Chapter 17: Mountain Windstorm

- Dynamics of Downslope Windstorms
- Chinook Windstorms of the Rockies
- Santa Ana Windstorms of California
- Katabatic Winds

Mountains and Lee Waves

- When air approaches a mountain, it must rise on the windward side and descend on the leeward side.
- A series of waves will form downstream of the mountain.
- These waves are called lee waves and are commonly observed east of the Rockies.

The Chinook Wind Event on January 16-17, 1982

- Chinook winds are usually warm and dry and may exceed 100 knots (115 mph) in the worst storms.
- Chinook winds are violent and are always extremely gusty, with the winds vary from over 100 to less than 10 miles per hour and back again in less than a minute.
Dynamically-Driven Chinook Winds

- When the cross-mountain flow near the mountain-top is strong and an inversion is present upstream just above the mountain top, the mountain wave pattern will take a form called “hydraulic jump”.
- Air passing over the mountain between the inversion level and mountain top accelerates downslope in a shooting flow toward the base of the mountain.
- The strongest winds in downslope windstorms occur as the shooting flow reaches the mountain base.
- Near or just beyond the mountain base, the flow abruptly rises to produce the “hydraulic jump”.
- Changes in the upstream wind speed and the height and strength of the inversion influence the character of a downslope windstorm.

Factors Affect the Temperature of Chinook Windstorms

- **Upstream air temperature**: Air upstream of the Rockies can be warm when it originates over the Pacific, or cold when it originates over western Canada and Alaska.
- **Latent heat release**: Latent heat is released when upstream air ascends on the windward side. Air descends on the lee side will be warmer than the air at the same altitude on the windward side.
- **Adiabatic warming**: The temperature of air arriving on the plains is adiabatic warm during descend.
- Air descending to the base of the mountains can have relative humidities lower than 10 percent.

Chinook Wall

The Chinook Wall, a wall of clouds that follows the mountain crest, is often present during downslope windstorms.

Forecasting Chinook Windstorms

- A stable (inversion) layer upstream of the mountain
- Strong surface-pressure gradient across the mountain
- Strong westerly background flow at the mountain top
Santa Ana Windstorms of California

- The Santa Ana River Canyon, which runs from the San Bernardino Mountain southwest through the cities of Riverside, Anaheim, and Santa Ana, experiences episodes of strong downslope windstorms that called Santa Ana winds.
- Santa Ana winds are generally not as strong as the Chinooks of Colorado, but are dangerous because of their ability to spread wild fires.
- Santa Ana winds are most common during late fall and winter.
- About 20 Santa Ana winds occurs every year, lasting for about 1.5 days.

Figure 17.11

Santa Ana Wind

DEFINITION
Strong warm and dry winds blow over the southern California from the Great Basin, with speeds exceed 25 knots (46 km/hr).

This is a picture of Fremont Canyon, located in the Santa Ana Mountains in Orange County. This canyon is known for its extremely high winds during Santa Ana wind events, where the winds can gust over 100 MPH during very strong Santa Ana wind events (picture from the Orange County Register).

Generation Mechanism

(From NWS/ Observation website)
**Diurnal and Seasonal Variations**

Diurnal variation:
- Stronger Santa Ana wind at night and weaker Santa Ana wind on the day.

Seasonal Variation:
- Occurs most frequently in winter (November to March).

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**Katabatic Winds**

- Chinook and Santa Ana winds are dynamically driven by the pressure gradient across the mountain.
- Katabatic winds are driven by the cold, dense airs flow downslope off the ice sheets.
- Katabatic winds can occur any time of the year, but are most common during winter, with gusts exceeding 100 knots.