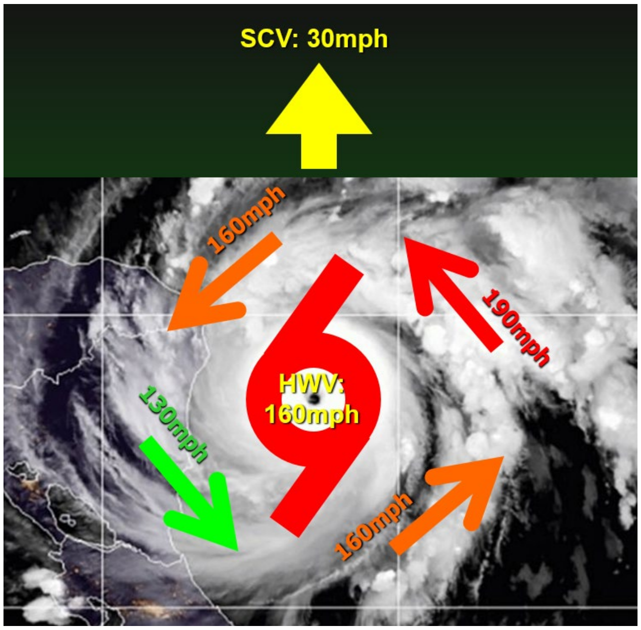
LECTURE #18: Hurricane Monitoring & Mitigation

Date: 26 March 2025

I. Hurricane Damage:

- storm surge *(covered in the last lecture)*
- wind damage *(covered in last lecture)*

- hurricane wind types
  - hurricane wind velocity (HWV)
    - speed of the storm's counterclockwise winds
    - this value is quoted when assessing the category of the storm
    - example: 79 to >155 mph
      - category 1 - 5
  - storm center velocity (SCV)
    - speed that the storm is moving over ocean/land
    - commonly from 5 to 60 mph
    - influenced by the upper-level winds, regional temperature, other weather patterns
      - example: Andrew in 1992 changed direction twice due to a high pressure system over the southeastern US and upper level winds over the Gulf of Mexico changing its SCV *(more on this next lecture)*
  - both winds can combine to cause more damage
  - **for a hurricane moving N**
    - in the NE quadrant *(upper right side)*
      - the HWV combines with the SCV
      - produces the *most* damaging winds
    - in the SW quadrant (lower left side) of a hurricane
      - the SCV is subtracted from the HWV
      - results in the *least* damaging winds



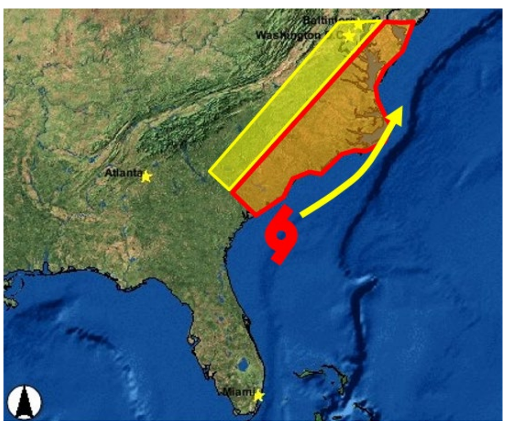
II. Landfall

- coast-parallel track:
  - storm moves along the coast
  - for an Atlantic hurricane along the east coast of the US, the stronger winds are over the ocean
  - land is affected by two storm surges
    - flood surge ahead of the storm
    - ebb surge behind it

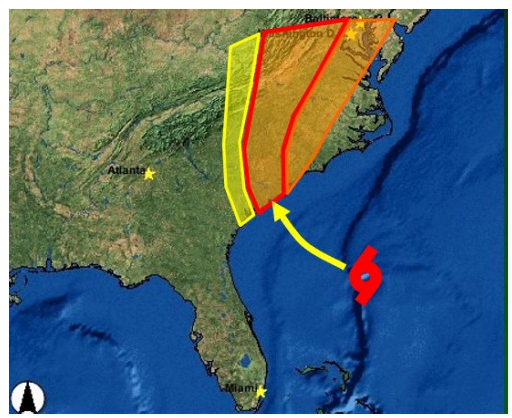
  - wind damage lessens the further from shore
    - results in moderate-heavy damage along the coast
    - less damage further inland

- coast-normal track:
  - storm moves perpendicular to coast, moving from the water onto the land
  - strongest winds on the right side of the storm (HWV + SCV)
    - produces a zone of higher damage off center to the right of the storm track
    - less damage to the “left” side of the eye

  - causes a large flood surge along the entire coastline where landfall occurs
    - ebb surge then follows



coast-parallel



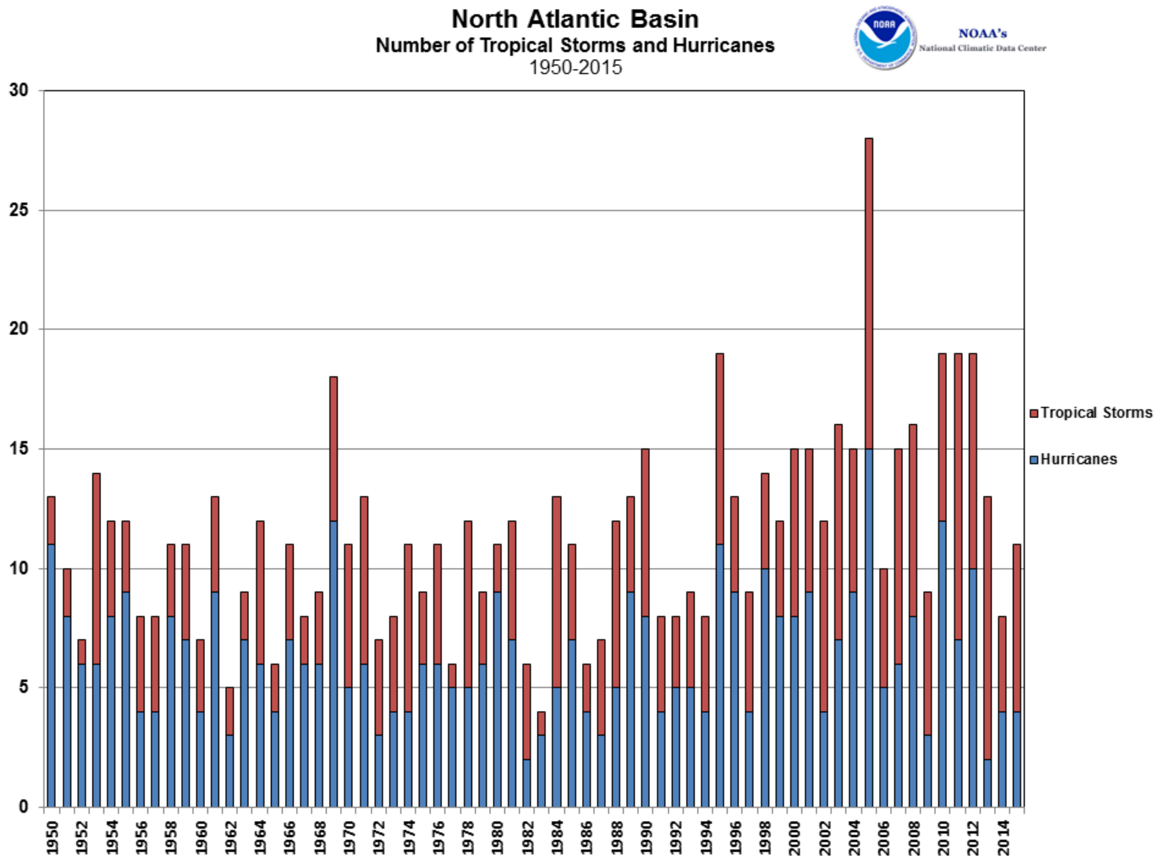
coast-normal

III. Hurricane Statistics:

- yearly averages
  - since 1878, about 6 – 7 hurricanes have formed in the North Atlantic every year
    - ~ 2 per year make landfall in the United States

  - intensity has risen noticeably over the past 20 years
    - 8 of the 10 most active years since 1950 have occurred since the mid-1990s

  - however, changes in observation methods
    - make it difficult to know whether tropical storm activity has actually shown an increase over time
    - *are we better at detecting these storms with improved satellite sensors?*



- Costliest US Hurricanes:

Name	Season	Cost *(2022 US$)*
Katrina	2005	$190 billion
Harvey	2017	$151 billion
Ian	2022	$113 billion
Maria	2017	$109 billion
Sandy	2012	$84 billion
Ida	2021	$80 billion
Irma	2017	$61 billion
Andrew	1992	$57 billion
Ike	2008	$41 billion

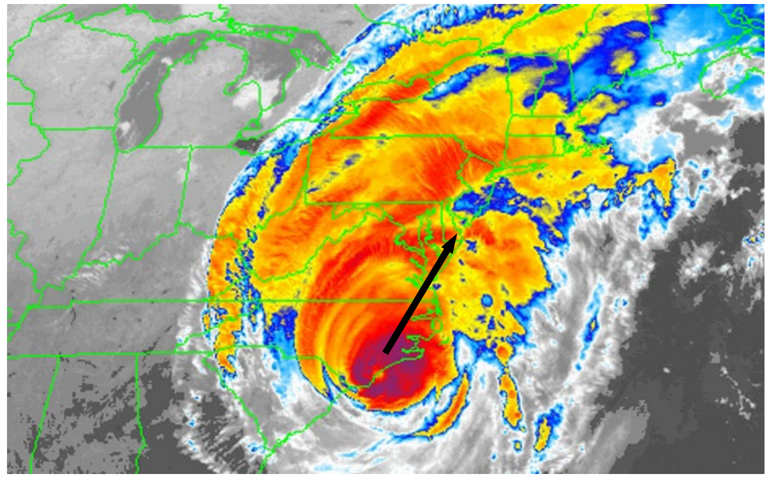
- Recent category-5 hurricanes:

Name	Date	Max Wind
Milton	2024	180 mph
Beryl	2024	165 mph
Ian	2022	160 mph
Dorian	2019	185 mph
Michael	2018	160 mph
Maria	2017	175 mph
Irma	2017	180 mph
Matthew	2016	160 mph
Felix	2007	175 mph
Dean	2007	175 mph
Wilma	2005	185 mph
Rita	2005	180 mph
Katrina	2005	175 mph

IV. Monitoring & Prediction

- can monitor a storm much better because of satellites
  - watch it spawn and develop
    - days to weeks timescale

- Doppler radar
  - examine the final movements prior to landfall
    - hours to days timescale

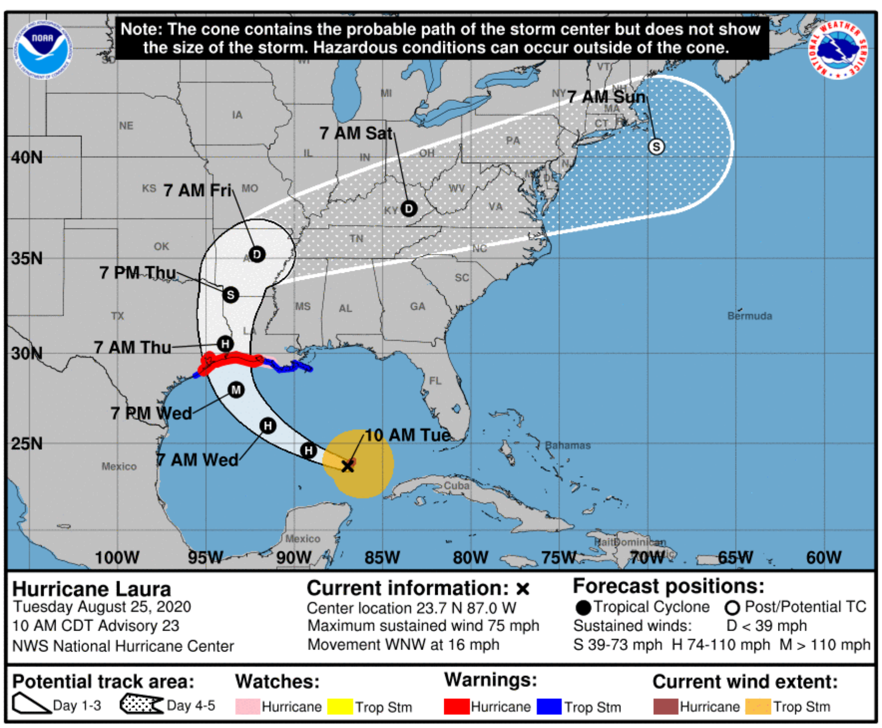


coast-normal track of Floyd
(colorized thermal infrared satellite image)

- visible and infrared satellite images every 30 minutes on average
  - can be acquired faster for certain locations and periods of time

- planes that fly though the storm center
  - measure vertical structure, wind speeds, pressure, and temperatures
  - use drop-sonde instruments to relay information regarding the change with height

- data from satellites and planes are used to create storm track maps using advanced atmospheric models
  - these show the cone of uncertainty several days into the future
  - poor data, different models, and/or larger times in the future lead to larger cones



storm track map example