Goals for today:

26 Oct., 2011

• continuing Ch 8: “Atmospheric Circulation and Pressure Distributions”

• Examples of synoptic scale and mesoscale circulation systems that are driven by geographic diversity – in topography, temperature, moisture

  • e.g. Chinook wind & lake breeze

• Oceanic general circulation

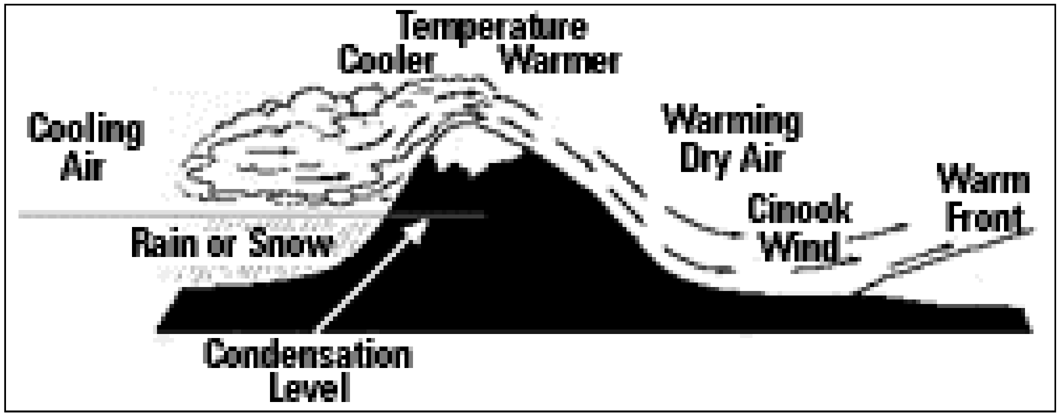
lec19.odp
JDWilson vers 31 Oct. 2011

Foehn/Chinook/etc. – synoptic scale wind down mountain slope

“when winds warmed by compression descend the eastern slopes of the Rocky Mountains in North America, they are called Chinooks” (native-American term meaning “snow-eater”). Condensation of vapour on the windward slopes also contributes to the warmth of the dry, descending lee-side current

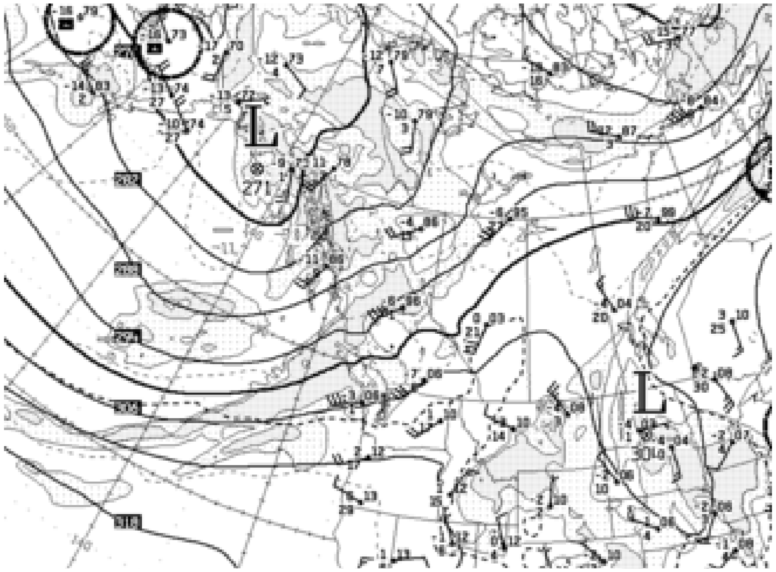
“Low-pressure systems east of the mountains cause these strong winds to descend the eastern slopes… most common in winter when mid-latitude cyclones routinely pass over the region”

Warm lee current may ride above a layer of cold dense air on the lee side… frontal boundary may move back and forth – rapid temperature changes

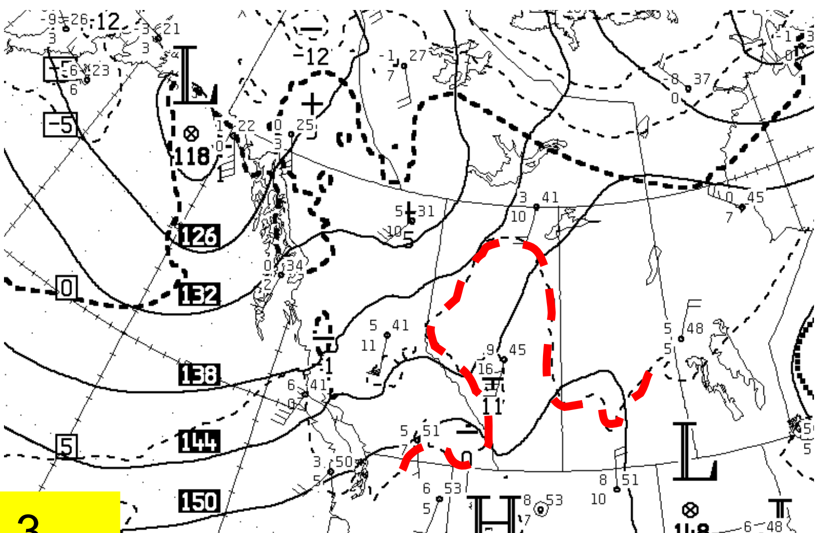


Chinook conditions in Ab. – same as conditions for strong lee trough

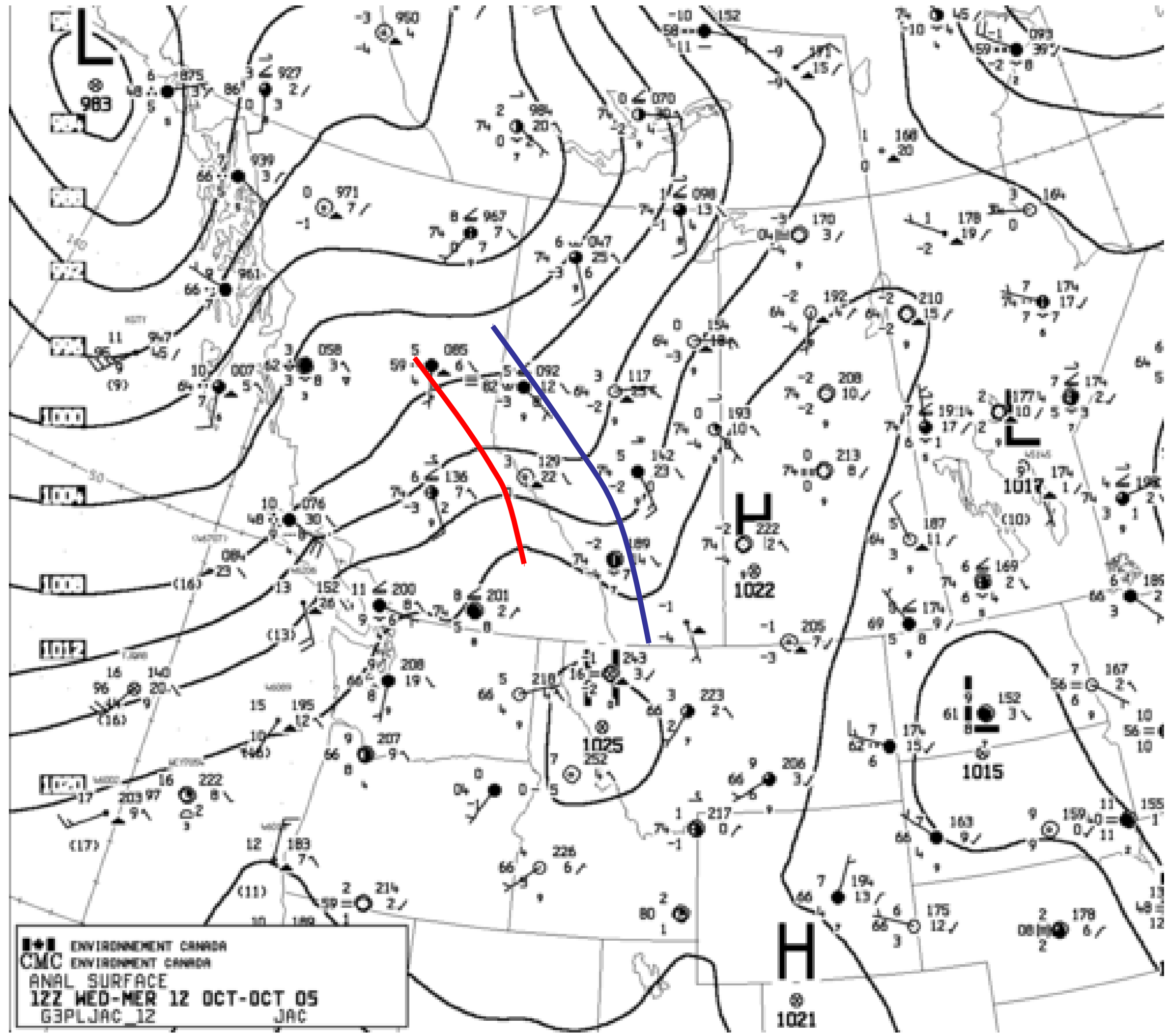
Strong SW 700 mb flow strikes mountains (approx.) perpendicularly



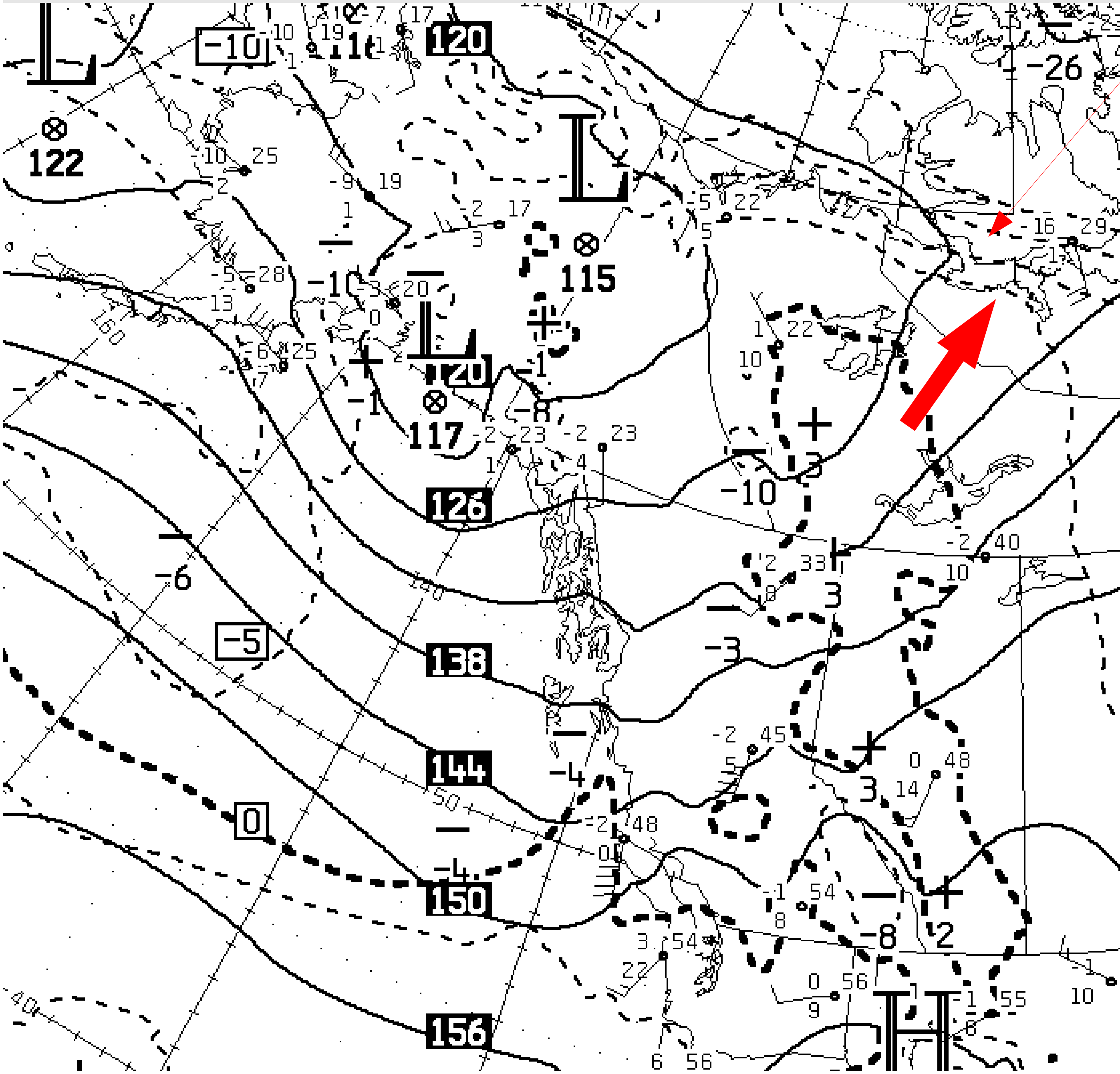
850 mb trowal in lee of Rockies (adiabatic compression)



Surface lee trough of low pressure; tight contours, windy.



We have an example today of the lee trough and associated conditions



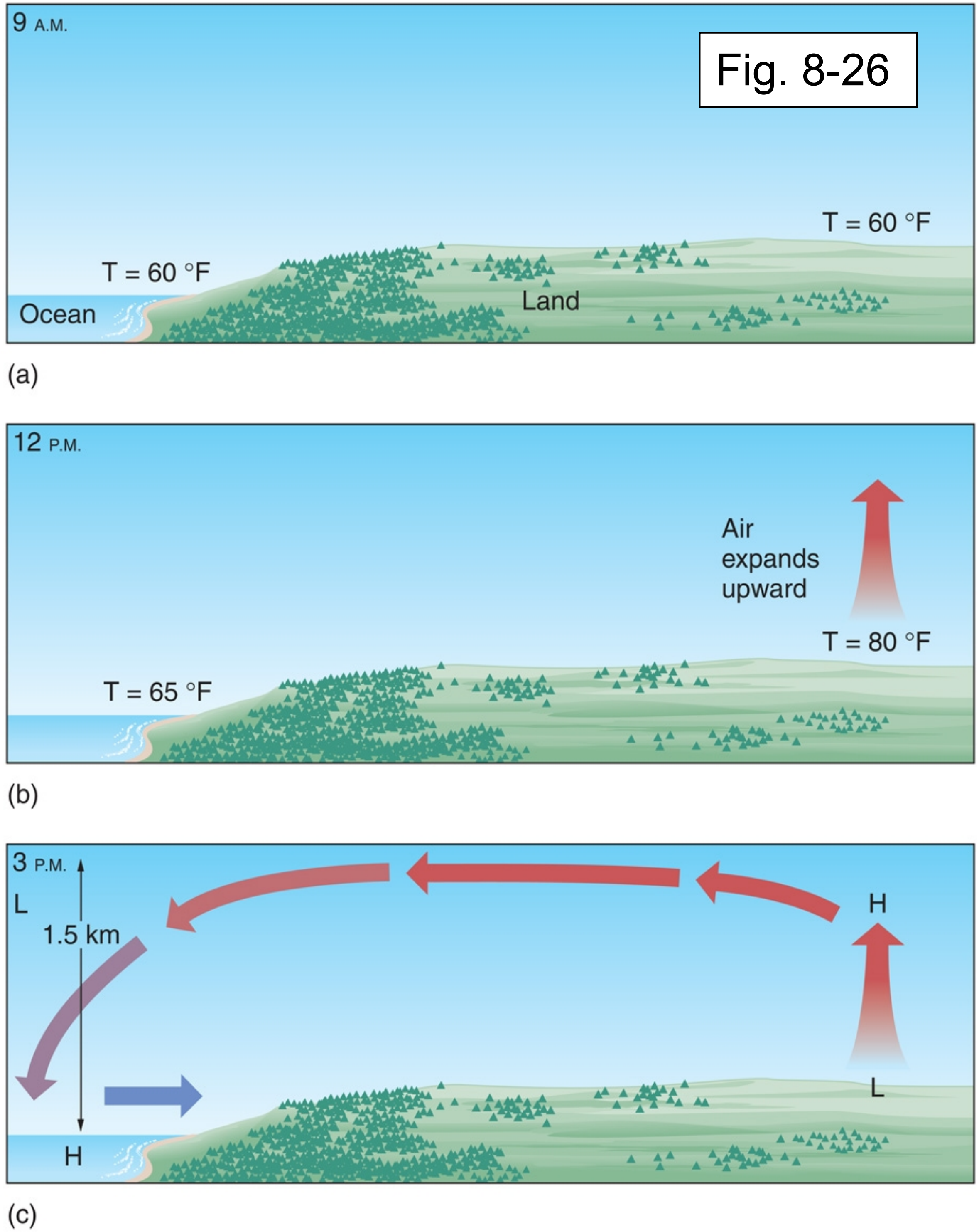
- strong temperature gradient (front)
- SW wind is blowing the cold air back towards the NE and replacing it with warm air
- lee trough downwind of Rockies
- warm air aloft – adiabatic compression on descending the lee side of the Rockies

The Santa Ana wind of S. California is a wind with an easterly component – air sinks as it moves west to the coast (see Fig. 8-22)

MSC 850 hPa analysis, 12Z today (26 Oct. 2011)

Sea breeze/lake breeze

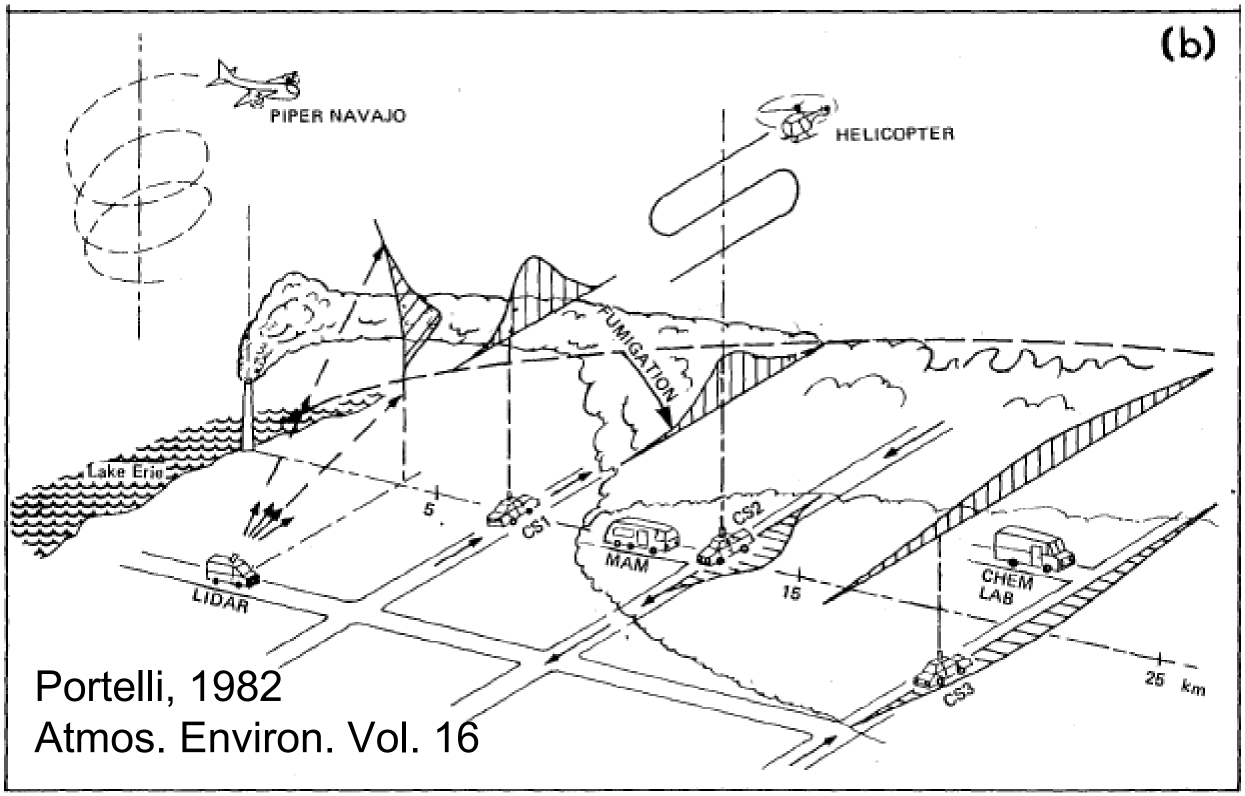
- mesoscale
- caused by differential warming ("thermally driven")
- shallow circulation
- masked (ie. effect over-ridden) by strong synoptic-scale winds
- may reverse at night ("land breeze")



• sea/lake breeze key aspect of climate of many coastal cities

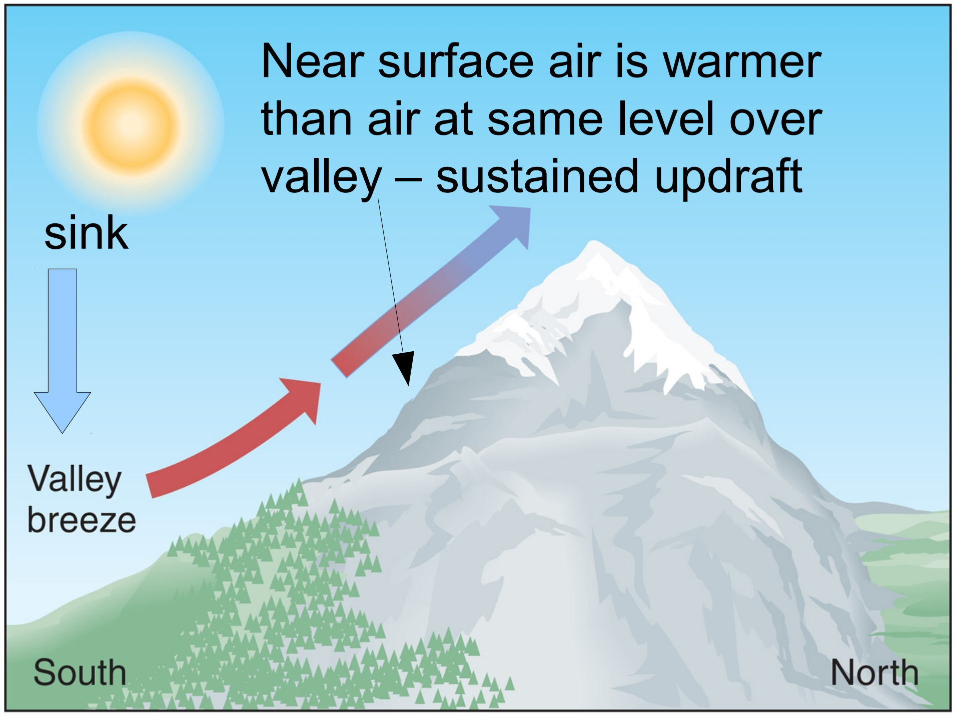
• also affects the air pollution meteorology

• e.g. here stably-stratified onshore wind off Lk. Erie is heated from below, becomes unstable, resulting in “fumigation” – elevated stack plume is mixed down to the surface

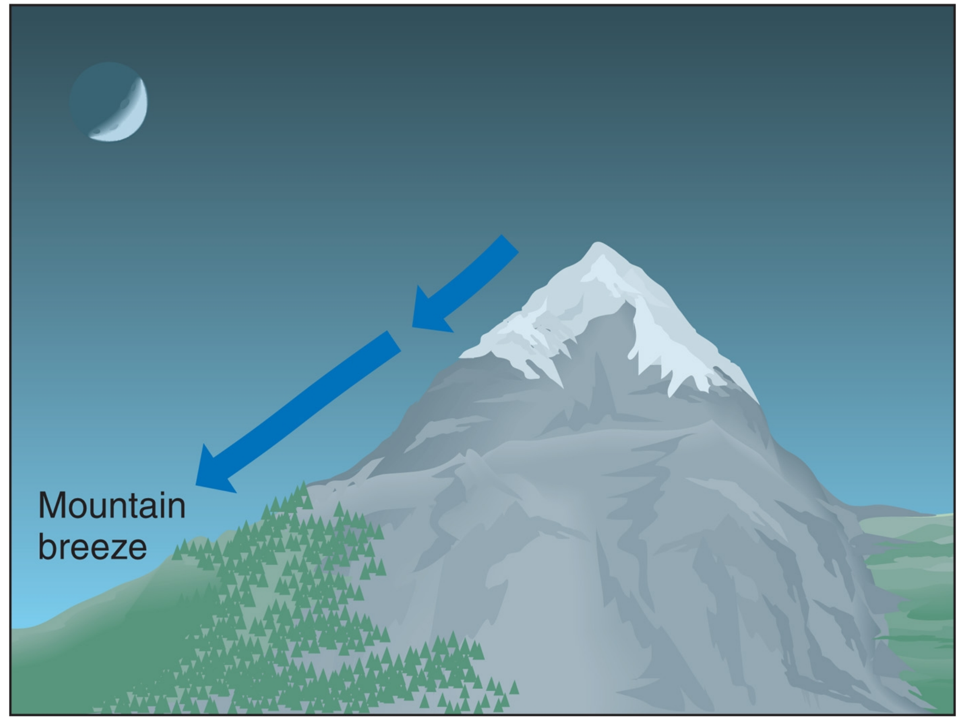


Portelli, 1982
Atmos. Environ. Vol. 16

Slope winds – buoyancy driven



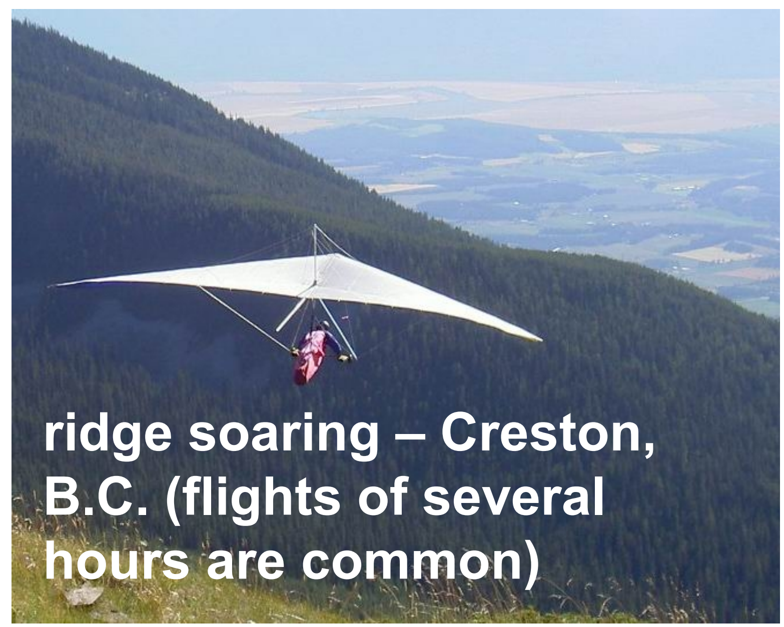
(a)



(b)

Result, commonly, is cloud along ridges and clear skies over valley

During light winds on clear nights minor topographic undulations result in buoyancy-driven "drainage flows" – and cold air will "pond" at the lowest elevations ("frost pockets")



General Circulation of the Oceans

• we saw that the distribution of continents results in an atmospheric general circulation that reflects non-uniformity of surface elevation and energy balance

• the oceanic circulation is even more definitively controlled by continents – coastal (side) boundaries have no analog in the atmosphere

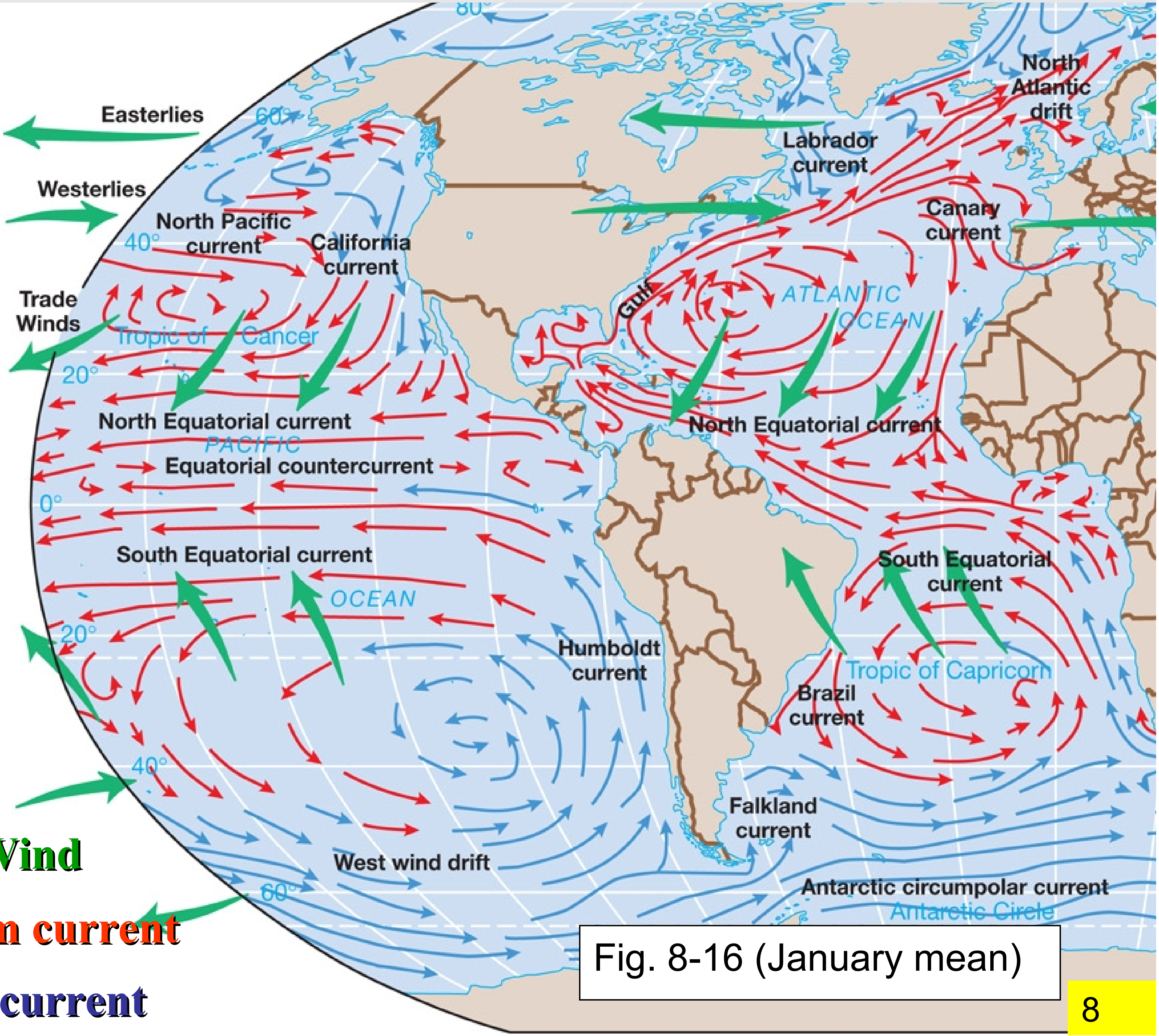
• oceanic currents are also an important mechanism for redistribution of heat – and their spatial distribution plays a role in climate (e.g. maritime versus continental climates) and weather

• oceans and atmosphere are a "coupled system" exchanging heat, water, momentum, carbon dioxide… air-sea interaction

• surface ocean currents are wind-driven; Coriolis force affects their direction; buoyancy (ocean temperature & salinity) also a factor

• like the atmosphere, the ocean has a boundary layer: indeed two – the ocean surface boundary layer and the ocean bottom boundary layer

Direction of sfc currents related to wind drag



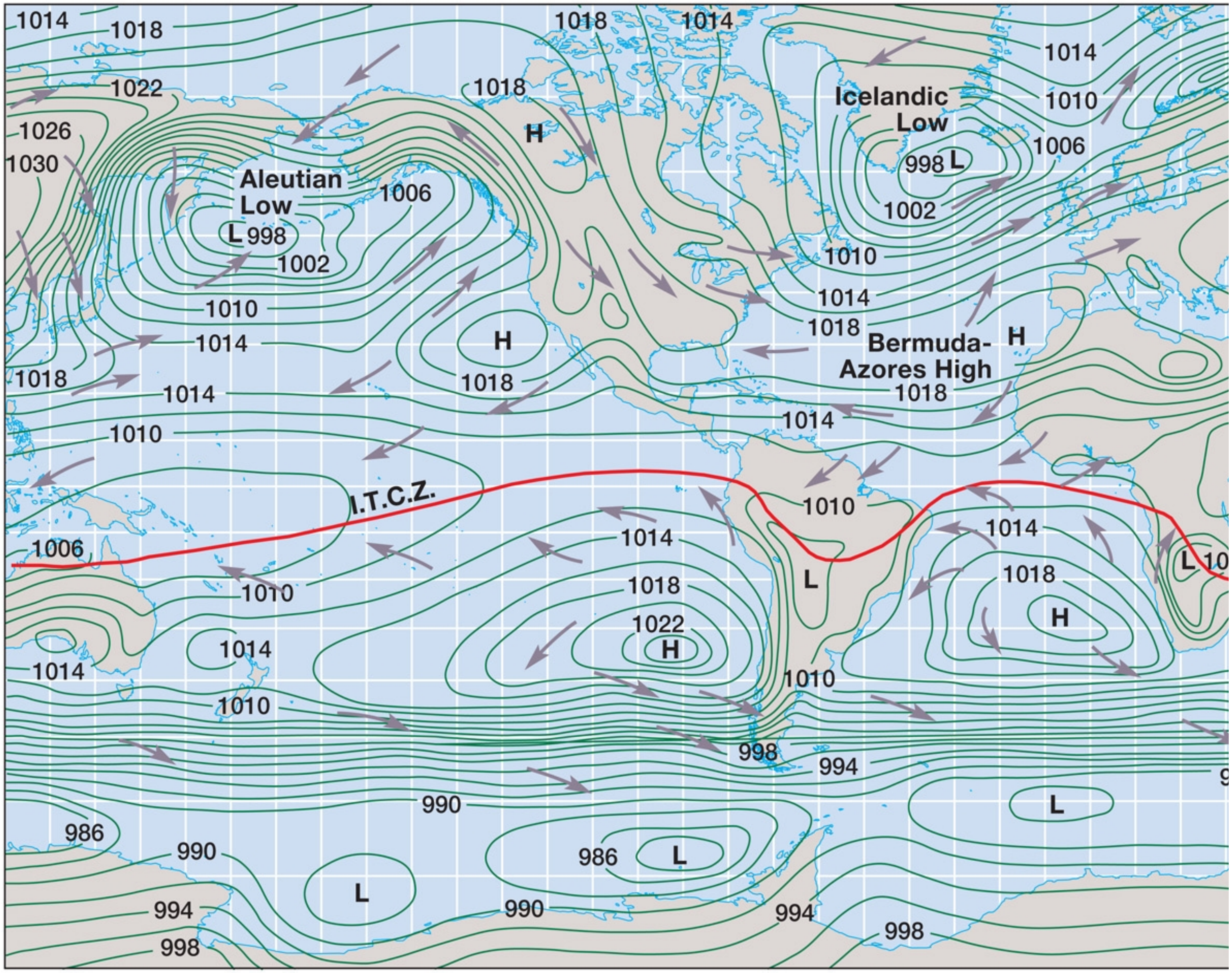
Sfc Wind

Warm current

Cold current

Fig. 8-16 (January mean)

Direction of sfc currents related to wind drag



(a) January

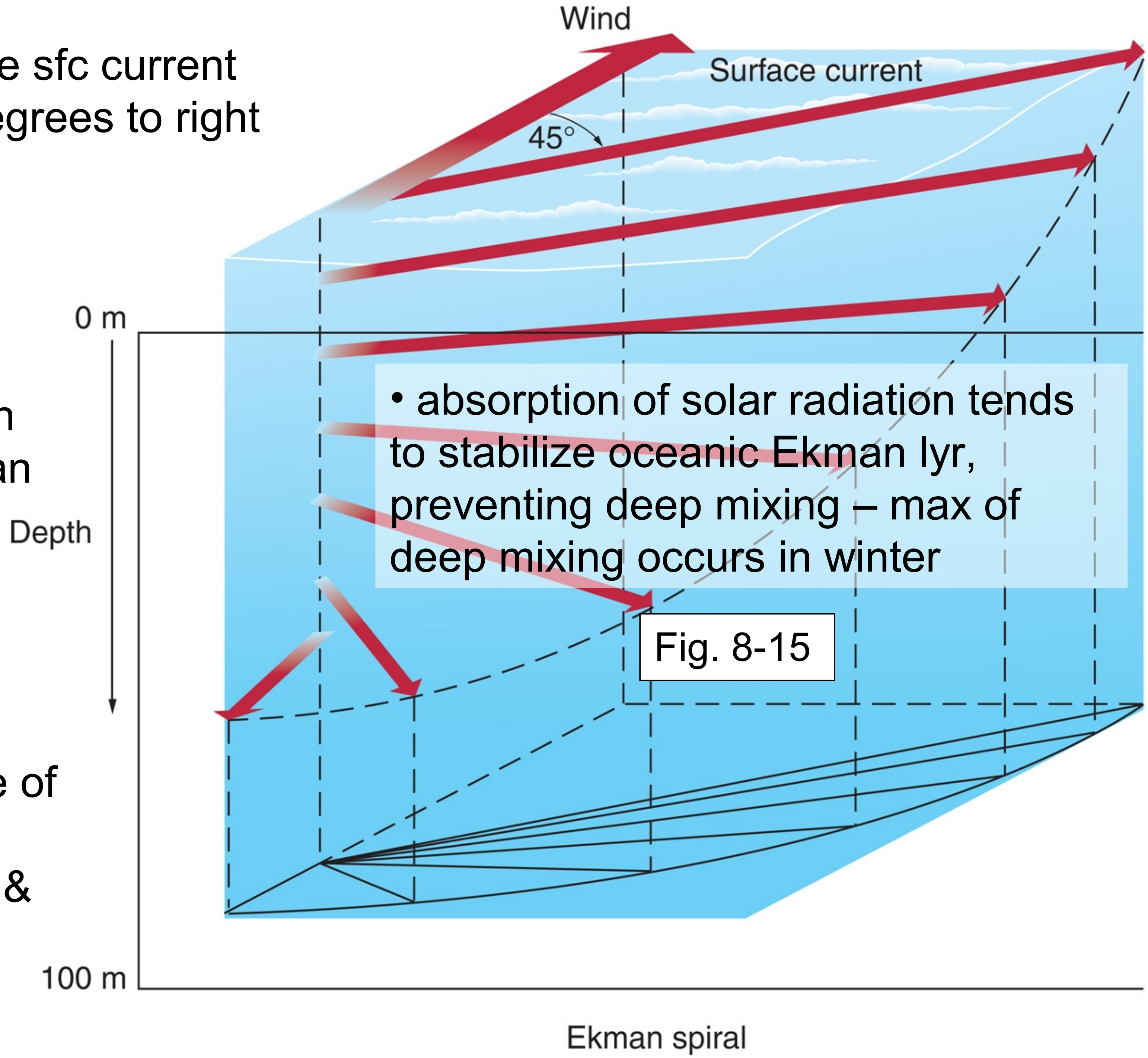
January…. Fig. 8-5a

Direction of sfc currents not identical to wind direction

- in N. hemisphere sfc current flows about 45 degrees to right of sfc wind

- current “spiral” in the oceanic Ekman layer has counterpart in the atmospheric boundary layer

- result of balance of multiple forces, including Coriolis & turbulent friction



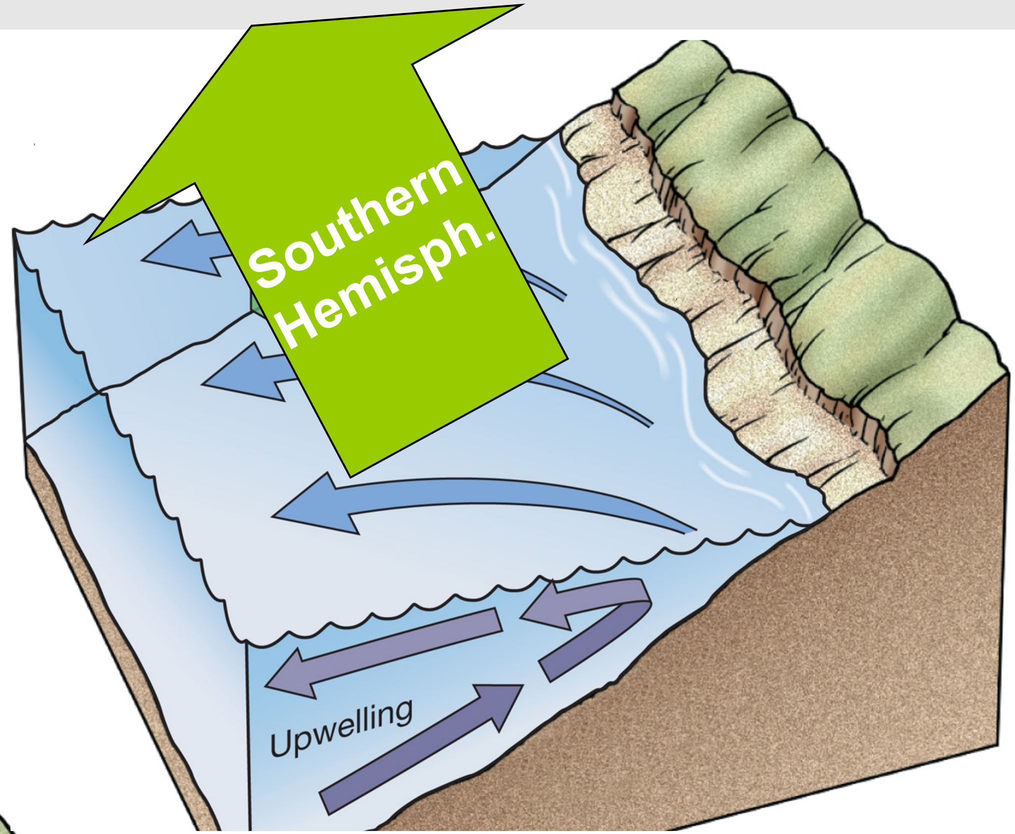
- absorption of solar radiation tends to stabilize oceanic Ekman lyr, preventing deep mixing – max of deep mixing occurs in winter

Fig. 8-15

… resulting in Coastal Upwelling

- wind parallel to coast induces surface current away from coast, colder water upwells**

- offshore winds produce same effect



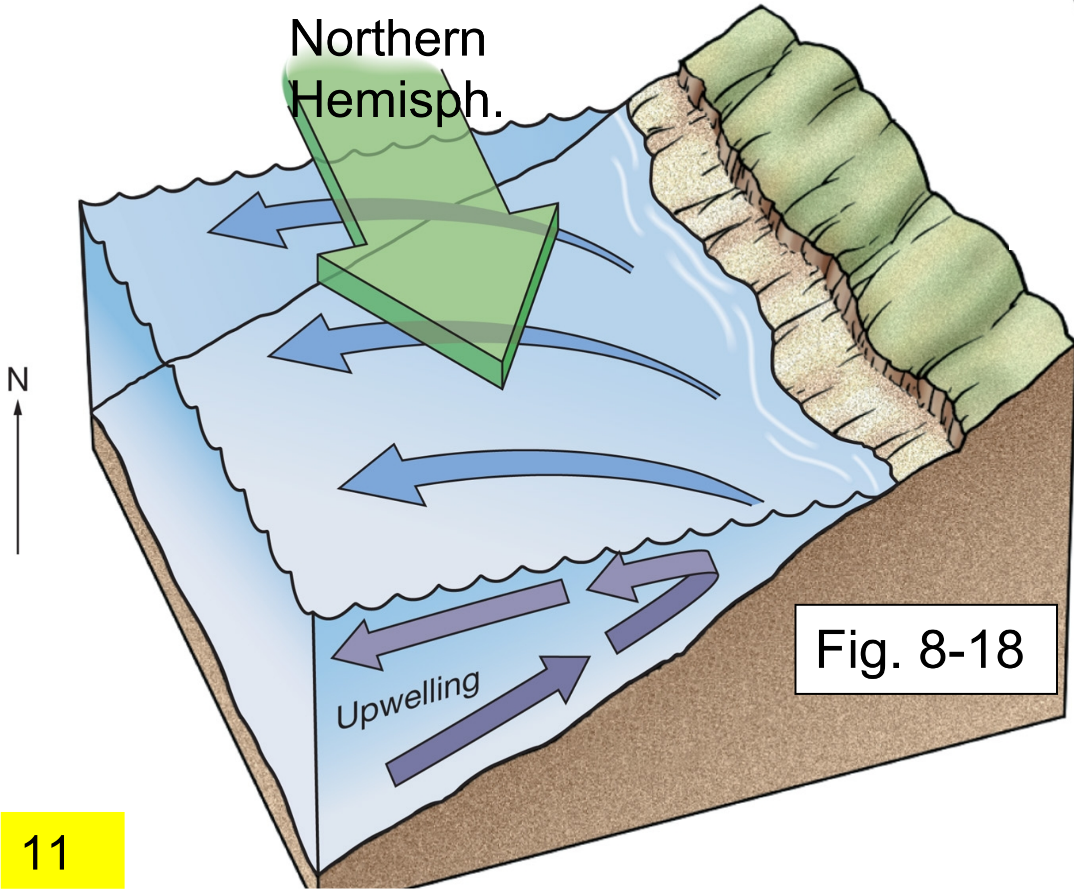


Fig. 8-18

** generally the ocean surface boundary layer is not very well mixed – because absorption of sunlight near the surface results in it's being stably stratified (except at high latitudes in winter)

El Nino/ La Nina

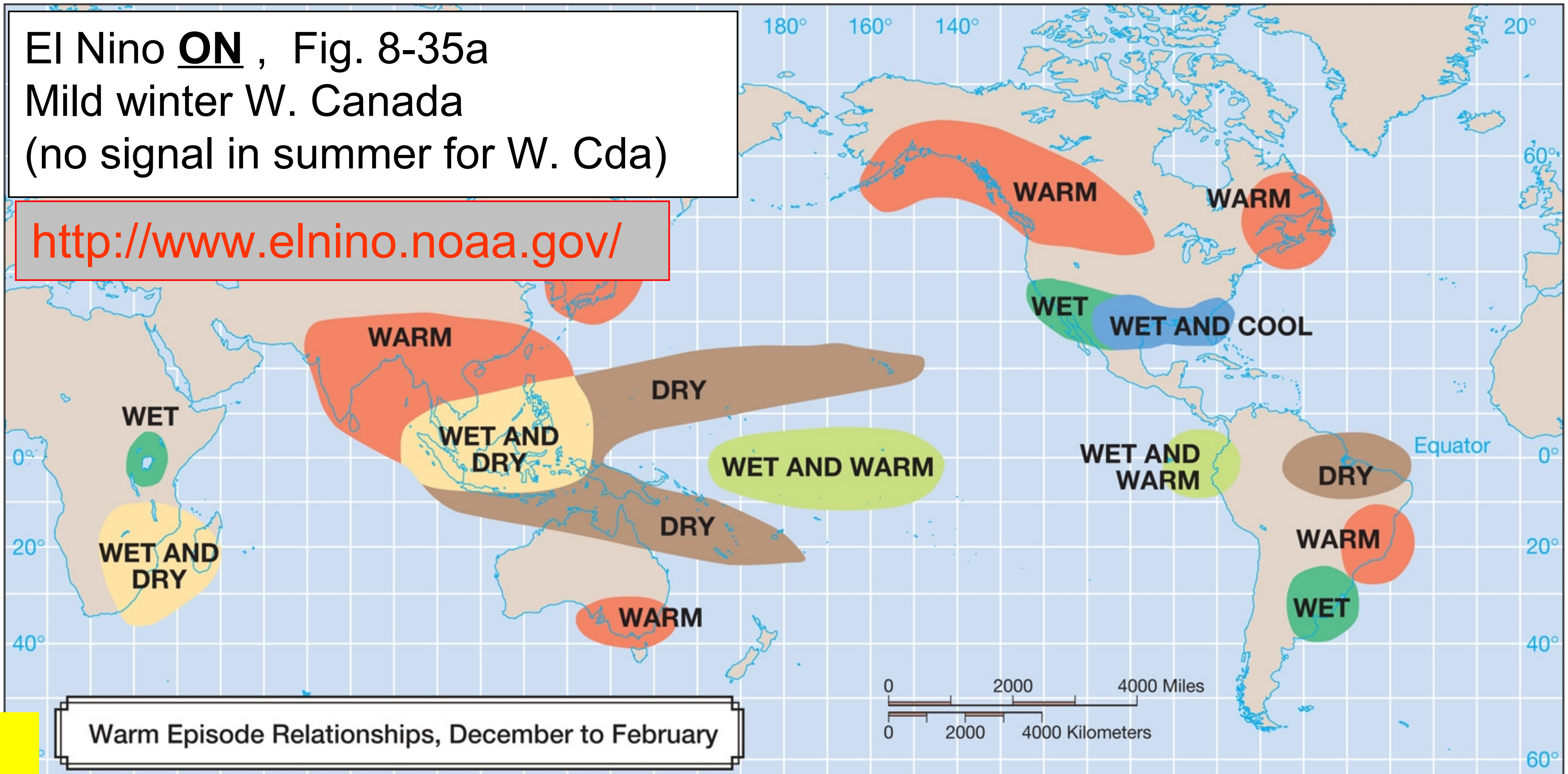
So potentially can be forecast by coupled oc/atmos prediction model

- An *internally-generated* disruption or instability of the ocean-atmos. system in the tropical Pacific having important consequences for weather around the globe and giving some basis for long range weather forecasting (though presently with low skill) – not externally forced**

**non-periodic, average interval between El Nino's is 40 months

El Nino **ON** , Fig. 8-35a
Mild winter W. Canada
(no signal in summer for W. Cda)

http://www.elnino.noaa.gov/

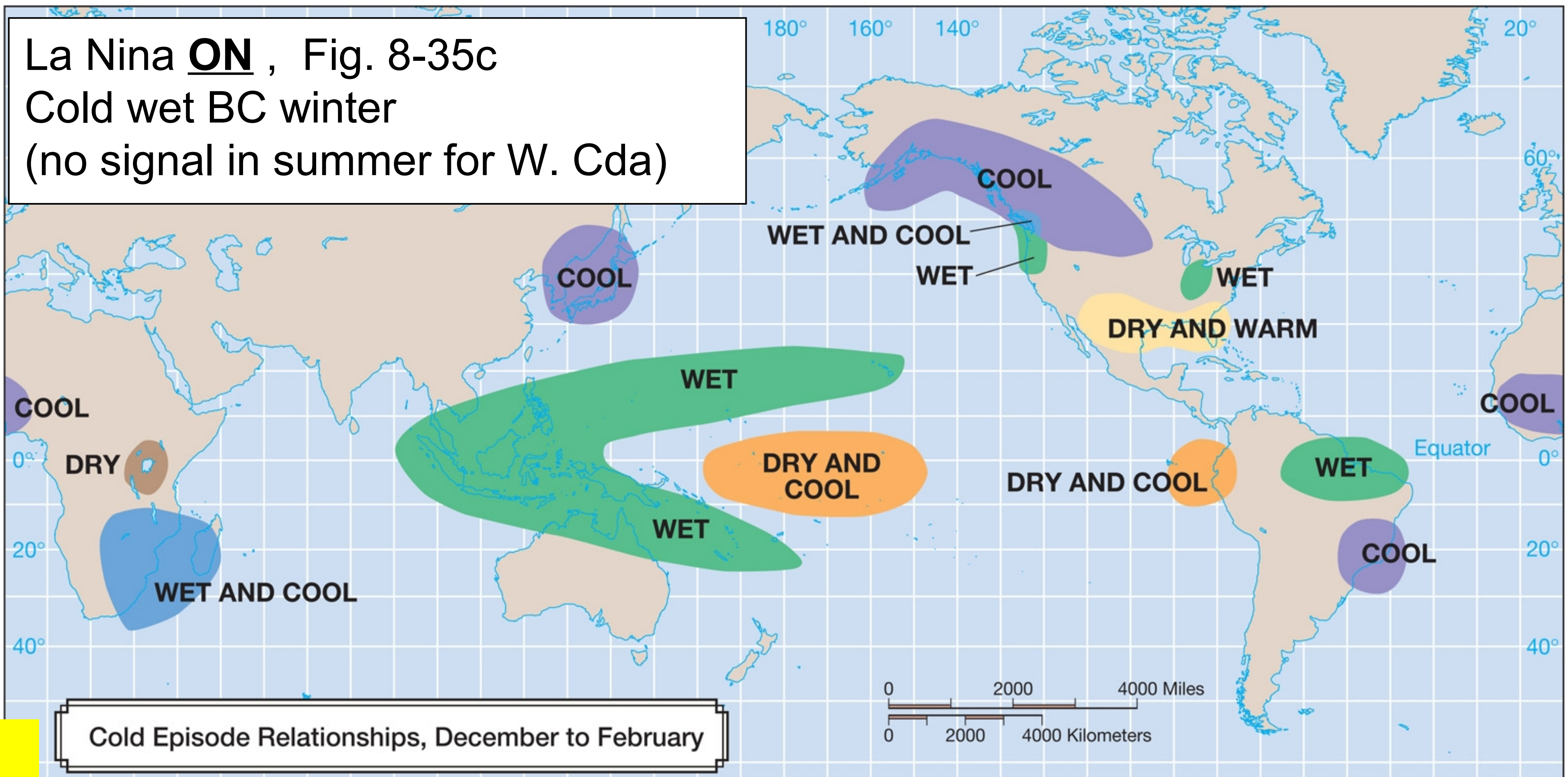


Warm Episode Relationships, December to February

El Nino/ La Nina

- An *internally-generated* disruption or instability of the ocean-atmos. system in the tropical Pacific having important consequences for weather around the globe and giving some basis for long range weather forecasting (though presently with low skill) – not externally forced

La Nina **ON** , Fig. 8-35c
Cold wet BC winter
(no signal in summer for W. Cda)



Cold Episode Relationships, December to February

El Nino/ La Nina

- An *internally-generated* disruption or instability of the ocean-atmos. system in the tropical Pacific having important consequences for weather around the globe and giving some basis for long range weather forecasting (though presently with low skill) – not externally forced

- Is connected with the Southern-Oscillation, a reversing anomaly in sea-level E-W pressure gradient across equatorial Pacific… El/La Niña opposite phases of the El Niño-Southern Oscillation (ENSO)

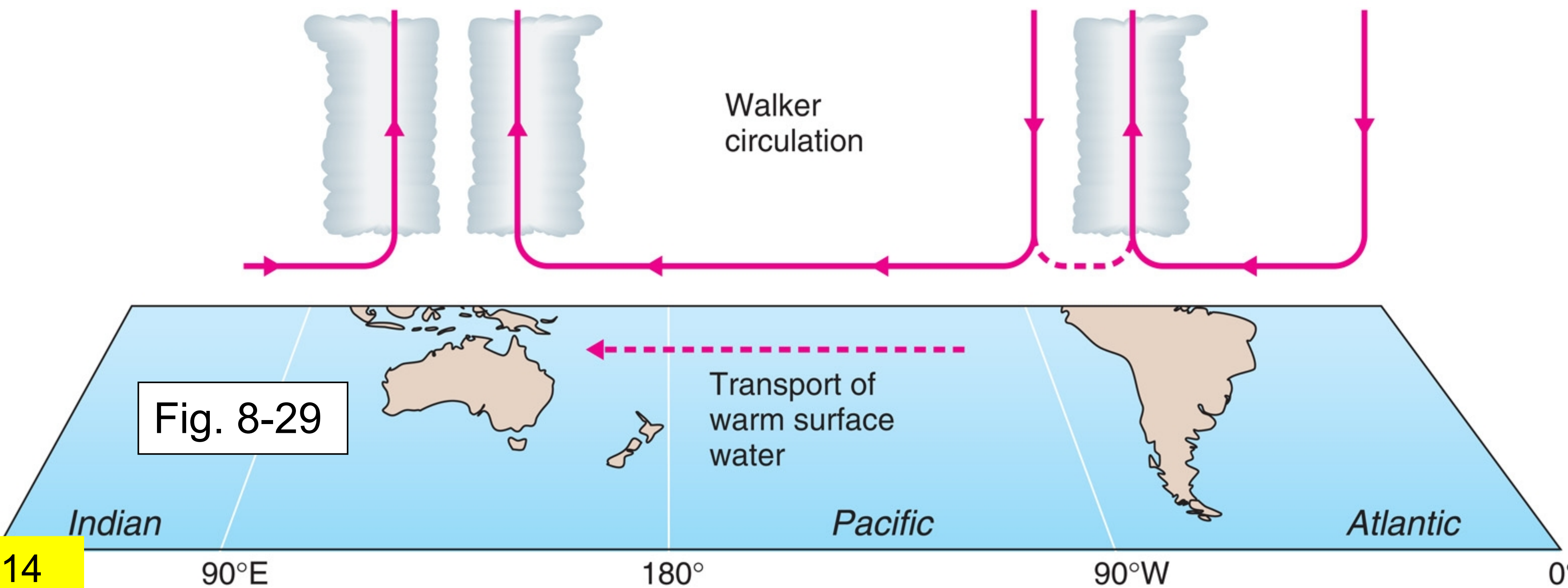


Fig. 8-29

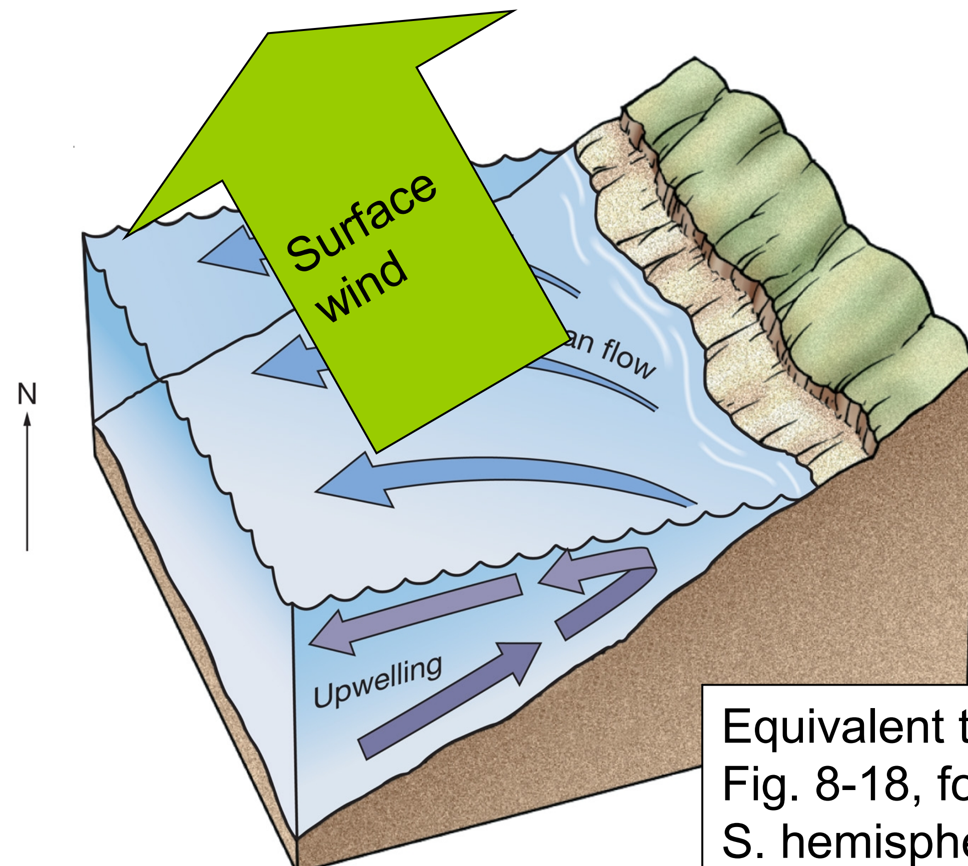
Normal conditions

• easterly Pacific tradewinds pile up warm surface water in the west Pacific - so that sea surface is about 1/2 meter higher at Indonesia than at Ecuador. A weak surface ocean counter-current then develops

• sea surface temperature is about 8°C higher in the west, with cool temperatures off South America, due to an upwelling of cold (nutrient-rich) water from deeper levels

- strong convection/rain over the warmest water, and the east Pacific is relatively dry

- strong equatorward-flowing coastal current ("Humboldt" or "Peruvian") sustains the upwelling cold deep-water



Equivalent to Fig. 8-18, for S. hemisphere