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Stationary and Transient Planetary Wave in Maintaining Stratospheric Polar Vortex Regimes in NH Winter

- Planetary waves can propagate into the stratosphere (green arrow in figure 1), affecting the stratospheric circulation when they break and get absorbed (e.g., Palmer, 1981), or be refracted downward and in meridional direction (blue arrow in Figure 1) and may in turn influence the planetary wave pattern in the troposphere and could induce changes in the zonal mean flow in the troposphere (e.g. Perlwitz and Graf, 1995);
- Stratospheric polar vortex usually forms in early winter as a consequence of the cooling of the northern polar atmosphere (Baldwin and Dunkerton, 2001) and undergoes inter-annual variations (Castanheira and Graf, 2003) with two different regimes: Strong and Weak Polar Vortex.
- Stationary planetary waves are more strongly attracted towards the polar region in the low phase of the tropospheric annular mode and, thus, a weaker stratospheric polar vortex is expected (Limpasuvan and Hartmann, 2000).
- Stationary planetary wave propagation helps maintaining the Stratospheric polar vortex regimes (Li et al., 2007).

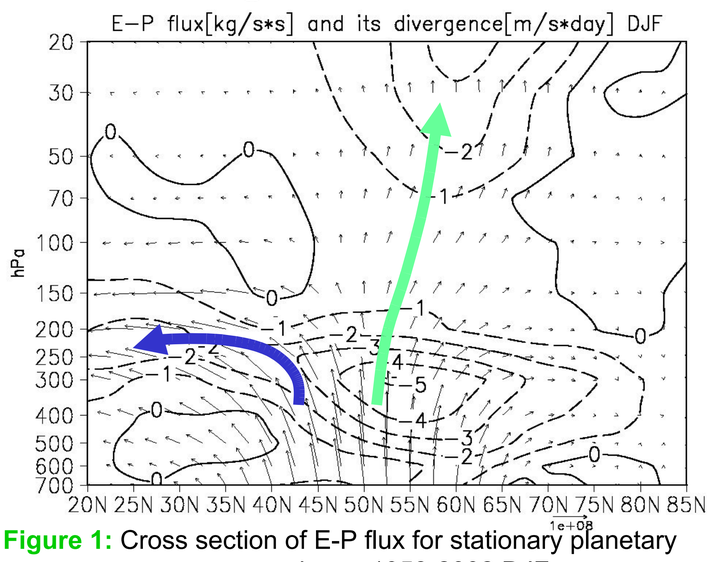
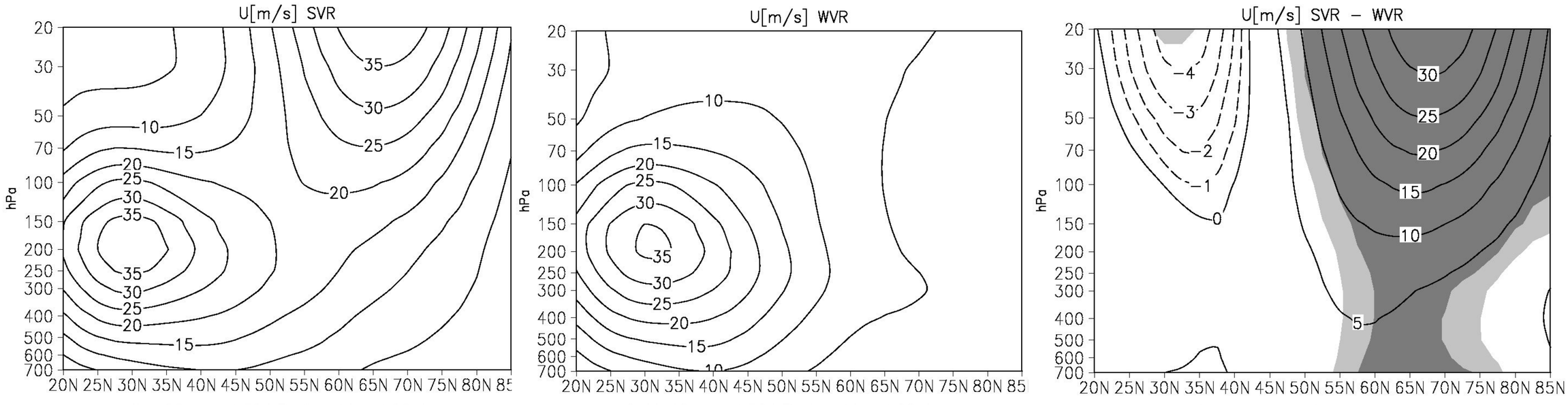


Figure 1: Cross section of E-P flux for stationary planetary waves averaged over 1958-2002 DJF

Figure 2: Zonal mean zonal wind for Strong Polar Vortex (SVR) and Weak Polar Vortex (WVR) and their difference

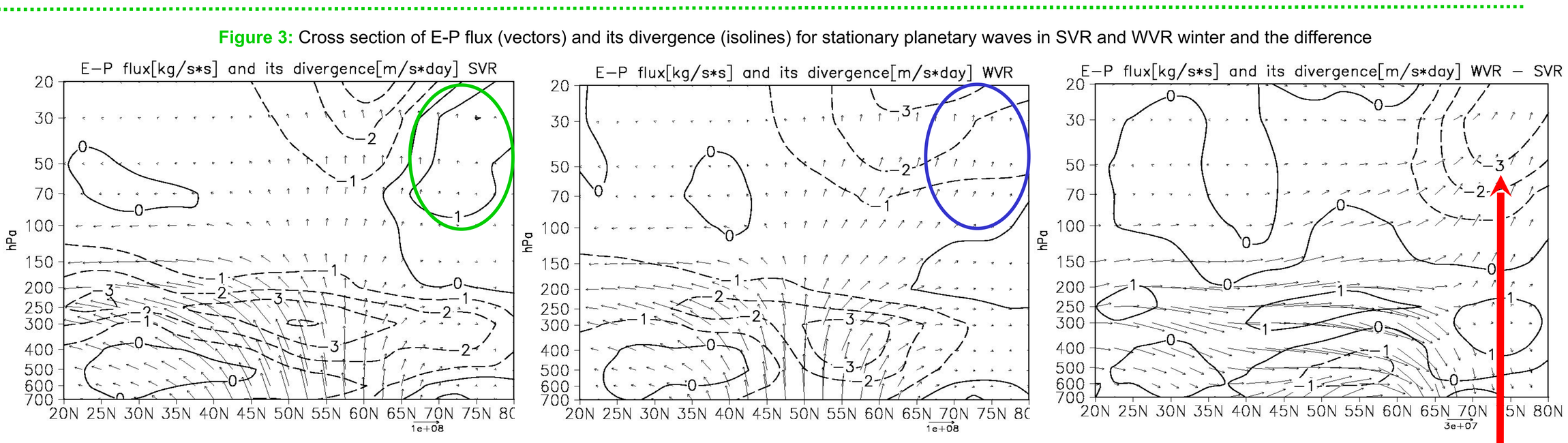


exceeding 20 m/s at 50 hPa for at least 30 days

0<U<10 m/s at 50 hPa for at least 30 days

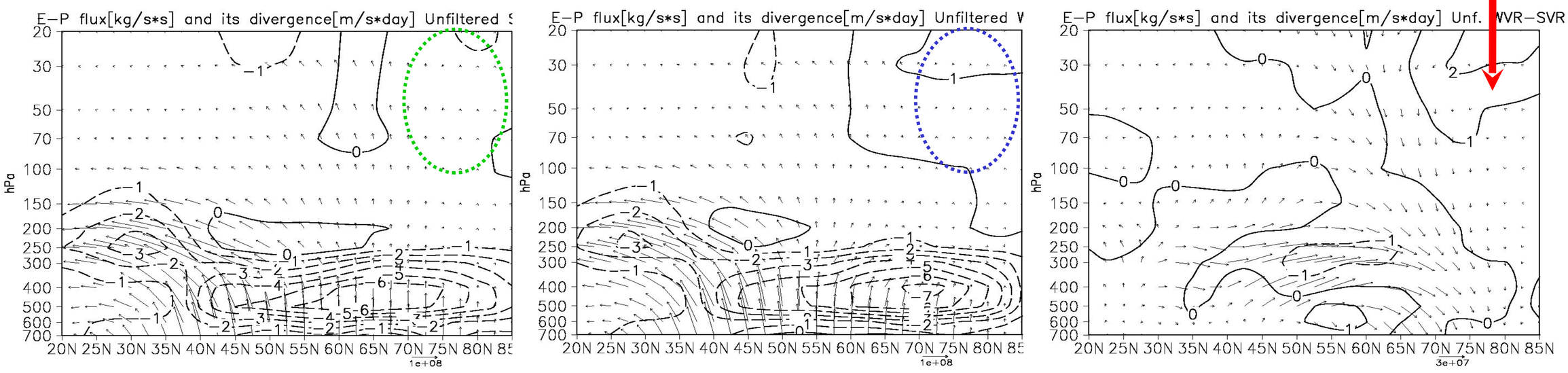
Statistical significance is shaded

Figure 3: Cross section of E-P flux (vectors) and its divergence (isolines) for stationary planetary waves in SVR and WVR winter and the difference



stationary planetary waves propagate much more from the troposphere to the stratosphere in WVR than in SVR

Figure 4: Cross section of E-P flux (vectors) and its divergence (isolines) for transient planetary waves in SVR and WVR winter and the difference



Larger amplitudes of equatorward vectors of E-P flux

- Stationary and transient planetary waves counteract each other in the higher latitude middle stratosphere while maintaining the Stratospheric Polar Vortex regimes.
- Stationary waves provide less (more) eddy heat flux to the polar stratosphere while the transient waves provide more (less) to the subpolar stratosphere in Strong (weak) Polar Vortex.
- The contribution of transient waves to the upward energy flux is mainly related to the low-frequency transients (figures not shown here).

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References: Palmer, 1981: J. Atmos. Sci.,28,844-855;
Perlwitz and Graf,1995: J. Climate, 8, 2281-2295;
Blackmon and Lau, 1980: J. Atmos. Sci., 37, 497-514
Castanheira and Graf, 2003:JGR,doi:10.1029/2002JD002754;
Limpasuvan and Hartmann, 2000:J. Climate, 13, 4414-4429.

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