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The use of geographical information systems (GIS) in palaeoclimatology : application during the Weichselian Late Glacial in the northern Atlantic region.

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It is now well known that the Weichselian Late Glacial is characterized by a succession of abrupt and widespread climatic changes. According to the Greenland isotopic curves, it is possible to clearly identify climatic episodes such as the :

- GS-2a or Oldest Dryas (15,1-14,7 cal ky BP)
- GI-1e or Bølling (14,7-14,05 cal ky BP),
- GI-1d or Older Dryas (14,05-13,9 cal ky BP),
- GI-1c or Allerød (13,9-12,6 cal ky BP)
- GI-1b, also called Intra-Allerød Cold Period, Killarney oscillation in Northern America or Gerzensee oscillation in Europe (13,15 to 12,9 cal ky BP)
- and GS-1 (12,6-11,5 cal ky BP), better known as the Younger Dryas event.

Furthermore, the resolution of some climatic events has been improved : it is currently known that the Younger Dryas is tripartite and that the Oldest Dryas may be punctuated by a sudden warming named Pre-Bølling Warming, even if its existence is not clearly shown by all the isotopic curves.

To better understand these climatic variations, a multi-proxy database has been created, from specialized publications and from electronic datasets (World Data Center

A for Palaeoclimatology, NAPD, EPD, Oxford and FSUM's lake-levels database or MPDB). Currently, this database numbers more than 600 sites mainly spread over Northern America, Western Europe, Northern Africa and Eurasia.

This multi-proxy approach focuses on two means to reconstruct abrupt climate changes : the first one consists in compiling several indicators to estimate **qualitative** parameters (warmth, cold, rainfall characteristics, direction and intensity of the wind) ; the second one is to **quantify**, at a large scale, climatic values, such as temperature and precipitation thanks to :

- The Climate Indicator Species method, developed by ISARIN (1997), RENSSEN and ISARIN (2001) and already used in the Multi Proxy Data Base (2005)
- and the Information Logical Analysis taken from VELICHKO et al. (2002) .

Both means are integrated in a GIS (Geographical Information System). This tool, created with the software Arc GIS 9 (Arc Map) permits to superpose several layers of palaeonvironnemental information on a current detailed map :

- A "*Vegetation layer*", which shows the global dispersion of Climate Indicator Species and other pollen counts. This layer can be used to describe the rhythms of vegetal colonisation and the dynamic of biomes over our fieldwork,
- A "*Topographic layer*", representing the position and the thickness of ice domes during each episode of the Late Glacial, coupled with the current topography
- A "*Palaeotemperature layer*" and a "*Precipitation layer*" obtained from the spatial interpolation of our palaeoenvironmental data.

The purpose of this GIS is to provide an useful tool, which requires few computation and geostatistical knowledge to give some relevant results concerning the understanding of past climatic changes. Currently, it is possible, thanks to this powerful tool, to produce a relatively sharp estimation of the spatial repartition of temperature and precipitation with a high temporal resolution (100 years). To a certain extent, it can be said that this spatial interpolation gives results which are not very different from those proposed by climatic models.

ISARIN R.F.B., 1997 - *The climate in north-western Europe during the Younger Dryas. A comparison with multi-proxy climate reconstructions with simulation experiments*. Academisch Proefschrift. Vrije Universiteit te, Amsterdam, 155 p.

MPDB: Multi Proxy Database, created by Tom v. TILBURG at the Faculty of Earth & Life Sciences, Vrije Universiteit Amsterdam

RENSSEN H., ISARIN R.F.B., 2001 – The two major warming phases of the last deglaciation at ≈ 14,7 and ≈ 11,5. ka cal BP in Europe : climate reconstructions and AGCM experiments. *Global and Planetary Change*, **30**, 117-153.

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