

Supplementary material for

Contribution of the solar wind-magnetosphere-ionosphere-atmosphere coupling to rapid intensifications of tropical cyclones and transition of Mediterranean subtropical cyclones to tropical-like cyclones

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Contents of this file

Figures S1, S2, S3, S4, S5, S6, and S7

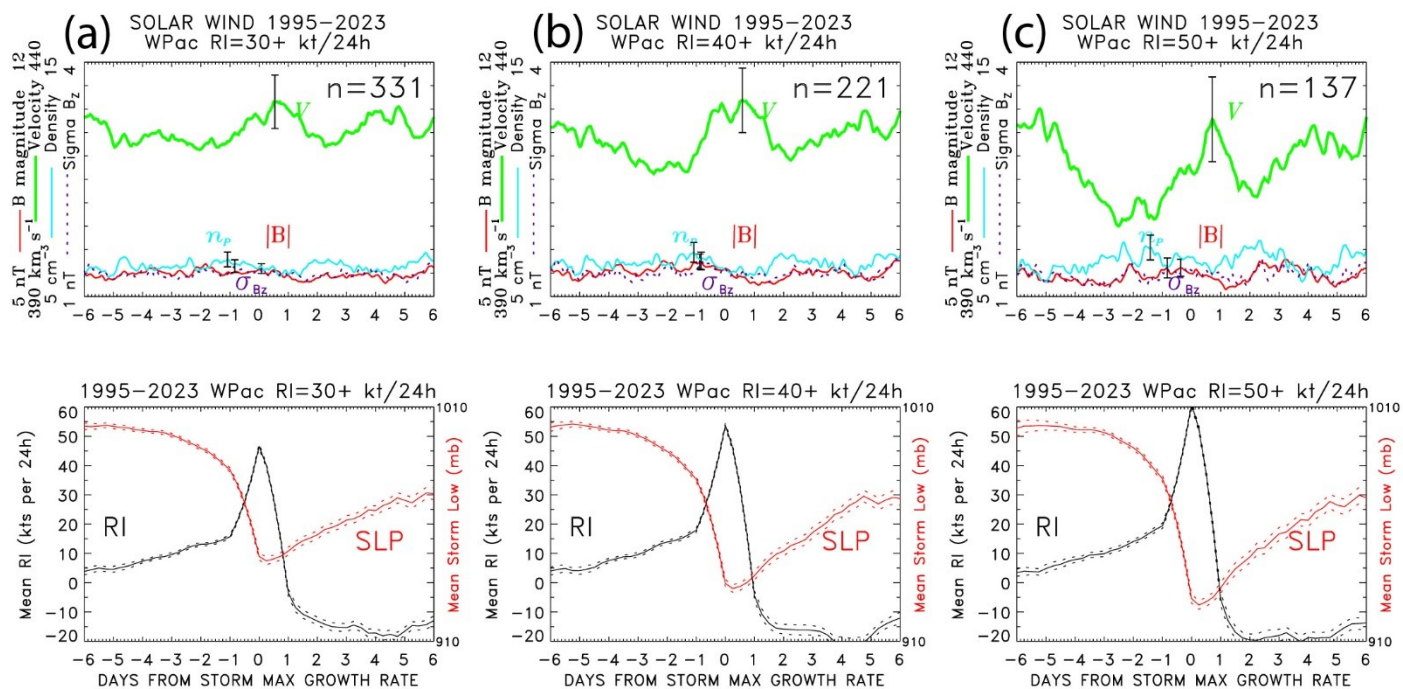


Figure S1: The SPE analysis of solar wind parameters keyed to the first maximum of rapid intensification of (a) 30+ kt/24 h, (b) 40+ kt/24 h, and (c) 50+ kt/24 h, of typhoons in the West Pacific.

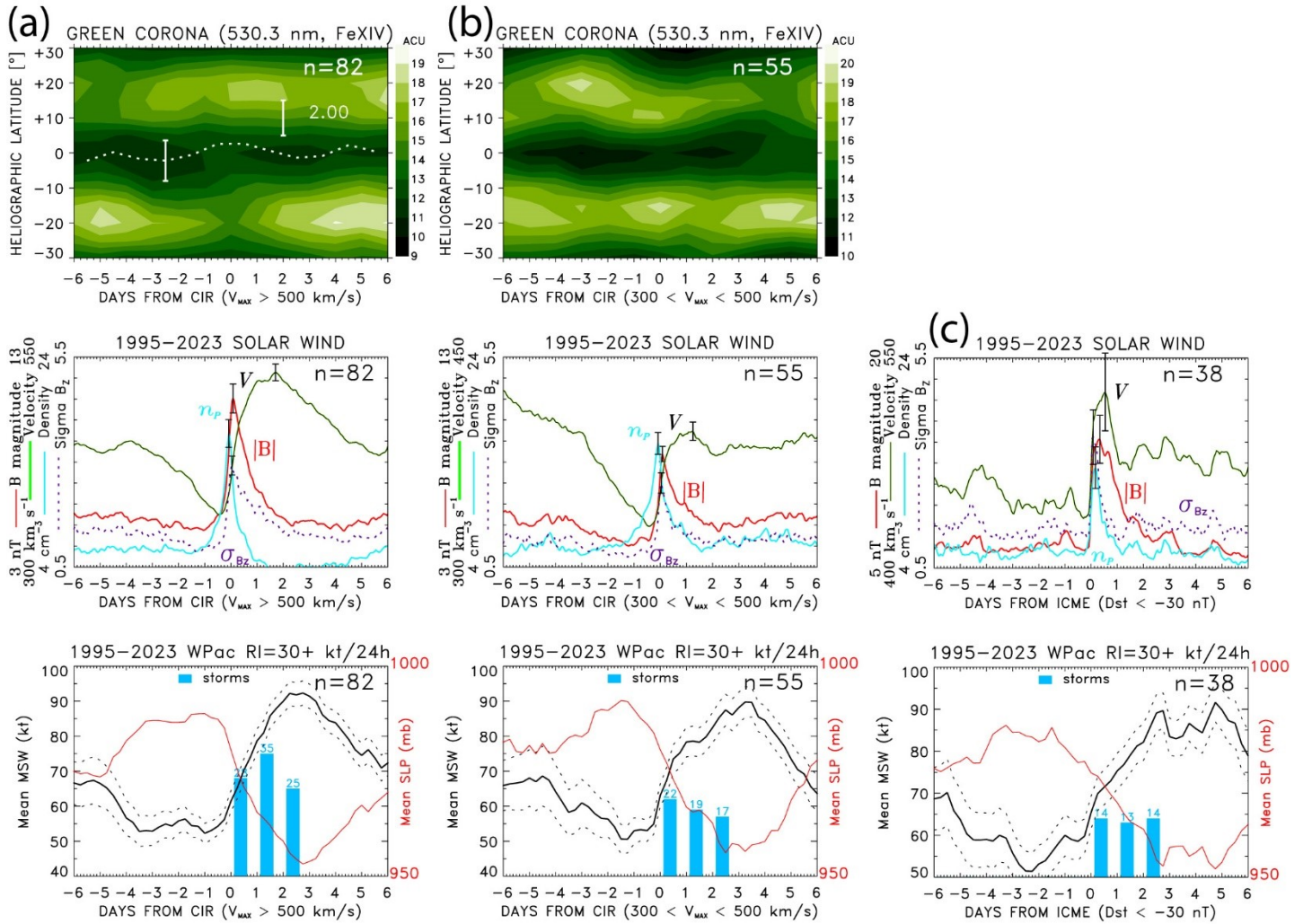


Figure S2: The SPE analysis of time series of green corona intensity, solar wind plasma variables, and the mean of the 6-hourly values of the maximum sustained wind (black lines) and the mean sea level pressure (red lines) for typhoons that intensified by $RI \geq 30$ kt/24h within 3 days following (a) CIRs ($V_{MAX} > 500$ km/s), (b) CIRs ($300 < V_{MAX} < 500$ km/s), and (c) ICMEs ($Dst < -30$ nT). The number of storms superposed in the bottom panel are shown by histograms (88/331: 27%; 58/331: 18%; 41/331: 12%)

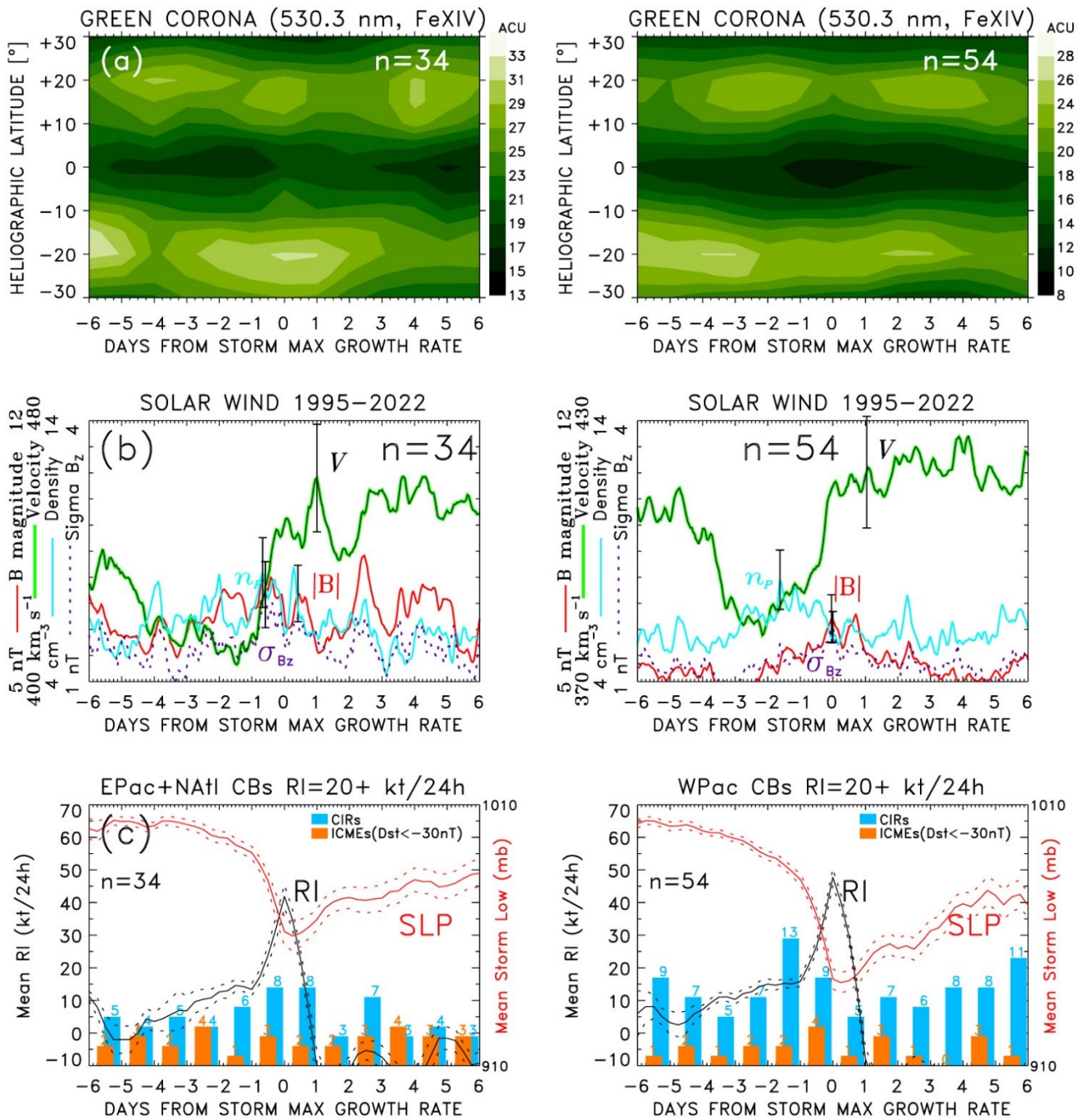


Figure S3: The SPE analysis of (a) green corona intensity, (b) solar wind plasma parameters and (c) SLP and RI keyed to the maximum intensification (RI = 20+ kt) of tropical cyclones with convective bursts (CBs), for hurricanes (left panels) and typhoons (right panels). The histograms of occurrence distributions of major HSSs/CIRs (light blue) and ICMEs (orange) are shown.

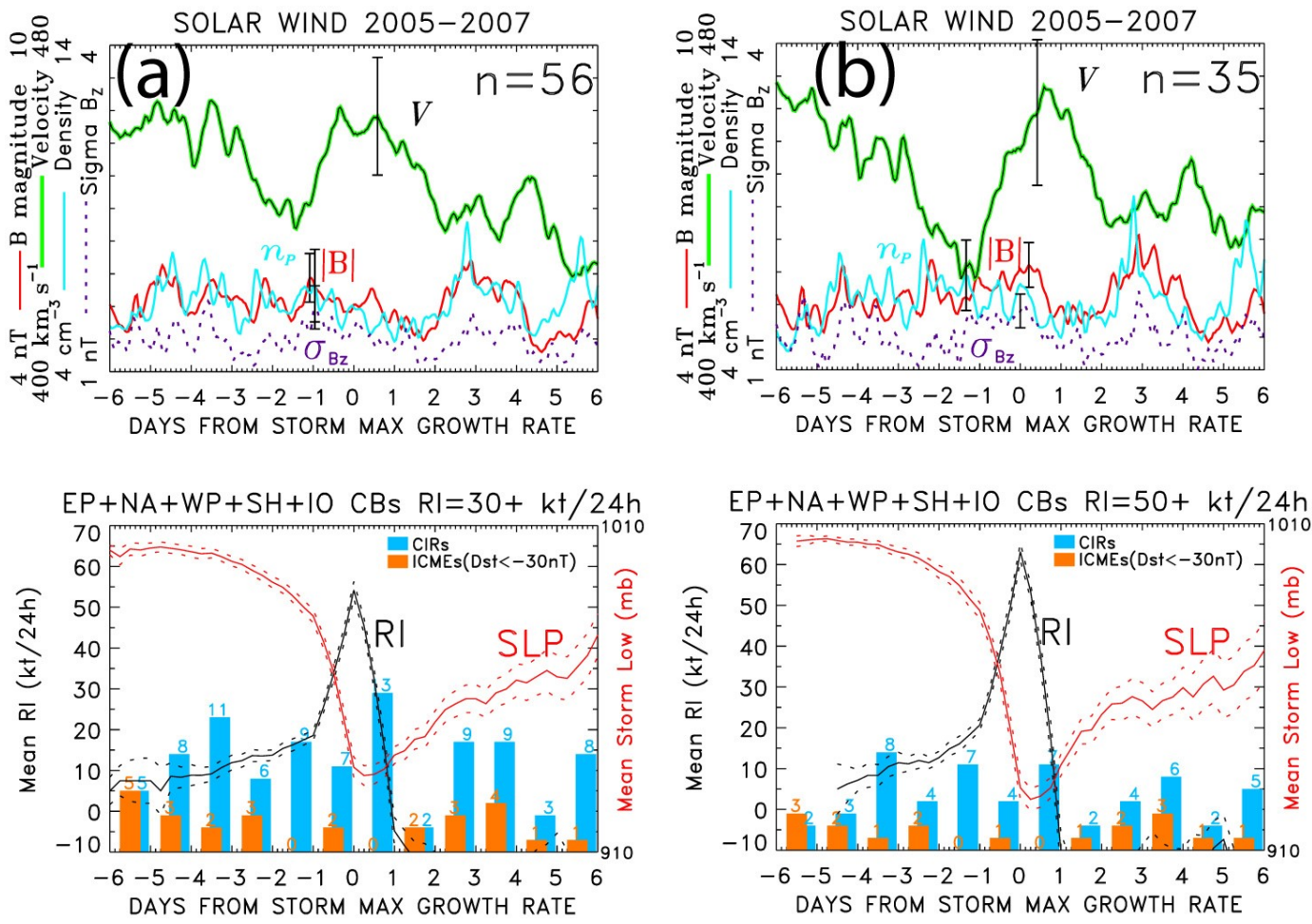


Figure S4: The SPE analysis of solar wind plasma parameters and SLP and RI keyed to the maximum intensification **(a)** 30+ kt and **(b)** 50+ kt of tropical cyclones that were preceded by increases in lightning activity (Price et al., 2009). The histograms of occurrence distributions of major HSSs/CIRs (light blue) and ICMEs (orange) are shown.

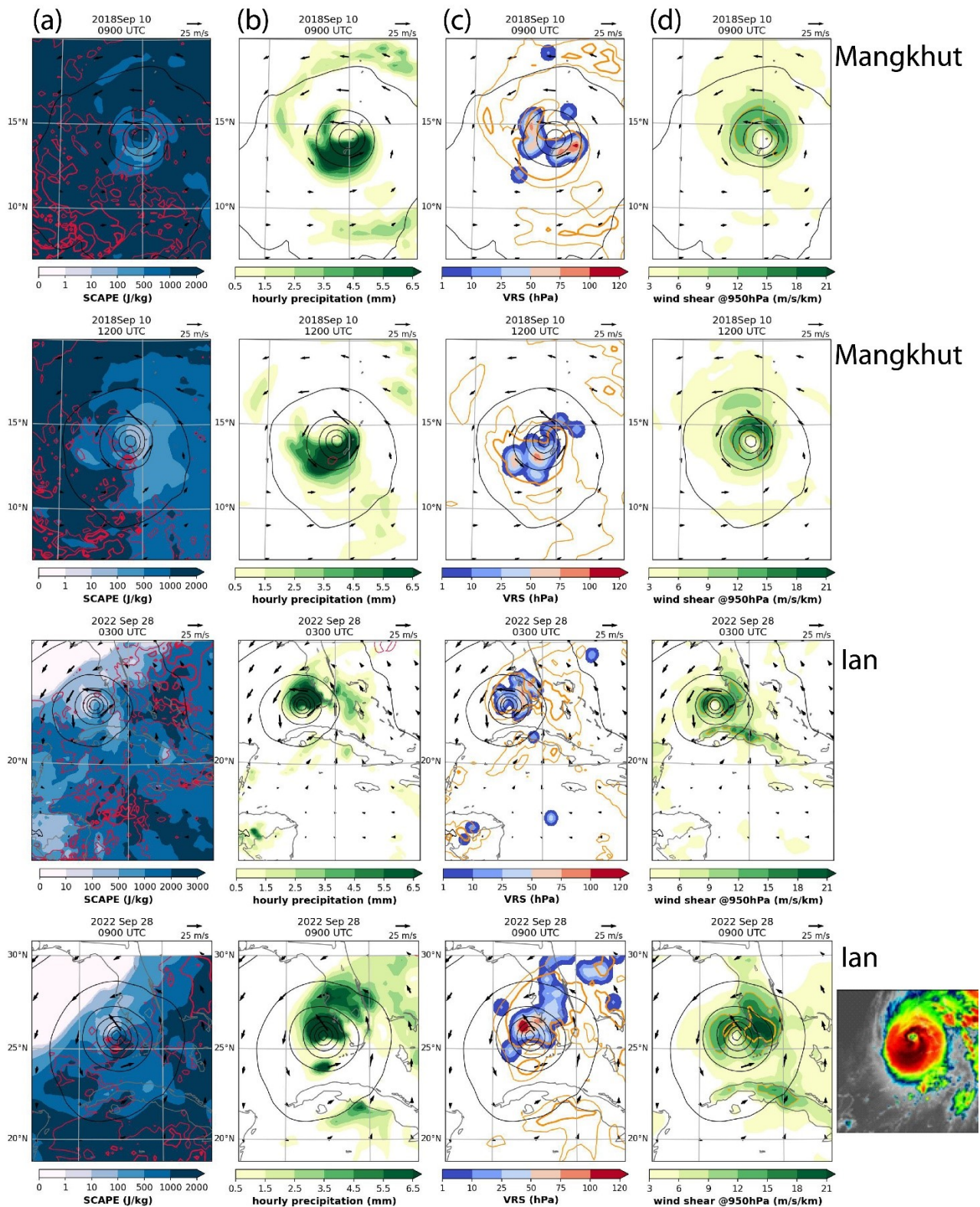


Figure S5: (a) SCAPE (shaded), SCAPE-CAPE (red contours; 100, 300, 500 J/kg), (b) 1-h accumulated precipitation (shaded), (c) VRS (shaded), precipitation (yellow contours; 0.5, 5.5 mm/h), (d) low-level wind shear (yellow contour; 12, 18 m/s/km). In all panels, the wind vectors (m/s) and the geopotential height (black contours at intervals of 50 m) at 950 hPa are shown. Top panels are for typhoon Mangkhut and the bottom panels for hurricane Ian.

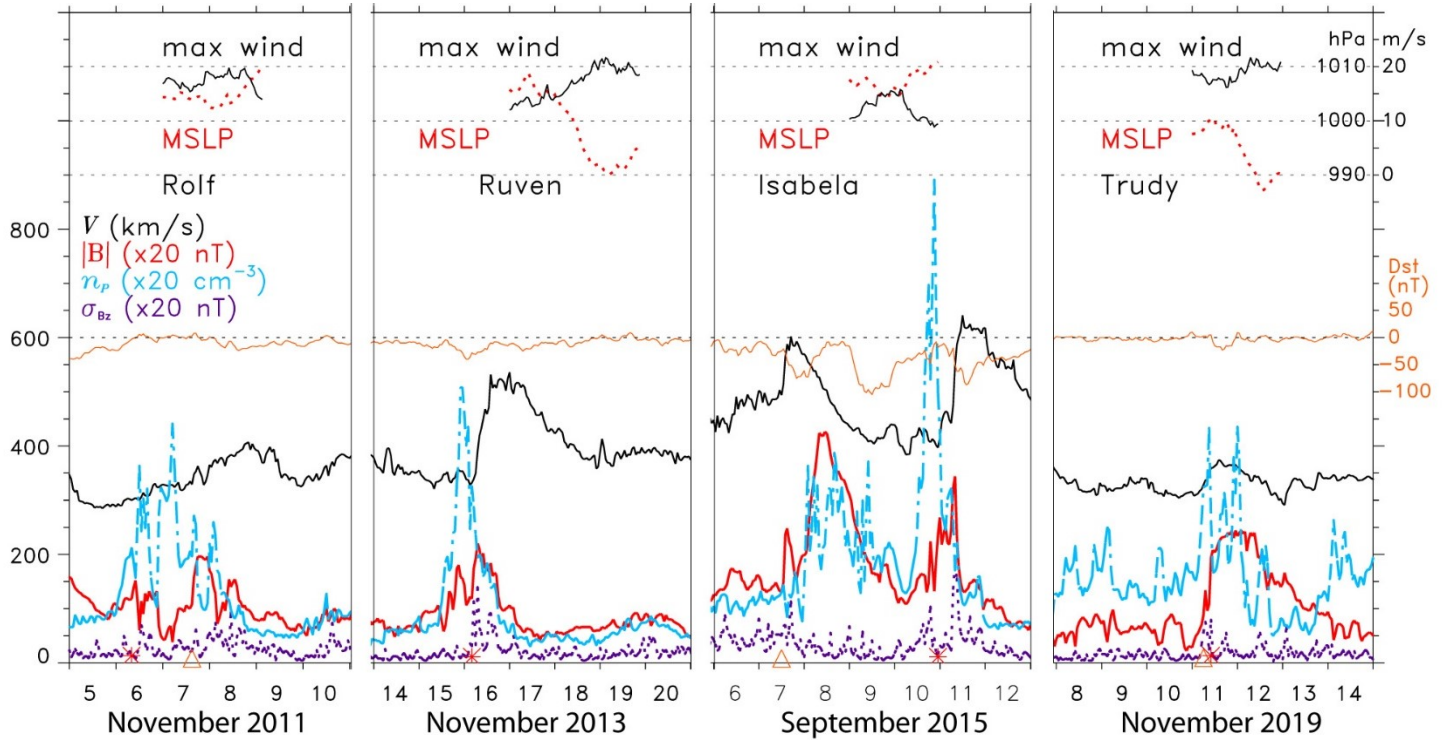


Figure S6: In the bottom half of each panel, the 1-hour OMNI solar wind data of V (green), B (red), n_p (broken light blue) and σ_{Bz} (dotted purple) are shown with the left y-axis scale factors printed. The geomagnetic storm index Dst is shown (orange line). Red asterisks and orange triangles on the time axis indicate CIRs and ICMEs, respectively. In the top half of each panel, the ERA5 derived minimum MSLP and the maximum wind speed at 10 m in the area $\pm 5^\circ$ latitude/longitude from the center of medicane storms **(a)** Rolf, **(b)** Ruven (Cleopatra), **(c)** Isabela, and **(d)** Trudy.

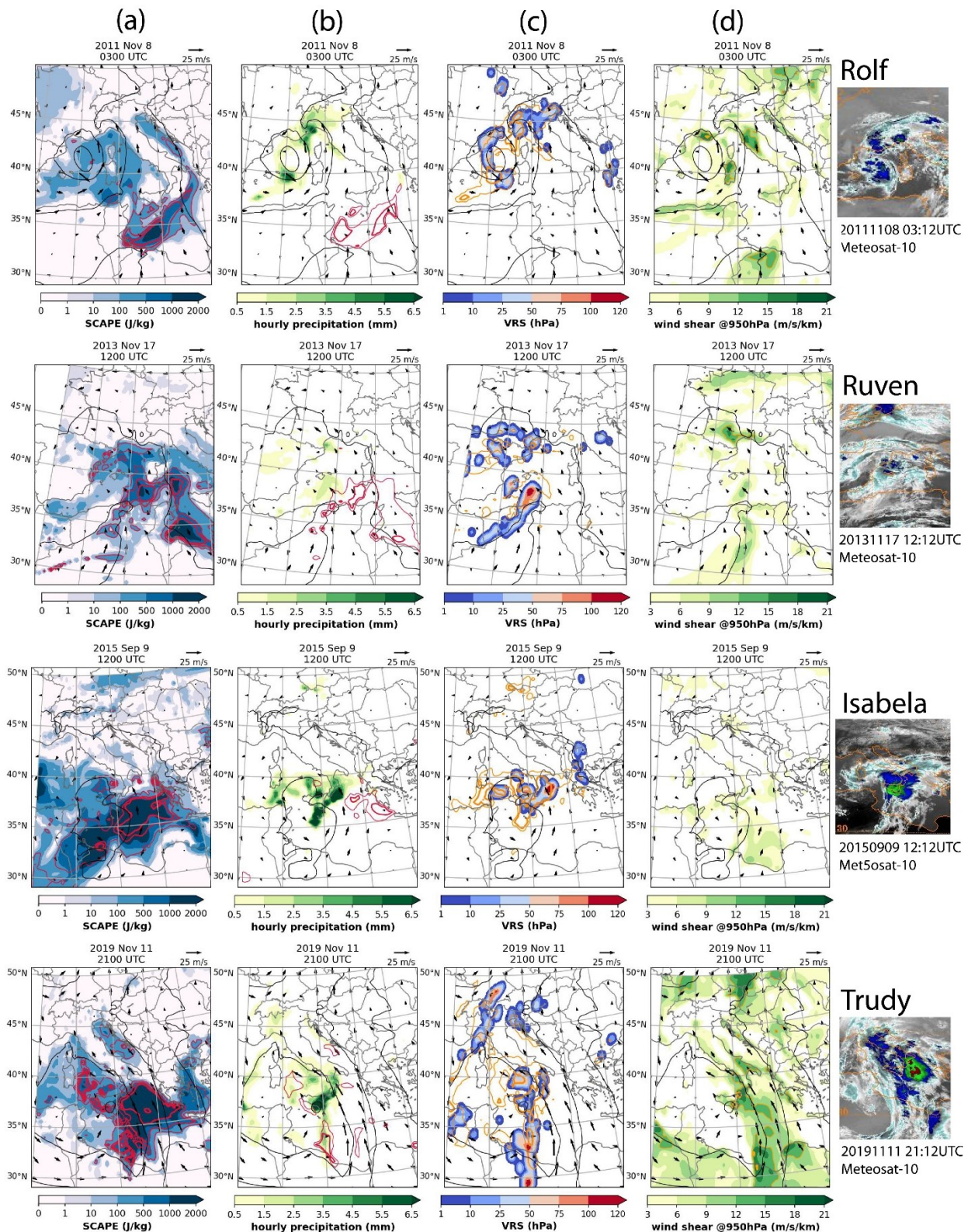


Figure S7: (a) SCAPE (shaded), SCAPE-CAPE (red contours; 100, 300, 500 J/kg), (b) 1-h accumulated precipitation (shaded) and f_s (red contours; thin for 0.5 and thick for 0.8), (c) VRS (shaded), precipitation (yellow contours; 0.5, 5.5 mm/h), (d) low-level wind shear (yellow contour; 12, 18 m/s/km). In all panels, the wind vectors (m/s) and the geopotential height (black contours at intervals of 50 m) at 950 hPa are shown. The Meteosat IR images of subtropical cyclones that developed into TLCs are shown on the right.

