



# Hell, High Water, and High Hopes

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# Plan of Work...

- What's happening right now.
- How bad could it get?
- Rays (solar) of hope.
- Implications for Alberta.

# It's Complicated...

- Scientists are very clear: it does not make sense to say that any *particular* event (Harvey, Maria, the Kenow fire) was caused *purely* by global warming.
- However (!), it is clear that the frequency and intensity of weather-related events (wildfires, floods, droughts, storms) is likely to increase because of global warming.
  - “Climate change attribution” getting much attention from scientists recently.
  - Basic idea: impose current warming on statistics of natural variation, and see how much difference it makes.
    - E.g.: recent “Lucifer” heatwave in southern Europe estimated to be 10x more likely because of global warming.

# Basic Physics

- Why?
- Climate is complicated, but the basic principle is very simple:
- Put extra heat into the atmosphere and oceans, and all that heat has to go somewhere.
- And go somewhere it will, regardless of whether our cities, farms, etc., happen to be in the way.

# How Bad Could It Get?

- Risk of “tipping points”: effects of climate change that accelerate non-linearly.
  - Collapse of grounded marine ice sheets (WAIS, Zachariae Isstrom, Totten...)
  - Major shifts in weather patterns.
  - Accelerated emissions of methane from permafrost, marine hydrates...
  - Species extinctions—including maybe the talking primates themselves.

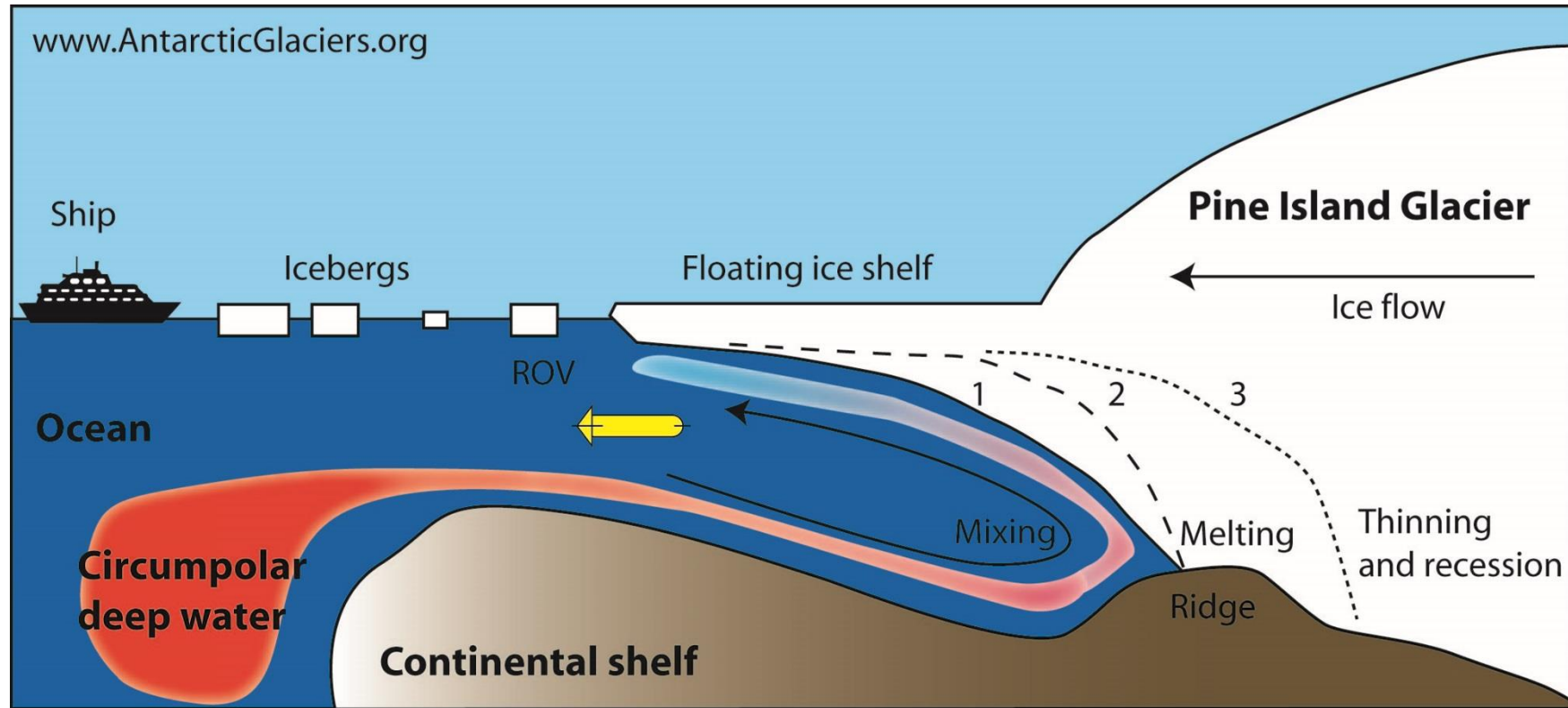
# Recent *Conservative* Prediction

- Human extinction due to AGW is not out of the question.
  - Recent paper by V. Ramanathan and Y. Xu:  
<https://scripps.ucsd.edu/news/new-climate-risk-classification-created-account-potential-existential-threats>
  - Unchecked emissions lead to 5% chance of catastrophic/existential outcomes by 2050.
- Ramanathan:
  - “When we say 5 percent-probability high-impact event, people may dismiss it as small but it is equivalent to a one-in-20 chance the plane you are about to board will crash. We would never get on that plane with a one-in-20 chance of it coming down but we are willing to send our children and grandchildren on that plane.”

# “I’m melting...!”

- Ice sheet collapse as case study of a tipping point:
- Grounded marine ice sheets are held in place by “ice over flotation”; they are inherently unstable under certain conditions.
  - Paleoclimate shows that sea level can rise 4 to 5 m/century due to ice sheet collapse (Meltwater Pulse 1A).
  - At 410 ppm CO<sub>2</sub>, we are “dialed in” for 15 to 25 m of SLR.
    - Only question is how long it will take; there *might* still be time to reverse it if we act soon.

# The Weak Underbelly of WAIS



1. Early 1970s. Pine Island Glacier is grounded at a bedrock ridge.
2. Warm, inflowing Circumpolar Deep Water melts the base of the glacier. The glacier steepens and accelerates.
3. Present day, observed by a remotely operated vehicle (ROV). Glacier is thinning and receding.



# Being Negative About Emissions

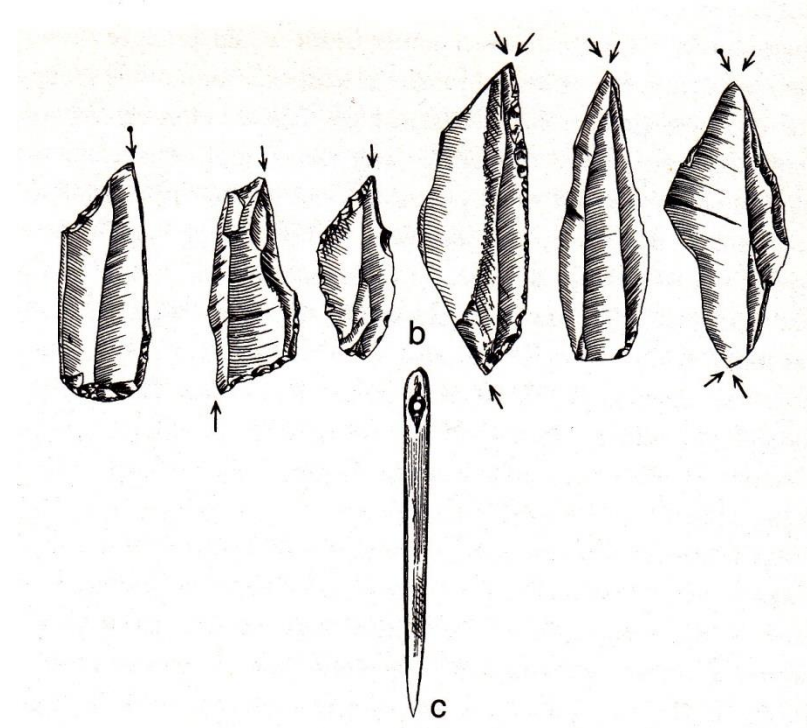
- But this implies that at current CO<sub>2</sub> level it is *not good enough* to stop emissions.
- Increasing recognition that we have to have *negative emissions*—something that will suck enough CO<sub>2</sub> out of the atmosphere to reduce total concentration to something close to pre-industrial levels *before* the grounded marine ice sheets let go.
- Such technology *does not yet exist*.

# The Gamble

- Everything we do has to be framed by the awareness that we are gambling with the ice sheets (and methane release in the Arctic).
  - Our gamble: we can maintain Business as Usual *a little longer* until we develop alternatives *at a comfortable pace*.
  - We have all our chips on the table for this round—we are *all* in.

# My Hope...

- Shift gears and look at this from another angle:
- Human beings have an amazing capacity for innovation, ingenuity, creativity—whatever we want to call it.
- A new innovation (in technology, science, art, design, social structures) is like getting new weapons or lives in a video game.
- Example from paleo-anthropology:



Burins (stone cutting tools) and bone sewing needle, made by Magdalenian people ca. 11,000 to 20,000 years ago.

--- from Brian Fagan, *Cro-Magnon* (NY: Bloomsbury, 2010)

# *A New Thing*

- Fagan: “The humble needle ranks alongside the taming of fire as one of early humanity’s most significant innovations.”
  - Why? --- Because one can make *tailored clothing*, and this is a significant survival advantage in the harsh sub-Arctic climate of Europe at the time.
- Before a certain time, there were no sewing needles—it is a *new thing*.
  - As a philosopher, I find this fascinating.

# End Game

- However (!), a culture can reach the point where it is out of time, out of options, to find the innovations that can prevent collapse, even if it wants to.
  - (Photo by K. Peacock of Ahu Tongariki, Rapa Nui, August 2014.)



# What Does This Mean for AB?

- Rachel Notley:
  - “Today I was asked about the future of the oil sands—how long into the future will the world need oil? Here’s what I'd like to say. Oil and gas will help power the global economy for generations to come. ... .”
- With respect to the Premier, I believe that she is *dead wrong* about this.

# A Political Gamble

- Right now, our governments (Alberta and federal) want to have it both ways:
  - They say Canada can lead in fight against climate change, *and* miraculously have a vigorous fossil fuel industry for decades to come.
- One can see why it may be politically expedient to take this line.
  - McKenzie King (WWII): “We’ll have conscription if necessary, but not necessarily conscription.”
  - Today: “We’ll reduce emissions if necessary, but we won’t necessarily reduce emissions...!”
- Maybe it would be better politics, in the long run, simply to tell the truth.



# Message From Mother Nature...

- We humans live in a vast physical universe that has its own rules (which we only partially understand).
- **It does not schedule events in accordance with what would be economically or politically convenient for the province of Alberta, Canada—or those who have invested in bitumen extraction from that province.**

# Some “Inconvenient” Truths

- In Alberta, we’ve gone from crude to crud:
  - We’re mining bitumen and fracking because that’s all we have left.
  - Most of the best-quality oil (the “low-hanging fruit”) has already been sucked out of the ground.
  - And most of the money from it has been sucked out of Alberta.
- Oil from bitumen (tar sands) is one of the most expensive types of oil to produce; as oil moves toward obsolescence, it will be the *first* to become uneconomical.
  - Sooner or later (sooner if there is a crisis such as collapse of West Antarctica) there will be irresistible international pressure to cut fossil fuel use due to climate change.

# Bitumen Will be Stranded

- Plus, even if climate were not an urgent issue, it is going to be so much *cheaper* to use non-fossil sources of energy that oil won't be able to compete.
- In 2013 a Tesla S was driven from Long Beach, CA, to Lethbridge, using \$65 worth of energy.
  - Soon Senator Inhofe will be driving a Tesla.

# Disruptive Tech on the March

- Around the world many people are working on technologies that will displace oil (and eventually natural gas):
  - Renewables; e.g., solar power at under 3¢ per kwh in Dubai.
  - Price of solar, wind technology is falling exponentially (like Moore's Law).
  - Biodiesel, bio-jet fuel in the works.
  - Artificial photosynthesis (several approaches being investigated).
- People working on alternatives are *not going to wait politely* until tar sands have amortized the billions invested in them.
  - They will be “stranded assets.”

# Our Greatest Asset

- IMHO, our greatest asset in Alberta is not our oil, wheat, timber...
- It is our human capital:
  - The source of the creative ingenuity that will find the “sewing needles” we need.
- Whatever we are investing now in education, research, and development, it is not enough.

# Push and Pull

- The carbon tax will help, but what is needed as well is to do everything that can be done to reduce the cost of non-fossil alternatives.
- The tax is a *push* away from fossil fuels, and the existence of cheaper alternatives is a *pull* toward something else.
  - It is not the cost of fossil fuels that matters as much as the *difference in cost* between them and alternatives.
  - It will be that “delta-\$” that gets us through, if anything can.

# The Big Picture

- “We have to think globally and act locally.”
- True—but we also have to *think globally and act globally*.
  - Rather than trying to “have it both ways,” Alberta can be a global leader in the movement out of the fossil fuel era.
  - The world is watching us!
- Or we can wait for someone else to do it for us, and then pick up the pieces afterwards... our call...!

## Some References

- Attribution studies: <https://www.theguardian.com/world/2017/sep/27/climate-change-made-lucifer-heatwave-far-more-likely-scientists-find>
- Lucifer Heatwave: <https://www.theguardian.com/world/2017/aug/04/extreme-heat-warnings-issued-europe-temperatures-pass-40c>
- Ramanathan and Xu summary on Scripps site: <https://scripps.ucsd.edu/news/new-climate-risk-classification-created-account-potential-existential-threats>
- This post from Peter Sinclair gives a pretty good picture of why glaciologists are *very* worried about what will happen to Antarctica (even though Peter made a typo: it is Pulse 1A, not 2B): <https://climatecrocks.com/2017/05/12/the-weekend-wonk-good-antarctic-synopsis-from-rolling-stone/> See the interview with distinguished glaciologist Eric Rignot: “The fuse is already blown.” Dr. Rignot’s comments on the difficulty of communication are very telling as well.
- A very interesting video on disruptive energy technologies; well worth the hour it takes to watch: <https://climatecrocks.com/2017/09/16/the-weekend-wonk-tony-seba-on-disruptive-energy-technologies/>
- The Doomsday Glacier: <http://www.rollingstone.com/politics/features/the-doomsday-glacier-w481260>
- A new class of batteries, from the co-inventor of the lithium ion battery: <https://news.utexas.edu/2017/02/28/goodenough-introduces-new-battery-technology>
- Tesla batteries to smooth out power peaks in California: <http://www.zmescience.com/science/news-science/socal-tesla-batteries/>
- One promising approach to artificial photosynthesis: <http://www.popularmechanics.com/science/green-tech/interviews/a23472/co2-ethanol-interview/>



- For references this talk is posted at

<http://scholar.ulethbridge.ca/kentpeacock/stumbling-anthropocene>