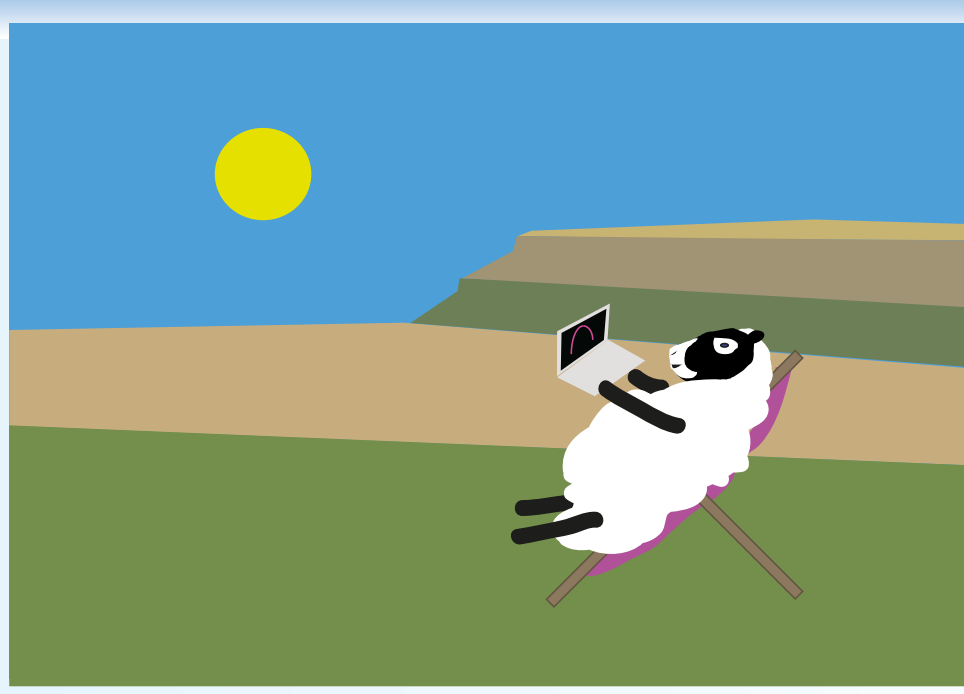


Could the Pliocene constrain the Equilibrium Climate Sensitivity?

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Introduction - The Past to Future Challenge:

- Identify and document quantitative relationships between past and future model runs and check consistency with available observations.
- Identify and implement suitable methodologies to use the information to explore quantitative constraints on future climate change.
- Identify whether underlying mechanisms between past and future changes are the same.

Previous Results for the Last Glacial Maximum

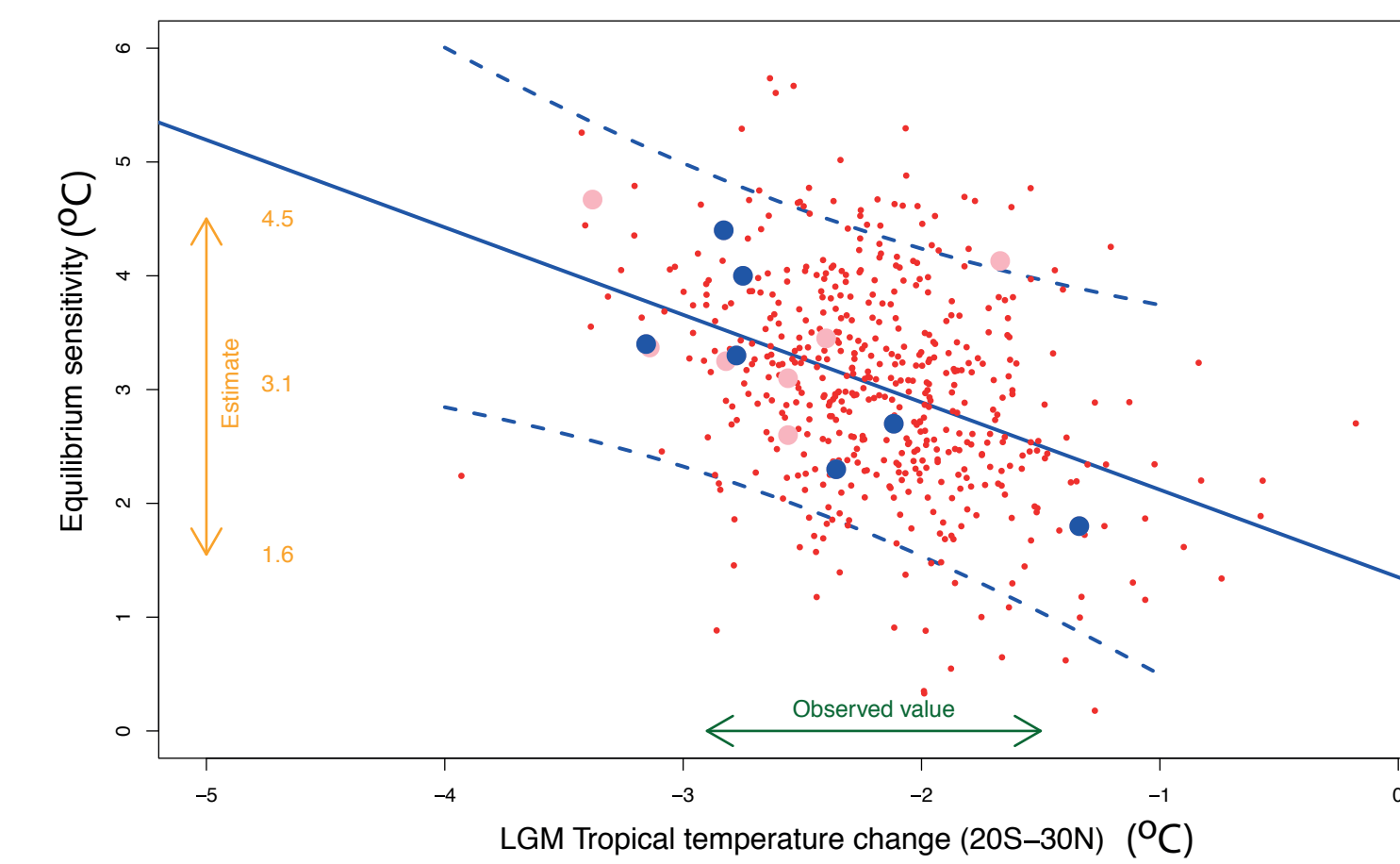


Figure 1

For PMIP2 there was a significant relationship between the tropical temperature change and climate sensitivity [1]. For PMIP3 with different or updated models (with more processes), the correlation disappeared [2]. The combined ensemble shows a correlation, but it is not helpful in constraining the ensemble further than the rejection sampling inherent to the MIP procedures [3].

New Results for the mid-Pliocene

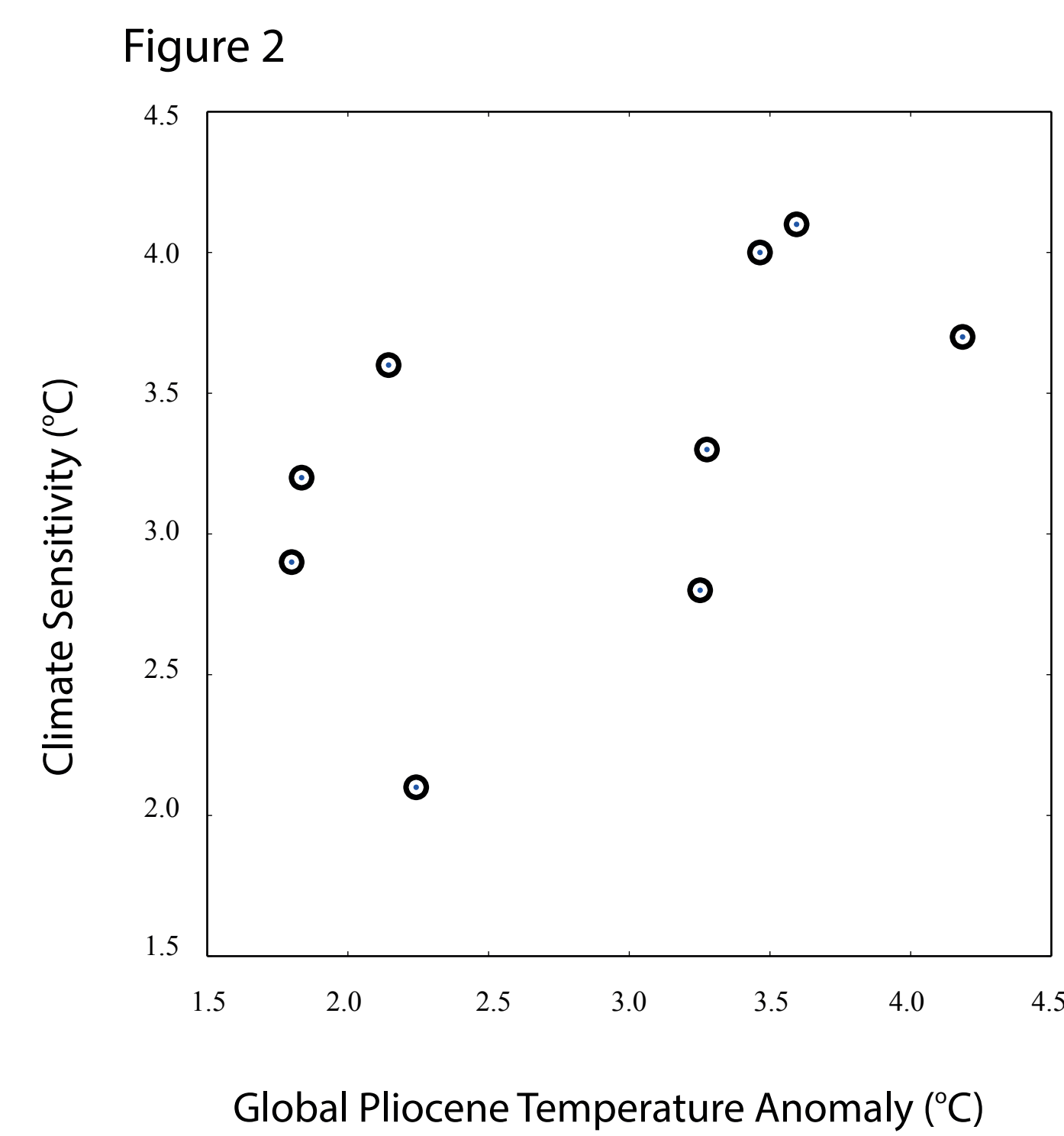
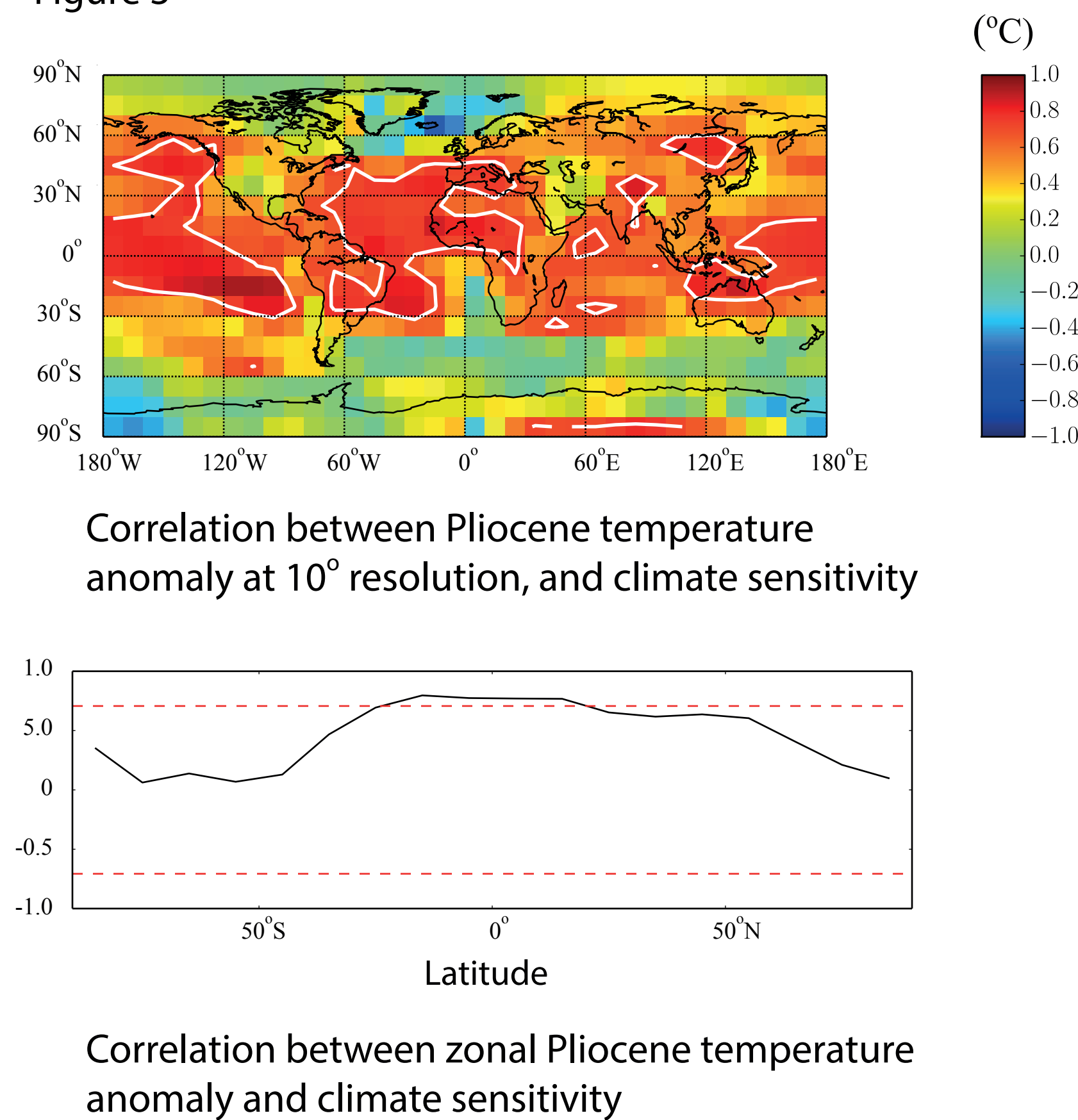


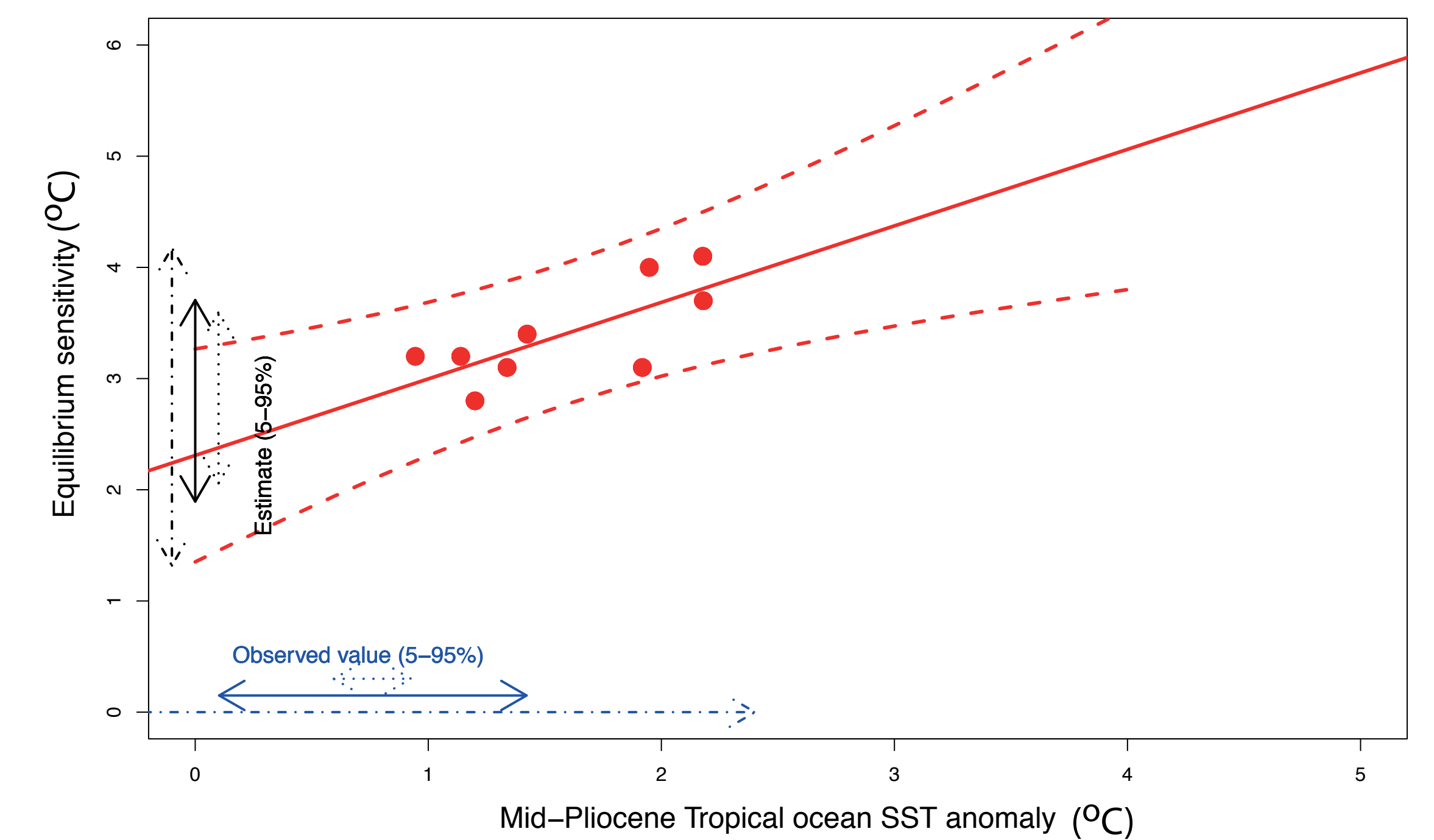
Figure 3



The Pliocene was a warmer period, 3 million years ago. For PlioMIP, a mixture of PMIP2 and PMIP3 models were used. We find no significant relationship globally (Figure 2), but do find a significant relationship between the tropical temperature change and climate sensitivity (Figure 3).

But is the result robust - perhaps this apparently "significant" correlation will disappear in CMIP6?

Figure 4: PRISM3_SST data constraint gives a climate sensitivity estimate of 1.9-3.7°C



Uncertainties

- Data - No uncertainty estimate provided for PRISM3_SST, so we test different possible values (see broken blue and black lines in Figure 4).
- Forcing - CO₂ value not well known. PlioMIP assume 405ppm CO₂, alternate value of 350ppm tested (Figure 5, pink dots/line)
- Modelling - Estimates of climate sensitivity use a variety of inconsistent approaches, and some model runs may not be well equilibrated.
- Methodological - Not clear which regression should be performed. Should regression pass through zero? (Figure 5, purple line)
- Time slab - PRISM3_SST data used for comparison with PlioMIP ensemble do not represent a time slice but rather an agglomeration of warm peaks.
- Robustness - Small ensemble may give unreliable estimate.

Consider this a hypothesis rather than a result!

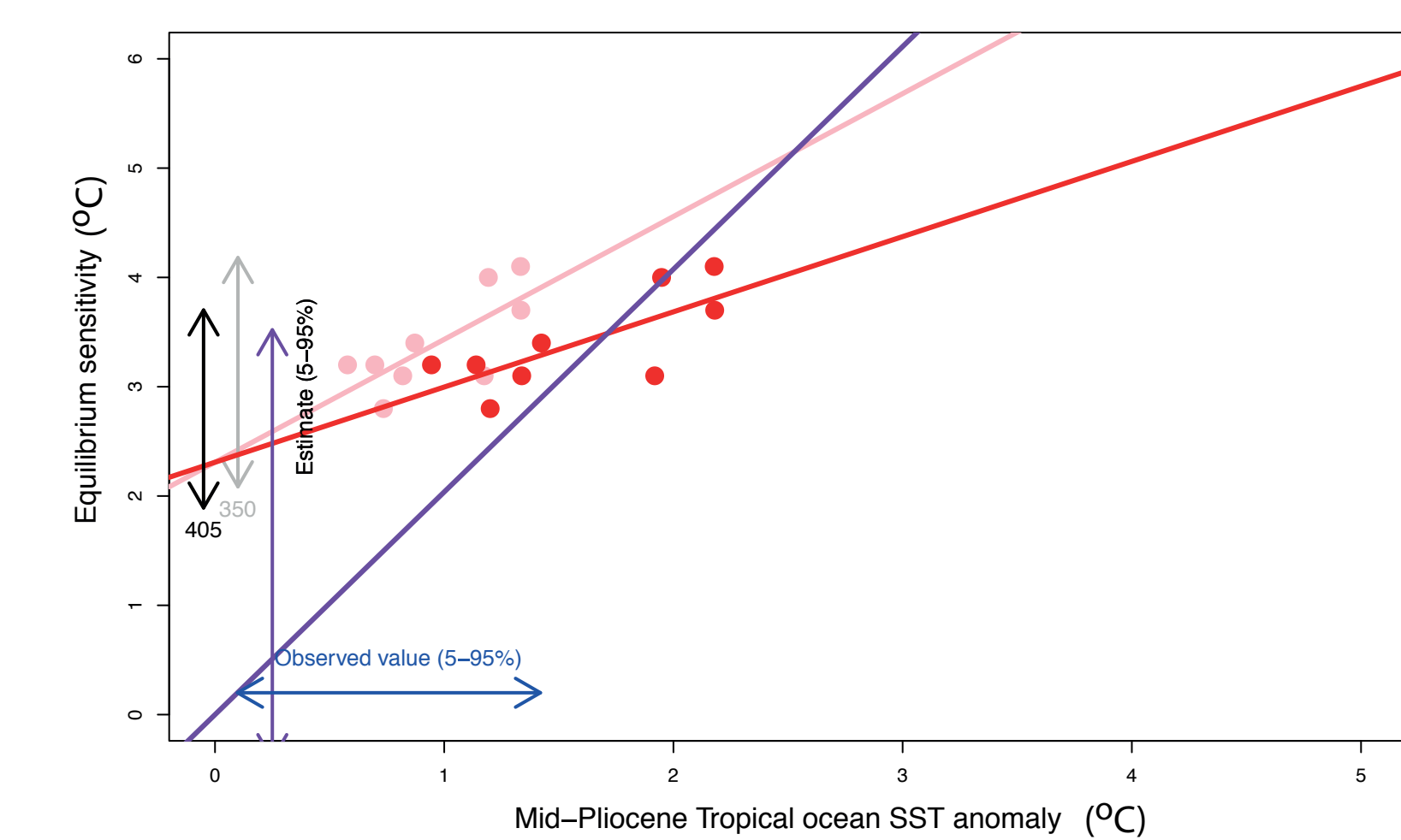


Figure 5

Uncertainties
- Bold red shows original result, pink and grey show estimated result if 350ppm CO₂ were used.
- Purple shows result if regression forced to pass through zero.

Bibliography
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Conclusion: It is possible to use the PlioMIP ensemble to estimate equilibrium climate sensitivity, but the result is tentative as there are many uncertainties. However, for CMIP6 (and PlioMIP2[4]), we expect advances to be made on all the uncertainties highlighted above.