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Moist static energy solves storm track intensity puzzle for Snowball Earth

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Modern theories of the midlatitude storm tracks connect their intensity to surface baroclinicity (latitudinal surface temperature gradient). However, simulations show storm tracks were weaker during past cold, icy climates relative to the modern climate even though surface baroclinicity was stronger. We revisit this surface baroclinicity-intensity puzzle for Snowball Earth using simulations across the climate model hierarchy. Here we show the Moist Static Energy framework for storm track intensity solves the puzzle for Snowball Earth. It connects the weaker storm track to the increase of surface albedo, decrease of latent heat flux and decrease of latitudinal surface Moist Static Energy gradient. Weaker intensity can be predicted assuming a surface ice albedo and zero latent heat flux (large Bowen ratio) everywhere in Snowball Earth. The weaker storm track is also consistent with weaker Mean Available Potential Energy (weaker upper-tropospheric baroclinicity), however that cannot be predicted. Overall, the exotic Snowball Earth climate reveals storm track intensity follows the surface Moist Static Energy gradient and not surface baroclinicity. Our insights may help resolve the puzzle in other climates such as the Last Glacial Maximum.