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Interactive Comment

Interactive comment on "Modelling transport and deposition of caesium and iodine from the Chernobyl accident using the DREAM model" *by* J. Brandt et al.

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General Comments

The authors present the application of the DREAM model to investigate various parameterizations of the deposition of radioactive tracer. This type of study is certainly of value in the context of the simulation of the atmospheric transport of radionuclides. The main finding of the paper is that the simple scheme based on relative humidity is the best representation of wet scavenging. This is not surprising considering the size of particles involved in the transport of radioactivity over long distances. The authors should explain, however, their finding using the theory of wet scavenging process. Some general suggestions concerning this issue are contained in point 9 of the specific comments.

Specific Comments

1) [page 1] It is not true that *"At the time of the accident only one simple model developed in France was operational (Piedelievre et al., 1990), and used to describe the development of the plume from the nuclear power plant"*. Immediately following the accident, the transport of radionuclides from Chernobyl was simulated by a relatively complex, operational three-dimensional atmospheric dispersion system ARAC (Atmospheric Release Advisory Capability); the model was executed at Lawrence Livermore National Laboratory.

2) [page 2] It is quite optimistic to state: *"However, models have improved considerably since the time of the Chernobyl accident with respect to the treatment of numerical methods, quality of parameterizations and model resolution, partly due to much faster computers."* In fact, the model described by the authors is not much different when compared to models used following the accident. In particular, the treatment of aerosol processes is still ignored despite of their importance. I suggest either to remove this statement or just to state that now we have much more powerful computers than those in mid-eighties so current models are executed on grids with relatively high resolution.

3) [page 3] The basic equation of the Eulerian model considered by the Authors is cast in the following form:

$$\frac{\partial C}{\partial t} = -\left(u\frac{\partial C}{\partial x}+v\frac{\partial C}{\partial y}+\dot{\sigma}\frac{\partial C}{\partial \sigma}\right)+K_x\frac{\partial^2 C}{\partial x^2}+K_y\frac{\partial^2 C}{\partial y^2}+\frac{\partial}{\partial \sigma}\left(K_\sigma\frac{\partial C}{\partial \sigma}\right)+E(x,y,\sigma,t)-\Lambda C-k_r C$$

There is most likely an error in the description of function C in equation (1). The authors stated: *C is the tracer mixing ratio*. On the other hand in the legend of Table 1, where emission term is defined, the authors stated: *"Release rates in Bq/day and relative distribution of material released in different heights of ^{137}Cs, ^{134}Cs and ^{131}I in the period of the release..."* Considering the definition of the source term given in Table

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1, I believe that C is not a mixing ratio but the specific activity field (units $[Bq/kg]$). This issue should be clarified. Furthermore, it would be quite useful to say whether C represents radioactivity transported in the gas phase or in the form of radioactive particles? Similarly, the reader would appreciate the more precise description of k_r; the authors stated: k_r *is representing the radioactive decay*, what is numerical value of k_r?

4) [page 3] The statement "K_x, K_y, K_σ *are the dispersion coefficients*" should be changed to "K_x, K_y, K_σ *are the eddy diffusion coefficients*". Similarly, *"u, v, $\dot{\sigma}$ are the wind speed components in the x, y, σ directions, respectively"* should be changed to: u and v are the wind speed components in the x, and y directions respectively, and $\dot{\sigma}$ is the vertical motion in the σ coordinate system.

5) [page 4] It is not precise to say: *"The model has been split into three sub-models (Brandt and Zlatev, 1998) including: 1) three-dimensional advection, horizontal dispersion and emission, 2) vertical dispersion and dry deposition, and 3) wet deposition and radioactive decay."* I would like to suggest to say simply that equation (1) is solved using the fractional steps method.

6) [page 5] The reference to (Hass et al., 1990) is not the best choice in the context of the description of the source term, I would like to suggest to refer to the original document where the source term was described.

7) [page 7] The authors stated: *"The change in the air mixing ratio due to dry deposition is calculated using the flux F from the air to the surface and is applied as a lower boundary condition for the vertical dispersion in the Eulerian model and is proportional to the mixing ratio C"* This statement should be corrected, C is not the mixing ratio but the specific activity.

8) [page 9] The authors stated: *"Little research has, however, been carried out in this field for the radioactive compound, iodine, and given the lack of experimental data and the uncertainties in determining the surface resistance for this species a fixed value of*

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r_c *has been used*. I would like to suggest to include the reference to Chamberlain and Chadwick (1966) (Chamberlain A. C. and R. C. Chadwick, (1966) Transport of iodine from atmosphere to ground, Tellus 18, 226-237).

9) [page 11] Please note that $(RH - RH_t)/(RH_s - RH_t)$ is a fractional cloud cover as defined by Sundqvist (1981) (Sundqvist, H., 1981, Prediction of stratiform clouds: Results from from a 5-day forecast with a global model, Tellus, 33, 242-253). We can write the "simple scheme" in the following alternative form:

$$\Lambda = \begin{cases} 0 & \text{If } U < U_t \text{ (no subgrid-scale cloudiness)} \\ \beta\lambda_a & \text{If } U \geq U_t \text{ (subgrid scale condensation)} \end{cases}$$

where U is the relative humidity, U_t is the relative humidity from which the subgrid-scale condensation can be initiated, $U_s = 1$, $\beta = (U - U_t)/(U_s - U_t)$ is the fractional cloudiness and $\lambda_a = 3.5 \times 10^{-5}$ is the typical in-cloud scavenging rate for submicron particles estimated assuming average cloud water content of precipitating clouds. The rationale for selecting this value of λ_a is quite simple. The long range transport of radioactivity from Chernobyl was associated mainly with particles in the submicron range for which in-cloud scavenging processes are much more important than below cloud scavenging, see Warneck (1988) (Warneck, P. (1988) Chemistry of the natural atmosphere, Academic Press, page 390)

10) I would like to suggest that the scheme given by equation (23) be described as subgrid-scale averaging scheme.

11) [page 15] The authors stated: *"The parameterization based on relative humidities is, in all cases, performing better than the parameterization based on precipitation rates, with respect to the global ranks. This indicates that the precipitation rates are relatively uncertain in the meteorological model."* This statement should be changed to: The parameterization based on subgrid-scale averaging is, in all cases, performing better than the parameterization based on precipitation rates (with respect to the global ranks).

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12) The fact that the parameterization based on subgrid-scale averaging *"is, in all cases, performing better than the parameterization based on precipitation rates, with respect to the global ranks"* can be explained relatively well by the arguments presented in point 9 of this comment.

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 825, 2002.