

UKESM1-0-LL model ensembles (and JULES-ES offline).

Figure 1 shows the permafrost area defined in two ways. The plot on the left shows a histogram of the permafrost extent for the 16 UKESM ensembles compared defined using the mean annual air temperature (MAAT - 1995-2014) and the relationship between MAAT and probability of permafrost defined by Chadburn et al. (2017) (PFchadburn). The plot on the right shows a histogram the permafrost extent defined using the soil temperature of the deepest soil level (PFsoil).

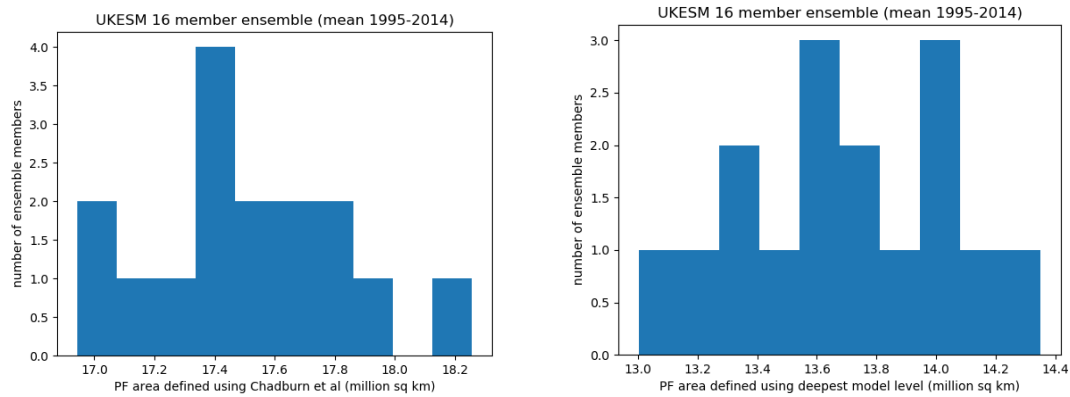


Figure 1 - PF extent for the UKESm ensembles

The spread of values for PFchadburn is between 16.9 and 18.2 million square kilometres (mean 17.5; standard deviation 0.33; standard error 0.08) and for PFsoil 13-14.3 million square kilometres (mean 13.7; standard deviation 0.34; standard error 0.08). Whilst this spread is 6-8 % of the permafrost extent it is still relatively small compared with the differences between models. When the permafrost extent is normalised by the area of land where the air temperature is less than zero the spread of values is small and can be considered a characteristic of the model (Figure 2 below). The mean is 0.66 with a standard deviation of 0.005 (spread 0.65-0.67).

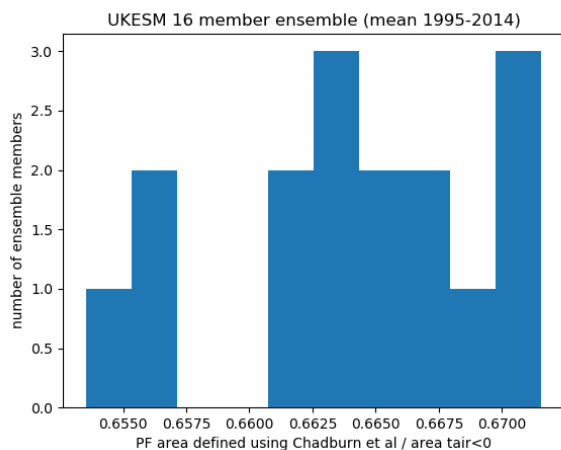


Figure 2 - PF extent/area tair less than 0 degrees C (See table S1-1 in paper).

The following relationships also appear to be a characteristic of the model and relatively independent of climate biases. Figure 3 shows the relationship between effective snow depth and winter surface to air offset for the UKESM1-0-LL ensemble members (orange). Figure 4 shows the relationship between MAGT and MAAT. Figure 5 shows the winter, summer and thermal offsets as a function of temperature. These relationships appears to be pretty robust. However, the differences between JULES-ES and UKESM1-0-LL require further analysis.

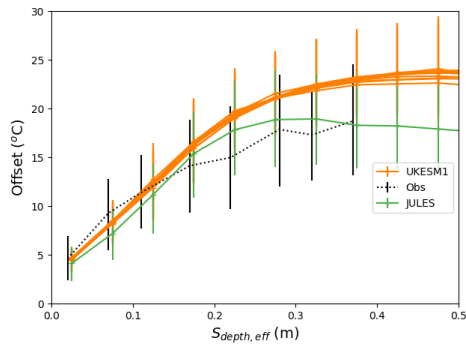


Figure 3- Relationship between effective snow depth and winter offset for UKESM1-0-LL and JULES-ES. Equivalent of Figure 6 in paper.

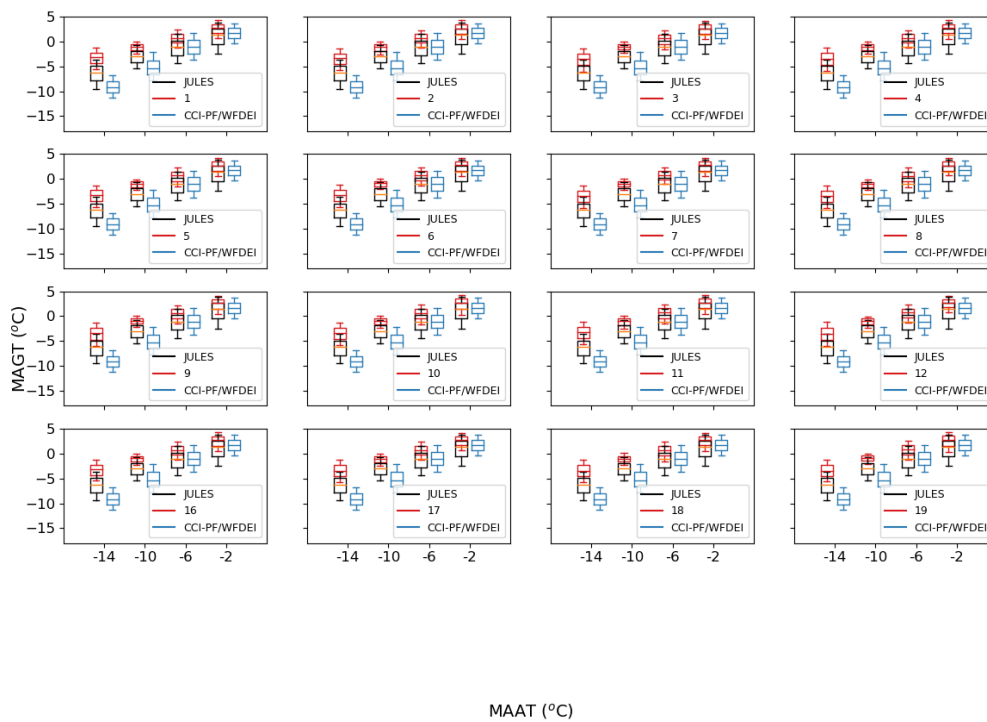


Figure 4 - Relationship between MAAT and MAGT compared with the CCI-permafrost observations and WFDEI tair. Each UKESM1-0-LL ensemble member is shown on a different figure and the same observations / JULES-ES simulation is shown on each plot. Equivalent of Figure 7 in paper.

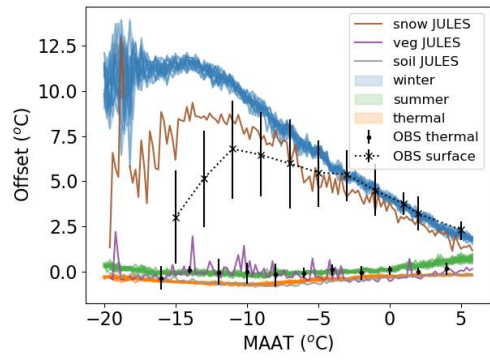


Figure 5 - The relationship between mean annual air temperature and winter, summer and thermal offsets for UKESM1-0-LL and JULES-ES. (Equivalent of Figure 5 in paper)