

# Negative Impact of Ocean on Tropical Cyclone Intensification

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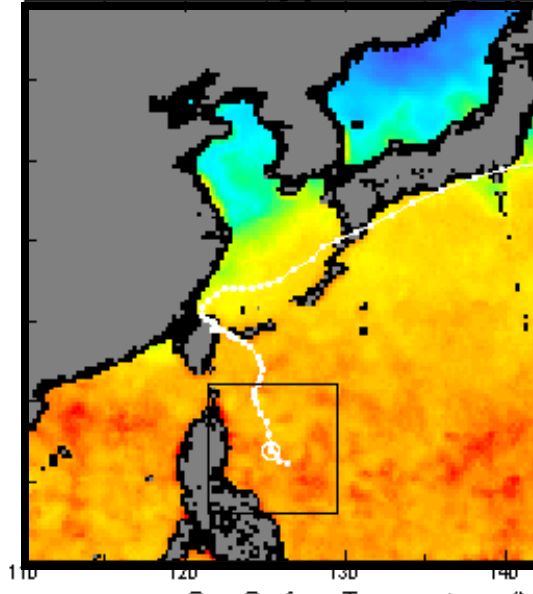
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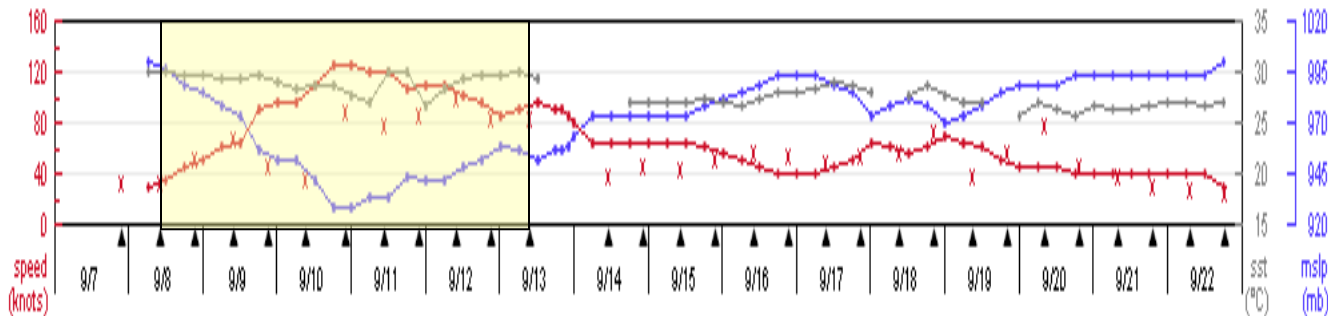
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# Tropical Cyclone Cold Wake

SST Animation of Typhoon Sinlaku (2008) cold wake



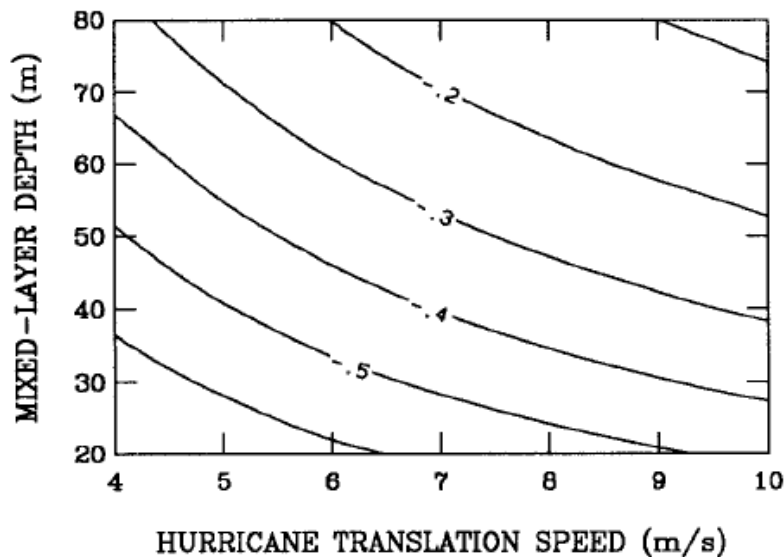
The process that govern the increase ocean cooling and decrease TC intensity is not well understood



[http://www.ssmi.com/hurricane/data\\_archive.html](http://www.ssmi.com/hurricane/data_archive.html)

# SST Feedback

## The feedback factor



Schade and Emanuel (1999)

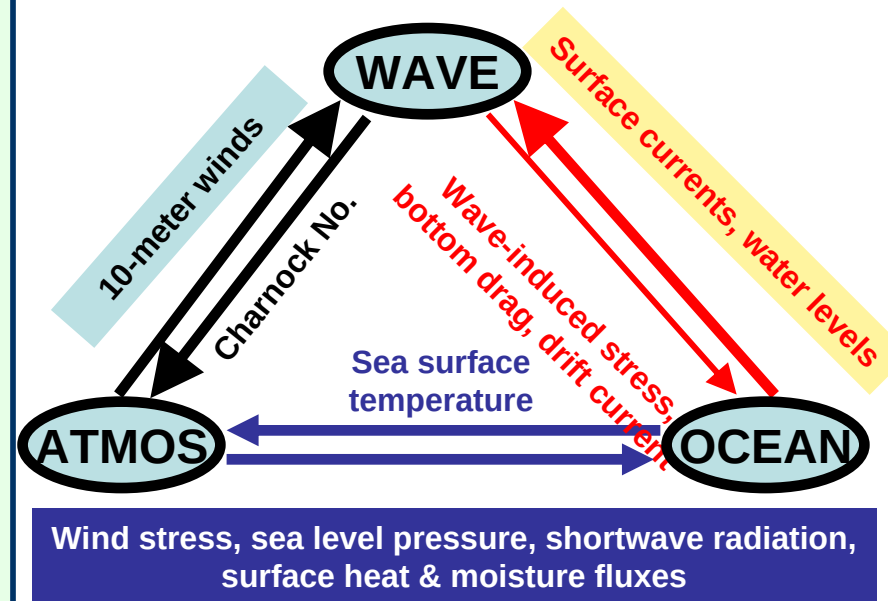
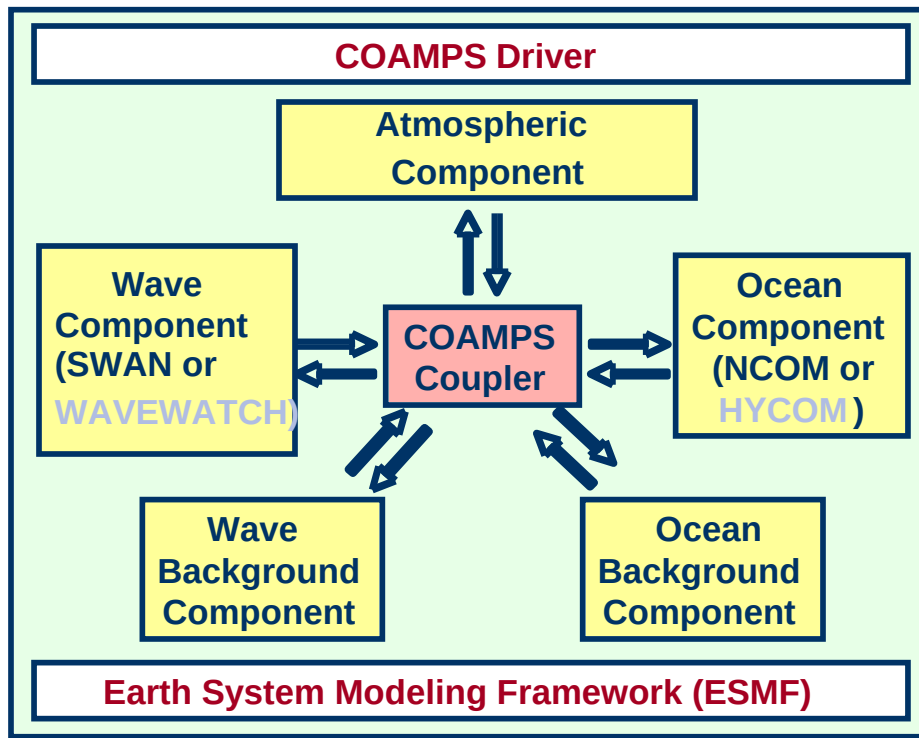
- the oceanic mixed layer is thinner,
- the storm moves slower,
- the intensity potential is larger,
- the storm is of greater horizontal size,
- the storm occurs at lower latitudes,
- the thermal stratification below the oceanic mixed layer is stronger, and
- the relative humidity in the atmospheric boundary layer is higher.

**Positive correlation  
between the cold wake size  
and TC intensity reduction**

Pre-storm oceanic cold eddies  
(Jaimes and Shay 2006, MWR)

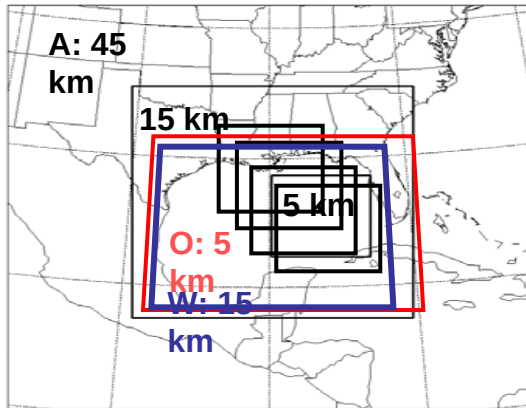
# COAMPS<sup>®</sup>1

To fully understand the complex interaction between TC and its cold wake, we need to use the tightly coupled model

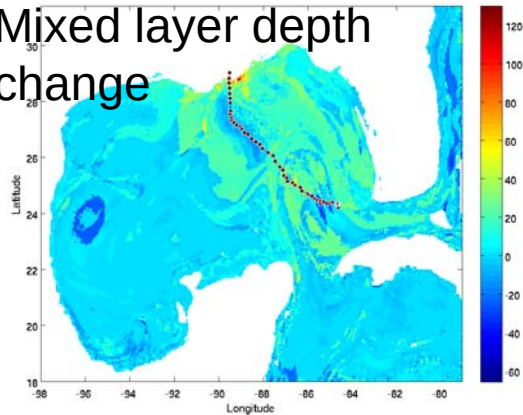


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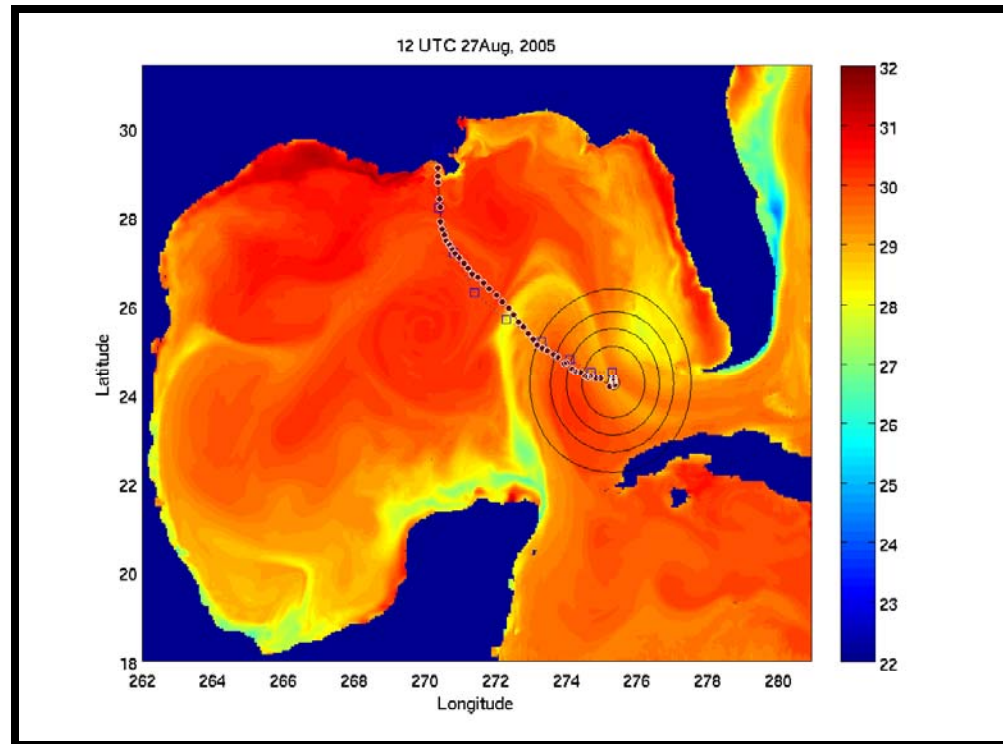
# Katrina Simulations



Mixed layer depth change



Animation of Katrina Cold Wake

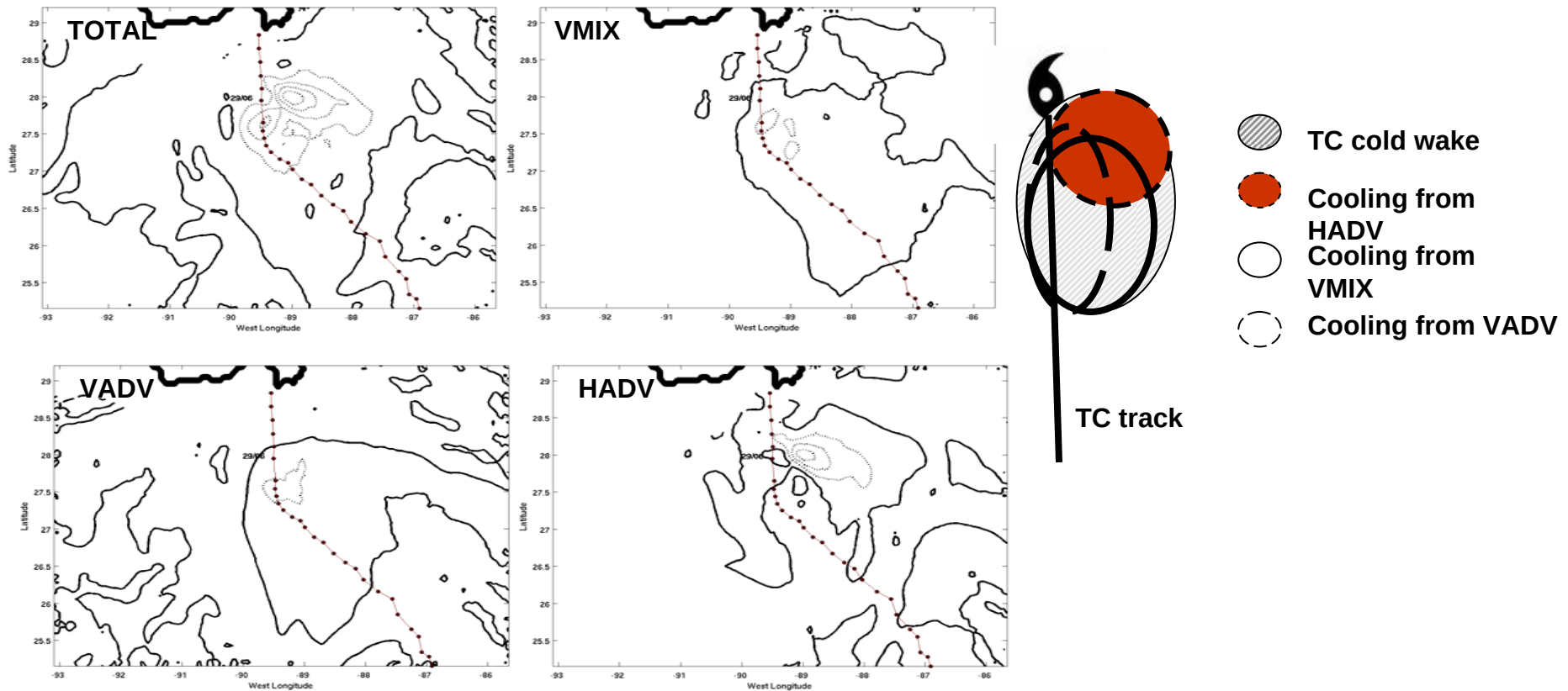


- Significant ( $>4^{\circ}\text{C}$  in average) cooling occurs around 13 UTC 28 Aug

- Maximum cooling located about 100 km SW of the storm's landfall location

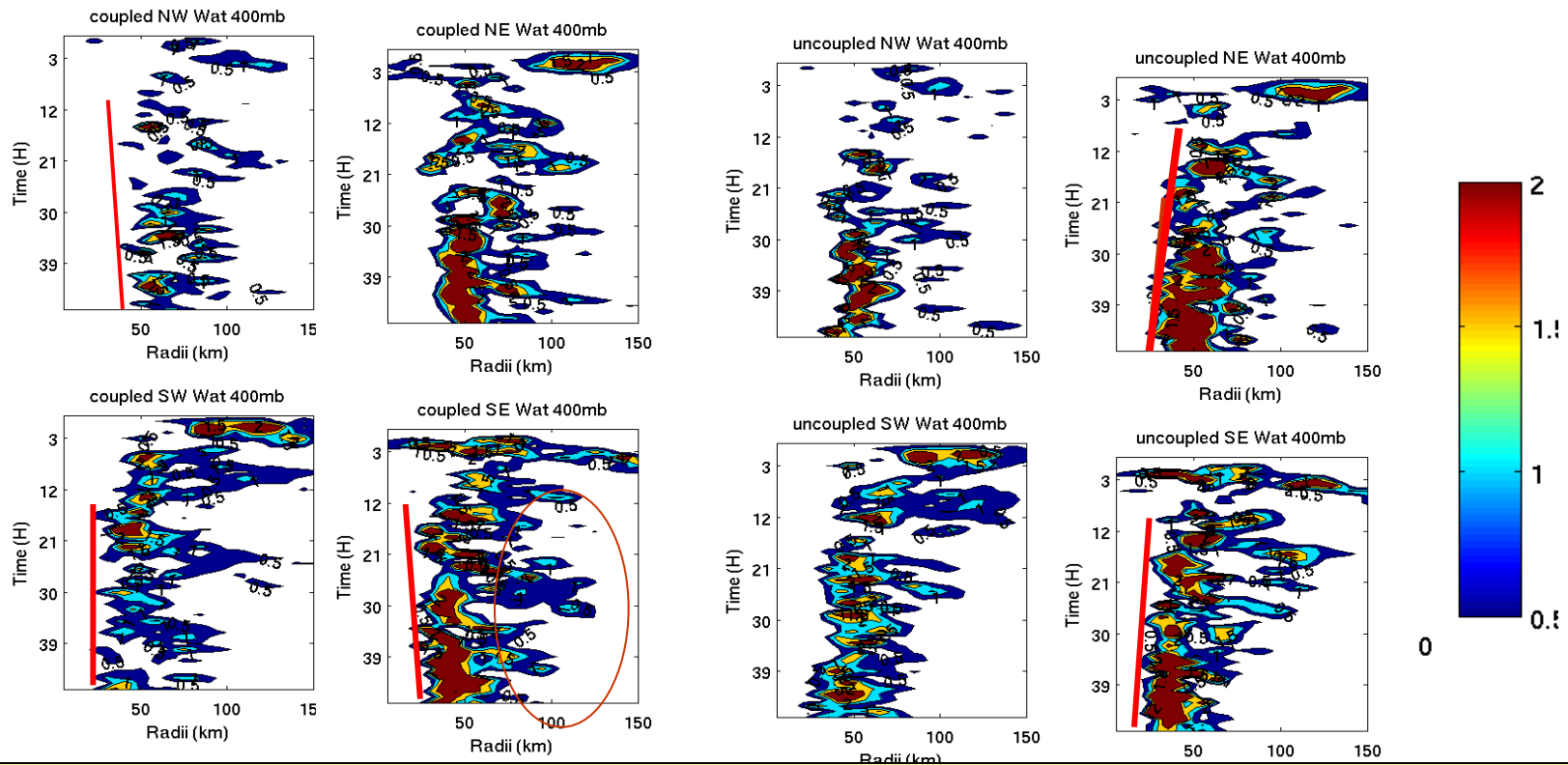
*Chen et al. (2010), MWR*

# Ocean Mixed Layer Temperature Budget



The wind mixing, vertical advection, and horizontal advection are the three primary causes for the wake formation. The advections are important to increase the horizontal length scale of the wake

# Azimuthally Averaged W at 400 mb

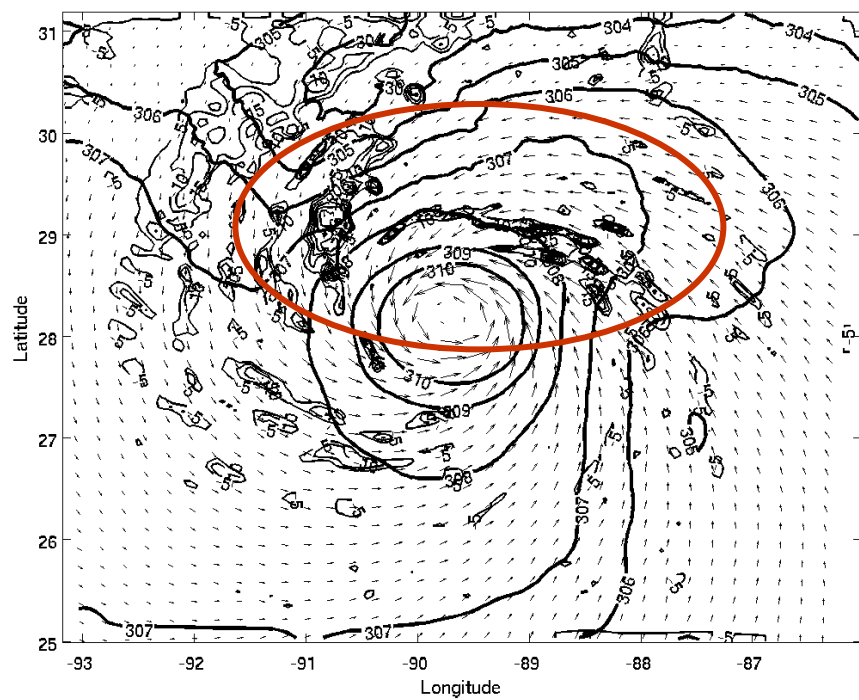


Uncoupled run has a steady progression in the reduction of the eyewall radius and reduction of deep convection at radii beyond the eyewall

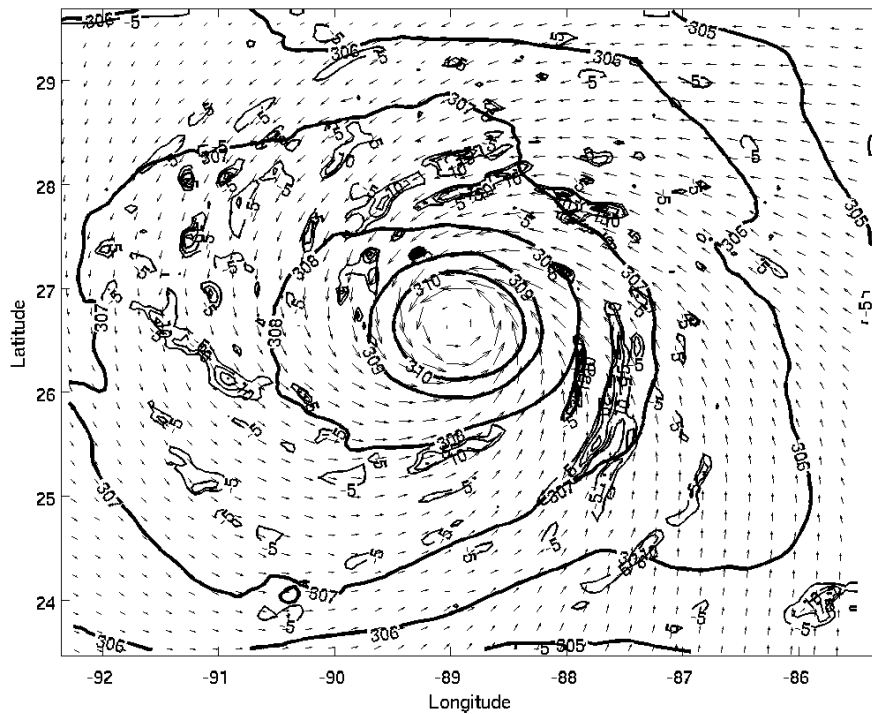
In the Coupled run, this progression is interrupted and weaker convection beyond the eyewall persists



## Coupled

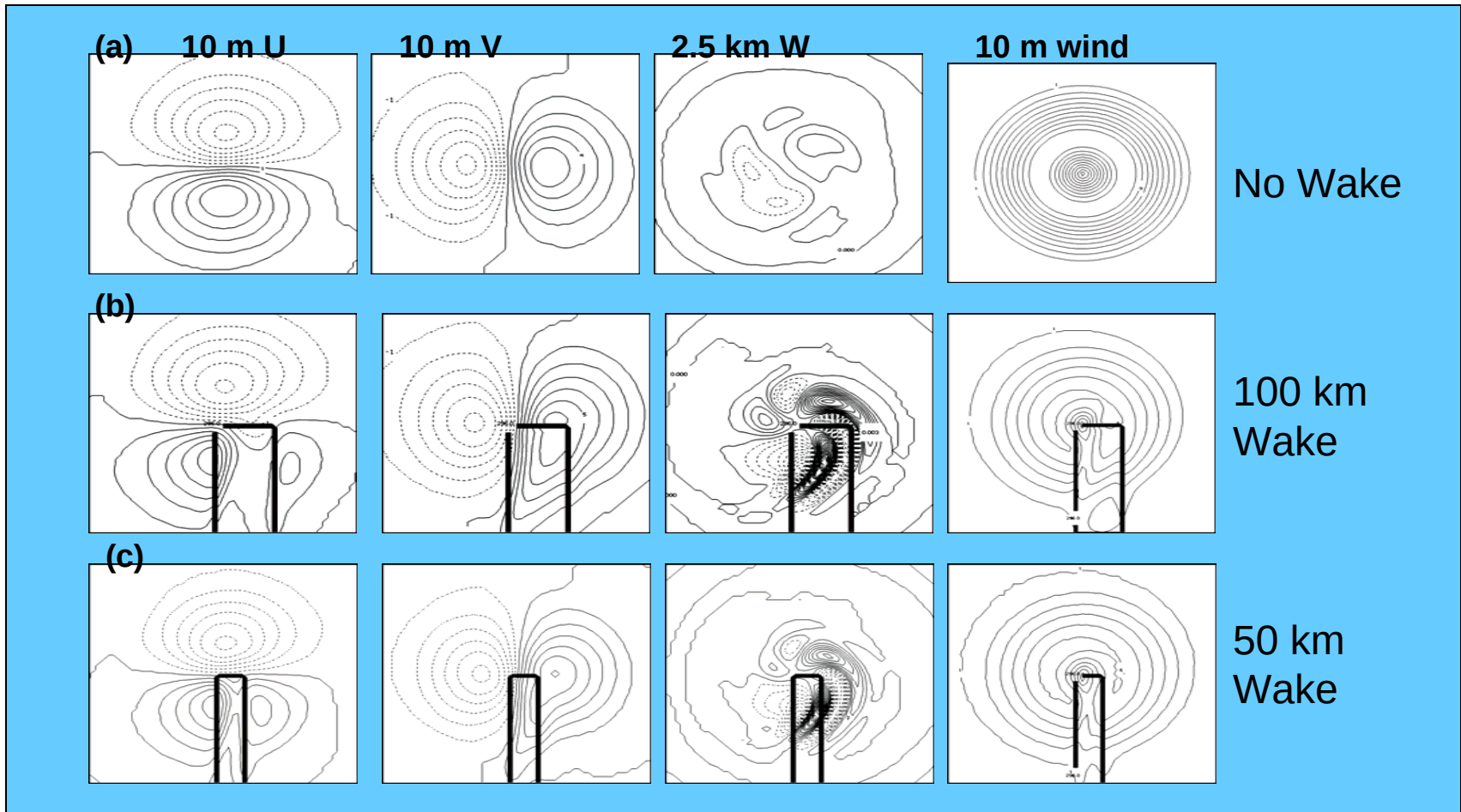


## Uncoupled



# Atmospheric Response to the Wake

Idealized axis-symmetric dry simulations

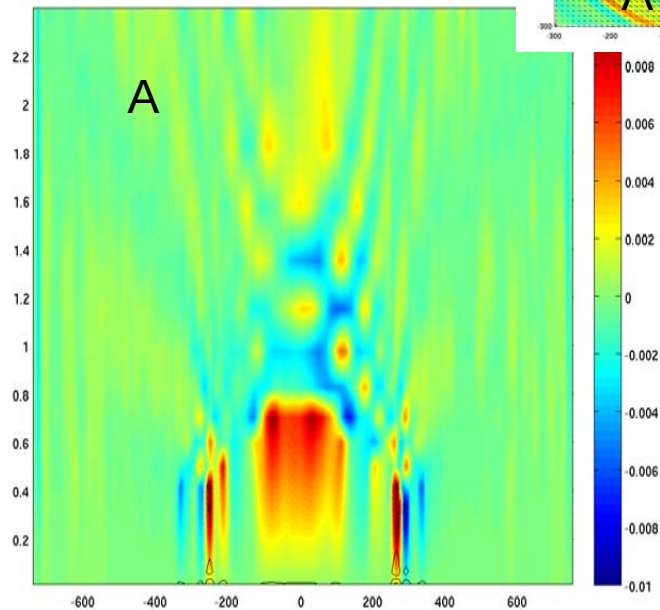


Wave # 3 response from a forced-stationary wake

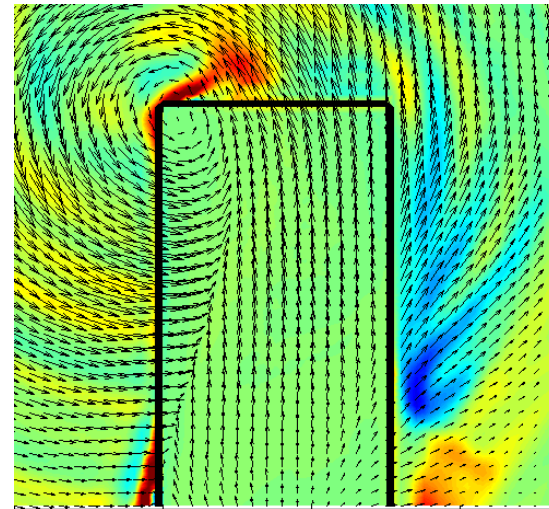
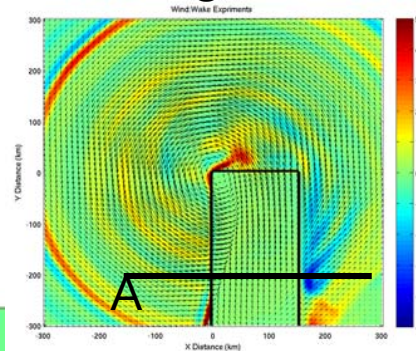
# Atmospheric Response to the Wake

## Idealized axis-symmetric dry simulations

Vertical velocity



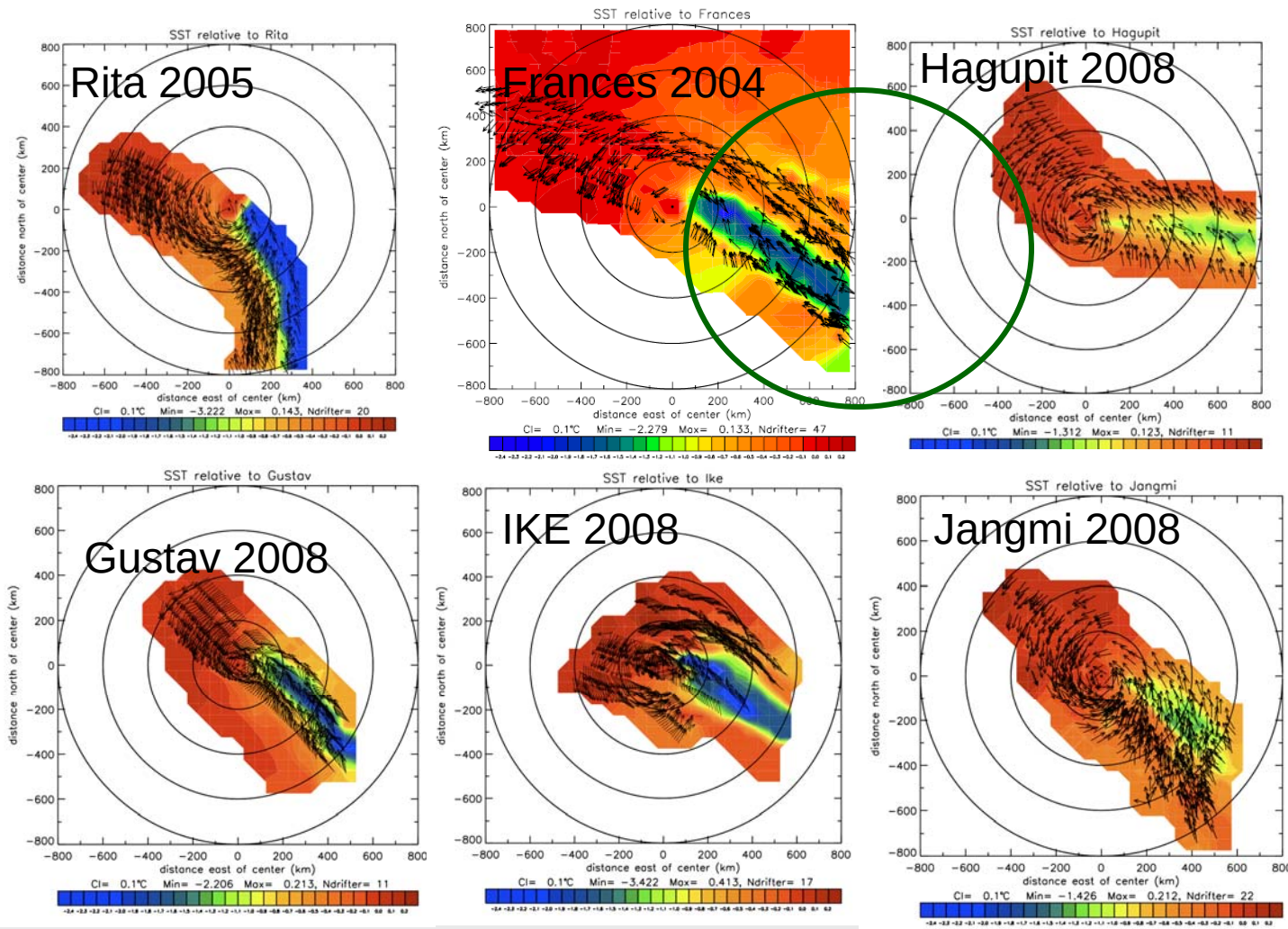
Divergence



The low-level wind response to the cold wake is to enhanced:

- A wake jet into the cyclone center
- Convergence downwind from the cold wake
- Divergence upwind from the cold wake

# Characteristics of TC Cold Wake



Morzel and Niiler (2010)

The wake comes in different size, shape, and magnitude

It is influenced by:

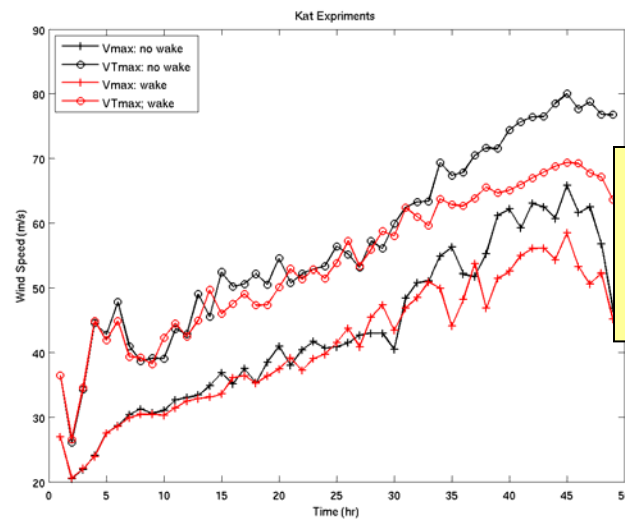
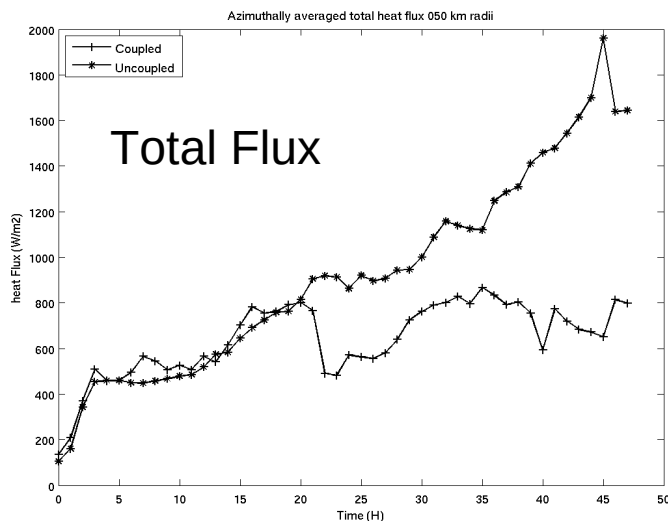
- Storm intensity
  - Storm size
  - Storm speed
  - Upper-ocean stratification
  - Inertial period
- Price (1981)

S. Chen

# Air-Sea Flux – Intensity Relationship

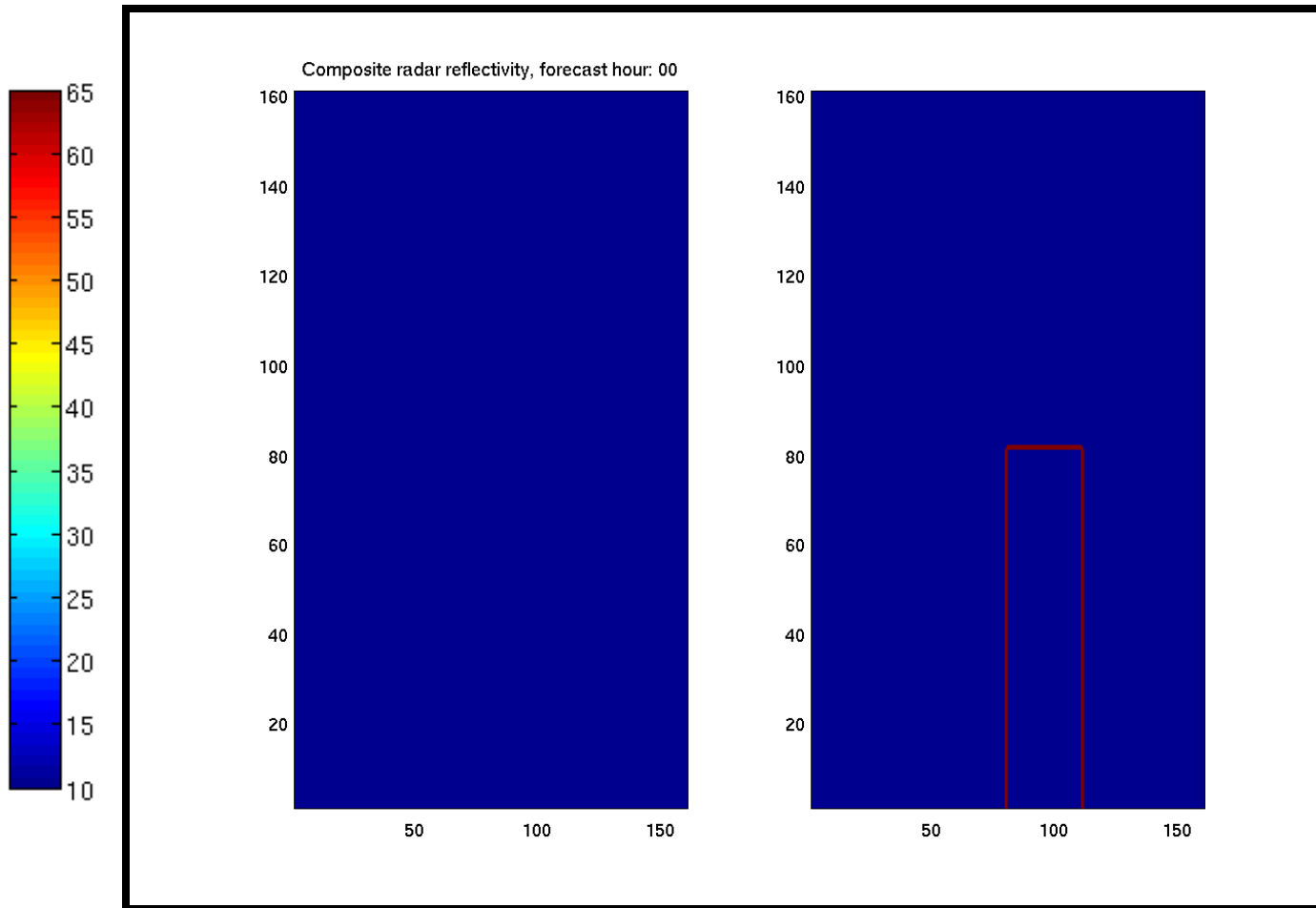
How does the wake affects the TC intensity?

- Reverse WISHE cycle – reduce flux - reduce evaporation at the air-sea interface – therefore decrease the radial inflow (Bender and Ginis, 1999)
- Vortical Hot Towers – (Montgomery et al. 2009)
- Does the wake disrupt the aggregation of the VHTs?



TC continues to increase, but at a slower rate

# Animation of Composite Radar Reflectivity



Model configuration:

Uncoupled

Idealized

3 km horizontal  
resolution

Imposed cold wake



# Summary

- The dry idealized mono vortex simulation suggests the wake setup a preferred convergence area downwind from the wake and a divergence area upwind from the wake
- The moist idealized simulation shows the wake changed the convective structure and distribution both in the eyewall and at outer radii
- The model wake disrupted and delayed the aggregation process of the VHTs in the Idealized axisymmetric simulation
- The wake width influences the idealized dynamic response of the simulated vortex structure
- Results from the fully coupled Katrina simulation also suggests similar conclusions