Climate prediction activities at Météo-France & CERFACS

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Acknowledgements:

L. Batté, C. Cassou,

M. Chevallier, M. Déqué,

A. Germe, E. Martin,

and D. Salas-y-Mélia

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Outlines

1. Seasonal prediction activities
   - Stochastic dynamics
   - Horizontal & vertical resolution
   - Sea ice & stratosphere
   - Hydrological forecasts
2. Decadal prediction activities (with CERFACS)
   - CMIP5
   - Ocean initialization
   - High-top versus low-top
   - Sea-ice

Conclusions & prospects

Stochastic dynamics: principle

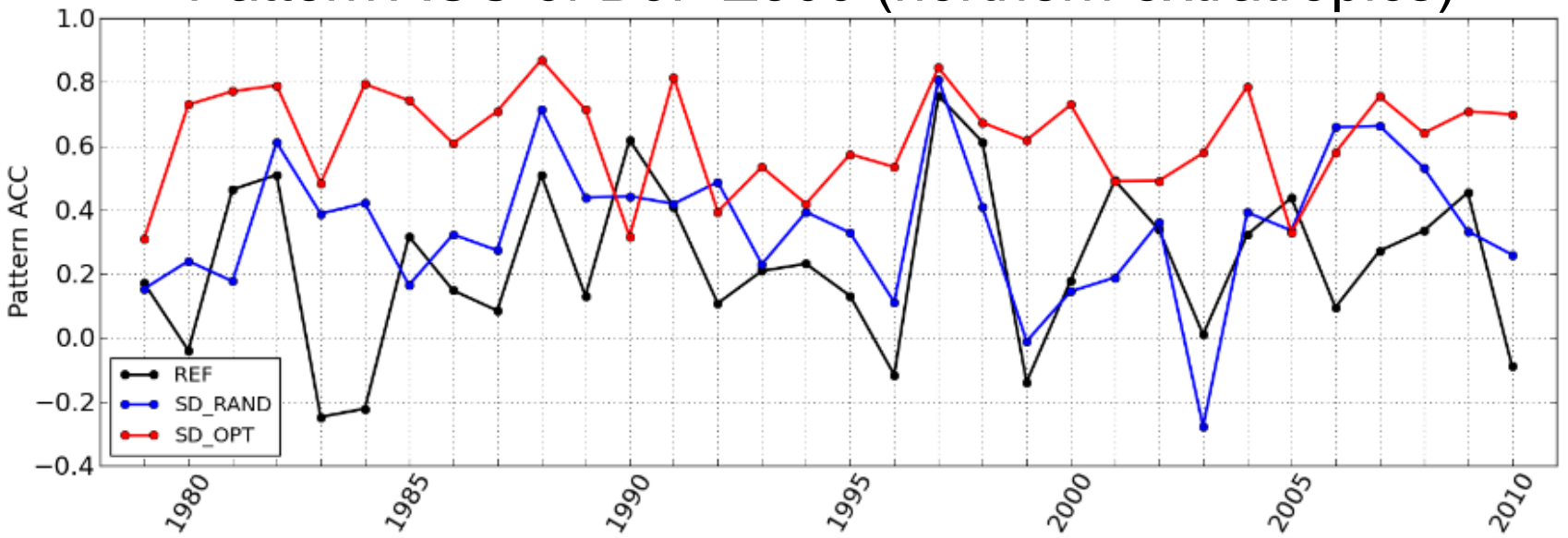
$$X(t + \Delta t) = X(t) + M(X(t), t) + \delta X$$

- Perturbed variables : T , Ψ, Q
- δX : random draw every 6 hours of a coherent initial tendency error correction term from a given population {δX} derived from a 32-winter 4-member coupled model run weakly (10-day relaxation time for Ψ, 1 month for T and Q) nudged towards ERA-Interim
- Classification of the {δX} population according to :
  - actual month (« perfect sampling »): SD_OPT
  - current month (november to february): SD_RAND
  - other criteria : ongoing research !

Courtesy of L. Batté

Stochastic dynamics: results

Pattern ACC of DJF Z500 (northern extratropics)



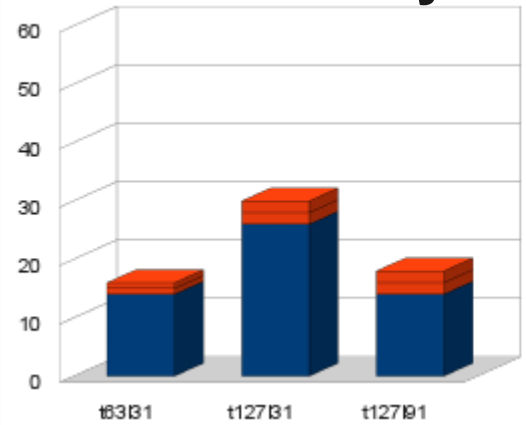
Mean Pattern ACC in DJF

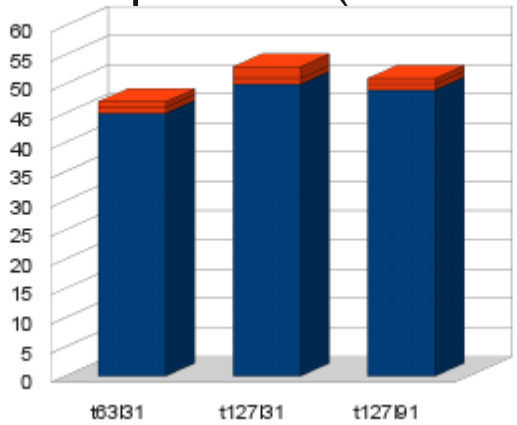
mACC	REF	SD_RAND	SD_OPT
Z500 NH (30°N-75°N)	0.26	0.37	0.65
Precip. Tropics (23°S-23°N)	0.56	0.55	0.60
2m Temperature Tropics	0.51	0.51	0.55

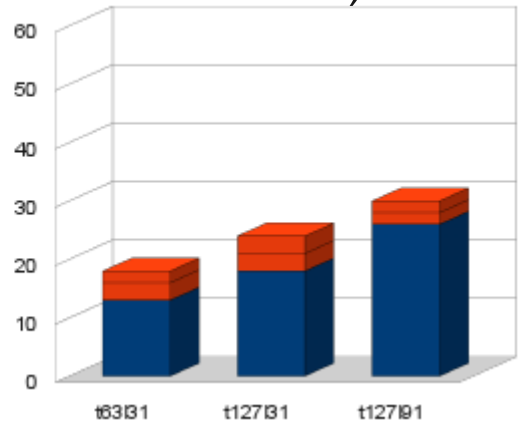
Courtesy of L. Batté

Horizontal & vertical resolution (CNRM-CM5)

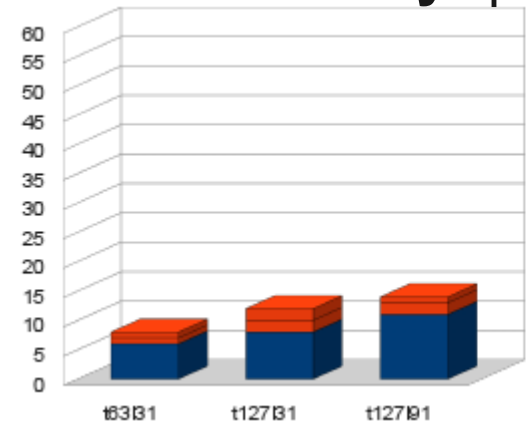
Mean ACC for **DJF** surface temperature (SST + T2M vs ERAI 1979-2010)



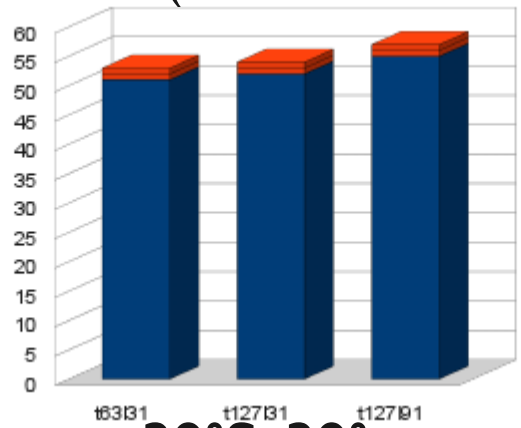




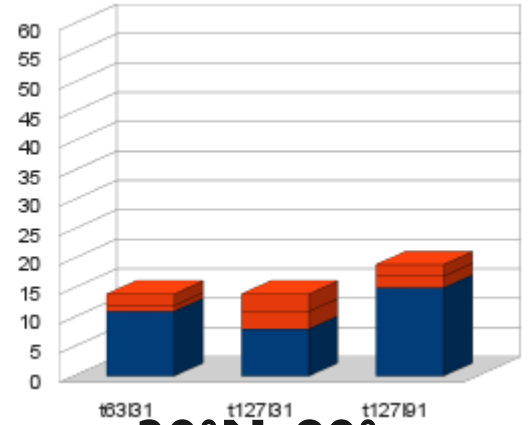
Mean ACC for **DJF** precipitation (vs GPCP 1979-2010)



90°S-30°S



30°S-30° N



30°N-90° N

Q5/Q50/Q95 ACC estimated by drawing 15 out of 60 members

Courtesy of M. Déqué

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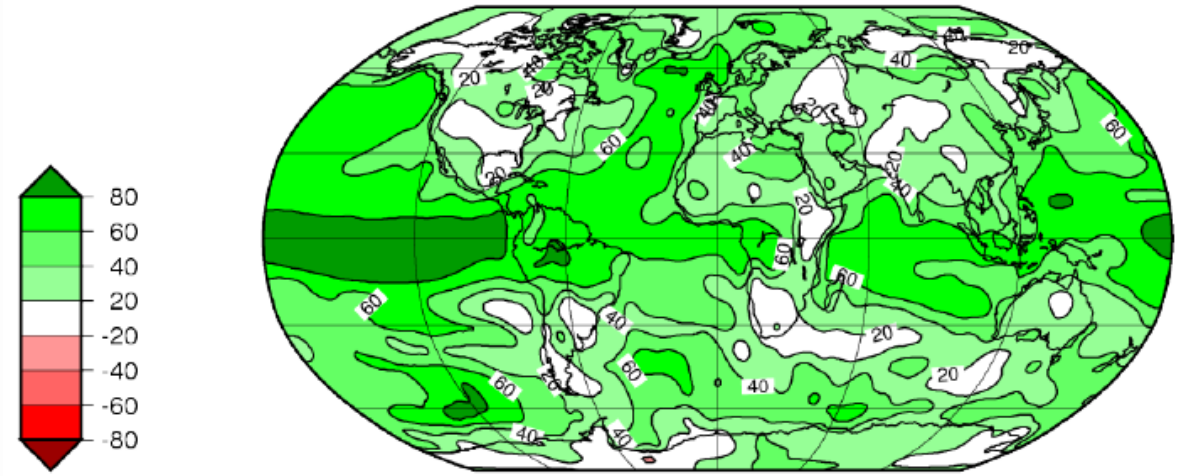
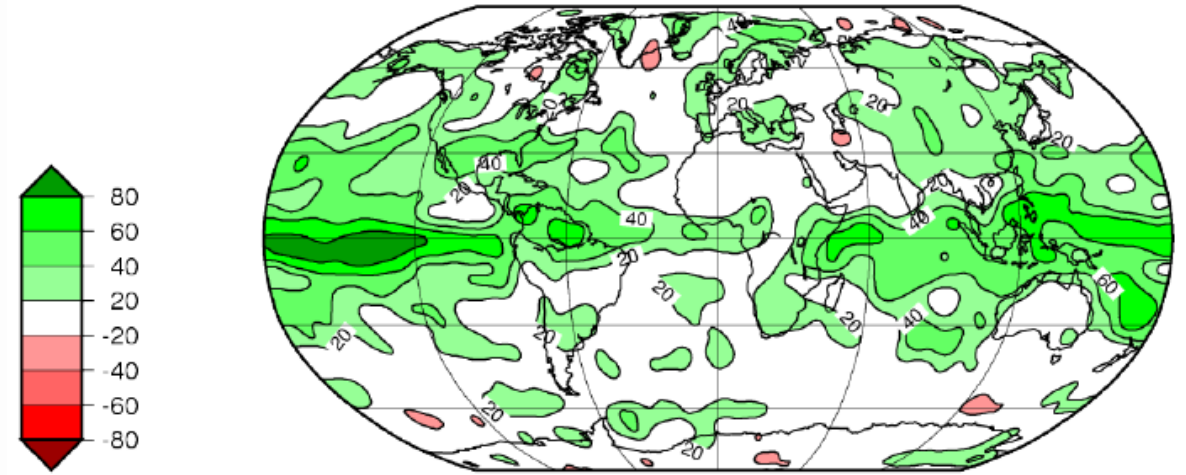
DJF scores with CNRM-CM5 T127L91



T127L91
DJF TS
(detrended)
vs ERAI



T127L91
DJF P
(detrended)
vs GPCP

Courtesy of M. Déqué

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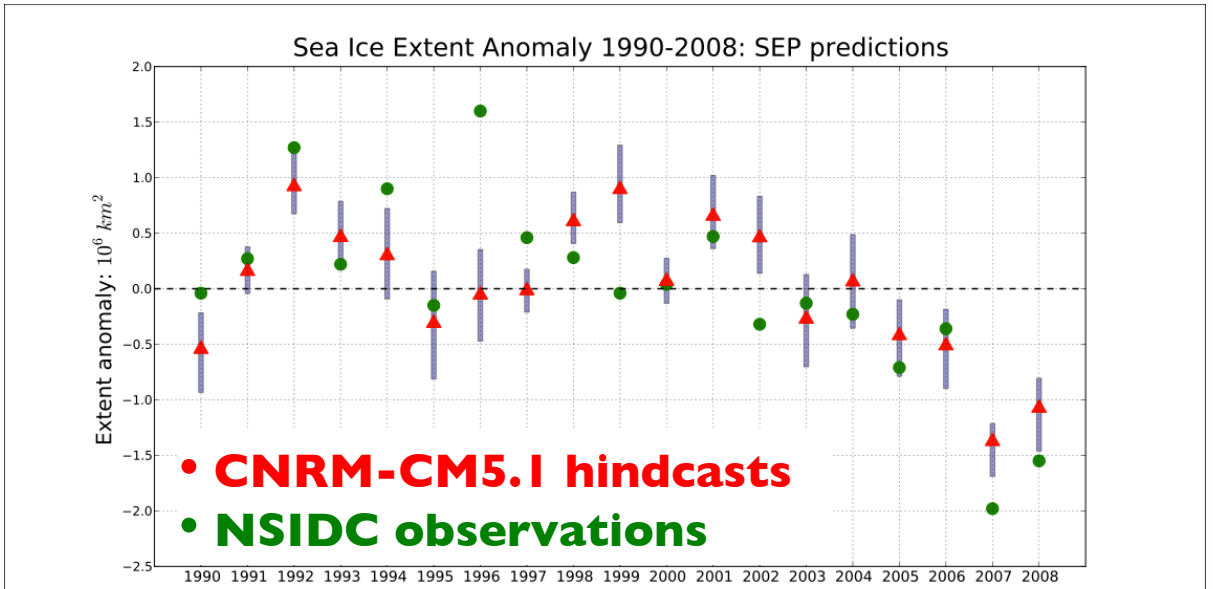
Predictability of Arctic sea-ice

Init: May 1st

ACC: **0.72**

(vs persistence: 0.27)

detrended: 0.60

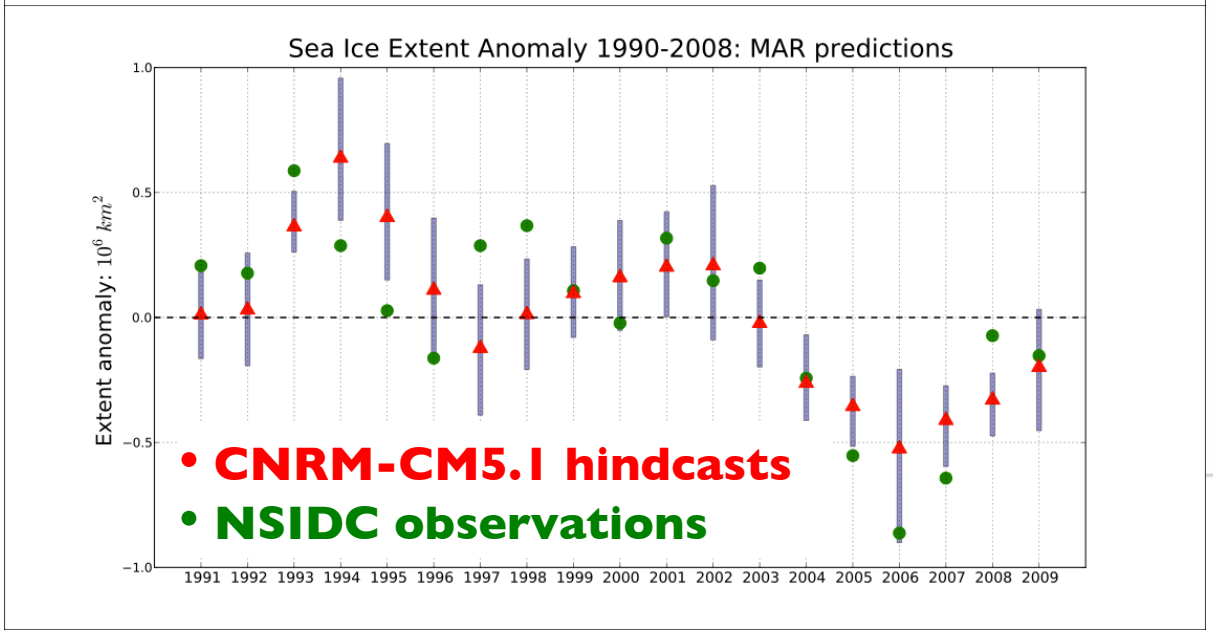


Init: November 1st

ACC: **0.74**

(vs persistence: 0.60)

detrended: 0.53



Courtesy of M. Chevallier
Also contributed to Ice-HFP

Nudging towards a « perfect » stratosphere

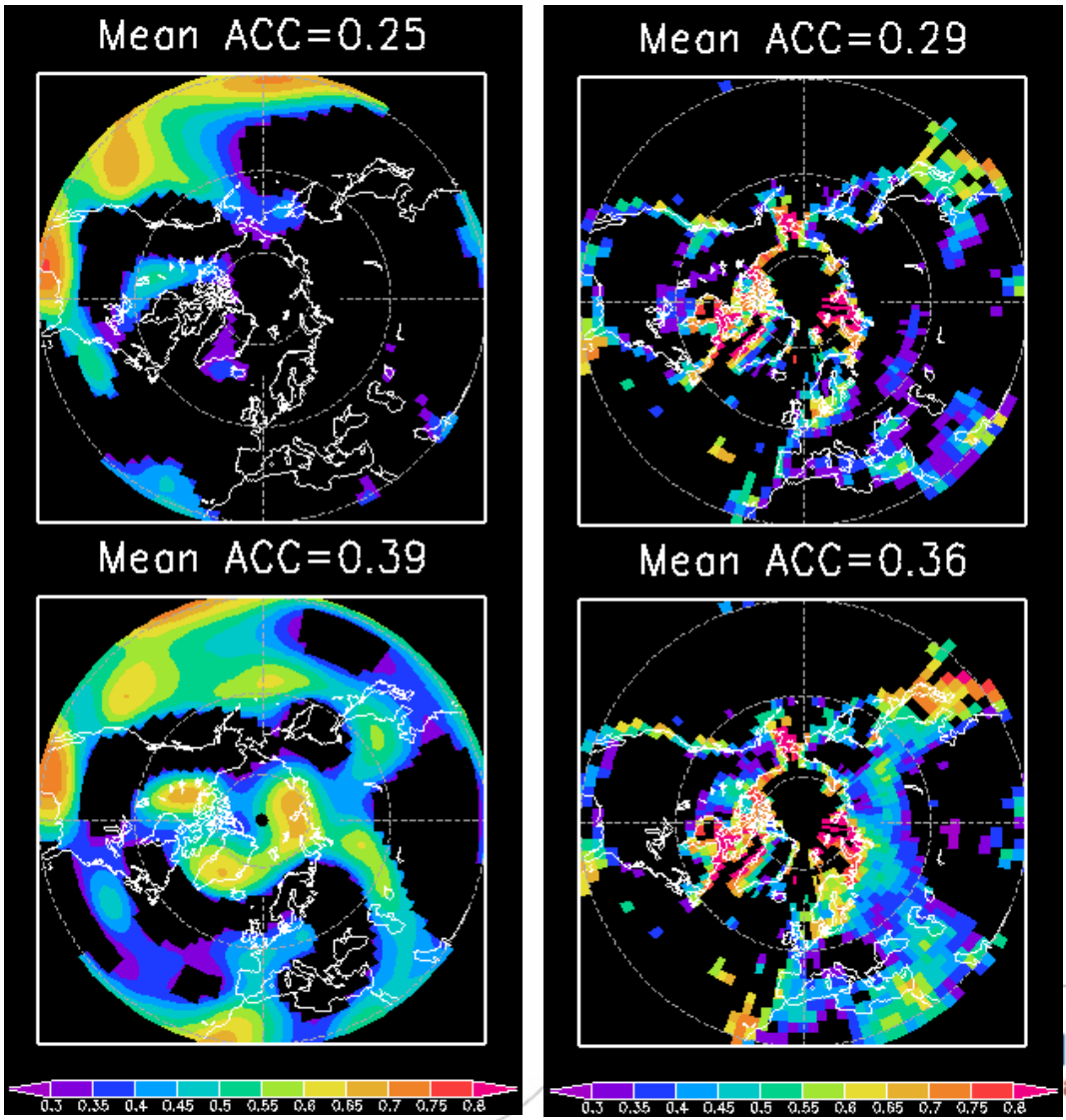
Extension of the study
by Douville (2009)
over 1958-2007

CONTROL

NUDGING

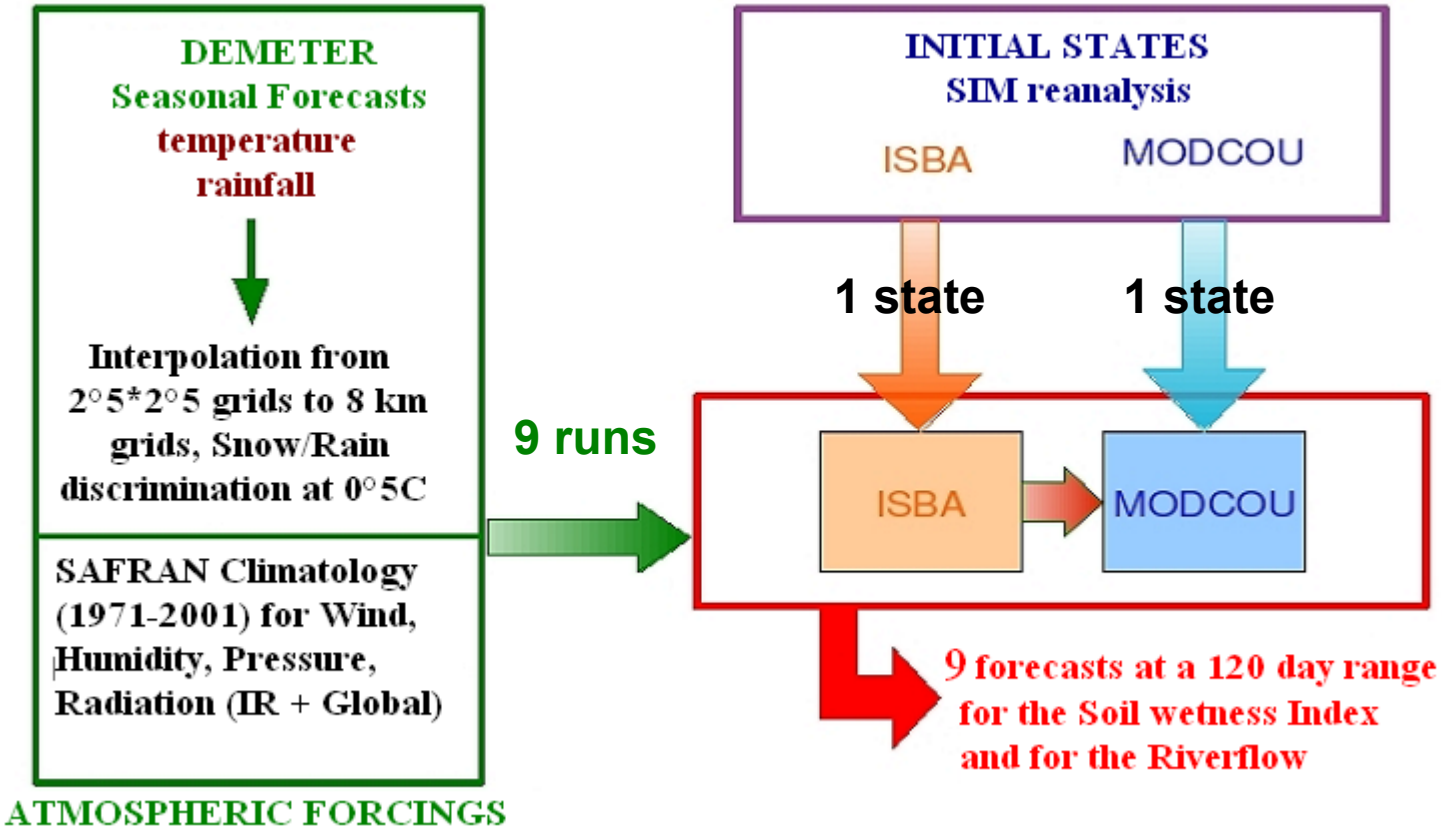
DJF Z500 ACC

DJF T2M ACC



Hydrological forecasts over France

Preliminary tests using DEMETER hindcasts
(should be operational at Météo-France before 2016)



Courtesy of E. Martin

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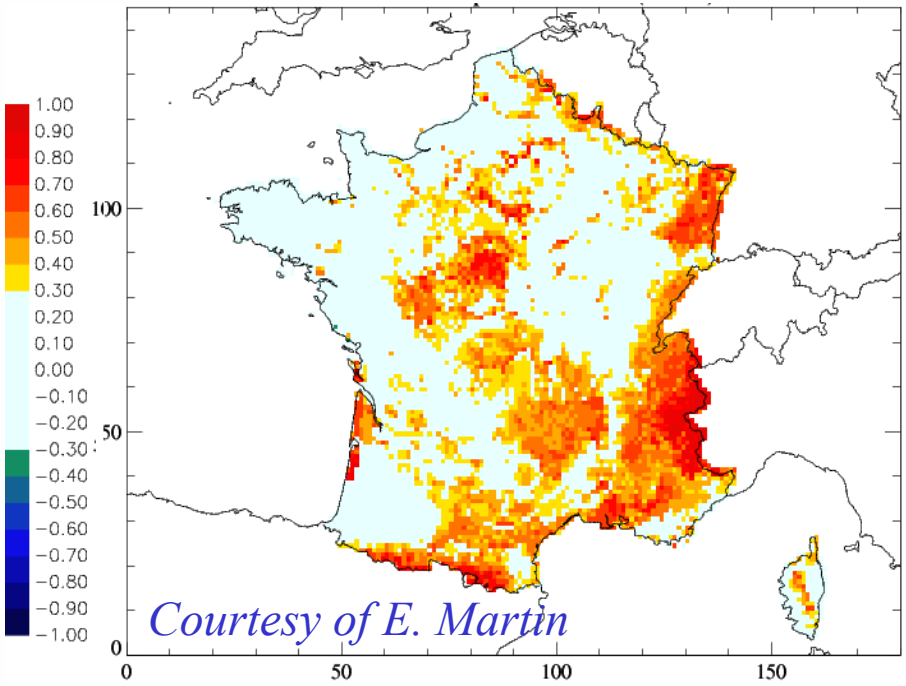
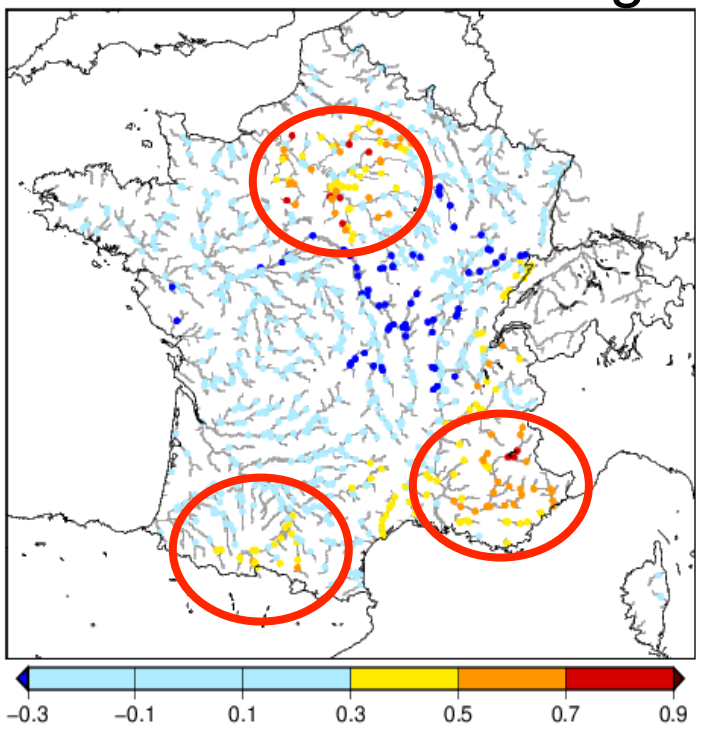
Hydrological forecasts over France

Correlation in Spring over the period 1960-2005
using *climatological* atmospheric forecasts
(impact of land surface initialisation only)

ACC for Soil Wetness Index



ACC for river discharge



Snow (Rhone and Garonne rivers)
Groundwater (Seine river)

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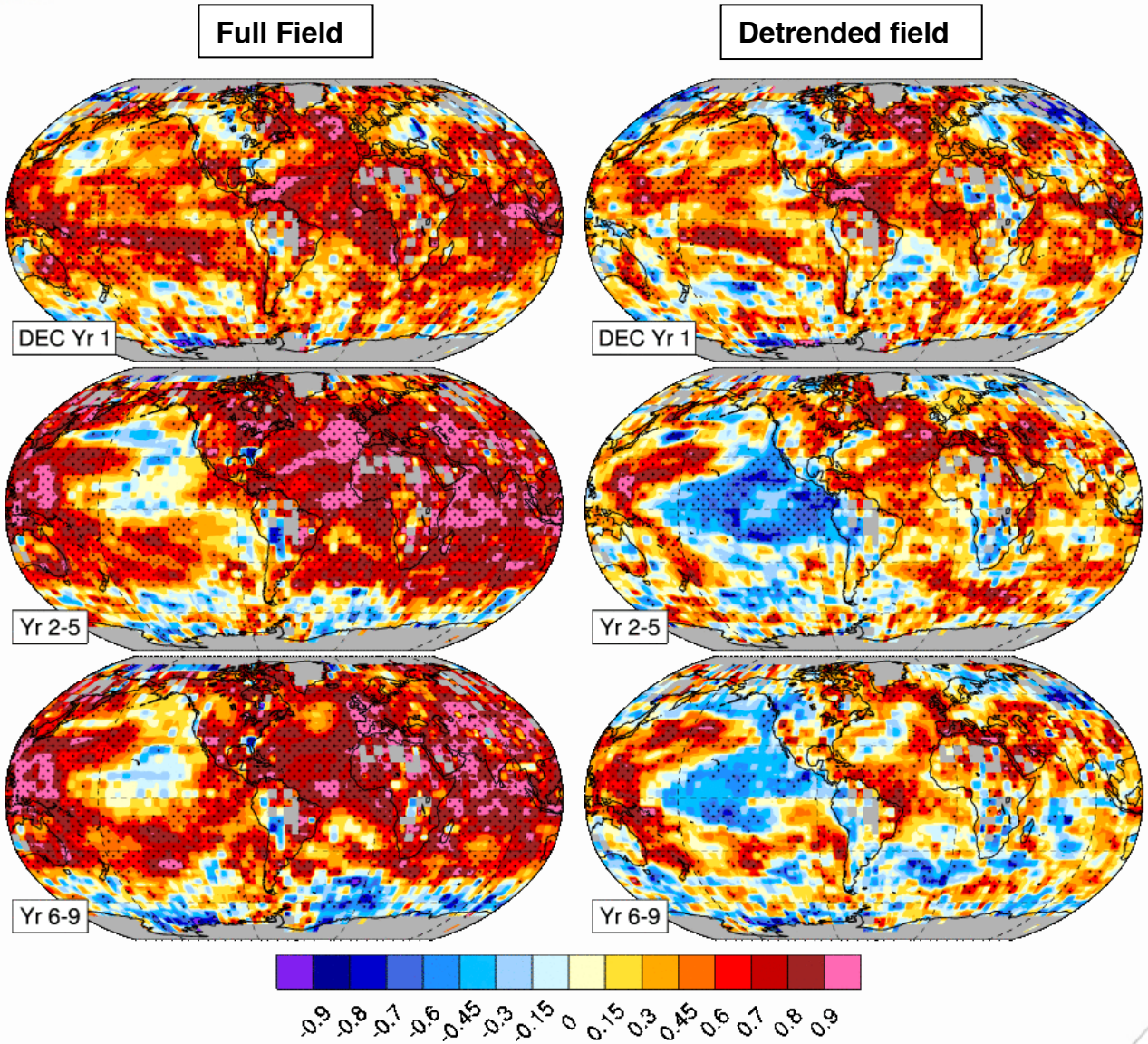
Decadal predictions: CMIP5



ACC of 2-m temperature

CNRM-CM5 contribution to CMIP5:

- 20 dates (1959, 1960, 1964, 1965 … 2004, 2005)
- 10 members

Skill mainly due to the trend. Added value of initialization and high skill:

- First year
- North Atlantic + western Pacific

Poor skill in the central and eastern Pacific

Courtesy of C. Cassou

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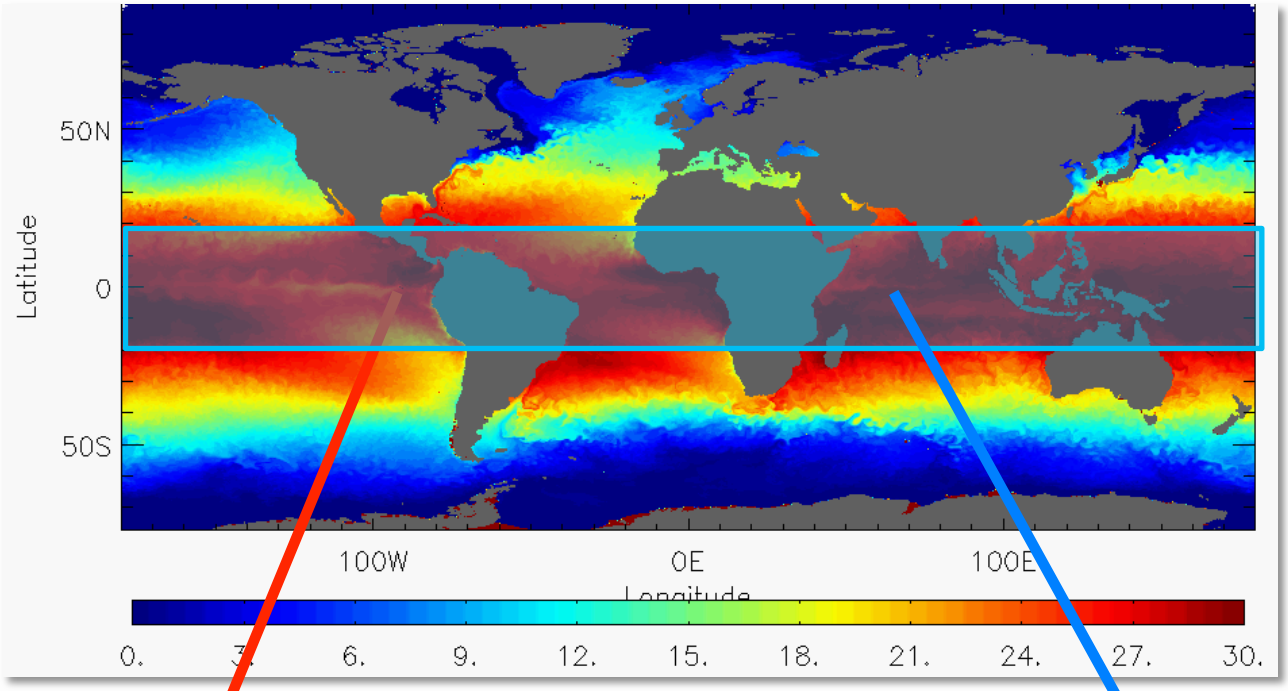
Sensitivity to ocean initialization

- **Ocean initialization :Nudging towards the ECMWF ocean reanalysis NEMOVAR (ORCA1°) [1958 -2008]**
- **Sensitivity test to tropical nudging: EXTROP vs GLOB**



GLOB → No 3D nudging within the 1°S-1°N band

EXTROP → No 3D nudging Within the 15°S-15°N band

Courtesy of C. Cassou

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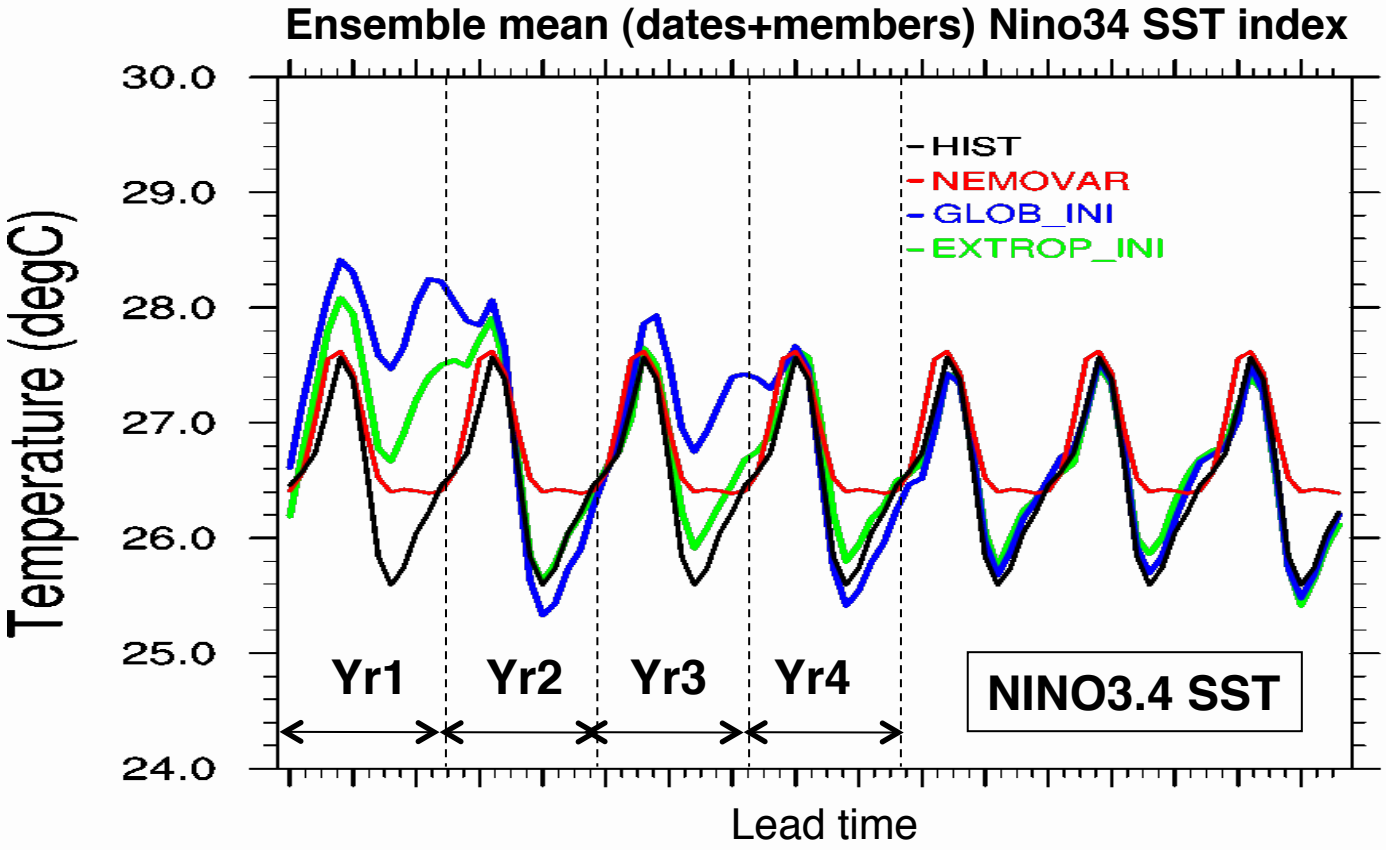
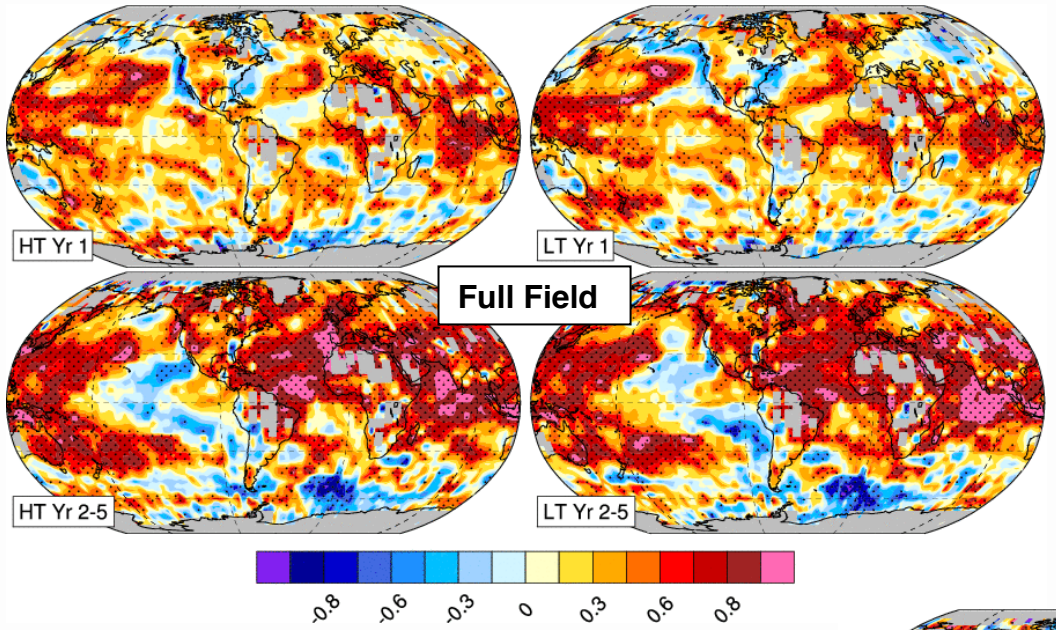
Sensitivity to ocean initialization



Perturbation of the tropical climate up to 4 years (systematic El Niño during years 1 and 3) when the subsurface is initialized in the tropics

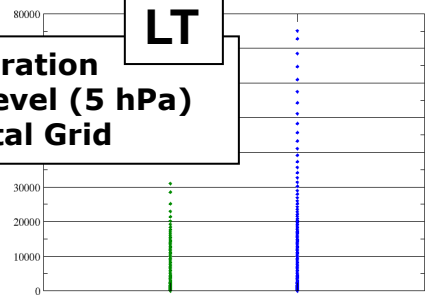
Courtesy of C. Cassou

Sensitivity to vertical resolution



LT

Low Top configuration
- **61 vertical level (5 hPa)**
- **T63 horizontal Grid**

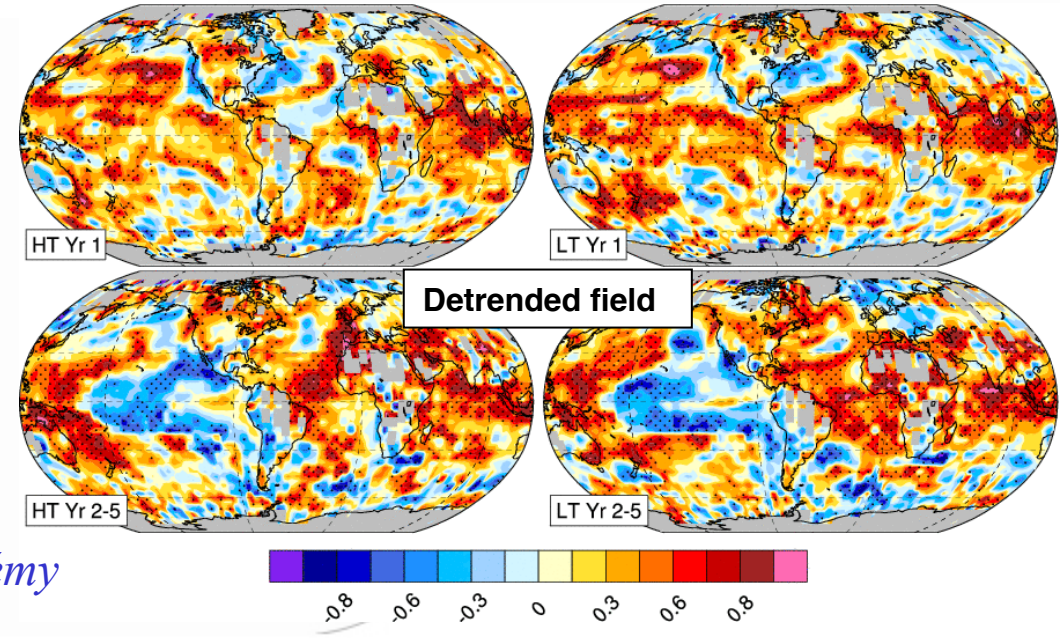


High Top configuration
- **91 vertical level (0.01 hPa) with exact same levels as LT in the troposphere**
- **T63 horizontal Grid**

HT

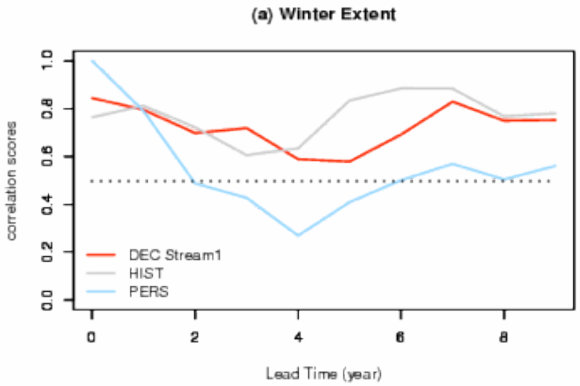
Experiments
- 10 dates (more to come)
- 6 members for each date
- 5 years long

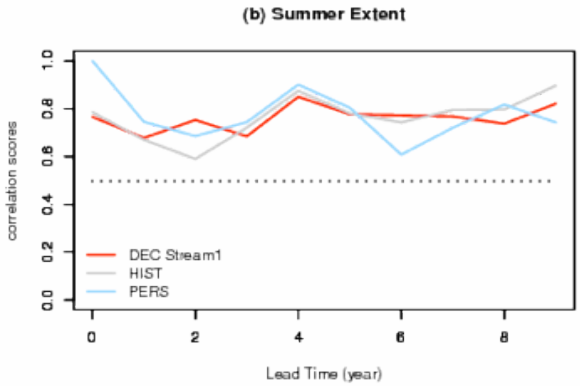
No significant change compared to CMIP5. No significant added value for the high-top model.

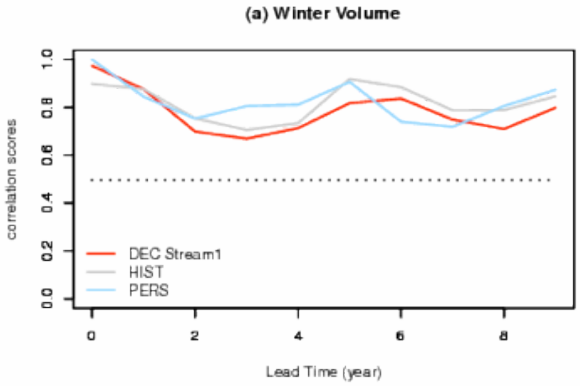


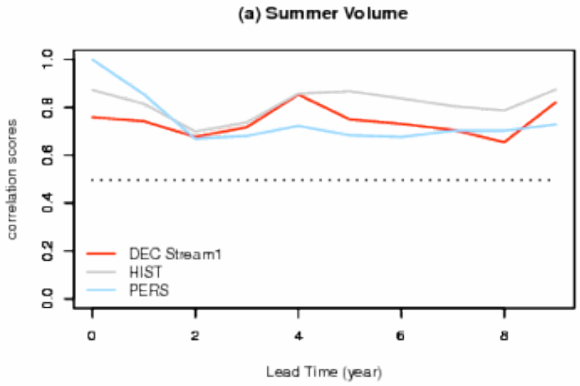
Courtesy of C. Cassou and J-F. Guérémy

Decadal prediction of Arctic sea-ice

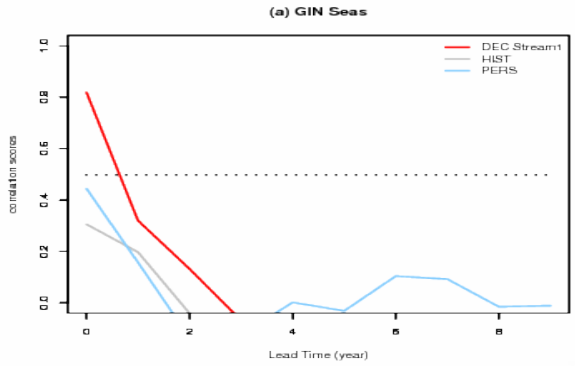








Positive impact of initialization for Nordic Seas during years 1 to 3



- Decadal
- Historical
- Persistence

Spread (not shown) shows a significant sea ice memory but skill is dominated by external forcings

Courtesy of A. Germe

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CONCLUSIONS

- EUROSIP: from system 3 (T63L91) to system 4 (T127L31) in line with the CMIP5 configuration of CNRM-CM
- Contribution to Strat-HFP and Ice-HFP
- Stochastic dynamics: positive impact mainly in the extratropics
- Seasonal hindcasts of sea ice over 1989-2010 (soon 1979-2012)
- Seasonal hydrological and cereal yield hindcasts over France

- Contribution to CMIP5 decadal predictions
- Sensitivity experiments to ocean initialization (sensitive) and vertical resolution in the stratosphere (not sensitive)
- Decadal hindcasts of Arctic sea ice: no added value of initialization outside the Nordic Seas
- Ensembles of 2006-2023 forecasts: significant impacts of a Pinatubo-like eruption in 2010 or of a suppressed 11-yr solar cycle, especially in the northern extratropics

PROSPECTS

- Towards system 5 (T127L91, stochastic dynamics)
- GELATO sea ice and SURFEX land surface hydrology with off-line analyses (SPECS)
- Improved non orographic gravity wave drag (QBO?)
- Sea ice prediction with NEMO-GELATO flux adjustement
- Preliminary tests with increased horizontal resolution for both seasonal (PRACE, 50km AGCM / 0.25°OGCM) and decadal (SPECS)
- Hydrological and cereal yield seasonal forecasts over France


End
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