

# Climate Change and Hurricane Frequency: Current Understanding and Predictions

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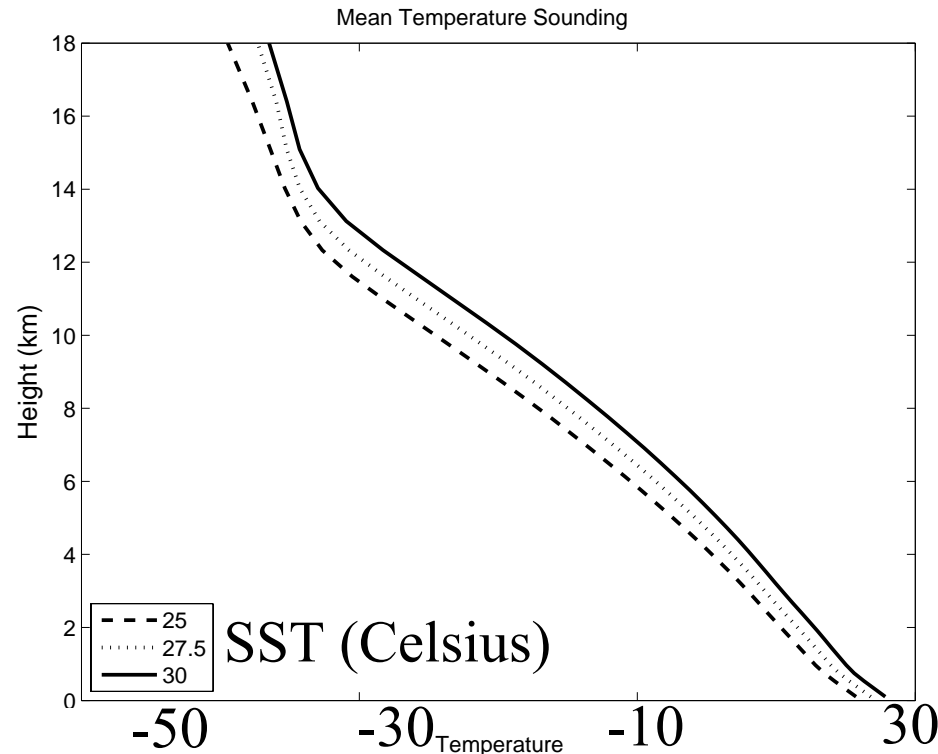
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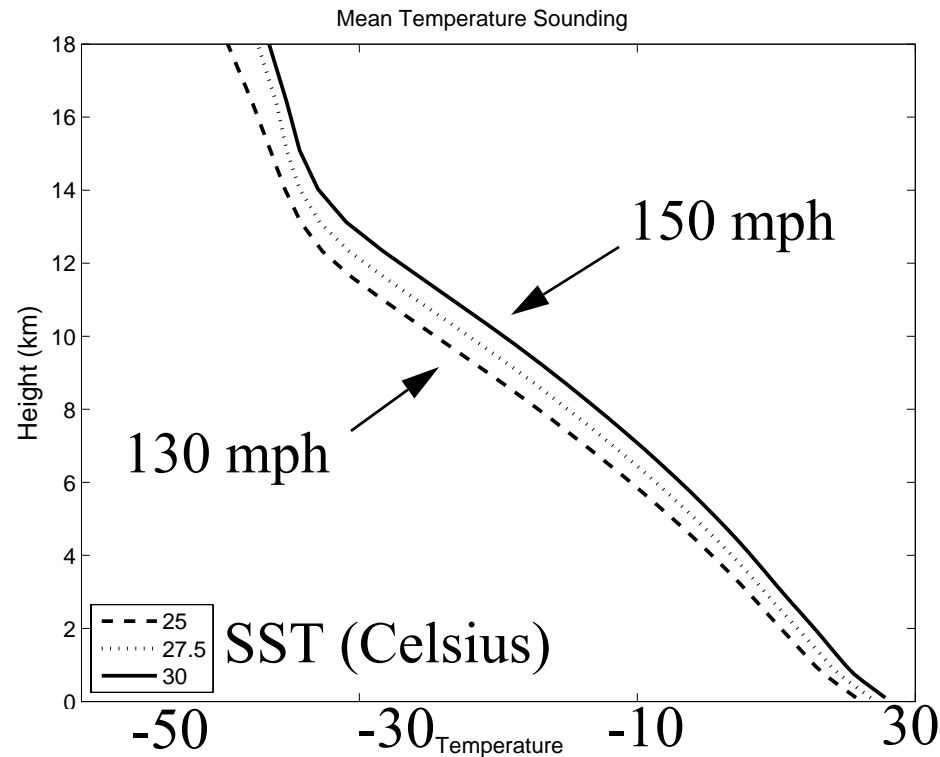
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# I. Previous Understanding of Hurricanes and Climate

- Considerable work in the 60s, 70s, and 80s led to our current understanding of the relationship between sea surface temperature (SST) and hurricane activity:
  - \* All other things being equal, higher SST means more storms
  - \* All other things being equal, higher SST means stronger storms
- But, as climate changes due to global warming, all things are not equal!  
For example, the atmosphere warms too:



- However, a very successful theory of hurricane intensity predicts that, even if the atmosphere warms to match the SST, hurricanes will still get stronger:



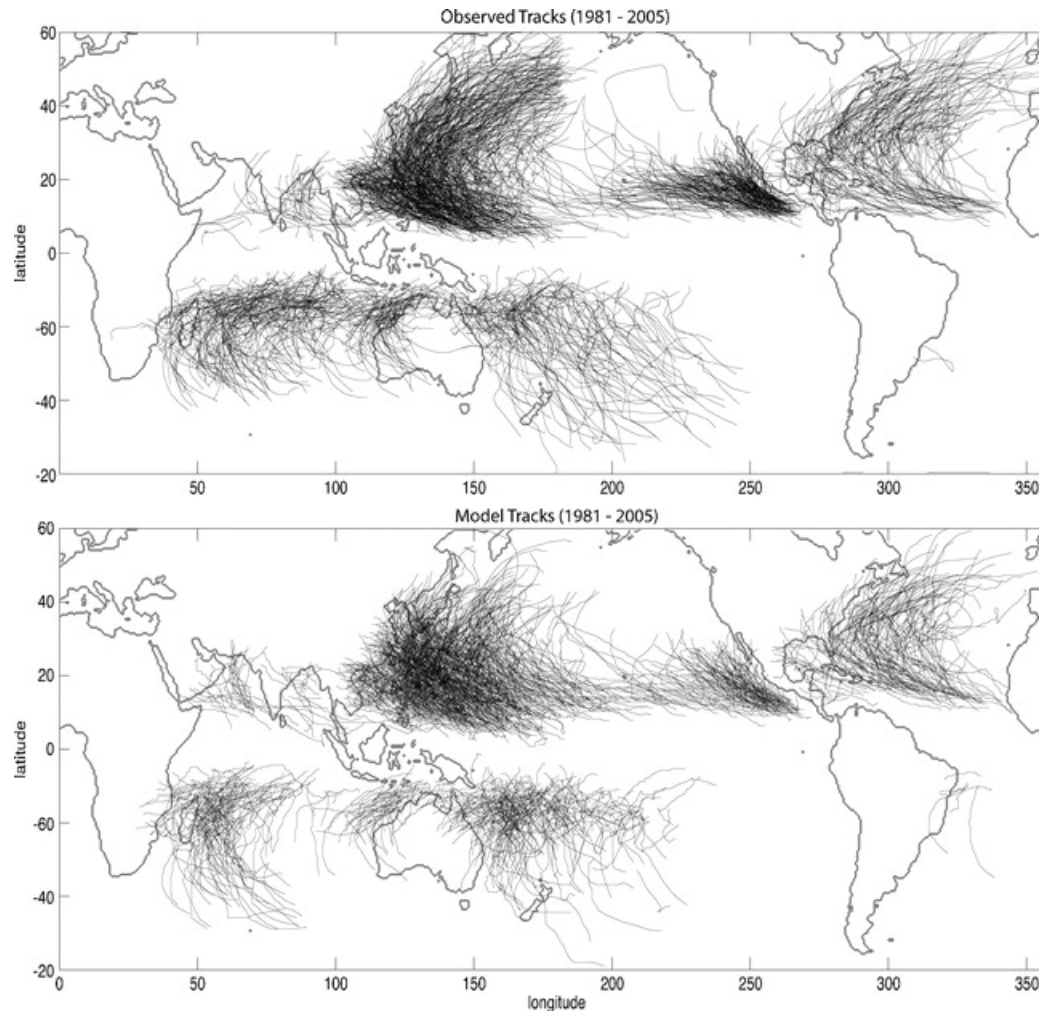
- Even so, many other factors could change with global warming as well:
  - \* Wind shear (the increase of wind speed with height)
  - \* Humidity
  - \* Weather patterns

## II. How might hurricane activity change in the future?

- The same computer models that predict global warming are the only guidance we have on the *details* of future climates.

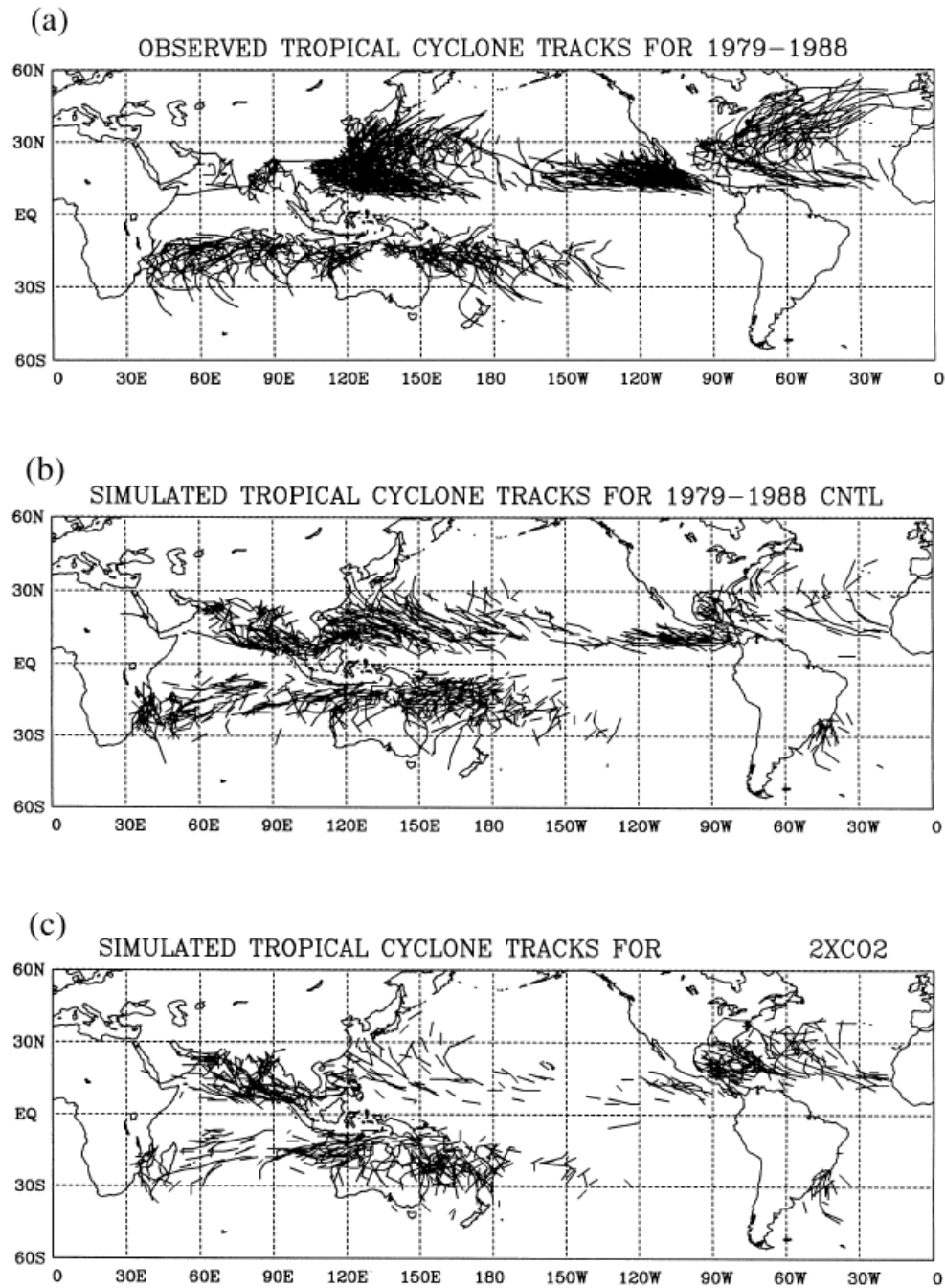
Figure from  
Zhao et al.  
(2009,  
*J. Climate*):

Climate  
simulated by  
NOAA/GFDL  
model.

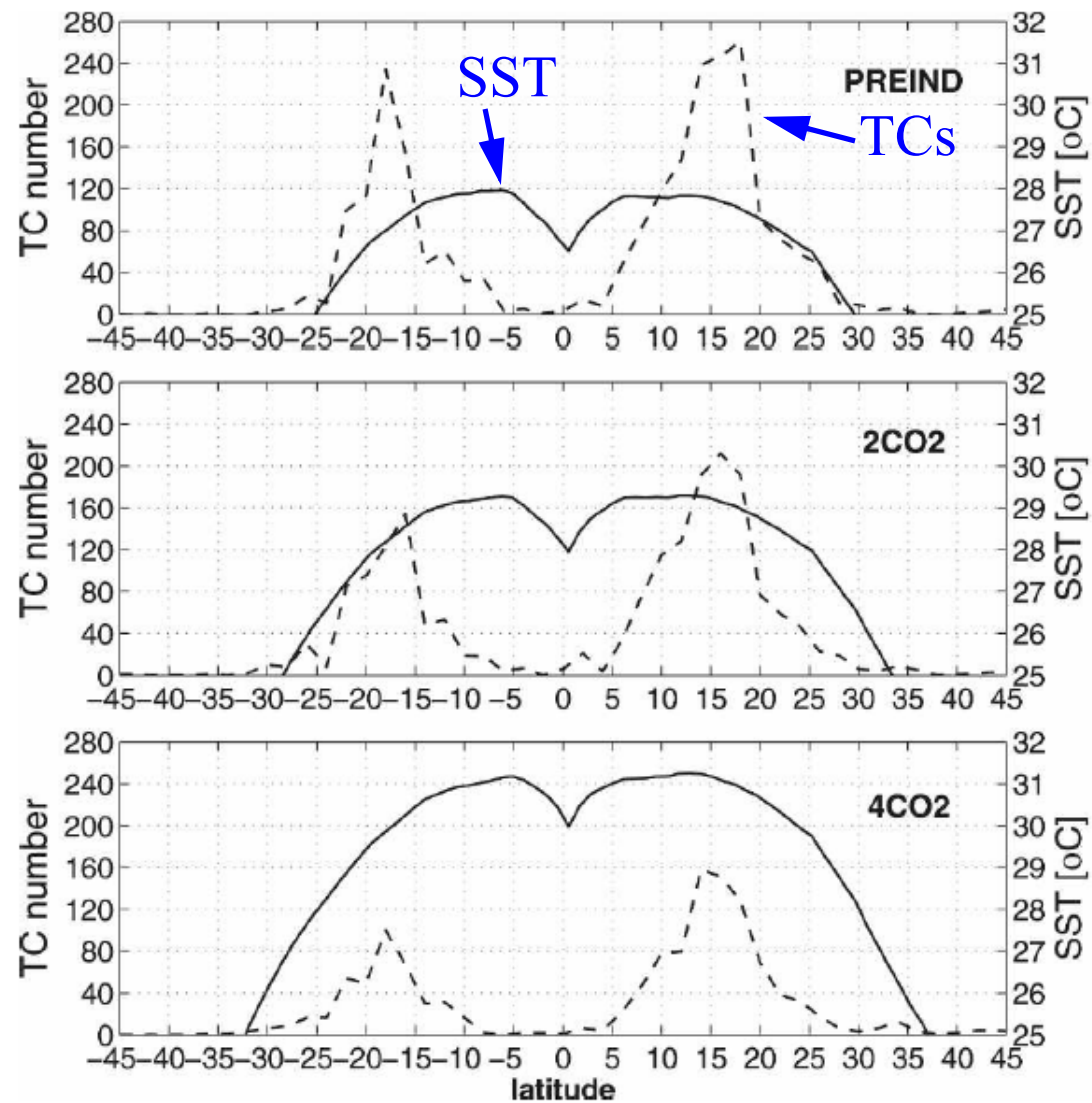


- A number of studies in the 80s and 90s predicted more hurricanes in the global warming world. But in the last decade, these predictions have changed.

An example: Sugi et al. (2002, *J. Meteorol. Soc. Japan*)



Gualdi et al. (2008, *J. Climate*) also show |  
a decrease in TC activity with warming:



# III. In a global warming world, why would there be less hurricanes?

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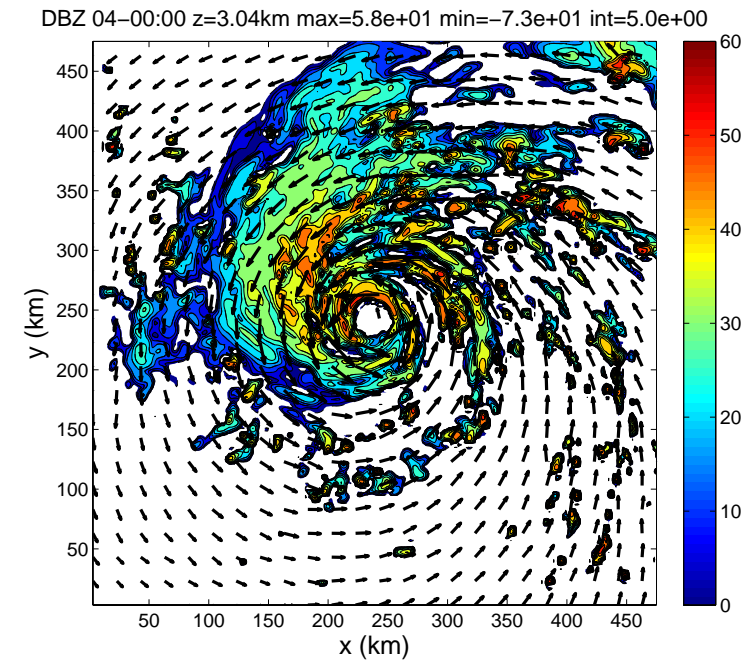
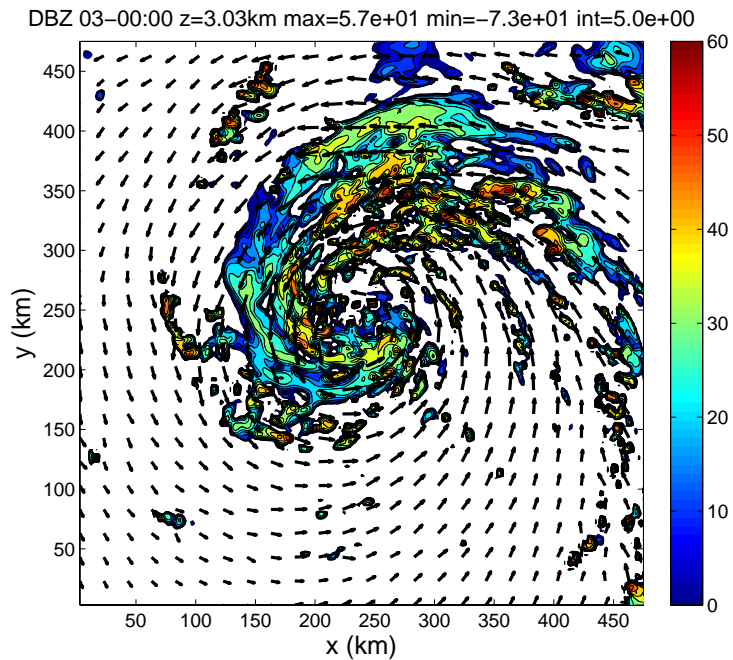
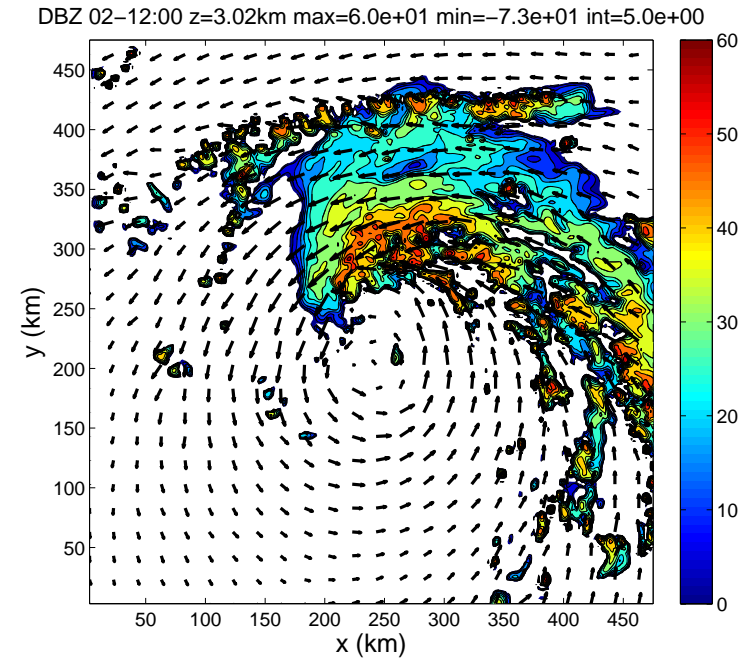
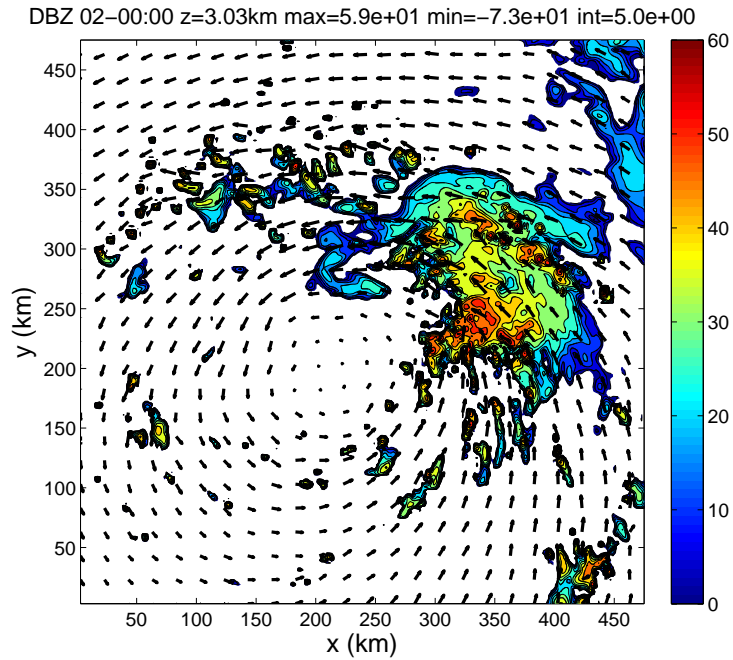
## Increased sensitivity of tropical cyclogenesis to wind shear in higher SST environments

David S. Nolan<sup>1</sup> and Eric D. Rappin<sup>1</sup>

[1] A new method for evaluating the sensitivity of tropical cyclone (TC) genesis to environmental parameters involves the simulation of tropical cyclone development with a cloud-resolving model in environments of radiative-convective equilibrium (RCE) generated by the same model. This method is extended to allow for the incorporation of mean wind shear into the RCE states, thus providing much more realistic and relevant simulations of TC genesis. The “finite-amplitude” nature of tropical cyclogenesis is reproduced, with cyclogenesis resulting only when the initial vortex strength is sufficient, which in turn depends on the environmental parameters. For fixed thermodynamic parameters, the required initial vortex strength necessary for genesis increases with the mean wind shear. However, an unexpected result has been obtained, that increasing sea surface temperature (SST) does not allow TC genesis to overcome greater shear. In fact, the opposite trend is found, that shear is more effective in suppressing TC genesis when the SST is higher. This increased sensitivity can be explained by several factors, such as the higher altitude of the developing mid-level vortex, stronger downdrafts, and increased static stability, all of which allow the shear to be more effective in disrupting the developing cyclone. **Citation:** Nolan, D. S., and E. D. Rappin (2008), Increased sensitivity of tropical cyclogenesis to wind shear in higher SST environments, *Geophys. Res. Lett.*, 35, L14805, doi:10.1029/2008GL034147.

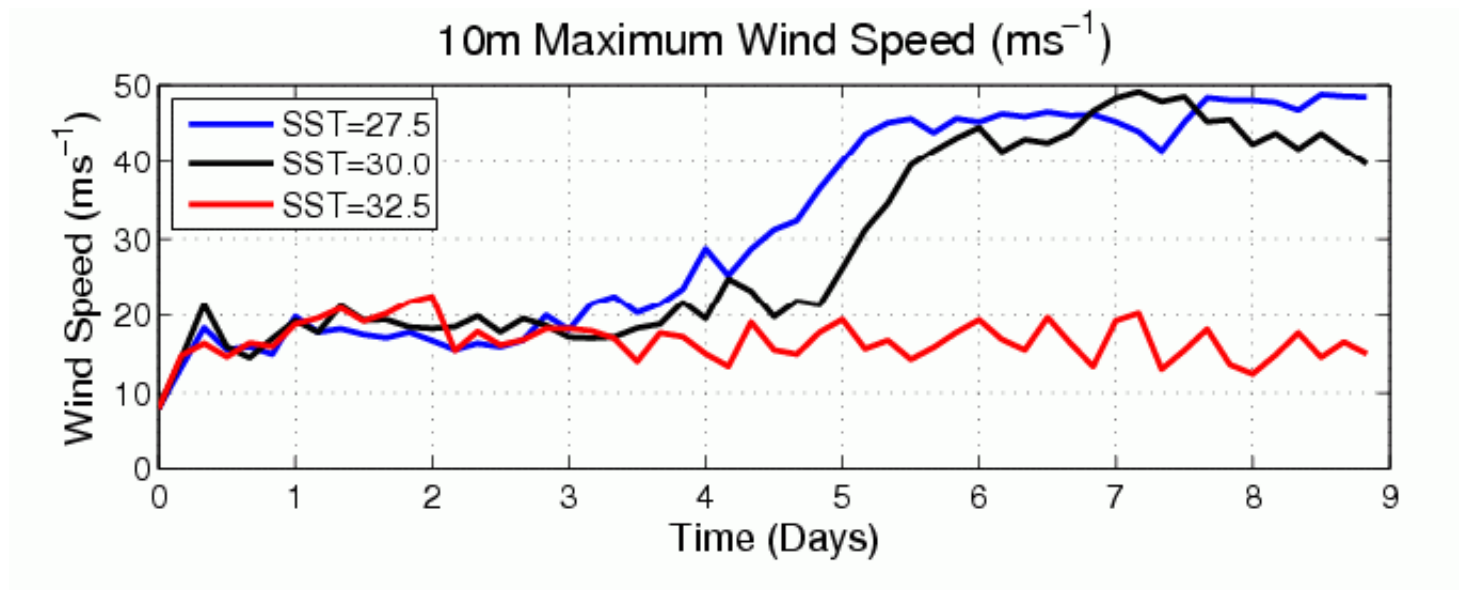


These results come from studies using computer model simulations of the formation of hurricanes:





- We designed a set of simulations to show that as SST increases, even if the atmosphere warms by the same amount, then storms will form more quickly.



- Instead, we found the opposite:  
that it is harder for hurricanes to form in a warmer environment.

It turns out that “wind shear,” which is the increase in wind speed with height in the atmosphere, is *more effective* at suppressing storms in a warmer world.

# Summary

- Earlier understanding of hurricanes and climate suggested that, in a global warming world, there would be more hurricanes and stronger hurricanes.
- A variety of global, regional, and storm-scale modeling techniques are being applied by many research groups to predict changes in hurricane activity with global warming.

The consistent answer from a number of recent studies by different research groups is that there will be less hurricanes in a global warming world.

But, the strongest storms will indeed be stronger.