Does the Tropical Cyclone's Response to Vertical Wind Shear Depend on the Near-core Tangential Wind Structure?

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Objectives:

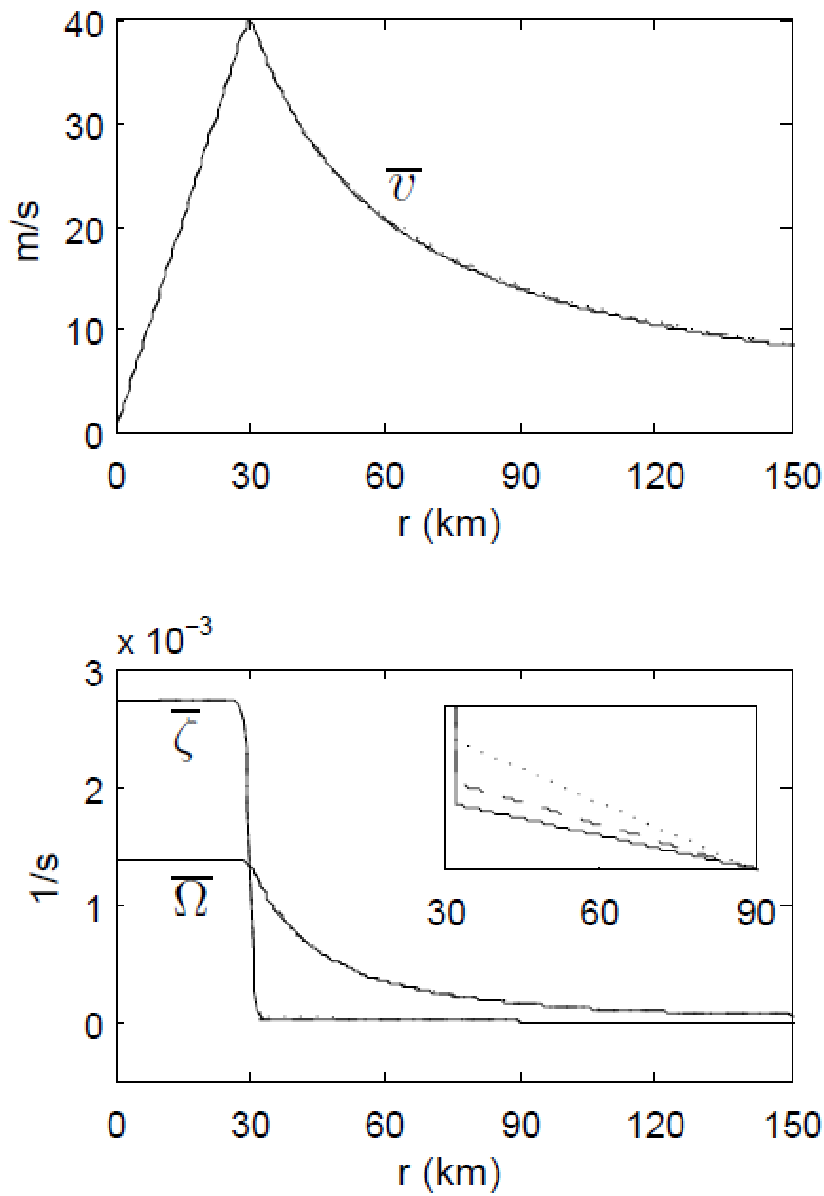
•Document sensitivity of sheared vortex evolution to changes in near-core vorticity gradient through idealized experiments

•Discuss approximate model for the vortex in shear and its predictions regarding near-core structure sensitivity

•Present first step in answering title question using obs-based profiles and parameterized latent heating

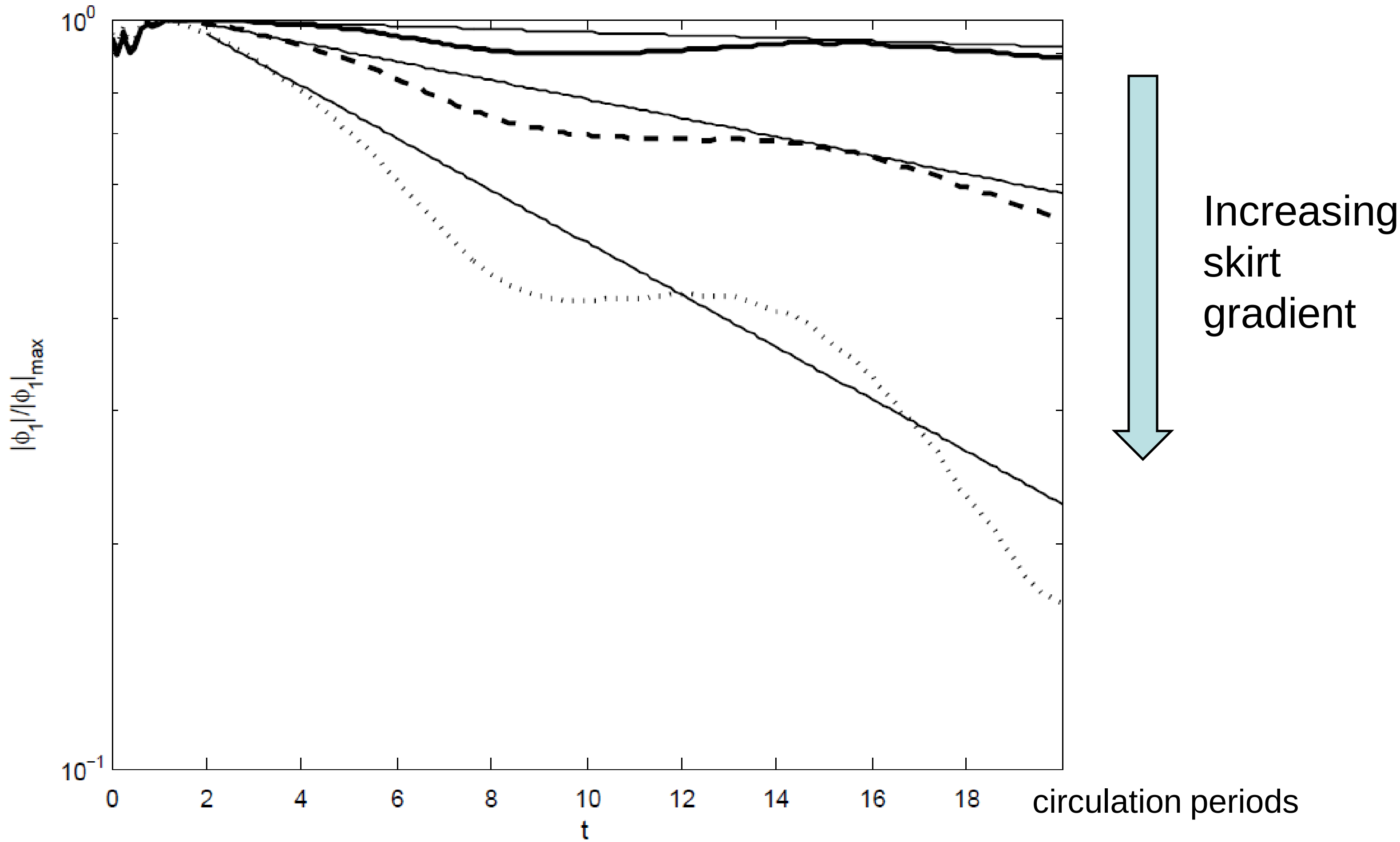
NOAA/AOML/HRD Science Meeting (December 8th *2011*)

Basic State for Linear PE simulations:



- 3 vortices with same **core** vorticity, but varying gradient in **skirt**
- Benchmark vortex has weakest skirt gradient and should damp **core VRW mode** (i.e., tilt perturbation) least effectively

Exponential Decay of Tilt Asymmetry:

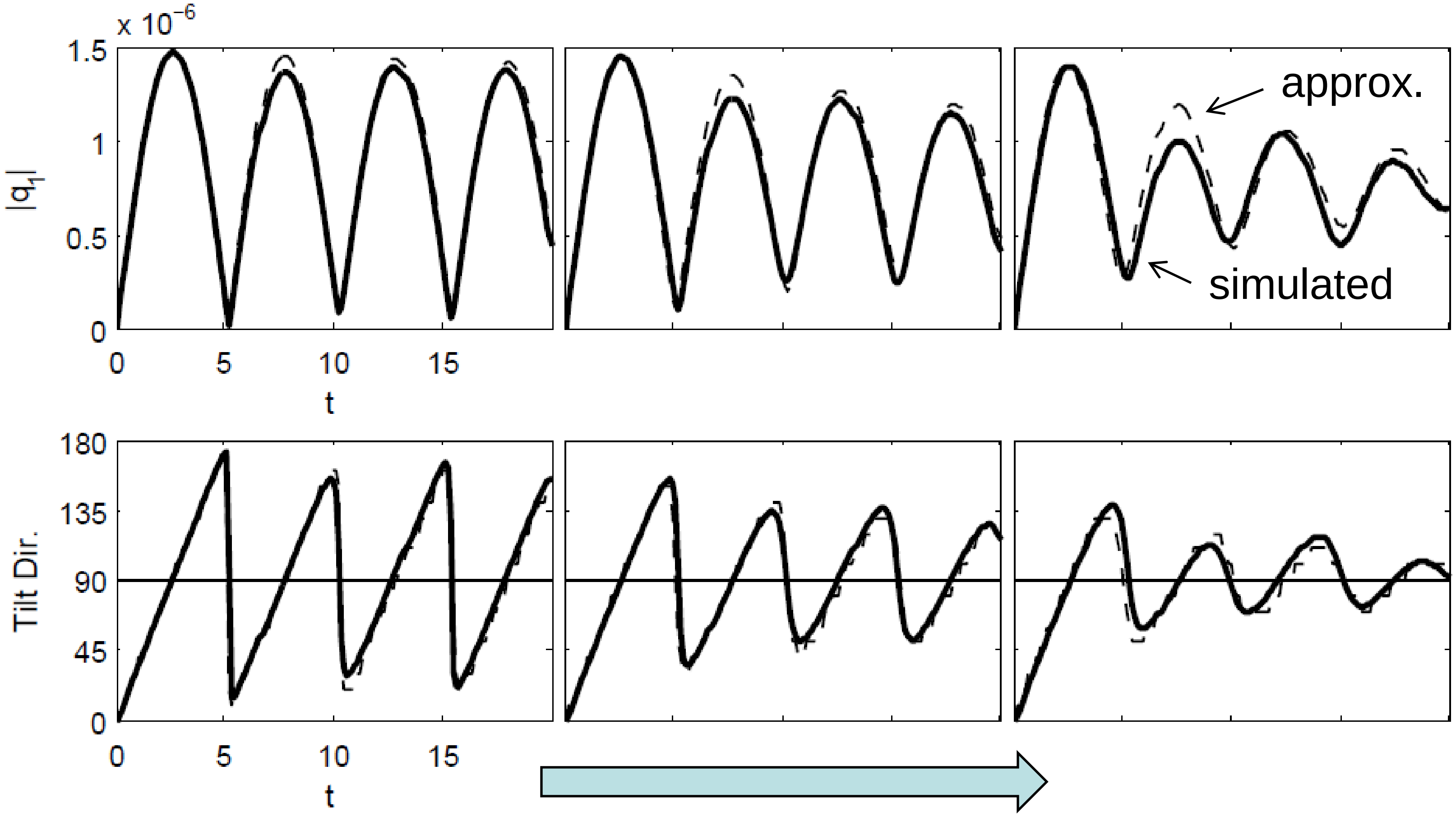


•Best fit to phase and amplitude timeseries yields damping rate (γ) and precession frequency (ω) of core VRW mode

Simulated Sheared Evolution Predicted by Approximate Solution:

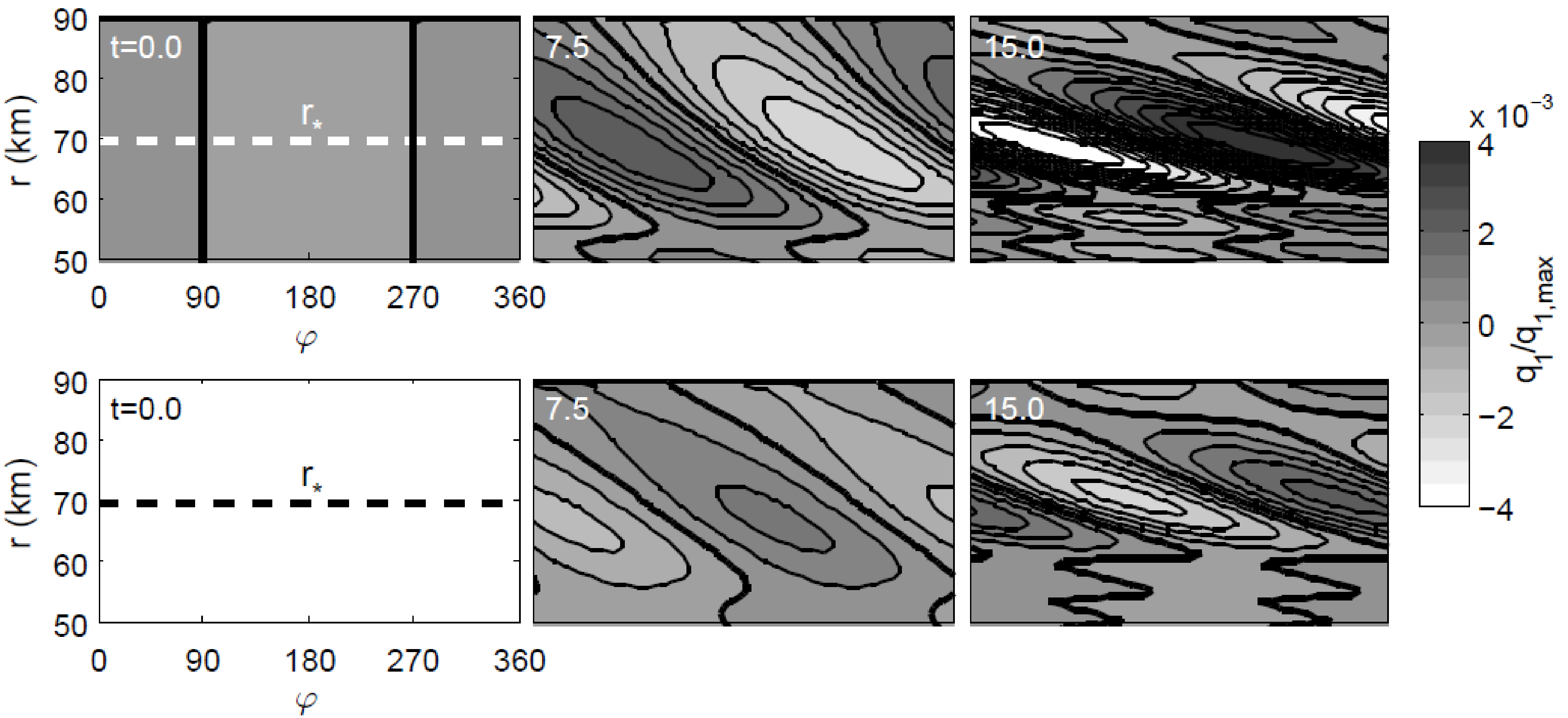
$$q'(r,\ \lambda,\ z,\ t) \approx -\frac{F_{q,s}(r,\ z)}{\omega_p}[e^{\gamma t}\sin(\lambda - \omega_p t) - \sin\lambda]$$

γ and ω "intrinsic" values from unforced solution



Increasing skirt gradient

Critical Layer Development at $r=r_*$:



•Sheared solution (bottom) develops PV critical layer as in unforced simulation (top)

•Approx. solution highlights fundamental role of core VRW mode resonance in *sheared* problem

Summary:

•In idealized linear simulations the vortex resilience in shear is *very* sensitive to the skirt (near-core) profile at 2-3 RMW

•Sensitivity is understood through core VRW mode resonance paradigm

•Simulations with parameterized diabatic heating shift the critical radius inward…but haven't fully analyzed $N^2 \rightarrow 0$ limit yet…