The classical view of stratosphere troposphere exchange (STE) near midlatitude jets is informed by striking cross-sections of dropwindsonde observations, which show nearly ubiquitous, thin sheets of stratospheric air curling poleward and downward around the jet, deep into the troposphere . What could cause this apparent poleward and downward circulation around the jet and why are the intrusions so thin? Steady-state Sawyer-Eliassen meridional circulation solutions do not seem to match modeled or tracer-inferred meridional circulations near the jet. Here we suggest a new mechanism for causing this signature: with active convection along a cold front the signature of a stratospheric intrusion can result simply from tropical upper tropospheric air overriding stratospheric air.

Case studies using the University of Wisconsin Nonhydrostatic Modeling System (UWNMS) of developing midlatitude cyclones in the upper Midwest show that convection along a cold front between the subtropical and subpolar jets can create inertially unstable air in the upper troposphere, facilitating poleward acceleration at the level of the subpolar jet. Vertically confined poleward motion overrides stratospheric air, creating the classical signature of a stratospheric intrusion through kinematic progression. Poleward surges of air can accentuate the intrusion signature via the induced peripheral circulation, similar to that around a rising warm plume. Lagrangian particle trajectories in midlatitude cyclone case studies with the Weather Research Forecast model (WRF) support the following picture: air in the “intrusion” moves roughly eastward at constant height, while air from near the subtropical jet moves northeastward over the intrusion in the upper troposphere and lower stratosphere.

Density variations in the meridional plane are consistent with a release of potential energy, where mixed stratospheric/tropospheric air can subside under tropospheric air. The STE signature is part of the 3D nature of Rossby waves breaking on the base of stratosphere, similar to a curling ocean wave breaking on the beach.