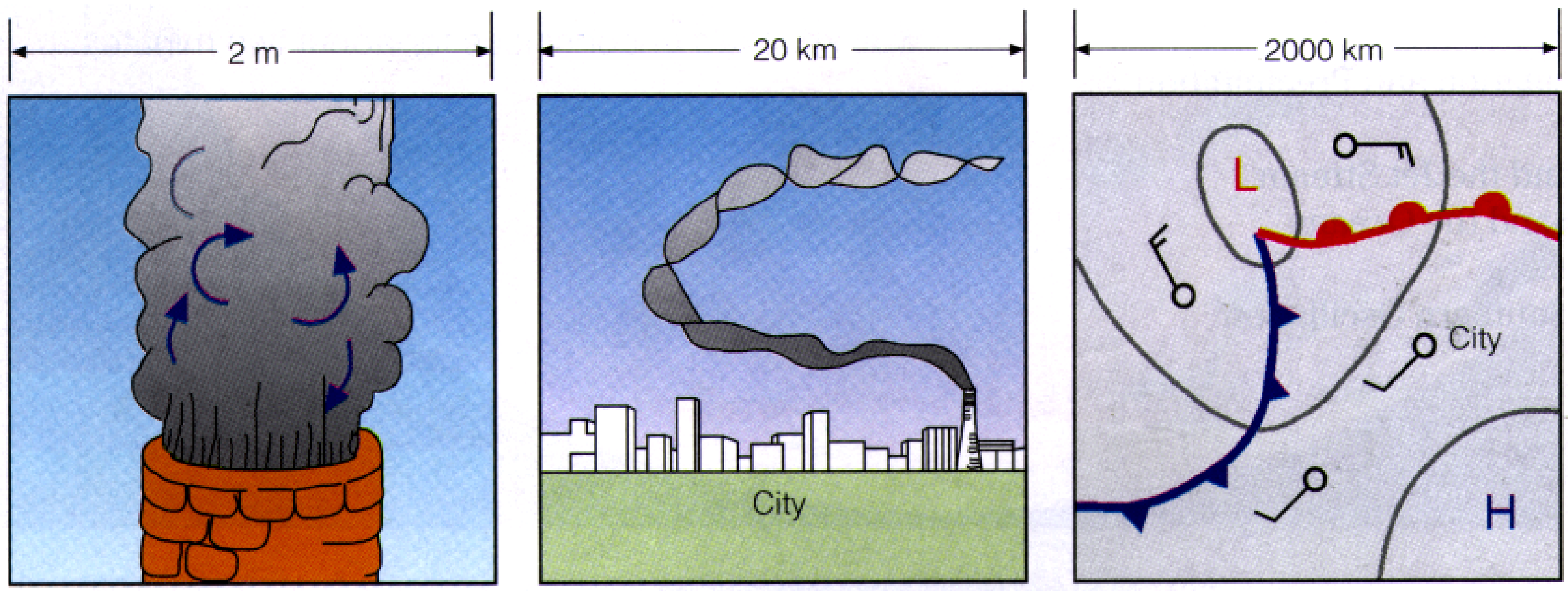
Lecture 10. Local Circulations

Scales of Air Motion

- Microscale (air circulation less than 5 km across)
- Mesoscale (5-500 km)
- Synoptic Scale (500-3000 km)
- Global Scale (3000 km or more)



(a) Microscale (b) Mesoscale (c) Synoptic scale

Figure 7.1 (EOM)
Scales of atmospheric motion. The tiny microscale motions constitute a part of the larger mesoscale motions, which, in turn, are part of the much larger synoptic scale. Notice that as the scale becomes larger, motions observed at the smaller scale are no longer visible.

Local circulations

Tied with *local* temperature contrasts or mountains, rather than blowing in from elsewhere.

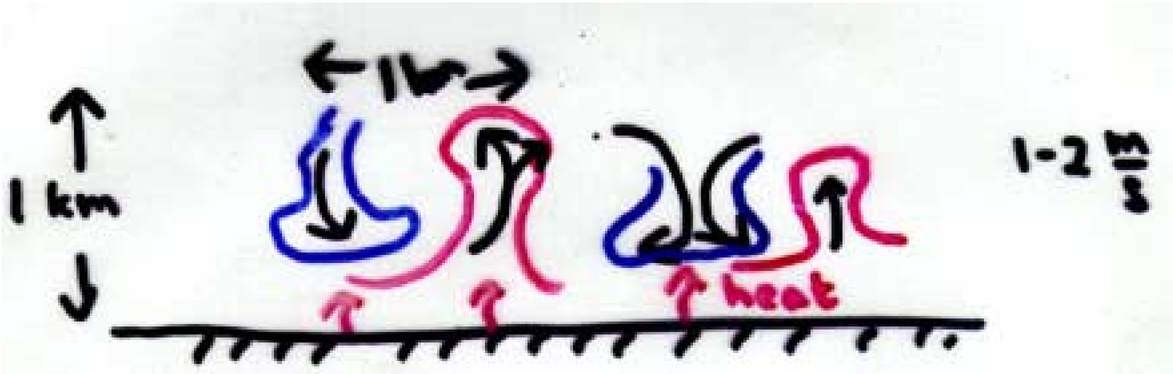
- Microscale (less than 5 km)
  - Convection
  - Clear-air turbulence
- Mesoscale (5-500 km)
  - Mountain waves
  - Land/Sea and Mountain/Valley breezes
- Synoptic/Global Scale (larger than 500 km)
  - Monsoons

Coriolis Force and Local Circulations

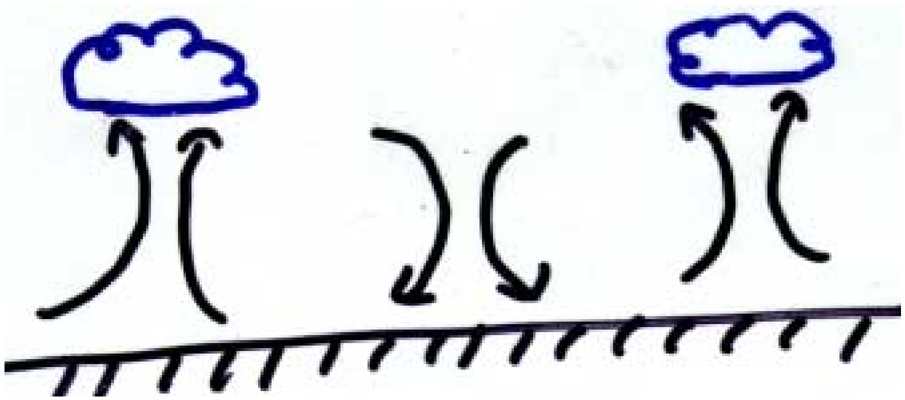
- The Coriolis force bends all winds to right (NH).
- If an air parcel experiences roughly the same PGF for half a day or more, it will blow roughly along the isobars at a speed that achieves geostrophic balance, with CF equal and opposite to PGF.
- However, air parcels move through many local circulations in a few hours or less. During this time, the Coriolis force bends the wind rightward, but PGF remains dominant; air mainly blows from high to low pressure.

Convection

- Heating of surface forces hot, less dense (buoyant) air to rise and cold air to sink.
- This takes place in *eddies* (whirls) a few hundred meters on a side.



- If the convection extends high enough, clouds may be visible on top of the updrafts



Clear Air Turbulence

The turbulence we sometimes feel as bumpiness on aircraft flights is often due to *wind shear*, or rapid change of winds with height.

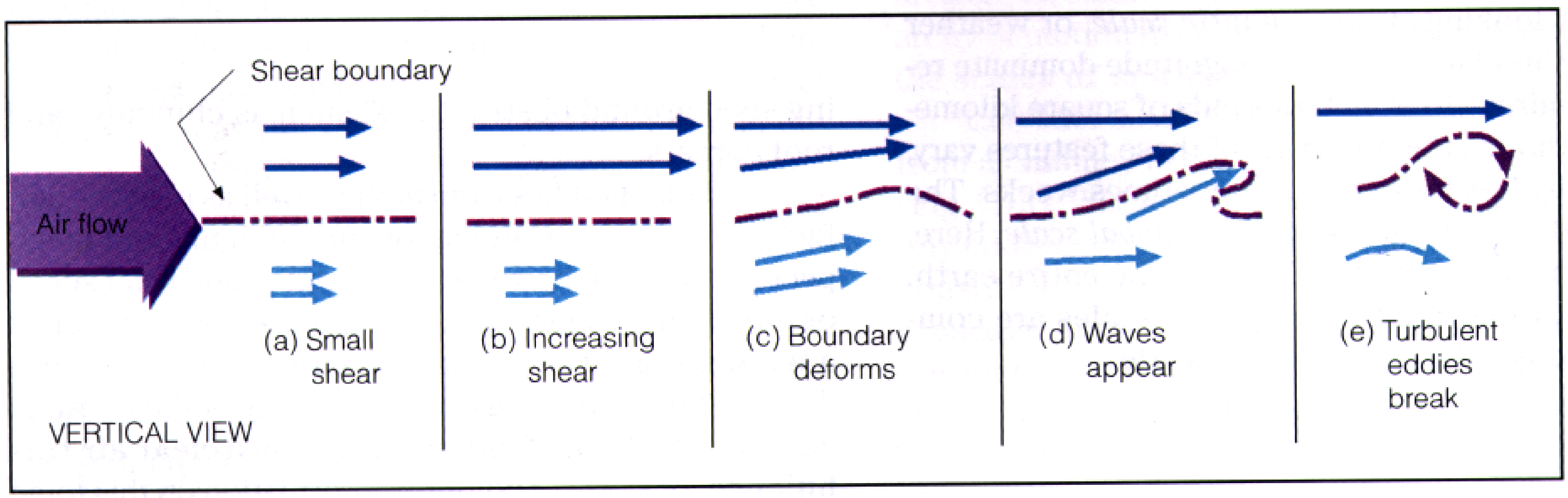


Figure 1
The formation of clear air turbulence (CAT) along a boundary of increasing wind speed shear.

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If lower layer cloudy, can see cloud billows due to wind shear

Figure 2
Turbulent eddies forming in a wind shear zone produce these clouds.

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Mountain Waves

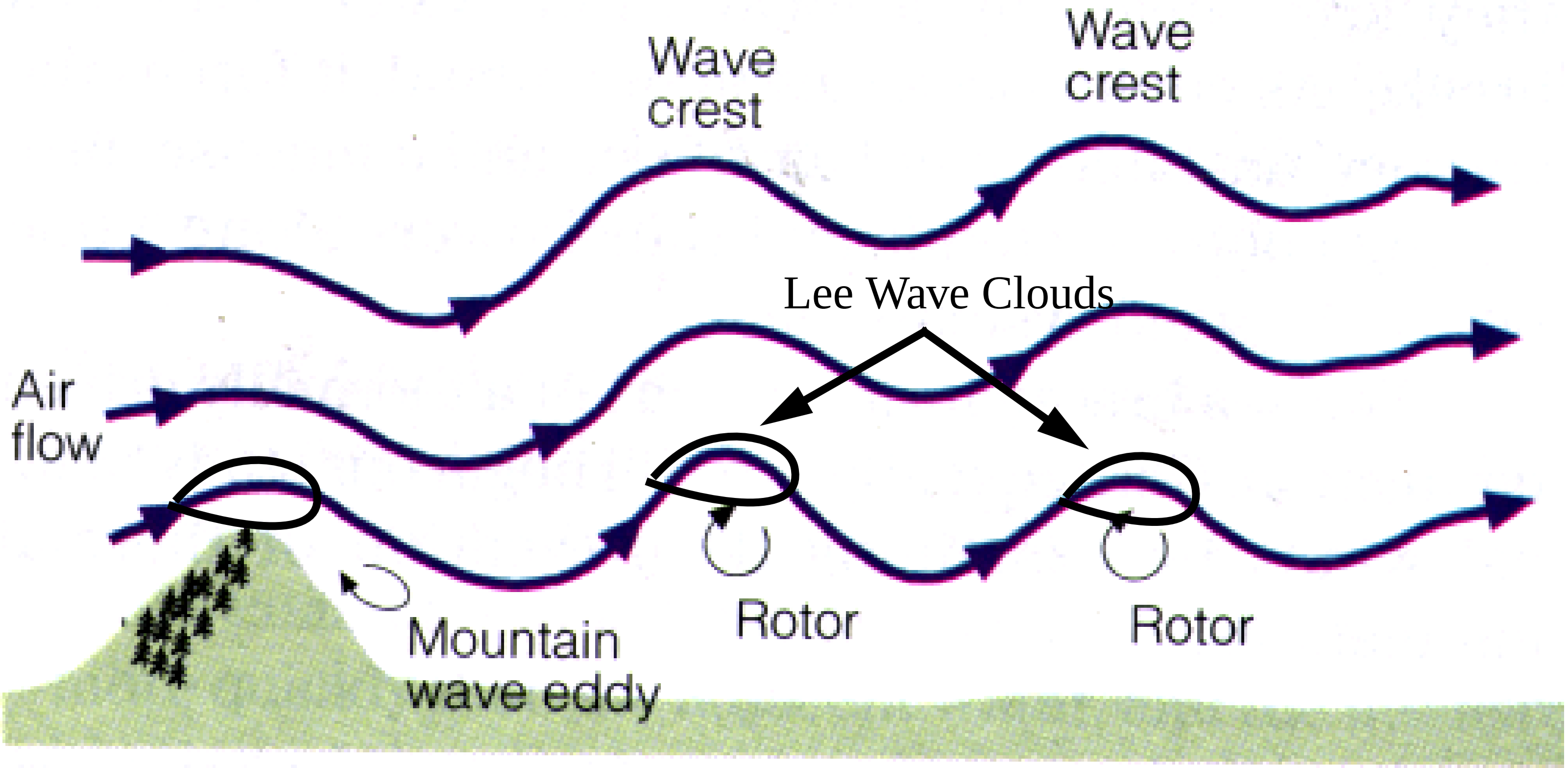
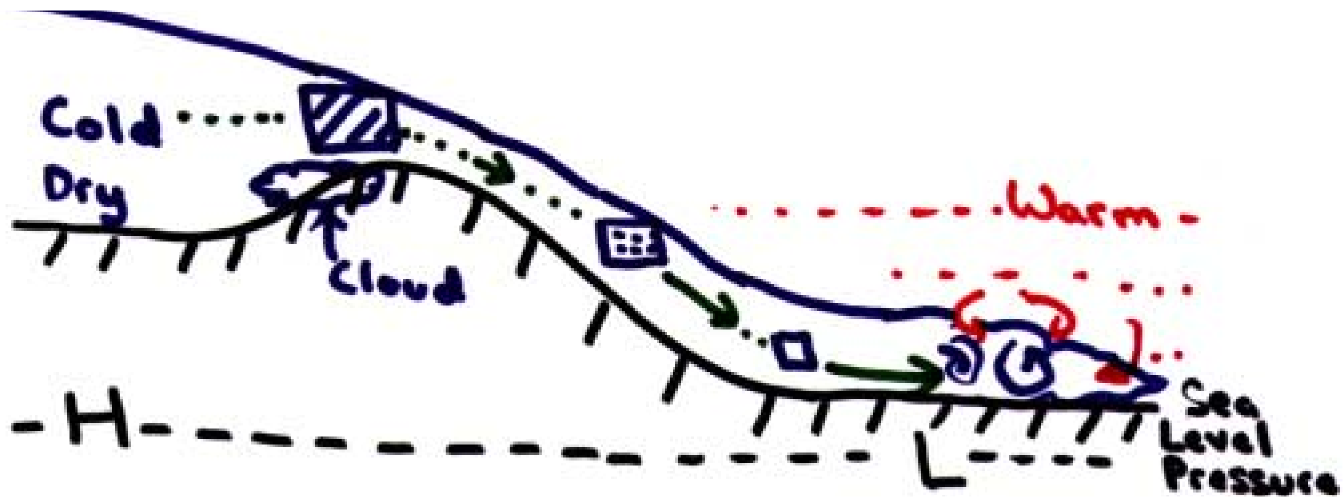


Figure 7.2 (EOM)
Under stable conditions, air flowing past a mountain range can create eddies many miles downwind from the mountain itself.

- Can produce strong winds in lee of mtns. (up to 150 mph in Boulder, CO)
- Often visible as ‘lee wave clouds’ at the wave crests.

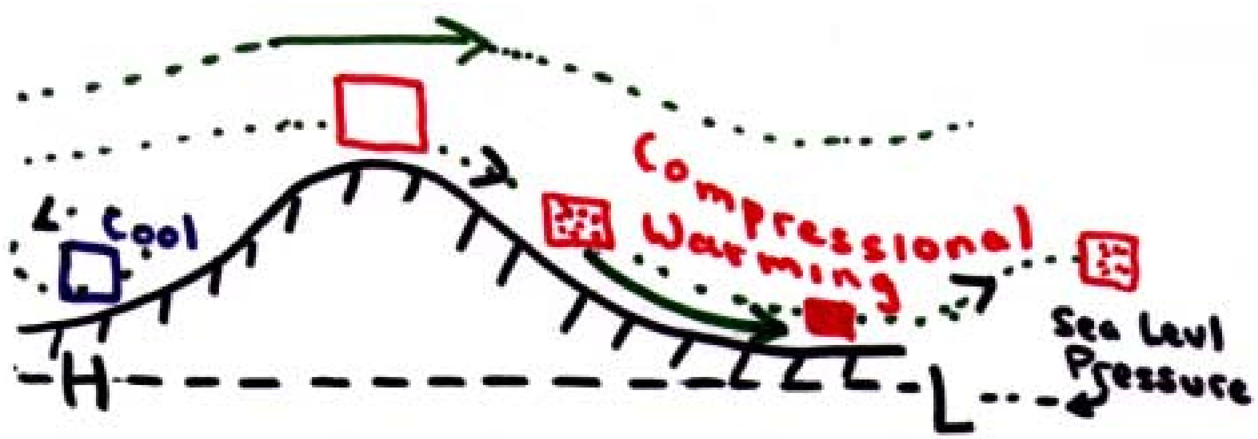
Strong Downslope Winds



Cold, dry winds occur:

- When a cold air mass builds over an elevated plateau. (Antarctic and Greenland icecaps)
- A cold continental polar airmass spills over the crest of and through gaps in a mountain range
  Yugoslavian Bora, French Mistral.
  Cold, dry easterly winds down Fraser, Snoqualmie, Columbia valleys.
- Cold dense air spills down the mountain slopes, accelerating as it descends.
- Strong downslope winds, especially in valleys downwind of gaps (100 mph winds in Enumclaw).
- Cold is reduced by compressional warming as air descends, but remains colder than mild marine air.

Warm downslope winds



- Chinook ('snoweaters') - E of Rockies
  Foehn - N of Alps
  Santa Ana Winds - LA
- Strong winds produce a mountain wave which forces mild mountaintop air down the lee side of the mountain even though it is not cold and dense.
- Air is compressionally warmed as it descends, producing a warm dry wind.
- Latent heating due to upslope precipitation can help raise mountaintop and lee-side temperatures.

EOM 7.9