Notes on Quasi-Geostrophic Processes for Short Waves (Ideal Case)

Geopotential tendency and omega equations

rising Φ produced by:	anticyclonic ζ advection warm advection decreasing with height
sinking Φ produced by:	cyclonic ζ advection cold advection decreasing with height
upward motion produced by:	cyclonic ζ advection increasing with height warm advection
downward motion produced by:	anticyclonic ζ advection increasing with height cold advection

Typical atmospheric conditions:

- Temperature advection is strongest in the lower-troposphere and near-zero in the midtroposphere.
- Relative vorticity advection is strongest in the midtroposphere and near-zero in the lower troposphere.

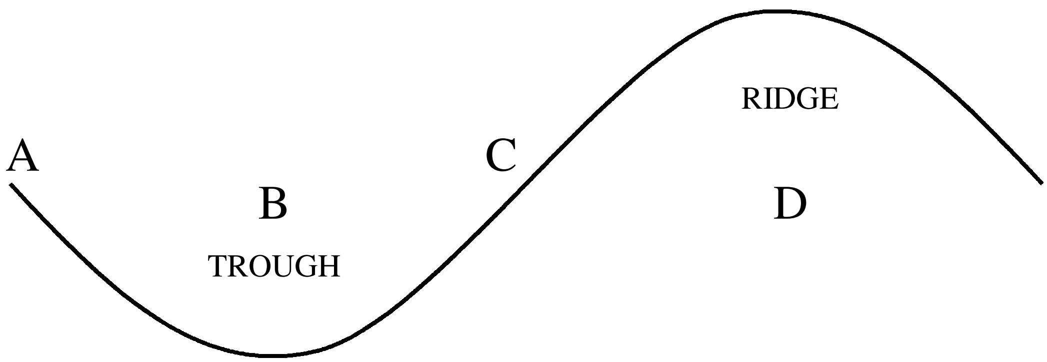
Typical growing extratropical cyclone:

- The 500 mb trough is west of the surface low
- Cold advection (b) under the trough (B) amplifies the trough
- Warm advection (d) under the ridge (D) amplifies the ridge
- Convergence (A) over the surface high (a) amplifies the surface high
- Divergence (C) over the surface low (c) amplifies the surface low

Typical decaying extratropical cyclone:

- The 500 mb trough is east of the surface low
- Cold advection (b) under the ridge (D) reduces the trough
- Warm advection (d) under the trough (B) reduces the ridge
- Convergence (A) over the surface low (c) reduces the surface low
- Divergence (C) over the surface high (a) reduces the surface high

Physical processes associated with a 500 mb short wave



West of upper-level trough (A)

- Anticyclonic vorticity advection causes increasing anticyclonicity
- Increasing anticyclonicity causes unbalanced inward Coriolis force (convergence)
- Midtropospheric convergence increases atmospheric column mass and hence raises surface pressure
- Midtropospheric convergence with small surface change causes downward motion in the lower troposphere
- Downward motion adiabatically warms lower troposphere and causes 500 mb geopotential to rise
- Rising 500 mb geopotential causes ridge to propagate eastward

At upper-level trough axis (B)

- No vorticity advection

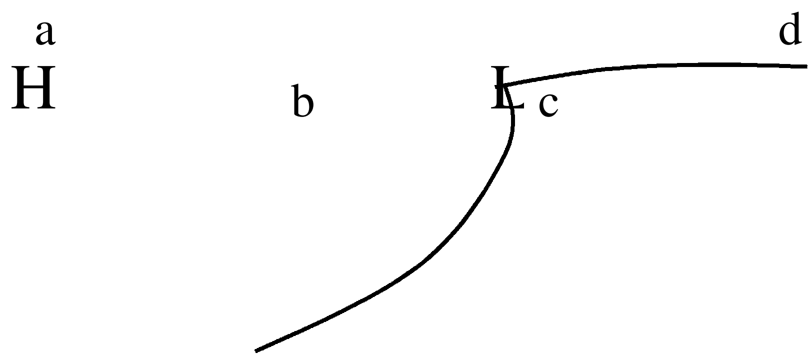
East of upper-level trough (C)

- Cyclonic vorticity advection causes increasing cyclonicity
- Increasing cyclonicity causes unbalanced outward Coriolis force (divergence)
- Midtropospheric divergence decreases atmospheric column mass and hence lowers surface pressure
- Midtropospheric divergence with small surface change causes upward motion in the lower troposphere
- Upward motion adiabatically cools lower troposphere and causes 500 mb geopotential to sink
- Sinking 500 mb geopotential causes trough to propagate eastward

At upper-level ridge axis (C)

- No vorticity advection

Physical processes associated with surface low and high centers



At surface high center (a)

- No temperature advection

West of surface low center (b)

- Cold advection in lower troposphere causes 500 mb geopotential to sink
- Sinking 500 mb geopotential causes unbalanced inward pressure gradient force (convergence)
- Midtropospheric convergence with small surface change causes downward motion in the lower troposphere
- Midtropospheric convergence increases atmospheric column mass and hence raises surface pressure
- Increasing surface pressure causes surface high to propagate eastward

At surface low center (c)

- No temperature advection

East of surface low center (d)

- Warm advection in lower troposphere causes 500 mb geopotential to rise
- Rising 500 mb geopotential causes unbalanced outward pressure gradient force (divergence)
- Midtropospheric divergence with small surface change causes upward motion in the lower troposphere
- Midtropospheric divergence decreases atmospheric column mass and hence lowers surface pressure
- Decreasing surface pressure causes surface low to propagate eastward