

1 **Supplementary Material for: Hydrological cycle changes explain weak Snowball Earth**
2 **storm track despite increased surface baroclinicity**

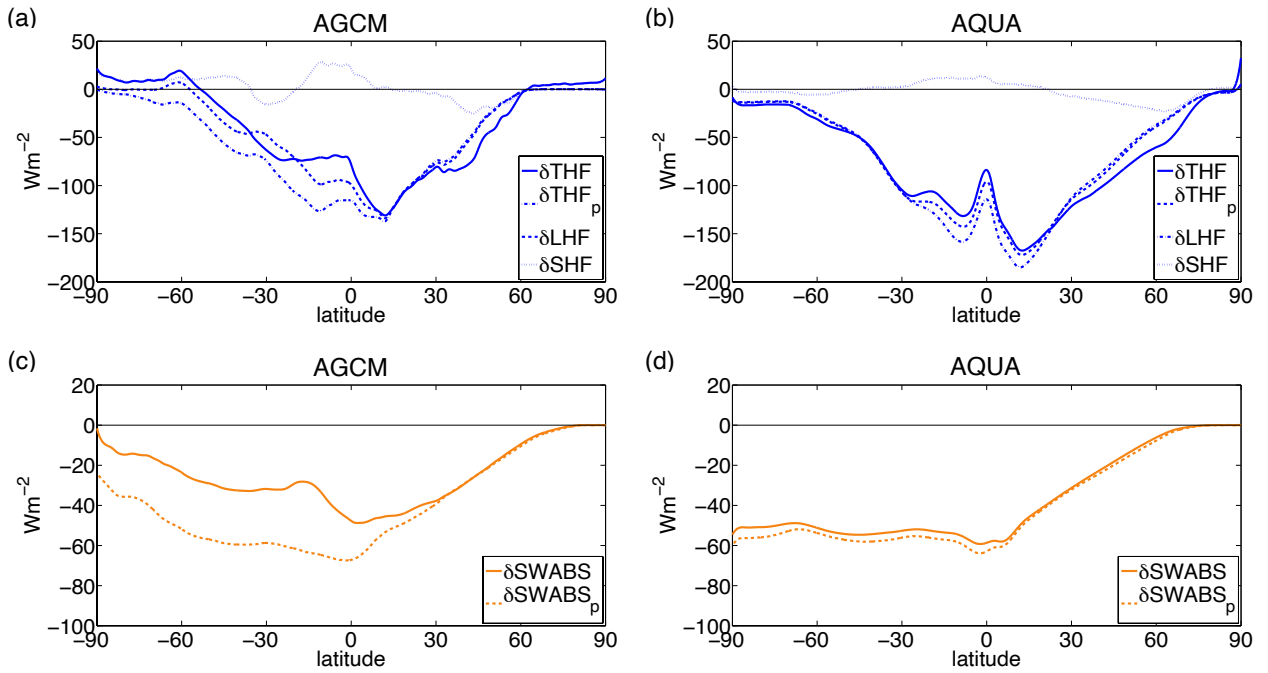
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4 ¹Department of the Geophysical Sciences, The University of Chicago, Chicago, IL, 60637

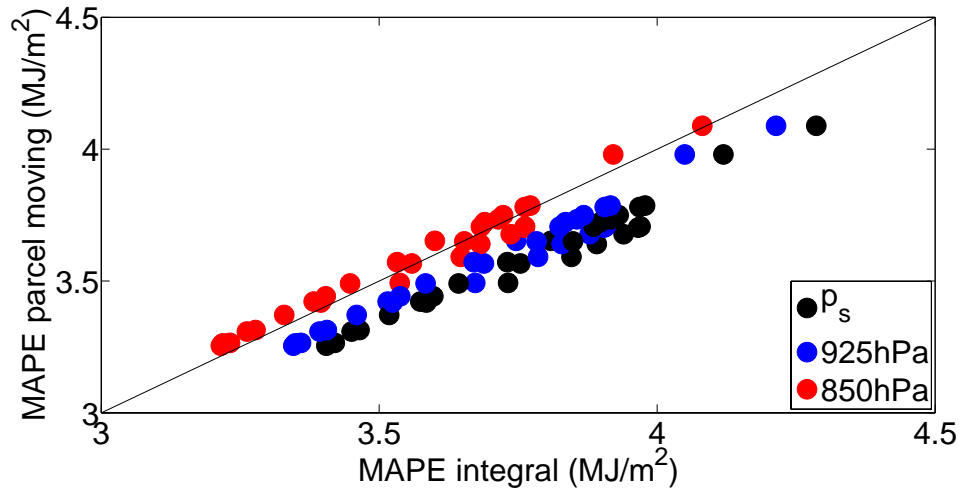
5 ²Department of Physics, The University of Oxford, Oxford, UK

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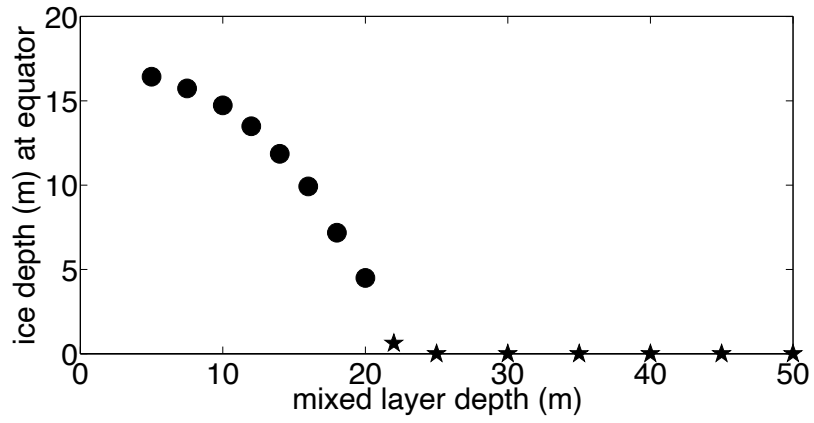
7 LIST OF FIGURES



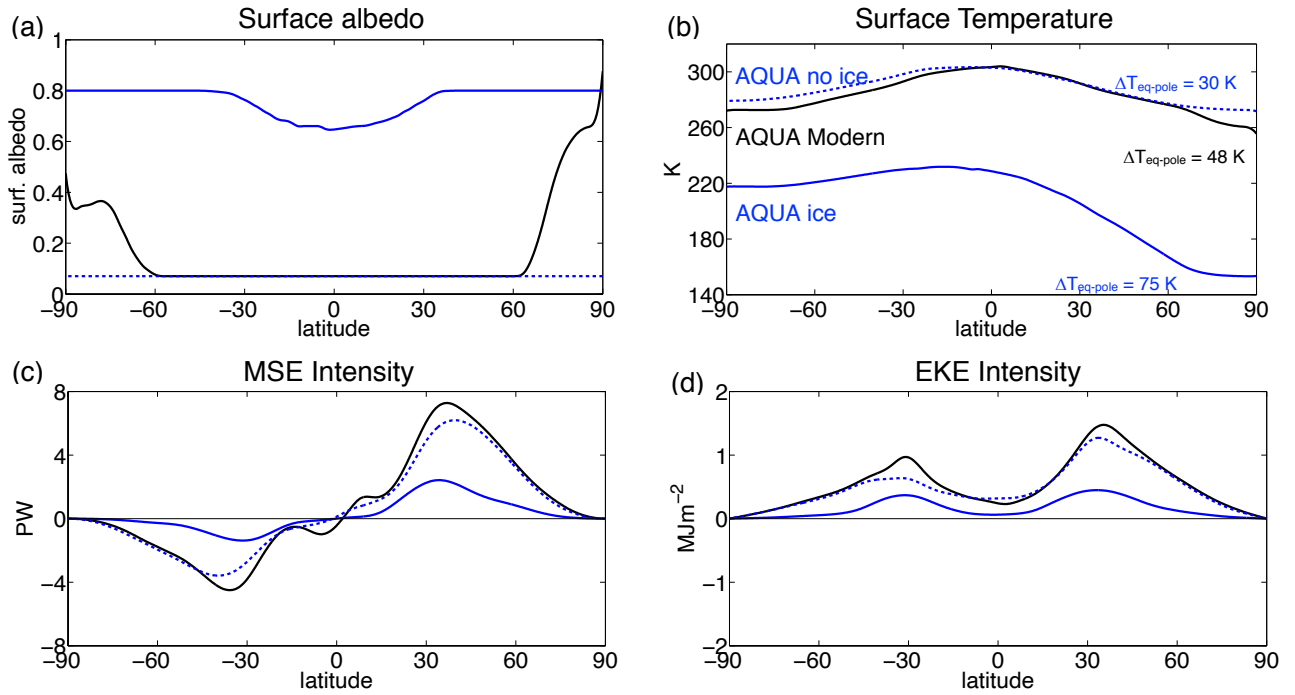
8 FIG. 1. Difference of (a,b) turbulent heat flux (THF), latent heat flux (LHF) and sensible heat flux (SHF) and
 9 (c,d) shortwave absorption (SWABS) between the Snowball Earth and modern climates for AGCM and AQUA.
 10 The subscript p indicates predictions (see section 2.1).



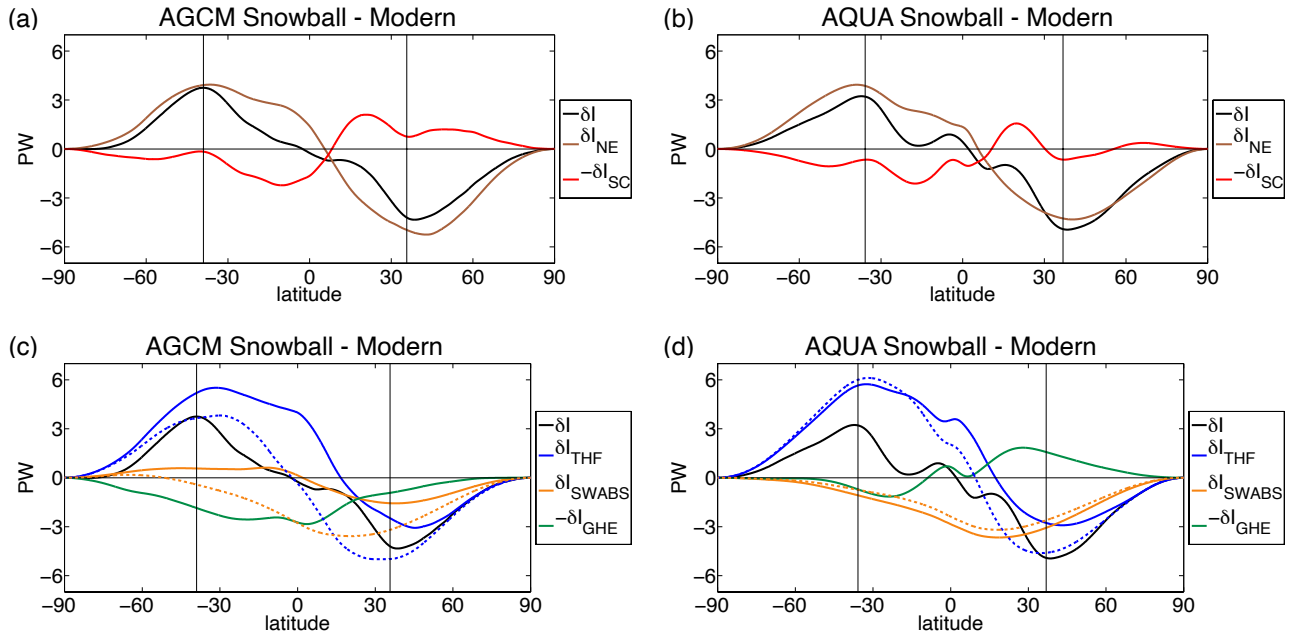
11 FIG. 2. MAPE calculated using the parcel moving algorithm (Stansifer et al. 2017) versus the integral
 12 algorithm with tropopause pressure as the upper integral limit and different lower integral limits indicated in the
 13 legend.



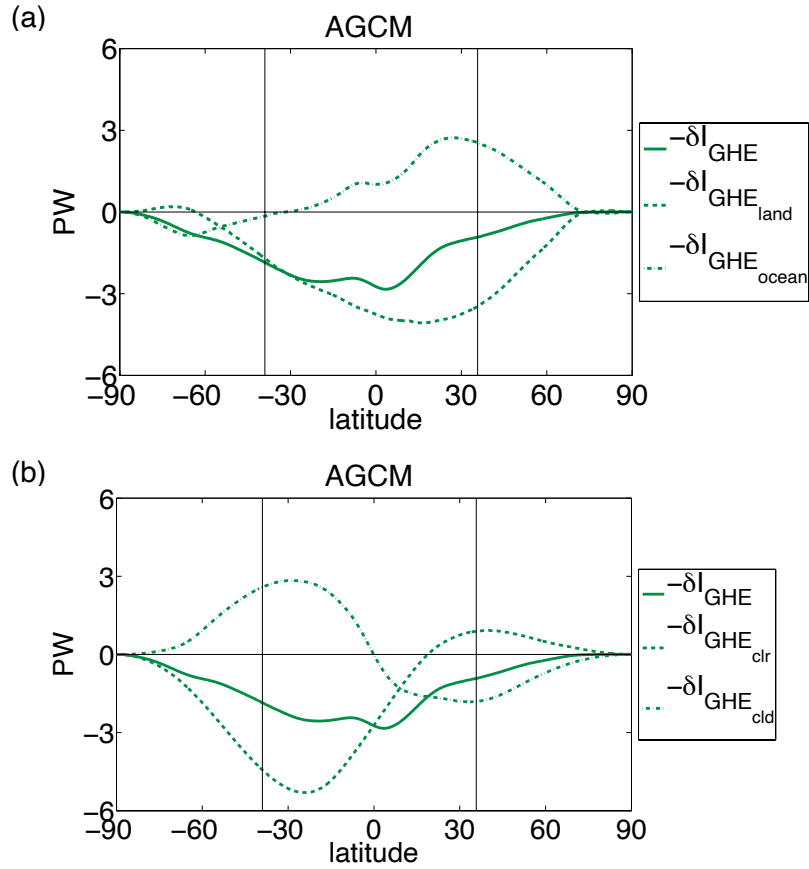
14 FIG. 3. Northern Hemisphere wintertime sea ice depth at the equator versus slab-ocean mixed layer depth (m)
15 in AQUA. Circles indicate Snowball Earth simulations.



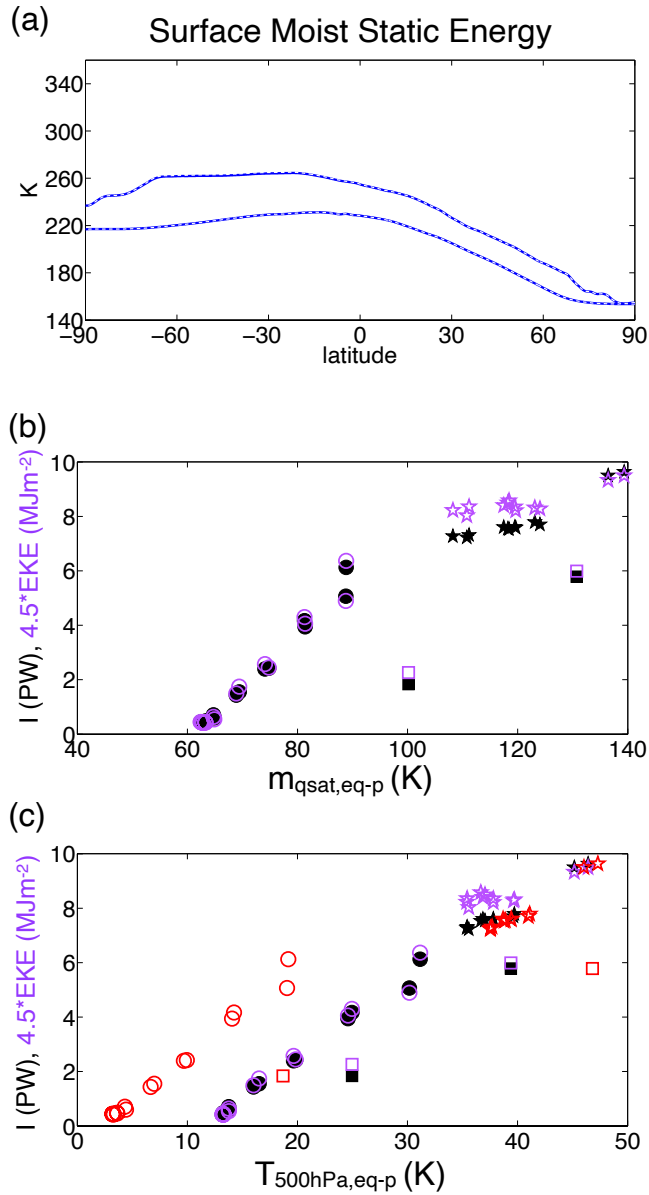
16 FIG. 4. Northern Hemisphere wintertime (a) surface albedo, (b) surface temperature and storm track intensity
 17 defined by (c) transient eddy MSE flux or (d) eddy kinetic energy for modern 50 m slab ocean AQUA (black)
 18 and Snowball Earth 15 m slab-ocean AQUA with sea ice (and ice albedo, solid blue) and without sea ice (and
 19 ocean albedo, dashed blue) simulations.



20 FIG. 5. Weakening of Northern Hemisphere wintertime storm track intensity (PW) between Snowball Earth
 21 and modern climates (δI , black) decomposed into (a,b) net energy input (δI_{NE} , brown), stationary circulation
 22 ($-\delta I_{SC}$, red), (c,d) shortwave absorption (δI_{SWABS} , orange), turbulent heat flux (δI_{THF} , blue) and greenhouse
 23 effect ($-\delta I_{GHE}$, green) contributions for AGCM (a,c) and AQUA (b,d) simulations. Dashed lines represent
 24 predicted values (see section 2.1). The vertical black lines indicate the storm track position in the modern
 25 climate.



26 FIG. 6. Weakening of Northern Hemisphere wintertime storm track intensity (PW) between Snowball Earth
 27 and modern climates due to the greenhouse effect ($-\delta I_{GHE}$, green solid) decomposed into (a) land ($-\delta I_{GHE,land}$,
 28 green dash) and ocean ($-\delta I_{GHE,ocean}$, green dash dot) and (b) clear-sky ($-\delta I_{GHE,clr}$, green dash)
 29 ($-\delta I_{GHE,clد}$, green dash dot) contributions for AGCM. The vertical black lines indicate the storm track position
 30 in the modern climate.



31 FIG. 7. (a) Snowball Earth surface moist static energy (blue) and surface moist static energy calculated using
 32 saturation specific humidity (white dashed) versus latitude. (b) Storm track intensity versus equator minus pole
 33 surface (2 m) MSE calculated using surface temperature and the Clausius Clapeyron relation. (c) As in Fig. 4d
 34 but with red symbols using equatorial temperatures at 500 hPa calculated following the moist adiabat using the
 35 equatorial surface temperature and relative humidity.