



Université
de Liège



**Evaluation of the present and future
general circulation over western Europe
simulated by the IPCC AR4/CMIP3 GCMs
with the help of a circulation type
classification**

A. Belleflamme, X. Fettweis, M. Erpicum
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GCM-based atmospheric circulation

- ▶ Used as forcing for downscaling methods
 - ▶ Biases of the GCM-based circulation are not corrected
- ▶ ~ Independent from surface and local features
- ▶ Large-scale variations (general circulation)
 - ⇒ Supposed to be better simulated by GCMs
- ▶ Essential predictor variable for ground variables
 - ⇒ Important to evaluate and compare GCM-based circulation

General Circulation Models

- ▶ Data for only 6 GCMs available (IPCC AR4/CMIP3)
 - ▶ BCCR-BCM2.0 (No)
 - ▶ CCCma-CGCM3.1/T47 (Ca)
 - ▶ CCCma-CGCM3.1/T63 (Ca)
 - ▶ IPSL-CM4_v1 (F)
 - ▶ UKMO-HadCM3 (UK)
 - ▶ UKMO-HadGEM1 (UK)

- ▶ CMIP5 model outputs availability delayed

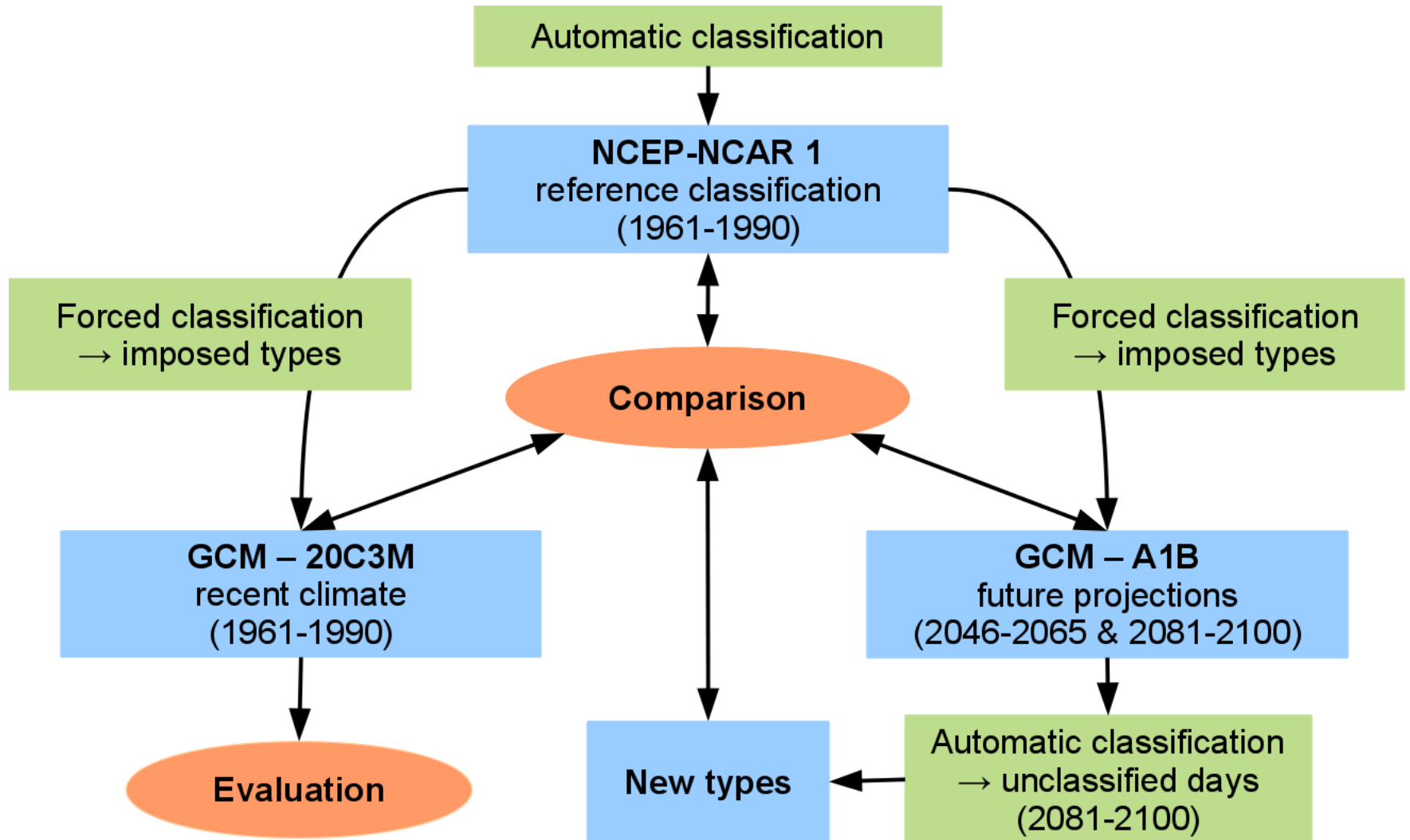
- ▶ Compared to 2 reanalysis datasets
 - ▶ NCEP-NCAR I (USA)
 - ▶ ERA-40 ECMWF (Europe)

- ▶ Periods
 - ▶ 1961-1990 20C3M
 - ▶ 2046-2065 & 2081-2100 A1B

Circulation type classification

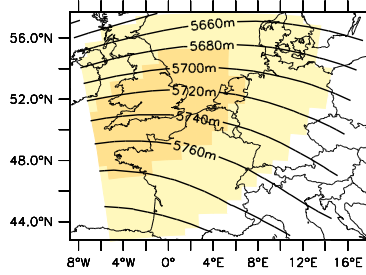
- ▶ Daily 500 hPa geopotential height for summer (JJA)
- ▶ Correlation-based method (similar to Lunds method)
 - ▶ Number of classes fixed by the user (12 classes)
 - ▶ Leader algorithm with varying threshold to minimise intra-class variability and build the requested number of classes
- ▶ Allows a precise analysis of each circulation type
 - ⇒ Focus on the ability of the GCMs to reproduce the variability of the atmospheric circulation
- ▶ But : automated classification
 - ▶ No influence on the types created
 - ▶ How to compare the datasets ?

Classification scheme

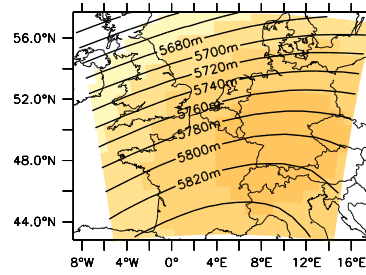


NCEP-NCAR 1 reference classification

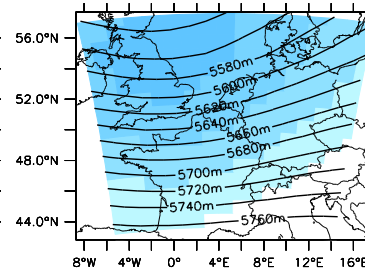
- ▶ Lines : class mean situation
- ▶ Colours : class anomaly ÷ seasonal mean



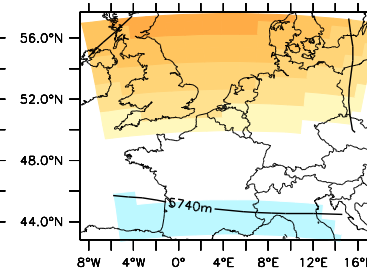
Class n°1 (8.8%)



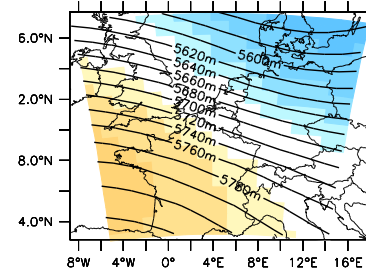
Class n°2 (11%)



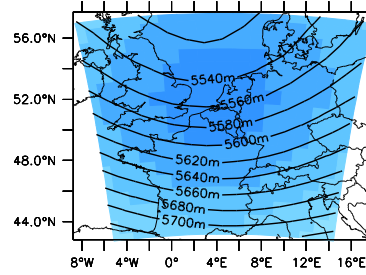
Class n°3 (15.8%)



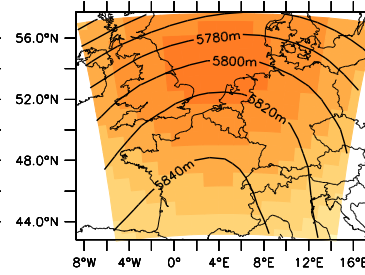
Class n°4 (14.2%)



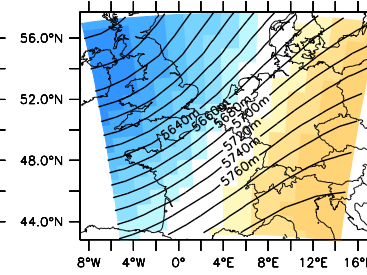
Class n°5 (11.6%)



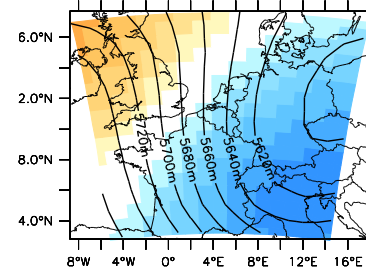
Class n°6 (11.7%)



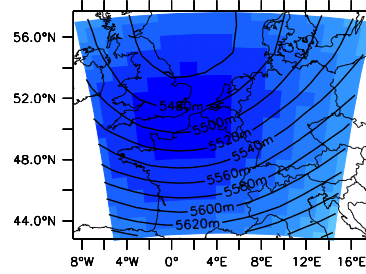
Class n°7 (11.5%)



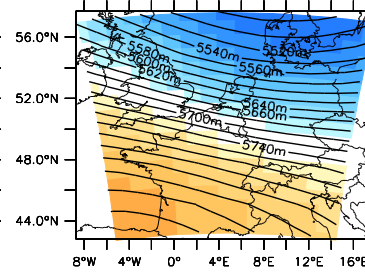
Class n°8 (6.2%)



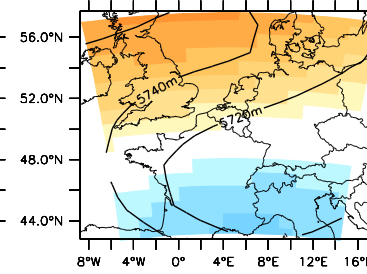
Class n°9 (4.9%)



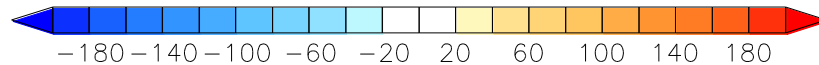
Class n°10 (2.5%)



Class n°11 (0.6%)



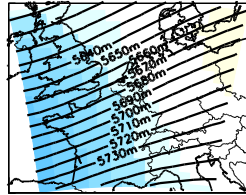
Class n°12 (0.8%)



Z500 anomaly (m)

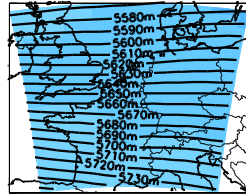
Seasonal mean geopotential height (JJA)

BCCR-BCM2.0



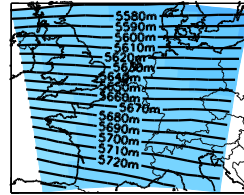
5686m

CCCma/T47



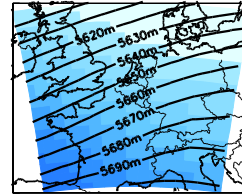
5653m

CCCma/T63



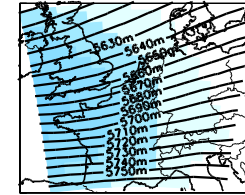
5657m

IPSL-CM4



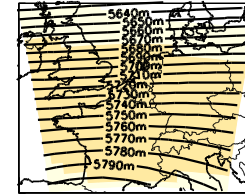
5656m

UKMO-HadCM3



5683m

UKMO-HadGEM1



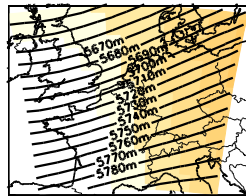
5725m

20C3M

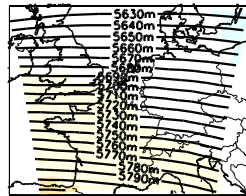
(1961-1990)

A1B

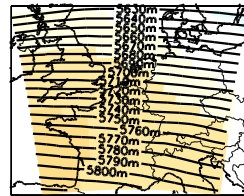
(2046-2065)



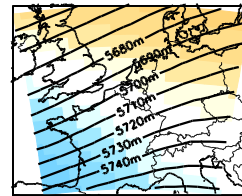
5723m



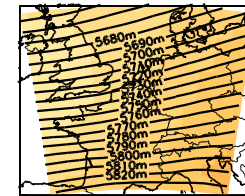
5711m



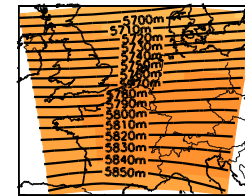
5723m



5706m



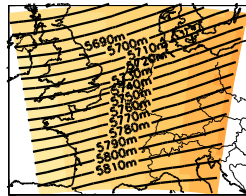
5745m



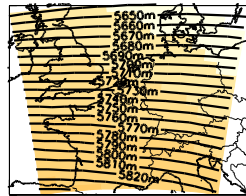
5780m

A1B

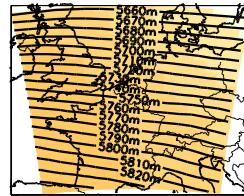
(2081-2100)



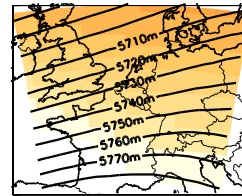
5750m



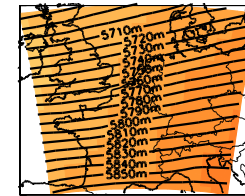
5736m



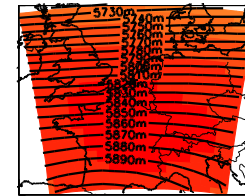
5747m



5737m

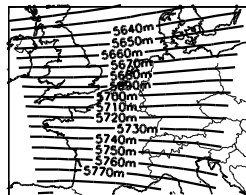


5777m



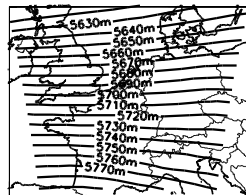
5826m

NCEP-NCAR 1



5703m

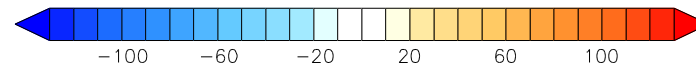
ERA-40



5704m

Reanalyses

(1961-1990)



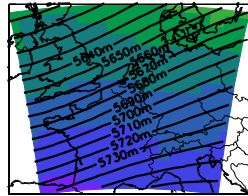
Z500 mean anomaly (m)

- ▶ Lines : seasonal mean situation
- ▶ Colours : anomaly ÷ NCEP-NCAR 1



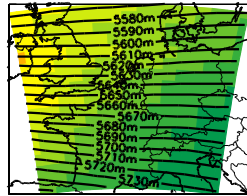
Seasonal standard deviation (JJA)

BCCR–BCM2.0



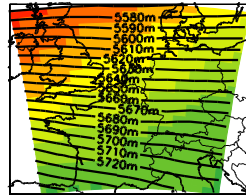
69.11m

CCCma/T47



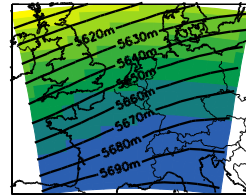
88.66m

CCCma/T63



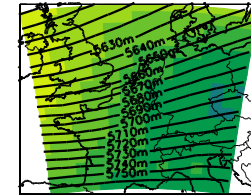
96.82m

IPSL–CM4



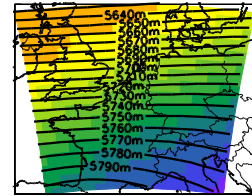
76.93m

UKMO–HadCM3



84.49m

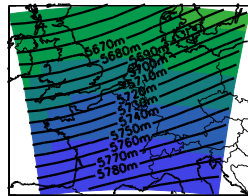
UKMO–HadGEM1



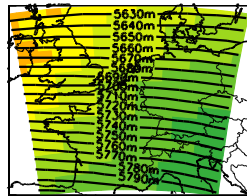
86.07m

20C3M
(1961–1990)

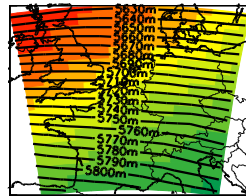
A1B
(2046–2065)



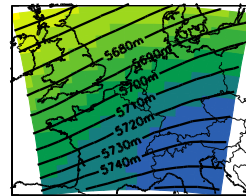
70.48m



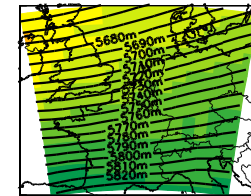
92.65m



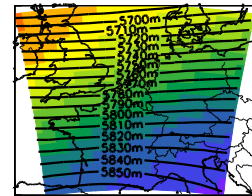
97.23m



78.68m

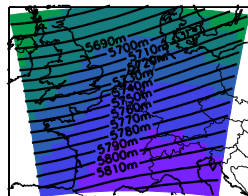


89.53m

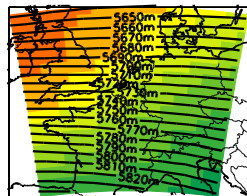


82.13m

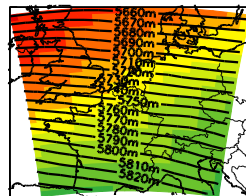
A1B
(2081–2100)



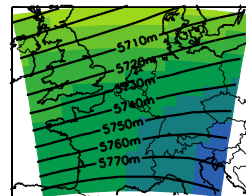
66.21m



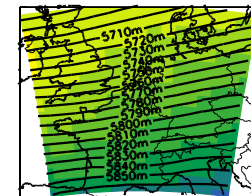
94.83m



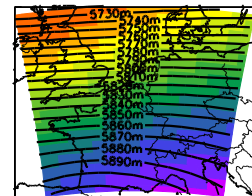
99.54m



79.27m

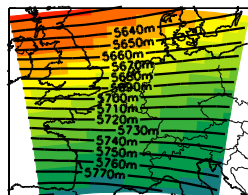


87.54m



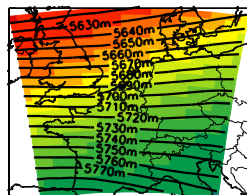
81.48m

NCEP–NCAR 1



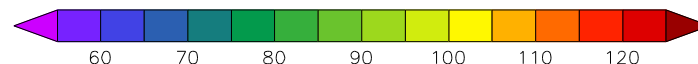
91.32m

ERA–40



94.38m

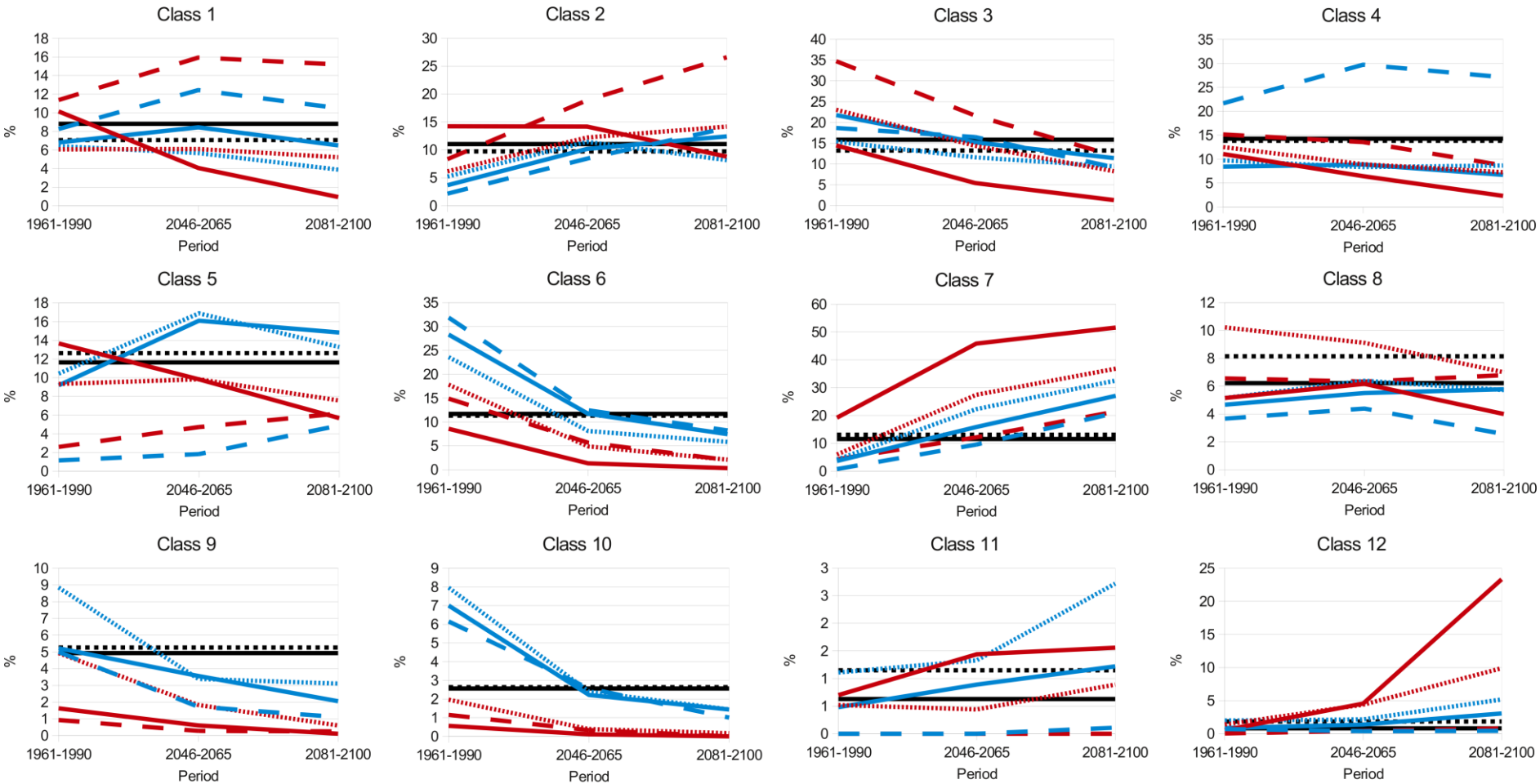
Reanalyses
(1961–1990)



Z500 standard deviation (m)

- ▶ Lines : seasonal mean situation
- ▶ Colours : standard deviation

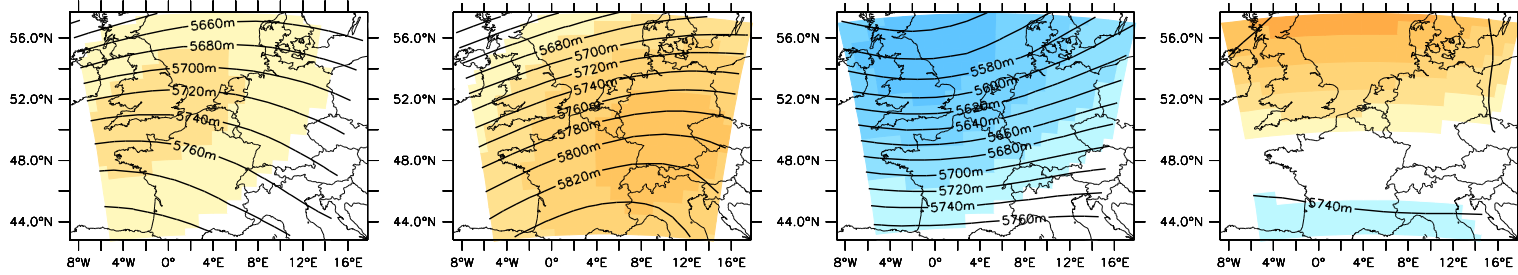
Frequency distribution and evolution



— NCEP ECMWF - - BCCR — CCCma47
 — CCCma63 HadCM3 — HadGEM1 - - IPSL

NCEP-NCAR 1 reference classification

- ▶ Lines : class mean situation
- ▶ Colours : class anomaly ÷ seasonal mean

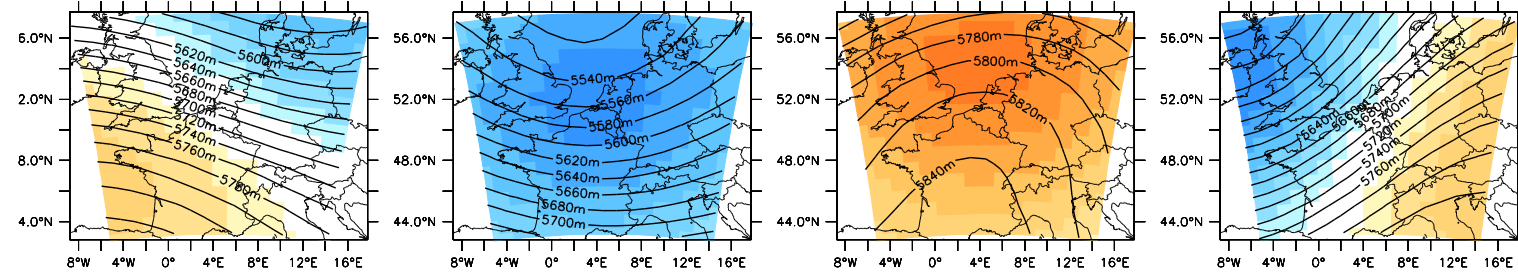


Class n°1 (8.8%)

Class n°2 (11%)

Class n°3 (15.8%)

Class n°4 (14.2%)

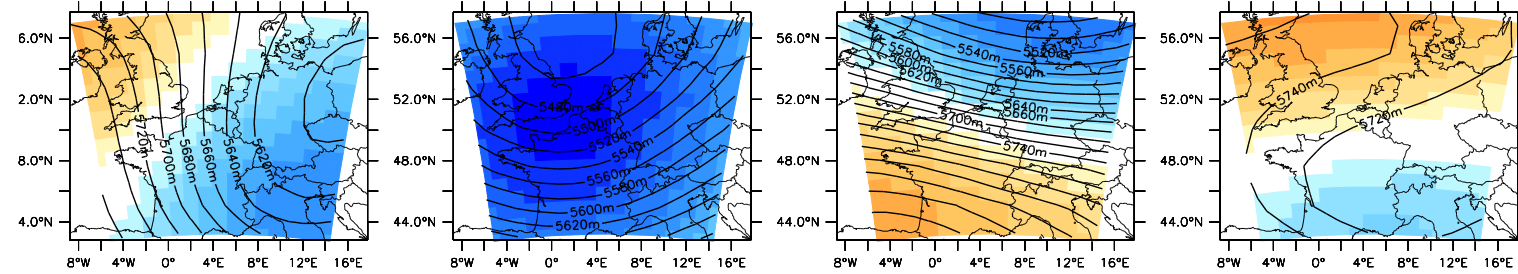


Class n°5 (11.6%)

Class n°6 (11.7%)

Class n°7 (11.5%)

Class n°8 (6.2%)

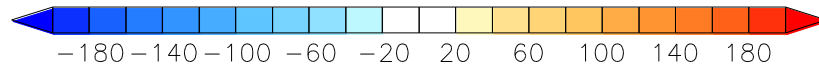


Class n°9 (4.9%)

Class n°10 (2.5%)

Class n°11 (0.6%)

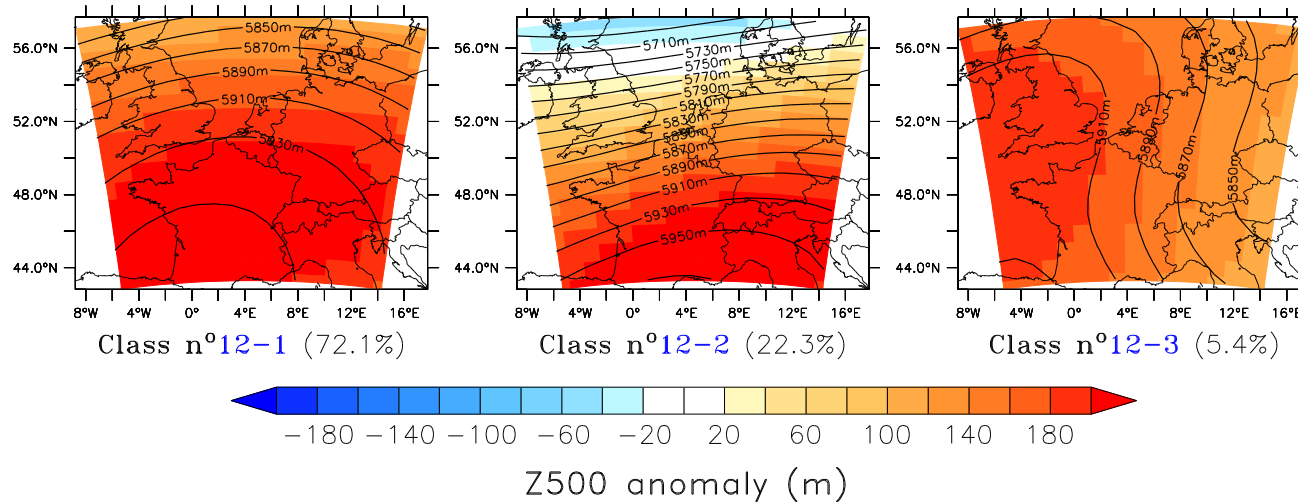
Class n°12 (0.8%)



Z500 anomaly (m)



Classification of class 12 – HadGEM1



- ▶ Lines : class mean situation
- ▶ Colours : class anomaly ÷ seasonal mean (NCEP-NCAR I)

- ▶ Emergence of two new types
 - ▶ Similar to existing ones
 - ▶ With much higher geopotential height
 - ▶ Similar for all GCMs

Conclusion

- ▶ Circulation type classification useful to evaluate GCM-based circulation and particularly its variability
- ▶ GCMs have difficulties to simulate well current climate circulation over western Europe
 - ▶ biases in mean geopotential height
 - ▶ underestimation of its variability
 - ▶ Best matching GCMs : CCCma-CGCM3.1/T63, UKMO-HadGEM1, UKMO-HadCM3
- ▶ Future projections
 - ▶ General increase of the geopotential height
 - ▶ Emergence of two new types
- ▶ Projected change lower or of the same order than uncertainties for current climate !

A topographic map of Europe showing contour lines. The map is light blue and white, with brown contour lines indicating elevation. Labels for contour lines are placed at regular intervals: 5850m, 5870m, 5890m, and 5910m. The text "Thank you for your attention." is overlaid in the center of the map.

Thank you for your attention.