WEATHER TO FLY

BY DAN GUDGEL

Terrain-Channeled Convergence

Last month, I introduced terrain-induced convergence citing the "Tehachapi Shear Line" and the "Elsinore Shear Line" as examples. This rendition of "Weather to Fly" will focus on yet another couple of scenarios that result in convergence as the result of terrain interaction with density driven winds.

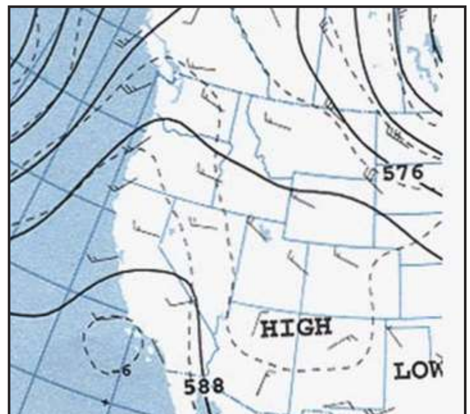
The eastern edge of the Southern Sierra Nevada Range (Spanish for "Snowy Mountains") along the California-Nevada state border is a sharp escarpment dropping from an average elevation of 13,000 feet Mean Sea Level (MSL) down to the Owens Valley at 4,000 feet MSL in just a couple of miles. This tremendous west-to-east variation in terrain height due to the Sierra Nevada across this portion of the country results in large temperature differentials.

Temperature differences develop across this region as the result of mountain slope effects, mountain-valley interactions, regional heating/cooling disparities due to surface moisture and vegetative differences, terrain-blocking influencing regional temperature advection, along with typical large-scale (synoptic) atmospheric changes. These effects and interactions can be cumulative, thereby increasing air density differences at various locations along the "Sierra Front" (the Sierra Nevada eastside escarpment). Explained in previous articles, temperature differences change air density and ultimately result in pressure differences. Pressure gradients thus result in a force that moves air from an area of higher pressure to lower pressure.

The west side of the Sierra Nevada is a gradual upward slope that lifts air as it moves in its general middle-latitude, hemispheric, west-to-east direction. This west side of the mountain range is forested and moist from winter rains and snow. In contrast, the lee side of the range, with its dramatic drop in terrain height, acts on air in a drying and warming process as it descends to the floor of the Owens Valley and the western valleys of Nevada in its crossing the crest of the Southern Sierra Nevada.

During the summer months especially, the air mass over the western Great Basin of Nevada is much hotter and drier than the California west side of the Southern Sierra Nevada. However, the Southern Sierra Nevada is not a solid, uniform high wall of granite along its range axis. There are gaps (passes) in the range that open to the east side high desert. With cooler air and lower air temperatures on the west side of the mountain range, local surface pressure is typically higher than pressure over the heated air of the western Great Basin during the warm-season afternoon hours.

Frequently, during the warm season, the synoptic weather pattern is dominated by High Pressure aloft over California and the western Great



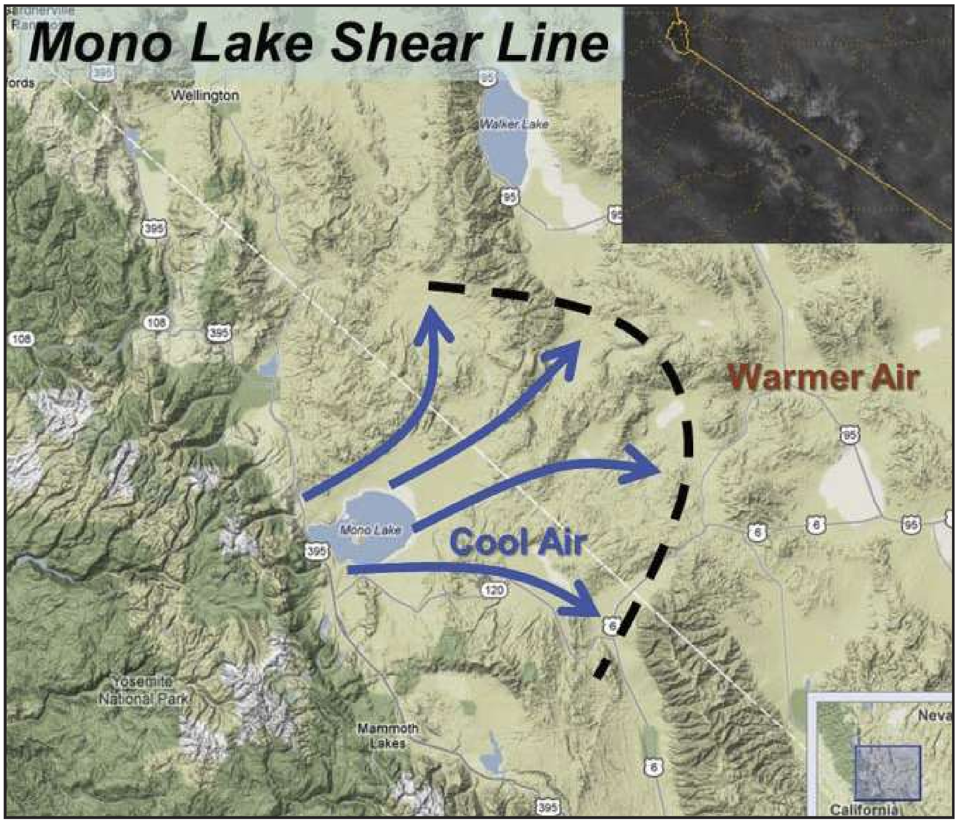
500 Mb Upper Air Chart
June 14, 1999

Basin (See ***Chart: "500 Mb Constant Pressure"*** on June 14, 1999). With the high pressure, synoptic pressure gradients are typically weak or "flat" over the region. However, regional average temperature differences develop in daily cycles from the aforementioned contributions of slope and mountain-valley heating and cooling effects. As each day begins, overnight radiational cooling and subsequent mixing due to overnight slope effects diminish temperature differences at the surface over the region. However, after sunrise, the dry atmosphere of the high desert of eastern California and western Nevada, combined with the dry soils of the basin mountain ranges, results in quick rises in sensible temperature. These high-desert temperature rises, in comparison to the west side of the Sierra Nevada that is forested and therefore more moist, are relatively fast. With this larger rise in temperature over the western Great Basin during a typical summer day, a density-driven westerly wind is encouraged along the "Sierra Front" which results in varying types of moving convergence lines as the wind sweeps out to the far-west Nevada Great Basin valleys.

The more robust afternoon west wind "Washoe Zephyr" over the Truckee Meadows and Carson Valley, with surface pressure higher due to the influences of a cold Lake Tahoe, is a well-known example of this meso-scale phenomenon. In a similar fashion but smaller in magnitude, this afternoon westerly wind along the Sierra Front is also shaped and locally augmented by the presence of Mono Lake, which affects the local pressure field due to its cooler surface as well as contributes some moisture from the lake at the Great Basin valley level to the otherwise drier air adjacent to the high desert surface.

At the start of a typical summer day under the domination of High Pressure aloft, skies are clear. Thermal trigger routinely occurs by mid-day with perhaps a few cumulus early over the higher terrain. As the day progresses, the aforementioned density-driven west wind develops over the Mono Lake area, focused by the Tioga Pass gap in the Southern Sierra near Lee Vining on the west side of Mono Lake and at the east-side base of Tioga Pass.

A convergence zone develops where the leading edge of this surface west wind, cooler and more stable, meets the near-calm, warmer, and drier air of the High Desert around Mono Lake. Often the air is so dry that the convergence line is "blue" or cloud-free as the moisture content at the convergence is insufficient to condense and form clouds with



the lifting process along the line. Under the right circumstances, however, the lower air layer moisture content becomes sufficient to result in cloud features formed in the lifting process of a convergence line.

On the afternoon of June 13, 1999, cloud features marked the convergence line's presence and confirmed the concept (See ***Diagram #1: "Mono Lake Shear Line"*** */ Photo Inset 1745 PDT; June 13, 1999*). With time this convergence line continues to spread north, east, and south during the afternoon until the temperature differences across the region begin to diminish after sunset and through the evening hours and winds subsequently subside.

Again, as a result of density-driven winds along the Sierra Front in the afternoon hours during the warm season, area mountain ranges and valleys direct air due to terrain-channeling that can develop additional smaller convergence lines. The formation, timing, exact location, and even the orientation of these convergence lines vary due to day-to-day changes in the synoptic-scale surface pressure field along with the diurnal changes in local temperature fields.

In the area north of Mono Lake and east of Bridgeport, CA, an additional west-to-east convergence zone often develops. During the late morning hours, thermals develop over the rapidly heating high desert region around Walker Lake. Surface winds are light. As the day progresses and the western Great Basin valleys continue to heat, surface pressure gradients support winds with a westerly component across the area.

The aforementioned cool air pushing across Mono Lake results in a northward-channeled wind of 10 to 15 knots along the East Walker River coming northward from Bridgeport and adjacent valleys. At the same time, an up-valley northwest wind develops by mid-afternoon in the East Walker River Valley well to the north of Mono Lake with typical speeds of 8 to 12 knots in the area. This southeastward moving air is warmer than that coming northward from Mono Lake.

This up-valley wind remains somewhat consistent through the afternoon and very early evening hours as it is encouraged by the push of west wind through the lower end of the Smith and Mason Valleys. By late afternoon on June 14, 1999, this channeled southeast-moving air met the northward moving air from the Mono Lake area, and a local convergence line marked by a cloud line was established in the vicinity south of the Flying "M" Ranch southwest of Walker Lake. (See ***Diagram #2: "Flying 'M' Shear Line"*** */ Photo Inset 1700 PDT; June 14, 1999*).

Again, due to terrain-channeling, density-driven winds can result in converging air flows. The astute soaring pilot needs to picture air moving in and around terrain features like a fluid (air, after all, is a fluid!). Good cross-country pilots keep monitoring surface wind flows for any terrain-channeling that might result in convergence and subsequent areas of lift for purposes of soaring flight.