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IFoA and Global Challenges Foundation Workshop on Global Risks – Climate Change

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Chair, Research Committee for the IFoA's Resource and Environment Board

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Global Risks – Climate Change

1. **Why are actuarial skills useful for thinking about climate change risk?**
2. Climate change risk
3. Implications for policy post-Paris Cop 21

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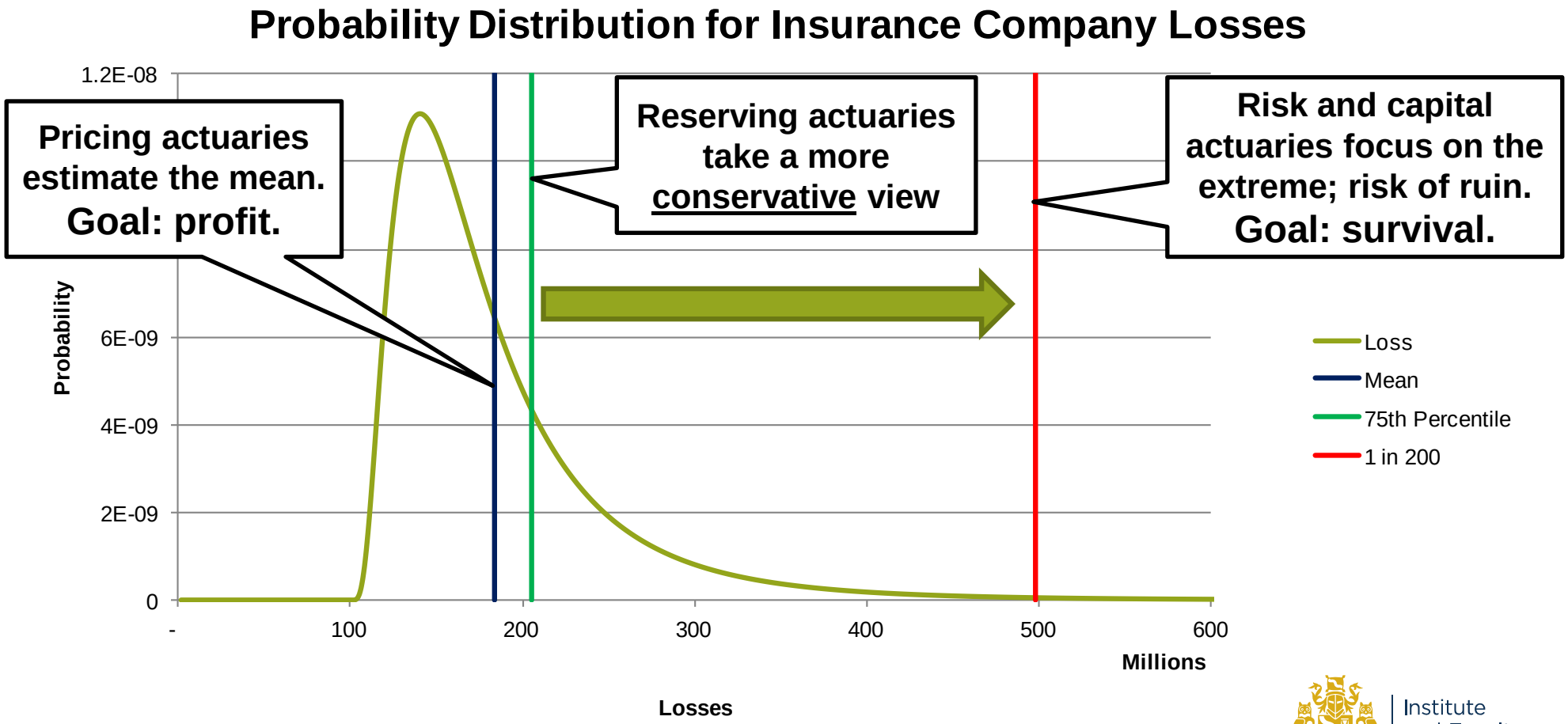
Actuaries evaluate insurance risk

Two of the largest ever insurance losses:

World Trade Center 9th Sept 2001

Hurricane Katrina, August 2005

Roles of Insurance Actuaries



These values are to scale for this probability distribution.

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Actuarial Skillset

- Base decisions on data/attempt to remove bias – have to be aware of human factors ("Making actuaries less human")

  e.g. avoidance of anchoring

- Forecasting the future (needs humility!)
  - "It's tough to make predictions, especially about the future."
- Estimating risk and handling uncertainty

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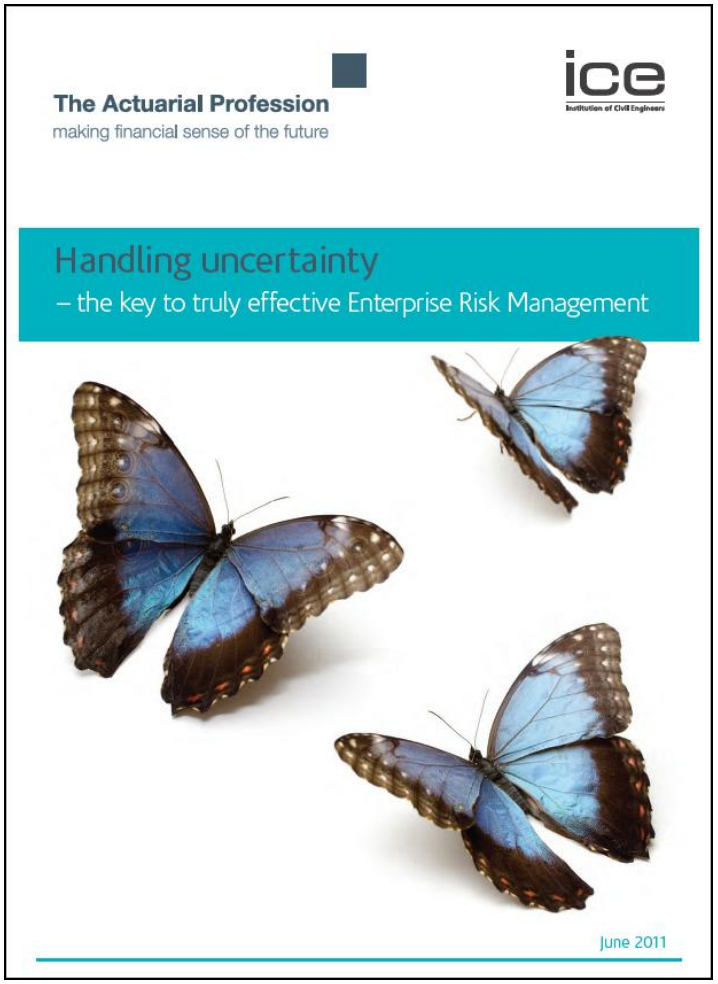
Risk vs Uncertainty



- How can we handle uncertainty, i.e. where the probability distribution is not known?
- Need to understand models.

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Source: Institution of Civil Engineers and Institute & Faculty of Actuaries, Risk Analysis and Management for Projects (RAMP) collaboration

Actuarial Skillset

- Often think long term (for life insurance and pensions)
- Often use discounting
- Frequent use of models; try to understand model risk

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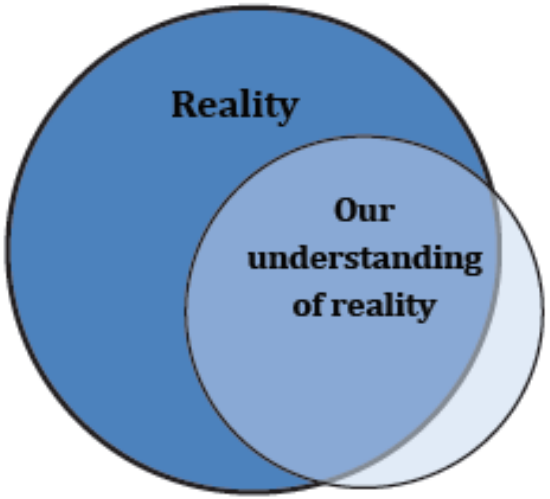
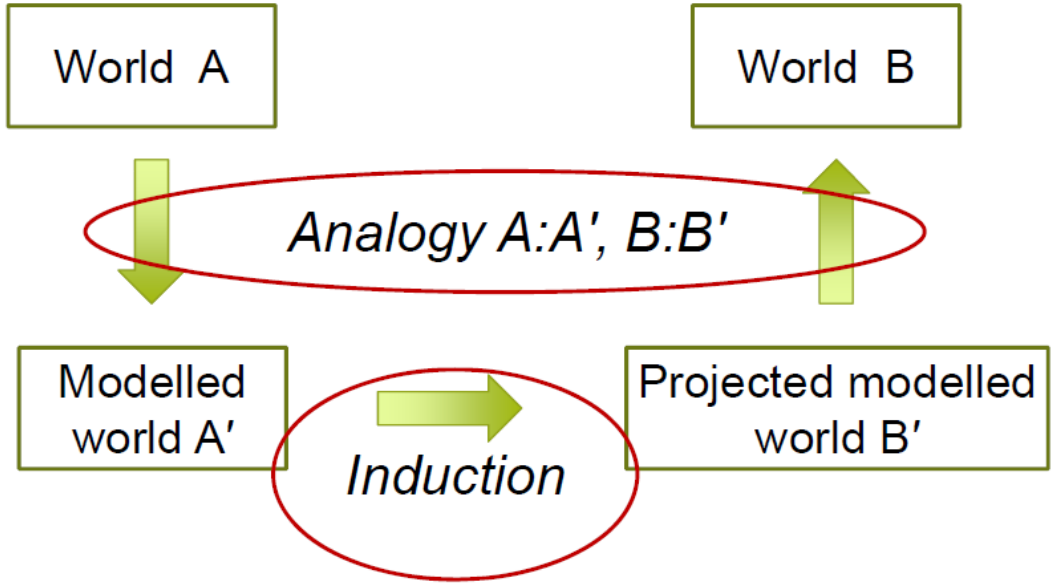
Issues of Risk Modelling – "The Philosophy of Modelling"

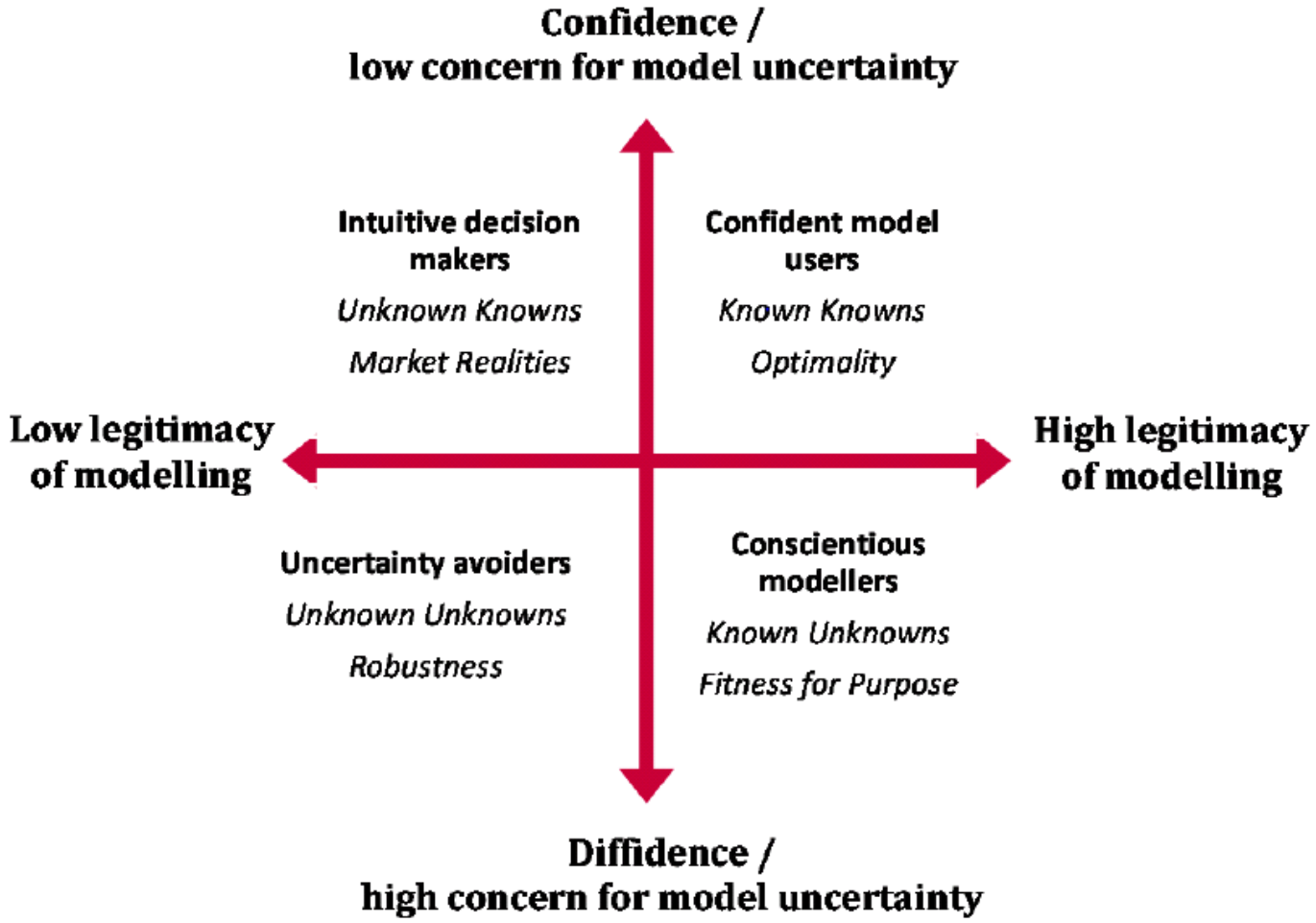
Probability range of model output is the range from the model, not the range of outcomes for the modelled system.





Diagrams from 'The Philosophy of Modelling', by Matthew Edwards and Zaid Hoosain, presented to the Staple Inn Actuarial Society, 26 June 2012
http://www.sias.org.uk/diary/view_meeting?id=SIASMeetingJune2012

Model Risk can be mitigated by evaluating Risk Culture/Modelling Culture



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Source: Model Risk Working Party
http://www.actuaries.org.uk/research-and-resources/documents/sessional-paper-model-risk-daring-open-black-box

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What is a risk?

Risk = Probability x Impact

But, what we call a risk depends on how much we care about the impact i.e. a value judgement.

Therefore risk is always a social construct.

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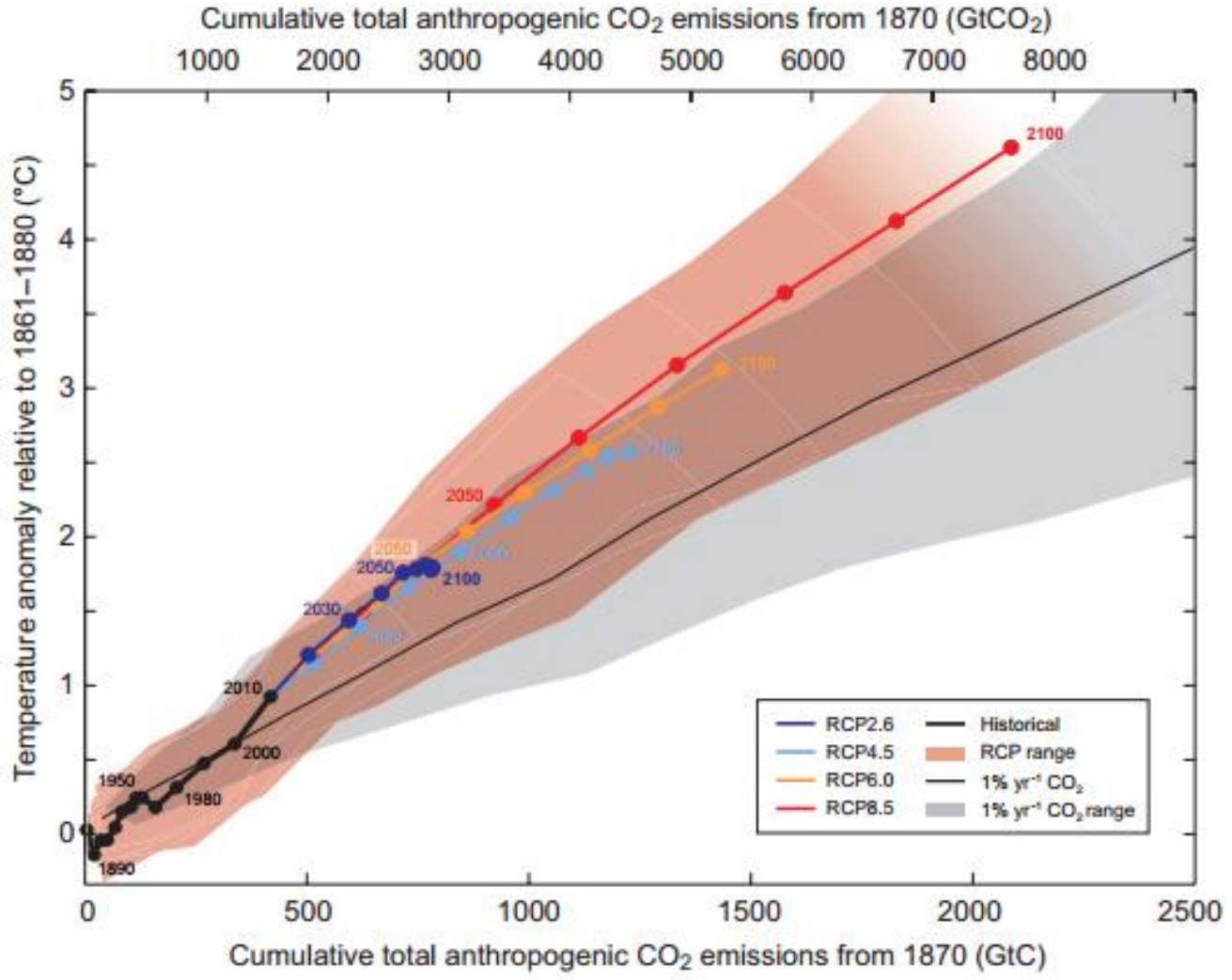
IPCC Climate change forecasts to 2100



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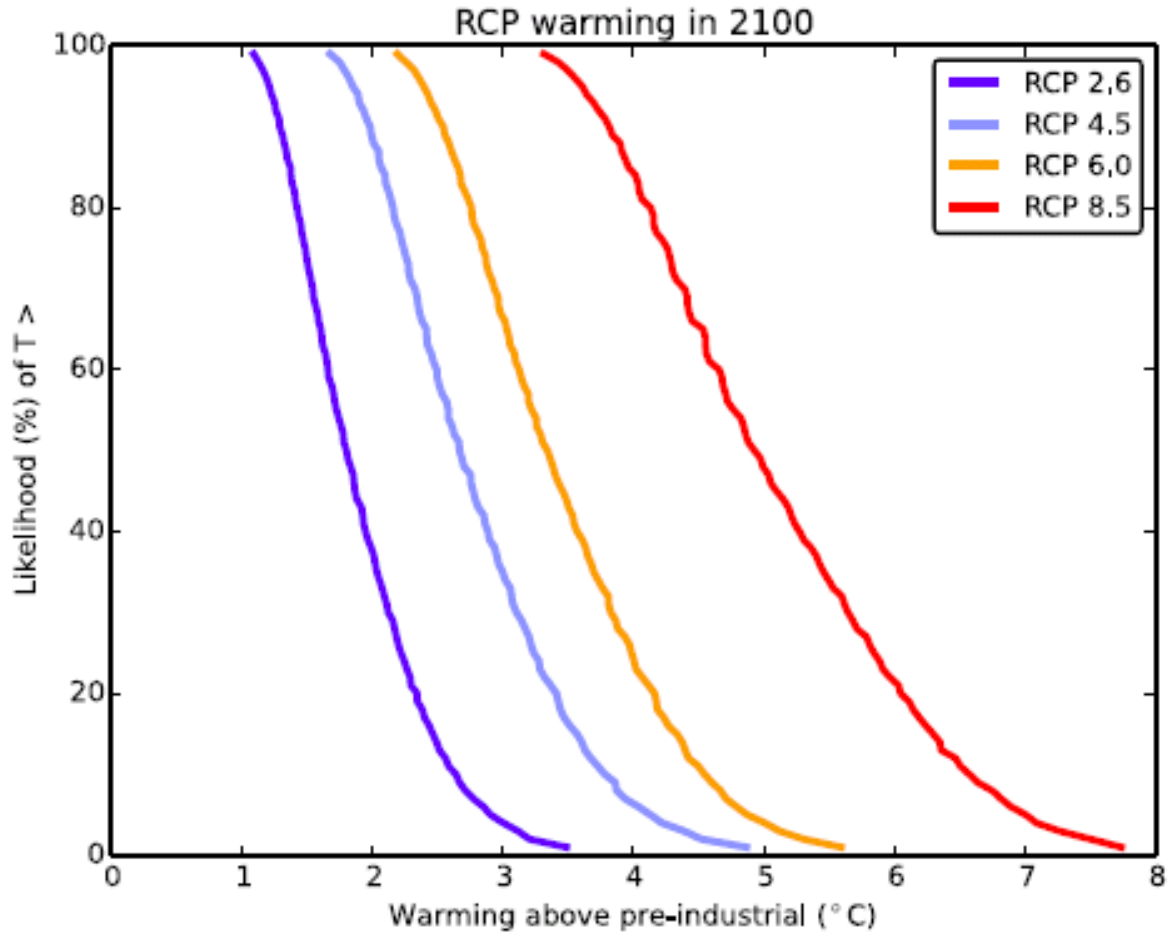
Intergovernmental Panel on Climate Change, 5th Assessment Report, Working Group 1, Summary for Policymakers

IPCC Climate change forecasts to 2100 – Risk based view



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Source: Foreign and Commonwealth Office report "Climate Change: A Risk Assessment"
https://www.gov.uk/government/news/baroness-anelay-launches-climate-change-risk-assessment

Relatively little research on effect of higher temperature rises (extracts from IPCC AR5)

- **Crops: "Relatively few studies have considered impacts on cropping systems for scenarios where global** mean temperatures increase by 4ºC or more."
- **Ecosystems: "There are few field-scale experiments on ecosystems at the highest CO2 concentrations** projected by RCP8.5 for late in the century, and none of these include the effects of other potential confounding factors."
- **Health: "Most attempts to quantify health burdens associated with future climate change consider** modest increases in global temperature, typically less than 2ºC."
- **Poverty: "Although there is high agreement about the heterogeneity of future impacts on poverty, few** studies consider more diverse climate change scenarios, or the potential of 4ºC and beyond."
- **Human security: "Much of the current literature on human security and climate change is informed** by contemporary relationships and observation and hence is limited in analyzing the human security implications of rapid or severe climate change."
- **Economics: "Losses accelerate with greater warming, but few quantitative estimates have been** completed for additional warming around 3ºC or above."

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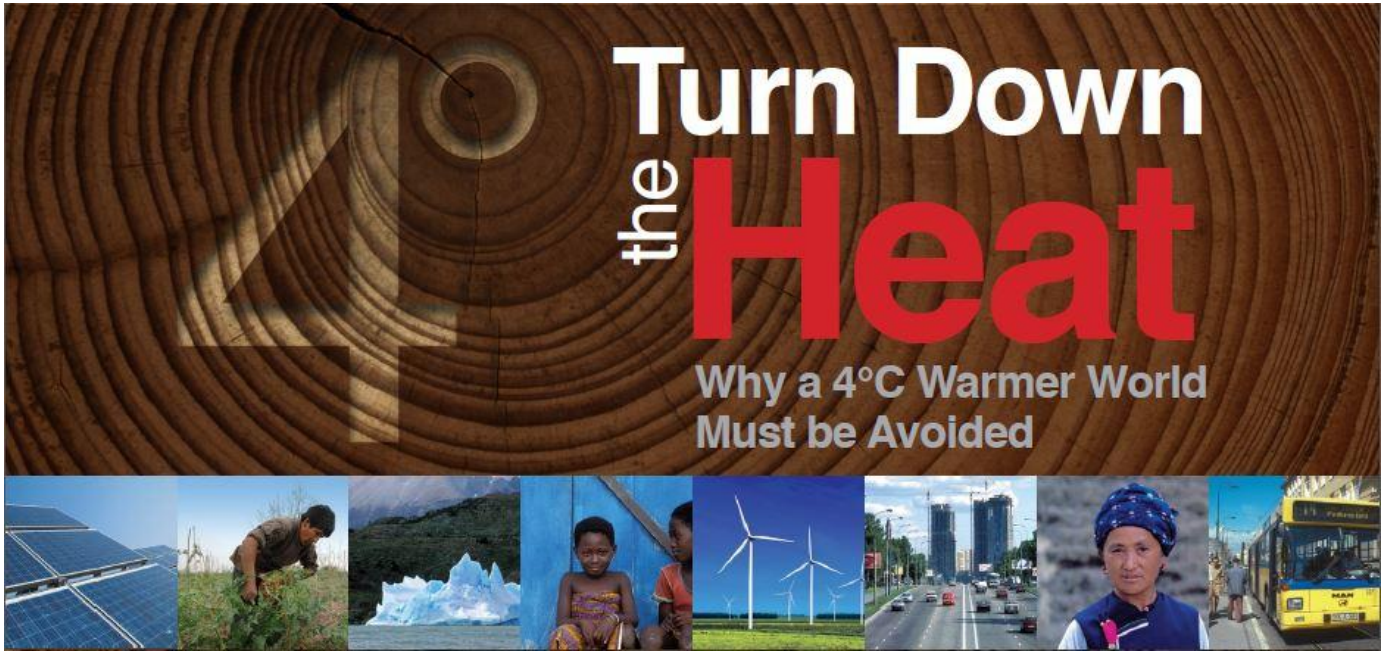
Source: Foreign and Commonwealth Office report "Climate Change: A Risk Assessment" – extracts from IPCC (2014)
https://www.gov.uk/government/news/baroness-anelay-launches-climate-change-risk-assessment

Report for the World Bank - Effect of 4°C global average temperature rise



Possible large-scale displacement of populations.
Risk of nonlinear tipping elements in the Earth system e.g. disintegration of West Antarctic ice sheet.
“there is no certainty that adaptation to a 4°C world is possible.”

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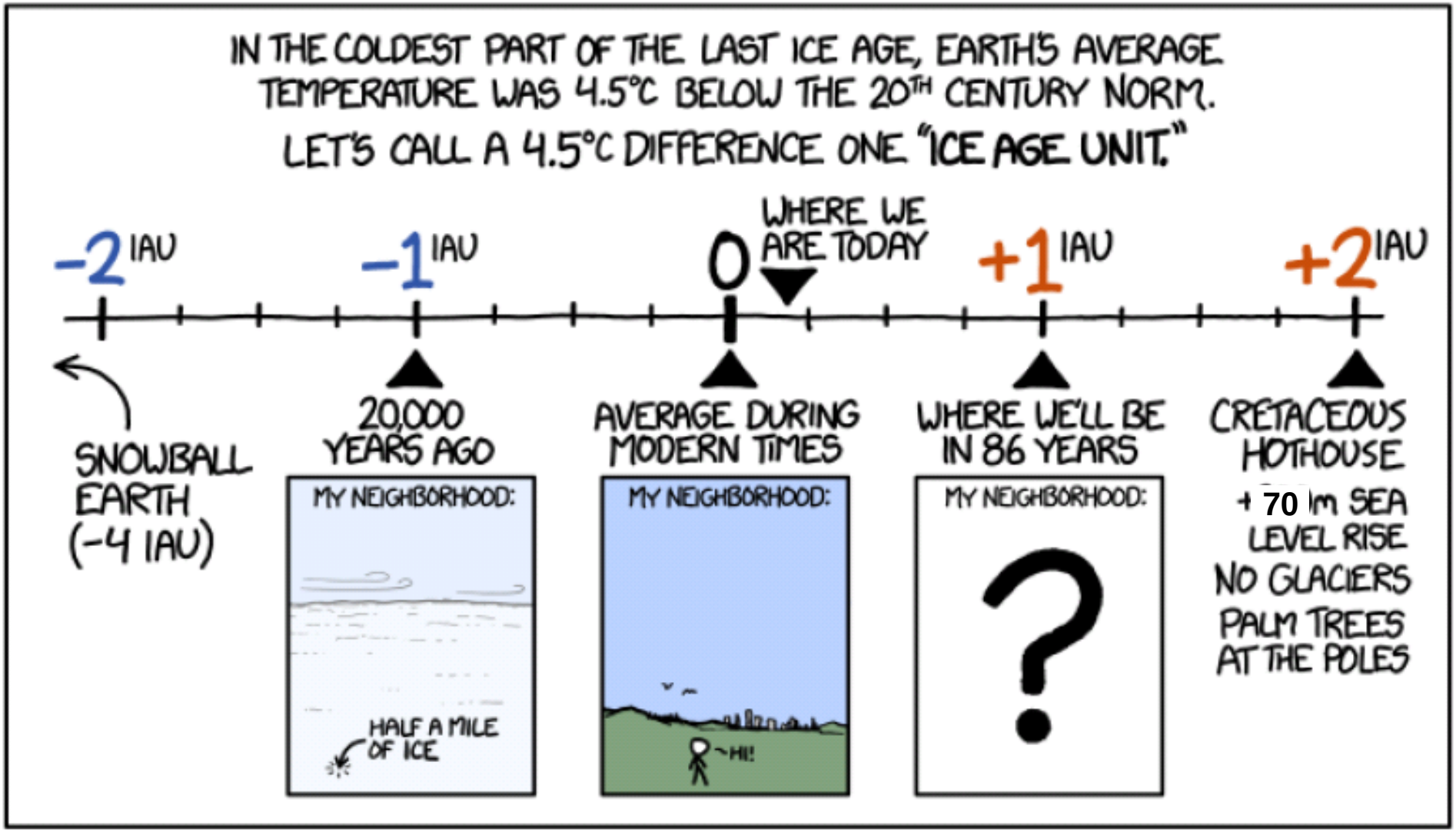
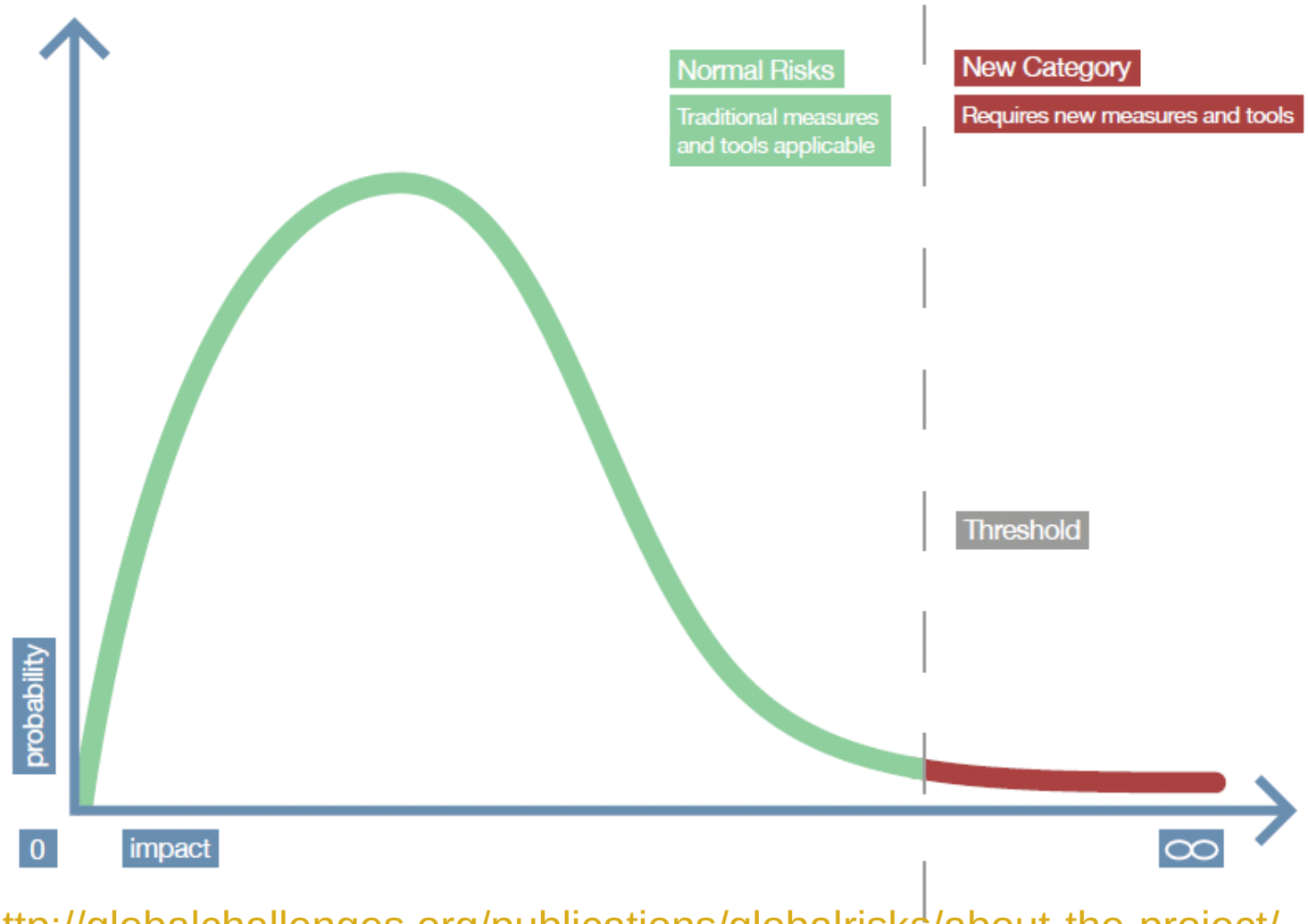
Source:http://climatechange.worldbank.org/sites/default/files/Turn_Down_the_heat_Why_a_4_degree_centrigrade_warmer_world_must_be_avoided.pdf

Effect of 4°C global average temperature rise



Source: https://xkcd.com/1379/ NB sea level rise in cretaceous has been corrected.

Climate change is an “Infinite Impact” Risk



Source: http://globalchallenges.org/publications/globalrisks/about-the-project/

Business as usual is not a risk

- Currently, global emissions are on a path consistent with the high scenario (RCP 8.5) i.e. “business as usual”
- Carrying on “business as usual” (BAU) is not a risk, by any normal meaning of the word
- BAU not a risk because probability of catastrophic outcome would be >50%
- The lowest IPCC emissions scenario (RCP 2.6) carries a high risk

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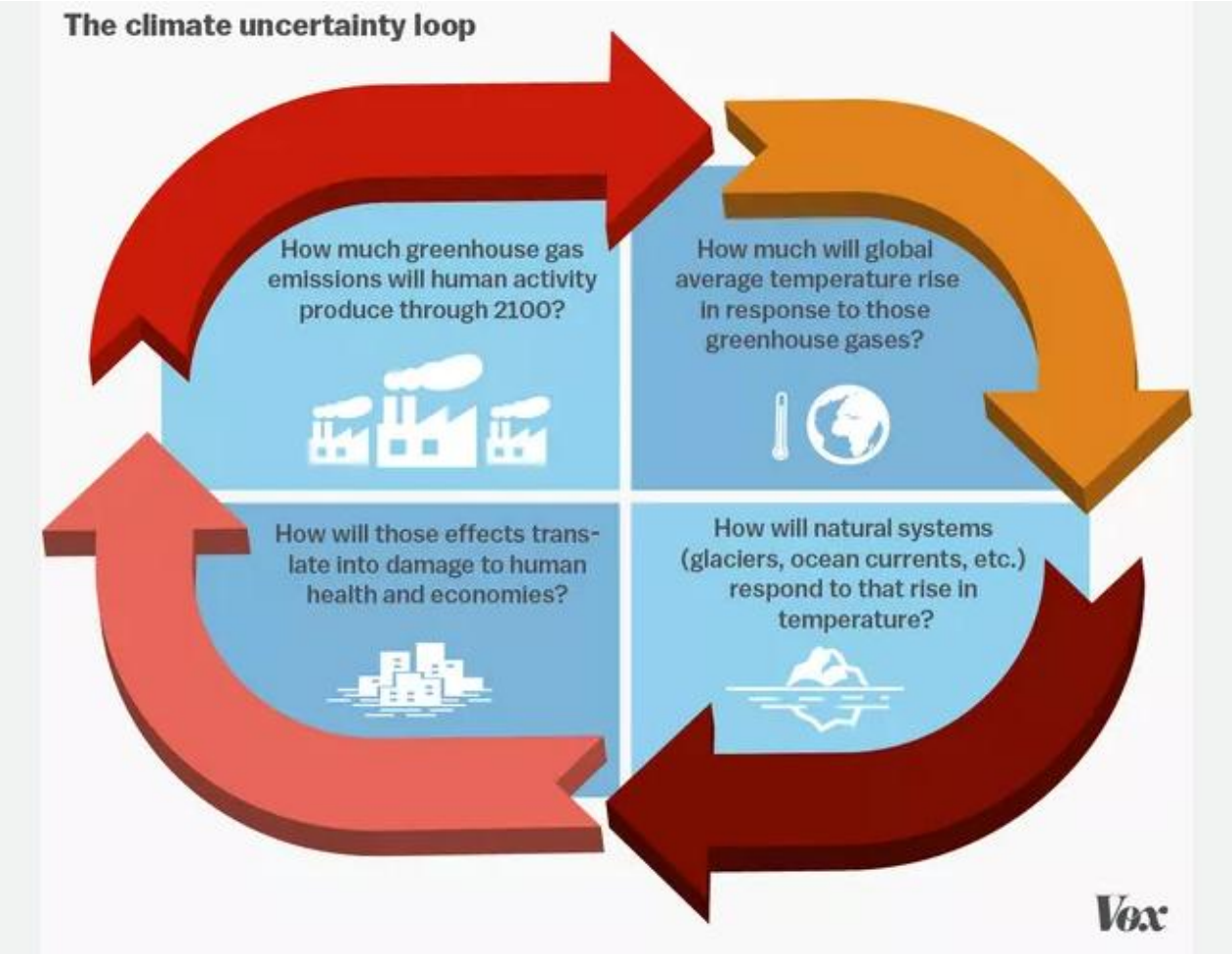
Model Risk in Integrated Assessment Models



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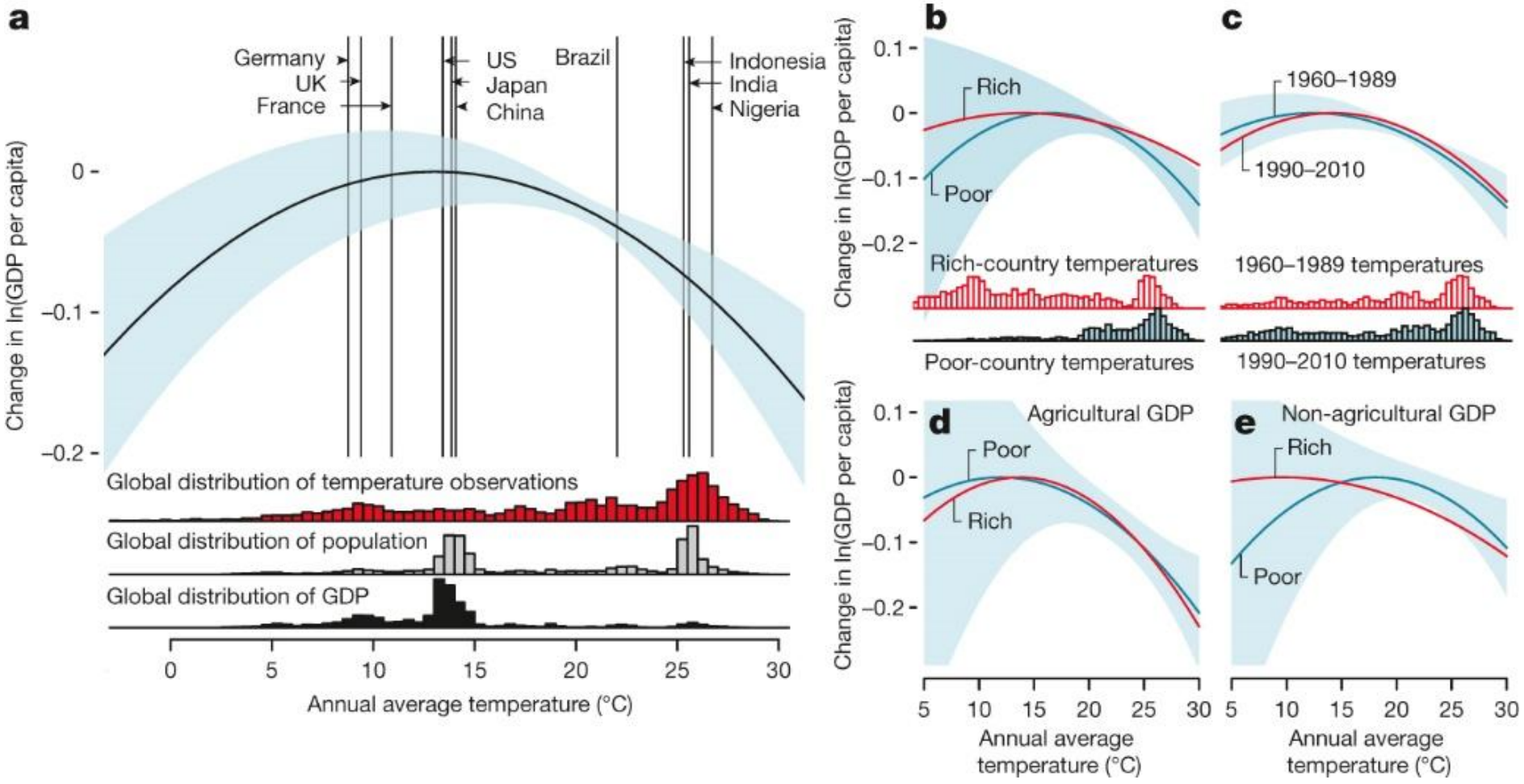
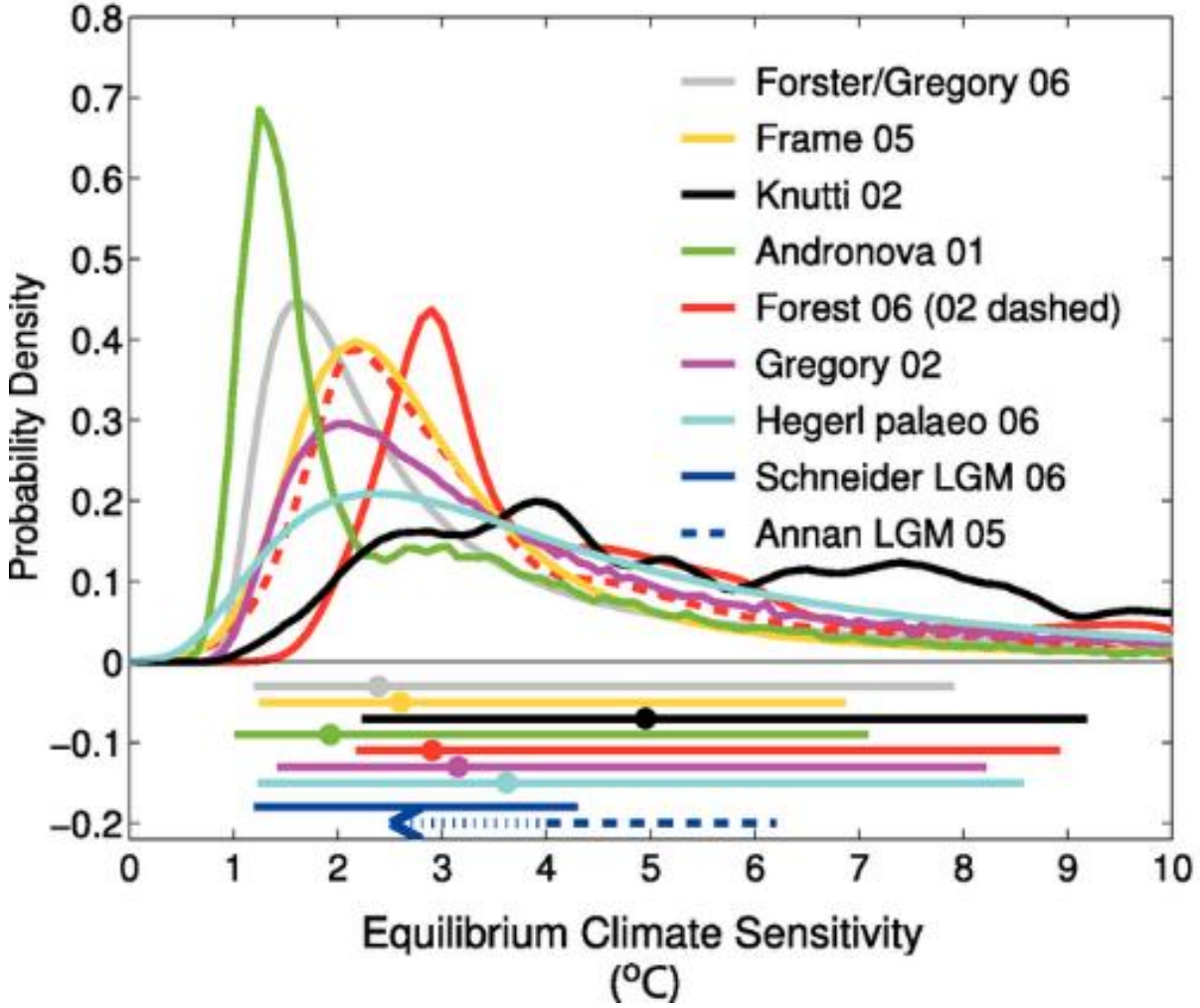
Source: http://www.vox.com/2015/10/23/9604120/climate-models-uncertainty

Global non-linear effect of temperature on economic production – Nature 2015



Source: Marshall Burke,Solomon M. Hsiang & Edward Miguel Nature (2015) doi:10.1038/nature15725

Model risk/tail risk - Climate Sensitivity is not well known yet



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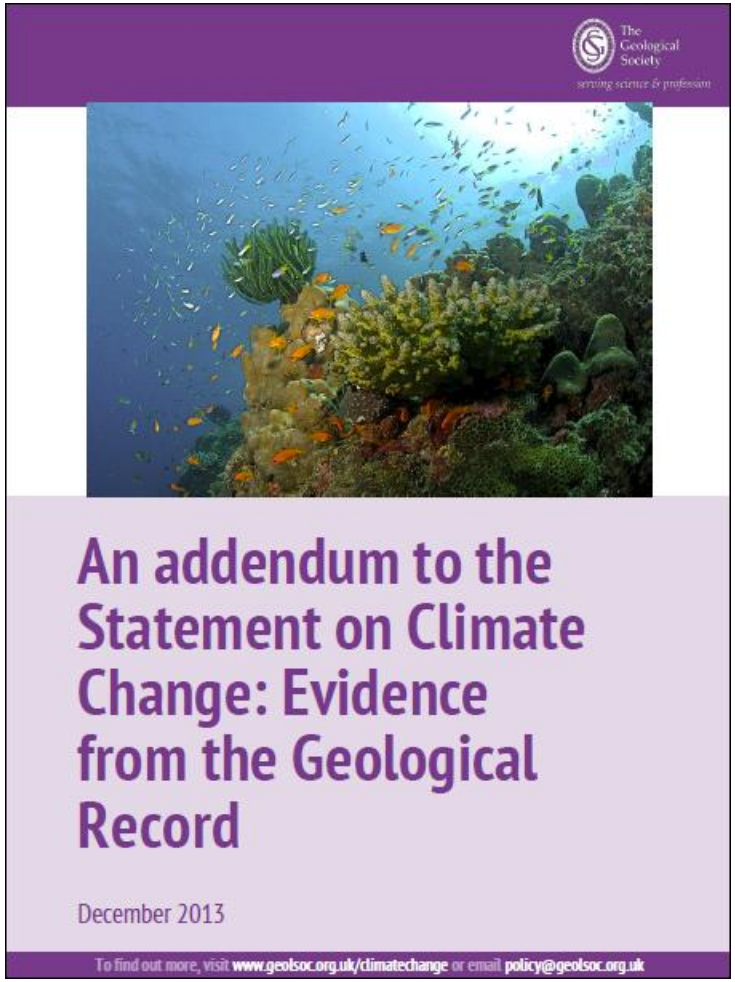
Source: IPCC 2007 4th Assessment Report, Working Group 1 (Figure 9-20-1)

Earth System Sensitivity



Summary

Since our original 2010 statement, new climate data from the geological record have arisen which strengthen the statement's original conclusion that CO_2 is a major modifier of the climate system, and that human activities are responsible for recent warming.

Palaeoclimate records are now being used widely to test the validity of computer climate models used to predict climate change. Palaeoclimate models can simulate the large-scale gradients of past change, but tend not to accurately reproduce fine-scale spatial patterns. They also have a tendency to underestimate the magnitude of past changes. Nevertheless they are proving to be increasingly useful tools to aid thinking about the nature and extent of past change, by providing a global picture where palaeoclimate data are geographically limited.

Geologists have recently contributed to improved estimates of climate sensitivity (defined as the increase in global mean temperature resulting from a doubling in atmospheric CO_2 levels). Studies of the Last Glacial Maximum (about 20,000 years ago) suggest that the climate sensitivity, based on rapidly acting factors like snow melt, ice melt and the behaviour of clouds and water vapour, lies in the range 1.5°C to 6.4°C. Recent research has given rise to the concept of 'Earth System sensitivity', which also takes account of slow acting factors like the decay of large ice sheets and the operation of the full carbon cycle, to estimate the full sensitivity of the Earth System to a doubling of CO_2. It is estimated that this could be double the climate sensitivity.

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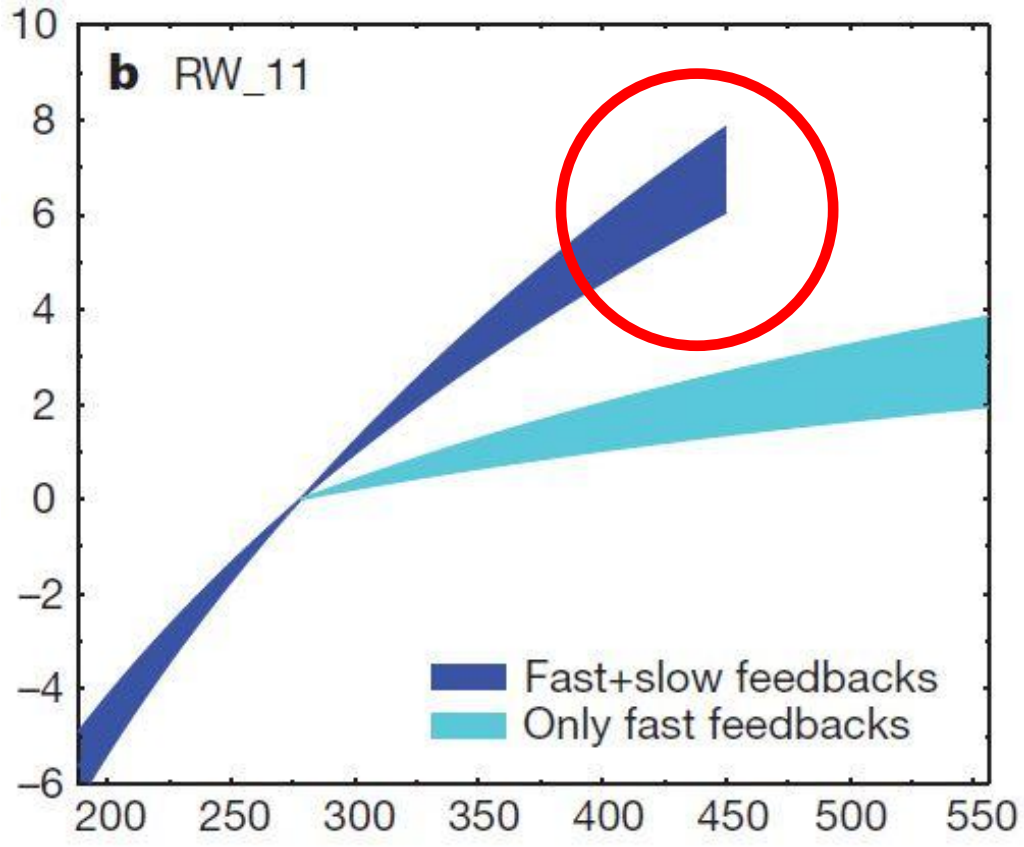
Slow climate feedbacks lead to higher warming, in the long term



- Long term changes e.g. to ice sheets and vegetation, leads to higher sensitivity of the climate to greenhouse gas
- Long term “Earth System Sensitivity” could be around 2x short term Climate Sensitivity

Source: Nature 2012 doi:10.1038/nature11574 PALEOSENS project members

Also see http://www.climatenewsnetwork.net/2013/12/earth-may-be-doubly-sensitive-to-co2/

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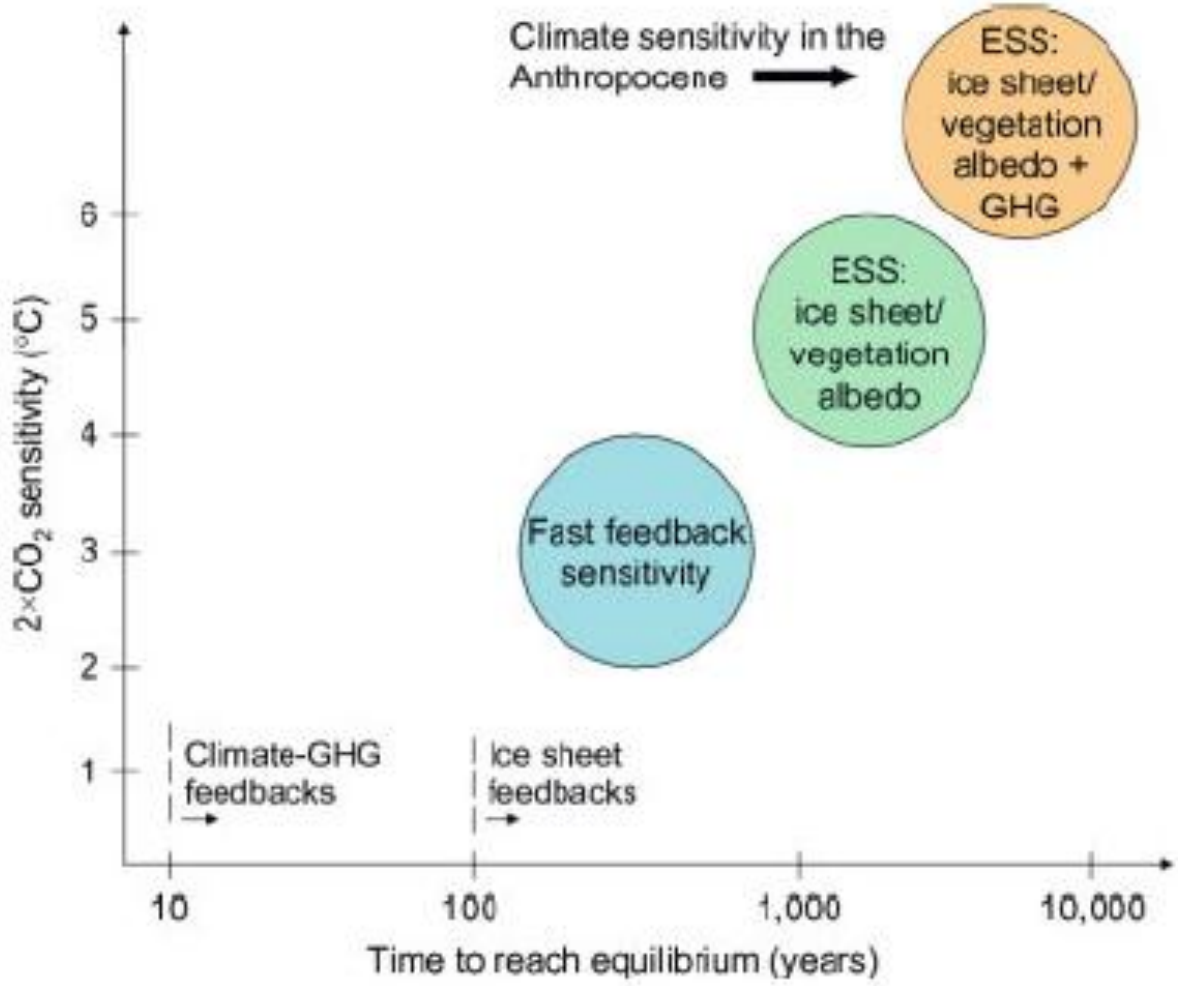
Climate Sensitivity and Earth System Sensitivity



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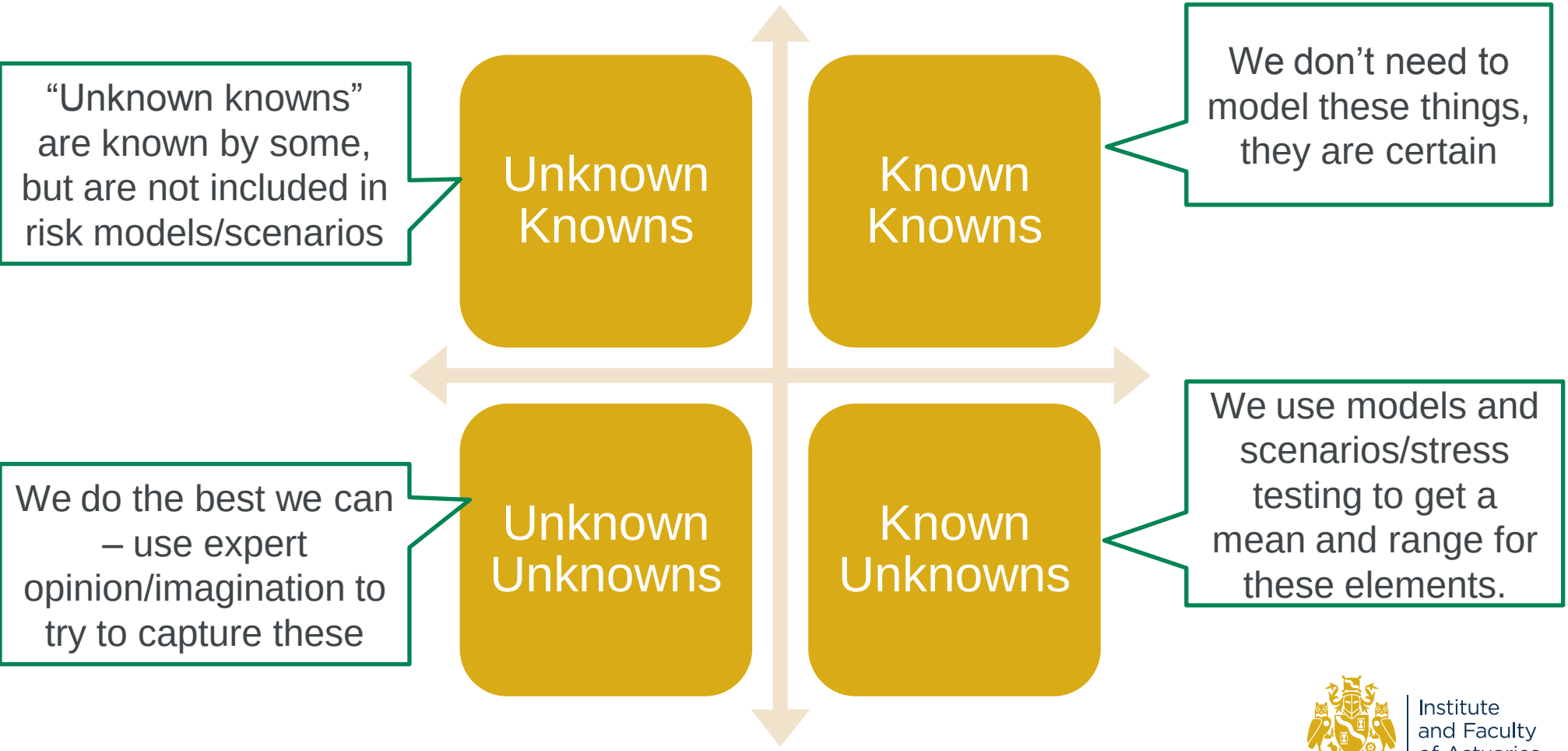
Source: **Quarterly Journal of the Royal Meteorological Society** ***Q. J. R. Meteorol. Soc. 139: 1121–1131, July 2013 A*** **Climate sensitivity in the Anthropocene**

Unknown Knowns and Risk Culture/ Modelling Culture



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For more on risk culture see http://www.actuaries.org.uk/research-and-resources/documents/sessional-paper-model-risk-daring-open-black-box

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IPCC scenarios for keeping under 2ºC assume negative emissions technology

- Framing of scenarios in terms of cumulative emissions and carbon budget was a major step forward, But…
- "Of the 113 scenarios with a "likely" chance (66% or better) of 2°C …, 107 (95%) assume the successful and large-scale uptake of negative emission technologies. The remaining 6 scenarios all adopt a global emissions peak of around 2010."

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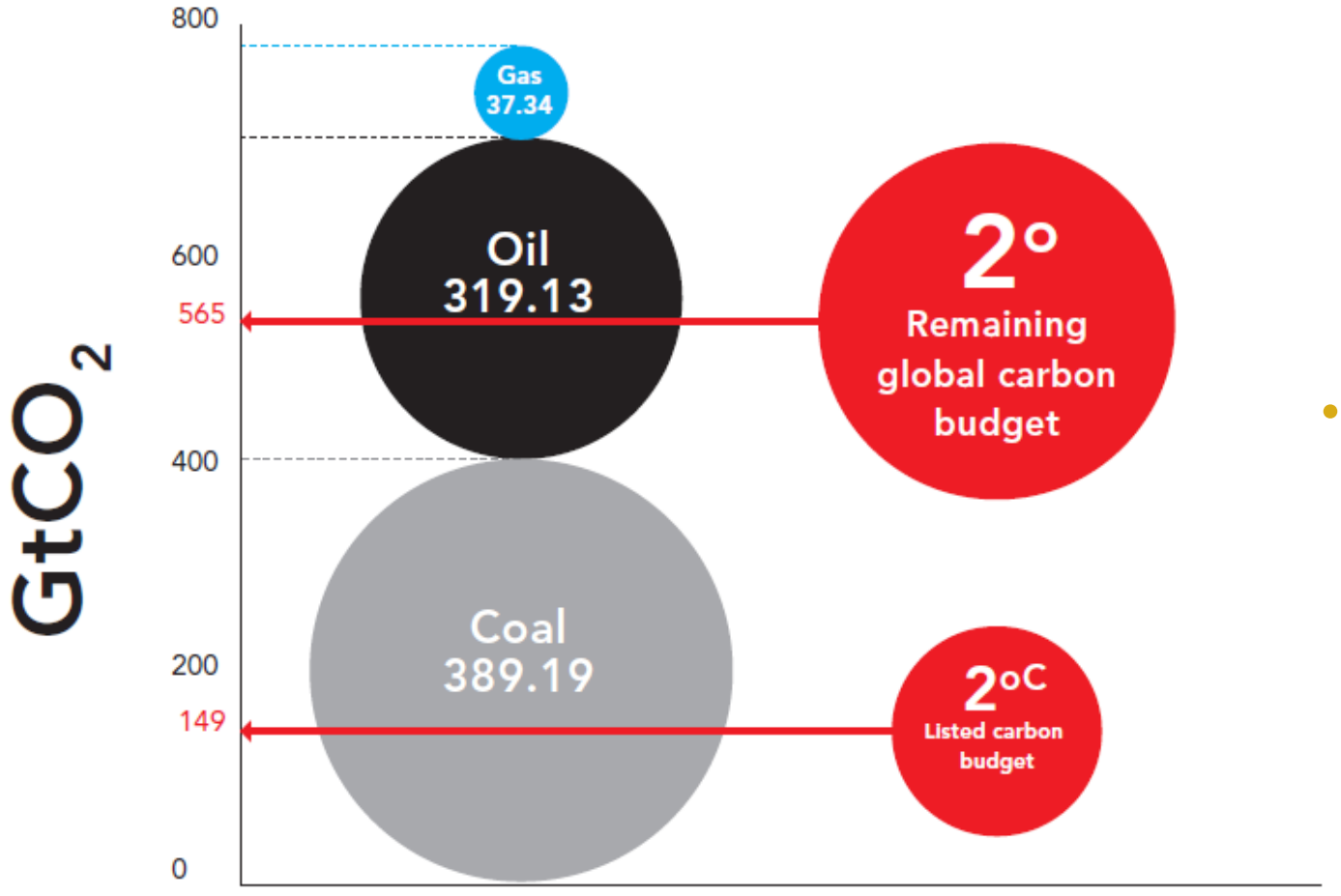
Source: Kevin Anderson, Nature Geoscience, 12th October 2015
http://www.nature.com/ngeo/journal/vaop/ncurrent/full/ngeo2559.html

Risk of Stranded Carbon Assets/ “Carbon Bubble”



- Many fossil fuel companies are valued assuming all resources will be extracted and consumed
- Consumption of proven fossil fuel reserves in top 100 quoted companies gives more than safe emissions.

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See: http://www.carbontracker.org/carbonbubble and http://www.bankofengland.co.uk/pra/Pages/supervision/activities/climatechange.aspx

What does this mean for policy?

- High amount of uncertainty about both probability and impact of climate change i.e. model risk
- There is a large tail risk of extreme climate change
- There is a risk that keeping under 2ºC in the future might require removal of CO_2 from the atmosphere
- Requirement for flexibility in policymaking
- Option value of leaving carbon in the ground should be recognised

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Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

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