Atmos. Chem. Phys. Discuss., 9, C4095–C4102, 2009
www.atmos-chem-phys-discuss.net/9/C4095/2009/

Atmospheric Chemistry and Physics Discussions

ACPD

9, C4095–C4102, 2009

Interactive Comment

Interactive comment on "Cluster analysis of an impact of air back-trajectories on aerosol optical properties at Hornsund, Spitsbergen" *by* A. Rozwadowska et al.

Anonymous Referee #2

Received and published: 21 August 2009

This paper addresses relevant scientific questions within the scope of ACP. To my knowledge the use of trajectory cluster analysis in an attempt to explain variations of AOD and Angstroem exponent is novel, especially at the Hornsund Arctic site. The authors give proper credit to related work. However, in my view the conclusions are obscured, and their value made questionable, by unclear exposition, a lack of tests of statistical significance, and questions about the treatment of the vertical dimension of trajectories.

My first major concern is most evident in Fig. 5a. For most of the 8 clusters that contain more than one case, the standard deviations of the mean AOD and ïĄą are larger

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

than the separations between clusters. Thus one wonders whether the 10 clusters are really statistically significant (or distinct). If not, how would the results have been affected by using a smaller number of clusters that are more distinct from each other? This concern propagates into Figs. 2-4, which show how relative variance depends on back-trajectory length and arrival height. One wonders how significant are the changes in relative variance shown compared to uncertainty in relative variance. These changes do not appear to be very systematic.

For example, in Fig. 3a, for back-trajectory length 5 days, the relative variance is clearly less for arrival height 5 km than for 1 and 2.5 km, but this advantage disappears completely for back trajectory length 8 days. In spite of this, the authors claim "cluster analysis of advection in free troposphere (trajectories at 5 km a.s.l.) decreases AOT variance twice as much as the clustering of boundary layer trajectories (advection at 1 km and a combination of altitudes of 1 and 2.5 km), which suggests a dominating role of advection in free troposphere in the AOT variability.[p15432, ll11-14]". No mention is made of (1) what trajectory length supports their claim, or, (2) more importantly, the fact that the difference in relative variance disappears at 8 days.

One is left with a general concern as to the significance of all the changes in relative variance shown in Figs. 2-4. This might be addressed by adding vertical bars showing the uncertainty in relative variance, or giving results of some other test of statistical significance.

My second major concern relates to the vertical coordinate of the trajectories. This concern has several sub-components.

1. Statements like "trajectories advected at an altitude of 5 km [p15432, l27 to p15433, l1]", "trajectories were calculated for three atmospheric heights: 1 km, 2.5 km, and 5 km a.s.l [p15428, l24]", and "5 days for advection at 5km [p15432, l17]" at the very least give the impression that the authors envision that each trajectory described in the paper is at a constant altitude. In fact, as shown in Figs. R1-R3 of this review,

NOAA HYSPLIT trajectories in general change altitude as a function of transit time (or horizontal location), and these altitude changes can be as large as several km. The terminology should be clarified as in the following examples: Change “trajectories advected at an altitude” to “trajectories arriving at an altitude” Change “trajectories were calculated for three atmospheric heights” to “trajectories were calculated for three arrival heights” Change: “5 days for advection at 5km” to “5 days for trajectory arrival at 5km” Change: “altitude of advection” to “arrival altitude of advection” or “altitude of arrival” Change: “clustering trajectories at a single altitude” to “clustering trajectories arriving at a single altitude” Change: “trajectory level” to “trajectory arrival level”

2. The statement “One-kilometer trajectory typically represents airflow in the boundary layer (BL), 5-km in free troposphere (FT), while 2.5-km in FT near the border between BL and FT (Engvall et al., 2008) [p15428, ll24-26]” needs to be buttressed by some data on actual boundary layer heights at Hornsund during the times and seasons of the AOD measurements. Since Hornsund is WMO station No. 01003, such data should be available. Also mentioned should be the fact that air arriving over Hornsund within the boundary layer may have previously been above the boundary layer, and vice versa (see Figs. R1-R3 of this review).

3. Eq. (1), which defines the Euclidian distance between a trajectory and its cluster mean trajectory, omits the vertical dimension. Thus, two trajectories having very different variations in the vertical but similar horizontal tracks would yield little difference via Eq. (1), when in fact the vertical difference could be very significant to the aerosols on the trajectory arriving over Hornsund.

Other recommendations:

Abstract: The wording “in spring changes in AOT values over the Hornsund station were influenced by the at least 8-day trajectories of air, which was advected both in free troposphere and in the boundary layer” could be more clearly stated as “in spring changes in AOT values over the Hornsund station were most strongly influenced by air

ACPD
9, C4095–C4102, 2009

trajectories of duration 8 days or longer, arriving both in the free troposphere and in the boundary layer."

P15425, l23: Kamchatka Peninsula is listed as an Arctic source, but its latitude, ∼55N, is well outside the Arctic Circle (∼66.6N).

P15428, l15: The discussion of AERONET data should refer to Fig. 1.

P15430, l14: The reference to Fig. 1 belongs in Section 2.1, not here.

P15431, ll6-9: Needs to be restated to improve clarity and refer to Fig. 1. The Julian day of key dates needs to be stated, so the reader can find the corresponding data points in Fig. 1.

P15431, ll23-24: "at least 8-day long air mass history" could be more clearly stated as "air mass history of 8 days or longer".

P15432, ll4-6: "Small drop of a relative variance along with an increase of trajectory length may be attributed to an impact of long-range transport on AOT variability" needs rewording for clarity.

P15432, ll17-20: "Most probably the cluster analysis of longer "single-level" trajectories is not representative anymore for a total (i.e. for all altitudes above the station) advection to the Hornsund station." Needs to be restated for clarity.

P15433, ll2-4: "This is an artifact of using the same number of clusters with growing number of altitude levels employed in the cluster analysis." Needs a better explanation.

P15434, ll12-13: "In this section all cases have been used, including the extreme ones, which were rejected during the rel VAR(AOT) analyses." The reason for this different treatment needs to be explained.

P15439, l3: Norilsk needs some explanation for why it is mentioned.

Fig. 6: Far too small to be legible. Caption refers to solid and dotted trajectories, which

ACPD

9, C4095–C4102, 2009

Interactive Comment

can't be distinguished.

Other points:

The paper should state how the trajectory arrival time input to HYSPLIT was chosen relative to the start & end times of each day's AERONET data set (used to compute daily mean AOT & Angstroem exponent). Table 2 shows these times can vary significantly from day to day.

The paper could be greatly strengthened by giving more physical explanation of likely reasons for the observed changes of relative variance.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 15423, 2009.

ACPD

9, C4095–C4102, 2009

Interactive Comment

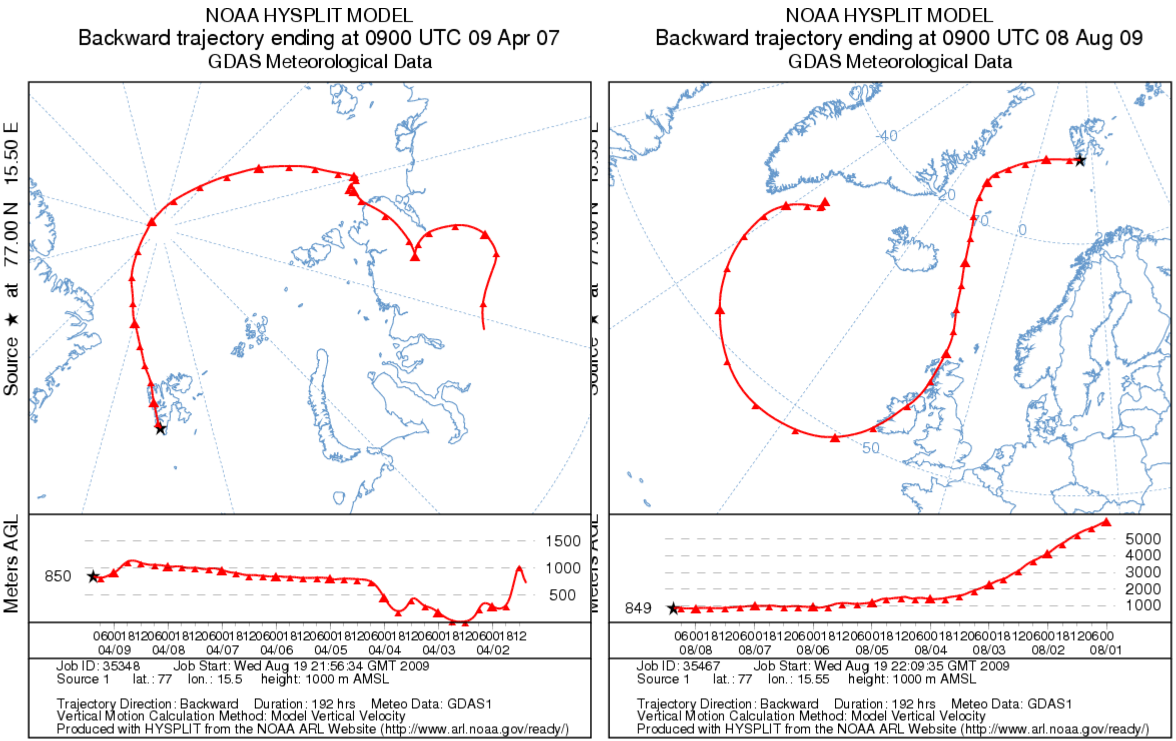

Fig. R1. NOAA HYSPLIT trajectories for Hornsund arrival height 1000 m a.s.l, arrival time 0900 UTC. Left: 9 Apr 2007. Right: 8 Aug 2009.

ACPD
9, C4095–C4102, 2009

Interactive Comment

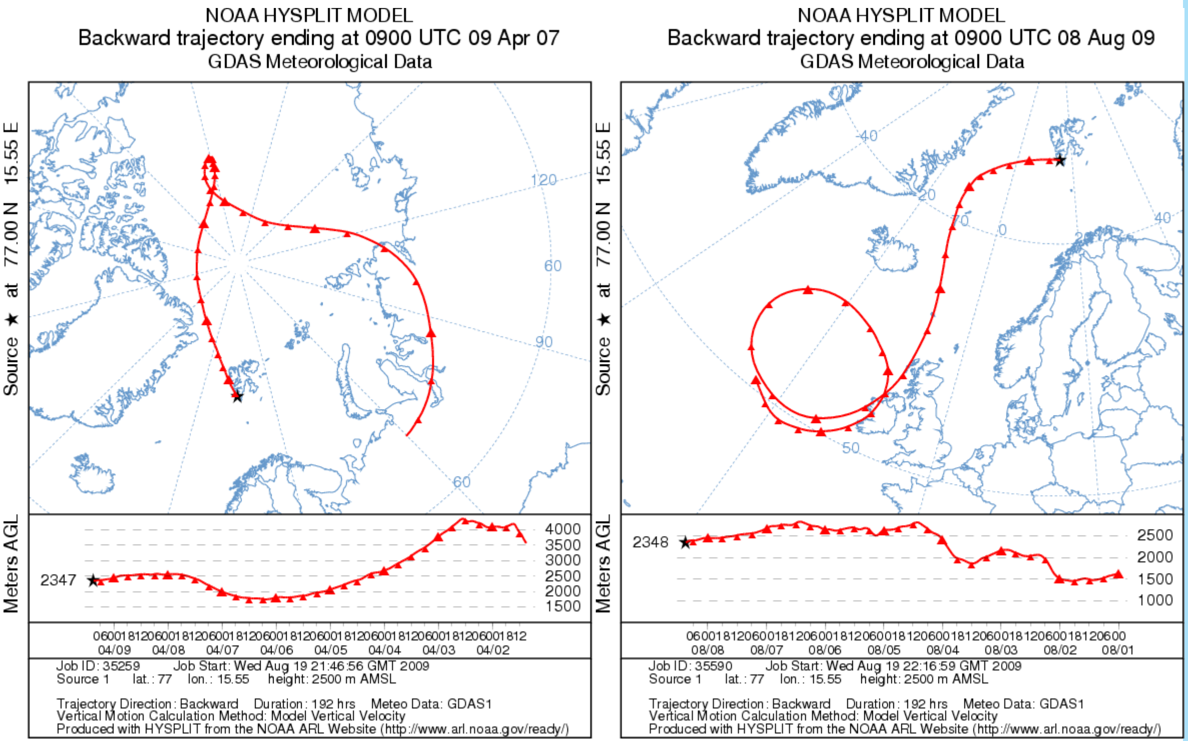

Fig. R2. As in Fig. R1, but for Hornsund arrival height 2500 m a.s.l.

ACPD
9, C4095–C4102, 2009

Interactive Comment

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

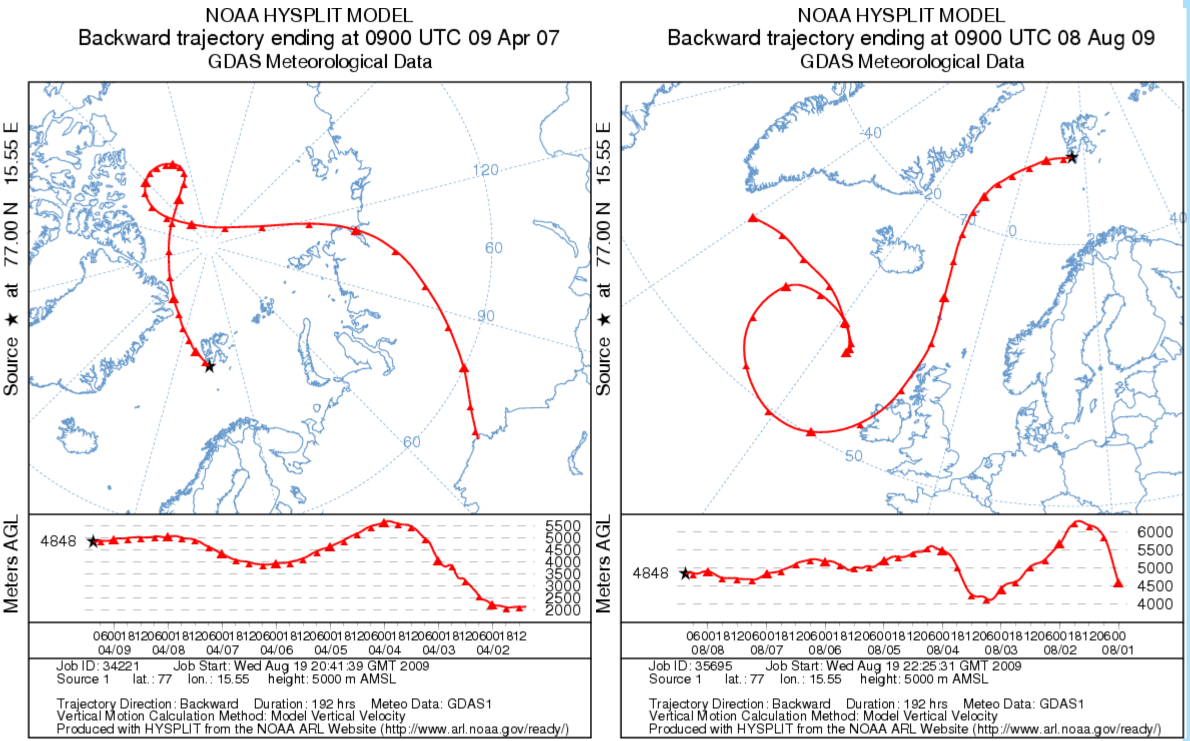

Fig. R3. As in Fig. R1, but for Hornsund arrival height 5000 m a.s.l.