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Interactive comment on "A simplified permafrost-carbon model for long-term climate studies with the CLIMBER-2 coupled earth system model" *by* K. A. Crichton et al.

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> Terminology

In the revised paper I will ensure that terminology is correctly used, thank you for identifying the errors in the original version. For the soil carbon concentration, indeed this should be "soil organic carbon content". This will be corrected in the revised version.

> Soil pools and parameters

The model is actually a two-pool model: the fast soil pool and the slow soil pool. I will make this clearer in the revised version. The reduced decomposition rates are

applied to carbon in both the fast soil pool and the slow soil pool for the fraction that is identified as "permafrost". If the permafrost extent model is not included, the model has 4 degrees of freedom: "a" and "b" for each of the soil pools (fast or slow). There are four settings for these values that provide agreement with total land carbon stocks estimates for the last glacial maximum (LGM) and the pre-industrial (PI) period. We only tune to model to two points in time: LGM and PI using the available estimates. Although there appears to be a lot of tuning in the model, in fact the end aim is have four permafrost carbon dynamic settings with which to perform transient experiments later.

> Compare with one box model

The advantage of a spatially distributed model is that we can look at the coupled feedbacks between climate conditions and soil carbon response. A one box model would necessarily need inputs to control how the carbon responds to insolation change – which is dependent on latitude; the effect of changing land ice sheet area – which is dependent on location; changes in local/regional climate which effect NPP – which is dependent on location. As it is a two pool model, changes in the fast soil pool also affect the slow soil pool, all of which is dependent on NPP (and climate). I will make this clearer in the revised version.

> Data validation

Indeed, the Ciais et al data was not used to validate the model (but to tune it), it should not appear to be in the validation section. I will correct this.

> Carbon-14 as tracer

Carbon-14 is a measure of the age of carbon matter, so, how long ago an organic organism stopped exchanging carbon with it surroundings (e.g. the atmosphere). In soil building, generally the carbon at the top of the soil is the youngest, and in lower horizons it is older (although this is complicated by cryoturbation, movement of carbon

content in cryosols). This means that the actual location of the carbon down the soil column is important for its 14C signature. CLIMBER-2 has no soil depth and all carbon in a soil pool is well mixed (i.e. has one value for 14C). If soil decomposition during thaw in permafrost soils of the real world in the soil column is top-down, the 14C age of respired carbon would initially be relatively young. In CLIMBER-2 this characteristic cannot be modelled, as all soil carbon has only one 14C age within a grid-cell.

I will take into account all comments in the revised version.

Thank you for your review.