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Biogeosciences Discussions

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

Anonymous Referee #1

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General comments

This paper provides a unique intercomparison of 4 REA systems for NH3, showing mixed results. The comparison is a useful exercise, and the characteristics, performances, pros and cons of each system are compared adequately and with enough detail, without over-elaborating unnecessarily.

Some REA flux measurements can be convincing when compared with the AGM, but the overall impression is that such systems are unlikely ever to be used successfully to measure vertical flux divergence, which is stated as the main objective and motivator for developing REA systems.

One problem in the interpretation of results is that the AGM flux is used throughout as

a "reference" for intercomparison with the REA: to what extent should the REA actually agree with the AGM, given that there may be significant vertical flux divergences and that ideally the purpose of developing REAs is precisely to quantify this vertical flux divergence? There is potentially a problem of logic here. Perhaps the term "reference" is slightly misleading as it implies that the AGM provides the "true" flux. Also, REA fluxes were measured at different zREA heights (between 1 and 2 m) above ground, but they are all compared with a common AGM flux, which results from concentration measurements at different heights (and thus different footprints). Thus, if there is a vertical flux divergence then there cannot be an agreement of ALL REA systems with one common reference. Please comment.

All REA datasets do show a deviation from the AGM at one point or another over the course of the experiment, which might be interpreted as a sign of vertical divergence, but the problem is that their divergences with respect to the AGM are not always mutually compatible (e.g. one may over-estimate while the other may under-estimate, etc...) and may be a result of sampling biases and lack of analytical precision and stability. While the discussion and conclusion make these points adequately, the abstract is rather optimistic with respect to the applicability of the REA technique for quantifying vertical NH3 flux divergence in the future.

Specific Comments

p 3972, line 19, is the liquid flow rate of NaHSO4 really 1 l/min i.e. 60 l/hr, or rather 1 ml/min? Table 1 gives 0.8 l/min as the liquid flow for the CEH/UMIST system. Please check.

p 3973, line 12: "...32 mm diameter tube as inlet close to the sonic anemometer that splits into two sample tubes..." : Fig.1 does not show this, rather 2 parallel tubes all the way, one for each up- and downdrafts, thus more prone to potential sample biases.

p 3974, line 26: "the NH3 concentrations should be equal..."

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p 3975, section 2.3.4: in the CEH/UMIST system the small deadband of w’<0.05ms-1 resulted in only a small fraction of time being spent on the deadband and thus this was deactivated. However the ECN used the same deadband (w’<0.05ms-1) (see line 17) but did sample into a third denuder. Presumably the time spent on deadband must have been identical to that in CEH/UMIST, so why the difference in approach (implementation vs. non-implementation of a deadband) ?

p3976, lines 25-13, and Fig.2: why are AGM and REA concentrations compared at 4 different heights (zREA) rather than at one common reference height i.e. zRef= 1m above d? All that is required is to apply Eq.5 not to C(AGM) but to C(REA), scaling from zREA down to 1m using REAflux. This would allow for a better comparability of concentration levels between the 4 REA systems.

p3977, line 21, section 3.3: Why call this "auto"-reference mode? This was called "reference mode sampling" in Section 2.33, but also called "auto-referencing" in the abstract, and "auto-calibration" on p 2984, line 23. What is the meaning of "auto", i.e. do the authors mean that this is an automated/automatic system, or a self-referencing system?

p3978, line 4: a systematic difference of 15% between up- and downdrafts in the reference mode seems rather alarming, even if this can be corrected for. The text does not specify whether the down-channel over- or under-estimated relative to the up-channel, and no explanation is offered for the phenomenon.

p 3979 and Table 4: the authors first compare "unselected" REA fluxes with AGM data, and then filter flux data for "proper micrometeorological conditions" (optimal fetch and u>1 ms-1) to show that the agreement is better. However, flux data that do not satisfy basic micrometerological requirements such as fetch, turbulence and a well developed surface turbulent layer should not be displayed in the first place, and the comparison between REA and AGM should only take place for adequately selected (filtered) flux data. The text does not say whether the data shown on fig.4 and fig.5 are selected or

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unselected data, but they must contain micrometeorologically suitable fluxes only.

p 3981, line 20: could the large bias of 30% be due to differences in T or RH between up and downdrafts in very warm and presumably dry conditions, leading to different evaporation rates of the stripping solution and different capture efficiencies in the 2 denuders?

p 3982, line 8-9, and rest of the paragraph: if the micromet / fetch conditions are unsuitable for flux measurements then these fluxes should be discarded (see comment above) for both AGM and REA. The authors seek explanations in the analytical procedures for the difference in flux between REA and AGM, but if fetch or stability are a problem ("low windspeed from the east") then there could be differences in footprints of the AGM and the four REA systems (measuring at different heights). Also, errors due to advection are likely to be greatest on the first day after fertilising, and advection errors will also be height-dependent, and therefore measurement system-dependent. Again, either the fluxes satisfy micrometeorologiocal requirements, or they don’t, in which case there is no case for arguing about differences between systems.

p 3982, line 25: "the AGM flux estimates might actually show levels that are too high" : compared with what reference flux?

p 3984, paragraph 4.3.2 on sampling height: these are theoretical considerations, but in practice could these explain observed differences between the REA systems during the experiment? Please comment.

p3984, line 23: do the authors mean "reference sampling mode"? (see comment above). My understanding is that this is not a "calibration" mode (there are no reference concentration standards applied). "Auto-calibration" should probably not be used in this context and paragraph.

Typographical or language errors

p 3970, line 10: "...leads to the fast instrument response times BEING necessary..."

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p 3970, line 20, "...estimated from measurements of fluxes OF other scalars..."

p 3971, line 18: "...other details of SITE conditions..."

p 3974, line 24 "operateD"

p 3994, the table header is missing (Table 3...)

p 3995, Table 3 is Table 4

p 3981, line 23: "the REA fluxes ... agree (no S) remarkably well"

p 3982, line 2: "seem (no S) to show.."

p 3983, line 7: "time delay" rather than "delay-time"

p 3984, line 3: an inlet cannot be "fast", but it can be "long" or "short" or "thin"...

Interactive comment on Biogeosciences Discuss., 5, 3965, 2008.