Decadal Prediction in the Mediterranean Region

Virginie Guemas[1,2], Javier García-Serrano[1,3,4], Annarita Mariotti[5], Francisco J. Doblas-Reyes[1,6], Louis-Philippe Caron[1,7]

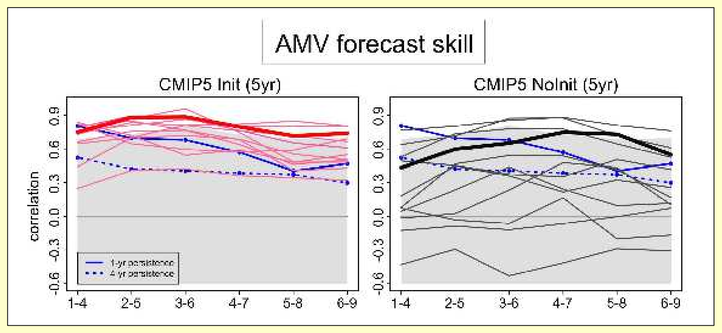
(1) Institut Català de Ciències del Clima, (2) Centre National de Recherches Météorologiques, (3) Atmosphere and Ocean Research Insitute, (4) Laboratoire d'Océanographie et du Climat, (5) National Oceanic and Atmospheric Administration, Climate Program Office, Silver Spring, (6) Institució Catalana de Recerca I Estudis Avançats, (7) Swedish Meteorological and Hydrological Institute

A – Mediterranean Climate

- Mediterranean region = one of the most sensitive to climage change in terms of warming and drying (Mariotti et al. (2008) --> Source of predictability
- During the 20th century, decadal variability has substantially modulated the climate change signal in the Mediterranean region (Mariotti and Dell'Aquila, 2012)

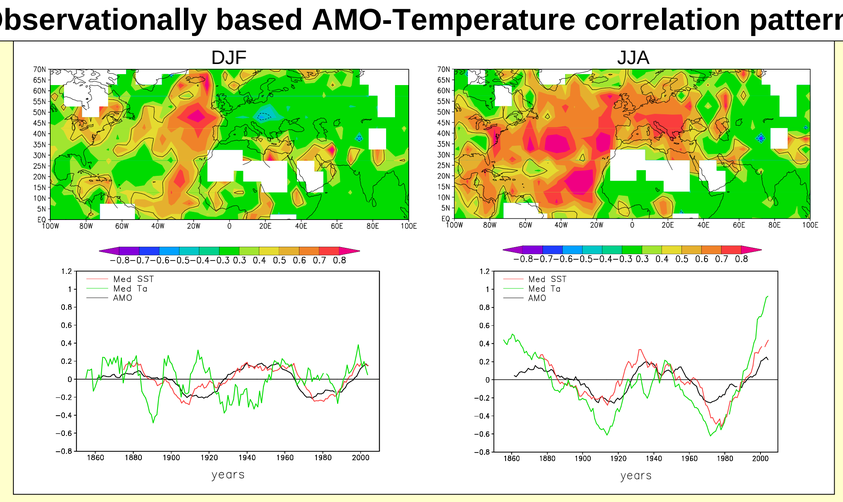
To which extent will natural variability enhance or reduce externally forced changes and for how long?

B – AMO-related predictability



From García-Serrano et al. (2013), AMV = North Atlantic mean SST (80W-0, 0-60N) – global mean SST (60S-60N)

Observationally based AMO-Temperature correlation patterns



From Mariotti and Dell'Aquila (2012)

Skill in predicting the Atlantic Multidecadal Oscillation enhanced by initialization

Strong connection between summer temperatures and AMO, weaker link in winter

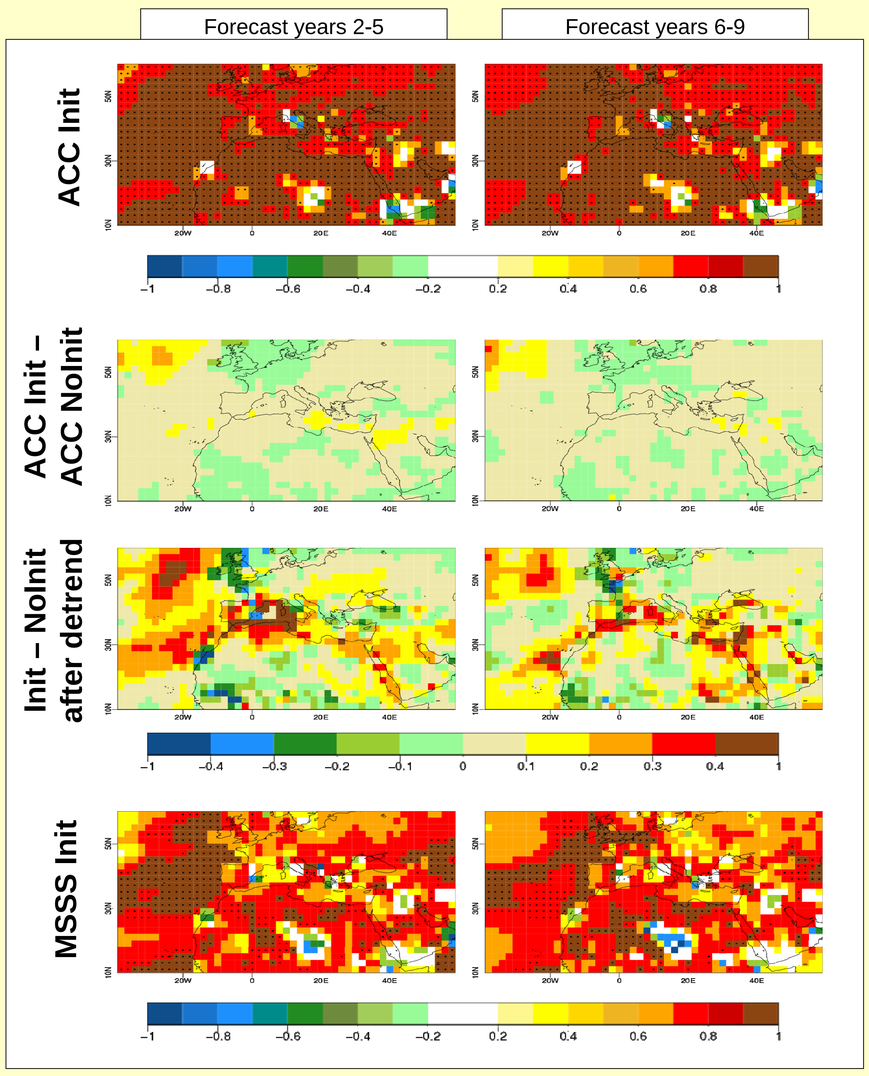
C – Data

- Multi-Model Ensemble (MME) = Model contributing to the CMIP5 decadal prediction exercise : HadCM3, MRI-CGCM3, MIROC4h, MIROC5, CanCM4, CNRM-CM5, MPI-M, GFDL-CM2, CMCC-CM, IPSL-CM5, Ec-Earth2
- Predictions initialized every 5 years, between 1 November and the following 1 January = 10 multi-member multi-model predictions = **CMIP5 Init**
- Compared to sister ensemble built from the historical simulations until 2005 and the RCP4.5 projections afterwards = **CMIP5 NoInit**
- The same radiative forcings are applied in Init and NoInit. They only differ by the lack of constraint of the simulated natural variability toward the contemporaneous observed one in NoInit.
- Observational data : For temperature, ERSST v3b over seas, GHCN over land except north of 60°N where GISTEMP is used; For precipitation, GPCCv5
- Temperature **detrending** = subtracting the global mean SST (60°S-60°N) at ocean grid points, and the global land mean (60°S-60°N) at ocean grid points
- **ACC** = Anomaly Correlation Coefficient = Correlation of the simulated anomalies with the observed ones after bias correction following the 'per-pair method'
- **MSSS** = Mean Square Skill Score = 1 – RMSE (Init) / RMSE (climatological forecast) where RMSE = Root Mean Square Error

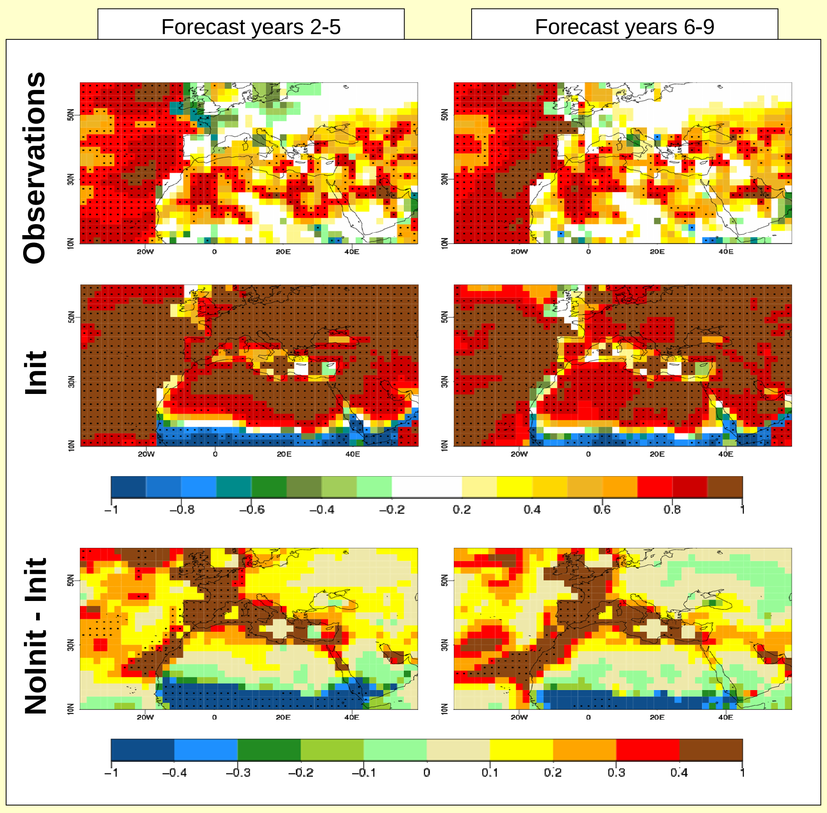
Assessment of the temperature and precipitation skill beyond that originating from the radiatively forced signal

D – Annual Mean Mediterranean Temperature

Skill in Annual Temperature



Correlation Annual Temperature with AMO



High and broadly significant ACC skill, MSSS pattern consistent with ACC one although slightly lower

Increase in ACC over Eastern Atlantic, Mediterranean Sea with initialization, with initialization decrease over Northern Europe and sub-Saharan Africa

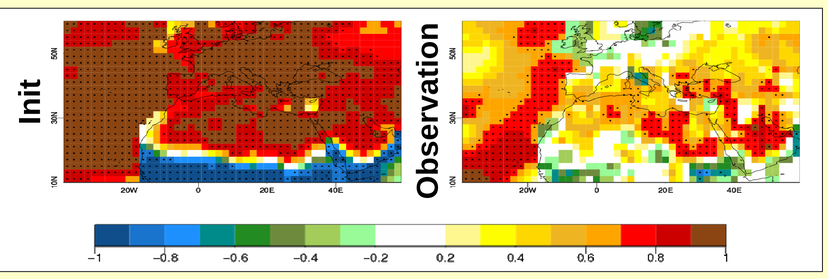
Init captures the positive correlations between AMO and temperature over Eastern Atlantic, Mediterranean Sea and northern North Africa which probably explains the increase ACC skill with initialization in those regions

Init exhibits positive correlations between AMO and temperature over Northern Europe and negative correlations over sub-Saharan Africa which might explain the decrease ACC skill with initialization in those regions

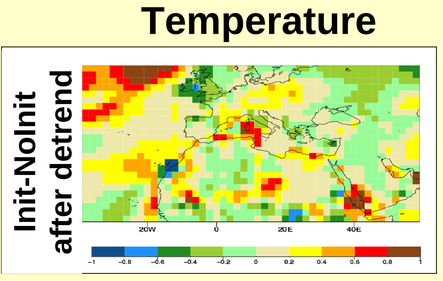
The pattern of Init-NoInit correlations of temperature with the AMO index share strong similarities with the pattern of Init ACC-NoInit ACC

E – JJA Temperature

Correlation JJA Temperature with AMO



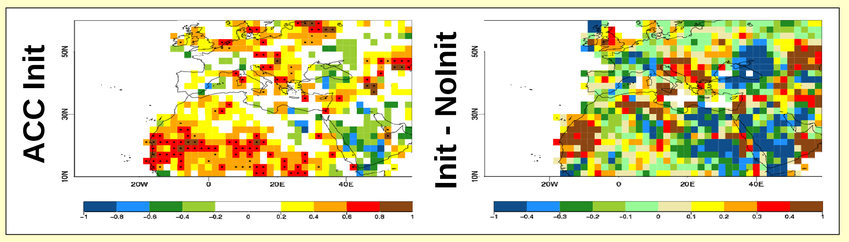
Skill in JJA Temperature



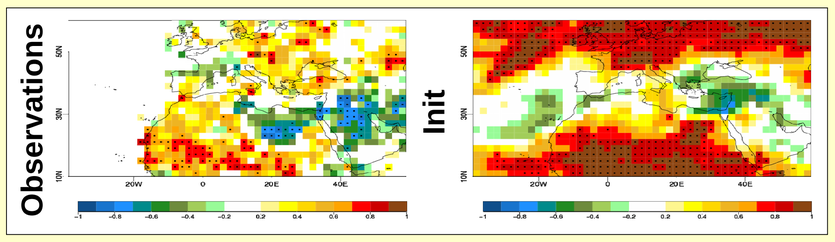
Correlation between observed JJA temperature and AMO become positive over Eastern Europe and negative over sub-Saharan Africa (compared to Annual) ; Simulated pattern is more consistent with the observed one there

F – Annual Mean Mediterranean Precipitation

Skill in Annual Precipitation



Correlation Annual Precipitation with AMO



Significant ACC over Northern Europe and sub-Saharan Africa mainly originating from radiative forcings

Positive correlations over Northern Europe and sub-Saharan Africa captured by Init, correspond to high skill

Conclusions

- High and significant skill in predicting 4-year average annual and summer mean temperature over most of the study domain, lower skill in winter
- Most of the skill originates from the radiatively forced climate signal
- The initialization contributes to the temperature skill over the Mediterranean region and surrounding land areas
- High correlation between the temperature and the AMO in the summer and annual means captured by Init which suggests that this improved skill is AMO-related.
- High and significant skill in predicting 4-year average annual and summer mean precipitation over northern Europe and sub-Saharan Africa
- Positive correlation between the AMO and precipitation over Western Africa during summer captured by Init, AMO-related skill in Western Africa in summer

References :

García-Serrano, J.,V Guemas and F.J. Doblas-Reyes (2013) Added-value from initialization in skilful predictions of North Atlantic multi-decadal variability, submitted to Geophysical Research Letters.

Guemas V., García-Serrano J., Mariotti A., Doblas-Reyes F., Caron L.-P., 2013, Decadal Prediction in the Mediterranean, submitted to Climate Dynamics.

Mariotti, A. et al., 2008: Mediterranean water cycle changes: transition to drier 21st century conditions in observations and CMIP3 simulations. Environ. Res. Lett, 3, 044001 (8pp) doi:10.1088/1748-9326/3/4/044001.

Mariotti A and Dell'Aquila A, 2012: Decadal climate variability in the Mediterranean region: roles of large-scale forcings and regional processes. Clim. Dynamics, 38 (5-6), 1129-1145, doi: DOI 10.1007/s00382-011-1056-7.