GEOENGINEERING

… as collective experimentation

UCL DEPARTMENT OF SCIENCE AND TECHNOLOGY STUDIES

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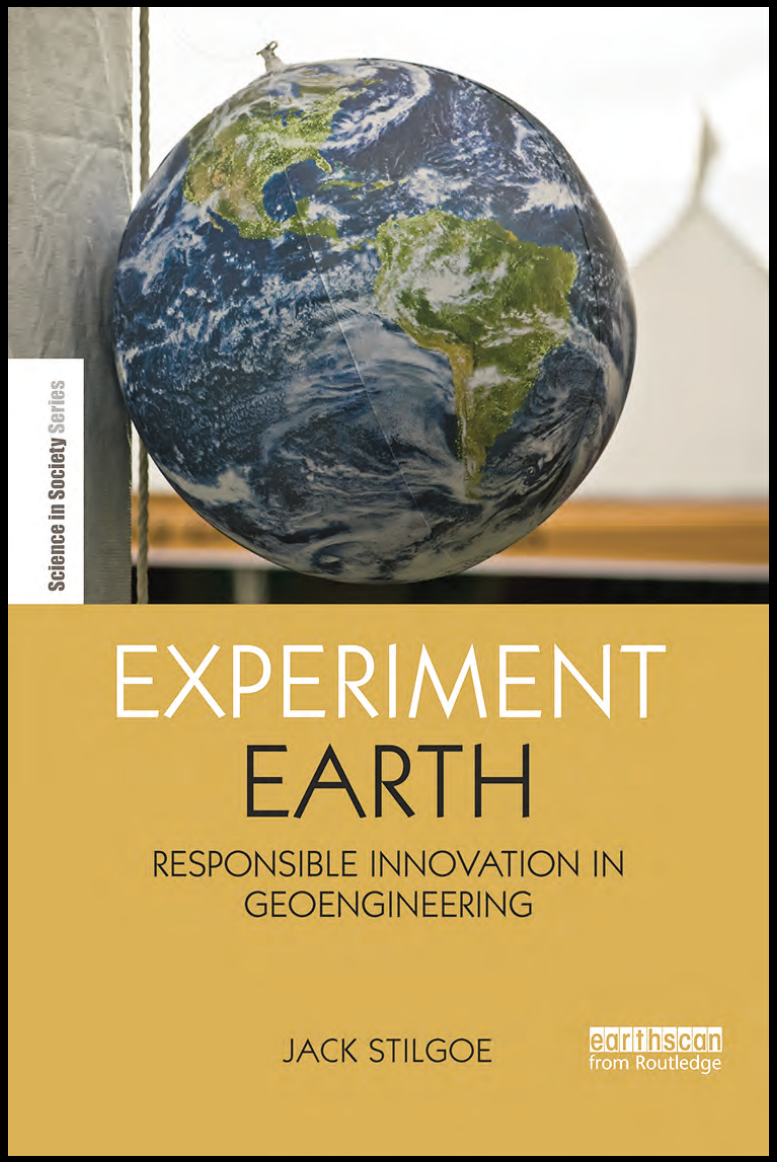
The 80,000 word version



The 8,000 word version

Sci Eng Ethics
DOI 10.1007/s11948-015-9646-0

ORIGINAL PAPER

Geoengineering as Collective Experimentation

Jack Stilgoe[1]

Received: 11 November 2014 / Accepted: 30 March 2015

Abstract Geoengineering is defined as the 'deliberate and large-scale intervention in the Earth's climatic system with the aim of reducing global warming'. The technological proposals for doing this are highly speculative. Research is at an early stage, but there is a strong consensus that technologies would, if realisable, have profound and surprising ramifications. Geoengineering would seem to be an archetype of technology as social experiment, blurring lines that separate research from deployment and scientific knowledge from technological artefacts. Looking into the experimental systems of geoengineering, we can see the negotiation of what is known and unknown. The paper argues that, in renegotiating such systems, we can approach a new mode of governance—collective experimentation. This has important ramifications not just for how we imagine future geoengineering technologies, but also for how we govern geoengineering experiments currently under discussion.

Keywords Geoengineering · Climate engineering · Governance · Responsible research and innovation · Collective experimentation

The 800 word version

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Books

Can volcanoes tackle climate change?

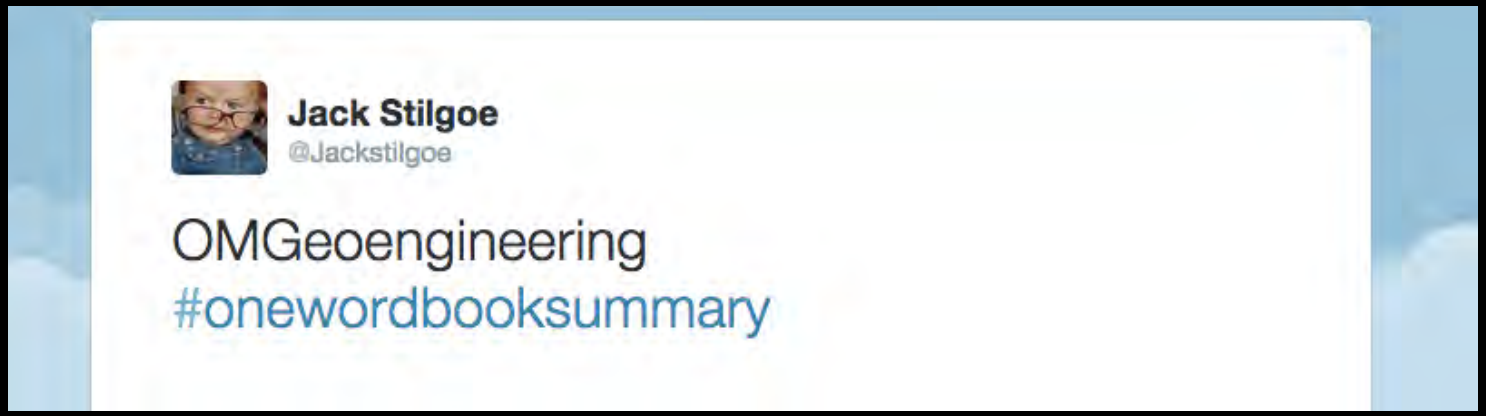
Two hundred years ago a volcanic eruption cooled the Earth. Could it help us tackle global warming today?

Recent massive volcanic eruptions have given some scientists cause for hope as well as fear. Photograph: Angela Platania/Demotix/Corbis

Jack Stilgoe
Friday 10 April 2015 13.16 BST

Shares 355 Comments 23

The one-word version



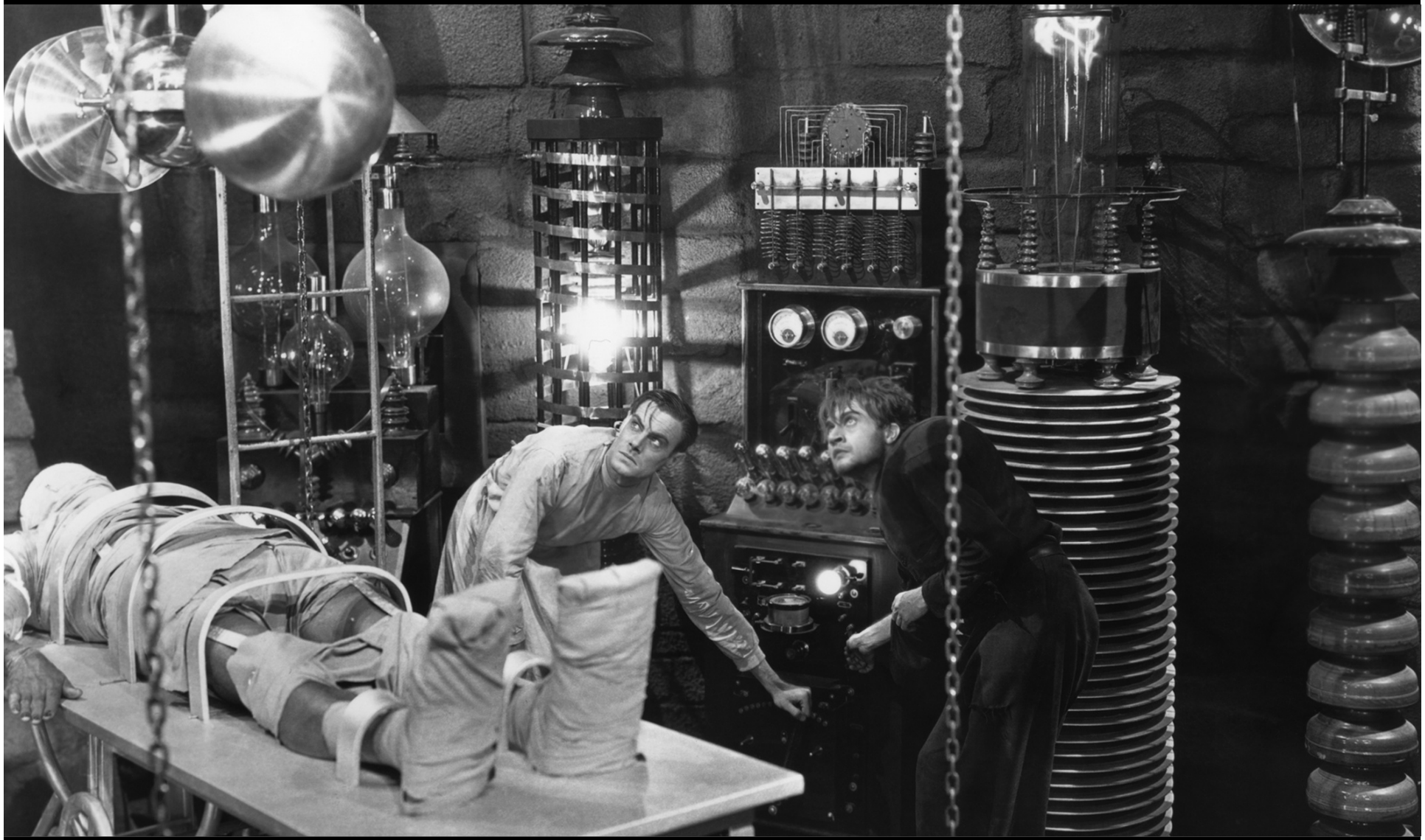
Talk structure

1. Loving our monsters
2. From noun to verb
3. Shared Space

Talk structure

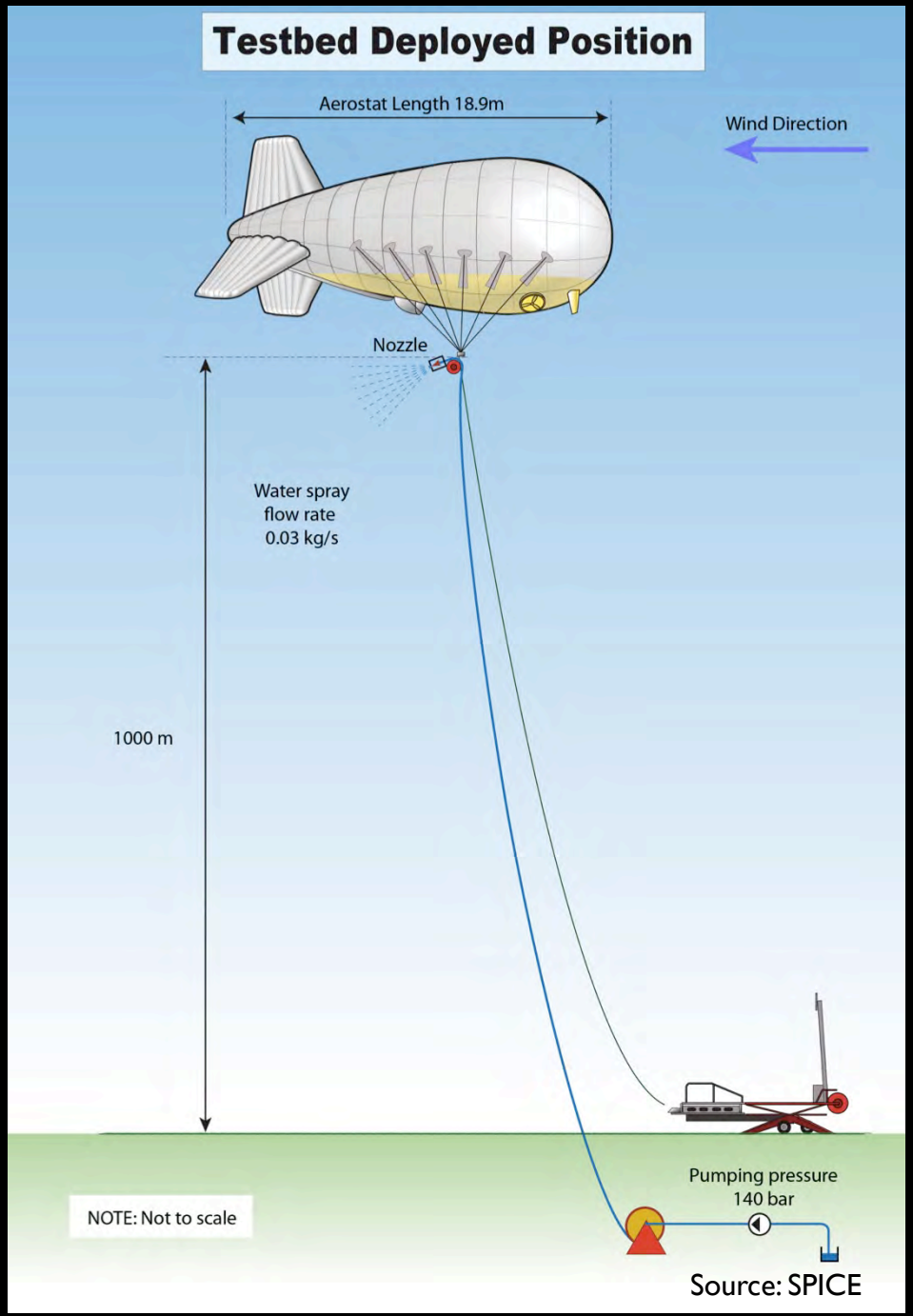
1. Loving our monsters
2. From noun to verb
3. Shared Space

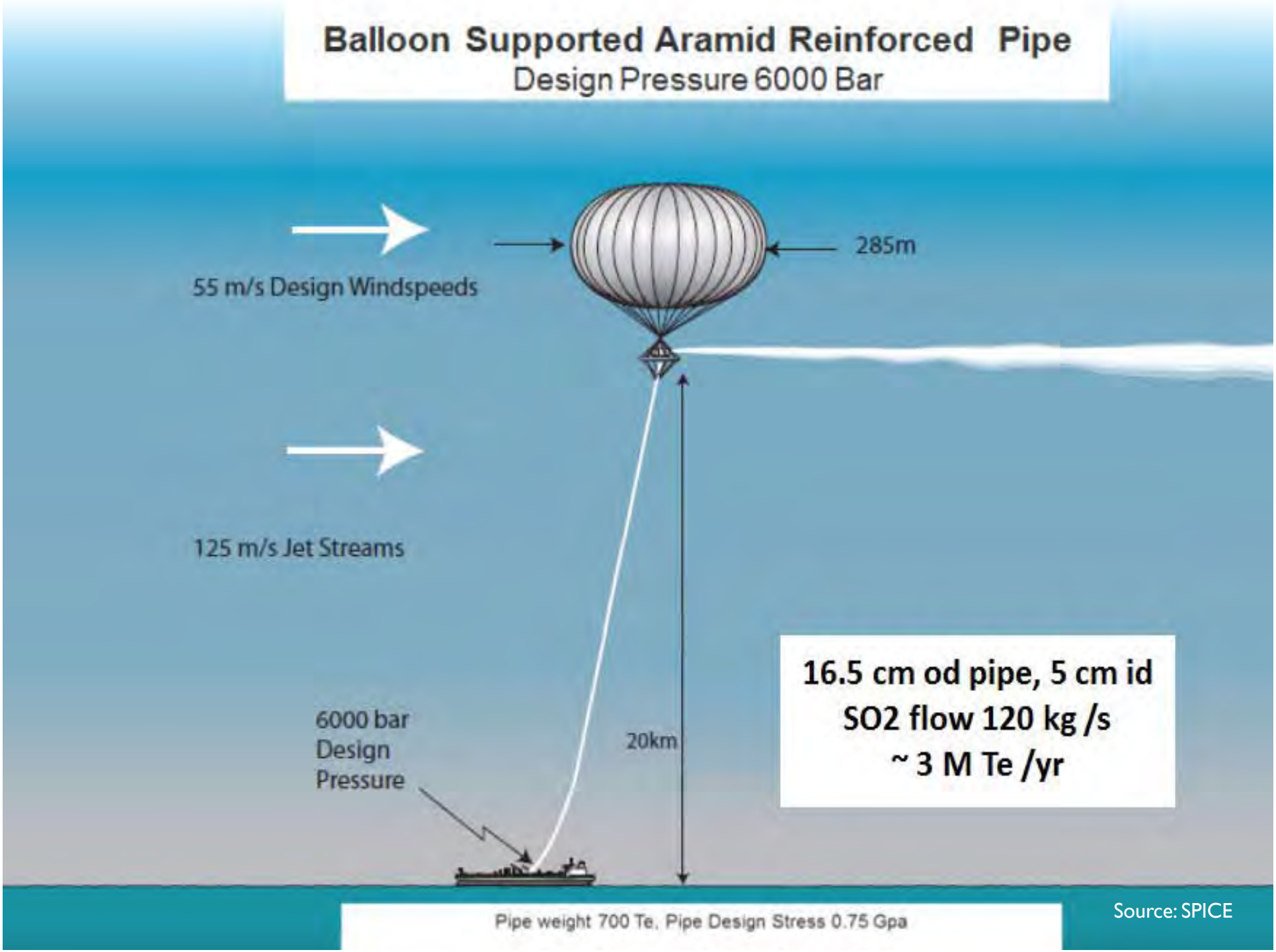
CLVIII — 54




F955HFJ

Stratospheric Particle Injection for Climate Engineering (SPICE)




Balloon Supported Aramid Reinforced Pipe
Design Pressure 6000 Bar
55 m/s Design Windspeeds
285m
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Pressure
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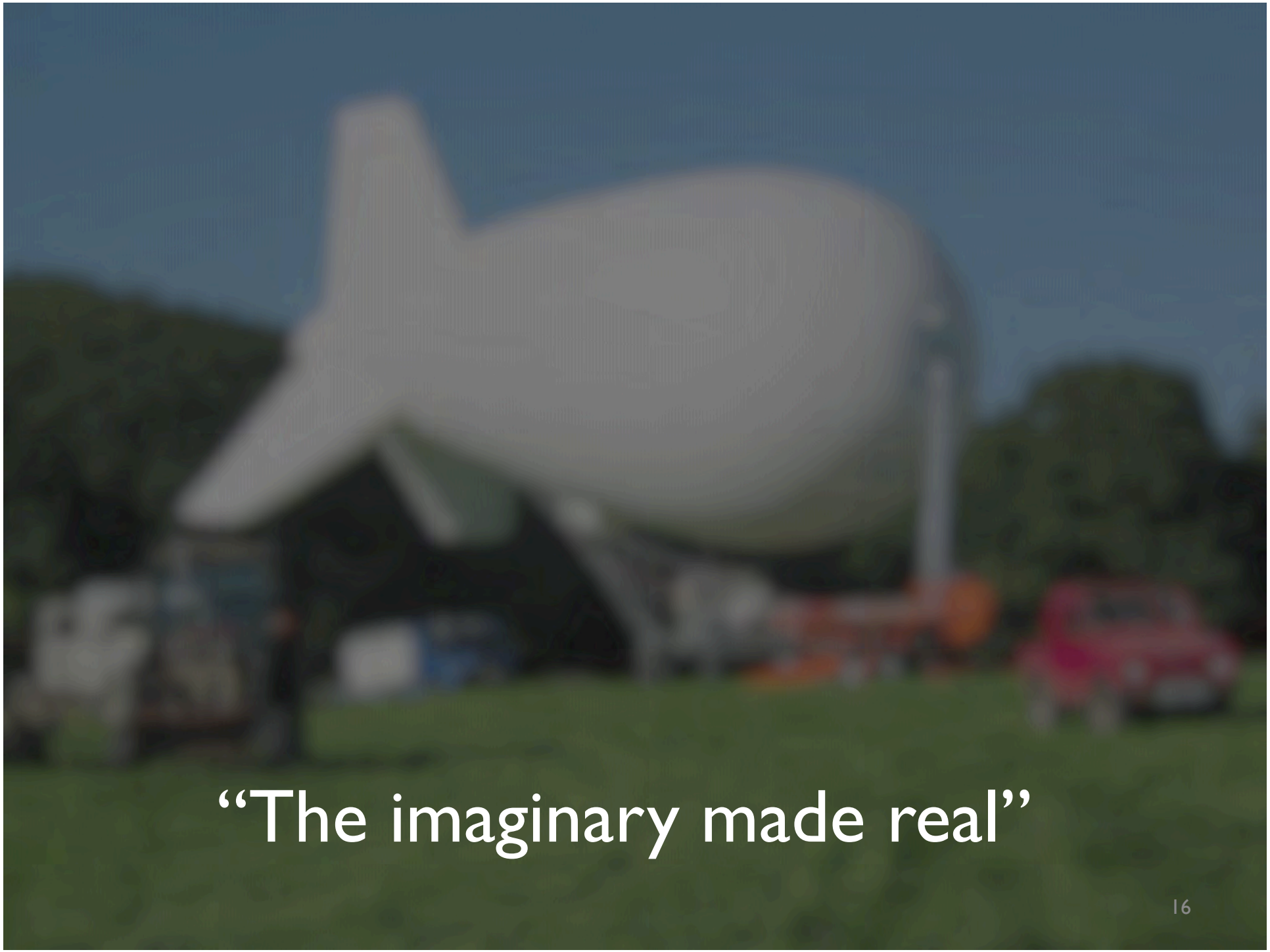
Pipe weight 700 Te, Pipe Design Stress 0.75 Gpa
Source: SPICE



“The imaginary made real”


Aerostat Length 18.9m
Wind Direction
1000 m
Source: SPICE
etc group
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Hose: No SPICE in our skies say
Environmental Justice Groups


Stop Geoengineering!
Hands Off Mother Earth
Our home is not a laboratory


STOPPT
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GENTECHNIK
IM ESSEN!
GREENPEACE
Genexperimente mit Lebensmitteln machen Menschen zu Versuchskaninchen.
Alle Infos unter: www.greenpeace.de/einkaufsnetz


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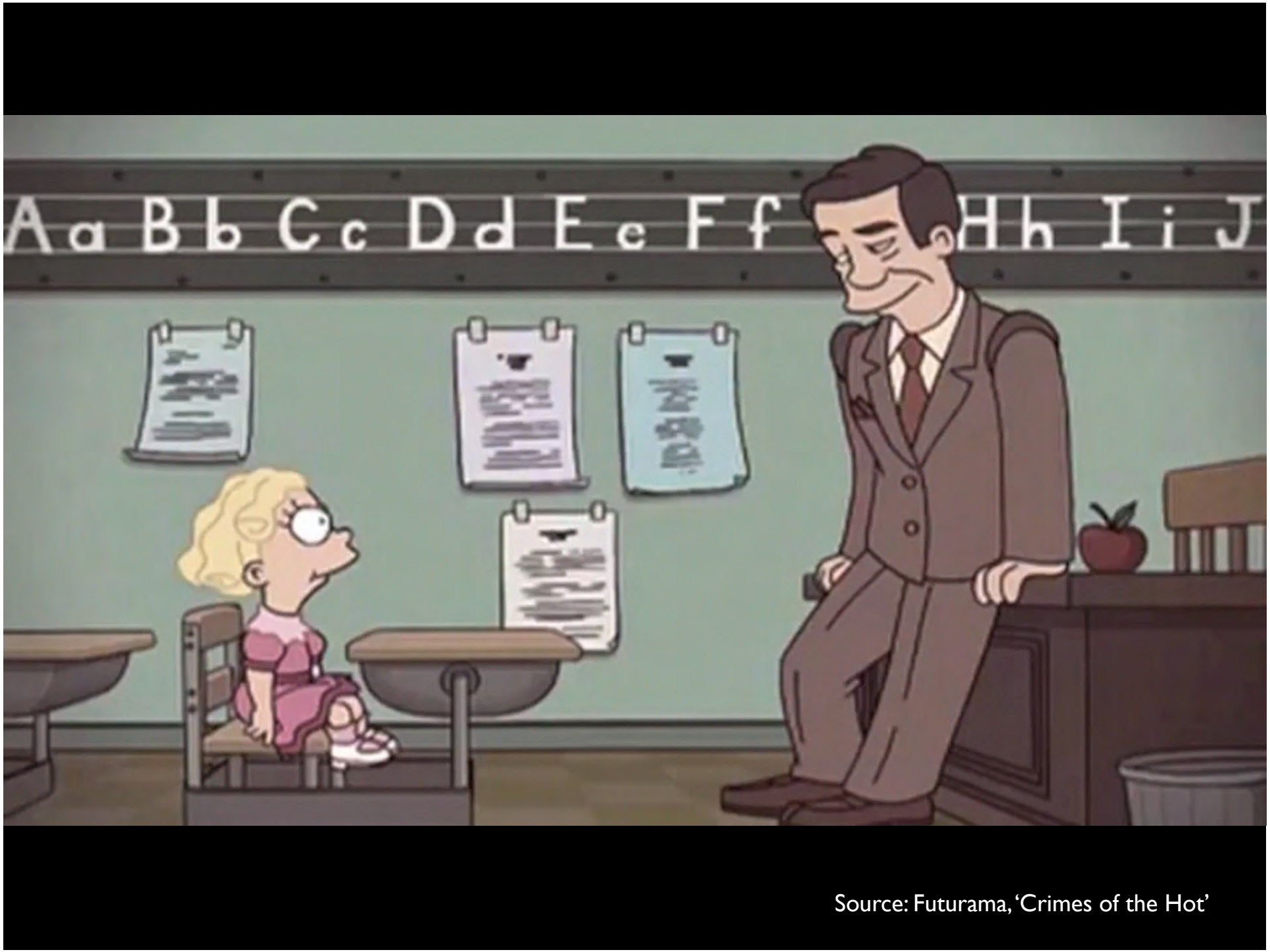
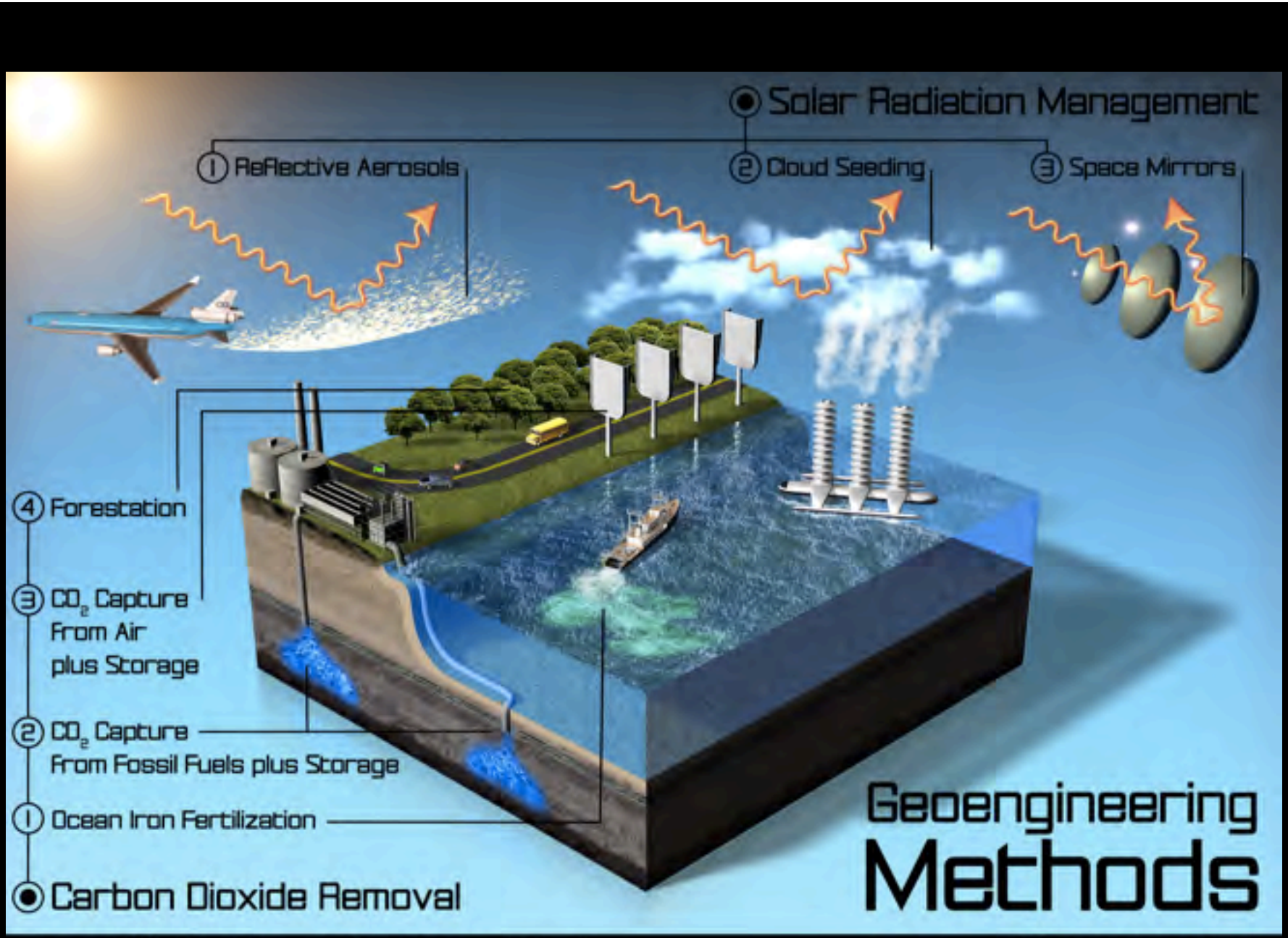
UN FILM DE JEAN-PAUL JAUD
TOUS COBAYES ?
OGM
Avec la voix de
Philippe TORRETON
Librement adapté
de l'ouvrage de
Gilles-Éric SÉRALINI
intitulé Tous cobayes !
Flammarion 2012
AVEC LA PARTICIPATION DU CRTLOG DU PROFESSEUR GILLES-ÉRIC SÉRALINI ET DE MADAME CORINNE LEPAGE SCÉNARIO JEAN-PAUL JAUD PRODUCTION BÉATRICE CAMURAT JAUD DIRECTEUR DE LA PHOTOGRAPHIE CYRIL THÉPENIER SON EMMANUEL GUIONET MONTAGE VINCENT DELORME AVEC LA PARTICIPATION DE CANAL+ AVEC LE CONCOURS FINANCIER DE LA RÉGION POITOU-CHARENTES LA FONDATION LEA NATURE ET GÉNÉRATION FUTURES BJORG ET BONNETERRE (GROUPE DISTRIBORG) NATURALIA SOCIÉTÉ MICHEL PELLETIER LES 2 VACHES SAS MOULIN DE MARION LA FONDATION NATURE VIVANTE ARCADIE SA AVEC LE SOUTIEN DE LA VILLE DE CAEN EN PARTENARIAT AVEC LE CENTRE NATIONAL DU CINÉMA ET DE L'IMAGE ANIMÉE
CANAL+
CNC
BJORG
Bonneterre
CAEN
CERES
DOLBY DIGITAL

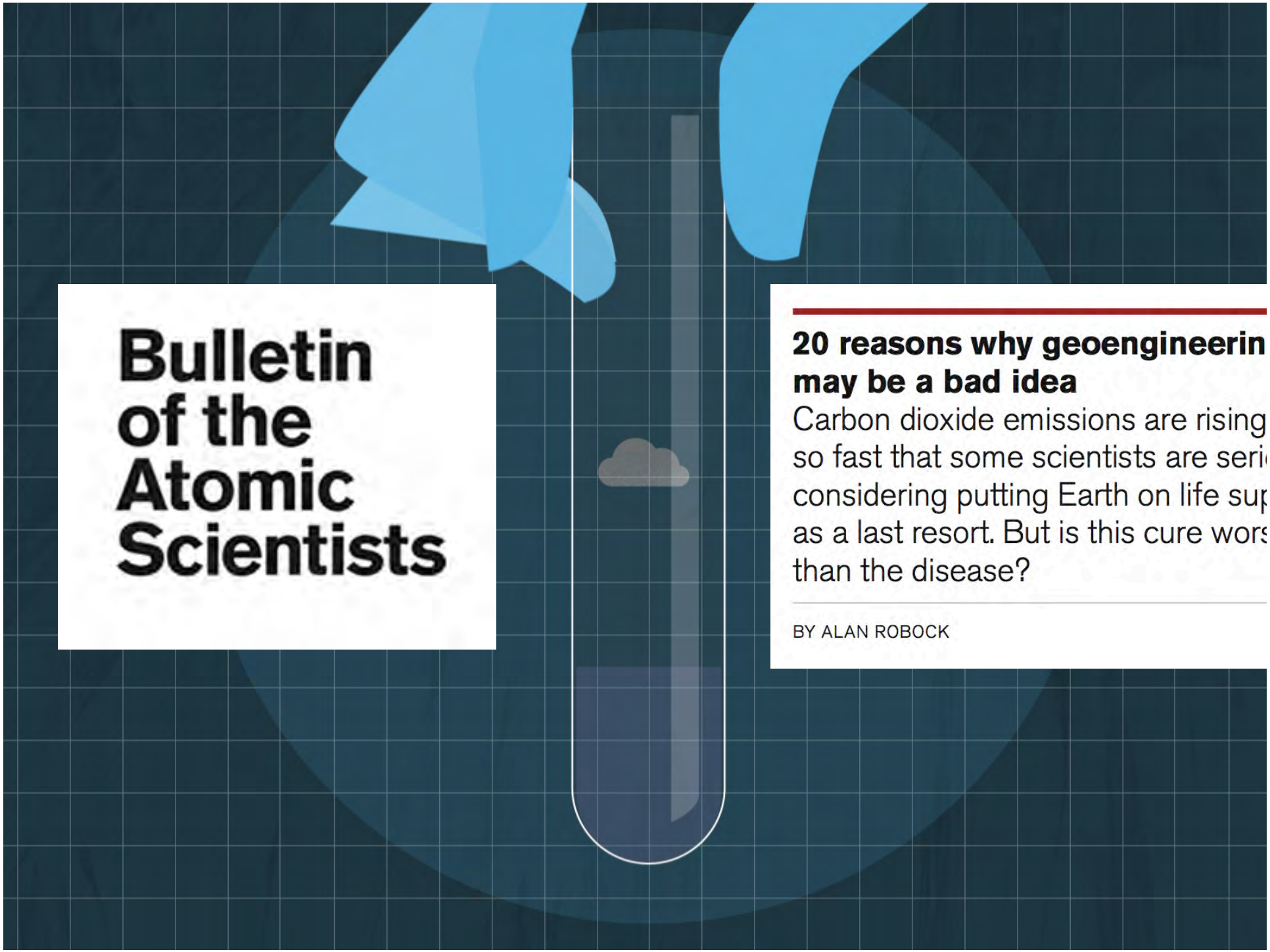


Source: Futurama, 'Crimes of the Hot'



Sources: IPCC / Royal Society | More info: www.get2.cc/5e

climatecentral.org

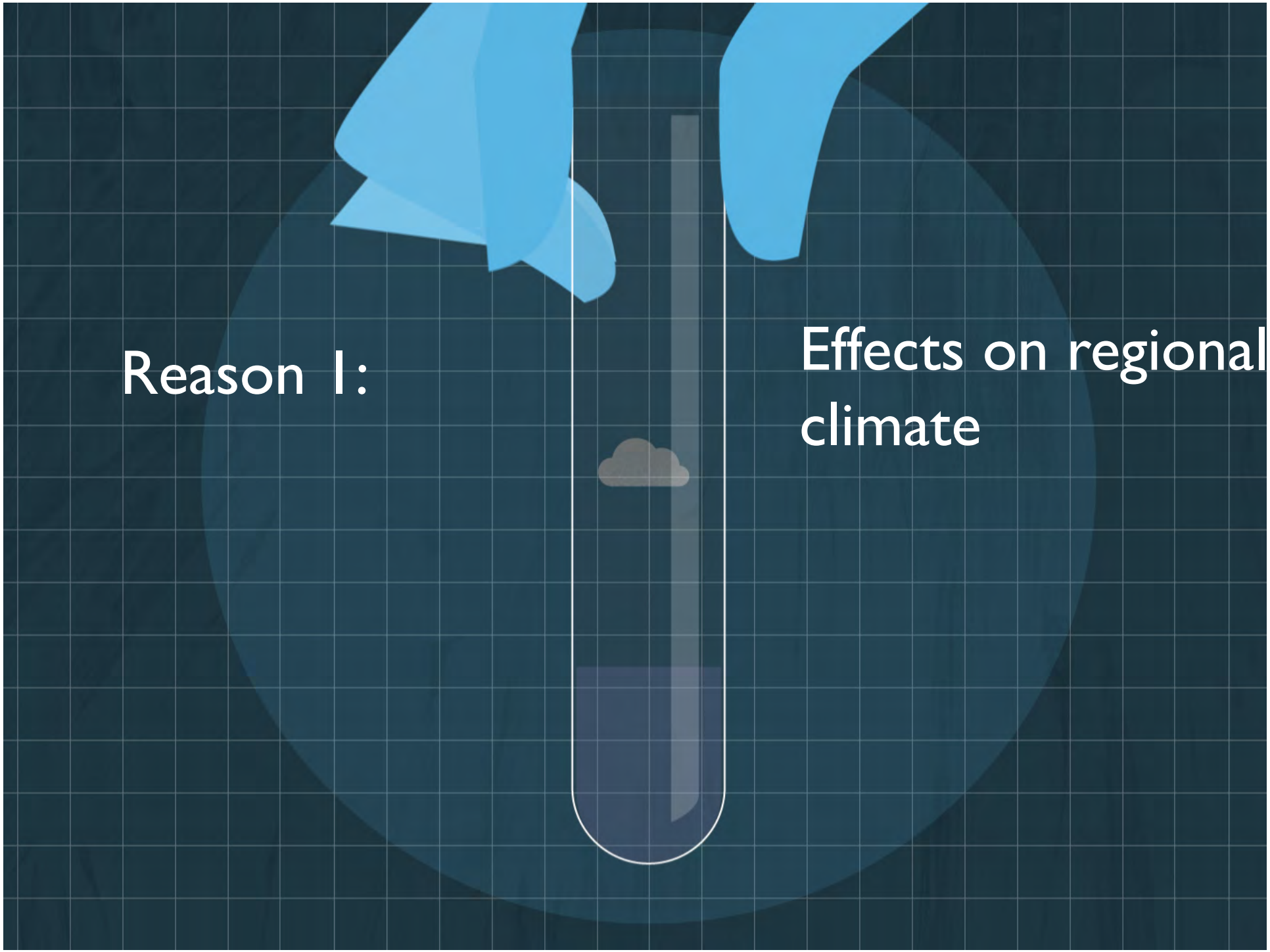


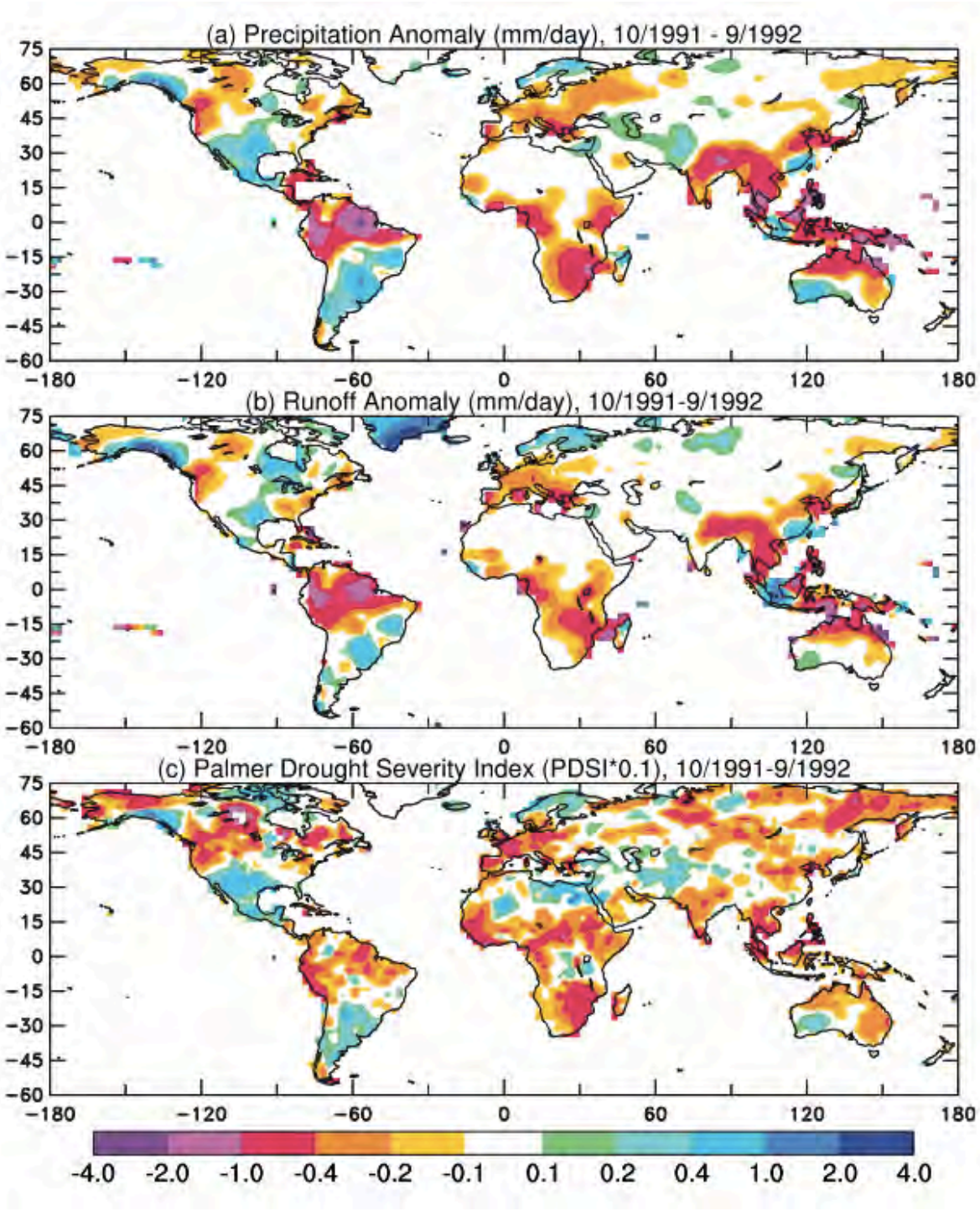
Bulletin of the Atomic Scientists

20 reasons why geoengineerin may be a bad idea

Carbon dioxide emissions are rising so fast that some scientists are seri considering putting Earth on life sup as a last resort. But is this cure wors than the disease?

BY ALAN ROBOCK


Reason 1:
Effects on regional climate

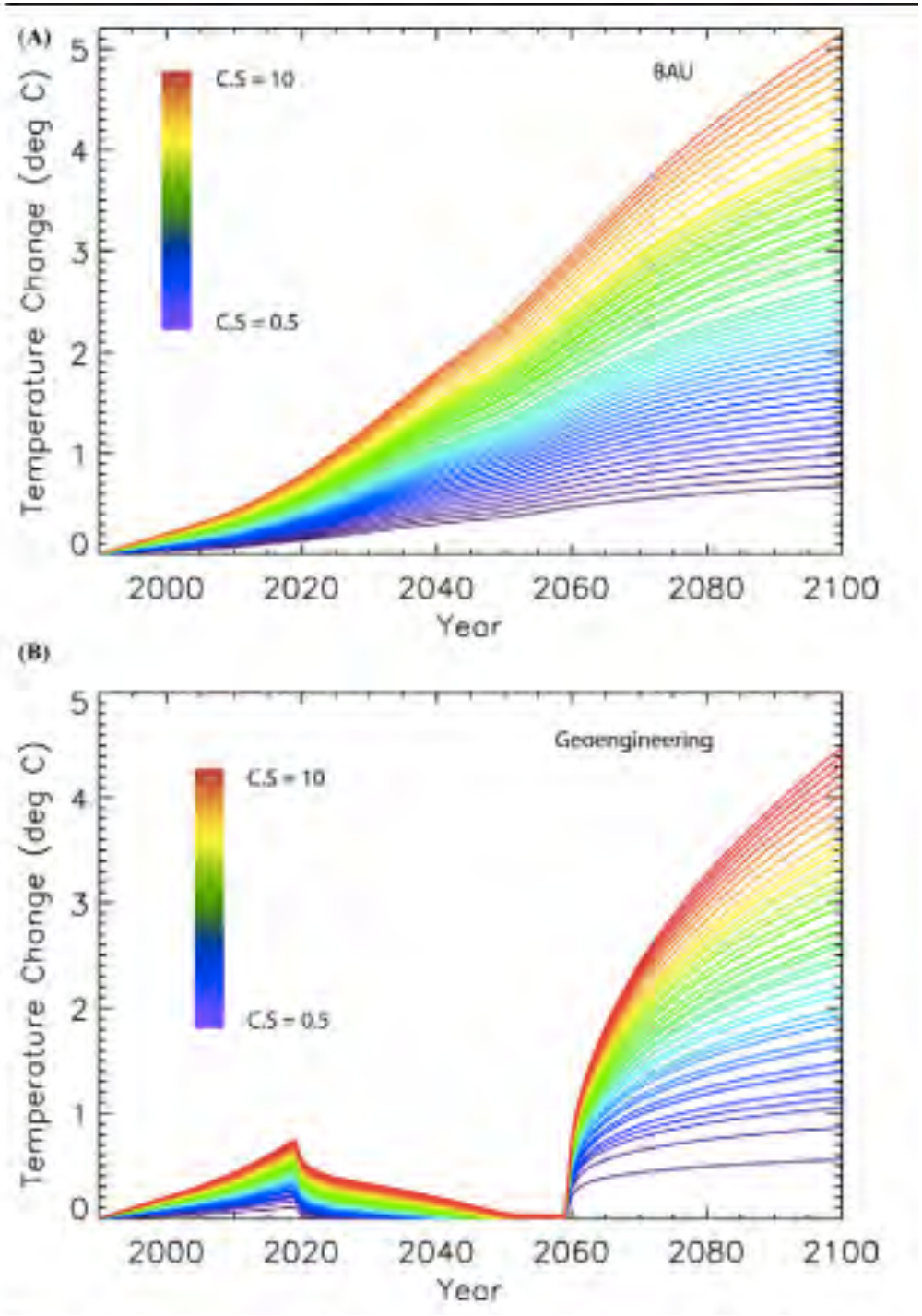


Source: Trenberth and Dai (2007), Effects of Mount Pinatubo volcanic eruption on the hydrological cycle *Geophys. Res. Lett.*


Reason 2:
Continued ocean acidification


Reason 11:
There's no going back

‘Termination shock’



Source: Ross & Matthews (2009).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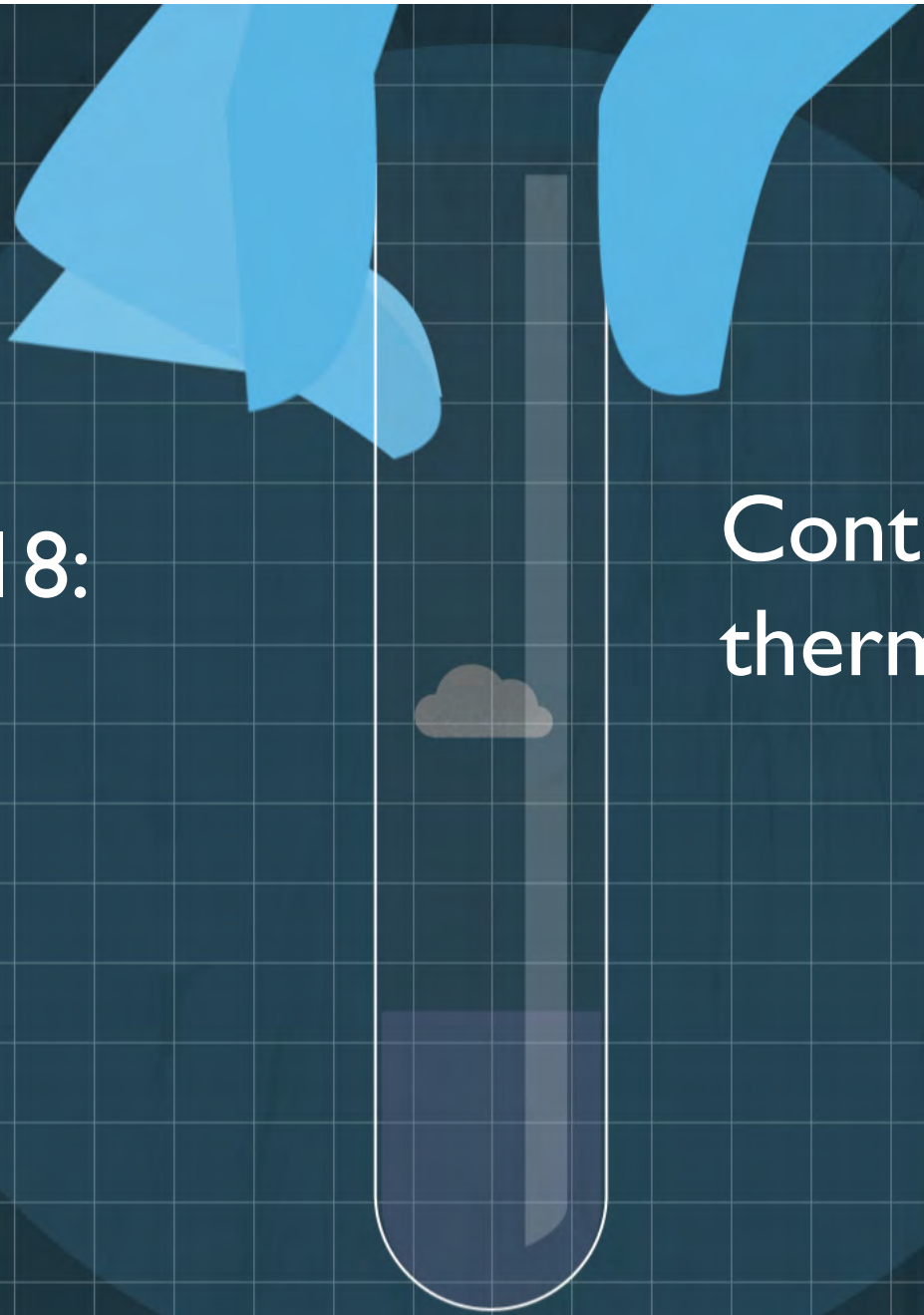
Reason 18:

Control of the thermostat




Reason 20:
Unexpected consequences

Community Chest

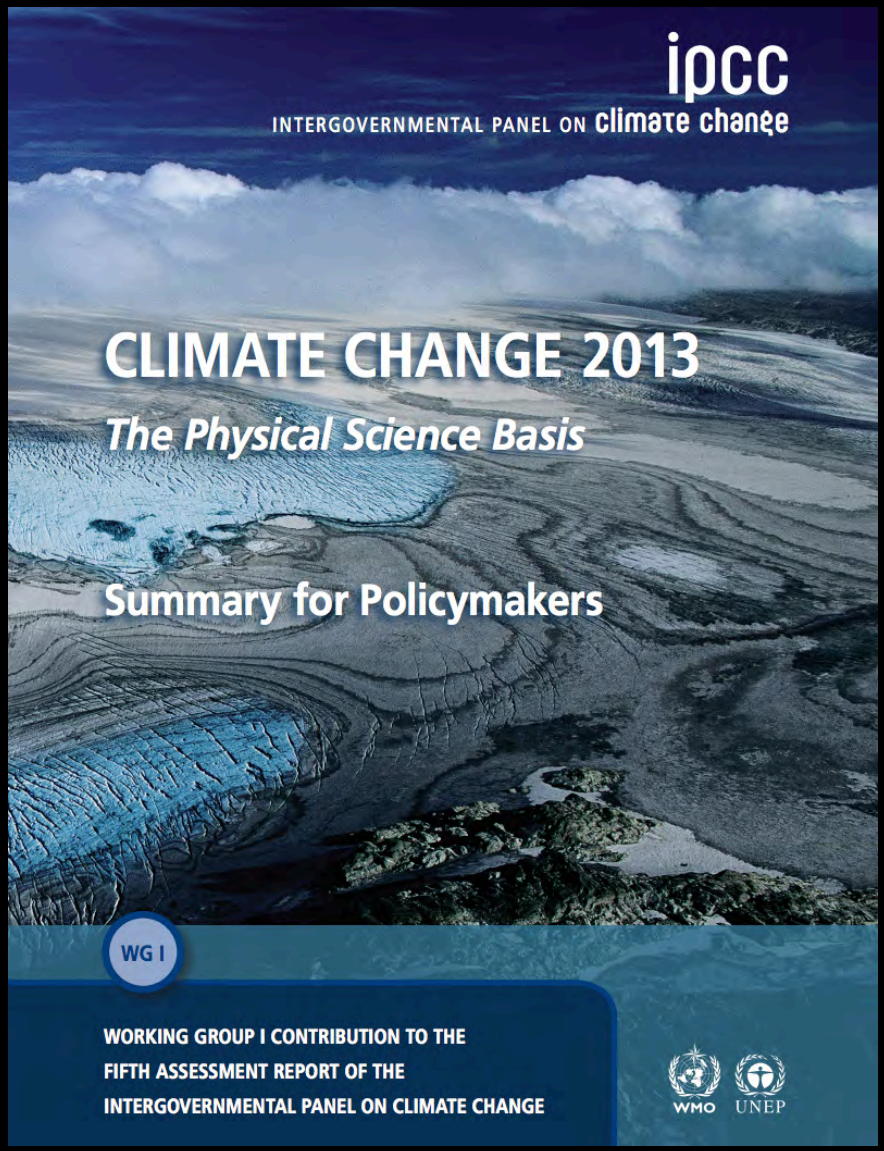
GET OUT
OF JAIL, FREE

THIS CARD MAY BE KEPT UNTIL NEEDED OR SOLD

Talk structure

1. Loving our monsters
2. From noun to verb
3. Shared Space

‘Methods that aim to deliberately alter the climate system to counter climate change, termed geoengineering, have been proposed… Modelling indicates that SRM methods, if realizable, have the potential to substantially offset a global temperature rise, but they would also modify the global water cycle, and would not reduce ocean acidification… CDR and SRM methods carry side effects and long-term consequences on a global scale.’



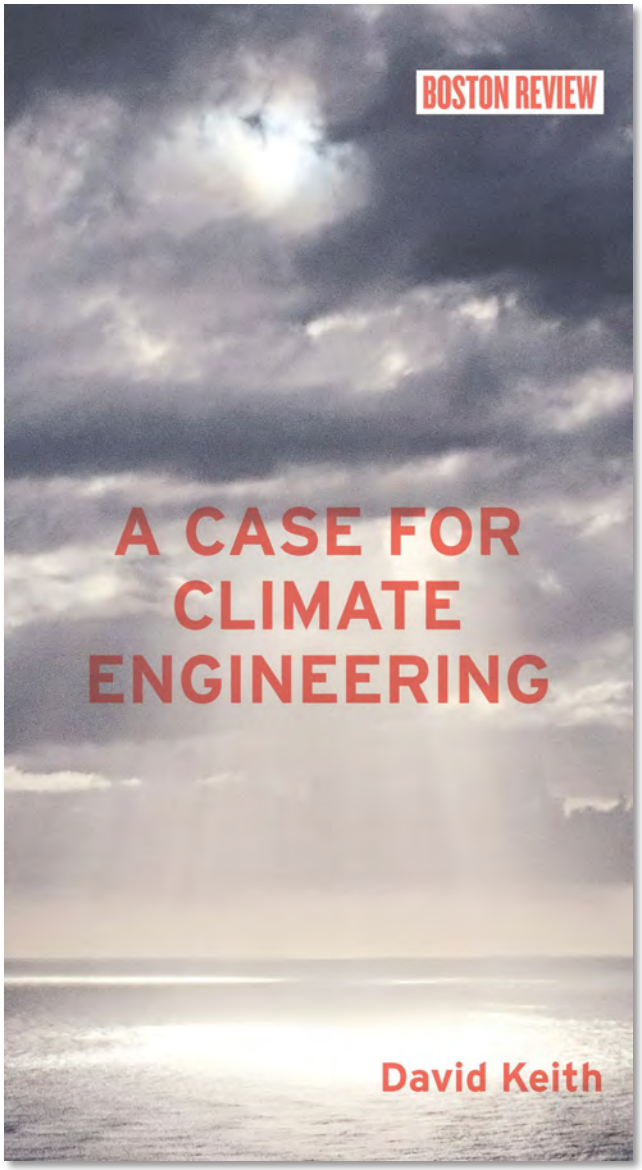
Naturalising geoengineering

"Research be considered separately from implementation… We should proceed as we would for any other scientific problem, at least for theoretical and modeling studies"

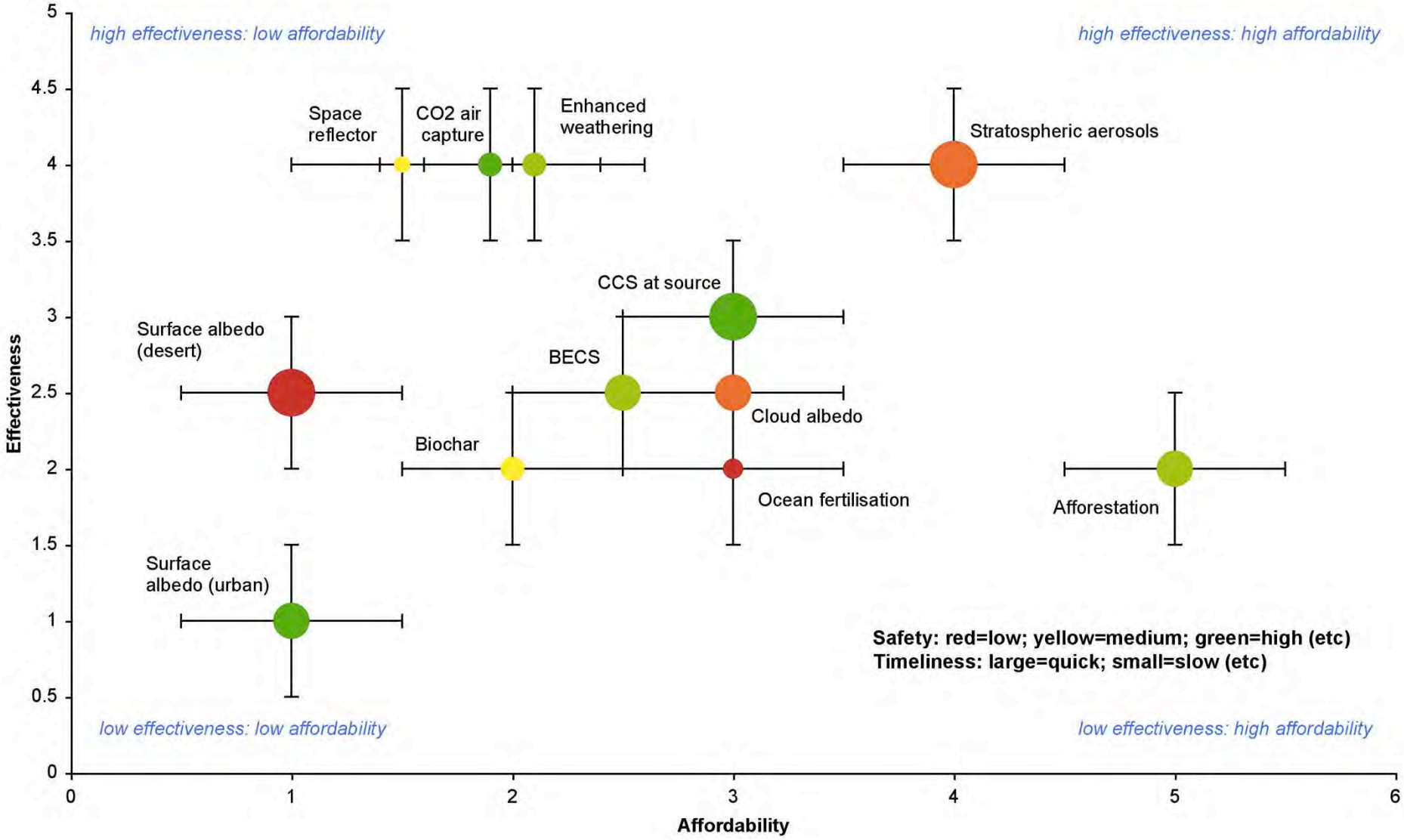
Ralph Cicerone, 2006

Geoengineering as inevitable

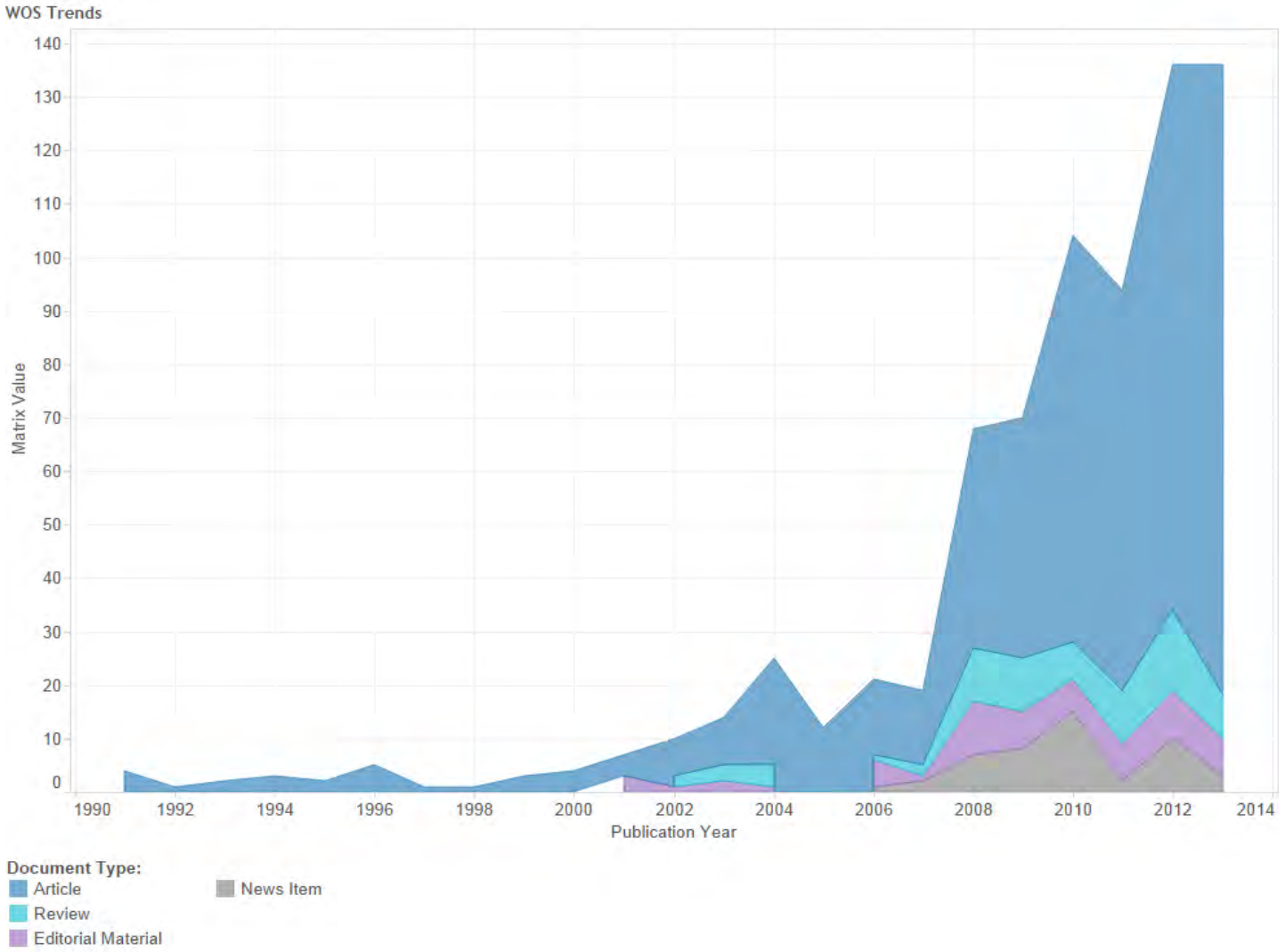
‘It is possible to cool the planet by injecting reflective particles of sulfuric acid into the upper atmosphere where they would scatter a tiny fraction of incoming sunlight back to space, creating a thing sunshade for the ground beneath… it is cheap and technically easy.’

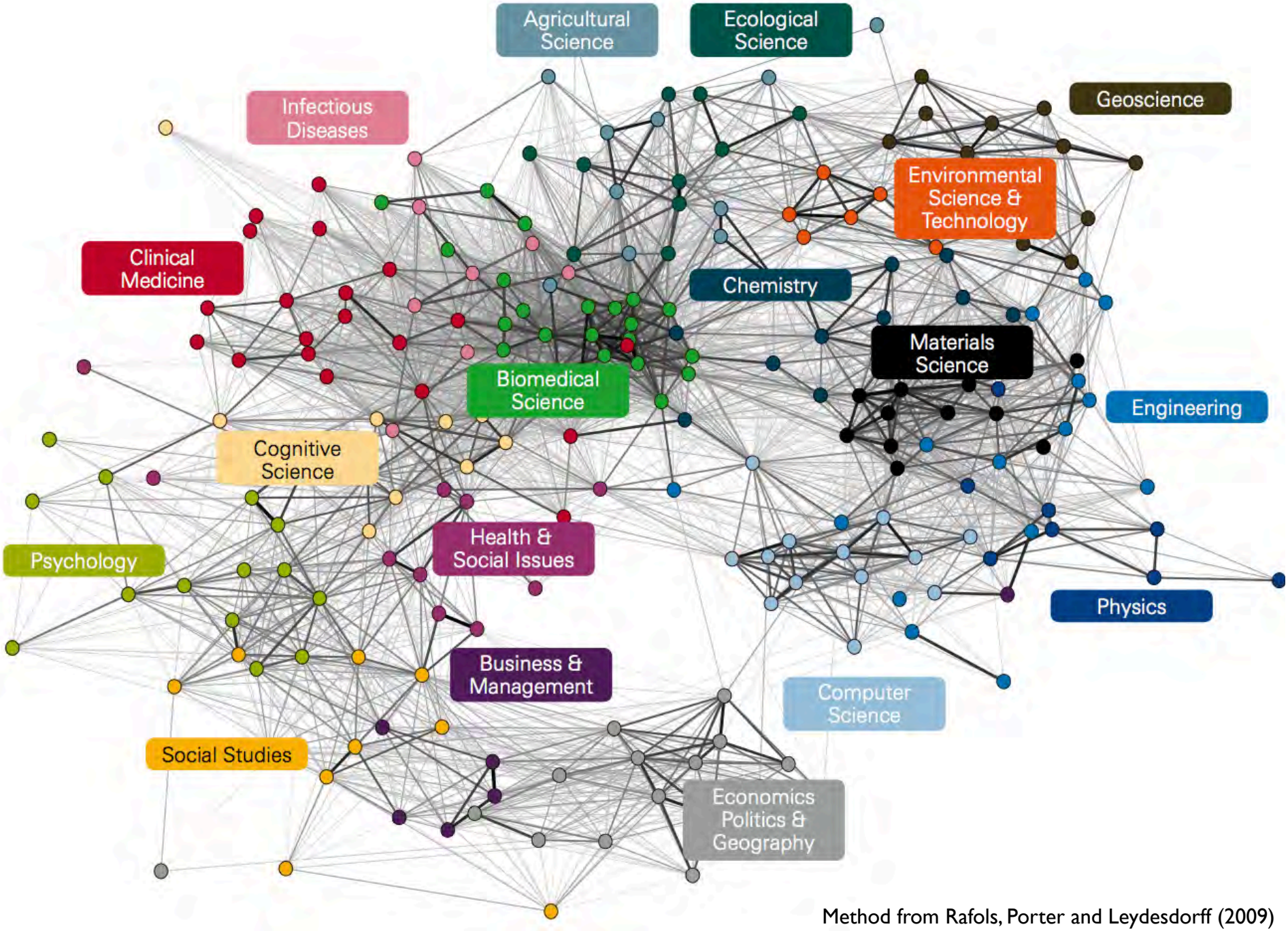


Royal Society, 2009



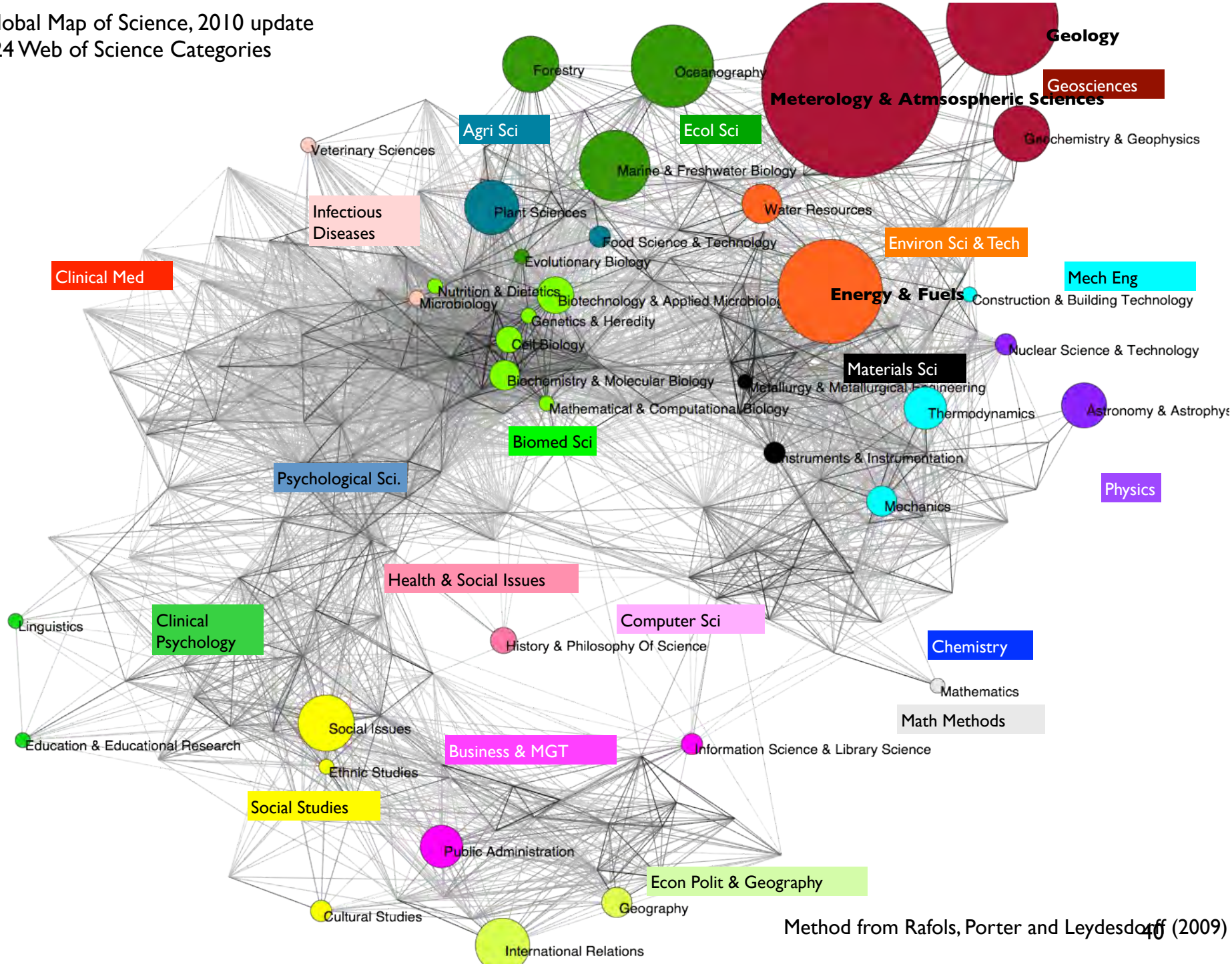
Geoengineering publications by year (Oldham et al 2014)





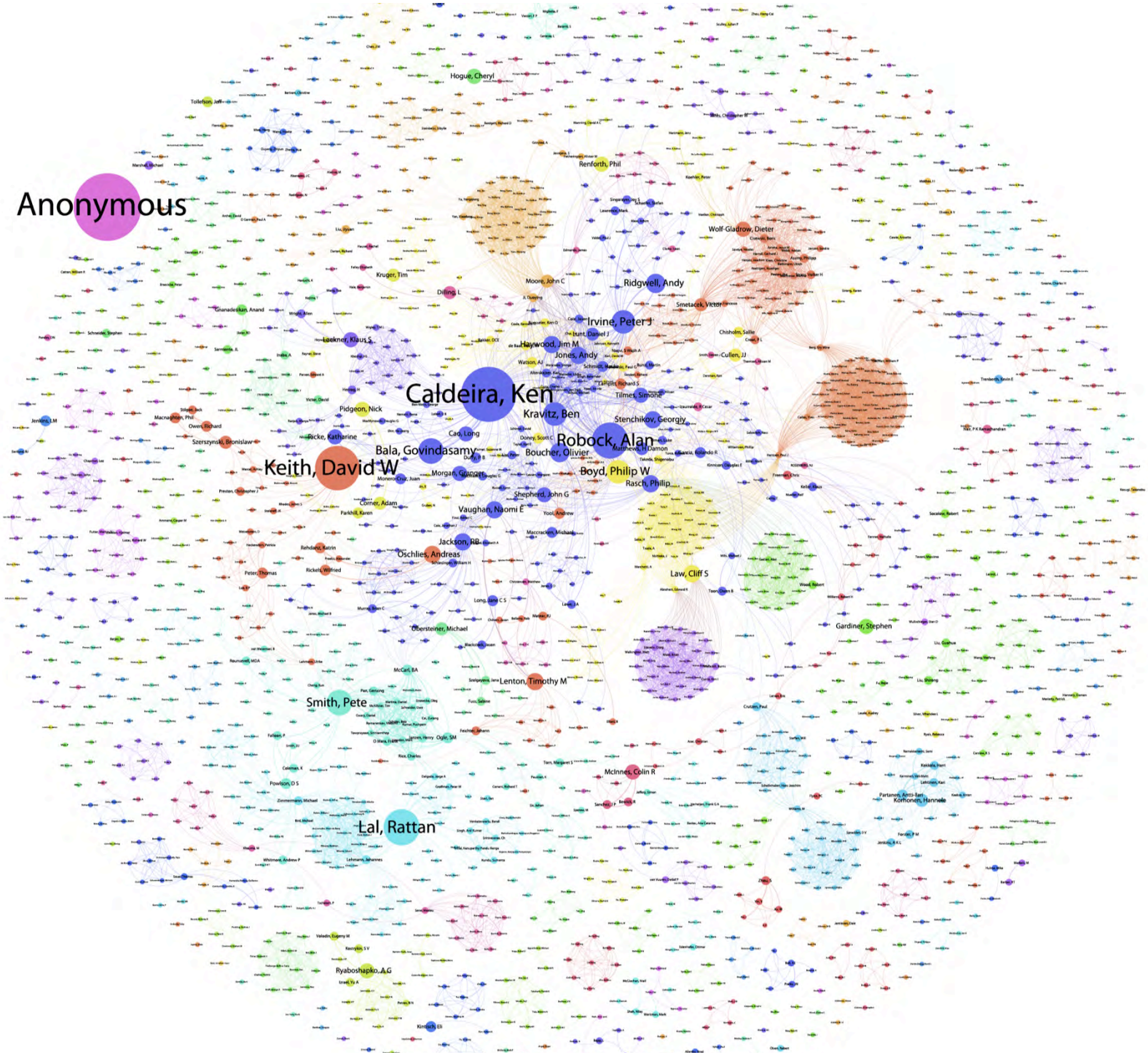
Method from Rafols, Porter and Leydesdorff (2009)

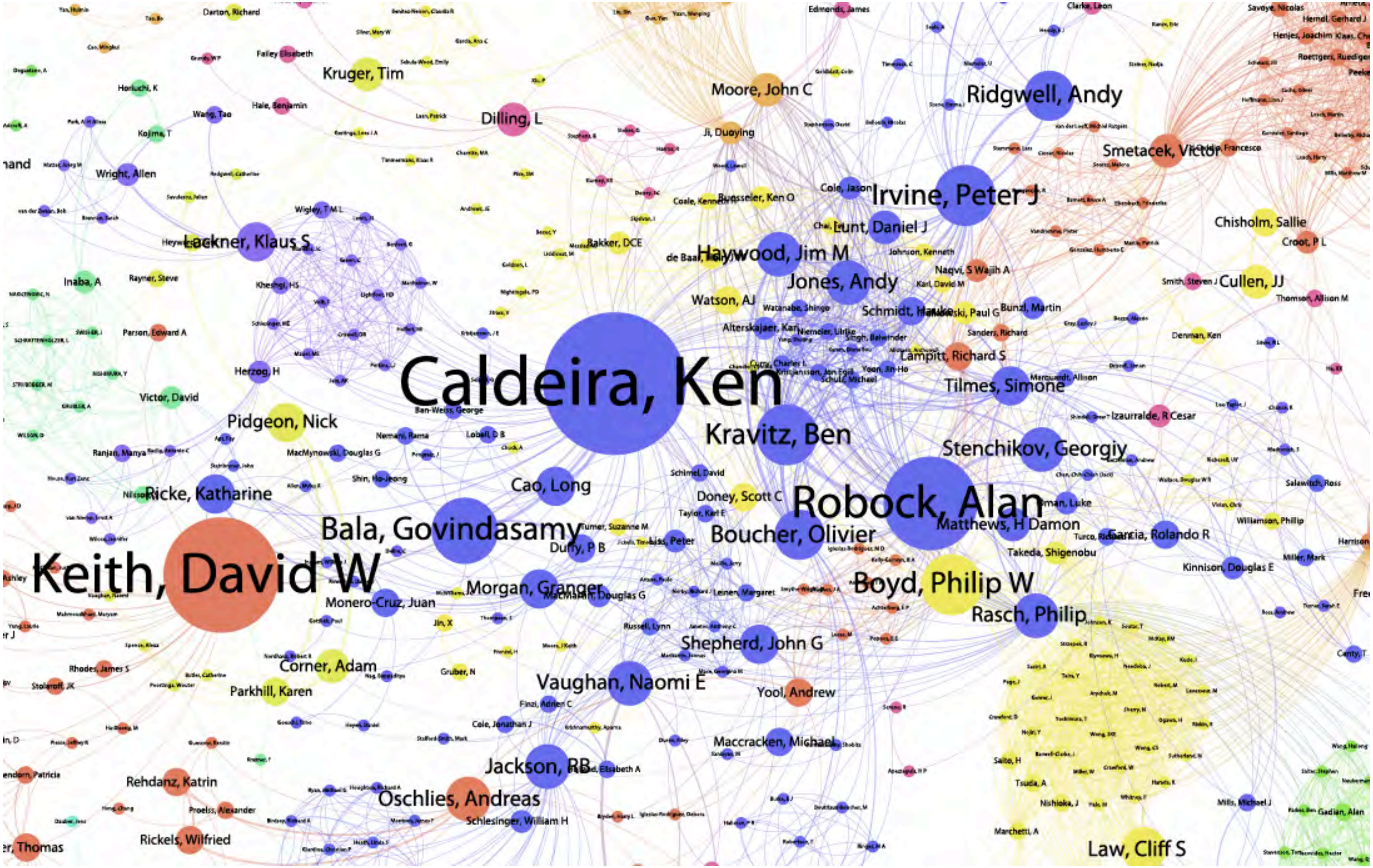
Global Map of Science, 2010 update
224 Web of Science Categories



Method from Rafols, Porter and Leydesdorff (2009)

Author networks





Caldeira, Ken
Keith, David W
Robock, Alan
Bala, Govindasamy
Irvine, Peter J
Kravitz, Ben
Haywood, Jim M
Jones, Andy
Ridgwell, Andy
Smetacek, Victor
Boyd, Philip W
Rasch, Philip
Stenchikov, Georgiy
Boucher, Olivier
Tilmes, Simone
Lackner, Klaus S
Vaughan, Naomi E
Jackson, RB
Oschlies, Andreas
Morgan, Granger
Shepherd, John G
Cao, Long
Ricke, Katharine
Pidgeon, Nick
Corner, Adam
Parkhill, Karen
Moore, John C
Dilling, L
Kruger, Tim
Lunt, Daniel J
Schmidt, Hauke
Lampitt, Richard S
Matthews, H Damon
Garcia, Rolando R
Maccracken, Michael
Yool, Andrew
Rehdanz, Katrin
Rickels, Wilfried
Schlesinger, William H
Monero-Cruz, Juan
Chisholm, Sallie
Cullen, JJ
Law, Cliff S
Watson, AJ
Duffy, P B
Takeda, Shigenobu
Wright, Allen
Inaba, A
Victor, David
Parson, Edward A
Herzog, H
Kinnison, Douglas E
Izaurralde, R Cesar
Bunzl, Martin

From noun to verb

	Regime of technoscientific promises	Regime of collective experimentation
'Geoengineering'	…as noun	…as verb
Theory of technology	Instrumentalism	Substantivism/critical theory
Responsibilities of researchers	Risk/benefit assessment	Implicated in realising futures
Role of social science	Anticipating controversies	Interrogating trajectories
Approach to uncertainty	Uncertainties seen as soluble through further research	Uncertainty seen as contested, inevitable and expanding
Approach to ethics	Speculative ethics and technology assessment	'Technology accompaniment'
Characterising problems	'Solutionism': problems are assumed rather than explored	Reflexive approaches to problem identification and definition
Construction of public concerns	Technological development and perturbative experimentation	Open-ended, but may include imaginaries
Relationship between research and use	Scientific research is divorced from technological deployment	Research and deployment are entangled in the same social experiment
Relevant uncertainties	Implications of geoengineering	Implications, costs, feasibility, design
Governing experiments	Creating a 'safe space' for research	Engaging with entanglements
Experimental systems	Bounded by science	Including publics, politics, ecosystems and scientists themselves

Talk structure

1. Loving our monsters
2. From noun to verb
3. Shared Space

Could geoengineering be tested?

NO

(Robock et al 2010)

- Impossible except with full deployment

YES

(MacMynowski et al 2011)

- With careful scaling up and pulsing

'Noise is only a signal which you have not learned to decode yet'

(Stephen Salter)

AGU PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER
10.1002/2014GL062240

Key Points:
- Large sustained emissions of SO_2 would be required to recover Arctic sea ice
- Decision process critical to managing uncertainties of geoengineering deployment
- Climate side effects unavoidable and problematic to quantify

Supporting Information:
- Figure S1
- Figure S2
- Figure S3
- Figure S4
- Figure S5
- Figure S6
- Tables S1 and S2
- Text S1

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Assessing the controllability of Arctic sea ice extent by sulfate aerosol geoengineering

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[1]Institute for Climate and Atmospheric Science, School of Earth and Environment, University of Leeds, Leeds, UK, [2]Lancaster Environment Centre, Lancaster University, Lancaster, UK, [3]School of Geographical Sciences, University of Bristol, Bristol, UK, [4]Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK

Abstract In an assessment of how Arctic sea ice cover could be remediated in a warming world, we simulated the injection of SO_2 into the Arctic stratosphere making annual adjustments to injection rates. We treated one climate model realization as a surrogate "real world" with imperfect "observations" and no rerunning or reference to control simulations. SO_2 injection rates were proposed using a novel model predictive control regime which incorporated a second simpler climate model to forecast "optimal" decision pathways. Commencing the simulation in 2018, Arctic sea ice cover was remediated by 2043 and maintained until solar geoengineering was terminated. We found quantifying climate side effects problematic because internal climate variability hampered detection of regional climate changes beyond the Arctic. Nevertheless, through decision maker learning and the accumulation of at least 10 years time series data exploited through an annual review cycle, uncertainties in observations and forcings were successfully managed.

Mike Hulme

can science fix climate change?

Geoengineering in public focus groups
(Macnaghten and Szerszynski, 2012)

Kathy: *Yeah. The experiment will be while we're here... and... for our children. What if the experiment goes wrong? Then what happens?*

Lorraine: *Do you think it could destroy the Earth?*

Kathy: *Yeah, it could go the other way. How can you test...? Can it be tested in a laboratory? But then it's got to go out there.*

Mod: *Yeah, sure. So that's the big question for you. We'll be living the experiment, in a sense. Is that what you're saying?*

Kathy: *Yeah.*

Nicole: *We're the lab rats.*

"As the French molecular biologist François Jacob once marvelously put it, [experiments] are systems "for concocting expectation," or "machines for making the future."

Hans-Jorg Rheinberger, 2003

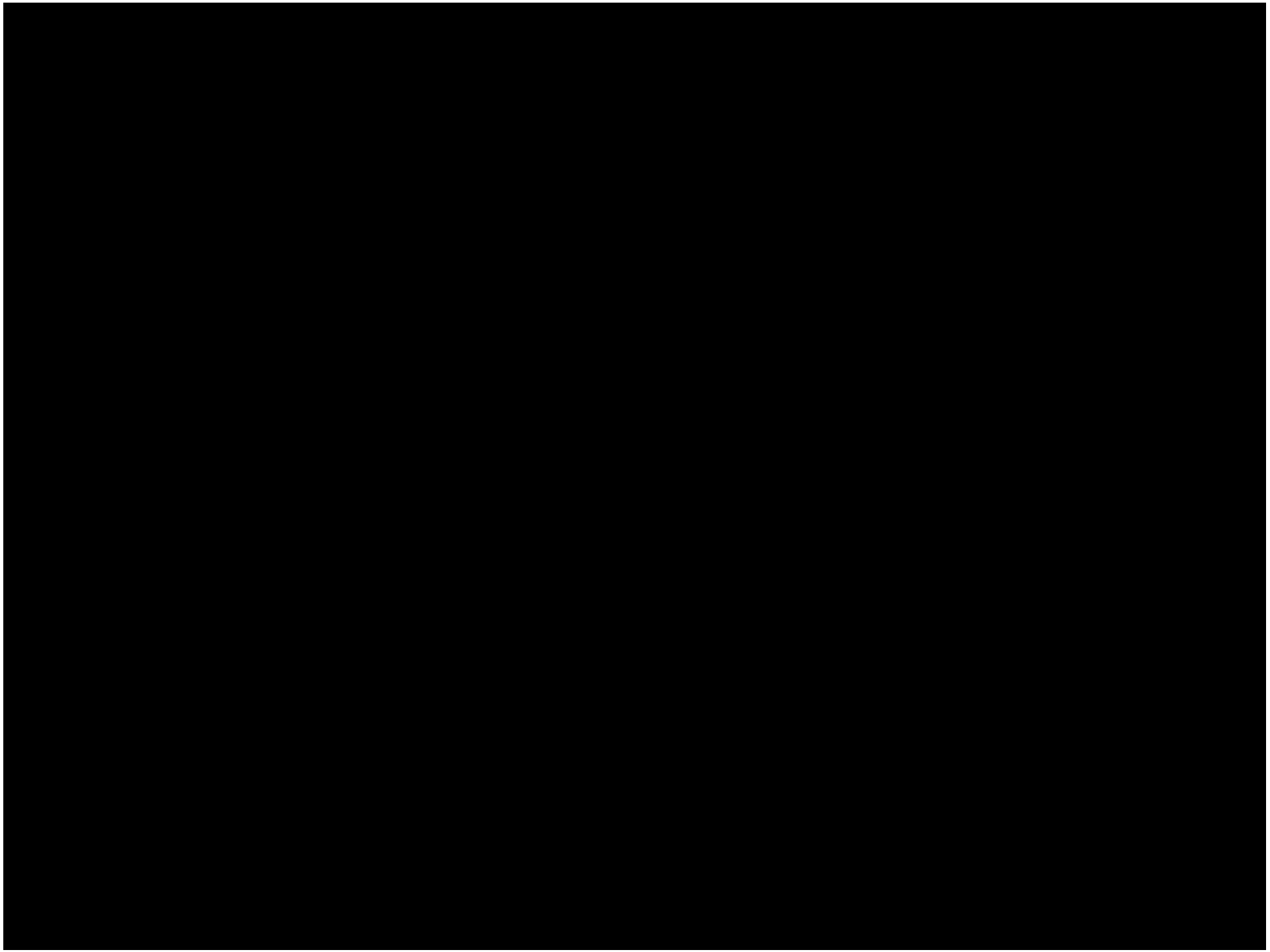
‘When we all stand in that field in Norfolk, all of the engineers will be jumping up and down because they’ve succeeded in doing something amazing, building the tallest structure anywhere on earth, and all of the natural scientists will be saying ‘Oh shit, we’re a step closer to doing something bonkers’.’

SPICE scientist

‘Safe space’

‘Shared space’


The End
It's a
Universal
Picture



An imagined 'governance gap'

"I think the science is certainly far out ahead of the politics"

Jason Blackstock, talking in 2012

"Right now, the politics of geoengineering are far ahead of the science"

David Victor and colleagues, writing in Foreign Affairs, 2013

Against speculative ethics

- Fleming: geoengineering is 'geo-scientific speculation'
- To which we add speculative ethics and social science
- Turns the 'if' into a 'when'
- But we still need anticipatory governance (cf Guston 2014, Nordmann 2014)