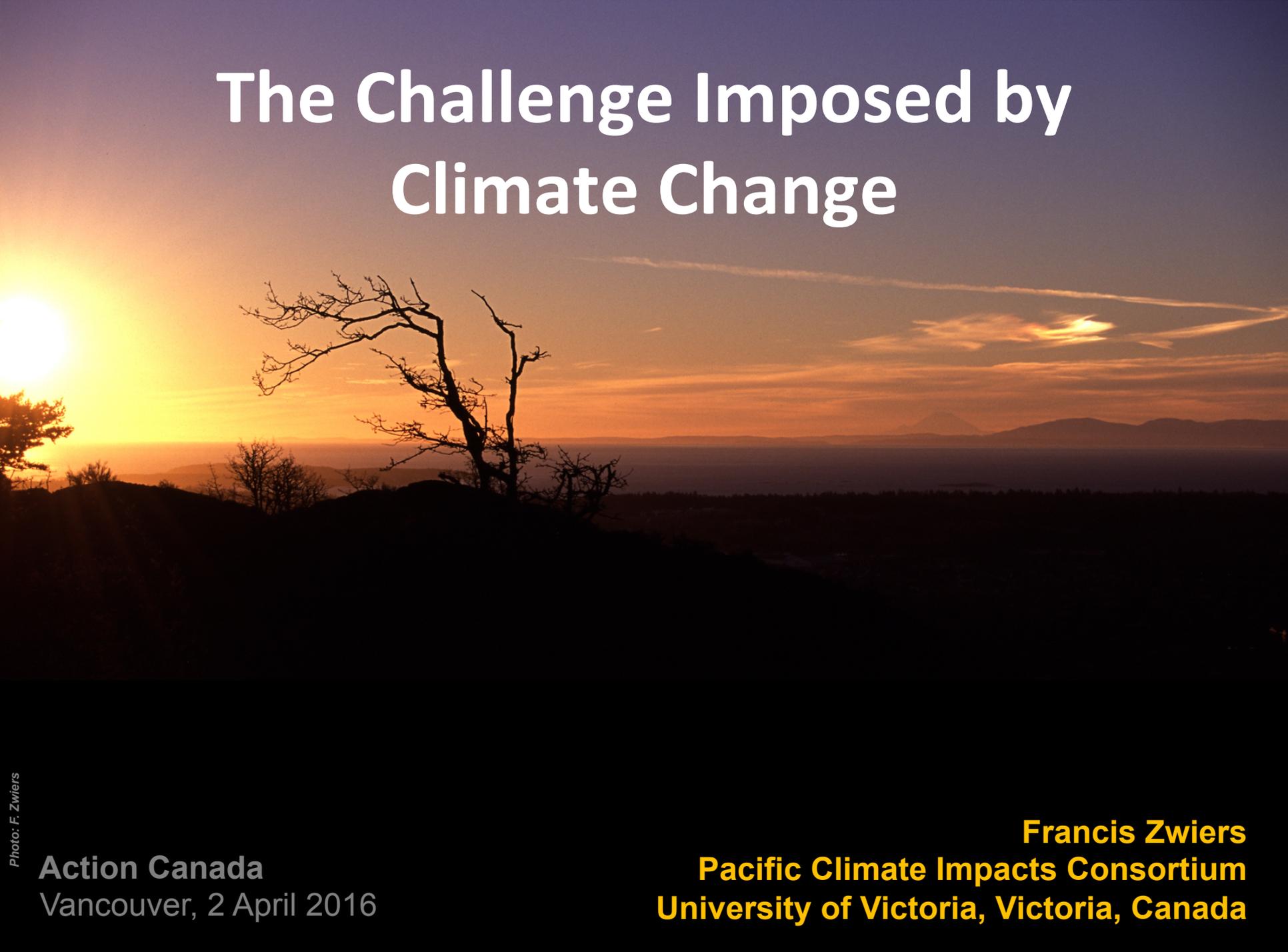


The Challenge Imposed by Climate Change

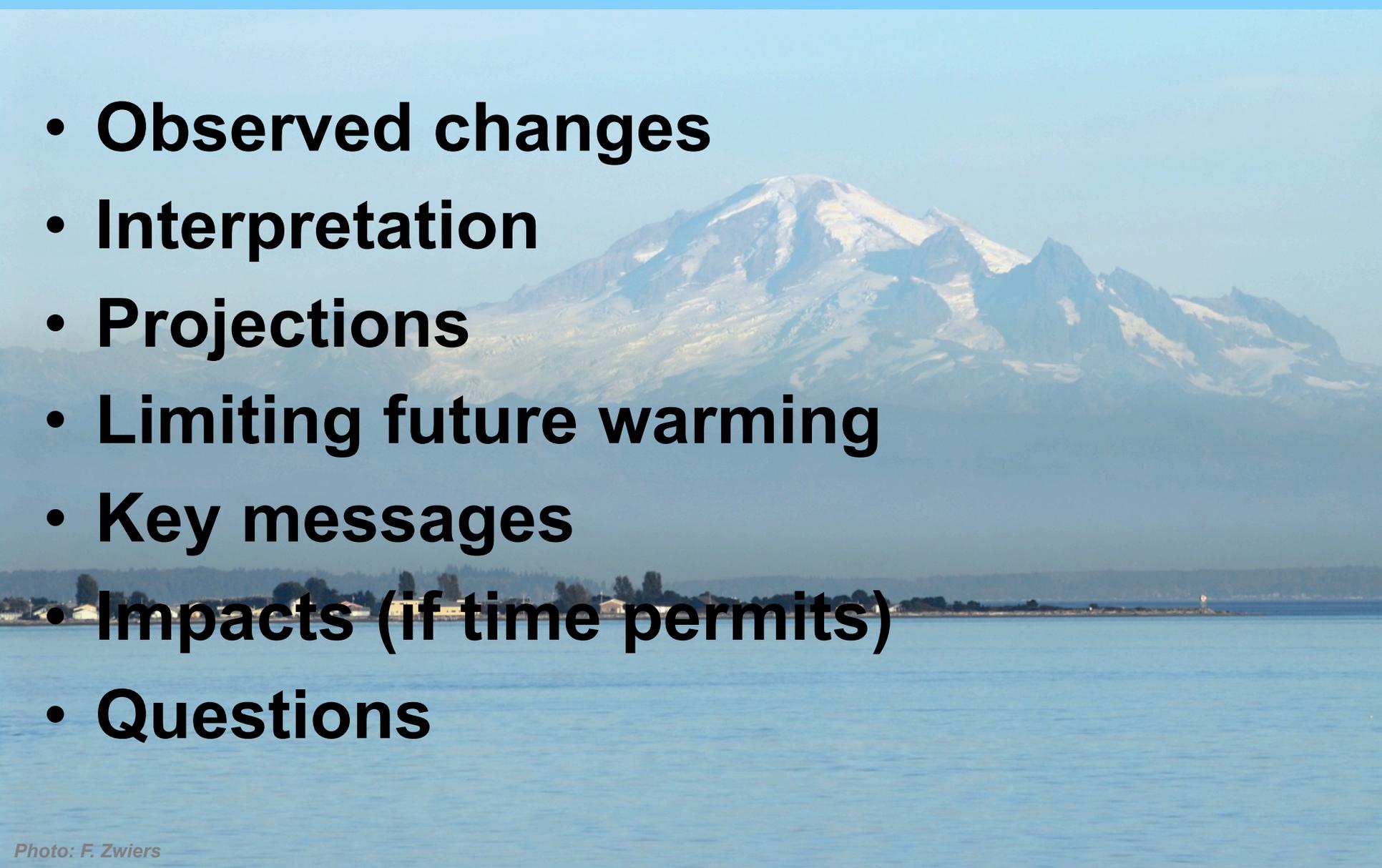


Action Canada
Vancouver, 2 April 2016

Francis Zwiers
Pacific Climate Impacts Consortium
University of Victoria, Victoria, Canada

Outline

- **Observed changes**
- **Interpretation**
- **Projections**
- **Limiting future warming**
- **Key messages**
- **Impacts (if time permits)**
- **Questions**



Observed Changes



Warming is unequivocal

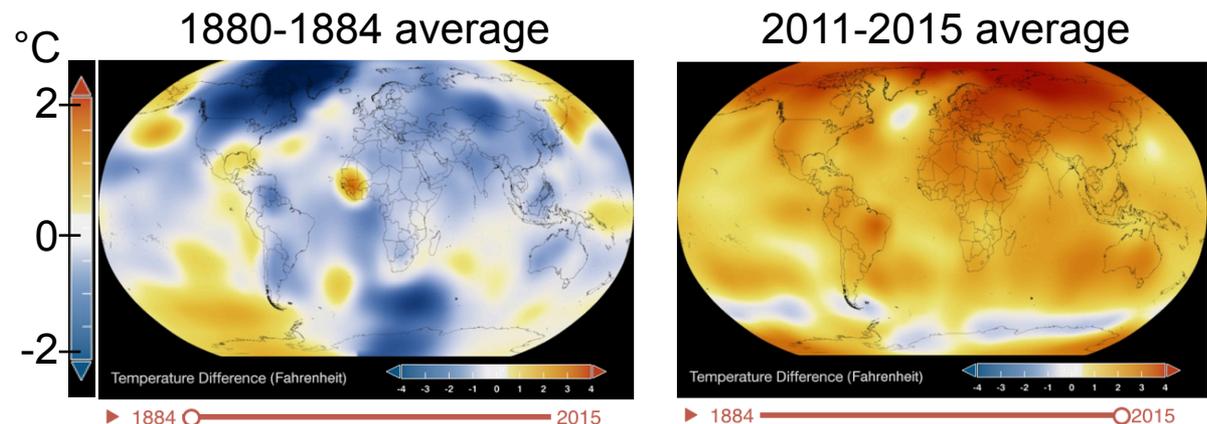
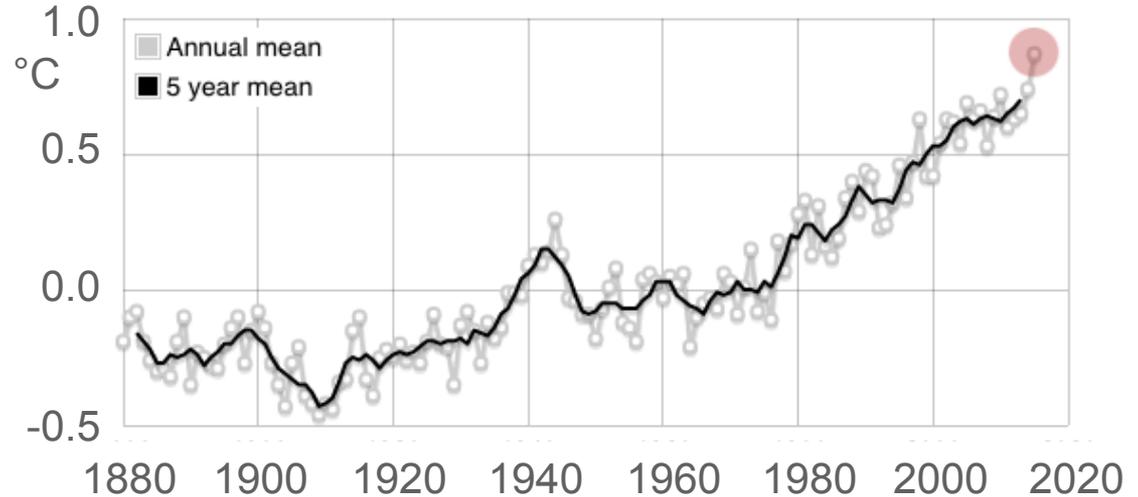
Multiple lines of evidence including

- Temperature
- Snow cover extent
- Arctic sea ice
- Ocean heat content
- Sea level rise

Associated changes in

- Precipitation
- Ocean surface salinity
- Temperature and precipitation extremes

Global mean temperature relative to 1951-1980



Courtesy [NASA GISS](#) (accessed 28 March 2016)

Interpretation of the Evidence

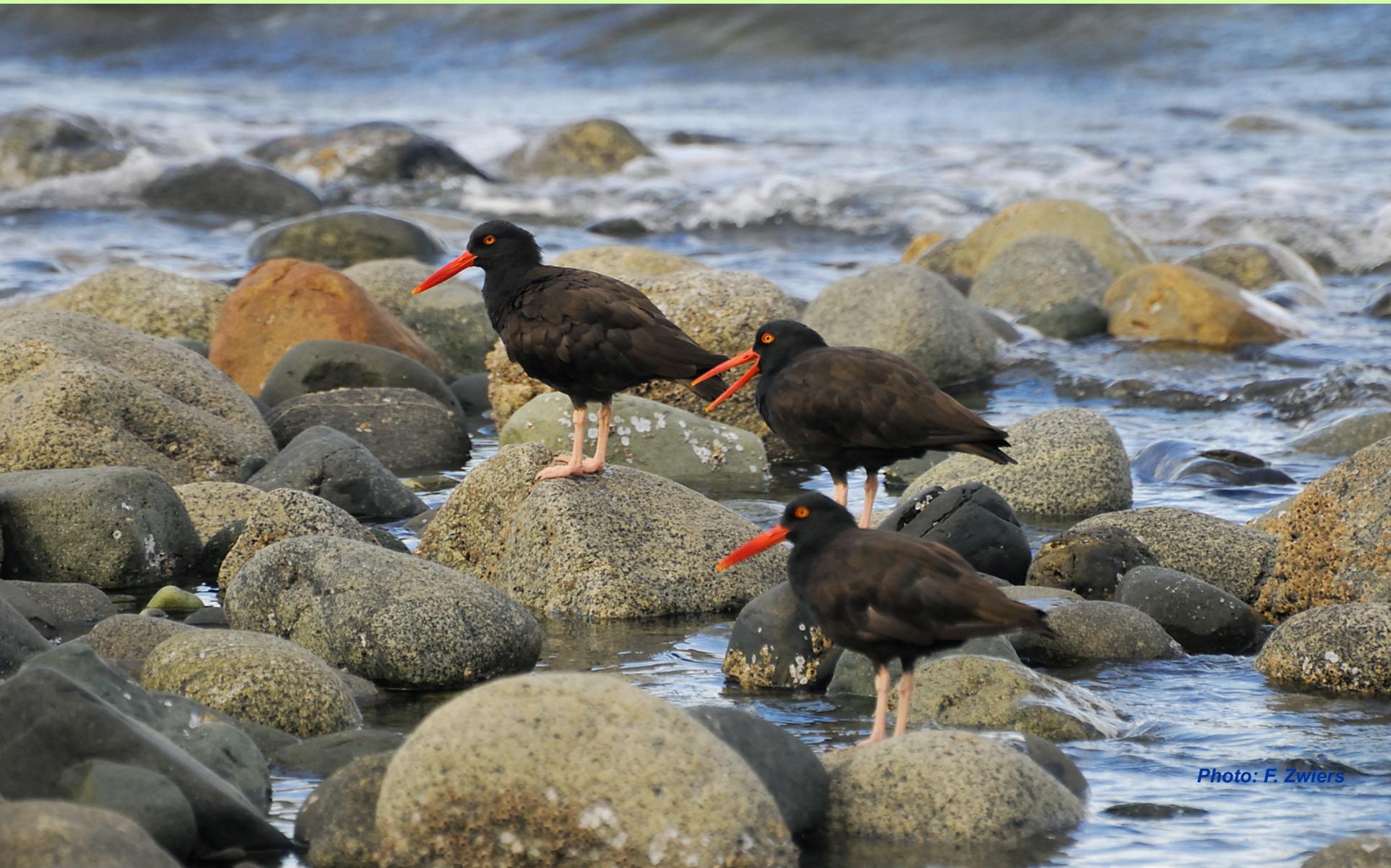
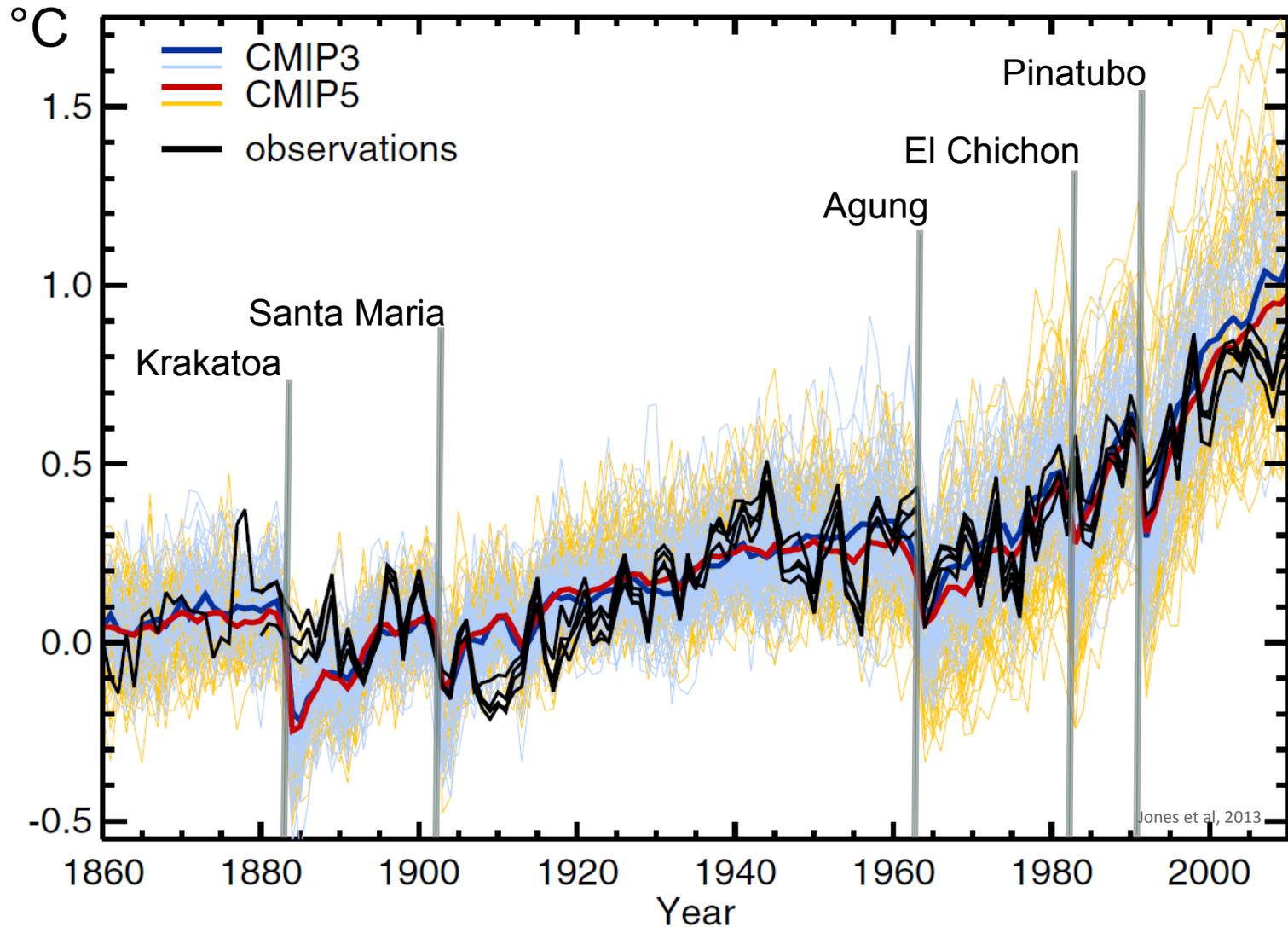
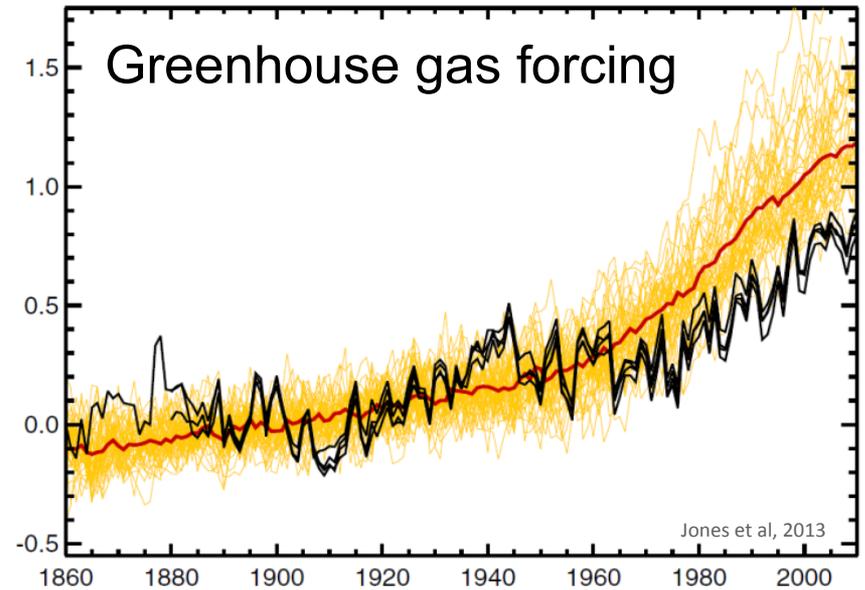
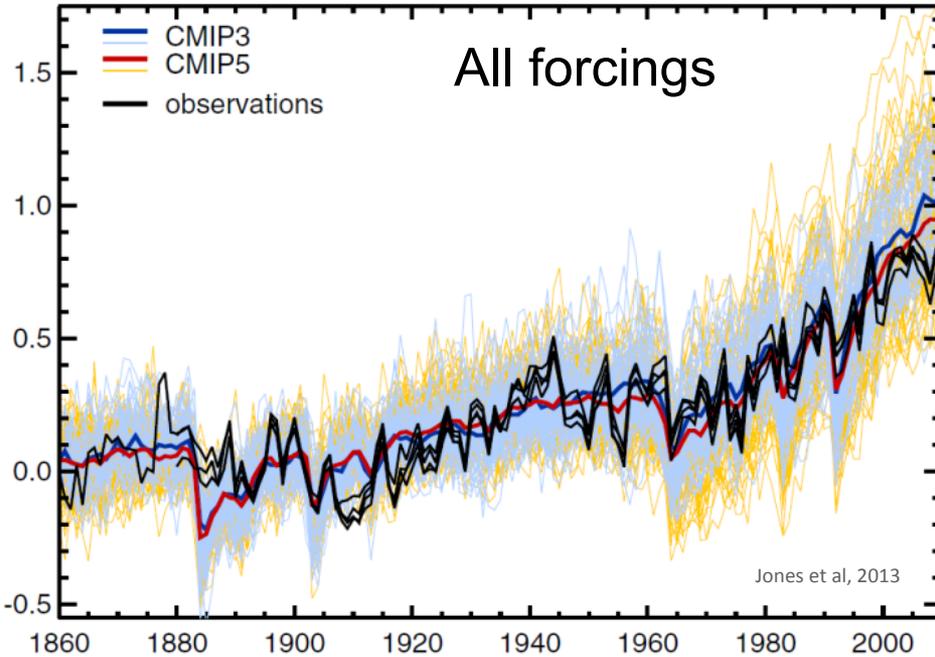


Photo: F. Zwiars

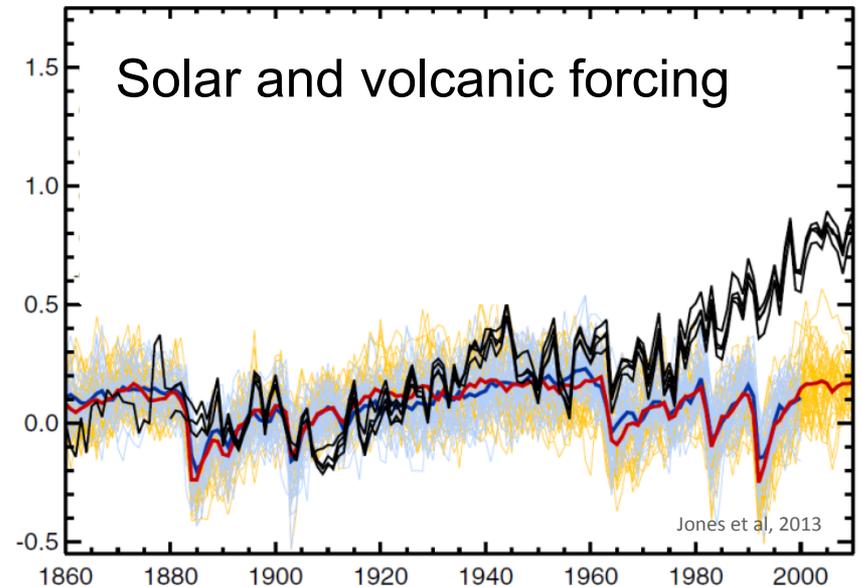
Global mean temperature anomaly



Global mean temperature anomaly



It is ***extremely likely*** that human influence has been the dominant cause of the observed warming since the mid-20th century.

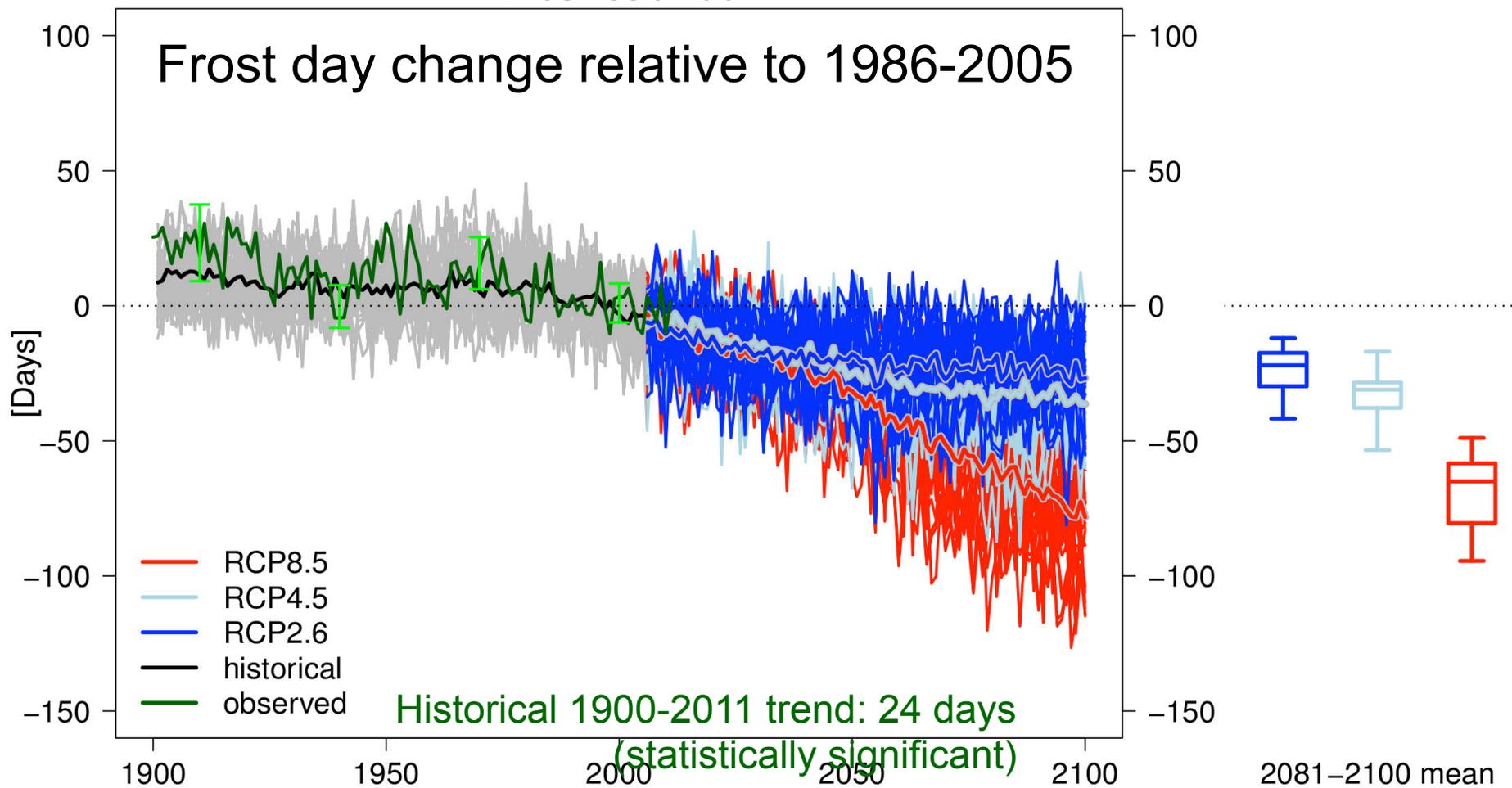


Impacts in BC

- Warming clearly evident
- Glaciers in retreat across the province
- Winter snowpack reductions
- Summer stream flow declining
- Large reduction in number of frost days each year
- Pine bark beetle infestation linked to less intense winter cold extremes

Annual frost days

Projected change in frost days
British Columbia

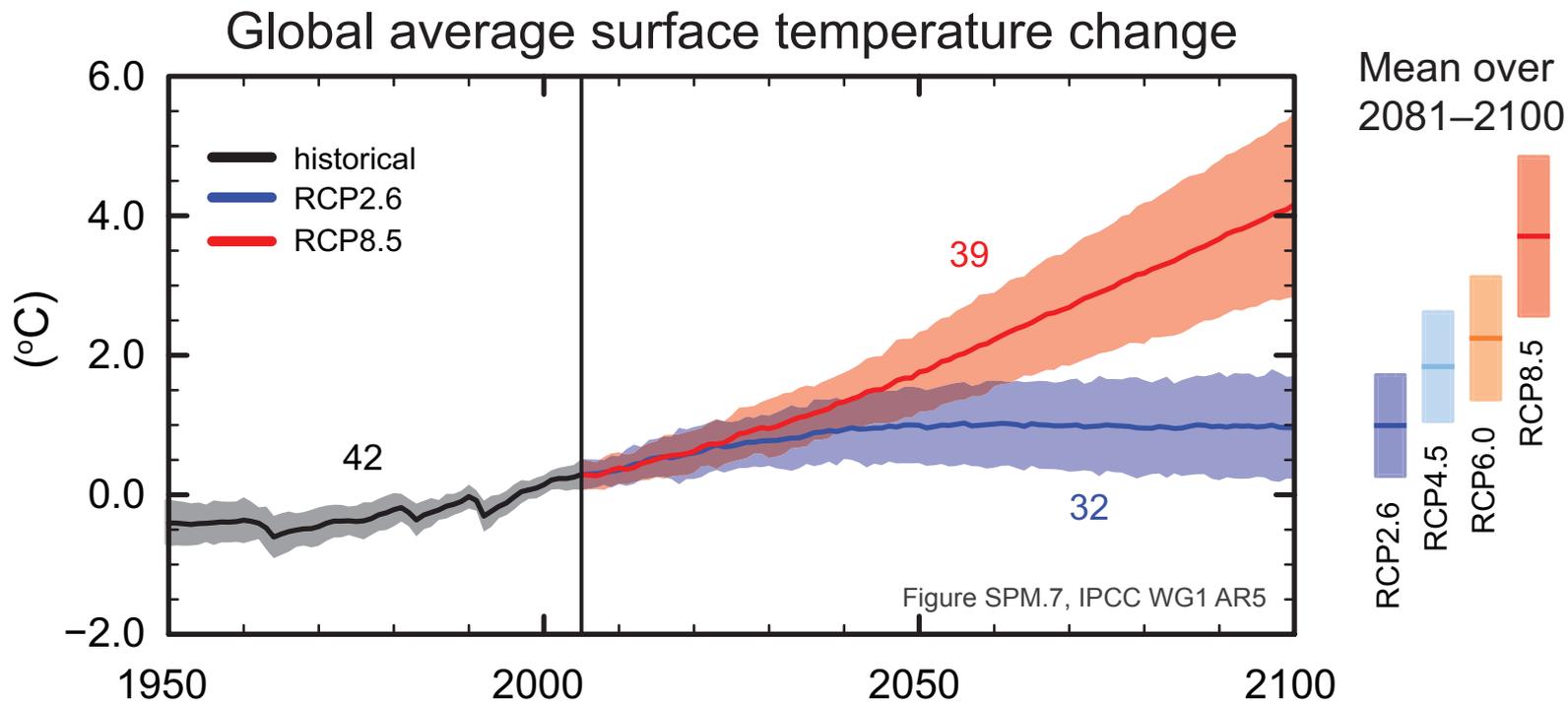
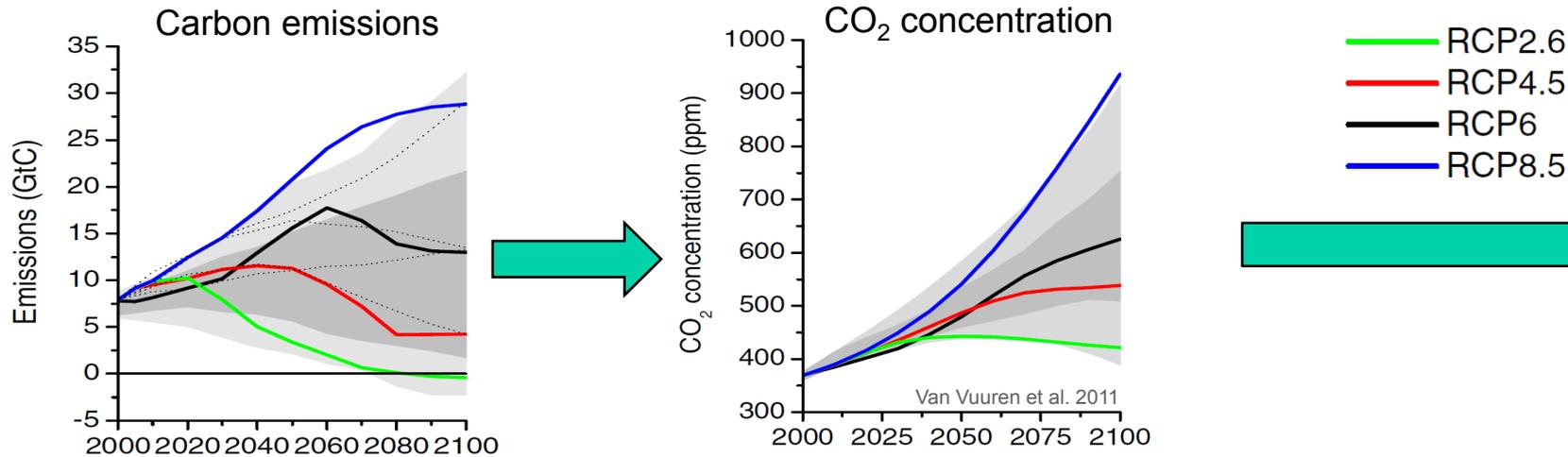


Projected climate change



Photo: F. Zwiers

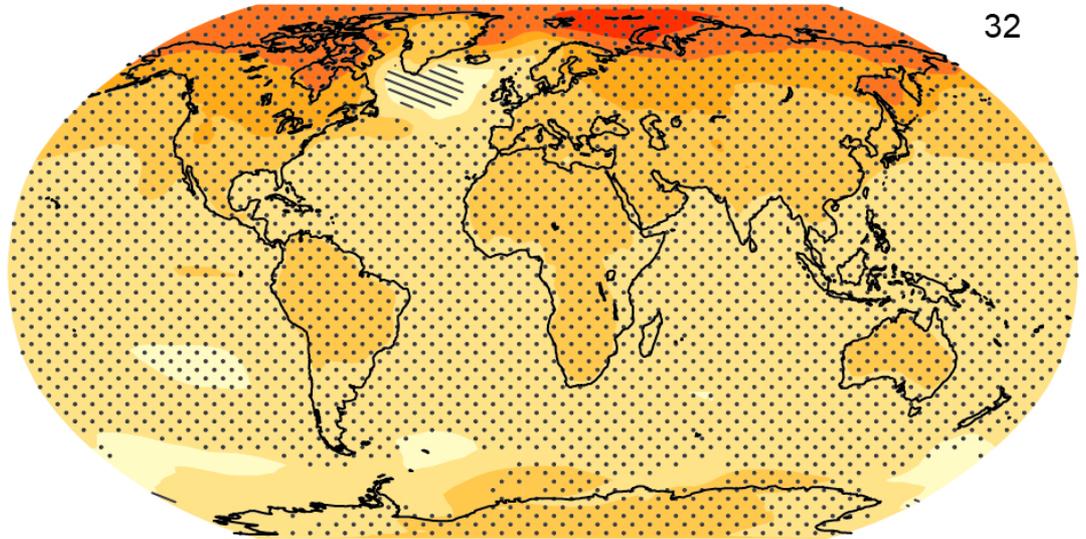
We have a choice ...



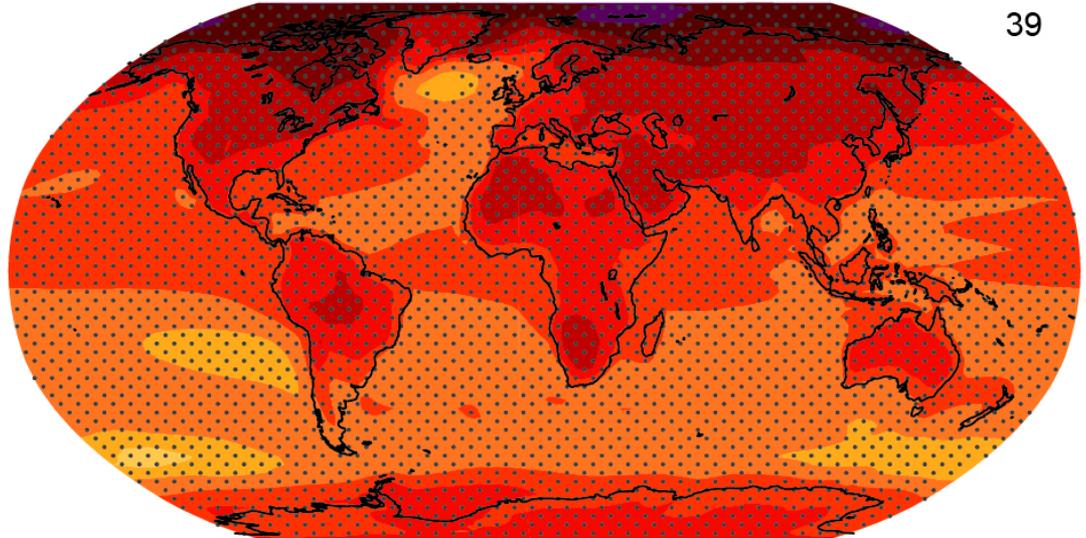
Projected warming (mean climate)

Difference between
1986-2005 and
2081-2100

RCP2.6



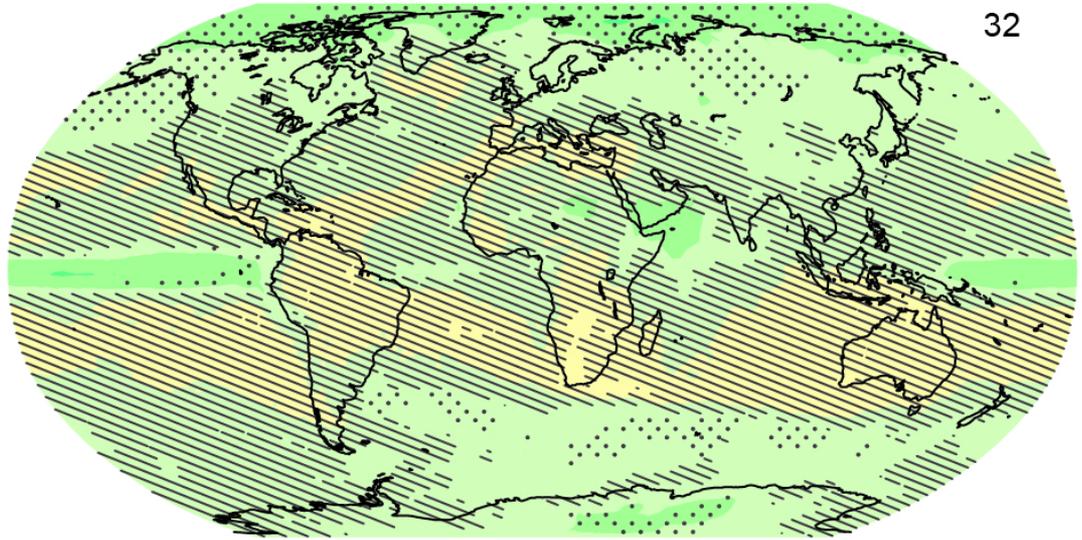
RCP8.5



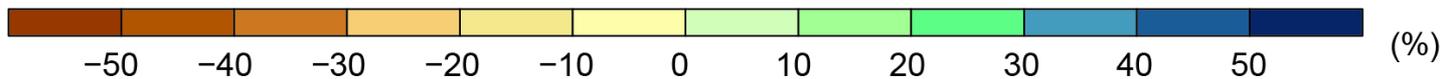
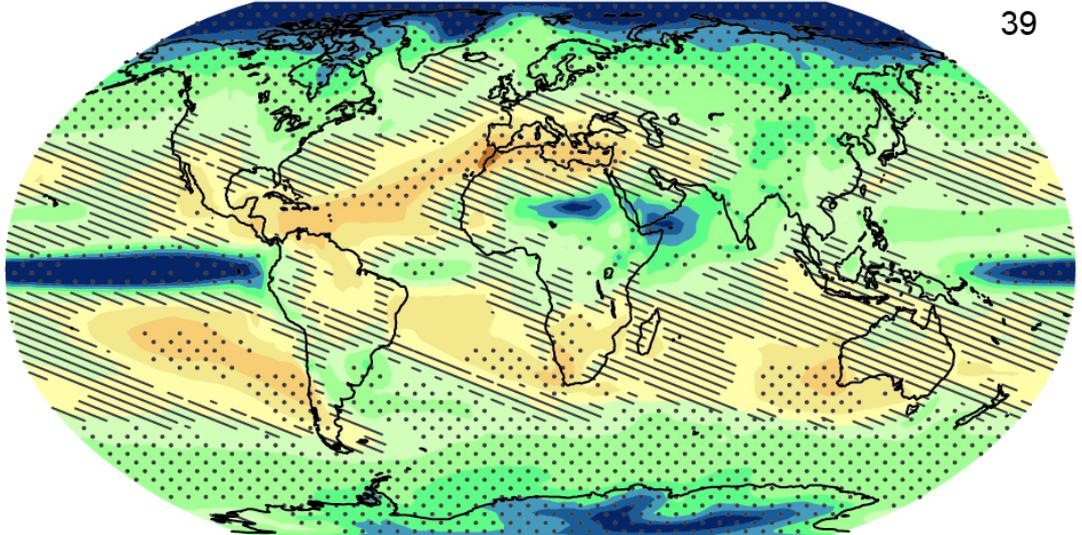
Projected mean precip change

Difference between
1986-2005 and
2081-2100

RCP2.6



RCP8.5



Limiting future warming



Keeping warming below 2°C ...

- Warming is essentially permanent (even if emissions are completely curtailed)
- Global temperature change is proportional to the total amount of carbon emissions accumulated over time.
- To have decent odds of keeping global warming below 2°C (*likely*, i.e., ≥ 2 chances in 3), the total amount of carbon dioxide emissions (since the pre-industrial era) needs to be limited to less than 1000 GtC.
- More than half of this amount has already been emitted.

Cumulative emissions and warming

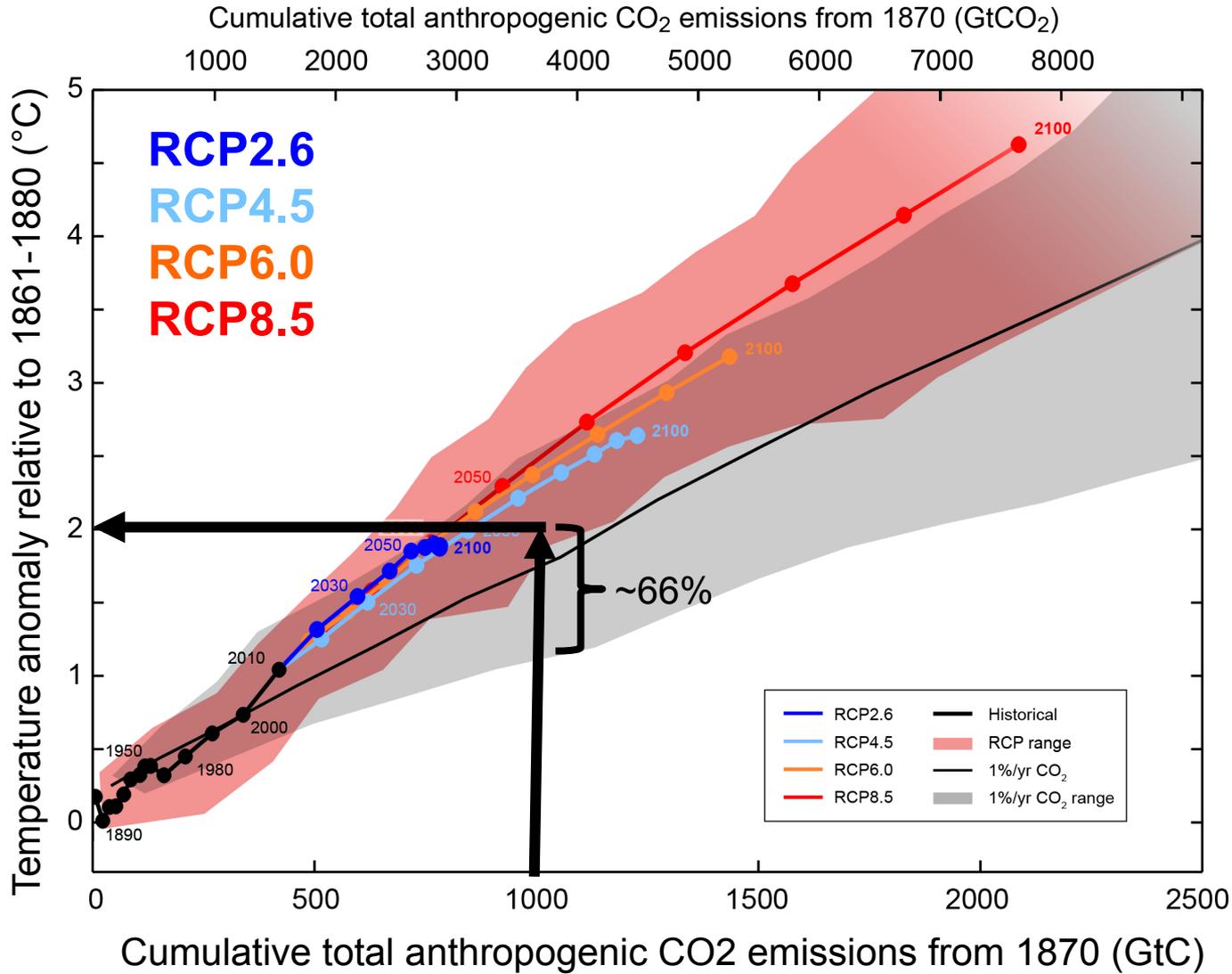


Figure SPM.10, IPCC WG1 AR5

Some key messages



Some messages

- Warming of the climate system is unequivocal
- Warming is essentially permanent
- Impacts are occurring
- Continued emissions will cause further warming and exacerbate some types of extremes
- Adaptation will be required to reduce impacts and risks
- The magnitude of impacts, risks and adaptation costs depends upon the level of warming
- Limiting warming will require deep emissions reductions
- Cumulative emissions largely determine the amount of long-term warming
- Selecting a warming limit implies a fixed, global, emissions budget

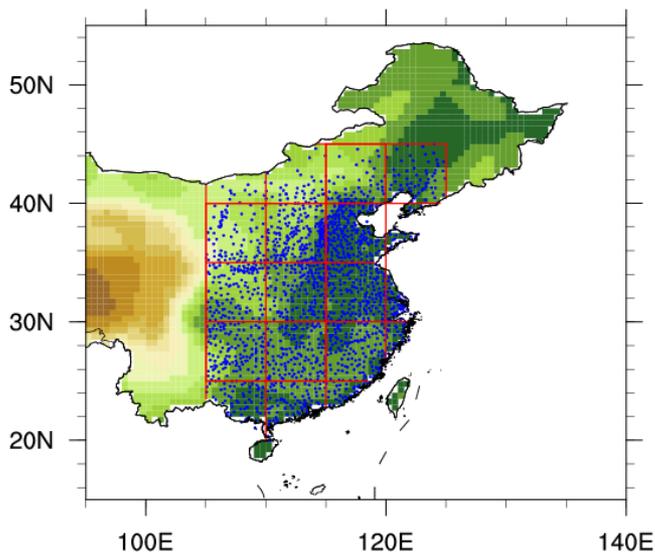
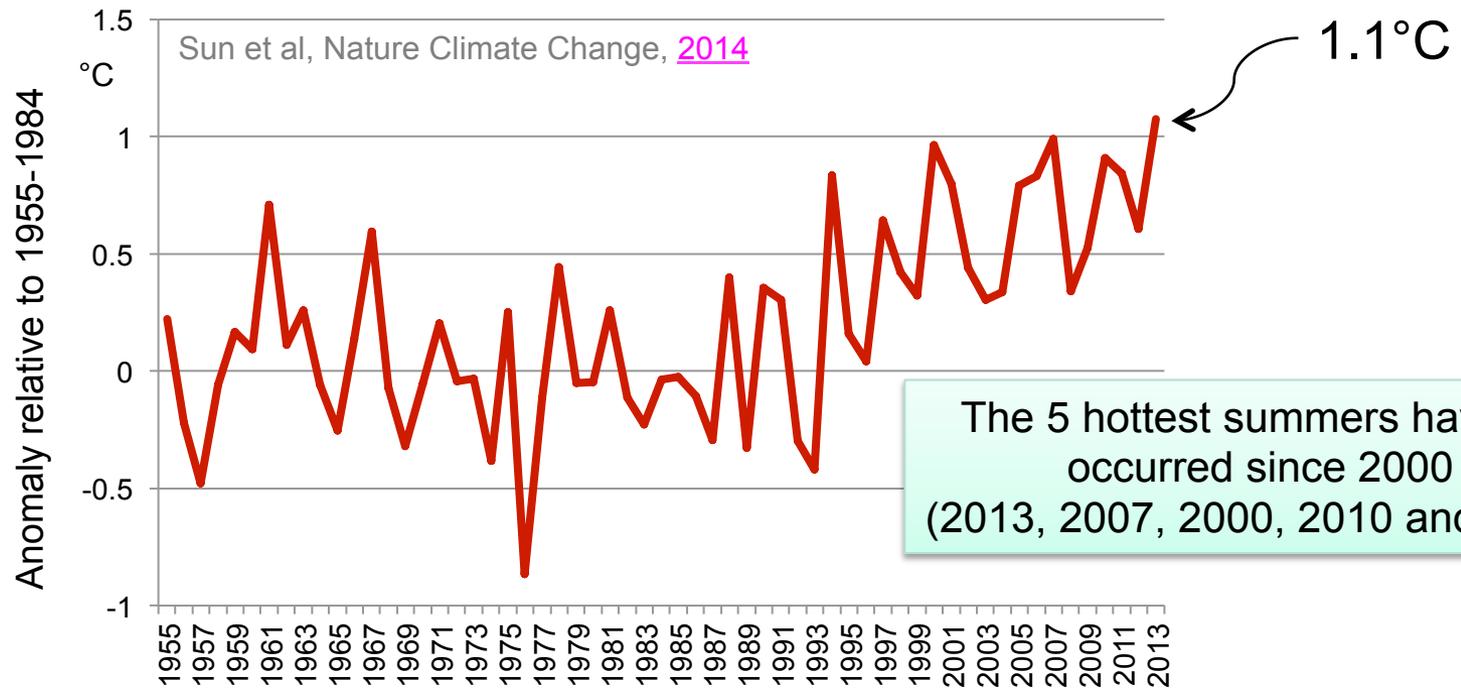
Impacts experienced via extremes



China's Summer of 2013



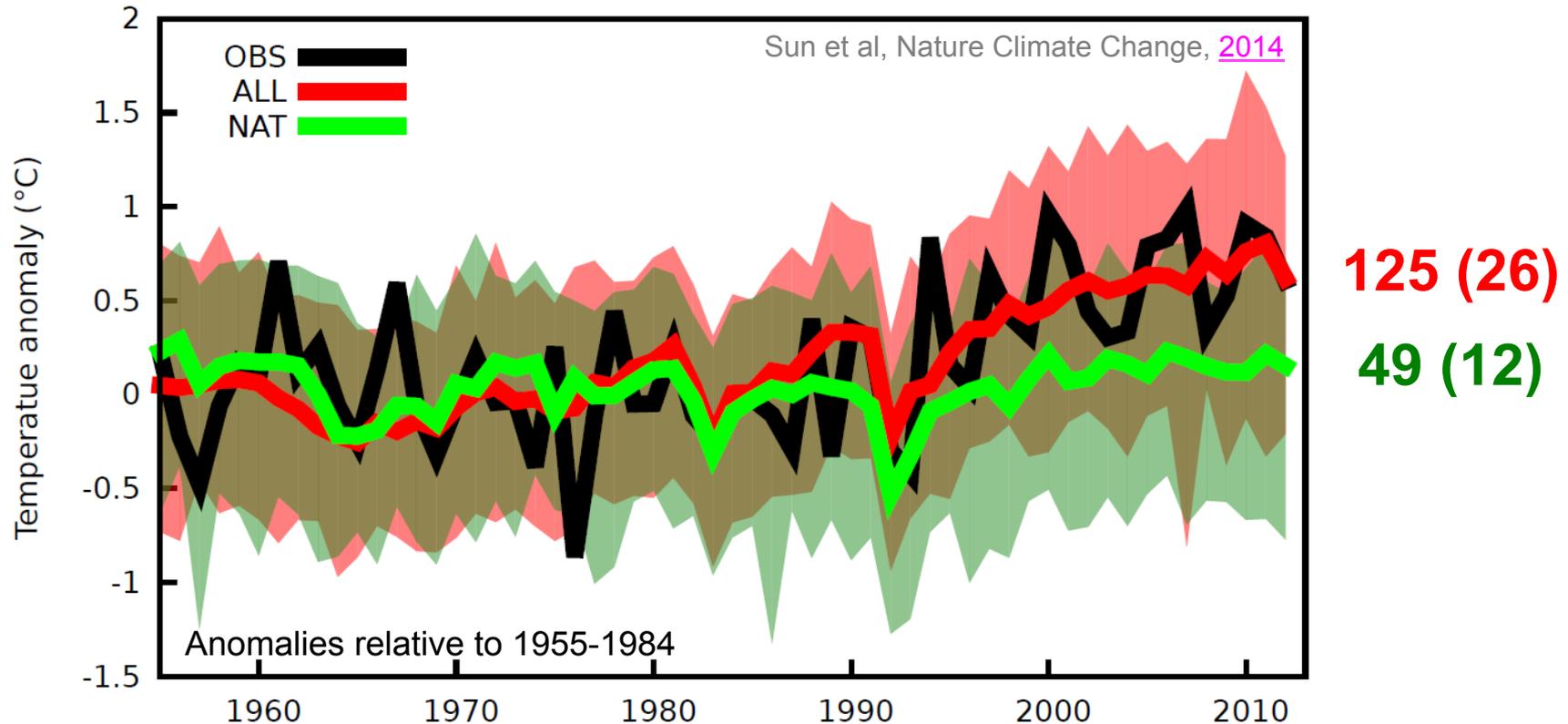
JJA mean temperature in Eastern China



Eastern China is densely observed

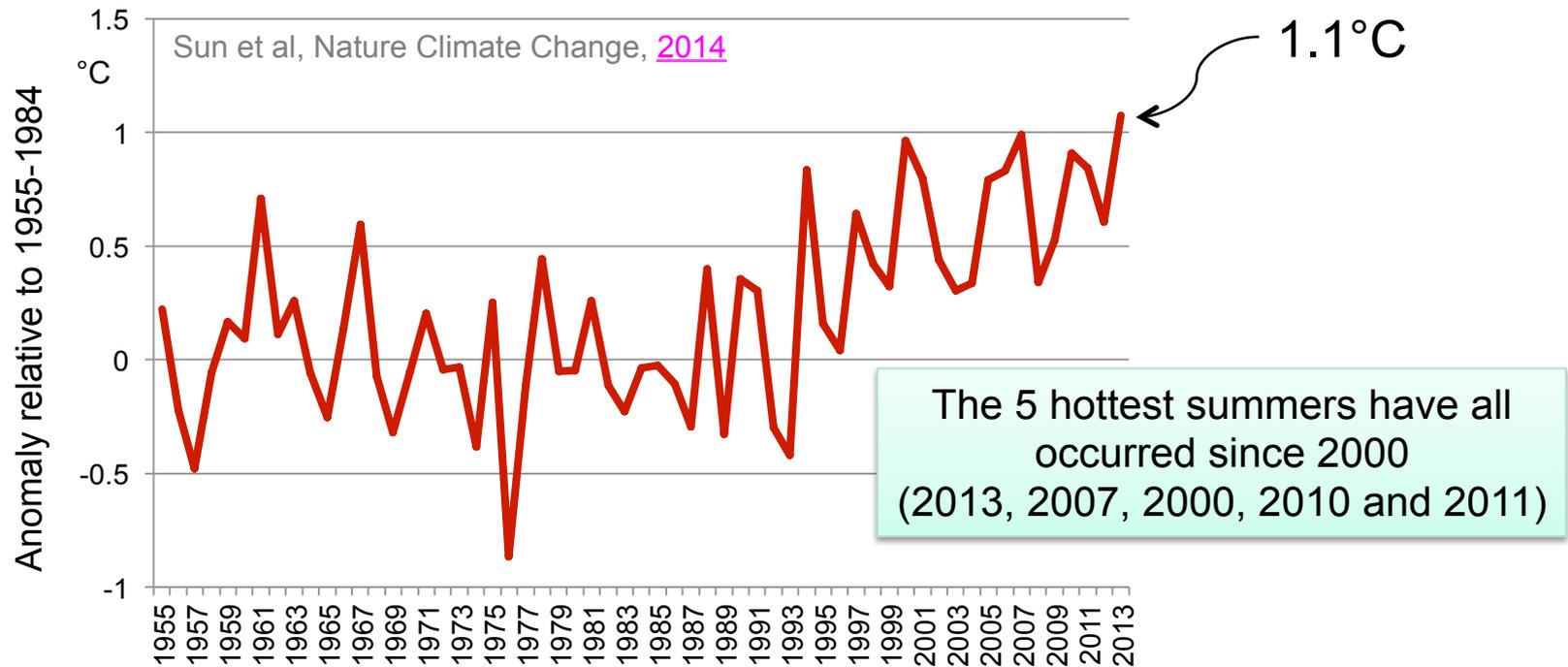
- 1749 stations (1955 onwards)
- JJA mean temperature increased 0.82°C over 1955-2013
- records were broken at more than 45% of stations in JJA 2013

Observed and simulated JJA mean temperature in Eastern China (1955-2012)



The multi-model ensemble mean (ALL forcing) well simulates the observed temperature record.

JJA mean temperature in Eastern China



- How rare was this event?
 - once in 270-years in control simulations
 - once in 29-years in “reconstructed” observations
 - once in 4.3 years relative to the climate of 2013
- Fraction of Attributable Risk in 2013: $(p_1 - p_0)/p_1 \approx 0.984$

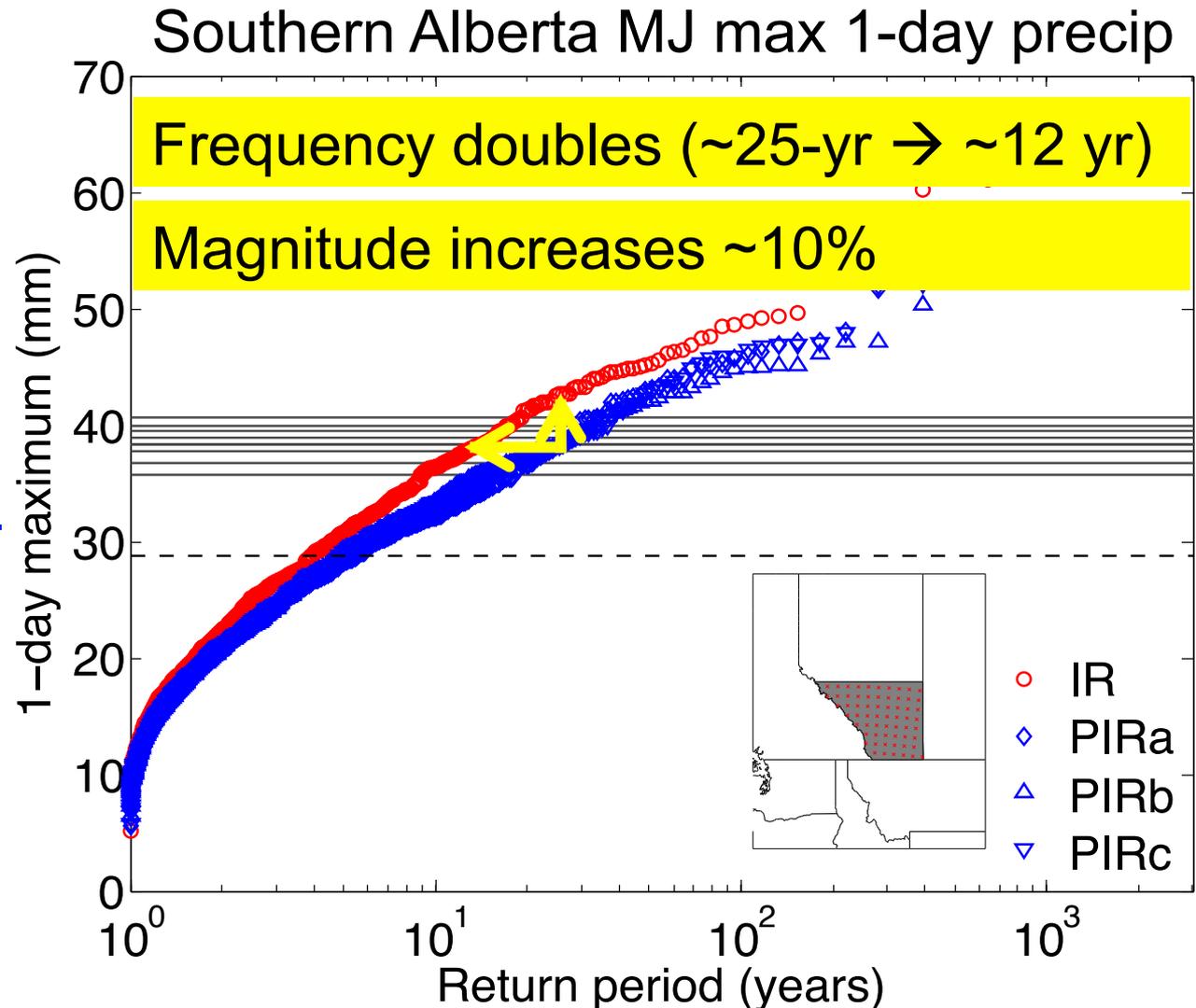
Calgary flood, 2013



Looking towards downtown Calgary from Riverfront Avenue (June 21, 2013), courtesy [Ryan L.C. Quan](#)

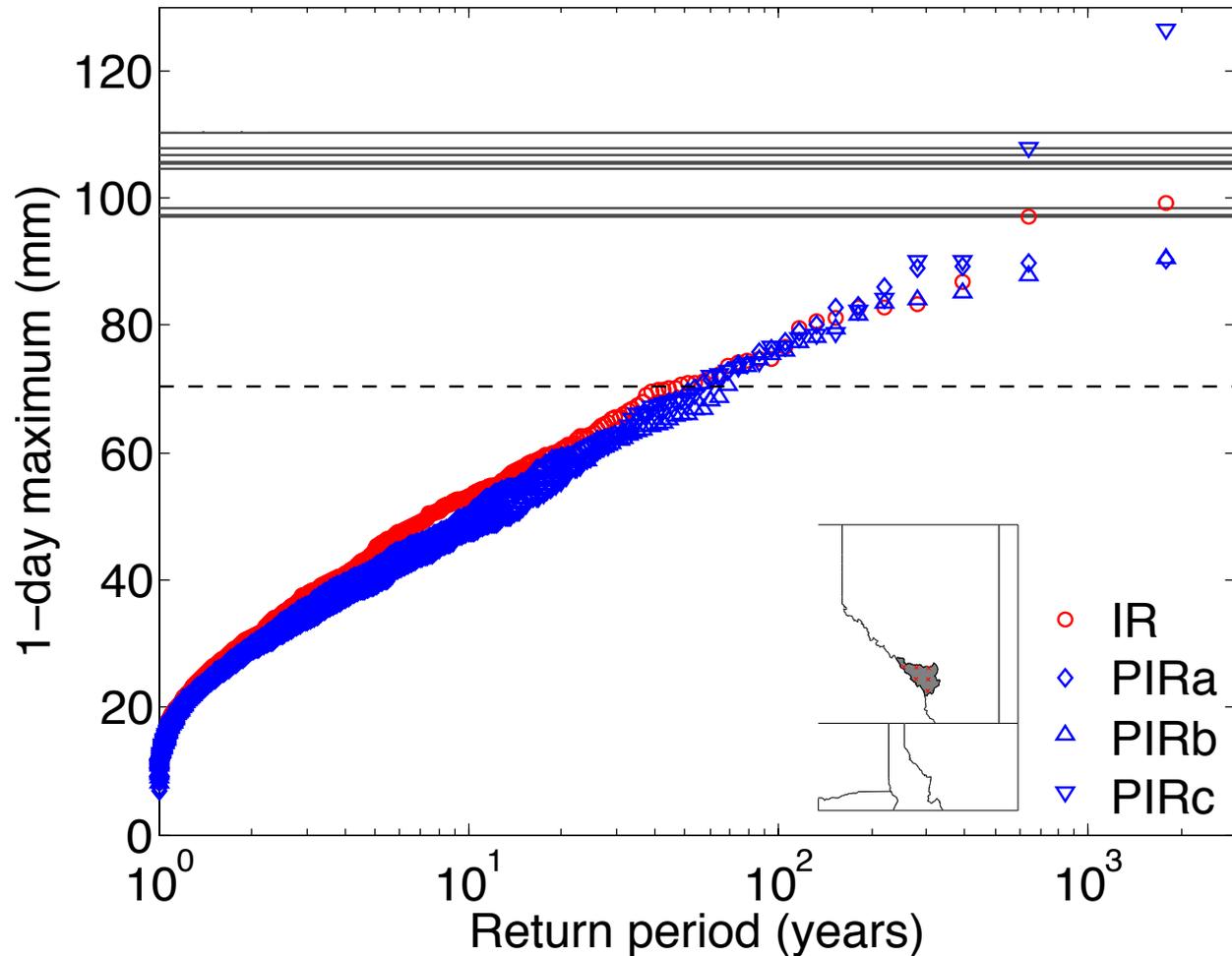
Calgary floods (Teufel et al, submitted)

Distribution of annual May-June maximum 1-day southern-Alberta precipitation in CRCM5 under **factual** and **counter-factual** conditions (conditional on prevailing global pattern of SST anomalies)



Calgary floods (Teufel et al, submitted)

Distribution of annual May-June maximum 1-day Bow River Basin precipitation in CRCM5 under **factual** and **counter-factual** conditions (conditional on prevailing global pattern of SST anomalies)



Thank You!



Photo: F. Zwiers

www.PacificClimate.org