Remote Sensing Data for the Visualization of the Water Cycle in the Current Climate System

Professional Development Seminar

Lehman College, May 14th 2015

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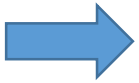
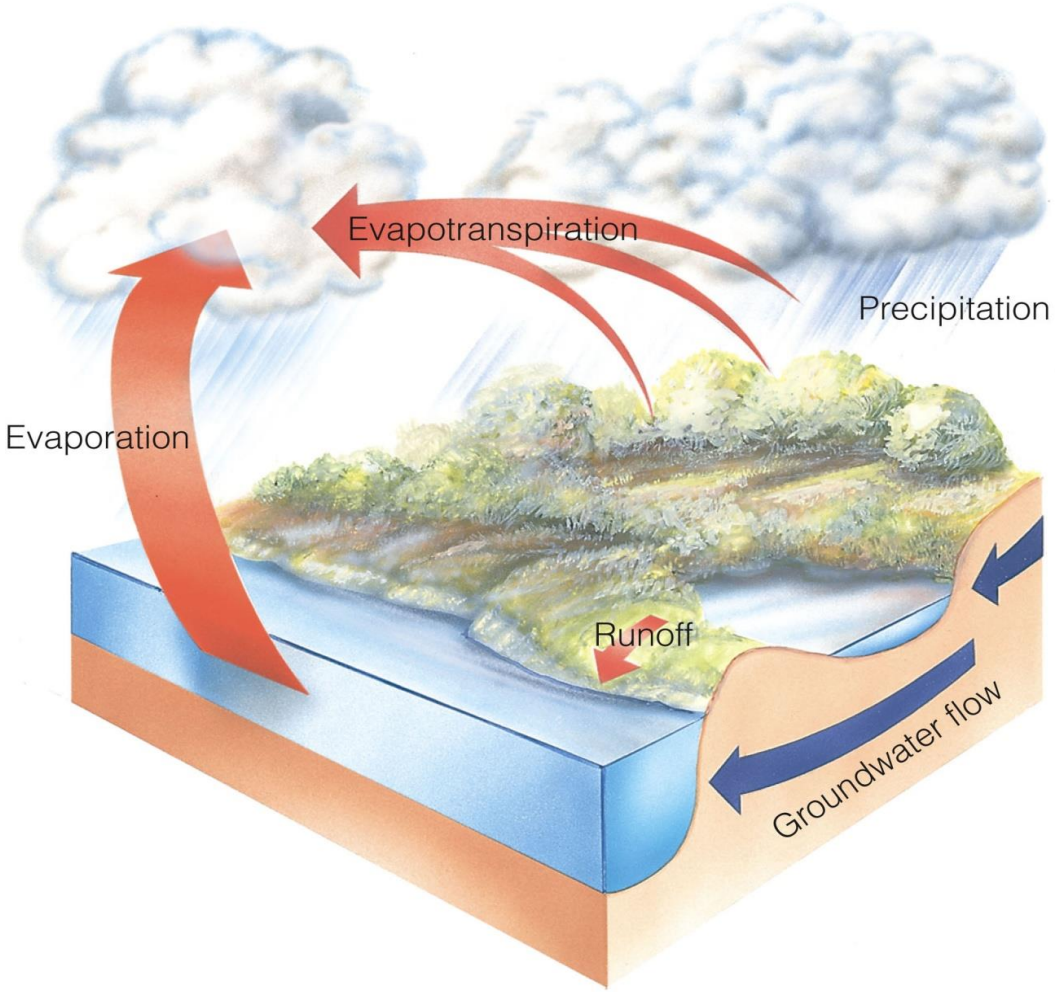


Objectives and Short overview

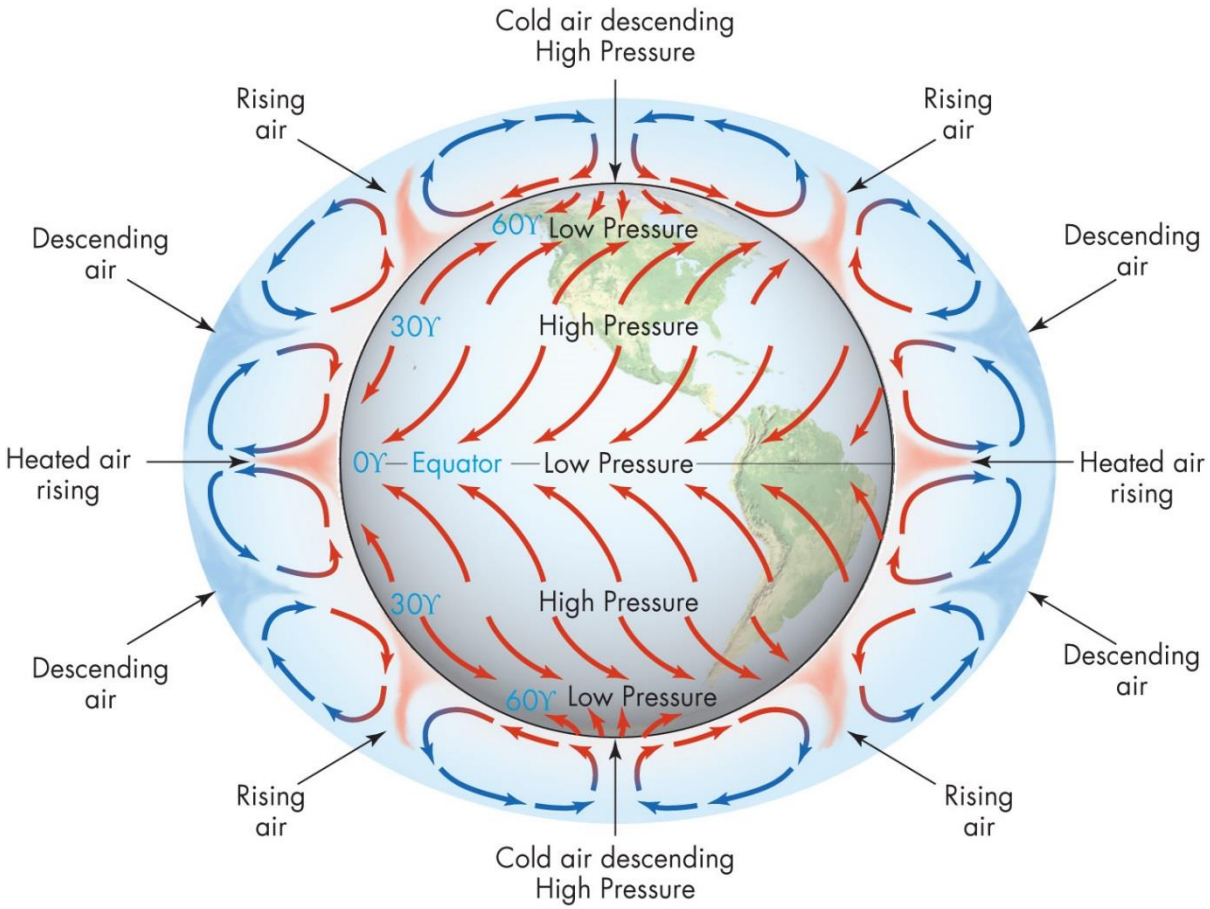
Objective : bridge education and science

- Basic concepts:
  - Water cycle
  - Coriolis effect
  - Remote Sensing: brief introduction and applications
  - Remote sensing technique in measuring moisture
  - Hurricane elements
  - Brief intro to Remote Sensing
- Exercises with TRMM and WINDSAT data using Sandy as an example
- Wrap-up and evaluation

Hydrologic Cycle: the driving force of life

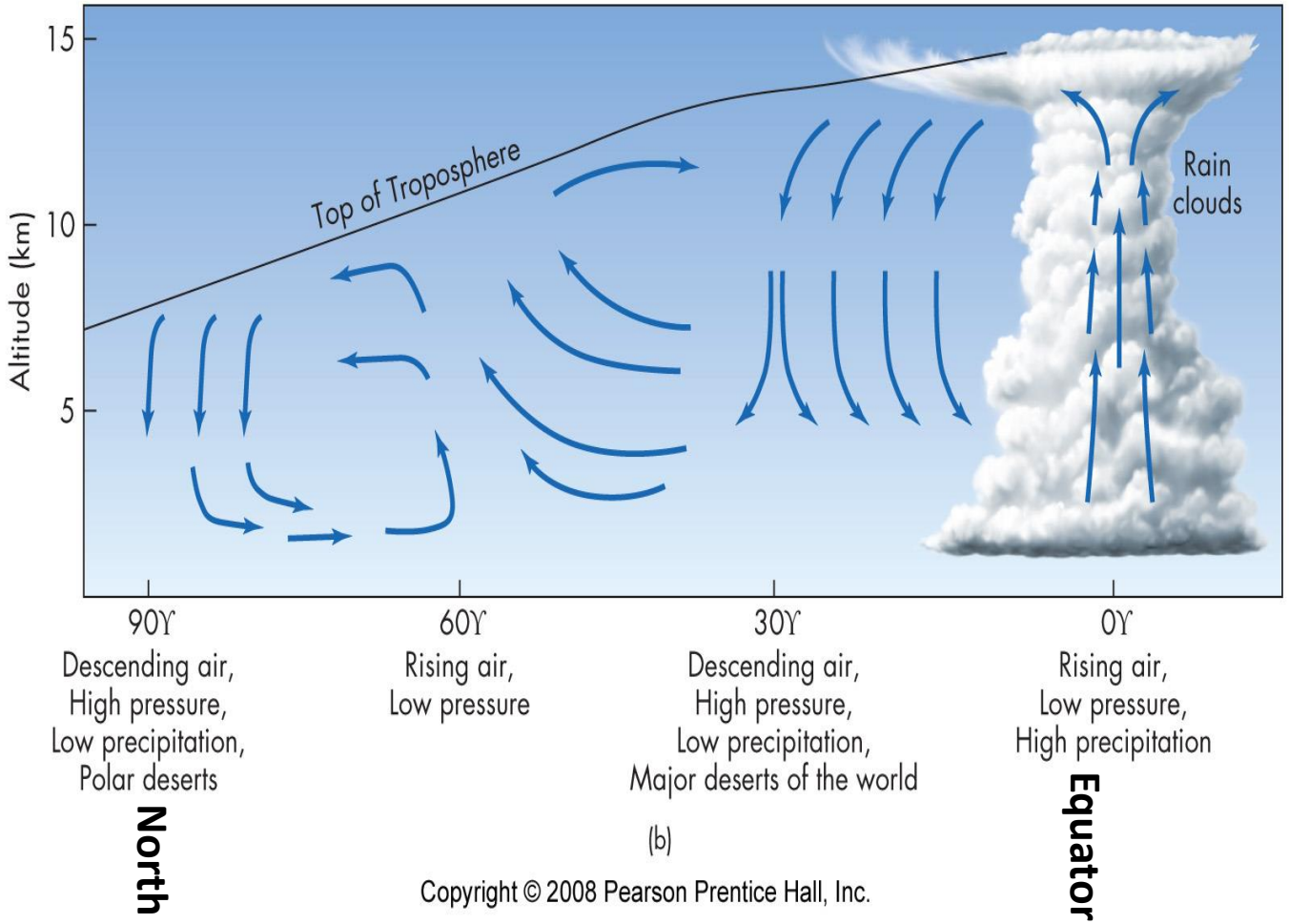


General atmospheric circulation



(a)

General atmospheric circulation

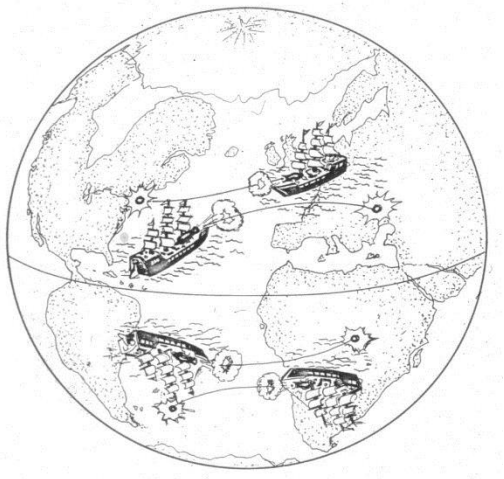


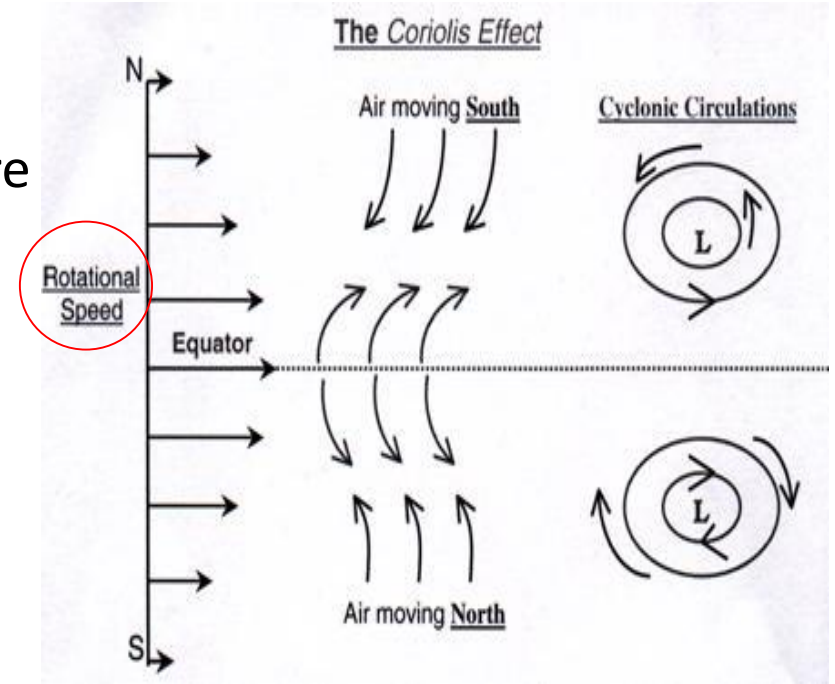
Coriolis Effect: distribution of forces driving winds and moisture

The Coriolis effect on a moving object is perpendicular to the direction the object is traveling (Northern hemisphere – right; Southern – left)

Cyclone: an area or center of **low pressure** with rotating winds

- Counter-clockwise in Northern Hemisphere
- Clockwise in Southern Hemisphere



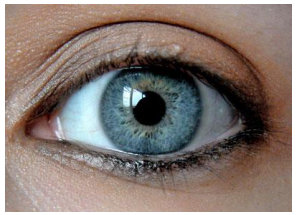


What is remote sensing?

- Any examples of remote sensing systems (in addition to satellites)?
- What is Remote about Remote Sensing?
- What is remote sensing actually sensing?

What is remote sensing (RS)?

Your eyes!



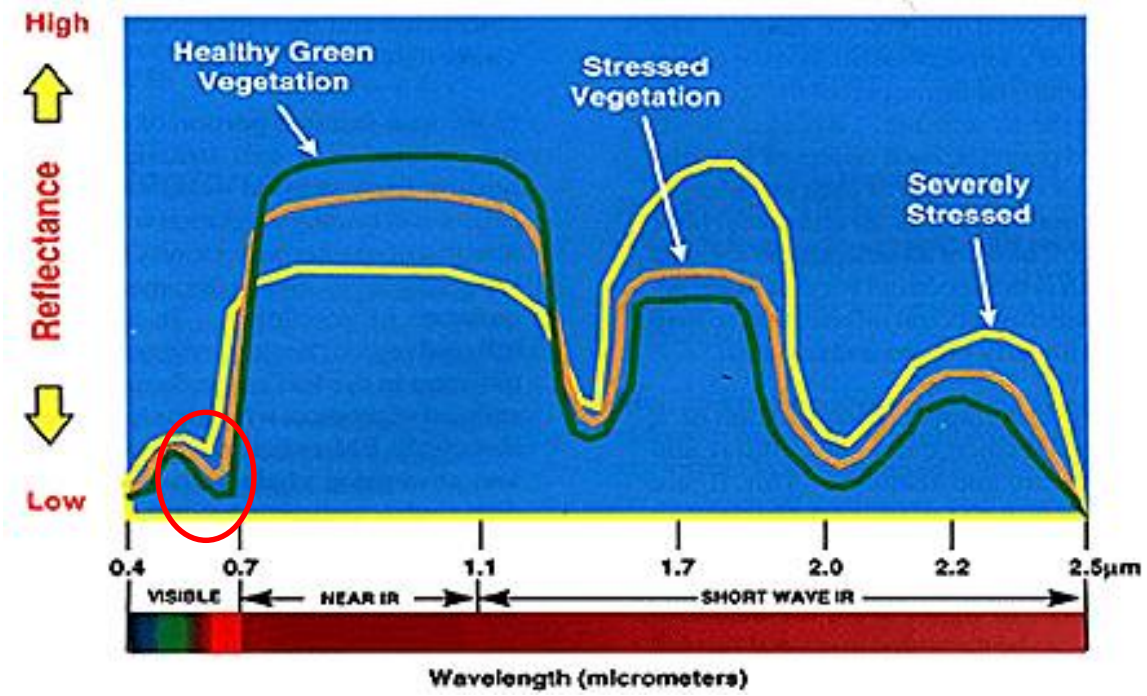
Airborne Data

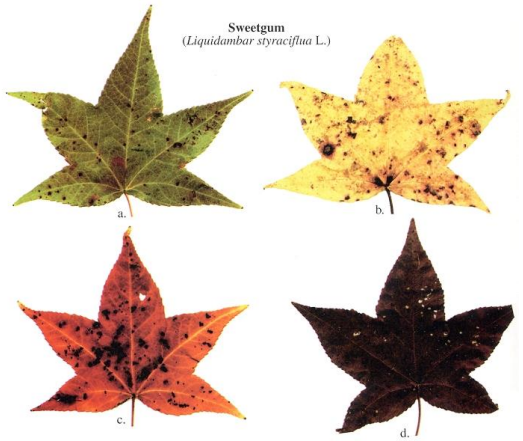
Satellite based

"The science of deriving information about an object from measurements at a distance from the object" (Landgrebe, 1978, p. 1)

More technical definition:

"the practice of deriving information about the Earth' s land and water surfaces using images acquired from an overhead perspective, using **electromagnetic radiation** … **reflected or emitted** from the Earth's surface" (Campbell, 2011, pp. 6)





http://rst.gsfc.nasa.gov

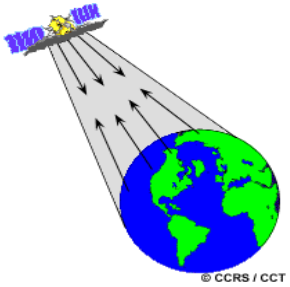
-> Basic principle of RS: Different features (e.g., earth surface) emit or reflect electromagnetic radiation differently

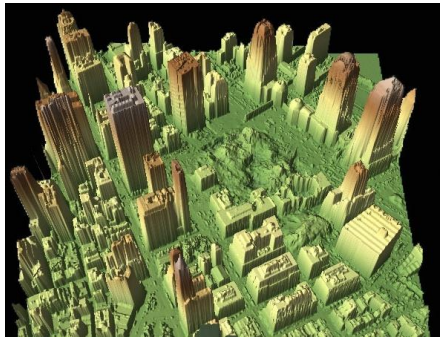
-> Example: healthy plants reflects more green light that red and blue in the visible.

Passive vs. Active RS

RS requires a source of energy to characterize different targets (e.g., land covers types)

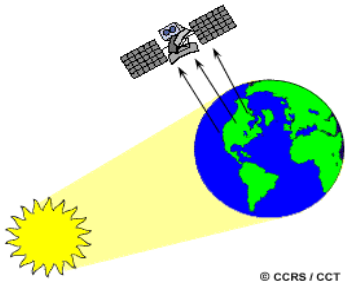
- **Active RS:** the sensor emits its own energy (e.g., radio waves) and records how long it takes them to come back along with their intensity (sonar, radar , LIDAR, etc)



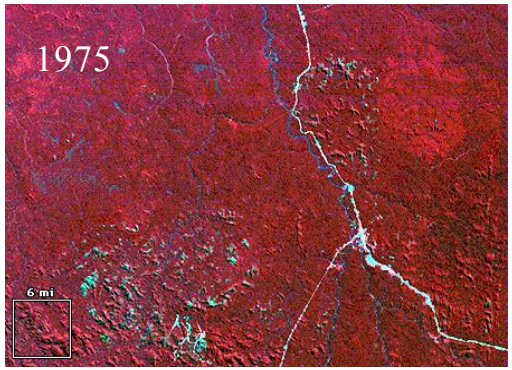


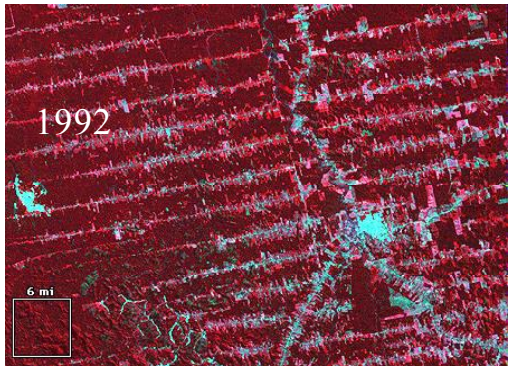
LIDAR image of ground zero (Sept. 27, 2001)

- **Passive RS:** the sensor records radiation, (e.g., solar energy) reflected or emitted back from the ground or atmosphere (e.g., particles)

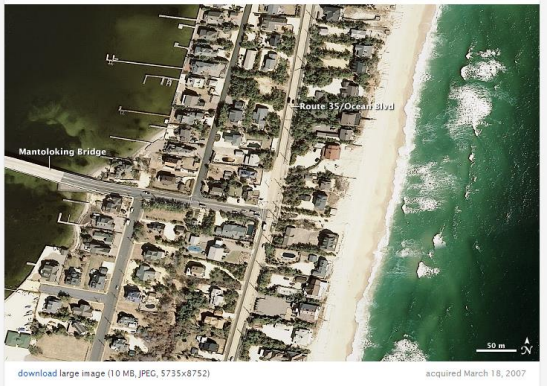


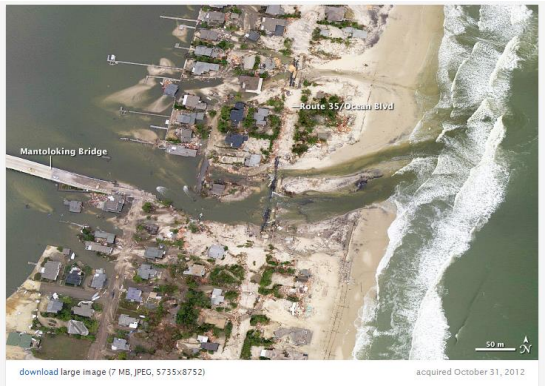
Some RS Applications



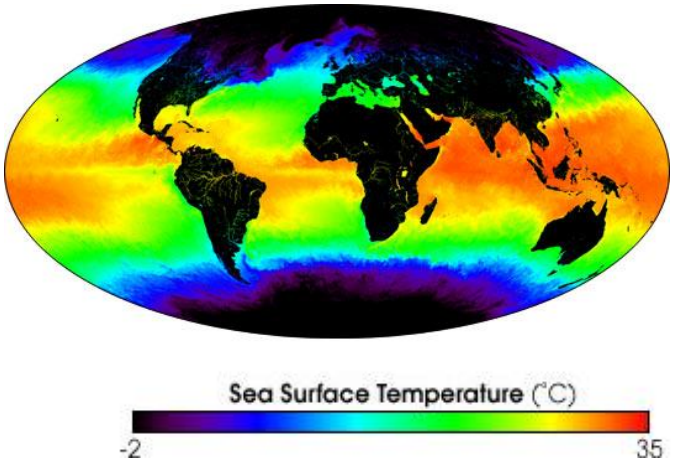


Environmental

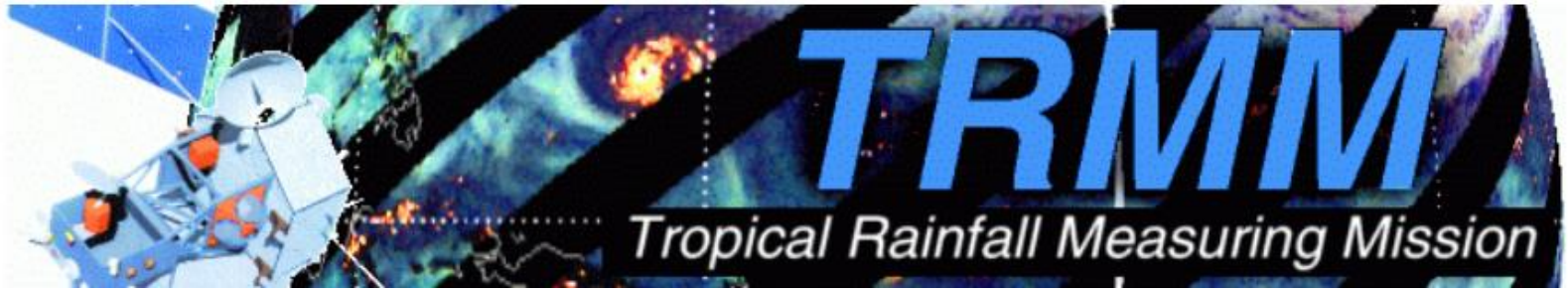


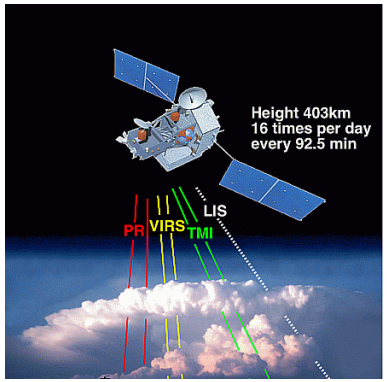


Disaster Management

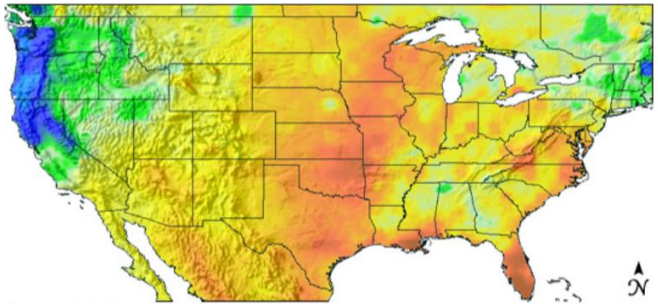


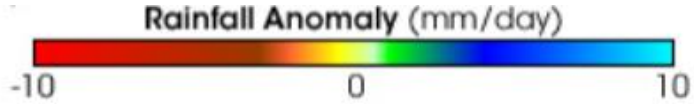
Weather and climate





- Active RS for rainfall (weather & climate)
- NASA and Japan Aerospace Exploration (JAXA) joint mission. Not only Tropical!
- 17 years of data (from 1998 (ended April 2015).
- Several instruments on board of TRMM (precipitation = Precipitation Radar-PR):
  - Storm structure (3D!), intensity and distribution of rain, monitoring drought, flooding …
  - Different products @ different temporal resolutions (e.g., global precipitation estimates, global ~ 28km every 3 hours)





Oct. 2005 – Jan. 2006

Main Data Sources for GIS and Remote Sensing (of weather and climate)

Precipitation

Continuous precipitation data (equatorial and sub-equatorial zones)

TRMM: http://trmm.gsfc.nasa.gov/

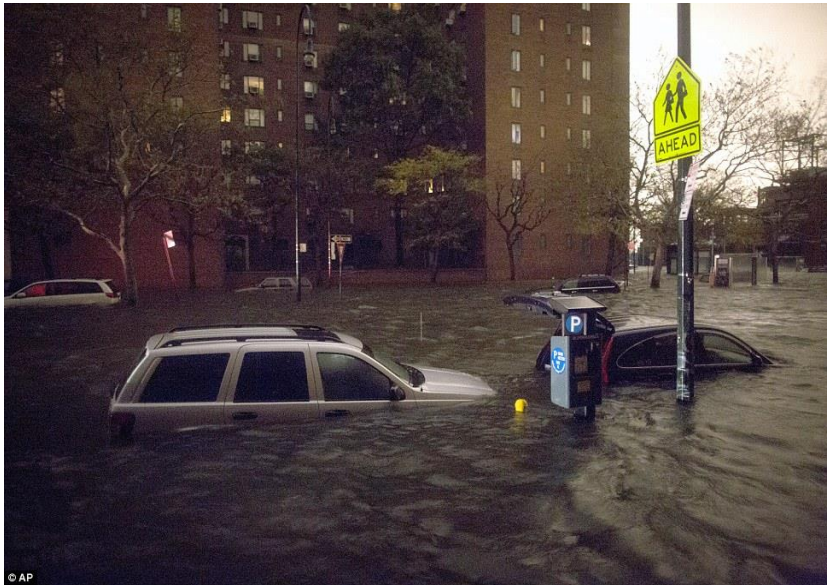
TRMM Video: https://www.youtube.com/watch?t=18&v=-2vdSmlpa8Q

Wind Direction

http://images.remss.com/wind/wind_vector_data_daily.html

Exercise:

Hurricane Sandy, 2012



Vehicles submerged on 14th Street near the Consolidated Edison power plant on Monday in Manhattan, New York

Subway station

Raging: More than 50 homes were destroyed at Breezy Point in the Queens area of New York, as a result of Hurricane Sandy

Flooded areas: Highlighted areas show flooding in New York.

An unprecedented 13-foot surge of seawater - 3 feet above the previous record - gushed into Gotham.

Aerial view of flooding on the bay side of Seaside, New Jersey.

Lobby of Verizon's headquarters in Manhattan.

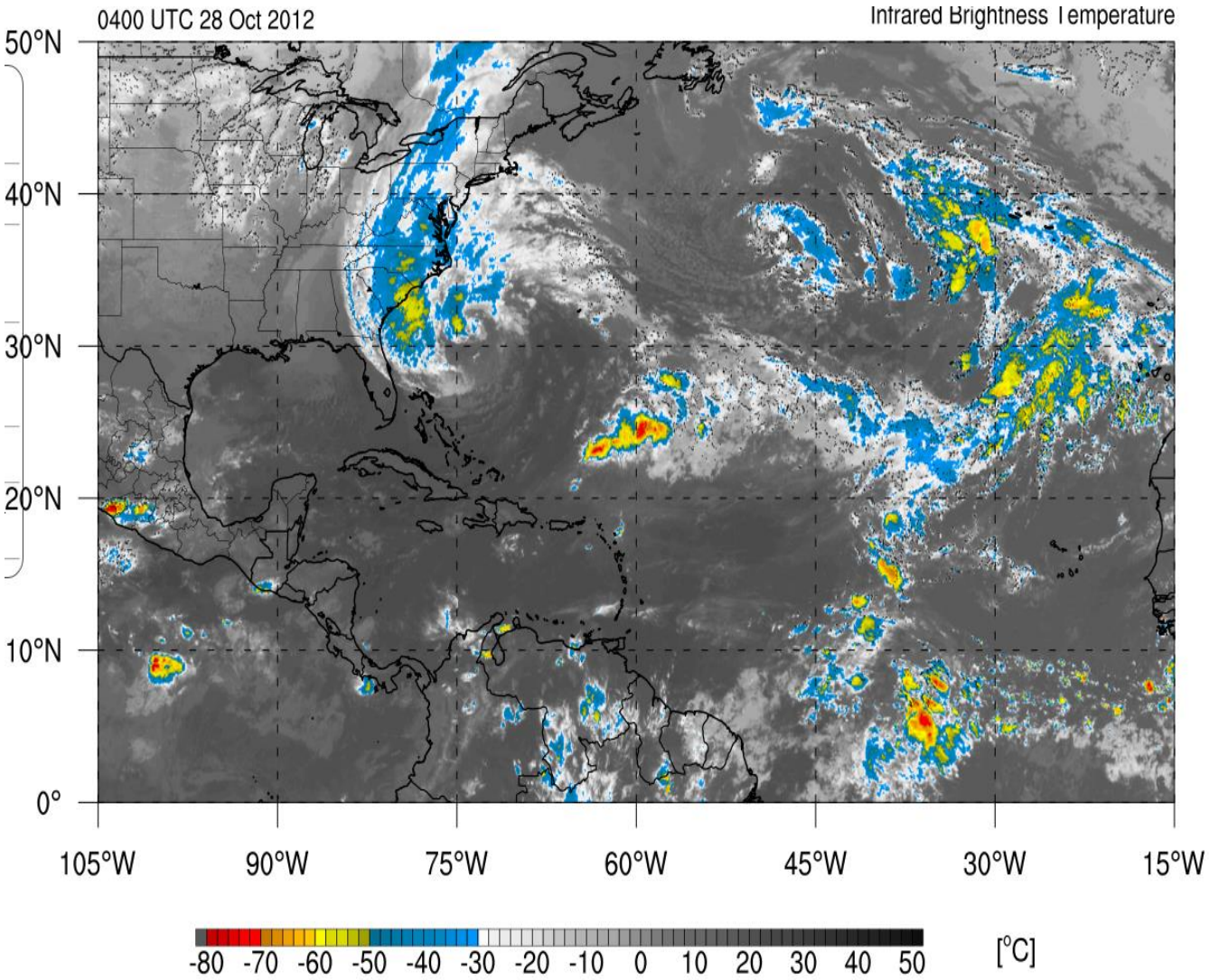
Cars floating after being pushed out a flooded basement in the city during Sandy.

A man looks at an uprooted tree which fell on a car when Superstorm Sandy swept through the Brooklyn borough of NY.

A 168-foot water tanker (John B. Caddell) sits on the shore where it ran aground on Front Street in the Stapleton neighborhood of NY's Staten Island.

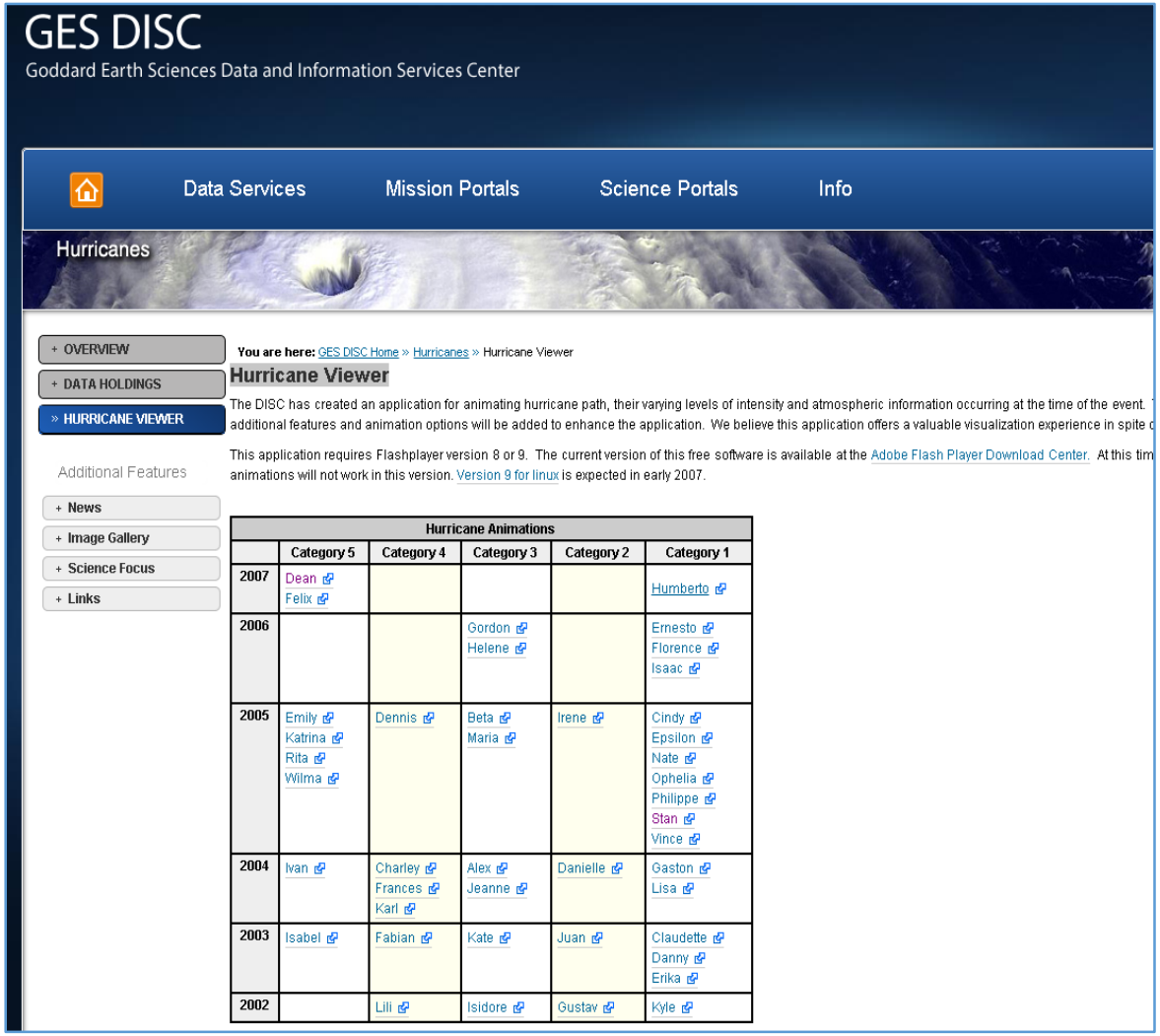
Sandy Visualization

http://www.atmos.albany.edu/student/ppapin/output/sandy/sandy_ir_large.html



http://www.atmos.albany.edu/daes/atmclasses/atm639/links.html

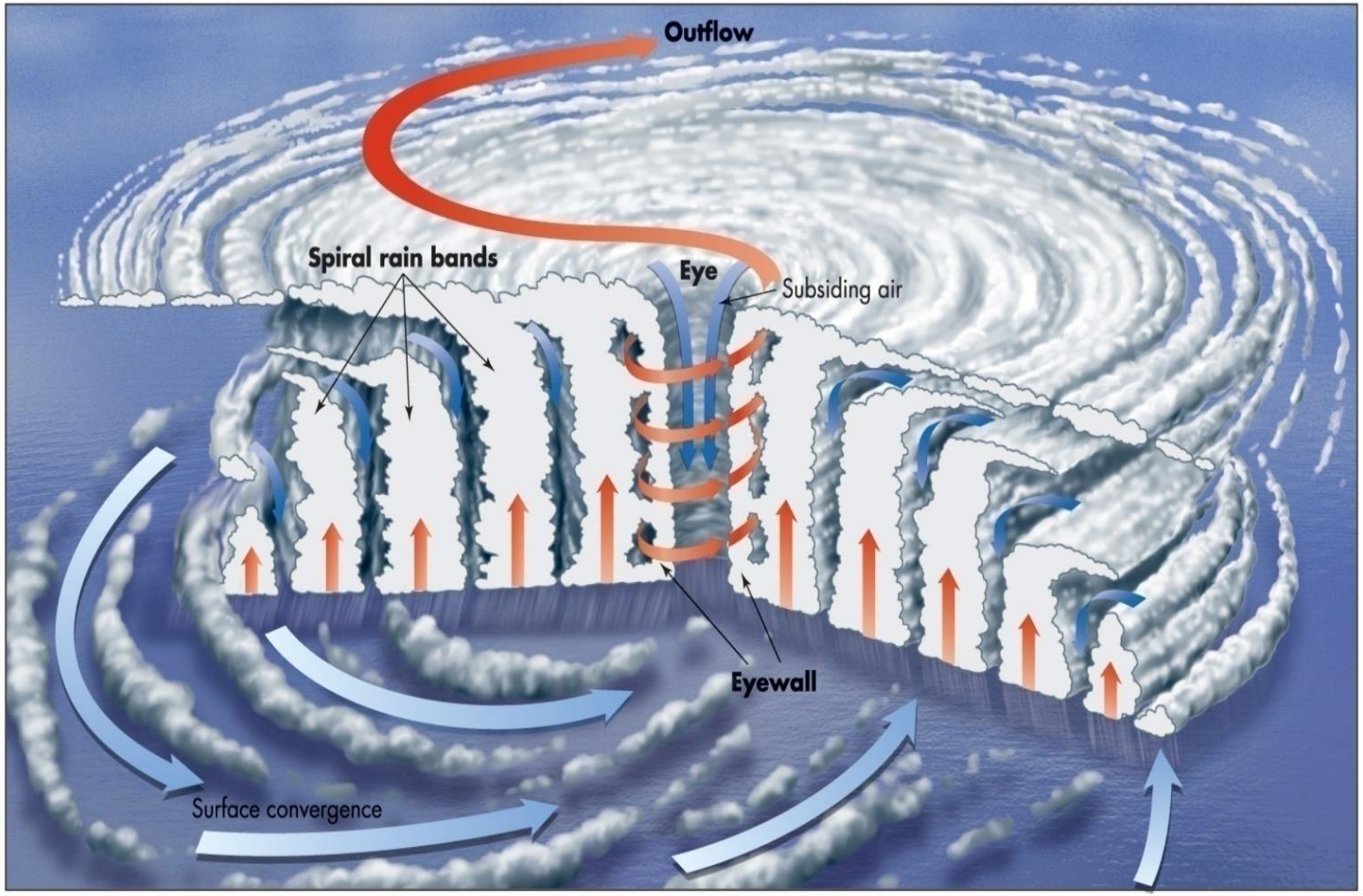
Hurricane Viewer:



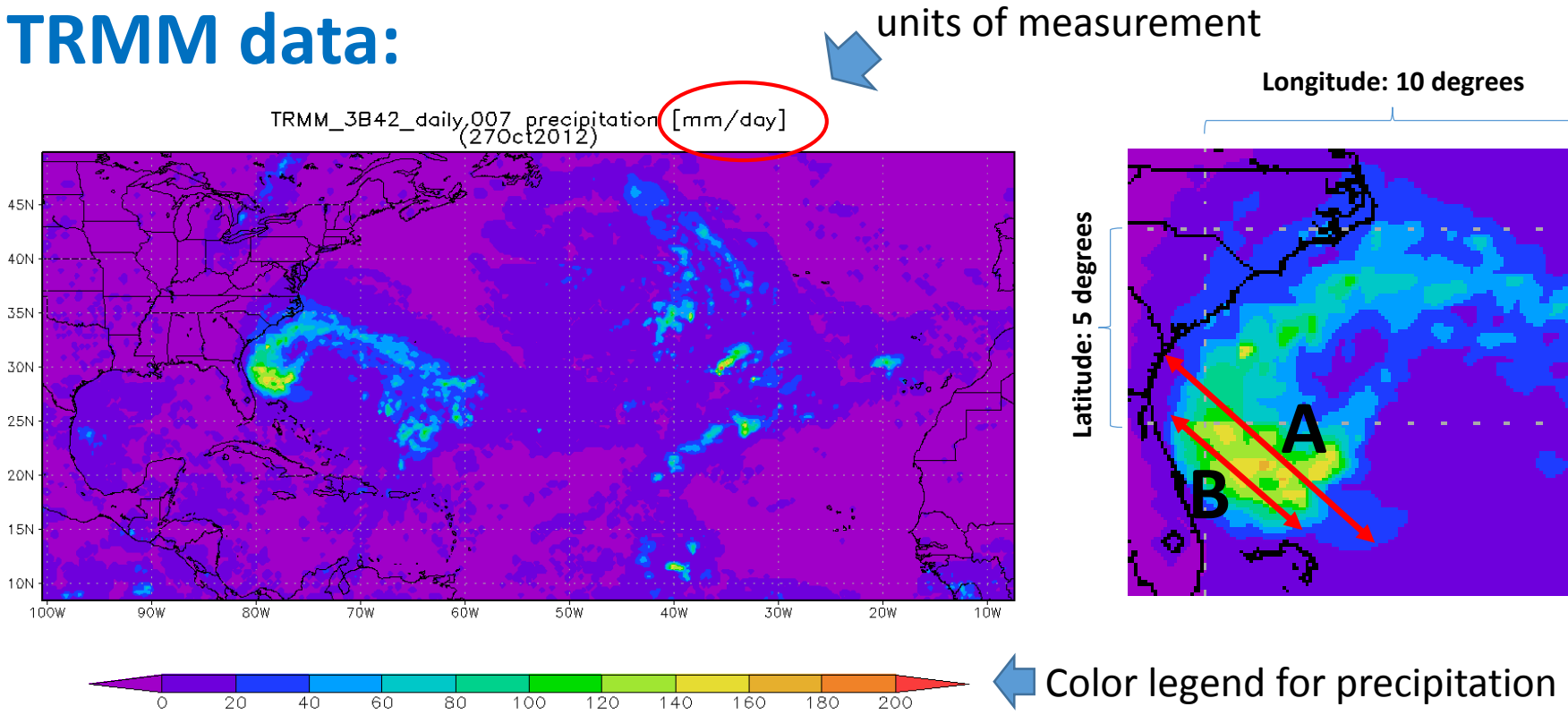
Hurricane Animations					
	Category 5	Category 4	Category 3	Category 2	Category 1
2007	Dean Felix				Humberto
2006			Gordon Helene		Ernesto Florence Isaac
2005	Emily Katrina Rita Wilma	Dennis	Beta Maria	Irene	Cindy Epsilon Nate Ophelia Philippe Stan Vince
2004	Ivan	Charley Frances Karl	Alex Jeanne	Danielle	Gaston Lisa
2003	Isabel	Fabian	Kate	Juan	Claudette Danny Erika
2002		Lili	Isidore	Gustav	Kyle

http://disc.sci.gsfc.nasa.gov/hurricane/hurricane-viewer

Hurricane elements:

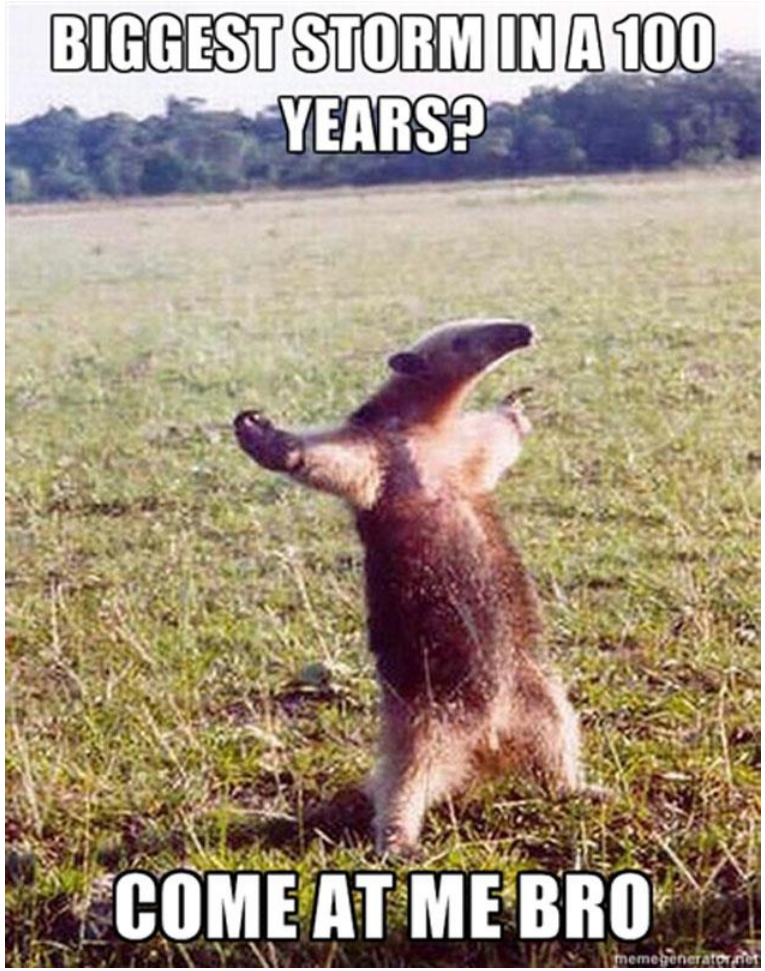


How do we estimate hurricane size (diameter) from TRMM data:



A: in this case we use precipitation threshold > 20 mm/day to identify the diameter of hurricane. Considering the size of latitude (vertical dashed line) = 5 degree (1 degree of latitude = 111 km), the approximate diameter of Sandy on that image (red arrow) is approximately = 8 degrees = 8 x 111 = 888 km

B: in this case we use precipitation threshold > 40 mm/day; Considering the size of latitude (vertical dashed line) = 5 degree (1 degree of latitude = 111 km), the approximate diameter of Sandy on that image (red arrow) is approximately = 5 degrees = 5 x 111 = 555 km



THANKS!