Review of ACP-2010-653

Summary: This paper examines the extent to which low-entropy environmental air (in the free troposphere) invades the core of a tropical cyclone that is exposed to vertical shear. The storm-relative flow at a given altitude is conceptualized as the superposition of a point-vortex, an (off-center) mass-sink, and a uniform velocity field. The conceptual model is shown to capture the basic flow topology that is seen in a realistic hurricane simulation. The penetration of environmental air into the vortex core is examined over a wide range of vortex intensities and relative flow velocities. The potentially adverse influence of such penetration on tropical cyclone intensity is discussed.

General Comments: In my view, this paper is interesting and well written. The contents should prove useful to meteorologists who specialize in hurricane dynamics. Moreover, the limitations of the conceptual model are adequately addressed. I have only a few "specific" and "technical" comments, most of which should be viewed as requests for clarification.

Specific Comments:

S1. Discussion below Eq. (28): The authors remark that the opening between separatrices depends on U and D only, but not on Γ. Might one expect D to increase with Γ in a tropical cyclone?

S2. Fig. 7, caption: I am not sure that I would call a non-attractive streamline an "emerging limit cycle."

S3. The introduction lists 3 important mechanisms by which vertical shear can allow environmental air to weaken a tropical cyclone: ventilation of eyewall convection, erosion of the upper level warm core, and depression of inflow layer θ_e. It might be helpful to explain how intensity change caused by these 3 mechanisms compares to that directly caused by vertical misalignment of potential vorticity.

Technical Comments:

T1. Equation 4: The notation is potentially confusing: "div" usually represents the divergence *operator*, such that div$(\mathbf{x}) = 2$ (in 2D).

T2. Equation 6: Is there a minus sign missing? If ψ is a streamfunction and $v = \partial_r \psi$, then $u = -\partial_\varphi \psi / r$ in a conventional cylindrical coordinate system. If the sign is wrong here, then Eq. (10) for ψ should also be modified. If my concern is legitimate, please double check all results that are derived from Eq. (10).

T3. Equation 9: If the background flow is westerly for positive U, shouldn't $u_{bg} = U \sin \phi$? That is, shouldn't the radial component of the background velocity (u_{bg}) have its maximum positive value at $\phi = \pi/2$ (east on the compass)?

T4. Equation 22: The authors state that if $D < 0$ (and $\Gamma > 0$), the stagnation point will shift anticyclonically from its $D = 0$ position. This seems consistent with Fig. 7. However, the azimuthal perturbation given by $\Delta = -D/\Gamma$ is positive. Doesn't positive Δ correspond to a cyclonic shift?