

AV Modeling and Interpreting the Impact of Severe Storms and Their Relation to Climate

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References

Bender, M.A., T.R. Knutson, R.E. Tulyea, J.J. Sirutis, G.A. Vecchi, S.T. Garner, and I.M. Held, 2010, Modeled Impact of Anthropogenic Warming on the Frequency of Intense Atlantic Hurricanes: *Science* 22, v. 327/5964, p. 454-458. DOI: 10.1126/science.1180568.

Emanuel, K., 2007, Environmental Factors Affecting Tropical Cyclone Power Dissipation: *Journal of Climate*, v. 20, p. 5497-5509. DOI: 10.1175/2007JCLI1571.1

Knutson, T.R., J.L. McBride, J. Chan, K. Emanuel, G. Holland, C. Landsea, I. Held, J.P. Kossin, A.K. Srivastava, and S. Masato, 2010, Tropical cyclones and climate change: *Nature Geoscience*, v. 3, p. 157-163. doi:10.1038/ngeo779.

Vecchi, G.A. and B.J. Soden, 2007, Increased tropical Atlantic wind shear in model projections of global warming: *Geophys. Res. Lett.*, v. 34, LO8702, 5 p. doi:10.1029/2006GL028905.

Website

NASA/GISS--global temperature--: land-ocean index <http://data.giss.nasa.gov/gistemp/graphs>

Modeling and Interpreting the Impact of Severe Storms and Their Relation to Climate



October 3, 2005

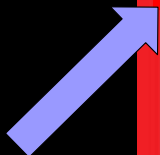
www.time.com AOL Keyword: TIME

POLITICS OF CRONYISM ■ GENERATION JIHAD ■ NEIL YOUNG SINGS

TIME

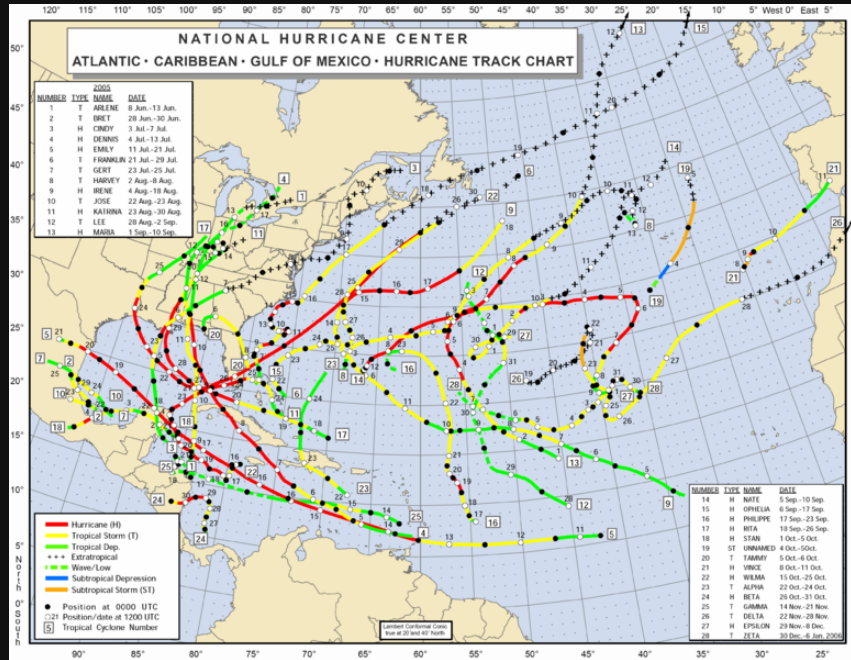
ARE WE MAKING HURRICANES WORSE?

- THE IMPACT OF GLOBAL WARMING
- THE COST OF COASTAL DEVELOPMENT
- PLUS: CHARTING THE GULF COAST DESTRUCTION



2005 Hurricane Season

“The most active season on record”



Presenter's Note:

Over \$100 billion in damage, over 3000 deaths, 3 of top 6 storms.



Before Katrina...

David & Kimberly King
Waveland, MS



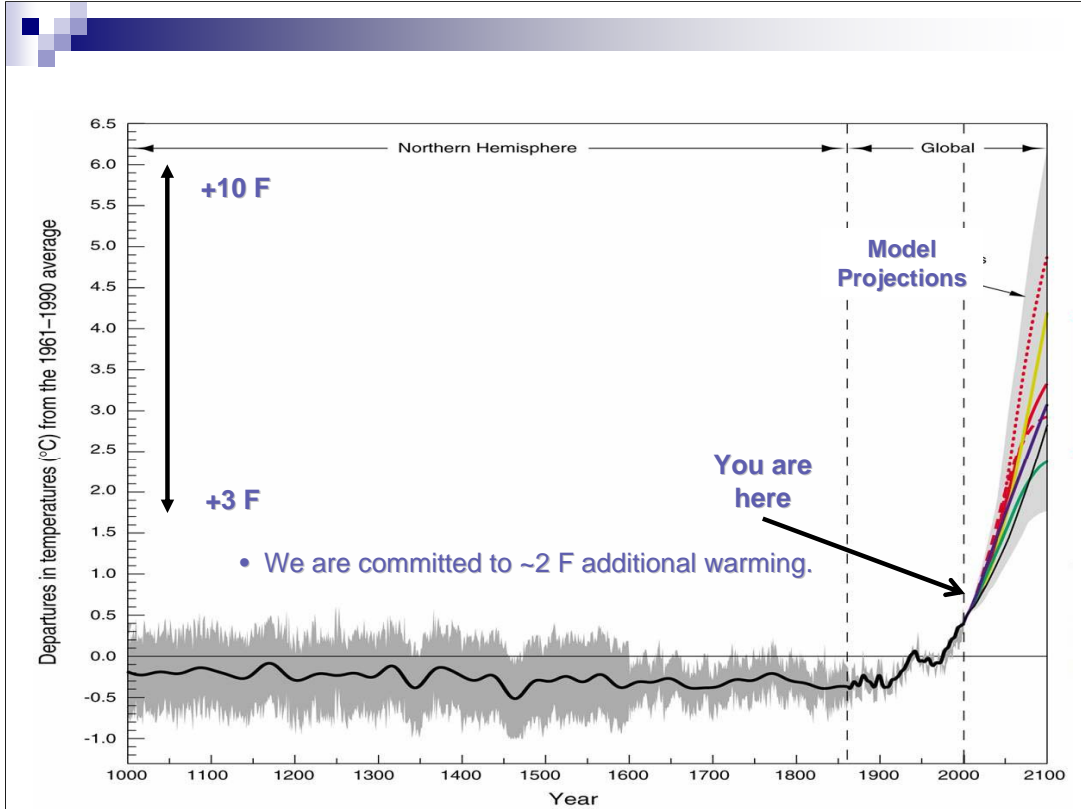
...After Katrina

David & Kimberly King
Waveland, MS



What do we know?

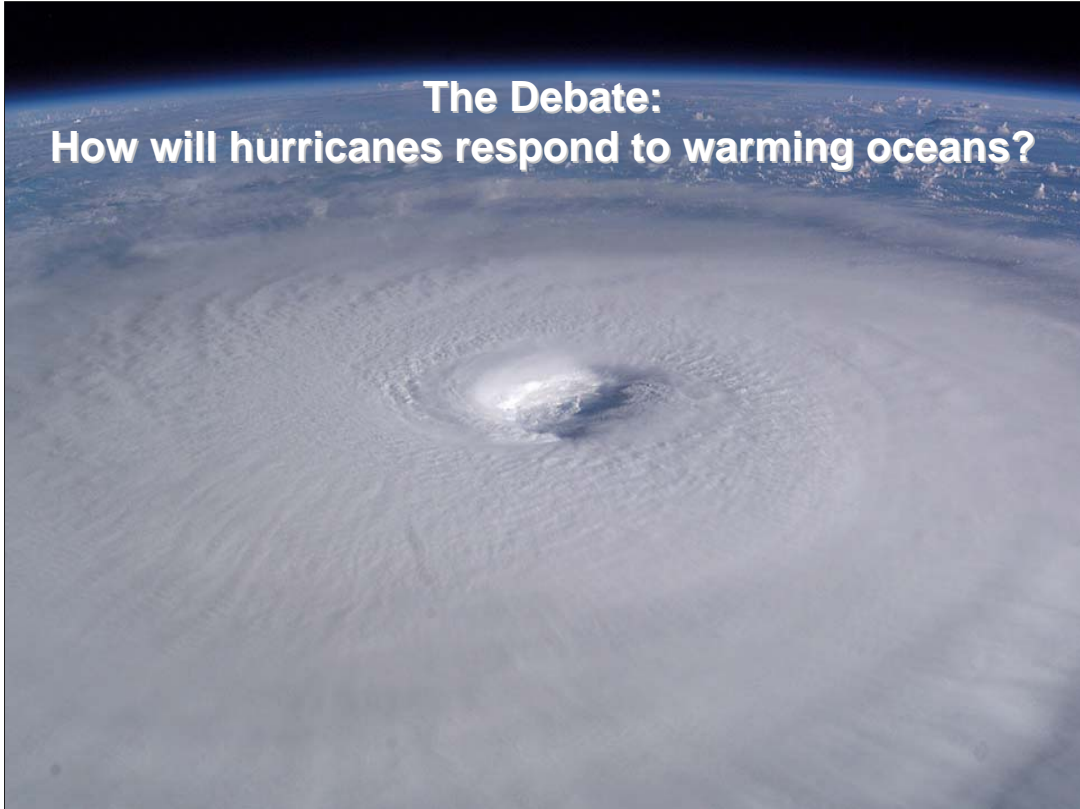
- 1) We know the climate has warmed.**
- 2) We know that human activities are primarily responsible for the warming over the past ~50 years.**
- 3) We know that future warming is unavoidable.**



Presenter's Note:

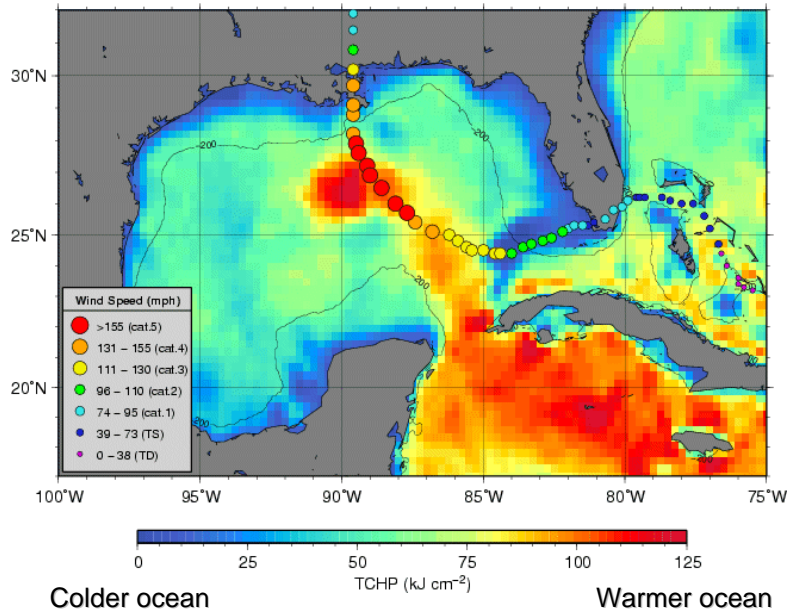
But how will it change life in FL?

**The Debate:
How will hurricanes respond to warming oceans?**

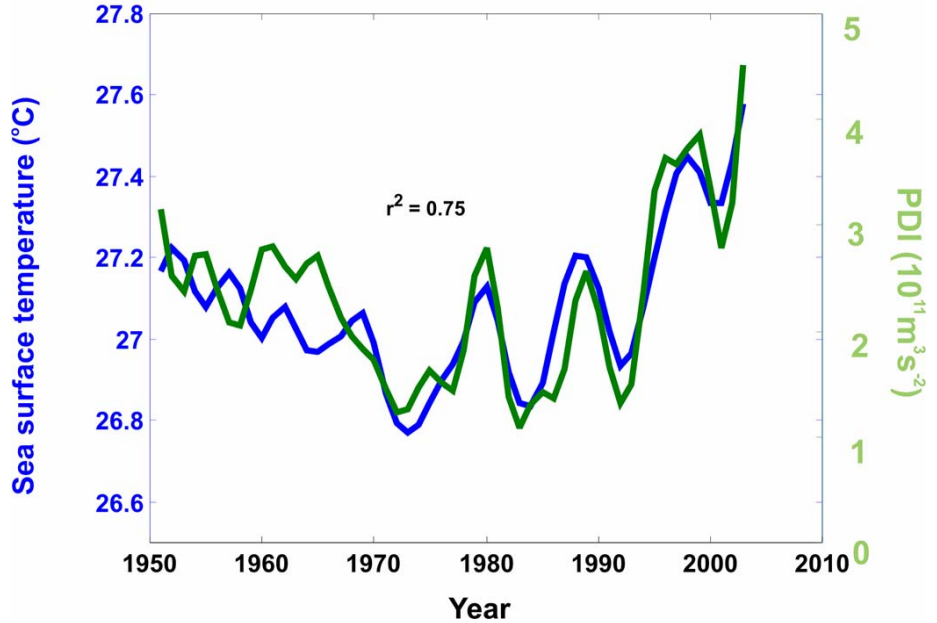


Intensification of Hurricane Katrina

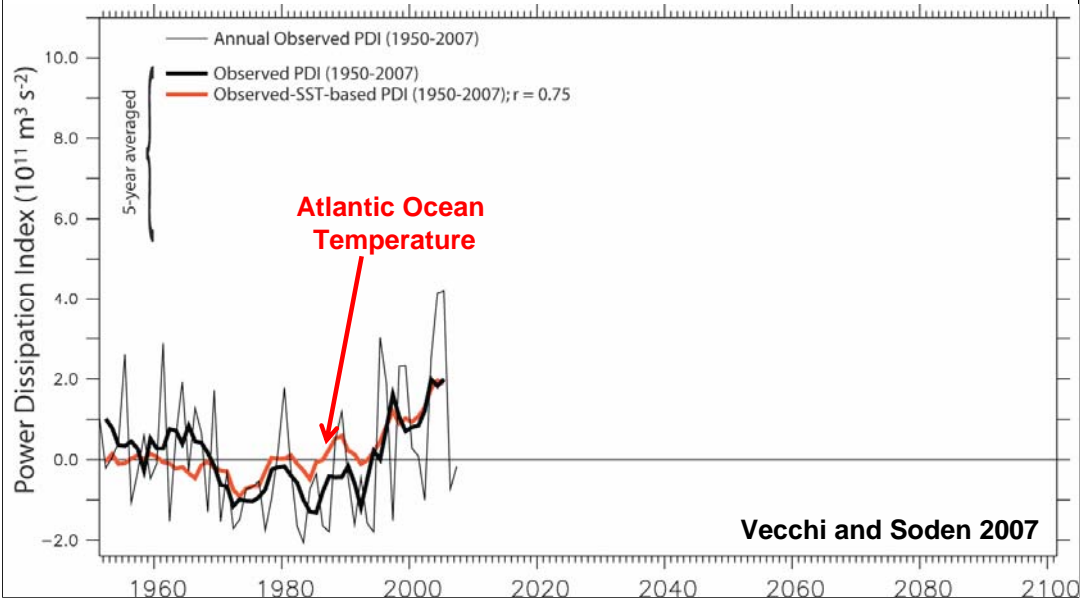
Gulf of Mexico – Tropical cyclone heat potential (TCHP) 08/28/2005



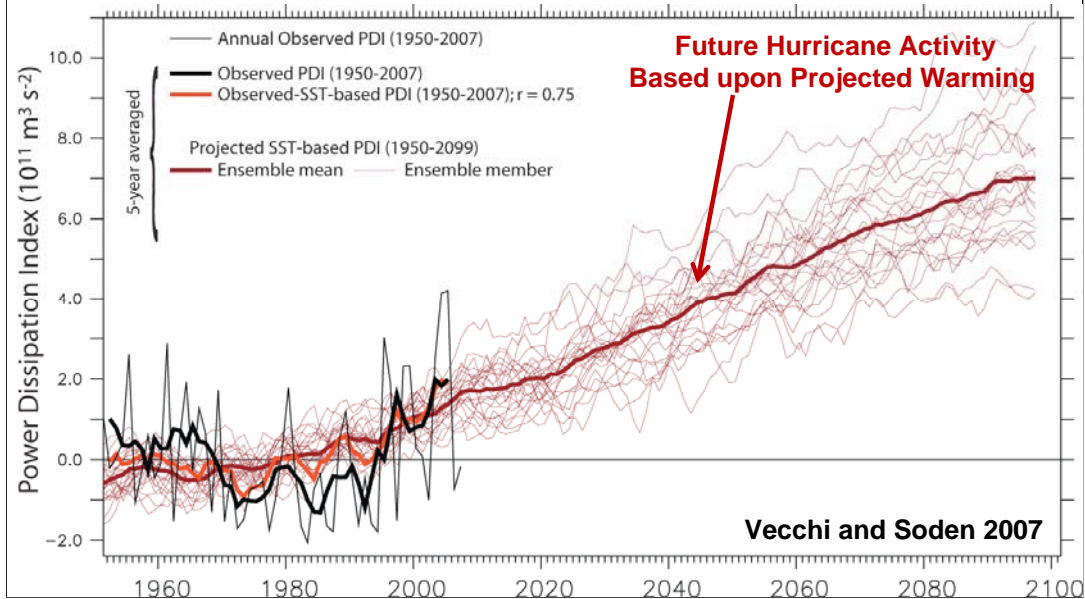
What do observations suggest?



Hurricane Activity in the 20th Century: Observations



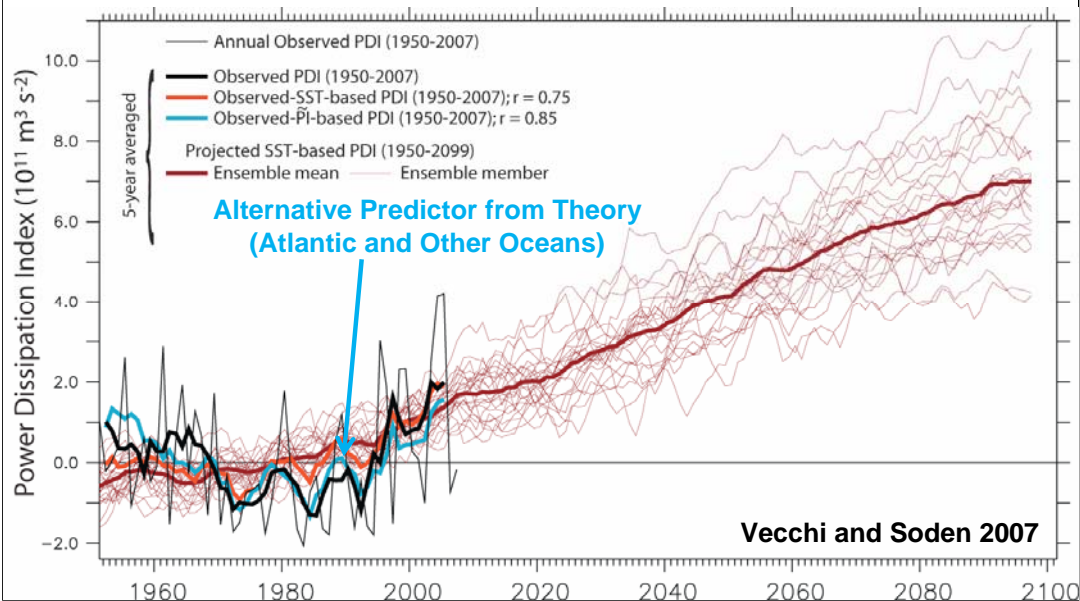
Hurricane Activity in the 21st Century: Based on Observed Relationship with SST



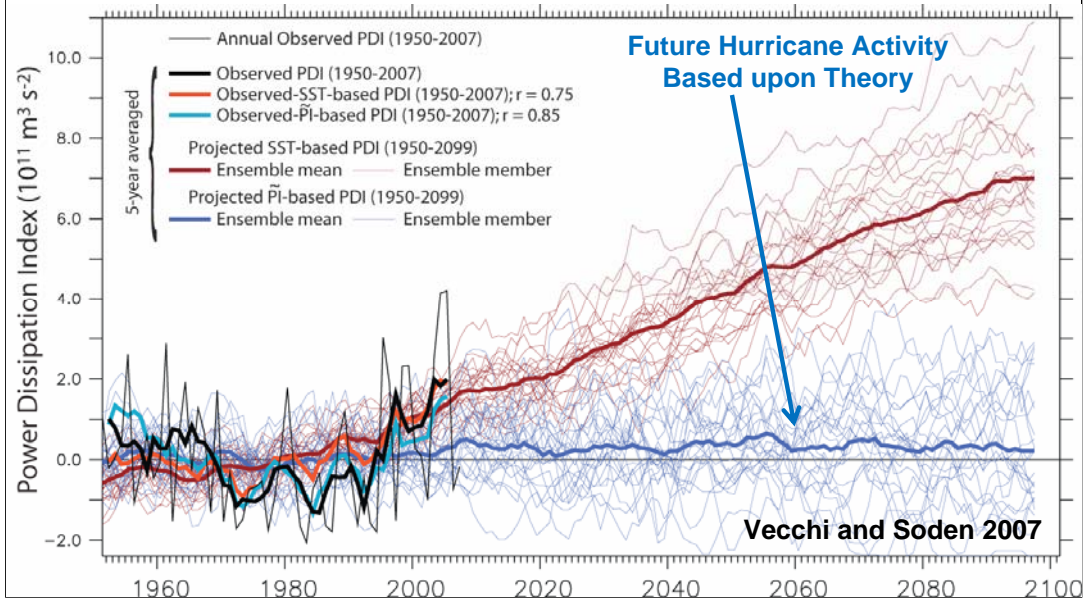
Presenter's Note:

By 2100: lower end = 2005; upper end $\geq 2 \times$ 2005.

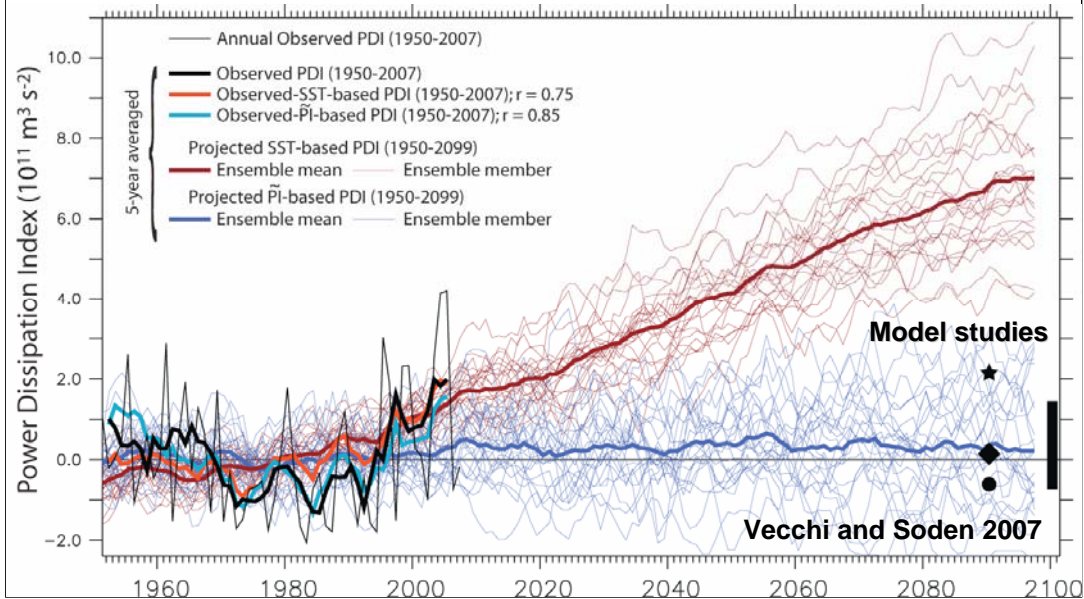
Hurricane Activity in the 20th Century: An Alternative Relationship Based on Theory

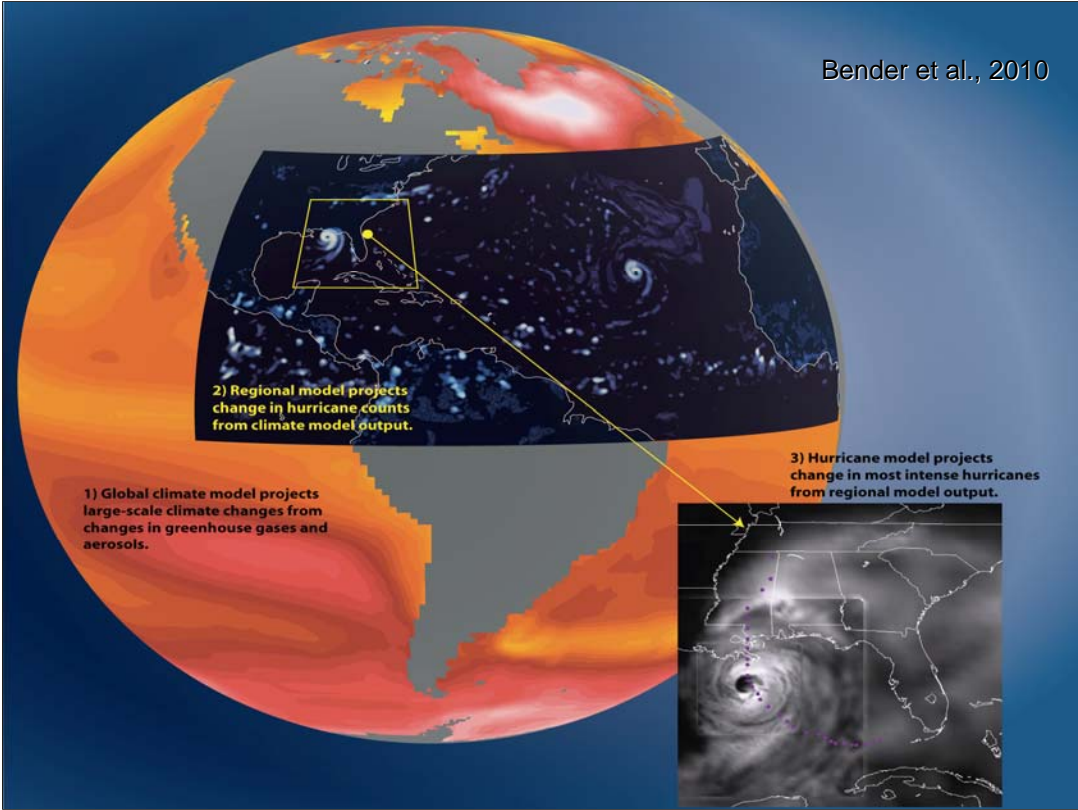


Hurricane Activity in the 21st Century: The Projection Based on Theory

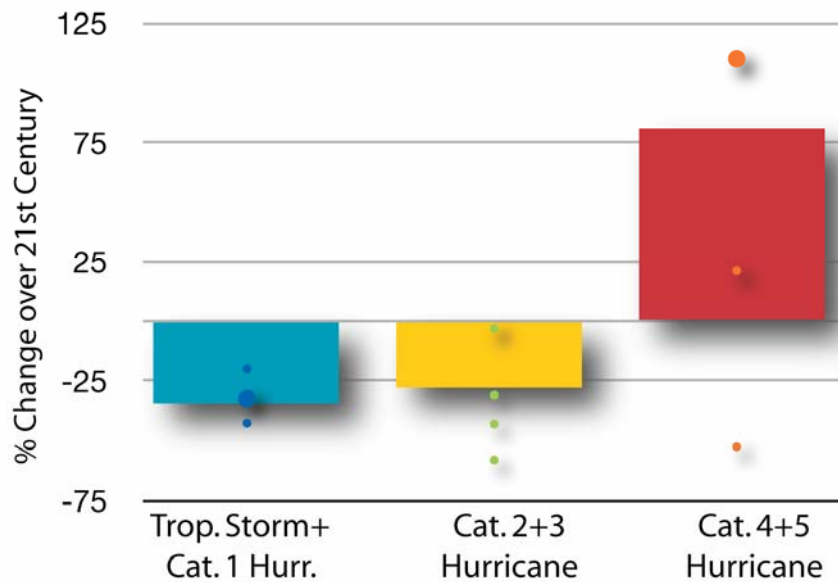


Hurricane Activity in the 21st Century: Model Projections

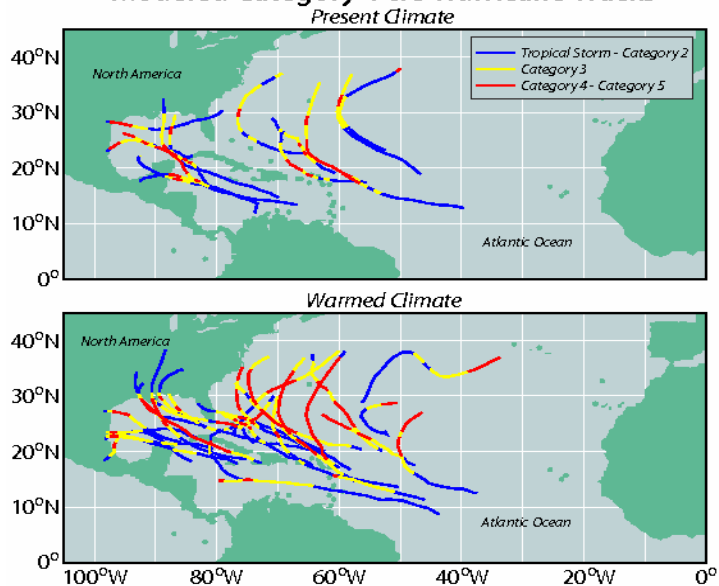




Projected Changes in Atlantic Hurricane Frequency over 21st Century



Modeled Category 4 & 5 Hurricane Tracks



The projected increase in Major Hurricanes occurs “close” to SE US.



Tropical Cyclones and Climate Change

Nature Geoscience, February 2010

(1) Intensity:

“Future projections based on theory and high-resolution dynamical models consistently indicate that greenhouse warming will cause the globally averaged intensity of tropical cyclones to shift towards stronger storms, with **intensity increases of 2–11% by 2100**.”

(2) Frequency:

Existing modelling studies also consistently project **decreases in the globally averaged frequency of tropical cyclones, by 6–34%**.

(3) Rainfall

Balanced against this, higher resolution modelling studies typically project substantial increases in the frequency of the most intense cyclones, and **increases of the order of 20% in the precipitation rate within 100 km of the storm centre.**”

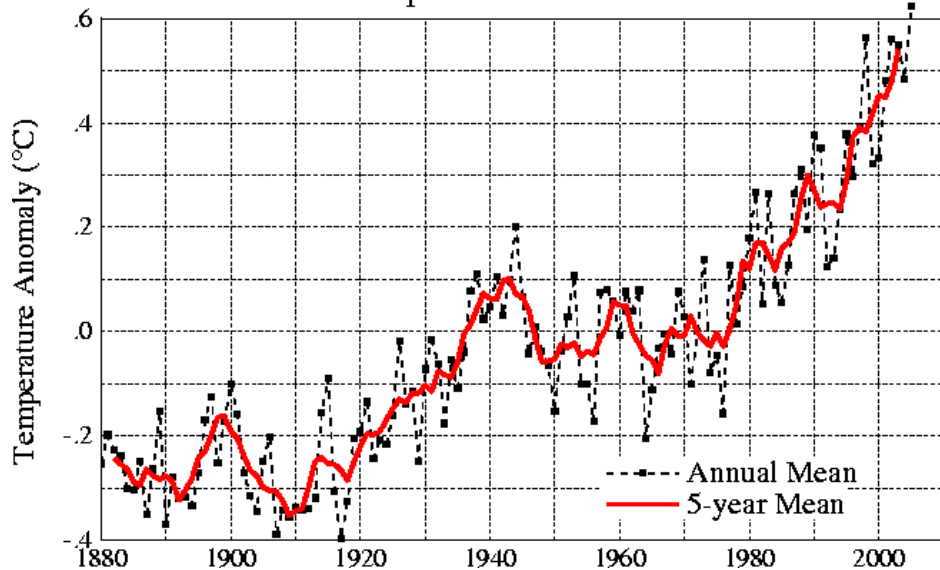
Knutson et al., 2010



Thank you

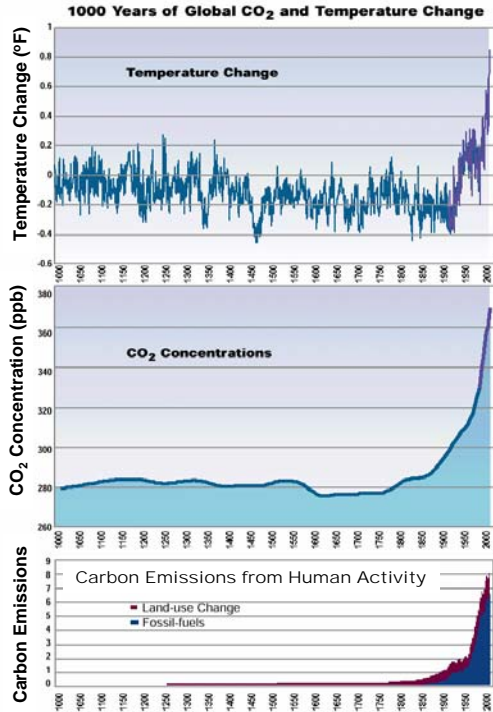
What do we know? The planet has warmed

Global Temperature: Land-Ocean Index



Source: NASA/GISS <http://data.giss.nasa.gov/gistemp/graphs/>

What do we know? Most of the warming is due to humans



The rate of warming over the past century is unusual.

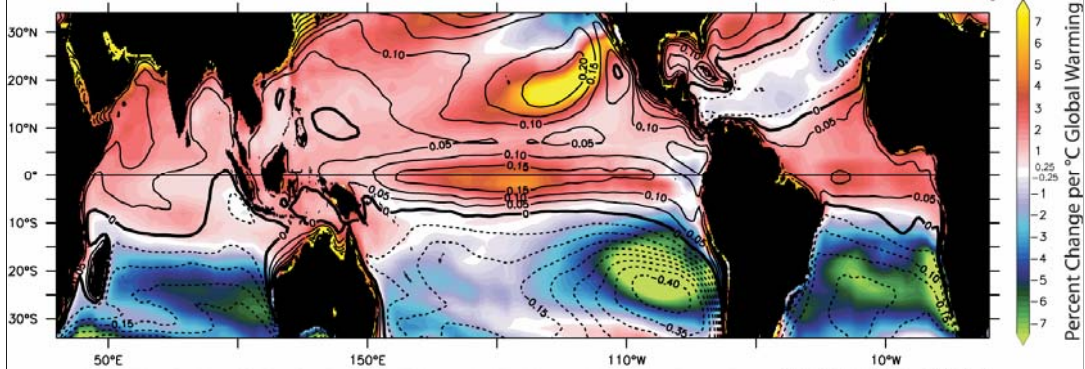
The rapid warming coincides with increasing carbon dioxide.

The increasing carbon dioxide is due to human activities, primarily burning fossil fuels.

What does the theory predict?

21st Century Change in Jun.-Nov. Velocity Maximum Pot. Int.

IPCC-AR4 Scenario A1B Multi-model Ensemble-mean, per °C Global Warming

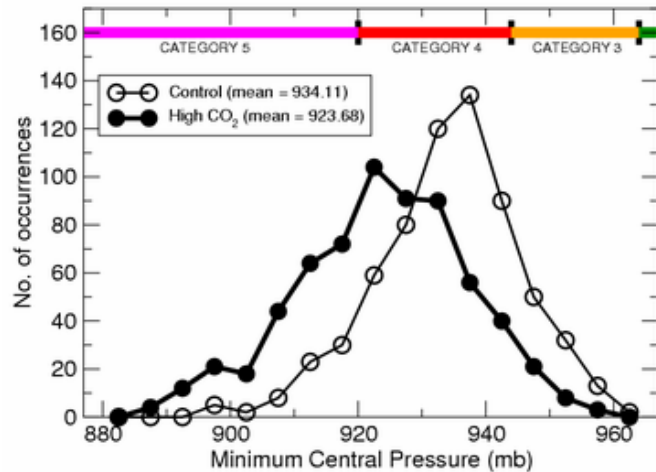


CONTOUR: FRACT. DEPARTURE FROM TROPICAL MEAN WARMING

From Vecchi and Soden (2007, GRL)

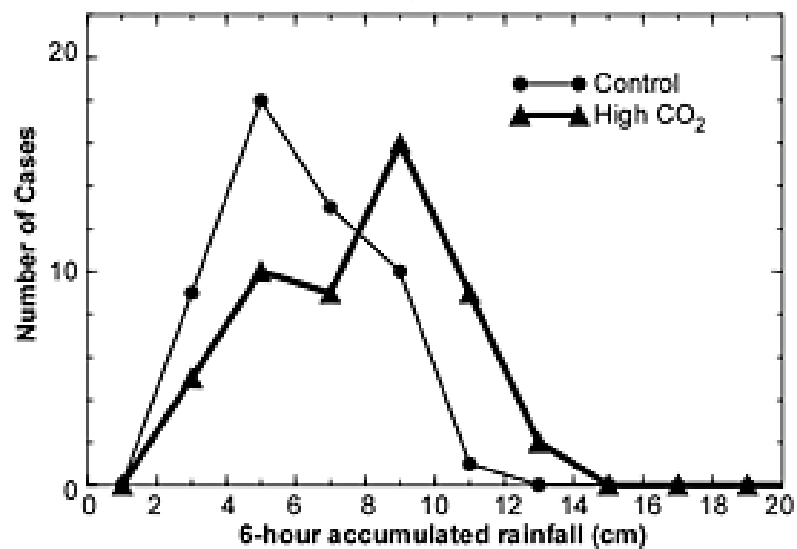
Idealized hurricane simulations

Aggregate results: 9 GCMs, 3 basins, 4 parameterizations, 6-member ensembles



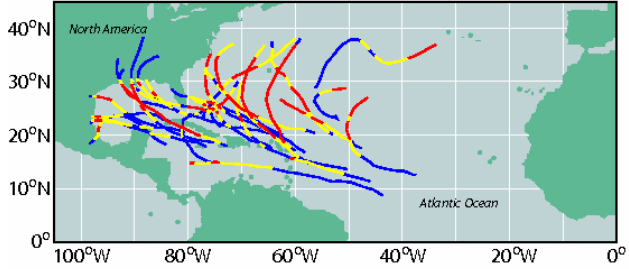
Near Storm Precipitation

51 cases per experiment





Warmed Climate



Multi-model Ensemble-mean, per °C Global W

