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Climatology and climate change – a solution

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Dave Parker (EDF) and others in the EP2 Demand Planning Focus Group

ECMWF Forecast Users Meeting, 10-12 June 2009



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nationalgrid



The EP2 Project

**Exploring risks –
Reducing exposure
Increasing resilience**



Energy demand forecasting: background/scope

For some customers, we should express our seasonal forecasts and verify them using this baseline!

- historical climatological temperature averages are no longer representative as baselines for planning
- need to know what the climatology is NOW – if we could measure it instantaneously – and for next ~10 years
- aim: develop predicted 30-year average temperatures climatologies centred on the current year and each of next 10 years
- provide at hourly and site-specific resolution...

e.g. the 30-year average temperature at 5am at Heathrow – now and in next 10 years

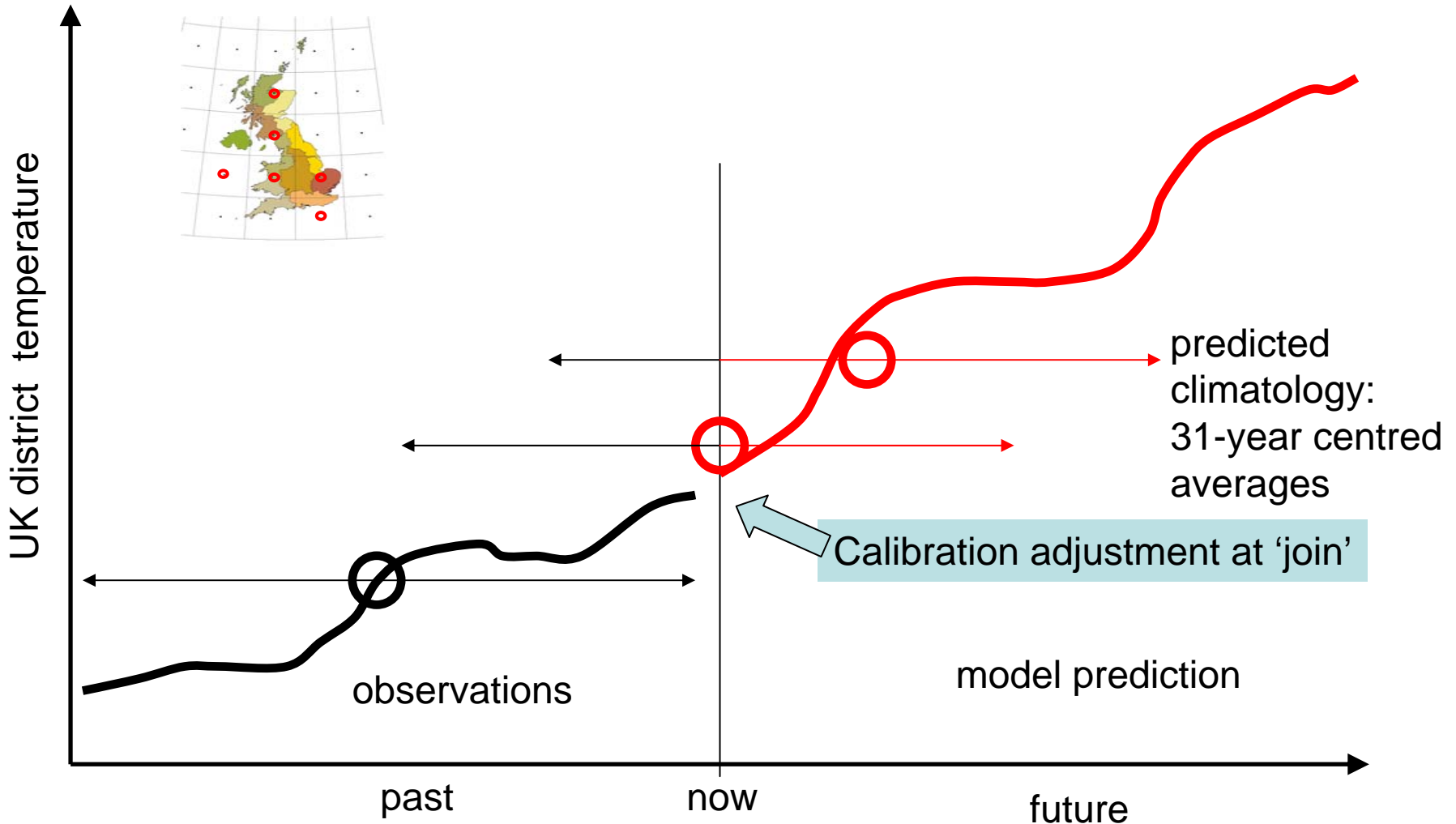


Content

- method used
- assessment of (part of) the method
- sample from final products delivered to the energy industry



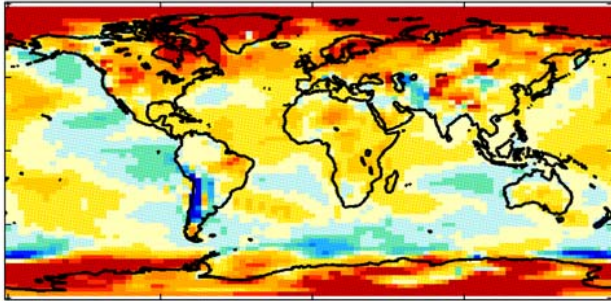
Step 1: UK district, monthly resolution: mix of observations and predictions



Choice of prediction model: DePreSys - initialised climate prediction

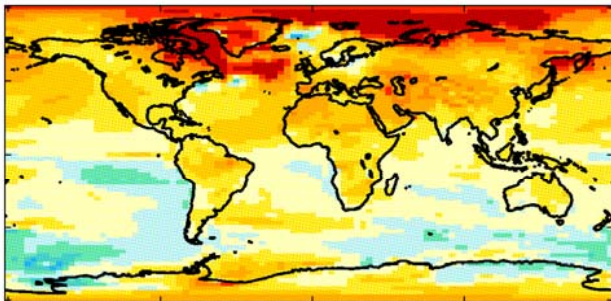
Smith et al., Science, 2007

Observed



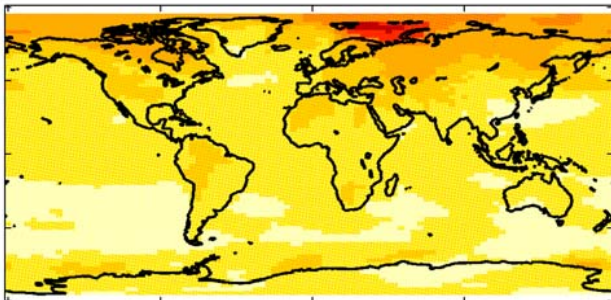
Observed surface temperature anomalies June 2005 to February 2008 (relative to 1979-2001 baseline)

Met Office decadal forecast

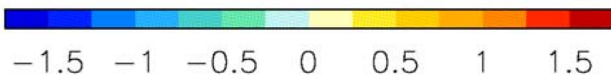


DePreSys:
Decadal system prediction, from June 2005:
includes greenhouse gases
AND influence of initial ocean-atmos. state
(data assimilation)

IPCC climate forecast

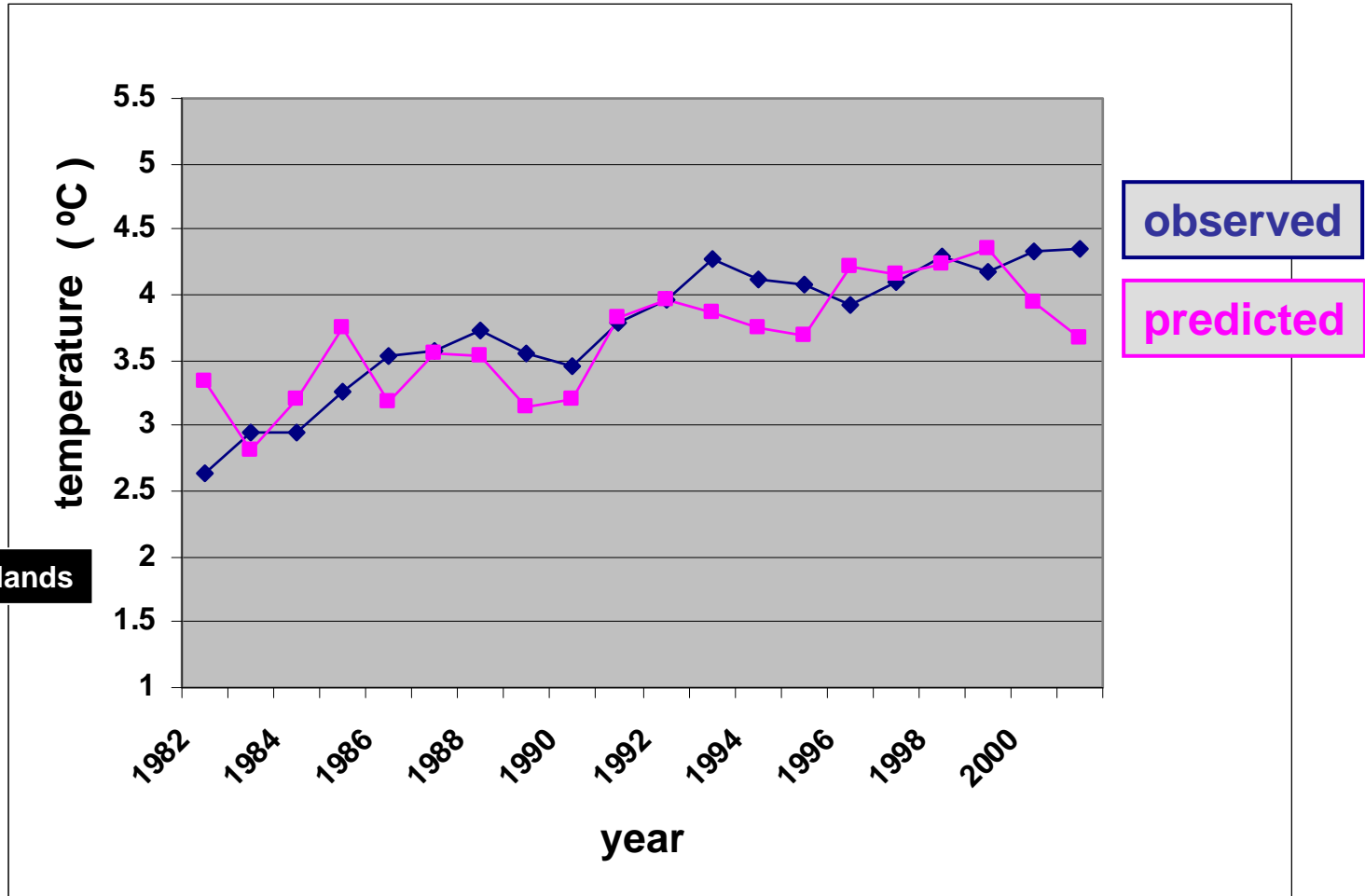
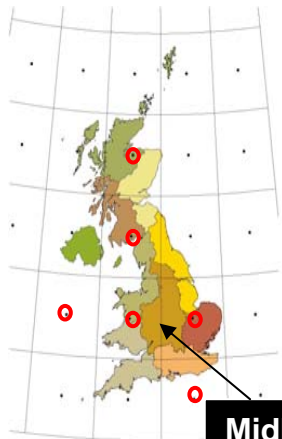


Equivalent prediction from IPCC AR4:
impact of greenhouse gases only



Evaluation on period 1982-2001

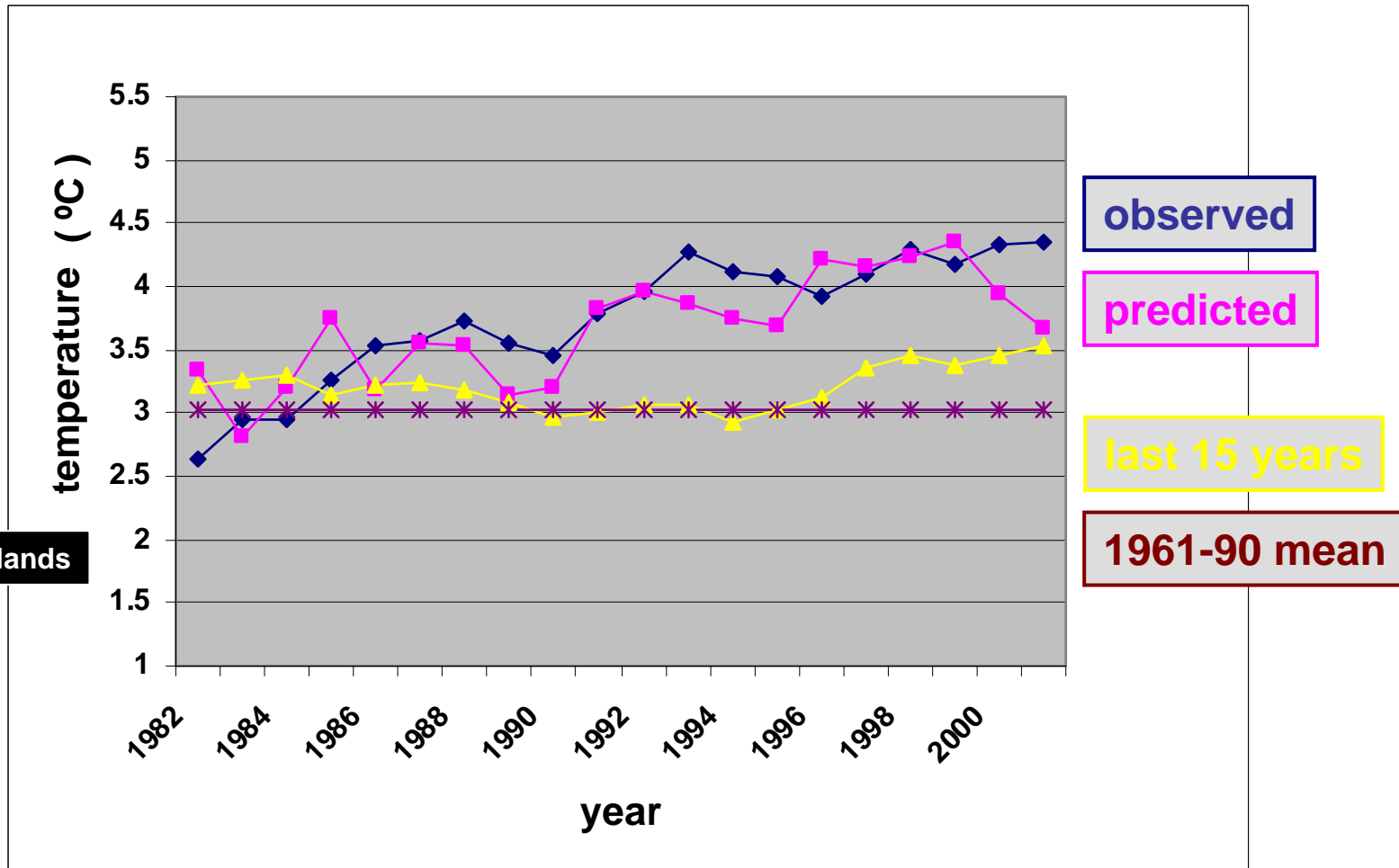
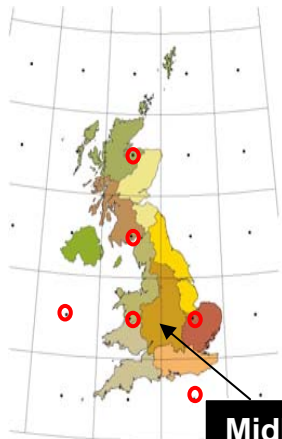
3-year ahead prediction of January climate: mean temperature, Midlands



evaluation is on 13-year centred averages (from 3 years of observations + 10 years of DePreSys forecasts)

Evaluation on period 1982-2001

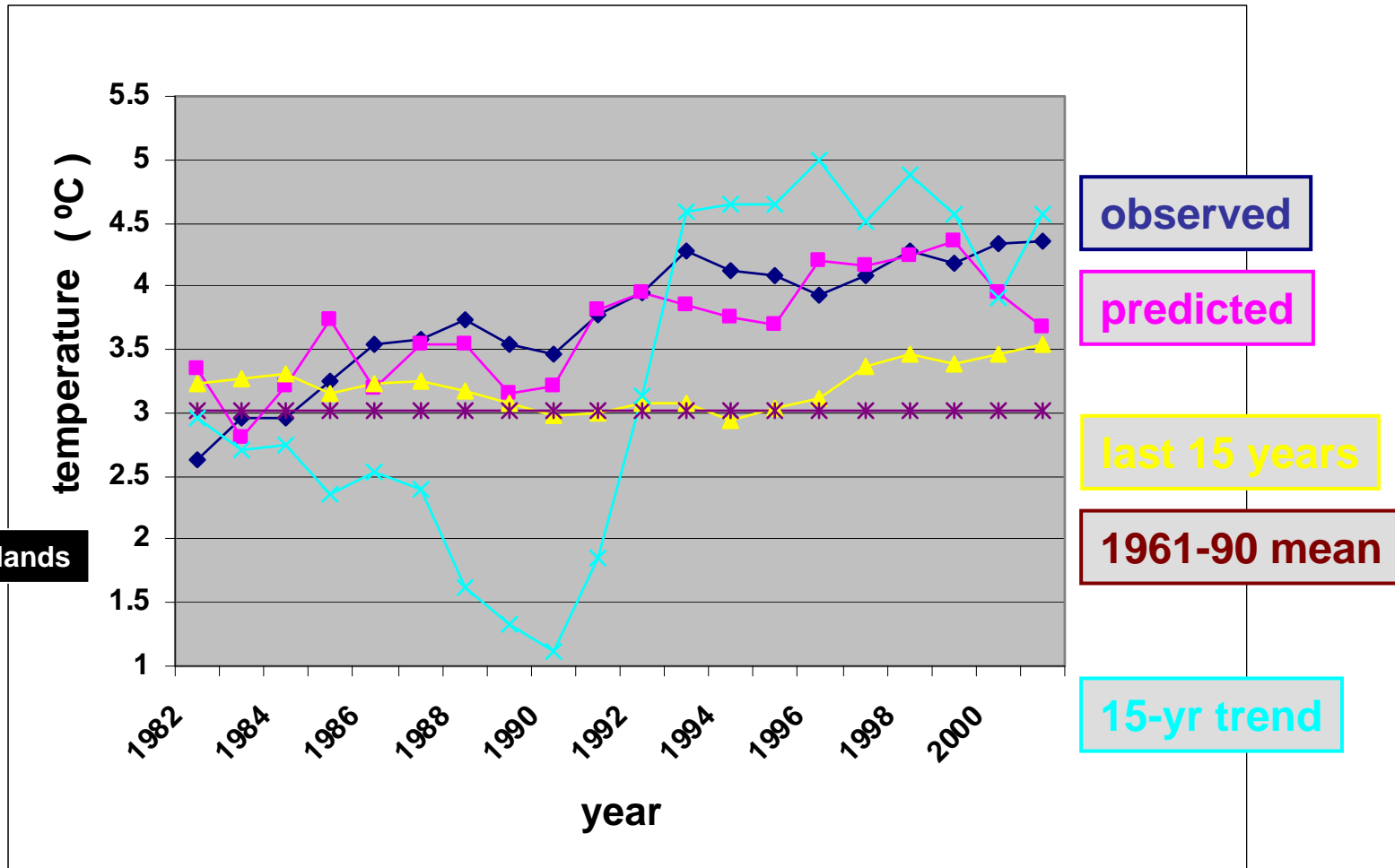
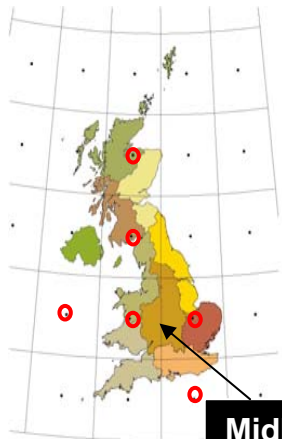
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3-year ahead prediction of January climate: mean temperature, Midlands



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Skill benefit (RMSSS) of 3-year-ahead predictions of UK district mean temperature climatology

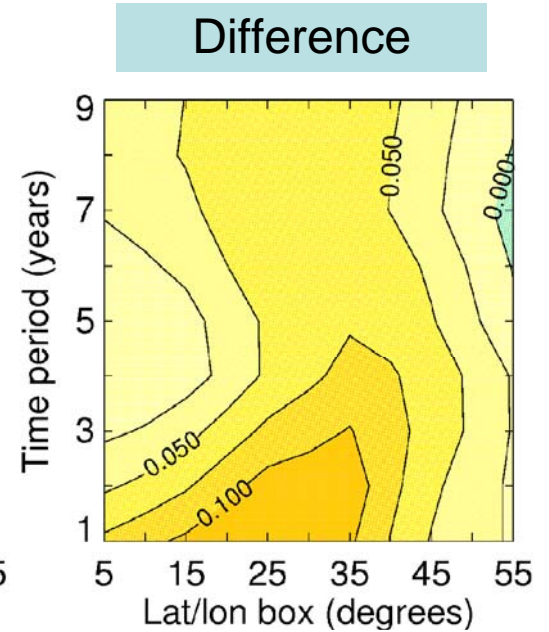
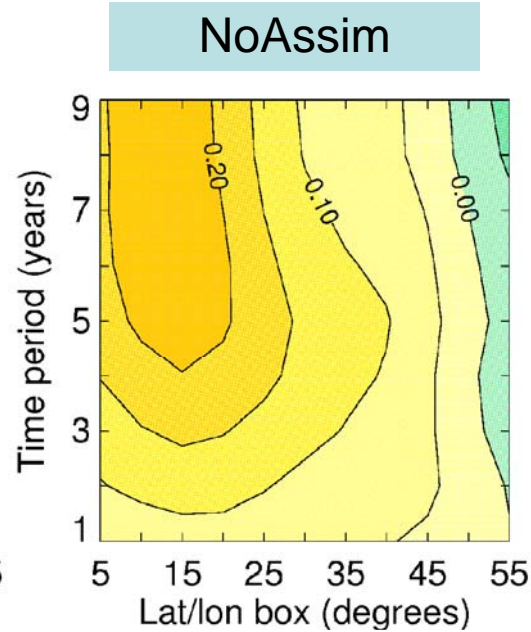
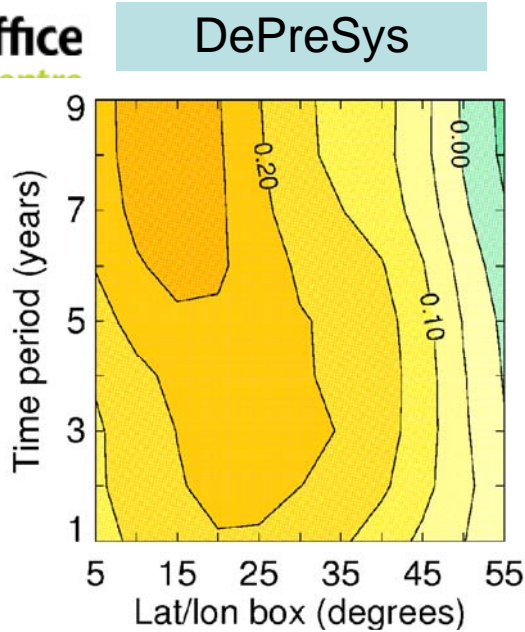
	RMSSS (%) for Tmean, relative to last 15-year mean (most competitive alternative)	
Range	using DePreSys	
Years 0-2	31.2	
Year 3	31.7	



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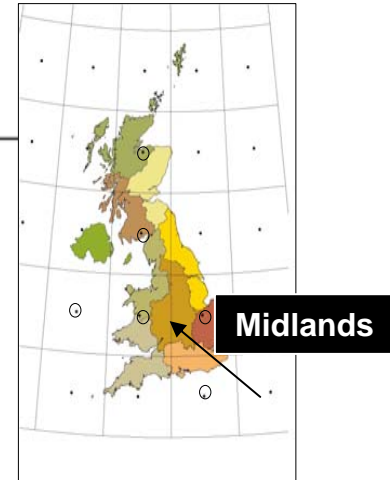
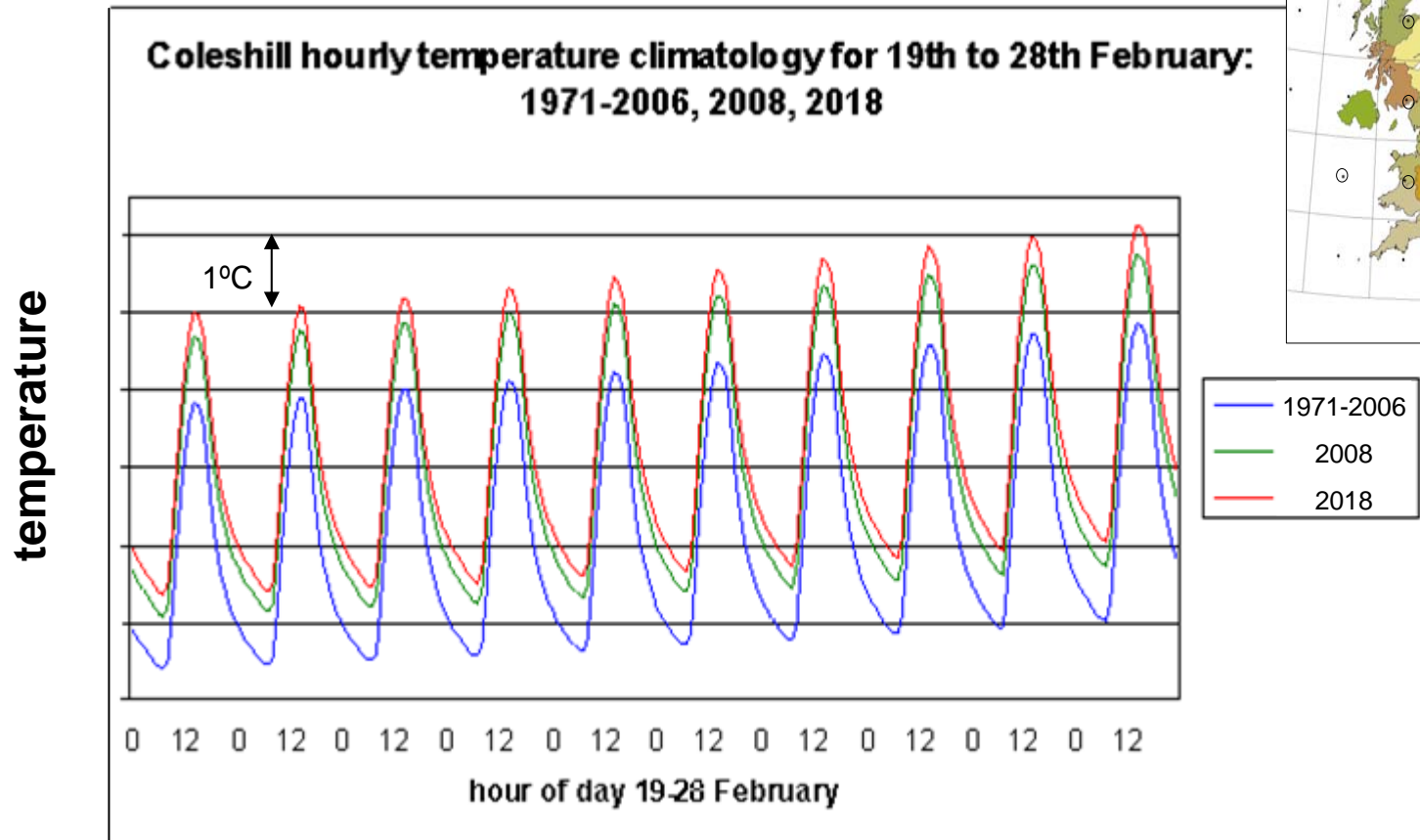
Surface temperature spatial correlation: land

1960-2005



Example final product: predicted hourly climatology for Coleshill

uses a real-time DePreSys forecast initialised March 2007



Summary

- Predicted site-specific, hourly temperature climatologies have been developed, making use of the DePreSys decadal prediction system
- Results update climatological averages to 'present day' and provide future projections
- 20-40% skill benefit found for predicted UK-district monthly temperature climatology, relative to example alternative methods
- Uncertainty estimates provided – from 10-member DePreSys ensemble
- DePreSys assimilation of initial state improves UK benefit for (at least) ~2 years ahead - relative to use of IPCC-type predictions
- Future work: extend the analysis to predicted changes in temperature variability (e.g. changes in the 1 in 20 cold winter day)



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Thank you! : Any questions?

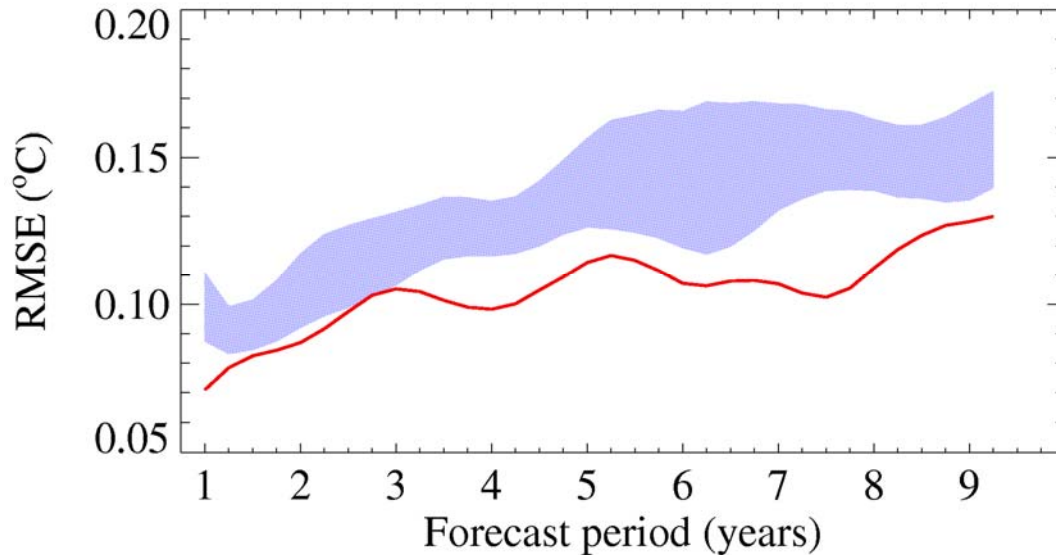
Step 1: method outline

- ensemble mean monthly average max and min temperature generated to 2033, from March 2007 initialisation
- weighted mean of 5 land-based UK gridpoints used to interpolate to UK climate districts (wider, northern European, arrays also tried)
- ‘splicing’ to observed district timeseries: DePreSys bias correction - using observed and predicted district values for 1992-2006.
- moving 31-year averages constructed for each month and UK district, centred 2008 to 2018 – expressed relative to 1971-2006
- predicted district max and min applied to adjust observed diurnal cycle at each of 21 sites



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Reduction in prediction error for global annual mean surface temperature: DePreSys



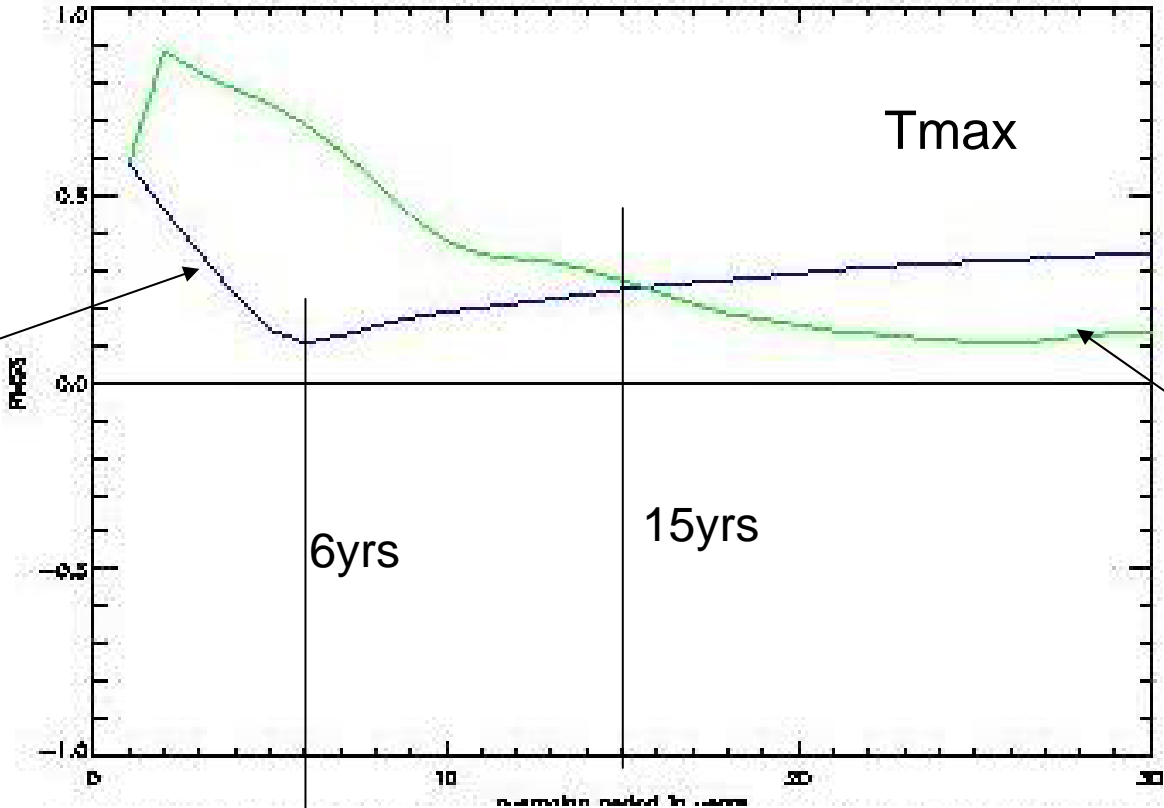
Global annual mean surface temperature (T_s)

- Improved performance is due to better representation of, e.g.
 - influences of El Niño/La Niña (first few years)
 - influences of other natural variations in ocean heat content
 - cooling effect of following major volcanic eruptions (dust decayed from beginning of forecasts)
 - based on hindcasts 1982-2001



DePreSys method beats conventional methods regardless of averaging period used

T2M POPP RMSS for 3-month binned smoothed hindcasts, all leads, all areas, all months
Climate hindcasts (blue) Trend regression hindcasts (green) 1982-2001



RMSSS score relative to last x years average

RMSSS score relative to extrapolation of trend over last x years

Years used for averaging window / trend extrapolation



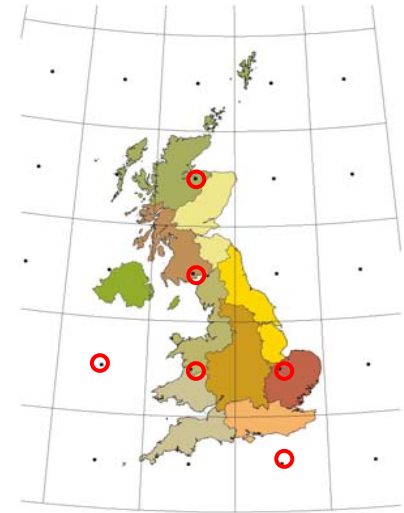
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Hourly, site specific climatologies are required: two-stage approach used

This talk

1. UK district and monthly scale:

use a climate model to predict changes in UK district, monthly climatology (relative to 1971-2006), out to 2018



Not covered in this talk

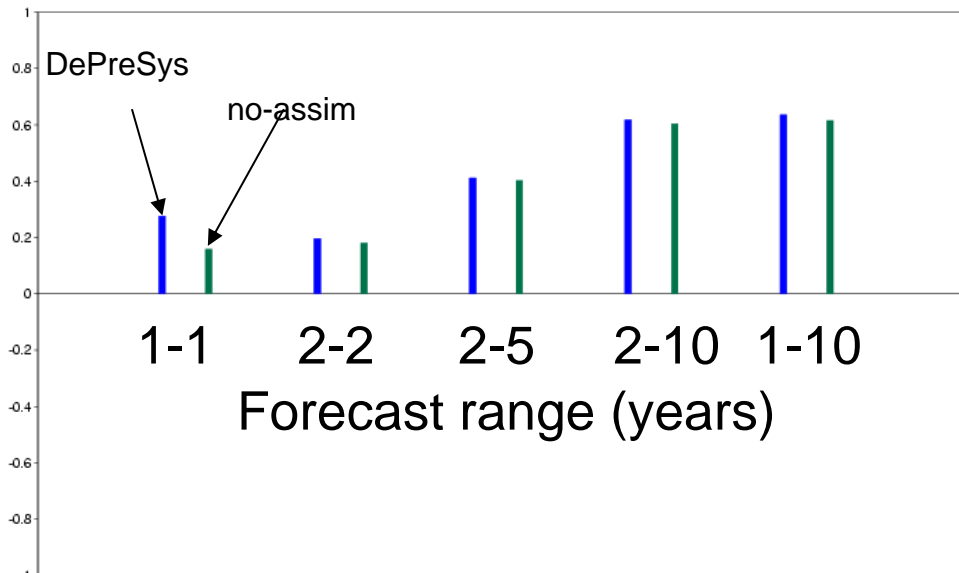
2. Site-specific and hourly scale:

apply the predicted increments for each district to adjust the observed hourly climatology (1971-2006) of sites in the district

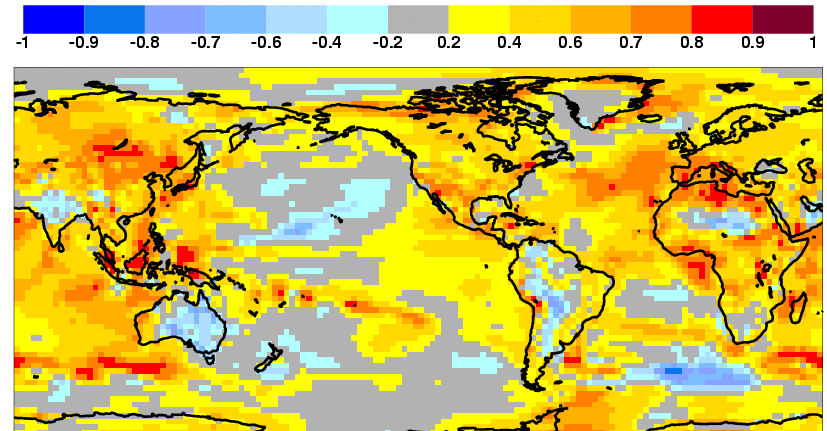


Consistency with results from ENSEMBLES analysis (1963-2005)

ACC NH near-surface temperature



Years 2-5: DePreSys



Years 2-5: no-assim

