



Squall Weather Handout (last updated June 08)

The Elements: Heat (sun), water, wind

- sun heats the earth,
- water absorbs, carries and releases heat
- wind moves the water around (in vapour form)
- three in combination create weather

Where does weather occur?

Atmosphere

- is approx. 100 km thick (80% of gases are within first 16 km – beyond this the air gets thinner and thinner until it merges with outer space – there is no final boundary line)
- 99 % of it is stable and calm (the airplanes fly here above & beyond 10km)
- the other 1 % (the first 10 – 15 km known as the Troposphere),
- Troposphere is the air in which we live and breath - always on the move, boiling, bubbling ,constantly swirling.

Global Circulation Pattern

- movements of the water (oceans) and air are largely controlled by the sun.
- air is heated at the equator (rising up) and cooled at the poles (air descends)
- the temperature and pressure differential between the two creates circulation in a circular pattern (Hadley cell in theory - in a perfect world which it is not)
- earth spins on axis and has continental land masses so this simple picture gets modified.
- the result : instead one perfect circulation cell, 3 develop in each hemisphere of the planet.
- cells meet at consistent latitudes - 30 and 60 degrees north
- Coriolis Effect – the result of the earth spinning diverts all air, water, even planes in the sky get diverted to the right in the northern hemisphere and to the left in the southern hemisphere.
- think of the air around us a fluid like water - one giant river of air that the whole planet shares, dipping, swirling, with different warm and cold streams that try to mix with each other - (unsettled weather occurs along the boundary of warm and cold)

Jet Stream

- strong stream of wind which forms high up and in between gaps in the Hadley cells
- acts a barrier to air masses
- in northern hemisphere moves south in winter preventing tropical air masses from reaching us and north in the summer keeping the cold away from us.



Air Masses

- Warm, moist air masses (warm air can hold lots of moisture - similar to a slightly moist sponge soaking up lots of H₂O)
- Cold , dry air masses (cold air cannot hold much moisture)

High Pressure System

- all air has weight creating pressure at the surface – descending air has more pressure than rising air - this pressure is measured in millibars.
- high pressure systems generally are composed of colder & drier air coming from 'high' up in the atmosphere & as the air descends it absorbs moisture as it heats up. Few clouds form as a result.
- think of the high pressure mass as a river of air descending from a high mountain peak towards the valley (the bottom of valley is the centre of the low pressure system)
- high pressure systems are stable

Low Pressure Systems

- low pressure systems generally are composed of warmer moister air that weigh less because the air is rising
- as this air rises into the cooler higher atmosphere - it has to shed the moisture as it cools and clouds start to develop
- clouds will also form in the presence of dust / pollution particles in the atmosphere (localized effect)
- extreme rising of air causing rapid cooling and rapid shedding of moisture results in thunderstorms.

Hot Things to remember about Air Masses

- remember highs only exist because of the development of low systems
- highs are not created by anything, they are simply a result of lows upsetting the balance of temperature and pressure
- the atmosphere is constantly trying to equalize itself in pressure and temperature.

Fronts

- fronts or division lines occur between the air masses both of different temperature and density - they don't like to mix - (think of a cold, clear blue mountain river merging with a warm muddy, cloudy river - often it takes several km's downstream before the two streams start to mix) (Stationary Front – no mixing – not enough temperature and pressure differential)
- along the front is where you get much of the active weather developing and occurring
- two air masses of different temperature, pressure, with different wind speeds circulate opposite to each other, like the traffic on the road (also known as surface trough). Along their boundary a shearing motion causes rotation to begin. This is the start of a low pressure system!
- once the fronts start to rotate within each other, a more pronounced wave pattern is seen - this is known as deepening or mature low – usually will form a warm front and cold front



- when the two fronts finally mix (warm penetrates cold mixes and equalizes and vice versa), the low fills, equalizes in temperature and pressure, then dissipates.
- occluded front – warm air mass sits overtop cold – expect very unstable weather

Troughs and Ridges

- weaker elongated areas of high or low pressure that may intensify or may dissipate.
- often they will have mild winds associated with them (also precipitation if a trough)
- they are not circular or well defined.

Winds

- remember air moves (or descends) from the highs (off the top of the mountain) towards the lows (bottom of the valley)
 - at the start of the journey (top of the mountain) all is calm with perhaps little or light wind
 - as air moves towards the outside edge of the high, it increases in speed, then gets sucked in towards an adjacent low picking up speed - big winds are often experienced along the front (line between a high and low) and during an approaching low pressure system.
 - high pressure system - air circulates clockwise with the biggest winds on the outside edge of the high and the lightest winds towards the centre.
 - low pressure system - air circulates counter clockwise and the biggest winds towards the centre and lighter winds found on the outside edge.
 - once the air finally finds its way into the centre of the low (after funnelling around and around several times) it rises up at the centre filling the low (remember low pressure air rises)

The Low as a Bowl....

- think of the low as a bowl that has to be filled by the air from the high- once the bowl is full to the brim, the pressure and temperature equalizes and the low ceases to exist.
- **however** if the Jet Stream (high air aloft of air masses) is blowing overtop of the low, it sucks the air (& moisture) up out of the centre carrying it out into right field..... in this case the low cannot fill up and continues to deepen and strengthen - this is when we get the big storm of precipitation and wind no matter what time of year.....

Signs of an Approaching Low

- wind direction & speed - south generally (se to sw)
- sundogs
- high cirrus clouds - (describe cloud types as low approaches and intensifies)
- pressure falling
- temperature rising



Buys-Ballot law - when the wind is at your back, the low pressure system is to your left

Wind Scale given in Marine Forecast:

Light	1-10 kn
moderate	11-19 kn
strong	20-33 kn
gale	34-47 kn
storm	48-63 kn
hurricane	64 kn or more

Great Lakes Wind Chant:

winds from the west are always best
winds from the north, the sun will shine forth
winds from the east are a beast,
winds from the south bring rain in their mouths

Winter Trends in the Great Lakes

- predominant air mass is continental polar
- jet stream moves further south preventing warm, moist air from reaching us
- pressure gradient is greater causing jet stream to flow straighter and faster - systems track more quickly west to east (known as **zonal flow**)
- highs and lows are carried along by Jet Stream (one giant fast moving conveyor belt) so the trend is frequent, short lived storms (winter blizzards)
- dominant wind direction is west & northwest
- 2/3 time days are overcast

Summer Trends in the Great Lakes

- predominant air mass is warm moist air
- jet stream moves further north allowing more warm air to dominate the region
- most summer lows track north of the Great Lakes
- pressure gradient is less, jet stream has steeper wave pattern causing systems (highs and lows) to pass overhead more slowly
- warm, sunny days prevail with frequent afternoon thunderstorms.
- nights are cool, calm mostly.
- fog is frequent especially close to coastal areas in early summer and fall

Summer Thunderstorms - can be associated with an approaching big low or can be localized during a hot and humid high pressure system.



Conclusion

Understanding and interpreting the basic weather patterns and the forecast will help us determine and plan what we will do, what we will wear, and where we will go. If we can remember some of the basic principals and indicators, then we can become our own weather forecaster.

As a paddler we are primarily interested in the following:

- wind direction and speed (this will affect the sea state i.e. waves!)
- precipitation (this will affect how we dress and pack for the day)
- air temperature

To predict the weather to come we can take note of the following indicators around us:

- pressure (need a barometer or get this off a radio forecast)
- wind speed (can guesstimate or use pocket wind gauge)
- wind direction (your compass)
- clouds (types of clouds visible in sky)

Resources and Obtaining a Forecast:

There are several places to seek out forecasts - most of the data is gathered and compiled by Environment Canada with the help of several volunteers all across Canada. If possible it is best to check multiple sources if possible to build a more accurate picture -

Web:

<http://weatheroffice.ec.gc.ca>

- Environment Canada - local forecast, weather maps, and regional radar

http://www.weather.ec.gc.ca/marine/marine_e.html?45137

- Environment Canada Marine Weather -

<http://www.theweathernetwork.com>

- lots of good maps, resources and interactive pages

<http://www.tor.ec.gc.ca>

- Meteorological Service of Canada

<http://www.sailon.org>

Ontario Sailing Association

<http://www.cps-ecp.ca>

- Canadian Power & Sail Squadron

<http://www.crh.noaa.gov/grr/marine/waveForecast.php>

- Wind and Wave Forecasts for Great Lakes

Radio:

- VHF Marine - channel 21 Great Lakes - Coast Guard continuous marine forecast -- issued 4 times a day at 0400, 1030, 1600, and 2130.



-Public Radio - most great lake regions have an assigned local FM or AM band devoted to continuous land and marine forecast - for example in Georgian Bay tune into FM 88.9 in the car on the way to your launch site...

TV:

- The Weather Network
- CBC Newsworld

Other Resources:

Living with Weather by Owen S. Lange - Environment Canada

Wind, Weather and Waves - Environment Canada

The Wind Came All Ways - by Owen S. Lange - Environment Canada

Weathering the Wilderness - by William E. Reifsnyder

“Catch the Drift” Video - Environment Canada

(Appendix A) – More on Winter Weather in the Great Lakes