A standard cyclogenetic situation is shown schematically in Fig. 21. Suppose, in the spirit of the thought-experiment of section 4, that a cyclonic upper air IPV anomaly (which to a greater or lesser extent will be associated with a low tropopause, depending on its exact size, shape and strength) arrives over a pre-existing low-level baroclinic region, as suggested in Fig. 21(a). Thermal advection by the induced low-level circulation will tend to create a warm low-level anomaly ahead of the upper IPV anomaly (Fig. 21(b)), enhancing the effects of any low-level warm advection already present. This warm surface anomaly will induce, as in Fig. 16(a), its own cyclonic circulation. At low levels this circulation will add to the circulation induced from upper levels (Figs. 21(b), 15(a)), giving an intense low-level cyclone whose centre is a little ahead of the advancing upper- level IPV anomaly. While the low-level anomaly remains ahead of the upper-level anomaly there may be positive feedback to upper levels, temporarily resembling the small-amplitude instability situation in the 'helping' case, i.e. the case depicted in Fig. 18. This will tend to phase-lock the two anomalies and promote their mutual intensification. In particular, the upward extension of the circulation induced by the low-level warm anomaly will tend to intensify the upper-level IPV anomaly by advecting high-PV air equatorwards, on the left of the picture, and, because this advection is strongest just behind the upper- level IPV anomaly, will also tend, in effect, to slow down its advance.

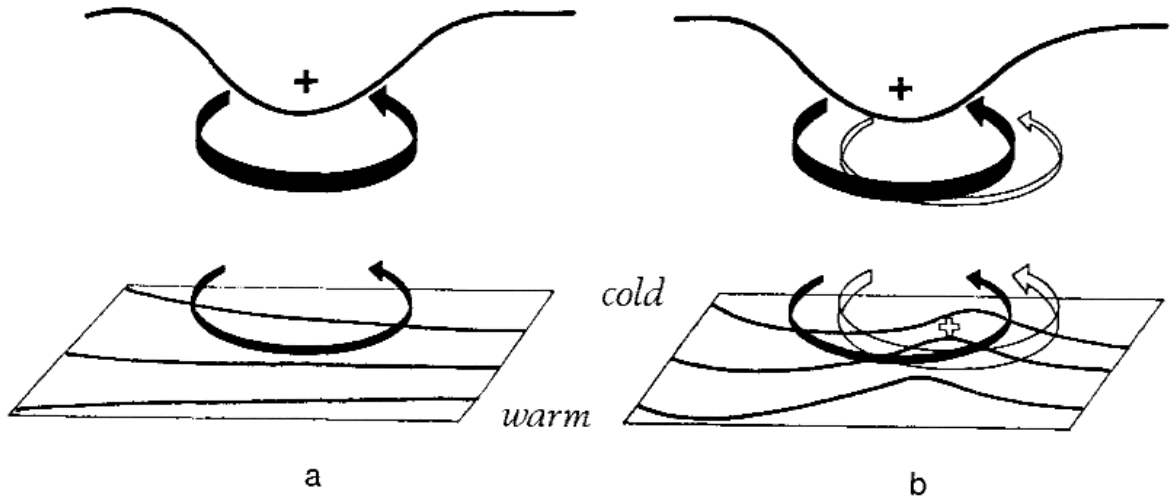

Figure 21. A schematic picture of cyclogenesis associated with the arrival of an upper air IPV anomaly over a low-level baroclinic region. In (a) the upper air cyclonic IPV anomaly, indicated by a solid plus sign and associated with the low tropopause shown, has just arrived over a region of significant low-level baroclinicity. The circulation induced by the anomaly is indicated by solid arrows, and potential temperature contours are shown on the ground. The low-level circulation is shown above the ground for clarity. The advection by this circulation leads to a warm temperature anomaly somewhat ahead of the upper IPV anomaly as indicated in (b), and marked with an open plus sign. This warm anomaly induces the cyclonic circulation indicated by the open arrows in (b). If the equatorward motion at upper levels advects high-PV polar lower-stratospheric air, and the poleward motion advects low-PV subtropical upper-tropospheric air, then the action of the upper-level circulation induced by the surface potential temperature anomaly will, in effect, reinforce the upper air IPV anomaly and slow down its eastward progression. (To this extent the situation is similar to the small-amplitude instability situation represented by Fig. 18 and described in section 6(*b*).)