

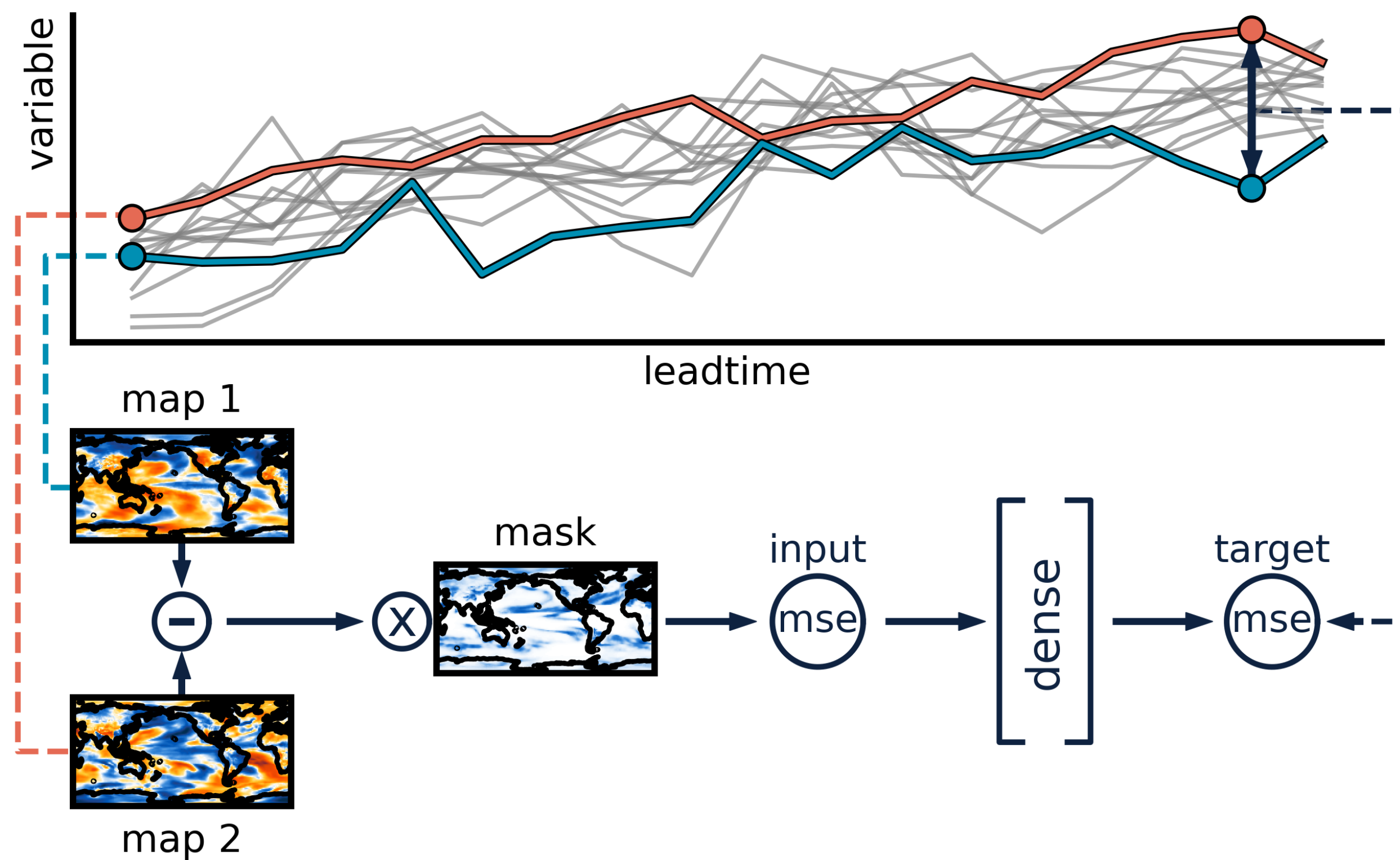


Ranking Earth System Models using Observations and Machine Learning Assisted Analog Forecasting



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analog prediction framework



Learn weighted mask for analogs:

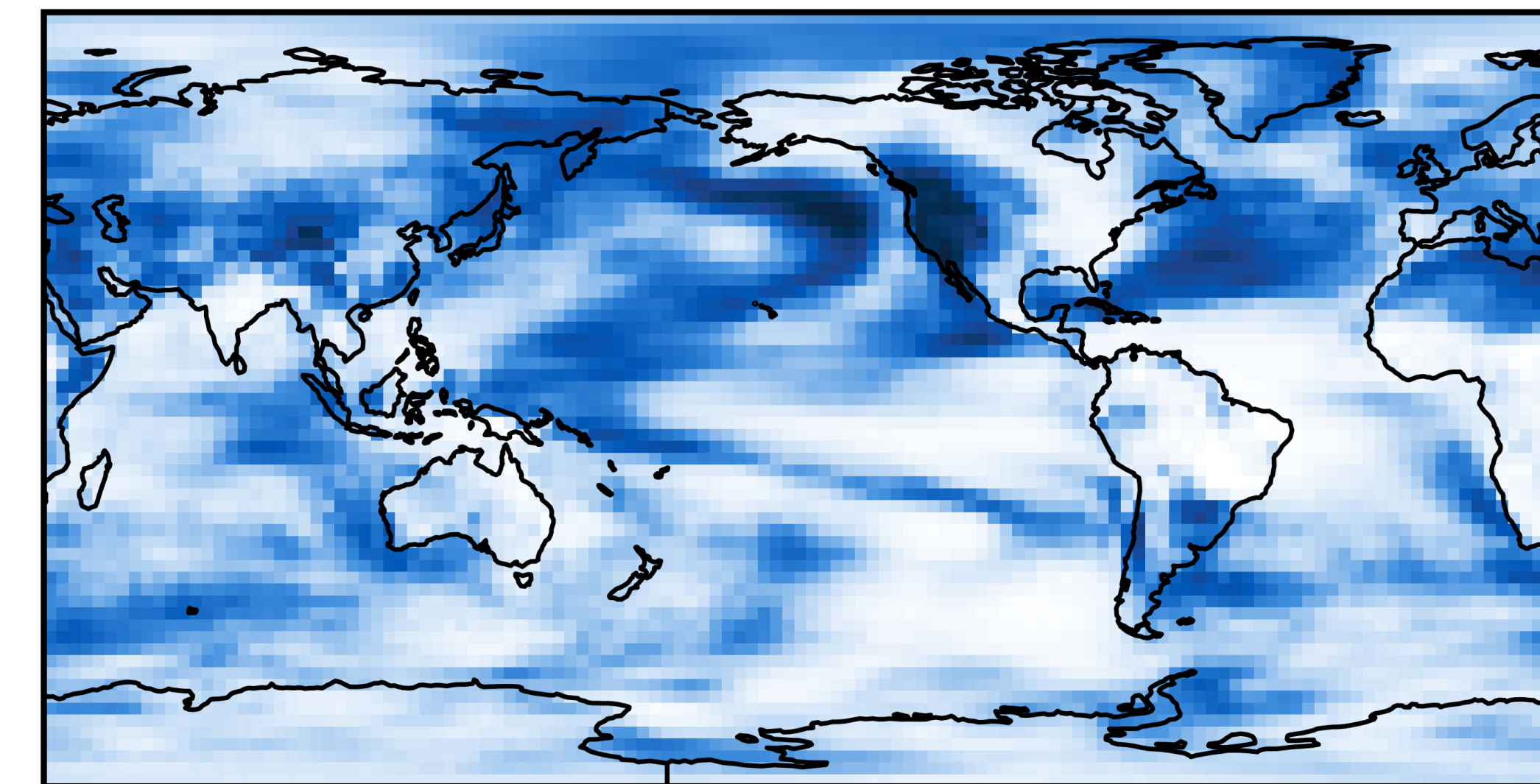
- update mask weights such that two weighted input maps (maps times current mask) are very different when they actually evolve differently, very similar when they evolve similarly.

Select analogs and make predictions:

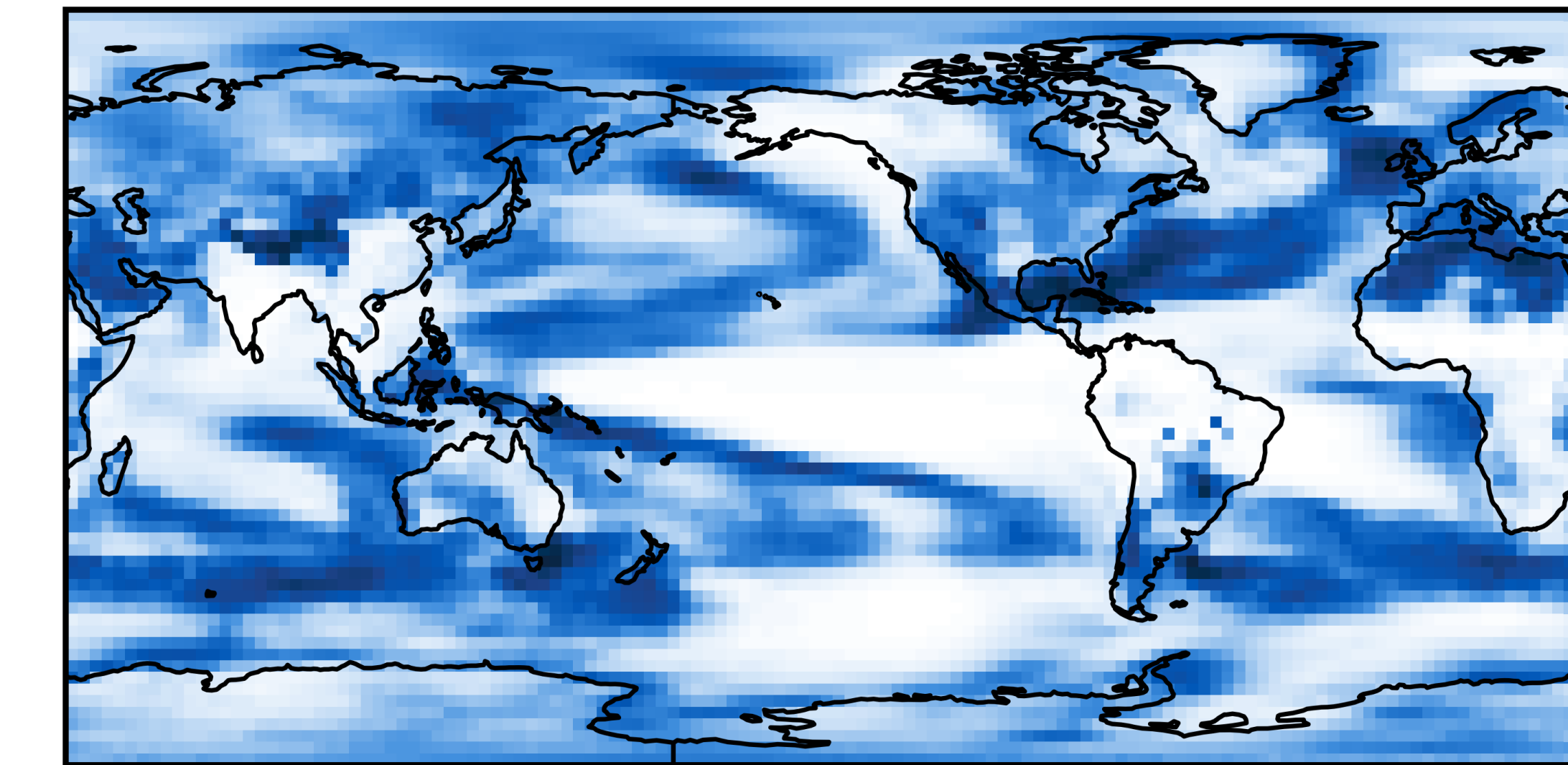
- the learned mask is then used to select the best analogs for a state of interest (SOI), for which we want to make predictions

*Analog library contains 12 Earth system models. Data set from BEST (Berkeley Earth Surface Temperatures) is SOI.

learned masks

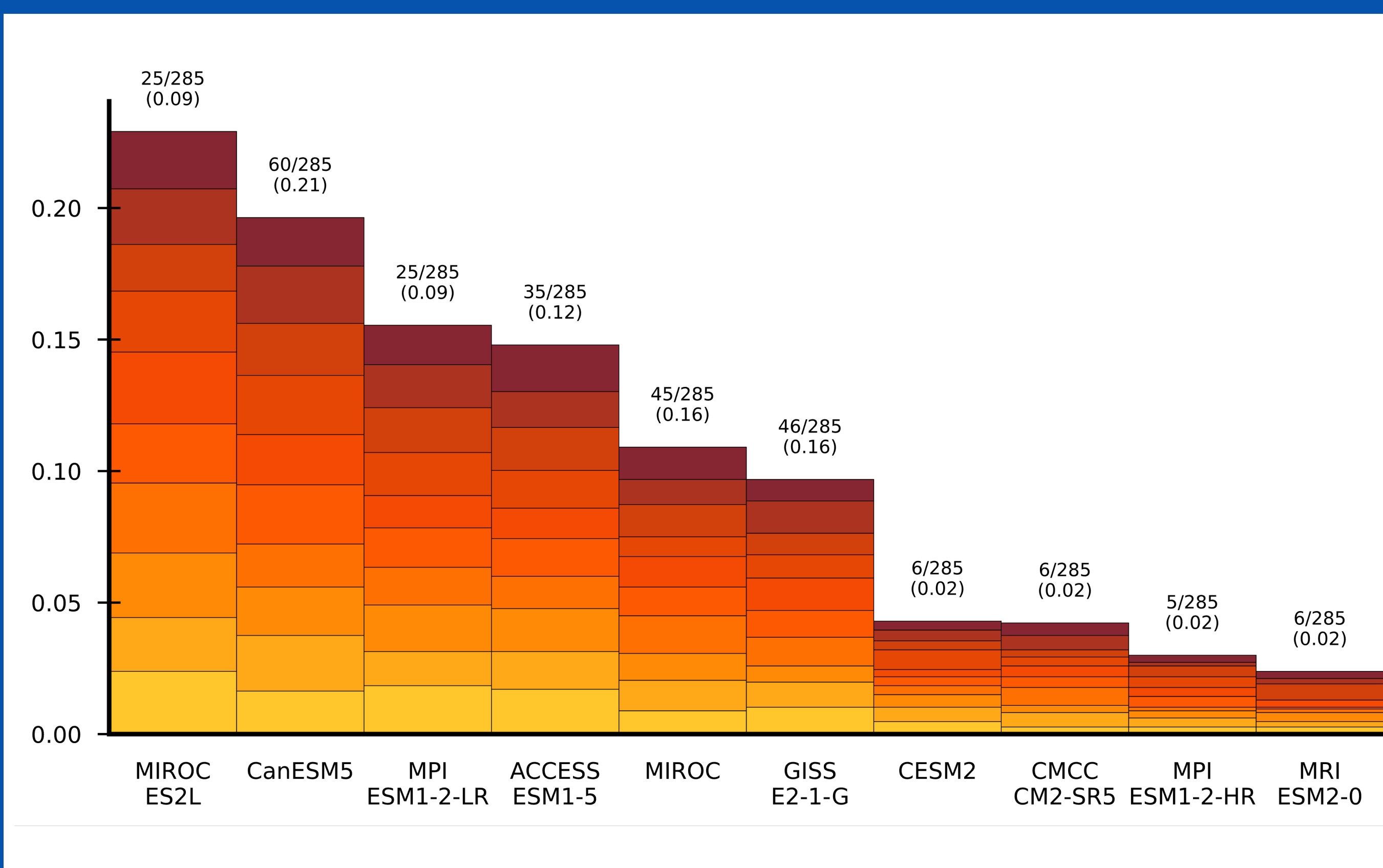


Mask weights 1 year lead: learned mask for predicting average surface temperature over the western US one year in the future. Weights are normalized (unitless).



Mask weights 10 year lead: same as the one year lead, but for a ten year lead time. In this case, targets are five year averages (centered on ten years in the future).

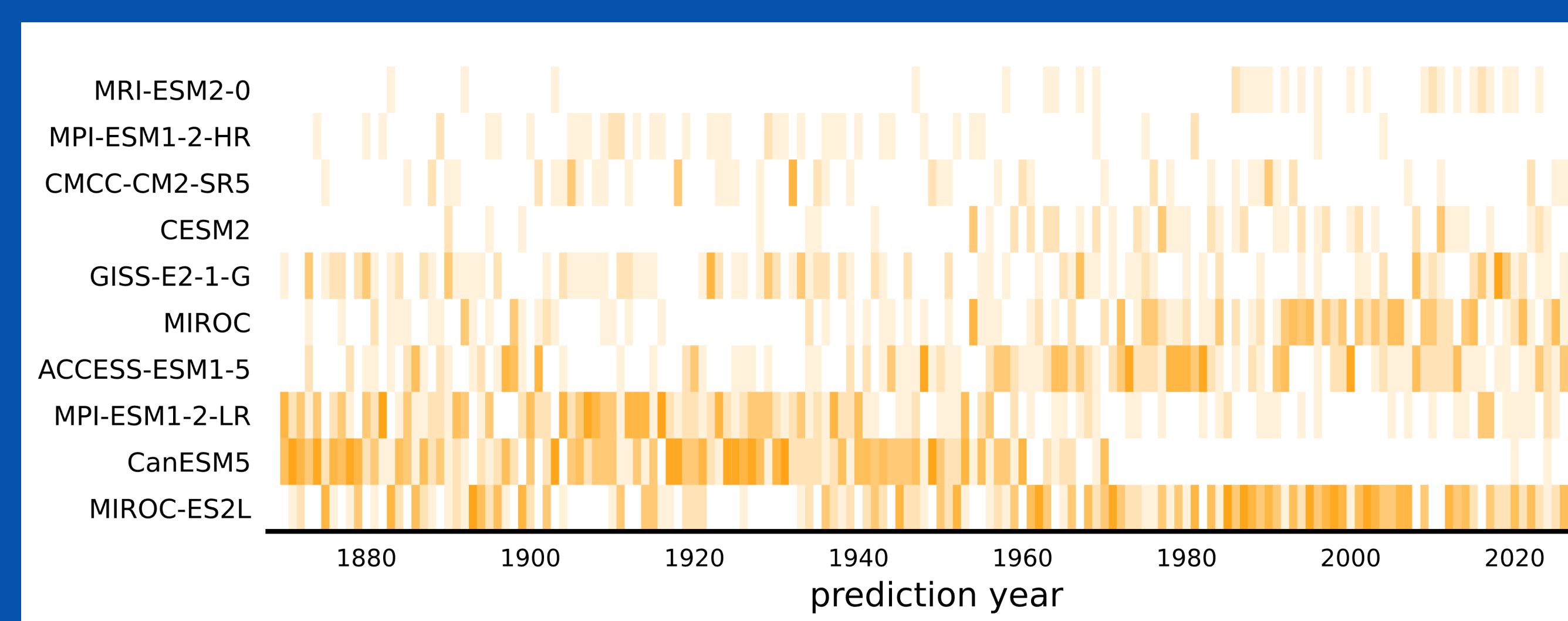
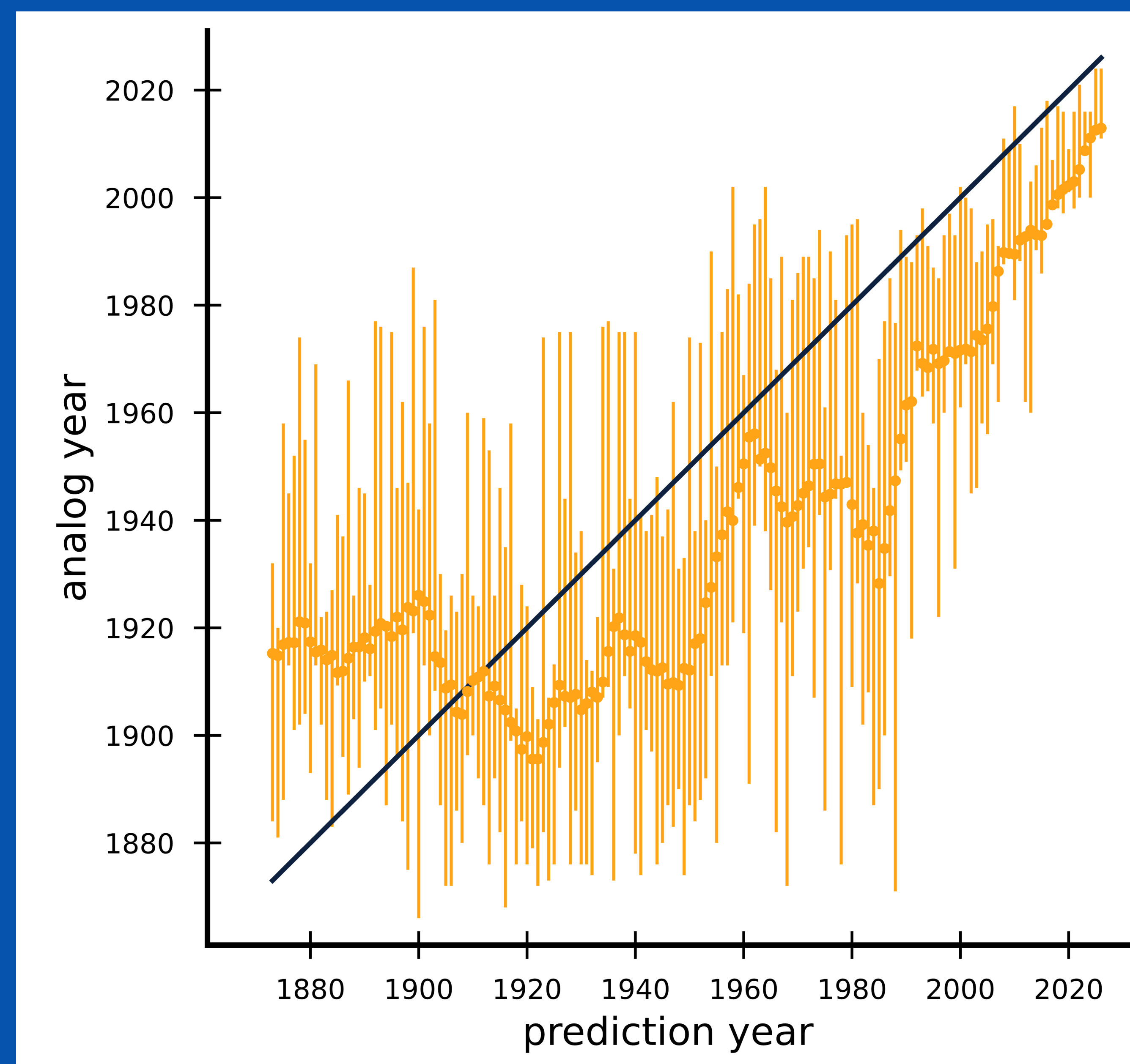
comparing models via observations



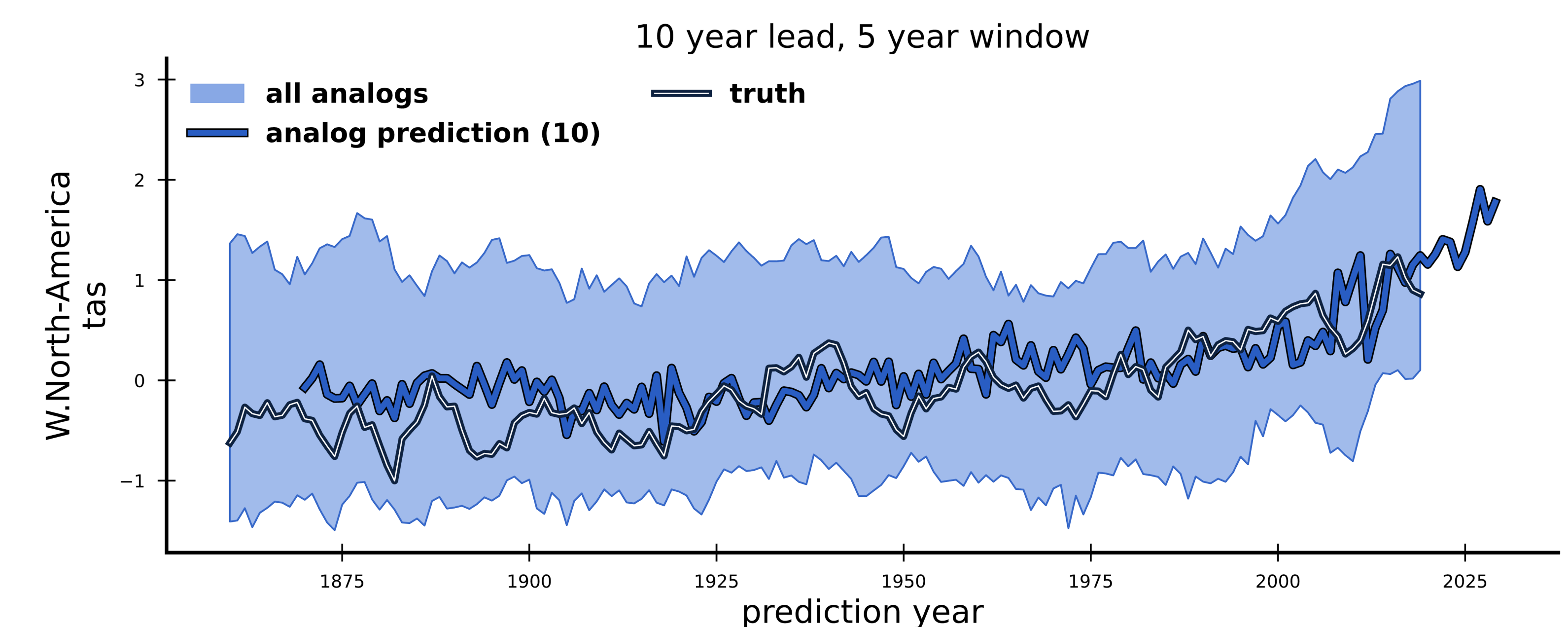
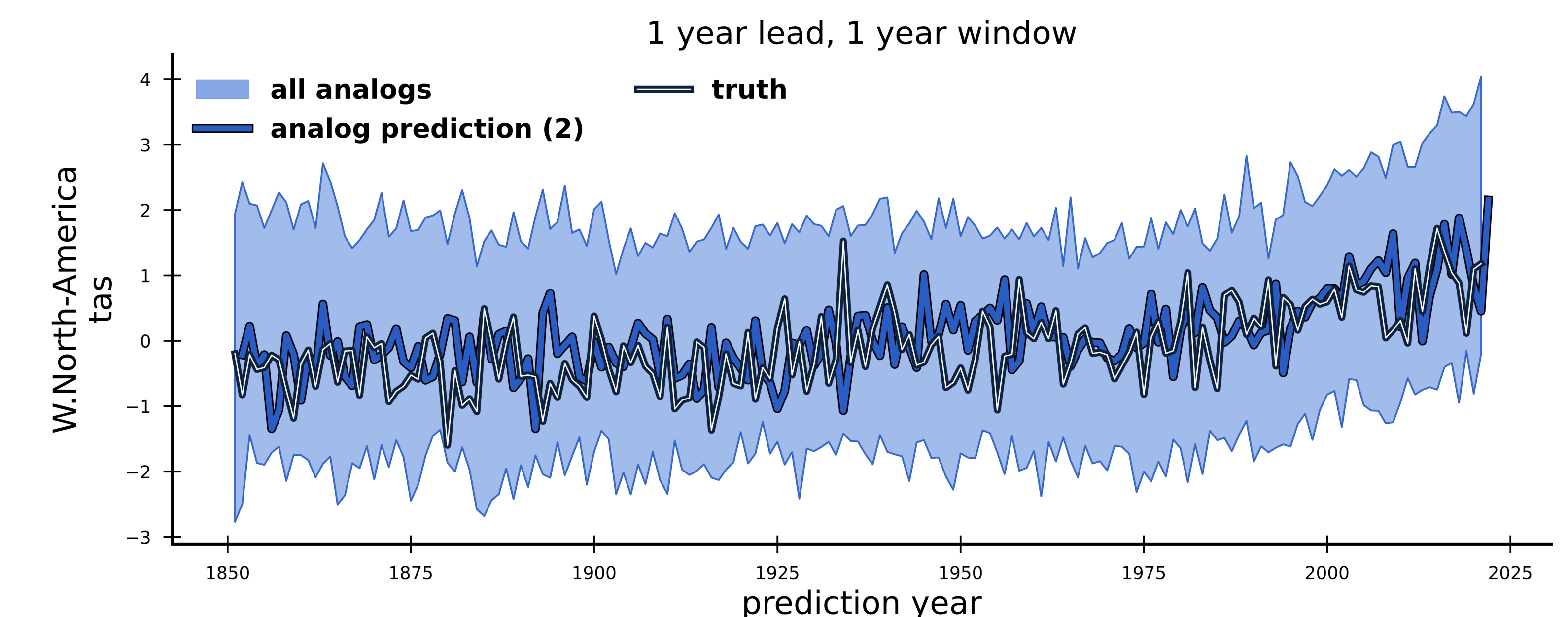
Top-left: frequency for which models were amongst the best ten analogs over the full time range for ten year lead predictions. Colors show frequency where the model was the best analog (yellow, bottom) to tenth best (dark red, top). Numbers at the top of the bars indicate the number of members (and fraction of total) in the analog library (full set of potential analogs). The SOI is BEST.

Top-right: for each predicted year, the median (dot) and range (20th and 80th percentile) of the year associated with the ten best analogs (rolling average taken over +/- 3 years). Black line shows the 1:1 line (selected analogs are from the same year as the prediction year).

Bottom-right: similar to the top-left panel, but shown over time. Darker colors indicate the model was selected more often for that prediction year. Both panels show only the top ten models.



predictions



Top: predicted average western US temperature using the one year lead mask. The average of the top two analogs selected is shown, along with the range of all possible analogs. The SOI for these predictions is BEST (shown as truth).

Bottom: same as top, but for the ten year lead mask (with five year window for truth and prediction). The prediction shown is the average of the top ten analogs.

