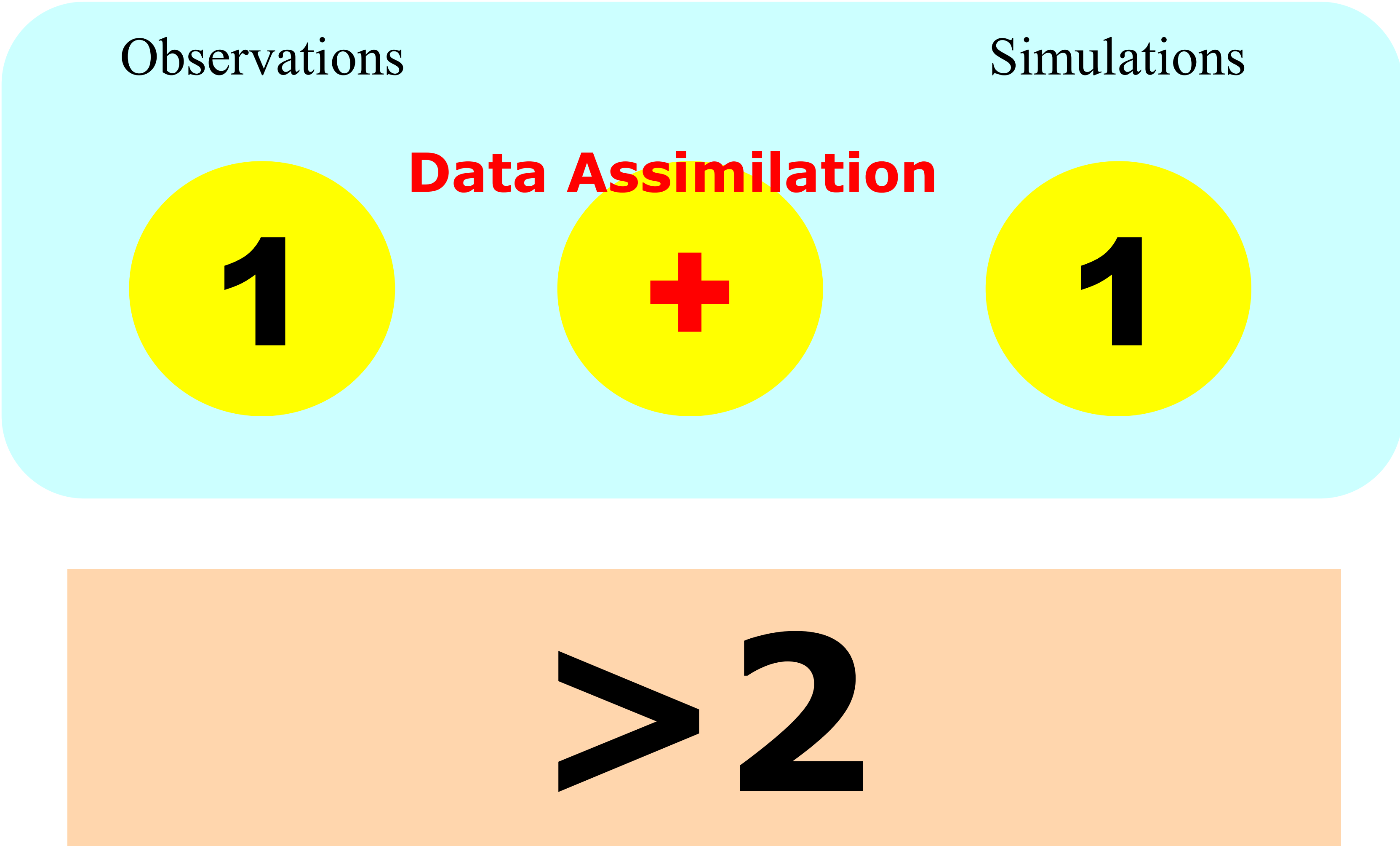
WELCOME!!

Chair: Takemasa Miyoshi

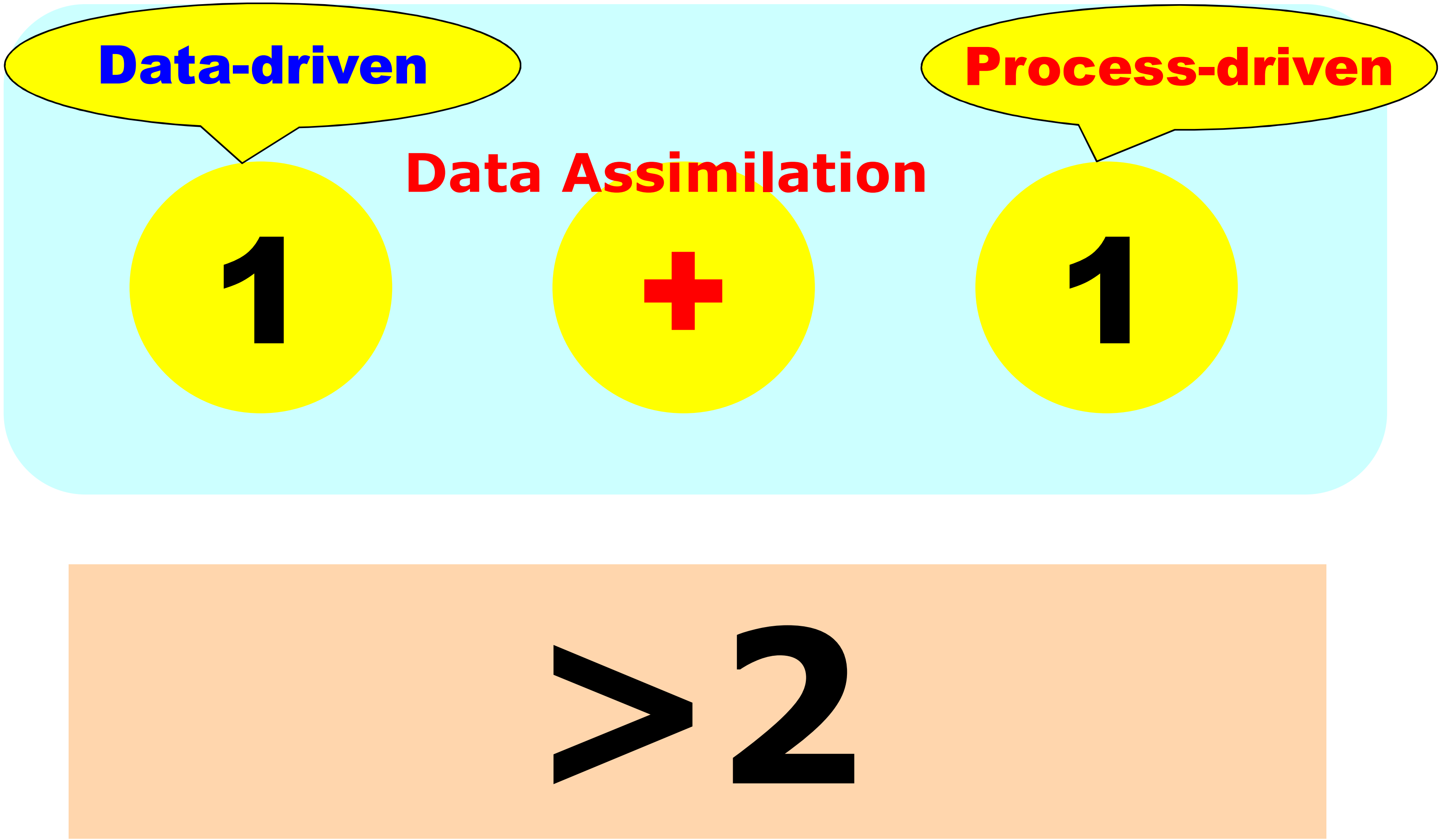
Data Assimilation (DA)

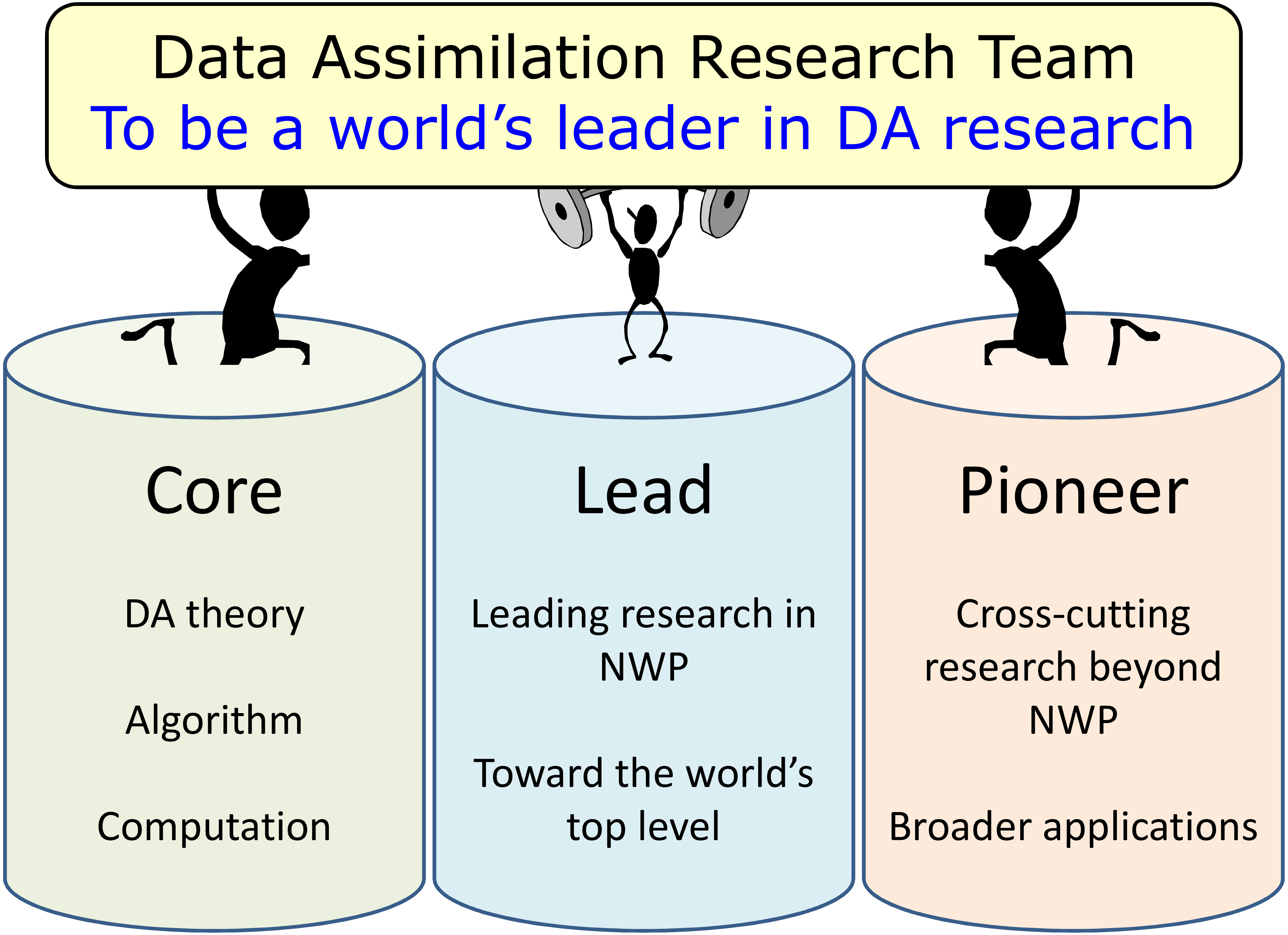
Data assimilation best combines observations and a model, and brings synergy.

Data Assimilation (DA)



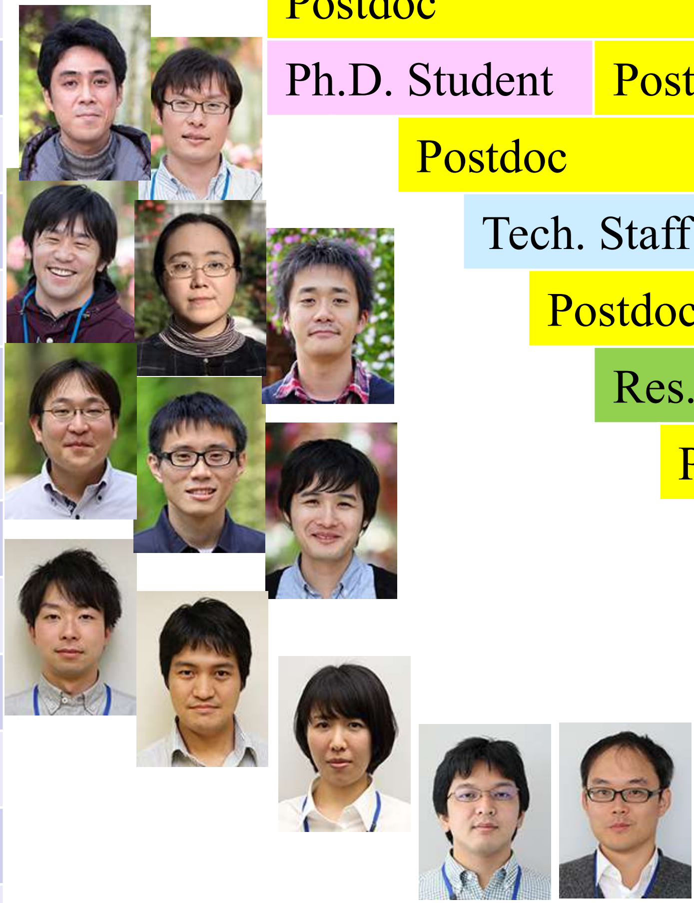
Data Assimilation (DA)




Data Assimilation Research Team
To be a world's leader in DA research
Core
DA theory
Algorithm
Computation
Lead
Leading research in NWP
Toward the world's top level
Pioneer
Cross-cutting research beyond NWP
Broader applications

History of RIKEN DA Team

	2012	2013	2014	2015	2016	2017
	10/1 founded					TODAY 2/27
Otsuka		Postdoc			Res. Sci.	
Kondo		Ph.D. Student	Postdoc			
Terasaki		Postdoc		Res. Sci.		
Arakida		Tech. Staff				
Kotsuki			Postdoc			
Maejima			Res. Assoc.			
Lien			Postdoc			
Honda				Postdoc		
Okazaki					Postdoc	
Sawada					Postdoc	MRI
Awadu					Tech. Staff	
Teramura					Postdoc	
Sakamoto					Tech. Staff	



[Tech. asst.] Ohhigashi (Hyogo U. D3), Kurosawa (Kobe U. M1)
[Visiting Sci.] Ruiz (Buenos Aires), Yang (Taiwan),
Penny (UMD), Shima (Hyogo U), Kunii, Otsuka, Okamoto (MRI)

Projects

Project	Period	Role
JAXA PMM 7th RA	2013-2016	PI: Miyoshi
JAXA PMM 8th RA	2016-2019	PI: Miyoshi
JAXA contract: Geostationary radar	2016-2019	PI: Miyoshi
CREST Big Data Application	2013-2019	PI: Miyoshi
CREST Big Data Core Technologies	2013-2019	PI: Prof. Matsuoka (Tokyo tech) Co-PI: Miyoshi
Post K field 4	FS: 2014-15 2016-2019	PI: Dr. Takahashi (JAMSTEC) PI of sub-theme A: Dr. Seko (MRI) Co-PI: Miyoshi
Hyogo/Kobe local government COE program	2013-2017	PI: Dr. Tomita (RIKEN) Co-PI: Miyoshi
Kakenhi young-B	2015-2018	PI: Kotsuki
Kakenhi young-B	2016-2019	PI: Otsuka
Kakenhi young-B	2016-2018	PI: Kondo
TEPCO contract: Dam operation	2017-2019	PI: Miyoshi

"Big Data Assimilation" Revolutionizing Severe Weather Prediction

by

Takemasa Miyoshi, M. Kunii, J. Ruiz, G.-Y. Lien, S. Satoh,
T. Ushio, K. Bessho, H. Seko, H. Tomita, and Y. Ishikawa

Bulletin of the American Meteorological Society

August 2016

doi:10.1175/BAMS-D-15-00144.1

JST 国立研究開発法人 科学技術振興機構 Japan Science and Technology Agency CREST

"Big Data Assimilation" Revolutionizing Severe Weather Prediction

BY TAKEMASA MIYOSHI, MASARU KUNII, JUAN RUIZ, GUO-YUAN LIEN, SHINSUKE SATOH, TOMOO USHIO, KOTARO BESSHO, HIROMU SEKO, HIROFUMI TOMITA, AND YUTAKA ISHIKAWA

Data assimilation (DA) integrates computer simulations and real-world observations based on statistical mathematics and dynamical systems theory, and plays a central role in numerical weather prediction (NWP). As computing and sensing technologies advance, DA will deal with "big simulations" and "big data." Here we focus on rapidly changing convective weather and explore a future direction of two orders of magnitude more rapid weather forecasting by innovating what we call "big data assimilation" (BDA) technology. Tremendous efforts have been devoted to convective-scale NWP and radar DA, including the U.S. effort on the "Warn-on-Forecast" project (Stensrud et al. 2009; 2013), which has been pioneering rapidly updated NWP to be used for warnings about convective-scale hazards. Sun et al. (2014) provided a comprehensive review on this subject with a rich body of literature. Extending a wealth of previous studies, this article presents the concept of BDA research and the first proof-of-concept results of a real high-impact weather case, exploring 30-min forecasts at 100-m grid spacing refreshed every 30 s—120 times more rapidly than hourly updated systems. This revolutionary NWP is only possible by taking advantage of the fortunate combination of Japan's most advanced technological developments: the 10-petaflops (floating-point operations per second) "K computer" and Phased Array Weather Radar (PAWR; Ushio et al. 2014; Yoshikawa et al. 2013). The science and analytics of big data, typically characterized by four "big V's" (volume, variety, velocity, and veracity), are growing rapidly, and BDA is one of the first two projects awarded by the Japanese government strategic funding program started in 2013 on general big data applications.[1]

In contemporary weather forecasting, radar observations and NWP play an essential role in real-time monitoring and short-term prediction of severe weather. The widely used parabolic-antenna radar observes rain intensity along a curvilinear beam track. The radar is rotated, and changes the azimuth and elevation angles to capture the whole sky typically in 5 min for 15 elevation angles. Also, typical convective-scale NWP updates forecasts every hour for the next $O(10)$ hours at $O(1)$-km grid spacing. However, convective weather systems evolve quickly in 5 min and undertake a nonlinear evolution. The current NWP systems that could possibly use all 5-min radar data at the highest frequency may still be far from sufficient to precisely represent individual convective activities.

Here we explore what the highest-end, next-generation supercomputing and sensing technologies can do at their full capacity, pioneering the future of weather forecasting for the next 10 years. The cutting-edge PAWR implemented in Osaka, Japan, in

AFFILIATIONS: MIYOSHI—RIKEN Advanced Institute for Computational Science, Kobe, Japan, Department of Atmospheric and Oceanic Science, University of Maryland, College Park, Maryland, and Application Laboratory, Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan; KUNII—RIKEN Advanced Institute for Computational Science, Kobe, Japan, and Meteorological Research Institute, Tsukuba, Japan; RUIZ—RIKEN Advanced Institute for Computational Science, Kobe, Japan, and CIMA, CONICET-University of Buenos Aires, Buenos Aires, Argentina; LIEN, TOMITA, AND ISHIKAWA—RIKEN Advanced Institute for Computational Science, Kobe, Japan; SATOH—National Institute of Information and Communications Technology, Koganei, Japan; USHIO—Osaka University, Suita, Japan; BESSHO—Meteorological Satellite Center, Kiyose, Japan; SEKO—Meteorological Research Institute, Tsukuba, Japan

CORRESPONDING AUTHOR: Takemasa Miyoshi, RIKEN Advanced Institute for Computational Science, 7-1-26 Minatojima-minami-machi, Chuo-ku, Kobe 650-0047, Japan
E-mail: takemasa.miyoshi@riken.jp

The abstract for this article can be found in this issue, following the table of contents.
DOI:10.1175/BAMS-D-15-00144.1

A supplement to this article is available online (10.1175/BAMS-D-15-00144.2)

[1] The other project is on pharmaceutical science, focusing on drug discovery and production.

Press Release

Previous Index Next

August 9, 2016

K computer and high-tech weather radar come together to predict sudden torrential rains

Today, supercomputer-based weather predictions are typically done with simulations that use grids spaced at least one kilometer apart, and incorporate new observational data every hour. However, due to the roughness of the calculations, these simulations cannot accurately predict the threat of torrential rains, which can develop within minutes when cumulonimbus clouds suddenly develop. Now, an international team led by Takemasa Miyoshi of the RIKEN Advanced Center for Computational Science (AICS) has used the powerful K computer and advanced radar observational data to accurately predict the occurrence of torrential rains in localized areas.

The key to the current work, to be published later this month in the August issue of the *Bulletin of the American Meteorological Society*, is "big data assimilation" using computational power to synchronize data between large-scale computer simulations and observational data.

Using the K computer, the researchers carried out 100 parallel simulations of a convective weather system, using the nonhydrostatic mesoscale model used by the Japan Meteorological Agency, but with 100-meter grid spacing rather than the typical 2-kilometer or 5-kilometer spacing, and assimilated data from a next-generation phased array

RIKEN

About RIKEN | Research | News & Media | Careers | Outreach | Community

Home > News

Press Rele

August 9, 20

K comp
sudden

Today, supe
least one ki
roughness
which can
led by Take
powerful K
torrential r

The key to t
Meteorologic
computer simulations and observational data.

Using the K computer, the researchers carried out 100 parallel simulations of a convective weather system, using the nonhydrostatic mesoscale model used by the Japan Meteorological Agency, but with 100-meter grid spacing rather than the typical 2-kilometer or 5-kilometer spacing, and assimilated data from a next-generation phased array

2005

News

Events & Symposiums

Press conference on Monday, August 1, 11am.
Press release on Tuesday, August 9, 7am.

Covered by

- Newspapers (Asahi, Yomiuri, Nikkei, Nikkan-kogyo, Nikkei-sangyo, Kobe)
- TV broadcast (NHK, FNN)
- Web sources (HPC wire, mynavi, engadget, PC Watch, etc.)

日経産業新聞 2016年8月10日 朝刊8面

ゲリラ豪雨、正確に予測

理研など「京」と最新レーダーで

理化学研究所の三好建正チームリーダーらは、情報通信研究機構（NICT）、大阪大学などと共同で、スーパーコンピューター「京」と最新の気象レーダーのデータを組み合わせ、ゲリラ豪雨の発生を正確に予測する手法を開発した。ゲリラ豪雨の兆候をいち早くつかみ、被害の軽減につなげる狙いだ。

スパコンによる天気予報のシミュレーションは通常、1キロメートルより粗い解像度で、1時間ごとに観測データを取り込んで更新している。この空間・時間精度では、わずか数分間で積乱雲が急速に成長するゲリラ豪雨の発生を予測するのは難しかった。

開発した手法では理研の京とNICTや阪大が開発した気象レーダーのデータを利用し、100メートルの解像度で30秒ごとに更新する。シミュレーションと実測データを組み合わせる「データ同化」と呼ぶ手法を応用した。膨大なデータを素早く取り込んで計算することで、ゲリラ豪雨の予測が可能になるという。

ただ、現状ではデータ同化の作業に時間がかかり、すぐには実際の天気予報などに活用できない。実用化に向け、データの転送や計算の高速化などの課題克服に取り組む。

朝日新聞 2016年8月9日 夕刊2面

スパコン「京」ゲリラ豪雨再現

数分後まで成功 予測に光

短時間で急激に発達するゲリラ豪雨の雨雲の動きをスーパーコンピューター「京」で予測するシステムを、理化学研究所計算科学研究機構などのグループが開発した。過去のゲリラ豪雨を一部再現することに成功した段階だが、将来は、雨雲のもととなる水蒸気の塊が発生した時点で30分先の予測が可能になるかもしれない。

30秒ごとにゲリラ豪雨の分布を詳細にとらえる性能を持つ大阪大などの最新気象レーダーの観測データを京に取り込み、シミュレーションと組み合わせる手法。2013年に京都市を襲ったゲリラ豪雨の降り始め時点のデータをもとに予測したところ、数分後まではほぼ正確に再現できた。10分後以降は誤差が大きくなった。

将来は、観測データをリアルタイムで取り込み、「京」ではない普及型のスパコンで30分後までの雨雲を正確に予測することを目指す。実現には精度の向上に加え、現状では10分かかっている計算速度の大幅な短縮が必要となる。理研の三好建正チームリーダーは「10年程度で運用可能な段階にしたい」と話している。（野中良祐）

朝日新聞（大阪版） 2016年8月9日 夕刊7面

「京」、ゲリラ豪雨予測へ一歩

理研などシステム開発

短時間で急激に発達するゲリラ豪雨の雨雲の動きをスーパーコンピューター「京」で予測するシステムを、理化学研究所計算科学研究機構などのグループが開発した。まだ過去のゲリラ豪雨を一部再現することに成功した段階だが、将来は、雨雲のもととなる水蒸気の塊が発生した時点で30分先の予測が可能になるかもしれない。

30秒ごとにゲリラ豪雨の分布を詳細にとらえる性能を持つ大阪大などの最新気象レーダーの観測データを京に取り込み、シミュレーションと組み合わせる手法。2013年に京都市を襲ったゲリラ豪雨の降り始め時点のデータをもとに、30分後までの変化を予測したところ、数分後まではほぼ正確に再現できた。10分後以降は誤差が大きくなった。

将来は、観測データをリアルタイムで取り込み、「京」ではない普及型のスパコンで30分後までの雨雲を正確に予測することを目指す。実現には精度の向上に加え、現状では10分かかっている計算速度の大幅な短縮が必要となる。理研の三好建正チームリーダーは「10年程度で運用可能な段階にしたい」と話している。（野中良祐）

神戸新聞 2016年8月9日 夕刊9面

9　4版　2016年(平成28年)8月9日　火曜日

ゲリラ豪雨30分前に予測

積乱雲の成長を再現

理研、スパコン「京」で

理化学研究所（理研）などは9日、30分後のゲリラ豪雨が予報可能となるシミュレーション手法を開発した、と発表した。最新鋭レーダーで観測された気象データを基に、雨雲の成長を神戸・ポートアイランドのスーパーコンピューター「京」で予測。研究グループは「ゲリラ豪雨が予測可能であることが示された。実用化に向けた大きな一歩だ」とする。（武藤邦生、佐伯竜一）

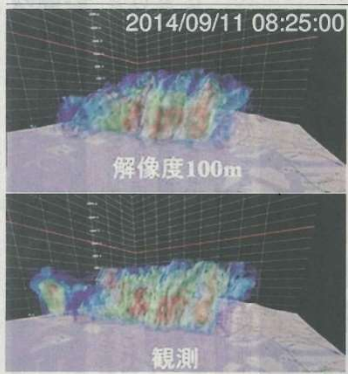
理研計算科学研究機構（神戸市中央区）の三好建正チームリーダーらによる成果で、近く米科学誌に掲載される。

ゲリラ豪雨を引き起こす積乱雲は直径が小さく、わずか10分ほどで急激に成長するため、現在の天気予報シミュレーションの精度では、詳しい予測が困難だった。

グループは、雨雲の状況を短時間で立体的に観測できる新型レーダーのデータを使用。大阪大（大阪府吹田市）にあるレーダーの観測値と、京の計算値を組み合わせ、現在の天気予報の100倍以上という高速で精細なシミュレーションに成功した。

神戸・阪神間に局地的豪雨をもたらした2014年9月11日朝の神戸市上空の雨雲をシミュレーションしたところ、実際の観測とほぼ一致。雨雲の内部の構造まで再現できた。

実用化には10年程度かかるとみられ、三好リーダーは「計算時間の短縮や予測精度の向上に取り組みたい」としている。



シミュレーションによって再現された2014年9月11日午前8時25分の神戸市上空の雨雲（上）と実際の観測データ（理研計算科学研究機構・三好建正チームリーダー提供）

読売新聞 2016年8月10日 朝刊2面

局地的大雨をスパコンで再現

理研「将来的に予測」

短時間で急激な大雨が降る「局地的大雨」をより正確に予測するのにつながる手法を開発したと、理化学研究所などのチームが米科学誌に発表した。最新のレーダーで30秒ごとに集めたデータをスーパーコンピューターで計算し、過去に実際に起きた局地的大雨の再現に成功した。チームは「将来的に、局地的大雨の予測を可能にする技術」と見ている。

気象庁のスパコンとレーダーを使う現在の手法は、2キロ・メートル四方ごとの降水量を予測しているが、その計算には1時間ほどかかり、局地的大雨を予測するのが難しかった。チームは最新のレーダーを使い、100メートル四方ごとの雨雲の分布や風速のデータを30秒ごとに収集。理研のスパコン「京」を使い、実際に起きた局地的大雨の大気の状態で試算した結果、雨の状況が正確に再現できた。

日刊工業新聞 2016年8月10日 朝刊25面

ゲリラ豪雨 30分先予測

理研

解像度100m 30秒ごと更新

理化学研究所計算科学研究機構データ同化研究チームの三好建正チームリーダーらは、30分後までのゲリラ豪雨を予測する手法を開発した。スーパーコンピューター「京」と、フェーズドアレイ気象レーダーから得られるデータを組み合わせることで、解像度100メートルで30秒ごとに新しい観測データを取り込んで更新する天気予報シミュレーションを実現。実際のゲリラ豪雨の動きを詳細に再現することに成功した。

スーパーコンピューターを使った天気予報シミュレーションは一般的に、1キロメートルより粗い解像度で1時間ごとに新しい観測データを取り込んで更新する。しかし、ゲリラ豪雨の場合、数分の間に積乱雲が急激に発生・発達するため、1時間の更新間隔では予測が困難だった。

また、1キロメートルより粗い解像度では、ゲリラ豪雨を引き起こす積乱雲を十分に解像できなかった。超高速かつ超高精細な天気予報につながる可能性がある。

情報通信研究機構、大阪大学などとの共同研究。成果は、今月下旬に米科学誌ブリティン・オブ・ザ・アメリカン・メテオロジカル・ソサエティーに掲載される。

日経新聞 2016年8月9日 夕刊16面

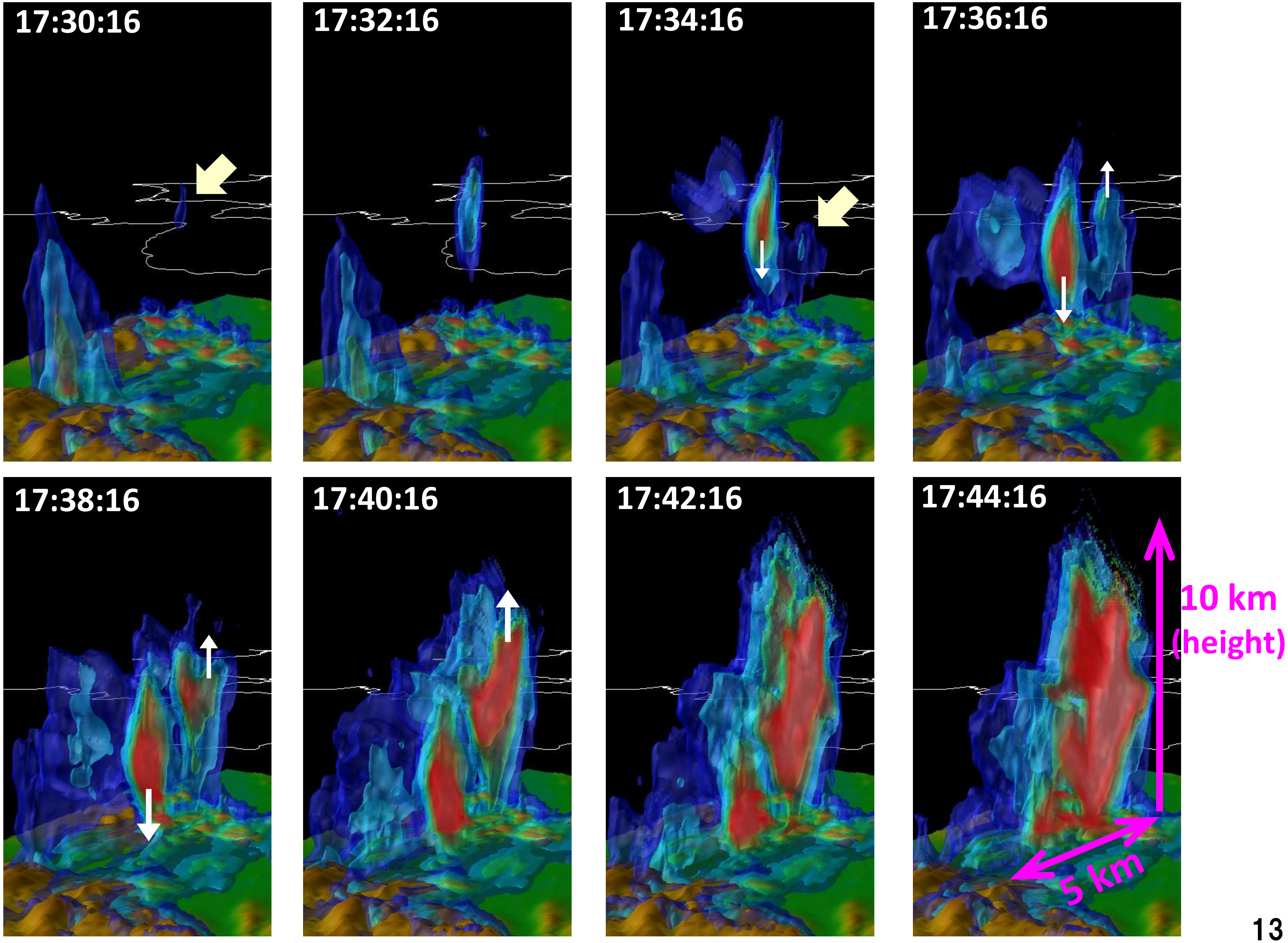
ゲリラ豪雨予測 スパコンで正確

理研など手法開発

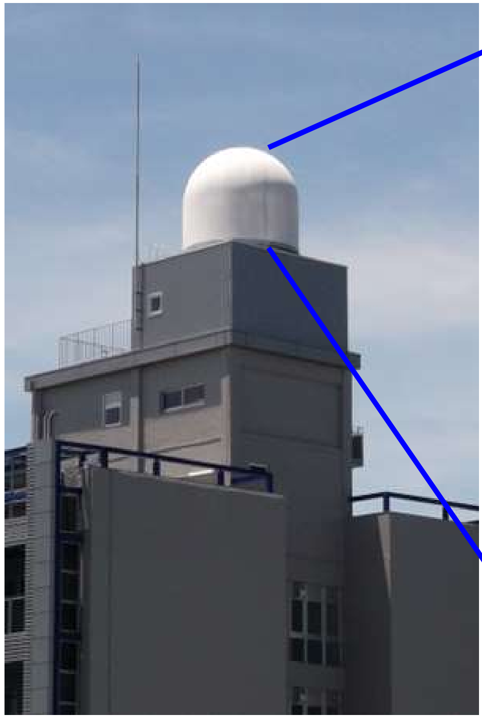
理化学研究所と情報通信研究機構（NICT）、大阪大などは9日、スーパーコンピューター「京」を使ってゲリラ豪雨の発生を正確に予測する手法を開発したと発表した。積乱雲の発達状況を瞬時に把握できる最新の気象レーダーを活用する。ゲリラ豪雨の兆候をいち早くつかむことができるという。

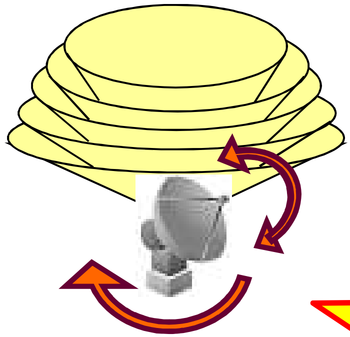
Only in 10 minutes!!

(Courtesy of NICT)



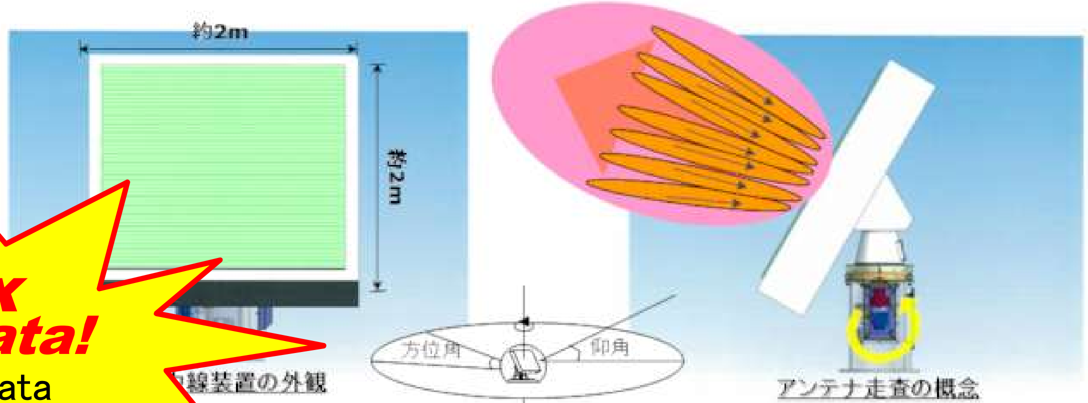
Phased Array Weather Radar (PAWR)





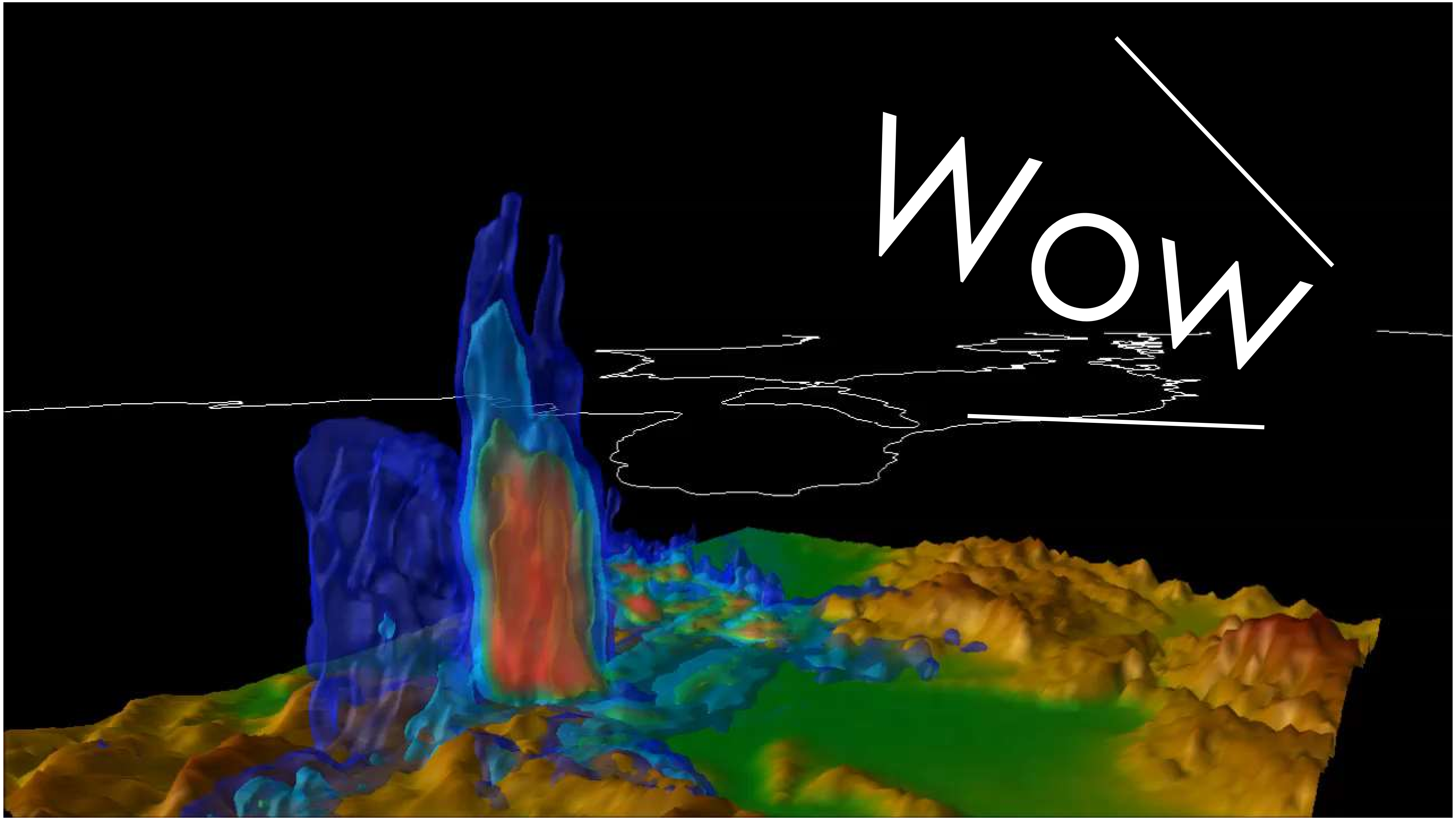
3-dim measurement using
a parabolic antenna (150 m,
15 EL angles in 5 min)

100x
more data!
10x more data
in a 1/10 period



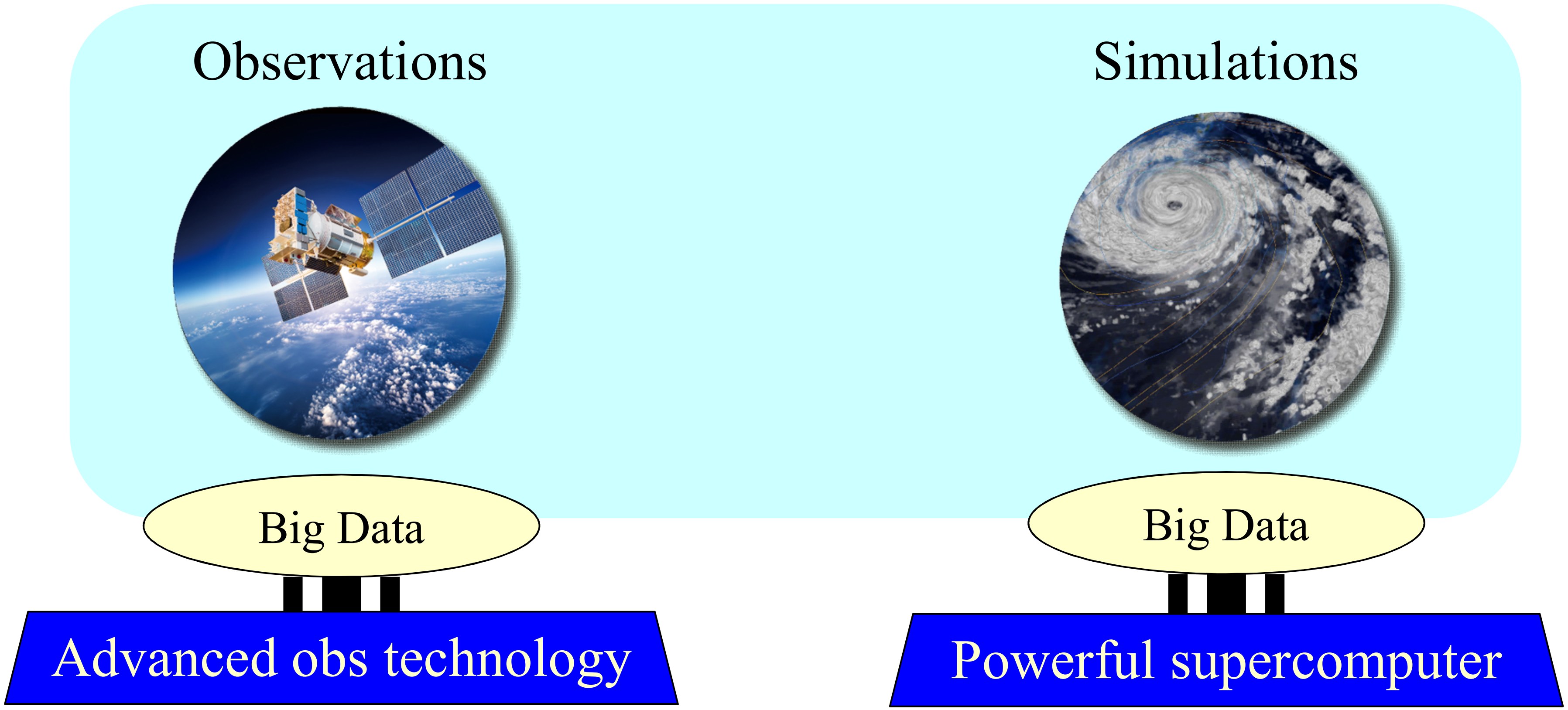
3-dim measurement using a phased array antenna
(100 m, 100 EL angles in 30 sec)

Phased Array Radar (every 30 sec.)

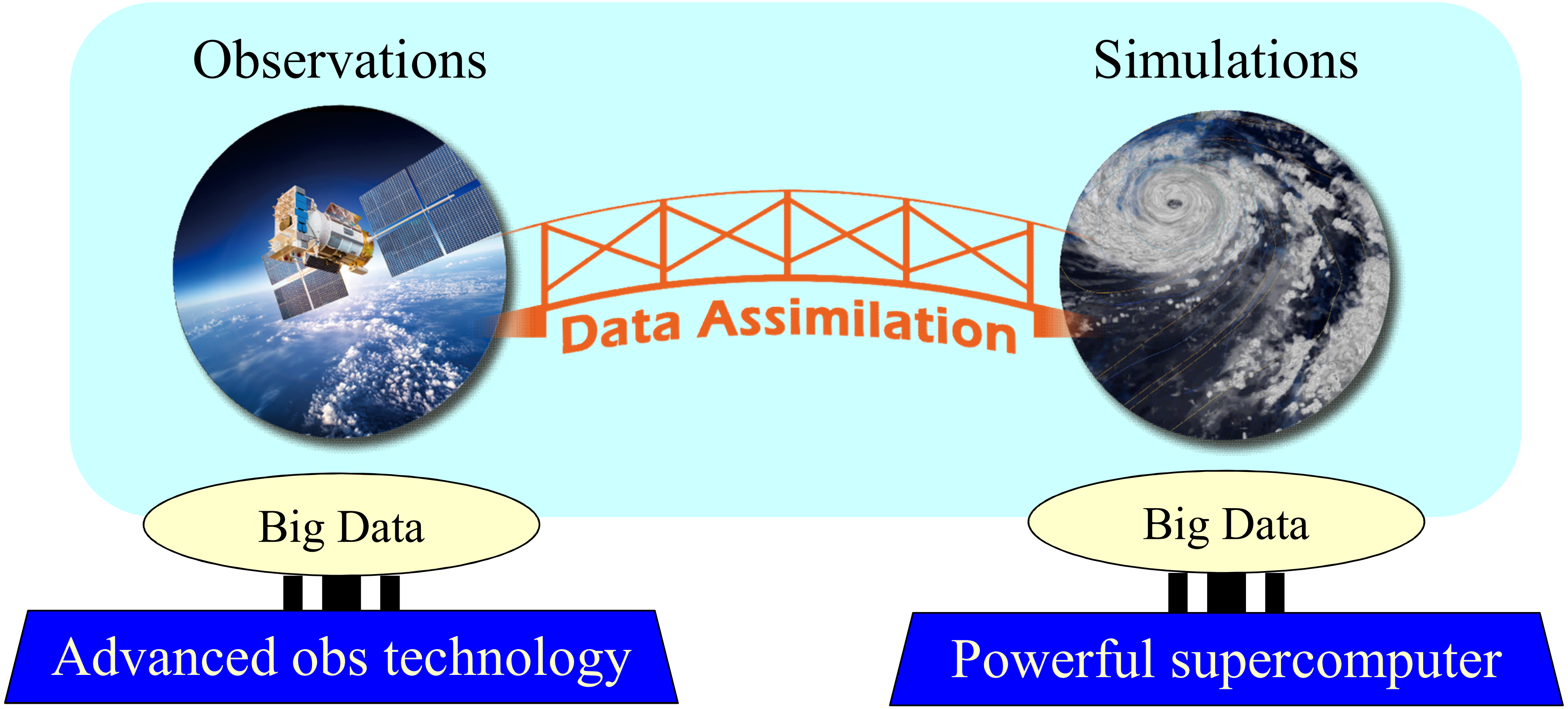


(Courtesy of NICT)

Sources of Big Data

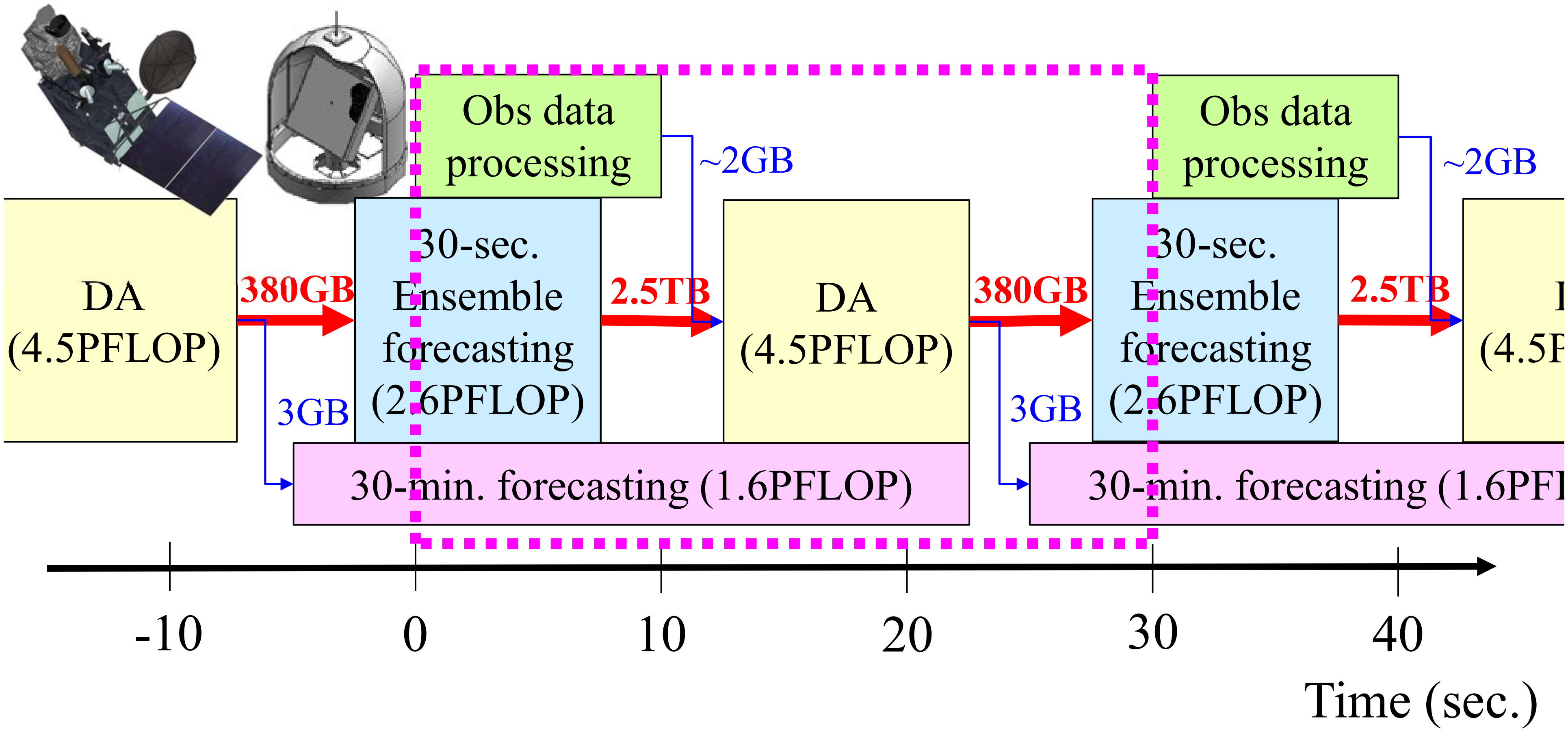


Big Data Assimilation



Pioneering "Big Data Assimilation" Era

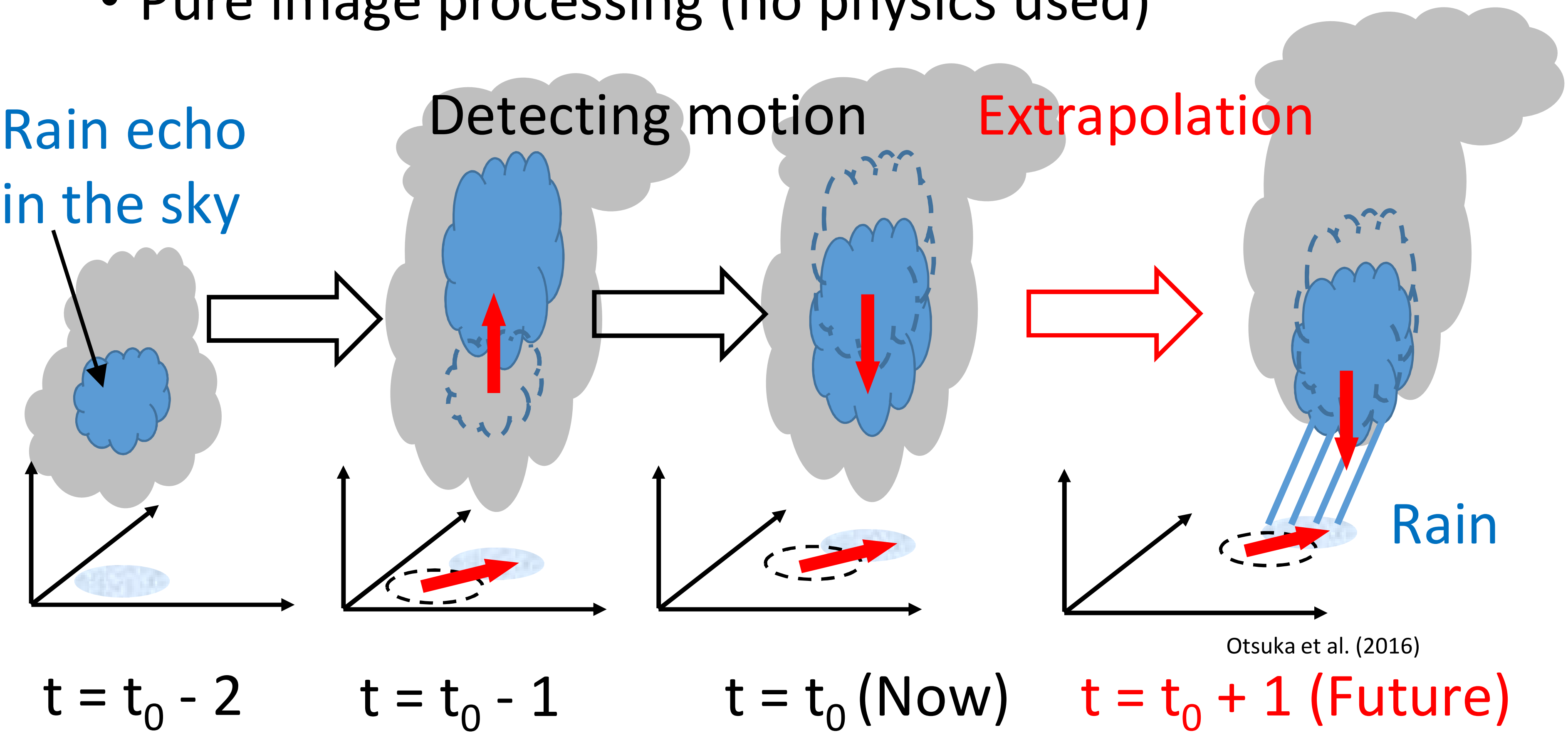
Revolutionary super-rapid 30-sec. cycle



120 times more rapid than hourly update cycles

3D nowcasting

- 3D motion extrapolation (assuming persistence)
- Pure image processing (no physics used)



Proceedings of the IEEE

(Miyoshi et al., 2016)

INVITED PAPER

"Big Data Assimilation" Toward Post-Petascale Severe Weather Prediction: An Overview and Progress

This article summarizes the activities and progress of the big data assimilation project for severe weather prediction and concludes with perspectives toward the post-petascale supercomputing era.

By Takemasa Miyoshi, Guo-Yuan Lien, Shinsuke Satoh, Tomoo Ushio, Kotaro Bessho, Hirofumi Tomita, Seiya Nishizawa, Ryuji Yoshida, Sachiho A. Adachi, Jianwei Liao, Balazs Gerofi, Yutaka Ishikawa, Masaru Kunii, Juan Ruiz, Yasumitsu Maejima, Shigenori Otsuka, Michiko Otsuka, Kozo Okamoto, and Hiromu Seko

ABSTRACT | Following the invention of the telegraph, electronic computer, and remote sensing, "big data" is bringing another revolution to weather prediction. As sensor and computer technologies advance, orders of magnitude bigger data are produced by new sensors and high-precision computer simulation or "big simulation." Data assimilation (DA) is a key to numerical weather prediction (NWP) by integrating the real-world sensor data into simulation. However, the current DA and NWP systems are not designed to handle the "big data" from next-generation sensors and big simulation. Therefore, we propose "big data assimilation" (BDA) innovation to fully utilize the big data. Since October 2013, the Japan's BDA project has been exploring revolutionary NWP at 100-m mesh refreshed every 30 s, orders of magnitude finer and faster than the current typical NWP systems, by taking advantage of the fortunate combination of next-generation technologies: the 10-petaflops K computer, phased array weather radar, and geostationary satellite Himawari-8. So far, a BDA prototype system was developed and tested with real-world retrospective local rainstorm cases. This paper summarizes the activities and progress of the BDA project, and concludes with perspectives toward the post-petascale supercomputing era.

KEYWORDS | Atmospheric measurements; computer applications; Kalman filtering; optimal control; phased array radar; remote sensing; simulation; supercomputers; weather forecasting

Manuscript received January 15, 2016; revised April 5, 2016 and August 7, 2016; accepted August 15, 2016. Date of publication September 26, 2016; date of current version October 18, 2016. This study was supported by CREST, Japan Science and Technology Agency (JST). *(Corresponding author: Takemasa Miysohi.)*

T. Miyoshi is with the RIKEN Advanced Institute for Computational Science, Chuo-ku, Kobe 650-0047, Japan, with the Department of Atmospheric and Oceanic Science, University of Maryland, College Park, MD 20740 USA, and also with the Application Laboratory, Japan Agency for Marine-Earth Science and Technology, Yokohama 236-0001, Japan (e-mail: takemasa.miyoshi@riken.jp).

G.-Y. Lien, **H. Tomita**, **S. Nishizawa**, **R. Yoshida**, **S. A. Adachi**, **B. Gerofi**, **Y. Ishikawa**, **Y. Maejima**, and **S. Otsuka** are with the RIKEN Advanced Institute for Computational Science, Chuo-ku, Kobe 650-0047, Japan (e-mail: guo-yuan.lien@riken.jp; htomita@riken.jp; s-nishizawa@riken.jp; ryoshida@riken.jp; sachiho.adachi@riken.jp; bgerofi@riken.jp; yutaka.ishikawa@riken.jp; yasumitsu.maejima@riken.jp; shigenori.otsuka@riken.jp).

S. Satoh is with National Institute of Information and Communications Technology, Koganei 184-8795, Japan (e-mail: satoh@nict.go.jp).

T. Ushio is with the Osaka University, Suita 565-0871, Japan (e-mail: ushio@comm.eng.osaka-u.ac.jp).

K. Bessho was with the Meteorological Satellite Center, Kiyose 204-0012, Japan. He is now with the Forecast Department, Japan Meteorological Agency, Tokyo 100-8122, Japan (e-mail: kbessho@met.kishou.go.jp).

J. Liao was with the RIKEN Advanced Institute for Computational Science, Chuo-ku, Kobe 650-0047, Japan. He is now with the Southwest University of China, Chongqing 400715, China (e-mail: jianwei.liao@riken.jp).

M. Kunii, **M. Otsuka**, and **K. Okamoto** are with the RIKEN Advanced Institute for Computational Science, Chuo-ku, Kobe 650-0047, Japan, and also with the Meteorological Research Institute, Tsukuba 305-0052, Japan (e-mail: mkunii@mri-jma.go.jp; motsuka@mri-jma.go.jp; kokamoto@mri-jma.go.jp).

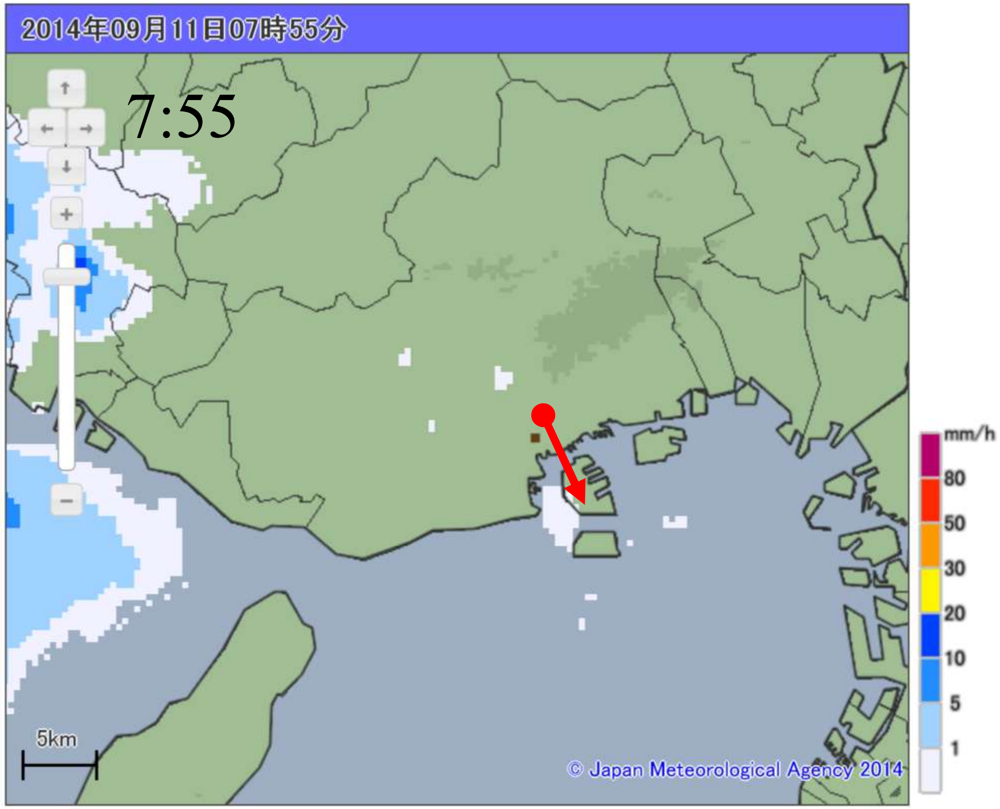
J. Ruiz is with the RIKEN Advanced Institute for Computational Science, Chuo-ku, Kobe 650-0047, Japan, and also with the CIMA, CONICET-University of Buenos Aires, Buenos Aires, Argentina (e-mail: jruiz@cima.fcen.uba.ar).

H. Seko is with the Meteorological Research Institute, Tsukuba, Japan (e-mail: hseko@mri-jma.go.jp).

Digital Object Identifier: 10.1109/JPROC.2016.2602560

9/11/2014 morning, sudden rain

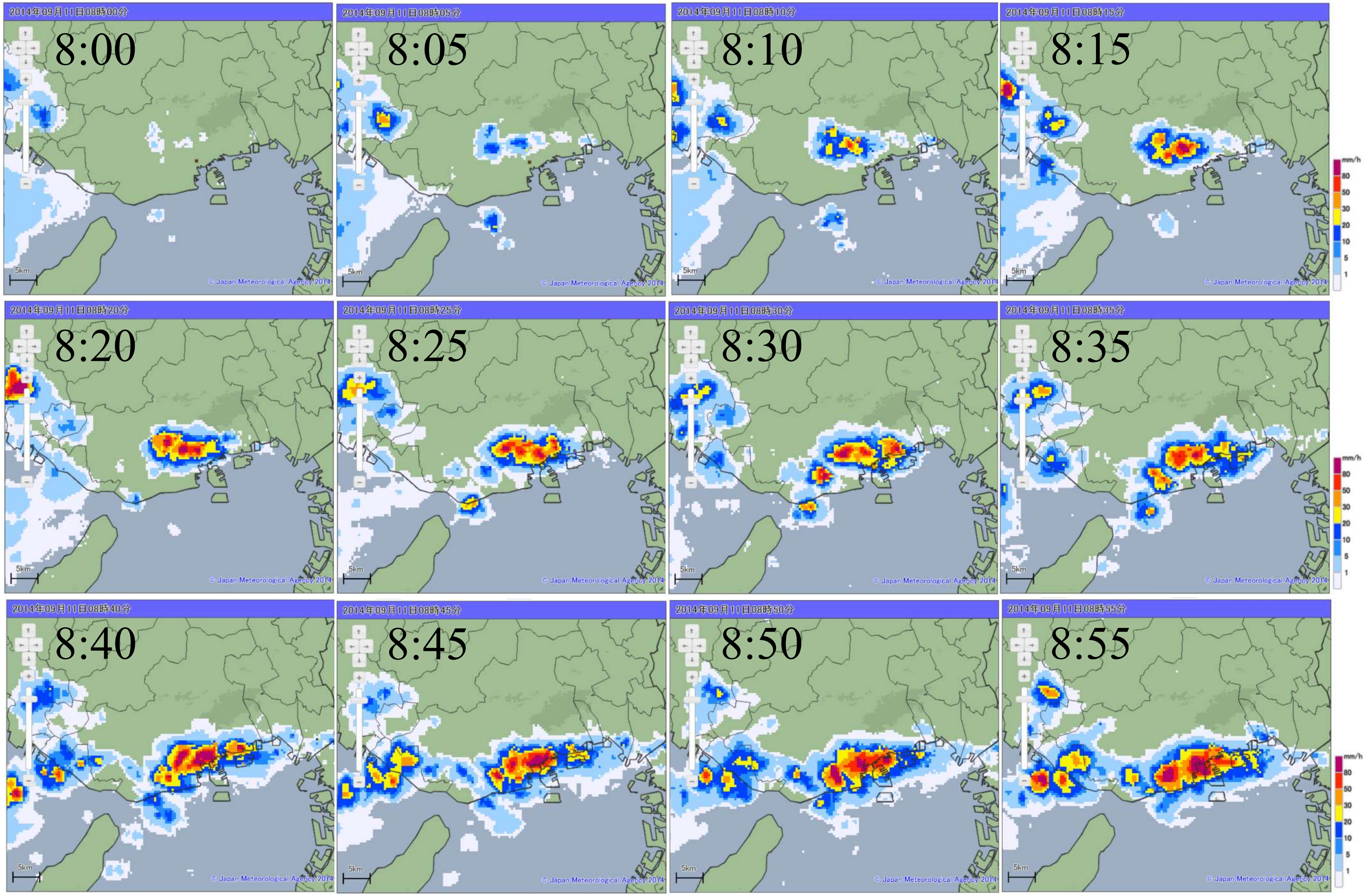
JMA observation



I looked at this obs
at 8 am.

Decided to bike to office.
It takes about 30 min.

9/11/2014 morning, sudden rain



9/11/2014 morning, sudden rain

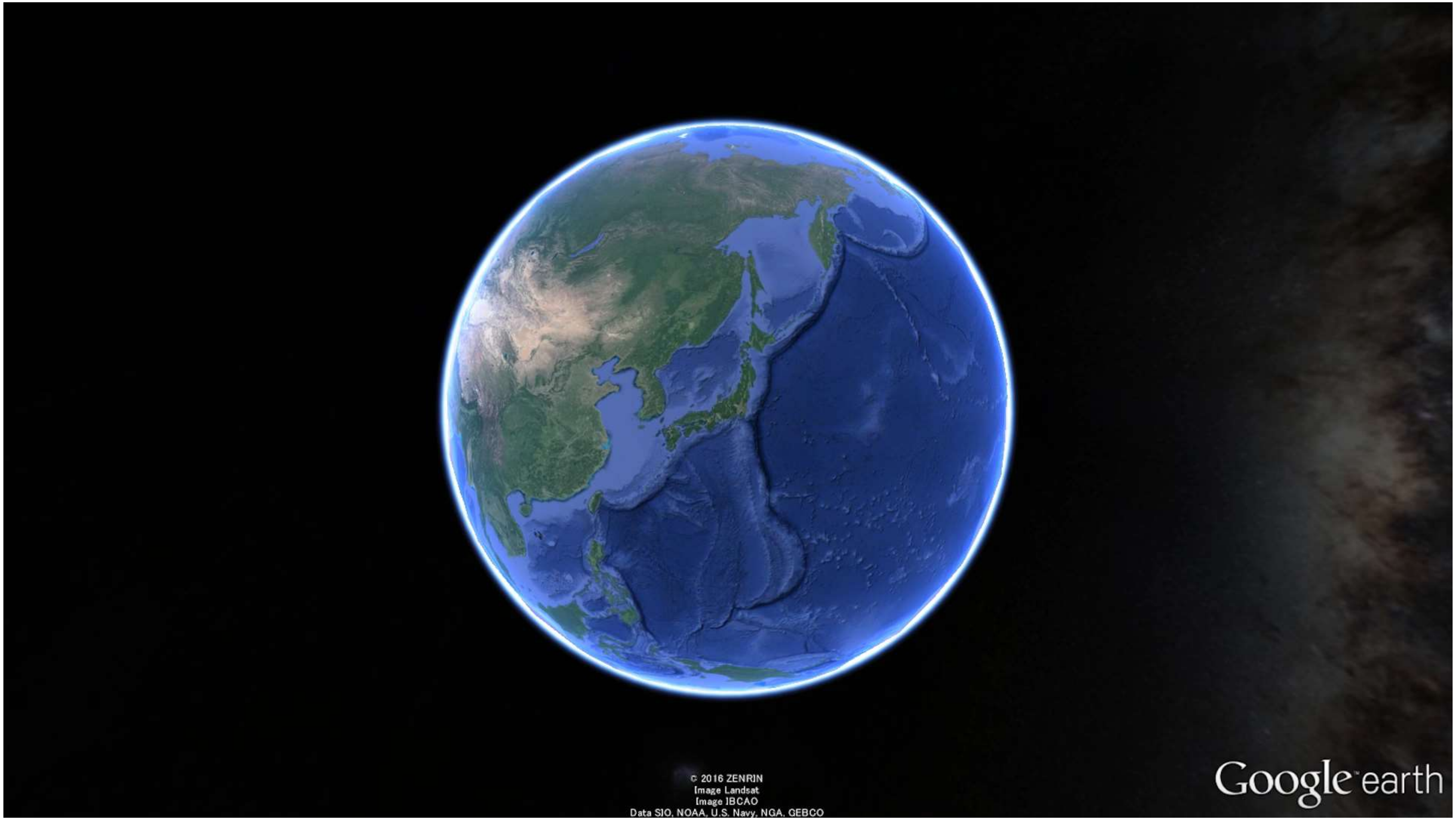
JMA observation

I looked at this obs
at 8 am.

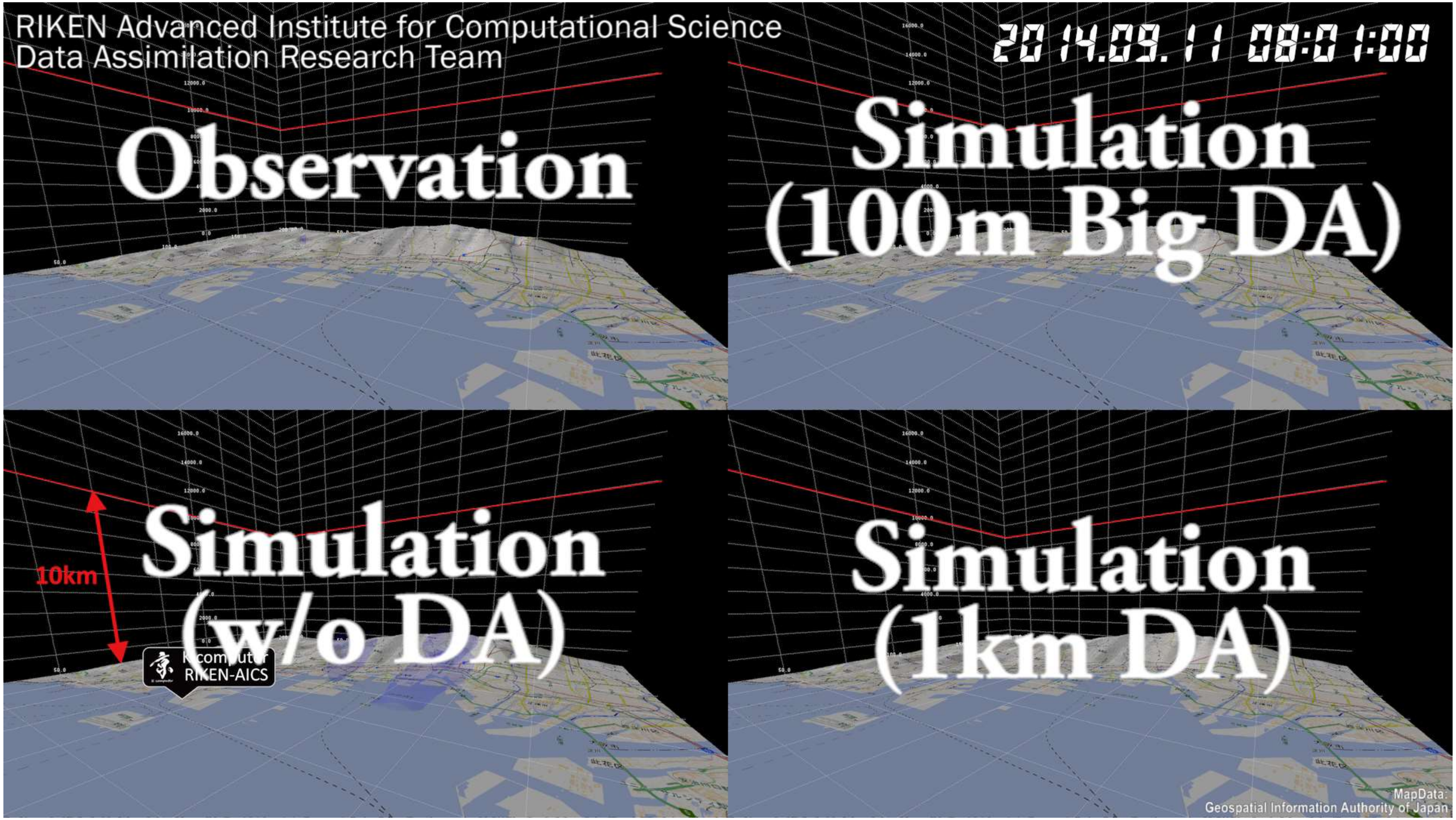
Decided to bike to office.
It takes about 30 min.

It is almost impossible
to predict from this obs!

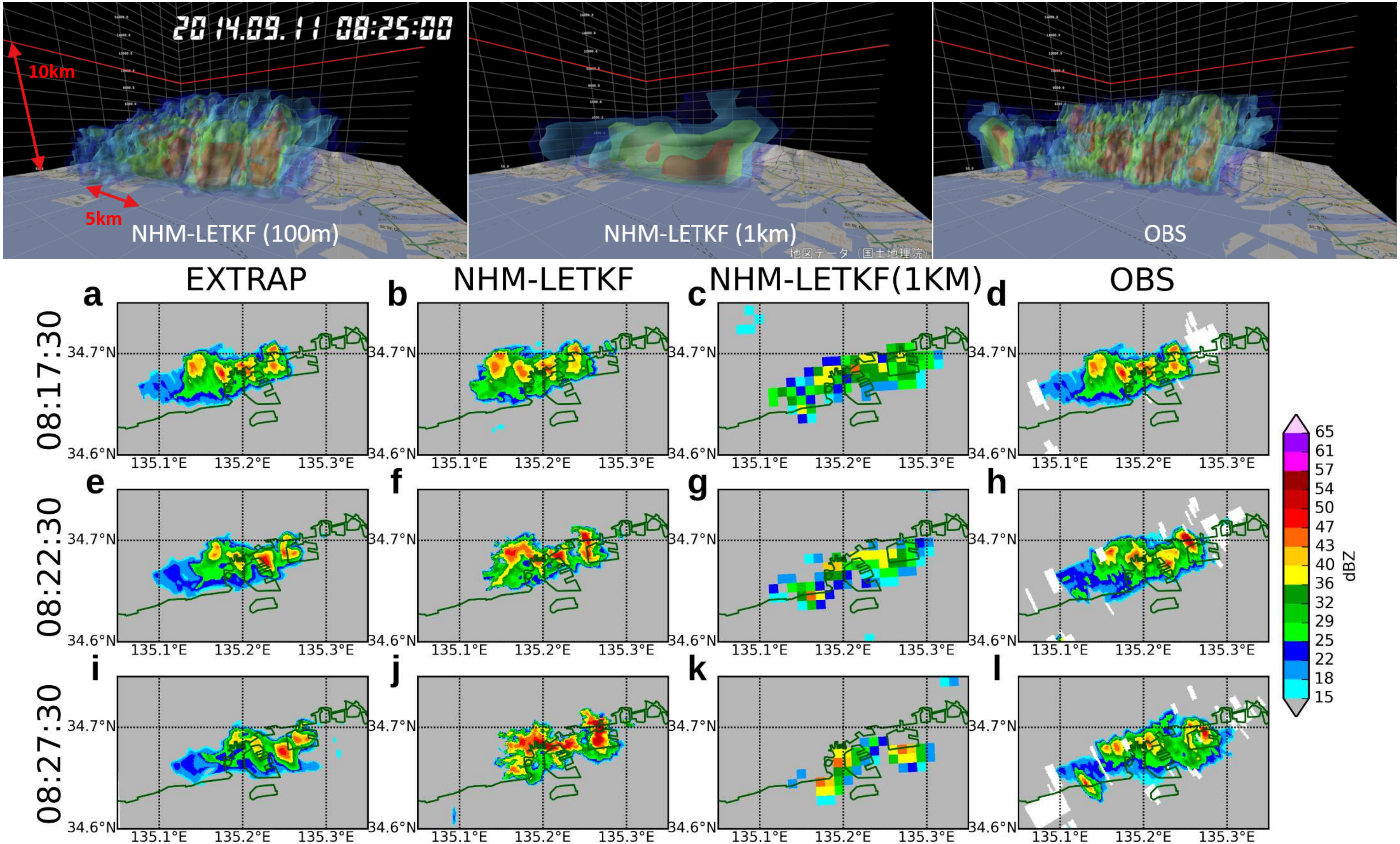
9/11/2014, sudden local rain



9/11/2014, sudden local rain



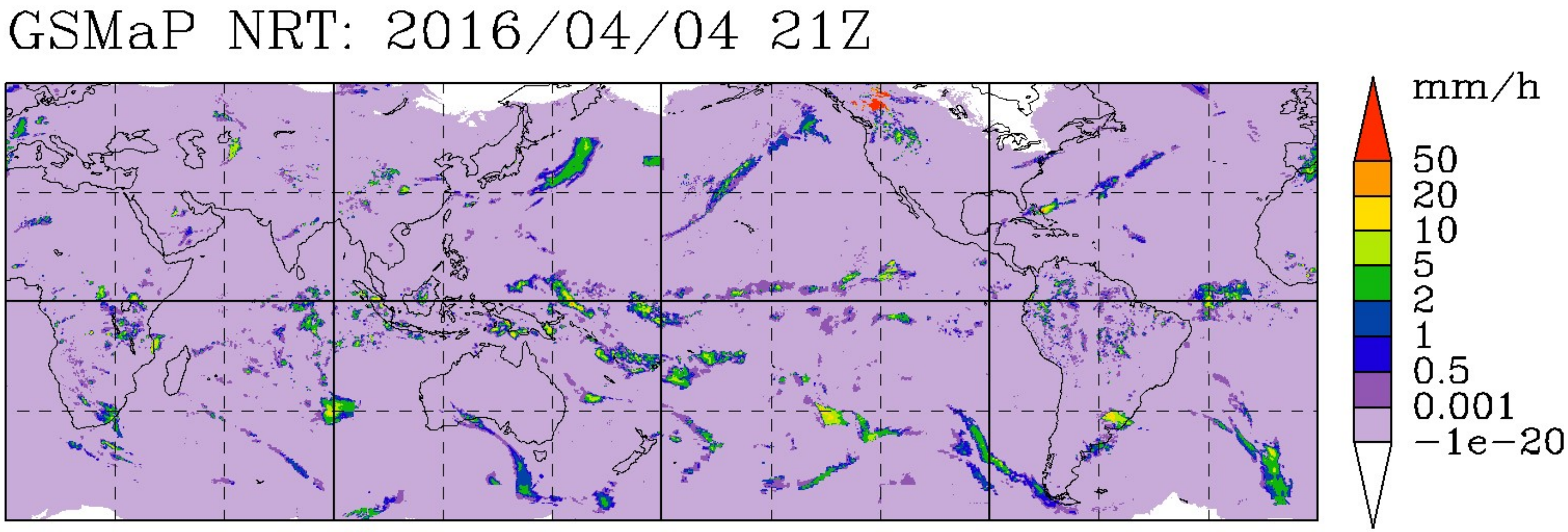
Inter-comparison (Case of 9/11/2014)



Updated Fig. 6-3 of ***Miyoshi et al. (2016, Proc. IEEE)***

GSMaP nowcasting

- Input: GSMaP Near-Real-Time product
  - Hourly, global (60˚S—60˚N), 0.1˚x 0.1˚



(***Otsuka et al. 2016***, WAF)

Nowcasting with Data Assimilation: A Case of Global Satellite Mapping of Precipitation

SHIGENORI OTSUKA AND SHUNJI KOTSUKI

RIKEN Advanced Institute for Computational Science, Kobe, Japan

TAKEMASA MIYOSHI

RIKEN Advanced Institute for Computational Science, Kobe, Japan, and Department of Atmospheric and Oceanic Science, University of Maryland, College Park, College Park, Maryland, and Japan Agency for Marine–Earth Science and Technology, Yokohama, Japan

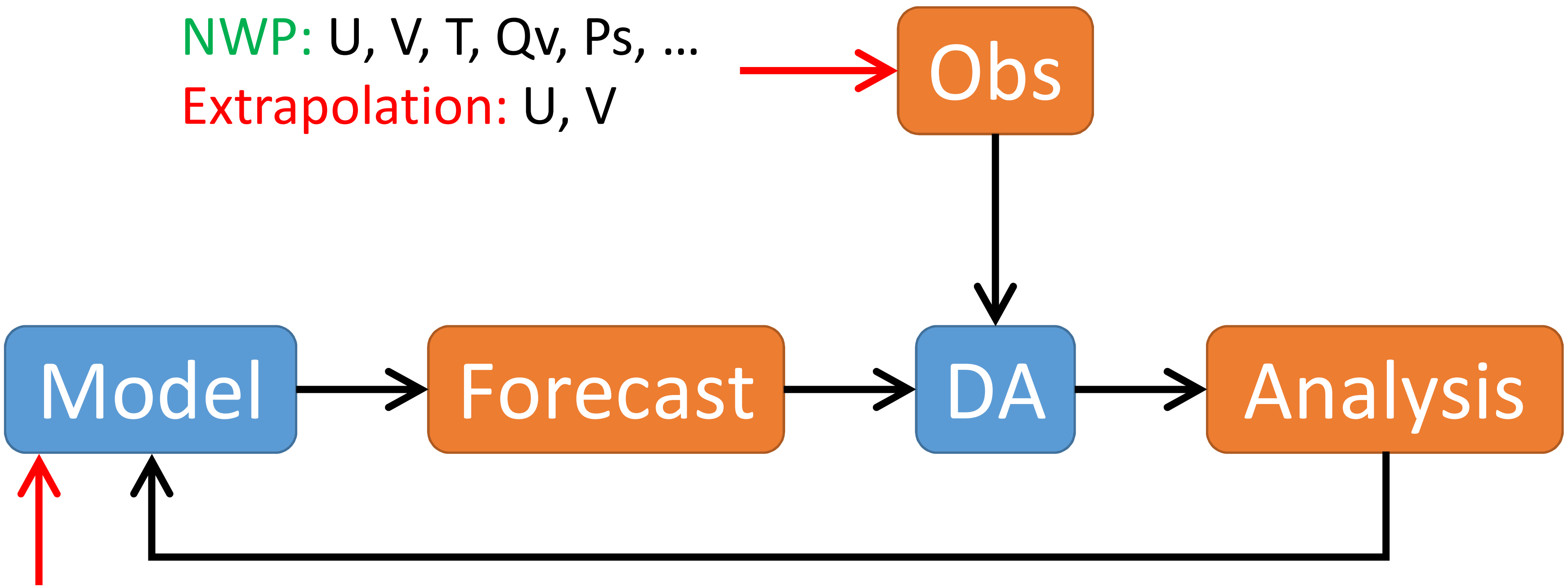
(Manuscript received 1 March 2016, in final form 13 June 2016)

ABSTRACT

Space–time extrapolation is a key technique in precipitation nowcasting. Motions of patterns are estimated using two or more consecutive images, and the patterns are extrapolated in space and time to obtain their future patterns. Applying space–time extrapolation to satellite-based global precipitation data will provide valuable information for regions where ground-based precipitation nowcasts are not available. However, this technique is sensitive to the accuracy of the motion vectors, and over the past few decades, previous studies have investigated methods for obtaining reliable motion vectors such as variational techniques. In this paper, an alternative approach applying data assimilation to precipitation nowcasting is proposed. A prototype extrapolation system is implemented with the local ensemble transform Kalman filter and is tested with the Japan Aerospace Exploration Agency's Global Satellite Mapping of Precipitation (GSMaP) product. Data assimilation successfully improved the global precipitation nowcasting with the real-case GSMaP data.

Applying DA to nowcasting

(*Otsuka et al. 2016*, WAF)



NWP:
full equations

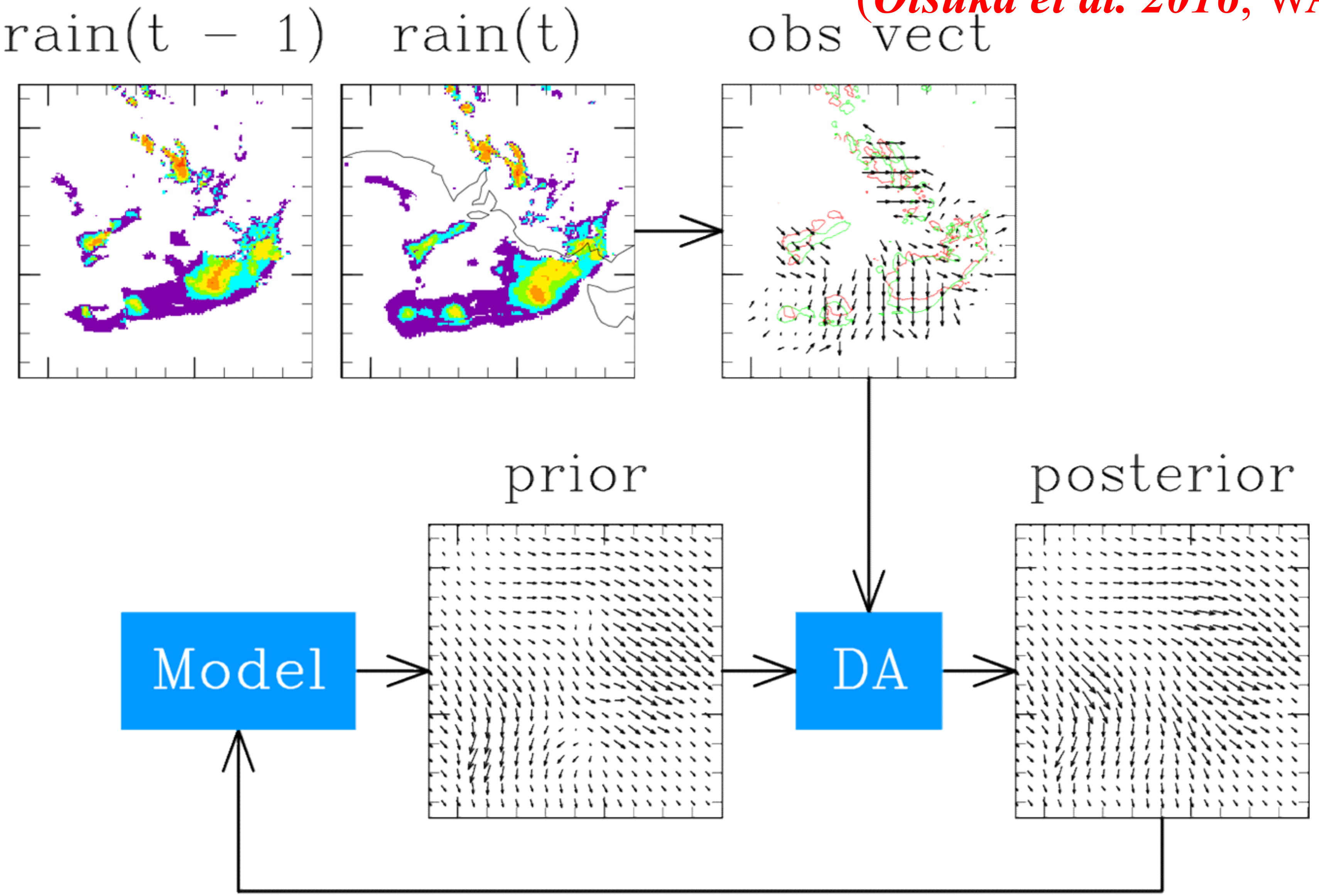
$$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} + \mathbf{f} \times \mathbf{u} = -\frac{1}{\rho} \nabla P$$

Extrapolation:
advection only

$$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} = 0$$

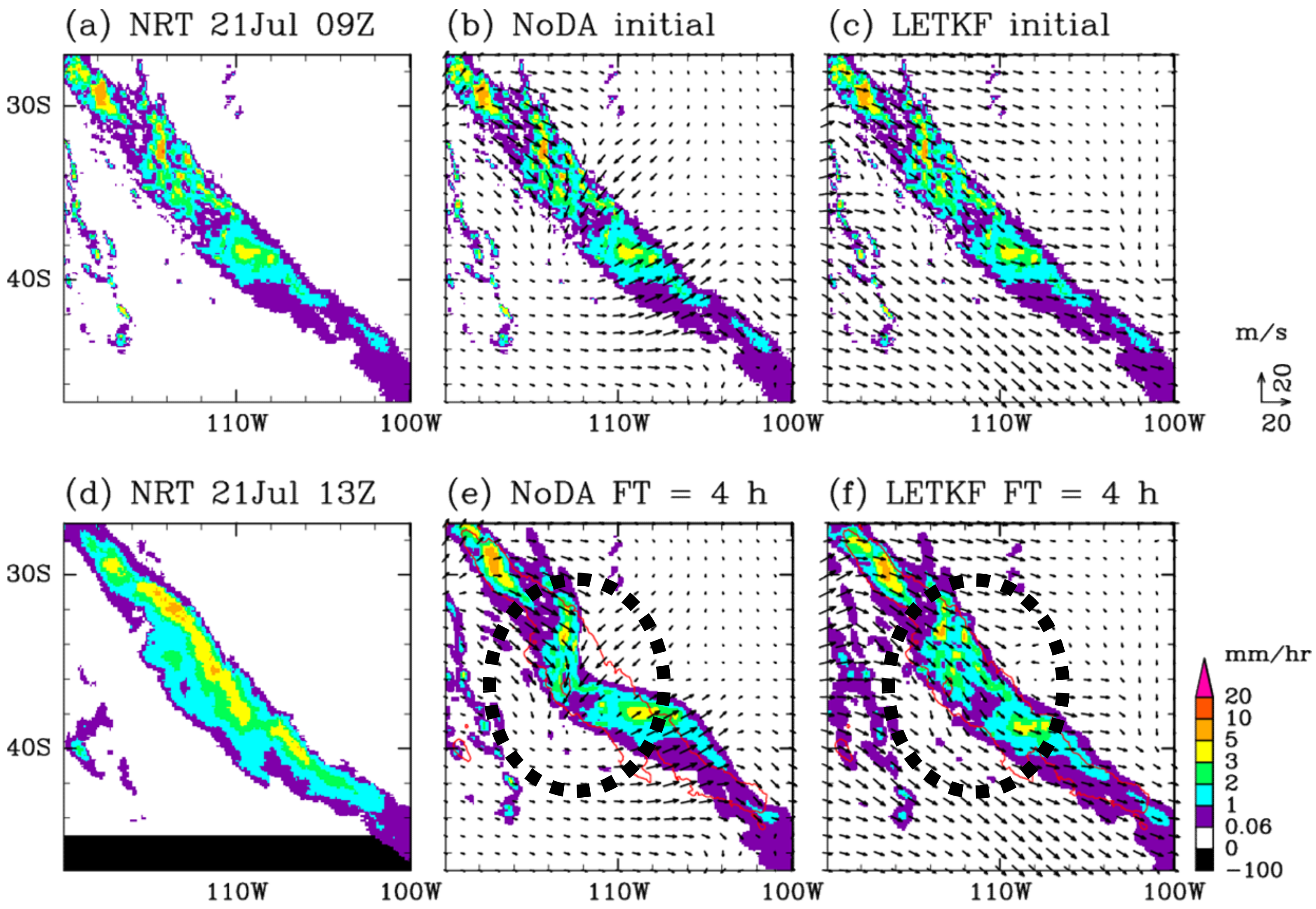
Applying DA to nowcasting

(***Otsuka et al. 2016***, WAF)



Advantage of DA

(*Otsuka et al. 2016*, WAF)



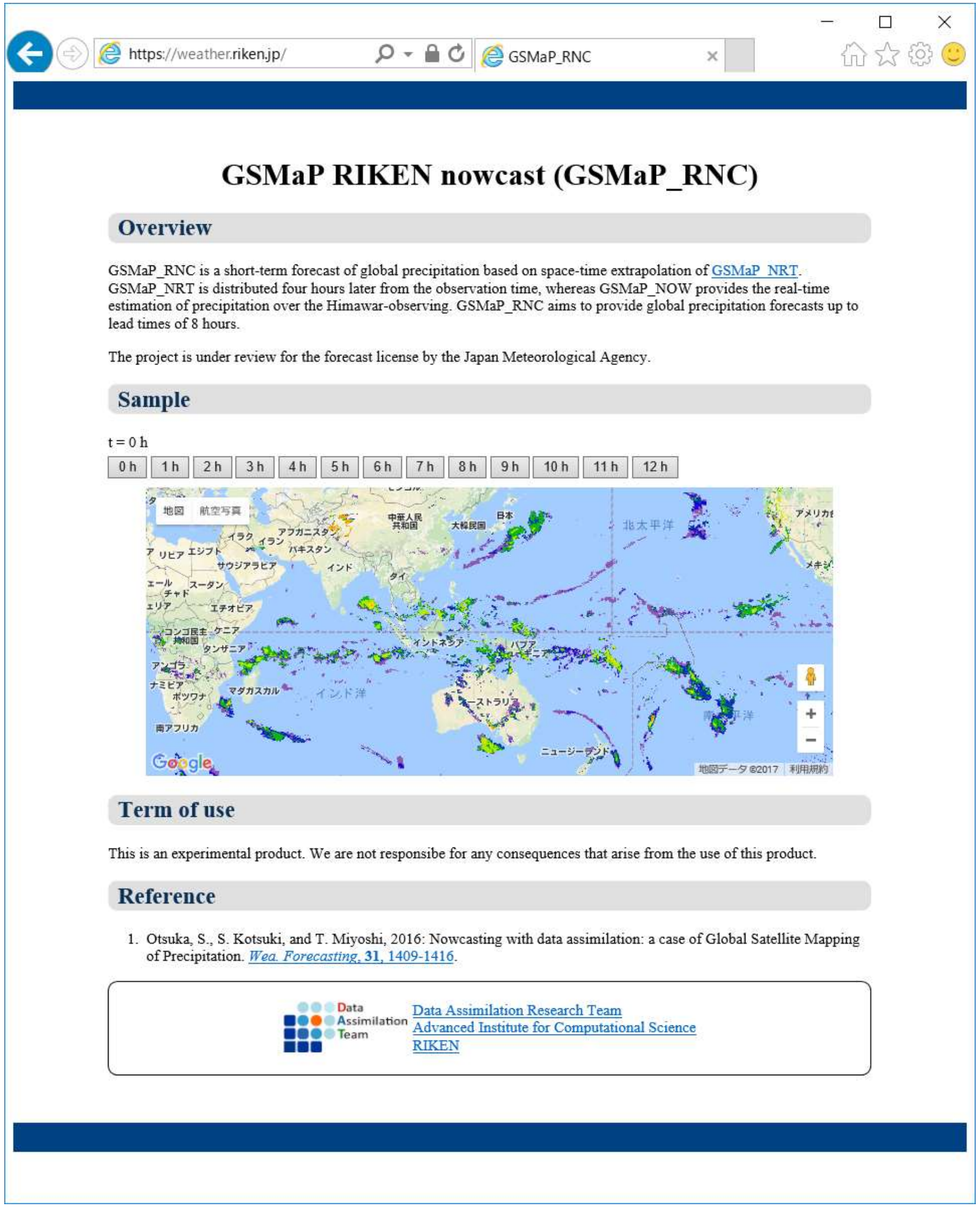
Real-time run

We are running 12-h nowcasting in real time.

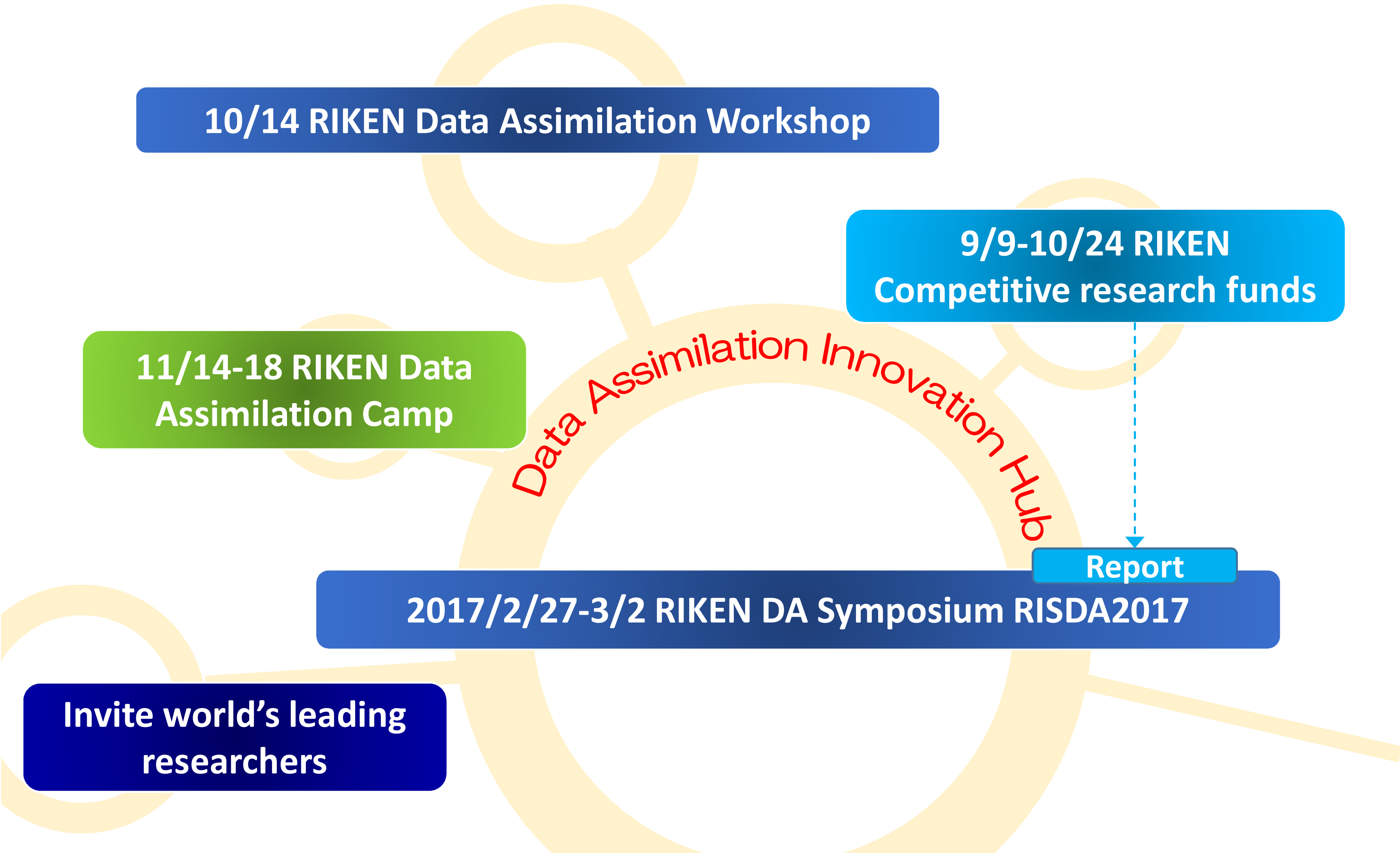
JMA forecast license was issued. Final preparation for the full operation.

➔http://weather.riken.jp

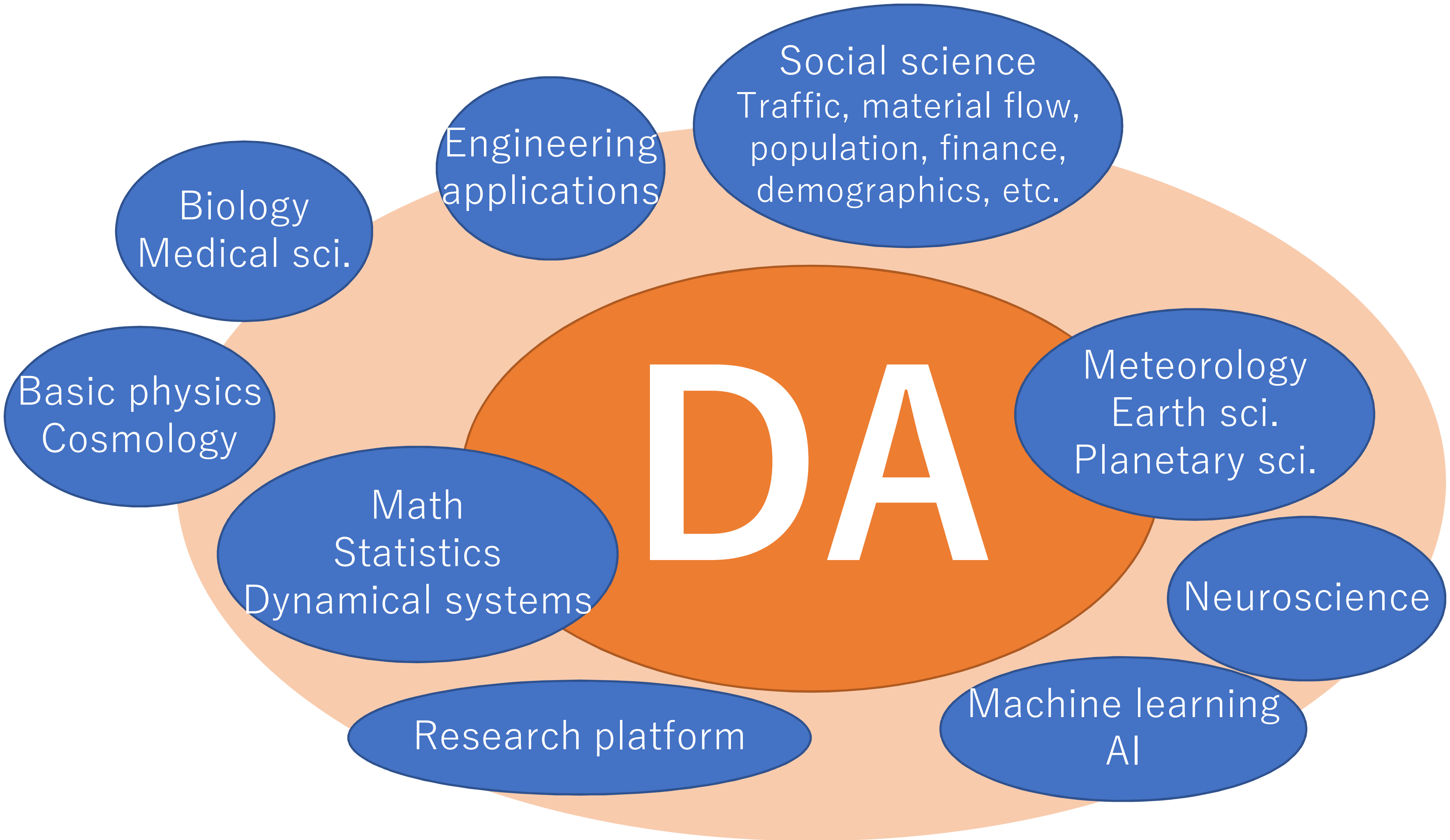
GSMaP_RNC
(Riken NowCast)



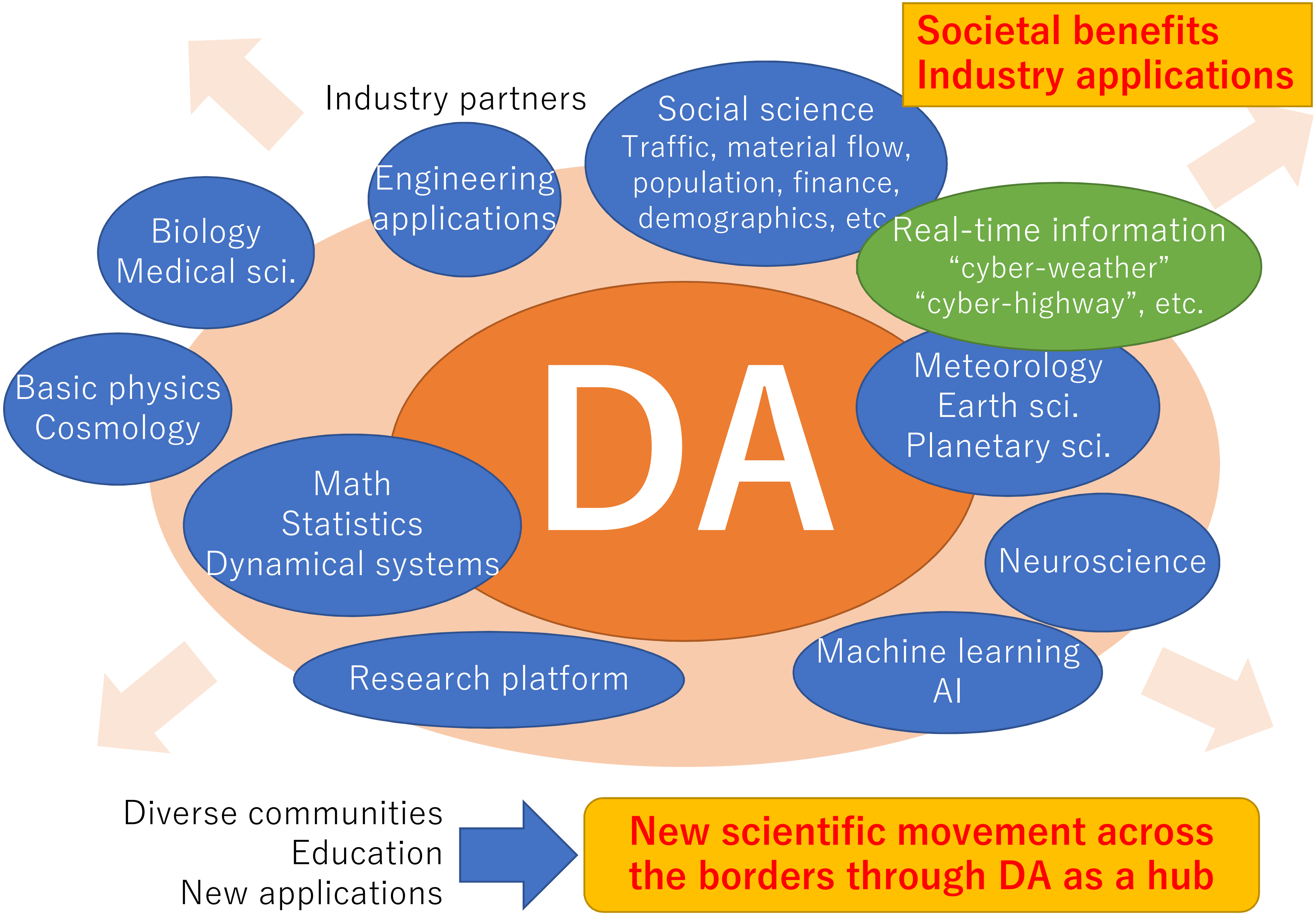
RIKEN President's Initiative on Data Assimilation Innovation Hub connecting mathematical science, experimental and observational science, and simulation science (FY2016)




DA
Math
Statistics
Dynamical systems
Meteorology
Earth sci.
Planetary sci.



Social science
Traffic, material flow,
population, finance,
demographics, etc.
Engineering
applications
Biology
Medical sci.
Basic physics
Cosmology
DA
Meteorology
Earth sci.
Planetary sci.
Math
Statistics
Dynamical systems
Neuroscience
Machine learning
AI
Research platform



Societal benefits
Industry applications
Industry partners
Social science
Traffic, material flow, population, finance, demographics, etc.
Engineering applications
Biology
Medical sci.
Real-time information
“cyber-weather”
“cyber-highway”, etc.
Basic physics
Cosmology
DA
Meteorology
Earth sci.
Planetary sci.
Math
Statistics
Dynamical systems
Neuroscience
Research platform
Machine learning
AI
Diverse communities
Education
New applications
New scientific movement across the borders through DA as a hub

iTHES Data Assimilation School

- 2016/9/12-14
- 44 participants
  - 16 from industry

- Keynote Lectures
- SPEEDY model exercize
- Presentations

RIKEN Data Assimilation Workshop

In October 2016

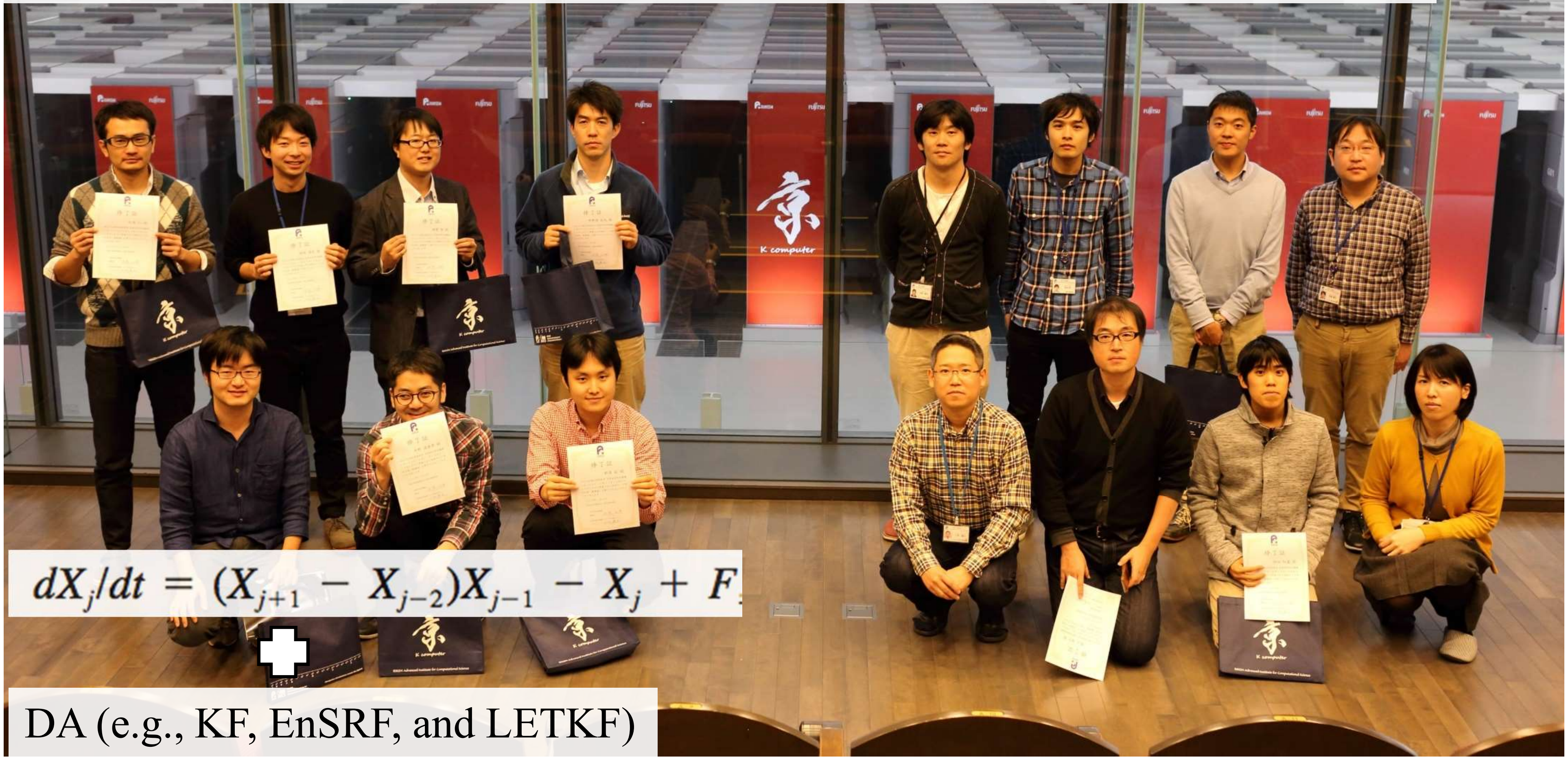
- The workshop aimed to create/expand a community for data assimilation by promoting communication among researchers applying data assimilation to various study fields.
- 34 participants from the fields of space science, brain science, drug discovery, iron and steel industry, and more!

1-week DA training camp

November 2016

Expanding the Japanese DA community!

- 10 participants (4 students and 6 researchers) from various fields (civil eng., atmos./ocean, cosmology, ecology, and biology).
- They developed a Lorenz-model DA system by "themselves".

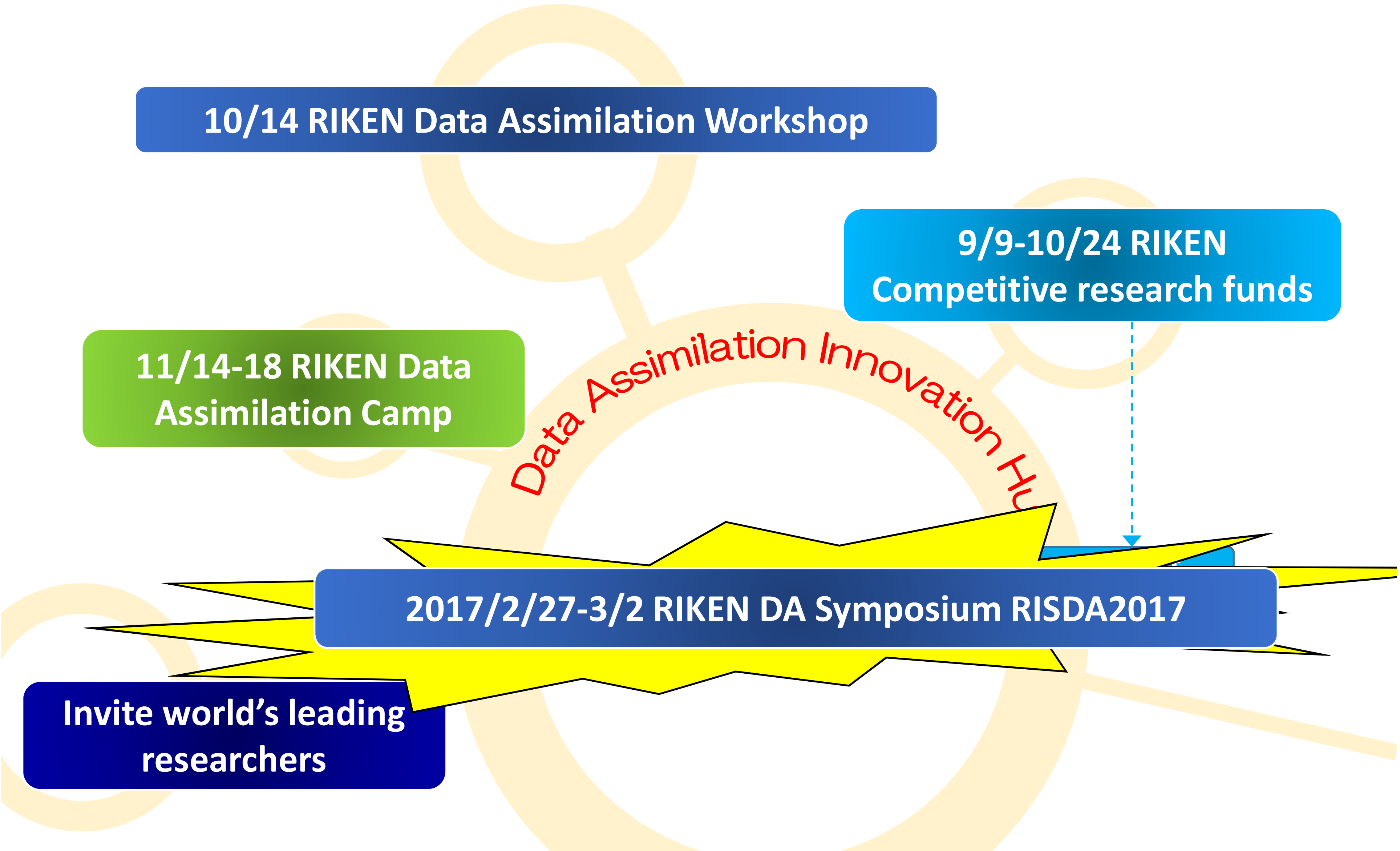


$$dX_j/dt = (X_{j+1} - X_{j-2})X_{j-1} - X_j + F$$

+

DA (e.g., KF, EnSRF, and LETKF)

RIKEN President's Initiative on Data Assimilation Innovation Hub connecting mathematical science, experimental and observational science, and simulation science (FY2016)



Schedules

Mon. February 27	Tue. February 28	Wed. March 1	Thu. March 2
9:00- Registration	9:00- Registration	9:00- Registration	8:30- Registration
9:30-10:45 [1] Opening / Keynote 1 (Chair: T. Miyoshi)	9:30-10:50 [6] Multi-scale & multi-component treatments 1 (Chairs: G. Ueno and S. Nakano)	9:30-10:30 [11] Applications in various physical and biological systems 1 (Chair: H. Abarbanel)	9:00-10:30 [16] Observational issues 1 (Chair: T. Kawabata)
10:45-11:05 Break	10:50-11:10 Break	10:30-10:50 Break	10:30-10:50 Break
11:05-11:50 [2] Keynote 2 (Chair: T. Miyoshi) 11:50-12:00 Group photo	11:10-12:20 [7] Multi-scale & multi-component treatments 2 (Chairs: G. Ueno and S. Nakano)	10:50-12:10 [12] Applications in various physical and biological systems 2 (Chair: H. Abarbanel)	10:50-12:20 [17] Observational issues 2 (Chair: T. Kawabata)
12:00-13:20 Lunch	12:20-13:10 Lunch 13:10-13:40 K computer tour (optional)	12:10-13:10 Lunch	12:20-13:20 Lunch
13:20-14:10 [3] Mathematical aspect 1 (Chair: R. Potthast)	13:40-14:30 [8] Mathematical aspect 2 (Chair: R. Potthast)	13:10-14:00 [13] Ideas for new applications 1 (Chairs: N. Nichols and J. Waller)	13:20-14:10 [18] Parameter optimization (Chair: J. Ruiz)
14:10-14:30 Break	14:30-14:50 Break	14:00-14:20 Break	14:10-14:30 Break
14:30-15:20 [4] Model-related issues 1 (Chair: N. Komori)	14:50-15:40 [9] Mathematical aspect 3 (Chair: R. Potthast)	14:20-15:10 [14] Ideas for new applications 2 (Chairs: N. Nichols and J. Waller)	14:30-15:20 [19] Mathematical aspect 4 (Chair: R. Potthast)
15:20-16:20 [p1] Poster Session 1	15:40-16:40 [p2] Poster Session 2	15:10-15:30 Break	15:20-15:30 [20] Closing (Chair: T. Miyoshi)
16:20-17:20 [5] Model-related issues 2 (Chair: N. Komori)	16:40-17:50 [10] High performance computing & Big data (Chairs: Y. Ishikawa and S. Greybush)	15:30-16:40 [15] Non-Gaussianity & nonlinearity (Chair: S. Penny)	== End of symposium==
-	-	18:30-20:30 Banquet	

RISDA2017 Sponsors

Hyogo Prefecture   Kobe City

JAXA

JST Japan Science and Technology Agency

RIKEN

AICS

iTHES
Interdisciplinary Theoretical Science Research Group

ENJOY!!

Chair: Takemasa Miyoshi