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Understanding the zonally symmetric circumpolar flow from potential vorticity inversion

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The structure and intensity of the zonally symmetric flow and temperature is determined by two zonally symmetric PV-anomalies. Both these PV-anomalies are centered over the pole. The first PV-anomaly coincides approximately with the extra-tropical tropopause region. Piecewise potential vorticity (PV) inversion in isentropic coordinates demonstrates that this PV-anomaly induces the "tropopause inversion layer", as well as the westerly winds in the troposphere and the lower stratosphere, including the subtropical jet, both in winter and in summer. The second PV-anomaly is located in the stratosphere. It exhibits a strong seasonal cycle: in winter it is positive, while in summer it is negative. Piecewise PV-inversion reveals that the negative stratospheric PV-anomaly in summer strongly reduces the westerly wind speeds in the troposphere, whereas the stratospheric positive potential vorticity anomaly in winter has a relatively small influence on the winds in the troposphere, because remnants of the negative PV-anomaly, which was formed in the summer, linger between 400 K and 500 K. Complications with PV-inversion that are associated with the lower boundary condition are discussed. A primitive equation model is used to investigate the processes that establish the observed zonally symmetric PV-distribution. Important processes in this respect are the meridional eddy sensible heat flux and latent heat release.