AAS03-01 会場:301A 時間:5 月 26 日 11:00-11:15

Short-term Climate Simulations of African Easterly Waves with a Global Mesoscale Model.

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SHEN, Bo-wen[1*]
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[1]San Diego State University
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Recent high-resolution global model simulations (Shen et al., 2010a, 2010b, 2012; 2013), which were conducted to examine the role of multiscale processes associated with tropical waves in the predictability of mesoscale tropical cyclones (TCs), suggested that a large-scale system (e.g., tropical waves) can provide determinism on the prediction of TC genesis, making it possible to extend the lead time of genesis predictions. Selected cases include the relationship between (i) TC Nargis (2008) and an Equatorial Rossby wave; (ii) Hurricane Helene (2006) and an intensifying African Easterly Wave (AEW); (iii) Twin TCs (2002) and a mixed Rossby-gravity wave (e.g., Silva-Dias et al. 1983) during an active phase of the Madden Julian Oscillation (MJO; Madden and Julian, 1971); (iv) Hurricane Sandy (2012) and tropical waves during an active phase of the MJO. In this talk, thirty-day simulations with different model configurations are presented to examine the model's ability to simulate AEWs and MJOs and their association with tropical cyclogenesis.

I will first discuss the simulations of the initiation and propagation of 6 consecutive AEWs in late August 2006 and the mean state of the African easterly jet (AEJ) over both Africa and downstream in the tropical Atlantic. By comparing our simulations with NCEP analysis and NASA satellite data (e.g., TRMM), it is shown that the statistical characteristics of individual AEWs are realistically simulated with larger errors in the 5th and 6th AEWs. Remarkable simulations of a mean African Easterly Jet (AEJ) are also obtained. Results from the sensitivity experiments suggest the following: 1) accurate representations of non-linear interactions between the atmosphere and land processes are crucial for improving the simulations of the AEWs and the AEJ; 2) improved simulations of an individual AEW and its interaction with local environments (e.g., the Guinea Highlands) could provide determinism for hurricane formation downstream. Of interest is the potential to extend the lead time for predicting hurricane formation (e.g., a lead time of up to 22 days) as the 4th AEW is realistically simulated; 3) however, the dependence of AEW simulations on accurate dynamic and surface initial conditions and boundary conditions (such as different sea surface temperatures, SSTs) poses a challenge in simulating their modulation on hurricane activity. In addition to the simulations of AEWs, I will also present the 30-day simulations of selected MJO cases, which were performed in support of the Year of Tropical Convection (YOTC) project, to examine the excitation of MRG waves.

It has been suggested that accurate simulations of moist processes are crucial for improving tropical weather systems (e.g., MJOs and TCs). Compared to coarse-resolution simulations, high-resolution simulations may produce excessive precipitations, leading more chaotic responses. The role of resolved heating-induced small-scale processes in system's stability (or predictability) is discussed with higher-order Lorenz models (LMs) as well as the original LM with a parameterized dissipation term (Shen 2014a,b). I will then compare the thermodynamic feedback in the nonlinear LMs with that in the column-based cumulus parameterization. In addition to the results from the global model and LMs, I will briefly discuss the performance of multiscale analysis tools (i.e., the parallel ensemble mode decomposition method) in revealing the multiscale processes during the TC formation associated with tropical waves.

キーワード: Global Mesoscale Model, Multiscale Interaction, Tropical Cyclogenesis, African Easterly Wave, Madden Julian Oscillation, Predictability
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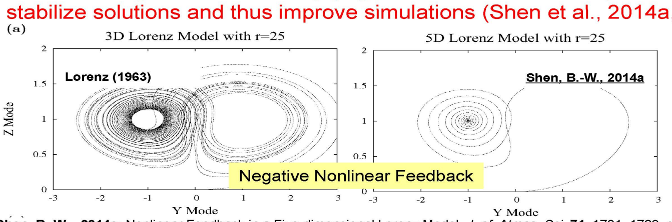
Are the Simulations of TC genesis Consistent with Chaos Theory?

- The butterfly effect of first kind: *sensitive dependence on initial conditions*.
- The butterfly effect of second kind: *a metaphor (or symbol) for indicating that small perturbations can alter large-scale structure*.
- Lorenz's studies suggested finite predictability and nonlinearity as the source of chaos.
- Increased degree of nonlinearity (e.g., multiscale interactions) can stabilize solutions and thus improve simulations (Shen et al., 2014a,b).



Shen, B.-W., 2014a: Nonlinear Feedback in a Five-dimensional Lorenz Model. *J. of Atmos. Sci.* **71**, 1701–1723. doi: http://dx.doi.org/10.1175/JAS-D-13-0223.1