

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

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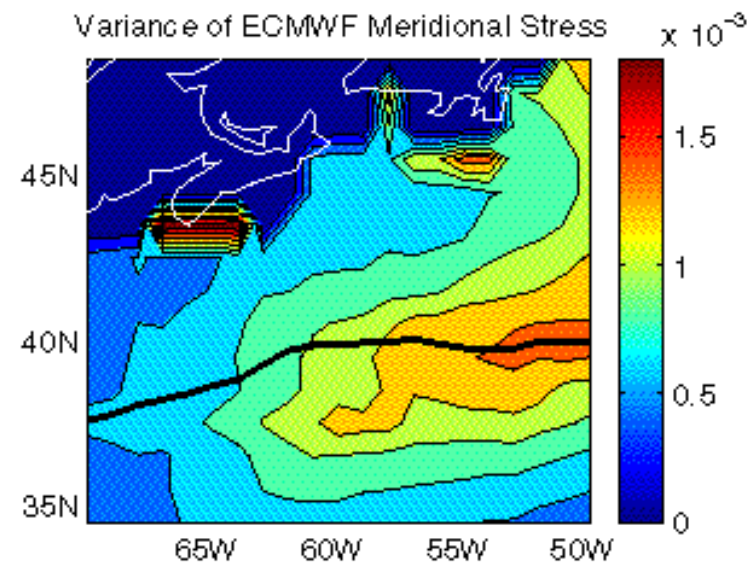
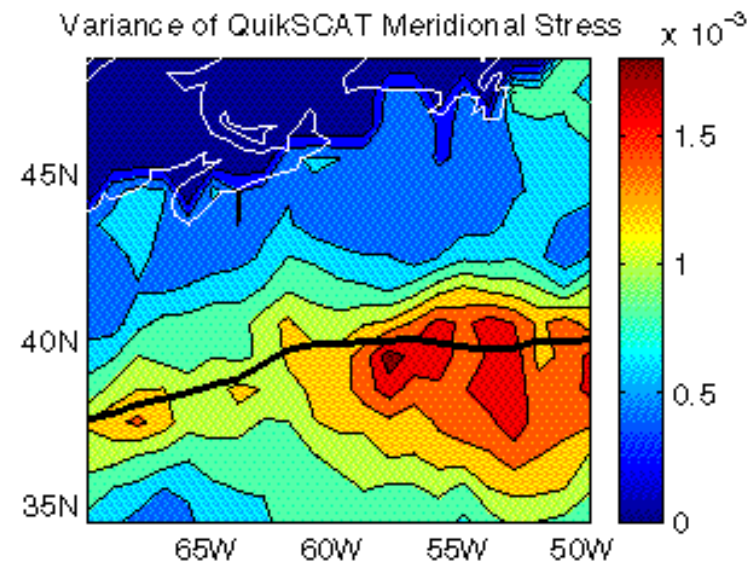


Goals

- 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
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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

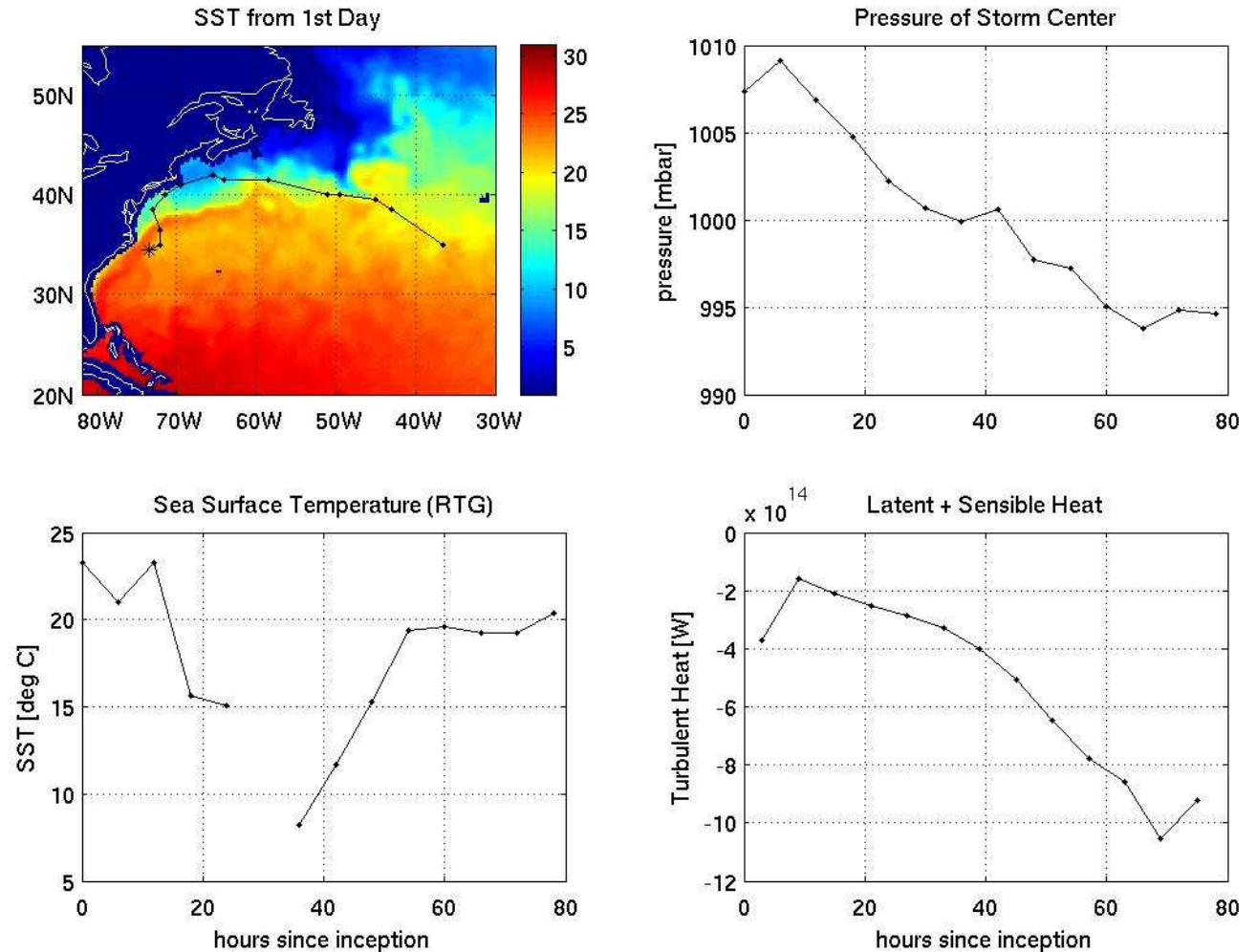
Using storm tracks derived from QuikSCAT data
(Foster, Brown & Patoux):

- 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

Storm Inception Dec 11, 2002



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

$$Q \sim u \Delta T$$

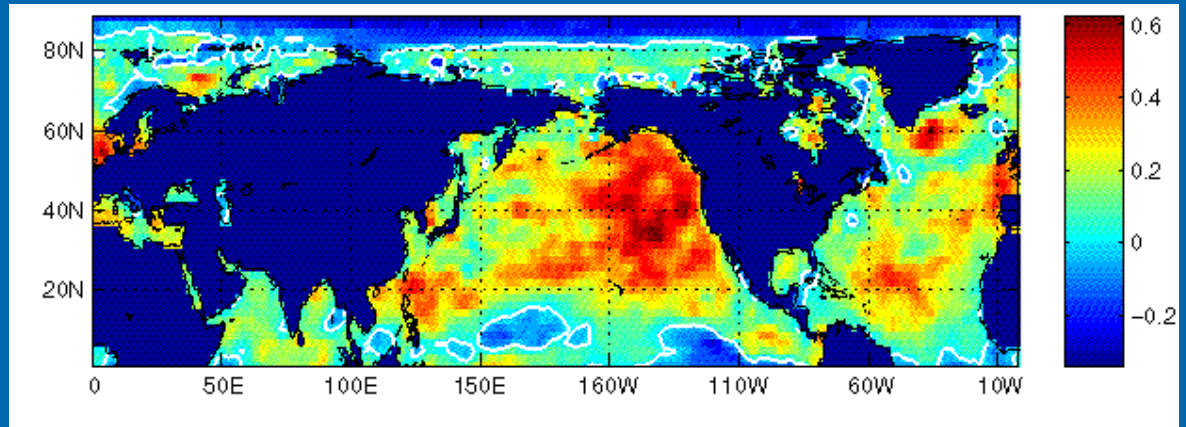
- ocean responds passively to fluxes

$$\frac{\partial T}{\partial t} \sim Q$$

WBCs: Not Your Usual Air-Sea Interaction

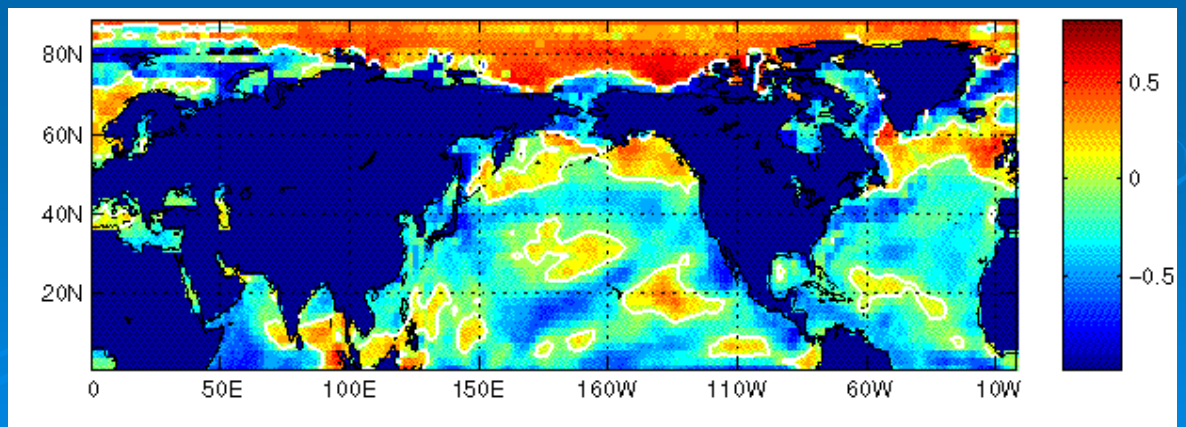
dT/dt versus Qnet correlation

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



In WBC Q_{net} proportional to negative SST (*oceanic advection effect*)

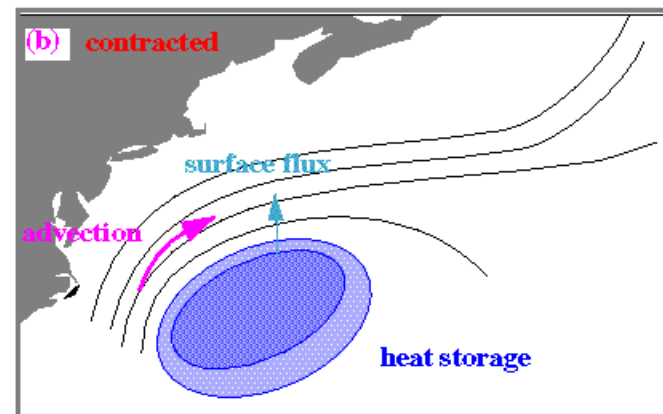
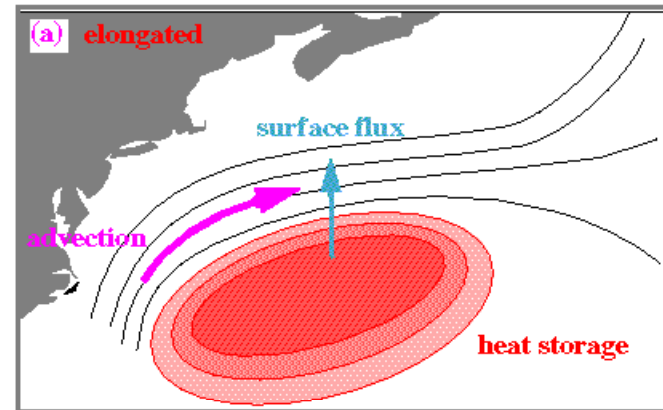
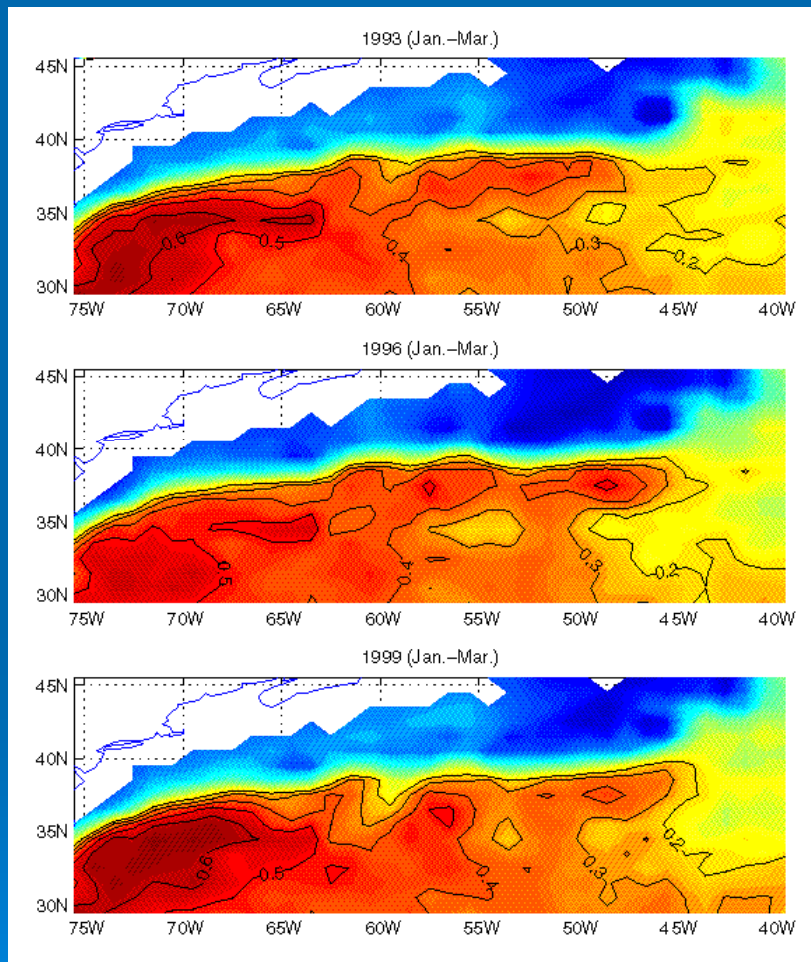
SST versus Qnet correlation



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