NORTHERN HEMISPHERE TELECONNECTION INDICES SIMULATED WITH CMIP3.

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1. INTRODUCTION.

Northern Hemisphere teleconnection [1] have widely studied due to their connection with climate around the world. Teleconnection indices can be applied for climate prediction. Therefore, it is important to assess whether climate models are able to simulate the indices at present and how teleconnections may be modified under climate change [2]. In this work, we use Partial Least Square regression [3] to obtain the teleconnection indices corresponding to climate models.

2. DATA.

- 500-hPa geopotential height data (Z_{500}) from the World Climate Research Programme´s (WCRP´s) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model data set [4] collecting the simulations performed for the IPCC AR4. 20C3M (1950-1999) and A1B (2001-2050) experiments.
- NCEP/NCAR 500-hPa geopotential height Reanalysis [5].

3. METHODS.

- Spatial Teleconnection Patterns (TP) corresponding to the indices provided by Climate Prediction Center (CPC) of NOAA are computed by means of correlations between Teleconnection Indices (TI) and standardized monthly Z_{500} anomalies from Reanalysis.
- Partial Least Squares (PLS) regression method is applied to obtain the simulated TI. The monthly TP from CPC are the predictors and the standardized monthly anomalies Z_{500} from model data are the predictand. The regression coefficients will be the simulated TI.
- Simulated TP are obtained by correlating simulated indices and standardized monthly Z_{500} anomalies from models.
- The simulated teleconnection against "observed" evaluation is performed spatially on the TP and temporally on the trend and Probability Density Functions (PDFs) of the TI.

The following TI are analyzed: North Atlantic Oscillation (NAO); East Atlantic (EA); East Atlantic West Russia (EWR) and Scandinavian (SCA), which have impact on climate variability over the Iberian Peninsula (IP). Results are presented for winter (DJF) by averaging the TI for nine models (Table 1). Initially, model data were interpolated to a common 2.5°×2.5° grid corresponding to NCEP/NCAR Reanalysis.

Table 1: CMIP3 used for the evaluation

Norway	**BCCR-BCM2.0**	Australia	**CSIRO-Mk3.5**	Japan	**MRI-CGCM2.3.2**
Canada	**CGCM3.1(T63)**	Germany	**ECHAM5/MPI-OM**	UK	**UKMO-HadCM3**
France	**CNRM-CM3**	USA	**GFDL-CM2.1**	UK	**UKMO-HadGEM1**

4. RESULTS.

A) Teleconnection patterns evaluation

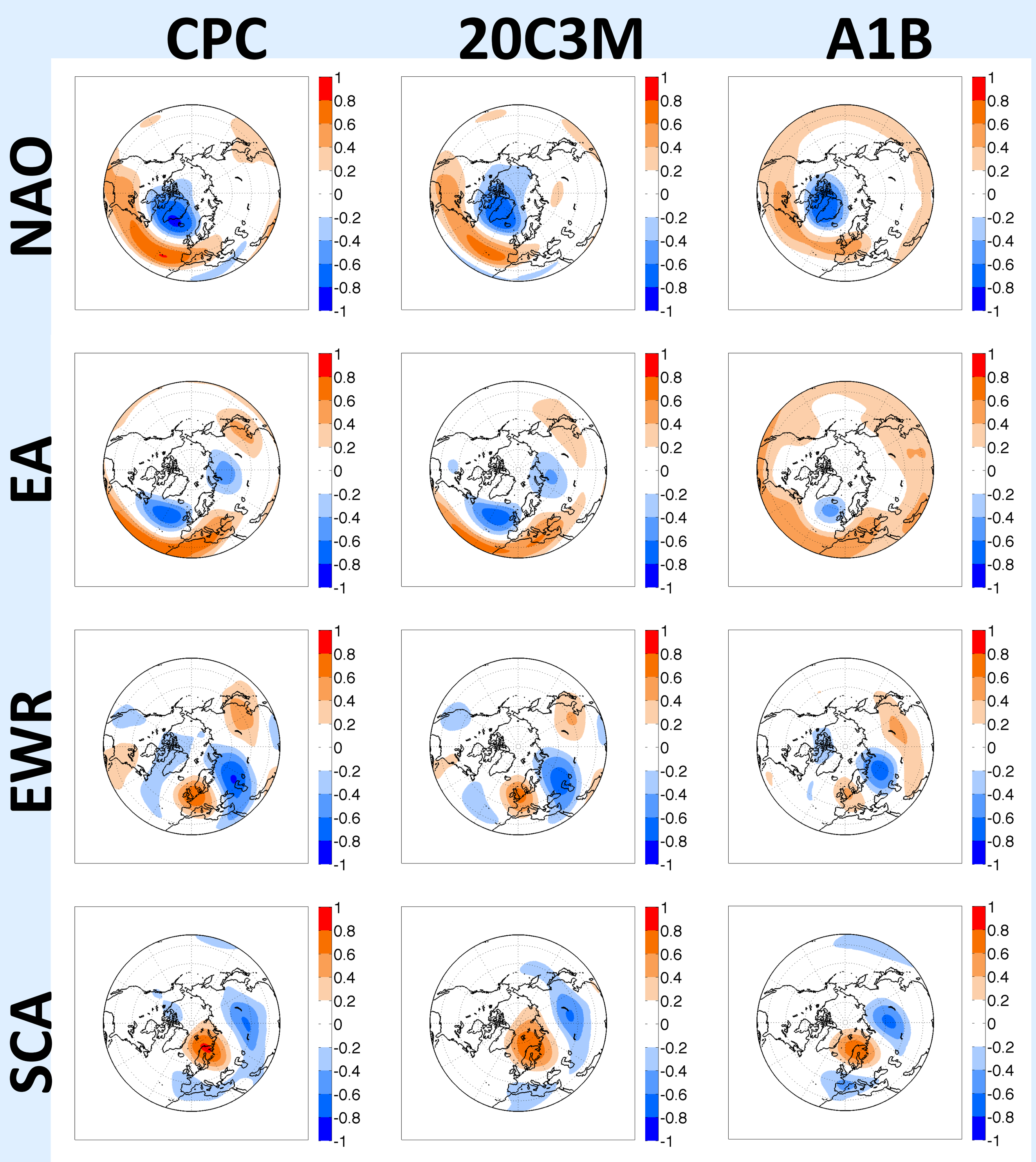

Figure 1: First column shows the TP corresponding to CPC, the second and third columns show the TP corresponding to the 20C3M and SRESA1B models for DJF.

The ability of models to simulate TP is quantified by obtaining spatial correlation coefficients (Table 2). 20C3M models agree quite well with CPC according to the correlation coefficients and Figure 1 indicates that the patterns are able to reproduce the main centers. The spatial correlation is less significant for A1B multi-model and the patterns project the following changes:

The NAO pattern experiments a shift toward northern latitudes, which has been previously documented. The positive center of EA pattern spreads over all tropical areas. The EATL/WRUS and SCAND patterns show more weaken structures.

Table 2: Spatial correlations between teleconnection patterns: 20C3M and A1B models against CPC

	20C3M	A1B
NAO	**0.96**	**0.84**
EA	**0.92**	**0.71**
EWR	**0.89**	**0.78**
SCA	**0.88**	**0.82**

B) Teleconnection indices evaluation

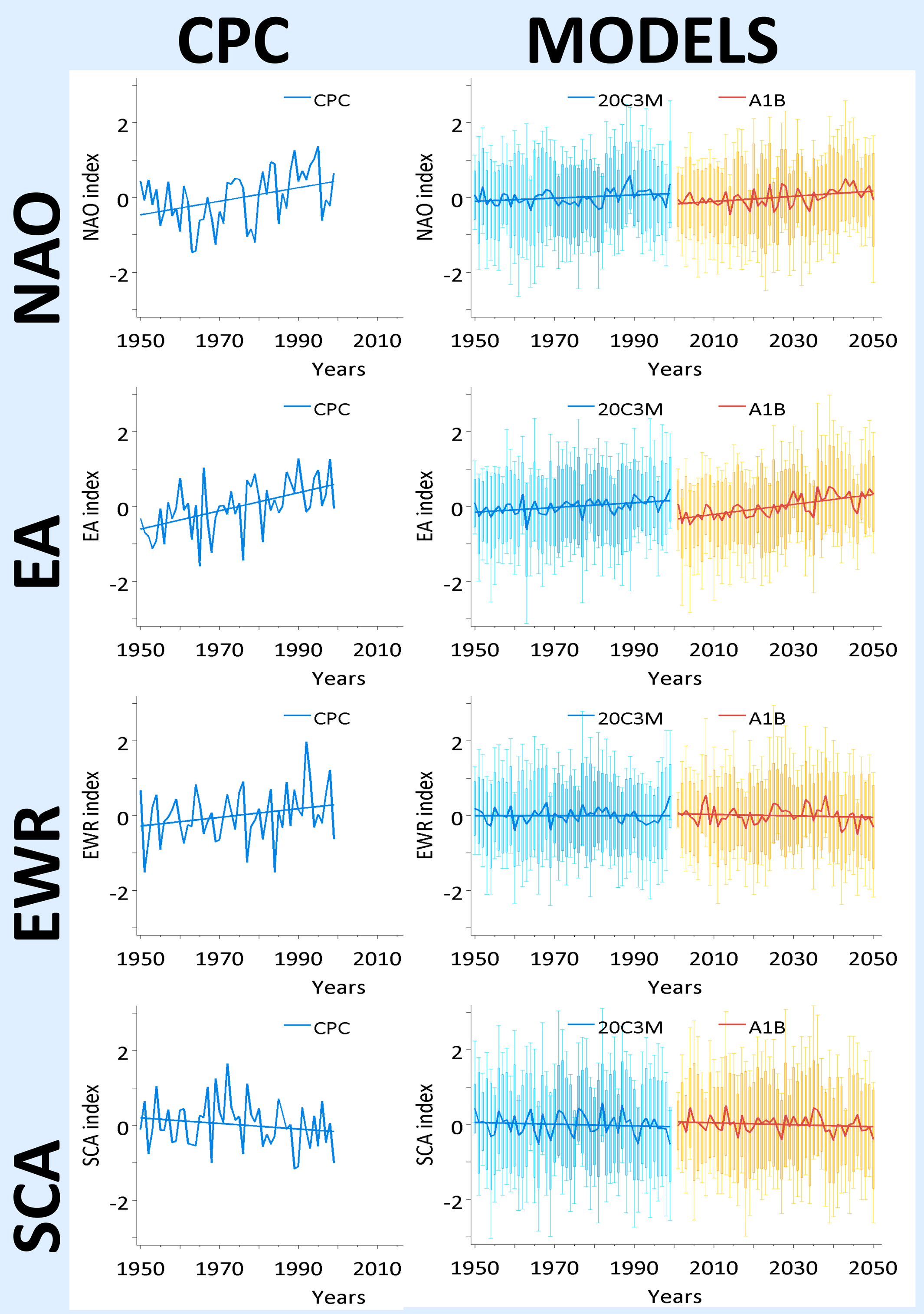

Figure 2: Left-hand column corresponds to CPC and right-hand column is for models. The thick lines represent the multi-model time series and the trend, the boxes represent the spread of models, measured by the standard deviation, and the whiskers represent the most extreme simulated indices.

Table 3 :Trend analysis per year

Z-Kendall	CPC	20C3M	A1B
NAO	**2.61**	**1.87**	**2.80**
EA	**3.71**	**3.40**	**5.03**
EWR	**1.50**	**-0.50**	**-0.58**
SCA	**-1.12**	**-0.64**	**-1.08**

The TI are shown in Figure 2; the models indices indicate less variability than the corresponding from CPC, which is a consequence of the averaging process. Trend parameters of the TI for the CPC and simulations are in Table 3. Trends are measured by the Kendall'Z test. The trend is significant for NAO and EA indices (Z > I2I). A1B models project an increase of the indices at a rate of 0.10/decade for the NAO and 0.13/decade for the EA. These results would cause a decrease on precipitation [6] and an increase on air temperature over the IP.

C) Probability density function evaluation

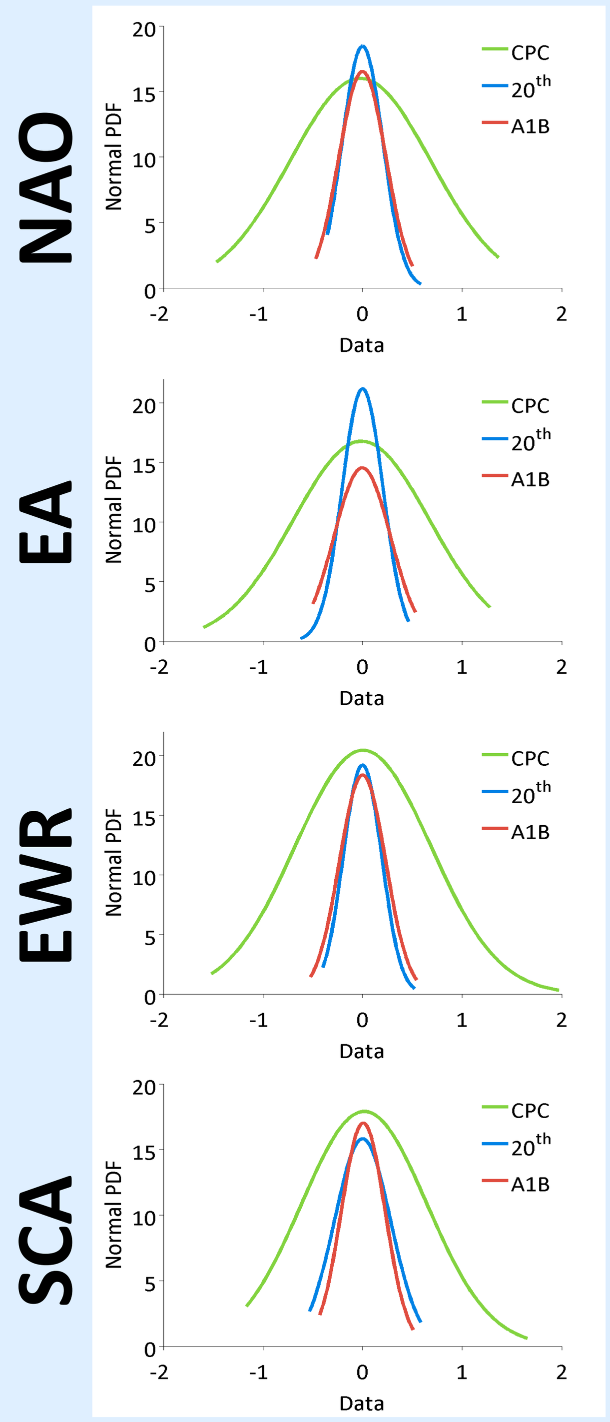

Figure 3: Probability Density Functions (PDFs) corresponding to CPC, 20C3M and A1B multi-model data.

Table 4: statistical parameters that characterize the distribution: Kurtosis (KT), Skewness (SK).

		20C3M	A1B	CPC
NAO	KT	**-0.05**	**-0.70**	**-0.71**
	SK	**0.47**	**0.13**	**-0.18**
EA	KT	**0.48**	**-0.97**	**-0.30**
	SK	**-0.38**	**0.28**	**-0.28**
EWR	KT	**-0.03**	**0.09**	**0.52**
	SK	**0.20**	**0.14**	**0.15**
SCA	KT	**-0.69**	**-0.17**	**-0.19**
	SK	**0.08**	**0.20**	**0.29**

Climate change of the TI can be presented by comparing PDF´s. All indices adjust to a normal distribution. Greater positive skewness is projected under A1B for NAO and EA with respect to CPC.

5. CONCLUSIONS.

In this preliminary study about evaluation of TI we have obtained the following results:

→The spatial configuration of 20C3M Teleconnection Paterns agree quite well with the corresponding from CPC.

→ For Teleconnection indices under SRES A1B:

- A shift to northern latitudes for the NAO.
- A spread of EA positive center to tropical areas.
- A weaken of SCAND and EATL/WRUS structures.
- An increase of the trend significance for the NAO (rate 0.1/decade) and EA (rate 0.13/decade).
- An increase to more positive phases for the NAO and EA according to the skewness parameter.

The causes of the TI changes under different climate conditions would be the objective of future work by taking into account the interactions between the TI with Sea Surface Temperature and stratospheric influences.

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REFERENCES.

[1]*Barnston AG, Livezey RE. 1987. Classification, seasonality and persistence of low-frequency atmospheric circulation patterns. Monthly Weather Review, 115: 1083–1126*

[2] *Handorf D, Dethloff K. 2009. Atmospheric teleconnection and flow regimes under future climate projections. Eur. Phys. J. Special Topics, 174: 273-255*

[3] *Smoliak, BV, Wallace JM, Stoelinga MT, Mitchell TP. 2010. Application of partial least squares regression to the diagnosis of year-to-year variations in Pacific Northwest snowpack and Atlantic hurricanes. Geophysical Research Letters, 37: L03801*

[4] *Meehl GA, Covey C, Delworth T, McAvaney B, Mitchell JFB, Stouffer RJ, Taylor KE. 2007. The WCRP CMIP3 multimodel dataset: a new era in climate change research. Bulletin of the American Meteorological Society 88: 1383–1394*

[5] *Kalnay E, Kanamitsu M, Kistler R, Collins W, Deaven D, Gandin L, Iredell M, Saha S, White G, Woollen J, Zhu Y, Chelliah M, Ebisuzaki W, Higgins W, Janowiak J, Mo KC, Ropelewski C, Wang J, Leetmaa A, Reynolds R, Jenne R, Joseph D. 1996. The NCEP/NCAR 40-year reanalysis project. Bulletin of the American Meteorological Society 77: 437–471*

[6] *Rodriguez-Puebla C, Nieto S. 2009. Trends of precipitation over the Iberian Peninsula and the North Atlantic Oscillation under climate change conditions. International Journal of Climatology. Published online in Willey InterScience. DOI: 10.1002/joc.2035*