

# Predictability and earlier awareness of extreme hydrological events

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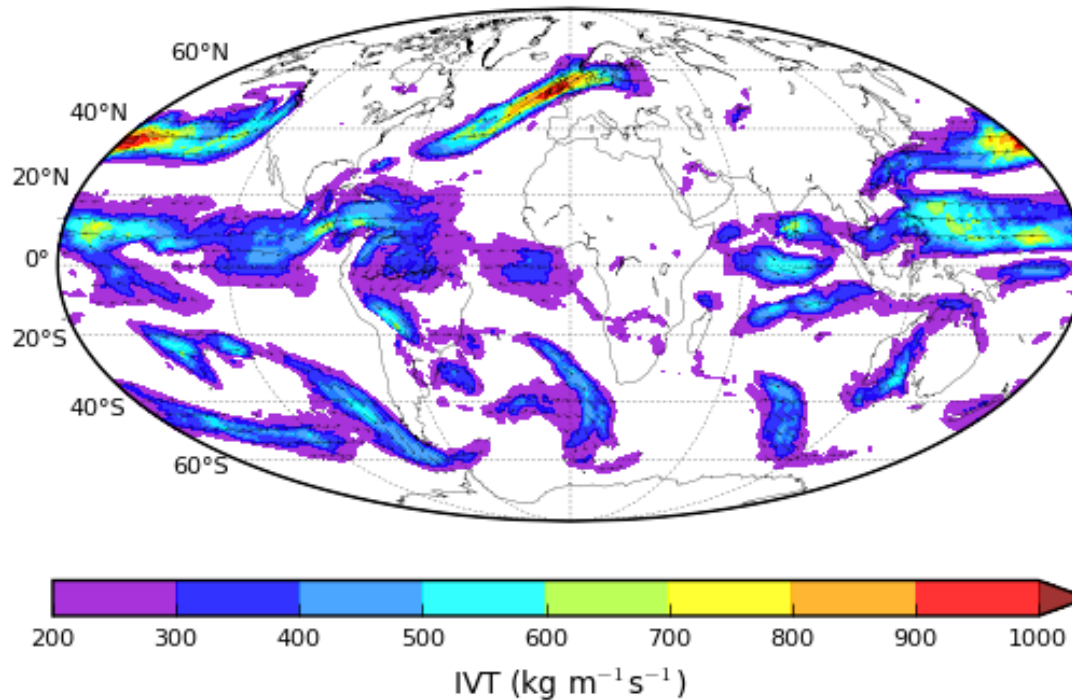
- Medium-range predictability of atmospheric river related variables.
- ECMWF forecasts, re-forecasts, and Extreme Forecast Index (EFI).
- EFI verification over Europe.
- Conclusions.

# Predictability - Potential for Earlier Warning

- Warnings of extreme events can be given based on precipitation or river discharge forecasts.
- An extreme event has a varying level of predictability depending on the predictor used.
- What other variables (or predictors) could provide increased warning of upcoming ARs?
- Water vapour transport (IVT) is an option.

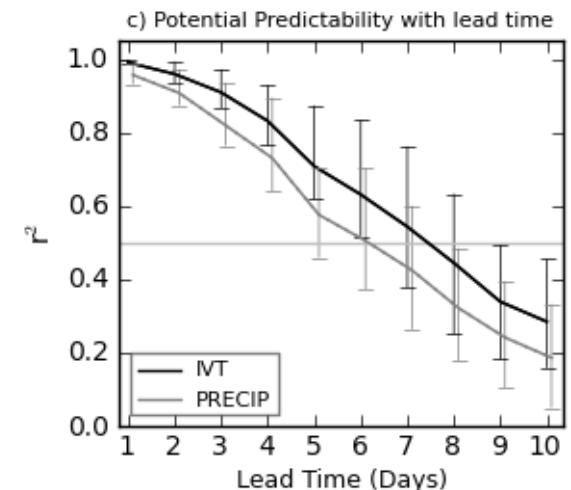
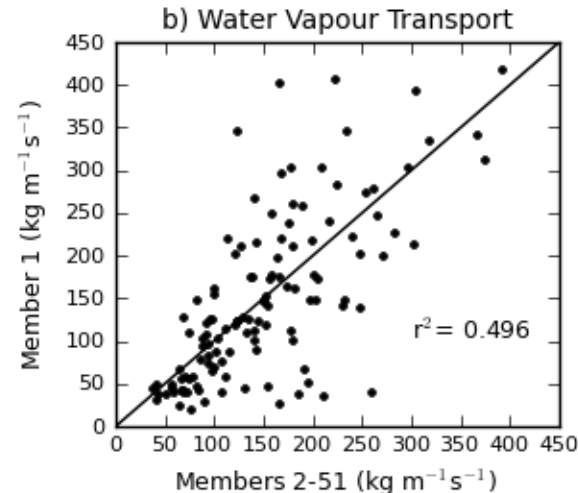
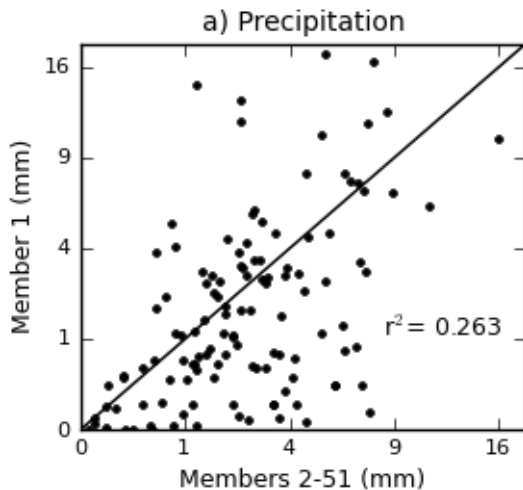
# AR diagnostic: Water vapour transport (IVT)

“Storm Desmond”

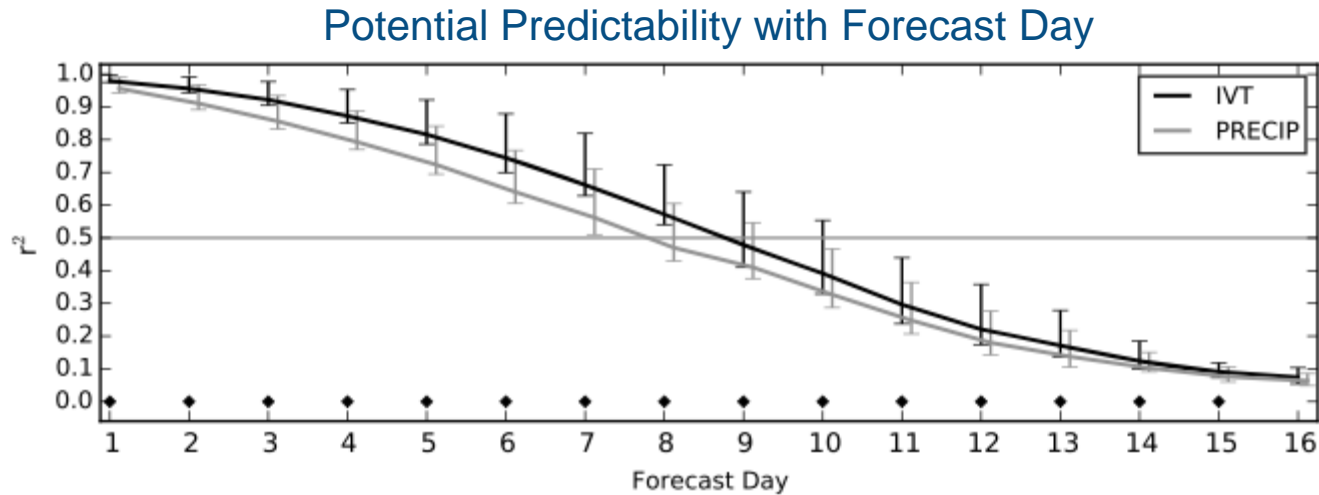


# Potential Predictability

- Use an approach called the ‘potential predictability’ to investigate whether IVT may be an alternative.
- The spread of the ensemble forecast provides a measure of the predictability of the variable.



# Potential Predictability in the western U.S.



NCEP GEFS; 11 members; DJF 1984/85 – 2014/15.  
Near San Francisco (38°N 122°W); n=2976.

# ECMWF ensemble forecasts, re-forecasts, and extreme forecast Index (EFI)

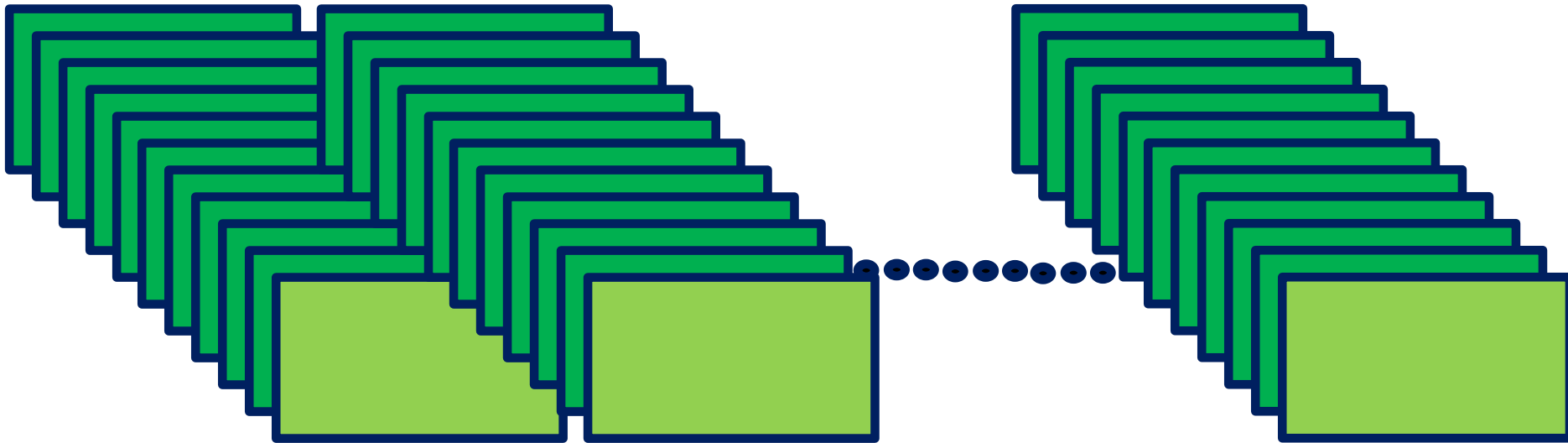
# ECMWF ensemble forecasts / re-forecasts

- **Forecasts:** 51 members initialized at 00 and 12 UTC.
- **Re-forecasts** (model climate): 11 members over the last 20 years from 9 start dates (n=1980).

Example: Thursday 27 October 2016:

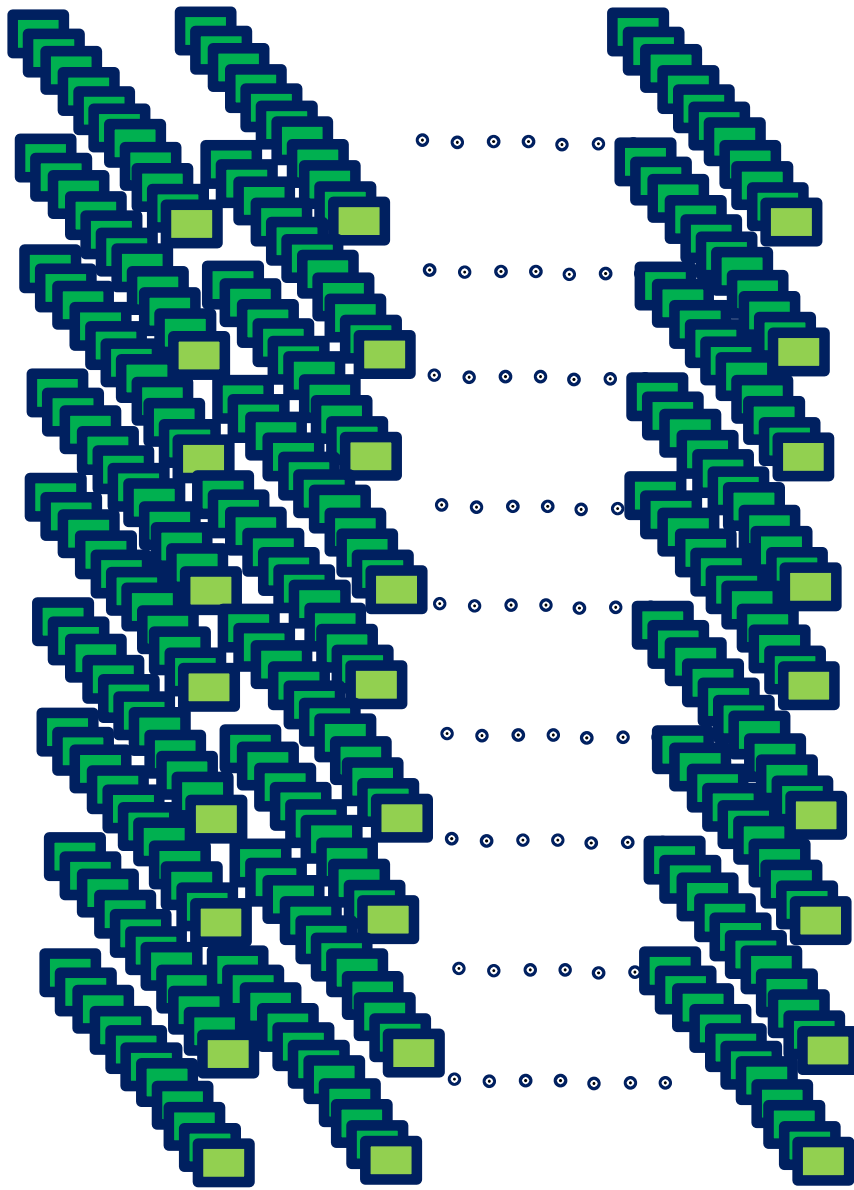
27 October 1996    27 October 1997

27 October 2015





9 x 11 x 20 = 1980 fields



13 October 2016

17 October 2016

20 October 2016

24 October 2016

27 October 2016

31 October 2016

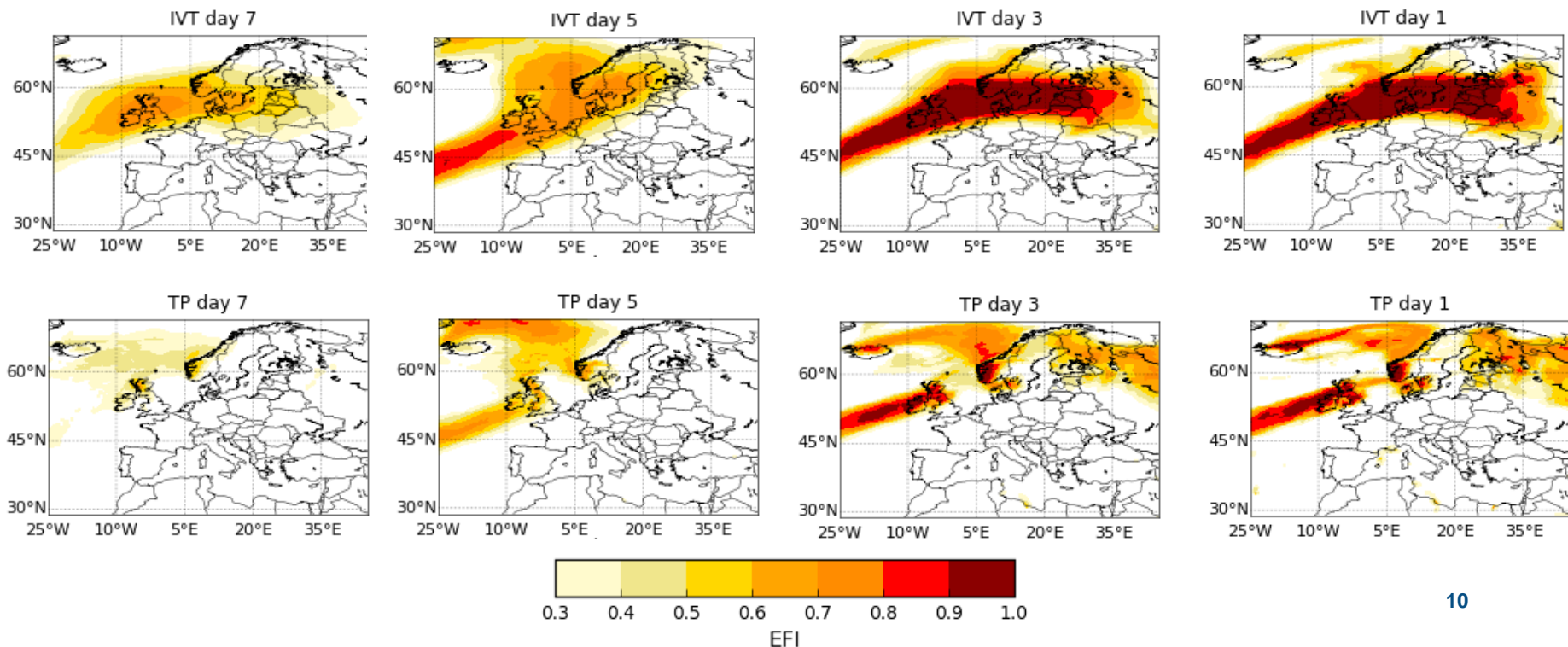
3 November 2016

7 November 2016

10 November 2016

# ECMWF Extreme Forecast Index (EFI)

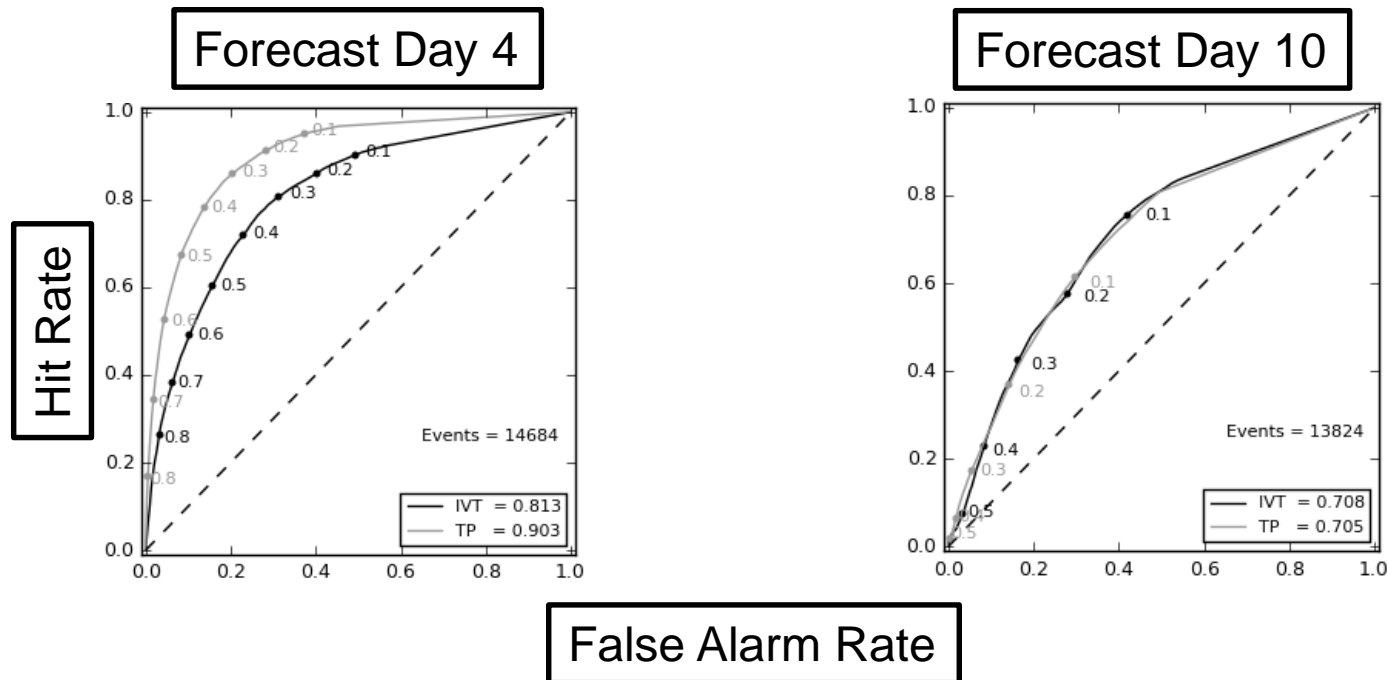
- EFI measures the difference between the forecast distribution and that of the model climate (re-forecasts).
- EFI values range from -1 to 1.
- Applied to IVT and precipitation 00UTC forecasts (days 1–10) in winter 2013/14, 2014/15, and 2015/16 (361 forecasts).



# EFI Verification

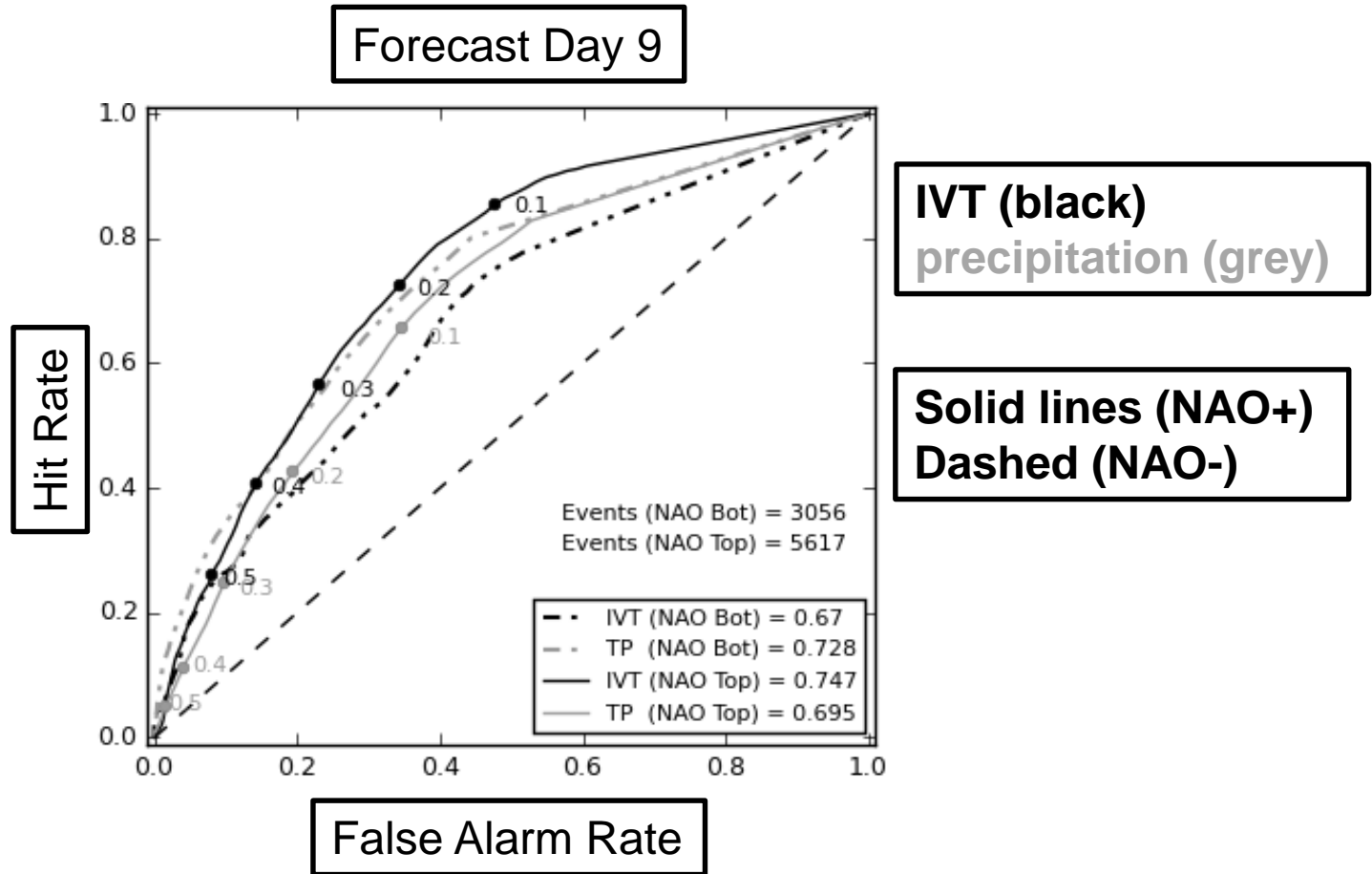
- Observed rainfall (from European Flood Awareness System).
- Relative Operating Characteristic (ROC) curves and areas using EFI thresholds from 0 to 1.

IVT (black); precipitation (grey)



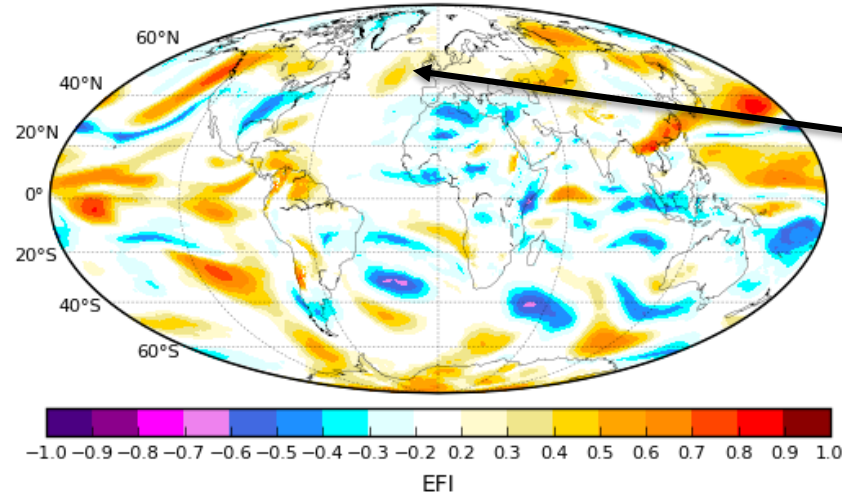
# EFI Verification conditioned on NAO

- North Atlantic Oscillation describes large-scale atmosphere; verification on initial NAO (top and bottom 90 forecasts).



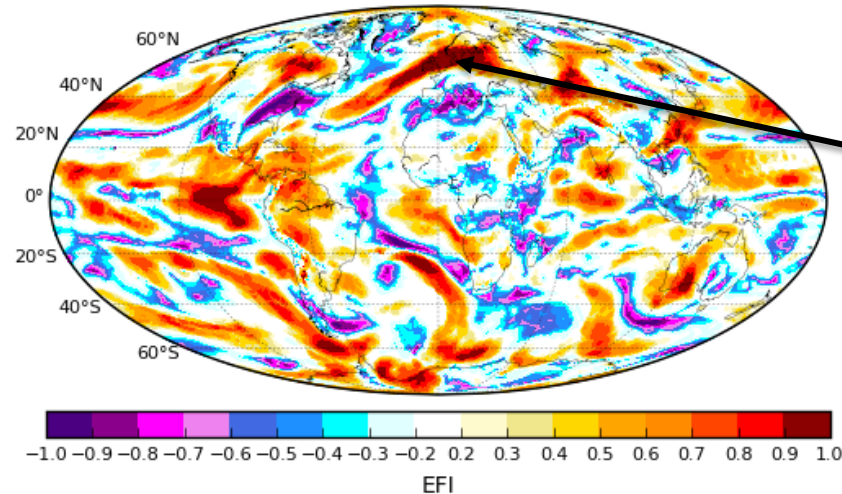
# EFI for storm Desmond

a. 27 Nov 2015 Forecast Day 9



Signal at forecast day 9.

b. 5 Dec 2015 Forecast Day 1



Atmospheric river is well captured.

# Conclusions

- IVT has higher predictability than rainfall forecasts.
- ECMWF EFI applied to IVT.
- IVT EFI is most useful in forecasts initialised in positive NAO conditions.
- Rainfall EFI is better in forecasts initialised in negative NAO conditions and at short lead times.
- At short lead times, IVT EFI provides synoptic context.