平成２０年度

科学技術総合研究委託費

委託業務成果報告書

＜アジア科学技術の戦略的推進＞

＜東南アジア地域の気象災害軽減国際共同研究＞

国立大学法人京都大学

本報告書は、文部科学省の科学技術総合研究委託事業による委託業務として、国立大学法人京都大学が実施した平成２０年度「アジア科学技術協力の戦略的推進・東南アジア地域の気象災害軽減国際共同研究」の成果を取りまとめたものです。

Ⅰ. 業務実績

1. 基礎実験・システム開発（京都大学相当分）

(ア) 領域モデルを用いた熱帯域気象の高精度高分解能予報実験

- 領域モデルを用いた、熱帯域でのダウンスケール予報実験
- 水蒸気輸送過程の全球モデル解析値からの改善度を定量的に評価
- 急峻地形対応、および大気海洋結合型の領域モデルに関する要素過程のプログラム開発

(イ) データ同化システムの試験開発と機動的観測データのインパクト評価実験

- 先端的アンサンブル4次元同化システムの開発・改良
- メソモデルにおける4次元データ同化システムを用いたGPS掩蔽データの同化実験と、そのインパクト評価（気象研究所と共同）
- 熱データの高度利用

(ウ) 統合型データベースの構築と気象災害軽減のための判断支援システムの構築

- 気象庁数値天気予報データおよび解析値の定期的取得、およびアーカイブ
- 当該データをデータベース化して可視化し解析するシステムの試作
- 応用気象分野での判断支援のための、ツール整備

(エ) 国際研究集会の開催と国際的技術協力の推進

- 2009年3月2-5日に、インドネシア・バンドン市において国際研究集会を開催
- 上記研究集会において、気象庁開発の非静力モデルを用いた講習会を開催
- 英文ニュースレターを2回(2008年10月, 2009年3月)発行・配布
- WEBホームページを更新し、本国際共同研究の活動概要を国際的に広く紹介

Ⅱ. 業務説明

１. 第 2 回国内ワークショップ

2008 年 9 月 9 日～10 日に､気象研究所において第 2 回国内ワークショップを開催した。参加者は業務参加者(京都大学 7 名・気象研究所 8 名)、業務協力者（気象庁 1 名)、招待講演者(海洋研究開発機構/地球環境観測研究センター2 名)､気象研究所関係者 10 名である。研究課題内容の再確認、基礎実験・システム開発進捗状況、実用モデル開発・応用実験進捗状況、本年度後半のスケジュールの確認について報告があった後、東南アジアにおける観測とデータ解析研究、ミャンマーサイクロンについての数値モデル研究、外部での数値モデル実行環境の整備と問題点、気象災害軽減判断支援システムの構築とデータ形式、データのアーカイブと公開のスケジュール、東南アジア若手研究者の招聘について議論した。さらに、2009 年 3 月 4 日～6 日に国際ワークショップ(インドネシア・バンドン)を開催す

ることを決定し、京都大学にサブ会場を設け、通信衛星 WINDS を用いた衛星会議方式を採用することとした。

２．第 2 回国際ワークショップ

2009 年 3 月 2 日～5 日に、インドネシア・バンドンのジャヤカルタホテルにおいて、第 2 回国際ワークショップを開催した。業務参加者(京都大学 5 名・気象研究所 5 名)、国内外の業務協力者(33 名)、科学技術振興機構課題担当者(2 名)が参加した（図 1)。この中で、京都大学で進めている研究の進捗報告として、高解像度モデルによる集中豪雨の再現実験、熱帯季節内振動が PNA パターンの予測可能性に及ぼす影響に関する研究、大気海洋相互作用に関する研究が報告された。また、気象研究所で進めている研究の進捗報告として、熱帯域における予報精度の検証、インド・ムンバイの集中豪雨やミャンマーのサイクロンの事例解析、GPS 掩蔽データの同化実験が報告された。さらに、業務協力者による研究の進捗報告として、気象庁非静力学数値天気予報モデル NHM による数値予報実験、機動的観測による台風進路予報実験、東南アジアにおける気象観測網の整備状況が報告された。その後、気象庁データ及び NHM に関する最新情報が提供され、デモンストレーションが行われた。また、ワークショップの最後には活発な討論セッションがあり、東南アジアにおける観測網・観測データ交換システムの整備について、数値天気予報・気象災害軽減に不可欠なものであるとの認識で一致した。そして、東南アジアの業務協力者による気象庁データの利用については、各国の気象庁との共同研究という形であれば可能であるので、大学の研究者と各国の気象庁との協力体制を作ることが有効であるとのコメントがあった。さらに、NHM による予報結果の解析ツールを研究者間で共有できるようにしたいという要望も出された。

３．国内における研究打ち合わせ

2009 年 2 月 4 日～5 日に、気象研究所において研究打ち合わせを行った。参加者は業務参加者(京都大学 1 名・気象研究所 8 名)、業務協力者(1 名)、および今後の業務参加者(1 名)である。業務協力者がこれまで行ってきたインドネシア・海洋大陸における数値天気予報と観測データによる検証について説明があった後、平成 21 年度の研究方針について議論した。本委託業務における位置づけについて確認した後、気象庁非静力学数値天気予報モデル NHM によるアンサンブル予報実験・メソデータ同化実験を行うにあたり、気象研究所側と京都大学・業務協力者側の役割分担・研究の進め方について議論した。また、NHM の最新版についての確認も行った。英文ドキュメントの整備について説明がなされた後、数値実験用シェルスクリプトの最新版についての説明とデモンストレーションが行われた。さらに、3 月の国際ワークショップに関する打合せも行い、NHM のチュートリアルセミナーの実施方法について議論した。

2009 年 3 月 27 日には、京都大学において業務参加者(京都大学 7 名・気象研究所 2 名)、科学技術振興機構課題担当者(1 名)、および今後の業務参加者(1 名)による戦略会議が開かれた。まず、平成 21 年度より採用の業務担当職員（京都大学）についての説明、インド・

CSIR/CMMCS 訪問の報告、平成 21 年度の事業計画の再確認、平成 22 年 2 月または 3 月に、別府で開催する国際シンポジウムの内容についての説明があった。それに引き続き、研究の進め方についての意見交換が行われた。まず、気象災害軽減のための判断支援システムについては、京都大学の新しい業務担当職員が主に担当することとなり、アンサンブル予報の情報から何を読み取るべきかという解説が必要であること、過去の典型的事例についてのインタラクティブな解説を作成することが話し合われた。次に、インド・CSIR/CMMCS 訪問の報告書については、ニュースレターに記事を書く担当者についての相談を行った。ベトナム・ハノイ大からの訪問要請については、7 月頃に訪問することとし、予算の調整が必要となることが話し合われた。気象庁データについては、気象庁の数値モデルを用いた予報研究には不可欠との意見で一致した。気象庁からは本委託業務における使用許可は出ているが、気象研究コンソーシアムからの二次配布が現状では出来ないため、契約内容の変更を検討してもらうこととした。また、京都大学に設置されたサーバーへのアクセス方法についても引き続き検討することになった。最後に、気象庁非静力学数値天気予報モデル NHM の最新版について、英文ドキュメントの整備状況、及び、数値実験用シェルスクリプトの最新版についての説明があり、今後の公開の方針について話し合いが行われた。

図 1 :「東南アジアにおける気象災害の防止と軽減」第 2 回国際ワークショップ集合写真

Ⅲ．「東南アジアにおける気象災害の防止と軽減」第２回国際ワークショッププログラム

The Second International Workshop on Prevention and Mitigation of Meteorological Disasters in Southeast Asia

PROGRAM

March 2-5, 2009
at the Jayakarta Bandung Suite Hotel & Spa, Indonesia

March 2 (Mon)

11:00 Registration
12:00 (Lunch)

Opening session (Chair: Tri Wahyu HADI)

13:30 Tri Wahyu HADI (ITB, Indonesia)
Welcome, opening remarks, and logistics
13:40 Emmy SUPARKA (ITB, Indonesia)
Welcome address
14:00 Takashi NISHIGAKI (JST, Japan)
Welcome address
14:20 Shigeo YODEN (DG/Kyoto U., Japan)
International Collaborations on Prevention and Mitigation of Meteorological Disasters in Southeast Asia
14:50 Mu MU (IAP/CAS, China)
Approaches to Adaptive Observation for Improving High Impact Weather Prediction: CNOP and SV
15:30 (Coffee break)

Session I: Downscale NWPs

16:00 Tri Wahyu HADI (ITB, Indonesia)
Prediction of Diurnal Variation over Java Island: A Four-Model Intercomparison
16:30 Shugo HAYASHI (MRI/JMA, Japan)
Statistical Verifications of Short Term NWP by NHM and WRF-ARW around Japan and Southeast Asia
17:00 Introduction of posters
Two minutes talk without ppt slides

17:30 (End of the first day sessions)

19:00 <<< Joint banquet with JSPS-AASP at the Jayakarta Hotel >>>

March 3 (Tue)

Session I: - continued (Chair: Toshiki IWASAKI)

08:30 Md. Nazrul ISLAM (SAARC/MRC, Bangladesh)
Regional Climate Model in Prevention of Meteorological Disaster in SAARC Region

09:00 KIEU Thi Xin (U. of Hanoi, Vietnam)
Implementing Regional Hydrostatical Models & NHM of MRI for the Historical Heavy Rain Case Caused Flooding in Hanoi in November 2008. Comparision
Development of a Short-Range Ensemble Prediction System at NCHMF: Preliminary Results (Le DUC, NCHMF, Vietnam)

09:30 Wai-kin WONG (Hong Kong Obs., Hong Kong)
Development and Applications of JMA-NHM in Support of Severe Weather Forecasting in Hong Kong

10:00 (Coffee break)

Session II: Tropical disturbances and precipitation process (Chair: Chun-Chieh WU)

10:30 Hiromu SEKO (MRI/JMA, Japan)
Structure of the Regional Heavy Rainfall System that Occurred in Mumbai, India, on 26 July 2005

11:00 Tetsuya TAKEMI (DPRI/Kyoto U., Japan)
High-Resolution Modeling Study of an Extreme Rainfall Event in a Complex Terrain under the Influence of Typhoon Fung-Wong (2008)

11:30 (Lunch)

Session II: - continued (Chair: Tieh Yong KOH)

13:30 Toshiki IWASAKI (Tohoku U., Japan)
Influences of Cloud Microphysical Processes on Structure and Development of Tropical Cyclone Part II: Effects of evaporation from rain

14:00 Yoichi ISHIKAWA (DG/Kyoto U., Japan)
Interaction between Tropical Convective Clouds and Ocean Mixed Layer Simulated by a High-Resolution Coupled Model

14:20 Madhavan N. RAJEEVAN (NARL, India)
Sensitivity of Different Microphysics Parameterization Schemes to the Simulation of Mesoscale Convective Systems Observed over Gadanki, India

14:40 Tohru KURODA (MRI/JMA, Japan)

NHM Utilities for SE Asian NWP and Numerical Experiments of Myanmar Cyclone Nargis

15:00 (Coffee break)

Session III: Observation network (joint with JSPS-AASP)

(Chair: Toshitaka TSUDA)

15:30 Manabu D. YAMANAKA (JAMSTEC, Japan)

Overview and Scientific Background of JEPP-HARIMAU Project: Long Coastlines of Maritime Continent Governing Global Climate

16:00 Masato SHIOTANI (RISH/Kyoto U., Japan)

Ozone and Water Vapor Observations in the Equatorial Pacific

16:30 Tieh Yong KOH (Nanyang T. U., Singapore)

Towards a Mesoscale Observation Network in Southeast Asia

17:00 Basuki SUHARDIMAN (ITB, Indonesia)

Trans European Information Network 3 (TEIN3) and Its Potential Use for the Weather and Climate Research in Southeast Asia

17:20 (End of the second day sessions)

<<< Group photo >>>

March 4 (Wed)

Session IV: New methods in observation, data assimilation, and NWPs (joint with JSPS-AASP) (Chair: Masato SHIOTANI)

08:30 Toshitaka TSUDA (RISH/Kyoto U., Japan)

Application of GPS Radio Occultation (RO) Data for the Studies of Atmospheric Dynamics and Data Assimilation into Numerical Weather Prediction Model

09:00 Seon Ki PARK (Ewha W.U., Korea)

Data Assimilation and Parameter Estimation to Improve Forecast Accuracy of Disastrous Weather Systems

09:30 Kevin CHEUNG (Macquarie U., Australia)

A Statistical Tropical Cyclone Rainfall Model for the Taiwan Area

10:00 (Coffee break)

Session IV: - continued (Chair: Mezak A. RATAG)

10:30 Chun-Chieh WU (National Taiwan U., Taiwan)

Targeted Observation for Improving Tropical Cyclone Predictability – DOTSTAR and T-PARC

11:00 DODLA V. Bhaskar Rao (Andhra U., India)
Ensemble Prediction of "SIDR" Cyclone over Bay of Bengal Using a High Resolution Mesoscale Model

11:30 Kazuo SAITO (MRI/JMA, Japan)
Ensemble Forecast Experiment of Cyclone Nargis

12:00 (Lunch)

Session V: Risk assessment and community preparedness (Chair: Kazuo SAITO)

13:30 Hirohiko ISHIKAWA (DPRI/Kyoto U., Japan)
Estimation of Meteorological Hazards Using Output from Numerical Weather Prediction Model

14:00 Kamol PROMASAKHA NA SAKOLNAKHON (TMD, Thailand)
Case Study: The Atmospheric Stability Indices and Applied GIS Risk Assessment Severe Thunderstorms in the Northeastern of Thailand

14:30 Mezak A. RATAG (BMG, Indonesia)
Roles of High Resolution Weather and Climate Models in Disaster Risk Management at District Level

15:00 (Coffee break)

Tutorials

15:30 Kazuo SAITO, Shugo HAYASHI, and Tohru KURODA (MRI/JMA, Japan)
Introduction to Non-Hydrostatic Model of MRI/JMA

17:00 (End of the third day sessions)

March 5 (Thu)

Session VI: Extended range NWPs (Chair: Mu MU)

08:30 Hitoshi MUKOUGAWA (DPRI/Kyoto U., Japan)
On the Influence of the Tropical Intraseasonal Oscillation to the Predictability of the Pacific/North American Pattern

09:00 Krushna C. GOUDA (CSIR/CMMCS, India)
Advance Prediction of Date of Onset of Monsoon: Dynamical Basis and Skill Evaluation

09:30 Donaldi Sukma PERMANA (BMG, Indonesia)
Comparisons between Conformal Cubic Atmospheric Model (CCAM) and Global Forecasting System (GFS): Global Model Output over Indonesia in September –

October – November (SON) 2008

10:00 (Coffee break)

Session VII: Data assimilation (Chair: Seon Ki PARK)

10:30 Yoshinori SHOJI (MRI/JMA, Japan)
Data Assimilation of Precipitable Water Vapor Derived from GPS Network in South East Asia

11:00 I Dewa Gede A. JUNNAEDHI (ITB, Indonesia)
Impact of Local Data Assimilation on Short Range Weather Prediction in Indonesia : A Preliminary Result

11:30 (Lunch)

Poster session

13:00 Kosuke ITO (DG/Kyoto U., Japan)
Improved Estimates of Air-Sea Fluxes in a Tropical Cyclone Using an Adjoint Method

Takuya KAWABATA (MRI/JMA, Japan)
Development and Results of a Cloud-Resolving Nonhydrostatic 4DVAR Assimilation System

Hyun Hee KIM (Ewha W.U., Korea)
Identification of Adaptive Observation Area in Typhoon Megi (2002) Using an Ensemble Data Assimilation Method

Masaru KUNII (MRI/JMA, Japan)
Sensitivity Analysis using the Mesoscale Singular Vectors

Jalu Tejo NUGROHO (LAPAN, Indonesia)
Solar Cycle Prediction using Periodicity Analysis of Weighted Wavelet Z-Transform

Shigenori OTSUKA (DG/Kyoto U., Japan)
Numerical Experiments on Formation Processes of Thin Moist Layers in the Mid-Troposphere over a Tropical Ocean

Kazuo SAITO (MRI/JMA, Japan)
Achievements and Experiences of MRI/JMA at the WWRP Beijing Olympic Research and Development Project

Hiromu SEKO (MRI/JMA, Japan)
Mesoscale Ensemble Experiments on Potential Parameters for Tornado Formation

Hiromu SEKO (MRI/JMA, Japan)
Mesoscale Ensemble Experiments on Heavy Rainfalls in Japan Area using LETKF

Tri Handoko SETO (BPPT, Indonesia)
Weather Modification Technology for Flood Prevention in Indonesia

Ibnu SOFIAN (BAKOSURTANAL, Indonesia)

Simulation of Wind-Setup Wave in the Indonesian Seas Using the Nesting Wavewatch III

Elza SURMAINI (Dept. of Agriculture, Indonesia)

Validation of ECMWF Seasonal Forecast Output in Indonesia

Closing session (Chair: Shigeo YODEN)

14:30 All Participants

Discussion for Future Activities

15:00 (Adjourn)

IV.「東南アジアにおける気象災害の防止と軽減」第 2 回国際ワークショップ口頭発表要旨

1. International Research for Prevention and Mitigation of Meteorological Disasters in Southeast Asia

Shigeo YODEN
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Department of Geophysics, Kyoto University

Risk of high-impact weather in Southeast Asia is potentially increasing because of the economical development and urbanization. Global warming and climate change might become another factor for the increase of the risk. It would be a good timing for us to start an international research project for prevention and mitigation of meteorological disasters in Southeast Asia, because the research environment is rapidly changing by the growth of computer powers and the improvement of internet infrastructures. Regional meso-scale models can be run with personal computers for downscale numerical weather predictions (NWPs). Data transfer via internet is getting fast enough to perform near-real time NWPs. Utilization of probability information obtained by ensemble NWPs is a challenge for the development of decision support tools. Assessments of the impact of new observational data on the improvement of NWPs with advanced data assimilation schemes are also important subject in these days.

In 2007, we started "International Research for Prevention and Mitigation of Meteorological Disasters in Southeast Asia (PMMDSA)" under the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Special Coordination Funds for Promoting Science and Technology, supported for FY 2007-2009 under Asia S & T Strategic Cooperation Program (http://www-mete.kugi.kyoto-u.ac.jp/project/MEXT/).

Three main affiliations of this international research project are Kyoto University, Meteorological Research Institute (MRI) of Japan Meteorological Agency (JMA), and Institut Technologi Bandung (ITB) in Indonesia. Fundamental research and system development will be done at Kyoto University, while operational model development will be done at MRI/JMA. Real-time experiment will be done at ITB and other institutes outside Japan. Our main purpose is to establish "International Scientist-Network for Prevention and Mitigation of Meteorological Disasters in Southeast Asia" through research and development of downscaling NWP systems. The First International Workshop on PMMDSA was held in March 2008 in Kyoto, and this is the second international workshop held in Bandung, Indonesia following the first one in collaboration with the colleagues in ITB. We hope this will be a good opportunity to expand and strengthen the international scientist-network for PMMDSA.

2. Approaches to Adaptive Observation for Improving High Impact Weather Prediction: CNOP and SV

Mu Mu, Feifan Zhou and Hongli Wang
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State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics (LASG), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

Linear singular vector (LSV) has been applied to adaptive observation, which and other approaches, such as ensemble Kalman filter, display the values of adaptive observation in prevention and mitigation of meteorological disasters. LSV has the limitation of linear approximation. The first author and his colleagues recently proposed conditional nonlinear optimal perturbation (CNOP) ,which is a natural extension of LSV into nonlinear category , to overcome the limitation. This study investigates the applications of conditional nonlinear optimal perturbation (CNOP) to the determination of sensitive areas in adaptive observations for tropical cyclone and precipitation prediction. The benefits obtained by approaches of CNOP and LSV are compared.

With respect to the metrics of kinetic and dry energies, CNOPs and the first singular vectors (FSVs) are obtained for cases of tropical cyclone and precipitation. Their spatial structures, energies, nonlinear evolutions as well as the resulting humidity changes are compared. Some sensitivity experiments are designed to find out what benefit can be obtained by reductions of CNOP-type errors or FSV-type errors. It is observed that the structures of CNOPs may much differ from those of FSVs depending on the constraint, metric and the basic state. The targeted-area predictions as well as the predictions are more heavily impacted by the CNOP-type initial errors than the FSV-type . The results of sensitivity experiments indicate that reductions of CNOP-type errors in the initial states provide more benefit than reductions of FSV-type errors. These suggest that it is worthwhile to use CNOP for the adaptive observation in prevention and mitigation of meteorological disasters.

3. Prediction of Diurnal Variation over Java Island: A Four-Model Intercomparison

Tri W. Hadi[1)], I Dewa Gede A. Junnaedhi[1)], Donaldi Permana[2)], and Mezak A. Ratag[2)]
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2) Center for Research and Development, Meteorological, Climatological, and Geophysical Agency of Indonesia (BMKG)
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Diurnal variation plays dominant role in generating weather variabilities in the Maritime Continent. Therefore, it is important to investigate whether Numerical Weather Prediction (NWP) models are able to correctly predict the phase and amplitude of the diurnal variation; prior to their application for weather forecasting in the region. Under collaborations with Kyoto University, and Meteorological Research Institute – Japan Meteorological Agency (MRI – JMA), we have been conducting experimental downscaling of global model output by using three mesoscale models i.e. MM5, WRF, and JMA Non-Hydrostatic Model (NHM). In addition, Center for Research and Development – Meteorological, Climatological, and Geophysical Agency of Indonesia (BMKG) in collaboration with the Australian *Commonwealth Scientific Research Organization* (CSIRO) have also been experimenting with *Cubic Conformal Atmospheric Model* (CCAM), which is an alternative global model with stretched grid system.

In the downscaling experiments, input to the mesoscale models are the NCEP-GFS output with horizontal grid spacing of 1º x 1º. The global model initial time is 1200 UTC, whereas boundary conditions are supplied at 6-hour interval. The mesoscale models are used to perform hindcast experiments by downscaling NCEP-GFS output up to 48-hour lead time prediction. The downscaling has been carried out in two nested domains with horizontal grid spacings of 27 and 9 km respectively, while the number of vertical levels is set to 32. Only one combination of model parameters was used for each model. As an alternative, CCAM was also used in the downscaling experiments but with different settings. Analysis of diurnal-variation prediction was performed by comparing all model outputs with surface meteorological data observed over Java Island.

This study is still ongoing but preliminary results show that all models can capture the phase and, to some extent, amplitude of observed diurnal variations in near surface temperature and relative humidity. However, predicted wind velocities show inconsistent agreements with observations. Further inspection revealed that descrepancies arised partially due to erroneous observations, but comparisons between model outputs also indicate significant ensemble error growth with forecast lead time. There are also large differences, for both amplitude and phase, in convective rainfall prediction between model outputs. These differences seemed to largely reflect the inability of the models in simulating local circulations. The results seem to demonstrate that even relatively high-resolution mesoscale models have inherent problems to resolve diurnal variations over Java Island. More experiments are proposed to find possible remedy for these model weaknesses.

4. Statistical Verifications of Short Term NWP by NHM and WRF-ARW around Japan and Southeast Asia

Syugo HAYASHI
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Meteorological Research Institute / JMA, Japan

1. Introduction

To develop a decision support system based on numerical weather prediction (NWP) for the mitigation of meteorological disasters, statistical verification of short term NWP experiments using the Japan Meteorological Agency (JMA) non-hydrostatic model (NHM) and the advanced research WRF (the weather research and forecasting model), referred to as WRF-ARW, was conducted around Japan and Southeast Asia.

2. Design of experiments

The same domain size, the same horizontal resolution, the same model top height and the same time step are used to ensure a fair comparison (Fig. 1). Initial and boundary conditions are taken from the global forecast system of the National Centers for Environmental Prediction (NCEP-GFS) every 3 hours. The NCEP-GFS forecast was selected because its data set can be downloaded through the Internet without strict restrictions. The model specifications and

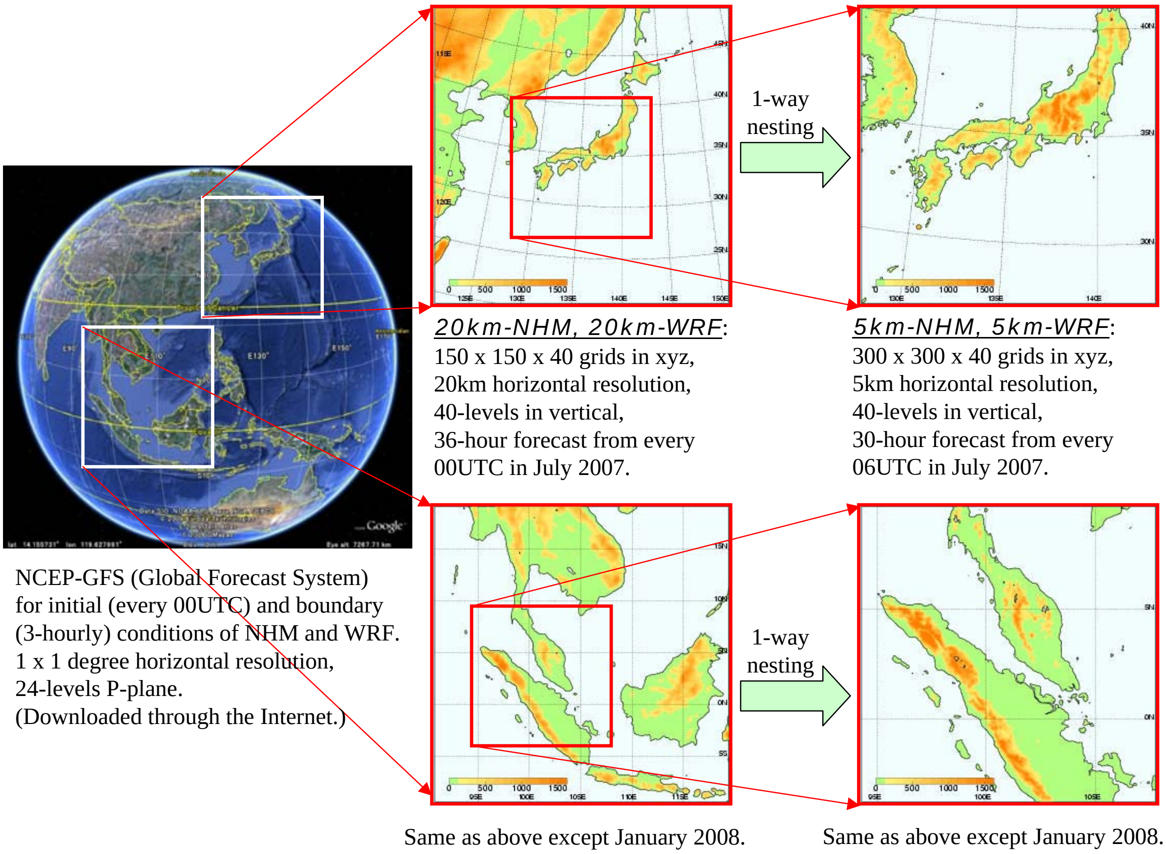

Fig. 1. The design of the experiments with topography.

parameter settings employed in the experiments use the recommended (or default) values without tuning. The reason for this is that many users do not change the recommended settings upon first use. The same settings in each model are applied to two regions, around Japan (Lambert conformal projection) and Southeast Asia (Mercator projection).

3. Statitical Verification (Precipitation of 20km models)

The model results were verified by the global surface rain, as estimated by passive microwave satellites (CMORPH). Figures 2 indicate the continuous 15 day accumulated precipitation around Japan in July 2007. The observed precipitation area (Fig. 2a), corresponding to the Baiu-front in south Japan, is well reproduced by the models (Figs. 2b, 2c). In contarst, precipitation over the western part of Japan and the Sea of Japan are overestimated in the models. Figure 3 is the same as Fig. 2 except that it is for Southeast Asia January 2008. The accumulated precipitation over the sea is overestimated in both models (Figs. 2b, 2c). In addition, WRF has excessive precipitation over Borneo Island.

The other scores of 20km-models and the results of 5km models will be presented at the conference.

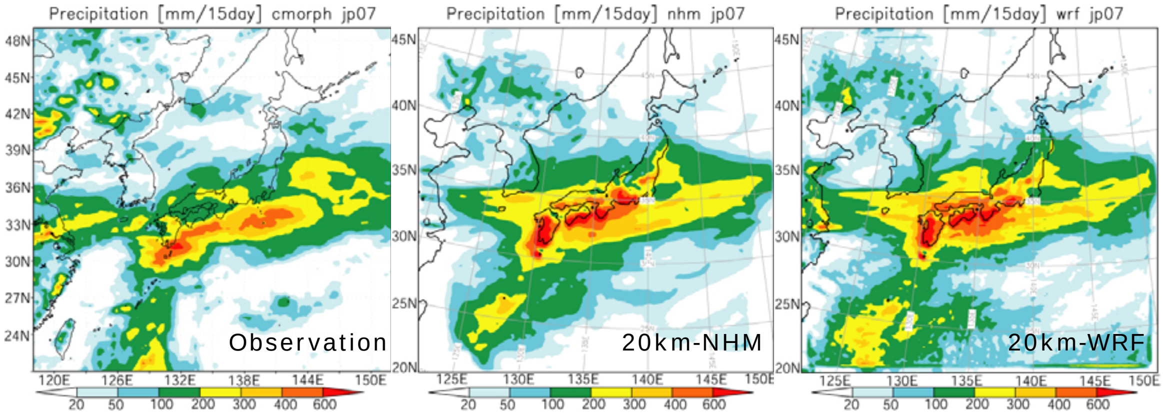

Fig. 2. Accumulated precipitation around Japan July 2007.
(a) Satellite observation, (b) 20km-NHM, (c) 20km-WRF

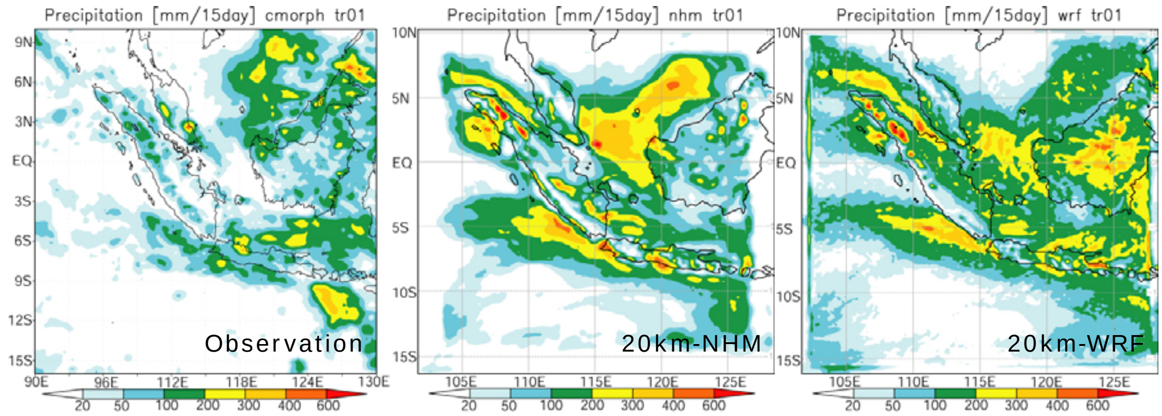

Fig. 3. Accumulated precipitation around Indonesia January 2008.
(a) Satellite observation, (b) 20km-NHM, (c) 20km-WRF

5. Regional Climate Model in Prevention of Meteorological Disaster in SAARC Region

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Meteorological disaster is one of the key issues to discuss in relation to the climate change. Generation of climate change scenarios can play vital role in prevention and mitigation of meteorological disasters. In this connection, this paper discussed the calibration and validation of climate model called PRECIS for Bangladesh. Satisfactory performance of the PRECIS encourages utilizing it in generation of future climate change scenarios for the entire SAARC region.

The South Asian Association for Regional Cooperation (SAARC) is the economic and political body of the eight South Asian nations- Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. The SARC region is the most vulnerable to climate change that is seriously affecting disaster management of this region. It is accounted that in the SAARC countries 21% of world population resides on only 4% of the world's total physical area. The World Bank climate change experts' opinion is that the poorest of the poor in South Asia are the most affected by climate change. Climate change is recognized as the greatest long-term threat to the SAARC region. The economic impact of climate change, rising food prices and assessment of food security are key issues to discuss in relation to preparedness for disastrous situation. Long-term planning on mitigation and prevention of meteorological disaster is impossible without any idea of the climate change to be happened in future. Climate models are the main tools available for developing projections of climate change in the future. This paper examines the calibration and validation of rainfall climatology in Bangladesh derived from a regional climate model called Providing REgional Climates for Impact Studies (PRECIS).

PRECIS was run with 50km horizontal resolution for the present climate (1961–1990) to calibrate PRECIS outputs with observed datasets. The model domain is selected 65–103°E and 6–35°N to cover entire SAARC region. Calibration and validation of PRECIS is considered for Bangladesh as to understand the model performance in simulating climate parameters. The Bangladesh Meteorological Department (BMD) collected surface rainfall throughout the country has been utilized for the calibration of PRECIS generated rainfall. Daily rainfall collected by BMD and obtained from model is processed to obtain monthly, seasonal, annual, decadal and long-term values. Through the regression expression the slopes and constants values are assigned from model and observed rainfall for the present climate. Estimated rainfall is obtained from model generated scenarios with the help of slopes and constants values. This estimated rainfall is useful for validation of PRECIS in Bangladesh. Finally, projections of rainfall scenarios are made for 2010-2020 in the SAARC domain.

In prevention of meteorological disaster the utilization of climate model outputs are invaluable because forecast is impossible without model. In this connection, the present work outlined the way of utilizing PRECIS outputs for the projection of rainfall in Bangladesh. The work will be extended to all the SAARC member states through which national planners will be able to prepare their long-term disaster prevention plans for the preparedness from meteorological hazardous situation.

6. Implementing Regional Hydrostatical Models & NHM of MRI for the Historical Heavy Rain Case Caused Flooding in Hanoi in November 2008. Comparision

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In order to show if NHM be able to use for prediction of meteorological disasters in Southeast Asia we have implemented some hydrostatical models and the simple MRI-NHM (with horizontal resolution of 10 km and 40 vertical levels) for the historical heavy rain in Hananoi in November 2008 and carried out some comparision of forecasts. The results show that rain forecast of hydrostatic and nonhydrostatic models depend much on dynamical initial conditions (first of all moist and wind) from gloabal model as well as on convection parameterization scheme. The use of subgrid-scale orography (SSO) improved rain forecast clearly. The rain case of November 2008 showed that both models (HRM & NHM) underestimate rainfall . Though we used only resolutions of 10 km and 40 vertical levels and inputs of global model GEM or GME as initial and boundary conditions but NHM provided better rain forecast in rain volume, rain location and rain pattern than HRM.

To develop a dynamical downscaling NWP system in Vietnam we are going to nest the nonhydrostatic model NHM in our system of 3DVAR+hydrostatic HRM for research**.**

Development of a Short-Range Ensemble Prediction System at NCHMF: Preliminary Results

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With the success of short-range ensemble forecasts in other centers, especially the probability of detection of extreme events like heavy rainfalls, a short-range ensemble prediction system (SREPS) was implemented in Vietnam National Center for Hydro-Meteorological Forecast (NCHMF) in 2008.

The most important thing in a SREPS is how to generate perturbations so that the ensemble spans the range of events. NCHMF took the multi-model multi-analysis approach with 4 models BoLAM, Eta, HRM and WRF-NMM, and initial and boundary conditions from 5 global models GEM, GFS, GME, GSM and NOGAPS. Now, the system is running in testing mode, four time per day, forecasts up to 72 hours. All products can access through intranet. This paper will shortly introduce the SREPS at NCHMF and show some preliminary products.

7. Development and Applications of JMA-NHM in Support of Severe Weather Forecasting in Hong Kong

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Hong Kong Observatory (HKO) has been developing a high-resolution mesoscale NWP model based on the JMA-NHM (Saito *et al.* 2006) since 2003. The primary mission of NHM is to support the short-range forecasting of rainstorms and severe weather phenomena.

The first trial of NHM, routinely run twice a day, began in April 2004 and provided 12-hour forecasts at the horizontal resolution of 5 km with 45 vertical levels and covering a domain of about 600 x 600 km^2 (Figure 1). Initial and boundary conditions were obtained from the HKO Operational Regional Spectral Model at the horizontal resolution of 20 km. In April 2005, NHM was upgraded to operate on an hourly basis to provide model-based quantitative precipitation forecasts (QPF). The QPF output was merged with radar-based nowcast products and led to the development of RAPIDS (Rainstorm Analysis and Prediction Integrated Data-processing System, Wong and Lai, 2006; also see Figure 2) and an improvement of QPF skills over out to a time horizon of six hours. To alleviate the spin-up problem of moisture fields in NHM, a mesoscale data analysis system based on NOAA/GSD LAPS (Local Analysis and Prediction System, Albers *et al.* 1996) was implemented together with the upgraded model. In addition to conventional observations and automatic weather station data, radar reflectivity and Doppler velocity, as well as infra-red brightness temperature and visible albedo data from geostationary satellites, are also ingested to generate the analysis of cloud hydrometeor contents for initializing the NHM. A more sophisticated data assimilation system on the basis of JNoVA-3DVAR (JMA-NHM based variational data assimilation system, Honda *et al.* 2005) is currently under development to improve the initial conditions in the future operational NHM suite with horizontal resolution of 2 km.

NHM has since been applied to various research areas and operation projects in an attempt to extend its applications from high resolution weather analyses/forecasts to risk assessment of high-impact weather such as heavy rain and high winds associated with tropical cyclones. For example, the forecast products from 5-km NHM are utilized as background fields in a new meso/local-scale analysis system using LAPS with horizontal resolutions of 5 km, 1.5 km and 500 metres, which can deliver real-time 3-dimensional analysis for the monitoring and nowcasting of potential development of severe convection (Figure 3). NHM-related projects since undertaken include: (a) the study and fine-tuning of parameters in the parameterization schemes to improve model QPF; and (b) implementation of new air/sea flux exchange process for the prediction of intensity and wind structure of tropical cyclones. NHM has also been successfully deployed in the WMO/WWRP B08FDP (Beijing 2008 Forecast Demonstration Project) to support the operation of HKO's nowcasting system in Beijing.

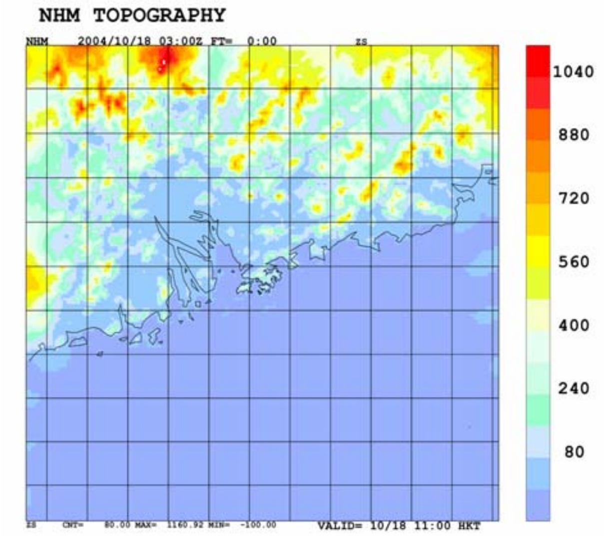

Figure 1. Domain of 5-km NHM.

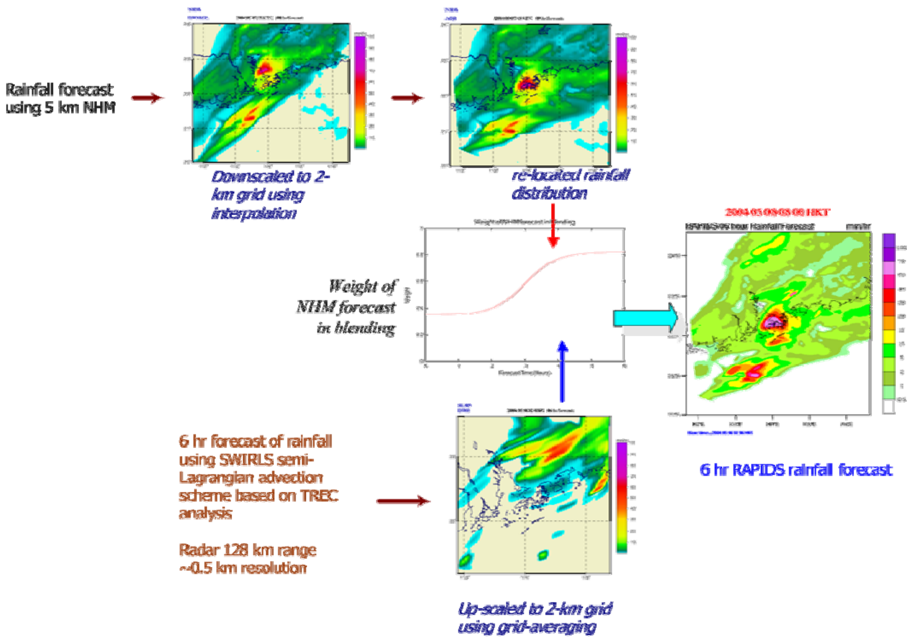

Figure 2. Schematic diagram of RAPIDS.

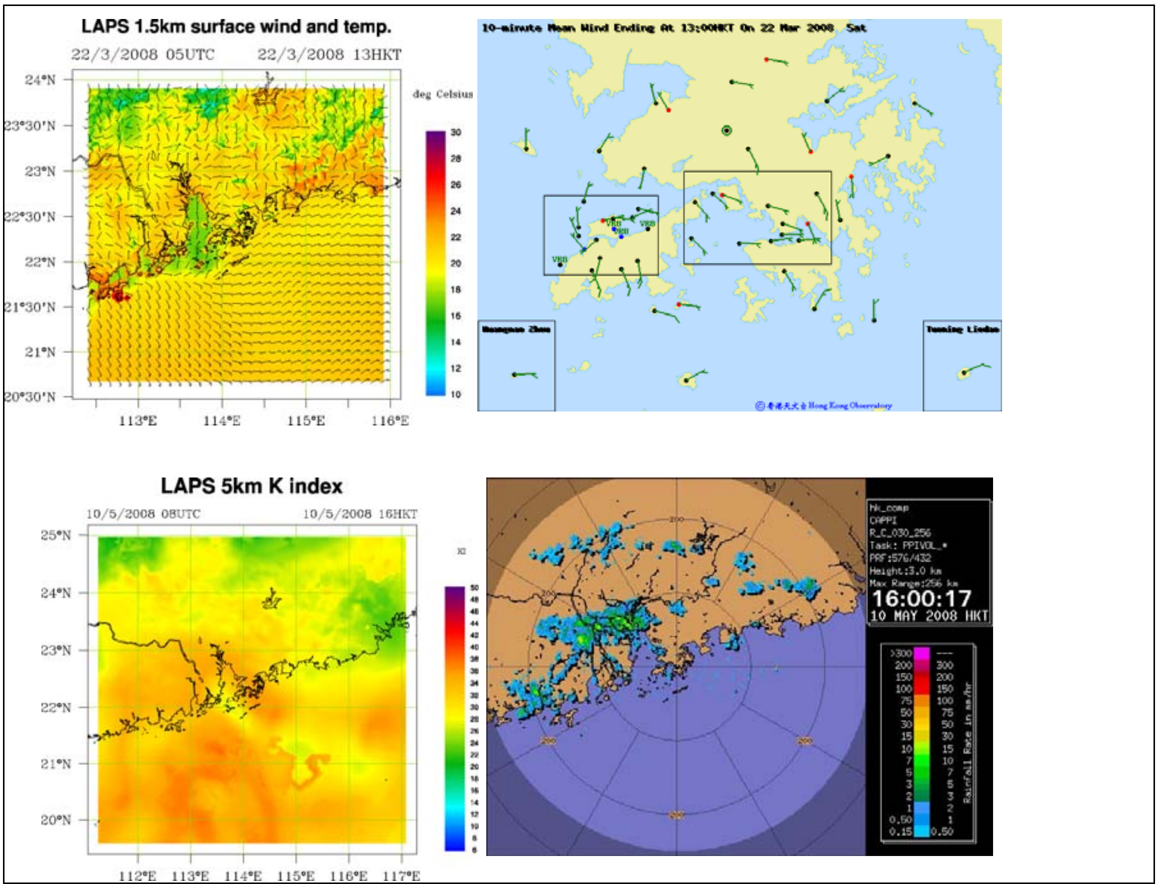

Figure 3. Top row - Analyses of surface wind and temperature (color shading) at 13 HKT 22 March 2008 by LAPS at 1.5 km horizontal resolution using 5 km NHM as background, wind observations over Hong Kong are shown in the figure on the right. Bottom row – K-index derived from 5-km LAPS products at 16 HKT 10 May 2008 showing high instability over the coastal areas of Guangdong that development of echoes are also observed from the radar imagery.

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8. Structure of the Regional Heavy Rainfall System that Occurred in Mumbai, India, on 26 July 2005

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1. Introduction

This study investigated the heavy rainfall that occurred at Santa Cruz, a suburb of Mumbai, on 26 July 2005. In this event, the 24 hour rainfall amount at Santa Cruz reached 944.2 mm (Bohra et al, 2005). A few analyses of this event have been conducted. Bohra et al. (2005) reported that this rainfall event was not reproduced by the global numerical models of the European Centre for Medium-Range Weather Forecasts, whose model resolution was TL511L60; the National Centers for Environmental Prediction (T382L64); or Japan Meteorological Agency (TL319L40). Because the heavy rainfall was caused by the regional convective system, it was expected that NHM with a finer horizontal grid interval would reproduce the rainfall system. In this study, the detailed structure of the heavy rainfall system was demonstrated by NHM with a grid interval of 1 km.

2. Observed features of the heavy rainfall

According to Bohra et al. (2005), the rainfall at Santa Cruz started at 0600 UTC (11.5 India Standard Time (IST)) on 26 July 2005, and continued for 18 hours. The rainfall region observed by the TRMM satellite revealed that the horizontal scale of this rainfall event was several tens of kilometers. These observed results indicated that the rainfall system had a long-lasting structure that brought a large quantity of rainfall to a small region. The precipitable water vapor (PWV) observed by the SSM/I indicated that a region of large PWV over 60 mm existed just north of the heavy rainfall system when the heavy rainfall occurred. This distribution of PWV suggested that the heavy rainfall might have occurred when this humid air was supplied to the rainfall system.

3. Design of experiment

This study used NHM with triple-nested grids (20 km, 5 km and 1 km). Hereafter, experiments with 20 km will be labeled 20km-NHM; those with 5 km will be labeled 5km-NHM; and those with 1 km will be labeled 1km-NHM. Initial and boundary conditions of 20km-NHM were obtained from the global analysis data of JMA. First, the analysis data at 11.5 IST (0600 UTC), 25 July were tested as the initial condition, but the heavy rainfall was not reproduced. Alternatively, the global analysis data at 5.5 IST (0000 UTC) 25 July were used as the initial condition of 20km-NHM. When this analysis was used as the initial data, an intense rainfall system was reproduced near Mumbai, though its generation time was 18 hours earlier than the observed one. In the satellite images of SSM/I, similarly developed convective systems existed on the western coast of India on 25 July, though their intensities were weaker than that of the heavy rainfall. Thus, we believe that the rainfall system simulated from this initial time had the information of the heavy rainfall.

Outputs of 20km-NHM and 5km-NHM provided the initial and boundary conditions of 5km-NHM and 1km-NHM. The initial data of 5km-NHM and 1km-NHM were given by the outputs at the forecast time (FT) of 6 hours. Specifically, the initial time of 5km-NHM and 1km-NHM were 11.5 IST and 17.5 IST of 25 July. The forecast period of 20km-NHM, was 36 hours; that of 5km-NHM was 30 hours; and that of 1km-NHM was 9 hours.

4. Evolution and structure of the simulated heavy rainfall

4.1 Evolution of the regional heavy rainfall (from FT=3-27 hours of 5km-NHM)

Figure 1a depicts the rainfall distributions from FT=3 to 27 (hours) produced by 5km-NHM. The rainfall regions were generated along the mountain range near the western coast of India by FT=3 (14.5 IST). An intense rainfall system was organized near Mumbai by FT=6 (17.5 IST). The system began to split into several rainfall cells along the mountain range at FT=18 (5.5 IST, 26 July), and then the intense rainfall was terminated at FT=23 (10.5 IST, 26 July). The rainfall amount in 17 hours from FT=6 to FT=23 caused by the system reached 1,149 mm. The rainfall amount and duration indicated that the heavy rainfall was quantitatively well-simulated.

4.2 Structure of the heavy rainfall system (at FT=6 hours of 1km-NHM)

Figure 2b depicts the rainwater mixing ratio of the regional rainfall system reproduced by 1km-NHM. The intense rainfall system had already been organized by FT=6 (23.5 IST) 100 km south of Mumbai. The horizontal scale of regional heavy rainfall was several tens of kilometers. The good agreement of the simulated position and the horizontal scale with observation indicated that 1km-NHM effectively reproduced the regional heavy rainfall.

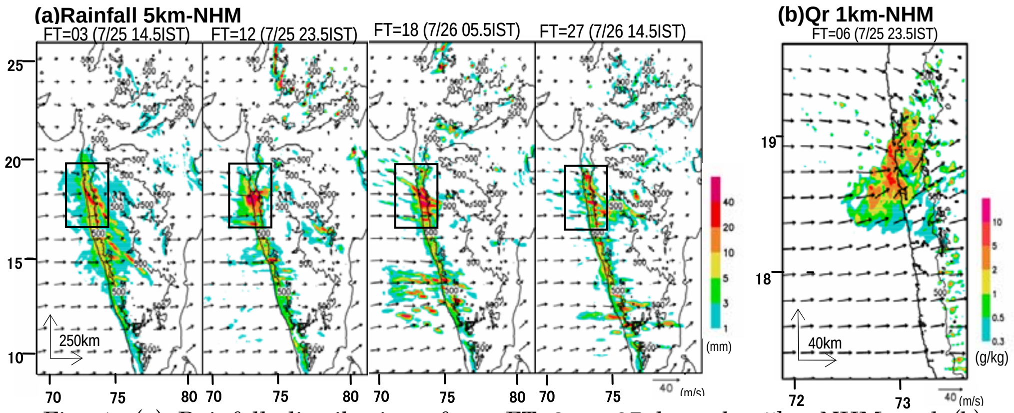

Fig. 1. (a) Rainfall distributions from FT=3 to 27 hour by 5km-NHM and (b) horizontal wind and rainwater mixing ratio (Qr) at z=0.53 km at FT=6 by 1km-NHM. Rectangles in (a) indicate the domain of (b). Large arrows in (a) and (b) indicate the horizontal scale of 250 km and 40 km, respectively.

The structure of heavy rainfall is revealed by the illustration of airflow (Fig. 3), and the distributions of temperature, water vapor and equivalent potential temperature (Figs. 2 and 4).

The intense rainfall region extended southwestward from the mountain range near Mumbai. A cold pool developed between the intense rainfall region and the mountain range (Fig 2a, cold pool in Fig. 3). A westerly flow near the surface (Figs. 2a and 2c, A in Fig. 3) intruded the intense rainfall region from the west of the rainfall system, changing its moving direction to southeastward. This flow overrode the cold pool along the western side of the intense rainfall region (Fig. 2a). The westerly flow on the southern side of the system (Fig. 2a, E in Fig. 3) changed its moving direction to northeastward, and then passed the southern side of the system.

At the height of 0.53 km, the westerly flow from the west of the heavy rainfall (A in Fig. 3) was warmer and more humid than that in the westerly flow on the south of the system (E in Fig. 3). This warm humid westerly flow (A in Fig. 3) overrode the cold pool, and then produced an intense updraft at over 5 m/s at a height of 1.69 km (not shown).

On the southern side of the intense rainfall region, a dry southwesterly flow occurred (Fig. 2c, head part of D in Fig.3). Figure 4a presents the vertical cross section of the equivalent potential temperature (θ_e) that crossed this dry flow region. The downdraft of low θ_e air, (dry airflow in Fig. 2c, head part of D in Fig. 3) occurred on the southern side of the system. This region extended northward as it descended, and then reached the lower layer (Fig. 4a). It was inferred that this descending dry airflow evaporated the rain droplets falling from the cloud region and produced the cold downdraft.

At a height of 2.51 km, two key

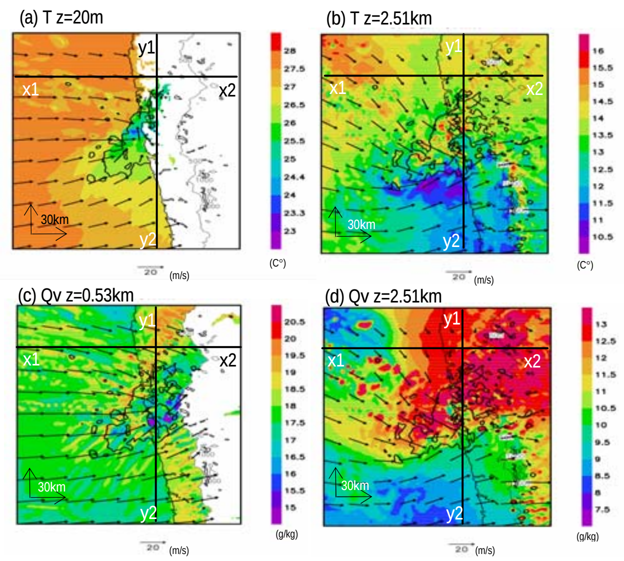

Fig. 2. Horizontal distribution of temperature (T) and water vapor mixing ratio (Qv) at FT=6 (23.5 IST) reproduced by 1km-NHM. Black contours indicate rainwater mixing ratio of 1 g/kg. Large arrows indicate the horizontal scale of 30 km.

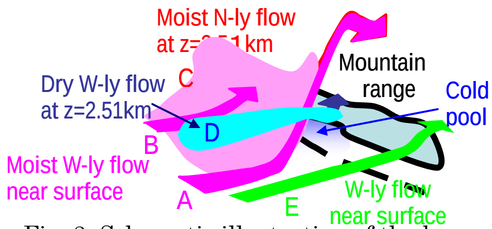

Fig. 3. Schematic illustration of the heavy rainfall.

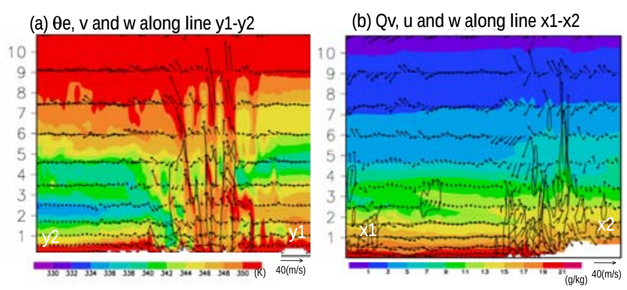

Fig. 4. Vertical cross sections of (a) equivalent potential temperature (θ_e) and (b) water vapor mixing ratio (Qv) at FT=6 (23.5 IST) along the lines in Fig. 2. Vertical velocities in (a) and (b) are multiplied by 10 and 50, respectively. Contours in (a) and (b) show the region where rainwater mixing ratio exceeds 1 g/kg and where vertical flux of water vapor exceeds 2.0×10^{-3} $kgm^{-2}s^{-1}$, respectively.

airflows were observed. The first one was a moist airflow that entered the rainfall system from the north (Fig. 2d, C in Fig. 3). This flow was expected to increase the rainfall amount because it provided water vapor to the rainfall system. Figure 4b depicts a vertical cross section of water vapor and vertical flux of water vapor along line x1-x2 in Fig. 2 where the humid westerly flow (B in Fig. 3) existed near the surface (Fig. 2c). Regions of upward water vapor flux exceeding 2×10^{-3} $kgm^{-2}s^{-1}$, whose top reached a height of 3 km, occurred over the western slope and on the western side of the mountain range. This distribution indicated that the thick humid layer originated from the low-level humid airflow (B in Fig. 3) stagnated by the topography effect of the mountain range. The second key airflow was the relatively dry westerly flow that intruded into the southern side of the rainfall system (D in Fig. 3), where the downdraft was dominant. This dry airflow was cooled by the evaporation of the rain droplets, and then became the downdraft in the southern side of the rainfall system. This cold airflow enhanced the convective instability and produced the cold pool. Both airflows (C and D in Fig. 3) were favorable for maintaining the heavy rainfall.

5. Summary

The heavy rainfall that occurred at Mumbai was reproduced by NHM. The results of this study are summarized below;

(1) The maximum rainfall amount produced by the simulated system was 1,149 mm, and the duration of intense rain was 17 hours. These amounts were comparable to the observed ones.

(2) The rain was caused mainly by a humid westerly flow near the surface, which overrode a cold pool near the mountain range (A in Fig. 3). Besides the westerly flow, the thick humid airflow from the north (C in Fig. 3) provided water vapor to the rainfall system.

(3) A northerly humid thick airflow (C in Fig. 3) was produced from the low-level humid westerly flow (B in Fig. 3) by the topography effect of the mountain range.

(4) When the intense rainfall system was organized, the relatively dry westerly flow at the height of 2.51 km (D in Fig. 3) intruded into the rainfall system from the south. This airflow decreased its temperature by evaporating the water substances and enhanced the cold outflow.

Although the heavy rainfall system was reproduced, a few points remain to be investigated. One of these is the generation time of the heavy rainfall. The time lag between the observed heavy rainfall and the simulated heavy rainfall was 18 hours. To reduce this time lag, the initial conditions must be improved with the data assimilation or ensemble techniques, but these are subjects for future study.

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9. High-Resolution Modeling Study of an Extreme Rainfall Event in a Complex Terrain under the Influence of Typhoon Fung-Wong (2008)

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The 2008 summer season in Japan faced the frequent occurrence of flooding disasters due to heavy rainfall. The land of Japan, like those of the East and Southeast Asian countries, is characterized by steep and complex topography, which may locally enhances rainfall and hence induces landslides and floodings of rivers. Among the 2008 flooding events, the case occurred in a western-to-central part (i.e., the Kinki and Hokuriku regions) of Japan during 27-29 July 2008 was one of the severest disasters. During the period, various types of meteorological disasters were spawned in many areas over Japan: disasters due to gusty winds, floodings, landslides, and thunders. The flush flooding of the Toga River in Kobe on 28 July, a tragic disaster killing those who were on the pedestrian deck of the river, can be associated with steep mountains just north of the urban district of Kobe. In order to diagnoze and forecast the locally induced heavy rainfall in a steep and complex terrain, a sufficiently fine resolution that can explicitly resolve small-scale terrain features is required for a numerical simulation.

The present study examines the structure and development of the 28 July 2008 extremely heavy rainfall event in the Kinki and Hokuriku regions of Japan by conducting high-resolution simulations using the Weather Research and Forecasting (WRF) – Advanced Research WRF (ARW) model (Version 3) developed by National Center for Atmospheric Research and the collaborators (Skamarock et al., 2008). The event occurred to the south of a stationary front and in relation to Typhoon Fung-Wong (2008) that went westward over the East China Sea.

By use of the WRF's nesting capability, we set a large computational domain covering the path of the typhoon for the outermost domain as well as three nested domains: the computational areas (grid spacings) for the four domains are 2200 km x 2400 km (10 km)/410 km x 480 km (2.5 km)/162.5 km x 175 km (500 m)/30 km x 25 km (100 m), respetively. The innermost domain covers the Toga River as well as the urban areas between Kobe and Osaka. The model top is set at the 50-hPa level, with 40 grids in the vertical. In order to generate the model topography for the 500-m and 100-m grid domains, we use the 50-m mesh digital elevation map data of Geographical Survey Institute of Japan. With the high-resolution elevation data, the model terrain can represent realistic small-scale features; on the other hand, the integration time step for the innermost domain has to be as small as 0.15 s in order to maintain the computational stability. The gridded analysis data of Japan Meteorological Agency (JMA) are used for the initial and boundary conditions.

We examine the sensitivity to the difference of gridded analysis data (e.g., the mesoscale analysis versus the global analysis of JMA) and the size of the outermost computational domain. We also examine the impact of the representation of the topography by creating the model terrain for the third and the fourth domains with coarse-mesh elevation data (i.e., GTOPO30).

Figure 1 shows the hourly accumulated rainfall at 0500 UTC 28 July 2008 in the innermost domain. Although the total amount of rain is not so significant (i.e., below 20 mm/h), the area of higher rainfall is concentrated locally and is around the upstream location of the Toga River. The rainfall distribution in Fig. 1 suggests that the steep and complex terrain features play a role in determining the location of rainfall. Regions with more organized and heavier rainfalls extend just north of the domain shown in Fig. 1. It is considered that the reason why the simulated rainfall is significantly smaller than the observed rain is due to the inappropriate propagation of rainfall. Not only the structure but also the propagation of extreme rain-producing storms should be properly represented in the model

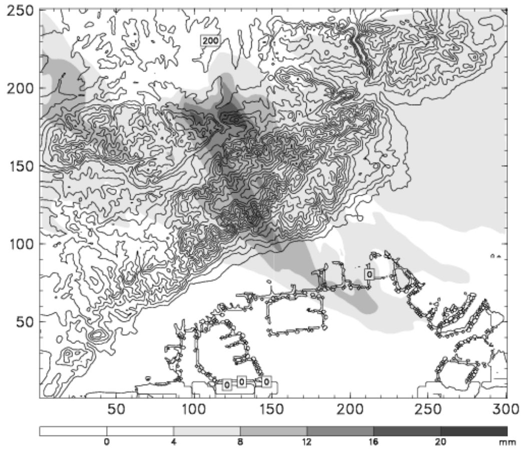

Fig. 1: The hourly rainfall (shaded) at 0500 UTC 28 July 2008 as well as the surface elevation (contoured) for the innermost domain (with 100-m grid). The numbers of the axes indicate the grid number.

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10. Influences of Cloud Microphysical Processes on Structure and Development of Tropical Cyclone Part II: Effects of evaporation from rain

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In the previous Workshop at Kyoto in the last year, we presented that cloud microphysical processes have large impacts on tropical cyclone development and structure, using idealized numerical experiments. Both of melting cooling from snow and evaporative cooling from rain delay the organization large-scale tropical cyclones particularly in the early developing stage. However, they give different impacts on the tropical cyclone size, i.e., the melting cooling reduces the tropical cyclone size, while the evaporative cooling significantly enlarges it. Such a difference arises from the formation of rain-bands. The evaporative cooling effectively form rain-band on the outside of the eye-wall. In the experiment without evaporative cooling, rain-bands almost disappear. The rain-bands generate large condensation heating of water vapor on the outside of the eye-wall and drive the secondary circulation greatly. The secondary circulation accelerates the inward transport of absolute angular momentum in the lower free-troposphere. The larger angular momentum results in the greater size of tropical cyclone as effects of centrifugal forcing. In this course, the rain-bands sustain the continuous development of tropical cyclone in the mature stage, although they prevent rapid development in early stage because of barrier effects of cold pools of air mass over the ocean.

The problem is how the evaporative cooling effectively form rain-bands. The evaporative cooling induces downdrafts due to large density in the area of heavy precipitation. The feedback from the downdrafts to precipitation is essential to the maintenance of rain-band. The downdrafts bring the cold air mass and form cold pools of air mass around the precipitation area over the ocean. The strong surface wind encounters the cold pool and forced updrafts cause heavy precipitation at outer and upstream edges of the cold pools. Again, the heavy precipitation induces downdrafts through the evaporative cooling. Furthermore, if the evaporative cooling is excluded, convective cells tend to move inward following the low-level inflows. It advances fronts of rain-bands outward and develop new convective cells at their upstream edges.

In conclusion, the evaporative cooling significantly enlarges size of tropical cyclone and continuously develops it in the mature stage through the formation of rain-bands. It must be expressed to predict tropical cyclones accurately.

11. Interaction between Tropical Convective Clouds and Ocean Mixed Layer Simulated by a High-Resolution Coupled Model

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The western tropical Pacific is a region characterized by high sea surface temperature (SST) and active convective clouds. Another distinct feature in this region is western wind bursts which are considered to play important roles on not only local weather but global climate. For example, they are recognized to control the life cycle of El Nino events, especially the onset process. Figure 1 shows the zonal component of surface winds along the equator derived from the NCEP2 reanalysis dataset. In year 2001, strong westerly winds occur several times, eventually leading to the onset of El Nino, while a wind burst blowing at the end of Nov. 2000 has no relation with the following event.

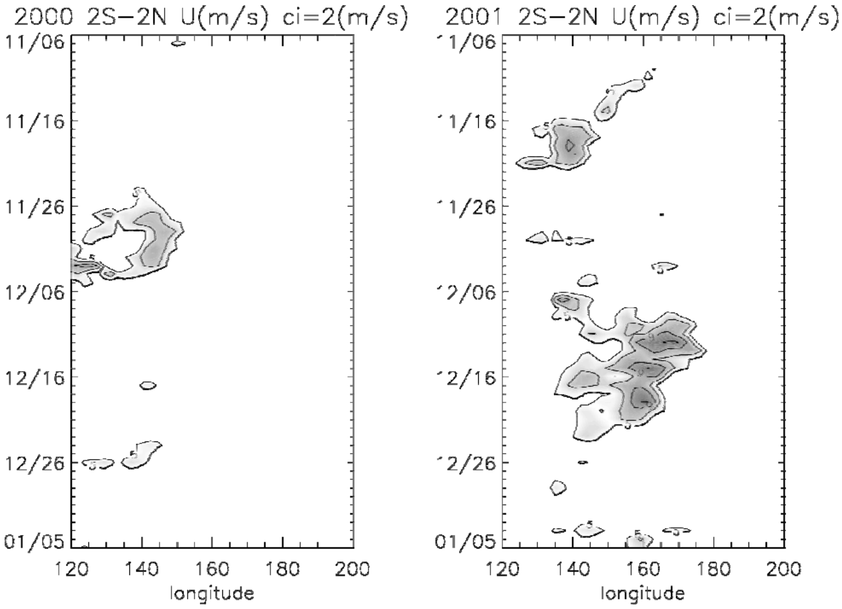

Fig. 1: Time series of zonal component of surface wind averaged over 2S-2N. Contour interval is 5m/s. (Left) Nov. 2000-Jan. 2001, (Right) Nov. 2001-Jan. 2002.

Recent studies pointed out that the air-sea interaction is a key issue for the generation and subsequent development of wind burst events. For example, the westerly wind burst events often occur in the region where SST is over 29 degree (Eisenman et al., 2006) corresponding to the vigorous evaporation range. However, such an active air-sea interaction process cannot be explained by talking into account the effect of SST alone. For the wind bursts events in year 2000 and 2001, there is no difference in SST between the onset of these two events. The vertical profiles of temperature, salinity and density derived from ocean reanalysis data (Masuda et al, 2007) are shown in Fig. 2. The significant difference in the vertical profiles between year 2000 and 2001 can be seen in surface salinity and sub-surface temperature. The mixed layer depth is shallower in year 2001 due to the surface low salinity and hence the warm barrier layer is formed between 30m and 50m. Our examination suggests that the formation of this warm barrier layer can affect the cloud activity through the air-sea interaction and ocean mixed layer processes. To understand the physical mechanism, we have carried out numerical experiments using a high-resolution atmosphere-ocean coupled model (Ishikawa and Satomura, 2009). As a result, active cloud convections taking place in the case with a warm barrier layer maintain much longer than in the case without a barrier layer, because the high SST condition is kept by the entrainment of subsurface warm water in the former case.

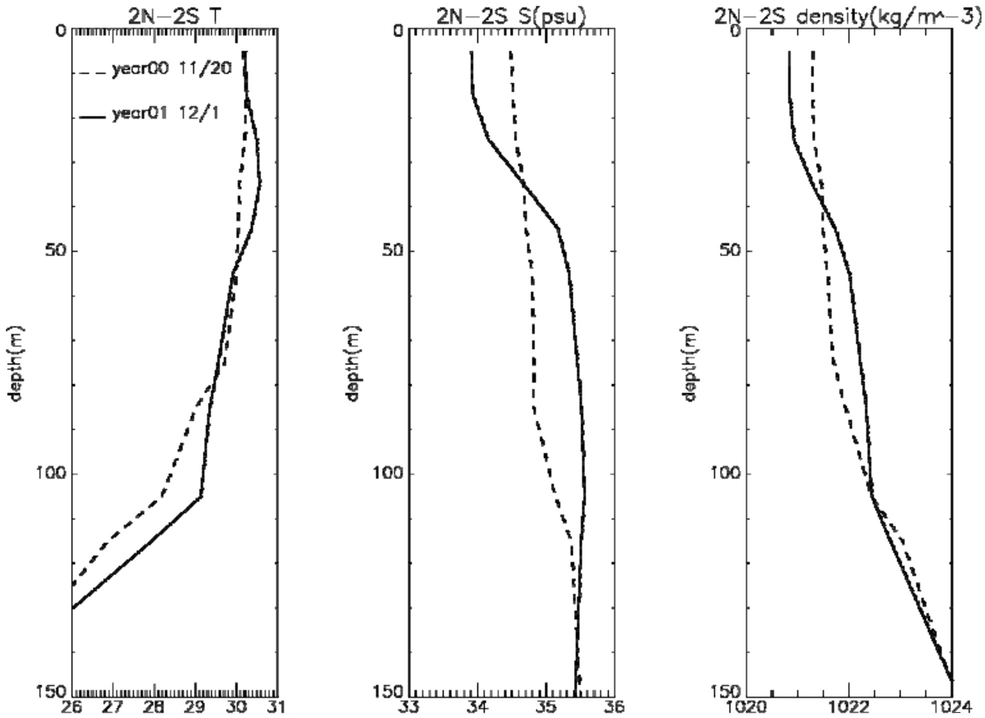

Fig. 2: vertical profile of (Right) Temperature, (Middle) Salinity, (Left) Density, at Nov. 20, 2000 (Dotted line), Dec. 1, 2001 (Solid line).

12. Sensitivity of Different Microphysics Parameterization Schemes to the Simulation of Mesoscale Convective Systems Observed over Gadanki, India

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National Atmospheric Research Laboratory (NARL), Gadanki (http://www.narl.gov.in) has very unique atmospheric observational systems like Mesosphere-Stratosphere-Tropsophere (MST) radar, Lidars, SODAR, GPS Sonde, Meteorological Tower, RASS and Automatic Weather Stations. Regular observations from these observational platforms are useful for assimilating into mesoscale models, validating physical parameterization schemes and to validate mesoscale forecasts/simulations. An atmospheric modeling group has been formed at NARL recently to undertake quality research on nowcasting of severe thunderstorms and quantitative precipitation forecasts with emphasis on data assimilation.

In this paper, we discuss the first results from the modeling group on the simulation of two mesoscale convective systems (MCS) observed at Gadanki, southern parts of India using the Weather Research and Forecasting (WRF) V3.0.1.1 model. For this purpose, we have considered two cases of MCS observed over the Gadanki area on 21 May and 24 September 2008. These systems caused heavy rainfall over Gadanki and neighbourhood during the evening of 21 May (25 mm) and 24 September (51 mm). The model configuration consisted of 3 two-way nested domains with 48, 12 and 3 km resolutions. The model simulations were initialized with the data of 1200 UTC of 20 May and 0000 UTC of 21 May for the first case and 1200 UTC of 23 September and 0000 UTC of 24 September for the second case. In addition, we have done data assimilation using observation nudging method with the observed data from AWS, wind profilers, MST radar, GPS sonde and satellite derived winds. The model was run for 36 hours to simulate the mesoscale events. Previous studies have shown that the choice of microphysical parameterization scheme can strongly influence the magnitude of predicted/simulated precipitation events. To examine the sensitivity of model simulations to the cloud microphysics, we have made simulations using different microphysical schemes. In addition, the model used the YSU planetary boundary layer, RRTM/Dudhia radiation, Noah land surface model and explicit cumulus convection in the innermost domain. The cloud microphysics schemes considered for the simulations are Thompson, Lin et al, Morrison, Kessler, Goddard and WSM6 schemes.

13. NHM Utilities for SE Asian NWP and Numerical Experiments of Myanmar Cyclone Nargis

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In the ‘International Research for Prevention and Mitigation of Meteorological Disasters in Southeast Asia’, to conduct experimental downscale NWPs in the tropics is the primary subject. In order to progress the project, several tools to execute the JMA Non-hydrostatic Model (NHM) in tropics have been developed, *e.g.,* utilities which convert JMA global model data to initial and boundary conditions of NHM. In this talk, at first, available data and relevant utilities to run NHM are explained. These tools enable us to conduct the investigation shown below.

On 27 April 2008 cyclone Nargis formed in the Bay of Bengal and made landfall on 2 May in southwestern part of Myanmar. The cyclone and the associated storm surge caused heavy human damages. If an appropriate warning was issued about 2 days before the landfall, the number of casualties might have been reduced drastically. In order to show the performance of the downscale NWP using NHM and JMA data, we performed a forecast experiment of Nargis.

We also simulated the storm surge with the Princeton Ocean Model (POM) using the NHM forecast data.

We conduct a regional forecast with NHM, using the JMA global analysis (horizontal resolution is about 20 km) as the initial condition and the GSM global forecast (horizontal resolution is about 50 km and valid time is every 6 hours) as the boundary condition. We also use the JMA global land surface analysis and JMA global SST analysis. These archived data are accessible for Southeast Asia researchers registered in this project. Using the utilities mentioned above, NHM is executed with a horizontal resolution of 10 km for a square region of 3400 km around the Bay of Bengal (Fig. 1).

Considering the lead time for waning, the initial time is set to 12 UTC 30 April, 2008. In the JMA analysis, Nargis was expressed as a weak depression of 999 hPa in the center of the Bay of Bengal, and its position was deviated eastwardly about 0.7 degree in longitude compared with the best track. After 42 hour (06 UTC 2 May), the depression developed to a 972 hPa cyclone and reached southwestern part of Myanmar in the NHM forecast (Fig. 1). Although this central pressure is weaker than estimated intensity of Nargis (Category 4), the value is much deeper than the GSM forecast (994 hPa). Cyclone landfall time in the NHM forecast was 6 hours earlier than the best track, and this is mainly attributable to the 0.7 degree positional lag in the initial condition mentioned above. Although the landfall point is deviated about 150 km northwardly than the best track, strong winds cover the southern part of Myanmar including the Irrawaddy and Yangaon Deltas. To investigate the impact of SST on track and intensity, we also conducted some sensitivity experiments, and the results will be shown in the presentation.

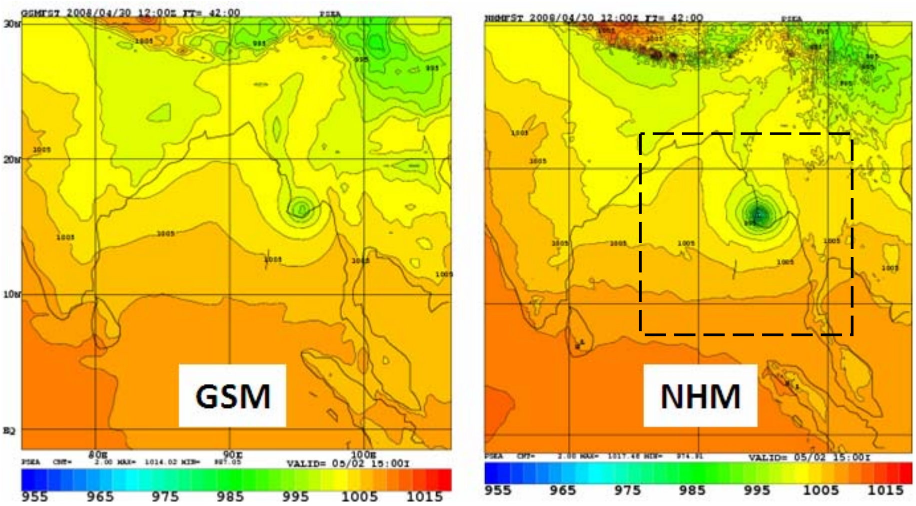

Fig. 1. Sea level pressure at 06 UTC 2 May 2008 (FT=42) predicted by GSM (left) and NHM (right). Figures show the domain of NHM and broken rectangle indicates the domain of POM.

14. Overview and Scientific Background of JEPP-HARIMAU Project: Long Coastlines of Maritime Continent Governing Global Climate

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The annual global energy and water balances of the earth's atmosphere are achieved by a zonal-mean rainfall peak of 2,000 mm/year around the equator, but it cannot be explained only by intertropical convergence zone (ITCZ) clouds which are quite inhomogeneous due to intraseasonal variations (ISVs). The Indonesian maritime continent (IMC) is known as the region of the most active convective clouds and their producing the largest rainfall on the earth, which mainly contributes to the equatorial rainfall peaks. This feature has been explained by the warmest seawater surrounding the IMC. Indeed, on one hand, if clouds are once generated, convection is developed spontaneously by so-called conditional instability, and larger evaporation from warmer sea surface may make more active convective cloud and larger rainfall. However, the largest rainfall does not occur over the open ocean. On the other hand, clouds must appear as a result of convection, which may be generated much easier on hotter land surface, but the largest rainfall does not occur on the true continent (Africa and South America). Thus the reason why the IMC has the rainfall peak has not yet explained well.

The earth's atmosphere covers both land and sea surfaces and interacts with them. If there are no lands, the solar heating determined only astronomically may induce global diurnal (tidal) and seasonal (hemispheric) oscillations, but the dominant atmospheric motions are ISVs in tropics and baroclinic waves in mid-latitudes. Because the heat capacity of land is smaller than of sea water, the solar heating is horizontally inhomogeneous also between land and sea surfaces, which induces local diurnal atmospheric oscillations (sea-land breeze circulations) and continental-scale annual oscillations (monsoons). In particular the local diurnal cycle near a coastline is the almost unique mechanism to generate convective clouds systematically near the equator almost free from any cyclone activities. An empirical formula between mean regional annual rainfall and coastline length divided by land area is obtained, which seems satisfied by several equatorial regions over the world. In consequence the longest coastlines of the IMC are essential to generate the most active clouds there.

The conclusion mentioned above implies that an observational network as well as a climate model needs to resolve the equatorial coastlines with a scale sufficiently smaller than 100 km. Such a high-resolution observation network may be possible by using meteorological radars and wind profilers. The Hydrometeorological ARray for Isv-Monsoon AUtomonitoring (HARIMAU), a 5-year bilateral project between Japan (represented by JAMSTEC under the Japan EOS Promotion Program (JEPP)) and Indonesia (hosted by BPPT) in order for contributing to the Global Earth Observation System of Systems (GEOSS), has begun in 2005 to set up a radar-profiler network for observing the world's most active convective activities over the IMC. This project is promoted bilaterally between the governments of Japan (represented by JAMSTEC) and Indonesia (BPPT). Until September 2008 we have installed five stations (one station in each of the five major islands: Sumatera, Jawa, Kalimantan, Sulawesi and Papua), as shown in Fig. 1. Rainfall and wind distributions are displayed in nearly real time on the internet. Significance and representability of wind observations over IMC have been examined in comparison with rawinsonde data and objective analysis.

Under the HARIMAU project both scientific understanding and practical concepts on the diurnal cycle and its interaction with ISVs and seasonal and interannual variations are being established. Scientific results include the rainy season (boreal winter monsoon) onset triggered by ISV, the diurnal (evening) rainfall enhancement by a cold surge, and so on. Capacity building to maintain the network and to apply it to meteorological prediction and atmospheric science is being planned by establishing an international center in Jakarta. By these activities the HARIMAU project has been nominated as one of the GEOSS early achievements demonstrated in recent summit meetings.

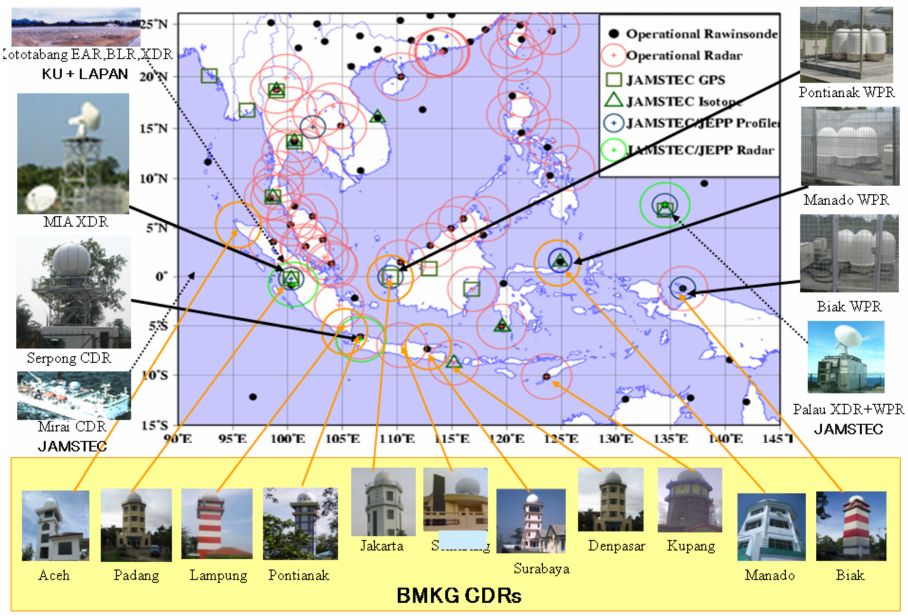

Fig. 1 The HARIMAU radar-profiler network (five stations), plotted with other related stations.

15. Ozone and Water Vapor Observations in the Equatorial Pacific

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Ozone and water vapor play crucial roles in chemical and radiative processes especially in the upper troposphere and the lower stratosphere (UT/LS). Ozone in the stratosphere shields us from the Sun's ultraviolet (UV) radiation, making life on Earth possible; that in the troposphere acts as a strong greenhouse gas and an environmental pollutant. Water vapor in the upper troposphere is a main emitter of the Earth's infrared radiation, controlling the Earth's radiative balance; that in the lower stratosphere affects the stratospheric ozone photochemistry and the recovery of the stratospheric ozone depletion. Due to lack of observational data, however, space-time variations of ozone and water vapor in the UT/LS region have not been well described yet.

The Soundings of Ozone and Water in the Equatorial Region/Pacific (SOWER/ Pacific) mission has been running campaigns since 1998 to improve our knowledge of ozone and water vapor distributions in the UT/LS in collaboration with international researchers, filling the gap of data sparse regions such as in the equatorial UT/LS. Ozone and water vapor sonde observations have been made at several places in the equatorial Pacific: the Galapagos Islands (Ecuador), Christmas Island, Tarawa (Kiribati), Watukosek, Bandung and Biak (Indonesia), including shipboard observations from research vessels.

In addition to the SOWER sonde observations in the equatorial Pacific region the Southern Hemisphere Additional Ozonesondes (SHADOZ) project has been providing ozonesonde data almost once-per-week at the maximum from 1998 to present at 13 regular ozone sounding stations. The primary scope of the SHADOZ project is to validate satellite observations by filling up the data sparse region of ozonesonde soundings especially in the tropics and subtropics.

By using these ozone and water vapor data, observational results on the variability with seasonal and interannual timescales will be presented, and their effects on the changes in atmospheric circulation and air quality will be discussed in this talk.

16. Towards a Mesoscale Observation Network in Southeast Asia

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The current weather observation network in Southeast Asia is unable to support the accurate monitoring and prediction of the region’s predominantly convective weather. Establishing a multi-sensor mesoscale observation network comprising automated in-situ instruments and atmospheric remote sensors (including weather radar) over land and exploiting weather satellite data especially over the sea would significantly improve the quantity and quality of data and benefit numerical weather prediction and tropical atmospheric science research. Several technical and organizational challenges need to be overcome in order to attain this goal. It is hoped that this article would motivate closer regional coordination in plans for developing infrastructure for atmospheric observation for weather research and forecast in Southeast Asia.

17. Trans European Information Network 3 (TEIN3) and Its Potential Use for the Weather and Climate Research in Southeast Asia

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The Trans European Information Network (TEIN) now became the third generation that we called TEIN3 Network. The TEIN3 network connected 11 countries among Asia and Europe. In Europe, this network connected to the Europe's GEANT2 network which is the biggest research network in the World. In every countries on Asia and Europe TEIN3 Network became a gateway to the National Research and Education Network (NREN) such as Inherent (Indonesia Higher Education Research Network) which is provided by the Directorate of Higher Education , Department of Education , Republic of Indonesia.

Since the TEIN network is beginning in 2005, The TEIN (TEIN2 and TEIN3) Network has been became enable for the researcher in the Asia and Europe. The TEIN3 network has a big capacity of the network in the southeast Asia, mostly they connected with 155 Mbps (STM-1) with the fiber optics in every countries. The high availability and reliability network for NREN are preferred for the researcher who needs the big capacity of the data transfer between Asia and Europe.

Several applications are running on the TEIN3 network, such as telemedicine, e-learning, and earth science (weather prediction). One of the examples is using TEIN3 network as test bed for the wireless sensor network containing temperature sensor, humidity sensor and connected using IPV6 network. The Wireless sensor is connected several countries in Asia and Europe. The network could be developed as a high reliability measurement of the monitoring the climate with put the weather sensor in each region such as put the weather sensor in Indonesia Area and connected to Inherent. And the data from Indonesia could deliver to the Southeast Asia country or Europe.

It is open for the researcher on the Asia and Europe especially in Southeast Asia Countries to collaborate with National NREN and using the TEIN3 network to deliver research data among the countries.

18. Application of GPS Radio Occultation (RO) Data for the Studies of Atmospheric Dynamics and Data Assimilation into Numerical Weather Prediction Models

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GPS radio occultation (RO) is an active limb-sounding satellite measurement, which provides an accurate temperature and humidity profile in the troposphere and stratosphere. The GPS RO is characterized by a good height resolution, comparable to a radiosonde, which is particularly valuable in the tropics and the southern hemisphere where routine balloon soundings are sparse. The GPS RO has recently been attracting close attention as an excellent remote-sensing technique to improve numerical weather prediction (NWP) models, to monitor global environmental changes, and to clarify the detailed behavior of atmospheric dynamics.

We are promoting a research project in Japan on utilization of GPS RO data in collaboration between universities, MRI of JMA, JAMSTEC and so on. In particular, three subjects are undertaken in the project: (1) development of retrieval algorithms for GPS RO data, (2) assimilation of GPS RO data into a meso-scale weather prediction model and (3) validation and scientific application of GPS RO data.

We will present in this paper data assimilation of GPS RO data into global and meso-scale weather prediction models at JMA, and the variations of the atmospheric wave activities along height, season, latitude and longitude.

19. Data Assimilation and Parameter Estimation to Improve Forecast Accuracy of Disastrous Weather Systems

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Accurate forecasting of disastrous weather systems (DWSs), including tropical cyclones, heavy rainfalls/snowfalls, convective storms, etc., relies mainly on numerical model and observations of adequate scales. Mesoscale/storm-scale meteorological models have widely been used to make predictions and detailed analyses of DWSs, which inherently include mesoscale and/or cloud scale features. Treatments in computational and physical processes have progressed significantly due to advances in modeling techniques, making high-resolution prediction feasible.

Observations, however, are not always available at desired scales, in both space and time, of specific DWSs. This can add uncertainty in initial conditions resulting in errors in numerical forecasts. To alleviate this problem, various observations from *in situ* and remote-sensing observing systems as well as conventional observations are utilized in numerical models. Incorporation of such data into model is achieved through *data assimilation* to produce dynamically-consistent optimal initial conditions. For example, dropwindsonde data collected inside and/or around tropical cyclones and assimilated into mesoscale models proved to improve typhoon forecasts. Derivative tools from some advanced assimilation techniques, such as adjoint, singular vector (SV), ensemble transformation Kalman filter (ETKF), maximum likelihood ensemble filter (MLEF), etc., can be used to identify targeting areas to reduce forecast errors when observations are enhanced therein.

Uncertainties in parameters of computational and physical processes in numerical models also bring about significant errors in forecasting DWSs. Optimal fitting of parameters to observations is called *parameter estimation*. This has been achieved mostly using the variational approach. Recently the genetic algorithm (GA) has been applied to improve forecast accuracy of a heavy rainfall event in Korea by optimally adjusting a parameter related to a convective parameterization.

It is demonstrated that forecast accuracy of DWSs can be improved through data assimilation and/or parameter estimation. Performance of those techniques will be discussed further in detail.

20. A Statistical Tropical Cyclone Rainfall Model for the Taiwan Area

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This presentation briefly summarizes a tropical cyclone (TC) rainfall climatology database for Taiwan and development of the TC rainfall climatology-persistence (CLIPER) model. The persistence component refers to using observed rainfall in the last few hours to forecast future rainfall. CLIPER then combines rainfall climatology and persistence with statistically optimized weightings for both components, and takes only the TC best tracks as input. This version of CLIPER for the Taiwan area is quite different from others such as that developed for Atlantic landfalling hurricanes particularly in terms of the rainfall database (in situ vs. satellite-estimated) used for climatology. For applications, the rain maps from CLIPER have a grid resolution of 1-2 km suitable for regional loss analysis and mitigation purposes.

Researches that improve the utilities of CLIPER are carried out in two directons. For the first one, binned distributions of hourly rainfall are examined and a power-law model is fitted to these distributions. The fitted model is fairly consistent with regard to TC rainfall or non-TC rainfall and is also similar for different years. By a simple statistical inversion method, random samples from this power-law model can be obtained and provide a stochastic component to replace the original persistence component in CLIPER. This replacement is useful for rainfall footprint analysis for simulated TC events in the absence of real rainfall observations.

Secondly, preliminary exploration of parameterization of the influence of topography in CLIPER was performed by considering the orographic lifting flux of moisture. A prescribed vortex circulation from a simple cyclone wind model that considers the TC position and maximum wind speed data in the TC best tracks as well as prescribed values of specific humidity were inputs to this moisture flux calculation. The estimated orographic rain depends on the direction of approach of a TC to Taiwan and its influence is greatest for the steepest slopes of the Central Mountain Range of Taiwan. Due to the assumption of perfect rain efficiency in the process of orographic lifting, overestimation of rainfall is generated in some areas, and methods to parameterize topographic effect properly into the CLIPER model will be disscussed.

21. Targeted Observation for Improving Tropical Cyclone Predictability – DOTSTAR and T-PARC

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Targeted observation to improve the tropical cyclone (TC) predictability is among one of the most important research and forecasting issues for TCs. To optimize the aircraft surveillance observations using dropwindsondes, targeted observing strategies have been developed and examined. The primary consideration in devising such strategies is to identify the sensitive areas in which the assimilation of targeted observations is expected to have the greatest influence in improving the numerical forecast, or minimizing the forecast error.

To gain more physical insights into several existing targeted techniques, studies to compare and evaluate the techniques have been conducted by Majumdar et al. (2006), Etherton et al. (2006), and Reynolds et al. (2007). As a follow-up work, and to highlight the unique dynamics features in affecting the TC tracks, in this paper we compare six different targeted techniques based on 84 cases of two-day forecasts of the Northwest Pacific tropical cyclones in 2006. The six targeted methods are total-energy singular vectors (TESVs) form European Centre for Medium-Range Weather Forecasts (ECMWF) and Navy Operational Global

Atmospheric Prediction System (NOGAPS), the TESV by Ensemble Prediction System (EPS) of Japan Meteorological Agency (JMA), the ensemble-transform Kalman-filter (ETKF) based on the multi-model ensemble members [ECMWF, National Centers for Environmental Prediction (NCEP) and Canadian Meteorological Centre (CMC)], the ensemble Deep-Layer Mean (DLM) wind variance by NCEP Global Forecast System (GFS), and the Adjoint-Derived Sensitivity Steering Vector (ADSSV) by Pennsylvania State University/National Center for Atmospheric Research fifth generation mesoscale model (MM5).

The similarities among the six products are evaluated using two objective statistical techniques to show the diversity of the sensitivity regions in large, synoptic-scale domains, and smaller domains local to the TC. It is shown that the three TESVs are relatively similar to one another in both the large and the small domains while the comparisons of the DLM wind variance to other methods show rather low similarities. The ETKF and the ADSSV usually show high similarity because their optimal sensitivity usually lies close to the TC. The ADSSV, relative to the ETKF, reveals more similar sensitivity patterns to those associated with TESVs.

Three special cases are also selected to highlight the similarities and differences between the six guidance products and to interpret the dynamical systems affecting the TC motion in the North western Pacific. Among the three storms studied, Typhoon Chanchu was associated with the subtropical high, Typhoon Shanshan was associated with the mid-latitude trough, and Typhoon Durian was associated with the subtropical jet. The adjoint methods are found to be more capable of capturing the signal of the dynamic system that may affect the TC movement or evolution than the ensemble methods.

Results from this work would not only provide better insights into the physics of the targeted techniques, but also offer very useful information to assist the targeted observations, especially for the Dropwindsonde Observations for Typhoon Surveillance near the TAiwan Region (DOTSTAR),Typhoon Hunting 2008 (TH08), and Tropical Cyclone Structure 2008 (TCS-08) in THORPEX-PARC (T-PARC), which have been successfully conducted in the summer of 2008.

Some highlights of the preliminary results from the targeted observations in DOTSTAR and T-PARC would also be presented in this workshop.

Appendix: DOTSTAR

The DOTSTAR (Dropsonde Observations for Typhoon Surveillance near the Taiwan Region) is an international research program conducted by scientists in Taiwan, partnered with scientists at the Hurricane Research Division (HRD) and the National Centers for Environmental Prediction (NCEP) of the National Oceanic and Atmospheric Administration (NOAA), Meteorological Research Institute/Japan Meteorological Agency (MRI/JMA), and Naval Research laboratory. This project marks the beginning of a new era for the aircraft surveillance of typhoons in the western North Pacific.

Built upon work pioneered at NOAA's HRD, the key to the project is the use of airborne sensors -- dropwindsondes, which are released from jet aircraft flying above 42,000 feet in the environment of a tropical cyclone. These sensors gather temperature, humidity, pressure, and wind velocity information as they fall to the surface. Information from the surveillance flights is transmitted in near real-time to the CWB of Taiwan, as well as to the NCEP, FNMOC, and JMA. The data are immediately assimilated into the numerical models of CWB, NCEP (AVN/GFDL), FNMOC (NOGAPS/COAMPS/GFDN), UKMET, and JMA. The DOTSTAR are expected to provide valuable data which can help increase the accuracy of TC analysis and track forecasts, to assess the impact of the data on numerical models, to evaluate the strategies for adaptive/targeted observations, to validate/calibrate the remote-sensing data, and to improve our understanding on the TC dynamics, especially over the TC’s boundary layer (Wu et al. 2005, BAMS).

On September 1, 2003, the first DOTSTAR mission was successfully completed around Typhoon Dujuan. NOAA remarked upon the successful collaboration in a press release. On November 2, the second mission was launched while the aircraft flew over the center of Typhoon Melor. Ten more flights have been conducted for Typhoons Nida, Conson, Mindulle, Megi, Aere, Meari, Nock-Ten and Namadel in 2004, with 193 dropsondes released. An average 20% improvement for the 12-72h track forecasts over the NCEP-GFS, FNMOC-NOGAPS, JMA-GSM, their ensembles, and the WRF model has been demonstrated (Wu et al. 2007, Wea. Fcsting). Seven flights have been conducted for Typhoons Haitang, Matsa, Sanvu, Khanun, and Longwang in 2005, five flights for Bilis, Kaemi, Bopha, Saomai, and Shanshan in 2006, four flights for Pabuk, Sepat, Wipha, and Krosa in 2007, and ten flights for Fengshen, Kalmaegi, Fung-wong, Nuri, Sinlaku, Hagupit, and Jangmi in 2008. In total, the DOTSTAR have conducted 38 surveillance flight missions for 31 typhoons, with 200 flight hours and 630 dropsondes released.

Multiple techniques have been used to help design the flight path for the targeted observations in DOTSTAR: (1) the area with the largest forecast deep-layer-mean wind bred vectors from the NCEP Global Ensemble Forecasting System at the observation time, (2) the Ensemble Transform Kalman Filter, which predicts the reduction in forecast error variance for all feasible deployments of targeted observations, and (3) the NOGAPS singular vectors that identify sensitive regions. Recently we have proposed a new theory (Wu et al. 2007, JAS) to identify the sensitive area for the targeted observations of tropical cyclones based on the adjoint model. By appropriately defining the response functions to represent typhoon’s steering flow at the verifying time, a unique new parameter, the Adjoint-Derived Sensitivity Steering Vector (ADSSV) has been designed to clearly demonstrate the sensitivity locations at the observing time. The ADSSV are being implemented and examined in DOTSTAR, as well as the hurricane surveillance program of NOAA’s Hurricane Research Division in the Atlantic in 2005 (Etherton et al. 2006, 27th Conf. on Hurr.). An inter-comparison study (Wu et al. 2009, MWR) had been conducted to examine the common feature and difference among all the different targeting techniques. Meanwhile, some better methods to combine the dropwindsonde data with the bogused vortex has also been examined in Chou and Wu (2007, MWR). Overall, the DOTSTAR has made significant impact to the typhoon research and operation community in the international arena.

With strong support from both CWB and NSC, we continue undertaking surveillance missions in 2006-2008. In particular, DOTSTAR participated the international THORPEX/PARC initiative under World Meteorological Organization (especially on the collaboration with the Japanese program, Typhoon Hunting 2008, TH08, as well as Tropical Cylcone Structure 2008, TCS-08). Joint flights among DOTSTAR, Falcon (DLR), P3 (NRL) and C130 (USAF) for Typhoons Nuri, Sinlaku, Hagupit, and Jangmi have been successfully conducted during T-PARC in the summer of 2008. The unprecedented data obtained would provide a great opportunity for the advance of the research on TC genesis, structure change, targeted observation, recurvature, and extratopical transition.

As the DOTSTAR research team continues to harvest important data and gain valuable experience, we believe that future typhoon observations will reach full maturity, enabling significant progress in both academic research and typhoon forecasting. It is hoped that DOTSTAR will shed light on typhoon dynamics, improve the understanding and predictability of typhoon track through the targeted observations, place the team at the forefront of international typhoon research, and make a significant contribution to the study of typhoons in the northwestern Pacific and East Asia region.

Some detailed information on DOTSTAR is available at
http://typhoon.as.ntu.edu.tw/DOTSTAR/English/home2_english.htm.

22. Ensemble Prediction of "SIDR" Cyclone over Bay of Bengal Using a High Resolution Mesoscale Model

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NCAR WRF model was used for numerical prediction of SIDR tropical cyclone over Bay of Bengal. WRF model developed at NCAR, USA is based non-hydrostatic dynamics and has the versatility to choose the domain region; horizontal resolution; interacting nested domains and with various options for the parameterization schemes of convection, planetary boundary layer, explicit moisture, radiation and soil processes. The model was designed to have three interactive two-way nested domains with resolutions at 90-30-10 km with the inner most domain covering the Bay of Bengal region. The initial conditions and the time varying boundary conditions were provided from NCEP and JRA-25 global analysis fields. The model was integrated with 8 different combinations of physical parameterization schemes with two cumulus parameterization schemes of Kain-Fritsch and Grell-Devenyi; two planetary boundary layer schemes of Mellor-Yamada-Janjic and Yonsei University and two cloud microphysics schemes of Lin and WSM3. An 8-member ensemble prediction of SIDR cyclone was produced from the different experiments. The model was integrated to produce 72 hour predictions and the vector track errors and intensity errors were computed through comparison with reports from India Meteorological Department.

SIDR had the life cycle during 11-16 November 2007 and attained intensity of 944 hPa and 115 knots and with a track towards northwest during 00UTC of 12 to 00 UTC of 13, then towards north up to 15 and then moved towards NNE with the landfall on Bangladesh coast. The model integrations were carried out starting from 00 UTC of 11, 12, 13 and 14 November 2007. The models could predict the landfall time at 18 UTC of 15 October coinciding with the observations and with vector track error of 150 km. However the model underestimated the intensity of the cyclone with the maximum attained wind speed of 72 knots. These results also indicate that the ensemble prediction of SIDR is better than individual experiments.

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23. Ensemble Forecast Experiment of Cyclone Nargis

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On 2 May 2008, cyclone Nargis made landfall in southwestern part of Myanmar and caused the worst natural disaster in the country which claimed more than one hundred thousand people by storm surge. This cyclone formed in the Bay of Bengal on 27 April 2008 and moved eastward while developing rapidly. Numerical simulations of Nargis and the associated storm surge have been performed by Kuroda and his coauthors in this proceeding. Storm surge about 3 m was simulated in their study despite a positional lag of the cyclone center of about 150 km. It is well known that magnitude of storm surge highly depends on the track and intensity of the tropical cyclone and the numerical weather prediction has inevitable forecast errors due to uncertainties of initial/boundary conditions and model dynamics/physics. Considering the destructive disasters caused by storm surge, the warning and measures should be issued and taken respectively preparing for the worst case scenarios. The ensemble forecast may present realistic spread of tropical cyclone tracks while current most ensemble prediction systems (EPS) for typhoon forecast are based on global models and their horizontal resolutions are not enough to simulate local storm surge. In this study, we conducted a mesoscale ensemble forecast of cyclone Nargis using a mesoscale model with a horizontal resolution of 10 km, and examined spread of simulated tide levels. Our simulation presents a prototype of core of a unified data base and decision support system to mitigate meteorological disasters in Southeast Asia.

A mesoscale EPS is developed to consider forecast errors in the storm surge forecast of cyclone Nargis. NHM with a horizontal resolution of 10 km is employed as the forecast model, which covers the Bay of Bengal and its surrounding areas by 341x 341 grid points. Hybrid-vertical coordinates with 40 stretched levels are used whose lowest level is located at 20 m AGL. These specifications are identical to the forecast experiment of Kuroda et al., and their simulation is adopted as the control run. Thus, JMA's high-resolution operational analysis at 12 UTC 30 April 2008 and the 6 hourly GSM forecast are used as the initial and boundary conditions of the control run. Initial and boundary perturbations are given by JMA's operational one-week EPS. Although the JMA's one-week EPS is conducted with a T213 (60km) L60 GSM, only 12 hourly low resolution (1.25 degrees) pressure plane (10 levels) forecast GPVs are available at MRI (and even at JMA) as the archived data. Incremental perturbations are extracted by subtracting the control run forecast from the first 10 positive ensemble members of JMA's one-week EPS, and are interpolated with time and space to the 6 hourly 10 km L40 initial and lateral boundary conditions for NHM. Since the highest level of the pressure plane forecast GPV is located at 200 hPa level and is lower than the model top of NHM (22 km), perturbations at highest 8 levels of NHM are extrapolated from the incremental perturbation at 32nd level assuming the perturbation becomes zero at the model top. Adding 10 negative members, 20 mesoscale ensemble perturbations are prepared in all, and the saturation adjustment is applied to all initial and lateral boundary conditions

Figure 1 (left) compares predicted tracks of Nargis by the control run and member p01 and m01 with the best track. Track of member m01 is predicted in south of the control run and closer to best track while member p01 is predicted too northerly. Control run and both p01 and m01 are all predicted in east of best track, which means these runs predicted the landfall time too early. Main reason of this discrepancy is attributable to the positional lag in initial condition of control run at FT=0. Right figure shows predicted tracks until FT=42 by all ensemble members. The center positions of Nargis are distributed in an elliptic area with 200-300 km distant from the control run. This spread of predicted positions is roughly comparable to the statistical errors of JMA's typhoon track forecast in northwestern Pacific at FT=48. The major axis of the ellipse is oriented along the direction of cyclone's movement, suggesting that Nargis's forecast was a case where timing of landfall was relatively difficult. Predicted positions of the cyclone center in member p02, m05, m09 and p10 were better than the control run, while the intensities were weaker than the control run. The predicted center pressures were between 972 and 985 hPa. Here, we show forecasts by member m01 and p02 in Fig. 2.

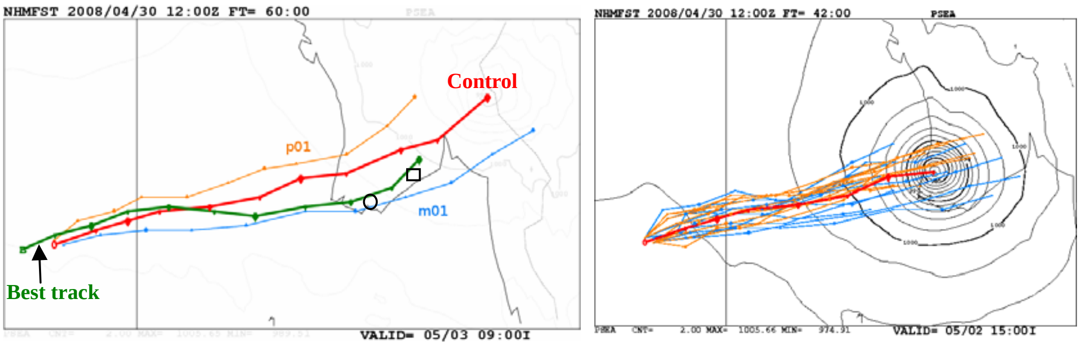

Fig. 1. Left: Right: Predicted tracks of Nargis until FT=60 (valid time 00 UTC 3 May 2008) by the control run (thick line) and the member p01 and m01. Corresponding best track is also indicated. Circle and square shows location of Irrawaddy and Yangon point, respectively. Right: Predicted tracks until FT=42 (valid time 06 UTC 2 May 2008) by the control run (thick line) and the ensemble prediction.

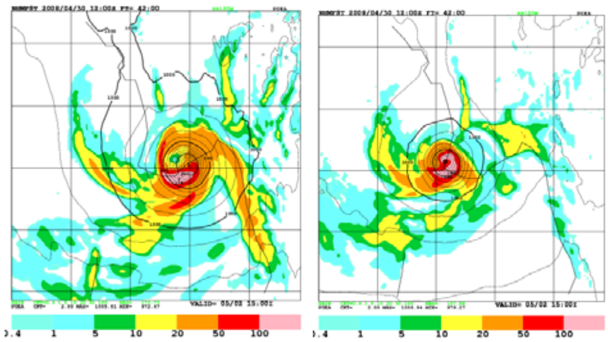

Fig. 2. Mean sea level pressure and 3 hour accumulated precipitation at FT=42 predicted by member m01 (left) and p02 (right).

Storm surge simulation is performed using surface wind forecasts by the mesoscale EPS. The Princeton Ocean Model (POM) is used with same specifications as in Kuroda et al.

Figure 3 shows time sequence of wind speeds, wind directions and tide levels predicted by all ensemble members at Irrawaddy (16.10N, 95.07E) and Yangon (16.57N, 96.27E) point. Wind speeds in some members have sharp minima in 2 May, corresponding to passage of the cyclone's 'eye'. At Irrawaddy point, tow members predict high tide levels near 4 m, while the timings are different from the control run. At Yangon point, where only moderate surge of 1.5 m was simulated in the control run, the maximum tide level reaches about 2.5 m. From the plume figures shown in Fig.3, we can compute the maximum, minimum and center magnitudes of tide levels with 25 % and 75 % probability values (Fig. 4). This result suggests that relying only on a single deterministic forecast is often dangerous. Quantitative information on forecast errors and reliability based on the ensemble prediction are very important for effective risk management, and will become indispensable in the future disaster mitigation system.

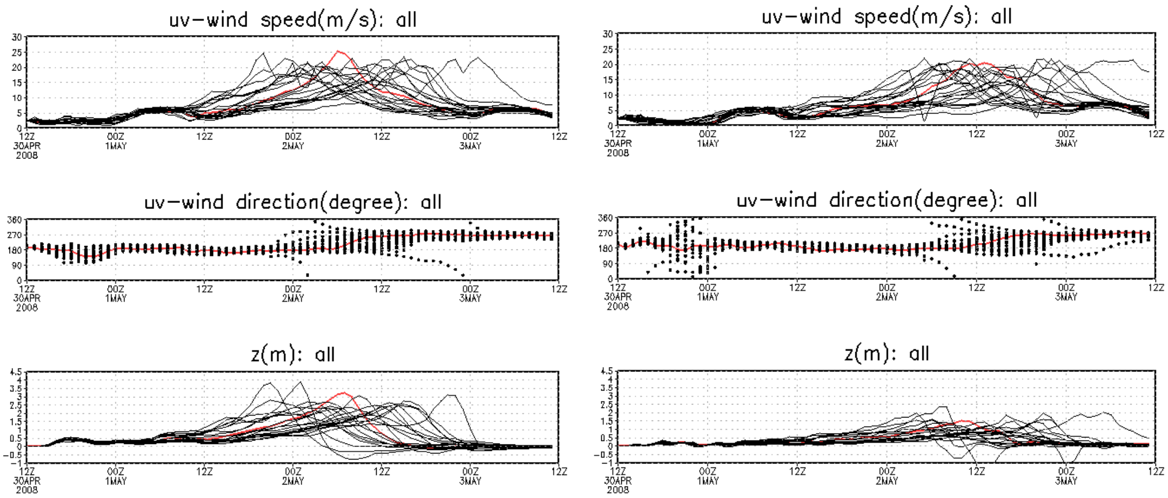

Fig. 3. Time sequence of wind speeds (upper), wind directions (middle) and tide levels (bottom) by all ensemble members at Irrawaddy (left) and Yangon (right) point.

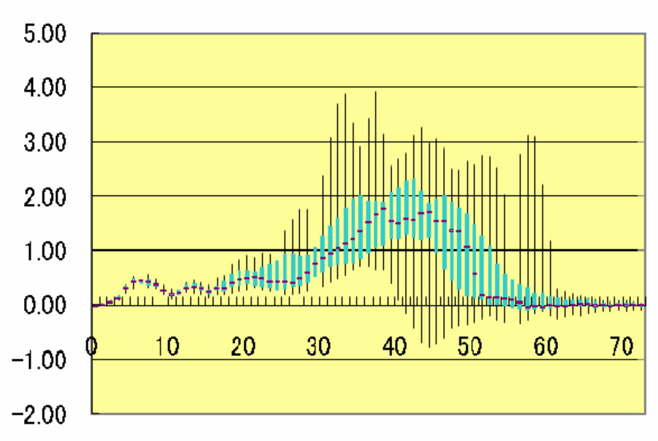

Fig. 4. Time sequence of the maximum, minimum and center magnitudes of tide levels at Irrawaddy point. Widths between 25 % and 75 % probability values are depicted with solid rectangles.

Acknowledgment: We thank Masaru Kunii of MRI and Nadao Kohno of JMA for their helps to run NHM and POM.

24. Estimation of Meteorological Hazards Using Output from Numerical Weather Prediction Model

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The major purpose of Numerical Weather Prediction (NWP) is, of course, issuing reliable and accurate weather forecasting. In addition, the outputs from NWM can be transferred to other computer modules to issue warning for some special meteorological disaster or to evaluate possible disasters. Such sub-modules which we call Disaster Evaluation Module (DEM) are, for example, wave prediction module and storm surge module for marine and coastal disasters, flood evaluation modules, landslide evaluation modules, high wind disaster estimation and the others (Fig.1).

The most straightforward way to evaluate marine and coastal disasters the surface wind vector and surface pressure computed by NWP are input to wave and storm surge model. The most recent wave model (e.g. SWAN, Simulating WAve Nearshore, http://www.wldelft.nl/soft/swan/) computes significant wave height, direction, phase speed etc. The storm surge model computes excess sea level height over astronomical tide using surface wind stress and surface atmospheric pressure. These results are displayed on a geographical map. In a more complicated structure in Fig.1, wave model and storm surge model dynamically interact with the NWP.

The NWP-predicted precipitation is input to catchment model which computes water discharge to river networks. The river model computes flow amount and/or water depth along the river network, and provides warning information for flood. There are several kinds of models in various complexities with different data requirement.

Recent developments at the DPRI, Kyoto Univ. are introduced.

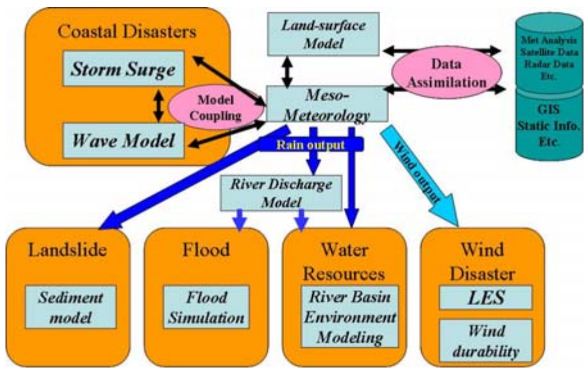

Fig. Relation of NWP with Disaster Evaluation Modules

25. Case Study: The Atmospheric Stability Indices and Applied GIS Risk Assessment Severe Thunderstorms in the Northeastern of Thailand

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Natural disasters come from thunderstorms are dangerous for life, property and economics of Thailand in every year. This experiment is to study the thunderstorms occurred in April of the Northeast of Thailand. The research performed experiment with the stability atmosphere from downscaling of numerical weather prediction products. The experiments were conducted by Weather Research Forecast (WRF) model version 3.0.1 to investigate the thunderstorms, and runs with grid resolution 15-km and 28 levels in the vertical. The technique used the weight factoring index by the stability indices as K index, Total-Total index and Convective Available Potential Energy (CAPE) to consider property thunderstorm input to the data based of geography information system (GIS) to analyze. Results showed display four classify levels of risk area of thunderstorms in a map: weak risk, moderate risk, strong risk and very strong risk. Therefore, the technology applied geographic information system (GIS) used to thunderstorms management then it can respond to the faster events of thunderstorms, and it can fixed area of thunderstorms with plot the area through villages in output of risk area map. Then, it can used to preparing and reduce of life and property from thunderstorms.
Key words: GIS, Thunderstorms Hazard Map

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26. Roles of High Resolution Weather and Climate Models in Disaster Risk Management at District Level

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27. On the Influence of the Tropical Intraseasonal Oscillation to the Predictability of the Pacific/North American Pattern

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It is important to reveal the predictability of the Pacific/North American (PNA) pattern which is one of the most dominant modes in the extratropical circulation of the boreal winter with the intraseasonal time-scale and hence crucially affects the prediction error of the hemispheric circulation. Recent observational study of Mori and Watanabe (2008) proposed a triggering mechanism of the PNA pattern by the tropical intraseasonal oscillation known as the Madden-Julian Oscillation (MJO). By the accompanied divergent winds near the Bay of Bengal, the anomalous convection with the MJO excites a Rossby wave train along the Asian jet stream, which in turn develops to the PNA pattern near the jet exit region. In this study, we examine the practical predictability of the PNA pattern in the boreal winter focusing upon the dependence of the predictability of the PNA pattern on the phase and the activity of the MJO. For this purpose, we analyze hindcast experiments conducted by the Japan Meteorological Agency during 10 years from 1992 to 2001.

The hindcast experiments were performed 3 times a month with 11 ensemble members for 40-day prediction time. The resolution of the model used in this experiment is spectral TL159 truncation in horizontal and 40 vertical level. The JCDAS/JRA-25 reanalysis datasets of the JMA are used to verify the forecast. To focus on the low-frequency variability in the boreal winter, we examine 7-day running averaged ensemble-mean predictions starting from November to March. The PNA pattern is defined as the first EOF of 500-hPa height field for a region of 120E-60W and 20N-90N. The associated principal component is referred to as PNA index.

Firstly, from the analysis on all (150) of the forecasts, it is found that the positive PNA pattern with cyclonic circulation anomaly over the north Pacific has better forecast skill compared with the positive PNA. The prediction error of the PNA index for the lead time shorter than 8 days becomes large when the active MJO is observed at the initial time of forecasts. The forecast skill of the PNA pattern also becomes worse when the active convective region associated with the MJO is observed over the Indian Ocean or the maritime continent.

Secondary, the predictability of the PNA pattern during its amplification stage is examined by extracting forecasts with the magnitude of the PNA index monotonically increasing until 9 days from the initial time of forecast. Then, it is found that the forecast skill of the PNA index crucially depends on the reproducibility of the Rossby wave trains along the Asian jet stream, consistent with the results of Mori and

Watanabe (2008). However, the Rossby wave train is not excited by divergent winds associated with the MJO near the Bay of Bengal, but is formed through the trap of another Rossby wave train propagating southeastward from Europe into the Asian jet stream over east Africa. Since the eastward prediction of the MJO is not well reproduced and the MJO tends to be stationary in the forecast, false divergent winds due to persistent convection over the Indian Ocean associated with the standing MJO in the prediction will obstruct the trapping of Rossby wave trains into the Asian jet. Thus, it is suggested that the reproducibility of the eastward propagation of the MJO is a key to understand the dependence of the forecast skill of the PNA pattern on the activity and the phase of the MJO.

28. Advance Prediction of Date of Onset of Monsoon: Dynamical Basis and Skill Evaluation

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A dynamical framework is considered for advance forecasting of Indian summer monsoon (ISM) which marks the beginning of the main rainy season for India; advance and accurate forecast of the day of the onset of monsoon (DOM) thus has application in many sectors. It is however, well known that the synoptic variability of (monsoon) rainfall has hardly any predictability at longer than a few days. Advance dynamical forecasting of DOM, is thus rarely attempted due to the poor skill of most GCM in predicting ISM rainfall. A primary cause for poor skill in forecasting parameters like rainfall appears to be the loss of predictability due to noise introduced by local synoptic processes. However, sharp transitions in the regional circulation pattern and associated rainfall, which are likely to be less affected by synoptic noise, may have higher predictability, somewhat similar to the way that monthly mean parameters are more predictable. We explore this premise for advance forecasting of onset of ISM over Kerala and show that significant skill is possible in advance forecasting of DOM. We use a global circulation model (GCM) with a special feature, variable resolution, to meet the special requirements of forecasting DOM. Based on a set of objective and validated criteria, hindcasts of DOM are generated in complete operational setting from a 5-member ensemble for each year for the period 1980 to 2003. Our results show that sharp and large-scale transitions have a certain degree of predictability even at long lead although day to day variability of rainfall may not be predictability at long-range.

29. Comparisons between Conformal Cubic Atmospheric Model (CCAM) and Global Forecasting System (GFS) Global Model Output over Indonesia in September – October – November (SON) 2008

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CCAM is an atmospheric global model based on Conformal Cubic grid and implementing Schmidt transformation for regional forecasting (downscaling) which developed by CSIRO, Australia. An effort to implement CCAM as a regional model in tropics area like Indonesia will be a new and an interesting research to test and accomplish, but firstly, it is important to see the performance of CCAM over Indonesia as global model without downscaling. In this research, CCAM uses an initial data from GFS (Global Forecast System) which is produced by NCEP-NOAA in every 6 hours; in this case uses 1° x 1° resolution and 24 vertical levels. When the initial data was produced, NCEP-NOAA was also produced global prediction up to 7 days in the future. GFS initial condition data was created by assimilation process of global observation data which is simulated by model, it means that it can be used as a real observation data and a control for validation.

In this research, it will be compared between the output of CCAM (C96) and GFS 1° resolution up to 7 days in the future. In running model and data post-processing, it uses 25 data samples of GFS initial condition data in SON 2008 as an input of CCAM which produced at 00 UTC. As a control for comparison, each prediction will be compared by a match GFS initial condition. Comparison was accomplished in spatially for some basic parameters such as MSLP, temperature, wind, relative humidity and geopotential height in several pressure vertical level. A general comparison was also analyzed for tropics area and northen and southern subtropics area around Indonesia.

Comparison results gives that the output of both models shows a similar pattern for tropics area in general, however by using a spatial correlation method, GFS prediction gives a better results compared by CCAM prediction for each parameter, for MSLP, a spatial correlation value of GFS prediction up to 7 days in the future ranging in 0.96 – 0.77 while CCAM ranging in 0.85 – 0.68. One of the possible causes of this problem is a different number of vertical levels which used by each global model, CCAM (C96) uses 18 vertical levels while GFS uses more levels. Nevertheless, fast speed in running model and less resources of machines and data storage of CCAM can be one of consideration for the use of global model CCAM in middle-range forecasting and as an input of regional model. It is also obtained for area around Indonesia, the performance of CCAM in subtropics area is better than in tropics area. Some analysis describes

for both GFS and CCAM results shows a similar equatorial pattern with pattern in SON season over Indonesia.

30. Data Assimilation of Precipitable Water Vapor Derived from GPS Network in Southeast Asia

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To assess the impact of water vapor information derived from a ground-based Global Positioning System (GPS) network in Southeast Asia, we performed assimilation experiments of near real-time (NRT) analysis precipitable water vapor (PWV). Experimental results using a mesoscale four-dimensional variational data assimilation system (Meso 4D-Var) show that the GPS derived PWV information has positive impacts on development of cyclone Nargis. This result encourages us to use GPS data to improve accuracy of weather prediction in Southeast Asia.

Water vapor is one of the most important parameters in weather monitoring and forecasting. The GPS can be a source of continuous data of water vapor. Several studies have confirmed that the accuracy of GPS derived PWV is comparable to those obtained by radio-sonde observations. The International GNSS Service (IGS) has been operating a continuous global network of ground-based GPS stations for GPS satellite tracking. In Southeast Asia, the observation density of the IGS network is sparse with about several hundred kilometers to several thousand kilometers (Fig. 1). Those data are accessible via IGS ftp server anonymously. Based on Shoji (2009), we performed a NRT GPS analysis for those IGS stations. Here, 'NRT GPS analysis' means retrieving PWV within several minutes after the observation to serve the numerical weather prediction (NWP).

Cyclone Nargis hit Myanmar on May 2, 2008 and caused a catastrophic disaster. In this study, we performed following four continuous assimilation experiments. Each experiment differs by assimilated observation data as follows:

(1) "CNTL": Conventional observations (radio-sonde, synop, ship, buoy, and aircraft), and wind, precipitation intensity and PWV field over the ocean

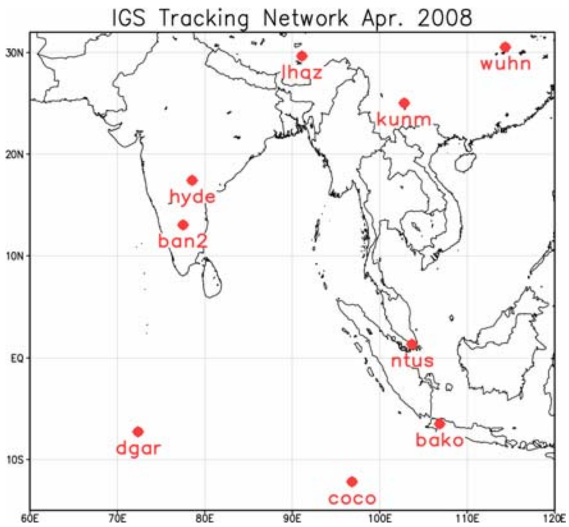

Fig. 1. Domain of the data assimilation experiment and IGS stations.

retrieved from satellite based micro wave scatterometer/radiometer. No tropical cyclone (TC) bogus is used in this experiment.

(2) "TCB": TC bogus data were added to CNTL.

(3) "GPS": GPS derived PWV were added to CNTL.

(4) "TCB+GPS": Both TC bogus and GPS derived PWV were added to CNTL.

Our target is to improve the forecast at initial time of 12 UTC 30 April 2008. In each experiment, we performed a pre-run of 12-hour sequential data assimilation from 00 UTC to 12 UTC of 30 April with three-hour assimilation windows. The JMA-nonhydrostatic model (Saito *et al*. 2007) with a horizontal resolution of 10 km (10km-NHM) was employed as the forecast model in the numerical prediction after the initial time and predicted cyclone track and intensity until 60 hours ahead.

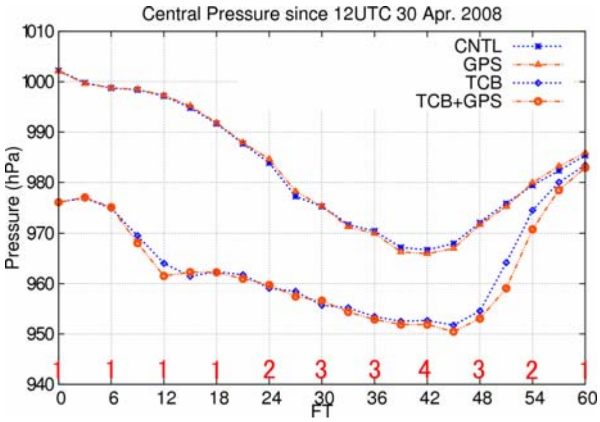

Fig. 2. Time sequence of cyclone category (red numerals above x-axis) and the predicted central pressures (line plots).

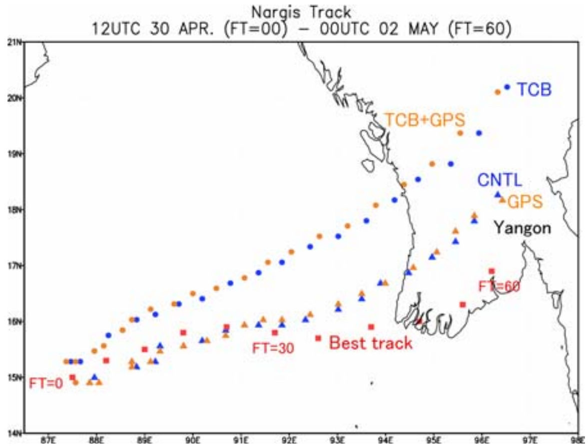

Fig. 3. Comparison of predicted cyclone tracks with the best track data.

Line plots in figure 2 show time series of predicted cyclone central pressure while red numerals represent Saffir-Simpson hurricane category stored in the Global Disaster Alert and Coordination System (GDACS: http://www.gdacs.org). Nargis reached category 4 at FT=42, and according to the GDACS data archive, maximum windspeed was 115 kt at that time. Therefore, order of 940hPa can roughly be expected for central pressure at FT=42. For prediction of cyclone development, TC bogus data has strong impact. "TCB+GPS" showed a similar result to "TCB", but predicted deeper pressure after the mature stage of the cyclone (FT35-FT60). Figure 3 compares predicted cyclone tracks. Using TC bogus ("TCB" and "TCB+GPS") resulted in northward bias on the cyclone track prediction. No large differences are seen between "CNTL" and "GPS".

These results are preliminary but suggest the potential of the GPS network in Southeast Asia. Further detailed design and results of the experiment will be discussed in the presentation.

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31. Impact of Local Data Assimilation On Short Range Weather Prediction in Indonesia: A Preliminary Result

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The need of a good weather prediction over South East Asia region is essential due to the significant intensity increasing of severe weather condition in this region lately. Within the fast urbanization and economic development, the weather prediction is needed to minimalize the impact of severe weather to human activity and infrastructure.

While a good weather prediction need a huge size of data, the rapid development of computer technology and internet service provide us with all we need to develop such weather prediction. Significant improvement in weather model and the ability to incorporate local data give us a chance to improve numerical weather prediction, particularly in tropical South East Asia region.

This research was conducted to asses the impact of data assimilation to the result of numerical weather prediction in Indonesia. Assimilation was conducted using three dimensional variational (3DVar) method with Automatic Weather Station (AWS) and Global Positioning System – Precipitable Water (GPS-PW) data. Weather Research and Forecasting – Advanced Research WRF (WRF-ARW) model was used to perform dynamical downscaling of global numerical model output, with and without data assimilation (control run). The global model output was obtained from National Center for Environmental Prediction – Global Forecast System (NCEP-GFS) through the internet. Prediction was conducted in 3 schemes, first without data assimilation (CTL), second with assimilation of AWS data (DA1), and the third with assimilation of AWS data plus GPS-PW (DA2). For each scheme, downscaling was carried out up to 48 hour lead-time prediction. Results from hindcast experiments during the period of 21-27 February 2008 were then validated by comparing with satellite imagery and AWS data.

It is found that, in general, the prediction using WRF model was able to reproduce the observed atmospheric diurnal variation. However, data assimilation could not yet improve the accuracy of predicted temperature, relative humidity and wind because improvement was caused primarily by dynamical downscaling process (fig. 1 and 2).

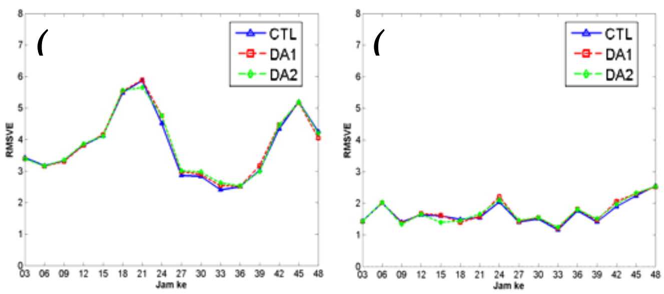

Fig. 1 Comparisons of wind prediction RMSVE (Root Mean Squared Vector Error) between control run (CTL), assimilation of AWS data (DA1) and assimilation of AWS data plus GPS-PW (DA2), at domain 1. (a) Comparison at station Cilacap and (b) comparison at station Lampung Barat.

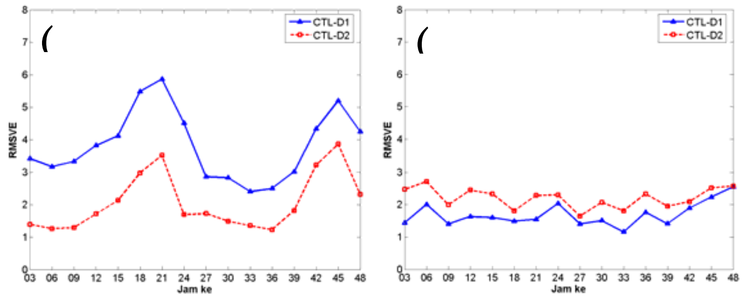

Fig. 2 Comparisons of wind prediction RMSVE (Root Mean Squared Vector Error) between control run at domain 1 (CTL-D1) and control run at nest domain or domain 2 (CTL-D2). (a) Comparison at station Cilacap and (b) comparison at station Lampung Barat.

Nevertheless, the effect of data assimilation was noticable in the improvement of rainfall prediction. The calculated prediction skill scores indicate that the use of GPS-PW data was, in particular, able to slightly improve rainfall prediction (fig. 3). But compared to the result from domain 1, threat score prediction of domain 2 is lower than domain 1. This would need further investigation by doing assimilation on nested run.

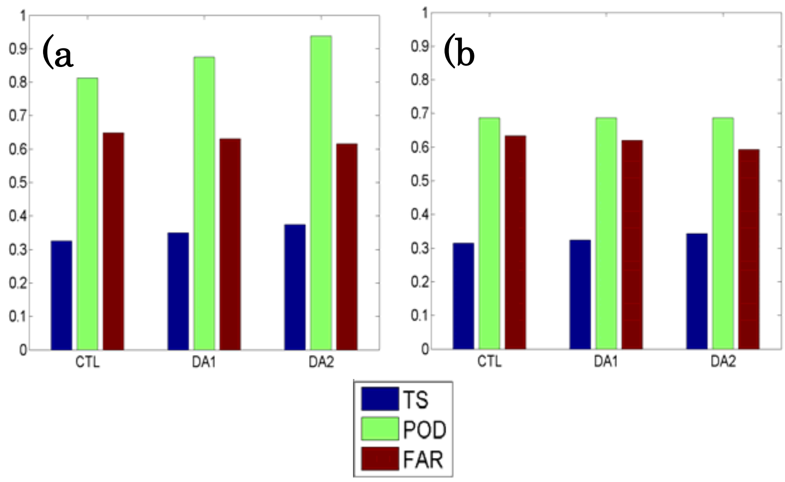

Fig. 3 Comparisons of threat score (TS), probability of detection (POD) and false alarm ratio (FAR) between control run (CTL), DA1 and DA2 for rain prediction at lead time 12 hour over West Java. (a) Prediction result from domain 1. (b) Prediction result from domain 2.

It seems that the number of AWS and GPS stations was still too insignificant to improve the accuracy of prediction through the application 3DVar data assimilation method. Even so, there is another chance to investigating further using different method or using a lot more observation that available nowdays.

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Ⅵ．学会等における口頭・ポスター発表

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ベンガル湾周辺のサイクロン（1）その特徴と被害 (ポスター)	林泰一，三浦優利子，宮本佳明，石川裕彦	日本地球惑星科学連合 2008 年大会（千葉）	2008 年 5 月 26 日	国内
ベンガル湾周辺のサイクロン-２．FY2C で見る 雲画像 (ポスター)	林泰一，石川裕彦，奥勇一郎	日本地球惑星科学連合 2008 年大会（千葉）	2008 年 5 月 26 日	国内
GPS で気温プロファイルを測る : GPS 電波掩蔽法 (口頭)	津田敏隆	第 14 回日本気象学会中部支部公開気象講座（名古屋）	2008 年 8 月 25 日	国内
Gfdnavi を用いた気象災害判断支援システムの試作(口頭)	西澤誠也，余田成男	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
南アジアにおけるメソ気象擾乱の研究の動向 (口頭)	林泰一	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
Nargis アンサンブル予報による高潮シミュレーション(口頭)	斉藤和雄	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
東南アジア域における領域同化実験 (口頭)	國井勝	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
NHM を用いて再現したムンバイ豪雨 (口頭)	瀬古弘	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
地上 GPS 全球リアルタイム解析と同化実験計画 (口頭)	小司禎教	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
メソ解析に表現された台風の構造と台風ボーガス(口頭)	上野充	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
外部公開データを利用した熱帯域 NHM 実行のための環境整備と Nargis の再現/予報実験 (口頭)	黒田徹，斉藤和雄，國井勝，高野洋雄	「東南アジア地域の気象災害軽減国際共同研究」第 2 回国内ワークショップ（つくば）	2008 年 9 月 10 日	国内
アンサンブルベースの 4 次元変分法 (口頭)	石川洋一、淡路敏之	2008 年度日本海洋学会秋季大会 (呉)	2008 年 9 月 27 日	国内
MJO が PNA パターンの予測可能性に及ぼす影響 (口頭)	向川均・林麻利子	研究会「長期予報と大気大循環」(東京)	2008 年 10 月 2 日	国内
GPS 掩蔽の気温データを用いた成層圏における大気波動の特性に関する研究 (口頭)	津田敏隆，Alexander Simon，河谷芳雄，高橋正明	第 124 回地球電磁気・地球惑星圏学会（仙台）	2008 年 10 月 9-12 日	国内
MJO が PNA パターンの予測可能性に及ぼす影響 (口頭)	向川均・林麻利子	平成 20 年度「異常気象と長期変動」研究集会 (宇治)	2008 年 10 月 31 日	国内
ラオスの気象レーダーを用いたビエンチャン近郊の降水特性につい てー続報ー (口頭)	山本恵子・里村雄彦	日本気象学会 2008 年度秋季大会（仙台）	2008 年 11 月 19-21 日	国内
z 座標系超高解像度メソ気象モデルの開発	山崎弘恵・里村雄彦	日本気象学会 2008 年度秋季大会	2008 年 11 月	国内

(口頭)		（仙台）	19-21 日	
非静力学モデルで再現したムンバイ豪雨 (口頭)	瀬古弘，林修吾，國井勝，斉藤和雄	日本気象学会 2008 年度秋季大会（仙台）	2008 年 11 月 19 日	国内
2007 年 11 月 15 日バングラデシュを襲ったサイクロン"Sidr" (口頭)	林泰一，村田文絵，橋爪真弘，M. N. Islam	日本気象学会 2008 年度秋季大会（仙台）	2008 年 11 月 21 日	国内
インド亜大陸北東部におけるプレモンスーン・モンスーン期の降水強度と降水量の日変化 (口頭)	林泰一，寺尾徹，M. N. Islam，村田文絵，山根悠介	日本気象学会 2008 年度秋季大会（仙台）	2008 年 11 月 21 日	国内
バングラデシュのプレモンスーン期シビアローカルストーム発生日における南アジア行きでの環境パラメータの空間分布について (口頭)	林泰一，山根悠介，木口雅司，江口菜穂	日本気象学会 2008 年度秋季大会（仙台）	2008 年 11 月 21 日	国内
バングラデシュとその周辺における雲システムの特徴 (口頭)	林泰一，津島俊介	日本気象学会 2008 年度秋季大会（仙台）	2008 年 11 月 21 日	国内
ミャンマーサイクロン Nargis の予報実験と高潮シミュレーション (口頭)	黒田徹，斉藤和雄，國井勝，高野洋雄	日本気象学会 2008 年度秋季大会（仙台）	2008 年 11 月 21 日	国内
次世代超高解像度メソ気象モデルの開発(口頭)	山崎弘恵・里村雄彦	第 10 回非静力学モデルに関するワークショップ（名古屋）	2008 年 11 月 27-28 日	国内
ミャンマーサイクロン Nargis のアンサンブル予報実験と高潮シミュレーション (口頭)	斉藤和雄，黒田徹，國井勝、高野洋雄	第 10 回非静力学モデルに関するワークショップ（名古屋）	2008 年 11 月 27 日	国内
強風状況下の海面フラックスについて ～台風の強度に対する感度実験及びアジョイント法による推定手法～ (口頭)	伊藤耕介，石川洋一，淡路敏之	第１０回非静力学モデルに関するワークショップ(名古屋)	2008 年 11 月 27 日	国内
熱帯域と日本域における 20km 解像度 NHM と WRF-ARW の統計的予報精度検証 (口頭)	林修吾，荒波恒平，斉藤和雄	第 10 回非静力学モデルに関するワークショップ(名古屋)	2008 年 11 月 28 日	国内
非静力学モデルで再現したムンバイ豪雨 (口頭)	瀬古弘，林修吾，國井勝，斉藤和雄	第 10 回非静力学モデルに関するワークショップ(名古屋)	2008 年 11 月 28 日	国内
ベンガル湾のサイクロン災害 (口頭)	林泰一，村田文絵，三浦優利子，奥勇一郎，山根悠介，津島俊輔	第 20 回風工学シンポジウム（東京）	2008 年 12 月 3 日	国内
ミャンマーサイクロン Nargis の予報実験と POM による高潮シミュレーション(口頭)	黒田徹，斉藤和雄，國井勝，高野洋雄	平成 20 年度京都大学防災研究所一般共同利用研究集会(宇治)	2008 年 12 月 18 日	国内
インド亜大陸北東部の気象と人間活動 (口頭)	林泰一	防災研究所＋生存圏研究所「気象災害軽減など人間活動の持続可能性に関する研究集会－南アジア地域を中心として」(宇治)	2009 年 1 月 29 日	国内
熱帯季節内振動が PNA パターンの予測可能性に及ぼす影響(口頭)	向川均・林麻利子	平成 20 年度防災研究所年次研究発表会(京都)	2009 年 2 月 25 日	国内