

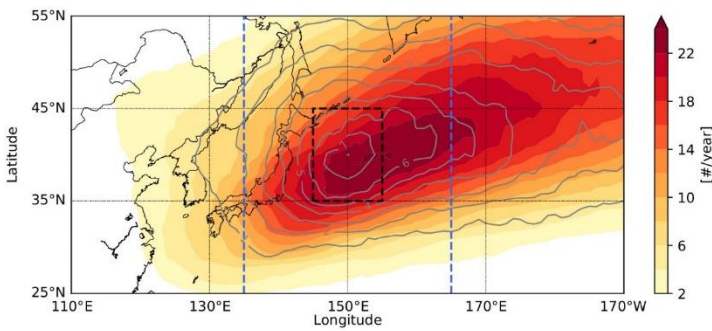
# Quantifying the development processes of explosive cyclones over the Northwest Pacific in potential vorticity perspective

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## Key Points

- A new method to perform prognostic analysis in PV perspective is proposed.
- The method is applied to explosive cyclones (ECs) over the Northwest Pacific in the cold season.



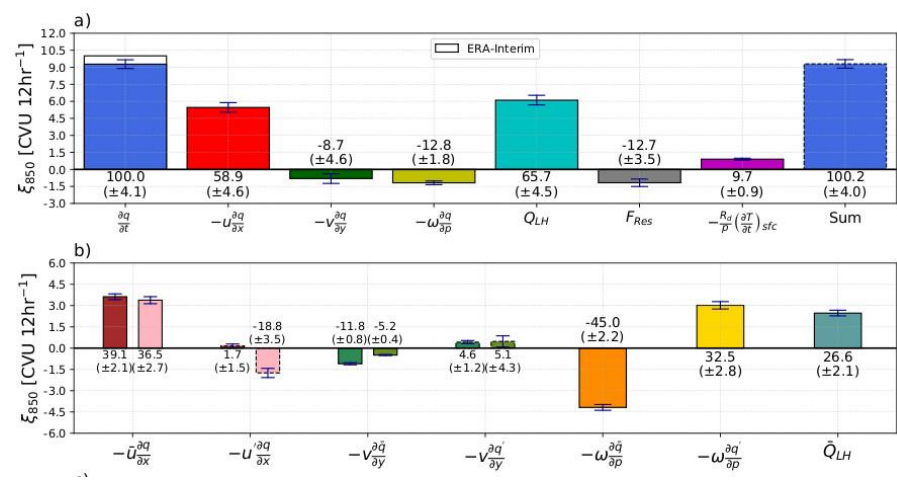
**Fig. 1.** Frequency of EC track (shadings) and maximum deepening (gray lines). The ECs are sampled from the black dashed box.

## Data and Methods

- ERA-Interim Reanalysis: 1.5°×1.5°, 6 hrs, (1979–2018)
  - Cyclone tracking using SLP
  - PV tendency equation (isobaric coordinates)
- $$\frac{\partial q}{\partial t} = -\bar{u} \frac{\partial q}{\partial x} - u' \frac{\partial q}{\partial x} - v \frac{\partial \bar{q}}{\partial y} - v \frac{\partial q'}{\partial y} - \omega \frac{\partial \bar{q}}{\partial p} - \omega \frac{\partial q'}{\partial p} + Q_{LH} + F_{RES}$$
- Geopotential tendency ( $\chi$ ) induced from each term in the PV tendency equation is calculated through inversion.
  - 299 ECs are investigated.

## Results

- $\xi_{850} \equiv \frac{\partial \zeta_g}{\partial t} = \frac{1}{f_0} \nabla^2 \chi$  at 850 hPa
- The explosive development of ECs is contributed 75.6% by zonal PV advection by the mean flow ( $-\bar{u} \frac{\partial q}{\partial x}$ ), 65.7% by latent heating, and 9.7% by warming of the surface ( $\frac{\partial T}{\partial t}_{sfc}$ ), with other negative contributors.



**Fig. 2.** Area-mean  $\xi_{850}$  from the inversion of the terms denoted on the x-axis. The numbers represent the relative contributions to  $\xi_{850}$  from  $\frac{\partial q}{\partial t}$ . In (b), the left (right) bars are the contributions from upper (lower) levels. [CVU: Cyclonic Vorticity Unit, 10<sup>-5</sup> s<sup>-1</sup>]

## References

Davis, C. A., and K. A. Emanuel, 1991: Potential vorticity diagnostics of cyclogenesis. *Mon. Wea. Rev.*, **119**, 1929–1953.  
 Selier, C., (2019): A climatological assessment of intense extratropical cyclones from the potential vorticity perspective. *J. Climate*, **32**, 2369–2380.  
 Tamarin, T., and Y. Kaspi, 2016: The poleward motion of extratropical cyclones from a potential vorticity tendency analysis. *J. Atmos. Sci.*, **73**, 1687–1707.  
 Wernli, H., and C. Schwierz, 2006: Surface cyclones in the ERA-40 dataset (1958–2001). Part I: Novel identification method and global climatology. *J. Atmos. Sci.*, **63**, 2486–2507.