

The Impact of Climate Change on the Atmospheric Circulation

Neil Tandon
March 23, 2012

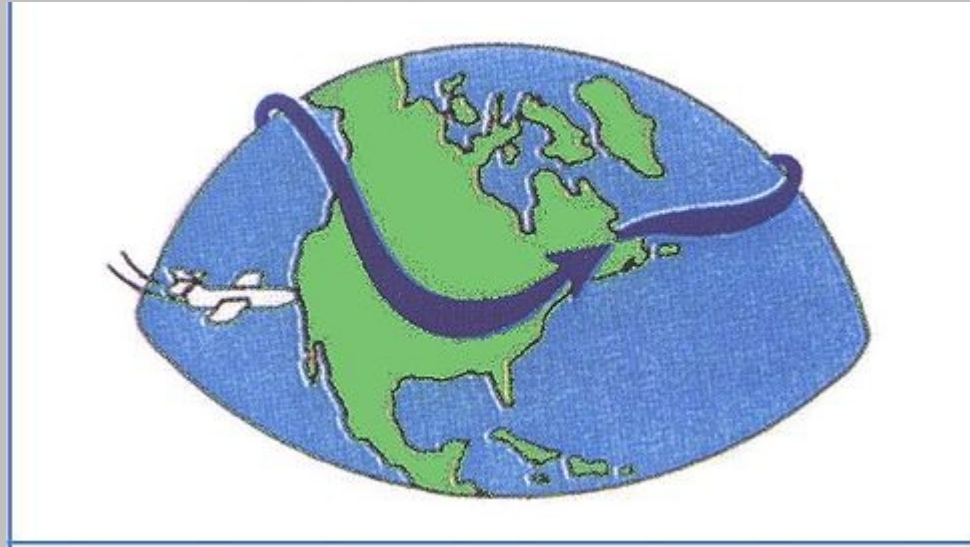
Collaborators: Lorenzo Polvani, Adam Sobel,
Ed Gerber, Sean Davis

The Atmospheric Circulation

- The jets (east-west)
- The meridional circulation (north-south)

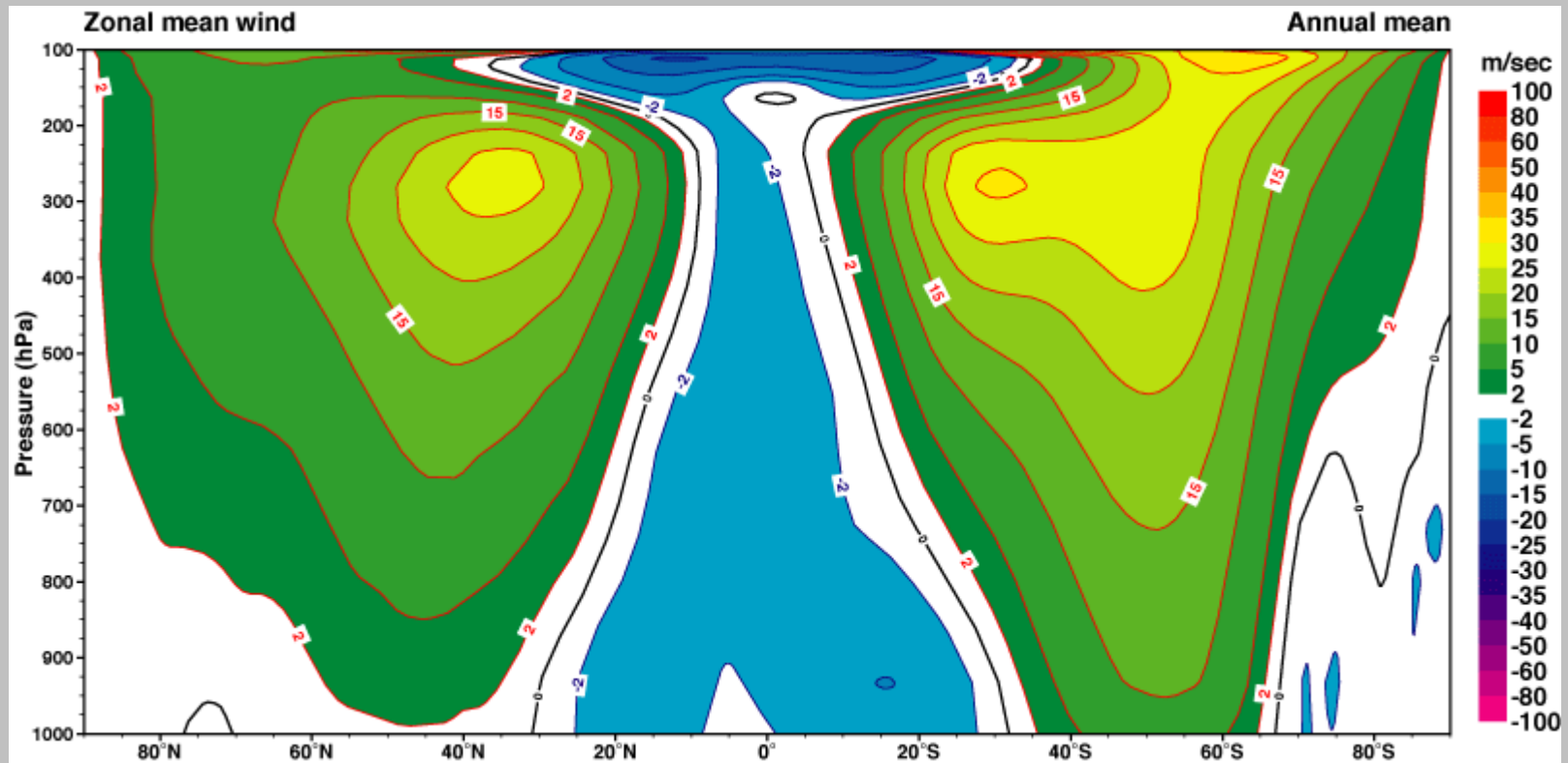
The Atmospheric Circulation

The Jets



The Atmospheric Circulation

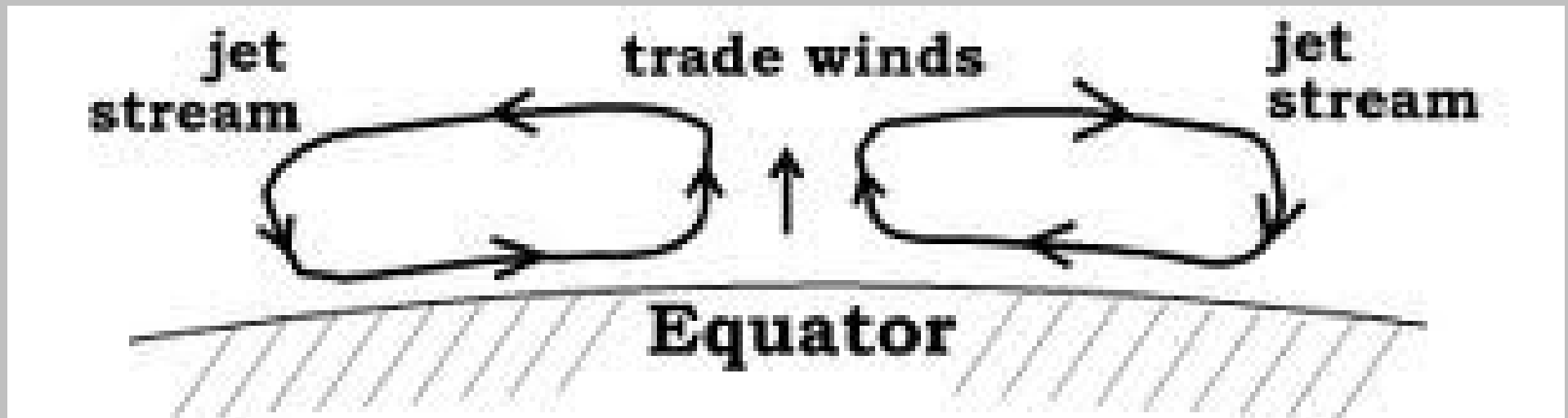
The Jets



eddy activity!

The Atmospheric Circulation

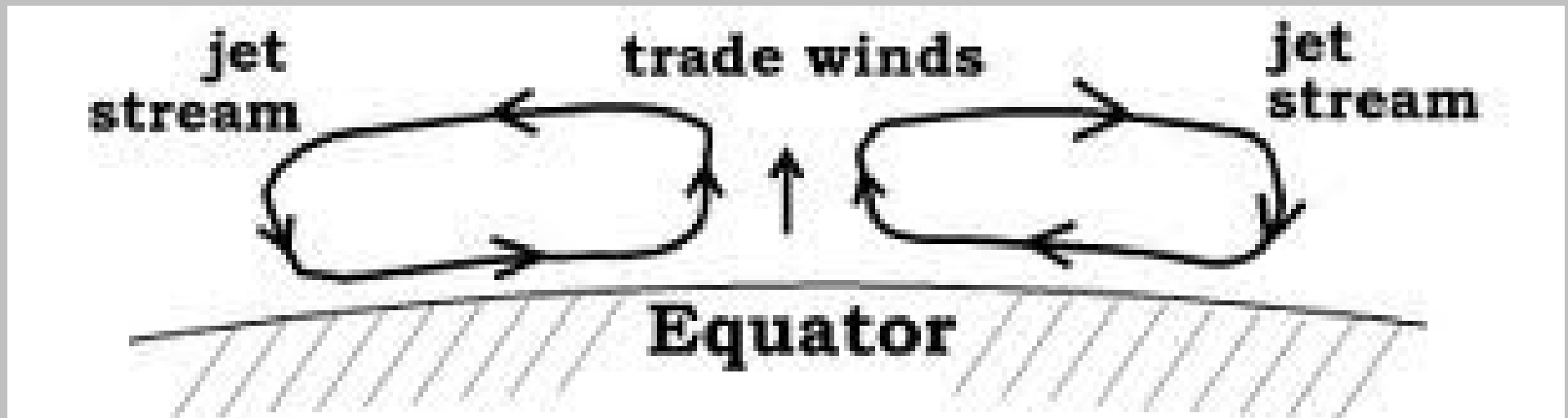
The Hadley Cells



The Atmospheric Circulation

The Hadley Cell

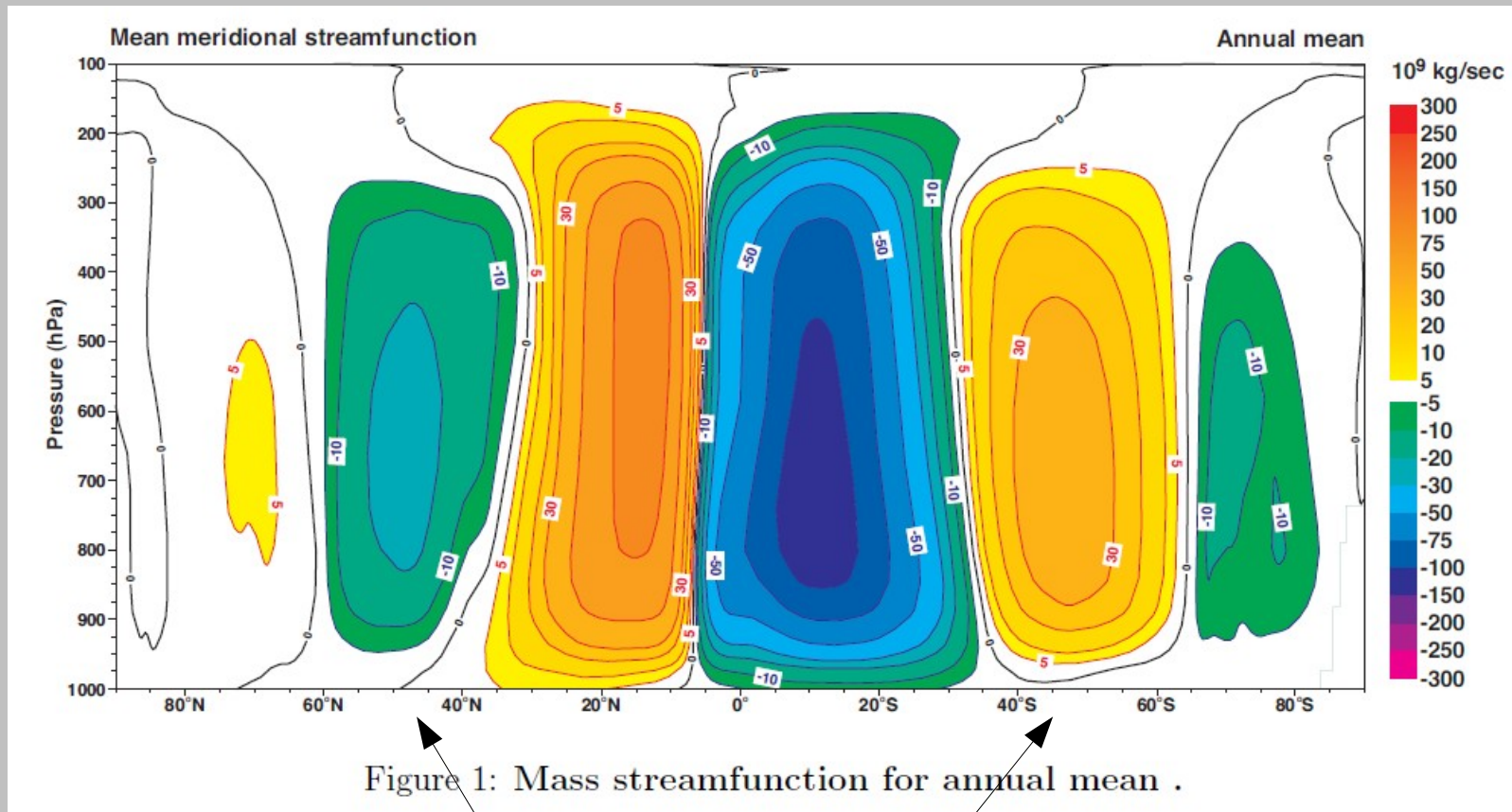
“width” of the tropics



rising moist air,
heavy rainfall

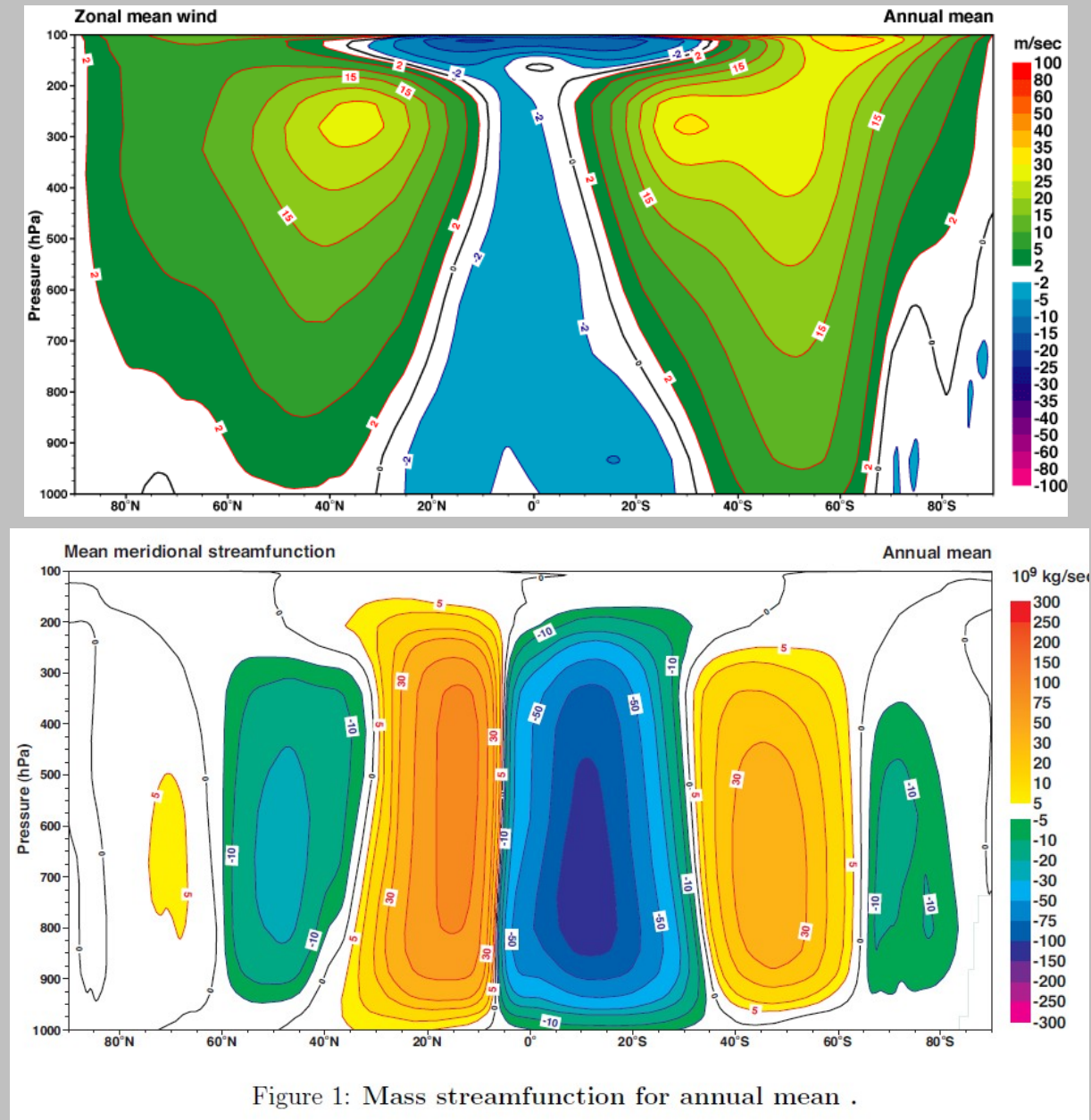
descending dry air,
desertification

The Atmospheric Circulation



Ferrel Cell

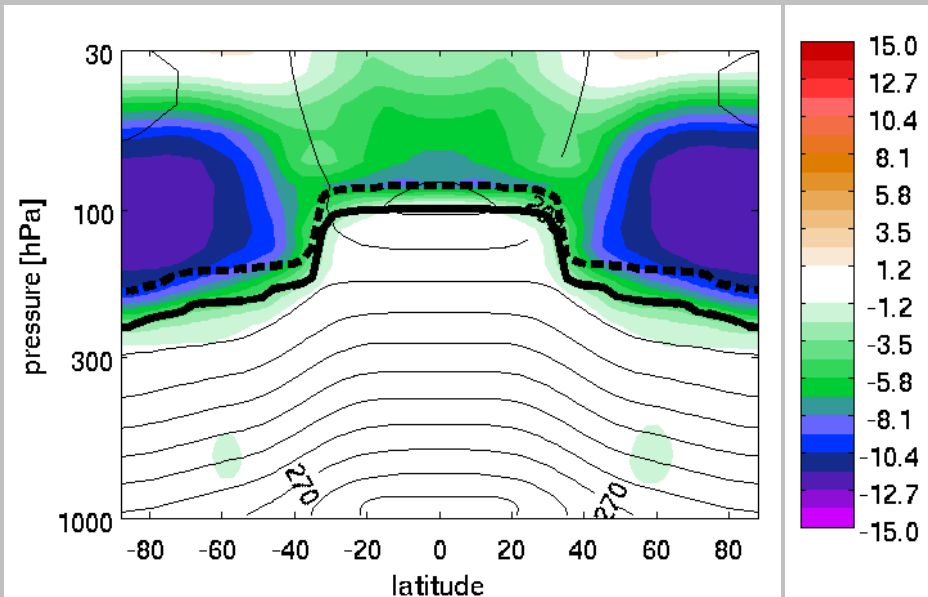
The Atmospheric Circulation



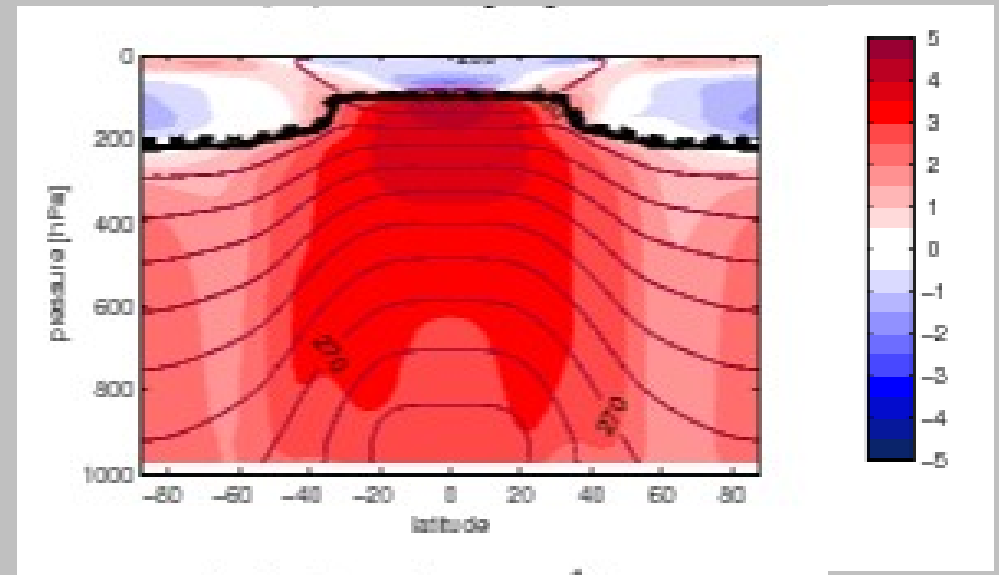
If you change the temperature,
the circulation changes!

Let's Change Temperatures!

Stratospheric Water Vapor Increase

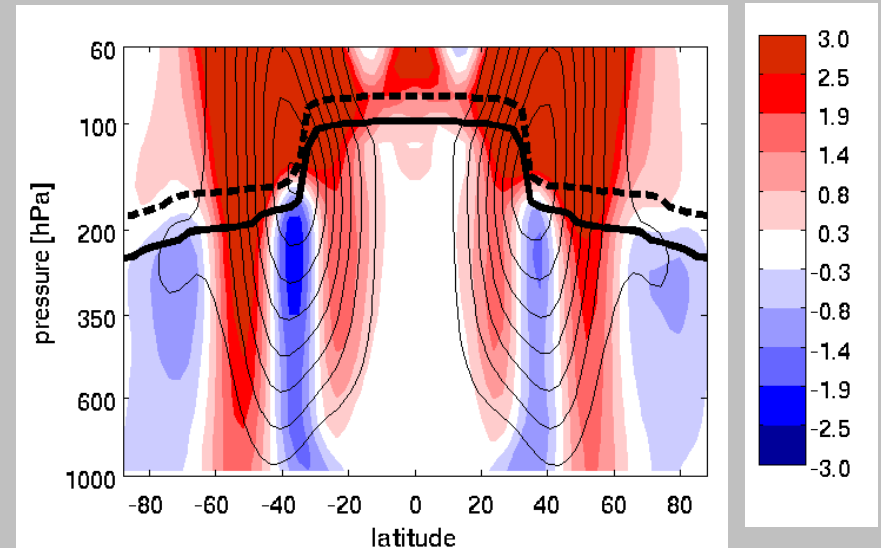


Carbon Dioxide Increase

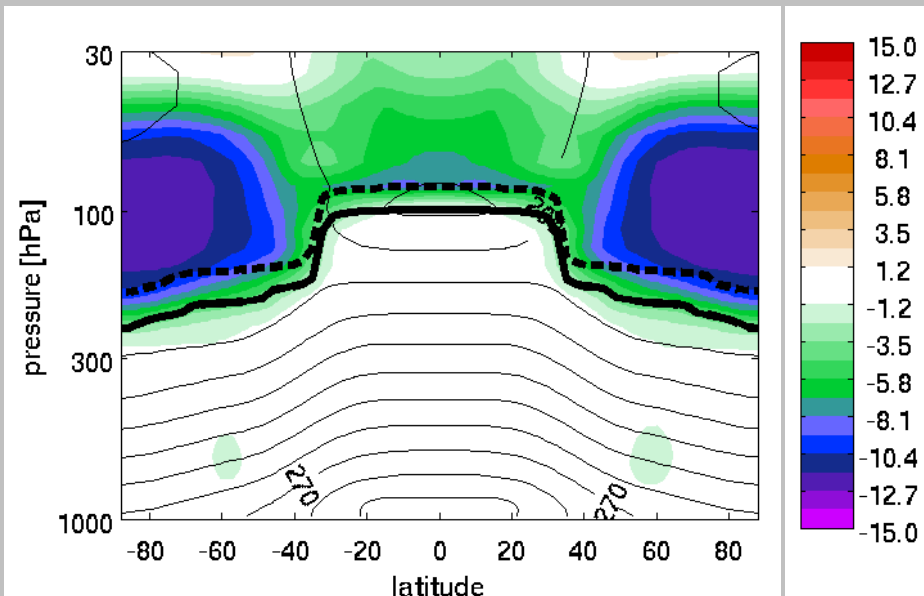


The Effect of Stratospheric Water Vapor Increase

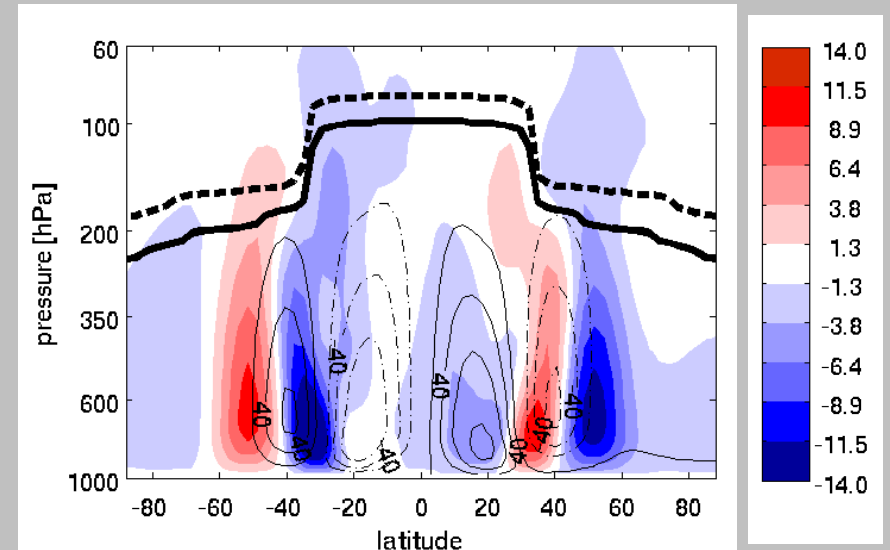
Change in zonal wind



Change in temperature

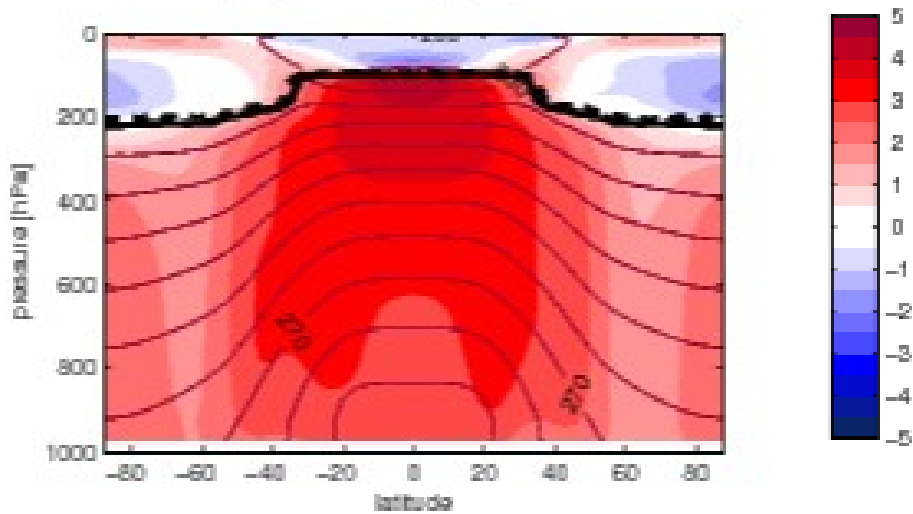


Change in meridional circulation

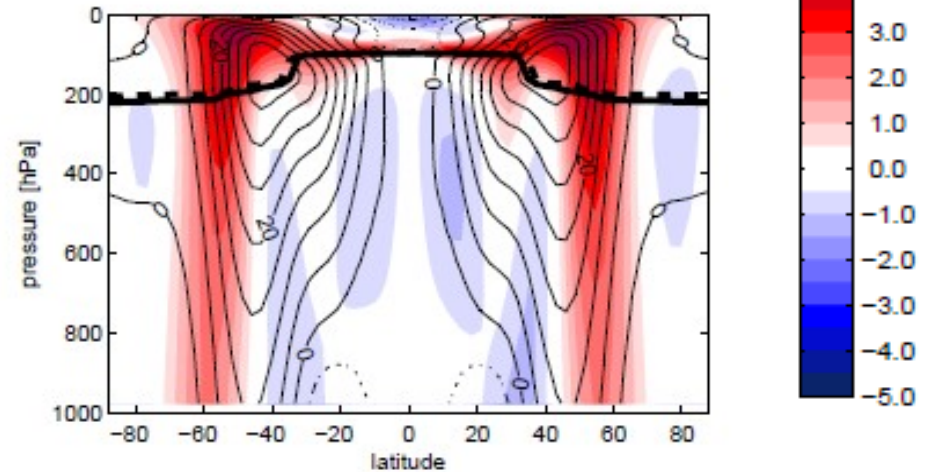


The Effect of Carbon Dioxide Increase

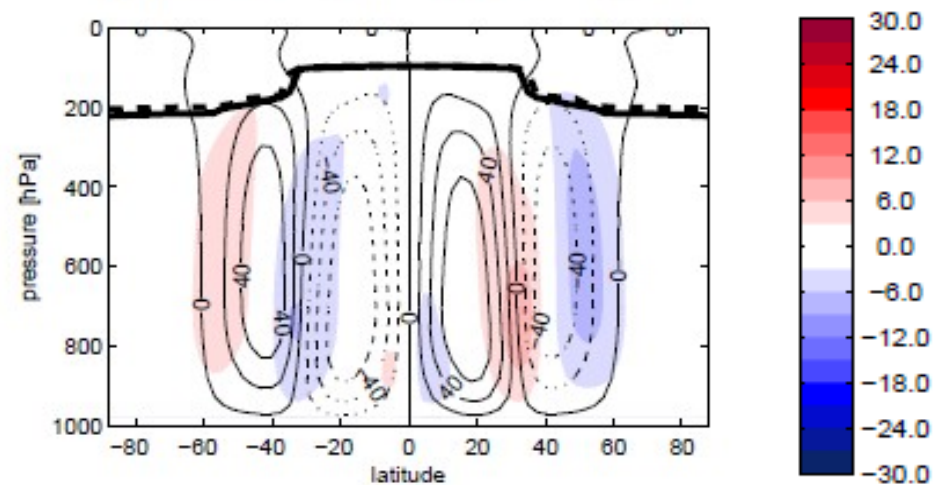
Temperature Change



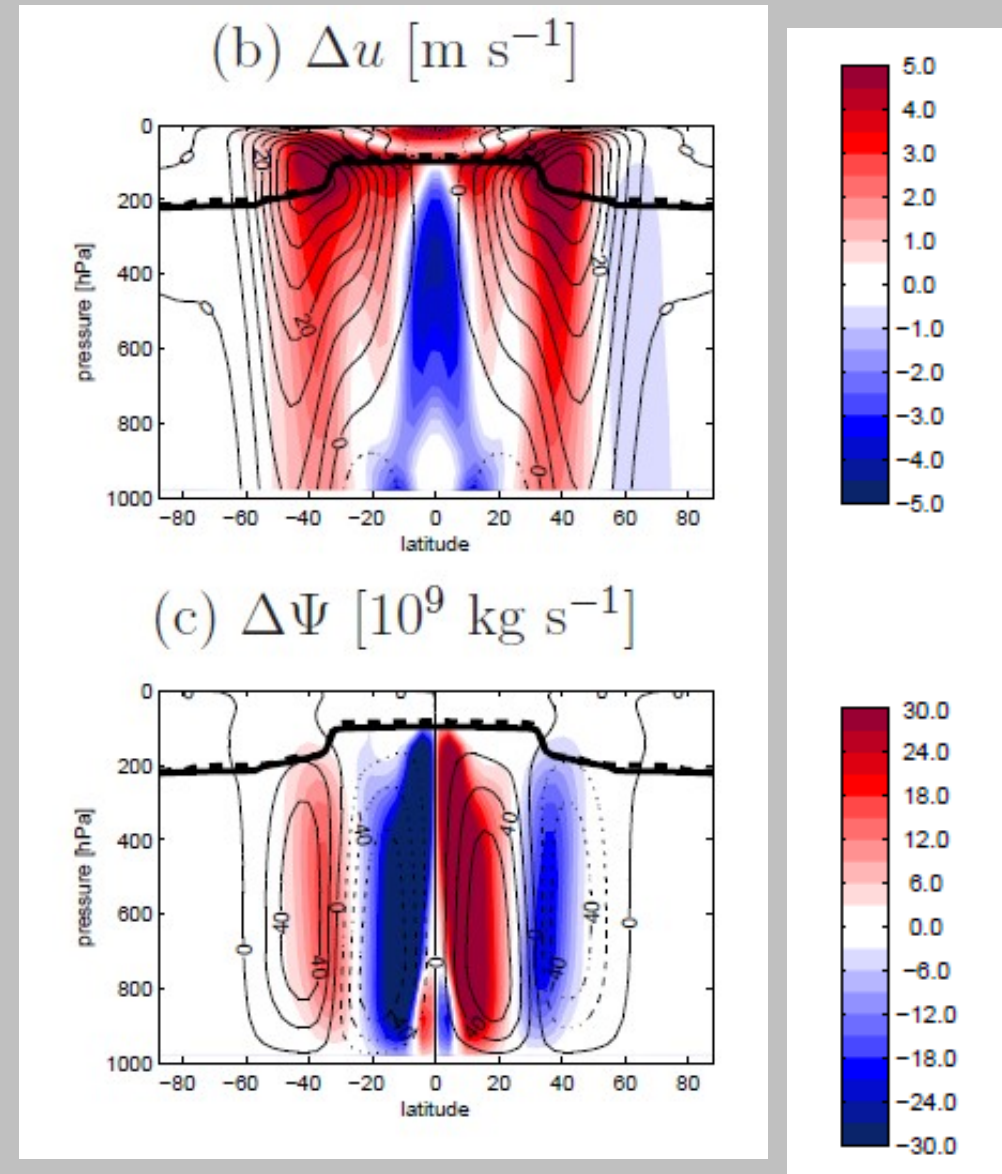
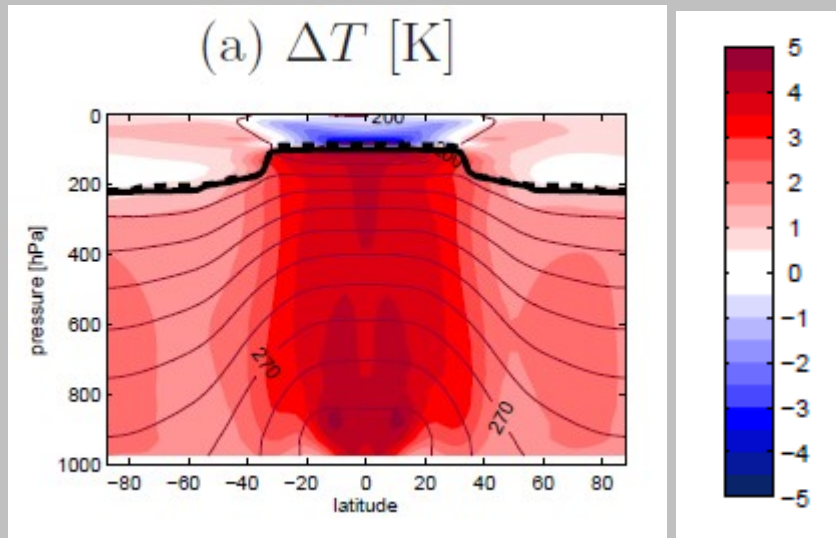
(e) Δu [m s^{-1}]



(f) $\Delta \Psi$ [10^9 kg s^{-1}]



A Slight Variation...



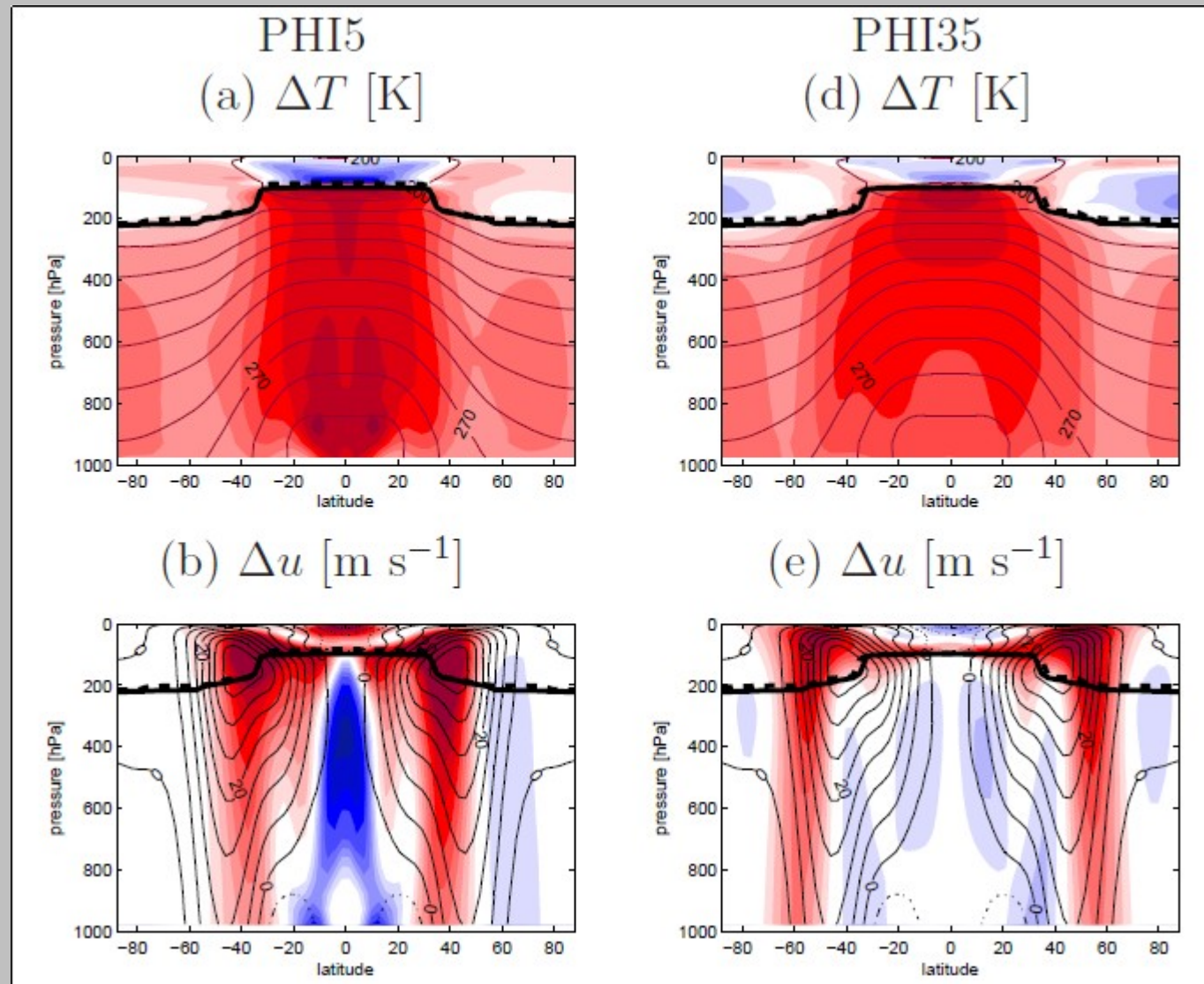
Why the Sensitivity?

- Thermal wind balance

$$f \frac{\partial u}{\partial z} \sim - \frac{\partial T}{\partial y}$$

...combination of geostrophic balance
and hydrostatic balance

Why the Sensitivity?



In Conclusion...

- Climate change will have an impact on both the Hadley circulation and the jets
- Increased stratospheric water vapor will cause the edges of the Hadley circulation and the position of the jets to move closer to the poles
- Increased carbon dioxide will have the same effect, but
- There is high sensitivity to the horizontal structure of warming in the troposphere