The rather short life time of $^{222}$Radon of 5.5 days makes this radioactive noble gas an almost ideal tracer of atmospheric transport processes. $^{222}$Radon, the gaseous progeny of $^{226}$Radium, which is a trace constituent of all soils, can escape the soil grains and make its way from the unsaturated soil zone into the atmosphere. The exhalation rate of $^{222}$Radon from continental surfaces depends on soil type and permeability, but is orders of magnitude larger than that from ocean surfaces. Therefore, the atmospheric $^{222}$Radon activity concentration can be used as a measure of the residence time of air over continental surfaces or to distinguish continental from marine air masses. At continental sites, the short-term variability of $^{222}$Radon is mainly determined by diurnal or synoptic-scale boundary layer mixing processes. If its continental exhalation rate is known, $^{222}$Radon can even be applied as a quantitative tracer for evaluating regional scale transport model performance. In the present study we use $^{222}$Radon activity concentration measurements from the ICOS atmospheric station network and STILT transport model results to assess the ability of this routinely used model to correctly simulate the (diurnal) variation of boundary layer transport. This uncertainty assessment is an important step towards reliable estimates of the contribution of transport model error in GHGs inversion studies that aim at providing accurate fluxes from inversion of atmospheric GHGs observations in ICOS.