

Towards the establishment of a drought monitoring and seasonal prediction system over Canada using the Variable Infiltration Capacity (VIC) hydrological model

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Abstract

Warming of the climate system is unequivocal. This unambiguous warning is clearly spelled out in the 21-page Summary for Policymakers released by the Intergovernmental Panel on Climate Change on 2 February 2007. Global warming would lead to more frequent extreme weather events, such as floods, droughts and heat waves. The establishment of an accurate and timely extreme event monitoring and prediction system is of prime importance for minimizing extreme weather damage.

A drought monitoring and seasonal prediction system is being developed for the Liard Basin, a sub-basin of the Mackenzie River Basin. Presently, the system uses the Variable Infiltration Capacity (VIC) land surface macroscale hydrology model driven by observed and forecast maximum and minimum air temperatures and precipitation to simulate daily soil moisture values starting from 1 January, 1951 up to the present. The simulated soil moisture values are used to calculate a soil moisture index for agricultural and hydrological drought severity. The drought monitoring component of the system comprises two modules: a 55-yr retrospective soil moisture climatology in the top 1-m layer from VIC, and a real time drought monitoring module using the operational Canadian GEM (Global Environmental Multiscale) model daily output for driving the VIC model. These modules have already been implemented over China. We plan to develop a seasonal drought prediction scheme for Canada with a focus on the Prairie regions, in collaboration with the seasonal Historical Forecast Project team.

The Liard Basin drains an area of 275,000 km² and is a sub-basin of the Western Canada Sedimentary Basin that straddles the Northwest and Yukon Territories boundary with the Province of British Columbia. The Liard River joins the Mackenzie River at Fort Simpson and is a major tributary of the Mackenzie River system. The VIC model is

applied over a grid of 2,800 points with a resolution of $1/8$ degree \times $1/8$ degree. Using the observed maximum and minimum air temperatures and precipitation, the VIC model is first calibrated and validated with daily hydrographs at Fort Simpson for the period 1 January, 1975 to December 31, 2001; calibrated VIC is then used to re-construct daily soil moisture values for the period 1 January, 1951 to 31 December, 2005. VIC performs well over both calibration and validation periods. The calculated soil moisture index explains well most documented drought events in the Liard Basin over the past 55 years. The real time drought monitoring is achieved by updating the soil moisture index fields every 24 hours with the lead time up to 10 days.