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A hydrochemical modelling framework for combined assessment of spatial and temporal variability in stream chemistry: application to Plynlimon, Wales

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Abstract. Recent concern about the risk to biota from acidification in upland areas, due to air pollution and land-use change (such as the planting of coniferous forests), has generated a need to model catchment hydro-chemistry to assess environmental risk and define protection strategies. Previous approaches have tended to concentrate on quantifying either spatial variability at a regional scale or temporal variability at a given location. However, to protect biota from 'acid episodes', an assessment of both temporal and spatial variability of stream chemistry is required at a catchment scale. In addition, quantification of temporal variability needs to represent both episodic event response and long term variability caused by deposition and/or land-use change. Both spatial and temporal variability in streamwater chemistry are considered in a new modelling methodology based on application to the Plynlimon catchments, central Wales. A two-component End-Member Mixing Analysis (EMMA) is used whereby low and high flow chemistry are taken to represent 'groundwater' and 'soil water' end-members. The conventional EMMA method is extended to incorporate spatial variability in the two end-members across the catchments by quantifying the Acid Neutralisation Capacity (ANC) of each in terms of a statistical distribution. These are then input as stochastic variables to a two-component mixing model, thereby accounting for variability of ANC both spatially and temporally. The model is coupled to a long-term acidification model (MAGIC) to predict the evolution of the end members and, hence, the response to future scenarios. The results can be plotted as a function of time and space, which enables better assessment of the likely effects of pollution deposition or land-use changes in the future on the stream chemistry than current methods which use catchment average values. The model is also a useful basis for further research into linkage between hydrochemistry and intra-catchment biological diversity.

Keywords: hydrochemistry, End-Member Mixing Analysis (EMMA), uplands, acidification

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