Interactive comment on “Atmospheric transport of persistent semi-volatile organic chemicals to the Arctic and cold condensation at the mid-troposphere – Part 2: 3-D modeling of episodic atmospheric transport” by Lisheng Zhang et al.

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We would like to thank the Referee’s comments and suggestions that improve the manuscript. Following are our responses to the Referee’s comments.

Referee’s comment: 1) The model is driven by the data obtained from the archived analysis of meteorological fields available on a global grid every six hours. How does this relatively coarse resolution affect the accuracy of the estimates of the boundary
layer fields and the parameters describing the exchange between soil and atmosphere?

Reply: The meteorological data driving our model was collected from 6-hourly inter-
val NCAR/NCEP reanalysis data. These data was interpolated into every 30 minutes
interval, the time step length of our model. We acknowledge that the data are ac-
tually temporally smoothed. In terms of the well-known similarity theory, in the sur-
face boundary-layer (below 100m above a surface under neutral condition) winds (and
other scalars) are always in equilibrium with underlying surface conditions, and hence
independent with time. Theoretically, soil/air exchange is a molecule exchange pro-
cess which occurs even below the roughness length height (the lower boundary of
turbulent boundary-layer), while this process is parameterized using winds in the sur-
face boundary-layer. We therefore expect the coarse resolution of meteorological data
would not affect soil/air exchange. On the other hand, because turbulence activities
can extend to planetary boundary layer (about 1000 m from a surface in neutral con-
dition), coarse resolution would influence the parameterization of turbulent mixing and
diffusion of meteorological variables and air concentration. In both MEDIA and Can-
METOP models, turbulence mixing is dealt with well-known sub-grid scale parameter-
ization methods using large-scale (coarse) winds and temperature data. These have
been described in the revised paper.

Referee’s comment: 2) Is the advection scheme used in the models mass conserving
to make it acceptable for long term simulations?

Reply: As stated in our previous study using the MEDIA (Zhang et al., 2008), we have
implemented and modified the advection scheme. An embedded advection-diffusion
module to transport chemical species has been adopted in the upgraded version of the
MEDIA. The algorithm was designated in particular for mass conservative for chemi-
cals and has been applied in Canada’s Global Environmental Multiscale (GEM) model
as well as Canada’s regional and global climate models (GCM) (Cote et al., 1998).
These statements have been added to the revised paper and a new reference on the
embedded advection-diffusion algorithm is also added to the Reference list.
Referee’s comment: 3) How is the information concerning the concentration of toxic substances in the ocean handled? It is not clear whether or not this information is calculated dynamically in the model or is obtained from observations.

Reply: Because transport of pesticides dissolved in oceans is much slower than that in the atmosphere (time scales of the order of years and days respectively) and sparse measurements, following Koziol and Pudykiewicz (2001) we assumed constant ocean concentration of selected substances (lindane in particular) in the present study. These statements have been added to the revised manuscript.

Referee’s comment: 4) The authors state that “significant improvement in solving the atmospheric tracer transport equation was made by a state-of-science numerical algorithm (Zhang et al., 2008)”. After reading the aforementioned paper I cannot clearly see how this new algorithm is formulated. Some additional information on this subject will improve the paper.

Reply: The details were described in Cote et al. (1998)’s article which has been added to revised Reference list.

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