COST 733 – WG4:

The application sandbox for circulation type classifications

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WG4 within COST733?

WG1: Existing methods and applications

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WG2: Implementation and development of weather types classification methods

WG3: Comparison of selected weather types classifications

WG4: Testing methods for various applications

WG4 within COST733?

WG1: Existing methods and applications

WG2: Implementation and development of weather types classification methods

WG3: Comparison of selected weather types classifications

WG4: Testing methods for various applications

WG4 within COST733?

WG1: Existing methods and applications

↓ ↓ ↓

WG2: Implementation and development of weather types classification methods

WG3: Comparison of selected weather types classifications

WG4: Testing methods for various applications

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I. Selection of dedicated applications

II. Collection/development of application software

III. Performance of the selected applications using available weather type data including those provided by WG2

IV. Comparison of the application results using different weather type methods

V. Final assessment of the results and uncertainties

VI. Presentation and release of results to the other WGs and the interested scientific community

VII. Recommend specifications for a new (common) method to WG2

I. Selection of dedicated applications

Some numbers:

32 case studies are submitted to the final report

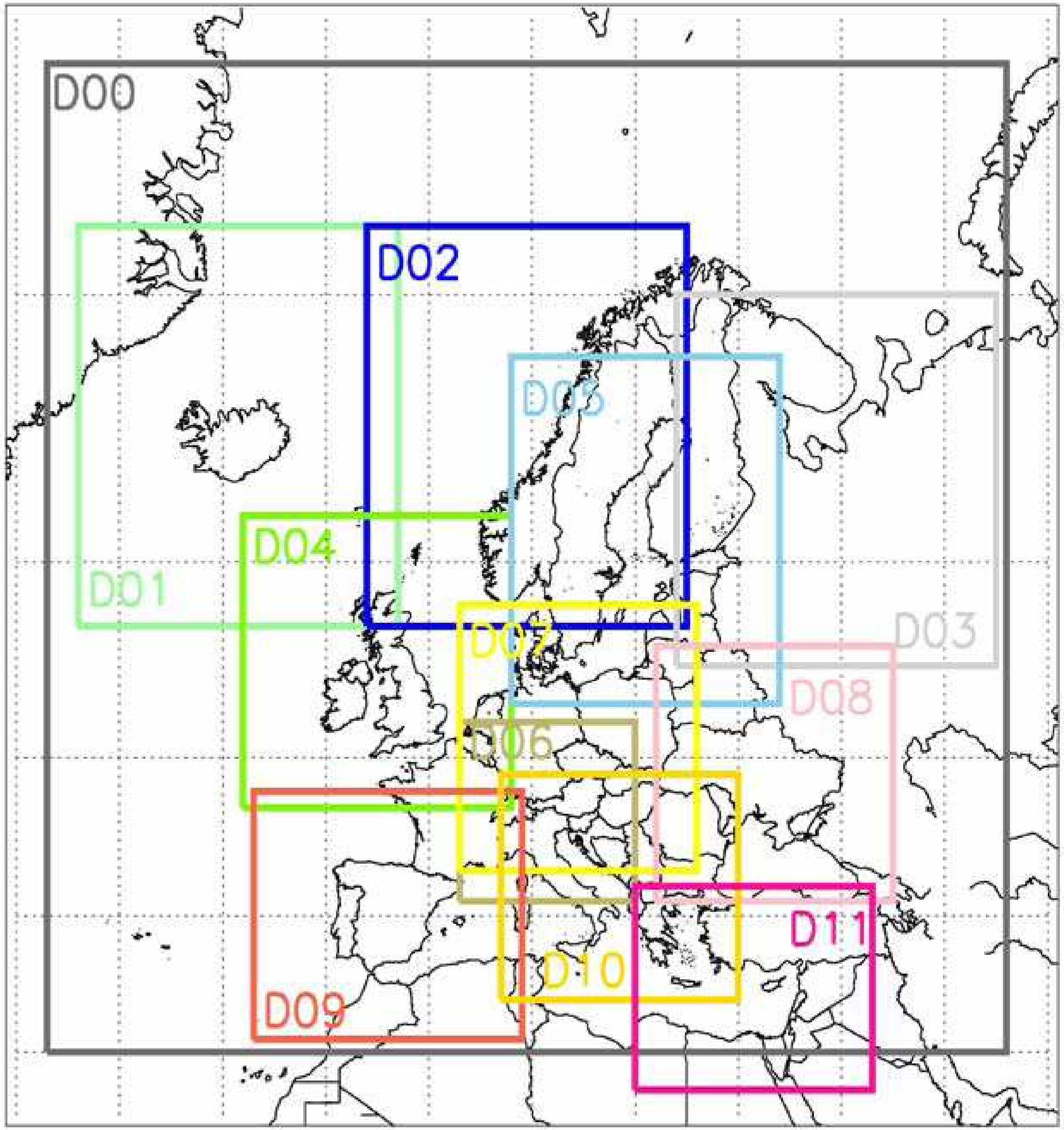
….as a result of the work of approximately 50 (co)authors

…from 15 countries

In general, 5 subgroups are formed within WG4, dealing with different types of applications for different geographical regions:

- Climatology
- Air quality
- Extreme events (meteorological / hydrological)
- Forest fires
- Others

Domains	Climatology	Air quality	Extremes	Forest fires	Other
D00	5	2	3	1	
D01	2				
D02	2				
D03	2				
D04	2				
D05	4	1			1
D06	5	1			1
D07	5	3			2
D08	3				
D09	4		1	2	1
D10	4	1	2	1	2
D11	3				



II. Performance of the applications & intercomparison of the application results between different methods

Where possible, the analyses evaluated systematically the benefits of options associated with circulation type schemes namely:

- Family of algorithms: the classification methods were assessed according to five different groups: SUBjective, THReshold, PCA, LeaDeR, and OPTimization
- Domain size: Whenever possible, tests were done for both a small domain and the large European domain D00
- Number of classes: Objective catalogues were produced with as close as 9, 18 and 27 number of types (or classes)

II. Performance of the applications & intercomparison of the application results between different methods

- Input variables: COST733 v2.0 includes catalogues defined with single or multiple input data
- Seasonal: COST733 v2.0 includes catalogues with types defined annually, or independently for each 3-month season
- Sequencing: COST733 v2.0 includes catalogues with types associated to each day independently, or where a minimum of several days sequence of the same type was enforced.
- Weights:test whether putting some weights on specific input parameters can improve results of applications

I. Climatology

II. Air Quality

II.1 Introduction

II.2 Applications

Case II.1 Surface ozone related to circulation patterns in Poland

Case II.2 Relations between circulation and winter air pollution in Polish urban areas

Case II.3 Relations between circulation and summer ozone concentration in different European locations.

Case II.4 Spectral analysis of total suspended particles in connection with circulation patterns in the central and eastern part of Europe

Case II.5 The explanatory power of circulation patterns on surface ozone concentrations in Central Europe

II.3 Conclusions and Recommendations

III. Extremes

III.1 Introduction

III.2 Applications

III.2.A Meteorology

Case III.1 Temperature extremes for DJF and JJA in Poland

Case III.2 Circulation types and associated severe weather in Romania

Case III.3 Circulation types and associated precipitations over Bulgaria

Case III.4 Circulation types associated with freezing precipitation over Bulgaria

III.2.B Hydrology

Case III.5 Links between circulation types and regional hydrological drought in north-western Europe

Case III.6 Links between atmospheric circulation and flood events in Europe

Case III.7 Atmospheric circulation type sequences applied to snow avalanches over the Eastern Pyrenees (Catalonia and Andorra)

III.3 Conclusions and Recommendations

IV. Forest fires

V. Other applications

V.1 Introduction

V.2 Applications

Case V.1 Stable isotopic signature of precipitation under various synoptic classifications

Case V.2 A regime dependent evaluation of the COSMO model over Germany

Case V.3 Objective optimization of the NWP forecast in Austria based on circulation patterns

Case V.4 Relating atmospheric circulation patterns to daily precipitation occurrence over the territory of Bulgaria using hidden Markov models

Case V.5 Connections between Circulation Type Incidence and the Modelled Potato Crop Yield in Estonia

Case V.6 Storminess and coastal erosion in Spain

Case V.7 Climate change analysis for the Carpathian basin

V.3 Conclusions and recommendations

Some examples of applications

1. Circulation types and precipitation over Spain

Authors: Maria Jesus Casado & Maria Asuncion Pastor

Aim: Improve the knowledge on the link between circulation types and precipitation in a spatial coherent way

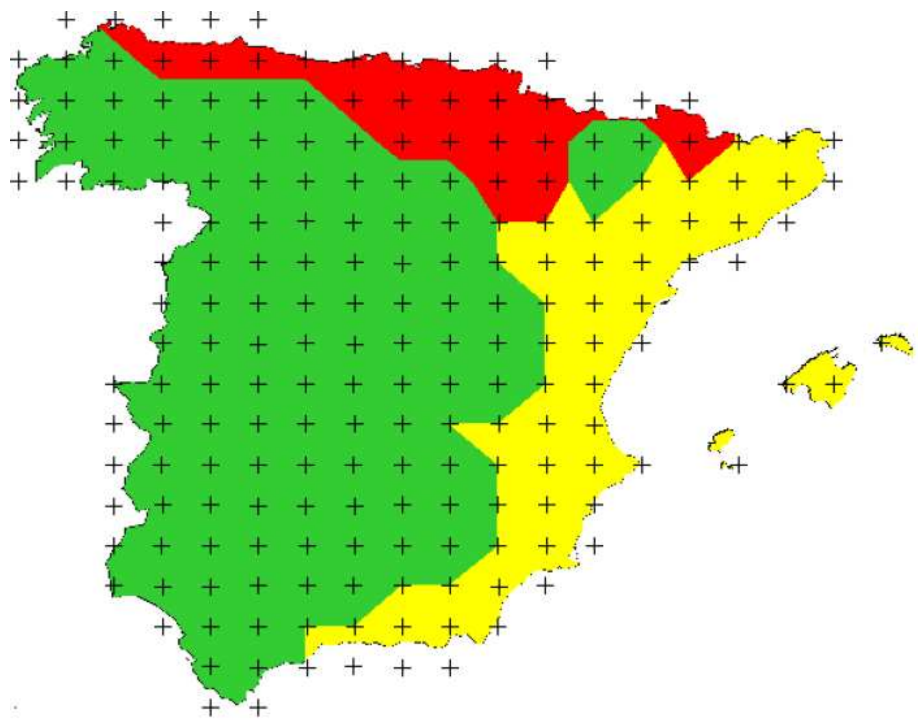


Figure: Grid-mesh of the precipitation data and study region of Spanish Atlantic (green), Spanish Mediterranean (yellow) and Northern Spain (red).

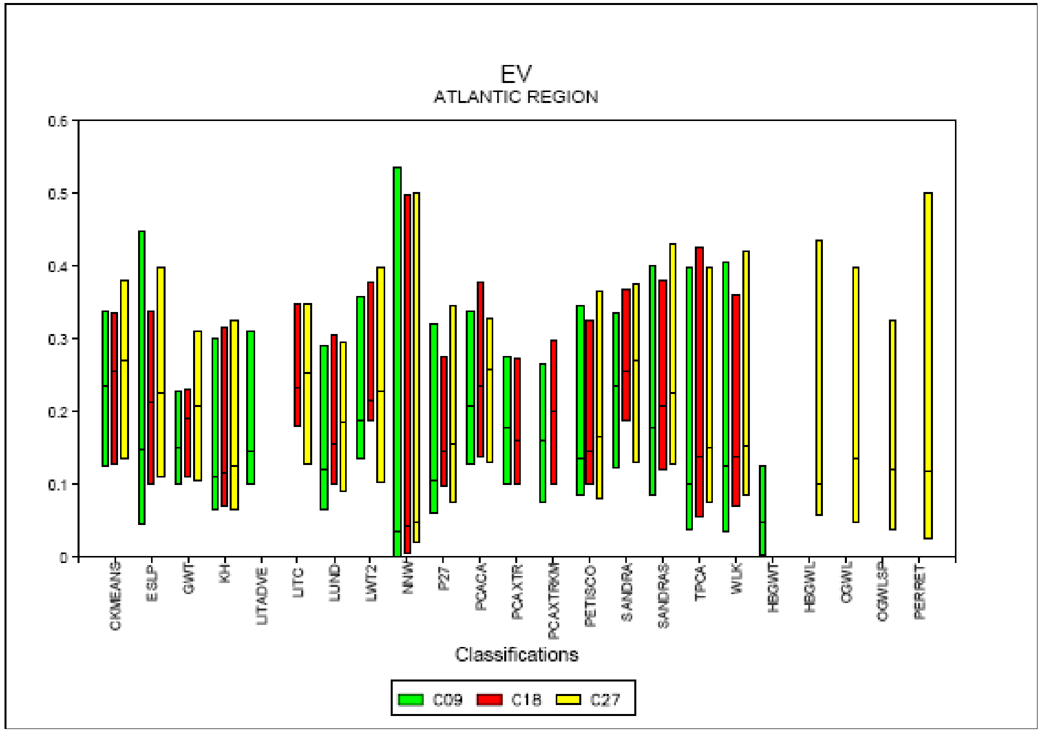
Data

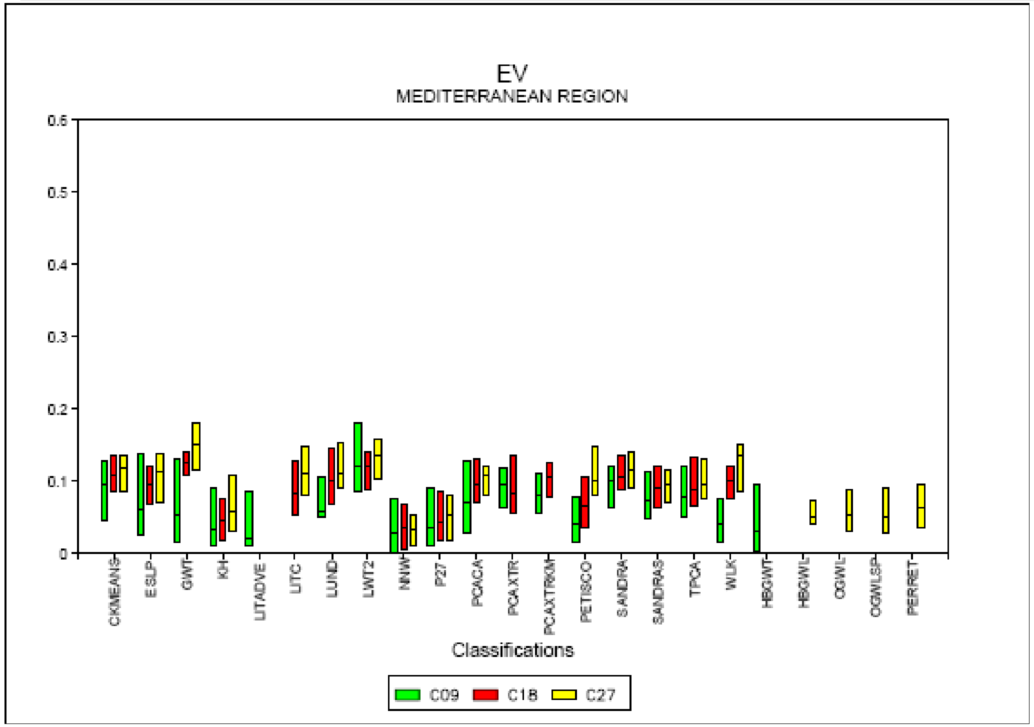
- 53 classifications from cat1.2 and a subset of classifications from the cat2.0
- Daily gridded observed precipitation data for the period 1961-1990
- Analysis for extended winter months: December to March

Evaluation criteria

Explained variance, pseudo F-index and the standard deviation

A bootstrap resampling is used to construct the 95% confidence intervals.


EV
ATLANTIC REGION
0.6
0.5
0.4
0.3
0.2
0.1
0
CKMEANS
ESLP
GWT
KH
LITADVE
LITC
LUND
LWT2
NNW
P27
PCACA
PCAXTR
PCAXTRKM
PETISCO
SANDRA
SANDRAS
TPCA
WLK
HBGWT
HBGWL
OGWL
OGWLSP
PERRET
Classifications
C09 C18 C27


EV
MEDITERRANEAN REGION
0.6
0.5
0.4
0.3
0.2
0.1
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CKMEANS
ESLP
GWT
KH
LITADVE
LITC
LUND
LWT2
NNW
P27
PCACA
PCAXTR
PCAXTRKM
PETISCO
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TPCA
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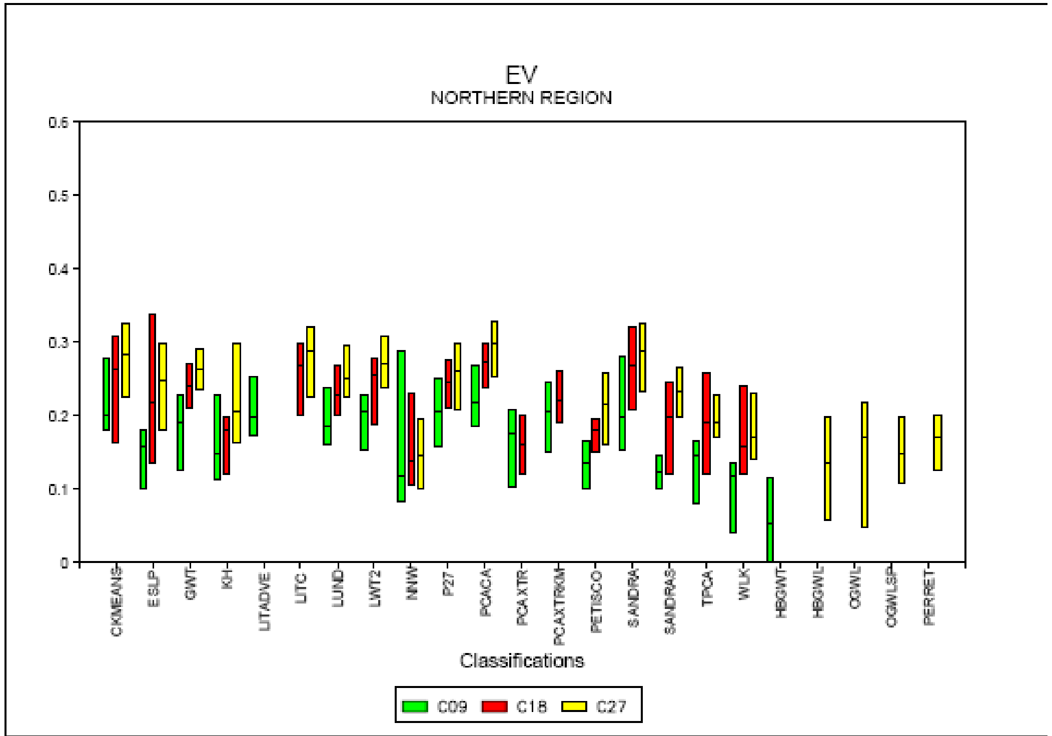
OGWL
OGWLSP
PERRET
Classifications
C09 C18 C27


EV
NORTHERN REGION
0.6
0.5
0.4
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0.2
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CKMEANS
ESLP
GWT
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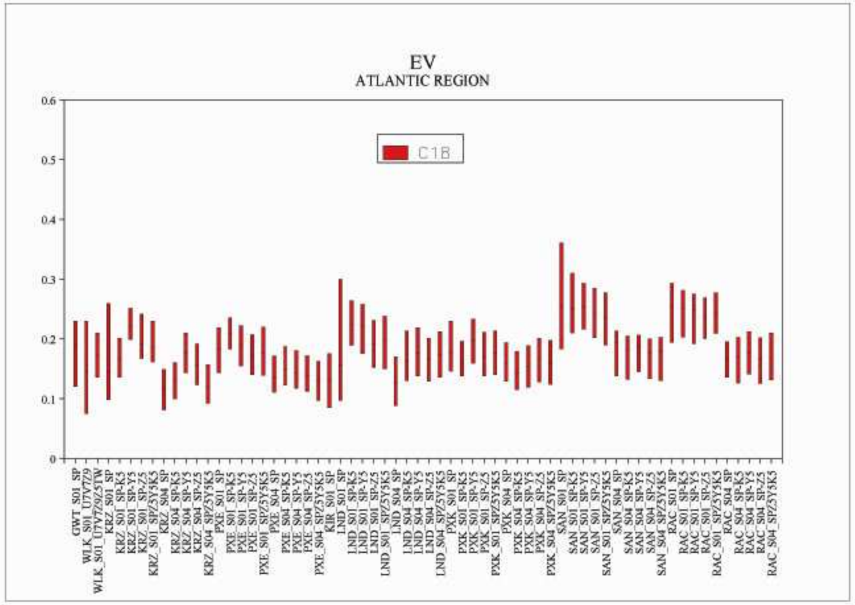
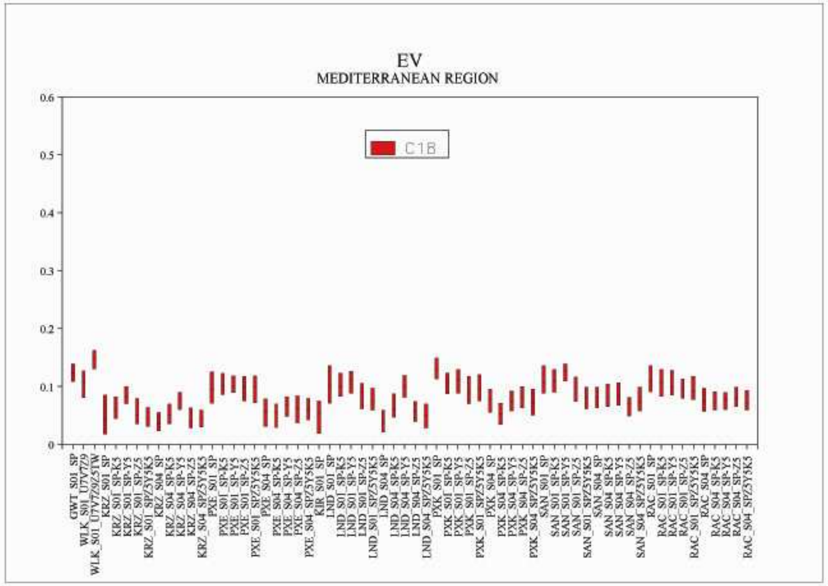
LITADVE
LITC
LUND
LWT2
NNW
P27
PCACA
PCAXTR
PCAXTRKM
PETISCO
SANDRA
SANDRAS
TPCA
WLK
HBGWT
HBGWL
OGWL
OGWLSP
PERRET
Classifications
C09 C18 C27

Cat v1.2


EV
ATLANTIC REGION
C1B
0.6
0.5
0.4
0.3
0.2
0.1
0


EV
MEDITERRANEAN REGION
C1B
0.6
0.5
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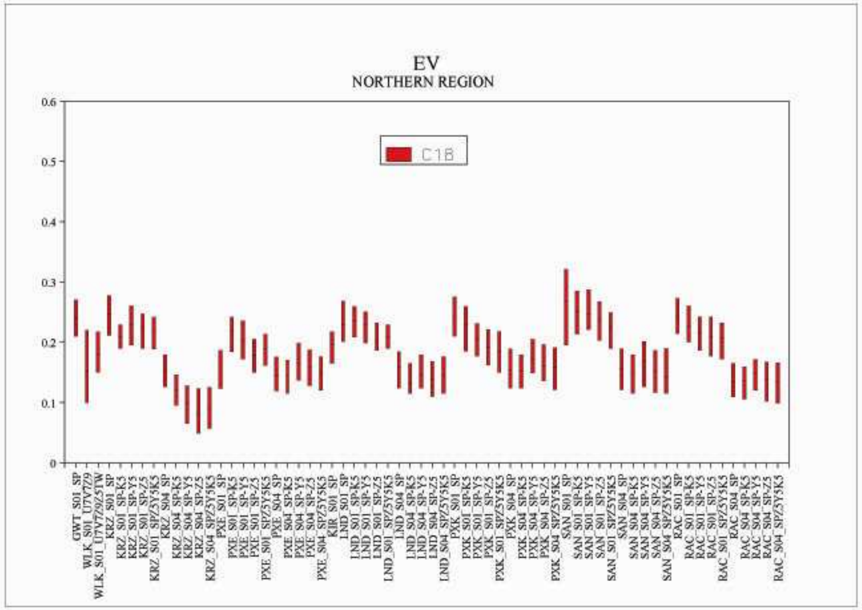

EV
NORTHERN REGION
C1B
0.6
0.5
0.4
0.3
0.2
0.1
0

Cat v2.0

Summary

The results suggest that the optimisation methods (e.g. CKMeans, SANDRA) are generally performing better

Explained variance is lowest for Meditteranean region, probably because this regions receives most of ist precipitation in autumn + the Northern and Spanisch Atlantic region are more influenced by large-scale depressions

To address the effect of the number of circulation types used, one has to consider to evalution measures. For EV, scores are higher when increasing the number of types, while e.g. the Pseudo F metric decreases.

2. Long-term trends in the frequency and persistence of atmospheric circulation types in European regions

Author: Monika Cahynova

Aim Distinguish between real circulation changes and those caused by manual synoptic classifications.

Data & Methods

Cat 1.2 version catalogue over all 12 spatial domains (Obj + Subj)

Trends are estimated using a linear least-squares regression applied to the seasonal occurence of days with a specific CT and to the average seasonal persistence (lifetime) of the CTs

T-test was used to check the statistical significance

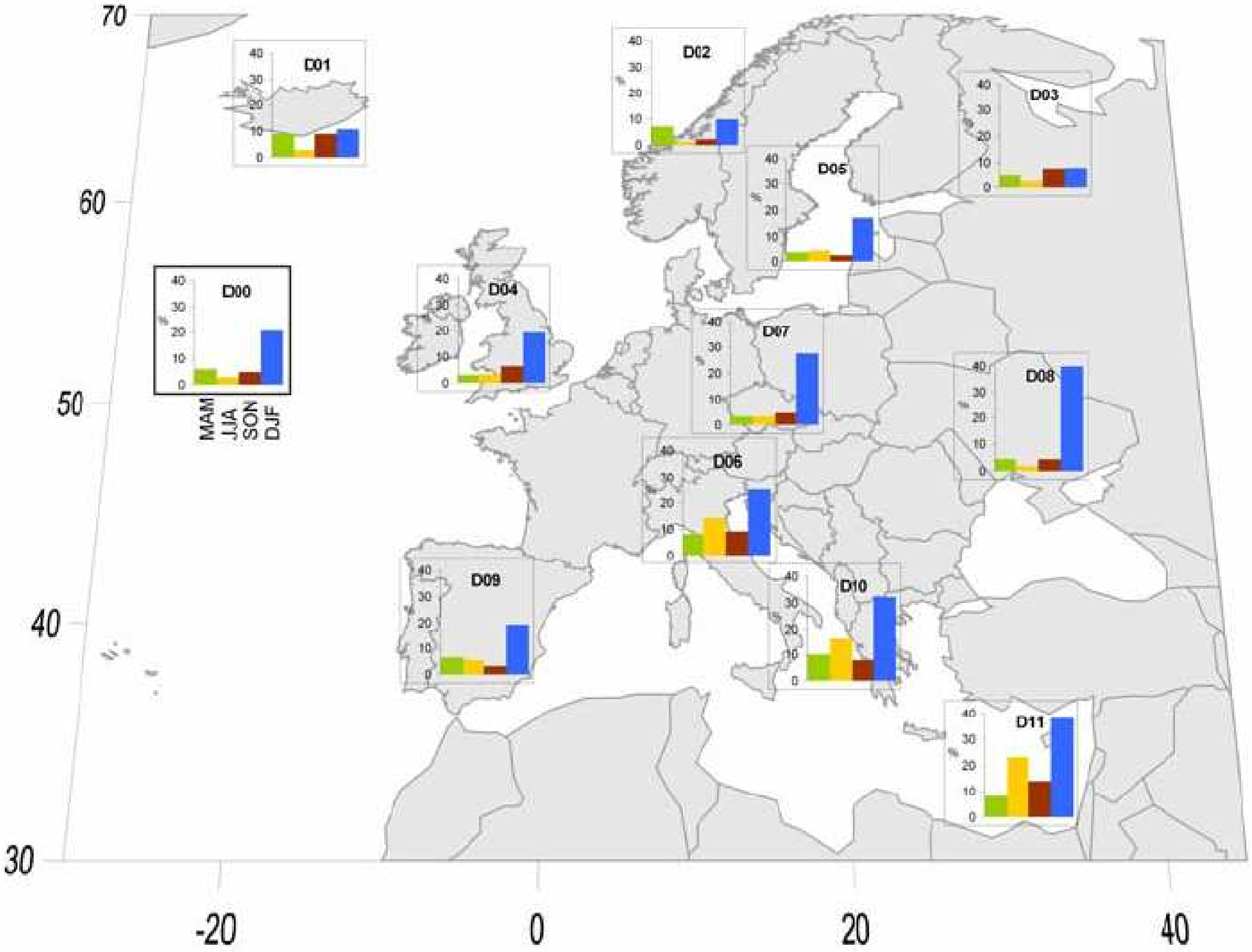


Figure: Seasonal percentage of days contained in circulation types with significant linear trend in frequency (at the 95% level). Average of all objective scalable classifications.

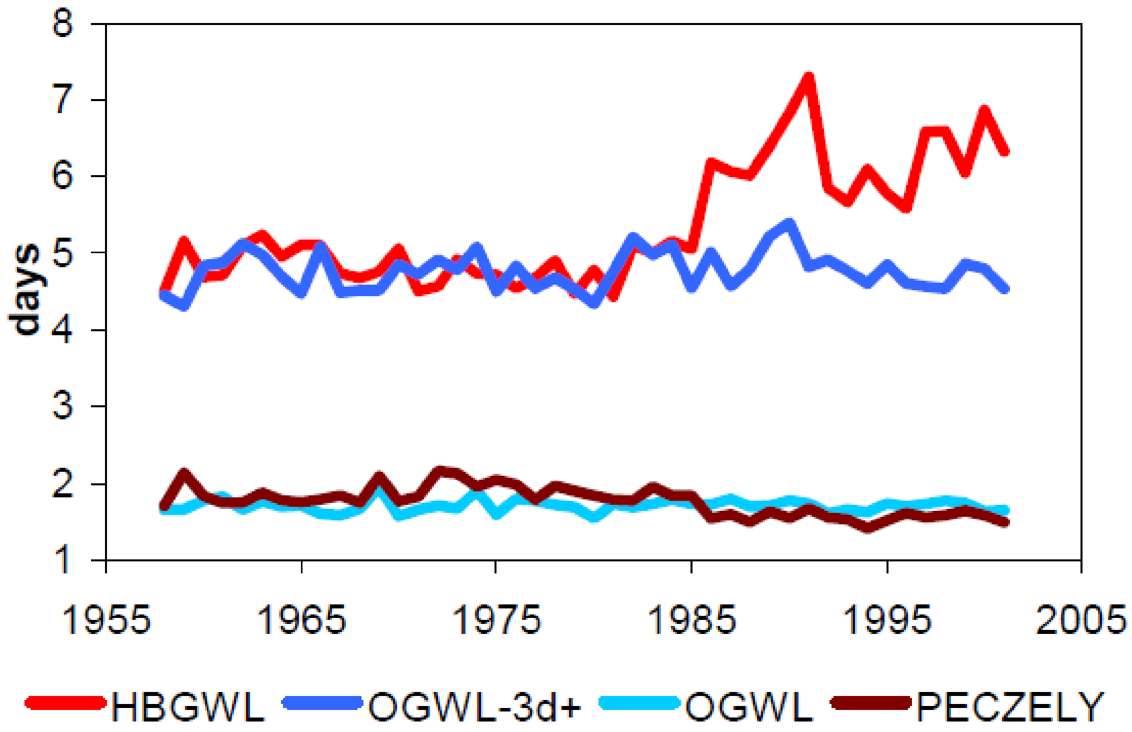


Figure: Average annual persistence of all circulation types combined. HBGWL = Hess-Brezowsky, OGWL-3d+ = objectivized Hess-B. with a minimum 3-day duration of types.

Summary

The percentage of days occupied by CTs that show a significant seasonal trend are overall low, apart for winter in Central and Eastern Europe and summer and winter in the Mediterranean region.

This suggest that apart from a winter intensification of the NAO, very few systematic changes took place during the period investigated (1957-2002)

The overall lifetime of CTs has not changed according to the objective catalogues

This suggest that the sudden shift in lifetime in the Hess-Brezowsky/PEZCELY catalogue around 1985/86 is more an artefact than a “real” change.

3. Links between circulation types and regional hydrological drought in Northwestern Europe

Authors: Anne Fleig, Lena Tallaksen

Aim

(a) Comparison of the CTs with respect to regional drought

(b) Physical interpretation of drought related CTs from the Objective Grosswetterlagen

Data & Methods

Cat 1.2 version catalogue over domain D00

Regional drought area index (based on deficits derived from daily river flow series). Event is considered as drought when RDAI > 0.7 (means that 70% of a region is affected by drought

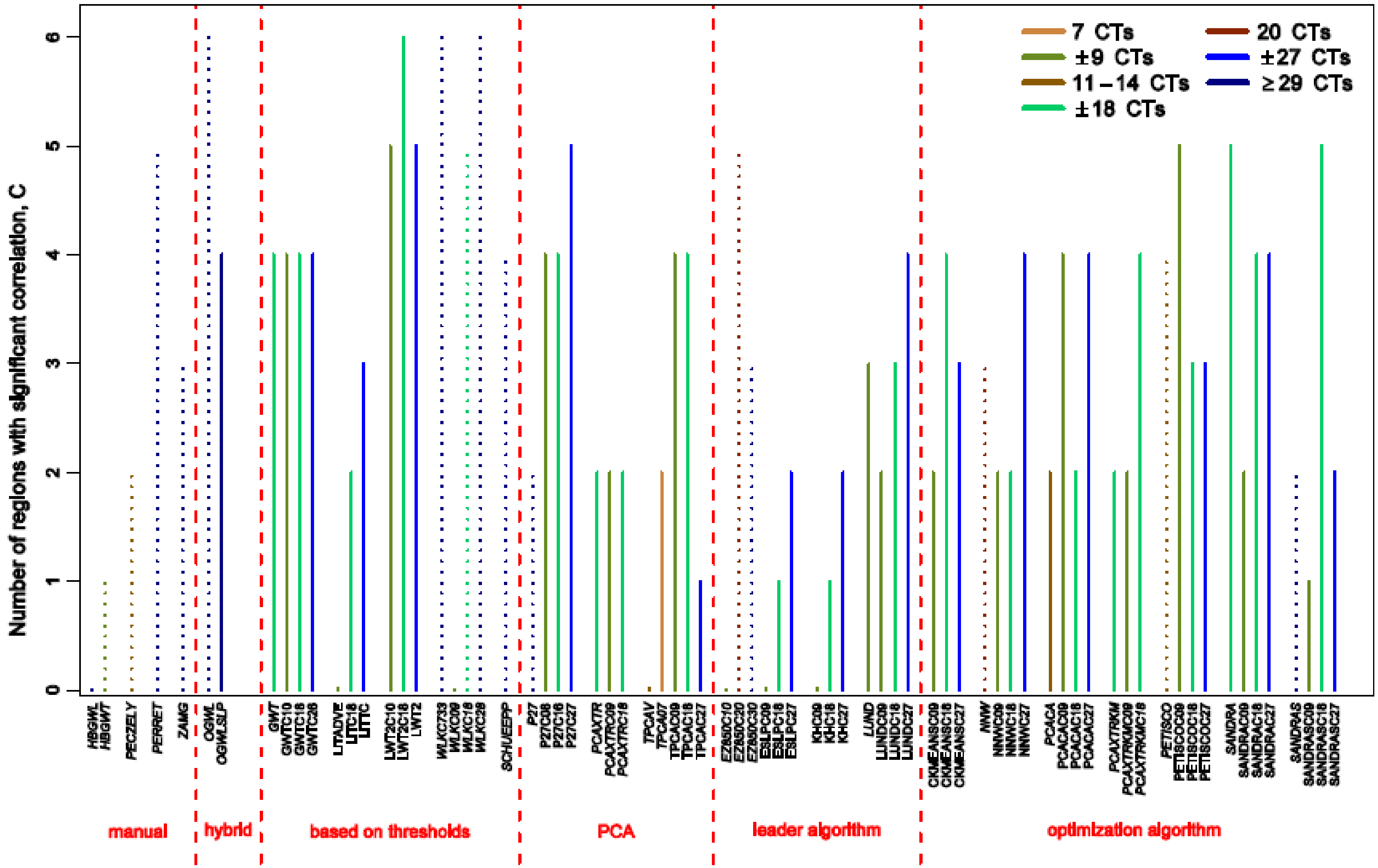


Figure: Performance, *C*, of the 73 CTCs ordered according to their general classification concept (red text). CTCs not included in COST733CAT(42) are written in italic and results for CTCs using input variables other than SLP-only are plotted as dotted lines

Summary

Best performing CTCs for hydrological droughts are OGWL, LWT2 and WLK.

The CTCs with a higher number of types seem to be favourable, except for the PCA-based methods

By looking more closely to the OGWL, it was found that the dominant dought yielding CTs varied between the six regions.

In general, high pressure conditions are important although southerly flow (northerly flow) also favour the development of droughts in UK (Denmark)

These characteristics refer to continental warm air advection

Different input variables were not tested, but WLK indicates that information from 2 pressure levels could improve the results.

4. A regime dependent evaluation of the COSMO model over Germany

Authors: Tom Akkermans, T. Böhme, M. Demuzere, S. Crewell, C. Selbach, T. Reinhardt, A. Seifert, F. Ament, N.P.M. van Lipzig

Aim

Test whether the bias in modelled precipitation with COSMO is dependent on a specific circulation type

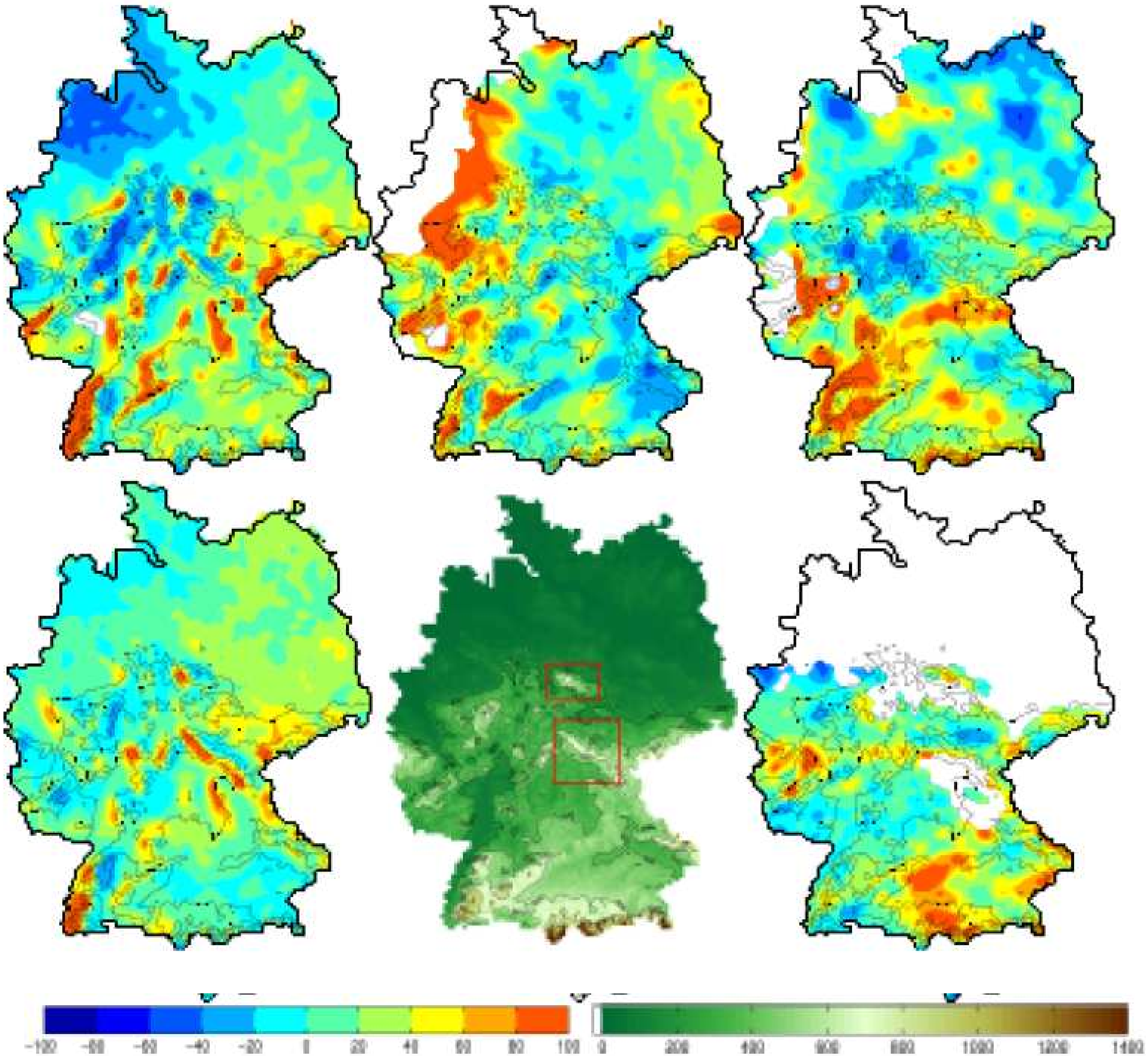
Data & Methods

Jenkinson-Collison types, derived over Germany using 850 hPa

RAINIE1: rain gauge interpolated precipitation fields with 6 hourly precipitation and 1 km resolution (2007-2008)

COSMO: non-hydrostatic numerical model, run over Germany at 7 and 2.8 km resolution (COSMO-EU and COSMO-DE)

Relative differences (in %) between predicted and observed accumulated precipitation (mm/6h) in Germany for each directional circulation regime using the COSMO-EU model and RANIE1 rain gauge observations. CT’s are Northwest, North, and Northeast (first row) and West and East (second row). A digital elevation model (m) at COSMO-EU resolution is given in the centre



Summary

The use of circulation patterns for a “regime-dependent” model evaluation is interesting, as bias signals could be leveled out in more simple approaches

The Tiedtke parameterization at the 7km scale triggers convection too often at the windward side of the mountain, while the leeward side is often too dry.

This occurs especially for the types with a NW and W flow, which have a total occurence of about 40%, which denotes the importance of these findings.

5. Climate change analysis for the Carpathian basin

Authors: Judit Bartholy, Rita Pongracz, Andreas Philipp, Christoph Beck, Aniko Kern

Aim

(a) to compare circulation pattern classification methods for Central Europe (COST733 domain 07 covering 43-58°N, 3-26°E) using observed and simulated present climate (1961-1990),

(b) to analyze the climate change effects on circulation patterns for the same region using different classification methods

Data & Methods

HIRHAM4 RCM, with 50 km resolution with scenarios A2 and B2 for present-day (1961-1990) and future periods (2071-2100)

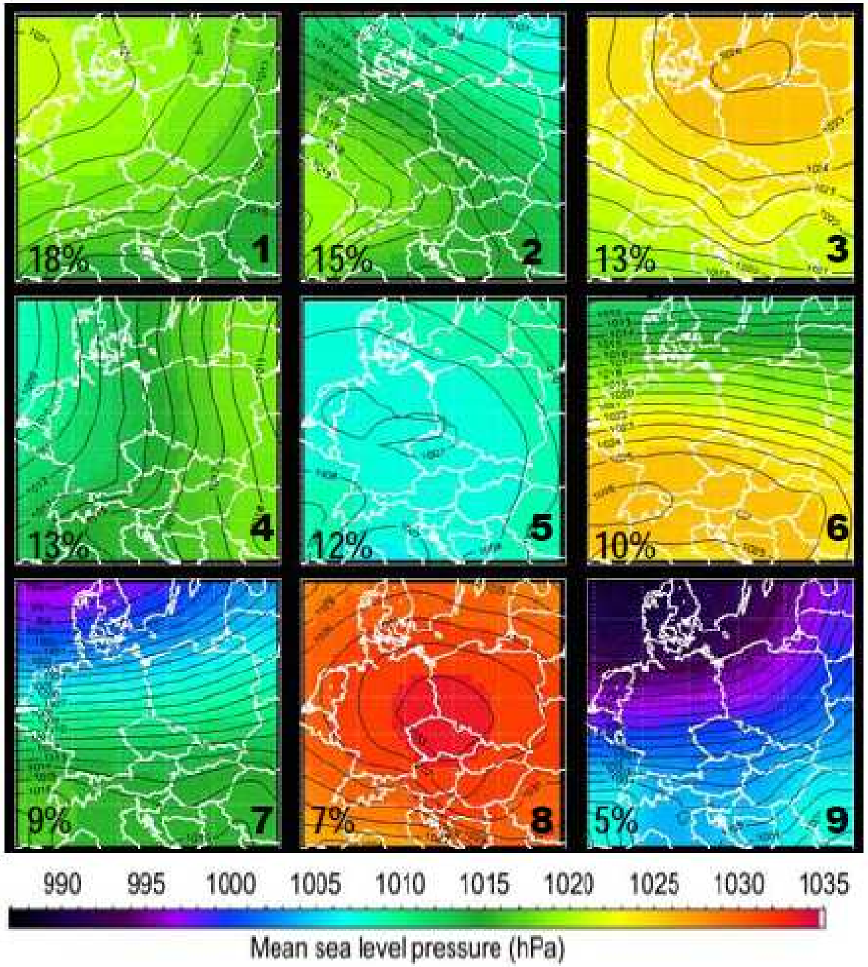


Figure : Centroids of 9 circulation patterns for DKMEANS method using ERA40, 1961-1990 period, region 07. The percentage values in the lower left corner indicate the relative frequency of the corresponding pattern

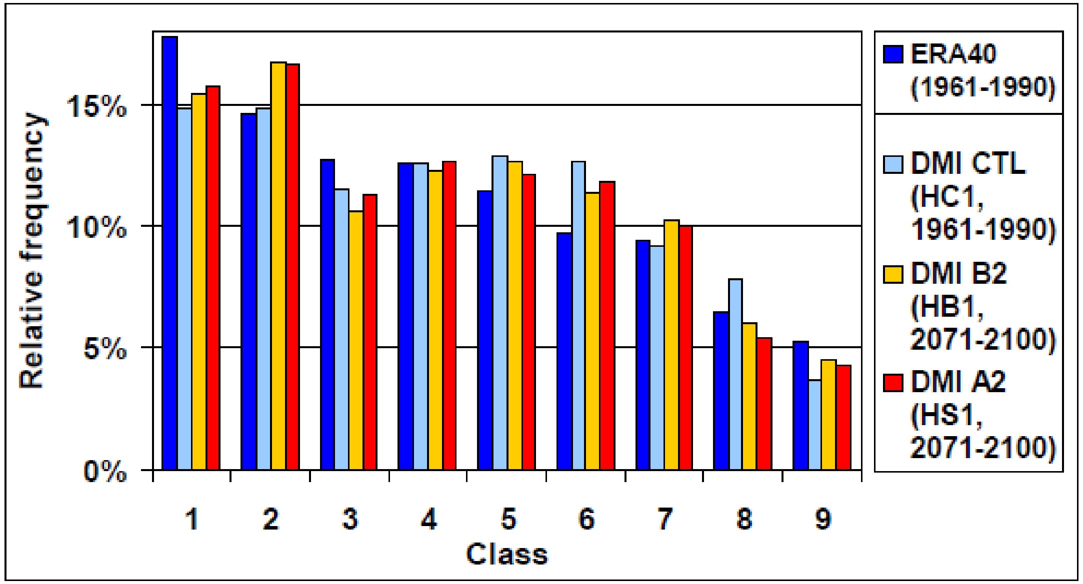


Figure : Relative frequency occurence of DKMEANS-C09 classes established using (i) ERA-40 data (1961-1990); (ii) RCM-control (1961-1990); (iii) RCM-A2 (2071-2100) and (iv) RCM-B2 (2071-2100).

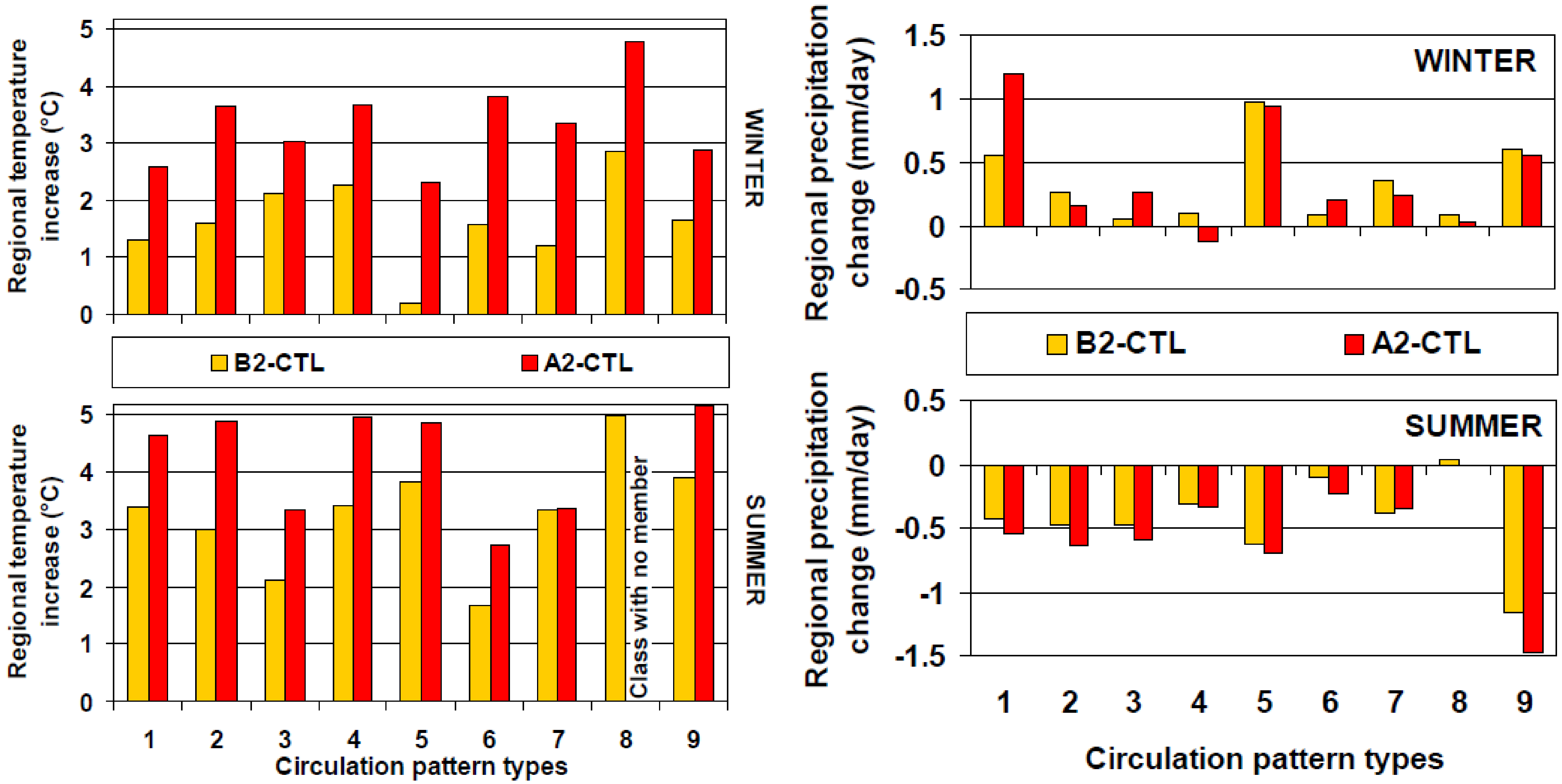


Figure : Projected mean seasonal temperature (left) and precipitation (right) anomaly changes in Hungary by 2071-2100 for each circulation pattern type using DKMEANS classification technique (compared to CTL, 1961-1990).

Summary

The evaluation using EV and WSD shows that the CTCs perform better in winter than summer and that optimisation methods tend to perform better than others

The change in relative frequency values of the DKMeans circulation patterns does not change much in the future (nor with scenario).

For temperature, all types show a warming in the future but this change is not identical for all circulation types.

The results suggest that winter/summer is expected to become wetter/drier compared to the reference period, 1961-1990

Similar as for the temperature, the rate of change is different over the different circulation type classes

Questions?

Where possible, the analyses evaluated systematically the benefits of options associated with circulation type schemes, with respect to the algorithm, preferred domain, number of classes, input, seasonal and sequencing

Table I.1: Summary of the results from the case studies I.1-I.10 in the subgroup “climatology”. The symbols refer to: (1) --/++: A lower/higher number of classes improve the results; (2) +/-: improvement/deterioration of the results; (3) ≈: no conclusive evidence for a significant impact and (4) blank: This criterion is not tested.

Catalogue version	Variable tested	Preferred algorithm (class)	Preferred domain (domain of interest)	Preferred # classes	Preferred input	Seasonal?	Sequence?
2.0	Wind	LDR, OPT	D10 (Slovenia)	++	+	-	
1.2 & 2.0	NAO	OPT	D00 (Spain)	--	-		-
1.2 & 2.0	Precipitation	OPT	D09 (Spain)	≈	+	≈	-
1.2	11 surface variables	≈	Small ones	++			

Outlook

- Finalisation of the case studies
- Consider whether specific recommendations for types of applications can be more clearly formulated
- Does this work gives us some ideas for future work with respect to circulation types (as will be discussed in the “open” discussion on Wednesday, 11h20 -12h00)

A big thanks

- to all of you as an audience,
- to all members of WG4 for their never-ending enthousiasm and numerous contributions to the final report
- to Zbigniew Ustrnul, for putting the first WG4 actions on the rails
- to Christel Prudhomme, for doing a great job as vice-chair of WG4

Additional Information

- COST733 on the web:
  - www.cost733.org (official website)
  - http://geo21.geo.uni-augsburg.de/cost733wiki/ (unofficial website)
- Final report: in progress