



Lessons learnt from seasonal forecasting...

...for the construction of long-range multi-model climate projections

11 June 2010

Forecast Product Users Meeting
ECMWF, Reading, UK

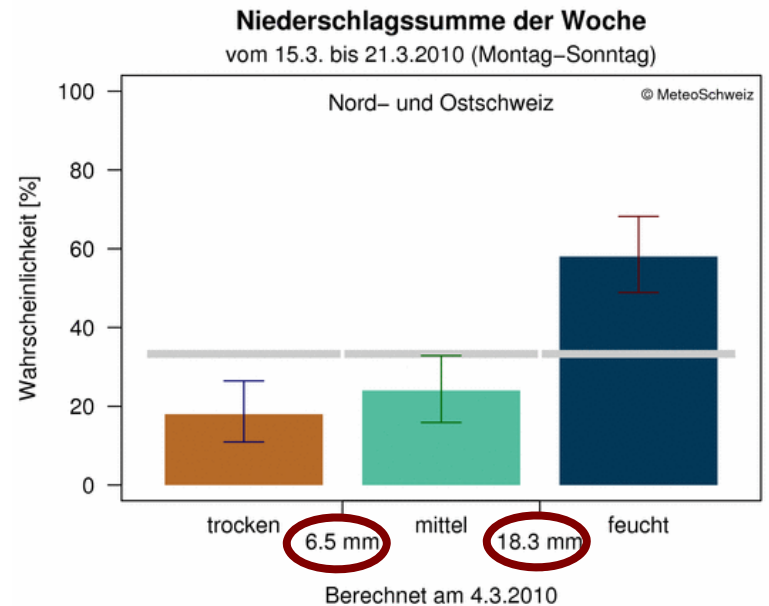
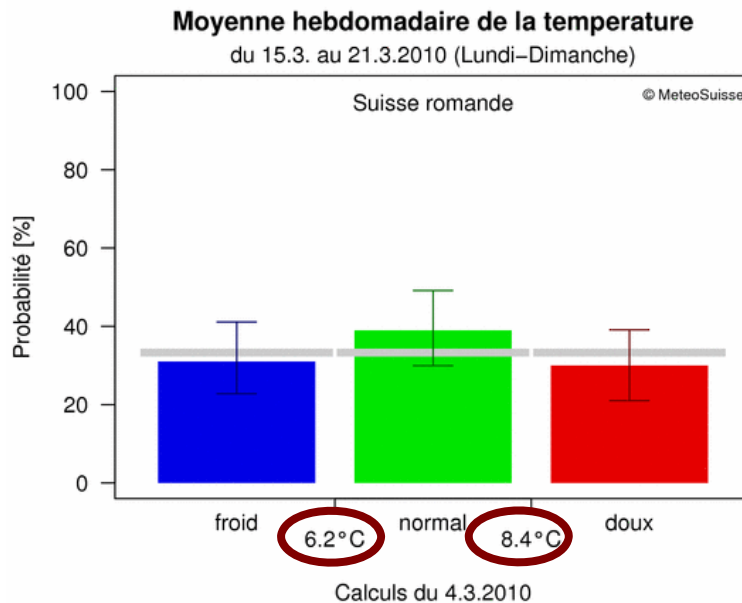
Andreas Weigel,
Reto Knutti (ETH), Mark Liniger, Christof Appenzeller





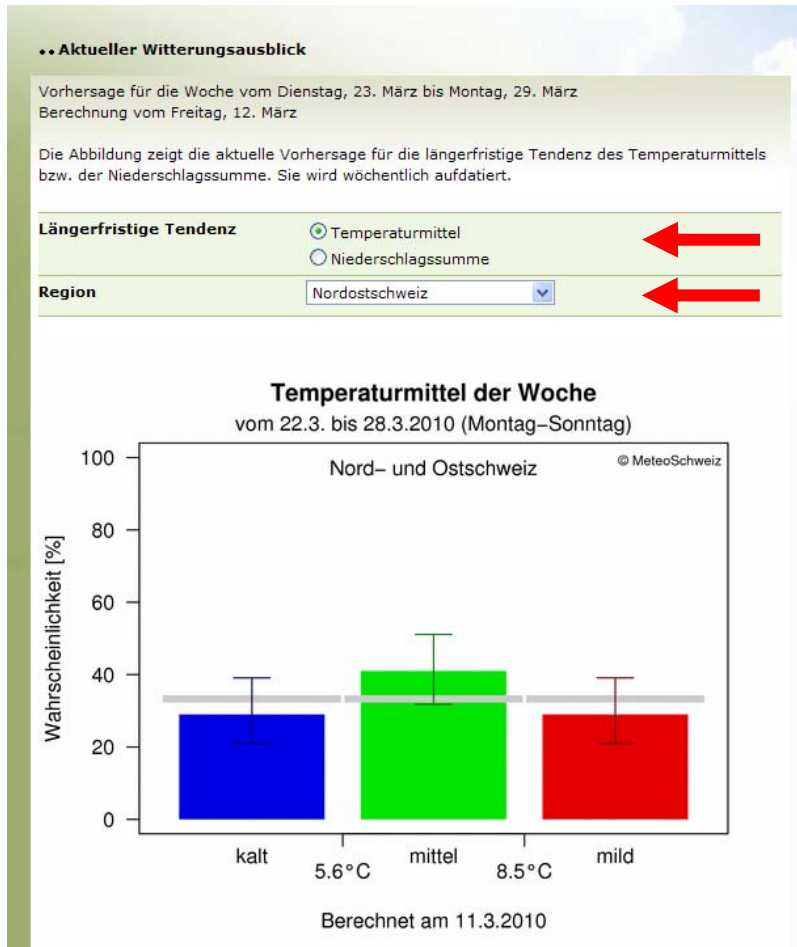
Forecasts of week 2 for the public

- Presentation similar to seasonal forecasts
- Terciles from station data





Forecasts of week 2 for the public



Wie sind diese Abbildungen zu verstehen?

In der Temperaturvorhersage bezeichnet die Höhe der farbigen Säulen die Wahrscheinlichkeit, dass die Temperatur in der Woche eher warm oder eher kalt als normal (normal) ist.

How should this diagram be interpreted?

Klimatologisch ist jede der drei Kategorien gleich wahrscheinlich (angedeutet durch die grauen Querbalken). Was man sich für die jeweilige Region und Jahreszeit konkret unter diesen drei Kategorien vorstellen muss, ist durch die Zahlenwerte auf der unteren Bildachse gegeben. Beim "Nord- und Ostschweizer Mittelland" beziehen sich die Zahlenwerte auf das Mittel der Stationen Basel, Bern und Zürich; bei "Suisse romande" beziehen sie sich auf die Station Genf, und bei "Sud delle Alpi" auf die Station Lugano.

→ Anleitung zur Interpretation dieser Art von Darstellung

→ Informationen zum technischen Hintergrund von Langfristprognosen

Wie unsicher sind diese Prognosen?

Vorhersagen, welche über ein paar Tage hinausgehen, sind naturgemäss mit einer hohen Unsicherheit behaftet.

What's the uncertainty of these forecasts?

Wettervorhersagen sind in der Regel für die nächsten Tage sehr genau. Durch eintrübendes Wetter würde man 50% erzielen. Wir empfehlen deshalb, diese Vorhersagen mit der entsprechenden Vorsicht zu verwenden.

Da die Vorhersage nur einmal pro Woche aufdatiert wird, verliert sie mit dem Näherrücken der vorhergesagten Woche an Wert. Die direkte Wettervorhersage bietet dann eine viel höhere Genauigkeit und Qualität.

Kann der Witterungsausblick auch weiter in die Zukunft und für andere Regionen berechnet werden?

Ja. MeteoSchweiz berechnet die Tendenz von wöchentlichen Mitteltemperaturen und Niederschlagssummen für bis zu vier Wochen in die Zukunft und dies weltweit. Natürlich nimmt die Vorhersagequalität mit zunehmender Distanz ab. Für die Schweiz ist die Vorhersagequalität in der Regel für die nächsten Wochen zu erzielbar.

Für weiter gehende Auskünfte kontaktieren Sie bitte MeteoSchweiz.

Can forecasts of this kind also be obtained for other regions and lead-times?



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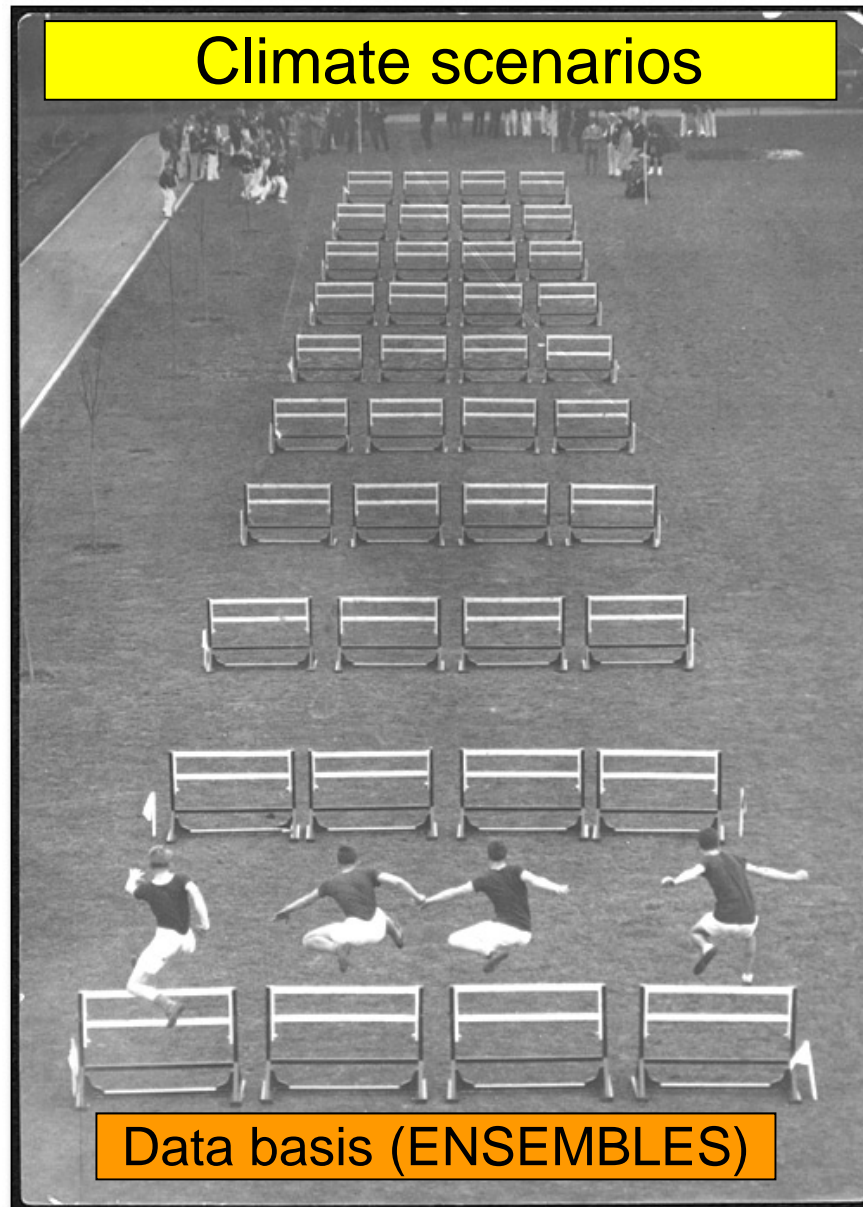
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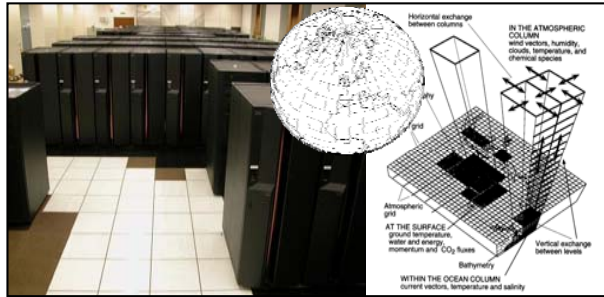
Climate scenarios



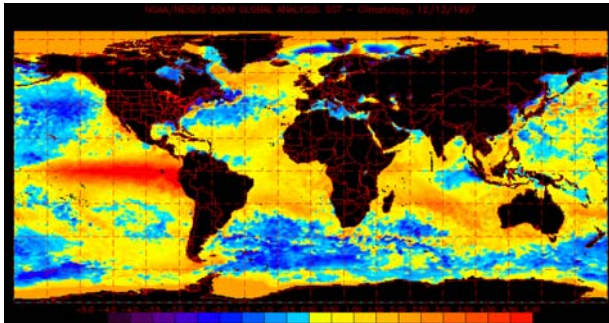
Data basis (ENSEMBLES)



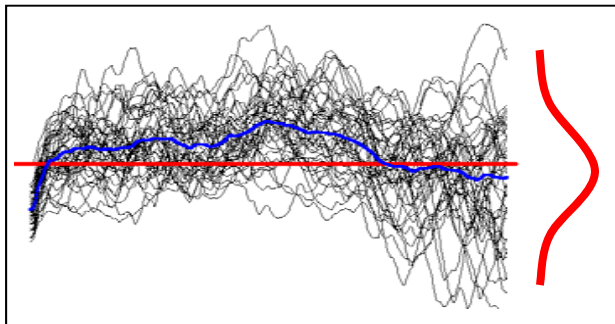
What can we learn from seasonal forecasts?



Technical similarities
(e.g. GCMs)



Processes
(e.g. El Niño)



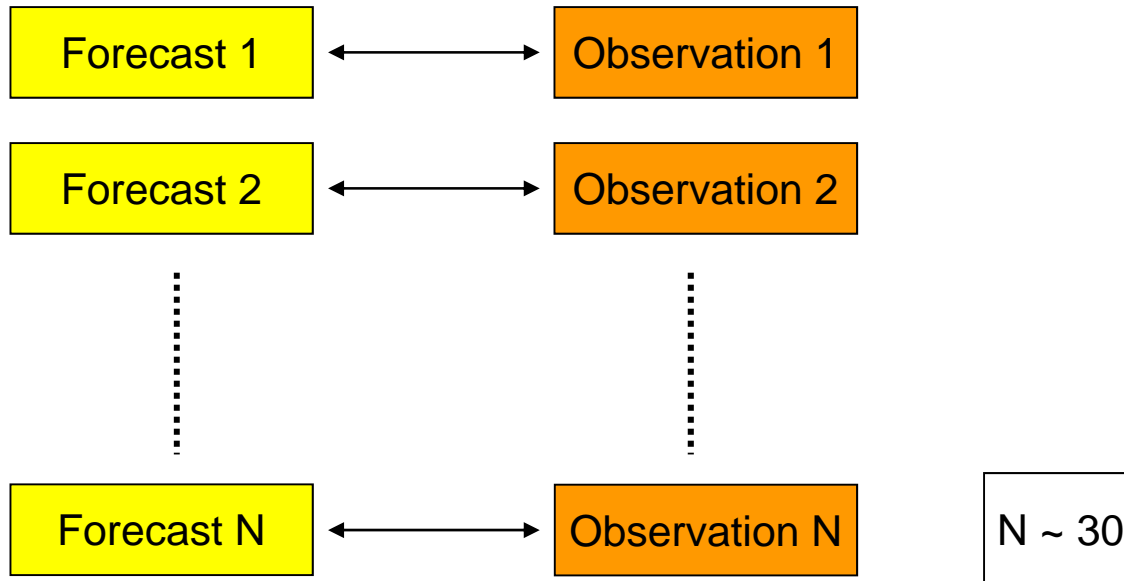
Conceptual analogies

- Boundary forcing
- Inherently probabilistic
- Ensembles
- Multi-models

Interpretation
Construction
Consequences



The big difference: Verification



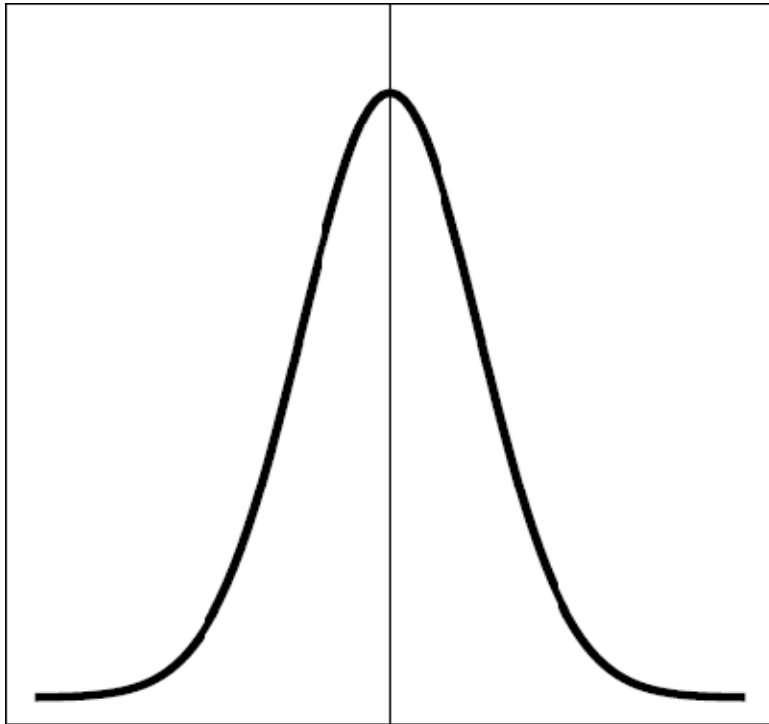
- Can literally sample projection uncertainty
- Can quantify model confidence objectively
- Can rank models according to their skill
- Can explore optimum ways of model-combination



The “mechanics” of multi-model combination in seasonal forecasting



A conceptual view

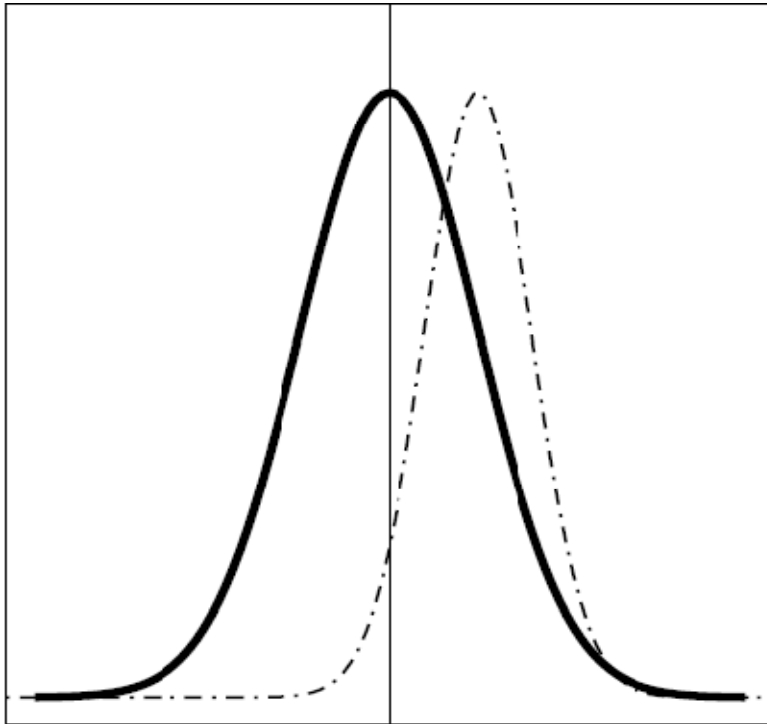


Climatology of observations

Weigel et al, 2009, Mon. Wea. Rev.



A conceptual view



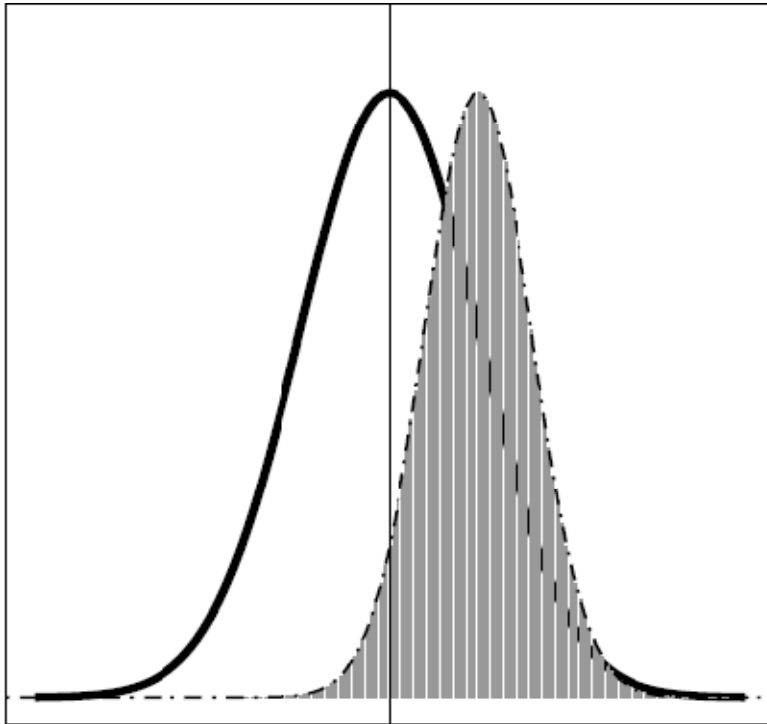
Boundary forcing
(e.g. anomaly in SST)

=> Prescribed forcing
constrains distribution
of possible outcomes

Weigel et al, 2009, Mon. Wea. Rev.



A conceptual view

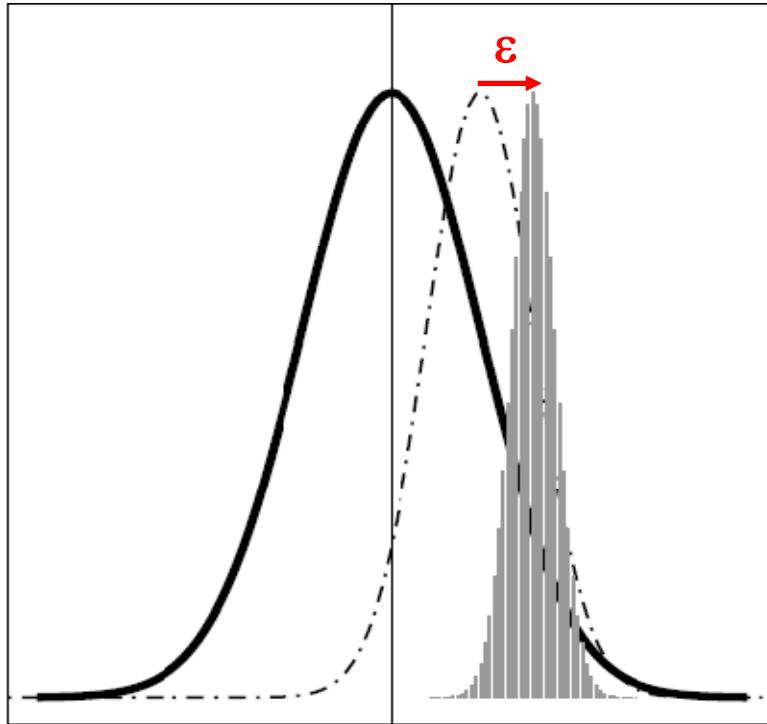


A **reliable** ensemble forecast correctly samples the distribution of possible values.

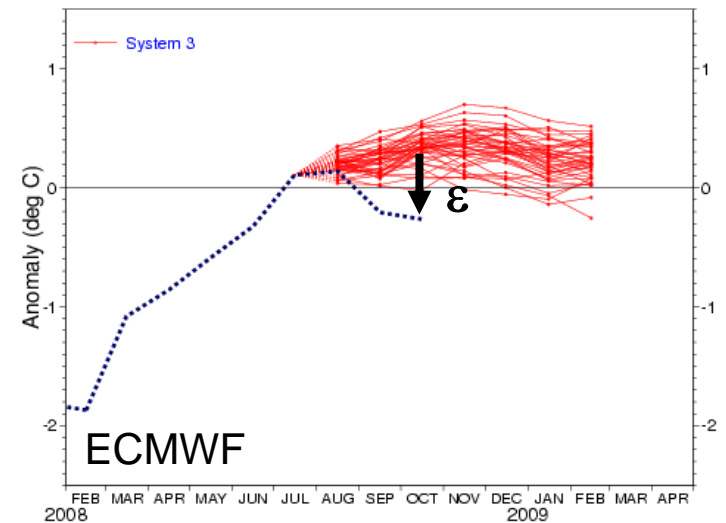
Weigel et al, 2009, Mon. Wea. Rev.



A conceptual view



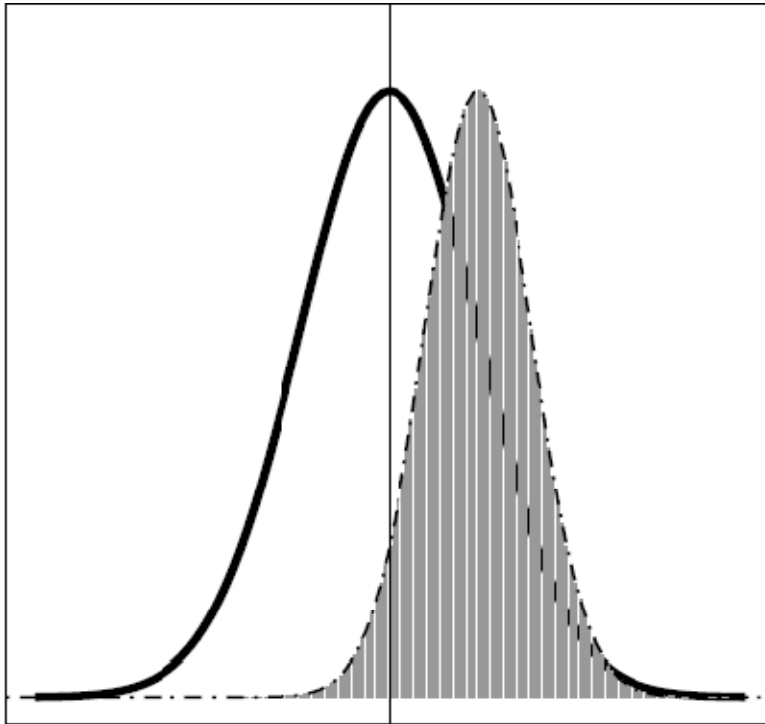
In reality, seasonal forecasts are often **overconfident**.



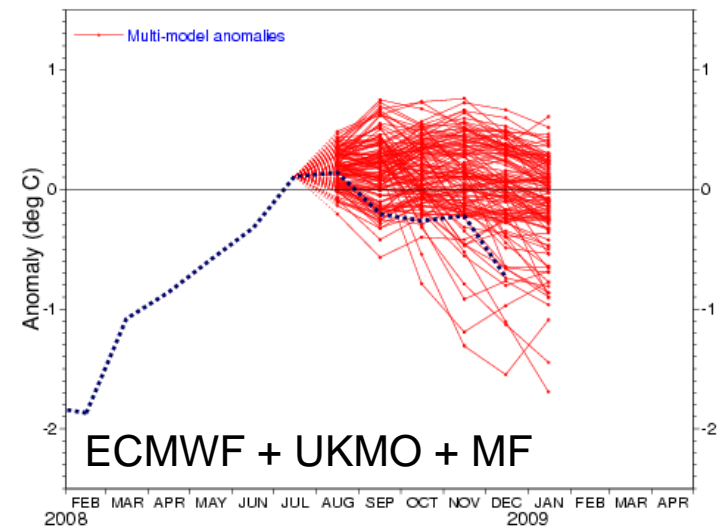
Weigel et al, 2009, Mon. Wea. Rev.



A conceptual view



Combination of overconfident forecasts increases reliability

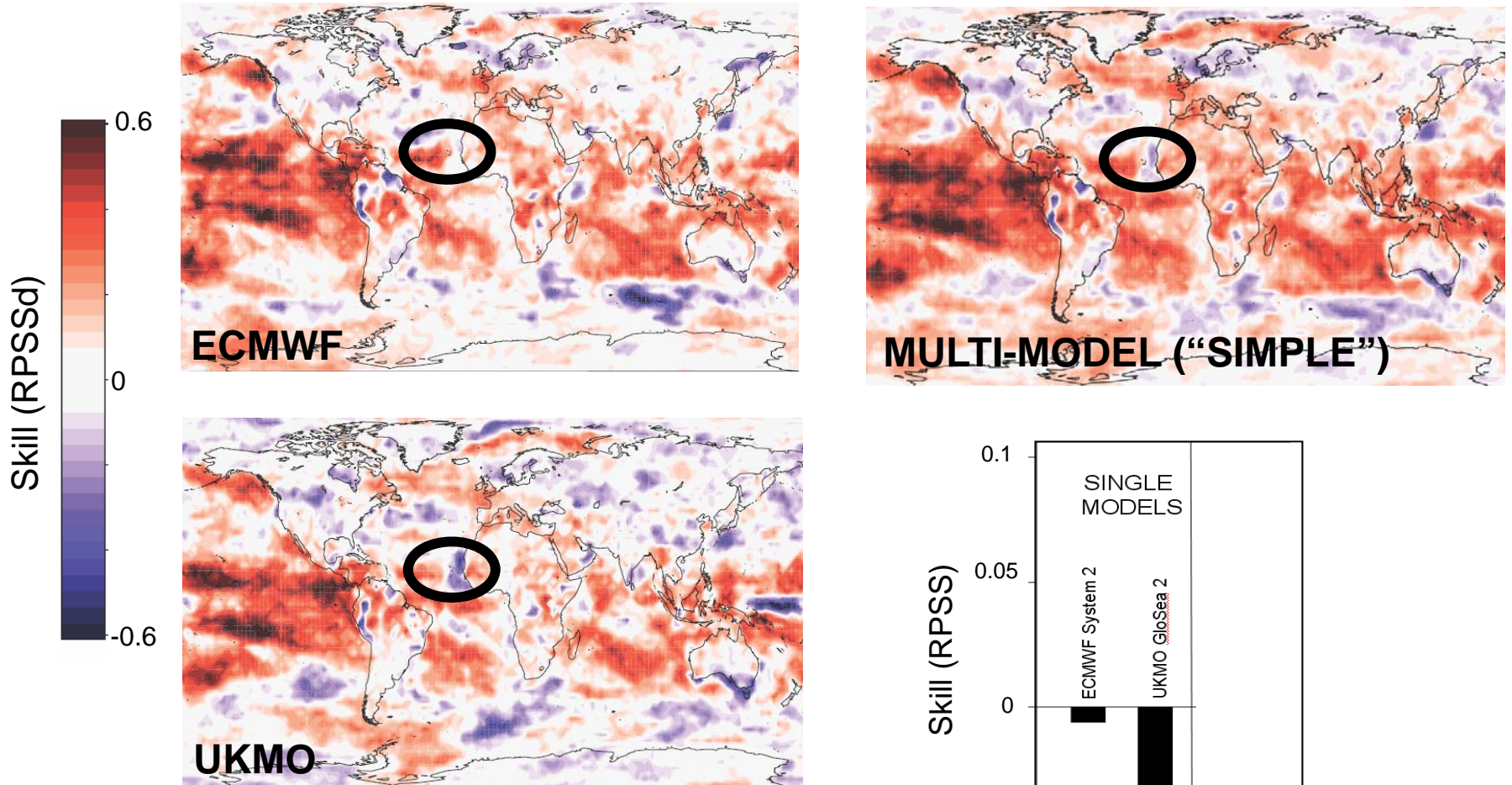


Weigel et al, 2009, Mon. Wea. Rev.



Skill of multi-models

Forecast skill of JJA 2m temperature, 1960-2001, lead-time 1 month

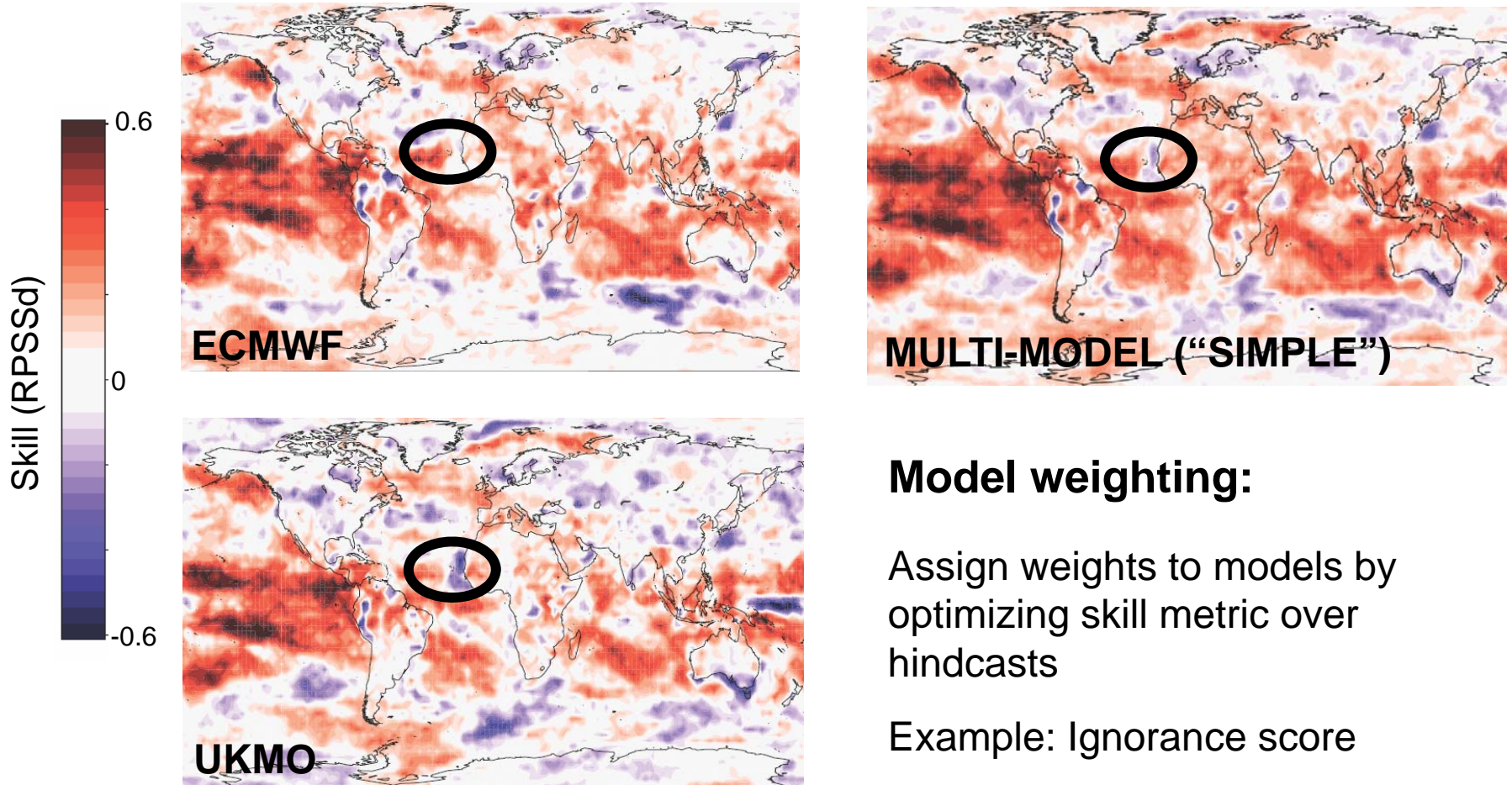


Weigel et al, 2008, Quart. J. Roy. Met. Soc



Skill of multi-models

Forecast skill of JJA 2m temperature, 1960-2001, lead-time 1 month



Model weighting:

Assign weights to models by optimizing skill metric over hindcasts

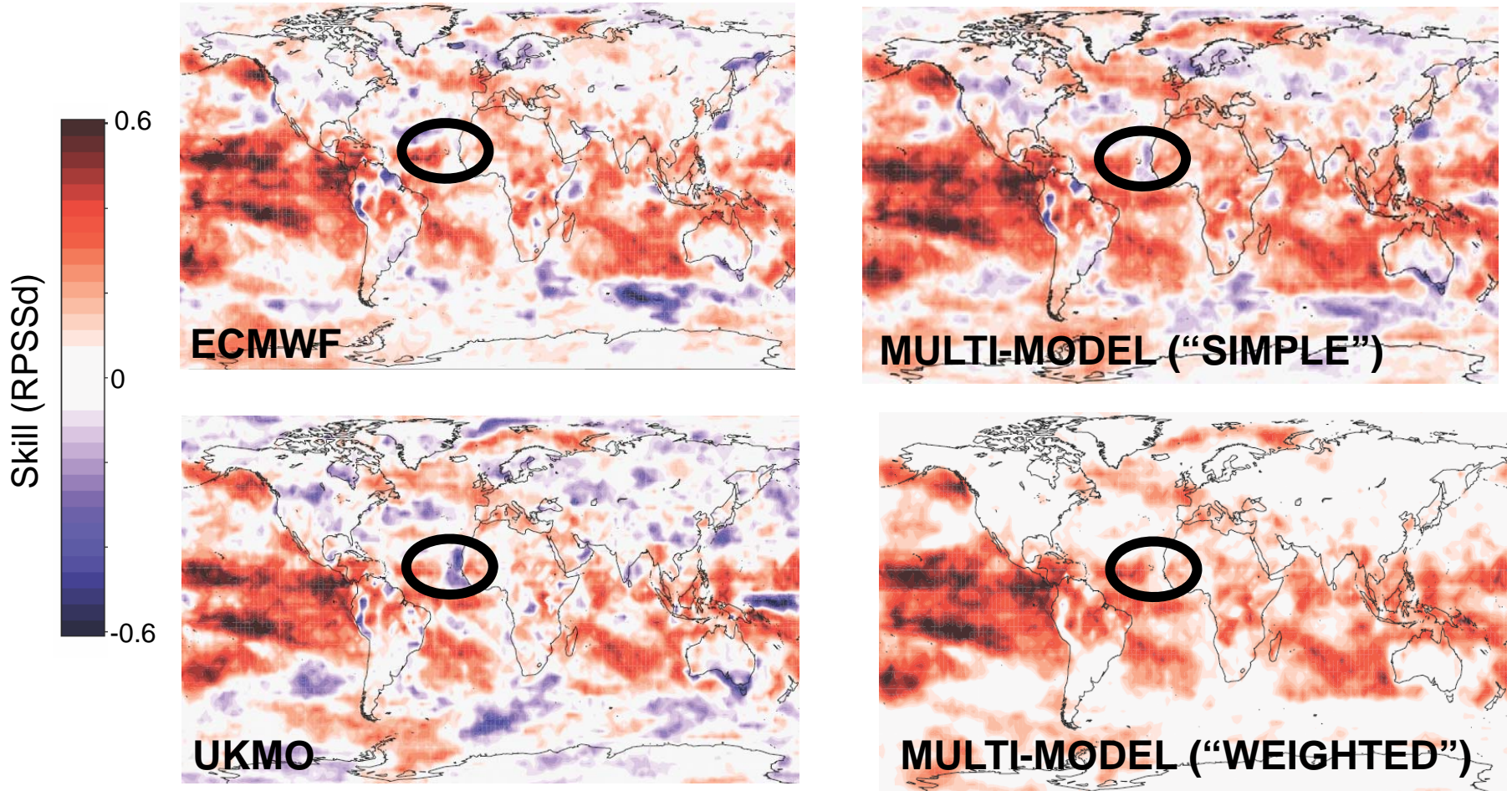
Example: Ignorance score

Weigel et al, 2008, Quart. J. Roy. Met. Soc



Skill of multi-models

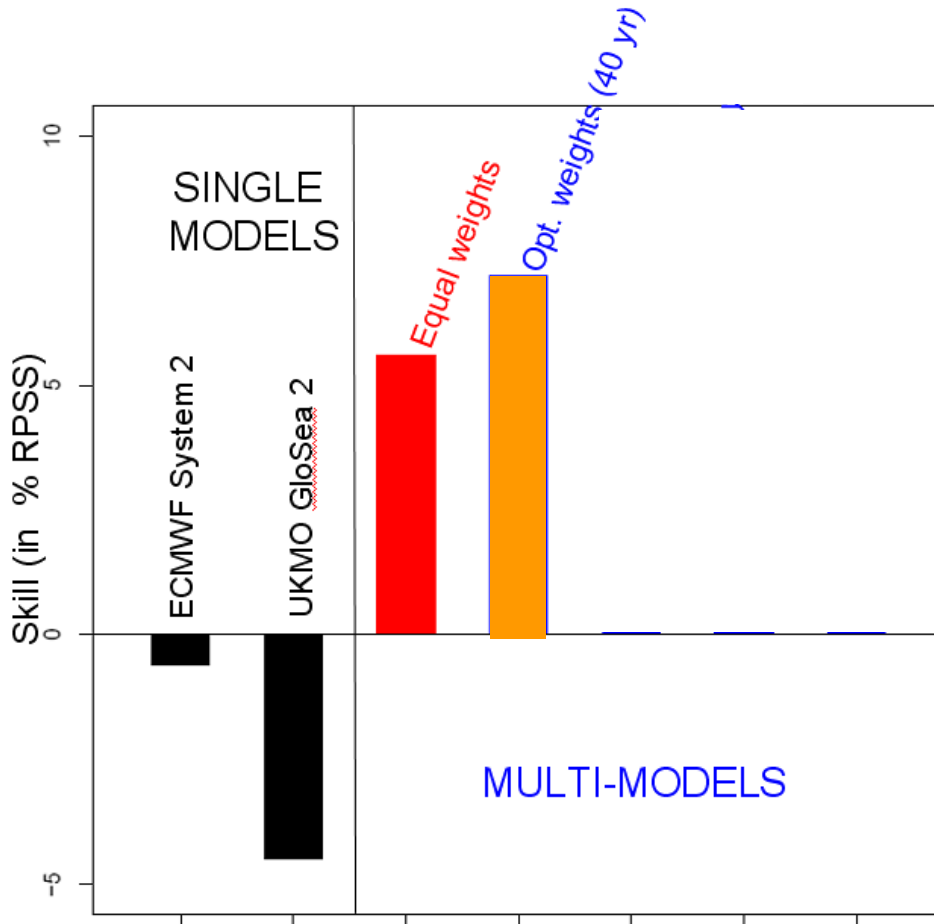
Forecast skill of JJA 2m temperature, 1960-2001, lead-time 1 month



Weigel et al, 2008, Quart. J. Roy. Met. Soc



Skill of weighted multi-models



Model weighting works

Model weighting is risky

Weights need to be robust and truly reflect the underlying uncertainties.

If weights are not robust, more information may be lost than could potentially be gained.

Weight robustness depends on length on training data (and other factors...)

Weigel et al, 2010, J. Clim, in press

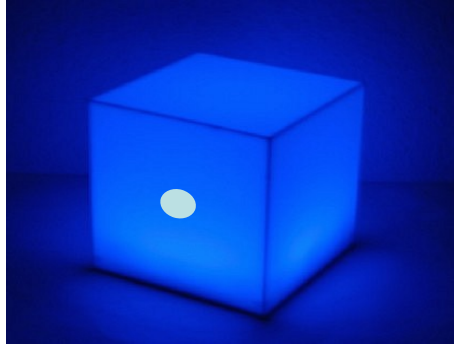


Consequences for multi-decadal climate projections



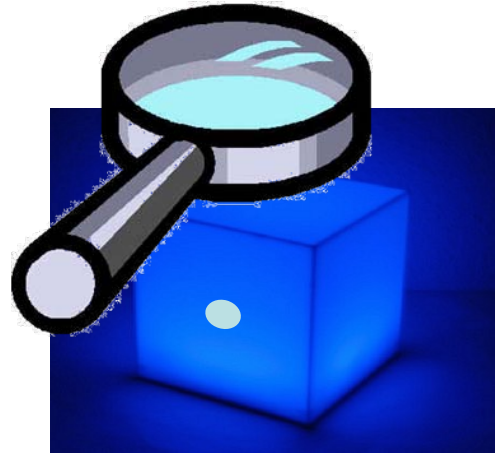
Weighting = Determining model uncertainty

What is the probability of throwing a “one” with this die?



Seasonal forecasts:
Many experiments

Climate projections:
One experiment



Make inference on
probability by analyzing
characteristics

Need to pick the
“right” characteristics



Extrapolation problem:
Is model performance
during control period
representative for
scenario period?

There is a risk that model weights, however obtained, are not representative of future projection uncertainties and thus not robust.

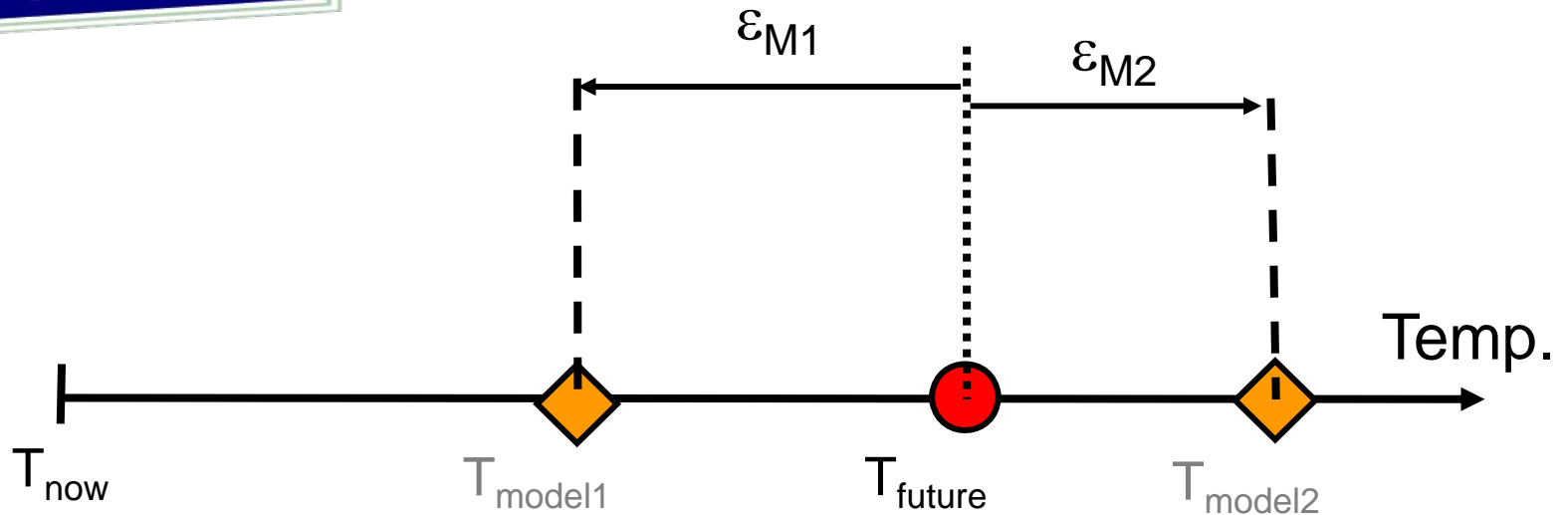


A conceptual view of climate change



Can average the two projections and systematically assess the multimodel projection error for various configurations:

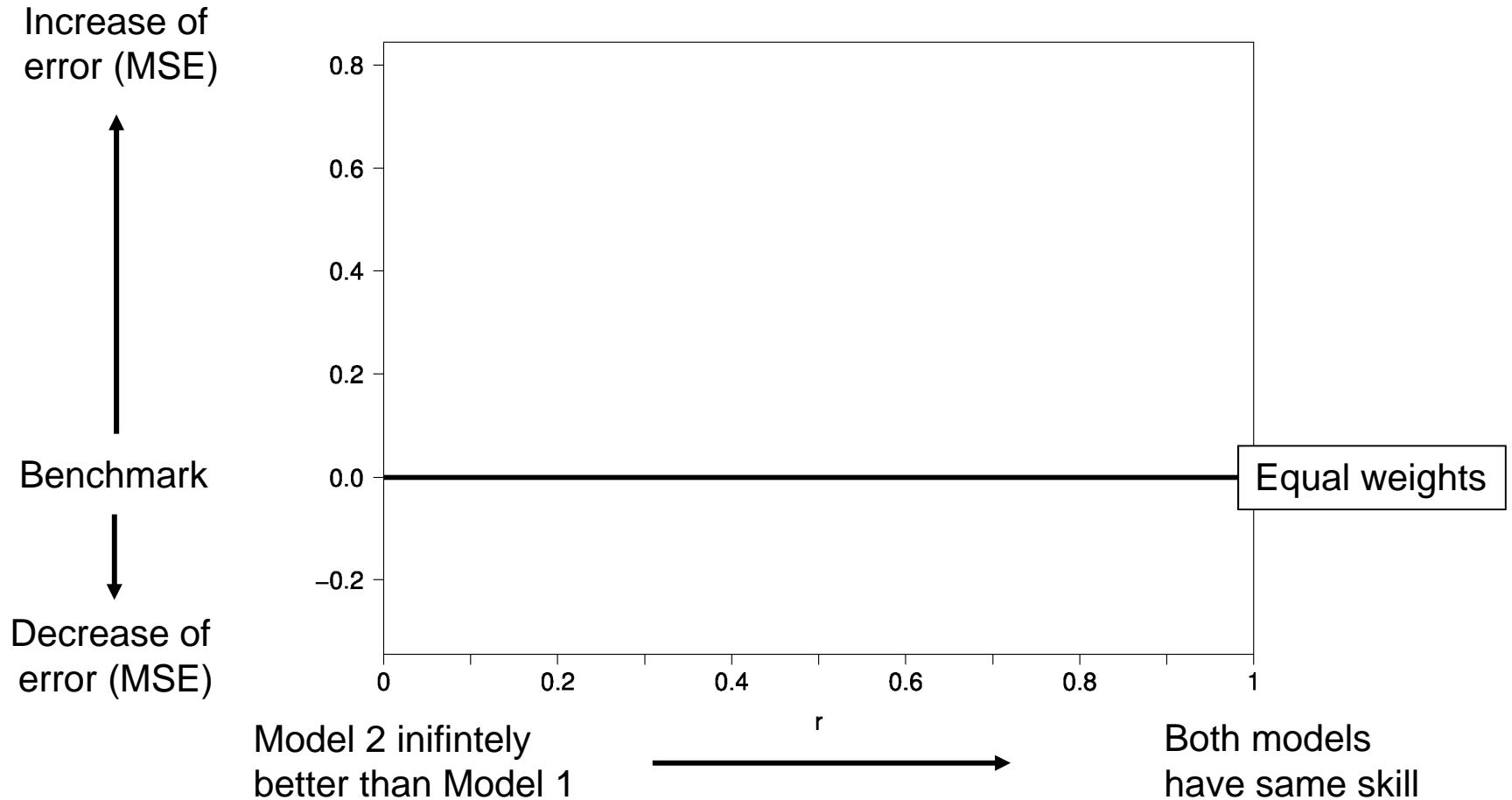
- with and without weights
- with correct or wrong weights
- for different model errors



Weigel et al, 2010, J. Clim., in press



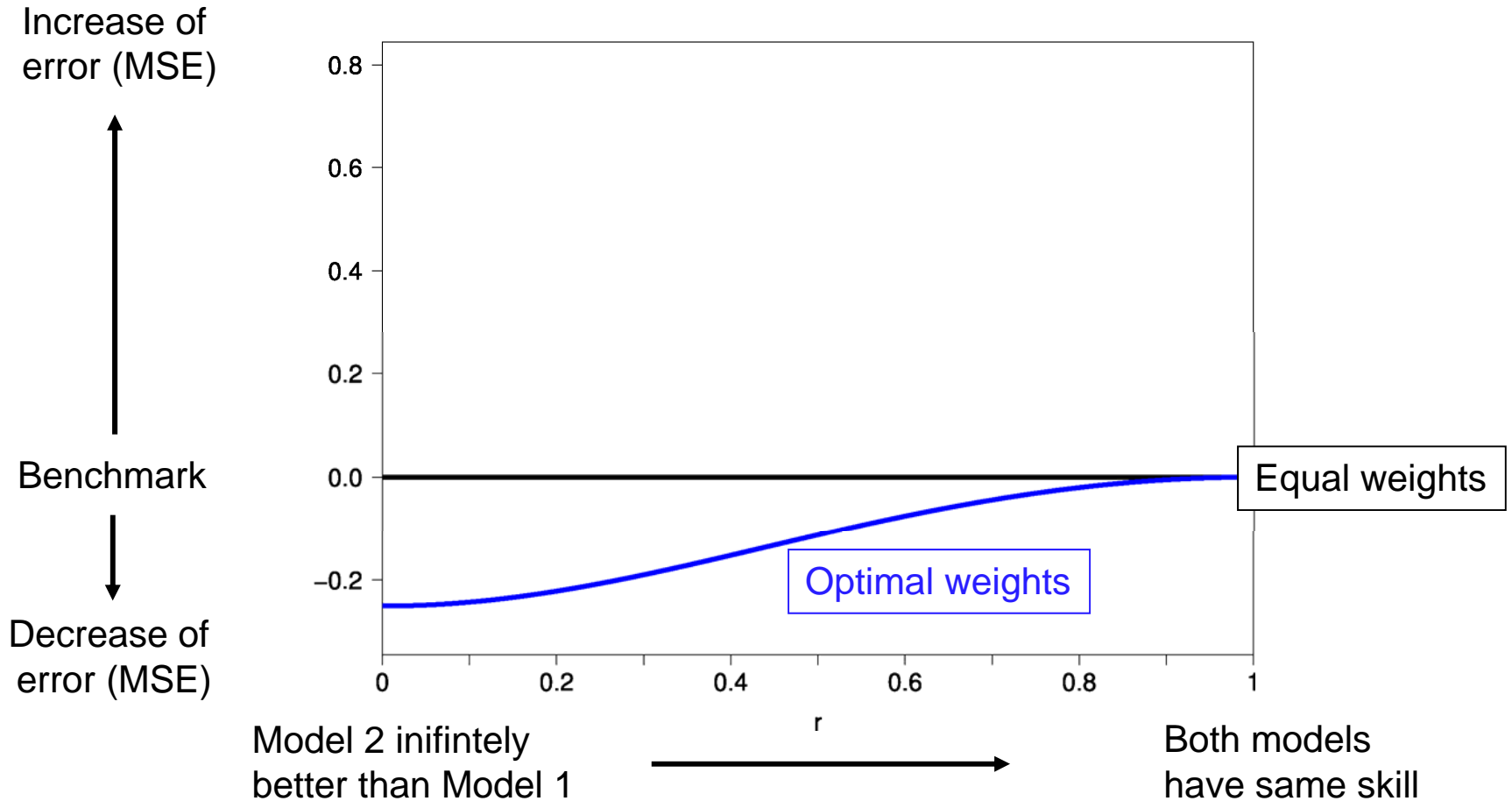
Effects of weighting



Weigel et al, 2010, J. Clim., in press



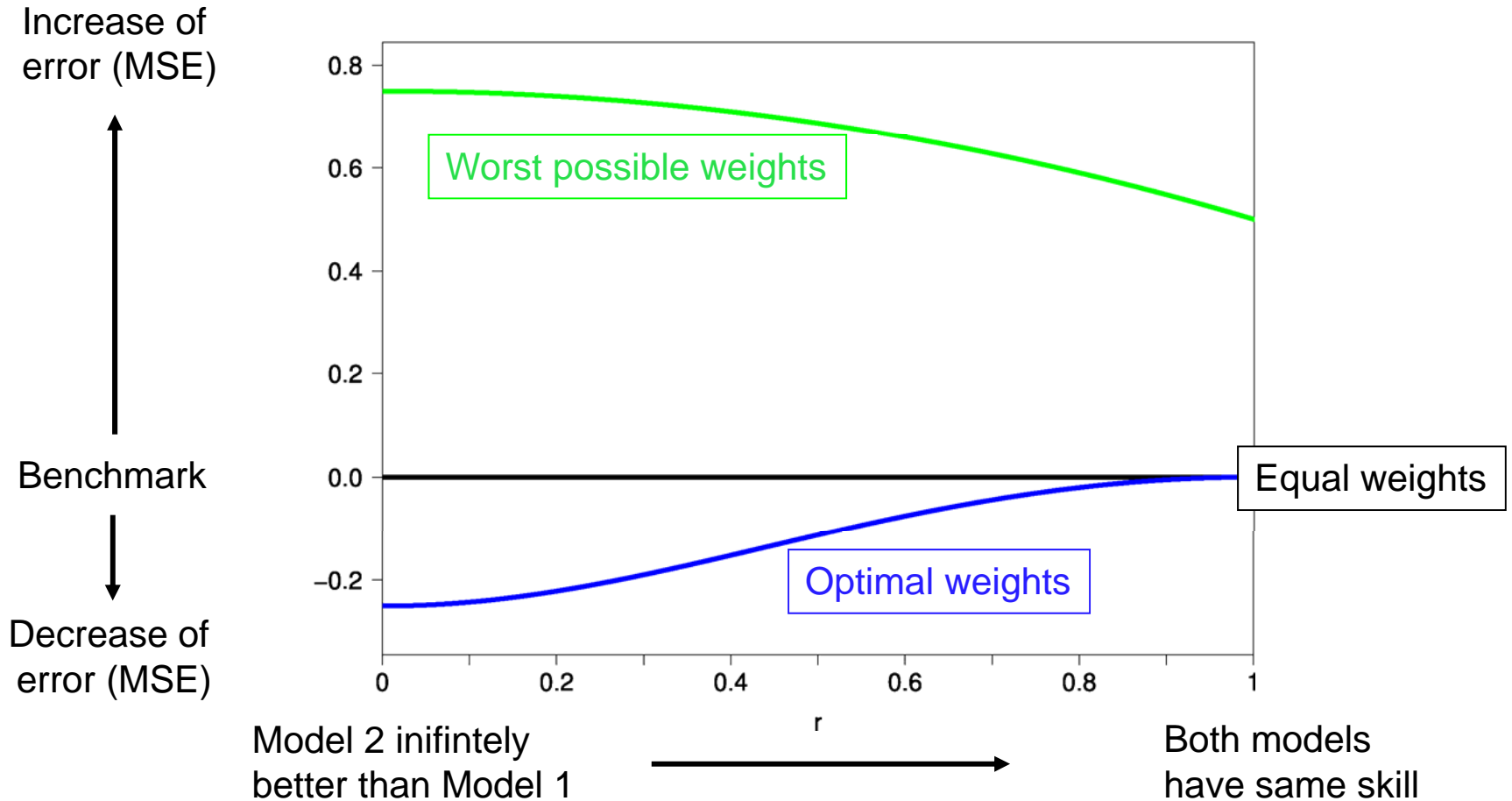
Effects of weighting



Weigel et al, 2010, J. Clim., in press



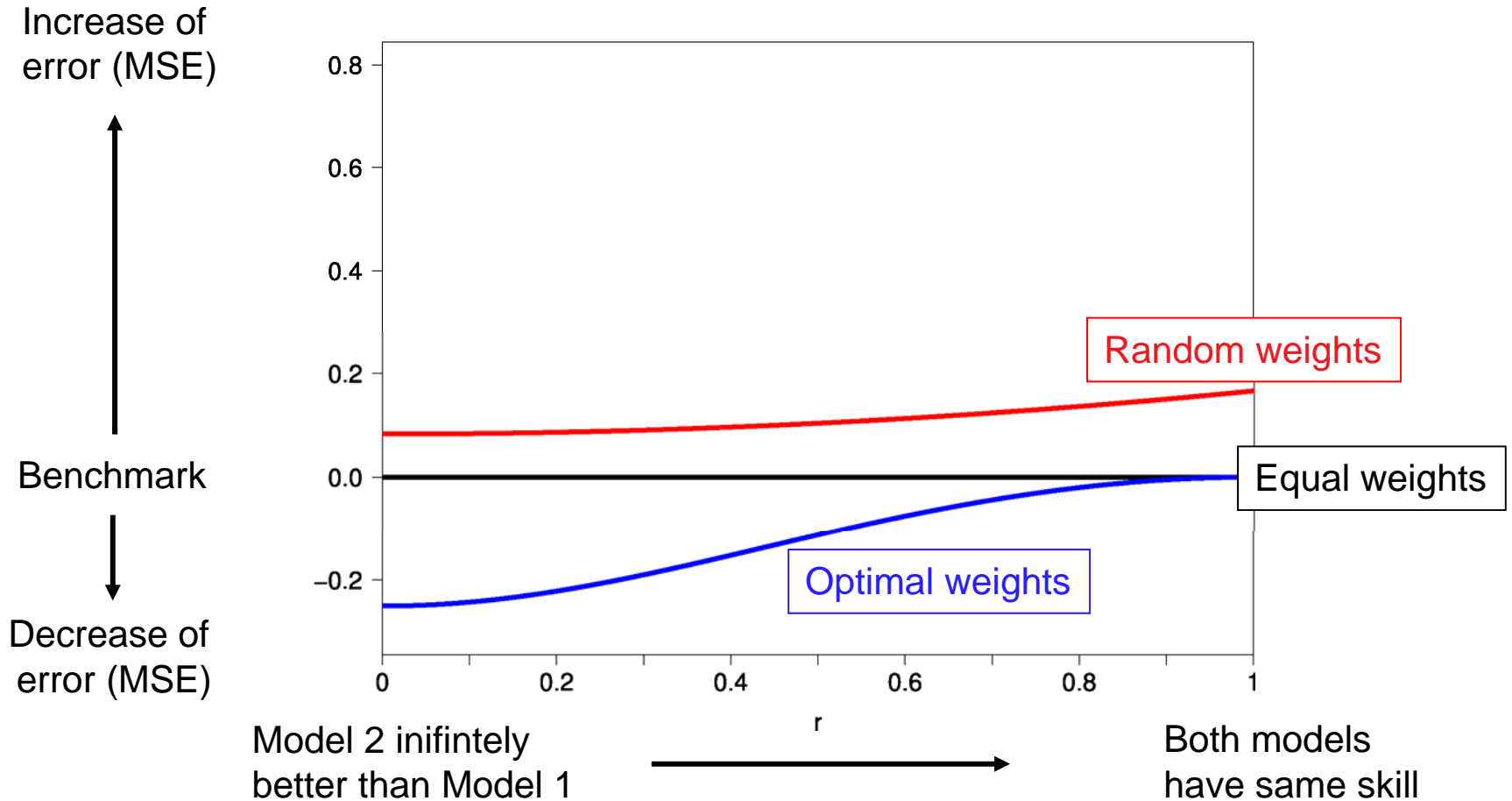
Effects of weighting



Weigel et al, 2010, J. Clim., in press



Effects of weighting



Weigel et al, 2010, J. Clim., in press



Conclusions

A decision to weight climate models should be taken with great care. More can be lost by applying “wrong” weights than could potentially be gained by “correct” weights.

To obtain robust weights, we need to know how, and whether at all, metrics of present day model performance map into future projection uncertainty.

=> At the moment, equal weighting may well be the safer way to go.

Results are consistent with what is known from seasonal forecasting