Forecast of 2019 Atlantic Hurricane Activity

August 12, 2019

Summary

CFAN's August hurricane forecast update continues to predict an active hurricane season for 2019. We predict: ACE 150 (±40), Hurricanes 8 (±3), 2 U.S. landfalls and 1 Florida landfall. These estimates suggest moderately above-average ACE, hurricane totals and landfall activity compared to averages during the recent active regime in place since 1995. Landfall forecasts are closer to averages during the past three years (2016-18), which have been more frequent over the U.S. and Florida with respect to the previous decade. The current forecast is consistent with CFAN's previously-issued seasonal forecasts for the 2019 Atlantic hurricane season.

North Atlantic ACE

Higher ACE total tend to occur with cool La Niña sea surface temperatures (SSTs) in the east-central equatorial Pacific and warm surface conditions around the Caribbean Sea and the western tropical North Atlantic. La Niña conditions tend to inhibit upper-level wind shear above the Atlantic, favoring tropical cyclone intensification. Warm surface conditions in the Caribbean/tropical Atlantic tend to promote low-level convergence and enhanced ascent in the troposphere above. Annual ACE totals are positively related to an east-west SST 'dipole' pattern with peak connections seen during the climatological height of the hurricane season in August-September-October (ASO).

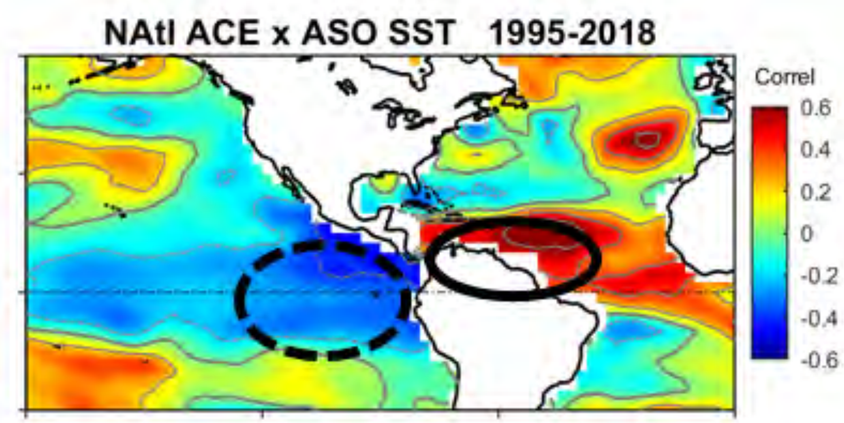


Figure 1. North Atlantic ACE index correlations x local ASO (August-September-October) SST hurricane indices, 1995-2018. Higher ACE totals are favored by an SST dipole, with below-normal anomalies in the east-central tropical Pacific (blue) and warm surface conditions in the Caribbean Sea – western tropical North Atlantic (red).

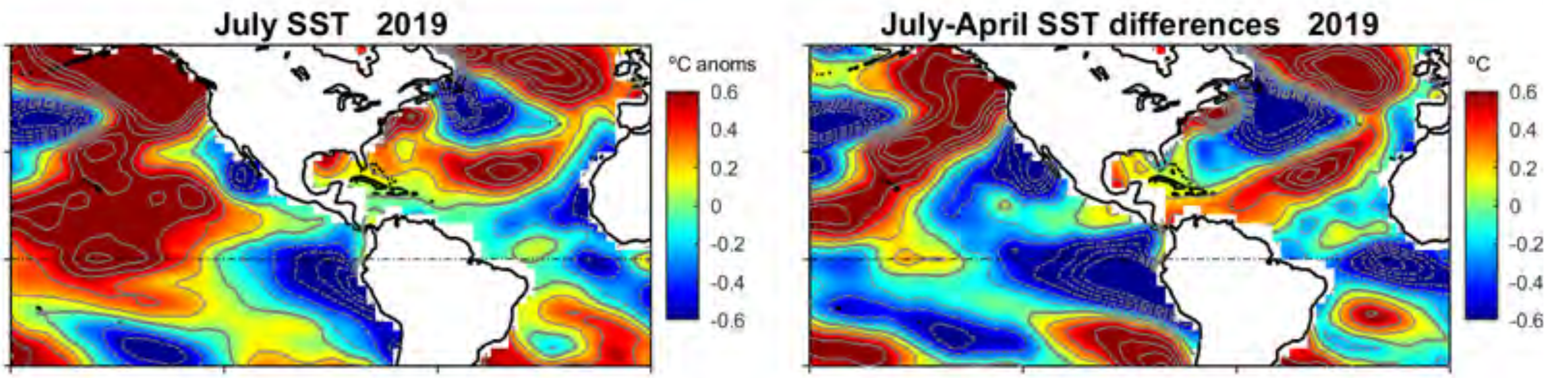


Figure 2. Sea surface temperature anomalies July (2019) left and July - April differences (trend).

Current SST anomalies (Figure 2) include elements of the ACE SST dipole pattern that favors above-normal activity. Cool SSTs are prevalent off the Pacific coast of South America, producing La Niña-like conditions in the far eastern Pacific. Warm SSTs in the central equatorial Pacific continue to produce an El Niño Modoki (see Appendix A for further discussion of the ENSO conditions and forecast), which is generally a favorable pattern for Atlantic hurricanes (see Appendix B for further discussion of Modoki). In the North Atlantic, warm SSTs appear in the central subtropics, extending toward the SE U.S., Gulf of Mexico and Caribbean. However, SSTs remain slightly below normal in the western Atlantic off Brazil, signifying incomplete development of the ACE SST dipole in July.

Seasonal SST trends, illustrated in July-April differences in Fig. 2, include hurricane-favorable tendencies related to the ACE SST Dipole. Steep and continuous surface cooling (<-1°C) in the far eastern equatorial Pacific coincided with moderate warming (+0.3°C) in the western tropical North Atlantic.

Currently, above-normal SSTs are seen over the subtropical Atlantic, the Caribbean, and Gulf Mexico (Fig. 3), due in part to very recent changes over the past 7 days. ACE Dipole SST anomalies and trends over multiple time periods are favorable to moderately above-normal ACE totals in 2019.

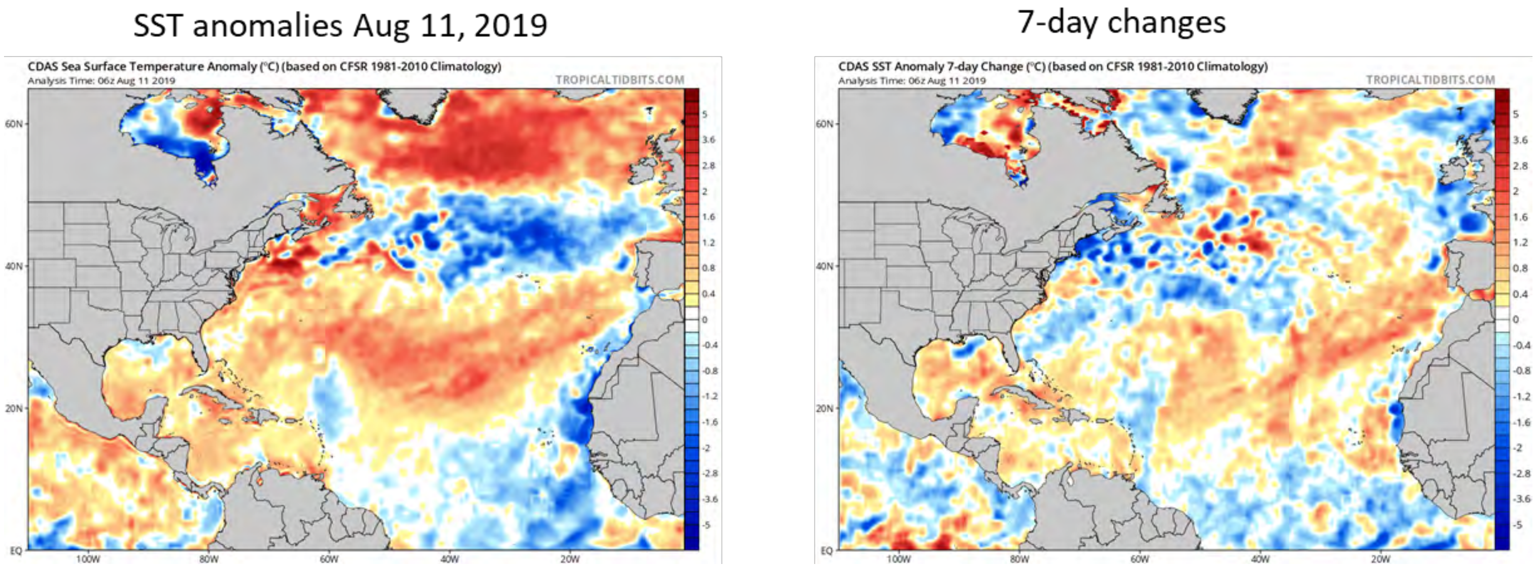


Figure 3. Sea surface temperature anomalies on August 11, 2019 (left) and 7-day changes (right).

Since 2010, North Atlantic ACE also displays a strong negative relationship with latitudinal gradients of stratospheric zonal 10-20 hPa (U10,20) winds within in a narrow subtropical band above North Atlantic and the broader Northern Hemisphere (NH) (Fig. 4, top left). Higher ACE totals occur systematically in connection with anticyclonic circulation anomalies in predominantly easterly stratospheric flow above the subtropical NH. Subtropical U-wind gradients in the stratosphere are sensitive to several patterns of circulation variability, including the tropical stratospheric Quasi-biennial Oscillation, NH stratospheric wind teleconnections to Southern Hemisphere winter polar vortex, and zonal ENSO-related circulation anomalies in the troposphere. Anomalous stratospheric ridging above the subtropical North Atlantic appears to enhance upper-tropospheric divergence above the Atlantic Main Development Region (MDR), thereby increasing hurricane activity. A strong relationship connects observed ACE totals and those predicted by opposite anomalies of U20 gradients in the subtropical North Atlantic (30°N, 60°W, r = -0.92, Fig. 4, right). In recent June-July 2019 observations (Fig. 4, bottom left) negative anomalies of U20 gradients can be seen within a narrow band (30°-35°N) throughout the subtropical NH. Weak gradients over the subtropical North Atlantic suggest an above-normal ACE total of ~150 (vs. the 1995-2018 mean of 132), based on recent relationships (Fig. 4, right). Similar factors suggest above-normal frequency of North Atlantic hurricanes in 2019, which we estimate at 8, compared to a mean frequency of 7.5.

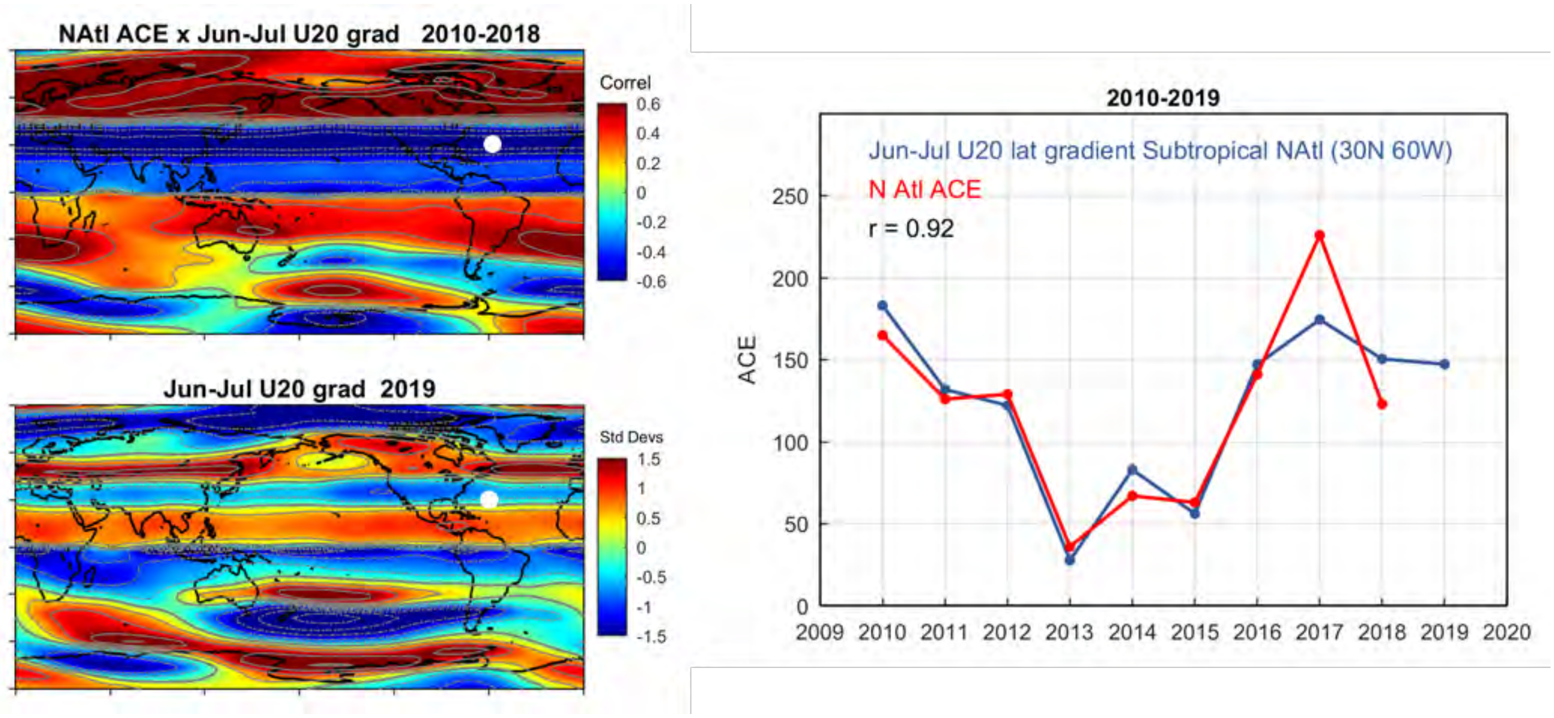


Figure 4. Top left: Correlations of the North Atlantic ACE index with latitudinal gradients of 20 hPa stratospheric zonal (U) winds, June-July means, 2010-2018. The band of negative correlations along ~30°N, reflects a strong relationship between ACE and relative strength/weakness of U20 anomalies to the north/south. Bottom left: U20 gradients during June-July 2019, including a narrow band of moderately negative anomalies along ~30°N. White markers at 30N, 60W mark the sites of U20 anomalies plotted in the right panel. Right: Observed ACE values, and estimates based on inverted, scaled U20 gradients at 30N, 60W. Current U20 gradients suggest above-normal ACE (~150) in 2019.

U.S. and Florida Hurricane Landfalls

Figure 5 illustrates annual totals of hurricane landfalls for the U.S. (mean 1.7) and Florida (mean 0.6) during the period from 1995 through 2018. Interannual variations in both landfall indices share substantial correlations with North Atlantic ACE (r ~0.75), such that landfalls tend to increase with overall North Atlantic cyclone activity, but landfalls also exhibit somewhat different histories, and respond to additional climate factors.

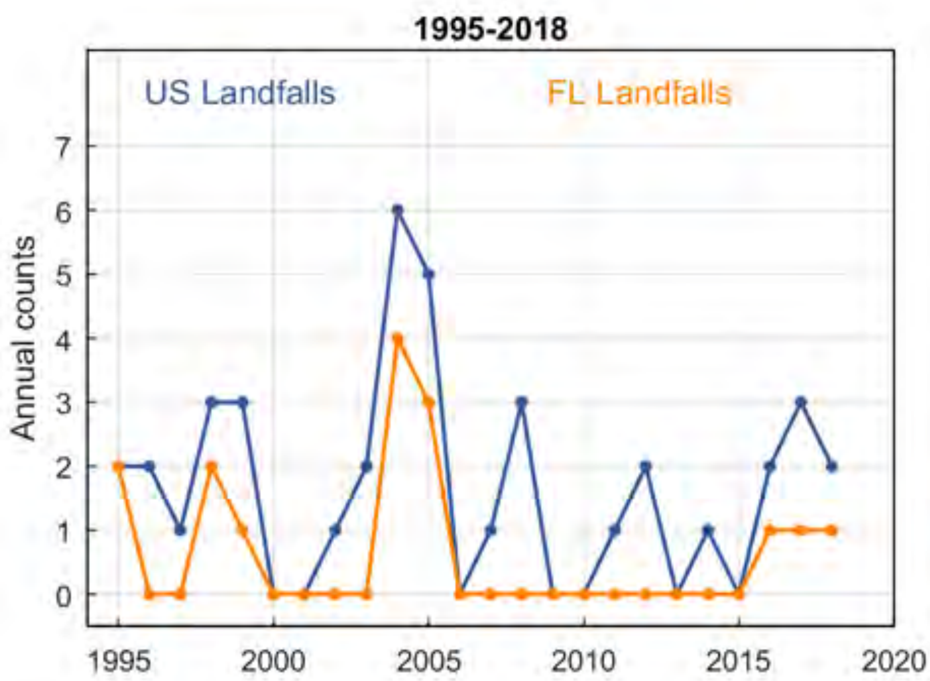


Figure 5. Annual number of US and Florida landfalling hurricanes for the period 1995-2018

U.S. and Florida hurricane landfalls reached extreme high levels in 2004-05, but a decade-long landfall 'drought' then followed from 2006 to 2015, with an average of just 0.8 U.S. landfalls per year and a complete absence of Florida landfalls. The three following years of 2016-18 experienced a resurgence of U.S.landfalls (averaging 2.4 per year), including one Florida hurricane during each of the past three years.

The recent 2016-18 active landfall regime has coincided with a period of unusually warm SSTs in the Atlantic off Florida and the eastern U.S., and in the subtropical NE Pacific, as shown in Figure 6 for May-June-July, (MJJ, top left) and July (bottom left). Similar anomalies are present again in 2019 for MJJ (Fig. 6, top right) and July (Fig. 6, bottom right), suggesting that regional climate conditions favoring enhanced U.S. and Florida landfalls from 2016-18 are likely to remain effective in 2019.

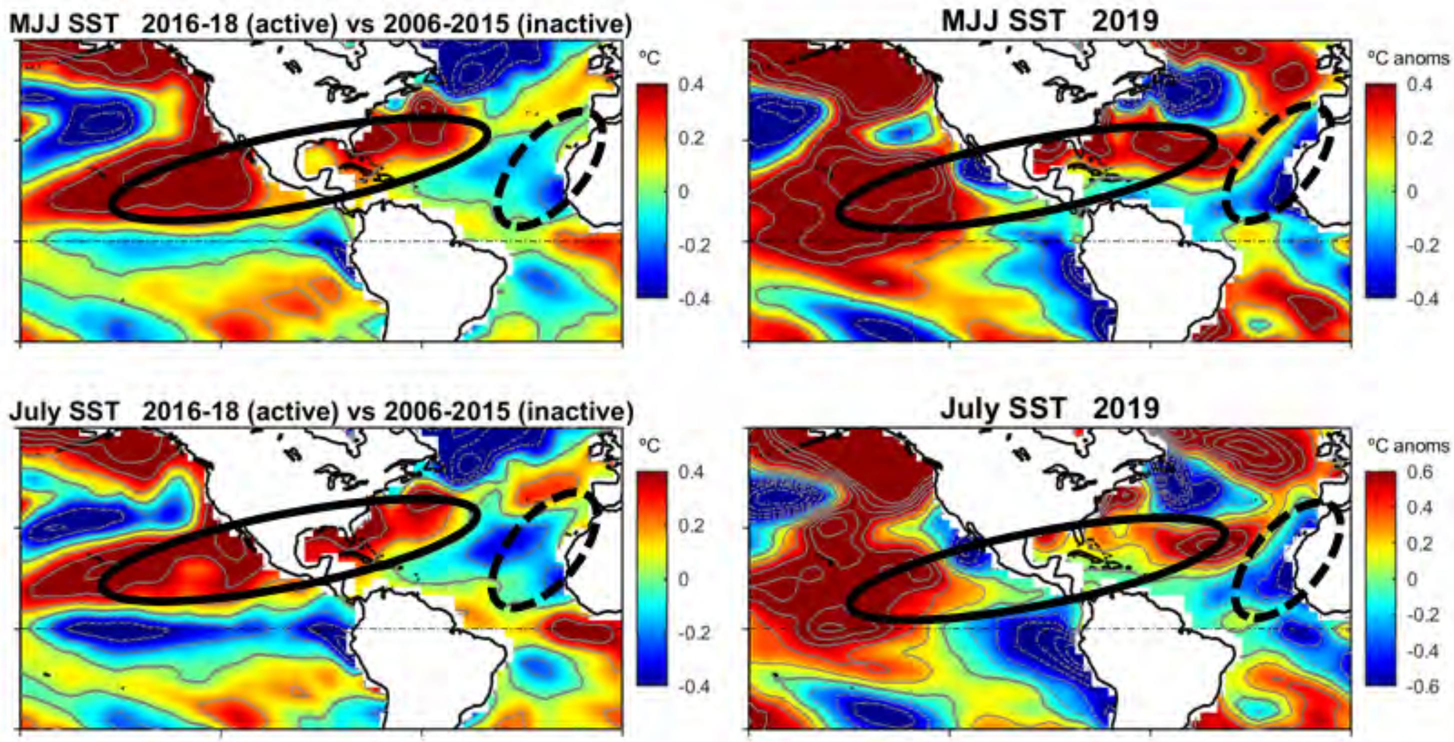


Figure 6. Left: SST anomalies during the recent active regime (2016-18) vs. previous decade of relatively little activity (2006-2015), in term of U.S. and Florida hurricane landfalls. Right: 2019 SST anomalies. Top rows show May-June-July SST averages; Bottom row show July anomalies. Solid ovals mark areas of anomalous warmth from the subtropical North Atlantic to the subtropical NE Pacific. Dashed ovals mark areas of cool surface temperatures along western Africa.

The physical relevance of the SST anomalies to hurricane behavior is suggested by patterns of anomalous June-July omega (downward vertical velocity) in the lower troposphere (1000-850 hPa averages) shown in Fig. 7. In recent years (2016-18) enhanced atmospheric ascent over the western Atlantic (red, solid ovals) above warmer water and relatively strong subsidence (dashed ovals, blue) above cool water in the eastern Atlantic may account for the increases in U.S. and Florida landfall frequencies. A similar MJJ circulation anomaly pattern is evident in 2019, suggesting a likelihood of above-average hurricane landfalls, comparable to levels seen during the past three years.

We do not find any statistically significant relationships to further breakdown potential landfall locations (e.g. Gulf of Mexico, Atlantic coast).

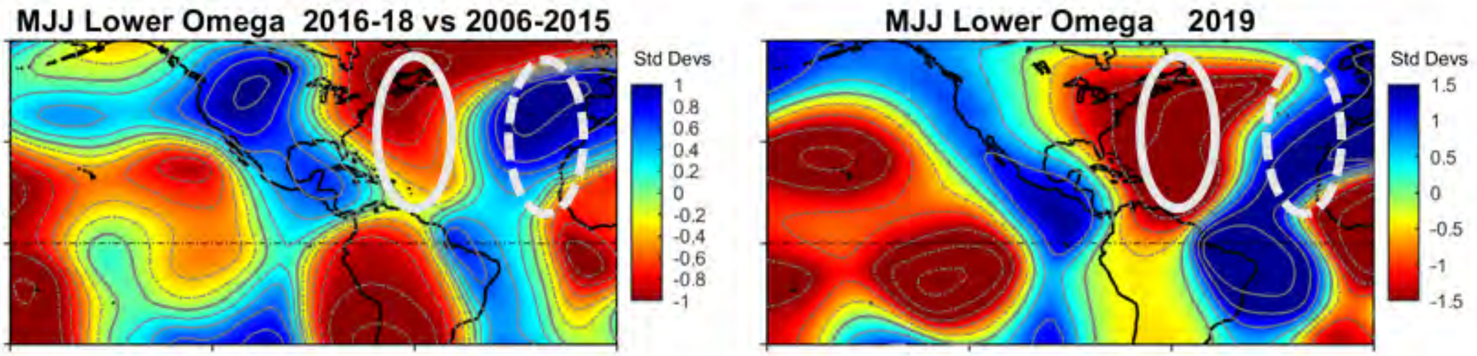


Figure 7. Left: MJJ anomalies of lower-tropospheric (1000-850 hPa) omega (downward vertical velocity) during the recent active regime (2016-18) vs. previous decade of relatively little activity, in term of U.S. and Florida hurricane landfalls. Right: MJJ 2019 omega anomalies. Color shading is reversed so that areas of enhanced ascent (red) correspond with areas of positive SST anomalies in Fig 6, and areas of enhanced subsidence correspond to areas of cool SSTs, consistent with physical expectations. Ovals above the North Atlantic highlight an east-west dipole favoring greater convection in the western tropical North Atlantic, simultaneous with the 2016-18 period of more frequent U.S. and Florida hurricane landfalls. 2019 anomalies suggest continuation of an active landfall regime.

Forecast summary

Our previous 2019 hurricane forecasts identified signals of an active hurricane season (Table 2), and current August estimates, in bold, also predict moderately above-normal totals of North Atlantic ACE (150 / mean 132), North Atlantic hurricanes (8 / 7.6), U.S. landfalls (2 / 1.7) and Florida landfalls (1 / 0.6).

Forecast	Model Period	**NAtl ACE**	**NAtl Hurs**	**US Landfalls**	**FL Landfalls**
November	1981-2018	163	7.7	3	x
November	1995-2018	192	9.8	2.5	x
March	2001-2018	126	6.2	2.4	1.4
May	1995-2018	167	8	0.9	0.4
August	**1995-2018**	**150**	**8**	**2**	**1**
Obs Means	1995-2018	132	7.5	1.7	0.6

Table 2. CFAN's current (Aug, bold) and previous November, March and May forecasts of 2019 hurricane activity.

Hurricane index estimates for 2019 are based on a consensus of statistical forecast models that predict past index values from a wide variety of ocean-atmosphere predictors at regional to global scales from the surface to the stratosphere. Patterns illustrated here represent a sample of skillful indicators, which generally point to conditions comparable to those over the past 3 years. Uncertainty estimates shown in Table 3 approximate the range of forecast model outputs. Current uncertainties stem from variable SSTs in the eastern Pacific and the tropical Atlantic, in addition to inherent uncertainties of hurricane activity associated with intraseasonal weather variations.

Current Forecast	NAtl ACE	NAtl Hurs	US Landfalls	FL Landfalls
Forecast	150	8	2	1
Low	190	5	1	0
High	110	11	3	2
1995-2018 Obs means	132	7.5	1.7	0.6

Table 3. CFAN's current August forecasts and uncertainty ranges and mean index values (bottom row).

Further information about CFAN's forecasts

Further information about CFAN's tropical forecast products – TropiCast – can be found at https://www.cfanclimate.net/products-tropical-cyclones.

Contact Information

Dr. James Johnstone, Senior Scientist
jajstone@gmail.com
Dr. Judith Curry, President
curry.judith@cfanclimate.com
(404) 803-2012

Appendix A: ENSO forecasts from global models

The latest ENSO update from NOAA[1] states that an El Niño is still present, although a transition to neutral conditions is expected in the next month or two. NOAA expects ENSO-neutral conditions to continue through fall and winter.

The IRI/CPC plume of model ENSO predictions from mid-July 2019 is shown in Figure A1. The latest official CPC/IRI outlook (Figure A2) calls for a 60% chance of neutral conditions through the end of 2019.

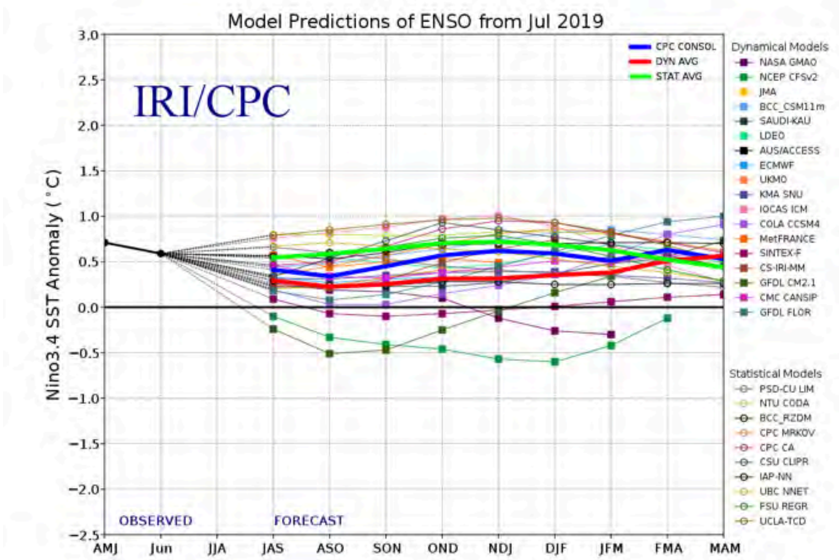


Figure A1. https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/

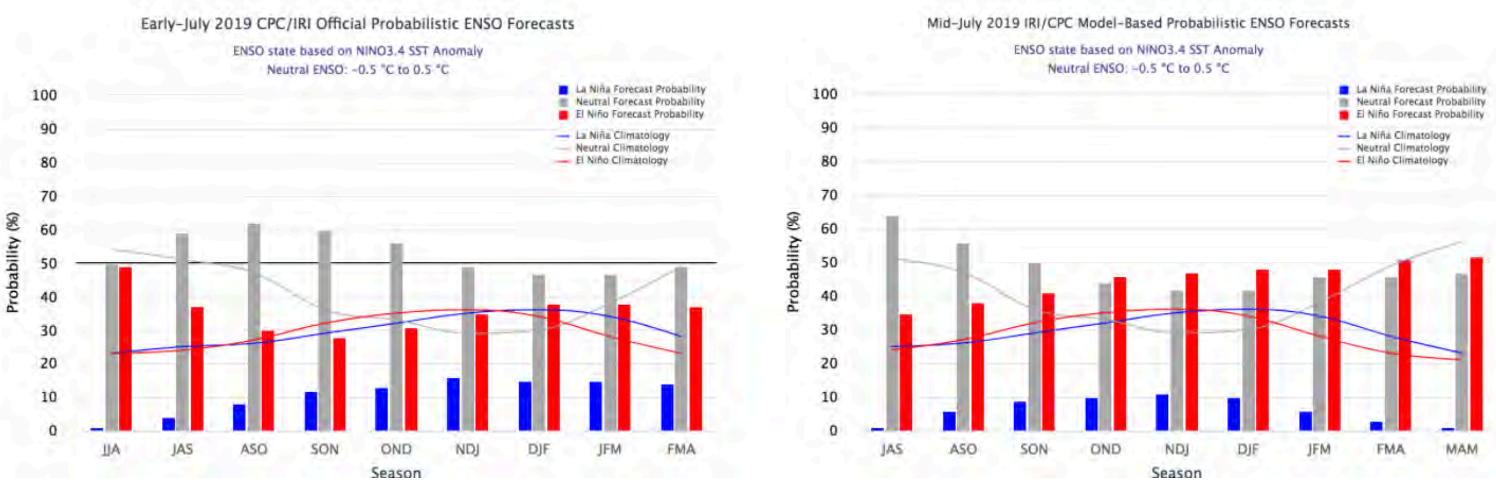
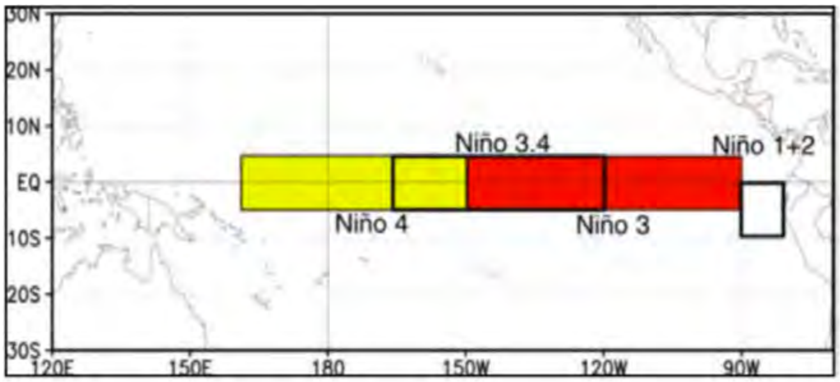
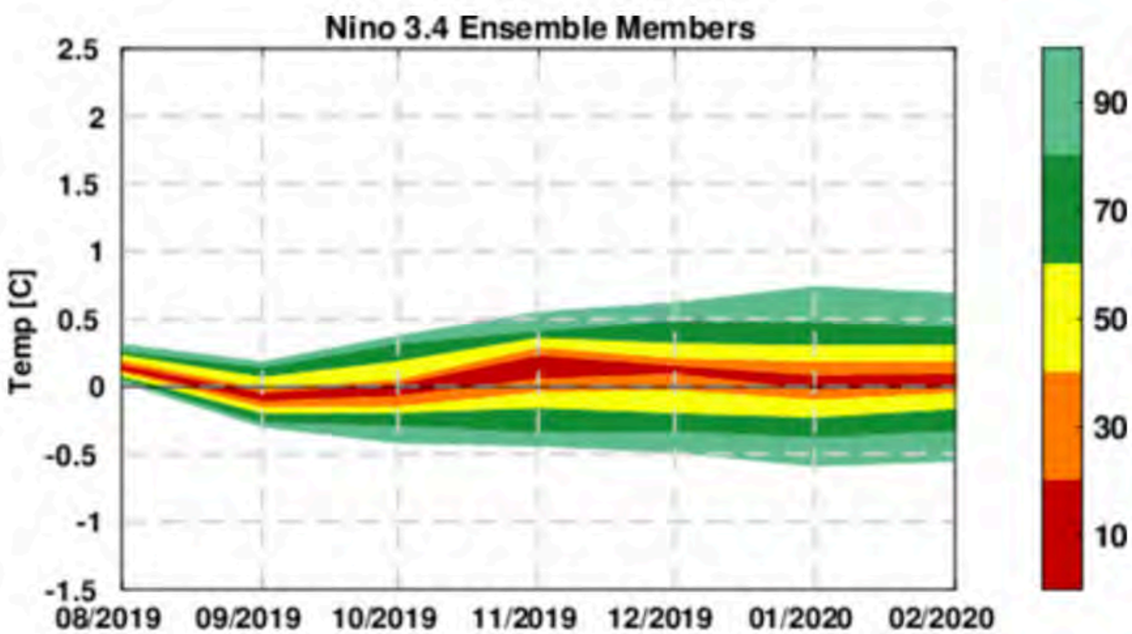


Figure A2. The official CPC/IRI outlook.

[1] https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf

CFAN's ENSO forecast plumes from ECMWF (initialized Aug 1) are shown in Figure A3, for Niño1.2, Niño 3, Niño4, and the Modoki Index. ECMWF shows a peak of Niño 3 in May 2019 and a peak in Niño 1.2 in April, with subsequent declining values. Niño 4 values peak in June, and there is a hint of a return to Modoki (> 0.5) by September.





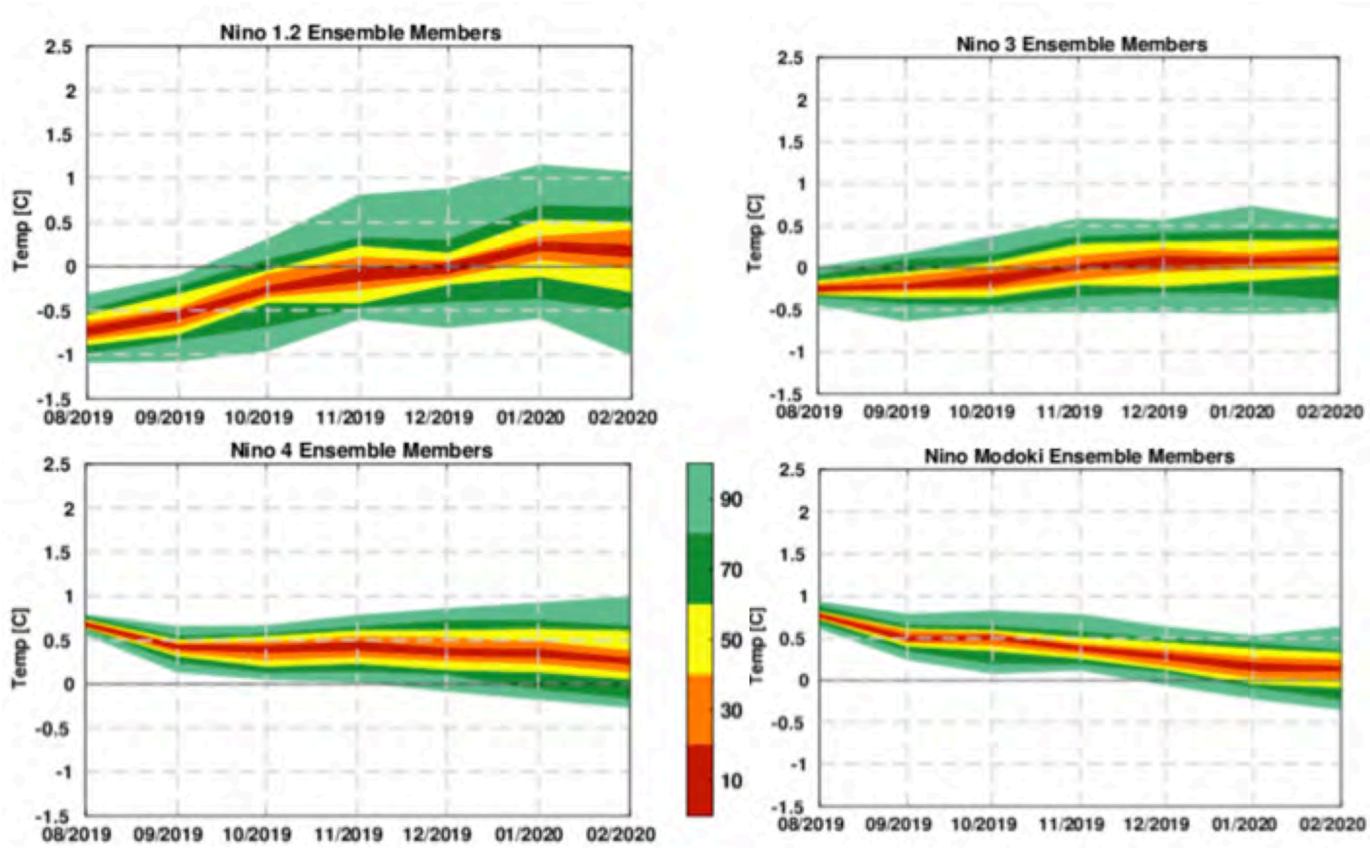


Figure 3: CFAN's analysis of ENSO forecasts from ECMWF SEAS5, initialized 8/1/19.

CFAN's analysis of the ENSO hindcast skill of the ECMWF SEAS5 seasonal forecast model (Figure A4) shows a correlation coefficient of >0.9 forecasts initialized in Aug (month 8, blue line) for the peak period of the hurricane season (Aug – Oct).

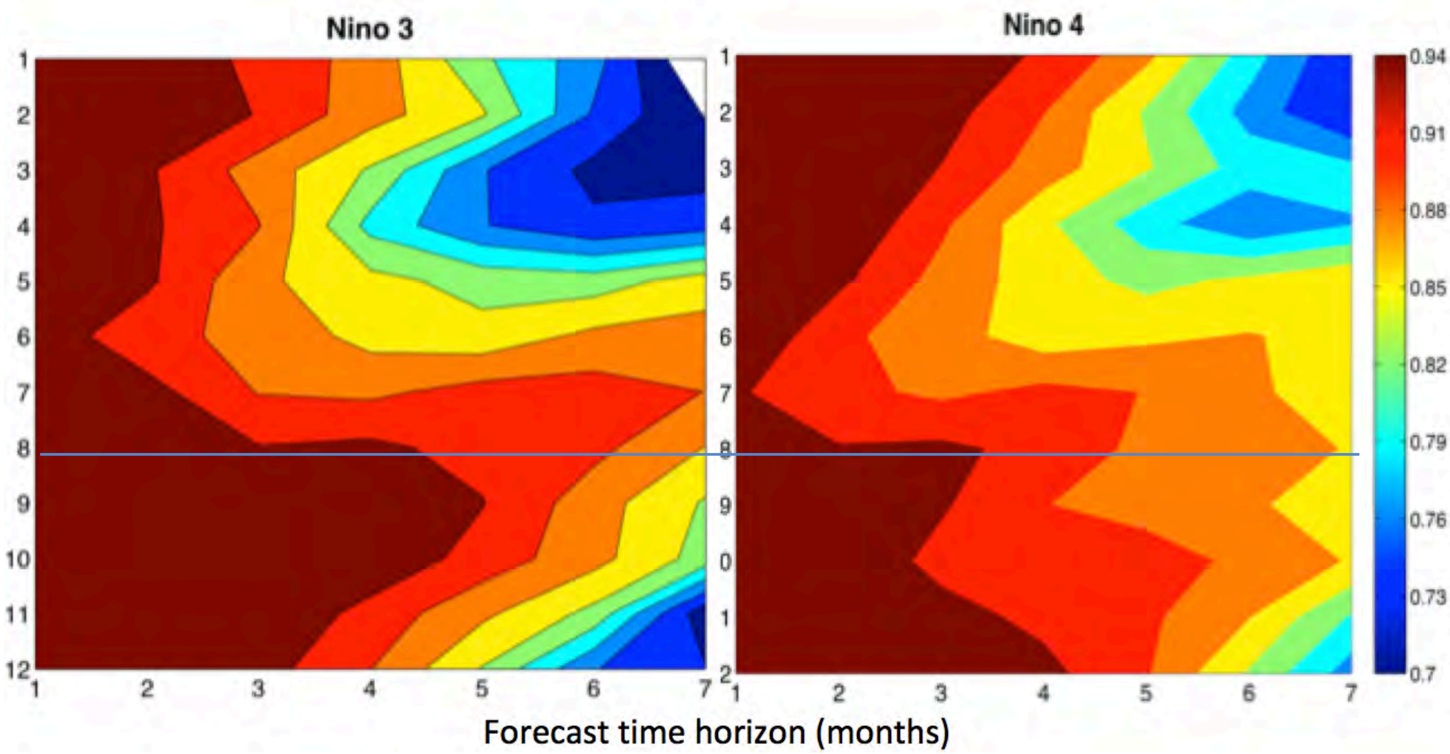


Figure A4: Evaluation of the predictability of the Niño 3 and Niño 4: correlation of observed versus predicted) from ECMWF SEAS5 as a function of initial month and lead-time. From Hirata, Toma and Webster, 2018: Updated quantification of ENSO influence on the U.S. surface climate. https://ams.confex.com/ams/98Annual/webprogram/Paper334884.html

Summary: For the peak period of hurricane activity (Aug-Oct), there is high confidence in the ECMWF ENSO forecast. In early Aug, we are currently under El Niño Modoki conditions, which has been declining and is projected to continue to decline, although Sept/Oct values may be borderline Modoki.

Appendix B: El Niño Modoki

El Niño Modoki is different from the conventional El Niño (‘Modoki is a Japanese word that means ‘similar but different’). Conventional El Niño is characterized by strong anomalous warming in the eastern equatorial Pacific (Figure B1), whereas El Niño Modoki is associated with strong anomalous warming in the central tropical Pacific and cooling in the eastern and western tropical Pacific (Figure B1). Li et al. (2019)[2] note a profound westward shift in atmosphere–ocean variability in the tropical Pacific during 2000–2017 relative to 1979–1999.

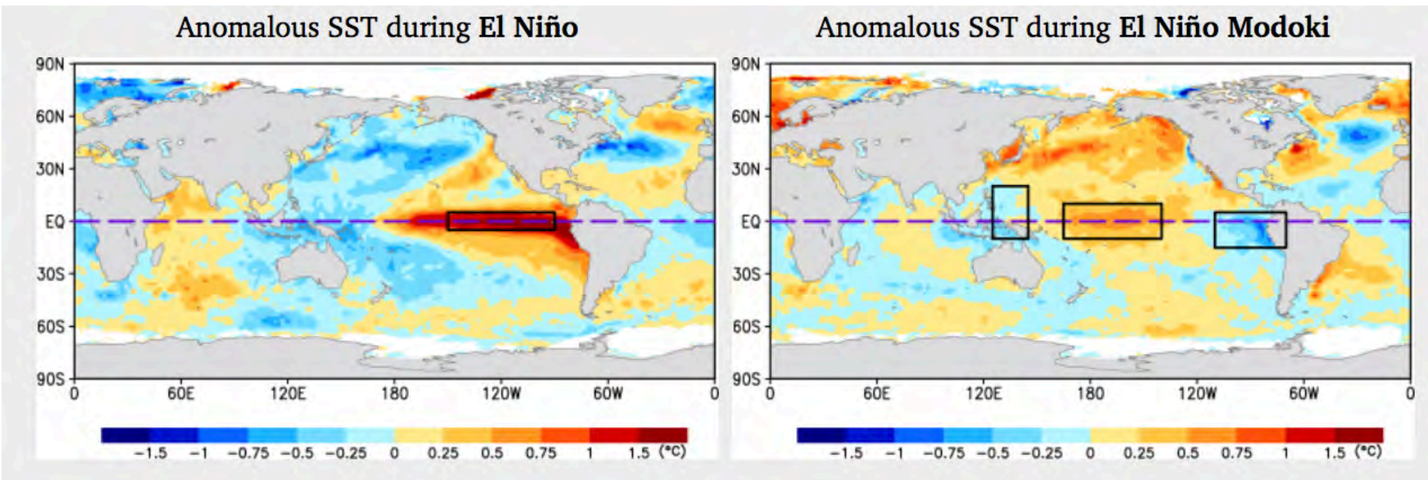


Figure B1: http://www.jamstec.go.jp/frcgc/research/d1/iod/enmodoki_home_s.html.en

Owing to the distinct warming/cooling patterns between conventional El Niño and El Niño Modoki, they are associated with substantially different impacts on weather and climate. Notably, they have very different impacts on tropical cyclones.

Kim, Webster and Curry (2009) analyzed the impacts of El Niño Modoki versus the El Niño Modoki on Atlantic hurricanes. In contrast to conventional El Niño events, El Niño Modoki episodes are associated with a greater-than-average frequency and increasing landfall potential along the Gulf of Mexico and Atlantic coasts. Differences are shown to be associated with the modulation of vertical wind shear in the main development region forced by differential teleconnection patterns emanating from the Pacific. Figure B2 compares the track density In the Atlantic, the impacts of an El Niño Modoki on hurricane activity more closely resemble a La Niña season, with elevated hurricane activity.

[2] https://link.springer.com/article/10.1007/s00382-019-04666-8

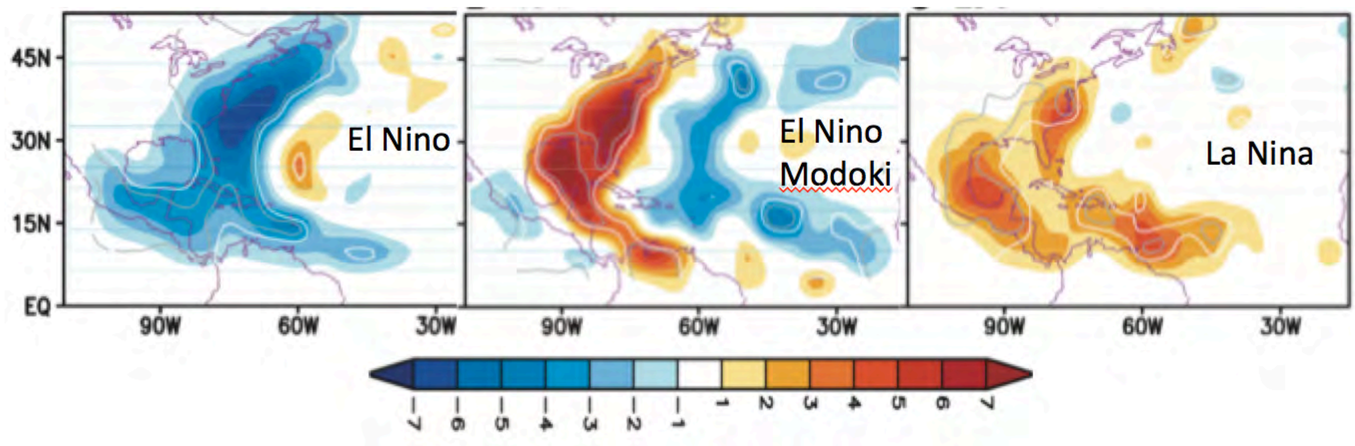


Figure B2 Composites of Atlantic track density anomaly (multiplied by 10) during the August to October period for (A) El Niño, (B) El Niño Modoki, and (C) La Niña. Source: Kim, Webster and Curry (2009)[3]

Kim et al. cite the following years as El Niño Modoki: 1953, 1991-1992, 1994-1995, 2002-2003, and 2004-2005. Since publication of the Kim et al. papers, 2009-2010 has been classified as a Modoki. There are also arguments for classifying the years 2015-2016 and 2017-2018 as Modoki for at least part of the period, although they transitioned to conventional El Niños (sometimes referred to as mixed events). The key issue for tropical cyclones is the state of the atmospheric circulation during the months of peak activity.

[3] http://web-static-aws.seas.harvard.edu/climate/seminars/pdfs/kim.etal.sci.2009.pdf