

Understanding Global Warming

Global warming calls for ingenuity, innovation and entrepreneurship. In order to attract venture capital, it is necessary to understand the task, its opportunities and risks. With an extent from the Arctic Ocean to the Baltic Sea, there are in the Kingdom of Denmark special interests and opportunities to examine the ongoing changes.

We also have qualified researchers for the job. One of them is Ole Humlum a Danish professor emeritus of physical geography at the University of Oslo, Department of Geosciences and adjunct professor of physical geography at the University Center in Svalbard. His academic focus includes glacial and periglacial geomorphology and climatology. He is an active communicator of climate data.

Greenland

O. Humlum et al. / Global and Planetary Change 79 (2011) 145–156

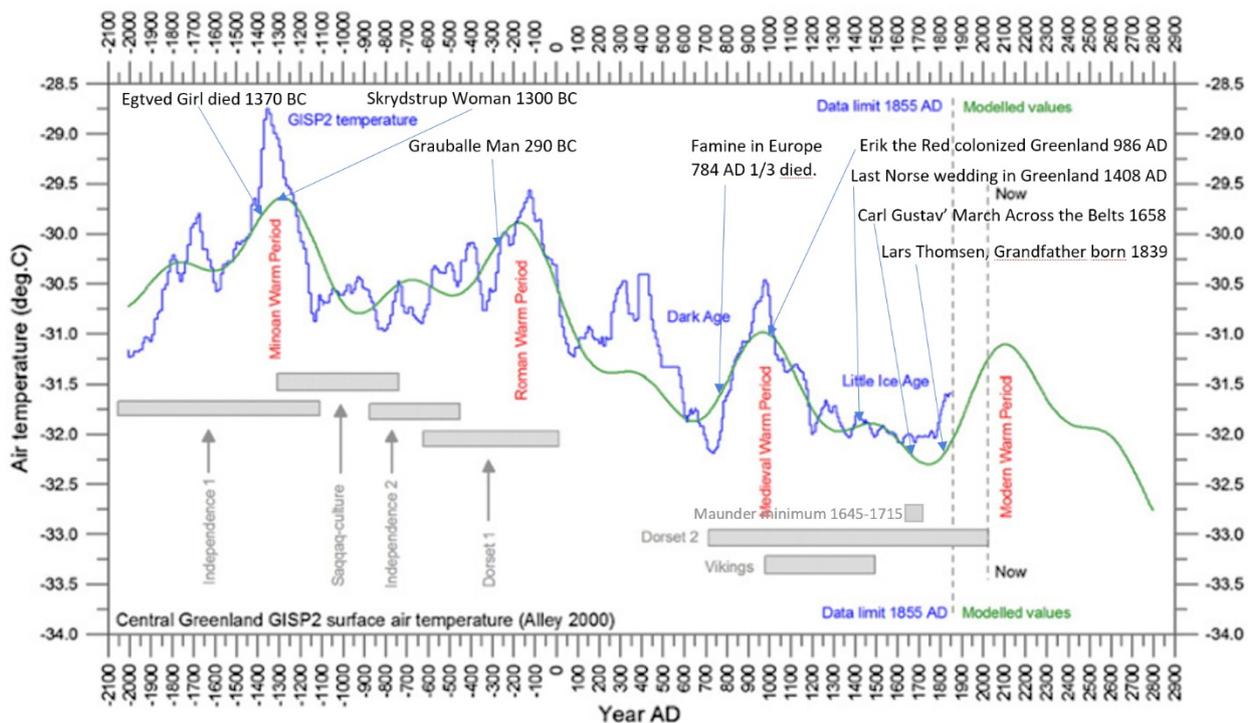


Figure 1. The green curve models the cyclic factors found. The superimposed historical events help to recognize the time axis.

Thanks to Danish Willi Dansgaard, we know a lot about the climate of the past. He was the first paleoclimatologist to demonstrate that measurements of the trace isotopes oxygen-18 and deuterium in accumulated glacier ice could be used as an indicator of past climate and he was the first scientist to extract



Understanding Global Warming

paleoclimatic information from the Greenlandic Camp Century ice core. In 1974, Willi Dansgaard predicted that the post-war declining temperatures would soon reach a valley followed by a short-term warming.

Thanks to Ole Humlum, who succeeded Willi Dansgaard at the Disco station, we know a lot about the cyclical factors that affected the globe in the past. Together with Jan-Erik Solheim and Kjell Stordahl, he published the article "*Identifying natural contributions to late Holocene climate change*" in *Global and Planetary Change* in 2011. Figure 1 is taken from this article.

Thanks to Henrik Svensmark, we know the natural forcing, which in particular has given rise to the cyclical changes shown. He is a Danish physicist and professor in the Division of Solar System Physics at the Danish National Space Institute in Copenhagen. He has shown the effects of cosmic rays on cloud formation as an indirect cause of global warming.

Jutland, Southern Denmark

England - once part of our North Sea Empire - now a neighbor 300 nautical miles to the west, from where we get most of our weather. This is significant because here close to us, instrumental temperatures are dating back to the middle of the 500-year cool period referred to as The Little Ice Age.

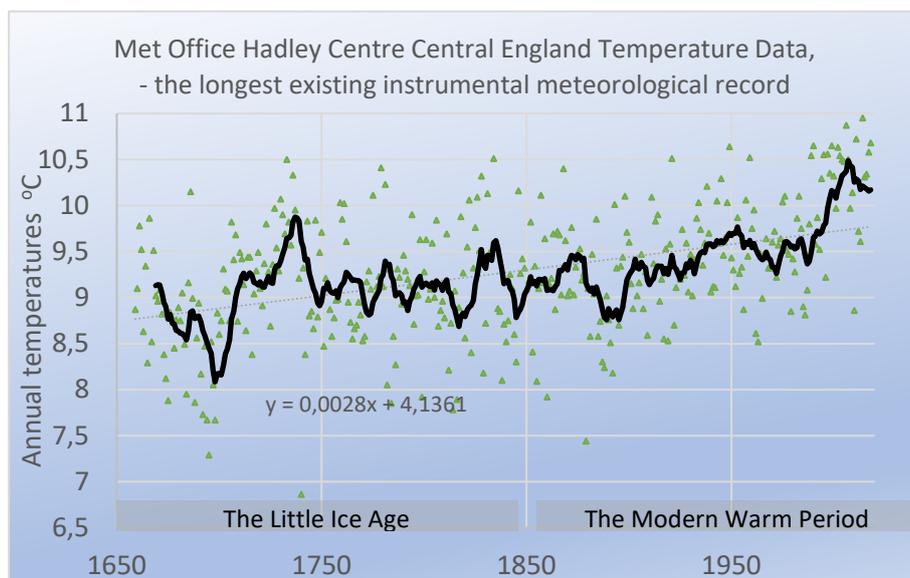


Figure 2. The average temperature in Denmark has developed in parallel to the Hadley data – only 1½-2 degrees colder.

The graph clearly shows how we gradually came out of the cold and into the Modern Warm Period. From the oldest measurement in 1659 and up to now, a trend of 0.28 °C per 100 years can be read. We also must go back to 1700 to find a faster and longer-lasting rise than the one we have just experienced (the one predicted by Willi Dansgaard).

In Jutland, the temperature range goes back to 1803 and it follows Hadley quite closely, but one to two degrees lower because we are a bit to the north.

Port of Aarhus

The sea water expands with warm weather. DTU Space, the Technical University of Denmark analyses sea level data from satellites in space and measuring stations on land. Since 1993 satellite radar altimeters have provided uninterrupted estimates of global mean sea level with a trend of 3,1 mm/year. It requires intensive calibration and data processing to measure that exactly from a mobile measuring station - Jason-3 is orbiting at 1336 km altitude. However, for the coastal population, classical water level measurements are still most

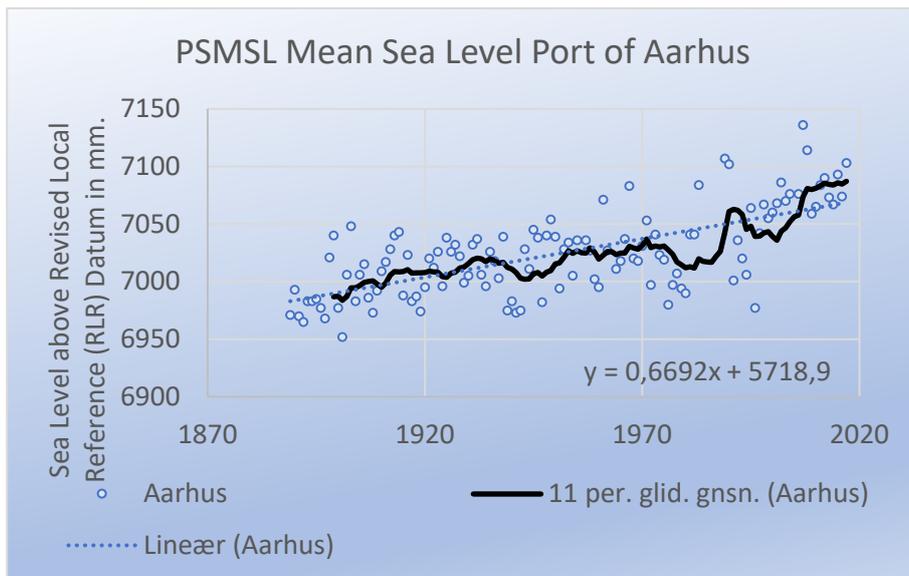


Figure 3. In Aarhus sea level data goes back to 1889 with a rising trend of 6,7 cm per 100 years. SONEL has no GPS position times series for Aarhus, but for nearby Esbjerg SONEL reports a Velocity (mm/yr.): -1.17 +/- 0.48 for station ESBH at the water front and a Velocity (mm/yr.): 0.72 +/- 0.49 (land uplift) for station ESBC 3,8 km away.

important. Data from tide gauges all over the world suggest an average global sea-level rise of 1–1.5 mm/year. For the Port of Aarhus, the Permanent Service for Mean Sea Level (PSMSL) reports figures with a rising trend of 6,7 cm per 100 years (Fig. 3).

In Greenland, the warmer weather melts more snow than falls - but not in the past two years, 2017-2018.

Consequently, Aarhus is preparing for extreme sea rises, even though they have not yet appeared.

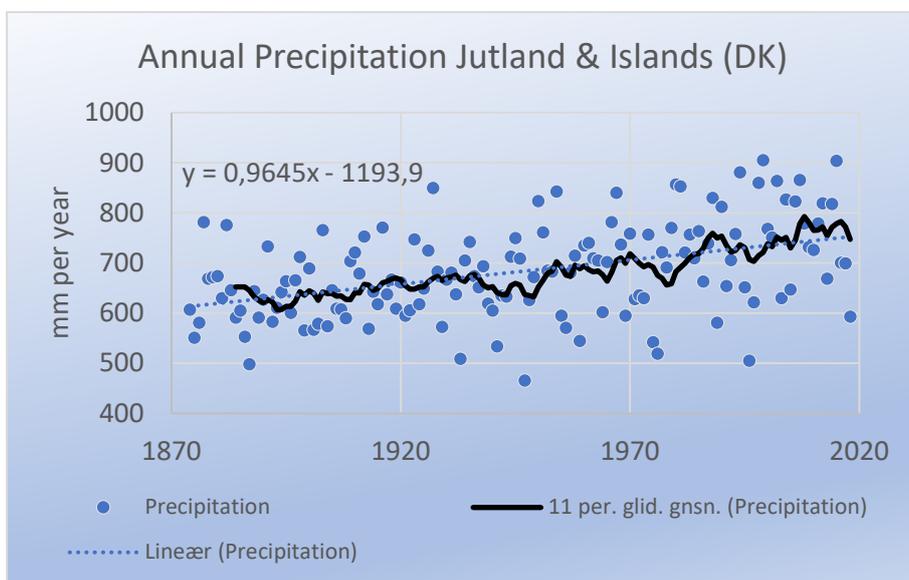


Figure 4. Precipitation is recorded in Denmark since 1874.

Precipitation in Southern Denmark

In Jutland and the islands, we get approx. 100 mm more rainfall a year than a hundred years ago.

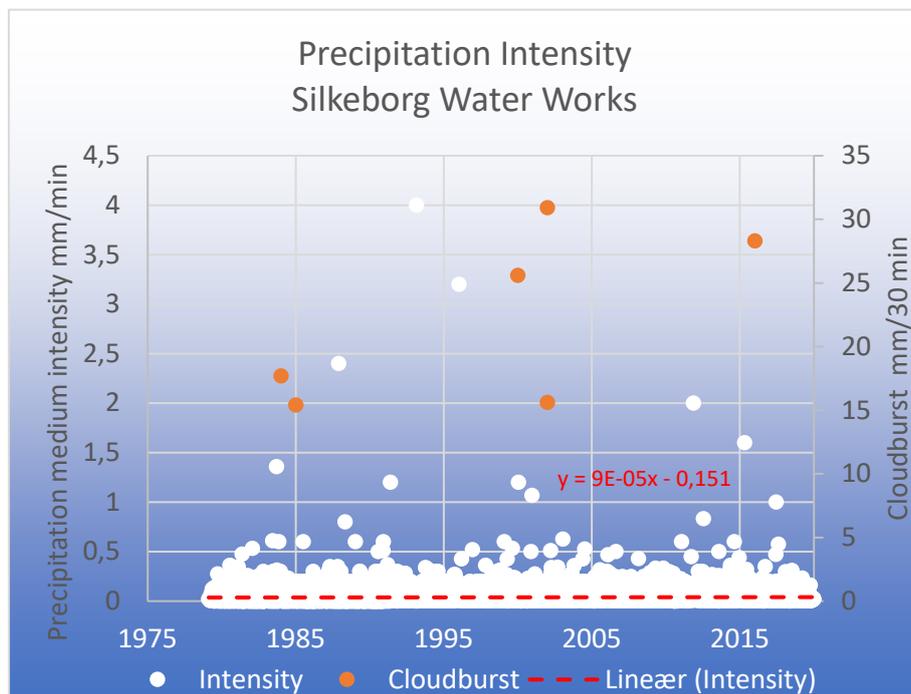
What interests the authorities and farmers the most is the intensity.

Precipitation intensity is measured on several automatic meters located around Denmark. The network is called the Waste

Water Committee's Rain Meter System (SVK) and there are measurements from 1979 to today. The number of meters has varied over the years. By the end of 2010, the number is 129 meters. The resolution of the measurement is 1 minute. Precipitation per unit of time is called intensity. The committee has investigated



whether significant changes have occurred in the intensity and volume of extreme rainfall events. The report concludes that there are almost as many stations with upward trends and with downward trends.



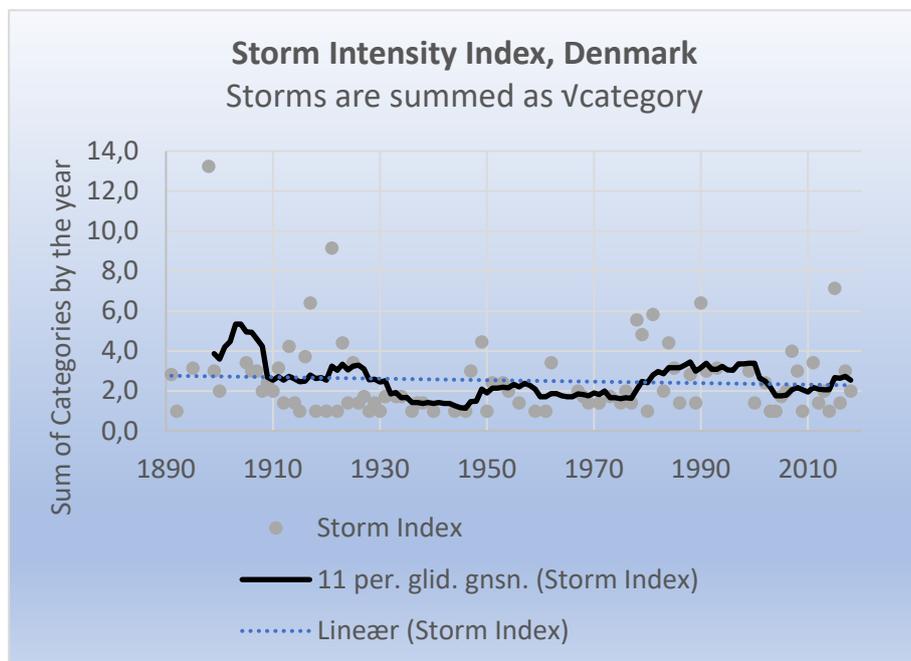
Silkeborg Water Works

Precipitation intensity for one of the stations – the one in Silkeborg – is plotted and for this station no upward or downward trend is found.

Only 6 cloudbursts have been recorded for the 40 years of operation.

Silkeborg is preparing for extreme weather, but it has not yet arrived.

Figure 5. For 11.000 datasets – each representing a rain shower – the medium intensities are plotted. For 40 years only 6 cloudbursts of more than 15 mm in 30 minutes are recorded.



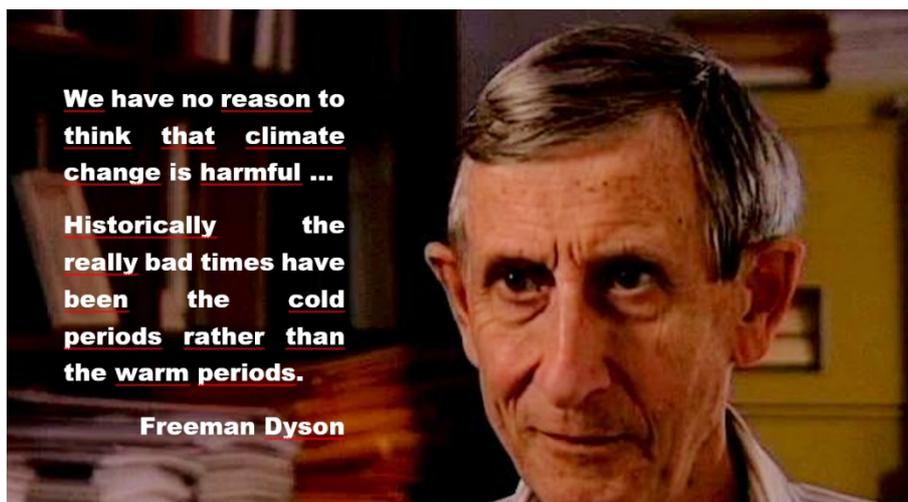
The Danish Storms.

Inspired by The Accumulated Cyclone Energy (ACE) index of tropical cyclone activity the Danish Storm List is indexed. In the absence of max wind speed and duration, the storms category has been used. By counting them as the square root of their category, stronger storms will come to their right.

Since 1891 only 13 strong storms/hurricanes category 4 (> 28,5 m/s) have been recorded.

In the past more than a hundred years, there is no trend towards more frequent or more severe storms.

Figure 6. The Danish Storm List records all storm by their category (1-4) since 1891. For each year the numbers are summed as the squared roots of their category. Thus, a strong storm in category four is counted as two storms, category 3 as 1.7 and category 2 as 1.4 storms.



IPCC

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations. The IPCC does not carry out original research, nor does it monitor climate or related phenomena itself. Rather, it assesses published literature. The IPCC is pretty well aware of the difficulty of predicting the climate. This is stated in the Executive Summary of the Third Assessment Report

Figure 7. Freeman Dyson finds the climate too complicated for it to be modeled

(TAR): "The climate system is a coupled non-linear chaotic system, and therefore the long-term prediction of future climate states is not possible". The IPCC, however, feels the challenges of understanding the Earth's system so daunting, that these challenges simply have to be met - Exitus acta probat.

Freeman Dyson

The IPCC has the largest collection of weather data and we look at the same data as the IPCC and see the same. We cannot look into the future, but the IPCC makes nevertheless an attempt using mathematical models. This can – acc. to Freeman Dyson - be the reason why extreme weather is not arriving as predicted.

Freeman Dyson, born 1923 a theoretical physicist and mathematician, now a professor emeritus in Princeton. He became very close to Niels Bohr and to Albert Einstein - they worked in the same building in Princeton for many years. His friend Syukuro Manabe - also Princeton - was the first to use climate models to investigate the impact of carbon dioxide in the atmosphere. He [S. Manabe] always said and still says, that models are excellent tools for understanding climate, but very bad tools for predicting climate. They are models only having a few of the factors in them and Freeman Dyson finds the climate far more complicated than the models. He sees the beneficial aspects of carbon dioxide on plant life and agriculture. He raises the question of the most desirable amount of carbon dioxide in the atmosphere and what to do the day we reach an undesirable level.

Against the Mainstream

Freeman Dyson's issue is not with the reality of climate change or greenhouse gases as a contributing cause. It is the extensive use of models he opposes and their absence of significant natural forcing. Many Scandinavian researchers and thinkers share his view. Bjørn Lomborg, President of Copenhagen Consensus Center campaigns against measures to cut carbon emissions in the short-term and argues for adaptation to short-term temperature rises, and for spending money on research and development for longer-term environmental solutions. March 12, 2019 the Danish geologist, prof. em. dr. Johannes Krüger, University of Copenhagen wrote the Danish Prime Minister, Lars Løkke Rasmussen an extensive letter concluding "We can and should do something about the environment, but climate is controlled by nature". The letter is translated and published in English and Dutch. Subsequently, the letter has been translated into Norwegian and – with



Understanding Global Warming

slight amendments – addressed to the Norwegian Prime Minister, Erna Solberg, together with signatures of 20 Norwegian scientists. Johannes Krüger, Ole Humlum and Henrik Svensmark are representatives of a diverse and credible Scandinavian research environment that one must lend ear if you want to understand global warming.



George Olah

George Andrew Olah was awarded a Nobel Prize in Chemistry in 1994 and in 2011, he accepted our invitation as an honorary member of the Danish Methanol Association. He died at his home in Beverly Hills on March 8 2017 but the association still honors him and his visions.

From the association's foundation in 2011, the introduction of methanol economy has been our key

issue - and in Denmark, of course, as biomethanol. Introduction of precisely biofuels is encouraged by the IPCC. For the benefit of our members, we try to understand global warming and the public reaction. We see the benefits of a methanol economy regardless of climate and for whatever reason. Whatever, biomethanol will be an attractive solution to our waste problems in agriculture and to the intermediate storage of our rapidly growing wind power.

Understanding Global Warming is an ongoing process. The present document is dated May 20, 2019.



Addendum

Freeman Dyson raised the question of the most desirable amount of carbon dioxide in the atmosphere and what to do the day we reach an undesirable level.

Beneficial level of carbon dioxide in the atmosphere.

NASA has shown the greening effect of the present CO₂ concentration, but at which concentration will the beneficial effect cease? Most plants generally benefit from the “CO₂ fertilization effect”, which boosts growth and yield. Tests showed that the optimal CO₂ concentrations occurred at 1.000-2.000 ppm CO₂ dependent species. That level will acc. to IPCC worst case (RCP8.5) be reached in 100-200 years from now.

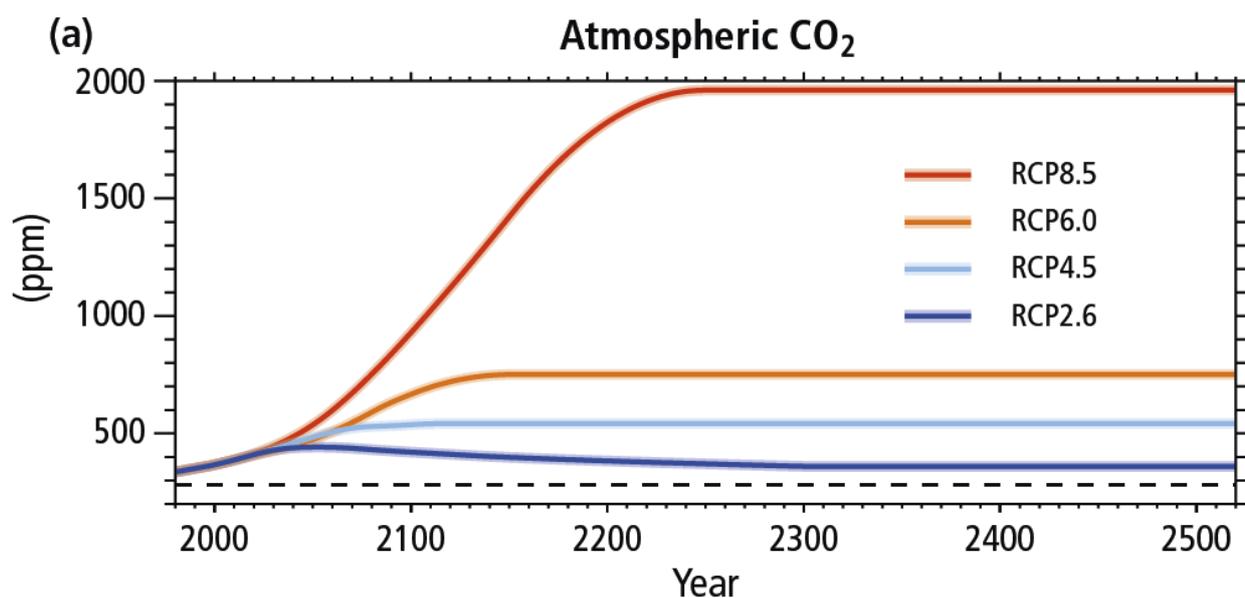


Figure 1. These graphs from the Intergovernmental Panel on Climate Change show projected concentrations of CO₂. In the IPCC's most pessimistic scenario, where the population booms, technology stagnates, and emissions keep rising, the atmosphere gets to a startling 2,000 ppm by about 2250. A Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC for its fifth Assessment Report (AR5) in 2014.

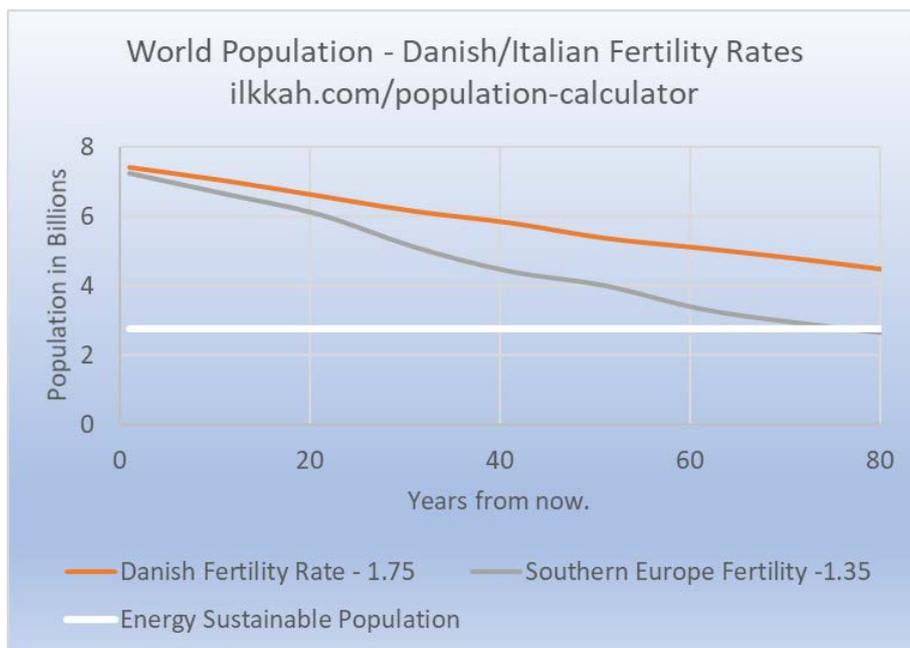
Means to control carbon dioxide concentration in the atmosphere.

Emissions of carbon dioxide from fossil fuels are currently well over 30 Gigatons per year. Almost half remain in the atmosphere for quite some time. Humanity can choose one or more ways to control the carbon dioxide concentration:

Carbon Capture and Storage (CCS). Capturing CO₂ from flue gas or direct from air and storing it physically underground or better as carbonate is possible but energy intensive.

Renewable Energy. Using solar energy as photovoltaic, heat (steam) or wind power etc. is ongoing. In Denmark the total annual energy consumption per inhabitant is 111 GJ and 34% is renewable.

Nuclear Power. Nuclear energy now provides about 11% of the world's electricity from about 450 power reactors. The OECD International Energy Agency and The World Nuclear Association has put forward an ambitious scenario to provide 25% by 2050.



Fertility Rate. Most affordable, however, will be to reach sustainability by closing the gap between needs and capability. Could the Danish birth rate (1.75) gain ground worldwide, sustainability will be achieved long before CO₂ concentration becomes undesirable. With a Southern European fertility rate (1.35), goals can be achieved before the turn of the millennium. This will at the same time solve other environmental problems.

Figure 2. Assuming Denmark's production of renewable energy as a realistic target for the world as a whole, the white line indicates a realistic size of a sustainable world population

Overall Considerations

IPCC performs excellent work and their studies and conclusions are supported by governments in all Member States. Several scientific bodies have issued official statements endorsing the findings of the IPCC. However, there are doubts. It may be because predictions are based on climate modeling, that the weather does not change significantly and not to the worse and that scientific objections are ignored. In addition, the Modern Warm Period is a good that does not make sense to change, even if we could. On the contrary, it moves attention from significant issues that we can do something about.