Land/Water

The third type of terrain is a land/water interface (Figure 3-27). Partly because of convenience, a number of large cities are located next to bodies of water. The land and water not only exhibit different roughness characteristics but different heating properties. The air flow and thus plume dispersion and transport can be very difficult to predict.

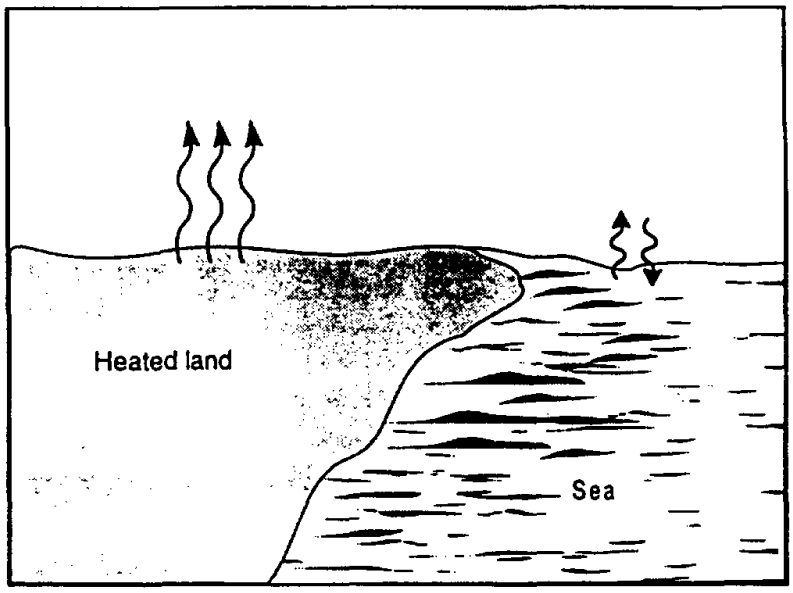

Figure 3-27. Thermal turbulence at land/water interface

The thermal properties of land and water are radically different. Land and objects on it will heat and cool relatively quickly. However, water heats and cools relatively slowly. Water temperatures do not vary much from day-to-day or from week-to-week. Water temperatures follow the seasonal changes, being delayed by as much as 60 days. For example, the warmest ocean temperatures are in late summer to early fall, and the coolest ocean temperatures are in late winter to early spring.

As the sun shines down on the land/water interface, solar radiation will penetrate several feet through the water. On the other hand solar radiation striking land will only heat the first few inches. Also, as the sun shines on the water surface, evaporation and some warming take place. The thin layer of water next to the air cools due to evaporation and mixes downward, overturning with the small surface layer that has warmed. This mixing of the water layer close to the surface keeps the water temperature relatively constant. On the other hand, land surfaces warm quickly, causing the adjacent air to heat up, become less dense, and rise. The cooler air over the water is drawn inland and becomes the well-known sea breeze (Figure 3-28). At night, the air over the land cools rapidly due to radiational cooling, which causes the land temperature to fall faster than that of the adjacent water body. This creates a return flow called the land breeze (Figure 3-29). The wind speeds in a land breeze are light; whereas the wind speeds in a sea and land breeze can be quite fast. Differential pressure over land and water causes sea breezes. With sea breezes (during the day), the pressure over heated land is lower relative to the pressure over the cooler water. With land breezes (during the night), the reverse is true.

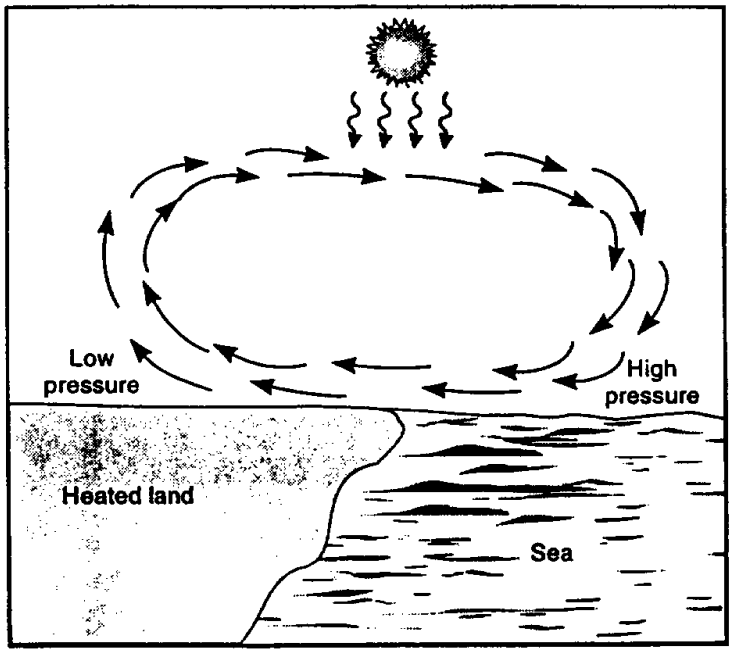

Figure 3-28. Sea breeze due to differential heating

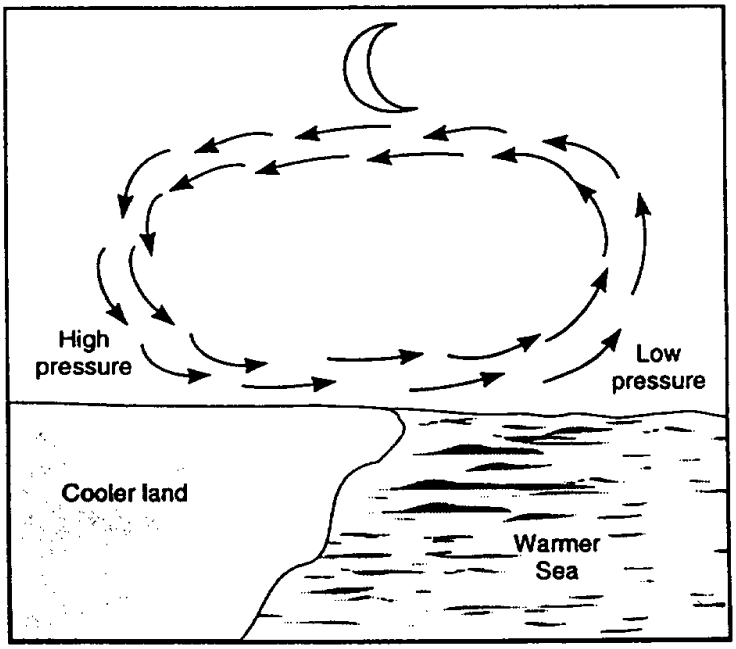

Figure 3-29. Land breeze due to differential heating

The roughness features of land and water are also different (Figure 3-30). The water appears to be quite smooth to the flow of air. As the wind speed increases, the water surface is disturbed, and waves form. With waves induced by strong wind the water surface is no longer as smooth as it was with a light wind. However, water is still smoother than most land features. Because of the change from relatively smooth water to rougher land, the air flow changes direction with the increased frictional influence (increased turbulence). The amount of direction change depends on the amount of roughness change.

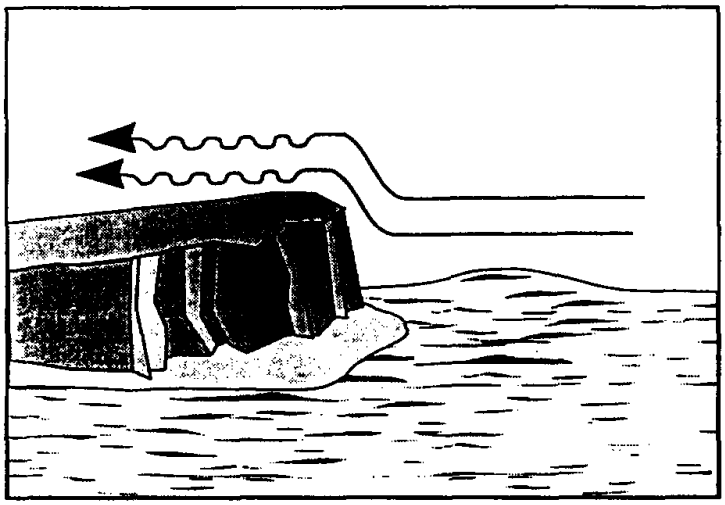

Figure 3-30. Mechanical turbulence at land/water interface