Interpretation of climate change using maps of climate analogues in the DRIAS climate services project

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Context – Rationale

- Global warming is unequivocal (IPCC, 2007)
  - Need for adaptation and mitigation
- Why an approach by analogy?
  - Analogy is an efficient way to communicate on complex issues
  - Results could be used by people with a no scientific background
- Climate analogues consist in seaching in the current climate, regions with similar climate than expected in the future for a considered city (c.f. Hallegate et al.,2007; Kopf et al. 2008)
- Why a study on climate around urban areas?
  - Most of the european populations live in a city
  - Strong impact of an increase of temperature in these areas (e.g. heat wave in 2003 or 2006)
- This study is lead in frame of the project DRIAS, which aims at facilitating the access to climate scenarios information

Presentation Outline

- 1°) Context - Rationale
- 2°) Data and Method
- 3°) Main Results
- 4°) Conclusion

Data: RCMs from ENSEMBLES project

- Main issues:
  - Taking uncertainties into account: need of several climate models
  - Necessity of high spatial resolution: need of regional climate models

The climate projections used in this study have been produced for the European project **ENSEMBLES**

Regional Climate Model and Driving General Climate Model used in the study:

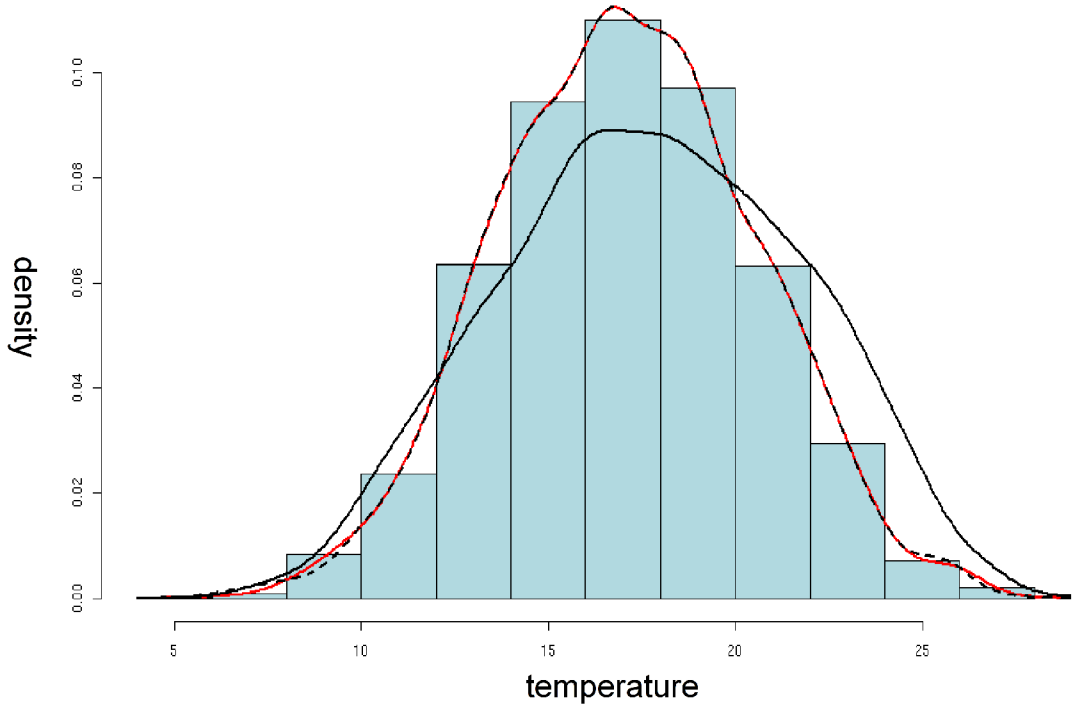
Institution	*RCM*	*Driving GCM*	*RCM References*
C4I	RCA	HadCM3Q16	Kjellström et al. (2005)
CNRM	ALADIN	ARPEGE_RM5.1	Radu et al. (2008)
DMI	HIRHAM	ECHAM5-r3	Christensen et al. (1996)
DMI	HIRHAM	ARPEGE	Christensen et al. (1996)
ETHZ	CLM	HadCM3Q0	Böhm et al. (2006)
ICTP	RegCM	ECHAM5-r3	Giorgi and Mearns (1999)
KNMI	RACMO	ECHAM5-r3	Lenderik et al. (2003)
MPI	REMO	ECHAM5-r3	Jacob (2001)
SHMI	RCA	ECHAM5-r3	Kjellström et al. (2005)

Parameters, resolutions and time periods

- **Parameters used:**
  - Surface temperature
  - Total Precipitation
- **Resolutions:**
  - Spatial: 25 km
  - Temporal: daily
- **Time periods defined:**
  - Reference: 1960-1990
  - Near projection: 2031-2060
  - Middle projection: 2051-2080
  - Far projection: 2071-2100
- **Seasons defined:**
  - Summer: June-July-August (JJA)
  - Winter: December-January-Febuary (DJF)

Pre-processing

- Spatial interpolation (bicubic interpolation)
- Ocean-Land mask
- Quantile-Quantile correction (Déqué, 2007)



Example of correction for summer temperature, for a grid-point (data from CNRM model)

Black line: raw output model PDF

Dashed black line: observations E-OBS PDF

Red line: corrected model PDF

Observations used are from the ENSEMBLES daily gridded observational dataset (called E-OBS; V3; Haylock et al., 2008)

A Statistical method used to computed analogues

The 2-Dimensional Kolmogorov-Smirnov test (Peacock, 1983; Kopf et al., 2008)

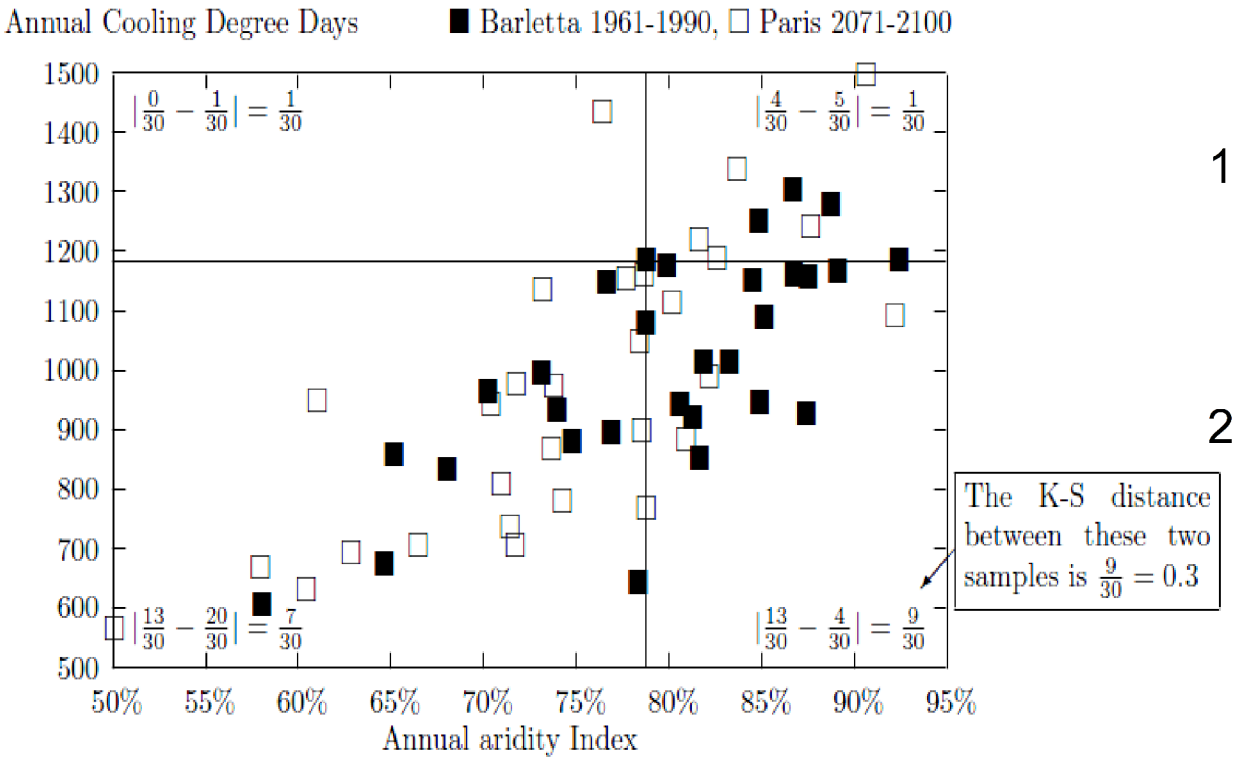


Illustration of the 2D KS-test for climatic samples (From Kopf et al., 2008)

1) Selection of future projections of seasonal temperature and precipitation of the closest grid-point for the studied city (e.g. Paris)

2) Statistical measure of climatic similarity with reference climate, for all the grid-point of the European domain studied

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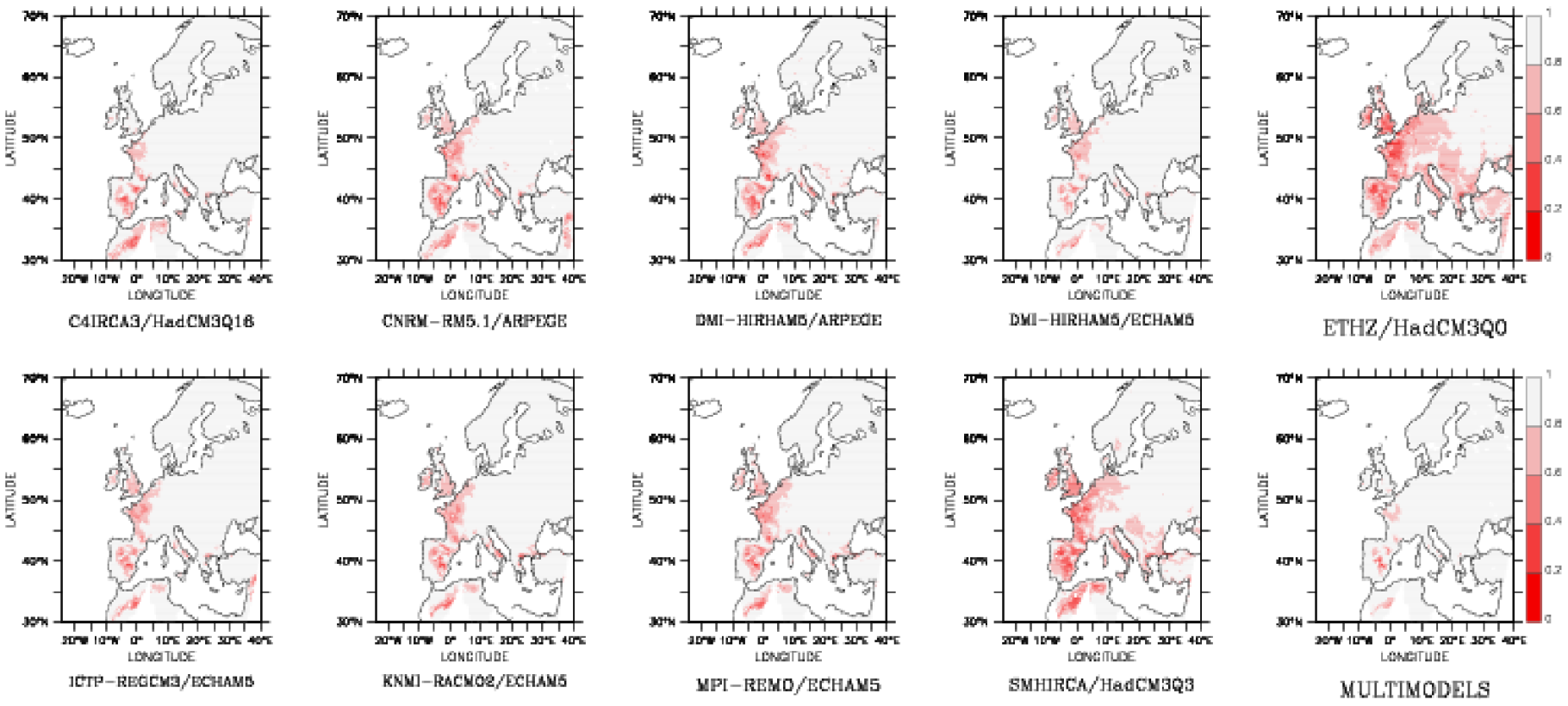
Inter-model spread (1/2)

- Results for :
  - **Paris**, **Winter** (DJF), Near Projection (**2031- 2060**)
  - 9 models and multimodels ensemble

Shade key:

1 -> Bad analogues

0 -> Good analogues



Inter-model spread (2/2)

- Results for :
  - **Paris**, **Summer** (JJA), Near Projection (**2031-2060**)
  - 9 models and multimodels ensemble

Shade key:

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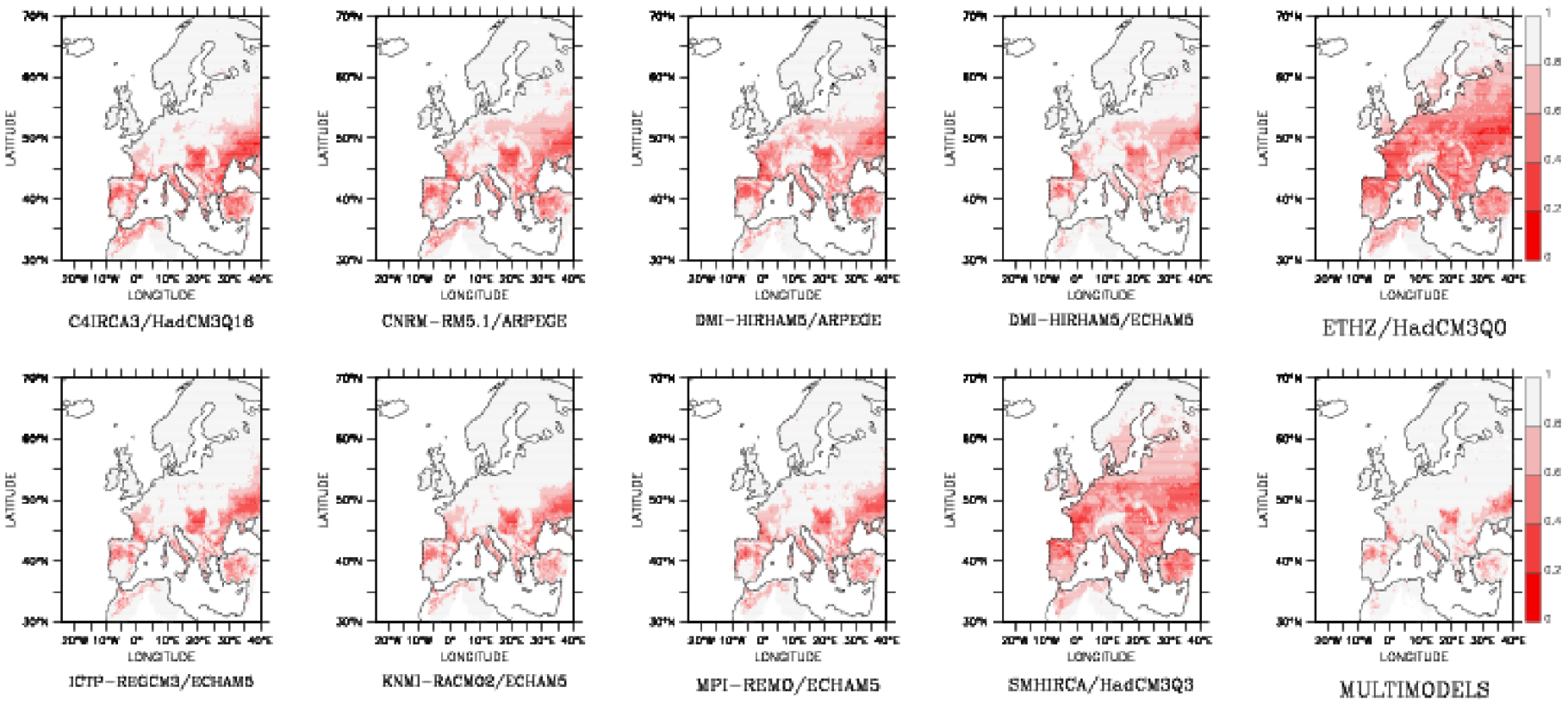
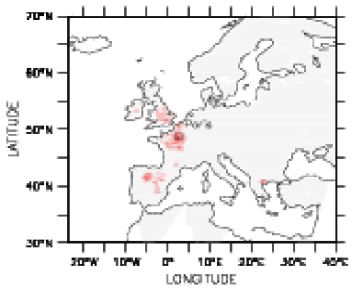
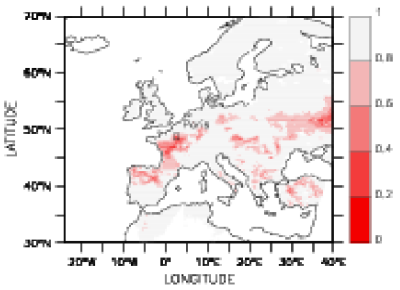
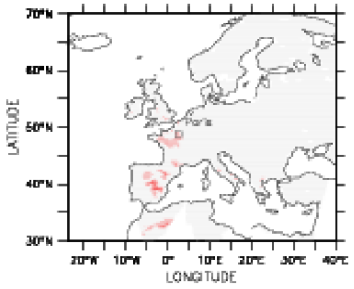
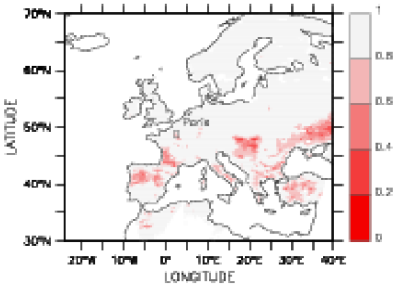
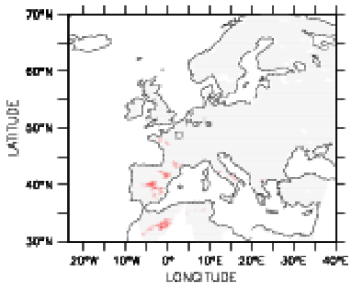
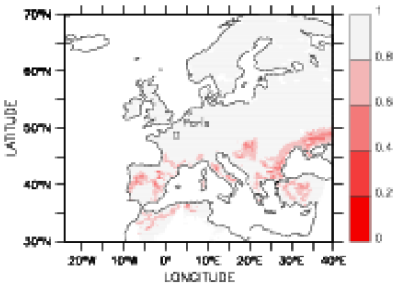
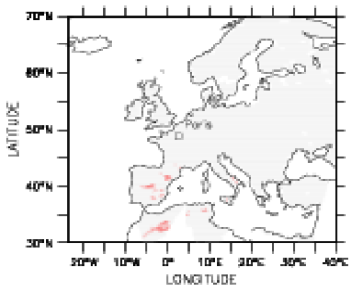
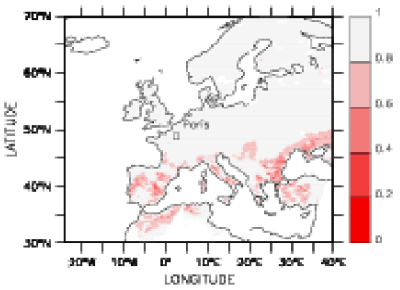


Climate analogues for **Paris** from multi-models ensemble

	Winter	Summer
1961-1990	 Paris DJF 1961-90	 Paris JJA 1961-90
2031-2060	 Paris DJF 2031-60	 Paris JJA 2031-60
2051-2080	 Paris DJF 2051-80	 Paris JJA 2051-80
2071-2100	 Paris DJF 2071-100	 Paris JJA 2071-100

Shade key:

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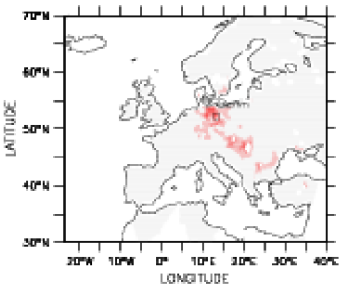
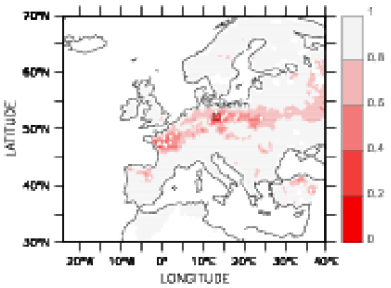
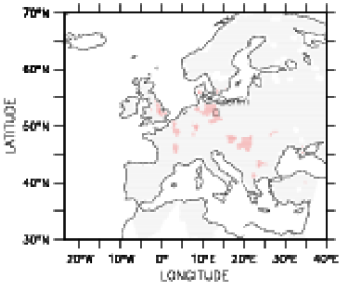
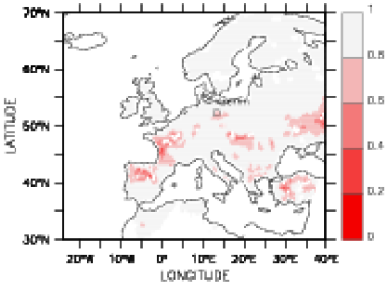
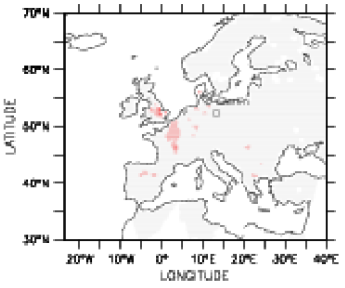
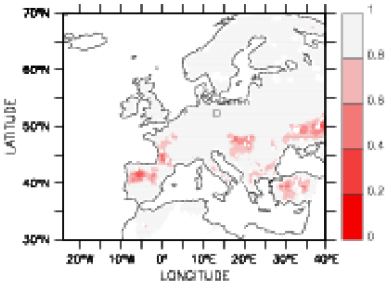
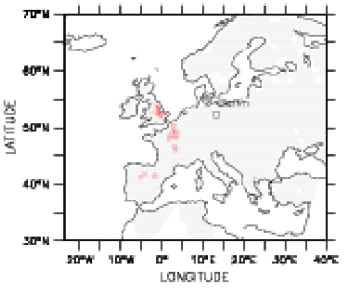
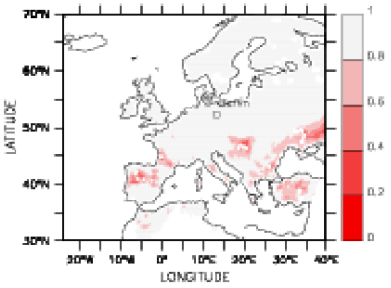
Climate analogues for **Berlin** from multi-models ensemble

	Winter	Summer
1961-1990	 Berlin DJF 1961-90	 Berlin JJA 1961-90
2031-2060	 Berlin DJF 2031-60	 Berlin JJA 2031-60
2051-2080	 Berlin DJF 2051-80	 Berlin JJA 2051-80
2071-2100	 Berlin DJF 2071-100	 Berlin JJA 2071-100

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trajectories of the best analogues

Blue: Winter (DJF)

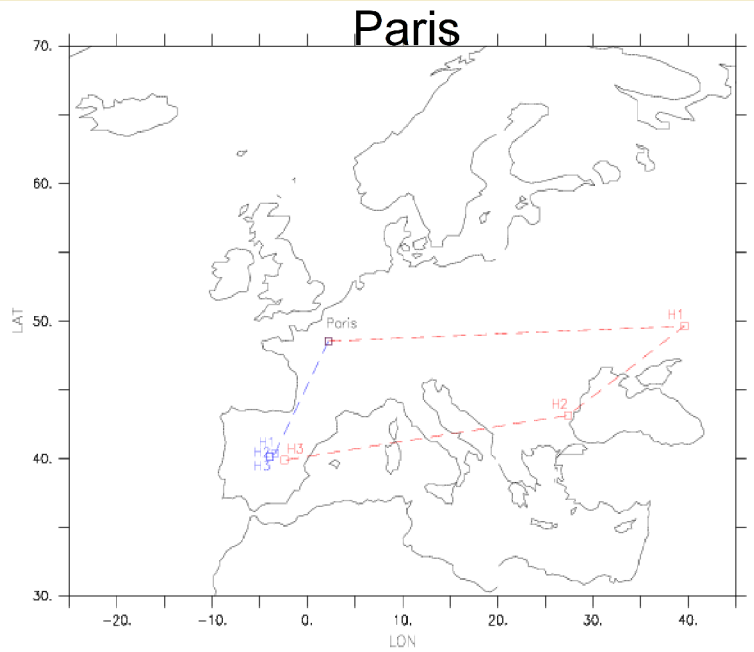
Red: Summer (JJA)

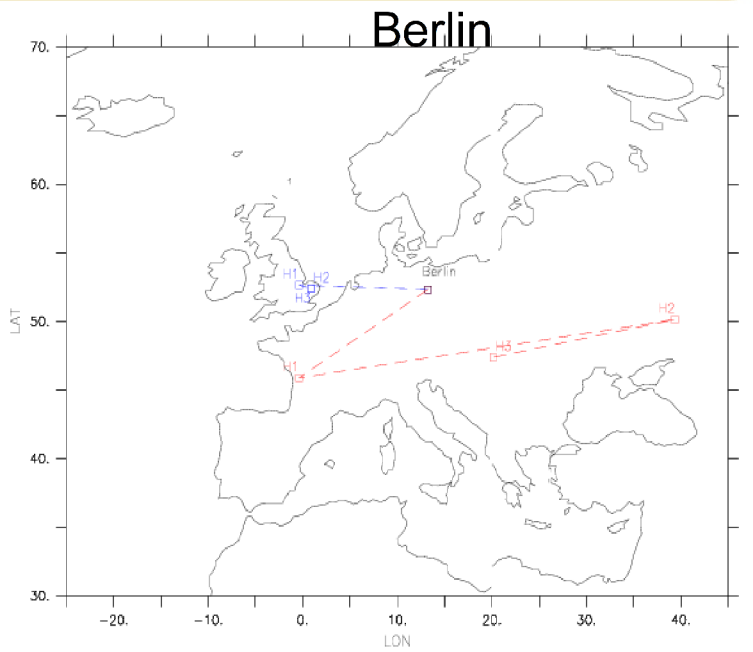
Best analogues for time periods:

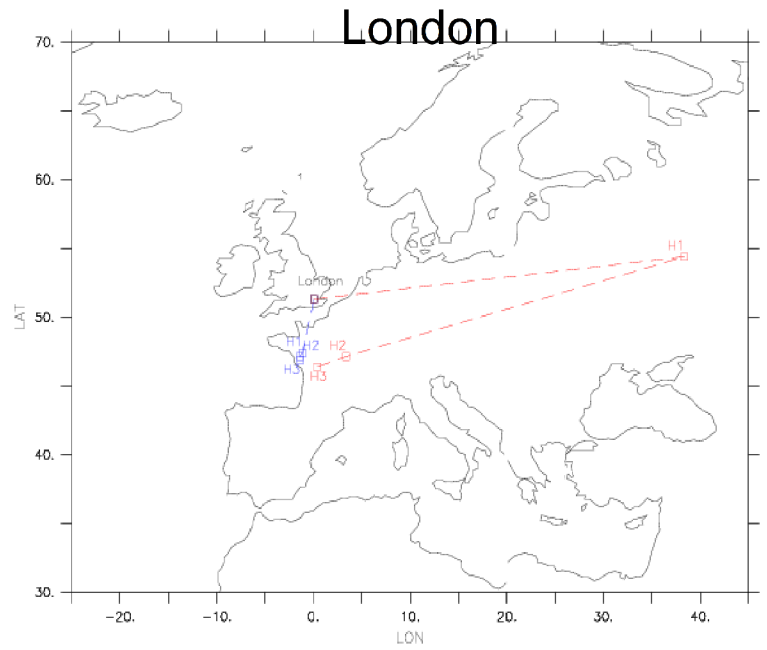
H1: 2031-2050

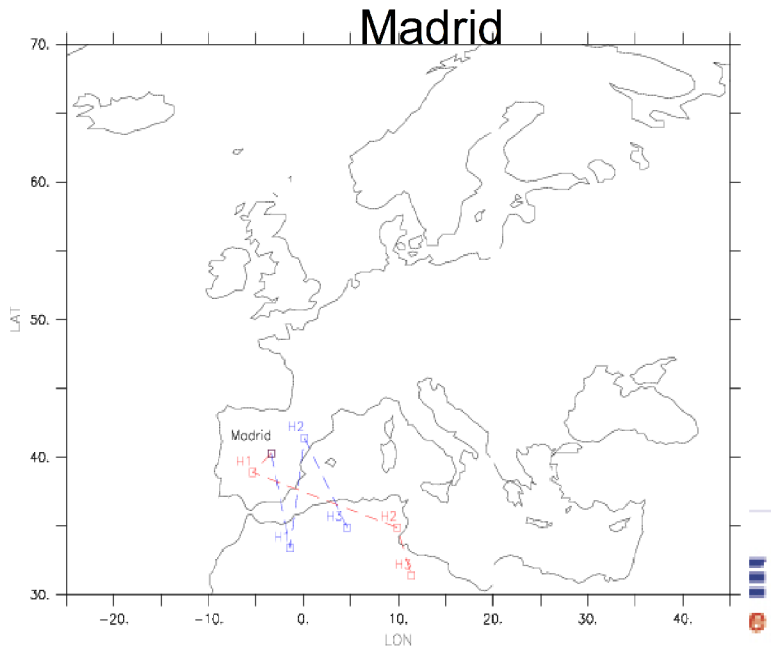
H2: 2051-2080

H3: 2071-2100









Conclusion

- This study's aims has been to develop, in frame of the project DRIAS, a climate product easily useable by people involved in impact and adaptation issues
- Following Hallegate et al. (2007) and Kopf et al. (2008), analogue approach has been used. That consist in seaching in the current climate, regions with similar climate than expected in the future for a considered city
- Maps of climate analogues and trajectories of best analogues have been computed using a 2D KS test and a multi-models ensemble (9 RCMs from the EMSEMBLES project)
- A seasonal study has been done on corrected data
- More sophistical definition of best analogue could be explored

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