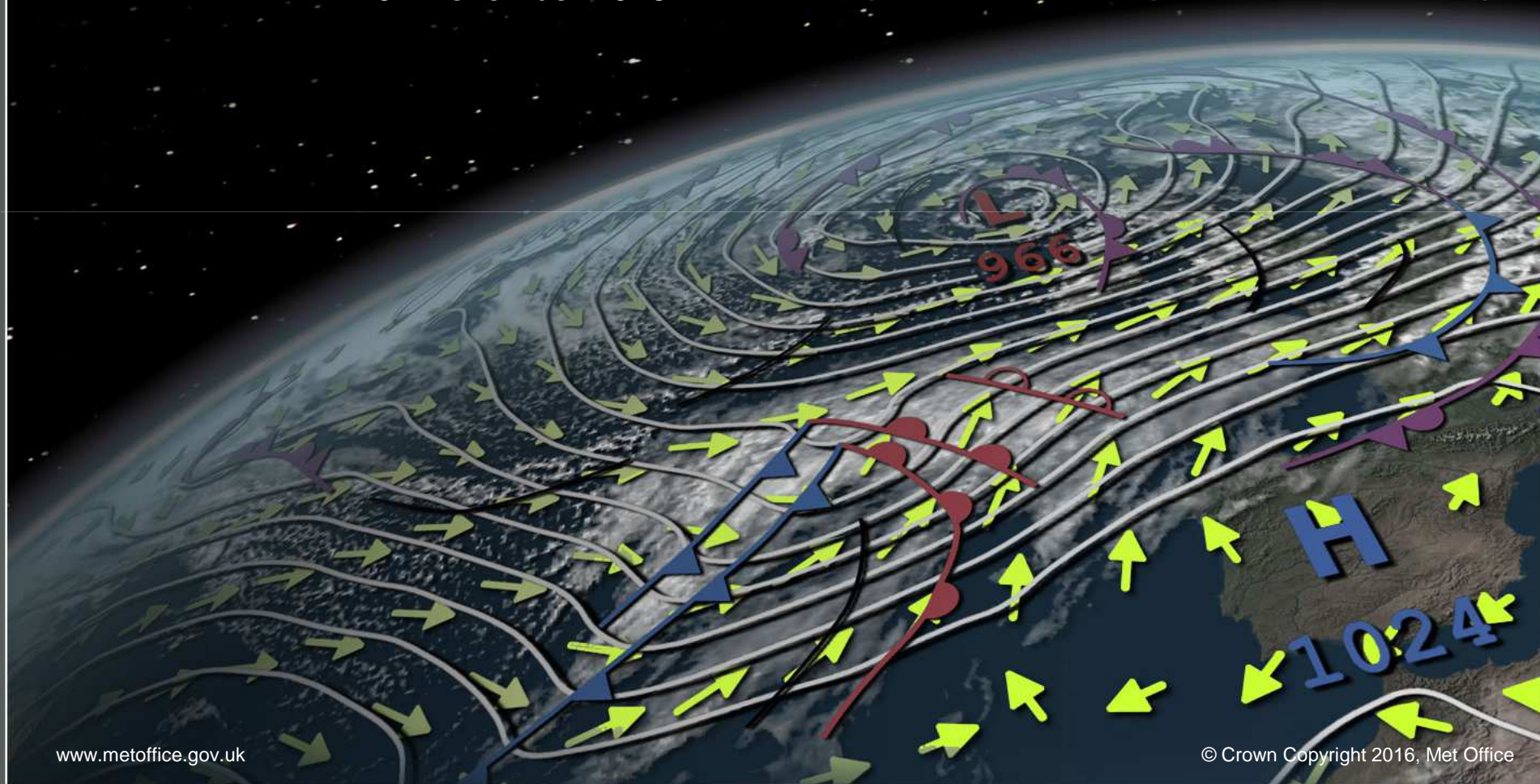




Seasonal rainfall prediction and plausible extremes

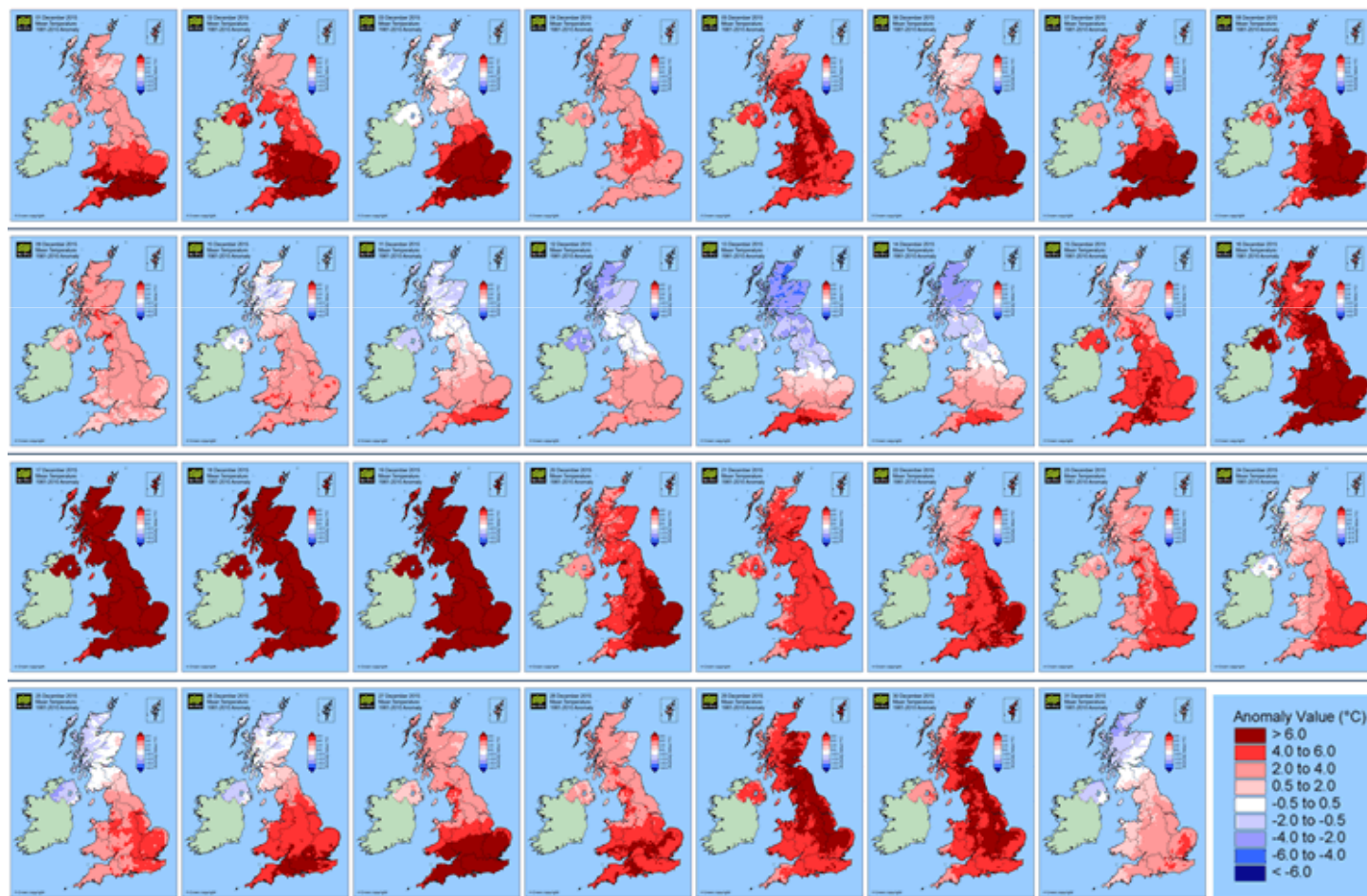
Case study of winter 2015/16

9th November 2016



Exceptionally mild and wet

December day by day

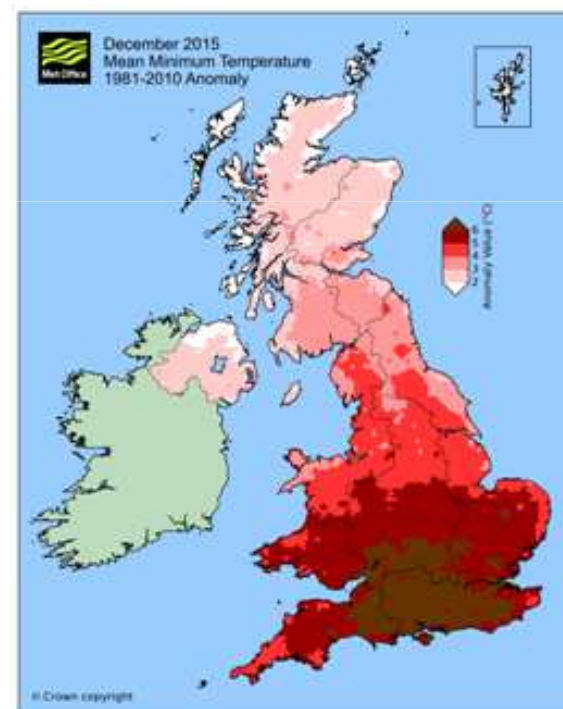
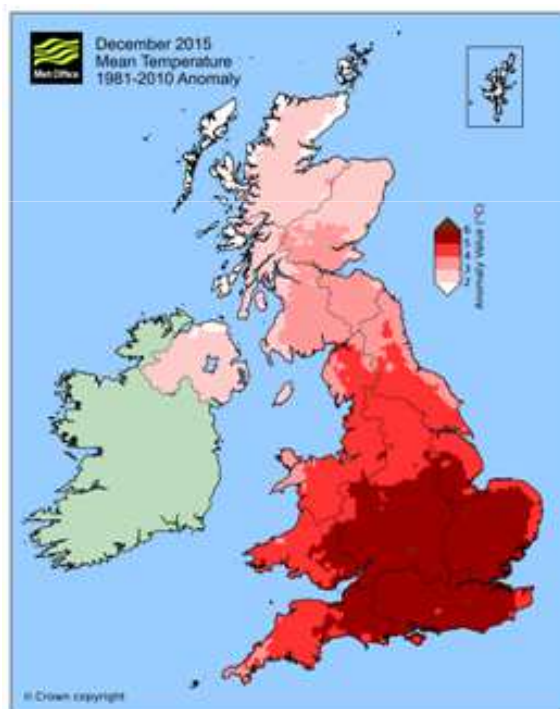
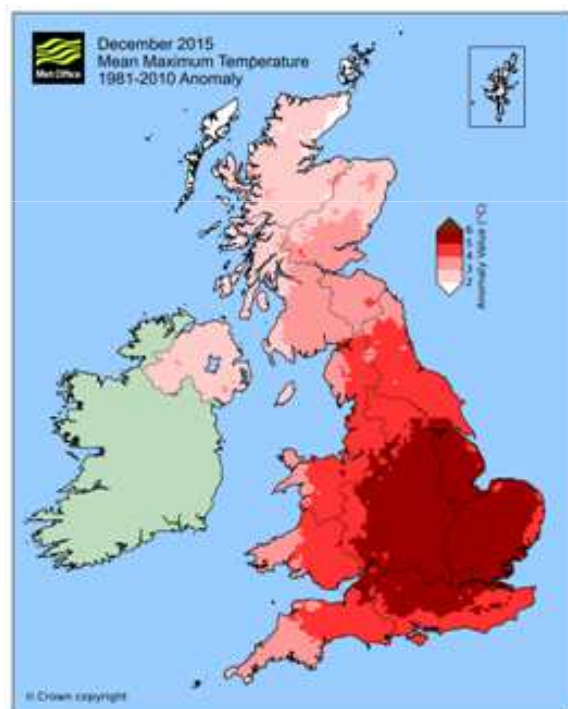




Met Office

Exceptionally mild and wet

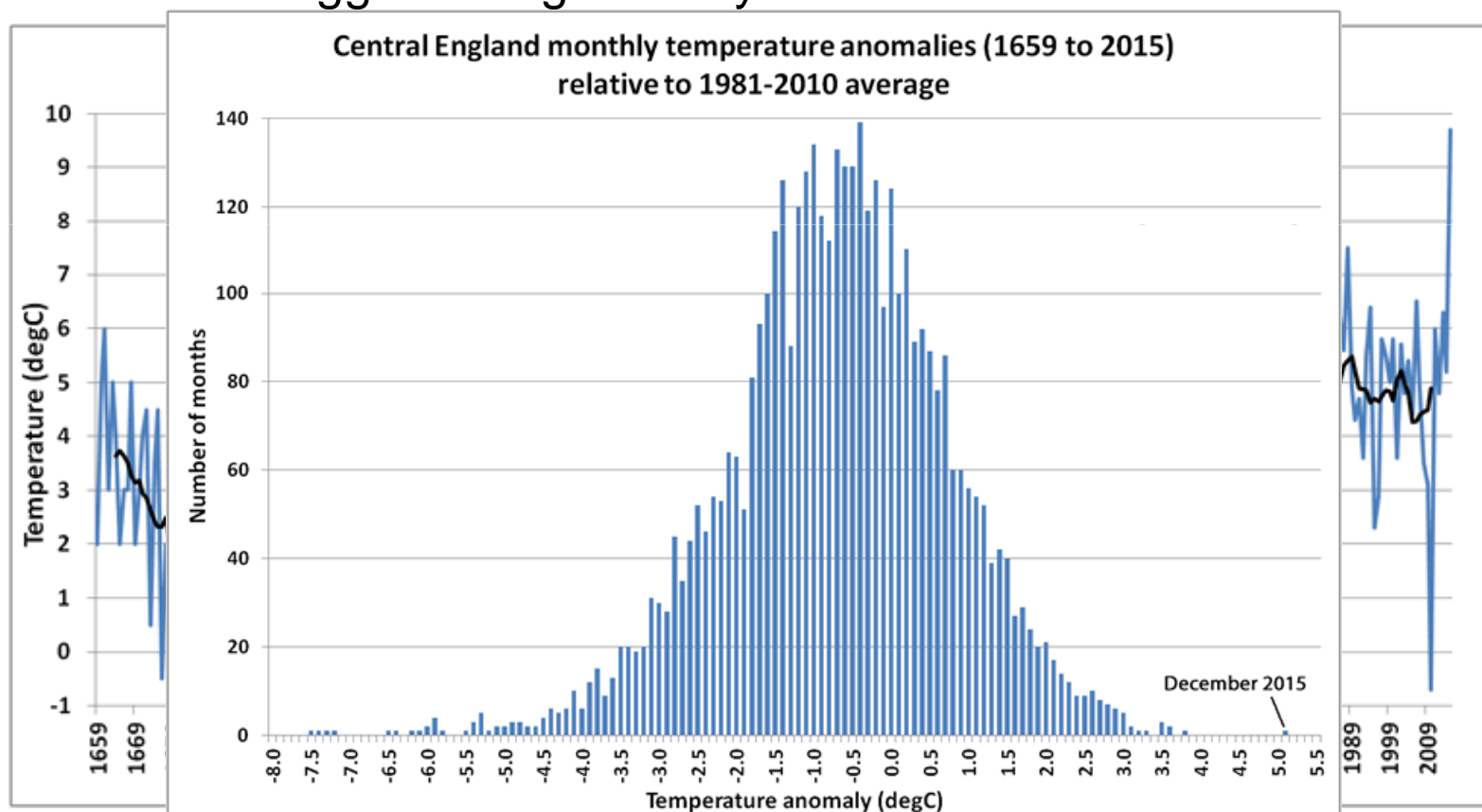
Anomalies up to +6C



Exceptionally mild and wet

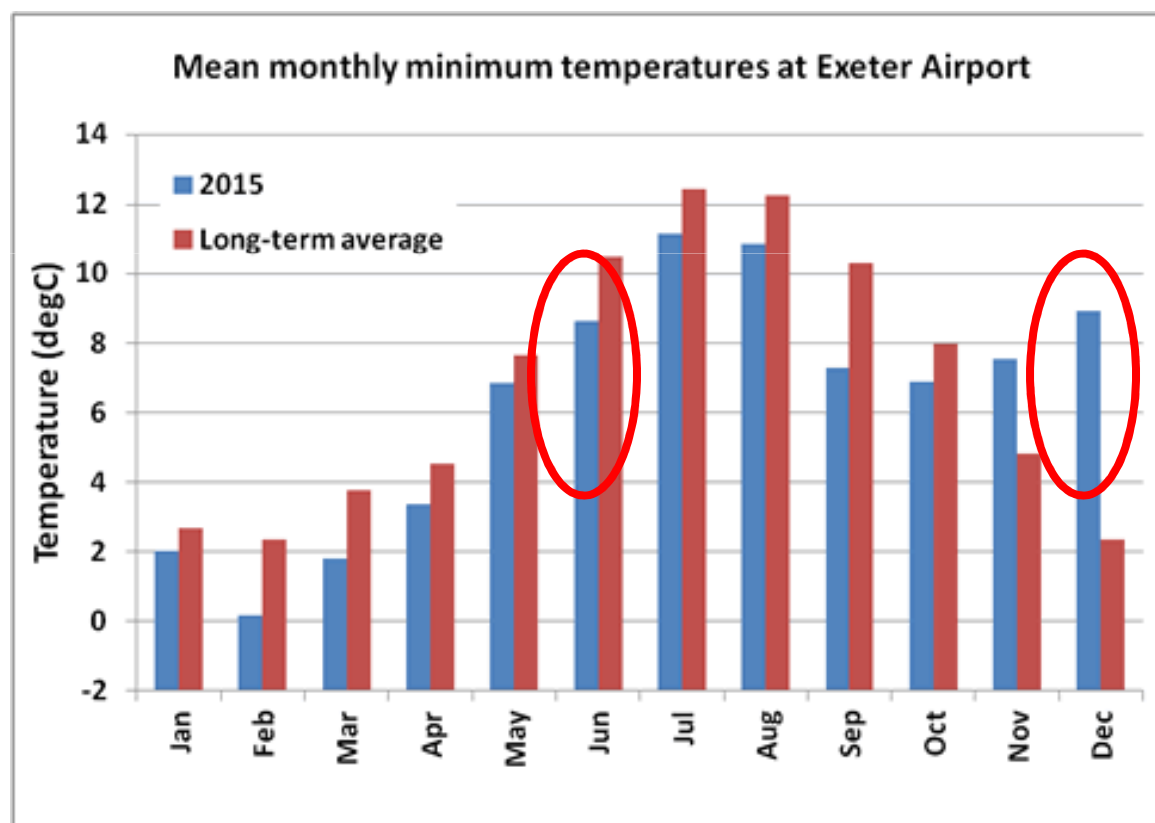
Mildest December in CET record (by 1.6C)

Biggest margin of any month



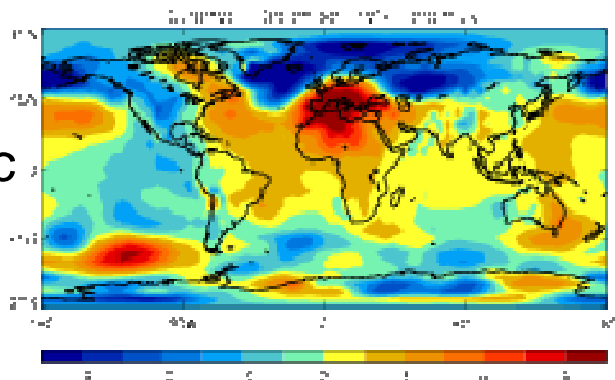
Exceptionally mild and wet

At Exeter, mean night time temperature above June!

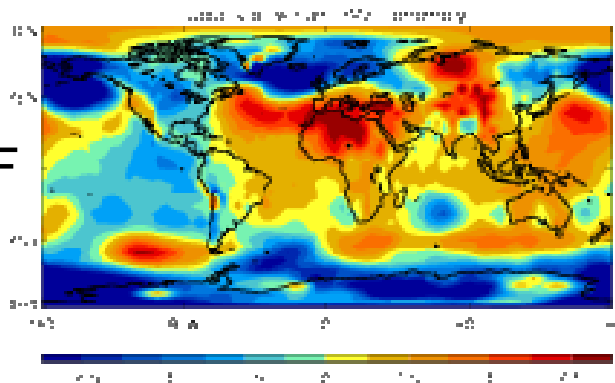


Winter 2015/16

Dec



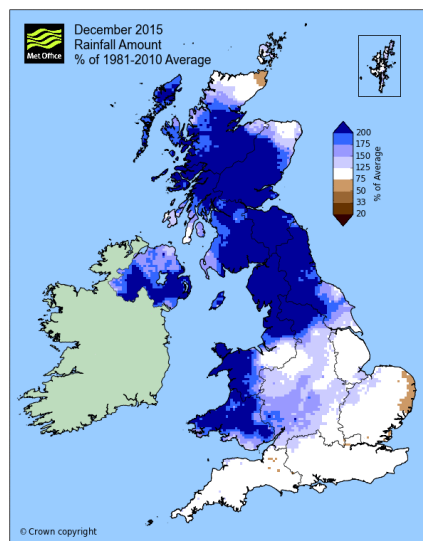
DJF



Strong meridional pressure gradient in Dec

Also for the Dec-Jan-Feb mean

=> Positive NAO, wet, stormy and mild

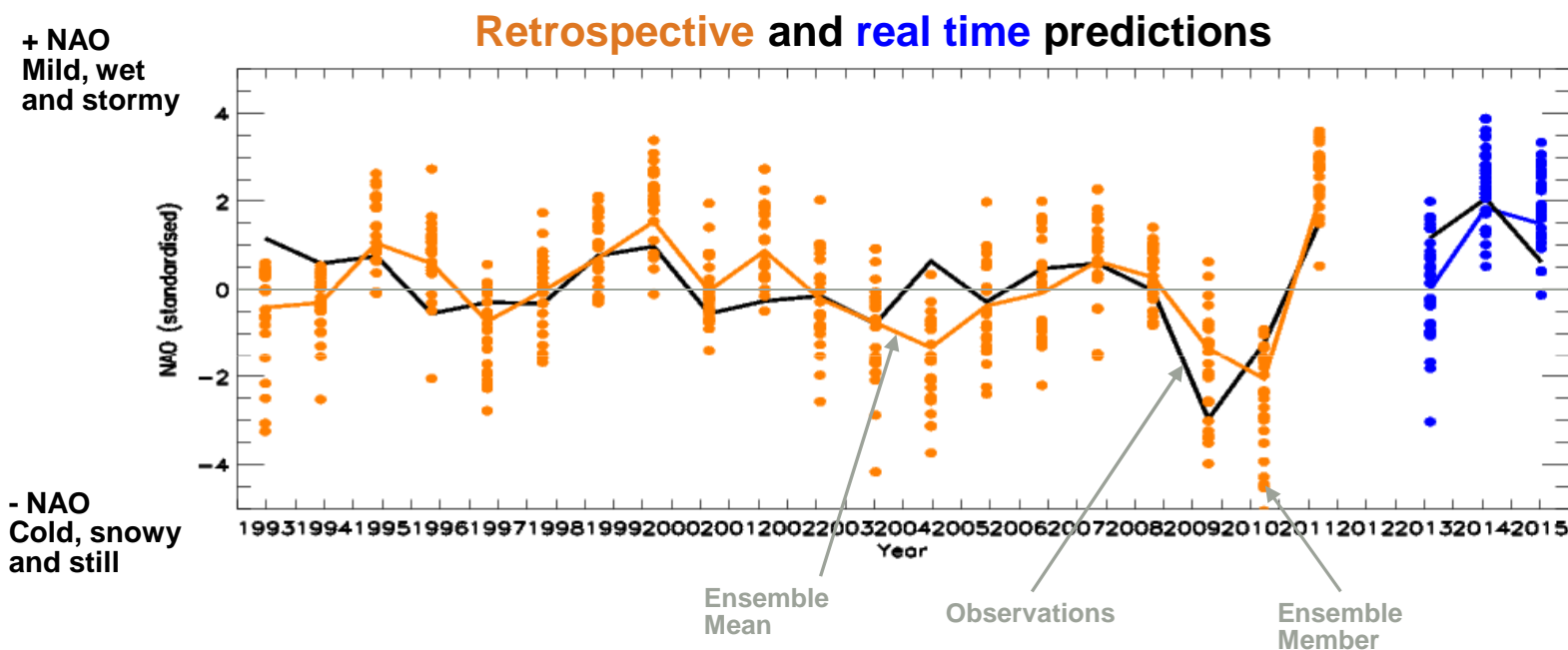


Adam Scaife

www.metoffice.gov.uk

© Crown Copyright 2016, Met Office

Long range predictions



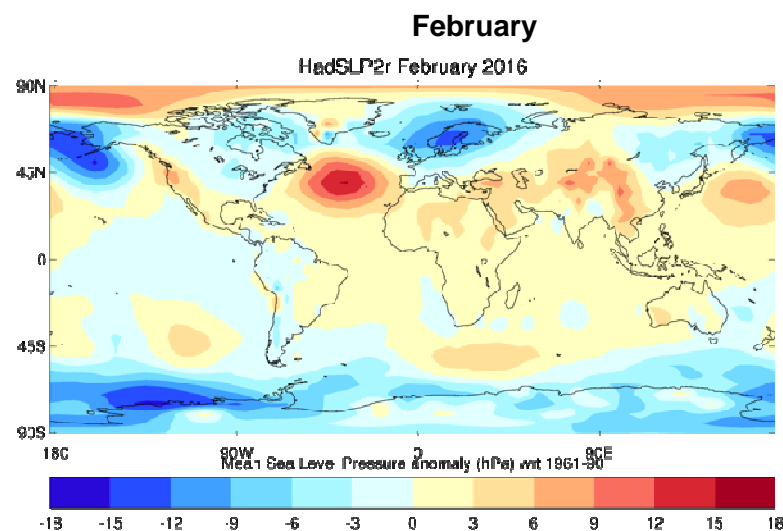
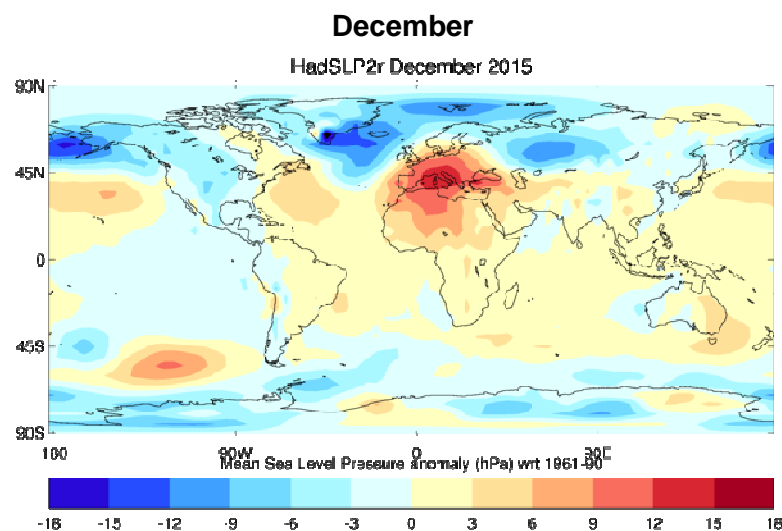
Scaife et al (2014)

Our original tests are shown in orange and indicate a correlation skill of 62%

More ensemble members => more skill and ~0.8 may be possible

So far so good with real time forecasts...

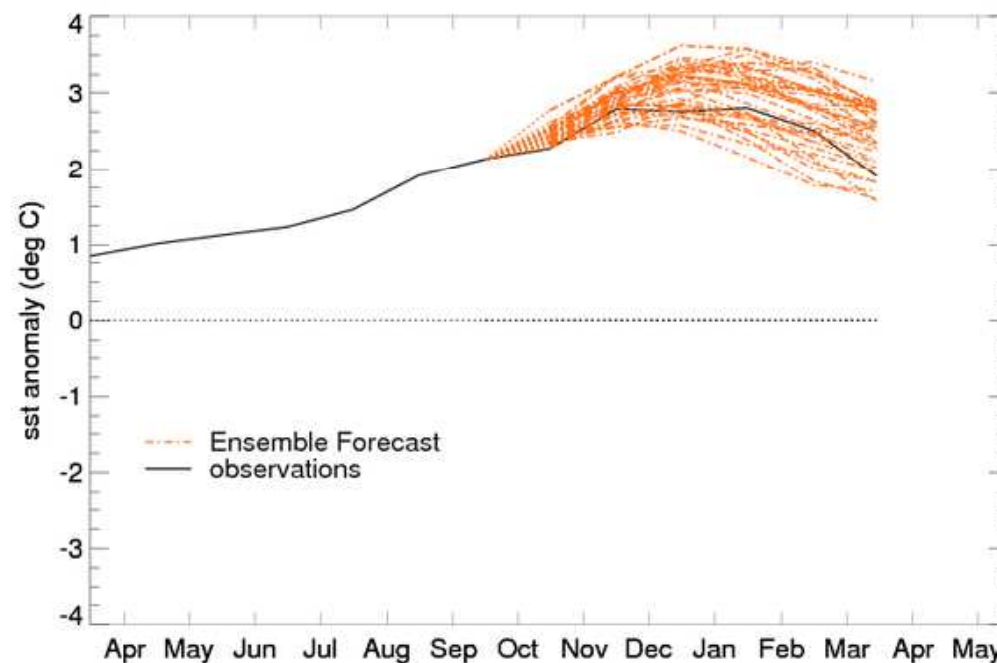
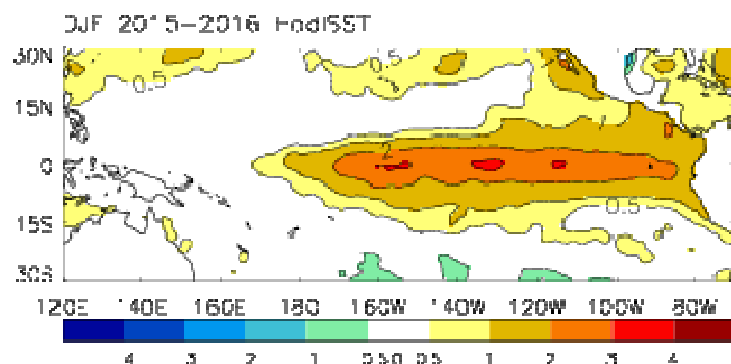
Winter 15/16: intra-seasonal shift



Early winter – strong westerly or south westerly flow

Late winter – Atlantic ridging and north westerly flow

Winter 15/16 and El Niño

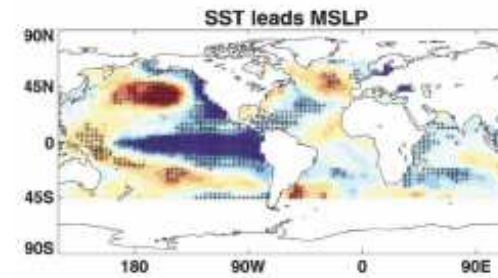
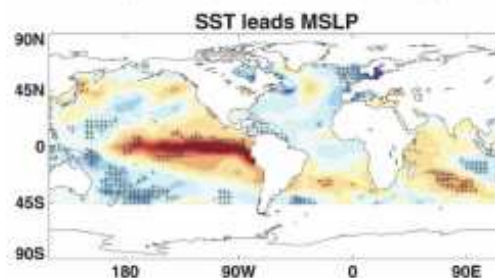
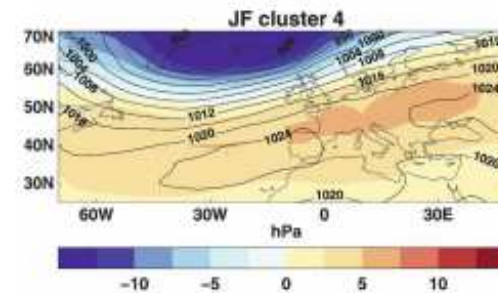
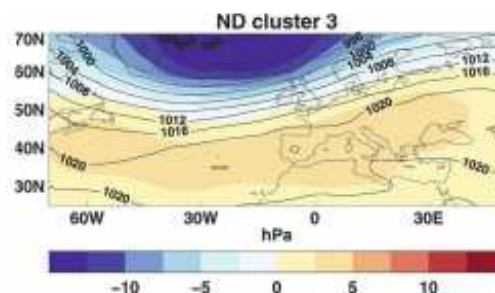
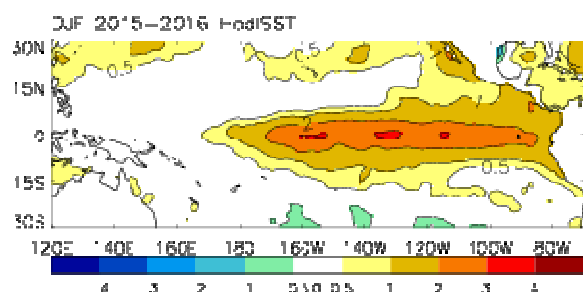


Adam Scaife, Sarah Ineson

www.metoffice.gov.uk

© Crown Copyright 2016, Met Office

Winter 15/16 and El Niño



Fereday et al. (2008)

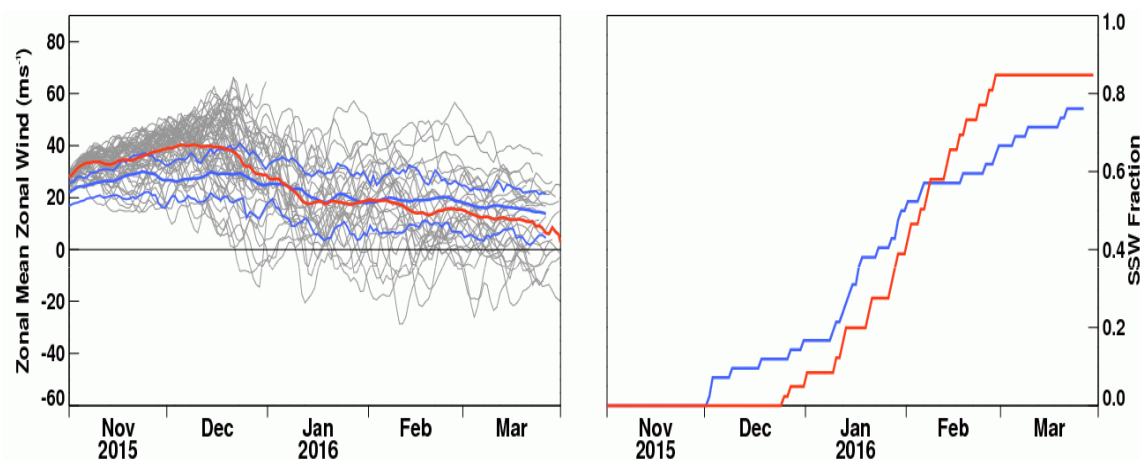
Signals from ENSO are opposite in early and late winter

El Nino winters => westerly flow in early winter, blocked late winter

La Nina winters => blocking in early winter, westerly in late winter

Stratospheric influence

Stratospheric Sudden Warming Forecast

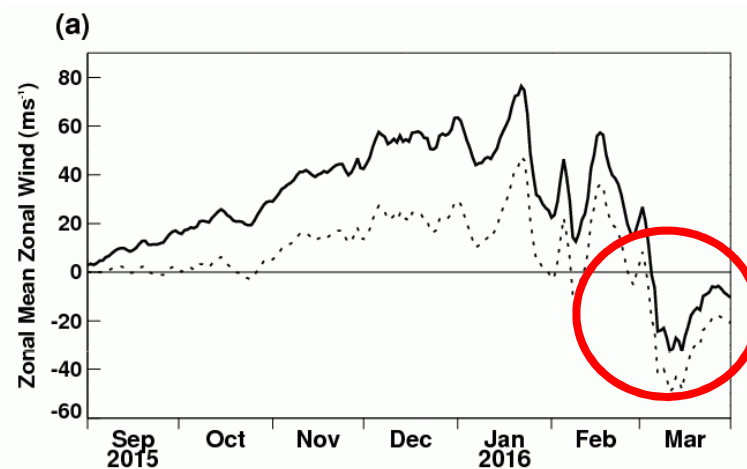


Very strong jet and low probability of a sudden warming predicted for December

A high probability (80-90%) of a sudden stratospheric warming predicted for late winter

Consistent with forecasts for other El Niño winters

Stratospheric influence

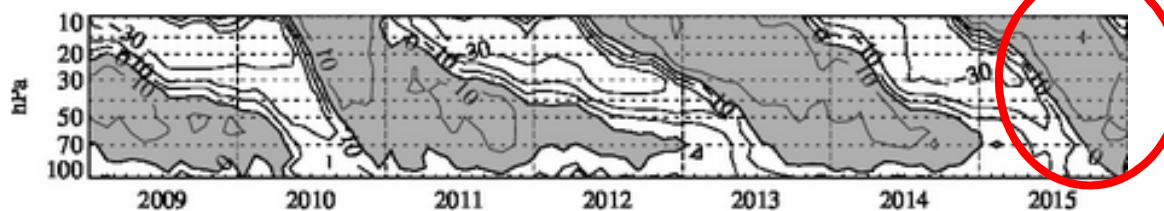


A sudden warming finally happened in early March (consistent with the cold dry start to spring)

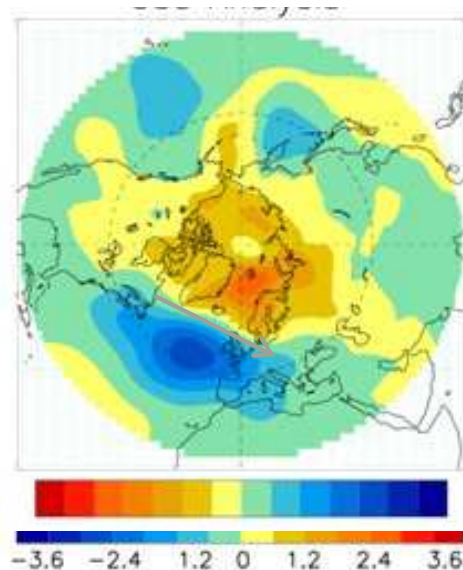
Later than the most likely time in the forecasts but within the spread of forecasts from Autumn

Tropical stratosphere - QBO

Zonal winds at the equator



Sea level pressure (E-W QBO)



Deep westerly phase of the QBO at start of winter

=> more westerly conditions

=> northward shifted jet

=> more storms and mild, wet winter conditions

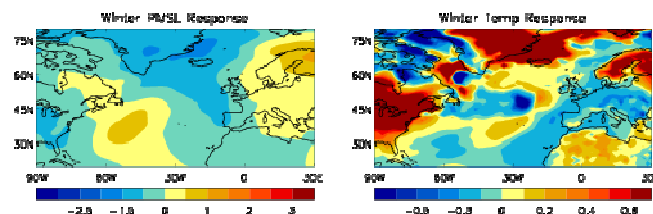
Scaife et al (2014)

www.metoffice.gov.uk

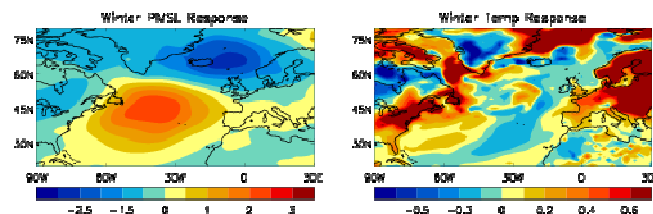
© Crown Copyright 2016, Met Office

Solar variability

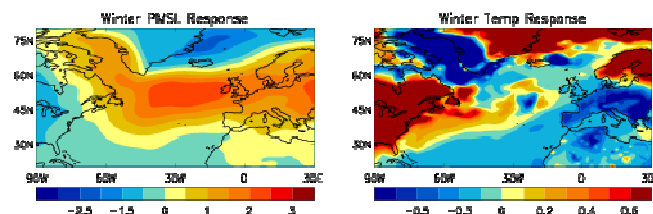
Winter 1



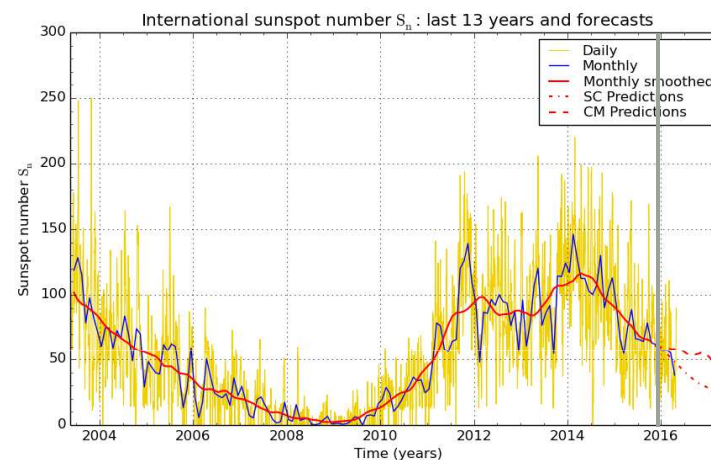
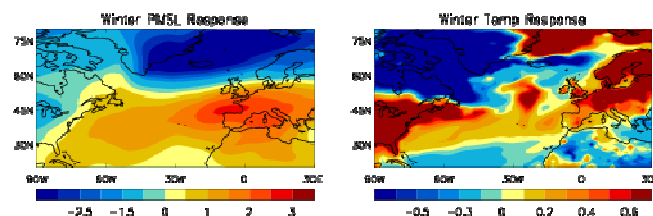
Winter 2



Winter 3



Winter 4



SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium 2016 May 1

Response to a constant forcing

Builds up year on year via ocean

Leads to a lagged response at about 2-3 years

Winter 15/16 was indeed ~2 years after solar max



Met Office

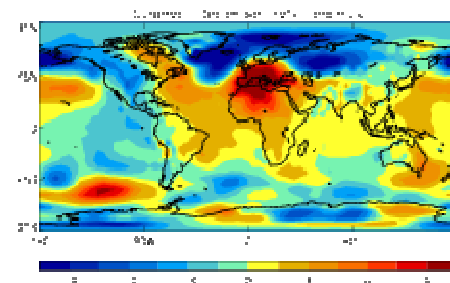
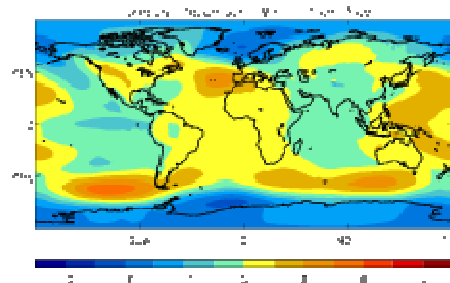
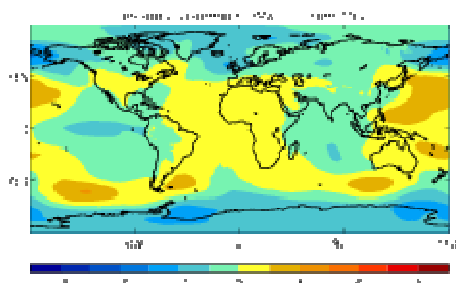
Winter 15/16 predictions

From October

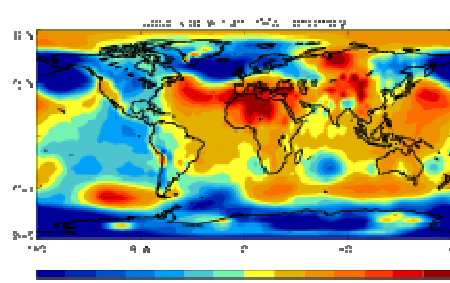
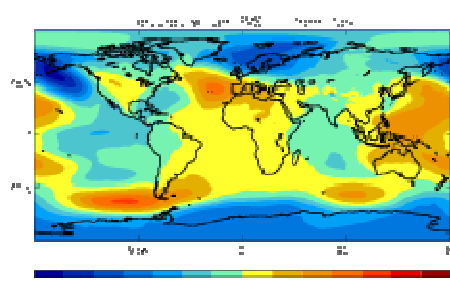
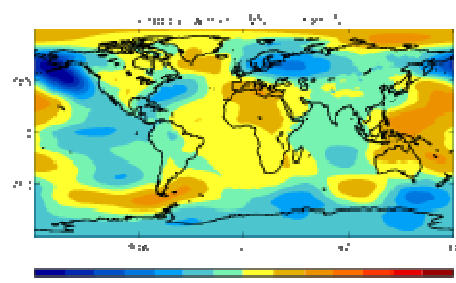
From November

Observations

Dec



DJF



A signal for a westerly winter from October

Good agreement with subsequent observations

Early warning of winter flooding

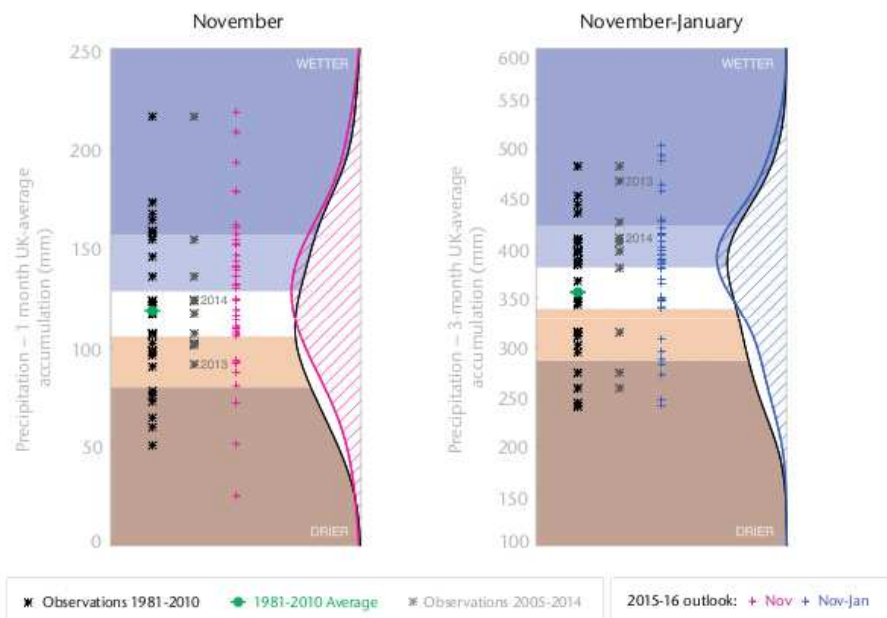
Adam Scaife

www.metoffice.gov.uk

© Crown Copyright 2016, Met Office

Winter 15/16: October forecast

1-month and 3-month UK outlook for precipitation in the context of observed climatology



October showed signal for increased precipitation

Early winter showed similar signal

Roughly twice as likely wet as dry

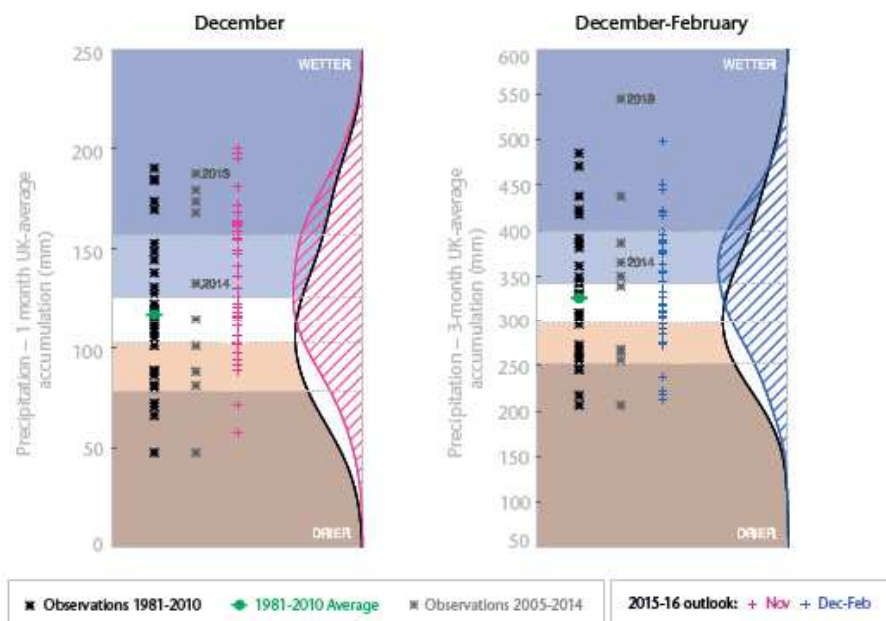
SUMMARY - PRECIPITATION:

For both November and November-December-January above-average precipitation is considered more probable than below-average.

The probability that UK-average precipitation for November-December-January will fall into the driest of our five categories is between 10% and 15% and the probability that it will fall into the wettest of our five categories is between 25% and 30% (the 1981-2010 probability for each of these categories is 20%).

Winter 15/16: November forecast

1-month and 3-month UK outlook for precipitation in the context of observed climatology



December showed a very clear signal for wet

Circulation implied increased storm risk

Dec-Feb showed similar signal overall but a switch to colder in late winter

SUMMARY - TEMPERATURE:

During December above-average temperatures are more likely than below-average temperatures. The likelihood of a prolonged spell of cold weather is relatively low compared to normal.

Predictions for UK-mean temperature for the whole of the winter season (December-January-February) show only a slight shift from the normal range of expected conditions. In this instance, however, there are reasons to believe that this unremarkable outlook conceals the likelihood of a switch from a mild start to winter towards colder conditions later on. These different phases balance the probability of above- and below-average conditions in the overall 3-month average, but that does not imply normal chances of weather impacts this winter. Specifically, we consider there to be an increased risk of storms and very wet conditions in the early part of the winter, and a greater risk of cold weather impacts in late winter.

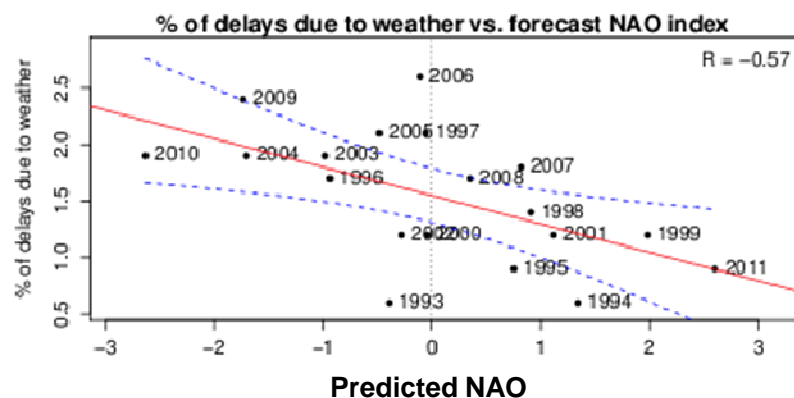
Overall, the probability that the UK-average temperature for December-January-February will fall into the coldest of our five categories is 15% and the probability that it will fall into the warmest of our five categories is between 20% and 25% (the 1981-2010 probability for each of these categories is 20%).



Met Office

Transport impacts prediction

Winter airport disruptions



Extreme winter weather has an impact on transport

Skill in the NAO translates to skill in impacts

Real time forecast for winter 15/16 gave good advice on risk

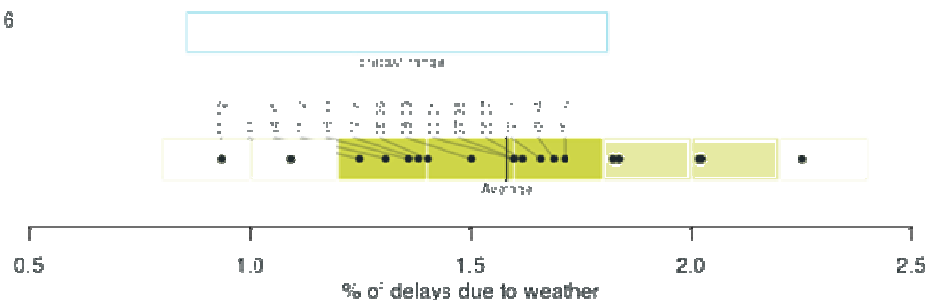
Winter 2015/16 Forecast



Forecast winter transport impacts

Winter 2015/2016
(forecast, DJF)

Past winters
(forecast, DJF)



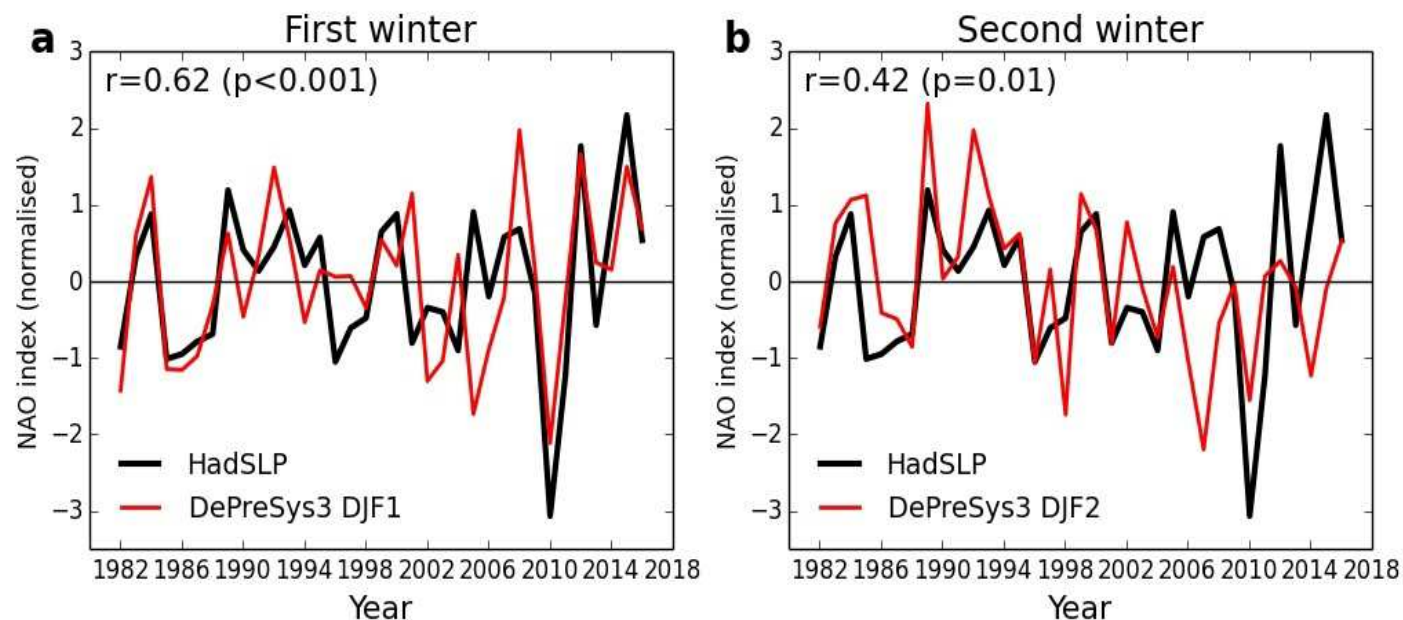
Palin et al. (2015)

www.metoffice.gov.uk

© Crown Copyright 2016, Met Office

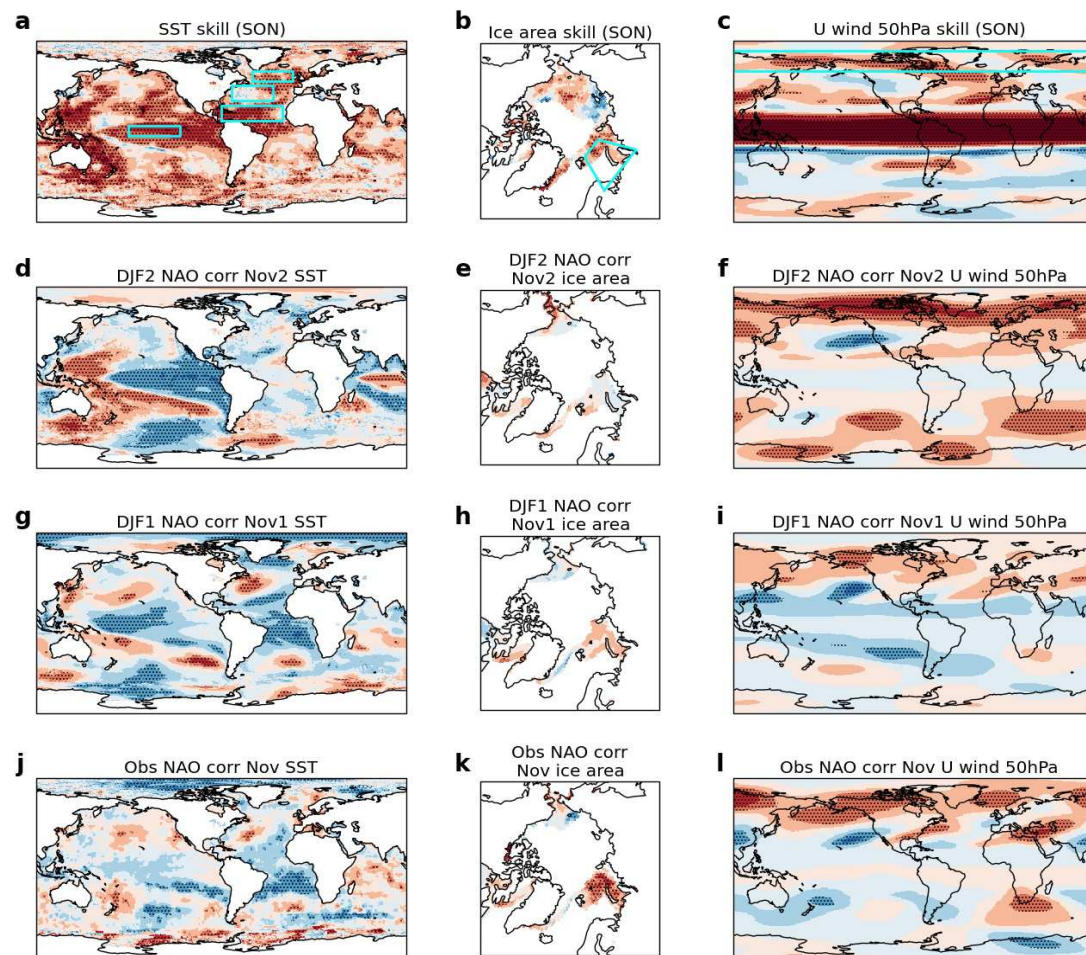
Skilful winter NAO 1 year ahead

Significant NAO skill in second winter



Nick Dunstone

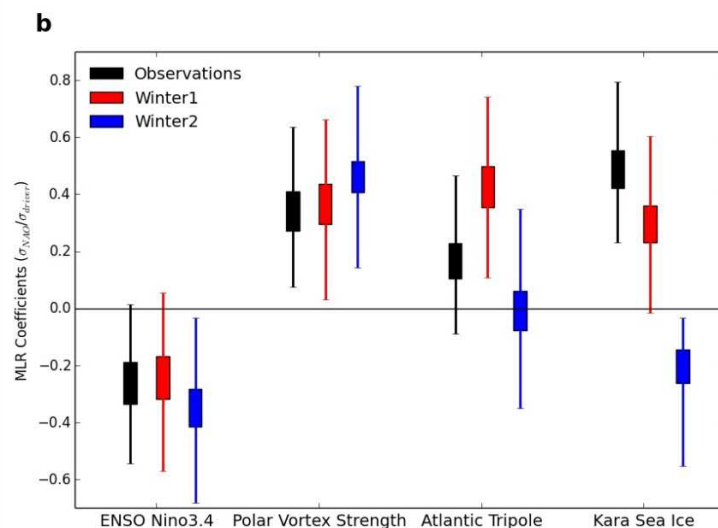
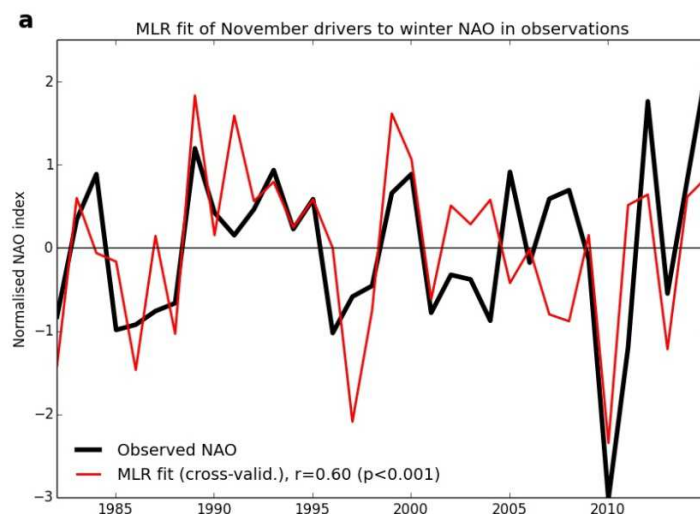
Skilful winter NAO 1 year ahead



Nick Dunstone



Skilful winter NAO 1 year ahead



Winter NAO predicted 1 year in advance with skill of $r=0.4-0.5$

Primary drivers are ENSO and stratospheric variability

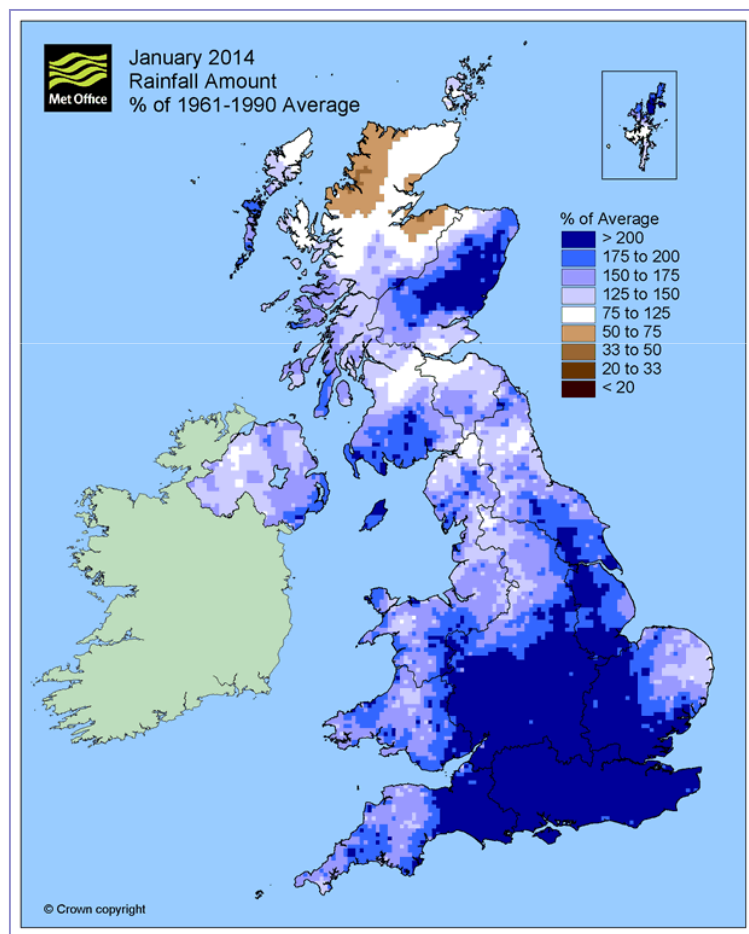
Reducing model drift in Arctic sea-ice could lead to increased 2nd winter NAO predictability



Plausible extremes: unprecedented events

- Using DePreSys decadal hindcast data
- Period: 1981 to 2015
- Mining the data for unprecedented extreme events: Oct-Mar monthly rainfall
- Not interested in predictability
- Looking at events which are dynamically possible
- Case study: South east England winter flooding

Plausible extremes: SE England Flooding 2013/14



In south east England, January 2014
saw the greatest monthly rainfall total
on record

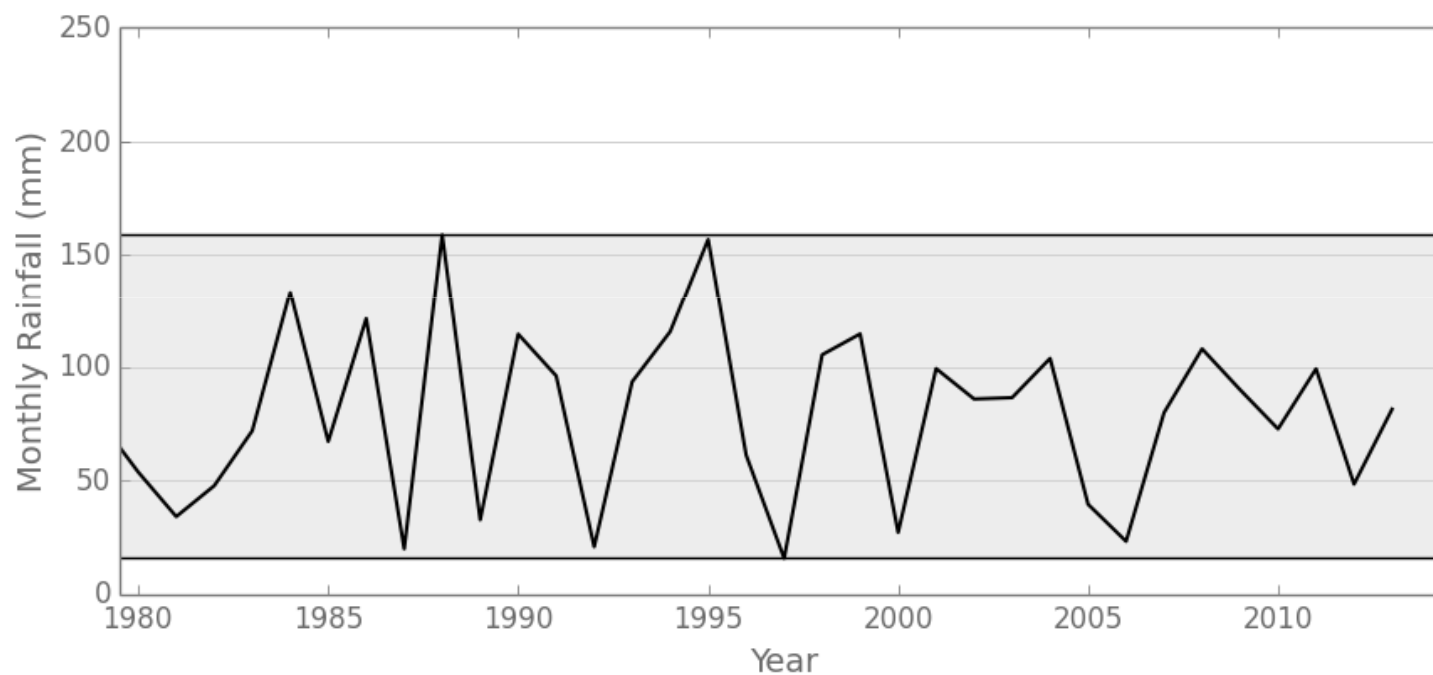
But could it have been even worse?

Vikki Thompson

www.metoffice.gov.uk

© Crown Copyright 2016, Met Office

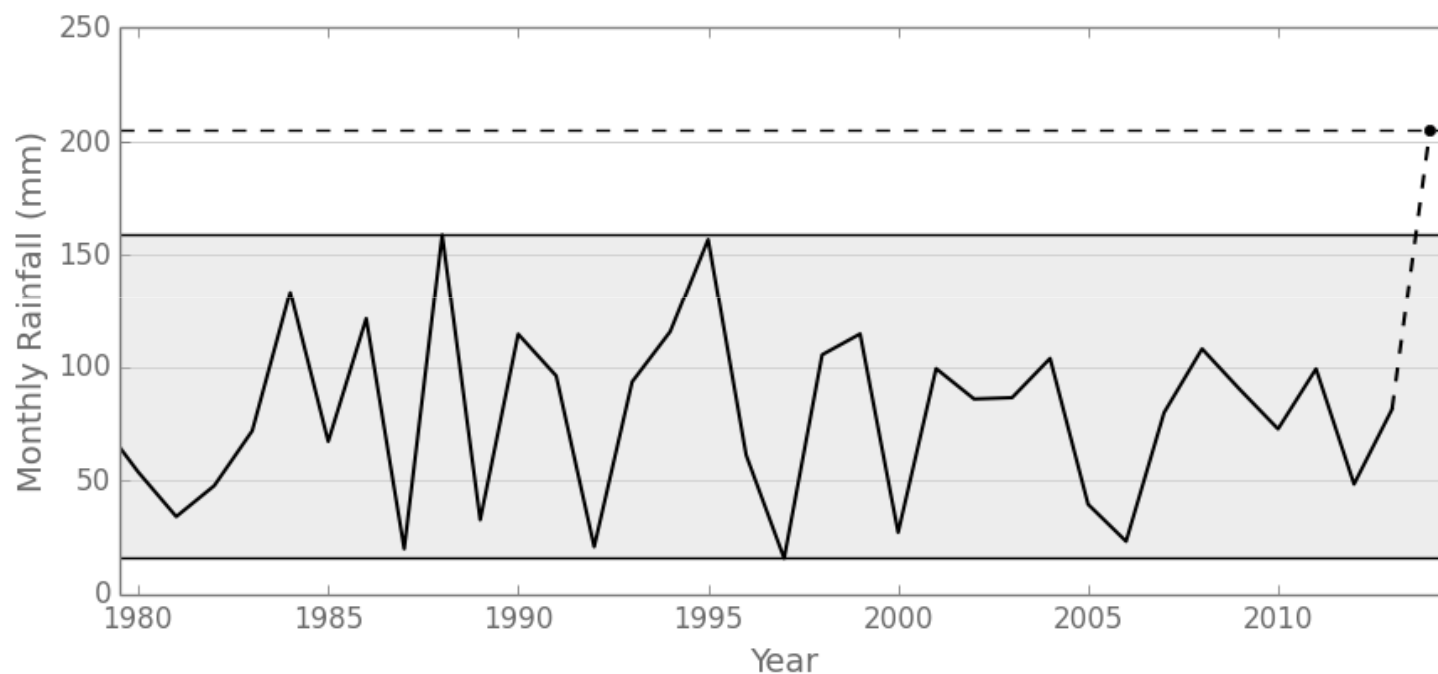
January rainfall





Met Office

January rainfall



The monthly rainfall total of January 2014 exceeded previous records

Vikki Thompson

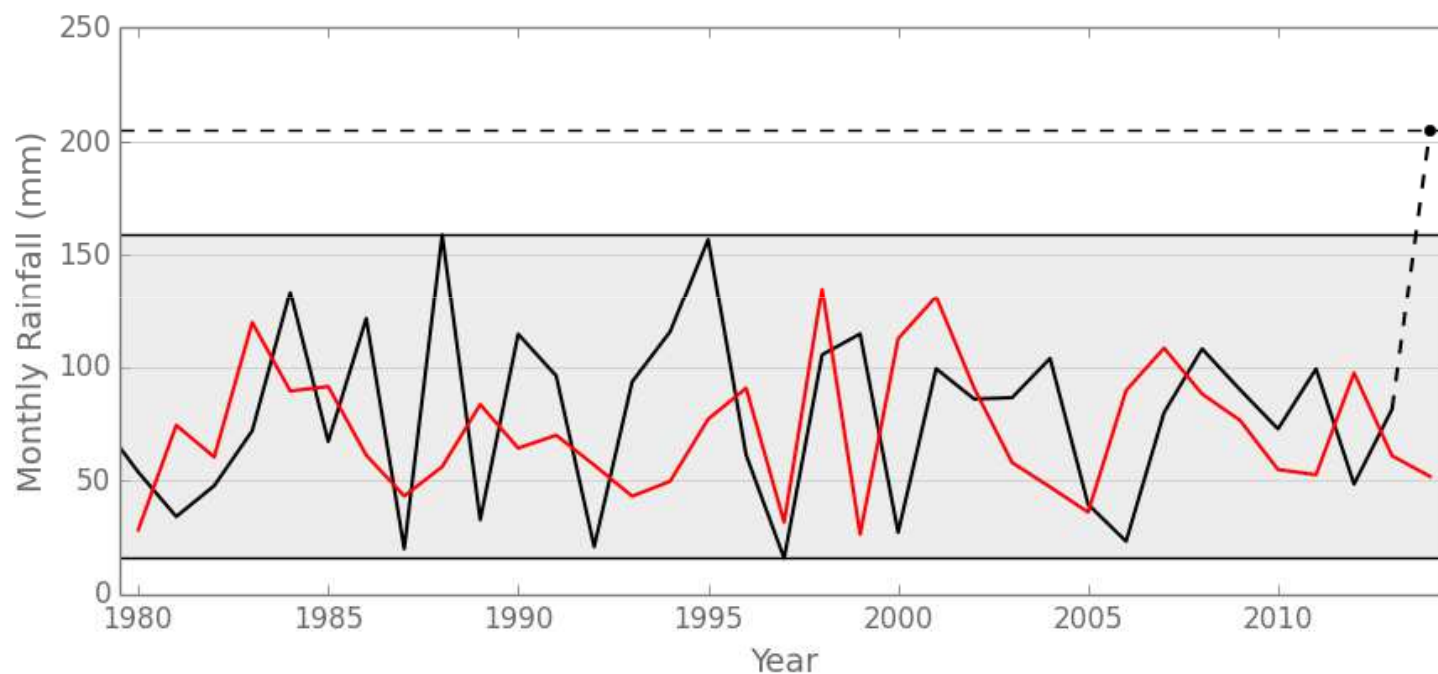
www.metoffice.gov.uk

© Crown Copyright 2016, Met Office



Met Office

January rainfall



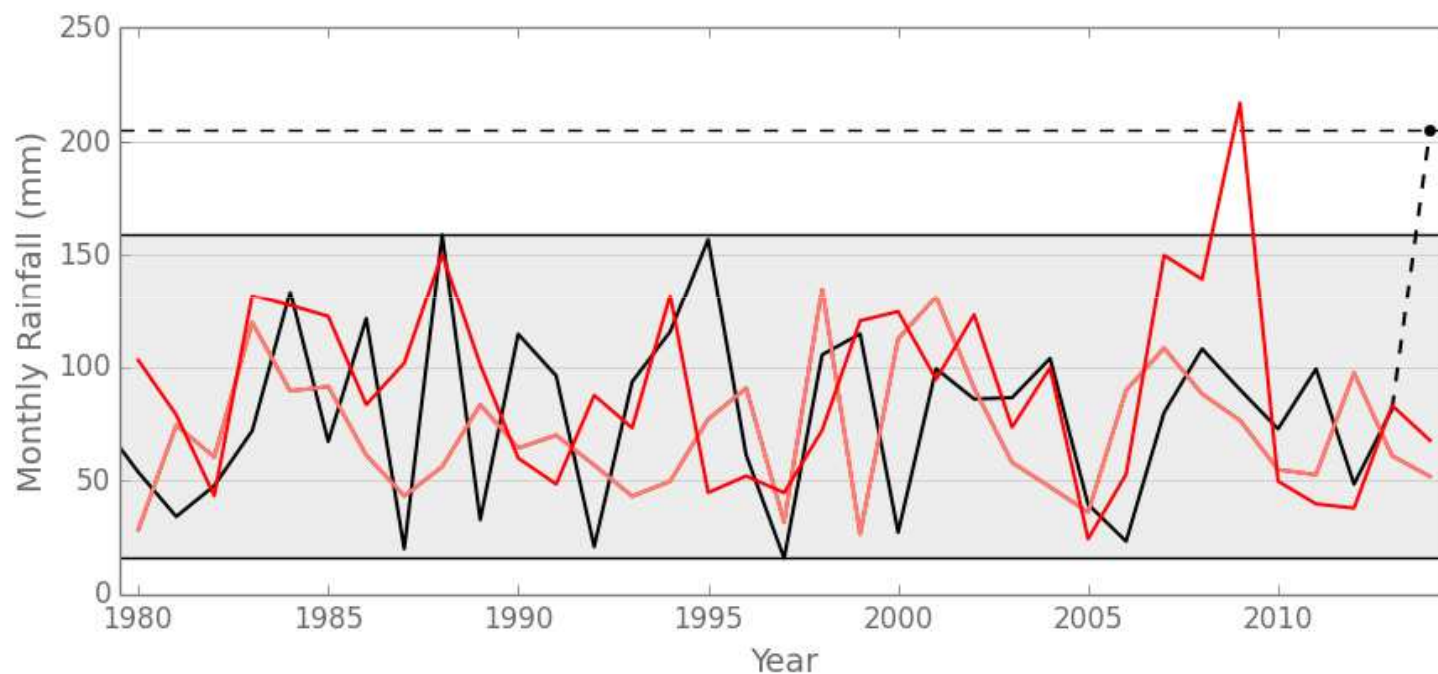
In many model simulations the values are within the range of observations

Vikki Thompson

www.metoffice.gov.uk

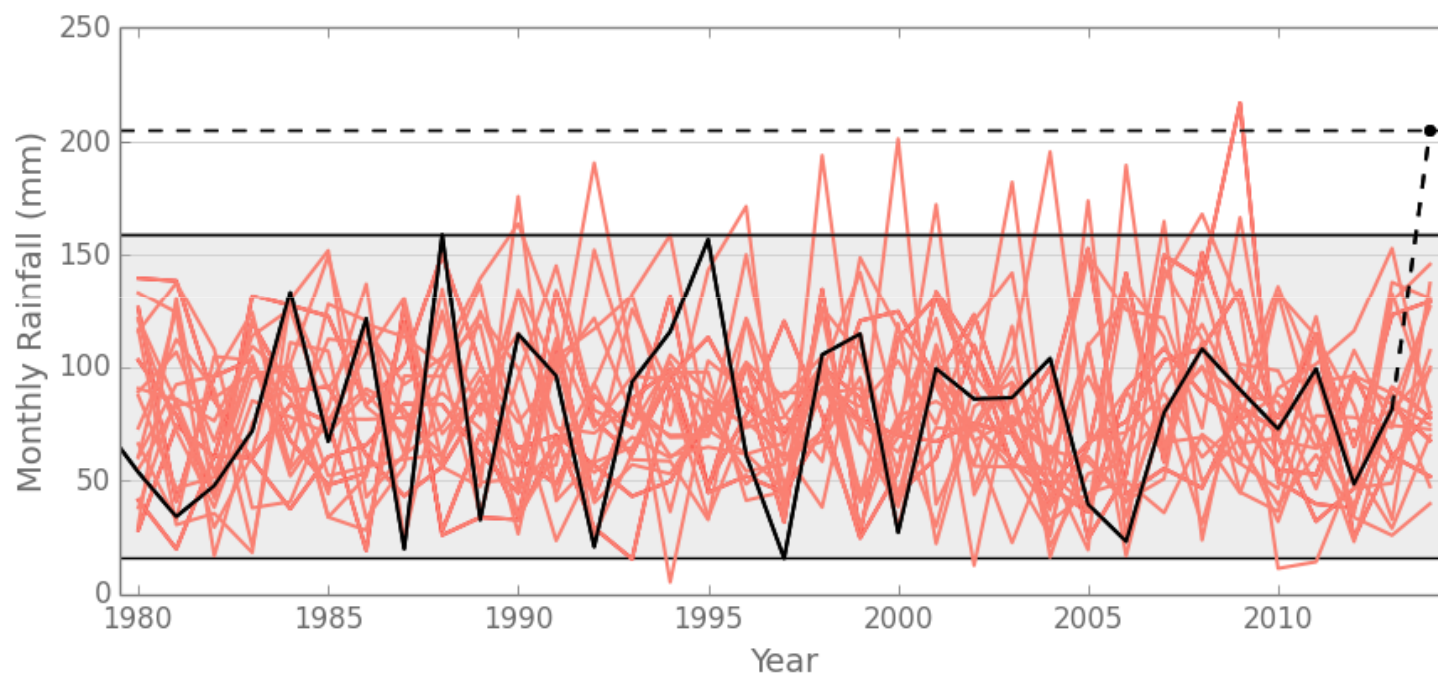
© Crown Copyright 2016, Met Office

January rainfall



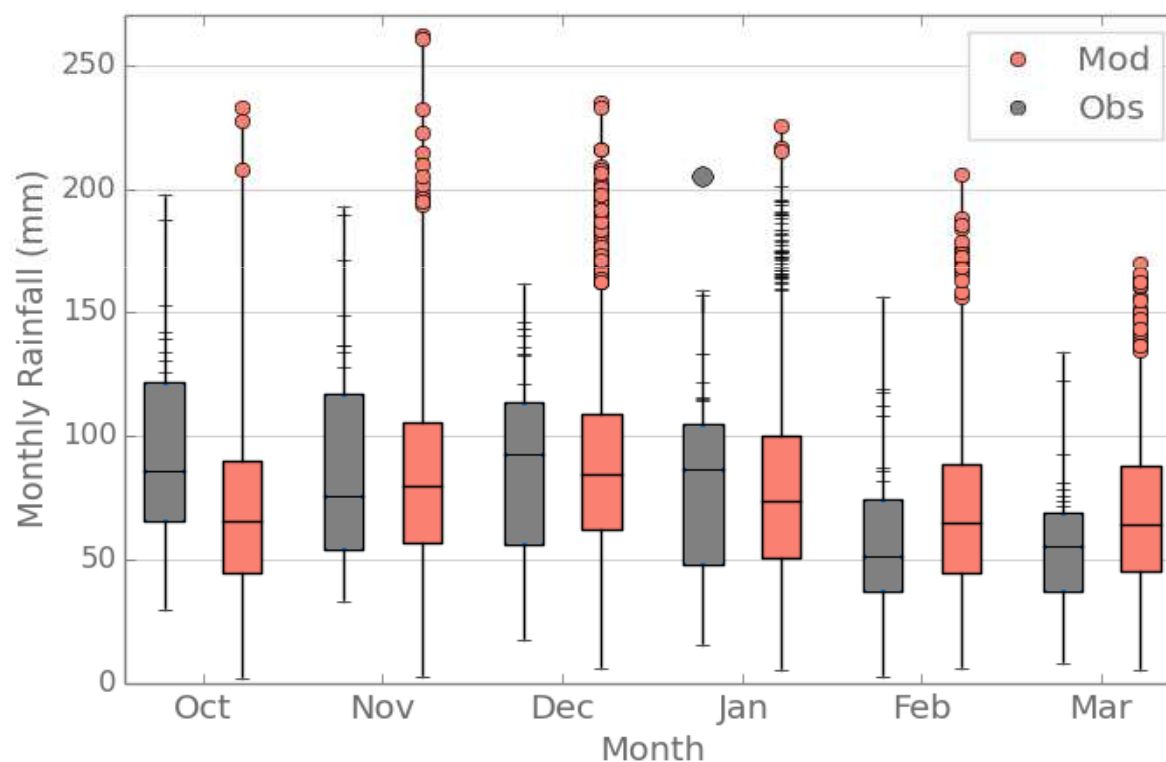
However, in some the model exceeds the observed record

January rainfall

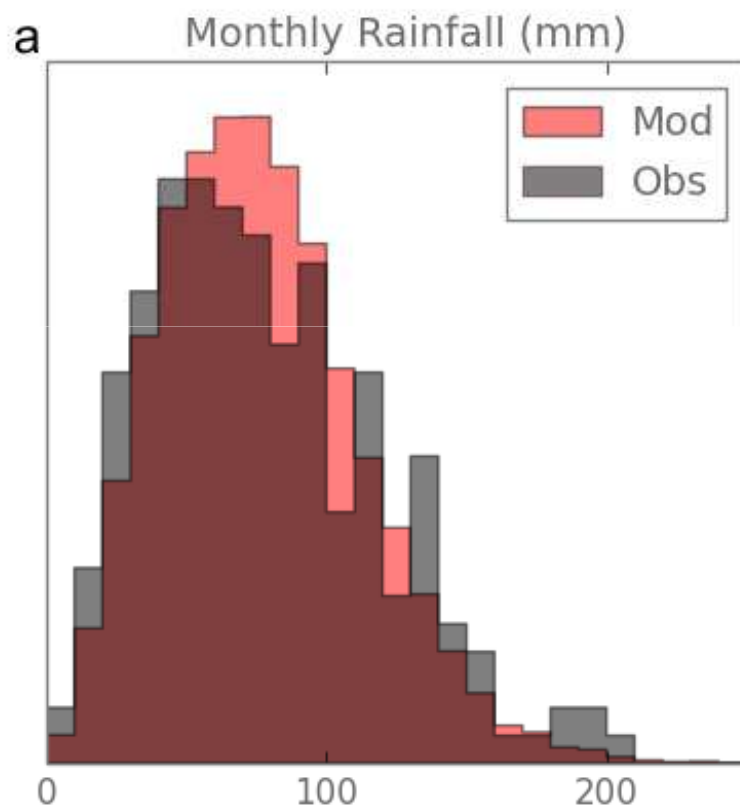


Using model simulations provides more information on these extremes

Model rainfall totals by month



Model fidelity



Model and observations distributions appear similar

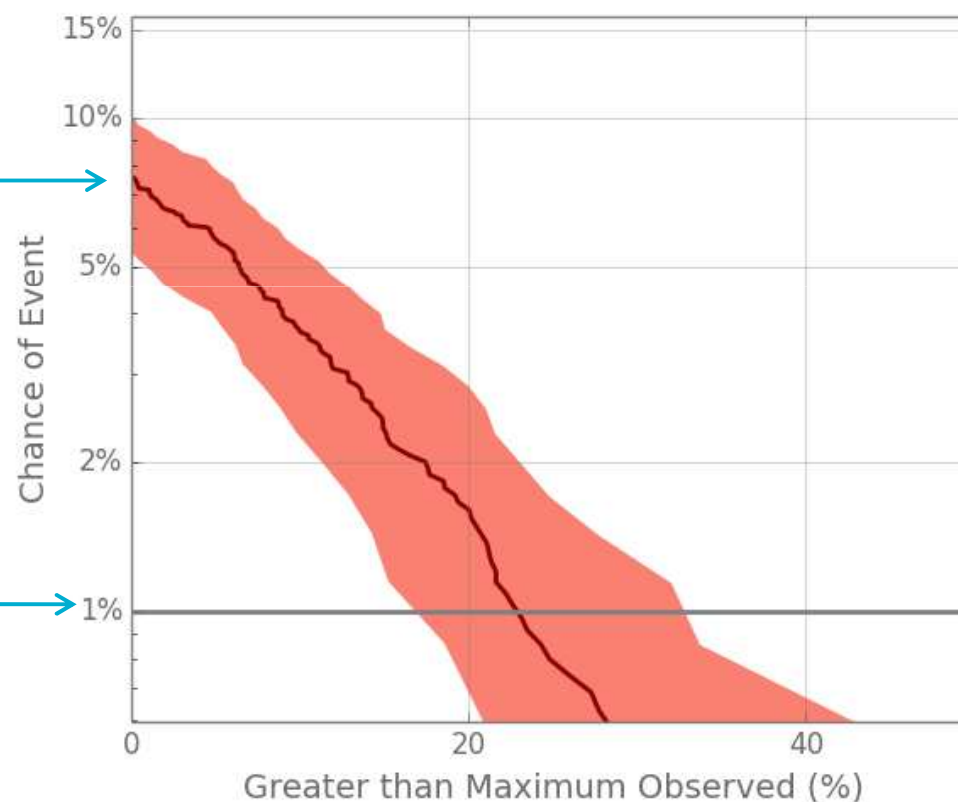


Met Office

Risk of an extreme

8% chance of a record
each winter for SE
England

1% chance of a month
with 15-30% uplift on
the rainfall record each
winter



Vikki Thompson

www.metoffice.gov.uk

© Crown Copyright 2016, Met Office

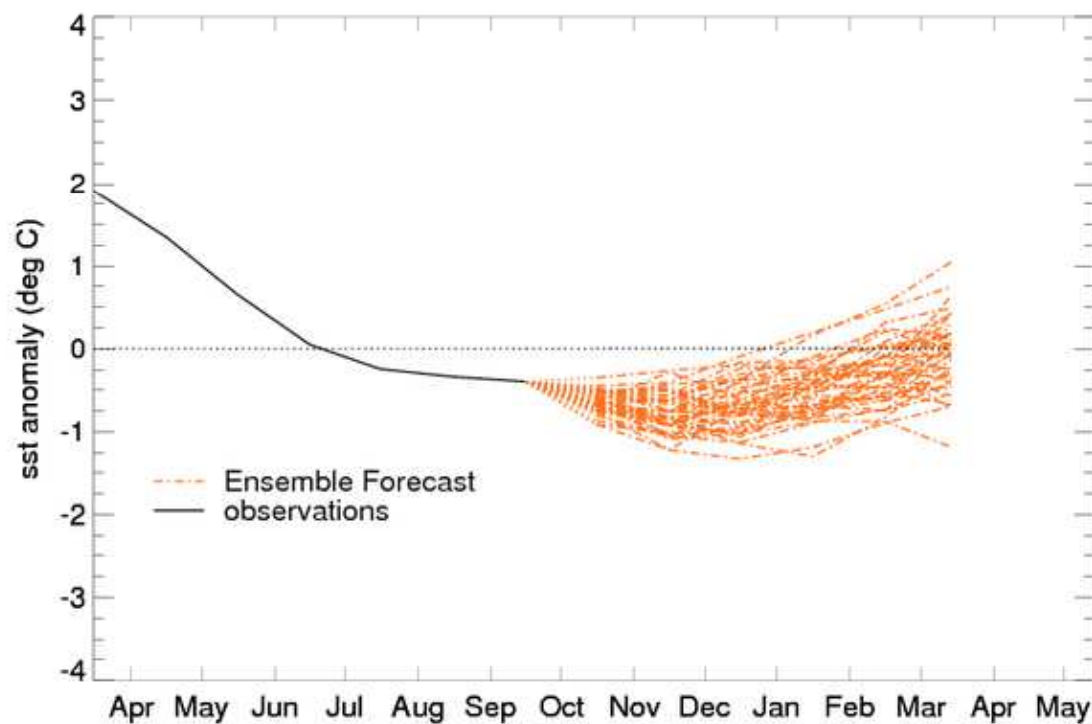
Conclusions

Capability of long range predictions

- Predictability on seasonal timescales
- Skill in forecasting drivers of winter 2015/16
- Drivers create conditions for flooding
- Possibility of skilful predictions further ahead
- Plausible extremes for planning
- So what about this winter...

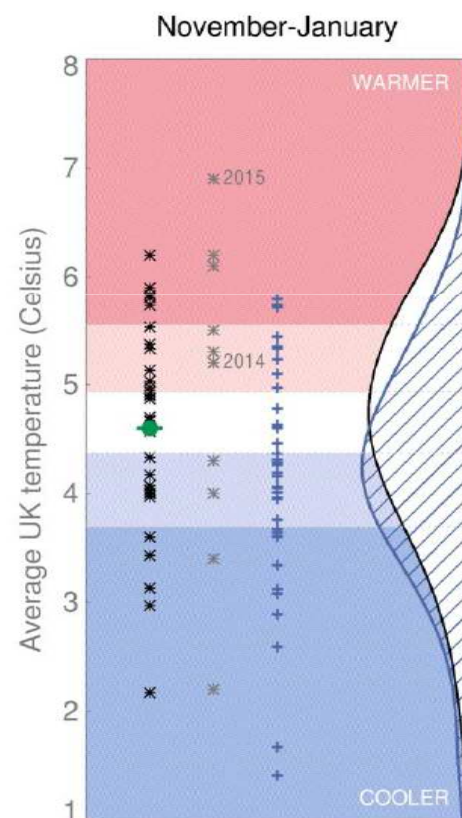
Forecast for winter 2016/17

El Nino declines to weak La Nina



UK winter 2016/17 outlook

3-month UK outlook for temperature in the context of observed climatology



* Observations 1981-2010

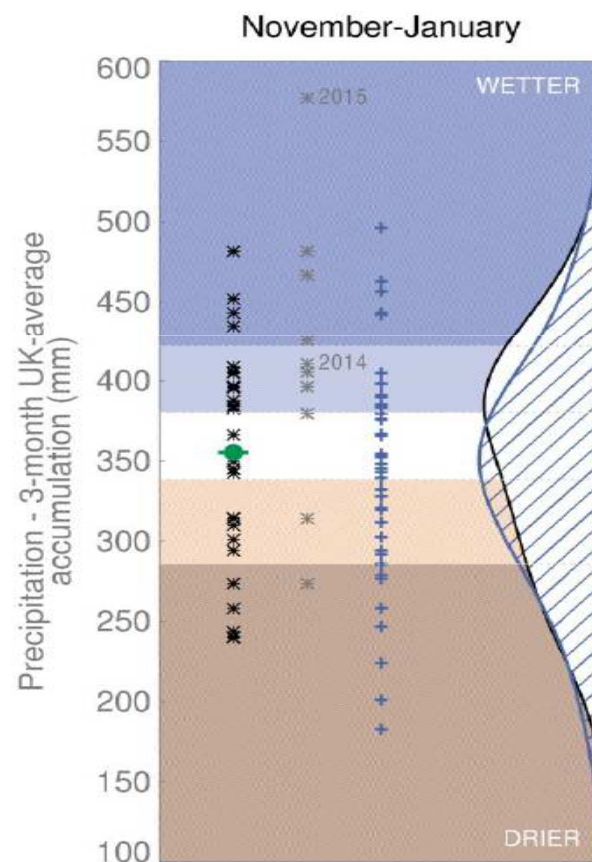
◆ 1981-2010 Average

* Observations 2006-2015

2016 outlook: + Nov-Jan

UK winter 2016/17 outlook

3-month UK outlook for precipitation in the context of observed climatology



* Observations 1981-2010

● 1981-2010 Average

* Observations 2006-2015

2016 outlook: + Nov-Jan



Met Office

Questions?

