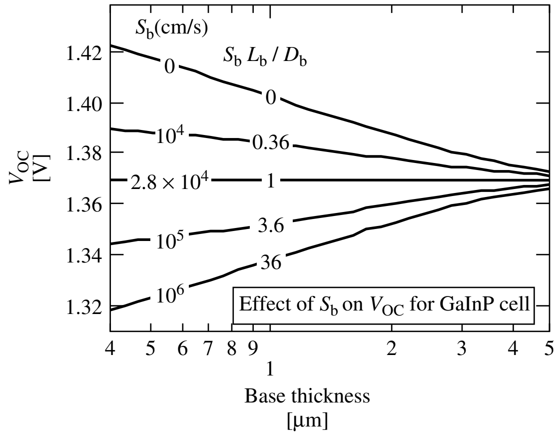

Figure 9.8 Effect of base thickness x_b and surface-recombination velocity S_b on V_{OC} for a GaInP top cell with $J_{SC} = 14$ mA/cm^2. The base is characterized by a *bulk* recombination velocity $D_b/L_b = 2.8 \times 10^4$ cm/s. Note that when the bulk and surface recombination velocities are equal, V_{OC} is independent of base thickness

9.5.7 Spectral Effects

The amount of light distributed to each subcell, and thus, the photocurrents generated by each subcell, is determined by the spectrum of the incident light. (See Chapters 3 and 16 for a more complete discussion of spectra and absorption.) Therefore, the optimal band gaps and the optimal top-subcell thinning depend on the incident spectrum. Figure 9.6(c) shows the efficiency versus top- and bottom-subcell band gap for the standard AM1.5 direct spectrum for the same two-junction device as was modeled for the global spectrum in Figure 9.6(b). For a given bottom-subcell band gap, the optimal top-subcell band gap E_{gt} is lower for the direct spectrum than for the global spectrum. This difference arises because the direct spectrum has less blue light than the global spectrum, resulting in a diminished J_{SCt}/J_{SCb}; lowering E_{gt} compensates for this by directing more light to the top cell. Likewise, for a given E_{gt} and E_{gb}, the optimal top-subcell thickness is greater for the direct spectrum than for the global spectrum. Figure 9.7(d) shows J_{SCt} and J_{SCb} for the {1.85, 1.42} eV band gap pairing as a function of top-subcell thickness as in Figure 9.7(a), but calculated for the direct spectrum instead of the global spectrum. The thickness required for current matching is roughly 1.2 μm, significantly greater than the 0.7-μm current-matching thickness for the global spectrum. For comparison, the AM0 spectrum is even more blue-rich than the AM1.5 global spectrum, and the top subcell would correspondingly be thinner, about 0.5 μm in thickness.

9.5.7.1 Spectral fluctuations

While the analysis above shows how to choose a top-cell thickness for a given spectrum, no one spectrum precisely represents the actual spectrum seen by a terrestrial solar cell. Fluctuations in the spectrum with time due to the changing position of the sun in the sky, and the changing atmospheric conditions, can be quite significant. The detailed