Gradients

- The *gradient* of a quantity is a measure of how rapidly the quantity varies from place to place.
- It is expressed as the *difference* in that quantity across each unit of distance between places.
- Examples:
  - *Temperature gradient*, expressed as the difference in temperature across a unit distance (for example, 100 kilometers, 100 miles, etc.).
  - *Pressure gradient*, expressed as the difference in pressure across a unit of distance.
- Contour maps make comparing gradients in different areas easy.
  - Contours closer together → larger gradient (that is, a bigger difference in the quantity across a fixed unit of distance)

Temperature Advection

At a particular location, when air leaves and is replaced by air from somewhere else with a different temperature, the temperature changes*. This process is called *temperature advection*.

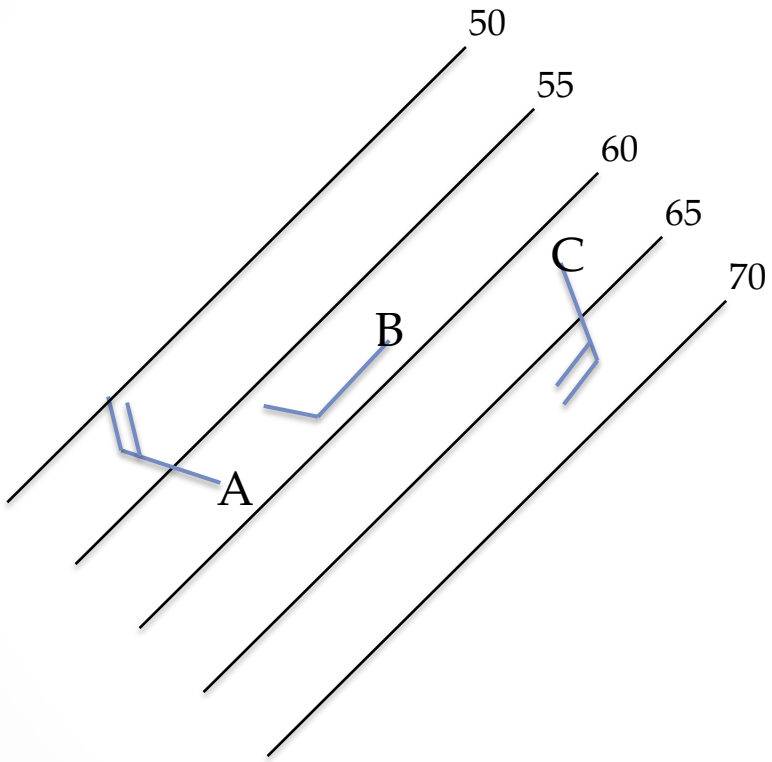
- *Cold advection:* Departing air is replaced by colder air.
- *Warm advection:* Departing air is replaced by warmer air.

What conditions are necessary for temperature advection to occur?

- Air must be moving (i.e., there must be *wind*)
- Temperature must vary from place to place
  (i.e., there must be a *temperature gradient* across the area)
- Arriving air must come from a place with a temperature different from the departing air.
  (On a contour map of temperature, *the wind must blow across the isotherms at some angle*.)

(*Note: Other processes can also affect the temperature at a location at the same time, such as solar absorption, infrared absorption, infrared emission, conduction, and evaporation or condensation. All [and maybe more!] must be taken into account to understand and predict changes in temperature there.)

Examples: A simple pattern of temperature with winds



Temperature Advection

Under what conditions would temperature advection be relatively large?

- Fast winds
- Large temperature gradient
- Large angle between the wind direction and temperature contours
  (90° angle is the maximum possible)