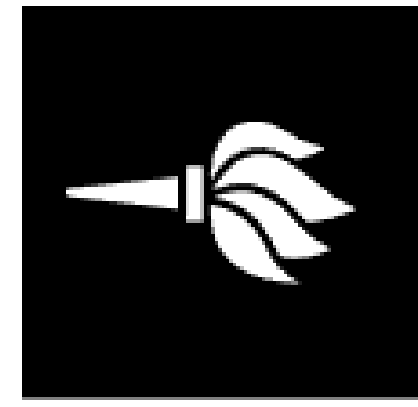


The Weakening of Tropical Free Tropospheric Temperature Gradients with Global Warming

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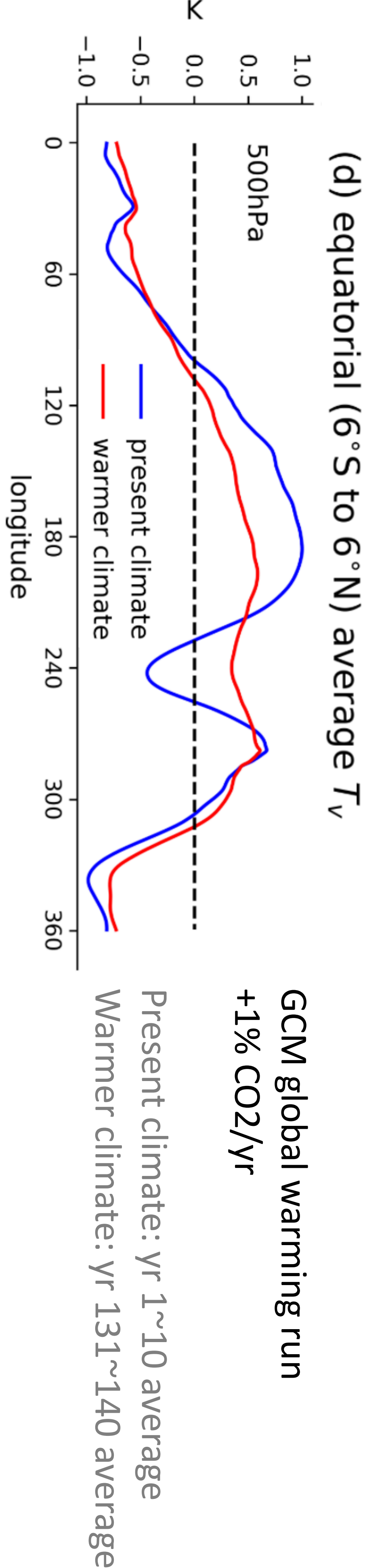
Motivation and conclusions

The **Weak Temperature Gradient (WTG)** approximation: The horizontal temperature gradient in the tropical free-troposphere is very small due to the weak Coriolis force.

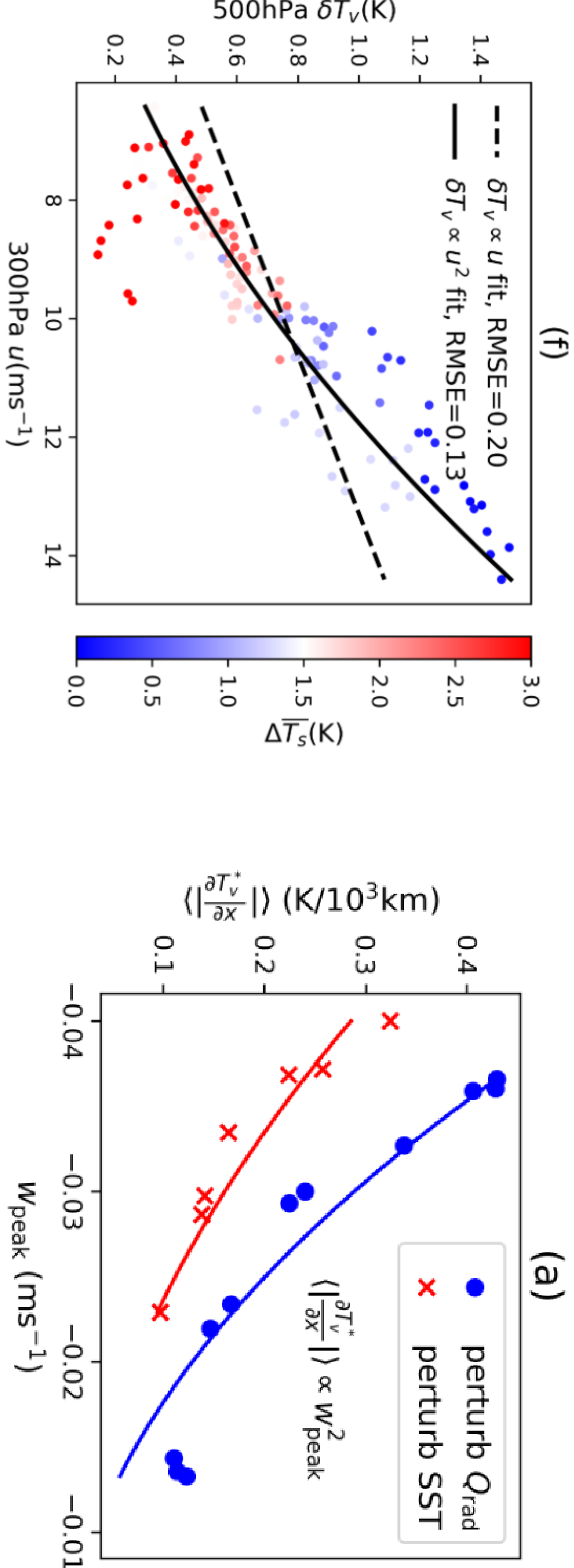
Question: How does this temperature gradient respond to global warming?

Conclusion: The weak temperature gradient will be **even weaker** in a warmer climate due to **weaker atmospheric circulation**, with the scaling $\delta T \sim U^2$ or $\delta T \sim W^2$.

Weaker temperature gradient in a warmer climate



Weaker temperature gradient ← weaker circulation



GCM global warming run, +1% CO2/yr

CRM 2-D mock-Walker runs

$$\delta T \sim U^2$$

$$\delta T \sim W^2, \text{ where } w = \frac{Q_{\text{rad}}}{s}$$

Each dot is a 10-year average
Region: 180°E to 240°E, equatorial
(6°S to 6°N) average

Group 1: Fix $\overline{\text{SST}} = 300\text{K}$, Q_{rad} ranging from -2.9Kday^{-1} to -0.9Kday^{-1}
Group 2: Fix $Q_{\text{rad}} = -1.7\text{Kday}^{-1}$, $\overline{\text{SST}}$ ranging from 294K to 303K

Discussion board: the WTG scaling $\delta T \sim U^2$ or $\delta T \sim W^2$