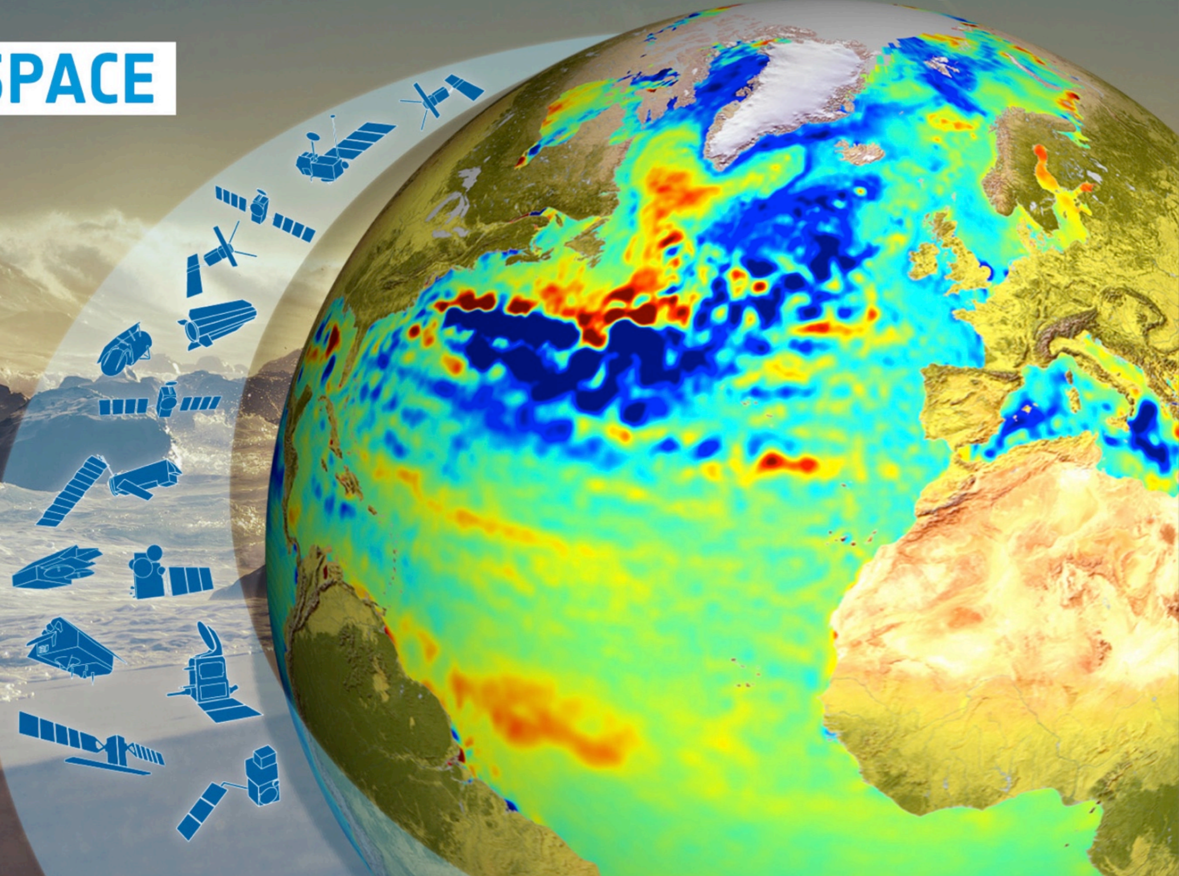
→ ATLANTIC FROM SPACE WORKSHOP

23–25 January 2019
National Oceanography Centre
Southampton, UK

The Atlantic Ocean And Factors Relating to Cyclogenesis



Dr. Liudmila Vanina-Dart

"Seeing Ear" Ltd, UK

Abstract

The Atlantic Ocean (AO)has a unique feature. In the different hemispheres, it has completely different results of cyclogenesis. For example, in the Northern Hemisphere we observe hurricanes of varying severity, often leading to significant destruction. But in the Southern Hemisphere these hurricanes are practically absent. As we know, in the AO specific water circulation influences the temperature background of surface waters. Temperature is one of the most important characteristics of cyclogenesis formation. However, we observe the absence of tropical cyclones when the ocean surface is warm enough for hurricanes creation . Apparently there is clearly the presence of another possible factor - salinity. Salinity is the main component of another parameter – density of water. Water circulation is dependant on water density. The author used the data of the Aquarius/SAC-D mission, launched on June 10, 2011. The mission was a joint venture between NASA and the Argentinean Space Agency (CONAE). The mission featured the sea surface salinity sensor Aquarius and was the first mission with the primary goal of measuring sea surface salinity (SSS) from space. Using these data we can understand why in different hemispheres with huge salinity in both hemispheres we observe the different result in hurricanes formation.

6 factors

The formation of tropical cyclones is the topic of extensive ongoing research and is still not fully understood. While 6 factors appear to be generally necessary, TCs may occasionally form without meeting all of the following conditions. TCs will not form spontaneously.

https://en.wikipedia.org/wiki/Tropical_cyclone

1.***Tw***(water temperature) **> 26.5 °C** (79.7 °F) are needed down to a depth of at least 50 m (160 ft);

2.Another factor is **rapid cooling** with height, which allows the release of the heat of condensation that powers a tropical cyclone.

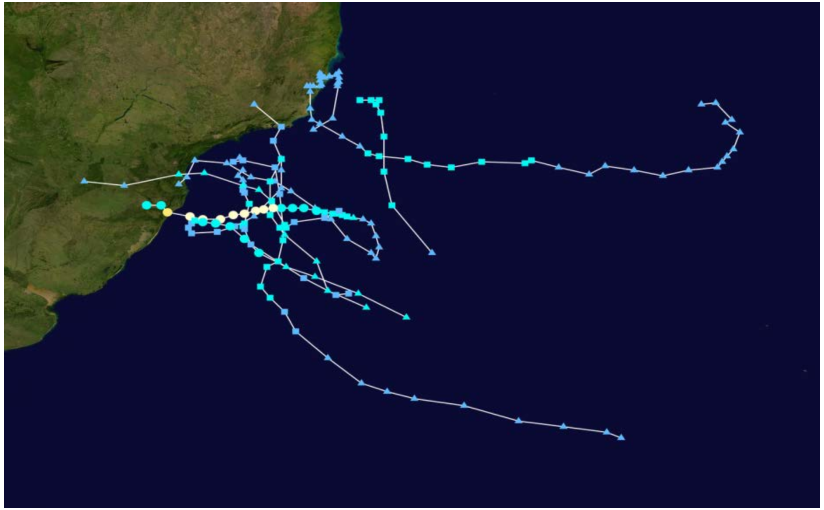
3.**High humidity** is needed, especially in the lower-to-mid troposphere; when there is a great deal of moisture in the atmosphere, conditions are more favorable for disturbances to develop.

4.**Low amounts of wind shear** are needed, as high shear is disruptive to the storm's circulation.

5.Tropical cyclones generally need to form **more than 555 km** (345 mi) or five degrees of latitude away from the equator, allowing the Coriolis effect to deflect winds blowing towards the low pressure center and creating a circulation.

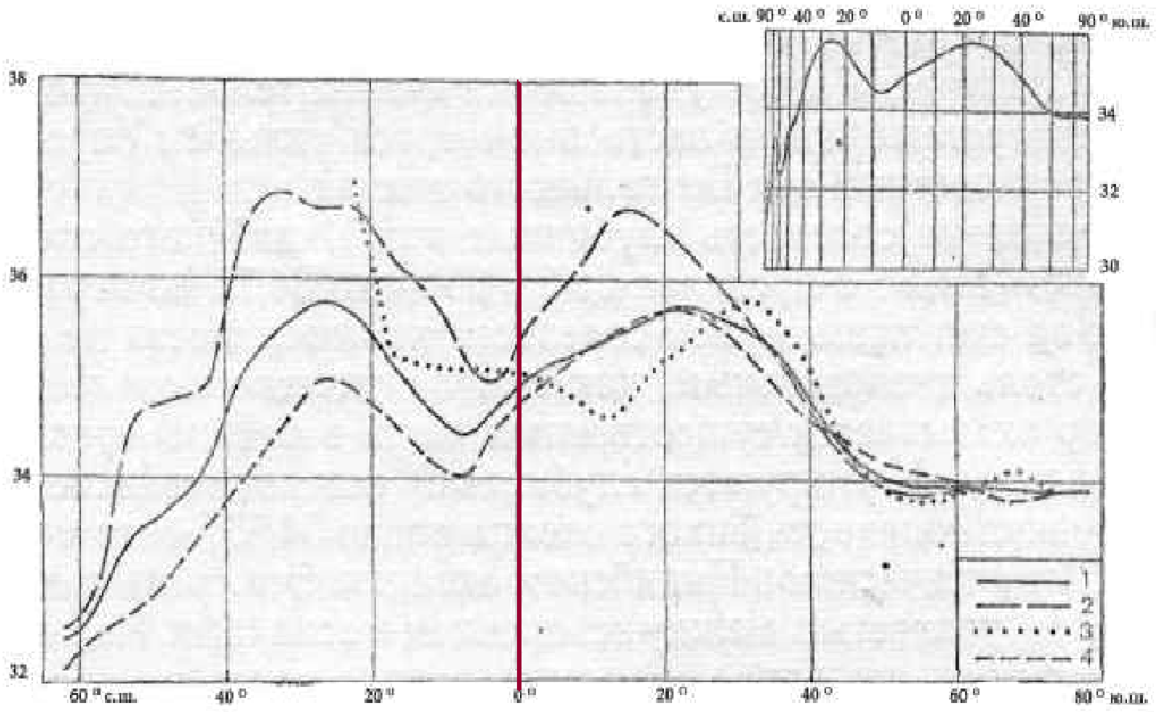
6.Lastly, a formative tropical cyclone needs **a preexisting system of disturbed weather.** Low-latitude and low-level westerly wind bursts associated with the Madden-Julian oscillation can create favorable conditions for Tropical cyclogenesis by initiating tropical disturbances.

Until April 1991, it was thought that TCs did not develop within the South Atlantic. Very strong **vertical wind shear** in the troposphere is considered a deterrent. The Intertropical Convergence Zone drops one to two degrees south of the equator, **not far enough from the equator** for the Coriolis force to aid development. **Water temperatures** in the tropics of the southern Atlantic **are cooler** than those in the tropical north Atlantic. (en.wikipedia.org)



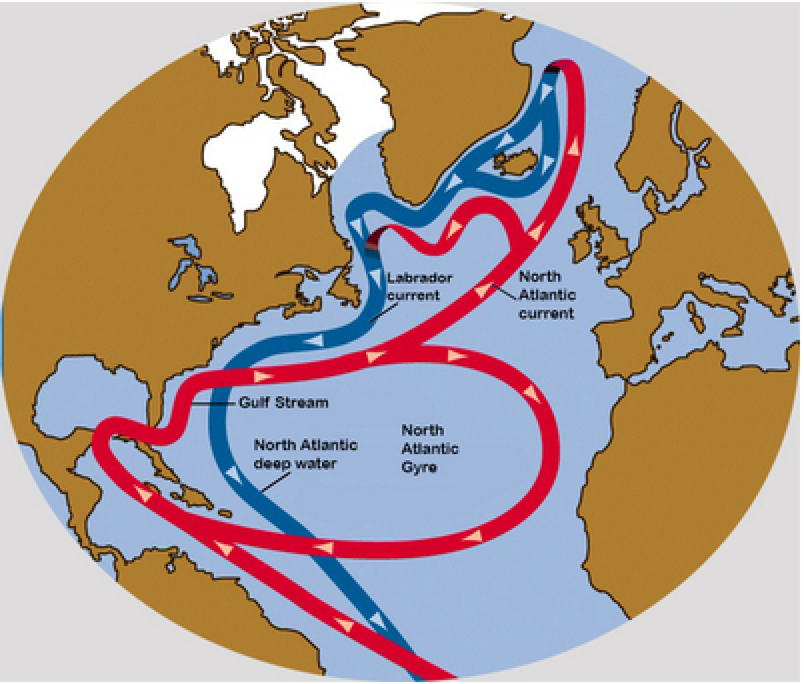
A study was subsequently performed and published during 2012, which concluded that there had been 63 subtropical cyclones in the Southern Atlantic between 1957 and 2007.

In 2011, the Brazilian Navy Hydrographic Center started to assign names to tropical and subtropical cyclones that develop within its area of responsibility, to the west of 20°W, when they have sustained wind speeds of at least 65 km/h (40 mph).



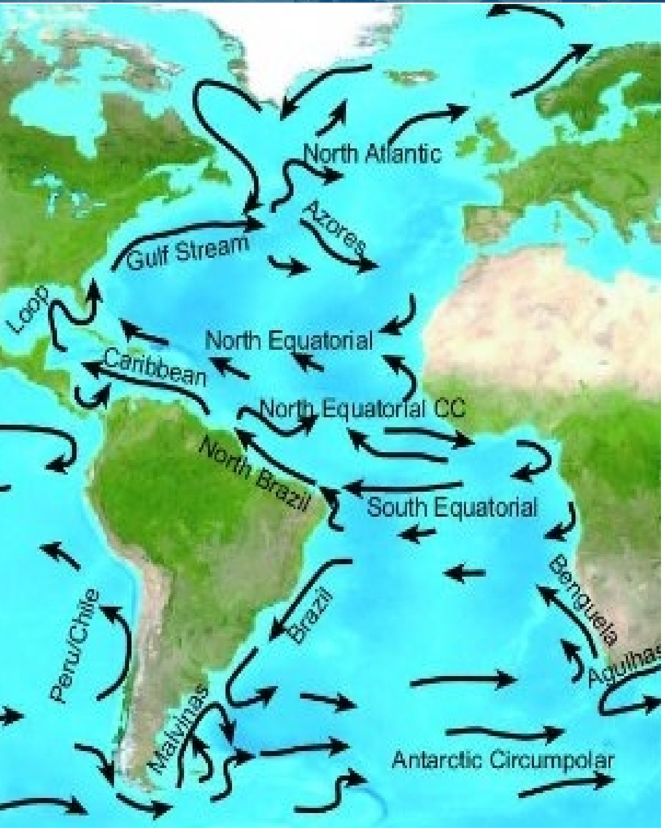
European Space Agency

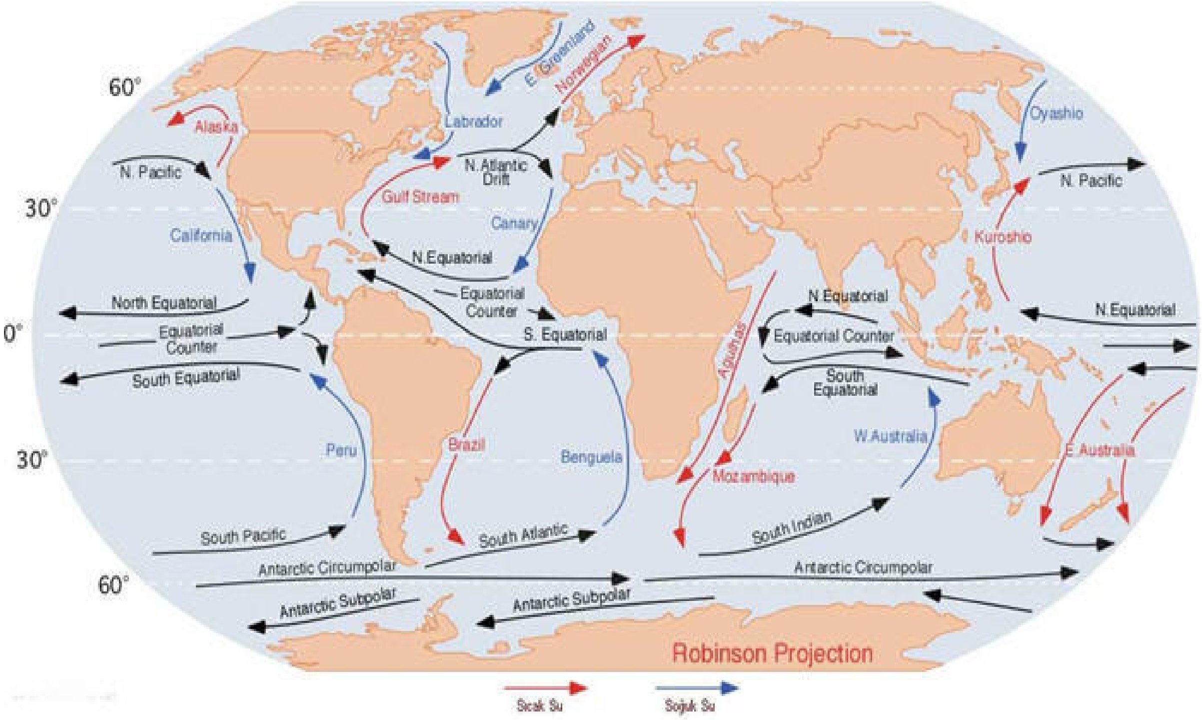
North Atlantic Ocean currents



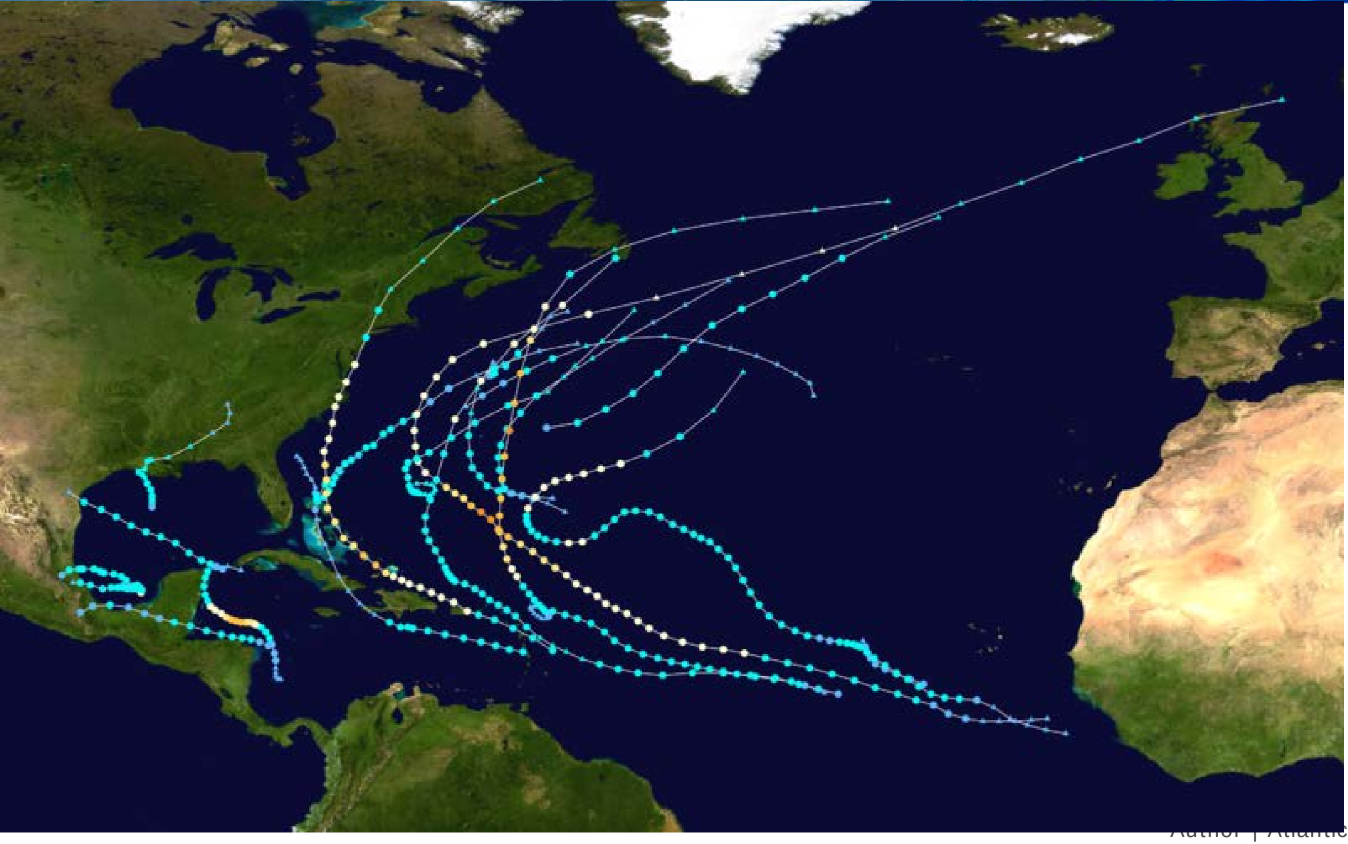
In this illustration we can see the warm flow of the North Atlantic Gyre and North Atlantic current, as well as the cold deep backflow heading South, eventually crossing under the Gulf Stream.

Atlantic Ocean currents





2011 *Atlantic hurricane season*



Seasonal statistics

Total depressions 20

Total storms 19

Hurricanes 7

Major hurricanes (Cat. 3+) 4

Total fatalities 112 total

Total damage $17.39 billion (2011 USD)

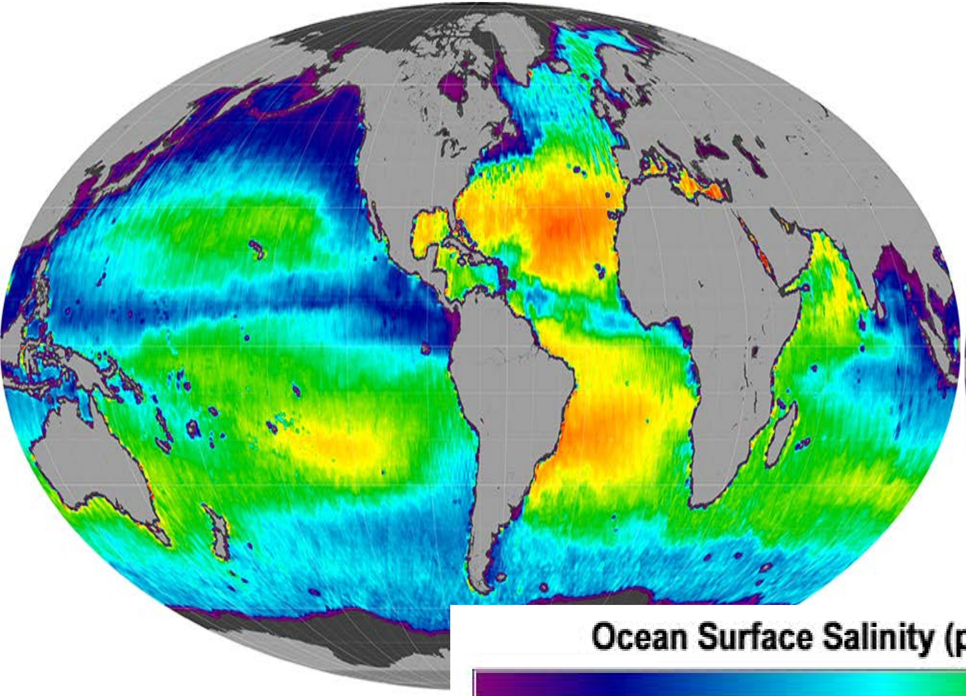
Seasonal boundaries

First system formed June 28, 2011

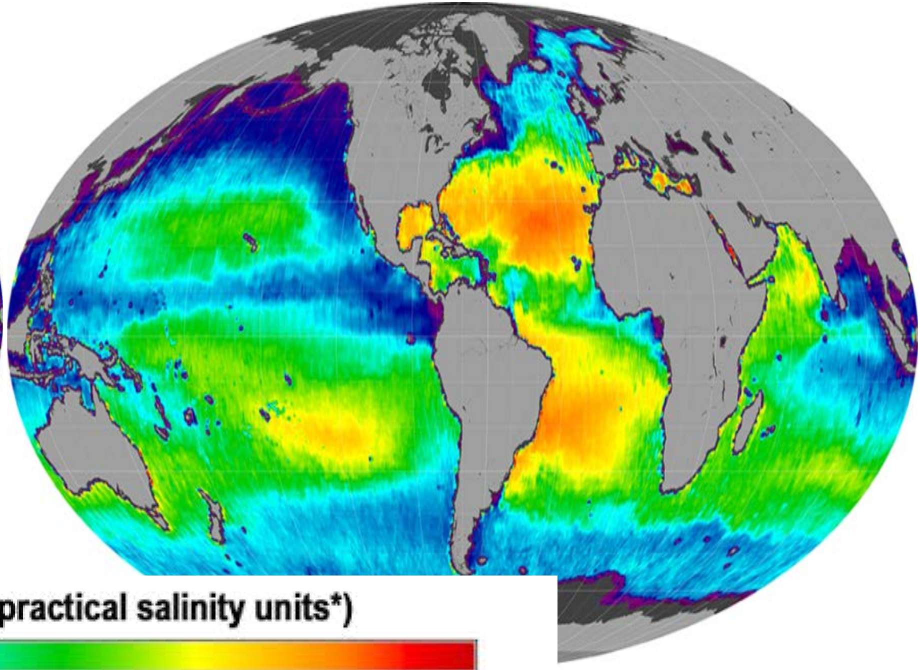
Last system dissipated November 11, 2011

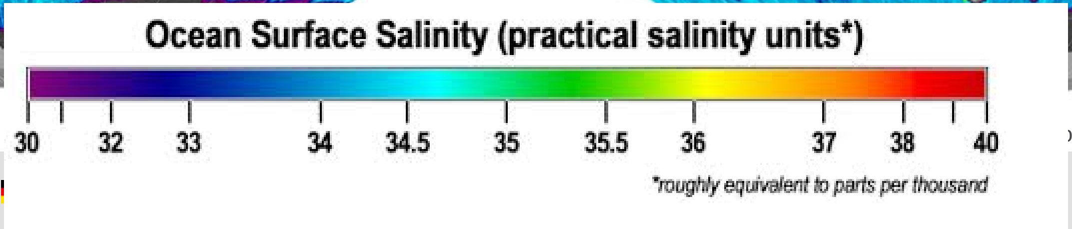
Sea Surface Salinity, Aquarius Data

November 2011

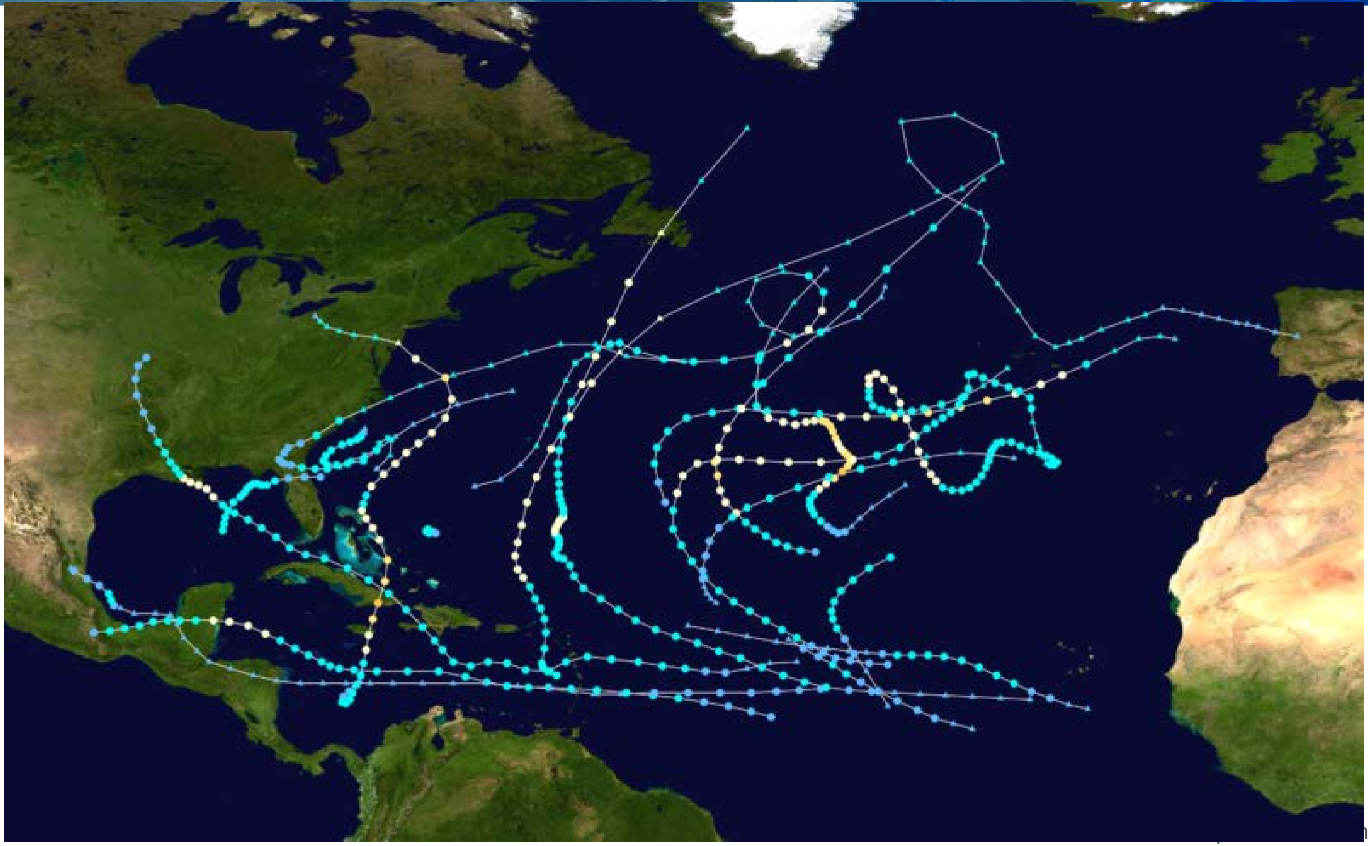


December 2011





2012 *Atlantic hurricane season*



Seasonal statistics

Total depressions 19

Total storms 19

Hurricanes 10

Major hurricanes (Cat. 3+) 2

Total fatalities 355 total

Total damage≥ $72.32 billion (2012 USD)

(Third-costliest tropical cyclone season on record)

Seasonal boundaries

First system formed

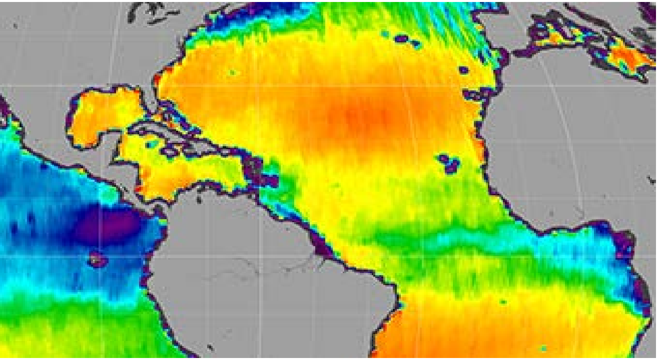
May 19, 2012

Last system dissipated

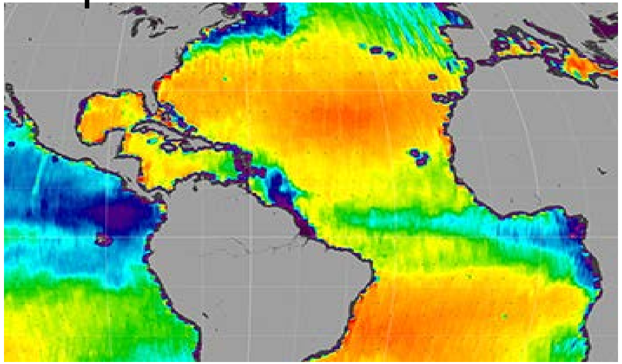
October 29, 2012

Sea Surface Salinity, Aquarius Data

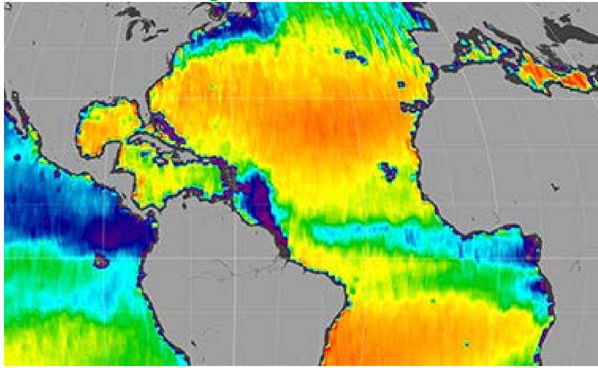
March 2012



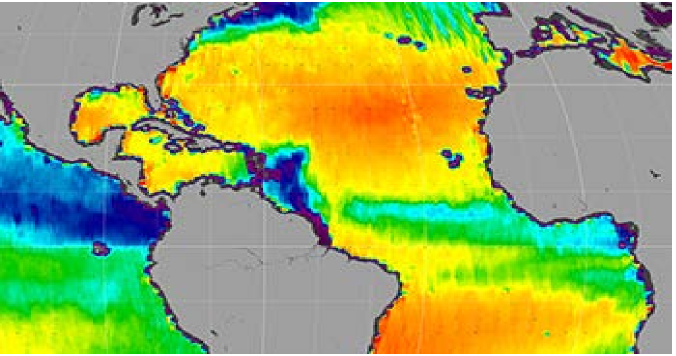
April 2012



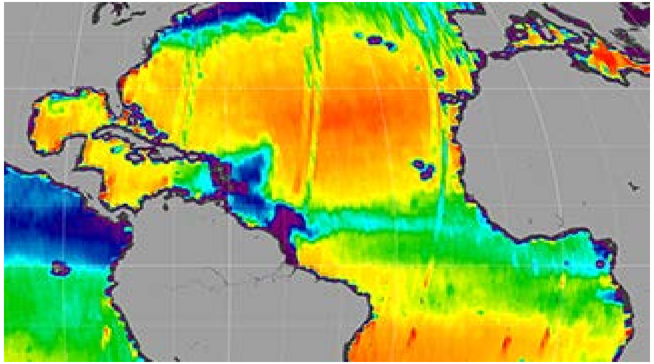
May 2012

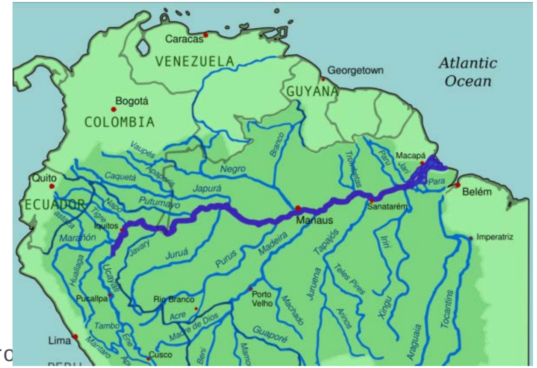


June 2012



July 2012

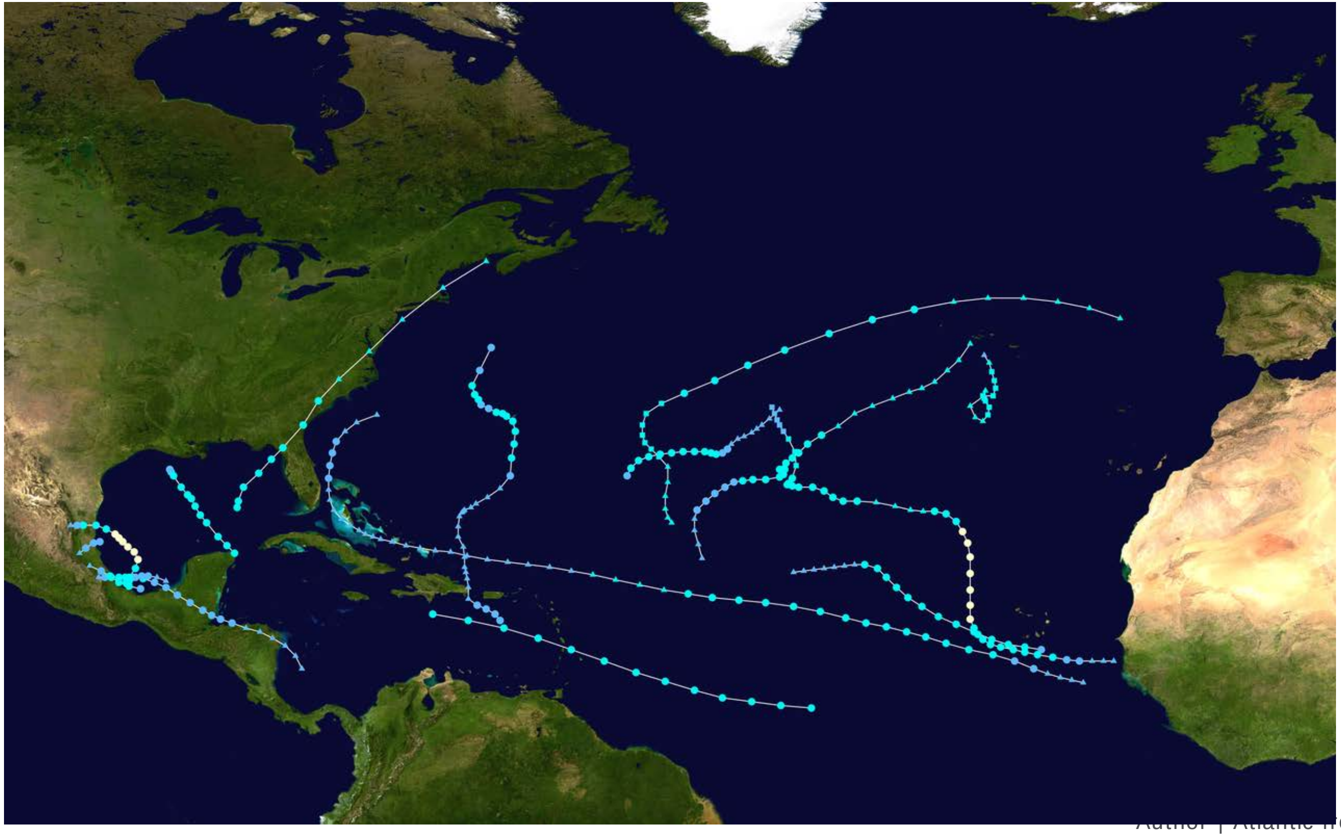




fro

The Hamza and the Amazon are the two main drainage systems for the Amazon Basin. The reported flow rate of the Hamza, at approximately 3,000 cubic metres (110,000 cu ft) per second, is 3% of the Amazon's.[3] It runs west to east, some 4,000 metres (13,000 ft) below the Earth's surface, and follows roughly the path of the Amazon river.[6] The Hamza empties in the Atlantic Ocean, deep under the surface. Its own water has a high salt content.[7]

2013 *Atlantic hurricane season*



Seasonal statistics

Total depressions1 5

Total storms 14

Hurricanes 2

Major hurricanes (Cat. 3+) 0

Total fatalities 54 total

Total damage≥ $1.512 billion (2013 USD)

Seasonal boundaries

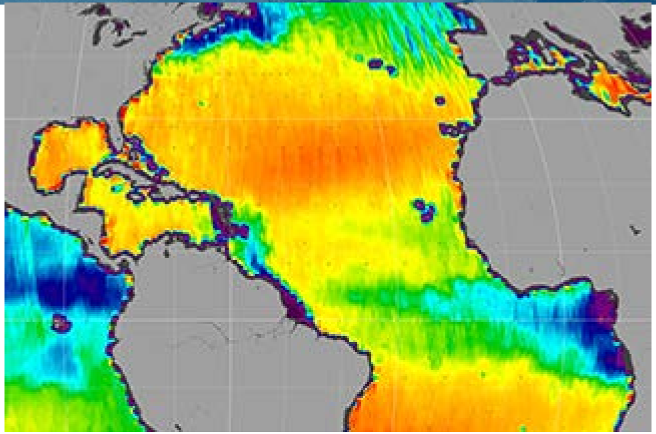
First system formed

June 5, 2013

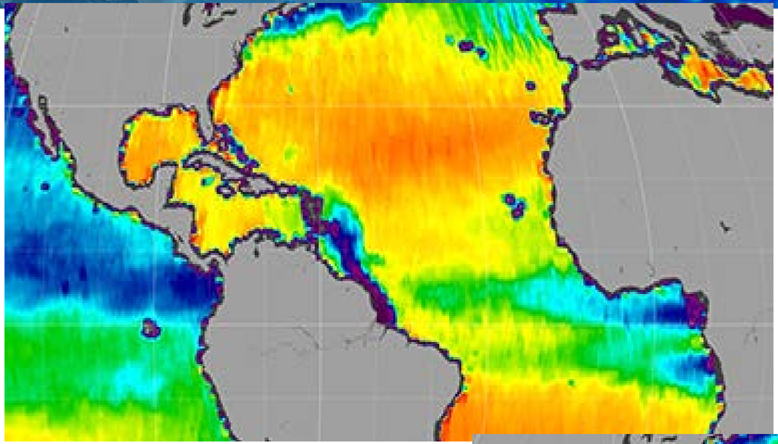
Last system dissipated

December 7, 2013

Sea Surface Salinity, Aquarius Data

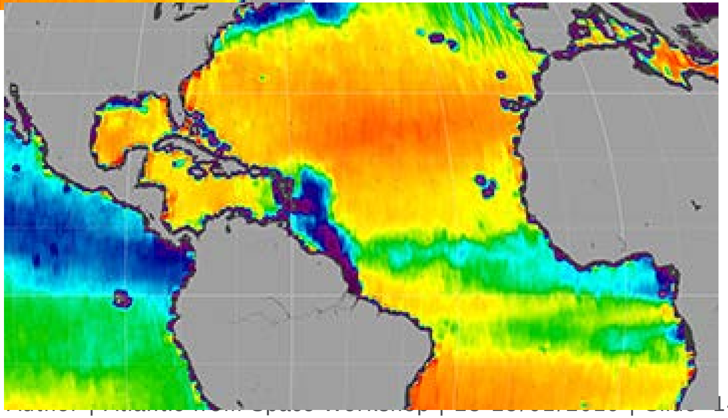


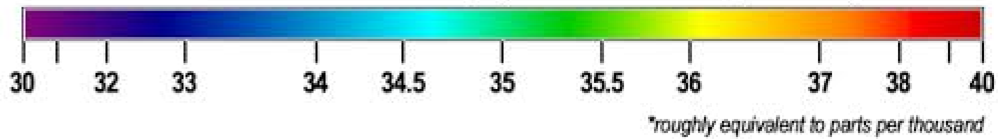
April 2013



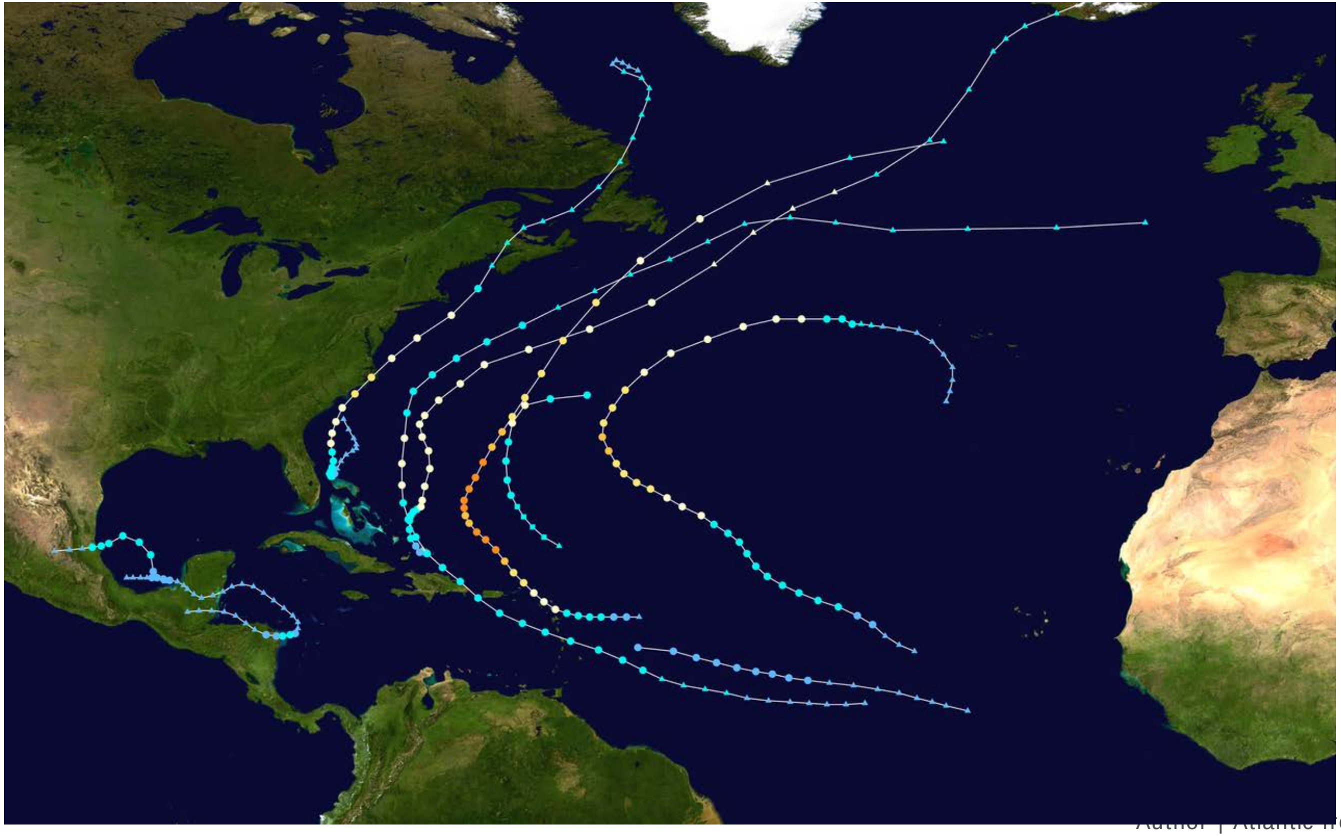
May 2013

June 2013





2014 Atlantic hurricane season



Seasonal statistics

Total depressions 9, 1 unofficial

Total storms 8,

1 unofficial

Hurricanes 6

Major hurricanes (Cat. 3+) 2

Total fatalities 21 total

Total damage≥ $343.1 million (2014 USD)

Seasonal boundaries

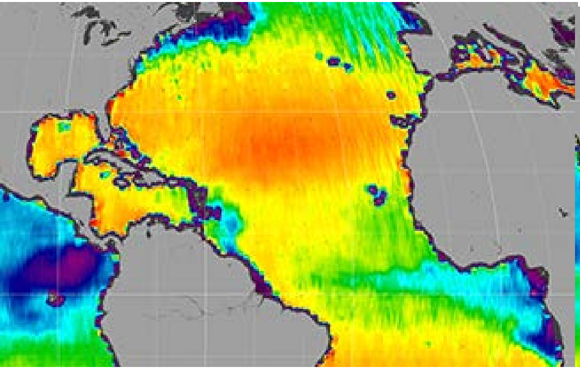
First system formed

July 1, 2014

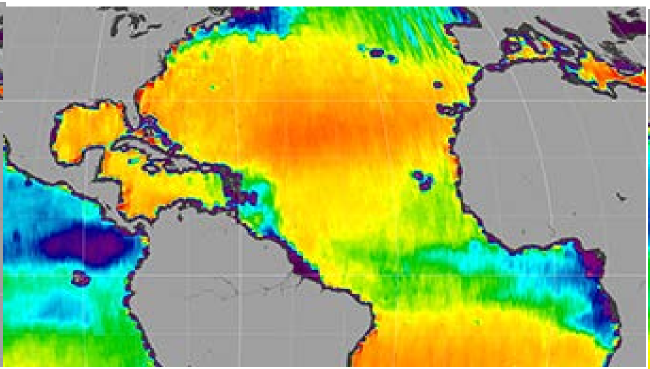
Last system dissipated October 28, 2014

Sea Surface Salinity, Aquarius Data

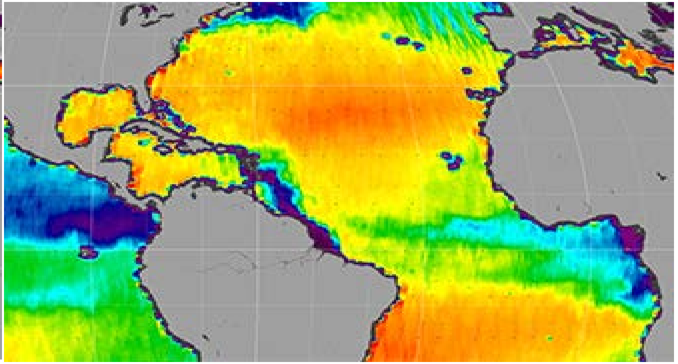
March 2014



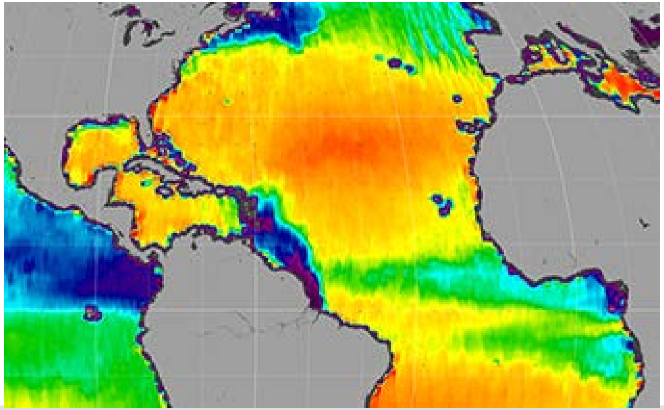
April 2014

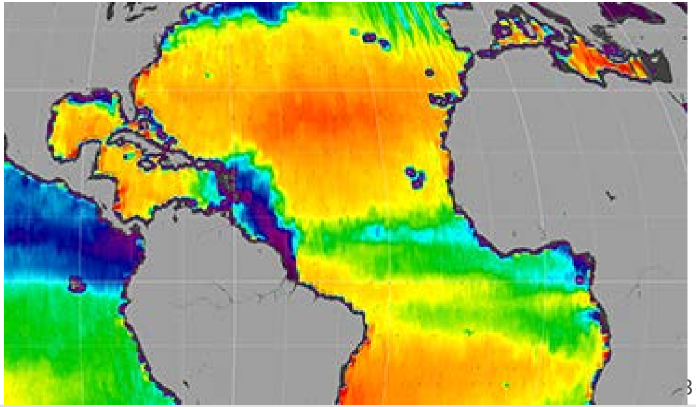


May 2014



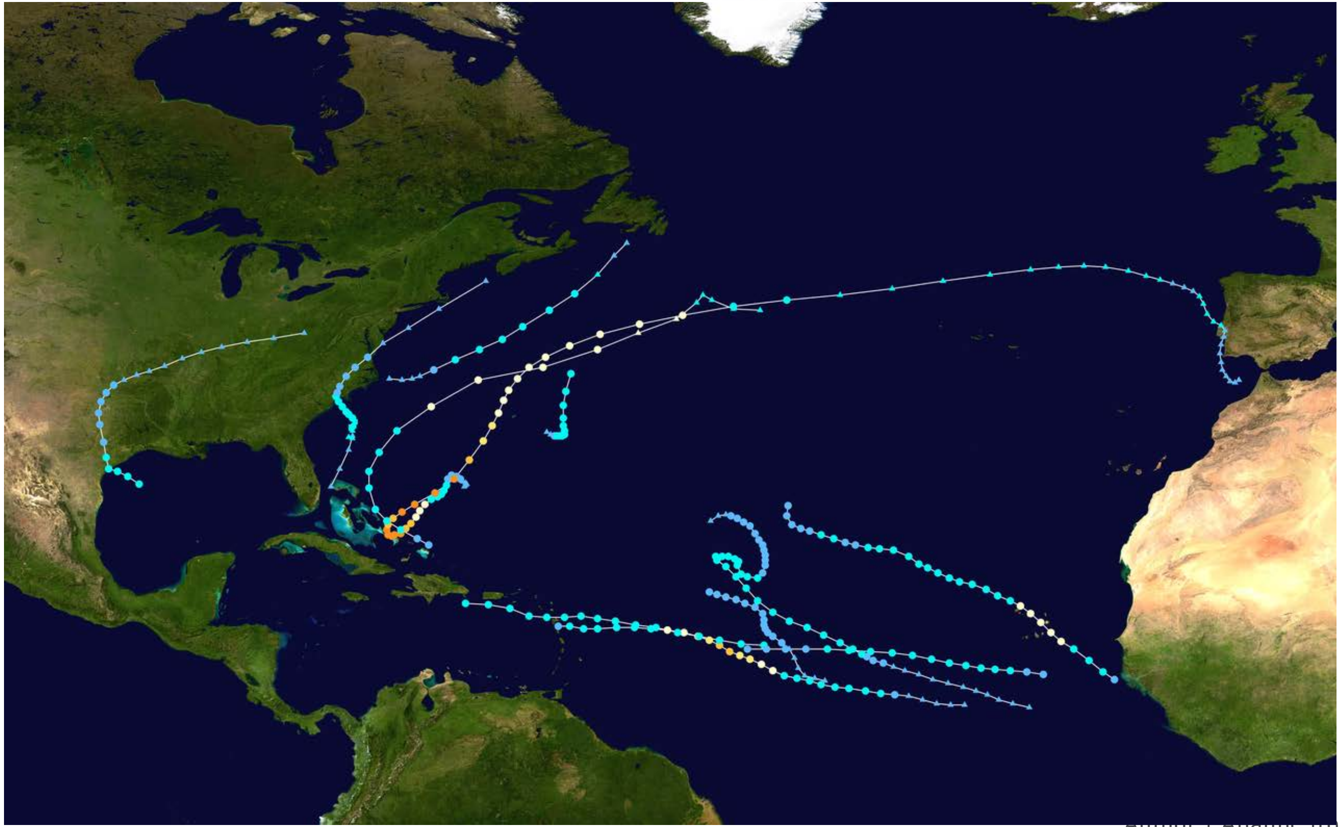
June 2014





July 2014

2015 Atlantic hurricane season



Seasonal statistics

Total depressions 12
Total storms 11
Hurricanes 4

Major hurricanes (Cat. 3+)2

Total fatalities 89 total
Total damage$731.8 million (2015 USD)

Seasonal boundaries

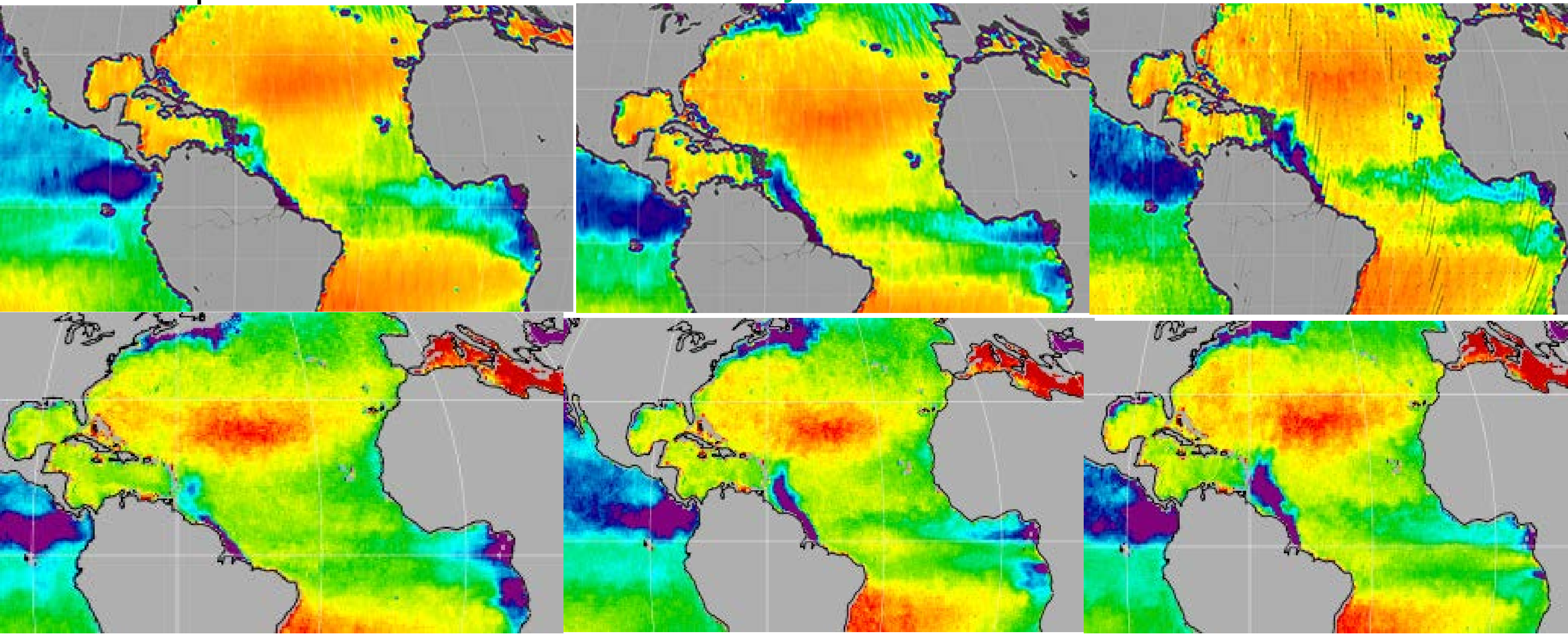
First system formed

May 8, 2015

Last system dissipated
November 11, 2015

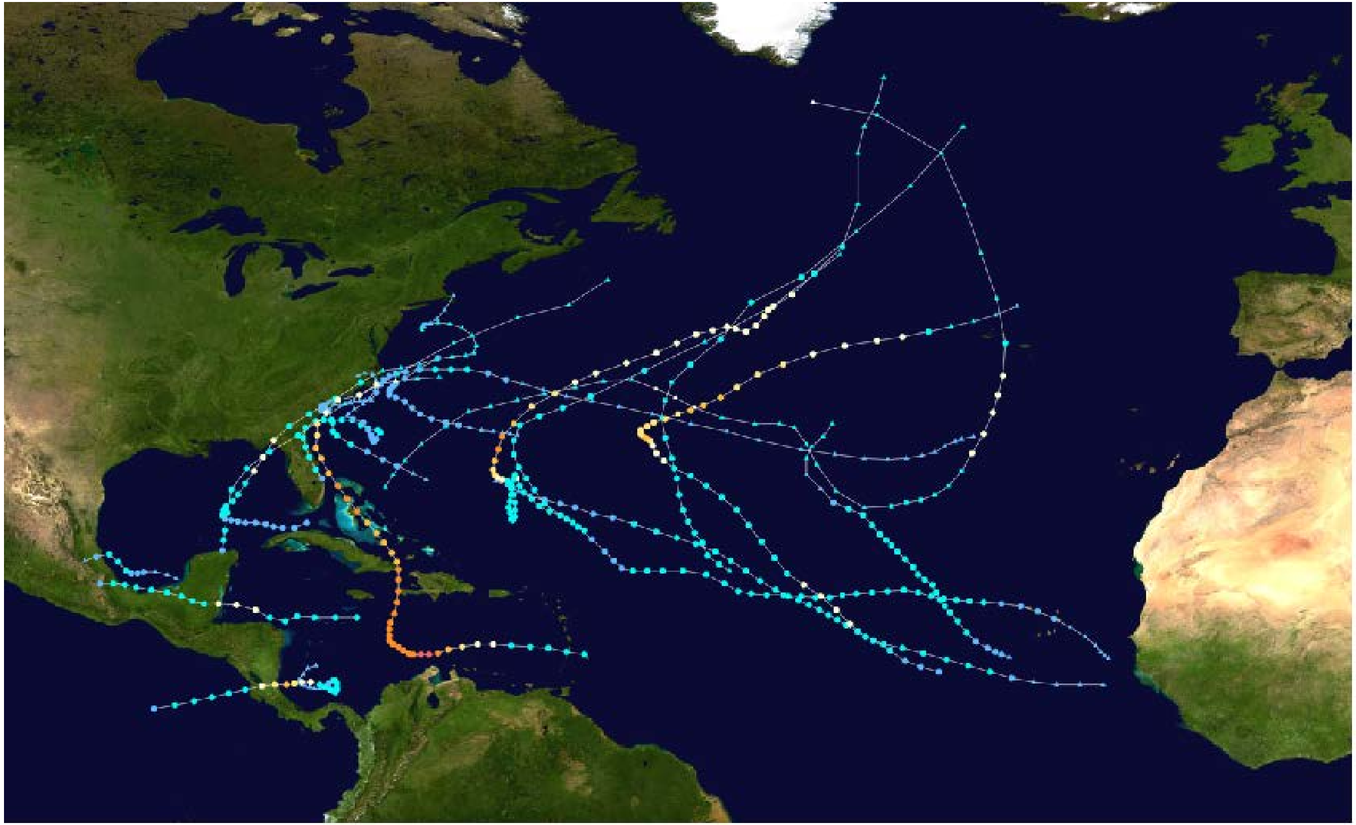
Sea Surface Salinity, Aquarius Data, SMAP Data

April 2015	May 2015	June 2015



NASA's Soil Moisture Active Passive (SMAP) mission began collecting sea surface salinity data in April 2015, overlapping with Aquarius observations for approximately three months. Using the same frequency as Aquarius (L-band; 1.41 GHz), SMAP's global salinity measurements continue the time series that began with Aquarius in August 2011.

There are key differences between Aquarius and SMAP. Aquarius used three radiometers at fixed angles (25.8°, 33.8° and 40.3°), whereas SMAP scans earth using a spinning antenna. This scanning ability gives SMAP a 1000 km (621 mi) wide swath, providing global coverage every three days. Aquarius, on the other hand, had a 350 km (218 mi) wide swath that covered earth's surface in seven days. **SMAP observations also have a smaller footprint (39 x 47 km; 24 x 29 mi) than Aquarius (150 x 150 km; 93 x 93 mi), providing opportunities to study salinity features at a higher spatial resolution but Aquarius had a radar (to help correct for roughness) and better thermal control.**



Seasonal statistics

Total depressions 16, 1 unofficial

Total storms15, 1 unofficial

Hurricanes 7

Major hurricanes (Cat. 3+) 4

Total fatalities 748 totalTotal damage≥ $16.1 billion (2016 USD)

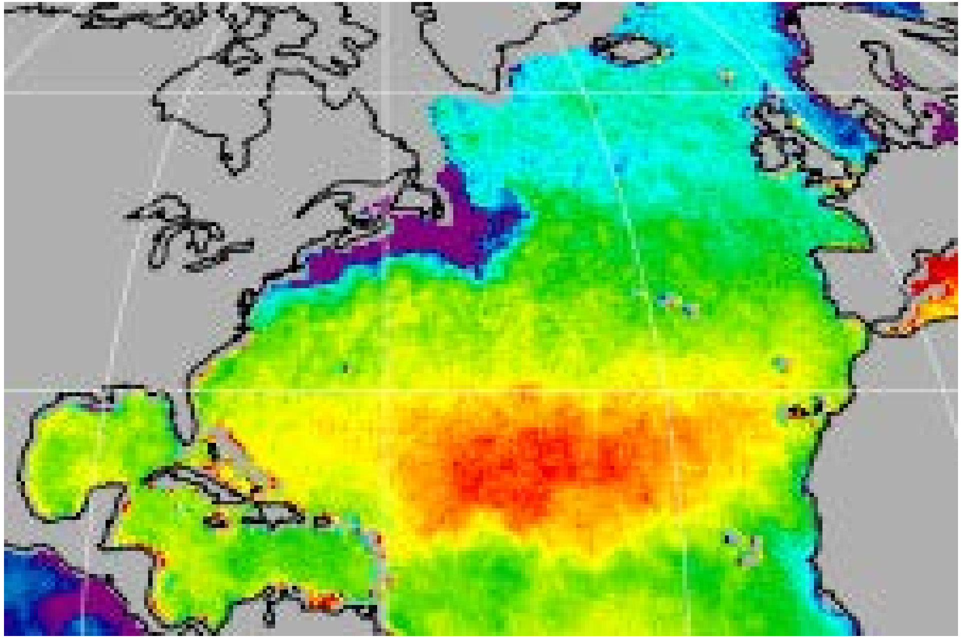
Seasonal boundaries

First system formed January 12, 2016

Last system dissipated November 25, 2016

European Space Agency

Sea Surface Salinity, SMAP Data



Category 1 hurricane (SSHWS)

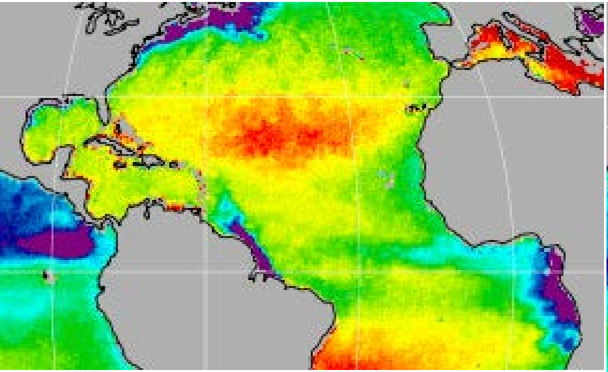
Duration	January 12 – January 15, 2016

Sea Surface Salinity, SMAP Data

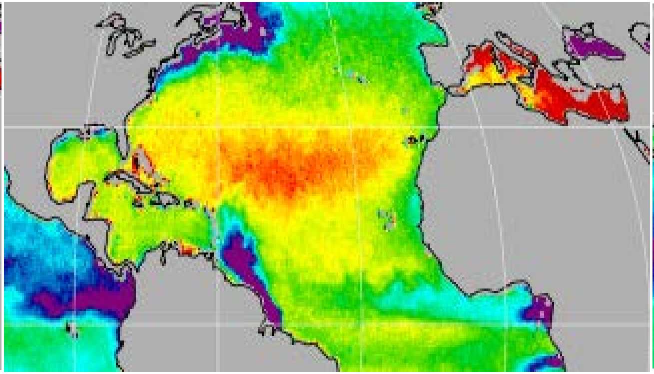
The season officially started on June 1

May 27 – June 4

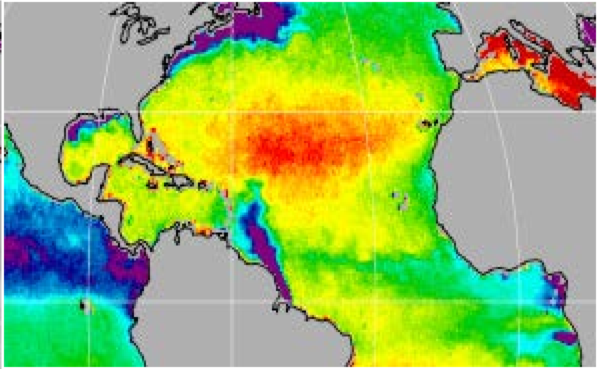
April 2016

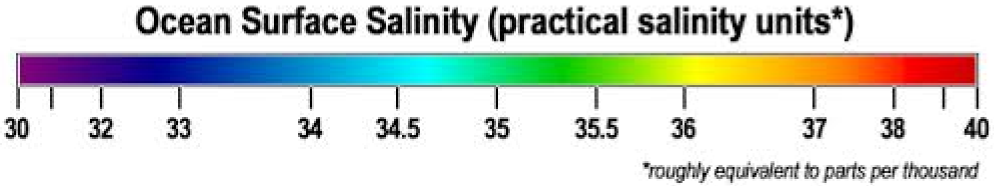


May 2016

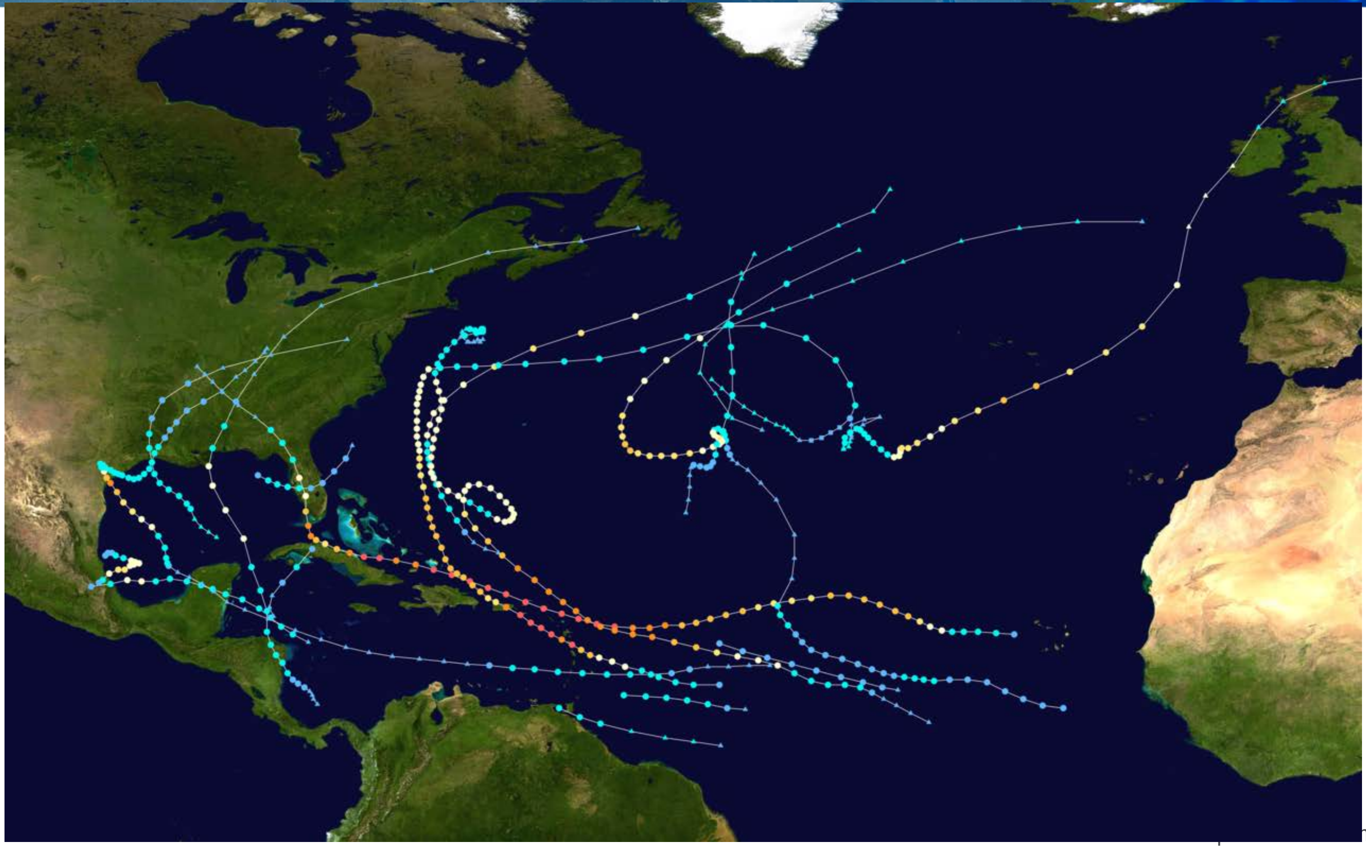


June 2016





2017 Atlantic hurricane season



a hyperactive and catastrophic hurricane season

Seasonal statistics

Total depressions 18

Total storms17

Hurricanes10

Major hurricanes (Cat. 3+)6

Total fatalities3 ,361 total

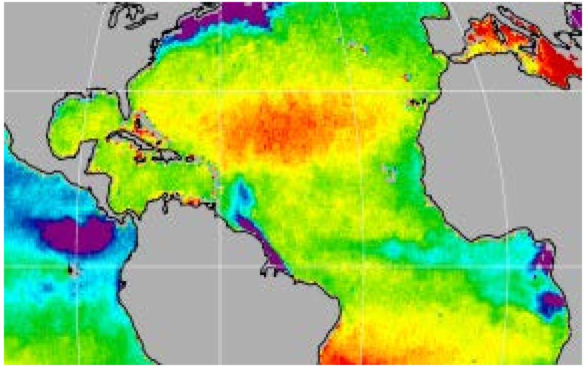
Total damage≥ $282.27 billion (2017 USD) (Costliest tropical cyclone season on record)

Seasonal boundaries

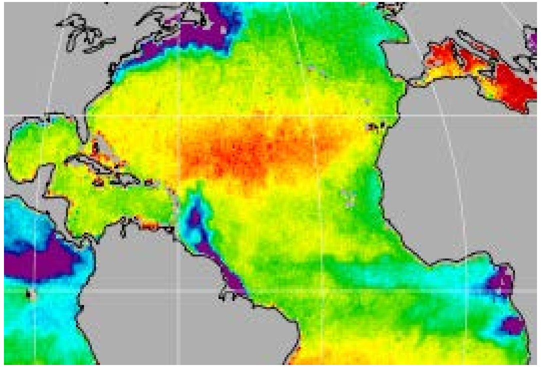
First system formed April 19, 2017 . Last system dissipated November 9, 2017

Sea Surface Salinity, SMAP Data

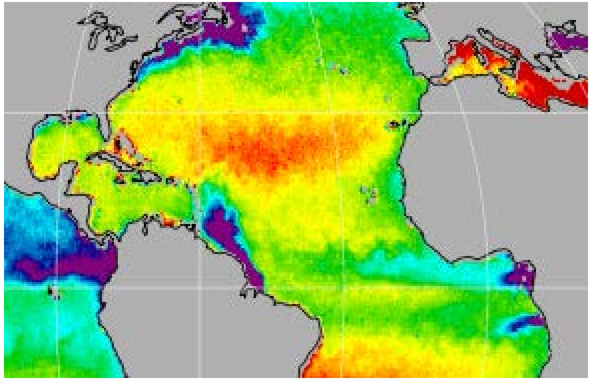
March 2017



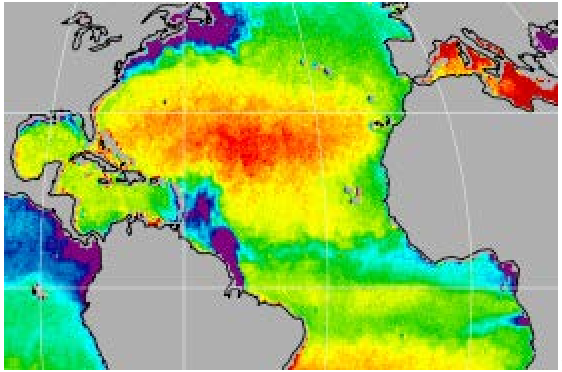
April 2017



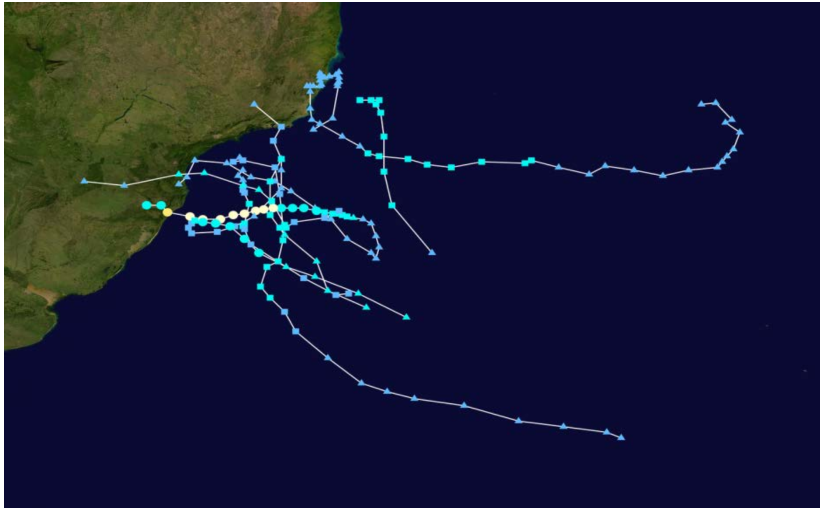
May 2017



June 2017



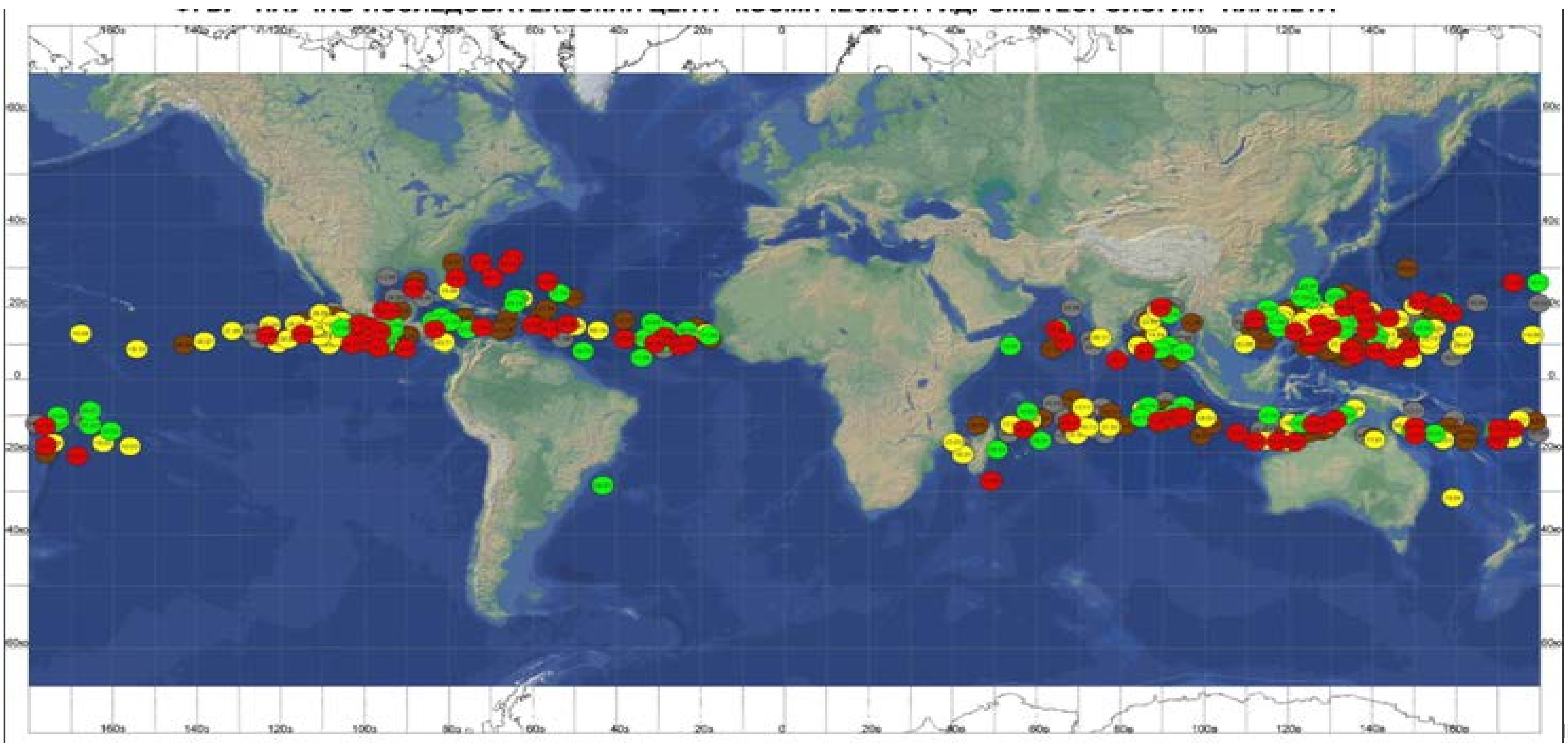
Until April 1991, it was thought that TCs did not develop within the South Atlantic. Very strong **vertical wind shear** in the troposphere is considered a deterrent. The Intertropical Convergence Zone drops one to two degrees south of the equator, **not far enough from the equator** for the Coriolis force to aid development. **Water temperatures** in the tropics of the southern Atlantic **are cooler** than those in the tropical north Atlantic. (en.wikipedia.org)

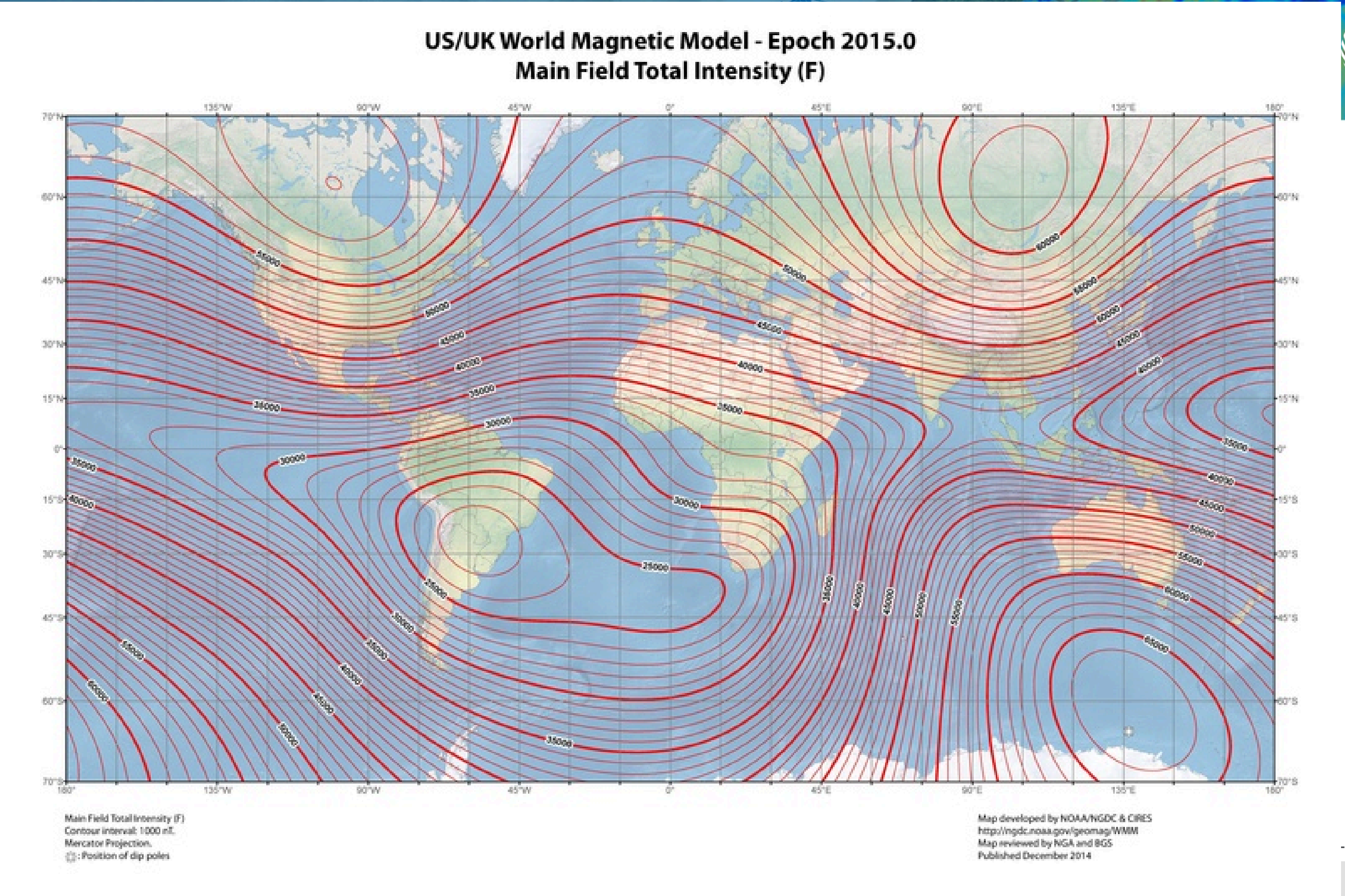


A study was subsequently performed and published during 2012, which concluded that there had been 63 subtropical cyclones in the Southern Atlantic between 1957 and 2007.

In 2011, the Brazilian Navy Hydrographic Center started to assign names to tropical and subtropical cyclones that develop within its area of responsibility, to the west of 20°W, when they have sustained wind speeds of at least 65 km/h (40 mph).

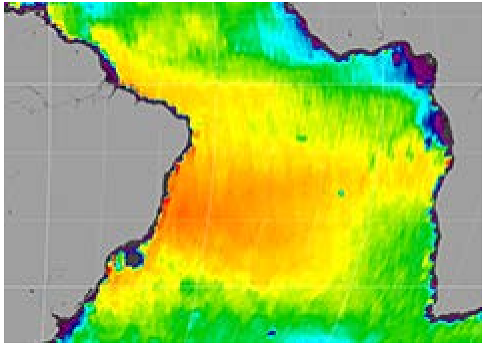
Global map of the born location of tropical cyclones in 2007-2011 y.y. www.planete.rssi.ru)



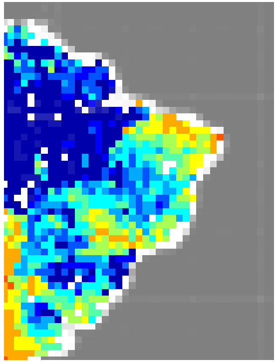

US/UK World Magnetic Model - Epoch 2015.0
Main Field Total Intensity (F)
Main Field Total Intensity (F)
Contour interval: 1000 nT.
Mercator Projection.
: Position of dip poles
Map developed by NOAA/NGDC & CIRES
http://ngdc.noaa.gov/geomag/WMM
Map reviewed by NGA and BGS
Published December 2014

Between December 23, 2013 and January 24, 2015, the CPTEC and Navy Hydrography Center monitored four subtropical depressions to the south of Rio de Janeiro. The first one lasted until Christmas Day, 2013. Two subtropical depressions formed in 2014: one in late-February 2014 and the other in late-March 2014. A fourth one formed in late January 2015.

Rio de Janeiro



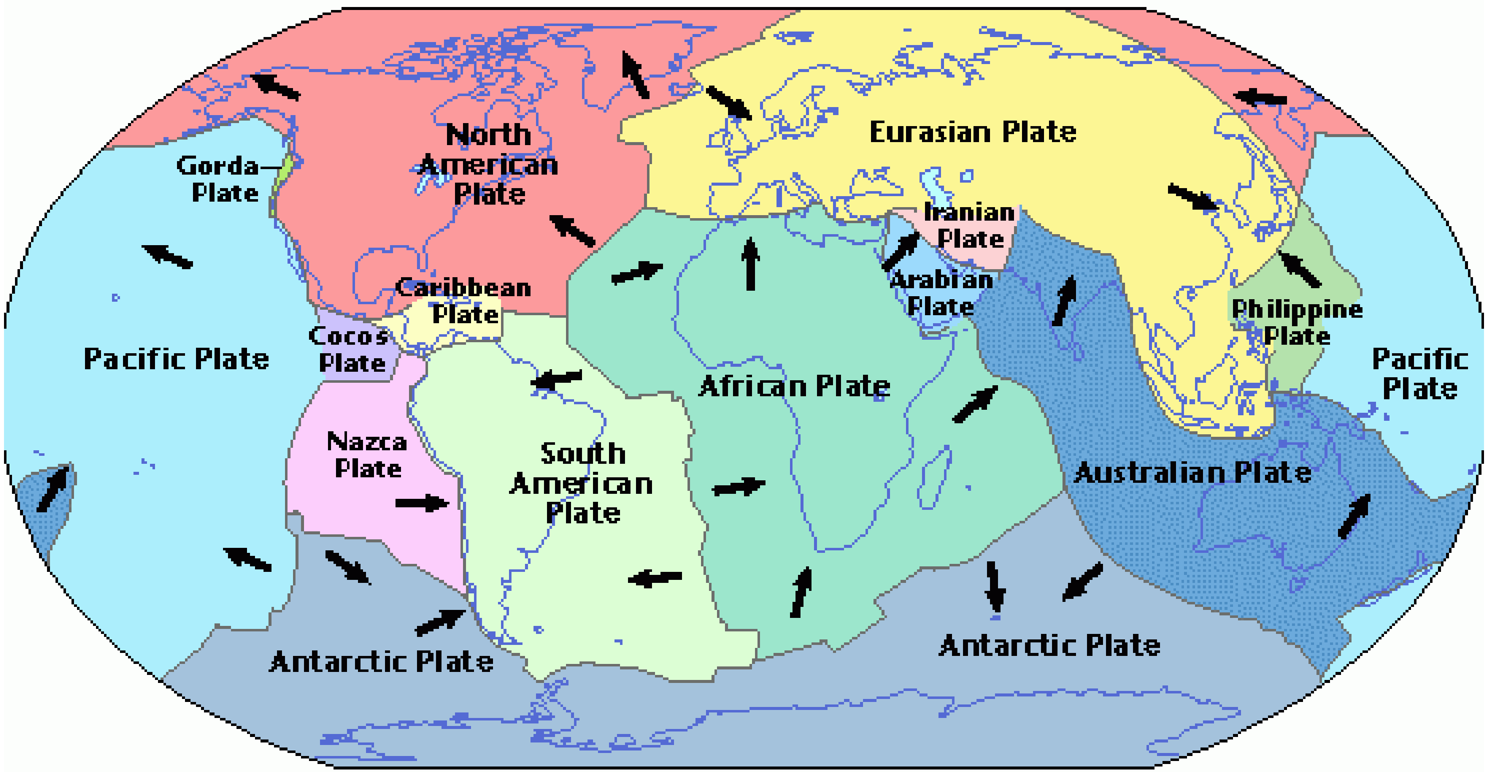
December 2013



Soil Moisture

Conclusions

1. Salinity is the valve of Ocean-Air interaction in cyclone genezis.



European Space Agency