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Interactive comment on "Cyclonic intensity study using sea level pressure estimations from Ocensat-II scatterometer winds over Bay of Bengal during 2013" *by* C. Purna Chand et al.

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Title: Cyclonic intensity study using sea level pressure estimations form Oceansat-II scatterometer winds over Bay of Bengal during 2013

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Recommend: Reject in its present form. I am willing to review a re-submitted manuscript.

The paper is premature and will leave a false impression in the literature that OceanSAT is incapable of retrieving sea-level pressure in tropical cyclones. This reviewer has

retrieved good quality SLP using OceanSAT scatterometer wind data and predicts that a successful system could be developed, which has the potential to benefit to the Indian meteorological community.

Synopsis: This paper describes the application of the generic "UW" sea-level pressure retrieval model to OceanSAT-II observations of three tropical cyclones (TCs). Very poor results are obtained; in one case the MSLP derived from the scatterometer is off by ∼54 mb when compared to the best track estimate.

The reasons for this discrepancy are obvious and have been discussed at various meetings. In summary: (1) the standard wind speed processing of the Ku-band scatterometers such as QuikSCAT and OceanSAT severely under-estimate the wind speeds beyond ∼25 m/s; (2) the wind direction retrievals in TC cores are biased, which can be easily seen in the derived TC shapes of Fig. 2; (3) the two-layer PBL model employed in the generic UW SLP code is a poor representation of the nonlinear mean flow dynamics of the TC boundary layer.

With reference to (1), if the scatterometer wind speeds are biased low (very low in the TC case), even a perfect PBL model will consequently produce low (or very low) estimates of the corresponding surface pressure gradient magnitudes.

With reference to (2), an important way to think about the directional errors is to consider how a mis-aligned wind vector will alias the azimuthal flow (primary circulation) into the radial flow (secondary circulation). Radial pressure gradients are much stronger than azimuthal pressure gradients. The strong radial pressure gradients are largely balanced by the nonlinear mean flow dynamics that are first-order in the TC PBL, but small in "normal" PBLs – see below.

Even if the pressure gradient magnitudes were correctly estimated by the surface winds and PBL model, systematic errors in the surface wind direction will pass through to errors in the corresponding pressure gradient orientations. Since the SLP code effectively integrates through the pressure gradients, the resulting field will have the wrong shape. (Random direction errors, if small enough, can be tolerated.)

With respect to (3), the TC PBL dynamics are quite different from the the basic PBL dynamics described in the Stevens et al. (2002) model. The important feature of the Stevens et al. PBL model is that it maintains a three-way force balance (ala mid-latitude Ekman layers) by substituting PBL-top momentum entrainment for the Coriolis force, which approaches zero at low latitudes. However, its scaling is inappropriate for the intense, swirling TC PBL mean flow.

Of key importance is that standard PBL scaling shows that only the nonlinear terms involving turbulent perturbations (Reynolds stresses) are of leading order in the mean flow equations. With appropriate substitutions and sign changes, the zonal and meridional PBL equations are the same.

In contrast, the TC PBL scaling shows that while the Reynolds stresses remain important, the nonlinear terms involving mean flow velocities are also of leading order. Inherently in the TC PBL, the equation describing the radial momentum balance is different from that describing the azimuthal momentum balance. Without the nonlinear mean flow dynamics, the strong radial pressure gradients would be be improperly balanced by other terms in the PBL model. This leads to errors in the estimated pressure gradients and resulting SLP fields.

It is possible to recover accurate sea-level pressure fields from remotely sensed surface wind vectors in TC conditions once these three issues are addressed. In the case of scatterometer winds, the standard model function-based wind retrievals should be replaced with TC-specific wind retrievals (e.g. Stiles et al. 2013). Secondly, the wind direction retrievals require specific filtering to improve their accuracy. Thirdly, the PBL model incorporated in the SLP retrieval code must be replaced by one that makes a better approximation to the TC PBL dynamics.

Using high-quality SAR surface winds, RMS errors in the SLP are less than 4 mb when compared to aircraft drop sonde observations. Such processing has also been

performed using QuikSCAT surface wind fields from the Stiles et al. processing. Compared to aircraft drop sondes, RMS errors of 5 to 6 mb are found. OceanSAT is fairly similar to QuikSCAT. So, I would expect that comparable SLP processing is possible given sufficient care. Preliminary results with OceanSAT winds have been promising.

I have attached a few plots showing an SLP retrieval of Hurricane Earl observed by OceanSAT on September 1, 2010. A TC-specific wind speed retrieval method was used. The PBL model in the UW SLP code was replaced by one that makes a better approximation to TC scaling. This example shows the residual importance of filtering out the error in the OceanSAT wind directions on the retrieved SLP fields leaving the wind speeds unchanged.

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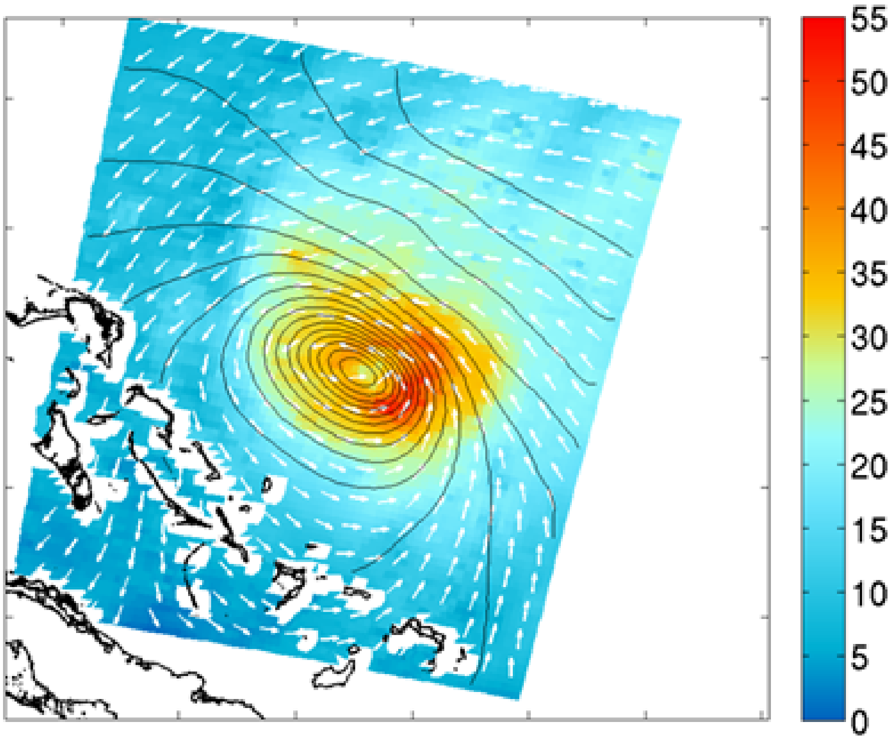

Fig. 1. OceanSAT wind directions

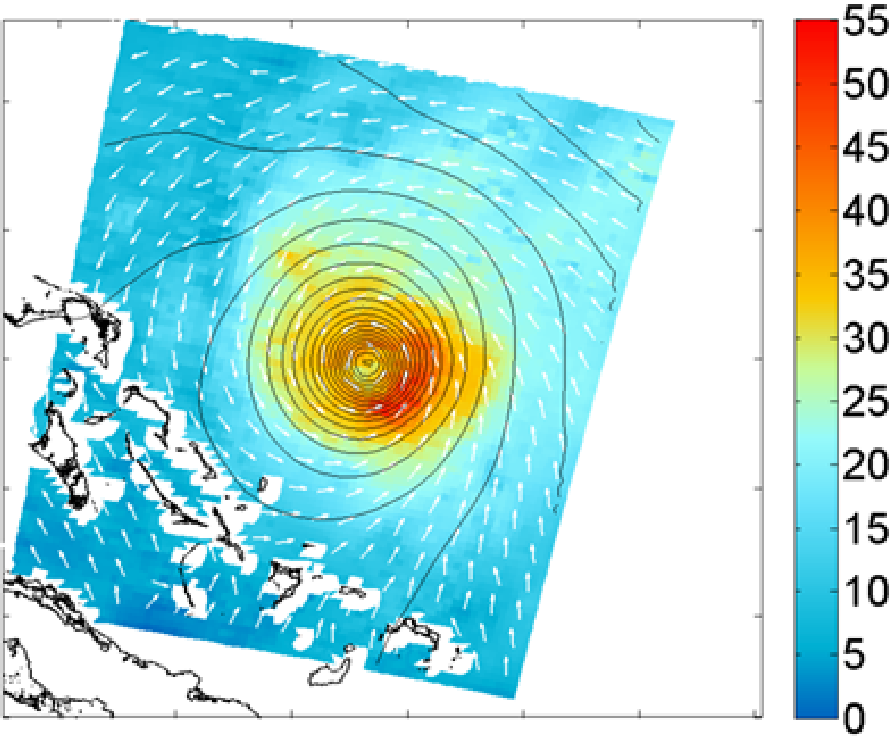

Fig. 2. Improved wind directions

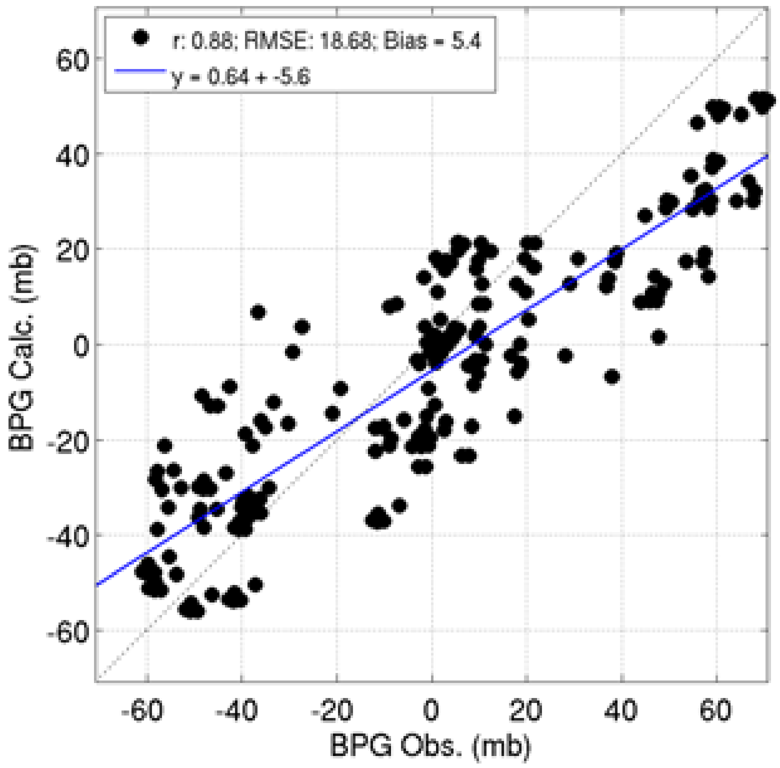

Fig. 3. Drop sonde pressure differences using OceanSAT wind directions

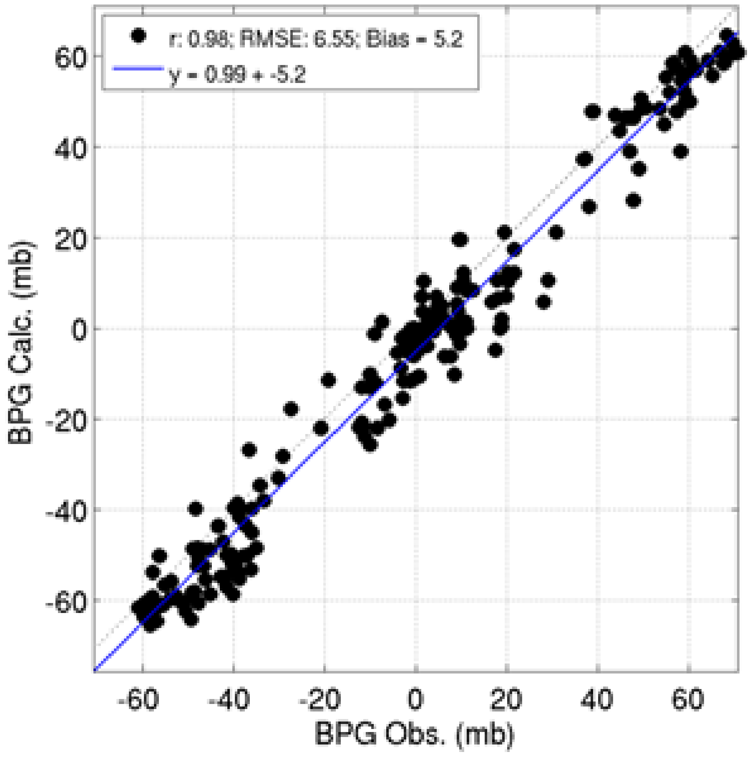

Fig. 4. Drop sonde pressure differences using improved wind directions