Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08631, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08631
EGU General Assembly 2008

Permian climate development, new insights from numeric modelling based on a modified palaeogeography

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Roscher & Schneider (2006) showed a new plate tectonic hypothesis on the formation of Pangaea. In order to validate the associated plate motions on a global scale we kept Baltica as a fix reference and rotated the other plates with respect to the reference. Resulting relative motions have subsequently been transformed into absolute values by climatic data only. The new plate tectonic concept is supported by palaeomagnetic data as it fits the 95% confidence interval of published palaeomagnetic data. The new palaeogeography was then used as the basis for climate modelling.

From the new palaeogeographic reconstruction (superimposed by an estimated palaeo-topography) distinct time slices which mark palaeogeographic and/or plate tectonic phases were chosen as the basis for the different modelling runs. We started at 340 Ma where the palaeogeography is marked by an open equatorial seaway. The 320 Ma reconstruction shows the closure of the Mid-Pangaean seaway and the onset of the Gondwana glaciation. The maximum of this icehouse occurs at about 300 Ma. The shift from the Palaeozoic icehouse to the following warmhouse stage started at about 290 Ma ago. The maximum of aridity on central Pangaea was reached during the Middle Permian (270 Ma) and the influence of the large Zechstein ingression is simulated in the 250 Ma reconstruction. All palaeogeographic reconstructions were transformed into digital grids which have a 2.8˚x2.8˚ (T42) resolution, suitable for high-resolution climate modelling.

Subsequent climate modelling used the PLASIM model (Fraedrich et al., 2005). CO_2 concentrations of the palaeo-atmosphere have been estimated from isotope records (Veizer et al., 1999) using the method of Freeman & Hayes (1992). Palaeo-insolation values were reconstructed according to the method given in Caldeira & Kastings (1992), and are approximately 3% lower than today's values.

To compare the model data with the geologic indicators, the absolute values of temperature and precipitation were coded to relative climate indicators. Therefore a simplified climate classification after Köppen-Geiger was used. The reconstructed occurrences of geological indicators like aeolian sands, evaporites, coals, tillites, phosphorites, cherts and reefs were then compared to the computed palaeoclimatic zones. Examples of the Permian Pangaea show a very good agreement between model results and geological climate indicators.

The Carboniferous maps are still in work, but the first results are very auspicious. The disappearance of the ever-wet tropics in the Late Carboniferous fits very well with the nearly complete extinction of the Lycopsides, typical swamp plants, in central Europe.

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