



# TIGGE (The THORPEX Interactive Grand Global Ensemble)

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# THORPEX

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THORPEX (The Observing system Research and Predictability Experiment) is a World Weather Research Program:

- ❖ 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)





# THORPEX objectives

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THORPEX key objectives are:

- ❖ To increase fundamental understanding of dynamics and predictability of the atmosphere
- ❖ To make significant, quantifiable, worldwide improvements in decision-making skills and consequent measurable reduction in societal distress
- ❖ To promote and fully exploit advances in NWP, observations, communications and data-assimilation techniques
- ❖ To deliver improved global and regional forecasting system with active involvement of developed, developing and least developed nations





# TIGGE

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TIGGE (the THORPEX Interactive Grand Global Ensemble) is:

- ❖ A framework for international collaboration in development and testing of ensemble prediction systems
- ❖ A resource for many THORPEX research projects
- ❖ A prediction component of THORPEX Forecast Demonstration Projects
- ❖ A prototype future Global Interactive Forecast System





## TIGGE objectives

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- ❖ An enhanced collaboration on development of ensemble prediction, internationally and between operational centres and universities
- ❖ New methods of combining ensembles from different sources and of correcting for systematic errors (biases, spread over-/under-estimation)
- ❖ A deeper understanding of the contribution of observation, initial and model uncertainties to forecast error
- ❖ A deeper understanding of the feasibility of interactive ensemble system responding dynamically to changing uncertainty (including use for adaptive observing, variable ensemble size, on-demand regional ensembles) and exploiting new technology for grid computing and high-speed data transfer
- ❖ Test concepts of a TIGGE Prediction Centre to produce ensemble-based predictions of high-impact weather
- ❖ The development of a prototype future Global Interactive Forecasting System





## TIGGE will benefit from existing ensemble systems

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- ❖ **Globally, there are 9 operational Global Ensemble Prediction Systems** (BMRC, CMA, CPTEC, ECMWF, FNMOC, JMA, KMA, MSC and NCEP) that produce daily 351 forecasts with horizontal resolution ranging from T62 to TL255 (~80km), and with forecast length ranging from 8 to 16 days. 3 further centres (MetOffice, NCMRWF, SAWS) are developing and testing global ensemble systems.
- ❖ **Over Europe, there are 3 operational Limited-area EPSs** (SRNWP-PEPS, COSMO-LEPS, PEACE) that produce daily 39 forecasts with horizontal resolution ranging from 7 to 25 km, and with forecast length ranging from 30 to 120 hours. 8 further centres (NOR, MetOffice, INM, DMI, HMS, MeteoSwiss, SAR, PIED-SE) are developing and testing LEPSs.
- ❖ **Over North-America, there is 1 operational Limited-area EPSs** (NCEP-SREF) that produces daily 30 forecasts with horizontal resolution of 32 km, and a 63-hour forecast length. Another centre (MSC) is testing a LEPS.
- ❖ **Over Australia, BMRC is testing a 16-member, 0.5 degree resolution, 72-hour LEPS.**





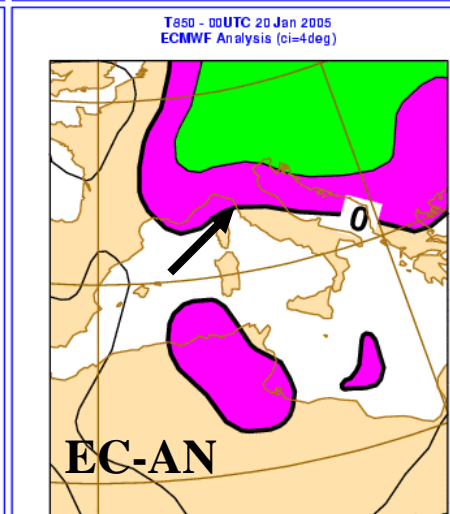
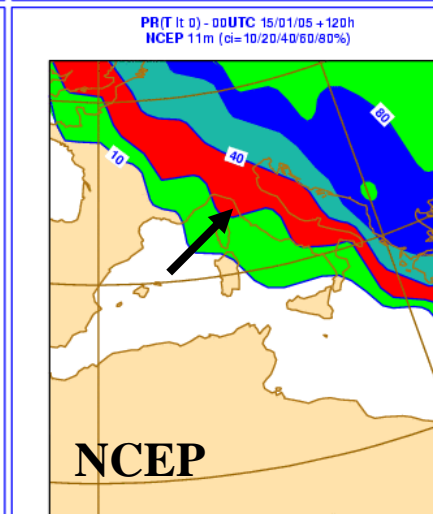
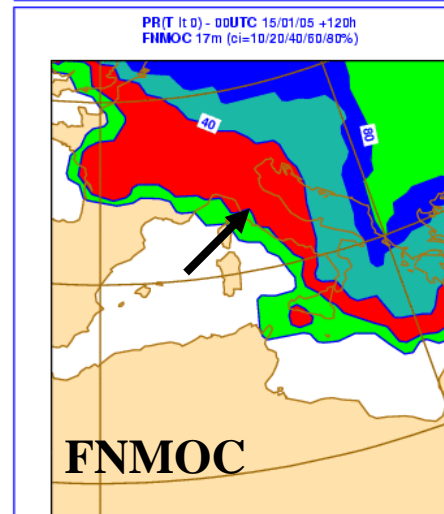
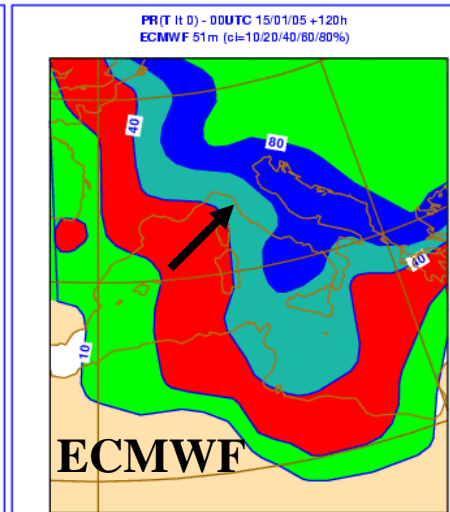
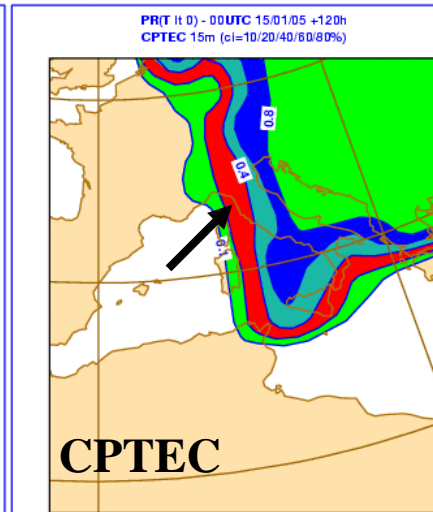
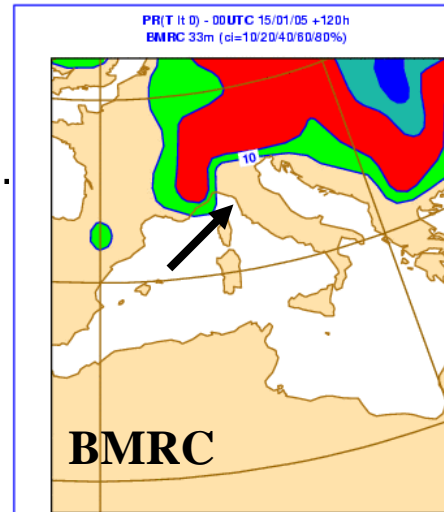
Ex:  $\pi_{Z500}(00,120h)$ : BMRC, CPTEC, ECMWF, FNMOC, NCEP

Europe: 120h  
forecast probability  
of  $T850 < 0$  degrees.

What is the  
 $PR(T850 < 0)$  in  
Firenze?

*BMRC gives 0%,  
the others more  
than 20%  
probability\*.*

*\* This is just one case:  
probability forecasts  
should be verified on a  
large dataset.*





Ex:  $\pi_{Z500}(12,120h)$ : BMRC, ECMWF, JMA, KMA, NCEP

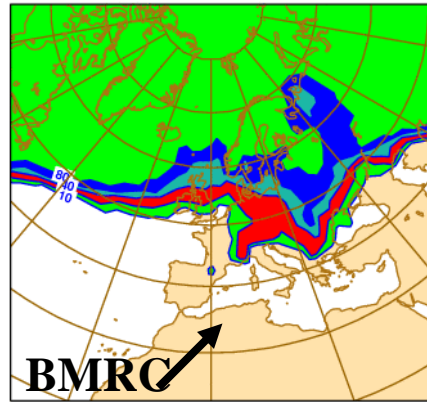
Europe: 120h  
forecast  
probability of  
 $T_{850} < 0$  degrees.

What is the  
PR( $T_{850} < 0$ ) in  
Tunisia?

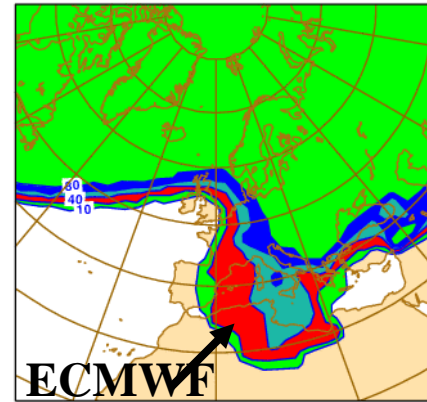
*BMRC gives a  
zero probability.\**

*\* This is just one case:  
probability forecasts  
should be verified on a  
large dataset.*

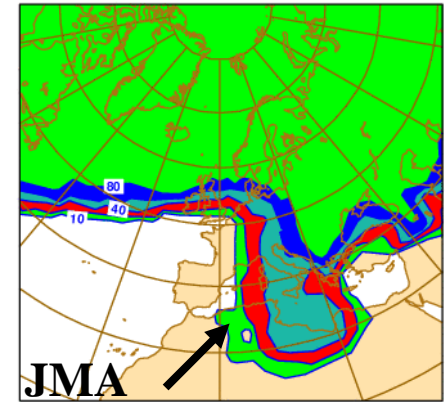
PR(T lt 0) - 12UTC 15/01/05 +120h  
BMRC 33m (ci=10/20/40/60/80%)



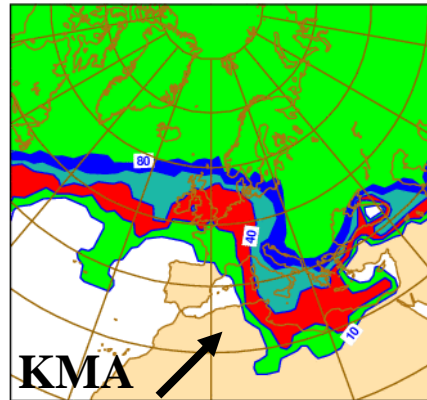
PR(T lt 0) - 12UTC 15/01/05 +120h  
ECMWF 51m (ci=10/20/40/60/80%)



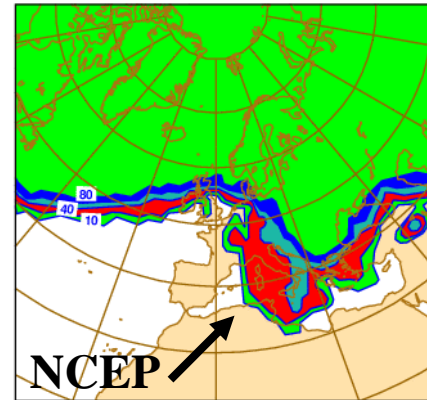
PR(T lt 0) - 12UTC 15/01/05 +120h  
JMA 25m (ci=10/20/40/60/80%)



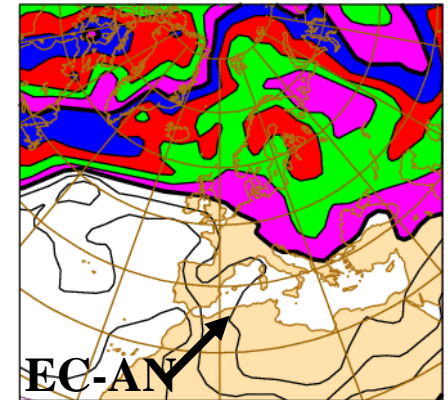
PR(T lt 0) - 12UTC 15/01/05 +120h  
KMA 17m (ci=10/20/40/60/80%)



PR(T lt 0) - 12UTC 15/01/05 +120h  
NCEP 11m (ci=10/20/40/60/80%)



T850 - 12UTC 20 Jan 2005  
ECMWF Analysis (ci=4deg)

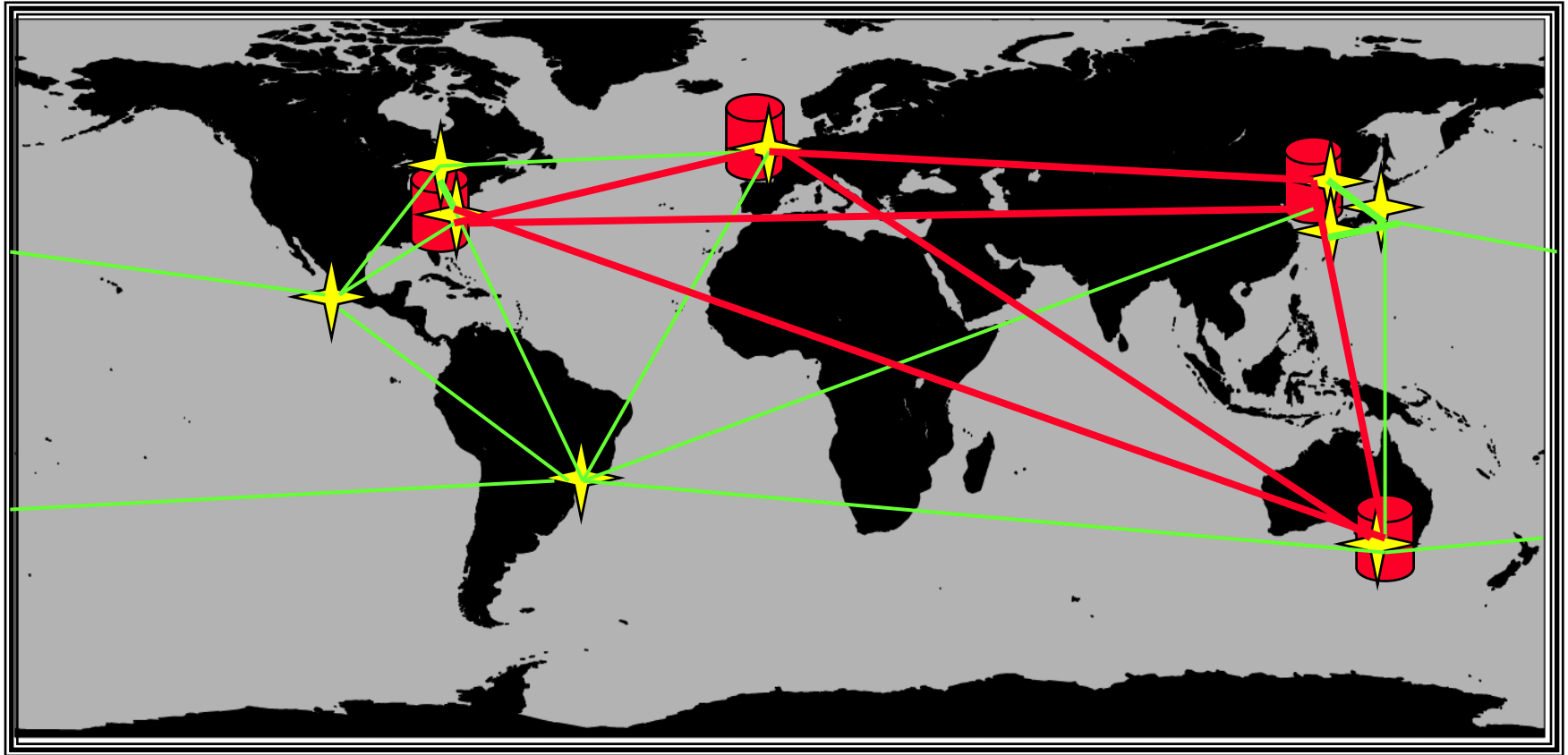






## TIGGE could lead to a MUMMA-GEPS

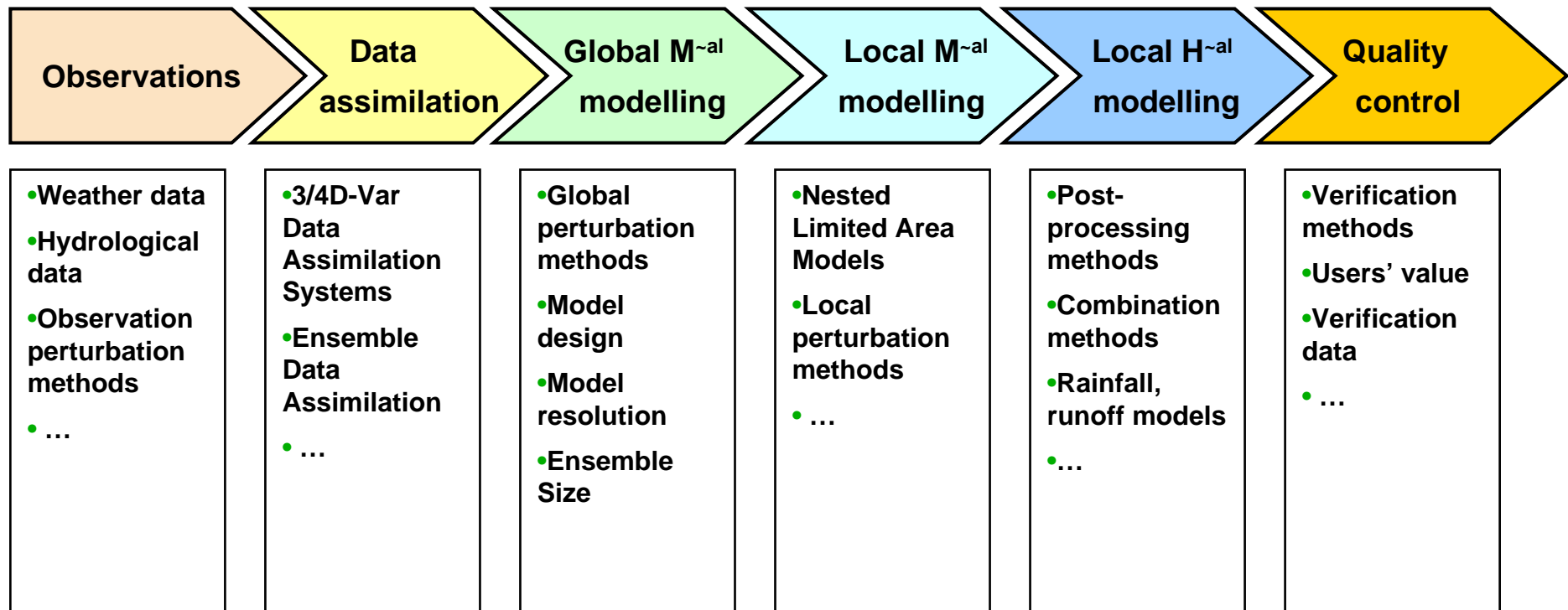
TIGGE could lead to a **Multi-Model, Multi-Analysis Global Ensemble Prediction System (MUMMA-GEPS)**, with N production centers (yellow stars) and few data-hubs (red) connected by high-speed, high-capacity communication lines.





# TIGGE should promote applications in flood forecasting

TIGGE could promote the establishment of strong links between EPSs with hydrological system, for example the ones developed by the European Flood Alert System (EFAS) and the Hydrological Ensemble Prediction Experiment (HEPEX).





## TIGGE could address open issues in ensemble forecasting

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TIGGE could confirm whether conclusions drawn by recent works (*Buizza et al* 2005, MWR, in press; *Bourke et al* 2004, MWR 132) are valid:

### ❖ **Model and data-assimilation quality matters more than perturbation method**

- “*The performance of EPSs strongly depends on the quality of the data assimilation system used to create the unperturbed initial conditions, and the numerical model used to generate the forecasts*”
- “*The superior quality of the ECMWF-EPS with respect to the BMRC-EPS is attributed primarily to the superior quality of the ECMWF analysis rather than model differences or model resolution*”

### ❖ **Ensemble design**

- What is the importance of the initial perturbation method?
- What is the importance of the method used to simulate model uncertainty?





# TIGGE could address open issues in ensemble forecasting

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## ❖ A 'sample-all' approach should be followed

- *“A successful ensemble prediction system should simulate the effect of both initial and model related uncertainties on forecast errors”*

## ❖ A multi-model multi-analysis system is necessary

- *“In the ECMWF, MSC and NCEP EPSs, the spread is still insufficient to systematically capture reality, suggesting that none of them is capable alone to simulate all sources of forecast uncertainties”*

## ❖ Increasing ensemble size beyond 50 matters less than increasing resolution

- A distributed, MUMMA-GEPS which involves several production centres can lead to a higher-resolution ensemble prediction system
- Now, 351 members are run daily with resolution from  $T_L119$  to  $T_L255$
- By sharing production costs, ~50 members could be run at  $T_L399$  (~60km)





## TIGGE 1<sup>st</sup> WS – ECMWF, 1-3 March 2005

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- ❖ The 1<sup>st</sup> TIGGE WS was held at ECMWF between 1-3 March, co-sponsored by the Met Office
- ❖ 70 delegates from international organizations, national and regional meteorological and hydrological services, universities and private companies attended the workshop
- ❖ One of the objectives of the workshop was to produce a report outlining user requirements and the infrastructure design, to be presented to the WMO THORPEX Executive Board and International Core Steering Committee (ICSC). This report could be treated as a detailed proposal for the execution of the TIGGE project.
- ❖ A draft report has been finalized, and the final version is expected to be completed by the end of April (it will be sent to WMO for publication)

