



# Introduction to THORPEX

## Links with AMMA

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*Based on a presentation by David Burridge, THORPEX IPO*

# THORPEX

## “THE Observing System Research and Predictability Experiment”

A World Weather Research Programme of WMO

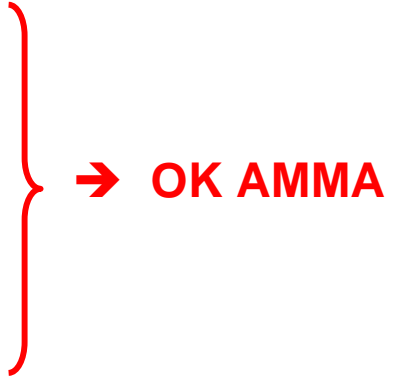
A Global Atmospheric Research Programme for 21<sup>st</sup> Century

**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**

# Aims - what will THORPEX do?

- **Increase fundamental understanding of dynamics and predictability of the atmosphere (OK AMMA)**
- **Make significant, quantifiable, worldwide improvements in decision-making skills and consequent measurable reduction in societal distress (OK AMMA)**
- **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 (OK AMMA)**

# Framework: Why THORPEX?

- THORPEX establishes an organisational framework for international collaboration between
  - Operational centres and academics
  - Developed and developing countries
  - Research scientists and end users

→ OK AMMA
- THORPEX will use this framework to coordinate research on **interactive forecasting systems** 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** → **relevant framework for future AMMA applications**



# To Mitigate Natural disasters

**Cf. AMMA**

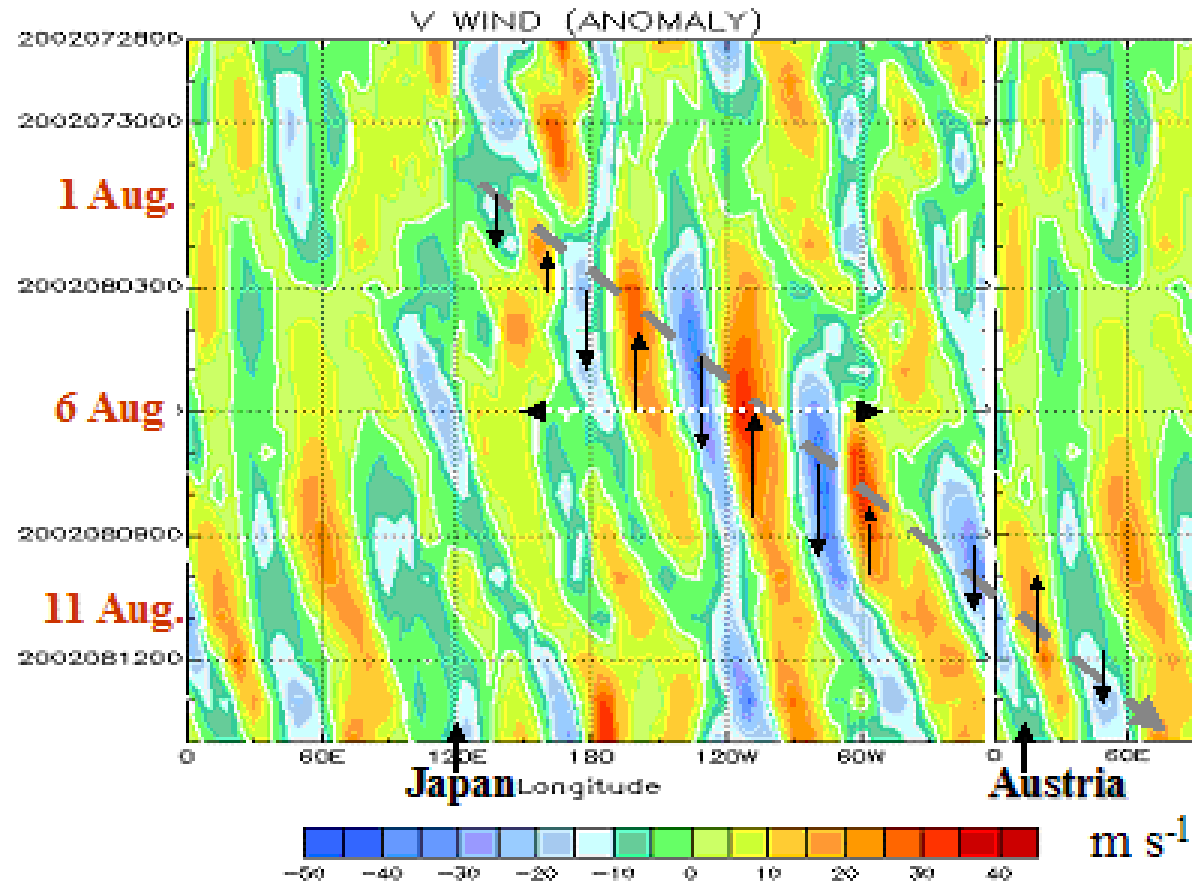
# THORPEX Science Plan

- **THORPEX International Science Plan**
  - Shapiro and Thorpe (2004) [www.wmo.int/thorpex](http://www.wmo.int/thorpex)
- **Four research sub-programmes**
  - **Predictability and Dynamical Processes**
  - **Observing Systems**
  - **Data Assimilation and Observing strategies**
  - **Societal and Economic Applications**

# Predictability and dynamical processes

- 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 (40-60° N). Mel Shapiro

# Accelerating improvements in the accuracy of high-impact 1-14 day weather forecasts for the benefit of society and economy

**Northern Italy  
28 November 2002**



**Eastern Switzerland  
17 November 2002**



**Austrian-German  
Alpine wind storm  
17 November 2002**

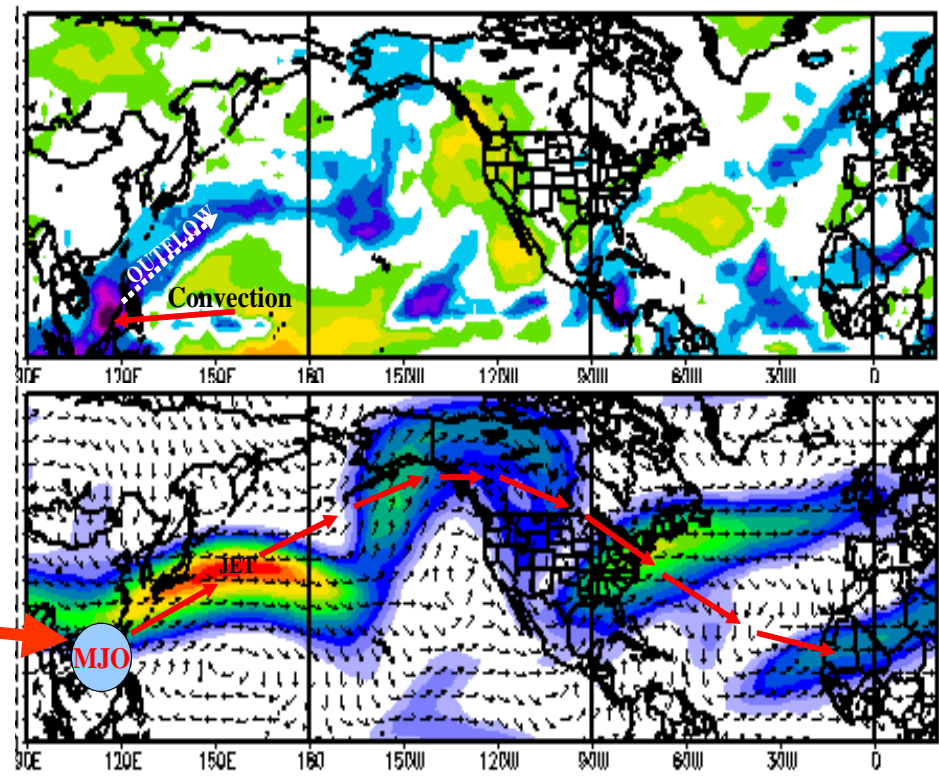
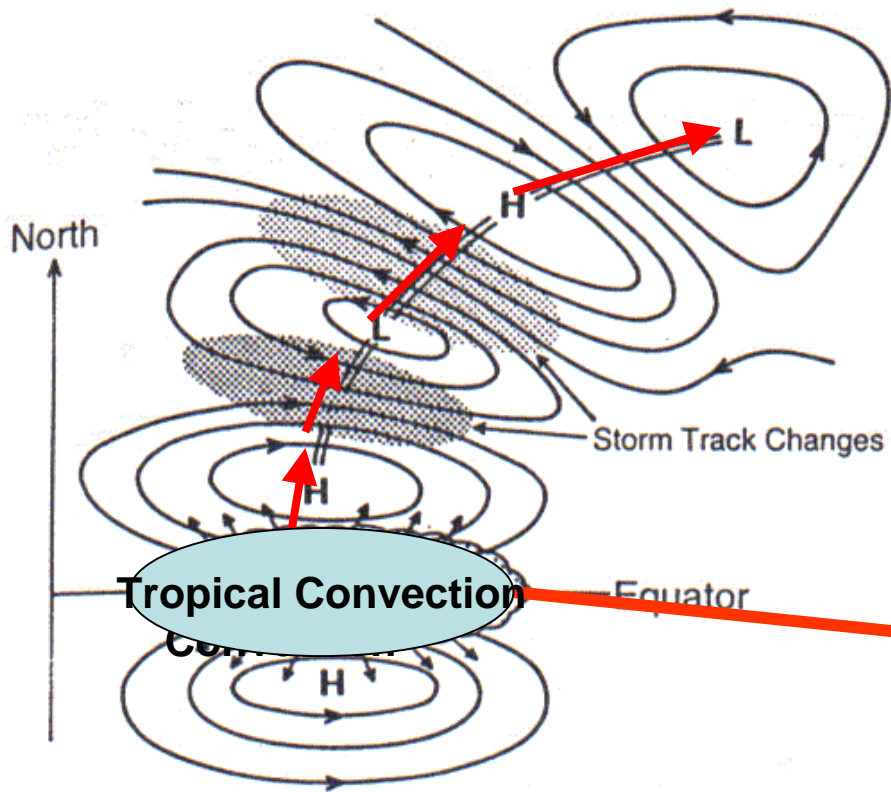


**Alpine Floods 16-17  
November 2002**

**Oil tanker "Prestige"  
disaster 13 November  
2002**

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.

# Northward Propagating Rossby-Wave Train Interaction with tropical convection



(Trenberth, et al. 1998)

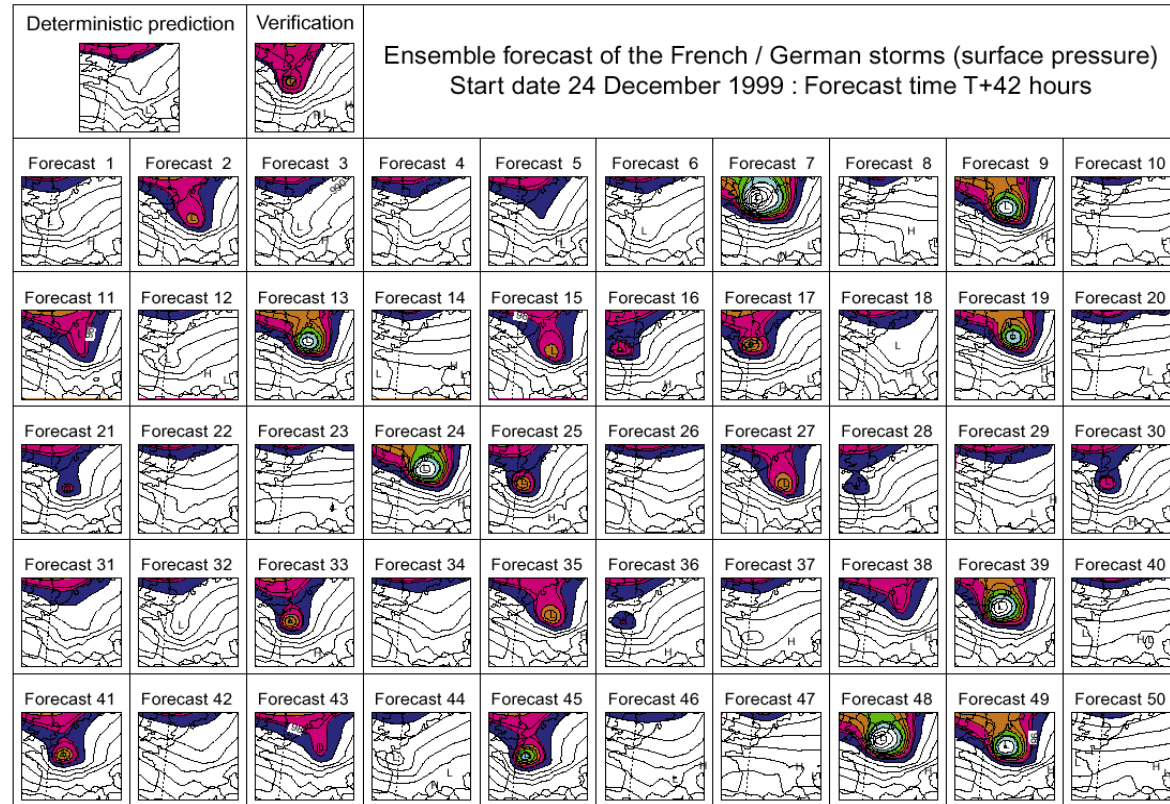
**AMMA has a symmetric and more integrative approach**

→ THORPEX/WCRP meeting on the MJO, organised by Julia Slingo and Mel Shapiro which will be held at ICTP (Trieste – 13-17 March 2006).

# 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



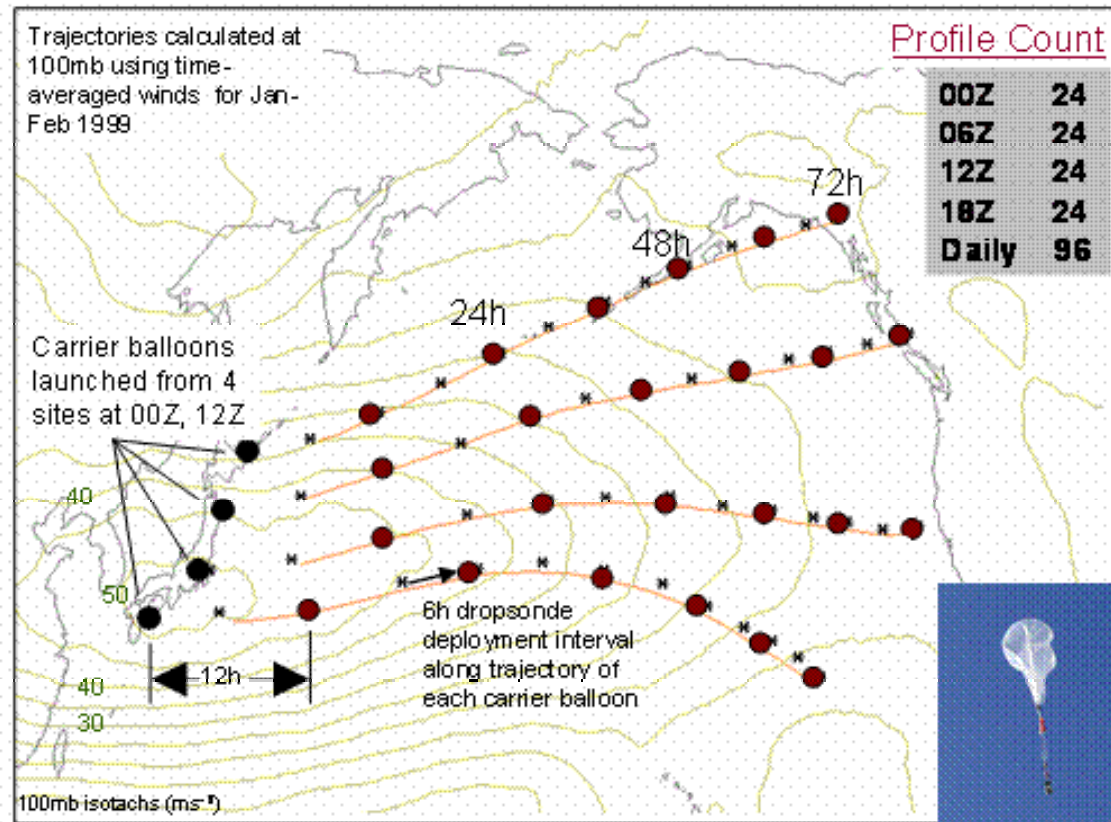
THORPEX will evaluate factors limiting predictability and develop new strategies to extend these limits

➔ AMMA approach regarding predictability and dynamics is much more process-oriented than THORPEX

# Observing systems

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

Simulated Driftsonde profile coverage at one data-assimilation time, after 3 days of sonde deployment from 100 mb. The carrier balloons were launched from 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)



→ Drift sondes during **AMMA SOP-D**

# Data Assimilation and Observing Strategies

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

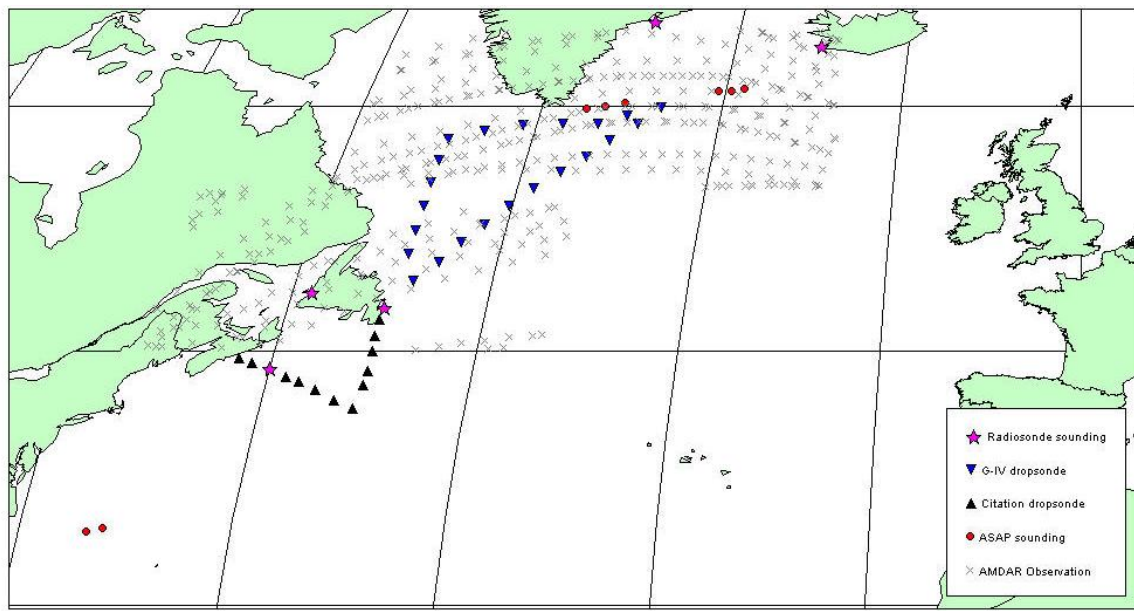
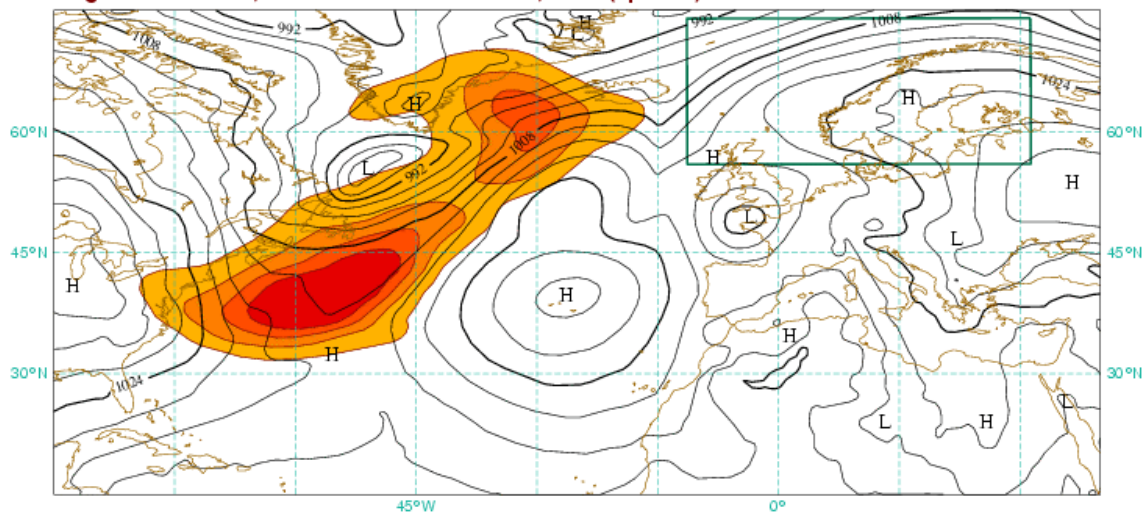
→ Is it mature enough for African Monsoon ?

- Adaptive control of observing network

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

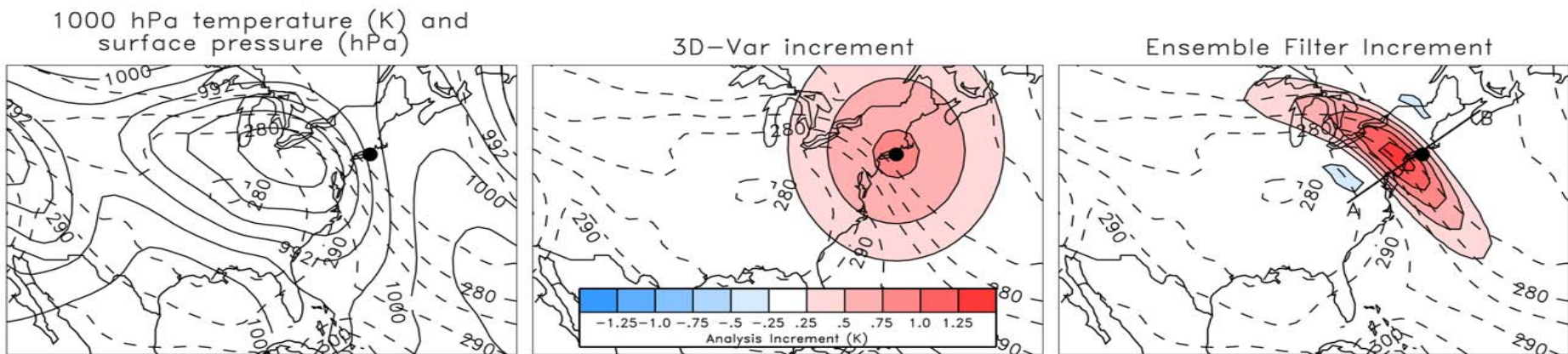
→ Current discussion within AMMA-THORPEX Group (especially SOP-D)

ECMWF-SAP based on TE-SVs (dry T42) and MSL  
Valid time: 20031202, 18 UT (Targeting Time)  
Shading: areas of 8, 4, 2, 1 x10<sup>6</sup> km<sup>2</sup>  
trajectory initialized from fc 20031130, 00 UT +66 h  
Targ. time: 20031202, 18 UT / Verif. time: 20031204, 12 UT (opt: 42h)



# Data Assimilation and Observing Strategies

- **Flow-dependent background errors**
- **Adaptive quality control of observations**
- **Inclusion of model uncertainty**



Impact of flow-dependent background error (Tom Hamill)

→ Is it as much relevant to convective scale as to synoptic scale ?

# Study on Observing Systems + Data Assimilation and Observing Strategy

→ Designing 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 the Global Earth Observation System of Systems (**GEOSS**)

→ Important issue  
for AMMA  
(except targetting)

# 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

→ Meets AMMA objectives

→ Relevant framework for future applications

i.e MHEWARS proposal submitted to EWC III by WMO:

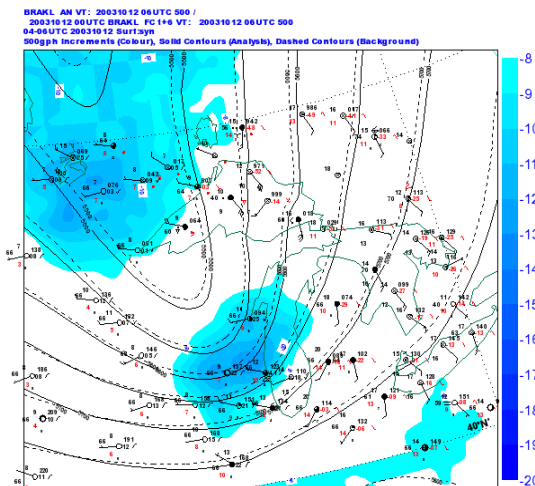
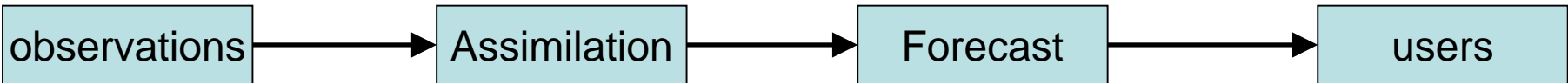
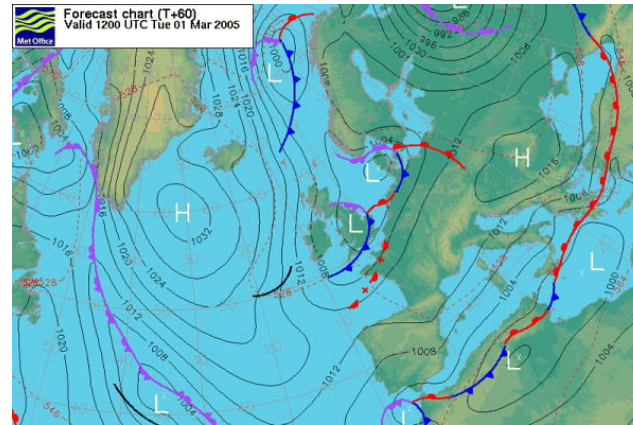
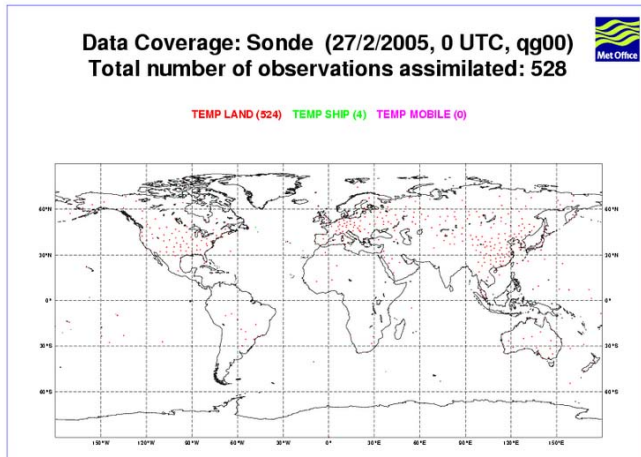
towards a **M**ulti-**H**azard **E**arly **W**arning and **R**esponse **S**ystem in West Africa:  
A multi-hazard approach to forecasting adverse health impacts in Africa

SEA WG will meet in early January 2006 in Geneva

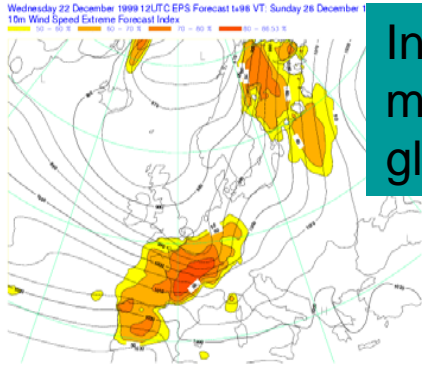
# Three structuring actions

- GIFS: Global Interactive Forecast System
- TIGGE : Thorpex Interactive Grand Global Ensemble
- TReCs: THORPEX Regional Campaigns

# From traditional forecast system to ...

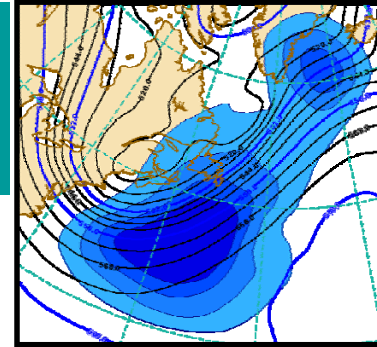


# ... a Global Interactive Forecast System



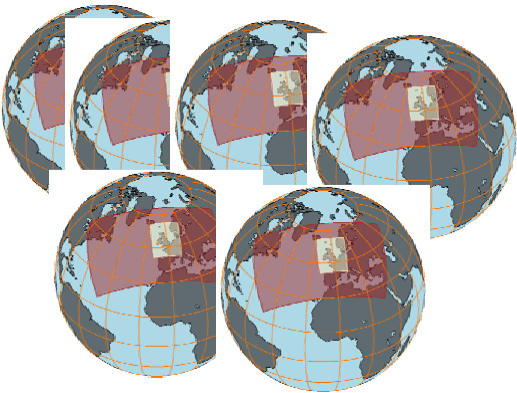
Initial risk from medium-range global ensemble

Forecaster runs 'sensitive area' prediction



Forecaster requests observations in sensitive area

Forecaster requests high resolution regional ensemble

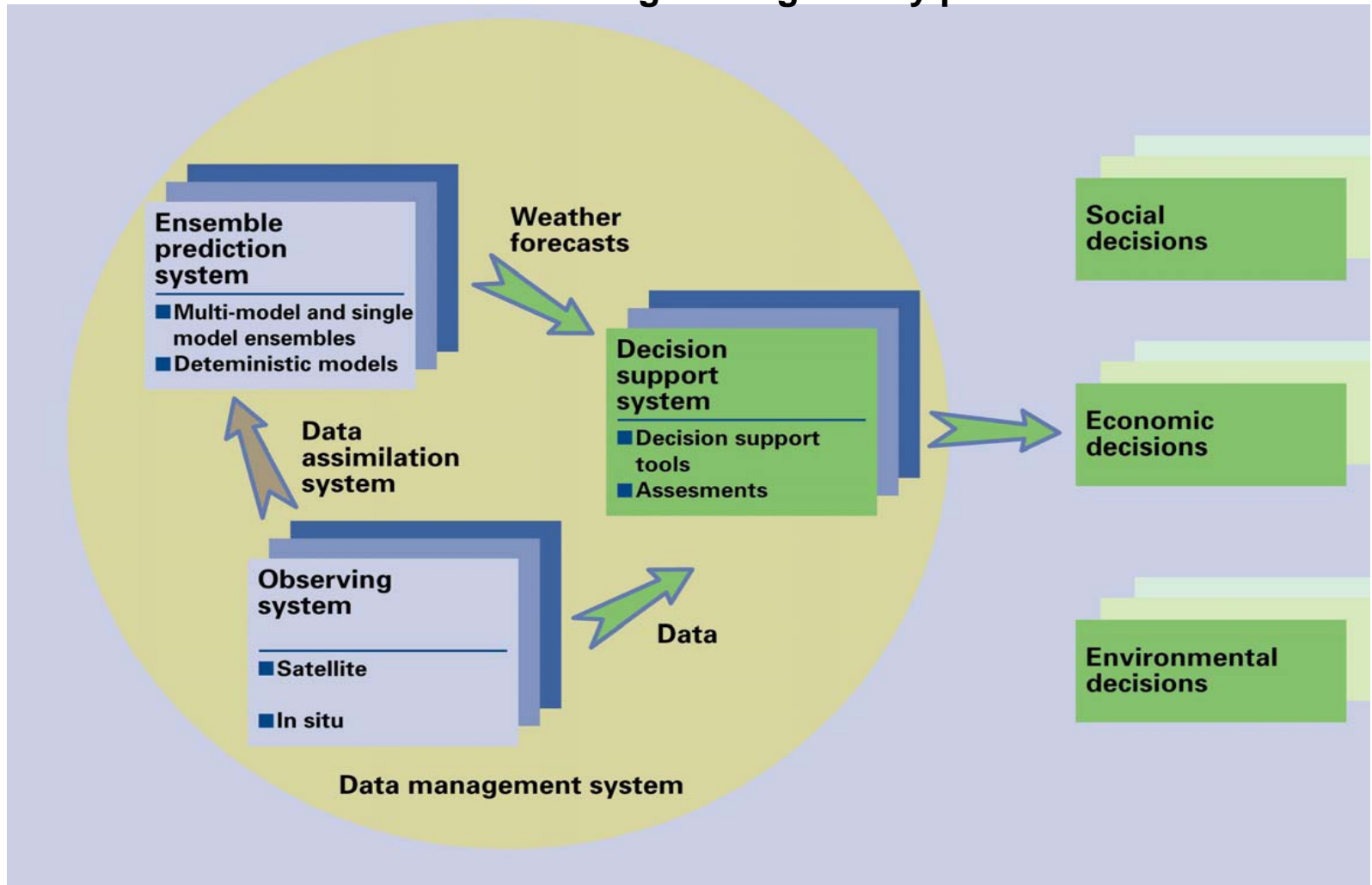


Initiate and maintain links with civil protection agencies



# Global Interactive Forecast System using the THORPEX INTERACTIVE GLOBAL GRAND ENSEMBLE (TIGGE)

End-to-end forecast system “tuned” for end users, using targeted observations called on in ‘sensitive areas’, adaptive data assimilation, grid computing and distributed archives accessible through a single entry point.



# THORPEX Interactive Grand Global Ensemble (TIGGE)

- **Framework for international collaboration in development and testing of ensemble prediction systems**
- **Resource for THORPEX research projects**
- **Component of THORPEX Forecast Demonstration Projects (FDPs)**
- **A prototype future Global Interactive Forecast System**
- **Initially develop database of available ensembles, collected in near-real time**
- **Co-ordinate research using this multi-model ensemble data, including interactive aspects**

# TIGGE will provide a valuable data set for research on ensembles

→ an answer to critical questions on ensemble prediction such as:

- **Is a multi-model multi-analysis system necessary?**
  - To produce forecast spread sufficient to capture reality
  - To represent more accurately the initial uncertainty
- **Increasing ensemble size beyond 50 matters less than increasing resolution ?**
  - Today, 351 members are run daily with resolution from T<sub>L</sub>119 to T<sub>L</sub>255. By sharing production costs, ~50 members could be run at higher resolution
  - Would such an approach lead to a more skilful ensemble system?
- **Communication with (end-) users**
  - While the use of ensemble products by forecasters has been increasing during the past few years, its use by the end-users is still rather limited.
  - Which is the best way to communicate uncertainty to end-users?

# THORPEX Regional Campaigns (TRECs)

**Relevant background to evaluate scientific and operational aspects for targetting**

- **ATReC (2003) - many groups are actively working with the data – a summary of current views will be available for the ICSC meeting in Melbourne**
- **European ETreC – D-Phase (MAP), COPS supported by the European regional committee (2007)**
- **Asian TRec (2008) – on tropical cyclone tracks, to coincide with Beijing Olympics Forecast Demonstration Project**
- **Pacific TReC (2008) – typhoons, extra-tropical transitions, tropical warm-pool physics and down-stream propagation**

**→ Difficult to consider AMMA SOPs as an actual TREC?**

# Which objectives are in AMMA and not directly in THORPEX ?

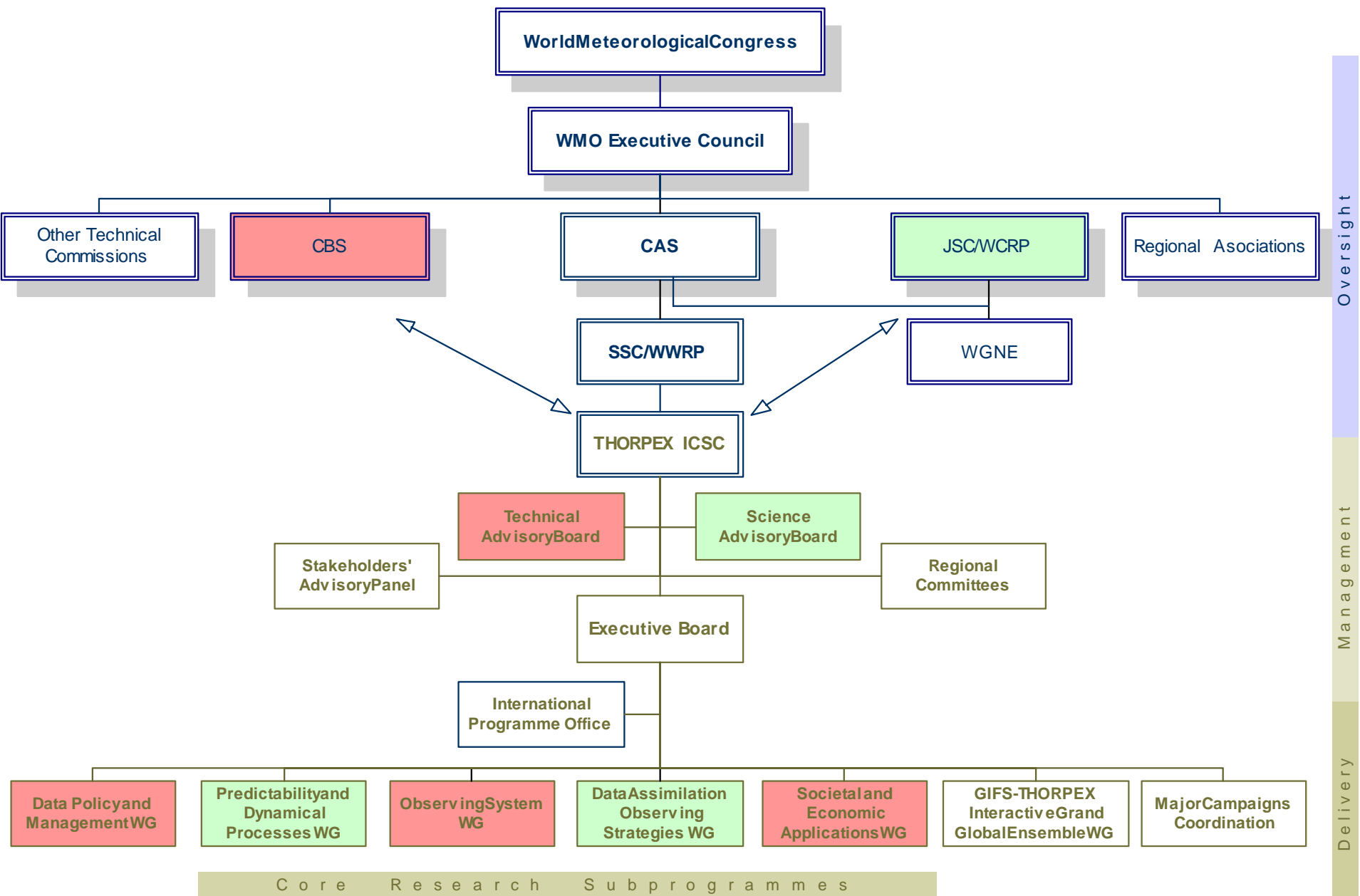
- Study on physical processes involved in the WAM (land processes, ocean-atmosphere interface, etc...)
- Atmospheric Chemistry
- Aerosols
- Meso-scale modelling vs Synoptic scale
- Interseasonal and Interannual Variability vs 1-day to 2-week but ...

# ...THORPEX and WCRP



- **JSC/WCRP member of ICSC and science groups**
- **THORPEX in WCRP/COPEs**
  - **Joint project initiated to develop a unified ultra-high-resolution global weather and climate prediction system**
  - **Collaboration in TIGGE**
- **TIGGE and TFSP**
  - **Similar technical issues (data, archiving, policy)**
  - **Potential for “seamless” days-seasons development**
  - **Links established between TIGGE WG and TFSP**

# THORPEX within the WMO structure



# AMMA-THORPEX links ...

## ... as seen from THORPEX Executive Board (1/2)

The Executive Board recommended that

- there should be a good linkage between the informal THORPEX-AMMA group and the EB
- that there should be a role for the THORPEX Working Groups in the scientific aspects of AMMA
- Operational centres should be involved in carrying out parallel runs during the AMMA field campaign.

Florence Rabier's membership of both the DAOS WG and the core THORPEX-AMMA Group will enable her to report on the activities at EB meetings.

# AMMA-THORPEX links ...

## ... as seen from THORPEX Executive Board (2/2)

For many of the THORPEX Working Groups, links are already in place as a result of joint membership of the AMMA-THORPEX Working Groups and THORPEX Working Groups. These are:

DAOS WG  
PDP WG  
SEA WG  
GIFS-TIGGE  
NARC  
ERC

Florence Rabier, Rolf Langland  
Sarah Jones  
Peter Webster  
Zoltan Toth  
David Parsons  
Sarah Jones

How does AMMA see THORPEX ?