DAOS Links To WWRP/Mesoscale Weather Forecasting Research (MWFR) WG

Dale Barker, with acknowledgements to members of WWRP/WG-MWFR

MWFR Membership (DA Expertise)

- Jeanette Onvlee (KNMI, Netherlands, Chair)
- Dale Barker (Met Office, UK)
- Kazuo Saito (JMA/MRI, Japan)
- Volker Wulfmeyer (Univ. Hohenheim, Germany)
- Stephane Belair (Environment Canada)
- Jimy Dudhia (NCAR, USA)
- Mattias Rotach (Univ. Innsbruck, Austria)
- Yu Hui (CMA, China)

New for 2011:

- Peter Steinle (Bureau of Meteorology, Australia)
- Tiziana Paccagnella (ARPA-SIMC, Italy)

UK Convective-Scale Weather Impacts

Damaging winds

Birmingham Tornado
13/07/2005

Flash floods

Boscastle: 16/08/2004

Fog, low cloud

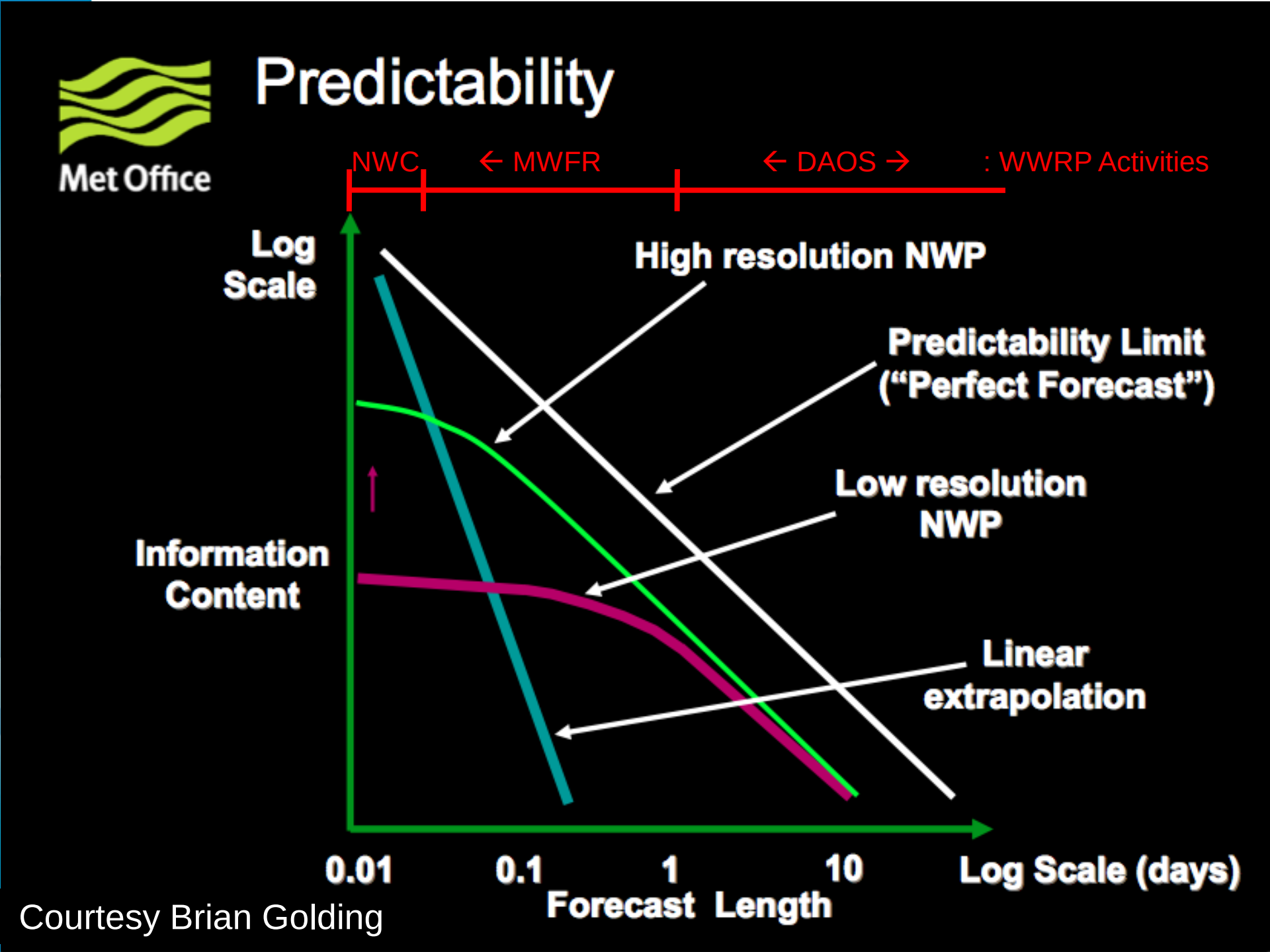
Luxair crash
06/11/2002 – 18 dead

Accident on M4
near Cardiff
10/12/2003

‘Weather’ varies over small scales, especially when extreme

Sue Ballard

Predictability



Courtesy Brian Golding

Comparison of NWP forecasts and STEPS / UKPP (advection) Nowcasts of Precipitation

RMSF error of 1hour accumulation > 1mm

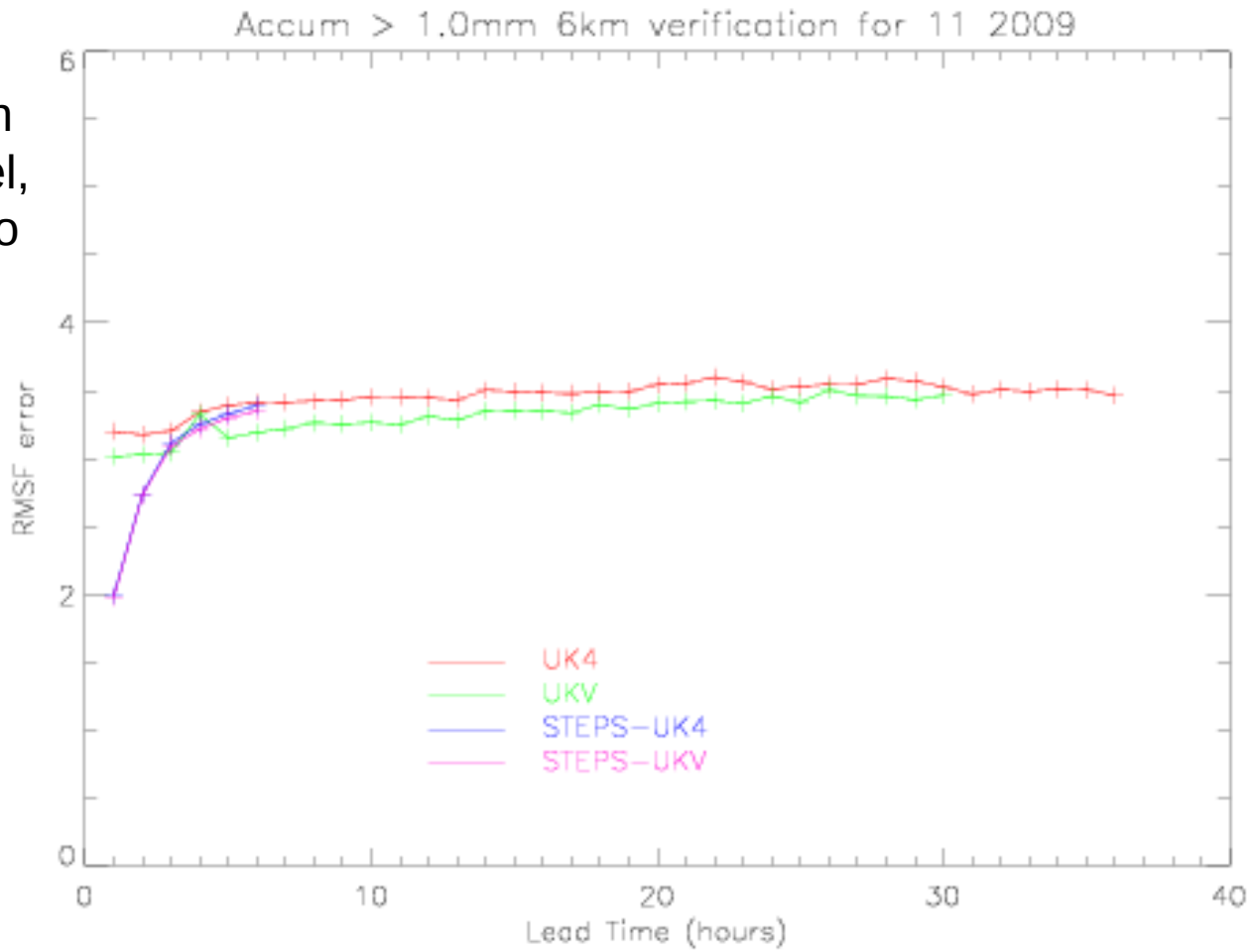
STEPS takes latest radar image and advects the rain according to an NWP model, whilst smoothly switching to NWP rain fields

$$RMSF = \exp(Sum/N)^{0.5}$$

$$Sum = \sum_{i=1,N} \log(F_i/O_i)^2$$

where
O=radar estimate, F=forecast

Both smoothed to 6km



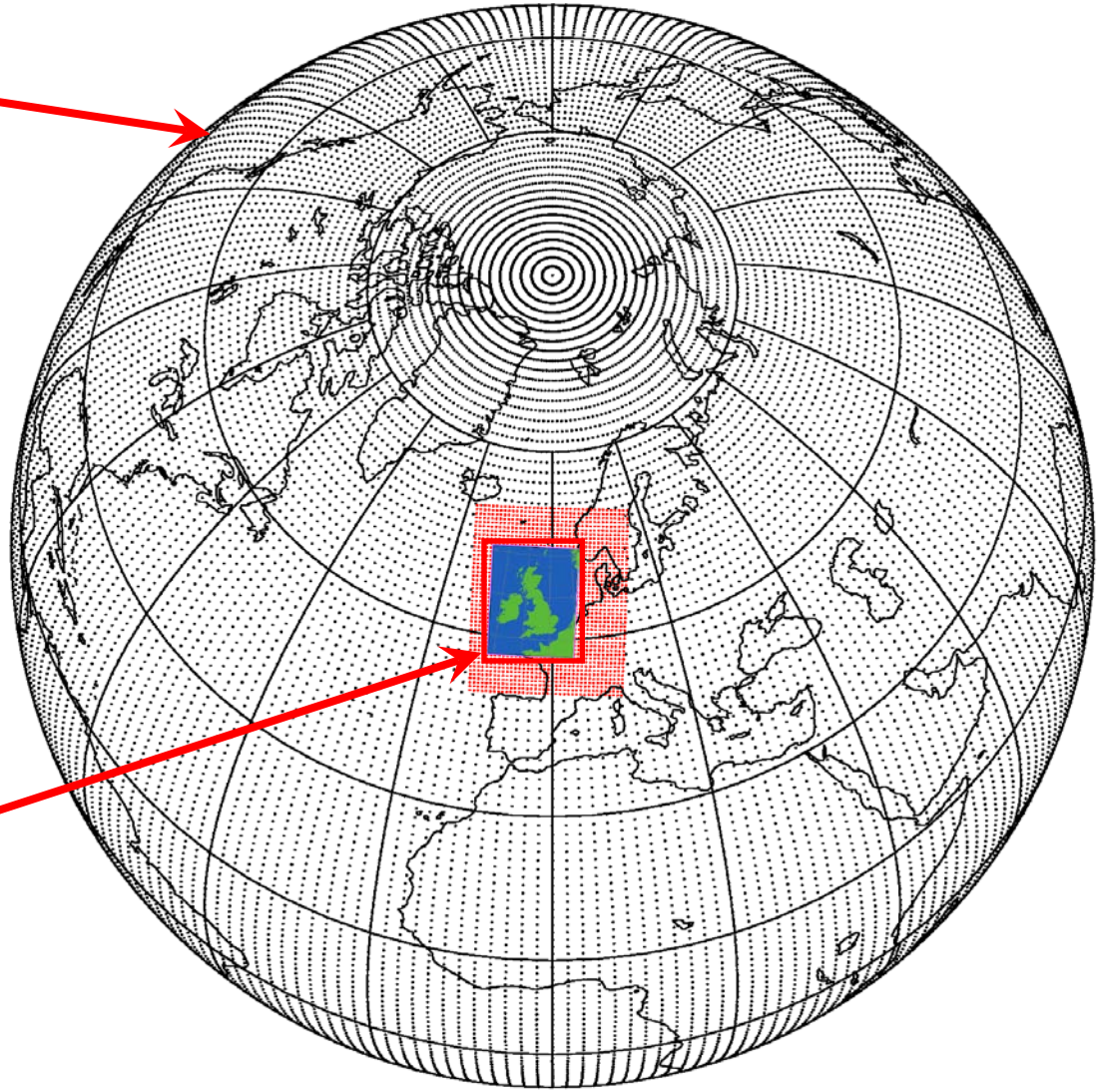
Operational NWP Configuration: 2013-2014

Global

- 17km 70L (80km top)
- Hybrid 4DVAR (40km inner-loop)
- 60 hour forecast twice/day
- 144 hour forecast twice/day
- 44/12member 33km Short-Range EPS

UKV

- 1.5km 70L (40km top)
- 3DVAR (hourly)
- 36 hour forecast, 4 times per day
- 12 member 2.2km High-Res Ensemble



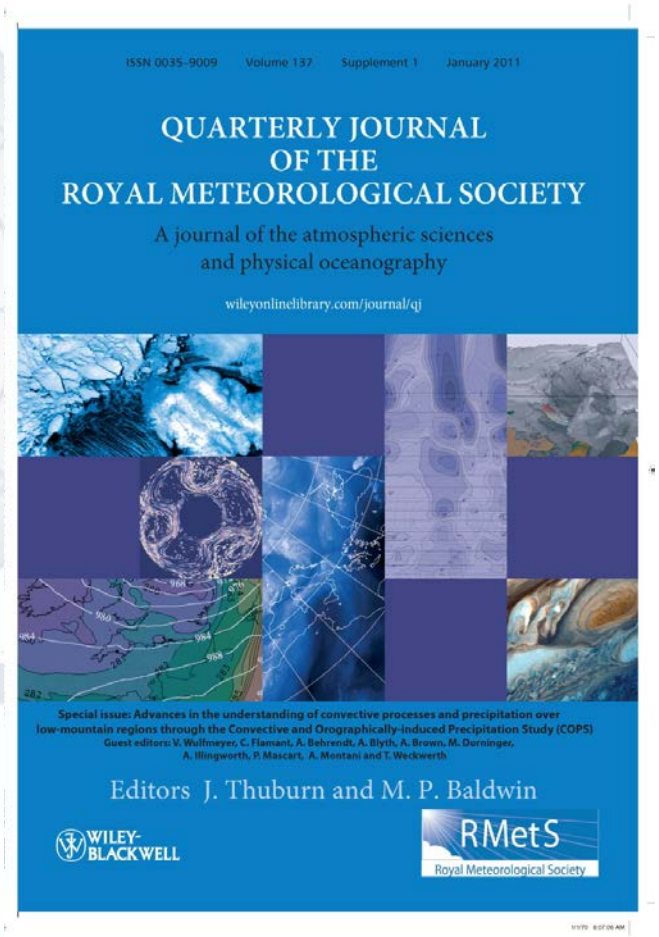
MWFR Activities

- Focus on 0.5-5km grid size models, extratropics
- Major focus to promote convective-scale **RDP** testbeds (e.g. COPS, B08RDP, Vancouver2010, HYMEX, TOMACS, Sochi2014, etc).
- Arrange/host dedicated **workshops** (e.g. 'Use Of NWP In Support of Nowcasting', Boulder, August 2011 -> BAMS summary article).
- Involvement in WMO Symposium organisation (DA, NWC).
- Liaison with other WMO WG (e.g. THORPEX/TIGGE-LAM, WWRP/NWC, JWGV, WGNE, …). No joint MWFR/DAOS activity as yet.
- Last (5th) meeting 10-11 September 2011, Berlin. Next May 2013, in Montreal, Canada.

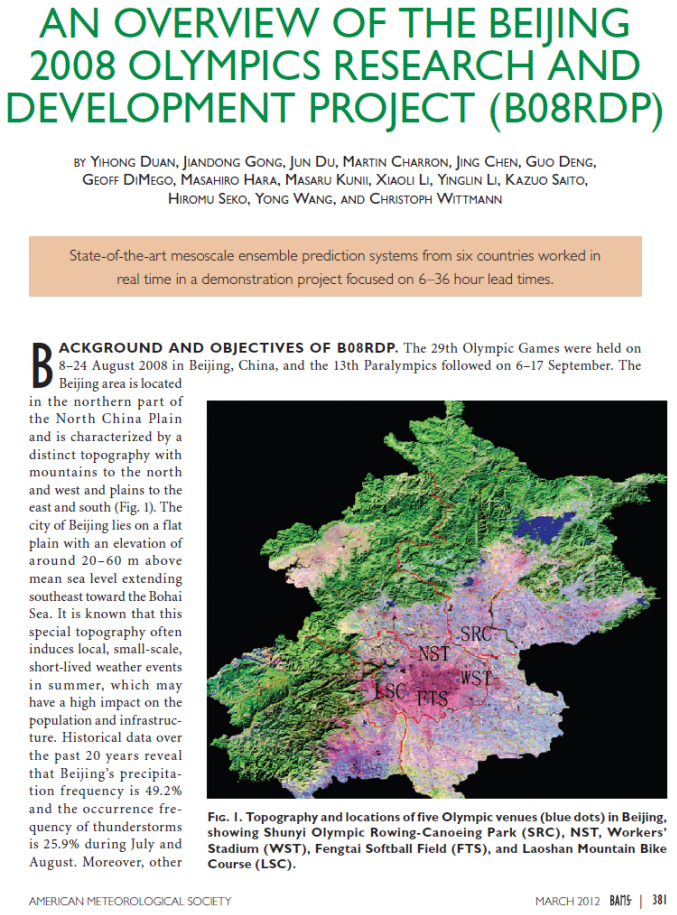
Completed RDPs

(see previous DAOS talk for more details)

- COPS: Dedicated QJRMS issue, 2011:



- Beijing 2008 RDP: BAMS Article



AN OVERVIEW OF THE BEIJING 2008 OLYMPICS RESEARCH AND DEVELOPMENT PROJECT (B08RDP)

BY YIHONG DUAN, JIANDONG GONG, JUN DU, MARTIN CHARRON, JING CHEN, GUO DENG, GEOFF DIMEGO, MASAHIRO HARA, MASARU KUNII, XIAOLI LI, YINGLIN LI, KAZUO SAITO, HIROMU SEKO, YONG WANG, AND CHRISTOPH WITTMANN

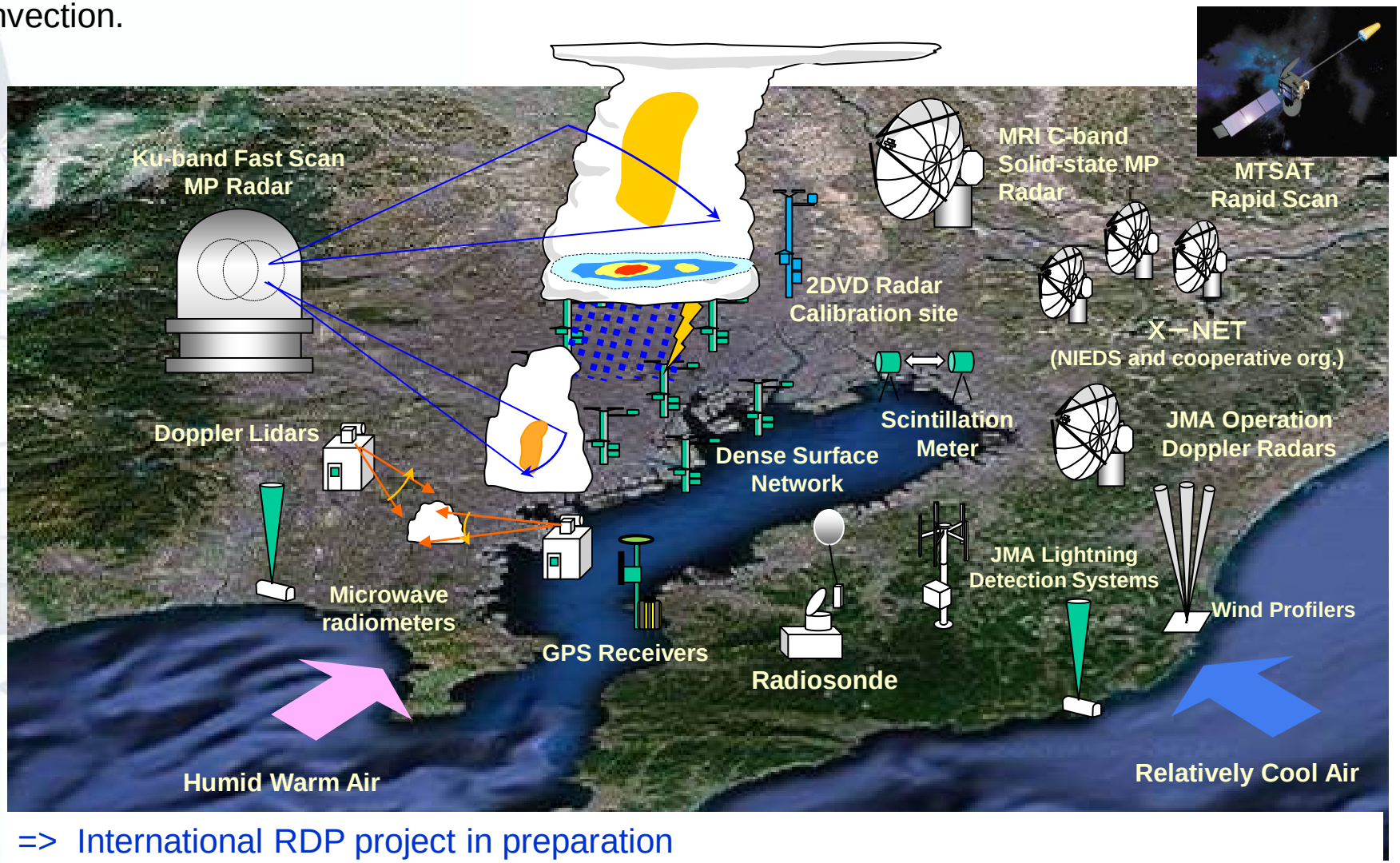
State-of-the-art mesoscale ensemble prediction systems from six countries worked in real time in a demonstration project focused on 6–36 hour lead times.

BACKGROUND AND OBJECTIVES OF B08RDP. The 29th Olympic Games were held on 8–24 August 2008 in Beijing, China, and the 13th Paralympics followed on 6–17 September. The Beijing area is located in the northern part of the North China Plain and is characterized by a distinct topography with mountains to the north and west and plains to the east and south (Fig. 1). The city of Beijing lies on a flat plain with an elevation of around 20–60 m above mean sea level extending southeast toward the Bohai Sea. It is known that this special topography often induces local, small-scale, short-lived weather events in summer, which may have a high impact on the population and infrastructure. Historical data over the past 20 years reveal that Beijing's precipitation frequency is 49.2% and the occurrence frequency of thunderstorms is 25.9% during July and August. Moreover, other

FIG. 1. Topography and locations of five Olympic venues (blue dots) in Beijing, showing Shunyi Olympic Rowing-Canoeing Park (SRC), NST, Workers' Stadium (WST), Fengtai Softball Field (FTS), and Laoshan Mountain Bike Course (LSC).

Field campaign in TOMACS (2011-2013)

A field campaign in the Tokyo metropolitan area with a dense observation network is conducted by MRI[1], NIED[2] and 12 research institutions in the summers 2011-2013, as a testbed for deep convection.



=> International RDP project in preparation

- Interest expressed by research groups in ~10 countries
- Draft plan tbd at international kickoff meeting Oct 2012

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Social Experiments on Extreme Weather Resilient Cities

Target: Local Heavy Rainfall in Urban Areas

Subject 1: Field Experiments TOMACS

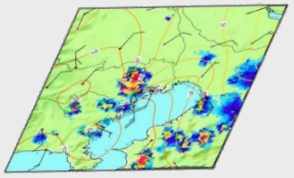
【Meteorology】

To obtain new insight on mechanisms of extreme weather

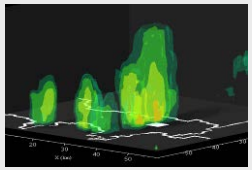
(1) Development of new technologies

(2) Field campaign in the Tokyo area (3) Statistical analysis

New observation facilities



Field campaign in the Tokyo Metropolitan area



Understanding the mechanism

to Issue More Accurate and Adequate Warning

to Evaluate and to Adapt the Nowcasting Systems

Subject 2: Early Detection and Prediction System

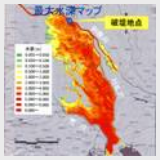
【Engineering】

Developments collaborating with end users

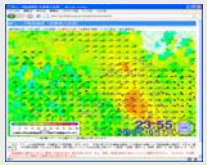
(1) Extreme weather nowcasting methods

(2) Development of test-beds of nowcasting systems

(3) Extreme weather database



Hazard Map



Nowcasting

Monitoring/Nowcasting System

Subject 3: Social Experiments

【Sociology】

Evaluation and adaption the developed nowcasting system

(1) Social experiments in rescue services, risk management, infrastructure and education

(2) Recommendations for extreme weather resilient cities

FROST-2014: FORECAST and RESEARCH in the OLYMPIC SOCHI TESTBED

To improve, develop, demonstrate, and exploit:

- Enhanced nowcasting observations in winter complex terrain;
- mesoscale (250m-2km) deterministic forecasts of meteorological conditions in complex terrain environment;
- regional EPS forecast products (>7km res);
- nowcasts of high impact weather phenomena in complex terrain.

To improve understanding of physics of high impact weather phenomena in winter complex terrain:

To demonstrate/deliver forecasts in real time to Olympic forecasters and decision makers in order to verify and quantify societal benefits of nowcasts and forecasts

Thoughts on DAOS/MWFR Links

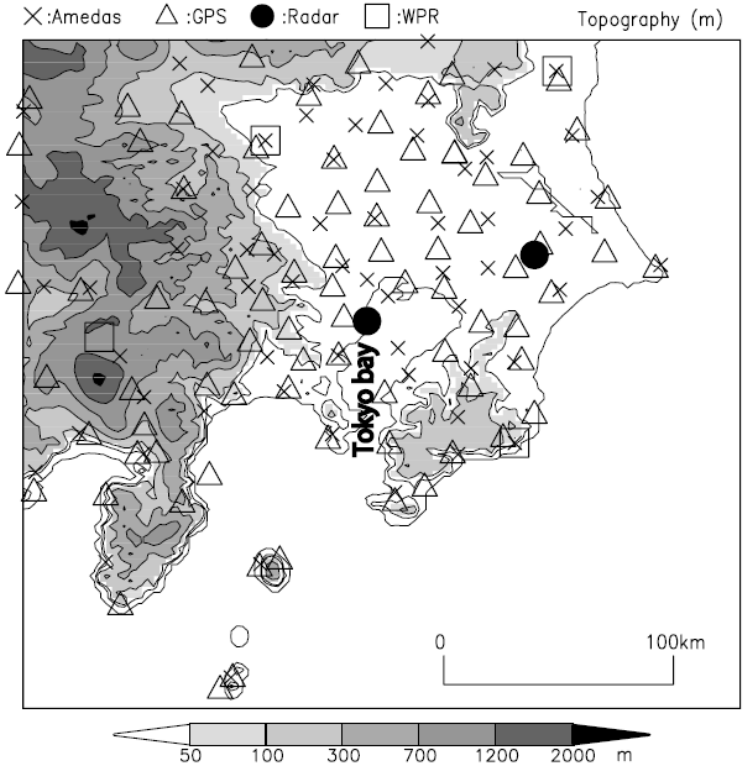
- WWRP/MWFR (convective-scale DA, <1day) complements WWRP/THORPEX/DAOS (Global DA, 1->=14day).

- MWFR closest links so far with other WWRP groups: Nowcasting, Verification, etc.

- Existing/potential MWFR/DAOS interactions:
  - Shared expertise in DA (caveat: we need to think differently for convective-scale, e.g. technique, observation sensitivities, etc).
  - Should MWFR provide guidance on high-res. DA for future global DA (e.g. cloud/precip DA)?
  - Provision of optimal LBCs for MWFR RDP/FDPs (WGNE?).
  - Treatment of large-scales within high-resolution DA.
  - Observation selection for low/high-res DA.
  - Assess added value of high-res. vs global/regional NWP/DA.

Cloud resolving 4DVAR with cloud microphysics

(Kawabata et al., 2011; *Mon. Wea. Rev.)*



Kessler warm rain process was implemented in LT/ADJ models.

4DVAR assimilation of

- Doppler Radar's Radial Winds
- Radar Reflectivity
- GPS precipitable water vapor
- Surface observations (wind, temperature)

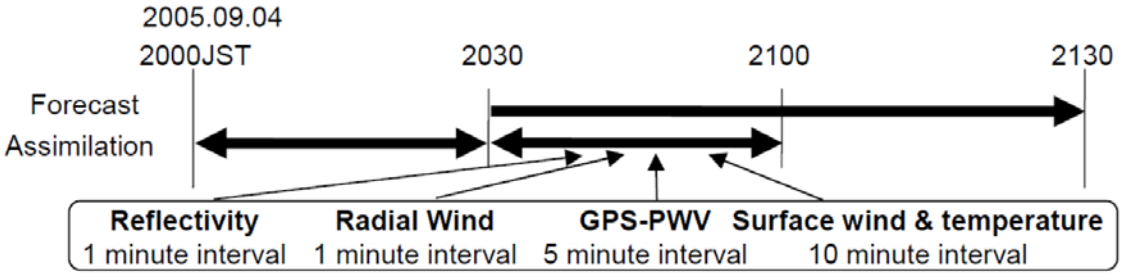


FIG. 9. Schematic diagram of assimilation experiment.

Scientists showing interest

- Korea: Pugyon National Univ., D.-I. Lee (2DVD, Pol.radar, nowcasting and modeling)
  Yonsei Univ., S.-Y. Hong (boundary layer and cloud microphysics)
  Ewha Womans Univ., S.-K. Park (sensitivity analysis and optimal parameter estimatio
- USA: CSU, V. Chandrasekar (DFW)
  NCAR, J. Sun (data assimilation)
  Univ. Georgia, M. Shepherd (urban meteorology)
  CAPS/OU, M. Xue (NWP nowcasting, data assimilation, radar meteorology)
  Univ. Massachusetts, B. Philips (social experiments at D-FW)
- Brazil: Sao Paulo Univ., A. Pereira（nowcasting and modelling)
- Australia: CAWCR, P. Steinle (nowcasting, data assimilation)
- Austria: ZAMG, Y. Wang (nowcasting, ensemble)
- Canada: EC, P. Joe (nowcasting), S. Belair (urban modeling)
- Germany：DWD, H. Reich (data assimilation)
- Hong Kong: HKO, P.-W. Li (radars and nowcasting)
- China: Nanjing University, K. Zhao (radar meteorology, modeling)

Milestones

- Field campaign: Summers of 2011-2013
- Symposium and Kickoff meeting
  - International symposium on extreme weather on Urban area
    23-24, October, 2012, Tokyo (Okuyo Hall)
  - TOMACS RDP Kick-off Meeting
    25, October, 2012, Tsukuba (MRI or NIED)
- RDP Proposal: April, 2013
- RDP International Workshops: Autumn, 2013-2015

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Organization

- International Science Steering Committee
- Local organization committee
- International Advisory Board

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Other (possible) new projects

- WG-MWFR members participating in:
  - PPP project
  - INCA-CE SAB
- Proposal to cooperate with JWGFVR in ICP2 project (intercomparison of spatial methods in complex terrain, using COPS (and HYMEX?) data)
- Role in Lake Victoria project under consideration
- Role in TM-related activities under consideration

Workshop “Use of NWP in support of nowcasting”

Joint WGNR-WG-MWFR Workshop, August 2011, Boulder.

Aims:

➔Strengthen interaction between NWP and NWC communities

➔Confront present and future prospects of NWP for NWC with challenges of NWC, recommendations on way forward

- ~45 participants
- Article for BAMS in preparation
- Workshop considered necessary and useful by participants, wish expressed for follow-up workshop in a few years

HiRCoT12

- Workshop in Vienna, February 2012
- Aims: review status, prospects and challenges of high-resolution modelling in complex terrain and the problems therein
- Sessions on limitations in parameterizations, numerical issues, input data and initialization, and computational issues
- Introductory presentations, much discussion
- Participants: ~30
- WMO support requested/used to make participations more "world-wide"

- "High-resolution numerical modeling in complex terrain is a hot issue, many groups have the same problems (and some have also solutions) and all this is worthwhile to be shared in the community."
- A publication summarizing the discussions and conclusions is intended.

Various other activities

- Preparations for workshop on physiographic data (temporarily halted)
- Organization of LAM EPS training for duty forecasters in cooperation with EUMETCAL (March 2012)
- Activities aiming at promoting international exchange of radar volume data within Europe for research and operational purposes (assimilation in NWP models)
  - Contacts EUMETNET/SRNWP and OPERA
  - Radar data for HYMEX SOP

Meetings/contacts

- Last WG-MWFR meeting: Berlin, September 2011
- New members from China, Australia. 9 members.
- Contacts with JWGFVR
  - Joint meeting, Berlin, Sept 2011
  - verification of clouds, extreme weather, LAM EPS, ...
  - Organize ICP2?
- Contacts with WGNR
  - Workshop on use of NWP as tool in support of nowcasting
  - Nowcasting Symposium, Rio de Janeiro August 2012
  - Common activities in FROST14, Hymex, TOMACS, INCA-CE, Lake Victoria, …
- Contacts with WGNE/GASS
  - Grey zone experimentation
  - Physiography workshop?
- Thorpex/DAOS: WG-MWFR participation
- TIGGE-LAM: chair ex-officio member of WG-MWFR

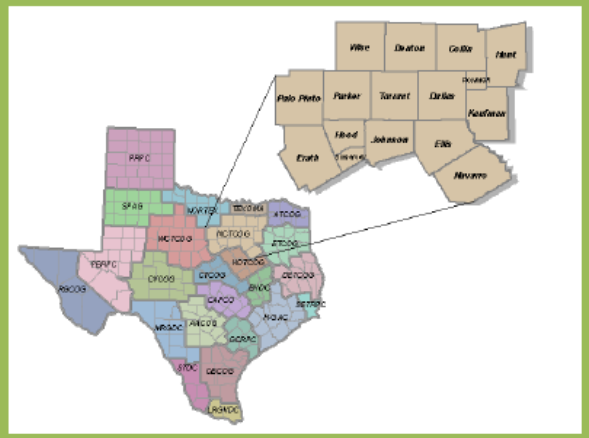
6. Liaison with the Dallas Fort Worth Urban Weather Demonstration

THE DALLAS FORT WORTH URBAN WEATHER DEMONSTRATION SYSTEM

BRENDA PHILIPS AND V. CHANDRASEKAR

The Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) has partnered with the North Central Texas Council of Governments (NCTCOG) and the National Weather Service (NWS) to establish the nation's only Urban Weather Demonstration System, the Dallas-Fort Worth Testbed (DFWT). Our vision is to create a national model for the future of urban weather observation from a technological, operational, and socioeconomic perspective where multiple stakeholders jointly fund operation of the testbed. We invite additional private, federal, and municipal organizations to join us in developing the DFWT.

Over the past eight years, CASA, a National Science Foundation Engineering Research Center, has developed and demonstrated a new and effective weather sensing paradigm based on densely-spaced networks of small, low-power radars. These networks observe the lowest levels of the atmosphere at a higher spatial and temporal resolution than is currently afforded by operational NWS radars. Such observations allow for precise flood, forecasters, and the public. The observations and forecasts provided by the CASA network increased lead time of tornado and flood warnings. CASA plans to deploy a similar network in the Dallas/Fort Worth (DFW) Metroplex to demonstrate public safety and economic benefits in a densely-populated urban environment, where the accurate and timely prediction of severe weather events becomes more challenging and critical. The major issue to be addressed in the DFW region is the urban flooding.



Map of the North Central Texas Metro region where the proposed radar network will be deployed (courtesy NCTCOG).

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Major COPS Results and Conclusions

1) **Logistics: Data collection and harmonization, common visualization tools, air traffic control, data base, ...**

2) **Processes:**

   better understanding of processes influencing convective precipitation over orography (behaviour of evapotranspiration, CAPE and CIN, influence of thermodynamically-induced flow on convective initiation,...)

3) **Model performance and verification: Extensive validation of convection-permitting vs coarser models**

   (overestimation of transpiration at low soil moisture, too deep BL over mountains, vertical wind too low in convergence zones, windward-lee effects leading to displacement of convergence zone triggering CI at wrong locations, better diurnal cycle of precip and QPF by convection-permitting models.)

Major COPS Results and Conclusions

4) Demonstration of new observations:

- **Water-vapor and temperature lidar: very high vertical and temporal resolution as well as accuracy.**
- **GPS STD and tomography very useful for studying moisture variability.**
- **VERA and C-band Doppler radar (partly dual-Doppler) applied for detection of convergence zones.**
- **Combination of ground-based and airborne sensors investigated aerosol-cloud microphysics.**
- **Lidar aerosol data improved the simulation of precipitation during Saharian dust outbreak over COPS area.**

- **Much more can be exploited with the COPS data set, emphasis should be on studying ABL and microphysics.**
- **New lidar technology available for long-term operational measurements.**

Major COPS Results and Conclusions

5) Data assimilation and predictability:

- **Positive impact of the assimilation of GPS STD on QPF.**
- **Positive impact of Doppler radar and reflectivity.**
- **3DVAR provides benchmark for DA systems on the CP scale**
- **Orography can increase the predictability of convection.**
- **The lead time is not limited by the lifetime of convective cells but by the lifetime of the forcing conditions leading to convection.**
- **Multi-model ensemble provided improved simulation of convective cells (14 h lead time).**

- **COPS and D-PHASE data can be used as DA testbed but testing and comparison of different DA techniques still needs to be done.**
- **More impact studies possible.**
- **COPS-D-PHASE data set unique for verification studies.**

HYMEX/TTM4

- One of the (newest) task teams of HYMEX, led by a WG-MWFR member
- Aim: set up testbed for DA based on HYMEX SOP data; organize/perform data assimilation experiments on e.g.:
  - Improved assimilation techniques (flow-dependent, hybrid ensemble assimilation, …)
  - Impact of new high-resolution observation types and how to make the best possible use of them
  - Rapid update cycling, spinup, balance and usefulness of mesoscale models/analysis systems for nowcasting
- Interest for participation gathered, solidify plans in next meeting at HYMEX workshop