Response to S. Ghosh:

S. Sippel et al., 2015

This is a very interesting work on bias correction of climate simulations preserving the physics. This is worth publishing.
We thank the reviewer for the encouraging feedback.

I have few minor points:
1. Is it possible to show that the physics is preserved, through the calculation of closure term of water and energy cycle. They may follow Trenberth and Fasullo (2013), GRL to compute the closure term. Trenberth, K. E., and J. T. Fasullo (2013), North American water and energy cycles, Geophysical Research Letters., 40(2), 365-369, doi: 10.1002/grl.50107.
Yes, this is indeed possible. However, our paper deals with a bias-correction that preserves the physics of the *regional climate model output*. Thus, our approach relies on the assumption that the output of the climate model is physically consistent, i.e. that water and energy balances are closed. We believe that evaluating the water and energy balance in the HadRM3P model is somewhat outside of the scope of our paper.
To this end, Massey et al (2014) showed that the HadRM3P model, including the new parametrization that was introduced in the latter paper, produces a realistic energy balance; and that the closure and realistic representation of the global radiation balance induces an important constraint on the system. In HadRM3P, the water balance is closed. (as much as this is possible in SST driven simulations)
In order to clarify this in the manuscript, we have additionally highlighted that "physical consistent" bias correction requires that water and energy balances are closed and realistic in the Discussion of the manuscript.

2. The authors must mention that bias correction is different from downscaling. There is a recent trend of mixing both of them just by adding a disaggregation to bias correction. This can be a good word of caution.
We agree with the reviewer that this distinction is crucial. In the revised version of the manuscript, this important point is included in the Discussion Section: Here, we emphasize that our bias correction is designed to alleviate biases in a physically consistent way, but is not designed for downscaling or to match any scale mismatches.

3. Is the bias stationary to apply for future climate projections?
An important implicit (and unavoidable) assumption for bias correction of future (or "counterfactual past") simulations is that the structure of the bias remains constant over time. Maraun (2012) had shown that this might be the case on large scales, but important non-stationarities exist locally and regionally. Therefore, in the Discussion Section we (generally) argue for caution in applying any type of bias correction to future simulations.

However, if one assumes stationarity of the bias structure through time, the method can be readily applied to future (or "counterfactual past") simulations (as the mapping function for the resampling step is defined between percentiles, not absolute quantities).

Lastly, to address the reviewer's comment, we have tested that the bias structure in the "bias correction period" in our paper (1985-2010) is stationary, by comparing the bias

structure in the first (1985-1997) and the second period (1998-2010). See the figure below for the results: Although of course this approach is limited by the small sample size (13 years for each period), the bias structure is very similar for both periods and both for the entire temperature signal and detrended temperatures (i.e. the biases (for example, the probability for an event in the hot tail) are not due to single "strange" years but rather occur systematically in every year in the ensemble).

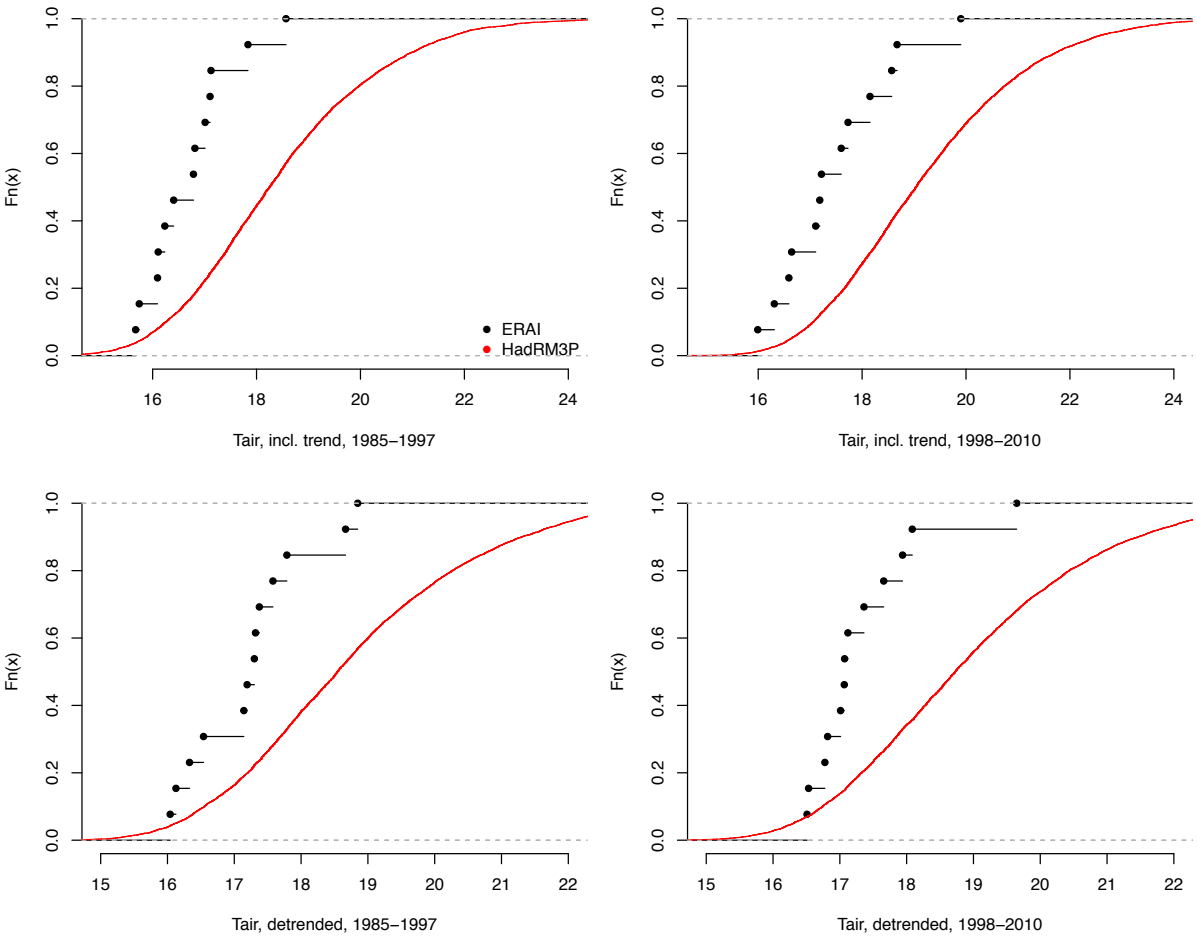

Figure 1: Stationarity of biases in two periods (1985-1997, and 1998-2010), for both the full temperature signal and detrended temperatures.