LOCAL WINDS

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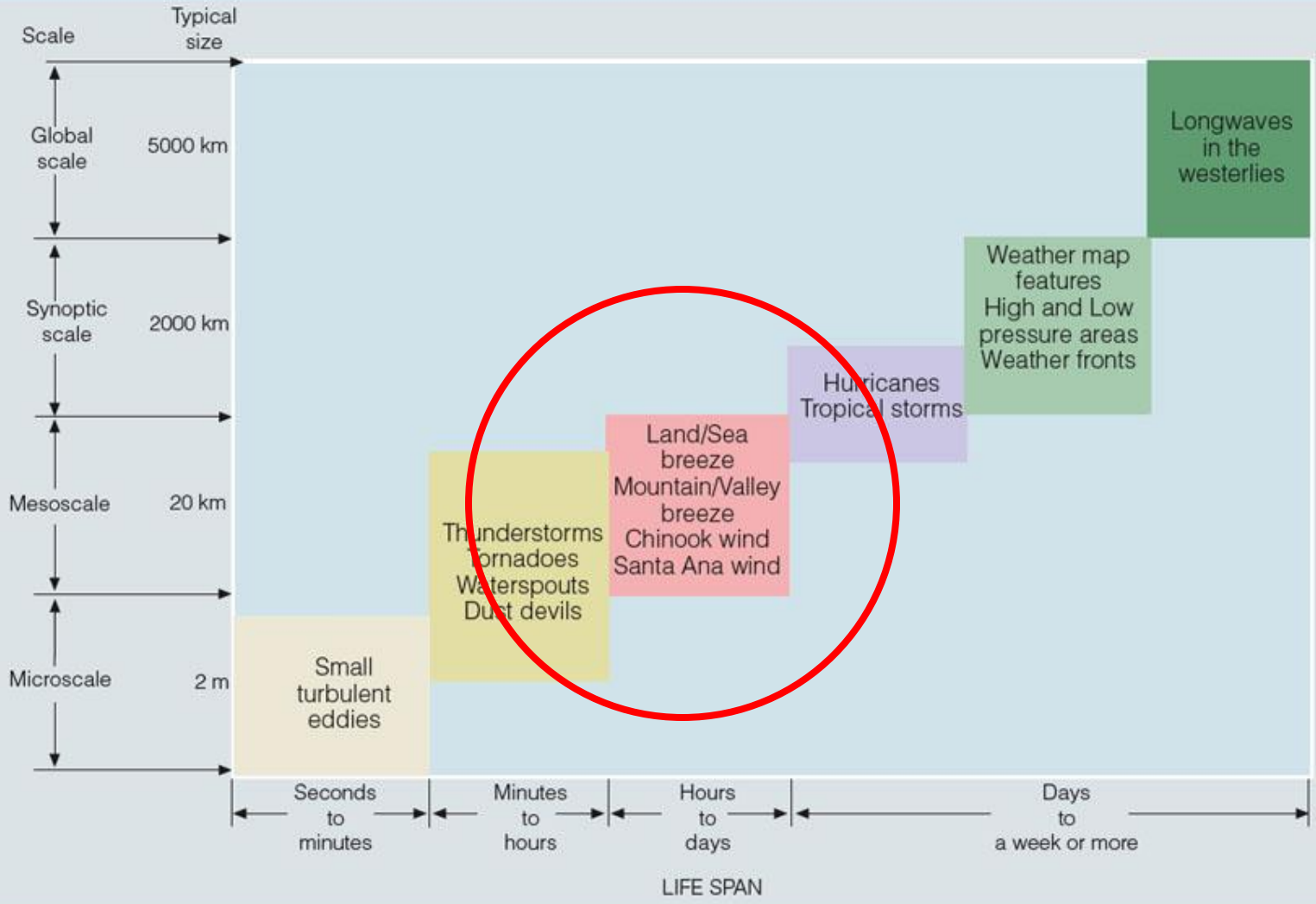
Guest lecture EVSC 1300

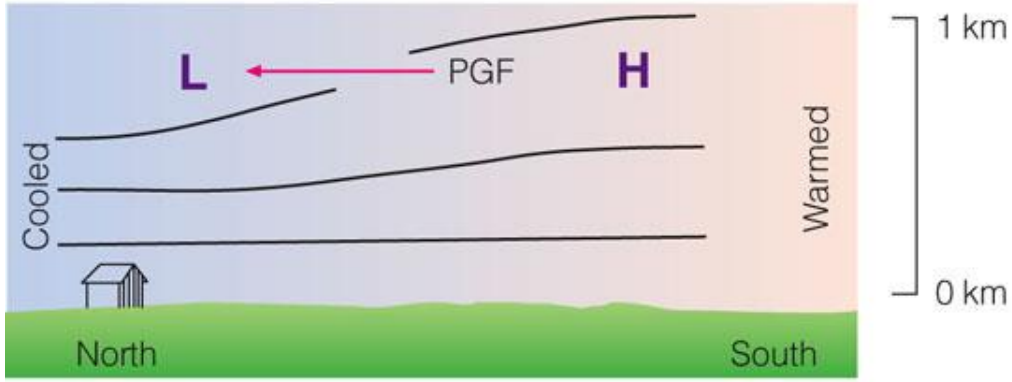
• TABLE 9.1

The Scales of Atmospheric Motion with the Phenomena's Average Size and Life Span*

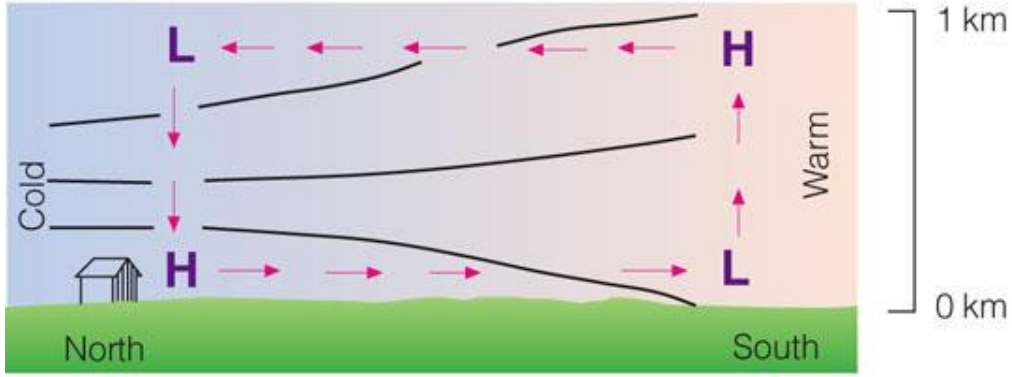


*Because the actual size of certain features may vary, some of the features fall into more than one category.

(a)

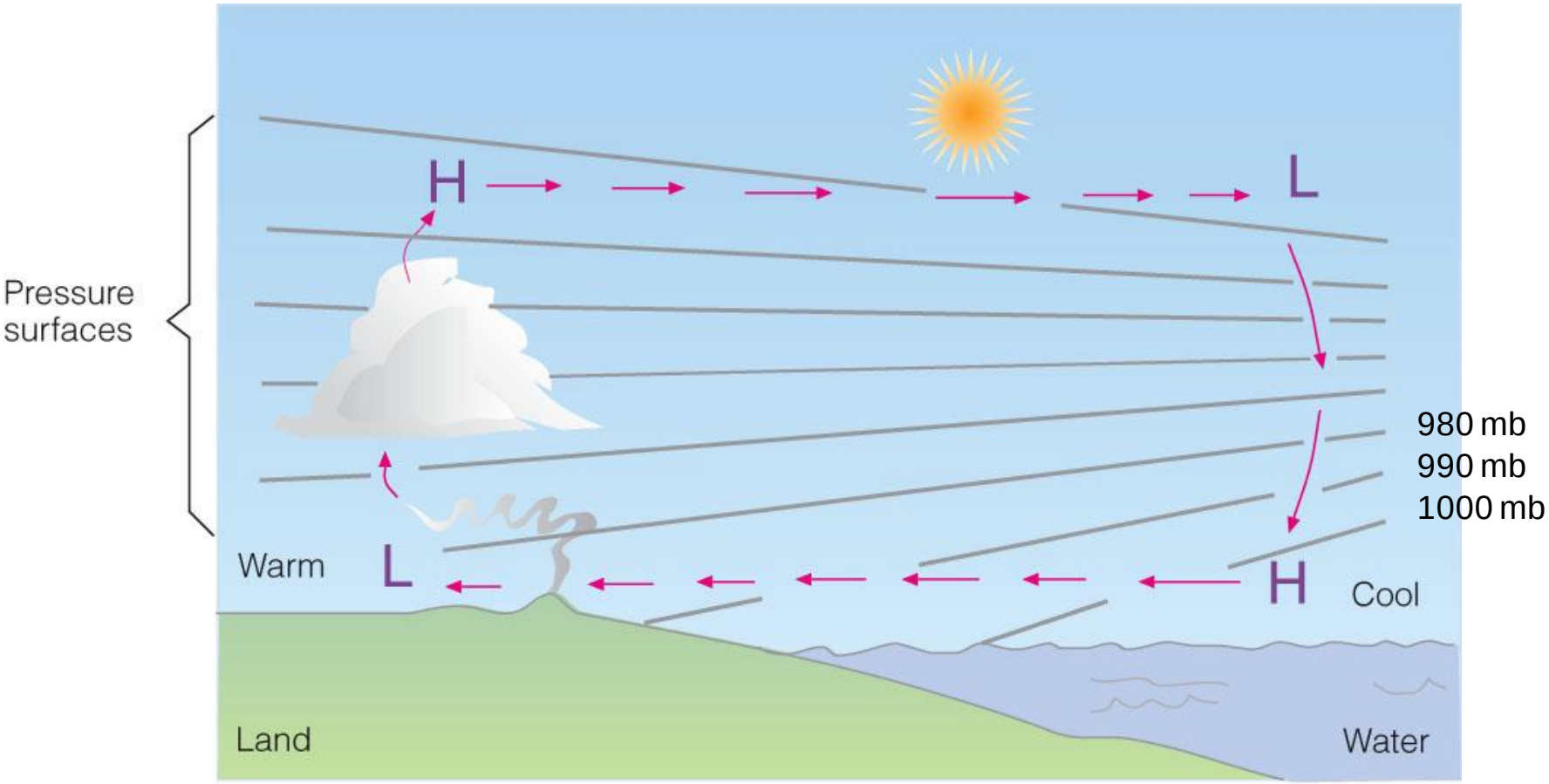


(b)



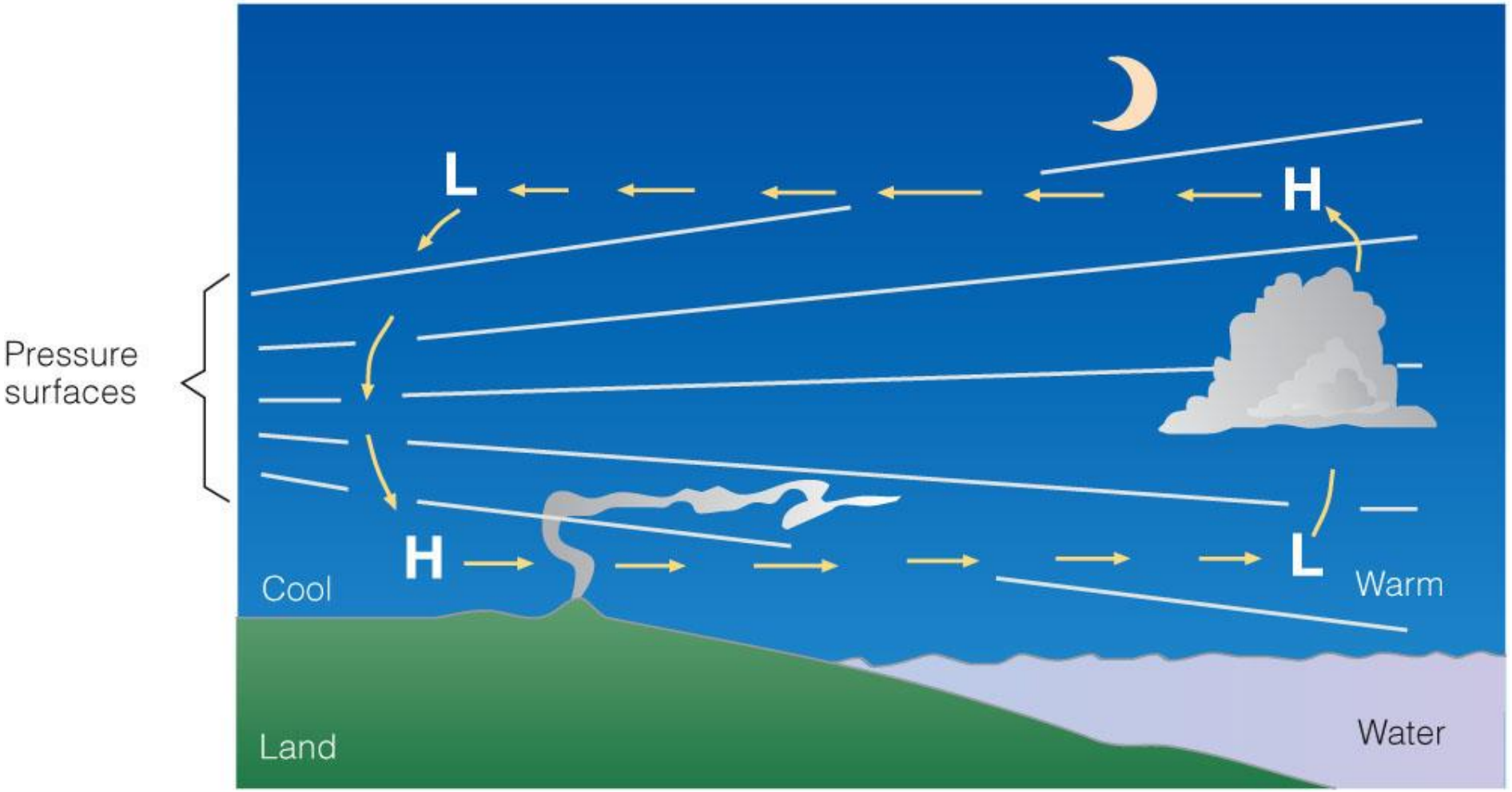
(c)

SEA BREEZE

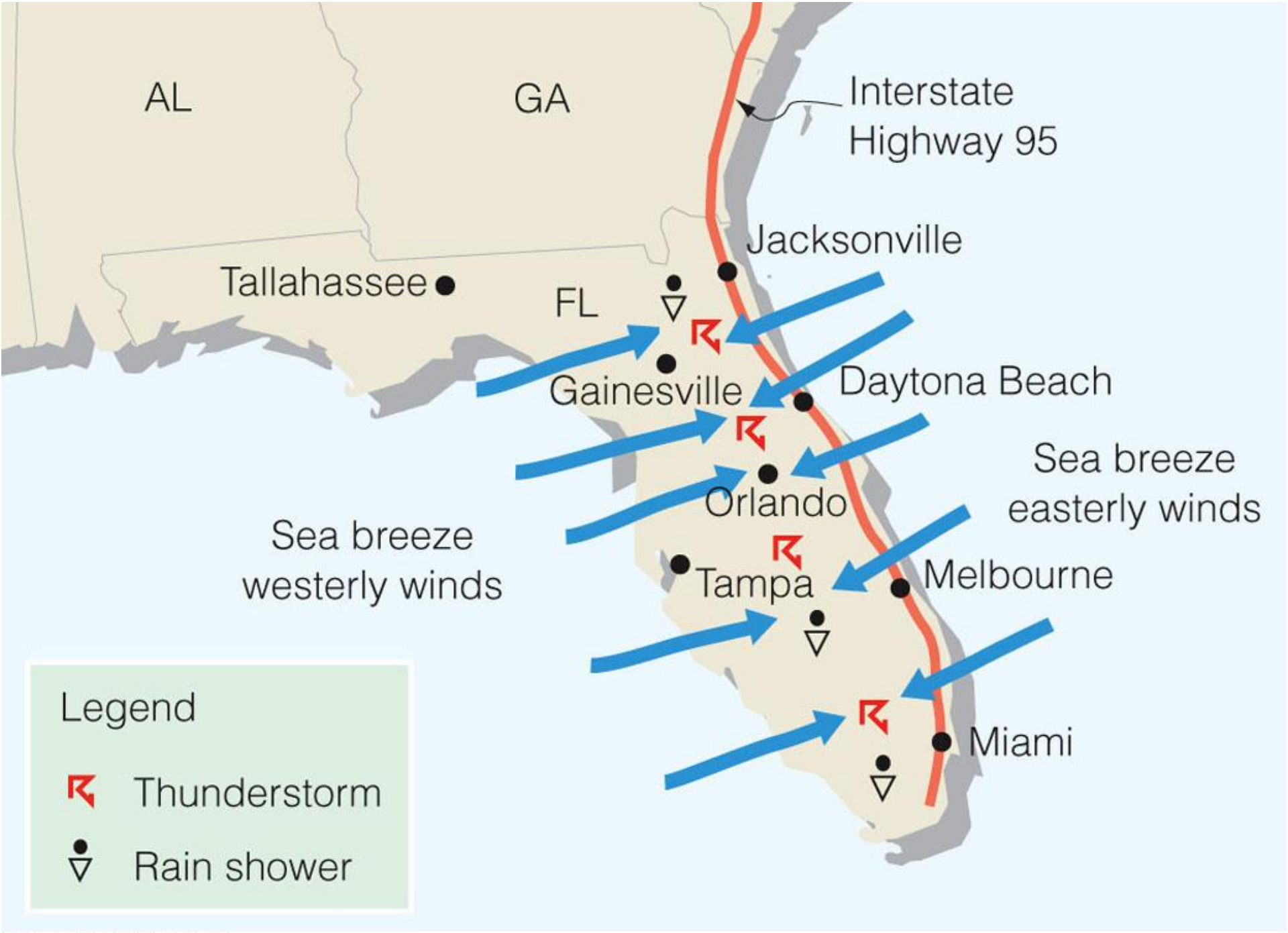


(a) Sea breeze

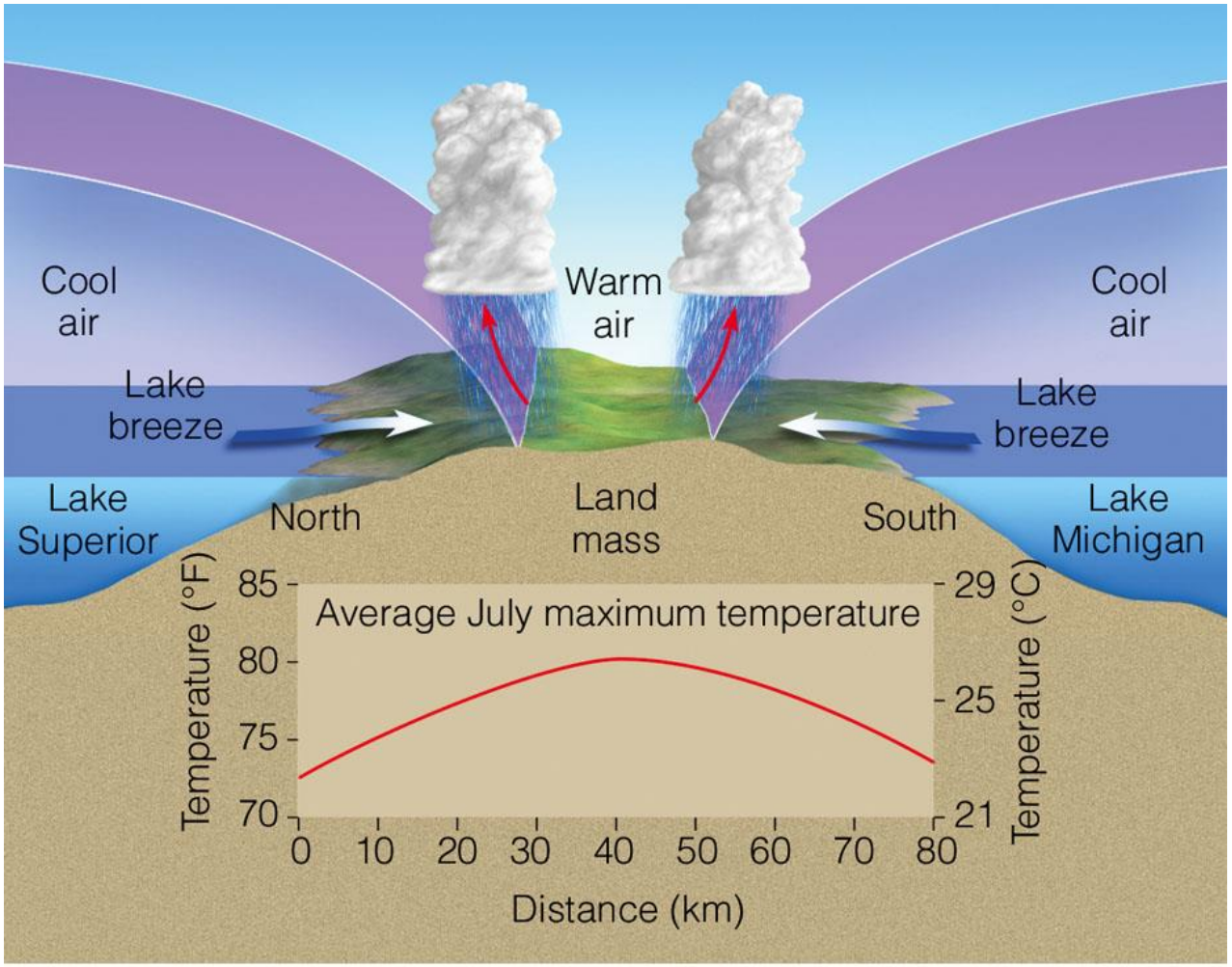
LAND BREEZE



(b) Land breeze



The convergence of two lake breezes and their influence on the maximum temperature



The sea-breeze is an example of a

diurnal wind

- Produced by horizontal temperature differences (and resulting horizontal pressure differences)
- Circulations are closed by return circulations aloft.
- Characterized by a reversal of wind direction twice per day
- strongest with clear skies when winds aloft are weak

This type of winds is ‘thermally driven’, hence also called thermally-driven winds

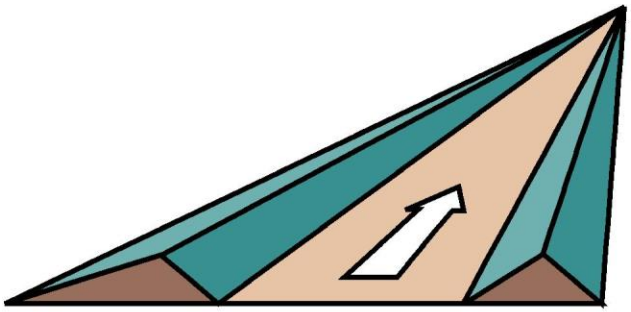
Other examples?

Diurnal mountain winds develop over complex mountainous terrain of all scales

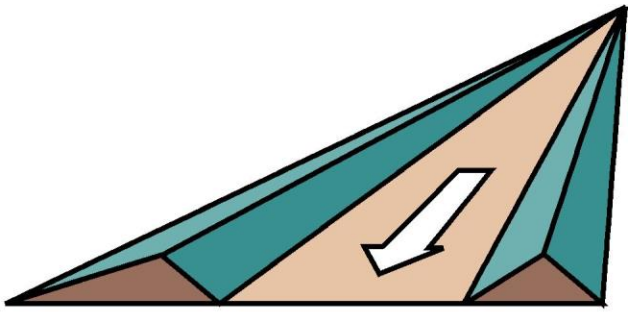
Thermally driven mountain wind systems

- Four wind systems are found over mountain terrain:
  - Slope wind system (upslope and downslope winds)
  - Along-valley wind system (up-valley and down-valley winds)
  - Cross-valley wind system (from the cold to warm slope)
  - Mountain-plain wind system (plain-mtn and mtn-plain winds)

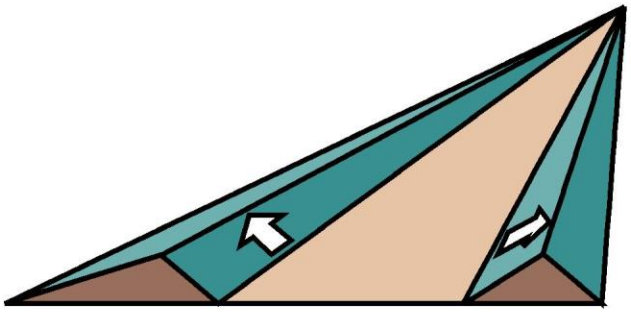
Wind Terminology



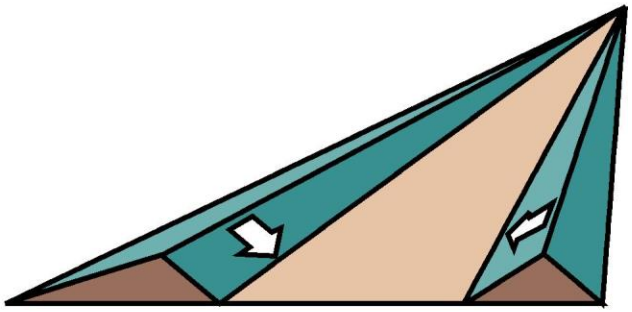
up-valley wind



down-valley wind

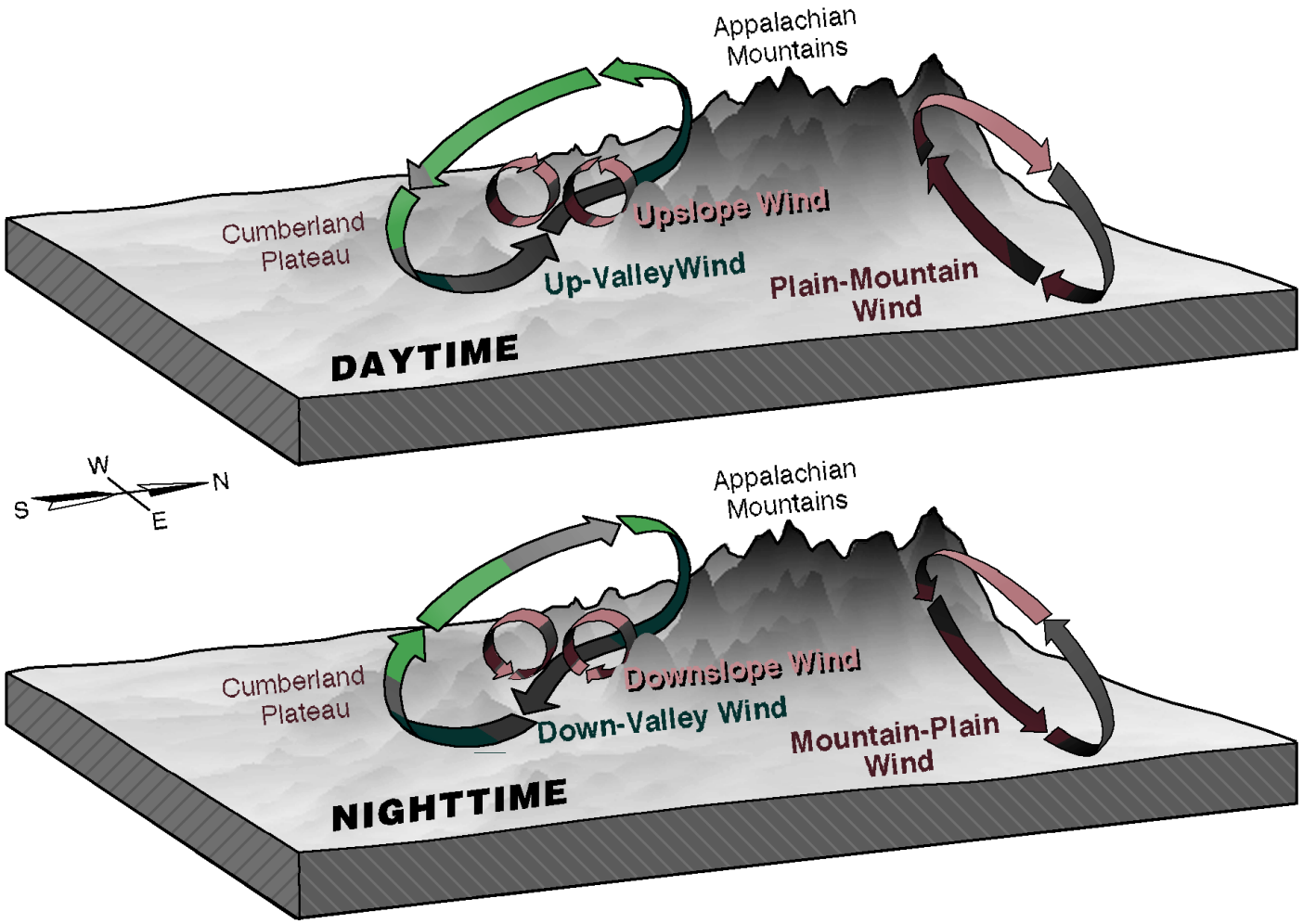


up-slope wind
(anabatic wind)

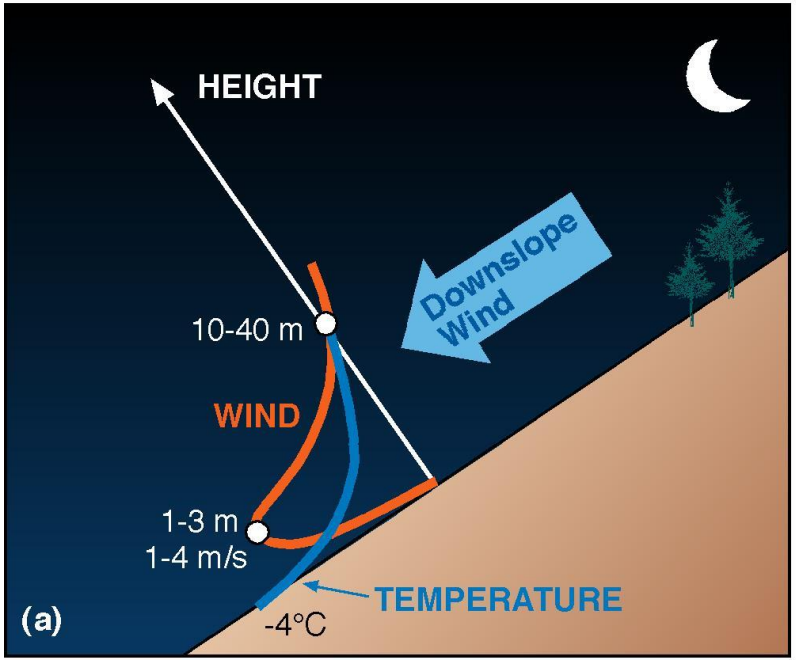


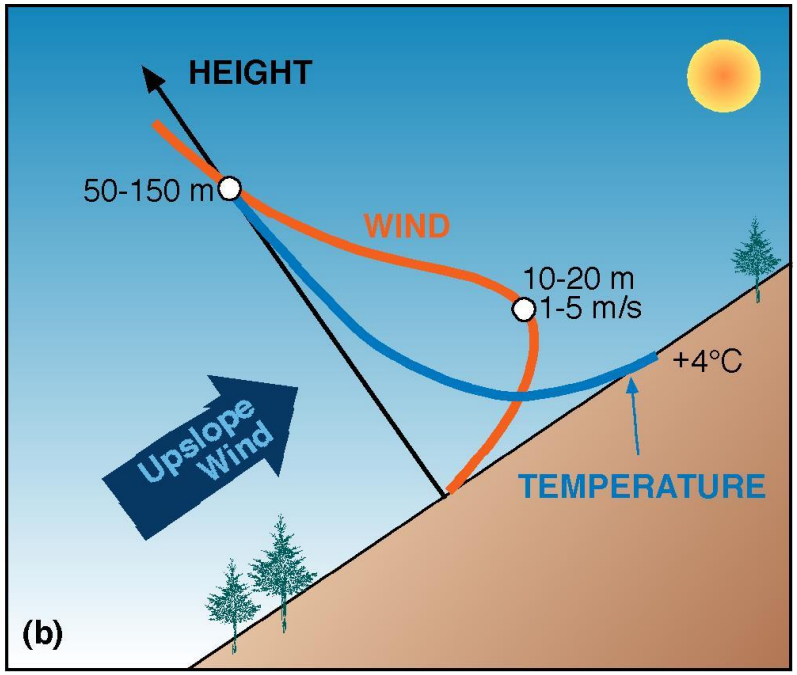
down-slope wind
(katabatic wind)

Thermally driven mountain wind systems



Slope flows


HEIGHT
Downslope Wind
10-40 m
WIND
1-3 m
1-4 m/s
TEMPERATURE
-4°C
(a)


HEIGHT
50-150 m
WIND
10-20 m
1-5 m/s
+4°C
Upslope Wind
TEMPERATURE
(b)

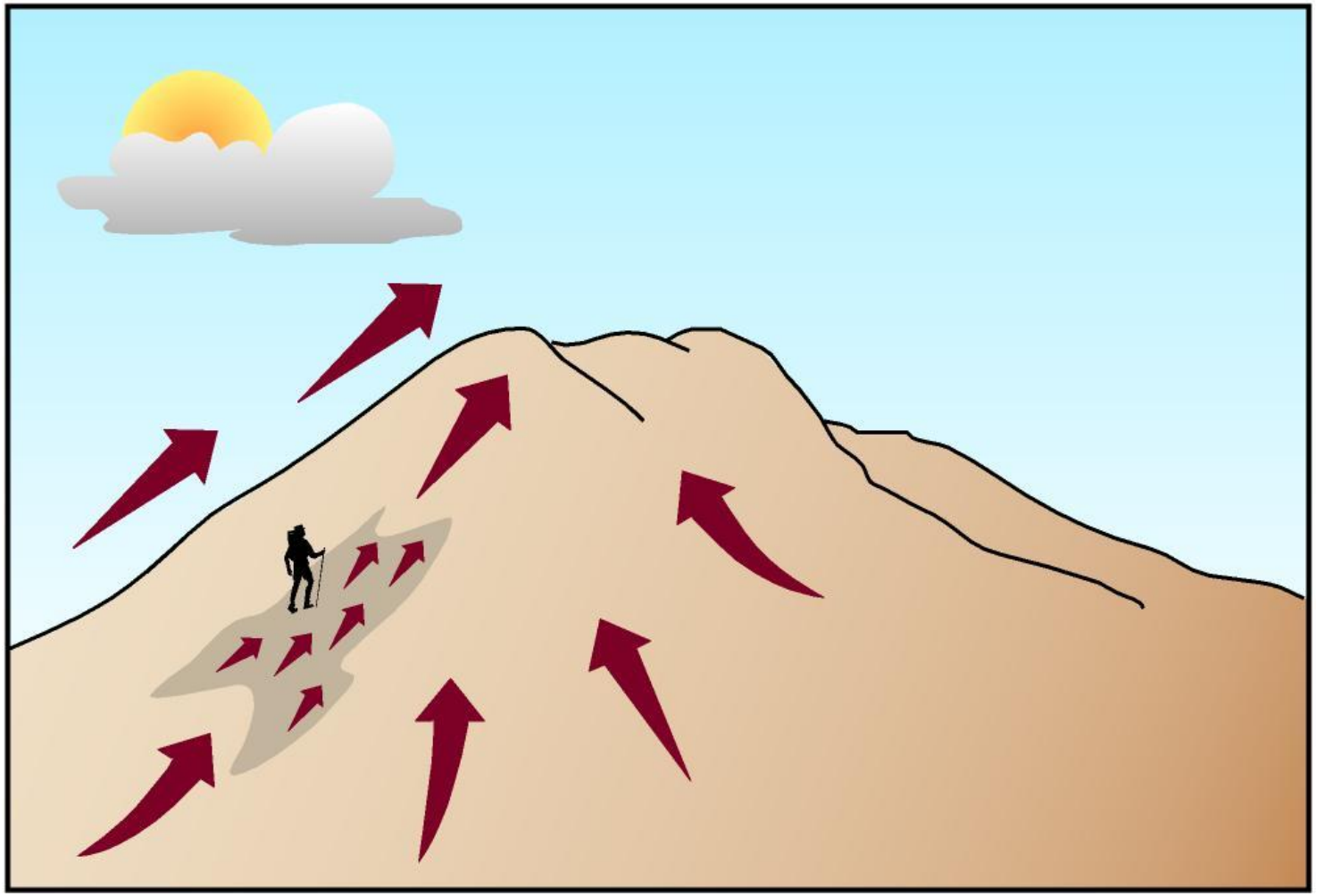
Slope winds

- Caused by differences in temperature between air heated or cooled over the mountain slopes and air at the same altitude over the valley center

- Difficult to find in a pure form. Affected by along-valley wind system, weather (radiation budget, ambient flows), changing topography or surface cover

- Best-developed in clear, undisturbed weather

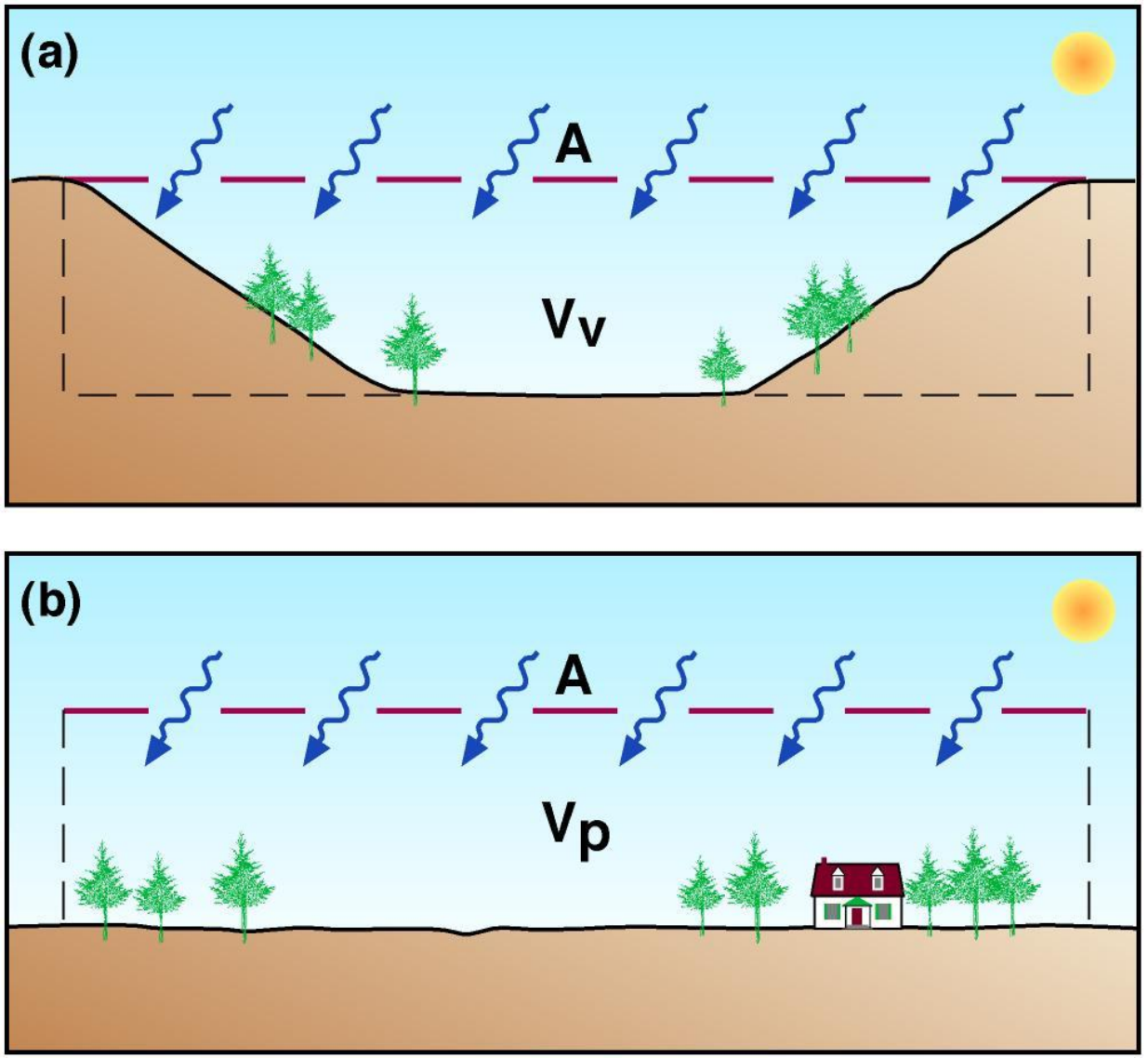
Slope flow intermittency

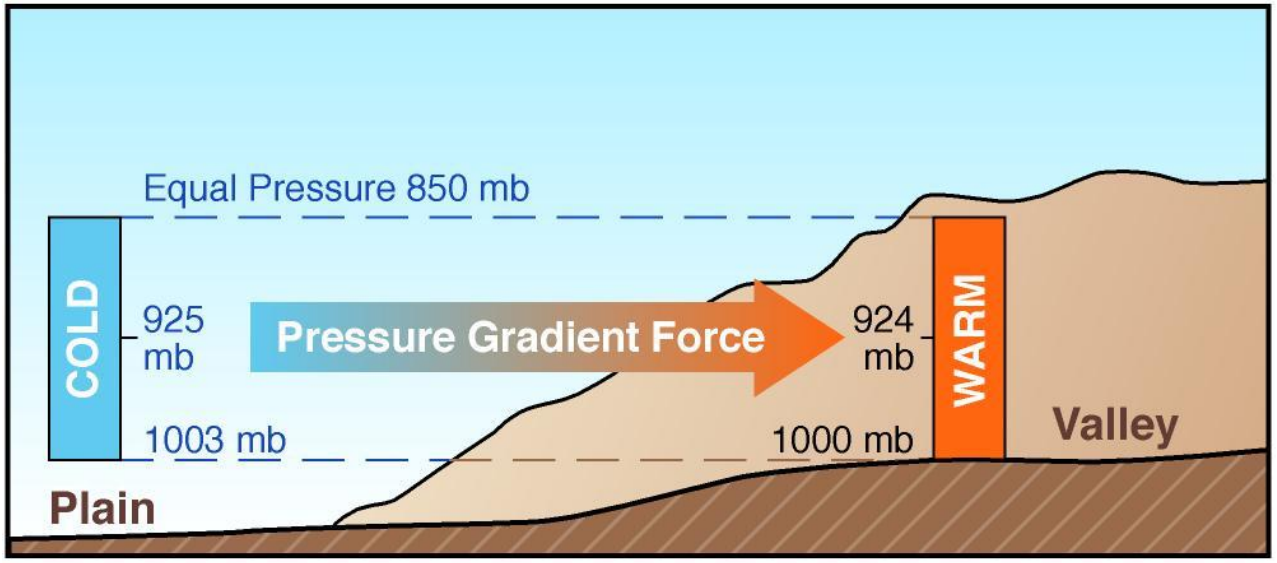


Valley Winds

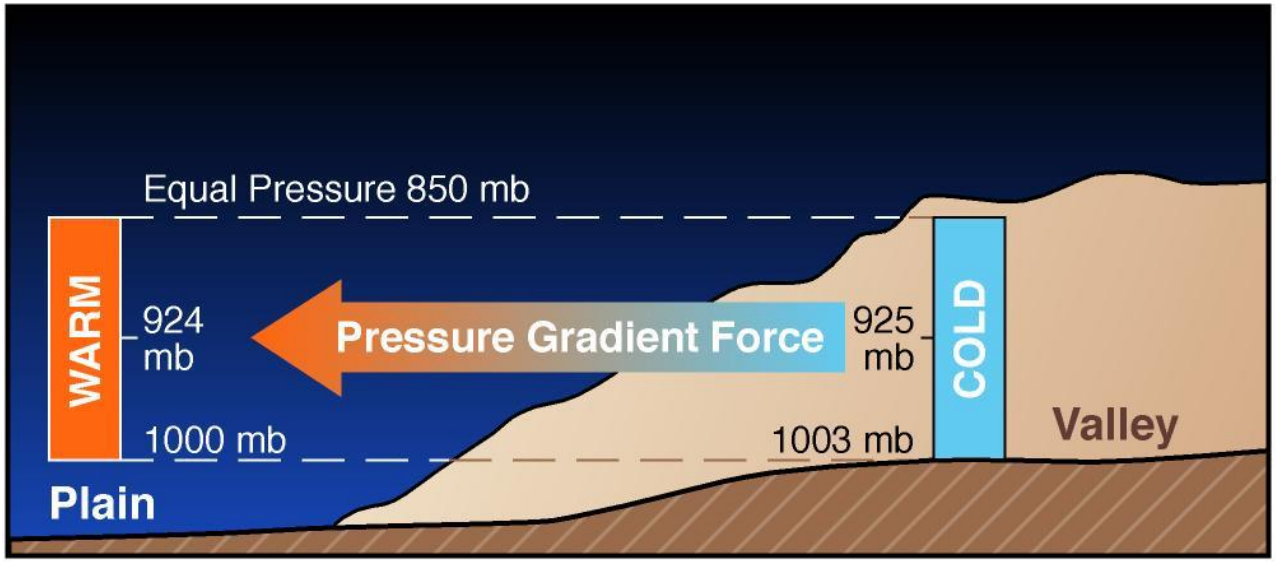
- Caused by the stronger heating and cooling of the valley atmosphere as compared to the adjacent plain
- Air currents trying to equalize horizontal pressure gradients built up hydrostatically between valley and plain
- Best-developed in clear undisturbed weather

Air volume is smaller in valley x-section than in a plains x-section, for the same area at the top





Daytime

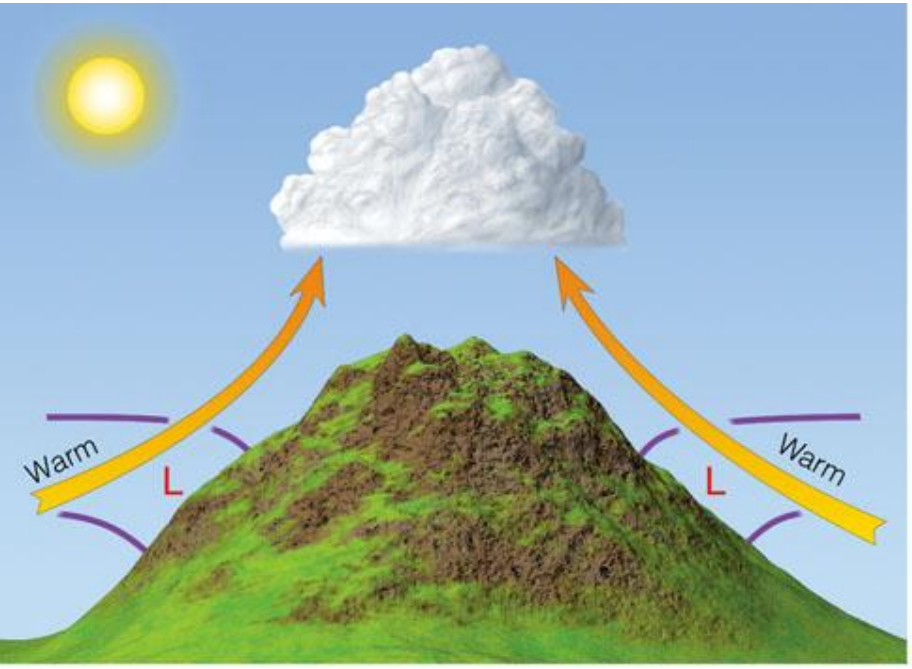


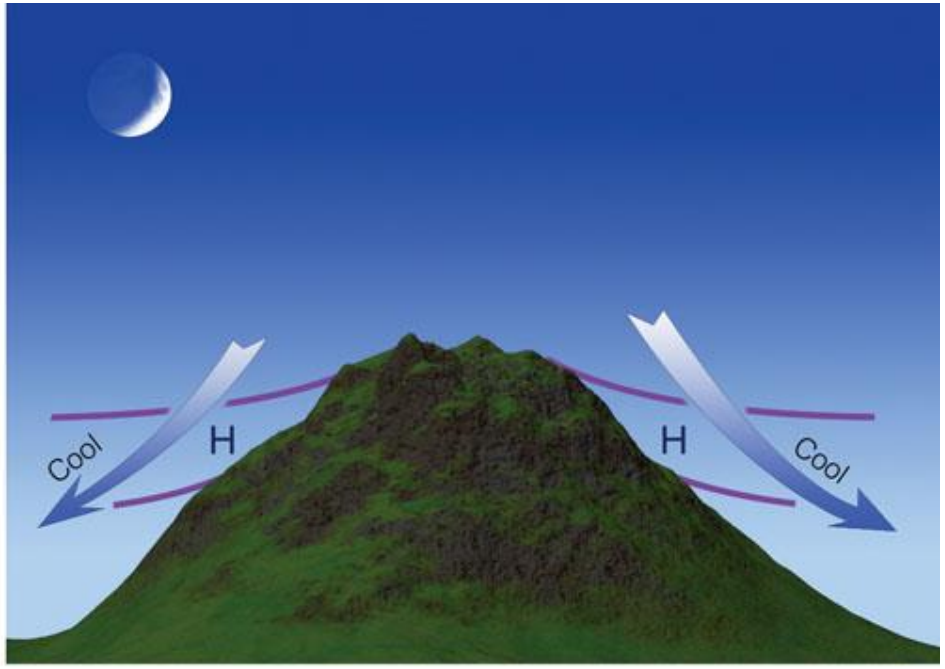
Nighttime

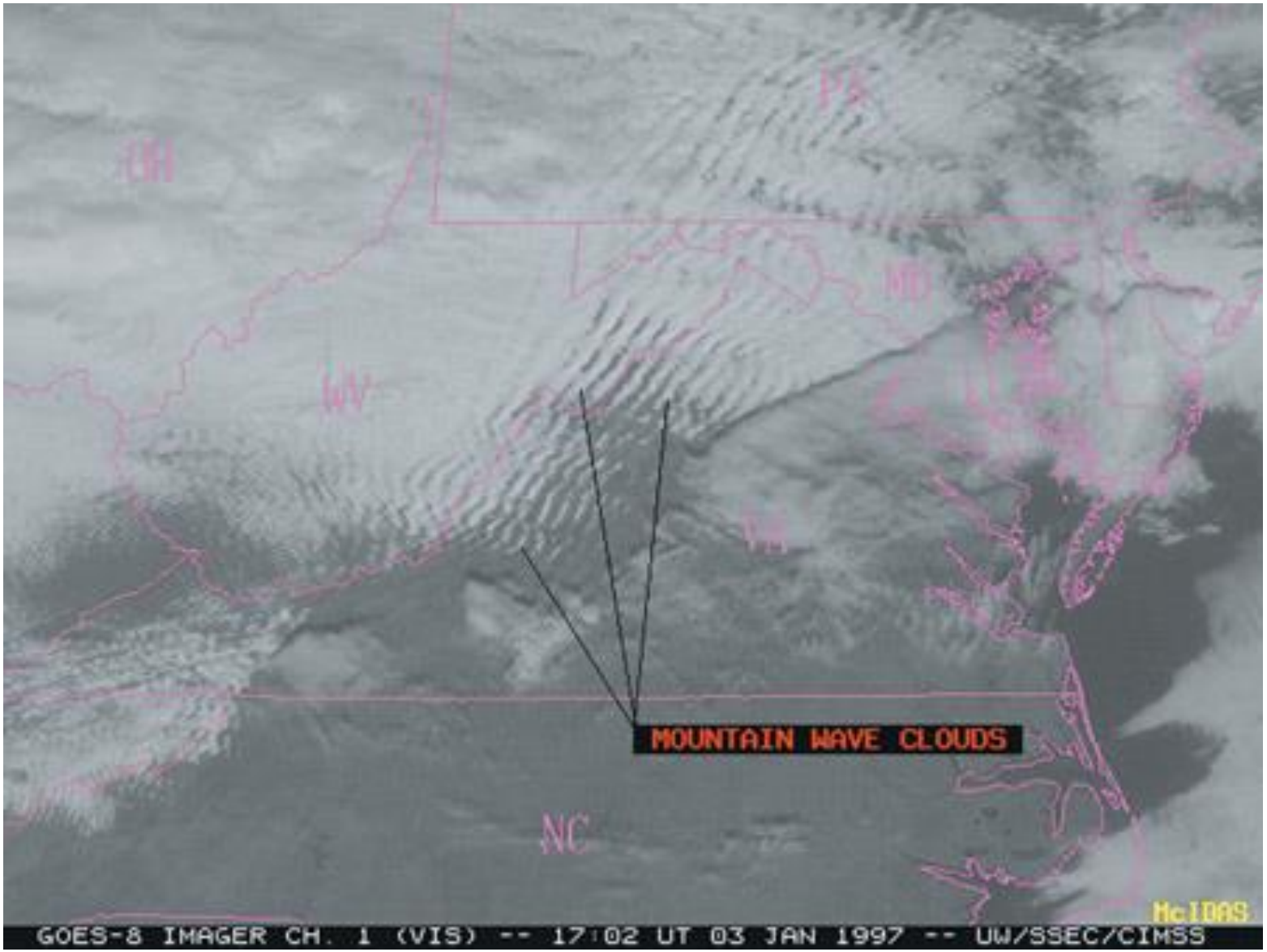
Along-valley flows

~~VALLEY BREEZE~~ Upslope flow

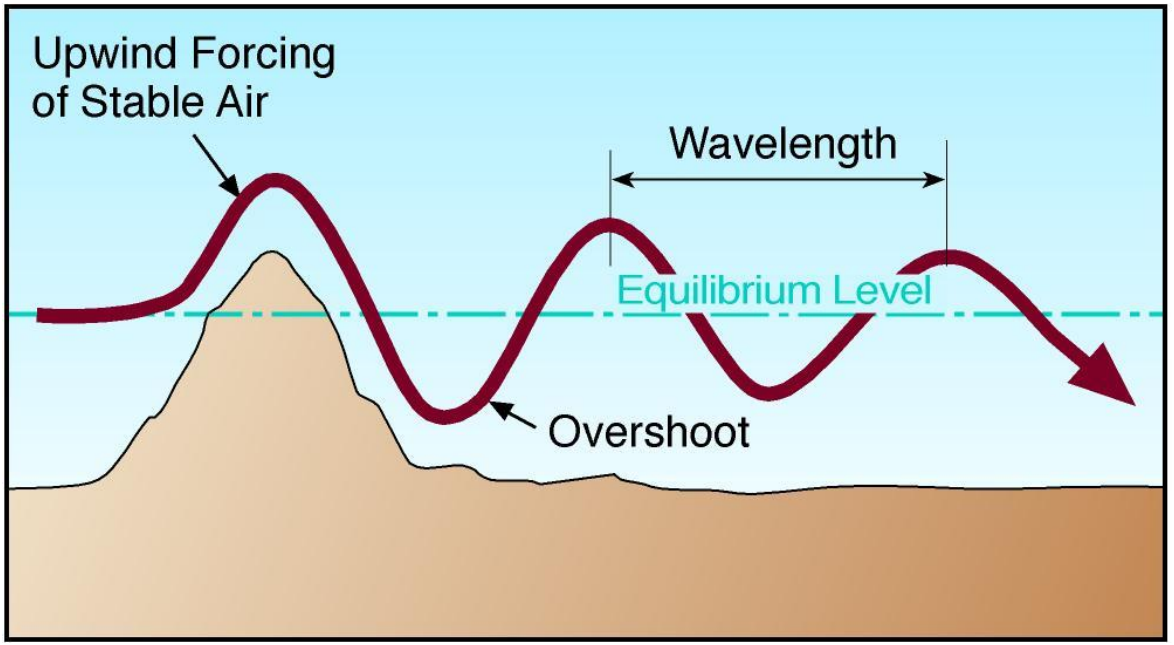
~~MOUNTAIN BREEZE~~ Downslope flow





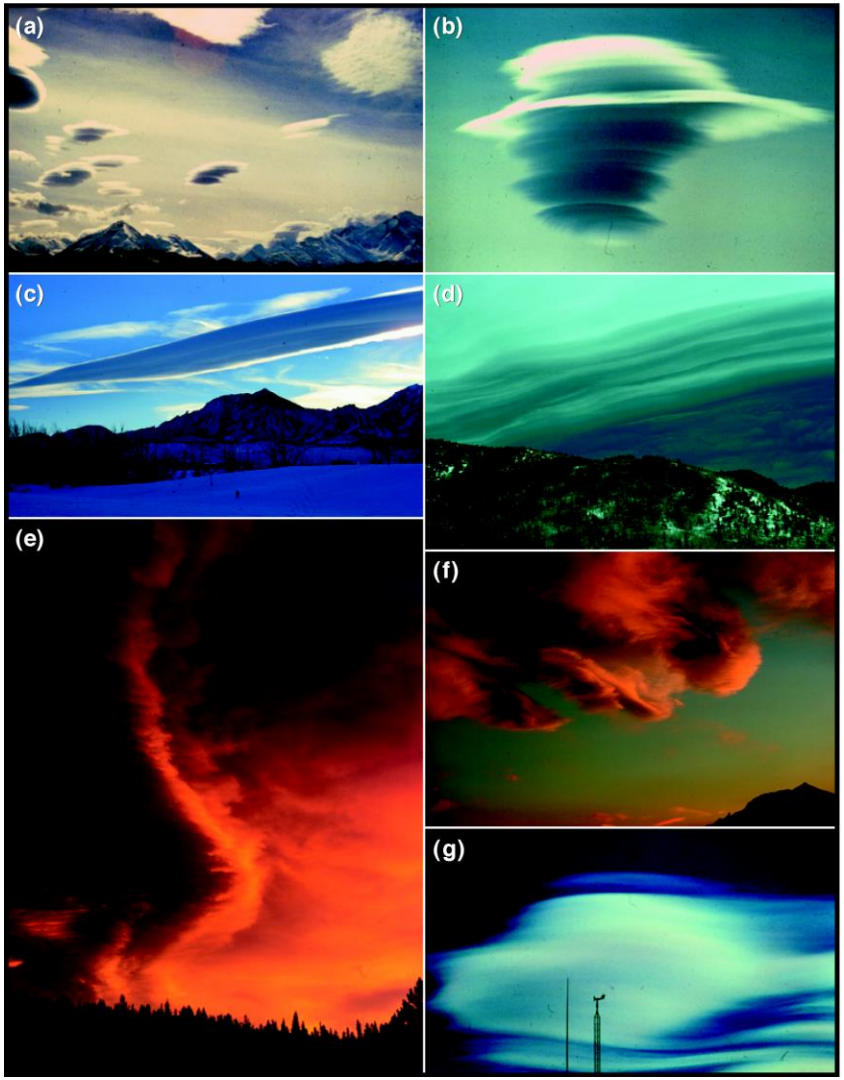

MOUNTAIN WAVE CLOUDS
NC
McIDAS
GOES-8 IMAGER CH. 1 (VIS) -- 17:02 UT 03 JAN 1997 -- UW/SSEC/CIMSS

Lee waves



Lee waves are *gravity waves* produced as stable air is lifted over a mountain. The lifted air cools and becomes denser than the air around it. Under gravity's influence, it sinks again on the lee side to its equilibrium level, overshooting and oscillating about this level.

Lenticular and wave clouds



The presence of lee *waves* is often indicated by lenticular or wave clouds.

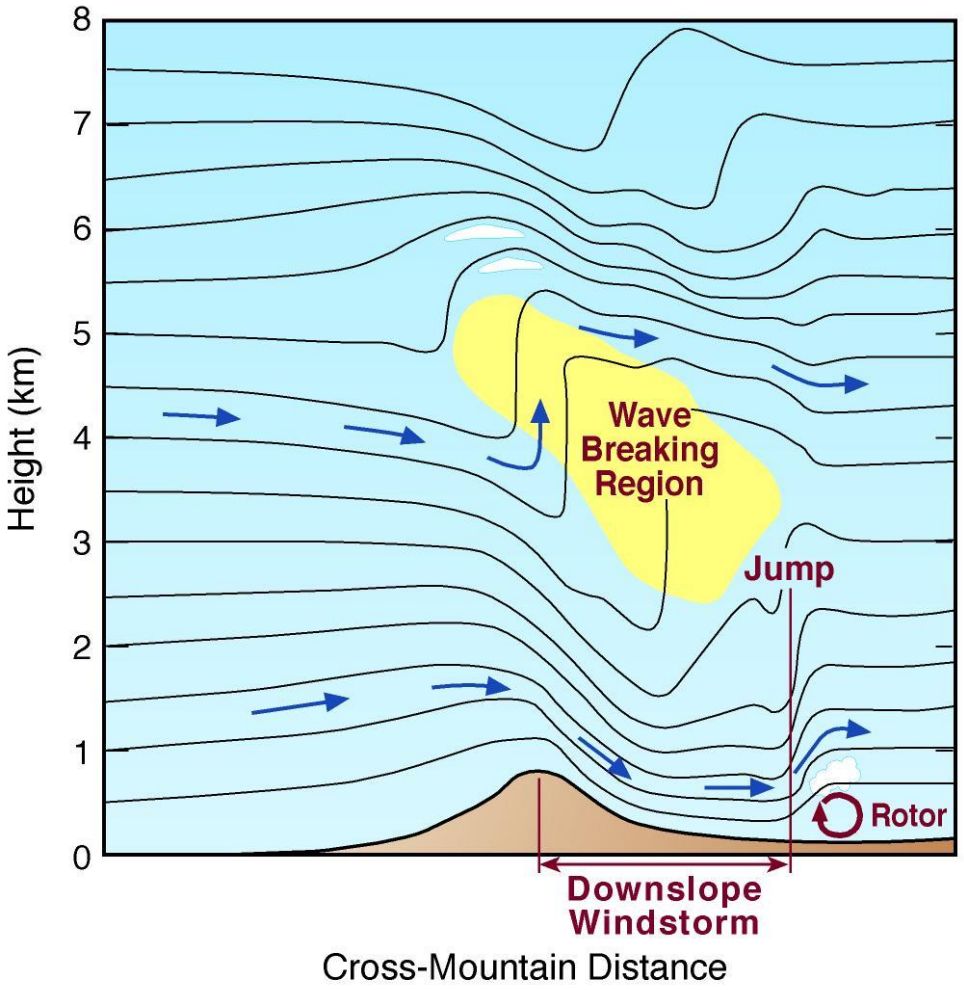
“altocumulus lenticularis”

Terrain-forced flows over mountains

Approaching flows tends to go over mountains if

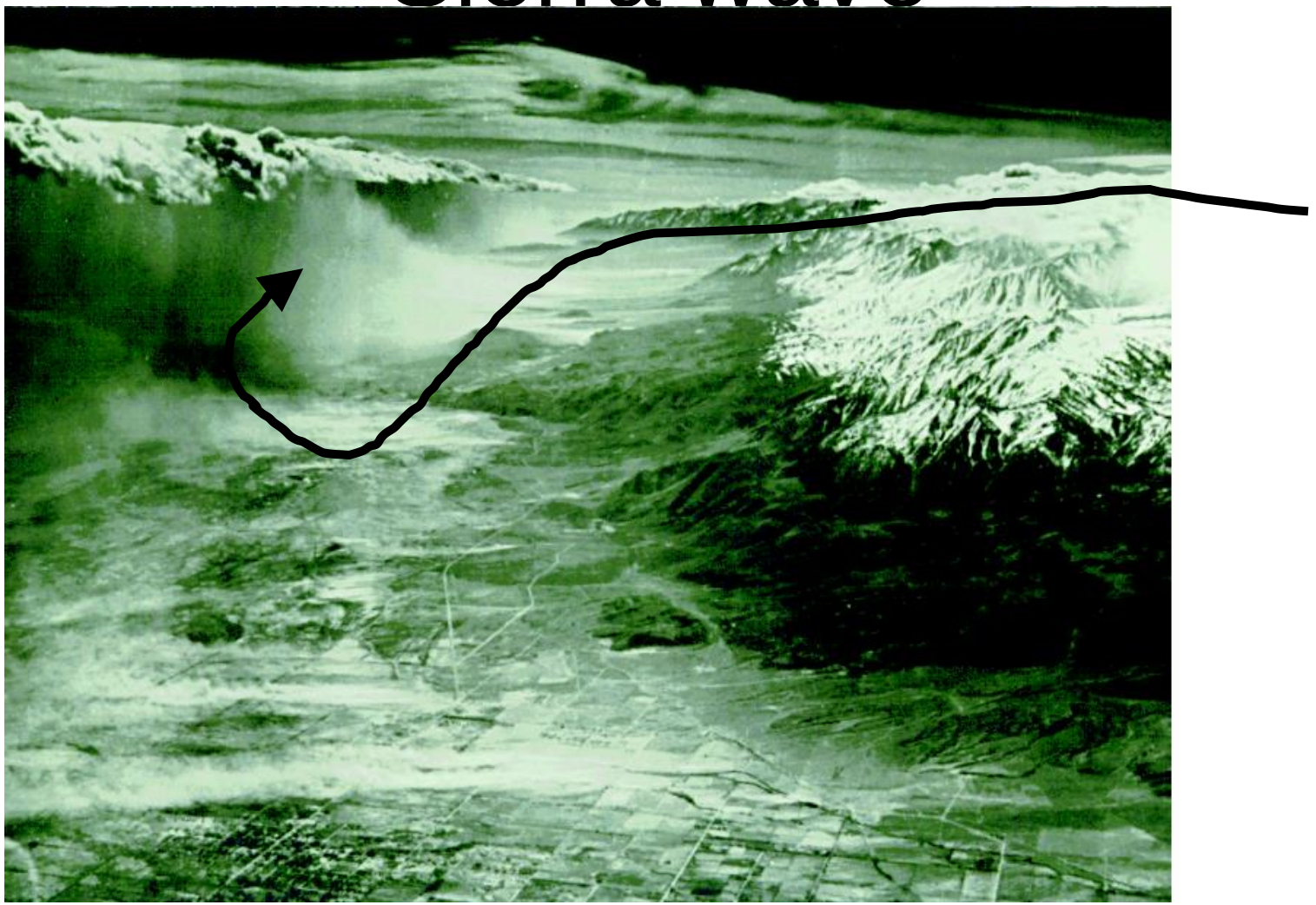
1) barrier is long,
2) cross-barrier wind component is strong, and
3) flow is unstable, neutral or only weakly stable

Hydraulic flow

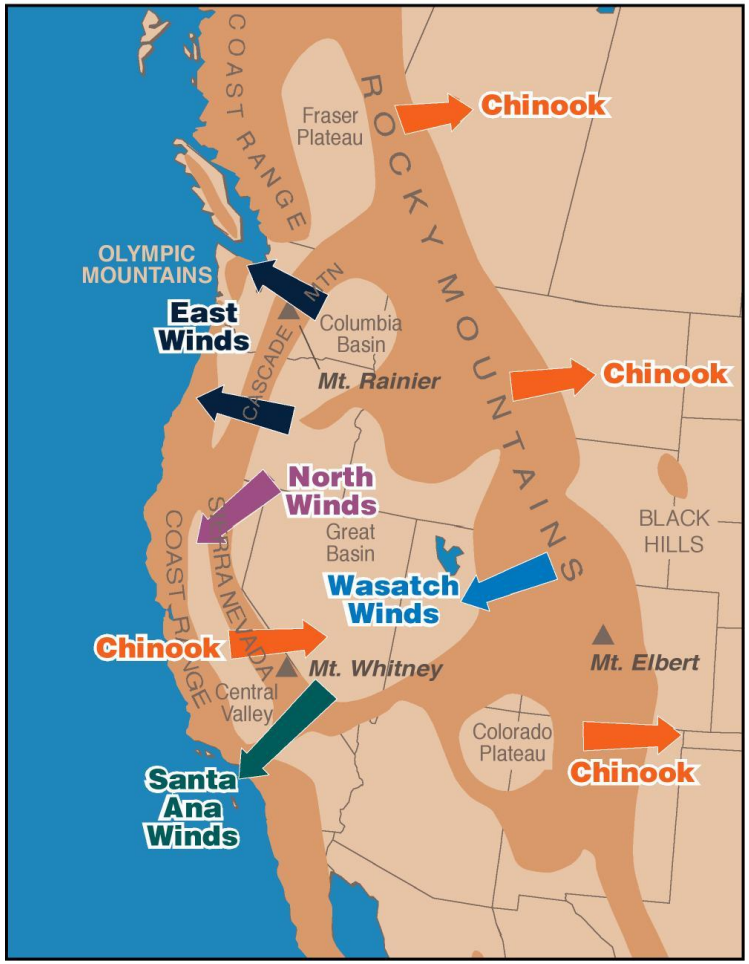


Under certain stability, flow and topography conditions, the entire mountain wave can undergo a sudden transition to a *hydraulic flow* involving a ***hydraulic jump*** and a turbulent ***rotor***. This exposes the lee side of the barrier to sweeping, high speed turbulent winds that can cause forest blowdowns and structural damage.

Sierra wave

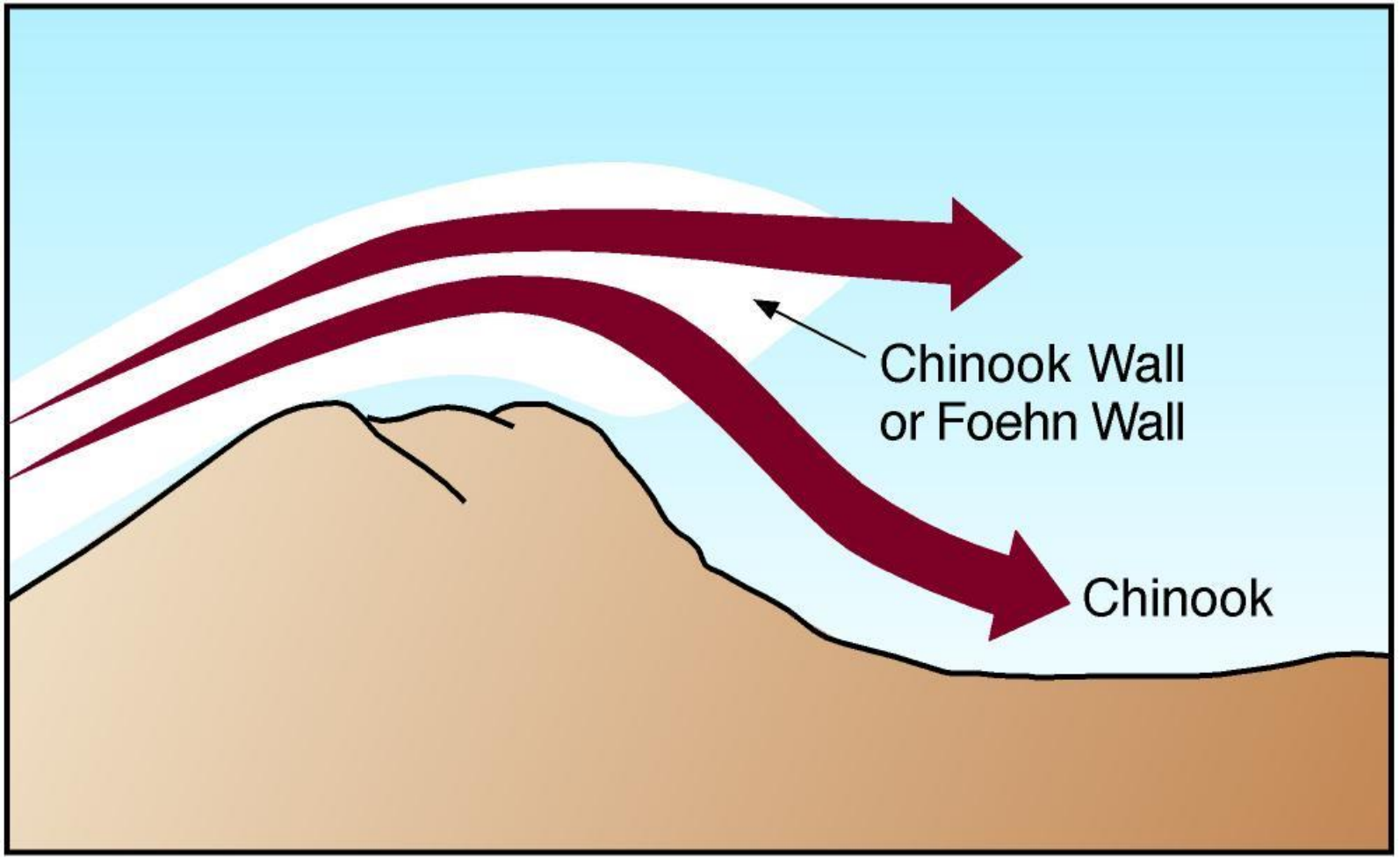


Foehn winds of the intermountain west

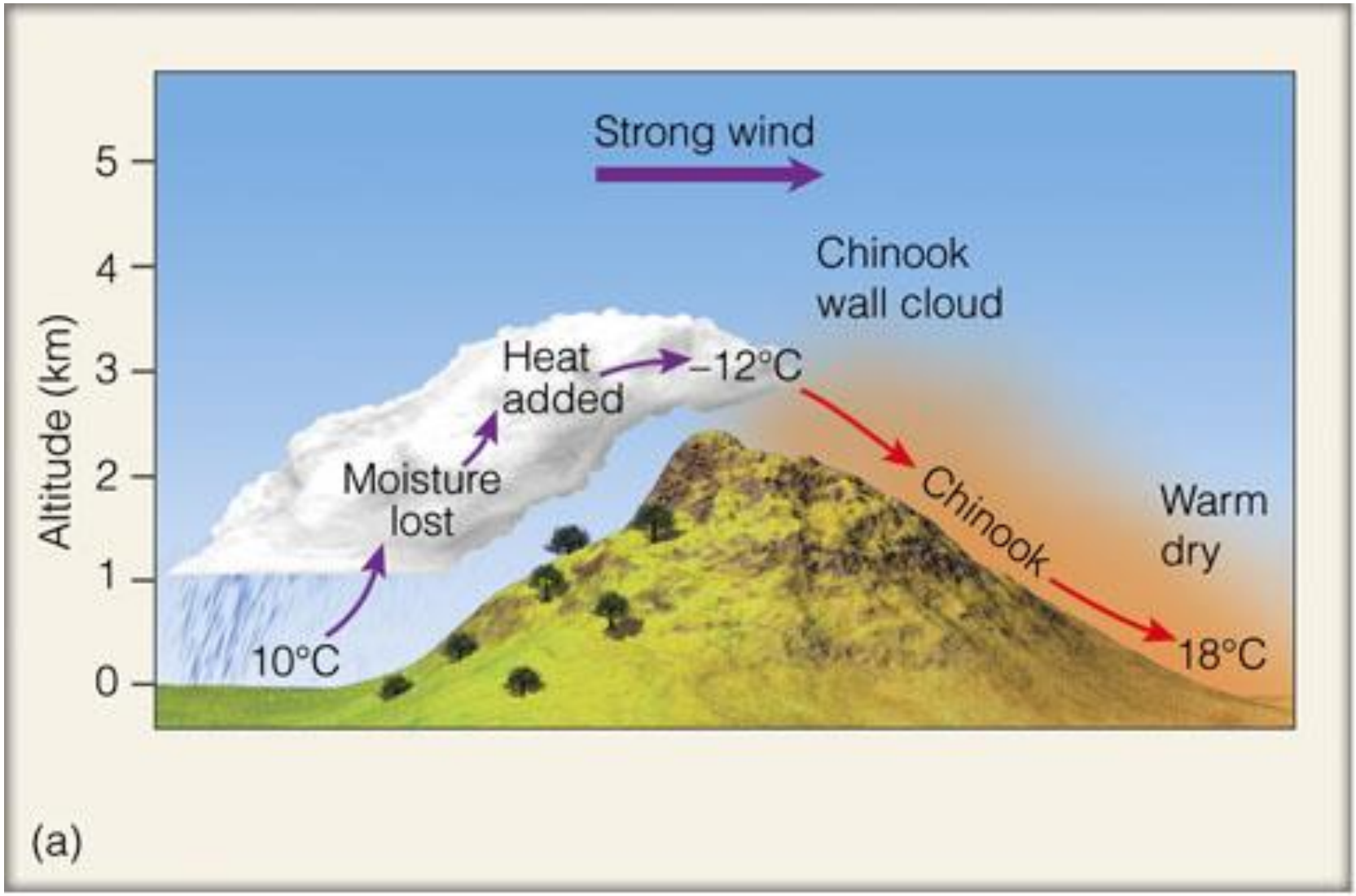


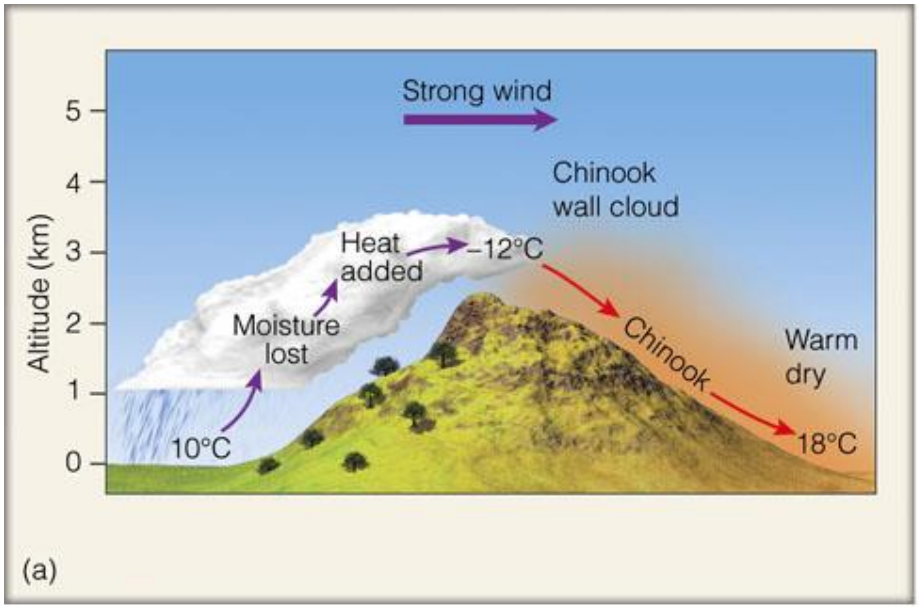
- Form on the lee side of high-relief mountain barriers when a stable air mass is carried across the mountains by strong cross-barrier winds that increase in strength with height.
- Occur primarily in winter
- Are associated with large amplitude lee waves

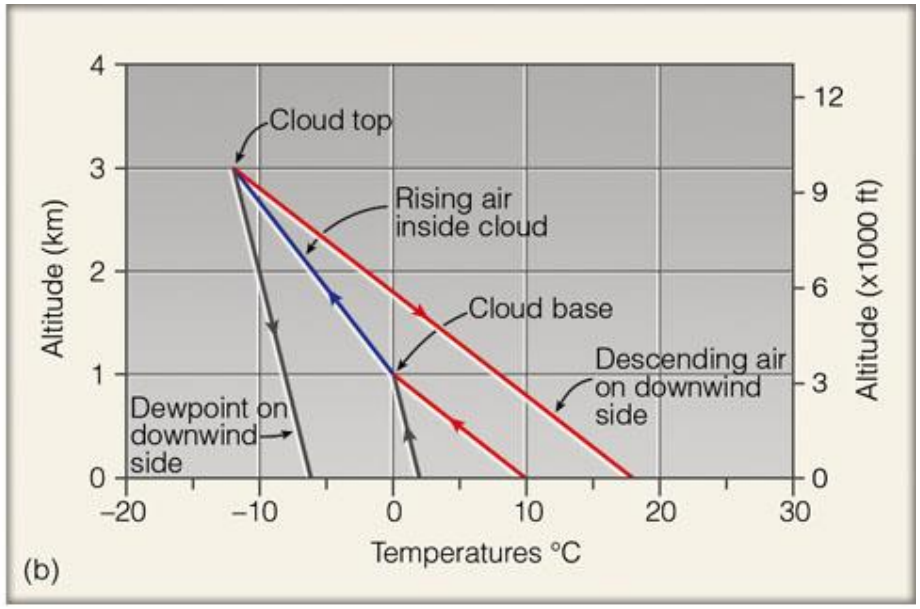
Chinook/Foehn wall

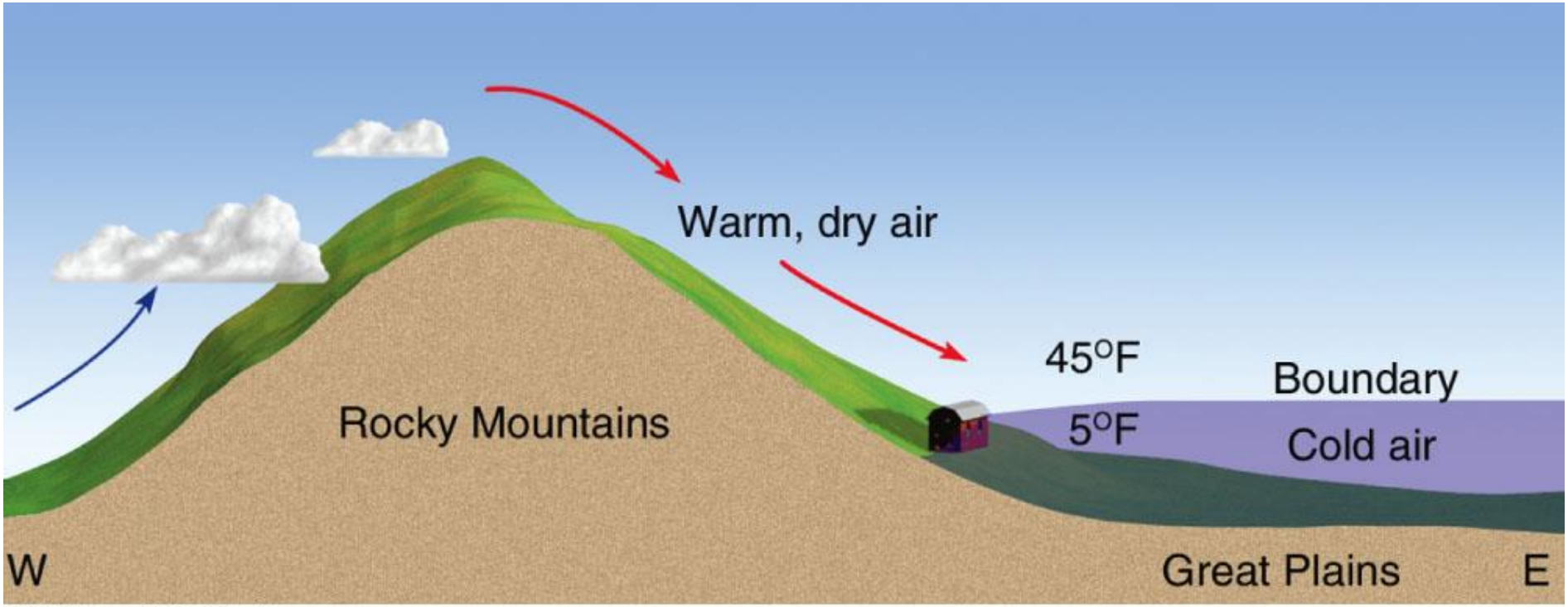


Chinook wall cloud

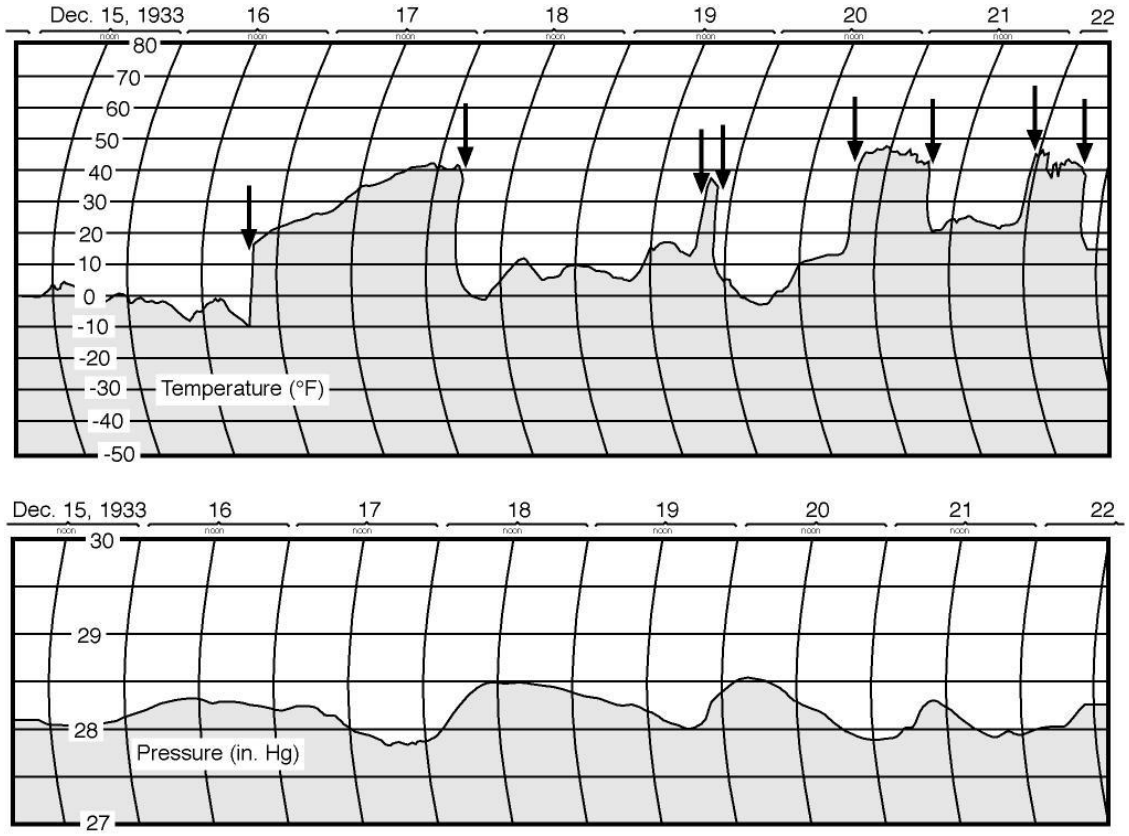








Foehn pauses & rapid temperature and pressure changes (Havre, MT)



Foehn (Chinook) pause: abrupt cessation of downslope winds.

Alternating strong wind break-ins and foehn pauses can cause temperatures to oscillate wildly.

Mountain Meteorology Fall 2017 (EVAT 5320)