The Impact of Ocean Current Systems on the Atmosphere: *A Study Using Vector Winds and Atmosphere-Ocean Modeling*

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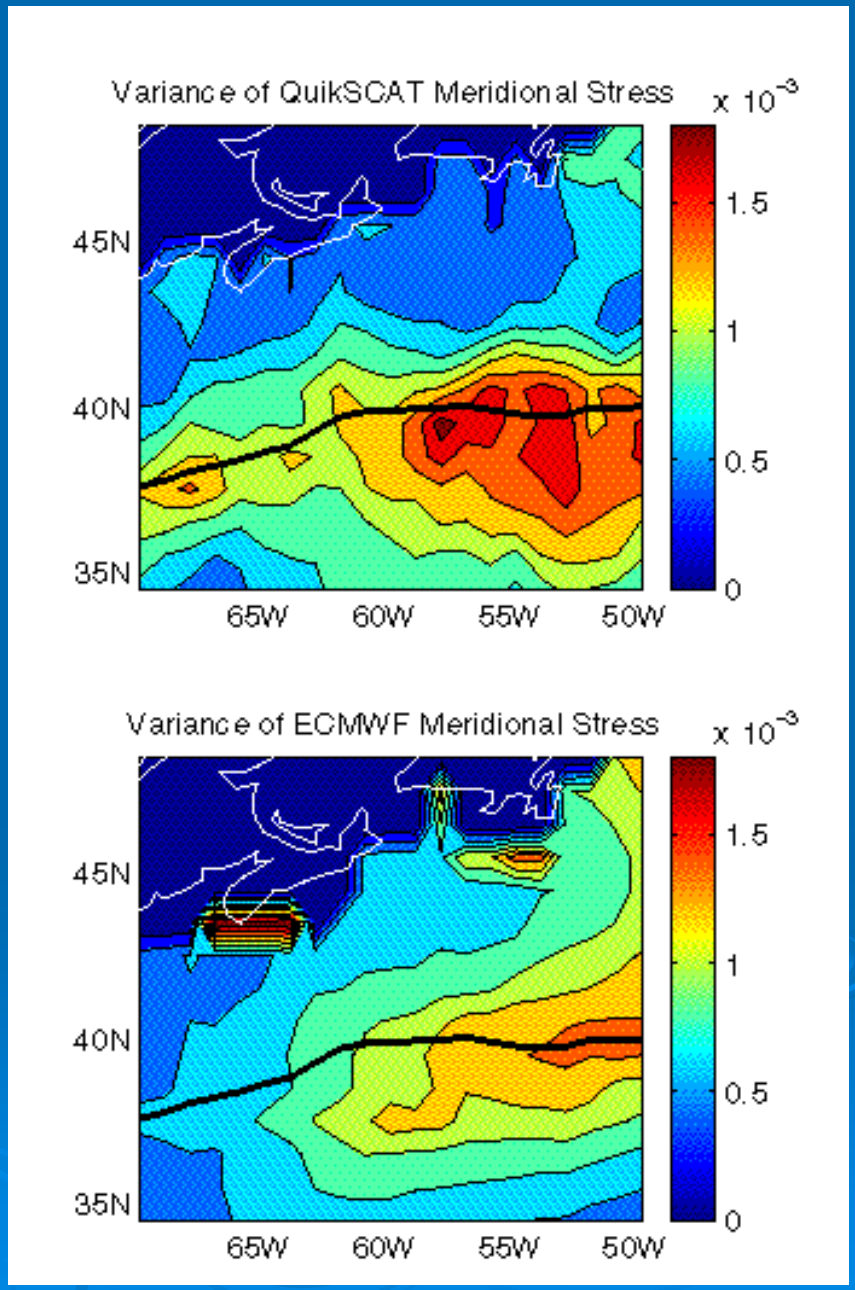
Goals

- understand relationship between ocean heat storage and storms over strong ocean currents (Gulf Stream region)
- understand role of the ocean in storm generation, intensification, and tracking
- predict seasonal storm statistics based on ocean state
- find potential applications for weather forecasts
- suggest improvements for coupled ocean-atmosphere model physics

Storm Track Steering by Strong Currents

- Meridional wind stress variance (proxy for cyclone activity)
- Maximum along Gulf Stream path (black)
- Similar for major current systems *(Nakamura et al., 2004)*



Planned Observational Studies

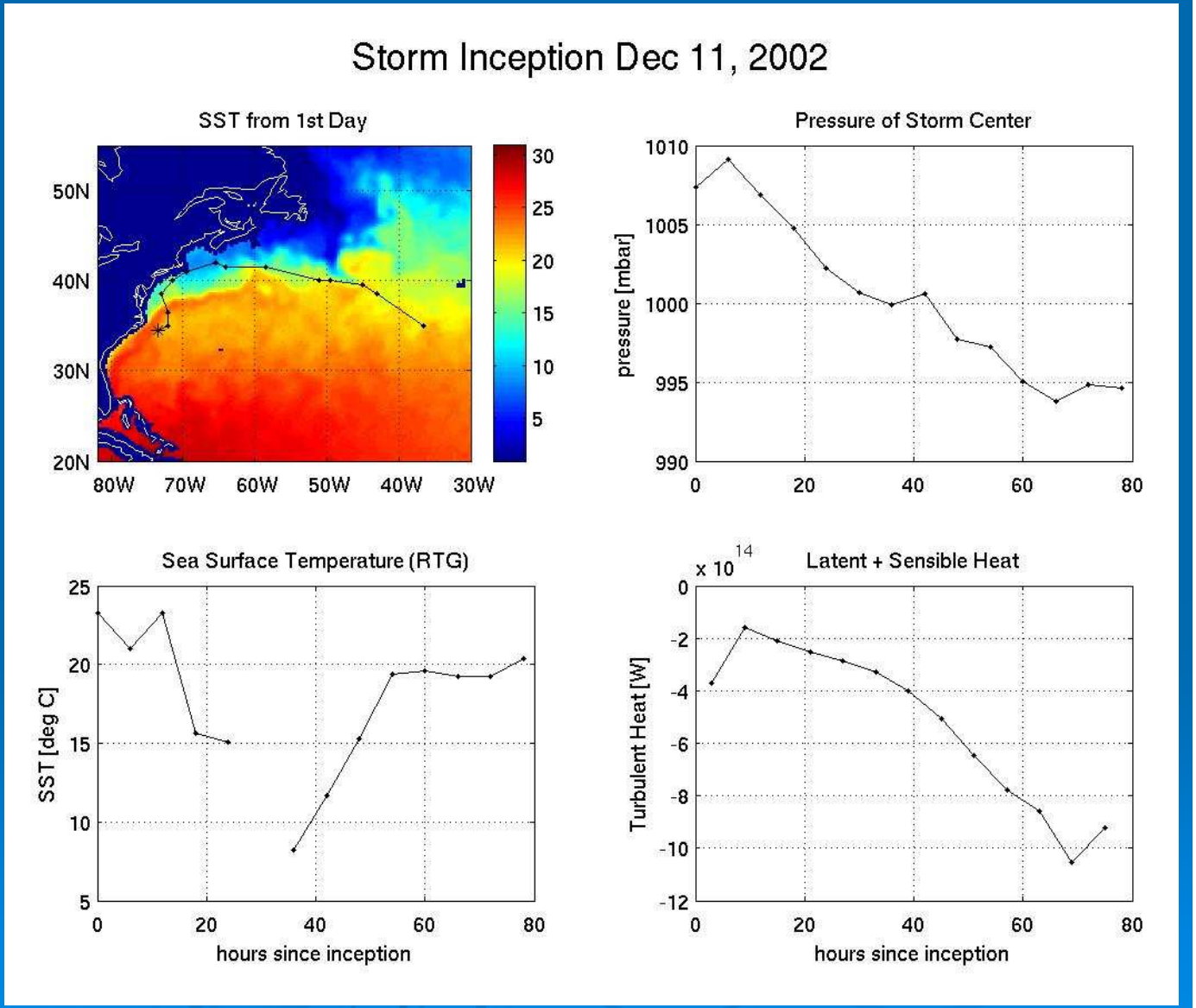
Using storm tracks derived from QuikSCAT data (Foster, Brown & Patoux):

- Develop a metric to measure storm intensity
- Examine relationship between changes in storm intensity and air-sea flux, SST, and heat content along storm track
- Examine interannual variations in storm intensification and path and ocean heat content
- Compare QuikSCAT and NWP storm statistics, (extend temporal statistics, if similar)

Storm Track Example

- QuikSCAT storm track (courtesy J. Patoux)
- 6-hr central pressure
- SST along track
- Turbulent flux (improvements: CLIMODE)

- Region of greatest storm intensification



Interannual Versus Storm Time Scales

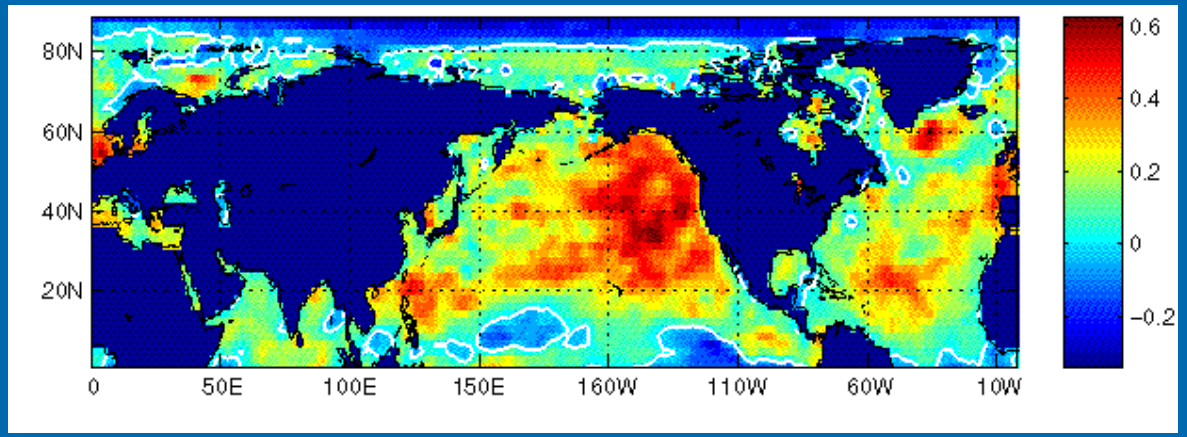
On *storm time scales:*

- storm responds to many variables (SST, upper level winds, etc)
- hurricanes intensify over warm ocean (G. Goni)
- air-sea flux depends on wind speed and air-sea temperature difference $$Q \sim u\,\Delta T$$
- ocean responds passively to fluxes $$\frac{\partial T}{\partial t} \sim Q$$

WBCs: Not Your Usual Air-Sea Interaction

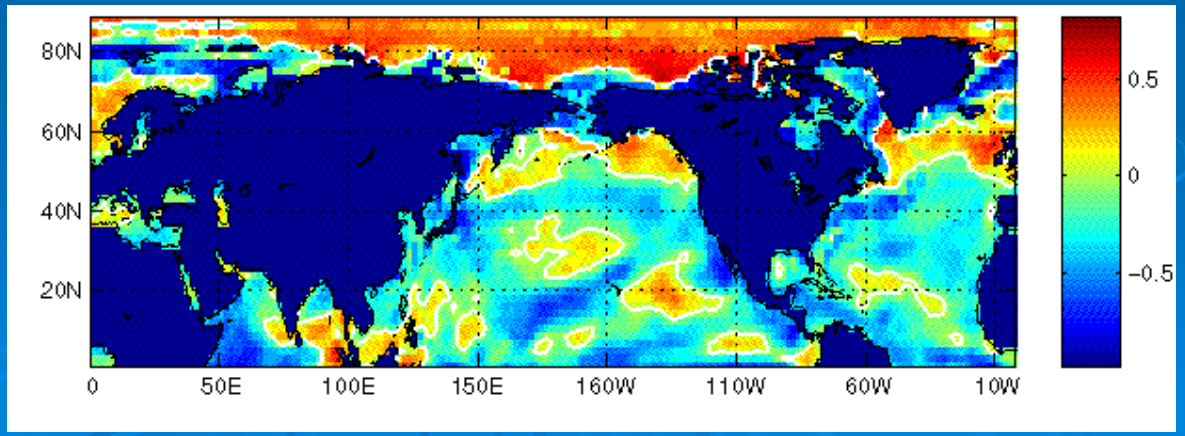
Passive ocean response (*Cayan, 1992*) but **not** in WBCs

dT/dt versus Qnet correlation



In WBC Qnet proportional to negative SST (*oceanic advection effect)*

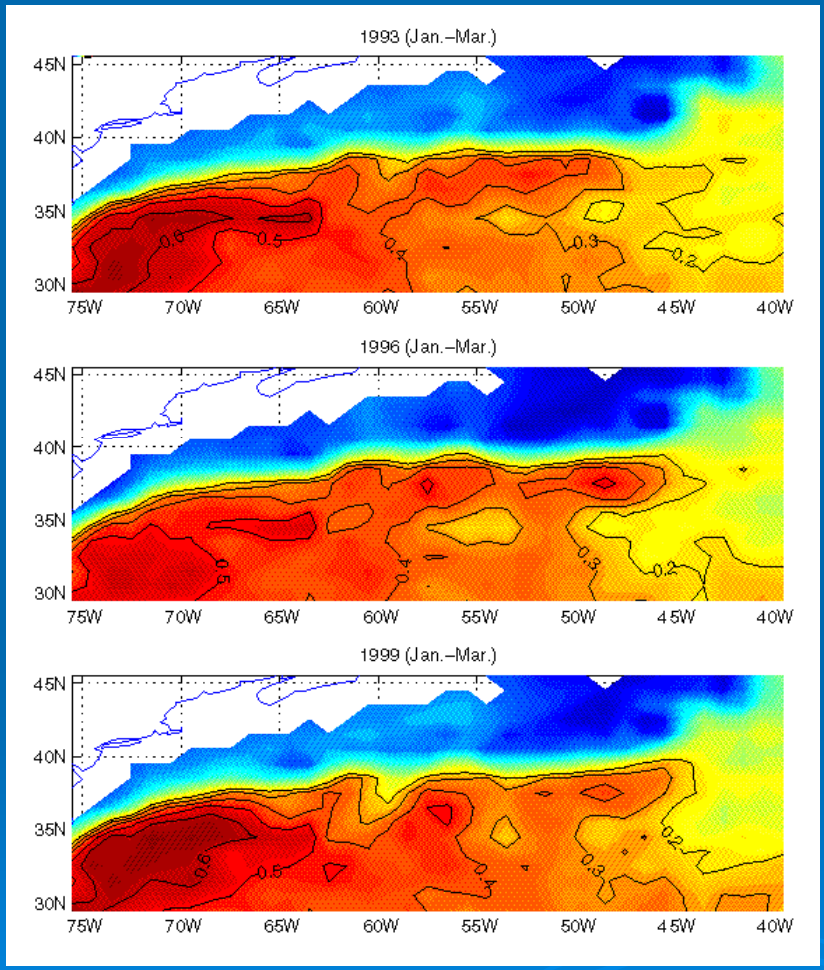
SST versus Qnet correlation

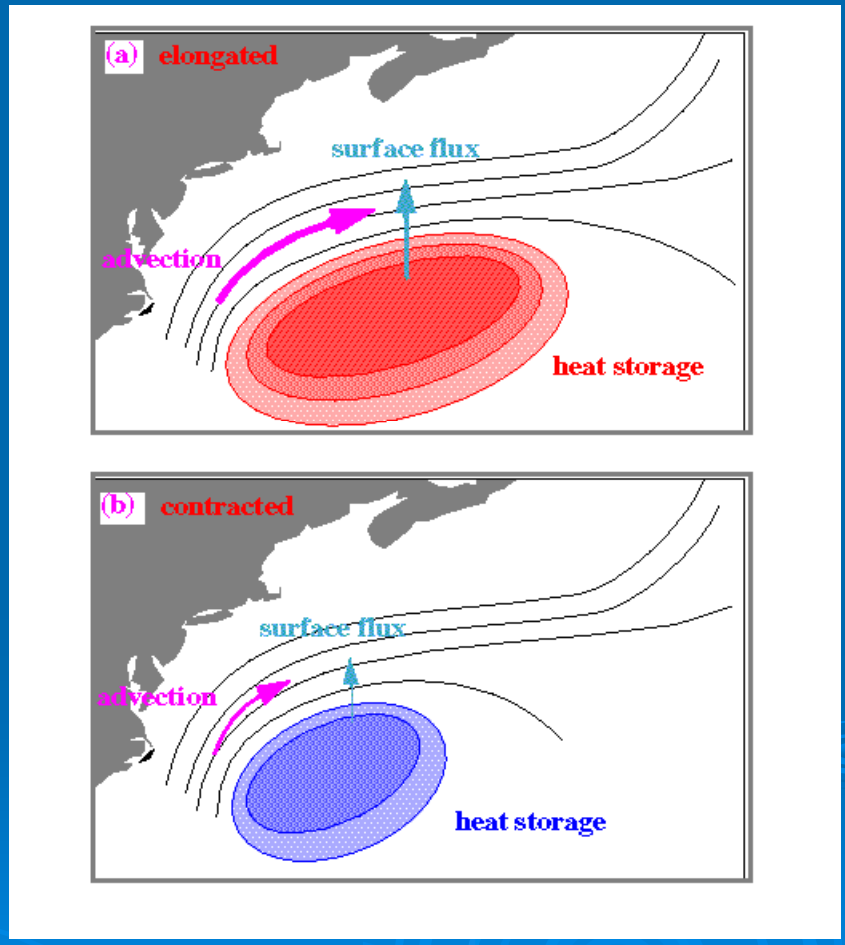


NCEP heat flux and SST (1948-2002)

Gulf Stream Gyre Expansion/Contraction and the Air-Sea Fluxes

sea surface height





Dong and Kelly, JPO, 2004

Effect of Ocean on Interannual Storm Statistics

- Interannual air-sea fluxes depend primarily on Gulf Stream heat content (Dong et al, 2006)

$$Q \sim -\int T\,dz$$

- Hurricane power increasing with global warming (K. Emanuel)

- How do interannual extratropical storm statistics depend on ocean heat content?

Planned Modeling Studies

Using a numerical atmospheric model, compare:

- storm intensification and tracks for different ocean states (fixed initial conditions)
- storm evolution for varying upstream conditions (fixed ocean state)
- effects on storms of increased heat in ocean (or stronger SST gradients for baroclinicity)
- observed and model storm statistics for accuracy of simulations