Dryline
Conceptual model (Carlson et al. 1983, MWR)

• Differential advection produces low-level warming and moistening with a capping inversion (lid) above

• The lid delays the release of convective instability so that moist static energy accumulates in low levels

• Instability is eventually released by:
  * “underrunning” at the lid edge
  * convergence or daytime heating (esp. where the lid is weak)
• So if we are to understand the dryline/EML (elevated mixed layer)/Lid, we will have to think about the history and trajectory of air masses. The standard conceptual model is the one proposed by Carlson et al. (1983).
• Note that lid is not necessarily of broad extent
• Recently there have been some revisions in the Carlson et al. conceptual model. In particular, it has been shown that “return flow” from cold air outbreaks can be modified by residing over the Gulf of Mexico for only a short time (e.g., 12-24h). Additionally, there can be multiple EMLs due to successive modifications of the airmass.
Virtual temperature is central to dryline dynamics and thermodynamics. Due to sloping terrain in western Great Plains, we usually refer to virtual potential temperature, $\theta_v$ where $\theta_v \approx \theta(1+0.61q)$ where q is given in kg/kg and not in g/kg. So we see that both the temperature and moisture are important to drylines. The lack of moisture on the western side (dry) of the dryline means that the diurnal temp. variations are amplified there.
• Several reasons for this:
  -- moist air has greater emissivity for LW radiation, which inhibits nocturnal cooling
  -- sfc tends to be dryer on the dry side → higher Bowen ratio (more sensible heat flux during the day).

Additionally, behind the dryline, the sfc dewpoint exhibits large diurnal ranges:
-- dry air \(\rightarrow\) rapid onset of a strong nocturnal inversion in the evening

-- inversion inhibits mixing \(\rightarrow\) evaporative flux is trapped near the sfc at night; get moistening during the night

-- after sunrise: inversion is eroded and dry air is mixed down from aloft \(\rightarrow\) rapid drying occurs near sfc

This evolution of the temp/moisture has important implications for the dryline:
-- in the morning, as dry air is mixed downward, the dryline “jumps” to the east. This is not due to advection of dry air (but instead differential turbulent flux divergence term)

-- in the afternoon, the greater heating on the dry side produces a hydrostatic pressure decrease relative to the moist air → generation of easterly ageostrophic wind

-- after sunset, the thermally-driven easterly wind moves the dryline back toward the west

-- during the night, the greater cooling on the dry side produces a hydrostatic pressure increase which opposes and retards the easterly flow
• Other processes can be important as well. There are some indications that the position of the dryline is affected by the entrainment of high-momentum air from aloft as the boundary layer grows during the day.
• Ziegler and Hane (1993, MWR) emphasize the dryline as a “mixing zone”
• Closely related to the dryline is the phenomena of the elevated mixed layer (EML) or lid. Just as the dryline is the horizontal boundary between the dry and humid airmasses, the lid represents their vertical interface.

• The lid has several important consequences for the development of deep convection. First, the strong stability acts to suppress the deep convection. This can allow the low-level heat and moisture to build up so that the atmosphere is strongly conditionally unstable. The deep convection then breaks out very severely when:
1) the air mass “underruns” the lid 
Or 2) occur in regions where the lid is thin or weak.
This occurs because the lid is not uniform. The EML originated as the convective boundary layer over the Mexican Plateau and therefore will reflect the diurnal cycle of heating and cooling but displaced spatially.
FIG. 1. Surface conditions at 2100 UTC 24 May 1989. Solid contours denote pressure (mb). Shading indicates where dewpoint temperature exceeds 20°C. Solid rectangular area denotes location of P-3 observations. Three-letter identifiers of surface sites discussed in the text are shown.
Fig. 10. Conceptual model of the relation between advective transport, turbulent mixing, and elevated moisture near the dryline. The solid curve delineates the edge of the high moisture content east of the dryline, while the dashed curve denotes the edge of the region of moderate moisture content. Circles denote air parcels that are being transported and mixed. Solid arrows denote transport by advection and turbulent diffusion, while the open arrow represents the ambient horizontal wind direction.
FIG. 14. Conceptual model of the dryline environment during midafternoon. Solid curves with arrows represent flow streamlines, while thin arrows represent vertical motions inferred from the observations. Solid and dashed curves represent inversions and discontinuities, respectively. Roman numerals refer to regions described in the text. Light stippling represents region containing relatively high water vapor content.