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# Two parameters are required for a Budyko function to describe the land-atmosphere interaction

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While the Budyko framework has been a simple and convenient tool to assess runoff (Q) responses to climatic and surface changes, it has been unclear how parameters of a Budyko function represent the vertical land-atmosphere interactions. Here, we explicitly derived a two-parameter equation by correcting a boundary condition of the Budyko hypothesis. The correction enabled for the Budyko function to reflect the evaporative demand ($E_p$) that actively responds to soil moisture deficiency. The derived two-parameter function suggests that four physical variables control surface runoff; namely, precipitation (P), potential evaporation ($E_p$), wet-environment evaporation ($E_w$), and the catchment properties (n). We linked the derived Budyko function to a definitive complementary evaporation principle, and assessed the relative elasticities of Q to climatic and land surface changes. Results showed that P is the primary control of runoff changes in most of river basins across the world, but its importance declined with climatological aridity. In arid river basins, the catchment properties play a major role in changing runoff, while changes in $E_p$ and $E_w$ seem to exert minor influences on Q changes. It was also found that the two-parameter Budyko function can capture unusual negative correlation between the mean annual Q and $E_p$. This work suggests that at least two parameters are required for a Budyko function to properly describe the vertical interactions between the land and the atmosphere.