2015
North Atlantic Hurricane Season Outlook

RMS REPORT

2015 Season Outlook

The 2014 North Atlantic hurricane season was relatively quiet, with just below the long-term average of 1900–2014 in terms of activity, closing with eight named storms, six hurricanes, and two major hurricanes.[1] It marked the longest period on record—nine consecutive years since Hurricane Wilma in 2005—that no major hurricanes made landfall over the United States, and also the ninth consecutive year that no hurricane made landfall over the coastline of Florida.

Most meteorological forecasts predict that the 2015 season will have similarly low activity rates, with fewer tropical storms, hurricanes, and major hurricanes than the long- and short-term averages (Table 1 and Table 2; see page 2).

Seasonal forecasts are attributing the predicted below-average hurricane activity to a combination of interrelated atmospheric and oceanic conditions, including the anticipated development of a strong El Niño phase of the El Niño-Southern Oscillation (ENSO) in the Pacific Basin. The tropical Pacific is now in the early stages of El Niño and present ENSO conditions favor strengthening of the El Niño phase during the 2015 North Atlantic hurricane season. Below-average sea surface temperatures (SSTs) and above-average sea-level pressure in the Atlantic Basin are also expected to contribute to below-average hurricane activity in the Atlantic Basin this season. Forecast groups also predict a below-average probability of hurricane landfall over the U.S. and Caribbean.

[1]Category 3 or higher on the Saffir-Simpson Hurricane Scale.

Seasonal Forecasts

The North Atlantic hurricane season officially runs from June 1 to November 30. A variety of forecast groups issue seasonal predictions as early as December for the coming year, with the reliability and skill of forecasts improving as the season approaches. Table 1 shows the most recent 2015 seasonal forecasts, including those from the three main forecast groups: Colorado State University (CSU), the National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC), and Tropical Storm Risk (TSR).

Table 1: Summary of the most recent 2015 North Atlantic season forecasts

Forecast Group	Tropical Storms	Hurricanes	Major Hurricanes	ACE Index[2] ($10^4 kt^2$)
CSU[3] (June 2015)	8	3	1	40
NOAA CPC[4] (May 2015)	6–11	3–6	0–2	-
TSR (May 2015)	10	4	1	37
U.K. Met Office[4] (May 2015)	8 (6–10)	5 (3–7)	-	74 (40–108)
Penn State University (May 2015)	7.5 (+/- 2.7)	-	-	-
Accuweather (May 2015)	8	4	1	-
WSI (April 2015)	9	5	1	-

The groups' predicted 2015 season figures are most similar to the 1900–2014 average,[5] which is the lowest of the three long-term seasonal averages (Table 2). Compared to the 2014 season, forecasters are projecting even fewer tropical storms, hurricanes, and major hurricanes in 2015.

Table 2: Summary of the average season activity and 2014 season storm totals

Period	Tropical Storms	Hurricanes	Major Hurricanes	ACE Index[2] ($10^4 kt^2$)
1900–2014 Average[5]	10	5.5	2.2	90.9
1950–2014 Average[5]	11.2	6.2	2.7	103
1995–2014 Average[6]	14.8	7.6	3.6	130.6
2014	8	6	2	66

The accumulated cyclone energy (ACE) values predicted by the forecast groups are significantly below those of all seasonal averages (Table 2). This suggests that we can expect both weaker and shorter-lived storms in the low number of named storms forecast.

Forecast groups are also predicting a below-average probability of a hurricane making landfall over the U.S. and the Caribbean. Despite this and the below-average number of storms expected, complex factors control the development and steering of storms; it only takes one event to cause material losses. As an example, Hurricane Andrew made landfall as a Category 5 storm over Florida in 1992, a strong El Niño year. The lower-than-expected wind shear and steering currents that directed the storm toward Florida made Andrew the fourth most intense landfalling U.S. hurricane recorded,[7] and the fourth costliest U.S. Atlantic hurricane.[8]

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[2]The Accumulated Cyclone Energy (ACE) Index is calculated as the square of the sum of the maximum sustained wind speed (in knots) at 6-hour intervals for the duration of the storm at tropical storm status or greater (sustained wind speeds of 35 knots or higher).

[3]CSU forecast ranges have a 67% probability of occurrence.

[4]Forecast ranges have a 70% probability of occurrence.

[5]The historical database for landfalling hurricanes is generally agreed to be complete since 1900. However, the record of hurricane activity in the Atlantic Basin itself is generally agreed to be complete only from 1950 onward, following increases in aircraft reconnaissance and the onset of satellite technology.

[6]Since 1995, it is widely recognized that the Atlantic Basin has been in a period of elevated activity compared to the long-term historical average of history, driven by a positive phase in the Atlantic Multi-decadal Oscillation (AMO).

[7]National Hurricane Center: Hurricane Research Division (May 28, 2014). "Atlantic hurricane best track (HURDAT version2)" http://www.nhc.noaa.gov/data/hurdat/hurdat2-1851-2013-052714.txt.

[8]Blake, Eric S; Landsea, Christopher W; Gibney, Ethan J; National Climatic Data Center; National Hurricane Center (August 10, 2011). "The deadliest, costliest and most intense United States tropical cyclones from 1851 to 2010" http://www.nhc.noaa.gov/pdf/nws-nhc-6.pdf.

Key Drivers of the Seasonal Forecasts

The 2015 forecasts anticipate a below-average season in the North Atlantic Basin in relation to the 1950–2014[5] and 1995–2014[6] averages. This conclusion is attributed to the following interrelated atmospheric and oceanic conditions:

- Below-average sea surface temperatures (SSTs) observed in the Atlantic Main Development Region[9] during the first half of 2015, when compared to the 1981–2010 average, which are expected to continue throughout the 2015 season
- Above-average sea-level pressure observed in the Atlantic Main Development Region in early 2015, when compared to the 1981–2010 average, which is anticipated to continue throughout the rest of the year
- The expected strengthening of an early stage El Niño phase, which is currently present in the tropical Pacific. The strengthening is expected to occur during the August to October peak period, alongside a low likelihood of neutral or La Niña conditions, which would typically increase hurricane activity in the Atlantic Basin.

Role of the Atmosphere and Ocean in the 2015 North Atlantic Hurricane Season

Sea Surface Temperatures (SSTs)

Warm Atlantic SSTs in combination with low levels of wind shear are essential for hurricane formation and development. SSTs higher than 80°F (26.5°C)[10] are required for hurricane development and for sustained hurricane activity. Since early spring 2015, CSU and TSR have reported significant anomalous cooling across the tropical Atlantic, with the eastern tropical Atlantic exhibiting below-average SSTs.

Forecast groups attribute this anomalous cooling to alterations in the position and intensity of the Atlantic Inter-Tropical Convergence Zone (ITCZ), which brings about changes in tropical vertical and horizontal wind shear patterns and changes in tropical Atlantic SST patterns. Below-average SSTs in the Atlantic are commonly associated with decreased activity during the Atlantic hurricane season through increased vertical wind shear, decreased vertical instability, and decreased mid-tropospheric moisture.

Many sea surface temperature–forecasting groups[11] predict a continuation of below-average SSTs in the tropical Atlantic throughout the season. If this occurs, it will likely act to reduce sufficient energy to fuel storm development and intensification. There is, however, uncertainty associated with predicting SSTs at this lead time.

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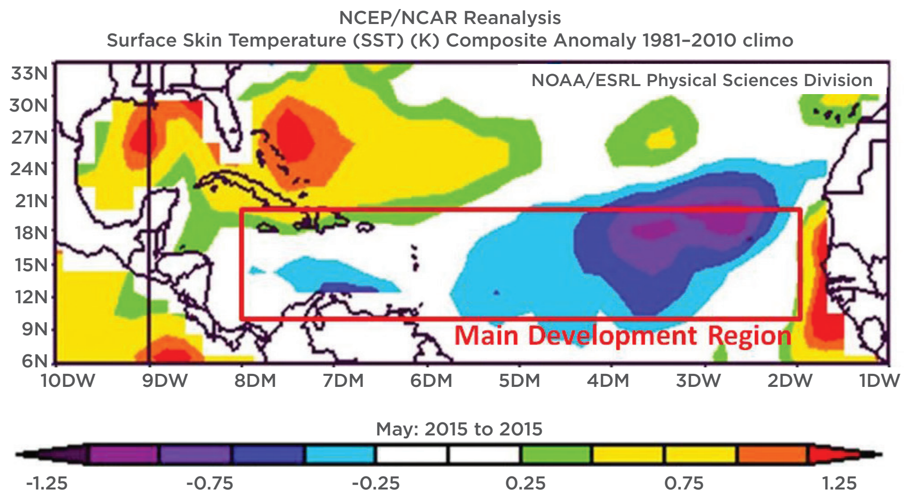
[9] The Main Development Region spans the tropical Atlantic Ocean and the Caribbean Sea between 10–20°N, 20–80°W.

[10] As indicated by NOAA Hurricane Research Division http://www.aoml.noaa.gov/hrd/tcfaq/A15.html.

[11] Groups include the National Center for Environmental Prediction Coupled Forecast System (NCEP CFS), the European Center for Medium-Range Weather Forecasts (ECMWF), and the International Research Institute for Climate and Society (IRI).

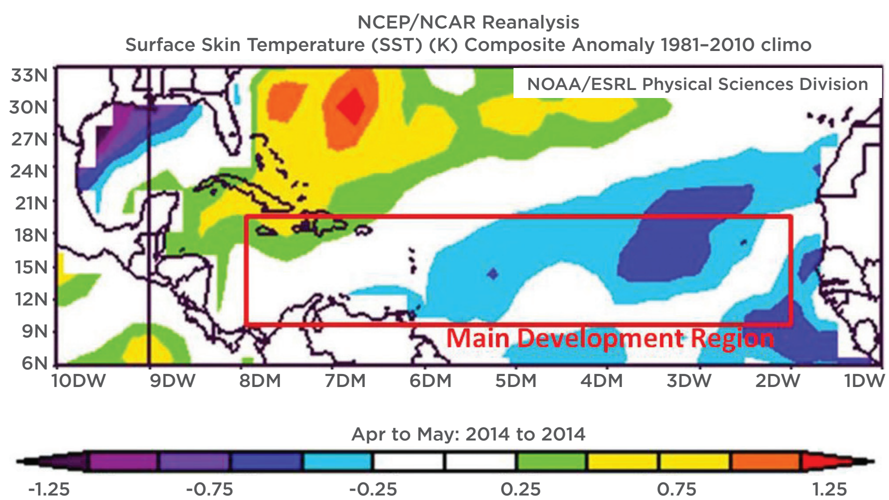
Figure 1 shows the SST anomalies (°C) for May 2015, highlighting regions where SSTs deviate from the 1981–2010 climatological average. The figure illustrates that SSTs measured over the eastern portion of the Main Development Region were around 0.25°C below average, with temperatures in the far eastern Main Development Region reaching around 1.00°C below average. Conversely, SSTs along the U.S. Atlantic Coast are above the climatological average, with SST anomalies reaching between 0.25°C and 1.25°C along the coast.

Figure 1: May 2015 SST anomalies (°C) in the tropical Atlantic[12]



For comparison, Figure 2 shows SSTs from April to May for the 2014 North Atlantic Hurricane season. SSTs measured over the entire Main Development Region were around 0.25°C below average and temperatures in the far eastern Main Development Region were around 0.5°C below average, which suppressed tropical cyclone development. Even though temperatures along the U.S. Atlantic Coast fell slightly above the climatological average, reaching 0.25°C along the coast, the negative anomalies in the Main Development Region had a greater effect on SSTs across the region, contributing to the below-average tropical cyclone activity in 2014.

Figure 2: April to May 2014 SST anomalies (°C) in the tropical Atlantic[12]



[12] Image from the NOAA/ESRL Physical Sciences Division, Boulder, Colorado http://www.esrl.noaa.gov/psd/. Data from Kalnay et al., (2006).

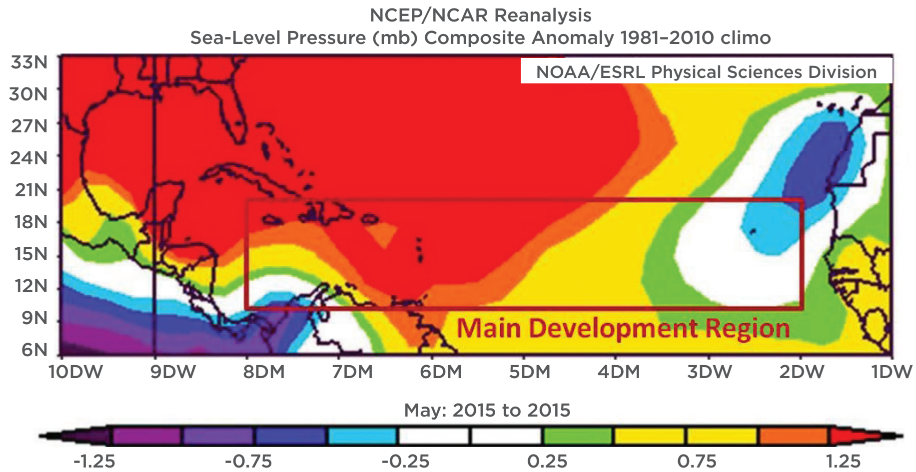
Sea-Level Pressure

Forecast groups are anticipating that high sea-level pressure will suppress tropical cyclone formation in the North Atlantic Basin and will contribute to a below-average season in 2015.

High sea-level pressure in the sub-tropical Atlantic (also known as the Azores High) strongly correlates with increased Atlantic trade winds, which enhances upwelling and ocean mixing, driving cooler SSTs throughout the basin. High sea-level pressure, low SSTs, and trade winds are factors that can have a suppressing effect on tropical cyclones. The converse is also true with lower sea-level pressure, which acts to enhance cyclonic activity due to increased instability and increased low-level moisture.

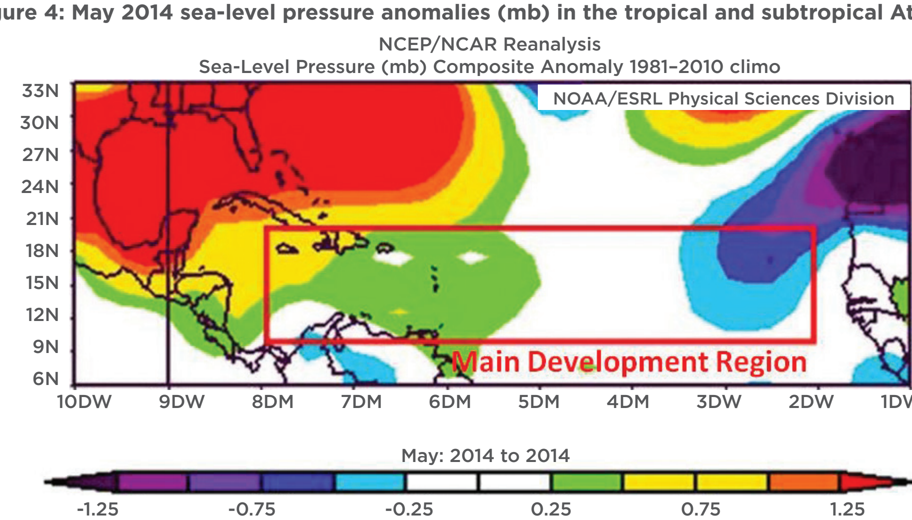
Figure 3 shows the sea-level pressure anomalies (mb) for May 2015, highlighting regions where sea-level pressure deviates from the 1981–2010 climatological average. The figure illustrates that sea-level pressure measured over the majority of the Main Development Region was 0.50mb to 1.25mb above average; with sea-level pressure along the U.S. Atlantic Coast measuring as high as 1.25mb above the climatological average.

Figure 3: May 2015 sea-level pressure anomalies (mb) in the tropical and subtropical Atlantic[12]



For comparison, the 2014 hurricane season experienced below-average sea-level pressure in the tropics and above-average sea-level pressure anomalies in much of the western Main Development Region (Figure 4). Although below-average sea-level pressure was observed in the tropics, this did not increase hurricane activity in the North Atlantic basin. The increased sea-level pressure in the western Main Development Region had a greater impact, reducing tropical cyclone activity and contributing to the below-average season in 2014.

Figure 4: May 2014 sea-level pressure anomalies (mb) in the tropical and subtropical Atlantic[12]



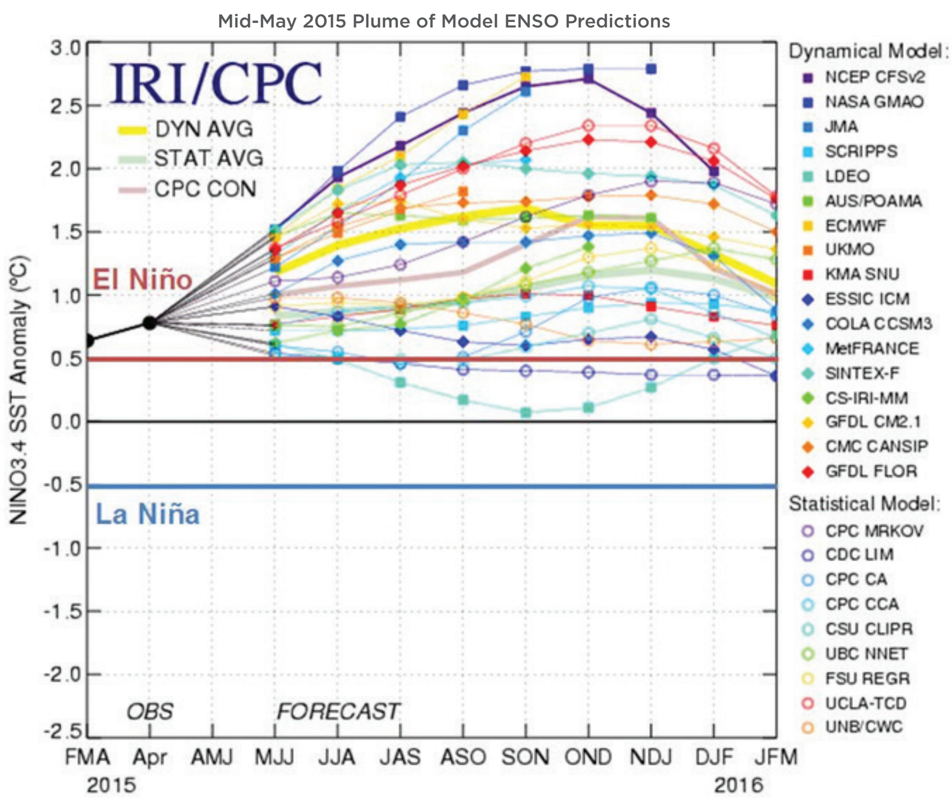
The El Niño-Southern Oscillation (ENSO) and Atlantic Wind Shear

The El Niño-Southern Oscillation (ENSO) is a climate fluctuation over the tropical Pacific Ocean that transitions from a warm phase (El Niño) to a cold phase (La Niña) over a 3–7 year cycle. ENSO can cause large inter-annual fluctuations in Atlantic hurricane activity through its impacts on upper-level atmospheric circulation and vertical wind shear in the Atlantic Main Development Region.[13] El Niño episodes are associated with strong vertical wind shear across the tropical Atlantic, creating conditions that inhibit hurricane activity by spreading the latent heat needed for hurricane development. The reverse is true for La Niña.

The Niño3.4 index, which indicates the departure in monthly SSTs from the long-term mean averaged over the Niño3.4 region (5–5°S, 170–120°W), is commonly used to define an El Niño or La Niña event. ENSO-neutral conditions persisted from October 2012 through to late 2014. The tropical Pacific is now in the early stages of El Niño and present ENSO conditions favor the further development and strengthening of the El Niño phase during the 2015 North Atlantic hurricane season.

Figure 5 illustrates the mid-May ENSO forecasts from various dynamical and statistical models of the likely progression of the Niño3.4 SST anomaly throughout the Atlantic hurricane season, provided by the International Research Institute for Climate and Society (IRI). The majority of models are calling for the strengthening of the present weak El Niño phase through the hurricane season, peaking around October and November. However, one dynamical model and one statistical model in each call for weakening of the El Niño phase and formation of ENSO-neutral conditions during the 2015 season. In 2014, models favored the development of a weak El Niño phase, though neutral ENSO conditions developed and persisted throughout the season.

Figure 5: Mid-May 2015 ENSO model forecasts of three-month SST anomalies in the Niño3.4 region based on the 1971–2000 climatology base period[14]



[13]Gray, W.M., 1984: "Atlantic seasonal hurricane frequency. Part I: El Niño and the 30 mb quasi-biennial oscillation influences." Monthly Weather Review, 112,1649-1668.

[14]Image provided by the International Research Institute for Climate and Society (IRI) http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/.

The May IRI probabilistic ENSO forecasts for the Niño3.4 region, shown in Table 3, strongly indicate El Nino conditions will likely persist through the season. The May forecast for August-September-October, which represents the climatological peak of the hurricane season, indicates an 88% probability of El Niño, an 11% probability of ENSO-neutral conditions, and a 1% probability of La Niña.

Table 3: The IRI probabilistic ENSO forecast for the Niño3.4 region, released in May 2015[15]

Season	La Niña	Neutral	El Niño
May-June-July 2015	~0%	3%	97%
June-July-August 2015	~0%	7%	93%
July-August-September 2015	~0%	10%	90%
August-September-October 2015	1%	11%	88%
September-October-November 2015	1%	12%	87%
October-November-December 2015	2%	16%	82%
November-December-January 2016	2%	16%	82%
December-January-February 2016	2%	19%	79%
January-February-March 2016	2%	23%	75%

The 2015 forecasts of strengthened El Niño conditions indicate that enhanced vertical wind shear, which acts to inhibit hurricane activity, is likely to play a major role in suppressing hurricane activity in the Atlantic Basin. However, if El Niño conditions weaken and ENSO-neutral conditions form, a reduction in vertical wind shear over the tropical Atlantic may increase the potential for elevated hurricane activity in the Atlantic Basin.

[15]Data provided by the IRI http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/.

Understanding the Skill Level of Seasonal Forecasts

Seasonal Forecast Implications

Many uncertainties are associated with seasonal forecasts, which are based on the status of a variety of atmospheric and oceanic factors that are challenging to quantify and predict. For example, the success of seasonal hurricane forecasts depends on the successful prediction of relevant climatological factors such as ENSO and the relationship between such factors and hurricane activity. For this reason, RMS recommends treating seasonal hurricane activity forecasts with a level of caution.

Seasonal forecast skill for predicting the number of North Atlantic hurricanes is relatively low in the months prior to the season's start, although the 2014 seasonal forecasts released in May and June estimated with some accuracy the number of tropical storms, hurricanes, and major hurricanes that occurred in the season. For example, the June 2014 Colorado State University (CSU) forecast predicted 10 tropical storms, 4 hurricanes, and 1 major hurricane, when in fact the season ended with 8 tropical storms, 6 hurricanes, and 2 major hurricanes. As the hurricane season progresses, statistical and dynamical models incorporate more information about the ocean's observed subsurface thermal structure. For example, the IRI ENSO model forecasts (Figure 5) are updated monthly, while the IRI probabilistic ENSO forecasts (Table 3) are updated biweekly. These updated forecasts generally increase the accuracy and predictive skill of subsequent forecasts.

Landfalling Hurricanes

Forecast groups, including Colorado State University (CSU) and Tropical Storm Risk (TSR), predict a below-average probability of hurricane landfall over the U.S. and Caribbean in 2015, in comparison to the long-term mean annual probability of hurricane landfall over the last century. The June CSU forecast[16] gives a 28% probability of one or more major hurricanes making landfall along the entire U.S. coastline, well below the 52% average over the last century. The CSU forecast gives a 22% probability of one or more major hurricanes making landfall along the Caribbean coastline, compared to the average for the last century of 42%.

There is greater uncertainty associated with forecasting hurricane landfalls than forecasting hurricane development in the Atlantic Basin; landfall forecasts are difficult to predict more than a few weeks in advance. This is due to the forecast uncertainty of steering currents (or steering winds) that influence storm direction. Steering currents are synoptic-scale systems (large-scale weather systems) that vary on intra-seasonal timescales, making them difficult to predict far in advance. Steering-current patterns observed during the 2011 and 2012 Atlantic hurricane seasons played a role in keeping storms away from the U.S., while in 2004 and to a lesser extent in 2005, steering currents were influential in directing a number of storms toward the United States.

[16] The CSU landfall probability is calculated based on the overall Atlantic Basin Net Tropical Cyclone Activity (NTC).

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