Goal 2: Development of a regional cloud-resolving ensemble analysis and forecast systems (領域雲解像アンサンブルシステムの開発と検証)

Meteorological Research Institute,
Japan Agency for Marine-Earth Science and Technology,
Japan Meteorological Agency,
Tohoku University,
Kobe University,
Disaster Prevention Research Institute, Kyoto University, etc.

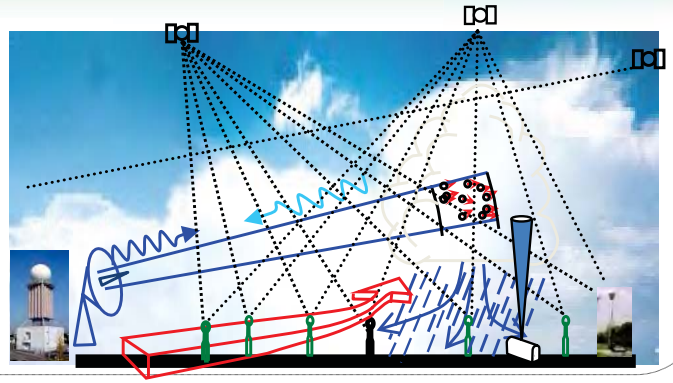
Research subject ②:Super high performance mesoscale NWP
（超高精度メソスケール気象予測の実証）

SPIRE Field 3

1) Development of cloud resolving 4DDA systems
（領域雲解像4次元同化技術の開発）

- feasibility of dynamical prediction of local heavy rainfall in very sort range forecast

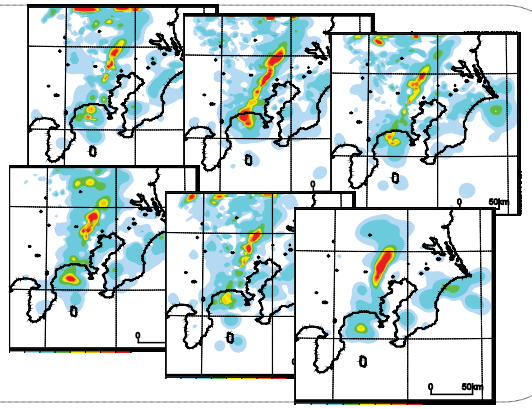
MRI, JAMSTEC, DPRI/Kyoto Univ., NIED, ISM



2) Development and validation of a cloud resolving ensemble NWP system
（領域雲解像アンサンブル 解析予報システムの開発と検証）

- quantitative prediction of the probability of local heavy fall with a lead time to disaster prevention

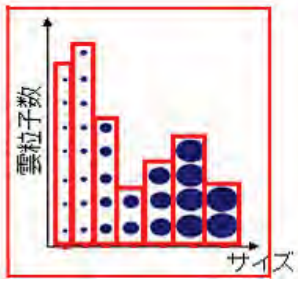
JAMSTEC, MRI, JMA, Tohoku Univ., DPRI/Kyoto Univ.



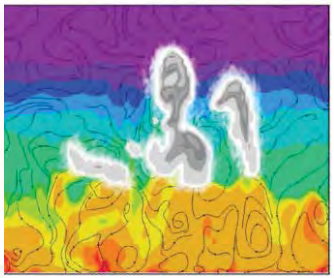
3) High performance atmospheric model
（高精度領域大気モデルの開発とそれを用いた基礎研究）

- Evaluation of model's uncertainty through super high resolution numerical experiments using LES and/or BIN models

JAMSTEC, MRI, Tokyo Univ., Nagoya Univ., DPRI/Kyoto Univ., etc.



Bin



LES

Goal 2: Development of a regional cloud-resolving ensemble analysis and forecast systems
（領域雲解像アンサンブル解析予報システムの開発と検証）

SPIRE Field 3

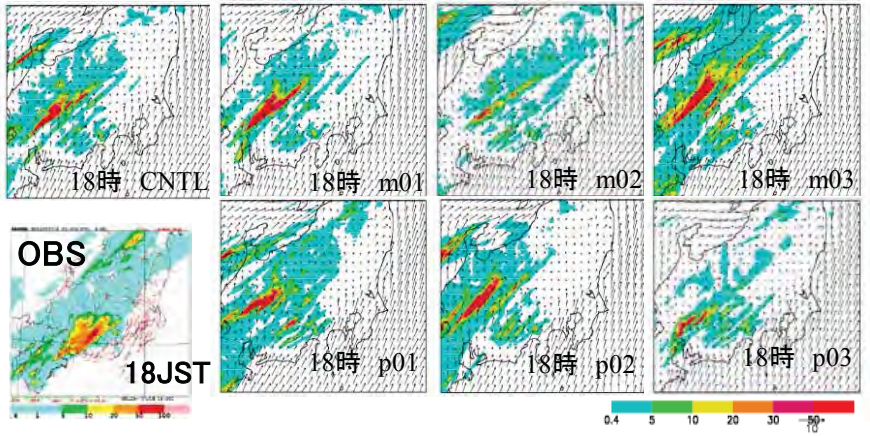
Goal2: Development of a regional cloud-resolving ensemble analysis and forecast systems

Conduct probability forecast of torrential rainfalls less than half-day earlier , while specifying the occurrence time, location and intensity using the cloud resolving ensemble forecasts.

第2目標：領域雲解像アンサンブル解析予報システムの開発と検証

雲解像アンサンブル予報により、集中豪雨の半日以上前の予測を、時間・場所・強度を特定して確率的に行う。

気象研究所・海洋研究開発機構・東北大学・京都大学・神戸大学・数値予報課



格子間隔2kmの降水分布(一部)

Goal 2: Development of a regional cloud-resolving ensemble analysis and forecast systems
（領域雲解像アンサンブル解析予報システムの開発と検証）

SPIRE Field 3

- Forecasts with probability are desired because it is difficult to predict severe events (予測が困難な顕著現象の確率予報).
- Ensemble prediction is also expected to reduce the miss rate of their forecasts because they provide many scenarios of severe phenomena（見逃しの減少への期待）.

- The ensemble forecast systems are under development using the K-computer, and then applied to several phenomena such as heavy rainfalls（京でアンサンブル予報システム開発、豪雨に適用）.
- The outputs of ensemble forecasts have been used as input data of flood and landslide predictions in this project（アンサンブル予報の出力を洪水モデルや土砂災害モデル等への適用）.

Goal 2: Development of a regional cloud-resolving ensemble analysis and forecast systems
（領域雲解像アンサンブル解析予報システムの開発と検証）

SPIRE Field 3

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Results of the ensemble forecast systems and the applications using the outputs of ensemble forecasts, which will be not present in the following talks of this session, are shown briefly （Web等で紹介している成果や、時間の都合等で今回の研究会で発表できない成果を紹介します）.

Goal 2: Development of a regional cloud-resolving ensemble analysis and forecast systems
（領域雲解像アンサンブル解析予報システムの開発と検証）

SPIRE Field 3

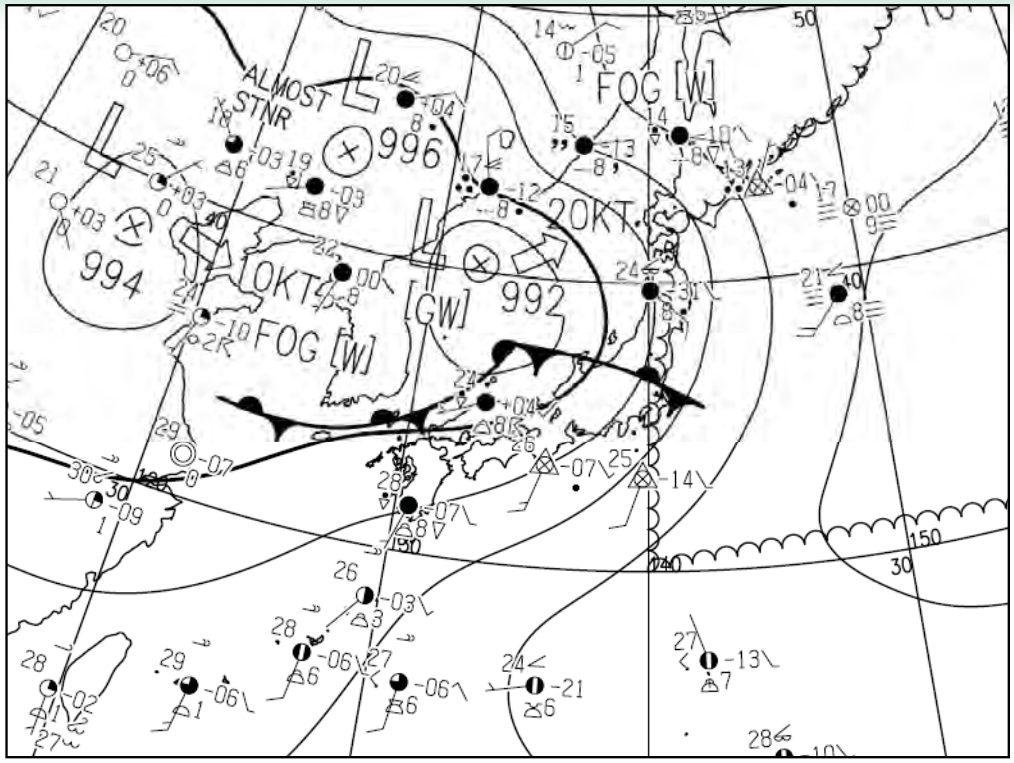
Leading products

- Northern Kyushu heavy rainfall in July 2012
  （2012年の九州北部豪雨の再現実験）
- Simulation of Sea breeze
  （海風侵入のシミュレーション）
- 1000 member’s ensemble forecasts
  （1000メンバーのデータ同化実験）
- Data assimilation and storm surge experiments
  （サイクロンナルギスの高潮のアンサンブル予報）

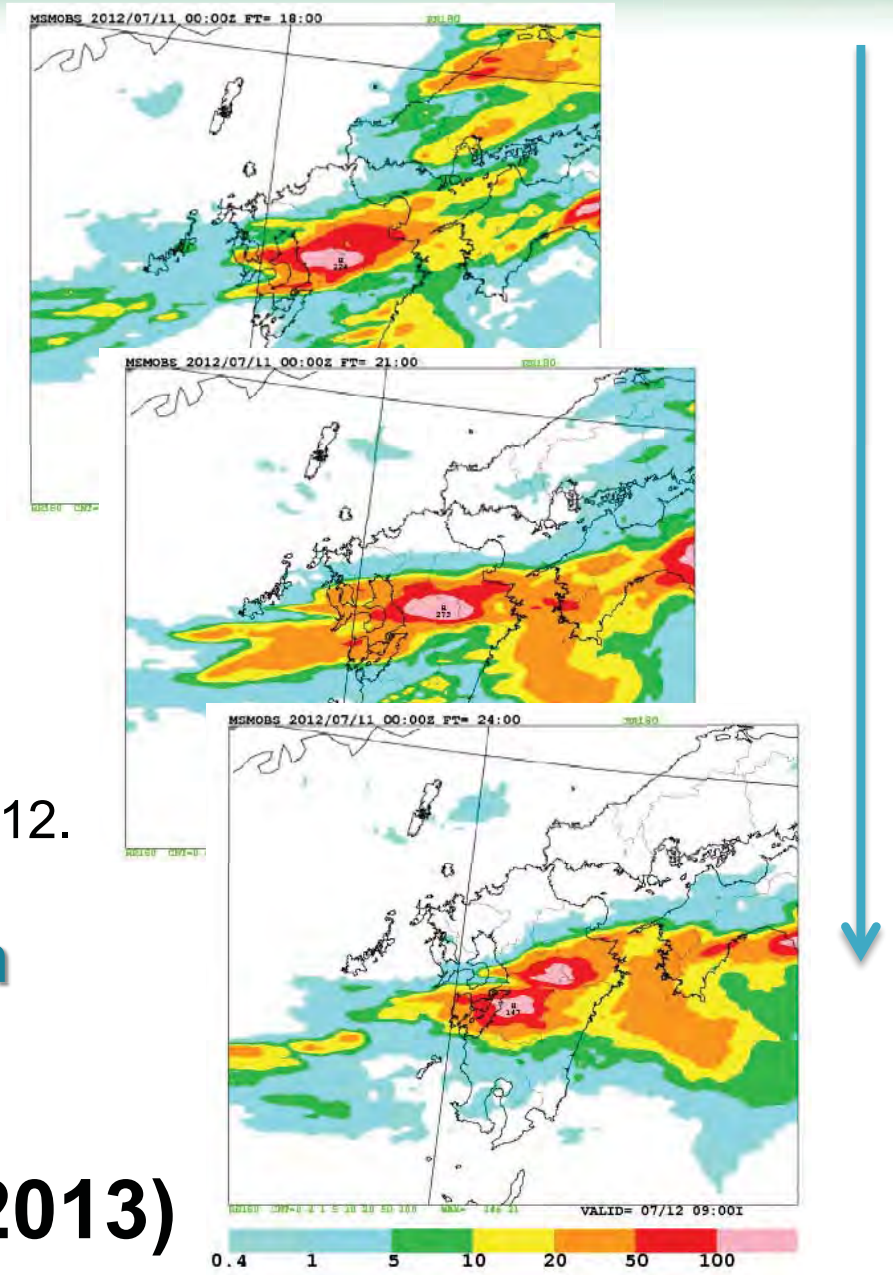
Northern Kyushu heavy rainfalls in July 2012
（2012年の九州北部豪雨の再現実験）

SPIRE Field 3

3-h accumulated rainfall (OBS)



Surface weather map on 1800 UTC 11 July 2012.



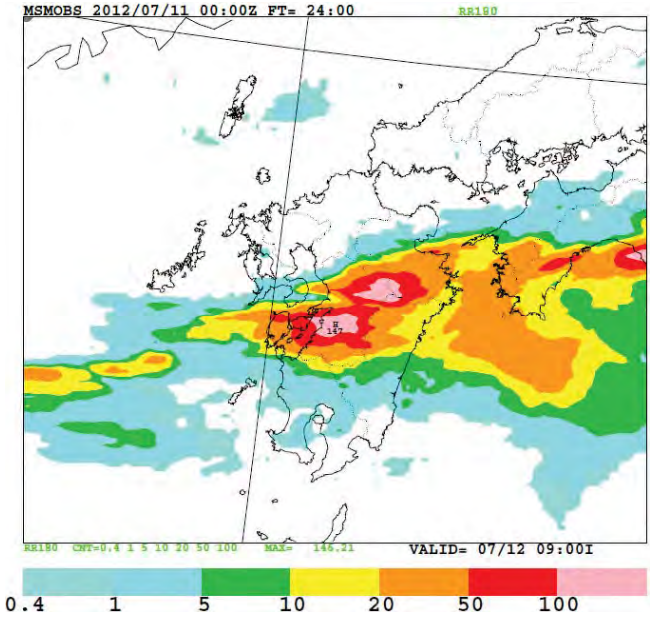
Rainfall totals reached as much as 800 mm over 5 days.

(Kunii, 2013)

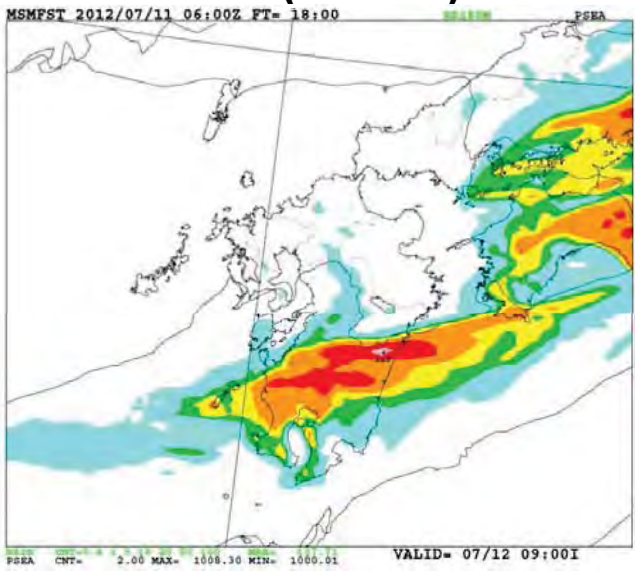
Forecast results (FT=18)

SPIRE Field 3

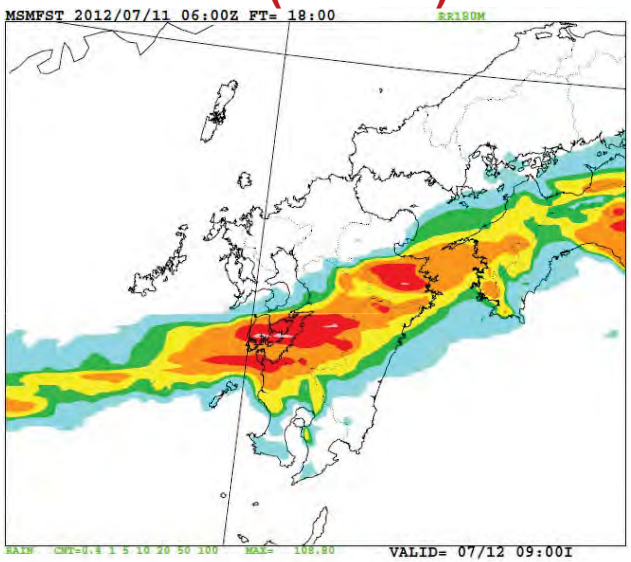
OBS



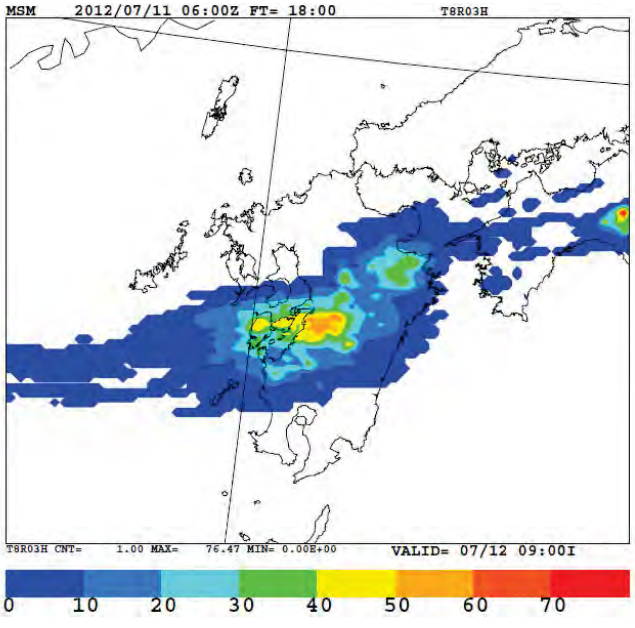
MSM (JNoVA)



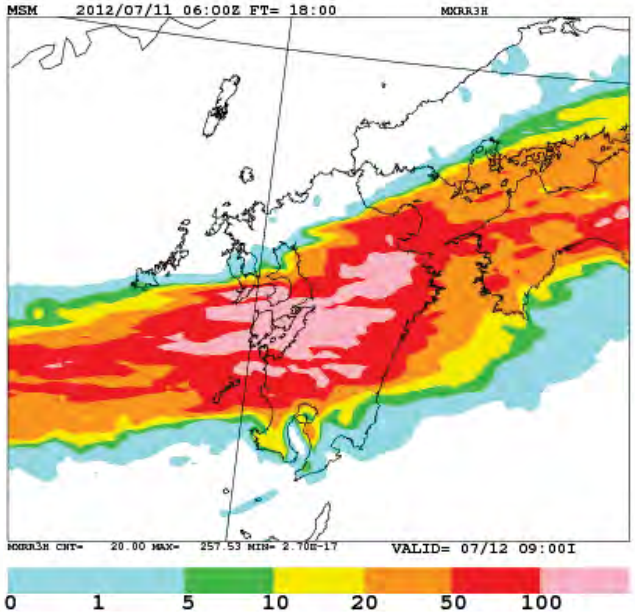
MSM (LETKF)



POP > 50mm/3h



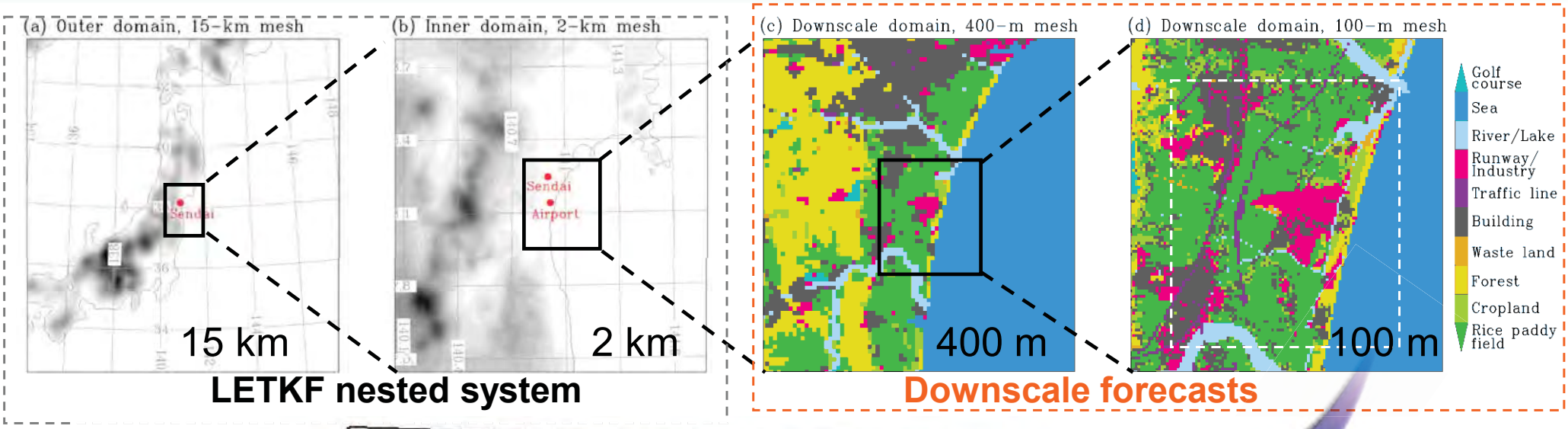
Maximum

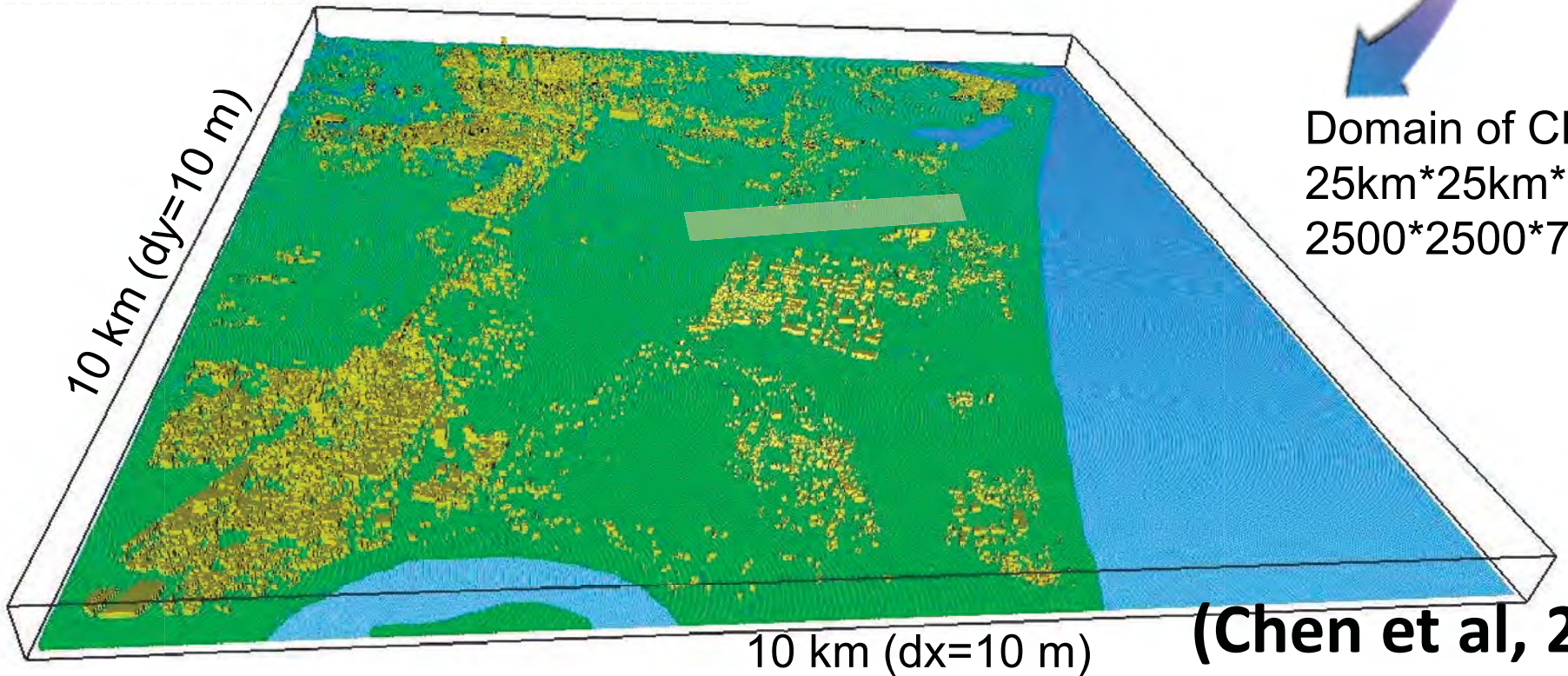


These information would contribute to decision-making process.

(Kunii, 2013)

Simulation of Sea breeze
(海風侵入のミュレーション)

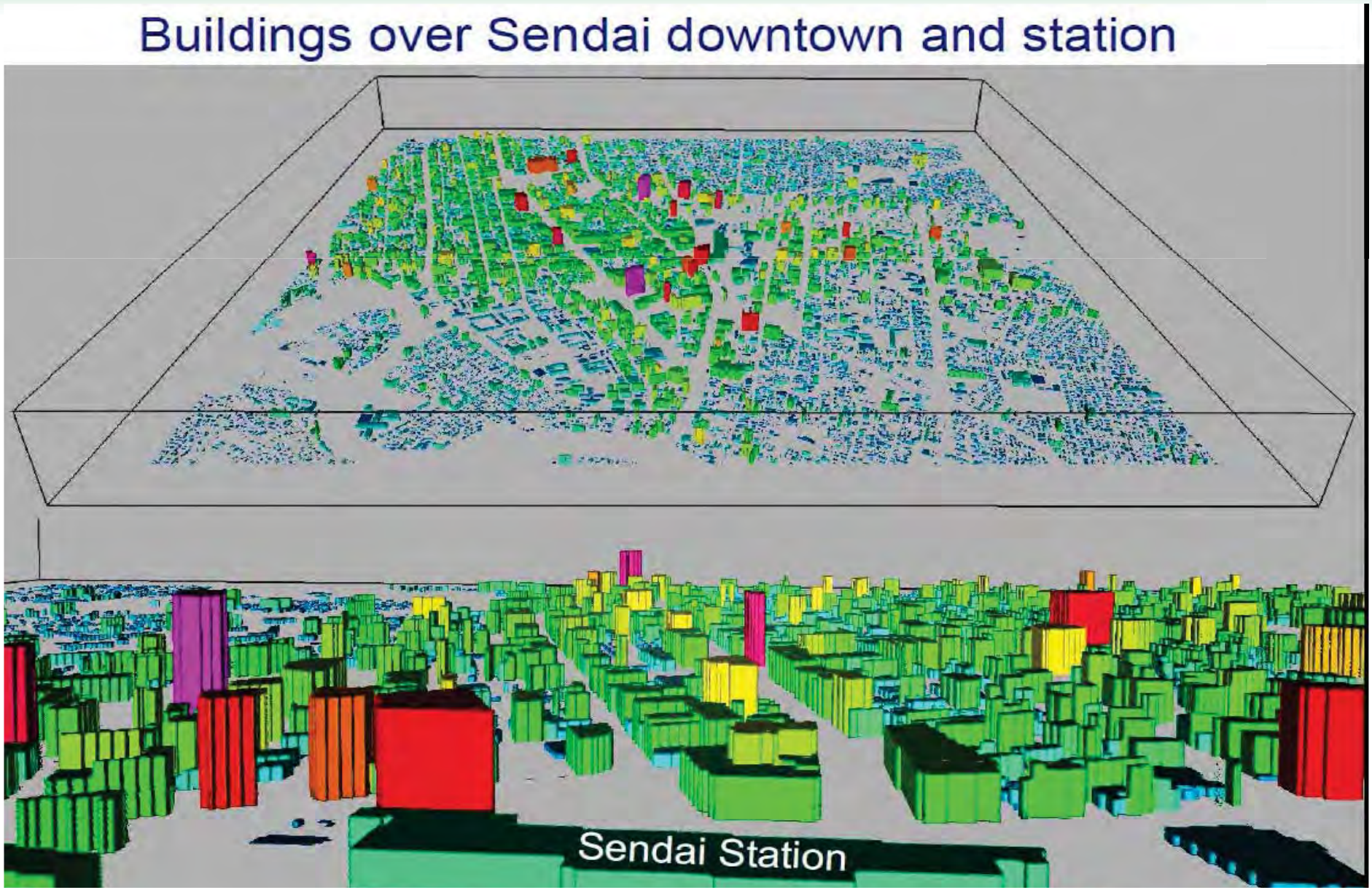




Domain of CFD
25km*25km*700m
2500*2500*70 points

(Chen et al, 2013)

Building resolving LES
(ビルを解像するLES)

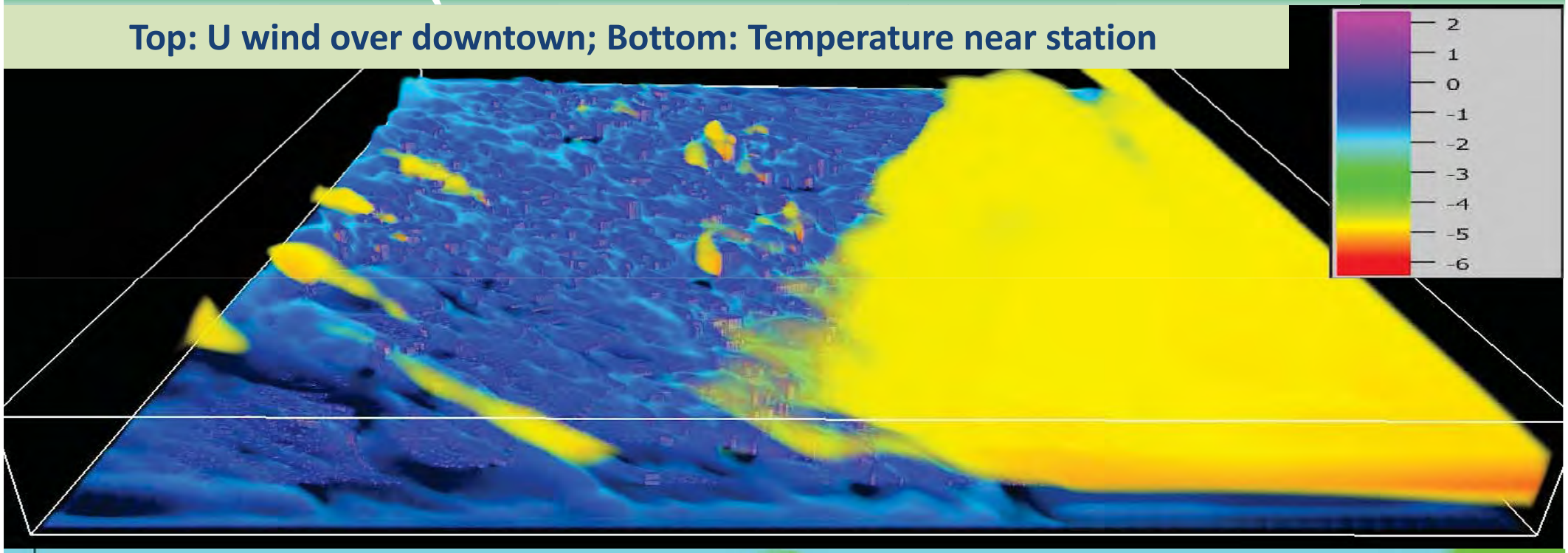


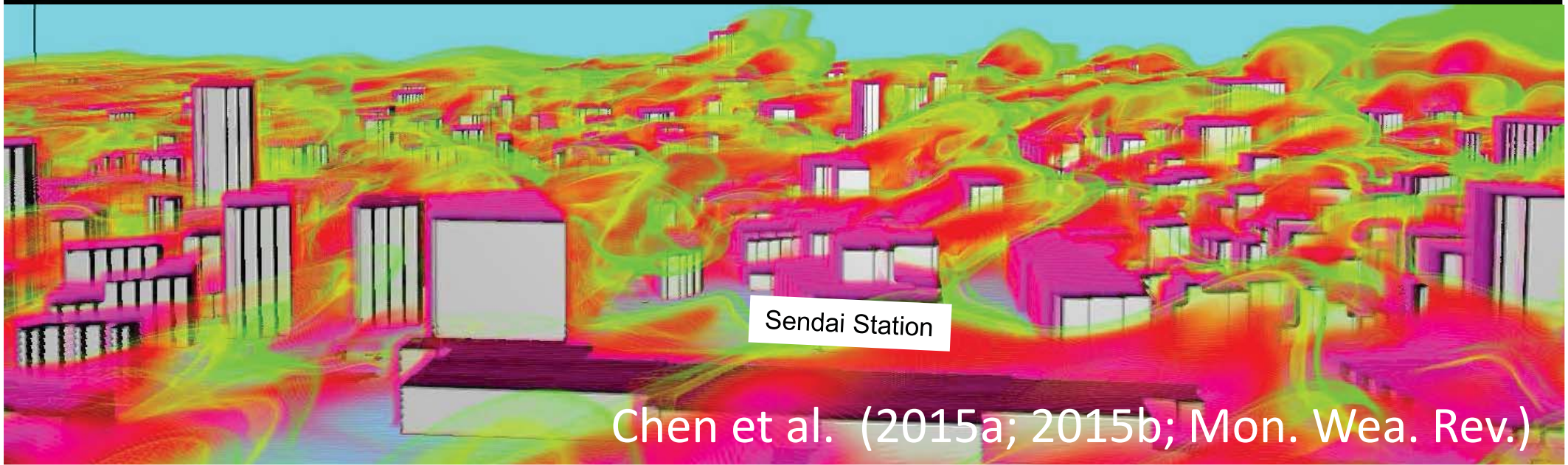
Chen et al. (2015a; 2015b; Mon. Wea. Rev.)

Building resolving LES
(ビルを解像するLES)

SPIRE Field 3

Top: U wind over downtown; Bottom: Temperature near station

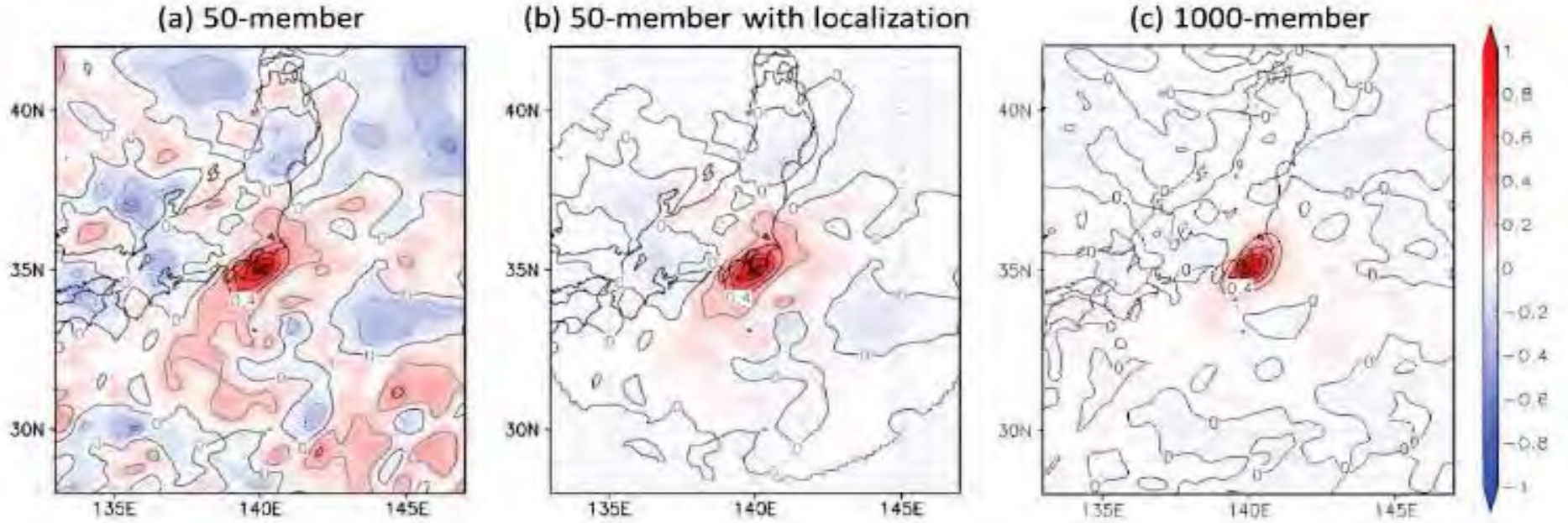




Chen et al. (2015a; 2015b; Mon. Wea. Rev.)

1000-member ensemble forecast
(1000メンバーのアンサンブル予報)

- The EnKF has an advantage that a flow-dependent background error covariance can be estimated explicitly in the process.
- The finite ensemble size introduces a sampling error into the background error covariance, leading to degradation of the accuracy of the analysis fields.



Maps of the horizontal distribution of the error correlation of the horizontal wind at the 500-hPa level from the center location. **(Kunii, 2014)**

Ensemble Kalman filter data assimilation and storm surge experiments of tropical cyclone Nargis
（サイクロンナルギスのデータ同化と高潮予測）

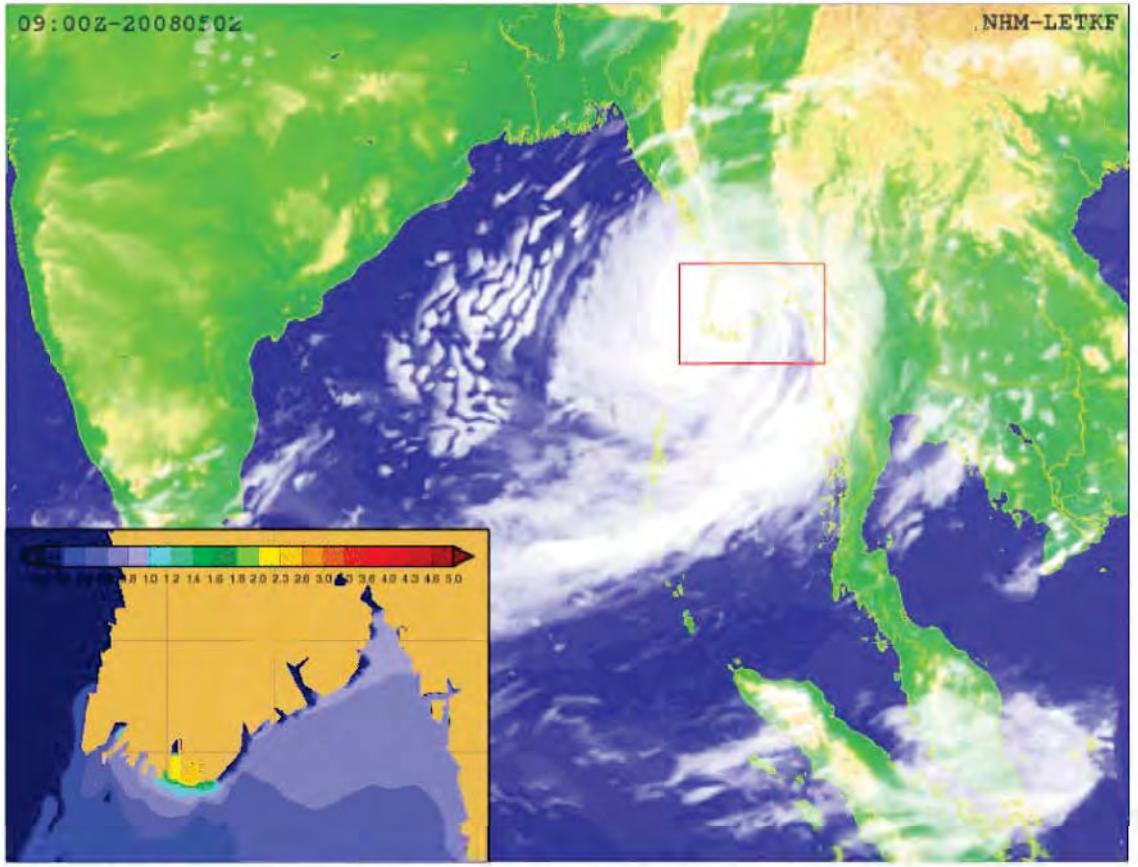


図4.本研究でのシミュレーションによる雲画像、海面水位。

Nargis was a severe storm which formed in Bay of Bengal in April 2008 and made landfall in the Irrawaddy delta, resulting in massive damage and loss of life in Myanmar.

(Duc, 2014)

Ensemble Kalman filter data assimilation and storm surge experiments of tropical cyclone Nargis
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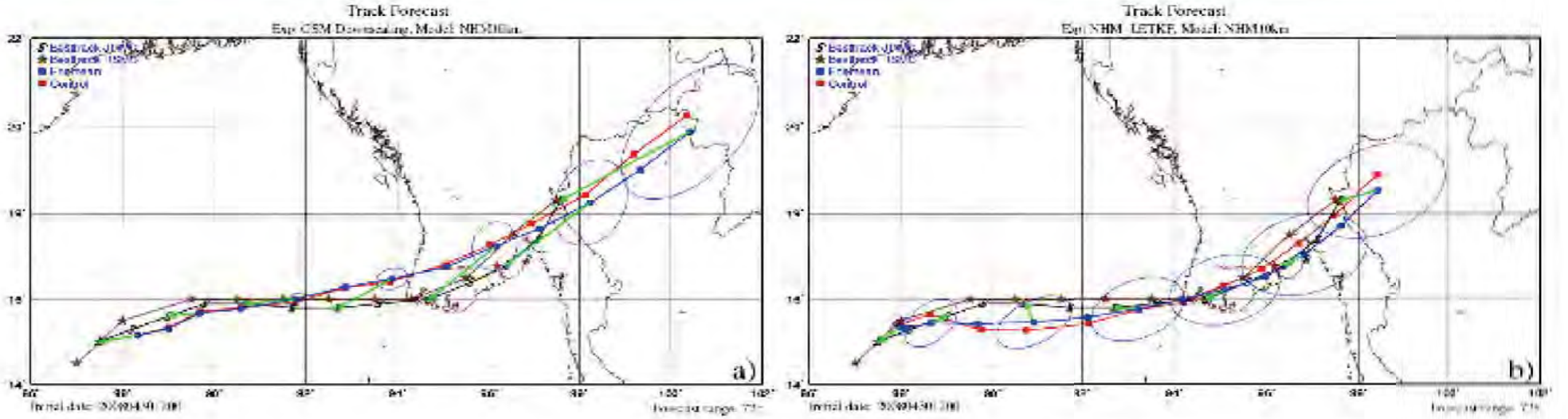


Figure 1: The 72-h forecasted tracks of Nargis initialized by: a) GSM analysis, and b) NHM-LETKF analysis in the control experiment. The ellipses represent the forecast error covariances of TC positions.

(Duc, 2014)

The control experiment resulted in a track forecast close to the observed one. This forecast outperformed GSM downscaling especially in the landfall location and time（上陸時刻・位置ともに、それまでの全球解析を初期値とする予報を大きく改善）.

Ensemble Kalman filter data assimilation and storm surge experiments of tropical cyclone Nargis
（サイクロンナルギスのデータ同化と高潮予測）

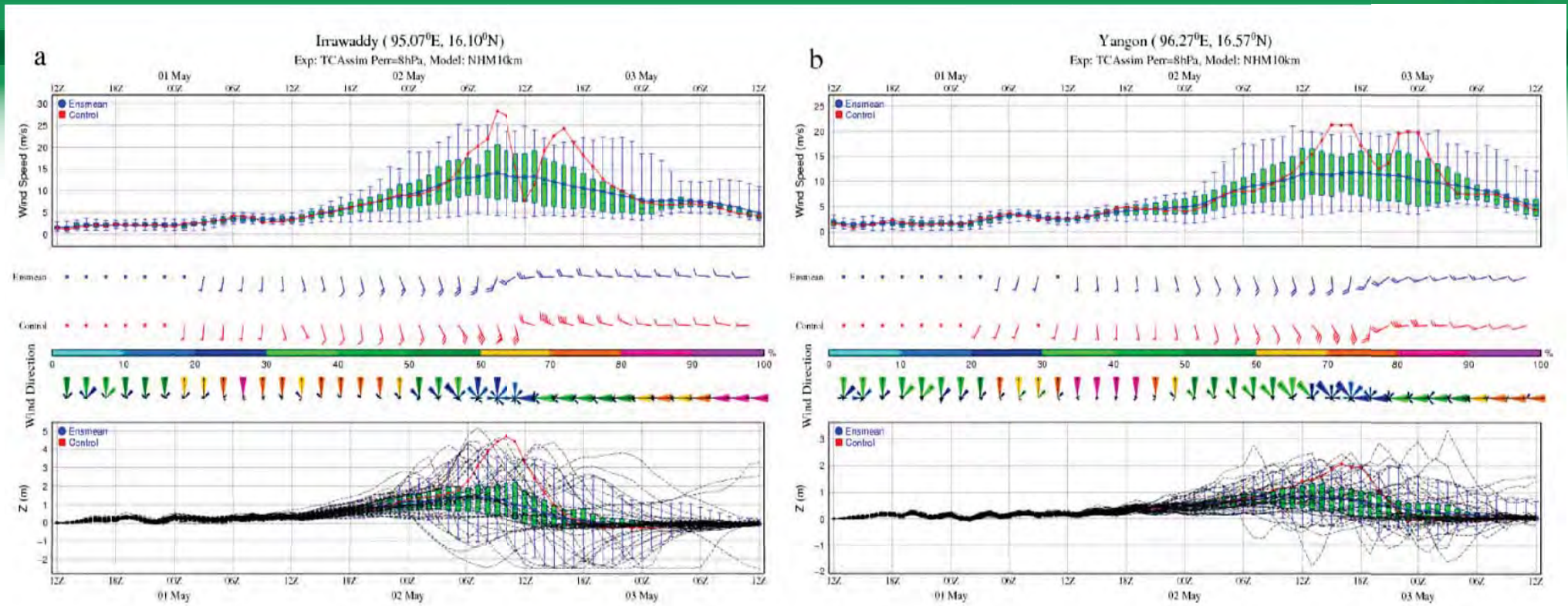


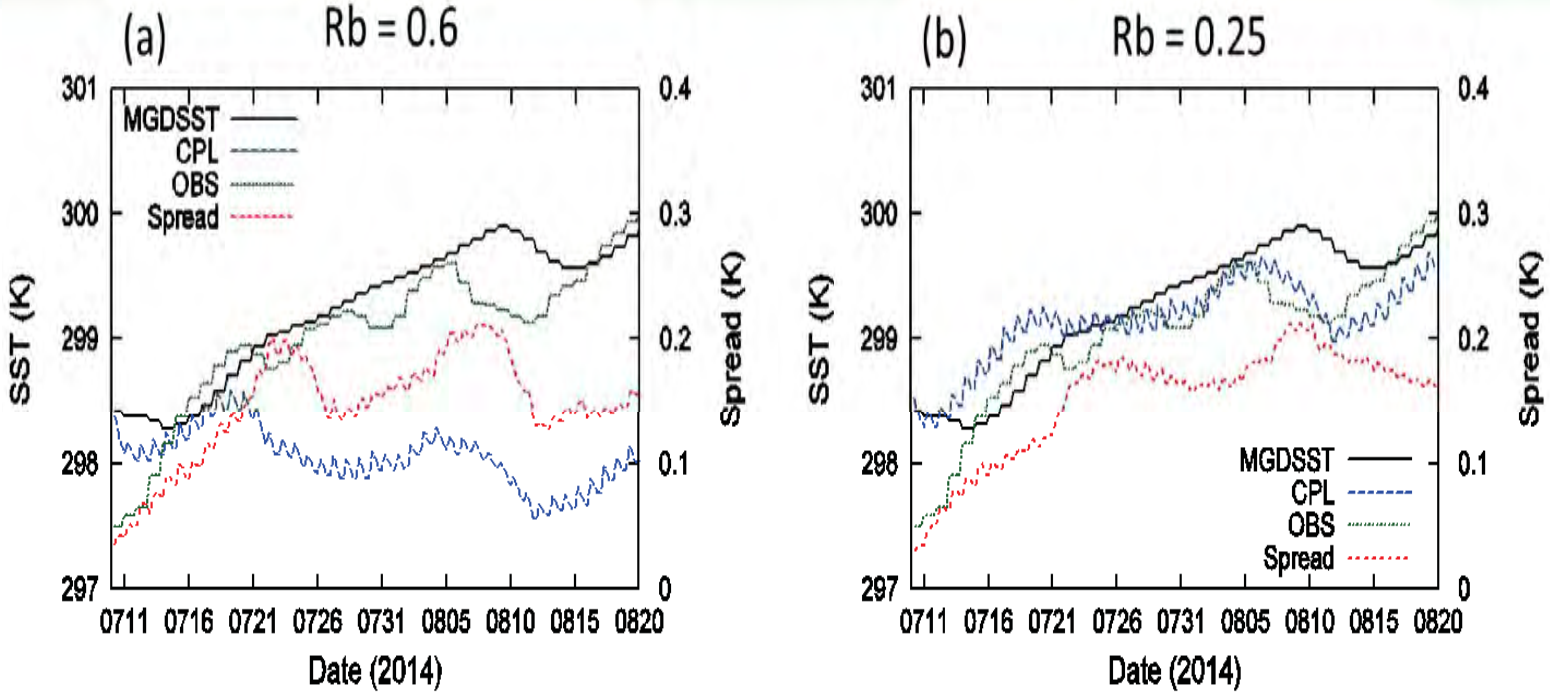
Figure 3: Forecasts of wind speeds, wind directions, and water levels based on the NHM-LETKF using assimilation of TC advisories with Perr = 8 hPa at: a) Irrawaddy point, and b) Yangon point.

(Duc, 2014)

Forecasts of the water levels at Irrawaddy and Yangon have significantly improved the results in the previous studies.（水位上昇のリスクの表現）

領域大気海洋結合モデルを用いたアンサンブルカルマンフィルタの構築

(Kunii et al. 2015)

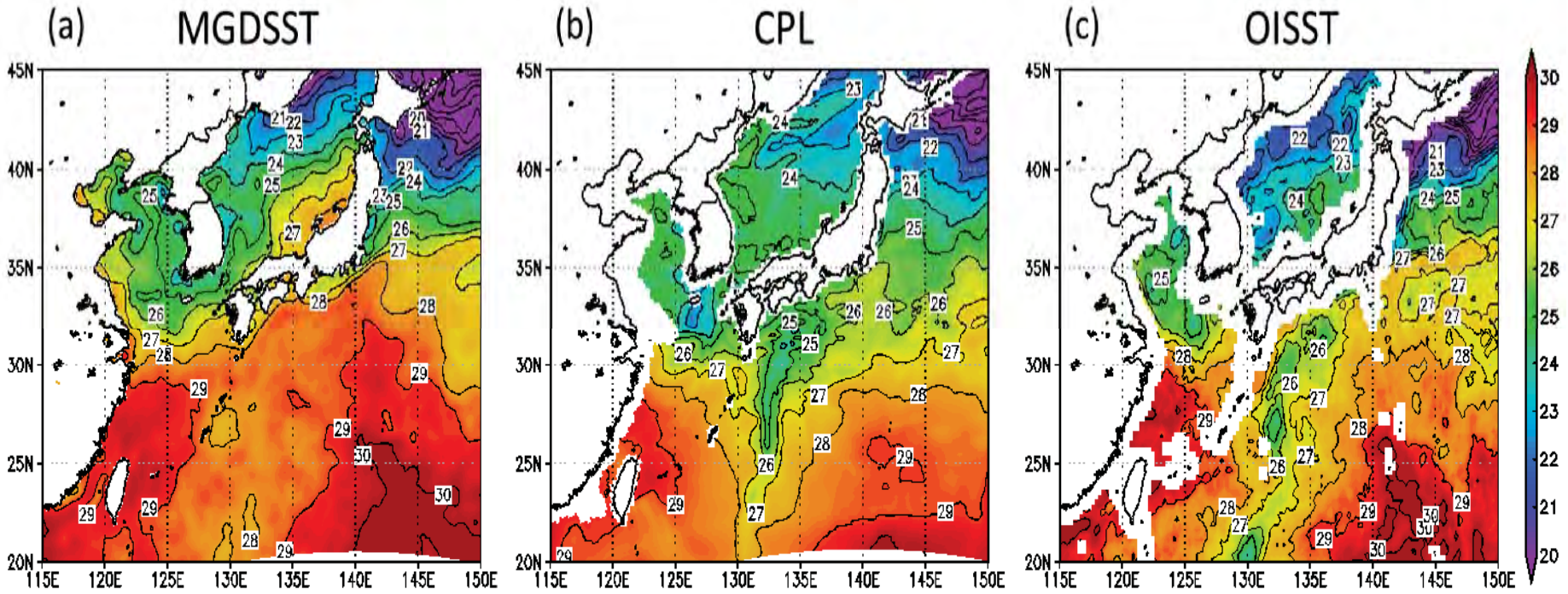


SSTの領域平均値（青：**1次元海洋表層モデルを結合したSST**，緑：**観測されたSST**）とアンサンブルスプレッド（赤）の時間推移．(a) Rb=0.6, (b) Rb=0.25とした実験．

混合層モデルの鉛直混合に関するパラメータ（critical bulk Richardson number Rb）の感度を調査した．Rbのを0.25とし鉛直混合を弱めたところ，**1次元海洋表層モデルを結合したSST**は実験開始後のスピンアップ期間において正バイアスが見られるものの，それ以降はOBSと良く一致しており，負バイアスも解消されている（図1b）．

領域大気海洋結合モデルを用いたアンサンブルカルマンフィルタの構築

(Kunii et al. 2015)



2014年8月10日00UTCにおけるSSTの分布．(a)気象庁全球日別海面水温解析値，(b) 1次元海洋表層モデルを結合したSST，(c)観測されたSST．

1次元海洋表層モデルを結合したSSTは台風11号による海面水温の低下を再現しており，気象庁全球日別海面水温解析値と比較すると観測されたSST（OISST）により近い分布を示している．

Results of the ensemble forecast systems and applications using outputs of ensemble forecasts

- 領域雲解像アンサンブル解析予報システム の開発と検証
  瀬古　弘(気象研究所/海洋研究開発機構)
- NHM-LETKFを用いたひまわり8号のラピッドスキャン同化実験
  國井　勝(気象研究所)
- Improving local weather forecast over complex surfaces using a building-resolving urban-scale prediction system
  陳　桂興(中国中山大学)
- 従来型観測のみによる日本域を対象とした長期領域再解析システム構築に向けた研究
  福井　真(東北大学/気象研究所)
- 京コンピュータを用いた広域・超高解像度数値予報
  大泉　伝(海洋研究開発機構/気象研究所)
- 山岳地域土砂災害予測のためのHydro-Debris2D と3Dの開発・改良
  山敷　庸亮(京都大学総合生存学館)
- 京コンピュータを用いた高速/高解像洪水氾濫シミュレーション
  小林　健一郎(神戸大学)
- Ensemble rainfall and flood forecasts for severe typhoon event using high-resolution Numerical Weather Prediction model based on NHM-LETKF system
  ユ・ワンシク(韓国忠南大学)

Results of the ensemble forecast systems and applications using outputs of ensemble forecasts

- Development and validation of a cloud resolving ensemble analysis and prediction system — Hiromu Seko (MRI/JAMSTEC)
- Data assimilation of rapid-scan atmospheric motion vectors derived from Himawari-8 with the NHM-LETKF — Masaru Kunii (MRI)
- Improving local weather forecast over complex surfaces using a building-resolving urban-scale prediction system — Guixing Chen (Sun Yat-sen Univ.)
- A study for constructing a long-term regional reanalysis system over Japan assimilating only conventional observations — Shin Fukui (Tohoku Univ./MRI)
- An Ultra-high Resolution Numerical Weather Prediction with a Large Domain using the K Computer — Tsutao Oizumi (JAMSTEC/MRI)
- Development and Improvement of Hydro-Debris 2D & 3D for prediction of sediment hazard in mountain zone — Yosuke Yamashiki (Kyoto Univ.)
- High-speed/high-resolution flood inundation simulation using K supercomputer — Ken-ichiro Kobayashi (Kobe Univ.)
- Ensemble rainfall and flood forecasts for severe typhoon event using high-resolution Numerical Weather Prediction model based on NHM-LETKF system — Yu Wansik (Chungnam National Univ..)