

**Format:** Please submit a tidy, organized report covering the exercise below (preferably as a single PDF file), double spaced with font size 12 pt. The page limit is **four**, not counting figures and tables.

**Task A:** By inspection of the 500 hPa analyses for height and vorticity, choose a time and location **P** for which strong vorticity advection is evident (a disturbance over the Pacific or in the interior of N. America would suit, to avoiding the unaccounted influence of mountains). Quantify the rate of vorticity advection at **P**, approximating this as  $-\mathcal{U} \partial\zeta/\partial s$  (in the natural coordinate system). Then, assuming the time tendency in  $\zeta$  can be neglected, use the quasi-geostrophic vorticity equation<sup>1</sup>

$$\frac{\partial\zeta}{\partial t} = 0 = -\mathcal{U} \frac{\partial\zeta}{\partial s} + f_0 \frac{\partial\omega}{\partial p} \quad (1)$$

to infer  $\partial\omega/\partial p$  at **P**. Compare this result for  $\partial\omega/\partial p$  with an “actual value”

$$\frac{\Delta\omega}{\Delta p} = \frac{\omega_{700} - \omega_{500}}{p_{700} - p_{500}} \quad (2)$$

deduced from the 500 hPa and 700 hPa analyses for vertical velocity  $\omega$  (make sure you are using the same units for both estimates). Patterns of  $\omega$  are generally quite “noisy,” and differences in  $\omega$  even more so: therefore in conjunction with your  $\Delta\omega/\Delta p$ , cite an indicative uncertainty range (i.e. an absolute or fractional error bound). This task should be completed using the RDPS black-and-white or colour charts<sup>2</sup>, whichever you find easier.

**Task B:** In relation to this same disturbance but now considering its development over 12 hours, comment on the utility of the guidance given by the quasigeostrophic omega and height tendency equations<sup>3</sup> Appealing to whatever evidence serves the purpose (i.e. analyses, satellite images, forecaster discussions, etc), give your opinion as to whether, for this case, the QG model’s emphasis on vorticity and temperature advection as the key to development is supported.

**Comment:** Stages here are case selection; evidence gathering; computation; and interpretation. The instructor has no à priori position on this, and your outcome (yes, QG model is supported; no, QG model not helpful) is of no real importance. Assignments will be assessed on the clarity and rationality of the argument presented.

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<sup>1</sup>Here the term in  $v_g \partial f/\partial y$  has been neglected.

<sup>2</sup>[http://weather.gc.ca/model\\_forecast/index\\_e.html](http://weather.gc.ca/model_forecast/index_e.html).

<sup>3</sup><http://www2.mmm.ucar.edu/people/tomjr/files/realtime/diagnostics.html>.