



*Supplement of*

**Record-breaking dust loading during two mega dust storm events over northern China in March 2021: aerosol optical and radiative properties and meteorological drivers**

**Ke Gui et al.**

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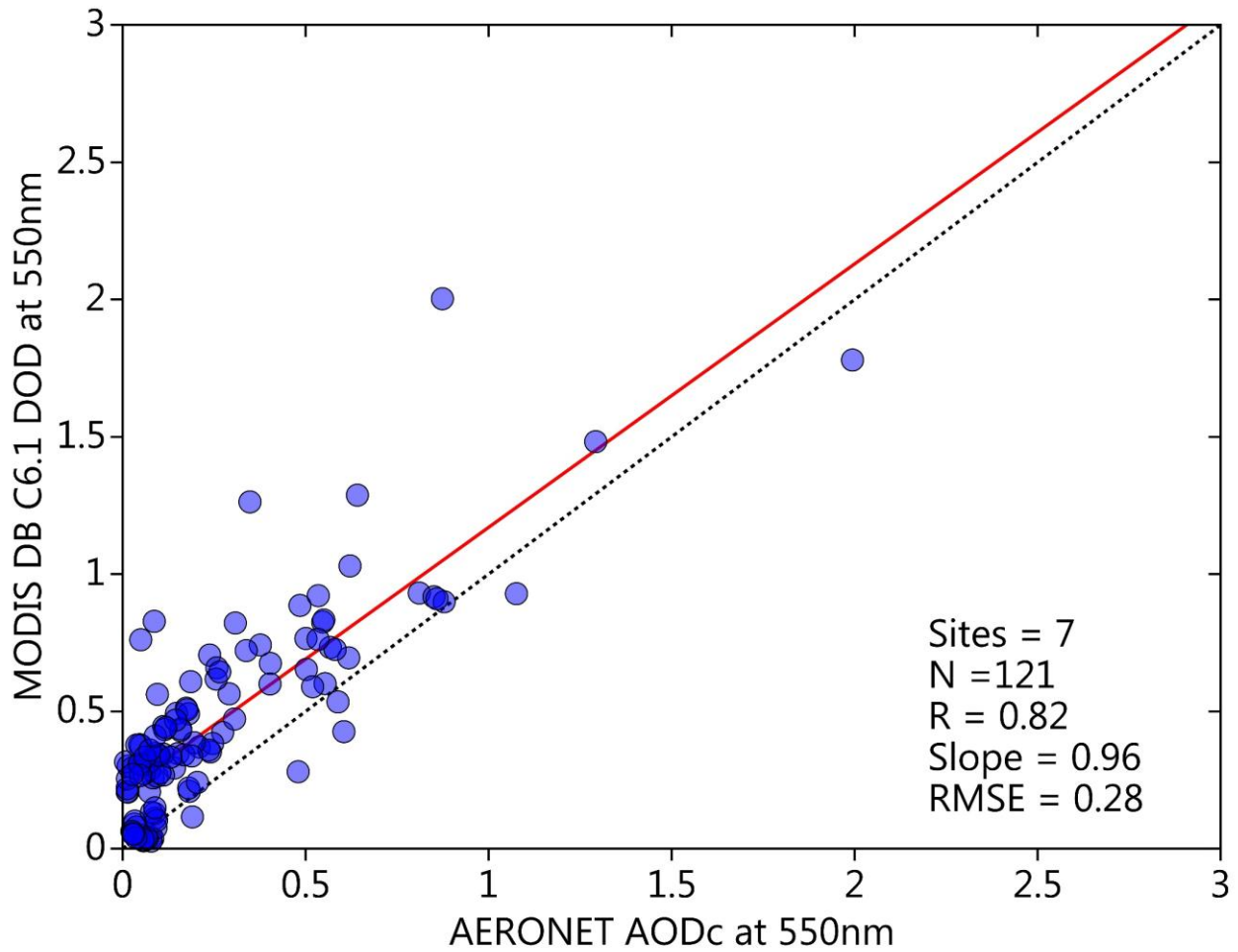
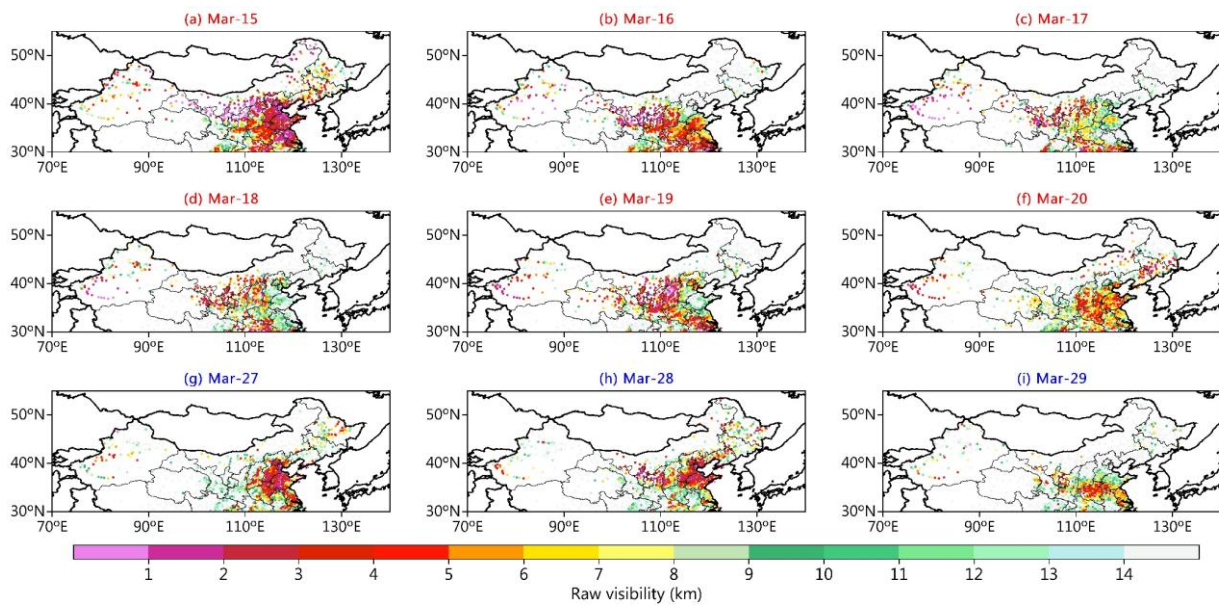
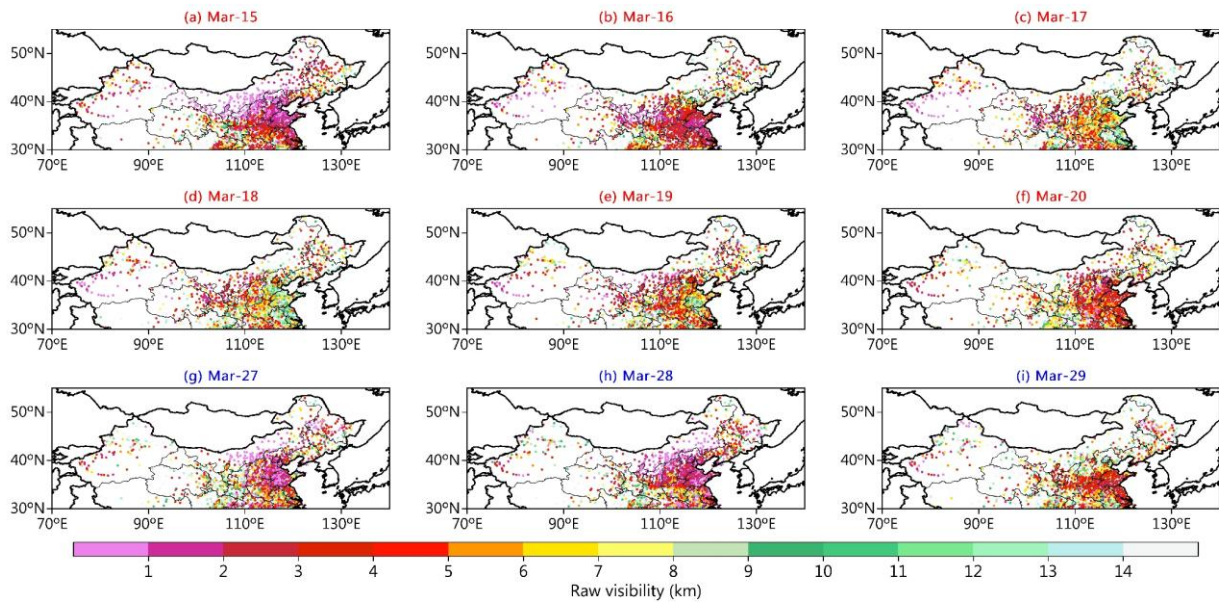


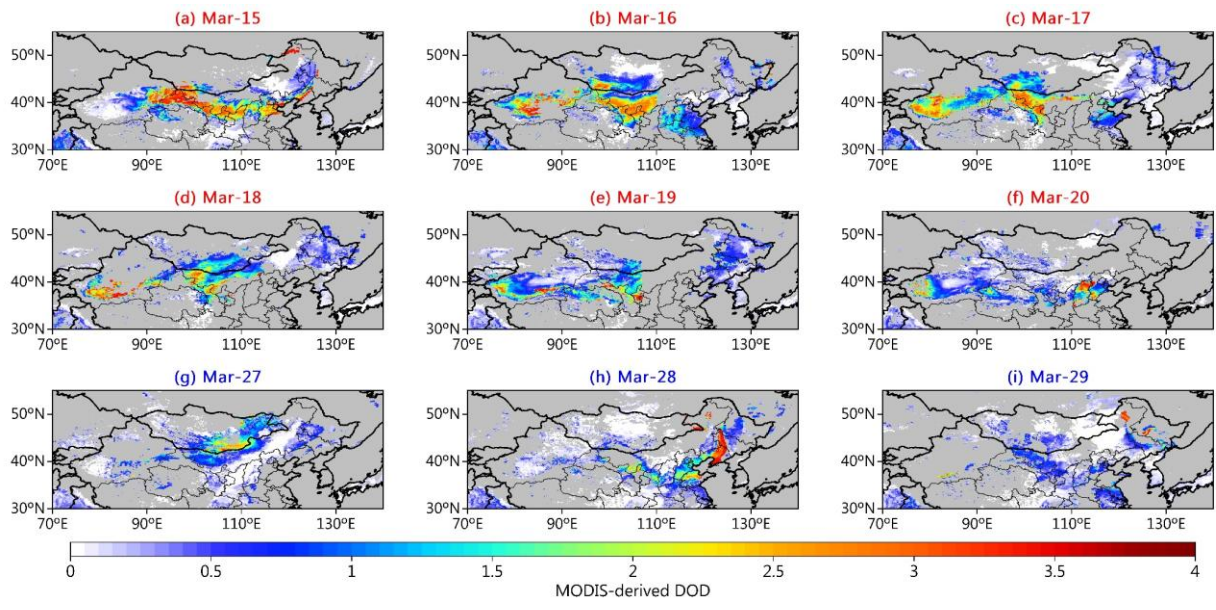
Figure S1: Scatter plot of the daily mean MODIS DOD against the AERONET coarse-mode AOD (AODc) retrieved at 550nm. The 1-to-1 line and linear regression line are shown by black dotted and red solid lines, respectively. The number of sites (Sites), matchups (N), Pearson correlation coefficient ( $R$ ), slope, and root mean square error (RMSE) of the linear regression are indicated in the lower right of the panel.



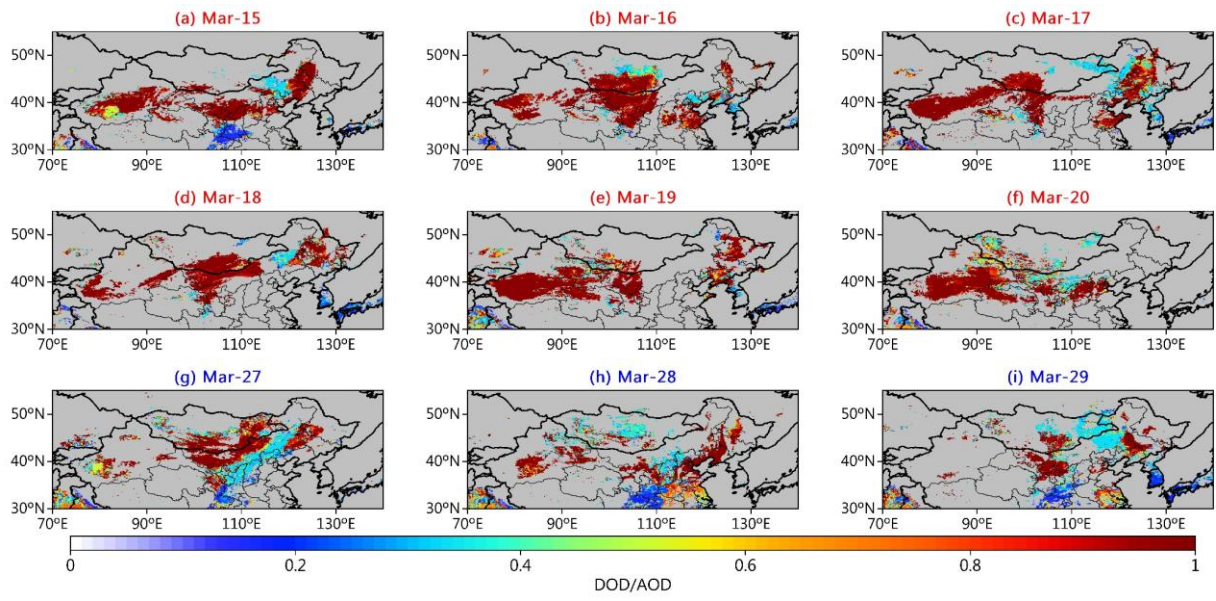
**Figure S2: Evolution of observed daily mean raw (uncorrected) visibility during (a–f) the 3.15 event (March 15–20, 2021) and (g–i) the 3.27 event (March 27–29, 2021).**



**Figure S3: Evolution of observed daily minimum hourly corrected visibility during (a–f) the 3.15 event and (g–i) the 3.27 event.**

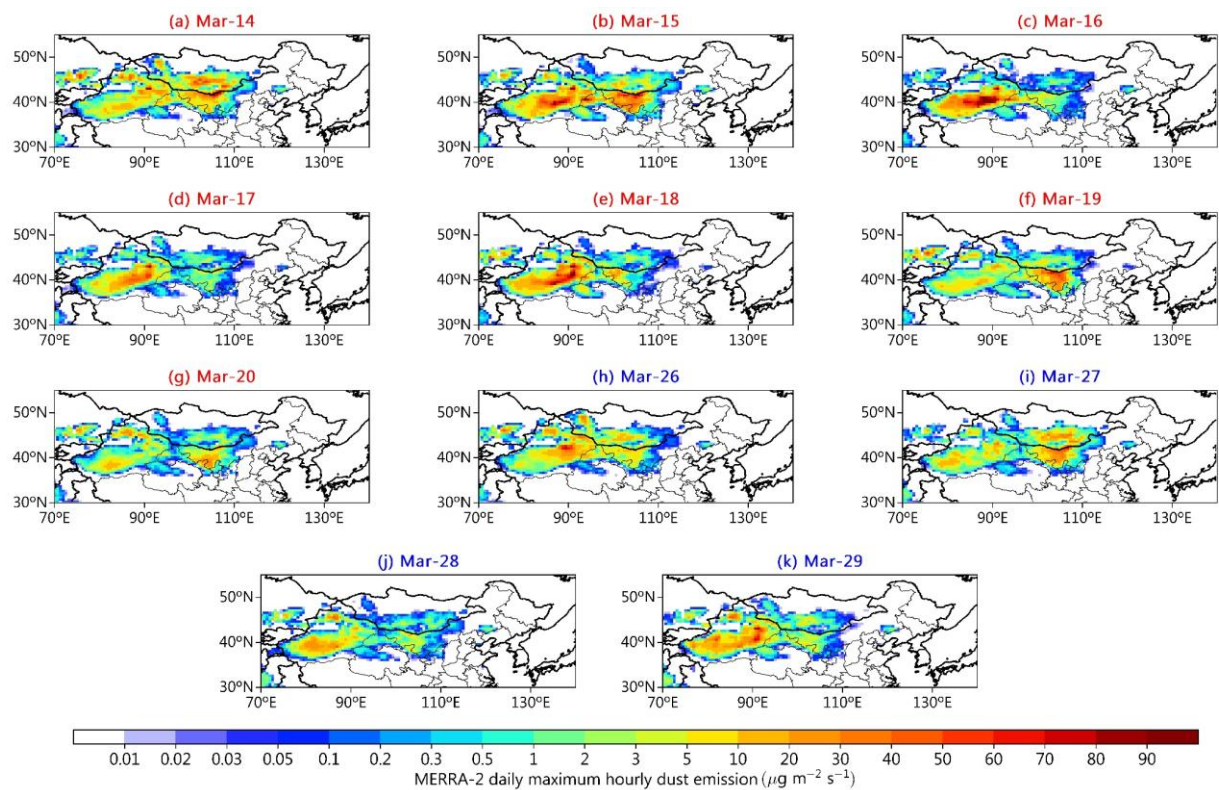


**Figure S4: Evolution of Aqua and Terra combined daily mean DOD during (a–f) the 3.15 event and (g–i) the 3.27 event.**

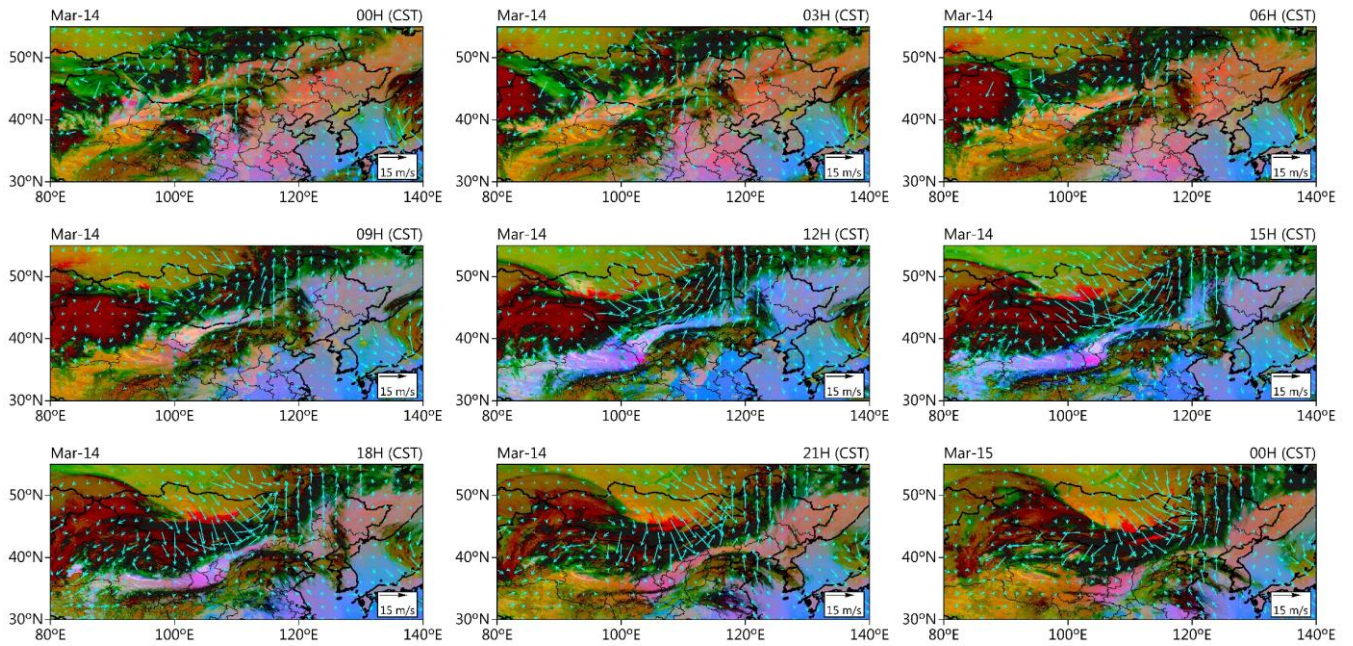


**Figure S5: As in Fig. S4 but for the daily mean DOD as a proportion of total AOD.**



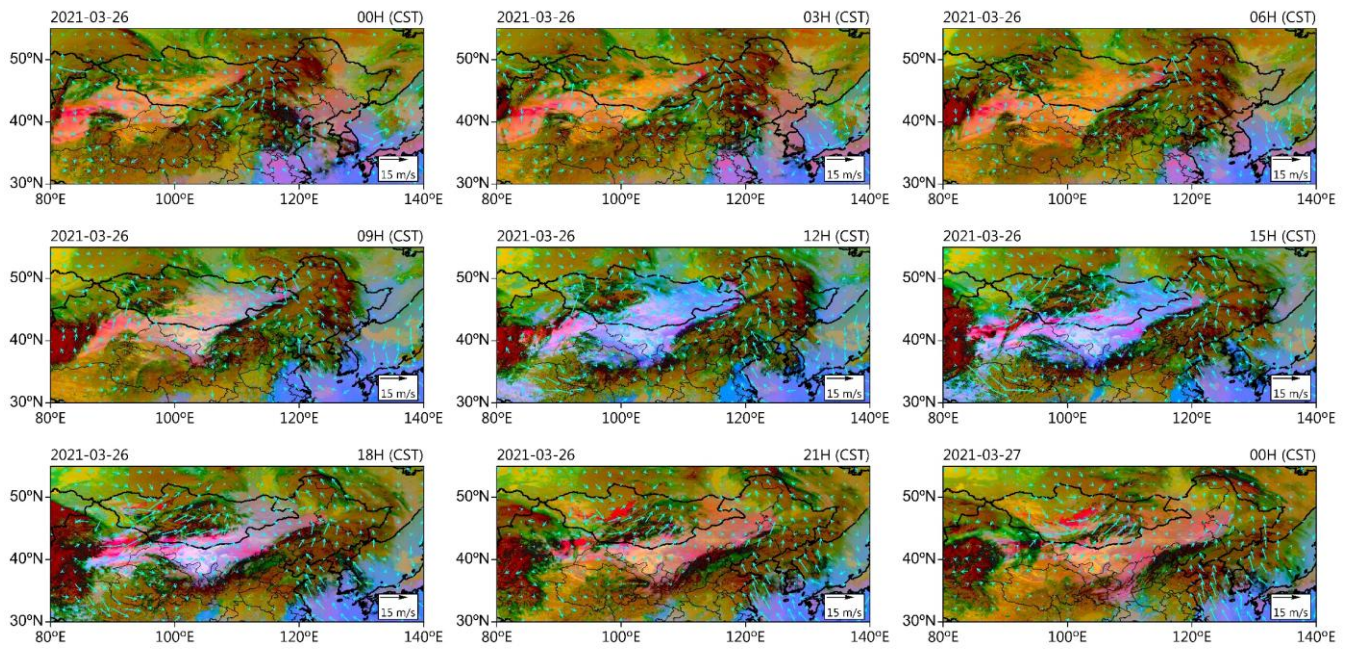


**Figure S6: Evolution of MERRA-2 daily maximum hourly dust emissions for all size bins during (a–g) March 14–20, 2021 and (h–k) March 26–29, 2021.**

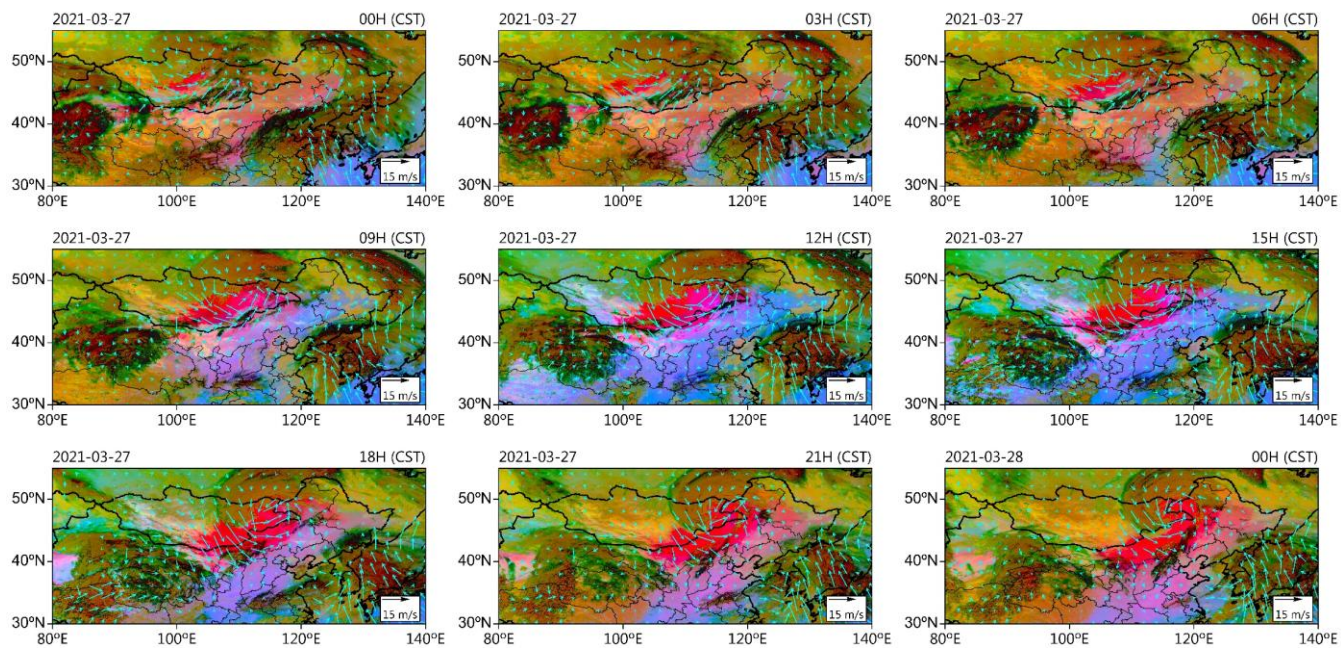


**Figure S7: The 3-h evolution of dust plumes (magenta) as revealed by Himawari-8 dust RGB composite images on March 14, 2021. Overlaid on the RGB imagery is the 3-h ERA5 wind vectors at 10m.**

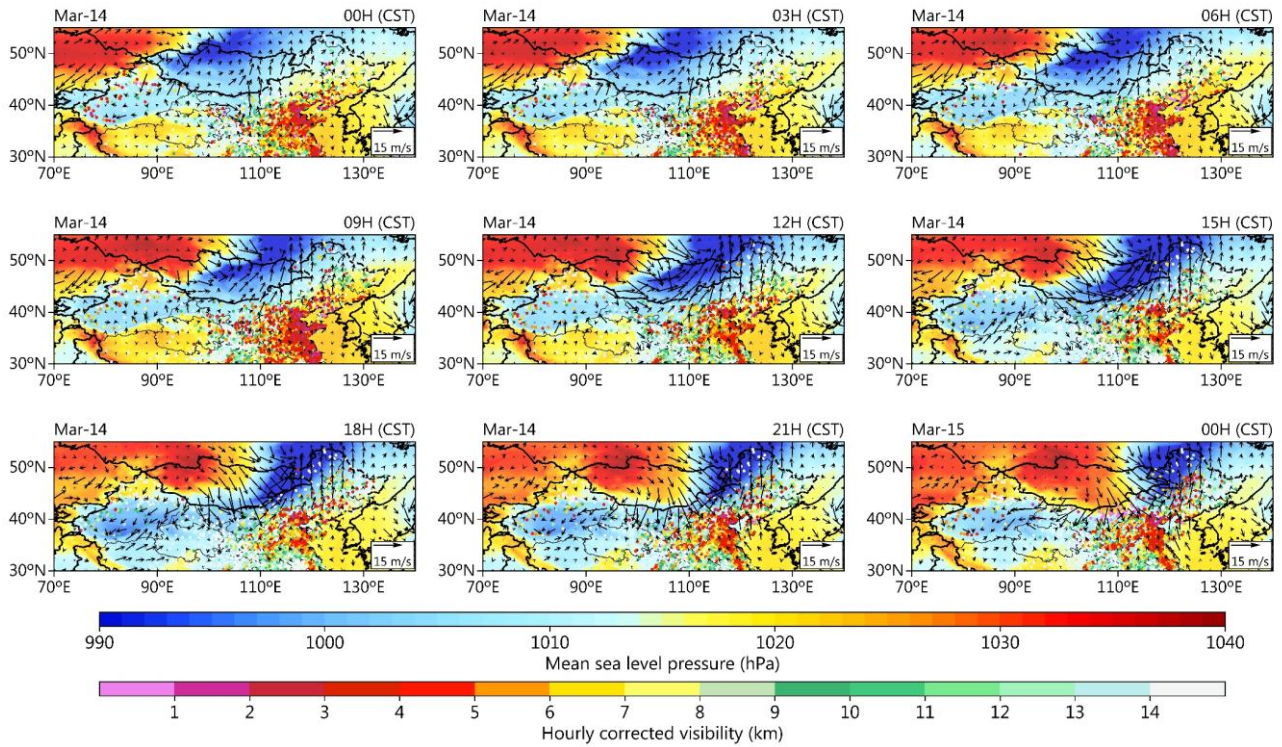




**Figure S8.** The same as Fig. S7, but for March 26, 2021.

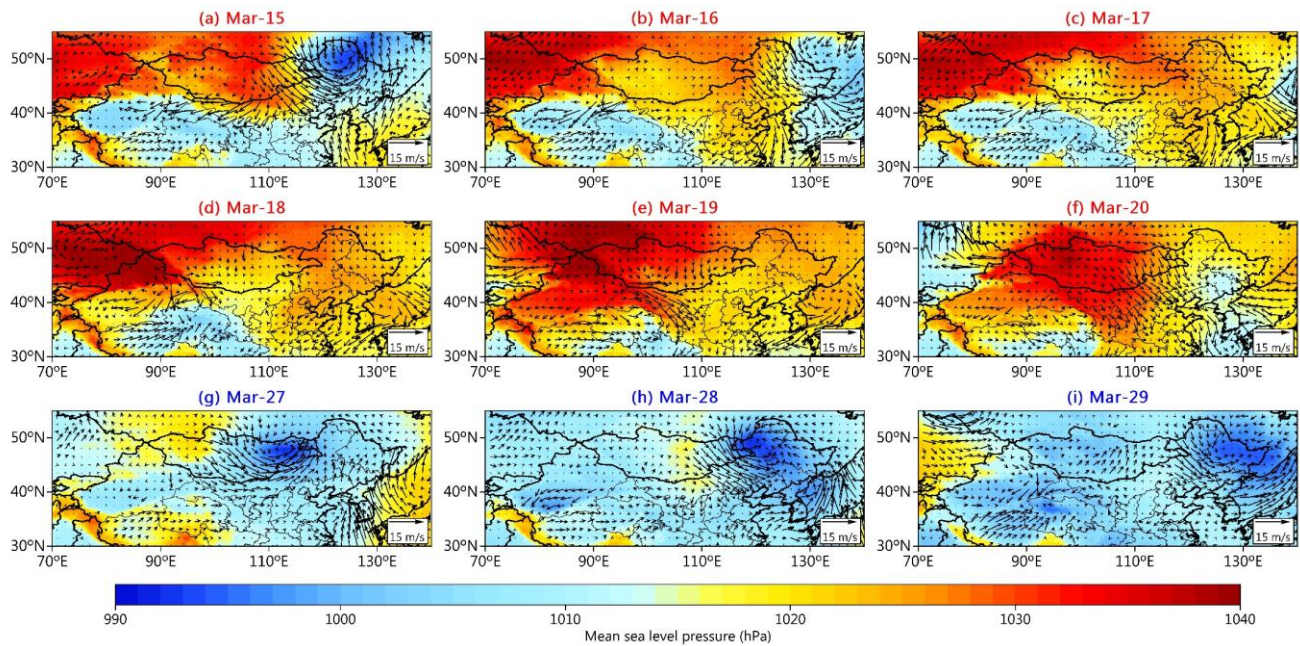


**Figure S9.** The same as Fig. S7, but for March 27, 2021.



**Figure S10: The 3-h pattern evolutions of ERA5 mean sea level pressure (SLP) and 10 m wind vectors on March 14, 2021. Overlaid on the SLP is the observed 3-h corrected visibility.**





**Figure S11: Pattern evolutions of ERA5 daily mean SLP (shading; hPa) and 10m wind vectors (black arrows;  $\text{m s}^{-1}$ ) on (a) March 15, (b) 16, (c) 17, (d) 18, (e) 19, (f) 20, (g) 27, (h) 28, and (i) 29, 2021.**

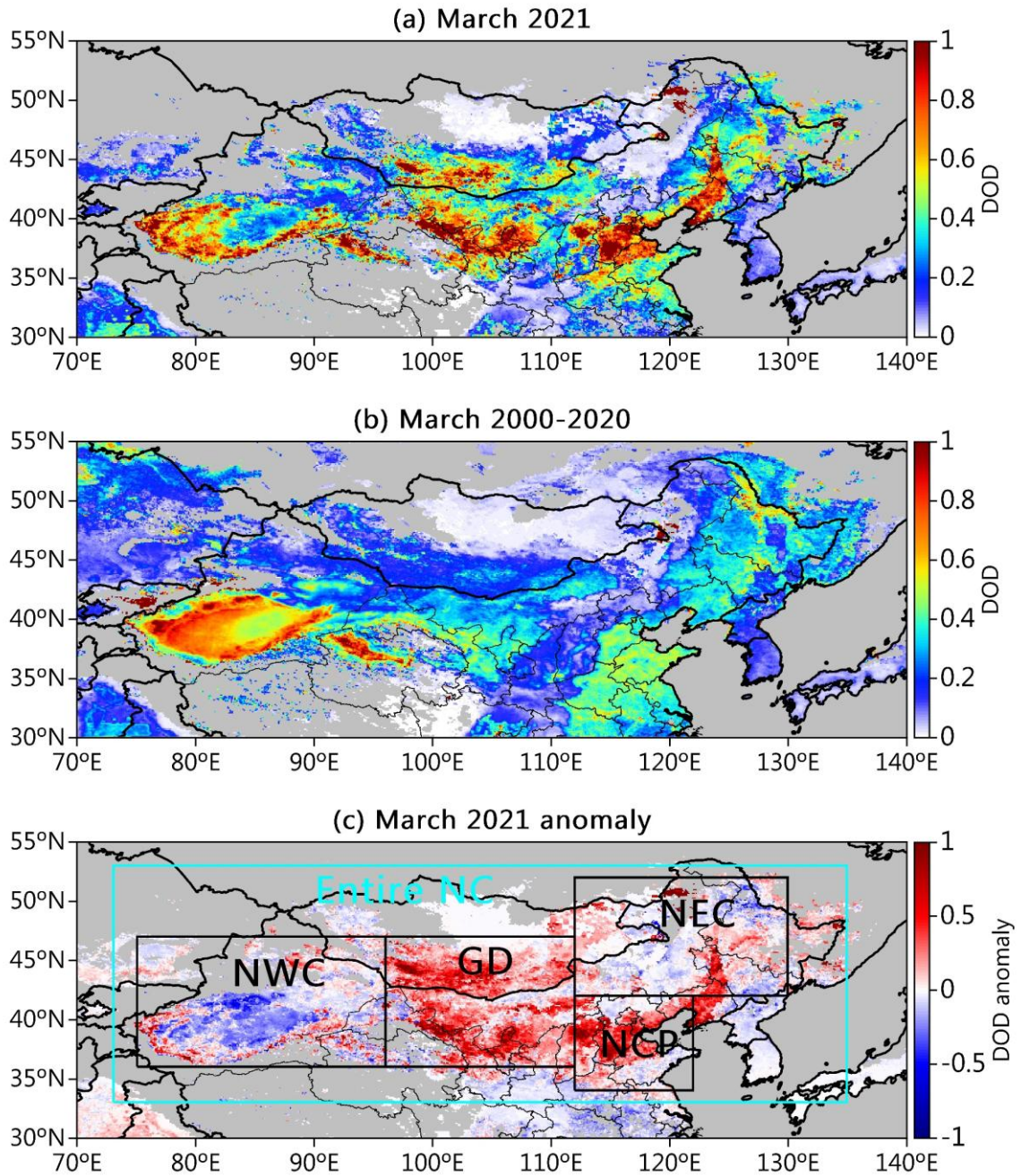


Figure S12: DOD retrieved from MODIS/Terra: (a) March 2021; (b) March climatology (2000–2020); (c) March 2021 anomaly.

Cyan and black boxes denote the averaging areas for the DOD time series.



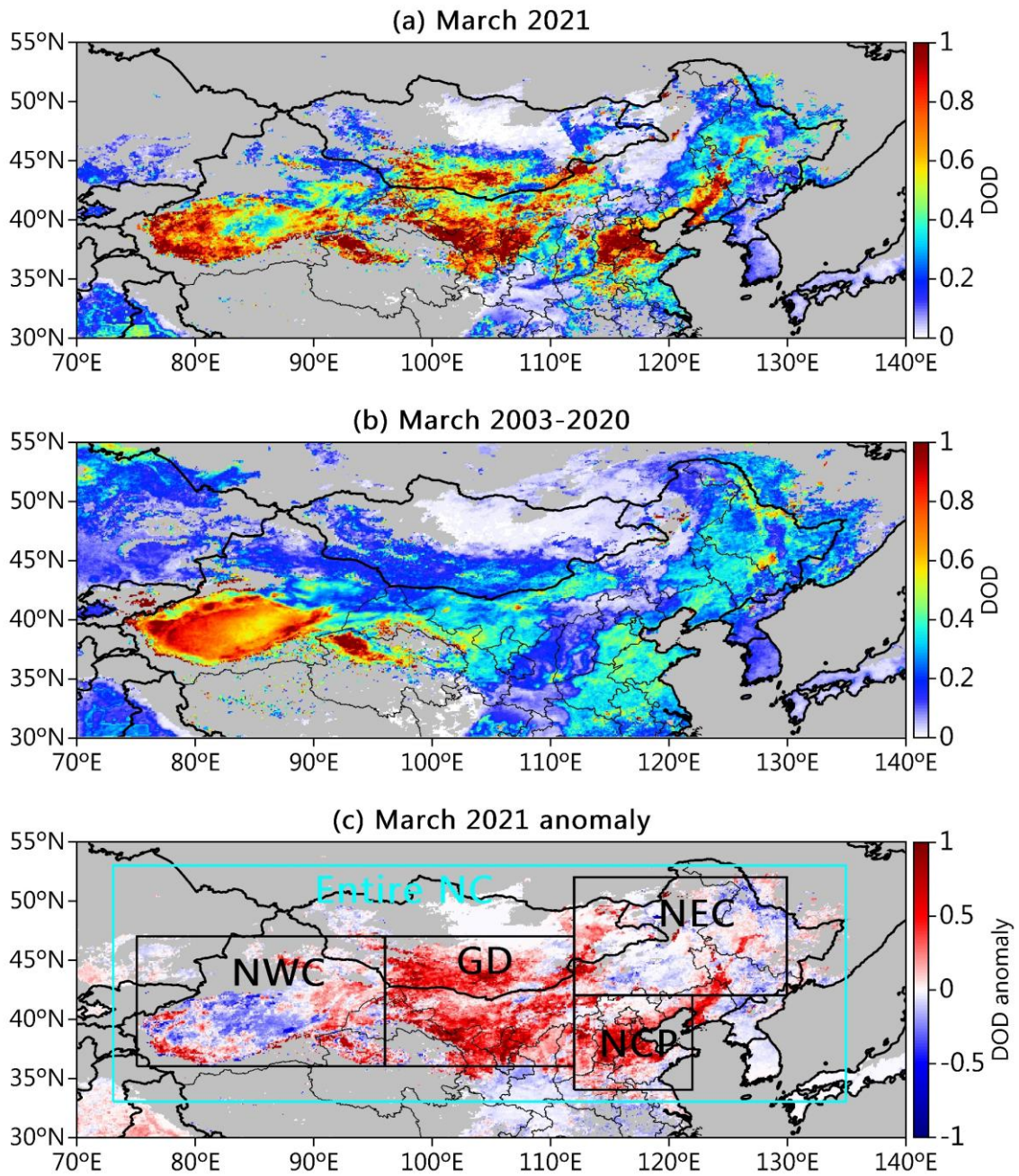
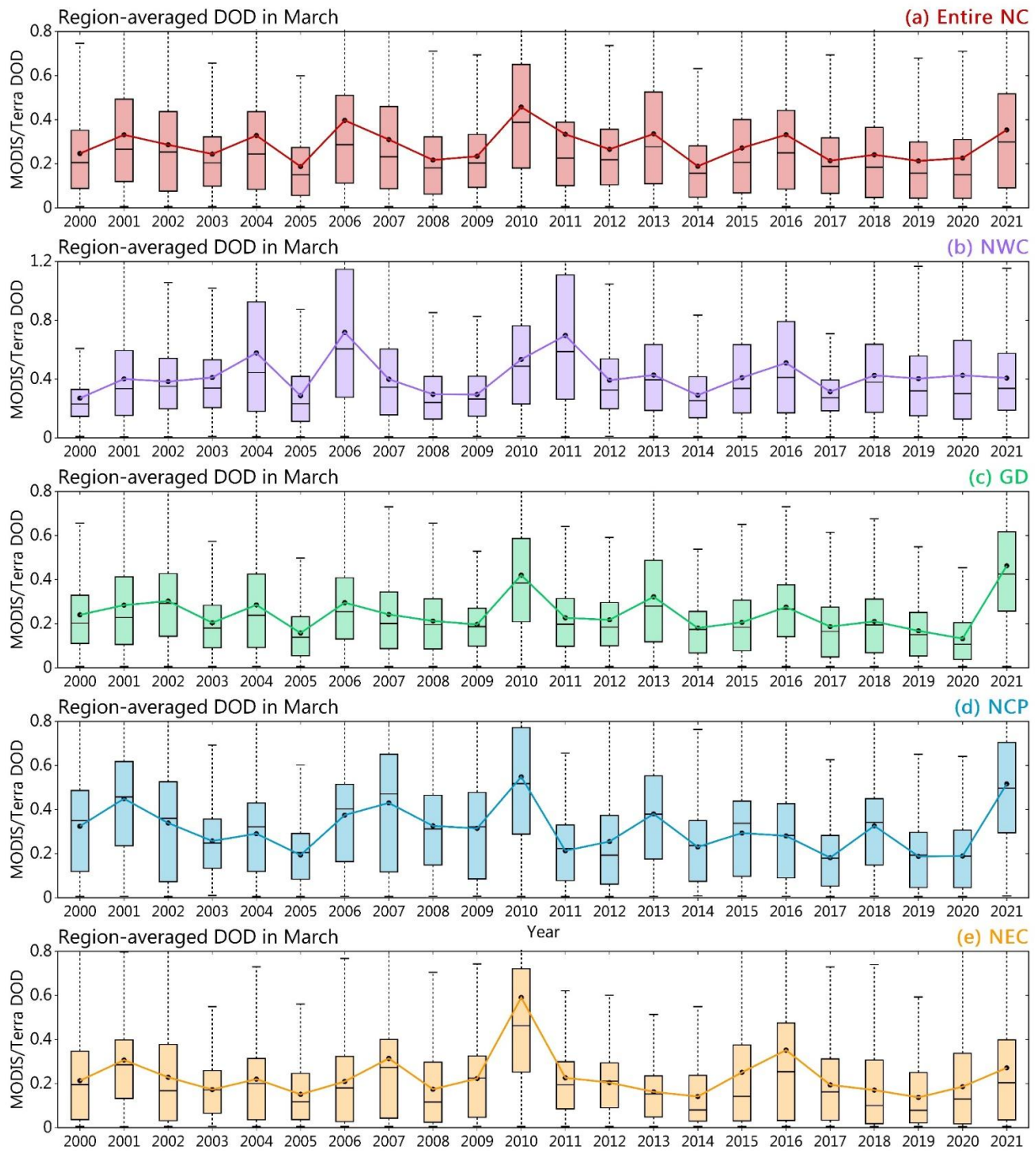
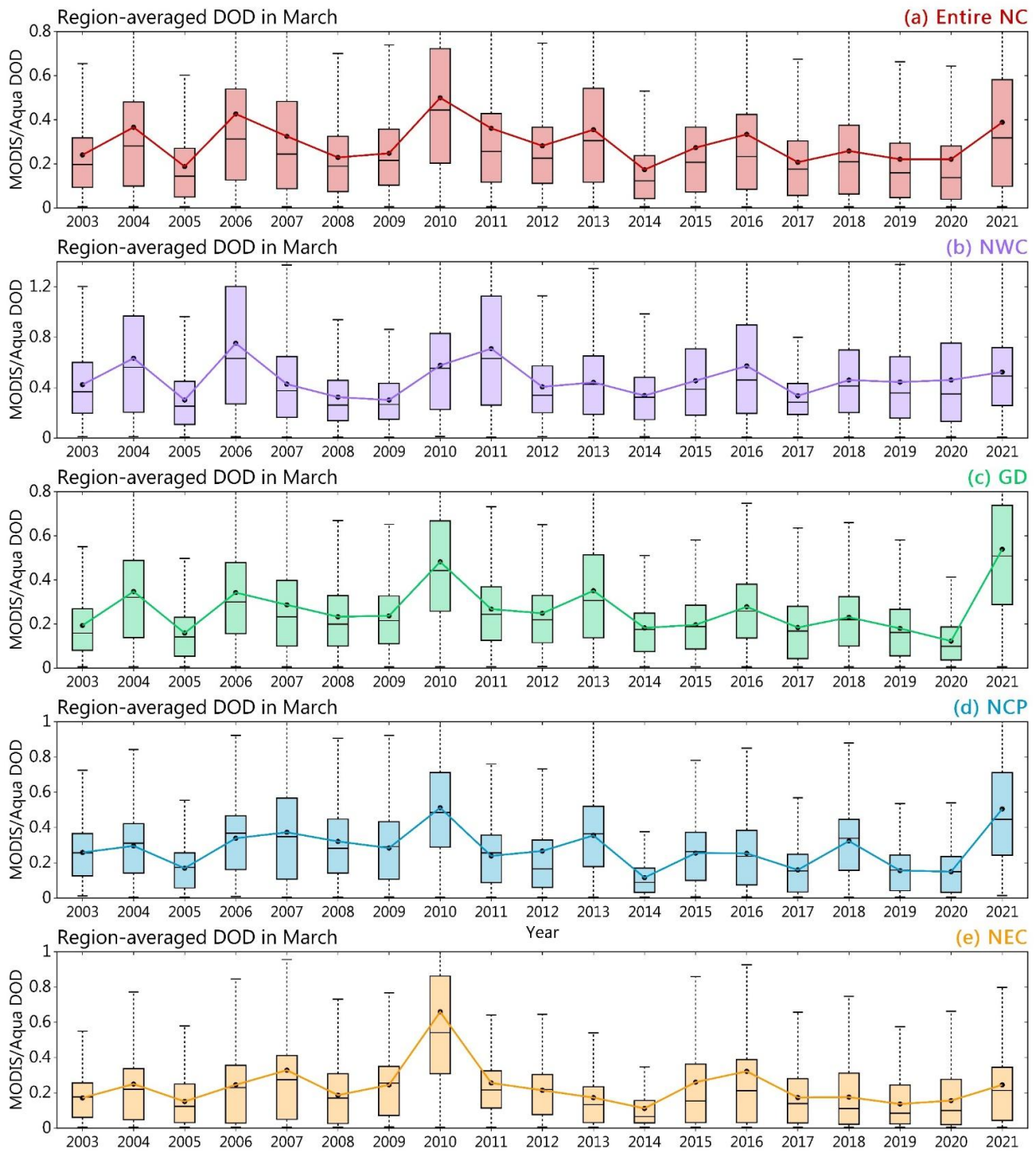


Figure S13: DOD retrieved from MODIS/Aqua: (a) March 2021; (b) March climatology (2003–2020); (c) March 2021 anomaly.

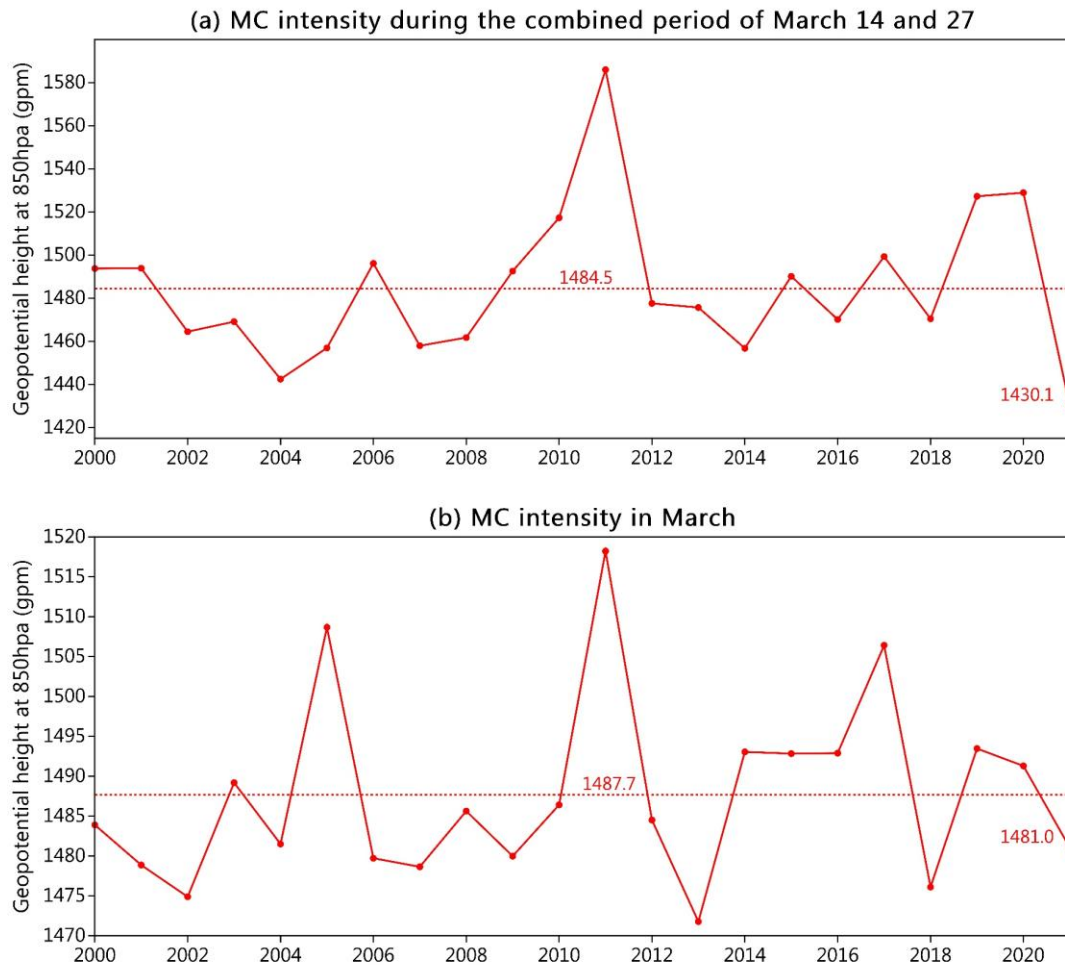


**Figure S14: Time-series boxplots of the regional-averaged DOD retrieved from MODIS/Terra over (a) the entire NC region, (b) NWC, (c) the GD, (d) the NCP, and (e) NEC in March from 2000 to 2021.**

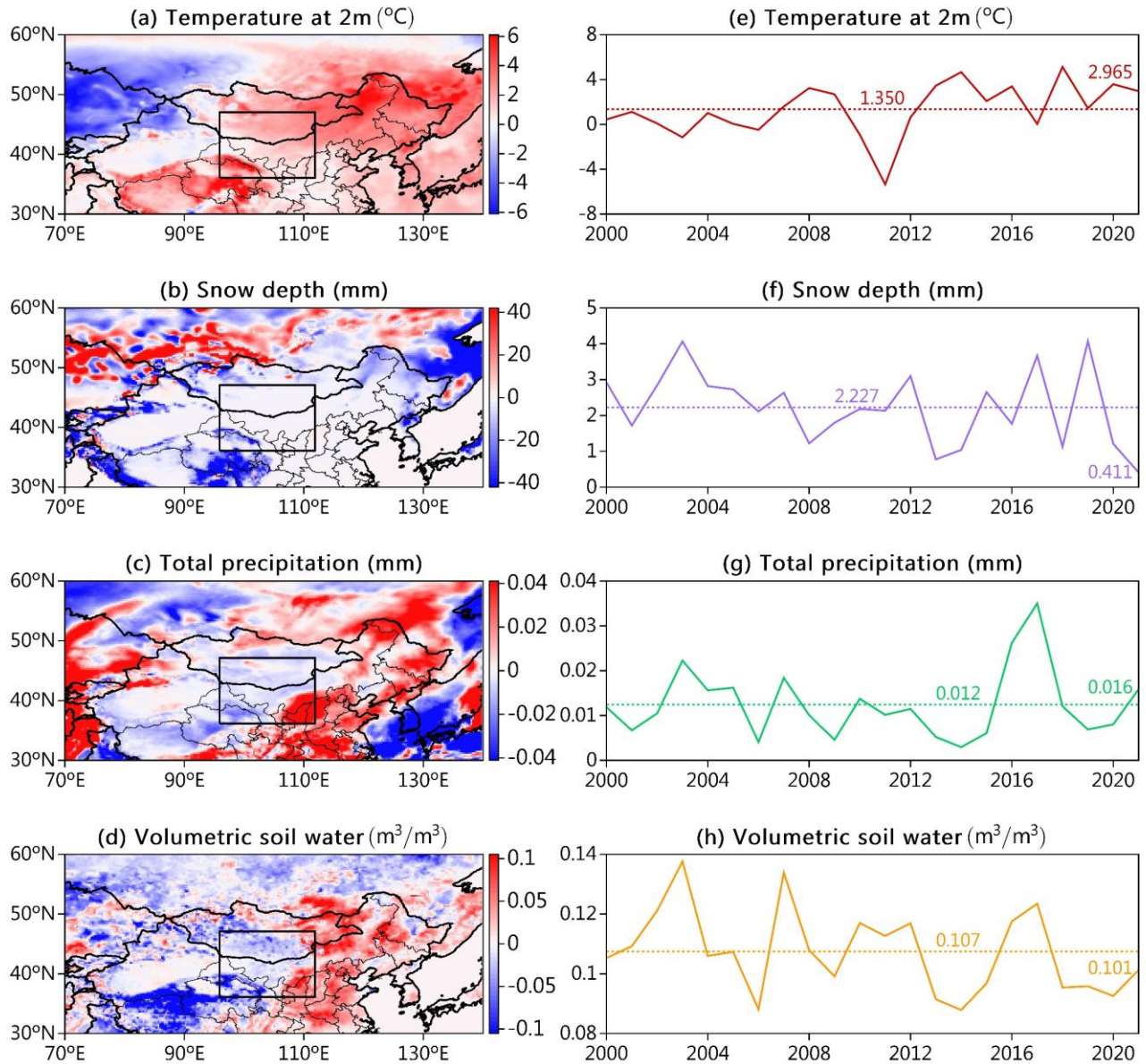


**Figure S15: Time-series boxplots of the regional-averaged DOD retrieved from MODIS/Aqua over (a) the entire NC region, (b) NWC, (c) the GD, (d) the NCP, and (e) NEC in March from 2003 to 2021.**





**Figure S16: Time-series of the Mongolian cyclone (MC) intensity index, which is the geopotential height at 850hPa averaged over the region of 36°–47° N, 96°–112° W, (a) during the combined period of March 15 and 27 and (b) in March from 2000 to 2021.**



**Figure S17: ERA5 meteorological anomalies two weeks (i.e., March 13–26, 2021) before the 3.27 SDS event: (a–d) anomalies of temperature at 2m (°C), and snow depth (mm), total precipitation (mm), and volumetric soil water (m<sup>3</sup> m<sup>-3</sup>) with reference to the 2000–2020 climatology. Black boxes in (a–d) denote the averaging areas (i.e., the GD; 36°–47° N; 96°–112° W) for the meteorological time series. (e–h) Time series of ERA5 meteorological factors two weeks before the 3.27 event averaged over the GD. The numbers and dashed lines represent the multi-year averages and their locations, respectively. Also, the magnitude for 2021 is labelled.**