Examples of frontogenesis (intensification of grad *T*) in response to deformation

Synoptic scale fronts form as a result of large scale ***deformation***... enhancing initially broad gradients of temperature (Markowski & Richardson, p115)

We've encountered these important "differential properties" of the wind field**

$$\delta = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = \frac{\partial v}{\partial s} + v\,\frac{\partial \beta}{\partial n}$$ horizontal divergence

$$\zeta = \frac{\partial v}{\partial y} - \frac{\partial u}{\partial x} = v\,\frac{\partial \theta}{\partial s} - \frac{\partial v}{\partial n}$$ vertical component of relative vorticity

Interpret "*v*" as the meridional component in *x*-*y* coords, but as horiz. speed in natural coords

Two others are considered significant:

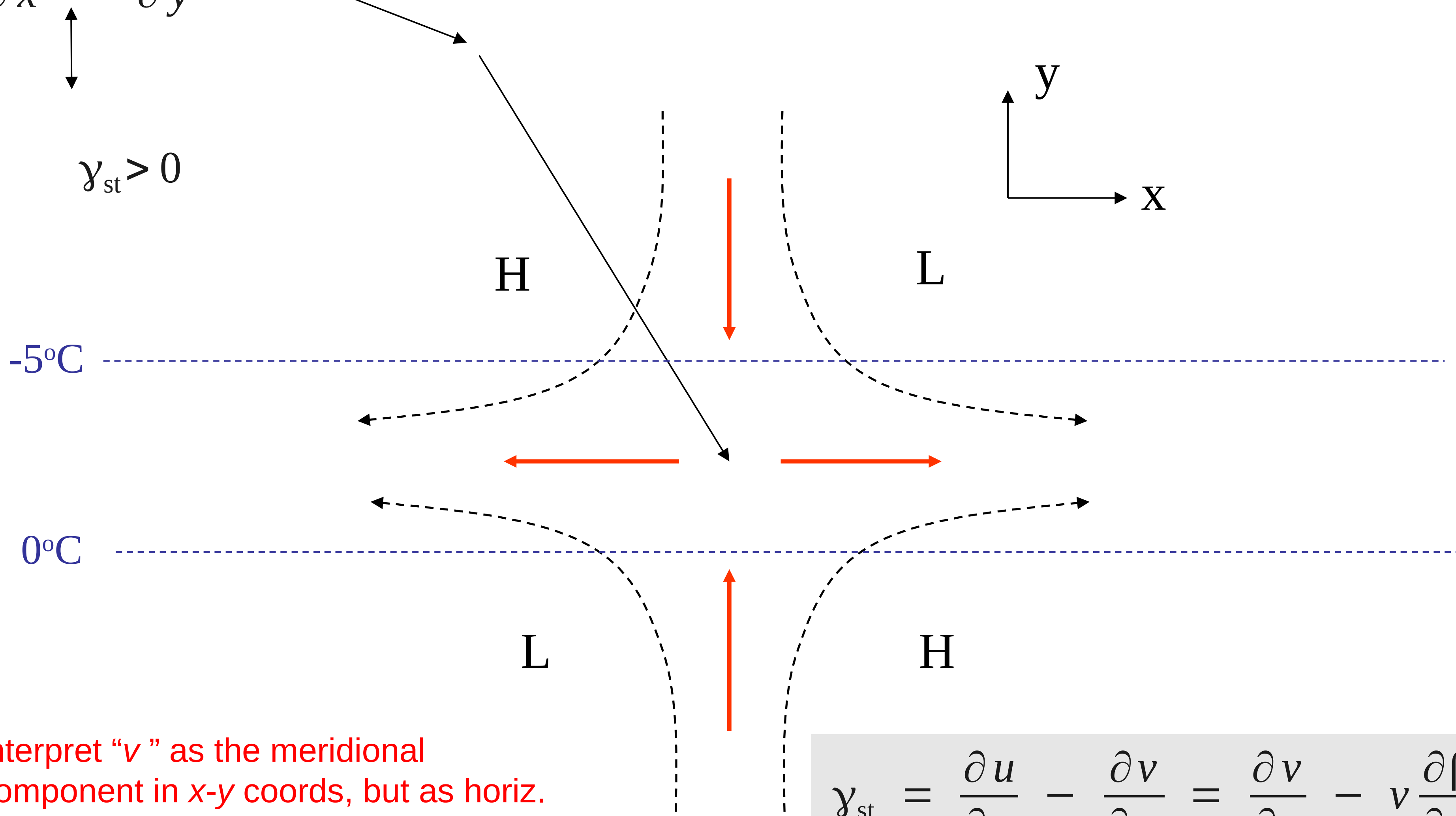
$$\gamma_{st} = \frac{\partial u}{\partial x} - \frac{\partial v}{\partial y} = \frac{\partial v}{\partial s} - v\,\frac{\partial \beta}{\partial n}$$ stretching deformation

$$\gamma_{sh} = \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y} = \frac{\partial v}{\partial n} + v\,\frac{\partial \beta}{\partial s}$$ shearing deformation

**A two-dimensional sheet of air can be brought from one position to another by the cumulative application of a translation, a deformation, an expansion/contraction, and a rotation

$$\frac{\partial u}{\partial x} > 0, \quad \frac{\partial v}{\partial y} < 0$$

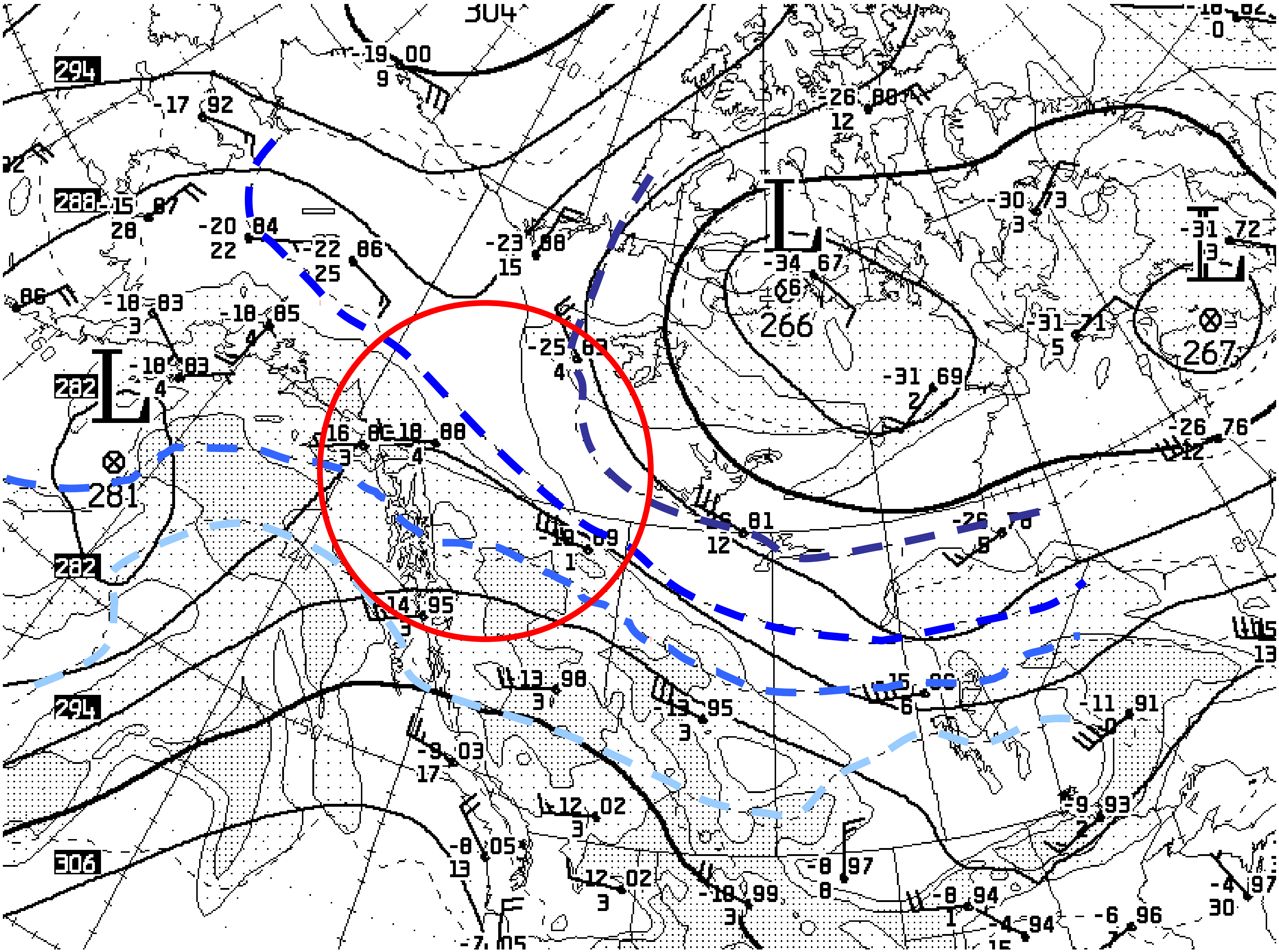
$$\gamma_{st} > 0$$



Interpret "*v* " as the meridional component in *x*-*y* coords, but as horiz. speed in natural coords

$$\gamma_{st} = \frac{\partial u}{\partial x} - \frac{\partial v}{\partial y} = \frac{\partial v}{\partial s} - v\frac{\partial \beta}{\partial n}$$

To evaluate which deformation component this exemplifies, focus on the centre-point. Streamline is undefined there, so we need to use the Cartesian axes. The stretching deformation is positive; however (assuming the contour pattern is symmetric) the shearing deformation is zero



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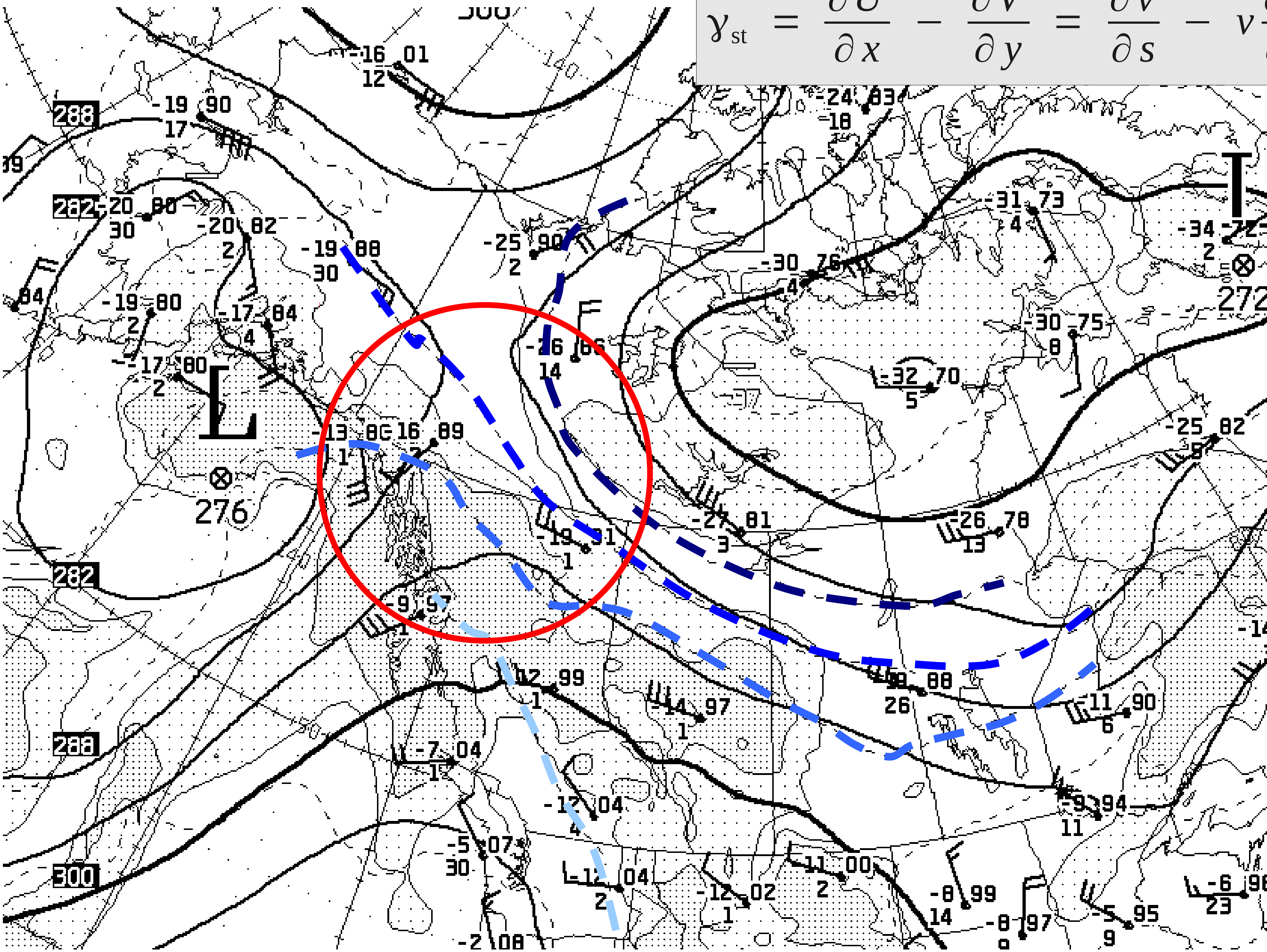

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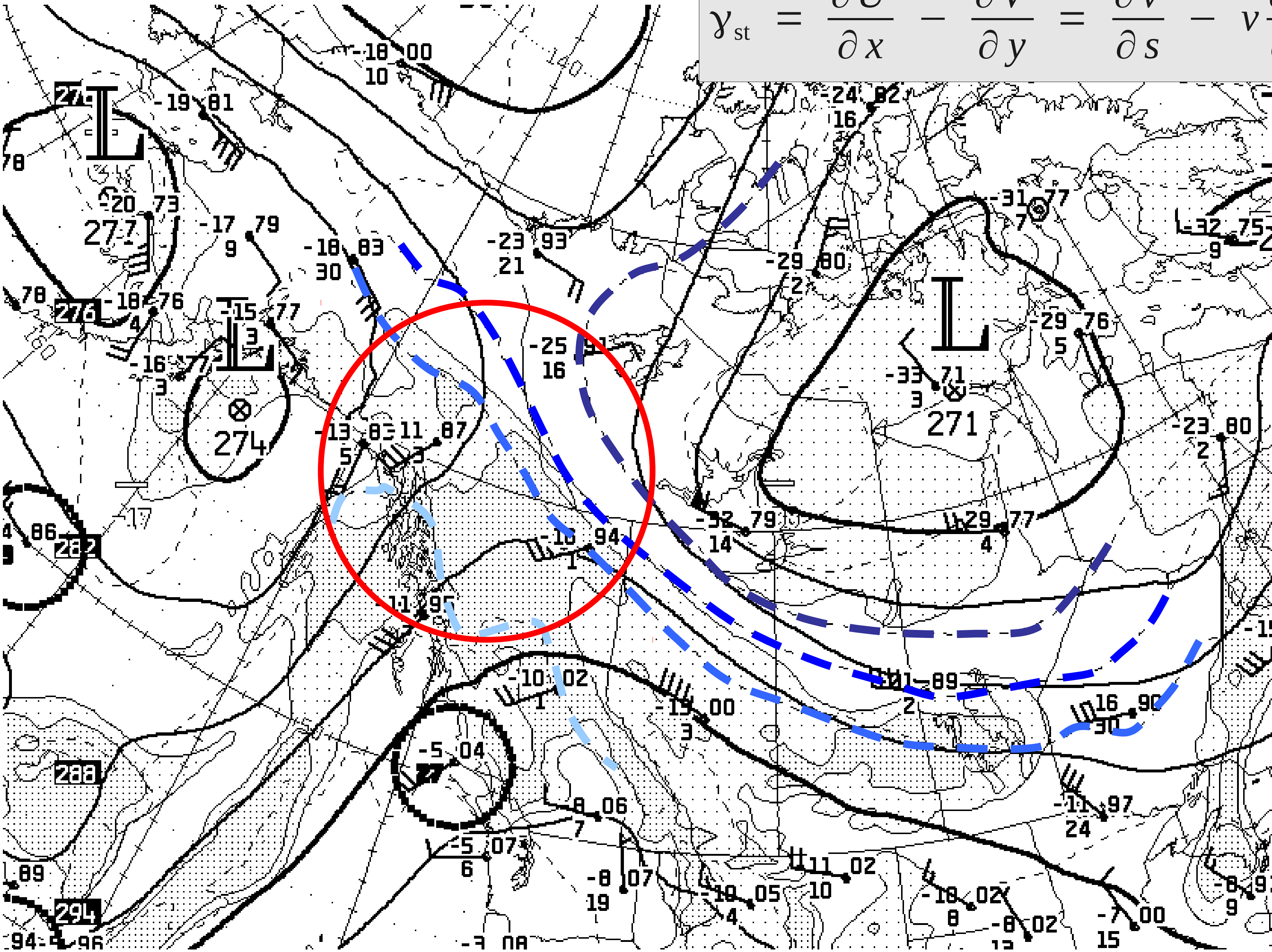

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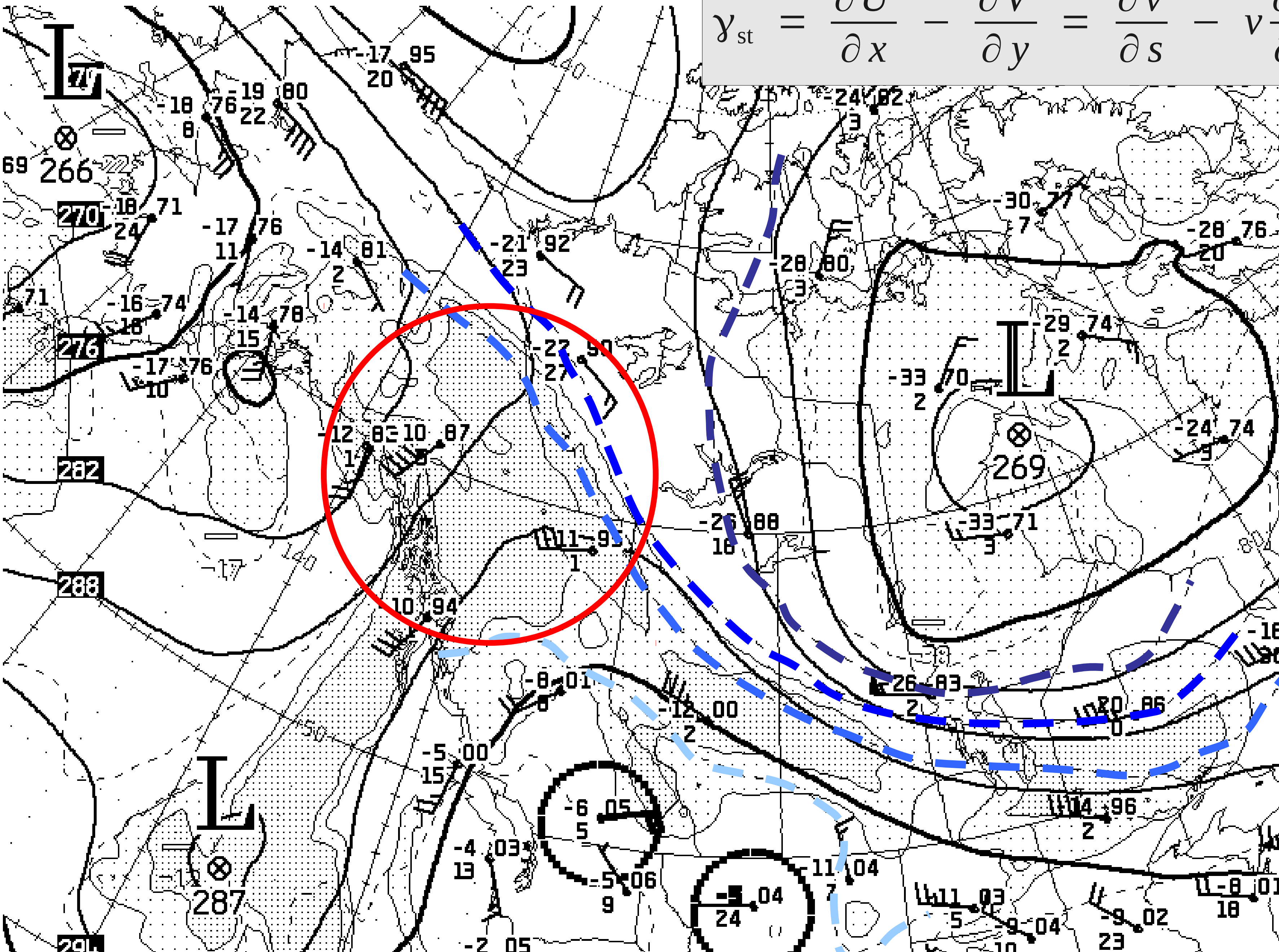

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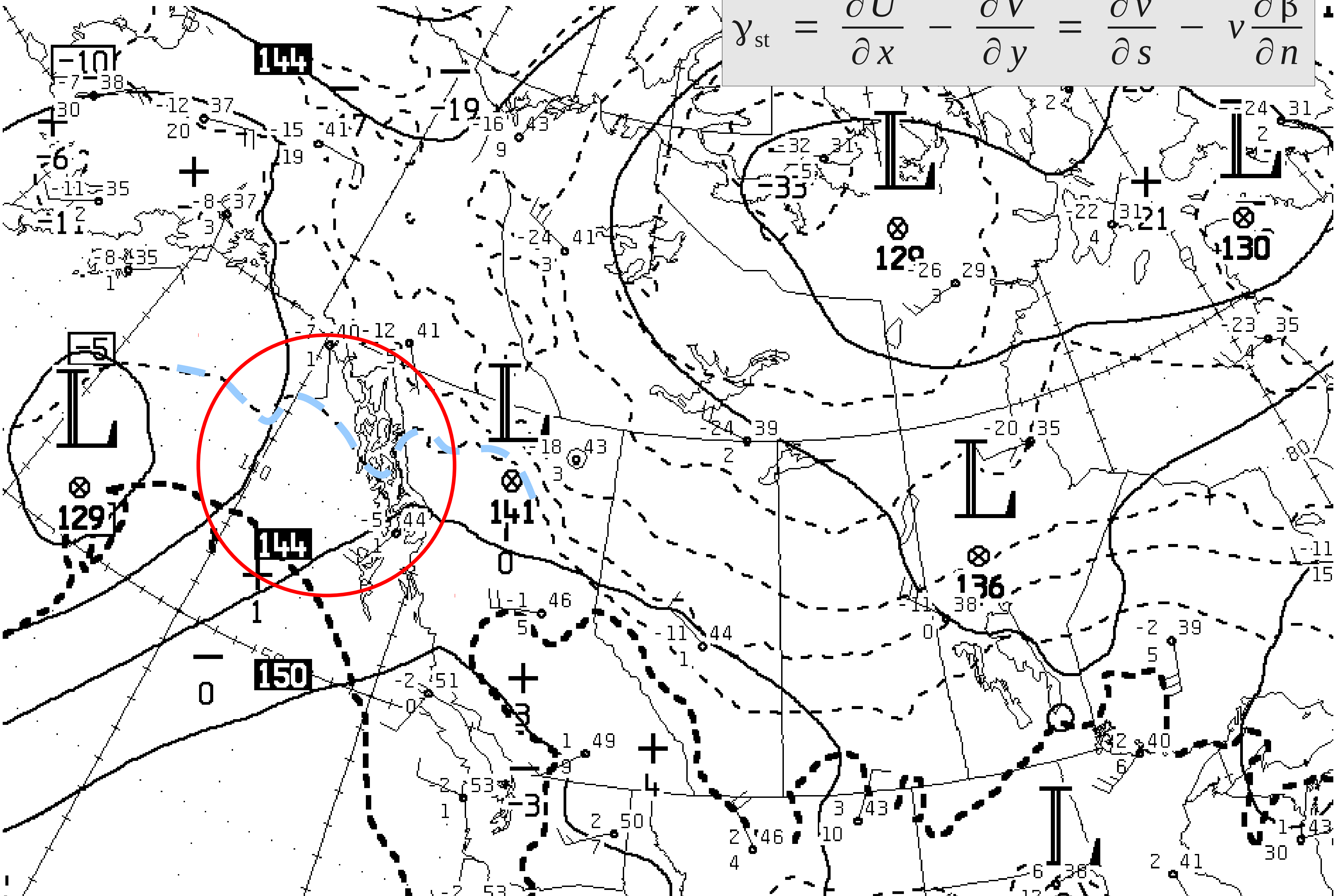

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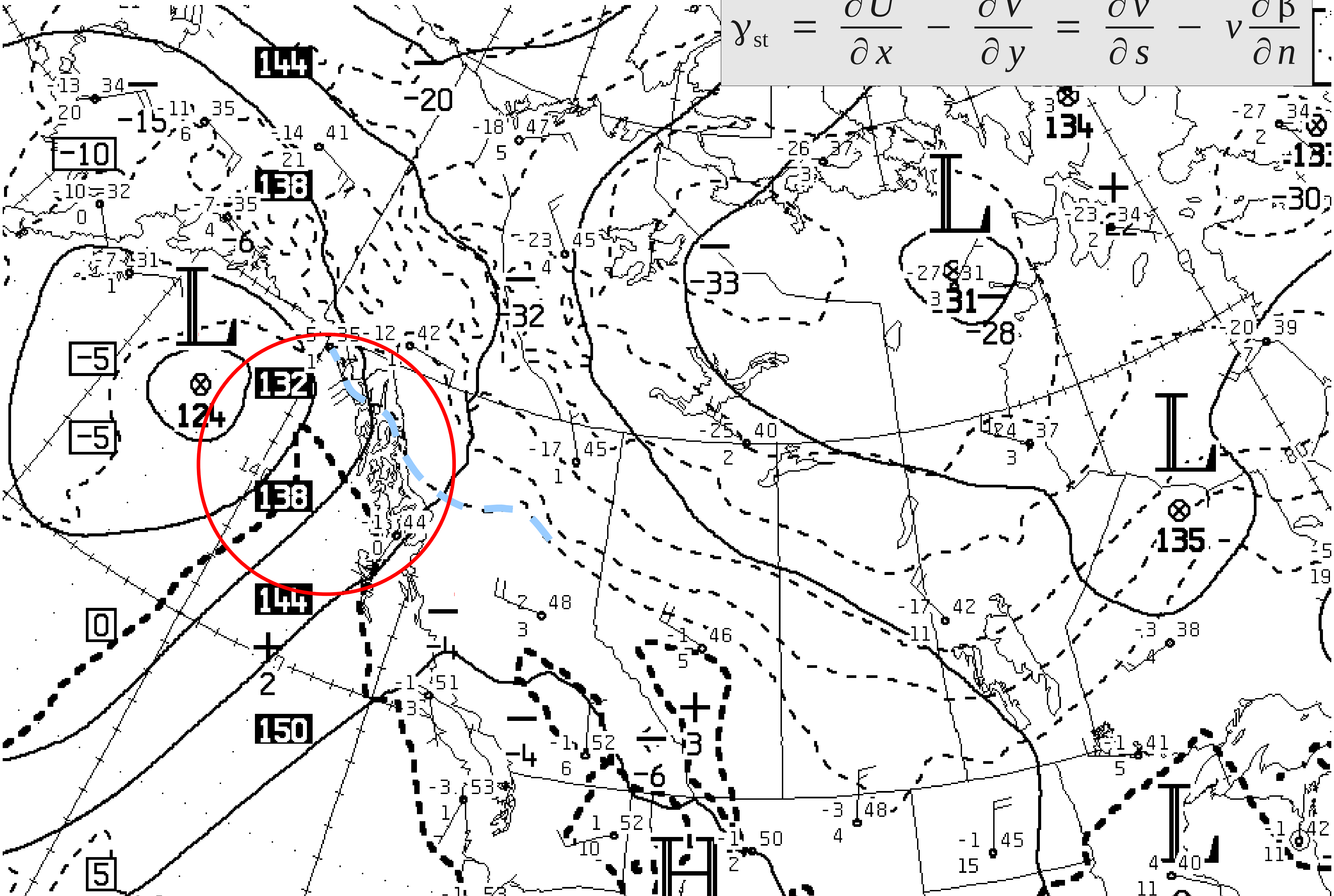

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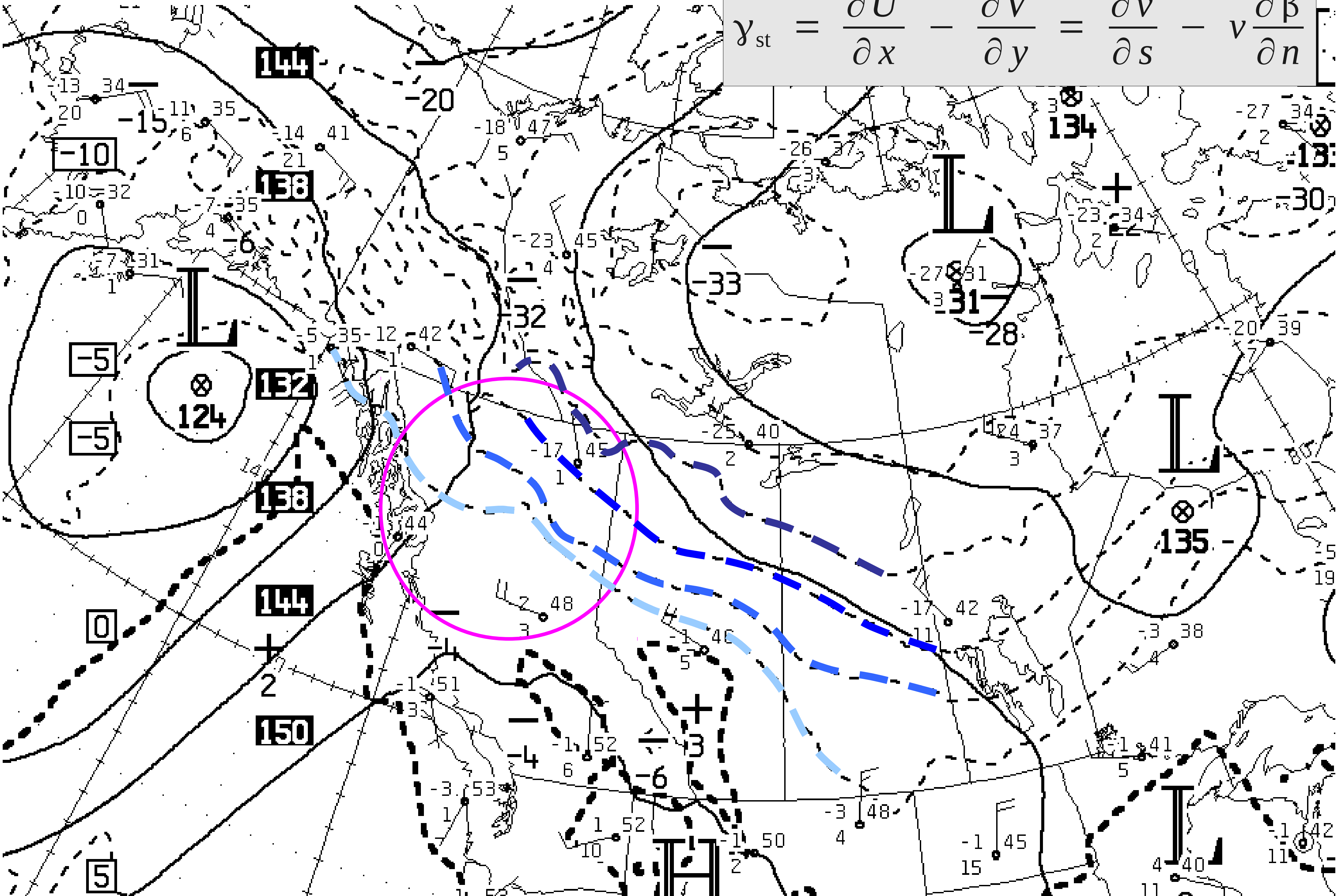

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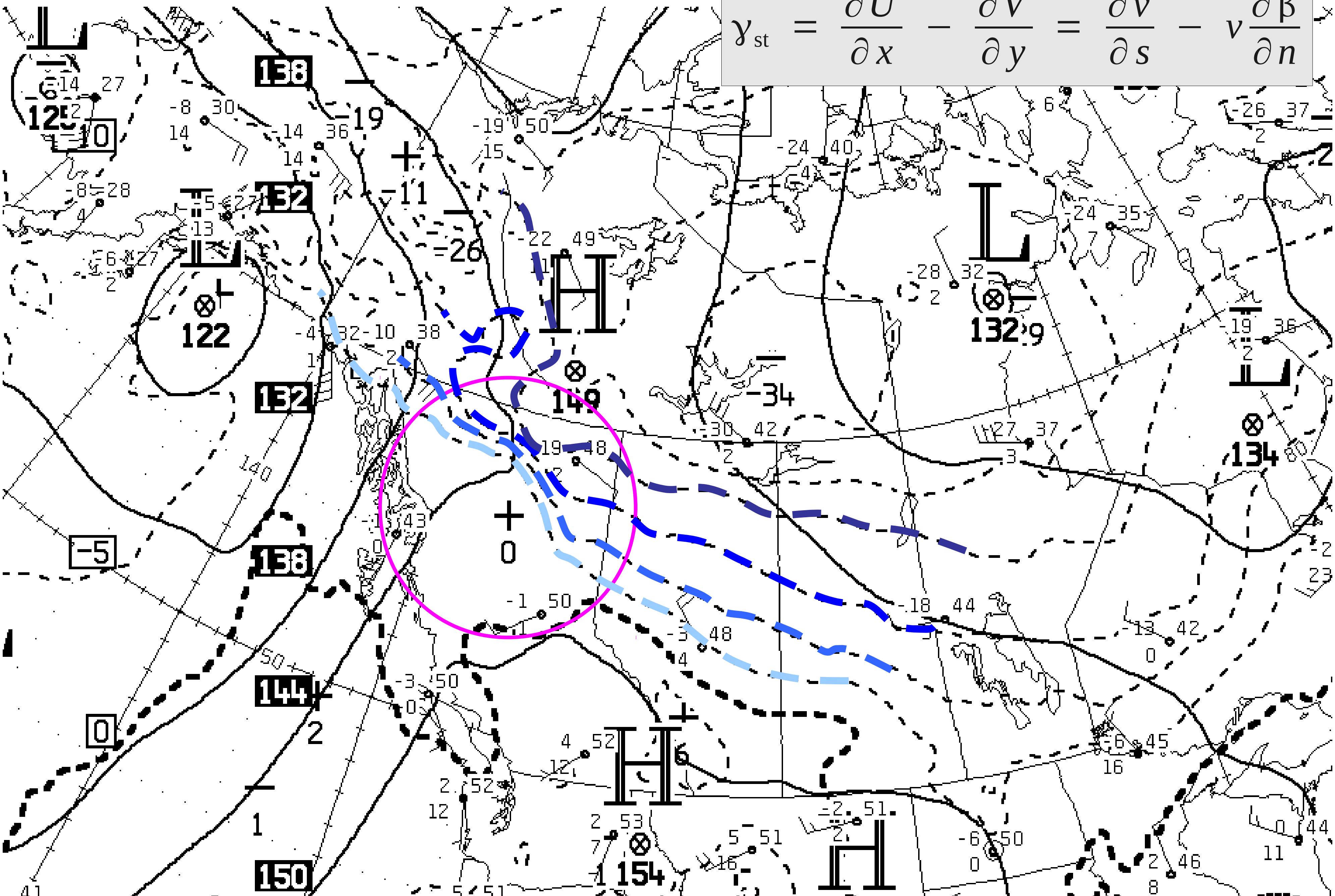

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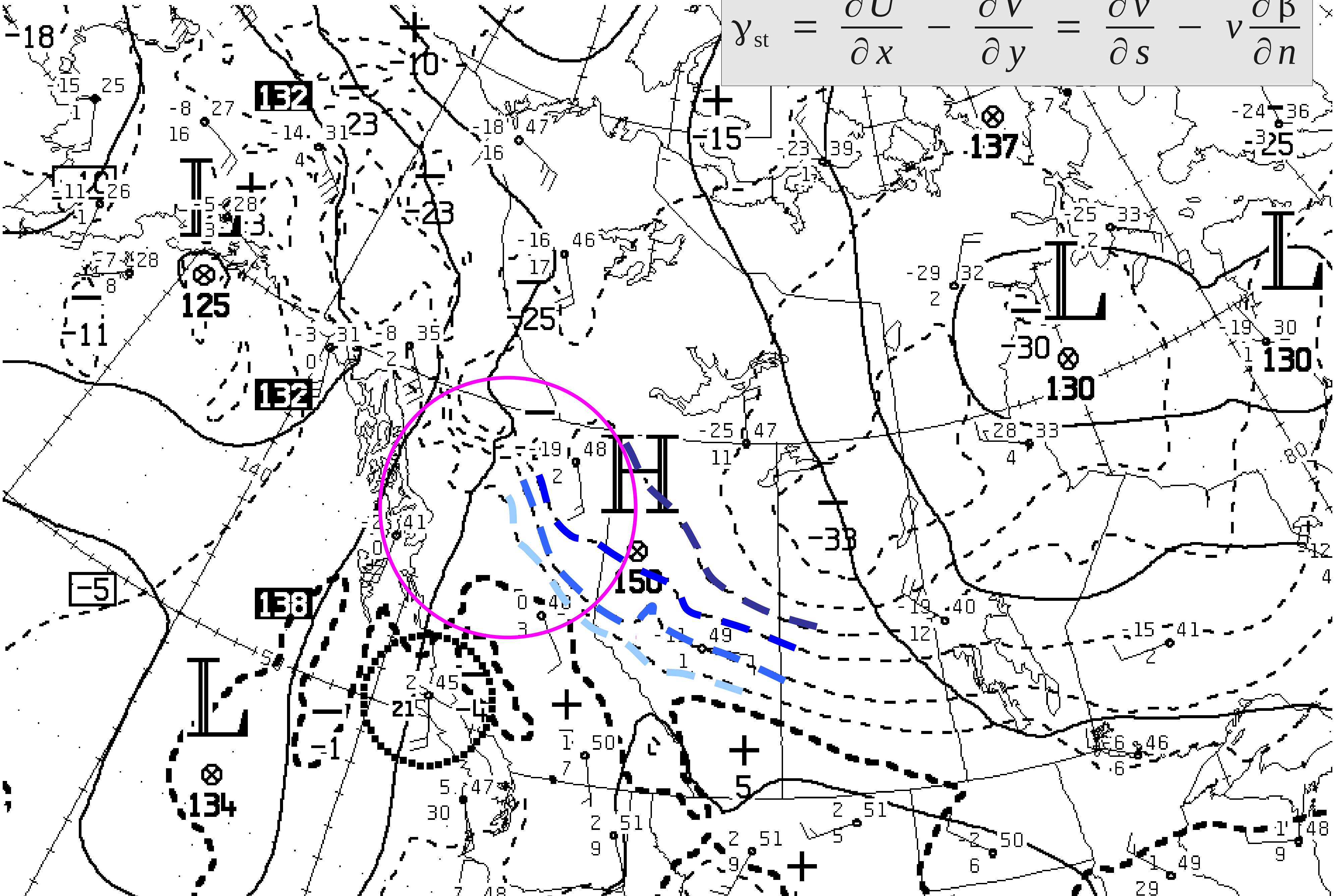

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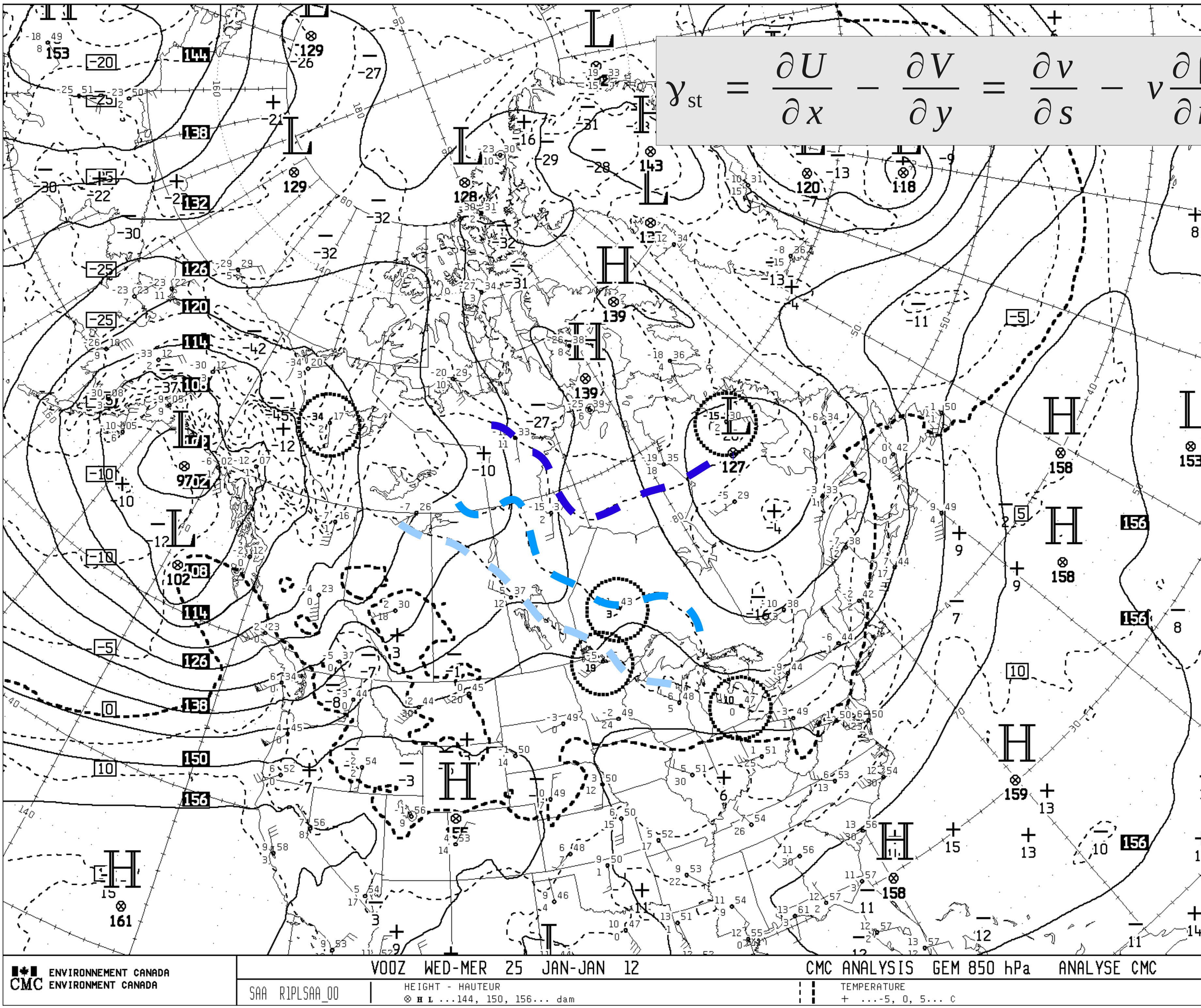

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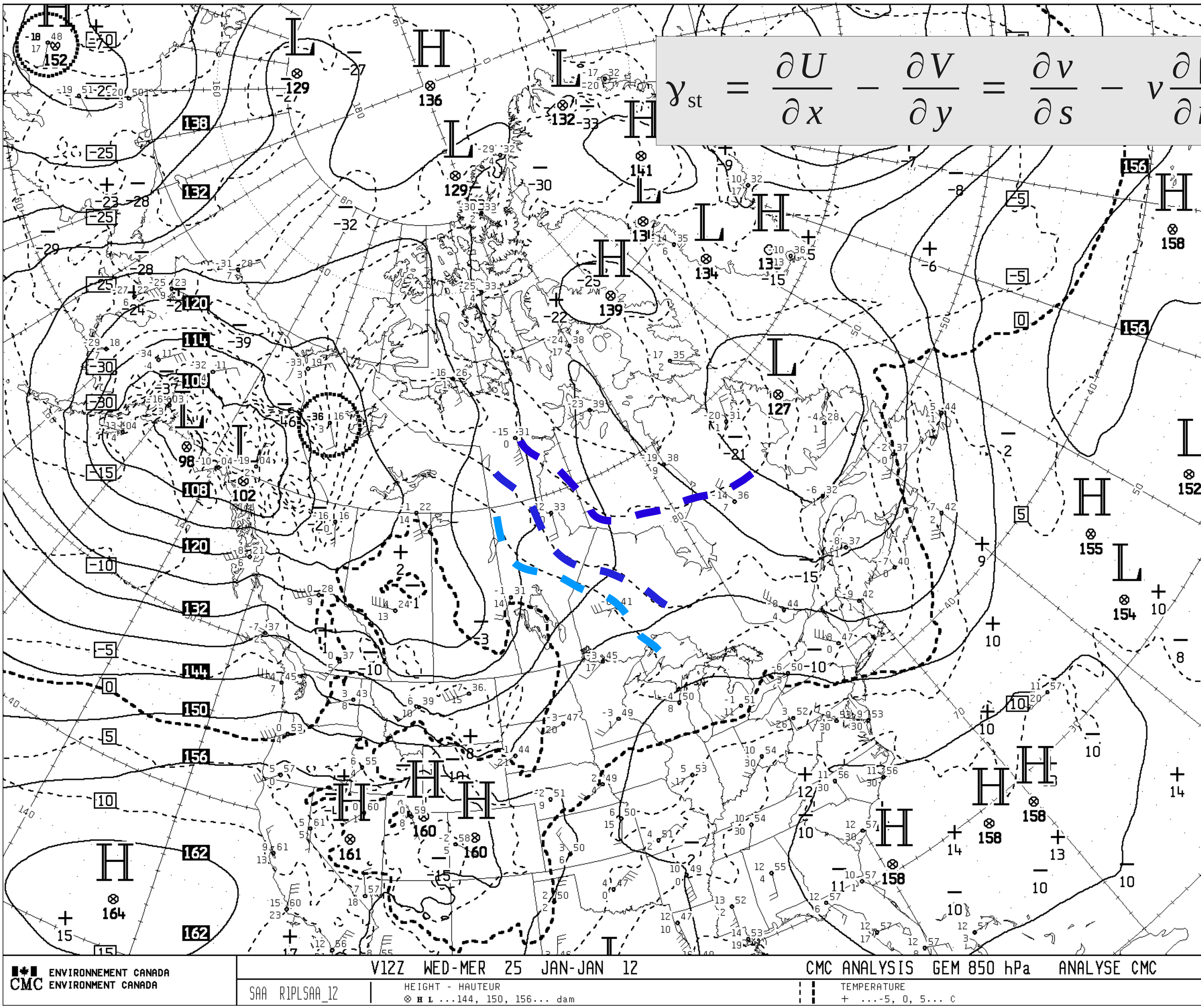

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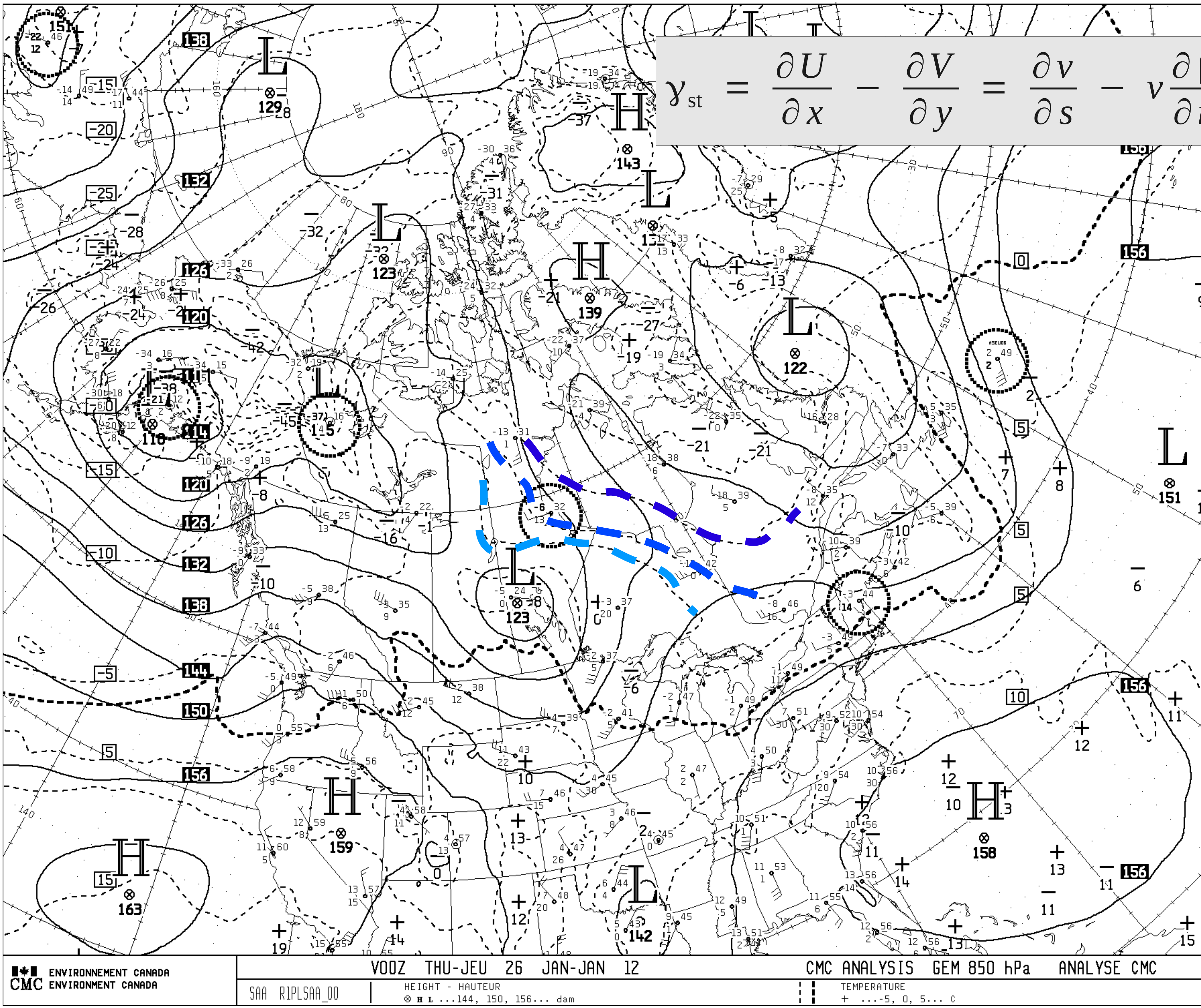

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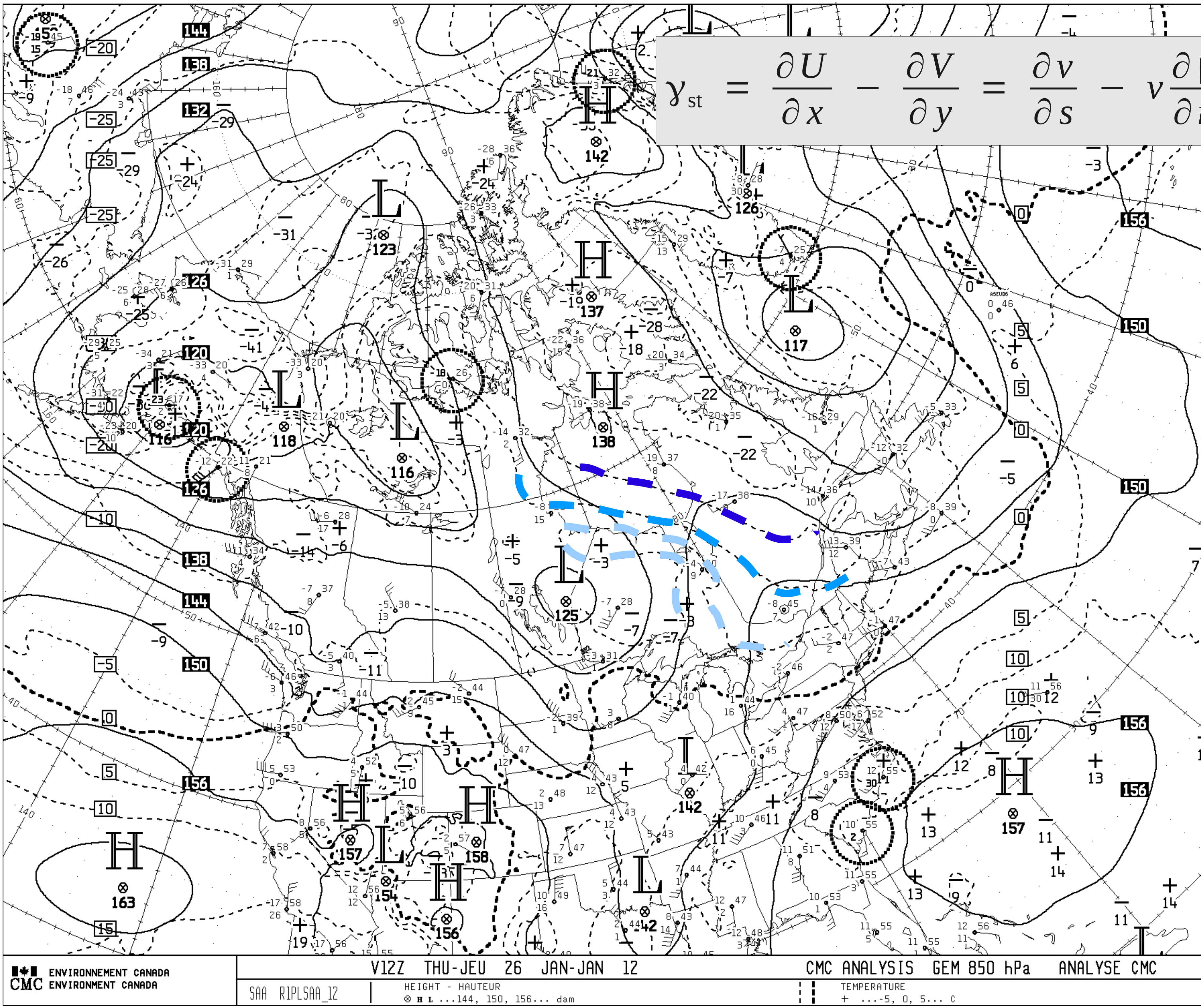

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