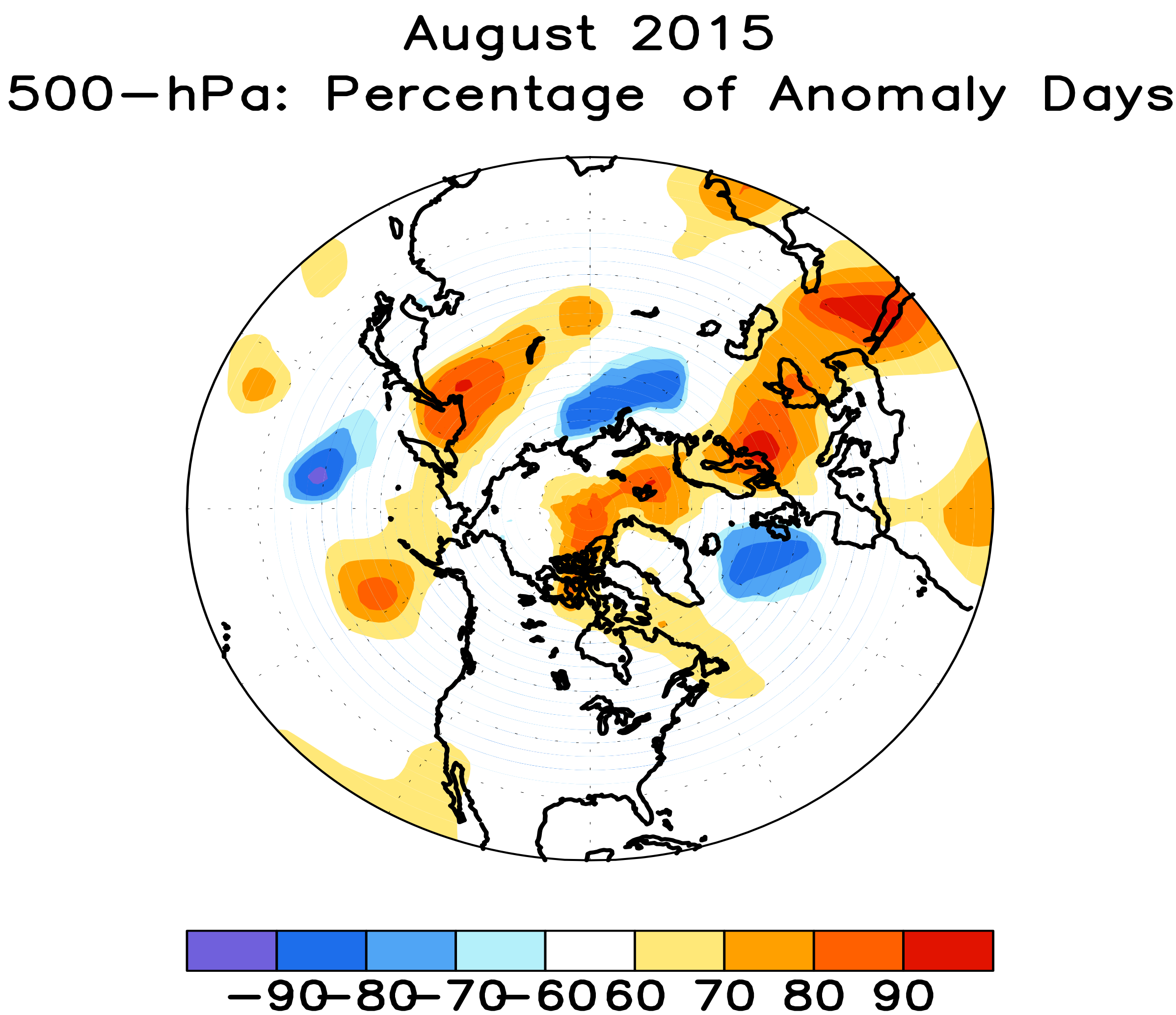


FIGURE E11. Northern Hemisphere percentage of days during AUG 2015 in which 500-hPa height anomalies greater than 15 m (red) and less than -15 m (blue) were observed. Values greater than 70% are shaded and contour in-

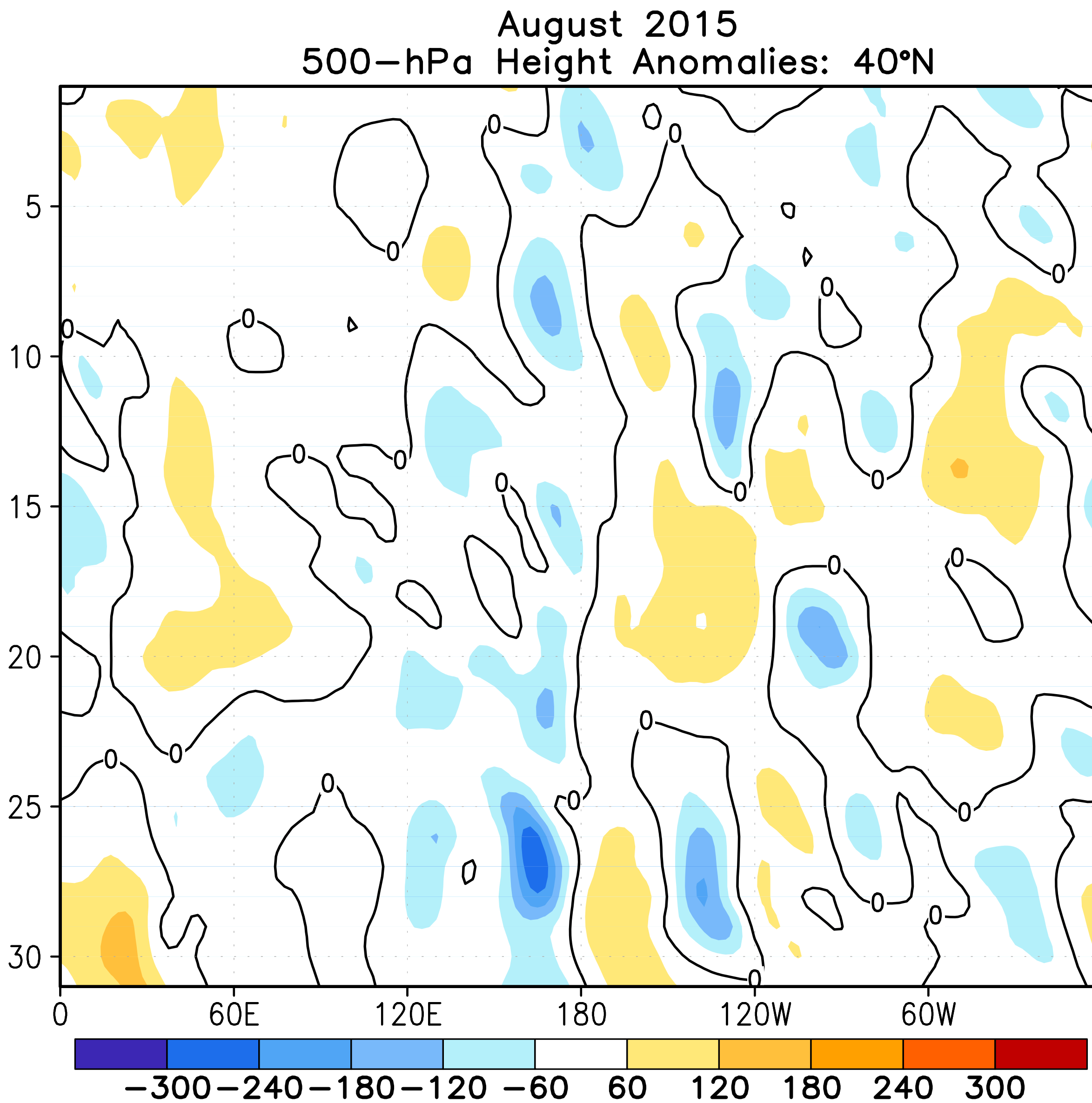


FIGURE E12. Northern Hemisphere: Daily 500-hPa height anomalies for AUG 2015 averaged over the 5° latitude band centered on 40°N. Positive values are indicated by solid contours and dark shading. Negative values are indicated by dashed coutours and light shading. Contour interval is 60 m. Anomalies are departures from the 1981-2010 base period daily means.

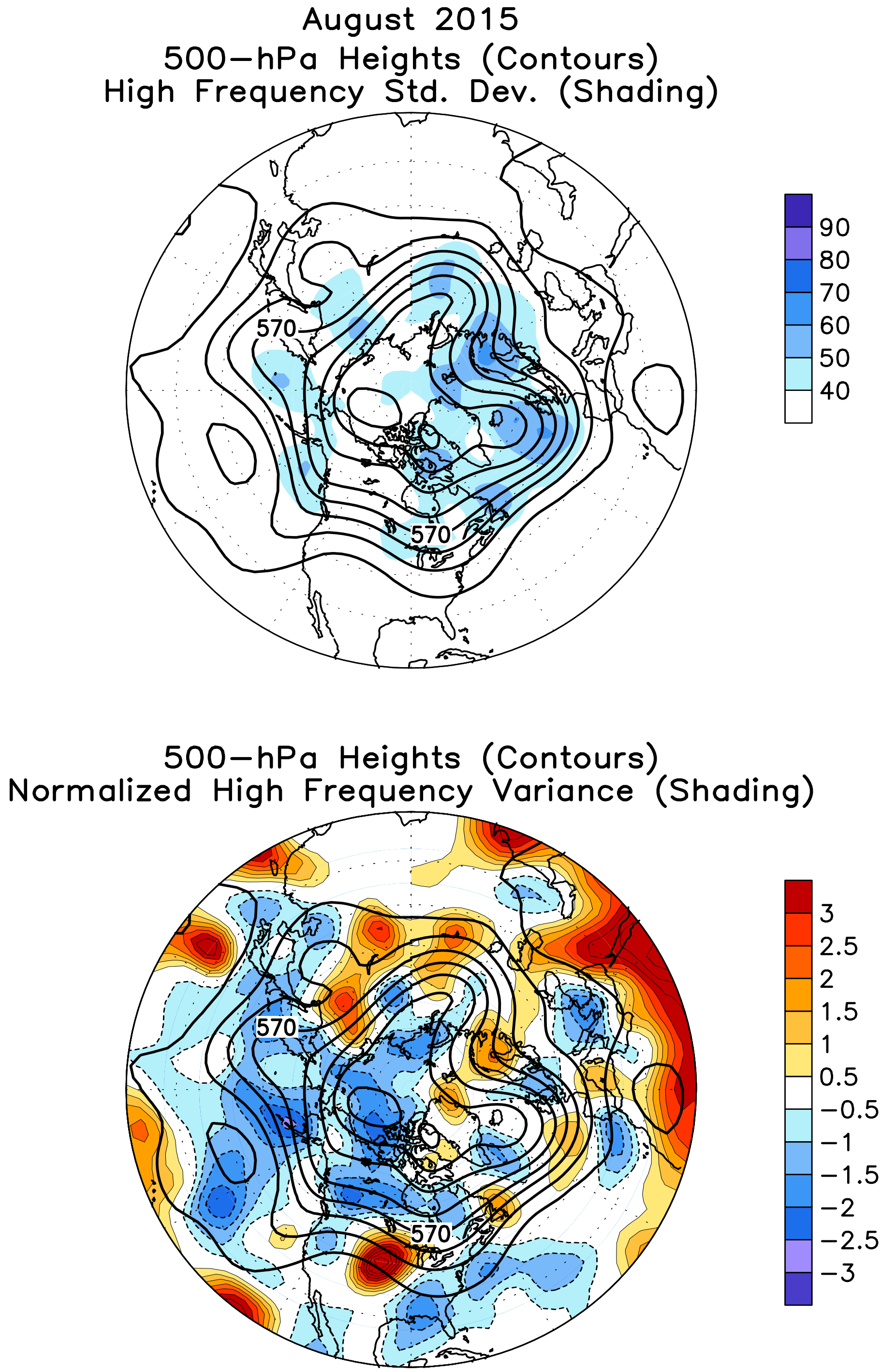


FIGURE E13. Northern Hemisphere 500-hPa heights (thick contours, interval is 6 dam) overlaid with (Top) Standard deviation of 10-day high-pass (HP) filtered height anomalies and (Bottom) Normalized anomalous variance of 10-day HP filtered height anomalies. A Lanczos filter is used to calculate the HP filtered anomalies. Anomalies are departures from the 1981-2010 daily means.

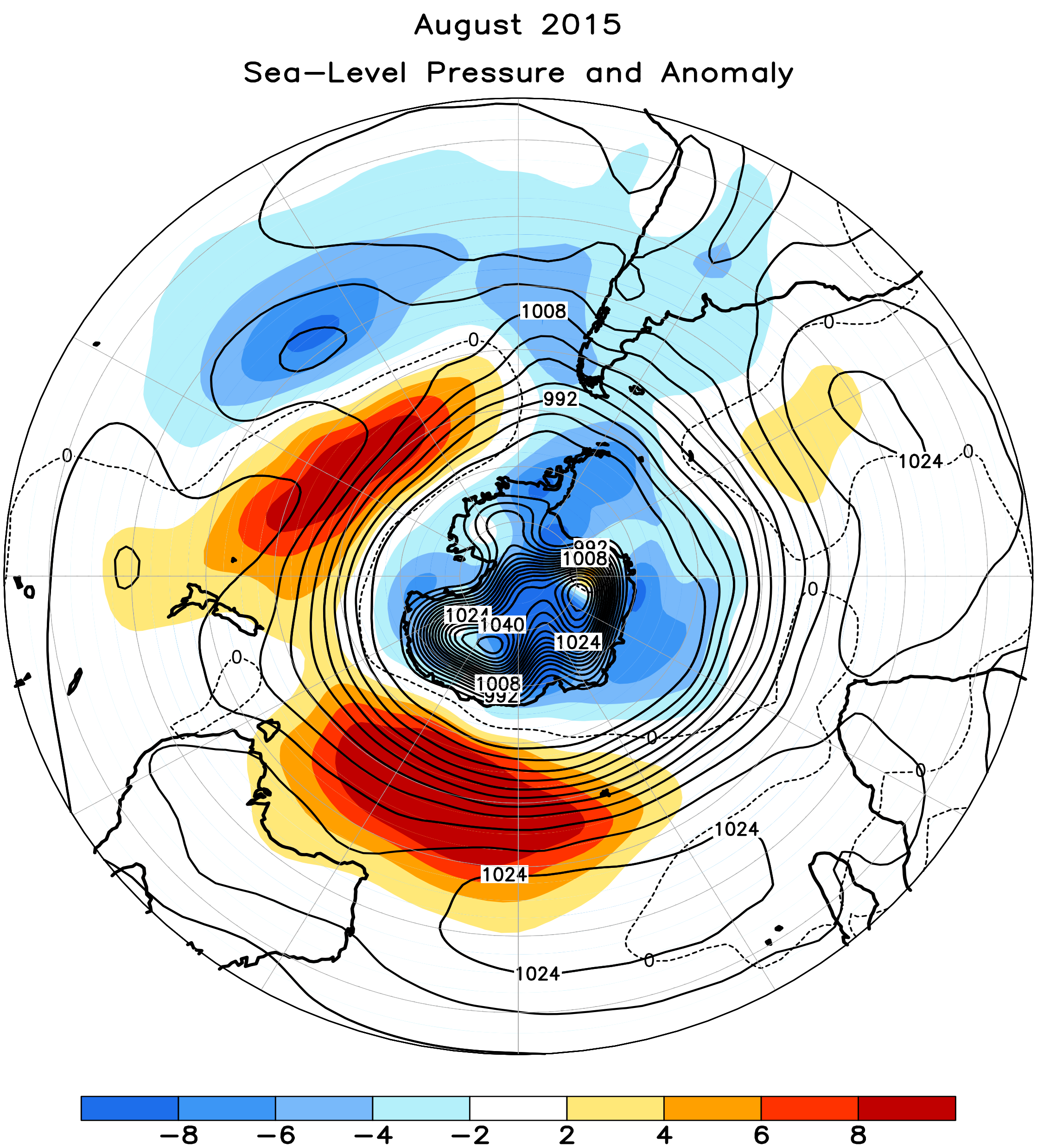


FIGURE E14. Southern Hemisphere mean and anomalous sea level pressure(CDAS/Reanalysis) for AUG 2015. Mean values are denoted by solid contours drawn at an interval of 4 hPa. Anomaly contour interval is 2 hPa with values less (greater) than -2 hPa (2 hPa) indicated by dark (light) shading. Anomalies are calculated as departures from the 1981-2010 base period monthly means.

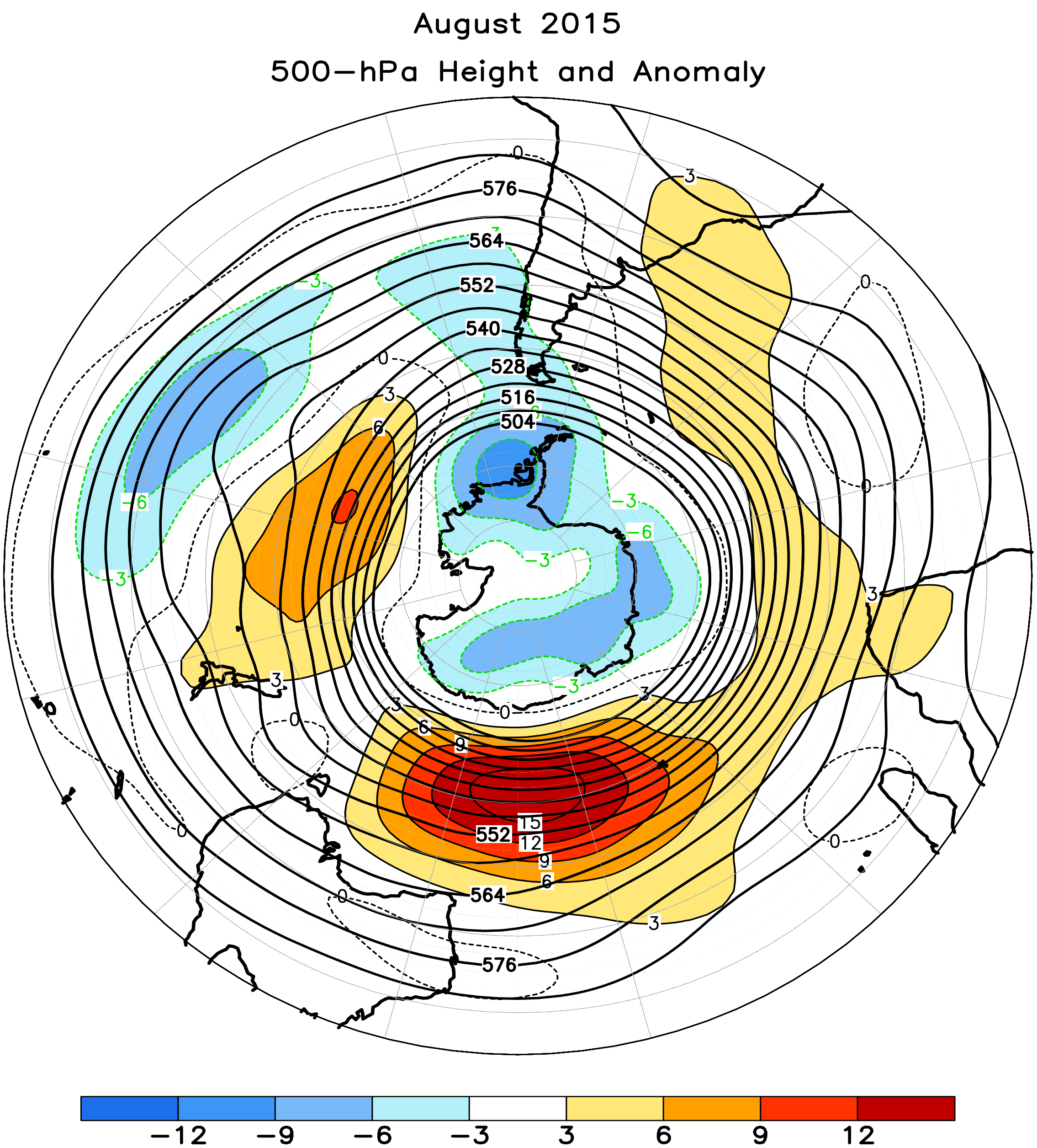


FIGURE E15. Southern Hemisphere mean and anomalous 500-hPa geopotential height (CDAS/Reanalysis) for AUG 2015. Mean heights are denoted by solid contours drawn at an interval of 6 dam. Anomaly contour interval is 3 dam with values less (greater) than -3 dam (3 dam) indicated by dark (light) shading. Anomalies are calculated as departures from the 1981-2010 base period monthly means.

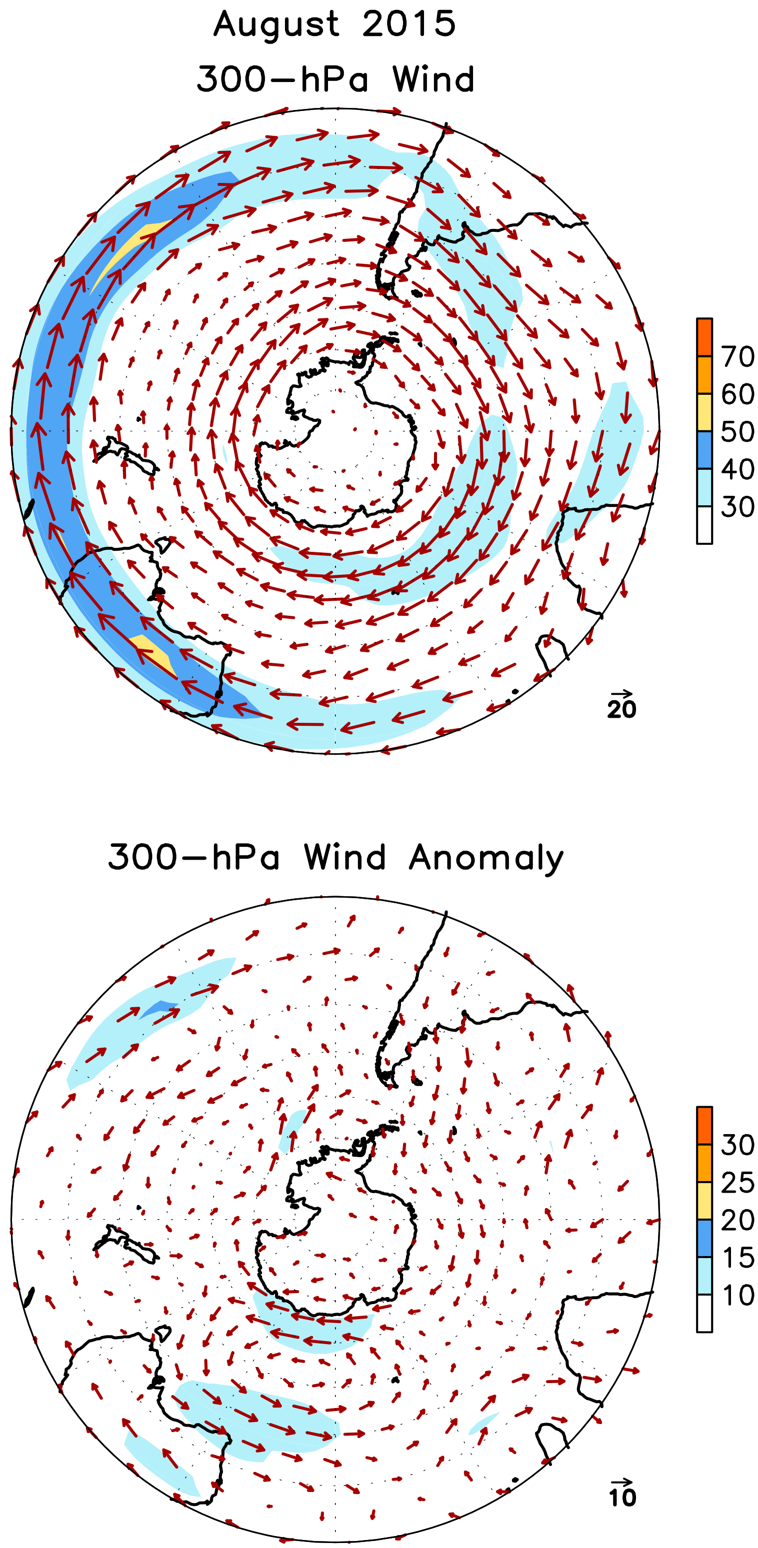


FIGURE E16. Southern Hemisphere mean (left) and anomalous (right) 300-hPa vector wind (CDAS/Reanalysis) for AUG 2015. Mean (anomaly) isotach contour interval is 10 (5) ms^{-1}. Values greater than 30 ms^{-1} (left) and 10 ms^{-1} (rights) are shaded. Anomalies are departures from the 1981-2010 base period monthly means.

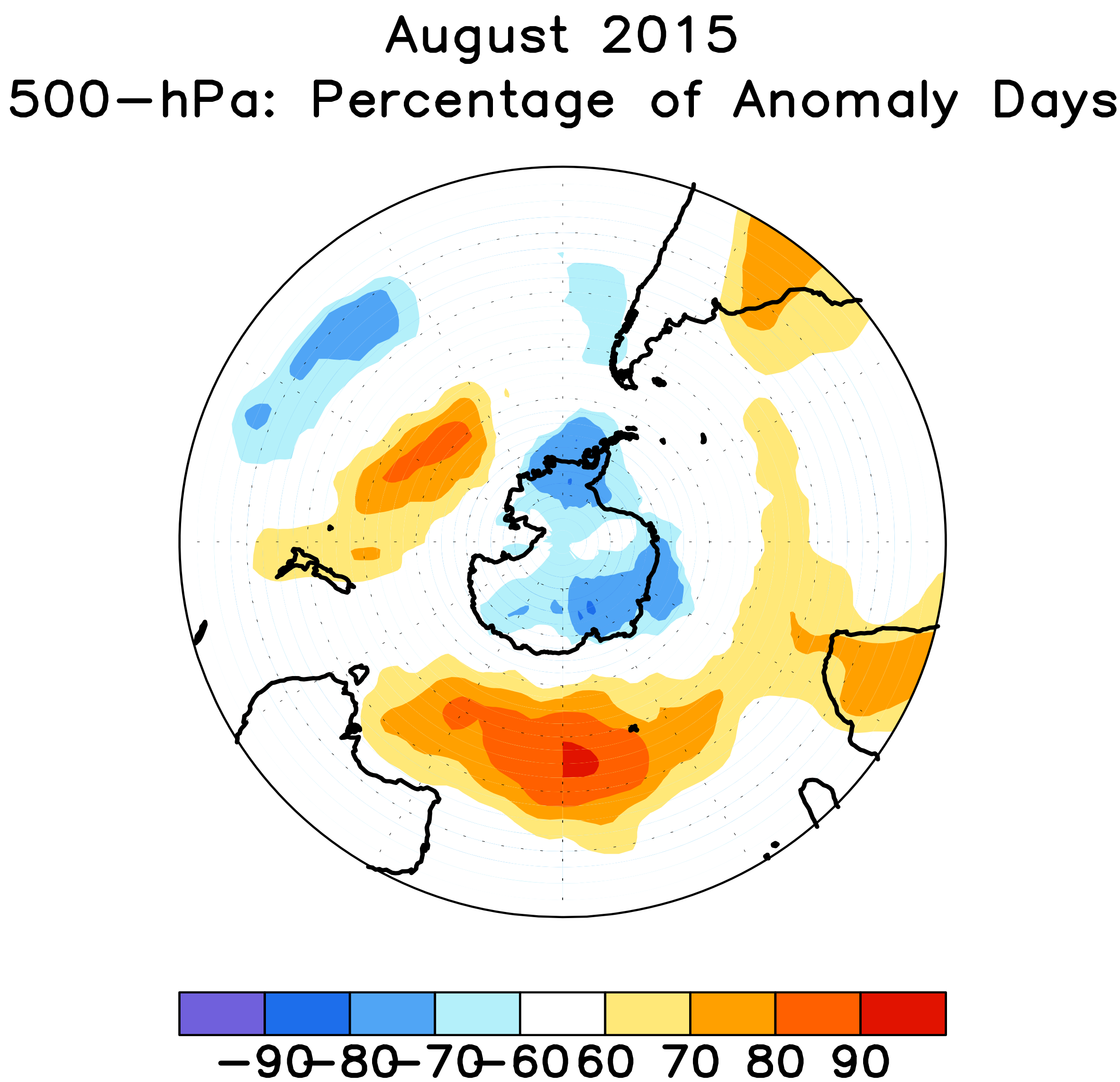


FIGURE E17. Southern Hemisphere percentage of days during AUG 2015 in which 500-hPa height anomalies greater than 15 m (red) and less than -15 m (blue) were observed. Values greater than 70% are shaded and contour in-

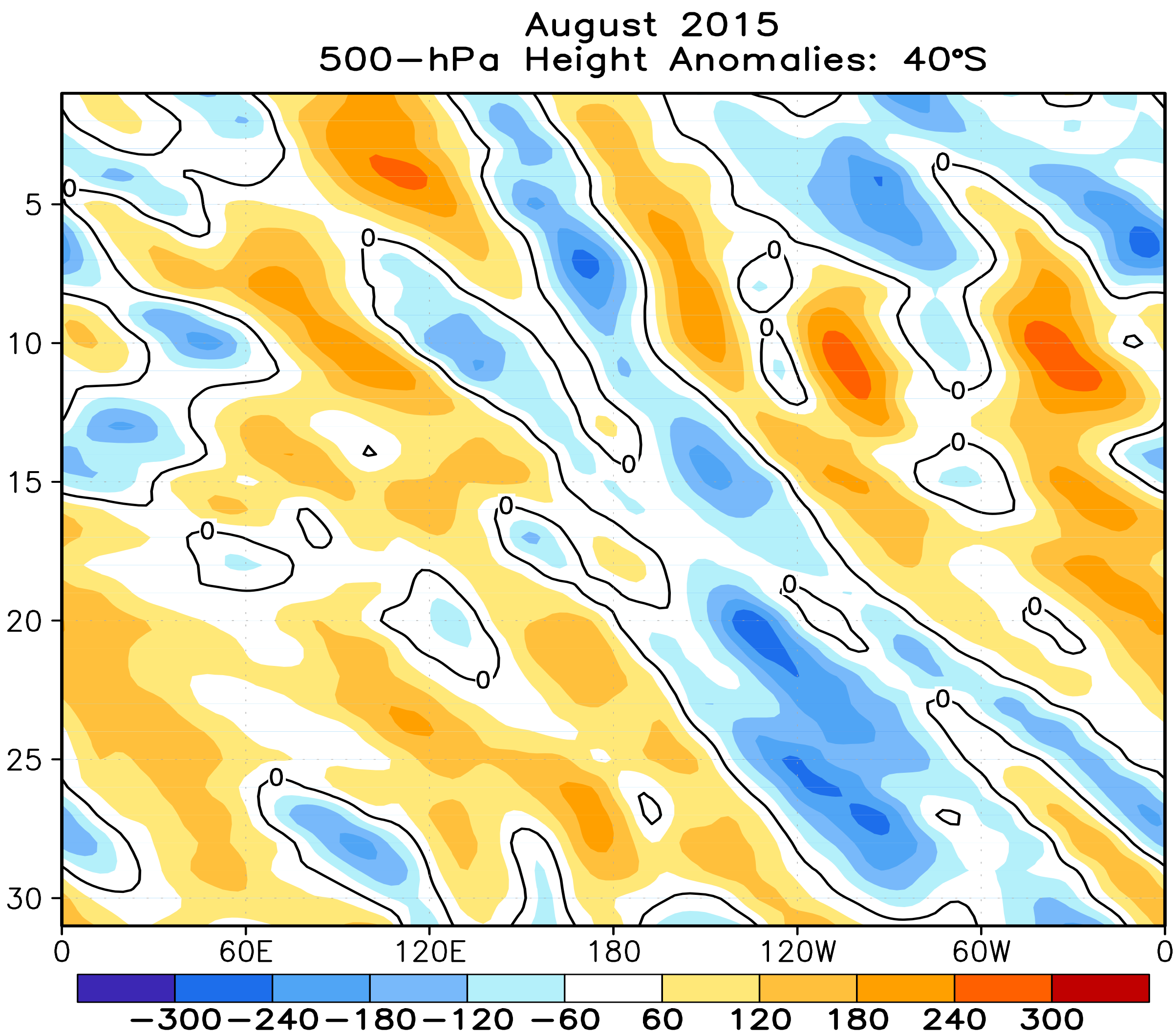


FIGURE E18. Southern Hemisphere: Daily 500-hPa height anomalies for AUG 2015 averaged over the 5° latitude band centered on 40°S. Positive values are indicated by solid contours and dark shading. Negative values are indicated by dashed coutours and light shading. Contour interval is 60 m. Anomalies are departures from the 1981-2010 base period daily means.

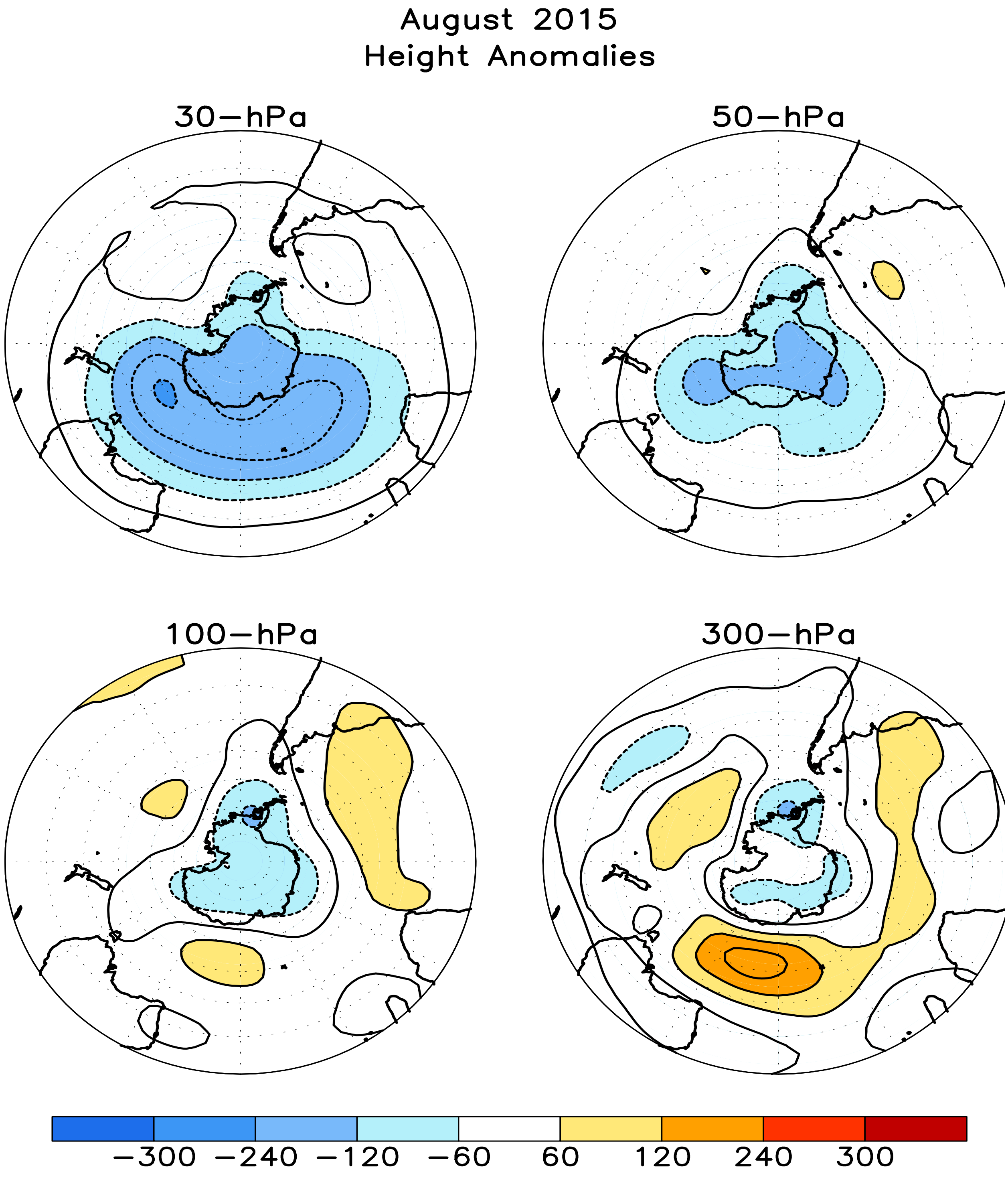


FIGURE S1. Stratospheric height anomalies (m) at selected levels for AUG 2015. Positive values are indicated by solid contours and dark shading. Negative values are indicated by dashed contours and light shading. Contour interval is 60 m. Anomalies are calculated from the 1981-2010 base period means. Winter Hemisphere is shown.

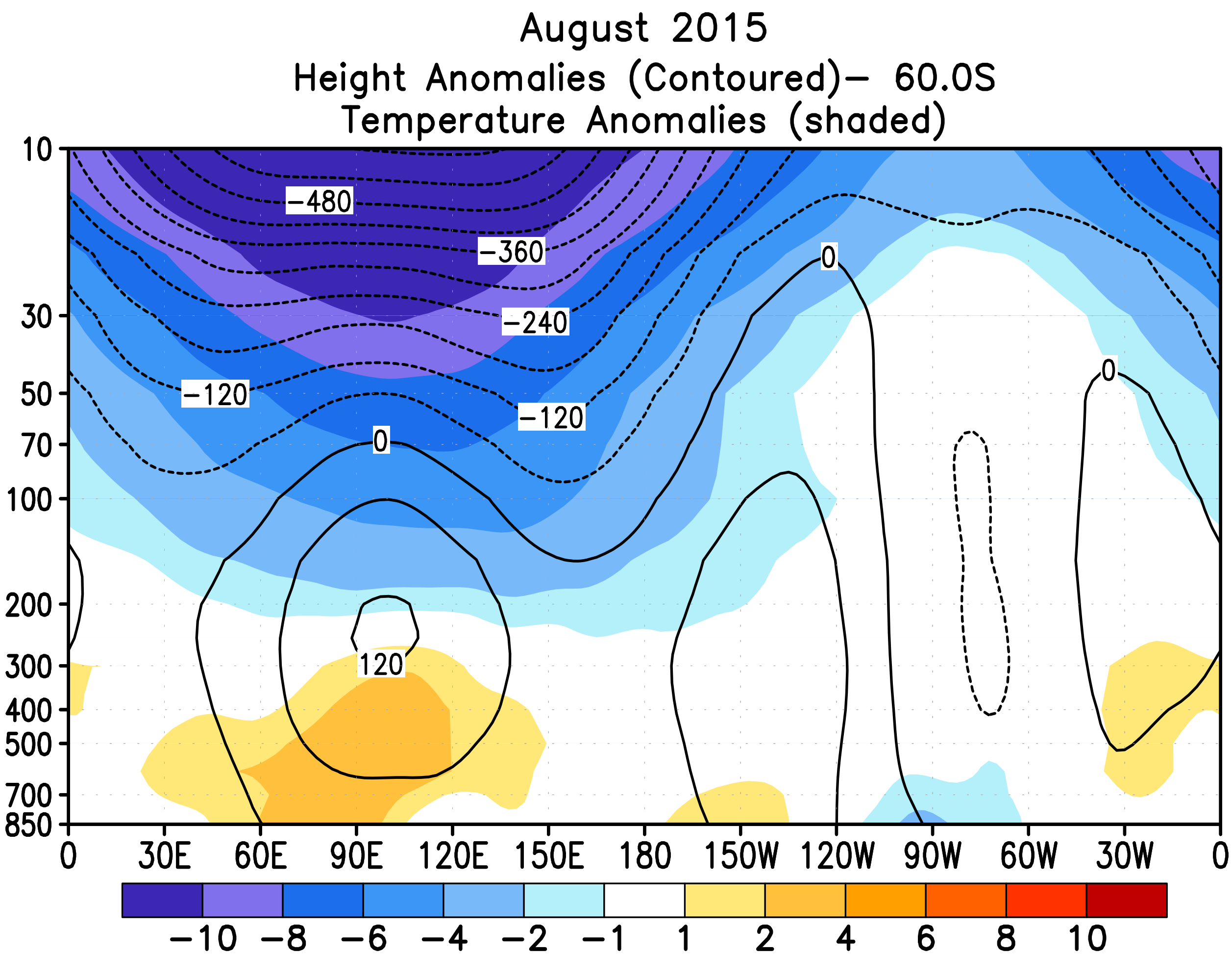


FIGURE S2. Height-longitude sections during AUG 2015 for height anomalies (contour) and temperature anomalies (shaded). In both panels, positive values are indicated by solid contours and dark shading, while negative anomalies are indicated by dashed contours and light shading. Contour interval for height anomalies is 60 m and for temperature anomalies is 2°C. Anomalies are calculated from the 1981-2010 base period monthly means. Winter Hemisphere is shown.

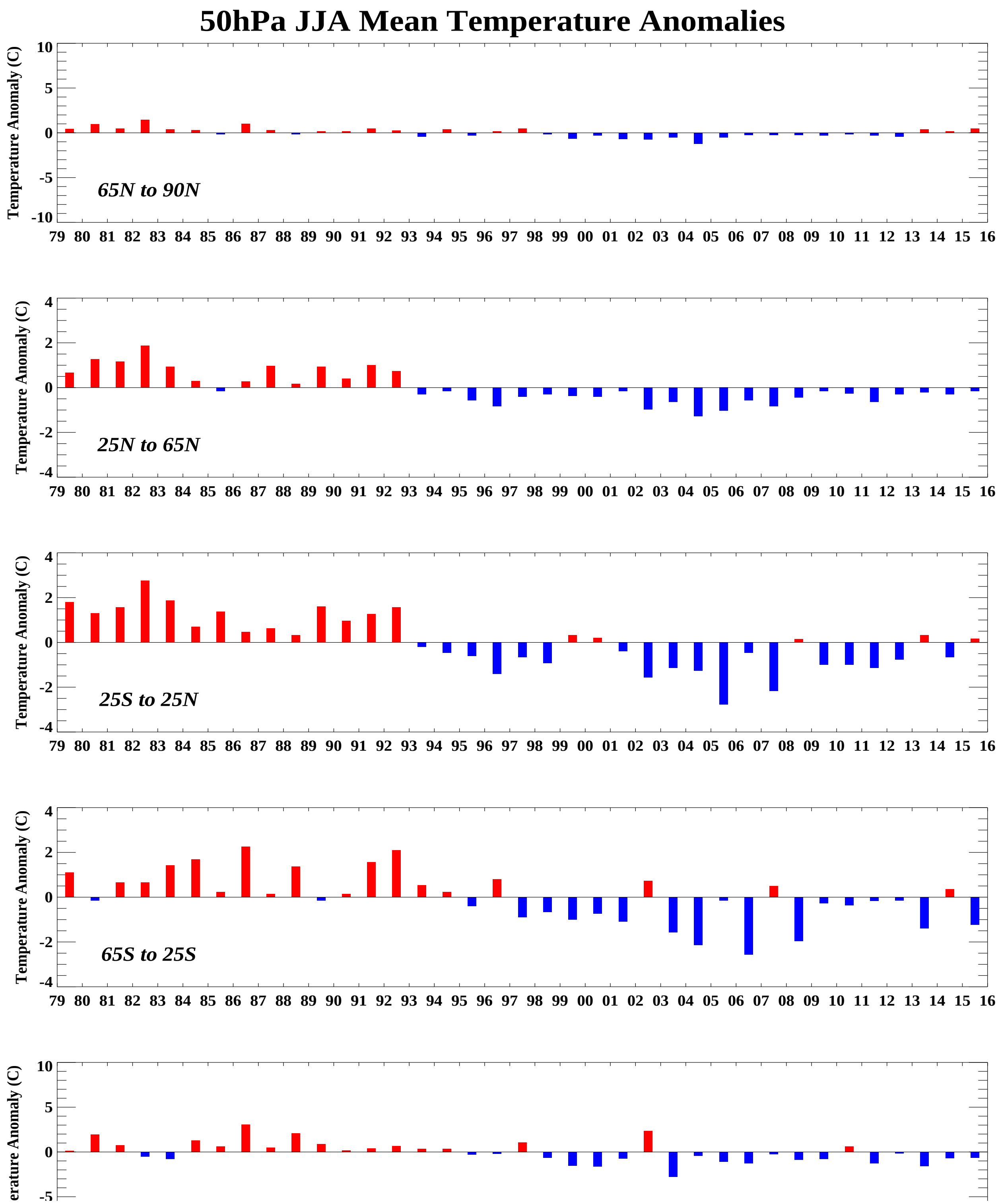


FIGURE S3. Seasonal mean temperature anomalies at 50-hPa for the latitude bands 65°–90°N, 25°–65°N, 25°N–25°S, 25°–65°S, 65°–90°S. The seasonal mean is comprised of the most recent three months. Zonal anomalies are taken from the mean of the entire data set.

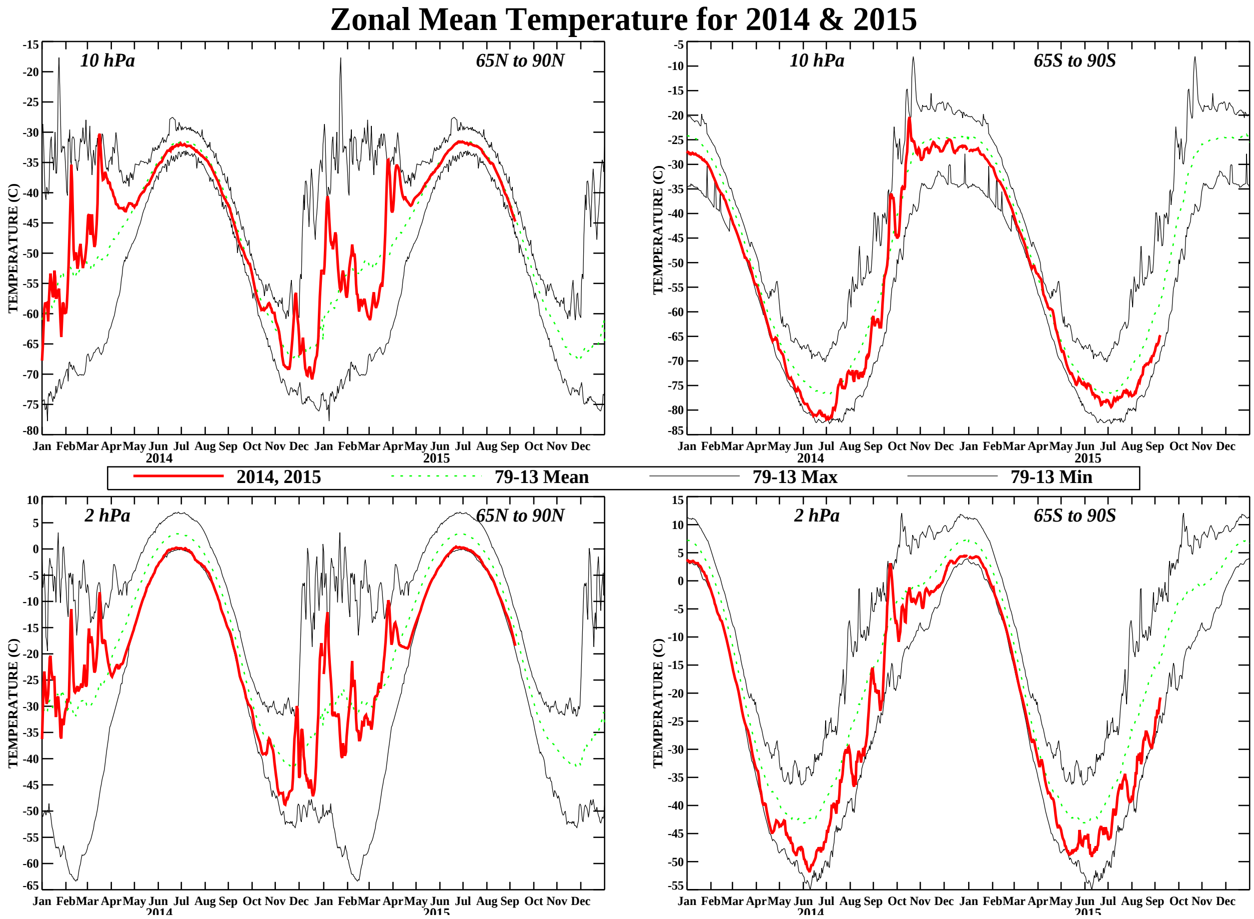


FIGURE S4. Daily mean temperatures at 10-hPa and 2-hPa (thick line) in the region 65°–90°N and 65°–90°S for the past two years. Dashed line depicts the 1981-2010 base period daily mean. Thin solid lines depict the daily extreme maximum and minimum temperatures.

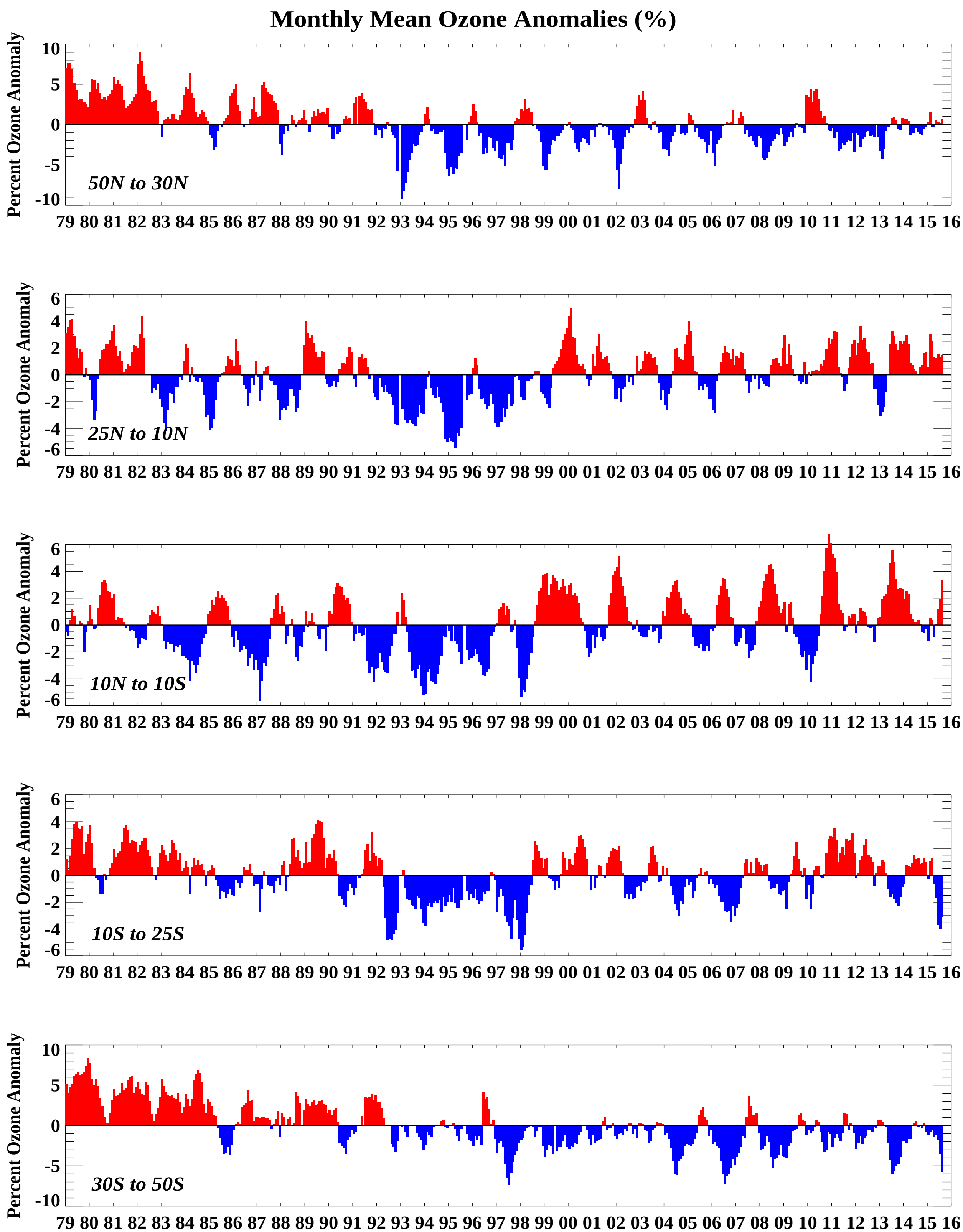


FIGURE S5. Monthly ozone anomalies (percent) from the long term monthly means for five zones: 50N-30N (NH mid-latitudes), 25N-10N (NH tropical surf zone), 10N-10S (Equatorial-QBO zone), 10S-25S (SH tropical surf zone), and 30S-50S (SH mid-latitudes). The long term monthly means are determined from the entire data set

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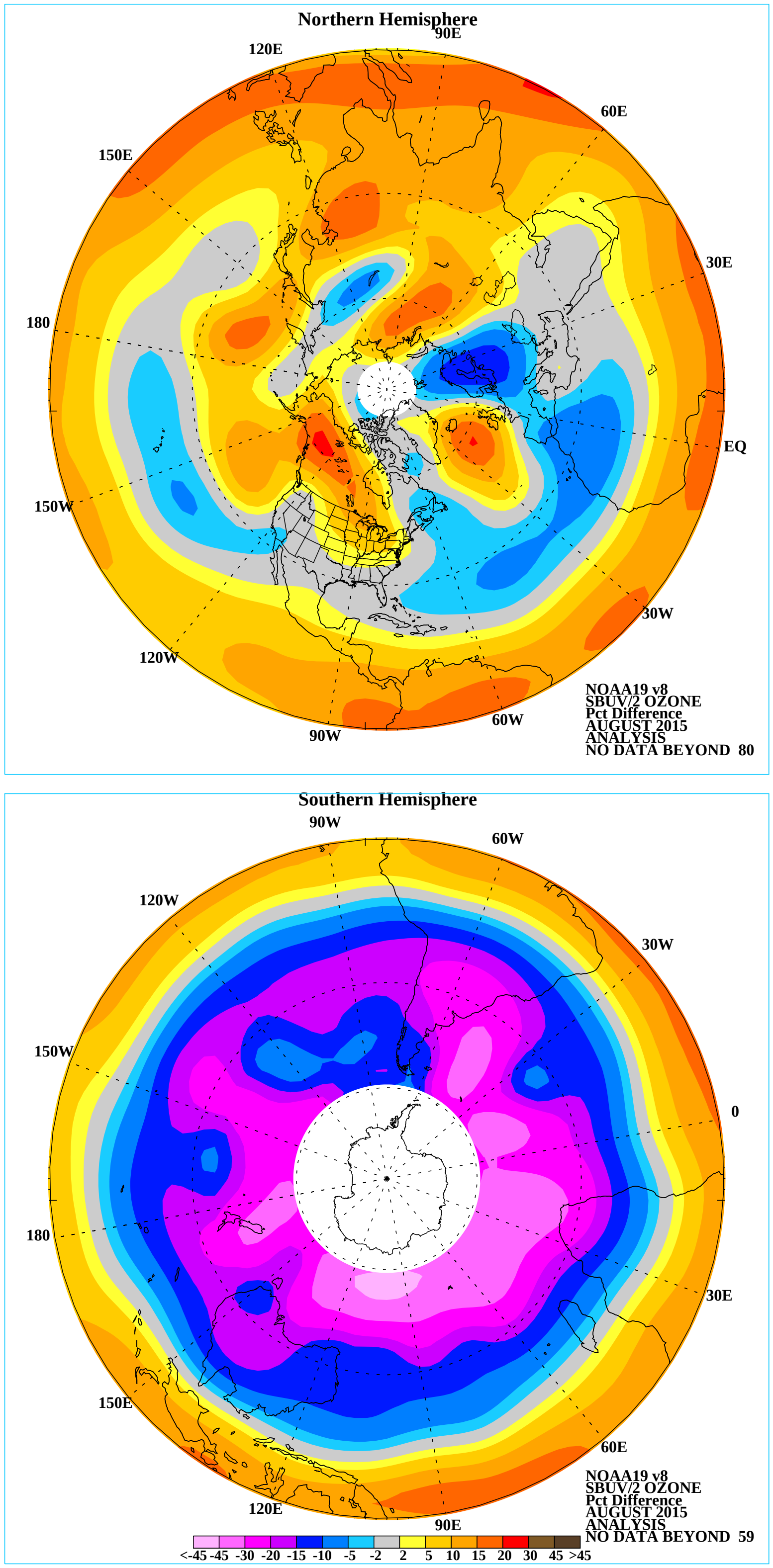

FIGURE S6. Northern (top) and Southern (bottom) Hemisphere total ozone anomaly (percent difference from monthly mean for the period 1979-1986). The region near the winter pole has no SBUV/2 data.

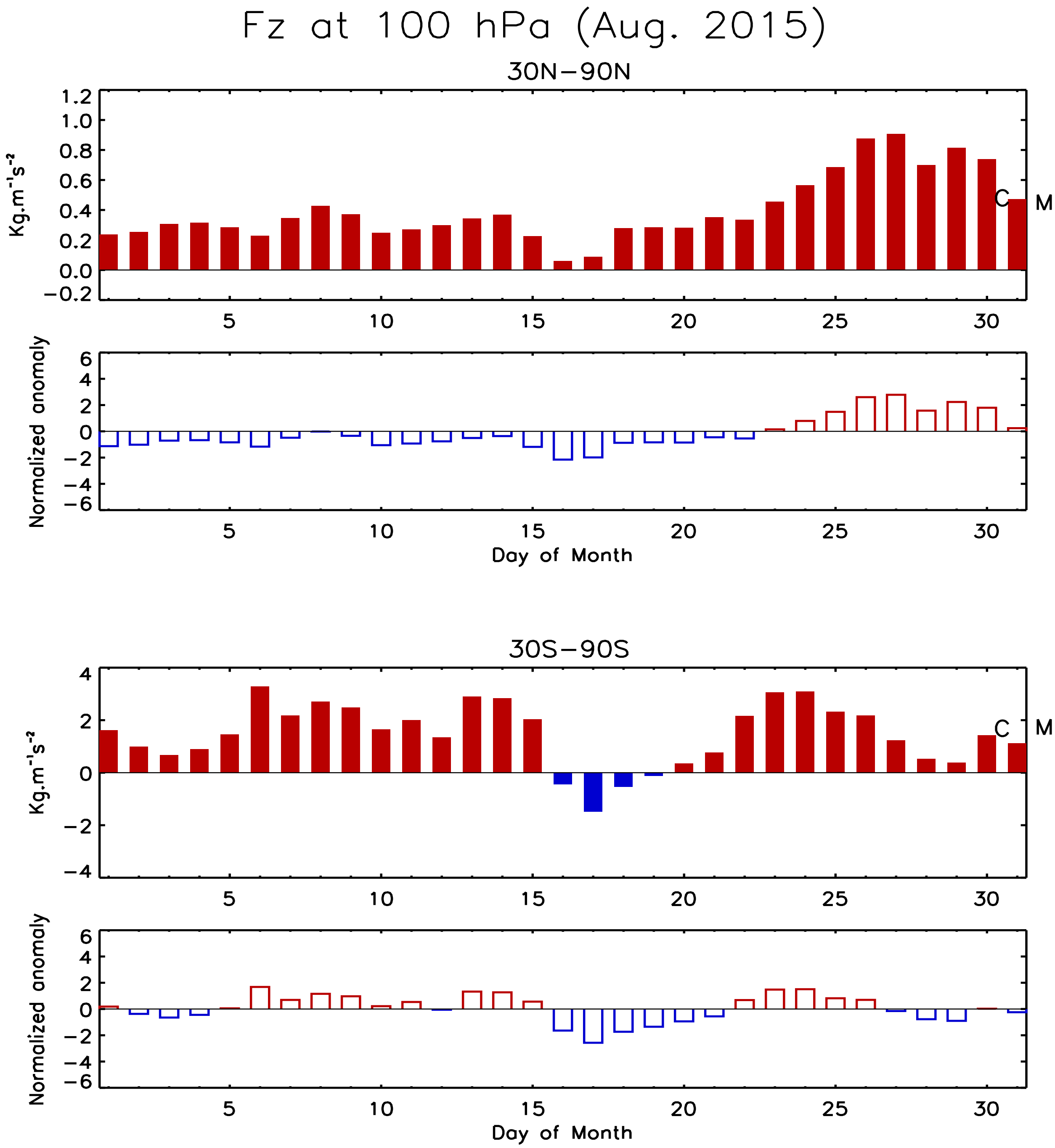

FIGURE S7. Daily vertical component of EP flux (which is proportional to the poleward transport of heat or upward transport of potential energy by planetary wave) at 100 hPa averaged over (top) 30°N–90°N and (bottom) 30°S–90°S for AUG 2015. The EP flux unit (kg m^{-1} s^{-2}) has been scaled by multiplying a factor of the Brunt Vaisala frequency divided by the Coriolis parameter and the radius of the earth. The letter 'M' indicates the current monthly mean value and the letter 'C' indicates the climatological mean value. Additionally, the normalized departures from the monthly climatological EP flux values are shown.

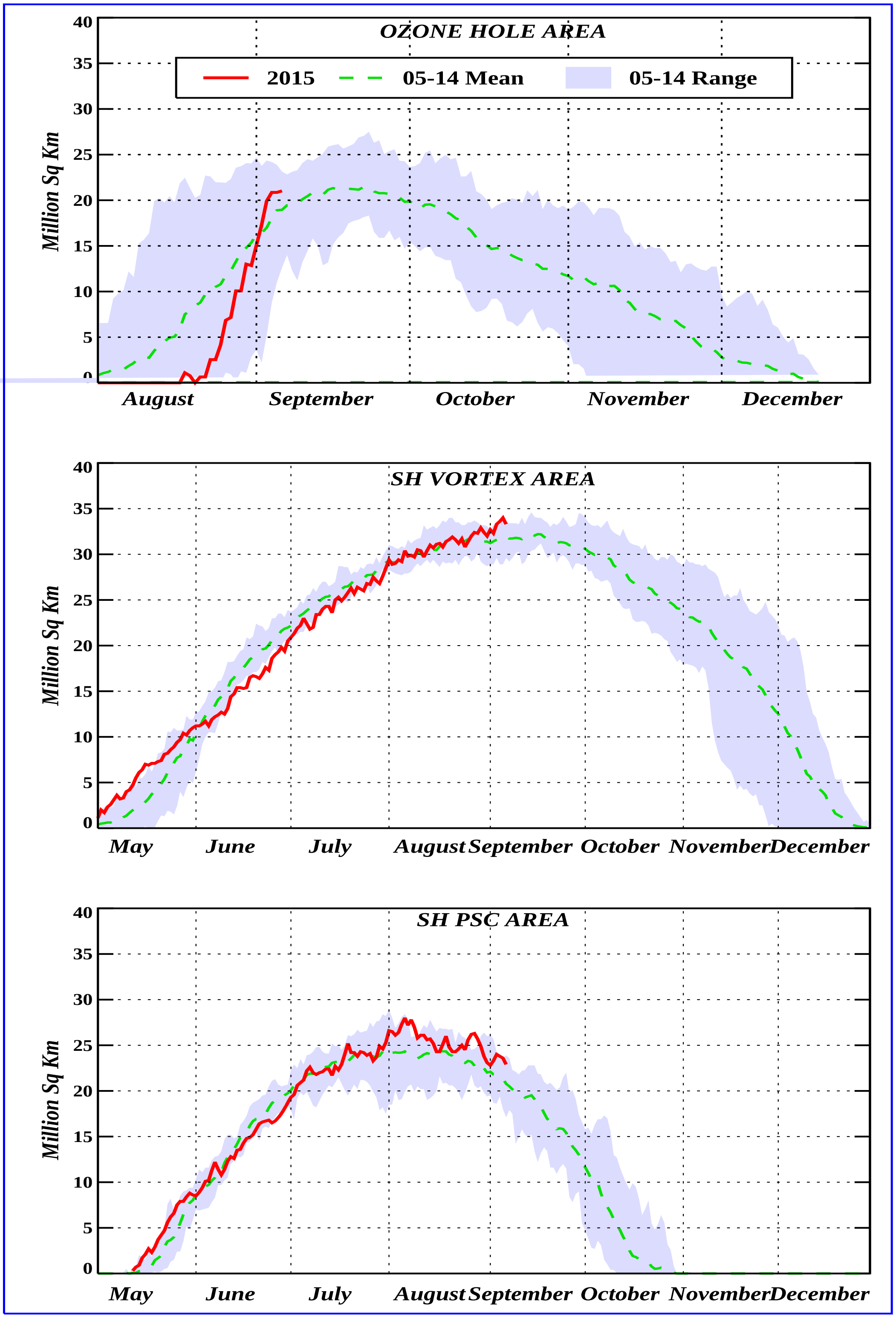

FIGURE S8. Daily time series showing the size of the SH polar vortex (representing the area enclosed by the 32 PVU contour on the 450K isentropic surface), and the areal coverage of temperatures < -78C on the 450K isentropic surface.

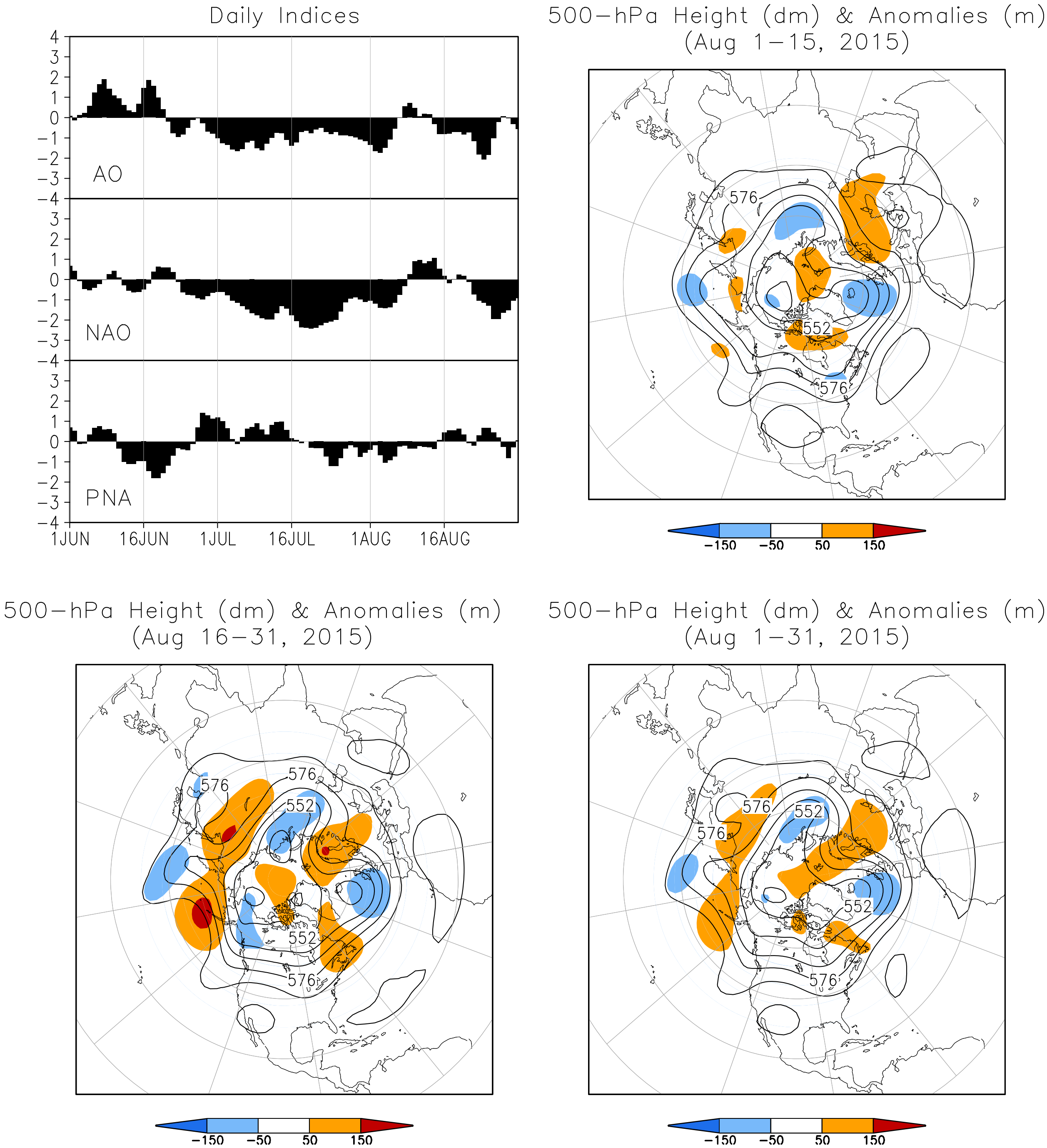

FIGURE A2.1. (a) Daily amplitudes of the Arctic Oscillation (AO) the North Atlantic Oscillation (NAO), and the Pacific-North American (PNA) pattern. The pattern amplitudes for the AO, (NAO, PNA) are calculated by projecting the daily 1000-hPa (500-hPa) height anomaly field onto the leading EOF obtained from standardized time- series of daily 1000-hPa (500-hPa) height for all months of the year. The base period is 1981–2010.

(b-d) Northern Hemisphere mean and anomalous 500-hPa geopotential height (CDAS/Reanalysis) for selected periods during AUG 2015 are shown in the remaining 3 panels. Mean heights are denoted by solid contours drawn at an interval of 8 dam. Dark (light) shading corresponds to anomalies greater than 50 m (less than -50 m). Anomalies are calculated as departures from the 1981-2010 base period daily means.

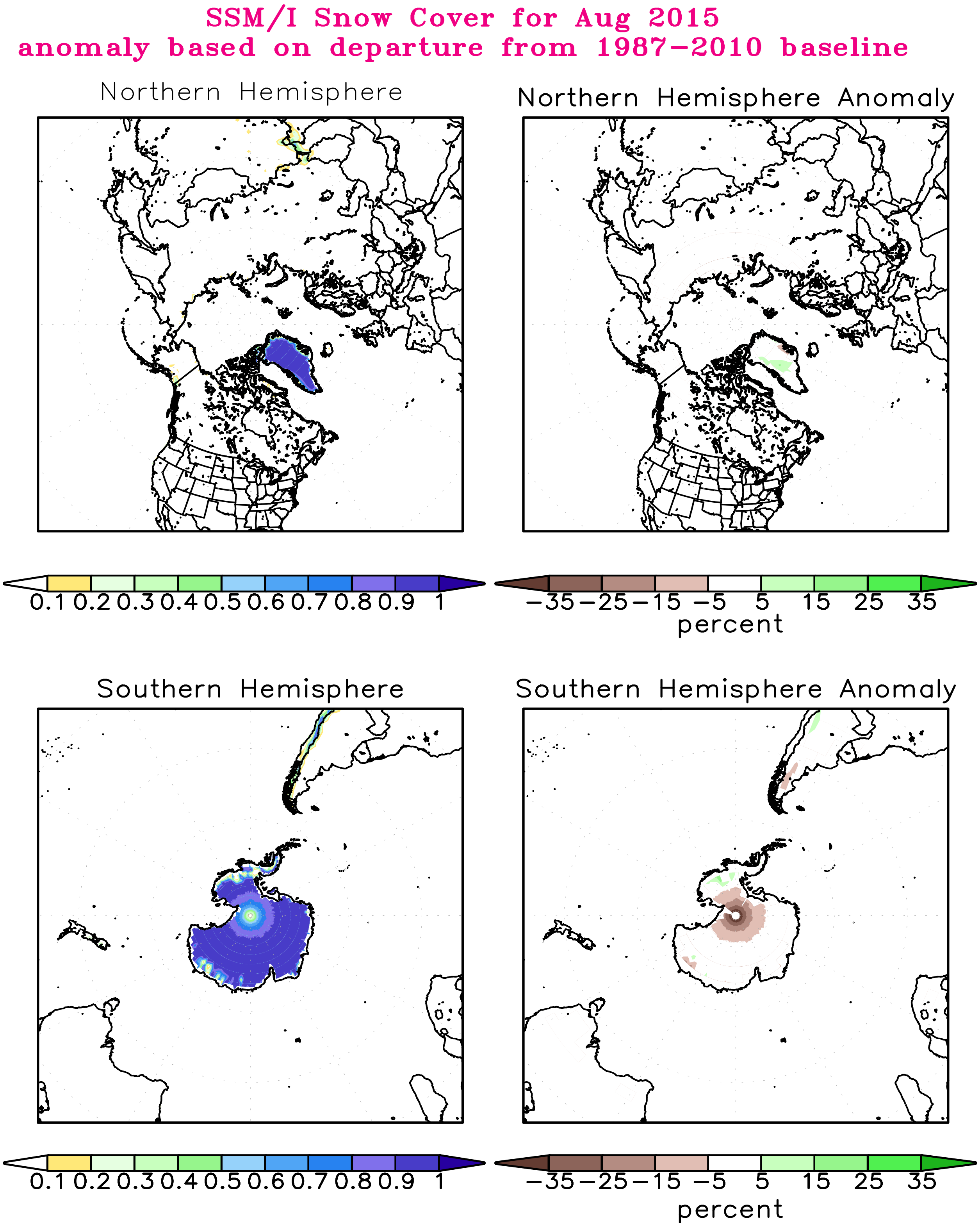

FIGURE A2.2. SSM/I derived snow cover frequency (%) (left) and snow cover anomaly (%) (right) for the month of AUG 2015 based on 1987 - 2010 base period for the Northern Hemisphere (top) and Southern Hemisphere (bottom). It is generated using the algorithm described by Ferraro et. al, 1996, Bull. Amer. Meteor. Soc., vol 77, 891-905.