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Evaluation of hydrological outputs from land surface carbon models using river discharge data and earth observations of snow for the pan-arctic region

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Hydrology plays a major role in determining the carbon balance in Dynamic Vegetation Models (DVMs). In northern regions the existence, magnitude and timings of the snow pack are critical factors involved in accurately modelling the hydrological cycle and thus plant productivity, through processes related to albedo, soil insulation, and the temporary increase in soil moisture storage capacity proffered by the snow pack.

This study evaluates the hydrological outputs of snow water equivalent (SWE) and runoff from 5 dynamic vegetation models using their default drivers: CLM4, Jules, LPJ-WM, ORCHIDEE and SDGVM for the pan arctic region (>50N). As well as comparisons between the models, observational data are also used to assess model performance. In order to assess modelled runoff, monthly river discharge data is utilised, provided by the Global Runoff Data Centre (GRDC). To assess the modelled snow water equivalent (SWE), two independent EO data-sets were utilised: the passive microwave SSM/I (Special Sensor Microwave/Imager), and Globsnow which is a combination of EO and ground data. Comparisons are made at monthly and yearly timescales on a 1 degree grid and at river basin scales.

At the one degree scale modelled SWE are in good agreement showing similar patterns and magnitudes at monthly scales. Most of the striking differences can be traced to the precipitation drivers, notably, in Alaska and Quebec\Labrador. Both Globsnow and SSM/I are in broad agreement with modelled SWE with regard to timings and Globsnow is also in good agreement with the modelled SWE magnitude but SSM/I consistently underestimates SWE magnitude. This is mainly due to saturation of the product.

Five of the largest northern basins were considered to evaluate runoff: Mackenzie, Yenisey, Lena, Ob and Khatanga. Monthly timings of runoff were in reasonable agreement with an early bias for the models. This was to be expected as the time taken for runoff to reach the river mouth from each model grid cell was not modelled. Inter-annual differences were well accounted for by the models but there was a large range in magnitudes mainly due to the difference in precipitation drivers.