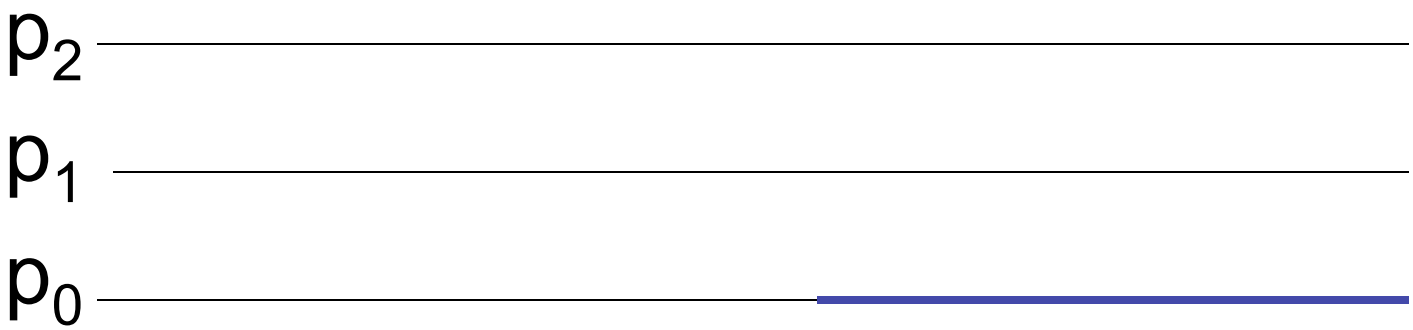
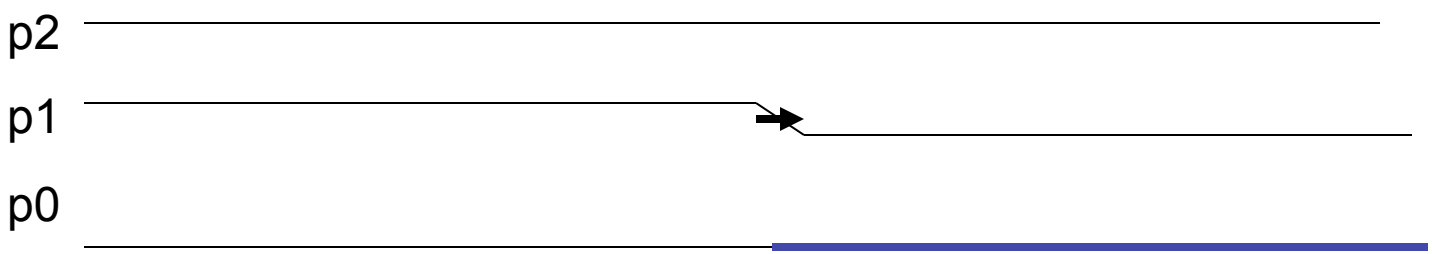
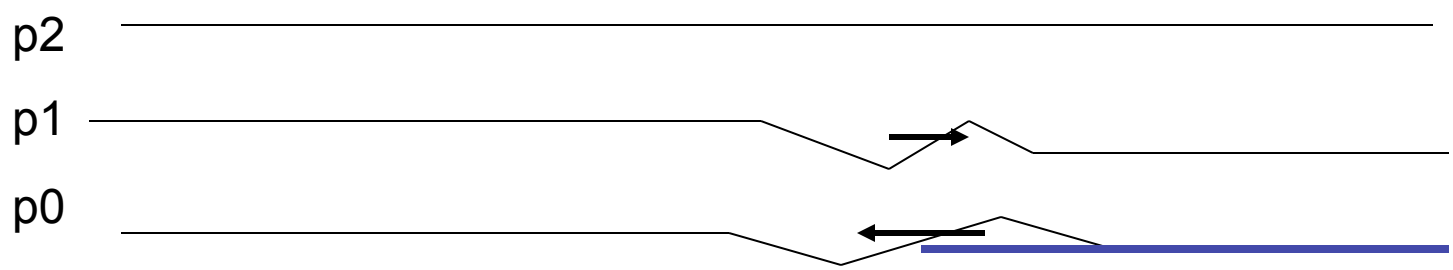
Typical Sea-breeze evolution



Assume the initial temperature field is horizontally uniform (in fact, early in the morning, the temperature would be colder over land than over the water). After sunrise, we heat the land; the heat is transported upward by turbulent eddies so that the pressure layer $\Delta p = p0 - p1$ warms and expands over the land.



- Above the coast near the original height of p1, we have a pressure gradient that is directed from land to sea. Note that the surface pressure as yet is unaffected.
- In response to the pressure gradient aloft, the atmospheric mass is transported from land to sea. Consider two atmospheric columns near the coast; one just inland, and one just offshore. The mass transport aloft causes a removal of mass from the inland column and an addition of atmospheric mass to the offshore column. Since the surface pressure is proportional to the total column mass, the surface pressure decreases inland and increases offshore.

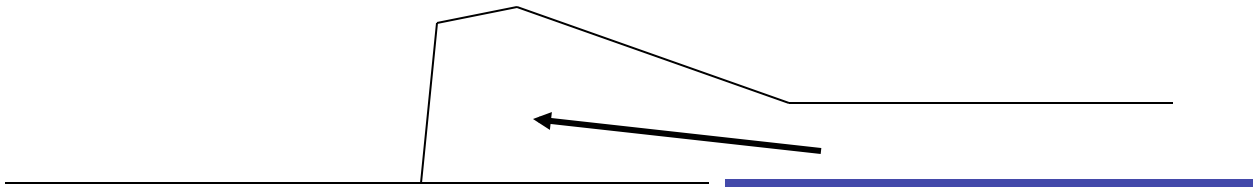


The result is a pressure gradient directed from sea to land close to the surface, i.e., the usual sense of the sea breeze

In the initial stages of SB development, the perturbations are small so that the nonlinear terms are small (i.e. products of perturbation terms are negligible). The response also tends to be symmetrical about the coastline in the absence of background wind

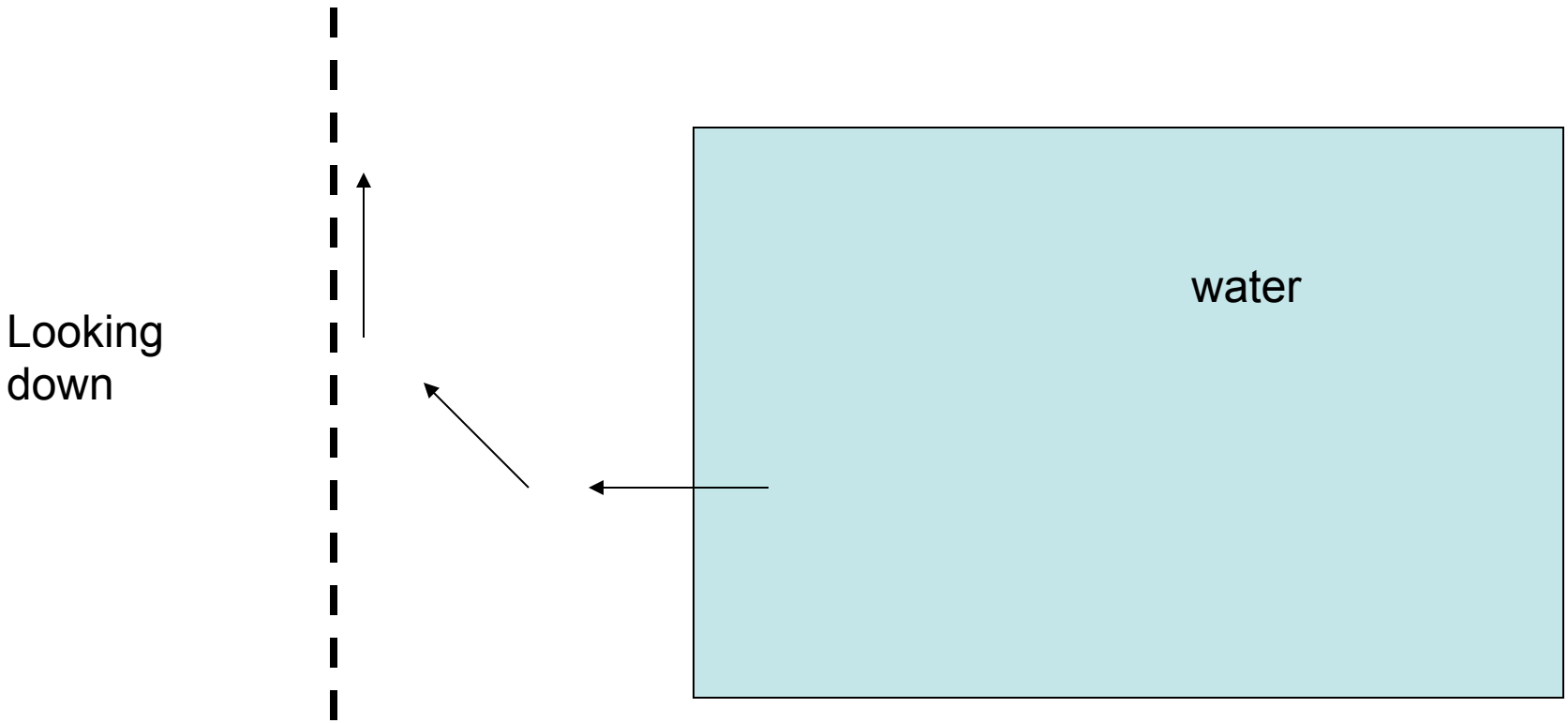
- As the sea breeze develops further, it changes character in several ways:

-- the depth becomes greater on the inland side than on the offshore side, because of the neutral/unstable stratification over land and stable stratification over water



-- the wind, temperature, and pressure gradients on the inland side collapse into a narrow “sea breeze front”. The strong convergence at the front often acts to trigger deep convection.

- Time scale for Coriolis force is ~ 1/f. In the afternoon the Coriolis force causes the winds to turn toward the right. In the upper latitudes this can limit the inland extent of the SB.



- Important to keep in mind that the Coriolis force acts in a lagrangian sense (i.e., following a parcel).
- In the evening, several things can happen:

-- opposing flow pushes the SB back offshore MIDLATITUDE THING

-- surface inversion insulates SB from friction; forming a gravity wave-like phenomenon that propagates far inland ("Morning Glory" in northern Australia) TROPICS (< 30 degrees)