8.4 Monsoons

8.4.1 Seasonal variations over the tropics

We saw the characterisitcs of the tropical circulation in Figs. 8.1 and 8.2. the correponding cloud distributions are shown in Fig. 8.14. As we noted

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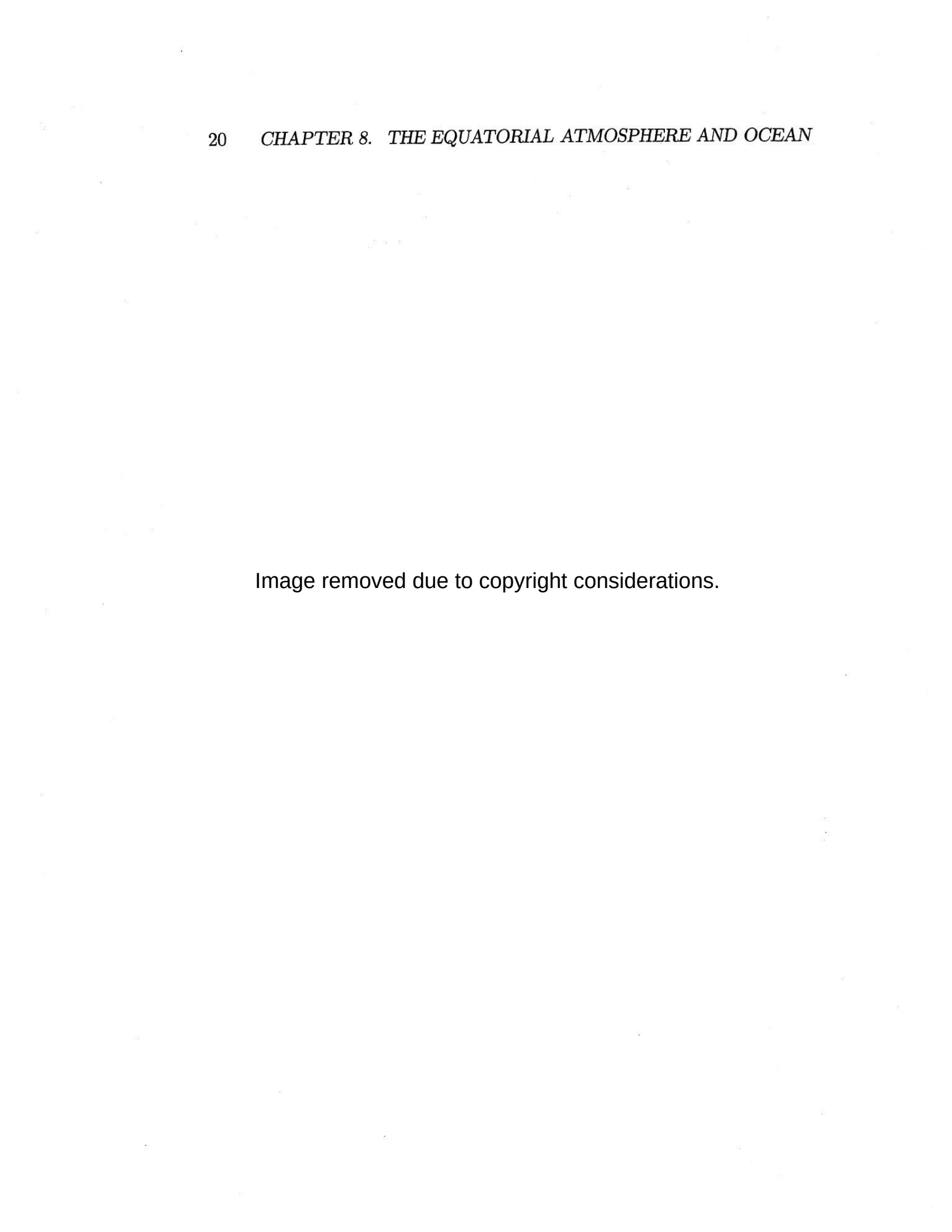
earlier, over the oceans there is a near-equatorial trough of low pressure—the Intertropical Convergence Zone (ICTZ)—that shows very clearly in the cloudiness (and rainfall). Over the contintents, however, the low pressure and cloudiness (and rainfall) is displaced well into the summer hemisphere. In places where there is ocean equatorward of the subtropical land, these sumertime regions of cloudiness are associated with very heavy rain and characteristic wind patterns—this is the monsoon circulation.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2. In northern summer, there is strong northward flow across the equator in the Indian ocean (especially in the west), eastern Atlantic, and eastern Pacific. In southern summer, southward cross-equatorial flow across the Indian Ocean to the date line.

3. In northern summer, low-level westerlies in the northern tropics over the Indian Ocean, west Africa, and (weakly) eastern Pacific. In southern summer, low-level westerlies in the southern tropics across the eastern Indian Ocean and north of Australia.

4. In northern summer, an intense upper-level anticyclone across south Asia at about 30 degN, with an intense easterly jet on its southern flank, extending from south-east Asia to the western Atlantic. There are much weaker upper-level anticyclones over northern Mexico and the eastern north tropical Pacific, though without much of an associated easterly jet. In southern summer, upper level anticyclones over northern Australia/Melanesia, with an easterly flow equatorward. There are other anticyclones over south tropical Africa and South America, though without much, if anything, to indicate an easterly jet (nor low-level westerlies).

Characteristics of the JJA circulation in the Indian Ocean region are summarized in Fig. 8.16. The cross-equatorial flow at low levels is concentrated in the "Findlater jet" on the eastern flank of the East African mountains[3]. Note also the strong upper-level anticyclone over south Asia and easterly jet equatorward of this.

8.5 Monsoon depressions and breaks

Within any monsoon season, rainfall is very variable: on synoptic time scales (a few days), as "monsoon depressions" propagate across th emonsoon region; and on time scales of 1-3 weeks, the so-called "active/break" cycle.

In practice, most rain falls in association with monsoon depressions. In the Indian monsoon, these usually propagate westward across the subcontinent, producing daily variability of rainfall through the monsoon season. They form over the Bay of Bengal, and move northwestward. In the vertical,

[3]This jet is actually below the level of the highlands, and has some similarites with western boundary currents in the ocean.

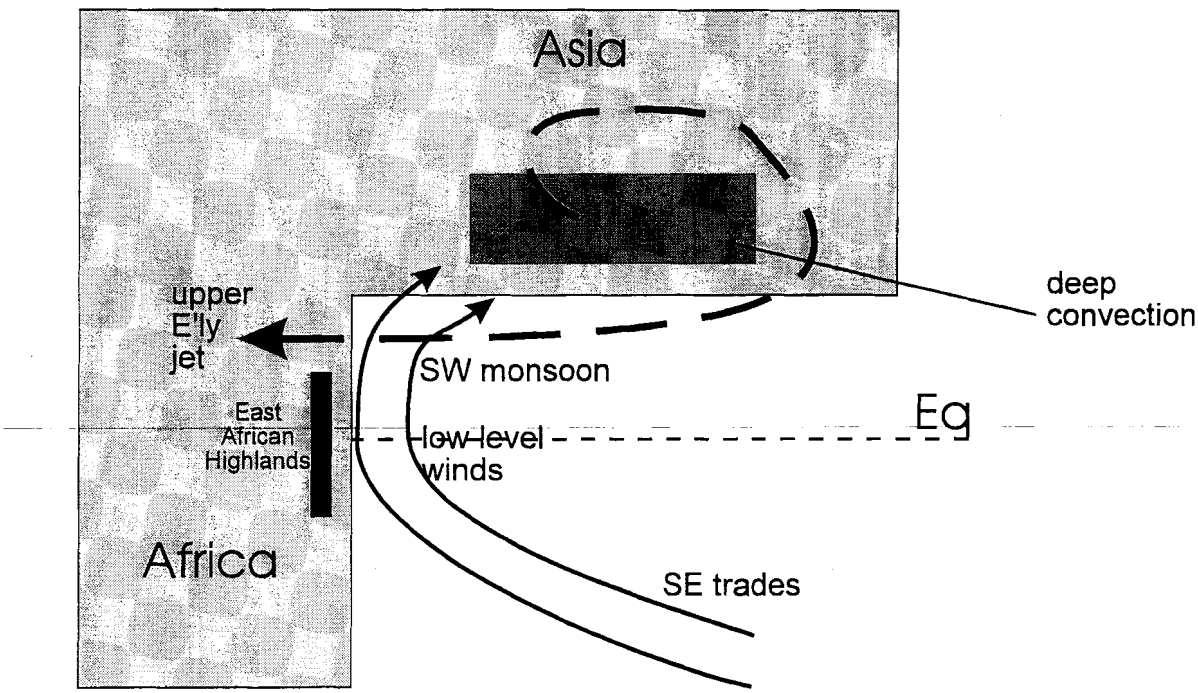
Asia
deep
convection
upper
E'ly
jet
SW monsoon
East
African
Highlands
Eq
low-level
winds
Africa
SE trades

Figure 8.16:

they show a characteristic southwestward tilt (Fig. 8.17). This structure is

reminiscent of the structure of midlatitude baroclinic cyclones; we saw that they must tilt westward in order to extract potential energy from the background flow. In fact, while there is still a range of opinions, it now seems likely that monsoon depressions are also produced in part from baroclinic instability (like midlatitude cyclones) but with an important contribution from latent heat release associated with their intense rainfall (like tropical cyclones).

There is an equally pronounced variability on time scales of 10-20 days, as illustrated in Fig. 8.18. The wet/dry periods are referred to as active monsoon / monsoon breaks. This variability appears to be a manifestation of the northward propagation of monsoon convection across the subcontinent, with new convective regions forming to the south.

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