Parametric study of prompt methane release impacts on global mean temperature

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Abstract

There have been important criticisms of IPCC recent reports for failing to communicate the dire nature of the current predicament facing civilization – so-called "scientific reticence" – as well as for assuming functional, planetary-effective scale biomass carbon capture and storage in its survivable scenarios [1-3]. In the light of major reports released in 2018 [4,5] which underscore the discrepancy between the current climate trajectory and best-case requirements to maintain global civilization, the current predicament is often described as an "existential" crisis [6]. Part of the confusion appears to stem from the lack of discussion of specific scenarios, such as rapid arctic methane release [7,8], which are not discussed by the IPCC in proportion to their catastrophic potential. This scenario is briefly examined using the Goddard Institute for Space Studies (GISS) ModelE v2 7.50.05 [9]. It is suggested that the results presented here represent a lower bound to climate disruption since in this set-up, neither the oceans nor arctic sea ice (a significant and ongoing runaway feedback [10]) respond to the changes modeled; namely, a sudden release of stored methane gas.

Board W-35: Parametric study of prompt methane release impacts on global mean temperature using GISS ModelE

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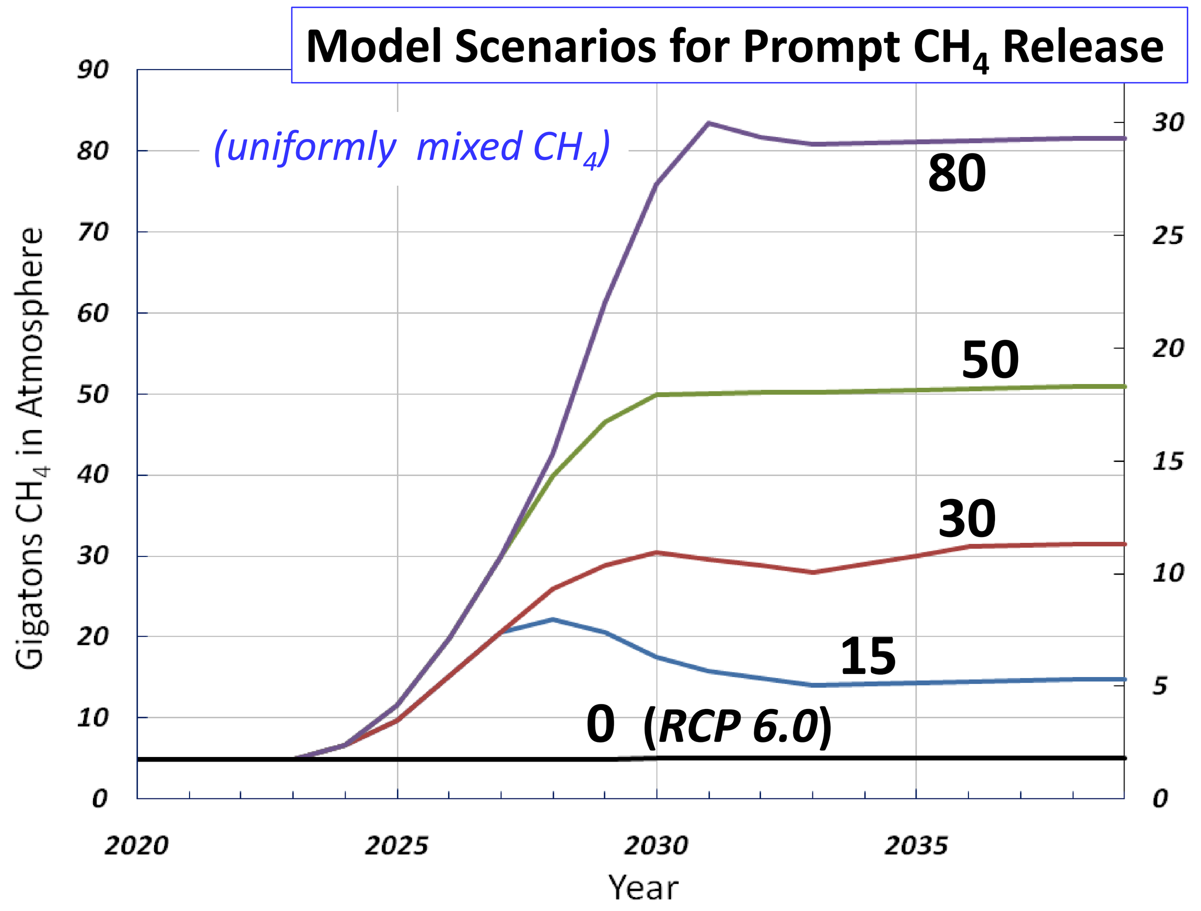
There have been important criticisms of the Intergovernmental Panel on Climate Change (IPCC) recent reports for failing to communicate the *dire* nature of the current predicament facing civilization – so-called "scientific reticence" – as well as for *assuming* functional, planetary-effective scale biomass carbon capture and storage in its survivable scenarios [*1-3*]. In the light of major reports released in 2018 [*4,5*] which underscore the discrepancy between the current climate trajectory and best-case requirements to maintain global civilization, the current predicament is often described as an "existential" crisis [*6*]. Part of the confusion appears to stem from the lack of discussion of specific scenarios, such as rapid arctic methane release [*7,8*], which are not discussed by the IPCC in proportion to their catastrophic potential. This scenario is briefly examined using the Goddard Institute for Space Studies (GISS) ModelE v2 7.50.05 [*9*]. It is suggested that the results presented here represent a lower bound to climate disruption since in this set-up, neither the oceans nor arctic sea ice (a significant and ongoing runaway feedback [*10*]) respond to the changes modelled; namely, a sudden release of stored methane gas.

Goddard Institute ModelE

- Standard "Non-Interactive" (NINT) atmospheric model template with prescribed ocean *(Hadley 1975 – 1984 annual SST)* and sea ice *(Hadley 1996 – 2005 annual Sea Ice)* observational datasets. [*11*]
- Model spin-up 100 years 1920 – 2020 (transient simulation) starting from default global atmosphere observations
- ***Likely these are conservative results as well-observed recent Arctic ice/snow changes are not modeled.***



Prompt Land Surface Temperature Response

Only land surface air temperature values were calculated. Temperatures were calculated by:

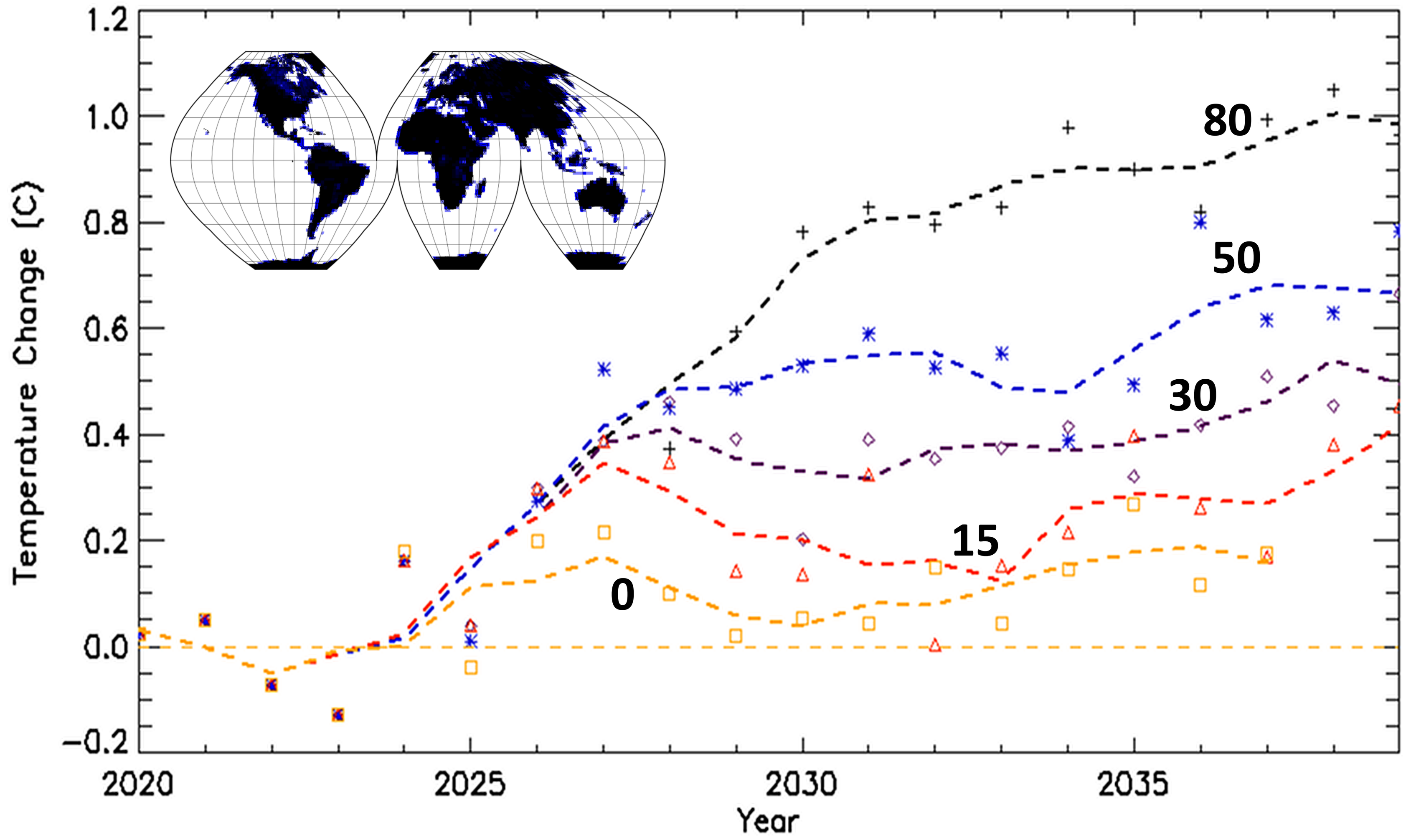
$$\Sigma_C (LF_C A_C P_C) / \Sigma_C (LF_C A_C)$$

...summing over all grid cells, LF_c = in-cell land fraction, A_c = cell area, P_c = in-cell model variable being averaged, for annual or seasonal averages of the monthly model outputs. CH_4 is assumed uniformly dispersed.

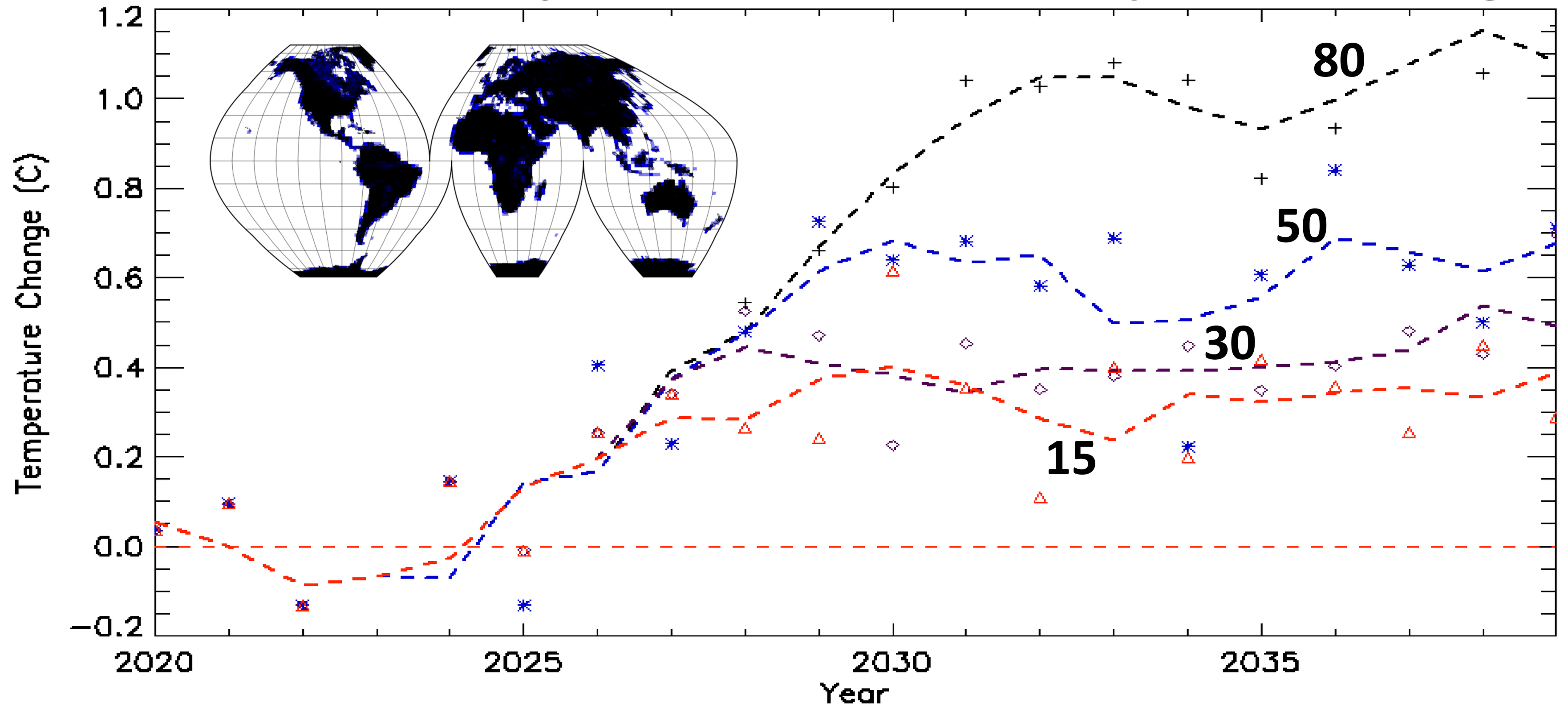
Mean grid cell temperatures were converted to *temperature change* by subtracting mean of 2020 – 2022 temperatures.

The temperature-change signal is noisy, but boxcar smoothing shows that it rises concomitantly with CH_4 loading, suggesting a *unit impulse response* for the system as modeled.

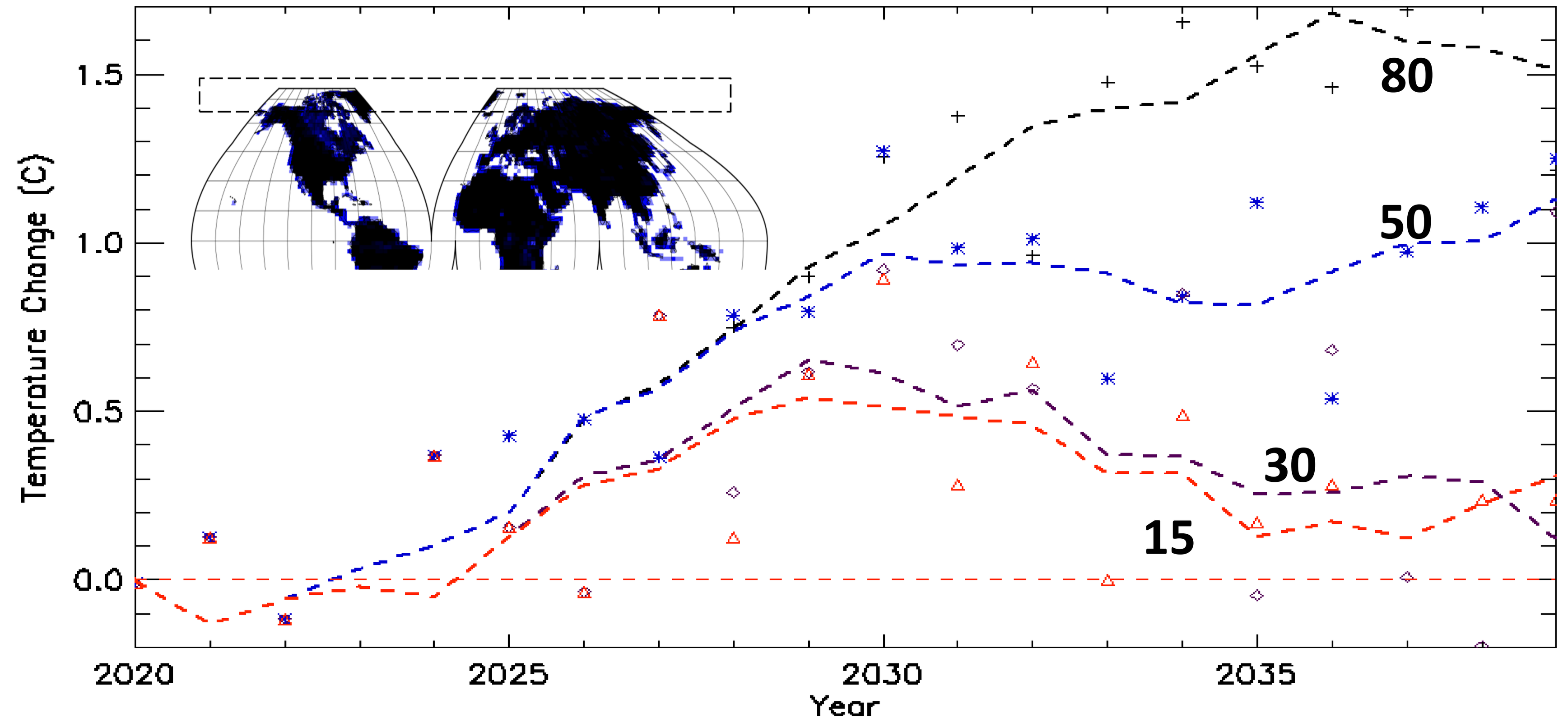
Global Land Surface Mean Annual Temperature Change

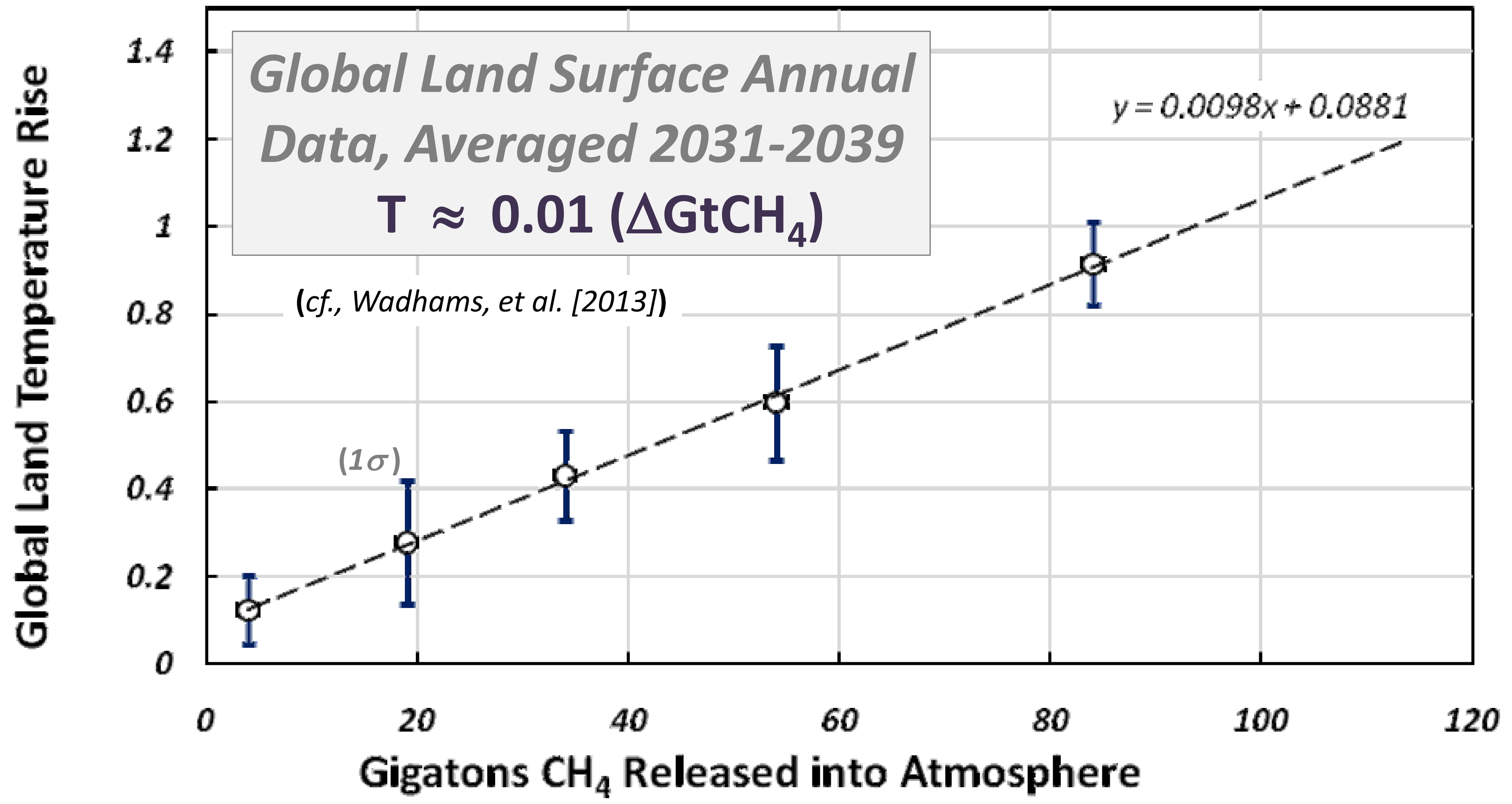


Global Land Surface Mean Summer Temperature Change



Arctic Land Surface Summer Temperature Change





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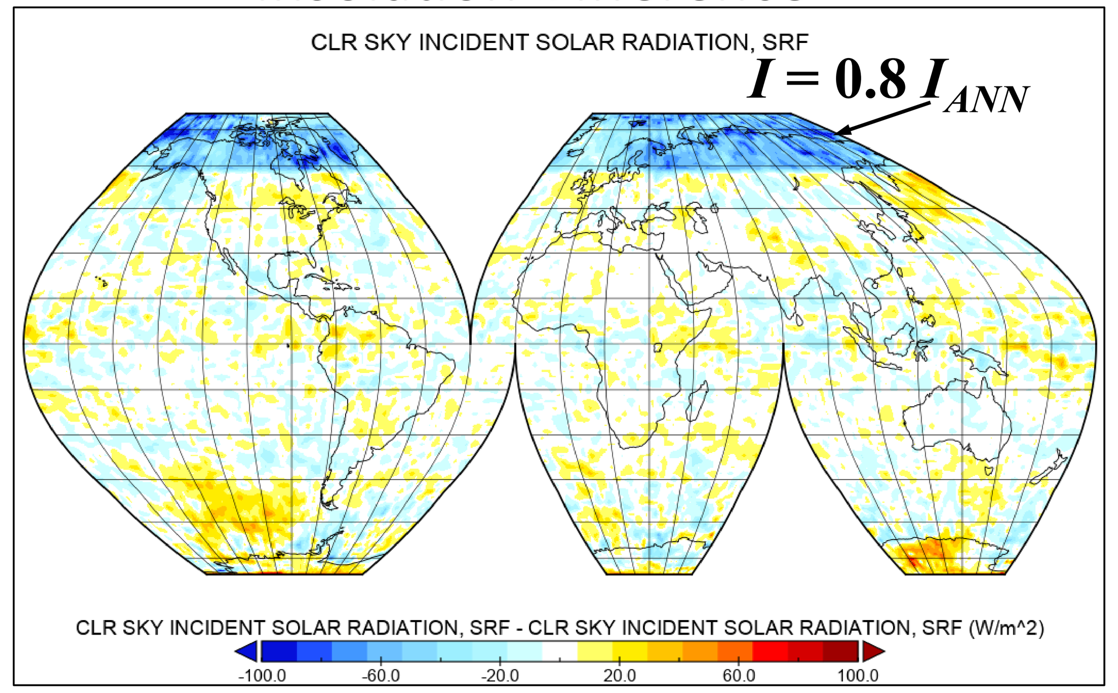
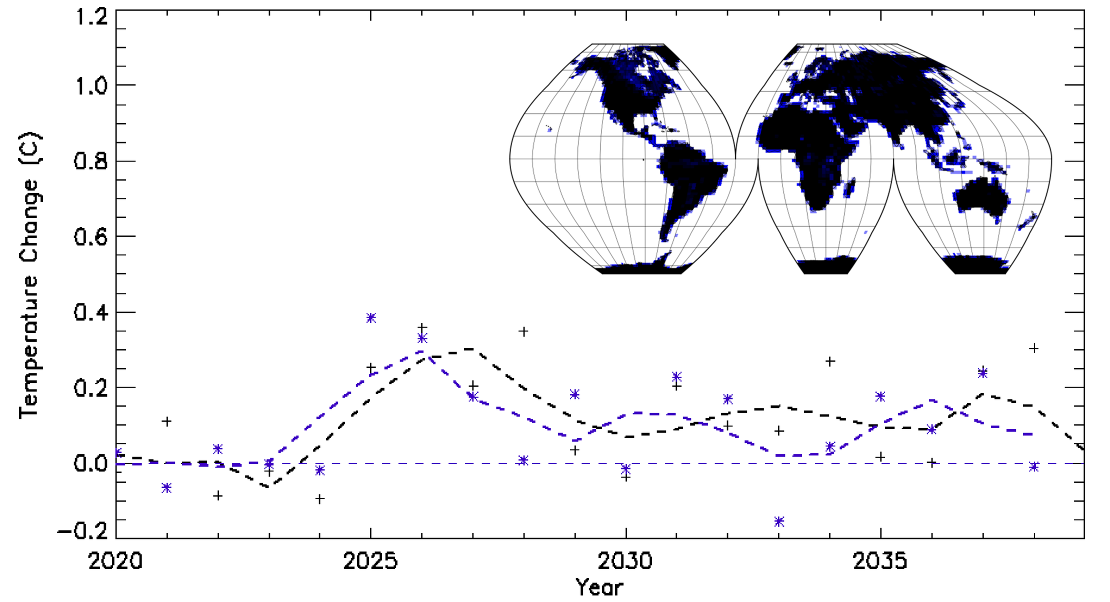
Model Effects of 20% Decrease in Mean Arctic Insolation

(*cf., Latham, et al. Phil.Trans.R.Soc.A 372 [2014]*)

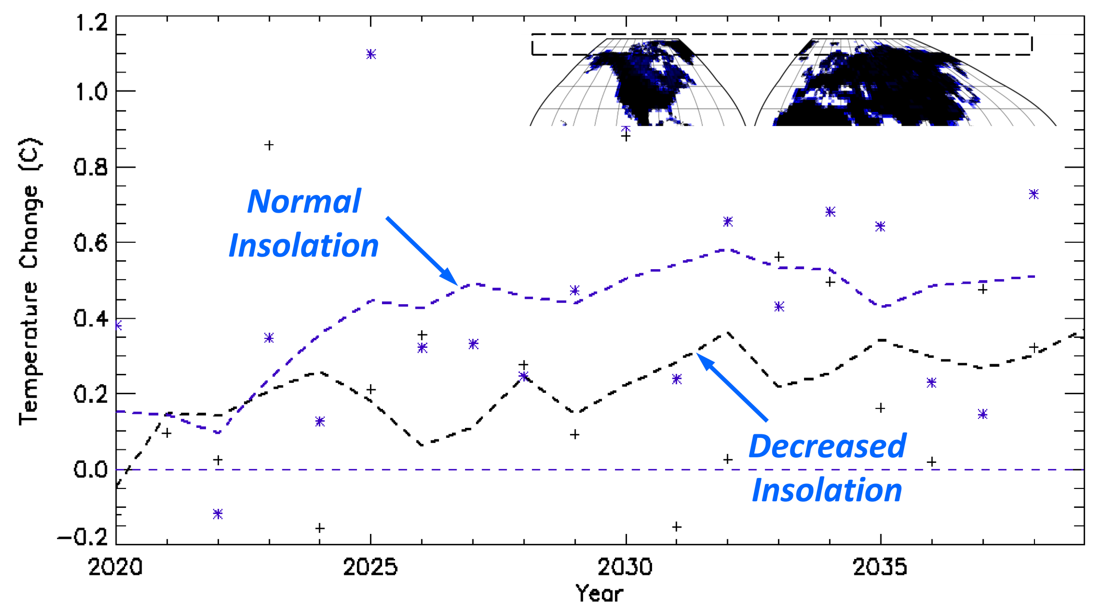
Insolation Difference



Global Land Surface Mean Temperature Change



Arctic Land Surface Mean Temperature Change



- **Unit impulse response (*fully-dispersed CH_4*)**
- **Temperature lags may be related primarily to CH_4 dispersion rates**
- **Larger warming over Arctic land surface (*oceans not investigated*)**
- **Decreased Arctic insolation measurably decreases mean Arctic land temperature**