GC35E-0744 - Parametric Study of Prompt Methane Release Impacts III: AOGCM Results Which Respect Historical PIOMAS Measurements

Wednesday, 15 December 2021

15:00 - 17:00

Convention Center - Poster Hall, D-F

Background: Of immediate widespread concern is the accelerating transition from Holocene-like weather patterns to unknown and *unstable* Anthropocene patterns. A fell example is (irreversible) Arctic phase change. It is not clear if existing AOGCMs are adequate to model anticipated *global* impacts in detail; however, the GISS ModelE AOGCM model physics can be used to *regionally* compare and extend the PIOMAS Arctic ocean historical ice-volume dataset into the near future. Arctic Amplification (AA) mechanisms are poorly understood; therefore, to enable timely results, a simple linear, Arctic TOA grid-boundary energy-input – about 2.5x the latent heat of icemelt (PIOMAS [2018]) – is used to continue to drive the AA *energy input* rate, observed over the last 40 years. The physical response of a detailed coupled AOGCM is used to observe expected Arctic responses in the near future. This approach avoids the perils of arbitrary modification of otherwise relatively well-studied grid-level parameterizations (e.g., restriction of local cloud-top heights to induce localized warming). Only PIOMAS April/September MAX/MIN *annual linear trends* (energy inputs) were tuned. This temporally-broad grid-boundary modification produces a surprisingly detailed consonance (see figure), showing excellent agreement with historical monthly trends in the PIOMAS dataset over a very broad time span (24 years as opposed to AR6 suggested 15 years). It should be noted that changes in *global circulations* may not be well modeled by *any* AOGCM as far out as 2050 or beyond; however, it is felt that the current AOGCM physics produces a reasonably reliable prediction of physical responses to AA in the Arctic basin itself over the next ~20 years.

Results: AOGCM physics extending PIOMAS ice-melt rates indicates a zero-ice-volume, *summer/fall half-year*, beginning ca. 2035 (1-sigma of ± ~5 years), with mean annual Arctic temperatures increasingly trending above freezing. General considerations of geostrophic flow suggests disruption of summer (i.e., food growing season) weather patterns. Persistent, Arctic phase change likely follows the 2035 transition about 20 years later. Fully ice-free winter Arctic Ocean may be unlikely in the near term. Importantly, the 500 hPa height minimum becomes no longer nearly-coincident with the pole, further suggesting jet stream disruption and its consequences to Northern Hemisphere food production. Hypothesized large clathrate-methane releases likely associated with Arctic temperature and phase change are also examined, and accelerate the modeled changes.

This work establishes a reasonably detailed timeline for the Arctic phase change based on well-studied AOGCM physics, with the Arctic slightly tuned to decades of PIOMAS data. Critically, this result points to the changing Arctic as a key, near-term site for localized, nondestructive intervention to mitigate Arctic phase change (e.g., Stjern [2018]), thereby slowing the Holocene -> Anthropocene growing-season disruption, crucial to global agricultural yield, which is already declining, and a prerequisite to maintaining large-scale human agency on the planet. Although such an intervention cannot itself accomplish the *requirements* of the IPCC SP-15 [2018], nor Planetary Boundaries (PB) theory, delaying the Arctic phase change is a necessary antecedent to extend the time-window for accomplishing the critical tasks of PB/SP-15 by extending the rapidly closing window of organized, large-scale human agency required to accomplish these tasks.