Challenging the scientific basis of the Paris climate agreement

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Abstract

Purpose – The purpose of this paper is to analyze the scientific basis of the Paris climate agreement.

Design/methodology/approach – The analyses are based on the IPCC's own reports, the observed temperatures versus the IPCC model-calculated temperatures and the warming effects of greenhouse gases based on the critical studies of climate sensitivity (CS).

Findings – The future emission and temperature trends are calculated according to a baseline scenario by the IPCC, which is the worst-case scenario RCP8.5. The selection of RCP8.5 can be criticized because the present CO_2 growth rate 2.2 ppmy^{-1} should be 2.8 times greater, meaning a CO_2 increase from 402 to 936 ppm. The emission target scenario of COP21 is 40 $GtCO_2$ equivalent, and the results of this study confirm that the temperature increase stays below 2°C by 2100 per the IPCC calculations. The IPCC-calculated temperature for 2016 is 1.27°C, 49 per cent higher than the observed average of 0.85°C in 2000.

Originality/value – Two explanations have been identified for this significant difference in the IPCC's calculations: The model is too sensitive for CO_2 increase, and the positive water feedback does not exist. The CS of 0.6°C found in some critical research studies means that the temperature increase would stay below the 2°C target, even though the emissions would follow the baseline scenario. This is highly unlikely because the estimated conventional oil and gas reserves would be exhausted around the 2060s if the present consumption rate continues.

Keywords Global warming, Greenhouse gas emissions, Baseline scenario, COP21, Paris climate agreement

Paper type Research paper

1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty dealing with the emissions, mitigation and adaption of greenhouse (GH) gases. At the 21st conference in Paris, the representatives of 195 countries reached a consensus and adopted the Paris Agreement, or COP21, on 12 December 2015 (21st Conference of the Parties). The COP21 went into effect on 4 November 2016. The climate agreement was ratified by 160 countries by the end of August 2017. The Paris agreement is now legally binding, but does not contain legally binding provisions that would require countries to take domestic legal actions (Clemencon, 2016).

The warming effects of GH gases are not identical, but they can be converted into the CO_2 equivalent by using the Global Warming Potential (GWP) of each GH gas. GWP values

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are integrated over a 100-year timescale and therefore are not accurate measures of the instantaneous warming effects (IPCC, 2013a). CO_2 emissions are reported as gigatons of carbon (GtC) or gigatons of carbon dioxide ($GtCO_2$). The GtC values can be transformed into $GtCO_2$ by multiplying by 3.664. Equivalent CO_2 (CO_2eq) is the concentration of CO_2 that would cause the same level of radiative forcing (RF) as a given type and concentration of GH gas. The major GH gases besides water and carbon dioxide are methane (CH_4), nitrogen oxide (N_2O) and halogens.

The aim of the COP21 (2015) is to keep a global temperature increase below 2°C by 2100 and to drive efforts to limit the temperature increase to 1.5°C above pre-industrial levels. By 30 September 2016, 162 countries had submitted to the UN's Climate Change Secretariat (UNFCCC, 2016) intended nationally determined contributions (INDCs). According to COP21, the GH gas emissions of the INDCs are 55 gigatons of carbon dioxide equivalent ($GtCO_2$eq) in 2030, which is not enough to keep the 2°C scenario. Therefore, the emissions should be reduced to 40 $GtCO_2$eq. In addition, the 1.5°C scenario demands that the emissions be reduced further (COP21, 2016), as anticipated in the special report to be prepared by the IPCC (Intergovernmental Panel on Climate Change) in 2018. The United Nations Environment Program UNEP (2016) reported a slightly higher emission target for 2030, namely, 42 $GtGO_2$eq.

The INDC emission of 55 $GtCO_2$eq can be compared to the total CO_2 emissions of 36.3 $GtCO_2$ in 2016. The CO_2 emissions in 2014 were almost the same, namely, 36.2 $GtCO_2$eq. These emissions include China 10.6 $GtCO_2$eq, the USA 5.3 $GtCO_2$eq and the EU 3.4 $GtCO_2$eq (Le Quere, 2016). China's emissions grow steadily, and they have not promised to reduce the emissions before 2030. According to the report of the World Bank (EDGAR, 2017), the global GH gas emission was 53.5 $GtCO_2$ in 2012. That means that the present emissions are practically the same as the INDC emissions of 55 $GtCO_2$eq in 2030.

The COP21 also includes a financial statement that the industrialized countries promise to deliver $100bn a year in aid to developing countries for climate-related projects prior to 2025.

Although there is a claim that the "climate change science is settled", scientific studies of the natural effects on global warming are still carried out and published. On the other hand, some climate change experts have commented that the Paris Agreement is too weak and too late to save our planet from warming above 2°C (Bowden and Independent, 2016).

The objectives of this article are to analyze the scientific basis of the Paris climate agreement: first, based on the IPCC's own reports; second, to analyze the observed temperatures versus the IPCC model-calculated temperatures; and third, to analyze the warming effects of GH gases based on the critical studies of climate sensitivity (CS).

2. The scientific basis of the Paris agreement

COP21 does not define the scientific basis of the agreement for the warming effects of the anthropogenic emissions, but it refers to a scenario. The IPCC publication "Summary for Policymakers: Mitigation of Climate Change" contributes to the objectives of the UNFCCC, and it has specified this scenario. The exact specification of IPCC (IPCC, 2014) is:

> Baseline scenarios, those without additional mitigation, result in global mean surface temperature increases in 2100 from 3.7°C to 4.8°C compared to pre-industrial levels (range based on median climate response; the range is 2.5°C to 7.8°C when including climate uncertainty).

Although the IPCC refers to multiple scenarios in the text above, the surface temperature increase to the average value of 4.25°C means one scenario only. UNEP (2016) has specified that "The baseline scenario reflects emission projections that assume no additional climate policies have been put in place from 2005 onwards." The IPCC (2007a) has specified four scenarios, and this article will find which scenario is closest to the baseline.

The term "scenario" in the COP21 has not been used according to its general specification, which is a future situation developed and compared to the present with selected conditions and terms. Using the year 1750 as a reference makes the temperature increase look greater. Because of this, the IPCC has used the term "projection" in AR5 (IPCC, 2013a) instead of "scenario," but later used the term "scenario" again (IPCC, 2014). Because the same term is used also in the COP21, "scenario" has also been used in this article.

The temperature increase has already gone 0.85°C from 1880 to 2012. The IPCC (2013a) has reported this warming value in its fifth assessment report (AR5):

> The globally averaged combined land and ocean surface temperature data as calculated by a linear trend show a warming of 0.85°C over the period 1880 to 2012, when multiple independently produced datasets exist.

Four different scenarios have been defined in AR5 (IPCC, 2013a), and the highest warming increase happens according to the RCP8.5 (Representative Concentration Pathway 8.5). The number 8.5 is the Radiative Forcing (RF) value of 8.5 Wm^{-2} in 2100 caused by GH gases. The warming value can be calculated according to the IPCC (2013a) as:

$$dT = \lambda \times RF \tag{1}$$

where dT is the global surface temperature change (K) starting from the year 1750, λ is the CS parameter (K/(Wm^{-2}) and RF is the radiative forcing (Wm^{-2}). The λ value is 0.5 K/(Wm^{-2}) per IPCC (2001). The temperature increase per RCP8.5 is thus 0.5 K/(Wm^{-2}) *8.5 Wm^{-2} = 4.25 K. It is the same as the mean value of the *baseline scenario* as described above. The RF value can be calculated according to the CO_2 concentration using the equation (2) represented by Myhre *et al.* (1998) and used by the IPCC as well as by general climate models (GCMs):

$$RF = k \times \ln(C/280) \tag{2}$$

where k is 5.35 (Wm^{-2}) and C is the CO_2 concentration (ppm). The RF value of 8.5 Wm^{-2} is a result of the CO_2eq concentration of 1,370 ppm. It means that the baseline scenario is the same as the RCP8.5 (IPCC, 2007a). The IPCC (2014) defines the baseline scenario with bold fonts to be the same as RCP8.5 according to the temperature increase, but in the very same section, the IPCC evaluates that the atmospheric CO_2 concentration levels of the baseline scenario are between the RCP6.0 and RCP8.5 pathways in 2100. The RCP8.5 was the worst-case scenario of AR5, and, by IPCC's efforts, it is selected as the baseline scenario of COP21, even though there is conflicting information. The emissions according to the RCP8.5 are about 110 $GtCO_2$eq in 2100.

The first challenge comes from the selection of the baseline scenario. According to the RCP8.5, CO_2 concentration would be 541 ppm in 2050 and 936 ppm in 2100 (IPCC, 2007a), meaning that the average yearly growth rate of 2.2 ppm during the past 10 years should increase to the yearly growth rate of 6.4 ppm during the next 84 years, which is 2.8 times greater. The same sharp growth rate increases would also be needed for methane and nitrogen oxide to reach 1370 CO_2eq. This high CO_2 growth rate can be criticized because during the past five years, the CO_2 emissions have stayed almost constant at a level of 34.7 to 35.7 $GtCO_2y^{-1}$. Therefore, an alternative scenario without mitigation effects could be a "business as usual" (BAU) scenario, which would mean keeping the CO_2 emissions at about the present level of 40 $GtCO_2$, and the total GH gas emissions at the level of 55 $GtCO_2$eq.

The author calls the equations (1) and (2) the IPCC model in this article. In Figure 1, the warming effect of CO_2 concentration increase is depicted per equations (1) and (2), and one can see that the CO_2 concentration of 590 ppm causes the warming effect of 2°C.

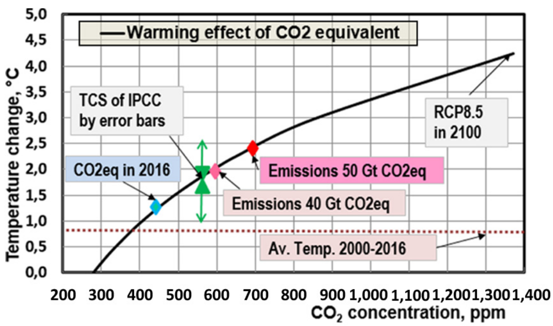
According to AR5 (IPCC, 2013b), the RF value of GH gases in 2011 was 2.29 Wm^2, and this value has increased to 2.44 Wm^2 (NOAA, 2017a, 2017b) in 2016. It corresponds to the warming value of 1.22°C, which would mean the CO_2eq value of 442 ppm. UNFCCC (2017) manifests on their web page that the CO_2eq concentration must not exceed 450 ppm to stay under 2°C. As one can see in Figure 1, the 450 ppm of CO_2eq would cause a temperature increase of 1.27°C, which is far below 2°C. This is conflicting information. It is not enough to know the stabilized emission levels from 2030 onward because the atmospheric CO_2 concentrations in 2100 can be calculated only by considering the CO_2 circulation between the atmosphere, the ocean and the biosphere.

3. The effect of CO_2 circulation for atmospheric CO_2 concentration

If the emissions stay at the present level of 36 $GtCO_2$, it would not mean that the atmospheric CO_2 concentration would stay at the present level. This is because of the huge CO_2 fluxes between the atmosphere, the ocean and the biosphere, which are depicted in Figure 2.

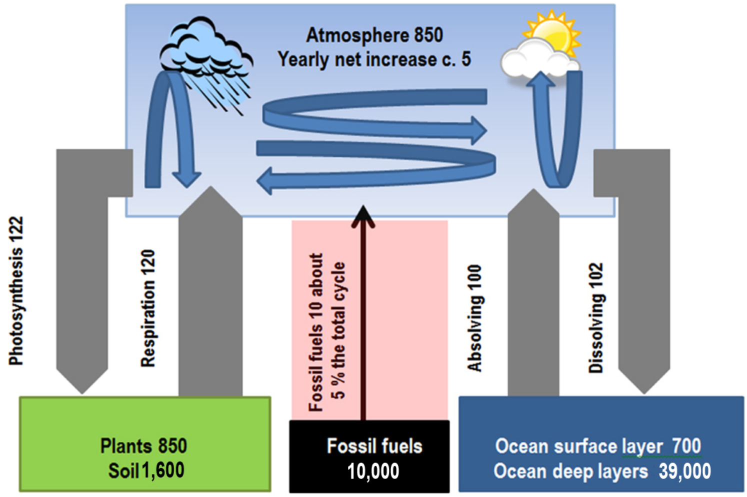
Since 1960, CO_2 circulation has behaved in practically the same way. About 55 per cent of the annual fossil fuel emissions stay in the atmosphere and the other 45 per cent is absorbed by the sink formed by the ocean and the biosphere. A comprehensive isotope measurement study of the dissolved CO_2 in the ocean (Sabine *et al.*, 2004) shows that the ocean is a sink for the anthropogenic CO_2, but the sink of the total CO_2 between the ocean and the biosphere is not clear. Ollila (2016) and the IPCC (2013a) suggest that the ocean is the main sink. This means that if the CO_2 recycling system works in the same way during this century, the atmospheric CO_2 concentration increases steadily.

Figure 3 shows the results of the simulations according to the one-dimensional, semi-empirical atmosphere-ocean-biosphere model (1DAOBM) version 2 (Ollila, 2016) keeping the GH emission rate at the 50 $GtCO_2$ from 2030 onward. The results illustrate that the atmospheric CO_2 concentration will increase to a value of 688 ppm in 2100 and will continue increasing to 935 ppm in 2300. The graph based on the empirical relationship shows a lower CO_2 concentration value. The reason for this difference is that the 1DAOBM-2 considers the gradual saturation of the surface layer of the ocean, meaning that the capability of the ocean



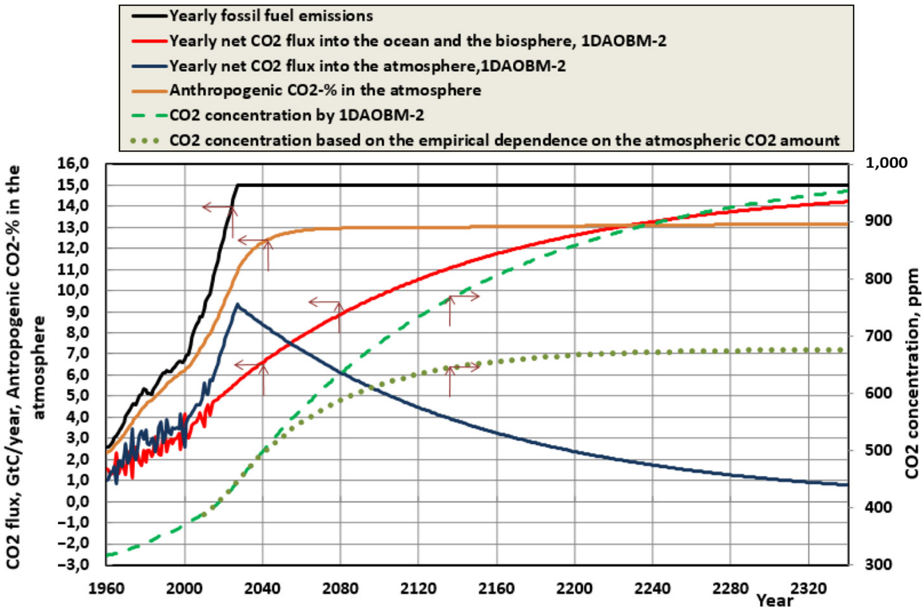
Note: The emission rates of 50 $GtCO_2$eq and 40 $GtCO_2$eq are constant from 2030 onward

Figure 1. The warming effect of carbon dioxide (CO_2) according to IPCC calculations



Note: The reservoirs are in gigatons of carbon (GtC = PgC) and fluxes in $GtCy^{-1}$

Figure 2.
A simple carbon cycle presentation is based on the average values from literature



Note: The empirical CO_2 trend is based on the empirical relationship from 1960 to 2015

Figure 3.
The future projections of CO_2 fluxes and the CO_2 concentration change for the fossil fuel rate of 50 $GtCO_2eqy^{-1}$ from 2030 onward

to absorb CO_2 decreases. Finally, a new balance between atmospheric CO_2 and the CO_2 in the ocean will be reached.

According to this simulation, the final CO_2 concentration in the atmosphere would be at the level of 1000 ppm. The CO_2 concentration of 688 ppm in 2100 would mean a temperature increase of 2.4°C according to the IPCC's model.

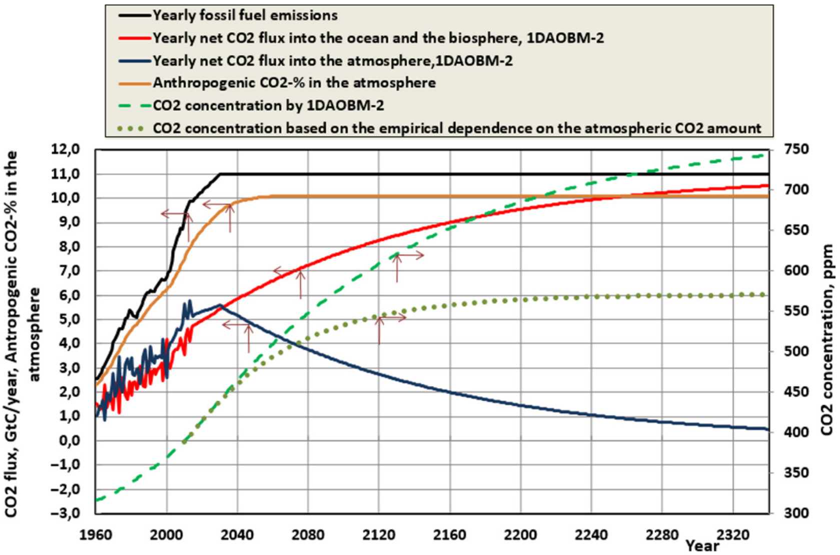
Another simulation was carried out using the 1DAOBM-2 by keeping the early GH gas emission rate at 40 $GtCO_2eq$ (about 11 GtC). This simulation could be called a "business as usual" scenario because it would mean keeping the emissions at the present level. The results are depicted in Figure 4.

This simulation shows that the CO_2 concentration would be about 580 ppm in 2100, corresponding to a temperature increase of 1.95°C. Also in this case, the CO_2 concentration increases after 2100. The balance value would be about 800 ppm corresponding to the temperature increase of 3.4°C. This simulation result is in line with the UNEP and UNFCCC that the emission level should not exceed 40 $GtCO_2$ after 2030 to keep the temperature below 2°C in 2100 per the IPCC's climate model. The temperature increase values of these two simulations are also depicted in Figure 1.

In the latest AR5 report (p. 469), the IPCC (2013a) states:

> The removal of human-emitted CO_2 from the atmosphere by natural processes will take a few hundred thousand years (high confidence). Depending on the RCP scenario considered, about 15 to 40 per cent of emitted CO2 will remain in the atmosphere longer than 1,000 years.

According to the simulations of Ollila (2016) by the 1DAOBM-2 model, the residence time of anthropogenic CO_2 is 16 years, and the same of total CO_2 is 55 years. The residence time of 55 years gives a relaxation time (meaning the end value of the change) of 4×55 years = 220 years, which is much shorter than that of the IPCC. The simulations show that even though the CO_2 emission rate could be kept at the level of 40 GtCO2 y^{-1} from 2030 onward, the



Note: The empirical CO_2 trend is based on the empirical relationship from 1960 to 2015

Figure 4.
The future projections of CO_2 fluxes and the CO_2 concentration change for the fossil fuel rate of 40 $GtCO_2eqy^{-1}$ from 2030 onward

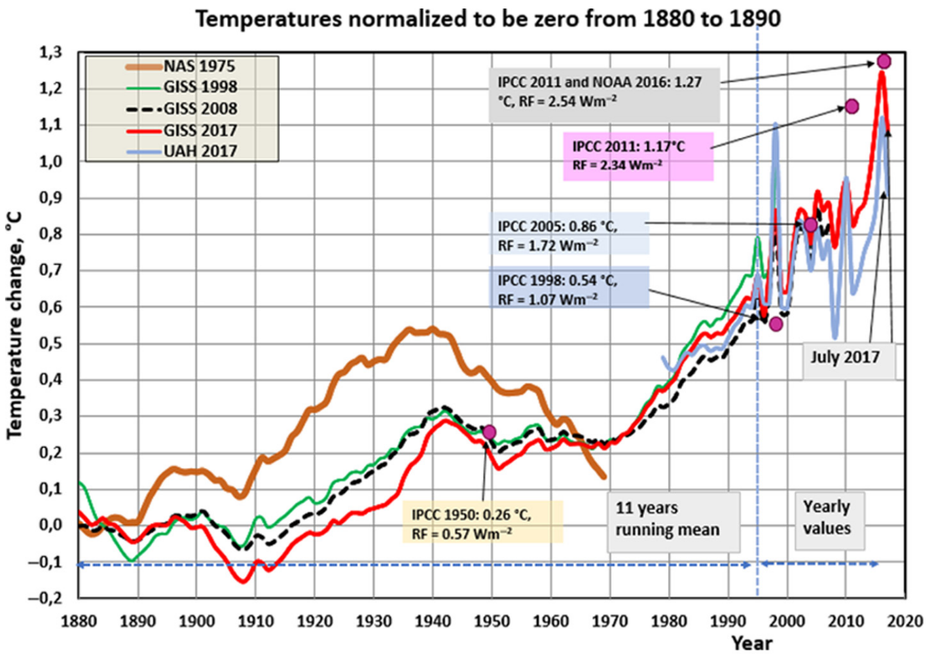
atmospheric CO_2 concentration would increase steadily at the present rate. However, the concentration of 580 ppm in 2100 according to the BAU scenario is much lower than the original baseline.

4. The climate models' calculated temperatures versus the observed temperature

In Figure 5, the observed temperatures and the IPCC model-calculated temperatures are depicted (IPCC, 2013a) and (NOAA, 2017a, 2017b).

The graph of Hansen and Lebedeff (1987) shows almost the same high-temperature peak in the 30s and 40s as the oldest graph of National Academy of Sciences published in 1975 (NAS, 1975). In the newer temperature data sets GISS-2008 and GISS-2017 by NASA Goddard Institute for Space Studies (GISS, 2008; GISS, 2017), this peak has almost disappeared. The decades from 1910 to 1940 in GISS-2017 is from −0.05°C to −0.1°C colder than in GISS-2008. The satellite-based temperature measurements (UAH, 2017) show practically no warming trend since 2000. The UAH temperature data starts from 1979 and has been equalized to be the same as GISS-2017 in 1979. The further warming of GISS-2017 during the 2010s seems to be about 0.2°C in comparison to the UAH temperature.

This means that the real warming rate is not very certain. Can we be confident that the history of the GISS dataset is now finally correct? Looking at the historical versions of GISS data sets, this is not probable. The author's conclusion is that the best estimate for the global temperature data set is the combination of NAS and Hansen data from 1880 to 1969, the



Notes: The temperatures are 11 years running mean values except the past five years; where the future temperatures are not known

Figure 5.
The observed temperature changes since 1880 according to different data sets and publications, and the IPCC model calculated temperatures

period from 1969 to 1979 covered by the GISS-2017 data set and thereafter by the UAH data set (Ollila, 2017b).

The IPCC model calculated temperature for 2016 is 1.27°C. It is 49 per cent higher than 0.85°C, which is the average temperature during the pause since 2000, according to the IPCC (2013a). The year 2016 saw the warmest and strongest El Niño event in direct measurement history, but the temperature has decreased almost back to the average level (UAH, 2017). The big difference between the IPCC model and the observations considerably weakens the reliability of the baseline scenario because they are based on the very same calculations, and the difference is already intolerable. It should be remembered that the IPCC (2013b) states that it is extremely likely that more than half of the observed temperature increase from 1951 to 2010 was due to the anthropogenic GH gases leaving an opportunity for natural causes.

The CO_2 emissions from 2000 onward represent about one-third of the total emissions since 1750, but the temperature has not increased, and it has paused at the present level. This is worthy proof that the IPCC's climate model has overestimated human-induced causes and has probably underestimated natural causes like the sun's activity changes, considering the historical temperatures during the past 2000 years.

5. The strength of carbon dioxide as a greenhouse gas

The strength of CO_2 as a GH gas is normally expressed as a CS, which is global warming caused by the CO_2 concentration doubling from 280 to 560 ppm. The IPCC reports in AR4 (IPCC, 2007b) that water vapor roughly doubles the response to the forcing of GH gases, and this is called positive water feedback. The transient CS (TCS) of IPCC includes water feedback, and this feature is inherently in the λ value 0.5 K/(Wm^{-2}) (IPCC, 2001). Ollila (2014) has calculated the λ value using the energy balance of the Earth and the result was 0.268 K/(Wm^{-2}), and spectral analysis gave the λ value 0.259 K/(Wm^{-2}). These results can be rounded to 0.27 K/(Wm^{-2}), which means that the amount of water in the atmosphere is constant, without positive or negative feedback.

The TCS definition resumes that the increase rate of CO_2 concentration is of maximum 1 per cent y^{-1}. The TCS can be calculated using equations (1) and (2), which give the value 1.85°C. In the IPCC's report AR5 (IPCC, 2013a), TCS is between 1.0 to 2.5°C, meaning the average value is 1.75°C, which is very close to 1.85°C.

Two other TCS values can be found in the AR5 (IPCC, 2013a). The IPCC reports:

> It can be estimated that in the presence of water vapor, lapse rate and surface albedo feedbacks, but in the absence of cloud feedbacks, current GCMs would predict a climate sensitivity (±1 standard deviation) of roughly 1.9°C ± 0.15°C.

In Table IX.5 of AR5 (IPCC, 2013a), the key figures of 30 GCMs have been tabulated. The model TCS mean of these GCMs is 1.8°C. The explanation for these practically identical TCS values of the GCMs and the IPCC's simple model is that the warming effect of CO_2 is calculated on the same basis. The present GCMs do not apply spectral calculations of their own, but they use the results of equations (1) and (2). It should be noticed that the baseline scenario and the RCP8.5 values are calculated using the λ value of 0.5 K/(W/m^{-2}) applicable for TCS calculation, and the 1 per cent y^{-1} CO_2 growth rate limit has not been exceeded.

There are several new research studies, which show lower equilibrium CS (ECS) values than those of the IPCC. According to these results, the best estimates and minimum values for ECS are 2.0°C/1.1°C (Aldrin *et al.*, 2012); 2.0°C/1.15°C (Bengtson and Schwartz, 2013); and 2.0°C/1.2°C (Otto *et al.*, 2013). Common features of these studies are mathematical methods like the theorem of Bayes to analyze the impact of CO_2 based on the measured global data of radiative forcing factors, temperatures and ocean heat content. All the studies use an RF value of 3.7 Wm^{-2} for CO_2 doubling, and they do not address the water feedback.

The IPCC confirms the results above in section 8.6.2.3 of the AR4 (IPCC, 2007b):

> The diagnosis of global radiative feedbacks allows better understanding of the spread of equilibrium climate sensitivity estimates among current GCMs. In the idealized situation that the climate response to a doubling of atmospheric CO_2 consisted of a uniform temperature change only, with no feedbacks operating (but allowing for the enhanced radiative cooling resulting from the temperature increase), the global warming from GCMs would be around 1.2°C.

The question is whether the positive water feedback can be confirmed by the real observations and whether the RF value of Myhre *et al.* (1998) is correct.

Ollila (2014) has reproduced the RF value of Myhre *et al.* (1998) using the same spectral analysis method. The result of this study is that the RF value can be calculated using the same kind of logarithmic formula, but the coefficient k is different:

$$RF = 3.12 \times \ln(C/280) \quad (3)$$

The RF value for the CO_2 concentration of 560 ppm is 2.16 Wm^{-2} according to equation (3), which is 42 per cent smaller than 3.7 Wm^{-2} used by the IPCC. The same study of Ollila (2014) shows that the CS parameter λ is 0.27 K/(Wm^{-2}), which means that there is no water feedback. Using this λ value, equation (3) gives a TCS value of 0.6°C only. This same result is also reported by Harde (2014) using the spectral analysis method. Abbot and Marohasy (2017) have used six temperature proxy data sets and an artificial neural network to create temperature projections throughout the twentieth century. Based on deviations between the projections and the measured temperatures, their estimate for TCS is 0.6°C. Figure 6 shows the observed temperature as the combination of GISS-2008 from 1880 to 1979 and UAH from 1979 to 2016.

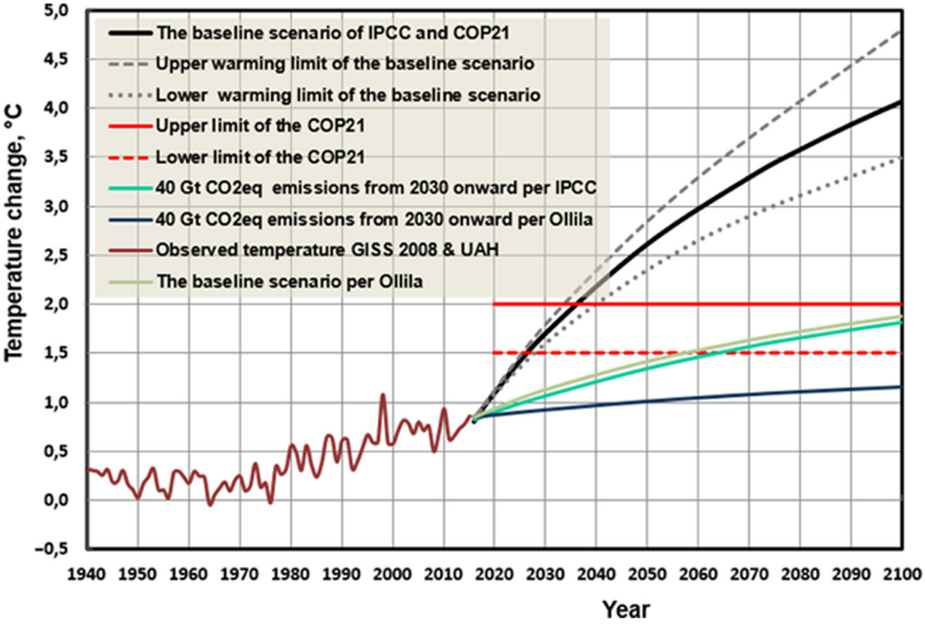
Figure 6 also depicts the baseline scenario of COP21 per the calculations of the IPCC and of Ollila (2014), two scenarios of 40 $GtCO_2eq$ from 2030 onward. In three scenarios, the temperature increase would stay below the upper temperature target of 2°C.

There are both theoretical- and measurement-based studies showing results that can be explained only by the fact that there is no positive water feedback. This result reduces the CS by 50 per cent. Some research studies show that the RF value of carbon dioxide is considerably smaller than the commonly used RF value, according to the equation of Myhre *et al.* (1998). Because of these two causes, the critical studies show a TCS of about 0.6°C instead of 1.9°C by the IPCC, a 200 per cent difference.

6. Validation of the scientific calculations

The validation of the scientific basis of the COP21 is important. The most decisive factor is the growth rate of GH gases, which cannot be validated. Only common sense can be used to evaluate whether the CO_2eq emissions could be at the 110 Gt level in 2100 because the present level remained at about 36 $GtCO_2eq$ for the past five years without the effects of the Paris Agreement.

The baseline and BAU scenarios can be evaluated against the estimated fossil fuel reserves using the conventional technology. The BP (2017) estimates are coal 1139 billion tons, natural gas 187 trillion cubic meters and oil 1707 billion barrels. Hansen *et al.* (2013) have reported similar estimates using the figures of three expert organizations. If the production and consumption of fossil fuels continue at the present rates, coal reserves will be exhausted by 2169, natural gas by 2068, and oil by 2066 (BP, 2017). Considering these



Note: All scenarios are fitted to start from the observed 11 years running mean temperature in 2016

Figure 6.
The temperature effects of different climate models

estimates, even the BAU scenario seems realistic only until the 2060s. The baseline scenario would mean the utilization of new unconventional technologies, making oil and gas prices after the 2050s much higher than today.

The IPCC's model can be validated using the observed and model-calculated temperatures. As noticed before, the IPCC model-calculated temperature for 2016 is 1.27°C, 49 per cent higher than the observed temperature of 0.85°C IPCC (2013a). This significant difference shows that there are substantial errors in this model. Two error sources have been identified in this article. The first error is the positive water feedback, which has been criticized in many scientific studies. The lower ECS values range from 1.1 to 1.2°C, indicating the absence of positive water feedback. In these calculations, researchers have used the RF value of Myhre *et al.* (1998). The latest version of GISS-2017 does not convincingly prove that the data set is now analysed and composed in the right way because the GISS versions have been changing throughout the years in the same direction.

Illustrative evidence about the missing positive water feedback in the climate is depicted in Figure 7. The graphs are based on the study of Ollila (2017a). The temperature effects of the water and CO_2 are based on spectral analysis calculations, which show that water is 11.8 times stronger a GH gas than CO_2 in the present climate.

The variable labeled "Factor X" is also depicted in Figure 7; it is the difference between the measured 11 years average temperature and the warming effects of CO_2, water and ENSO events. Factor X is needed to explain the observed warming. It is a combination of natural forces like the activity changes of the sun. It is easy to notice that the short-term temperature changes – mainly ENSO events – very closely correlate to the total precipitable water (TPW) changes.

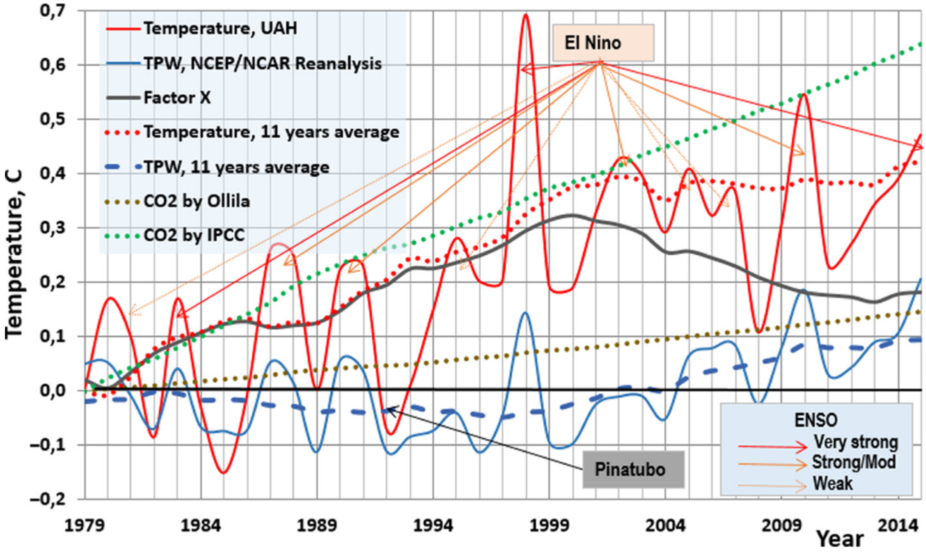


Figure 7. The temperature trend from according to UAH (2017) and the major warming factors, which are absolute humidity (NVAP, 2017) and CO_2 (NOAA, 2017a, 2017b)

Notes: El Niño events are marked by their strengths; and they are followed by La Niña events which are not marked

There are essential features in the long-term trends of temperature and TPW, which are calculated and depicted as mean values 11 years running. The temperature has increased about 0.4°C since 1979 and has now paused at this level. The long-term trend of TPW effects shows that it has slightly decreased during the temperature-increasing period from 1979 to 2000. This means that the absolute water amount in the atmosphere does not follow the temperature increase, but is practically constant, reacting only very slightly to the long-term trends of temperature changes. The assumption that relative humidity is constant and that it amplifies the GH gas changes over the longer periods by doubling the warming effects finds no grounds based on the behavior of the TWP trend. The positive water feedback exists only during the short-term ENSO events (≤4 years).

Another reason for the lower TCS value of Ollila (2014) is the radiative forcing value of the CO_2. Myhre *et al.* (1998) have used the temperature and humidity data profiles of the European Centre for Medium Range Weather Forecasts (Myhre and Stordal, 1997), which are not openly available. Ollila (2014) has used five temperature and humidity profiles from the Spectral Calculator (Gats, 2014), which are combined to create an average global atmosphere profile with a surface temperature of 15°C and a TWP value of 2.6 cm. The warming effects of CO_2 are always based on calculating the total absorption caused by GH gases in the atmosphere. In clear sky conditions, the total absorption should be the same as the downward total absorption at the surface according to Kirchhoff's radiation law. The synthesis analysis of Stephens *et al.* (2012) shows an average value of 314.2 Wm^{-2} based on 13 independent observation-based studies. The value of the same flux by Ollila (2014) is 310.9 Wm^{-2}, meaning a difference of 1.0 per cent. This result is not a direct validation of the correct warming value of CO_2, but is rather convincing. The error of the CO_2 absorption calculation code of HITRAN (2014) has been confirmed to be less than 1 per cent in the actual atmospheric conditions (Turner *et al.*, 2012). The LW radiation flux at TOA in the clear sky conditions according to the spectral analysis calculations (Ollila, 2014) is 265.3 Wm^{-2}. According to the NASA CERES (2017) satellite observations from 2000 to 2010, this flux has been 265.8 Wm^{-2}. The difference is only 0.19 per cent.

Ollila (2016) has shown that the 1DAOBM-2 model can calculate the atmospheric CO_2 concentration from 1960 to 2013 using the annual emission rates and the actual sea water temperatures with an error of only 0.2 per cent.

7. Discussion

The science basis of COP21 has been challenged in different ways in this study. An error of the IPCC climate model has increased steadily during the temperature pause of the 2000s and is now about 50 per cent. The removal rate of increased CO_2 from the atmosphere is much shorter than the estimated value of the IPCC, but even this shorter CO_2 residence time means steady growth of CO_2 concentration. The CO_2 growth rate of the present 2.2 $ppmy^{-1}$ according to the BAU scenario is much more realistic than the 6.4 $ppmy^{-1}$ according to the baseline, which is not even possible regarding the fossil fuel reserve amount.

Using the BAU scenario as a basis for the future temperature estimate, it is possible to keep the temperature increase below 2°C according the IPCC climate model. The evidence of the missing positive water feedback alone will decrease the temperature increase to 1°C according to the BAU scenario.

Germany's "Energiewende" (Energy transition) to create a low-carbon, affordable and reliable energy supply has failed in all its targets: The price of electricity is the second highest in Europe, the CO_2 emissions have not decreased and the solar and wind power are not reliable. The portion of solar and wind power in Germany is 3.3 per cent of its primary energy consumption (AGEB, 2017), and the same figure worldwide is only 0.8 per cent. Today, the renewables represent 13.8 per cent, which can be compared to 15.6 per cent in 1966 (International Energy Agency (IEA), 2017). Considering these factors, the ultimate and very expensive methods of the COP21 for restricting CO_2 emissions are hasty, oversized, ineffective and very expensive.

Because there is actually no compelling need to rush limitations of CO_2 emissions from the present level, there is time to create concrete and well-proofed energy supply methods for industrialized countries. The USA has been able to reduce CO_2 emissions by increasing the portion of shale gas in its energy production. The most effective way to reduce CO_2 emissions is nuclear power, but some countries like Germany are moving in the opposite direction.

Developing countries are not able to invest in cheap and reliable coal power plants. This is a result of World Bank policy: They do not give loans for these kinds of power plants creating CO_2 emissions. At the same time, industrialized countries like Germany and China build new high-capacity coal power plants. This situation is ambivalent, and it is an outcome of UN policy. In the end, this policy is based on the science of the IPCC, which is not solid.

8. Conclusions

The major concern of the Paris Agreement (COP21) is to keep the global temperature increase below 2°C by 2100. The IPCC's conclusion has been that the present high temperatures of the 2000s are unprecedented (IPCC, 2013a). The proxy temperature analyses show two warm periods (Lungqvist, 2010), namely, the Roman warm period from 250 BC to AD 450 and the Middle Age warm period from AD 950 to 1250. The retreating Mendenhall glacier in Alaska has exposed forest remnants older than 1000 years based on their radiocarbon ages according to a statement by Professor Connor (2013). Evidence shows that these warm periods, which have been called climate optimum periods, have been long and at least as warm as the present one.

The major concerns of the increased global temperature have been the increased amount of hazardous climate events and decreased crop amounts. The frequency and accumulated cyclone energy do not show an increasing trend (Policlimate, 2017). The world's wheat production has increased steadily, even in the warmest countries like India and Brazil (Faostat, 2017). India's government reports that food grain production was estimated to be at an all-time high in 2016-2017 (Livemint, 2017). The temperature increase of 2°C would probably not stop the increasing crops in the mid-latitude countries, which are the main producers of wheat.

The COP21 could find neither a scenario definition for the GH gas emissions from the present-day to 2100 nor the warming calculations showing a temperature increase of over 2°C. It turns out that this scenario, which is called a baseline scenario, has been defined in the mitigation report of the IPCC for the policymakers (IPCC, 2014) and in the UNEP (2016) report. In the EU Commission report (Labat *et al.*, 2015), the original baseline scenario was modified to be approximately in the middle of the RCP6.0 and the RCP8.5. This study uses the original baseline, the worst-case scenario RCP8.5, which is one of the four projections of the AR5 (IPCC, 2007a).

The selection of RCP8.5 as the baseline scenario can be criticized because the present CO_2 growth rate of 2.2 ppmy^{-1} should be 2.8 greater in the baseline. The CO_2 emissions have stayed at the same level during the past five years. A more justified baseline scenario would be a "business as usual" (BAU) scenario, meaning the present GH gas emissions are at levels of about 40 $GtCO_2$ (55 $GtCO_2$eq) and the present CO_2 growth rate of 2.2 ppmy^{-1}. The estimated oil and gas reserves favor the BAU scenario.

The warming calculations of the RCP8.5 are the same as those used to calculate the TCS. The COP21 (2015) and the more detailed UNEP (2016) do not show the actual calculations needed to find CO_2 concentrations in 2100 for each scenario. Anyway, the simulation of this study shows that in the mitigated scenario of 40 $GtCO_2$eq, the temperature increase would stay below 2°C according to the IPCC's climate model calculations. The CO_2 circulation simulations referred to in this study are in line with the results of UNEP (2016), even though the calculations of UNEP are only until the year 2050.

The validity of the IPCC model can be tested against the observed temperature. It turns out that the IPCC-calculated temperature increase for 2016 is 1.27°C, which is 49 per cent higher than the observed 0.85°C. This validity test means that the IPCC climate forcing model using the radiative forcing value of CO_2 is too sensitive for CO_2 increase, and the CS parameter, including the positive water feedback doubling the GH gas effects, does not exist.

The research studies of Ollila (2014) and Harde (2014) show a TCS value of 0.6°C instead of the IPPC's TCS value of 1.9°C. The TCS value of 0.6°C is also supported by the study of Abbot and Marohasy (2017) based on the empirical data analysis. This lower TCS of CO_2 can explain why the IPCC model temperature 1.27°C in 2016 exceeds the present-day temperature of 0.85°C, but the lower warming value of CO_2 shows only a 0.28°C increase for GH gases, leaving room for natural forces.

The lower TCS value of 0.6°C means that the temperature increase caused by GH gases as high as a CO_2 concentration of 1370 ppm – which is the baseline concentration in 2100 – would increase the temperature only 1.9°C from 1750 to 2100. The mitigated scenario of 40 $GtCO_2$eq would increase the temperature by only 1.2°C, assuming that the natural forces would remain the same. The expensive mitigation actions would actually not be needed. The lower TCS value of 0.6°C also means that there are natural forces, which are the main driving forces of global warming. These same forces can explain the present temperature pause. The obvious culprit is the sun, which has shown a rather strong decrease in its activity (Ollila, 2017b). If the present temperature pause continues, there is no need to rush into a strong reduction of GH gas emissions.

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