For those who still doubt about global warming and sea level rise? Update 2, April 11, 2017.

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Abstract

In 2007 a person could swim at the North Pole; in September 2022 it is expected that the ice volume at the North Pole vanishes; in 2030 50% of the year will be without ice at the North Pole. At that moment the sun in not reflected any more during 50% of the year at the Arctic area. It can be even verified that the local expected >5°C rise in the North Pole region corresponds to melting of the whole Greenland ice sheet about 240 years, counting for 7.2m ocean rise. If we continue to emit CO2 and methane, even the Antarctic regions can melt at 1m/year rate, taking in account the larger surface. It corresponds then to a seal level rise of 7m in 120 years. Ultralight electric vehicles, unnecessary high light levels, lower temperatures in rooms and more clothing, sun screening of buildings to avoid airco could drastically reduce the energy needs and related greenhouse gases. What are we waiting for? Things are changing fast, so that a normal delay of finishing a paper in a normal style end getting it to a larger conference makes the information older. The update2 contains more details, text corrections, editing, but the conclusions are similar.

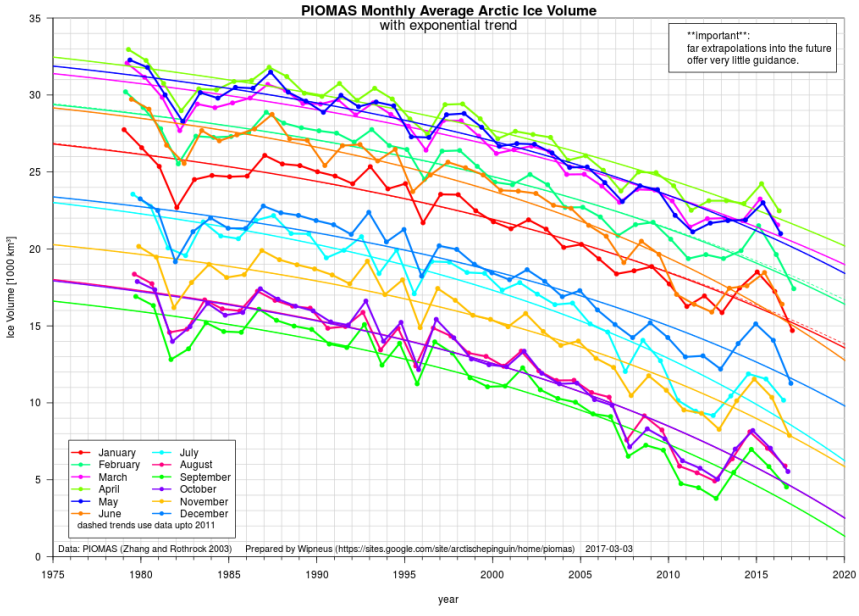
Introduction

The style of the paper is close to "blog style", update 2, follows these ones:
https://www.researchgate.net/publication/314117508_For_those_who_still_doubt_about_global_warming_and_sea_level_rise
https://www.researchgate.net/publication/315651801_For_those_who_still_doubt_about_global_warming_and_sea_level_rise_Update_March_26_2017

Several signs are getting clear now

1) *Lewis Pugh undertaking the* ***first swim across the Geographic North Pole on the 15th of July 2007****. The 1km swim across an open patch of sea was undertaken to highlight the dramatic melt of Arctic sea ice, as the result of climate change.*
Lewis Pugh - First swim across the North Pole
https://www.youtube.com/watch?v=WNmY_EAoXnU

2) The ice volume at the North Pole is expected to vanish in September 2022.
http://greatwhitecon.info/resources/arctic-sea-ice-graphs/ →
The "*albedo effect*": sunlight is reflected by snow. **Within 5 years from now, in September 2022,** green line, there will be probably no ice volume left at the North- Pole anymore. From 2032 on, a very low albedo effect has to be expected from the Artic regions, as 50% of the year, the Artic Sea will be ice free and absorbs even more light. Note also that, at the end of 2015, the largest natural gas atmospheric release



happened in USA history: in California. A more rapid melting followed (look at the sudden slope downwards in the graph at 2015), it may be even more relevant than El Niño, and probably continued by shale gas production leaks. Note also the reduction the months: January February and March 2017 compared to the corresponding months in 2016, the slope in the two last years is 3 times higher than the last 20 years.

3) Rapid Greenland ice sheet melting?

https://www.dmi.dk/en/groenland/maalinger/greenland-ice-sheet-surface-mass-budget/

Analysis of gravity data from GRACE satellites indicates that the Greenland ice sheet lost approximately 2900 Gt (0.1% of its total mass) between March 2002 and September 2012. The mean mass loss rate for 2008–2012 was 367 Gt/year

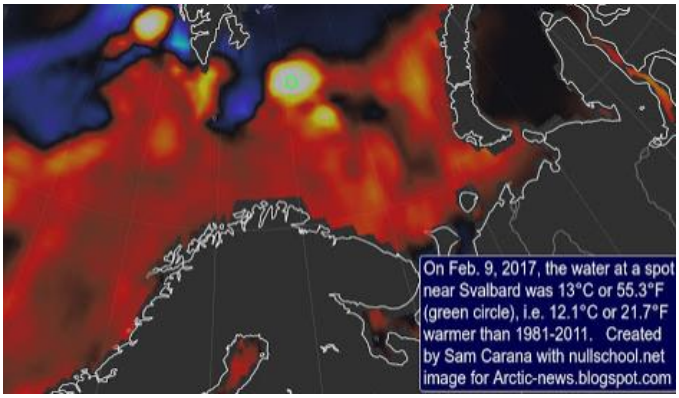
This is (0.9168 specific density of ice) $400.3*10^3$ km^3/year. The ice surface is about $1.71*10^6$ km^2 → 0.234 m/year in average, this seems not alarming, but in the next decades, much less albedo will be present in the Arctic region compared to that time! Note that the mass loss is a difference between a precipitation of 0.2-0.9m and melting. It could be interpreted as 0.8m average melting and 0.55m average precipitation. Now things change dramatically and the climate specialists know it:

http://www.nakedcapitalism.com/2017/02/greenland-ice-sheet-melting-600-percent-faster-predicted-current-models.html

Climate models predict 3°C to 9°C increase in Greenland before the end of the 21th century. As it is already melting now, the additional temperature will drastically induce the melting rate.

https://en.wikipedia.org/wiki/Greenland_ice_sheet The usual scientific articles have difficulties to follow the yearly changes, and there is often a delay between writing and when it is read. We had 3-4 °C rise short time in the Arctic Region, compared to only 0.8°C global. However, in the near future it 5-6°C average increase has to be expected in the Arctic region.

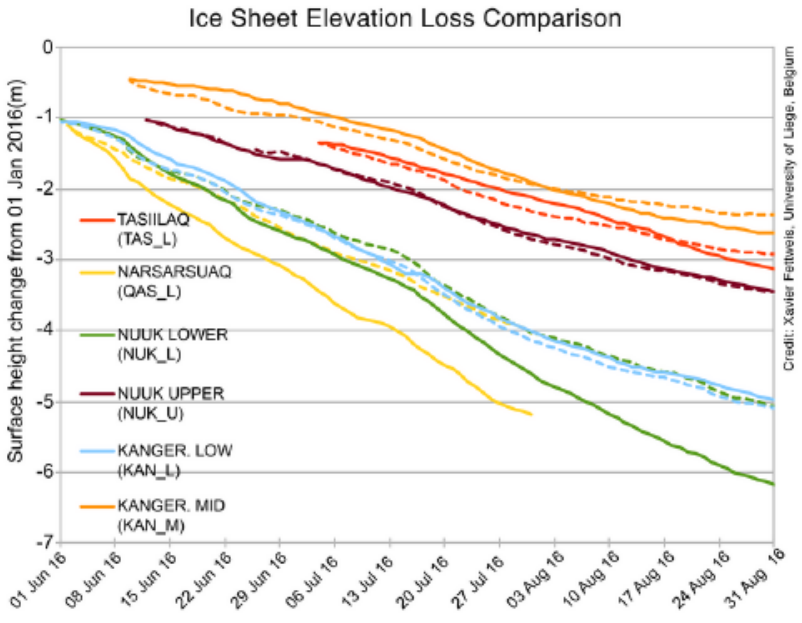
In 2016, we had an average 6°C in Reykjavik, Greenland is cooler due to the Labrador Sea current, but if there is no ice on the North Pole, for how long will it be cooler? The image on the right shows that on **February 9, 2017**, the water at a spot near Svalbard (Spitsbergen) (marked by a green circle) was 13°C, i.e. **12.1°C warmer than the average of 1981-2011**.



Another reference for the melting rate:

http://nsidc.org/greenland-today/

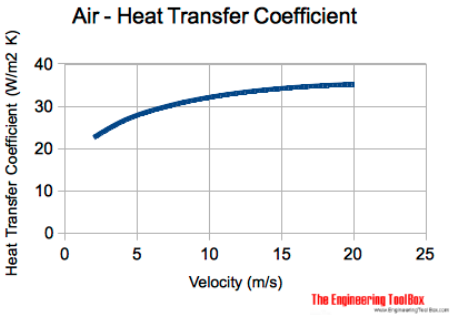
http://nsidc.org/greenland-today/files/1999/10/GrnToday_18Oct2106_Fig6-1-1024x792.png



It seems that the ice can now **melt 5 meter in 3 in three months,** but as the "summer" in Greenland will get longer, up to 10m/year can to be expected within about 20 years, over a rather 6 months period. The 2500 m thickness at that rate is some 250 years. The added ice by snow precipitation is almost negligible; this is about 200-900 mm/year and will this might be rather rain than snow. But there is also glacier movement, order of magnitude: 0.2 up to

2 km/yr. It is helped by the earth heat flux of 0.1W/m^2, 100 m of ice has 45 W/K/m, because of less heat drain at the top it can be heated from the bottom.
https://forums.theregister.co.uk/forum/3/2015/07/13/geothermal_heat_from_planets_core_is_melting_the_west_antarctic_ice/
But also melting water gets in cracks and helps lubricating the bottom. The solar radiation on a horizontal surface in Greenland is some 850 kWh/m2 = 85W/m2 averaged, fresh snow reflects about 60%, against the ocean about 6%. As ice melts it gets also dirtier and darker getting to a reflection of only about 30% http://onlinelibrary.wiley.com/doi/10.1029/96WR00712/abstract . In previous times, the absorbed solar radiation energy was removed by convection of cold air. The average temperature over Greenland is now -5°C.
http://www.kangerlussuaq.climatemps.com/temperatures.php . Some places in Greenland (Nanortalik) do have +2°C in average, with peak temperatures of 23°C in 2016.
http://www.accuweather.com/en/gl/nanortalik/1779/month/1779?monyr=8/01/2016
The major part of the surface is at the limit of melting in the summer. But what melts in the summer does not return back in winter.

4) An own rapid check:



Sometimes coarse models help to check what big models may predict. The major effect of today seems to be the heat transfer by air convection. We take an example of 5K average difference. At 20 W/m^{2}K it is 100W/m^2 (20W/m^2/K=4.5 radiation + convection with some wind). We expect a convection-rate of not more than 20 W/m^2, as the surface is very big large and the heat transfer is less for large surfaces.
http://www.engineeringtoolbox.com/convective-heat-transfer-d_430.html →
It seems that a +/-25% deviation is observed in outdoor measurements on the models, and Greenland is also not homogenous. *"A thermal model for photovoltaic panels under varying atmospheric conditions" S. Armstrong*, W.G. Hurley, Applied Thermal Engineering 30 (2010) 1488e1495*
8765 hours/year, 100W, and 3600 seconds/hour; 8765*100*3.600 kJ/m^2/yr = 3155400 kJ for melting ice 335kJ/kg for latent heat results in 9419 kg/m^2 melted ice/m^2 ; 0.9168 specific density of ice results in up to **10.273 m/year** . The ice sheet has a 2500m average thickness. In that scenario, it could take about 245 years.
https://en.wikipedia.org/wiki/Greenland_ice_sheet . Melting the Greenland ice sheet causes the ocean level to rise 7.2m, 3m/century; so this is if only Greenland melts and Antarctica does not. Note that a change in the average precipitation on Antarctica (now 166 mm/yr) will not compensate the ice loss of Greenland. The average depth of the ocean is 3700 m, at 100 ppm/K water dilatation and 1K rise it results in 0.37m rise. This is adds to the story, but seems not a major effect. Consider that a big part of Flanders is below 7m above sea level. The lab of the author at the Ghent University building at Technologiepark 913 Zwijnaarde is about 7m above sea level, and it is already 60km inland. So the problem does not only concern Tuvalu, The Maldives the Netherlands and Manhattan …
Up to now, the text was focused on Greenland and the arctic region. If society continues emitting large quantities of CO2 and CH4, the global warming will also melt a part of the Antarctic region. It is has an ice sheet surface of 14*10^6 km^2 , this is 8 times more than 1.71*10^6 km^2 for the Greenland ice sheet. Fortunately it is not likely to melt at the same rate. However, it is sufficient that the average melting rate would be 8 times less: 1.25m/year average melting at the Arctic region would double the effect of rate of the sea level rise due to Greenland. This can and should be avoided, even if it asks for changing our way of living.

5) What can be done?

For mobility, a factor 4 reduction in greenhouse gas is possible if ultra-light electric vehicles are used instead of "normal" electric vehicles, the ultra-light label could be given to vehicles that weigh less than the transported people. A two-person ultra-light vehicle of less than 150 kg, and maximum speed of 90km/h may need 2-4 kWh/100km, this is 15 gCO2/km if powr plants of 500g/kWh are used. This is which is about 5 times less than a

conventional electric vehicle, and 8 times less than an efficient ICE vehicle concerning CO2 emission. It is one of the major reasons for the author to be active in that area. What else can be done? The electricity consumption of IT may be reduced by more energy efficient software. Less number of rooms might be heated in houses. Innovation might be done in clothing so that people can live comfortable at a lower room temperature; why not use battery heated shoes or boots, it exists, but for outdoor only. Light intensity standards could be revised to lower levels; we don't need them while using screens. Limited light could be considered in streets as well, limited in time and surface. A better sun screening for buildings in warm regions asks for less air conditioning. The author is confident that the reader finds his own examples.

Conclusion

It is already clear what can happen, mainly people of the scandinavian countries are aware of it. It is just statitics of the northern part of those countries. However, the information should be spread to motivate the world society. The Greenland ice sheet melting may cause 7.2 meter ocean rise in 240 year, but it can be worse if the world continues emitting gases such as CO2 and CH4. If the whole world follows the oil and coal revolution as promoted by Donald Trump, Antarctica may start melting at a similar rate, so that after some decades the rate of sea level rise might double. Such scenarios should be avoided. Our today society is not enough aware of the quantitative effects of what really happens in the arctic region. It is even not just by "switching" from internal combustion to electric vehicles that the problem will be solved. A much bigger reduction can be obtained by developing and using *ultra-light* electric vehicles. It is time for action rather than just modeling and discussing the climate change. For example a factor 4-6 reduction is possible in people mobility by ultra-light electric vehicles. Probably other sectors can perform similar improvements such as unnecessary high light standards in offices and buildings? Use a lower room temperature and innovate in clothing? Use well-designed sun screening to avoid air conditioning? IT related power consumption? Avoid unnecessary transport?

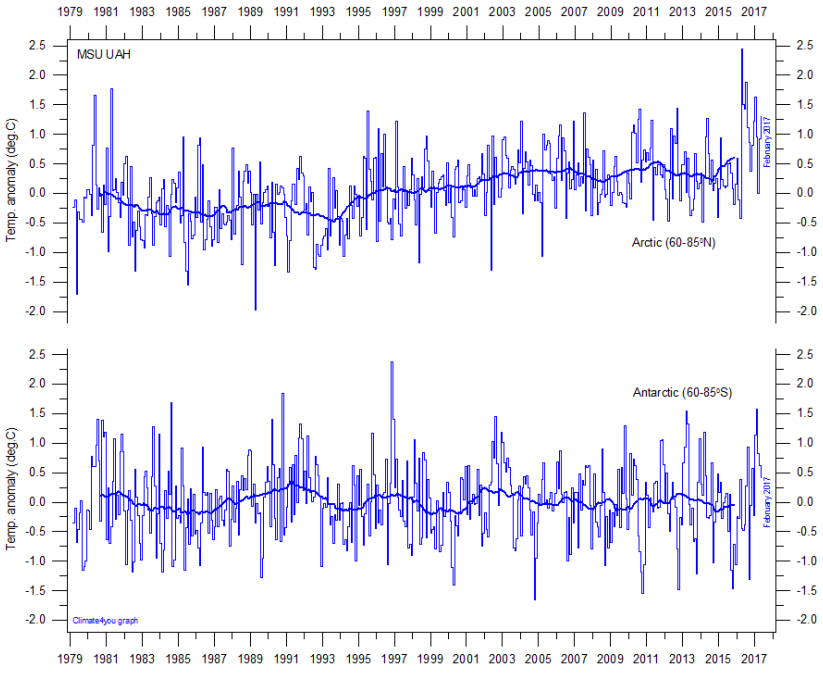
Nobody has the whole truth, but take care of predictions that use the statistics that "by chance" stop at the end of 2015. A kind of methane cloud above the Arctic regoion, might remain there for longer periods floating above the downwards vortex at the North pole. A normal prediction could be that, if shale gas is used on a large scale, the associated methane leaks will increase, and hence an unexpected rapid global warming and associated sea level rise would occur.

Appendices

Appendix 1. What about Antarctica?

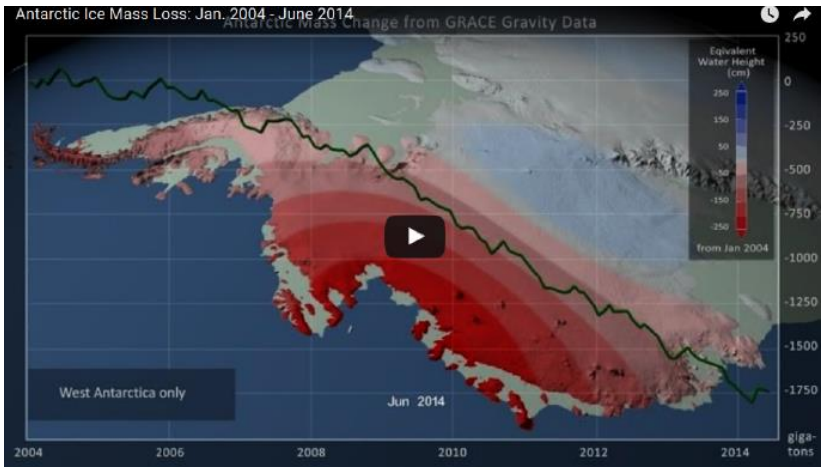
Fortunately, it is not so clear that Antarctica will melt completely in the next centuries (but it would result in 60m sea level rise).

https://www.skepticalscience.com/antarctica-gaining-ice.htm



So pay attention to details, that reference took very large pole regions from 60° to 85°N. Note that Oslo and St. Petersburg are at 60° North, this lowers the listed temperature rise. Some change in *sea ice* surface floats in the Antarctic region and does not reduce the sea level increase, it changes a lot yearly, and is news for newspapers. However, the temperature in Antarctica will definitely not rise as fast as in the Arctic regions. The reason is that there is no big change in albedo effect at the South Pole regions for the moment. However, if we continue to increase the CO2 and CH4 ppm, it will also

start melting at an accelerated rate. The Antarctic ice sheet surface is 8 times bigger than Greenland, so, even if it gets at an average melting rate in 1.25 m/year, 8 times less than Greenland it would still double the rate of sea level rise.



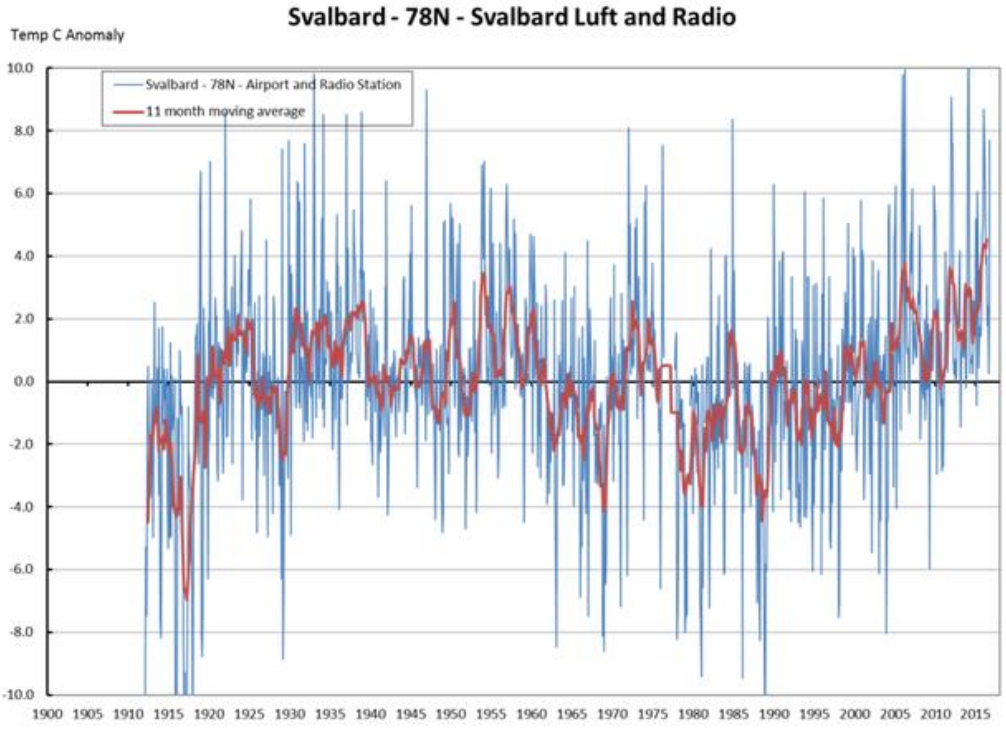
The South West Antarctica melted form 0 to 2.5 m in about 10 years, for about 20% of the Antarctic surface. https://www.nasa.gov/feature/goddard/warming-seas-and-melting-ice-sheets → Averaged 0.125 m/year in that region. This is despite of a typical precipitation of 0.2 m in that area (so rather 0.315 m melting and 0.2m water in snow form). If it follows the global warming, and melting would increase 4 times (form 0.8 to 3.2 °C globally) the influenced area could be 4 times larger and at 4 times more rate, it could get to 1 m average/year in melting (0.315*4*4*0.2=1.008) and at the same precipitation 0.8m average loss in Antarctica. So even if it is hardly visible now, it does not mean that it cannot happen. At 4°C global warming the equation would get the average melting rate beyond 1m/year (0.315*5*5*0.2=1.575 m). Even an increased precipitation would not help balancing it. A global 4°C rise, is the prediction of climate models in 2100. https://www.epa.gov/climate-change-science/future-climate-change

Appendix 2. The temperature in Svalbard, Spitsbergen, could get typical for the Arctic region

It is not strange to take an example of an average of 5°C air temperature that could melt the ice in Greenland, if we look at the temperature evolution in Svalbard (Spitsbergen), it is already close to 4°C now. →

https://wattsupwiththat.com/2016/12/10/what-is-next-for-weather-and-climate/

As Greenland will get gradually uncovered, it will rather react as similar land surfaces (iceland) at that latitude.

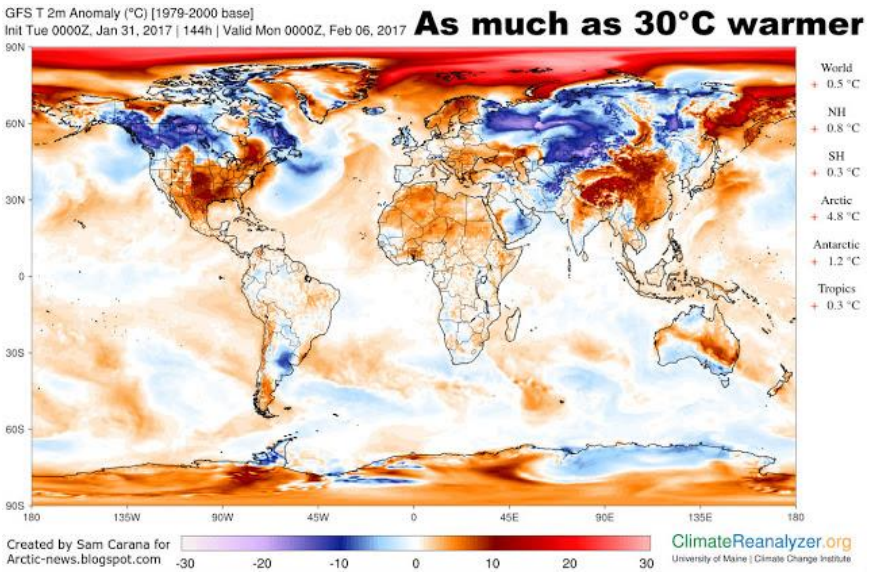


Appendix 3. Recent global trends and hot spots

In 2017 even much more changes were recorded, even in winter, due to sea currents and also air effects of the jet stream.

http://arctic-news.blogspot.be/2017_01_01_archive.html

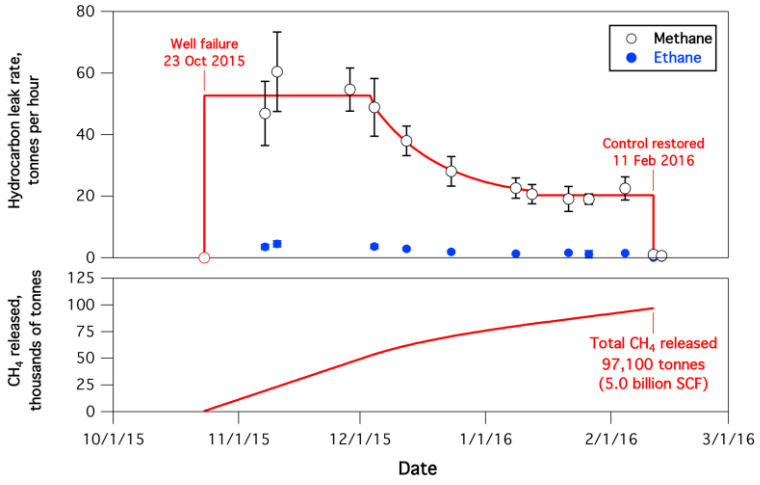
"Above forecast for February 6, 2017, shows that temperatures over parts of the Arctic Ocean will be as much as 30°C or 54°F higher than they were in 1979-2000"



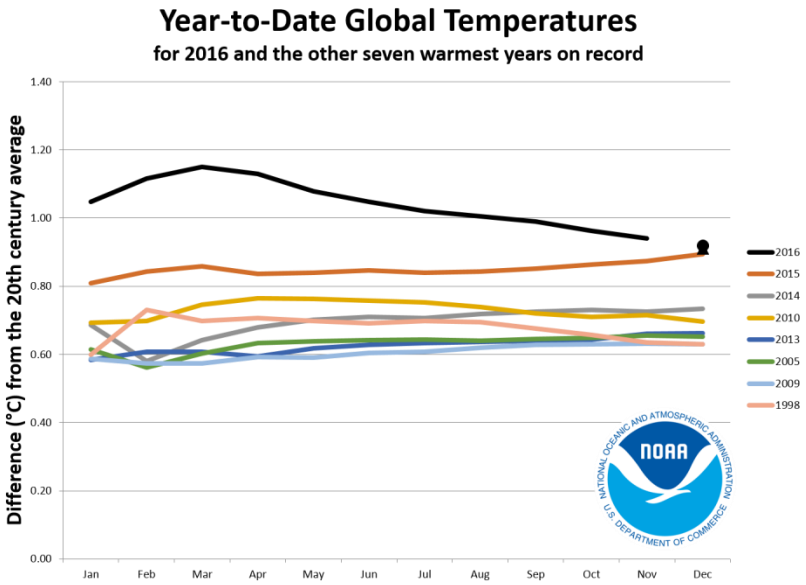
The large hot spots support the 5°C average temperature rise hypothesis in a few years in the arctic regions.

Appendix 4. Methane impact

Large methane leaks rise easily to the stratosphere and are spread as a blanket. Methane is transparent for light but absorbs well 3.35 µm infrared wavelengths, acting like a greenhouse, on a different wavelength than CO2. So it adds more than just an increased CO2 level. The temperature rise at beginning of 2016 is likely to have been caused by the methane leak in California end 2015. It is also referred to as a "blow out" of the largest natural gas storage in the USA.
https://www.ncdc.noaa.gov/sotc/global/2016/11/supplemental/page-2 →
We may have to be "grateful" for this "world scale experiment", whereas it is more difficult to model such things.

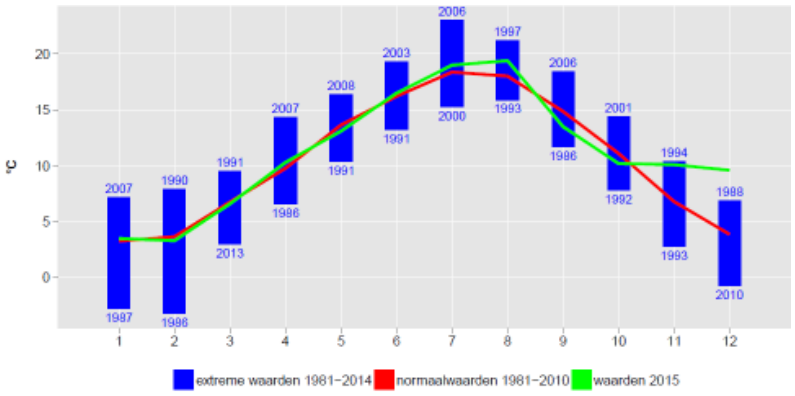


The peak global temperature in 2016 coincides with the cumulated emission of Alison canyon in California taking one month delay to spread it over the world. It is significantly larger than other influences such as El Niño that were present in other record years.
https://esrl.noaa.gov/csd/news/2016/1810225.html →



In December 2015, an average temperature of 2.5 °C more-than-ever-recorded has been noted in Belgium (look at the green line at the right). The delay is shorter as there was a dominant W-wind, coming from USA.

http://www.meteo.be/resources/climateReportWeb/klimatologisch_jaaroverzicht_2016.pdf →



In fact, this element made the author aware of the problem. Note that El Niño happens rather in the southern hemisphere and that this temperature peak was rather pronounced in the Northern hemisphere. Note also that the largest previous El Niño was in 1998, which did even not appear in any Belgian month temperature record. Apart from direct human induced leaks, more emissions are also expected from the reducing permafrost in Siberia and Northern Canada. It acts as a positive feedback, with a tendency to a runaway. A negative feedback could happen due to more water evaporation, resulting in more snow in winter in the Nordic regions.

Appendix 4 Educational aspects:

There are several major effects of global warming:

1) The average temperature rise resulting in large areas, where it will get too warm:

The maximum meteorological temperature in Iraq:

Basra city 53°C, (even not far from sea and lakes) **Baghdad 51°C** 20th July 2016,

http://indianexpress.com/article/world/world-news/iraq-records-hottest-day-so-far-this-year-in-basra-city-2931374/

But also in Algeria, **Adrar 48.8°C** July 2016.

http://www.infoclimat.fr/climatologie/annee/2016/adrar/valeurs/60620.html

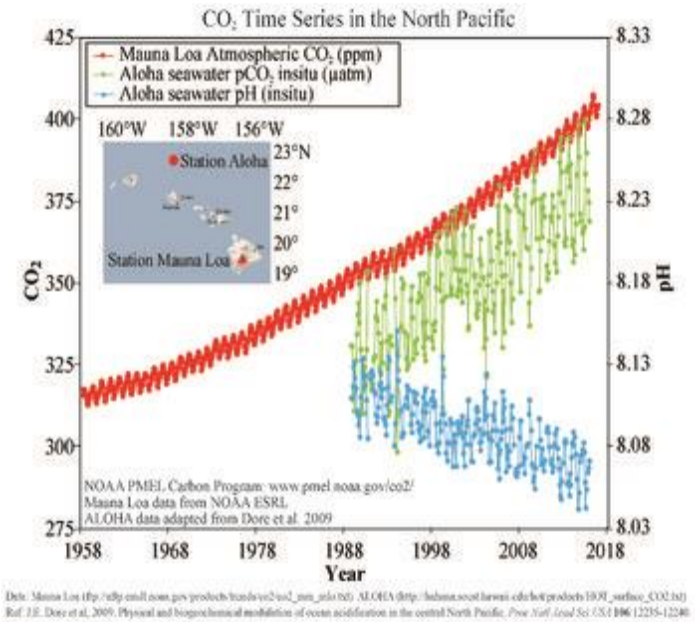
The consequence is that gradually it gets impossible to survive in some regions without using electricity and air-conditioning.

2) Sea level rise (described above, it can be 7m in 240 years, but could be faster if we take no action)

3) The pH of the ocean gets lower in a few decades, this is due to the increased ppm CO2, see right

CO2_time_series_03-08-2017 →

https://www.epa.gov/climate-indicators/climate-change-indicators-ocean-acidity



Some people are happy that some CO2 gets dissolved in the ocean, reducing the ppm in the atmosphere, but it results in disasters as well.

ec.europa.eu Feb 9, 2017

"Europe could suffer major shellfish production losses due to ocean acidification" Journal of Environmental Planning and Management: 1–19. DOI: 10.1080/09640568.2016.1162705.

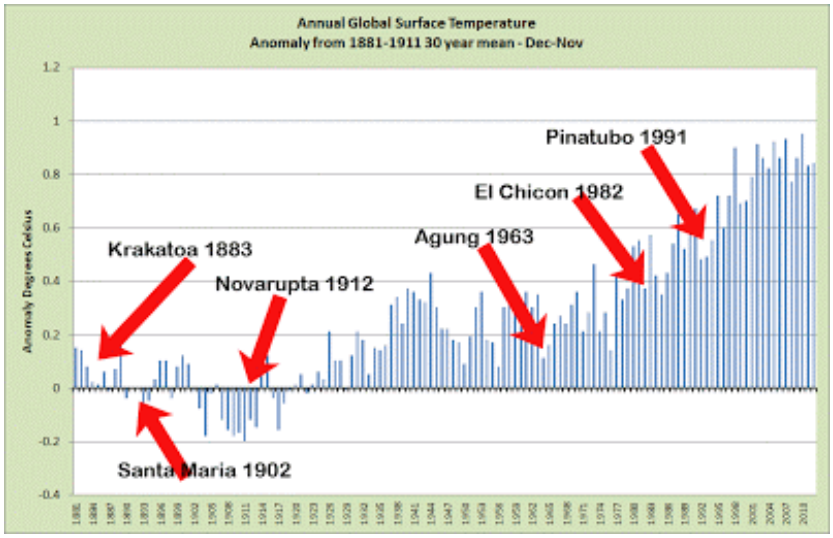
katrin.rehdanz@ifw-kiel.de

It concerns shellfish, mussels, plankton, but in fact the whole sea life will be disturbed.

http://news.mit.edu/2015/ocean-acidification-phytoplankton-0720

4) Global warming and volcano eruption frequency?

A difference in temperature may cause thermal stresses in the earth's crust. The thermal dilatation of rock is about 5-10 ppm/K, this means for 5°C rise, a 100km rock formation a dilatation of 2.5 to 5 m, this is not much, but could amplify existing stresses; however we are not at that temperature rise in the critical regions. A second effect is that the sea-level rise causes a different mass repartition on the globe; it may "crack" the borders of the oceans. A third effect is that the reduction of the permafrost also causes a different local stress in the cold regions. But as we are still in the beginning of global warming the major part of these effects are still to come. The "good news" is that big volcano eruptions tend to cool down the global temperature. →



http://blog.hotwhopper.com/2013/05/wondering-willis-volcanoes-and-dunning.html →

The Pacific Ocean is surrounded by volcanos; it is called the "ring of fire". But big volcano eruptions or super volcanoes can cause world disasters.

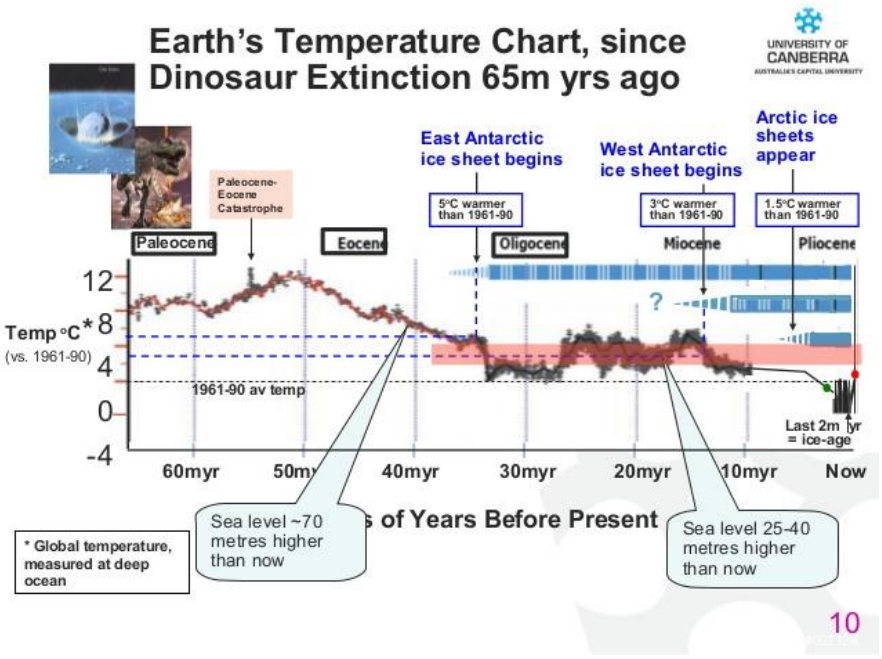
Up to this moment no real proof this risk is given.

5) Paleontology

For the remaining people in doubt, maybe we can also learn from history: 25-40 m sea level rise seems only a difference of less than 2°C rise compared to now.

A big part of today good agricultural land disappears at that sea level.

https://www.slideshare.net/ColinButler/climate-change-and-health-anucombined →



Appendix 5.Additional methane leaks

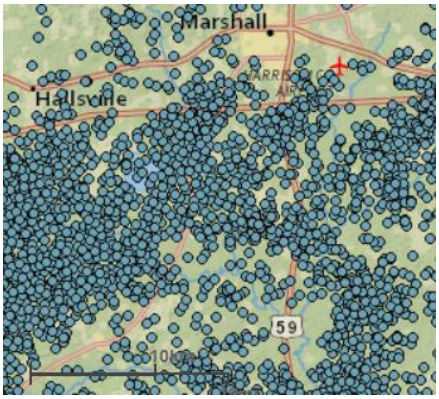
When Aliso Canyon stopped, other leaks continued.

https://www.edf.org/blog/2016/08/16/what-2500-square-mile-methane-cloud-tells-us-about-gas-leaks

Shale gas drillings can be found in these maps:

https://www.eia.gov/state/maps.php

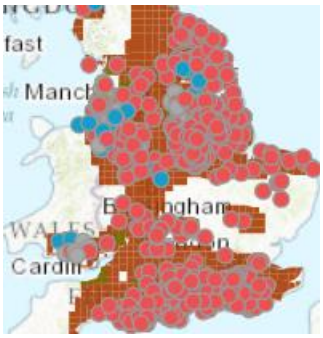
(Use the right "map layers") This is south of the city Marshall, each circle is a gas drill hole, some 6 per square km →



It seems that there are **1.7 million active** gas and oil wells in USA.

https://www.fractracker.org/2015/08/1-7-million-wells

And if a few % may leak? Even abandoned wells leak.
For comparison: there are only 0.5 million "dirty" VW cars in USA, this is less than the number of gas wells.
https://www.theguardian.com/vital-signs/2016/mar/02/methane-leaks-aliso-canyon-ghg-epa-edf-environmen-climate-change-gas
Methane leaks across USA pose a much greater threat than Aliso Canyon. Most scientists concede that a certain amount of methane loss is to be expected as part of natural gas production, but nearly all agree the current numbers are far too high. In fact, researchers have found methane losses of nearly 17% of production in the Los Angeles Basin, losses of 6-12% of natural gas production in the Uintah Basin and losses of approximately 4% of production in the Denver-Julesburg Basin.
If CH4 is considered 25 times worse greenhouse gas than CO2, it is worse' than coal. But at short time it acts as 120 times worse.
In Europe there are almost no gas leaks? May be the "information leaks" are effectively stopped? →



Appendix 6. A special reference about global warming by known climatologists
A rapid check was made based on heat transfer, for 5°C difference for melting. 7.2 m in 240 yr is 3m/century if the same rate happens at Antarctica it gets 6 m/century. Afterwards the author discovered an earlier paper of specialists. Noe that it is based on data of 2015 which were not so alarming.
http://reason.com/blog/2015/07/21/worlds-most-famous-climate-scientist-pre
10 feet in 50 years: this is 6.1 m/century, similar to the simplified model.
http://www.thedailybeast.com/articles/2015/07/20/climate-seer-james-hansen-issues-his-direst-forecast-yet.html?utm_content=buffer1b0f4&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer
"James Hansen's new study explodes conventional goals of climate diplomacy and warns of 10 feet of sea level rise before 2100. The good news is, we can fix it."
It is not in contradiction with 10 feet in 50 years, as in the next 25 years an effect is also that the melting water cools the ocean temporary, and melting of Antarctica is a delayed effect. … *"CO2 as a climate control knob".*
http://www.atmos-chem-phys.net/16/3761/2016/ --- with 19 authors ---
Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming could be dangerous
James Hansen1, et al. Received: 11 Jun 2015 – Discussion started: 23 Jul 2015
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http://www.atmos-chem-phys.net/16/3761/2016/acp-16-3761-2016.pdf
"A sea level rise of 5m in a century is about the most extreme in the paleo-record (Fairbanks, 1989; Deschamps et al., 2012), but the assumed 21st century climate forcing is also more rapidly growing than any known natural forcing." so the worst case of 6m/century is not impossible if CO2 and CH4 emission control is neglected.

To conclude with some Latin: "Luctor et Emergo" the coat of arms of Zeeland, "I struggle and I emerge": it will be applicable for much larger parts of the world, we have to turn the CO2 knob seriously down as an urgent priority, among the solutions: the ultra-light electric vehicles, less gas leaks, much less energy consumption.