STARDEX

STAtistical and Regional dynamical Downscaling of EXtremes for European regions

EVK2-CT-2001-00115

Deliverable D13

RECOMMENDATIONS ON THE MOST RELIABLE PREDICTOR VARIABLES AND EVALUATION OF INTER - RELATIONSPHIPS

PART I

FOREWORD

The STARDEX project on STAtistical and Regional dynamical Downscaling of Extremes for European regions is a research project supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the Key Action "global change, climate and biodiversity" within the Environment, Energy and Sustainable Development.

STARDEX will provide a rigorous and systematic inter-comparison and evaluation of statistical and dynamical downscaling methods for the construction of scenarios of extremes. The more robust techniques will be identified and used to produce future scenarios of extremes for European case-study regions for the end of the 21st century. These will help to address the vital question as to whether extremes will occur more frequently in the future.

For more information about STARDEX, contact the project co-ordinator Clare Goodess (c.goodess@uea.ac.uk) or visit the STARDEX web site:
http://www.cru.uea.ac.uk/projects/stardex/

STARDEX is part of a co-operative cluster of projects exploring future changes in extreme events in response to global warming. The other members of the cluster are MICE and PRUDENCE. This research is highly relevant to current climate related problems in Europe. More information about this cluster of projects is available through the MPS Portal:
http://www.cru.uea.ac.uk/projects/mps/

STARDEX is organised into five workpackages including Workpackage 2 on 'Observational analysis of changes in extremes, their causes and impacts' which was responsible for the production of this deliverable (D9). Workpackage 2 is co-ordinated by András Bárdossy from the Institut für Wasserbau, University of Stuttgart, Germany.

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1. Introduction

The purpose of deliverable D13 is to recommend the most reliable predictor variables and to evaluate their inter –relatioships. According to D10 the predictor studied and used are:

- The geopotential field of 500hPa
- The geopotential thickness field (1000-500hPa)
- The circulation types in 500hPa (Maheras et al. 2000)
- The circulation types in the thickness field (1000-500hPa)

2. Data and Methodology

The data sets used consist of time series of NCEP-NCAR re-analysis data and the mean values of the three ensemble members of the HadAM3P data (addfa, addfb, addfc) for the geopotential field of 500hPa and thickness field (1000-500hPa). The study period runs from 1960-1990 (hereafter referred to as mean HadAM3P).

As a first step the seasonal mean values of the 500hPa geopotential height and the thickness field of 1000-500hPa for both data sets have been computed and the mean seasonal patterns were constructed. Afterwards using the daily catalogues of 14 (500hPa and thickness level 1000-500hPa) circulation types for the study period, the equivalent patterns were constructed. The anticyclonic types are A1, A2, A3, A4, A5 and A6. The cyclonic types are C, Cs, Csw, Cnw, Cne, Cse, Cn and Cw. A comparison between the two data sets has been done, using the biases of the mean values (HadAM3P – NCEP). Finally, the ratios of the standard deviation (Std addfa/StdNCEP) have been calculated only for the first ensemble member HadAM3P(addfa).

3. Results

3.1 Field of 500hPa.

3.1.1. Mean seasonal field of 500hPa

In winter, the mean HadAM3P values of 500hPa geopotential are overestimated in Western Europe and Western Mediterranean (max 40hPa) (Figure1). In spring, mean HadAM3P and NCEP do not present any significant biases for almost the whole of Europe. The only exceptions are found in Eastern Europe and the Balkan Peninsula where the model’s results underestimate the geopotential heights of this field (absolute negative maximum biases = 20hPa). On the other hand, during summer the simulated data present lower values for the study region except for Eastern Europe where the biases are positive. The distribution of the isopleths of biases for autumn is complicated. 500hPa geopotential heights, computed by the mean of the three ensemble members, show a good agreement with NCEP data in Central and Eastern Europe. However, in Southern Europe, the mean HadAM3P tends to underestimate the 500hPa heights while in Northeastern Europe an overstimate is apparent.

The study of the StdRatios in winter, reveals that the model exhibits lower variability than NCEP everywhere in Europe except the eastern part where the ratios are almost equal to 1. In spring the two data sets present the same variability (ratio=1) in central Europe and in the Atlantic Ocean while in the rest of the study area the

HadAM3P data (the addfa ensemble member) have lower variability. For summer the simulated data have relatively higher variability than NCEP for the north and northeastern Europe while in the Mediterranean the two data sets have almost equal variability. On the contrary, autumn values show that the addfa data have lower variability everywhere in Europe.

3.1.2. Mean seasonal field of 500hPa for each circulation type.

From the composites constructed for each circulation type, it is obvious that the distribution of the biases in the study area for both anticyclonic and cyclonic types in winter (Figure2) has a similar pattern with the winter mean seasonal distribution of the biases at 500hPa except for A1 and A2. In A1 pattern, Mean HadAM3P values are underestimated in Western and Central Europe and in the A2 pattern, positive biases are found in the Southwestern Europe and negative ones in the northeastern parts of the study area. The patterns of the spring circulation types (anticyclonic and cyclonic) biases are generally negative for most of Europe and the Mediterranean except for A5 type where the simulated data magnitudes are higher. In summer, the distribution of the biases of the circulation types is similar to the mean seasonal pattern, which suggests that the model underestimates the geopotential heights for the Mediterranean. Finally, for autumn the biases patterns of the circulation types show some resemblance to the mean seasonal composite, except for the A1 and Cnw type, where the biases are positive in northern and eastern Europe and in the whole Europe respectively.

From the distribution of the StdRatioss constructed for each of the circulation types, it seems that for winter there are similarities between the anticyclonic patterns and the mean seasonal one, for most of Europe and the Mediterranean, with the exception of Northeastern Europe (A1, A2, A3, A5 and A6). For the cyclonic types for the greatest part of the study region addfa appears to have lower variability than NCEP, except for Italy and Greece where the ratios are greater than 1. The spring circulation type ratio patterns present a relatively good agreement with the mean seasonal one. In some cases, especially for the anticyclonic types the simulated variability is lower than the mean seasonal variability. In summer, the ratio patterns of circulation types present several similarities with the mean seasonal one. There are some exceptions as for the types A1, A2, C, Cs and Cnw, where the ratios are lower that 1 in the largest part of the Mediterranean and in the Balkan area. Finally, in autumn, for almost all of the circulation types, the model variability is much lower than that of NCEP in central Europe, Italy and Greece. In some cases these ratios reach the value of 0.5.

3.2 Field of thickness (1000 – 500hPa).

3.2.1. Mean seasonal thickness field (1000 – 500hPa)

In winter, mean HadAM3P underestimates the thickness field in Eastern and North-eastern Europe as well as in the southern part of the Eastern Mediterranean. In central and western Europe the biases are positive (20 to 30hPa) whereas in western and central Mediterranean biases are equal to zero (Figure 3). In spring, in the central, Northwestern Europe and in the eastern part of the Mediterranean, mean HadAM3P values are similar to NCEP values. Generally, summer is characterized by positive biases where the highest values appear in the east and south of Europe (50hPa). The only exception is the region of the eastern Mediterranean where the two data sets have similar magnitudes. For autumn, the biases are not significant for the larger part of the study area.

The pattern of the distribution of the standard deviation ratios in the case of winter is more complicated. In the Iberian Peninsula, Italy, Greece and central Europe, addfa model presents a higher variability than NCEP, whereas in the Eastern Mediterranean the variability of the model is equal to the NCEP variability. In spring, the model appears to have higher variability in western Europe (Iberian Peninsula, Mediterranean), while in the central and northern Europe the two data sets seem to have almost the same variability. During summer, for the whole study region the model has higher variability for the thickness field 1000-500hPa than NCEP. Finally, during autumn, the model exhibits lower variability than the NCEP in France but in the Balkan area and in the Eastern Mediterranean the two data sets show similar variability.

3.2.2. Mean seasonal thickness field (1000 – 500hPa) for each circulation type.

The inspection of the mean thickness patterns associated with each type revealed that most anticyclonic types and cyclonic types (Figure 4) follow the mean seasonal pattern during winter, except for A1 type, where negative biases are present for the whole of Europe. The first three anticyclonic spring types patterns (A1, A2, A3) show many common features with the mean seasonal one. On the other hand, for the A5 type, mean HadAM3P overestimates the thickness field values for the entire Europe. Generally, the model for the cyclonic types underestimates the thickness fields in northern, central and Eastern Europe and overestimates them in southwestern Europe and the Mediterranean. The limits in each of these areas differ from type to type. During summer, the most of the anticyclonic and cyclonic types show good agreement with the mean seasonal composite. Finally for autumn, no general conclusion can be drawn regarding the anticyclonic types due to the fact that the distribution of the biases varies from type to type. The cyclonic types present differences from the seasonal bias patterns where for example the types Cs and Cnw, show negative, and positive biases respectively.

Concerning the StdRatio analysis, during winter, the anticyclonic ratio patterns present some similarities with the mean seasonal pattern for the greatest part of Mediterranean and the Balkan area. Also, most of the cyclonic types have some resemblance with the mean seasonal ratio pattern. For spring, the standard deviation ratios decrease from west – southwest to the north – northeast of Europe. In the Greek area, addfa has lower variability than NCEP. Both anticyclonic and cyclonic summer type patterns are quite similar to the mean seasonal summer pattern though with higher ratio values than the corresponding mean seasonal ones. Finally, for autumn, the anticyclonic type ratio patterns are similar to the mean seasonal pattern but with greater magnitudes. On the other hand, the cyclonic types do not show great resemblance, and for most of them, the model has lower variability over the central and eastern Mediterranean and the Balkan area. The most intense discrepancies appear for Cs, Cnw and Cse type where the ratio values lower to 1 cover the whole of Europe and the Mediterranean.

Conclusions

The largest biases between the mean HadAM3P simulated and the observed mean geopotential heights at 500hPa over the European – Mediterranean window considered here, occur in winter, where the geopotential values are overestimated (positive biases) over a large part of western and central Europe. Moreover, during winter the biases over the largest part of the Mediterranean are positive, whereas during all other seasons they are negative or equal to zero. We found it difficult to trace these seasonal variations in geopotential 500hPa error through to seasonal variations in circulation type error, although the sign of the circulation type errors is sometimes different in winter than in the other seasons. Another problem with the simulation of geopotential is that the standard deviation of their mean values is systematically underestimated except for summer where the Stds are systematically overestimated in the Eastern parts of Europe.

Concerning the behavior of biases for 1000-500hPa thickness field the largest values occur in summer where thickness is overestimated over all of Europe and over the western and central Mediterranean. On the contrary, over the Eastern Mediterranean the two data sets have similar magnitudes.

In conclusion, mean HadAM3P has some success in reproducing the mean seasonal patterns at 500hPa geopotential height as well as the patterns of the observed circulation types for the same surface, although systematic errors occur more in winter than in the other seasons. On the contrary, for the mean seasonal pattern of 1000-500hPa thickness field, systematic positive errors occur more often in the summer than in any other season.

References

Maheras P, Patrikas I, Karacostas Th and Anagnostopoulou Chr, 2000a: Automatic classification of circulation types in Greece: Methodology, Description, Frequency, Variability and Trend Analysis *Theor and Appl Climatology*, 65, 205-223.

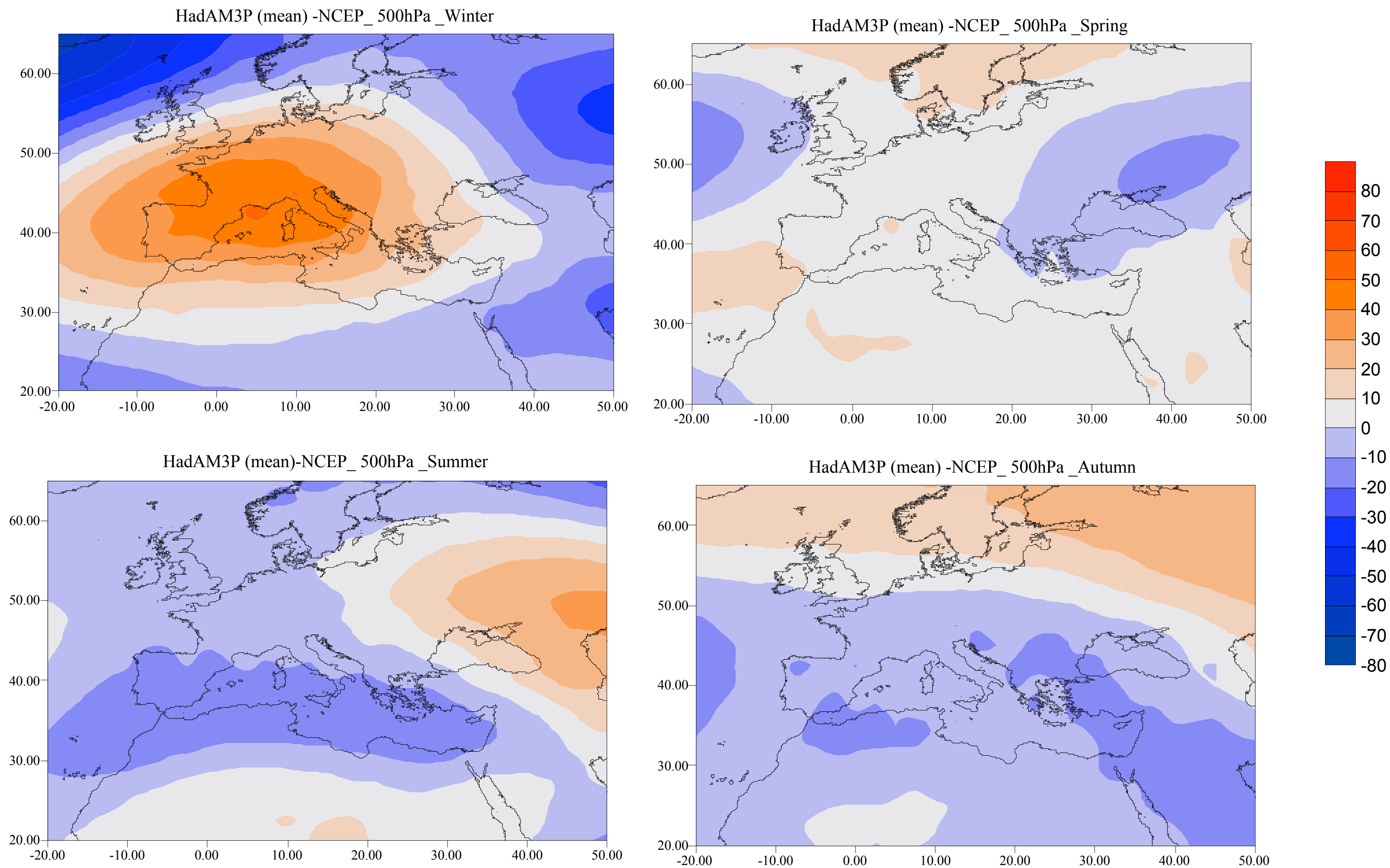

Figure1. Mean seasonal biases for the geopotential field of 500hPa.

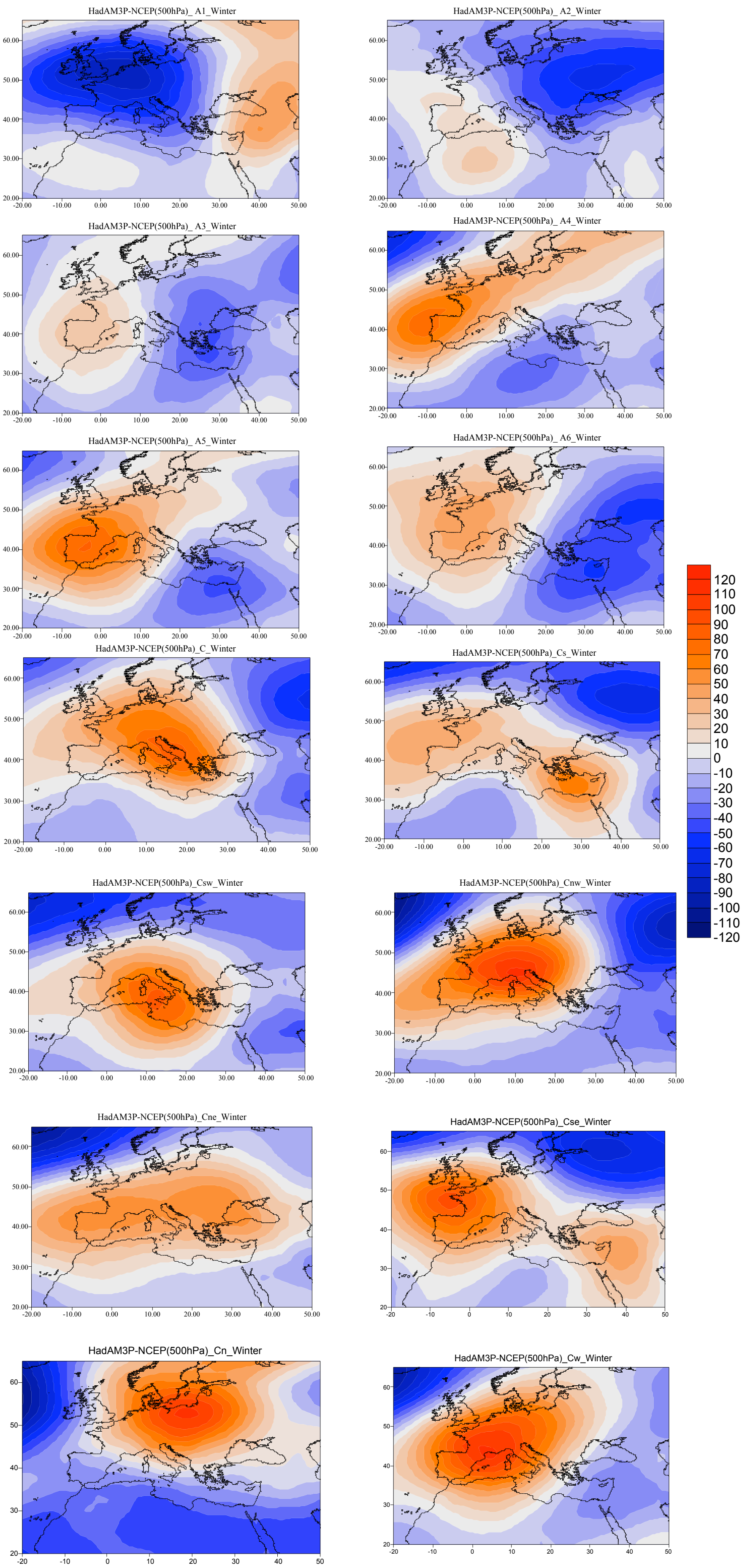

Figure 2. Circulation type biases patterns for the 500hPa field in the case of winter

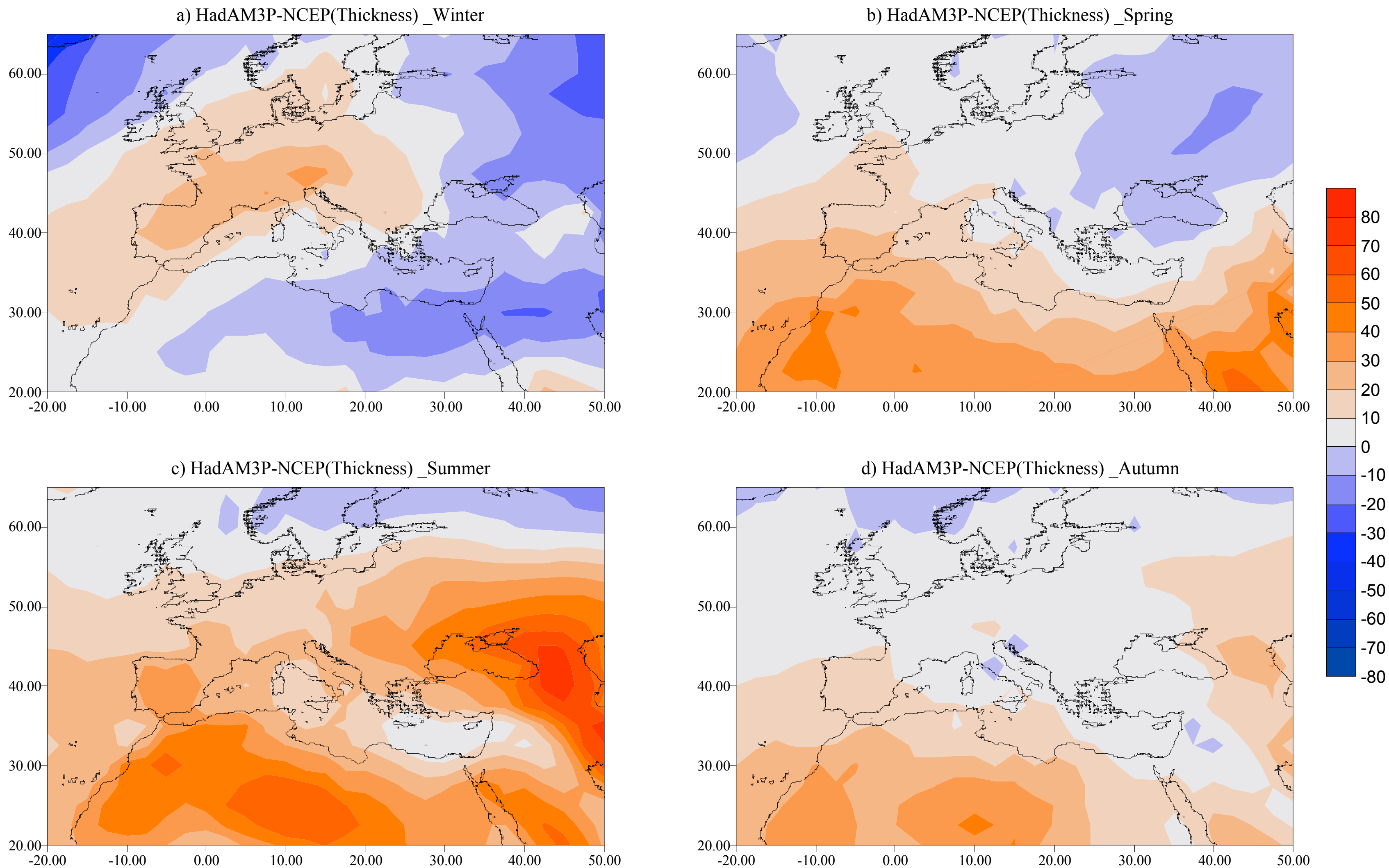

Figure 3. Mean seasonal biases for the thickness field of 1000-500hPa.

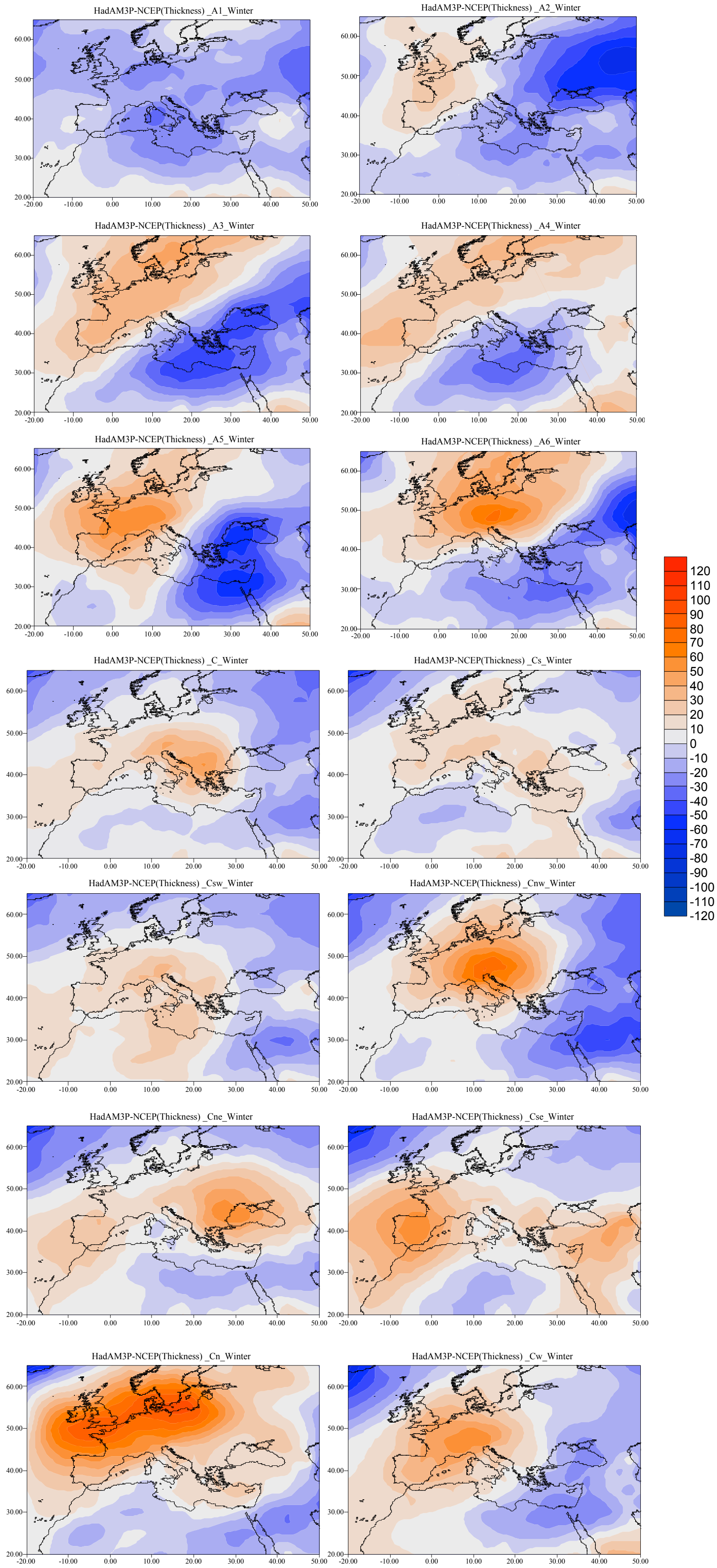

Figure 4. Circulation type biases patterns for the thickness field of 1000-500hPa in the case of winter