A Tale of Climate Change: The Caged Bird and the Golden Bull

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A Parallel Narrative

Reality

Climate Change
- Arctic sea ice
- The natural environment
- Greenhouse gases
- Geoengineering
- Abrupt climate change
- etc.

Metaphor

The Tale
- The Caged Bird
- The coal mine
- Hazardous gases
- Mine ventilation system
- Coal mine accident
- etc.

BC³ BASQUE CENTRE FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

www.bc3research.org
Should I use my car or my shoes?
Should I use my car or my shoes?

Geoengineering (a.k.a. climate intervention): is the deliberate, large-scale human intervention in the Earth’s climate system with the aim of alleviating or reverting some of the adverse effects of global warming.
Is this geoengineering?

The Red Stiletto
By Michael Sauers (CC lic.)
June 13, 2006

http://www.flickr.com/photos/travelinlibrarian/with/166514354/
Sea Ice and Icebergs
A Climate Change Tale: The Caged Bird and the Golden Bull

By Sérgio H. Faria ©2017
The village

Village in Ticino, Switzerland. Author unknown (CC lic.).
The Golden Bull

*Bullock cart in Sogndal.* By Nils Olsen Reppen (1856–1925), Sogn og Fjordane County Archives (CC lic.)

https://commons.wikimedia.org/wiki/File:Bullock_cart_Sogndal_ca._1898-1900.jpg

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The Caged Bird

The Arctic
Arctic Sea Ice Melting

Arctic sea ice extent over the last 1,450 years

- Reconstructed sea ice extent
- Modern observations

The Coal Mine

Une petite exploitation minière vers Matarrosa del Sil. By Didier Duforest (CC lic.)
The Coal Mine

Grinkle mine culvert collapse. By Philld (CC lic.)
http://www.geograph.org.uk/photo/1546942
Changing Habits
Paleoclimate Records
The EDML Deep Ice Core, total depth 2774.15 m
Paleoclimate Records
The EDML Deep Ice Core, from snow to firn and bubbly ice
Atmospheric CO₂ (ppm)

- Siple ice core: Neftel et al., Nature 315 (1985)

yBCE = years before common era; kyBCE = thousands of years before common era
Contact: andy.jacobson@noaa.gov

Jan 2016: 403 ppm
Jan 1979: 336 ppm
Preindustrial: about 278 ppm
Ice ages: about 185 ppm

NOAA, Earth System Research Laboratory

NOAA, Earth System Research Laboratory
Epilogue
Excerpt from “Caged Bird”
by Maya Angelou (1928–2014)

The caged bird sings
with a fearful trill
of things unknown
but longed for still
and his tune is heard
on the distant hill
for the caged bird
sings of freedom.

Energy the sun supplies: 240 W m$^{-2}$

Energy humans consume: 0.035 W m$^{-2}$

* World’s average.

Source: Richard Alley “Good News on Energy and Environment”
<https://www.youtube.com/watch?v=z_qYlUeKUI4>
The “Fat Tail” Distribution

Severity of the event

Likelihood of occurrence

- Air bags, ABS, ESC, RSC,...
- crumple zones, collision bars,
- child seats,
- no-drink-and-drive campaigns,
- no-cell-phone-while-driving campaigns,
- no-drugs campaigns,
- traffic control, and so on...

Run over by drunk truck driver

Some traffic, silly “summer Party” hits

No traffic, great tunes

Lots of traffic, political ads for next election

After: “Abrupt Climate Change In The Arctic”, AGU Fall Meeting 2013
<https://www.youtube.com/watch?v=yEUyjDyXckE> with modifications

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The Climate Change Problem

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The diagram illustrates the relationship between the severity of the event and the likelihood of occurrence. It shows a curve that peaks with a high likelihood of occurrence for faster or larger changes, and decreases for slower or smaller changes.

- **IPCC (best estimate)**: This line represents the best estimate according to the Intergovernmental Panel on Climate Change.
- **Faster or larger changes**: These are associated with a higher likelihood of occurrence.
- **Slower or smaller changes**: These are associated with a lower likelihood of occurrence.
- **Abrupt climate changes**: This section refers to significant and rapid changes in the climate system.

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After: “Abrupt Climate Change In The Arctic”, AGU Fall Meeting 2013
<https://www.youtube.com/watch?v=yEUyjDyXCkE>
with modifications

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The Climate Change Problem

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The Climate Change Problem
Final thoughts: a common dilemma…

1937 Morgan Super Sports Tricycle V Twin Matchless 1000
Woolwich, London, England, GB
By Ken (CC lic.)
July 4, 2010
http://www.flickr.com/photos/kenjonbra/with/4762601826/

By Paul Bence (CC lic.)
May 27, 2007
http://www.flickr.com/photos/paulbence/with/522008064/
Why not switching to renewables?

By Michael Carruth (CC lic.)
July 4, 2007
http://www.flickr.com/photos/michaelcarruth/with/8711465589/
Thank you!

By Lee (CC lic.), April 24, 2009,
http://www.flickr.com/photos/64663706@N00/with/3472630396/
The “Fat Tail” Distribution (of Doom?)

Prof. Richard Alley
Penn State University

“Slip Slidin’ Away: Ice Sheets and Sea Level in a Warming World”
Stanford University, October 2012
<https://www.youtube.com/watch?v=jt4QLcocveE>

“Abrupt Climate Change In The Arctic”
AGU Fall Meeting 2013
<https://www.youtube.com/watch?v=yEUyjDyXckE>

Arctic Sea Ice Extension, Thickness, and Drift
Sep 1979 – Aug 2007

By Ignatius Rigor and John M. Wallace. International Arctic Buoy Program.
http://iabp.apl.washington.edu/research_seaiceageextent.html
Methane Hydrates in Shallow Arctic Shelves

Predicted deposits of shallow methane hydrates (purple) over the Arctic Ocean. Red line marks the 50 m isobath.

Distribution of subsea permafrost. ESAS = East Siberian Arctic Shelf

Earth’s temperature history in the last 4.6 billion years


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**Climate Research Milestones**

- **1843**: Invention of the telegraph
- **1853**: 1\textsuperscript{st} International Maritime Conference, Brussels
- **1873**: 1\textsuperscript{st} International Meteorological Congress (1\textsuperscript{st} IMC), Vienna
- **1879**: 2\textsuperscript{nd} IMC, Rome
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- **1882-83**: 1\textsuperscript{st} International Polar Year (1\textsuperscript{st} IPY)
- **1914-18**: WW1
- **1914-18**: WW2
- **1932-33**: 2\textsuperscript{nd} IPY
- **1951**: IMO is incorporated to UN as WMO (World Meteorological Organization)
- **1957-58**: International Geophysical Year (formerly 3\textsuperscript{rd} IPY)
- **1979**: 1\textsuperscript{st} World Climate Conference (1\textsuperscript{st} WCC), Geneva
- **1972**: Stockholm Conference and foundation of UNEP

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1st: Polar regions are essential components of the global climate system.
Seasonal cycles in polar regions
The Antarctic Ice Sheet

- Ice volume: 24.7 x 10^6 km^3
- Ice mass: 22.6 x 10^{18} kg
- Potential sea level rise: 56.6 m
The Antarctic Ice Sheet: cross section
The Antarctic Ice Sheet: cross section
The Antarctic Ice Sheet: flow lines
Methane Hydrates Deposits in Shallow Arctic Shelves

By Ignatius Rigor and John M. Wallace. International Arctic Buoy Program.
http://iabp.apl.washington.edu/research_seaiceageextent.html

Ruppel, Nature Knowledge, Hydrates/Climate, April 2011
Arctic Sea Ice Volume
Annual Maximum and Loss, and Ice Remaining at Minimum

- Ice remaining at yearly minimum
- Yearly Ice maximum
- Yearly Ice loss

* in progress
Graph: Jim Pettit
Most recent data: Sep 2012
Arctic Sea Ice Extension, Thickness, and Drift
Sep 1979 – Aug 2007

By Ignatius Rigor and John M. Wallace. International Arctic Buoy Program.
http://iabp.apl.washington.edu/research_seaiceageextent.html
Multiscale Structures in Ice Sheets
1 Statement of the Problem
Growth of Climate Modeling

- 60s: Atmospheric/Land Surface/Vegetation
- 70s: Ocean
- 80s: Coupled Climate Model
- 90s: Sulfate Aerosol
- 00s: Biogeochemical Cycles
- 10s: Upper Atmosphere

www.bc3research.org
Creep and recrystallization of polycrystals
ocean

ice sheet

atmosphere

lithosphere

ocean
Arctic Sea Ice Minimum Volume

1980  1990  2000  2010

PIOMAS Vol/1000km³

1979  16855 km³

2014  6810 km³

Source: http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly/
The EDML Deep Ice Core
Air bubbles (EDML, 450 m depth)
From snow to bubbly ice and air hydrates
The EDML Deep Ice Core
The EDML Deep Ice Core

From snow to bubbly ice and air hydrates

The EDML Deep Ice Core
Total length 2774.15 m
3rd: Polar ice sheets are invaluable archives of Earth’s past climate

May 2017

**CO₂**: 410 ppm

**Trend**: 406 ppm

Growth rate: 3 ppm/year