GEOGRAPHY 205, CHUGIAK-EAGLE RIVER 1-30-2008
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Chapter 5 Atmospheric Pressure, Winds, and Circulation Patterns (all)
(Session 3)

This is a long chapter. I suggest you plan to break the reading up into different sessions.

Atmospheric pressure at seal level (average):

Torrecelli's mercury barometer – 14.7 lbs / in^2, or 1034 gm/cm^3, or 1013.2 millibars of pressure.

Mercury: 72cm column = 29.92 inches at sea level.

What would happen to a column of mercury on the moon?

What is the "purpose of weather"?

VARIATION IN ATMOSPHERIC PRESSURE:

Denali Pass on Mount McKinley, 18,000 feet = 1/2 atm. pressure.
Mount Everest, 29,028 feet = 1/3 atm. pressure.

Make sure you keep in mind that latitude lines go east-west. Longitude lines go north-south.

Pressure and density of gas in inversely proportional to temperature. So, when the temperature goes up, what happens to the density of gasses?

Horizontal Variations in Pressure:

Thermal - unequal distribution of temperature because of differences
In INSOLATION (incoming solar radiation).
Dynamic – motion.

Heat at the Equator sends excess heat poleward. Dynamic motion due to rotation of the Earth (Coreolis Effect) piles up air pressure at 30º North and South latitudes.

BASIC PRESSURE SYSTEMS:

Cyclone:

Low pressure with ascending (upward) motion of air.
Cloudy/rain/stormy.
Convergent air. (1)

Anticyclone:
High pressure with descending air.
Clear/dry.
Divergent air.

Air pressure maps are adjusted to sea level.

Mapping Pressure Distribution.
Isobars: lines (points) of equal pressure.
Pressure Gradient – strong if Isobars close together.

Wind – horizontal movement due to differences in atmospheric pressure.

0º to 38º latitudes excess solar energy accumulates.
38º to 90º latitudes receives the excess solar energy transported by "weather".

Winds always blow from high to low pressure areas. Wind also drives ocean currents.

Power in wind for wind turbines is proportional to the cube of the wind speed. A doubling of the wind speed increases energy production eight times.

Coriolis Effect – stronger as one approaches poles. No effect at the equator.
As one moves north or south from the equator, objects, including wind, are deflected eastward.

Rotation:
Equator: 1050 mph
Anchorage (61ºN) 525 mph
Polar region speed?

What does a pendulum show?

Advection is the horizontal movement of air.

Land surface Friction.

Geostrophic Wind: the resulting wind from the combined effect of the Coreolis Effect and Pressure Gradient.

Surface Wind: the combined effect of Coreolis Effect, Pressure Gradient and Friction.

In the Northern Hemisphere:
Winds going from a high pressure area go clockwise.
Winds coming to a low pressure area go counterclockwise.

In the Southern Hemisphere, the reverse is true.

Wind terminology:
Where the wind is coming "out of": south, north, etc…
Windward.
Leeward.
Prevailing Winds

SUBGLOBAL SURFACE WIND SYSTEMS (Important when sailing.):
Local winds:
Land Breeze during the day. Cools beaches, but can also bring fog and rain.
Sea Breeze during the night.

Valley Breeze – sun on warmer upper ridges draw wind out of lower valleys.
Mountain Breeze – land gives off more radiation to outer space than it receives, thereby creating a cooling effect. Temperature inversions can set in. Wind comes down valley.

Drainage Winds
Katabatic winds.
Taku (Alaskan term).
Knik Glacier blasting the Matanuska Valley.
Antarctica blasting New Zealand.

Chinook Winds – as air moves over a mountain, heat is released from condensation, or perhaps even snow formation. So, when the air rolls down the leeward side of the mountain and as air pressure increases again, it is unusually warm.

Whittier to Anchorage – warm winds melt snows in Anchorage during some "terrible" winters.

Santa Ana Winds – in summer high pressure in inland desert dries vegetation. With ignition source, winds add oxygen to fires.

Monsoon Winds – determined by season (sun angle).
India experiences 180º wind change.
Winter: inland high pressure causes cold wind to drain out over India.
Summer: India "moves" south with the changing of the seasons. Large low pressure trough over ocean to the south moves tropical moist air to land. Also the warm continent to the north helps to pull in air from the south (double effect). Clouds pile up against land / mountains causing precipitation of up to 37" in one day. Winds 30-50 mph, max 100 mph.

GLOBAL PRESSURE BELTS – idealized semi permanent pressure systems.

Trough at the Equatorial Low with sun directly overhead and rising air.

Subtropical Highs with sinking high pressure air at 30º N and S latitudes.

Subpolar Lows with rising air at 65º N and S latitudes. (Southeast Alaska).

Polar High pressure systems.

The Global patterns of Atmospheric Pressure.

Mountains break up pressure belts.

Differential land and sea heating is most influential.

Belts shift with the changing of the seasons.

January in the Northern Hemisphere:

Land is cool, so Siberian and Canadian high pressure systems develop. Fair and cool weather.

Oceans are relatively warmer, so the Icelandic and Aleutian low pressure systems develop. Stormy weather.

July in the Northern Hemisphere:

The Pacific and the Bermuda/Azores high pressure systems develop. Ever wonder why hurricanes tend to swing up north along the Eastern US coastal areas?

Similar systems in the Southern Hemisphere.

Semi-permanent pressure systems migrate with the seasons.

GLOBAL SURFACE WIND SYSTEMS.

Idealized Model of Atmospheric Circulation in the Northern Hemisphere.

Polar Easterlies form the NE.

Westerlies from the SW.

Trade Winds from the NE.

Trade Winds: 5º to 25º North and South.

Hawaii experiences tropical easterlies. On which side of the islands do most rains fall? Which side has the deserts?

The old "square riggers" circled the Atlantic in a clockwise motion. predictable for interception by pirates.

Doldrums (bored or depressed state of mind): 5º North to 5º South.

The Intertropical Convergence Zone (INTC) – no strong winds.

Subtropical Highs: 25º to 35º North and South.

Horse Latitudes: throw the horses overboard to conserve water and other rations while you wait for wind in your sails.

Westerlies: 35º to 65º North and South.

Less consistent winds, but usually stronger. Produces stormy weather for Anchorage.

Polar Winds: 65º and northward. Can give clear and cold weather in Anchorage, with north, northeast winds.

Polar Fronts – often battling it out over Anchorage.

Effects of Sun's Seasonal Migration:

5º to 15º latitude (North or South)

Summer – wet

Winter – dry

30º to 40º latitude (North or South)

Summer – hot and dry

Winter – wetter

Longitudinal Differences in Winds

North American Monsoon. In the summer Atlantic cool air sinks in the center and blows out anticyclonically (clockwise). The US East Coast gets storms.

UPPER AIR WINDS

Both hemispheres:

From 15º - 20º latitude and heading towards the poles, upper air Westerlies gradually spiral downward toward the poles.

Between 15º - 20º latitude north to the same general latitude area to the south (Equatorial Area), Upper Air Easterlies form. These are an extension of the trade winds loop.

Jet streams strongest in winters.

Polar Front Jet Stream – a strong upper air Westerly:

25-100 miles in width

1-2 miles deep

Strongest in the winters.

Subtropical Jet Stream:

Above 30º North and South deserts of sinking air. Also strongest in the winters.

Rossby waves:

Oscillations or Long Waves in the Polar Fronts.

When it is cold in Anchorage, it is often warm in Minneapolis. The reverse pattern is also common.

Triggered by El Niño and La Niña patterns?

Ocean Currents:

Gyres around subtropical highs. Counterclockwise in northern hemisphere due to Coriolis effect.

Currents affected by:

Coriolis Effect, size, shape, depth of ocean basins, temperature and salinity differences, tides and wave actions.

Gyres: broad circulation patterns, clockwise in the north.

Warm currents: Gulf Stream and Kuroshio (near Japan) Current.

Cool currents: California and Humbolt Curents.

Upwelling along western coasts, both hemispheres

El Niño ("Christ child").

Best developed during November and December months off Peru's coast. Local phenomenon if two months or less. If ocean water temperatures increase 0.5º C for 6 consecutive months, a broad El Niño designation is given.

Trade winds slow, stop or even reverse.

Rich upwelling currents diminish. Fishing industry can collapse in the area.

Rain can hit western deserts of the Americas, while fires from lack of Rains, rage in Australia.

Fewer hurricanes develop.

A moderate El Niño is expected to continue into the spring of 2008.

El Niño and the Southern Oscillation.

Trade winds are enhanced by a high pressure air mass along the coast of Peru, and a low pressure system near Australia. El Niños are generally accompanied by a weakening in this pressure gradient.

La Nina ("Little Girl"):

Currents, upwelling and trade winds stronger than usual.

El Niño and Global Weather.

Cycles are occurring more frequently.

16^{th} Century cycles every 6 years.

Now the cycles are every 2.2 years and getting stronger.

North Atlantic Oscillation (NAO).

Strengthening of Subtropical High (Azores) and Subpolar Low (Iceland).

Mild wet winters in the US.

Cold and dry North Canadian winters.