8.9 COMPARISON OF PHOTOSYNTHESIS AND NON-PHOTOSYNTHESIS BASED CANOPY RESISTANCE FORMULATIONS FOR ESTIMATING DEPOSITION VELOCITY IN NUMERICAL MODELS

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We present results comparing the deposition velocity estimates for use in air pollution models via three different canopy resistance formulations. These formulations are: Wesely's scheme as in RADM, Pleim - Xiu based Jarvis scheme as in MM5 coupled with RADM, and a photosynthesis based gas exchange scheme GEM coupled with MM5. The three approaches differ in their representation of the vegetation-atmosphere interactions. Gas deposition velocity (Vd) is then calculated using an electrical resistance-analog approach in a coupled soil-vegetation-atmosphere transfer (SVAT) model coupled with the MM5 modeling system. In the first part of this study, we present coupled 1D model results, with episodic field validations for ozone deposition velocity estimates over different agricultural landscapes (over a soybean field C3 photosynthesis pathway; and a corn field C4 photosynthesis pathway). Overall, observed Vd and modeled Vd show good qualitative and quantitative agreement. Results suggest that photosynthesis-based physiological approaches can be adopted to efficiently develop deposition velocity estimates over natural surfaces. The nonphotosynthesis approach lacked the dynamic variability even though the resistance scheme is fully coupled within a SVAT module. Further, the non-photosynthesis schemes were very sensitive to the minimum stomatal resistance prescription, which is a difficult variable to realistically estimate. The photosynthesis approach, though more generalized, posed problems for simulating deposition velocity estimates for drought conditions or for dry vegetation canopy. In the second part we have performed 3D simulations with MM5 modeling system to study the impact of the three different formulations on the simulated surface and boundary layer fields. We also present intercomparison of the deposition velocity fields from the three methods over eastern US.

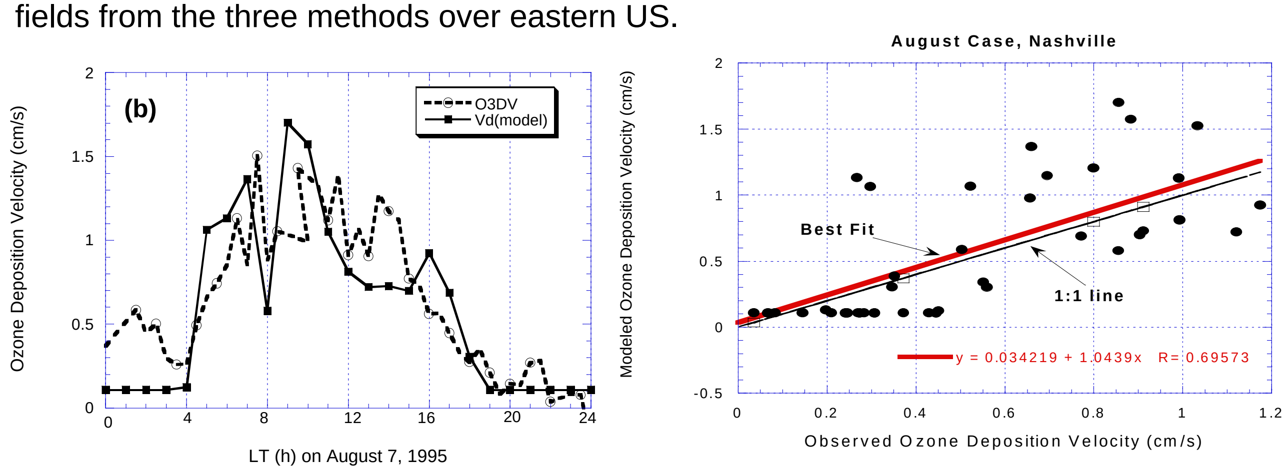

Fig. 1 Observed and a photosynthesis model based ozone deposition velocity over a fully grown agricultural field.

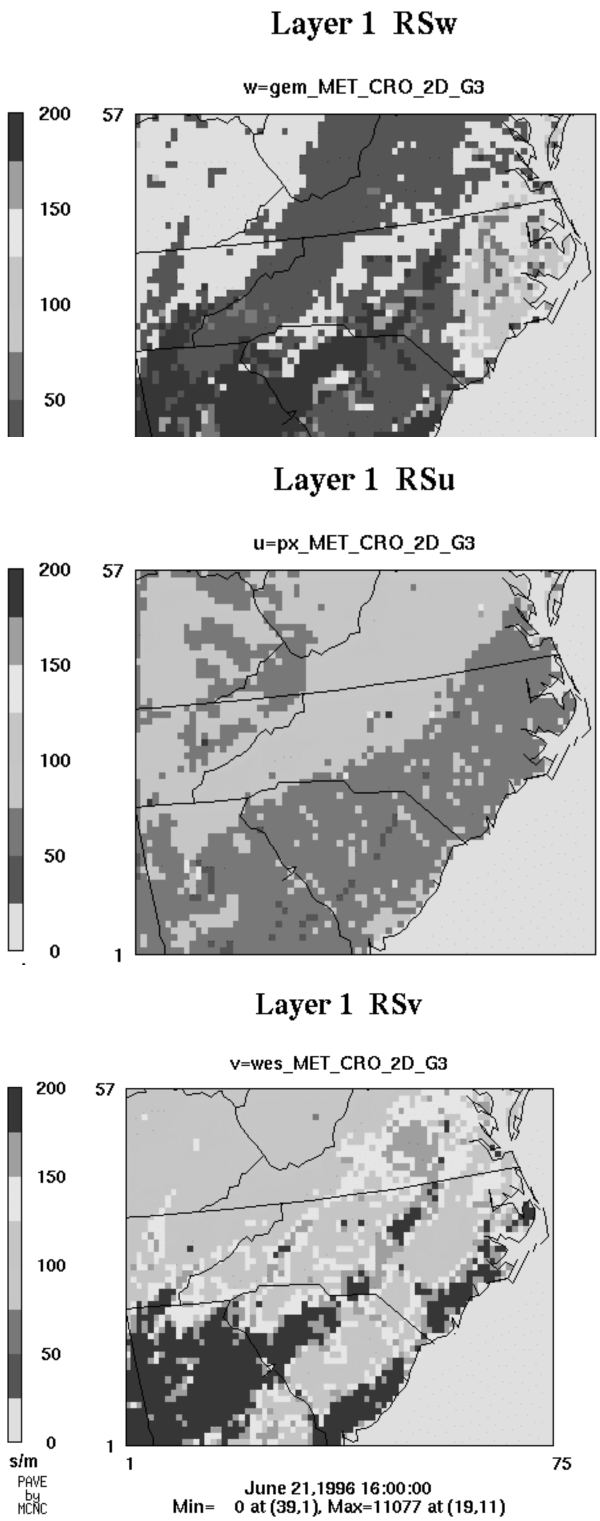

Fig. 2 Modeled canopy resistance (Rc), which is a dominant term for estimating deposition velocity using (a) photosynthesis based scheme; (b) Jarvis-type scheme; and (c) Simple Radiation based scheme.