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ATMOSPHERIC COMPOSITION CHANGE
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BIAFLUX Exchange of Staff 2006 – REPORT

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BIAFLUX EXCHANGE OF RESEARCH STAFF – REPORT

1.	Research staff participation
Award Holder/ Project Leader	Juha-Pekka Tuovinen, Finnish Meteorological Institute, Helsinki, Finland
Team Members/ Collaborators	David Simpson, EMEP MSC-W, Oslo, Norway (c/o Chalmers University of Technology, Gothenburg, Sweden) Nuria Altimir, University of Helsinki, Finland
2.	**Project /Activity**
Title of Project	New parameterisation of non-stomatal ozone deposition for the EMEP chemical transport model
Objectives of Activity	The objectives of the activity are to improve and test the DO_3SE (Deposition of Ozone and Stomatal Echange) deposition module incorporated in the EMEP chemical transport model. In particular, (1) to develop and test parameterisations for the non-stomatal deposition of ozone; (2) to implement these parameterisations into the DO_3SE module of the EMEP model; (3) to evaluate the effects of the revised parameterisation on the output of the EMEP model.

3. Results and Achievements

The work related to this activity was carried out at the Chalmers University of Techology in Gothenburg, Sweden in November-December 2006. It consisted of the following four elements.

(1) Sensitivity of modelled ozone fluxes to non-stomatal deposition

The EMEP model was run over a full year using different values for the non-stomatal resistances. These sensitivity runs made it possible to investigate how much the parameterisation of non-stomatal deposition processes may affect the results of the EMEP model. Changes in the modelled ground-level ozone concentration, AOT40 exposure index, stomatal flux and AFstY dose index were evaluated across Europe.

(2) New parameterisation for non-stomatal deposition to wet surfaces

The current parameterisation of non-stomatal deposition in the DO_3SE module consists of two parallel resistance terms, a constant leaf-scale resistance to deposition to external plant surfaces (r_{ext}) and a constant canopy-scale resistance to deposition to ground surface (R_{gs}).

To better reflect the current understanding of factors governing the surface exchange of ozone, this parameterisation was modified by defining different resistances for dry and wet vegetation and ground surfaces. Surface wetness has been observed to enhance the non-stomatal deposition to forest canopies, thus corresponding to a lower r_{ext} than in dry conditions. On the other hand, R_{gs} has been observed to be higher when the soil is wet. In addition, both r_{ext} and R_{gs} are increased in low temperatures.

The transition from dry to wet conditions was expressed as a strongly non-linear function of relative humidity (RH). For a low to moderate RH, the effective r_{ext} and R_{gs} have values close to those defined for dry conditions. When RH increases towards 100%, the values defined for wet conditions are approached.

The revised parameterisation was tested against an extensive micrometeorological dataset collected in a Scots pine forest (Hyytiälä, Finland) in 2002-2003. The comparison of modelled surface resistances with those derived from the measurement data showed that the revision improved the model performance.

(3) Implementation of the parametrisation into the EMEP model

In order to succesfully employ the improved parameterisation within the EMEP modelling system, two additional topics need to be considered. Firstly, the required meteorological data must be available and, even if available in principle, their quality needs to be investigated. Secondly, the need for sub-grid parameterisations must be

3.	Results and Achievements (continued)

assessed.

The meteorological input data for the EMEP model are obtained from the HIRLAM weather prediction model. The most important variables for the parameterisation of the non-stomatal deposition are the near-surface air temperature and humidity. For some earlier years the humidity data are only available at the lowest vertical grid point (at about 45 m) of HIRLAM.

Different possibilities for estimating the land-cover specific near-surface temperature and relative humidity were compared and tested against field data. The tests showed that the derivation of reliable sub-grid data from the available HIRLAM data is problematic in stable conditions, especially for RH. In addition, some inherent limitations in the data quality were observed in winter.

A preliminary version of the stand-alone DO_3SE module was programmed.

(4) Improvements to the methodogy for calculating stomatal uptake and AFstY

In order to accurately model the total surface resistance, it was found necessary to adjust the parameterisation of stomatal uptake, in addition to the non-stomatal component. The factor representing the phenological development of coniferous forests was changed, resulting in more realistic ozone fluxes at the start and end of the growing season. Furthermore, the maximum stomatal conductance, which is a key parameter in DO_3SE, was estimated from the measurement data.

The calculation of the accumulated dose, expressed as the AFstY index, is based on the concentration at the top of the canopy and therefore depends on the estimation of the vertical profile of ozone concentration. This profile is determined by both aerodynamic resistance (R_a) and the total surface resistance. The improvements to the non-stomatal resistances described above are part of the latter, and thus have an effect on the modelled canopy-top concentration. In addition, the formulation of R_a was made more realistic by introducing the so-called roughness sub-layer (RSL) into the model. The inclusion of the RSL effects on R_a results in a less steep concentration gradient just above the canopy top, which in turn increases the stomatal flux and AFstY to the upper part of the canopy.

4.	Expected output / research development

We aim at implementing a generic parameterisation of the non-stomatal ozone deposition into the EMEP model. This work will continue depending on the outcome of the review that is expected to emerge from the Biaflux Ozone Workhop (Grignon, 11-12 July 2006). The stand-alone version of DO_3SE will be finalised accordingly.

Based on the work carried out so far, we are planning to submit a manuscript on ozone fluxes to northern European forests. The model developments will be presented in the EMEP Reports published annually and in a paper documenting the complete DO_3SE module.

5.	Additional information

Is continuing collaboration between you and the hosting institute planned/anticipated?
If yes, give details

Yes, the model development will continue in close collaboration. It is expected that further improvements can be achieved as results of the Biaflux ozone deposition review become available.

Please tick as appropriate for this project

X	Training/Knowledge transfer
X	Research Development
X	Measurement/Modelling activity

Early career researchers involved (less than three years post-doctoral research experience)

Name	Affiliation
Nuria Altimir	University of Helsinki, Finland

Signature of Project Leader

Date