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Prepared by WMO
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THORPEX: A WMO WORLD WEATHER RESEARCH PROGRAMME

(Submitted by WMO)

Summary and purpose of document

Recommendation for CGMS on the implementation of THORPEX. In particular, CGMS Members are requested to respond to a set of questions in paragraph 28.

PROGRESS/ACTIVITY REPORT

Background

1. THORPEX through the WMO World Weather Research Programme (WWRP) is a major contributor to the WMO Natural Disaster Reduction and Mitigation Programme. It will contribute to WMO's goal to halve the number of deaths due to natural disasters of meteorological, hydrological and climatic origin over the next 15 years.

2. In order to further reduce and mitigate the results of weather-related disasters it is crucial to improve the accuracy of high-impact weather forecasts. High-impact weather is defined by its effect on society, the economy and the environment.

3. Under the auspices of THORPEX, regional and global projects and experiments will be carried out to

- improve forecast skill by advancing the knowledge of global-to-regional influences on the initiation, evolution and predictability of weather systems;
- target satellite and in situ observations to design the strategy for interactive forecasting and observation, thus contributing to the evolution of the WMO Global Observing System (GOS), a core component of the Global Earth Observation System of Systems (GEOSS);
- to create and evaluate systems for the assimilation of targeted observations from satellites and in situ measurements;
- accelerate improvements in the accuracy of numerical weather prediction, probabilistic forecasting and the description of uncertainty in initial conditions;
- test and demonstrate the effectiveness of a global multinational multi-model multi-analysis ensemble forecasting system;
- demonstrate societal and economic benefits of improved forecasts, by improving decision-support tools, which utilize advanced forecasting products to benefit directly social and economic sectors.

Organization

4. The THORPEX International Core Steering Committee (ICSC) of the WMO Commission for Atmospheric Sciences (CAS) leads the development and implementation of the programme in coordination with the CAS Science Steering Committee for the World Weather Research Programme, the WMO/ICSU/IOC Joint Scientific Committee (JSC) for the World Climate Research Programme, the CAS/JSC Working Group on Numerical Experimentation (WGNE), and the WMO Commission for Basic Systems.

5. The THORPEX International Science Plan, (www.wmo.int/thorpex/mission.html) has been developed and the plan was published in November 2003. The peer-review of this science plan, organized by the Scientific Steering Committee for WWRP, was completed successfully. An ICSC Group of Experts developed the THORPEX International Research Implementation Plan (TIP) and following its approval, in December 2004, the ICSC agreed to proceed with the implementation of the TIP. The TIP is available at www.wmo.int/thorpex.

6. Regional THORPEX Committees, aligned with WMO regional associations, coordinate activities of regional groups of nations. Currently, there are Regional Committees for North America (2002), Asia (2003), Europe (2003) and the Southern Hemisphere (2006). Work to develop a plan for Africa is currently underway.

7. The THORPEX International Programme Office (IPO) at the WMO Secretariat in Geneva directs, coordinates and monitors activities between various elements of the programme. The THORPEX (IPO) and the international programme activities are supported through voluntary contributions of the governments of the WMO Members participating in the World Weather Research Programme through THORPEX, including donations to the THORPEX Trust Fund established by WMO. The Director of THORPEX IPO was appointed in May 2005, the Boards and Working Groups reporting to the ICSC were formed in autumn 2005 and since then they have all met.

Global Interactive Forecast Systems

8. THORPEX will contribute to the development of a future global interactive forecasting system, which would generate numerical probabilistic products, available to all nations. At the heart of THORPEX is the research needed for the design and demonstration of a global interactive forecasting system that allows information to flow interactively between forecast users, numerical forecast models, data assimilation systems and observations. Such a system can also be adapted to allow the observing system, observations, assimilation and the model to be configured to maximize forecast skills for specific societal and economic uses. The THORPEX design of the strategy for interactive forecasting and targeted observations will contribute to the evolution of the WMO Global Observing System (GOS), a core component of the Global Earth Observation System of Systems (GEOSS).

Regional Campaigns - ATReC

9. The first THORPEX Regional Campaign (TReC) carried out under the auspices of THORPEX, the Atlantic regional Campaign (ATReC), tested the hypothesis that short-term forecast errors over Europe and the Eastern seaboard of the USA can be reduced by targeting extra observations over sensitive areas determined each day by the forecast flow patterns using NWP techniques. The field campaign took place in the autumn of 2003. It was the first attempt at real time adaptive control of a full set of operational observing systems (in an international context) in addition to the deployment of research aircraft.

10. The ATReC field campaign was very successful technically and has provided valuable datasets to test targeting issues. Many targeted observations were made available to NWP centres in real-time and in standard formats, making them easy to use for operations and research, and convenient to archive. Some research observations (e.g., aircraft Doppler wind lidar data) were not available in real time but they were processed and made available in convenient form and without long delay, allowing important data assimilation experiments to be conducted. The ATReC was an example of quasi-operational targeting of observations that involved considerable planning and good collaboration between operational forecasters, observation providers and research scientists which contained many examples of good practice. This experience will be taken into consideration in the planning of other THORPEX activities.

11. Various data impact experiments have been performed, showing a small but positive impact of targeted observations. The impact is not always systematically positive in the verification area because of the statistical assumptions involved in the data assimilation procedure, and is not always consistent between Centres. In general however, there are about twice as many cases when the forecast is improved as when it is degraded. Additional data have been found to have more impact during the last part of the field campaign (November/December) when the weather has been more unsettled. However, the overall forecast uncertainty during the campaign was small, thus a large reduction in error due to a small number of additional observations could not really be expected.

Regional Plans – future campaigns and experiments

THORPEX Pacific Asian Regional Campaign (TPARC) 2008

12. The concept of a THORPEX Pacific Asian Regional Campaign (TPARC) 2008 is being developed as a result of a workshop held in Seattle in June 2005 and the subsequent continuing dialogue between the NARC and the ARC. The proposed campaign is planned for the second half of 2008 and in this case would coincide with the IPY and with campaign to take additional measurements in support of the Beijing Summer Olympics (including Asian measurements in the vicinity of typhoons and perhaps over the Asian continent) and may continue into the November-December time-frame to study tropical cyclone tracks, extra-tropical transitions, tropical warm-pool physics and down-stream propagation.

European TReC (ETReC)

13. Several major research activities relating to summertime high impact weather are planned for the year 2007, most importantly the WWRP forecast demonstration project occurring as part of MAP, and the international field experiment COPS. The European Region Committee are proposing to initiate ETReC 2007, to support these programs, link them and leverage their efforts to contribute to THORPEX scientific goals.

TIGGE - the THORPEX Interactive Grand Global Ensemble

14. Many evolving weather situations may be characterized as low probability/high risk; that is, the event is unlikely, but the consequences of occurrence may be catastrophic in terms of loss of life, property damage, loss of revenue, cost of compensation and operating costs. Decision-making in this category of events is most difficult, stretching the capabilities of the tools and the decision makers. The recent shift in the weather forecasting community towards probabilistic forecasts offers a solution. By characterizing the probability of a particular weather event, we can now provide more specific information on the likely outcomes. For this information to be useful, it must become an integral part of decision support tools.

15. The TIGGE, the THORPEX Interactive Grand Global Ensemble, is a key component of the WMO's World Weather Research Programme to accelerate the improvements in the accuracy of 1-day to 2-week high-impact weather forecasts.

16. The key objectives of TIGGE are:

- An enhanced collaboration on development of ensemble prediction, internationally and between operational centres and universities;
- New methods of combining ensembles from different sources and of correcting for systematic errors (biases, spread over-/under-estimation);
- A deeper understanding of the contribution of observation, initial and model uncertainties to forecast error;
- Real-time support for demonstration projects and field experiments;
- Societal applications leading to increased benefits to society.

17. The first TIGGE workshop was held on 1-3 March 2005 in the ECMWF. Sixty scientists, from international organizations, national and regional meteorological and hydrological services, universities and private companies, attended the workshop. The workshop discussed the scientific aims, user requirements and infrastructure for TIGGE databases and Centres. The report of the workshop has been posted on the WMO website and has been published in the WMO series WMO/TD-No. 1273 WWRP/THORPEX No. 5.

18. Since then progress has been rapid:

- A technical proposal for Phase 1 (global analyses and forecasts) has been developed by three archive centres (CMA, ECMWF and NCAR) and agreed by eleven potential providers (BMRC, CMA, CPTEC, ECMWF, FNMOC, JMA, KMA, Météo-France, Environment Canada, NCEP, UKMO);
- Letters have been sent by the WMO Secretary General to request the commitment of all partners of the project and commitments have been received from nine Centres;
- The CMA, ECMWF and NCAR (the three phase 1 archive centres) have been in close contact for some time and test data has been sent routinely from ECMWF to NCAR.

19. It is now highly likely that routine access to the database of global forecasts will be possible in winter 2006/7 and that a start will be made on a TIGGE LAM (Limited Area Model) Ensemble Prediction Systems approach later this year.

Partnerships

20. A key element of the THORPEX strategy is to develop working partnerships with other programmes and considerable efforts have been made over the last 12 months to develop collaboration as follows:

With the WCRP

A joint project has been initiated to develop a unified approach to the development of ultra-high-resolution global systems for weather prediction and climate simulation;

Collaboration in tropical meteorology including tropical convection (a successful joint workshop on the MJO was held in March 2006);

TIGGE and Task Force on Seasonal Prediction (TFSP) – given the similar technical issues (data, archiving, policy) there is a potential for “seamless” days-seasons prediction systems.

***With GEOSS – involvement* in four main GEO tasks**

HEALTH	To improve predictability of major health hazards in W. Africa
WEATHER	Further develop TIGGE and societal applications
AGRICULTURE	Help improve the predictability of food supplies in Africa
ENERGY	Demonstration project to improve energy management techniques

21. These tasks represent a very important and wide-ranging contribution from THORPEX to the GEO initiative and they will also mandate assistance and support from the GEOSEC to THORPEX for their successful completion.

With AMMA

22. Strong scientific and administrative links have been developed with AMMA. Recently this has lead to a successful driftsonde demonstration test involving the deployment of new mist mini-dropsondes from drifting gondolas that crossed from Africa to the tropical Atlantic Ocean – enabling observation of convection in the trough area of African easterly waves and the sampling of the dry Saharan air mass that leaves the African coast which is scientifically important for its impacts on a variety of topics from hurricane genesis and the biology of the upper-ocean).

With CGMS

23. A CGMS THORPEX rapporteur has been established within the THORPEX ICSC and THORPEX focal points have been established by each CGMS member. Refer to paragraph 27 below.

IPY

24. A THORPEX cluster proposal to the IPY has been approved.

MEDEX

25. MEDEX has now been incorporated within the THORPEX structure.

Highlights

26. Since its establishment in 2003 by Cg-XIV, the THORPEX programme has developed rapidly and the following areas, where the existence of THORPEX has been crucial, are worthwhile stressing.

- The scientific and technical success of ATReC;
- The development of enhanced Regional NWP activity involving a widened range of scientists from Universities and Research Institutes (through the existing Regional Committees and the SH planning activity) and the National Meteorological Services;
- The International plans for ETReC and TPARC;
- The establishment of TIGGE – the global phase 1 implementation and the development of the EPS LAM plans for real-time experiments;
- The collaboration with WCRP - with a way forward for joint research and development in forecasting research to improve week 2 forecasting and a TIGGE approach to longer-range forecasting;
- Completion of a successful driftsonde demonstration test in collaboration with AMMA;
- Credible plans for NWP elements in GEO and the IPY cluster.

Activities of the CGMS THORPEX Rapporteur to the ICSC

27. On 12 May 2006, names were put forward to CGMS Members as contact points for THORPEX for satellite related issues; comments were received back by the CGMS THORPEX Rapporteur and the following list now stands:

EUMETSAT:	Dr Johannes Schmidt and Dr. Ken Holmlund
NESDIS:	Dr Jim Yoe and Dr. Tim Schmit
CMA/NSMC:	Mr Xiaoxiang Zhu
IOC	Dr Albert Fischer
ESA/ESRIN	Dr Evangelina Oriol-Pibernat
IMD	Dr Remash Bhatia
ISRO	Mr A.S. Kiran Kumar
JAXA	Dr Tsuguhiko Katagi
JMA	Mr Yoshishigo Shirakawa
NASA	Dr Ramesh Kakar
Russian Federation	Ms Anna Khoklova

28. On 11 January 2006, the CGMS THORPEX Rapporteur provided all CGMS Members with two information documents: (a) a 20-page PDF version of WMO/TD No.1267, "Implementation

Plan for Evolution of Space and Surface-based Sub-systems of the GOS"; and, (b) an 8-page table, R&D Environmental Missions and Instruments with Potential Operational Use. Also provided were copies of a set of questions (below) that were sent to the Co-chairs of the THORPEX Regional Committees, who are responsible for coordinating THORPEX Regional Campaigns and THORPEX Observing System Tests.

(1) CGMS Members are requested to identify specific activities that address THORPEX Observing System Goals as spelled out in the THORPEX Implementation Plan_V1:

   (a) What activities are underway within regional planning to assure maximum participation of WMO Members within your Region?
   (b) What are the plans for interaction with Global and Regional NWP Centers with respect to your regional campaign(s)?
   (c) What research and reporting mechanism(s) is (are) being planned, or are in place, that will provide information to the various technical commissions of WMO concerning your THORPEX related planning and findings?
   (d) What are the plans for THORPEX Observing System Tests (TOSTs) with regard to in-situ systems (same for satellite in #3 below)?

(2) What actions are underway to address the various goals set forth in the World Weather Watch "Implementation Plan for Evolution of Space and Surface-based Sub-systems of the GOS", available as WMO/TD No. 1267 (adopted at CBS 2005 in St. Petersburg).

(3) What are the plans with respect to operational and research satellite data?

   (a) Who specifically is aiding you in your planning for the use of satellite data?
   (b) What plans do you have for use of research satellite data as part of your activity?
   (c) What plans do you have for use of operational satellite data as part of your activity?
   (d) Do you have any plans for THORPEX Observing System Tests (TOSTs) of future satellite observing systems?
   (e) What satellite agencies are you in contact with as a part of your planning?

29. The THORPEX Executive Board is chaired by the THORPEX Director and includes the Co-chairs of the THORPEX Regional Committees, co-chairs of the THORPEX Science Advisory Board (SAB) and Technical Advisory Board (TAB), and the co-chairs of the six THORPEX working groups: 1) Predictability and Dynamical Processes Working Group (PDP WG); 2) Observing System Working Group (OS WG); 3) Data Assimilation and Observing Strategies Working Group (DAOS WG); 4) Societal and Economic Applications Working Group (SEA WG); 5) GIFS TIGGE WG; and, 6) Data Policy and Management Working Group (DPM WG). While the activities of all WGs are of interest to CGMS, of particular interest are the Observing System Working Group (OS WG) and Data Assimilation and Observing Strategies Working Group (DAOS WG). Co-Chairs of those WGs are: 1) OS WG, Dr James Purdom and Dr Walter Dabberdt; and, 2) DAOS WG, Dr Florence Rabier and Dr Pierre Gauthier. More information may be accessed through the THORPEX web site from item #5 above.

30. Meetings of interest are listed below:

2006		
20-24 March Reading, UK	THORPEX Working Group meetings and workshop	**Documents**
13-17 March Trieste, Italy	Joint WCRP-WWRP/THORPEX Workshop on "Organization and Maintenance of Tropical Convection and the Madden-Julian Oscillation"	**Report**
3-7 April Geneva, Switzerland	WWRP/THORPEX Health Demo Project Team Kick-off Meeting and WWRP/THORPEX Health Application Workshop	
15-16 May Geneva, Switzerland	2nd Session of the THORPEX Executive Board	
Fall Seoul, Korea	Asian THORPEX Science Workshop	
4-8 December Landshut, Germany	Second THORPEX International Science Symposium (STISS)	**Announcement**
	6th Session of the CAS International Core Steering Committee for THORPEX (ICSC-6)	
2007		
Spring	THORPEX Conference on societal/economic benefits	