EURO-ATLANTIC VARIABILITY MODES

SIMULATED BY IPCC-AR4 MODELS IN WINTER

M. J. Casado [(1)], M. A. Pastor [(1)] and E. Rodriguez-Camino [(1)]

(1) Agencia Estatal de Meteorología (AEMET), Madrid, España (mcasadoc@aemet.es)

1. INTRODUCTION AND GOAL

The choice of variability modes as a tool for climate model assessment can be justified by the fact that modes of variability determine local climatic conditions and their likely change may have important implications for future climate changes. The main goal of this study is to analyze the ability of the multi-model simulations from IPCC AR4 to simulate the main leading modes of variability over the Euro-Atlantic region in winter: the North-Atlantic Oscillation (NAO), the Scandinavian mode (SCAND), the East/Atlantic Oscillation (EA) and the East Atlantic/Western Russia mode (EA/WR). These modes of variability have been spatially evaluated, by analyzing the intensity and location of their anomaly centers. For more details see Casado and Pastor (2011).

2. DATA

- Daily Mean Sea Level Pressure (MSLP) from the ECMWF ERA40 (Uppala et al. 2005), as reference data.
- Daily MSLP from 16 IPCC AR4 models (those with daily MSLP data available) (http://www-pcmdi.llnl.gov).

ERA40 and AR4 models datasets have been interpolated to a common longitude-latitude grid (2.5^0 X 2.5^0).
Spatial domain: 25^0N-70^0N, 45^0 W-50^0E.
Temporal domain: Winter season (DJF), from 1980 to 1999.

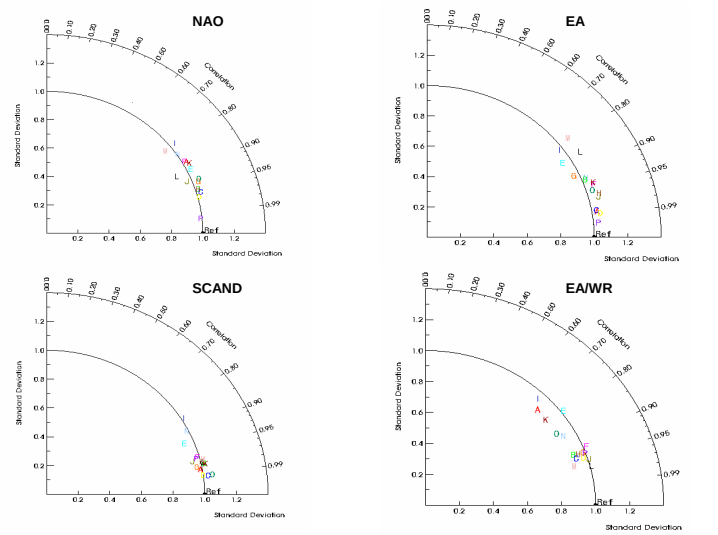

Figure 2. Taylor diagrams for comparison of spatial patterns between the AR4 models (color letters) and ERA40 (Reference value (Ref), black point): for NAO, SCAND, EA and EA/WR.

3. METHODOLOGY

Variability modes have been estimated using an S-mode Principal Component Analysis (PCA) following the same procedure and notation described in Casado et al. (2008). PCA was carried out on a covariance matrix with 741x741 elements, with each element weighted by the normalized cosine of the latitude of each grid point. In a second stage, to reduce the effect of merging patterns, the varimax orthogonal rotation (Richman 1986) has been applied. A LEV diagram is considered to determine the number of PCs to retain, resulting in four. These four modes explain the 69% of the total ERA40 variance (Table 1).

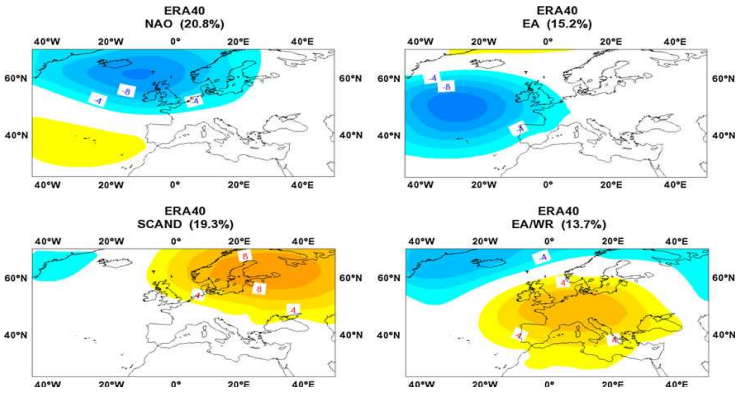

Figure 1. ERA40 variability modes (Interval: 2 hPa). In parenthesis the percentage of the explained variance

	*	NAO	SCAND	EA	EA/WR	TOTAL
ERA40		20.8	19.3	15.2	13.7	69.0
BCCR-BCM2.0	A	16.7	16.0	15.7	18.7	67.1
CCSM3	B	18.6	19.6	15.6	16.1	69.9
CGCM3.1(T47)	C	18.7	15.7	15.8	16.5	66.7
CGCM3.1(T63)	D	19.7	18.9	15.7	13.5	67.8
CNRM-CM3	E	12.6	22.6	21.4	12.0	68.6
CSIRO-Mk3.0	F	16.9	14.4	15.6	14.4	61.3
ECHAM5/MPI-OM	G	16.4	19.1	18.3	13.9	67.7
GFDL-CM2.0	H	19.5	15.6	14.4	14.9	64.4
GISS-AOM	I	15.0	14.1	25.1	9.6	63.8
INM-CM3.0	J	19.5	15.9	15.6	17.2	68.2
MIROC3.2(hires)	K	17.4	16.0	17.9	15.0	66.3
MIROC3.2(medres)	L	15.8	14.4	16.1	15.8	62.1
MRI-CGCM2.3.2	M	18.7	12.8	20.5	17.9	69.9
PCM	N	17.4	18.3	17.6	14.2	67.5
UKMO-HadCM3	O	17.8	14.0	17.0	13.0	61.8
UKMO-HadGEM1	P	20.1	19.2	15.0	14.1	68.4

Table 1. Percentage of the explained variance of ERA40 and AR4 models variability modes. * Letters identify individual AR4 models.

4. SUMMARY AND CONCLUDING REMARKS

- The ERA40 variability modes (Figure 1), based on daily data, are quite similar to those obtained in the literature with monthly data for the winter over the Euro-Atlantic region (Wallace and Gutzler 1981; Barnston and Livezey 1987). The 16 AR4 models are able to reproduce the main spatial features of the corresponding ERA40 modes. The NAO and SCAND explained variances are underestimated by most models (up to 16 and 14 respectively) whereas the EA and EA/WR explained variances are overestimated by the majority of models (see Table 1) .

- To analyze in more detail, the main differences between the ERA40 and AR4 modes, the Taylor diagram is used (Taylor 2001) (Figure 2). These sets of diagrams display for each mode, in a single view, correlation coefficient, variances ratio and centred root mean square error of models with respect to ERA40. All AR4 models considered here, show high correlation coefficients ranging from 72.7% to 99.5%, being SCAND the mode with greater number of models within an area of high correlations. With respect to the ratio of variances most models show values close to one, mainly for SCAND and NAO, whereas they tend to underestimate the variance for EA/WR and overestimate for EA.

- UKMO-HadGEM1 and CGCM3.1(T63) are the models best simulating spatial characteristics whereas GISS-AOM shows the biggest bias for the four modes.

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