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Surface energy balance in an ensemble of simulations of the past centuries

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Four simulations with the model ECHO-G covering different periods of the past millennium (either since 1000 A.D. or since 1750 A.D.) , driven by greenhouse gases, varying total solar irradiance and and a simple volcanic forcing scheme, have been used to analyze the past surface energy balance over the the ocean and on over land. One of these simulations has been extended until 2100 under two SRES forcing scenarios. In a first step, and to avoid uncertainties related to statistical reconstructions methods, the model output is compared to long instrumental and early-instrumental records. It is found, for instance, that the simulations reproduce quite well the trend of the Central England Temperature record, and that a control simulation with the same model does not produce any comparable trends. This would argue against small past changes in Total Solar Irradiance, as the model TSI change between today and the Late Maunder Minimum is 0.3% of the current TSI. The surface energy balance will be presented stratified by season and by latitudinal bands. One main result is that model global cloud cover acts as a negative short-wave feedback to global temperature changes. For instance, modeled downward surface solar radiation is larger in periods colder than today, although TSI was smaller. This effect , with opposite sign, also occurs in the 21st century, when downward surface solar radiation is reduced due to enhanced cloud cover. The simulated radiation imbalances at the end of the 20th century, about 0.85 watt/mˆ2, is in accordance with observational estimates. Most of the additional heat flux penetrates into the ocean, but land surface also absorbs a non-negligible amount of heat.