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Land surface downscaling using a spatially and temporally varying lapse rate.

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Temperature near the surface varies with altitude accordingly to the environmental lapse-rate (ELR). The ELR depends on the overlying air masses, large-scale situation and local effects. The characterization of the ELR has several applications, in particular to downscale global/regional numerical weather predictions, reanalysis and climate projections in complex terrain regions. From an observational point of view, complex terrain regions also constitute a challenging environment due to the difficulties associated with the installation and maintenance of observational networks. In this study we propose the derivation of the ELR from atmospheric reanalysis lower troposphere vertical profiles of temperature. This is then used to downscale near-surface air temperature from the new ECMWF atmospheric reanalysis ERA5. High resolution (9km) land surface only simulations driven by these downscaled fields were carried out and evaluated over U.S taking advantage of a variety of observations including the GHCN daily maximum and minimum temperatures as well as SNOTEL snow depth and soil temperature. The ERA5 ELR estimates compare favourably with estimates derived from in-situ observations over U.S. denoting both spatial and temporal variability. The downscaled simulations with and without topographic correction and with a constant ELR show the added value of this approach directly in near-surface air temperature but also in other surface fields like soil temperature and snow depth. The results suggest some benefits of using this new ELR over complex terrain regions, when compared

with a constant value. We propose this new methodology as a default approach for downscaling temperature from reanalysis on the global/regional scale, either directly or to force other models, where in-situ observations are scarce and computational resources limit dynamical downscaling. This methodology could be applied to perform land simulations at resolutions comparable with Earth Observations (e.g. land surface temperature) allowing detailed evaluation and development while avoiding spatial regridding which add uncertainties.