Essay

On the Evaluation of Climate Models

Model Oddities

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Abstract

Over many years there have been discussions, and also disagreement, about how well climate models can predict the future climate. The IPCC asserts that climate models are based on established physical laws along with a wealth of observations, so the models must be very good representations of nature. A prominent climate scientist and energy analyst asserts that climate models do remarkably well, and that most of the projections are statistically indistinguishable from observations. However, an analysis of the model ensemble used in the Climate Model Intercomparison Project 6 (CMIP6), shows a very wide spread of individual projections. Moreover, the hindcasts also vary greatly even if the full temperature history is known. So, what does the models say about the warming since "pre-industrial times"? There is almost a four-fold variation in results, with warming from 0.6 ºC to almost four times that, 2.3 ºC.

Keywords: Climate models; Evaluation of climate models; Fundamental physical laws

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1. Introduction

In this short essay, an analysis of the model ensemble used in the Climate Model Intercomparison Project 6 (CMIP6), is performed. The IPCC AR4 [1] describes computer climate models as follows:

"Climate models are mathematical representations of the climate system, expressed as computer codes and run on powerful computers. One source of confidence in models comes from the fact that model fundamentals are based on established physical laws, such as conservation of mass, energy and momentum, along with a wealth of observations."

And in AR5 [2], they say:

"The Atmosphere–Ocean General Circulation Models, Earth System Models and Regional Climate Models evaluated here are based on fundamental laws of nature (e.g., energy, mass and momentum conservation)."

And it's a good thing that these models are *"based on fundamental laws of nature"* and are *"run on powerful computers"*, because they are being used to tell us to totally restructure the global energy system, change our personal lives, increase our taxes, warn us that some weather event is made eleven times more likely because of "climate change", and to require that we make endless costly sacrifices to an unknown climate god.

We are constantly assured that these models are the real deal, totally lit, not to be questioned. Zeke Hausfather [3] says: *"We found that climate models – even those published back in the 1970s – did remarkably well, with 14 out of the 17 projections statistically indistinguishable from what actually occurred."*

2.Materials and Methods

The following analysis is based on the latest group of climate models, those used in the Climate Model Intercomparison Project 6 (CMIP6). If the 1970s models were as good as Hausfather says, the more recent models should be even more accurate, especially since they are" *based on established physical laws, such as conservation of mass, energy and momentum, along with a wealth of observations."*

The computer code used in the analysis is given in Appendix A, and the data in Appendix B.

3. Results and Discussion

To start with, Figure 1 shows what thirty-six of those recent CMIP6 models say about the global surface air temperature from 1850 to 2024. Note that for the period 1850-2014 they are given as inputs what we believe are the actual concentrations of greenhouse gases and aerosols, the solar and volcanic changes, and all the other input variables, so that period is a hindcast. The forecasts with predicted concentrations begin only after 2014.

Given that the models all have exactly the same inputs, we would expect at least their hindcasts to be quite similar. However, the modelled surface air temperatures vary wildly, across a range of more than 2 ºC, as shown in Figure 1,

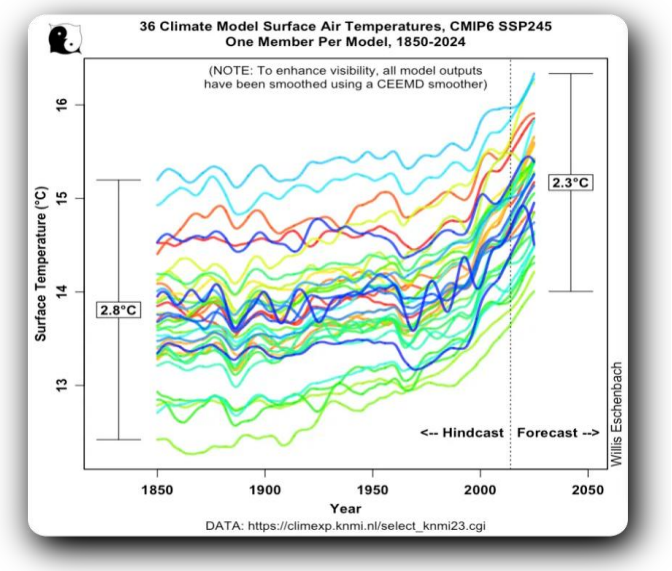


Figure 1: Absolute global average surface air temperatures from 36 CMIP6 climate models.

The results are very surprising, to say the least. It is hard to be more confused than that. I wonder how many of these Zeke Hausfather would claim are *"statistically indistinguishable from what actually occurred".*

There's a further oddity about Figure 1. It is unclear why the models that start out colder warm up more compared to the models that start out warmer. It seemed possible that it might be the result of the relationship between energy flux W/m^2 and temperature, which involves temperature to the fourth power, so that was checked. It turns out, it's not from that—the temperature change

is far too small for the fourth-power relationship to make a meaningful difference. The cause remains unknown.

Next, note the huge differences in overall shape of the individual model outputs. In some there is a relatively steady increase in temperature from 1850 to 2024. Others run about level or even cool down from 1850 to around 1970 and then rise rapidly to 2024. And others are constantly going up and down over the entire period.

Now, it's not reasonable to expect them to get individual years right. They're not designed for that. But that variation in results in a 175-year run indicates serious problems.

It seems that either the models or the modelers have *very* different ideas about what constitutes "established physical principles". If they were actually all based on the same physical principles, their results should be much closer to each other.

Next, given the endless fascination with the warming since "pre-industrial times", those model results were investigated. People keep saying that if we warm more than 1.5°C or 2°C since "pre-industrial times", it will be disastrous and the oceans will boil. Well, perhaps not literally, but the UN Secretary-General António Guterres actually said, *"the era of global warming has ended; the era of global boiling has arrived"*, so we should be very afraid.

Now, the average temperature from 1850 to 1899 is what is generally used by mainstream climate scientists as the "pre-industrial temperature". Although actually, it's nothing of the sort. The Industrial Revolution is generally thought to have started around 1760, which was immediately preceded by the very cold depths of the Little Ice Age.

So, following that standard practice, all the model outputs used in Figure 1 above were graphed, expressed as anomalies around their 1850-1899 average temperatures. Figure 2 shows that example of basic physics.

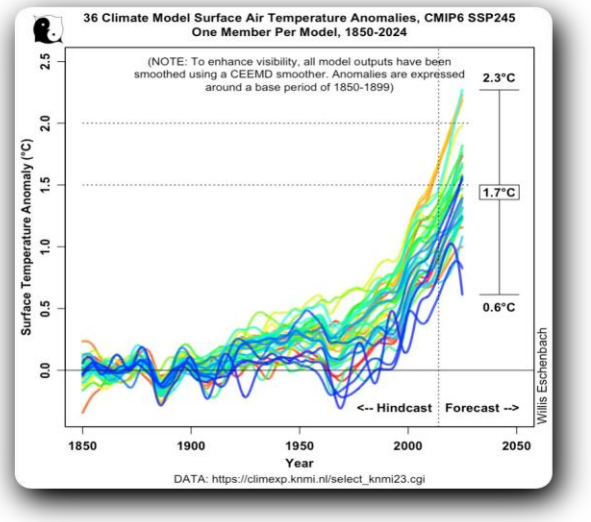


Figure 2: What the models say about the warming since "pre-industrial" times.

Have we surpassed the 1.5°C threshold? Fifteen models say yes, twenty-one say no. How about surpassing the 2 °C threshold? Four say yes, thirty-two say no. Indeed, you can find a model that tells us that it's warmed since "pre-industrial times" at anything from 0.6 °C all the way up to

almost four times that, 2.3 °C. Almost a four-fold variation in results, with a number of them saying the temperatures in ~1960 – 1980 were below the "pre-industrial" average. This is supposed to be basic physics at its finest.

4. Conclusion

It is shown that even if the climate models used in CMIP5 are said to be *"based on fundamental laws of nature"* and are *"run on powerful computers"*, their projections vary by a factor of four and they are nowhere near what is observed. Even in hindcasting, where the history should be well known, the models are failing.

It was originally planned to compare the model results to reality. But upon consideration, I realized that it would only lead to arguments about how models can't be compared to reality because models are showing purely surface air temperatures, but historical reconstructions like Berkeley Earth or HadCRUT use ocean surface temperatures as a proxy for air temperatures, and the like. In addition, that isn't really the issue. The real issue is the following:

If all of these wonderful models are *"based on established physical laws, such as conservation of mass, energy and momentum, along with a wealth of observations"*, then why do their results differ so greatly?

And of course, the corollary to that:

Why does anybody pay the slightest attention to this inaccurate, ludicrously unfit-for-purpose climate model farrago? As Chester Nimitz said in his message to Bull Halsey … *"The world wonders"*.

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References

[1] IPCC AR4 Chapter 8 Climate Models and Their Evaluation, Chapter.8_FINAL.5.9.07.indd

[2] IPCC AR5 Chapter 9 Evaluation of Climate Models, WG1AR5_Chapter09_FINAL.pdf

[3] Z. Hausfather, H.F. Drake, T. Abbott and G.A. Schmidt, *Evaluatiing the Performance of past Climate Model Projections,* Geophysical Research Letters, Vol 47, 2020, http://dx.doi.org/10.1029/2019GL085378

Appendix A Computer Code

```
thepath="CMIP6 TAS/"
filenames=dir(thepath)
(goodfiles=grep("245",dir(thepath)))
goodnames=filenames[goodfiles]
```

```
(thelocs=str_locate(goodnames,"_ssp"))

justnames=left(goodnames,thelocs[,1]-1)
i=1
alltemps=ts(matrix(NA,2100,length(goodfiles)),1850,frequency=12)
rawtemps=ts(matrix(NA,2100,length(goodfiles)),1850,frequency=12)
allfits=ts(matrix(NA,2100,length(goodfiles)),1850,frequency=12)
rawfits=ts(matrix(NA,2100,length(goodfiles)),1850,frequency=12)

for (i in 1:length(goodfiles)){
        print(i)
        whichfile=goodfiles[i]
        (testfile=paste0(thepath,dir(thepath))[whichfile])
        (theskip=last(grep("#",readLines(testfile))))

        rawdata=read.table(testfile,skip=theskip)
        # head(rawdata)
        testts=window(residual(tabletots(rawdata[,2:13],rawdata[1,1])),end=c(2024,12))

        rawtemps[,i]=testts
        rawfits[,i]=xcfit(testts,4)

        testts=testts-mean(window(testts,end=c(1899,12)))
        alltemps[,i]=testts

        allfits[,i]=xcfit(testts,4)
}
save(alltemps,allfits,rawtemps,rawfits,file="cmip6 245.tab")
berkshort=window(ballts,end=c(2024,12))
berkshort=berkshort-mean(window(berkshort,end=c(1899,12)))
berkfit=xcfit(berkshort,4)
# adj temps ------------------------------------------------------------
plot.zoo(allfits,plot.type="s",col=rainbow(36,alpha=.8,end=2/3),lwd=3,
                                xlim=c(1850,2050),ylim=c(min(allfits),2.5),
                                xlab="Year",ylab="Surface Temperature Anomaly (°C)")
abline(h=0)
abline(v=2014,lty="dotted")
```

```
texty=-.3
text(2017,texty,"Forecast -->",adj=0)
text(2011,texty,"<-- Hindcast",adj=1)
rightx=2042
arrows(x0=rightx,y0=min(allfits[2100,]),y1=max(allfits[2100,]),angle=90,code=3,length=.25)
thediff2=max(allfits[2100,])-min(allfits[2100,])
boxed.labels(rightx,mean(c(min(allfits[2100,]),max(allfits[2100,]))),paste0(round(the-
diff2,1),"°C"),
                                                    ypad=thepad)
offset=.1
text(rightx,min(allfits[2100,])-offset,paste0(round(min(allfits[2100,]),1),"°C"))
text(rightx,max(allfits[2100,])+offset,paste0(round(max(allfits[2100,]),1),"°C"))


text(mean(par("usr")[1:2]), 2.4, hardwrap(60,"(NOTE: To enhance visibility, all model outputs
have been smoothed using a CEEMD smoother. Anomalies are expressed around a base period
of 1850-1899)"),
                font=1,cex=.9)


logo()
sigline()


title(sub=paste0("DATA: https://climexp.knmi.nl/select_knmi23.cgi"),
cex.sub=.9,line=3.1,font.sub=1)
title(main=paste0("36 Climate Model Surface Air Temperature Anomalies, CMIP6
SSP245\nOne Member Per Model, 1850-2024"),cex.main=1,line=.8)
ablineclipv(h=c(1.5,2),x1=1850,x2=2028,lty="dotted")
write_clip("CMIP6 SSP245 since 1850")
```

Appendix B Data

The data is in the folder below.

https://mail.google.com/mail/u/0?ui=2&ik=94470906cc&attid=0.1.1&permmsgid=msg-f:1872336359259385223&th=19fbdfffa9b42d87&view=att&zw&disp=safe

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