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Impact of a spectrally resolved emissivity and its far-infrared variability in GCM

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Comparisons between climate models and reanalysis show persistent biases in surface temperature over polar regions, particularly in the wintertime Arctic. A recent study (Kuo et al., 2018) using the Community Earth System Model (CESM) suggests that incorporating a more realistic spectrally varying surface emissivity can substantially reduce these discrepancies. In this work we investigate whether a similar effect is seen in UK HadGEM-GA7.1 by replacing the current simplified assumptions of surface type and characteristics with simulated estimations of spectrally resolved surface emissivity as introduced by Huang et al., 2016. We describe the non-trivial steps involved in incorporating such a change in the land (JULES) and atmospheric components of the model (UM and SOCRATES). The radiative transfer model SOCRATES is updated to estimate the upwelling flux from the surface based on simulated spectrally resolved emissivities. On its side, the land model decomposes the surface into 9 different tile types (ice, urban, 5 various plant function types, bare ground and water), providing to the atmospheric model information about the surface temperature and grey body emissivity for each tile, and the area fraction for each tile. However, the land model only considers broadband short wave and long wave fluxes while SOCRATES considers 9 bands (3 in the far-infrared). Hence, in the computation of the net radiative flux, a correction is applied on the surface Planck function along with the downwelling longwave flux absorption while ensuring consistency in the exchanges between the model components. The radiative impact of these changes on the upwelling flux is then estimated on short time scale as well as their influence on long-term trends in surface characteristics, we also highlight the importance of far-infrared variability of snow/ice emissivity and results are compared with CESM.