

**To name or not to name...
a tropical cyclone!
Insight on the NHC cyclone
naming process**

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WHERE AMERICA'S CLIMATE AND WEATHER SERVICES BEGIN



Outline

- **Cyclone Types and Energy Sources**
- **The Reality of Marginal Systems**
- **Clearing Up Some Misconceptions**
- **Use of New Technologies**
- **Several Recent Cases**

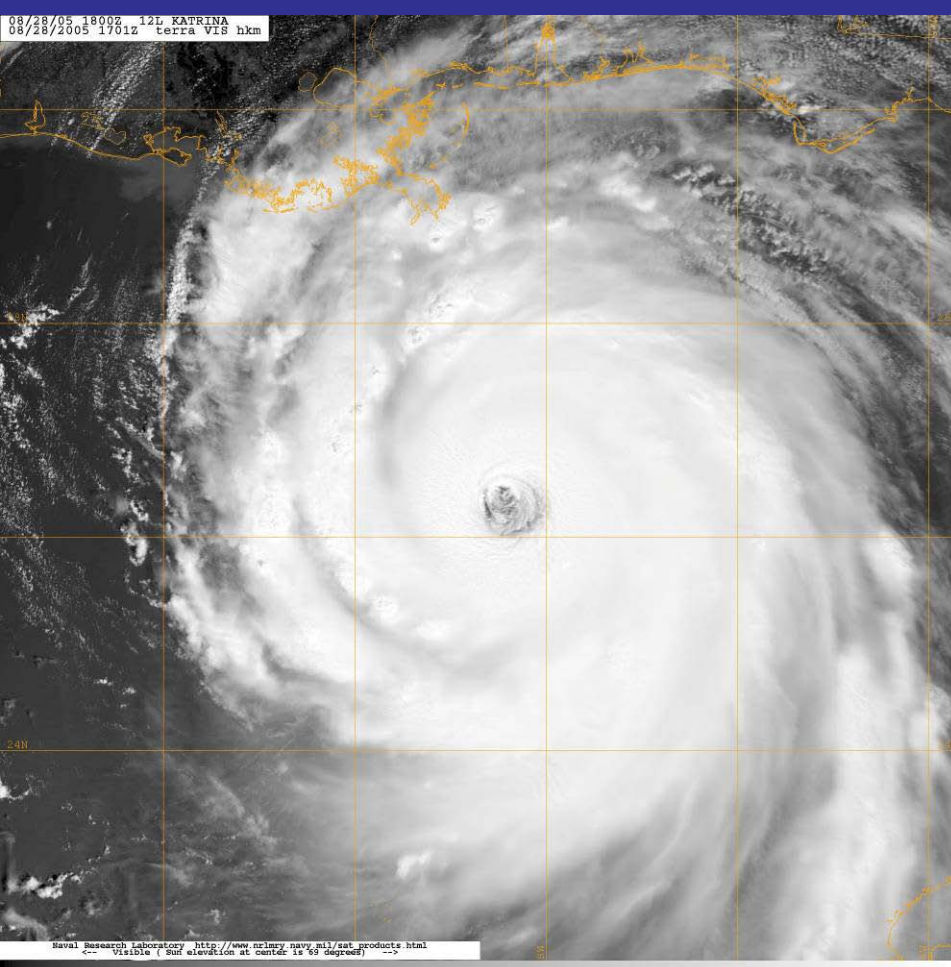
True or false?

All synoptic-scale cyclonic storms with 75 mph or greater winds are hurricanes

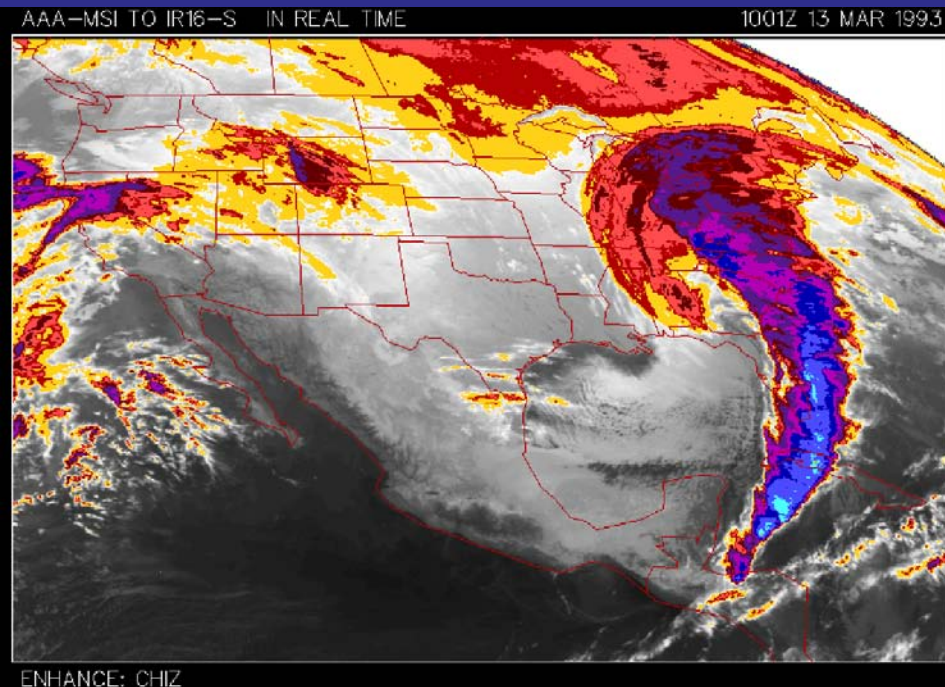
FALSE!

The Extremes:

Tropical vs. Extratropical Cyclones



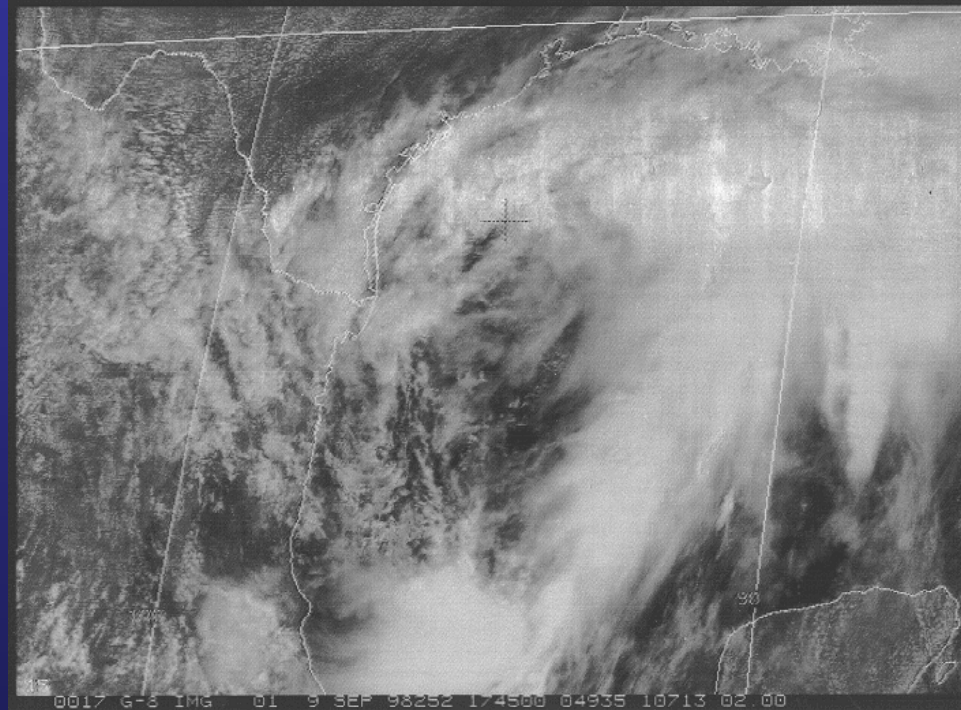
Hurricane Katrina (2005)



Superstorm Blizzard of March 1993

Cyclone Energy Sources

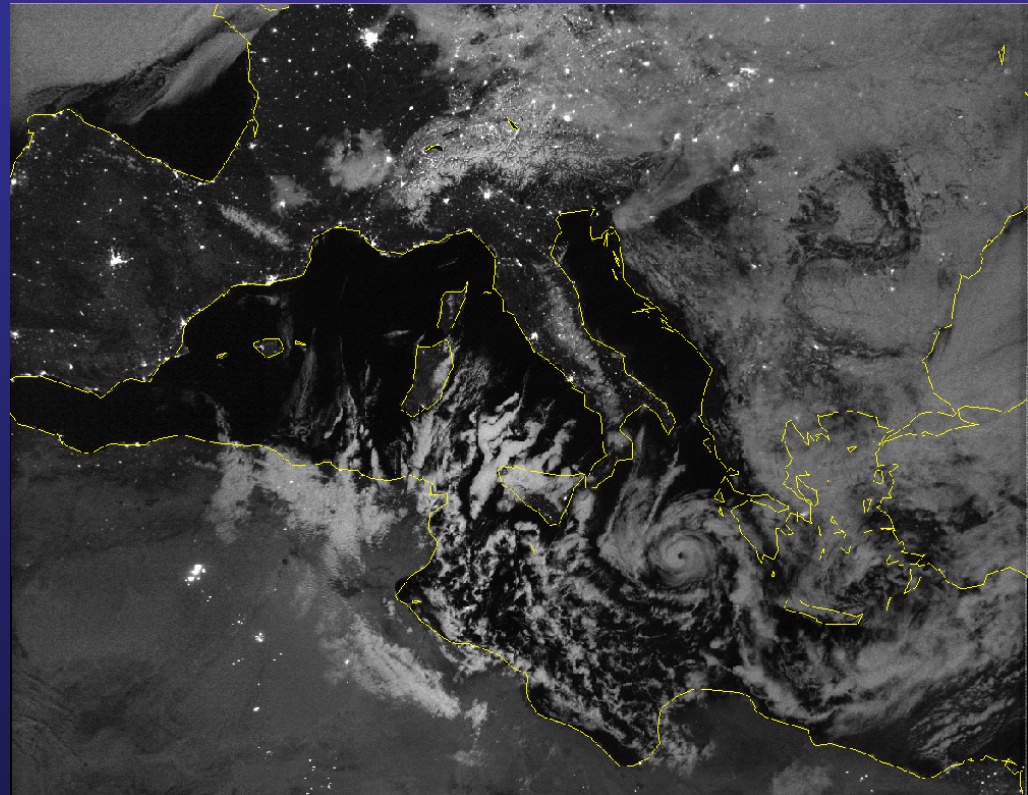
- **Atmospheric cyclones require energy to maintain themselves or strengthen. Possible energy sources include:**
 - **Baroclinic energy:** Energy available in temperature gradients that occur along fronts and *vertical* wind shear (extratropical/frontal cyclones)
 - **Barotropic energy:** Energy available in *horizontal* wind shear (monsoon cyclones)
 - **Diabatic energy:** Energy available in moisture evaporated from the ocean surface and released in thunderstorms (tropical cyclones)



Tropical Storm Frances (1998) – an uncommon development from a monsoon-type cyclone in the Gulf of Mexico

Cyclone Energy Sources

- Atmospheric cyclones can use any or all of these sources. There are a fair number of hybrid systems that use more than one.
- They can also *change* their primary energy source during their lifetimes. This includes such process as extratropical transition and tropical transition.
- The processes that drive hurricanes can work in a variety of places and environments, not just over warm tropical oceans!



January 1995 Mediterranean “hurricane”

NHC Definitions

Tropical Cyclone: A warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere. In this they differ from extratropical cyclones, which derive their energy from horizontal temperature contrasts in the atmosphere (baroclinic effects).

Subtropical Cyclone: A non-frontal low pressure system that has characteristics of both tropical and extratropical cyclones. This system is typically an upper-level cold low with circulation extending to the surface layer and maximum sustained winds generally occurring at a radius of about 100 miles or more from the center. In comparison to tropical cyclones, such systems have a relatively broad zone of maximum winds that is located farther from the center, and typically have a less symmetric wind field and distribution of convection.

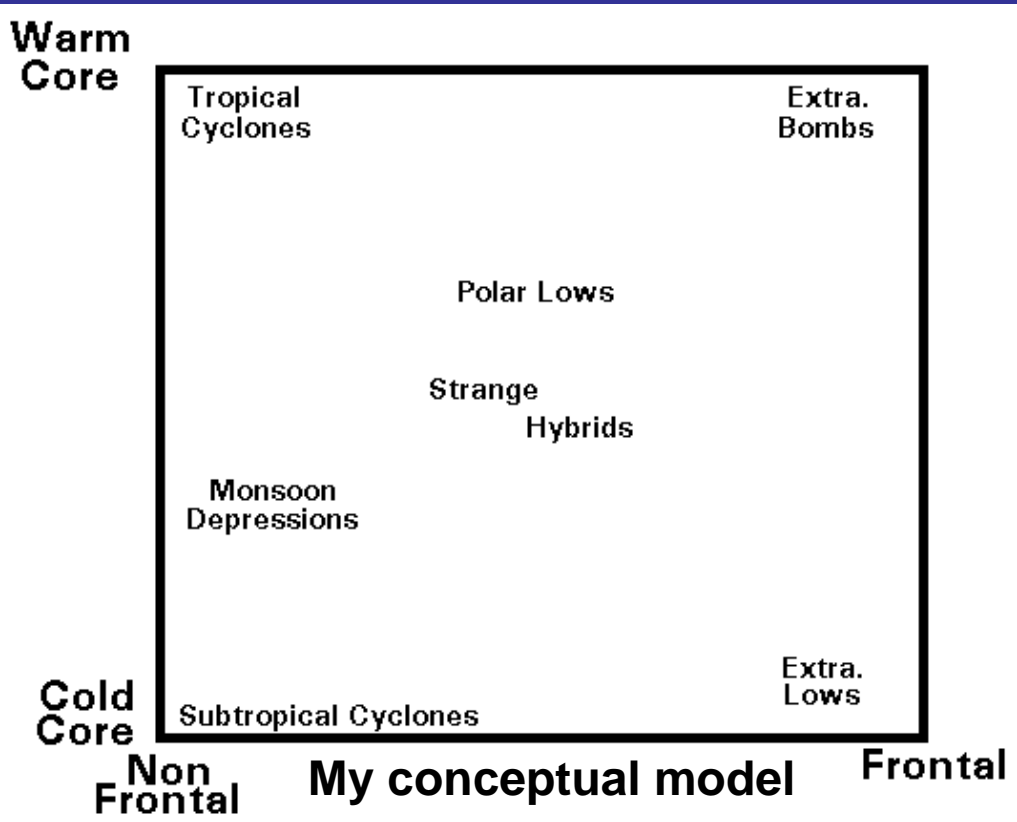
Marginal Systems

Every year, there are some systems that are on the verge of meeting these criteria:

- **Some tropical cyclones do not clearly have winds strong enough to be called tropical storms**
- **Some potential tropical cyclones lack a well-organized center of circulation**
- **Some potential tropical or subtropical cyclones lack sufficient organized convection**
- **Some potential subtropical cyclones have organized convection but remain frontal in nature**

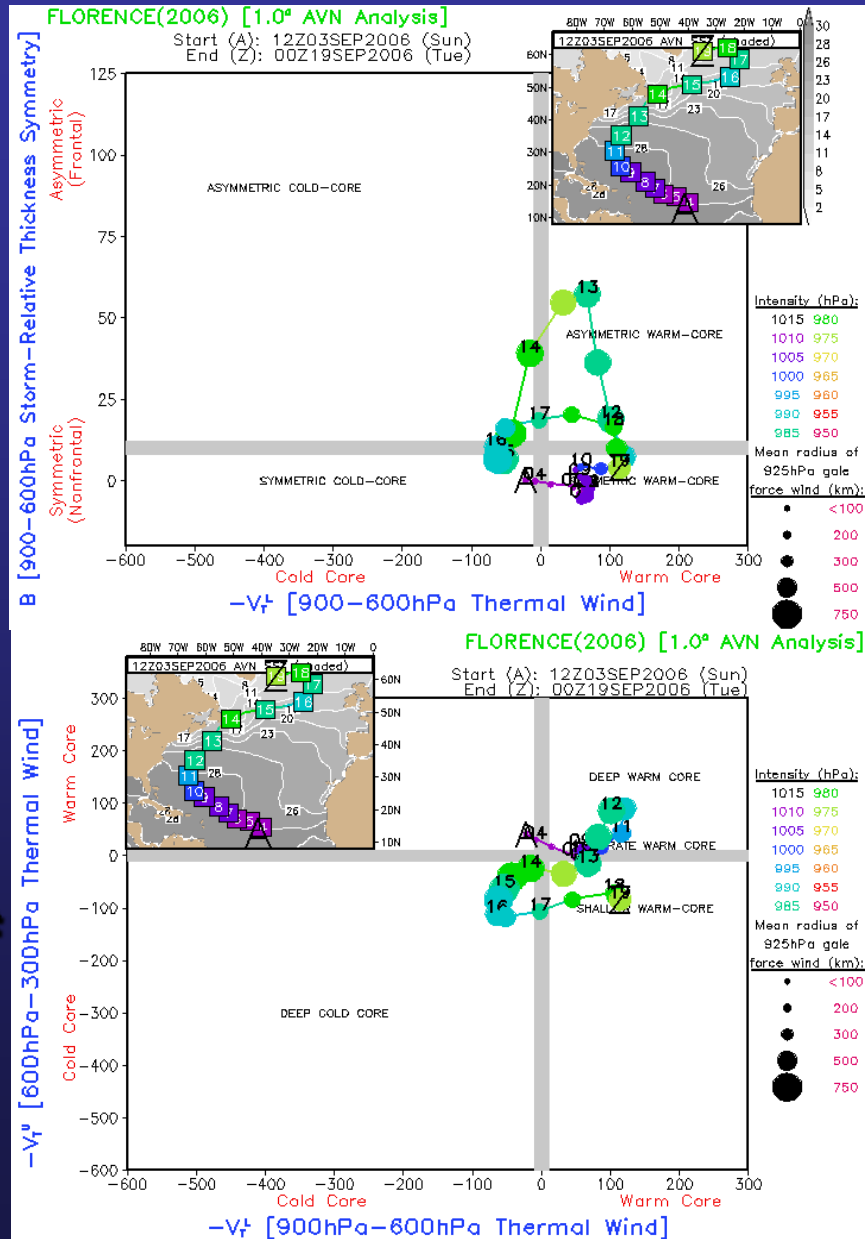
It is not always clear-cut whether a given system meets the NHC criteria, and the name/no name (or start/no start) decision often comes down to forecaster judgement.

Reality has lots of shades of gray



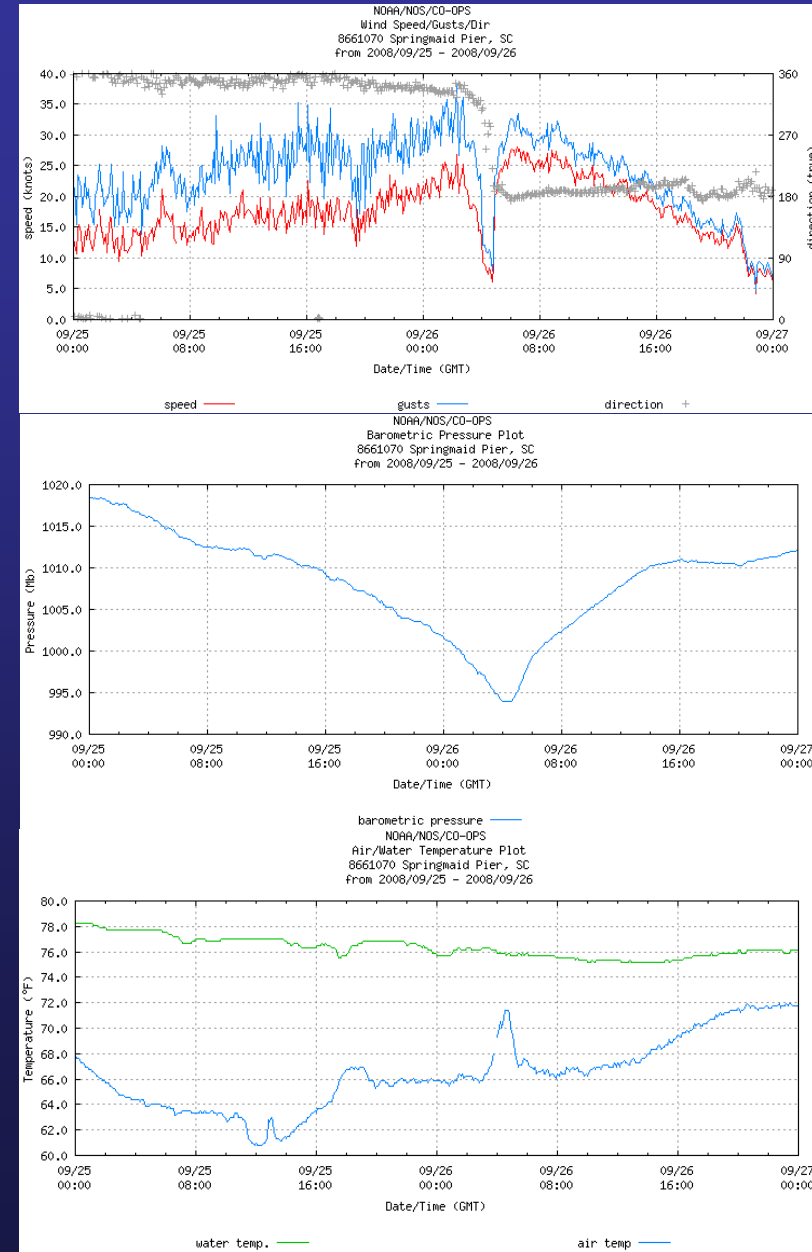
Cyclones occur in a continuum of structures rather than in discrete types

Hart and Evans Cyclone Phase Space



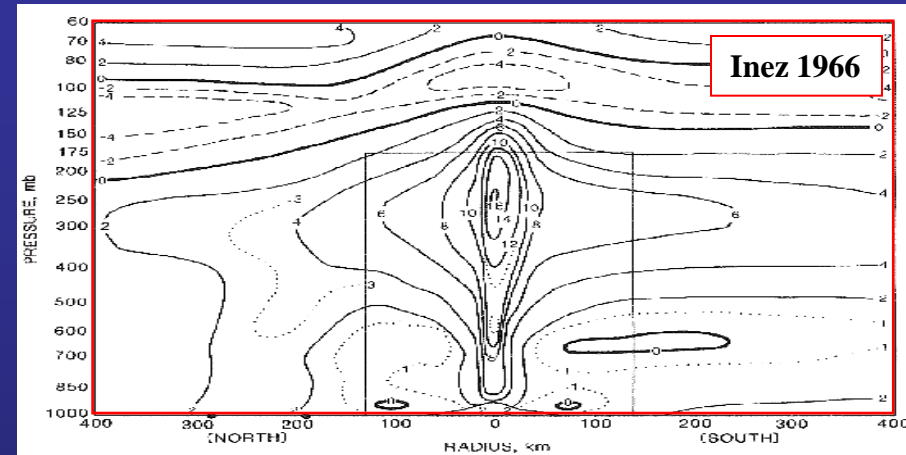
Why are the distinctions important?

- Cyclone type and the associated transitions are 'shades of grey' or continuum issues.
- Operational handling of cyclone types is a 'black and white' or 'yes or no' response – TC warnings or non-tropical gale/storm warnings.
- This situation can lead to inconsistencies in the warning process, response, and climatology.
- But, if *you* get hit by 70 mph winds, 6 ft above normal tides, and/or 12 in of rain, does the nature of the system really matter?

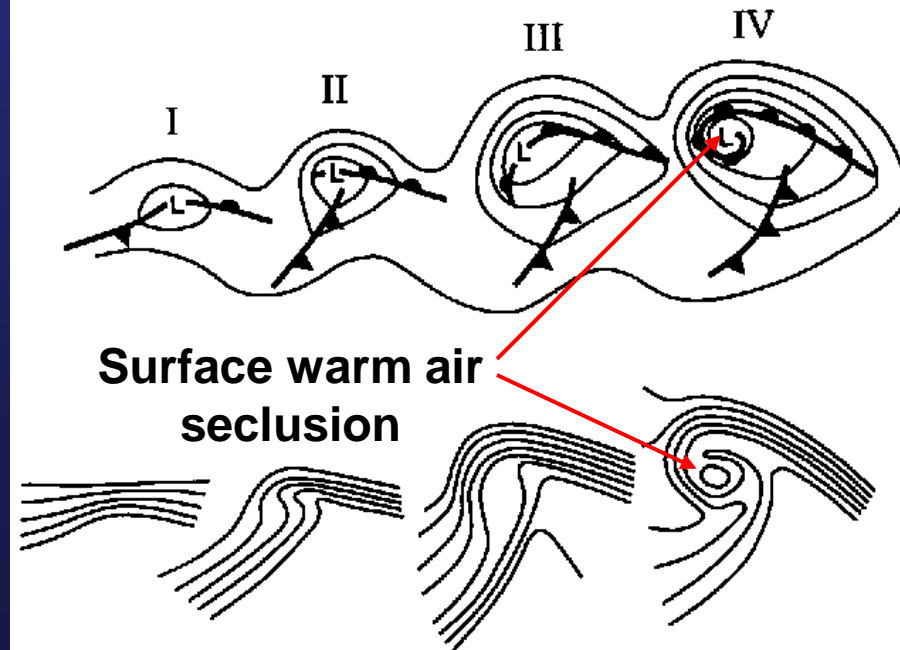


What about a warm core?

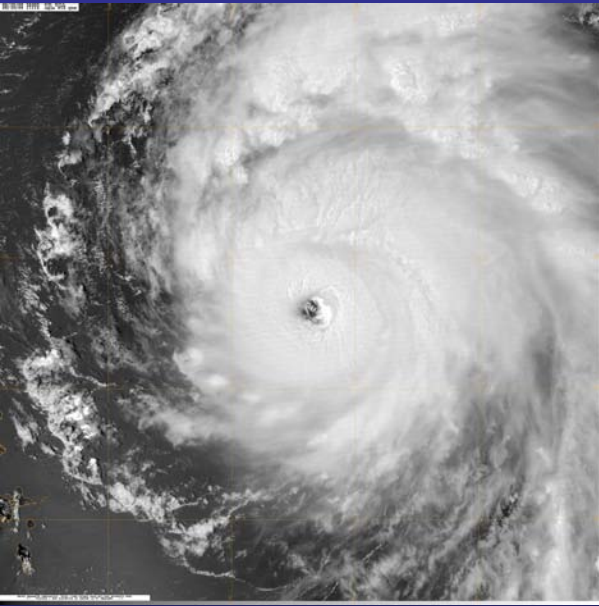
- Tropical cyclones have a deep warm core formed and maintained by the heat released in the associated showers and thunderstorms.
- Non-tropical cyclones can form a warm core when air gets cut off near the cyclone center during the evolution of the associated fronts (seclusion process). This is a different warm core than that of tropical cyclones.



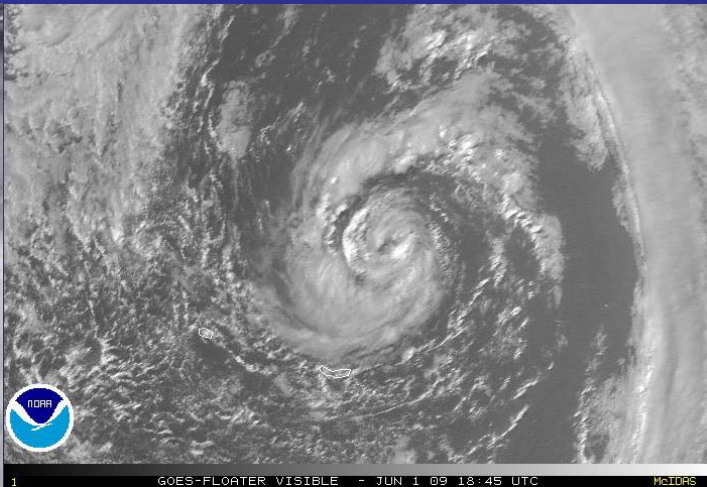
(b) Shapiro–Keyser Model



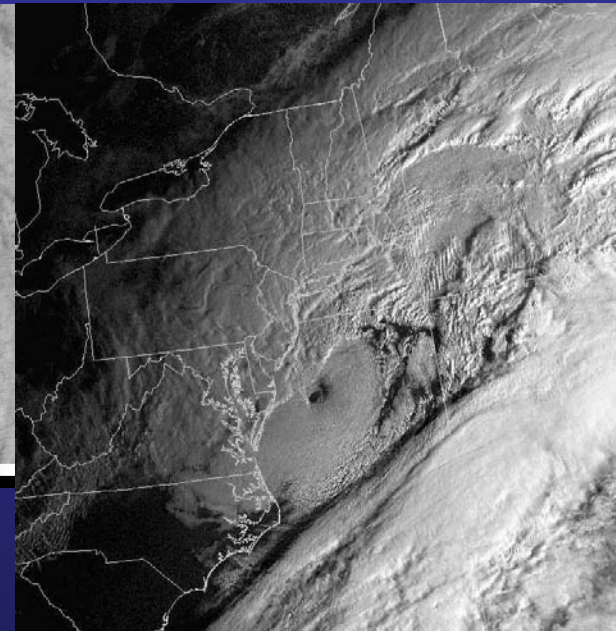
An eye doesn't tell the whole story



Hurricane Bill (2009)



June 2009 Azores Cyclone

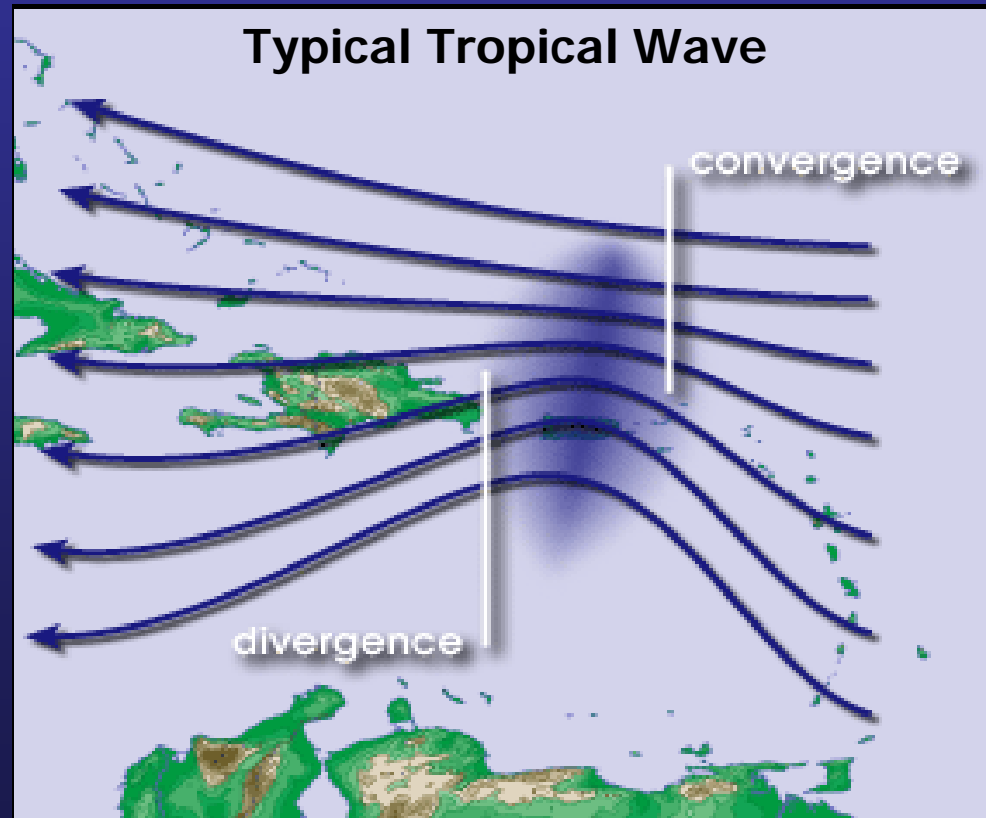


February 2006 Blizzard

The “eyes” in these images came about through different meteorological processes. Knowledge of the structure and evolution of a cyclone is necessary to evaluate the significance of an eye.

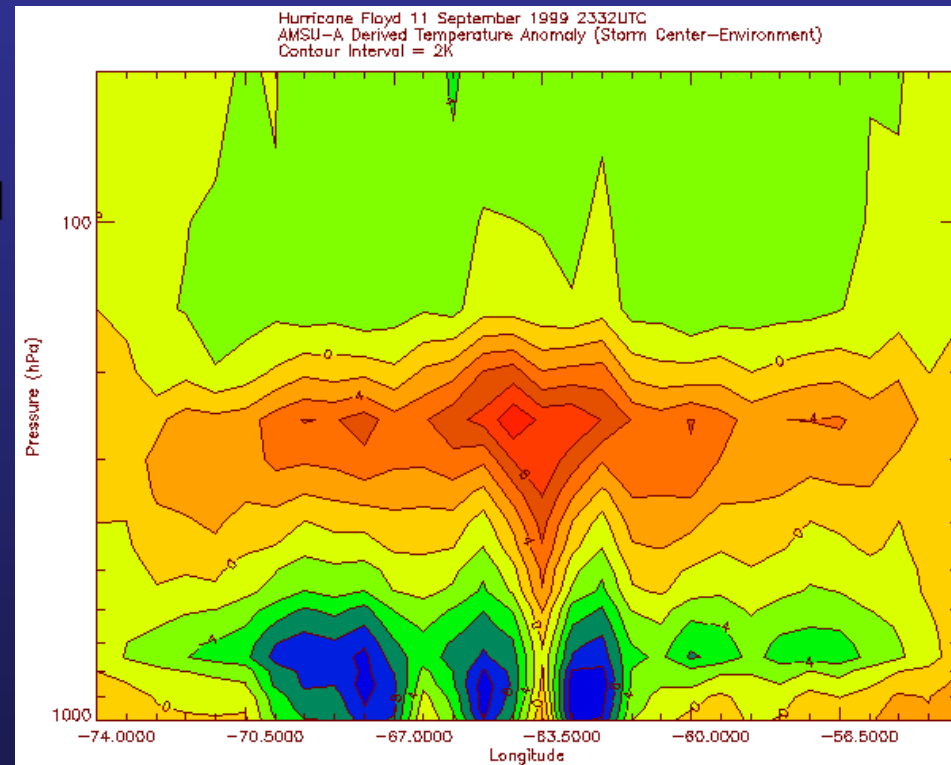
“The plane found a westerly wind!”

- Most Atlantic tropical cyclones develop from tropical waves, which are perturbations in the easterly trade winds that lack a closed circulation.
- An observed westerly wind associated with a tropical wave would mean a closed circulation is present or forming.
- This criteria is mainly important for *tropical waves*! Other weather systems can have westerly winds and still not be tropical cyclones.



Some relatively recent name-changing technology

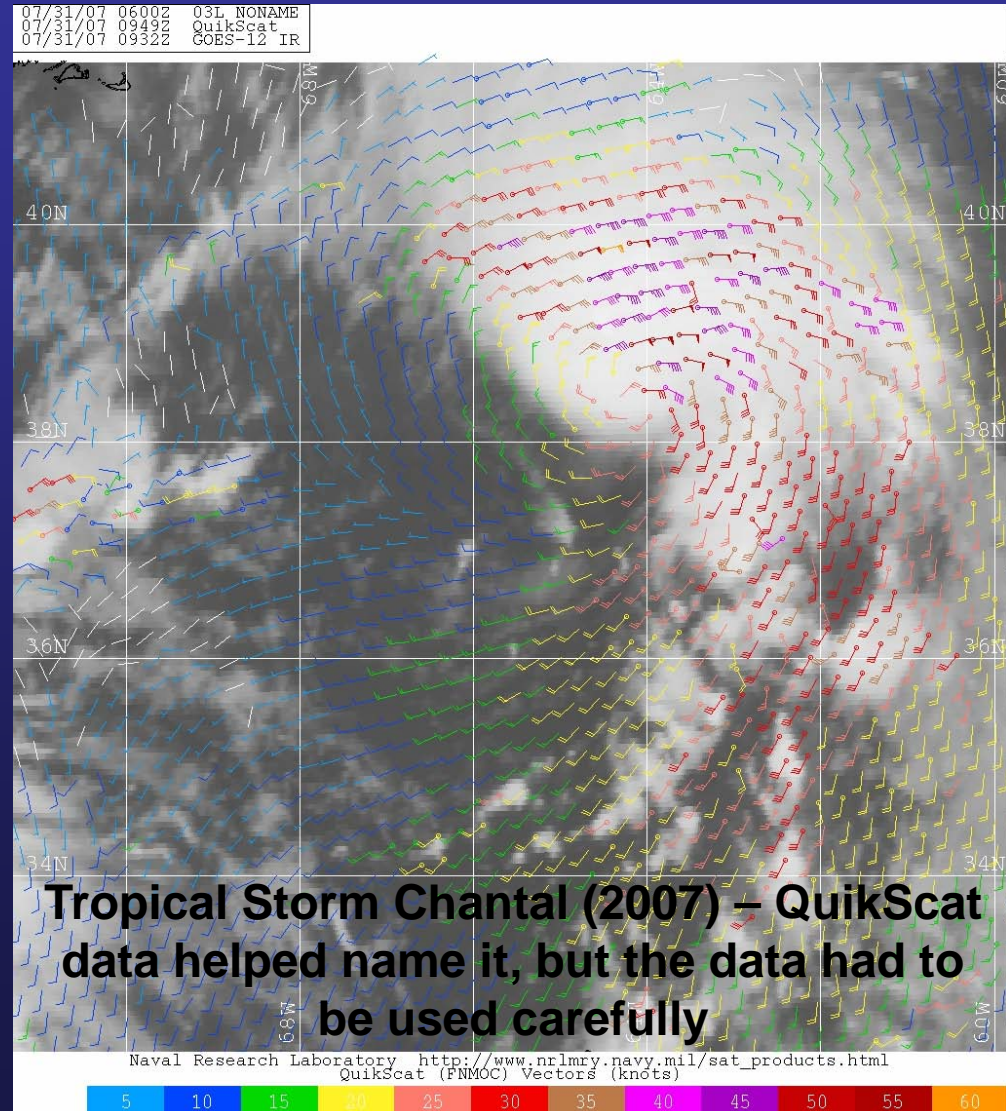
- **Scatterometers (ASCAT and QuikScat)** – satellite-based instruments that report estimates of ocean surface wind speed and direction
- **Stepped Frequency Microwave Radiometer (SFMR)** – aircraft-based instrument that reports surface wind speed estimates
- **Advanced Microwave Sounding Unit (AMSU)** – satellite-based instrument that measure atmospheric temperatures, which in a tropical cyclone can be related to the intensity



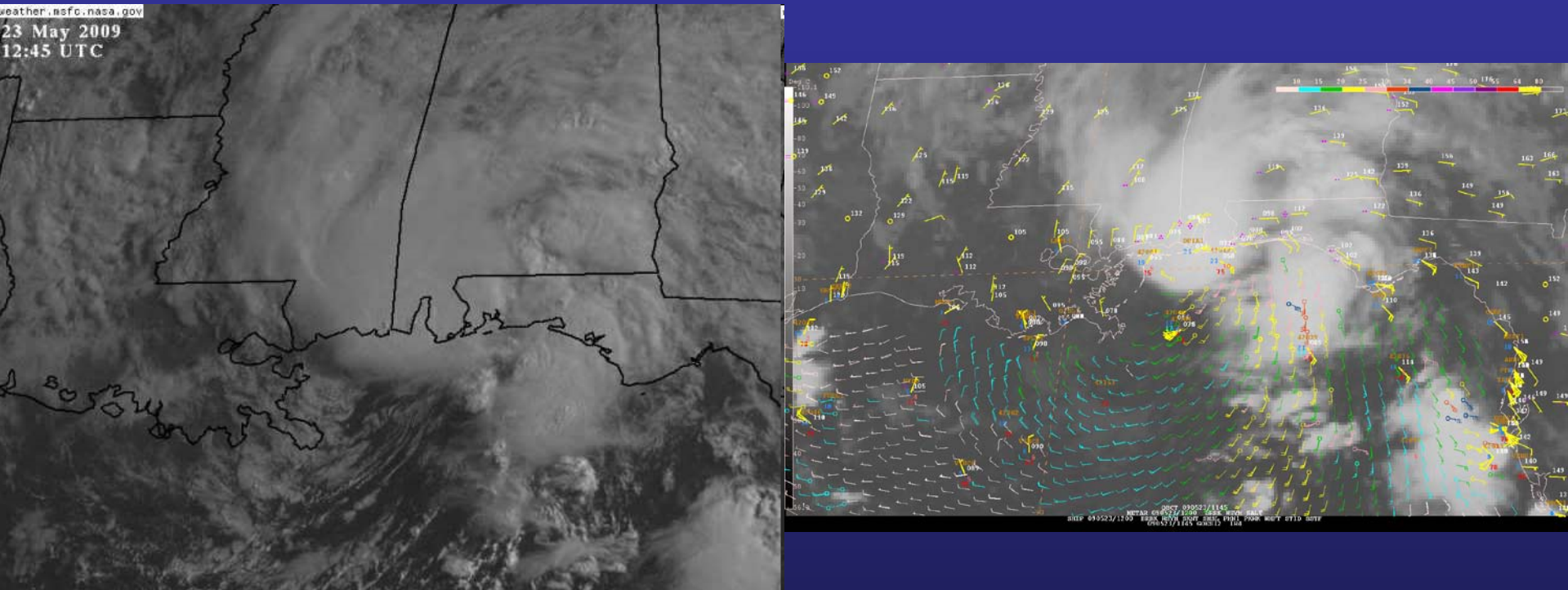
AMSU-derived cross-section of temperature anomalies in Hurricane Floyd (1999)

Some relatively recent name-changing technology

- These instruments have allowed the NHC to identify tropical storms that in years past might have been called tropical depressions.
- These particular technologies have issues with winds in the 30-35 kt range, and thus must be interpreted with caution.

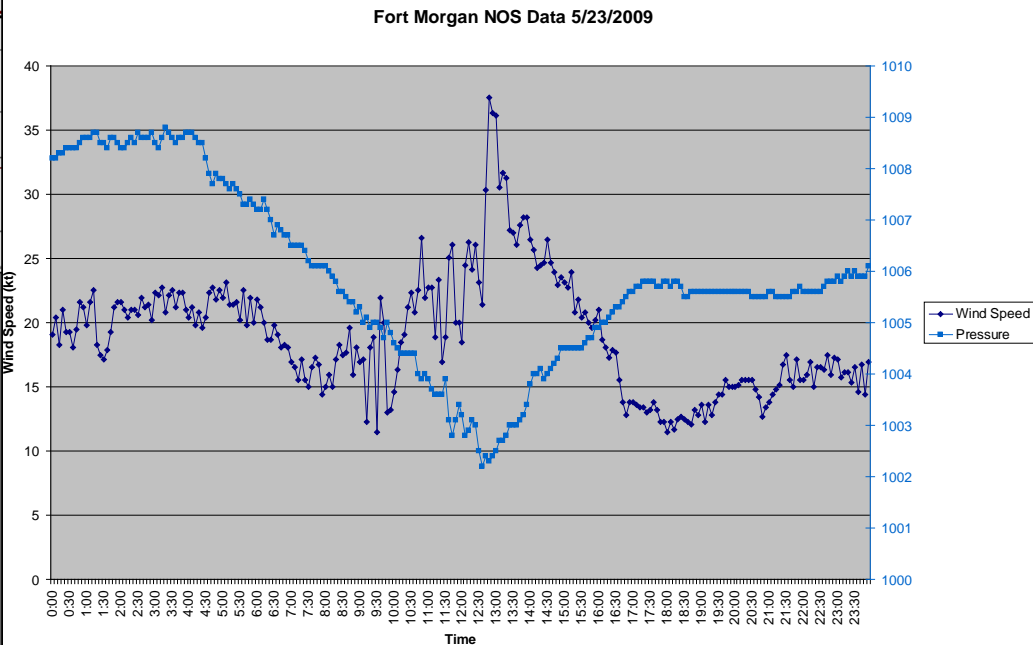
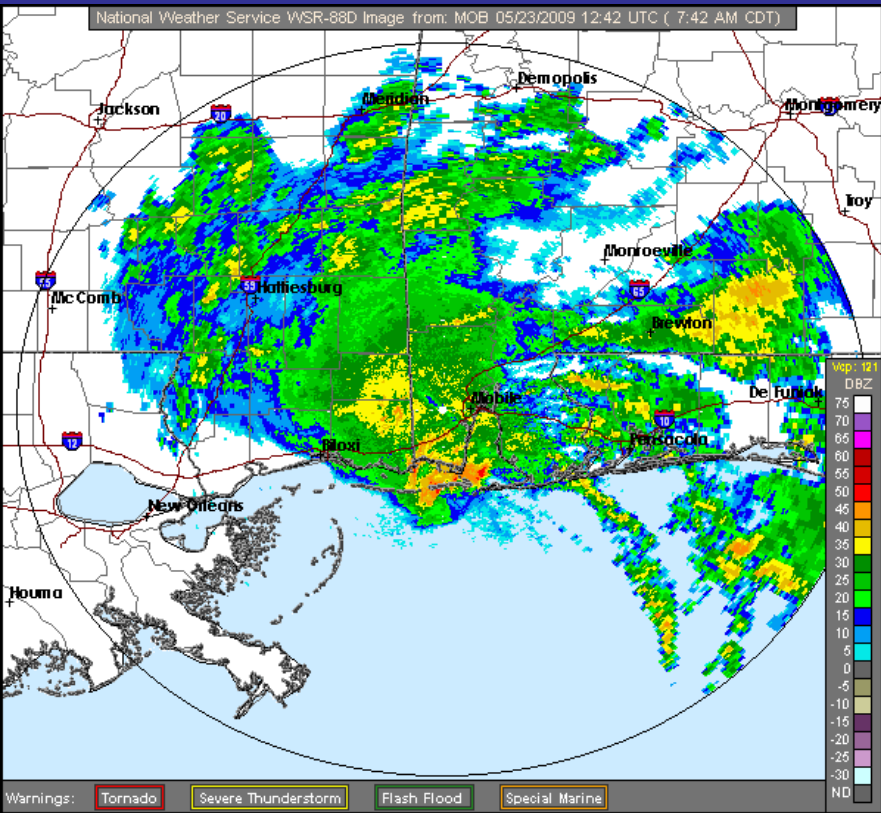


May 2009 Gulf Coast System



A non-frontal low-pressure system over the northern Gulf of Mexico developed central convection just before it made landfall on the northern Gulf coast. Sustained tropical-storm force winds occurred along portions of the Alabama coast.

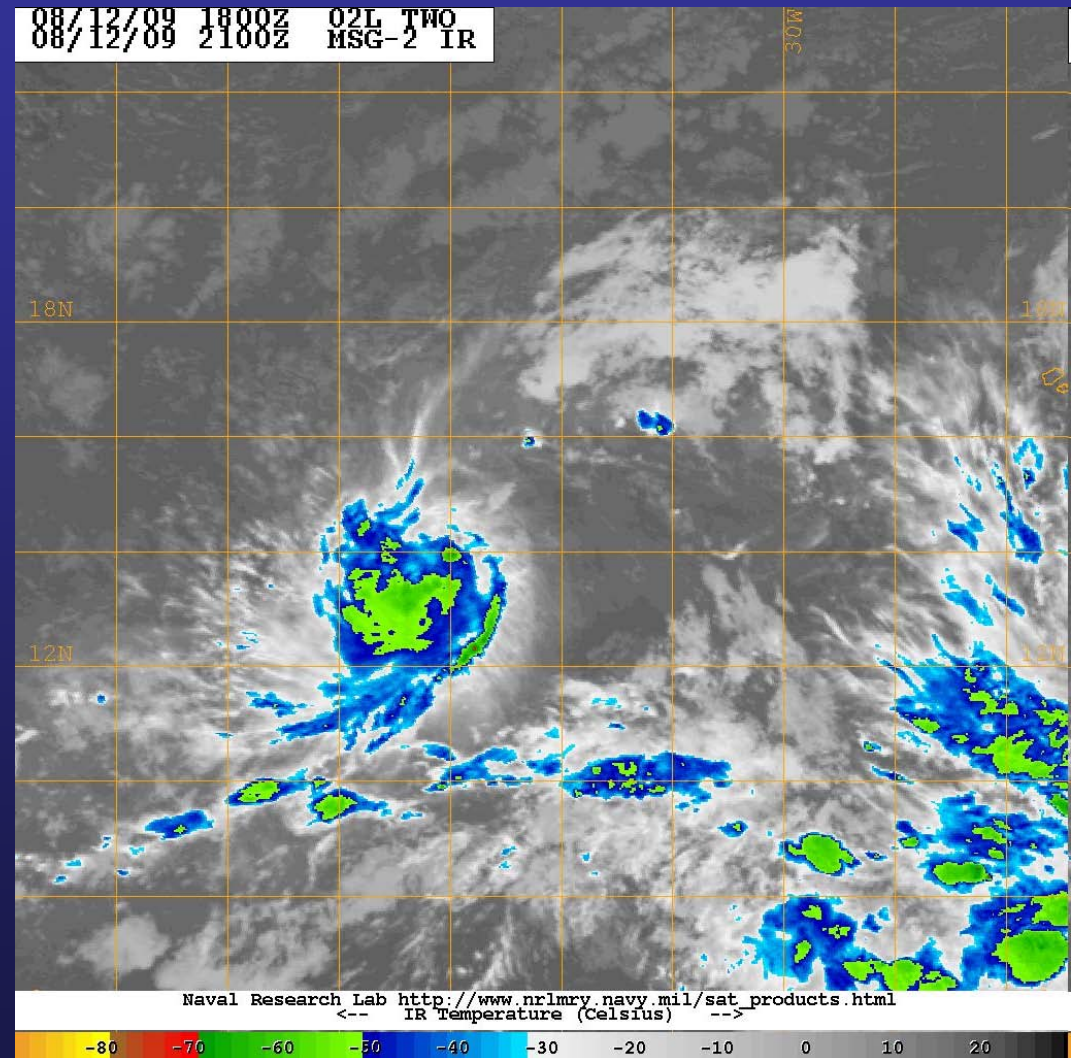
May 2009 Gulf Coast System



After internal debate, it was decided not to call the system a tropical storm after the fact due to doubts of whether the system met the well-defined circulation and organized convection criteria.

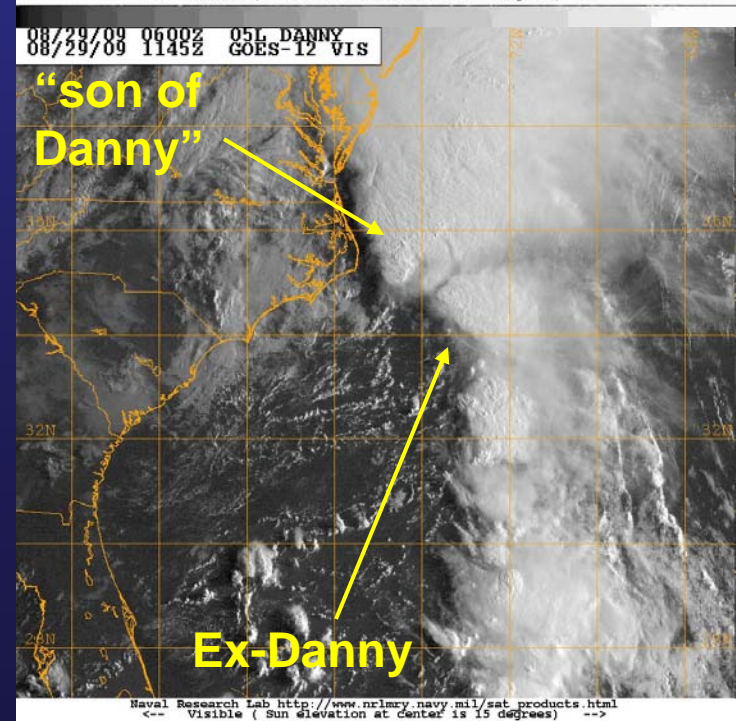
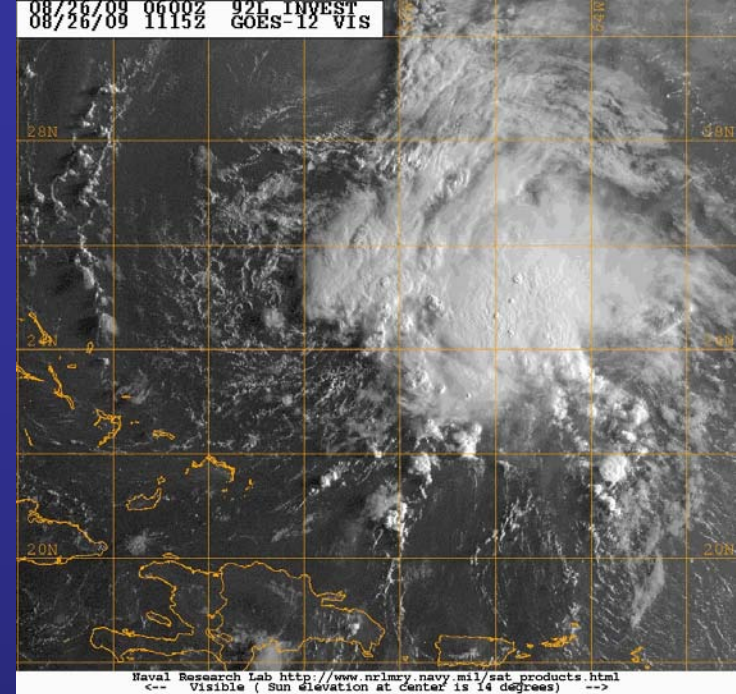
Tropical Storm Ana

- Satellite intensity estimates at 1800 UTC 12 August were 35 kt. However, the thunderstorms decreased significantly between then and the advisory time 3 hours later.
- The decision: Not to name at that time! The depression was named Ana three days later.

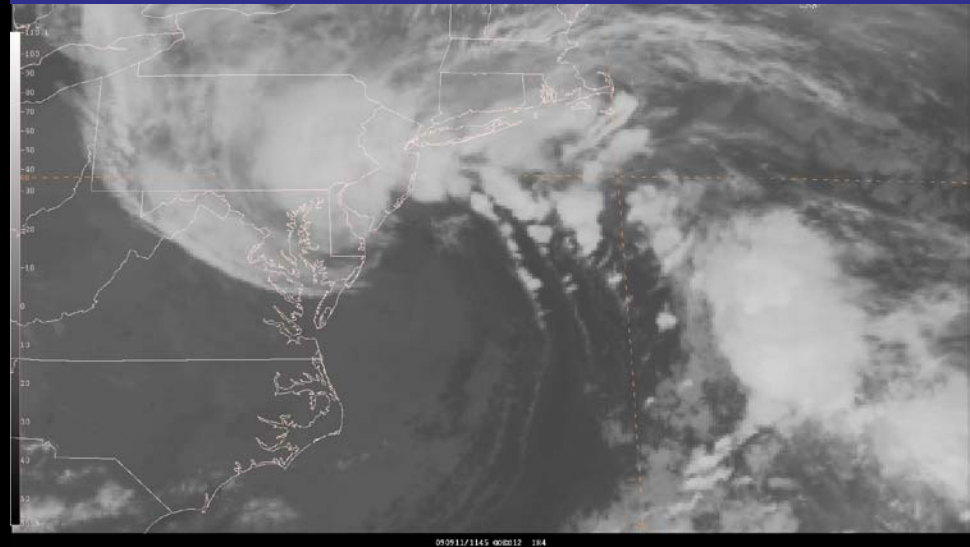
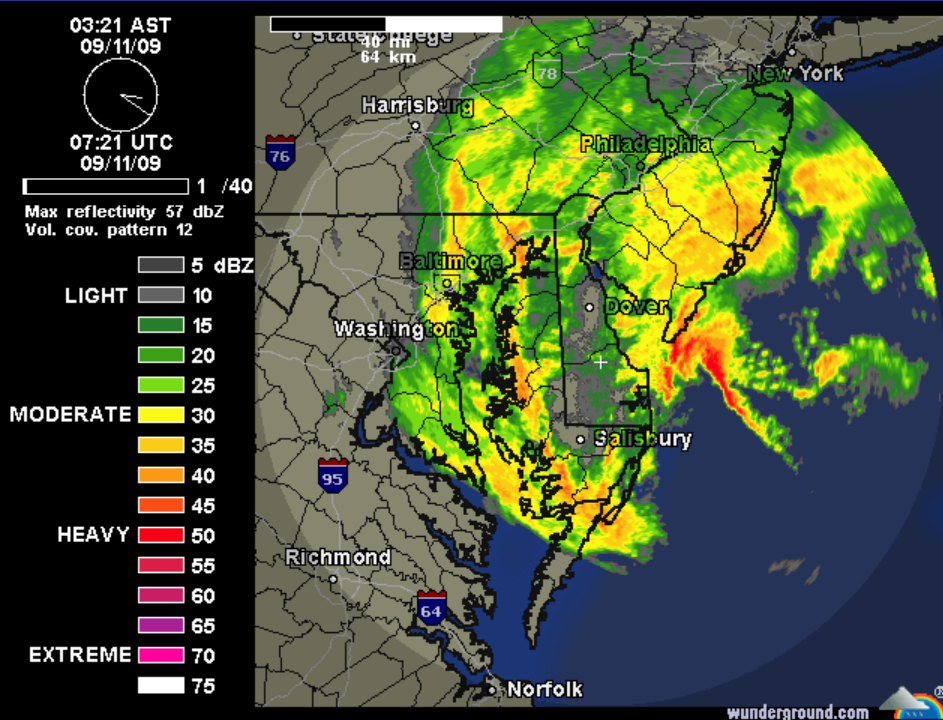


Tropical Storm Danny

- An aircraft mission on 25 August reported tropical-storm force winds, but no closed circulation. Not named then!
- Danny was named the next day when satellite imagery showed a circulation had formed.
- Danny could have been subtropical for parts of its life.
- Was “son of Danny” a subtropical cyclone? Probably not.



New Jersey Coast Low September 2009

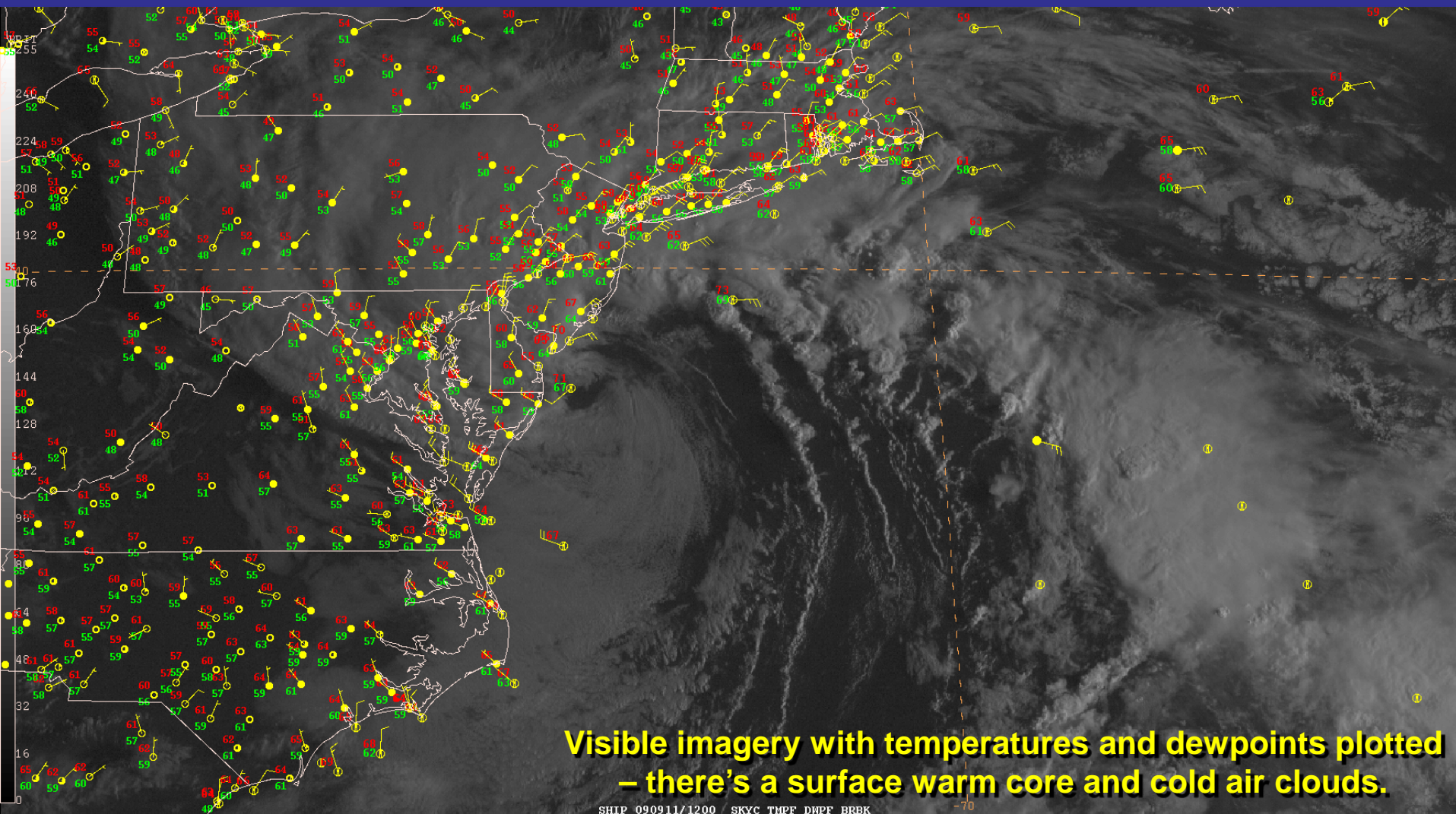


**Radar animation courtesy of the
Weather Underground**

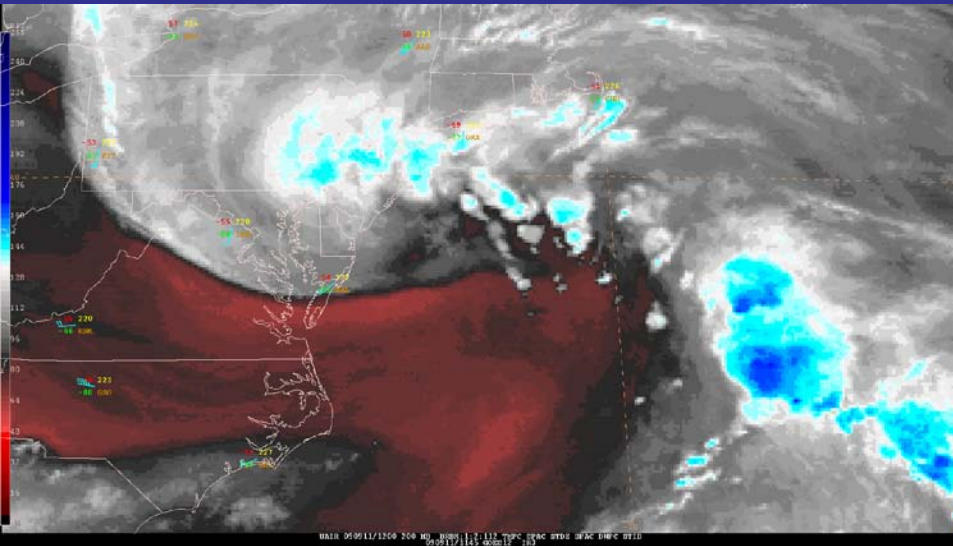
**Infrared imagery showing the
associated convection**

A low-pressure area moving northeastward off the U. S. east coast merged with a front, then turned northwest toward the Mid-Atlantic states. Convection developed as the low approached New Jersey.

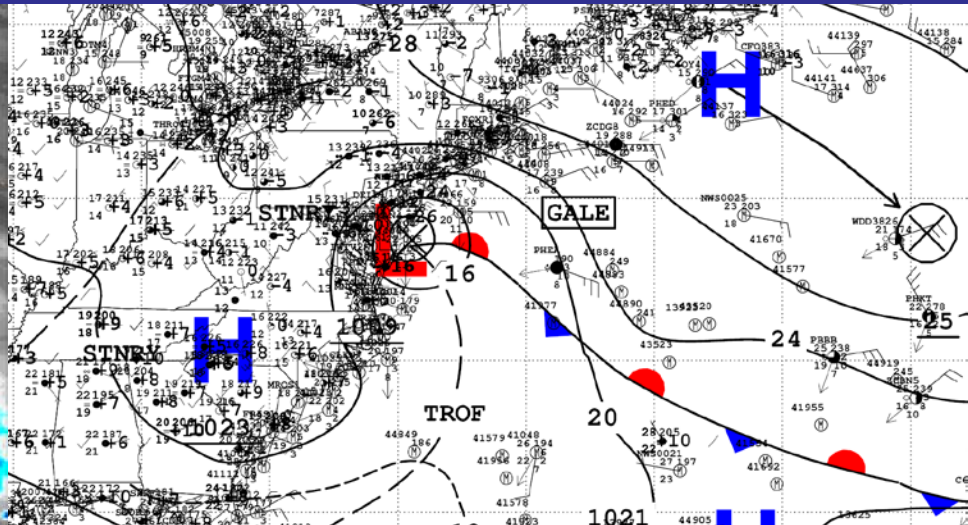
New Jersey Coast Low September 2009



New Jersey Coast Low September 2009



Water vapor imagery and 500 mb raobs

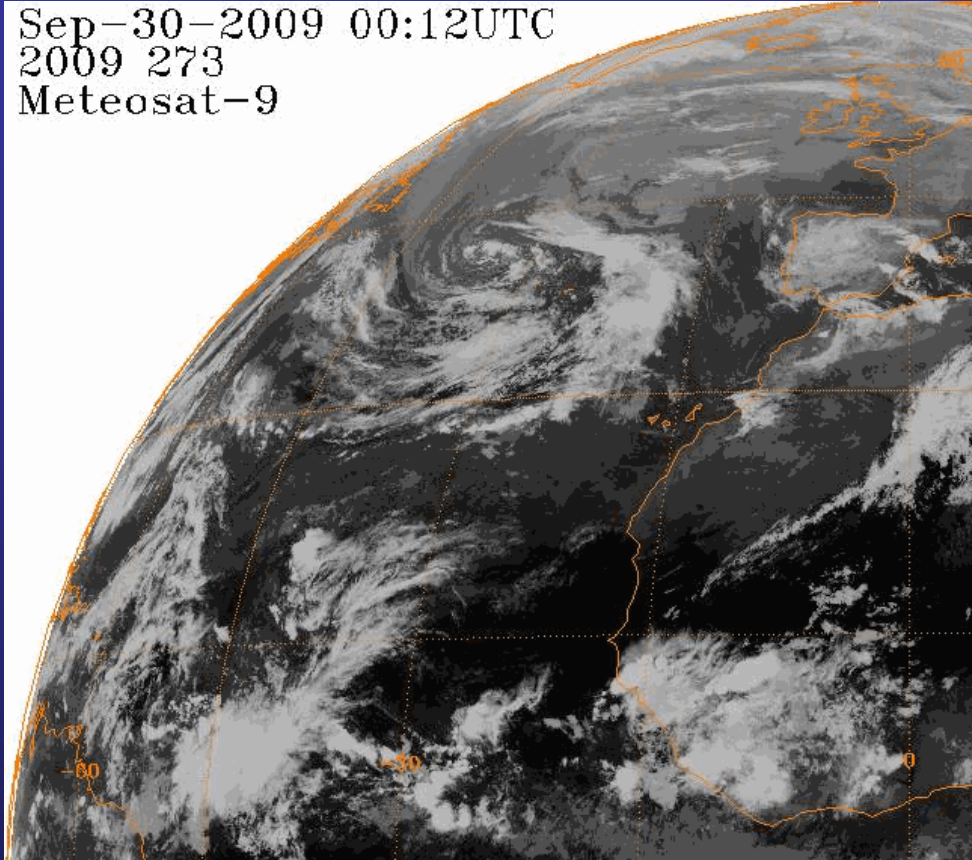


Surface map

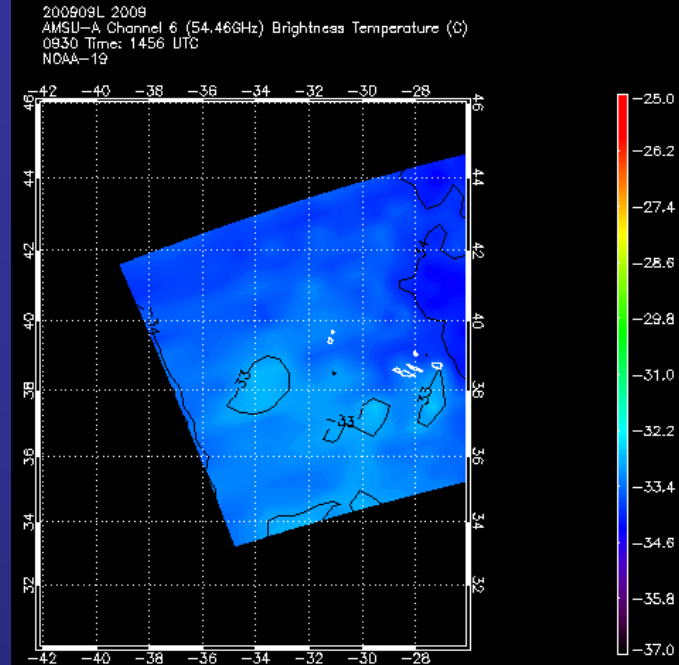
This system had a warm core and some organized convection. However, the warm core resulted from a seclusion process, and the system maintained frontal features until after landfall. It had too much frontal character to be considered a tropical or subtropical cyclone.

Tropical Storm Grace

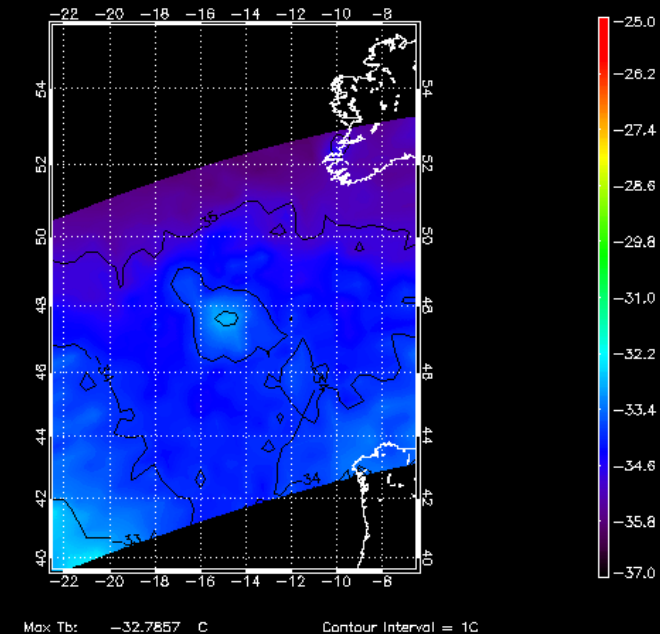
Sep-30-2009 00:12UTC
2009 273
Meteosat-9



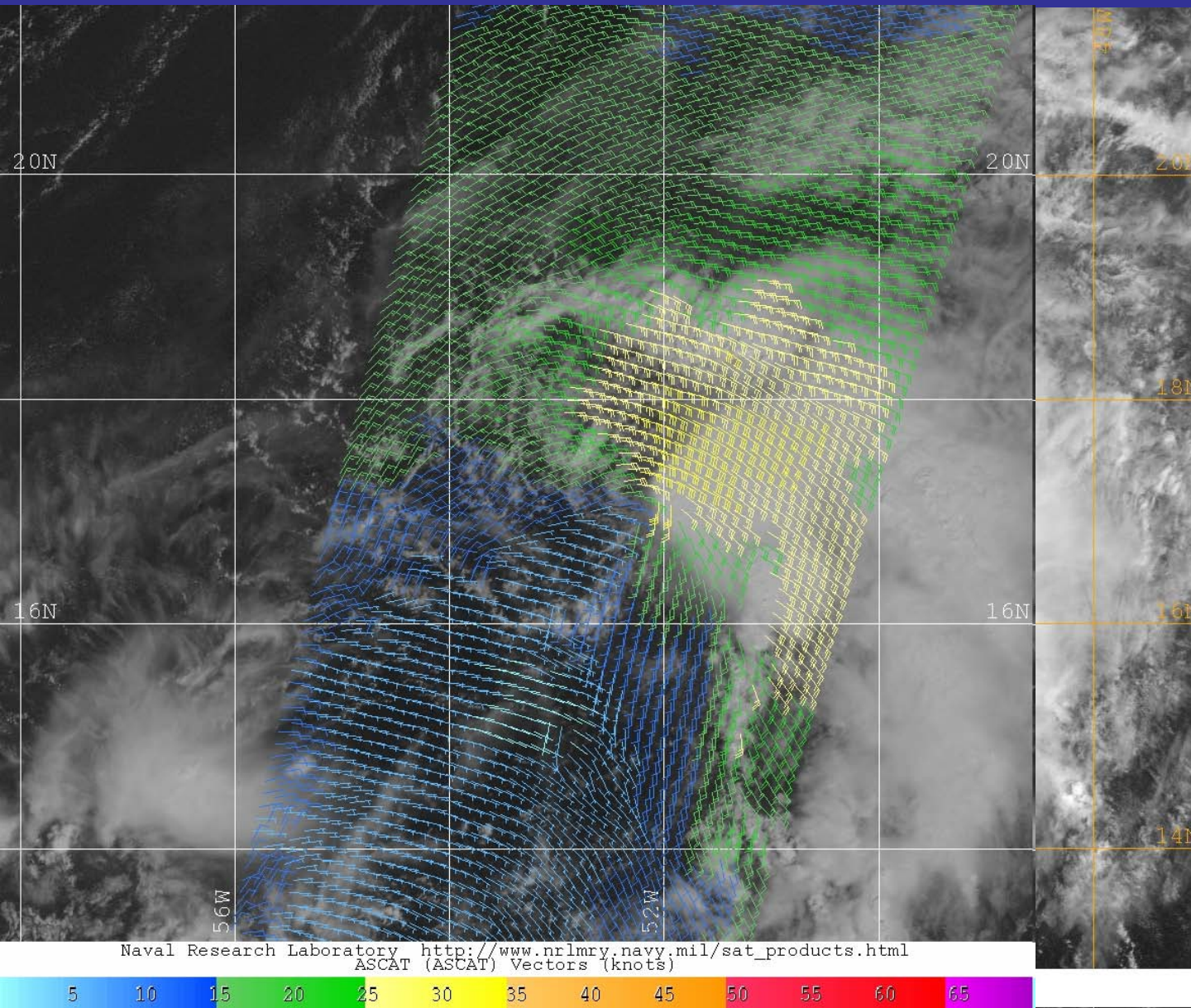
Grace was problematic in terms of naming. The pre-Grace low developed organized convection long before it lost frontal characteristics or developed a tropical cyclone warm core. It also was never embedded in a truly tropical air mass or over tropical SSTs.



Max Tb: -32.8154 C Contour Interval = 1C
200909L 2009
AMSU-A Channel 6 (54.46GHz) Brightness Temperature (C)
1005 Time: 2150 UTC
METOP-A



Tropical Storm Henri

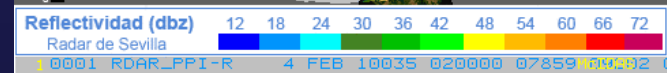
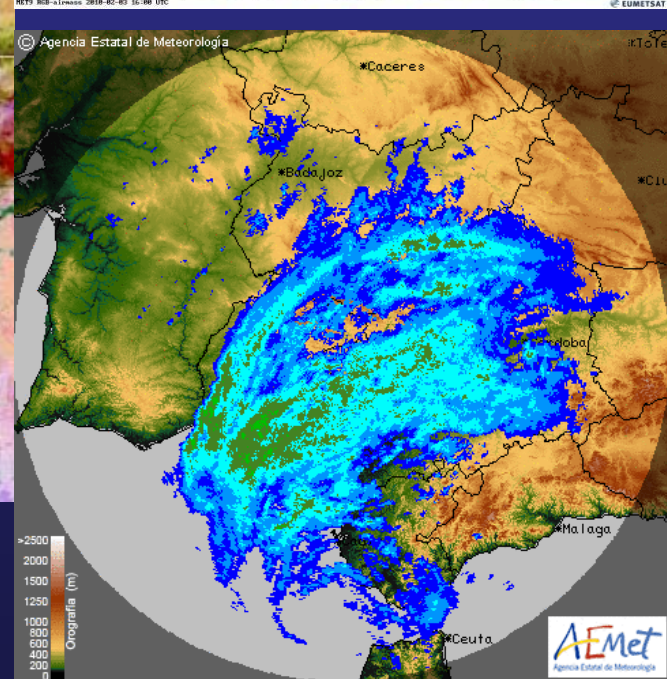
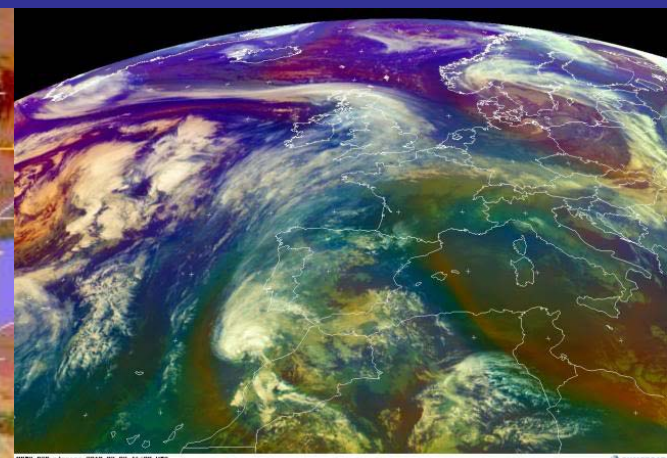
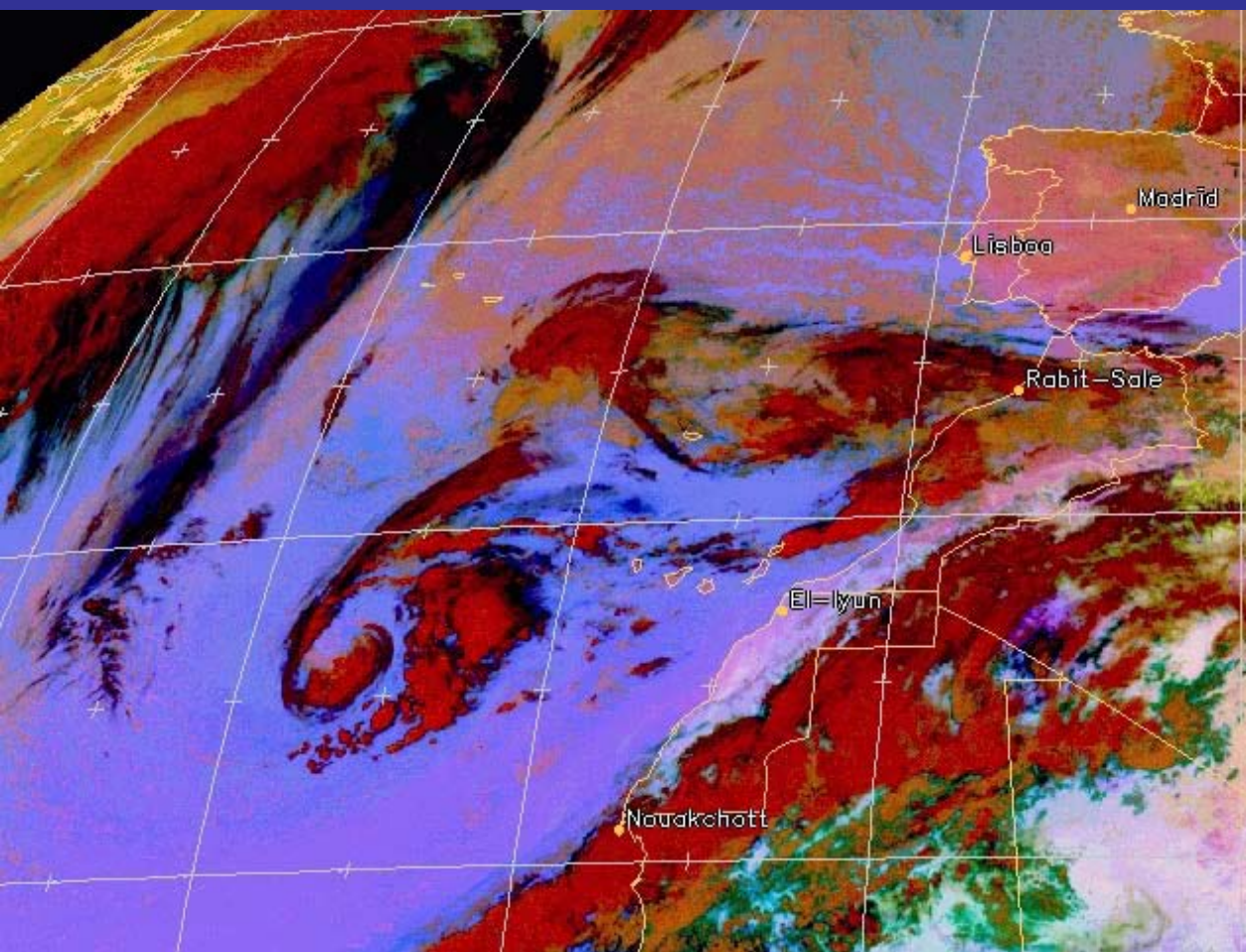


ASCAT data showed 35 kt winds, but there was no closed circulation when the low-cloud swirl first appeared!

Henri was named when visible imagery showed a closed circulation had formed.

Storms named due to scatterometer data may become less frequent with the demise of QuikScat.

February 2010 Canary Islands Low



Non-tropical low pressure area that developed organized convection, but was likely too frontal to be a tropical or subtropical cyclone.

Summary

- Designating a system a tropical or subtropical cyclone is not a trivial matter. It affects not only warning and response, but climatology as well.
- Cyclones can have one or more of the characteristics of a tropical or subtropical cyclone, but still not have enough of *all* of them to meet the NHC definitions.
- Even with today's technology, it can be difficult to determine if a cyclone meets the NHC definitions.
- Our understanding of cyclone types still needs some work!