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 adequately model anticipated resulting *global* impacts in detail; however, 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 is used – an annual increase of about 2.5× the latent heat calculated for the observed icemelt rate (PIOMAS [2018]) – to drive AA icemelt as observed over the last 40+ years. The physical response of an AOGCM allows the observation of expected Arctic responses in the near future *assuming AA energy inputs continue at the historical rate*. This approach avoids the perils of simple historical PIOMAS data extrapolation, as well as arbitrary modification of otherwise relatively well-studied grid-level AOGCM parameterizations (e.g., restriction of local cloud-top heights to induce localized warming). Only PIOMAS April/September MAX/MIN *linear* trends (energy inputs) were used as tuning metrics to determine the constant AA energy increase rate. This simple 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 (at least 24 years as opposed to AR6 suggested 15 years). It is not clear if current AOGCMS can product global predictions of Arctic changes, but it is felt that the current AOGCM physics produces a reliable extension of the physical responses in the Arctic Ocean basin to continuing AA over at least the next 20 years. The grid boundary modification used here is intended as a reliable, rapid, local, short-term predictor, not a fundamental modeling advance, useful until details of AA modeling are better understood.

Results: Using AOGCM physics to extend PIOMAS ice-melt rates indicates continuing mean ice loss, with a zero-ice-volume summer/fall half-year beginning ca. 2035 (1-sigma of ± ~5 years). Mean annual Arctic temperatures increasingly trend above freezing, and general planetary geostrophic flow considerations suggest increasing disruption of summer (i.e., the food growing season) weather patterns. Persistent, Arctic phase change is suggested to follow the 2035 transition about 20 years later. Fully ice-free winter Arctic Ocean is not predicted in the near term. Importantly, the polar 500 hPa height minimum becomes is no longer nearly-coincident with the pole, further suggesting jet stream disruption and its consequences to Northern Hemisphere weather patterns and food production. Hypothesized large Arctic shallow continental shelf clathrate-methane releases likely associated with Arctic temperature and phase change are also examined, and these accelerate the modeled changes. On the other hand, some AR6 AOGCM submissions appear to predict that AA has ended *ca* 2020. This discrepancy should be resolved in a few years; however, action at the later date may not be effective.

This work establishes a detailed timeline for the Arctic phase change based on well-studied AOGCM physics, 40 years of PIOMAS observations, and the assumption of AA energy inputs continuing at historical rates. Fundamentally, 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]). Although controversial on a *global* scale, such an intervention may be both tolerable and necessary in the Arctic, and may be required to slow the rate of Anthropocene growing-season disruption. Reliable food production is crucial to global agricultural yield, and is a prerequisite to maintaining large-scale human agency on the planet. Although such an intervention cannot itself accomplish the implied *requirements* of the IPCC SP-15 [2018] or Planetary Boundaries (PB) theory, delaying the Arctic phase change is a necessary antecedent to extend the remaining short *time-window* to do so. The accomplishment of the critical tasks of PB/SP-15 by extending this rapidly closing window for organized, large-scale human action is intended to maintain large-scale civilization.