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Biogeosciences Discussions

Interactive comment on "Simulation of nitrogen deposition in the North China Plain by the FRAME model" *by* Y. Zhang et al.

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We thank both the referees for their comments. We would like give feedback both in general and in detail. No general reply to the first referee's comments is given, because these were very positive. However, detailed revisions were made and are listed in the following table.

We accept the comments of Referee 2 that FRAME is a relatively simple modeling system by modern standards and our work could be regarded as a preliminary screening level study. We look forward to seeing the results of future application of complex models at a fine resolution in this region. We believe that the usefulness of the model should be assessed not purely on its degree of complexity but on it fitness for purpose and level of performance. Dry deposition is well known to vary on a diurnal and

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seasonal basis. However the aim of the study is to estimate annual nitrogen deposition. Use of appropriate average annual deposition velocities can achieve this with a reasonable degree of success.

The FRAME model has been compared with other Atmospheric Transport Models (including state of the art models such as CMAQ and EMEP4UK) over the UK. This included a detailed comparison of the models with measurement data on gas and aerosol concentrations in air and ion concentrations in precipitation from the national monitoring networks. There was no clear evidence of the complex models achieving an overall significantly better correlation with annually averaged measurements than a simple model. Different models gave better performance for the various chemical compounds. Notably, FRAME achieved one of the best correlations with measurements for gas concentrations (NO2 and NH3) in this study (Carslaw, 2011). This may be due to the fine vertical resolution of 1 m near the ground for FRAME, which can be important for nitrogen compounds (such as NH3 and NOx which are emitted at low level). The report from this study is in the public domain and we invite the reviewer to read the contents: http://uk-air.defra.gov.uk/library/reports?report_id=652. (Figures and Tables of the correlation and statistics were attached in appendix 1 in the end of the feedback)

An optional representation of the bi-directional exchange of ammonia is included in FRAME and this has been reported by Vieno (2005) for the UK. The results showed that permitting a net emission of ammonia from the surface resulted in a small elevation of ammonia concentrations. However this only significantly influenced average annual ammonia concentrations in remote regions with very low ammonia concentrations. The difference between use and non-use of bi-directional exchange did not significantly alter the correlation of the model with annual average ammonia concentrations. As the concentrations of ammonia in the North China plains are several times higher than in the UK, we expect bi-directional exchange to be even less significant in this region.

There is very little reported in the published literature on nitrogen deposition modeling in this region. Our work is a preliminary study intended to focus interest on environ-

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mental issues in a global nitrogen hot spot. The data bases applied to support the model application are clearly not as highly developed as in North America or Europe. However, this study offers useful preliminary estimates of the scale of the issue of nitrogen deposition in the North China Plains. We need a model which works effectively and can be supported by the current database, to start this work, rather than wait for model input data and measurement data which is as detailed as an American or European database. We agree that the results of this work are limited by the shortage of other modeling results to compare. However, it is important to note that it is exactly the limited application of atmospheric transport models in this region to date which is the primary reason for us to conduct this work. This is the first time a model has been applied to fully calculate the emission, transportation and deposition processes and estimate the potential exceedance of N-compounds at a high resolution in this global hotspot region. We consider that the results of this study are important not only to inform policy makers on abatement of pollutant emissions and ecosystem protection but also to initiate further detailed studies.

Vieno, M. (2005) The use of an Atmospheric Chemistry-Transport Model (FRAME) over the UK and the development of its numerical and physical schemes, PhD thesis, University of Manchester

We have made revision lists to all the questions from the referees in detail. These are separately listed in the feedback to every referee.

Interactive comment on Biogeosciences Discuss., 8, 8161, 2011.