Are Data-Model Results Bias Towards the Warm Low Latitudes?*

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Abstract

Climate plays a huge role in determining styles of depositional processes at different latitudes. Climate modelling may therefore provide important information for new ventures projects in predicting the presence or absence of suitable hydrocarbon plays. The key is to validate the model results against proxy data to determine whether they provide feasible results across all latitudinal belts. Palaeoclimate proxy data is most often from low-mid latitude regions and bias towards warm climate states. However, General Circulation Models (GCMs) tend to be bias toward the low end of the climate spectrum, struggling to make the high latitude regions warm enough to sustain forests we know were present in Greenhouse periods, such as the Cretaceous, without concomitant warming of the equatorial regions.

Introduction

The HadCM3 GCM has been run to obtain results for each Stage of the Cretaceous using new palaeogeographic basemaps provided by Getech Group plc. Here we compare the results for the Aptian (118.5 Ma) and Albian (105.8 Ma) with palaeoclimate proxy data from the high latitudes in order to determine if the model produces viable results for the high latitudes. Palaeoclimate analysis of the fossil wood from conifer forests of Aptian-Albian age of Svalbard (Figure 1) suggests that they grew in moist cool upland areas with warmer temperate lowland regions, probably with rivers and/or swampy areas present. Study of the conifers from the Canadian Arctic islands (Figure 1) indicate that they grew under slightly cooler conditions than on Svalbard, similar to northern Canada today. HadCM3 GCM results for Svalbard show that the dominant biome was evergreen taiga/montane forest with lowland temperate grassland also present during the Albian Stage (cold boreal forest with short hot summers under the Köppen-Geiger classification). The modelled Mean Annual Temperature (MAT) was ~-3.6°C with summer temperatures rising to a mean of ~18°C (Figure 2). Mean Annual Precipitation (MAP) was ~584 mm.

Discussion and Conclusions

In the Canadian Arctic, the model indicates that the biomes were more mixed than on Svalbard. The Aptian Stage biome was dominantly deciduous taiga/montane forest with temperate grassland in low laying areas. The Albian was dominated by evergreen taiga/montane forest with some elements of deciduous taiga and shrub tundra. Both stages were classified as cold boreal forest with short hot summers under the Köppen-Geiger classification scheme. MAT was modelled to be ~-6.6°C with summer temperatures reaching a mean of ~13°C (Figure 2) and MAP was ~402 mm. These results suggest that the HadCM3 produces a good match to the climate proxy data in these difficult to model high latitude areas without overheating the low latitudes. The HadCM3 may therefore provide an additional tool in assessing conditions for source and reservoir production and preservation to reduce exploration risk in new ventures regions.

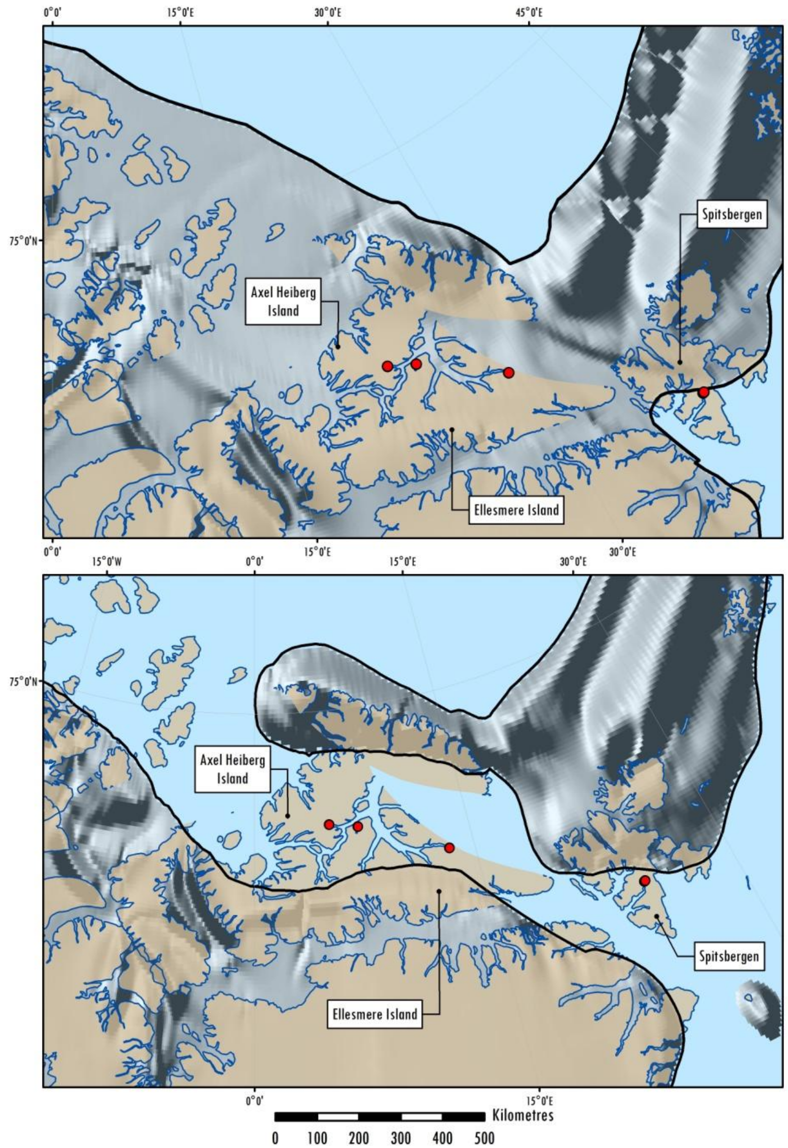

Figure 1. Palaeogeographic maps showing the Canadian Arctic and Svalbard sample sites (red circles; Getech, 2011). The present day international country boundaries have been rotated to their palaeo-positions to allow the locations of interest to be easily identified (filled in brown). The palaeohighstand line is shown in black. Top: Aptian (118.5 Ma) showing the pre-rift palaeogeography, volcanism was occurring in the uplifted area to the north of Spitsbergen and rifting to the southeast at this time. Bottom: Albian (105.8 Ma) showing the marine transgression following rifting.

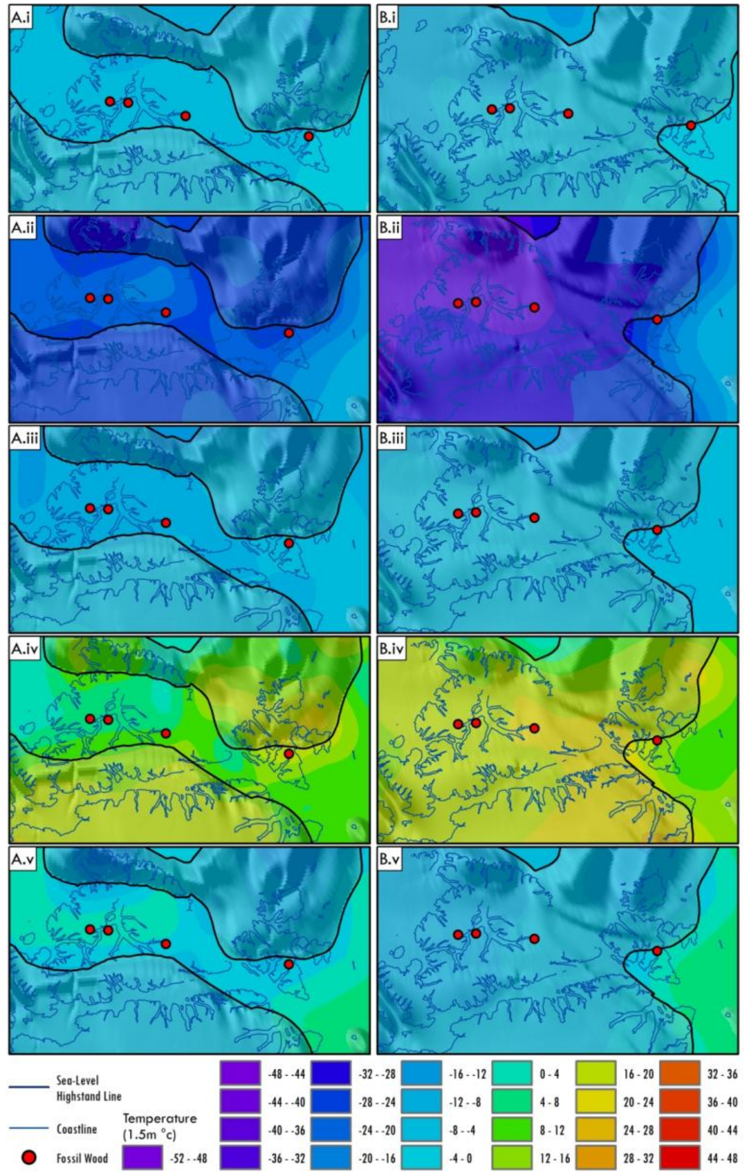

Figure 2. Palaeotemperature model results for 1.5m above the surface given in °C A) Albian B) Aptian i) mean annual temperature ii) mean winter temperature (December, January, February) iii) mean spring temperature (March, April, May) iv) mean summer temperature (June, July, August) and v) mean autumn temperature (September, October, November).