ATM S 442/504: Atmospheric Motions II

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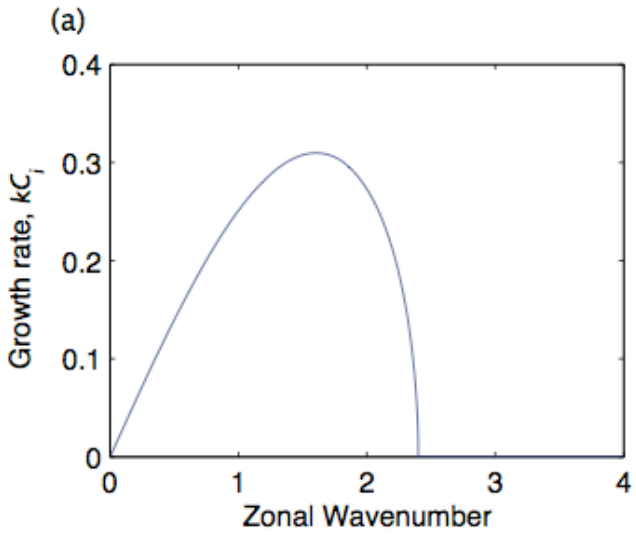
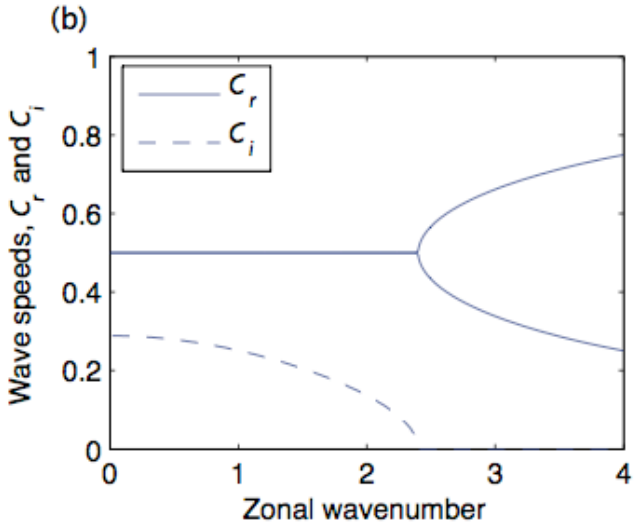
Eady Model

Growth rates (imaginary part of frequency)



Stable for large wavenumbers, unstable for small wavenumbers

Wave speeds (real part of frequency divided by k)



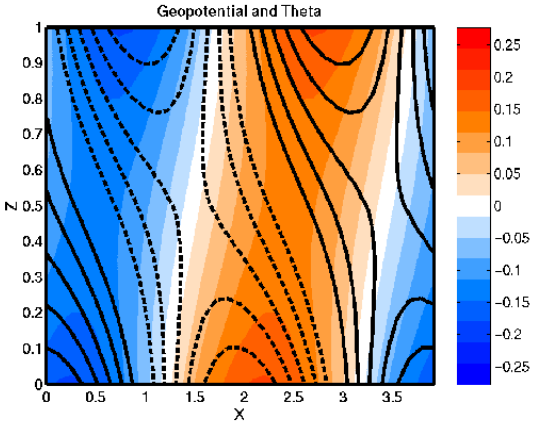
Phase speed for unstable modes = mean flow speed at midtroposphere.

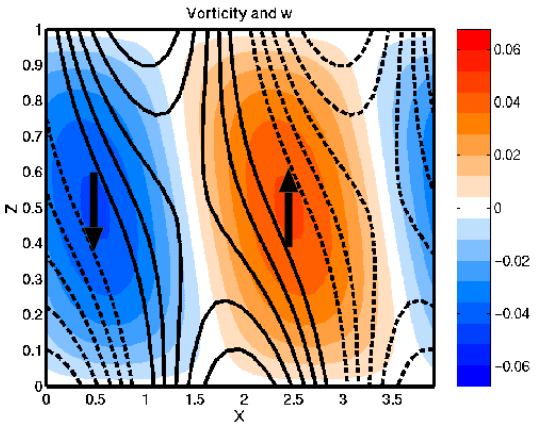
Eady Model of Baroclinic Instability

Height (contours)
& theta (colors)

Vorticity (contours)
& w (colors)

Most Unstable Mode (Growing





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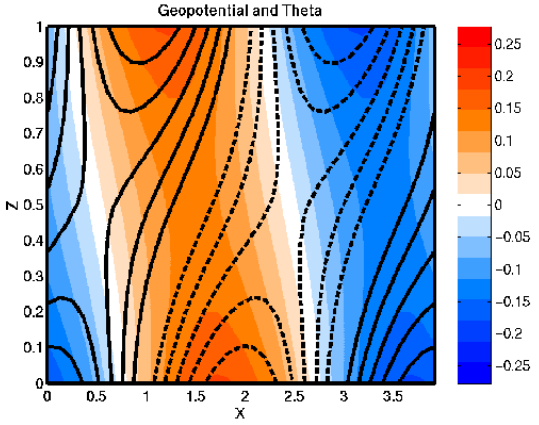
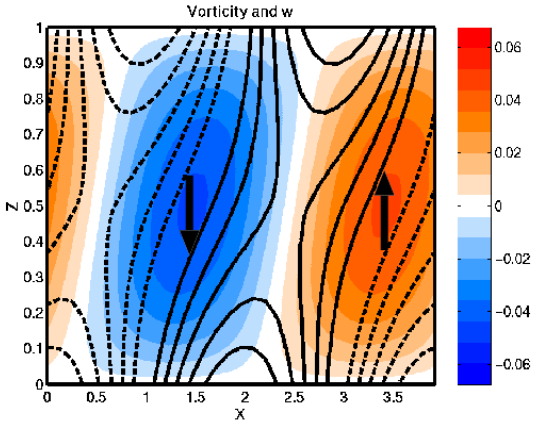
Most Unstable Mode (Decaying





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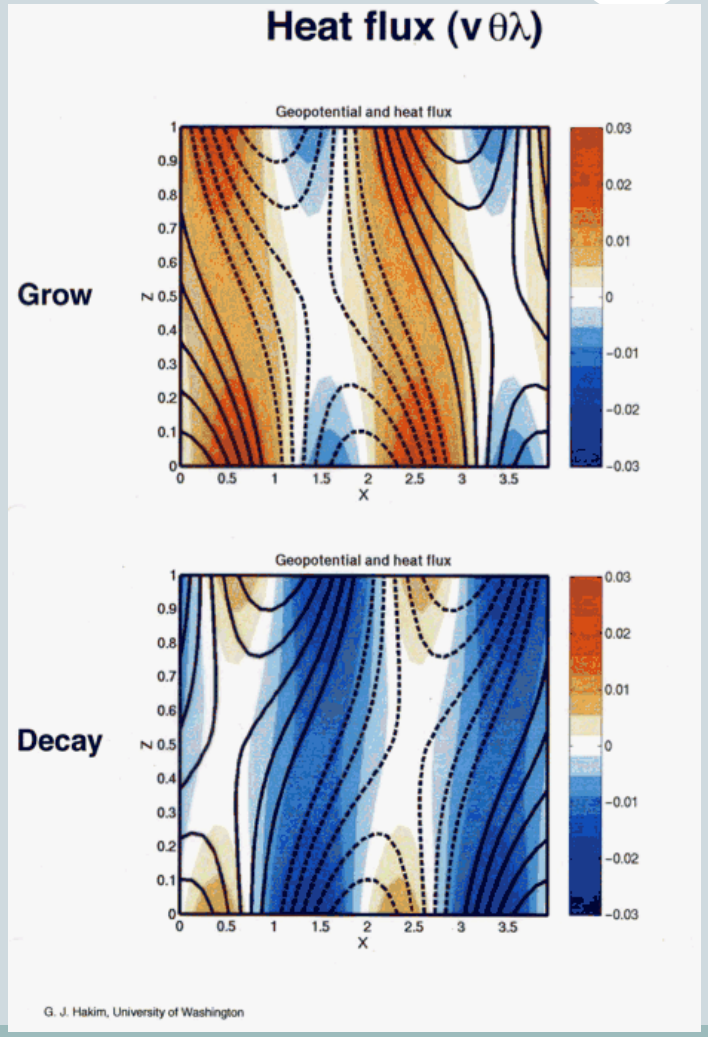
Heat fluxes



Growing mode has heat flux poleward

Decaying mode has equatorward heat flux (upgradient!)

Observed Cyclogenesis

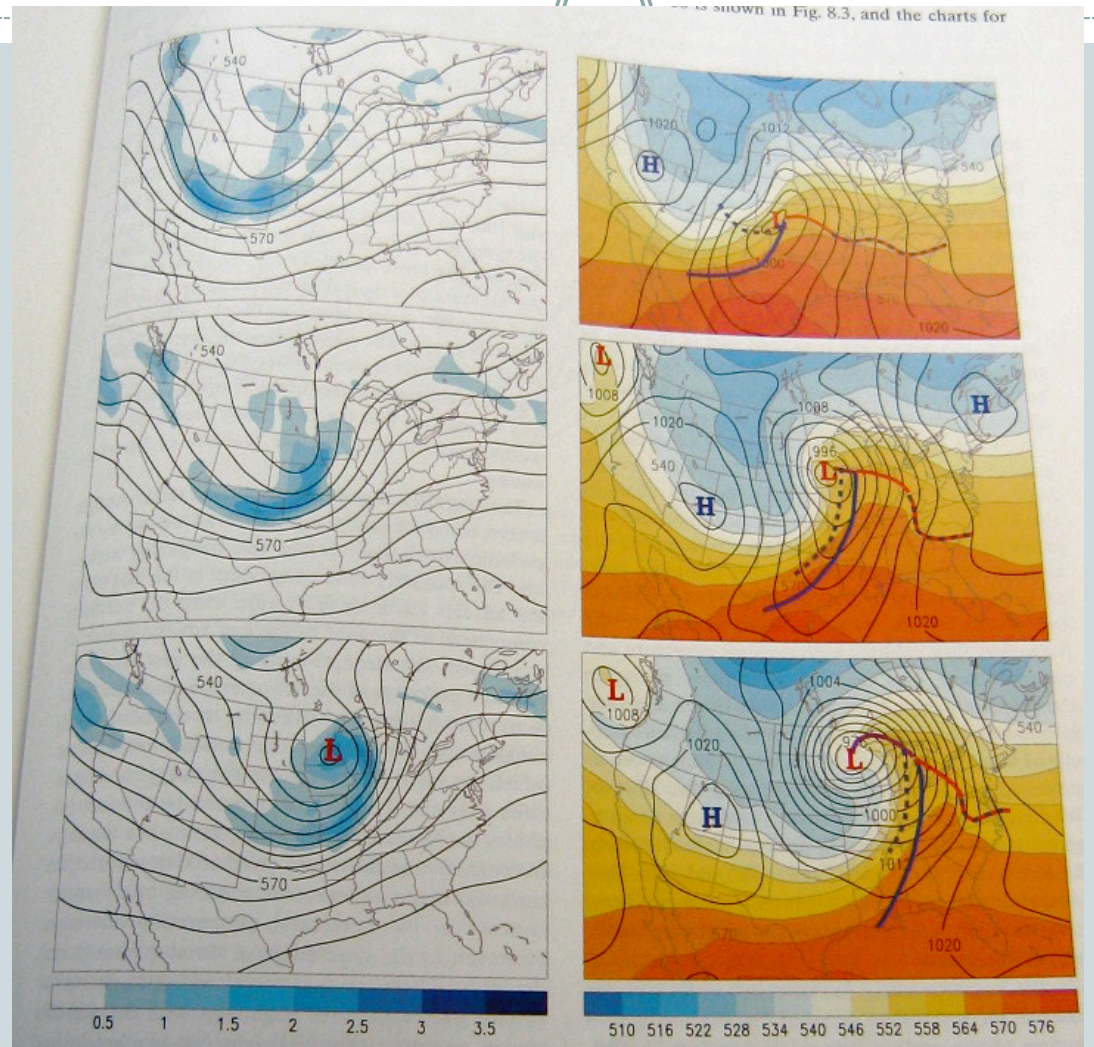


Fig. 8.3 Synoptic charts at 00, 09, and 18 UTC Nov. 10, 1998. (Left) The 500-hPa height (contours at 60-m intervals; lab in dkm) and relative vorticity (blue shading; scale on color bar in units of $10^{-4}\ s^{-1}$). (Right) Sea-level pressure (conto at 4-hPa intervals) and 1000- to 500-hPa thickness (colored shading: contour interval 60 m; labels in dkm). Surface fron positions, as defined by a skilled human analyst, are overlaid. [Courtesy of Jennifer Adams, COLA/IGES.]

Observed Phase Tilts

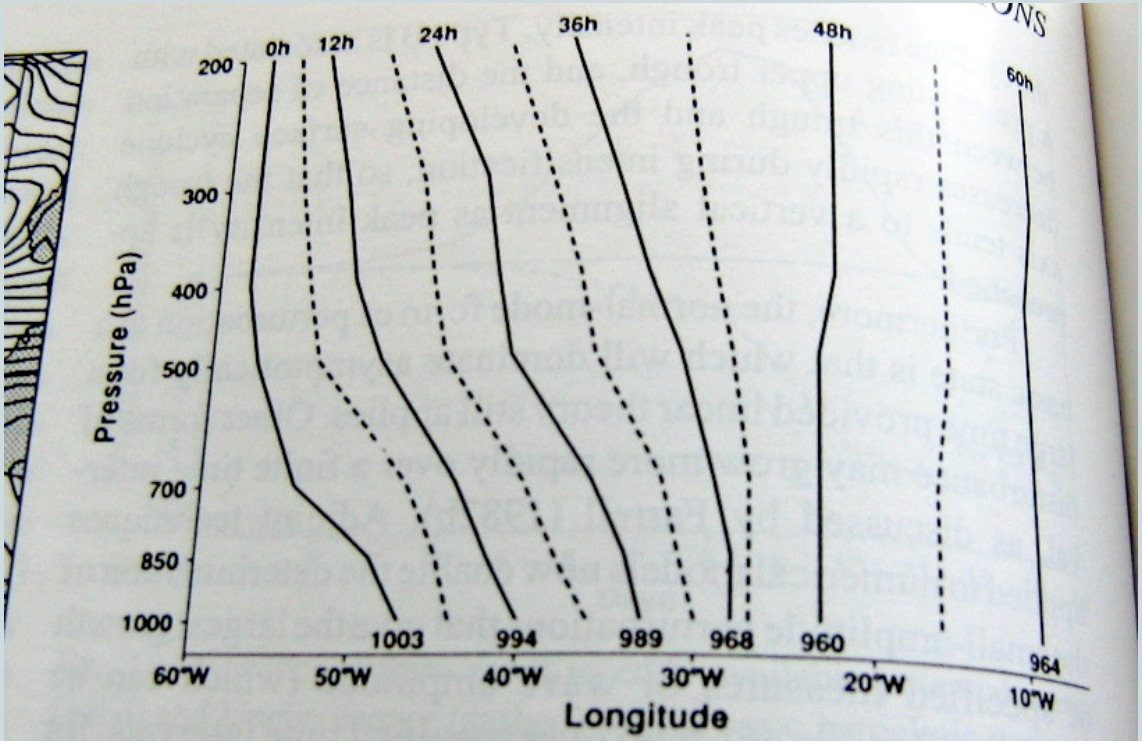
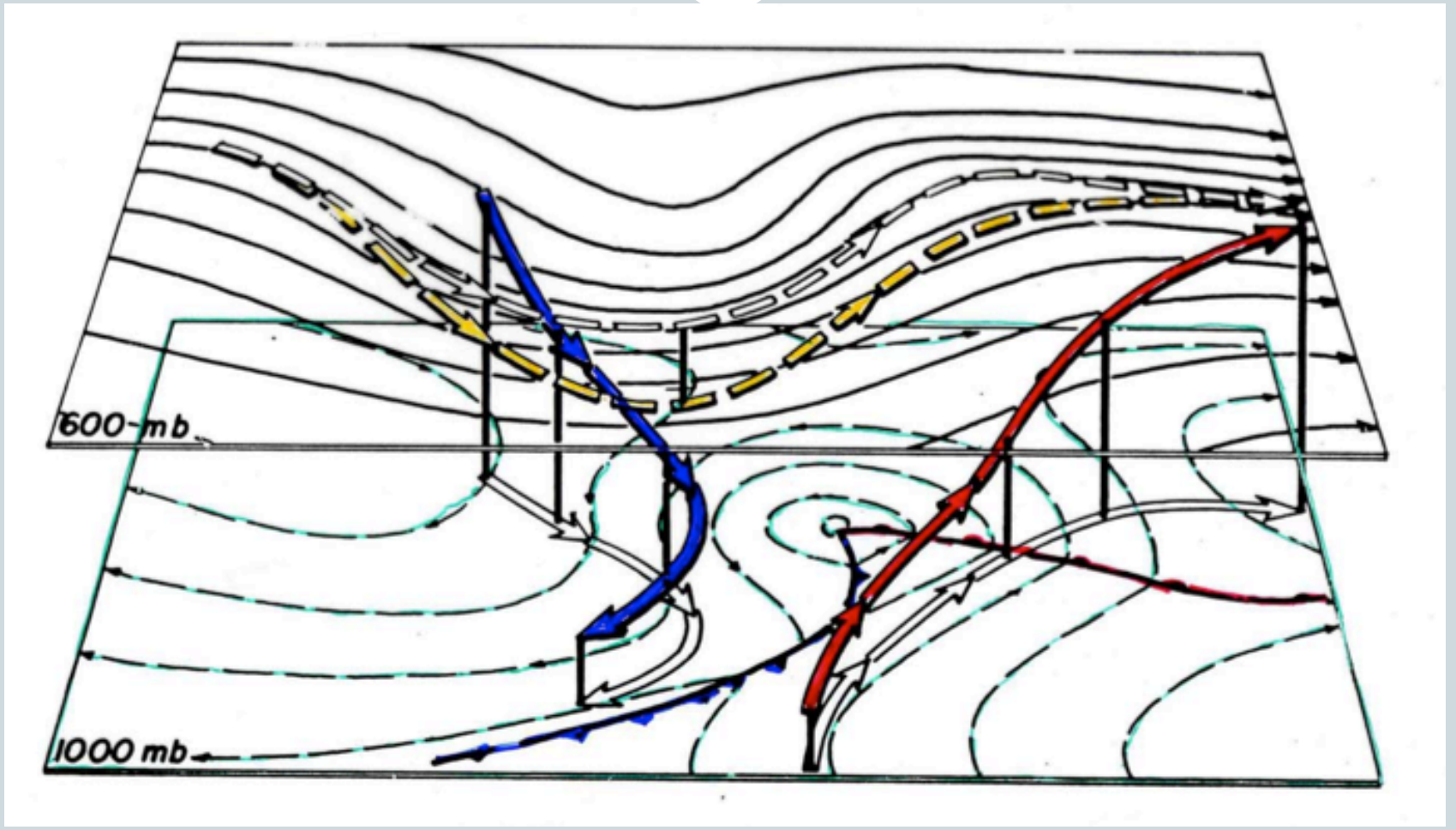
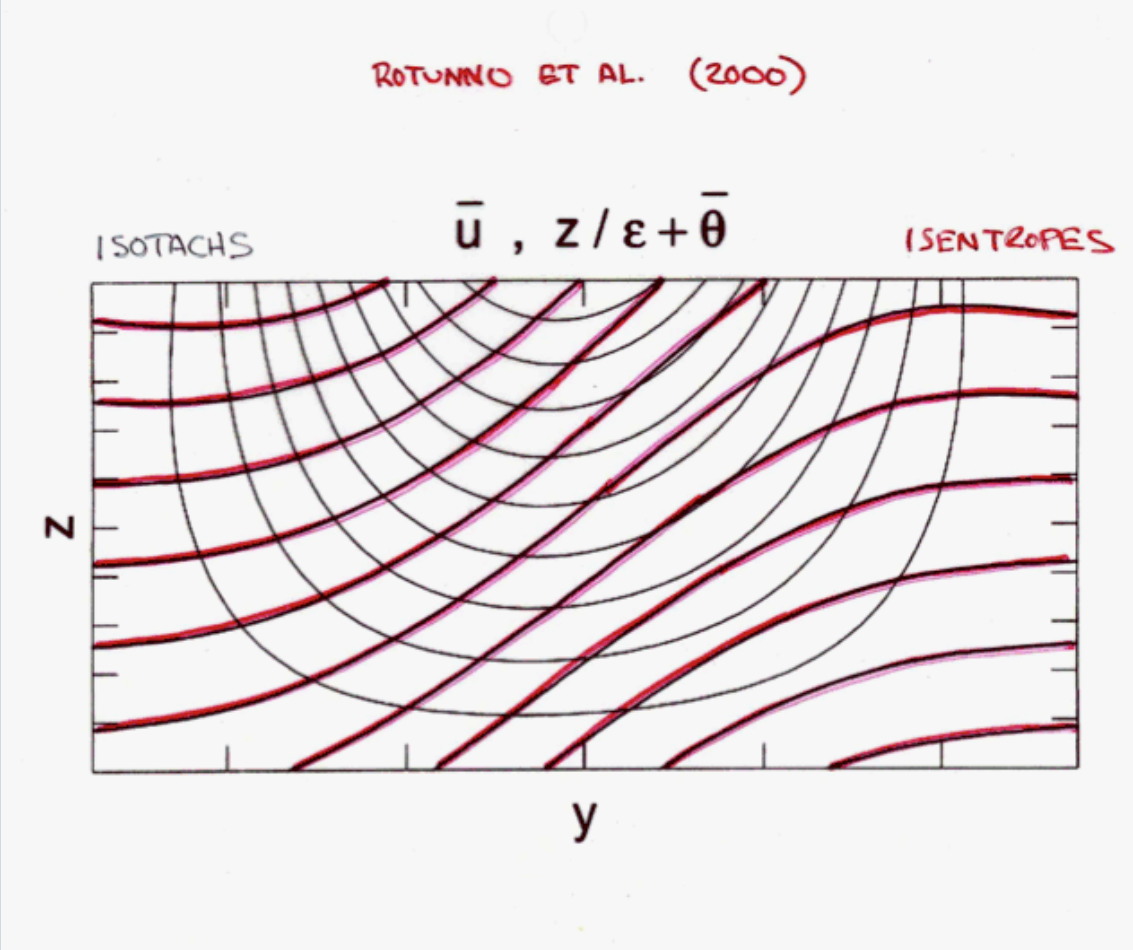


FIG. 3. Pressure/longitude section showing trough positions of Atlantic low at 6-hourly forecast intervals up to hour 60 for the forecast from 1200 UTC 27 January 1994. Also shown are the surface pressures at the center of the low, at 12-hourly

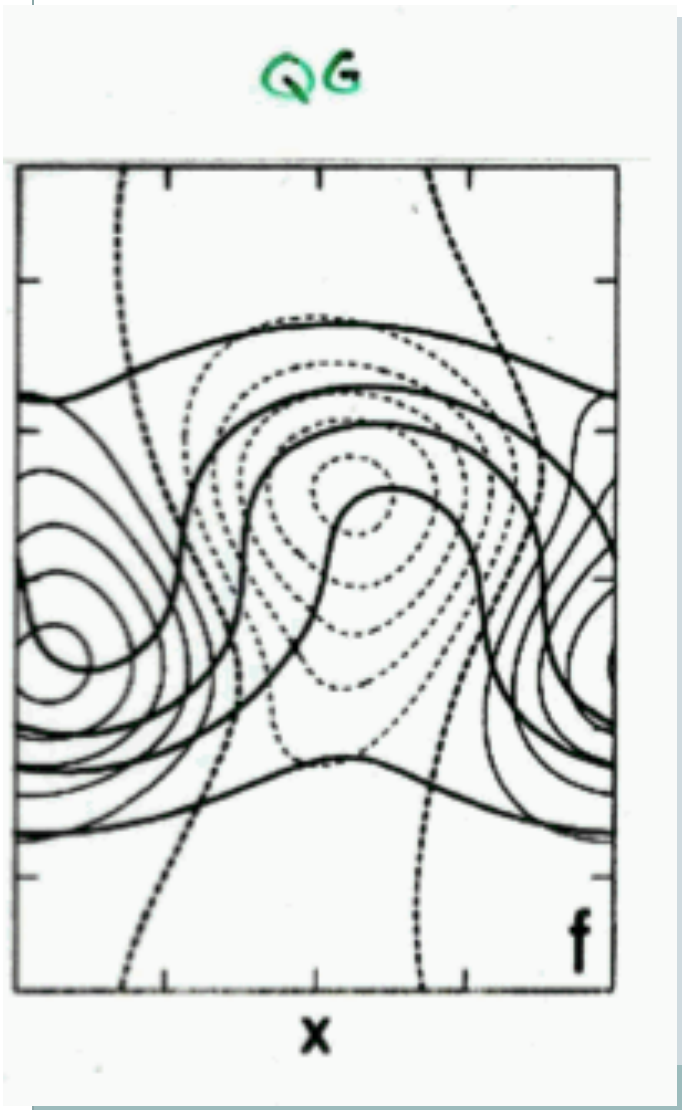
Cyclone Structure

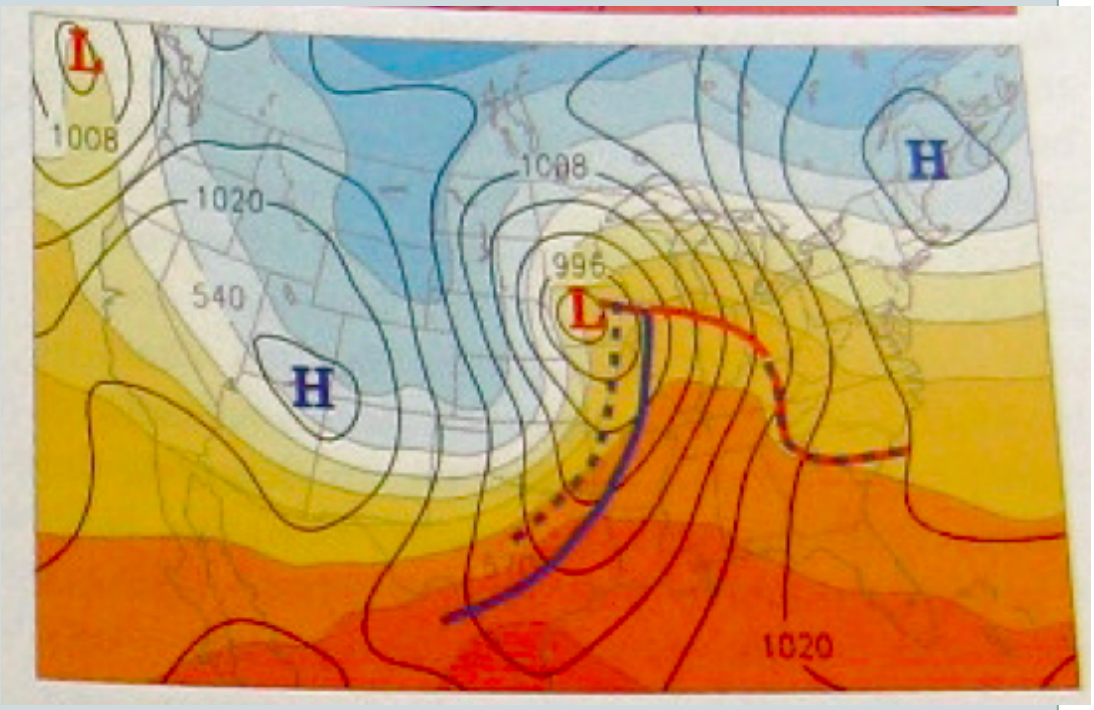


Idealized Cyclogenesis



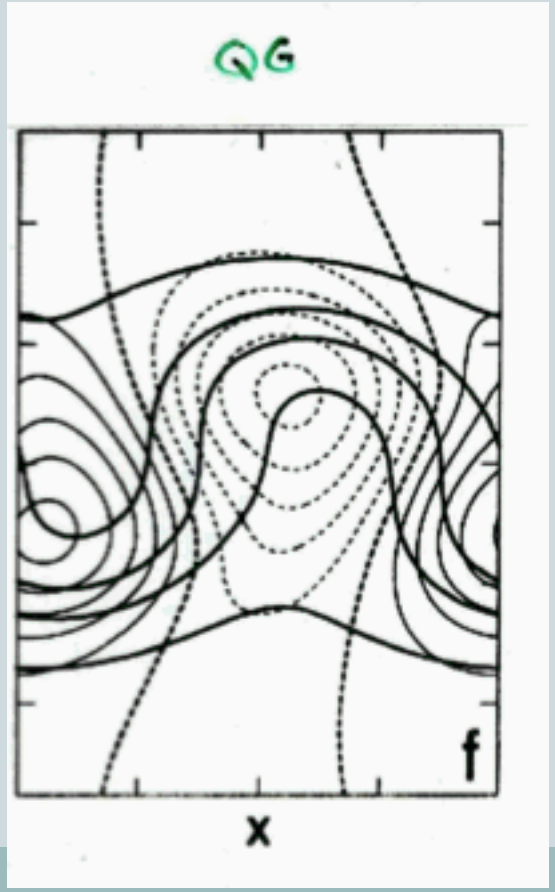
Idealized cyclogenesis

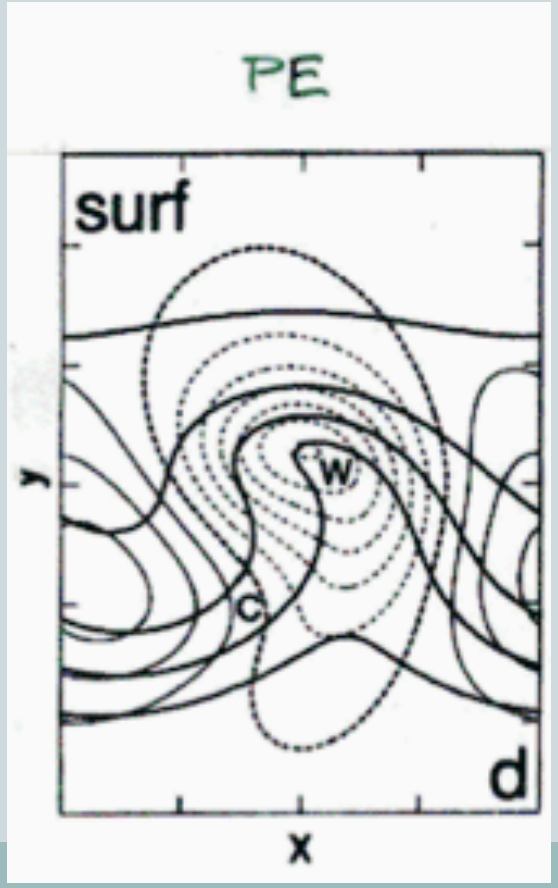




Non-QG Effects

Nonlinear baroclinic instability simulations with a QG model and with a primitive equations model





Stretching of relative vorticity amplifies cyclones and weakens anticyclones

(this is a non-QG effect – cyclones and anticyclones are symmetric in QG)