

# Asian THORPEX Implementation Plan

## 1. Introduction

This document is to describe the Implementation Plan of the Asian THORPEX, that the Asian THORPEX Regional Committee (ARC) approves.

THORPEX was established by the 14<sup>th</sup> WMO Congress in May 2003, as a ten-year international global atmospheric research and development programme. THORPEX aims to reduce the social and economic risk due to high-impact weathers events by improving numerical weather forecasts from 1 day up to 2 weeks.

The success of THORPEX depends on advances in the knowledge of atmospheric science, such as i) predictability of the atmosphere and ii) large-scale influences or flow-regime dependency on extreme events, and developments of the forecasting technology, such as iii) data assimilation technique with advanced satellite data and iv) ensemble forecast technique. These advances and developments will lead us to the establishment of the Global Interactive Forecast System (GIFS). The GIFS is a new concept of the weather forecast system under THORPEX to demonstrate the close interaction between observation and forecast models. Information from a forecast model can identify the sensitive areas with large uncertainty that would have large impact on the extreme event in the verification area. Following this guide adaptive observations in the targeting areas are performed to improve the initial condition.

Wide international-regional and academic-operational collaborations are required for the success of THORPEX. That is why THORPEX is considered as the second GARP (Global Atmospheric Research Programme) Global Experiment (SGGE), as the first GARP Global Experiment (FGGE) was performed globally in 1979.

The Asian THORPEX program will be coordinated with the International THORPEX program and other regional efforts, to promote the activities of THORPEX in Asia.

At the first ARC meeting, held in Seoul, March 2004, the ARC agreed that the main objective of the ARC was to improve the forecasts of heavy rainfall during the rainy period and tropical cyclones over the region. Every year huge damages are caused due to heavy rainfalls and tropical cyclones. Heavy rainfall events occurred in China in 2003, landfall or approach of tropical cyclones in Korea in 2002 and 2003 and in Japan in 2004. The ARC is also interested in improving forecasts of other regional high-impact weather events, such as Asian sand and dust storms or those induced by Madden-Julian Oscillation, and is ready to implement relevant researches when a member proposes to pay attention to these phenomena.

This document describes the general research objectives in the section 2, the research plans in the section 3. The section 4 is to document the organization and the section 5 describes the data exchange. The section 6 is to list up the observational experiment plan and the section 7 is for other topics.

## 2. General Research Objectives

The goal of the Asian THORPEX program is to improve the forecast of high-impact weather in Asia through the establishment of the GIFS that will be maintainable for the future by the end of THORPEX. The Asian THORPEX program will promote research, development and application of GIFS in the Asian countries. It will also encourage exchange of data, scientific knowledge and forecasting technology not only within Asia but also with the global research and development community.

In order to achieve this goal, the research plan is established as in Section 3. One of the main reasons for the difficulty in predicting severe weather events is their multi-scale structure in time and space. While transient and local conditions are very important for heavy rainfall, some of the events seem to be triggered by long-lived and global phenomena, such as propagation of a Rossby wave packet and the Madden-Julian Oscillation and the variability of Monsoon. In these cases, longer-term predictability may be expected even in local severe weather events as long as the long-term global phenomena are well predicted, and dynamical effects of inter-scale interactions are well understood. Another challenge is to clarify the role of moisture, which is particularly important in moist environment in Asia. Therefore, it is necessary to promote studies in ***Dynamical Process and Predictability*** through collaborations with meso-scale and climate communities.

Uncertainty in weather forecast will never be eliminated. While probabilistic prediction by ensemble forecasts has been already established, it is necessary to precede more in order to get more meaningful statistical information. It is not known clearly, yet, what kind of statistical information would lead to better probabilistic prediction. However, it seems extremely difficult, if not impossible, to detect high-impact severe weather events with very low-probability only by looking at the ensemble mean and spread from a current ensemble forecast system. Therefore, it is necessary to promote studies in ***Ensemble Forecasts*** and establish methods to incorporate uncertainty of meso-scale moist instabilities that would grow into severe events.

Maintenance of the GIFS in the future after THORPEX is crucial for disaster control in the changing global climate. In order to achieve this, it is necessary to construct a cost-effective observational network system, especially in data sparse regions over ocean and mountains, using in-situ and advanced remote-sensing techniques. Therefore, ***Targeting Observations*** and ***Observational System Experiments*** will be promoted for the optimal solution in designing the system.

Last, but not least, research activities in ***Data Assimilation*** will be also promoted. Recently, research, development and practical application of the four-dimensional variational method (4D-Var) have been very active at many operational centers. 4D-Var can be considered as a natural extension from the three-dimensional variational method (3D-Var) and the optimal interpolation method (OI) that were widely used in current or older data assimilation and forecast systems. On the other hand, some activities in research and development of ensemble Kalman filter (EnKF) and its variations have been increasingly more visible at research centers over the world. These efforts for both 4D-Var and EnKF are expected to lead to more advanced data

assimilation and forecast systems. Also new instruments and sensors have been feeding more information into the data assimilation and forecast systems. It is desirable to utilize them fully in order to attain better prediction for minimizing the loss caused by high-impact severe weather events in Asia.

### **3. Research Plan**

The ARC members work closely under the following research areas.

#### **3.1 Dynamic Process and Predictability**

THORPEX dynamic process and predictability research includes the following activities focusing upon large-scale influences or flow-dependency upon local severe events:

- Investigating mechanisms on the generation, intensification, decay and extratropical transition of typhoons;
- Investigating mechanisms on the generation and development of sub-synoptic cyclones along the Baiu/Meiyu/Changma frontal zone;
- Clarifying the role of the low-level moisture distribution on the development of meso-scale convective systems;
- Investigating the generation and maintenance mechanisms of Madden-Julian Oscillations and emanation of Rossby waves to extratropics.

#### **3.2 Ensemble Forecasts**

Objectives of THORPEX ensemble forecast research are:

- Investigating the effects of initial condition and model uncertainty on forecast of interesting phenomena in Asia, i.e. tropical cyclones, Asian monsoon and intraseasonal oscillations;
- Development of improved ensemble prediction systems, i.e. advanced initial perturbation method including moist process, stochastic parameterization and multi-model ensemble method permitting various convective schemes;
- Promoting exchange of Ensemble Prediction System (EPS) products among participating members, e.g. gridded data for the area and time series data at specific locations;
- Participating in the THORPEX Interactive Grand Global Ensemble (TIGGE) project to develop an interactive observing-assimilation-forecast system and a prototype for a multinational multi-model ensemble prediction system.

#### **3.3 Observational network design**

THORPEX observing system optimal design studies have following aims:

- Development of techniques for the optimal design of observing networks;
- Design and redesign of the regional observing networks in Asia;
- Evaluation of the network design in the NWP impact studies including future THORPEX observational campaigns;
- Estimation of the observing system information content based on TIGGE datasets;

- Development of the recommendation addressed to national meteorological services aiming on improvement of the observing network design.

### **3.4 Targeting Observation**

THORPEX targeting observation research includes the following activities:

- Development and improvement of targeting techniques appropriate for a better prediction of high impact weather in Asia;
- Design and refinement of targeting strategies for high impact weather in Asia;
- Implementation of a targeting observation system to demonstrate real-time campaigns;
- Assessing performance and efficacy of the targeting observation system and recommending a plan to implement the operational system.

### **3.5 Four-dimensional Data Assimilation**

Objectives of THORPEX four-dimensional data assimilation research are:

- Development and improvement of methods for evaluating flow-dependent background errors;
- Quantifying observing system errors and developing adaptive quality control methods;
- Development of methods for efficient utilization of high-volume data such as hyper-spectral sounders especially for geostationary satellites in later stage of the period;
- Improvement in assimilation of water vapor, cloud and rain rate data from satellite observations.

### **3.6 Observing System Experiments (OSEs)**

THORPEX OSE research should be carried out to:

- Demonstrate new observing techniques in both in-situ and remote sensing observation;
- Design and refine observing strategies against interesting phenomena in Asia;
- Implement observing field experiments in concert with an operational observation system;
- Investigate the effect of the experimental observation data on forecast of interesting phenomena in Asia.

### **3.7 Social and economic impact assessment**

THORPEX research in above area should be carried out to achieve following aims:

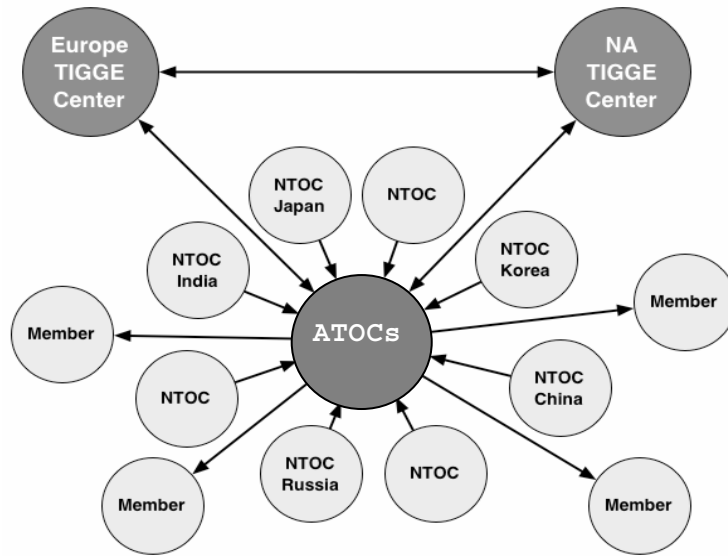
- Evaluation of impact of strong precipitation forecast improvement on human activity in various parts of Asia;
- Assessment of impact of cyclonic connected high impact weather events on key industries – agricultural, fuel and energy complex, municipal economy, motor and rail transport, construction activity, forestry.

To promote and review research activities through exchanging the information and outputs among the members, a workshop will be held regularly.

## 4. Organization

### 4.1 Asian THORPEX Operation Center (ATOC)

To promote activities related to the sections 2 and 3, ATOCs be established. ATOCs share the following functions (Refer to the Figure):



ATOC and NTOC

- 1) Headquarters during each observation experiment period over the Globe and Asia;
- 2) Data archive and distribution center, to store, manage and provide the data (ensemble data, intensive observation period data and the data currently not available on the GTS) and to distribute experimental data to the participating members on near real-time basis;
- 3) TIGGE Asian center, to promote the TIGGE project in collaboration with TIGGE centers in other regions.

### 4.2 National THORPEX Operation Center (NTOC)

Each participating member establishes an NTOC. Each NTOC has the following functions:

- 1) National Archive Data Center;
- 2) To organize and implement local OSE programs;
- 3) To discuss scientific achievements on THORPEX research issues;
- 4) To be a focal point on collaborative efforts through ATOC.

### 4.3 Working Group (WG)

The ARC will create a Working Group (WG) for data management (data archive and exchange). The ARC will request the WG to report the recommendation to the ARC

and to coordinate the data management issues. The WG will submit an interim report to the ARC.

The task of the WG is to help the ARC in implementing the specific technical arrangement and coordination for data archive and data exchange.

## **5. Data Exchange**

### **5.1 Observational Data**

The ARC members exchange observational data, which are currently not available on the GTS but expected to be useful to improve the forecasts. The potential data include the ground radar, wind-profiler data, ACARS data and the direct ATOVS receiving data.

### **5.2 Numerical Products**

The ARC members exchange numerical products. The potential data include the ensemble forecast data and the targeting products.

As a prototype, the 2<sup>nd</sup> ARC agreed that typhoon track forecast information (both deterministic model output and ensemble model output) would be exchanged in real-time before the typhoon season in 2005.

## **6. Individual Observation Experiment Plan**

### **6.1 Rainy Periods (Baiu, Meiyu or Changma)**

#### **Objective**

Improvement of understanding and forecast skill on heavy rainfall events up to 2 days

#### **Adaptive Observation**

Enhanced upper soundings by several vessels over the East China Sea

#### **Potential Participant Members**

China, Japan, South and North Korea, etc.

#### **Status of Domestic Plans**

JMA and KMA will have special observations (Baiu Hunter 2005 for JMA, KEOP 2005 for KMA) for the rainy period in 2005 over the East China Sea.

#### **THORPEX Regional Campaign (TReC) Plan**

Period: Hopefully in 2007 for TOST, after 2010 for TReC

### **6.2 Tropical Cyclones**

#### **Objective**

Improvement of understanding and forecast skill on tropical cyclone up to one week

**Adaptive Observation**

Environmental observation of a tropical cyclone by Smart Balloon/Unmanned Aircraft

**Potential Participant Members**

Cambodia, China, India, Japan, South and North Korea, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, etc.

**Status of Domestic Plans**

CMA is planning to have a special experiment for a typhoon landing program over South China.

**THORPEX Observation System Test (TOST) and Regional Campaign (TReC) Plan**

Period: Hopefully in 2008 for TOST, after 2011 for TReC

**6.3 Intraseasonal Variations in the Asian Monsoon****Objective**

Improvement of ensemble forecast of intraseasonal variations up to two weeks

**Adaptive Observation**

None

**Potential Participant Members**

China, India, Japan, Korea, etc.

**Status of Domestic Plans**

TBD

**6.4 Asian Sand and Dust Storms****Objective**

Potential Forecast for Asian dust Storm up to 5 days

**Adaptive Observation**

None

**Potential Participant Members**

China, Japan, Kazakhstan, South and North Korea, Mongolia, etc

**Status of Domestic Plans**

This project was proposed at the 7th session of WWRP/SSC as a WWRP Research and Development Project.

The monitoring of Asian dust concentration has been performed at 5 observatories of CMA in cooperation with KMA.

KMA has operated 2 storm monitoring towers at Inner Mongolia and Shanshi province in cooperation with Peking University and Seoul National University.

## **7. Others**

ARC members should encourage and facilitate participation of National Meteorological Services, academic and related communities of the Asian region in the Asian THORPEX activities by using every occasion.