Chapter 14

Cold Waves

Cold Waves

• An influx of unusually cold air from the arctic that intrudes into the lower and middle latitudes
• Can freeze vegetation and cause structural damage
• Generally affect much larger areas than blizzards, ice storms, etc.

Effects of Cold Waves

• NWS keeps statistics on deaths related to cold weather outbreaks
  – On average, (3, 30, 300) deaths are attributed to cold waves
• CDC estimates that (60, 600, 6000) deaths are attributed to hypothermia
  – May not necessarily be related to a cold outbreak
  – Only includes deaths directly related to cold
  – Disproportionately occur amongst elderly males
Cold Wave outbreaks

- Where are economic losses greatest?
- What is meant by a “Cold Wave”?

Cold Wave Intensity Measure

- Temperatures during cold waves are not the most meaningful measure of a cold waves intensity. What is?

Lowest Temperatures on Record by State
Cold Wave Development

- Core develops as a strong (high-pressure/low-pressure) system at high latitudes
- Air cools near the ground by conductive heat loss to the ground
- Air density increases, temperature decreases, what happens to pressure?
- What type of airmass develops?

Arctic Air

- Temperatures in the Arctic Regions can sometimes drop below -40°C. What problems does this cause?

Development of Polar Airmasses

- What is typically colder, Arctic Ocean regions near the pole or land locations (Siberia, Northern Canada, Alaska)? Why?
## Polar Airmass Depths

- Generally shallow
- Characterized by strong temperature inversions
- Can lead to temperatures at the surface that are (5, 10, 15) °C colder than several hundred meters aloft
- How does topography play a role in enhancing temperature inversions?

## Airmass Intensification

- What other factors can intensify the airmass?
Cold Wave Outbreaks

- Cold air outbreaks require a cold airmass to form at high latitudes and move south
- What makes them move (two factors)?
  - The more quickly it moves to middle latitudes, the less time it has to modify

Equatorward Motion

- Occur when jet stream winds have a southerly component
  - Upper air pattern contributes to both convergence aloft and southern movement of the airmass
- Factor of ridge intensification over eastern North Pacific

Ridge Intensification

- Air over North Pacific Waters is (warmer/colder) than air over land at same latitudes
- Aleutian low transports warm air northward
- Northward flow of maritime air leads to warming of the lower troposphere. What does this do to the jet stream?
Ridge Intensification

- Second factor is flow associated with strong cyclones originating on the east side of the Rockies or along the eastern Seaboard
- Cyclones transport cold air southward on their (eastern/western) side
- Enhances southward component of jet stream flow on troughs western side, enhancing upstream ridge

Cold Wave Pattern

Cold Wave Movement
Subsidence Effects

• How does subsidence modify the airmass?

• Can cold airmasses pass over the rockies and head west?

• What other variables can affect cold wave outbreaks?

Cold Outbreak Summary

• What five factors influence the outbreak of a cold wave?

Extreme Cold in Europe and Asia

• Siberia
  – What enhances the extreme cold in Siberia?
North Atlantic Oscillation

• Typical flow is west to east
• Flow is consequence of the Icelandic low and high pressure near the Azores
• Both pressure centers weakening substantially leads to the NAO
• Allows cold Siberian air to move southwestward

North Atlantic Oscillation

North Atlantic Oscillation

• Negative phase when pressures and winds are all weaker than normal
• Positive when all are stronger
European Cold Outbreaks

Wind Chill Factor
- Accounts for the effect of temperature and wind on the rate at which exposed skin will cool
- Solid and liquid surfaces lose heat more rapidly at a given wind speed as winds increase
- Object loses heat due to conduction
- Evaporation from skin also increases as wind speed increases

Wind Chill Index
- Estimate of perceived temperature based on wind speed and actual temperature
- Scientists first began development in 1940's, where at?
- Measured time required for cooling and freezing of known volumes of water starting at various temperatures
- Latest refinement made in 2001
Wind Chill Index Modifications

- 2001 adjustments included factors accounting for:
  - Advances in science, tech and modeling of heat loss
  - New formula based on model of human face
  - Assumes nighttime, doesn’t account for sunshine warmth

Wind Chill Index

Advisory vs Watch

- What is the difference between a Wind Chill Advisory and a Wind Chill Warning?
Cold Wave Warning

- Issued based on forecast of prolonged temperatures well below normal

Cold Waves and Climate Change

- What hazards are associated with cold wave outbreaks?

- What will climate change mean for cold wave outbreaks?