Atmos. Chem. Phys. Discuss., 3, S520–S525, 2003
www.atmos-chem-phys.org/acpd/3/S520/

Interactive comment on "A revised parameterization for gaseous dry deposition in air-quality models" *by* L. Zhang, J. R. Brook, and R. Vet

L. Zhang, J. R. Brook, and R. Vet

Received and published: 9 May 2003

Specific comments:

Page 1778 line 9: We will change 'leaf-stomatal-resistance model' into 'two-big-leaf stomatal resistance sub-model' to avoid confusion. Other models that can be used to calculate stomatal resistance include: simple parameterization as a function of solar radiation and some other LUC specified parameters, one- or two-big-leaf models, multi-layer models. Some discussion on this issue can be found in the Introduction (Page 1779).

Page 1781 line 17: The reviewer is right in that uncertainties can be large in stable conditions. We have some detailed discussion on the uncertainties of Ra and Rb in Zhang et al. (2003) and we do not want to repeat in this paper. We will revise the text to reflect the reviewer's point.

Page 1781 line 19: The equations follow Zhang et al. (2002b). It is also similar to many other existing models, though slightly different. We will add one reference in the revised paper.

Page 1782 line 18: We will make changes according to the reviewer's comments in the revised paper.

Page 1783 equation 6f: Different formulas exist for calculating water stress effects on stomatal resistance. We agree that explicitly including soil moisture in the formula of stomatal resistance is more appropriate than just including solar radiation. However, we chose not to include soil moisture at this time because soil moisture is often not available in most air-quality models and we do not have LUC-specific information on the soil moisture effects on stomatal resistance. Having said this, we recognize that Wesely (2001) (Report to USEPA), in his model developed for USEPA ISC3, did use a formula that included soil moisture.

Page 1786 equation 8b: We have not found any references that distinguish soil resistance wetted by dew and rain except some discussions in our early study (Zhang et al., 2003). We added this reference for equation 8b.

Page 1787 line 11: An upper limit of 2 is specified for the term exp[0.2(-1-T)]. We think that a factor of 2 is big enough to limit the deposition velocity within a reasonable range of observed values under low temperature conditions.

Page 1788 line 8: We will correct in the revised paper as suggested.

Page 1788 line 22: z0=0.000002 Uˆ2.5. This and other similar formulas can be found in the literature related to boundary layer meteorology and we do not plan to discuss the details in this paper.

Page 1789 line 8: We will add information on the site and the measurement data in the revised paper. Measured meteorological data, rather than GEM output, were used to produce the modeled Vd. Line 16: earlier models specified a constant cuticle resistance and soil resistance for dry and wet canopies and thus meteorological conditions (e.g., u*) were not explicitly considered. The only model that considers meteorological condition is Erisman et al. (1994) which includes RH in calculating cuticle resistance for O3, but not for SO2. Some of these discussions have been presented in Zhang et al. (2003) and we do not want to repeat here.

Figure 3 includes both dew and rain conditions. We do not separate dew and rain due to very small data set for SO2. Most daytime wet data were caused by rain while nighttime data could be caused either by dew or rain.

Page 1789 line 20: The reason we are so sure about the improvements over earlier model results over wet canopies is that the earlier models did not include meteorological conditions for cuticle resistance and did not provide a correct diurnal curve. We included discussions on this issue in our two earlier studies, Zhang et al. (2002b) and Zhang et al. (2003). Since this reviewer and the other reviewer both suggested to add a comparison with earlier model results, we decided to add the results from our own earlier model (Zhang et al. 2002a) for wet canopies. Results for dry canopies do not differ much, especially during daytime when stomatal uptake dominates.

Page 1790 line 14: Most of these values are based on the data we have. For example, In figure 3 of Zhang et al. (2002b), u* can be larger than 1.1 m sˆ-1 over forest area and around 0.7 m sˆ-1 over short vegetation. That figure did not include all data (we excluded a small percentage of data with extreme values). By looking at all data, we found u* over forests can be as high as 1.5 m sˆ-1 over forests and 0.8 m sˆ-1 over short vegetation. Since we are trying to get the maximum (or very close to the maximum Vd), we thus used the upper limit of u* that has been observed. We will mention this point in the text.

Page 1790 line 28, In the present study, we tried to present important and really necessary information so the reader can reproduce the model if they want to. So, for model results, we choose only to present the most important results, which certainly can not cover all situations. Readers can get some ideas of maximum Vd under wet conditions by comparing values presented in Figure 5 under dry and wet conditions and then compare again with values presented in Table 2. We chose to present 9 most commonly considered species, since we think readers can get approximate Vd values of other species by comparing the scaling parameters presented in Table 1 of Zhang et al. (2002a). Based on this reviewerąŕs suggestion, we can certainly extend Table 2 to include all 31 species and also provide values for wet canopies in the revised paper.

Page 1790 line 29: We will modify these sentences based on the reviewerąŕs suggestion. It is true that we can expect large Vd under certain conditions based on the equations presented in the paper. We also believe that values in Table 2 do represent maximum possible Vd, or very close to possible maximum Vd.

Page 1791 line 22: Most values presented in Figure 4 are median (or close to median) values of the data we have. For those LUC that we do not have any data, we compare the relative roughness length with those land types that we have data. We will add this explanation to the text.

Page 1792 line 4: We will add example LUC in the revised paper.

Page 1792 line 5: Based on our earlier studies, we believe wetness increases the SO2 Vd more for vegetated surfaces than non-vegetated surfaces. The model is then constructed to give such results. For O3, wetness increases cuticle uptake, but possibly decreases stomatal uptake due to the stomatal blocking as explained in details in Zhang et al. (2002b). We will replace Figure 5 by a table and also add wet night conditions based on the reviewerąŕs suggestions.

Page 1793 line 7: As mentioned above, we will add some results from our earlier models for wet canopies.

Page 1793 line 18: More recently, studies (most in Europe) found that the flux based

ACPD
3, S520–S525, 2003

Full Screen / Esc
Print Version
Interactive Discussion
Discussion Paper

approach is more sutiable than the traditional AOT40 index. We had mentioned this in Zhang et al. (2002b). We can add a little bit more text here based on the reviewer's comment.

Technical corrections:

We will address all technical corrections in the revised paper. We thank the reviewer for his/her careful review and suggestions for improvement. Following are answers to some further questions listed by the review.

Regarding the differences of some equations and parameters between the present paper and Brook et al. (1999): equation (22b) of Brook et al. (1999) has a typing error: division '/' should be a multiplication '*'. Unit in that equation is also different from the one used here. In the present study, we try to use units that are most common. For example, for water vapor, we use MPa in the present study while in Brook et al. (1999) we used meter of water which followed Sellers et al. (1996). Also bvpd in Table 3 of Brook et al. (1999) were not correctly presented, all values should be multiplied by 100.

References for rsmin include: Our model tests show that 250 s mˆ-1 is too big and the model produces Vd values that are too small. As pointed out by this reviewer, the model gives Vd values that are not large enough even though we use a value of 150 s mˆ-1. A French group at INRA also found that their model (modified from Wesely; 1989) gives too small Vd values when using 250 s mˆ-1 for tropical forest. We think 150 s mˆ-1 is more appropriate for this LUC. For crops, some references use 40 s mˆ-1 for wheat, but substantially higher for other crops. We chose rsmin values that give best results compared to published Vd and also within a reasonable range of known rsmin values.

References for z0: Same answer for z0 as for rsmin. We chose a value for tropical forest that was within a reasonable range of published values (e.g., summary of z0 in Pielke 1984: Mesoscale Numerical Modelling) and also give reasonable u* and Ra values.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 1777, 2003.