THE BIG MELTING RECORD

THAT DID NOT SHAKE THE WORLD...

By Rolf Schuttenhelm, climate science journalist for Bitsofscience.org

This commentary on September 2012 sea ice conditions in the Arctic Ocean is dedicated to Dutch Quaternary Geologist (ret.) Dr R.T.E. (Ruud) Schüttenhelm, who showed me the buzzards in the sky, the plants between the grass, the rocks in the wall and minerals in the rocks, the footsteps of previous generations everywhere around us, and how always there is so much more to see when simply you keep your eyes open – and who is the best dad I could have, not only as an Earth science communicator, but for a multitude of other reasons.

It is the intention of this commentary to help raise awareness about current events in the Arctic Ocean in order to preserve this pristine landscape that has such great importance to system Earth.
Do you recall the big Arctic melting records of 2005 and 2007? Probably you do.

Scientists had noticed the Arctic ice was on a declining trend and predicted this would continue under expected climate change. But no one expected the ice to respond that fast. In September 2005 to everyone’s surprise suddenly 23 percent of the normal summer ice was gone – and in September 2007 ice extent was even 37 percent below normal.

Scientists were shocked – and journalists reported the events in all of the world’s media – so the news reached you and millions of others...

What has happened to the ice in subsequent Arctic summers has received less media attention. That is perhaps understandable. The sea ice minima have all been very low, but from 2008 onwards none have been able to breach the record – although in 2011 that was down to satellite resolution and the margins were exceptionally small.

The new Arctic record: almost half the summer sea ice gone

This year the margins are massive as once more something extraordinary is happening in the Arctic Ocean: rapid, massive summer sea ice melting. Already hundreds of thousands of square kilometers of extra open Arctic Ocean separate the current sea ice conditions from those during the ‘old’ record, of 2007.

According to the US National Snow and Ice Data Center (NSIDC) on September 5 the total Arctic sea ice area was for the first time since satellite measurements began smaller than 4 million square kilometers, 45 percent smaller than ‘it should’ be by this time of year [based on climate average of 1979-2000]. It literally means almost half the ice that is supposed to be there in summer is gone – and it is an exact doubling of the world-shocking melting event of September 2005.
This year’s melting season is not yet over. The day-to-day graph shows [image above is daily NSIDC update September 11, 2012] some stagnation, but it is still likely the ice extent of 2012 will dip a little further before the actual summer ice minimum of 2012 is reached and a [for the time being] definite new record is set.

Official alarm bell due to sound later this month

We can expect an official release from the NSIDC with the official figures after the Arctic sea ice has had its first 5 full days of net growth.

But will the official Arctic record-breaking release – probably the single loudest alarm bell Earth’s climate system has at hand – impact the media and the wider world as the ice minima of 5 and 7 years back? If you think not we are likeminded – and perhaps you too wonder what it is in us humans that makes us so oddly incapable of grasping slow-running trends.

Personally I then suddenly feel confronted with a bigger fear – that nothing can ever shock us enough to get into action – to force a trend breach – and that we humans are collectively over-confident, totally ignoring the clear and present signs of our own incompetence.

No, I’m not talking about present-day climate skeptics and the failure of the UNFCCC route to come up with any meaningful international climate policy. I’m talking about a near double-century of apathy...
190 years of climate wisdom – and just as many years of ignorance

When it comes to assessing the reality of climate change and distinguishing a warming trend, there are two things: theory and observation. All those who were surprised [not to be confused with shocked] when confronted with the outcome of the 2011 all-encompassing Berkeley temperature study BEST, which showed global land temperatures have clearly risen since 1955 (by almost 1 degree Celsius), should perhaps do good to realise that they’ve been ignoring scientific understanding which dates back to the 19th century – namely the heat absorbing properties of CO2 (essentially defining it as a greenhouse gas) which were discovered thanks to experiments by French physicist Joseph Fourier (onwards from 1822), Irish physicist John Tyndall (in 1863) – and Swedish physicist Svante Arrhenius (in 1896).*

[*] For further reading about the history of discoveries concerning the CO2-climate link, please go the special appendix at the end of this article.

It is safe to say that we (should) have known about the basics for over a century, and as CO2 absorbs heat and Earth is constantly trying to radiate heat away to space – the probable temperature effect of having an ever thicker blanket of atmospheric CO2 around Earth is really not that difficult to imagine...

[To back up the physics paleoclimatologists can show that Earth’s ancient warm periods almost always coincide with high carbon (as CO2 or CO2 and methane) atmospheres – at least showing temperature and CO2 are positively correlated. At NASA [those guys were actually clever enough to put a man on the moon even before the digital age] they make it clear that – although our planet’s atmosphere, oceans and biosphere are indeed all part of one big interconnected feedback loop – clouds and water vapour are just responders that cannot change the direction of the process – and it is CO2 [and of course other increasing greenhouse gases] that is the actual driver of climate warming.]

Then as we are on a slowly accelerating rise in atmospheric CO2 concentrations from a preindustrial level of 280 parts per million (per volume) somewhere around 1850 to 350 in 1988 to 394 ppm* in 2012 – no one should have been surprised** that there is already a measurable temperature effect.

[*) Seasonally adjusted value – spring value at Mauna Lao was already at 397 ppm CO2 and local Arctic station noted 400 ppm for the first time. At an annual rise of just over 2 ppm an average value of 394 ppm means – including other greenhouse gases – we are just a few years away from passing the official UN climate target of staying below 450 ppm CO2 equivalents.]

[**] Although indeed, from a strictly scientific perspective, it is always ‘nice’ the see your theoretical reasoning being backed up by actual field data – especially considering since BEST we now have a single data set, closely scrutinised for any thinkable bias, that comprises billions of temperature measurements spread out across all continents over several decades. It shows like nothing else that after well over a century it is now really time for mankind to recognise CO2 as an undeniable climate warming agent.]

**More recent possible climate awareness turning points**

‘We’ may have known about the ‘greenhouse properties’ of CO2 since 1822, there are a couple of suggested turning points when it comes to the awareness of climate change that lie much more in recent history.
Their relative impact probably depends on where you live. If it’s South East Asia and Australia you may recall the endless heat and massive wildfires of 1997 and 1998, the hottest year of the 20th century. In 2003 it was West Europe that saw a summer it hadn’t seen before, with continued heat waves, dried out nature and cropland, and an estimated 50,000 human casualties due to heat exhaustion. In 2010 the Russian summer heat was even worse, and a year later many people in the US saw temperatures rise like they had never risen before, to be repeated over much of 2012. Globally 2010 was (tied with 2005) the hottest year on record, but with another El Niño ahead that temperature record may well be broken soon.

Some say the big climate awareness turning point was Al Gore’s climate documentary An Inconvenient Truth of 2006, the release of the IPCC’s fourth assessment report in 2007 and the UNFCCC negotiations that again picked up in December that same year, with the big climate summit in Bali – coinciding with recognition by the Nobel Peace Prize committee for the importance of both Gore’s and the IPCC’s work as communicators of a matter of urgency for global stability.

Others say Gore’s message – essentially one directed at an American audience – would not have resonated if the US hadn’t suffered such damage with Katrina*, in 2005

[*] even though the damage by Katrina isn’t such a clear-cut example – the influence of global warming on Atlantic hurricanes is one of the more uncertain fields of climate impact research.

For me personally it was a different event. Climate change had been that slow inevitable trend from the school books just until September 2005 – the 21st to be precise. That’s when the NSIDC announced something big had been happening in the Arctic – a ‘staggering 23 percent’ seasonal ice loss, as you can read above. It was staggering at least to me – and I recall thinking ‘this, is wrong – this, we should not want – this, we will have to try to stop’ – as close to making a personal pledge as anyone reading a Saturday’s newspaper can probably get.

The Arctic canary has become a phoenix

Now we are 7 summers away from the big Arctic shocker of 2005 – and if the physical reality was our concern today we should feel shaken exactly twice as hard – as the Arctic again experiences record sea ice loss, and indeed exactly twice as much as in 2005.

Stating the current climate record is twice as large may not sound fair, as climate change and indeed Arctic warming act in a cumulative way, just like the atmospheric CO2 concentration keeps rising under elevated annual emissions – the 2012 melting record builds on that of 2005 and 2007.

But that is not what the Arctic ice extent graph shows us – quite surprisingly the seasonal melting is in fact twice as large. There seems to be a large discrepancy between sea ice conditions during the Arctic summer and during the Arctic winter. In summer there is a lot of melting, but as soon as the long polar night again sets in each year there seems to be almost equal recovery [in ice area – we are not discussing ice thickness here, although probably we should].

The ‘fixed’ spring melting starting point – is the ice loss just caused by seasonal variability??

The weird thing therefore is that summer melting kicks off at a seemingly fixed spot each spring. Just how small the ice area will get in summer therefore seems to simply depend on seasonal conditions – of that same summer.
So just how extraordinary is the summer melting, and for that matter, again, how shocked should we actually be?

The NSIDC graph helps us firstly to appreciate the magnitude of the summer melting records – as it shows (in gray) the statistical margin of 2 standard deviations from the climatic average of between 1979 and 2000. From that we can simply see all the big melting events were significant events. In fact, that entire graph area under the gray band should represent only 2.5 percent of summer [due to seasonal variability] – of which it would still be much more likely these events would lie considerably closer to the climate average.

This in itself answers what is the force behind recent summer melting events. There has to be an underlying trend – represented by another NSIDC graph below – the trend of climate change.

Note that this NSIDC graph does not present annual ice minima (which tend to occur in September) but August sea ice extent averages. The trend shows a 10.2 percent sea ice decline per decade.

**But what is going on in winter?**

In winter the story is a bit different. Although indeed the annual sea ice maxima (usually somewhere in March) are not fixed and here too signs of ice melting are visible (like the [2011 lowest winter ice maximum](#) – in 2012 remarkably, the [Arctic had a good winter](#), with near average sea ice extent[1]) NSIDC analysis shows many of these maxima are still within the 2SD range of the average – meaning they’re not to be called events of significant ice loss.
There are many reasons why this is the case. Firstly in winter the polar night casts a deep-black sky over the ice, meaning that all-important albedo feedback cannot amplify the climatic warming. Other research shows a thermal inversion forms over the ice surface in winter – which affects both winter ice formation and heat storage in the wider Arctic climate system, favouring a speedier onset of melting once the spring sun reappears.

But the most important reason is geographical. The Arctic Ocean is water bordered by land masses – and still small enough to completely freeze up, no matter if the winter is mild or strong. Whether the Arctic winter expands over the tundra and taiga of Canada and Siberia is irrelevant for sea ice conditions. Any variation in ice extent therefore solely depends on possible ice formation on the Pacific (Bering Sea) and Atlantic margins – where thanks to the Gulf Stream water temperatures have always been much higher – so sea ice variability is comparatively small.

From this we can conclude that if you want to monitor sea ice development in the Arctic, it is probably the best and easiest thing to keep comparing the September sea ice minima.

But perhaps indeed we would only be shocked once more if that event brought good news.
Appendix: A climate chronology of CO₂

- **1822/1824/1827**: ‘Discovery of the greenhouse effect’ by French mathematician and physicist Joseph Fourier. Considering the distance between the Earth and the Sun and the amount of incoming solar radiation Fourier reasoned Earth – like the Moon – should be considerably colder. To explain the temperature difference, according to Fourier, either radiation from outer space would offer additional energy to system Earth – or Earth’s atmosphere would have to act as an insulator, meaning it would contain greenhouse* gases. [*] The word greenhouse may have been coined due to earlier experiments cited by Fourier and carried out by French … Horace-Bénédict de Saussure, who found air contained in glass heats up when exposed to sunlight – which means air absorbs part of the energy that is transformed from visible light to infrared radiation. In case of Earth’s climate of course the greenhouse comparison is a bit flawed as there is no glass roof over our heads – instead the transition to infrared energy takes place at Earth’s surface, which fails to reflect all of the incoming solar radiation.

- **1863**: First correct measurements of the relative infrared absorptive powers of the most important atmospheric gases, including nitrogen, oxygen, water vapour, ozone, methane and CO₂, by Irish physicist John Tyndall. Using his measurements Tyndall was the first to be able to correctly explain the average temperatures of Earth’s climate – concluding water vapour was the most important atmospheric heat absorber, and that absorption by the other greenhouse gases [like CO₂] was comparatively small, but not negligible.

- **1896**: First prediction of global climate warming as a result of rising atmospheric CO₂ concentration due to the combustion of (fossil) fuels, by Swedish physicist Svante Arrhenius. Arrhenius devised a formula for radiative forcing of a rise in atmospheric CO₂ concentrations, expressed in Watts per square meter, which is still used today. In his calculations Arrhenius even included water vapour feedbacks and latitudinal heat transportation. He did not yet foresee cloud feedbacks and air convection changes.

- **1958-61**: First measured evidence that atmospheric CO₂ concentrations were [indeed, as theorised] rising, by American geochemist Charles Keeling. Keeling was the first to device an instrument to measure precise amounts of CO₂ in atmospheric air samples. Working for the Scripps Institution of Oceanography Keeling established the now famous CO₂ measuring station on Mauna Loa in Hawaii, a spot relatively unaffected by seasonal fluctuations and proximity of industrial CO₂ sources. In his honour the atmospheric CO₂ concentrations graph that shows the cumulative rise of this greenhouse gas is called the ‘Keeling Curve’. Keeling showed in 1958 CO₂ concentrations were at 315 ppm.

- **1988**: Climatology knocks on politics’ door, with lead climate researcher of NASA James Hansen’s testimony before the US Congress. NASA’s Goddard Institute for Space Studies (GISS) had first (in 1985) shown world average temperature over the last one hundred years had risen by between 0.5 and 0.7 degrees Celsius. By the time of the Congressional testimony 4 of the hottest years ever measured had fallen in the 1980s, including then record hottest year 1988. Hansen showed the politicians GISS model projection which stated that the global climate would keep getting warmer if atmospheric greenhouse gas
concentration would keep rising. Also in 1988 the atmosphere broke through the 350 ppm CO2 threshold – a level Hansen and others today refer to as the upper safe limit to prevent (long-term) dangerous climate consequences.

• 1997: The world agrees on the Kyoto Protocol, a framework for international greenhouse gas reducing policies intended to prevent dangerous climate change.

• 2009: During the UN climate summit in Copenhagen the world fails to agree on a first international climate treaty with binding emission reduction targets for the year 2020. This in spite of the fact that in 2007 the UN’s own climate research panel IPCC had assessed that industrialised nations would all have to limit their greenhouse gas emissions by 25-40 percent between 1990 and 2020, in order to maintain a 50 percent chance of limiting average climatic warming to no more than 2 degrees Celsius – the officially agreed international climate target of that same year.

• 2012: Seasonally adjusted average atmospheric CO2 concentration has risen to 394 ppm. At an annual growth of just over 2 ppm per year, by 2015 the 400 ppm threshold will be passed. Since other greenhouse gases, like methane and nitrous oxide, contribute an additional ~50 ppm in CO2 equivalents – around that same year the official UN climate target of stabilising atmospheric greenhouse gases at no more than 450 ppm CO2 equivalents will also be reached, [under the present trend] even before any significant slowdown in the rise of the atmospheric CO2 concentration has been accomplished by the international community.
The Scripps Institution for Oceanography’s ongoing CO2 Program offers different ‘Keeling Curves’ for atmospheric CO2 concentrations. This is the unadjusted version produced by the famous measuring station on Mauna Loa, Hawaii – which shows seasonal fluctuation due to the fact that most land lies on the northern hemisphere, which biosphere inhales extra CO2 during the growing season, and exhales CO2 in winter due to dead biomass degradation. The trendline through the seasonal fluctuation shows the actual atmospheric rise of CO2. In 2012 the average concentration lies around 394 parts per million per volume of air.

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