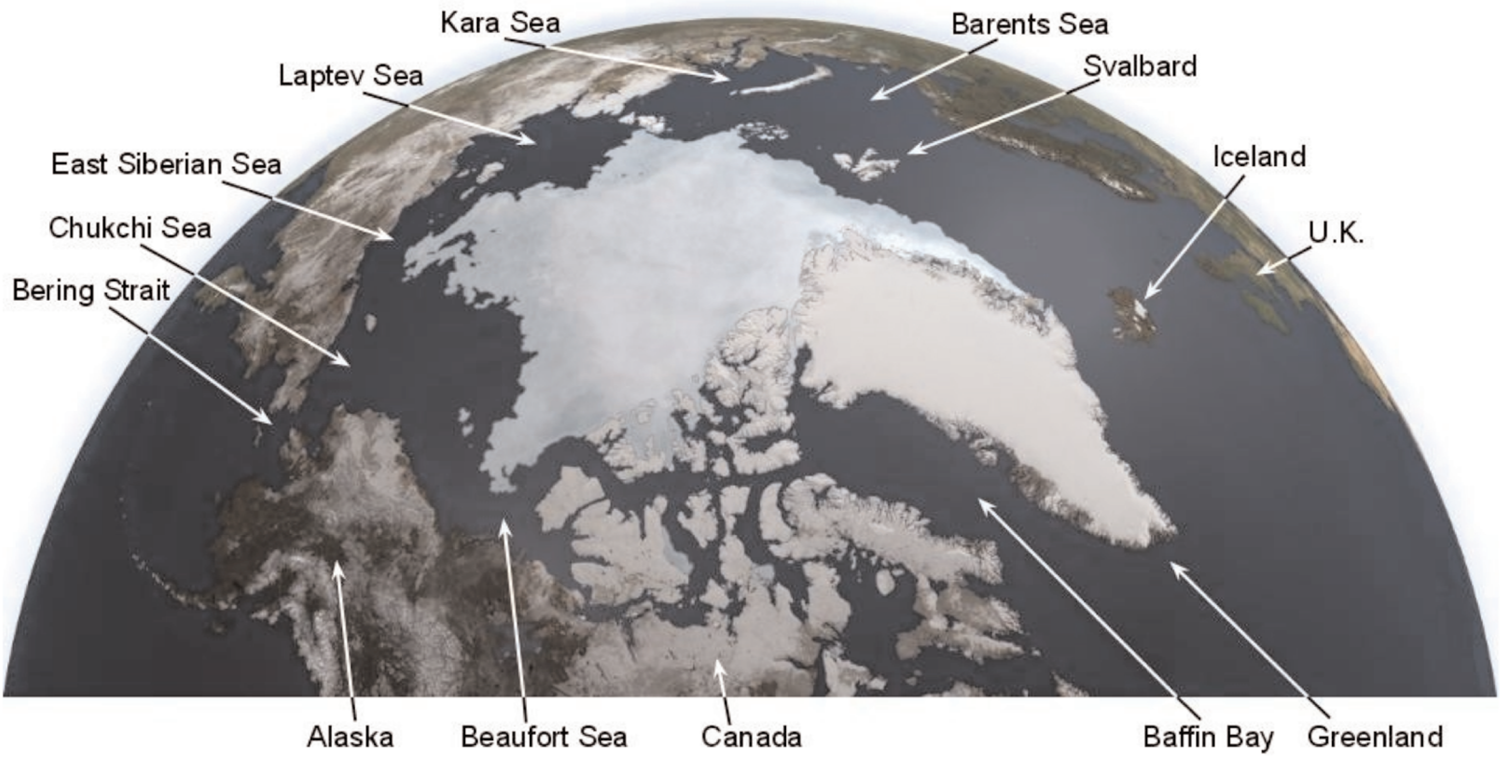
Arctic Methane Alert

Call for an urgent escalation of scientific inquiry and development of countermeasures



"Methane is an especially powerful greenhouse gas. There are large amounts of methane presently locked up, frozen, in high latitude tundra and, especially, in ocean sediments on continental shelves. We know from Earth's history that this frozen methane can be released suddenly by sufficient warming – thus this methane has the potential to greatly amplify humanmade global warming, if that warming reaches a level, a tipping point, such that large volumes of frozen methane begin to melt"

James Hansen

Club of Rome speech, Amsterdam, 2009

Arctic Methane Alert

has been written and produced by the
Arctic Methane Emergency Working Group

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The inaugural meeting of the group was held on Oct 15/16 2011 in Chiswick, London, and was attended by Prof. Wadhams, Prof. Salter, Prof. Jon Egill Kristjansson, Prof. Michel Halbwachs, Brian Orr, Jon Hughes, Richard Harley, Graham Ennis, Doly Garcia. Full details at www.arctic-methane-emergency-group.org. Other attendees, not AMEWG members or contributors, Andrew Lockley and Emily Lewis Brown.

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P8:Generic
P9: Nasa and ONAA
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More references and credits available at
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IPCC ASSESSMENT

This report has used as a starting point the conclusions made by the IPCC Fourth Assessment Report, 2007, and subsequent updating in the Copenhagen Diagnosis 2009, both of which addressed the risks posed from Arctic summer sea ice loss and methane carbon feedback.

Key sections include
[1] Risk of Catastrophic or Abrupt Change The possibility of abrupt climate change and/or abrupt changes in the earth system triggered by climate change, with potentially catastrophic consequences, cannot be ruled out. Positive feedback from warming may cause the release of carbon or methane from the terrestrial biosphere and oceans which would add to the mitigation required.

[2] In both polar regions, components of the terrestrial cryosphere and hydrology are increasingly being affected by climate change (very high confidence). These changes will have cascading effects on key regional bio-physical systems and cause global climatic feedbacks.

[3] Methane hydrates are stored on the seabed along continental margins where they are stabilised by high pressures and low temperatures, implying that ocean warming may cause hydrate instability and release of methane into the atmosphere. Methane is also stored in the soils in areas of permafrost and warming increases the likelihood of a positive feedback in the climate system via permafrost melting and the release of trapped methane into the atmosphere.

For full IPCC references please visit: www.arctic-methane-emergency-group.org

The authors also welcome the UNEP/WMO report calling for reductions in black soot emissions [4], which serve to disproportionately cause heating in the Arctic and so further threaten the collapse of sea ice and release of methane.

Arctic Methane Alert

OVERVIEW

"The Arctic atmospheric methane concentration today is the highest in 400,000 years"

Natalia Shakhova NSF video interview 2010

Until now, governments have been told that climate change is a long-term problem. They have been trying to do their best for their citizens by pursuing strategies for emissions reductions over decades, to prevent global warming exceeding a 'safe' limit. But the situation has dramatically changed. We now face a problem requiring emergency action, to stop the point of 'no return' being reached. The loss of Arctic sea-ice in September is now considered to be that point, as it will set off a chain reaction of events that cannot be halted.

The very rapid rise in greenhouse gases, and the near collapse of the protective cooling of the Arctic sea ice, is unprecedented in the past 2.5 million years. The last time there was explosive growth of methane, of the amount we are liable to encounter as the sea ice retreats, was in the PETM around 55 million years ago – the last major extinction event.

Warnings about the catastrophic impacts of a methane release from the Arctic have been circulating for many years. Former US Department Geologist John Atcheson wrote in 2004: "A temperature increase of merely a few degrees would cause these gases to volatilize and 'burp' into the atmosphere… Once triggered this cycle could result in runaway global warming, the likes of which even the most pessimistic doomsayers aren't talking about…" [1]

NASA scientist Jay Zwally said in 2007 the rate of collapse indicated an ice-free summer by 2012. The Copenhagen Diagnosis (2009) states: "Summer-time melting of Arctic sea-ice has accelerated far beyond the expectations of climate models." The PIOMAS findings confirm this acceleration and probability that collapse is now occurring at an exponential rather than linear rate, pointing to an Arctic ice-free during the summer being reached sooner (2013-18) rather than later (2100) (p5). The inevitability of an ice-free Arctic releasing vast quantities of methane is widely recognised, as stated by Nobel Laureate, Steven Chu [2].

Failure to make ready to counteract the Arctic methane threat would amount to a failure of duty of care that governments have for their citizens [3]:

"The Parties should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures."

It is against this background we urge you to read this report and consider its contents.

DR. IGOR SEMILETOV

Dr. Igor Semiletov, crew leader of a recently returned Arctic methane research expedition, was interviewed on Oct 20 in Vladivostok, Russia, by an associate of a U.S.-based documentary team. Here are some excerpts, released by kind permission of 590 Films (www.590films.org/methane.html)

Note: Dr semiletov was speaking as an individual and not reporting official findings.

Scale of emissions

"For sure **there was a sense of urgency in our preparation.** It was caused by the new data, which had been gathered during the past two years and not published yet. **This data presents plenty of reason to have concern.** In our article for Science magazine in 2010, we estimated the scale of methane emission from this region to be 8 million tons ...... But the more recent data shows that the emissions from the East Siberian Arctic Shelf (ESAS) are much bigger. **There are actually huge plumes of bubbles emitting from the sea bottom.** Using the equipment available on this voyage – four geophysical methods, seismic profiling on different frequencies, hydro-acoustics on three frequencies, we measured these fountains of bubbles and the methane concentration in the air .... That was highly precise measuring.

"We conducted 115 stationary checkpoints and discovered fields of fantastic scale – I think of a scale not seen before in the ocean. **Some fountains of methane were a kilometre and more in diameter. Emissions into the atmosphere were also 100 times higher than normal** – what would be considered sustainable – levels. Such emissions would unavoidably cause impacts on climate change – the only question concerns the scale, kinetics, and speed of the emissions."

Unprecedented warming

"The international climate community is now beginning to seriously examine this mechanism of rapid methane emissions as a possible cause of fast climate changes on the Earth. I agree with the opinion of most climate experts working in the Arctic. We see reduction of ice cover. It is obvious not only from satellites, but we also can see it directly while we are working there… In 2007, we were on a fairly small ship Victor Buinitzki and reached 82 degrees latitude, and the **surface temperature was plus 3°C (3°C above freezing). This is unprecedented warming, and it is a fact."**

Thaw feedback

"Such warming will have an unavoidable impact on hydrates, and we know how. When ice has gone, there are stronger winds and waves and a deeper mixing of water which causes the comparatively warm upper layer to mix with water at deeper levels. There are already studies which confirm that in some areas, bottom temperature in summer is 2 to 3 degrees above zero celsius (freezing). This means that **when we determine average temperature of the year, it is already somewhere close to zero degrees celsius (the freezing / thaw point).** And in some regions – for instance near the mouth of the great Siberian rivers like Lena, that warming can play a very serious role. As this warming spreads to a larger area, the more that shelf-based permafrost will thaw. The impact from global warming on hydrates will cause more winds and warming of surface waters. This will also interact with deeper waters and lead to the increasing of summer temperature to positive (above freezing)."

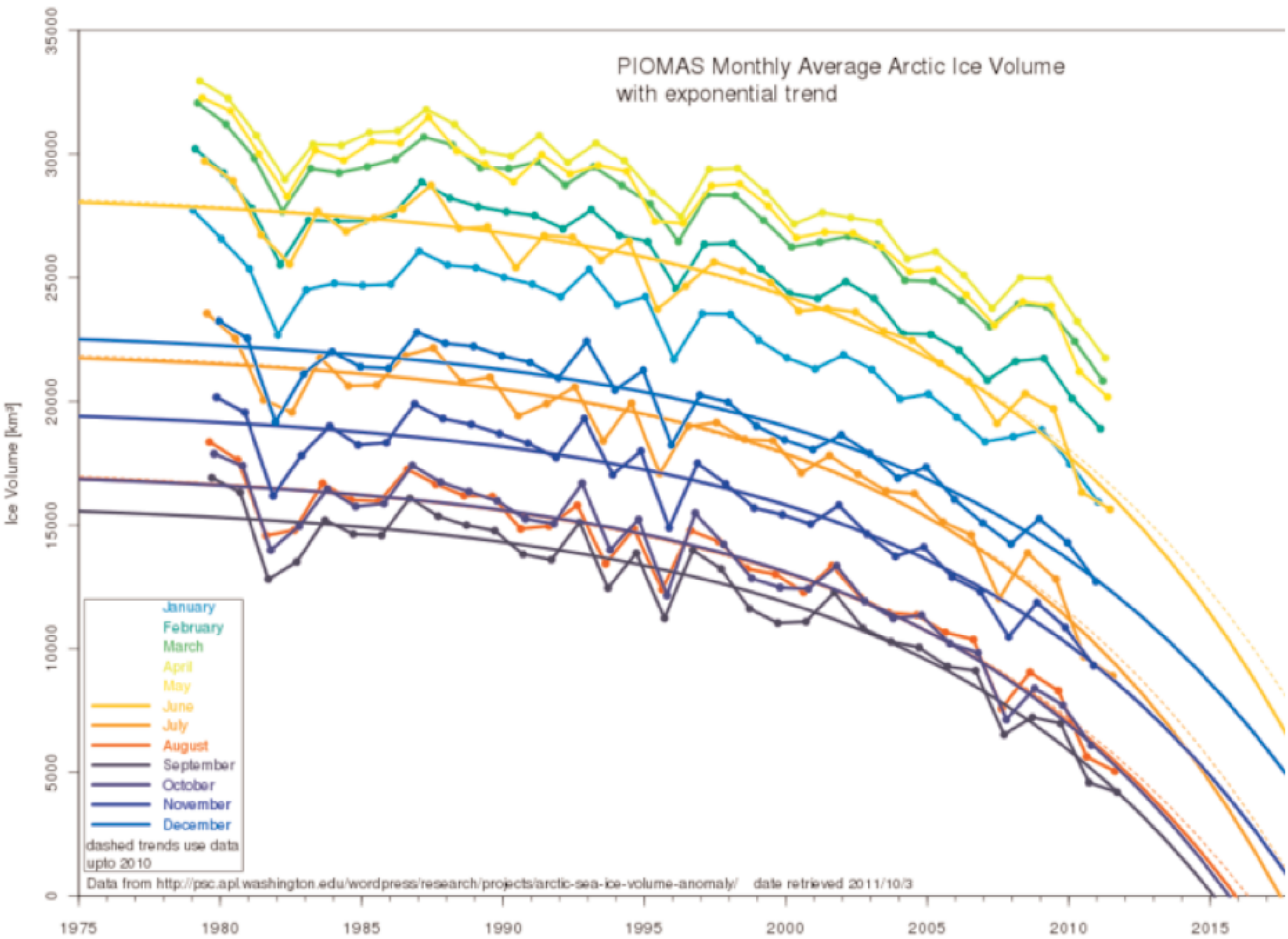
"The Arctic is often cited as the canary in the coalmine for climate warming. Now, as a sign of global warming, the canary has died. It is getting even worse than the climate models predicted"

Jay Zwally, Nasa

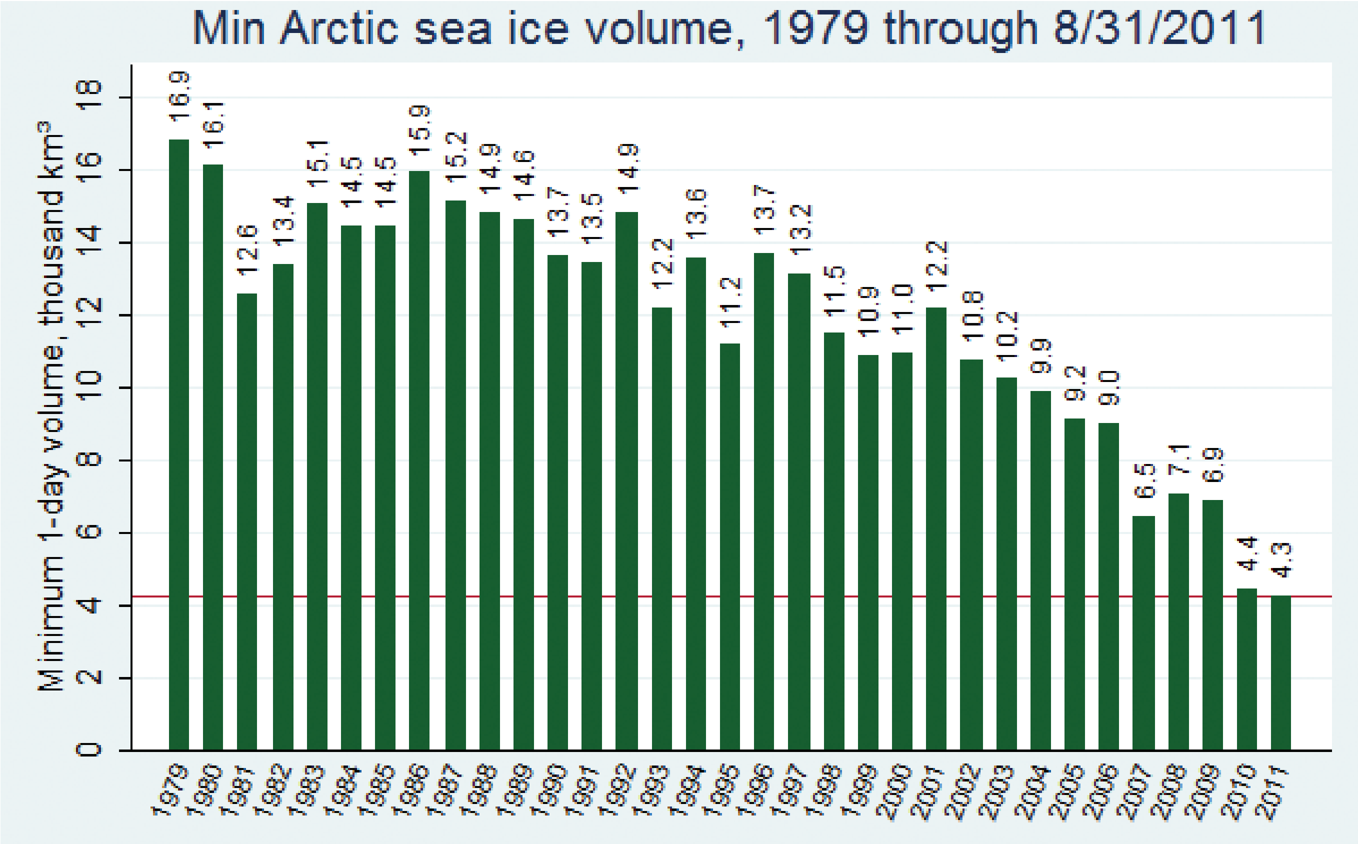
ICE LOSS

Over the past four years as more evidence has become available forecasts for the loss of Arctic summer sea ice (May-Oct) have changed dramatically, from 2100 (IPCC 4AR, 2007[1]), to 2060, (Copenhagen Diagnosis, 2009 [2], noting models had underestimated the speed of retreat by 40%), 'most likely 2030' (Arctic Roadmap, US DoD, 2011 [3]), to 2020 (Piomas, 2011 [4]). A clear signal that what has long been presumed by governments to be a 'long-term' issue is now an immediate 'near-term' issue.

This graph describes how much ice is being lost, and how much ice will be lost, based on



monthly readings taken by submarine and satellite [5]. It shows an exponential trend. Summer sea ice it predicts will disappear entirely within a few years, starting as early as September 2013, with a best guess at 2015. This conclusion has been endorsed by experts



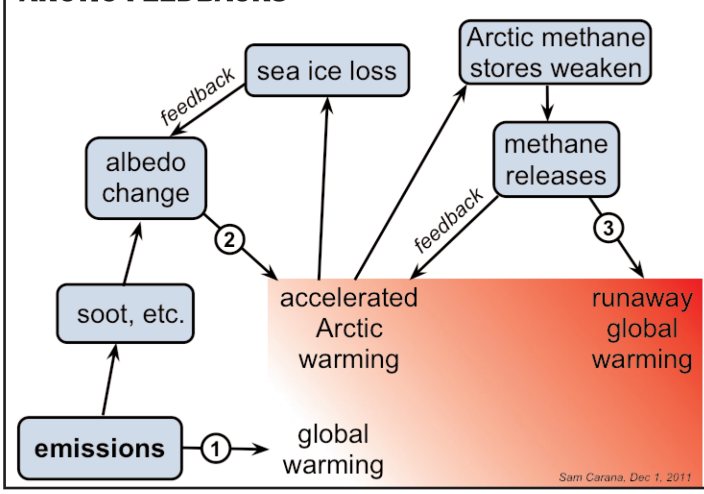
such as Peter Wadhams, Professor of Ocean Physics at Cambridge University, and Dr Wieslaw Maslowski, of American Naval Postgraduate School, who consider the first disappearance of sea ice in September to be the 'point of no return', as the following year all ice will be even more vulnerable 'new ice'[6].

It is also in line with warnings delivered by Nasa climatologist Jay Zwally in 2007, who then said the Arctic would be nearly ice-free at the end of summer by 2012, disappearing at rate of around 8-9% a year [7].

DECLINE AND FALL

In 2011 ice coverage in the Arctic reached an historic low of 4.24 million square kilometres (m km2). In October 2011, while sea ice extent increased rapidly as expected it showed a

ARCTIC FEEDBACKS



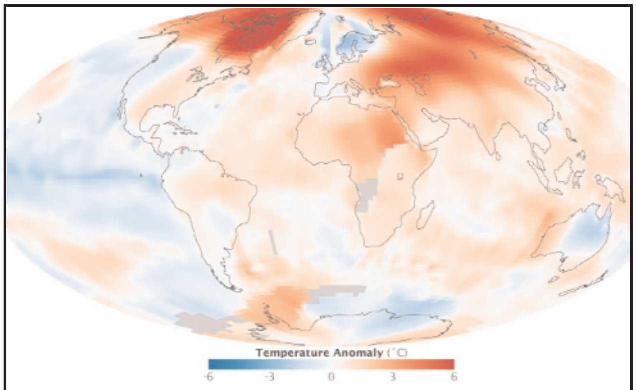
GHG emissions cause global warming (1). The global warming heats the Arctic, and the currents and rivers flowing into the Arctic. This causes sea ice to retreat. The warmer water thaws the undersea methane hydrates and permafrost, releasing methane, some of which is broken down to CO2 by microbes in the water, thus warming the water in a local feedback loop (2). Any methane not broken down or dissolved in the water, bubbles to the surface and into the air, where it is blown around the planet, producing a global warming effect, which further accelerates the Arctic warming and more methane release in a feedback loop – sufficient to cause runaway global warming (3) because of the vast quantities of methane involved.

long-term downward trend. Average ice extent for October 2011 was 7.10m km2 (2.74 million square miles), 2.19m km2 (846,000 square miles) below the 1979 to 2000 average [8].

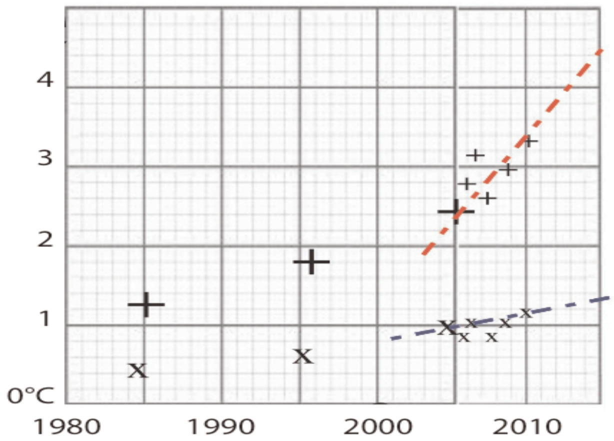
Age and volume of ice are key indicators of its increasing fragility. Young ice is more vulnerable to melting. Ice older than two years now accounts for less than 10% of ice cover, whereas for the period 1981-2000 older ice made up an average of 30%. Between late March and late July (2011) first-year (youngest) Arctic sea ice declined by 30%, multi-year ice has declined by 14%, and the oldest ice, or ice older than 5 years, has declined by 16% [9].

FASTER WARMING OVER THE ARCTIC

Arctic ice reflects 90% of the heat from the sun (solar energy) back into space. As the ice retreats 90% of that heat is absorbed by the ocean, which in turn causes more ice to melt, which causes more heat to be absorbed and so on, creating what is known as a positive feedback (see Arctic Feedbacks below) [10].

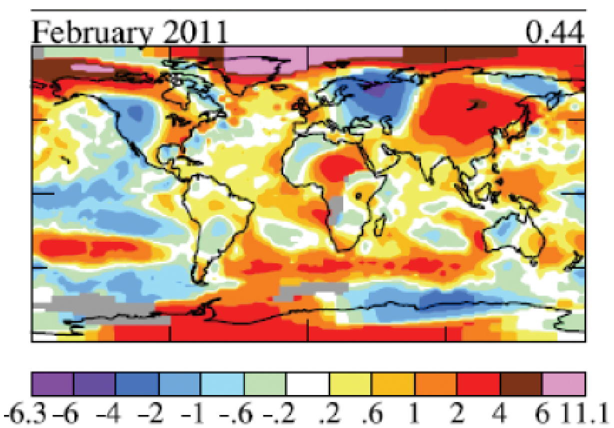


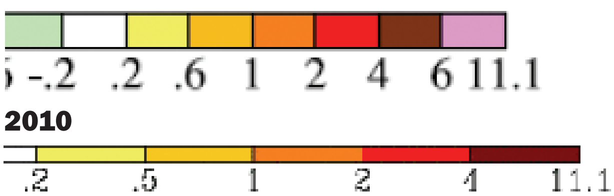
Temperature rises are more prominent in the Arctic. The projection above shows an average temperature rise in the Arctic set to reach 10°C (Nasa). Below, the red line shows how Arctic temperature is rising at an accelerated pace compared to global mean



This process is driving increases in Arctic temperatures, which are rising at a far greater rate than the global mean 0.7°C worldwide average. The temperature rise in the Arctic is at 3 to 4°C – four to five times greater than the global temperature rise [11]. The target of a 2°C global average implies 8° or 10°C in polar regions [12, 13].

The surrounding land areas in Greenland, Canada, Alaska, Russia and Norway are simultaneously affected – further driving local warming and causing temperatures to rise at a far faster pace than anywhere else in the world. These are the conditions it has long been predicted would cause global warming to runaway – to become self-generating.

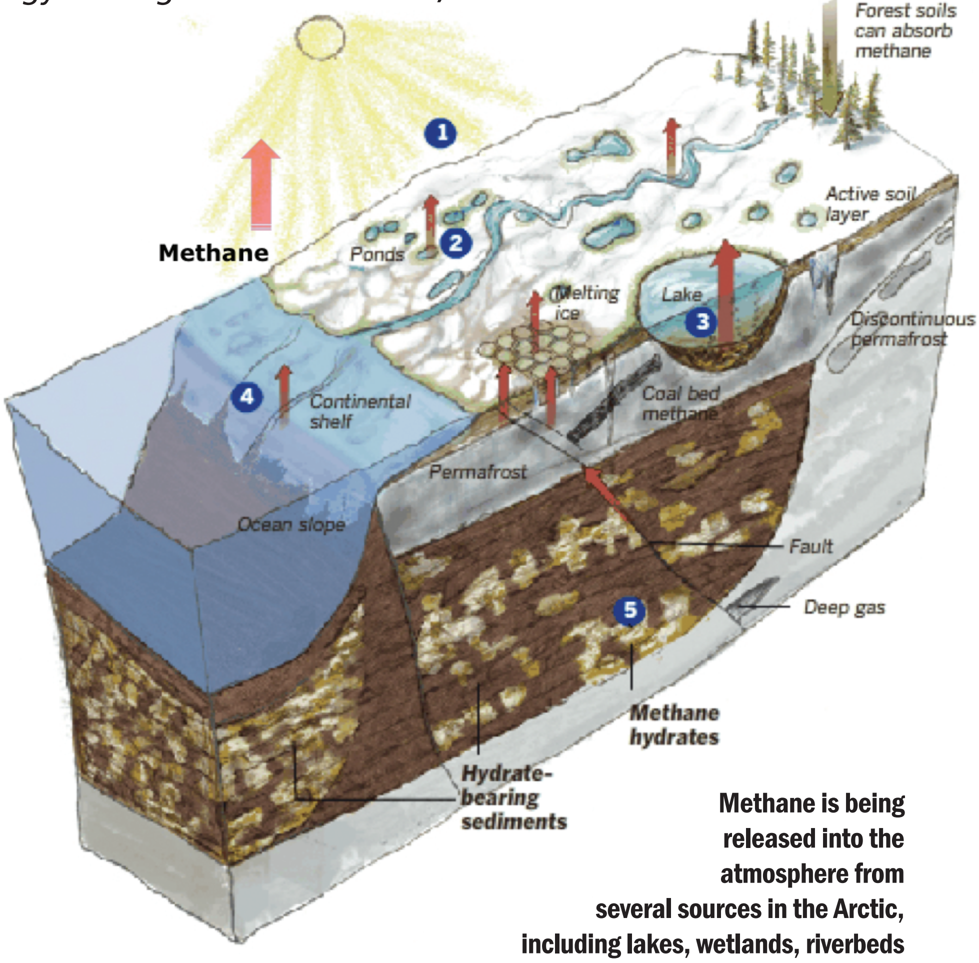




This year Nasa scientists added a new colour code to reports, identifying temperature anomalies between 6-11°C, to replace 4-11°C; clearly signalling 4-6°C and 6-11°C are increasingly common features of global temperature records. Note the Arctic is brown and pink.

"If we trigger this runaway release of methane, there's no turning back. No do-overs. Once it starts it's likely to play out all the way"

Former US Department for Energy Geologist John Atcheson, 2004



Methane is being released into the atmosphere from several sources in the Arctic, including lakes, wetlands, riverbeds and peatbogs, as well as from hydrates.

As a GREENHOUSE GAS Methane is a potent GHG. IPCC models calculate its warming effect to be 72x that of CO2 over the first 20 years and 21x CO2 over 100 years [1]. However, as temperatures in the Arctic are more extreme in response to local conditions so is the global warming impact of methane (see 120x CO2 below [2]).

James Hansen at Nasa observed in 2009, "Methane is an especially powerful greenhouse gas. There are large amounts of methane presently locked up, frozen, in high latitude tundra and, especially, in ocean sediments on continental shelves. We know from Earth's history that this frozen methane can be released suddenly by sufficient warming – thus this methane has the potential to greatly amplify human-made global warming, if that

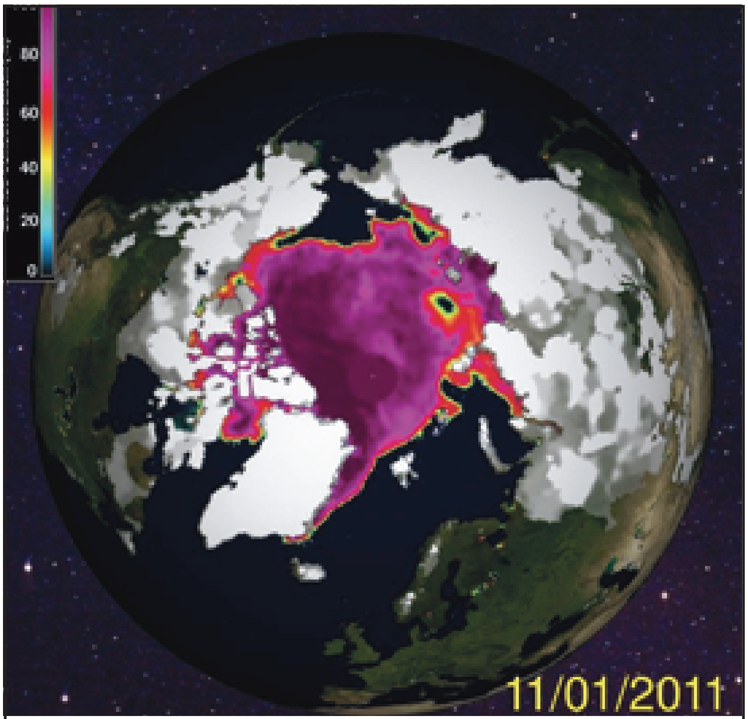
120 x C02(e) and Hydroxyl

Atmospheric hydroxyl radicals (HO) oxidise methane (CH4), turning it into carbon dioxide (CO2) – the comparatively less harmful GHG. High methane concentrations in the atmosphere, however, stunt hydroxyl levels, reducing the capacity to perform this function. Increased global emissions of methane has caused a 26% decrease in hydroxyl in the atmosphere with the consequence that methane now persists longer in the atmosphere, before getting transformed into the less potent C02. This means that concentrated releases of methane, as would occur over the Arctic have a far greater GHG potency than the IPCC assumption, rising to as much as 120x C02 over the first 20 years [2].

Methane level rises in atmosphere

Much of the methane is created in the northern hemisphere higher latitudes, and the level is much higher than the global average, so there is a natural flow of methane from there to the tropics (see diagram,

warming reaches a level, a tipping point, such that large volumes of frozen methane begin to melt." [3]



A persistent hole in the ice (polynia) over the Laptev Sea in the ESAS region has been observed by satellite – seen as a black circle outlined by green. It is possible that this is a result of localised warming caused by undersea methane releases

METHANE PROCESS

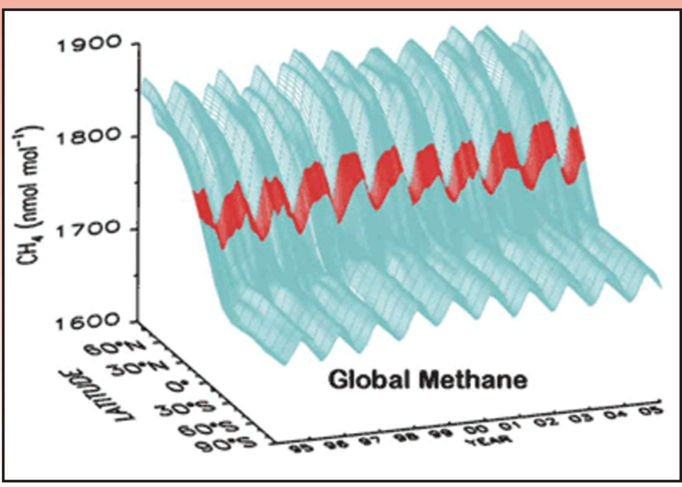
Methane is stored as hydrates in the Arctic and sub-Arctic and in surrounding permafrost. 1672Gt (1Gt = 1 billion tons) of methane is stored under terrestrial permafrost alone, twice the current atmospheric content of carbon [4]. Ongoing observations and analysis forecast a similar amount is held in sub-sea stores. As undersea permafrost thaws it releases the stores of 'free' gas (or methane hydrates) hidden beneath it. A sudden 50Gt release is deemed increasingly "highly possible" [5].

This represents less than 2.5% of the potential 2,200 Gt estimated to be capable of release in the ESAS area. Yet it would increase the burden of methane in the atmosphere by 11 or 12 times. This would cause global warming to speed up by a factor of 4 or 5 times, and the local warming by a much greater factor, resulting in further methane release – a methane feedback. Thus it would almost certainly lead to runaway global warming, with abrupt and catastrophic climate change [6].

BELLWETHER VENTING

The East Siberian Arctic Shelf is the bellwether for methane activity in the Arctic. A methane-rich area of more than two million km located about 50 metres or less below the surface of the Ocean, it is the methane store most vulnerable to warming.

As the ice retreats and surface temperature increases, this sub-sea permafrost is also



right). But recently it has been observed that the general level in parts of the Arctic has risen to being 20% above the global average, and this suggests that methane from certain Arctic sources has increased compared to emissions in the rest of the world. However, the global level of methane has also been increasing after a number of years of stability around the 1750 ppb mark. This observed steady increase could be in part due to ESAS emissions, demanding an immediate intensification of scientific inquiry.

attacked by warm waters flowing off the simultaneously melting terrestrial permafrost (see box, right).

Dr Semelitov says methane from ESAS is currently entering the atmosphere at a "fantastic rate", much greater than previous observations. While reported findings from their latest mission to the Arctic won't be available until Spring 2012, what is to be reported clearly dwarf previous results reported in 2010 [7].

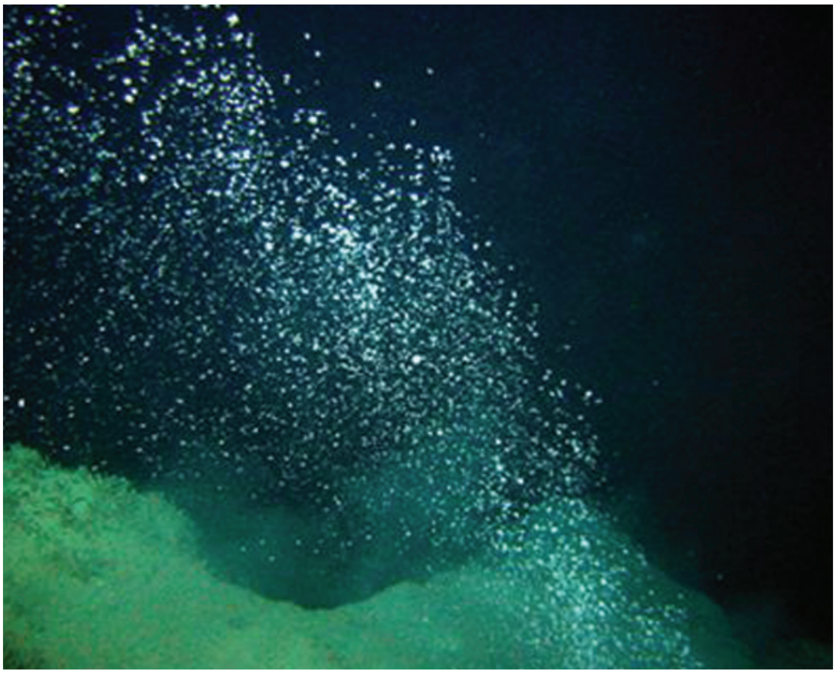
Then the research team reported methane emissions from ESAS could equal emissions from all the other world oceans put together. The study also reported that more than 80% of the deep water and more than 50% of surface water had methane levels more than eight times that of normal seawater [8].

Above: thermokarst lakes in thawing permafrost along the Lena River Delta in East Siberia. Melting permafrost swells Siberian rivers with warm, methane rich water, and suspended organic material. This warm methane-saturated water flows over the East Siberian Arctic Shelf, melting the permafrost cap over ESAS methane stores

Unexpected levels of methane emissions have also been observed in the Atlantic Arctic [9] and around the West Spitsbergen Sea [10]. Over the past year a 'hole' (polynia) has appeared in ice over the Laptev Sea (see previous page).

THAW POINT

It is clear that the thaw point of ice and methane are on a collision course. As undersea permafrost is salty it thaws at temperatures hovering around zero. As Arctic temperatures rise, warm surface waters, bolstered by warm river run-off and combined with greater winds serve to churn the warm water to the bottom of the ocean. Surface and sub-sea temperatures along ESAS have been measured at +3°C. The conditions for game-changing amounts of methane to be released are clearly developing.



A methane plume being released from the sea bed

Call for an urgent escalation of scientific inquiry and development of countermeasures

by
Arctic Methane Emergency Working Group
Chairman, Jon Nissen

The shrinking of the Arctic sea-ice sheet, in thickness and volume, has been almost two orders of magnitude faster than in IPCC model projections of sea ice extent [1]. As sea ice retreats, more water is exposed, which is then heated to cause further retreat, in what is known as a 'positive feedback loop' (see page 6). Current projections of sea ice volume [2] signal September Arctic sea ice will have disappeared by 2015, but possibly by 2014 or 2013.

Outweighing this alarming state of affairs is the consequential rise in methane released from the Arctic sea-bed and the surrounding tundra. The massive quantity of methane currently locked up in a frozen state in the Arctic presents an effective climate change 'time bomb', with a fuse measured in just a few years and already burning. Although the 'explosion' of this 'bomb' may take years, the point of no return, when the positive feedback becomes unstoppable, could be very soon.

It is now clear that there are two critical problems confounding one another: the rapid loss of sea ice and the emergence of methane from a thawing seabed. They both call for rapid intervention: to cool the region and to capture the methane. This is a colossal challenge because of the timescale demanded.

There is clearly no longer any alternative to large-scale intervention (also known as 'geoengineering') for reducing the risk of disaster. And this has to be done extremely quickly – possible large-scale deployment in Spring 2013 – which is an enormous challenge for the development of new technology and its deployment.

The critical regions for methane capture include the East Siberian Arctic Sea (ESAS), extending on the north into the Laptev Sea and on the east into the Chukchi Sea. However, more general cooling is required over the whole Arctic and Sub-Arctic. In particular, cooling needs to cover areas draining into rivers such as the Lena, whose waters are currently warming the ESAS area.

Cooling Techniques

A combination of three cooling techniques is proposed, to give flexibility in deployment and maximise the chances of success:

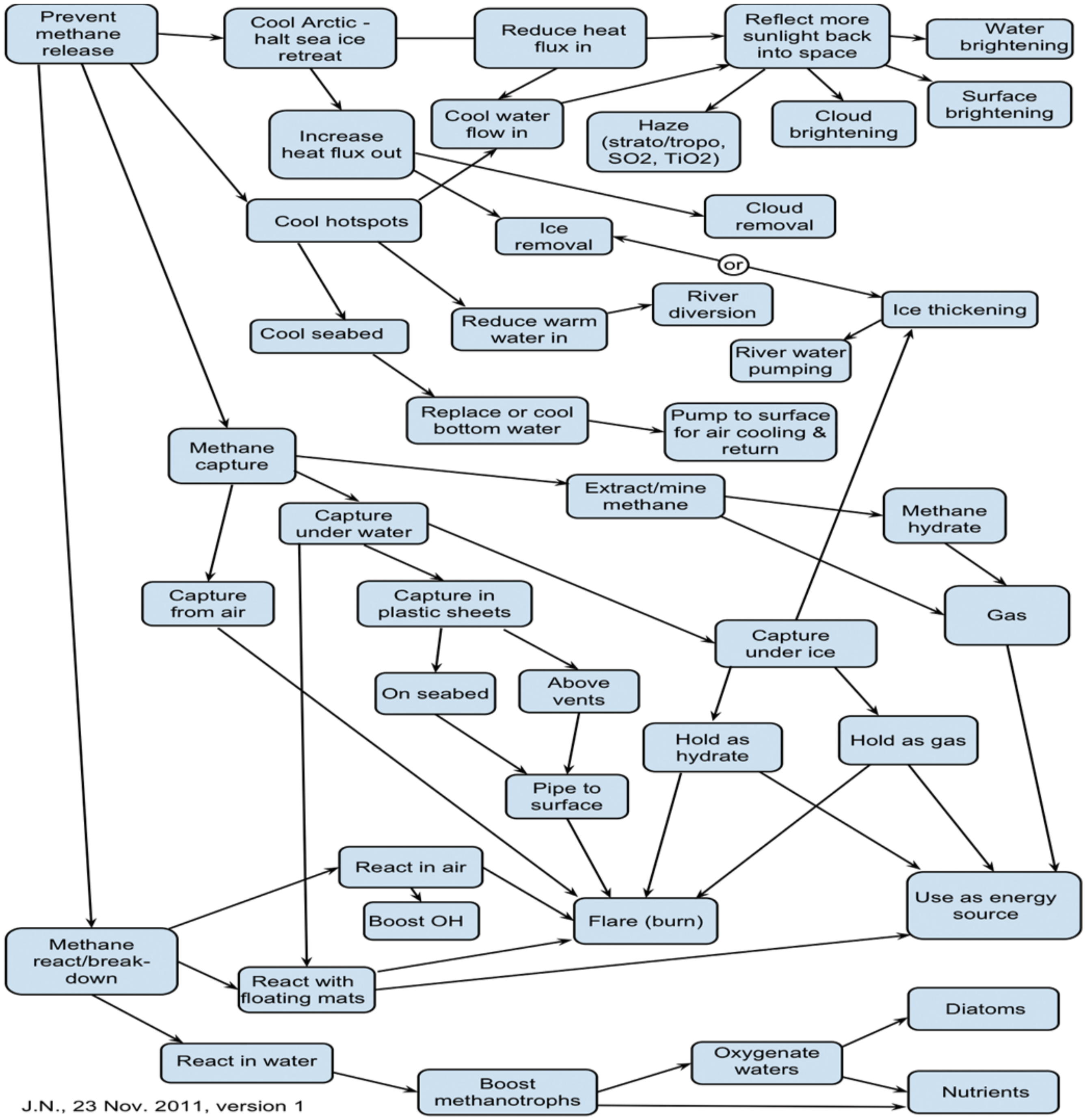
- stratospheric aerosols to reflect sunlight
- cloud brightening to reflect more sunlight
- cloud removal to allow thermal radiation into space.

The first technique mimics the action of large volcanoes such as Mt. Pinatubo, which erupted in 1991 and had a cooling effect of 0.5°C over 2 years due to the sulphate aerosols it produced in the stratosphere. However, larger particles in the aerosol are liable to reflect thermal radiation from the planet surface, hence having a warming effect. To avoid this, there is an advantage in using TiO_2 particles, as used in white paint. These can be engineered to a constant size and coated to produce required properties, such as not sticking to one another.

Large quantities could be dispersed at high latitudes in the lower stratosphere, either using stratotankers or balloons, to have an effect lasting a few months during spring, summer and early autumn. Due to circulating winds, the aerosol will spread around the latitude where it has been injected.

Cloud brightening is a technique whereby a very fine salt spray is produced from special spray nozzles mounted on a ship, and gets wafted up to clouds where it increases their reflective power. Whereas stratospheric particles can provide blanket cooling at particular latitudes, the brightening technique can be used to cool particular locations, using sophisticated modelling to decide when and where is best to do the spraying.

ARCTIC GEOENGINEERING: Proposals for action to prevent methane releases (top left-hand corner)



The third cooling technique involves removing certain high clouds during the months of little or no sunshine, when they are having a net blanketing effect – reflecting heat back to the ground.

Additional techniques (see fig. left) should be considered for more local cooling, especially by increasing surface albedo. For example one could increase snowfall over land or brighten water by injection of tiny bubbles. Another technique is to break up the sea ice in autumn and winter, which has the effect of thickening the ice and producing what looks and acts like multi-year ice. A very promising approach is to reduce currents carrying water into the Arctic Ocean, in particular the partial damming of the Bering Strait.

Note that all the above techniques are expected to enhance the Arctic ecosystem, which is in danger of sharp decline as a result of sea ice collapse.

Methane Capture Techniques

The problem with trying to deal directly with methane below the seabed permafrost is that any disturbance is liable to trigger an eruption of methane through gaps in the permafrost known as taliks. Commercial methods of extraction of natural gas can be used when there is an impermeable layer above the gas, but could be risky in this situation because of the danger either from puncture of the permafrost or from enlarging existing taliks. The possibility of relieving gas pressure just offshore by drilling along the coast could be considered. There is also the possibility of capturing methane leaks (see over).

In the bed of the sea or lake there are methanotrophs microbes, capable of 'digesting' the methane and converting it into less harmful products. Supply of oxygen and nutrients to such microbes could be helpful. This would be valuable for reducing the considerable emissions from wetlands, which is a major source of methane. However in the shallow sea of the ESAS the methane is bubbling to the surface before it can be digested or dissolved in the water. Therefore it has to be captured, preferably as close to the seabed as possible.

An existing technique for larger plumes of methane bubbles is to use an underwater hood

GEOENGINEERING REQUIREMENTS

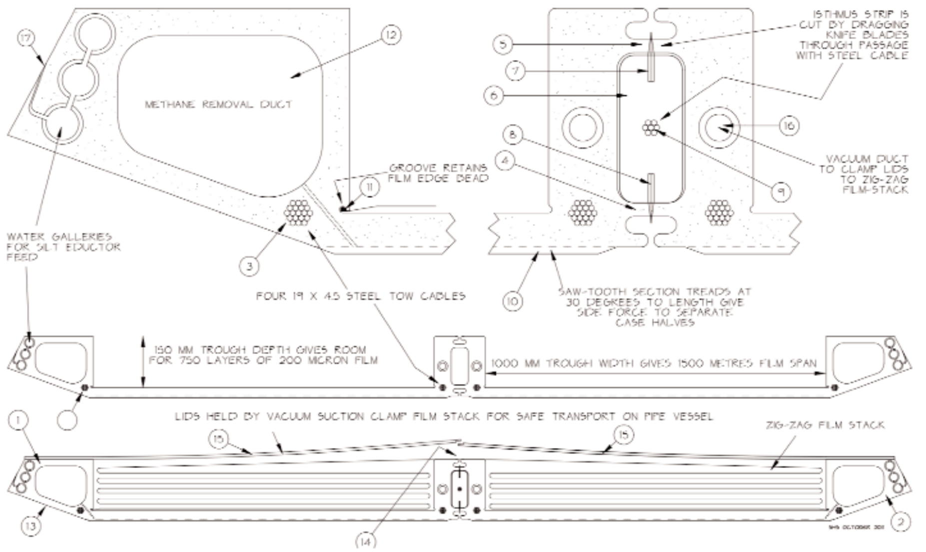
Flux to be overcome to save the sea ice

- Arctic warming is much faster than global warming, by a factor of about 6 times, and the warming is accelerating, due to positive feedback
- Warming is mostly driven by currents from the Atlantic, and the albedo effect
- The extra heat flux, which is warming the Arctic with respect to its pre-industrial temperature, is currently of the order of one petawatt
- September sea ice volume trend is to zero in 2014 or 2015, by which time the heat flux would be nearly double what it is at present
- This is the 'point of no return', when it becomes impossible to prevent further retreat of the sea ice, with accelerated Arctic warming causing ever larger methane emissions in a feedback loop until runaway global warming is inevitable
- Geoengineering techniques for cooling the Arctic have to be applied as early as Spring 2013, to reduce that risk as far as it is possible to do so

Flux from a sudden large emission of methane

- Under shallow seas there is around 1000 Gt methane as methane hydrate and 700 Gt methane as free gas
- Up to 50 Gt (3%) of this methane might be unexpectedly released, e.g. by an earthquake, thus increasing atmospheric concentration by up to 12 times
- The global forcing from such a pulse could rise to around 9 Watts/m over the course of a single year and then fall only slowly
- Such forcing could send global warming over 2°C in a decade
- The local forcing would also lead to further Arctic methane release in a positive feedback loop, with runaway global warming inevitable
- Geoengineering techniques for cooling and for methane capture have to be applied as soon as possible to reduce the risk from unexpectedly large emissions of methane into the atmosphere

Emergency intervention is needed both to save the Arctic sea ice and to reduce the risk of catastrophic global warming from a sudden large emission of methane.



Professor Stephen Salter's 'methane mat' was conceived out of discussions at the Arctic Methane Emergency Working Group Workshop. The mat is designed to capture gas on land and Ocean floor, be remote-controlled, manoeuvrable and recoverable from undersea deployment. It also is constructed using existing (tried and tested) components, making it available for rapid development and deployment.

to channel the methane into a pipe. There can be difficulties in anchoring the hoods because of currents and storms, and with thousands of plumes to deal with, this approach could be unworkable. Now in ESAS the methane is bubbling out at a low level over a large area.

It is proposed to capture this methane in very large plastic sheets, spread across the seabed (see above). Each sheet is concertinaed into both sides of a joined pair of long plastic troughs. These trough pairs are rolled up onto the drum of a ship designed for laying cables. The ship can then lower the pair of troughs so it runs along the seabed. By an ingenious system, the pair of troughs is separated and the troughs are moved apart while the plastic sheet spreads out between them. The captured methane would be brought to the surface in pipes.

There is the problem of floating ice. It is proposed to cut through the ice as it moves, to let the pipes protrude above the surface and collect or flare the methane. Eventually one can imagine the collection of large quantities of methane to be piped to land and used as an energy source.

For rapid intervention, flaring is expected to be the norm. If the methane is already bubbling to the surface, then the priority is to capture before it escapes into the atmosphere. If the methane collects under the ice in quantity, pockets could be detected, holes bored through the ice, and the methane flared.

One would like to find a way to flare any methane that bursts into the atmosphere. But in remote areas, and in open water, this could be problematic. Furthermore, methane only burns in air at between 5-15% concentration by volume. As it disperses quickly, one would need to torch the methane within seconds of eruption. It is almost impossible to imagine how this could be done in a remote location.

Removing methane from the atmosphere

Capture of methane from the atmosphere is a last resort, if all other approaches failed, or if there were a sudden large emission of methane with serious warming potential. If possible such capture would be done locally, as the air capture efficiency is improved by having the methane at higher concentration. In nature most methane is destroyed by reaction with hydroxyl radicals in the tropics, but it is difficult to imagine how such a process could be enhanced.

For a more detailed assessment of proposed countermeasures visit: www.arctic-methane-emergency-group.org

We declare there now exists an extremely high international security risk* from abrupt and runaway global warming being triggered by the imminent collapse of Arctic Summer Sea Ice and release of huge quantities of methane gas from the Ocean floor. Such global warming would destroy the planet's climate control system and inexorably lead to the collapse of civilisation in the planet's sixth major extinction event. This colossal threat demands an immediate emergency scale response.

The decline in multiyear ice has been remarkable and the best modelling we have on sea ice retreat suggests that the first sea-ice-free ocean might be seen within a year or two. In this situation it is going to be extremely difficult to halt the retreat, let alone reverse it. At the same time there seems to be an acceleration of methane emissions from the East Siberian Arctic Shelf, which means that, even if we halted both the sea ice retreat and the Arctic warming, the methane emissions would continue to accelerate on their own accord. This is the dreaded methane feedback which Nobel Laureate Steven Chu refers to (see quote on back cover).

Thus, not only do we have to halt the sea ice retreat, but we have to cool the Arctic and capture as much methane as we can from the seabed to prevent this methane feedback building up. The imperative is to get the cooling started as fast as humanly possible and at the same time, with equal urgency, design and implement effective measures for preventing an escalation of Arctic methane into the atmosphere. We have considered that the first conceivable date for implementing large-scale cooling technology is Spring 2013, but a collapse in sea ice could happen next year and the methane escalation is liable to gather pace.

We are so close to a point of no return that we must act immediately and decisively.

Governments must adopt a plan of action to halt the retreat of the Arctic sea ice and slow the release of methane. A variety of technologies are available, some of which may be classed as geoengineering. But intervention on a large scale has to be accepted in order to avert the ultimate catastrophe of runaway global warming. No amount of adaptation or insulation could make that survivable.

We urge for all nations to pull together in battle against these threats. This is a moral duty: to fight against destruction of the climate system in order to protect the lives of all citizens.

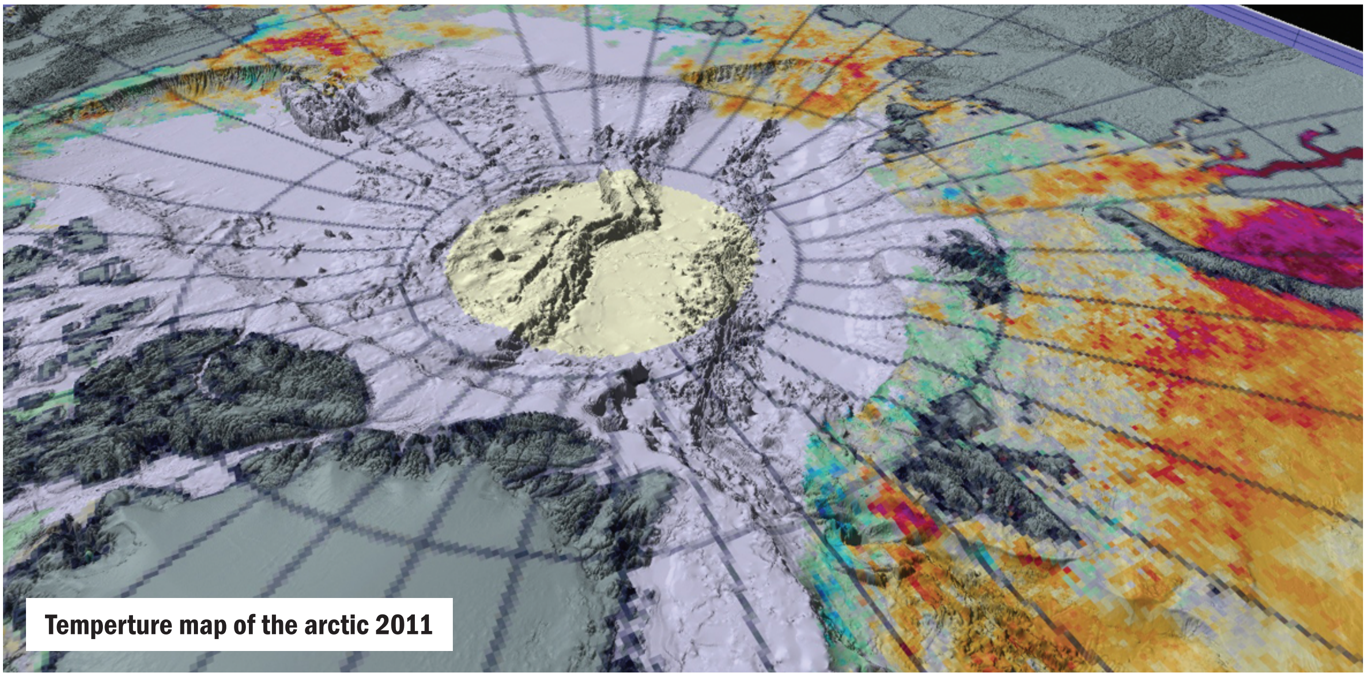
** risk in the scientific sense, meaning the 'combination of the probability of an event and its consequences' (IPCC 2007, AR4 WG 3)*

"It's not enough that we do our best; sometimes we have to do what's required"

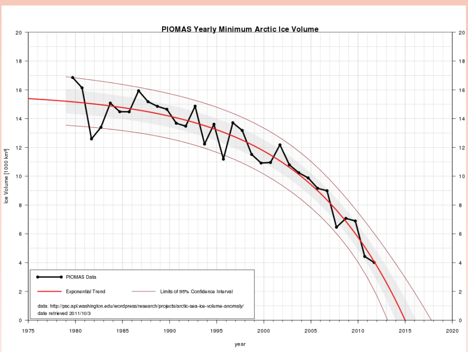
Sir Winston Churchill British politician (1874–1965)

“A runaway effect….. At that point, it is completely out of our control in the sense that even if humans stopped emitting more greenhouse gases, the release of the trapped carbon material just “runs away”. We don’t know exactly what temperature this is going to occur, but as we go to warmer and warmer temperatures - 4, 5, or 6 degrees Centigrade – many scientists are feeling that this may really kick in. We cannot go there ….”

Nobel Laureate and US Energy Secretary
Steven Chu, on permafrost feedback


Temperture map of the arctic 2011

5-10%



PROBABILITY
of September sea ice disappearing by
2013

VISIT

www.
arctic-methane-emergency-group
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To find out more and to lend your support to the call for an urgent escalation of scientific inquiry and development of countermeasures