Japan Geoscience Union Meeting 2015
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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.

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

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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
Keywords: Global Mesoscale Model, Multiscale Interaction, Tropical Cyclogenesis, African Easterly Wave, Madden Julian Oscillation, Predictability

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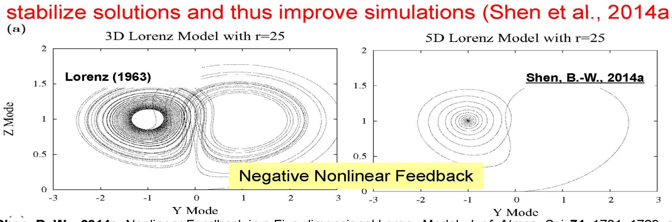
Are the Simulations of TC genesis Consistent with Chaos Theory?

- 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

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AAS03-02 会場:301A 時間:5 月 26 日 11:15-11:30

降雨域の誤差相関のスケールを考慮した局所化半径を用いる同化実験
Assimilation experiment by using localizations considering horizontal scale of error correlation in rainfall area

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アサンサンブルカルマンフィルタでは、少ないアンサンブルメンバー数に起因するサンプリングエラーに対処するため局所化を行い遠方の格子点で計算される不自然な誤差相関を除去している。この際、現象が持つ誤差相関の水平スケールを考慮して局所化の半径を決める必要がある。例えば、青梨　(2011) では、物理量の誤差相関の水平スケールが非降水域よりも降水域で小さくなることが報告されており、2 スケールでのスペクトル局所化の有用性が調べられている。しかし、観測局所化を行う LETKF(Local Transform Ensemble Kalman Filter) を用いた研究で降水域内の物理量に対して小さい局所化半径を用いる効果について調べた研究はない。本研究では、LETKF を用いて降水域内の物理量に対して小さい局所化半径を適用し、降水量のシミュレーション結果に与える影響について調べる事を目的とする。

気象庁非静力学モデル (JMA-NHM)(Saito et al., 2007) を使用し、同化システムに NHM-LETKF のネストシステム (Seko et al., 2013) を使用した。対象とした事例は 2012 年 8 月 13 日の夜から 2012 年 8 月 14 日の朝に京都府宇治市の大雨をもたらした線状降水帯の事例である。13 日 21LT から親 LETKF(水平格子 15 km) から子 LETKF(水平格子 1.875 km) を行い 1 時間のアンサンブルシミュレーションと同化のサイクルを 8 回行った。降水帯周辺の GNSS 連続観測システム (GEONET) 観測点 10 点と宇治市付近に独自に構築した稠密 GNSS 観測網 (Sato et al., 2013) の PWV データを Seko et al., (2011) の方法で相対湿度のプロファイルに変換して子 LETKF での同化に使用した。この他に、気象庁の現業で使用されている地上と高層観測データを親及び子 LETKF に同化している。気象庁全国合成レーダーを使用して強雨域 (>10 mm/h) の判別を行った。解析点が強雨域の場合は局所化半径を 1 格子分として強雨域の GNSS 観測点のデータのみ同化し、それ以外は、局所化半径を 5 格子分として強雨域にはない GNSS 観測点のデータを同化した。

レーダーの 1 時間積算雨量値をモデルの格子点位置に内挿し、子 LETKF で計算した 1 時間雨量の第一推定値の RMSE を 8 サイクルについて調べた。その結果、局所化半径を強雨域で小さくした事により、8 サイクル中 5 サイクルで誤差の改善がみられ、RMSE が悪化したのは 1 サイクルのみであった。実況で降水強度が最も強かった 14 日 05 LT までの 1 時間雨量では、約 10%の誤差の改善が見られており、強降水域の位置等に影響していた事が分かった。

キーワード: GPS 可降水量, データ同化, LETKF, 局所化
Keywords: GPS derived PWV, Data assimilation, LETKF, Localization

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AAS03-03 会場:301A 時間:5 月 26 日 11:30-11:45

High resolution WRF downscaling of the SINTEX-F1 CGCM seasonal forecasts over the Kanto region

High resolution WRF downscaling of the SINTEX-F1 CGCM seasonal forecasts over the Kanto region

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The Weather Research and Forecasting (WRF) regional model is used to downscale an ensemble of the SINTEX-F1 generated seasonal forecasts over the Kanto region. WRF model with three two-way interacting domains at horizontal resolutions of 27km, 9km and 3 km and 30 vertical levels is used for the downscaling. The cloud resolving WRF models ability to reproduce the climate of the Kanto region was initially tested by making the model simulation with ERA-Interim reanalysis data as the boundary conditions. Comparing the WRF model simulated precipitation and temperature with the AMeDAS observed precipitation and temperature data showed that the model could realistically capture the variations of the parameters from seasonal to diurnal time scales.

Comparing the SINTEX-F1 downscaled forecasts of the last few years with the AMeDAS observed data shows that the WRF model improves the spatial and temporal distribution of the precipitation and temperature over the Kanto region with respect to the SINTEX-F1 forecasts. The improvements in the WRF forecasts are seen to be due to better representation of the orography over the Kanto region.

キーワード: WRF, SINTEX-F1, Seasonal Forecast
Keywords: WRF, SINTEX-F1, Seasonal Forecast

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Stochastic analysis of spatio-temporal variations of high-resolution GNSS wet delays for meteorological applications

Stochastic analysis of spatio-temporal variations of high-resolution GNSS wet delays for meteorological applications

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Although designed for positioning purposes, the Global Navigation Satellite System (GNSS) can be also exploited for atmospheric sounding and in particular for troposphere water vapor content monitoring. The water vapor content in fact reflects in a GNSS signal delay, which can be evaluated in terms of Zenith Wet Delay (ZWD). This is an average parameter accounting for delays affecting the signals arriving to a GNSS receiver from all satellites in view.

The modeling of water vapor variations in space and time is still a challenging research topic: since it is difficult to characterize it in a deterministic way, stochastic approaches are often preferred; moreover, the turbulent behavior demands a high-resolution sampling both in time and space.

ZWDs derived from regional permanent GNSS networks result in high-rate time series, but the space resolution is still too loose for reconstructing the turbulent component of the water vapor content. Possible solutions can be envisaged from the coupling of GNSS with radar or SAR products or by the possibility to densify existing networks by exploiting low-cost GNSS receivers designed in view of meteorological applications.

With the aim of assessing the potential use of GNSS observations for this purpose, a network of 17 dual-frequency receivers, installed near the Uji campus of Kyoto University, Japan, was used. The network covers an area of about 10×6 km^2 and inter-station distances range between 1 and 2 km. All receivers are identical and observe GPS, GLONASS and QZSS at 1 Hz. Weather stations are installed within the network, measuring ground pressure and temperature for accurate ZWD and precipitable water vapor (PWV) retrieval.

In this work we exploit ZWDs derived by Precise Point Positioning (PPP) on observations of this network, which were extensively validated in previous studies by comparison with independent measurements by radiosondes and microwave radiometers.

The delay at a given epoch is modeled as a homogeneous random field. The estimated values, properly reduced to account for the height-dependent component, are used epoch-by-epoch to determine isotropic and anisotropic variograms, describing the spatial correlation of the ZWDs themselves.

In order to investigate the relationship between these second order statistics, rain-gauge observations and radar-derived precipitation values, an ad-hoc software tool was developed, able to compare all these data types.

From this comparison it results that meteorological atmospheric instabilities, associated to precipitation, reflect in specific behaviours of the ZWD variograms.

Directional variograms enhance a clear azimuth-dependent signature, consistent with the main direction of movement of precipitation clouds detected by radar.

Encouraged by these results, we start exploring the joint temporal and spatial variability of the ZWD field. On-going research activities on this subject, and specifically on the estimation of average wind velocities based on the frozen flow hypothesis will also be presented.

キーワード: GNSS, troposphere, zenith wet delay, covariance
Keywords: GNSS, troposphere, zenith wet delay, covariance