Topic 16: Winds and Weather

https://geowiki.ucsd.edu/sio15

Weekly test #5 (Mon 11/4)
will include homework 3!
Questions on geowiki under 'tests' tab

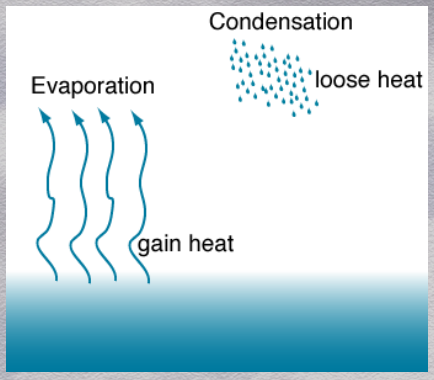
short video 12b

beachwalk signup closes at 5 pm
Sat 11/2 noon PDT
Sun 11/3 noon PST

watch beachwalk prep video!

Review Lecture 2: Latent Heat "hidden heat"

it takes 600 cal to evaporate 1g water



evaporation:
water vapor absorbs heat

condensation:
water vapor releases heat

Moist and Dry Air

absolute humidity:	actual water vapor content; e.g. by volume; 0.3% deserts/ 4% tropics
relative humidity:	water vapor content with respect to maximum that air can hold under current conditions (saturated)
dew point:	T to which air with current rel. hum. has to cool to become saturated
condensation:	air cools below dew point -> fog/clouds/frost

The January 2007 Big Freeze

- unusually (unexpected???) dry air (low rel. humidity)
- low dew point

-> temperature could drop below freezing
==> $1 Billion damage to CA citrus industry

Fig. 11.13

CA farmers did NOT have time to do this to protect citrus

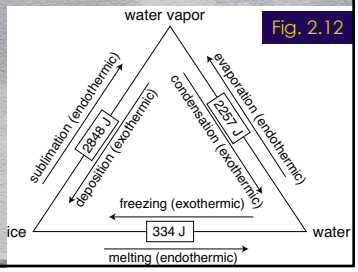
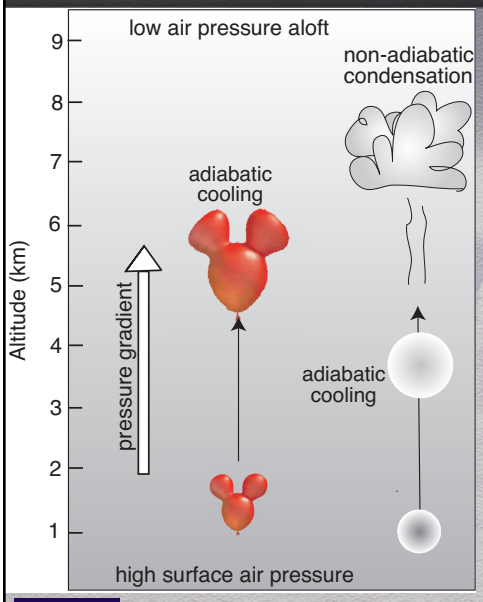


Fig. 2.12

Lecture 2:
condensation releases latent heat
freezing releases latent heat

Vertical Air Flow - Adiabatic Cooling



adiabatic: air moves to different pressure without adding or losing heat

Example: Air Column

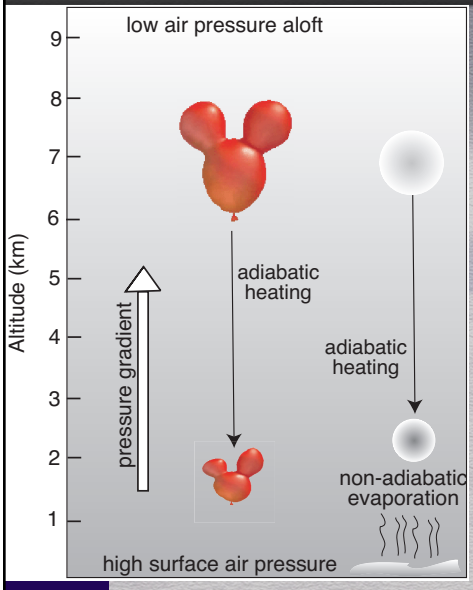
rising air:
from high surface P to low P aloft,
expands, cools

END:
condensation: release of latent heat

Fig. 12.4a

P: air pressure

Vertical Air Flow - Adiabatic Heating



sinking air:
from low P aloft to high surface P,
contracts, warms

END:
evaporation: absorption of l. heat

jet cabin pressure
~ 2000 m
-> bottle compressed upon landing at sea level

Fig. 12.4b

Adiabatic Changes: T and Relative Humidity of Air

warm/cold air:

with current water vapor, rel. humidity increases with decreasing T

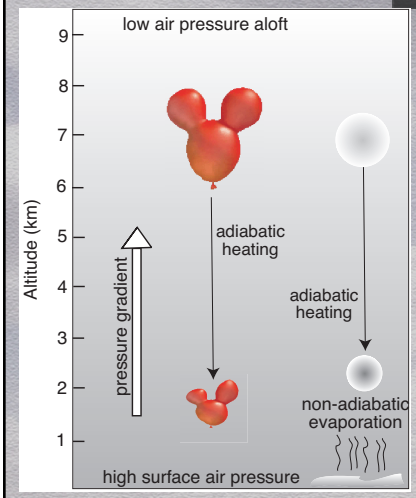


Fig. 12.4b

rising air (adiabatic cooling)

likely to lose moisture;

sinking air (adiabatic heating)

likely to absorb moisture;

condensation and evaporation are no longer adiabatic!

Vertical Air Flow - High and Low Surface Pressure

rising air
-> L at surface

sinking air
-> H at surface

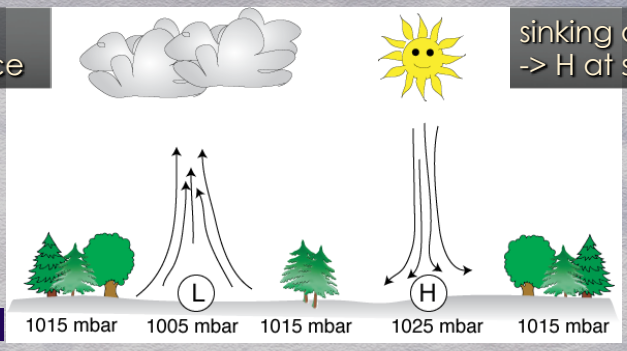


Fig. 12.5

- air rises in a low pressure system (clouds)
- air sinks in a high pressure system (fair)

On- and Offshore Flow at SIO Pier

wind direction: where the winds comes from

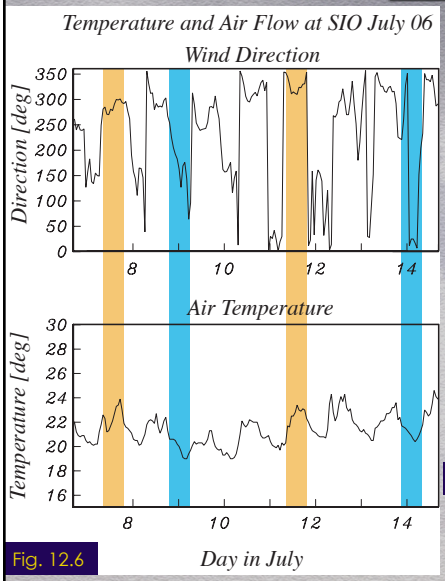


Fig. 12.6

on-shore flow in afternoon, when land T is high (low pressure on land)

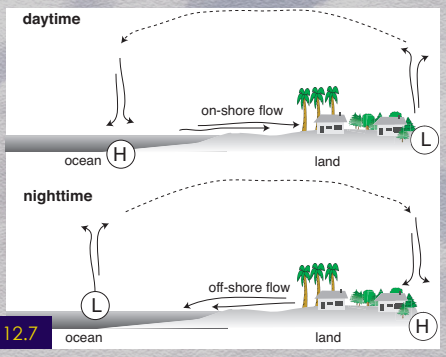
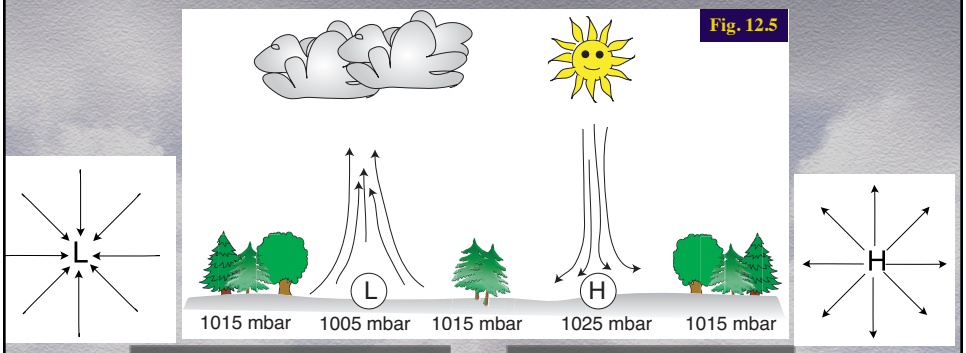


Fig. 12.7

off-shore flow at night/morning, when land T is low (low pressure at sea)

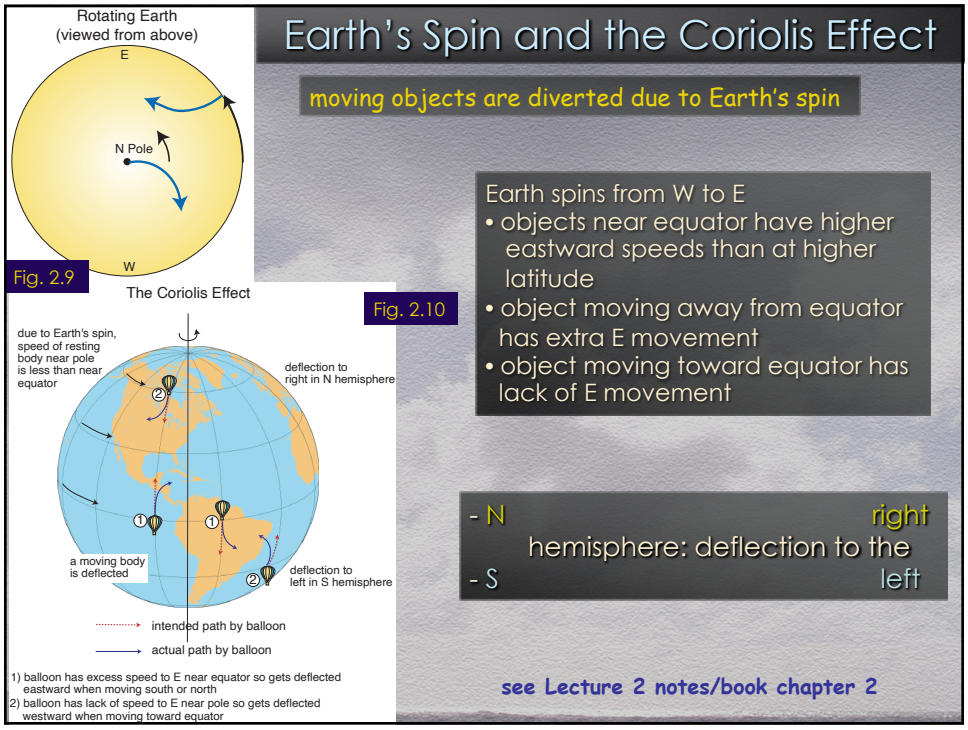
Vertical Air Flow - High and Low Surface Pressure

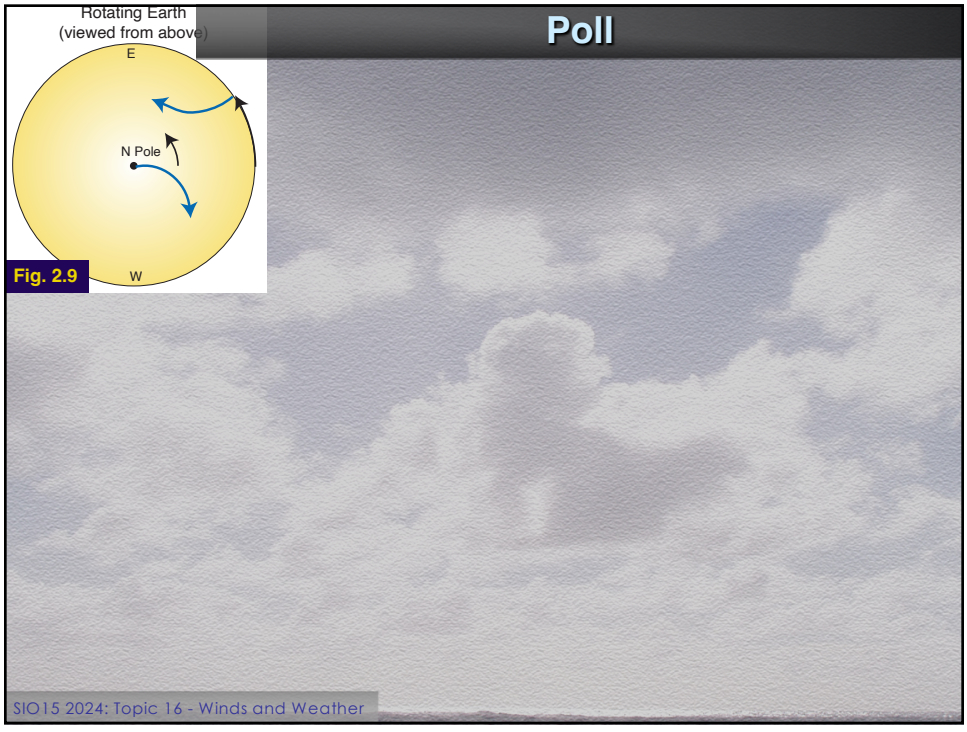


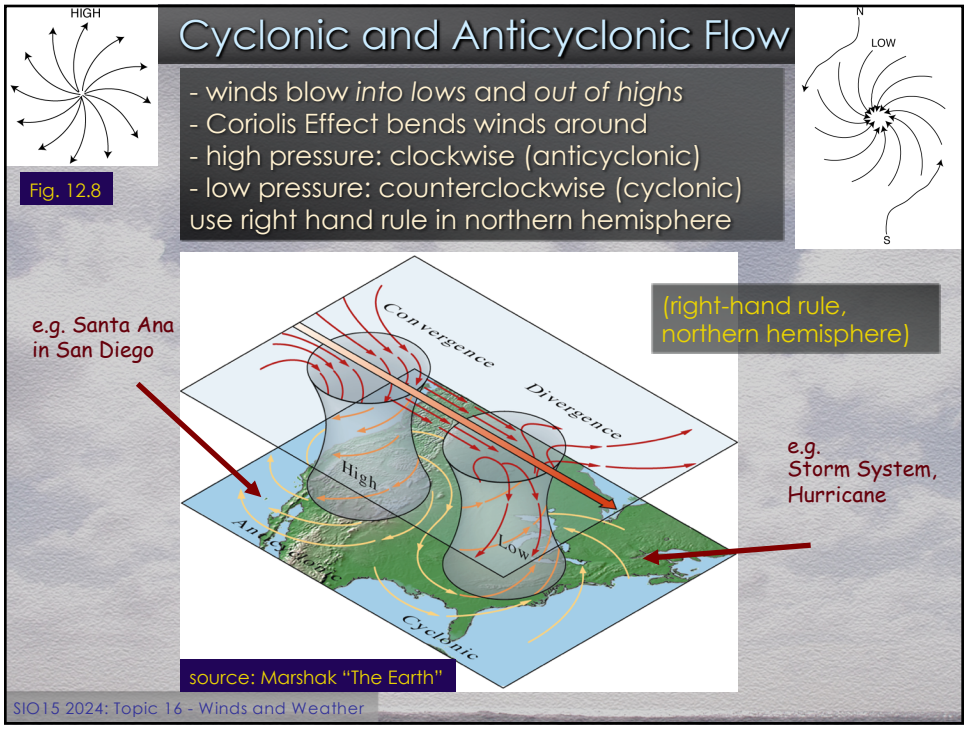
L
- air rises
- surface air moves TOWARD L

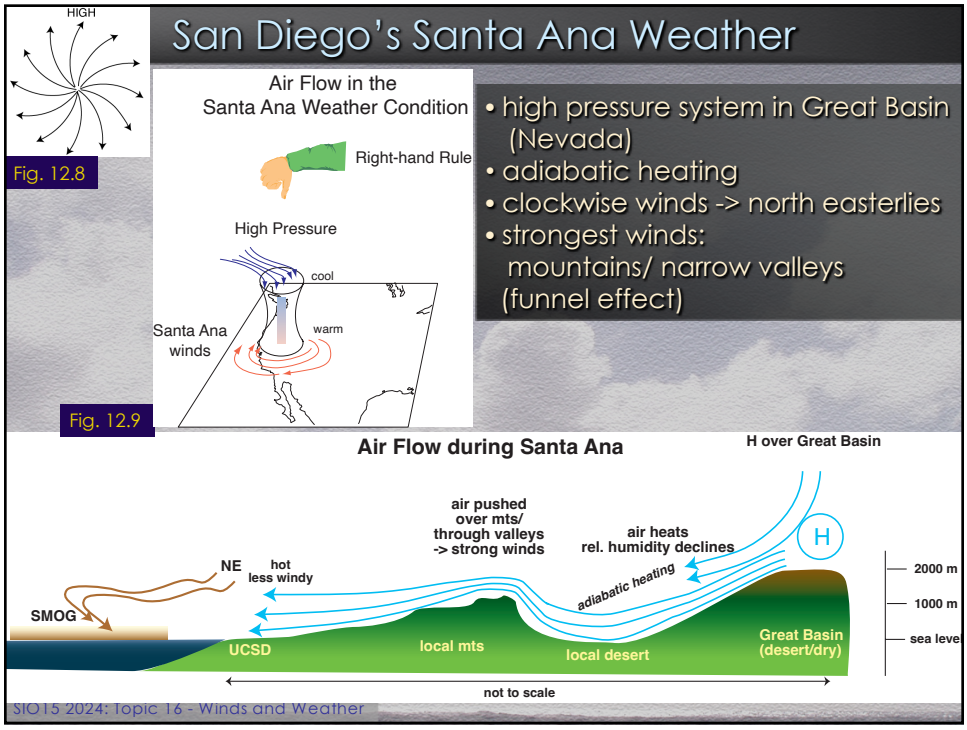
H
- air sinks
- surface air moves AWAY from H

air flows from H to L


Rotating Earth
(viewed from above)
E
N Pole
W
Fig. 2.9
Earth's Spin and the Coriolis Effect
moving objects are diverted due to Earth's spin
Earth spins from W to E
• objects near equator have higher eastward speeds than at higher latitude
• object moving away from equator has extra E movement
• object moving toward equator has lack of E movement
The Coriolis Effect
Fig. 2.10
due to Earth's spin, speed of resting body near pole is less than near equator
deflection to right in N hemisphere
a moving body is deflected
deflection to left in S hemisphere
intended path by balloon
actual path by balloon
1) balloon has excess speed to E near equator so gets deflected eastward when moving south or north
2) balloon has lack of speed to E near pole so gets deflected westward when moving toward equator
- N right hemisphere: deflection to the
- S left
see Lecture 2 notes/book chapter 2


Rotating Earth
(viewed from above)
E
N Pole
W
Fig. 2.9
Poll
SIO15 2024: Topic 16 - Winds and Weather


HIGH
Fig. 12.8
Cyclonic and Anticyclonic Flow
- winds blow *into lows* and *out of highs*
- Coriolis Effect bends winds around
- high pressure: clockwise (anticyclonic)
- low pressure: counterclockwise (cyclonic)
use right hand rule in northern hemisphere
N
LOW
S
e.g. Santa Ana in San Diego
(right-hand rule, northern hemisphere)
Convergence
Divergence
High
Low
Anticyclonic
Cyclonic
e.g. Storm System, Hurricane
source: Marshak "The Earth"
SIO15 2024: Topic 16 - Winds and Weather


HIGH
Fig. 12.8
San Diego's Santa Ana Weather
Air Flow in the Santa Ana Weather Condition
Right-hand Rule
High Pressure
cool
warm
Santa Ana winds
Fig. 12.9
• high pressure system in Great Basin (Nevada)
• adiabatic heating
• clockwise winds -> north easterlies
• strongest winds: mountains/ narrow valleys (funnel effect)
Air Flow during Santa Ana
H over Great Basin
air pushed over mts/ through valleys -> strong winds
air heats rel. humidity declines
H
NE
hot less windy
SMOG
adiabatic heating
2000 m
1000 m
sea level
UCSD
local mts
local desert
Great Basin (desert/dry)
not to scale
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Poll

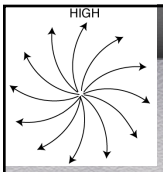
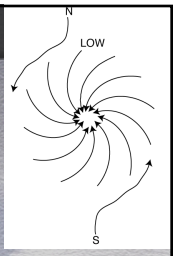


Fig. 12.8



(right-hand rule, northern hemisphere)

Air Circulation on Idealized (non-rotating) Earth

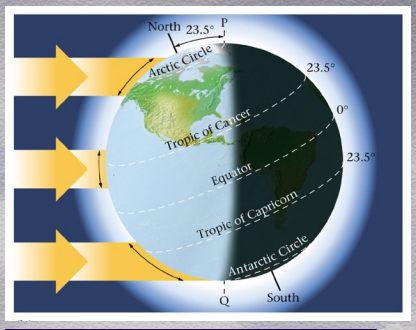
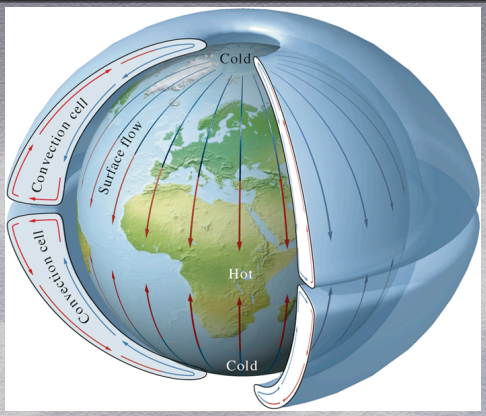


Fig. 11.2a; source: Marshak "The Earth"

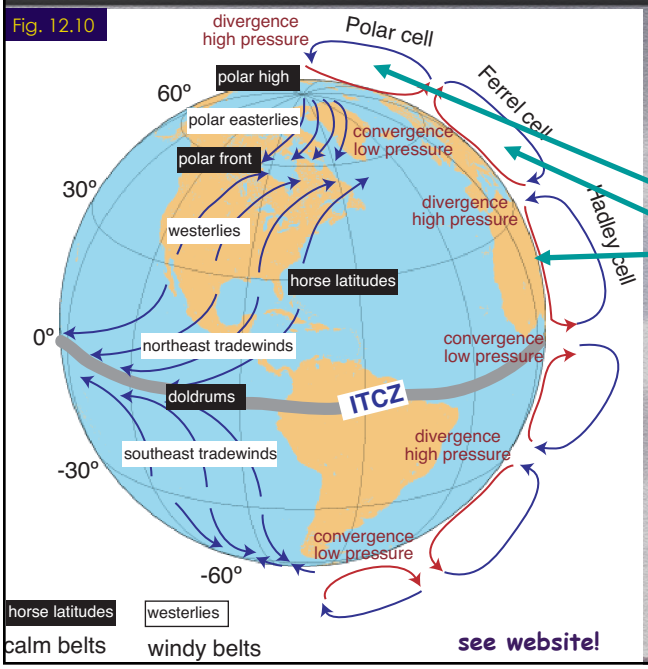


short Video 12b

due to difference in insolation:
- adiabatic cooling near equator (formation of low-pressure system)
- adiabatic heating near poles (formation of high-pressure system)

-> convection cells forms

The 3 Basic Convection Cells

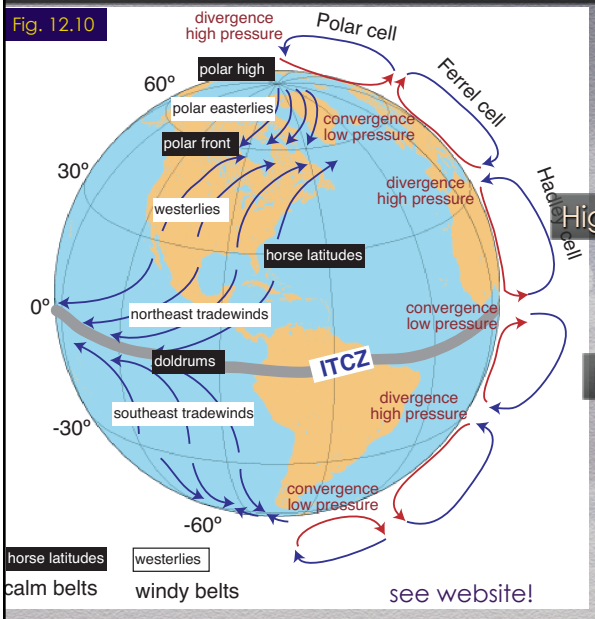


Coriolis Effect
(causes 3 cells!)

1) polar
2) Ferrell
3) Hadley

short Video 12b

Pressure Systems and Surface Winds



Calm Zones:
- divergence (dry)
- convergence (wet)

High Pressure (30°, 90°)

Low Pressure (0°, 60°)

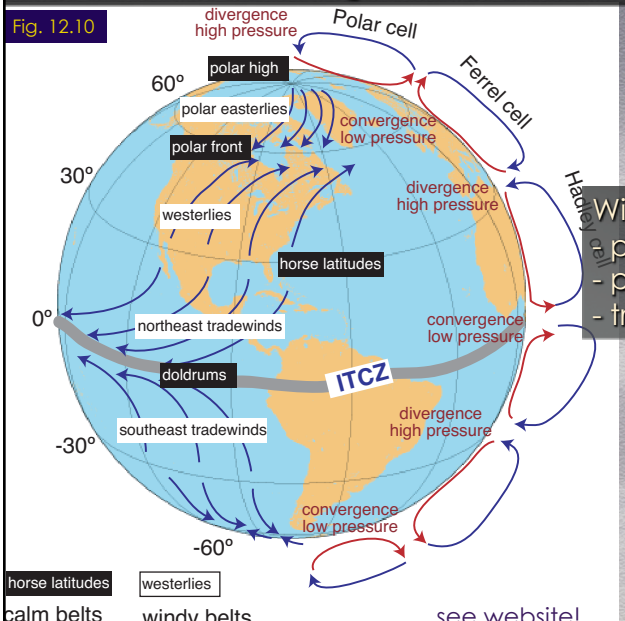
wind blows from high to low pressure!!

short Video 12b

Poll - Deserts

Prevailing Winds at the Surface

Fig. 12.10



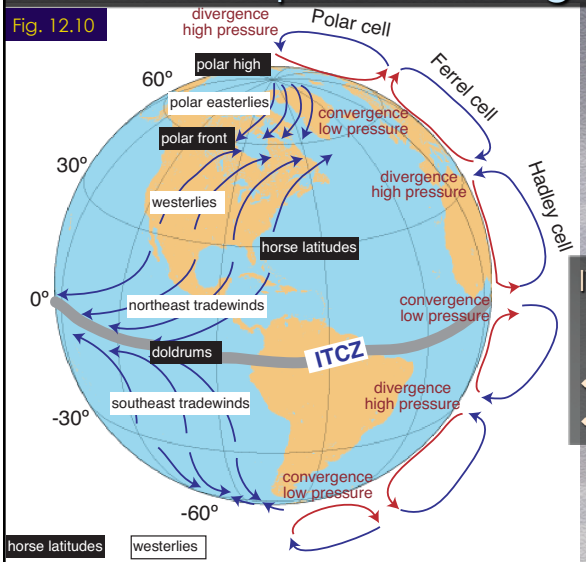
see website!

Windy areas:
- polar easterlies
- prevailing westerlies
- trade winds

short Video 12b

The Intertropical Convergence Zone (ITCZ)

Fig. 12.10



see website!

ITCZ: inter-tropical convergence zone

- moves throughout year
- controls monsoons

short Video 12b

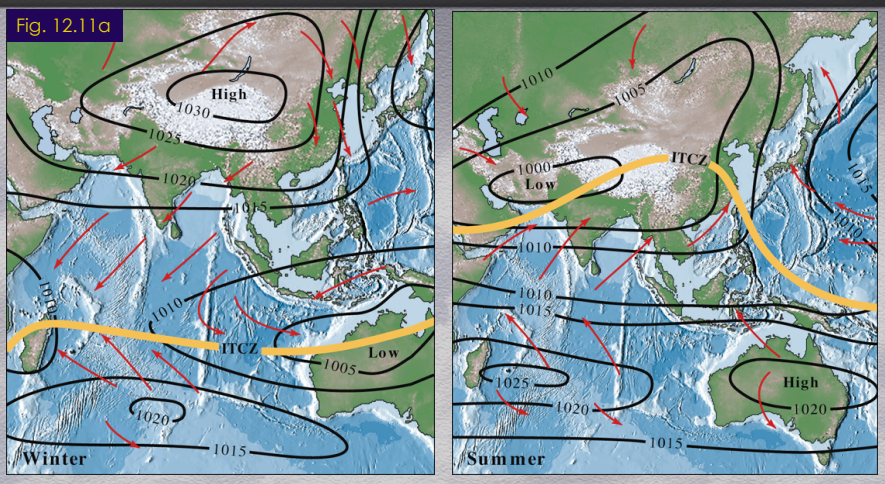
Monsoons

MONSOONS:
- Seasonal rainy periods
- mainly in Sahel and India, but also elsewhere

- major reversal in wind direction
- shift of ITCZ

Western Ghats, India; source:wikipedia

The Asian Monsoon: The Classical View



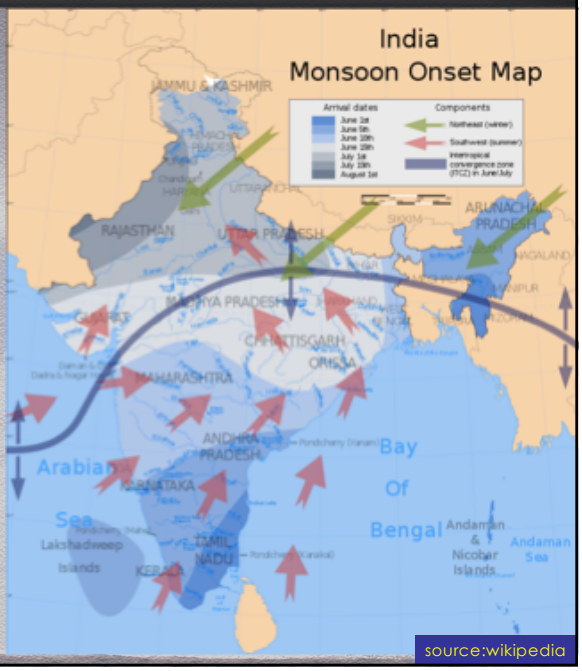
ITCZ: intertropical convergence zone

winter: high pressure over Asia
due to cold air
drought in India

summer: Asia heats up
causing low-pressure system
Monsoon in India

The Asian Monsoon: Onset Date Varies

Indian Monsoon
arrives June 1 – Aug 1



source:wikipedia

Monsoons

MONSOONS:
- blessing: farming; household; reservoirs; industry
- curse: extensive flooding
- consequences can have global reach

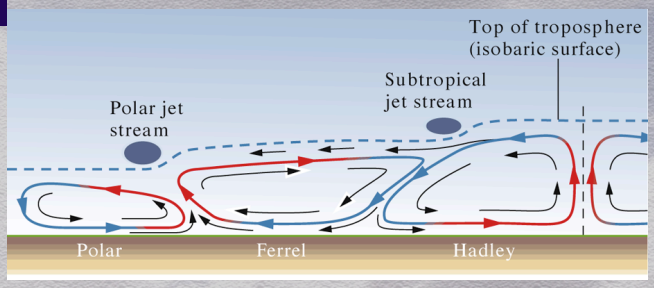
Thailand, 2011/Topic 13

Source: Associated Press/U-T

Philippines 2012 by Gail Gutierrez (SIO15 student)

Global Air Circulation Cells

Fig. 12.12

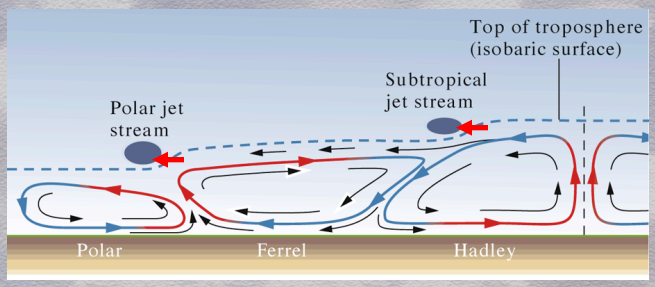


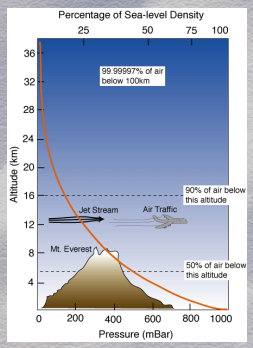
- polar surface air colder than tropical air
- polar cell compressed
- Troposphere thinner at high latitudes

Jet Streams

jet stream:
- high altitude winds at tropopause
- between convection cells

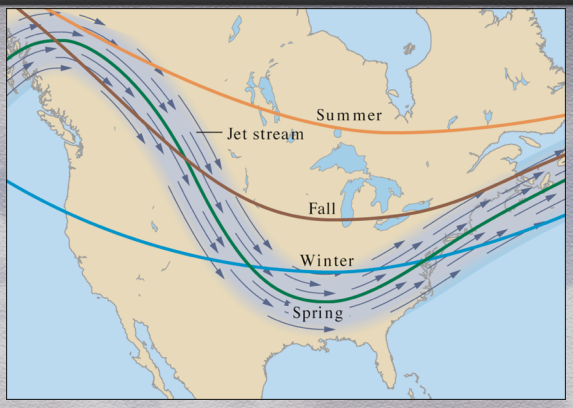
Fig. 12.12





- top-of-troposphere isobar has kinks
-> two places with larger pressure gradient:
-> strong winds (horse latitudes; polar front)
-> winds from S to N (H to L) -> westerlies
- Polar jet stream typically dominates

The Polar Jet Stream



- 200-400 km/h wind speed
- controls weather; steers (winter) storms
- seasonal variations (farther south in winter)
- strong spring undulations
- provides "favorable" conditions in Tornado Alley

Jet Stream – Storms – Atmospheric Rivers

- typically Dec/Jan
- unusually heavy and mild-T rainstorms in SoCal
- jet stream south of normal
- L fed by moisture moving in from Hawaii

La Conchita, CA – Jan 2005

used to be called Pineapple Express

Nov 2006 Pac NW
Dec 2010 SoCal
Dec 2014 Cali
2017 West Coast
Jan 2021 Cali
Nov 2021 Pac NW