Atmos. Chem. Phys. Discuss., 15, C1731–C1734, 2015
www.atmos-chem-phys-discuss.net/15/C1731/2015/

Atmospheric Chemistry and Physics Discussions
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Interactive comment on "A numerical study of convection in rainbands of Typhoon Morakot (2009) with extreme rainfall: roles of pressure perturbations with low-level wind maxima" *by* C.-C. Wang et al.

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Received and published: 21 April 2015

Review of Roles of pressure perturbations in rainband convection of Typhoon Morakot [acpd-15-8479-2015]

General Comments

This manuscript documents a numerical simulation of Typhoon Morakot on 8 August 2009, during its multi-day historic interaction with Taiwan in which catastrophic flooding

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occurred, due in part from the repeated formation and west-to-east passage of intense convective cells that impacted a significant proportion of Taiwan, particularly the southern half of Taiwan. The numerical simulation of this study produces a realistic simulation of the rainband activity observed in Morakot on 8 August. The authors focus on the back-building behavior and merger of cells within within east-west-oriented rainbands that impinged upon the Central Mountain Range at a time in which such convective cells were particularly vigorous. A pressure perturbation analysis applied on a characteristic convective cell clearly shows the local shear vector (associated with a strong low-level jet) produced a favorable dynamic pressure perturbation force that favored upstream development of new updraft, a slowing of mature convection, and thereby a favored mechanism for convective updraft mergers. This is an excellent study that likely applies to many more tropical cyclone cases than this particular Morakot example. I therefore enthusiastically recommend that the manuscript should be published after some minor revisions. The minor revisions are listed below as specific comments and are only meant to enhance the current analysis, which appears to be sound overall.

Specific Comments

1. In several of the figures, axis, contour, and colorbar labeling is very difficult to read due to small font size (e.g., Figs. 2, 10-15 are very difficult, and Figs. 1b, 3a, 7, 9 are marginal). Please consider resizing the fonts to be more legible.

2. p. 8489, l. 6-8: An interesting question that arises is what percentage of the accumulated rainfall is accomplished by the intense cells that are the focus of this study vs. the more widespread stratiform rain associated with the rainbands (seen in all panels of Fig. 7)? This is not an essential question to answer in revisions, but, as a suggestion, if the calculation is readily available, it may bolster the practical significance of this study.

3. Fig. 10b. It is easy to see that this convective cell does not produce an intense cold pool characteristic of some storms (such as midlatitude continental convection),

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but it is difficult to conclude whether there may be a weak cold pool or not. It seems conceivable even a 0.5 to 1-K magnitude cold pool (not uncommon in moist tropical cyclones) could produce some low-level lift, but such a cold pool would be difficult, if not impossible, to see in Fig. 10b. If possible, it might be nice to see a snapshot or two of the lowest model level's temperature field in the box shown in Fig. 7a at 0630 UTC with sufficiently small contouring intervals to discern the magnitudes of "cold" pools produced here.

4. p. 8493, l.4: Equation (9) is not linearized.

5. p.8493, l.6: This is the anelastic approximation, but not quite the Boussinesq approximation since the density is a function of height in the continuity equation. The fourth fluid extension term would disappear in eqn (13) in a Boussinesq fluid.

6. This analysis may benefit from presentation (or verbal explanation) of the temporal evolution of vertical motion forcing mechanisms. For example, do the relative vertical motion forcing mechanisms (dynamic PGF, buoyant PGF, and buoyancy) maintain relative proportions of magnitude throughout the lifecycle of a given convective cell and/or birth of a new cell? This may help demonstrate also whether there are feedback loops. For example, higher buoyancy (even if transient) could induce stronger dynamic and buoyant pressure perturbations. Likewise, as I think is somewhat alluded to in this analysis (Fig. 14), the shearing terms in the dynamic pressure perturbation equation may induce a vertical motion pattern that reinforces the fluid extension term in a positive feedback loop. The temporal perspective may provide a deeper intuition into these complexities.

7. Fig. 15 is a very important figure that really brings together the manuscript as it clearly illustrates the impacts of the pressure perturbation forces vs. buoyancy on the vertical accelerations, particularly the importance of the dynamic PGF induced by the strong vertical shear structure. Still, in reference to the discussion on p. 8498, I recommend plotting the sum of the buoyancy and buoyant pressure perturbation gradient

force alone (i.e., B - d pb / dz) as a separate panel, since it does appear that throughout a significant portion of the updraft, the buoyancy term B still dominates the buoyant pressure perturbation gradient force. Typically buoyancy dominates the PGF associated with buoyant pressure perturbations in mature updrafts in other idealized studies of convection.

Technical Corrections

1. Eqn (13): The friction term from eqn. (12) mysteriously drops.

2. p. 8493, l.17: Simplify/spell check “are the Piosson equations of the laplacian of” to just “Poisson’s equations of” since the Laplacian operator is implicit to Poisson’s equation, by definition.

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