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Global Warming by Anthropogenic Heat Release

In the 2007 report by the Intergovernmental Panel on Climate Change (IPCC) [1], *"Anthropogenic Heat Release"* is the heading of a section (2.5.7 from Working Group I), where it is stated that "*human energy production is a small influence at the global scale"* on temperature. Therefore it has been neglected in all calculations, even in those reaching up to the year 3000 (within section 10.7.2 from Working Group I). These calculations will be discussed after the contrary results by R. Döpel in his earlier publication *"On the geophysical limit of industrial energy production"* [2]. His simple calculations have been compared to the IPCC results by the author in an updated form under the title "Robert Döpel and his model of global temperature increase: An early warning – and its updating" [3][2]. The most important results are given in Fig. 1, corresponding to "Bild 1" in [2]. Their calculations shall be given concisely.

Calculations according to Döpel

The global radiation balance is $\sigma T_e^4 = l_s = 239\ \mathrm{W/m^2}$, where σ is the STEFAN-BOLTZMANN constant, T_e (255 K) is the effective radiation temperature of the atmosphere, and l_s is the net solar radiation flux density into the atmosphere. Approximating the differential quotient dl_s / dT_e by the difference quotient results in

$$\Delta T_e = \frac{T_e}{4l_s}\Delta l_s = \lambda_e \Delta l_s = \lambda_e F_w, \quad with \quad \lambda_e = 0.27\frac{K m^2}{W}.$$

In a contemporary terminology, λ_e is the climate sensitivity constant with respect to the atmosphere and the additional flux density of energy Δl_s is the climate forcing F_w due to the anthropogenic heat release ($\mathrm{W/m^2}$). (Alternatively, with $\Delta l_s = F_s$ from variations of solar radiation, their influence can be discussed in a first approximation with the solar climate sensitivity constant $\lambda_s = \lambda_e$ [3].)

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[2] In this context biographical data and earlier works by Robert Döpel (1895-1982), especially in experimental nuclear physics for energy production in cooperation with his wife and with the theoretician Werner Heisenberg have been described. They were the first physicists to achieve a net neutron production within a uranium pile (1942): http://www.deutsches-museum.de/archiv/archiv-online/(Geheimdokumente)

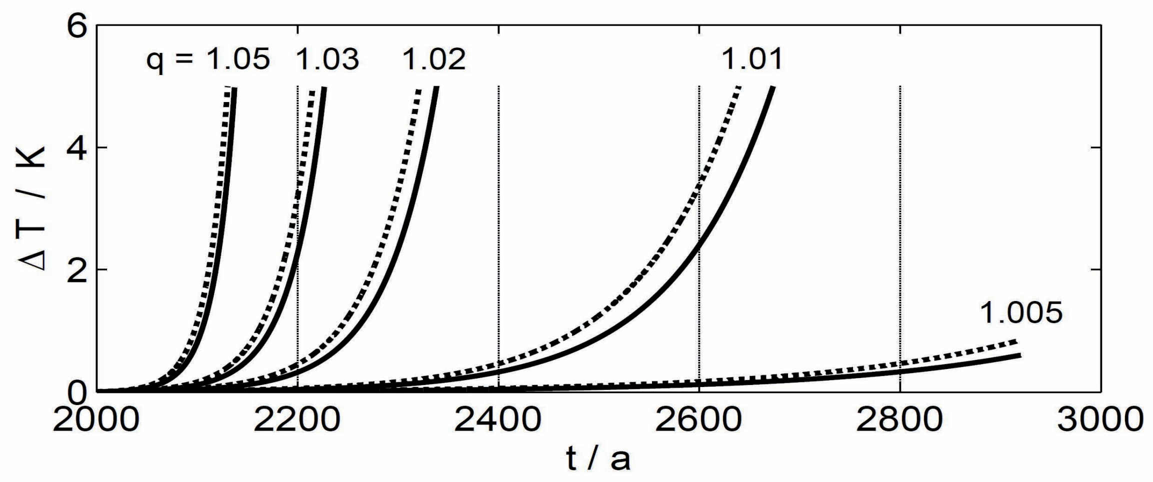

Fig. 1. Time-dependent increase of the global temperature as a function of the rate of annual increase in anthropogenic heat release by the factor q.

Solid lines: $\Delta T = \Delta T_e$, the change of the effective temperature of the atmosphere (T_e = 255 K) due to anthropogenic heat release (corresponding to the curves for T_e by Döpel [2]).

Dashed lines: $\Delta T = \Delta T_{ob}$, which is a "very probable" lower limit for the change of the mean global surface temperature ΔT_s (288 K) due to anthropogenic heat release.

For F_w Döpel assumed an exponential increase with an annual enhancement coefficient q (corresponding to a growth of (q–1)% p.a.) :

$$F_w = F_{w,o}\exp([q-1]\cdot\Delta t/a) \approx F_{w,o}\cdot q^{\Delta t/a}.$$

Starting with the year 2000, we take[3] $F_{w,o}$ = 0.023 W/m^2, which yields the solid curves in Fig. 1. Since Döpel's starting year 1970, the annual increase has been approximately 2% in average [4]. Consequently, his curve for q = 1.02 is approximately consistent with the data in Fig. 1. The differences for the other q values are also marginal, since the influence of changes in the pre-exponential factor is small compared to the influence of q.

This factor has to be enlarged due to feedbacks (owing to additional clouds, melting ice sheets *etc.*), which have not been taken into account quantitatively by Döpel. He merely declares ΔT_e as the lower limit of the increase $\Delta T_{s,w}$ of the global mean surface temperature ΔT_s (288 K

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[3] „Hauptgutachten 2003 des Wissenschaftlichen Beirats ‚Globale Umweltveränderungen' der BRD": http://www.wbgu.de/wbgu_jg2003.html . Here, 13% have been subtracted from the total value in Tab. 4.4-1 due to regenerative energies.

or 15°C) due to the anthropogenic heat release. As the upward transport of this additional heat is driven by the difference between T_s and T_e, T_e cannot become smaller than T_s.

To estimate the difference between $\Delta T_{s,w}$ and ΔT_e, this quantity has been compared with the corresponding difference for the anthropogenic greenhouse effect due to CO_2 [3]. Already early estimations have started with $\Delta T_{e,c} = \lambda_e F_c$ without feedbacks. For a doubling of the CO_2 concentration since pre-industrial time, the actual forcing formula [1; 5] gives $F_{c,do} = 3.7\ \mathrm{W/m^2}$, resulting in $\Delta T_{e,do} = 1.0$ K. This can be compared with the climate sensitivity S and especially with its "equilibrium" value (after very long times) $S^{gl} = \Delta T_{s,do}{}^{gl}$. Extensive model calculations with statistical evaluations [1] showed that S^{gl} amounts "*very likely*" (which means with a probability of 90%) to more than 1.5 K. Therefore, a factor of 1.5 has been applied to obtain a "very probable" lower limit $\Delta T_{ob} = 1.5\Delta T_e$ of the increase $\Delta T_{s,w}$ of the global mean surface temperature, resulting in the dashed curves in Fig. 1.

The IPPC report [1] further remarks that S^{gl} "*probably*" (which means a probability of 66%) lies between 2 and 4.5 K. The "*best estimate*" is 3 K and corresponds to $\Delta T_{s,w} = 3\Delta T_e$. However, one has to account for several uncertainties with respect to the feedbacks, *e.g.* that S^{gl} is specific for CO_2 exchanging with the ocean, while only an exchange of heat has to be considered here. Additionally, $\Delta T_{s,w}$ is an actual and not an equilibrium quantity. In spite of such uncertainties, $\Delta T_{s,w}$ supposedly is less than an order of magnitude larger than ΔT_e.

Comparison with IPCC results – and the limits of growth

Fig. 1 has to be compared with part **(b)** of Fig. 2, which shows the global mean surface warming $\Delta T_{s,c}$ from IPCC calculations due to the fictitious [CO_2] scenario given in part **(a).** The fictitious result from both effects is $\Delta T_s = \Delta T_{s,c} + \Delta T_{s,w}$, which significantly lies above the $\Delta T_{s,c}$ curves from CO_2 alone in later centuries, if release of heat continues to grow exponentially.

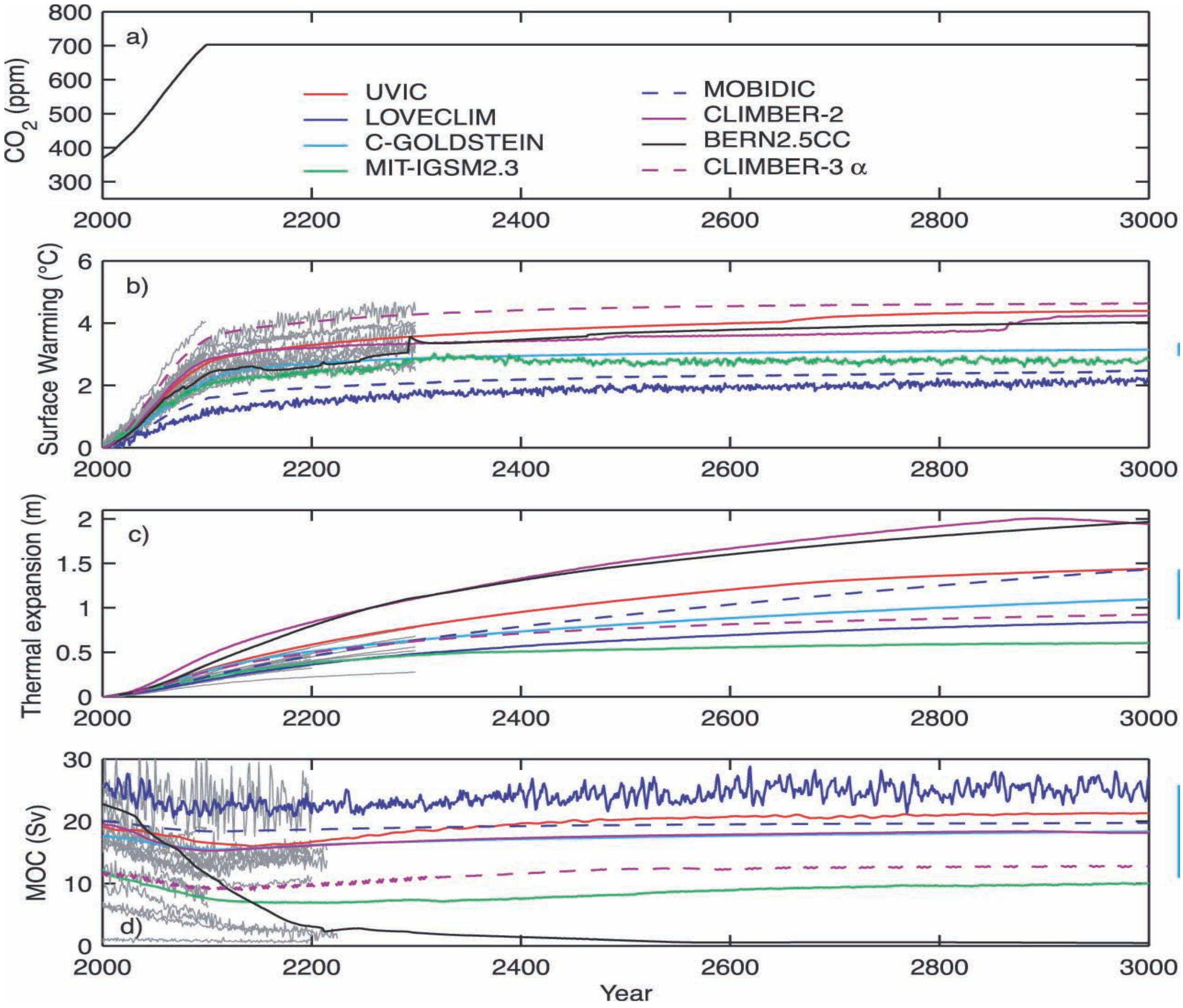

Fig. 2

is identical with Figure 10.34 from [1], chapter 10, and has to be reproduced here without any change and with the full legend[4]:

*"**(a)** Atmospheric* CO_2 *,*

***(b)** global mean surface warming,*

***(c)** sea level rise from thermal expansion and*

***(d)** Atlantic meridional overturning circulation (MOC)*

*calculated by eight EMICs for the SRES A1B scenario and stable radiative forcing after 2100, showing long-term commitment after stabilisation. Coloured lines are results from EMICs, grey lines indicate AOGCM results where available for comparison. Anomalies in **(b)** and **(c)***

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[4] The chapter and parts from it have to be cited as: Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao, 2007: Global Climate Projections.
In: *Climate Change 2007: The Physical Science Basis.Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)].
Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

are given relative to the year 2000. Vertical bars indicate ±2 standard deviation uncertainties due to ocean parameter perturbations in the C-GOLDSTEIN model. The MOC shuts down in the BERN2.5CC model, leading to an additional contribution to sea level rise. Individual EMICs (see Table 8.3 for model details) treat the effect from non-CO2 greenhouse gases and the direct and indirect aerosol effects on radiative forcing differently. Despite similar atmospheric CO2 concentrations, radiative forcing among EMICs can thus differ within the uncertainty ranges currently available for present-day radiative forcing (see Chapter 2).“

Abbreviations:

EMIC - *Earth System Model of Intermediate Complexity*.

AOGCM - *Atmosphere-Ocean General Circulation Model*, the most complex climate model type at present.

SRES - *Special Report on Emission Scenarios* (IPCC 2000), URL: http://www.ipcc.ch/ipccreports/sres/emission/index.htm.

On the other hand, Döpel has discussed the hypothesis of the exclusive use of photovoltaic energy[5], resulting in a constant global temperature. For the solar input l_s, he estimated a utilization coefficient $K = 6\cdot 10^{-3}$ (*vs.* $1.2\cdot 10^{-3}$ according to [1], WG III Tab. 4.2.). Together with the factor of 1.5 due to the "*very probable*" lower limit for $\Delta T_{s,w}$ (*vide supra*), the annual temperature increase is

$$\Delta t_K / a = (\ln q)^{-1} \ln \frac{K l_s}{1.5 F_{w,o}} \approx (q-1)^{-1} \ln \frac{4\cdot 10^{-3} l_s}{F_{w,o}} \approx \frac{4\cdot 10^2}{q-1}$$

Starting with year 2000, the time of constant global temperature Δt_K would be approximately 200, 400, or 800 years for $q = 1.02$, 1.01, or 1.005, respectively, corresponding to an annual increase in the anthropogenic heat release by 2, 1, or 0.5%. After those time intervals[6], non-photovoltaic energy would have to be used (with limited possibilities for the other regenerative energies). So, the curves in Fig. 1 will hold soon again.

Starting with the year 1970 and an annual increase of the anthropogenic heat release by 5%, which was slightly below the increase rates of those times, Döpel calculated the possible

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[5] The corresponding heading of section 5.3 in [2] reads: *Most intensive utilization of the insolated solar energy.*

[6] If non-regenerative energies were used instead during those time intervals, $\Delta T_{s,w}$ would be less than 0.5 K. On the other hand, the anthropogenic greenhouse effect already has caused $\Delta T_{s,c} = 0.8$ K from the beginning of industrial times.

“photovoltaic time” to end in the midst of the 21st century[7]. In each case, his conclusion reveals that the gradual change to a constant energy production is the only possibility to prevent a threatening increase of global temperatures due to heat release. (With such a change, the projections in Fig. 2 could become more realistic.)

This most important result of Döpel’s work from 1973 concerning sustainability corresponded to the more general statements on the “Limits of Growth” [6] published for the first time in the famous report to the *Club of Rome* [6] that had appeared just one year before. But only in the second report, released in 1974 [7], the risks of anthropogenic heat release were mentioned in this context, whereas they have been omitted again in an update from 2004 [8]. The discussion of their influence seems to be repressed widely by the greenhouse gas problems, which are much more imperilling at present.

Of course, CO_2-free techniques, as they are presumed in the projections of Fig. 2, have absolute priority. But the most tax-supported of these techniques, especially nuclear fusion, are not sustainable due to heat release and radioactive waste, and even regenerative energies will allow further growth of production only for a transition time of few generations, as we have seen above.

On the other hand, for nuclear waste deposition, safety for one million years (due to half-times) will become a governmentally accepted condition, *e.g.* in Germany. However, more attention has to be paid for sustainability with respect to the next decades and centuries. With regard to the current economical problems that endanger commencements of a global climate policy, the Deputy Chairman of the German Council for Sustainable Development Klaus Toepfer[8] has delivered the following statement:

„The collapse of the financial industry and the real economy can be overcome despite great difficulties. The collapse of a planet ruined by climate change cannot.”

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[7] At that time, nuclear fusion energy is expected to become available commercially [1] for the strongly growing human population.

[8] http://www.nachhaltigkeitsrat.de/en/the-council/council-members/profdrklaus-toepfer/. From 1998-2006, K. Toepfer has been Executive Director of the UN Environmental Programme (UNEP). In 2009, he was appointed founding director of the Institute for Advanced Sustainability Studies (IASS) at Potsdam, Germany.

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[3] Arnold, H., *Robert Döpel und sein Modell der globalen Erwärmung: Eine frühe Warnung – und die Aktualisierung.* Universitätsverlag Ilmenau (http://www.tu-lmenau.de/universitätsverlag) 2009.

[4] World Energy Council, URL: http://worldenergycom with a booklet "*Energie für Deutschland 2006"* for download fromURL: http://www.weltenergierat.de

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[6] Meadows, D., et al., *Limits to growth.* Universe Books, New York 1972.

[7] Mesarovic, M., Pestel, E., *Mankind at the Turning Point. 2nd Report to the Club of Rome.* Dutton, News York 1974.

[8] Meadows, D., et al., *Limits to growth: the 30-year update.* Chelsea Green Publ. Co. 2004.