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AgDRIFT®: A MODEL FOR ESTIMATING NEAR-FIELD SPRAY DRIFT FROM AERIAL APPLICATIONS

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Abstract—The aerial spray prediction model AgDRIFT® embodies the computational engine found in the near-wake Lagrangian model AGricultural DISPersal (AGDISP) but with several important features added that improve the speed and accuracy of its predictions. This article summarizes those changes, describes the overall analytical approach to the model, and details model implementation, application, limits, and computational utilities.

Keywords—Spray model Lagrangian Drift Deposition Aerial application

INTRODUCTION

Drift of pesticides from the target site during aerial spray applications is a source of environmental concern due to its potential human health impacts, downwind contamination and damage to crops and livestock, and endangerment of ecological resources. The Spray Drift Task Force, a coalition of agricultural chemical companies, has gathered field and laboratory data based on the assumption that pesticide drift is primarily a function of environmental conditions, physical properties of the spray solution, and application equipment configuration and not of the active ingredient per se [1]. The sensitivity of drift to numerous factors, including atmospheric conditions [2–6] and application equipment [6–8], makes field testing the full range of possible meteorological and application scenarios difficult. Modeling provides a coherent framework for evaluating the potential risks of spray operations and the potential effectiveness of possible mitigation options. Both the Spray Drift Task Force and the U.S. Environmental Protection Agency's Office of Pesticide Programs strongly felt that a spray drift modeling tool supported by input databases and postprocessing toolbox utilities would improve both the efficiency and reliability of the pesticide product evaluation and registration process. AgDRIFT® (Stewart Agricultural Research Services, Macon, MO, USA) is the realization of this joint vision of a spray drift assessment tool suitable for use in the regulatory arena.

A number of models have been developed to predict the drift and deposition from aerial spray applications [9–18]. These aerial spray models fall into two general categories—empirical and mechanistic. The empirical models [9,10] do not take into account any physical basis for spray drift and are generally applicable only to situations very similar to those for which they were developed. The ideal model for evaluating off-site movement of pesticides, setting buffer zones around sensitive areas, and determining effectiveness of mitigation options needs to include mechanistic descriptions of important processes such as gravitational acceleration, air resistance, droplet evaporation, and mode of application.

Simple mechanistic models developed for evaluation of spray generally fall into two categories based on the mathematical approach to turbulent mixing, i.e., Gaussian dispersion equations and particle tracking models (Lagrangian particle trajectory) [19]. Gaussian modeling [11,14,16,17] is a classical approach used in atmospheric dispersion modeling of releases from tall stacks and line, area, and volume sources and is well suited for modeling moderately long-range drift (0.5–10 km) and simulating the effects of atmospheric stability. However, the Gaussian approach does not provide much resolution in the representation of equipment and near-field dynamics in the flow field near the aircraft. Lagrangian models [12,15,18], on the other hand, track a cohort of droplets in a given drop size category and overlay a random component on the movement of the droplets to account for atmospheric turbulence. The Lagrangian approach lends itself to detailed modeling of the effects of application equipment on spray dispersal and thus, as an approach, most effectively meets the needs for a regulatory assessment tool that can be used to evaluate the mitigating effects of alternative equipment uses and near-field buffer zones.

The real power of the model presented here lies in its relative simplicity. AgDRIFT does not employ a full-physics Navier–Stokes approach but instead incorporates a much simpler method that yields high correlations with observed deposition. This simplicity is very desirable in a regulatory context and lends itself to wide use and consistent results.

The AGDISP model [12] forms the computational engine of AgDRIFT. The AGDISP is based on a Lagrangian approach to the solution of the spray material equations of motion and includes simplified models for the effects of the aircraft wake and aircraft-generated and ambient turbulence. Reed [20] first developed the equations of motion for spray material released

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