



A World Weather Research Programme

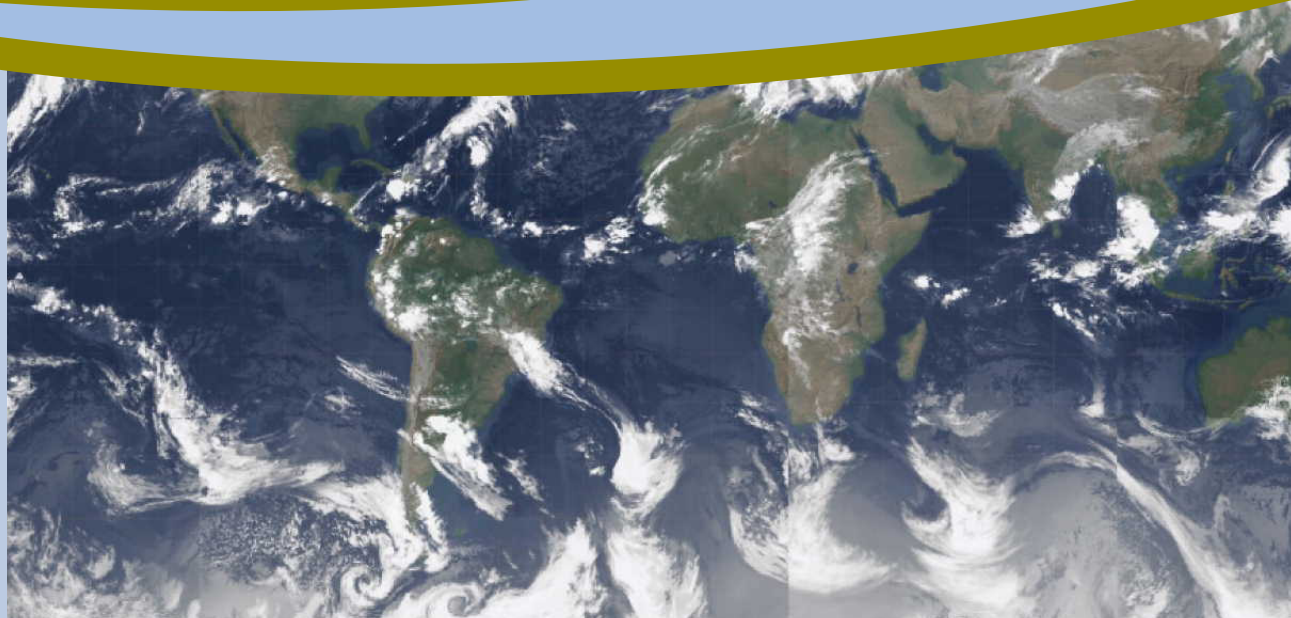
Accelerating improvements in the accuracy of one-day to two-week high-impact weather forecasts for the benefit of society, the economy and the environment



**World
Meteorological
Organization**

Weather • Climate • Water

WMO-No. 978



World Weather Research Programme



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NOTE

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Contents

Foreword	4
What is THORPEX?	5
Why THORPEX?	6
What will THORPEX do?	8
THORPEX demonstration projects	10
THORPEX desired outcomes	11
Where?	12
Who participates and benefits?	13
How is THORPEX organized?	14
References	



Foreword

THORPEX was established in 2003 by the Fourteenth World Meteorological Congress under the auspices of the WMO Commission for Atmospheric Sciences (CAS) as a part of the WMO World Weather Research Programme (WWRP) and in close cooperation with other WMO technical commissions. The programme is one of the most ambitious, fundamental, complex and promising international efforts in the field of atmospheric and related sciences.

THORPEX is a key research meteorological component of 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. Among the greatest research challenges of the twenty-first century are the reduction and mitigation of natural disasters and the adverse effects of weather, and realization of societal, economic and environmental benefits of improved weather forecasts. THORPEX is already addressing these challenges by aiming to extend the range of skilful weather forecasts up to 14 days, to develop user-specific products ready for use in decision-making support tools, and to assess the value of these products when applied in societal,

economic and environmental activities.

The WWRP/THORPEX series of publications will provide an understanding of the fundamental problems, projects, prospects and plans for programme implementation, and respective roles and responsibilities of all participants.

THORPEX demonstrates an outstanding degree of international cooperation between academic institutions, operational forecast centres and users of forecasts, in the search of a solution for global weather research and forecast problems. It establishes an international framework whereby all nations of the world can contribute to the development of weather forecasting. I believe that this cooperative spirit achieved during the planning of the programme will ensure that THORPEX makes a major contribution for the benefit of all nations.



(M. Jarraud)
Secretary-General

What **iS** THORPEX ?

THORPEX is a 10-year international research and development programme to accelerate improvements in the accuracy of one-day to two-week high impact weather forecasts for the benefit of society, the economy and the environment.

THORPEX establishes an organizational framework that addresses weather research and forecast problems whose solutions will be accelerated through international collaboration among academic institutions, operational forecast centres and users of forecast products.

THORPEX was launched in 2003 by the Fourteenth World Meteorological Congress.
THORPEX is a part of the WMO World Weather Research Programme.
THORPEX falls under the auspices of the WMO Commission for Atmospheric Sciences.

THORPEX is a key research meteorological component of the WMO Natural Disaster Prevention and Mitigation Programme and several international initiatives such as the International Polar Year (IPY). THORPEX is integrated with all relevant WMO Programmes (such as the World Weather Watch Programme, the Hydrology and Water Resources Programme, the Applications of Meteorology Programme, the World Climate Programme, the Public Weather Services Programme, the WMO Space Programme) and jointly sponsored programmes such as the World Climate Research Programme (WCRP). It cooperates with international organizations such as the European Centre for Medium-Range Weather Forecasts (ECMWF), the Coordination Group for Meteorological Satellites (CGMS), the African Centre of Meteorological Applications for Development (ACMAD), the IOC of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and other organizations.

THORPEX benefits from cooperation with WMO Commission for Basic Systems and other technical commissions of WMO.

What "THORPEX" means?

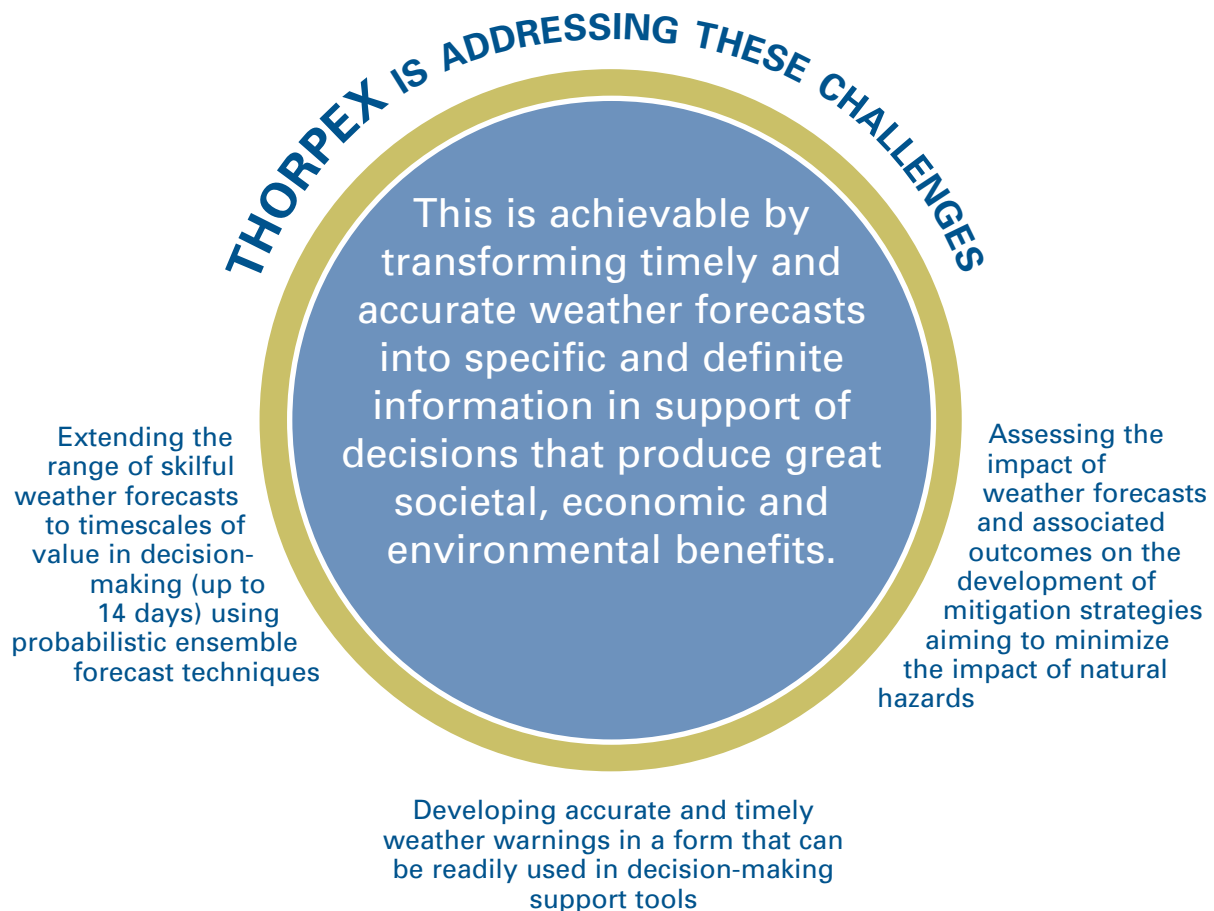
The programme developed from the initially planned experiment called "The Observing System Research and Predictability Experiment (THORPEX)" into a broad programme in atmospheric and related sciences equivalent to the Global Atmospheric Research Programme (GARP). The present name of the programme is "THORPEX: A World Weather Research Programme".

Why THORPEX?

Major societal challenges of the twenty-first century

To reduce and mitigate natural disasters and the adverse effects of weather.

To realize fully the societal, economic and environmental benefits of improved weather forecasts.



Improving the skill of weather forecasts

There is an increasing requirement for more accurate high-impact weather forecasts to reduce and mitigate weather-related disasters. The disasters are the societal/economic impacts of weather-related hazards (and not directly the hazards themselves) and their reduction can be substantially contributed to by improved weather forecasts and early warnings enabling society to take appropriate action. Skilful weather forecasts can prove to be a significant resource for a more productive and efficient economic activity. Advance notice of environmental conditions that affect business, such as in the food, energy and fresh water supply industries, is of considerable benefit.

High-impact weather forecasts

High-impact weather forecasts are defined by their effect on society, the economy and the environment. They are typically associated with forecasts of cyclones of extratropical and tropical origin that contain significant embedded mesoscale weather and its impacts, e.g., localized flooding by convective and orographic precipitation; blizzards; destructive surface winds; duststorms. They also encompass meteorological conditions affecting air quality, periods of anomalous high/low temperature and drought and non-extreme weather, which can have high impact without being conventionally severe (e.g., unusually hot summer 2003 in Europe). The term "high-impact weather forecasts" also emphasizes those societal and economic benefits resulting from advances in meteorological science.

Towards probabilistic forecasts

Many 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.

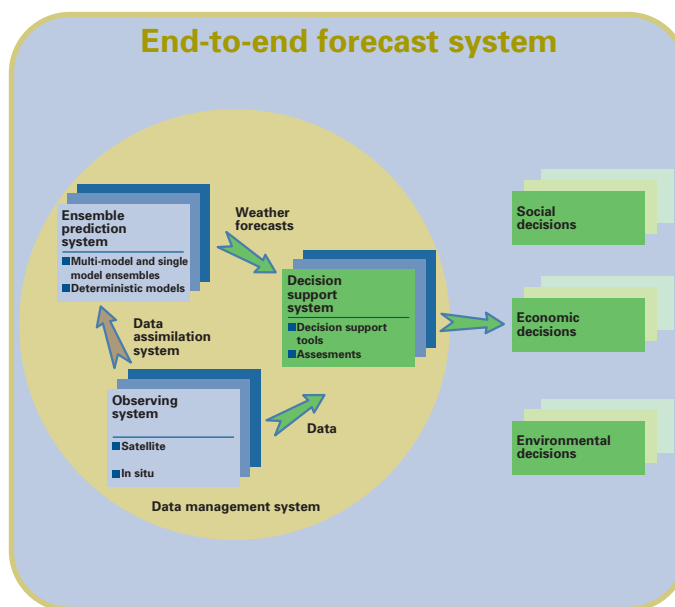
What will THORPEX do ?

THORPEX addresses fundamental research issues; it develops new forecasting techniques; explores new data assimilation and observational techniques; and tests, evaluates and demonstrates new forecast, observing, data assimilation, and decision support systems.

The combination of basic and applied research conducted within the framework of, and in collaboration with, operational services ensures that THORPEX research findings can be readily transferred and translated to operations, thus enabling timely improvements in operational systems.

THORPEX will contribute to the development of a future global interactive forecasting system, which would generate numerical probabilistic products, available to all nations — developed or developing. 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.



THORPEX will conduct a series of regional and global projects including experiments on:

Improvements in forecast skill

Advance the knowledge of global-to-regional influences on the initiation, evolution and predictability of weather systems

Targeted satellite and in situ observations

Design the strategy for interactive forecasting and targeted observations, thus contributing to the evolution of the WMO Global Observing System (GOS), a core component of the Global Earth Observation System of Systems (GEOSS)

Targeted observing strategies will incorporate dynamical information from the numerical forecast model itself to identify when, where, what types and how observations provide the greatest improvement to specific weather forecasts.

Data assimilation

Create and evaluate systems for the assimilation of targeted observations from satellites and in situ measurements

Numerical weather prediction systems

Accelerate improvements in the accuracy of weather forecasts; test and demonstrate effectiveness of a global multinational multi-model multi-analysis ensemble forecasting system

Demonstrations on societal and economic benefits of improved forecasts

Improve and demonstrate decision-support tools, which utilize advanced forecasting products to benefit directly social and economic sectors

Methods are needed that enhance the utility of weather forecasts through: (a) the use of new user-specific probabilistic forecast products; (b) the introduction of interactive procedures that make the forecast system more responsive to user needs; (c) the design of, and training in, the use of user-specific forecast products. This research will identify and assess the societal and economic costs and benefits of THORPEX recommendations for implementing interactive forecast systems and improvements in the global observing system.

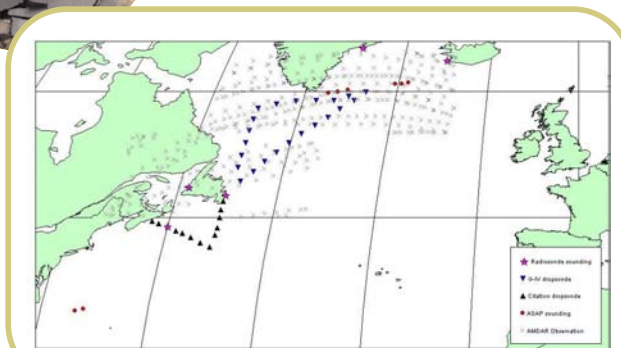
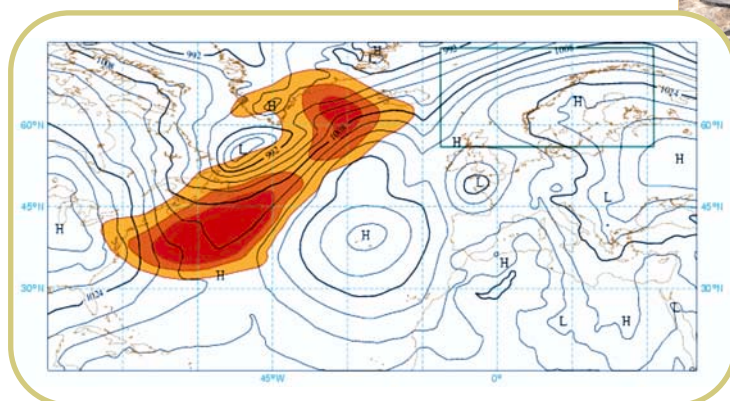


Illustration of targeted observations from the THORPEX North-Atlantic Regional Campaign (NA-TReC) in November–December 2003.

Left panel: sensitive-area calculation (colour shaded).

Right panel: targeted observations deployed to reduce initial condition uncertainty: G-IV dropsondes, supplemental radiosonde ascents, automated radiosonde ascents from ships of opportunity (ASAP), targeted high spatial/temporal resolution commercial aircraft reports (AMDAR).

THORPEX projects demonstration

THORPEX initiates demonstration projects around the world, which will benchmark new forecasting tools and techniques resulting from THORPEX research. These aim to demonstrate an increase in the number of positive social and economic outcomes that would result from the implementation of these tools and techniques. The unique contribution of these THORPEX demonstration projects is their adherence to using ensemble predictions of meteorological phenomena.

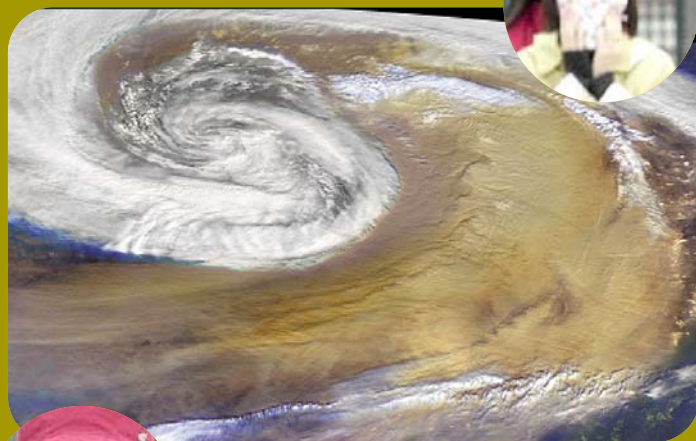
In the least developed and developing countries we are focusing on new tools to mitigate and reduce the impact of natural disasters. The emphasis is on the construction and application of decision support tools

to forecast social and economic risk associated with adverse weather on timescales of one to 14 days.

For developed countries, the emphasis is likely to be on economic efficiency.

For all National Meteorological and Hydrological Services, these projects offer additional opportunities to test and evaluate new ways of delivering information to their consumers in different sectors of the economy: public health, energy, water resource management, tourism, and for special events (e.g., Olympics).

THORPEX demonstration projects are intended to benefit all nations.



Respiratory distress from a duststorm over eastern China, driven by cyclone development in the lee side of the Tibetan Plateau during early April 2001. MODIS visible satellite image on 7 April 2001 showing the major cyclone cloud circulation and duststorm and two women covering their faces in their effort to mitigate the health-threatening impact of poor air quality.

public health - energy - water resource management - tourism - disaster management - food security



THORPEX desired outcomes

An increased fundamental understanding of the dynamics and predictability of the atmosphere

Significant, quantifiable improvements in decision-making skills throughout the world and a consequent measurable reduction in societal distress

The development of a much improved global and regional forecasting system, with the active involvement of developed, developing and least developed nations by fully exploiting advances in numerical prediction, observations, communications and data-assimilation techniques

THORPEX International Science Plan

defines four core research objectives:

- (a) Global-to-regional influences on the evolution and predictability of weather systems;
- (b) Global observing system design and demonstration;
- (c) Targeting and assimilation of observations;
- (d) Societal, economic and environmental benefits of improved forecasts.

THORPEX International Research Implementation Plan

establishes a roadmap for all THORPEX activities. It defines principal tasks, summarizes the expected outcomes derived from completion of each of these tasks, considers how these tasks may be accomplished, the roles and responsibilities for the participants, as well as the required levels of international cooperation, time and the resources.

THORPEX Regional Plans

focus of specific activities responding to the requirements and priorities of the regions and contributing to overall objectives.

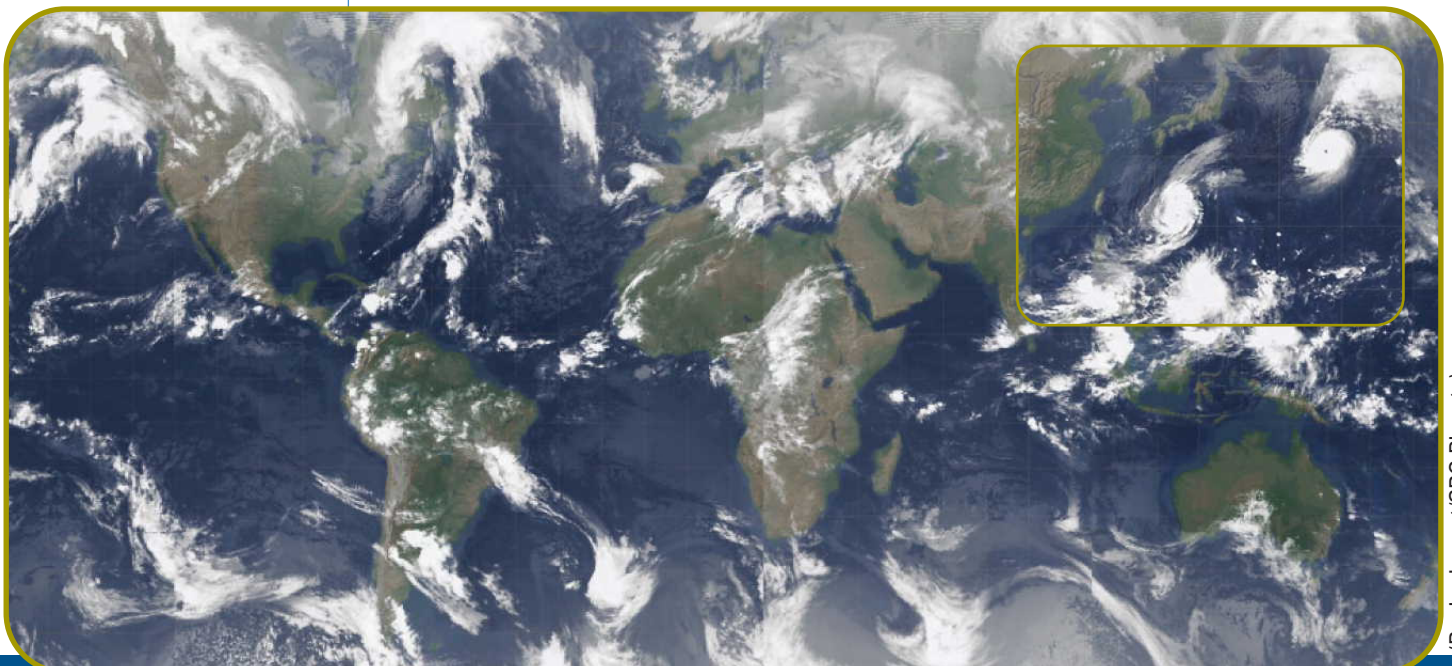
Where?

Globally, focusing on the extratropical and tropical Pacific and Atlantic, the Pacific-Indian Ocean warm pool, and polar regions.

THORPEX is planned and coordinated internationally, within the regional framework of WMO, where each region contributes to global aspirations and objectives. Collaboration between regions contributes to the advances in basic knowledge of atmospheric processes and predictability, and to the development of demonstration projects, trials and benchmarks of new forecasting techniques.

THORPEX Observing-System Tests and THORPEX Regional Campaigns are organized and coordinated by regional groups of nations under their respective THORPEX Regional Committees. All regions will participate in the Polar THORPEX experiment associated with the International Polar Year 2007–2008.

THORPEX Global Campaign will be organized to demonstrate all aspects of the THORPEX interactive forecasting system, over the globe for a season to one year. This will be an assessment of the utility of improved weather forecasts and user products, encompassing new developments in observing systems, targeting, adaptive data assimilation, model improvements and global interactive forecast system.



(Roshydromet/SRC Planeta)

Global mosaic of cloudiness made from five satellite images (two METEOSAT, two GOES and one GMS) with (inset, enlarged) two typhoons, Ketsana and Parma, on 24 October 2003.

Who participates and benefits?

- National Meteorological and Hydrological Services (operational and research branches)
- Academic institutions
- Space agencies
- International organizations and initiatives, such as IPY, GEOSS
- Users of forecast products and services
- The public at large

Virtually every nation of the world will participate and benefit, including developing and least developed countries. Some will provide technical, human and financial resources for research activities, observing and demonstration campaigns, host experimental data and modelling centres; others will contribute in addressing the needs of the operational forecast community and the users of weather forecasts.



How is THORPEX organized?

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, and the WMO Commission for Basic Systems.

Regional THORPEX Committees, aligned with WMO regional associations, coordinate activities of regional groups of nations.

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 programme activities are supported through voluntary contributions of the governments of the WMO Members participating in THORPEX, including donations to the THORPEX Trust Fund established by WMO.

Current Regional THORPEX Committees: North American (2002), Asian (2003), European (2003); others are under development in different regions of the world.



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"Today, about three-quarters of all natural disasters are related to weather, climate and water and their extremes.... Progress in meteorological and hydrological sciences shows that the impacts of natural hazards can be reduced through preparedness and mitigation.... It is WMO's ambition to halve the number of deaths due to natural disasters of meteorological, hydrological and climatic origin over the next 15 years... Indeed, at no time in history has so much been expected from the sciences of meteorology, hydrology and related geophysical sciences in addressing the challenges associated with sustainable development in areas such as disaster mitigation, food security, water resources management, transportation, tourism and pollution control... WMO's World Weather Research Programme (WWRP) will bring significant benefits from improved forecasts of high-impact weather. A major challenge will be to transform research results into operational applications."

Michel Jarraud
Secretary-General of WMO

"Natural hazards are a part of life. But hazards only become disasters when people's lives and livelihoods are swept away.... let us remind ourselves that we can and must reduce the impact of disasters by building sustainable communities that have long-term capacity to live with risk."

Kofi Annan, Secretary-General of the United Nations



A photographic collage of the societal, economic and ecological impacts of severe weather associated with four Rossby wave-trains that encircled the globe during November 2002.

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