CGMS-XXXII
WMO WP-28
Prepared by WMO
Agenda item: E.2
Plenary

THORPEX: A Global Atmospheric Research Programme

(Submitted by WMO)

Summary and purpose of document

To inform CGMS Members on the status and activities of the THORPEX and seek CGMS involvement in THORPEX

ACTION PROPOSED

(1) CGMS Members to note the status of THORPEX.

(2) CGMS Members to request representation in observer status on the THORPEX ICSC and designate a Rapporteur for that purpose.

(3) CGMS Members to contribute to development of the THORPEX Implementation plan in coordination with WMO Space Programme.

Reference: Terms of Reference and a more complete description of THORPEX may be accessed via Internet at the following address: http://www.wmo.int/thorpex

DISCUSSION

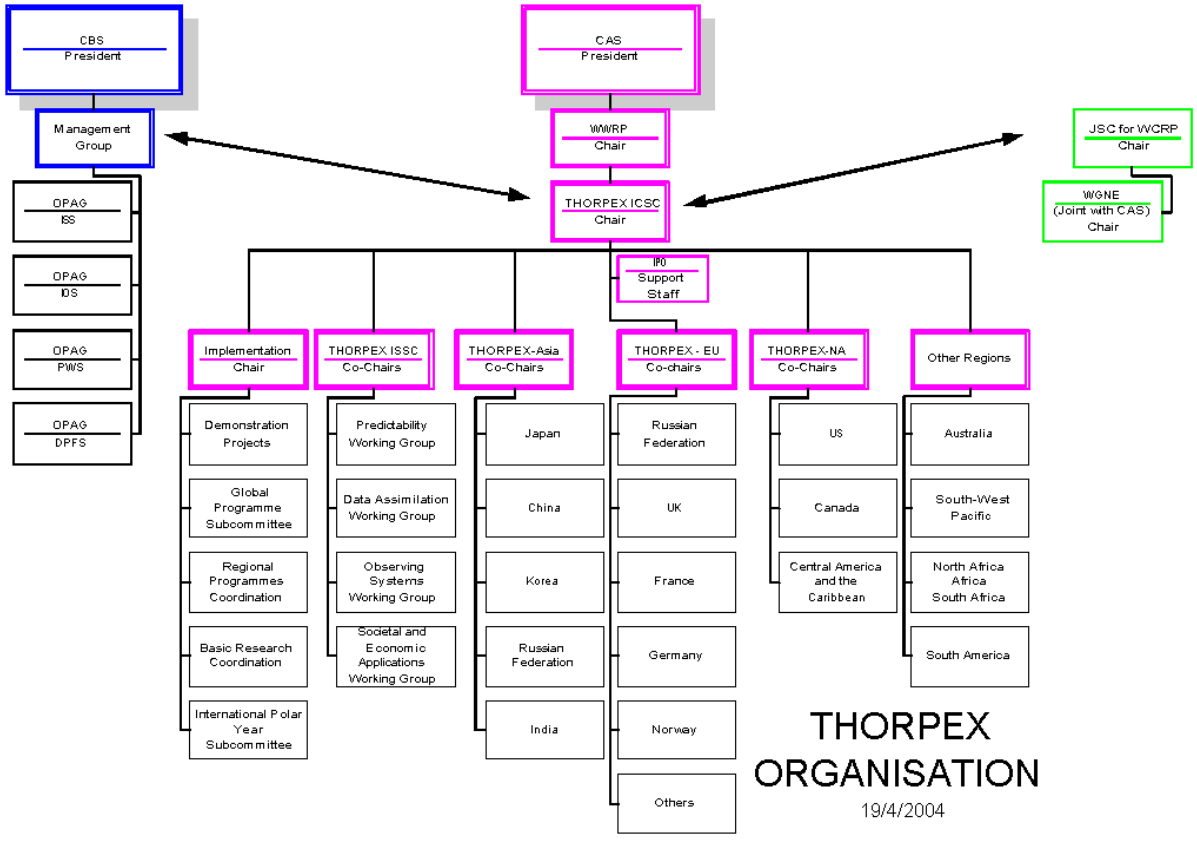
Background

1. THORPEX was established in May 2003 by the Fourteenth World Meteorological Congress (Resolution 12) as a ten-year international global atmospheric research and development programme under the auspices of the WMO Commission for Atmospheric Sciences (CAS). THORPEX is a component programme of the WMO World Weather Research Programme (WWRP).

2. THORPEX: A Global Atmospheric Research Programme is an international research and development programme to accelerate improvements in the accuracy of 1 to 14 day high impact weather forecasts for the benefit of society and the economy. The programme builds upon ongoing advances within the basic-research and operational- forecasting communities, and will make progress by enhancing international collaboration between these communities and with users of forecast products.

Organization, responsibility and membership

3. The CAS International Core Steering Committee (ICSC) and International Science Steering Committee (ISSC) lead THORPEX in coordination with the CAS Science Steering Committee for the WWRP, joint CAS/JSC Working Group on Numerical Experimentation (WGNE), and the WMO Commission for Basic Systems (CBS). North American, European and Asian Regional Committees coordinate regional activities.



?? CAS International Core Steering Committee (ICSC)

(a) Delivers THORPEX to the WMO Commission for Atmospheric Sciences;

(b) Sets research priorities, reviews and approves International Science Plan prepared by ISSC;

(c) Plans and guides THORPEX implementation, identifies and mobilises national and international resources (financial, technical and human) to support THORPEX activities;

(d) Provides guidance to NMHSs on participation in THORPEX and transition of research and development results to operations;

(e) Coordinates activities to provide maximum benefit to WMO Members;

(f) Develops international collaboration.

(g) Committee Membership

?? Members - Representatives of contributing WMO Members nominated by Permanent Representatives

?? ex-officio Members – WMO Commission representatives, regional committee chairs and two scientist co-chairs

?? Observers – ECMWF is an only observer at this time

?? CAS International Science Steering Committee (ISSC)

(a) Develops THORPEX Science Plan;

(b) Guides implementation of the programme;

(c) Provides recommendations to the ICSC

(d) Committee Membership

?? Scientists with expertise in various of the THORPEX areas selected by the ICSC

?? International Program Office (IPO)

(a) THORPEX International Programme Office was established in WMO headquarters (Geneva, Switzerland) to provide direction and support for THORPEX programme implementation.

(b) The IPO is supported by the THORPEX participating countries through the Trust Fund.

?? The THORPEX Trust Fund was established in WMO to support the THORPEX International Programme Office and THORPEX programme activities. The income of the Fund includes voluntary contributions by the Members and international organizations, awards, grants, donations and other contributions. The Fund is managed by WMO according to an annual budget adopted by the CAS International Core Steering Committee (ICSC) for THORPEX

(c) Staffing of the IPO is envisaged through secondment and WMO external recruitment process.

(d) The IPO operates as an integral part of WMO Secretariat and is supervised by the Director of Atmospheric Research and Environment Programme Department.

?? Regional Committees

(a) North American, European and Asian Regional Committees coordinate regional activities.

(b) Committee Membership

?? Two co-chairs for each region, selected by appropriate members.

PROGRAMME IMPLEMENTATION

1. The THORPEX International Research Implementation Plan (TIP) will guide the execution of the programme for the next decade. TIP is under development and will be prepared by the end of 2004.

2. TIP builds on the THORPEX International Science Plan, regional plans and new opportunities to rapidly accelerate improvements in forecasting and the use of improved forecasts in social and economic decision-making.

3. The development of the TIP is being undertaken by the ICSC Group of Experts selected from the members of THORPEX community actively participating in planning and development of the programme.

4. General Objectives of the THORPEX International Research Implementation Plan (TIP)

(a) Define THORPEX deliverables based on the expectations of the operational meteorological community, research scientific opportunities and the availability of resources;

(b) Follow the THORPEX International Science Plan and the regional science plans for Asia, Europe, North America and other regions or nations whenever their contribution to THORPEX is defined;

(c) Define milestones and deliverables from each of the THORPEX participants;

(d) Identify opportunities for collaboration between THORPEX and other programmes;

(e) Define decision points and the necessary steps to carry out THORPEX research and development;

(f) Facilitate the transition of results to operations within the Members' organizations.

5. Specific Objectives of the THORPEX International Research Implementation Plan (TIP):

(a) Connect the science opportunities of the International Science Plan with validated future operational requirements,

(b) Determine a key set of requirements from the operational community;

(c) Identify regional priorities that are consistent with the THORPEX International Science Plan and the operational NWP requirements and reconcile the regional programs to the international plan;

(d) Identify and compensate for gaps in the science planning;

(e) Identify funding requirements and funding of key programme elements, including personnel, equipment for field programmes and other research activities;

(f) Establish a roadmap for THORPEX activities;

(g) Integrate THORPEX with other relevant programs and initiatives, such as WWW, WCRP, WMO Space Programme, WMO Programme on Natural Disasters Reduction and Mitigation, International Polar Year 2007-2008, Asian Pacific Climate Programme, as well as with other organizations (ICSU, IOC) and cooperative programmes identified;

(h) Ensure coincidence between THORPEX and GEO framework;

(i) Establish clear roles and responsibilities for all of the actors in THORPEX;

(j) Identify national commitments to key THORPEX activities;

(k) Assess risks associated with the project and develop a mitigation strategy to ensure that the THORPEX goals as met.

PRIMARY RESEARCH ACTIVITY BEING ADDRESSED BY THORPEX

6. Four Major Theme Areas are being addressed by the THORPEX, all have components that are of interest to CGMS Members

(a) Predictability and Dynamical Processes

(b) Observing Systems

(c) Data Assimilation and Observing Strategies

(d) Social and Economic Impacts

7. Areas of specific interest to CGMS: Although all four major theme areas have components that are of interest to CGMS Members, the three outlined below deserve special consideration

(a) **Observing system task 2: Carry out demonstrations of prototype remote - sensing systems for future satellite deployments**

(i) This effort will include both earth-based field experiments and experiments using space-based observations. It will include observations from ground based, airborne and spaceborne radiometers, scanning radars and lidars to obtain: i) individual remote-sensor profiles for comparison with simultaneous *in-situ* observations; ii) area-averaged profiles that simulate existing and future satellite's field-of-view. Testing for future space based sensors (both operational and research) occurs at a variety of levels. Most relevant to THORPEX will be demonstrations associated with TOSTs within diverse geographical regions and meteorological conditions: a significant challenge for satellite remote sensing system calibration and evaluation.

(ii) **Expected Outcomes:**

?? Evaluation of feasibility for a remote sensing system to be tested on a research satellite platform.

?? Evaluation of a prototype remote sensing system's performance and an assessment of its potential contribution (generally from a research satellite platform) if added to the operational arm of the space-based GOS.

?? Guidance for optimisation of the satellite observing portion of the GOS.

(b) **Data Assimilation Task 1 - Improved Use of Observations**

(i) **Quantify observing -system errors:** Estimate observation erro rs, especially errors of Representativeness, which are likely to be flow -dependent and correlated between nearby observation locations. Test the effects of improved observation-error statistics on forecast skill.

(ii) **Develop methods for efficient utilization of high-volume datasets**: Develop and test adaptive methods for thinning large datasets so that the most useful observations are retained. Develop techniques for assimilating high-resolution observations, including proper characterization of horizontal correlations and averaging (or *super-obing*) of nearby measurements. Develop techniques to extract the maximum information content from hyper-spectral sounders, and other observing systems when, for example, it is computationally impractical to assimilate radiances from all channels.

(iii) Improve the use of satellite observations: Improve the use of visible, infrared and water vapour image -sequences, both from geostationary and polar orbiting satellites, to infer wind information. This may require innovative approa ches, such as interactive height assignment methods or the use of imagery sequences directly in the assimilation. Improve the use of satellite data in cloudy regions and over land.

(iv) Improve assimilation of physical processes: New methods to assimilate certain satellite observations (e.g., those from active microwave sensors and cloud and precipitation imagery) are required in order to infer physical processes such as diabatic heating.

(v) **Expected Outcomes:**

?? Information and guidance will be provided to satellite operators on how to best use the adaptive observing capability of their geostationary satellites in synergy with polar and other low earth orbiting satellite systems.

?? Assimilation of satellite derived rainfall, atmospheric motion vectors, land surface properties, surface temperature, vertical temperature and moisture as well as cloud information into NWP models. This will require substantial improvements in the areas of data assimilation, parameterization and model physics.

?? In synergy with other activities in THORPEX, improved use of satellite data in regional and global scale NWP leading to better forecast.

?? Guidance for optimisation of the GOS.

(c) **Data Assimilation Task 2 - Targeting techniques**

(i) **Refine targeting strategies:** Perform observing system experiments (OSEs) and Observing system simulation experiments (OSSEs), including demonstrations with data sets from field experiments, to evaluate the performance of targeting strategies. This evaluation will lead to refinements in targeting strategies.

(ii) **Generalise existing targeting techniques:** Account for non -linearity and non - normality, especially for longer forecast lead times (>2-3 days) and/or in flow

regimes where physical processes such as moist convection and clouds play a dominant role.

(iii) **Test targeting algorithms for a wide range of weather systems:** Candidate forecast problems include: i) hurricane track and intensity forecasts; mid-latitude summer heavy rainfall episodes; iii) and extended range (week-two) predictions. This should include research on the dynamical processes that propagate information spatially and temporally between the targeted regions and the selected weather events.

(iv) **Design observational networks**: Develop and test systematic and objective techniques for the design of observing networks**.** Quantify the required accuracy and resolution for the measurement of various quantities, and evaluate trade-offs between accuracy and resolution, or between resolution and areal coverage.

(v) **Expected Outcomes:**

?? Evaluations of the impact of targeting strategies on the reduction of forecast errors. This will require evidence utilising forecast re-runs that are plentiful enough to achieve statistical significance. In this context the term targeting is being used in the widest possible way.

?? The development of more accurate theoretical/numerical methods of targeting including relaxation of the assumption of linearity and other restrictions inherent in current techniques. These new methods will be evaluated as described in sub-section (a).

?? This should test sensitive area predictions for a wide variety of weather types, systems and geographical areas. It will provide outcomes that show targeting methods have a wide applicability and validity. It will also give a dynamical understanding of how perturbations in sensitive regions propagate and develop to affect the verification region forecast.

?? This topic will address how observations should be deployed or used within sensitive regions. The outcomes will include recommendations to other groups such as CBS/WWW on how to design the global observing system to include an adaptive component. The relative merits of different deployment and utilisation strategies will be provided. For this purpose the global observing system as a whole will be considered, included surface-based, in-situ, satellite and airborne components.

8. THORPEX Data Management

(a) CGMS members are invited to consider means and policy for providing access to data which will be used in THORPEX experiments as well as to contribute to THORPEX data management plan seeking a solution for real time exchange of large volumes of data.

9. Anticipated Impacts resulting from THORPEX

(a) Advance the knowledge of global-to-regional influences on the initiation, evolution, and predictability of high-impact weather;

(b) Design the strategy for interactive forecasting and targeted observations thus contributing to the process of evolving the WMO Global Observing System (GOS) which is recognized as a core component of future Global Earth Observation System of Systems (GEOSS). The TIP identifies THORPEX as a user of the GEOSS;

(c) Create and evaluate systems for the assimilation of targeted observations from satellites and in -situ measurements;

(d) Accelerate improvements of the accuracy of weather forecasts; test and demonstrate effectiveness of a multinational multi-model multi-analysis global ensemble forecasting system (THORPEX Interactive Grand Global Ensemble – TIGGE);

(e) Improve and demonstrate decision support tools, which utilise advanced forecasting products, in the most representative social and economic sectors.

SUMMARY

THORPEX is an exceptionally important International programme in which satellite observations will play a major role. The programme's success will help insure optimal utilization of satellite data across forecast scales from 1 day to two weeks, and likely into seasonal to inter-annual scales. Results from THORPEX will help guide the utilization of satellite data and future satellite roles as part of the Global Observing System. Information gleaned from THORPEX will help guide the future development of satellite systems. To ensure maximum realization of satellites potential as a part of the THORPEX program, CGMS should request observer status on the THORPEX ICSC and contribute to the THORPEX planning in coordination with WMO Space Programme.