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Climate Impact Company Research

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Record Negative Quasi-biennial Oscillation Signal Influence of North Atlantic Tropical Cyclone Season and Winter Ahead

Discussion: According to NOAA/CPC the July 2018 quasi-biennial oscillation (QBO) is -29.10 the strongest negative (easterly) value in the 1948-2018 climatology (***Table 1***). The QBO is an alternating east and west wind in the lower stratosphere/upper troposphere over the equatorial region with a reliable period of variability of 28-29 months. In the easterly phase of the QBO deep convection in the tropics associated with the intra-tropical convergence zone (ITCZ), tropical waves and tropical cyclones is reduced due to greater vertical speed shear. Coupled with anomalous cool water this condition is present now and helps to explain why almost no convection has been present in the deep tropics during mid-summer (***Fig. 1***).

	JUL-2018	OCT-2007	OCT-2005	JUL-1994	JUN-2018
-QBO	-29.10	-29.05	-28.76	-28.65	-28.45

Table 1: *The strongest monthly negative (easterly) quasi-biennial index occurring in the 1948-2018 climatology.*

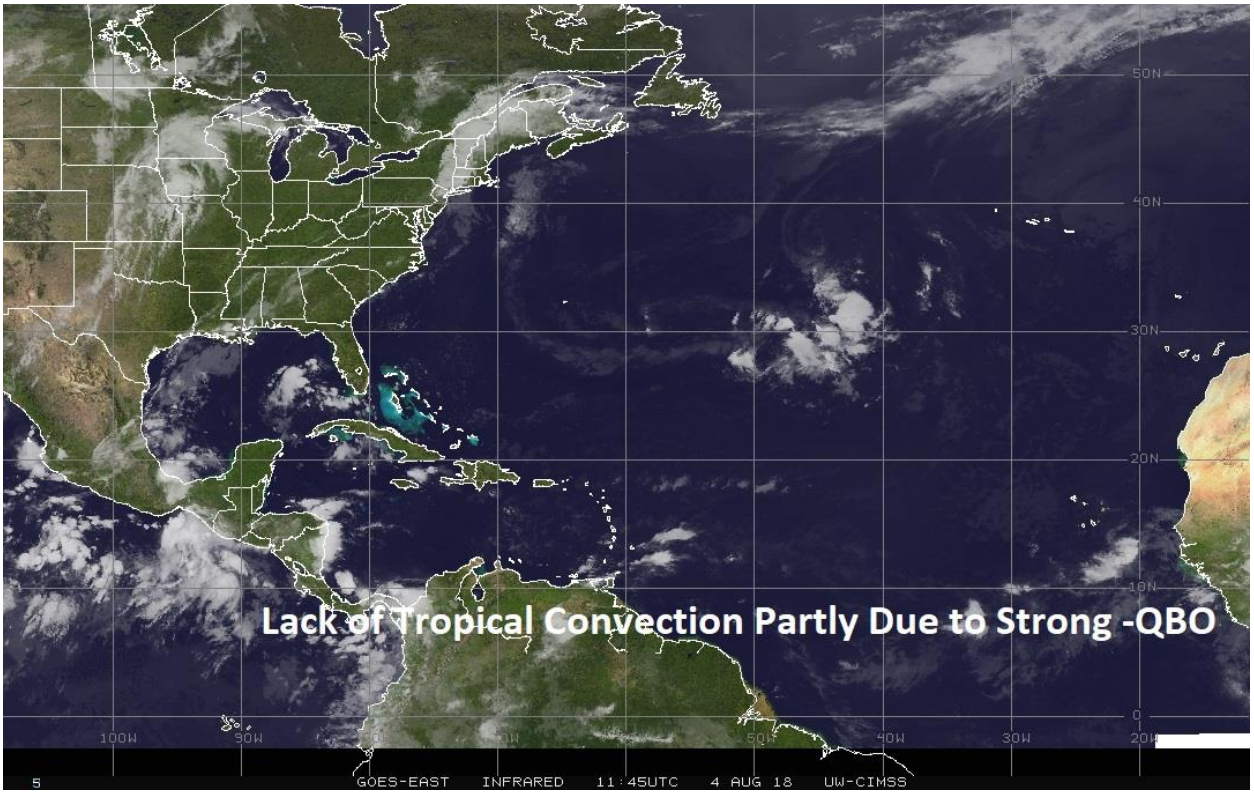

Fig. 1: *Into early August 2018 the tropical North Atlantic basin is unusually clear of any tropical convection.*

QBO gained popularity as a climate predictor of tropical cyclone activity in 1984 by William Gray at Colorado State University (CSU), a renowned seasonal tropical cyclone (TC) season forecaster. However, the QBO became less reliable as a tropical cyclone predictor the past 10+ years and was dropped as a prediction index by CSU. Speculation is the QBO relationship to North Atlantic tropical cyclone activity may have changed during the past 15-20 years due to the warming North Atlantic (warm phase of the Atlantic multi-decadal oscillation) which was in the long-term cool phase in the 1970's/1980's/early 1990's when the initial QBO relationship to seasonal TC activity was proposed (***Fig. 2***).

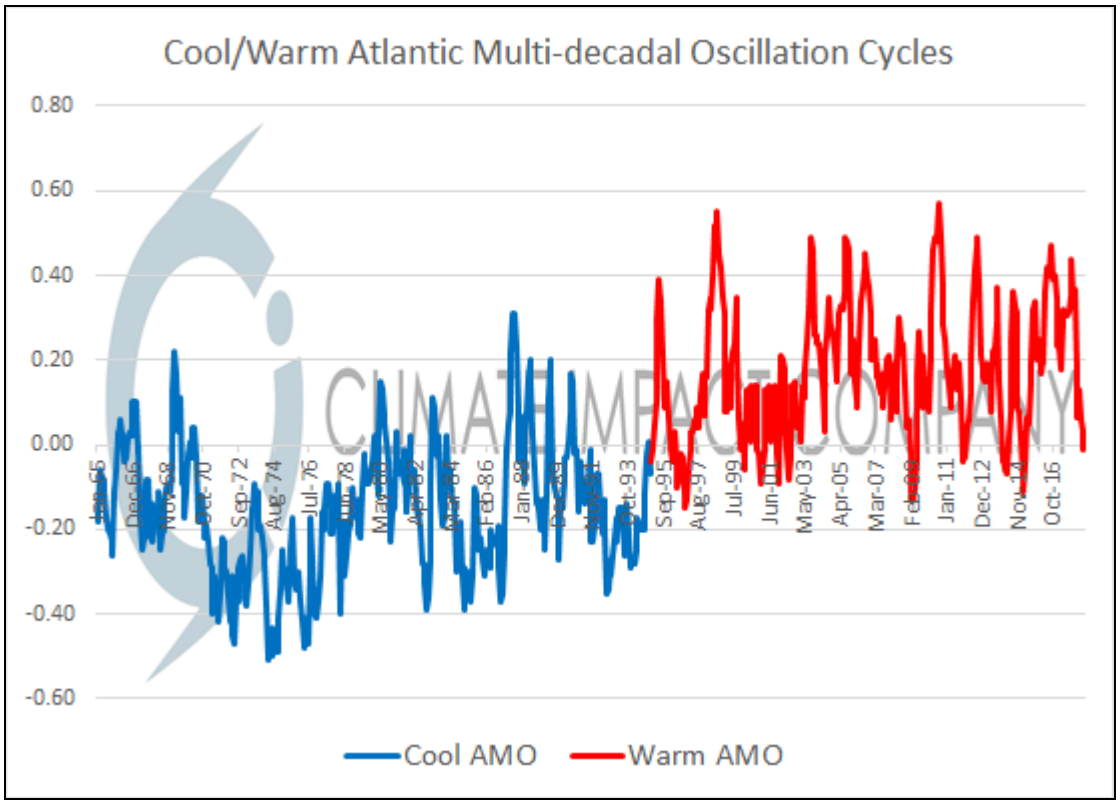

Fig. 2: *The long-term cool (1965-1994) and warm (1995-2018) cycles of the Atlantic multi-decadal oscillation. Will the cooler 2018 signature intensify signaling a phase change?*

For the first time this century the North Atlantic basin has featured a cool sea surface temperature anomaly (SSTA) regime south and southwest of Greenland and in the deep tropics during the onset of the most active part of the tropical cyclone season (***Fig. 3***). There is a real possibility that the long-term warm cycle of the AMO is reversing to the cool phase. The tropical North Atlantic (TNA) index which measures SSTA in the main development region (MDR) for North Atlantic hurricanes in-between the Caribbean and west coast of Northwest Africa is historically cool (***Table 2***). The somewhat reliable relationship between QBO phase and North Atlantic tropical cyclone activity may be returning.

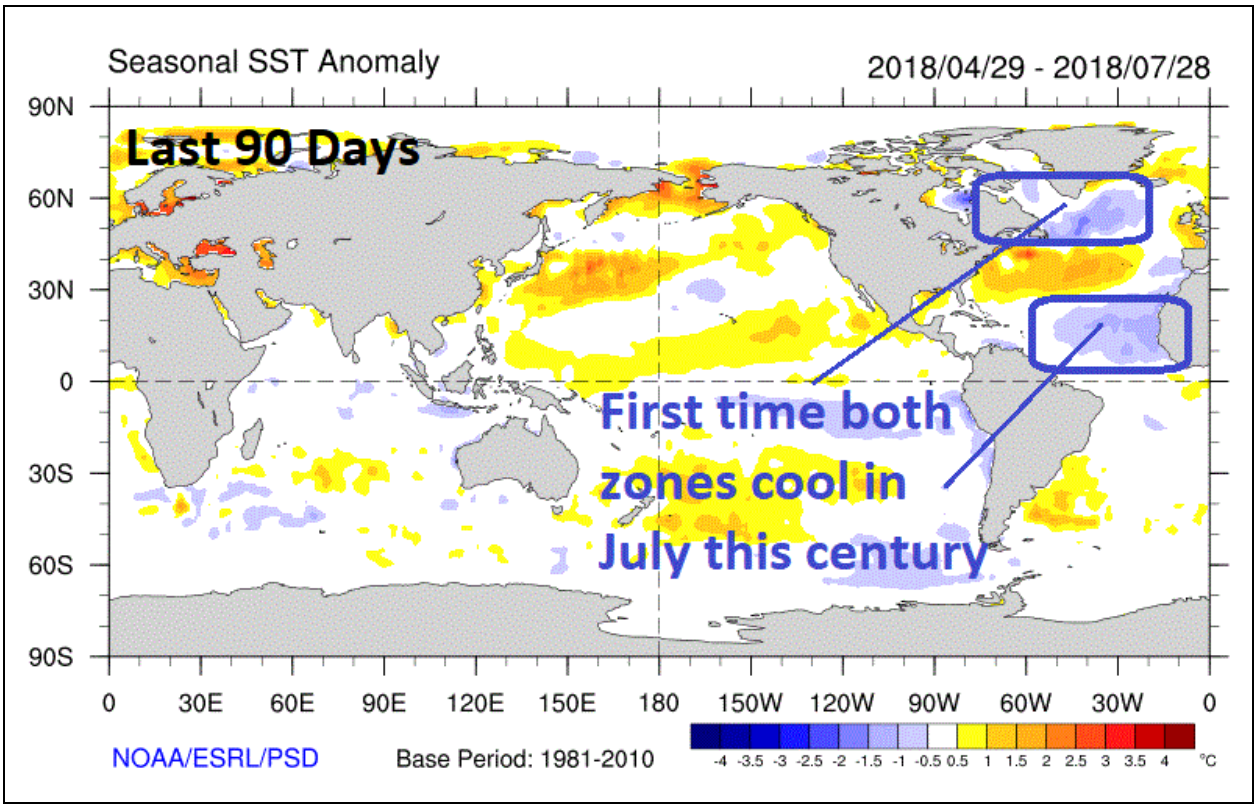

Fig. 3: *The global SSTA analysis for the past 90 days ending July 28, 2018 identifies significant cool zones confined to the North Atlantic basin.*

	JN/JL 2018	JN/JL 1974	JN/JL 1971	JN/JL 1986	JN/JL 1976
-TNA	~-0.70	-0.56	-0.54	-0.49	-0.48

Table 2: *The coolest environment on the ocean surface of the main development region for North Atlantic hurricanes occurring early in the tropical cyclone season in the 1950-2018 climatology is indicated. The 2018 value is estimated as the official July index has not yet been reported by NOAA.*

Since 1950 a strong –QBO in July when the AMO was neutral to cool phase and ENSO was forecast to become El Nino occurred only once in 1994. Strong –QBO with a cool North Atlantic occurred on 4 other occasions (1996, 1984, 1979 and 1968) when ENSO was neutral. The 5 analog years cited have similarities to QBO, ENSO and AMO in mid-2018 (***Table 3***).

Year	QBO	ENSO	AMO
2018 (TC/H/IH)	-29.10	+0.2E	~-0.10
1996 (13/9/6)	-23.93	-0.3N	-1.05
1994 (7/3/0)	**-28.65**	**+0.4E**	**-2.30**
1984 (12/5/1)	-24.39	-0.3L	-2.58
1979 (9/5/2)	-21.27	0.0N	-0.09
1968 (18/12/5)	-21.00	+0.6N	-2.30

Table 3: *Reasonably close past months of July (since 1950) when QBO was strong negative, ENSO was weak and AMO was neutral to cool. The 1994 conditions are projected for 2018. Note that if El Nino fails TC activity can be substantially higher.*

During the 1 year when –QBO occurred with an El Nino evolving as expected in 2018 tropical cyclone activity was reduced to 7 tropical storms, 3 hurricanes and 0 intense hurricanes. Tropical cyclone activity was substantially more active if ENSO was neutral. All of these (5) analog years the North Atlantic was neutral to cool.

During years of strong –QBO regardless of ENSO phase the wind speed shear in the deep tropics is sufficient to suppress tropical cyclone activity. However, in the subtropics the opposite is true. Therefore if ENSO and AMO are favorable for an active tropical cyclone season the deep tropics may be quiet due to –QBO while most activity occurs in the subtropics. The record 2005 season is an excellent example as strong –QBO was present forcing most of the record 28 tropical cyclones that formed that year to flourish in the subtropics (***Fig. 4***).

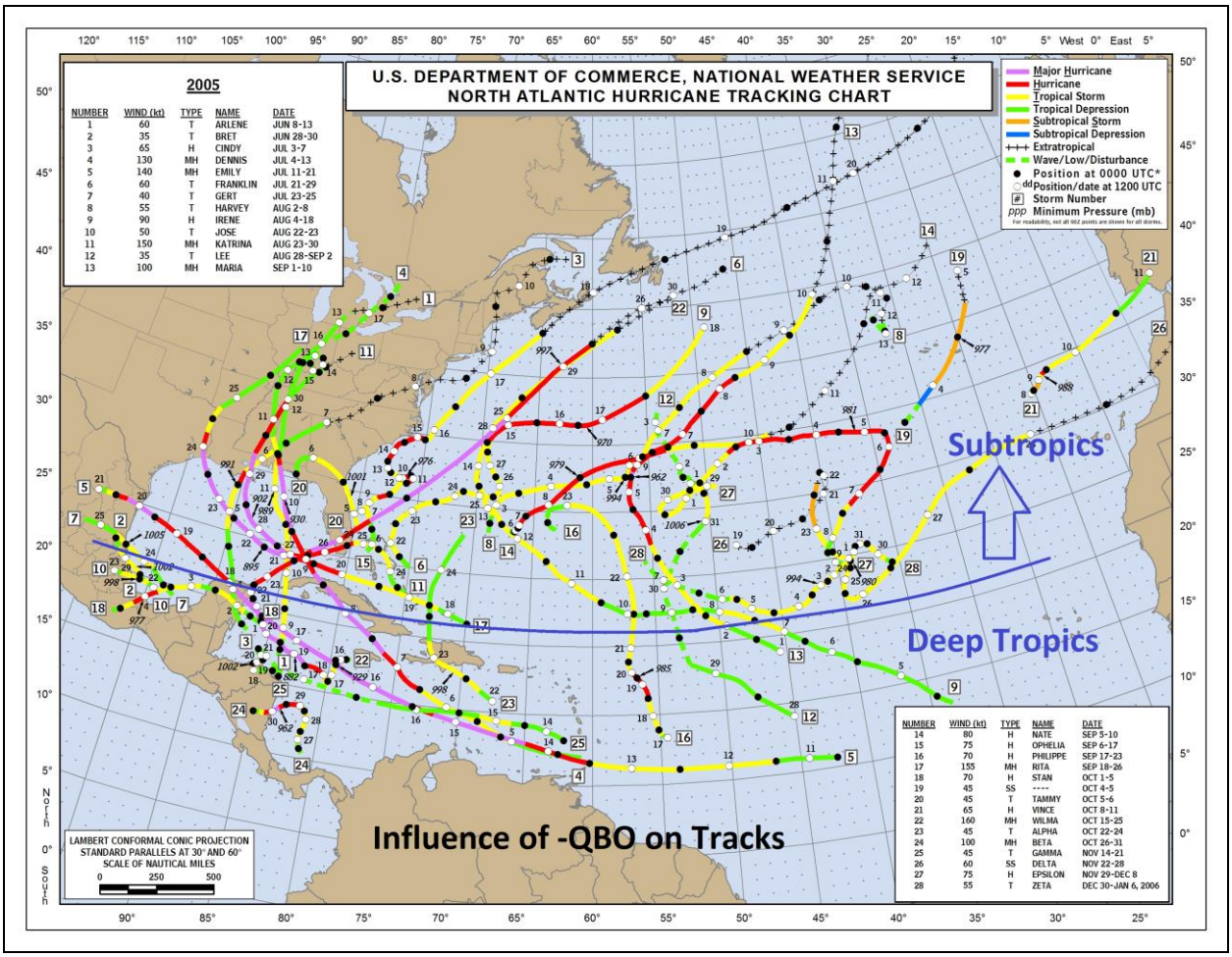

Fig. 4: *The 2005 North Atlantic tropical cyclone season tracks. Note how most activity occurred in the subtropics caused by the upper easterly shear associated with –QBO in the deep tropics.*

A likely scenario in 2018 is reduced seasonal activity due to an approaching El Nino, cool North Atlantic and record –QBO but most of the activity that does occur is in the subtropics (versus the tropics). If El Nino fails to develop the season will be more active but most storms that develop flourish in the subtropics.

There is also a relationship between the QBO and mid-latitude jet streams most resonant during the cold season. When the QBO is in the easterly (negative) phase the mid-latitude jet streams during the cold season are slower and more susceptible to buckling causing stronger storms, increased snowfall and associated cold. High latitude blocking patterns are also more common.

Given the very predictable character of QBO the historic easterly phase present now is likely to continue through northern hemisphere winter and weaken in 2019. The susceptibility to cold/snowy climate in the middle latitudes when a strong –QBO is present outweighs the milder climate pattern currently forecast by most global models for northern hemisphere due to an expected El Nino.

El Nino 2018-19 is forecast by most dynamic/statistical models (***Fig. 5***) but is having difficulty developing due to limited to almost no reaction of the atmosphere to the marginal warming of the equatorial East Pacific (so far). El Nino is not a guarantee. However, the intense –QBO has developed and will remain through winter. Therefore the most reliable predictor of climate for winter 2018-19 may be the historic –QBO versus ENSO. Normally, this would not be the case but the current –QBO regime is so dramatic that its influence (on tropical cyclone season and following winter) cannot be ignored.

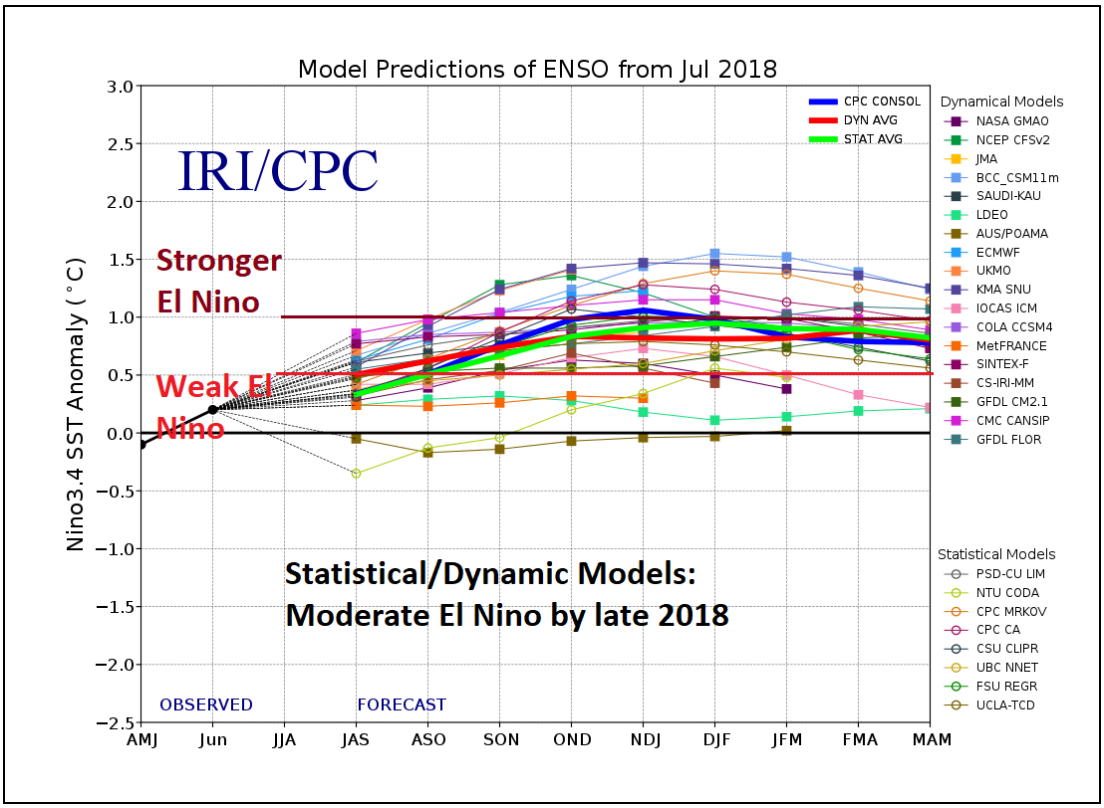

Fig. 5: *A collection of dynamic and statistical ENSO phase forecast models using Nino34 SSTA by the International Research Institute for Climate and Society reveal El Nino is ahead.*

The North Atlantic basin temperature regime is a significant player on this potential cold projection for winter 2018-19 in the middle latitudes of the northern hemisphere. The 5 analog years cited above featured –QBO in years when the North Atlantic was cooler than normal. –QBO occurring when the North Atlantic is warmer than normal produced mild winter seasons. The susceptibility to blocking patterns creating a colder than normal winter climate is easier if the oceans are cooler than normal as they were in the 1965-1995 cool cycle of the AMO (***Fig. 6-7***). Again, as previously indicated the North Atlantic may be heading back into the long-term cool phase of AMO given the extraordinary cooler than normal regime in-place in 2018 south of Greenland and in the deep tropics.

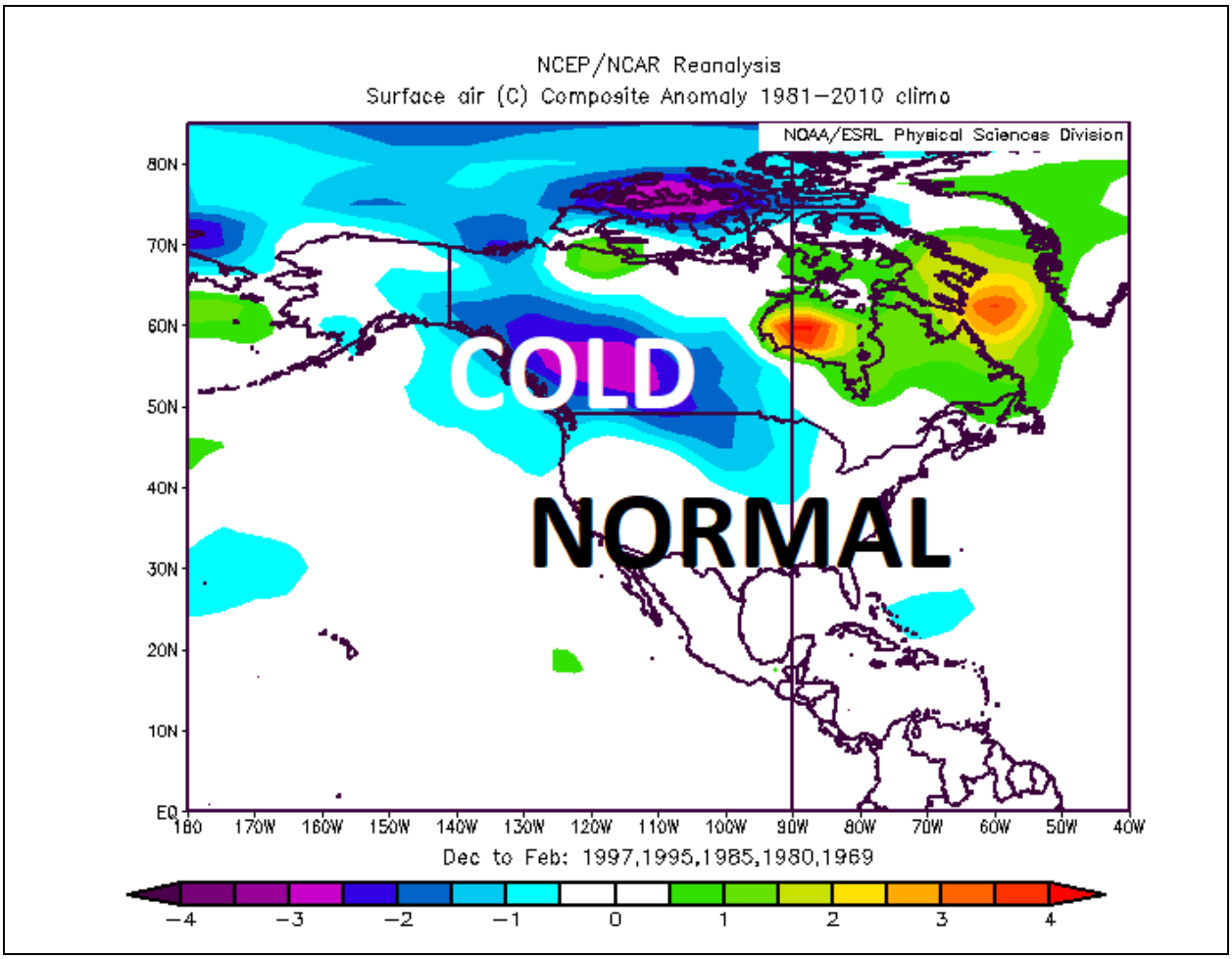

Fig. 6: *The analog years when –QBO was strong during summer and ENSO was neutral and the North Atlantic cool-to-neutral had following winter seasons that were cold in the northern U.S. with near normal temperatures the remainder of the U.S.*

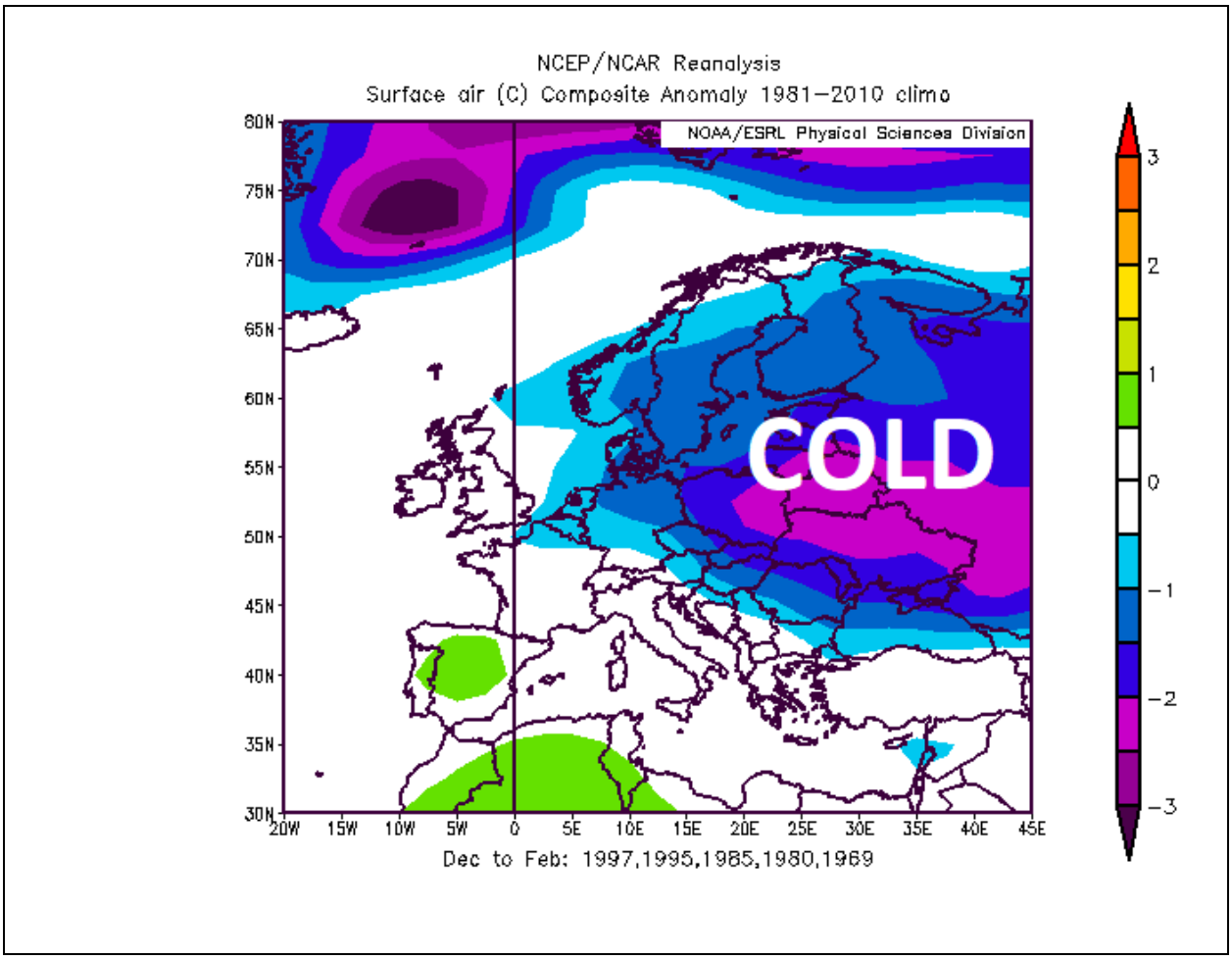

Fig. 7: *The analog years when –QBO was strong during summer and ENSO was neutral and the North Atlantic cool-to-neutral had following winter seasons that were cold across much of Europe.*

Conclusions: We are in the climate change era (as we always have been). Anytime a leading mode of climate variability used to assess and predict climate reaches never-seen-before character recognition of further implications must be attempted. Climate Impact Company encourages all sources of climate forecasts to review these rare events. In June/July 2018 the quasi-biennial oscillation has reached the most negative index (easterly phase) in the 1948-2018 climatology. The relationships of –QBO to global climate is dependent on other aspects of the current climate pattern such as El Nino southern oscillation and sea surface temperature anomalies of various ocean basins. However, evidence supports diminished tropical cyclone activity in the North Atlantic basin during –QBO if the North Atlantic basin is cooler than normal. Additionally, -QBO occurring during winter when

the North Atlantic basin is cooler than normal leads to higher than normal frequency of high latitude blocking patterns leading to anomalous cold and snow in the middle latitudes of the northern hemisphere.

How do these assessments relate to the 2018 North Atlantic tropical cyclone season and the following winter 2018-19?

Global oceans are near record warmth and this has been the case for the past 5-6 years. The North Atlantic has contributed to that warming until 2018 (and at times in 2013-2016). A cool pool of ocean water developing south of Greenland occurred earlier this decade and lasted several years before fading last year. However, this cool pool has returned in 2018 and is vigorous and coupled with strong cooling in the tropics/subtropics of the North Atlantic basin. More recently the subtropics in the South Atlantic basin have cooled dramatically. Is the long-term cycle of the Atlantic multi-decadal oscillation returning?

The cool pattern described is intensifying and given this trend anticipated is a neutral to slightly cooler Atlantic basin average for the remainder of 2018 which is substantially cooler than the late 1990's to middle 2010's climatology.

The cooler North Atlantic basin combined with a historic intense easterly phase of the already in-place QBO increases the likelihood of limited hurricanes in the North Atlantic basin in 2018 with most activity that does occur in the subtropics. The strong –QBO occurring with a cooling North Atlantic basin increases the risk of sneaky cold and snowy climate for the northern hemisphere middle latitudes for winter 2018-19. Only a strong El Nino would negate this colder expectation.

Models are forecasting El Nino ahead but short-term trends are pointing away from El Nino as the atmosphere is struggling to react to the marginal ocean warming in the eastern equatorial Pacific Ocean.

There are many implications for risk managers given the scenario described. However, identifying just 2 is projected as most helpful. They are:

1. The 2018 North Atlantic tropical cyclone season activity is below the long-term average and substantially less than last year. However, several hurricanes are likely. Hurricanes are most likely to form or travel toward warmer than normal SSTA areas which in 2018 is only the Gulf of Mexico and off the U.S. East Coast. Therefore while seasonal activity is below normal there is risk of fast developing significant tropical cyclones very close to the U.S. land mass leaving minimal time for preparations.
2. For now El Nino for winter 2018-19 is forecast and climate models are generally forecasting a warm winter for most of the middle latitudes. Be prepared for a colder/snowier forecast for mid-latitude high population areas such as the eastern U.S., Europe and Western Russia.