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What causes surface pressure to fall?

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Cyclone evolution and intensification are typically described by the central surface (or sea-level) pressure of these systems. Therefore, researchers are often interested in the various processes that contribute to the tendency of surface pressure changes. In the hydrostatic limit for synoptic-scale systems, surface pressure changes can only occur through the redistribution of mass in the vertical atmospheric column. Over the last hundred years, however, researchers have proposed alternative causes for surface pressure change, including more recent tendency equations for hydrostatic surface pressure that rely on changes in temperature within layers in the column.

In this presentation, we review existing diagnostics that are used to calculate surface pressure tendencies and pinpoint their deficiencies and limitations, particularly in the light of controversial discussions in the literature. In particular, the widely used pressure tendency equation by Godson has served as the basis for more recent derivations by other authors. These authors have claimed causal relationships based on their diagnostics. We argue that the physical mechanism as elucidated by the governing equation for hydrostatic pressure change in the atmosphere does not allow one to draw causal inferences about the reasons for surface pressure changes. We also consider the effects of moisture and latent heat release and discuss how hydrostatic surface pressure changes are indirectly related to these processes.