Overview of the Beijing 2008 Olympics Forecast Demonstration Project

WANG Jianjie Tom Keenan et al.

气象出版社
China Meteorological Press

Overview of the Beijing 2008 Olympics Forecast Demonstration Project

WANG Jianjie, Tom Keenan, Paul Joe, Jim Wilson, Edwin S. T. Lai, LIANG Feng, WANG Yubin, Beth Ebert, YE Qian, John Bally, Alan Seed, CHEN Mingxuan, XUE Jishan, Bill Conway

气象出版社
China Meteorological Press

图书在版编目(CIP)数据

北京 2008 奥运预报示范项目报告＝Overview of the Beijing 2008 Olympics Forecast Demonstration Project：英文/王建捷等编著．—北京：气象出版社，2011．1

ISBN 978-7-5029-5156-6

Ⅰ．①北…　Ⅱ．①王…　Ⅲ．①天气预报-研究-英文　Ⅳ．①P45

中国版本图书馆 CIP 数据核字(2011)第 008673 号

Overview of the Beijing 2008 Olympics Forecast Demonstration Project

by

WANG Jianjie, Tom Keenan, et al.

Publisher: China Meteorological Press

(46 Zhongguancun Nandajie, Haidian District,

Beijing 100081, China)

(http://www.cmp.cma.gov.cn　E-mail: qxcbs@cma.gov.cn)

First published in November 2011

First printed in November 2011

Tel:86-10-68407112

Press Responsible Editors: ZHANG Panjuan, WU Xiaopeng

Printed in Beijing

PREFACE

The 29th Olympic Games which were held in Beijing from August 8 to 24 in 2008 were the largest ever Olympic Event in history. New and higher demands were proposed for weather services from a variety of competition events, activities related to the Olympic Games, the public daily life and the city operation during the Games. Also, the games occurred during the later half of summer when the risks of severe convective weathers such as heavy rainfall, thunderstorms, strong winds, hails, etc. appeared higher; timely weather forecast and warning to the development and evolution of these weather phenomena were a significant challenge for the international meteorological community. Therefore, to develop and apply the advanced short-term, nowcasting weather technique as well as its operational system for severe convective weathers became one of the key and most important tasks for Beijing Olympic weather services.

Based on the success and experience of the Forecast and Demonstration Project for the Sydney 2000 Olympic Games, China Meteorological Administration (CMA) applied in 2003 to the World Meteorological Organization (WMO) to organize and implement the Beijing 2008 Olympic Forecast Demonstration Project targeted to enhance the technical support for the Beijing Olympic weather services. In the summer of 2004, an international advisory group nominated by the WMO surveyed and assessed in Beijing as to the project content of CMA and revisions were suggested. In October 2004, at the seventh session of Scientific Steering Committee of the World Weather Research Program (WWRP) of the WMO, the Beijing Forecast Demonstration Project (hereafter referred to as the B08 Project) was officially approved. The B08 Project included two sub-projects, the Nowcasting Forecast Demonstration Project (B08FDP) and the Mesoscale Research and Development Project (B08RDP). The B08FDP aimed at the development, application and demonstration of the advanced nowcasting (0—6 h, especially 0—2 h) techniques and systems for severe convective weather, with its focus on the operational application of nowcasting products. Meanwhile, it offered forecast demonstrations to the end users and carried out the socioeconomic impact assessment. The B08RDP fixed its goal at the development and experiment of the mesoscale short term (6—36 h) ensemble weather forecast system, emphasizing the shaping of real-time experimenting products for high impact weather forecast. Considering the obvious differences in technical methods and application between the B08FDP and B08RDP, also the relative independence of their contents, aims, participating systems, operational environment of these two projects, CMA assigned two of its subordinates, the Beijing Meteorological Bureau and the National Meteorological Center, to implement the B08FDP and the B08RDP respectively. This book is a review and summary for the organization and implementation of the B08FDP.

The B08FDP involved 8 advanced nowcasting weather prediction systems from different countries and regions such as Australia, Canada, China, Hong Kong of China, and the United States etc. The 5-year (from Oct. 2004 to Jul. 2009) project had four major phases: the setup of the operational environment and platform for the international nowcasting systems; the technical development, system test and improvement, including the training on the application; forecast demonstration during the Olympics; and finally the summary of the project. On the basis of the Sydney 2000 Olympic Forecast Demonstration Project, the B08FDP set and achieved a new and higher scientific aim. It included the development of the multi-radar application technique for nowcasting system, improvement of the used algorithms and research on new methods for nowcasting (such as irregular polygon fitting for the single-cell tracking algorithm, the blending of radar-based extrapolation forecasts with numerical model prediction, probability and ensemble products based multi nowcasting sgstems, and severe convective concept diagnostic models, etc.) , development and application of the nowcasting real-time verification techniques, and assessment technique on social and economic impact, etc. During the Beijing Olympic Games and Paralympic Games, the internationally prevalent, advanced nowcasting prediction techniques including the above techniques were demonstrated successfully through the real-time operation of the 8 nowcasting systems.

The implementation of the B08FDP introduced the internationally advanced weather nowcasting techniques and concepts into the Beijing Meteorological Bureau, which in turn improved the operational capability of the weather forecasters for very short-range and nowcasting technique in Beijing. And it became a direct, strong technical support to the Beijing Olympic weather services. At the same time, it was a good experiment, comparison, and communication platform for scientists of different countries and regions to research and develop the advanced nowcasting systems. It promoted mutual understanding between scientists and improved cultural communication between different countries and regions as well. As it is, significant benefits along with positive influence arise in many aspects such as science, society and culture, etc.

Recalling every detail during the 5-year process of the B08FDP, we are still deeply impressed by the strict scientific attitude of the scientists, their meticulous work style, their spirit of sincere cooperation and dedication, their enthusiastic and optimistic spirit towards life. Due to the joint efforts of the scientists from different countries and regions, an encouraging result has been successfully achieved. We would like to compile part of the result into this book to share it with you all, and also as a gift to express our sincere appreciation to every individual who contributed to the project and the World Meteorological Organization (WMO), the China Meteorological Administration, the Beijing Meteorological Bureau, the Australian Bureau of Meteorology, the Meteorological Service of Canada, the Hong Kong Observatory, the National Center for Atmospheric Research (NCAR) of the United States, etc.

Jianjie Wang

Oct. 2010

Executive Summary

A WMO World Weather Research Program (WWRP) Forecast Demonstration Project (FDP) was conducted during the Beijing 2008 Olympics to demonstrate the benefits of state-of-the-art nowcasting systems for mitigating high impact weather. The Beijing 2008 Forecast Demonstration Project (B08FDP) was conducted from 2004—2009 with the objective of enhancing the technical weather support to the 2008 Olympic weather services of the China Meteorological Administration (CMA), and to provide an international focus for research and development leading to operational nowcasting. Eight participating international nowcasting systems from Australia, Canada, the United States, China and Hong Kong of China were deployed at the Beijing Meteorological Bureau (BMB) of the CMA to demonstrate and quantify the benefits of an end-to-end nowcasting weather service during the Beijing Olympics. Using the latest science and technology the B08FDP focused on the prediction of convective severe weather in the next six hours, with particular emphasis on the 0—2 hour period.

The B08FDP met its objectives and it was felt by all that it was a very successful implementation of the WWRP Forecast Demonstration Project from many perspectives. It brought together state of the art nowcasting systems and merged them into a seamless total nowcasting system that addressed a wide range of scales and a broad spectrum of forecast issues.

The B08FDP demonstrated an enhanced use of observing systems. CMA made several improvements to its radar infrastructure including the synchronization of four radars within the Beijing region (one of which were newly installed), and implementation of inter-radar calibration. Many other types of observations were made available in real time to the project, including an intensive network of AWS measurements, radiosondes, wind profilers, GPS, lightning sensors, and satellite observations. Efficient data frameworks were set up for exchanging observation and nowcast data, including the use of standard NetCDF formats for AWS and gridded data, and the development of a new XML-based format (WXML) for thunderstorm and threat area nowcasts.

The nowcasting systems demonstrated in the B08FDP included both established and new systems. Some mature systems included echo extrapolation and tracking algorithms, as well as severe weather and precipitation nowcasting diagnostics. A recent development in nowcasting science is the blending of radar-based extrapolation forecasts with model output from numerical weather prediction (NWP). Several systems demonstrated this approach, primarily for rainfall nowcasting. It appears that NWP is not yet sufficiently accurate to add value in many cases. Another new approach is the use of ensemble and probability based nowcasts to provide uncertainty information in aid of decision making. Probabilistic precipitation and thunderstorm nowcasts showed a high degree of skill, signifying that the probabilistic approach is extremely promising. Three nowcasting systems including the forecasters in the process, thus added the capability to modify, improve, or override the automated guidance. For the first time, real time nowcast verification was available in the FDP which allowed forecasters and experts to get an up-to-the-minute picture of the performance of the various nowcasting systems. The verification gave important quantitative information on biases and random errors to assist users in interpreting the nowcasts.

Several enhancements of the nowcasting process were demonstrated in the B08FDP. This was particularly relevant in BMB where nowcasting is a fairly new practice. To integrate the nowcasts of several automated systems, consensus products for probability of light, moderate, and heavy precipitation, as well as thunderstorm strike probability, were generated and made available to forecasters. As well as having access to the products from individual systems, forecasters could get an "integrated assessment" from the consensus products that enabled effective decision making without being unwieldy. The consensus products formed the basis for the official warnings prepared in BMB using the newly developed VIPS production system.

In preparation for the FDP numerous surveys were conducted with a variety of end users of nowcast products to understand their particular needs for weather and warning information. A user-oriented service strategy was adopted whereby external users in government, the Olympic Organizing Committee, the business sector, and the public accessed the consensus precipitation and thunderstorm products on a special web page. Forecasters had access to the full range of nowcasting products and verification information. Survey results showed positive feedback from decision makers in all spheres, indicating that nowcast products provided useful and timely meteorological information and increased the economic and social benefits of meteorological services.

From a program perspective, the Olympic would weather support provided a firm focus and hard deadline to accelerate developments that would have a long-lasting legacy. The keys to establishing a successful FDP included a shared and articulated vision, along with a common set of goals and objectives that were clearly defined. The importance of strong leadership could not be underestimated, including careful project management, effective communication, and follow up of tasks. Finally, forecast demonstration projects were extremely large and complex, both in terms of the technology and the personnel, and could not succeed without sufficient resources.

In terms of technology transfer from research to operations, the project employed several strategies to enable project ownership. The timing of the project followed new infrastructure and service initiatives within BMB to advance the state of severe weather forecasting and nowcasting (e. g. , CINRAD radar network modernization, supercomputing facility at BMB, development of a nowcasting service). BMB was actively and fully engaged in the collaborative integration and advanced system design, being eager to adapt and accept new technology. Moreover, FDP experts were actively committed to the support of B08 Forecasting Services. Training by experts made in-depth, first-hand knowledge accessible to the forecasters and local champions to clearly articulate the strengths and weaknesses of the new systems. An interactive hands-on training methodology provided a controlled simulation environment to facilitate in-depth discussions and learning. At a more personal level, mentoring by experts at home institutes and in ad hoc situations overcame misconceptions and professional barriers and created mutually satisfying peer-level relationships.

Many of the unique scientific achievements in B08 were made possible through the participation of several international nowcasting groups and experts in the forecast demonstration project. A complete end to end nowcasting system, starting with high resolution observations and ending with meteorological weather and warning services for external users, was designed and demonstrated. The FDP allowed the inter-comparison of first generation extrapolation-NWP blending systems, and the comparison with blended automated-human nowcast systems. Ensemble nowcasting was a concept developed for B08 and proved highly successful, as did the real-time nowcast verification.

The B08FDP demonstrated some gaps in scientific knowledge and technical capability that must be addressed in order to improve the accuracy of nowcasting and very short range forecasting. For example, there were different approaches and philosophies that were used to track radar echoes, depending on the goal of the nowcast (accurate precipitation prediction, severe weather warning, etc.). There was no "one approach fits all" and understanding the differences was important for their appropriate use in the weather office. There was a need for more diagnostic functionality in automated nowcasting and verification systems, to assist the user in understanding the situation-dependent behavior of the weather. Nowcasting systems must be tuned for local conditions (e. g. , appropriate Z-R relationships), which could be challenging in the face of limited data availability in advance of a FDP. For use in automated nowcasting systems the radar data must be of the highest quality, which wants that effective quality control procedures were critical. Other types of high resolution data must be available as input to many of the nowcasting schemes, and as verification data for the nowcast products. The experience of B08 indicated that successful blending of extrapolation forecasts with NWP required that the model forecasts be sufficiently accurate to add value at time scales beyond an hour or so. This meant that radar wind and/or reflectivity data must be assimilated into the model in order to correctly specify convective elements and wind fields at the start of the model run. Even with radar assimilation, further model improvements were necessary to improve their accuracy in the 4—6 hour range. Finally, wind nowcasts remained a challenge.

ACKNOWLEDGEMENTS

We acknowledge and express our gratitude to many scientists from the international science community and the China Meteorological Administration for their contribution to the success in B08FDP (in alphabetical order):

Linda Anderson-Berry	Tony Bannister	BO Li	Barbara Brown
Philip K. Y. Chang	CHEN Min	DUAN Yuxiao	FENG Yerong
Jaymie Gadal	HAN Jiarui	HU Sheng	David Hudak
Kwok Keung	KONG Rong	Ronald Lee	LEI Zhaochong
LI Xun	LIU Ke	LIU Liping	MENG Jinping
Rita Roberts	David Scurrah	SU Debin	SUN Chengyun
Jenny Sun	Pierre Vaillancourt	WANG Yingchun	Sarah Wong
W. K. Wong	XIAO Xian	XIE Pu	Linus H. Y. Yeung
Man Chuen Young	YU Dongchang	YU Haiyan	YU Xiaoding
YUAN Lili	ZENG Qin	ZHANG Chian	ZHANG Jianyun
ZHAO Wenfang	ZHUANG Wei		

1.WWRP Advisory and Evaluation Meeting (Jul. 19-21, 2004, Beijing, China)

2. The First International Workshop (Mar. 29-31, 2005, Beijing, China)

3. The Second International Workshop (Aug. 30-Sep. 1, 2006, Beijing, China)

4. The Third International Workshop (Sep. 20-22, 2007, Qingdao, China)

5. The Fourth International Workshop (Apr. 21-24, 2009, Guangzhou, China)

6. System Trial