



Supplement of

An aerosol classification scheme for global simulations using the K-means machine learning method

Jingmin Li et al.

Correspondence to: Jingmin Li (jingmin.li@dlr.de)

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Figure S1: The distribution of lower tropospheric clusters with K-means for k ranging from 3 to 14.

Lower tropospheric clusters K-Means



Middle tropospheric clusters K-Means

Figure S2: The distribution of middle tropospheric clusters with K-means for k ranging from 2 to 13.



Tropopause region clusters K-Means

Figure S3: The distribution of tropopause region clusters with K-means for k ranging from 2 to 13.

Mineral dust Mineral dust Standarization Minmaxscale Mineral dust Normalize Mineral dust Robustscaler 12 8 (%) JGJ 40 PDF (% ď. 0 0. 20000 30000 1.0 0.8 0.0×10⁻¹⁴ 0.8×10⁻¹⁴ 1.6×10⁻¹⁴ 2.4×10⁻¹⁴ 10000 15 -3.0 1.0 3.0 0.0 0.4 40 80 ndarization Black ca log10 M Robus scale 60 60 12 8 60 40 40 40 PDF (%) PDF (%) PDF PDF. P.C. 20 20 20 0 0 200 400 0.4 0.8 0.0×10⁻¹⁶ 1.0×10⁻¹⁶ 2.0×10⁻¹⁶ 3.0×10⁻¹ -3.0 -1.0 1.0 0.0 SNA log10_s ndarizatio SNA Normalizer **SNA** Raw larization SNA scal 30 30 12 30 30 02 20 50 JDL 20 20 20 Ľ, HC. , La 10 10 10 0 0 8000 0.8 4000 0.4 12000 1.0 2.0×10⁻¹⁵ 4.0×10 -3.0 1.0 0.0 0.0×10 10 3.0 РОМ POM Normal R Standarlza PON POM Minma> ом Robustsc 40 40 40 (%) 20 20 PDF (%) 40 PDF. 4 20 20 0 0 1000 2000 3000 0.4 0.8 2.0×10⁻¹⁵ -3.0 -1.0 0.0 1.0 0.0×10⁻¹ 2 Seasalt Rav Standarizatio log10 darizatio Minmaxscale Seasalt , Robustscale Se Seasalt Normalize 24 24 12 40 24 16 16 PDF (%) DF (%) 20 5 0 0 -0 0 400 -1.0 1.0 3.0 5.0 -3.0 1.0 1.0 0.4 0.8 0.0×10⁻¹⁶ 4.0×10⁻¹⁶ 8.0×10 1.0 1.0 3.0 0.0 Standarizat Minmaxscale NA Robustscale 30 18 12 00 (%) 20 12 20 20 b Ľ, , FO ä 10 10 0 0 -0 -0 0 0 1.0 3.0 8 -1.0 5.0 -3.0 1.0 1.0 3.0 0.0 0.4 0.8 0.2 0.6 -2.0 2.0 6.0 N A0 Ray ΝA Standarization Min 24 24 12 16 12 PDF (%) 2.0 0.0 4.0 0.8 0.5 4.0 4.0 2.0 0.0 0.4 0.0 2.0

Figure S4: Similar to Fig. 7, but showing the pdf of middle tropospheric aerosol before scaling and after S1-S5 scaling.

4.0 0.0 0.3

0.7 0.9 -2.0

-4.0

0.0

-2.0

Middle troposphere



Middle tropospheric clusters

Figure S5: Similar to Fig.8, but showing the comparison of middle tropospheric aerosol cluster distributions using S1-S5 scaled data via K-means clustering, and S1 scaled data via HAC clustering.



Figure S6: Similar to Fig. 7, but showing the pdf of tropopause region aerosol before scaling and after S1-S5 scaling.



Tropopause region clusters

Figure S7: Similar to Fig.8, but showing the comparison of tropopause region aerosol cluster distributions using S1-S5 scaled data via K-means clustering, and S1 scaled data via HAC clustering.

Figure S8: Similar to Fig. 9, but showing the dendrogram plot of HAC clustering for middle tropospheric aerosols.

Figure S9: Similar to Fig. 9, but showing the dendrogram plot of HAC clustering for tropopause region aerosols.