Hurricane Forecasting for Engineers

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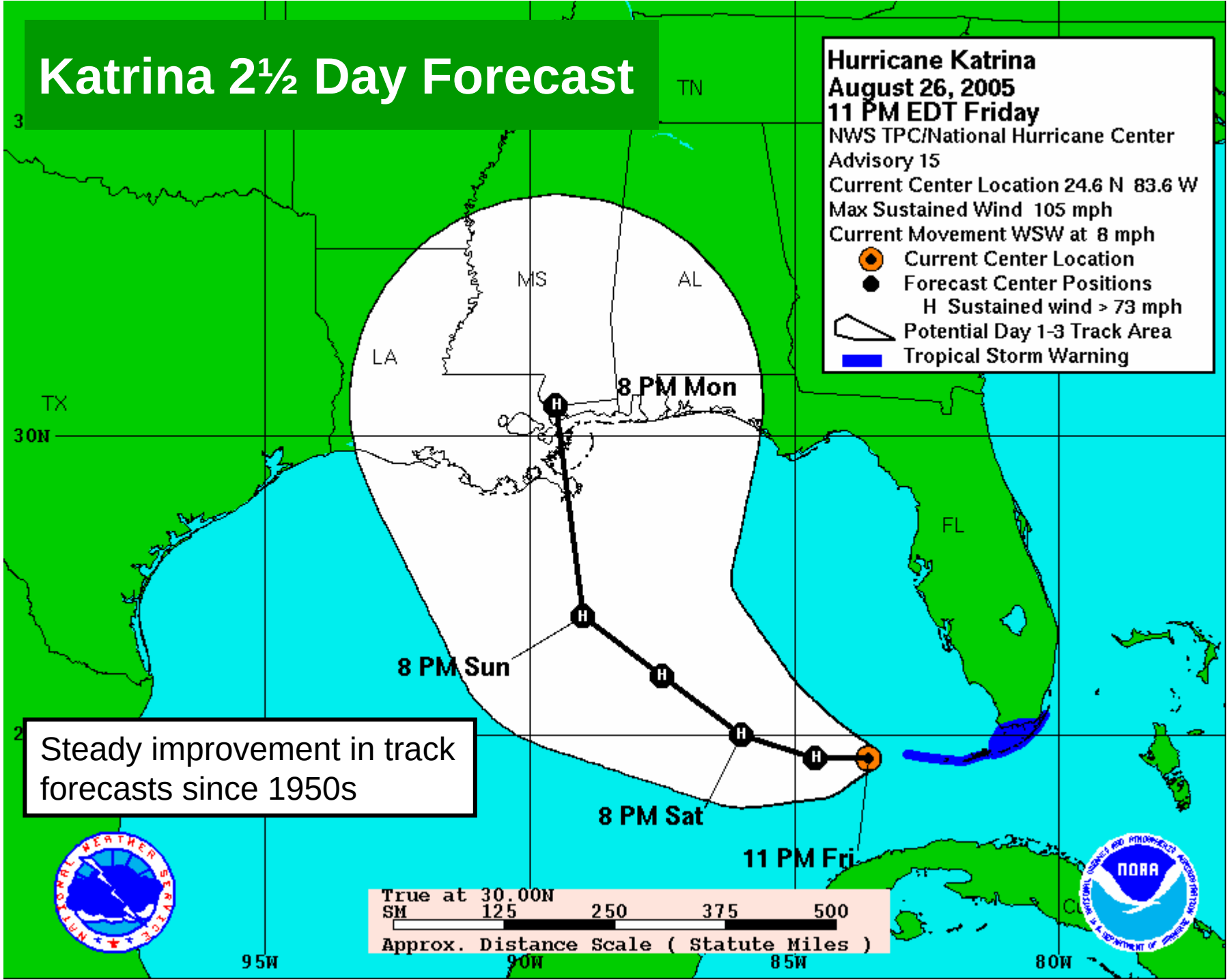
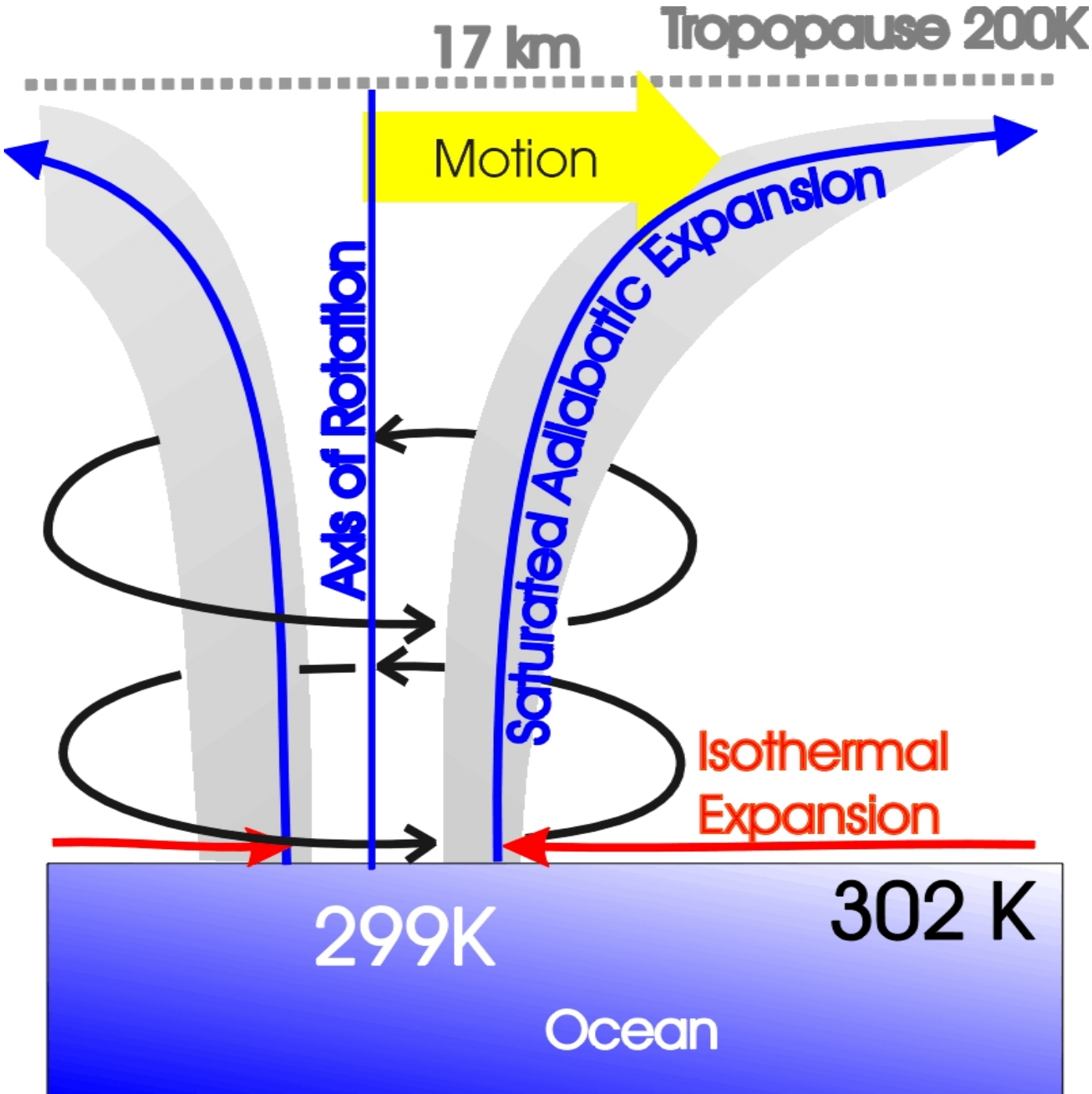
Day-to-day forecasts
The next decade or two
Beyond…

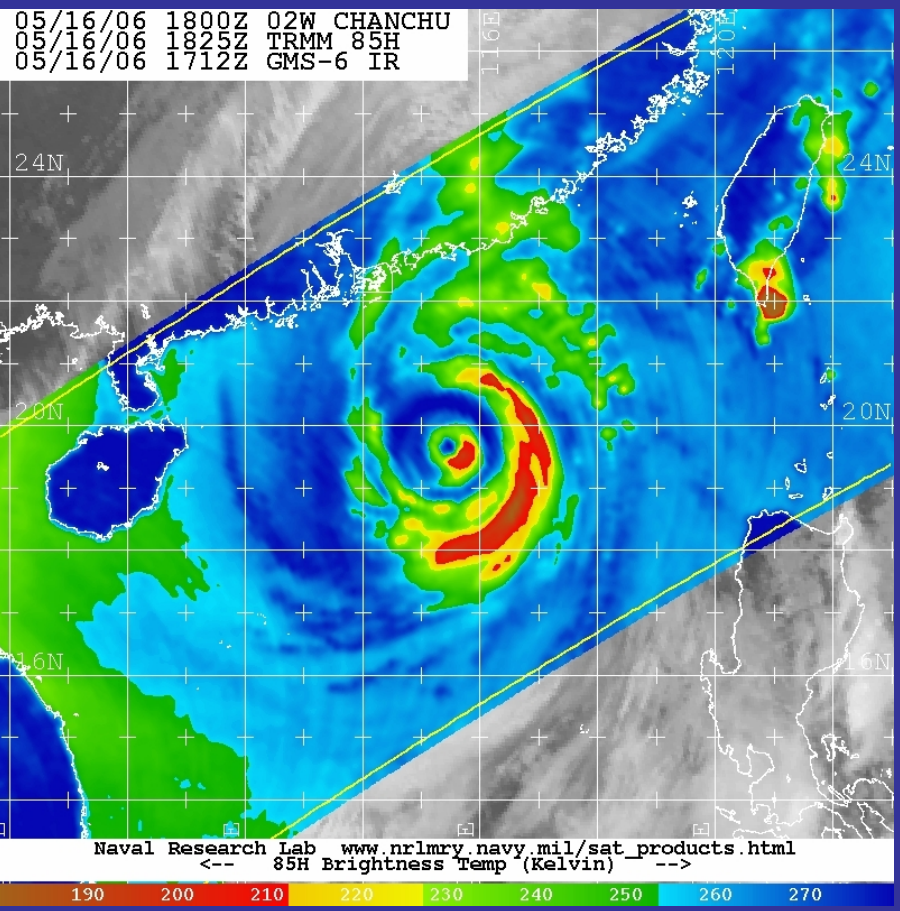
Forecast Process

- Track –where is it going?
- Intensity –how strong?
- Storm surge –wind-driven rise of the sea
- Distributions of wind and rainfall
- Observations at synoptic times (**00**, 06,**12**,18 UTC → 7PM, 1AM, 7AM, 7PM CDLT)
- Suite of numerical models (guidance)
- Advisories at 10 PM, 4 AM, 10 AM, 4 PM CDLT
- TPC raises watches and warnings
- Local authorities direct emergency responses


Katrina 2½ Day Forecast
Hurricane Katrina
August 26, 2005
11 PM EDT Friday
NWS TPC/National Hurricane Center
Advisory 15
Current Center Location 24.6 N 83.6 W
Max Sustained Wind 105 mph
Current Movement WSW at 8 mph
Current Center Location
Forecast Center Positions
H Sustained wind > 73 mph
Potential Day 1-3 Track Area
Tropical Storm Warning
TN
MS
AL
LA
TX
FL
30N
8 PM Mon
8 PM Sun
8 PM Sat
11 PM Fri
Steady improvement in track forecasts since 1950s
True at 30.00N
SM 125 250 375 500
Approx. Distance Scale (Statute Miles)
95W
90W
85W
80W
NOAA

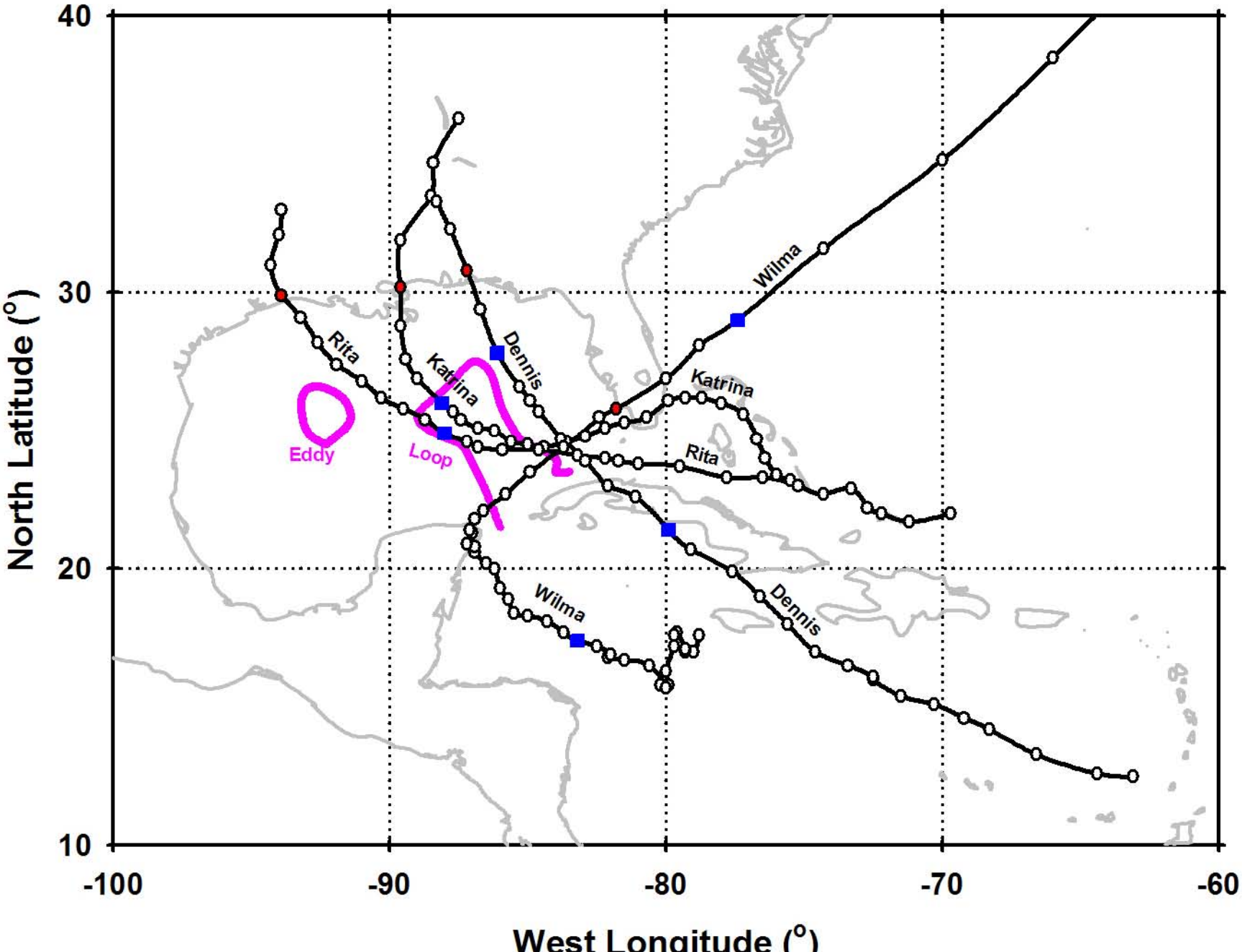

17 km
Tropopause 200K
Motion
Axis of Rotation
Saturated Adiabatic Expansion
Isothermal
Expansion
299K
302 K
Ocean

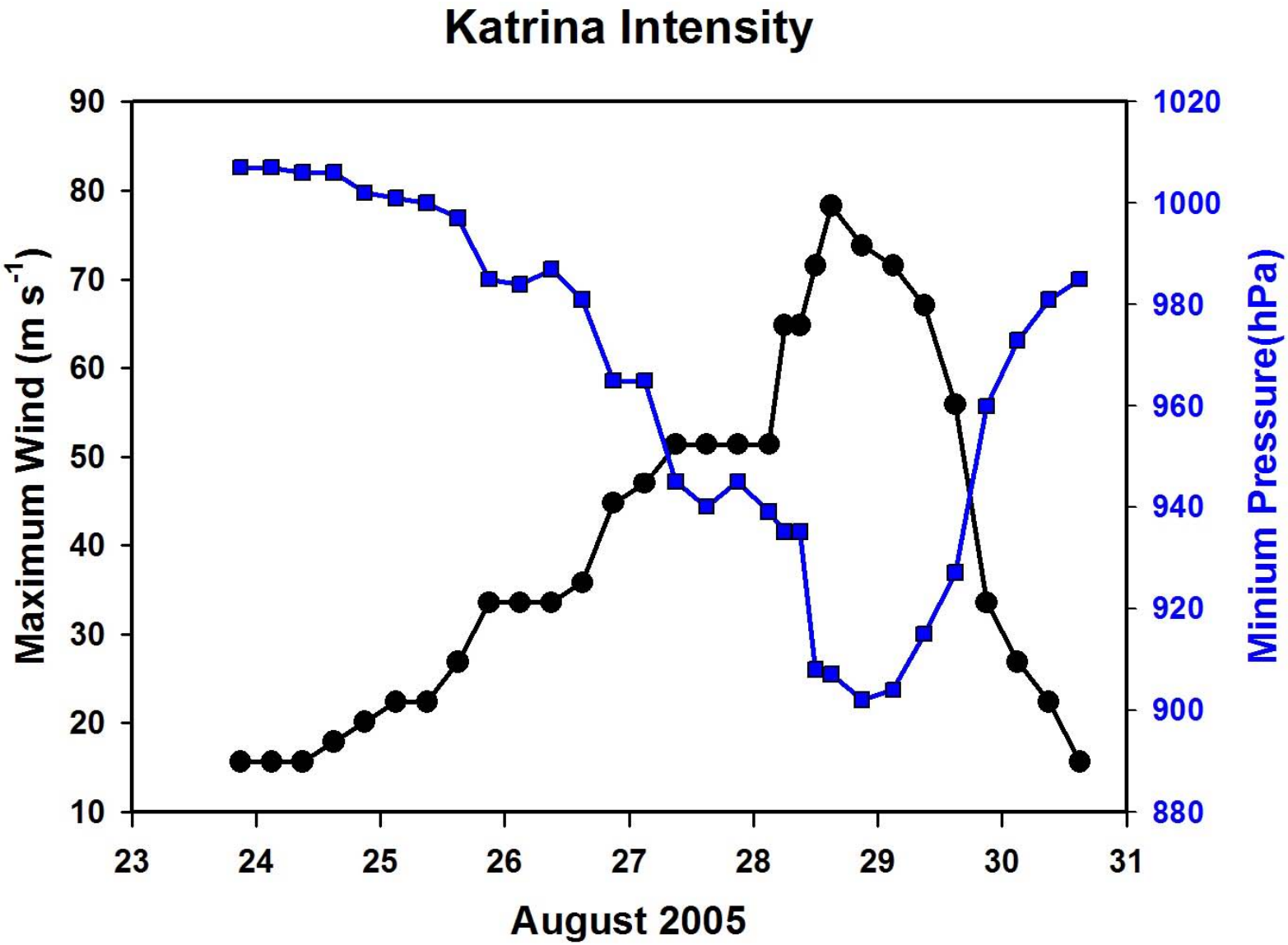
Vortex Structure and Intensity



- Shear of the surrounding winds.
- Dry-air intrusion
- Concentric eyewall replacements
- Encounters with land
- Most don’t reach thermodynamic potential
- Structure and intensity forecasts need improvement.
- WRF model

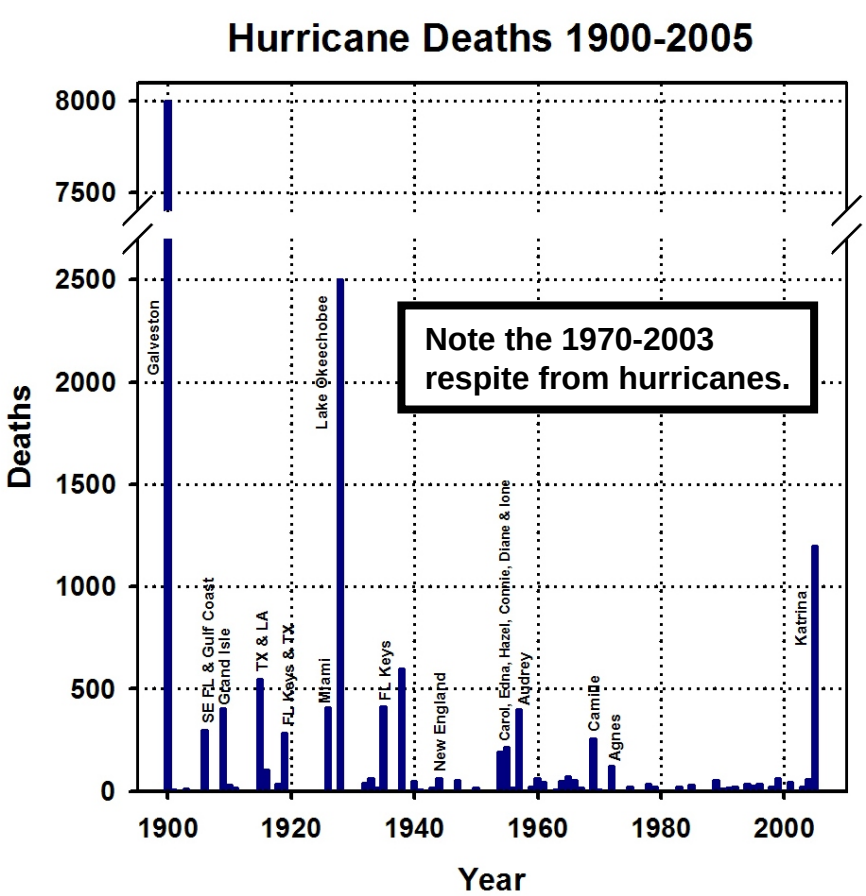
Role of the Loop Current

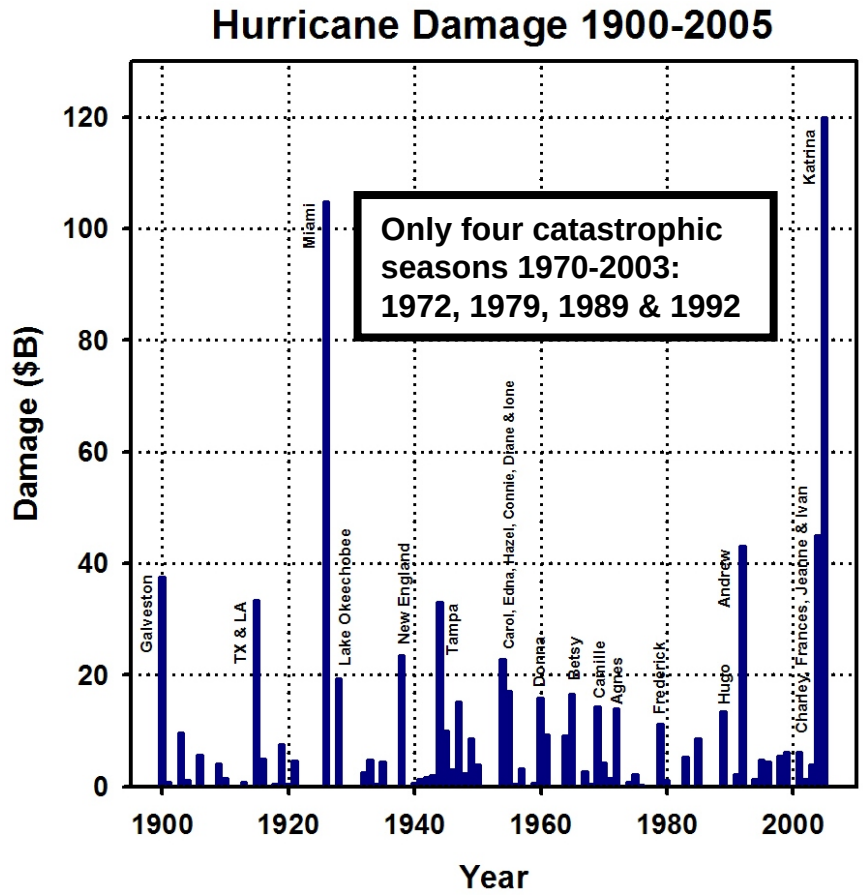




Intensity forecasts have limited skill, especially for Rapid Intensification, which can transform a hurricane from CAT 2 to CAT 4 or 5 in 12-25 h

Hurricane Impacts 1900-2005

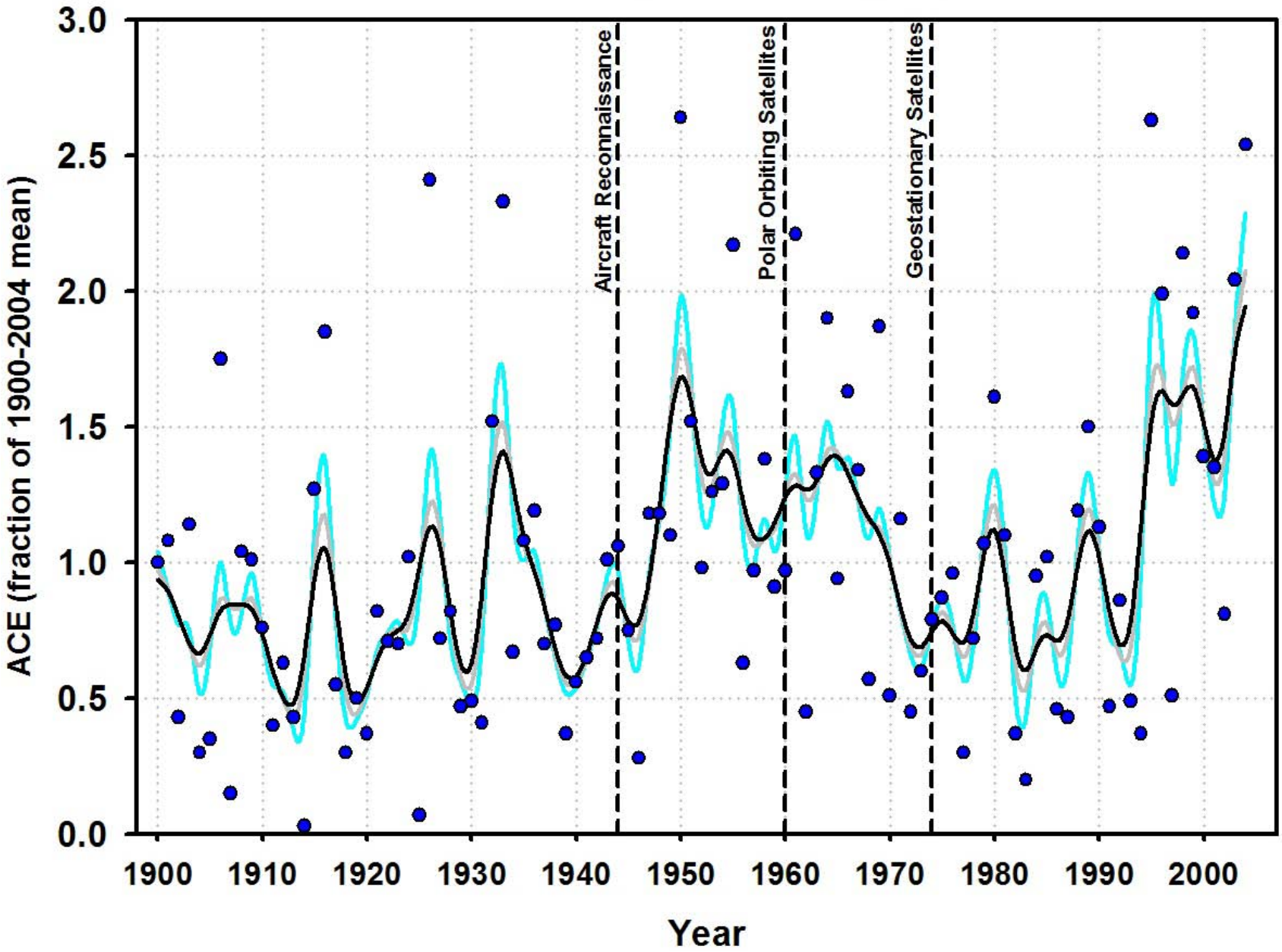




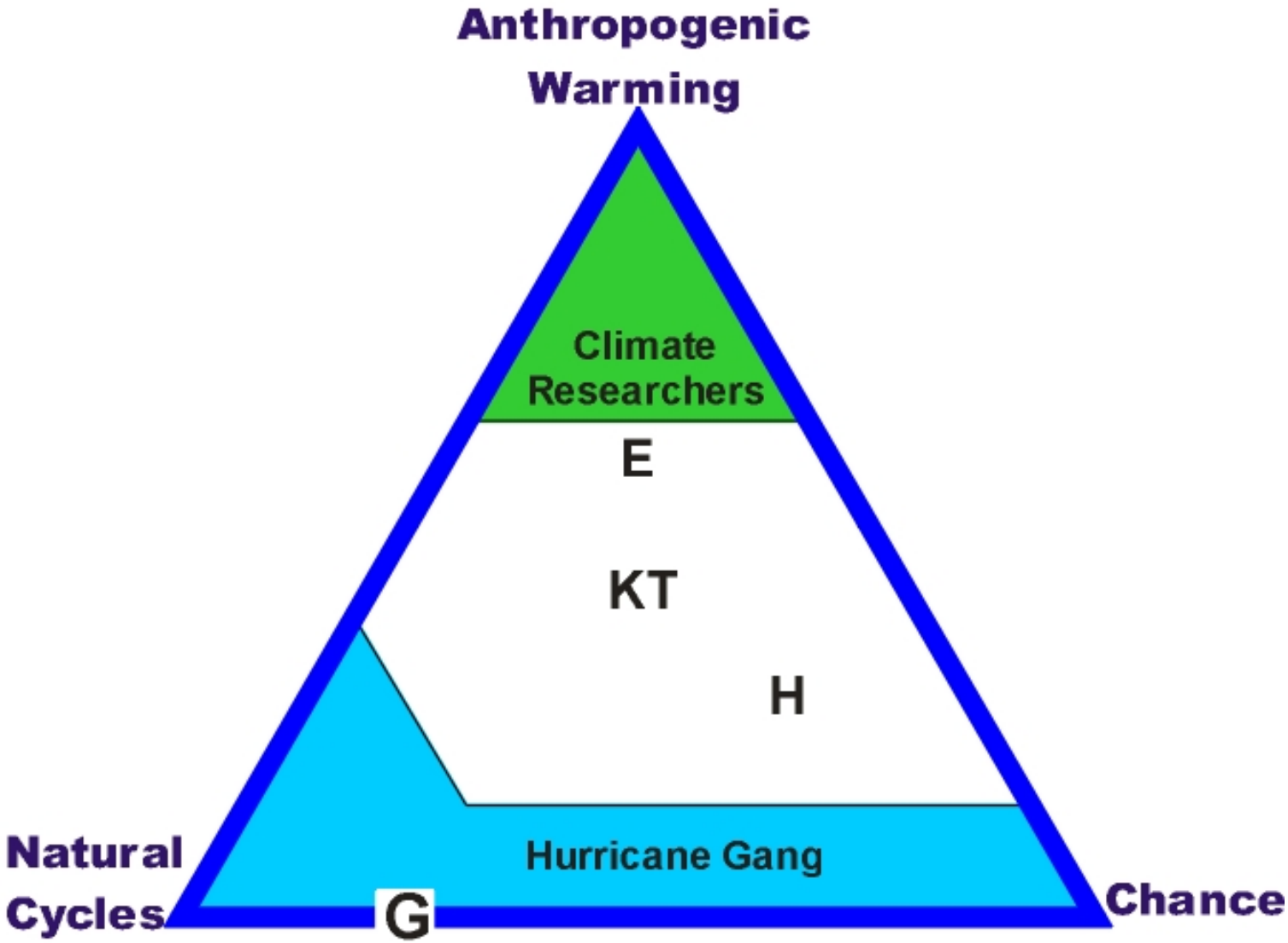
Damage is "Normalized" to correct for inflation, population increase and greater personal wealth.

A Role for Global Warming?

- **Hurricanes are heat engines that draw energy from the tropical ocean**
- **Knutson & Tuleya (2004)---numerical study with 2 x CO_2 environment**
- **Strongest hurricanes become 5-6 m/s stronger and rain 25% more, but no increase in numbers**
- **Emanuel (2005): Increased hurricane energy dissipation since early 1970s**
- **Webster et al. (2005): More CAT 4 & 5 worldwide, but no increase in total numbers.**
- **Potential problems with satellite intensity estimates, and other aspects of the data**


Accumulated Cyclone Energy by Year
ACE (fraction of 1900-2004 mean)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Year
Aircraft Reconnaissance
Polar Orbiting Satellites
Geostationary Satellites

Why were 2004 & 2005 so Different from 1970-2003?




Either way, expect
more hurricanes
Thank you for your attention.
Questions?