The Transient Sensitivity of Sea level Rise

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Proposed concept: ”Transient Sea Level Sensitivity”

TSLS characterize the near term sea level sensitivity

A century is near term for sea level

How fast is the sea level response?

UNITS: m/century/K

Sea level in 2100 is not simply a function of temperature in 2100

- but also of how warm the century has been.

The pathway is important.

HENCE PLOT:

Average sea level rate in a time period

vs

Average GMST in same period

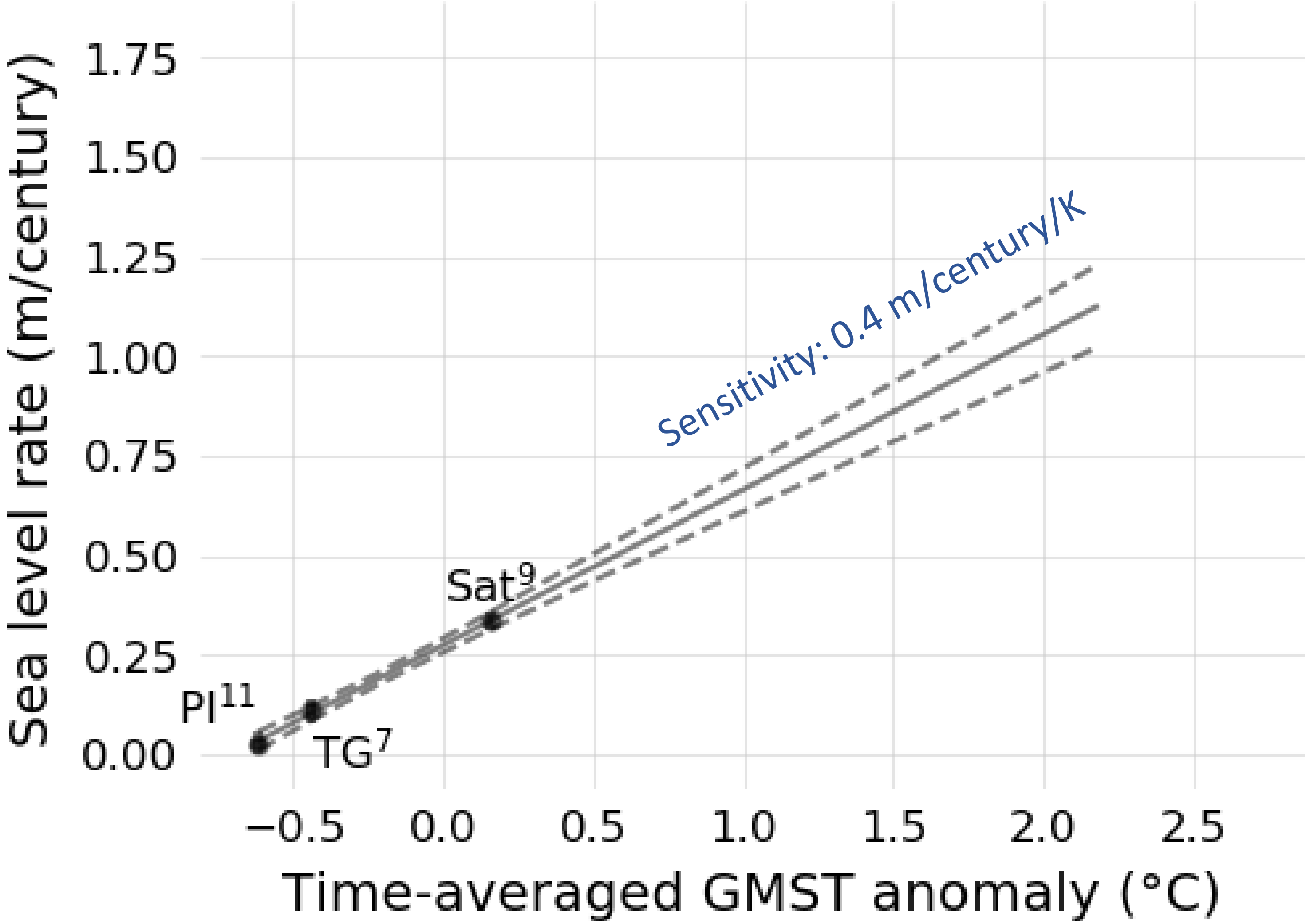
Historical data

TSLS is the slope in plot

Obs. fall on a line which implies a historical TSLS of **0.4 m/century/K**

Notes:

- PI: Pre-industrial estimate 1850-1900 from Kopp et al.
- TG: Tide gauge average rate 1900-1990 from Dangendorf
- Sat: Altimetry (1993-2018) from AVISO
- Temperatures from HADCRUT4
- All uncertainties shown are ”likely ranges”



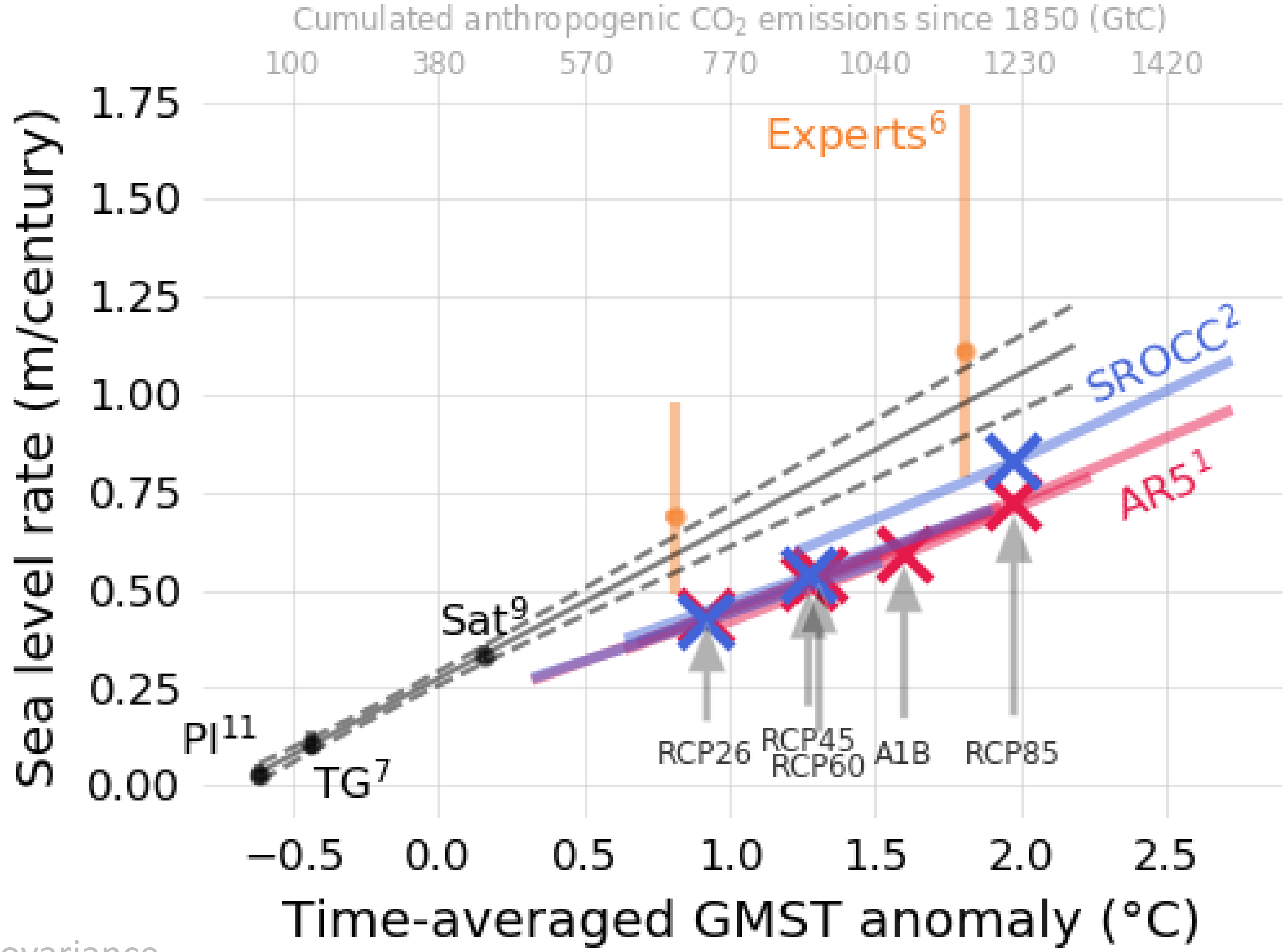
Projections

Expert estimates align with extrapolation from historical data.

Process models hard to reconcile with experts and observations.

AR5 sensitivity too low.

SROCC sensitivity better, but possibly too close to equilibrium at start of simulation.



Experts based on Bamber et al.
Slanted errorbars on AR5 assume full uncertainty covariance.

Conclusion / Discussion

TSLS useful: Clear monotonic relationship between time averaged warming and sea level rise in both historical data, and in projections.

SROCC and AR5 hard to reconcile with observations. Needs explanation.

Our interpretation:

AR5 Sensitivity is clearly too low

SROCC models are too close to equilibirum. Spin-up issues?

Supplement

Table 1: Transient sea level sensitivity, and balance temperatures estimated from different sources.

	Sea level sensitivity m/century/K	**Balance Temperature** °C
Observations	0.39 [0.34 – 0.43]	-0.71 [-0.79 – -0.65]
SROCC	0.39 [0.36 – 0.43]	-0.14† [-0.42 – 0.23]
AR5	0.27* [0.26 – 0.30]	-0.63 [-0.70 – -0.41]
Expert elicitation	0.42 [0.33 – 0.73]	-0.68 [-0.79 – -0.54]

Intervals are likely ranges (17-83%). Symbols indicate that the difference from the observational estimate is significant at $p<0.05$ (*), and $p<0.1$ (†).

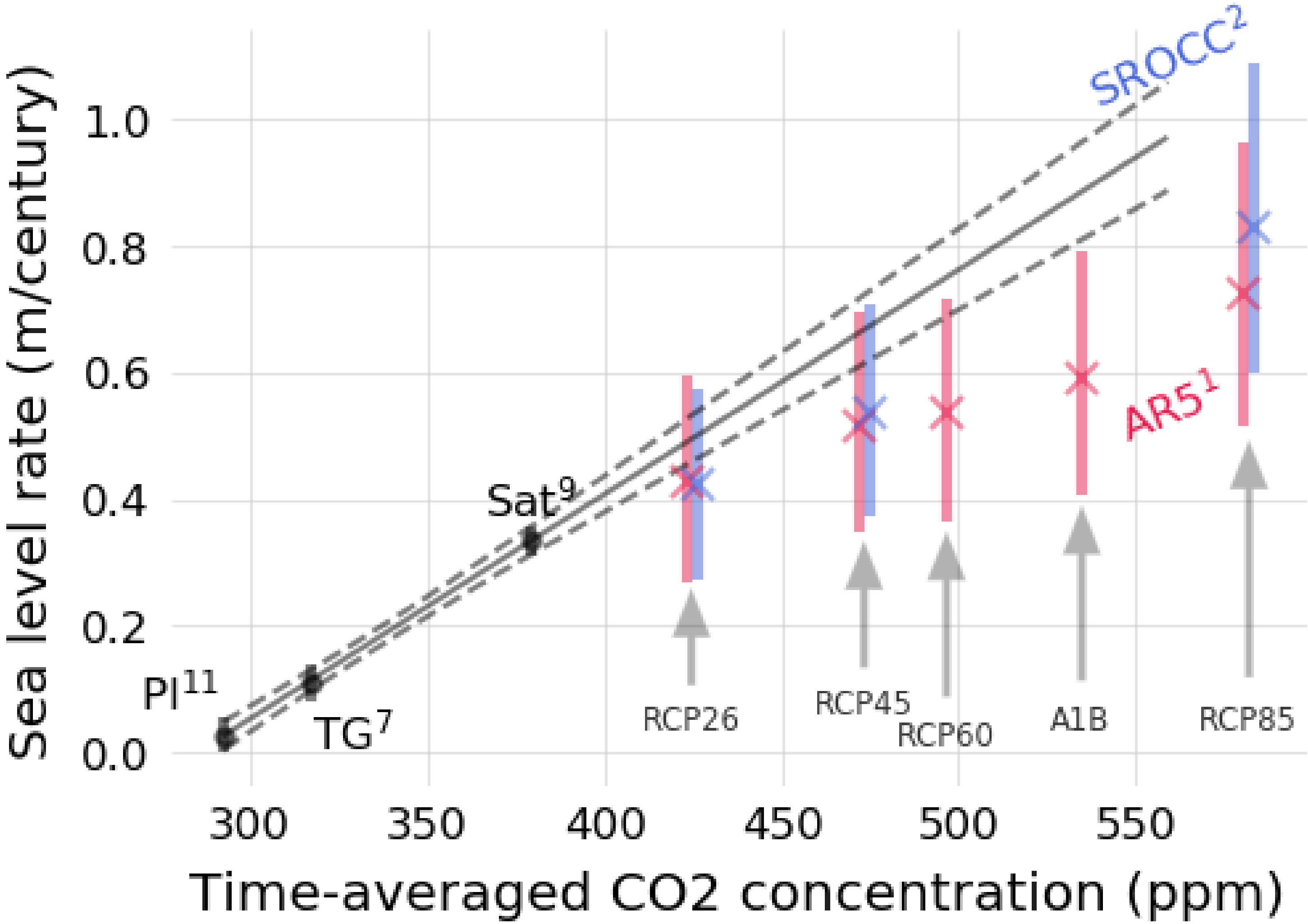
Why quantify sensitivity to warming?

- Alternatives: CO_2 conc, radiative forcing, cumulative emissions. (see supplement)

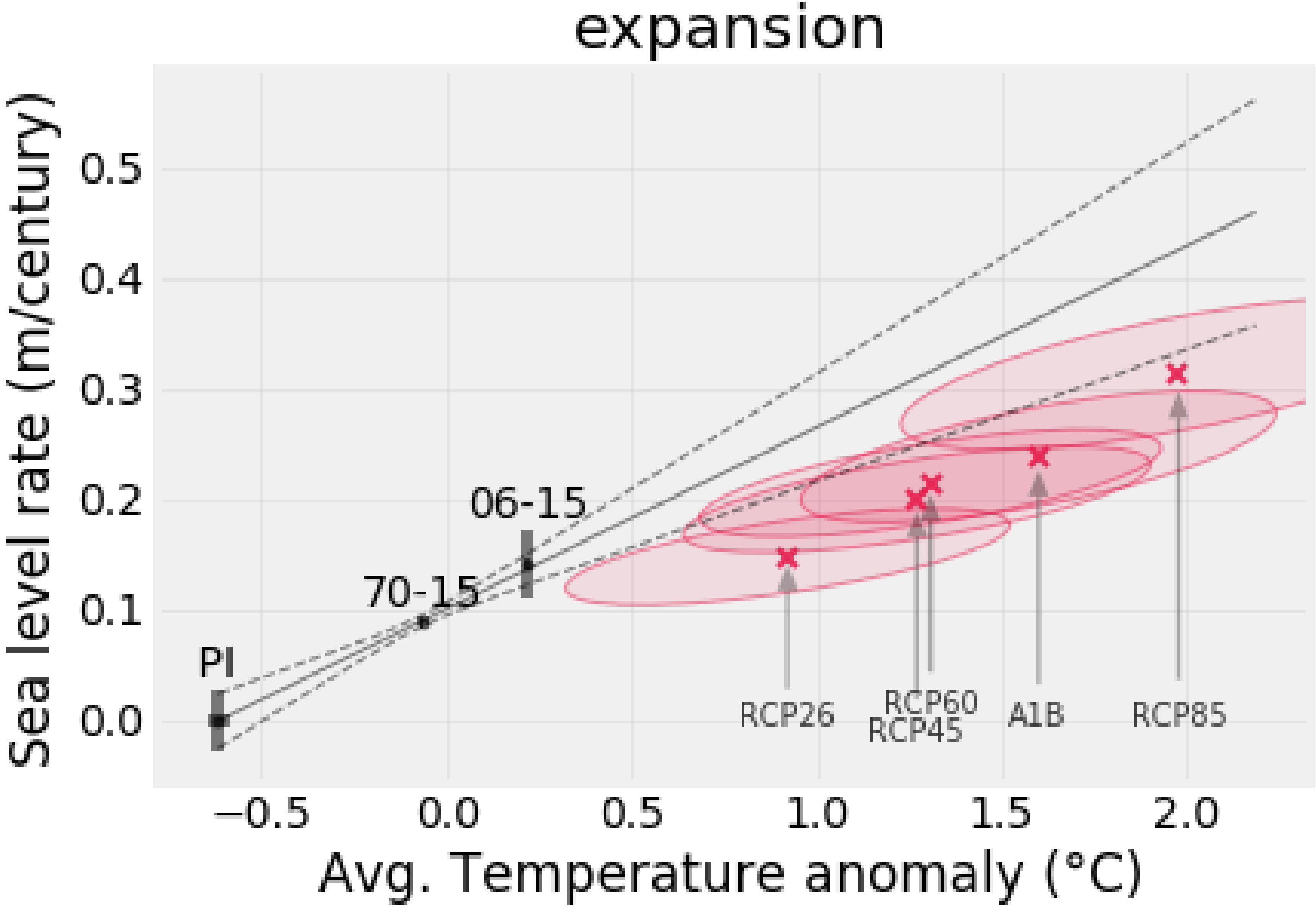
- All the ice contributors predominantly responds to warming. So a large part of the uncertainty is related to uncertainties.

- E.g. if you compare the output of two Greenland RCMs then a substantial part of their difference could be due to the climate sensitivity of the GCM they are embedded in.

Transient sensitivity to CO2



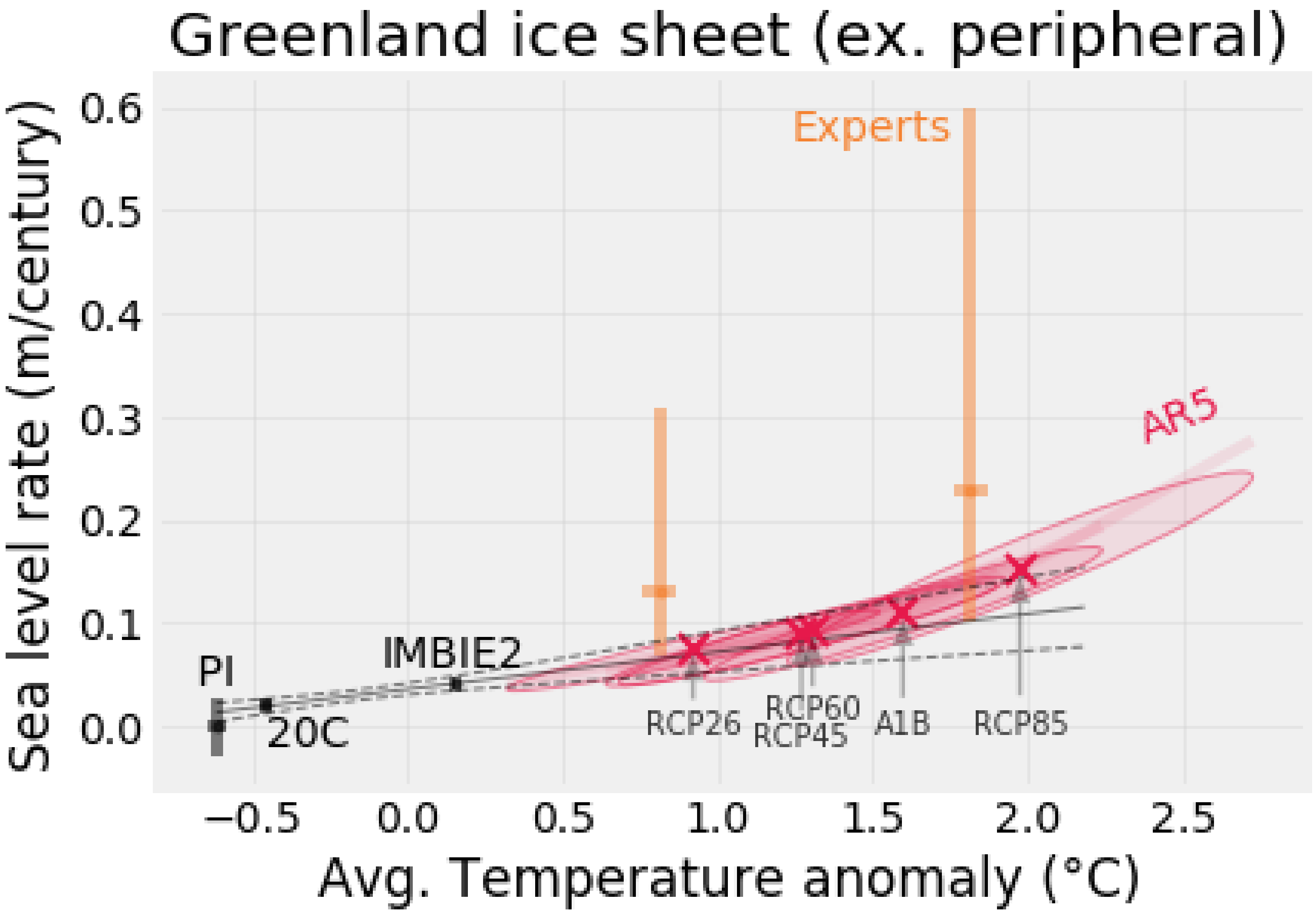
Thermal expansion



NOT A FINAL PLOT BUT:

Models appear less sensitive than observations

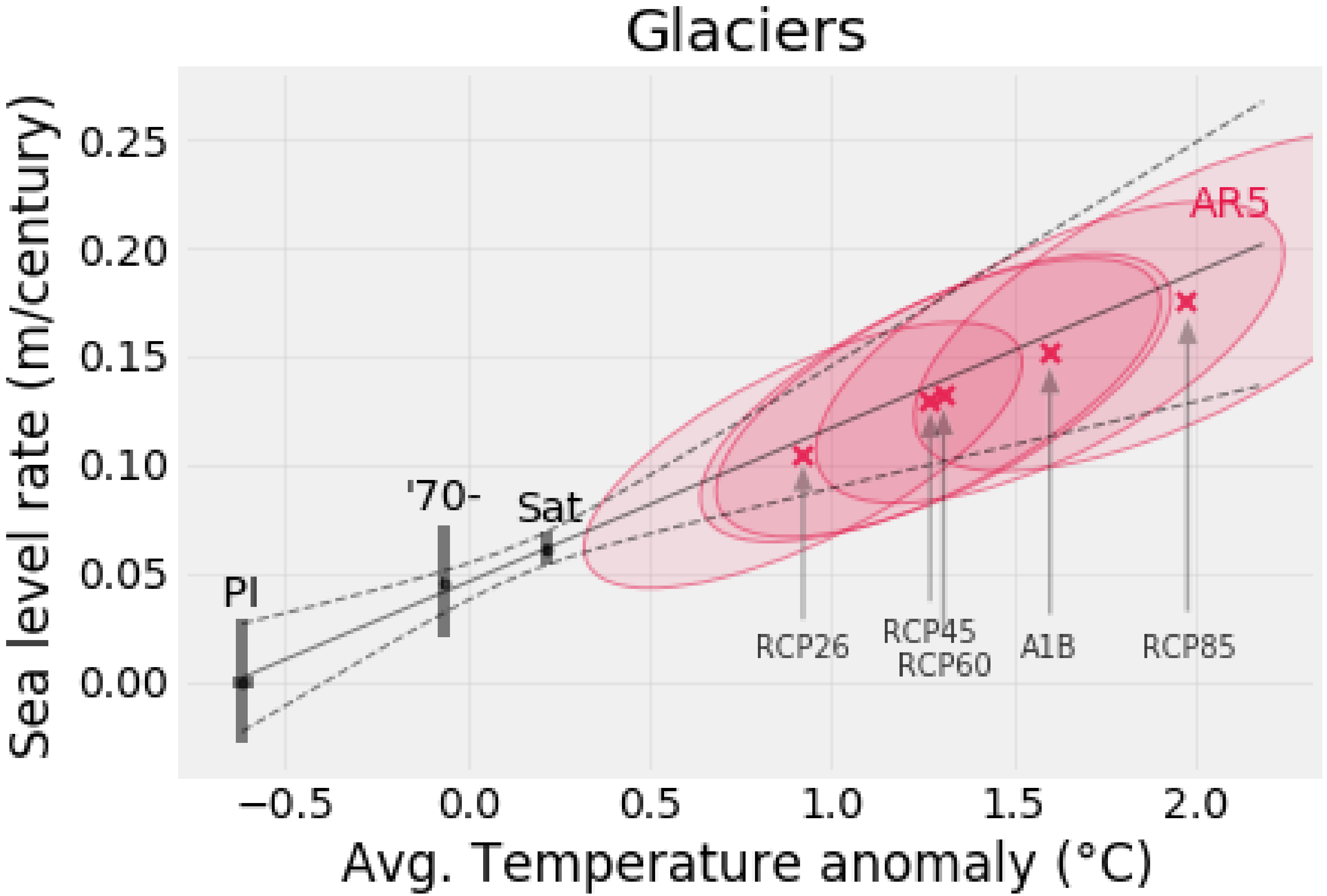
(Preindustrial value is not a solid estimate. TODO: make)



Experts seem to expect substantially faster loss from Greenland

AR5 consistent with historical.

CAVEAT: not a final plot. PI estimate not solid. TODO: verify consistent peripheral treatment.



Nice match

CAVEAT: not a final plot. PI estimate not solid.

Antarctic

- This is the main difference between between AR5 and SROCC
- CAVEAT: historical lines are probably quite wrong. No good PI estimate.