# A Scientific Challenge for Copernicus Climate Change Services: EUCPXX

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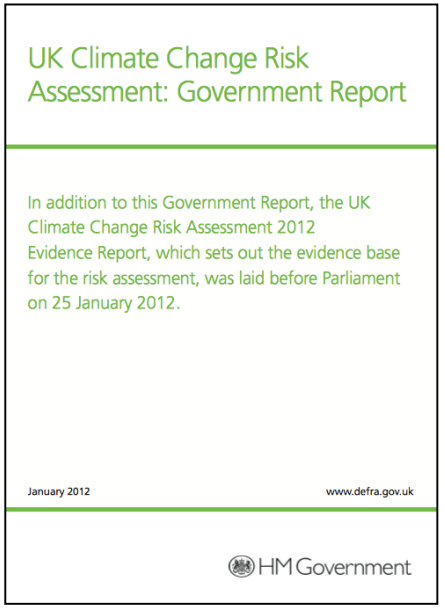
# Aspects of my worldline

1. EU Framework Programme

   PROVOST, DEMETER ➔EUROSIP

2. Committee on Climate Change Adaptation Sub-Committee (ASC)➔ DEFRA Climate Change Risk Assessment



There is a statutory requirement in the 2008 UK Climate-Change Act for the Government to produce 5-yearly Climate-Change Risk Assessments

These CCRAs provide the basis for the Government's recommendations on how the UK should adapt to future climate change. E.g. the 2012 CCRA report is based around five key themes:

Natural Environment
Buildings and Infrastructure
Health and Wellbeing
Business and Services
Agriculture and Forestry

The 2012 CCRA fed into the 2013 National Adaptation Programme.

Increasingly such CCRAs will be needed by all European Member States

They will also play an important role for mitigation, in showing whether the impacts associated with some emissions pathways are so costly to adapt to, it would be significantly cheaper to mitigate!

The First CCRA (2012) was based on probabilistic output from UKCP09 (Hadcm3 – perturbed parameters + statistical emulators), converted into user-relevant variables using application specific utility functions (HR Wallingford).

The Second CCRA (2017) will also be largely based on UKCP09. The Met Office is currently in negotiation with DEFRA to produce a new UKCP (UKCP17?) for the third CCRA (2022)

Scientifically, it makes no sense for such CCRAs to be based on just one model, especially as Europe has a strong modelling capability (ICON, EC-Earth, Arpège, HadGEM….)

Following on from earlier and existing coordinated climate modelling studies (PROVOST, DEMETER, ENSEMBLES, SPECS….), we need a more coordinated European approach to aid climate adaptation decisions: UKCP09➔EUCPXX:

Need for global high res, initialised multi-decadal ensemble integrations (certainly to 2050).

Why high res?

1.Better definition of weather extremes
2.Better definition of large-scale weather regimes

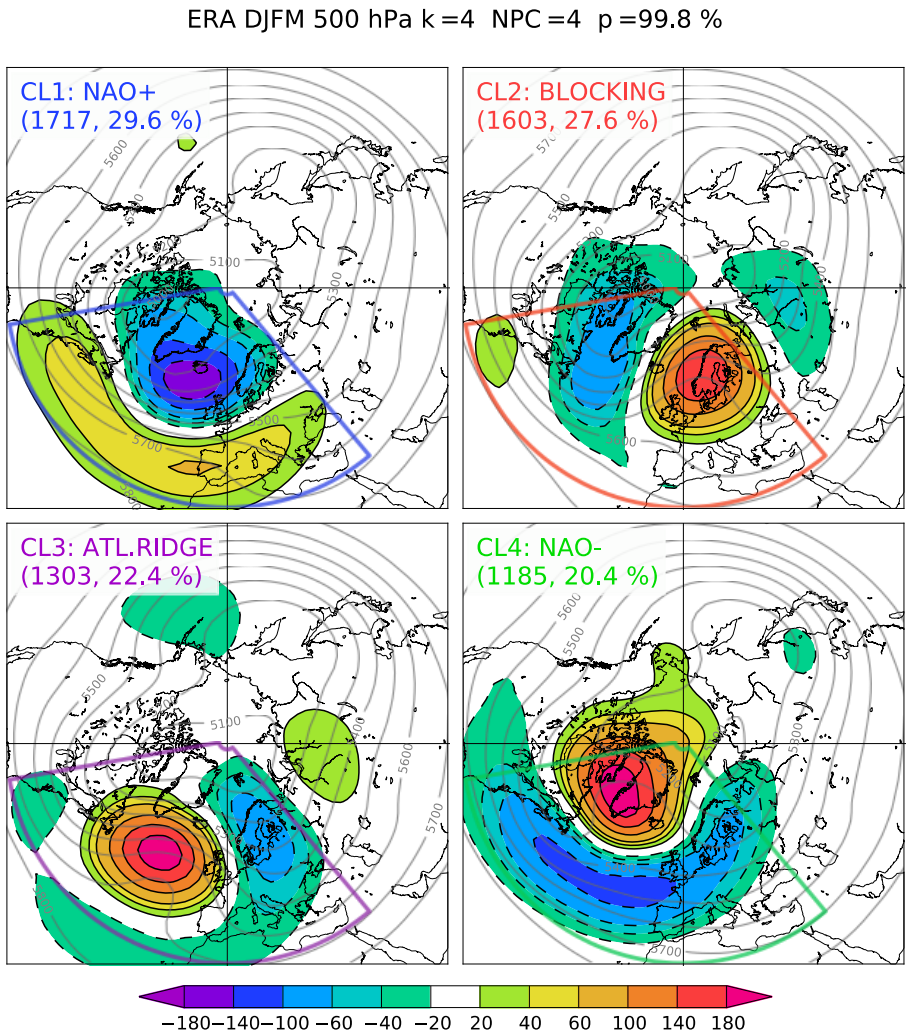
Why initialised?

1.There may be some useful predictability for the first couple of decades
2.Avoids costly ocean spin up

How can users be confident such MMEs produce reliable predictions?

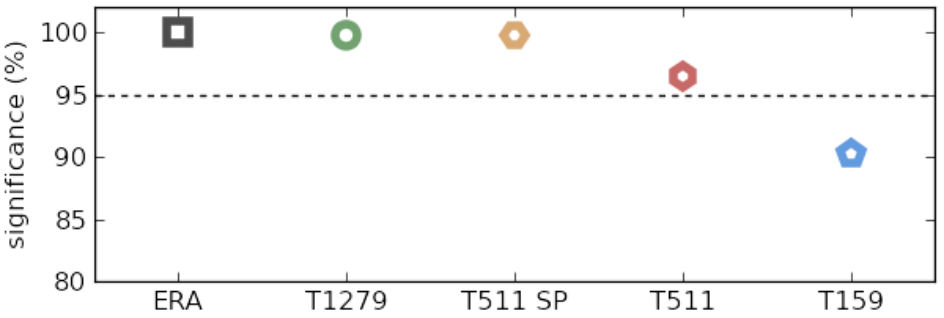
1. Blend seamlessly into seasonal to interannual prediction technology (i.e. Eurosip)

# Athena: AMIP runs

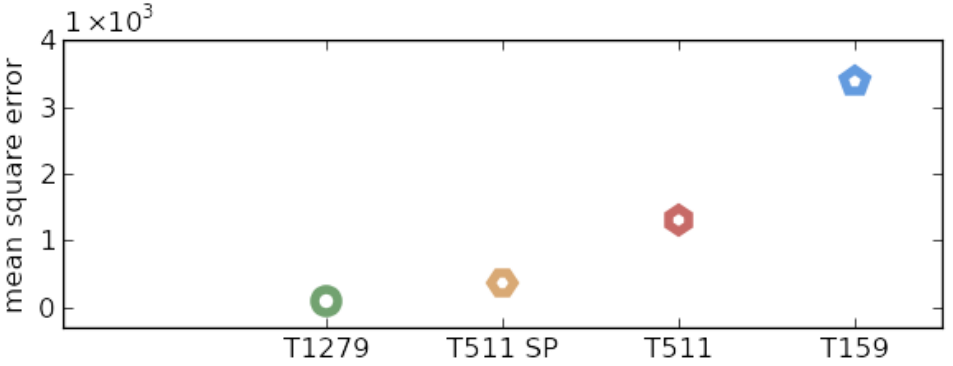



Dawson et al, GRL 2012

Dawson et al, Clim Dynamics, 2014




Probability that clusters are not produced from a chance sampling of a gaussian




RMS error of simulated clusters against ERA

Following on from earlier and existing coordinated climate modelling studies (PROVOST, DEMETER, ENSEMBLES, SPECS….), we need a seamless coordinated European approach to this problem: UKCPxx➔EUCPxx:

Need for global high res, initialised multi-decadal ensemble integrations (e.g. 50 years from 2020 to 2070).

Why high res?

1.Better definition of weather extremes
2.Better definition of weather regimes

Why initialised?

1.There may be some useful predictability for the first few decades
2.Avoids costly ocean spin up

How can users be confident such MMEs produce reliable predictions?

1. Blend seamlessly into seasonal to interannual prediction MMEs (i.e. Eurosip)

# Reliability categories (example)

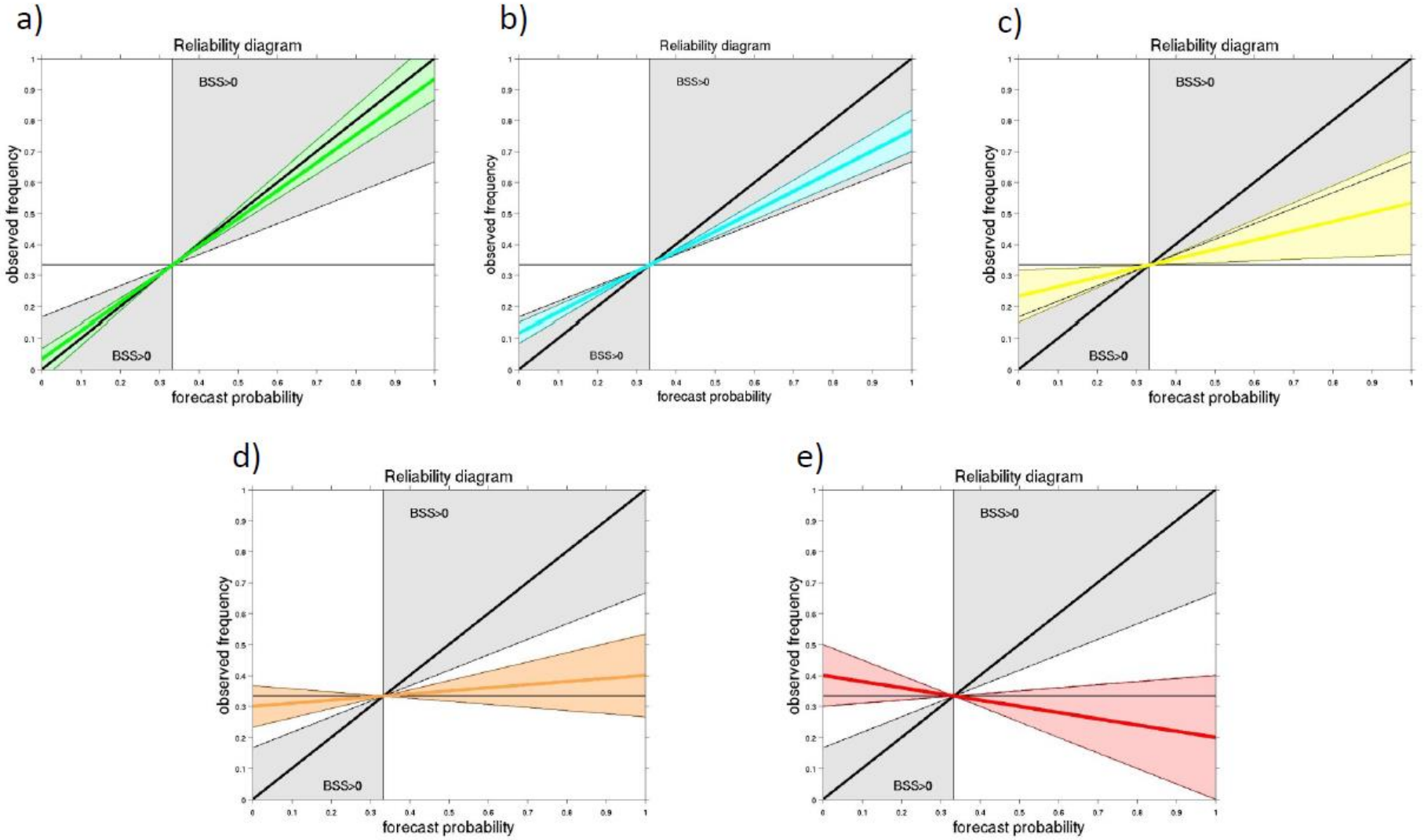



**Figure 2:** Five categories of reliability: a) perfect, b) after calibration still very useful for decision making, c) marginally useful after calibration, d) not useful, and e) dangerously useless.

Weishermer and Palmer (2014)

**Reliability of System 4 seasonal forecasts for precipitation**

(*a*) Dry DJF, (*b*) wet DJF, (*c*) dry JJA and (*d*) wet JJA.

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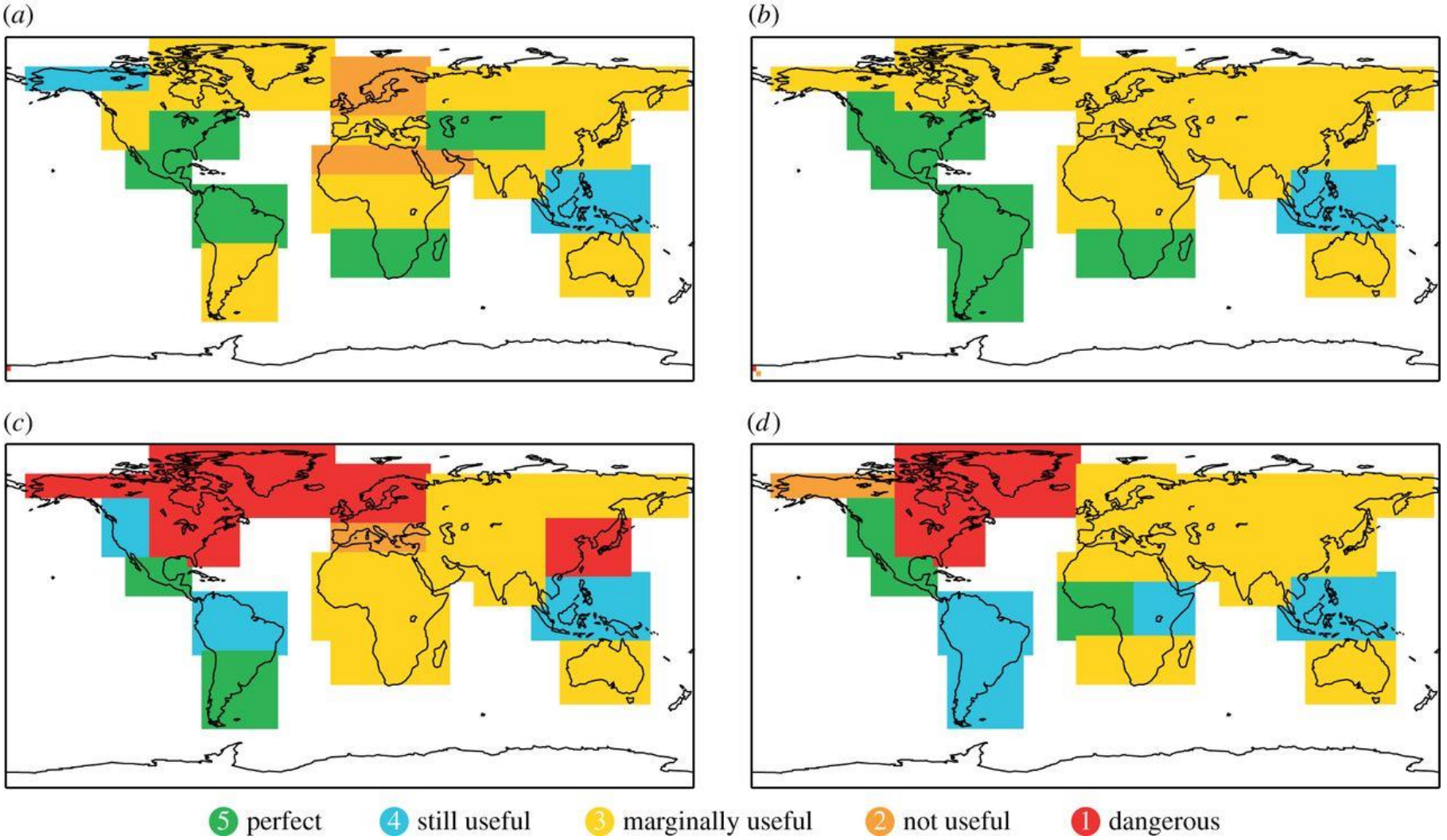
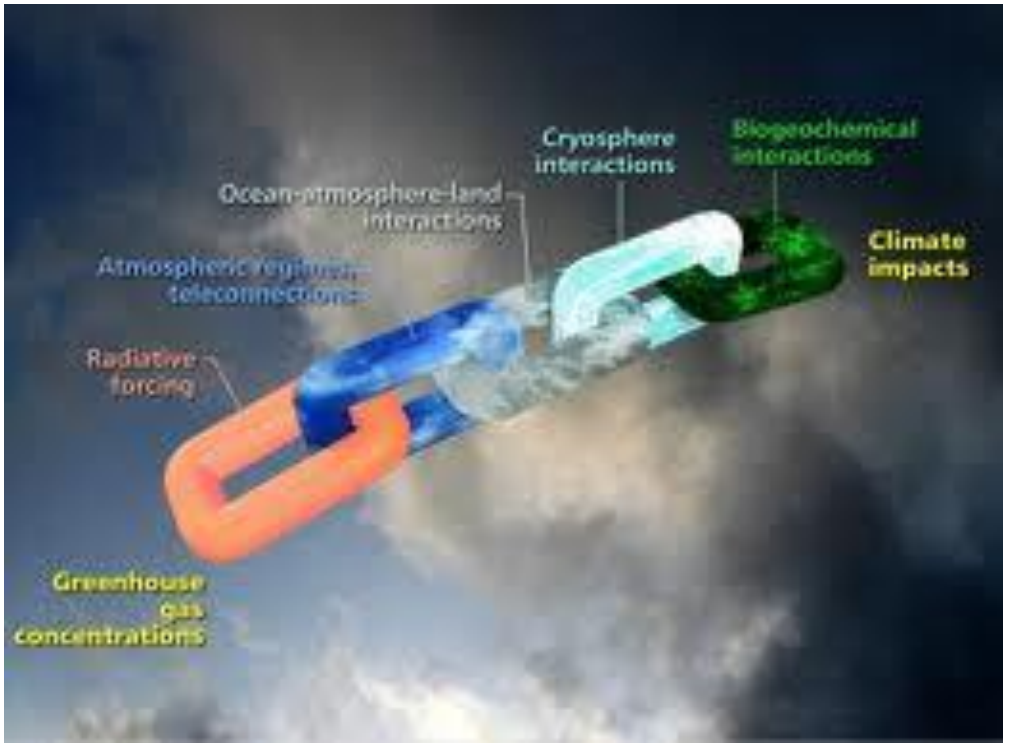



**A. Weisheimer, and T. N. Palmer J. R. Soc. Interface 2014;11:20131162**

JOURNAL OF THE ROYAL SOCIETY Interface




T. N. Palmer, F. J. Doblas-Reyes, A. Weisheimer, and M. J. Rodwell, 2008: Toward Seamless Prediction: Calibration of Climate Change Projections Using Seasonal Forecasts. *Bull. Amer. Meteor. Soc.*, **89**, 459–470.

# **Calibrating** multi-decadal **climate predictions with estimates of seasonal forecast reliability**

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3: European Centre for Medium-Range Weather Forecasts, UK



# Experimental design

**Model:**

MRI-AGCM3.2 (Mizuta et al. 2012, JMSJ)

**Model resolutions:**

TL959L64 (20km, NWP model resolution) "Truth"
TL95L64 (180km, climate model resolution)

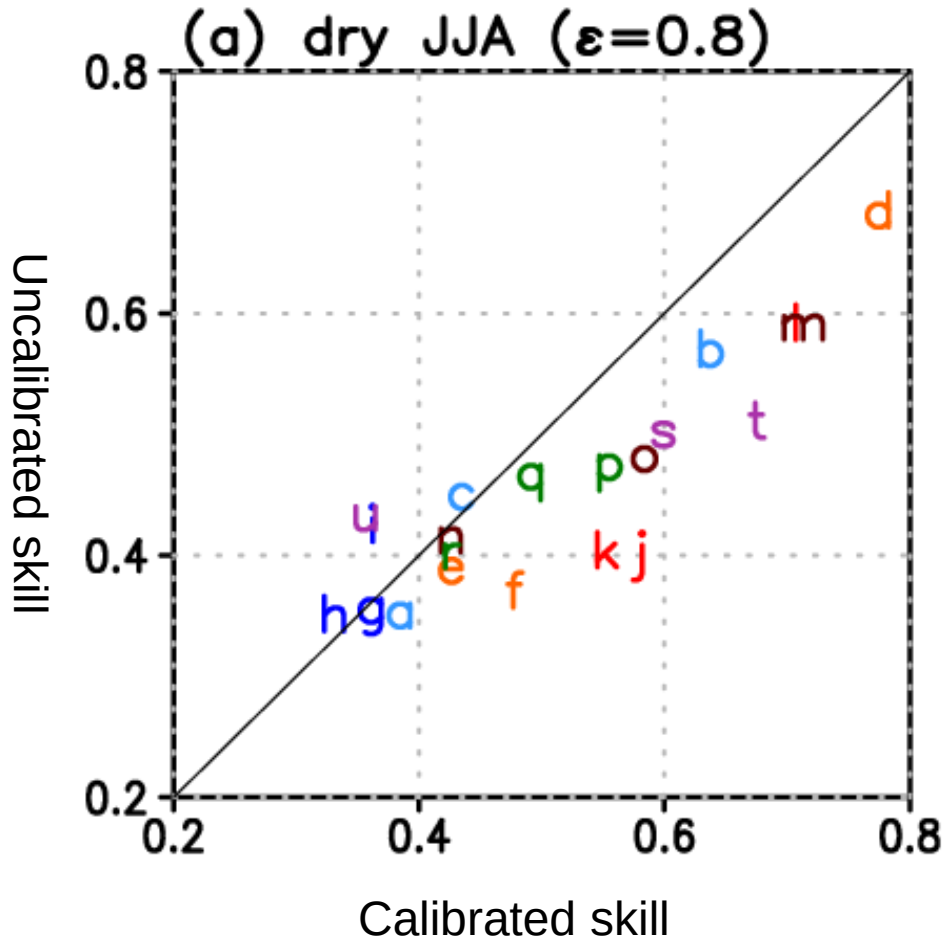
**Simulations:**

1. 20C simulation by the TL959 and TL95 models
   (observed SST and sea ice, 1979–2003)
2. 21C time-slice projections by the TL959 and TL95 models
   (A1B scenario, CMIP3 mean SST and sea ice, 2075–2100)
3. 21-member 4-month seasonal retrospective predictions by the TL95 model
   (observed SST and sea ice, initialised with Japanese reanalysis on around 1st May and 1st November in 1979–2003 for DJF and JJA, respectively)

Note: There are large differences of surface variables (e.g. snow) between reanalysis and TL959's 20C. Ideally, the seasonal prediction should be initialised on the TL959 world.

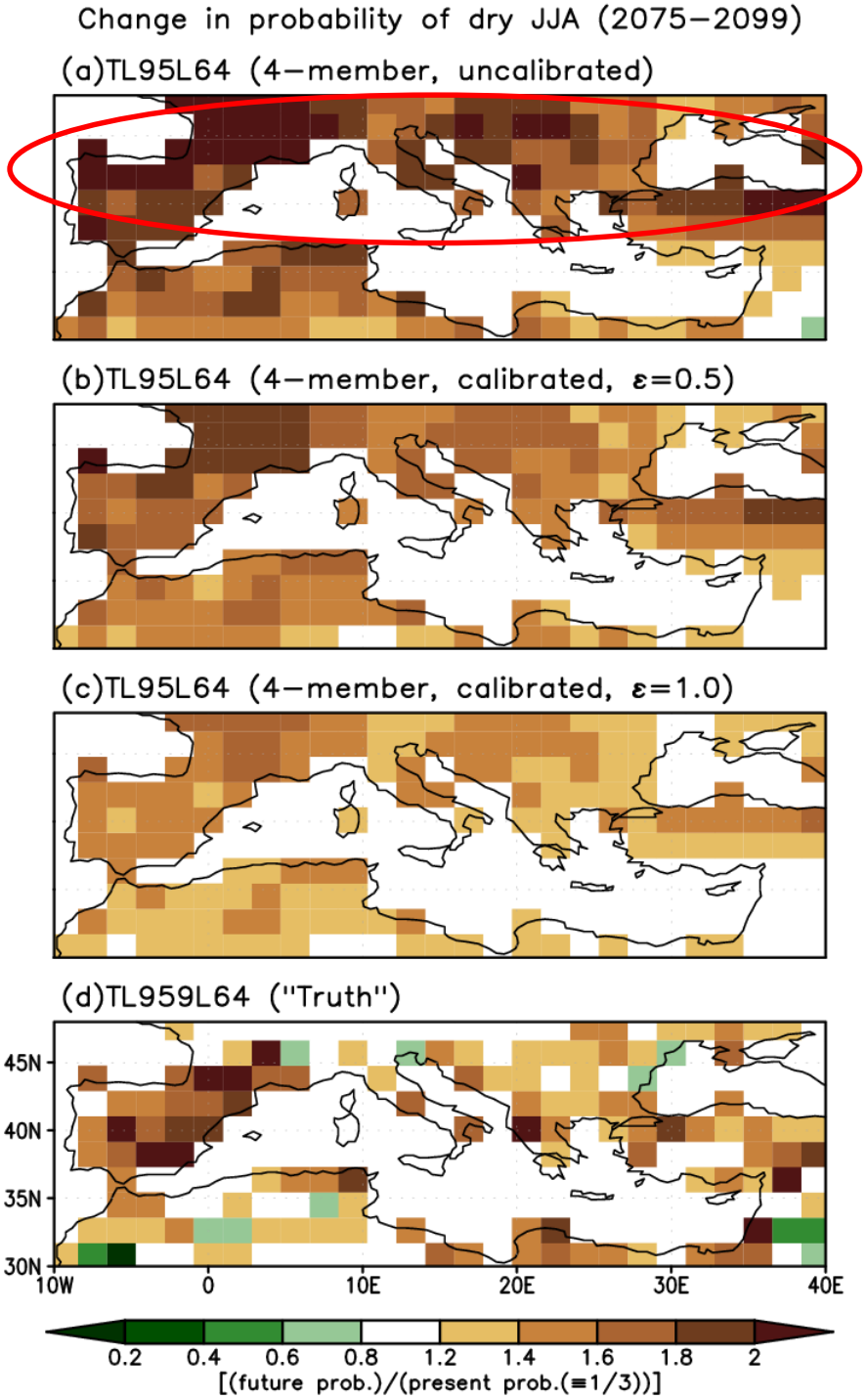
The TL95 seasonal predictions have been verified against TL959's 20C ("Truth").

Using a high res integration as “truth”, low res model climate change precip projections are more reliable if calibrated using seasonal forecasts made with the low-res model.



# Example of calibration

Probability of dry summer in 21C are defined based on the lower tercile of the corresponding 20C distribution.



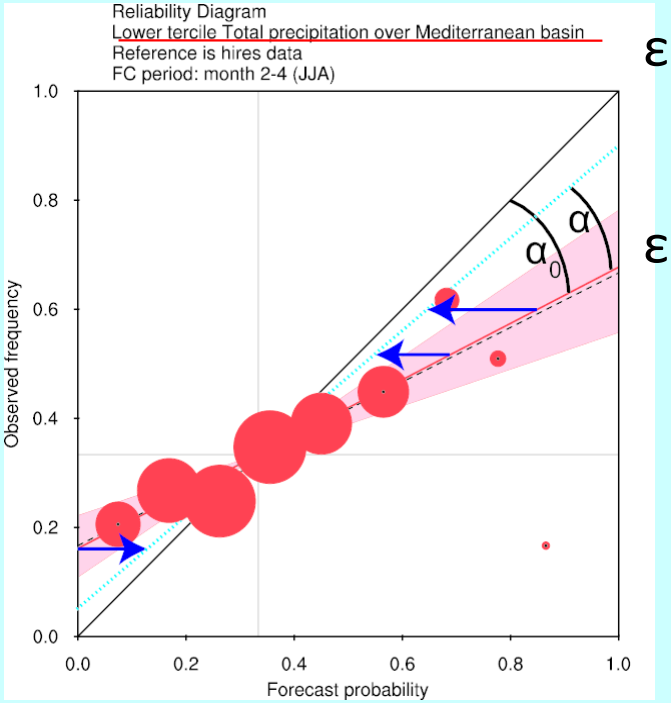

TL95L64
(no calibration)
ε=0

TL95L64
(full calibration)
ε=1

TL959L64
("Truth")

The strong drying signals over the Mediterranean region become weak by calibration.

## Calibration method

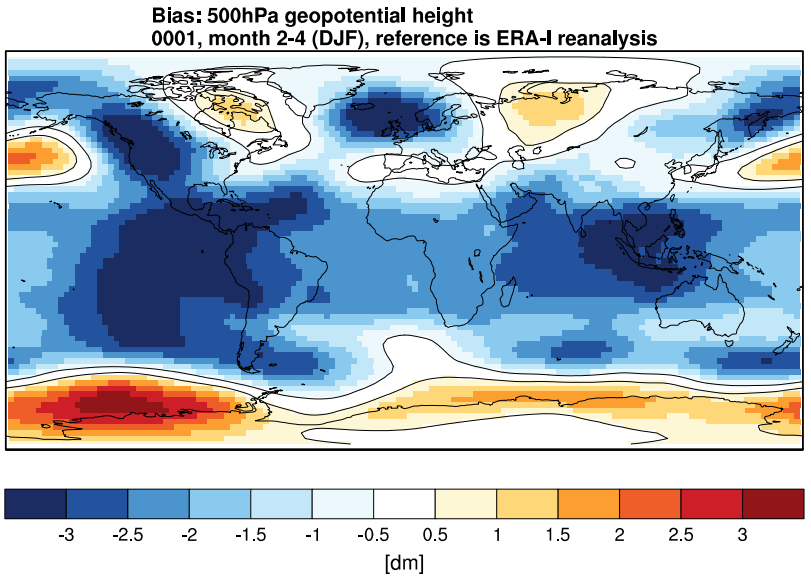


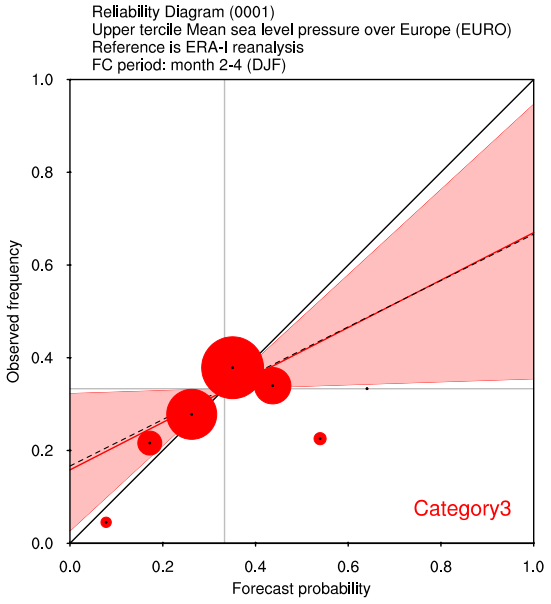

Reg. line: $P_{obs} = a\, P_{fcst} + b$

$P_{calib} = (1-\varepsilon\alpha)P_{raw} + \varepsilon\alpha/3$

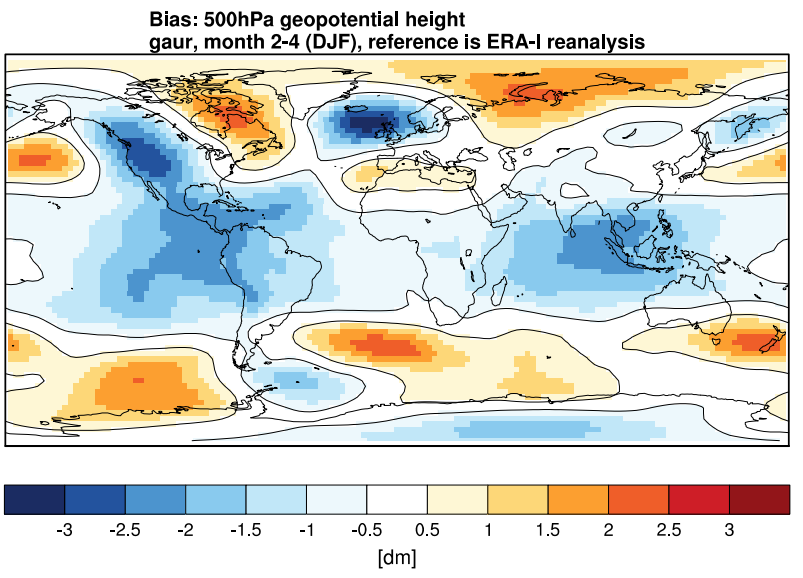
(here, $\alpha=1-a$)

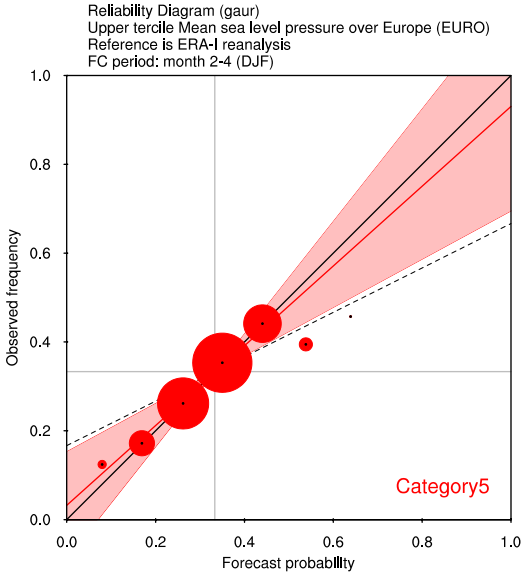
# ECMWF Sys 4




# ECMWF 41r1




Nathalie Schiller, Antje Weisheimer

# Conclusions

We should be developing a coordinated EUCPXX to meet the needs of the users of CCCS, especially for climate adaptation decisions

We should develop EUCPXX as a seamless extension of EUROSIP. Why?

1. Where seasonal forecasts are not reliable, EUCPXX forecasts may not be reliable. Users may have the option of waiting (eg 5 years) until more reliable forecast systems have been developed.

2. Users of CCCS can benefit from improvements made to seasonal forecast systems.

EUROSIP ➔ EUCPXX. Research or operations? I would argue mostly the latter. Copernicus can fund much of this transitional work. Further research developments can be funded by Horizon2020.