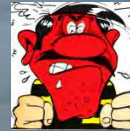


Pourquoi je vire au rouge quand on me dit prévision décennale



Hervé Douville
GMGEC/VDR

21/11/2012



METEO FRANCE
Toujours un temps d'avance

Quel est mon problème ?

Si j'avais fait médecine à la fin des années 80...

Maladie

- | | |
|--------------------------------|-----------------------|
| ✓ Paludisme (WGSIP) | Prévision saisonnière |
| ✓ Alzheimer | Prévision décennale |
| ✓ Sida (WGCM) | Changement climatique |
| ✓ Cancer de la prostate | Régionalisation* |

**en Europe*

Quel est mon problème ?

1. Quelles sont les grandes lignes des changements climatiques à attendre d'un accroissement de la concentration des GES ?
2. Selon quels mécanismes ?
3. Quels changements peut-on déjà observer et éventuellement attribuer aux activités humaines (distinguer si possible GES et aérosols) ?
4. Quelles émissions demeurent compatibles avec un forçage radiatif donné ? => **mitigation**
5. Quelle modulation spatiale (régionalisation) et temporelle (prévision décennale) ? => **adaptation**

Sommaire

1. Quelle raison d'être (« rationnelle ») ?

- Le « sweet spot »
- La demande « sociétale »

2. Quels résultats ?

- « Hindcasts » sur la période 1960-2005
- Prévision 2012-2017

3. Quelles marges de progression ?

- D'après les modèles CMIP5
- Au cours des 10 prochaines années (cf. sea ice)

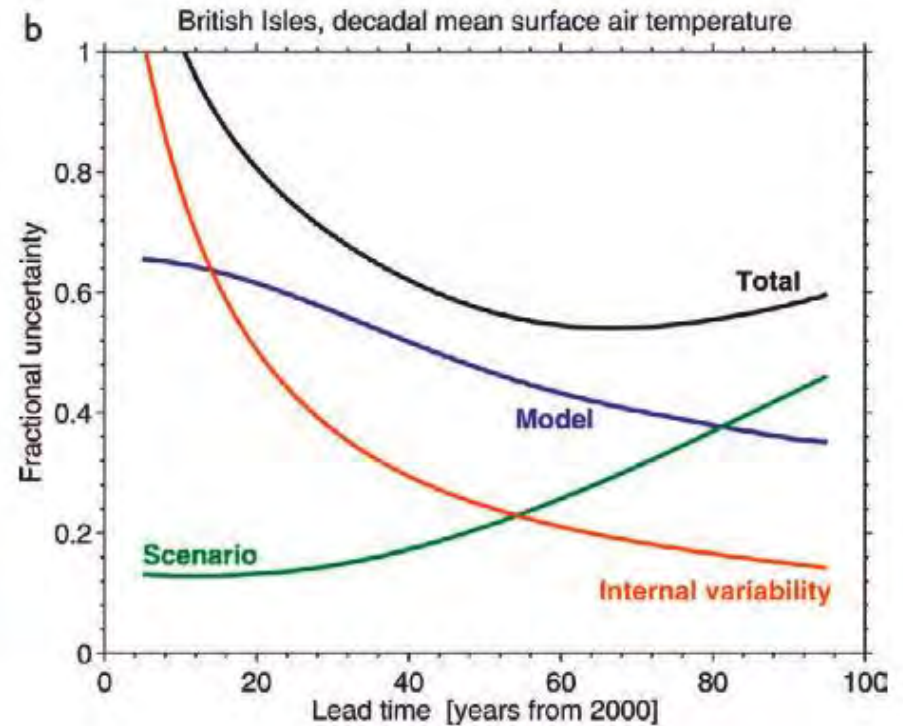
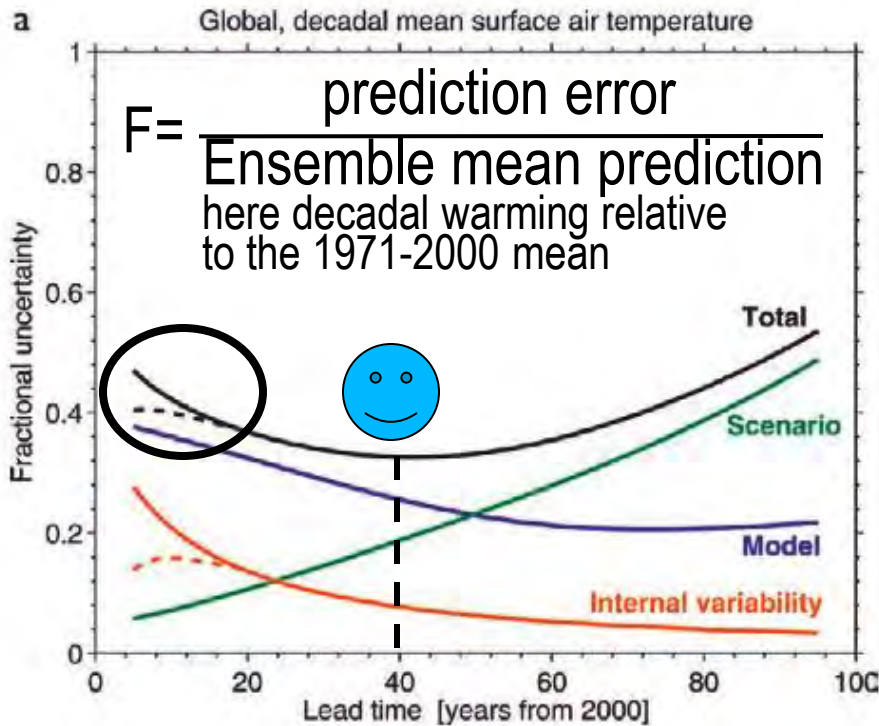
4. Quelle utilisation des ressources ?

- Travailler à moindre coût
- Promouvoir d'autres activités

5. Conclusions

Quelle raison d'être ?

« The signal-to-noise ratio ($1/F$) for surface air temperature has a maximum at a lead time of a few decades (Cox and Stephenson 2007; Hawkins and Sutton 2009). » [AR5 SOD]



Hawkins and Sutton (2009)

« The *value for decision making* of predictive information depends, to a large extent, on the signal-to-noise ratio of the prediction, i.e. how large is the expected change compared to the uncertainty in the prediction »

Even more questionable for precip.

Quelle raison d'être ?

Useful decadal prediction at regional scales? A look at the ENSEMBLES stream 2 decadal hindcasts (sur la base de 4 AOGCMs dont CNRM-CM via le CERFACS)

“...do not yet have sufficient skill to drive impact models on decadal timescales”

MacLeod et al. (2012)

Volcans ?

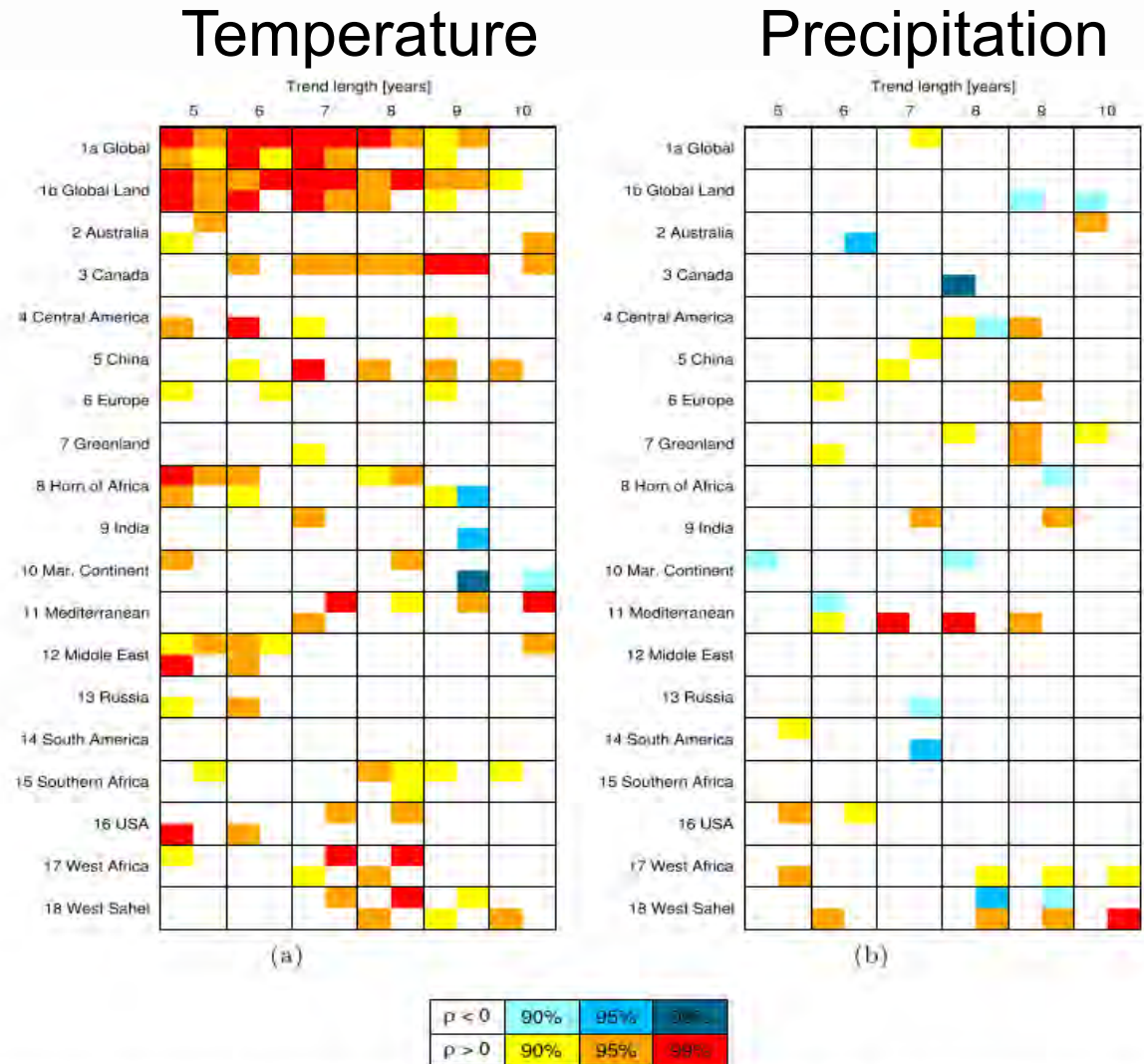
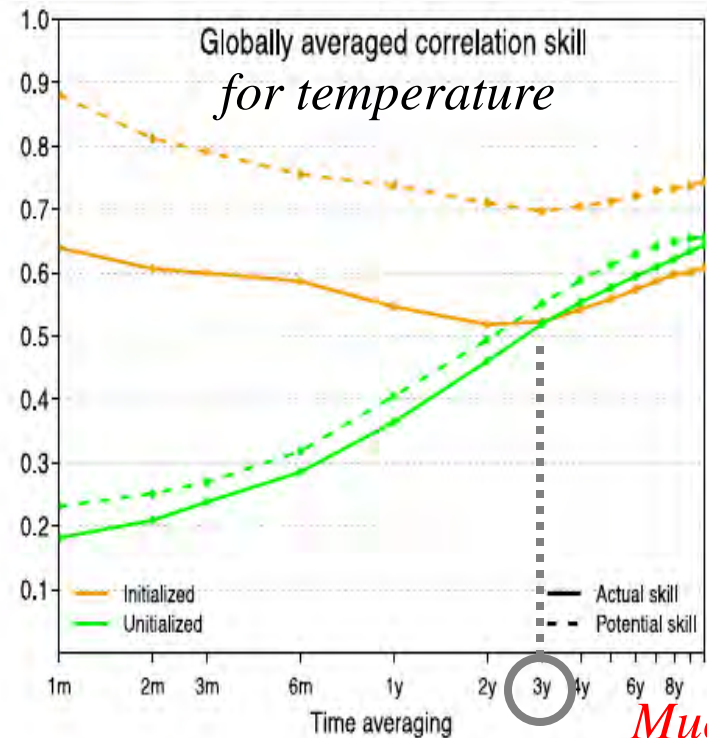


Figure 4. Multi-year trend correlation significance levels for annually averaged temperature (left) and precipitation (right) (reference dataset is NCEP reanalysis). Each quadrant in each square stands for one of the four models in the ENSEMBLES decadal hindcasts (clockwise from top left: UK Met Office, ECMWF, IFM-GEOMAR, CERFACS). The three variations in warm (cold) colours indicate Spearman's rank correlation coefficients significantly above (below) zero at the 90%/95%/99% levels respectively (levels at ± 0.324 , ± 0.382 , ± 0.491).

Quelle raison d'être ?

« In this example at least (based on Boer et al., 2012) the skill of the initialized predictions and of the uninitialized simulations become indistinguishable beyond about a **three-year** average forecast. (...) »
[SOD AR5]



Much less for precip.

Figure 11.2: The global average of the local correlation skill score (solid lines) and the corresponding predictability measure (dashed lines) for temperature averaged over periods from a month to a decade. Results plotted for the monthly average correspond to the first month, those for the annual average to the first year and so on up to the decadal average. The orange lines are the results for initialized forecasts which attempt to predict the evolution of both internally generated and forced components of the climate. The green lines are the results for uninitialized forced climate simulations.

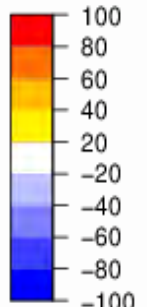
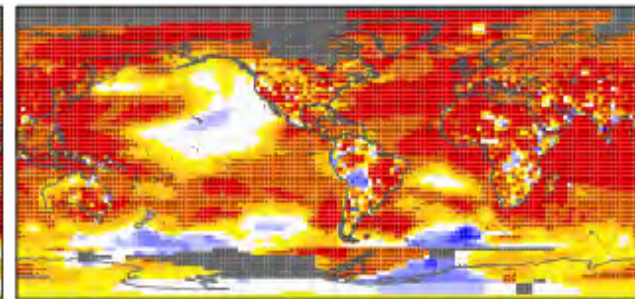
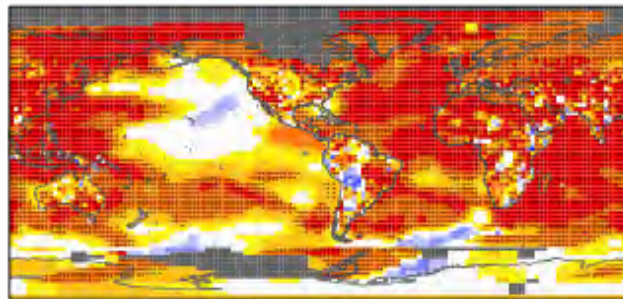
Quels résultats? SST+T2m

Multi-model ensemble-mean **correlation** from CMIP5 decadal predictions vs ERSST-GHCN temperature over 1960-2005 (5-yr start date frequency)

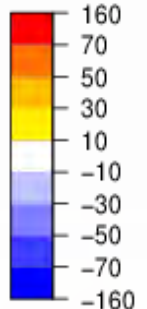
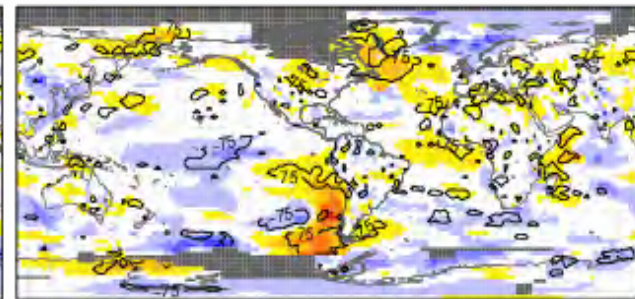
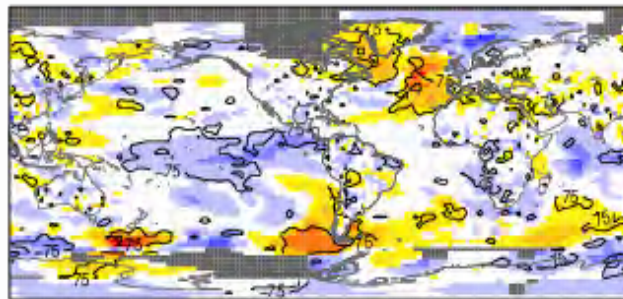
Years 2-5

Years 6-9

Init



Init-Noinit



Doblas-Reyes et al. (2012)

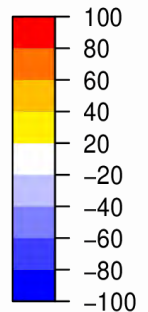
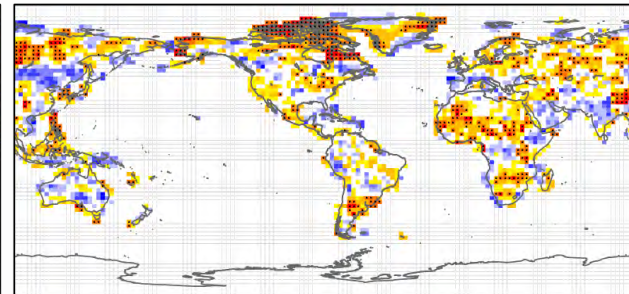
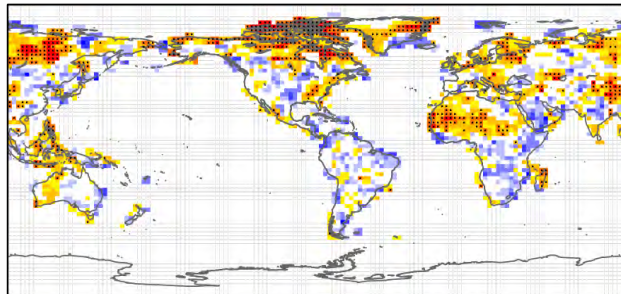
Quels résultats? Précipitations

Multi-model ensemble-mean **correlation** from CMIP5 decadal predictions vs GPCP for precipitation over 1960-2005 (5-yr start date frequency)

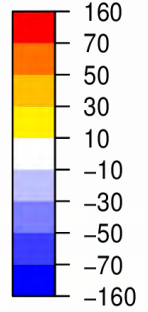
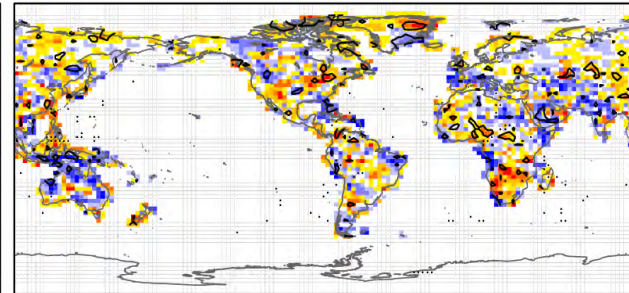
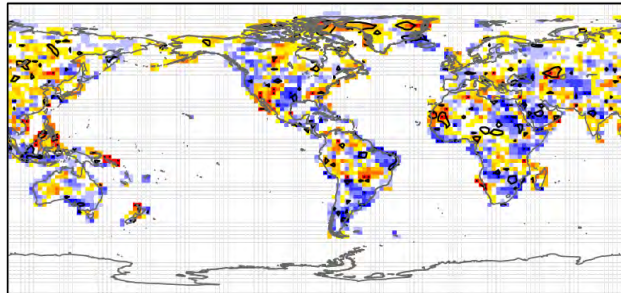
Years 2-5

Years 6-9

Init



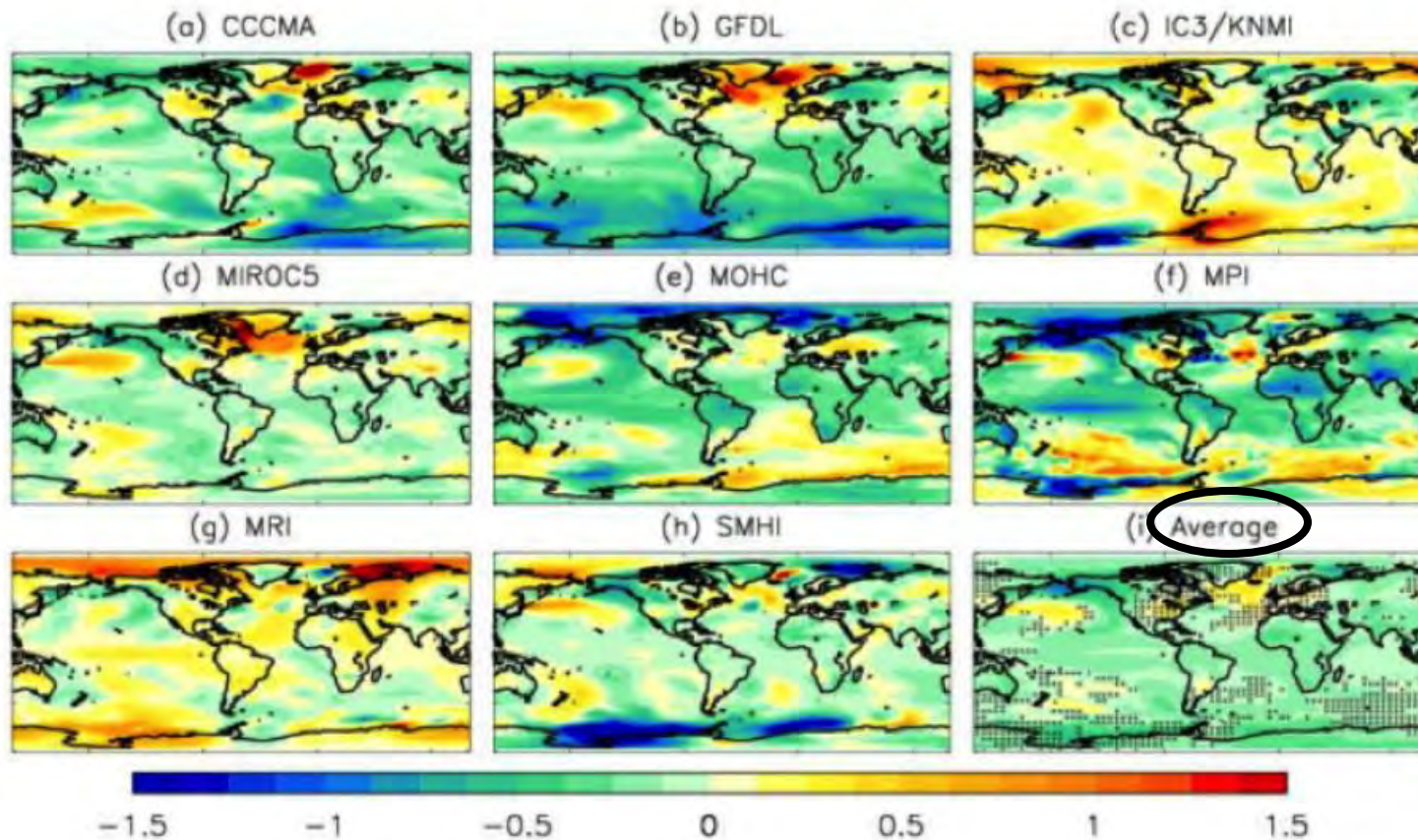
Init-Noinit



Doblas-Reyes et al. (2012)

Quels résultats? Prévvision 2013-2017

Impact de l'initialisation (fin 2012) sur la prévision à 5 ans



*Only
annual
mean
T2M is
exchanged*

Figure 11.10c: Impact of initialization (initialized minus non-initialized ensemble means) on forecasts of the period 2013 to 2017 initialized near the end of 2012. Unstippled regions in (i) indicate a 90% or higher probability that differences between the initialized and non-initialized ensemble means did not occur by chance (based on a 2 tailed t -test of differences between the two ensemble means assuming the ensembles are normally distributed).

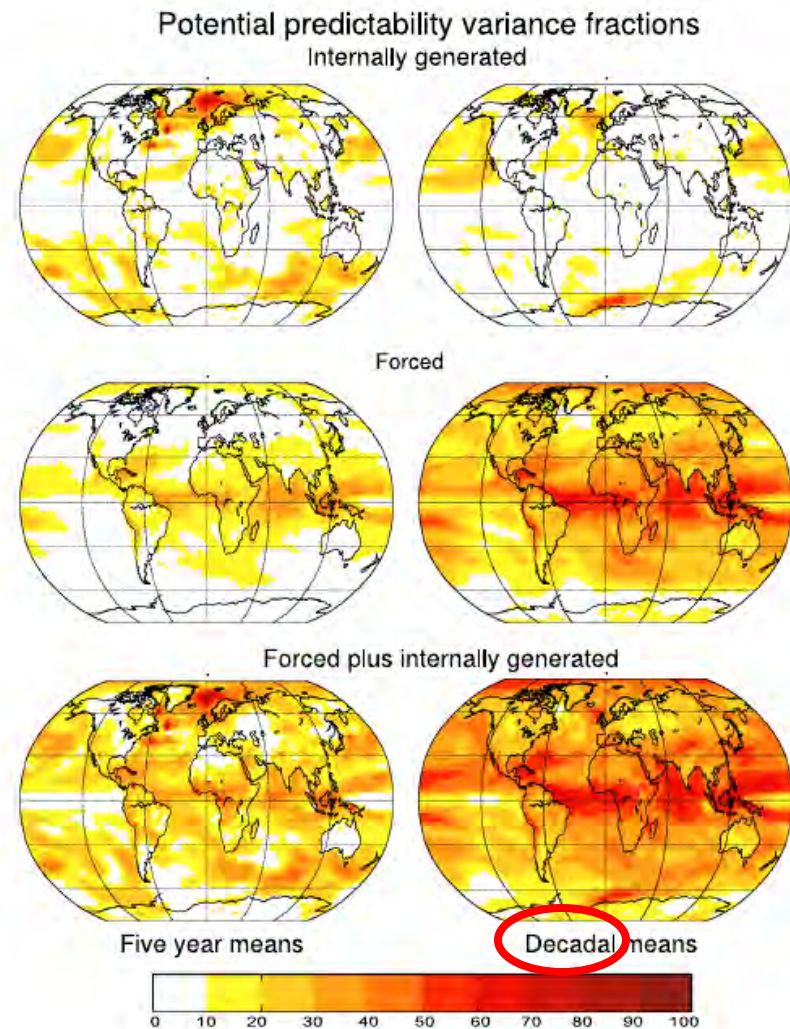
Quelles marges de progression ?

- ✓ *Prévisibilité potentielle dans les modèles CMIP5:*
 - ✓ *« It is likely that the predictability (...) of the internally generated component is largest for extra-tropical oceans and modest over extra-tropical land.*
 - ✓ *Multi-model results for precipitation indicate a generally low level of predictability, although there are some exceptions (...) due mainly to the forced component.*
 - ✓ *There is limited agreement and medium evidence that the Atlantic Multidecadal Variability (AMV) and Pacific Decadal Variability (PDV) patterns (...) exhibit predictability on timescales up to a decade. » [SOD AR5]*

- ✓ *Au delà de CMIP5 et de la prévisibilité potentielle:*
 - ✓ Amélioration des modèles et des méthodes d'initialisation
 - ✓ Accroissement de la résolution (*homo supercomputus*) ?
 - ✓ Prévision statistique ???

Quelles marges de progression ?

Etude diagnostique de la prévisibilité potentielle (à 5 et 10 ans) sur la base des scénarios **RCP4.5** (forced+internally generated potential predictability) de 17 modèles CMIP5
Boer et al. 2012



Even lower for precip.

Higher for stronger forcing

Figure 11.4: The potential predictability of five year and decadal means of temperature (lower panels), the contribution from the forced component (middle panels) and from the internally generated component (upper panels). These are multi-model results from CMIP5 RCP4.5 scenario simulations from 17 coupled climate models following the methodology of Boer (2011). The results apply to the early 21st century.

Quelles marges de progression ?

- ✓ (...) *there is merit in devoting resources to develop the capability to initiate decadal range forecasts ...*
- ✓ *On the other hand, our results indicate that quantification of the value in added skill that is potentially realizable as a result of initializing decadal forecasts is highly uncertain ...*
- ✓ (...) *any comprehensive program aimed at the decadal prediction problem needs to carefully assess the predictability of the model it uses...*
- ✓ *For CCSM3, (...) the imprint of Atlantic Ocean predictability on the atmosphere was weak, but of course this aspect of predictability may also vary from model to model and is poorly understood in the observed climate system.*
- ✓ (...) *systematic estimates of predictability can be determined without recourse to computationally expensive ensemble experiments...*

Branstator et al. (2012)

Quelle utilisation des ressources ?

Bilan septembre 2012 de la participation à CMIP5:

- Control & historical: 48
- RCP4.5 & 8.5 (core): 40
- RCP2.6 (tier1): 29
- RCP6 (tier1): 22
- 1%CO2 (core): 32
- Abrupt 4xCO2 (core): 30
- Paléo (tier1/tier2): 13/7
- **Decadal hindcasts (core): 18**
- **D&A (tier1&2): 17 (9 avec $n \geq 3$?)**
- AMIP (core): 28
- AMIP 4xCO2 (core) & AMIP+4K unif (tier2) or not (tier1): 12
- Aquaplanet (tier1): 11

- Le label « core » est incitatif (cf. RCP)
- Le coût n'est pas que numérique (cf. Aqua)
- Participation similaire aux ensembles (lourds) « Decadal » et « D&A »
- Limiter le « core » et profiter pleinement du « tier » ???

Conclusions

1. Quelle raison d'être ?

- Le « sweet spot » n'est qu'une hypothèse
- La demande sociétale ne pourra être satisfaite avant que les scénarios ne perdent l'essentiel de leur intérêt

2. Quels résultats ?

- Effet initialisation significatif sur l'Atlantique Nord
- 2012-2017 globalement un peu plus froid que les RCP

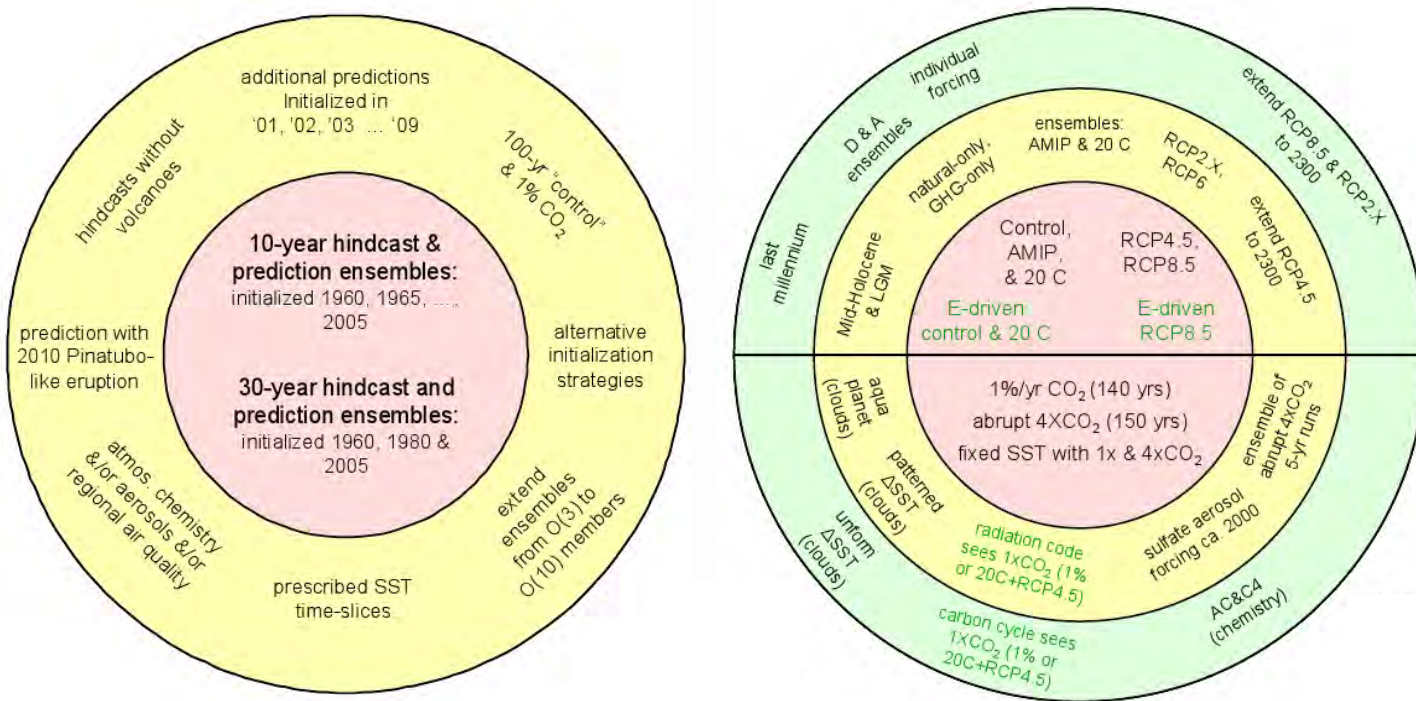
3. Quelles marges de progression ?

- Potentiellement significative pour l'effet des forçages
- Globalement modeste pour l'effet initialisation

4. Quelle utilisation des ressources ?

- Privilégier les études de prévisibilité et de processus
- Promouvoir d'autres activités plus urgentes

Ce que je propose pour CMIP6



- ✓ Merge Near Term & Long Term in a common framework
- ✓ Move Decadal Hindcasts from Core to Tier 1
- ✓ Move D&A (aerosol & ANT) from Tier 2 to Tier 1
- ✓ Add « off-line » OGCM and LSM simulations (evaluation)
- ✓ More emphasis on SST patterns
- ✓ More emphasis on O-A/L-A/O-L-A coupling
- ✓ Other / better ideas ?



Fin



METEO FRANCE
Toujours un temps d'avance