

WCRP Flagship Workshop

Hamburg, 24-26 February 2020

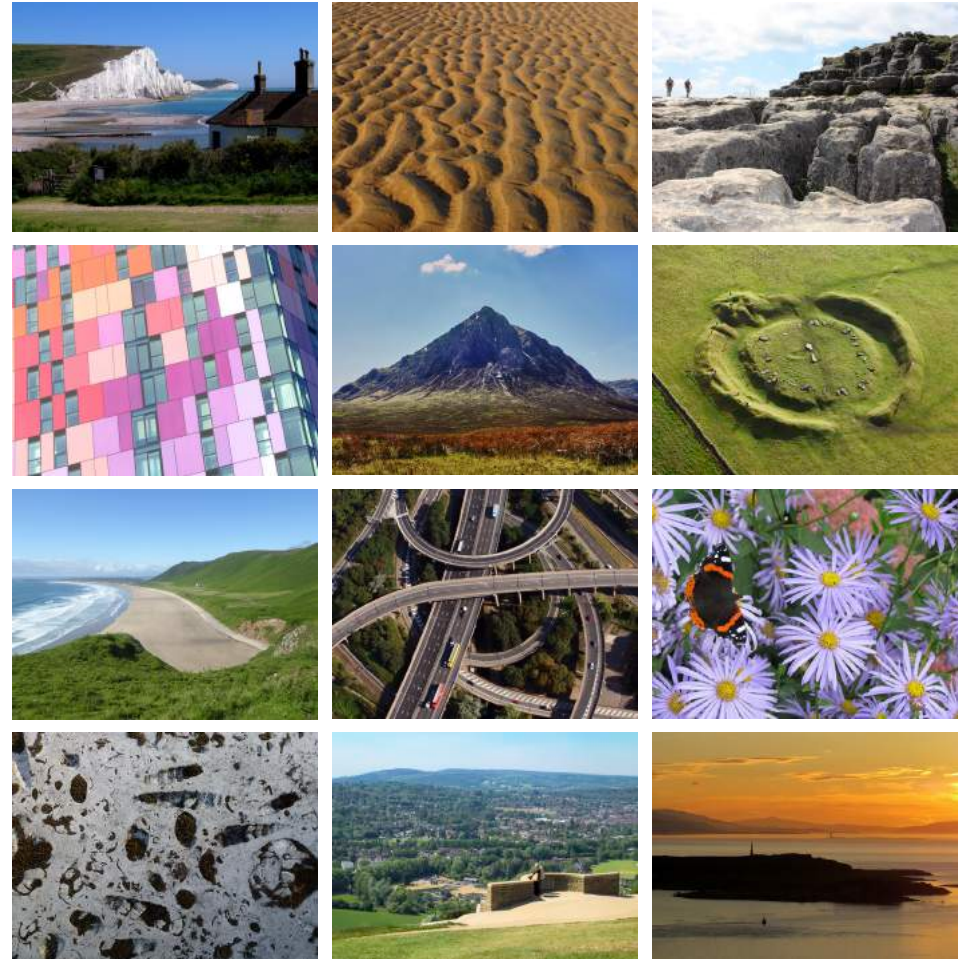


EVERY LANDSCAPE HAS A STORY TO TELL

Flagship Objective: To bring meaning to climate change at the local scale

Ted Shepherd

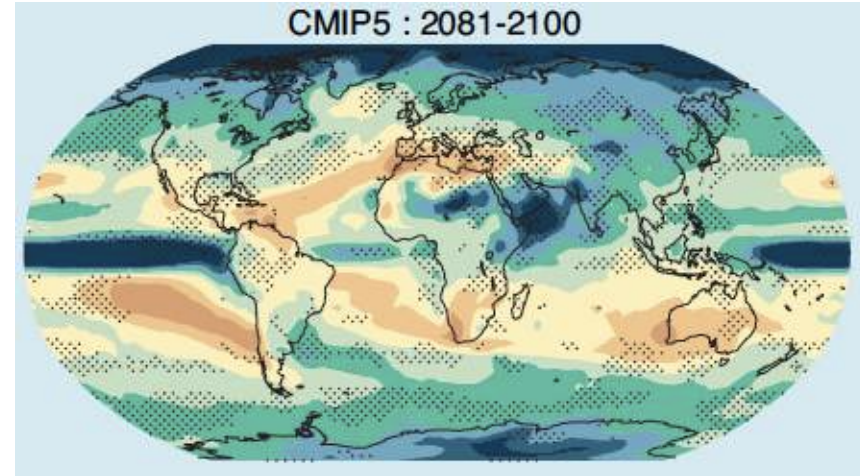
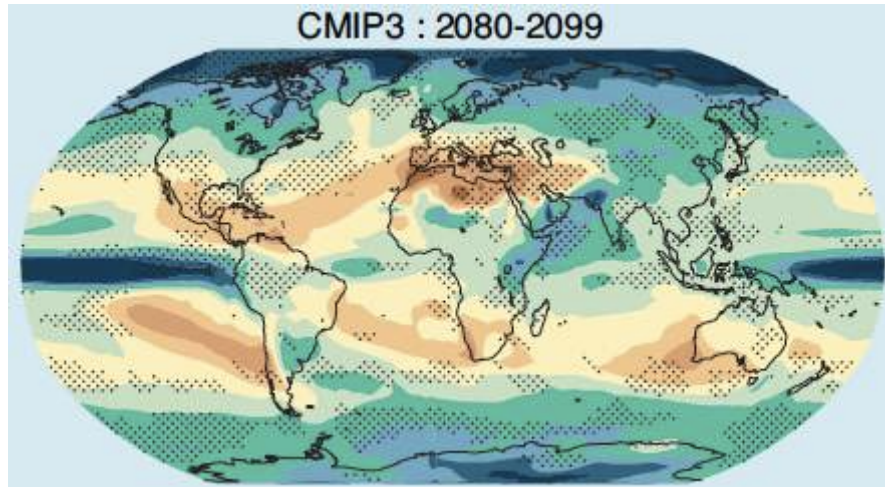
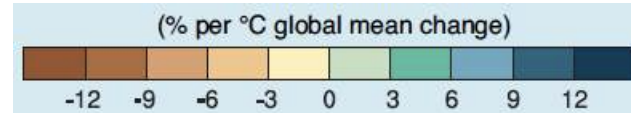
Department of Meteorology,
University of Reading



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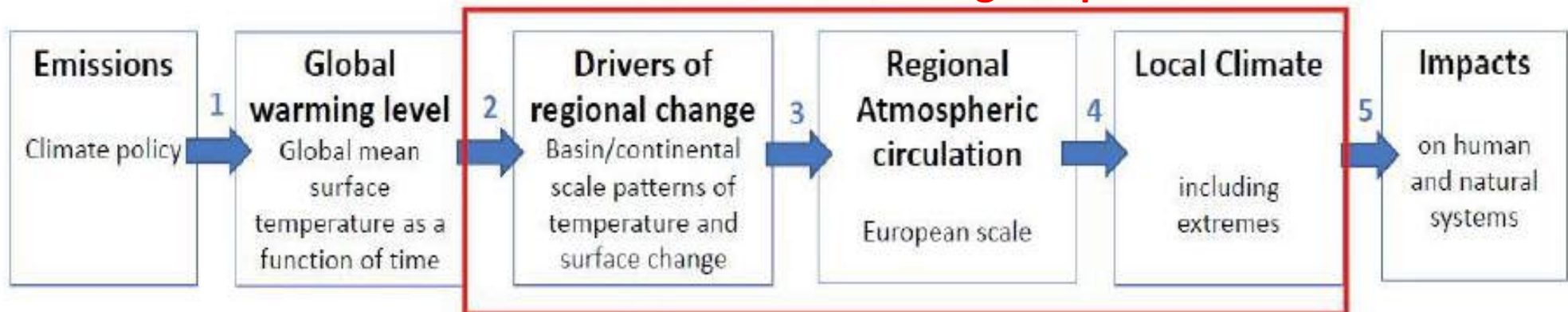
- The situation has not changed with subsequent generations of models; *why does so much of our resource go into this?*

Precipitation scaled by global T (% per °C)



IPCC AR5 WGI (2013)

The Knowledge Gap

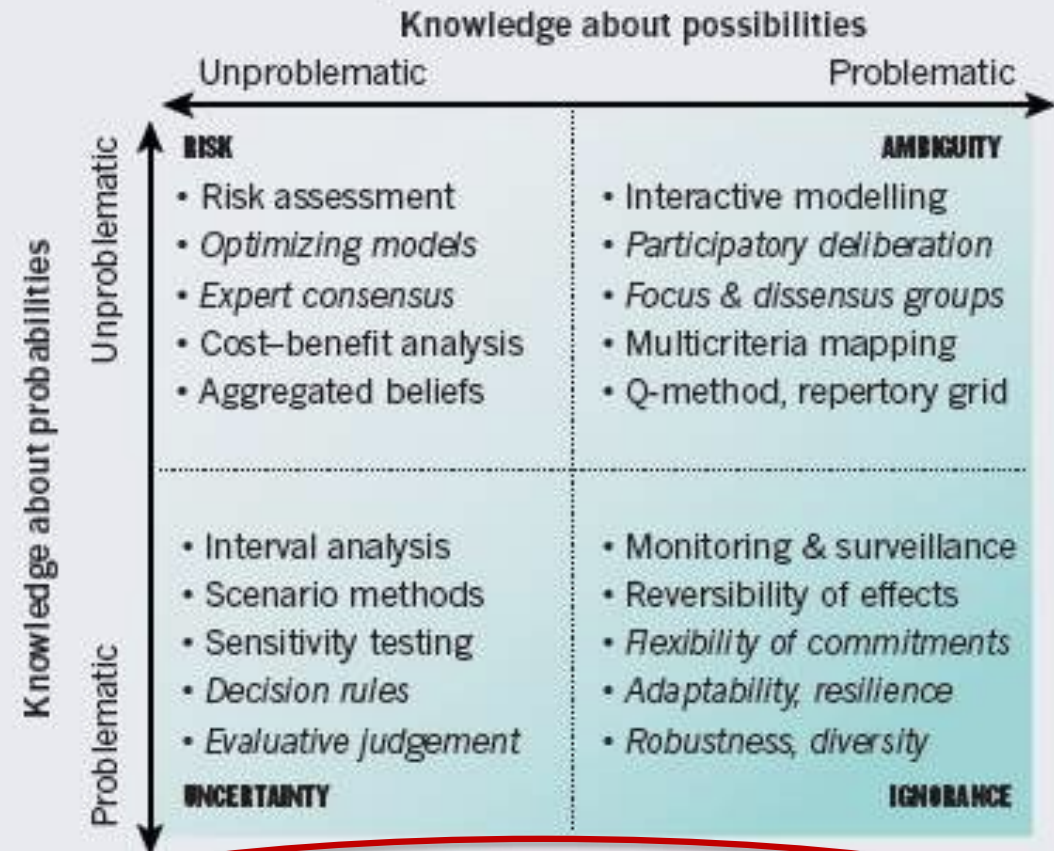


Courtesy of Rowan Sutton (University of Reading & NCAS)

- **Methods for decision-making under uncertainty**

UNCERTAINTY MATRIX

A tool to catalyse nuanced deliberations: experts must look beyond risk (top left quadrant) to ambiguity, uncertainty and ignorance using quantitative and *qualitative* methods.

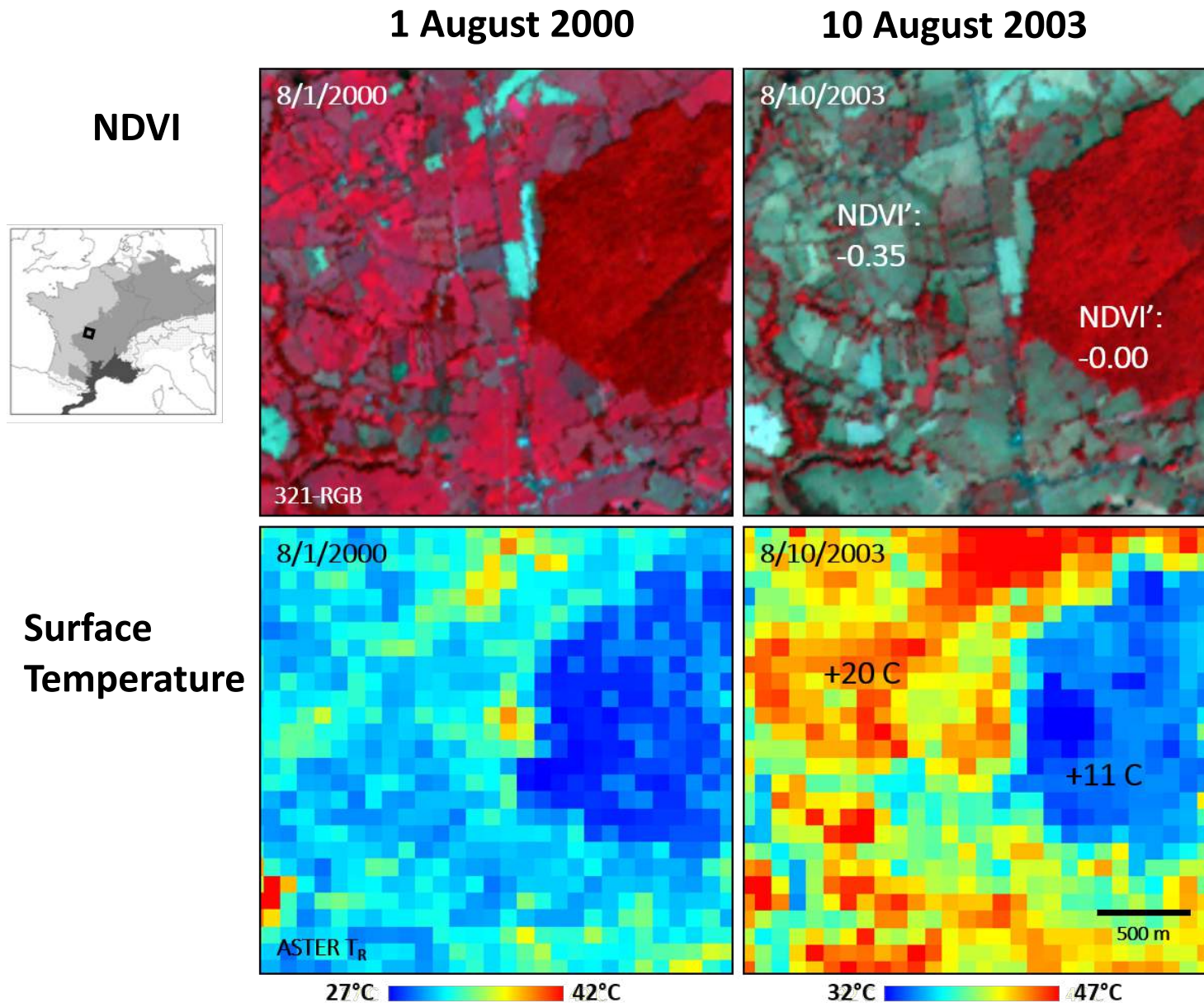


Political pressures tend to push attention from 'plural conditional' (dark shading) to 'single definitive' (light shading) methods.

- For physical aspects of climate change, it is more the probabilities than the possibilities that are problematic
- We need a language for expressing a 'plural conditional' state of knowledge

Stirling (2010 Nature)

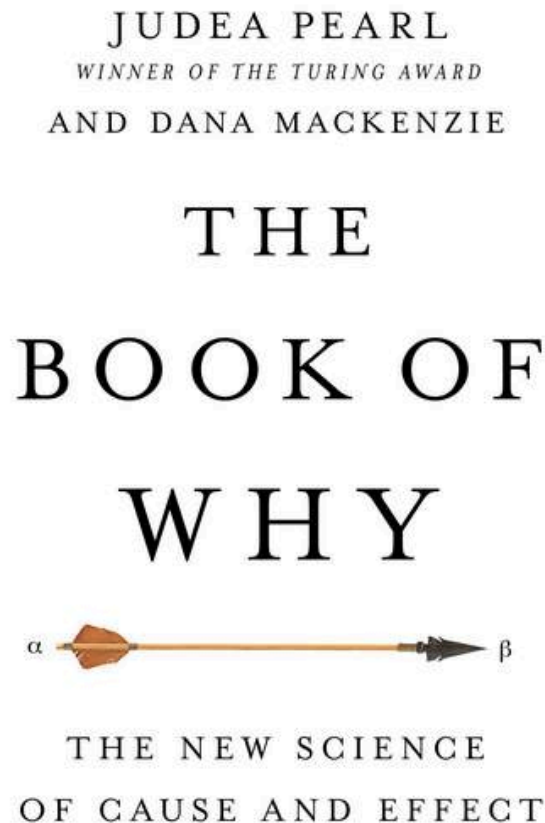
- **Learning from samples of one or fewer** (March et al. 1991 Org. Sci.)
 - The summer 2003 heat wave in central France



**There is
(conditional)
information
here!**

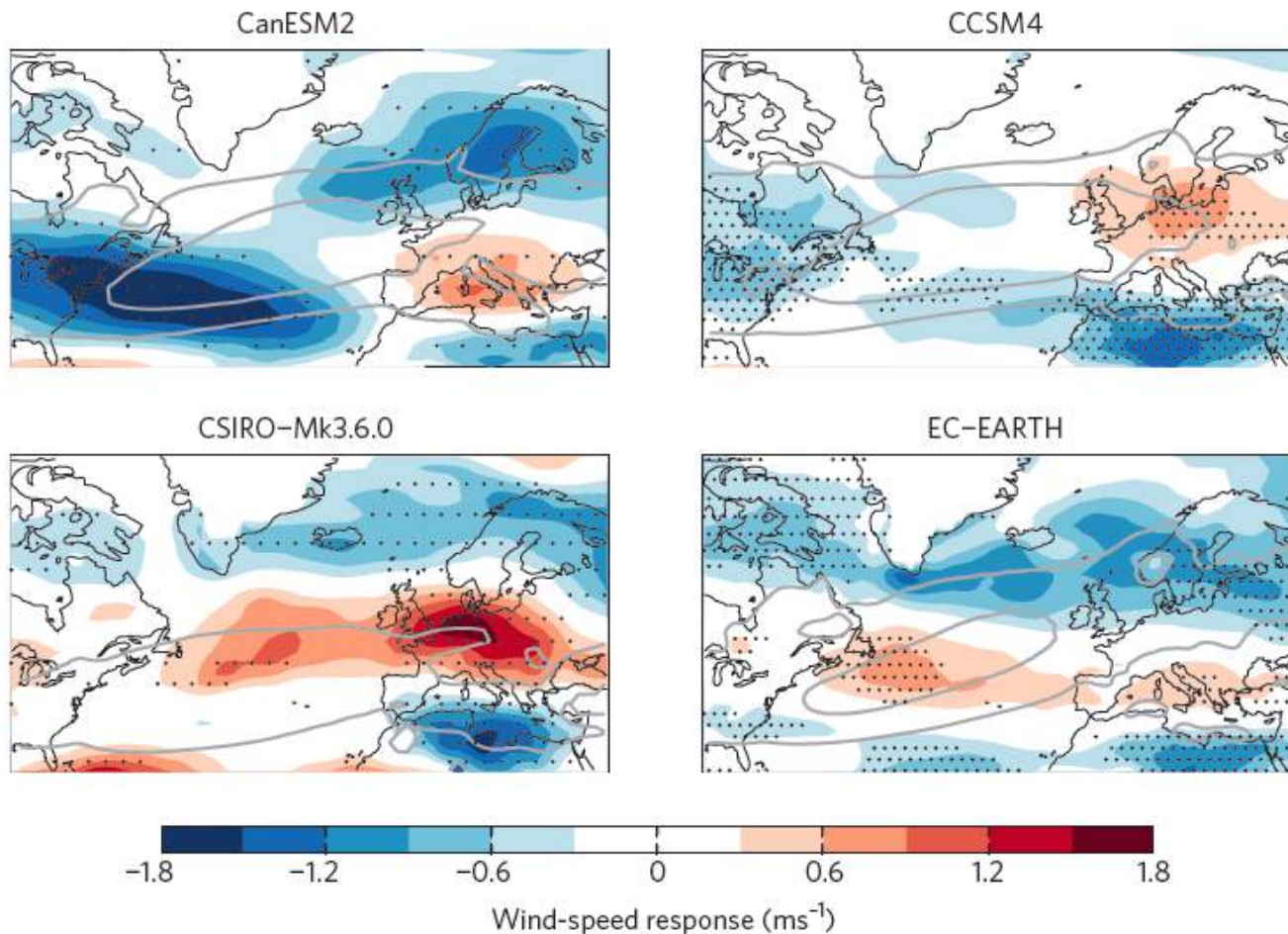
Zaitchik et al.
(2006 Int. J.
Clim.)

Pearl's "Ladder of Causation"



- *Association (correlation):*
 - Climate system is non-stationary, and sampling is incomplete
 - Aggregation and conditioning always involves assumptions
- *Intervention:*
 - Not possible, though there are natural experiments (e.g. volcanic eruptions)
- *Counterfactuals:*
 - Requires imagination; by definition, not “real” (and cannot be created)
 - Where theory and models come in
- Conclusion: **primacy of causal reasoning**
 - But it's very hard to *prove* anything!

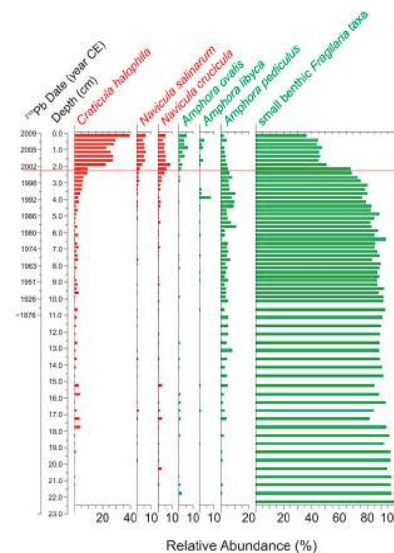
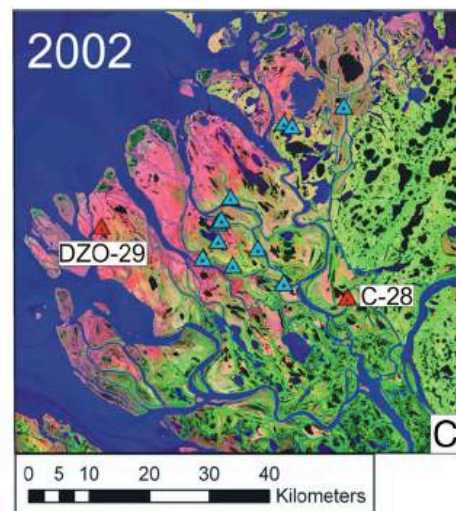
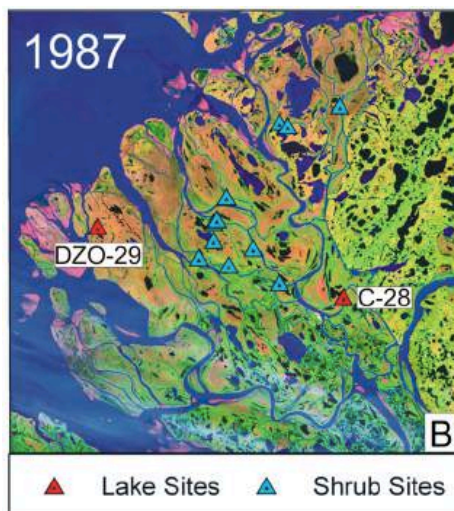
- Unfortunately, climate models (and theory) can **disagree on the nature of the circulation response** to climate change
 - Has direct implications for precipitation and for weather-related extremes such as droughts and heat waves
 - The average of such different projections has no meaning!



Wintertime lower tropospheric zonal wind speed climatology (contours) and end-of-century response to RCP 8.5 (shading)

Shepherd (2014 Nature Geosci.)

- Epistemic uncertainties are different from aleatoric (random) uncertainties, and cannot be treated in the same way
 - Epistemic uncertainties are intrinsically **subjective**
 - Raises issue of **trust** and **intelligibility**
- One approach is **storylines**: physically-based unfoldings of past climate or weather events, or of plausible future events or pathways (Shepherd et al. 2018 Climatic Change): *causal accounts*
- Climate attribution of ecosystem extreme events generally takes a **forensic rather than a probabilistic approach**, focused on building causal accounts (Lloyd & Shepherd 2020 Ann. NY Acad. Sci.)



Example of unprecedented Arctic ecosystem collapse, from Pisaric et al. (2011 PNAS)

- Thomas Kuhn: “If we can learn to substitute **evolution-from-what-we-know** for **evolution-toward-what-we-wish-to-know**, a number of vexing problems may vanish in the process.”
- Thus:
 - Keep the focus local and contextual
 - Start from the present, and from the observed record
 - Construct plausible storylines for the observed behaviour
 - Propagate those storylines into present-day risk as well as near-term (and potentially also longer-term) projections
 - Connect with the S2S perspective
- The argument for this is both practical (in terms of stakeholder interest) and scientific (in terms of connecting process understanding; e.g., prediction is the cornerstone of causality)
 - Chapter 10 of the AR6 WGI report is already mainstreaming this approach, through its regional case studies
 - I think there would be a lot of energy for this amongst ECRs

Cautionary notes

- WCRP can all too easily create ‘clubs’, which exert an intellectual hegemony that maintains the status quo and suppresses creativity and new ways of thinking
 - WCRP should do things that aren’t being done, rather than trying to ‘mark territory’ in things that are already being done
- ‘Authoritative’ information has a ‘gatekeeper’ connotation
 - Trustworthiness is what is important, but others, not us, decide on our trustworthiness; this inverts the power relationship
 - ‘Expert judgement’ should not be self-declared
- Climate science is a competitive business, and the business model tends to work against generosity of spirit
- Weather and climate variability in a changing landscape may sometimes be as big a driver of climate risk as climate change
- We should aim to empower regional ‘communities of practice’ (or ‘ecosystems’) to which we bring our climate knowledge