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Geosci. Model Dev., 7, 3037-3057, 2014
www.geosci-model-dev.net/7/3037/2014/
doi:10.5194/gmd-7-3037-2014

Technical/Development/Evaluation Paper

18 Dec 2014

Evaluation of North Eurasian snow-off dates in the ECHAM5.4 atmospheric general circulation model

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Received: 19 Mar 2014 – Published in Geosci. Model Dev. Discuss.: 05 Jun 2014
Revised: 07 Nov 2014 – Accepted: 24 Nov 2014 – Published: 18 Dec 2014

Abstract. The timing of springtime end of snowmelt (snow-off date) in northern Eurasia in version 5.4 of the ECHAM5 atmospheric general circulation model (GCM) is evaluated through comparison with a snow-off date data set based on space-borne microwave radiometer measurements and with Russian snow course data. ECHAM5 reproduces well the observed gross geographical pattern of snow-off dates, with earliest snow-off (in March) in the Baltic region and latest snow-off (in June) in the Taymyr Peninsula and in northeastern parts of the Russian Far East. The primary biases are (1) a delayed snow-off in southeastern Siberia (associated with too low springtime temperature and too high surface albedo, in part due to insufficient shielding by canopy); and (2) an early bias in the western and northern parts of northern Eurasia. Several sensitivity experiments were conducted, where biases in simulated atmospheric circulation were corrected through nudging and/or the treatment of surface albedo was modified. While this alleviated some of the model biases in snow-off dates, 2 m temperature and surface albedo, especially the early bias in snow-off in the western parts of northern Eurasia proved very robust and was actually larger in the nudged runs.

A key issue underlying the snow-off biases in ECHAM5 is that snowmelt occurs at too low temperatures. Very likely, this is related to the treatment of the surface energy budget. On one hand, the surface temperature T_s is not computed separately for the snow-covered and snow-free parts of the grid cells, which prevents T_s from rising above 0 °C before all snow has vanished. Consequently, too much of the surface net radiation is consumed in melting snow and too little in heating the air. On the other hand, ECHAM5 does not include a canopy layer. Thus, while the albedo reduction due to canopy is accounted for, the shielding of snow on ground by the overlying canopy is not considered, which leaves too much solar radiation available for melting snow.

Citation: Räisänen, P., Luomaranta, A., Järvinen, H., Takala, M., Jylhä, K., Bulygina, O. N., Luojus, K., Riihelä, A., Laaksonen, A., Koskinen, J., and Pulliainen, J.: Evaluation of North Eurasian snow-off dates in the ECHAM5.4 atmospheric general circulation model, Geosci. Model Dev., 7, 3037-3057, doi:10.5194/gmd-7-3037-2014, 2014.