The “ageostrophic wind” and the "isallobaric wind"

- QG model emphasizes role of horizontal divergence, i.e.
  \[
  \frac{D g \eta}{D t} = -f_0 \nabla \cdot \vec{V}_{ag}
  \]

- Geostrophic wind (on an \( f \) plane**) is non-divergent, so interest is the ageostrophic wind

- Above the friction layer, horiz. mtm eqns. can be written
  \[
  \begin{align*}
  \frac{D u}{D t} &= - \frac{1}{\rho} \frac{\partial P}{\partial x} + f v = f \left[ v - V_g \right] = f \, v_{ag} \\
  \frac{D v}{D t} &= - \frac{1}{\rho} \frac{\partial P}{\partial y} - f u = -f \left[ u - U_g \right] = -f \, u_{ag}
  \end{align*}
  \]

  or
  \[
  \frac{\hat{k}}{f} \times \left[ \frac{D \vec{V}}{D t} - \vec{F}_{fric} \right] = \vec{V}_{ag}
  \]

  \[
  \begin{vmatrix}
  \hat{i} & \hat{j} & \hat{k} \\
  0 & 0 & 1/f \\
  \frac{D u}{D t} & \frac{D v}{D t} & 0
  \end{vmatrix}
  \]

  \[
  = u_{ag} \, \hat{i} + v_{ag} \, \hat{j} + 0 \, \hat{k} = \frac{-1}{f} \frac{D v}{D t} \, \hat{i} + \frac{1}{f} \frac{D u}{D t} \, \hat{j} + 0 \, \hat{k}
  \]

  The ageostrophic wind is in the horiz. plane, perpendicular (and oriented to the left of) the acceleration vector

**A local approximation of the spherical earth as a plane normal to the zenithal component of the earth's rotation... \( f \) is assumed to be constant on the plane... valid in describing motions with time scales smaller than or comparable to \( 1/f \). (AMS Glossary)... [as distinct from "beta plane" which allows linear variation of \( f \) with \( y \)]
“Ageostrophic wind” in relation to jet streaks: locations of con/divergence

\[ \hat{k} \times \frac{D\vec{V}}{Dt} = \vec{V}_{ag} \]
The "isallobaric wind"

\[ \vec{V}_{ag} = \frac{k}{f} \times \left[ \frac{\partial \vec{V}}{\partial t} + [\vec{V} \cdot \nabla] \vec{V} + \omega \frac{\partial \vec{V}}{\partial p} \right] \]

\[ \vec{V}_g = \hat{k} \times \frac{1}{\rho f} \nabla P \]

Define the "isallobaric wind" to be that part of the ageostrophic wind that is contributed by the first term (non-stationarity). Under the approximation that terms on the rhs are evaluated using the geostrophic wind, the isallobaric wind is

\[ \vec{V}_{ia} = \frac{\hat{k}}{f} \times \frac{\partial \vec{V}_g}{\partial t} = \frac{\hat{k}}{f} \times \frac{\partial}{\partial t} \left[ \frac{1}{\rho f} \nabla P \right] = \frac{-1}{\rho f^2} \nabla \frac{\partial P}{\partial t} \]

- lines of constant surface pressure tendency are "isallobars"
- isallobaric wind “driven” by spatial gradient in pressure tendency
- or (equivalently) by tendency in the pressure gradient
- isallobaric wind blows PERPENDICULAR to isallobars
The "isallobaric wind"

Let coordinate $s$ increase down the isallobaric gradient, i.e.

- from where $p$ is rising rapidly towards where $p$ is rising less rapidly, or
- from where $p$ is rising towards where $p$ is falling, or
- from where $p$ is falling slowly towards where $p$ is falling faster

Then the isallobaric wind is

$$
\vec{V}_{ia} = \frac{-1}{\rho f^2} \frac{\partial}{\partial s} \left[ \frac{\partial P}{\partial t} \right]
$$

Is this a "real" wind? Yes, it is one component of the departure from the geostrophic wind (within the ABL, and particularly near the surface, friction is liable to be a more important deviation). Furthermore its divergence is important (our starting point), given by

$$
\nabla \cdot \vec{V}_{ia} = \frac{-1}{\rho f^2} \nabla^2 \frac{\partial P}{\partial t}
$$
Isallobaric chart (from Vizaweb) – relevant to 12Z winds and our fcst for Wed. 12Z**

**YEG reported "18010KT" at 12Z Wed.