



## Why no Antarctic polar vortex in ECHAM5?

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No Antarctic polar vortex (APV) in ECHAM5 - reason unknown. This has been the situation for years, mostly irrespective of horizontal or vertical resolution. A realistic APV would underpin projections of climate and atmospheric chemistry.

We conduct a range of sensitivity simulations to narrow down the search: South America flattened, gravity-wave parameterization modified, specific humidity prescribed, shallow and mid-level convection switched off, ocean roughness modified. None of them generates a realistic APV. Note that the simulations use observed sea-surface temperatures and sea-ice concentrations. However, the APV improves slightly for a blurred Antarctic convergence. In addition, we compare the ECHAM5 dynamics against the ERA-INTERIM reanalysis. It turns out that the quasi-stationary wave I is too strong in the polar stratosphere, corrupting the APV. The enhancement in wave I reaches into the lowermost stratosphere / uppermost troposphere. There, it changes phase and shifts towards the mid-latitudes. Phase change and shift coincide with a too strong Eliassen-Palm convergence from enhanced synoptic activity. The enhancements in synoptic activity and wave I reach down to Earth's surface.

Finally, tropospheric static stability in ECHAM5 is too neutral over the oceans, particularly right above the planetary boundary layer. The closer to neutral, the easier synoptic and quasi-stationary waves can propagate upward. Hence, the too neutral static stability might intensify the wave regimes, disrupting the APV. Complementary results with nudging against observations support this hypothesis.