Can we provide robust advice to support infrastructure design?

Adaptation Canada, 13 April 2016

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Photo: F. Zwiers (Longji)


Observed changes
Photo: F. Zwiers (Tofino)

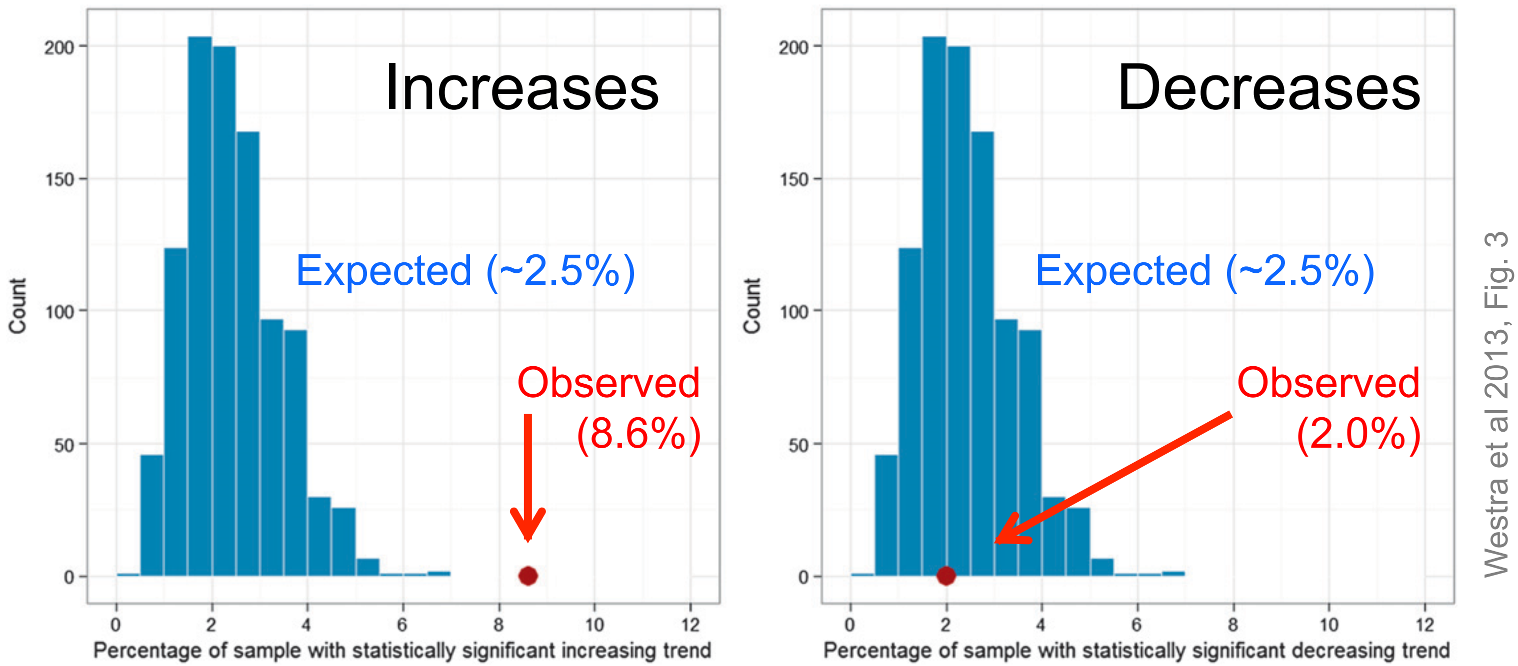
Precipitation extremes

- Observational studies suggest intensification is occurring, although local detection is very hard (eg., Westra et al, 2013)

- Expectation of intensification is supported by
  - attribution of warming (eg, Bindoff et al, 2013),
  - attribution of observed increase in atmospheric water vapour content (eg, Santer et al, 2007), and
  - D&A studies of change in mean precipitation (eg., Zhang et al., 2007; Noake et al., 2012; Polson et al, 2013; Marvel and Bonfils, 2013; Wu et al, 2013) and surface salinity (eg., Pierce et al., 2012).

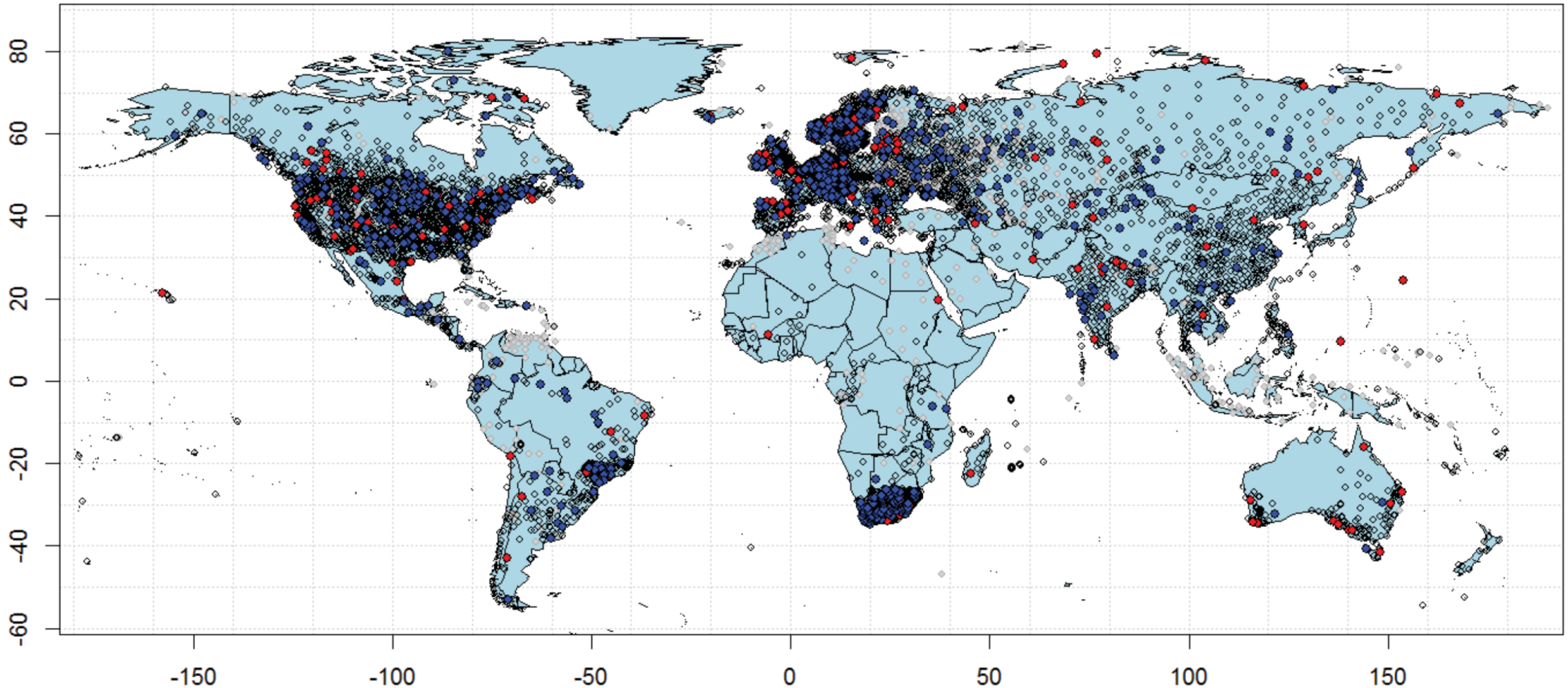
Stations with significant trends in annual maximum 1-day precipitation (1900-2009)

Based on 8376 stations with 30-years or more data



- Tests conducted at the 5% level (two sided)
- There are more statistically significant increasing trends than expected by random chance (blue bootstrap distributions for rejection rate).

Is there an association between annual maximum 1-day precipitation and global mean temperature?

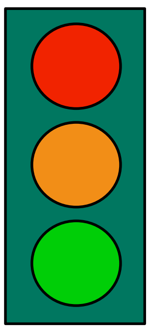


- 8376 stations with > 30 yrs data, median length 53 yrs
- Significant positive (10.0% of stations, expect 2.5%)
- Significant negative (2.2% of stations, expect 2.5%)
- Estimate of mean sensitivity over land is ~7%/K

Westra et al (2013, Fig. 5)

Precipitation extremes

- VERY few D&A studies yet on extreme precipitation (eg, Min et al 2011, Zhang et al, 2013)
- Available studies have been conducted on a hemispheric scale
- Require very strong assumptions



Attributed intensification:

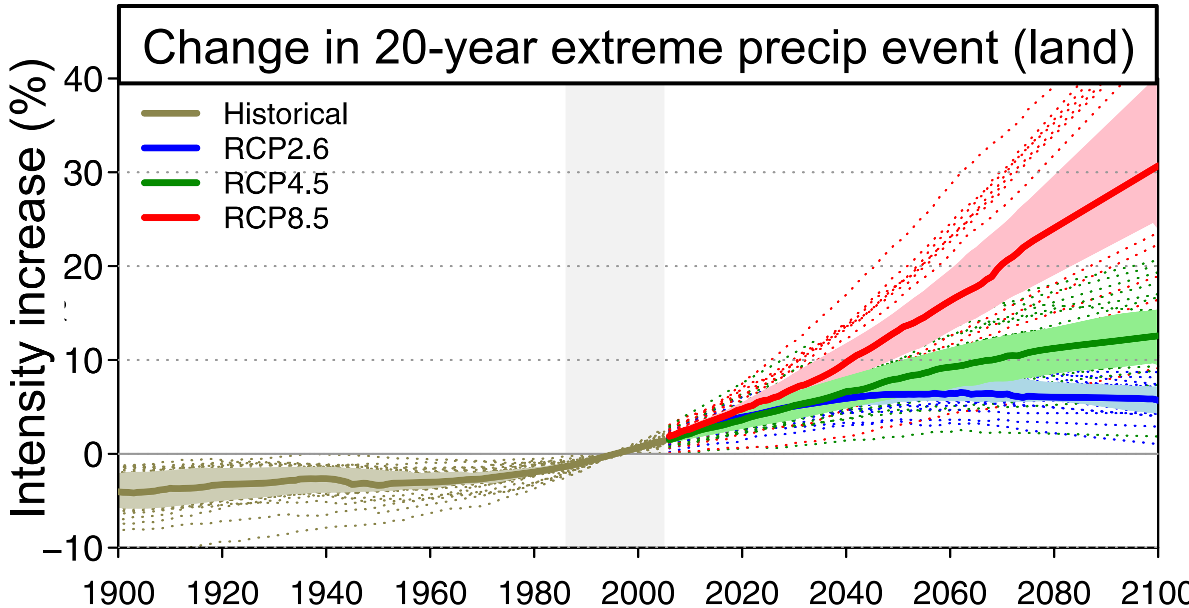
- 3.3% increase over 55 years due to human effects
  - uncertainty range [1.1 – 5.8]%
- 5.2% increase per degree of warming
  - uncertainty range [1.3 – 9.3]%

Estimated waiting time for 1950’s 20-year event:
~15-yr in the early 2000’s

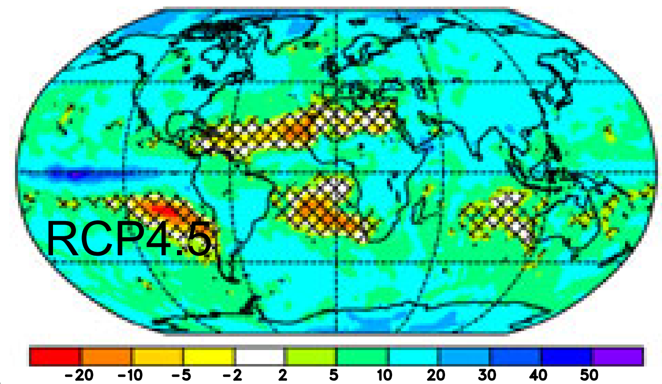
- A few “event attribution” studies have been conducted (including for the Calgary floods, Teufel et al, 2016)

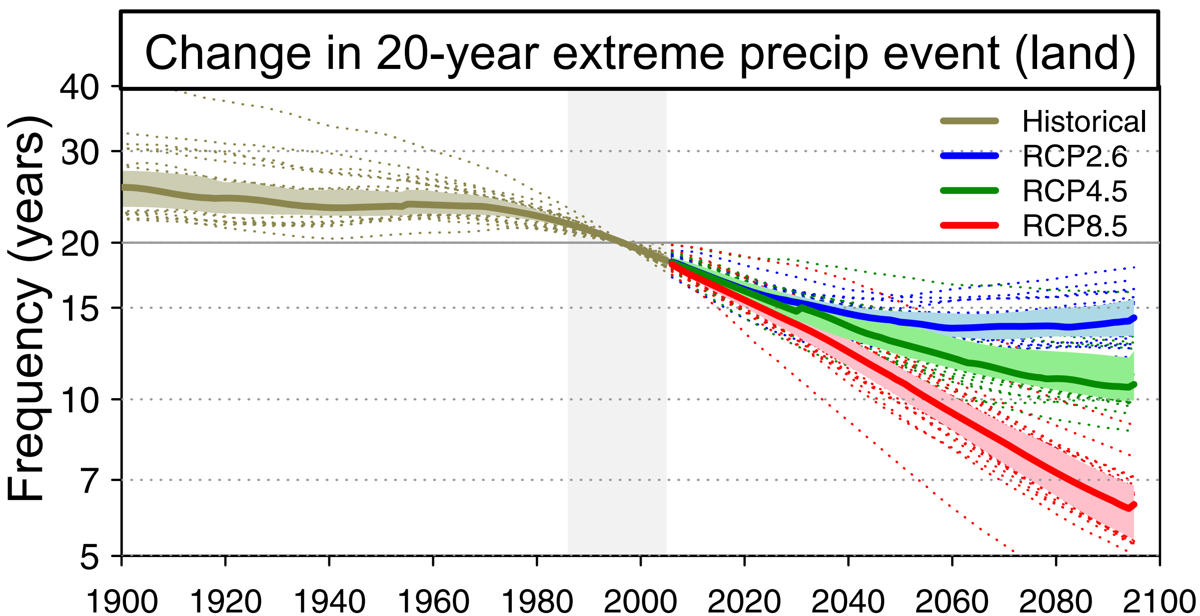

Projected changes
Photo: F. Zwiers

Projected 20-year 1-day precip event

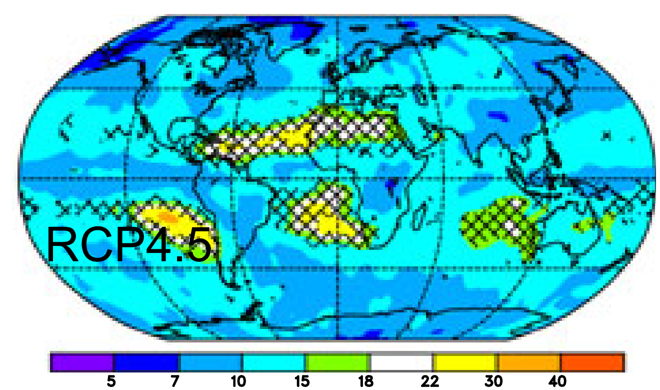


20-year 1-day precip event
2081-2100 vs 1986-2005 (%)





Frequency of 20-year event
2081-2100

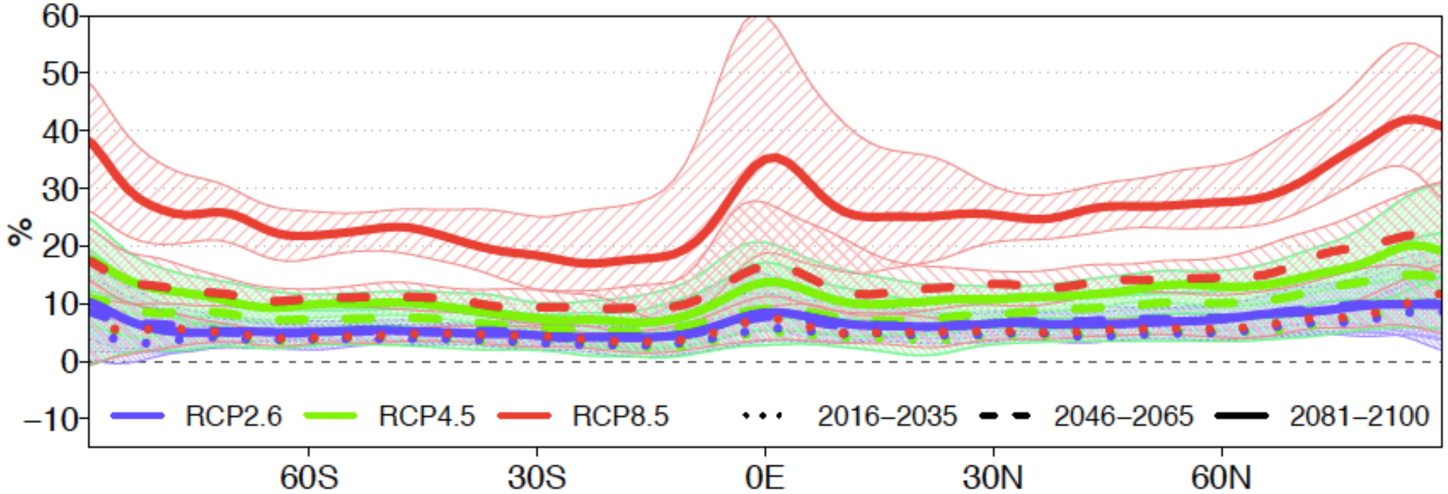


Kharin et al (2013)

Uncertainty

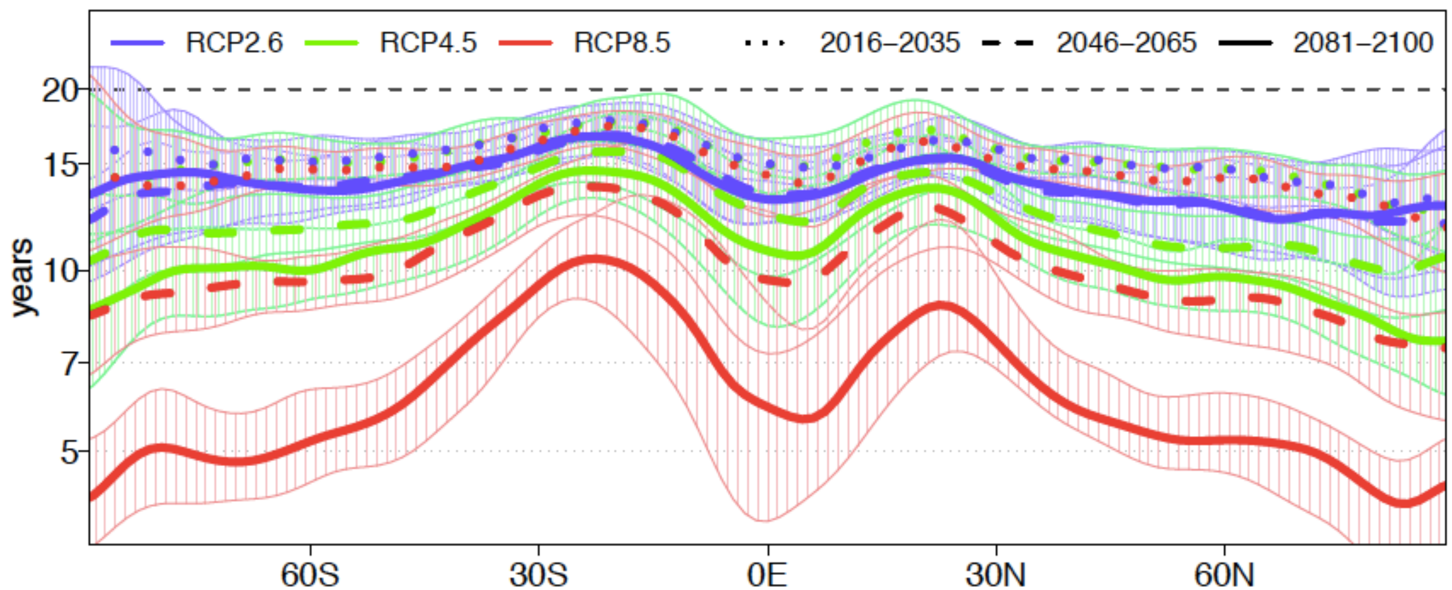
Intensity

Change in magnitude of 20-year 1-day event



Frequency

Change in frequency of 20-year 1-day event



Kharin et al (2013)

Discussion

Photo: F. Zwiers (Ucluelet)

Discussion

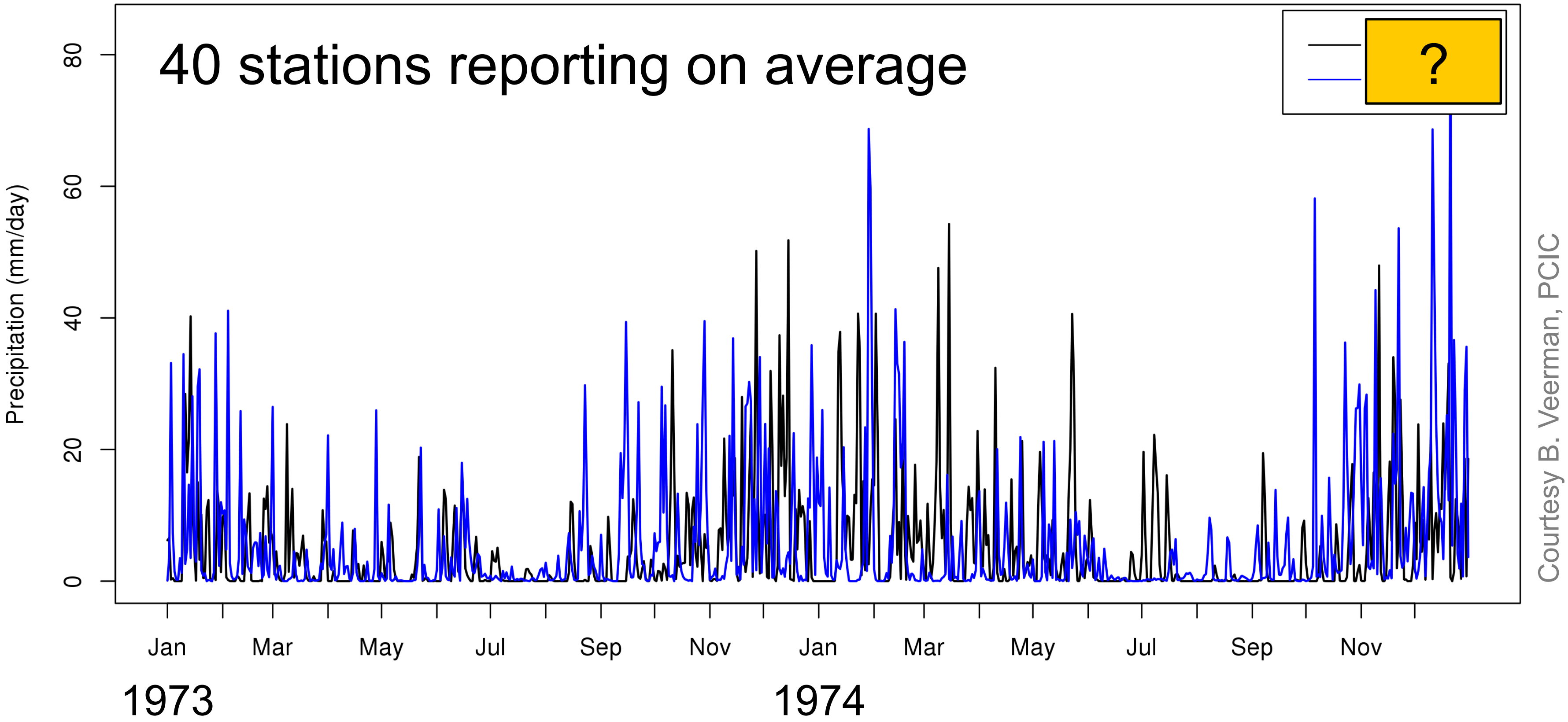
- Understanding of the impact of anthropogenic forcing on extremes remains limited
  - But it IS safe to conclude that stationarity is dead
- Projected changes are large
  - Emissions scenario, time horizon and model dependent
- We do not yet know much about accumulation periods shorter than 1-day
- If we could produce robust, complete future IDF curves, would we know what to design for?
  - Average 2% annual probability of failure over a 50-year design lifetime?
  - Maximum 2% probability of failure in any year of a 50-year design lifetime?

Key message:

Stationarity is dead, but we don't yet have a good approach for dealing with non-stationarity.

Photo: F. Zwiers (Emlun Cove sunrise)

Mean daily precipitation in the MIROC4h grid box centered on 49.1N, 123.2W (Vancouver)



For some evaluation of CMIP5 models wrt precipitation extremes see

- for indices, Sillmann et al (2013, JGR),
- for long-period return values, Kharin et al (2013, Climatic Change)