

## Chapter 14: Cold Waves



Courtesy of Sam Harrel, Fairbanks News-Miner

- ❑ Formation of Cold Airmasses
- ❑ Cold Air Outbreak

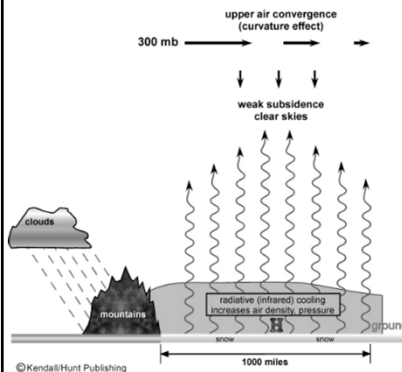


## Cold Wave

- ❑ A cold wave is an influx of unusually cold air into middle or lower latitudes.
- ❑ Cold waves affect much larger areas than blizzards, ice storms, and other winter hazards.
- ❑ In the Northern Hemisphere, cold waves occur when very cold, dense air near the surface move out of its source region in northern Canada or northern Asia.
- ❑ The “wave” in cold wave is apparent in the upper-air flow (the jetstream), which is usually amplified into a strong ridge-trough pattern during a major cold outbreak.
- ❑ Meteorologists measure cold waves by the departure from the normal temperature.



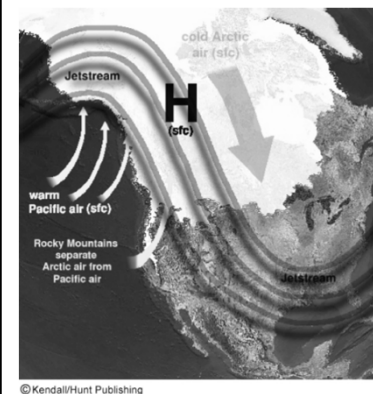
## Formation of Cold Waves



- ❑ The core of a cold wave at the surface is a strong high-pressure center that forms during winter in high latitudes.
- ❑ Cold polar or Arctic airmasses are relatively shallow, extending one to several km above the surface.



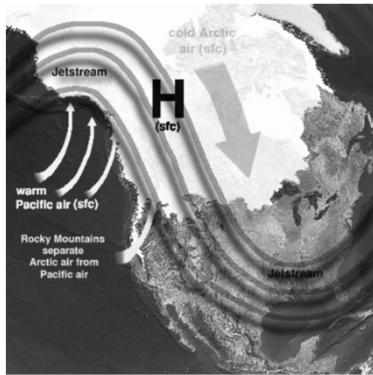
## Upper-Level Flow Pattern



- ❑ The surface high-pressure center of the cold air is accompanied with an upper-level convergence.
- ❑ An upper-level ridge to the west of the surface high pressure can intensify the surface high-pressure center.
- ❑ The ideal location of an upper-level ridge is located over Alaska or the West Coast of North America.



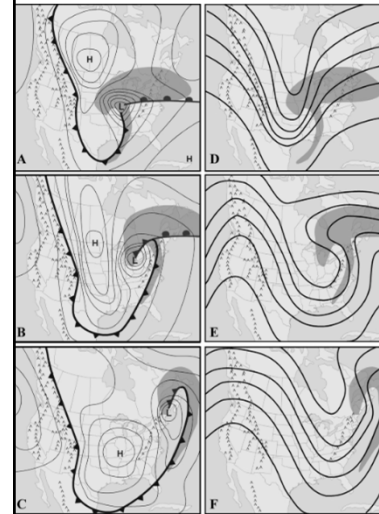
## Equatorward Motion of Cold Airmasses



- ❑ Two factors contribute to the equatorward motion: (1) cold dense air moves toward warm light air and (2) upper-level steering winds.
- ❑ To the east of the upper-level ridge, the upper-level flow has an equatorward component that steers cold air masses equatorward.
- ❑ Pacific cyclone and cyclone east of the Rockies or along the East Coast can intensify the upper-level ridge.



## Surface and 500-mb Weather Associated with a Cold Wave



- ❑ Surface high begins its southward movement as the ridge intensifies.
- ❑ The movement of surface cyclone from the central to eastern United States contributes to the intensification of the midwestern trough.
- ❑ As the cyclone moves northwestward and occludes, the surface high moves southeastward.
- ❑ The progression occurs over a period of only two to three days.



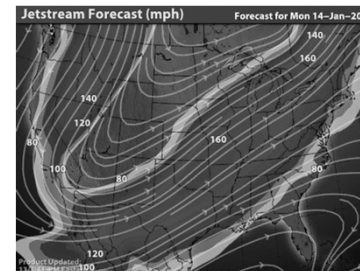
## Cold Waves in California?

- ❑ The coldest air was forced by topography to track just to the east of the Rocky Mountains.
- ❑ Occasionally, a cold airmass may be deep enough to spill over the Rockies, with cold air entering the Great Basin from the northeast and affecting Nevada and Utah.
- ❑ In rare cases, a cold airmass can spill westward over the Sierra Nevada range and into California.
- ❑ In such situations, the sub-freezing air can damage the crops grown in California's Central Valley, as in January 2007.
- ❑ However, the downslope (adiabatic) motion results in sufficient adiabatic compression that air temperature in Coastal cities (SF, LA, SD) typically will warm considerably.



## Why Has It Been So Cold in Southern California?

- ❑ "Southern California and the rest of the Southwest United States are undergoing a cold snap that has set records in many areas throughout the region."
- ❑ "Los Angeles set a record daily low of 34°F (1°C) in the morning of 14 January, 2013 the coldest it's been in 22 years, according to the National Weather Service."



Today's Jetstream



## Major Factors for Cold Outbreaks over US

- ☐ Buildup of a ridge in the jetstream level over western North America.
- ☐ Formation of a surface high-pressure center over northern Canada or Alaska.
- ☐ Movement of the cold airmasses in response to steering by the upper-level winds.
- ☐ A mechanism to enhance the winds that transport the cold air southeastward. The triggering mechanism is often a strong winter cyclone crossing central or eastern North America.
- ☐ Extensive snow cover over central North America to keep the polar airmasses “refrigerated”.



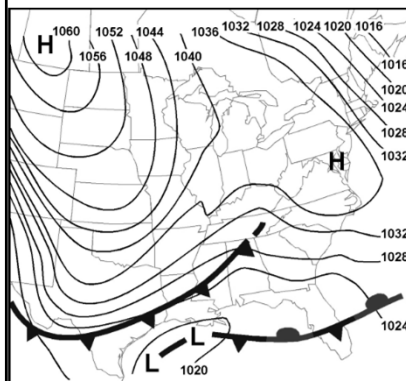
## Cold Waves in Europe and Asia



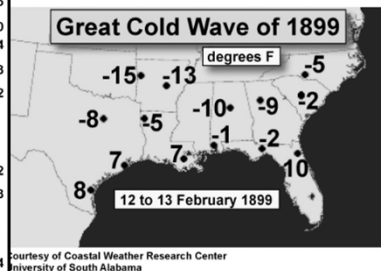
- ☐ The most extreme area of all is northern Asia (Siberia).
- ☐ Where the formation of cold surface air is enhanced by (1) the large distance to the nearest unfrozen ocean, isolating the area from warmth and moisture, and (2) the presence of mountains to the east and south, serving as barriers to trap and further isolate the cold surface air once it has formed.



## Great Cold Wave of 1899



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Courtesy of Coastal Weather Research Center  
University of South Alabama

