Introduction to THORPEX and TIGGE

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Thanks to:
Mel Shapiro, Alan Thorpe, co-chairs THORPEX ISSC
David Rogers and THORPEX Implementation Plan Expert Group
Elena Manaenkova, Director AREP, WMO
Roberto Buizza, Renate Hagedorn and TIGGE Workshop Organising Committee

And many others

Contents

The presentation covers the following sections

- Overview of THORPEX programme

- The THORPEX Interactive Grand Global Ensemble (TIGGE)

- Structure of the Workshop

- Next steps

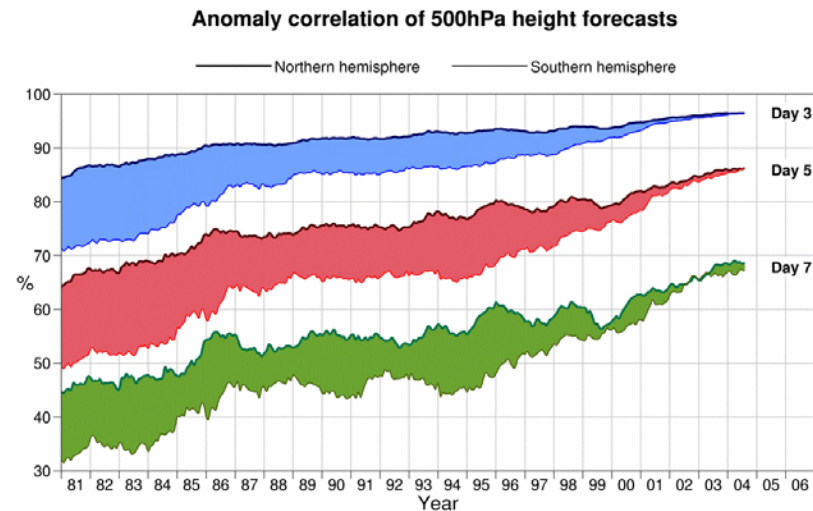## Major societal and scientific challenges of 21st century

- To reduce and mitigate natural disasters and adverse effects of weather

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

Major societal and scientific challenges of 21st century

- To realise fully the societal, economic and environmental benefits of improved weather forecasts

Anomaly correlation of 500hPa height forecasts

Evolution of forecast skill for the northern and southern hemispheres: 1980-2004. Anomaly correlation coefficients of 3, 5, and 7-day ECMWF 500-mb height forecasts for the extratropical northern and southern hemispheres (running means). Shading shows differences in scores between hemispheres at the forecast ranges indicated (after Simmons and Hollingsworth, 2002, Q.J.R.Met. Soc., **128**, 647-677).
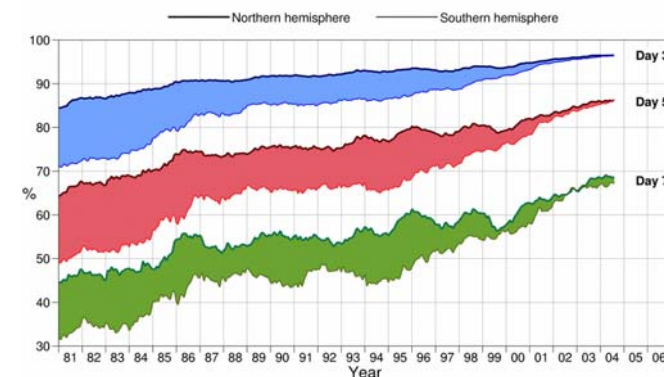
The challenge

Major societal and scientific challenges of 21st century

- To reduce and mitigate natural disasters and adverse effects of weather

- To realise fully the societal, economic and environmental benefits of improved weather forecasts

Anomaly correlation of 500hPa height forecasts

— Northern hemisphere   — Southern hemisphere

THORPEX is a response to these challenges

The response: THORPEX

- **THORPEX: A World Weather Research Programme**
  - 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
  - One of the most ambitious, fundamental, complex and promising international efforts in the field of atmospheric and related sciences (M Jarraud, Secretary-General, WMO, 2004)

- **Originally**
  - THe Observing system Research and Predictability EXperiment

THORPEX under WMO

- Established in 2003 by 14th WMO Congress

- Under auspices of WMO Commission for Atmospheric Sciences
  - Part of World Weather Research Programme

- Integrated with all relevant WMO Programmes

- Key research component of WMO Natural Disaster Prevention and Mitigation Programme

- Contribute to WMO goal to halve number of deaths due to natural disasters of meteorological, hydrological and climatic origin over next 15 years
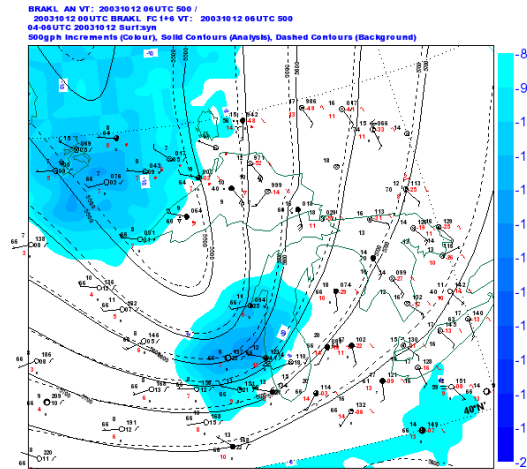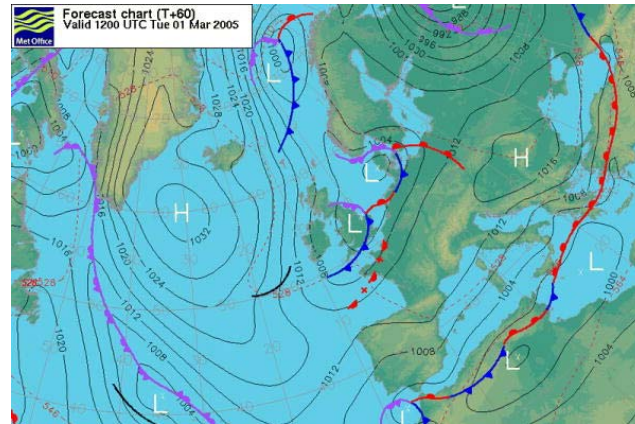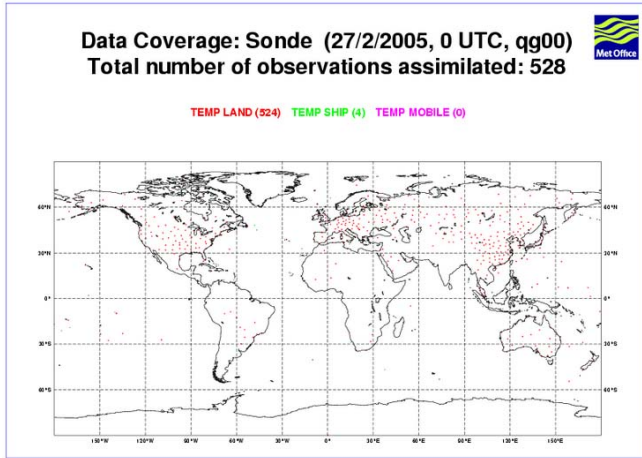
Desired outcomes - what will THORPEX do?

- Increase fundamental understanding of dynamics and predictability of the atmosphere

- Make significant, quantifiable, worldwide improvements in decision-making skills and consequent measurable reduction in societal distress

- Promote and fully exploit advances in NWP, observations, communications and data-assimilation techniques to …

- Deliver much improved global and regional forecasting system with active involvement of developed, developing and least developed nations
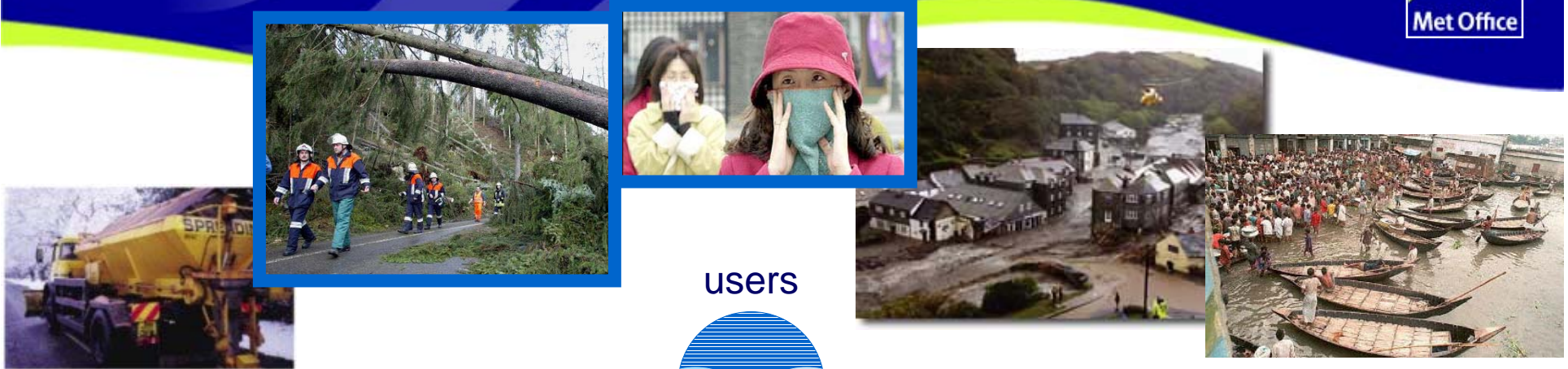
Why? What is special about THORPEX?

- THORPEX establishes organisational framework for international collaboration between
  - Operational centres and academics
  - Developed and developing countries
  - Research scientists and end users
- THORPEX will use this framework to coordinate research on interactive forecasting system that allows information to flow interactively between forecast users, NWP models, data assimilation systems and observations
- THORPEX will contribute to the development of a future global truly integrated interactive forecast system, which would generate probability-based decision-support tools, available to all nations, developed and developing.

1st TIGGE Workshop, ECMWF, 1-3 March 2005

Traditional forecast system

Data Coverage: Sonde (27/2/2005, 0 UTC, qg00)
Total number of observations assimilated: 528

TEMP LAND (524)   TEMP SHIP (4)   TEMP MOBILE (0)

Forecast chart (T+60)
Valid 1200 UTC Tue 01 Mar 2005

| observations | → | Assimilation | → | Forecast | → | users |

BRAKL AN VT: 20031012 06UTC 500 /
20031012 00UTC BRAKL FC t+6 VT: 20031012 06UTC 500
04-06UTC 20031012 Surf:syn
500gph increments (Colour), Solid Contours (Analysis), Dashed Contours (Background)

Global Interactive Forecast System

users
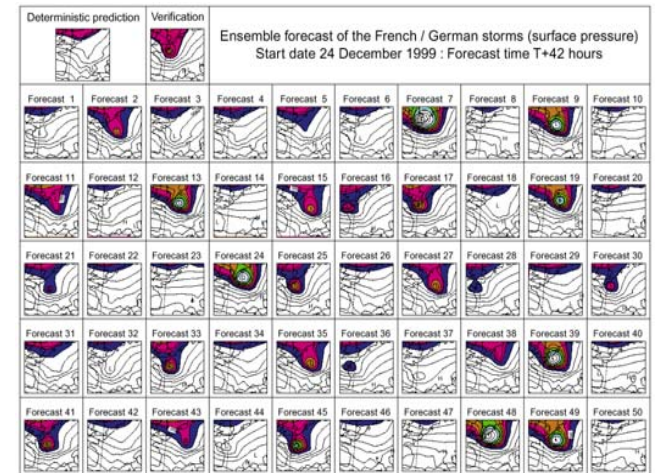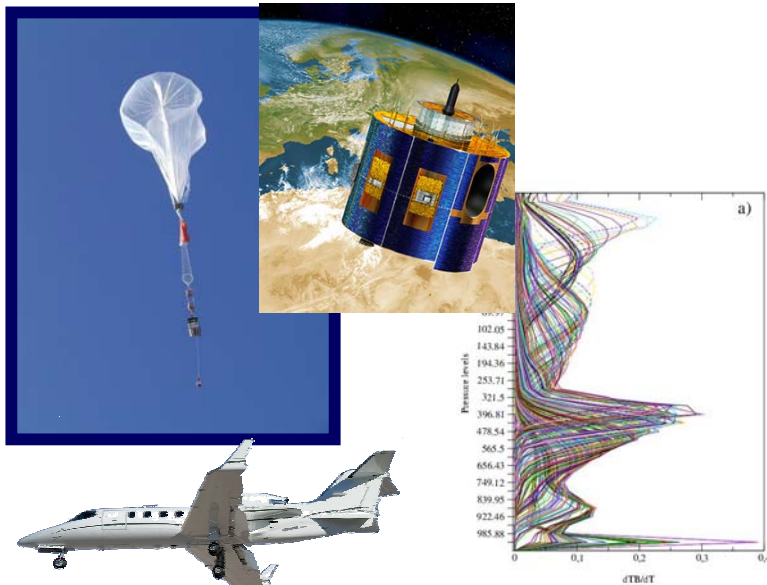
observations   forecast

assimilation

Global Interactive Forecast System (GIFS)

A concept for future weather prediction

Global

- Global participation, global application, global and regional models

Interactive

- observation-assimilation-forecast-user: all parts of system integrated, adaptive, interactive. Changes according to situation and user needs.

We cannot say now what a future Global Interactive Forecast System will be − a goal of THORPEX is to determine this

The development, evaluation and testing of a future GIFS will depend on results from all four components of THORPEX

THORPEX Science Plan

- **THORPEX International Science Plan**
  - Shapiro and Thorpe (2004) www.wmo.int/thorpex

- **Four research sub-programmes**
  - Predictability and Dynamical Processes
  - Observing Systems
  - Data Assimilation and Observing strategies
  - Societal and Economic Applications

- On 1 August, a Rossby wave train was excited by cyclogenesis east of Japan, followed by rapid downstream development of high-amplitude Rossby waves, culminating in severe flooding in Europe on 11 August 2002.

-

- A skilful forecast of the cyclogenesis east of Japan is necessary to obtain skilful medium-range forecasts over Europe.
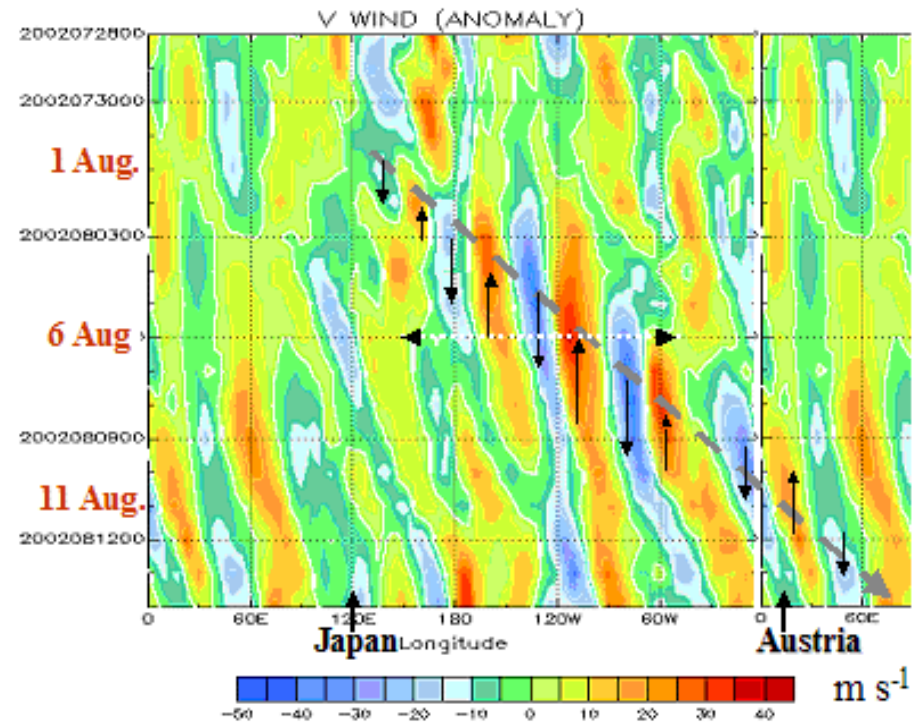

Hovmöller diagram of 250-mb meridional wind component (m/s) 28 July - 14 August 2002 (40-60⁰ N). Mel Shapiro
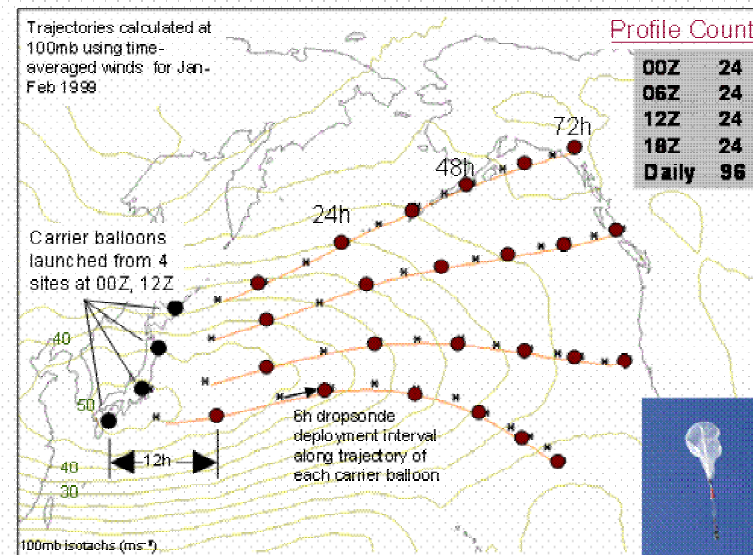
Predictability and dynamical processes

- 42-h ECMWF ensemble forecast for the destructive French/German wind storm "Lothar"

  - Deterministic forecast (top left) misses extreme event
  - 14 ensemble members predict a storm of equal or greater intensity than the verifying analysis

Ensemble forecast of the French / German storms (surface pressure)
Start date 24 December 1999 : Forecast time T+42 hours
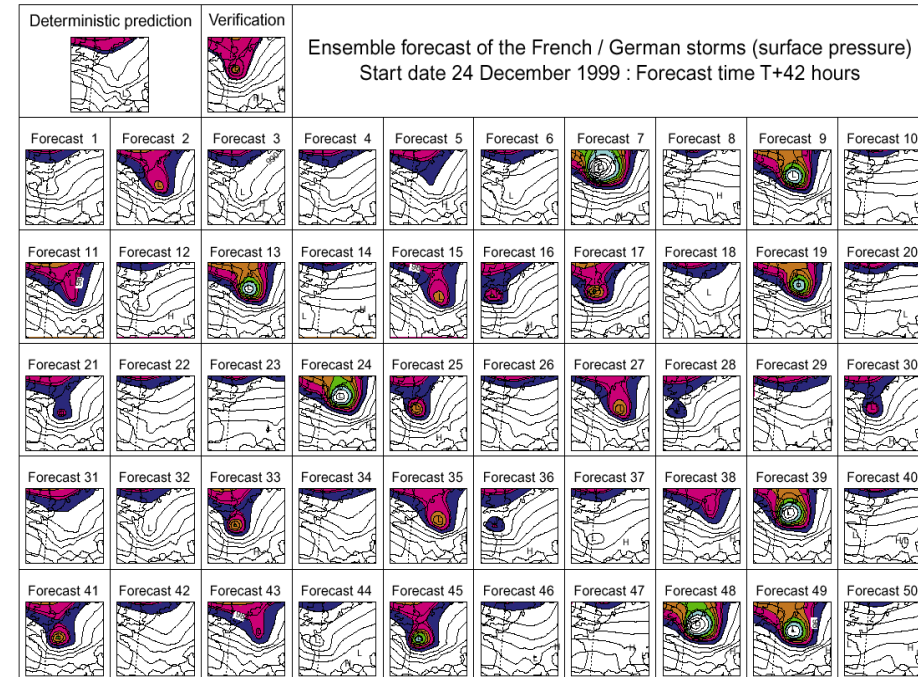
- THORPEX will evaluate factors limiting predictability and develop new strategies to extend these limits

Observing systems

- Evaluate the potential of new observing techologies, in-situ and remote sensing

Trajectories calculated at 100mb using time-averaged winds for Jan-Feb 1999

Profile Count
00Z	24
06Z	24
12Z	24
18Z	24
Daily	96

Carrier balloons launched from 4 sites at 00Z, 12Z

6h dropsonde deployment interval along trajectory of each carrier balloon
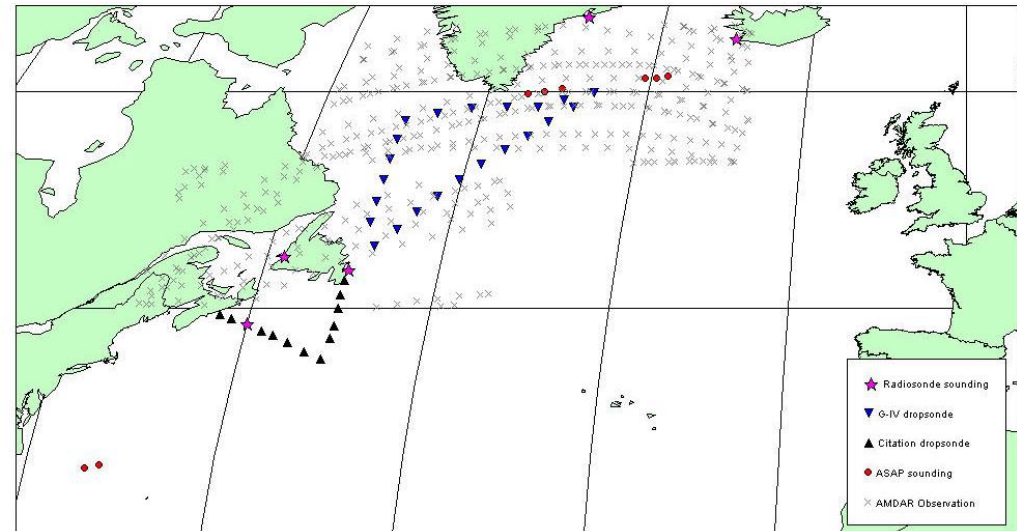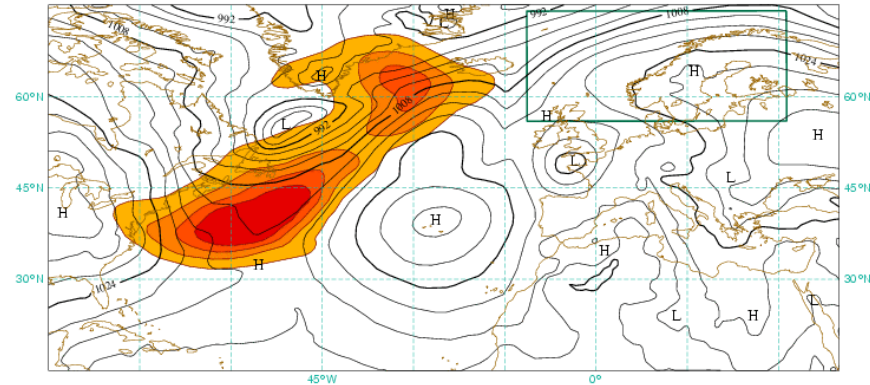
100mb isotachs (ms-1)

- Simulated Driftsonde profile coverage at one data-assimilation time, after 3 days of sonde deployment from 100 mb. The carrier balloons were launched from 4 sites in Japan (black dots). Each dot represents a separate carrier balloon / gondola and GPS dropsonde profile locations at 0000 or 1200 UTC (red dots). Stars are profile locations at 0600 or 1800 UTC. (Rolf Langland)

Observing strategies

- Prediction of sensitive areas where extra observations will provide most benefit to forecasts

- Adaptive control of observing network

- Targeted use of satellite data (adaptive, intelligent thinning)

ECMWF-SAP based on TE-SVs (dry T42) and MSL
Valid time: 20031202, 18 UT (Targeting Time)
Shading: areas of 8, 4, 2, 1 x10⁶ km²
trajectory initialized from fc 20031130, 00 UT +66 h
Targ. time: 20031202, 18 UT / Verif. time: 20031204, 12 UT (opt: 42h)

Radiosonde sounding
G-IV dropsonde
Citation dropsonde
ASAP sounding
AMDAR Observation

Data assimilation

- Flow-dependent background errors

- Adaptive quality control of observations
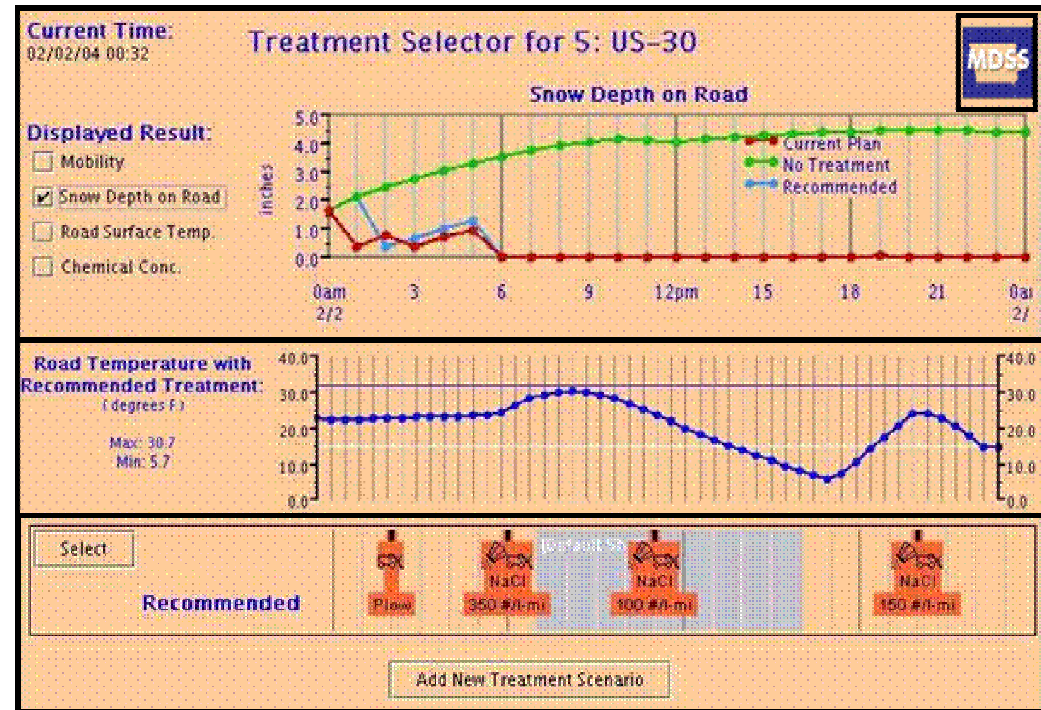
- Inclusion of model uncertainty
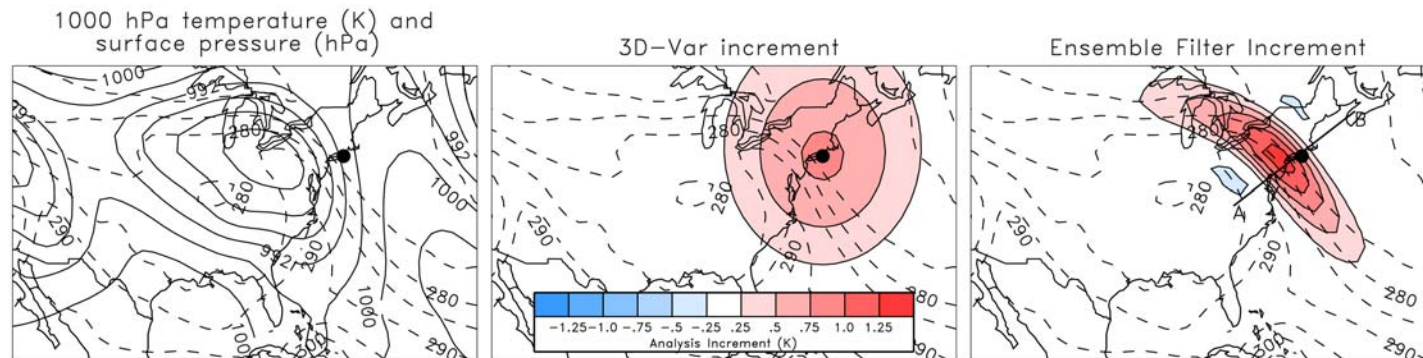
Impact of flow-dependent background error (Tom Hamill)

Societal and economic applications

- Identification of high-impact weather forecasts

- Development of systems that respond to users' needs

- Evaluation of benefits of forecasts to users

Current Time: 02/02/04 00:32 — **Treatment Selector for 5: US-30**

Snow Depth on Road

Displayed Result:
☐ Mobility
☑ Snow Depth on Road
☐ Road Surface Temp.
☐ Chemical Conc.

Current Plan / No Treatment / Recommended

Road Temperature with Recommended Treatment: (degrees F) Max: 30.7 Min: 5.7

Select / Recommended / Add New Treatment Scenario

ll) Real-time display from the winter road Maintenance Decision Support System (MDSS) showing the predicted 24-hr snow depth, road temperature, and treatment plan for snow impact mitigation on state highway 30 near Ames, Iowa. This system is used by highway maintenance personnel for planning de-icing operations. In this example, the system recommends a single snow removal operation followed by several salt applications of between 100 and 350 pounds per driving-lane mile (courtesy Bill Mahoney NCAR/RAP).

## THORPEX Interactive Grand Global Ensemble

- Framework for international collaboration in development and testing of ensemble prediction systems

- Resource for many THORPEX research projects

- Prediction component of THORPEX Forecast Demonstration Projects (FDPs)

- A prototype future Global Interactive Forecast System

- Global and regional components

- Initially develop database of available ensembles, collected in near-real time

- Co-ordinate research using this multi-model ensemble data
    - Compare initial condition methods
    - Compare multi-model and perturbed physics
    - Develop ways to combine ensembles
    - Boundary conditions for regional ensembles
    - Regime-dependence of ensemble configuration (size, resolution, composition)

    - Observation targeting (case selection, ETKF sensitive area prediction)
    - Societal and economic impacts assessment

- Close interaction with other THORPEX sub-programmes

TIGGE organisation

THORPEX ICSC will establish TIGGE working group

- Design structure of TIGGE dataset considering potential scientific research subprojects and possible real-time applications (cf NAEFS)

- Prioritise requirements of different subprojects

- Monitor work and results done with TIGGE data

- Report on progress to THORPEX, funding bodies, data providers

- Feed progress into development of GIFS

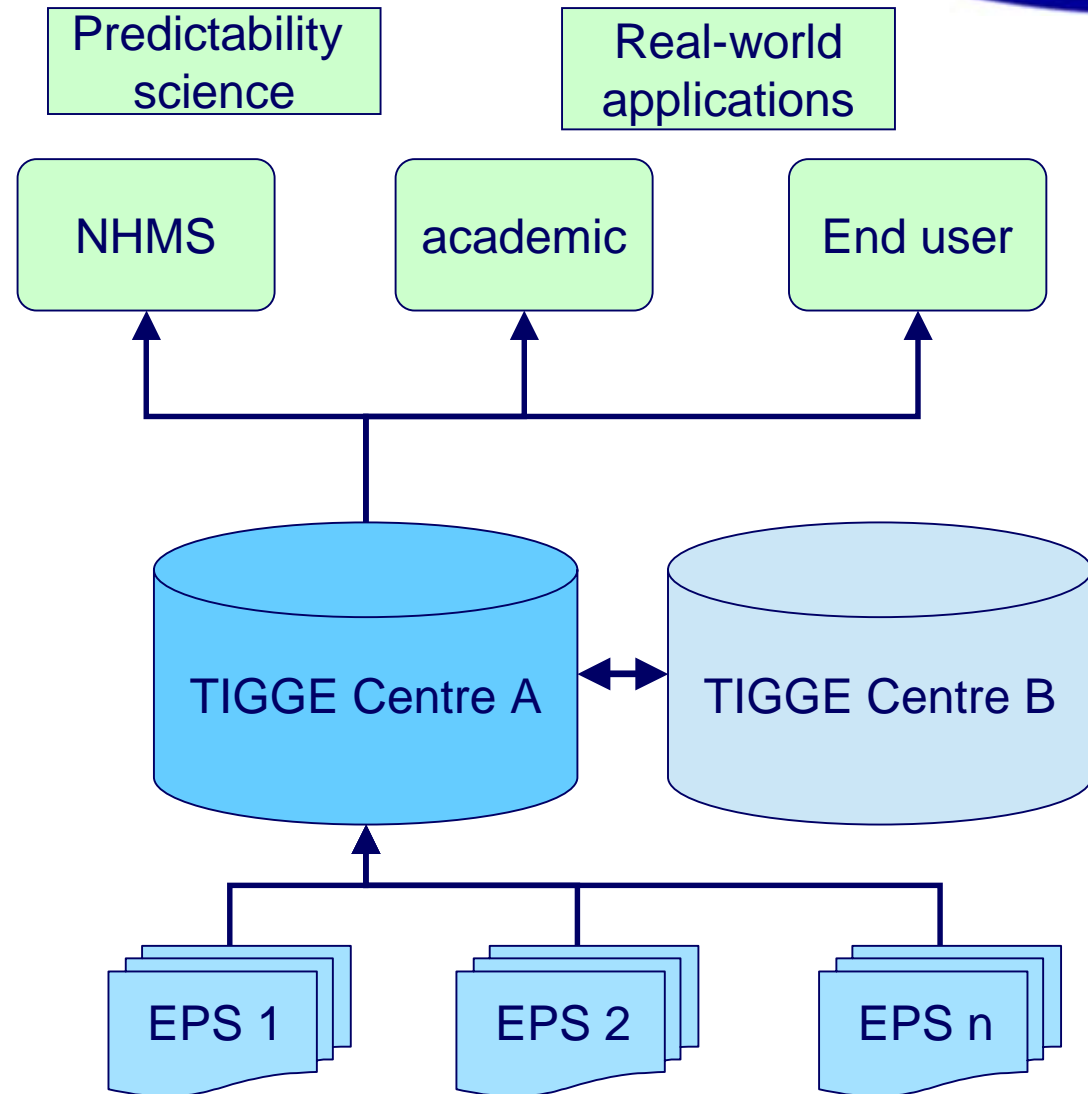- Take necessary action to ensure success of project

TIGGE in THORPEX
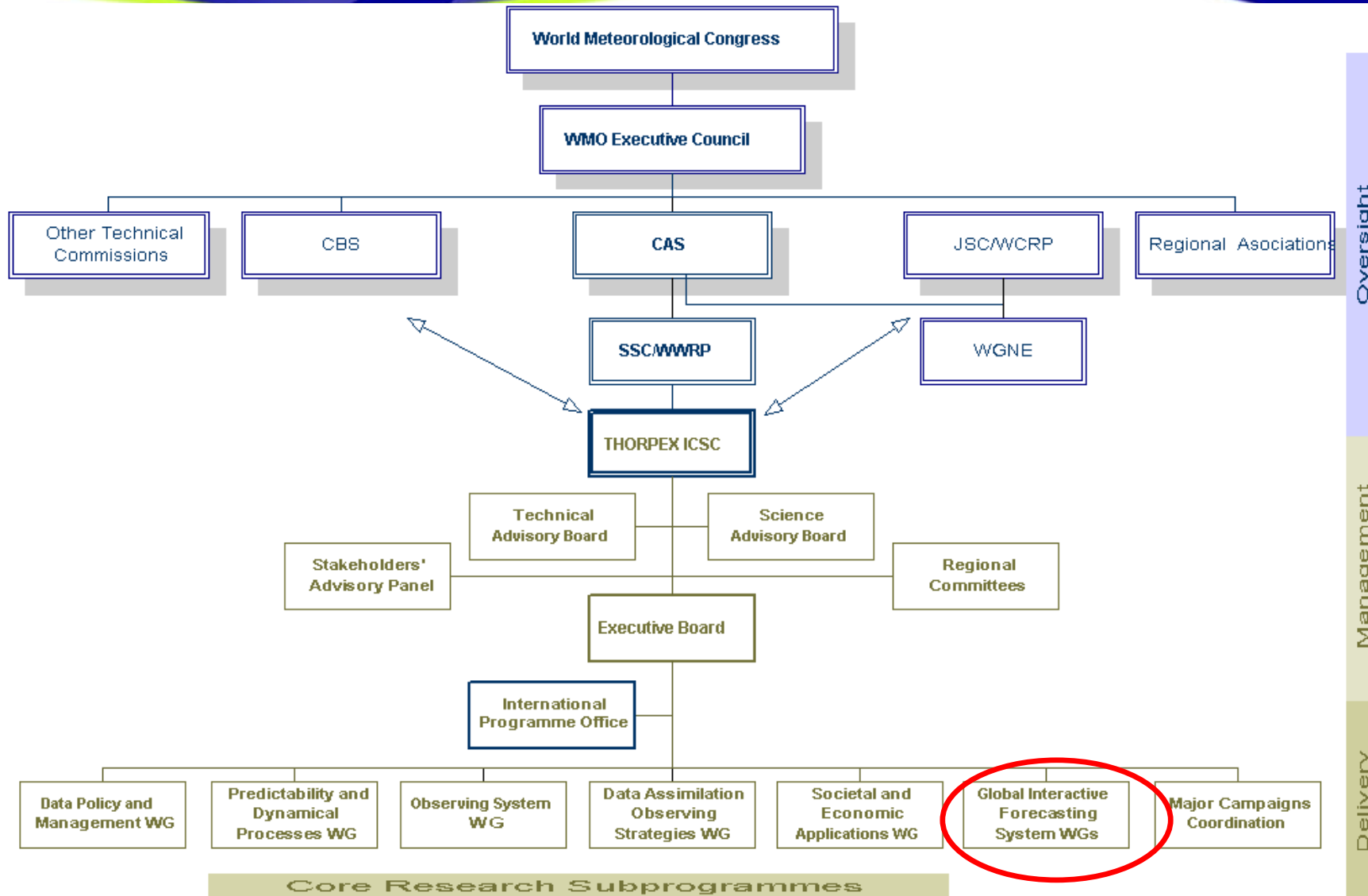
TIGGE Workshop: aims

Aim: Define user-requirement for TIGGE data

- Users
  - Who?
  - What for?
  - How?
  - When?
- Requirements
  - What data?
  - Format?
  - How to access?
- Contributors

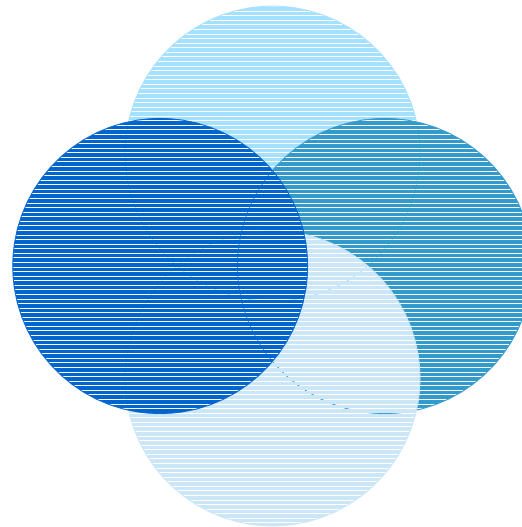
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TIGGE Workshop: organisation

- Invited talks - overviews of main areas
- Working Groups
- Plenary sessions

TIGGE Workshop: working groups

WG1: Predictability, science and design of TIGGE model systems
Martin Ehrendorfer, Jim Hansen

WG2: Post-processing and verification
Tom Hamill, Beth Ebert

WG3: Applications
Mark Roulston, Francois Lalaurette

WG4: Infrastructure
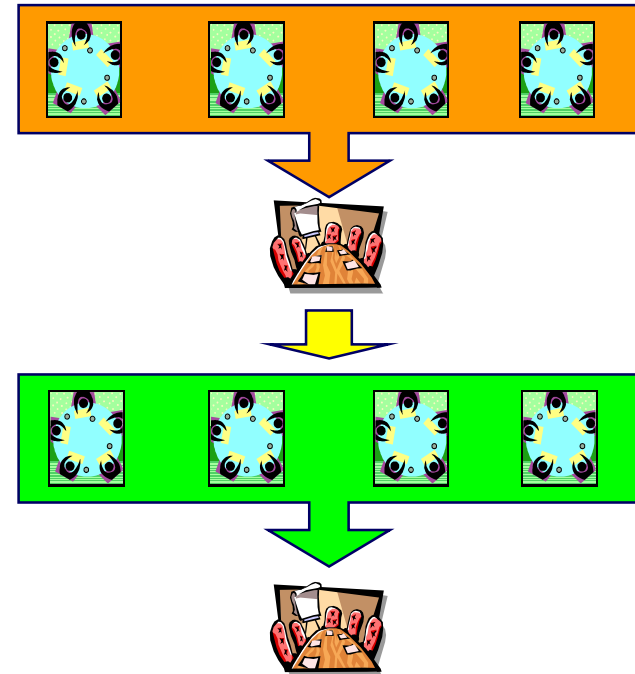Horst Boettger, Laurie Wilson

TIGGE Workshop: Plenary

- The flow of information:

  … Wed PM   : WGs

  … Thu AM   : plenary

  … Thu AM/PM: WGs

  … Thu   PM: plenary

- Plenary discussion will include short (~10 minutes) presentations by WG chairpersons, followed by open discussion
  - Each WG to prepare 2-3 PowerPoint slides

- What are the scientific issues?
- What are the consequent requirements for TIGGE data?
- Prioritized list of data and access requirements
  - 10-year programme so what should be done when?

TIGGE – next steps
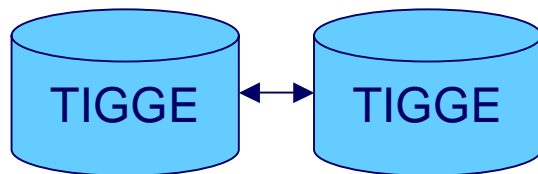
- Write up workshop report
  - Organising Committee, Invited speakers, Working Group chairs on Friday
- Convert user requirement into draft specification for TIGGE data archive and access centres
  - Resources, costs
- Report to THORPEX Executive Board, ICSC
- Establishment of TIGGE Working Group
- Commitments from contributors, TIGGE centres, users, funding sources

1st TIGGE Workshop, ECMWF, 1-3 March 2005

Questions

We look forward to your input throughout the Workshop –

We need your help!