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Supplement of

Synoptic climatology of extratropical transition of tropical cyclones over the Southern Hemisphere

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S1. Justification for the selection of the optimal cluster number

The justification for the selected optimal number of clusters is presented as follows. The Silhouette score decreases rapidly for k < 4 and remains at low values for k >4, and the Davies-Bouldin index has the lowest value at k = 2 and the second lowest value at k = 4 (Fig. S1). Considering both metrics, k = 2 or 4 is a sensible choice, as they maximise the Silhouette coefficient while minimising the Davies-Bouldin index. However, k = 2 accounts for less variability in ET-associated synoptic patterns; therefore, k = 4 is considered the optimal cluster number.

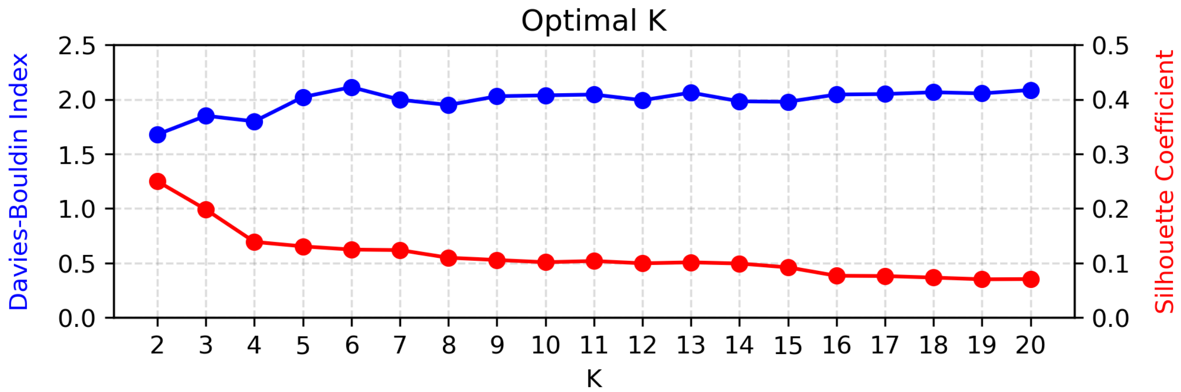

Figure S1. Silhouette score and Davies-Bouldin index for determining the optimal cluster number k.

S2. Examine baroclinicity for C2 and C3

To confirm that cyclones in C2 move into a stronger baroclinic environment than those in C3, we use the vertical wind shear (between 200 and 850 hPa) and the Eady growth rate (EGR; Lindzen and Farrell 1980) to measure the background baroclinicity. Following Besson et al. (2021), the EGR is calculated in a discretised form as follows:

$$EGR = 0.31 \frac{f}{N_{500-850}} \cdot \left[\left(\frac{u_{500}-u_{850}}{z_{500}-z_{850}}\right)^2 + \left(\frac{v_{500}-v_{850}}{z_{500}-z_{850}}\right)^2 \right]^{1/2}, \text{ with } N = \left(\frac{g}{\theta} \frac{\partial\theta}{\partial z}\right)^{1/2}$$

where N is the Brunt-Väisälä frequency, and $N_{500-850}$ is a pressure-weighted average of N in a layer between 500 and 850 hPa. u, v, and z are the horizontal wind components and geopotential height at pressure level, f is the Coriolis parameter, and θ is the potential temperature.

At ET time, the cyclones in C3 are surrounded by a stronger vertical wind shear than those in C2, whereas the differences in EGR between the two clusters are relatively small (Fig. S2a and c). After ET, however, C2 features stronger lower-level baroclinicity compared with C3 (Fig. S2a and c).

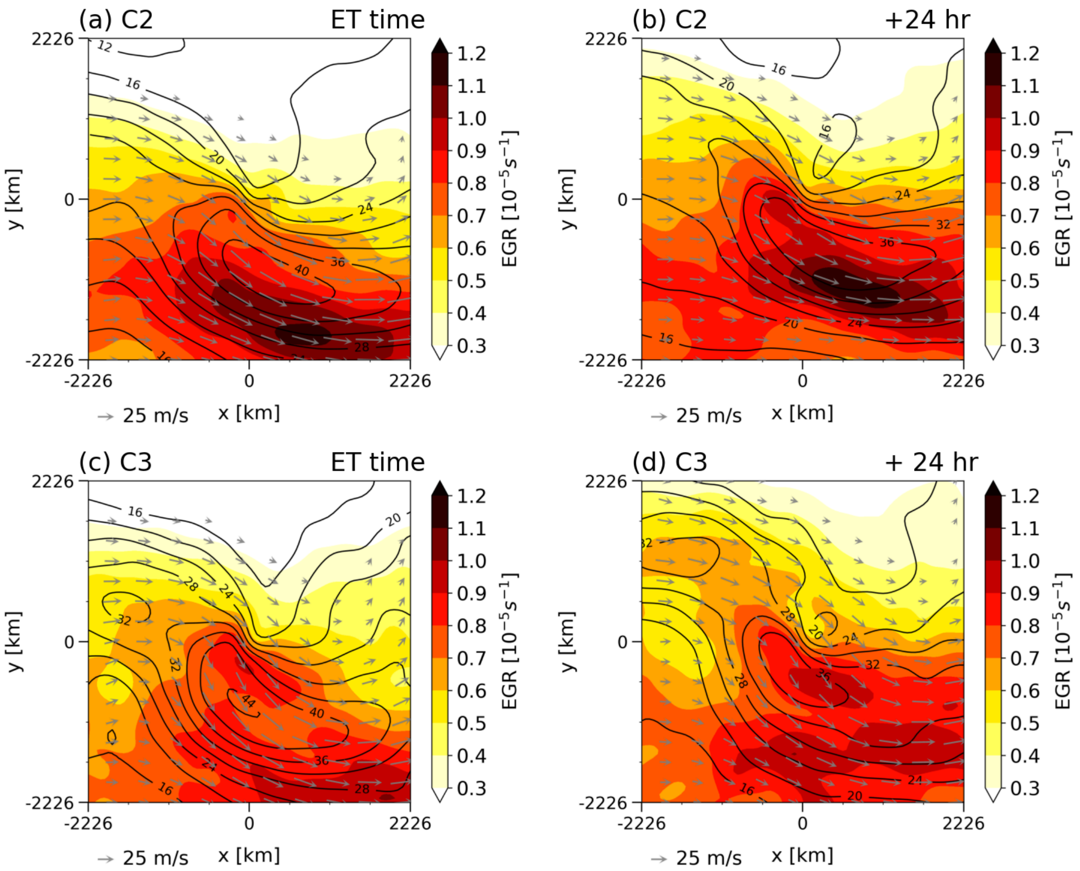

Figure S2. Composite fields at ET time and +24 hr for (a-b) C2 and (c-d) C3. Vertical wind shear between 200 and 850 hPa is marked in black contours (every 4 m/s). EGR are shaded as per the colourbar. 200-300-hPa averaged wind is shown in vectors (only for magnitude greater than 10 m/s). Coordinates are in km relative to the cyclone centre. The bottom (right) of the composites aligns with south (east).

References

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Lindzen, R. S. , & Farrell, B. (1980). A Simple Approximate Result for the Maximum Growth Rate of Baroclinic Instabilities. Journal of Atmospheric Sciences, 37(7), 1648-1654. https://doi.org/10.1175/1520-0469(1980)037<1648:ASARFT>2.0.CO;2