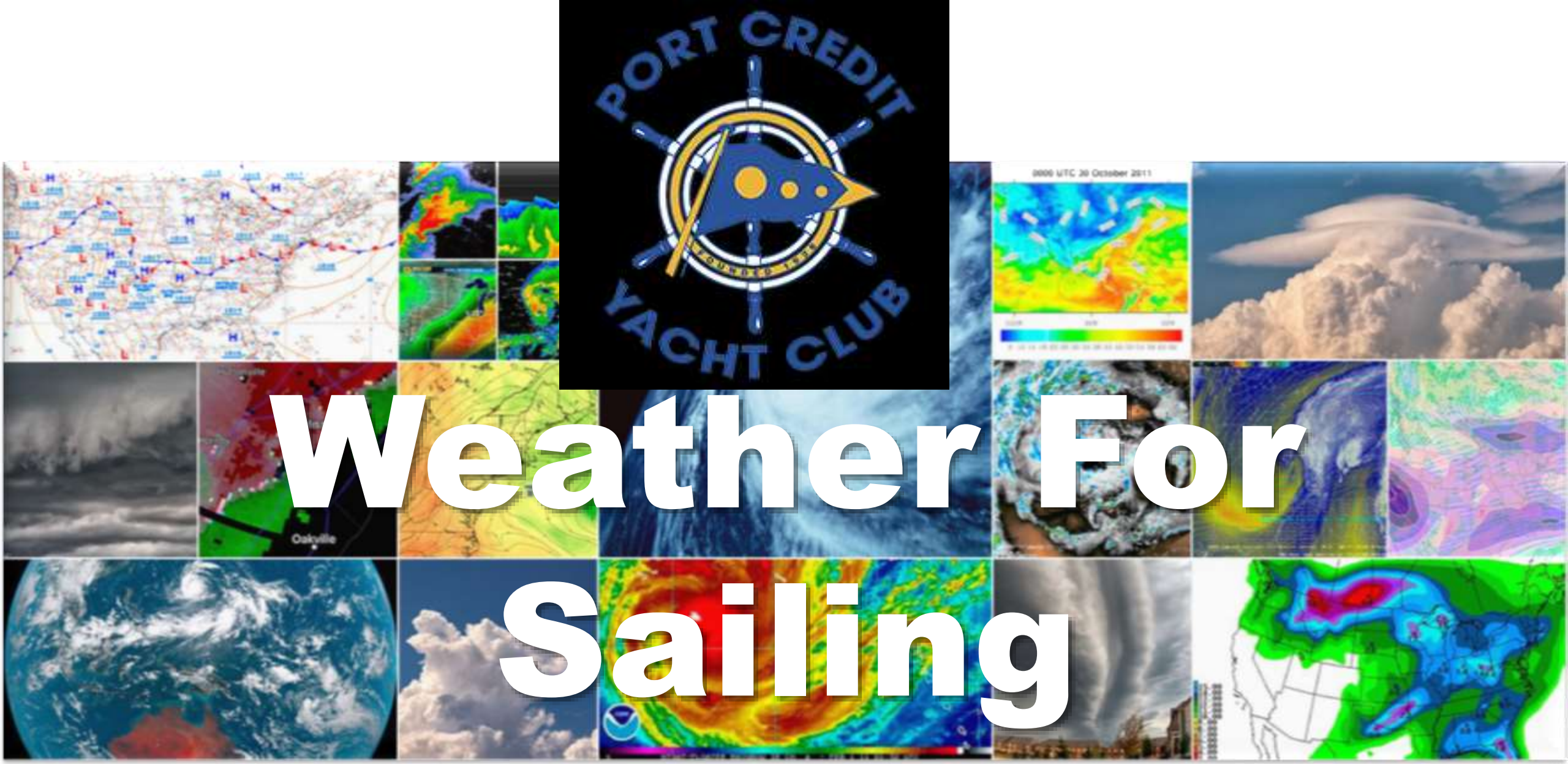


Weather For Sailing

Presented by: Ron Bianchi - Meteorologist/Sailor

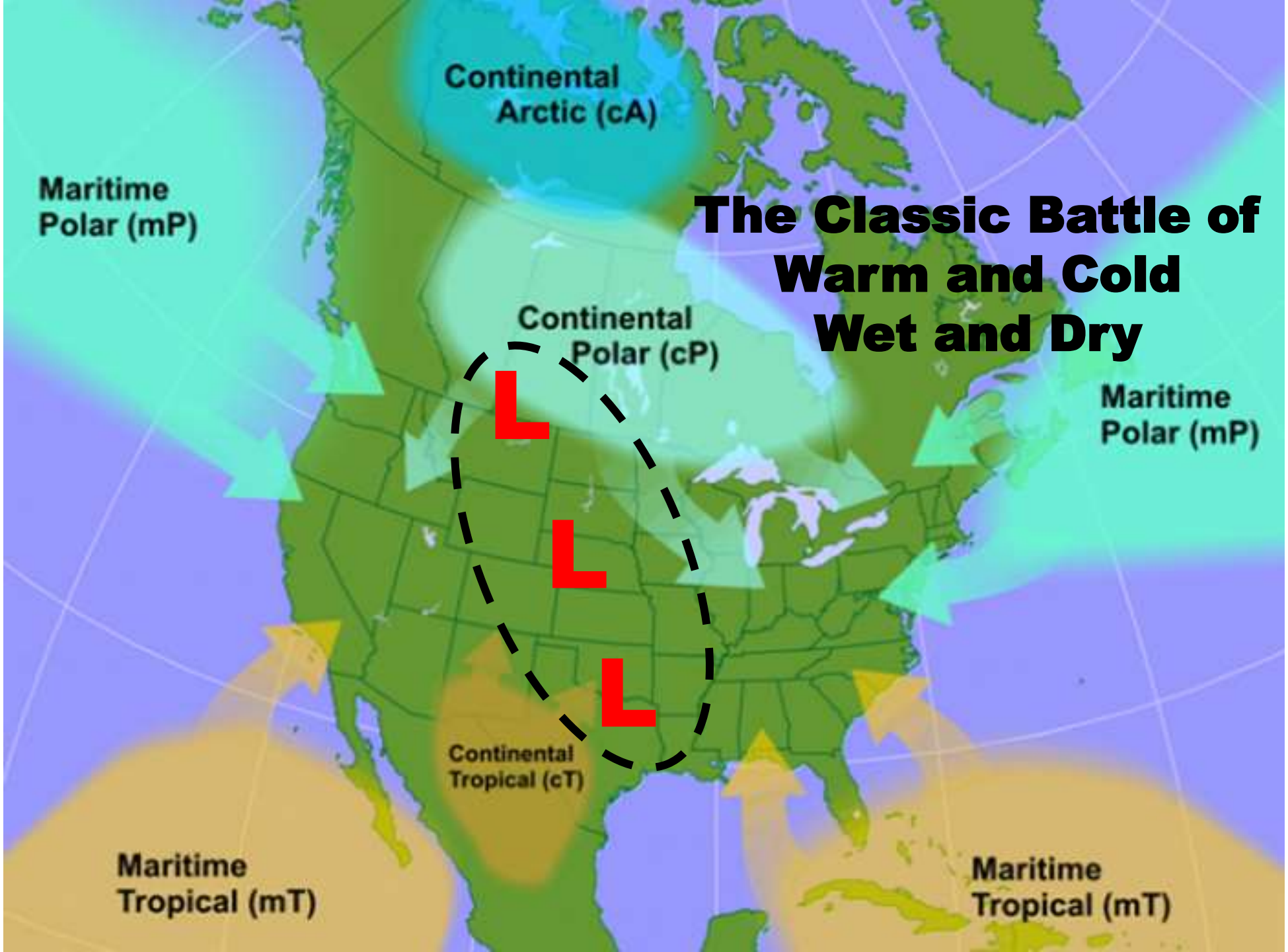
ronbianchi@rogers.com

@mrwx4caster

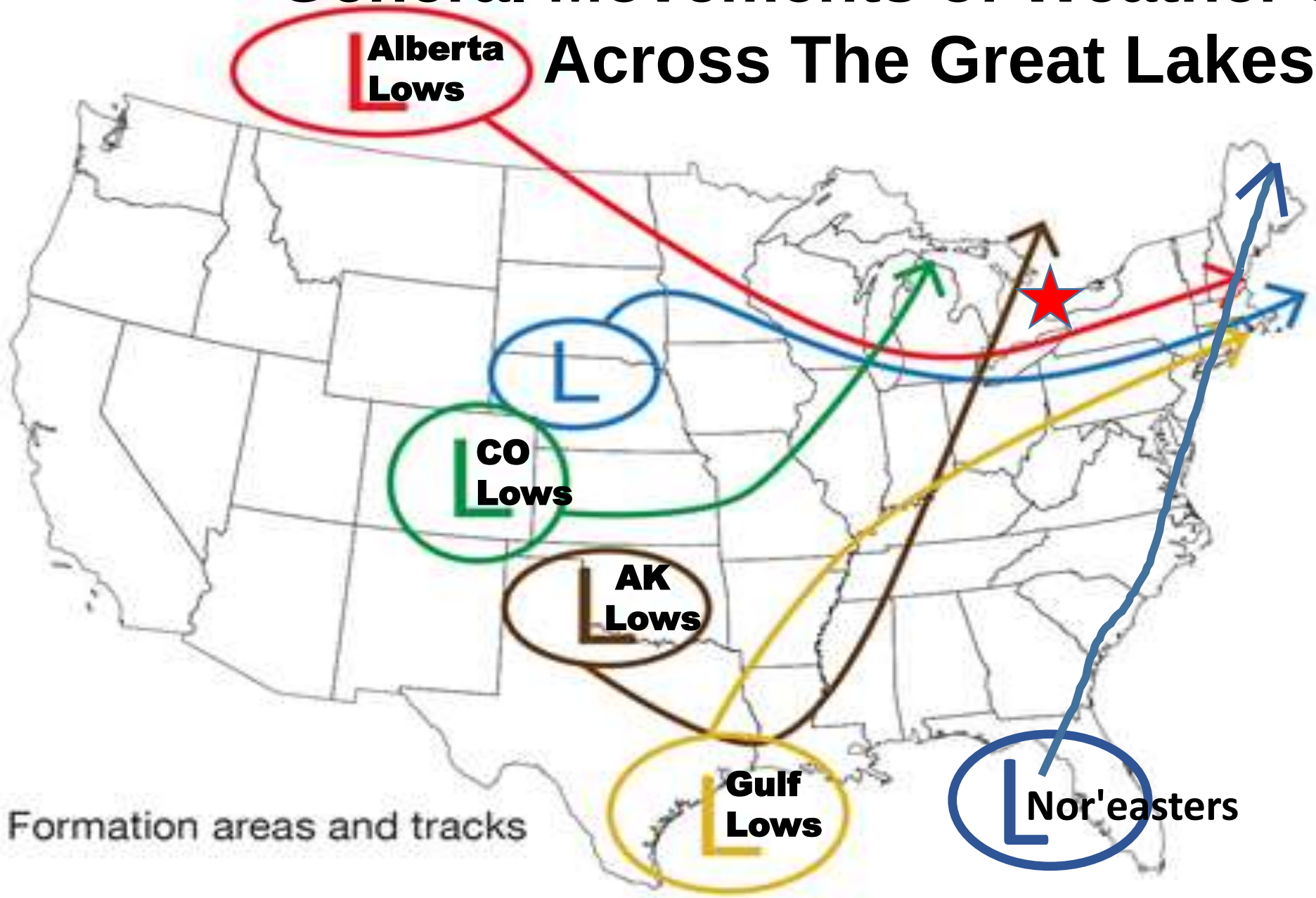
https://ca.linkedin.com/in/ronbianchi

What we are going to cover this evening

- *The Basics – How does the weather work?*
- *Basic Cloud Identification*
- *The Pressure and Gradient*
- *The Local Winds*
- *Lightning*
- *Weather Apps*
- *Q & A*

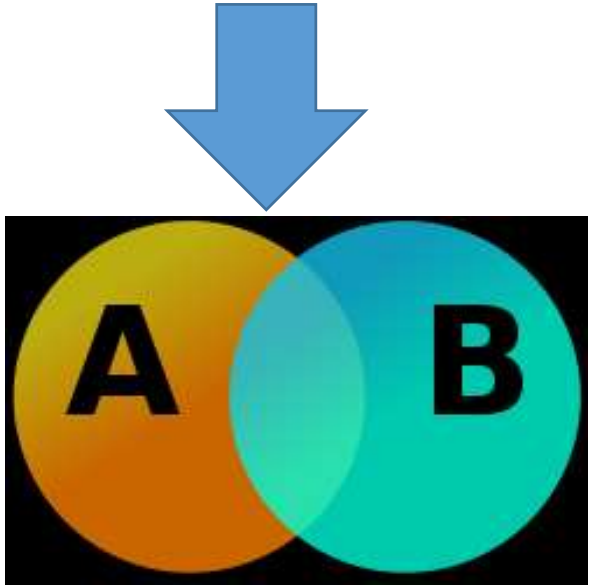

Continental
Arctic (cA)
Maritime
Polar (mP)
The Classic Battle of
Warm and Cold
Wet and Dry
Continental
Polar (cP)
Maritime
Polar (mP)
L
L
L
Continental
Tropical (cT)
Maritime
Tropical (mT)
Maritime
Tropical (mT)

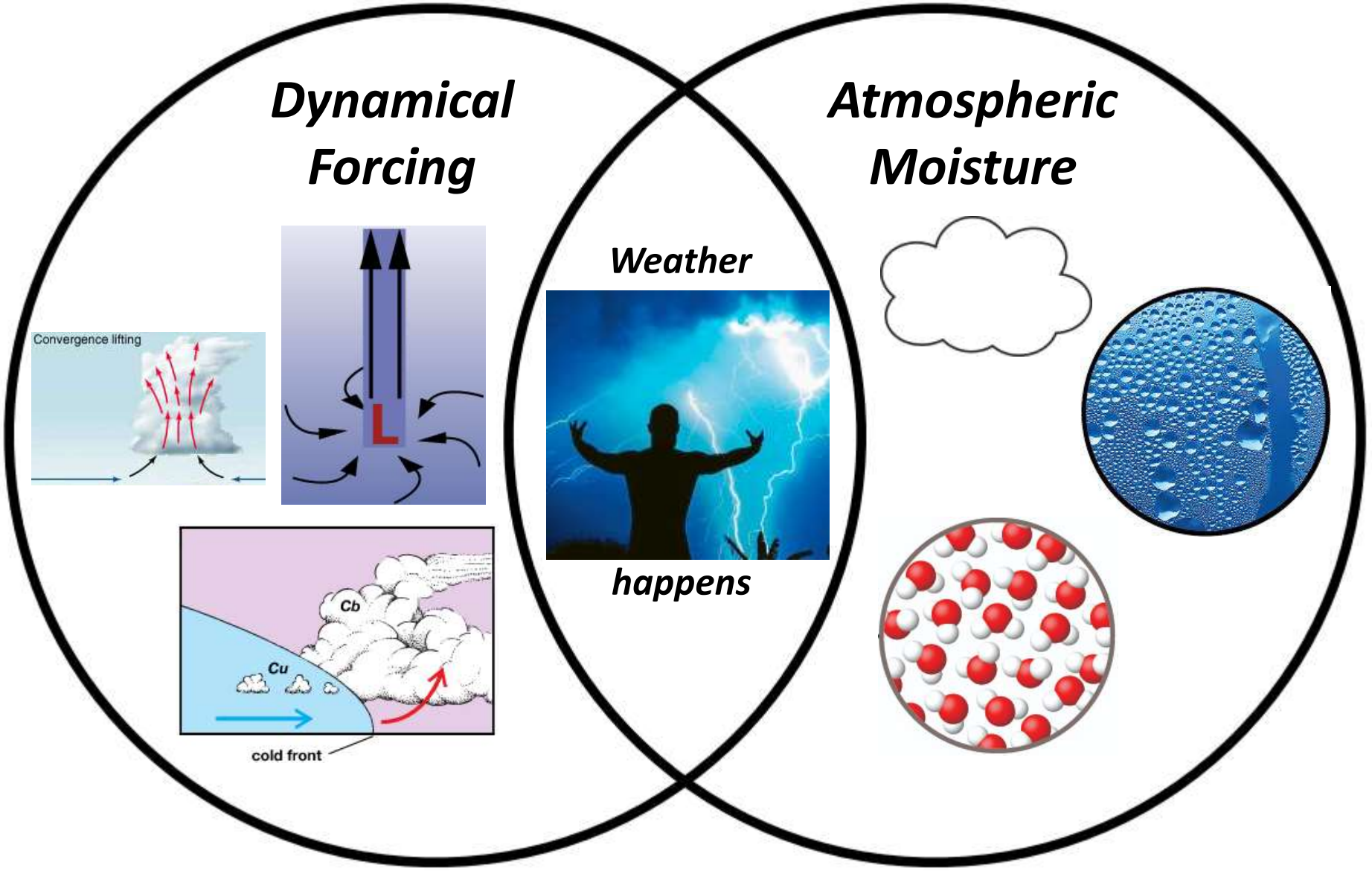
General Movements of Weather Systems Across The Great Lakes



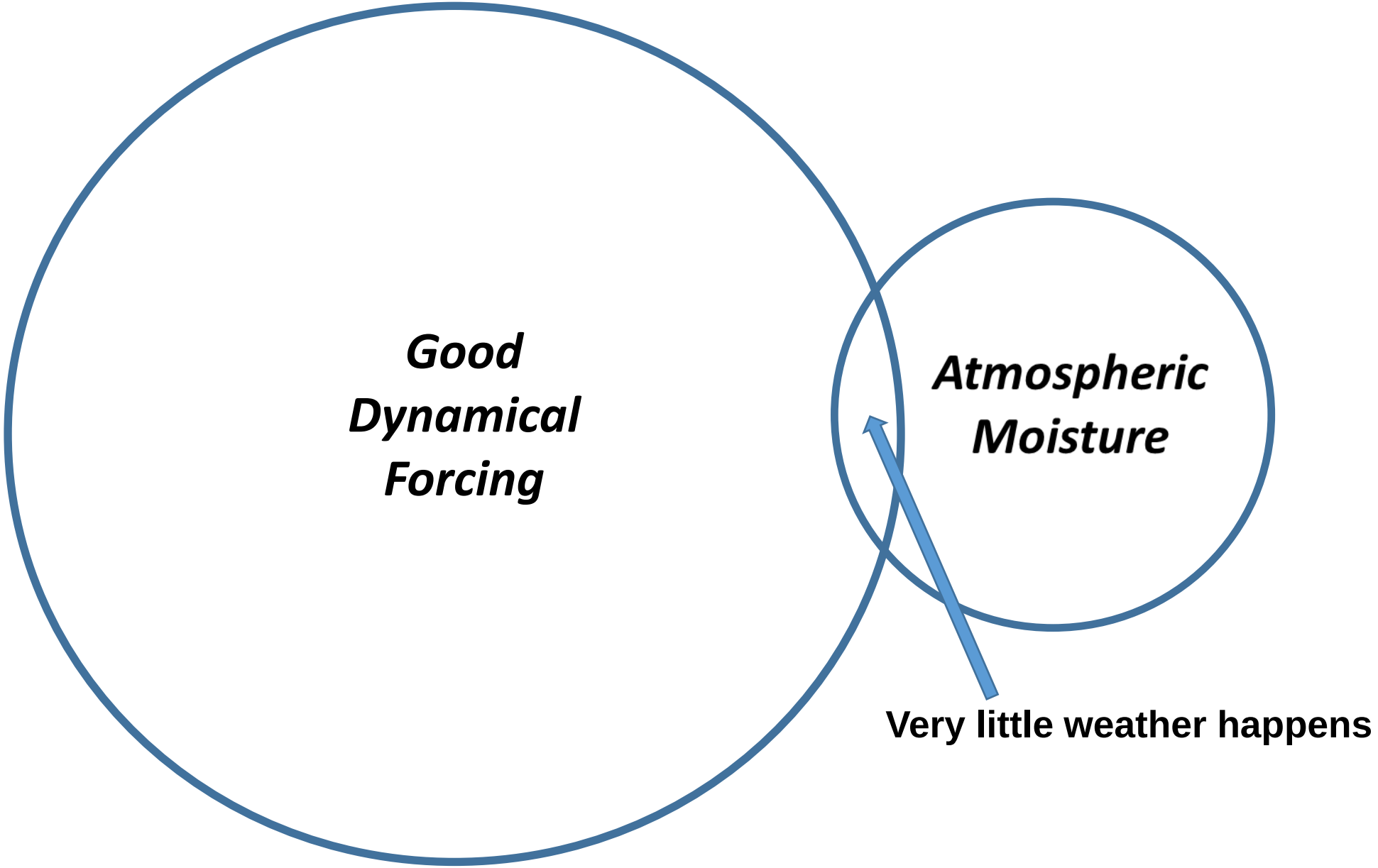
Weather – It is really this simple?

John Venn



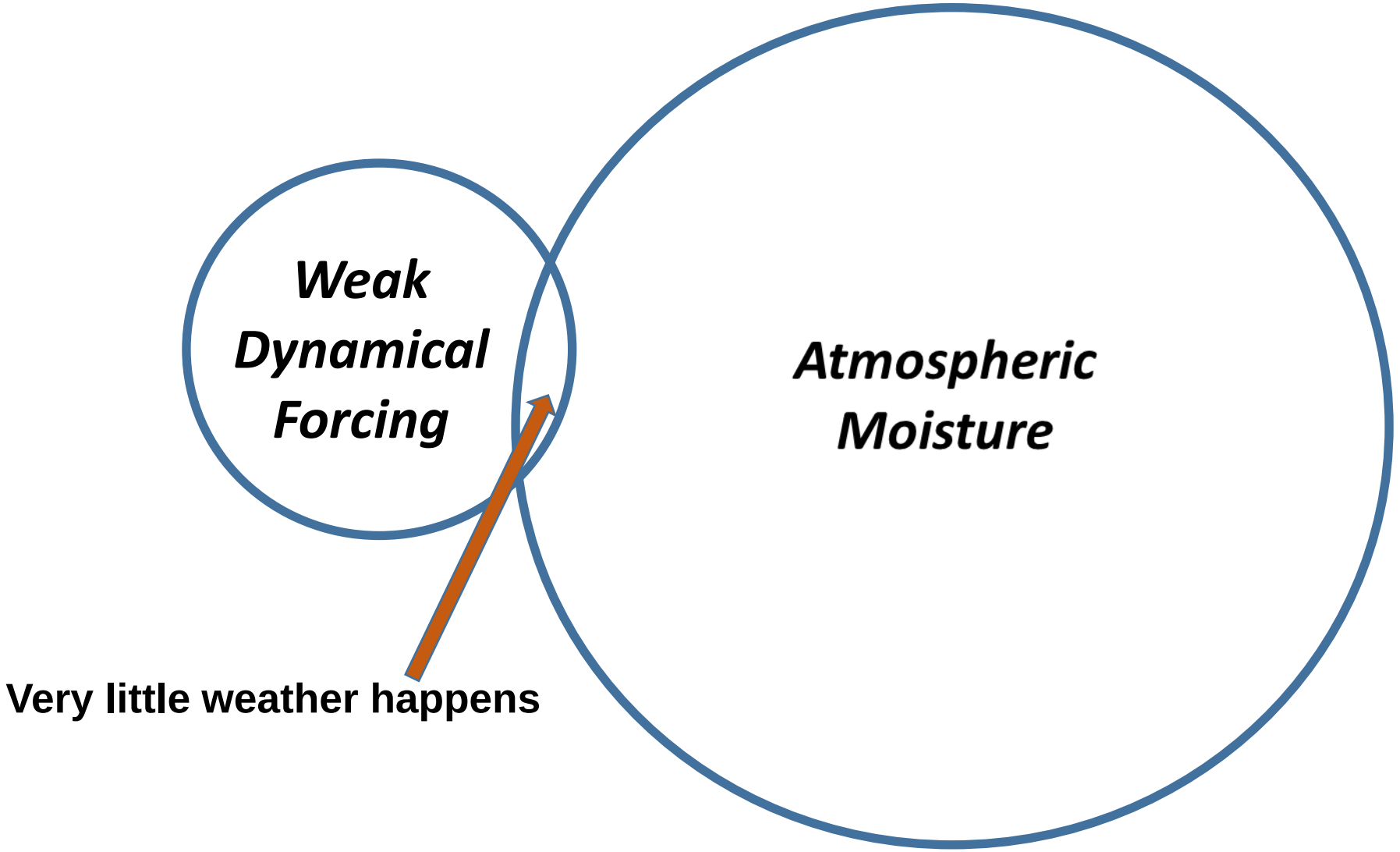


Good Upward Forcing + Very Little Moisture =
Very Little Weather Happens



Weak Upward Forcing + Lots of Moisture =

Very Little Weather Happens



HEAT ENERGY TAKEN FROM ENVIRONMENT

Sublimation

Ice

Freezing

80 Cal

334 Kj/kg

Liquid

Condensation

530 Cal

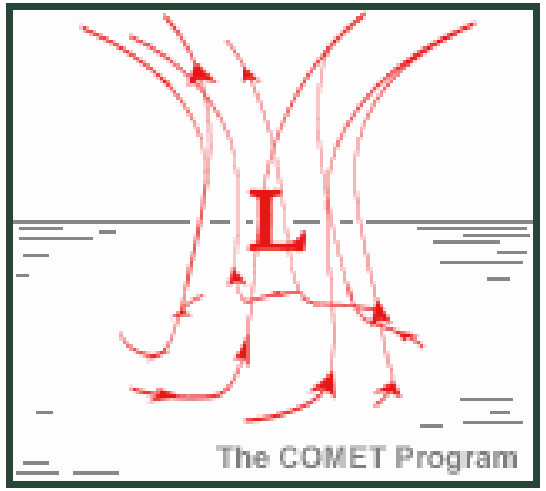
2257 Kj/kg

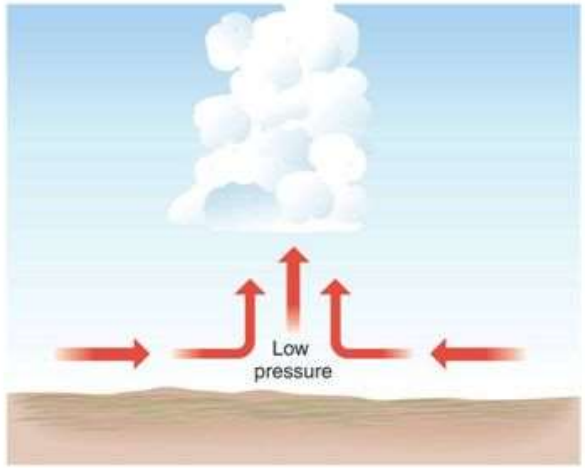
Vapor

Deposition

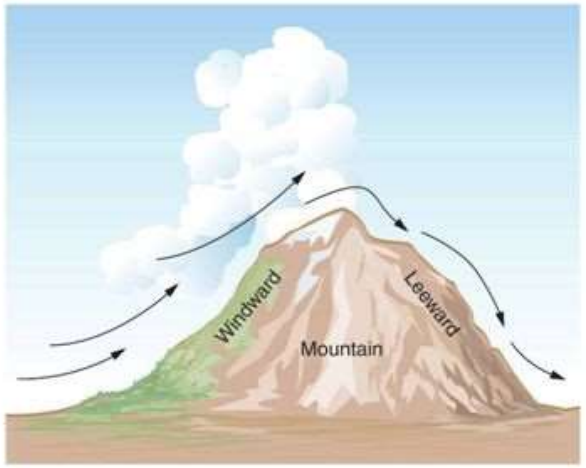
HEAT ENERGY RELEASED TO ENVIRONMENT

Atmospheric Lifting Mechanisms

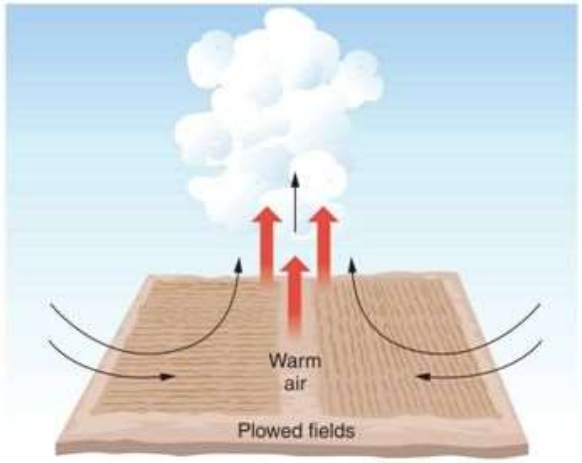




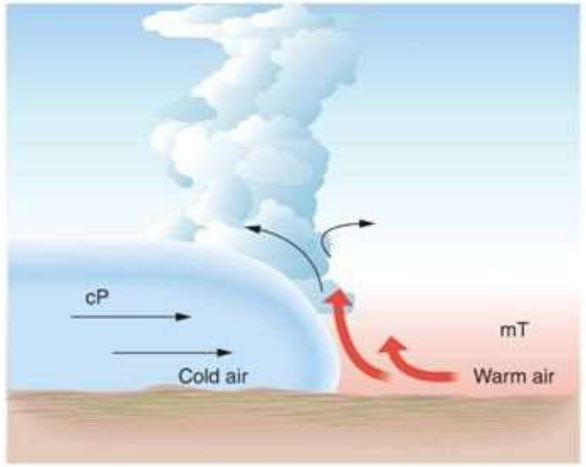
(a) Convergent



(c) Orographic (barrier)



(b) Convectional (local heating)



(d) Frontal (e.g. cold front)

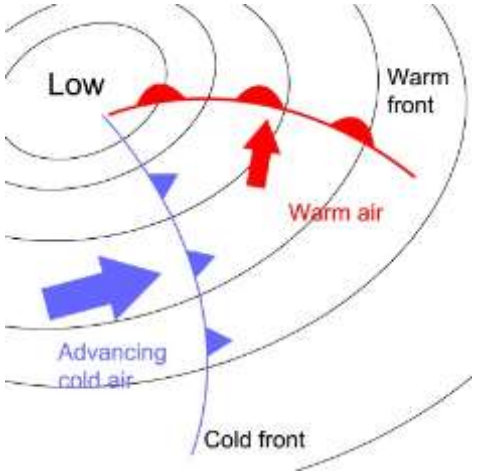


Figure 8.6

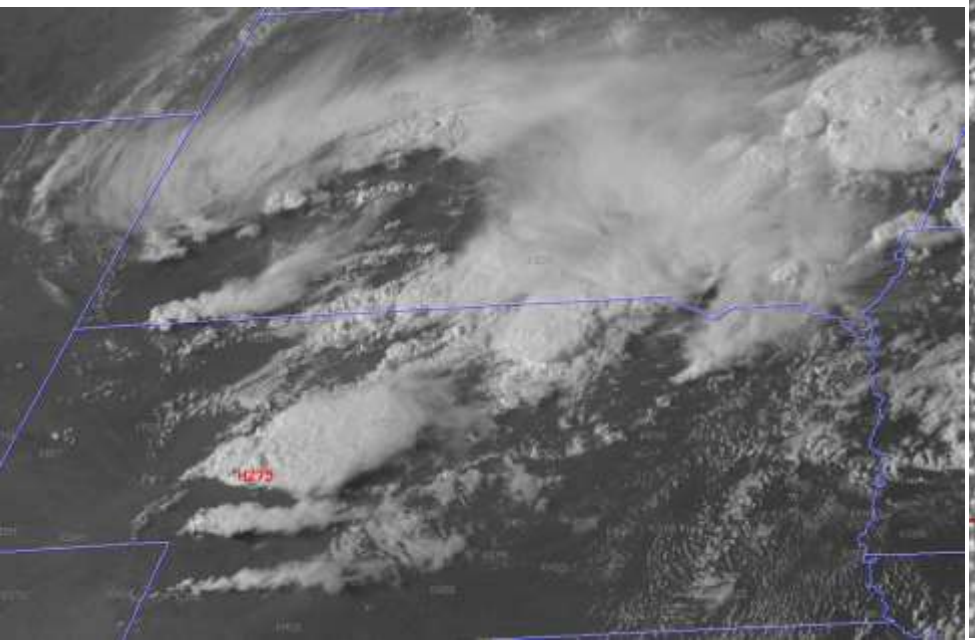
Moisture + Lift = Clouds…more clouds……

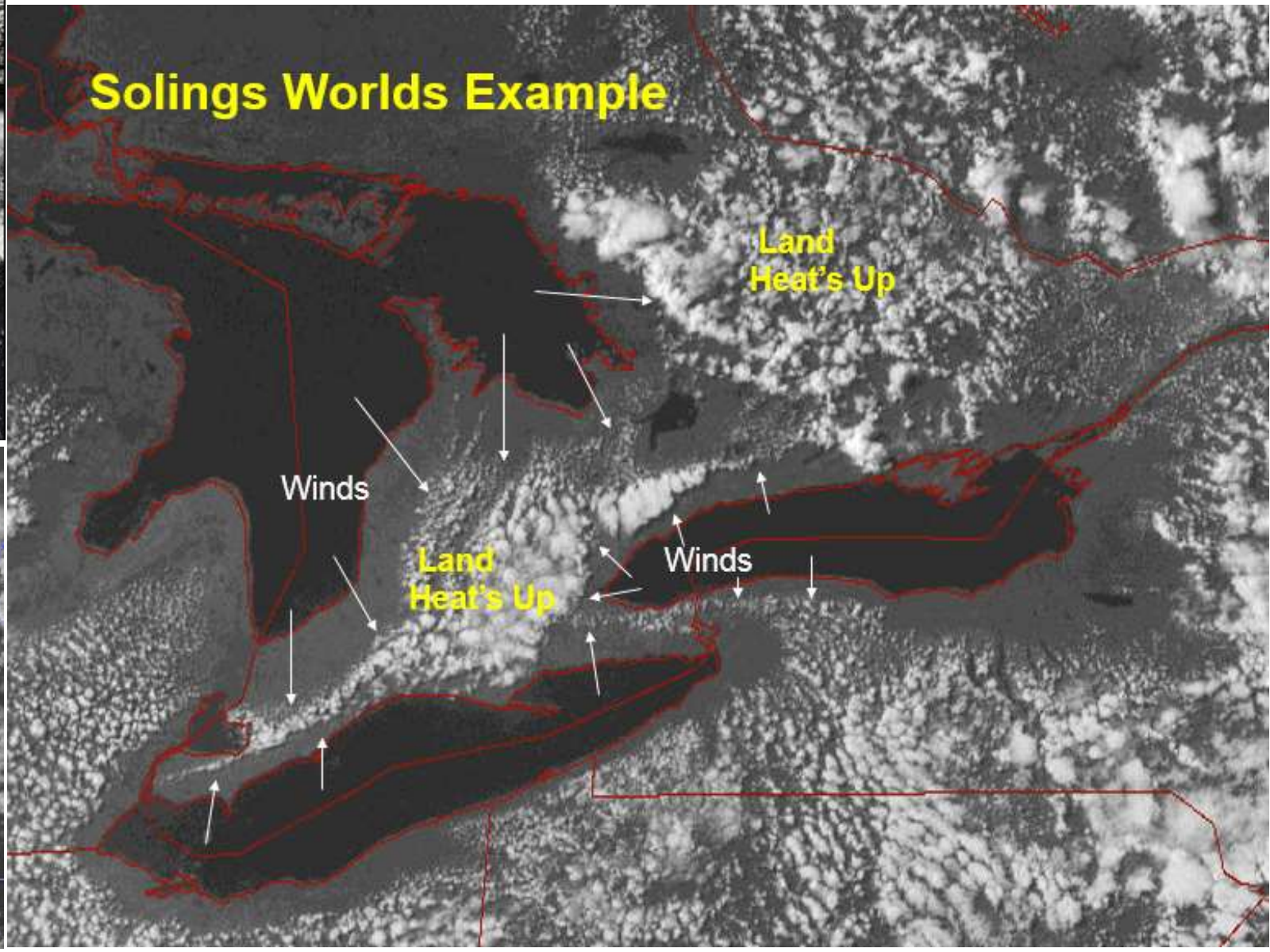
Who invented the cloud classification system?

Luke Howard - "the father of meteorology" (28 November 1772 – 20 March 1864) was a British manufacturing chemist and an amateur meteorologist with broad interests in science.

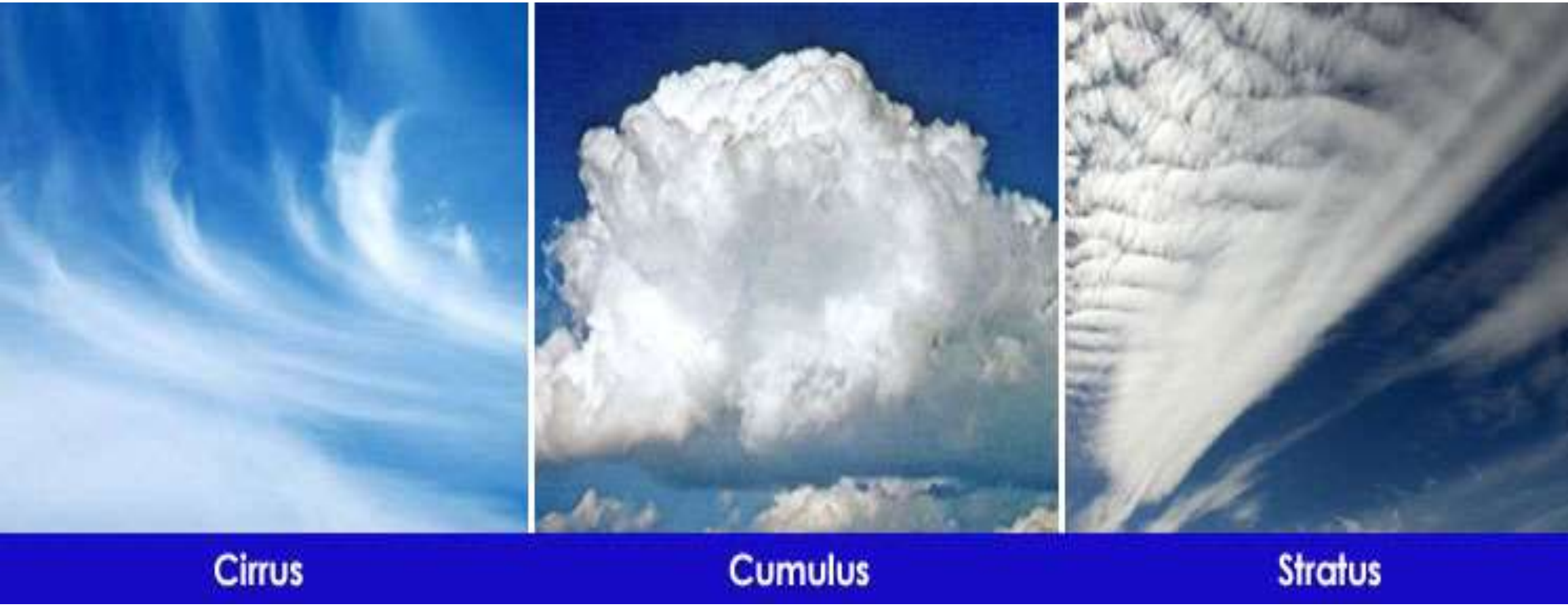
His lasting contribution to science is a nomenclature system for clouds, which he proposed in an 1802 ….and stands today

Why Study or Look At Clouds



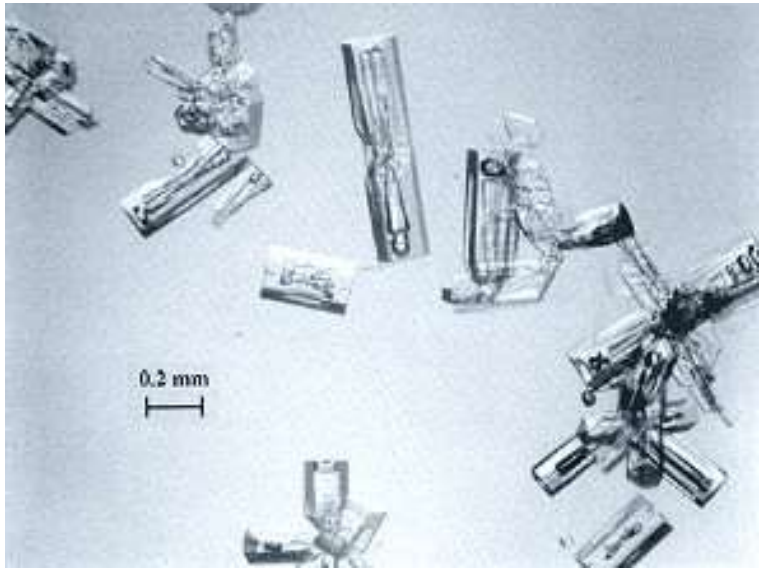


Keep it Simple

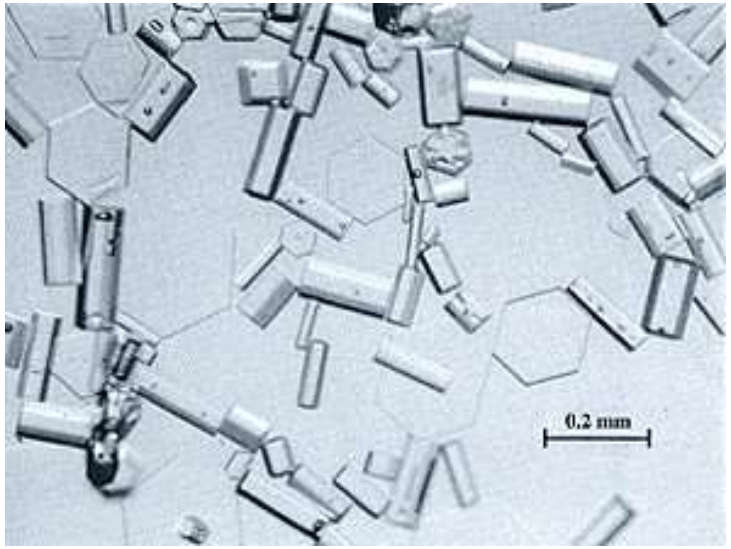


High-Level Clouds

- High-level clouds form above 20,000 feet (6,000 meters)
- Made up of all Ice Crystals


0.2 mm


© H. Michael Mogil HOW THE WEATHER WORKS


0.2 mm

So what does it tell the Mariner – Falling Barometer, Winds from the East…

Weather Change is ~24 hours away. So enjoy you day out on the water


You are here
L

Cirrostratus Clouds

sheet-like and nearly transparent

Weather Change is ~24 hrs. away

Cirrostratus Clouds

High clouds that thinly cover the entire sky with ice crystals.

Light passing through these crystals may form a halo.

Cirrocumulus Clouds

High clouds that are rounded puffs, possibly in rows, are less common than cirrus.

Cirrocumulus clouds

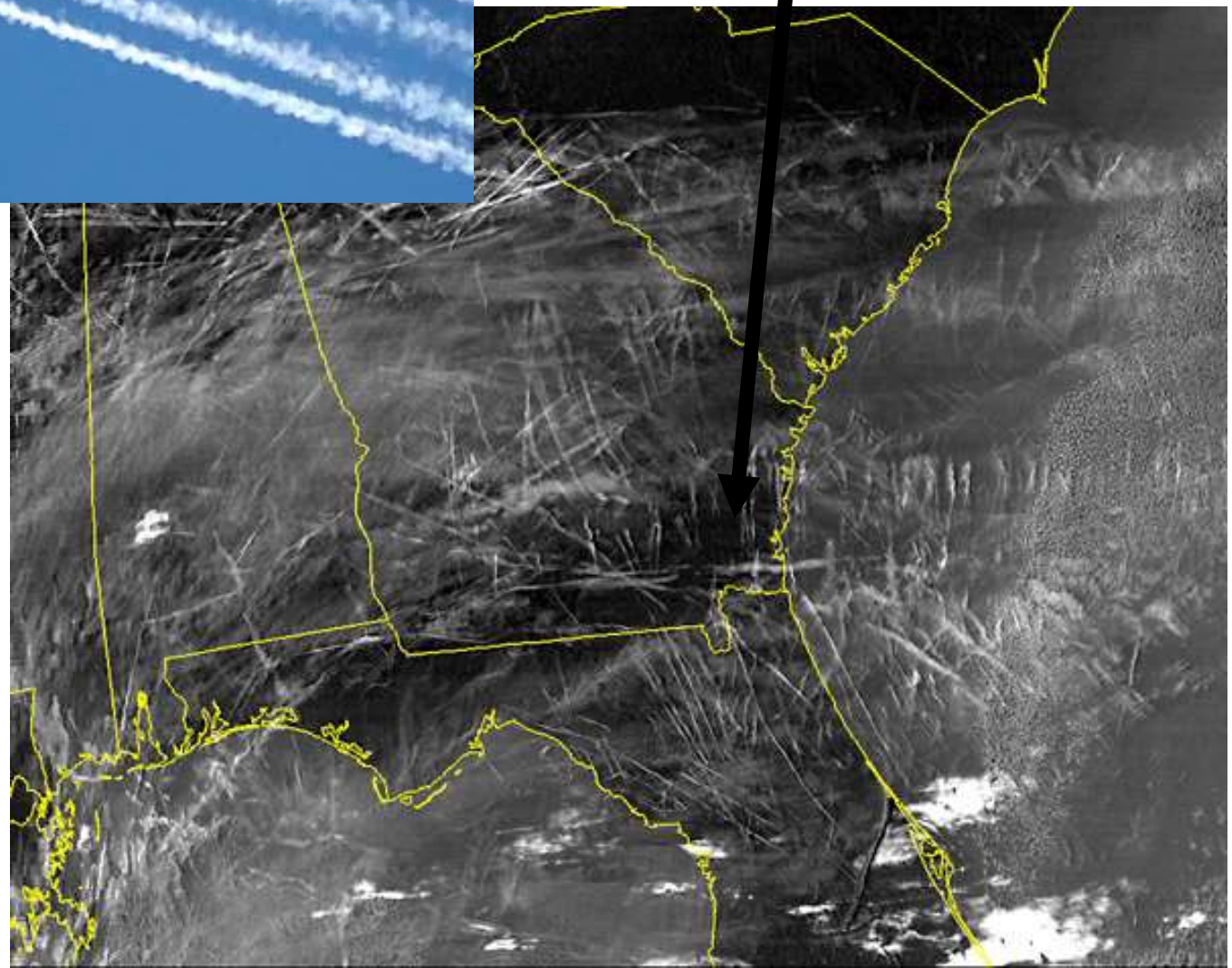
Small, rounded white puffs.

small ripples in the cirrocumulus resemble the scales of a fish. "mackerel sky."

Again Change is ~24 hrs. away

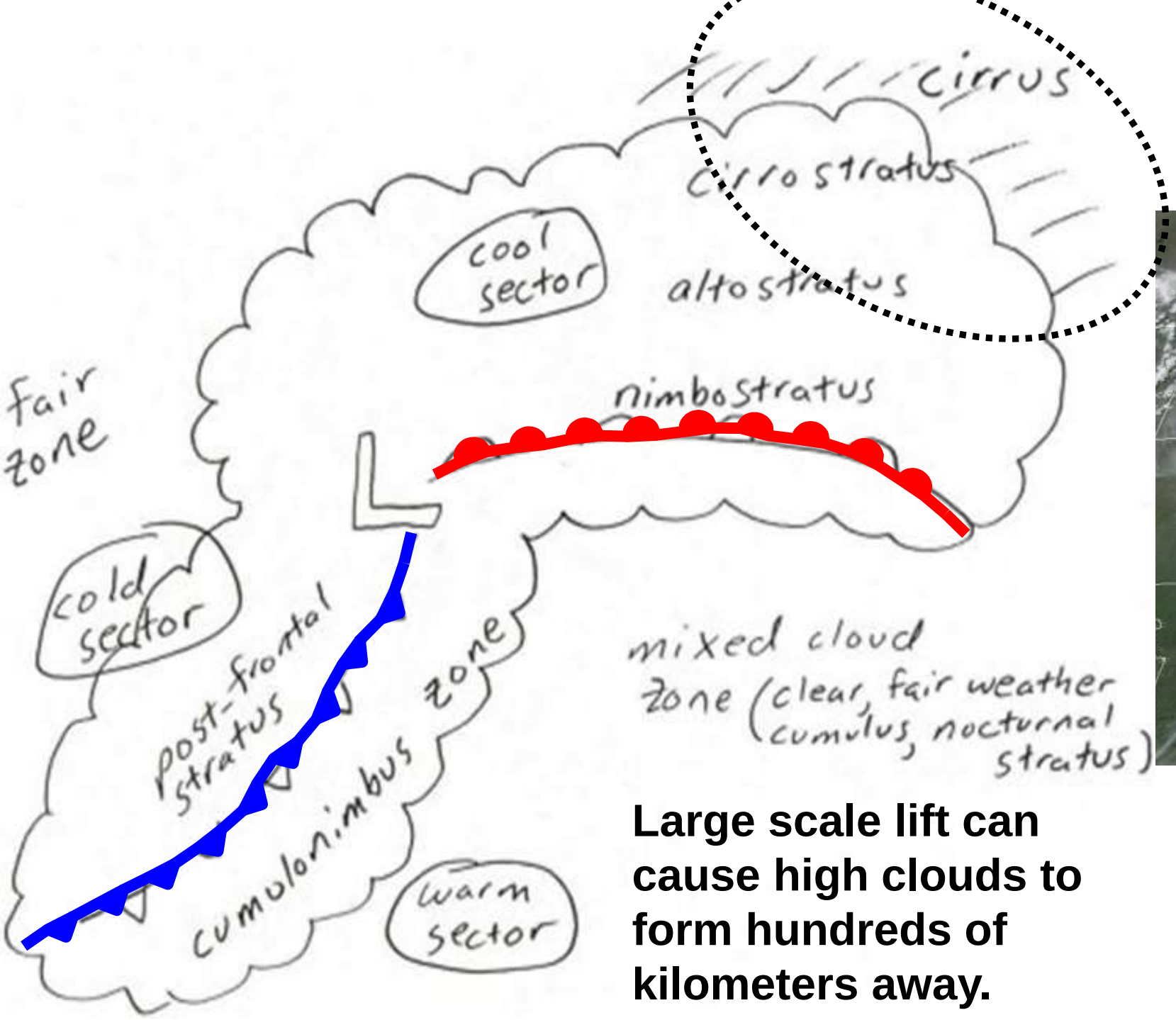
Altostratus Clouds

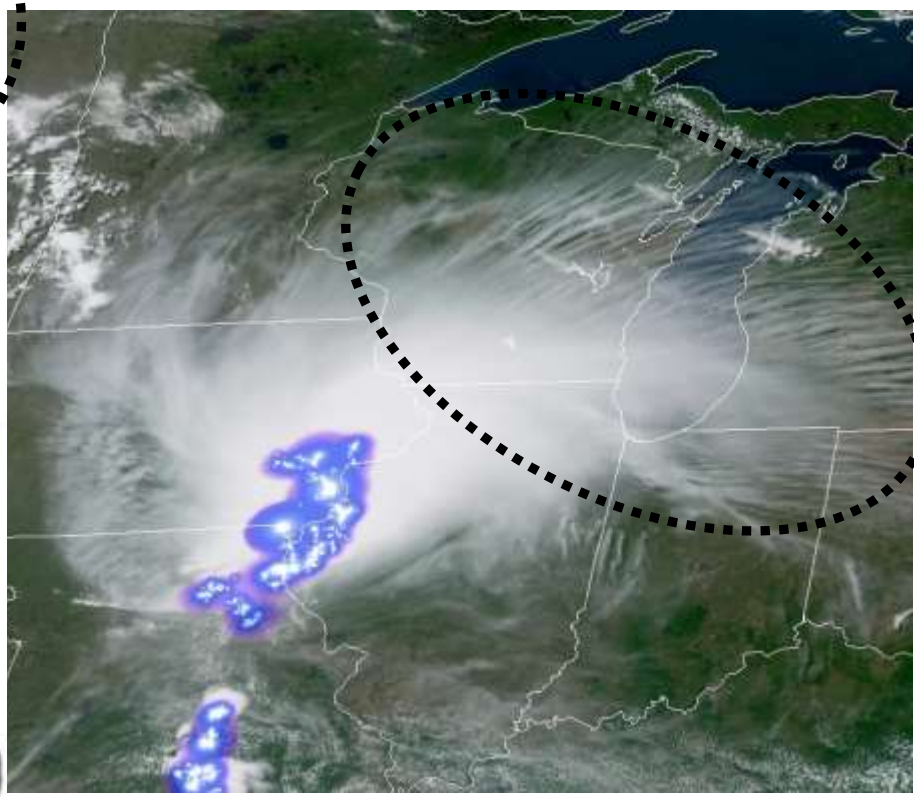
What are these????



Picture Taken Wed at 3:45pm

Picture Taken Next Day at 3:45 pm (light snow) (~23 hrs)

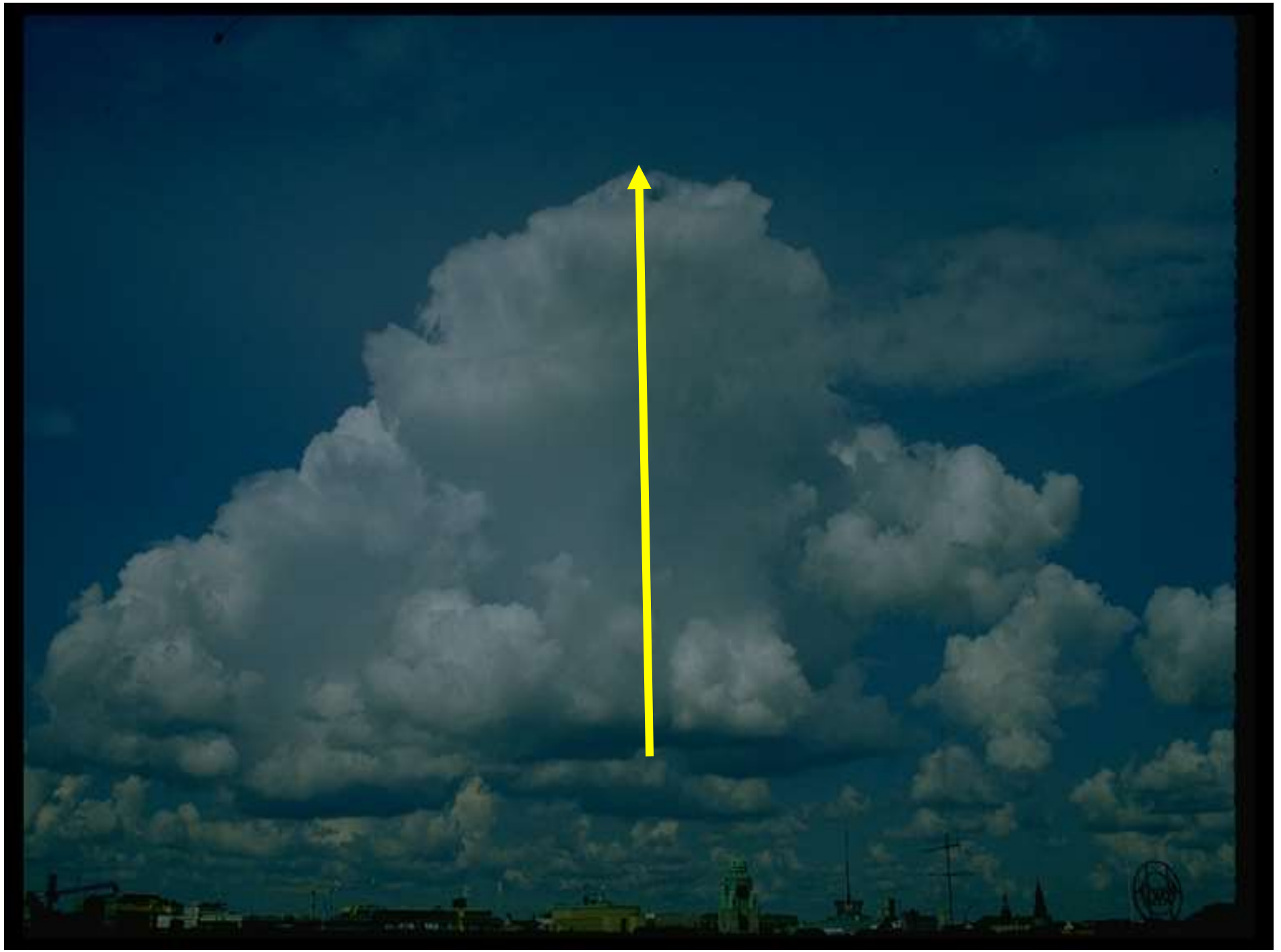


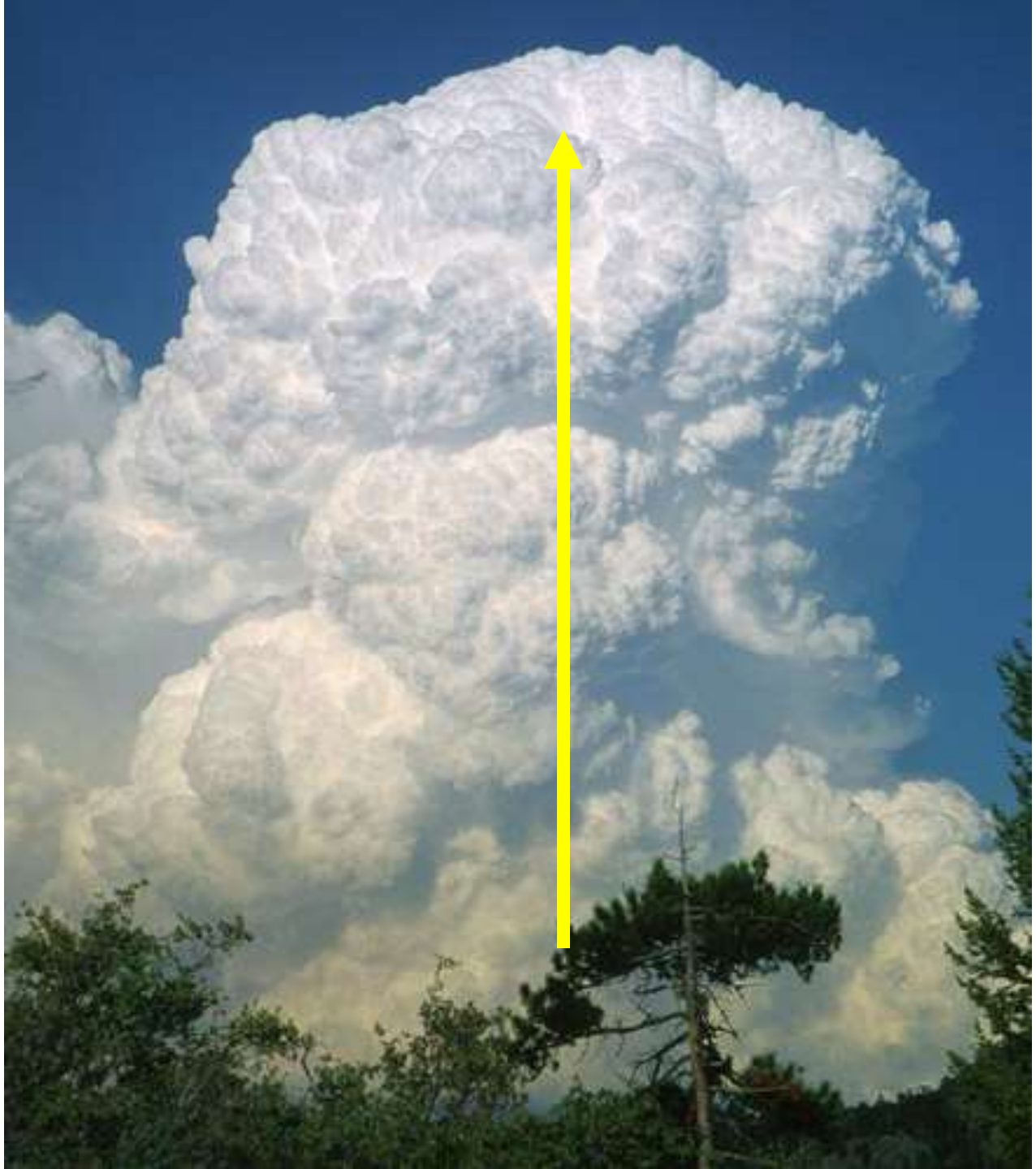


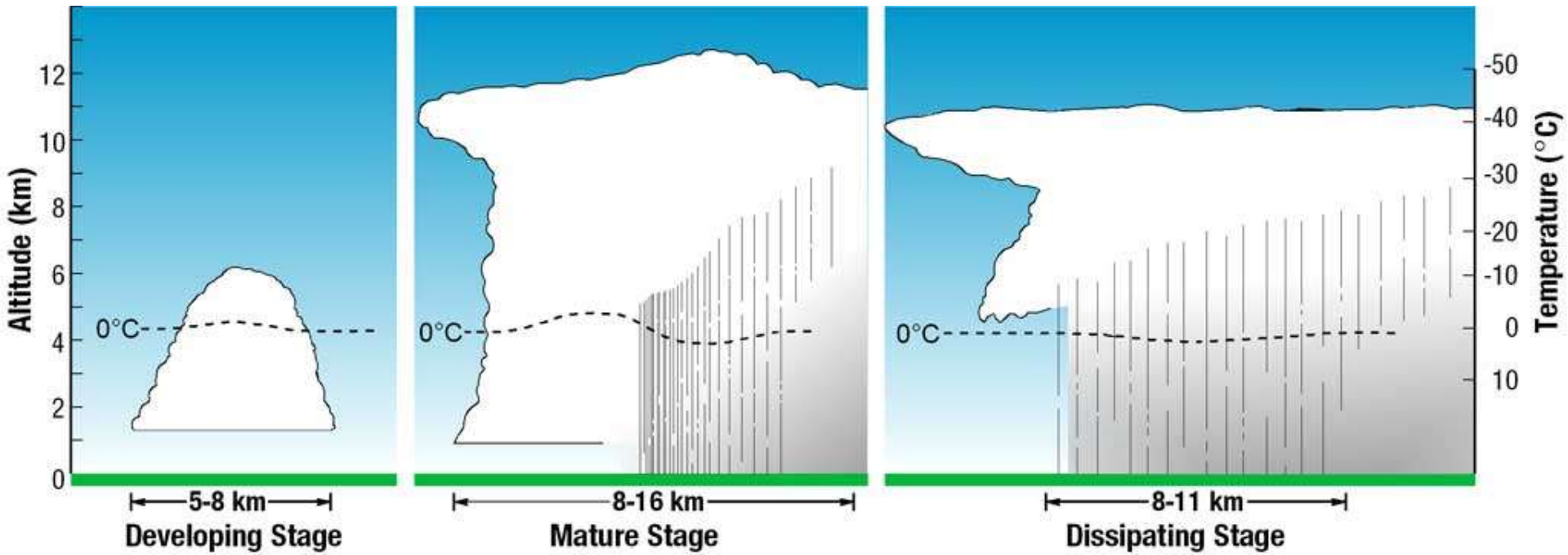
Large scale lift can cause high clouds to form hundreds of kilometers away.

Fair Weather Cumulus

If these cumulus do not change height in 3-5 hrs. then fair weather continues

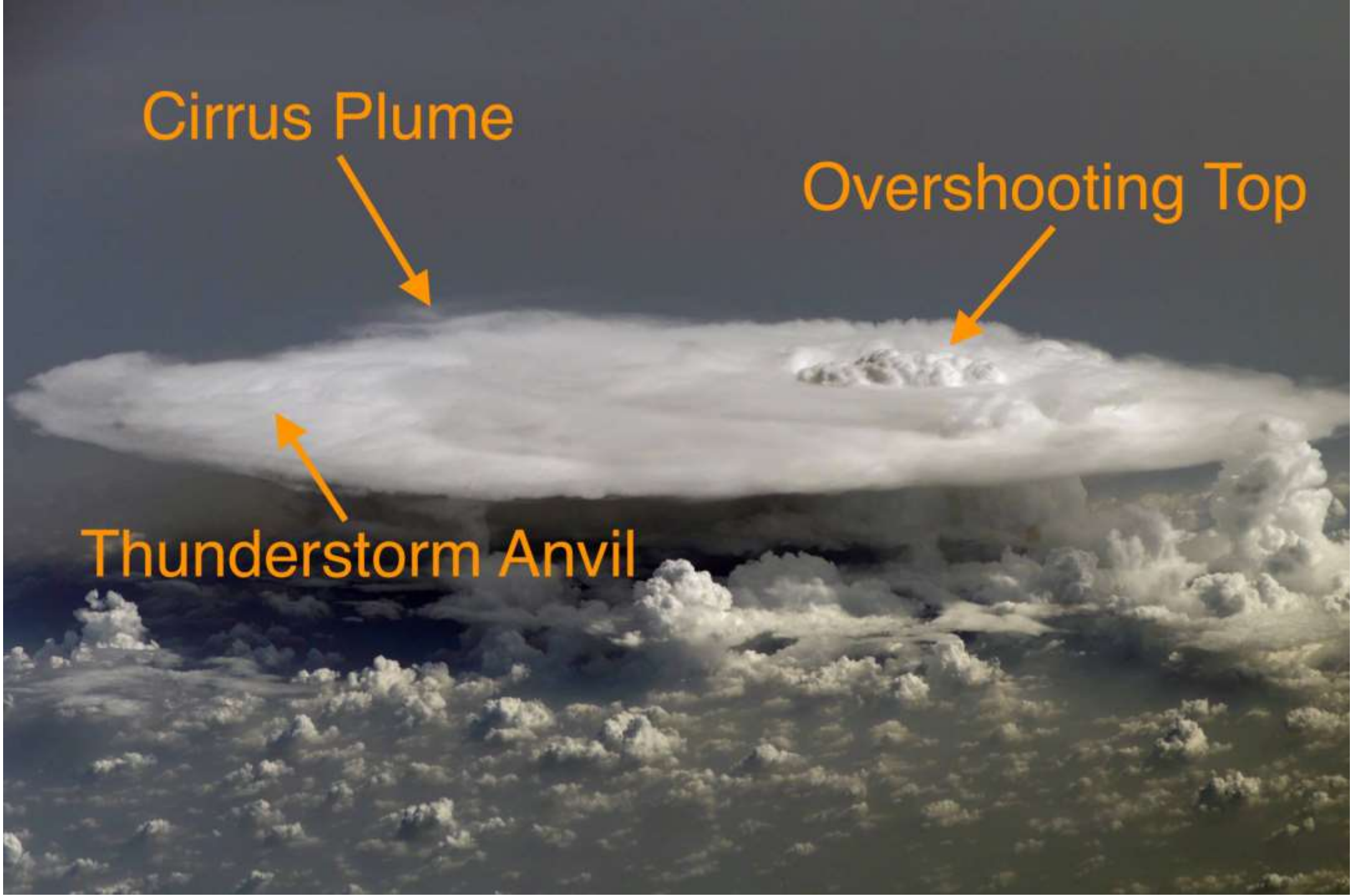





Altitude (km)
12
10
8
6
4
2
0
0°C
5-8 km
Developing Stage
0°C
8-16 km
Mature Stage
0°C
8-11 km
Dissipating Stage
-50
-40
-30
-20
-10
0
10
Temperature (°C)

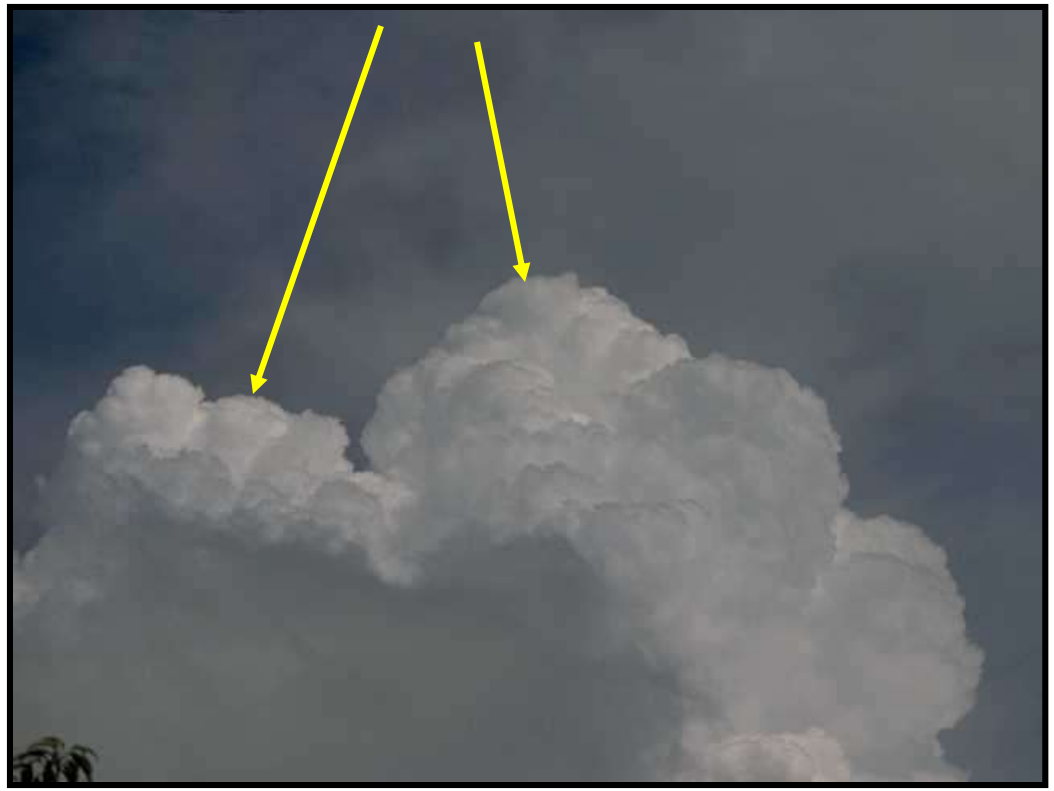
Cumulus Congestus Clouds

Clouds with vertical development that become larger in height, with tops taking a ragged shape similar to cauliflower. Change is certain! maybe just 1 or 2 hrs away


Cirrus Plume
Overshooting Top
Thunderstorm Anvil

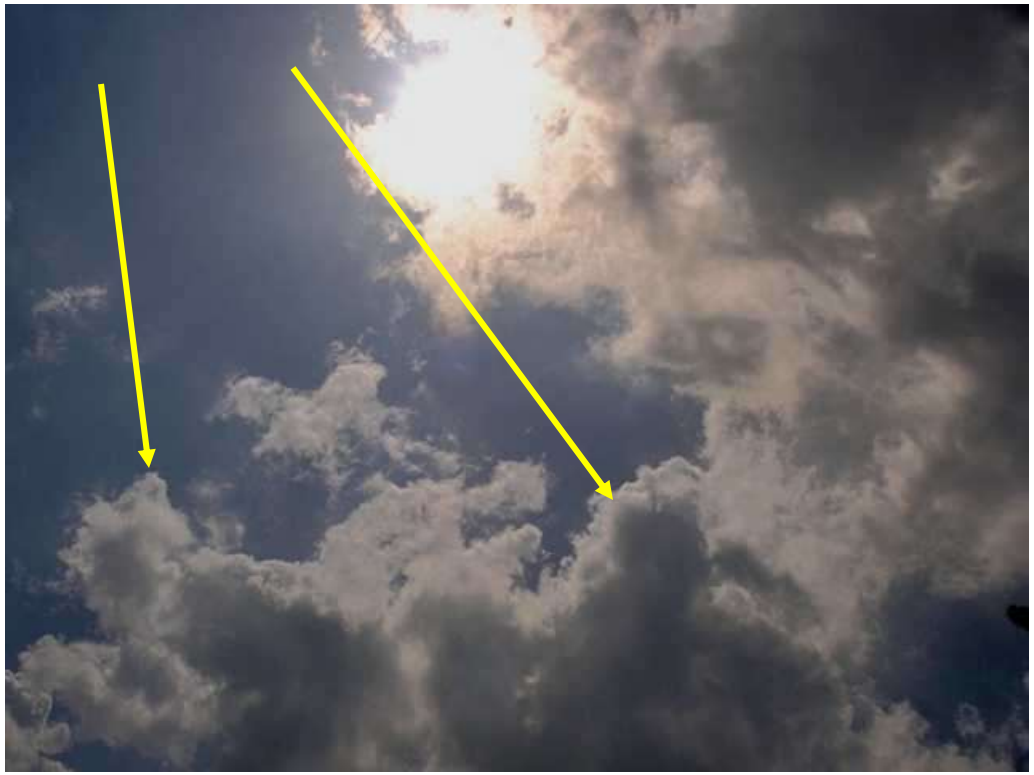
Rules of Thumb for Convection - 1

- If cumulus tops are ‘crisp’ and ‘well defined’...
  - the cloud **<u>will</u>** continue to grow.

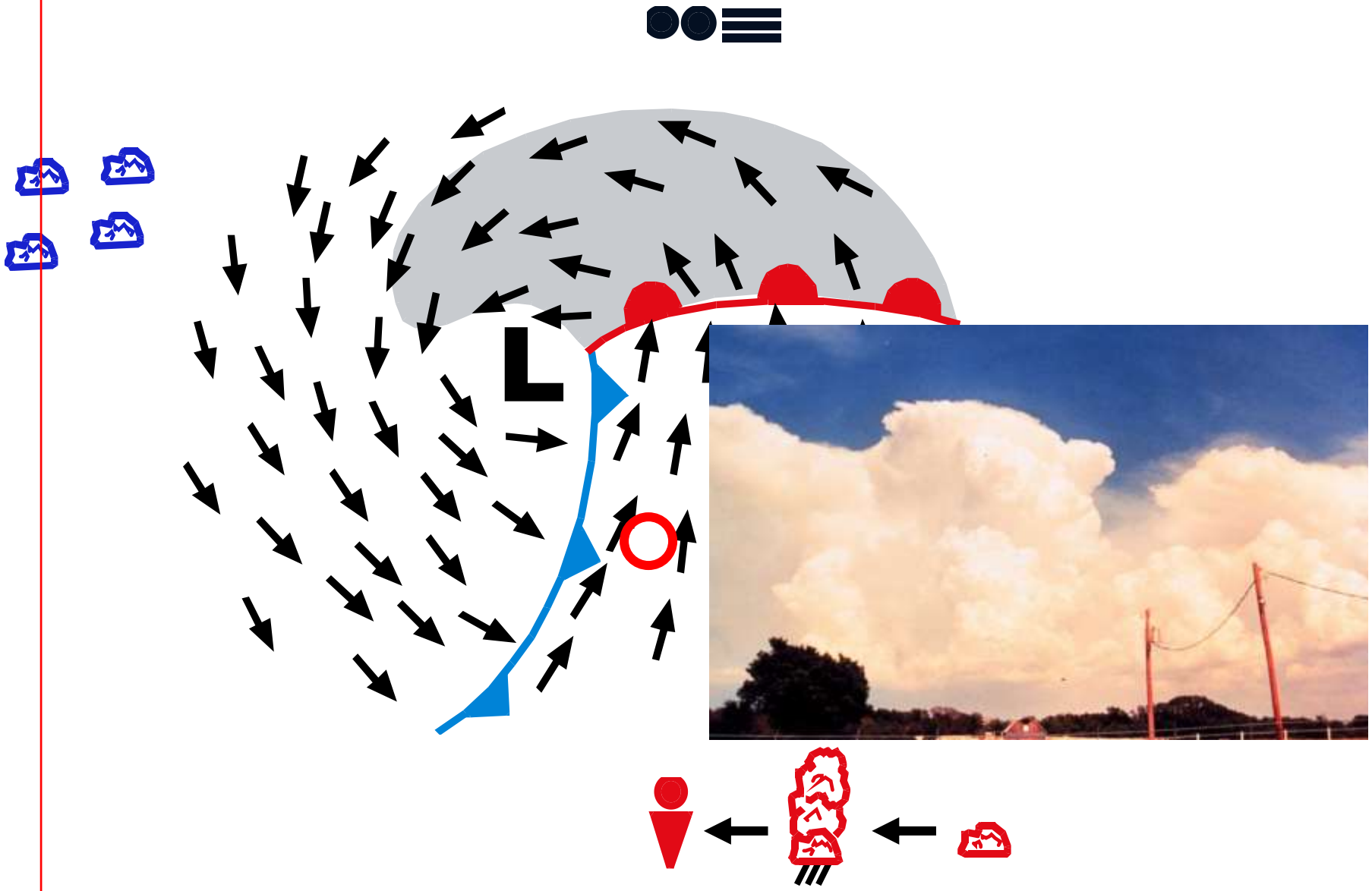


Rules of Thumb for Storm Development - 2

- If cumulus tops are ‘ragged’ and ‘ill-defined’...
  - the cloud **<u>will</u>** **<u>not</u>** continue to grow.

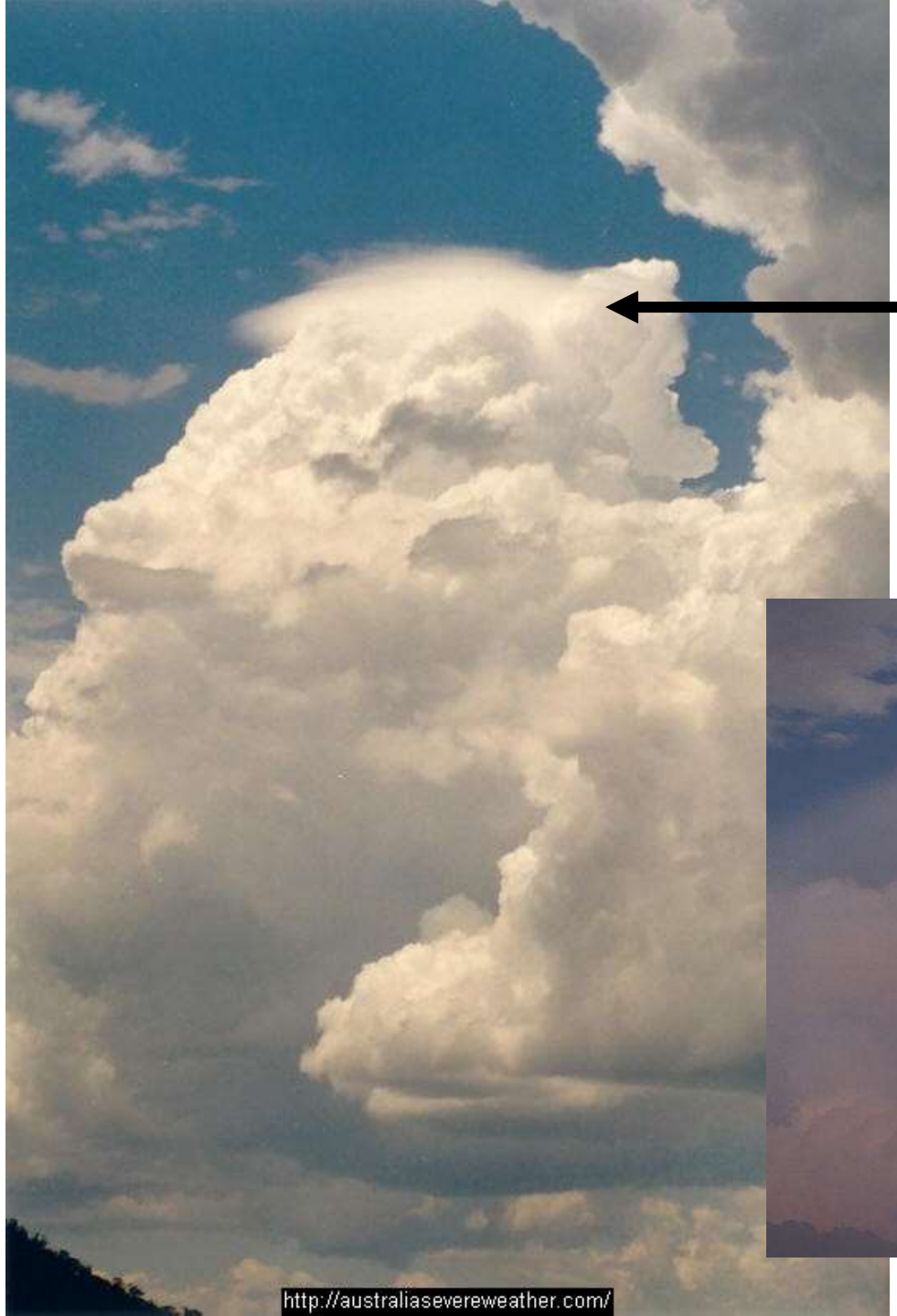


Cloud Formation Leading to Sudden Severe Weather


L

Pileus Cloud

An unusual cloud that forms above a building cumulus by deflected moist winds.



Pileus Cloud

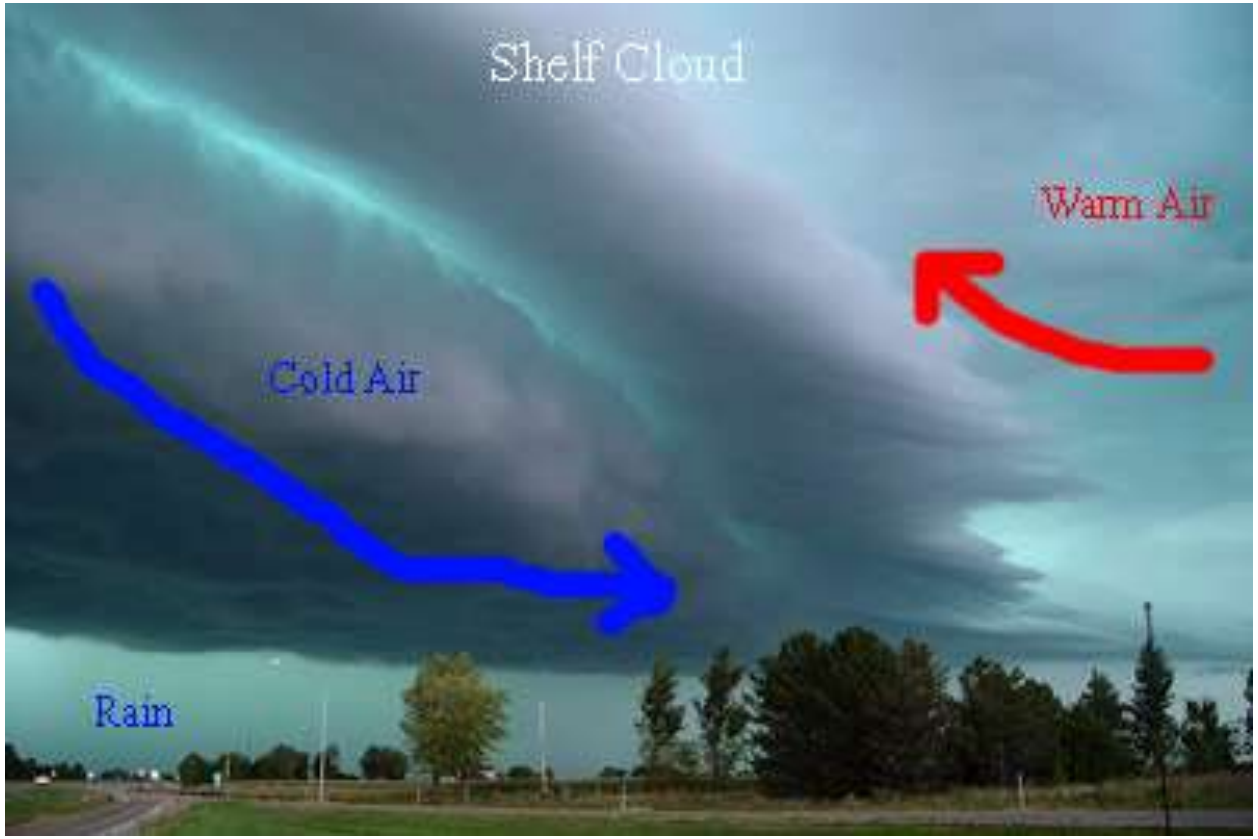

Anvil
Overshooting Top


Mammatus
Cumulus
Copyright © 2004 - Jorn C Olsen


Copyright © 2004 - Jorn C Olsen


Green and Yellow
Colouring
Copyright © 2004 - Jorn C Olsen


Leading edge of Gust Front
Gusts up to 50+ Knots


Shelf Cloud
Warm Air
Cold Air
Rain

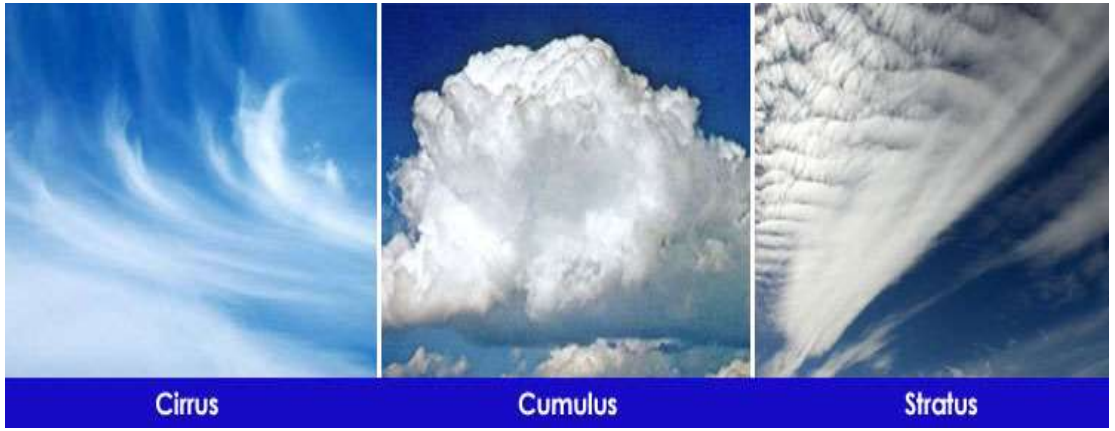

© David Floyd

Back to the Basic's of Forecasting

Barometers

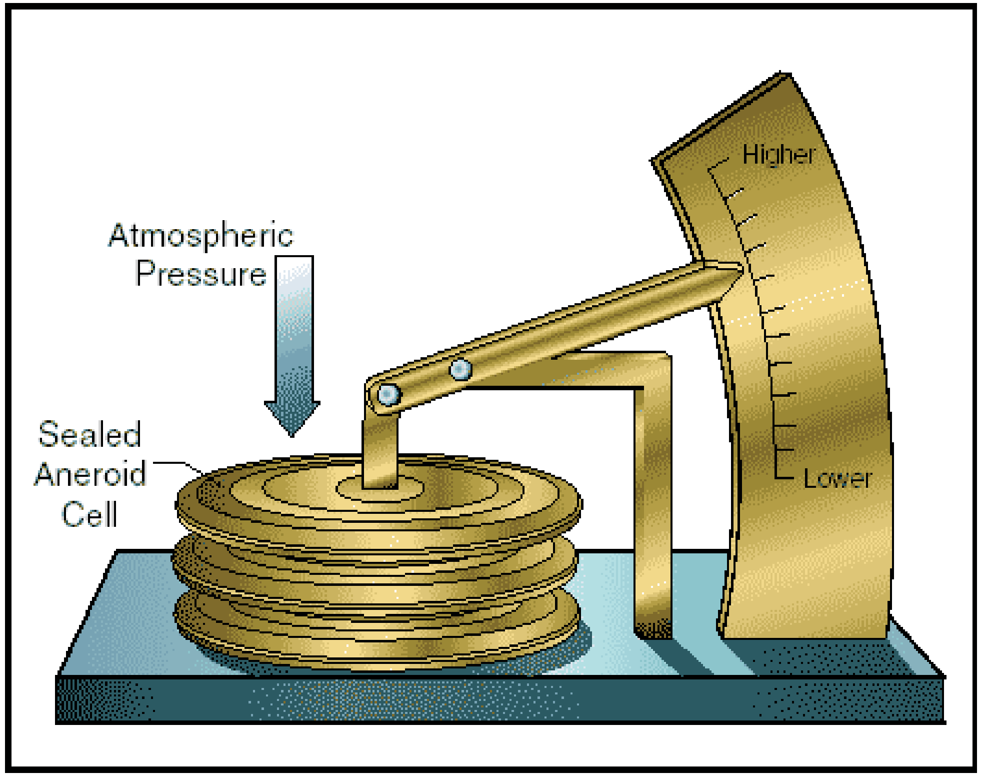
Wind Vane

Cloud Identification

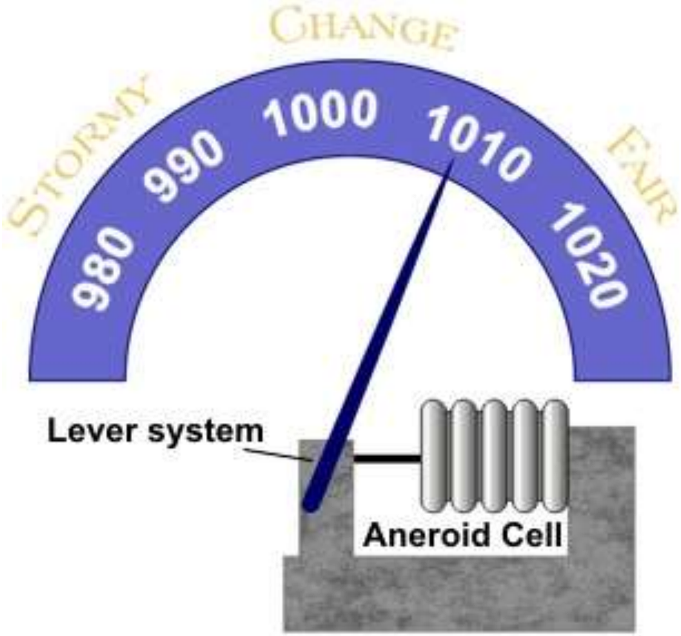


Evangelista Torricelli (1608–1647) was an Italian physicist and mathematician, best known for his invention of the barometer

- ***Aneroid***

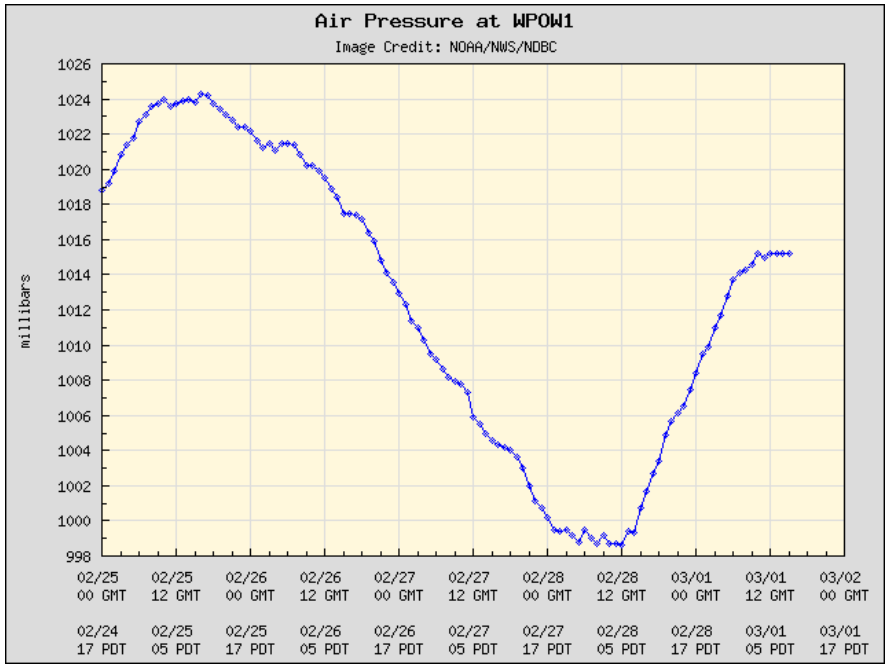

Higher
Atmospheric Pressure
Sealed Aneroid Cell
Lower


1000
1010
1020
1030
990
980
970
960
950
1040
1050
1060
1070
760
770
780
790
800
750
740
730
720
Barometer

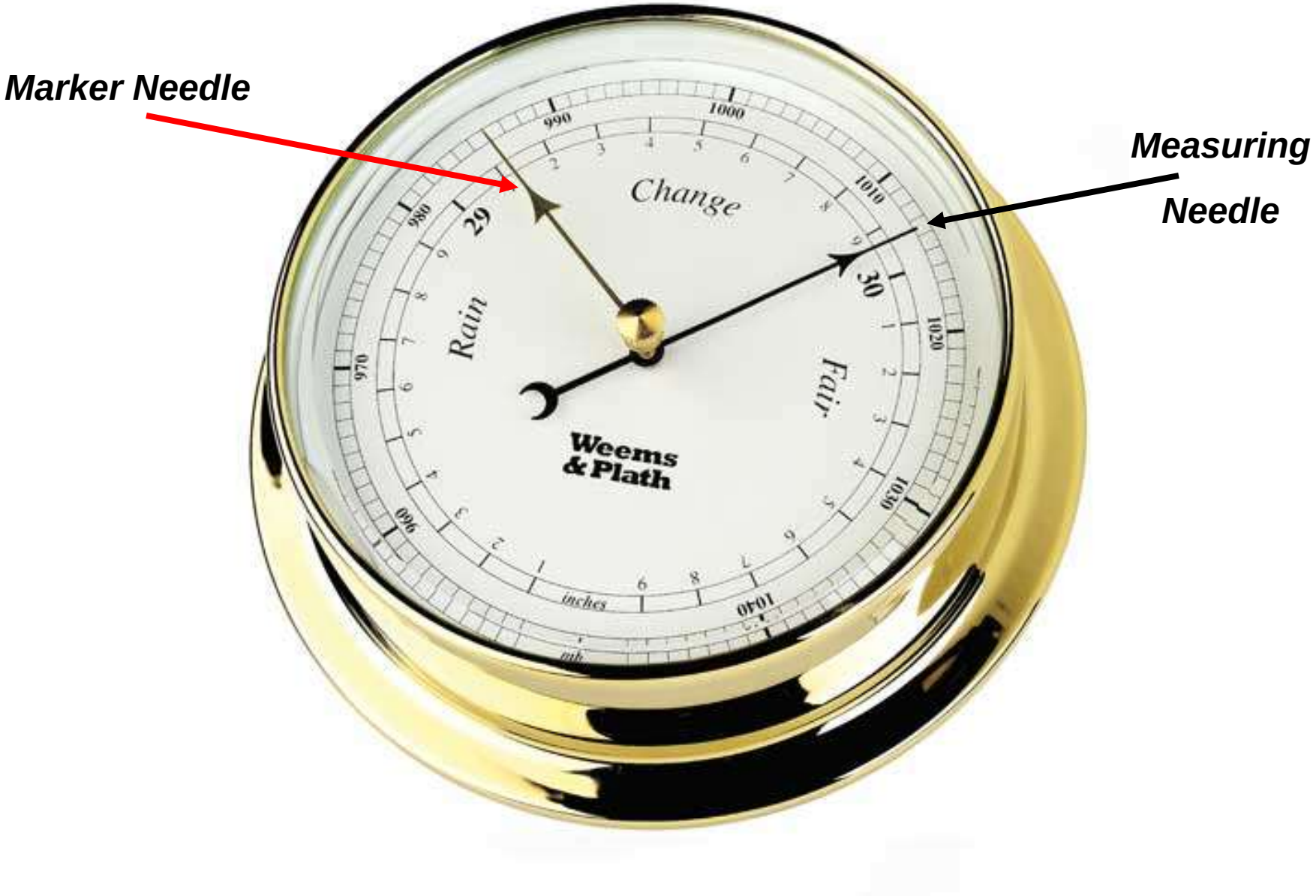

CHANGE
STORMY
FAIR
980
990
1000
1010
1020
Lever system
Aneroid Cell

•*Digital/Electronic*

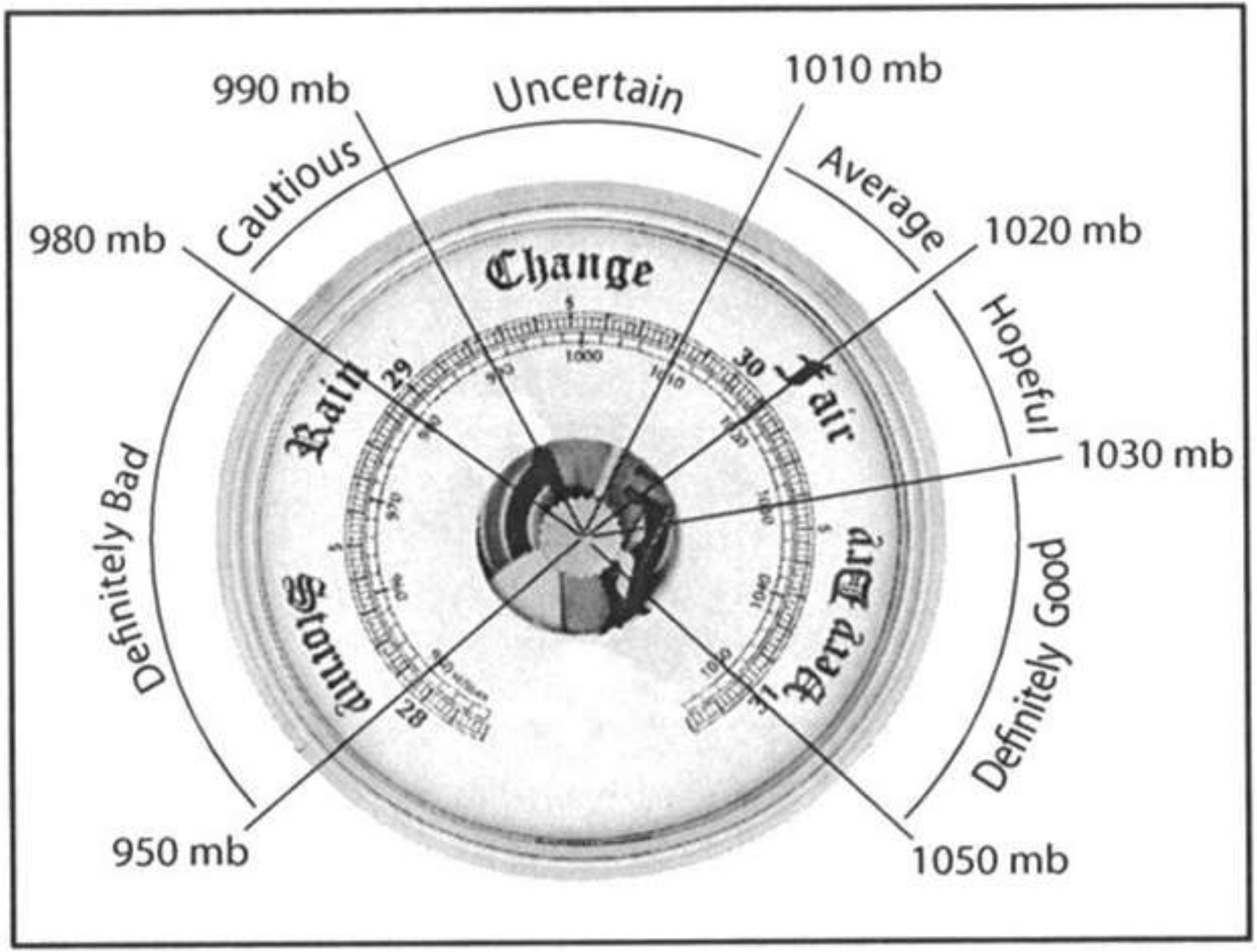
Typical sensor



How to use, read and calibrate the Barometer



“Adjusting” or “Calibration” Screw on the back of and Aneroid Barometer


990 mb
Uncertain
1010 mb
Cautious
Average
980 mb
1020 mb
Change
Hopeful
Definitely Bad
Rain
Fair
1030 mb
Storm
Very Dry
Definitely Good
950 mb
1050 mb

Barometers and Weather Forecasting

Actual Pressure vs Change of Pressure

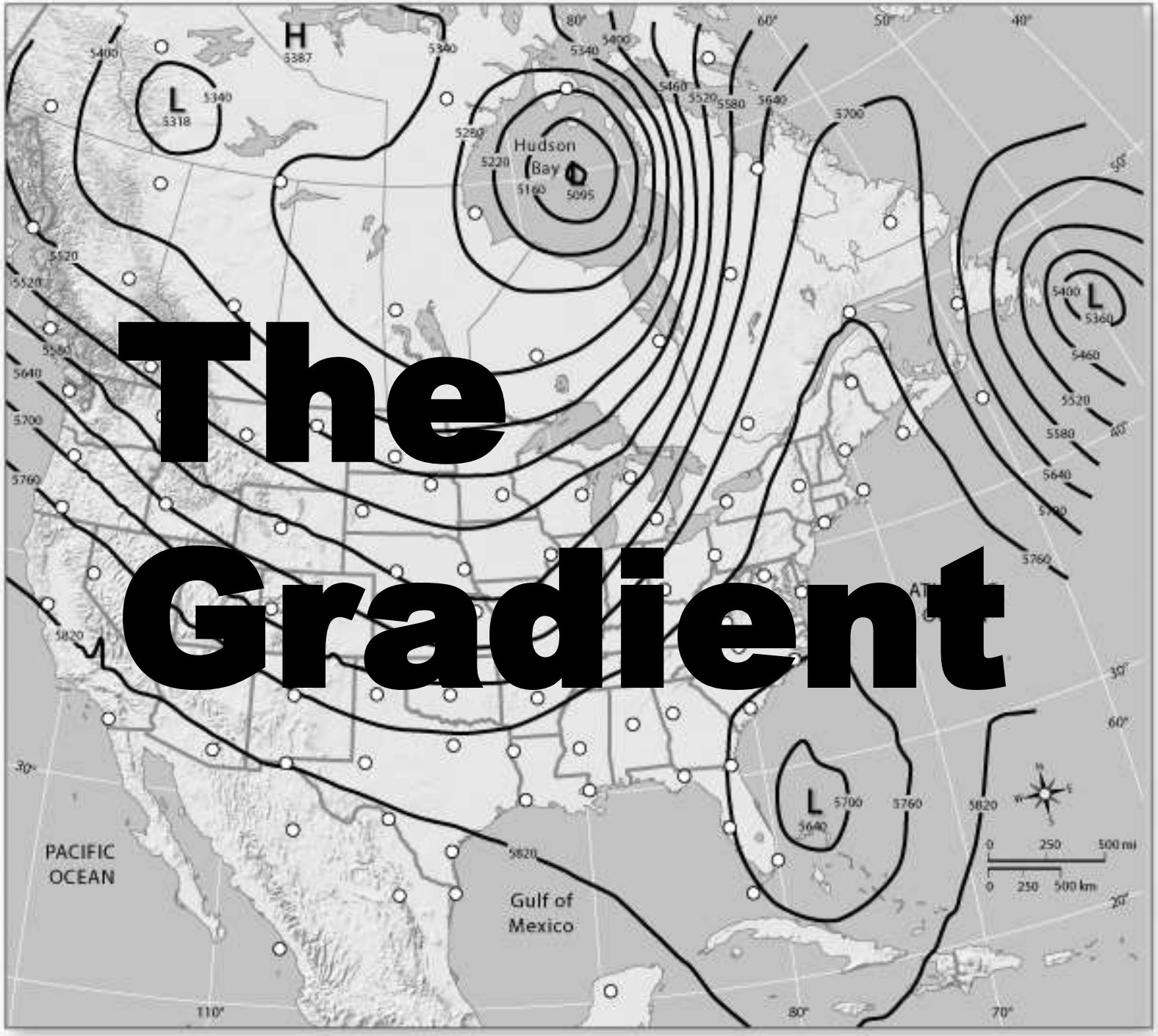
Table 5.5-2 NWS Definition of Rapid Change[1]		
Term	*Pressure change over 1 Hour*	*Minimum change over 3 Hours*
Rising or falling rapidly	2 mb or more	at least 1 mb

Table 5.5-3 Met Office Definition of Pressure Change[1]		
Term	*Pressure Change Over 3 Hours*	*Pressure Change Over 6 Hours*[2]
Steady	Less than 0.1 mb	Less than 0.2 mb
Rising or falling slowly	0.1 to 1.5 mb	0.2 to 3 mb
Rising or falling	1.6 to 3.5 mb	3.2 to 7 mb
Rising or falling quickly	3.6 to 6.0 mb	7.2 to 12 mb
Rising or falling very rapidly	More than 6.0 mb	More than 12 mb

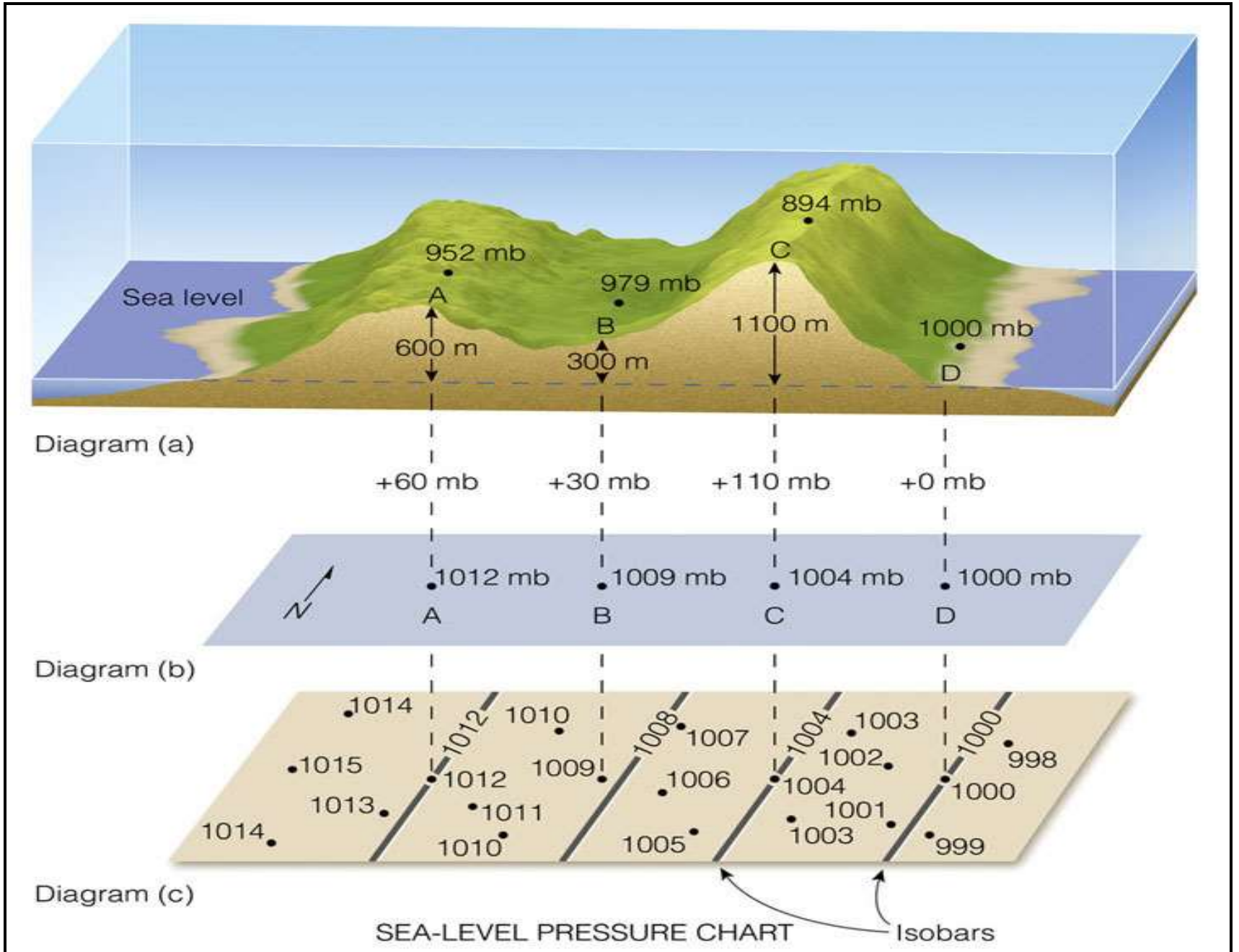
General Rule for Wind Speed Increase and Pressure Change

"4-5-6" Guideline to Pressure as Wind Forecaster	
Likely Significance	*Steady pressure drop over 6 Hours*
Alert	Less than 3 mb
Caution	3 to 4 mb
Definite warning	4 to 5 mb
Too late for forecasting	More than 5 mb

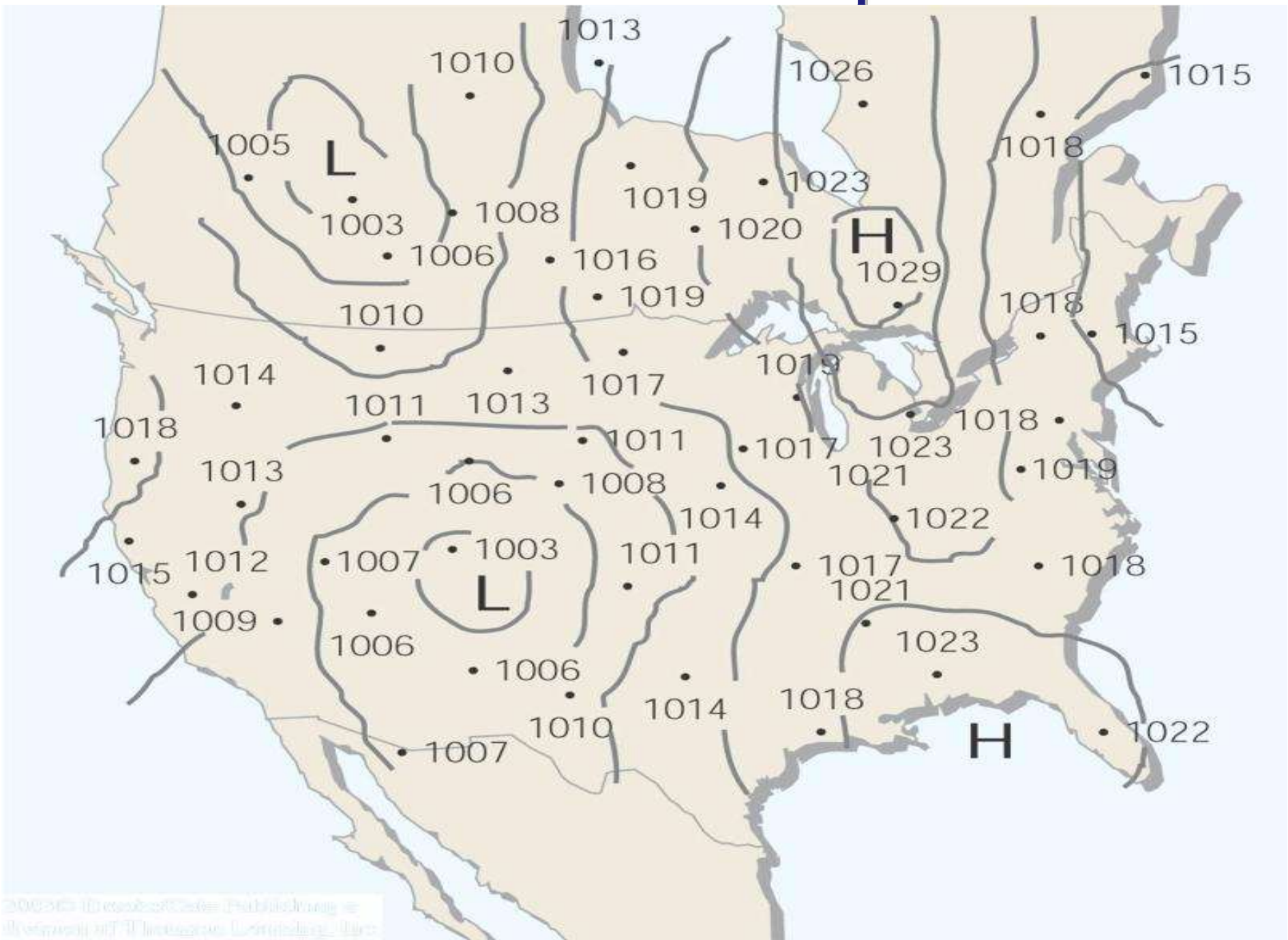
Appendix 5a. Weather Forecasting Table — Northern Hemisphere*			
BAROMETER AT SEA LEVEL		*WIND*	*CHARACTER OF WEATHER*
Rising			
1019 to 1023	Rising rapidly	SW to NW	Fair followed within 2 days by rain.
≤ 1016	Rising slowly	S to SW	Clearing within a few hours and fair for several days.
≤ 1009	Rising rapidly	Going to W	Clearing and colder
Steady			
≥ 1023	Steady	SW to NW	Continued fair with no decided temperature change.
1019 to 1023		SW to NW	Fair with slight temperature changes for 1 or 2 days.
Falling			
≥ 1023	Falling slowly	SW to NW	Slowly rising temperature and fair for 2 days.
	Falling slowly	E to NE	In summer with light winds, rain may not fall for several days. In winter, rain in 24 hours.
1019 to 1023	Falling slowly	S to SE	Rain within 24 hours.
		SE to NE	Rain in 12 to 18 hours.
	Falling rapidly	S to SE	Wind increasing in force; rain within 12 to 24 hours.
		SE to NE	Increasing wind and rain within 12 hours.
≥ 1019	Falling rapidly	E to NE	In summer, rain probably in 12 hours. In winter, rain or snow with increasing winds will often set in when the barometer begins to fall and the wind sets in from the NE
≤ 1016	Falling slowly	SE to NE	Rain will continue 1 or 2 days.
	Falling rapidly	SE to NE	Rain with high winds, followed within 36 hours by clearing and, in winter, colder temperatures.
		S to E	Severe storm imminent, followed within 24 hours by clearing and, in winter, colder temperatures.
≤ 1009	Falling rapidly	E to N	Severe NE gale and heavy rain; in winter, heavy snow followed by a cold wave.



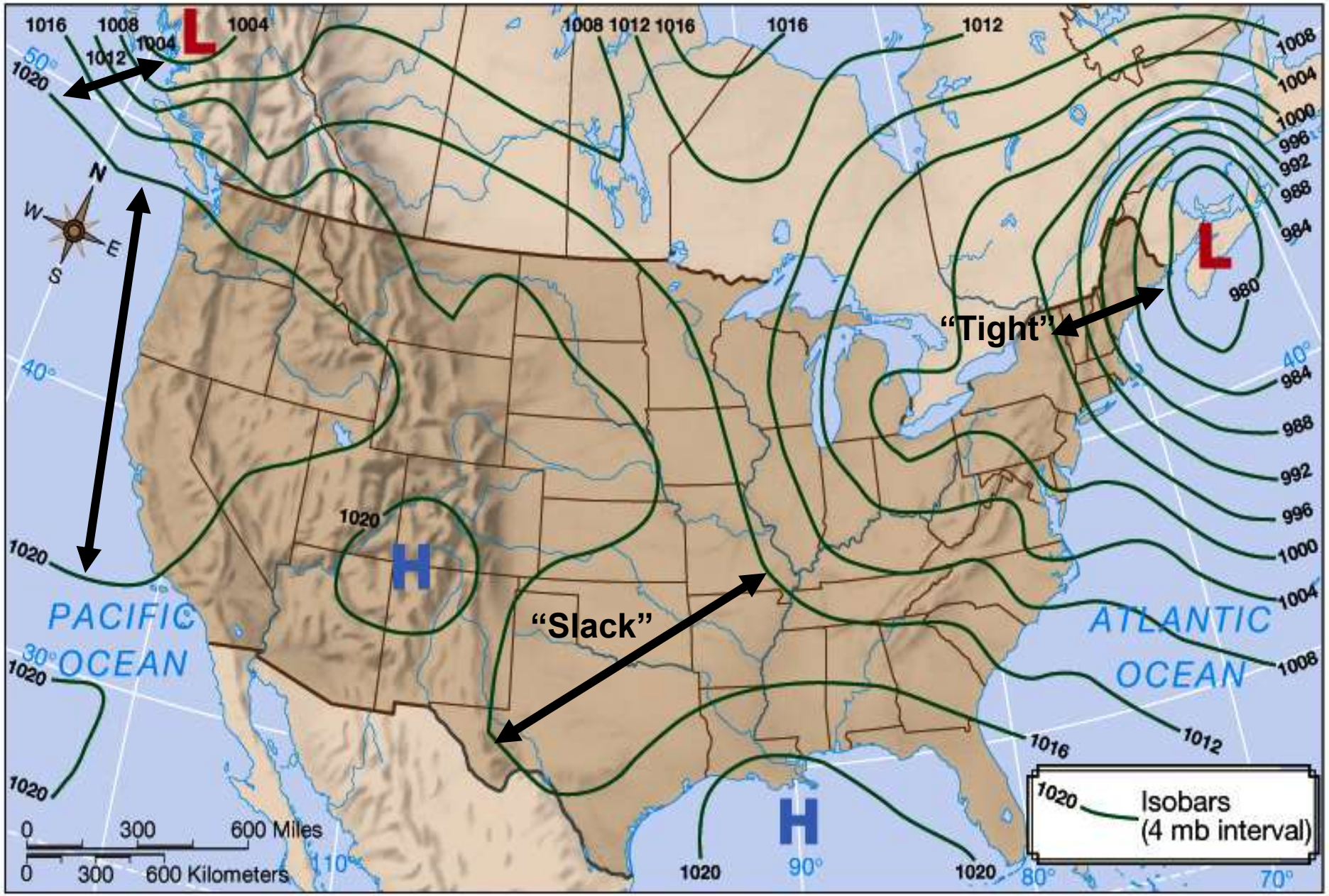
The Gradient



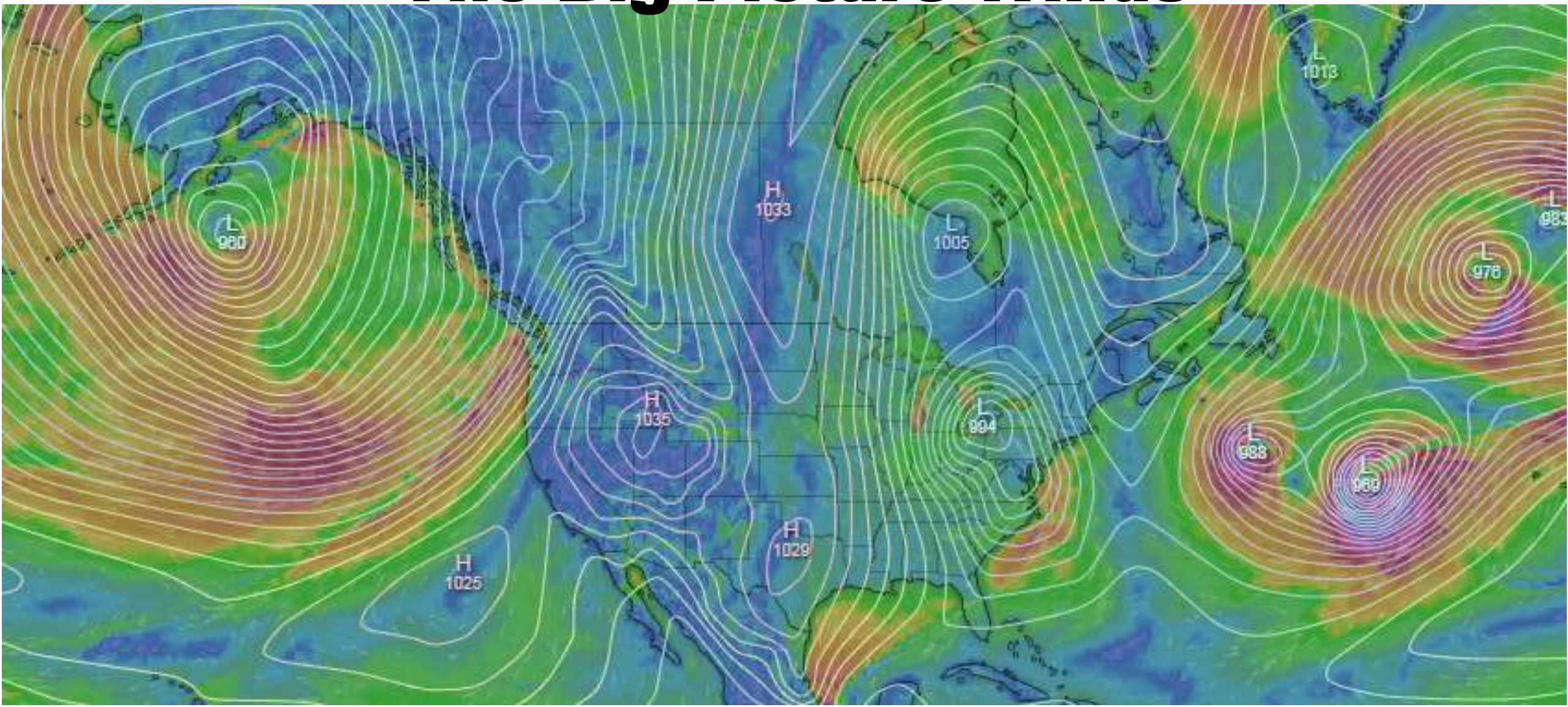
Smoothed Isobar Maps

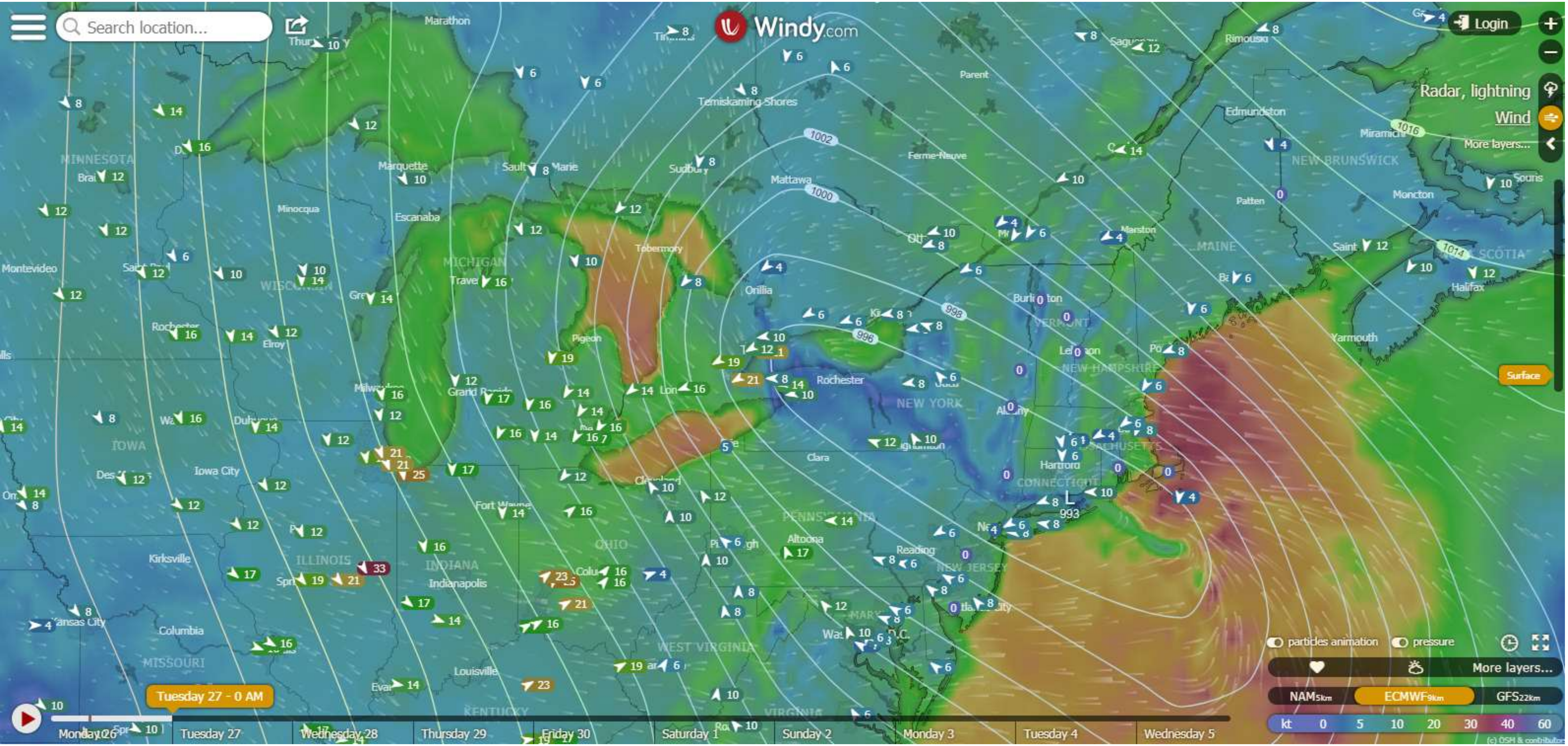


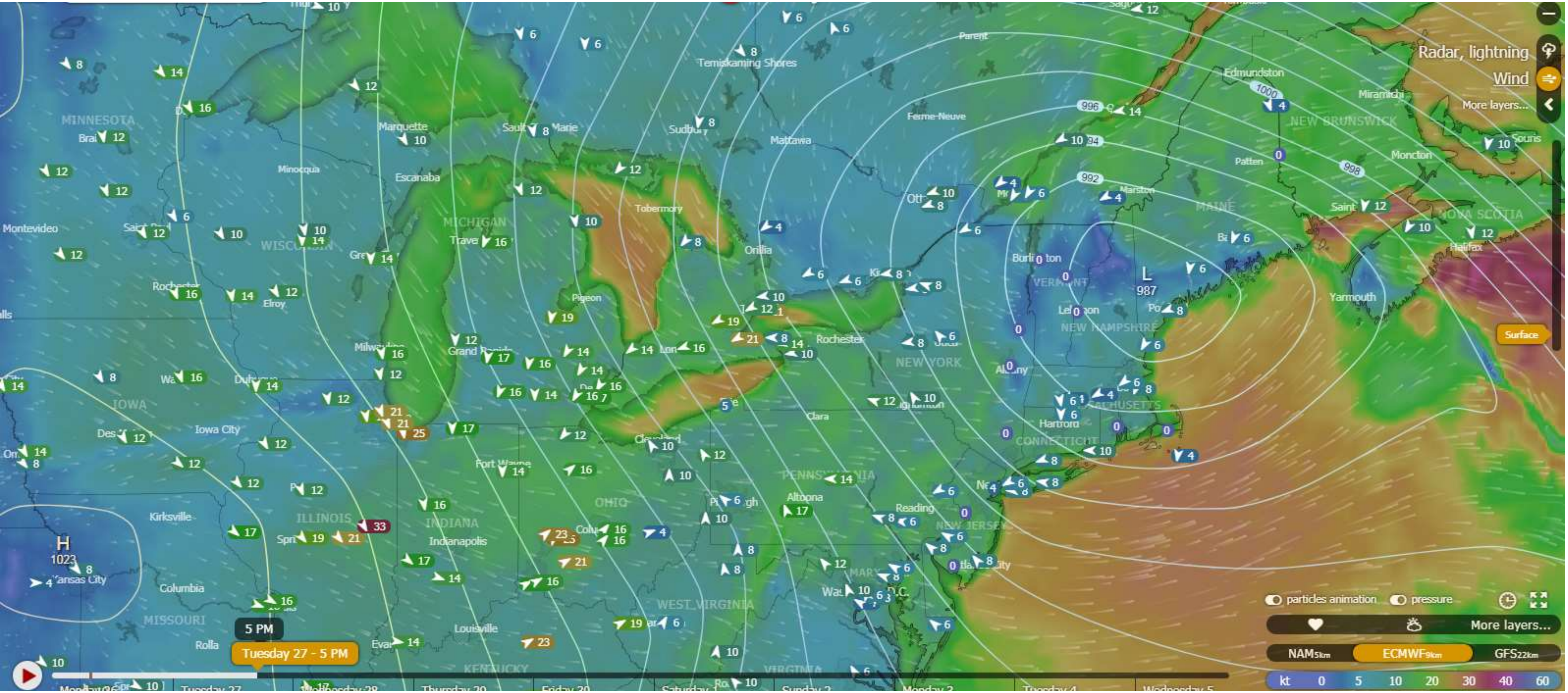
Isobars Basics – The Gradient



The Big Picture Winds




Windy.com
Search location...
Login
Radar, lightning
Wind
More layers...
Surface
particles animation
pressure
More layers...
NAM5km
ECMWF9km
GFS22km
kt 0 5 10 20 30 40 60
Tuesday 27 - 0 AM
Monday 26
Tuesday 27
Wednesday 28
Thursday 29
Friday 30
Saturday 1
Sunday 2
Monday 3
Tuesday 4
Wednesday 5
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
ILLINOIS
INDIANA
OHIO
MISSOURI
KENTUCKY
WEST VIRGINIA
VIRGINIA
PENNSYLVANIA
NEW YORK
NEW JERSEY
VERMONT
NEW HAMPSHIRE
CONNECTICUT
MAINE
NEW BRUNSWICK
NOVA SCOTIA
Marathon
Temiskaming Shores
Parent
Rimouski
Edmundston
Miramichi
Moncton
Halifax
Yarmouth
Patten
Marston
Ferme-Neuve
Mattawa
Sudbury
Marquette
Escanaba
Minocqua
Tobermory
Orillia
Rochester
Clara
Altoona
Reading
Hartford
Indianapolis
Louisville
Columbia
Kirksville
Iowa City
Montevideo
Elroy
Pigeon
1002
1000
998
996
993
1016
1014
(c) OSM & contributors



Radar, lightning
Wind
More layers...
Surface
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
ILLINOIS
INDIANA
OHIO
MISSOURI
KENTUCKY
WEST VIRGINIA
VIRGINIA
PENNSYLVANIA
NEW YORK
NEW JERSEY
CONNECTICUT
VERMONT
NEW HAMPSHIRE
MAINE
NEW BRUNSWICK
NOVA SCOTIA
Marquette
Escanaba
Minocqua
Montevideo
Elroy
Iowa City
Kirksville
Columbia
Rolla
Indianapolis
Louisville
Tobermory
Pigeon
Orillia
Mattawa
Ferme-Neuve
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Temiskaming Shores
Rochester
Altoona
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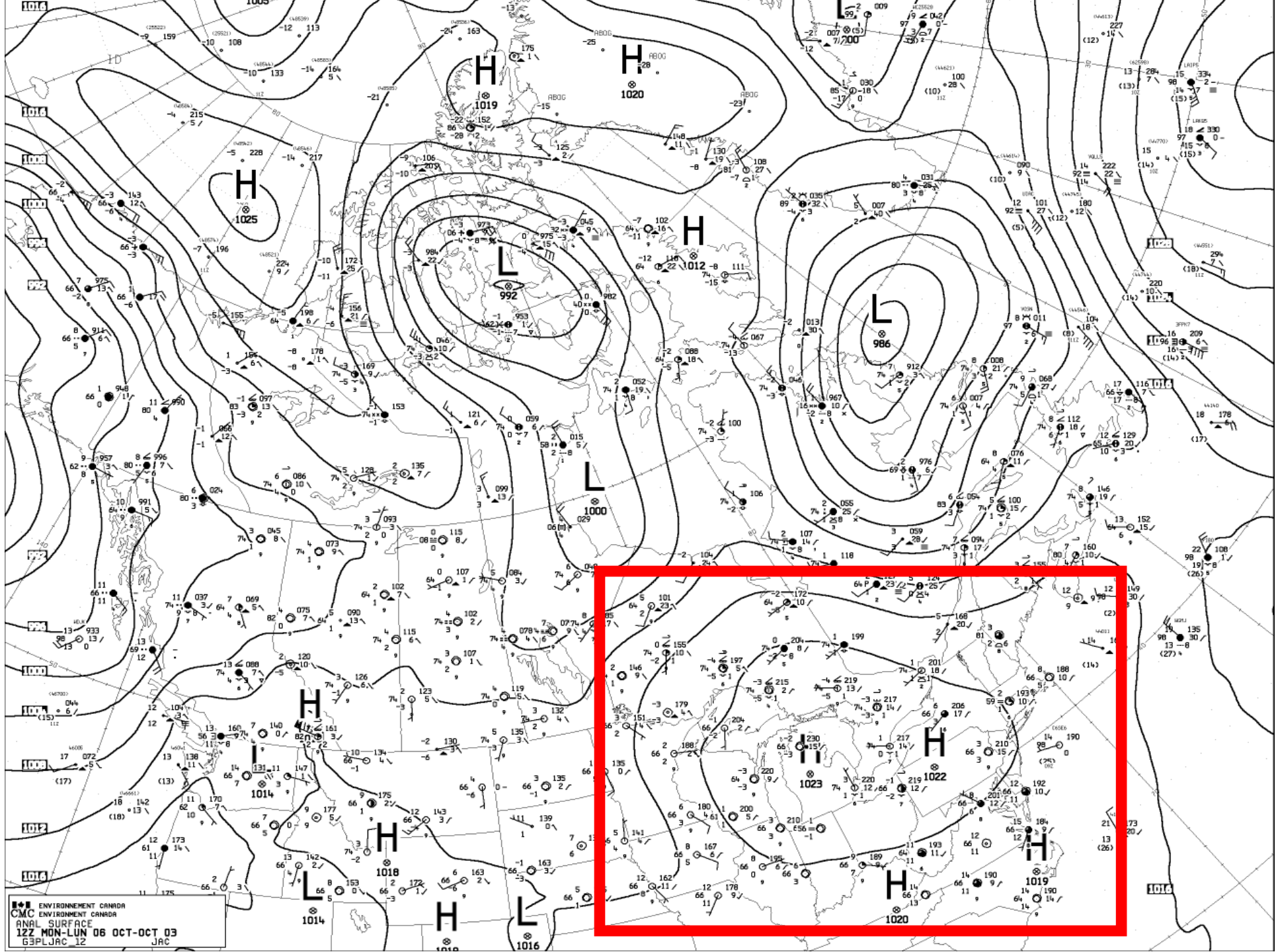
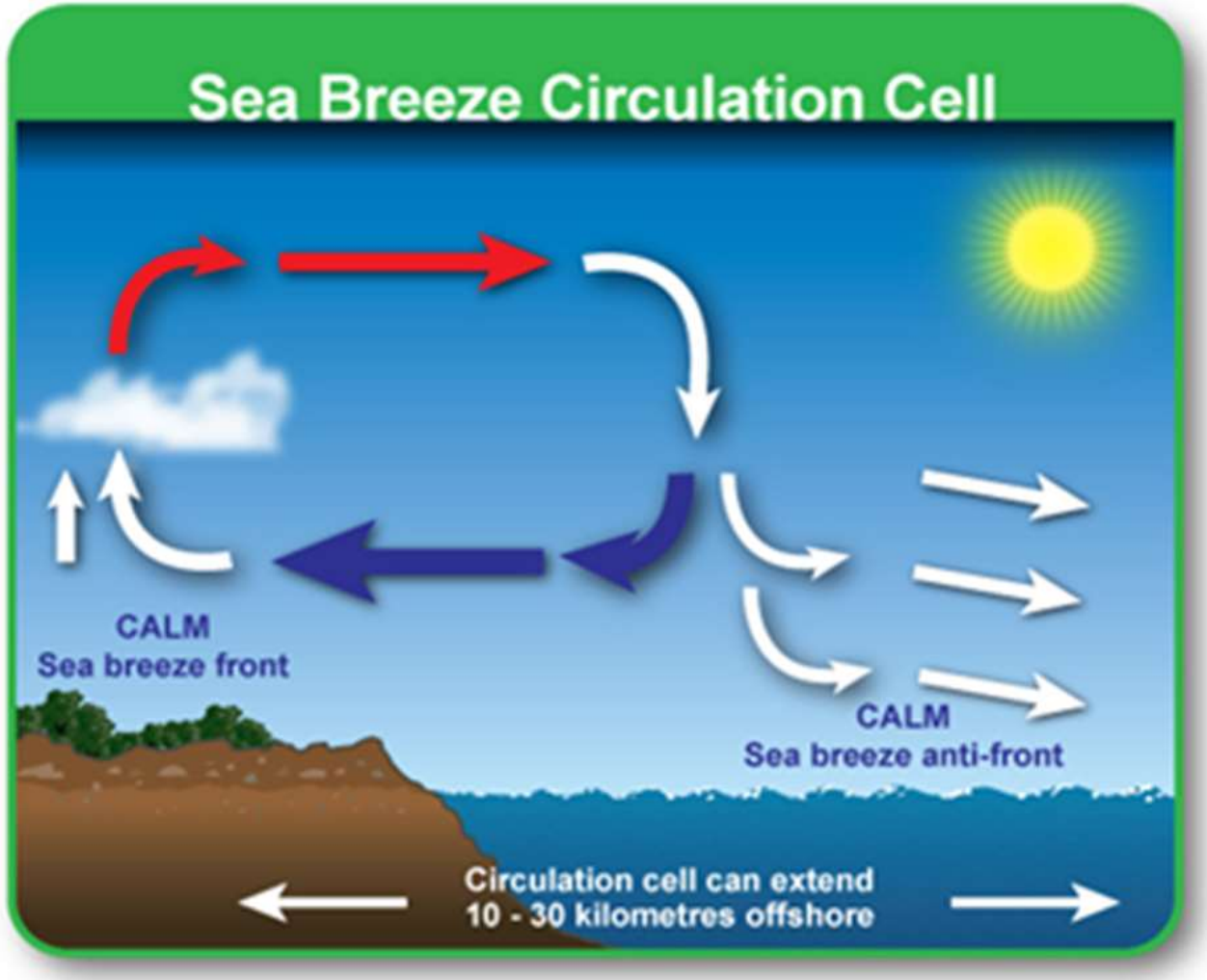
Hartford
Yarmouth
Edmundston
Miramichi
Moncton
Halifax
Patten
H
1023
L
987
996
992
998
1000
particles animation
pressure
More layers...
NAM5km
ECMWF9km
GFS22km
kt 0 5 10 20 30 40 60
5 PM
Tuesday 27 - 5 PM
Tuesday 27
Thursday 29
Friday 30
Sunday 2
Tuesday 4
Wednesday 5

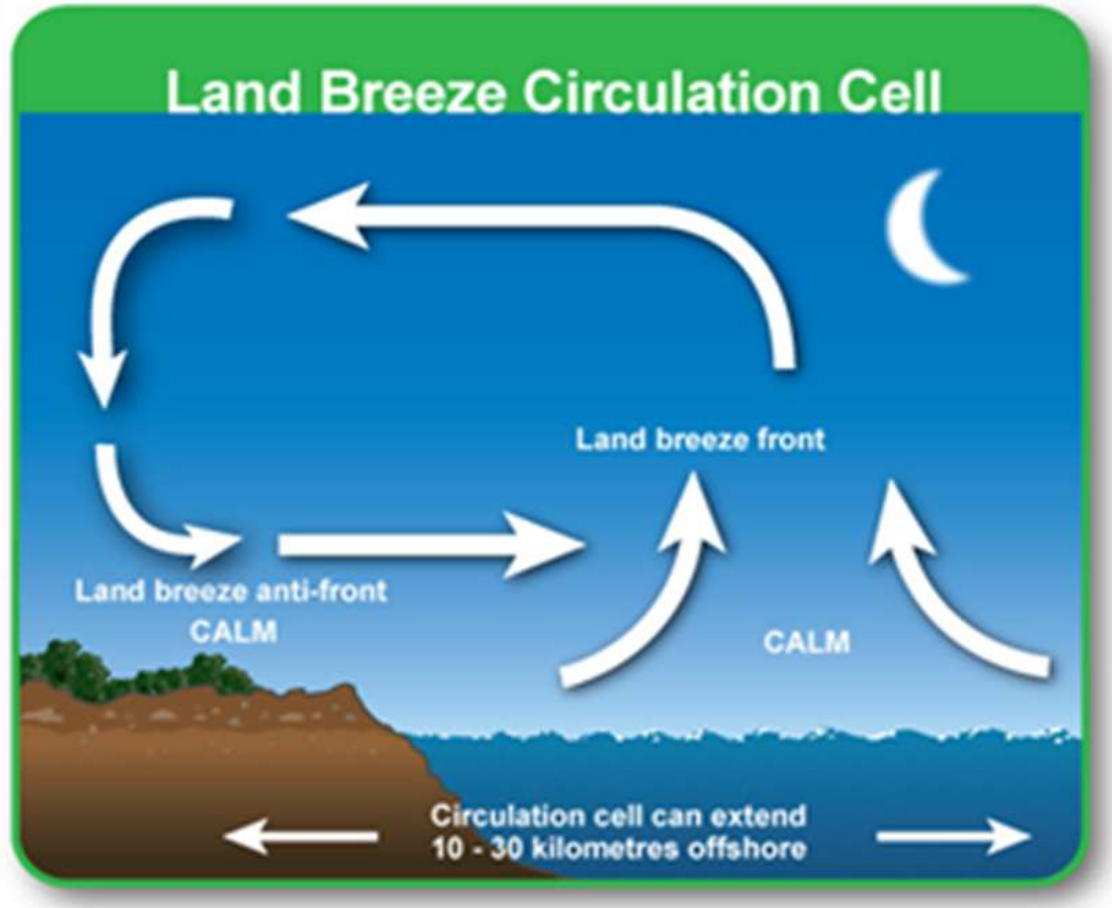
Understanding The Local Winds

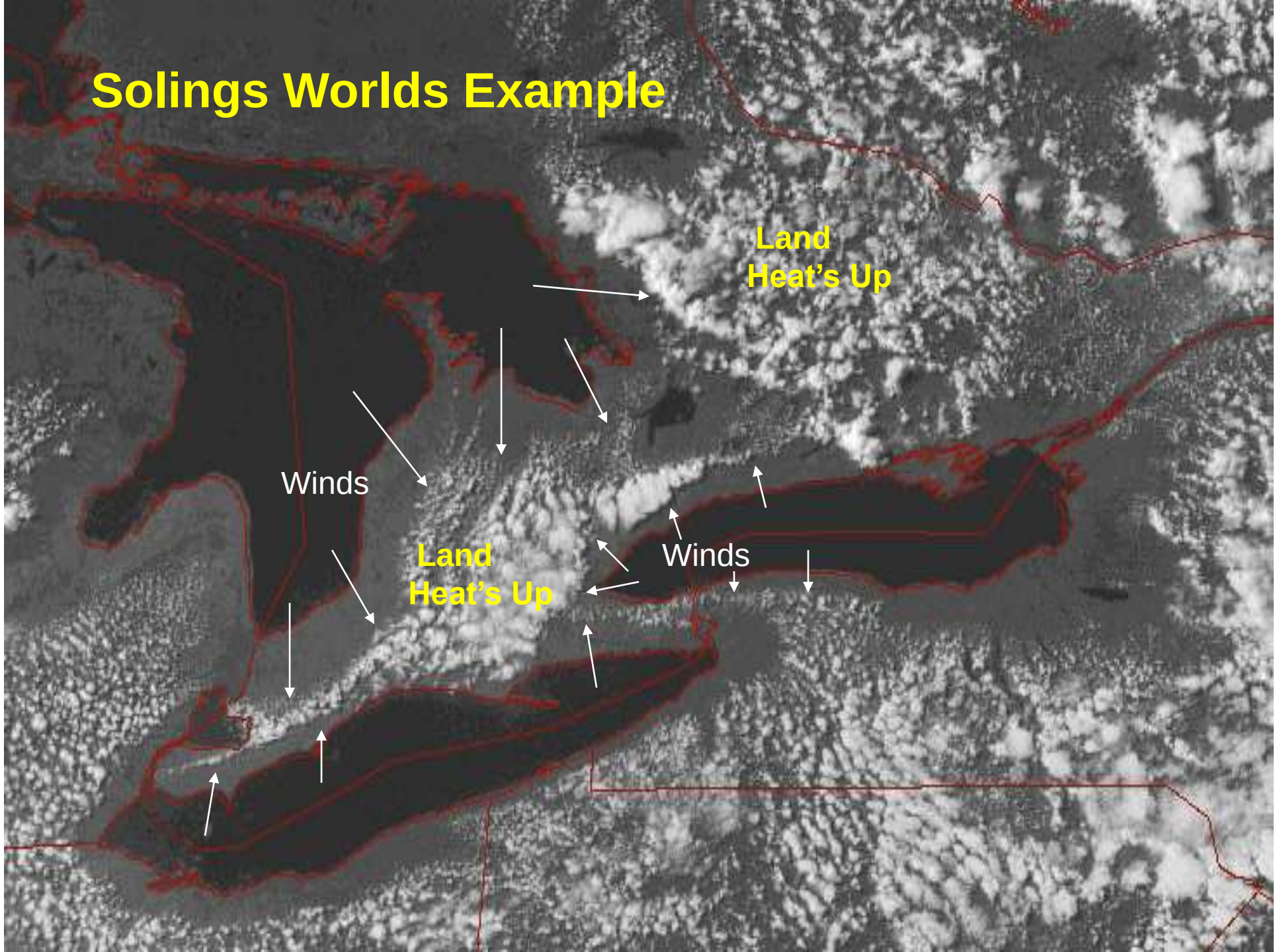
Other Forces That Act On the Local Wind

- Stable and Unstable air
- Time of Day
- Inversions
- Geography and Topography
- Local Lake and Land Breezes
- Cumulus Clouds and Storms

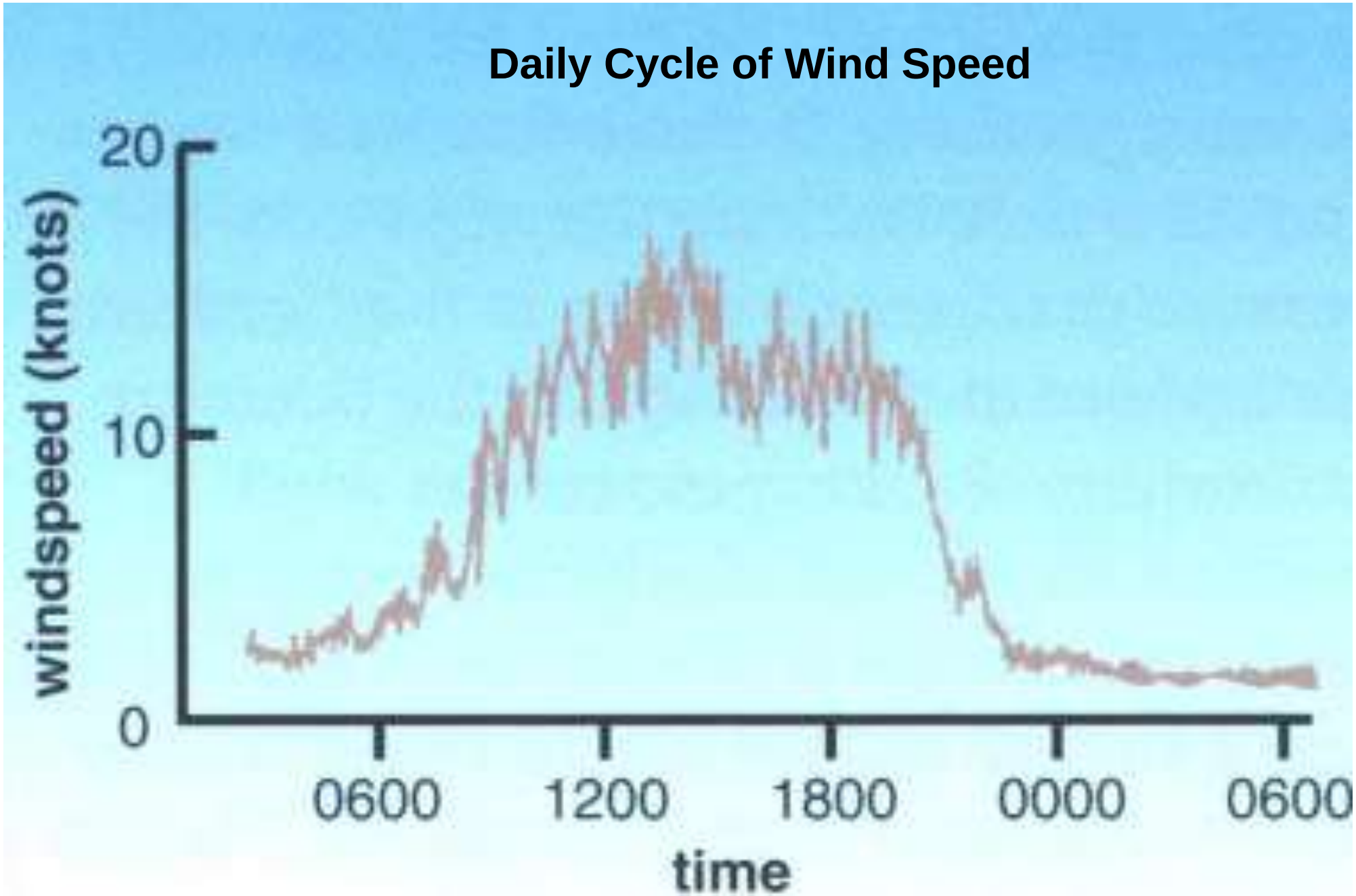

ENVIRONNEMENT CANADA
CMC ENVIRONNEMENT CANADA
ANAL SURFACE
12Z MON-LUN 06 OCT-OCT 03
G3PLJAC_12
JAC


Sea Breeze Circulation Cell
CALM
Sea breeze front
CALM
Sea breeze anti-front
Circulation cell can extend
10 - 30 kilometres offshore


Land Breeze Circulation Cell
Land breeze front
Land breeze anti-front
CALM
CALM
Circulation cell can extend
10 - 30 kilometres offshore


Solings Worlds Example
Land
Heat's Up
Winds
Land
Heat's Up
Winds

Under a Weak or Flat Gradient – A weak Weather Regime

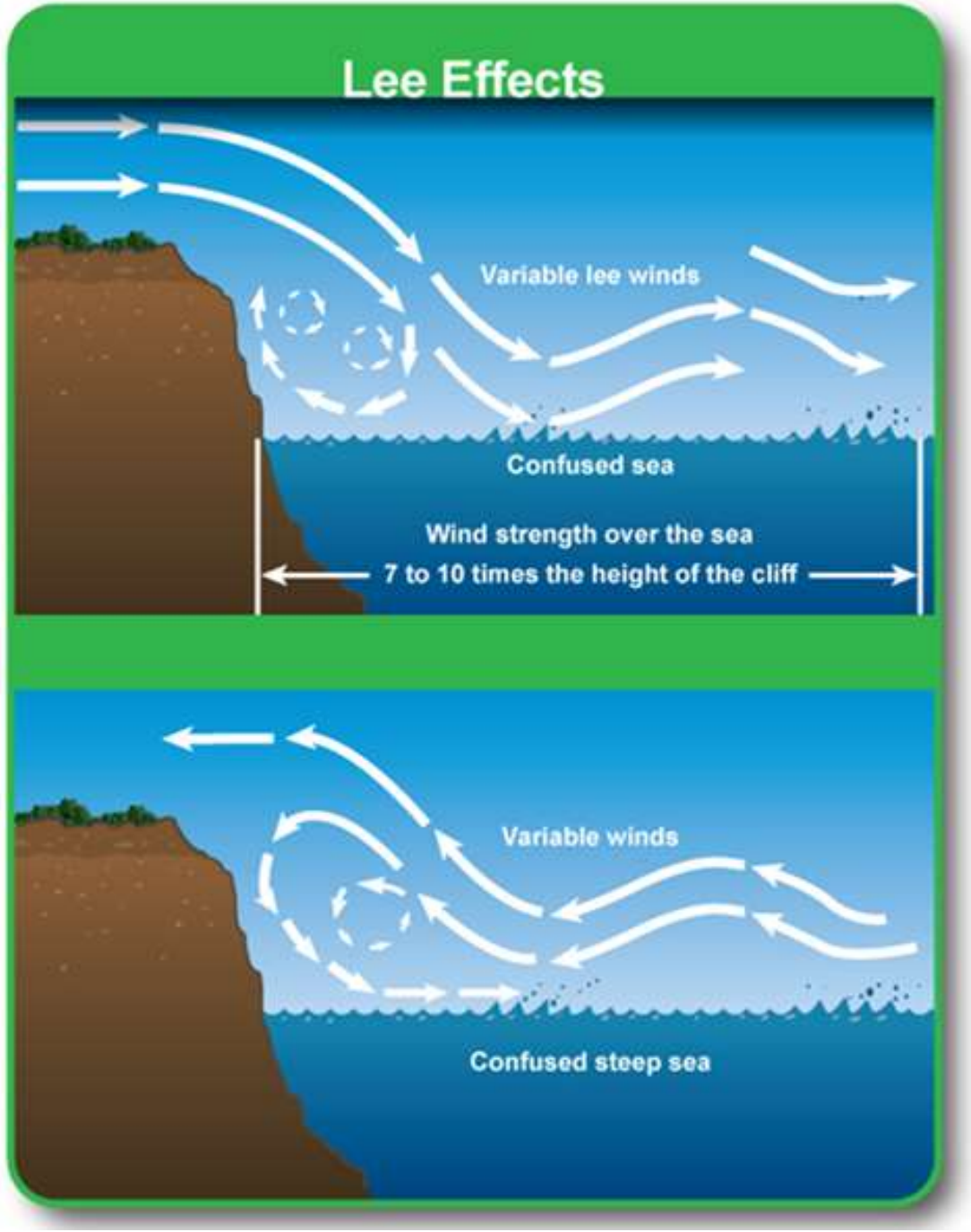



Funnelling

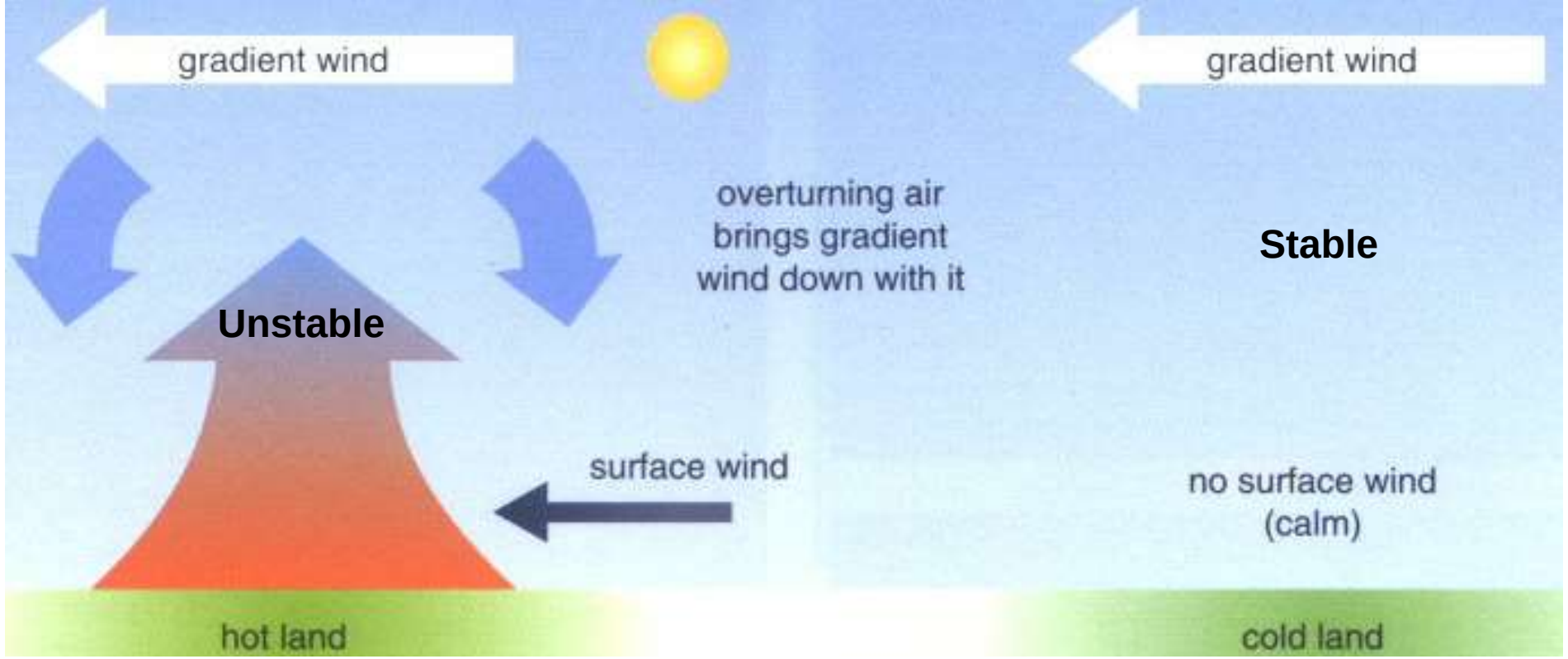

Channelling Winds


Coastal Convergance Due to Channelling
Cobourg
Oshawa
401

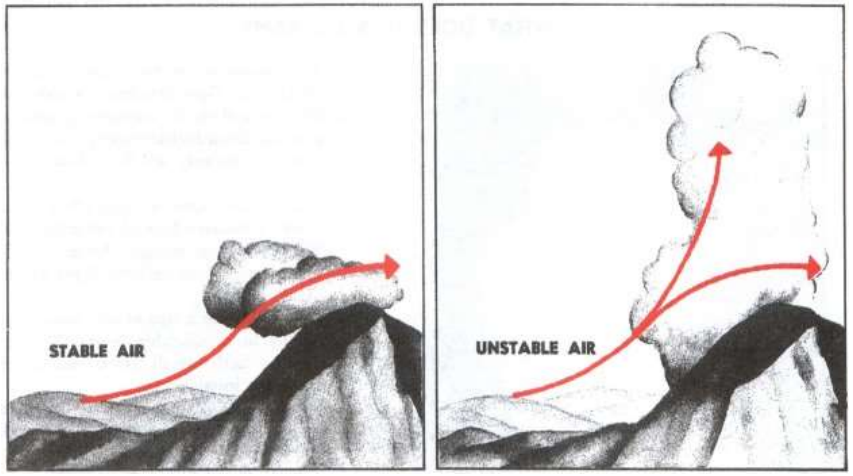

Onshore Winds
High Land
Cliff
Confused seas


Lee Effects
Variable lee winds
Confused sea
Wind strength over the sea
7 to 10 times the height of the cliff
Variable winds
Confused steep sea

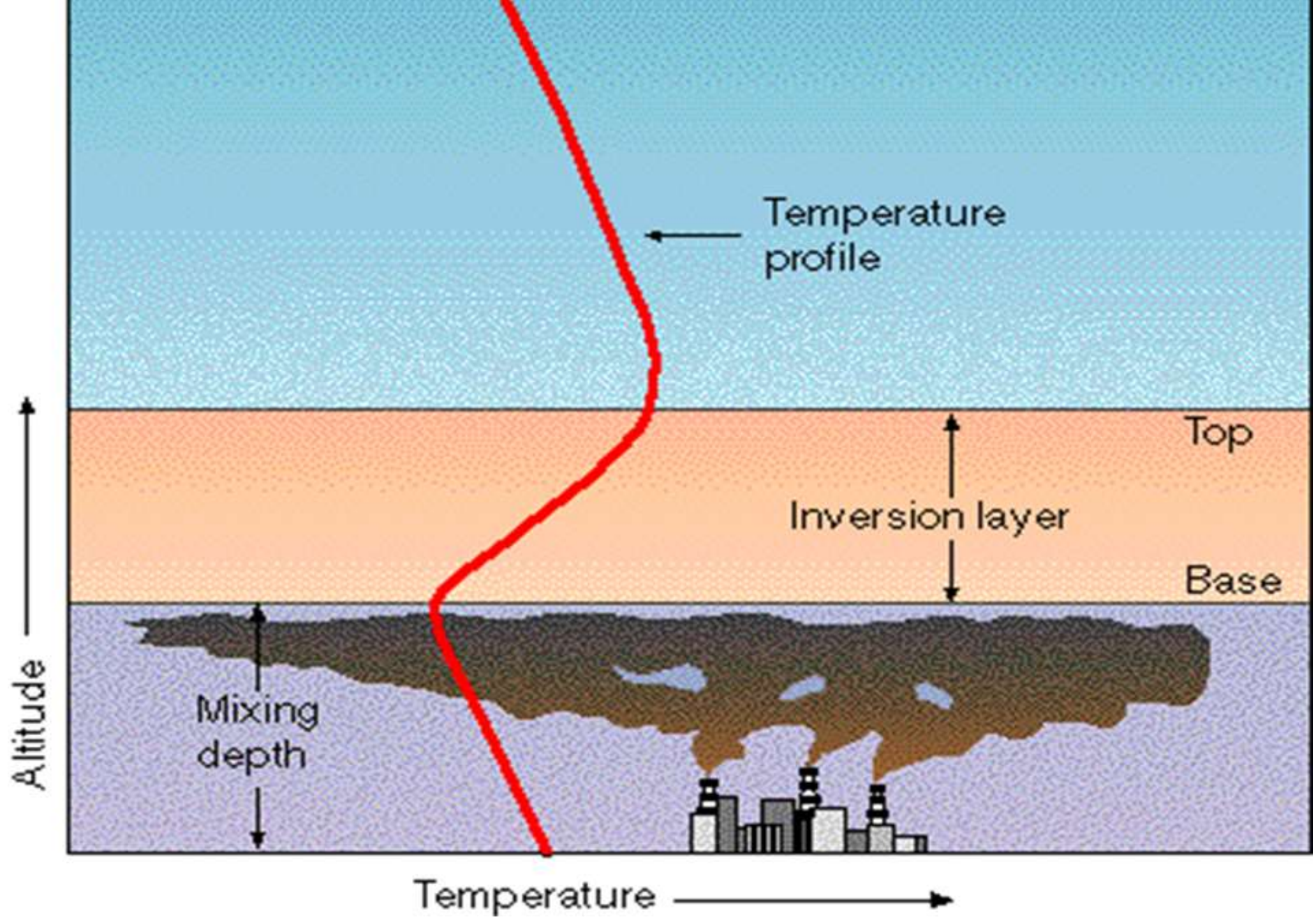

© 2010 Google
Image © 2010 DigitalGlobe
Image © 2010 TerraMetrics
© 2010 Europa Technologies
©2009 Google
Imagery Date: Aug 31, 2009
43°38'19.18" N 79°19'50.16" W elev 215 ft
Eye alt 11562 ft

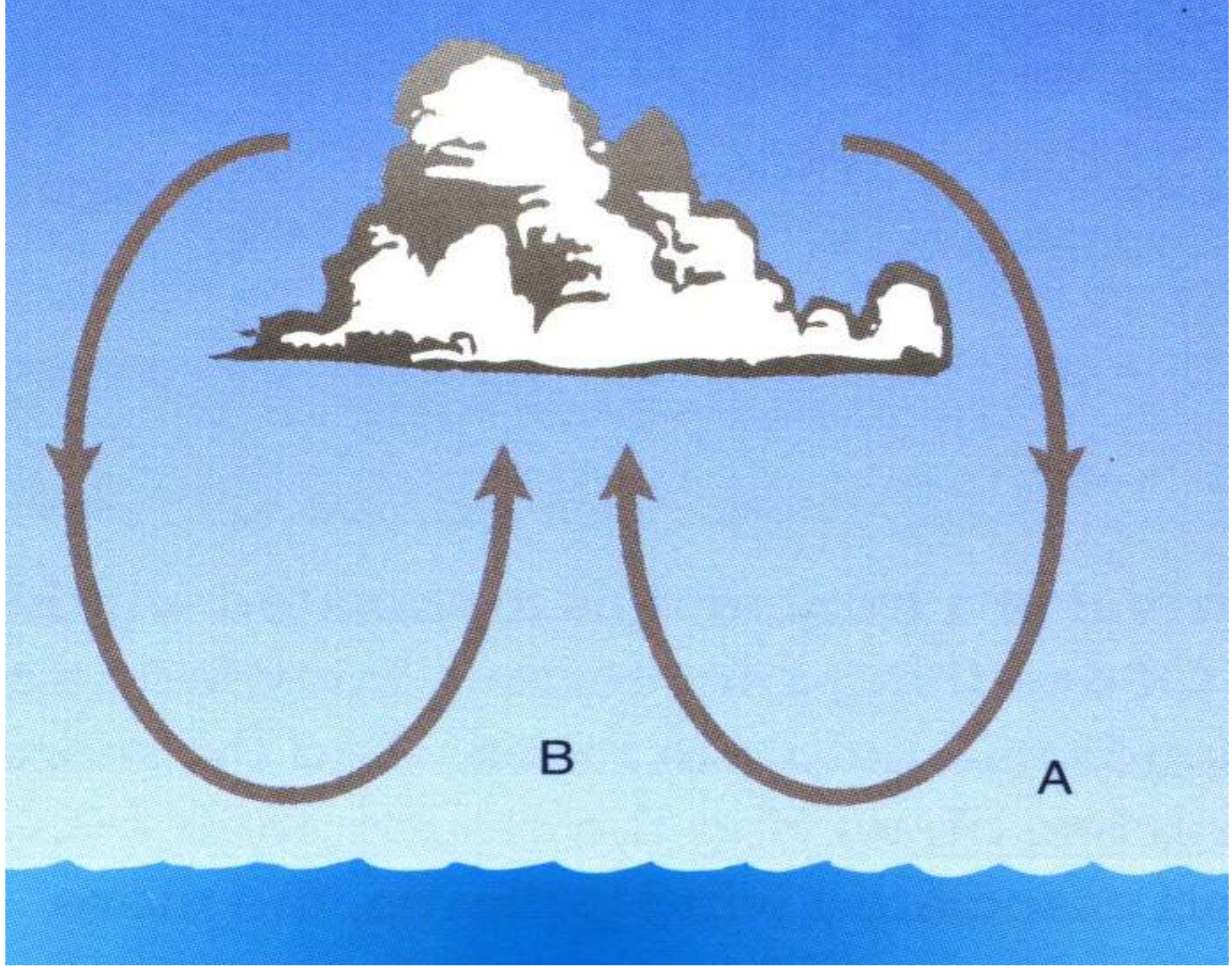


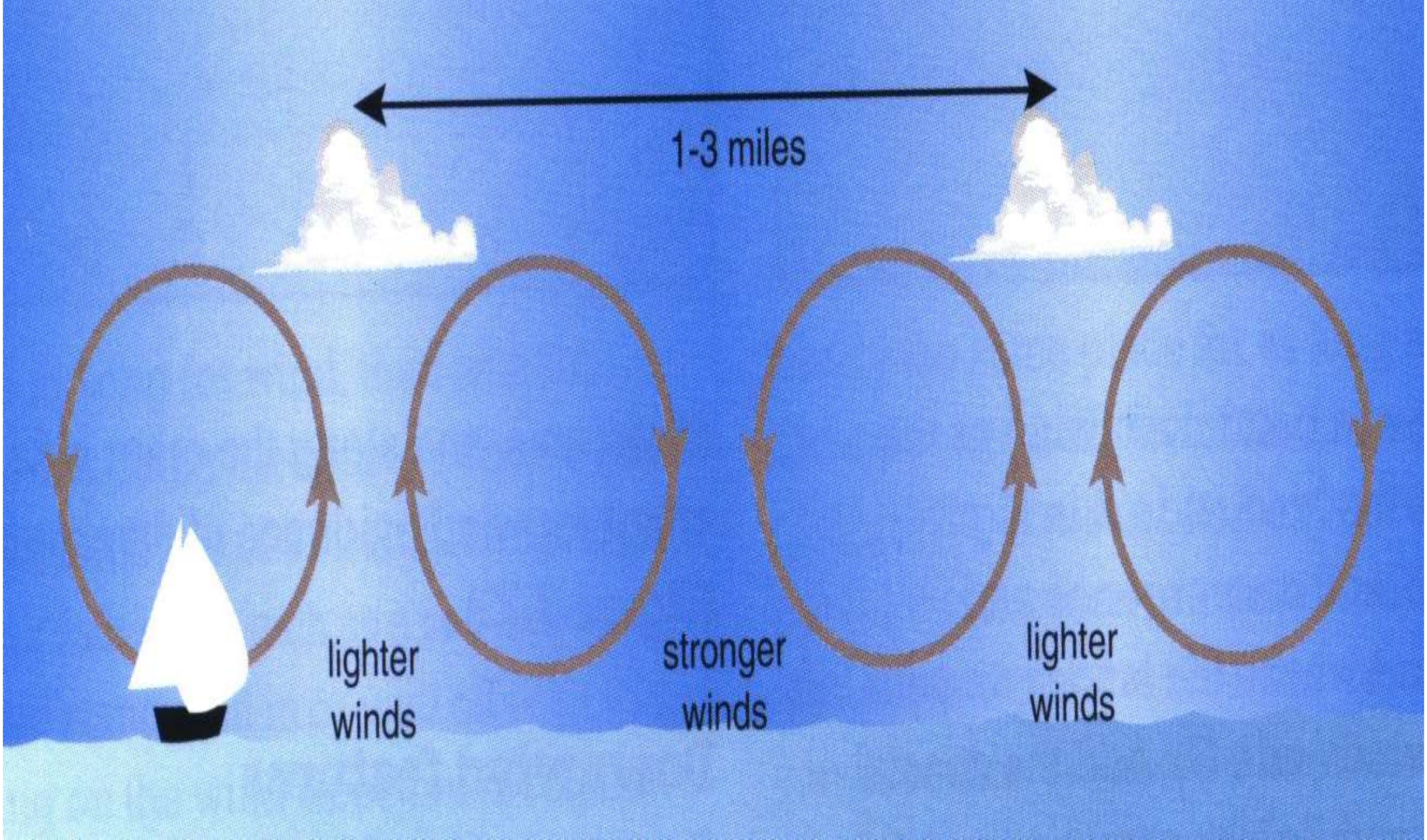
Unstable Air promotes mixing from winds above the ground to the Surface - *Stable does not*

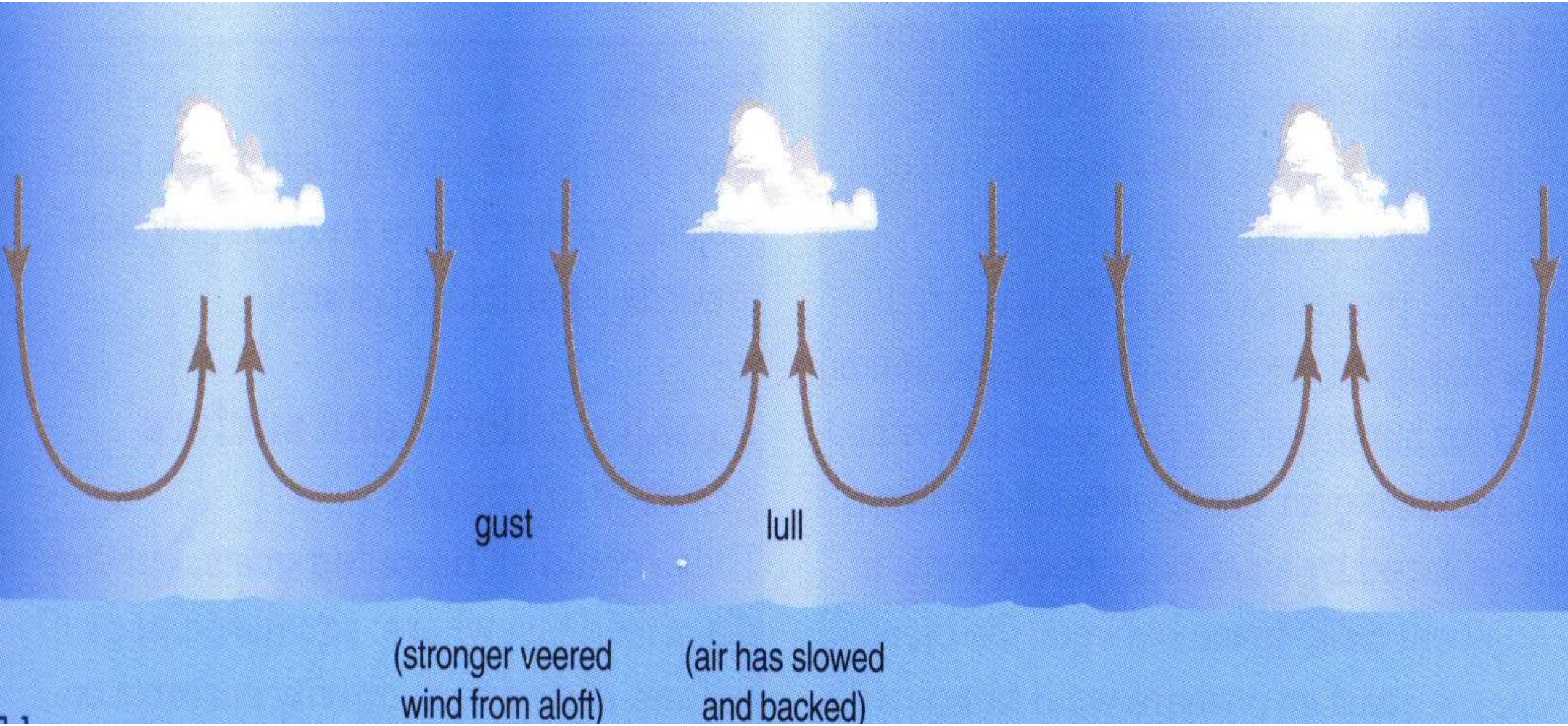



Warmer Air Above
Cooler Air Below


Temperature
profile
Top
Inversion layer
Base
Mixing
depth
Altitude
Temperature


B
A


1-3 miles
lighter winds
stronger winds
lighter winds


gust
lull
(stronger veered
wind from aloft)
(air has slowed
and backed)

Lightning and the Sailor

Facts and myths about lightning

- **The purpose of lightning protection is NOT to stop the lightning from striking. (T or F)**

- **Lightning grounding systems controls the "PATH" of the lightning after it hits. (T or F)**

- **Lightning can strike in the same place twice or more. (T or F)**

- **Lightning always strikes the tallest object. (T or F)**

- **Rubber tires protect you in a car during a lightning storm. (T or F)**

What are the Chances of Lightning Striking Your Boat?

The following statistics are based on all of the BoatUS Marine Insurance claims for lightning damage over a five-year period.

Auxiliary Sail .6% Six out of 1000

Multi-hull sail .5% Five out of 1000

Trawlers .3% Three out of 1000

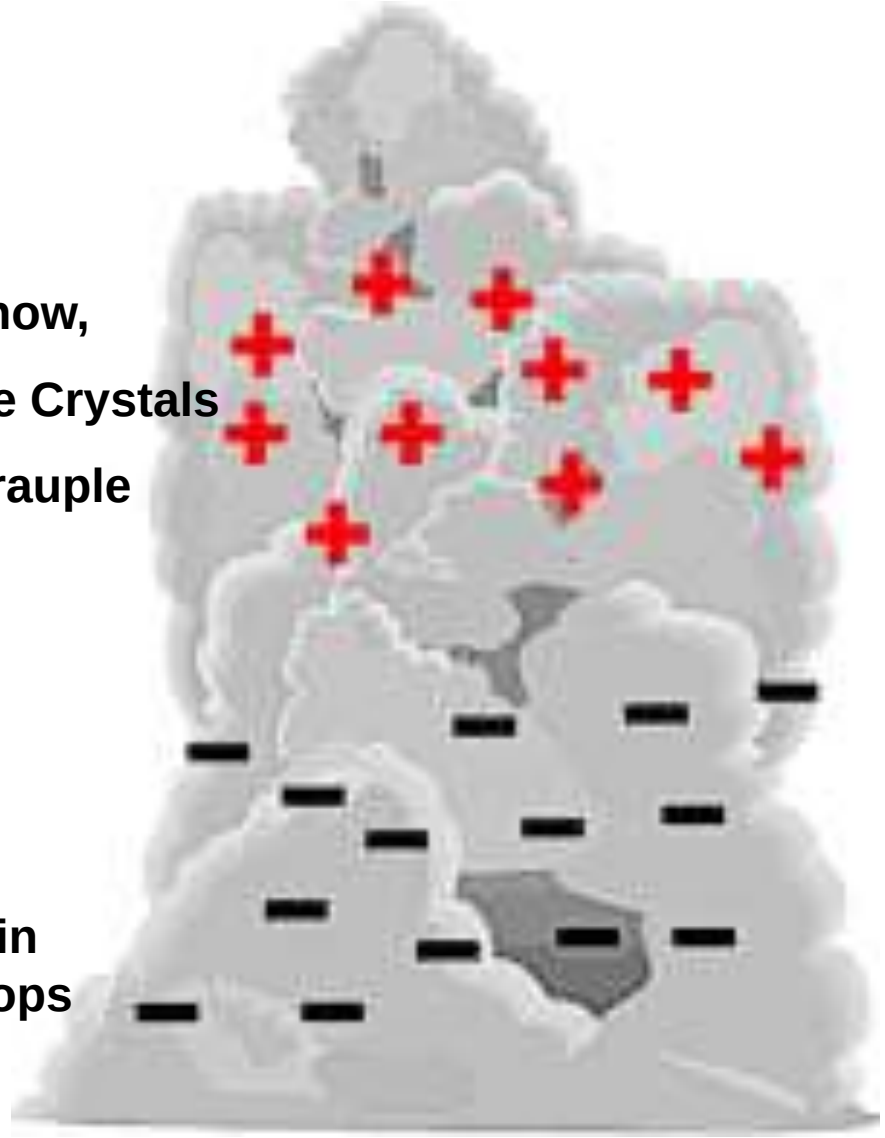
Sail Only .2% Two out of 1000

Cruisers .1% One out of 1000

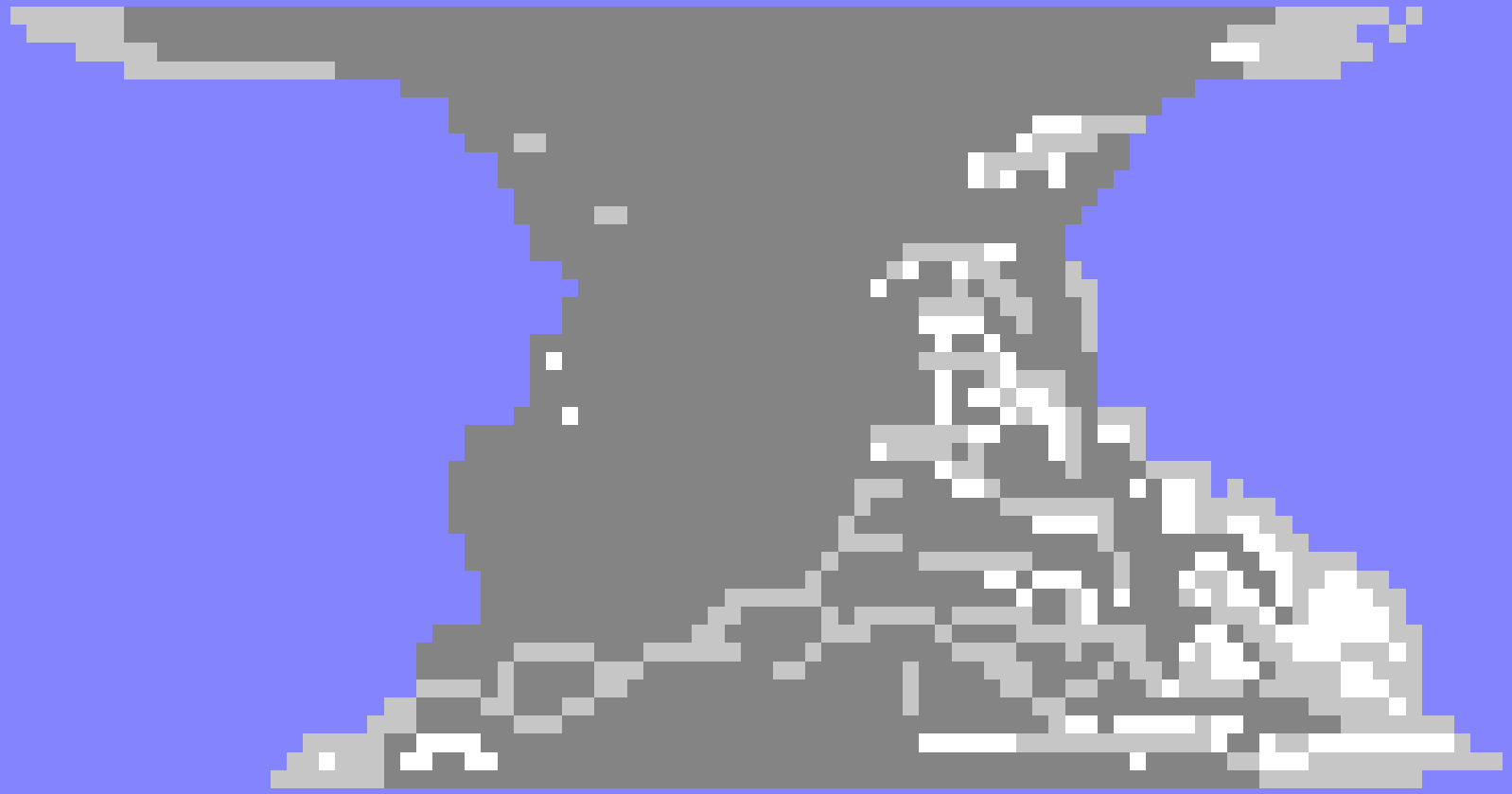
Runabouts .02% Two out of 10,000

Source: BoatUS Marine Insurance Claim Files

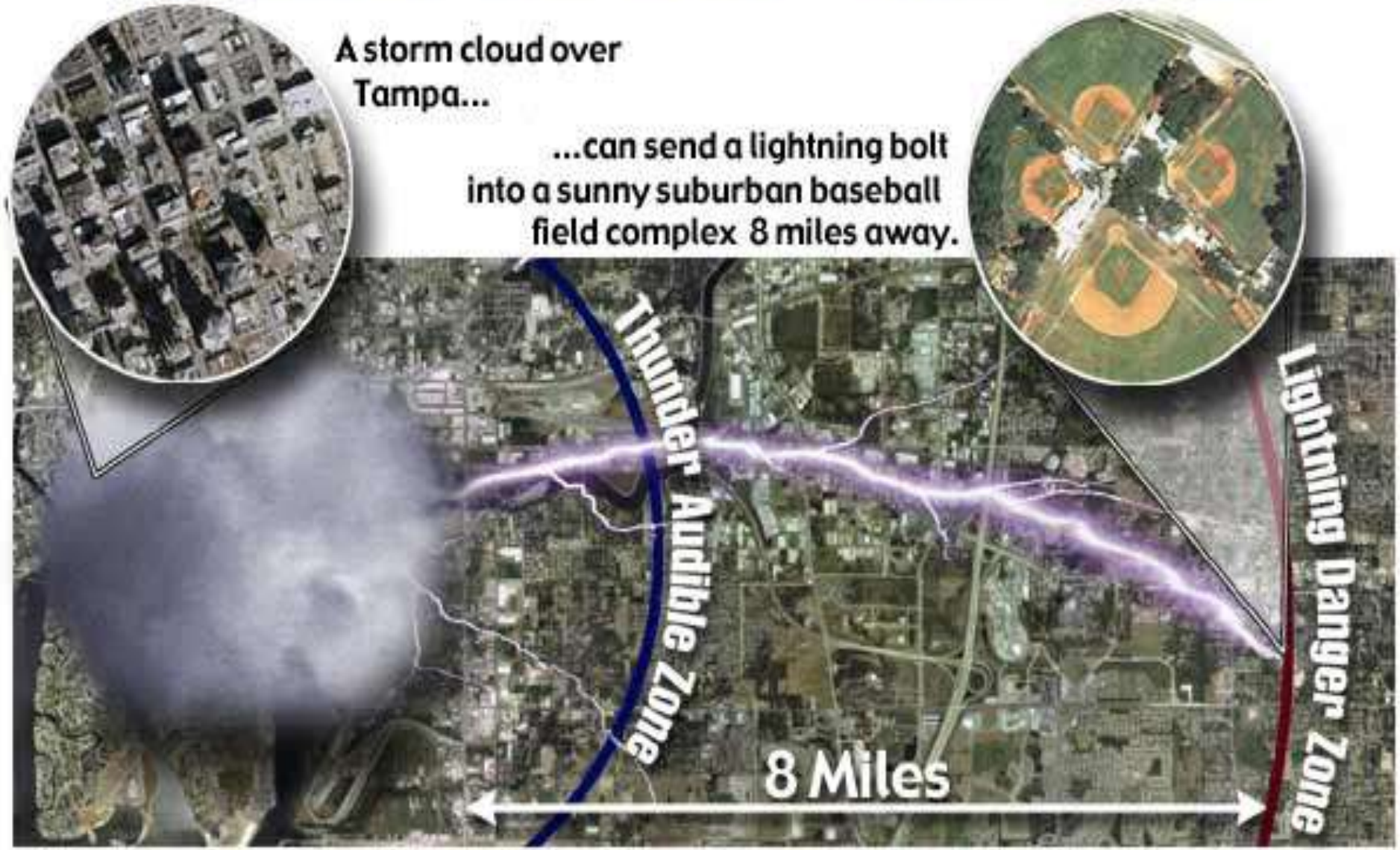
****General Population 1 in 14.5 Million****



Electric charge leaking from her head



A BOLT OUT OF THE BLUE



The top half of the decorative ornament was found some 100 feet on the other side of the building. Notice the shiny melted region, the point of contact with the lightning strike. The top of this ball was “physically” punched from within, most likely a compression burst of air being super heated by the lightning strike.


(C) InspectAPedia.com Wallace

THUNDER

Thunder is the acoustic shock wave caused by the extreme heat generated by a lightning flash.

- **The air is instantaneously heated to as much as 50,000 F (~28,000 C), *five times* the surface of the sun!**
- **Its expansion rate exceeds the speed of sound, and a sonic boom (thunder) results.**

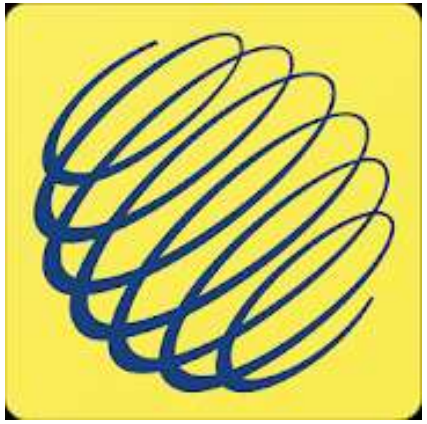
Learn the "30-30 rule"

- **Take appropriate shelter when you can count 30 seconds or less between lightning and thunder.**
- **Remain sheltered for 30 minutes after the last thunder.**
- **New Rule *"When Thunder Roars – Go Indoors!"***

What to do if you are outside

1. Seek shelter in a truck, car, or van.
2. Stay 15 feet away from other people to avoid transfer of shock.
3. Stay away from trees, picnic shelters or rain shelters, and canopies.
4. Hide in ditches or places of lower levels, but try to avoid water
5. If this is not an option, crouch down with your feet together and cover your ears to protect them from the thunder.

Weather Apps



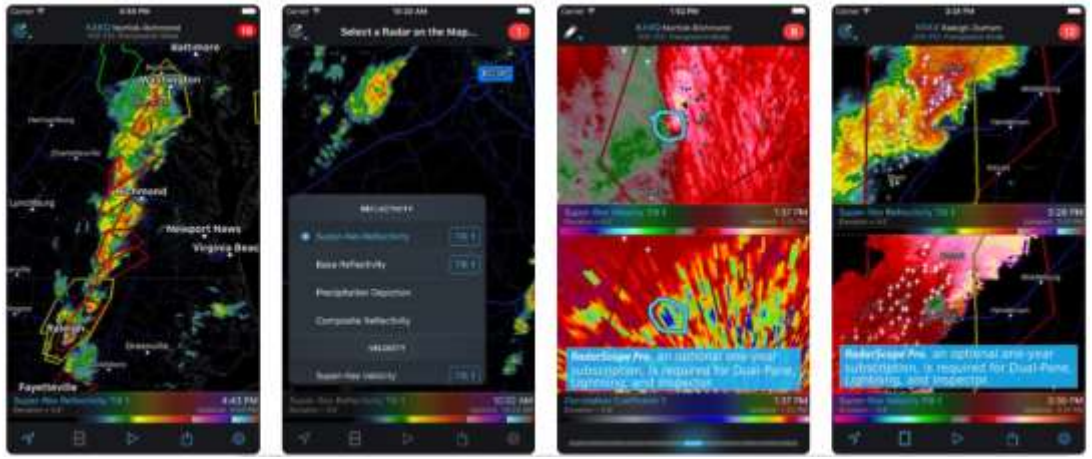




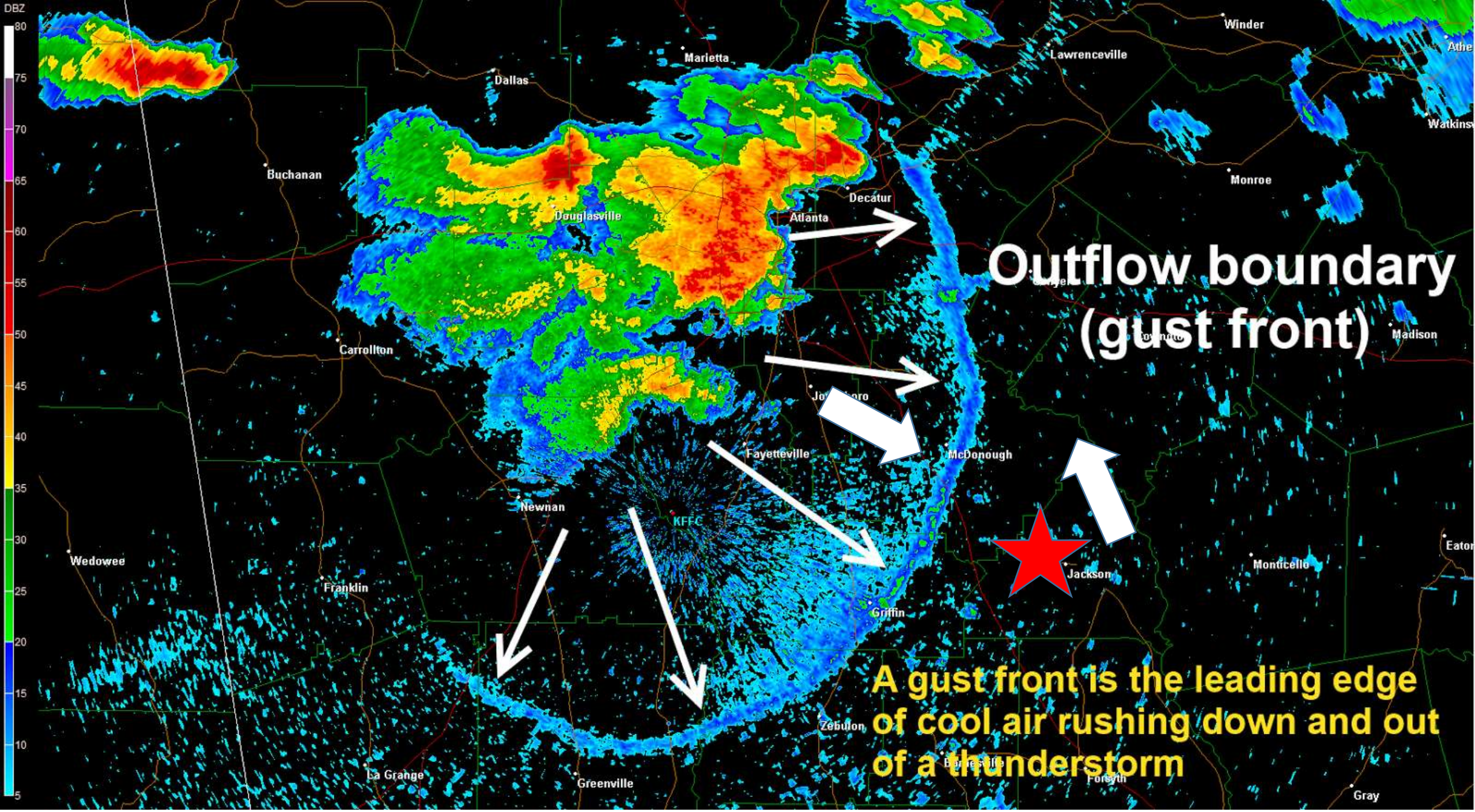




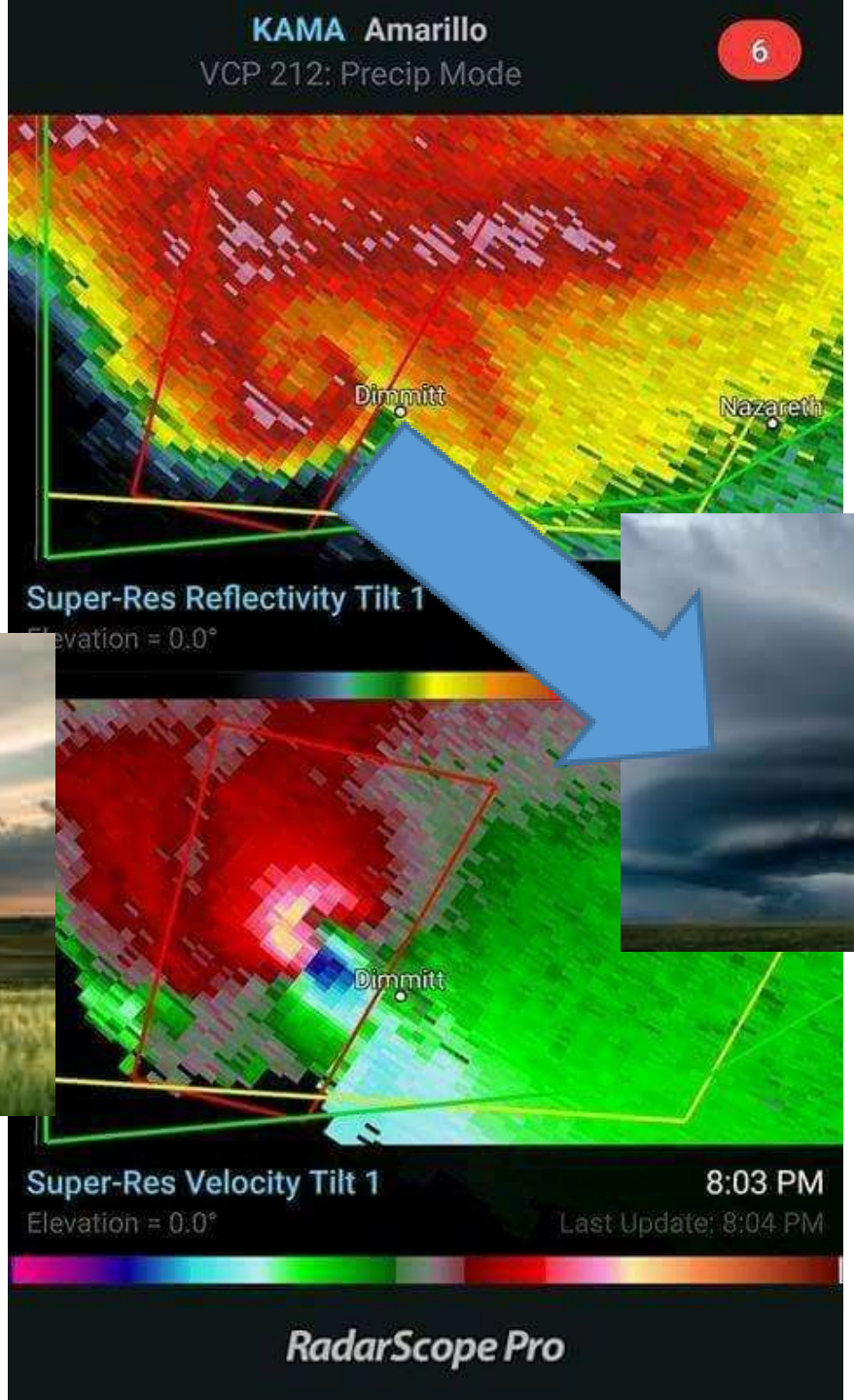

Met Tools - Radar



https://radarscope.io/

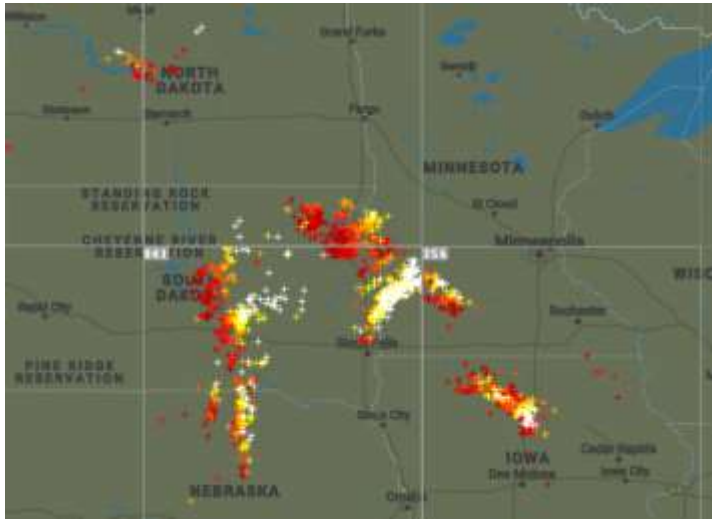

DBZ
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Marietta
Dallas
Winder
Lawrenceville
Buchanan
Douglasville
Decatur
Atlanta
Monroe
Carrollton
Madison
Fayetteville
McDonough
Newnan
KFFC
Wedowee
Franklin
Jackson
Monticello
Griffin
Zebulon
La Grange
Greenville
Forsyth
Gray
Outflow boundary
(gust front)
A gust front is the leading edge
of cool air rushing down and out
of a thunderstorm


Wichita, KS KICT
12:56 AM EDT 5/29/15
15
Salina
Lindsborg
McPherson
Hillsboro
Marion
Inman
Moundridge
Peabody
Butler
Hutchinson
Newton
Sedgwick
Valley Center
Maize
Bel Aire
Wichita
Cheney
Goddard
Oaklawn-Sunview
Derby
Clearwater
Mulvane
Conway Springs
Belle Plaine
Wellington
Oxford
Winfield
VCP: 212 Precip Mode (Elevation = 0.5°)
Last Updated: 1:11 AM
RadarScope
Base Reflectivity Tilt 1


KAMA Amarillo
VCP 212: Precip Mode
6
Dimmitt
Nazareth
Super-Res Reflectivity Tilt 1
Elevation = 0.0°
Dimmitt
Super-Res Velocity Tilt 1
8:03 PM
Elevation = 0.0°
Last Update: 8:04 PM
RadarScope Pro

Met Tools - Lightning

https://weather.gc.ca/lightning/index_e.html

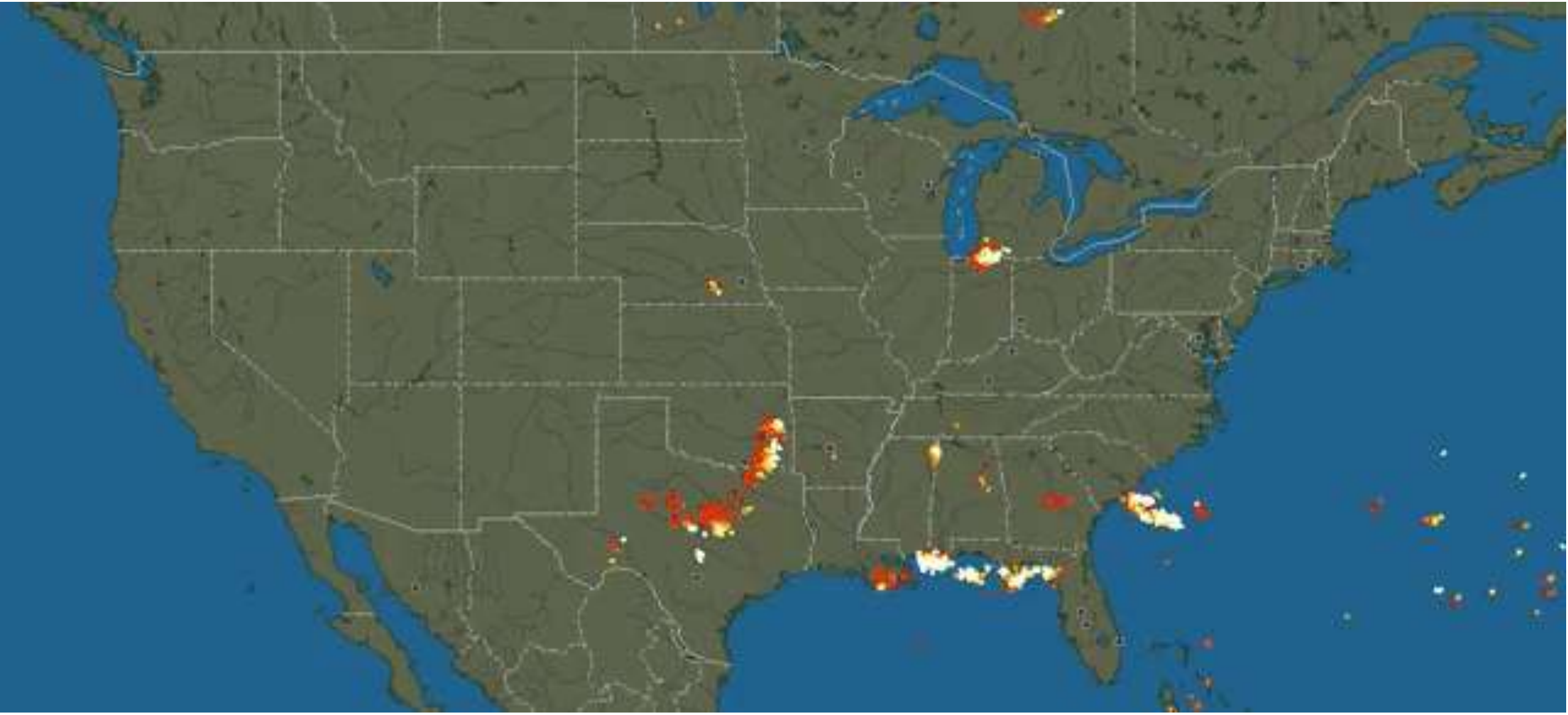


https://www.lightningmaps.org
https://http://en.blitzortung.org

BlitzortungLive
Iphone/IPAD

Blitzortung Lightning Monitor
Android

https://skyscancanada.com/

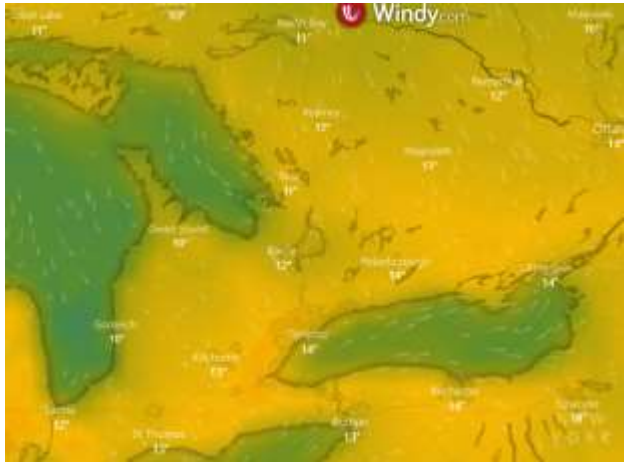


Met Tools - Websites

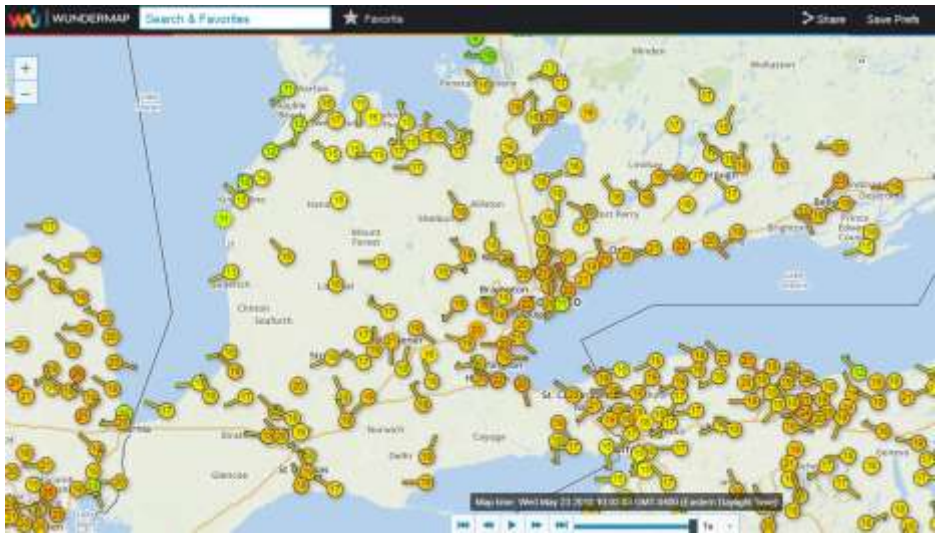
https://weather.gc.ca/

The Weather Network

https://www.theweathernetwork.com/ca



https://www.windy.com



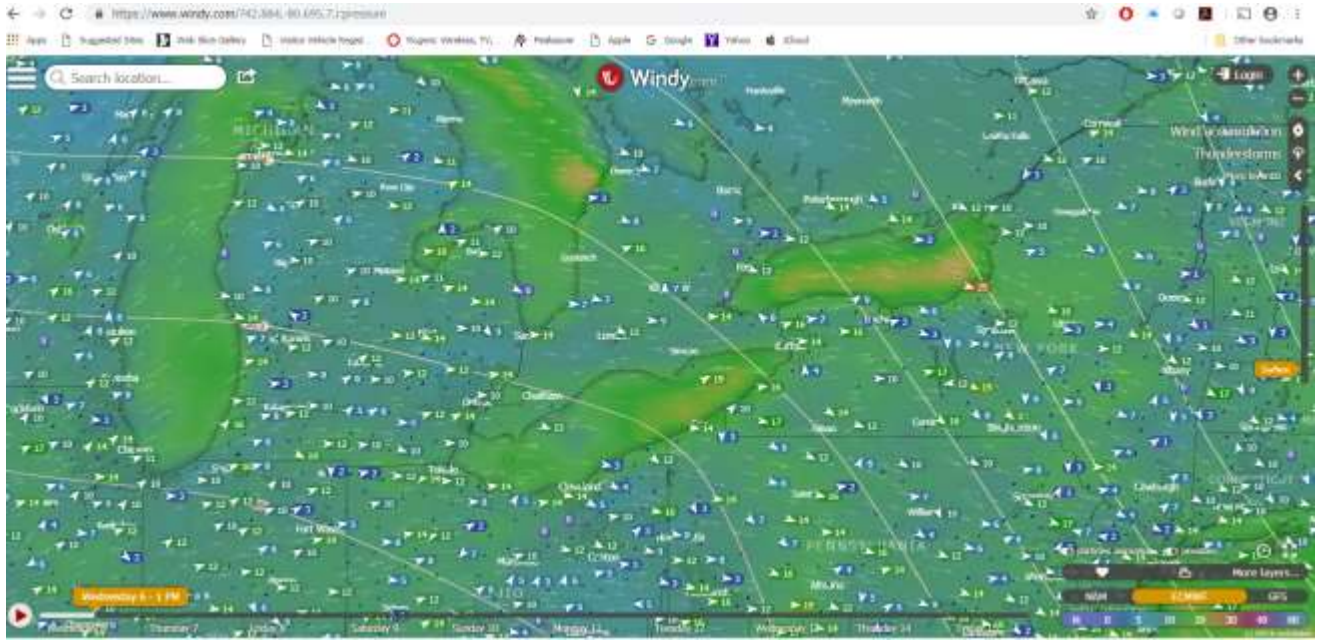
https://www.wunderground.com/wundermap

But Be Careful….

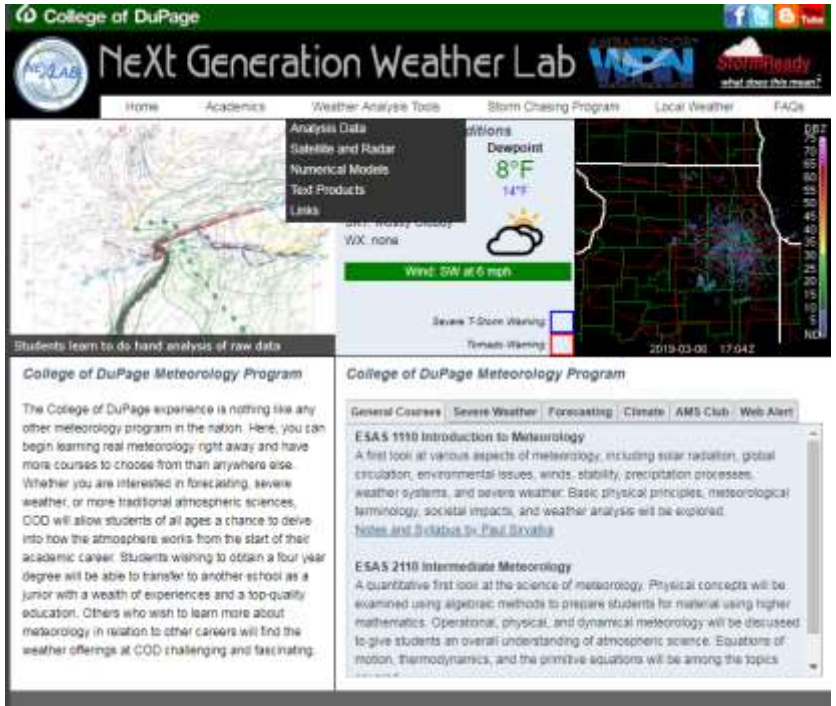
Lots of free websites and API's are not monitored and are machine only products, May not be current, linkages to Canadian weather incorrect

https://www.tropicaltidbits.com/

https://www.pivotalweather.com/



https://www.windy.com/



https://weather.cod.edu/#

https://www.predictwind.com/

zyGrib

http://zygrib.org/

Windy (IOS AND Android)

WINDFINDER

www.windfinder.com
(IOS AND Android)

Canada

WeatherCAN

Env. & Climate Change Canada

★★★★☆ 398

OPEN

Environment Canada
WeatherCAN
(IOS AND Android)

Windguru PRO

www.windguru.cz

Print

Day														Sun 02								Mon 03								Tue 04								Wed 05							
Local Time		08	09	10	11	12	13	14	15	16	17	18	19	22	01	04	07	10	13	16	19	22	01	04	07	10	13	16	19	22	01	04	07	10	13	16	19	22	01	04	07	10	13	16	19	22
Speed (Knots)	PWG	6	7	9	10	13	15	17	19	19	19	20	20	18	19	10	20	17	19	17	24	14	14	19	21	17	19	17	17	17	17	16	15	14	13	12	12	10	5	12	12	14	16	13	17	15
	PWE	5	7	7	8	12	12	15	17	19	20	21	21	19	18	9	13	14	16	18	17	10	12	14	16	16	8	17	16	16	16	16	14	12	10	9	11	12	8	8	9	13	15	11	16	14
	GFS	6	6	8	9	13	16	19	20	21	19	21	22	18	16	15	13	17	18	22	22	21	20	17	14	15	16	16	16	14	14	12	12	10	8	7	7	5	5	4	8	12	12	14	15	15
	ECMWF	4	4	7	7	7	10	10	10	13	13	13	14	16	14	12	9	6	12	8	10	11	9	8	7	12	11	10	9	8	6	4	8	9	8	5	6	8	8	3	7	8	8	8	7	8
Direction (True)	PWG	NE	E	SE	SE	E	E	E	E	E	E	E	E	E	SE	SE	S	SW	SW	SW	SW	SW	SW	W	W	W	NW	NW	N	N	N	N	N	NW	NW	NW	NW	N	NW	NW	W	W	W	W	W	W
	PWE	NE	E	E	E	E	E	E	E	E	E	E	E	E	E	SE	S	SW	SW	SW	SW	SW	SW	SW	SW	SW	W	NW	N	N	N	N	NW	NW	NW	NW	NW	NW	NW	W	W	W	W	W	W	W
	GFS	E	SE	SE	E	E	E	E	E	E	E	E	E	E	E	SE	S	S	SW	SW	SW	W	W	W	NW	N	N	N	N	N	N	NW	NW	NW	NW	NW	NW	NW	W	W	W	W	W	W	W	W
	ECMWF	E	E	SE	SE	SE	E	E	E	E	E	E	E	E	E	E	E	SE	SW	SW	SW	SW	W	W	NW	NW	NW	NW	NW	N	NW	NW	W	NW	W	N	W	W	W	W	W	W	W	W	W	W	W
Gust (Knots)	PWG	9	10	10	12	17	19	21	23	23	24	24	24	24	26	26	40	33	33	29	32	26	29	30	32	20	23	20	21	19	19	19	18	17	15	15	14	11	6	14	14	16	18	16	19	17
	PWE	7	8	9	11	13	14	17	21	24	26	27	28	23	26	23	37	34	33	34	30	28	31	32	32	25	14	22	23	22	21	20	17	15	12	11	13	13	11	11	11	16	18	14	19	18
	GFS	8	9	10	11	15	18	21	23	24	21	24	25	21	18	18	22	30	28	32	28	29	27	21	15	18	17	18	18	15	14	14	14	11	9	8	7	5	5	6	9	13	13	14	16	17
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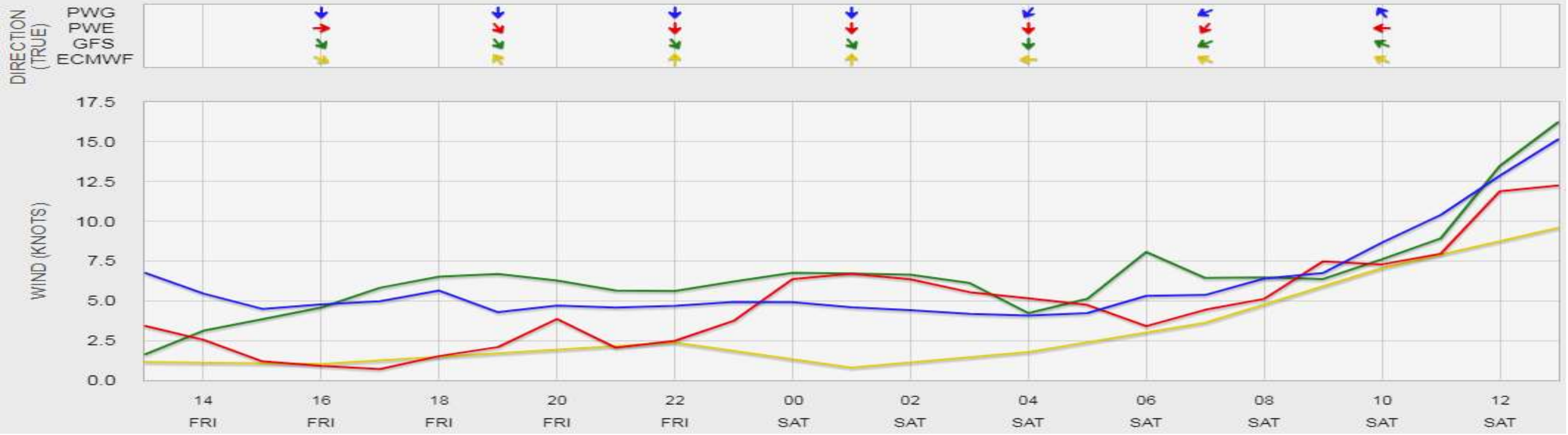

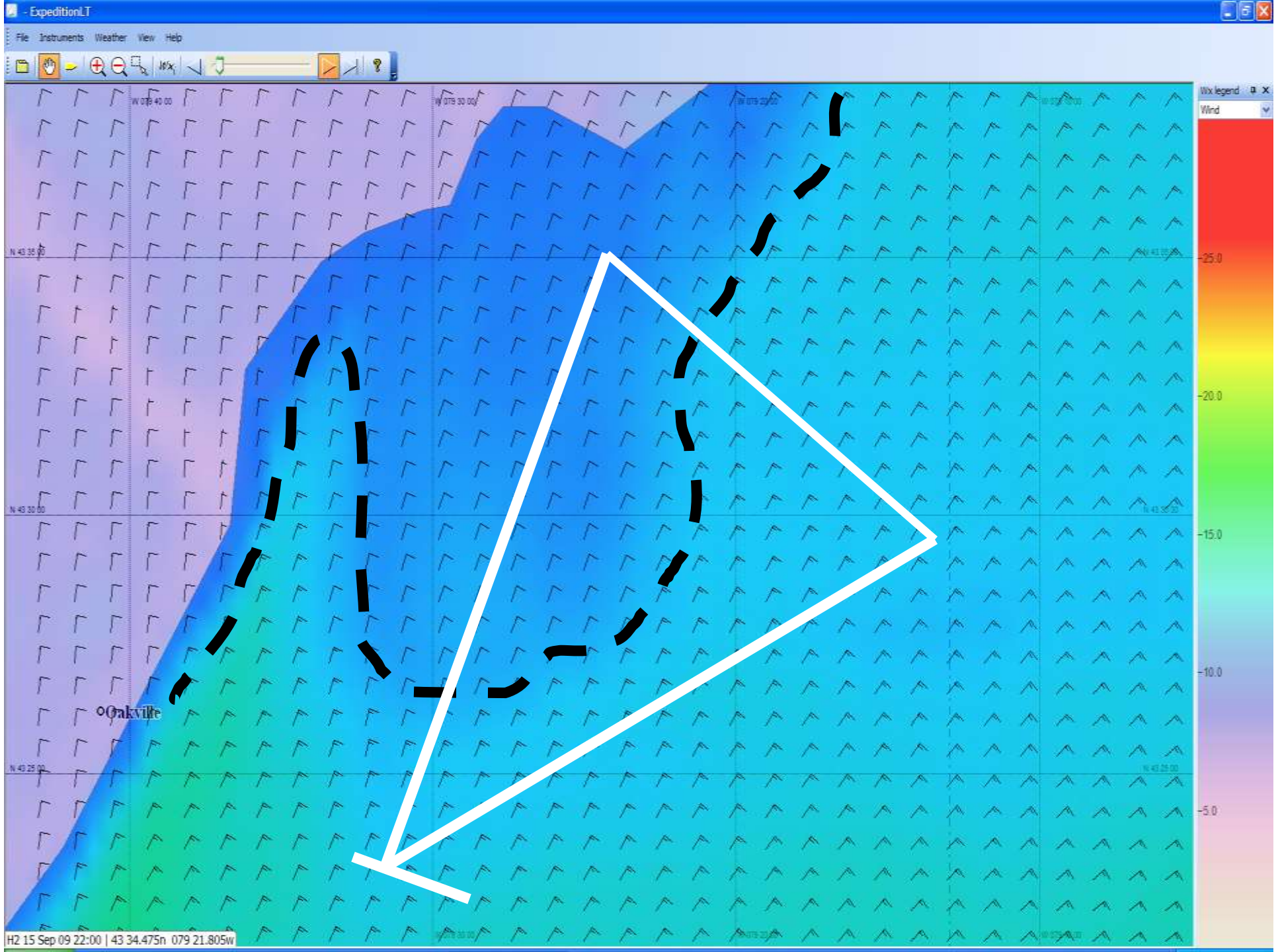
- ExpeditionLT
File Instruments Weather View Help
Wx legend
Wind
25.0
20.0
15.0
10.0
5.0
Oakville
H2 15 Sep 09 22:00 | 43 34.475n 079 21.805w

Any Questions?

ronbianchi@rogers.com

@mrwx4caster

https://ca.linkedin.com/in/ronbianchi