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Topographic cause of accumulation of methane lakes near the north pole of Titan

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Most hydrocarbon lakes on Titan are currently located near the north pole. Previously, seasonal asymmetry in Titan's climate caused by Saturn's orbital eccentricity was proposed as a possible cause of the asymmetric lake distribution. However, climate studies of other planets indicate that such seasonal asymmetry can also be caused by a hemispheric asymmetry in geography such as the ocean-continent distribution or topography. A global climate model is used to investigate whether orbital forcing or hemispheric asymmetry in geography is more important for the seasonal asymmetry in Titan's climate and distribution of polar deposits of methane. In the absence of geographic variability, orbital forcing causes a slight hemispheric asymmetry in the polar annual precipitation minus evaporation, which changes from epoch to epoch. If instead the observed geography is taken into account in the climate simulation, the annual precipitation minus evaporation becomes substantially more asymmetric in favour of the north polar region and is barely sensitive to orbital parameter changes. This asymmetry can be explained by the hemispheric difference in the latitudinal gradient of topography at high latitudes. The steep latitudinal slope near 60°S and deep basin around the south pole induce an additional atmospheric circulation near the south pole, which acts to transport dry air from the upper troposphere downward and thereby reduces the precipitation in summer relative to the north pole. The concentration of Titan's lakes near the north pole could therefore be a semi-permanent feature that resists the Croll-Milankovitch cycle.