Comment 5: Greenland and Global reconstructed temperatures and their use for empirical 21st century global temperature forecasts

In order to provide more complementary information to the ESD-2021-84 paper in discussion, with shorter temporal scales, the present comment is associated with the Greenland and Global temperature and their influences on global climate.

Part 1. Greenland Temperature (GrT)

DATA. The Greenland temperature (GrT) information is based on ice-core analysis, (Kobashi et al., 2017).

RESULTS. To estimate global climate oscillations in the reconstructed record GrT, a linear and lagged transformation is adjusted to GT record. The GT model based on GrT that was linearly adjusted considering a lag of 75 years, is shown in in Figure 5.1.1. An additional bias for values later 1750 AD was applied, it is shown without and with bias application in parts a) and b) of Figure 5.1.1, respectively.

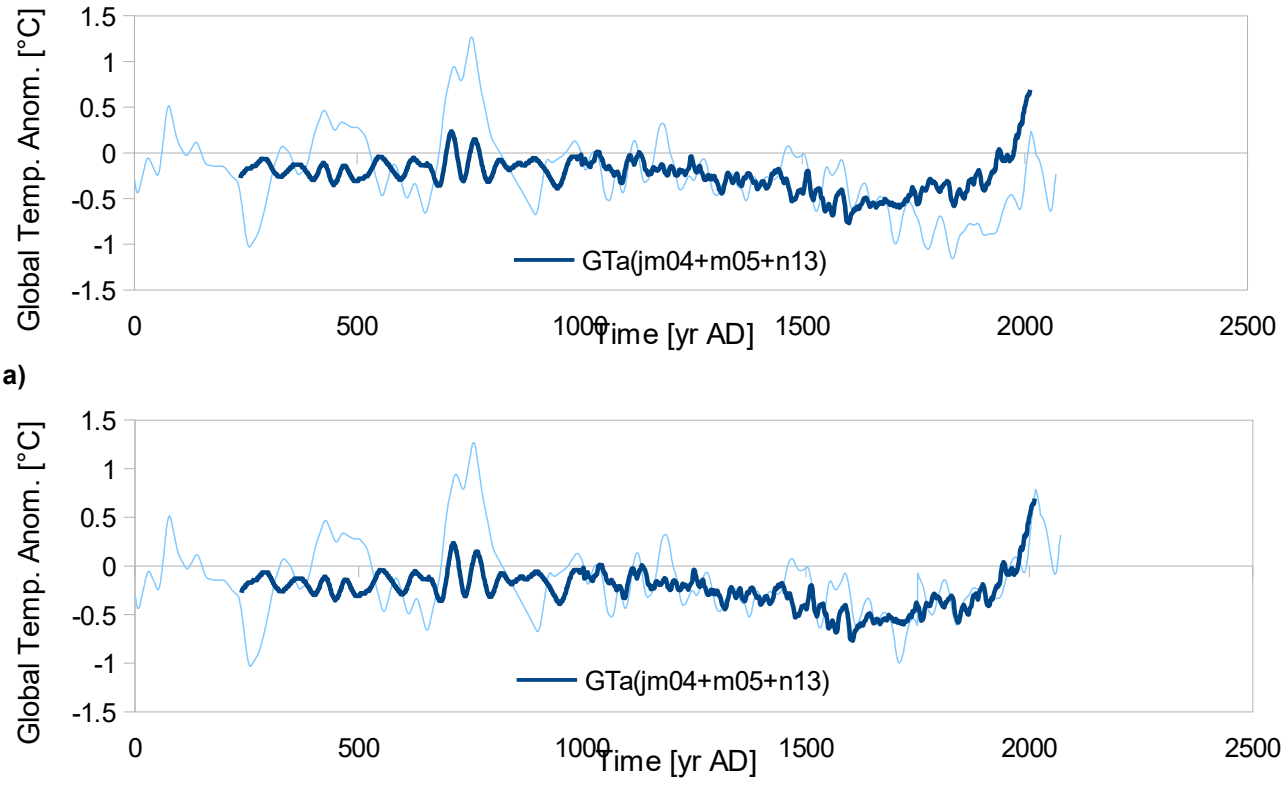


Figure 5.1.1 Modelling of GT based on Greenland Temperature reconstructed record (K18). Linear adjusted and lagged (75 yr) GrT record a) withouth, and b) with bias correction (+0.55 °C) over the last 250 years.

It is important to mention that the use of constant bias to adjust GrT information to GT records over more than the last two centuries emphsize two aspcts:

1) a cooling event around Greenland that influence its temperatures, and
2) a constant connection between GrT and GT over the last 250 years.

The coresponding 21st century scenario provided by the transformed, lagged and adjusted GrT record is shown in Figure 5.1.2

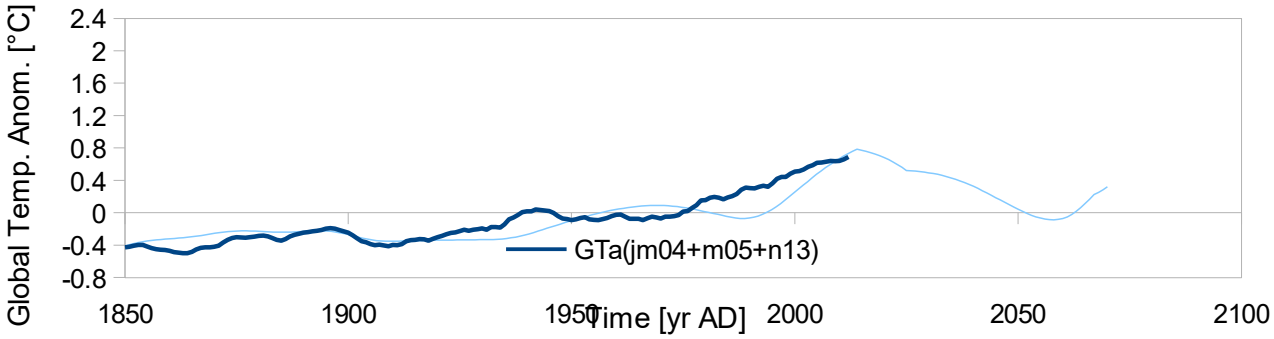
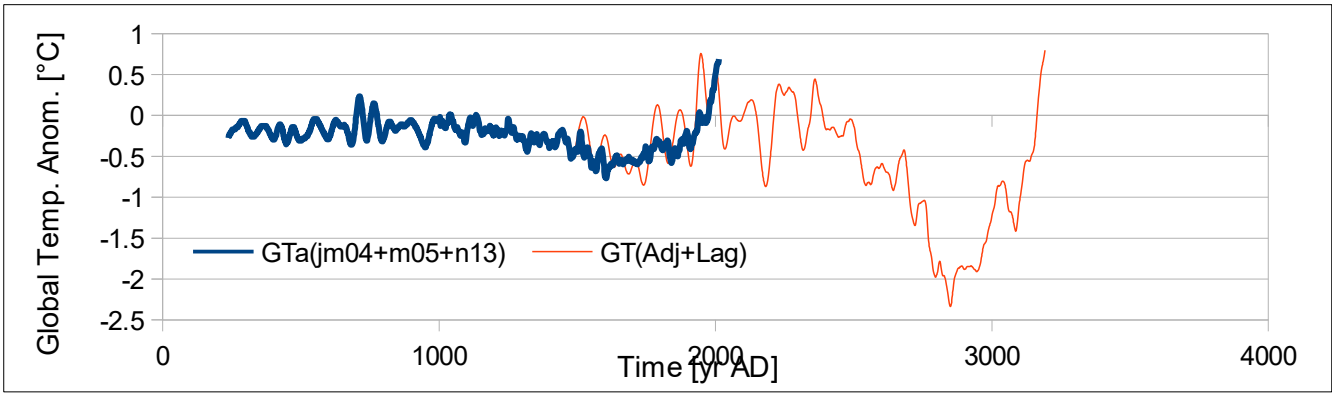


Figure 5.1.2 Global temperatures and its empirical forecast 2010-2100. A linearly adjusted and lagged GrT annual values to the GT integrated record 238-2010; a forecast for the next five decades is shown.

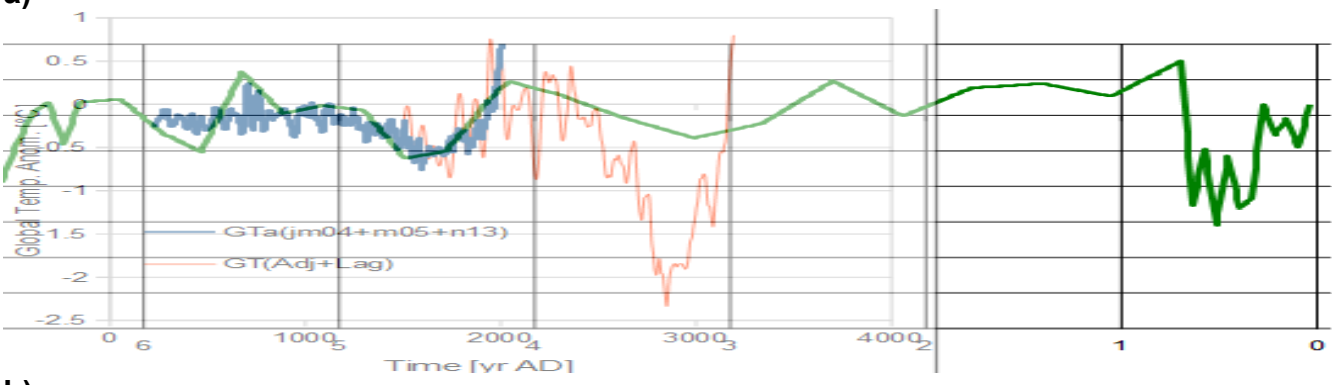
Part 2. Global temperature.

DATA. The Global temperature (GT) information was integrated in main part of ESD-2021-84 paper.

RESULTS. To estimate global climate oscillations in the reconstructed record GT, an analog modelling with linear and lagged (around 1300 yrs later) are applied. Its results, with an amplification of around 5 times and its simple verification, are shown in Figure 5.2.1



a)



b)

Figure 5.2.1 Global temperatures and its empirical forecast 2010-3000. a) A linearly adjusted and lagged GrT annual values to the GT integrated record 238-2010; a forecast for the next millennium is shown; b) In order to verify, the GT(GrT) shown in a), is overlapped on the crbT record image (with times in Kyr BP), wich is almost directly affected by solar activity. Then its possible to verify lagged influences on GT

more than 4000 years later that are also depicted and show a long-term cooling increasing-trend for the next centuries.

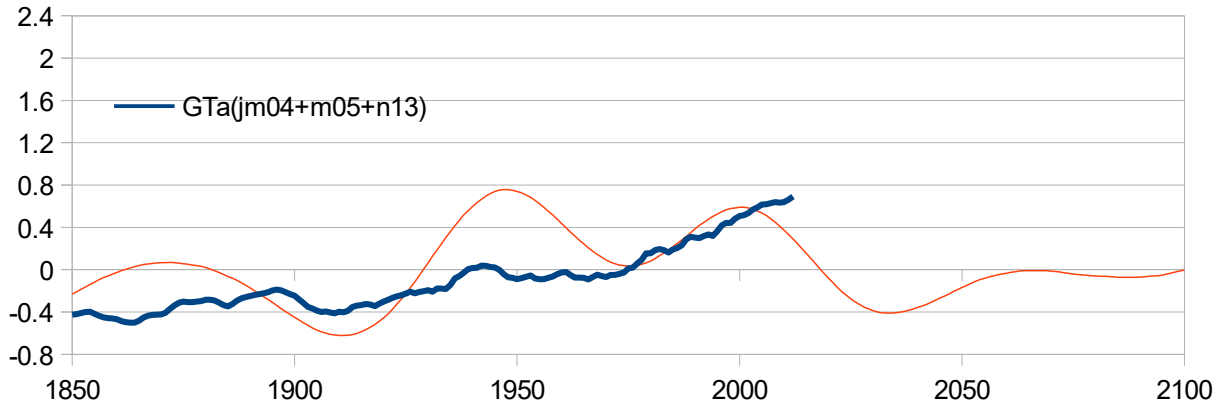


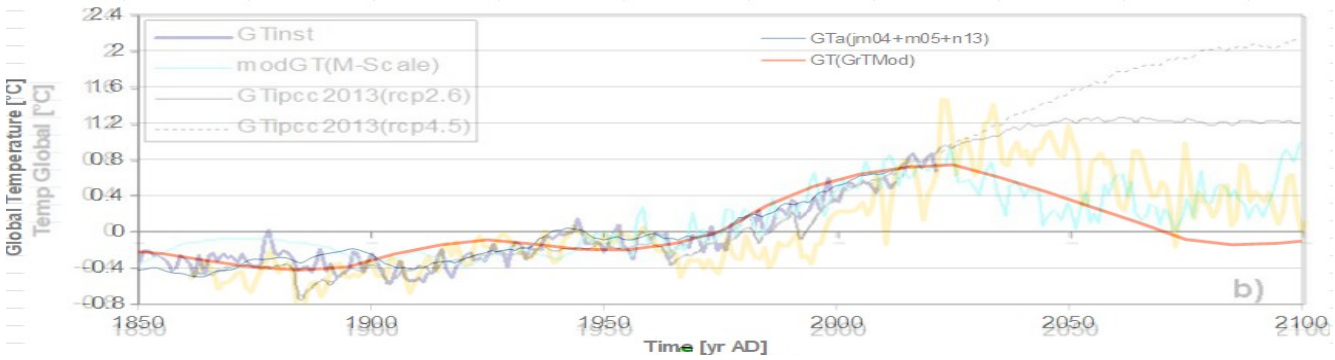
Figure 5.2.2 Global temperatures and its empirical forecast 2020-2100. A linearly adjusted and lagged model, of the same GT integrated record 238-2010; a forecast for the next decades is shown.

Part 3. New Global temperature scenarios.

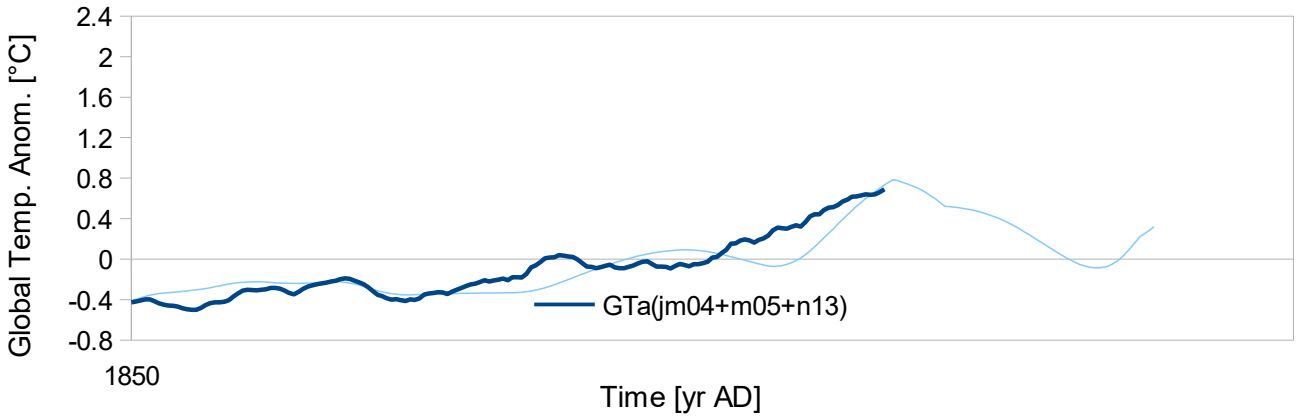
The next table shows a comparison of all scenarios estimated in this study (main part of ESD-2021-84 paper in discusion and its comments).

Scenario	Modelling elements	See details In
0	solar, lunar and other shorter recurrent contributions	main part of ESD-2021-84 paper
1	calcites of a Northern Sweden cave over the last 4000 years lagged 270 years [with a bias over the last centuries]	comment 1 of the ESD-2021-84 paper
2	SSTepac (extended with Niño 12 recent data)	comment 2 of the ESD-2021-84 paper
3	IPCC scenarios (an average of extrapolated version of the rcp2.6, rcp4.5 and rcp8.5 scenarios to estimate the rcp0.0 scenario. This scenario correspond to "zero GHG emissions" at the end of the 21st century.)	comment 3 of the ESD-2021-84 paper
4	Arctic temperature (AT)	comment 4 of the ESD-2021-84 paper
5	Central England Temperature (CET)	comment 4 of the ESD-2021-84 paper
6	Greenland temperature [with a bias over the last 250 yrs]	This comment
7	Global tempertaure (integrated record)	This comment

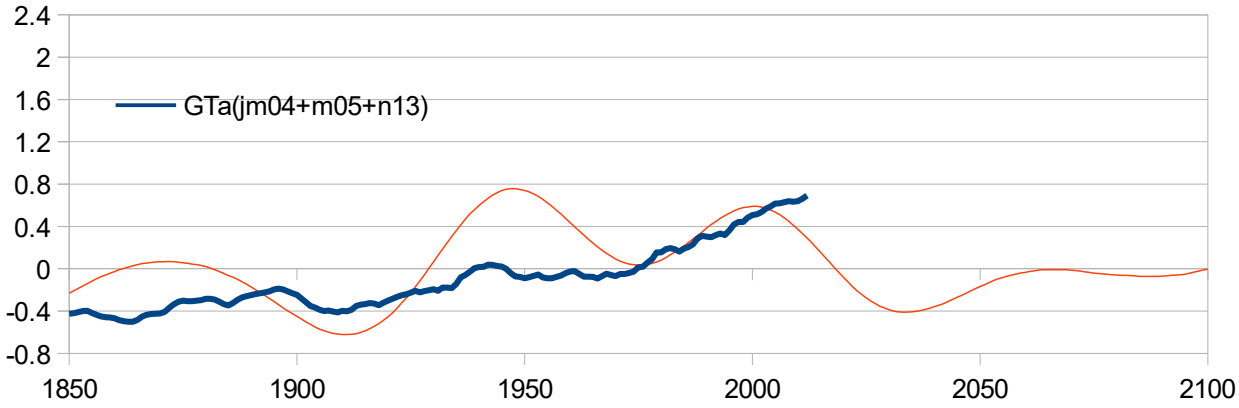
A simple comparison of the last two scenarios presented in this comment is shown in Figure 5.3.1. The two new scenarios (6 and 7) present, similarly as scenarios 1, 2, 3 and 4, a decaying values for the next decades.



a)



b)



c)

Figure 5.3.1 Comparison of global temperature scenarios 1850-2100. An adapted Figure 11b from the paper ESD-2021-84 in discussion with the first scenario estimated (Scenario 0, with cyan line), the Average rcp0.0 values (Scenario 3 in yellow line) and Arctic temperatures (T) (Scenario 4, in red wide line), with the ajusted and lagged forecast based on: a) Greenland temparature (Scenario 6, in ligth blue line); b) the Global temperature (GT) (Scenario 7, in red thin line).

Part 4. Preliminary conclusions (of this and previous coments)

Our results, not only are providing general cooling trend scenarios for the rest of the 21st century, but also support that, non-linearity and multi-scale modeling efforts are required for accurate modeling and forecasting of climate-related issues.

Our results also have placed astronomical low-frequency (with multi-millenial and multi-centennial) processes, with its long-term and delayed influences (with ocean-atmospheric mechanisms) on climate variability in an important place for climate modeling and analysis, and of course, for climate forecasting.

REFERENCES

Kobashi, T., Menviel, L., Jeltsch-Thömmes, A. et al. Volcanic influence on centennial to millennial Holocene Greenland temperature change. Sci Rep 7, 1441. https://doi.org/10.1038/s41598-017-01451-7, 2017