

Bias-correction of down-scaled meteorological drivers

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Using the period 1960-1990, I compared the CRUNCEP data (0.5-degree, 6-hourly) to the downscaled output from the CCSM4 model (same resolution) to examine bias in the downscaled GCM model output. Bias was calculated as the difference between the monthly mean of the CRUNCEP and CCSM4 data as an additive change for temperature, and a ratio change for radiation, humidity, and precipitation. Please see the PalEON GitHub page (<https://github.com/PalEON-Project/metRegional>) for code detailing this bias-correction. The bias corrections were applied to the entire PalEON spatial domain, but for the sake of comparison, changes within the Harvard Forest grid cell are plotted below.

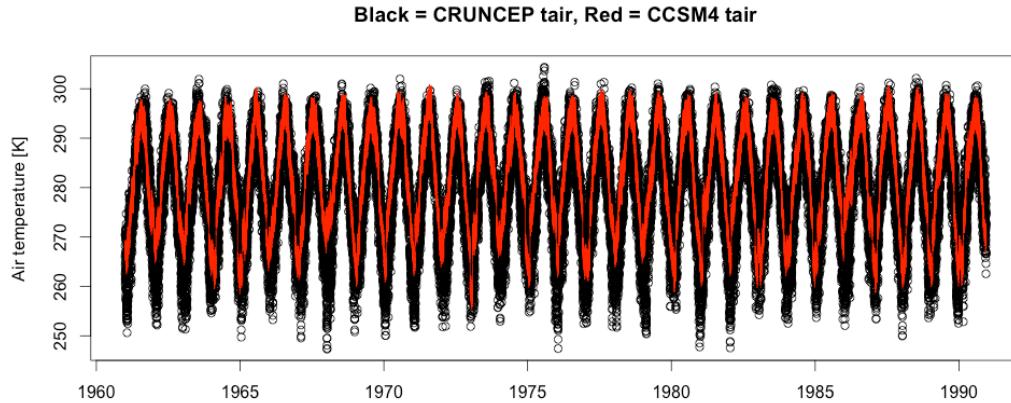


Fig A1a. Air temperature bias in 6-hourly data for 1961-1990: CRUNCEP mean = ~279.5K, CCSM4 mean = ~281.5K, by an addition approach the bias correction is -2K.

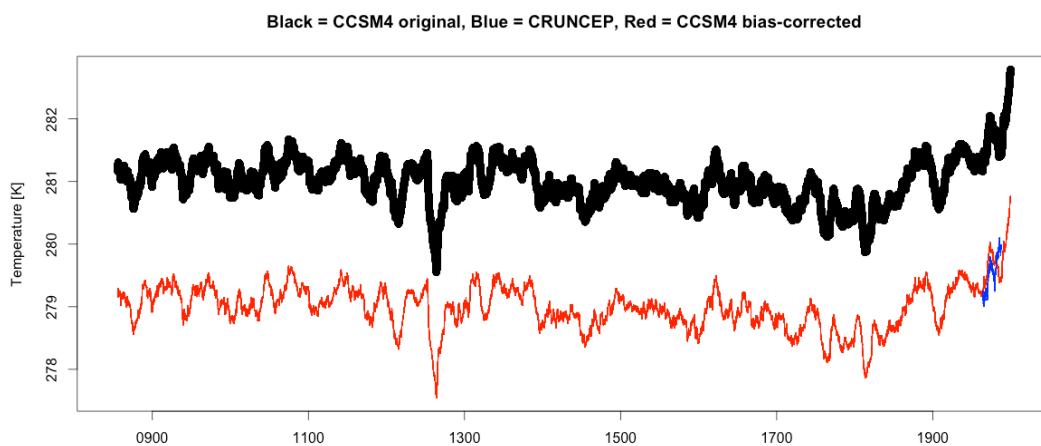


Fig A1b. Air temperature bias correction: Applying the CRUNCEP-CCSM4 temperature bias correction of -2K across the whole PalEON time domain, displayed as a 10-year moving window average.

PRECIPITATION:

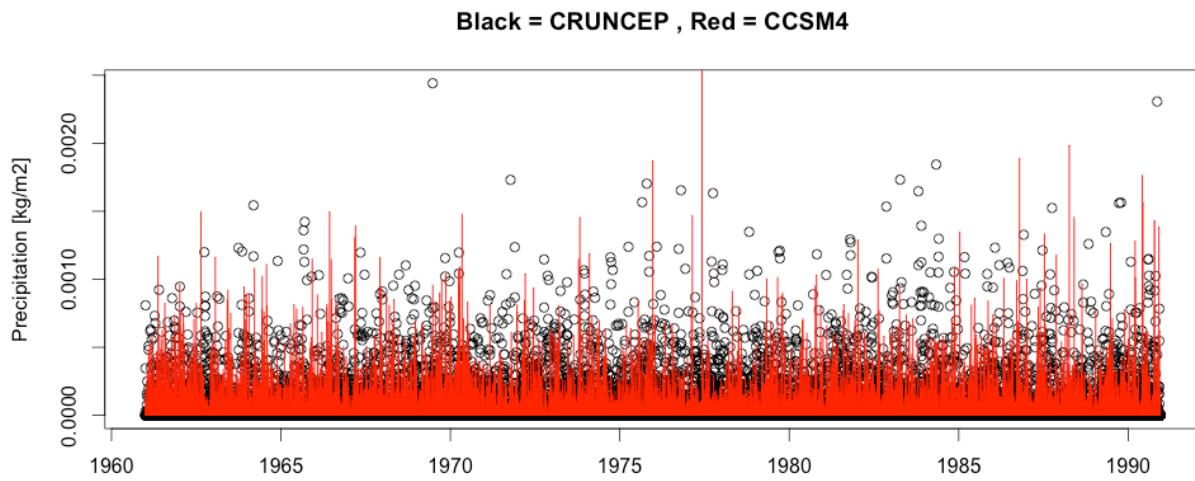


Fig A2a. Precipitation bias in 6-hourly data for 1961-1990: CRUNCEP mean = $3.41\text{e-}05$ kg/m², CCSM4 mean = $3.80\text{e-}05$ kg/m², by a ratio approach (CRU/GCM) the bias correction is ~0.898.

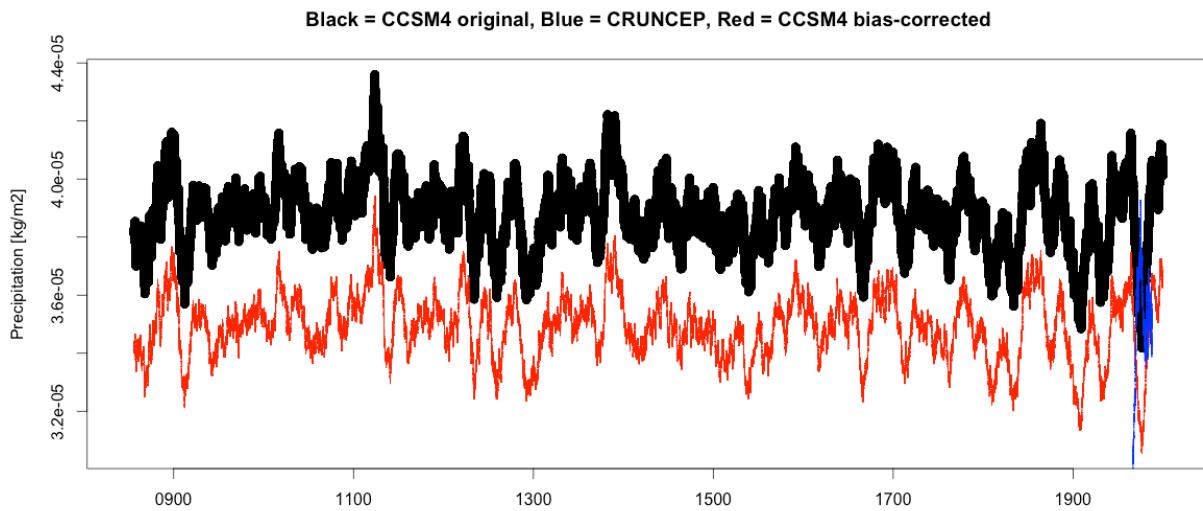


Fig A2b. Precipitation bias correction: Applying the ratio approach CRUNCEP/CCSM4 bias correction, displayed as a 10-year moving window average for the CCSM4 original and bias-corrected data, and a 1-year moving window average for CRUNCEP.

INCOMING SHORT-WAVE RADIATION:

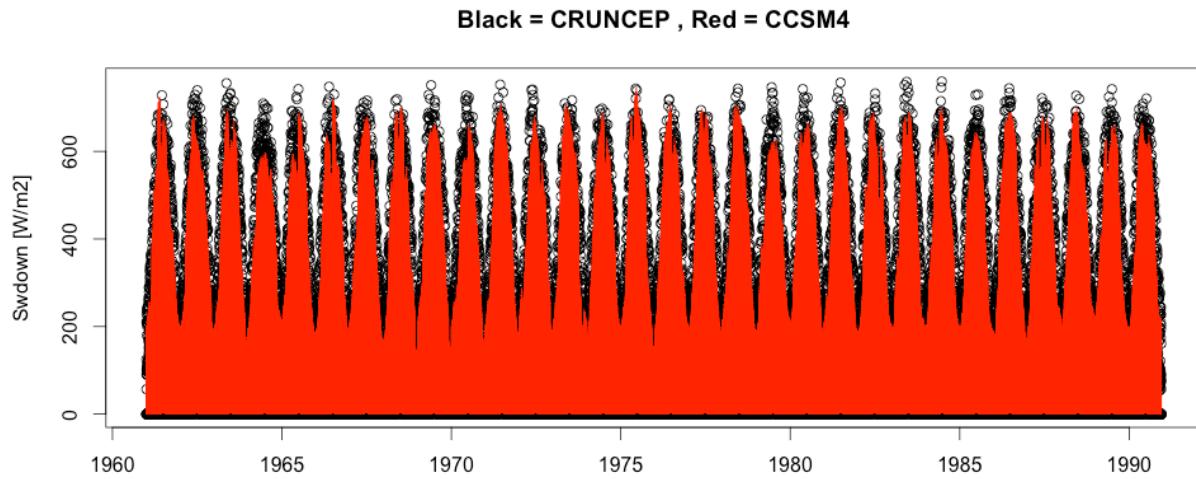


Fig A3a. Incoming short-wave bias in 6-hourly data for 1961-1990: CRUNCEP mean = 170 W/m², CCSM4 mean = 178 W/m², by a ratio approach (CRU/GCM) the bias correction is ~0.958.

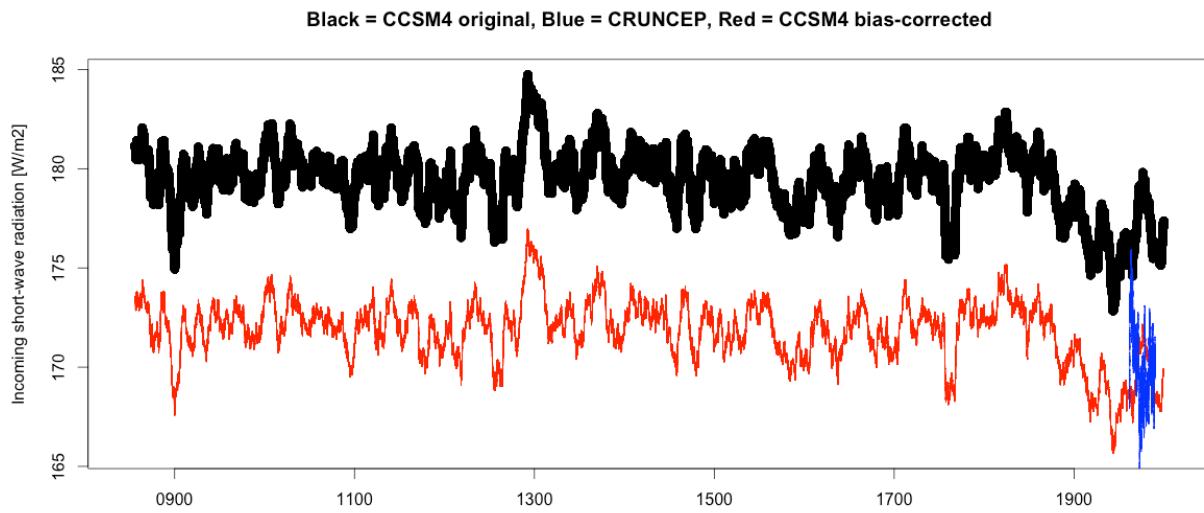


Fig A3b. Incoming short-wave radiation bias correction: Applying the ratio approach CRUNCEP/CCSM4 bias correction, displayed as a 10-year moving window average for the CCSM4 original and bias-corrected data, and a 1-year moving window average for CRUNCEP.

INCOMING LONG-WAVE RADIATION:

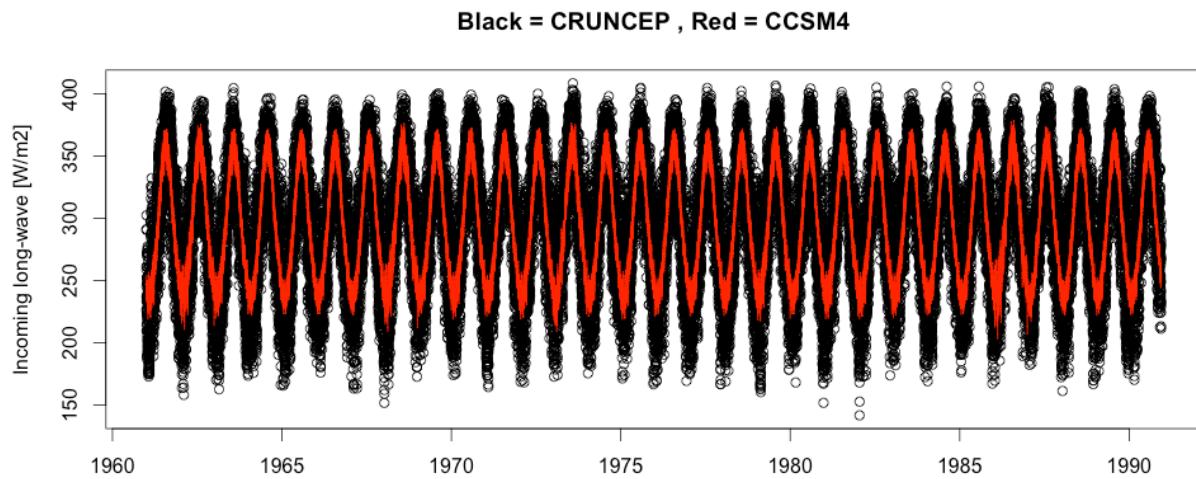


Fig A4a. Incoming long-wave bias in 6-hourly data for 1961-1990: CRUNCEP mean = 295 W/m², CCSM4 mean = 292 W/m², by a ratio approach (CRU/GCM) the bias correction is ~1.01.

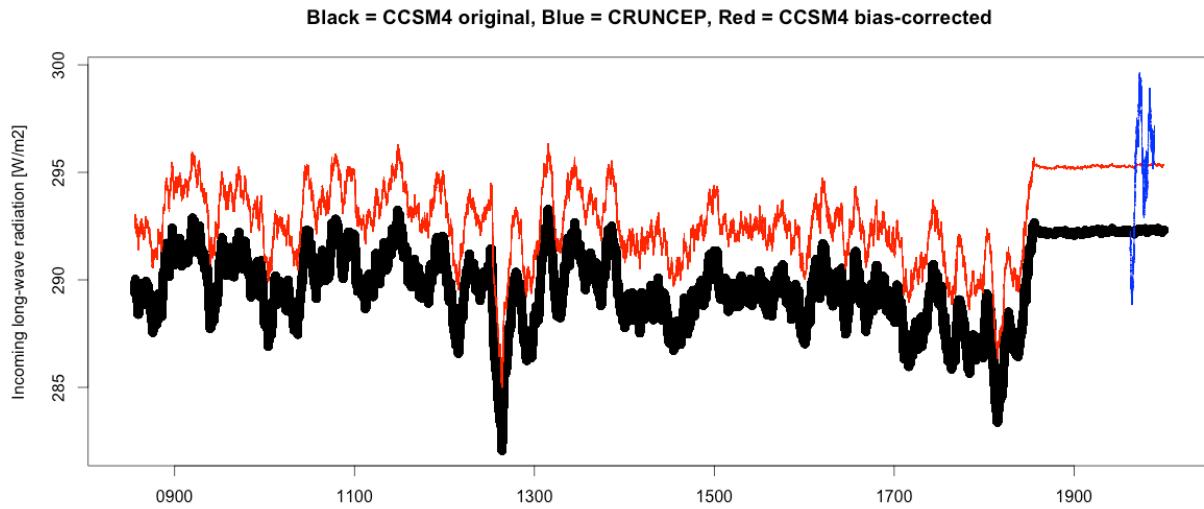


Fig A4b. Incoming long-wave radiation bias correction: Applying the ratio approach CRUNCEP/CCSM4 bias correction, displayed as a 10-year moving window average for the CCSM4 original and bias-corrected data, and a 3-year moving window average for CRUNCEP. Note the strange lack of variability in the down-scaled CCSM4 historical model from 1850-2005 – I checked this, and it's a feature inherent within the monthly CCSM4 model output for this time period, not a down-scaling error or artifact. For whatever reason, the CCSM model produces very low variance in incoming long-wave radiation during the historical period.

HUMIDITY

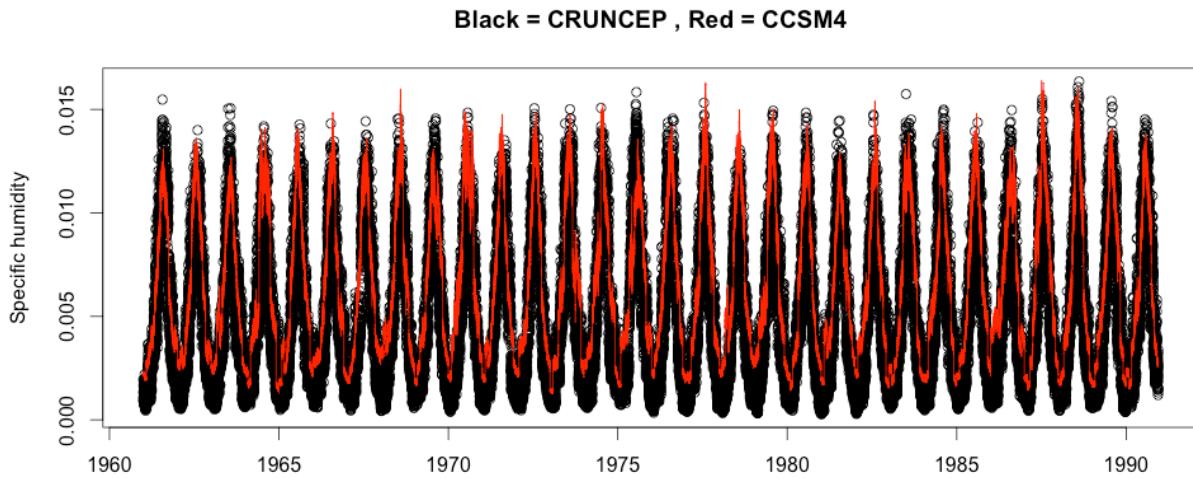


Fig A5a. Incoming humidity bias in 6-hourly data for 1961-1990: CRUNCEP mean = 0.00510, CCSM4 mean = 0.00636, by a ratio approach (CRU/GCM) the bias correction is ~0.802.

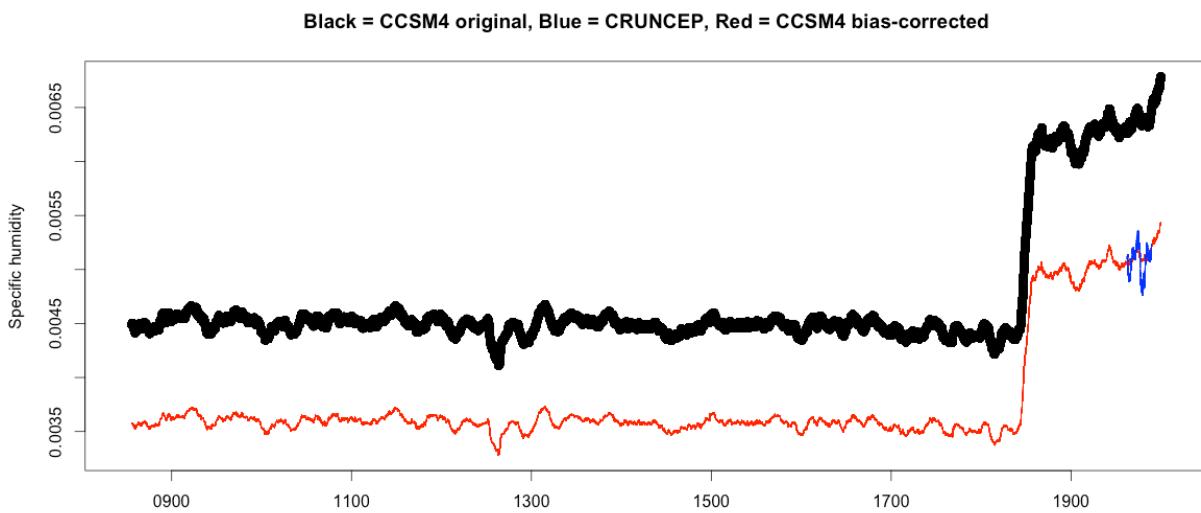


Fig A5b. Specific humidity bias correction: Applying the ratio approach CRUNCEP/CCSM4 bias correction, displayed as a 10-year moving window average for the CCSM4 original and bias-corrected data, and a 3-year moving window average for CRUNCEP. You'll notice a lagging large jump between the past1000 CCSM4 run and the historical CCSM4 run at year 1850. I investigated VPD, since this is likely more ecophysiological relevant for the models (see below).

VAPOR PRESSURE DEFICIT

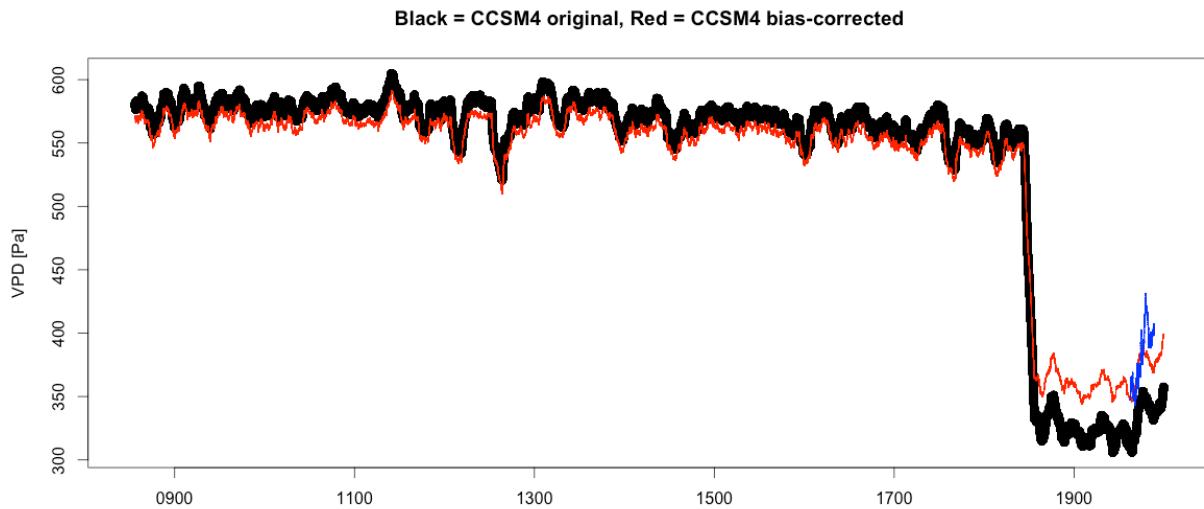


Fig A6. Vapor pressure deficit correction: Using the values of specific humidity, air temperature, and surface pressure, I calculated vapor pressure deficit to see if a large bias remained as in specific humidity. The bias-correction for temperature (there was no bias correction on surface pressure) works to slightly reduce the VPD jump at 1850, but not enough to compensate the large change in specific humidity between models.

SURFACE PRESSURE

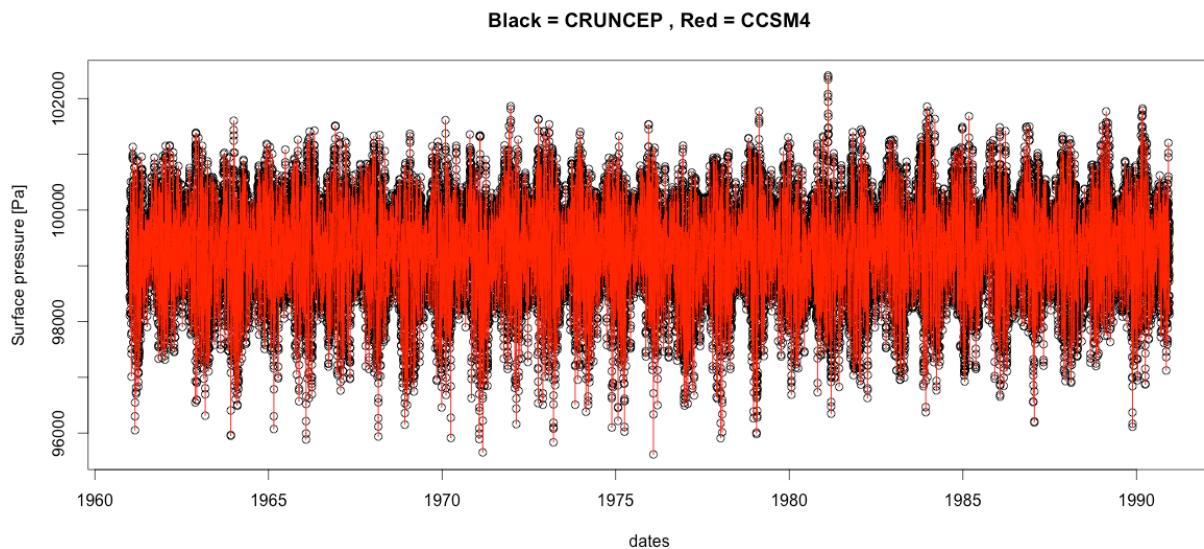


Fig A7. Surface pressure bias in 6-hourly data for 1961-1990: CRUNCEP mean = 99278 Pa, CCSM4 mean = 98104. Did not bias correct since the variables are very close and match very well in both mean and variability.

WIND SPEED

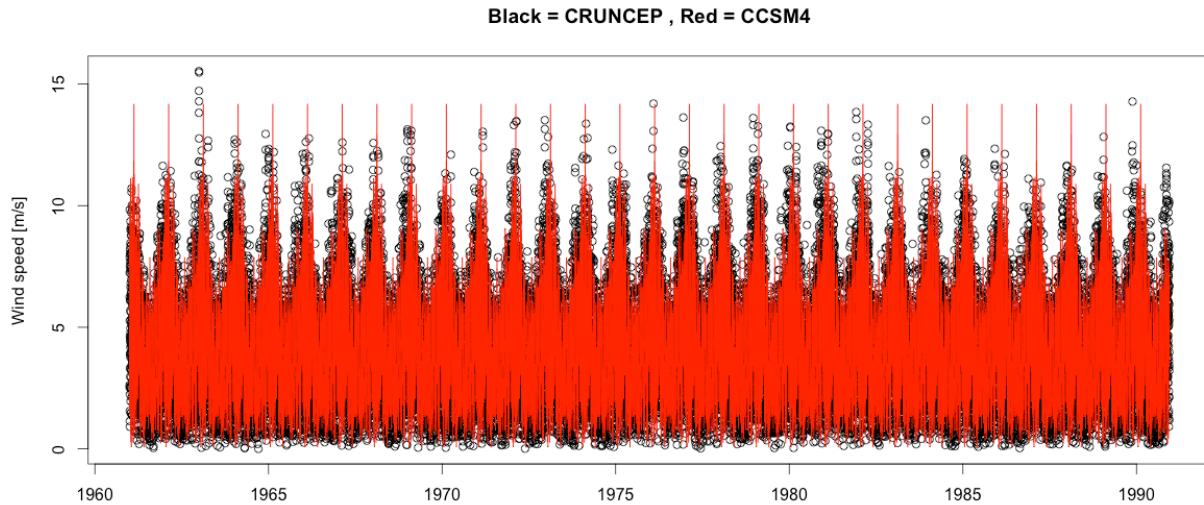


Fig A8. Wind speed bias in 6-hourly data for 1961-1990: CRUNCEP mean = 4.21m/s, CCSM4 mean = 4.27m/s. Did not bias correct since the variables are very close and match very well in both mean and variability.

SPECIFIC HUMIDITY – ALTERNATE BIAS CORRECTION

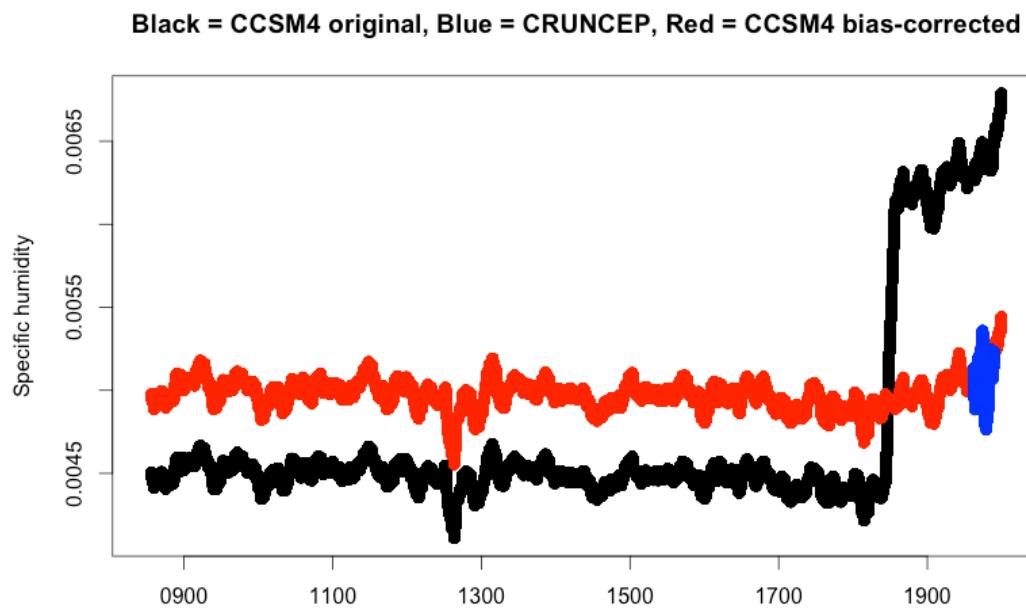


Fig A8. I corrected the historical run (1850-2005) to the CRUNCEP data. I then used the first 15 years of the corrected historical run to match the monthly means for the last 15 years of the past1000 run, and bias-corrected the past1000 run based on this relationship. Please see the PalEON GitHub page (<https://github.com/PalEON-Project/metRegional>) for the specific humidity (qair) correction code.