Geophysical Research Abstracts
Vol. 15, EGU2013-2422, 2013
EGU General Assembly 2013

The impact of nonlinearity on the targeted observations for typhoon prediction

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This study examined the impact of nonlinearity on the targeted observations for typhoon prediction. The nonlinearity of the typhoon had been determined by comparing the first singular vector (FSV) and the conditional nonlinear optimal perturbation (CNOP), which is the nonlinear extension of FSV. If the similarity between the CNOP and FSV was larger than 0.5, then the typhoon would be taken as weak nonlinearity, otherwise, the typhoon would be taken as strong nonlinearity.

Typhoon Meari (2004) had been chosen as the representation of weak nonlinear cases, and was herein referred to as the linear case, while typhoon Matsa (2005) had been chosen as the representation of strong nonlinear cases and was herein referred to as the nonlinear case.

In the linear case, the sensitive areas identified for special forecast times when the initial time was fixed resemble those identified for other forecast times. Targeted observations deployed to improve a special time forecast would thus also benefit forecasts at other times. In the nonlinear case, the similarities among the sensitive areas identified for different forecast times were more limited. The deployment of targeted observations in the nonlinear case would therefore need to be adaptive to achieve large improvements for different targeted forecasts. For both cases, the closer the forecast time, the higher the similarities of the sensitive areas.

When the forecast time was fixed, the sensitive areas in the linear case diverged continuously from the verification area as the forecast period lengthens, while those in the nonlinear case were always located around the initial cyclones. The deployment of targeted observations to improve a special forecast depended strongly on the time of deployment.

An examination of the efficiency by reducing initial errors within the identified sensitive areas confirmed these results.