List of Revision

Our response to referee's comments are listed as Red (Referee 3) and Blue (Referee 4) in a marked pdf file.

Referee 3 had 3 major and 5 minor comments.

Referee 3's Major Comments

(Comment 1) *The lack of the HYSPLIT model description, scientific methods must be outlined clearly.*

(Response to Comment 1)

Physical principles of the HYSPLIT was extended as follows:

✓ Line 28, Page 2 – Line 2, Page 3

The spirit of Lagrangian HYSPLIT model relies on the determination of air concentration, as a cumulative summation of dust flow per unit grid cell. Each dust flow is considered as an independent particle flow puffed by advection, and is represented by its trajectory. Backward trajectories are constructed on the basis of Stochasitc Time Inverted Lagrangian Transport (STILT) model. The STILT is a widely used model for tracing atmospheric mixing between the source and the receptor point in terms of 2-dimensional upstream surficial fluxes.

(Comment 2) *Pollutant transport and dispersion are affected by atmospheric dynamics, fluid physical phenomena that occur in the atmosphere, and physical laws that govern them. These may facilitate or constrain transport and dispersion. All these topics are not considered in this manuscript.*

(Response to Comment 2)

Description on the pollutant transport and dispersion was explained as follows:

✓ Lines 8-11, Page 3

The HYSPLIT model describes transport and dispersion dynamics of aerosol, incorporating boundary stability determined by turbulent velocity, wind-blown dust emission algorithm, convectional plume rise produced by buoyancy of heat, wind velocity, atmospheric friction velocity, and in-cloud wet scavenging.

(Comment 3) *Pollutant transport and dispersion are affected also by different scales of motions as microscale, mesoscale, and synoptic scale. The authors make reference to this point only indirectly, as in section 3 in line 17 they commented that the data files to run HYSPLIT model comes from NCEP/NCA reanalysis, that I suppose with horizontal resolution of 2º, but they left many questions unanswered about this topic.*

Resolution of NCEP/NCA Reanalysis-1 was introduced.

✓ Line 32, Page 3 – Line 2, Page 4

The NCEP/NCAR Reanalysis-1 (https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html) provides meteorological data with grid resolution of 2.5° every 6 hours, regarding the vertical distribution of global aerosol and cloud from 1958 to present.

(Comment 1) *In the introduction, in line 29, you must change irradiation by radiation, they are different concepts.*

(Response to Comment 1) Line 29, Page 1

Revised as "radiation".

(Comment 2) *Which version of the HYSPLIT model do you have used?*

(Response to Comment 2) Lines 5-6, Page 3

September 2015 version was now added.

(Comment 3) *You have used data from NCEP/NCAR analysis and you claim in the last sentence of the introduction that your results correspond to a local scale, are you sure?*

(Response to Comment 3) Line 25, Page 2

"in local scale" is specified as "in Eastern Asia"

(Comment 4) *Do you can explain the reason to consider the HYSPLIT backward trajectories at the altitudes of 1000 m, 1500 m and 2000 m, could you have considered backward trajectories at different heights?*

(Response to Comment 4) Lines 4-5, Page 4

Backward trajectories at cloud forming height was explained.

(Comment 5) *Please, use dust air concentration, not dust density.*

(Response to Comment 5)

Revised as suggested throughout the context.

Referee 4 had 5 minor comments.

(Comment 1) *The authors concluded a recent increase of ADS occurrence rate that was statistically significant in 99.9 % confidence limit, regardless of the locations of the observed stations and the threshold time divide. This is robust. But it seems that there may be also a decline in n_{ADS}, say after ~2007-08 (figure 2)? The trend seems clearly and consistently present at different stations. It is possible to test this signal statistically, similar as what has been done in Table 3 but with different year intervals. Some relevant discussion is necessary.*

(Response to Comment 1)

We tested a new temporal threshold of year 2007/2008, which was statistically insignificant. However, statistical significance was barely failed to discriminate the null hypothesis. Results were included in Table 3, and discussion was extended accordingly.

✓ Lines 21-24, Page 5

It is also apparent that there may be also a decline in ADS occurrence with respect to 2007/2008. Results for Welch's t–test are in the order of 10-2, slightly over the statistical threshold for the acceptance of the null hypothesis. Despite its failure of the null hypothesis, we cannot completely rule out the possibility as the temporal separation in 2007/2008 leaves only 8 data-points for recent intervals (Table 3).

(Comment 2) *Descriptions of model input data. In the Data section, the authors mentioned that they use meteorological data, including air pollution monitoring, such as in-situ dust density measurements. This is very general. What specific meteorological data were used as input parameters in the HYSPLIT modelling? What data were used directly for time-series analysis? More detailed and clear data description would be useful for the readers to understand the modelling and the results (Fig.2-8). Moreover, are there any criteria and reasons for choosing these four particular meteorological stations from 28? I guess it is possibly concerned with spatial distribution and longer coverage of observation periods etc.*

(Response to Comment 2)

As the referee pointed out, meteorological data collected from 4 stations were selected on the basis of efficient spatial and temporal coverage.

✓ Lines 20-23, Page 3

These stations are located at the western front (BR), southern edge (KS), eastern tail (UR), and central region (DJ) in South Korea, respectively. They were selected on the basis of spatial distribution and longer decadal coverage of observation periods.

The input data that we used were retrieved from the NCEP/NCAR Reanalysis-1 site at (https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html)

✓ Lines 27-32, Page 3

To trace the ADS provenance source, online version of backward trajectories HYSPLIT model (September 2015) was used. We used inputs of meteorological data from the National Centers for Environmental Prediction (NCEP; http://www.ncep.noaa.gov/) and the National Center for Atmospheric Research (NCAR: https://ncar.ucar.edu/) Reanalysis-1. Vertical motion of aerosol was adopted from the "Model Vertical Velocity" option on the HYSPLIT model (September 2015). Results of backward trajectories were displayed on ArcGIS program.

(Comment 3) *Please consider moving the added description of HYSPLIT model from the Introduction section to the second section (Data and analysis)?*

(Response to Comment 3) Section 2

A new section was made to include the extended explanation of HYSPLIT.

Section 2 The HYSPLIT Model

(Comment 4) *There are some repetitions of texts (for example, lines 22-23 at page 4 and lines 26-27 at page 3). Similar repetitions also occur for other texts, particularly in the result and discussion sections. Please check through.*

(Response to Comment 4)

Repeated sentences were deleted.

(Comment 5) *Page 5, line 4: "regional" may be a better word to replace "local" in the sentence "seasonal variation of ADS is a local, natural phenomenon in Eastern part of Asia".*

(Response to Comment 5) Line 30, Page 5

Revised as "regional".