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Comment

Interactive comment on "Inter-comparison of ammonia fluxes obtained using the relaxed eddy accumulation technique" *by* A. Hensen et al.

Anonymous Referee #2

Received and published: 31 October 2008

General Comments: The paper details an inter-comparison of four relaxed eddy accumulation (REA) systems to measure ammonia flux with an aerodynamic gradient method (AGM) used as an independent reference. The authors focus on the robustness of the REA techniques while analysis and discussion of ammonia fluxes are addressed in companion papers (as listed in footnotes). Quantification of ammonia flux using the REA technique requires consideration of both theoretical and practical issues. The authors appropriately address such issues as beta coefficient determination, deadband implementation, and detector specifications. This reviewer had initial questions concerning the individual analytical methods utilized by each REA system. Most questions were subsequently answered in latter portions of the paper. The authors should give some consideration to reorganizing the Materials and Methods section to

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improve the flow of the paper. After the initial discussion of REA theory and site description, the REA systems (and their specifications) should be introduced individually within separate subsections. Discussing each REA system entirely within four subsections would provide a clearer depiction of individual system specifications. Additionally, such a restructured section would better complement Table 1 and Figure 1.

The acronyms used by the authors to identify the REA systems are not consistent throughout the paper. For example, the ECN is referred to as ECN, ECN REA, and REA-ECN The authors should select a single acronym for each REA system and use such in the text and accompanying figures/tables.

Specific Comments: Page 3968 Line 22: The addition of references for REA application on aircraft and in urban areas would be beneficial for interested readers. The literature lists previous airborne REA measurements of VOCs (Zhu et al., 1999) and isoprene (Delon et al., 2000). However, REA application in urban areas is admittedly less well-documented. Lines 23-24: NH3's adsorptive properties are a direct result of its polarity. The authors should consider providing a brief explanation of this, especially as a lead in to the next sentence concerning NH3's source/sink relationship with H2O covered surfaces. Page 3969 Line 12: Quantify the approximate uncertainty range in the flux estimates. Page 3971 Equation 3: Define all variables. Clarify the use of b0=0.4 and b1=1.9 (specifically for the coefficient for T since other variables may be utilized). Lines 16-17: Although Sutton et al., 2008 provides detailed site characteristics, this paper should list some key details (e.g. type of fertilizer application, vegetation height pre- and post-cutting) that are relevant to flux measurements but can be included in a concise manner. Page 3977 Line 4: Reference to CEH/UMIST usage throughout the campaign is at odds with Sec. 2.2 (page 3971) where experimental period is listed as 21 May-15 June. From Table 2, CEH/UMIST ran from 25 May -14 June. Line 11: The ECN and RISOE deadbands are specifically mentioned, but the CEH/UMIST deadband is not. Is it due to CEH/UMIST's larger sample flow rate? Page 3978 Line 4: Is there a technical issue that caused the 15% difference for ECN in upward versus downward

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channels during reference measurements? Line 7: Were relative differences variable for FAL and RISOE? Line 15: r2 values in Fig. 3 range from 0.66-0.79. Why the discrepancy? Page 3979 Lines 12-14: The RISOE and ECN data have small changes in slope due to the correction factor, but the change in r2 is considerable, especially for ECN (0.11 increase). Line 17: The improvement for CEH and ECN data is substantial, but not necessarily proven significant unless statistically tested. Page 3982 Lines 6-8: Earlier in the manuscript, the fertilization date is listed as 5 June. However, these lines refer to the first day after fertilization as 5 June. Which is correct?

Technical Corrections: Page 3967 Line 2: Identify chemical symbol at first use, i.e. exchange of ammonia (NH3); Line 9-10: Consider revising for clarification, i.e. before and after both cutting and fertilizing. Line 22: Consider using adsorptive instead of sticky. Page 3969 Line 6: Delete comma between EC and measurements. Line 7: Delete one use. Line 15: Remove Sutton et al. from the parenthetical reference and place in a sentence such as An overview is given by Sutton et al. (2008). Page 3970 Line 6: Reword to avoid double use of given. Line 6: Remove redundancy of see and e.g. Line 14: Replace e.g. with ~. Lines 18-19: Place derived from fast response measurement of w' in parentheses. Page 3971 Line 2: Show equation for beta calculation from H. Line 12: Check accuracy of coordinates with Sutton et al., 2008. Line 14: Replace second the with a. Page 3972 Line 18 and in other places: Check consistency of chemical symbol or chemical name usage. Preferably use both at first use. Page 3973 Line 10: Add ; or , and between distortion and the air flow. Line 27: Add s to system. Page 3974 Line 1: Ortho prefix for phthaldialdehyde should be lower case letter o. Looks like number 0. Line 9: Change to in a 10 min period. Line 24: Instead of in the end of the field campaign use at (near) the end. Page 3975 Line 8: Separate updraft and downdraft equation into 4a & 4b or 4 & 5. Line 8: Include reference(s) for equations. Line 17: Change moving to dynamic. Page 3977 Line 11: Delete , after ECN. Line 23: Instead of using Eq. (4) using a linear write using Eq. (4) with a linear. Page 3979 Line 5: Change is to are to agree with plural results. Line 9: Add reference to Table 4. Page 3982 Line 2: Delete s from seems. Page 3983 Line 11: Add +; indicator for pos-

itive charge on NH4+. Page 3987 Line 2: Consider using adsorptive instead of sticky. Page 3992 Table 1: List reference modes for FAL and RISOE, possibly with footnotes. Page 3993 Table 2: REA System, though not the header for the first column, is listed as such. Table 2: Superscript 1 in unit for u*. Page 3994 Table is not numbered. I assume it should be Table 3. Table 3: Add - to m-3. Table 3: Add . after No. Page 3995 Change number to Table 4. Table 4: Add decimal to 0.74 on 8th row, 3rd column. Page 3996 Figure 1: Change and CEH/UMIST to , CEH/UMIST. Page 3997 Figure 2: Add markers on each plot denoting 5 June (fertilization date). Page 3998 Figure 3: System names should appear in bold type and possibly in upper right corners of plots to be more noticeable.

References Delon, C., Druilhet, A., Delmas, R. and Greenberg, J.: Aircraft assessment of trace compound fluxes in the atmosphere with Relaxed Eddy Accumulation: Sensitivity to the conditions of selection, J. Geophys. Res., 105(D16), 20,461/20,472, 2000.

Zhu, T., Wang, D., Desjardins, R.L., and Macpherson, J.I.: Aircraft-based volatile organic compounds flux measurements with relaxed eddy accumulation, Atmos. Environ., doi:10.1016/S1352-2310(98)00098-3.

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