Supplementary Information for

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

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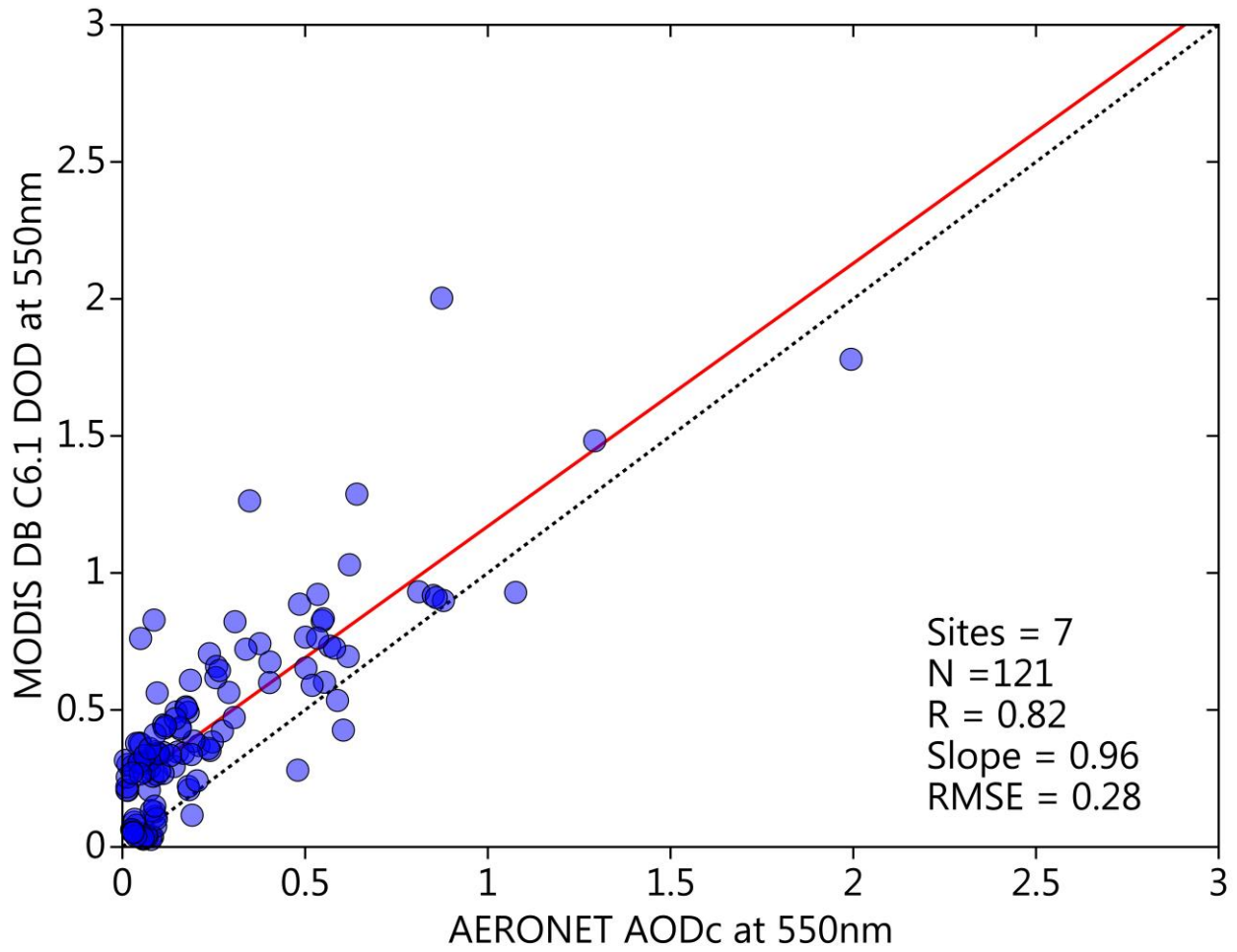15 *Correspondence to*: Huizheng Che (chehz@cma.gov.cn)

**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.
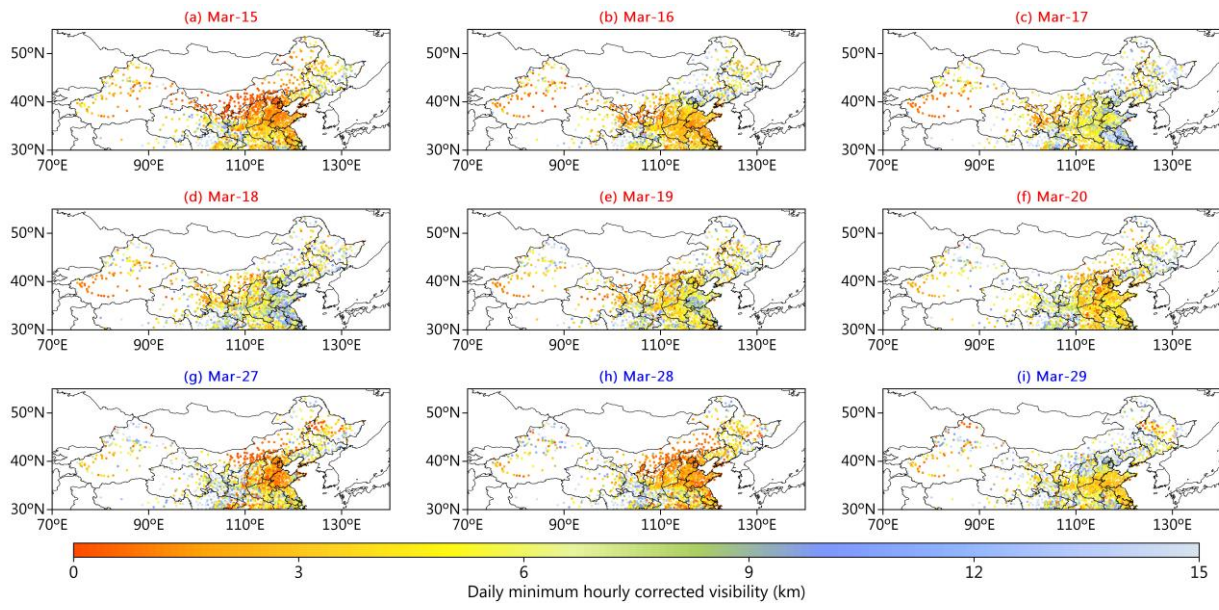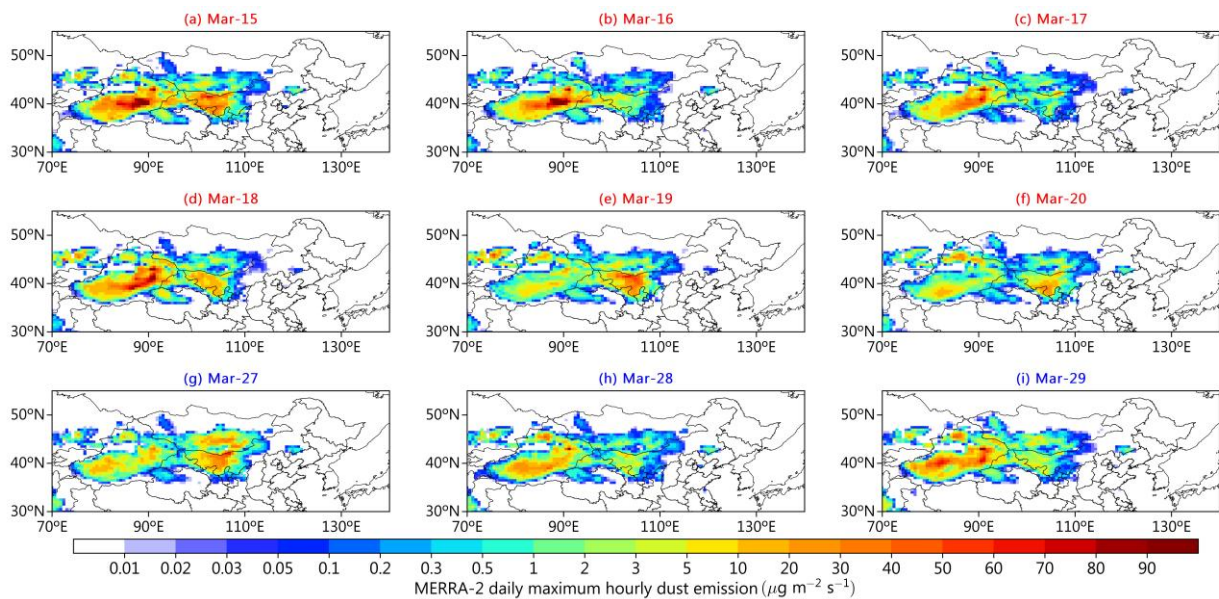
25 **Figure S2: Evolution of observed daily minimum hourly corrected visibility during (a–f) the 3.15 event (March 15–20, 2021) and (g–i) the 3.27 event (March 27–29, 2021).**
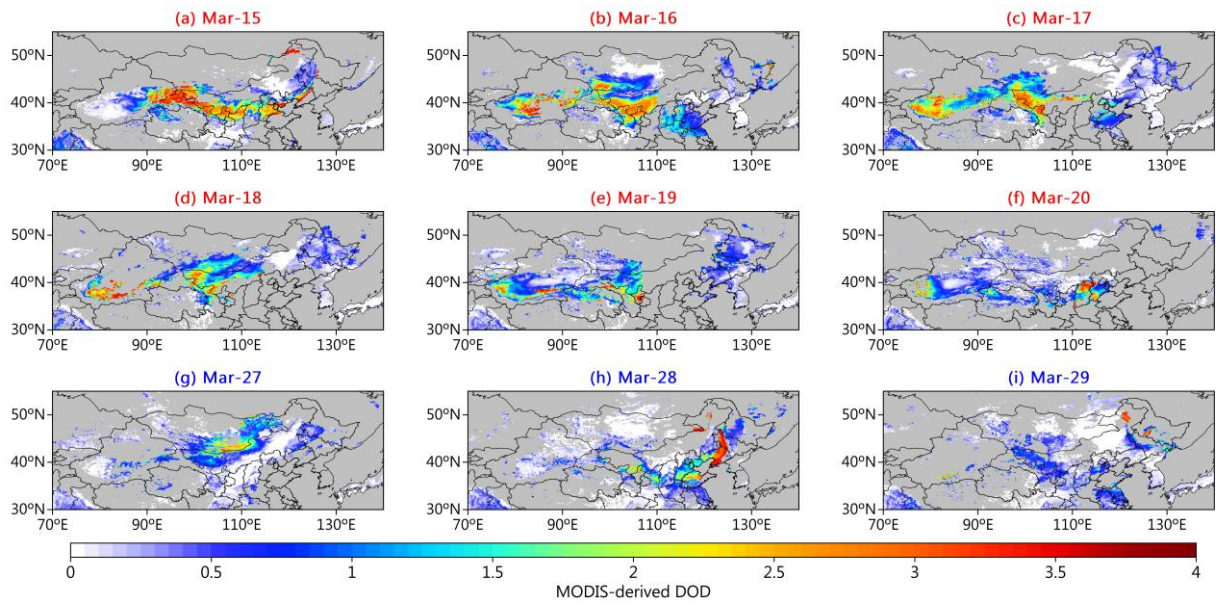
Figure S3: Evolution of Aqua and Terra combined daily mean DOD during (a–f) the 3.15 event and (g–i) the 3.27 event.

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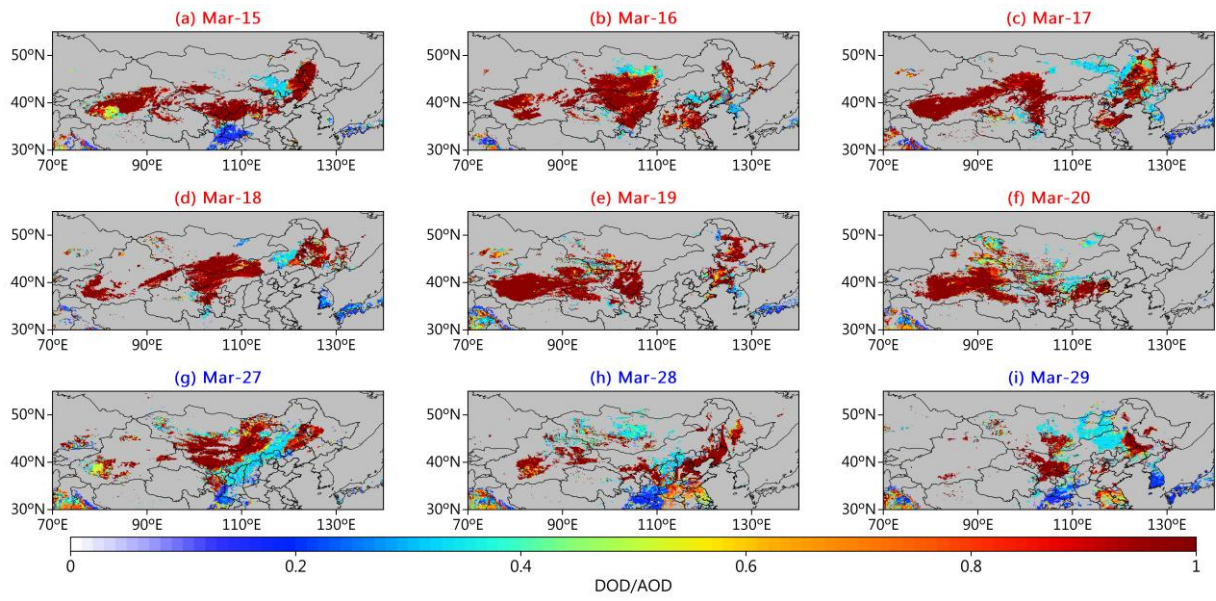
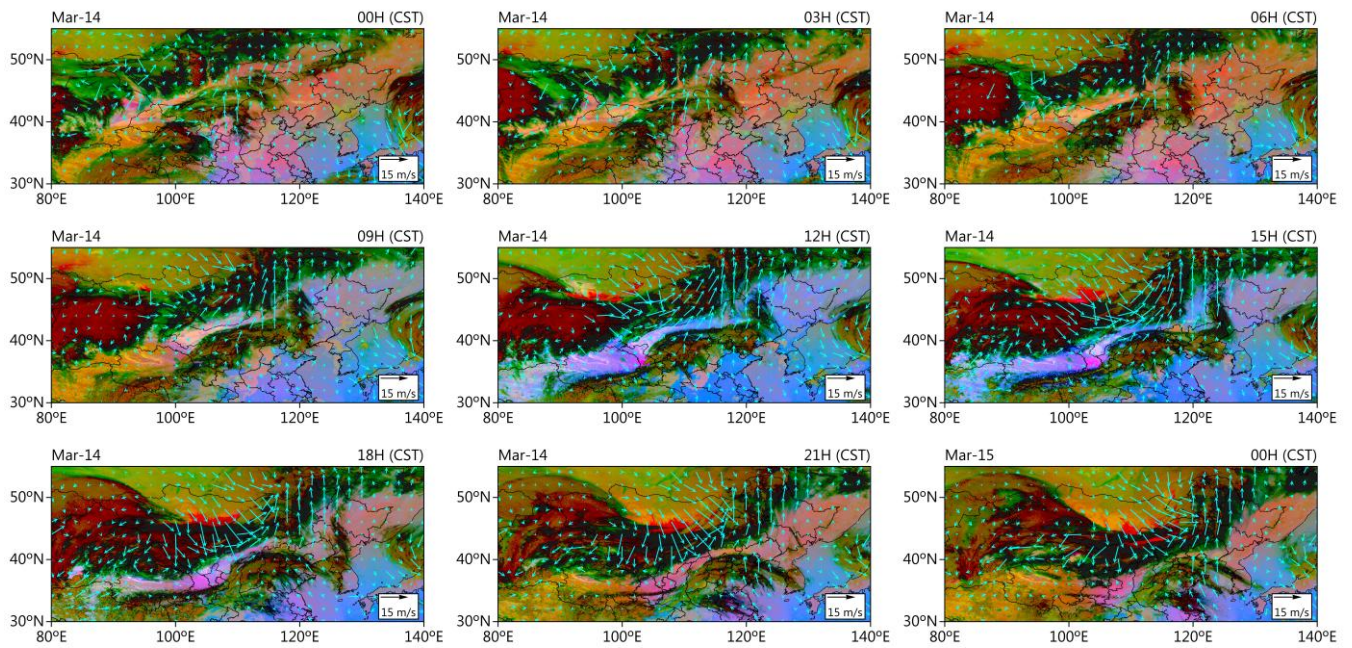**Figure S4: As in Fig. S3 but for the daily mean DOD as a proportion of total AOD.**
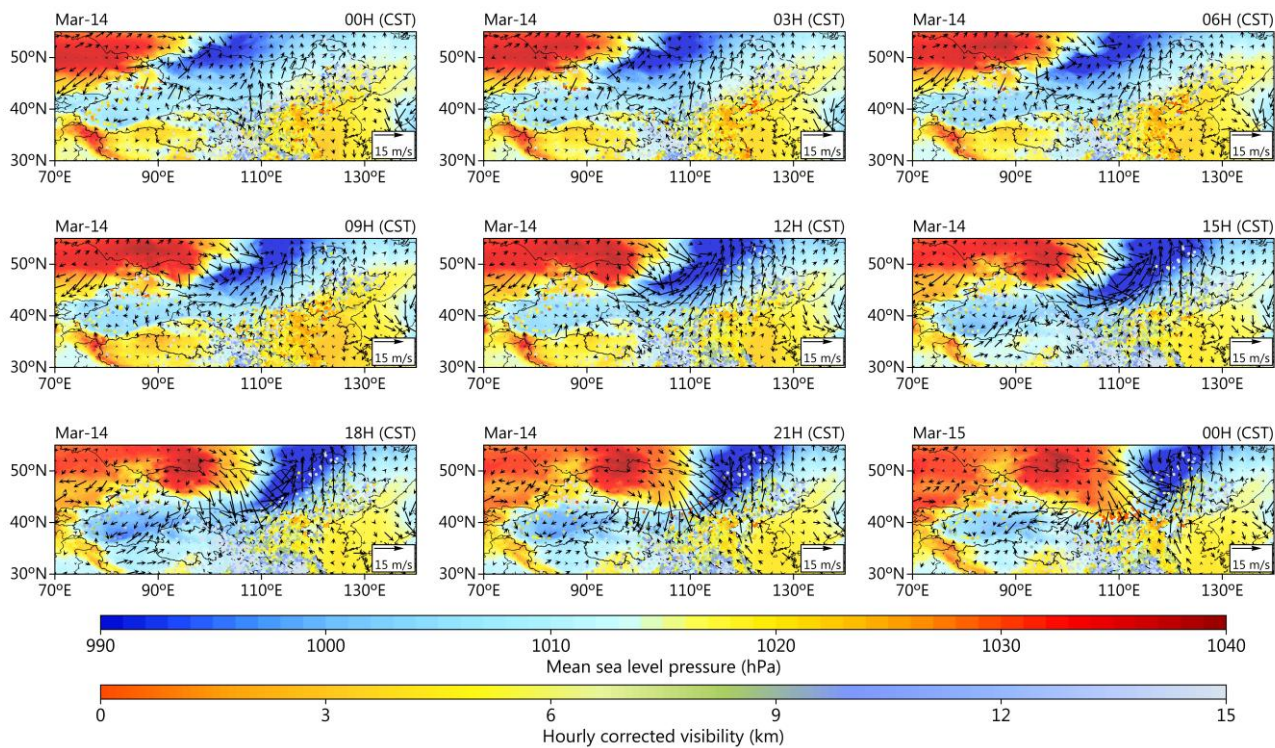
Figure S5: Evolution of MERRA-2 daily maximum hourly dust emissions for all size bins during (a–f) the 3.15 event and (g–i) the 3.27 event.
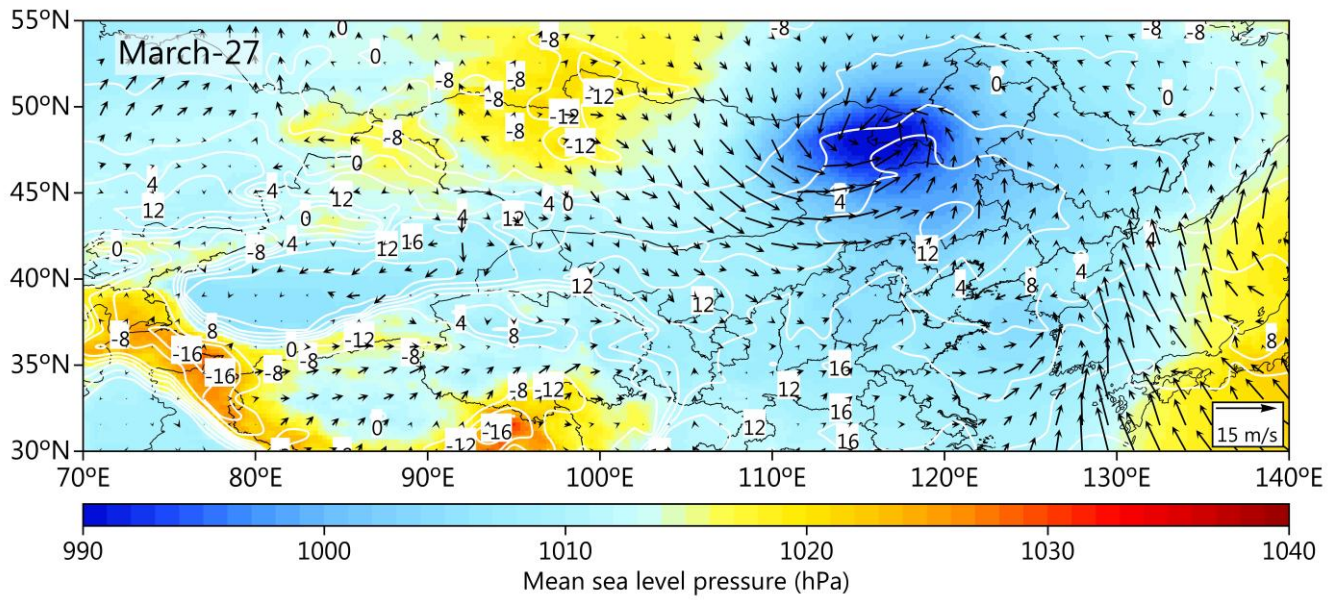
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Figure S6: The 3-h evolution of dust plumes (magenta) as revealed by Himawari-8 dust RGB composite images on March 14, 2021. Overlaid on the RGB imagery is the 3-h ERA5 wind vectors at 10m.
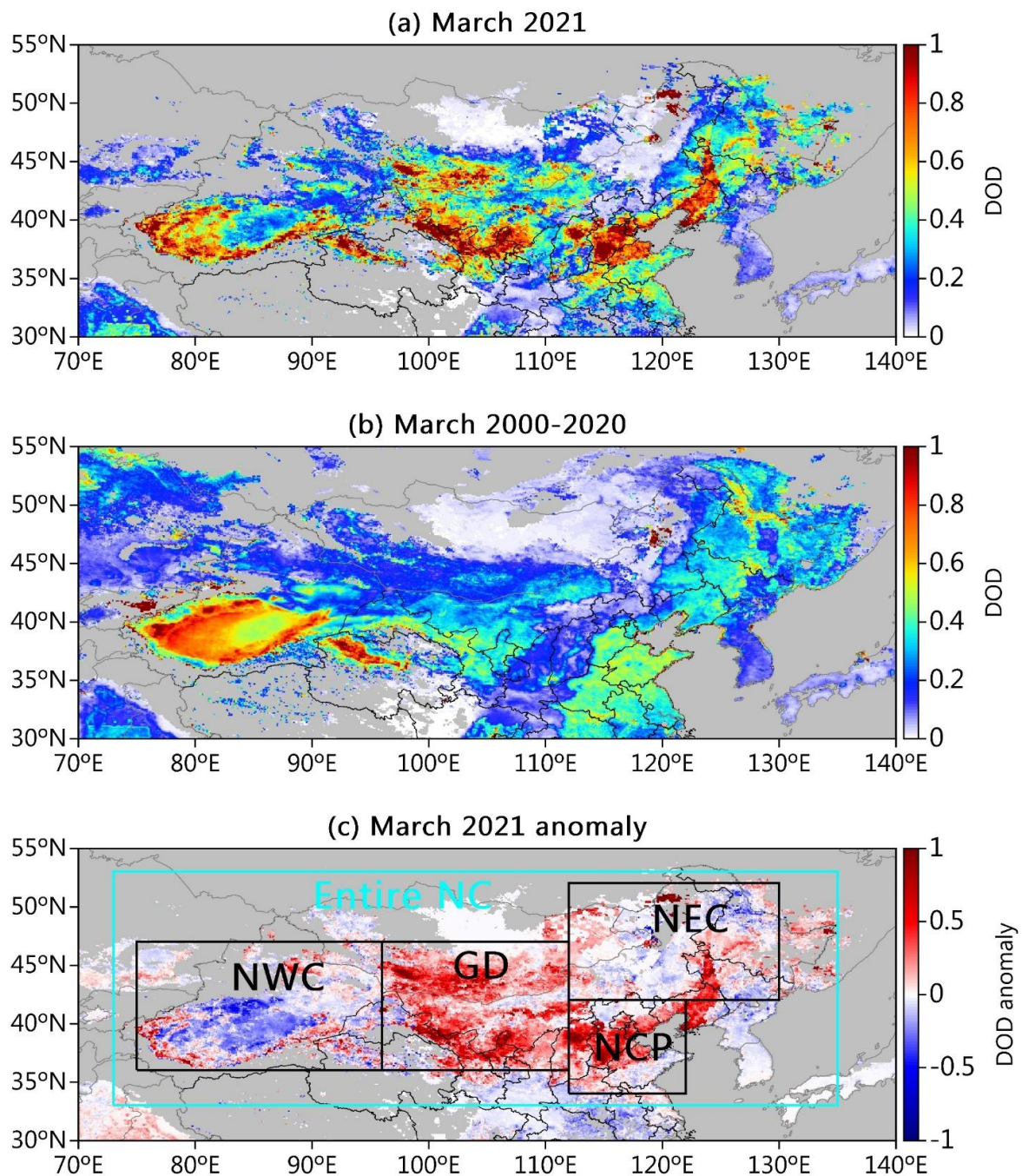
Figure S7: The 3-h pattern evolutions of ERA5 mean sea level pressure (SLP) and 10 m wind vectors on March 14, 2021.Overlaid on the SLP is the observed 3-h corrected visibility.
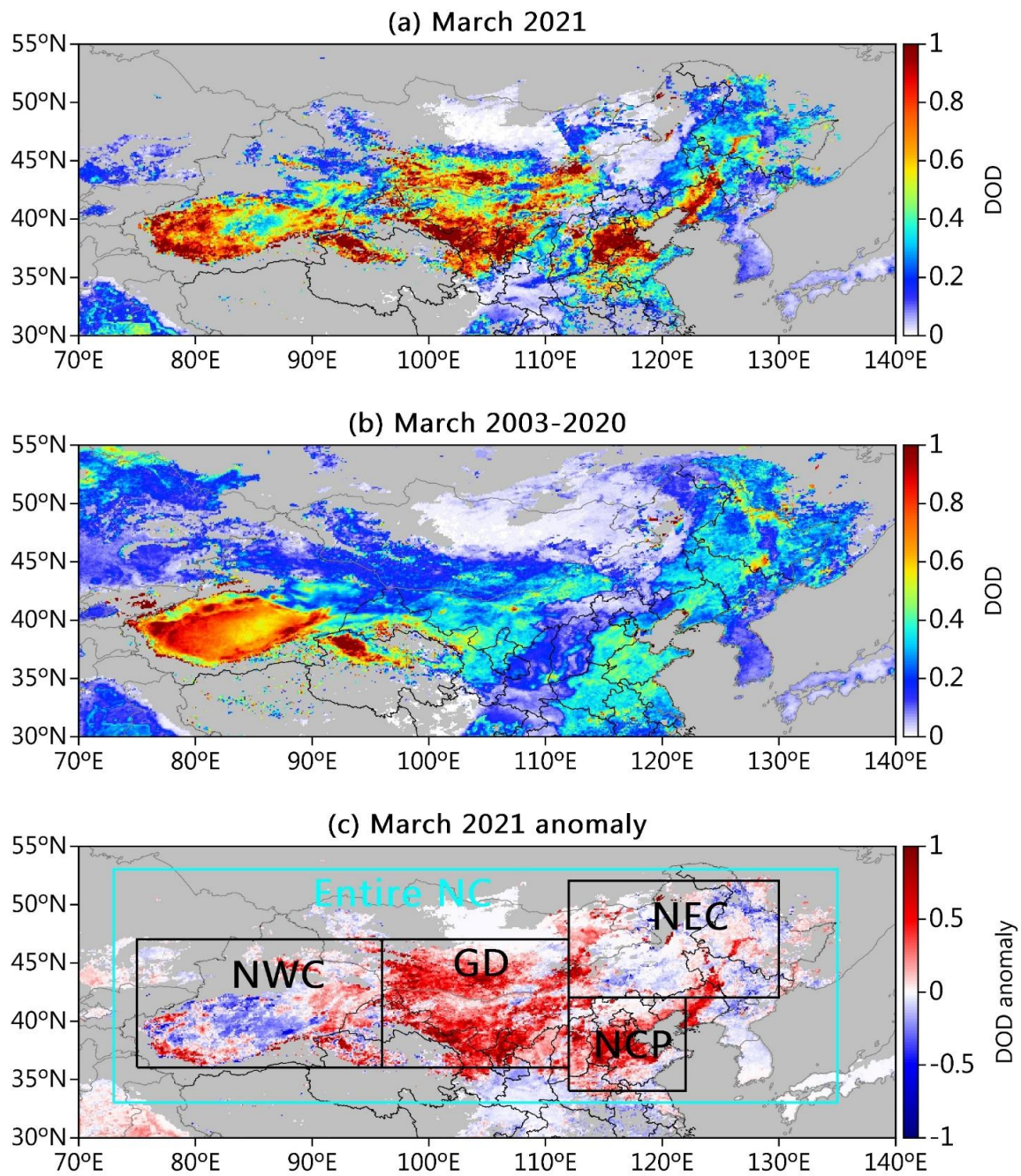
Figure S8: Daily mean SLP (shading; hPa) and temperature at 2 m (contour; ℃) on March 27, 2021. Overlaid on the map are the ERA5 wind vectors at 10 m.
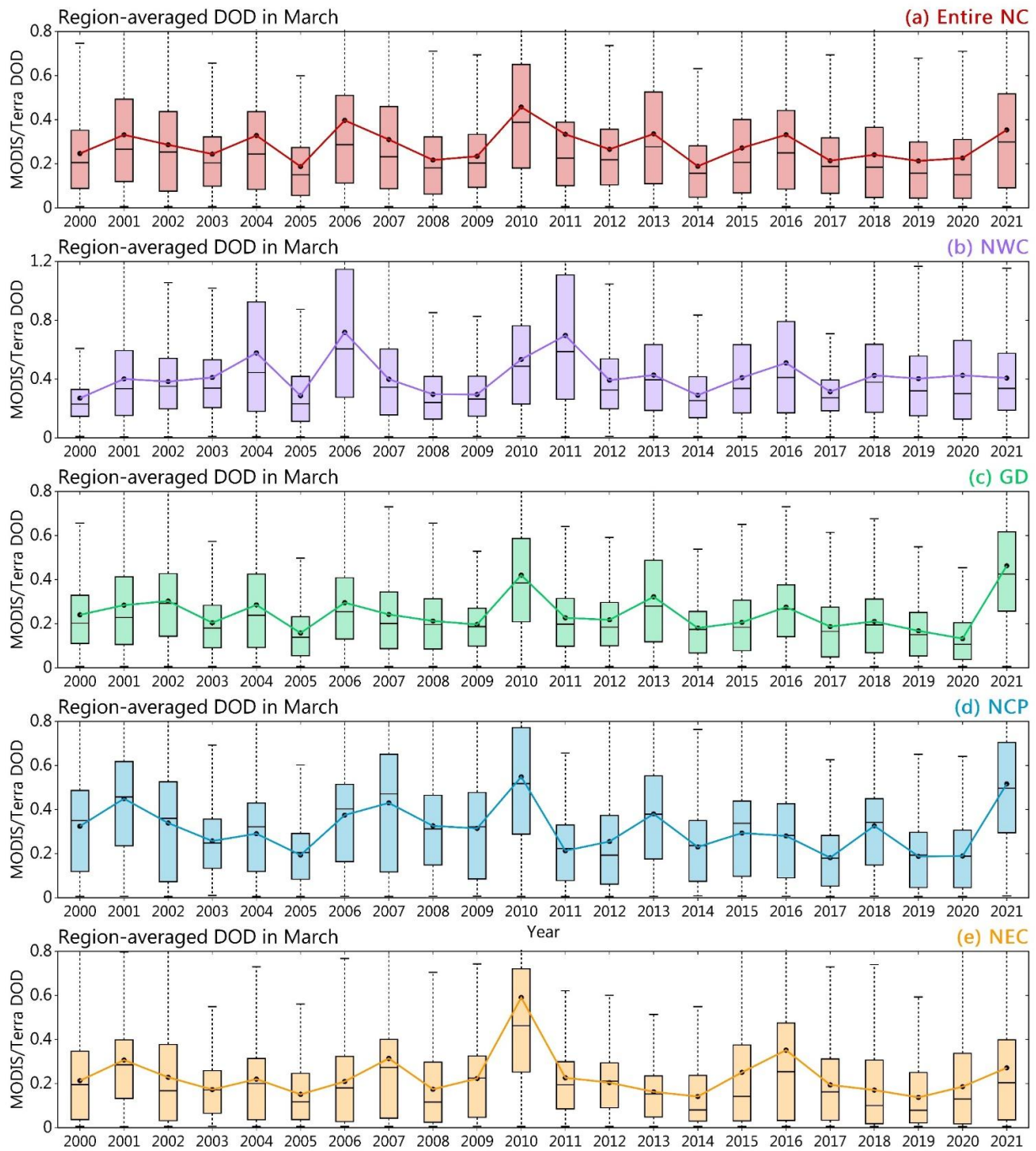
Figure S9: DOD retrieved from MODIS/Terra: (a) March 2021; (b) March climatology (2000–2020); (c) March 2021 anomaly. Cyan and black boxes denote the averaging areas for the DOD time series.
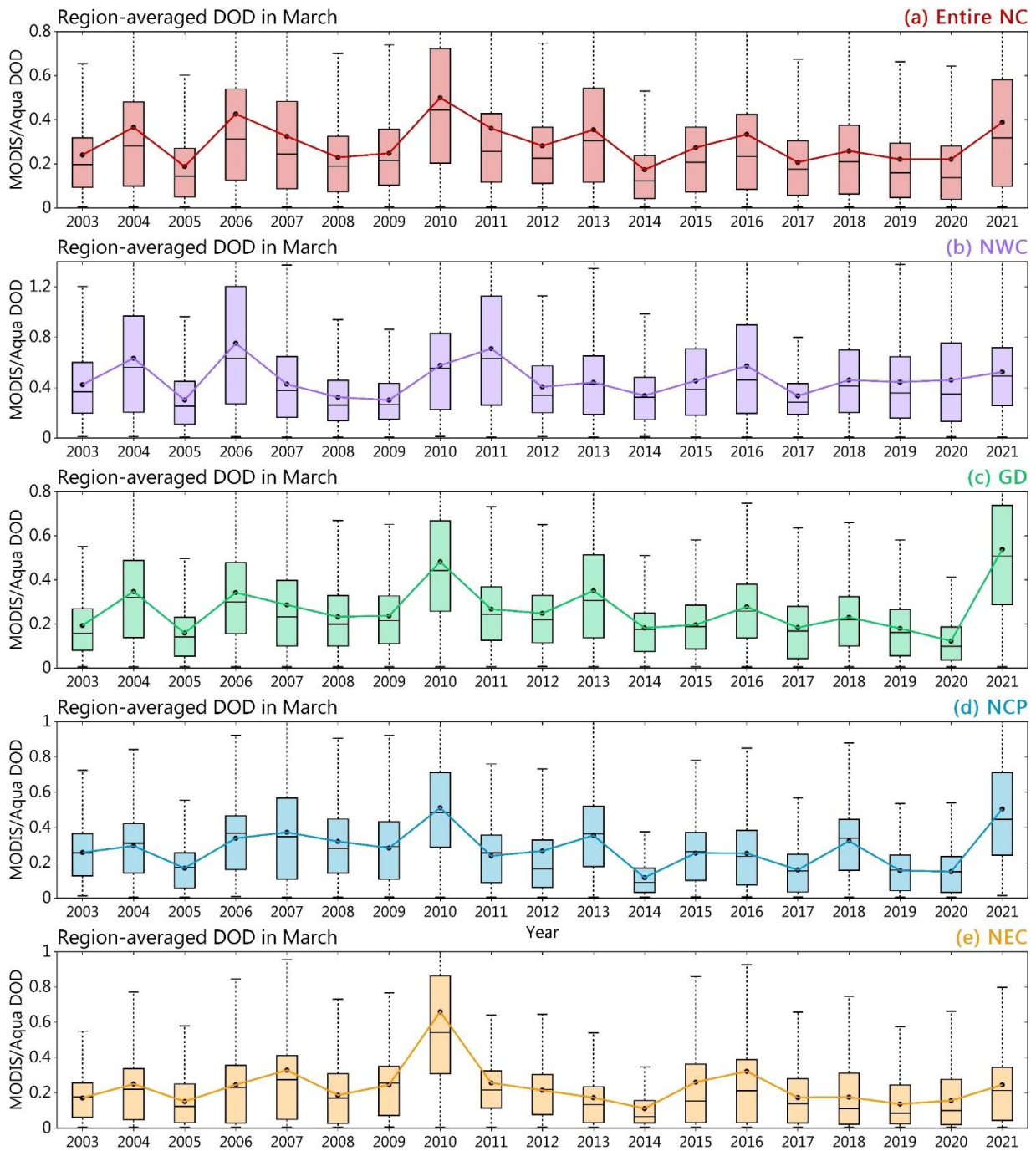
Figure S10: DOD retrieved from MODIS/Aqua: (a) March 2021; (b) March climatology (2003–2020); (c) March 2021 anomaly.
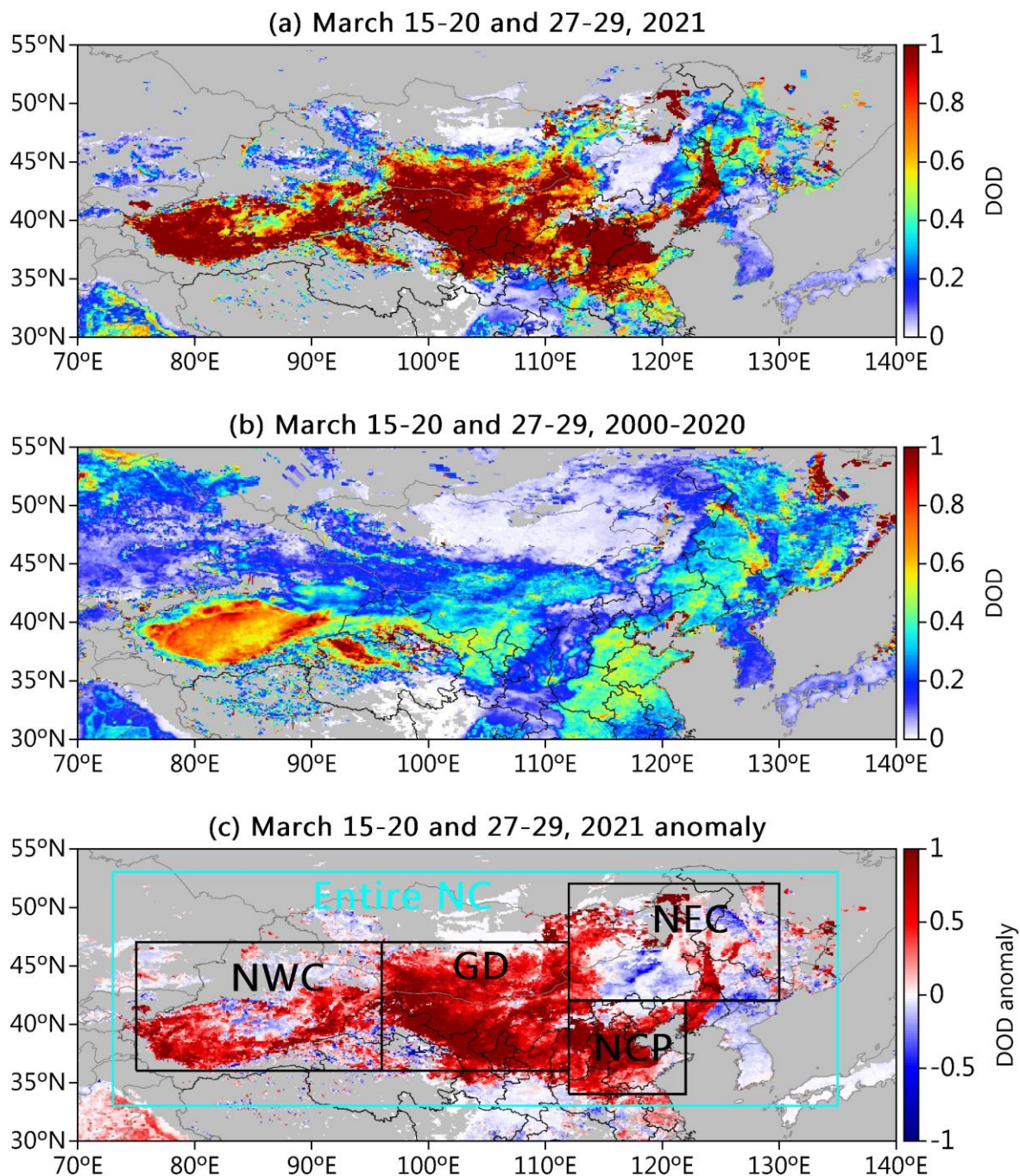
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Figure S11: Time-series boxplots of the regional-averaged DOD retrieved from MODIS/Terra over (a) the entire NC region, (b) NWC, (c) the GD, (d) the NCP, and (e) NEC in March from 2000 to 2021.

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Figure S12: 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 S13: As in Fig. S9 but for the combined MODIS-retrieved DOD from Terra and Aqua during the combined period of March 15–20 and 27–29.
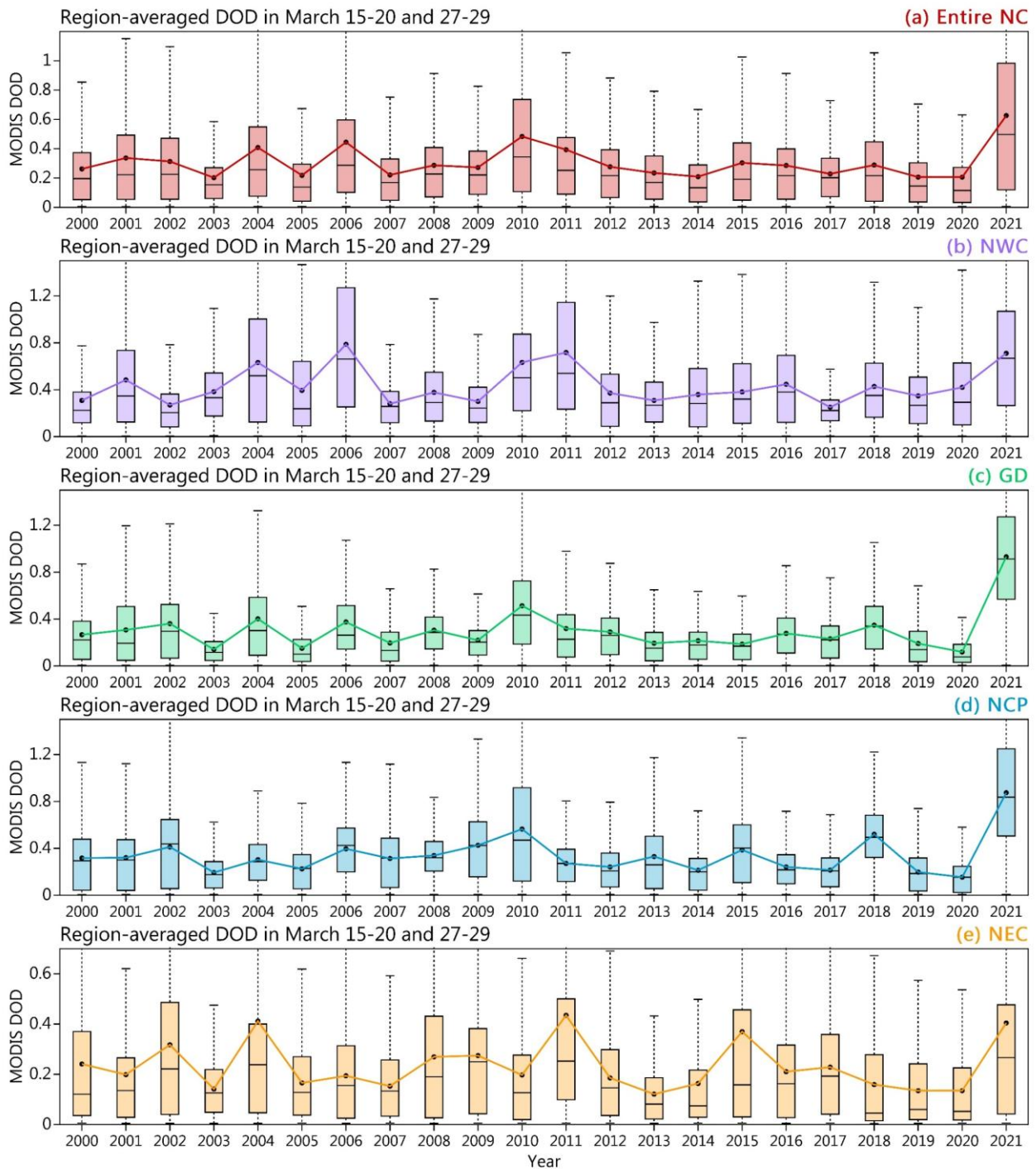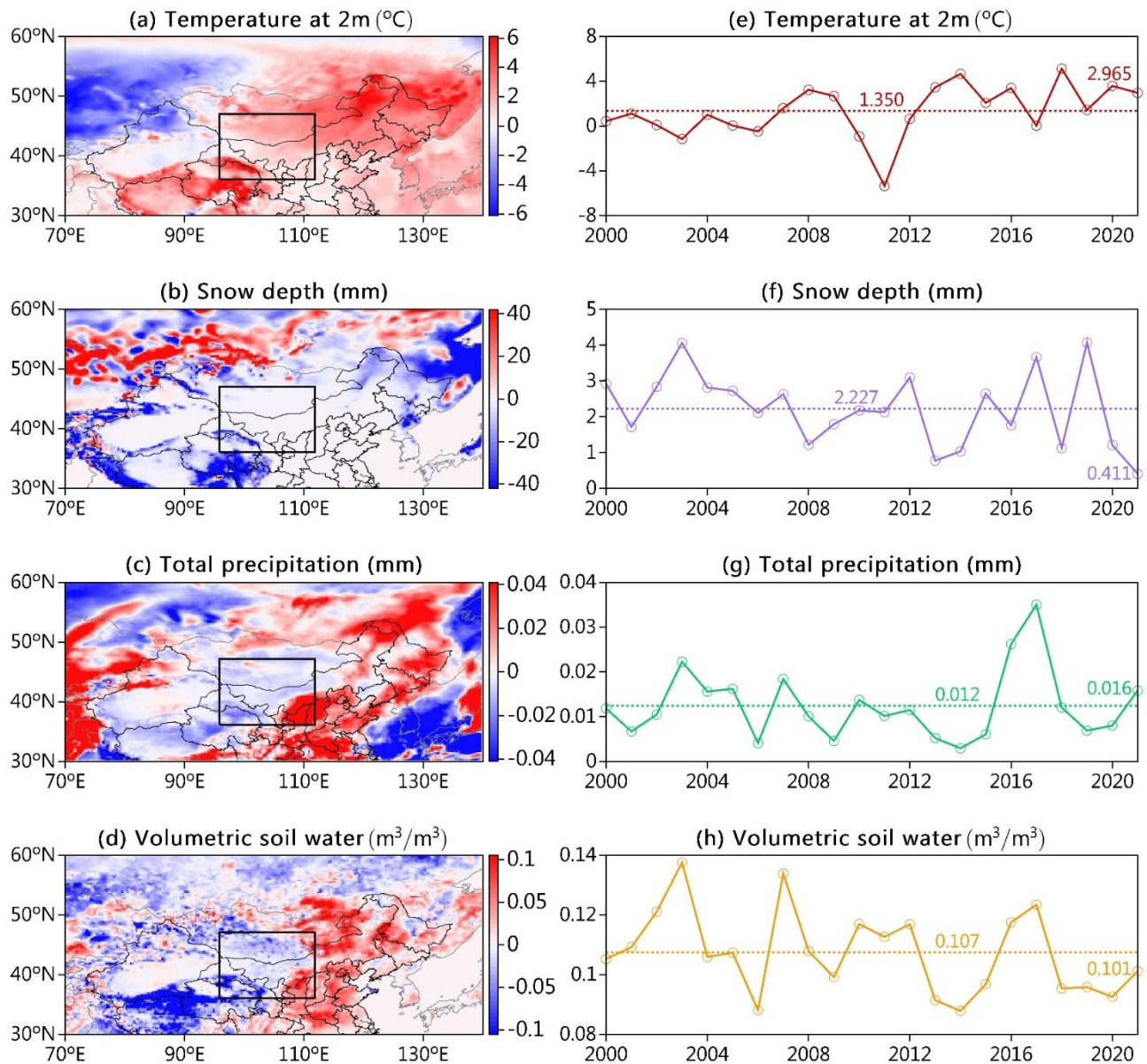
Figure S14: As in Fig. S11 but for the combined MODIS-retrieved DOD from Terra and Aqua during the combined period of March 15–20 and 27–29.

Figure S15: ERA5 meteorological anomalies two weeks before the 3.27 SDS event (March 27–29, 2021): (a–d) anomalies of temperature at 2m (℃), and snow depth (mm), total precipitation (mm), and volumetric soil water (m³ m⁻³) 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.