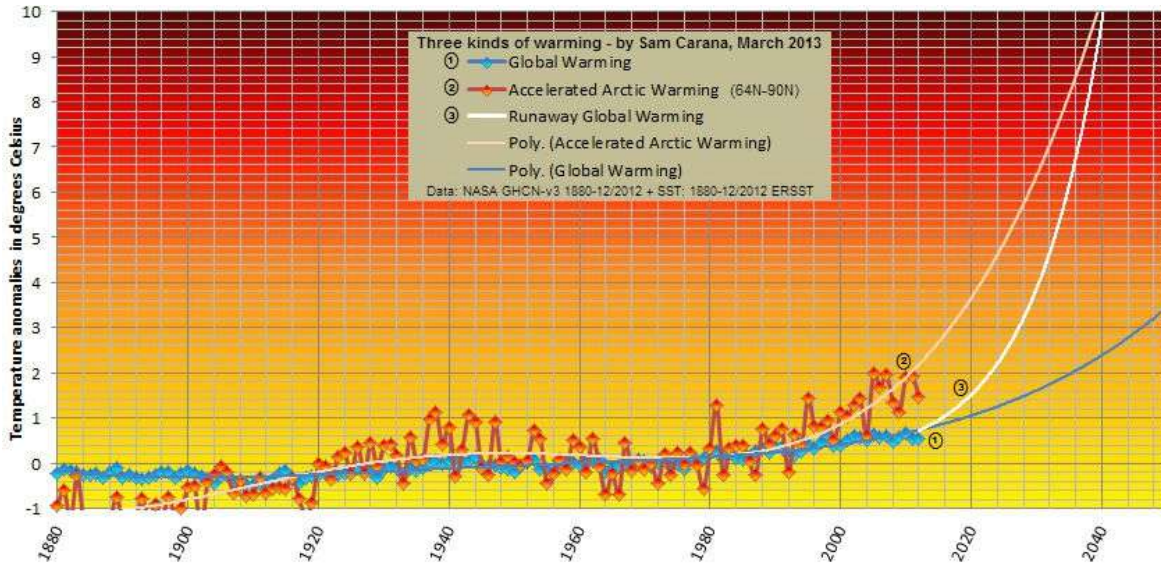
Chapter 5 – Positive Feedback and Climate Catastrophe

We continue in this chapter the blog of Guy McPherson (Google ref. "Nature bats last"; http://guymcpherson.com/climate-chaos), dealing with positive feedbacks which will lead to climate catastrophe. This essay brings attention to recent forecasts and positive feedbacks. He presented much of this information at the Bluegrass Bioneers conference (Alex Smith at Radio Ecoshock has evaluated his presentation). More recently, he delivered an updated version on the campus of the University of Massachusetts. All information and sources are readily confirmed with an online search, and links to information about feedbacks can be found there.

Positive feedbacks

1. Methane hydrates are bubbling out the Arctic Ocean (*Science*, March 2010). As described in a subsequent paper in the June 2010 issue of *Geophysical Research Letters*, a minor increase in temperature would cause the release of upwards of 16,000 metric tons of methane each year. According to NASA's CARVE project, these plumes were up to 150 kilometers across as of mid-July 2013. Global-average temperature is expected to rise by more than 4 °C by 2030 and 10 °C by 2040 based solely on methane release from the Arctic Ocean, according to Sam Carana's research (see especially Image 24 below).



Whereas Malcolm Light's 9 February 2012 forecast of extinction of all life on Earth by the middle of this century seems premature because his conclusion of exponential methane release during summer 2011 was based on data later revised and smoothed by U.S. government agencies, subsequent information — most notably from NASA's CARVE project — shows the grave potential for catastrophic release of methane. (I doubt industrial civilization is able to kill all life on Earth, although that clearly is the goal.)

Catastrophically rapid release of methane in the Arctic is further supported by Nafeez Ahmed's thorough analysis in the 5 August 2013 issue of the *Guardian* as well as Natalia Shakhova's 29 July 2013 interview with Nick Breeze (note the look of abject despair at the eight-minute mark). In early November 2013, methane levels well in excess of 2,600 ppb were recorded at multiple altitudes in the Arctic. Later that same month, Shakhova and colleagues published a paper in *Nature Geoscience* suggesting "significant quantities of methane are escaping the East Siberian Shelf" and indicating that a 50-billion-tonne "burst" of methane could warm Earth by 1.3 °C. Such a burst of methane is "highly possible at any time." By 15 December 2013, methane bubbling up from the seafloor of the Arctic Ocean had sufficient force to prevent sea ice from forming in the area. Nearly two years after his initial, often belittled analysis, Malcolm Light concluded on 22 December 2013, "we have passed the methane hydrate tipping point and are now accelerating into extinction as the methane hydrate 'Clathrate Gun' has begun firing volleys of methane into the Arctic atmosphere." According to Light's analysis in late 2013, the temperature of Earth's

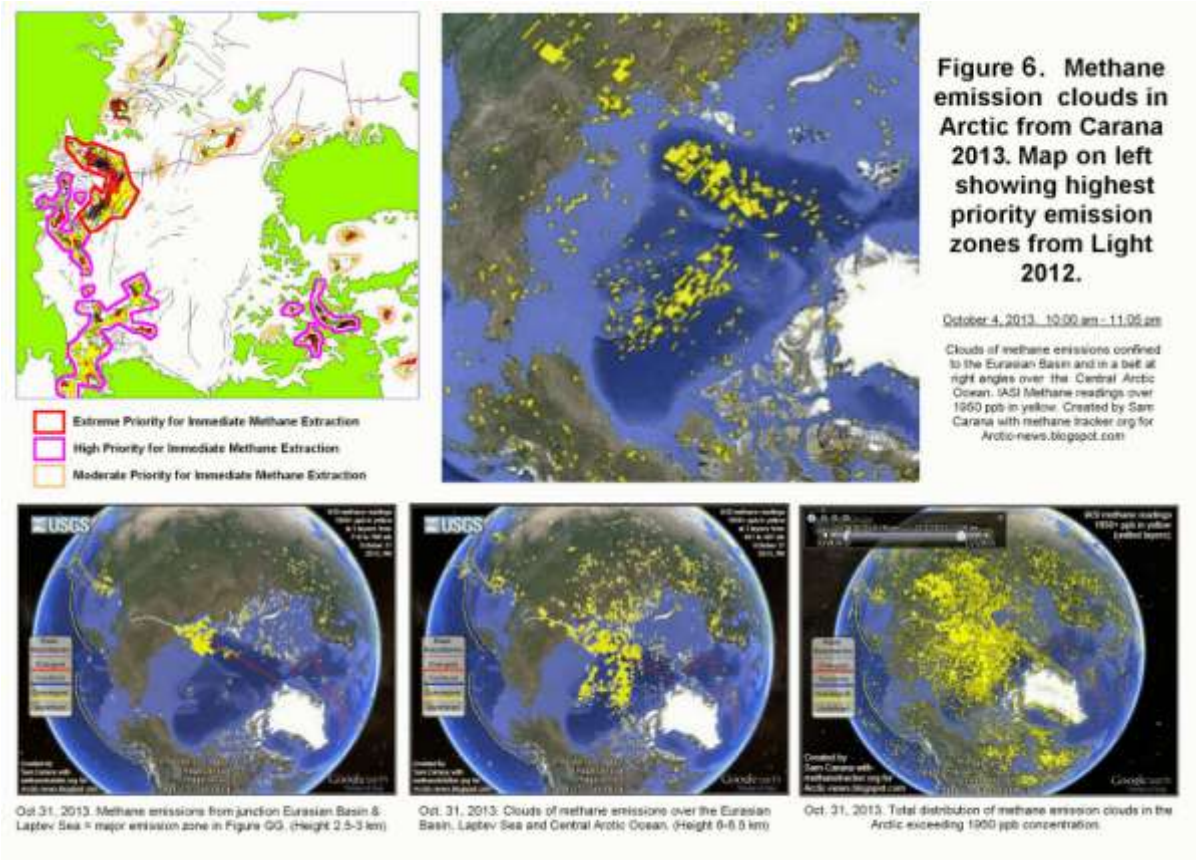


Figure 6. Methane emission clouds in Arctic from Carana 2013. Map on left showing highest priority emission zones from Light 2012.

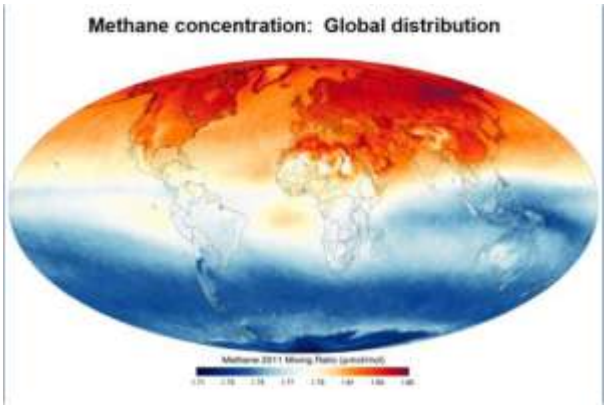
Oct.31, 2013. Methane emissions from junction Eurasian Basin & Laptev Sea = major emission zone in Figure GG. (Height 2.5-3 km)

Oct. 31, 2013. Clouds of methane emissions over the Eurasian Basin, Laptev Sea and Central Arctic Ocean. (Height 6-6.5 km)

Oct. 31, 2013. Total distribution of methane emission clouds in the Arctic exceeding 1950 ppb concentration.

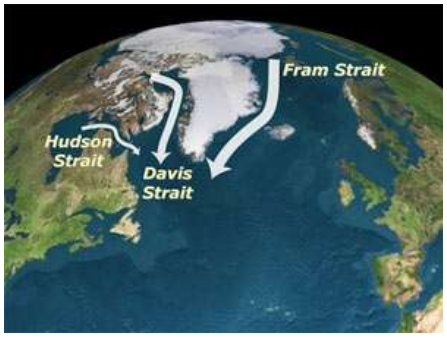
atmosphere will seem like that of Venus before 2100. Two weeks later, in an essay stressing near-term human extinction, Light concluded: "The Gulf Stream transport rate started the methane hydrate (clathrate) gun firing in the Arctic in 2007 when its energy/year exceeded 10 million times the amount of energy/year necessary to dissociate subsea Arctic methane hydrates."

Discussion about methane release from the Arctic Ocean has been quite heated (pun intended). Paul Beckwith was criticized by the conservative website, Skeptical Science. His response from 9 August 2013 is available.



Robert Scribbler gives a terrifying summary on 24 February 2014, and concludes, "two particularly large and troubling ocean to atmosphere methane outbursts were observed" in the Arctic Ocean. Such an event hasn't occurred during the last 45 million years. Scribbler's bottom line: "that time of dangerous and explosive reawakening, increasingly, seems to be now."

Image source: NASA



2. Warm Atlantic water is defrosting the Arctic as it shoots through the Fram Strait (*Science*, January 2011). Subsequent melting of Arctic ice is reducing reflection of sunlight, hence increasing absorption of solar energy. "Averaged globally, this albedo change is equivalent to 25% of the direct forcing from CO_2 during the past 30 years," according to research published in the 17 February 2014 issue of the *Proceedings of the National Academy of Sciences*. Unbalancing the deep circulation in the Atlantic Ocean may be "spasmodic and abrupt rather than a more gradual increase" as earlier expected, according to a paper published in the 21 February 2014 issues of *Science*. Models continue to underestimate relative to observations, as reported in the 10 March 2014 issue of *Geophysical Research Letters*.

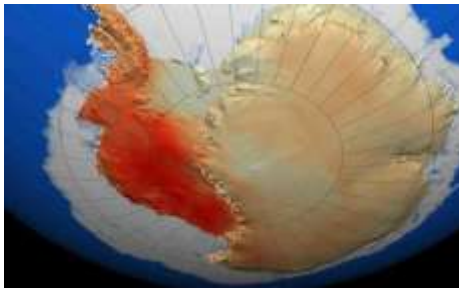
3. Siberian methane vents have increased in size from less than a meter across in the summer of 2010 to about a kilometer across in 2011 (*Tellus*, February 2011). According to a paper in the 12 April 2013 issue of *Science*, a major methane release is almost inevitable, which makes me wonder where the authors have been hiding. *Almost* inevitable, they report, regarding an ongoing event.

4. Peat in the world's northern coniferous, or boreal, forests is decomposing at an astonishing rate (*Nature Communications*, November 2011).

5. Invasion of tall shrubs warms the soil, hence destabilizes the permafrost (*Environmental Research Letters*, March 2012).

6. Greenland ice is darkening (*The Cryosphere*, June 2012).

7. Methane is being released from the Antarctic, too (*Nature*, August 2012). According to a paper in the 24 July 2013 issue of *Scientific Reports*, melt rate in the Antarctic has caught up



to the Arctic and the West Antarctic Ice Sheet is losing over 150 cubic kilometres of ice each year according to CryoSat observations published on 11 December 2013, and Antarctica's crumbling Larsen B Ice Shelf is ready to finish its collapse, according to Ted Scambos, a glaciologist at the National Snow and Ice Data Center at the annual meeting of the American Geophysical Union.

Further confirmation of large methane releases is revealed by clouds shining at night over the southern hemisphere from 21 November 2013 to 6 December 2013.

8. Russian forest and bog fires are growing (NASA, August 2012), a type of phenomenon consequently apparent throughout the northern hemisphere (*Nature Communications*, July 2013). The *New York Times* reports hotter, drier conditions leading to huge fires in western North America as the "new normal" in their 1 July 2013 issue. A paper in the 22 July 2013 issue of the *Proceedings of the National Academy of Sciences* indicates boreal forests are burning at a rate exceeding that of the last 10,000 years.

9. Cracking of glaciers accelerates in the presence of increased carbon dioxide (*Journal of Physics D: Applied Physics*, October 2012).

10. The Beaufort Gyre apparently has reversed course (U.S. National Snow and Ice Data Center, October 2012).

11. Exposure to sunlight increases bacterial conversion of exposed soil carbon, thus accelerating thawing of the permafrost (*Proceedings of the National Academy of Sciences*, February 2013). Subsequent carbon release "could be expected to more than double overall net carbon losses from tundra to the atmosphere," as reported in the March 2014 issue of *Ecology*. Arctic permafrost houses about half the carbon stored in Earth's soils, an estimated 1,400 to 1,850 petagrams of it, according to NASA.

12. The microbes have joined the party, too, according to a paper in the 23 February 2013 issue of *New Scientist*

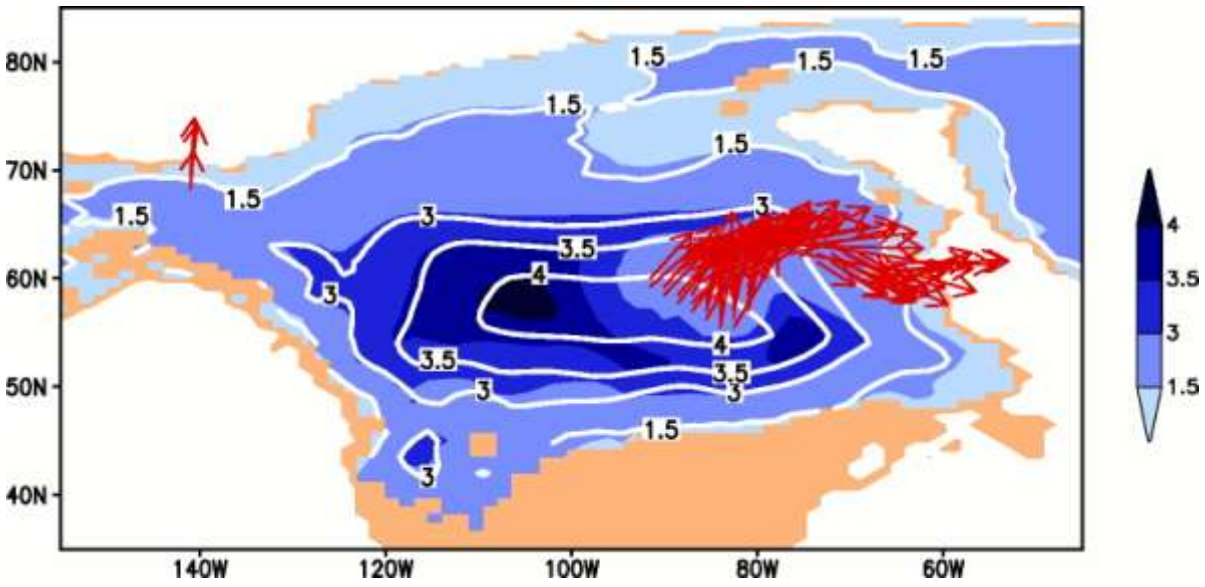
13. Summer ice melt in Antarctica is at its highest level in a thousand years. Summer ice in the Antarctic is melting 10 times faster than it was 600 years ago, with the most rapid melt occurring in the last 50 years (*Nature Geoscience*, April 2013). According to a paper in the 4 March 2014 issue of *Geophysical Research Letters*, which assumes relatively little change in regional temperature during the coming decades, "modeled summer sea-ice concentrations

decreased by 56% by 2050 and 78% by 2100″ (Robert Scribbler's in-depth analysis is available). Although scientists have long stated concern about the instability of the West Antarctic Ice Sheet (WAIS), a research paper published in the 28 August 2013 of *Nature* shows the East Antarctic Ice Sheet (EAIS) has undergone rapid changes in the past five decades. The EAIS is the world's largest ice sheet and was previously thought to be at little risk from climate change. But it has undergone rapid changes in the past five decades, signalling a potential threat to global sea levels. The EAIS holds enough water to raise sea levels more than 50 meters.

14. Increased temperature and lack of water in the southwestern interior of North America makes movement of dust from low-elevation deserts to high-elevation snowpack easier, thus accelerating snowmelt, as reported in the 17 May 2013 issue of *Hydrology and Earth System Sciences*.

15. Floods in Canada are sending pulses of silty water out through the Mackenzie Delta and into the Beaufort Sea, thus painting brown a wide section of the Arctic Ocean near the Mackenzie Delta (NASA, June 2013). Pictures of this phenomenon are shown on a NASA website.

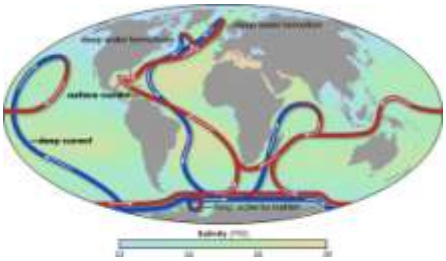
16. Surface meltwater draining through cracks in an ice sheet can warm the sheet from the inside, softening the ice and letting it flow faster, according to a study accepted for publication in the *Journal of Geophysical Research: Earth Surface* (July 2013).



Laurentide ice sheet during a Heinrich event. The blue shading shows the height of the ice sheet in km. The red arrows show the ice flow which drains the ice sheet in the region of Hudson Bay and Hudson.

It appears a Heinrich Event has been triggered in Greenland. Consider the description of such an event as provided by Robert Scribbler on 8 August 2013:

In a Heinrich Event, the melt forces eventually reach a tipping point. The warmer water has greatly softened the ice sheet. Floods of water flow out beneath the ice. Ice ponds grow into great lakes that may spill out both over top of the ice and underneath it. Large ice dams may or may not start to form. All through this time ice motion and melt is accelerating. Finally, a major tipping point is reached and in a single large event or ongoing series of such events, a massive surge of water and ice flush outward as the ice sheet enters an entirely chaotic state. Tsunamis of melt water rush out bearing their vast flotillas of icebergs, greatly contributing to sea level rise. And that's when the weather really starts to get nasty. In the case of Greenland, the firing line for such events is the entire North Atlantic and ultimately the Northern Hemisphere.



17. Breakdown of the thermohaline conveyor belt is happening in the Antarctic as well as the Arctic, thus leading to melting of Antarctic permafrost (*Scientific Reports*, July 2013). In the past 60 years, the ocean surface offshore Antarctica became less salty as a result of melting glaciers and more precipitation, as reported in the 2 March 2014 issue of *Nature Climate Change*.

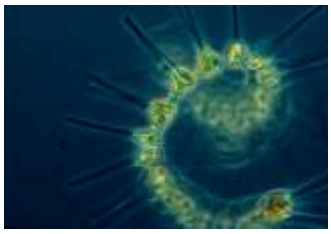
18. Loss of Arctic sea ice is reducing the temperature gradient between the poles and the equator, thus causing the jet stream to slow and meander (see particularly the work of Jennifer Francis). One result is the creation of weather blocks such as the recent very high temperatures in Alaska. As a result, boreal peat dries and catches fire like a coal seam. The resulting soot enters the atmosphere to fall again, coating the ice surface elsewhere, thus reducing albedo and hastening the melting of ice. Each of these individual phenomena has been reported, albeit rarely, but to my knowledge the dots have not been connected beyond this space. The inability or unwillingness of the media to connect two dots is not surprising, and has been routinely reported (recently including here with respect to climate change and wildfires) (July 2013).

19. Arctic ice is growing darker, hence less reflective (*Nature Climate Change*, August 2013)

20. Extreme weather events drive climate change, as reported in the 15 August 2013 issue of *Nature* (*Nature*, August 2013).

21. Drought-induced death of trees contributes to increased decomposition of carbon dioxide into the atmosphere and decreased absorption of atmospheric carbon dioxide. Such mortality has been documented throughout the world since at least November 2000 in *Nature*, with recent summaries in the February 2013 issue of *Nature* for the tropics and in the August 2013 issue of Frontiers in Plant Science for temperate North America. One extremely important example of this phenomenon is occurring in the Amazon, where drought in 2010 led to the release of more carbon than the United States that year (*Science*, February 2011). In addition, ongoing deforestation in the region is driving less precipitation at a rate much faster than long thought, as reported in the 19 July 2013 issue of *Geophysical Research Letters*. An overview

of the phenomenon, focused on the Amazon, was provided by Climate News Network on 5 March 2014.



22. Ocean acidification leads to release of less dimethyl sulphide (DMS) by plankton. DMS shields Earth from radiation. (*Nature Climate Change*, online 25 August 2013). Plankton form the base of the marine food web, and are on the verge of disappearing completely, according to a paper in the 17 October 2013 issue of *Global Change Biology*.

23. Sea-level rise causes slope collapse, tsunamis, and release of methane, as reported in the September 2013 issue of *Geology*. In eastern Siberia, the speed of coastal erosion has nearly doubled during the last four decades as the permafrost melts.

24. Rising ocean temperatures will upset natural cycles of carbon dioxide, nitrogen and phosphorus, hence reducing plankton (*Nature Climate Change*, September 2013)

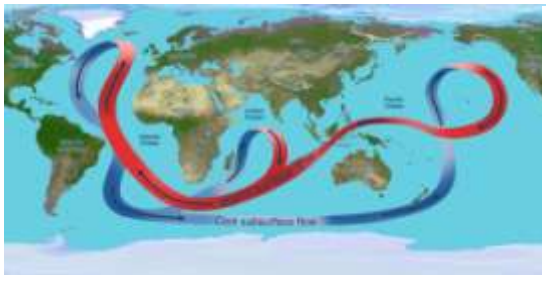
25. Earthquakes trigger methane release, and consequent warming of the planet triggers earthquakes, as reported by Sam Carana at the Arctic Methane Emergency Group (October 2013)

26. Small ponds in the Canadian Arctic are releasing far more methane than expected based on their cover viewed from the air (PLoS ONE, November 2013). This is the first of several freshwater ecosystems releasing methane into the atmosphere, as reviewed in the 19 March 2014 issue of *Nature*.

27. Mixing of the jet stream causes change, too. High methane releases follow break up of the jet stream, accounting for past global-average temperature rises up to 16 °C in a decade or two (Paul Beckwith via video on 19 December 2013).

28. Research indicates that "fewer clouds form as the planet warms, meaning less sunlight is reflected back into space, driving temperatures up further still" (*Nature*, January 2014).

29. "Thawing permafrost promotes microbial degradation of cryo-sequestered and new carbon leading to the biogenic production of methane" (*Nature Communications*, February 2014).



30. Deep ocean currents apparently are slowing. According to one of the authors of the paper, "we're likely going to see less uptake of human produced, or anthropogenic, heat and carbon dioxide by the ocean, making this a positive feedback loop for climate change." Because this phenomenon contributed to cooling and sinking of the Weddell polynya: "it's always possible that the giant polynya will manage to reappear in the next century. If it does, it will release decades-worth of heat and carbon from the deep ocean to the atmosphere in a pulse of warming." (*Nature Climate Change*, February 2014;

model results indicate “large spatial redistribution of ocean carbon,” as reported in the March 2014 issue of the *Journal of Climate*).

31. Arctic drilling was fast-tracked by the Obama administration during the summer of 2012.

32. Supertankers are taking advantage of the slushy Arctic, demonstrating that every catastrophe represents a business opportunity, as pointed out by Professor of journalism Michael I. Niman and picked up by Truthout (ArtVoice, September 2013).

As nearly as I can distinguish, only the latter two feedback processes are reversible at a time scale relevant to our species. Once you pull the tab on the can of beer, there’s no keeping the carbon dioxide from bubbling up and out. These feedbacks are not additive, they are multiplicative: They not only reinforce within a feedback, the feedbacks also reinforce among themselves. Now that we’ve entered the era of expensive oil, I can’t imagine we’ll voluntarily terminate the process of drilling for oil and gas in the Arctic (or anywhere else). Nor will we willingly give up a few dollars by failing to take advantage of the long-sought Northwest Passage.

Robin Westenra provides an assessment of these positive feedbacks at Seemorerocks on 14 July 2013. It’s worth a look.