4.4 **Surface pressure conditions**

The most permanent features of the mean sea-level pressure maps are the oceanic subtropical high-pressure cells (Figures 4.9 and 4.10). These anticyclones are located at about 30° latitude, suggestively situated below the mean subtropical jet stream. They move a few degrees equatorward in winter and poleward in summer in response to the seasonal expansion and con- traction of the two circumpolar vortices. In the northern hemisphere, the subtropical ridges of high pressure weaken over the heated continents in summer but are thermally intensified over them in winter. The principal subtropical high-pressure cells are located: (1) over the Bermuda–Azores ocean region (at 500 mb the centre of this cell lies over the east Caribbean); (2) over the south and southwest United States (the Great Basin or Sonoran cell) – this continental cell is seasonal, being replaced by a thermal surface low in summer; (3) over the east and north Pacific – a large and powerful cell (sometimes dividing into two, especially during the summer); and (4) over the Sahara – this, like other continental source areas, is seasonally variable both in intensity and extent, being most prominent in winter. In the southern hemisphere, the subtropical anticyclones are oceanic, except over southern Australia in winter.

The latitude of the subtropical high-pressure belt depends on the meridional temperature difference between the equator and the pole and on the temperature lapse rate (i.e. vertical stability). The greater the merid- ional temperature difference the more equatorward is the location of the subtropical high-pressure belt (Figure 4.11).

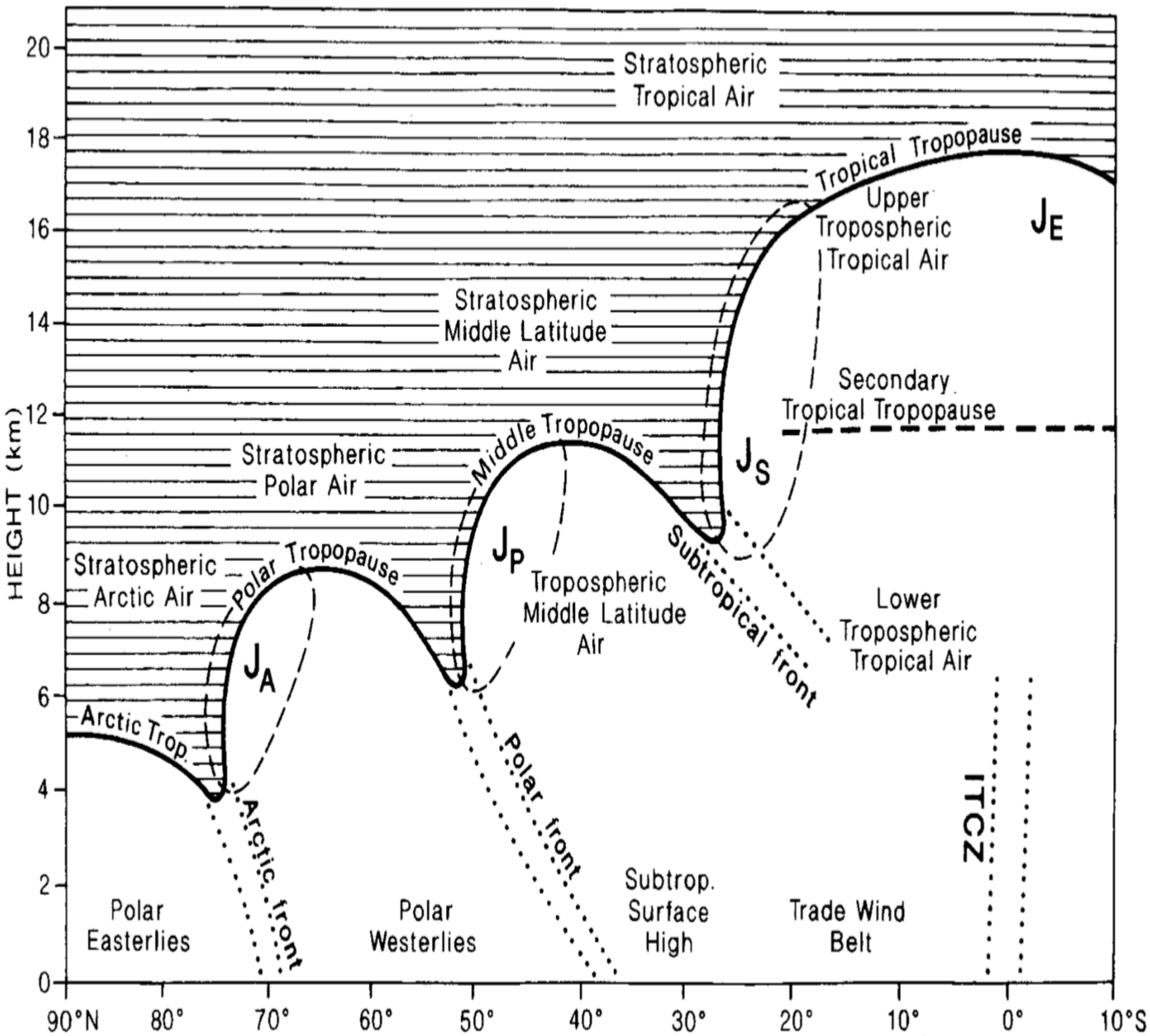

Figure 4.8 The meridional structure of the tropopause and the primary frontal zones. The 40 m s^{-1} isotach (dashed) encloses the Arctic (J_A), polar (J_P) and subtropical (J_S) jet streams. The tropical easterly (J_E) jet stream is also shown. Occasionally, the Arctic and polar or the polar and subtropical fronts and jet streams may merge to form single systems in which about 50 per cent of the pole-to-equator mid-tropospheric pressure gradient is concentrated into a singe frontal zone approximately 200 km wide. The tropical easterly jet stream may be accompanied by a lower easterly jet at about 5 km elevation.

Source: Shapiro *et al*. (1987) *From Monthly Weather Review* 115, p. 450, by permission of the American Meteorological Society

In low latitudes there is an equatorial trough of low pressure, associated broadly with the zone of maximum insolation and tending to migrate with it, especially towards the heated continental interiors of the summer hemisphere. Poleward of the subtropical anticyclones lies a general zone of subpolar low pressure. In the southern hemisphere, this sub-Antarctic trough is virtually circumpolar (see Figure 4.10), whereas in the northern hemisphere the major centres are near Iceland and the Aleutians in winter and primarily over continental areas in summer. It is commonly stated that in high latitudes there is a surface anticyclone due to the cold polar air, but in the Arctic this is true only in spring over the Canadian Arctic Archipelago. In winter, the polar basin is affected by high- and low-pressure cells with semi-permanent cold air anticyclones over Siberia and, to a lesser extent, northwestern Canada. The shallow Siberian high is in part a result of the exclusion of tropical air masses from the interior by the Tibetan massif and the Himalayas. Over Antarctica, it is meaningless to speak of sea-level pressure but, on average, there is high pressure over the 3 to 4-km-high eastern Antarctic plateau.

The mean circulation in the southern hemisphere is much more zonal at both 700 mb and sea-level than in the northern hemisphere, due to the limited area and effect of landmasses. There is also little difference between summer and winter circulation intensity (see Figures 4.3, 4.4 and 4.10). It is important here to differentiate between mean pressure patterns and the highs and lows shown on synoptic weather maps. Thus, in the southern hemisphere, the zonality of the mean circulation conceals a high degree of day-to-day variability. The synoptic map is one that shows the principal pressure systems over a very large area at a given time, ignoring local circulations. The subpolar lows over Iceland and the Aleutians (see Figure 7.9) shown on mean monthly pressure maps represent the passage of deep depressions across these areas downstream of the upper long-wave troughs. The mean high-pressure areas, however, represent more or less permanent highs. The intermediate zones located about 50 to 55°N and 40 to 60°S are affected by travelling depressions and ridges of high pressure; they appear on the mean maps as being of neither markedly high nor markedly low pressure.

On comparing the surface and tropospheric pressure distributions for January (see Figures 4.3, 4.4 and 4.9, 4.10), it is apparent that only the subtropical high- pressure cells extend to high levels. The reasons for this are evident from Figures 4.1B and D. In summer, the equatorial low-pressure belt is also present aloft over South Asia. The subtropical cells are still discernible at 300 mb, showing them to be a fundamental feature of the global circulation and not merely a response to surface conditions. world's major wind belts, shown by the maps in Figure 4.12. In the northern hemisphere, the pressure gradients surrounding these cells are strongest between October and April. In terms of actual pressure, however, oceanic cells experience their highest pressure in summer, the belt being counterbalanced at low levels by thermal low- pressure conditions over the continents. Their strength and persistence clearly mark them as the dominating factor controlling the position and activities both of the trades and the westerlies.

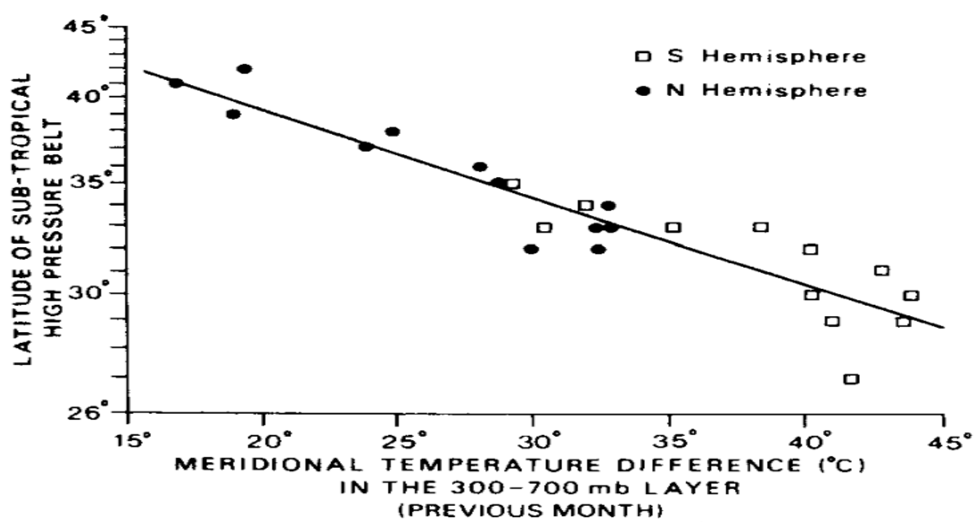

Figure 7.11 A plot of the meridional temperature difference at the 300 to 700-mb level in the previous month

against the latitude of the centre of the subtropical high-pressure belt, assuming a constant vertical tropospheric lapse rate.

Source: After Flohn, in *Proceedings of the World Climate Conference*, WMO N0.537 (1979, p. 257, Fig. 2).

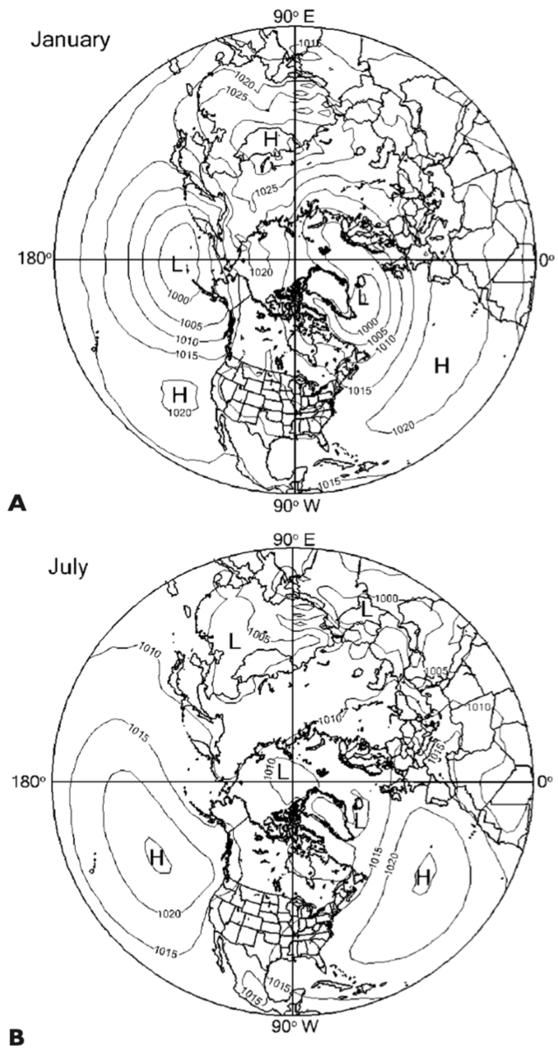

Figure 4.9 The mean sea-level pressure distribution (mb) in January and July for the northern hemisphere, 1970 to 1999.

Source: NCEP/NCAR Reanalysis Data from the NOAA-CIRES Climate Diagnostics Center.

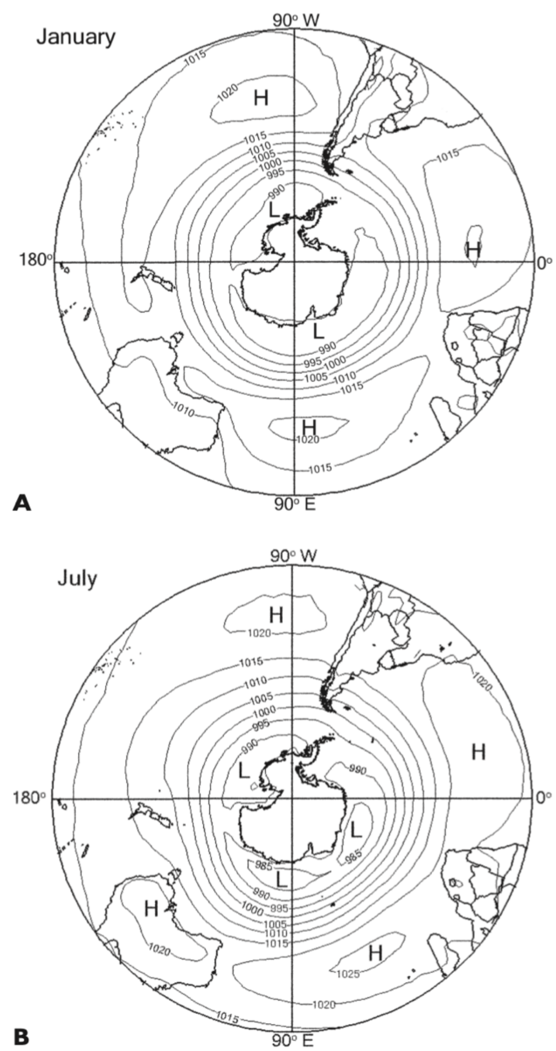

Figure 4.10 The mean sea-level pressure distribution (mb) in January and July for the southern hemisphere, 1970 to 1999. Isobars not plotted over the Antarctic ice sheet.

Source: NCEP/NCAR Reanalysis Data from the NOAA-CIRES Climate Diagnostics Center