

VU Research Portal

Methods for observation and quantification of trace gas emissions from diffuse sources

Hensen, A.

2012

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Hensen, A. (2012). *Methods for observation and quantification of trace gas emissions from diffuse sources*. Ipskam Drukkerij.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl

Bibliography

- Ammann, C., and Meixner, F., 2002: Stability dependence of the relaxed eddy accumulation coefficient for various scalar quantities, *J. Geophys. Res.*, 107(D8), 4071, doi:10.1029/2001JD000649.
- Amon, B., Amon, Th., Boxberger, J., 2001: Alt, C., Emissions of NH₃, N₂O and CH₄ from dairy cows housed in a farmyard manure tying stall (Housing, manure storage, manure spreading). *Nutrient Cycling in Agro ecosystems* 60, 103-113.
- Amstel, A. van, Kroeze, C., van Eerd, M., Dumont, M., Both, D., 2003: National emissions of methane and nitrous oxide from agriculture in the Netherlands: current estimates and future trends. Workshop on Inventories and Projections of Greenhouse Gas and Ammonia Emissions from Agriculture. 27-28 February 2003, European Environmental Agency, Copenhagen.
- Andreas, E.L., Hill, A.J., Gosz, J.R., Moore, D.I., Otto, W.D. and Sarma, A.D., 1998: Stability dependence of the eddy-accumulation coefficients for momentum and scalars, *Boundary-layer Meteorol.*, 86, 409-420.
- Asman, W. A. H., 1992: Ammonia emission in Europe: updated emission and emission variations. Report 228471008, National Institute of Public Health and Environmental Protection (RIVM), Bilthoven, The Netherlands.
- Aubinet, M., Grelle A., Ibrom, A. et al. 2000: Estimates of the annual net carbon and water exchange of forests: The EUROFLUX methodology. *Advances in Ecological Research*, 30: 113-175.
- Baldocchi, D. D., 2003: Assessing the eddy covariance technique for evaluating carbon dioxide exchange rates of ecosystems: past, present and future. *Global Change Biology*, 9, 1-14.
- Bannink, A., Schijndel, M.W.van, Dijkstra, J., 2011: A model of enteric fermentation in dairy cows to estimate methane emission for the Dutch National Inventory Report using the IPCC Tier 3 Approach, *Animal Feed Science and Technology*.(in Press)
- Bergamaschi, P., C. Lubina, R. Königstedt, H. Fischer, A. C. Veltkamp, and O. Zwaagstra, 1998: Stable isotopic signatures ($\delta^{13}\text{C}$, δD) of methane from European landfill sites, *J. Geophys. Res.*, 103(D7), 8251–8265, doi:10.1029/98JD00105.
- Berkhout A.J.C., Hoff G.R. van der, Bergwerff J.B., Swart D.P.J., Hensen A., Kraai A., Bleeker A., Huijsmans J.F.M., Mosquera J., Pul W.A.J. van, 2008: Measuring ammonia emissions from manured fields, RIVM rapport 680150003
- Beusen, A.H.W., Bouwman, A.F., Heuberger P.S.C., Van Drecht G., Van Der Hoek K.W., 2008: Bottom-up uncertainty estimates of global ammonia emissions from global agricultural production systems. *Atmospheric Environment* 42, 6067– 6077.
- Börjesson, G., Samuelsson J., Chanton J., 2007: Methane oxidation in Swedish landfills quantified with the stable carbon isotope technique in combination with an optical method for emitted methane, *Environ. Sci. Technol.*, 41, 6684-6690.
- Blaha, D., Bartlett, K., Czepiel, P., Harris, R., Crill, P., 1999: Natural and anthropogenic methane sources in new England. *Atmospheric Environment* 33, 243–255.
- Blatter, A., Neftel, A., Dasgupta, P.K. and Simon P.K., 1993: A combined wet effluent denuder and mist chamber system for deposition measurements of NH₃, NH₄⁺, HNO₃ and NO₃⁻. Presented at the 6th European Symposium of Physico-Chemical behavior of atmospheric Pollutants, Varese, Italy.
- Bobbink, R., Boxman, D., Fremstad, E., Heil, G., Houdijk, A., Roelofs, J., 1992: Critical loads for nitrogen eutrophication of terrestrial and wetland ecosystems based upon changes in vegetation and fauna. In: Critical loads for nitrogen (Grennfelt, P. and Thörnölöf, E., eds.), pp. 41. Nordic Council of Ministers, Copenhagen.

- Bobrutzki, K. von, Braban, C. F., Famulari, D., Jones, S. K., Blackall, T., Smith, T. E. L., Blom, M., Coe, H., Gallagher, M., Ghalaieny, M., McGillen, M. R., Percival, C. J., Whitehead, J. D., Ellis, R., Murphy, J., Mohacsi, A., Junninen, H., Pogany, A., Rantanen, S., Sutton, M. A., and Nemitz, E., 2009: Field inter-comparison of eleven atmospheric ammonia measurement techniques, *Atmos. Meas. Tech. Discuss.*, 2, 1783-1836.
- Bogner, J., Meadows, M., Czepiel, P., 1997: Fluxes of methane between landfills and the atmosphere: natural and engineered controls. *Soil Use and Management* 13, 268–277.
- Bogner, J., and E. Matthews, 2003: Global methane emissions from landfills: New methodology and annual estimates 1980–1996, *Global Biogeochem. Cycles*, 17(2), 1065, doi:10.1029/2002GB001913.
- Bouwman, A. F., Lee, D. S., Asman, W. A. H., Dentener, J. F., van de Hoek, K. W., Olivier, J. J. G., 1997: A global emission inventory for ammonia. *Global Biogeochemical Cycles*, 11, 561-587.
- Breemen, N. van, Burrough, P.A., Velthorst, E.J., van Dobben, H.F., de Wit, T., Ridder, T.B., Reijnders, H.F.R., 1982: Soil acidification from ammonium sulphate in forest canopy throughfall. *Nature* 288, 548-550.
- Brink, H. M. ten, J. P. Veefkind, A. Waijers-Ijpelaan, and J. C. van der Hage, 1996: Aerosol light-scattering in the Netherlands, *Atmos. Environ.*, 30, 4251-4261.
- Burgerhart N., 2001: Mogelijkheden voor Koolstofopslag in Nederlandse ecosystemen. Rapport voor Staatsbosbeheer. WUR/NCP (in Dutch).
- Burkhardt J., Flechard C.R., Gresens F., Mattsson M., Jongejan, P.A.C., Erisman J.W., Weidinger T., Meszaros R., Nemitz E. and Sutton M.A., 2009: Modelling the dynamic chemical interactions of atmospheric ammonia with leaf surface wetness in a managed grassland canopy, *Biogeosciences*, 6, 67-83.
- Businger, J.A., and Oncley, S.P., 1990: Flux Measurements with Conditional Sampling. *J. Atmos. Oceanic Technol.* 7(2), 349-352.
- Bussink, D. W., Oenema O., 1998: Ammonia volatilization from dairy farming systems in temperate areas: a review. *Nutrient Cycling in Agroecosystems*, 51, 1352-2310.
- CEC (2006) Regulation (EC) 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC, 4 February 2006, Brussels, Belgium
- Coenen, P. W. H. G., Harmelen, A. K., Draaijers, G. P. J. and Van Grootveld, G., 2000: Emission Data for The Netherlands 1997 and Estimates for 1998, VROM, The Hague.
- Cole, J. J., Prairie, Y. T., Caraco, N. F., McDowell, W. H., Tranvik, L. J., Striegl, R. G., Duarte, C. M., Kortelainen, P., Downing, J. A., Middelburg, J. J., and Melack, J., 2007: Plumbing the global carbon cycle: Integrating inland waters into the terrestrial carbon budget, *Ecosystems*, 10,171–184.
- Coops, O., L. Luning, H. Oonk, and A. Weenk, 1995: Validation of landfill gas formation models, in *Proceedings Sardinia 95 Fifth International Landfill Symposium*, vol. I, edited by T. H. Christensen, R. Cossu, and R. Stegmann, pp. 635– 646, Environ. Sanit. Eng. Cent. (CISA), Univ. of Cagliari, Sardinia, Italy.
- Corré, W.J., 2002: Agricultural land use and emissions of methane and nitrous oxide in Europe. Report 40, Plant Research International, Wageningen.
- Crutzen P. J., Mosier A. R., Smith K. A., Winiwarter W., 2007: N₂O release from agro-biofuel production negates global warming reduction by replacing fossil fuels, *Atmos. Chem. Phys. Discuss.*, 7, 11191–11205.
- Crutzen, P. J., 1970: The influence of nitrogen oxides on the atmospheric ozone content, *Q. J. Roy. Meteor. Soc.*, 96, 320–325.
- Czepiel, P.M., Mosher, B., Crill, P.M., Harriss, R.C., 1996a: Quantifying the effect of oxidation on landfill methane emissions. *Journal of Geophysical Research* 101, 16721–16729.

- Czepiel, P. M., Mosher, B., Harriss, C., Shorter, J. H., McManus, J. B., Kolb, C. E., Allewine, E. and Lamb, B. K., 1996b: Landfill methane emissions measured by enclosure and atmospheric tracer methods, *J. Geophys. Res.* 101, 16711-16719.
- Czepiel, P.M., Shorter, J.H., Mosher, B., Allwine, E., McManus, J.B., Harriss, R.C., Kolb, C.E., Lamb, B.K., 2003: The influence of atmospheric pressure on landfill methane emissions. *Waste Management* 23, 593–598.
- Delon, C., Druilhet, A., Delmas, R. and Greenberg, J., 2000: 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.
- DelSontro, T., McGinnis, D. F., Sobek, S., Ostrovsky, I., and Wehrli, B., 2010: Extreme methane emissions from a Swiss hydropower reservoir: contribution from bubbling sediments, *Environ. Sci. Technol.*, 44, 2419–2425, doi:10.1021/es9031369.
- Demmers, T. G. M., Burgess, L. R., Short, J. L., Phillips, V. R., Clark, J. A., Wathes, C. M., 1999: Ammonia emissions from two mechanically ventilated UK livestock buildings. *Atmospheric Environment*, 33, 107-116.
- Denmead O.T., 1983, Micrometeorological methods for measuring gaseous losses of nitrogen in the field. In J.R. Freney and J.R. Simpson, editors, *Gaseous loss of nitrogen from plant-soil systems*. Martinus Nijhoff, The Hague, The Netherlands.
- Denmead, O.T., Raupach, M.R., 1993: Methods for measuring atmospheric gas transport in agricultural and forest systems. In: *Agricultural Ecosystem Effects on Trace Gases and Global Climate Change*.
- Denmead, O.T., 1995: Novel meteorological methods for measuring trace gas fluxes. *Phil. Trans. R. Soc. London Ser. A: Math. Phys. Sci.* 351, 383–396.
- Denmead, O.T., Harper, L.A., Freney, J.R., Griffith, D.W.T., Leuning, R., Sharpe, R.R., 1998: A mass balance method for non-intrusive measurements of surface–air trace gas exchange. *Atmos. Environ.* 32, 3679–3688.
- Denmead, O.T., Leuning, R., Griffith, D.W.T., Jamie, I.M., Esler, M.B., Harper, L.A., Freney, J.R., 2000: Verifying inventory predictions of animal methane emissions with meteorological measurements. *Boundary-Layer Meteorology* 96, 187–209.
- Desjardins R.L., Ph.D. Dissertation, Comcll University, 1972.
- Desjardins, R.L., Denmead O.T., Harper, L., McBain M., Masse´d D., Kaharabata S., 2004: Evaluation of a micrometeorological mass balance method employing an open-path laser for measuring methane emissions, *Atmospheric Environment* 38, 6855–6866
- Dirks, B.O.M. & J. Goudriaan J., 1994: Diurnal and seasonal CO₂ fluxes between grassland ecosystems and the atmospheric boundary layer in The Netherlands. Dutch National Research Programme on Global Air Pollution and Climate Change Report 410 100 043. Department of Theoretical Production Ecology, Wageningen Agricultural University, Wageningen.
- Döhler, H., Dämmgen, U., Berg, W., Bergschmidt, A., Brunsch, R., Eurich-Menden, B., Lüttich, M., Osterburg, B., 2002: Adaptation of the German emission calculation methodology to international guidelines, determination and forecasting of ammonia emissions from German agriculture, and scenarios for reducing them by 2010 (in German, summary in English), in print at Umweltbundesamt (Berlin).
- Dolman, A.J., E.J. Moors & J.A. Elbers, 2002: The carbon uptake of a mid latitude pine forest growing on sandy soil. *Agric. and Forest. Met.*, 111 (3): 157-170.
- Dolman A.J., Valentini R., Freibauer, A., 2008: The Continental-Scale Greenhouse Gas Balance of Europe, *Ecological studies*, Volume 203, 2008, DOI: 10.1007/978-0-387-76570-9

- Dore, C. J., Jones, B. M. R., Scholtens, R., Huis in'T Veld, J. W. H., Burgess, L. R., Phillips, V. R., 2004: Measuring ammonia emission rates from livestock buildings and manure stores - Part 2: Comparative demonstrations of three methods on the farm. *Atmospheric Environment*, 38, 3017-3024.
- EMEP Webdab emission data hosted by the Centre on Emission Inventories and Projections (CEIP): <http://www.ceip.at/>, last access: 20 August 2009.
- Emmeneger, L., Mohn, J., Sig, M., 2004: Measurement of ammonia emissions using various techniques in a comparative tunnel study. *Int. J. Environment and Pollution*. 22, 326-341.
- Erismann, J.W., Otjes, R., Hensen, A., Jongejan, P., van den Bulk, P., Khlystov, A., Möls, H., Slanina, S., 2001: Instrument development and application in studies and monitoring of ambient ammonia. *Atmos. Environ.* 35, 1913-1922.
- Erismann, J. W., Sutton, M. A., Galloway, J. N., Klimont, Z., and Winiwarter, W., 2008: 100 years of ammonia synthesis: how a single patent changed the world, *Nature Geosci.*, 1, 636–639.
- Eugster, W. and Senn, W., 1995: A Cospectral Correction Model for Measurement of Turbulent NO₂ Flux. *Boundary-Layer Meteorology*, 74(4): 321-340.
- Eugster W., DelSontro T. and Sobek S., 2011: Eddy covariance flux measurements confirm extreme CH₄ emissions from a Swiss hydropower reservoir and resolve their short-term variability, *Biogeosciences Discuss.*, 8, 5019–5055, 2011.
- Famulari, D., Fowler, D., Hargreaves, K., Milford, C., Sutton M.A., Nemitz, E. and Weston, K., 2004: Measuring eddy-covariance fluxes of ammonia using tunable diode laser absorption spectroscopy. *Water, Air and Soil Pollution Focus* 4 (6) 151-158.
- Fehsenfeld, F.C., Huey, L.G., Leibrock, E., Dissly, R., Williams, E., Ryerson, T.B., Norton, R., Sueper, D.T., Hartsell, B., 2002: Results from an informal intercomparison of ammonia measurement techniques. *J. Geophys. Res.* 107(D24), 20001JD001327.
- Fiore, A. M., West J. J., Horowitz L. W., Naik V., and Schwarzkopf M. D., 2008: Characterizing the tropospheric ozone response to methane emission controls and the benefits to climate and air quality, *J. Geophys. Res.*, 113, D08307, doi:10.1029/2007JD009162.
- Fischer, M. L. and Littlejohn, D., 2007: Ammonia at Blodgett Forest, Sierra Nevada, USA, *Atmos. Chem. Phys. Discuss.*, 7, 14139–14169.
- Flechar, C., Fowler, D., Sutton, M. A. and Cape J. N., 1999: A dynamic chemical model of bi-directional ammonia exchange between semi-natural vegetation and the atmosphere. *Quart. J. R. Met. Soc.* 125, 2611-2641.
- Flechar, C.R., Ambus, P., Skiba, U., Rees, R.M., Hensen, A., van Amstel, A., van den Pol-van Dasselaar, A., Soussana, J.F., Jones MClifton-Brown, J., Raschi, A., Horvath, L., Neff, A., Jocher, M., Ammann, C., Leifeld, J., Fuhrer, J., Calanca, P., Thalman, E., Pilegaard, K., Di Marco, C., Campbell, C., Nemitz, E., Hargreaves, K.J., Levy, P.E., Ball, B.C., Jones, S.K., van de Bulk, W.C.M., Groot, T., Blom, M., Domingues, R., Kasper, G., Allard, V., Ceschia, E., Cellier, P., Laville, P., Henault, C., Bizouard, F., Abdalla, M., Williams, M., Baronti, S., Berretti, F., Grosz, B., 2007, Effects of climate and management intensity on nitrous oxide emissions in grassland systems across Europe. *Agric. Ecosyst. Environ.* 121, 135–152.
- Flesch, T. K., Wilson, J. D., Harper, L. A., Crenna, B. P., 2005: Estimating gas emissions from a farm with an inverse-dispersion technique. *Atmospheric Environment*, 39:4863-4874.
- Flesch, T. K., Wilson, J. D., Harper, L. A., Todd, R. W., Cole N. A., 2007: Determining ammonia emissions from a cattle feedlot with an inverse dispersion technique. *Agricultural and Forest Meteorology*, 144:139-155.
- Fowler D., Duyzer J.H., 1989: Micrometeorological techniques for the measurement of trace gas exchange, *Exchange of trace gases between terrestrial ecosystems and the atmosphere*, Andreae M.O., Schimel D.S. eds., John Wiley and Sons, 1989, pp. 189-207.
- Freibauer, A. 2003: Regionalised inventory of biogenic greenhouse gas emissions from European agriculture. *European Journal of Agronomy*, 19(2): 135–160.

- Freibauer, A. and Kaltschmitt, M. 2003: Controls and models for estimating direct nitrous oxide emissions from temperate and boreal agricultural mineral soils in Europe. *Biogeochemistry*, 63(1): 93–115.
- Freibauer A., 2008: Designing an observation strategy for N₂O. In: Dolman AJ; Valentini R (Eds.): The continental-scale greenhouse gas balance of Europe. *Ecological Studies*. Vol. 203. Springer, New York [u.a.]. pp. 135-151
- Galle, B., Samuelsson, J., Svensson, B.H., Börjesson, G., 2001: Measurements of methane emissions from landfills using a time correlation tracer method based on FTIR absorption spectroscopy. *Environmental Science & Technology* 35 (1): 21-25.
- Galle, B., Klemetsson, L., Griffith, D.W.T., 1994: Application of a Fourier transform IR system for measurements of N₂O fluxes using micrometeorological methods, an ultralarge chamber system, and conventional field chambers. *J. Geophys. Res.* 99 (D8), 16575–16583.
- Galloway, J. N., Aber, J. D., Erisman, J. W., Seitzinger, S. P., W., H. R., Cowling, E. B., and Cosby, B. J., 2003: The nitrogen cascade, *BioScience*, 53, 341–356.
- Galloway, J. N., Dentener, F. J., Capone, D. G., Boyer, E. W., Howarth, R. W., Seitzinger, S. P., Asner, G. P., Cleveland, C.C., Green, P. A., Holland, E. A., Karl, D. M., Michaels, A. F., Porter, J. H., Townsend, A. R., and Vorosmarty, C. J., 2004: Nitrogen cycles: past, present and future, *Biogeochemistry*, 70, 153–226.
- Galloway, J. N., Townsend, A. R., Erisman, J. W., Bekunda, M., Cai, Z., Freney, J. R., Martinelli, L. A., Seitzinger, S. P., and Sutton, M. A., 2008: Transformation of the Nitrogen Cycle: Recent Trends, Questions and Potential Solutions, *Science*, 320, 889–892.
- Galloway, J. N., 1998: The global nitrogen cycle: changes and consequences, *Environ. Poll.*, 102, 15–24.
- Galloway, J.N., 1995: Acid deposition: perspectives in time and space. *Water, Air and Soil Pollution* 85, 15-24.
- Gao, W., 1995: The vertical change of coefficient b used in the relaxed eddy accumulation method for flux measurements above and within a forest canopy. *Atmos. Environ.* 29(17): 2339-2347.
- Gash, J. H. C., 1985: A note on estimating the effect of a limited fetch on micrometeorological evaporation measurements, *Boundary Layer Meteorology*, 35, 409-413.
- Gilmanov, T. G., Soussana, J.-F., Allards, A. L., Ammann, C., Balzarolo, M., Barza, Z., Bernhofer, C., Campbell, C. L., Cescatti, A., Clifton-Brown, J., Dirks, B. O. M., Dore, S., Eugster, W., Fuhrer, J., Gimenco, C., Gruenwald, C., Haszpra, L., Hensen, A., Ibrom, A., Jacobs, A. F. G., Jones, M. B., Laurila, G., Lohila, A., Manca, G., Marcolla, B., Nagy, Z., Pilegaard, K., Pinter, K., Pio, C., Raschi, A., Rogiers, N., Sanz, M. J., Stefani, P., Sutton, M., Tuba, Z., Valentini, R., Williams, M. L., and Wohlfahrt, G., 2007: Partitioning European grassland net ecosystem CO₂ exchange into gross primary productivity and ecosystem respiration using light response function analysis, *Agric. Ecosyst. Environ.*, 121, 93–120.
- Ham, J.M. and Baum, J.M., 2007: Measuring Ammonia Fluxes from Cattle Feedlots using Time-Averaged Relaxed Eddy Accumulation. *International Symp. on Air Quality and Waste Management for Agriculture*, 16-19 Sept 2007, Broomfield, Colorado.
- Hargreaves, K. J., Fowler, D., Pitcairn, C. E. R. et al., 2001: Annual methane emission from Finnish mires estimated from eddy covariance campaign measurements. *Theoretical and Applied Climatology* 70(1-4): 203-213.
- Heij, G.J., Schneider, T., eds., 1991: Acidification research in the Netherlands, pp. 3-24. *Studies in Environmental Science* 46, Elsevier, Amsterdam.
- Heij, G.J., Schneider, T., eds., 1995: Dutch Priority Programme on Acidification. Final report No. 300-05, National Institute of Public Health and Environmental Protection (RIVM), Bilthoven, The Netherlands.

- Hendriks, D. M. D., Dolman, A. J., van der Molen, M. K., and van Huissteden, J., 2008: A compact and stable eddy covariance set-up for methane measurements using off-axis integrated cavity output spectroscopy, *Atmos. Chem. Phys.*, 8, 431–443.
- Hendriks, D. M. D., 2009: Integrated observations of greenhouse gas budgets at the ecosystem level. Changing environment and management practices in peat meadows, Dissertation VU Amsterdam.
- Hensen, A., Kieskamp, W.M., Vermeulen, A.T., v.d.Bulk W.C.M., Bakker, D.F., Beemsterboer, B., Möls, J.M., Veltkamp, A.C., Wyers, G.P., 1995: Determination of the relative importance of sources and sinks of carbon dioxide, ECN-C-95-035.
- Hensen, A., Vermeulen, A.T., Wyers, G.P., Zhang, Y., 1996: Eddy correlation and relaxed eddy accumulation measurements of CO₂ fluxes over grassland. *Phys. Chem. Earth* 21, (5-6) 383-388, 1996.
- Hensen, A., 2000, Op zoek naar onbekende bronnen van broeikasgassen, ECN report ECN-C-00-12 (in Dutch)
- Hensen, A., Scharff, H., 2001: Methane emission estimates from landfills obtained with dynamic plume measurements, *Water, Air and Soil pollution, Kluwer, focus1*: 455-464.
- Hensen, A., Groot, T.T., van den Bulk, W.C.M., Blom, M.J., Flechard, C., Vermeulen, A.T., 2005: Greenhouse gas emissions from dairy farms in the Netherlands, MIDAIR WP4 and WP2.1 contribution report. ECN-C--05-017.
- Hilhorst, M., Monteney, G.J., Mosquera, J., 2003. Monitoring GHG emissions from manure storages at organic and conventional dairy farms: development of a method for monitoring emissions from covered slurry storages. Report from MIDAIR-project. IMAG, the Netherlands.
- Hovde, D. C., Stanton, A. C., Meyers, T. P., and Matt, D. R., 1995. Methane emissions from a landfill measured by eddy correlation using a fast response diode laser sensor. *J. Atmos. Chem.* 20(2), 141–162.
- Huang, C. H., A theory of dispersion in turbulent shear flow, *Atmospheric Environment*, 13, 453-463, 1979.
- Huijsmans, J. F. M., Hol, J. M. G. and Hendriks, M. M. W., 2001: Effect of application technique, manure characteristics, weather and field conditions on ammonia volatilization from manure applied to grassland, *Neth. J. Agr. Sci.*, 49(4), 323-342.
- Huijsmans, J. F. M., Hol, J. M. G. and Vermeulen, G. D., 2003: Effect of application method, manure characteristics, weather and field conditions on ammonia volatilization from manure applied to arable land, *Atmos. Environ.*, 37(26), 3669-3680.
- Huis in 't Veld, J.W.H., Monteney, G.J., 2003: Methane emission from cubicle housing systems for dairy cows. Report 2003-01. IMAG, the Netherlands.
- IPCC AR3, Third Assessment Report, Climate Change, 2001.
- IPCC AR4, Forth Assessment Report, Climate Change, 2007.
- Jacobs J., Scharff H., Hensen A., Kraai A., Scheutz C., Samuelsson J., 2007: Testing a simple and low cost methane emission measurement method, Sardinia 2007, Eleventh International Waste Management and Landfill Symposium.
- Jacobs, C. M. J. , Jacobs, A. F. G., Bosveld F. C. , Hendriks, D. M. D., Hensen A., Kroon P. S., Moors E. J. , Nol L. , Schrier-Uijl A., Veenendaal, E. M., 2007: Variability of annual CO₂ exchange from Dutch grasslands *Biogeosciences*, 4, 803–816.
- Janssens, I.A., Freibauer, A., Ciais, P., Smith, P., Nabuurs, G.-J., Folberth, G., Schlamadinger, B., Hutjes, R.W.A., Ceulemans, R., Schulze, E.-D., Valentini, R., Dolman, A.J., 2003: Europe's Terrestrial Biosphere Absorbs 7 to 12% of European Anthropogenic CO₂ Emissions. *Science* 300, 1538-1542; Published online May 22, 2003; 10.1126/science.1083592.
- Jarvis S.C., Pain, B.F., 1990: Ammonia volatilisation from agricultural land. Proceedings of the Fertilizer Society 298, 35 pp. The Fertilizer Society, Peterborough.

- Judd, M.J., Kelliher, F.M., Ulyatt, M.J., Lassey, K.R., Tate, K.R., Shelton, I.D., Harvey, M.J., Walker, C.F., 1999: Net methane emissions from grazing sheep. *Global Change Biology*, 647–657.
- Jungbluth, T., Hartung, E., Brose, G., 2001: Greenhouse gas emissions from animal houses and manure stores. *Nutrient Cycling in Agro ecosystems* 60, 133-145.
- Khan, R.Z., Müller, C., Sommer, S.G., 1997: Micrometeorological mass balance technique for measuring CH₄ emission from stored cattle slurry. *Biol. Fertil. Soils* 24, 442-444.
- Kesik, M. et al. 2005: Inventories of N₂O and NO emissions from European forest soils. *Biogeosciences*, 2(4): 353–375.
- Kirchgessner, M., Windisch, W., Müller, H.L., 1995: Nutritional factors for the quantification of methane production. In: Engelhardt, W.V., Leonhard-Marek, S., Breves, G., Giesecke, D. (Eds.), *Ruminant Physiology: Digestion, Metabolism, Growth and Reproduction*. Proceedings VIII International Symposium on Ruminant Physiology, pp. 333-348.
- Kohsiek, W., 1991: Infra Red H₂O-CO₂ sensor with fibre optics, 7th AMS symposium on Meteorological observations and instrumentation, January 13-18 1991, New Orleans, USA.
- Kormann, R., Meixner, F.X., 2001: An analytical footprint model for nonneutral stratification, *Boundary Layer Meteorology*, 99, 207-224.
- Kroon, P.S., Hensen, A., Jonker, H.J.J., Zahniser, M.S., Veen, W.H. van 't & Vermeulen, A., 2007: Suitability of quantum cascade laser spectroscopy for CH₄ and N₂O eddy covariance flux measurements. *Biogeosciences*, 4, 715-728.
- Kroon, P.S., Hensen, A., van den Bulk, W.C.M., Jongejan, P.A.C., Vermeulen, A.T., 2008: The importance of reducing the systematic error due to non-linearity in N₂O flux measurements by static chambers. *Nutr. Cycl. Agroecosyst.* 82, 175–186, doi:10.1007/s10705-008-9179-x.
- Kroon, P. S., Hensen, A., Jonker, H. J. J., Ouwensloot, H. G., Vermeulen, A. T., and Bosveld, F. C., 2010: Uncertainties in eddy covariance flux measurements assessed from CH₄ and N₂O observations, *Agr. Ecosyst. Environ.*, 150, 806–816..
- Kroon, P. S., Schrier-Uijl A. P., Hensen A., Veenendaal E. M., Jonker H. J. J., 2010: Annual balances of CH₄ and N₂O from a managed fen meadow using eddy covariance flux measurements. *Eur. J. Soil Sc.* 61,2010
- Kroon-van Loon, P. S., 2010: Eddy covariance observations of methane and nitrous oxide emissions: Towards more accurate estimates from ecosystems. Dissertation TU Delft, Juni 2010.
- Kruit Wichink, R. J., van Pul, W. A. J., Otjes, R. P., Hofschreuder, P., Jacobs, A. F. G. and Holtslag A. A. M., 2007: Ammonia fluxes and derived canopy compensation points over non-fertilized agricultural grassland in The Netherlands using the new gradient ammonia*high accuracy*monitor (GRAHAM) *Atmos. Environ.* 41, 1271-1287.
- Wichink Kruit, R.J., Volten H., Haaima M., Swart D.P.J., Zanten M.C. van., Pul W.A.J. van, 2009: Ammonia exchange measurements over a corn field in Lelystad, the Netherlands in 2009, RIVM Bilthoven, Report 680180002/2010
- Kutzbach, L., J. Schneider, Sachs, T. E. A., 2007: CO₂ flux determination by closed-chamber methods can be seriously biased by inappropriate application of linear regression. *Biogeosciences*, 4, pp. 1005–1025.
- Lamb, B., McManus, B., Shorter, J., Kolb, C., Mosher, B., Harriss, R., Allwine, E., Blaha, D., Howard, T., Guenther, A., Lott, R., Siverson, R., Westberg, H., 1995: Development of atmospheric tracer methods to measure methane emissions from natural gas facilities and urban areas. *Environmental Science & Technology* 29,1468–1479.
- Langeveld, C.A., R. Segers, B.O.M. Dirks, A. van Den Pol - van Dasselaar, G. Velthof & A. Hensen, 1997: Emissions of CO₂, CH₄ and N₂O from pasture on drained peat soils in the Netherlands. *European Journal of Agronomy*, 7, 35-42.

- Laurila, T., Tuovinen, J.-P., Lohila, A., Hatakka, J., Aurela, M., Thum, T., Pihlatie, M., Rinne, J., and Vesala, T., 2005: Measuring methane emissions from a landfill using a cost-effective micrometeorological method. *Geophys. Research Letters* 32, L19808.
- Laville, P., Henault, C., Renault, P., Cellier, P., Oriol, A., Devis, X., Flura, D., and Germon, J. C., 1997: Field comparison of nitrous oxide emission measurements using micrometeorological and chamber methods, *Agronomie*, 17, 375–388.
- Lee, X., Massman W., Law, B. (Eds.) 2004: *Handbook of Micrometeorology. A Guide for Surface Flux Measurement and Analysis*. Series: Atmospheric and Oceanographic Sciences Library, Vol. 29, XIV, 250 p.
- Lin, J. S., Hildemann, L. M., 1997: A Generalized mathematical scheme to analytically solve the atmospheric diffusion equation with dry deposition. *Atmospheric Environment*, 31, 59-71.
- Loubet, B., Milford, C., Sutton, M.A., Cellier, P., 2001: Investigation of the interaction between sources and sinks of atmospheric ammonia in an upland landscape using a simplified dispersion-exchange model, *Journal of Geophysical Research.*, 106(D20), 24183-24196.
- Loubet, B. and Cellier, P., 2002: Experimental assessment of atmospheric ammonia dispersion and short-range dry deposition in a maize canopy. *Water Air and Soil Pollution*, Vol 1(5/6), 157-166.
- Loubet, B., Cellier, P., Milford, C. and Sutton, M.A., 2006: A coupled dispersion and exchange model for short-range dry deposition of atmospheric ammonia. *Quart. J. Royal. Meteor. Soc.* 132, 1733-1763.
- Loubet, B., Milford, C., Hensen, A., Daemmgen, U., Erisman, J.-W., Cellier, P., and Sutton, M. A., 2009: Advection of NH₃ over a pasture field and its effect on gradient flux measurements, *Biogeosciences*, 6, 1295–1309.
- Loubet, B., Générumont, S., Ferrara, R., Bedos, C., Decuq, C., Personne, E., Fanucci, O., Durand, B., Rana, G. and Cellier, P., 2010. An inverse model to estimate ammonia emissions from fields. *European Journal of Soil Science*, 61: 793-805.
- Maas, C.W.M. van der, Coenen, P.W.H.G., Zijlema, P.J., Brandes, L.J., Baas, K., van den Berghe, G., van den Born, G.J., Guis, B., Geilenkirchen, G., te Molder, R., Nijdam, D.S., Olivier, J.G.J., Peek, C.J., van Schijndel, M.W. en van der Sluis, S.M., 2009: Greenhouse Gas Emissions in the Netherlands 1990-2007. Publicatienummer 50008012, Planbureau voor de Leefomgeving, Bilthoven/Den Haag.
- Magnani F, Mencuccini M, Borghetti M, Berbigier P, Berninger F, Delzon S, Grelle A, Hari P, Jarvis PG, Kolari P, Kowalski AS, Lankreijer H, Law BE, Lindroth A, Loustau D, Manca G, Moncrieff JB, Rayment M, Tedeschi V, Valentini R, Grace J., 2007: The human footprint in the carbon cycle of temperate and boreal forests. *Nature* 447: 848-850
- Mészáros, R. , Horváth, L. , Weidinger, T. , Neftel, A. , Nemitz, E. , Dämmgen, U. , Cellier, P. , Loubet, B., 2009: Measurement and modelling ozone fluxes over a cut and fertilized grassland, *Biogeosciences Discuss.*, 6, 1069-1089.
- Meyers, T. P., Luke, W. T., Meisinger, J. J., 2006: Fluxes of ammonia and sulfate over maize using relaxed eddy accumulation. *Agric. For. Meteor.* 136, 203-213.
- Michorius, J. A. T., Hartog, K. D., Scholtens, R., Harssema, H., 1997: Measuring ammonia emissions from building complexes using the flux frame method and the Gaussian plume model: a feasibility study, Translation - Silsoe Research Institute.
- Milford C., Theobald M.R., Nemitz E., Hargreaves K.J., Horvath L., Raso J., Dämmgen U., Neftel A., Jones, S.K., Hensen A., Loubet B., Sutton M.A., 2009: Ammonia fluxes in relation to cutting and fertilization of an intensively managed grassland derived from an inter-comparison of gradient measurements. *Biogeosciences*, 6, 819-834.
- Milieubalans 2009: report 500051015, Planbureau voor de leefomgeving Bilthoven, The Netherlands, 2009. (In Dutch)
- Milne, R., Beverland, I.J., Hargreaves, K., Moncrieff, J.B., 1999: Variation of the beta coefficient in the relaxed eddy accumulation method. *Boundary-Layer Meteorol.* 93(2), 211-225.

- Milne, R., Mennim, A., Hargreaves K., 2001: The value of the α coefficient in the relaxed eddy accumulation method in terms of fourth order moments. *Boundary-Layer Meteorol.* Volume 101, Number 3, pp. 359-373(15).
- Moncrieff, J.B., Massheder, J.M., de Bruin, H., Elbers, J., Friborg, T., Heusinkveld, B., Kabat, P., Scott, S., Sogaard, H., Verhoef, A., 1997: A system to measure surface fluxes of momentum, sensible heat, water vapour and carbon dioxide. *Journal of Hydrology* 188–189, 589–611.
- Monna, W.A.A., v.d.Vliet, J.G., 1987: Facilities for Research and weather observations on the 213 m tower at Cabauw and remote locations, scientific report WR-nr87-5, KNMI.
- Monteith J. L., Unsworth M. H., 1990: *Principles of Environmental Physics*, 2nd ed., 291 pp., Arnold, New York.
- Moore C.J., 1986: Frequency response corrections for eddy correlation systems, *Boundary Layer Meteorology*, 37.
- Moors E.J., J.A. Elbers, C.M.J. Jacobs, W.W.P. Jans, B. Kruijt, S. Supit, et al., 2009: Variability in carbon exchange of European croplands. *Agriculture, Ecosystem & Environment* doi: 10.1016/j.agee.2010.04.013.
- Mosier, A., Kroeze, C., Nevison, C., Oenema, O., Seitzinger, S., van Cleemput, O., 1998: Closing the global N₂O budget: nitrous oxide emissions through the agricultural nitrogen cycle. *Nutrient Cycling in Agro ecosystems* 52, 225-248.
- Mosquera J., Hensen, A., van den Bulk, W. C. M., Vermeulen A. T., Erisman J. W., 2001: Long Term NH₃ Flux Measurements above Grasslands in The Netherlands Water, Air, and Soil Pollution: Focus 1: 203–212.
- Mosquera, J., Monteny G. J., Erisman J. W., 2005: Overview and assessment of techniques to measure ammonia emissions from animal houses: the case of the Netherlands. *Environmental Pollution*, 135, 381–388.
- Mosquera, J., Ogink, N.W.M., 2008: Analyse ammoniakemissieniveaus van praktijkbedrijven in de varkenshouderij (1990-2003). Lelystad, Rapport / Animal Sciences Group 135. (in Dutch)
- Myles, L., Meyers, T.P., Robinson, L, 2007.: Relaxed eddy accumulation measurements of ammonia, nitric acid, sulfur dioxide and particulate sulfate dry deposition near Tampa, FL, USA., *Environ. Res. Lett.* 2 034004 (8pp) doi: 10.1088/1748-9326/2/3/034004.
- Neftel, A., Blatter, A., Gut, A., Hoegger, D., Meixner, F. X., Ammann C., and Nathaus F. J., 1998: NH₃ soil and soil surface gas measurements in a triticale wheat field. *Atmos. Environ. (Ammonia Special Issue)* 32 (3), 499-506.
- Neftel, A., Blatter, A., Otjes R., Erisman, J. W. and Hansen, A., 1999: State of the art REA NH₃ flux measurements. In: *Proc. 10th Nitrogen Workshop*, Copenhagen, August 1999. II.49. Royal Veterinary and Agricultural University, Copenhagen.
- Neftel, A., Ammann, C., Fischer, C., Spirig, C., Conen, F., Emmenegger, L., Tuzson, B., Wahlen, S., 2009: N₂O exchange over managed grassland: Application of a quantum cascade laser spectrometer for micrometeorological flux measurements, *Agr. Forest Meteorol.*, in press, doi:10.1016/j.agrformet.2009.07.013.
- Nemitz, E., Flynn, M., Williams, P.I., Milford, C., Theobald, M.R., Blatter, A., Gallagher, M.W., and Sutton, M.A., 2001: A Relaxed Eddy Accumulation system for the automated measurement of atmospheric ammonia fluxes. *Water Air Soil Poll. Focus* 1(5-6), 189-202.
- Nemitz, E., Dorsey, J. R., Flynn, M. J., Gallagher, M. W., Hensen, A., Erisman, J.-W., Owen, S. M., Dämmgen, U., and Sutton M. A., 2009a: Aerosol fluxes and particle growth above managed grassland, *Biogeosciences Disc Atmos. Chem. Phys.*, 9, 2635–2645.
- Nemitz, E., Hargreaves, K. J., Neftel, A., Loubet, B., Cellier, P., Dorsey, J. R., Flynn, M., Hensen, A., Weidinger, T., Meszaros, R., Horvath, L., Dämmgen, U., Frühauf, C., Löpmeier, F. J., Gallagher, M. W., Sutton M. A., 2009b: Intercomparison and assessment of turbulent and physiological exchange parameters of grassland, *Biogeosciences*, 6, 1445-1466.

- Norman M., Spirig C., Wolff V., Trebs I., Flechard C., Wisthaler A., Schnitzhofer R., Hansel A., Nefftel A., 2009, Intercomparison of ammonia measurement techniques at an intensively managed grassland site (Oensingen, Switzerland) *Atmos. Chem. Phys.*, 9, 2635–2645, 2009
- Nowak, J. B., Huey, L. G., Russell, A. G., Tian, D., Neuman, J. A., Orsini, D., Sjostedt, S. J., Sullivan, A. P., Tanner, D. J., Weber, R. J., Nenes, A., Edgerton, E., and Fehsenfeld, F. C., 2006: Analysis of urban gas phase ammonia measurements from the 2002 Atlanta Aerosol Nucleation and Real-Time Characterization Experiment (ANARChE), *J. Geophys. Res.*, 111, D17308, doi:10.1029/2006JD007113.
- Oenema, O., Velthof, G., Kuikman, P., 2001: Technical and policy aspects of strategies to decrease greenhouse gas emissions from agriculture. *Nutrient Cycling in Agro ecosystems* 60, 301-315.
- Ogor, Y., 2005: Comparison of landfill methane emission models: a case study, 10th International waste management and landfill symposium, Sardinia.
- Olesen, J.E., Schelde, K., Weiske, A., Weisberg, M.R., Asman, W.A.H., Durhuus, J., 2005: Modelling greenhouse gas emissions from European conventional and organic dairy farms. *Agric. Ecosyst. Environ.*
- Oonk H., Boom T., 1995: Landfill gas formation, recovery and emission, TNO-report 95-203, TNO, Apeldoorn, the Netherlands.
- Oonk, J., Scheepers, M., Takke, J.W., 1993: Overzicht Stortgasprojecten in Nederland 1983–1991. Adviescentrum Stortgas. Apeldoorn, Netherlands.
- Pain, B.F., van der Weerden, T.J., Chambers, B.J., Phillips, V.R., Jarvis, S.C., 1998: A new inventory for ammonia emissions from UK agriculture. *Atmospheric Environment* 32, 309-313.
- Pasquill, F. 1974: *Atmospheric Diffusion*, 2nd ed., J. Wiley & Sons, New York.
- Pattey, E., Desjardins, R.L., and Rochette, P., 1993: Accuracy of the relaxed eddy-accumulation technique, evaluated using CO₂ flux measurements. *Boundary-Layer Meteorol.* 66, 341-355.
- Pattey, E., Strachan, I.B., Desjardins, R.L., Edwards, G.C., Dow D., MacPherson, J.I., 2006: Application of a tunable diode laser to the measurement of CH₄ and N₂O fluxes from field to landscape scale using several micrometeorological techniques, *Agricultural and Forest Meteorology* 136 (2006) 222–236.
- Philip, J. R., 1959: The theory of local advection: 1, *J. Meteorol.*, 16, 535-547.
- Phillips, V. R., Lee, D. S., Scholtens, R., Garland, J. A., and Sneath, R. W., 2001: A review of methods for measuring emission rates of ammonia from livestock buildings and slurry or manure stores, part 2: monitoring flux rates, concentrations and airflow rates. *Journal of Agricultural Engineering Research*, 78, 1-14.
- Pihlatie, M., Rinne, J., Ambus, P., Pilegaard, K., Dorsey, J. R., Rannik, U., Markkanen, T., Launiainen, S., and Vesala, T., 2005: Nitrous oxide emissions from a beech forest floor measured by eddy covariance and soil enclosure techniques, *Biogeosciences*, 2, 377–387.
- Rapsomanikis, S., Wake, M.T., Kitto, A.-M. and Harrison, R.M. 1998: Analysis of atmospheric ammonia and particulate ammonium by a sensitive fluorescence method. *Envir. Sci. Technol.* 22, pp. 948–952.
- Raupach, M. R., 1989: Stand overstorey processes, *Philos. Trans. R. Soc. London, Ser. B*, 324, 175-190.
- Savanne D., Arnaud A., Beneito A., Berne P., Burkhalter R., Cellier P., Gonze M.A., Laville P., Levy F., Milward R., Pokryszka Z., Sabroux J.C., Tauziède C., Tregoures A., 1997: Comparison of different methods for measuring landfill methane emissions. Sardinia '97 Sixth International Landfill Symposium. Vol. IV, pp. 81-85.

- Schrier-Uijl, A.R., 2010: "Flushing meadows. The influence of management alternatives on the greenhouse gas balance of fen meadow areas", Dissertation, Wageningen University, Netherlands.
- Schulze, E. D., Luysaert, S., Ciais, P., Freibauer, A., Janssens, I. A., Soussana, J. F., Smith, P., Grace, J., Levin, I., Thiruchittampalam, B., Heimann, M., Dolman, A. J., Valentini, R., Bousquet, P., Peylin, P., Peters, W., Rödenbeck, C., Etiope, G., Vuichard, N., Wattenbach, M., Nabuurs, G. J., Poussi, Z., Nieschulze, J., Gash, J. H., and the CarboEurope Team, 2009: Importance of methane and nitrous oxide for Europe's terrestrial greenhouse-gas balance, *Nat. Geosci.*, 2, 842–850 + Corrigendum, doi:10.1038/ngeo686.
- Scharff, H., Oonk, J., Vroon, R., Hensen, A., de Visscher, A., Boeckx, P., 2003: A comparison of measurement methods to determine landfill methane emissions. NOVEM Programme Reduction of Other Greenhouse Gases (ROB), projectnumber 0373-01-01-04-001, Utrecht, Netherlands, <http://www.robklimaat.nl/docs/3730040010.pdf>
- Scharff, H., Jacobs, J., 2006: Applying guidance for methane emission estimation for landfills, *Waste Management*, Vol. 26, Issue 4, pp 417-429.
- Scharff H., Hensen A., 2009: Further development of a cheap and simple methane emission measurement method, *Proceedings Sardinia 2009, Twelfth International Waste Management and Landfill Symposium*, S. Margherita di Pula, Cagliari, Italy; 5 -9 October 2009.
- Scheepers M.J.J., van Zanten, B., 1994: Handleiding Stortgaswinning Adviescentrum Stortgas, Utrecht, The Netherlands (in Dutch).
- Scholten, R., Dore, C. J., Jones, B. M. R., Lee, D. S., Phillips, V. R., 2004: Measuring ammonia emission rates from livestock buildings and manure stores - Part 1: Development and validation of external tracer ratio, internal tracer ratio and passive flux sampling methods. *Atmospheric Environment*, 38, 3003-3015.
- Shaw, W. J., Spicer, C.W, and Kenny, D.V., 1998: Eddy correlation fluxes of trace gases using a tandem mass spectrometer, *Atmos. Environ.*, 32, 2887-2898.
- Sintermann J., Spirig C., Jordan A., Kuhn U., Ammann C., Neftel A., 2011: Eddy covariance flux measurements of ammonia by high temperature chemical ionisation mass spectrometry, *Atmos. Meas. Tech.*, 4, 599–616.
- Sinterman BGD 2011
- Smeets C. J. P. P., Holzinger R., Vigano I., Goldstein A. H., and Röckmann T., 2009: Eddy covariance methane measurements at a Ponderosa pine plantation in California *Atmos. Chem. Phys.*, 9, 8365–8375.
- Smith, F. B., 1957: The diffusion of smoke from a continuous elevated point source into a turbulent atmosphere, *Journal of Fluid Mechanics*, 2, 49-76.
- Smith, K.A., Clayton H., Arah J. R. M., Christensen S., Ambus P., Fowler D., Hargreaves K. J., Skiba U., Harris G. W., Wienhold F. G., Klemetsson L., Galle B., 1994. Micrometeorological and chamber methods for measurement of nitrous oxide fluxes between soils and the atmosphere: Overview and conclusions. *Journal of Geophysical Research*, 99(D8): 16541–16548.
- Smith, K. A. and Dobbie, K. E., 2001: The impact of sampling frequency and sampling times on chamber based measurements of N₂O emissions from fertilized soils. *Global Change Biology*, 7: 933–945. doi: 10.1046/j.1354-1013.2001.00450.x
- Sneath, W., Beline, F., Hilhorst, A., Peu, P., 2005: Monitoring GHG from manure stores on organic and conventional dairy farms. *Agric. Ecosyst. Environ.*
- Sommer, S. G., McGinn, S. M., Flesch, T. K., 2005: Simple use of the backwards Lagrangian stochastic dispersion technique for measuring ammonia emission from small field-plots. *European Journal of Agronomy*, 23:1-7.
- Sommer, S.G., Petersen, S.O., Møller, H.B., 2004: Algorithms for calculating methane and nitrous oxide emissions from manure management. *Nutrient Cycling in Agro ecosystems* 60, 133-145.

- Sommer, S.G., Petersen, S.O., Søgaard, H.T., 2000: Greenhouse gas emission from stored livestock slurry. *J. Environ. Qual.* 29, 744-751.
- Sørensen, L. L., Hertel, O., Ambelas Skjøth, C., Lund, M., Pedersen, B., 2003: Fluxes of ammonia in the coastal marine boundary layer. *Atmos. Environ.* 37, Suppl. 1, 167-177.
- Sørensen, L.L., Granby, K., Nielsen, H. and Asman, W.A.H., 1994: Diffusion scrubber technique used for measurements of atmospheric ammonia. *Atmos. Environ.*, 28, 3637-3645.
- Soussana, J.-F., Allard, V., Pilegaard, K., Ambus, P., Ammann, C., Campbell, C., Ceschia, E., Clifton-Brown, J., Dominiques, R., Flechard, C., Fuhrer, J., Hensen, A., Horvath, L., Jones, M., Kasper, G., Martin, C., Nagy, Z., Neftel, A., Raschi, A., Rees, R. M., Skiba, U., Manca, G., Sutton, M., Tuba, Z., and Valentini, R., 2007: A full accounting of the greenhouse gas (CO₂, N₂O, CH₄) budget of nine European grassland sites, *Agric. Ecosyst. Environ.*, 121, 121–134
- Spokas, K., Graff, C., Morcet, M., Aran, C., 2003: Implications of the spatial variability of landfill emission rates on geospatial analyses. *Waste Management* 23, 599–607
- Stull, R. B., 1988: *An introduction to Boundary Layer Meteorology*. Kluwer Academic Publishers.
- Sutton M.A., Milford C., Nemitz E., Theobald M.R., Hill P.W., Fowler D., Schjoerring J.K., Mattsson M.E., Nielsen K.H., Husted S., Erisman J.W., Otjes R., Hensen A., Mosquera J., Cellier P., Loubet B., David M., Genermont S., Neftel A., Blatter A., Herrmann B., Jones S.K., Horvath L., Führer E., Mantzanas K., Koukoura Z., Gallagher M., Williams P., Flynn M. and Riedo M., 2001: Biosphere-atmosphere interactions of ammonia with grasslands: experimental strategy and results from a new European initiative. *Plant and Soil* 228 (1):131-145.
- Sutton, M. A., Nemitz, E., Theobald, M. R., Milford, C., Dorsey, J. R., Gallagher, M. W., Hensen, A., Jongejan, P. A. C., Erisman, J. W., Mattsson, M. E., Schjoerring, J. K., Cellier, P., Loubet, B., Roche, R., Neftel, A., Hermann, B., Jones, S., Lehman, B. E., Horvath, L., Weidinger, T., Rajkai, K., Burkhardt, J., Lopmeier, F. J., and Daemmgen, U., 2009a: Dynamics of ammonia exchange with cut grassland: strategy and implementation of the GRAMINAE Integrated Experiment, *Biogeosciences*, 6, 309-331.
- Sutton, M. A., Nemitz, E., Milford, C., Erisman, J. W., Hensen, A., Cellier, P., David, M., Loubet, B., Personne, E., Schjoerring, J. K., Mattsson, M. E., Dorsey, J., Gallagher, M., Horvath, L., Weidinger, T., Daemmgen, U., Neftel, A., Herrmann, B., Lehman, B., and Burkhardt, J., 2009b: Dynamics of ammonia exchange with cut grassland: Synthesis of results and conclusions, *Biogeosciences*, 6, 1121-1184.
- Sutton, O. G., 1932: A theory of eddy diffusion in the atmosphere. *Proc. R. Soc .A*, 135: 143-165.
- Thomson, D. J. 1987: Criteria for the selection of stochastic models of particle trajectories in turbulent flows, *Journal of Fluid Mechanics*, 180, 529-556.
- Tranvik, L. J., Downing, J. A., Cotner, J. B., Loiselle, S. A., Striegl, R. G., Ballatore, T. J., Dillon, P., Finlay, K., Fortino, K., Knoll, L. B., Kortelainen, P. L., Kuster, T., Larsen, S., Laurion, I., Leech, D. M., McCallister, S. L., McKnight, D. M., Melack, J. M., Overholt, E., Porter, J. A., Prairie, Y., Renwick, W. H., Roland, F., Sherman, B. S., Schindler, D.W., Sobek, S., Tremblay, A., Vanni, M. J., Verschoor, A. M., van Wachenfeldt, E., and Weyhenmeyer, G. A., 2009: Lakes and reservoirs as regulators of carbon cycling and climate, *Limnol. Oceanogr.*, 54, 2298–2314.
- Trebs, I., Meixner, F., Slanina, J., Otjes, R., Jongejan, P., & Andreae, M., 2004: Real-time measurements of ammonia, acidic trace gases and water-soluble inorganic aerosol species at a rural site in the Amazon Basin. *Atmospheric Chemistry and Physics*, 4(1), 967-987.
- Trégourès A., Beneito A., Berne P., Gonze M.A., Sabroux J.C., Savanne D., Pokryszka Z., Tauziède C., Cellier P., Laville P., Milward R., Arnaud A., Levy F., Burkhalter R., 1999: Comparison of seven methods for measuring methane flux at a municipal solid waste landfill site, *Waste Management & Research*, Vol. 17, No. 6, 453-458

- Veefkind, J. P., J. C. H. van der Hage, and H. M. ten Brink, 1996: Nephelometer derived and directly measured aerosol optical depth of the atmospheric boundary layer. *Atmos. Res.*, 41, 217–228.
- Veen, W.A.G., 2000: Veevoedermaatregelen ter vermindering van methaanproductie door herkauwers, Schothorst Feed Research, Lelystad (in Dutch).
- Velthof G. L., Jarvis S. C., Stein A., Allend A. G., Oenema O., 1996: Spatial variability of nitrous oxide fluxes in mown and grazed grasslands on a poorly drained clay soil *Soil Biology and Biochemistry*, Volume 28, Issue 9, September 1996, Pages 1215-1225
- Verma, S.B., Ullman, F.G., Billesbach, D. et al., 1992: Eddy correlation measurements of methane flux in a northern peatland ecosystem. *Boundary-Layer meteorology* 58: 289-304.
- Villoria, D, Hensen A., Wyers G.P., 1996: The effect of Agricultural Management on the CO₂ exchange between atmosphere and grassland: ECN report. ECN-C-96-071.
- Vitousek, P. M., Aber, J. D., Howarth, R. W., Likens, G. E., Matson, P. A., Schindler, D. W., Schlesinger, W. H., Tilman. D. G., 1997: Human alteration of the global nitrogen cycle: sources and consequences. *Ecol. Appl.* 7(3):737-750
- Vroom, C. 1997: Direct flux measurement of DMS and other volatile sulphur gases from marine systems, RUG, Groningen
- Wallace, J. M. and Hobbes, P. V. 2006: *Atmospheric Science – An Introductory Survey*. 2nd Edition, Elsevier Publishers.
- Wamelink et al., 2008: Effects of nitrogen deposition on biodiversity and carbon sequestration, *Forest Ecol. Manage.*
- Webb, E. K., G. I. Pearman, R. Leuning, 1980: Correction of flux measurement for density effects due to heat and water vapour transfer. *Q. J. Roy. Meteor.Soc.*, 106, pp. 85–100.
- Welch, D. C., Colls, J. J., Demmers, T. G. M., Wathes, C. M. A., 2005a: methodology for the measurement of distributed agricultural sources of ammonia outdoors--Part 1: validation in a controlled environment. *Atmospheric Environment*, 39, 663-672.
- Welch, D. C., Colls, J. J., Demmers, T. G. M., Wathes, C. M., 2005b: A methodology for the measurement of distributed agricultural sources of ammonia outdoors - Part 2: Field validation and farm measurements. *Atmospheric Environment*, 39, 673-684,.
- Whitehead, J.D., Twigg, M., Famulari, D., Nemitz, E., Sutton, M.A., Gallagher, M.W., and Fowler, D., 2008: Evaluation of Laser Absorption Spectroscopic Techniques for Eddy Covariance Flux Measurements of Ammonia, *Environ. Sci. Technol.*, 42 (6), 2041–2046.
- Wienhold, F. G., Frahm, H., and Harris, G. W. , 1994: Measurements of N₂O fluxes from fertilized grassland using a fast response tunable diode laser spectrometer, *J. Geophys. Res.*, 99(D8), 16557– 16567.
- Wilson, J.D., Shum,W.K.N., 1992: A re-examination of the integrated horizontal flux method for estimating volatilization from circular plots. *Agric. For. Meteorol.* 57, 281–295.
- Wilson, J. D., Thurtell, G. W., Kidd, G. E., Beauchamp, E. G., 1994: Estimation of the rate of gaseous mass transfer from a surface source plot to the atmosphere, *Atmospheric Environment*, 16, 1861-1867.
- Winegardner, D. L., 1995: *An introduction to soils for environmental professionals*. Lewis publishers, Florida.
- Wrage N, Velthof GL, Beusichem ML van, Oenema O., 2001: Role of nitrifier denitrification in the production of nitrous oxide. *Soil Biology and Biochemistry* 33: 1723-1732.
- Wyers, G.P., Otjes, R.P. and Slanina, J., A., 1993: continuous-flow denuder for the measurement of ambient concentrations and surface-exchange fluxes of ammonia. *Atmospheric Environment*, 27A(13), 2085-2090, 1993.
- Yeh, G. T., and C. H. Huang, 1975: Three-dimensional air pollutant modeling in the lower atmosphere. *Boundary Layer Meteorology.*, 9, 381-390.

- Zahniser, M.S., Nelson, M.S., McManus, J.B., Kebabian, P.L., 1995: Measurement of Trace Gas Fluxes Using Tunable Diode Laser Spectroscopy, *Phil. Trans. Roy. Soc. Lond. A.*, 351, 371-382.
- Zhang, G., Strom, J. S., Li, B., Rom, H. B., Morsing, S., Dahl, P. and Wang, C., 2005: Emission of ammonia and other contaminant gases from naturally ventilated dairy cattle buildings. *Biosystems Engineering*, 92, 355–364.
- Zhu T., Pattey, E. and Desjardins, R.L., 2000: Relaxed eddy-accumulation for measuring ammonia volatilization. *Environ. Sci. Technol.* 34(1): 199-203.
- Zhu, T., Wang, D., Desjardins, R.L., and Macpherson, J.I., 1999: Aircraft-based volatile organic compounds flux measurements with relaxed eddy accumulation, *Atmos. Environ.* 33,1969-1979.