North2Warm: The Impact of 1.5^{0}C or Greater Warming on the Arctic and Canada's North

Paul Kushner[1], on behalf of the North2Warm authors:
G. Flato[2], S. Howell[2], D. Lemmen[3]
J. Dawson[4], C. Derksen[2], S. Déry[5], C. Duguay[6], J. Fyfe[2], N. Gillett[2], L. Mudryk[2], M. Sigmond[2], X. Zhang[2], F. Zwiers[7]

1: University of Toronto
2: Environment and Climate Change Canada/CRD/CCCma
3: Natural Resources Canada
4: University of Ottawa
5: UNBC
6: University of Waterloo
7: PCIC

North2Warm: The Impact of 1.5^{0}C or Greater Warming on the Arctic and Canada's North

- The UNFCCC 1.5^{0}C and related targets have a sound basis in climate science and carbon budget ideas.
- But understanding the targets' implications is a scientific and communication challenge.
- North2Warm –– a work in progress –– is looking at what these targets mean for the Arctic and Canada's North.

Where does the 1.5^0C target come from?

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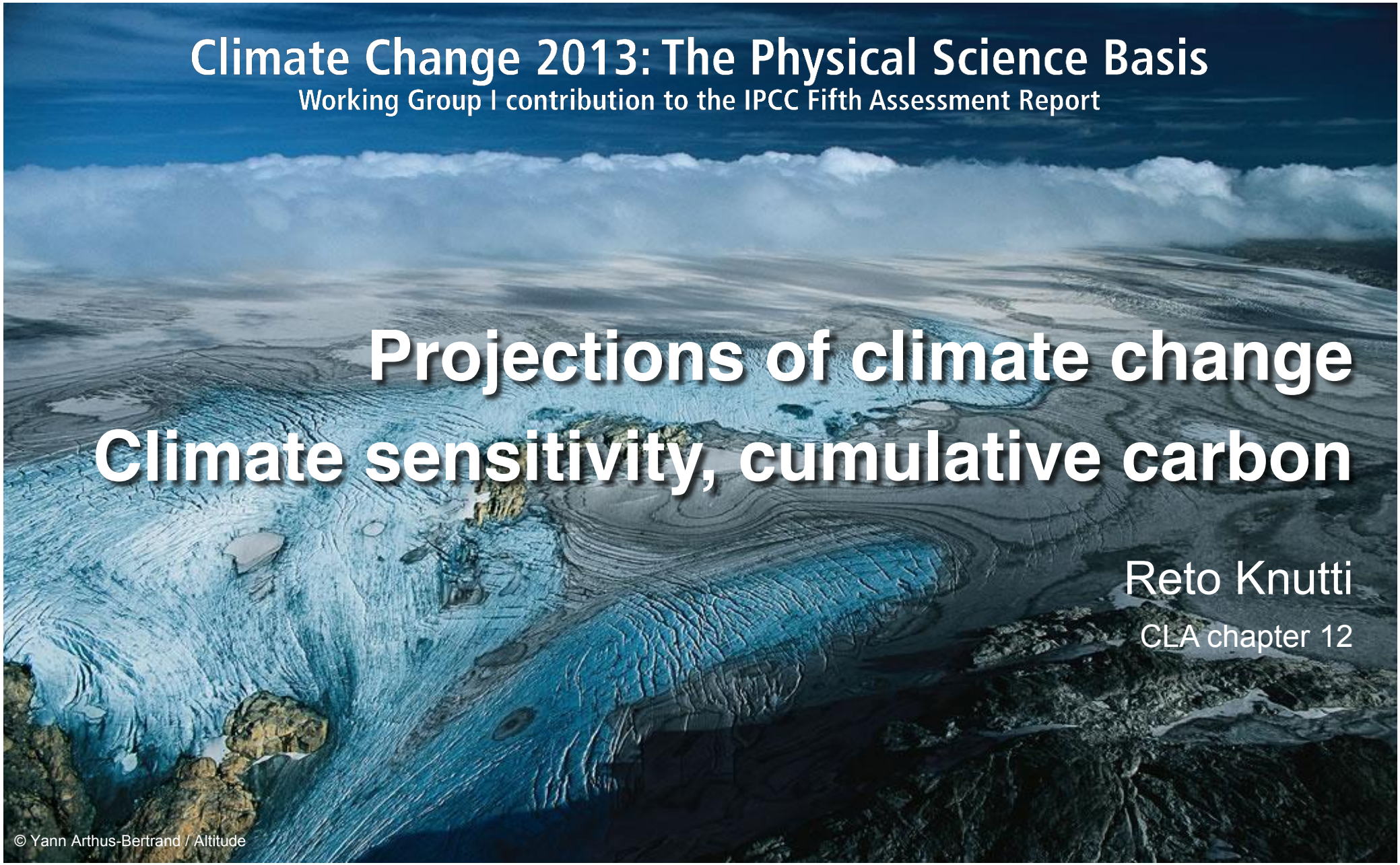
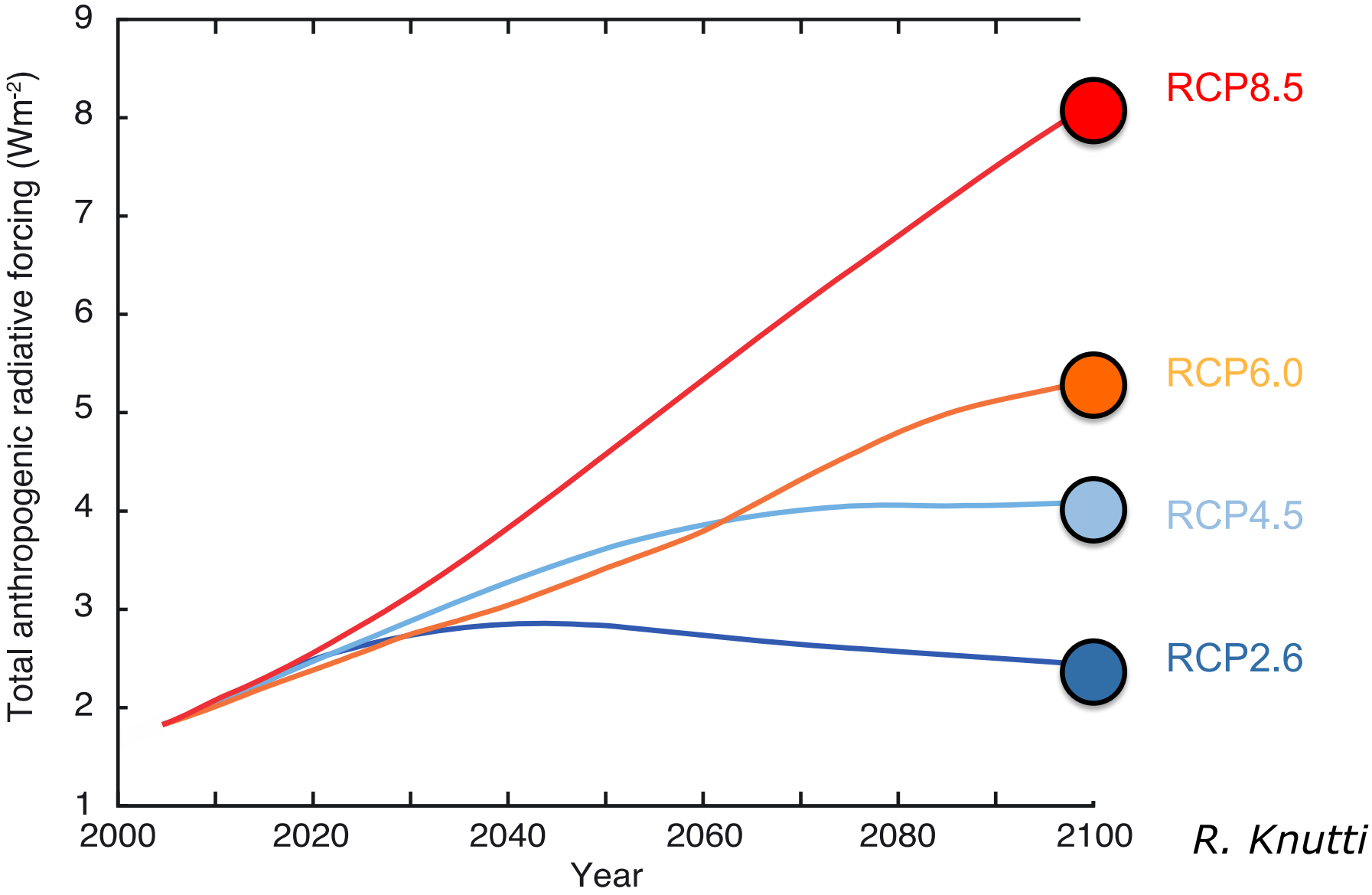
Transient Response to Cumulative CO_2 Emissions (TCRE): Total carbon emitted is a proxy for global warming.



https://www.ipcc.ch/pdf/unfccc/cop19/2_knutti13sbsta.pdf

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Representative Concentration Pathways (RCP)



R. Knutti

Box TS.6 for further details

Projections

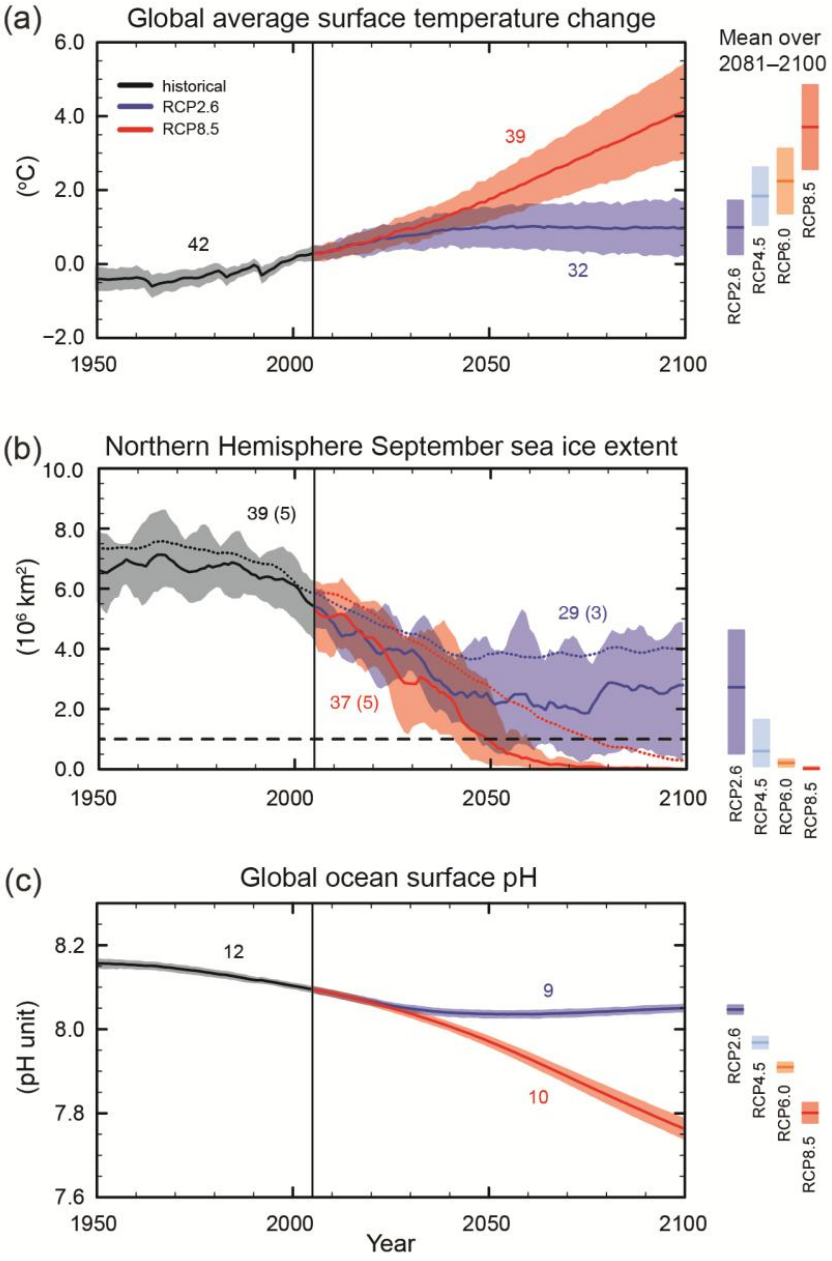
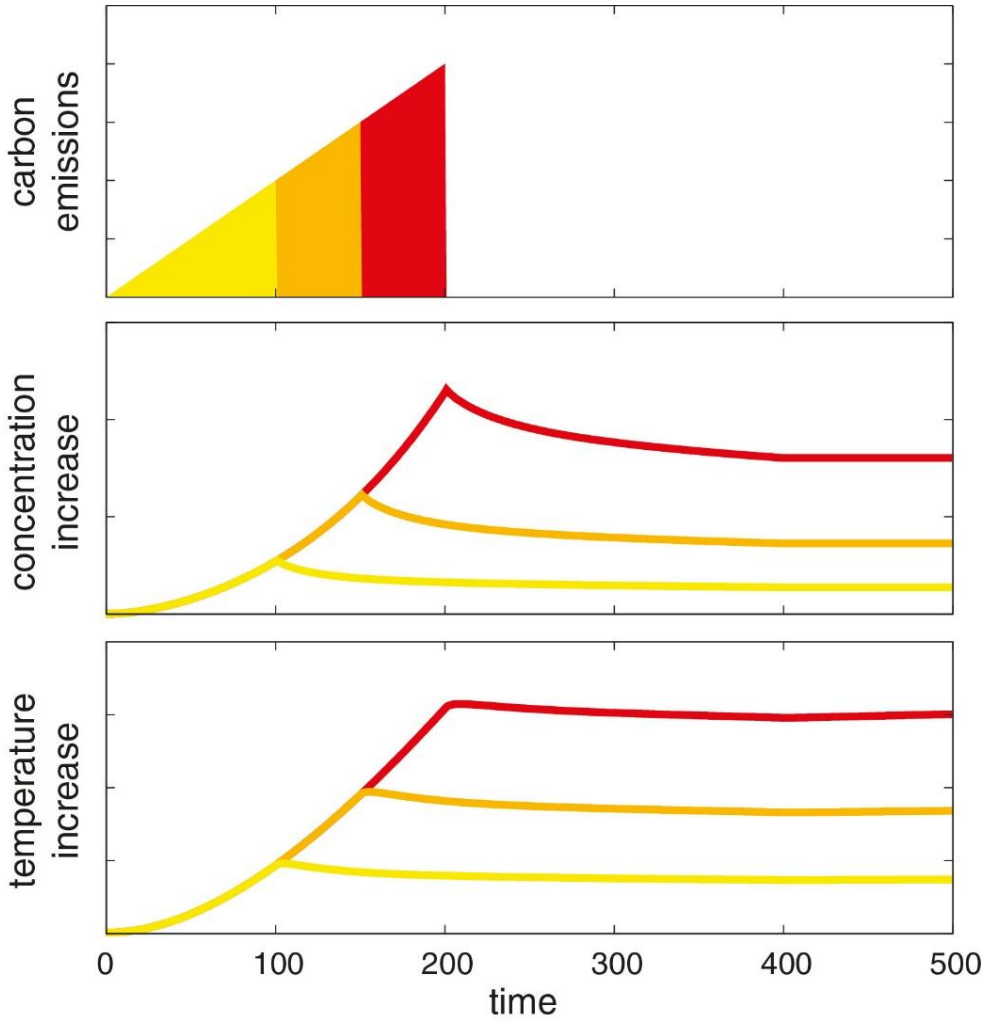


Fig. SPM.7

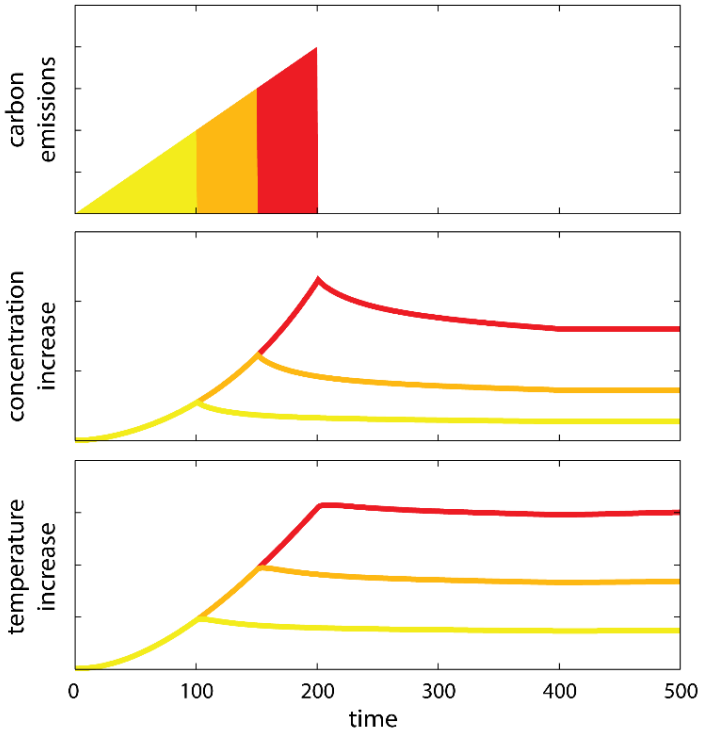
R. Knutti

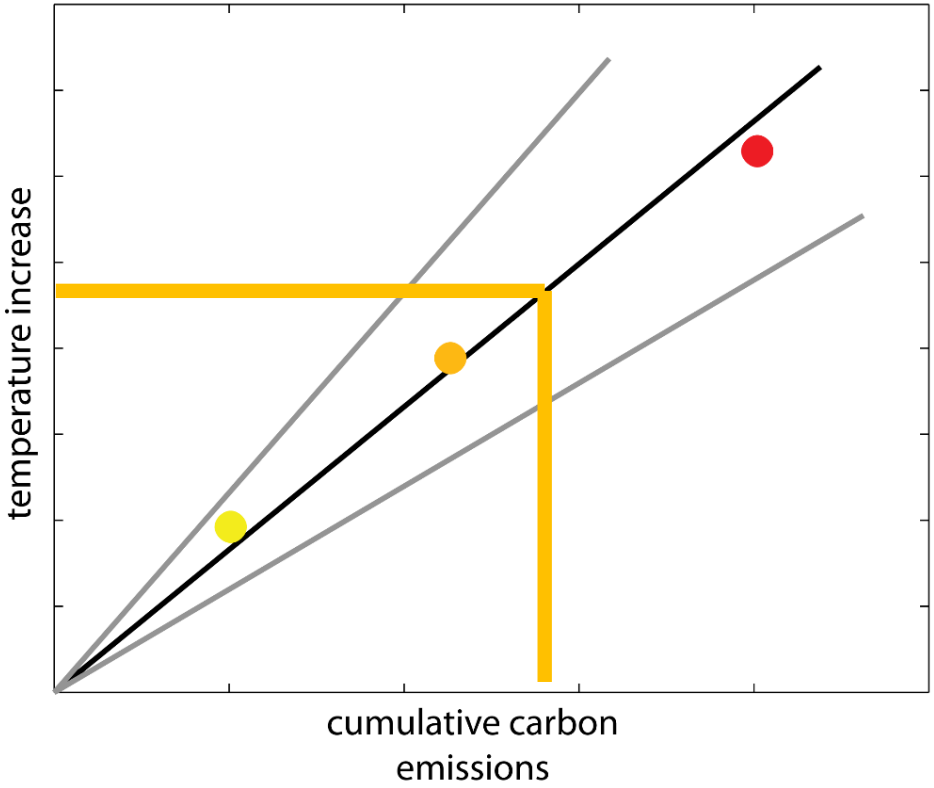
Warming will persist for centuries



- Zero CO_2 emissions lead to near constant surface temperature.
- A large fraction of climate change persists for many centuries.
- More emissions early imply stronger reductions later.
- Any temperature target implies a maximum in cumulative CO_2 emissions. This is purely a physical and carbon cycle problem.
- Allocation over time is a economic and policy question.
- Overshooting the budget will overshoot the target.

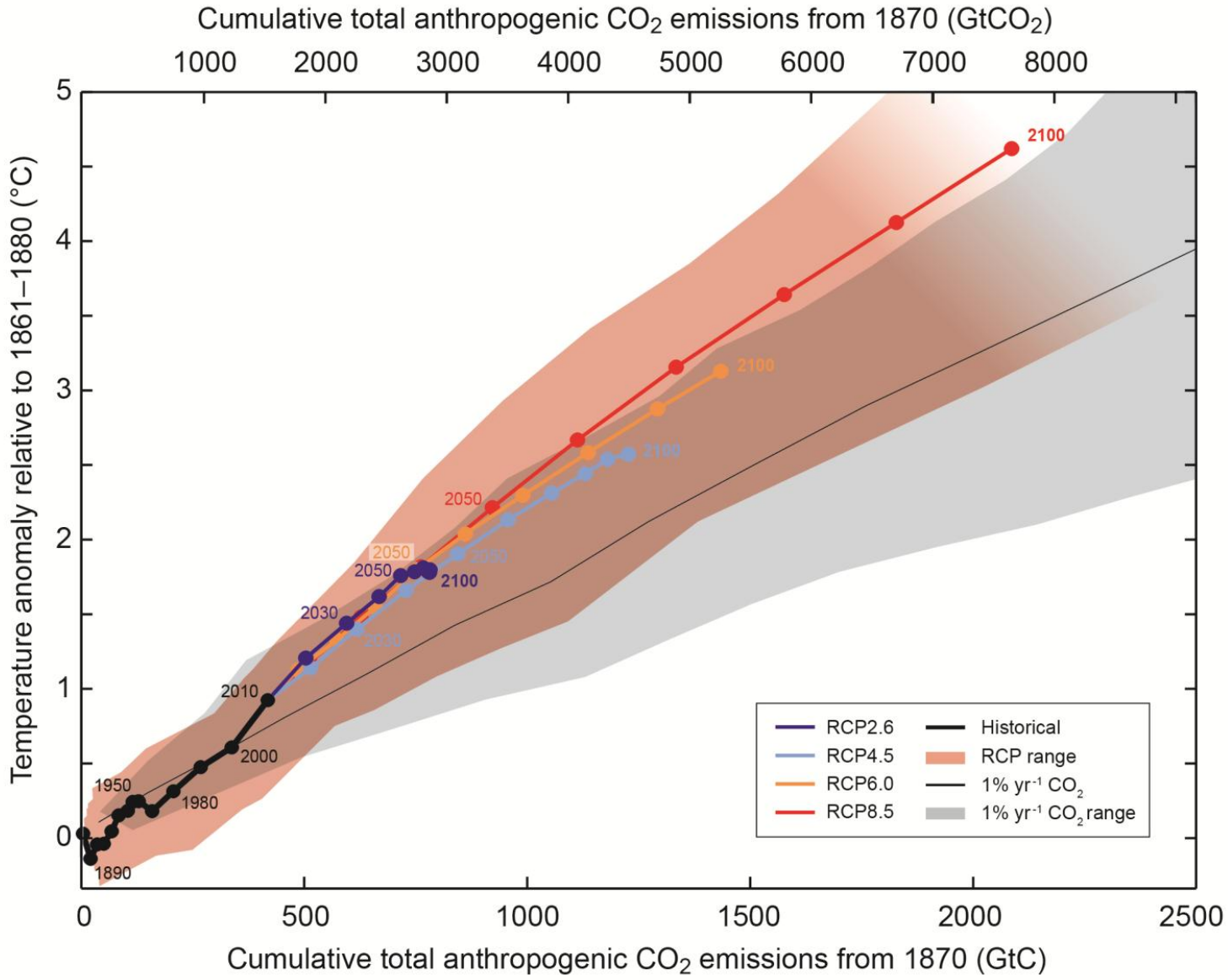
Cumulative carbon determines warming





- Peak warming is approximately proportional to cumulative (total) emissions.
- Transient climate response to cumulative carbon emissions TCRE = Warming per 1000 PgC

Cumulative carbon determines warming



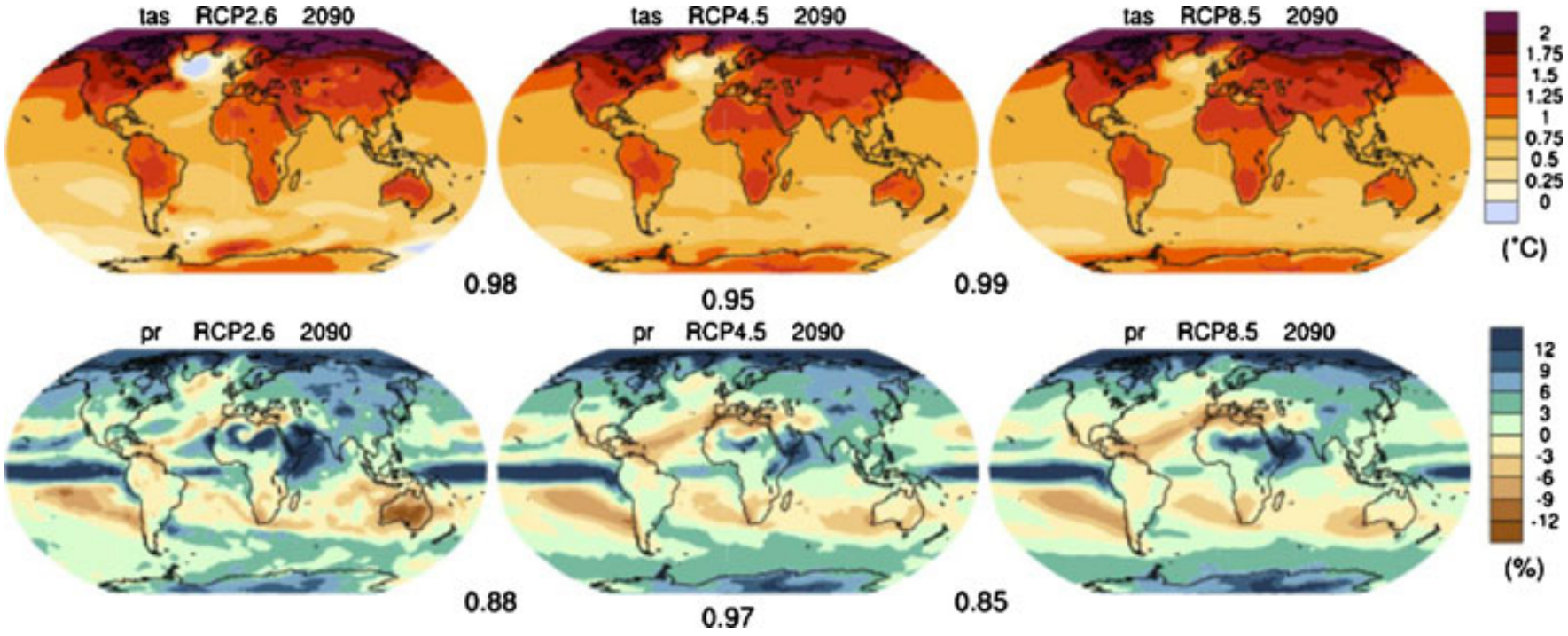
SPM.10

Where does the 1.5^0C target come from?

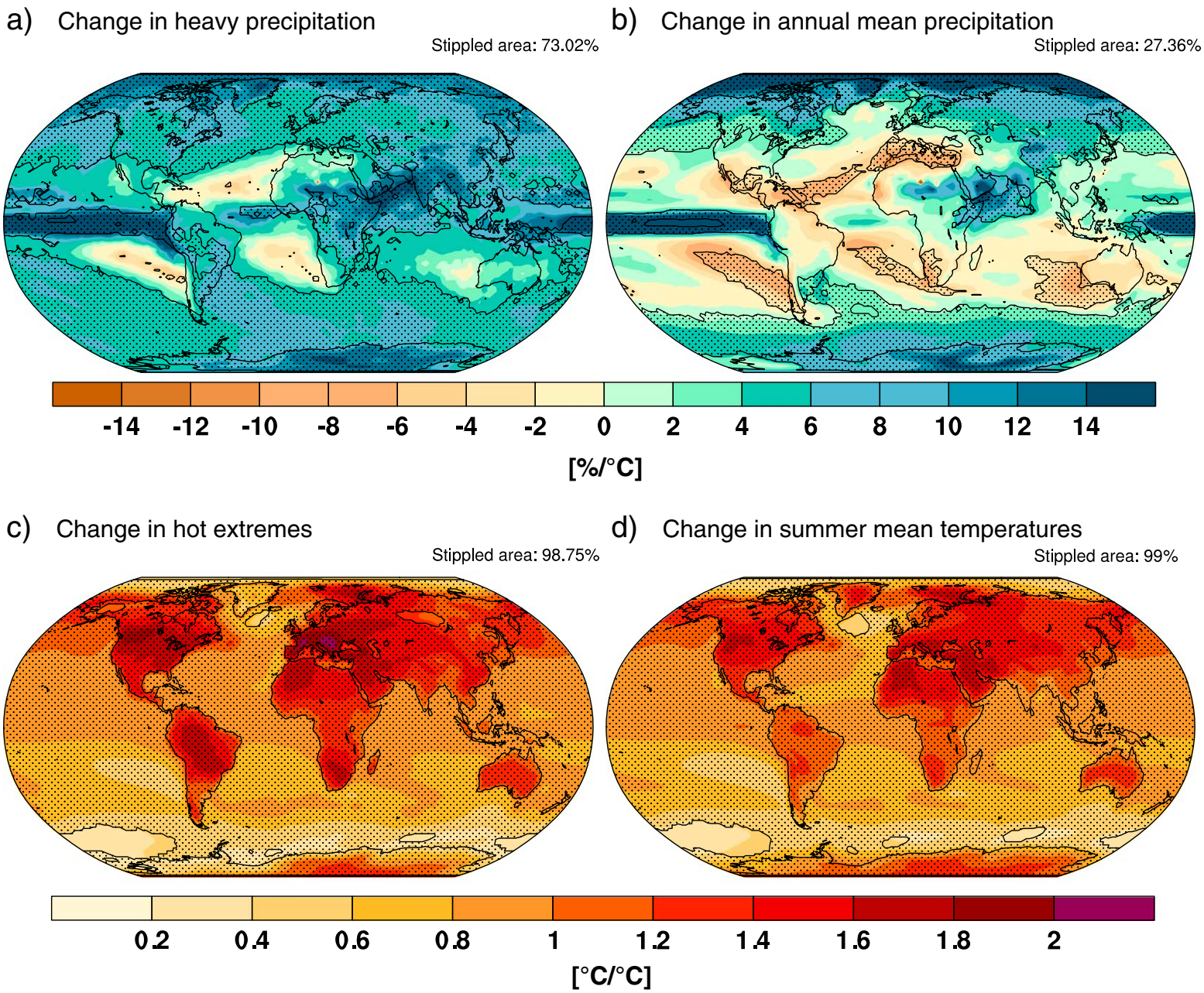
Pattern scaling: Global surface temperature is an indicator of many impacts

Pattern Scaling on Temperature

ANN Surface Temperature and Precip Response, per degree of warming, CMIP5



Tebaldi and Arblaster 2014



Changes in extremes and mean, using scaling by global mean temperature, stippling indicating agreement across individual models.

Fischer et al. 2014

Where does the 1.5^0C target come from?

Mitigating Risk: 1.5^0C *avoids "dangerous" levels of global warming.*

Paris Agreement

Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

   (a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

   (b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;

   (c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

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The 1.5^0C target is grounded in the impacts as we understand them now (sea level rise, etc.).

Paris Agreement

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There are technical issues: choosing 'preindustrial', numerical simulations, etc.

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The 1.5^0C target is grounded in the impacts as we understand them now (sea level rise, etc.).

But another challenge is figuring out what the targets mean and how to talk about them.

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21. *Invites* the Intergovernmental Panel on Climate Change to provide a special report in 2018 on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways;

Discussion Break

1. How do you think 1.5 degrees, 2 degrees or greater warming will impact your life *and* your domain of research (or other work)?

2. How would you communicate the Paris targets and the impacts to others: your family, your friends, stakeholders, environmentalists, climate change skeptics, business partners, etc..?

Discussion Break (5 minutes?)

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Pair and Share!

IPCC Special Report and North2Warm

- North2Warm, funded by NSERC, is an activity of the Canadian Sea Ice and Snow Evolution Network (CanSISE)
- Its purpose is to provide a strong Canadian contribution to this Special Report, that would focus specifically on Canada's North.
- Purpose: produce review paper to be submitted in time to be considered in the Special Report.
- Such a paper would also serve the Canadian policy and impacts/adaptation community.
- We held a community workshop and plan for submission of the review in fall 2017.
- Many who were at the meeting are here at CSI.

Questions at the March N2W Workshop

1. What does the Paris agreement's 1.5 degree or 2.0 degree target **actually mean to you in a practical sense**? What does it imply for your areas of interest with respect to Canada's North and cold regions?

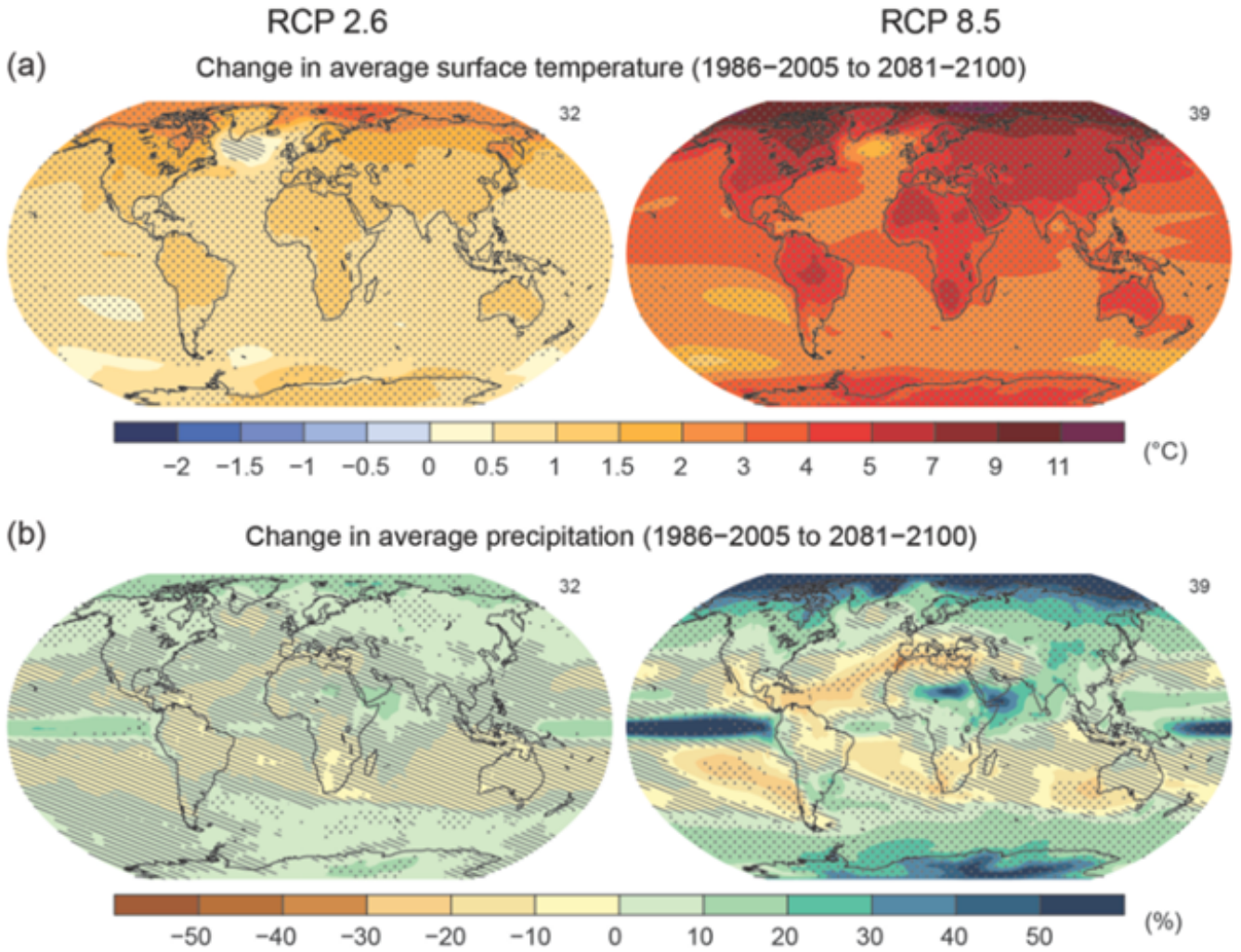
2. In the context of the Paris targets, **what adaptation measures are you aware of** that are underway or anticipated in Canada's North and cold regions? What additional measures would be useful to undertake?

3. **What metrics** or diagnostics of environmental parameters **would be most useful for adaptation** and planning in Canada's North and cold regions in the context of the Paris targets? These could relate to observations and/or to models. (E.g. location of the 0^0C isotherm, timing of 1.5^0C versus 2^0C, differential impacts of 1.5^0C versus 2.0^0C on extremes, permafrost impacts, etc.)

N2W Workshop Agenda

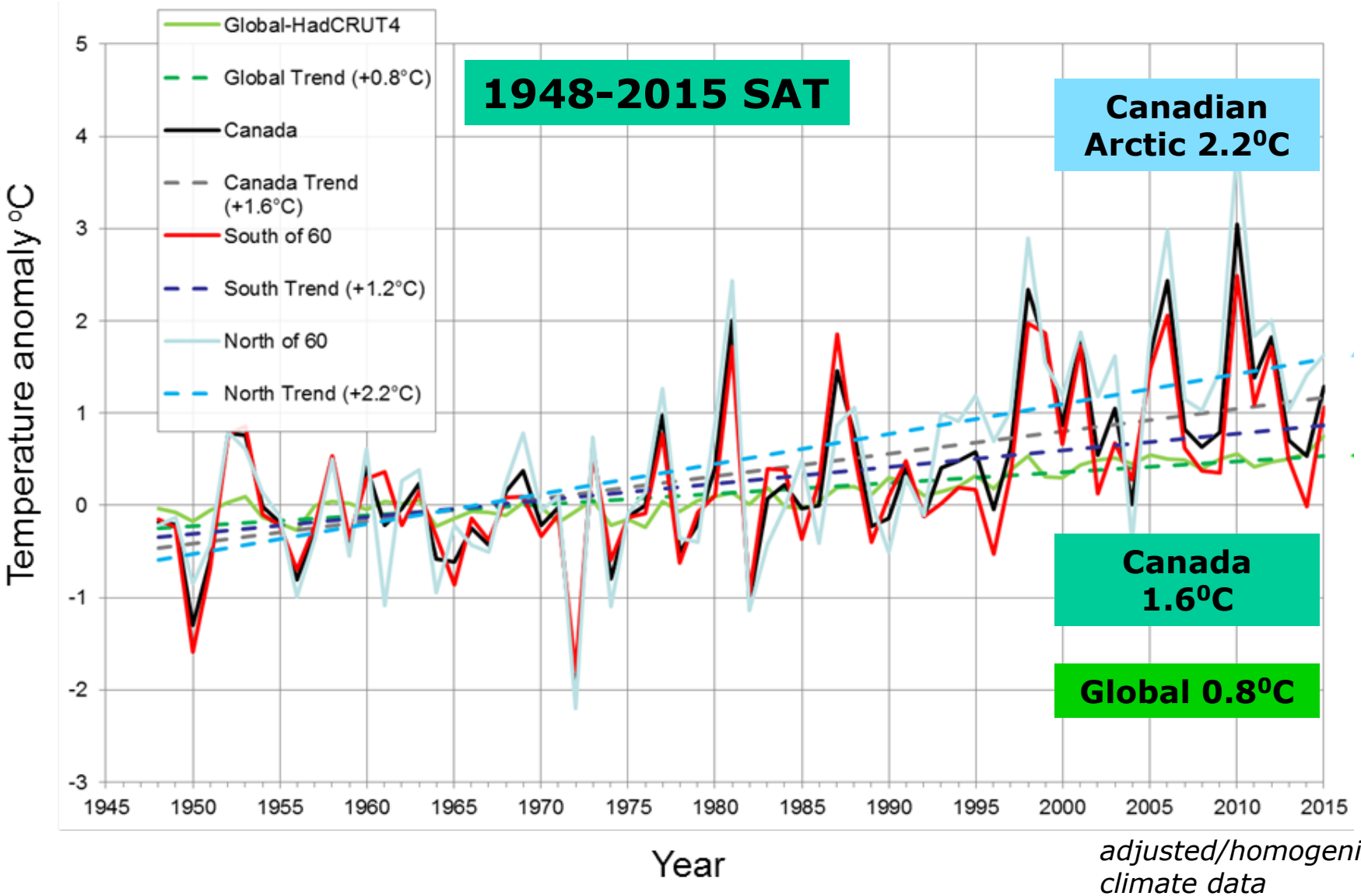
09:30-10:00	Introductory talk/Overview. Greg Flato: **The IPCC Special Report on 1.5 degrees, purpose of N2W and aims of this workshop.**
10:30-12:00	**Panel 1: Observed changes**. Stephen Howell (chair), Chris Derksen, Claude Duguay, Sharon Smith, Bruno Tremblay, Xuebin Zhang
13:30-15:00	**Panel 2: Projected changes** under the UNFCC targets. Greg Flato (chair), Chris Fletcher, John Fyfe, Nathan Gillett, Michael Sigmond, Francis Zwiers
15:30-17:00	**Panel 3: Adaptations underway and anticipated**. Don Lemmen (chair), Lukas Arenson, Bronwyn Benkery, Jackie Dawson, Marie-Eve Neron, Scot Nickles
17:00-18:00	**Recap/Discussion/Knowledge Gaps**

Why the Arctic and Canada's North?



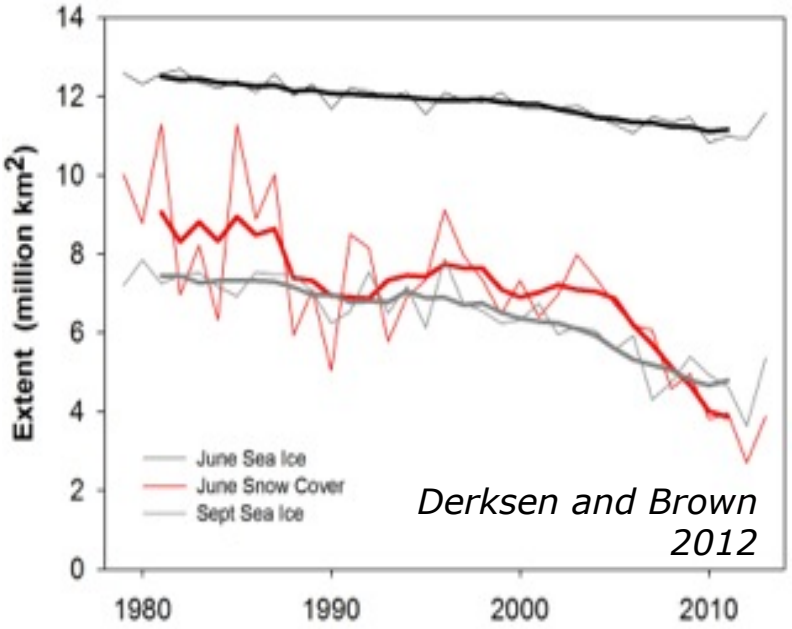
IPCC 5th Assessment

Where we are now: 1^0C.



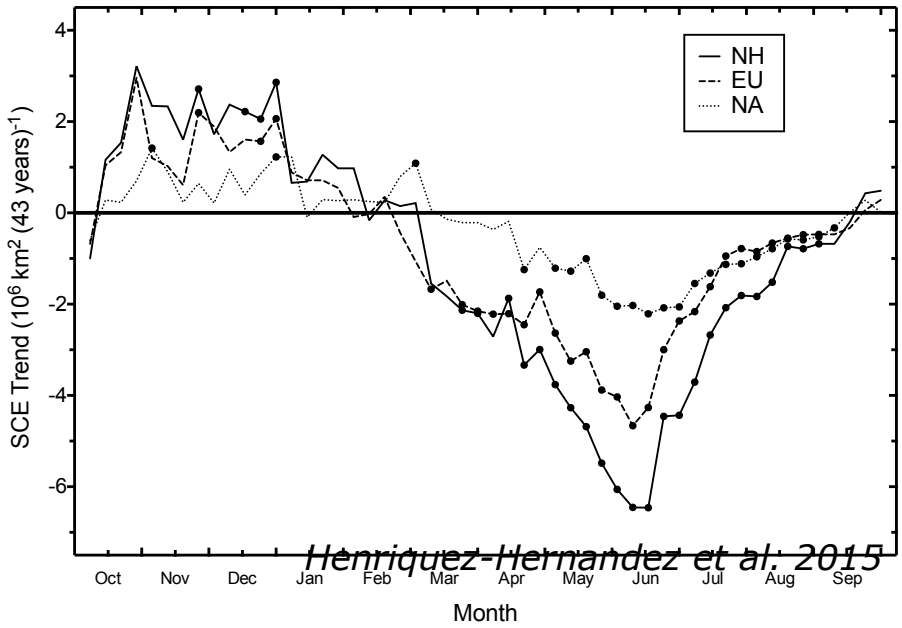
adjusted/homogenized climate data

Sea Ice and Snow Cover



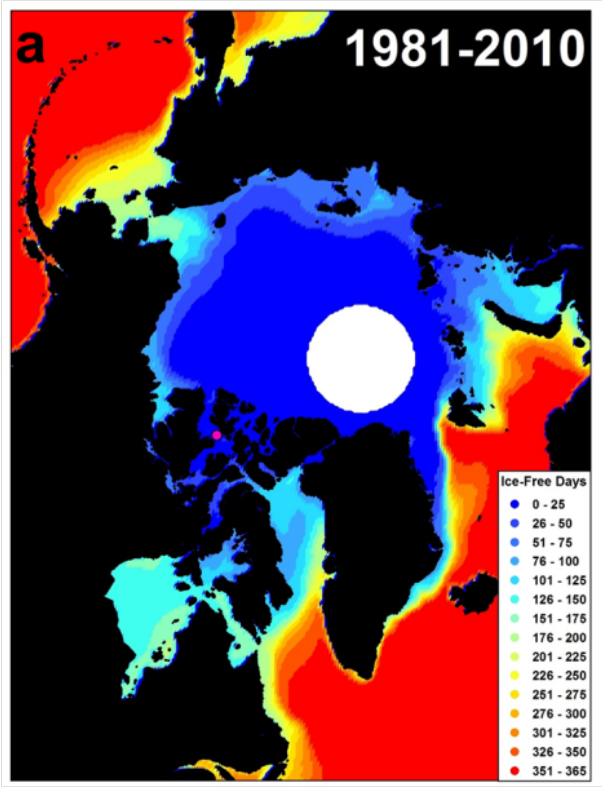
Derksen and Brown 2012

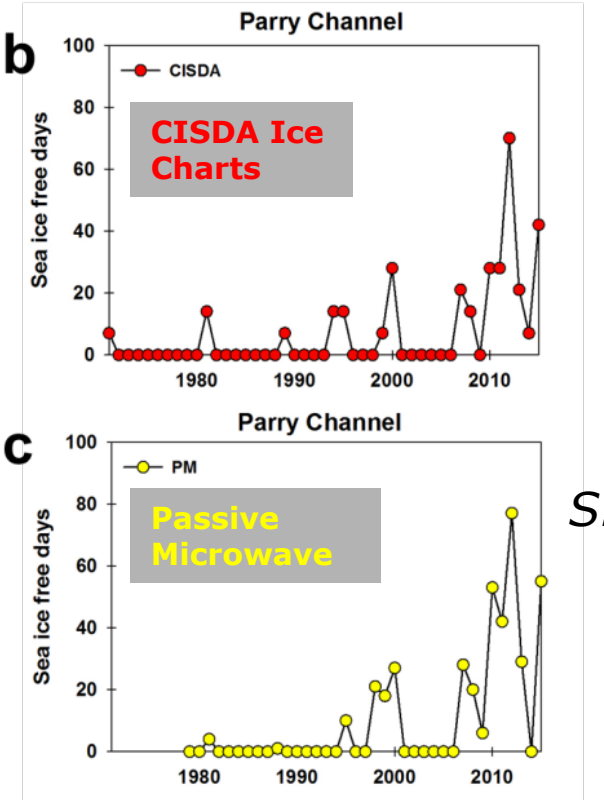
Snow Cover Trends 1971-2014



Henriquez-Hernandez et al: 2015

Ice Free Days





S. Howell in prep.

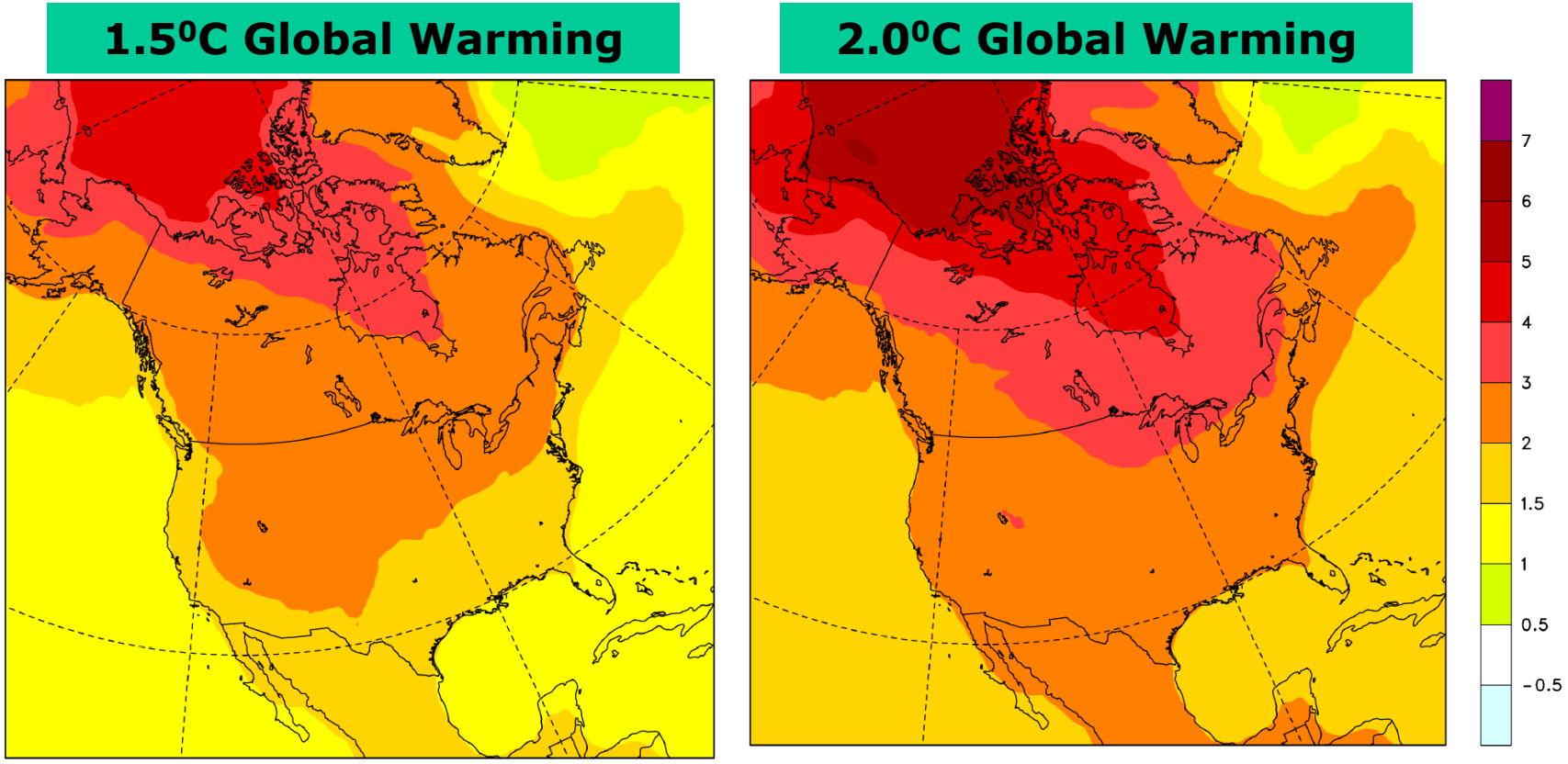
Where will we be under 1.5^0C or 2.0^0C?

Where will we be under 1.5^0C or 2.0^0C?

Simple rule of thumb: 1.5^0C is about 50% more warming and 2.0^0C is about double the warming we've experienced.

I've talked about this for CMOS at
https://itunes.apple.com/us/podcast/cmos-51st-congress-future-earth-interviews/id1229726669?mt=2

Warming mean temperatures

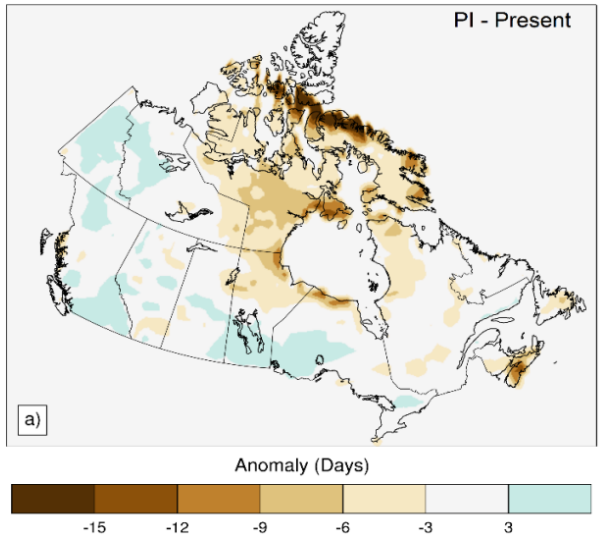


Based on CMIP5 multi-model ensemble.

Figure courtesy S. Kharin, CCCma

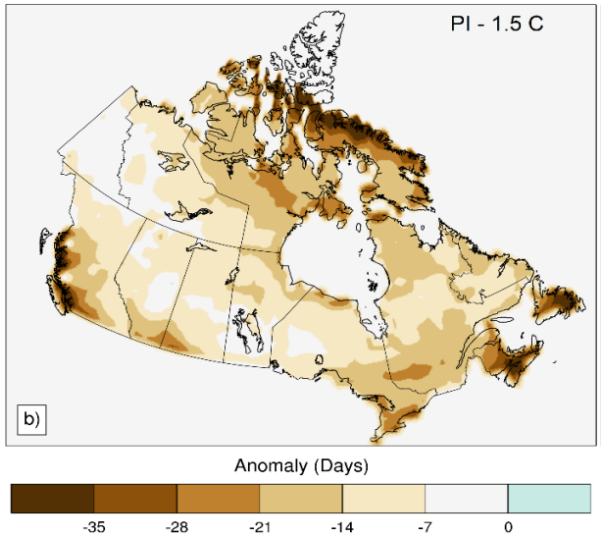
Reduced Snow Cover Duration

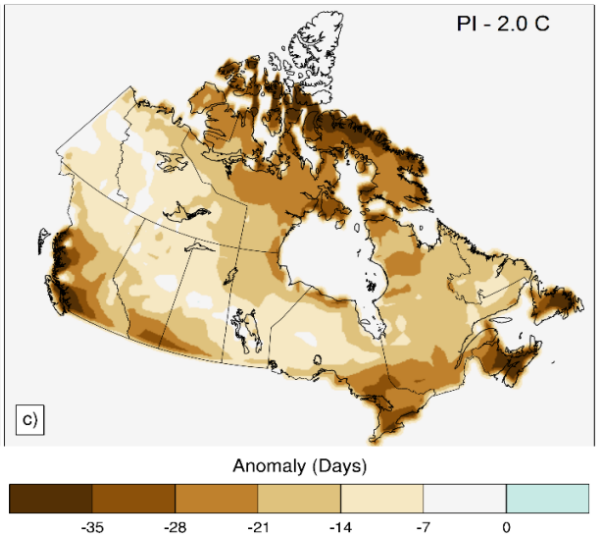
To Present Day



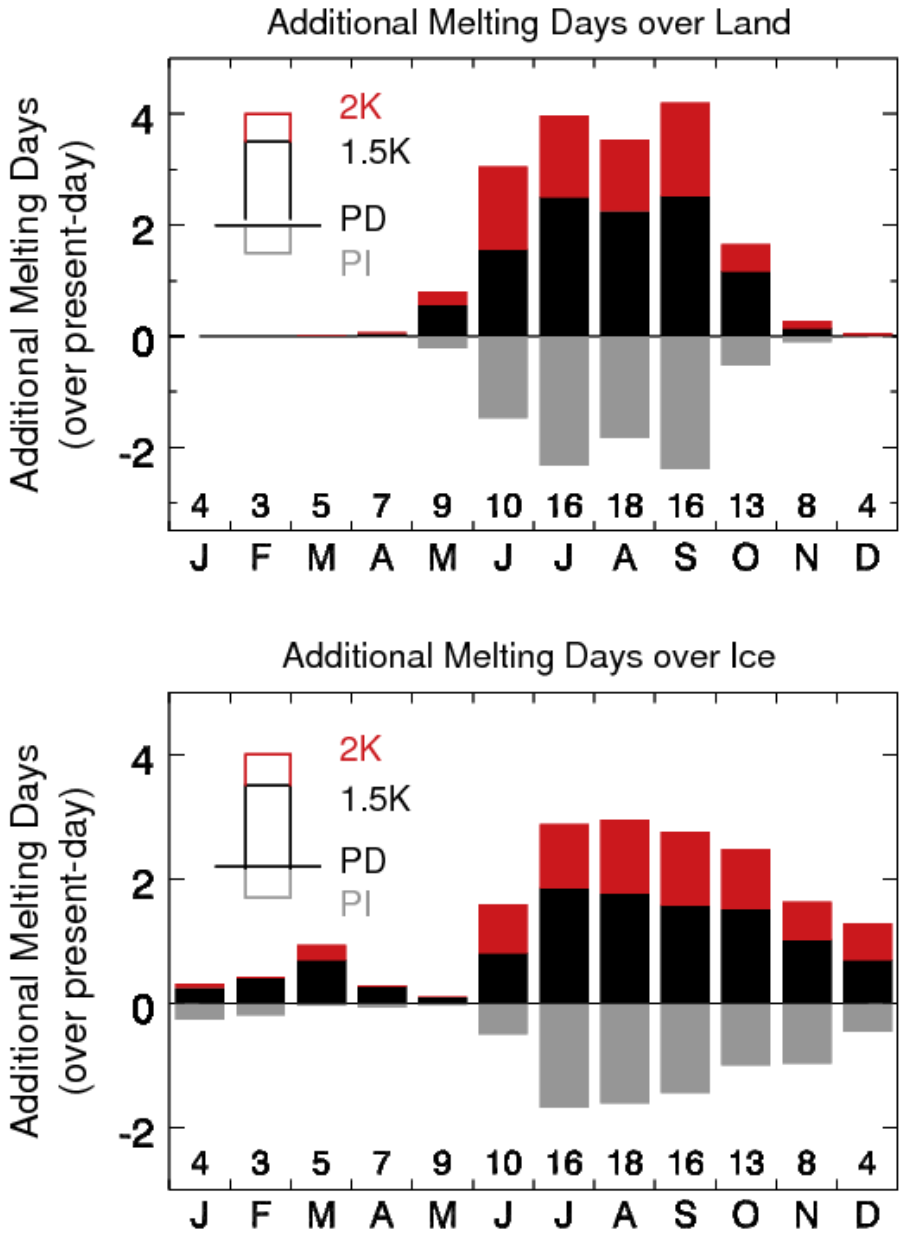
Chad Thackeray, from NCAR CESM

+1.5^{0}C





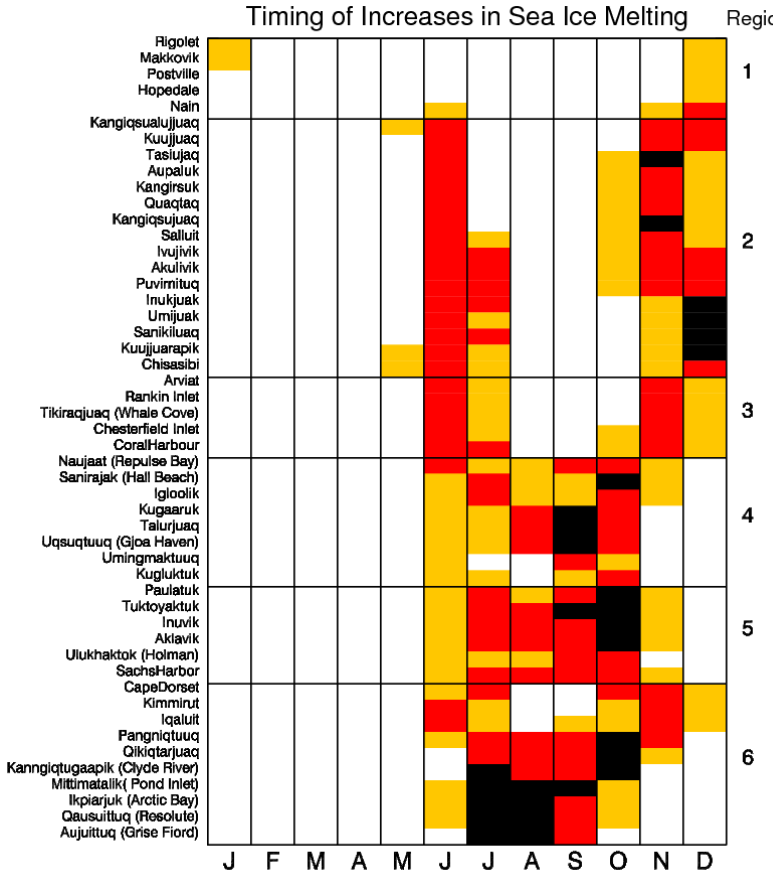
+2.0^{0}C

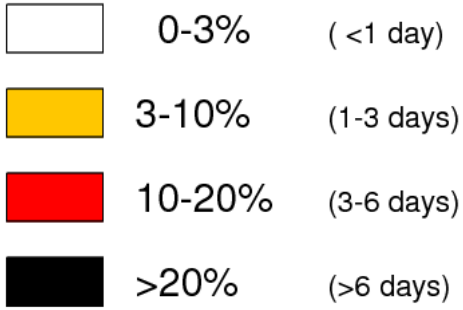


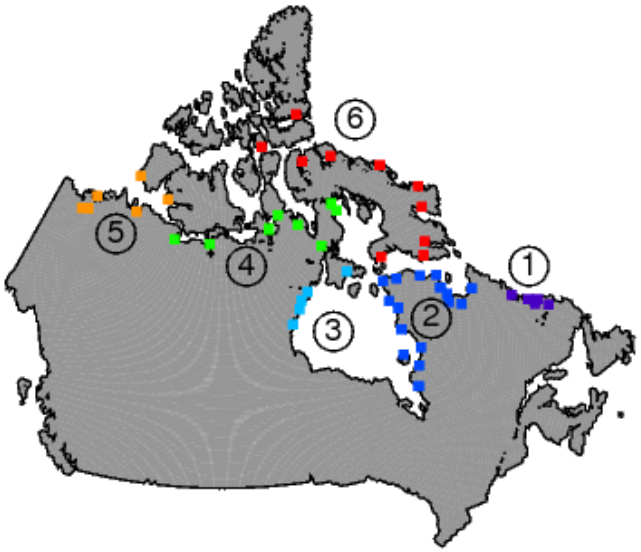
Lawrence Mudryk, from NCAR CESM

Simulated change in mean number of melting days (T_{mean} < 0°C) averaged over Canadian land ecozones 1-3 (top) and over Canadian Arctic water (bottom) compared to present day conditions. Numbers listed for each month give the number of melting days for present-day conditions. Bars indicate the number of melting days relative to these numbers for preindustrial conditions (grey), 1.5K of warming (black) and 2K of warming (red).

Degraded Coastal Ice and Frozen Roads







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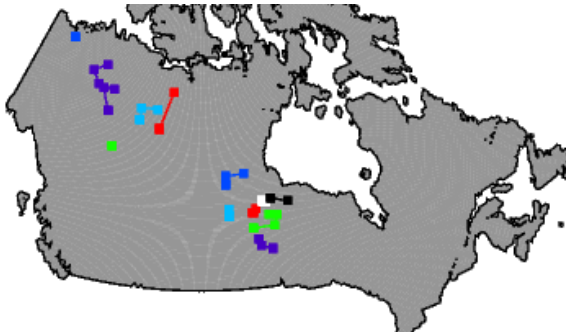
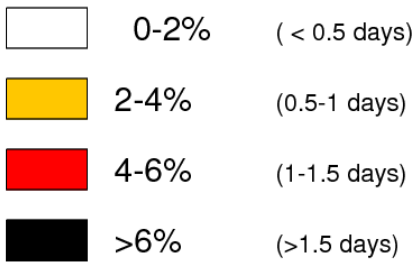
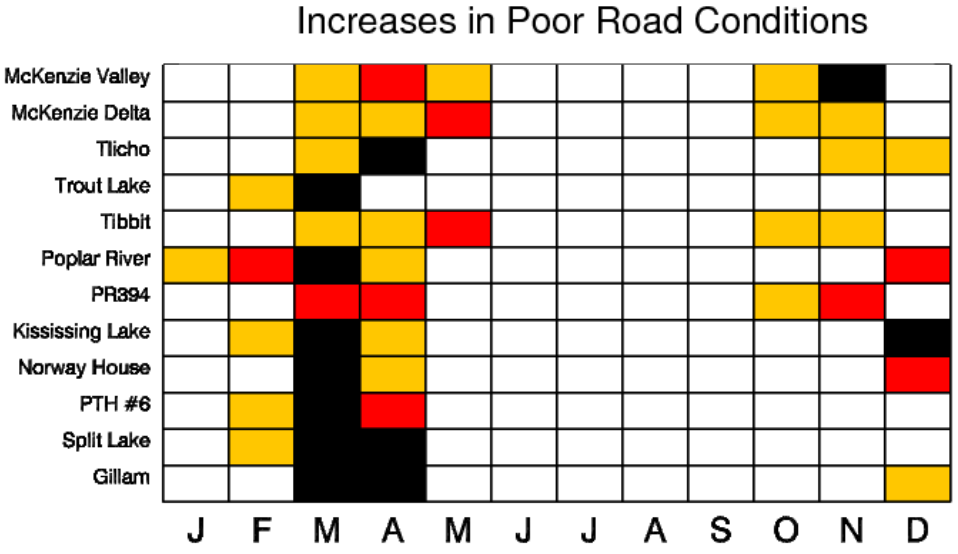






Lawrence Mudryk, from NCAR CESM

North2Warm – A Few Personal Thoughts

Paul's Observations

- We have only gotten started on the range of questions we had.
- The scientists are challenged by technical issues.
- The adaptation and impacts community are challenged to conceptualize and communicate the targets and their relevance.
- The relevance of 1.5^0C is questioned.
- *But the exercise is still worth doing and extending.*

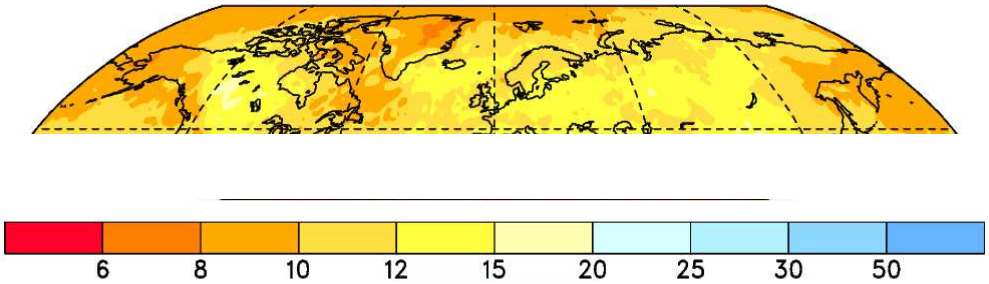
Recap

- The 1.5^0C+ targets are scientifically excellent but
- How to limit warming to this level and how to figure out the targets' relevance to impacts are a real challenge.
- The differences between 1.5^0C and 2.0^0C can be quantified and will likely be important for decision making in the coming decades.
- There is a lot of interest in this topic from the broader public (CMOS).
- Working through the communication and impacts challenge is a very healthy exercise.

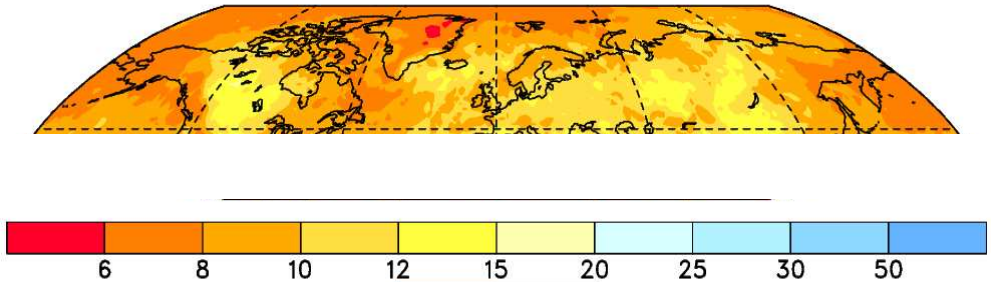
Increased precipitation extremes

Return period for preindustrial 20-year event

+1.5^{0}C



+2.0^{0}C



Francis Zwiers and Slava Kharin