On the reduced North Atlantic storminess during the last glacial period: the role of topography in shaping synoptic eddies

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ABSTRACT

The North Atlantic storminess of Last Glacial Maximum (LGM) fully coupled climate simulations is generally less intense than that of their pre-industrial (PI) counterparts, despite having stronger baroclinicity. An explanation for this counterintuitive result is presented by comparing two simulations of the IPSL full climate model forced by PMIP3 (Paleoclimate Modelling Intercomparison Project Phase 3) LGM and PI conditions. Two additional numerical experiments using a simplified dry general circulation model forced by idealized topography and a relaxation in temperature provide guidance for the dynamical interpretation. The forced experiment with idealized Rockies and idealized Laurentide Ice Sheet has a less intense North Atlantic storm-track activity than the forced experiment with idealized Rockies only, despite similar baroclinicity. Both the climate and idealized runs satisfy or support the following statements. The reduced storm-track intensity can be explained by a reduced baroclinic conversion which itself comes from a loss in eddy efficiency to tap the available potential energy as shown by energetic budgets. The eddy heat fluxes are northeastward oriented in the western Atlantic in LGM and are less well aligned with the mean temperature gradient than in PI. The southern slope of the Laurentide Ice Sheet topography forces the eddy geopotential isolines to be zonally oriented at low levels in its proximity. This distorts the tubes of constant eddy geopotential in such a way that they tilt northwestward with height during baroclinic growth in LGM while they are more optimally westward tilted in PI.