Overview of Current and Potential Future National and Regional Activities

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THORPEX Goals

1. Advance our understanding of global-to-regional influences on the initiation, evolution, and predictability of high-impact weather.

2. Contribute to the design of the future national and global observing system for weather through GEOSS (Global Earth Observation System of Systems) and other co-ordinated efforts.

3. Contribute to the design of the next-generation data assimilation and forecast systems.

4. Increase the benefit of weather prediction to society, the economy, and environmental stewardship.
“In recent decades, the emphases in the atmospheric sciences have moved simultaneously in two directions: toward smaller space and time scales involved with physical processes and toward larger scales involved in the evolution and prediction of climate and environmental change.” -- From *The Atmospheric Sciences: Entering the 21st Century*, Board of Atmospheric Sciences and Climate, National Academies, 1998.

THORPEX is a global atmospheric research program that seeks to advance knowledge and accelerate forecast skill for high-impact weather events on the 1 to 14-day time-scale for the benefit of society, the economy, and the environment.

By bridging mesoscale and climate studies, THORPEX fills an important gap in our knowledge and in addressing societal needs.
Current Activities

– Formation of a U.S. THORPEX Executive Committee
– Results from U.S. Participation in the Atlantic TREC
– Contribution to THORPEX from ONR and NRL
– NOAA THORPEX program
– Societal and Economic Applications
U.S. THORPEX Executive Committee

- Coordinate Federal involvement in U.S. THORPEX activities
- First meeting 19 August 2005; regular meetings thereafter
- Provide oversight, review, and approval of U.S. THORPEX Science and Implementation Plans
- Support formation of Science Steering Committee
- Encourage linkage of research to operations
- Provide input to North American and international THORPEX working bodies and activities
U.S. THORPEX Executive Committee: Membership

• Rick Rosen (Chair) <rick.rosen@noaa.gov>
• Ramesh Kakar <ramesh.k.kakar@nasa.gov>
• Pamela Stephens <pstephen@nsf.gov>
• Steve Tracton <steven_tracton@onr.navy.mil>
• Louis Uccellini <louis.uccellini@noaa.gov>
The Atlantic THORPEX Regional Campaign (A-TREC)

- IOP - ran from 13 Oct. until 12 Dec 2003
- 21 TReC cases
- Targeted observations from
  - Radiosonde sites
  - Flight level data from commercial aircraft
  - Dropsondes from research aircraft
  - Prototype satellite sensors

TReC_026 -- 8 Dec: prolonged, heavy snow; gale-force winds in Boston

TReC_023 2 Dec: Heavy Mediterranean rainfall, severe flooding Marseilles
A-TREC Results

The impacts of targeted measurements on forecast skill was positive, but the improvements were generally small.

Courtesy of Z. Toth, NOAA
A-TREC Results

• The results of A-TREC and other targeting studies have been used to understand the forecast impacts of targeting in the context of an evolving global observing system (e.g., Langland et al. 2006).

• Dropsondes have large impacts per observation, but the relatively small number of soundings will often limit the forecast improvement.

• Flight-level commercial aircraft measurements had the largest overall impact.

• Due to the large number of observations, adaptive use of satellite data should be explored.

• Impact in terms of societally relevant parameters is relatively unexplored.
DOD/NAVY THORPEX ACTIVITIES

- Naval Research Laboratory/Monterey: $2.14M FY06 in-house Science and Technology funding related to THORPEX science objectives.
  - 2% annual growth rate with 4% fluctuations
- Office of Naval Research
  - Partial secondment of S. Tracton to THORPEX International Program Office
  - Very limited support possible for PI basic research
NOAA THORPEX PROGRAM

• 12 grants awarded in four research areas
  – Ensemble data assimilation
  – Model uncertainty
  – Use of observations/adaptive data collection
  – Socio-economic Impacts

• Results presented at NOAA THORPEX PI Workshop;

• A focus is on examining whether ensemble Kalman filter-based techniques should be implemented as the next generation operational data assimilation system.
Socio-economic Impacts of Weather

“...some one-third of the private industry activities, representing annual revenues of some $3 trillion, have some degree of weather and climate risk. This represents a large market for atmospheric information.” -- Dutton, BAMS, 2002

Attempts are underway to quantify this number for different sectors:

a) The most important parameters for the public are the chance and amount of precipitation. A preliminary estimate of the household value of maximum improvement is ~$1.6 billion. [Jeff Lazo, Societal Impacts Program]

b) Teisberg et al. (BAMS, Dec. 2005) show that $166 Million per year is saved by US electricity generators based on 24-h temperature forecasts.
Potential Future Activities

• U.S. participation in international priorities
  – TIGGE (THORPEX Interactive Grand Global Ensemble) and the North American Ensemble Forecast System (NAEFS)
  – NASA N-AMMA Campaign
  – Research at the intersection of weather and climate
  – Regional aspects of high impact weather, including the proposed THORPEX Pacific Asian Regional Campaign (PARC)

• Areas of U.S. research community interest in support of THORPEX goals
Ensemble Forecast Systems

• Canada, Mexico and the US have agreed to establish the North American Ensemble Forecast System (NAEFS), which will combine ensemble members from NOAA/NCEP and the Environment Canada/CMC. Research access to operational data in real-time.

• North American operational participation in the THORPEX Grand Global Ensemble (TIGGE) is also likely. TIGGE will make all the members of the world’s global ensemble forecasts available for research. NCAR has agreed to host the TIGGE data sets and support access by the research community.

  – TIGGE will begin with a 48-h delay, with real-time access for major field campaigns and demonstration projects.

  – Both TIGGE and NAEFS will include diagnostic fields to support basic research and will further applied research aimed at increasing the value of weather products by exposing users to probabilistic weather prediction.

  – TIGGE and NAEFS will enable research exploration of the concept of moving toward the vision of an international Global Interactive Forecast System (GIFS).
RESEARCH SYNERGY
• NASA’s Heritage of Hurricane

• Research Field Programs
  • Joint partnership with NOAA HRD
  • Blending of in situ and satellite data sets
  • Improved parameterization of models
  • Data assimilation to improve models
  • Technology testbed (i.e. ER-2 dropsonde, Aerosonde)

**CAMEX-3**
- Inner core dynamics
- Synoptic flow environment
- Landfalling intensity change
- Genesis environment

**CAMEX-4**
- Rapid intensification
- Storm movement
- Structure and dynamics
- Scale interactions
- Remote sensing techniques

**TCSP**
- Genesis in EPAC, GOMEX, ATL
- Rapid intensification
- Easterly wave dynamics
- Satellite cal/val

*Tropical Cloud Systems and Processes Mission*
Costa Rica - Summer 2005
ESS Planned Hurricane Field Campaign: NAMMA-06

- Out of Africa: African Easterly Waves are the progenitors of many late-season, strong category hurricanes that strike the U.S.
- Leverages off AMMA SOP-3 and will be based in Cape Verde
- Multidisciplinary approach involving Weather, Water & Energy, Composition foci
- Partnering with European consortium, NOAA HRD
- NAMMA-06 science in line with CCSP objectives
- Platforms to include DC-8, Aerosonde, TOGA & NPOL radars, micropulse lidars

African SAL: Impact on tropical cyclogenesis - hypothesize to be a hurricane suppressant, in an ocean marginally suitable for hurricane generation; examine SAL impact on microphysics, thermodynamic instability, shear, airmass dessication
RESEARCH AT THE WEATHER-CLIMATE INTERFACE

PROBLEMS HINDERING PROGRESS IN BOTH WEATHER AND CLIMATE

One Topic -- TROPICAL CONVECTION AND TWO-WAY SCALE INTERACTIONS

Weather Perspective
See Shapiro and Thorpe (2005)

CA wildfire, $2 billion in damage

Climate Perspective
Rasch et al. 2005

Large biases in tropical rainfall intensity

43,000 homeless in Vietnam

Most high-impact weather involves precipitation

Rainfall poorly predicted

Downstream effects of tropical convection is a key to accurate week 2 predictions

ENSEO is too long

Diurnal cycle is even poorly represented
Regional High Impact Weather -- A Series of Three Poorly Predicted Major Downstream Events Initiated by Tropical Convection

Western WA flood (Seattle 1-day record)

BC’s flood of the Century (18.5”)

CA Wild Fires (downslope winds)

Credit for the analyses given to M. Shapiro, L. McMurdie, and D. Parsons
What is happening in this region?

BC’s flood of the Century (18.5”)

Western WA Flood (Seattle 1-day record)

CA Wild Fires (downslope winds)
The US Weather Disasters Had Their Roots in Tropical Convection Days Earlier
THORPEX Pacific Asian Regional Campaign (PARC)

- July – December 2008
- Collaboration between Asian and North American Regional Committees with some EU participation
- Link to IPY with tropical to polar interactions
- **Asian interest** -- Advancing understanding and prediction of typhoons from genesis to decay/ET
- **North American interest** -- Advancing understanding and prediction of high impact weather that has its dynamical roots and medium range forecast errors in conditions over east Asia and the western Pacific
Areas of U.S. Research Community Interest

– Determination of factors limiting predictability (e.g., error growth and scale interaction, model error vs. initial condition error, regime dependence of forecast errors)

– Research on advanced data assimilation methods (e.g., should the U.S. operational system be 4-d var, modified 3-d, or ensemble Kalman-based techniques)

– Satellite data assimilation

– Design of the global observing system

– Impact of global and local non-hydrostatic modeling

– How to improve society’s utilization of forecast products (e.g., risk, uncertainty, and use of probabilistic forecasts)
Examples of Community Interest

• White Paper entitled “THORPEX Predictability Research and the National Science Foundation Research Community”

• Led by Jim Hansen (MIT) and Steve Mullen (U of Arizona)

• 32 Participants

• Representing 16 institutions: Florida State University; Georgia Tech; Harvard; Iowa State University; MIT; NCAR; State University of New York, Albany; Texas A&M University; University of Arizona; University of Miami; University of Oklahoma; University of Hawaii; University of Maryland; University of North Carolina, Charlotte; University of Washington; University of Wisconsin, Madison

• PARC has a similar number of investigators within the U.S. plus investigators from Canada, Japan, Korea, China, Taiwan, and interest from several countries of the EU
Next Steps

1) Formation of a national THORPEX Science Steering Committee to examine how to mesh international priorities and areas of national needs, agency mission, expertise, and grass roots interest.

2) The committee will examine the status and proposed future priorities set forth in current THORPEX planning documents and present a U.S. THORPEX Science Plan to the federal agencies in March/April.

3) For details on the international THORPEX program see http://www.wmo.int/thorpex and for North American activities see http://www.ucar.edu/na-thorpex