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Coupling Complex Physical Environmental Process Models with Specific Question-driven Ecological Models

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Abstract: Specific question-driven ecological models often require representation of general physical environmental processes for which complex, widely-accepted meteorological, hydrological, and oceanographic models are available. Although conceptual coupling of physical environmental and ecological models is straightforward, computational linkages often pose insurmountable problems to ecological modelers with limited access to software engineering expertise. Establishing an ongoing dialogue during the course of a simulation between georeferenced physical environmental models and spatially-explicit ecological models can be particularly problematic. We describe a general coupling framework that allows for a modular structure through an intermediate layer between the existing physical models and the custom-written spatially-explicit ecological models. We demonstrate the applicability of this general framework by computationally linking HYSPLIT with a spatially-explicit ecological model implemented in NetLogo. HYSPLIT is a widely-used complex meteorological model whose applications include simulation of air particle transport, dispersion, and deposition. With reference to ecological applications, the “air particles” can represent air-borne insects such as aphids. NetLogo is a popular programming platform for spatially-explicit, individual-based ecological modelling which we have coupled with HYSPLIT to simulate regional aphid population growth and spread. We describe a custom-written program that facilitates an ongoing dialogue between these two models. The dialogue takes place along a temporal scale, on a daily basis, for a period of time constrained only by the study objective. The program should be readily adaptable to coupling other sets of physical environmental and ecological models with adjustments for the used programming language and the specificity of the input/output files.

***Keywords**:* HYSPLIT; Model integration; NetLogo; Physical environmental model; Spatially-explicit individual-based model