Early warning products for severe weather events using operational medium-range ensemble forecasts

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References

[1] Matsueda M., and T. Nakazawa, 2014: Early warning products for severe weather events derived from operational medium-range ensemble forecasts. *Meteorol. Appl.* doi: 10.1002/met.1444.

[2] Swinbank et al., 2014: The THORPEX Interactive Grand Global Ensemble (TIGGE) and its Achievements. *Submitted to BAMS*.

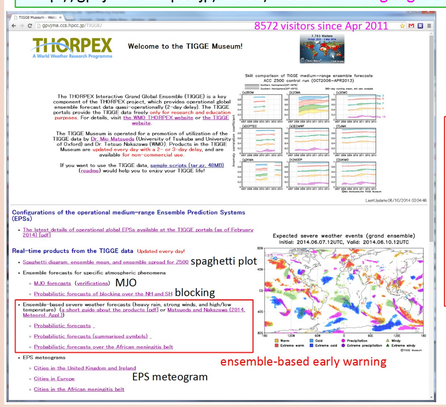
[3] WMO 2005a: THORPEX: International Science Plan. WMO, WMO/TD-No. 1246, 57pp.

Introduction

THORPEX is a 10-year international research program organized by WMO to accelerate improvements in the accuracy of 1 day to 2 week forecasts of severe weather events for the benefit of the society, the economy, and the environment (*WMO*, 2005).
THORPEX provides 10 global ensemble forecast datasets through the TIGGE data portal with a 2-day delay, since October 2006 (*Swinbank et al.*, 2014). The present study introduces ensemble-based early warning products for severe weather events (heavy rainfall, strong surface winds, and high/low surface temperatures; *Matsueda and Nakazawa*, 2014). The products are based on operational medium-range ensemble forecasts from four of the leading global NWP centres: ECMWF, JMA, NCEP, and UKMO, and are now routinely available at the TIGGE Museum.

The TIGGE Museum

http://gpvjma.ccs.hpcc.jp/TIGGE/index.html or google "TIGGE Museum"



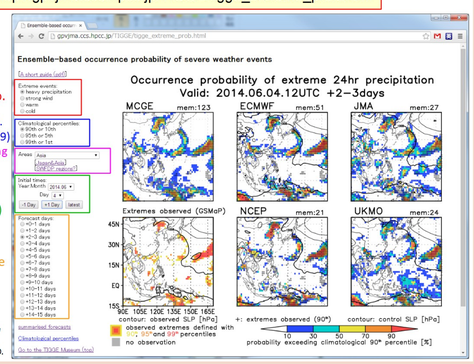
Updated everyday with a 2.5-day delay

Real time products
- spaghetti plots
- MJO forecast
- blocking forecast
- early warning of severe weather
- EPS meteogram
- forecast skills
- model's biases

Products are available for past forecast cases after October 2006.

Early warning products for high impact weather using TIGGE

http://gpvjma.ccs.hpcc.jp/TIGGE/tigge_extreme_prob.html



extreme events
- heavy rain
- strong winds
- high/low temp.

thresholds for prob. forecasts(90, 95 &99)
15 regions (including 4 SWFDP regions)
past forecast cases with observation (Oct. 2006-current)

forecast lead time (up to +15 days)

A real-time version of the products for SWFDP will be introduced into UKMO.

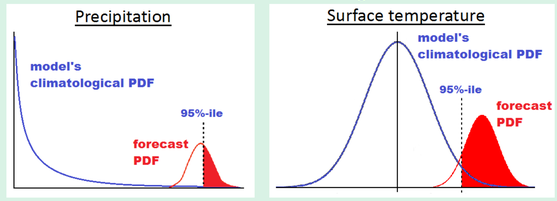
Methodology

- Data -

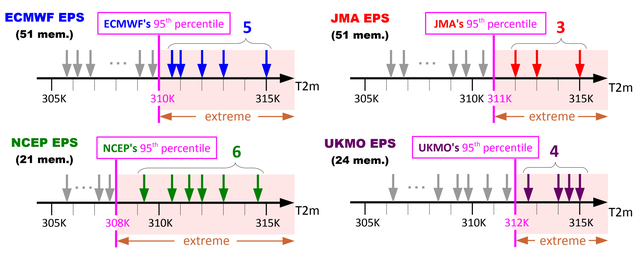
Ensemble data: ECMWF, JMA, NCEP, and UKMO (from TIGGE portal)
Observation: GSMaP (precipitation) and ERA-Interim (T2m and WS10m)
Variables: precipitation, T2m and WS10m (U10m, V10m) on 1.25 deg. grid

- Definition of forecast probability -

The forecast probability of the occurrence of severe weather events is defined based on each model's climatological PDF.



Example: forecast probability of surface temperature at Oxford

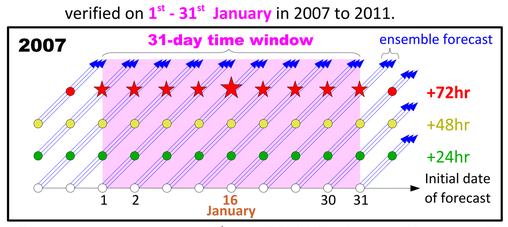


18 (=5+3+6+4) members predict a higher value than each model's climatological 95%-iles (310, 311, 308, and 312K). Then, occurrence probability of extreme high temperature is defined as 12.2% (=18/(51+51+21+24)).

- Estimation of model's climatological PDF -

A model's climatological PDF used here is:
- calculated for each EPS using TIGGE data (all members in each EPS) during October 2006 to January 2011
- defined at each grid point for each calender day in each forecast lead time with the 31-day time window.

Example: A climatological pdf for 72-hr ECMWF ensemble forecast verified on 16th January is made from all the 72-hr ECMWF forecasts (members) verified on 1st - 31st January in 2007 to 2011.



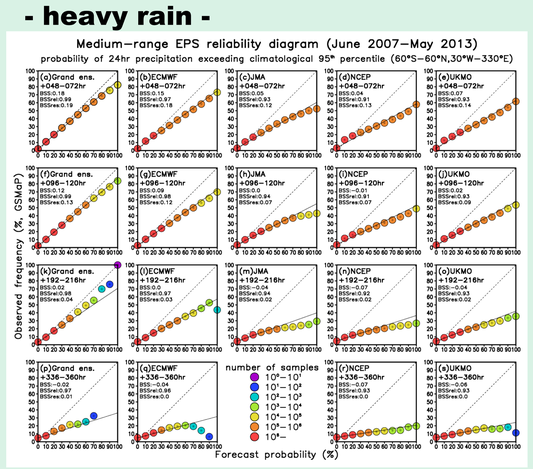
No bias correction.

x 5 years

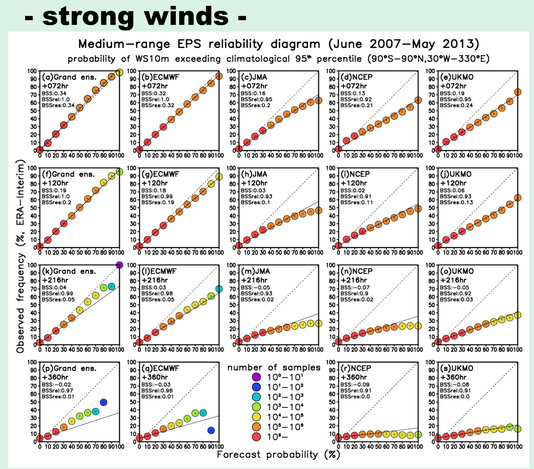
Total number of samples (★) for ECMWF: 31days x 51 mems x 5yrs = 7905

Verifications (reliability diagram)

- heavy rain -

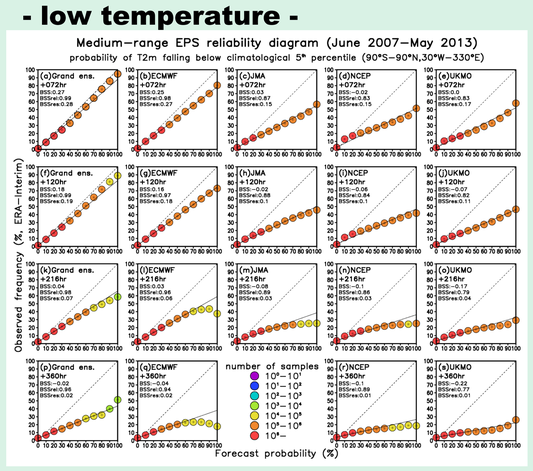


- strong winds -

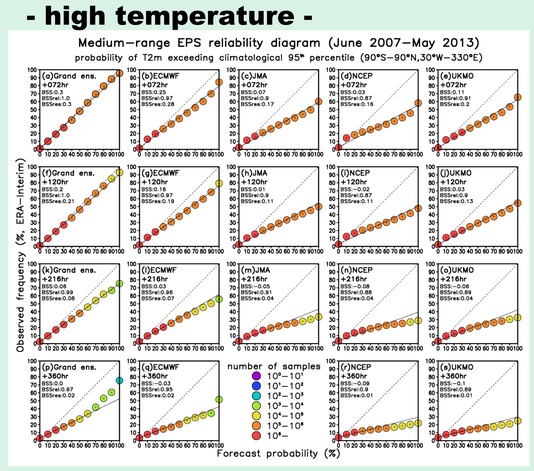


+3days
+5days
+9days
+15days

- low temperature -



- high temperature -



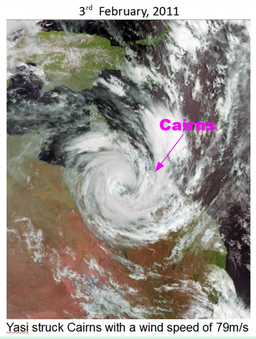
+3days
+5days
+9days
+15days

Conclusions

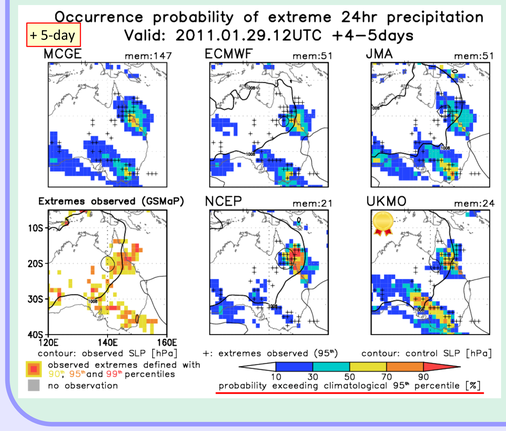
1. The construction of a grand ensemble by combining four single-centre ensembles can improve the probabilistic skills of forecasts of severe events, up to a lead time of + 360 h.
2. The improvements in forecast skills are more pronounced for severe surface temperature and precipitation.
3. The grand ensemble provides more reliable forecasts than single-centre ensembles, particularly with respect to strong wind speeds and severe temperature, aiding the advance detection of severe weather events to help mitigate the associated catastrophic damage, especially in developing countries.

Examples

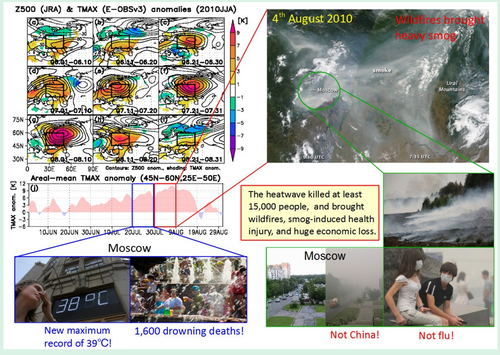
Cyclone Yasi (Feb. 2011)

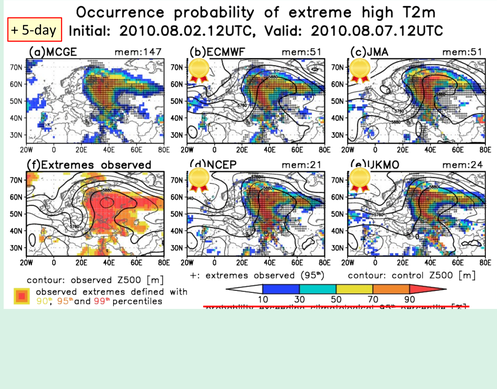


Yasi struck Cairns with a wind speed of 79m/s



Russian Heatwave (JJA 2010)





Pakistan Floods (July 2010)

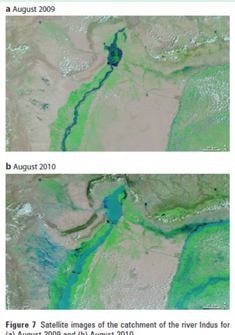
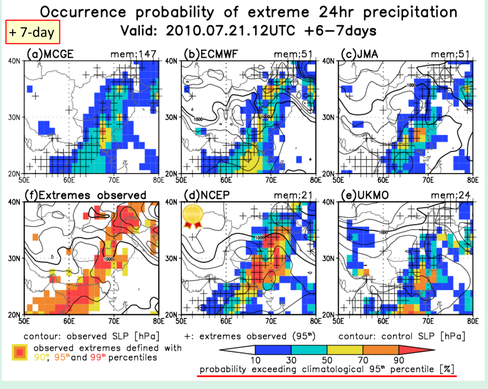
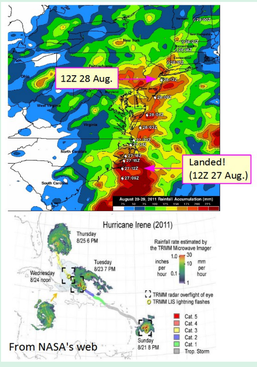
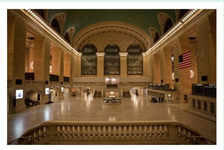


Figure 7 Satellite images of the catchment of the river Indus for (a) August 2009 and (b) August 2010.
ECMWF Newsletter (No. 125, 2010)



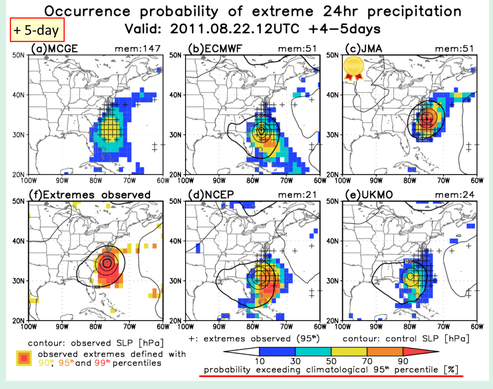
Hurricane Irene (August 2011)





Central Grand Station, NY, USA (27 August, 2011)

Kill Devil Hills, North Carolina, USA (25 August, 2011)

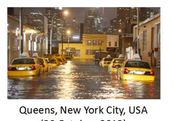


Hurricane Sandy (October 2012)

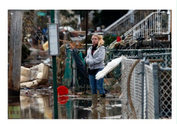
Hurricane Sandy (28 October, 2012)

Early warning (28 October, 2012)

New England, USA (30 October, 2012)



Queens, New York City, USA (30 October, 2012)



Staten Island, New York City, USA (1 November, 2012)