



Australian Government
Bureau of Meteorology

Weather and Climate Basics

Laura Boekel

Forecaster at Bureau of Meteorology

Aims of this presentation...

- To describe what I do as a forecaster at the Bureau of Meteorology
- To provide an interesting introduction to weather and climate
- To present examples of how theory relates to real-world forecasting

Forecasters at the Bureau

- Aviation forecasting
- Fire weather
- Public weather
- Severe weather
- Volcanic Ash Advisory Centre
- Tropical Cyclone Advisory Centre
- Climate
- Hydrology



Aviation Forecasting

- All of NT
- 24 hours
- Issue products and warnings
- Weather watch
- Hazards: Fog and low cloud, thunderstorms, turbulence.

AMEND AREA FORECAST 110300 TO 111700 AREA 80.

OVERVIEW:

ISOLATED SHOWERS NORTH OF SHEPP/YELD/HOKOR. AREAS OF MIST/FOG AND BROKEN LOW CLOUD DEVELOPING OVER LAND E OF YMYH/YHOV/KTG/ANP AND OVER LAND W OF ABVUV/YBCR/YAUV AFTER 15Z. AREAS OF SMOKE OVER LAND BELOW 7000FT, LOCALLY THICK NEAR FIRES. DUST DEVILS BELOW 7000FT TILL 08Z.

WIND:

3000	5000	7000	10000	14000	18500
090/15	090/15	090/15	090/10 PS11	160/20 PS03	230/15 MS09

REMARKS:

[1] 3000/5000FT WINDS TENDING 180/15 SE OF HANKY/YDLW AFTER 12Z.
[2] 10000FT/14000FT WINDS TENDING 270/20 S OF YPKT/YNGU.
[3] 18500FT WINDS 20KT STRONGER S OF YVRD/YBRL.

CLOUD:

BKN ST 0500/2000 LAND E OF YMYH/YHOV/KTG/ANP AND OVER LAND W OF ABVUV/YBCR/YAUV AFTER 15Z.
SCT ST 1000/2000 IN SHRA.
SCT CU/SC 2000/10000 N OF ABVUV/YOEN/YNGU/HANKY, BASES TO 5000 INLAND.

WEATHER:

FG, BR, SHRA, FU, PO.

AMD VISIBILITY:

0500M IN FG.
3000M IN BR.
6KM IN SHRA.
8KM IN FU, 2000M THICK FU.

FREEZING LEVEL:

16000FT.

ICING:

NIL SIGNIFICANT.

TURBULENCE:

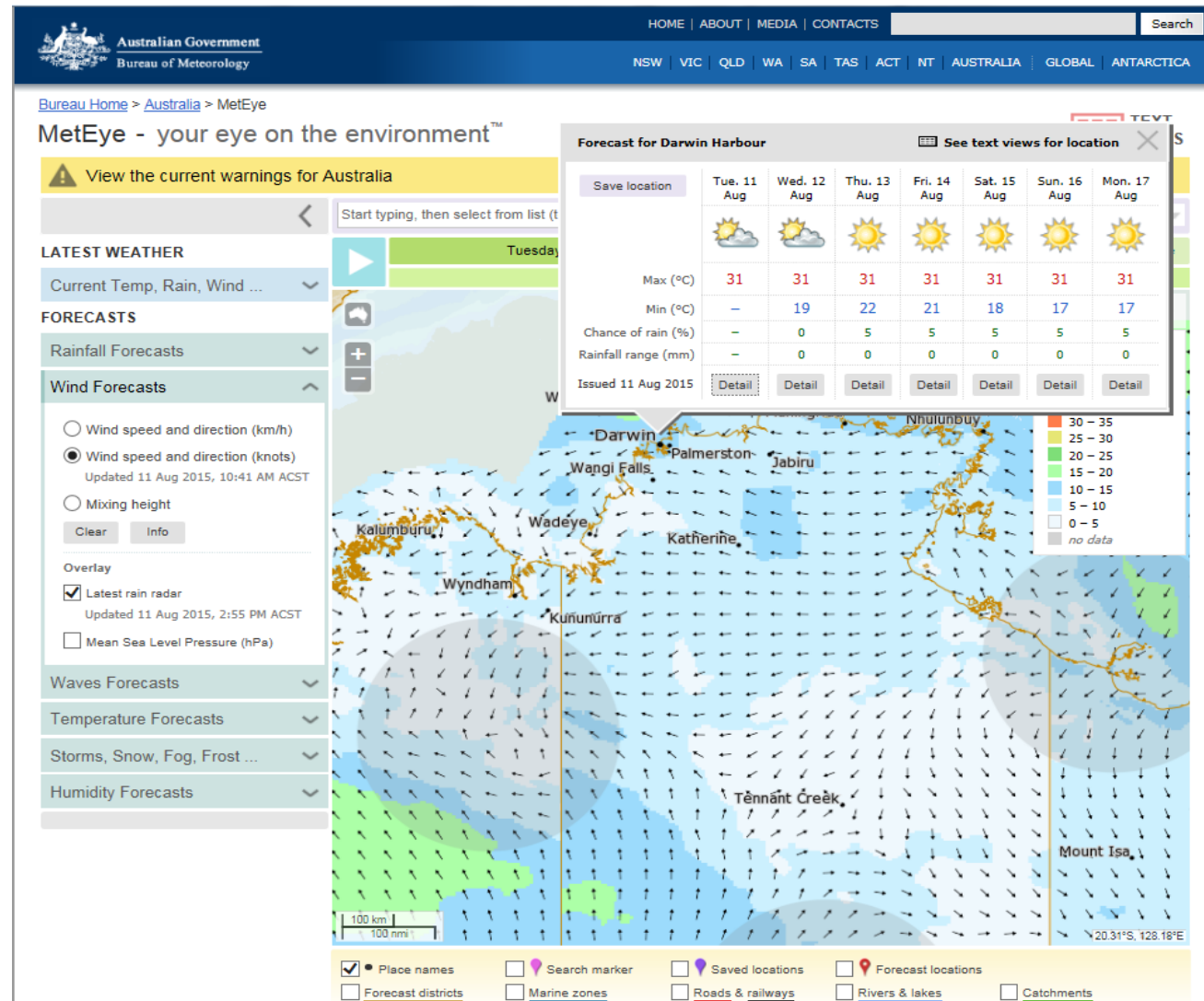
MOD WITH CU.
MOD BLW 7000FT IN THERMALS/PO TILL 08Z.

REMARKS:

WIND 1000FT: 100/20KT, TENDING 080/10KT S OF YPDN/YPGV.
SEA STATE: SEAS TO 1.5M.
FOR A MORE DETAILED BRIEFING CALL [08] 8920 3814.

Public Weather

- Radio interviews
- Tweeting (@bom_NT)
- Take calls from the public
- Draw streamlines for NT news
- 7 day weather outlook



Fire weather

- Use meteorological parameters to decide weather to issue a fire weather warning
 - Temperatures
 - Humidity
 - Winds

Bureau of Meteorology: Sample Fire Ban Advice

AUSTRALIAN GOVERNMENT - BUREAU OF METEOROLOGY VICTORIA

Fire Ban advice for Victoria

Issued at 5.30pm EDT on Saturday 10 December 2004 valid until 11:59 pm EDT on Sunday 11 December 2004

The Country Fire Authority has declared a Total Fire Ban for Sunday 11 December 2004 in the South Western Total Fire Ban District.

For information contact the Country Fire Authority on 1800 240 667 or go to <http://www.cfa.vic.gov.au/>

CFA advises people living in areas at risk of fire to activate their bush fire plan.

FIRE DANGER RATING
Category
CATASTROPHIC (CODE RED)
EXTREME
SEVERE
VERY HIGH
HIGH
LOW – MODERATE



Australian Government
Bureau of Meteorology

Weather Basics



Weather Basics: Topics

- The atmosphere
- Air pressure
- Horizontal motion
- Vertical motion
- Cold fronts
- Tropical cyclones

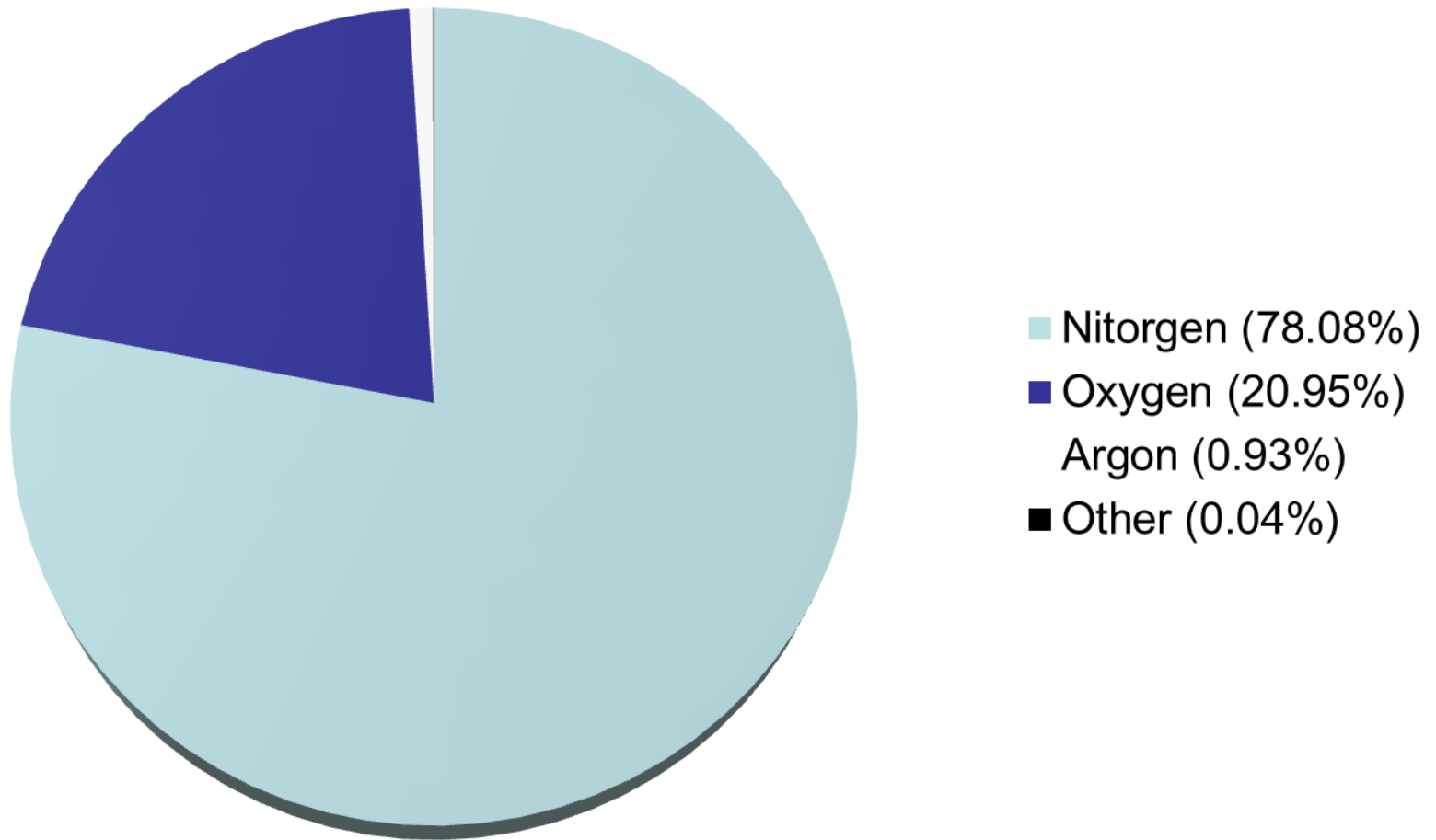


Weather Basics: Topics

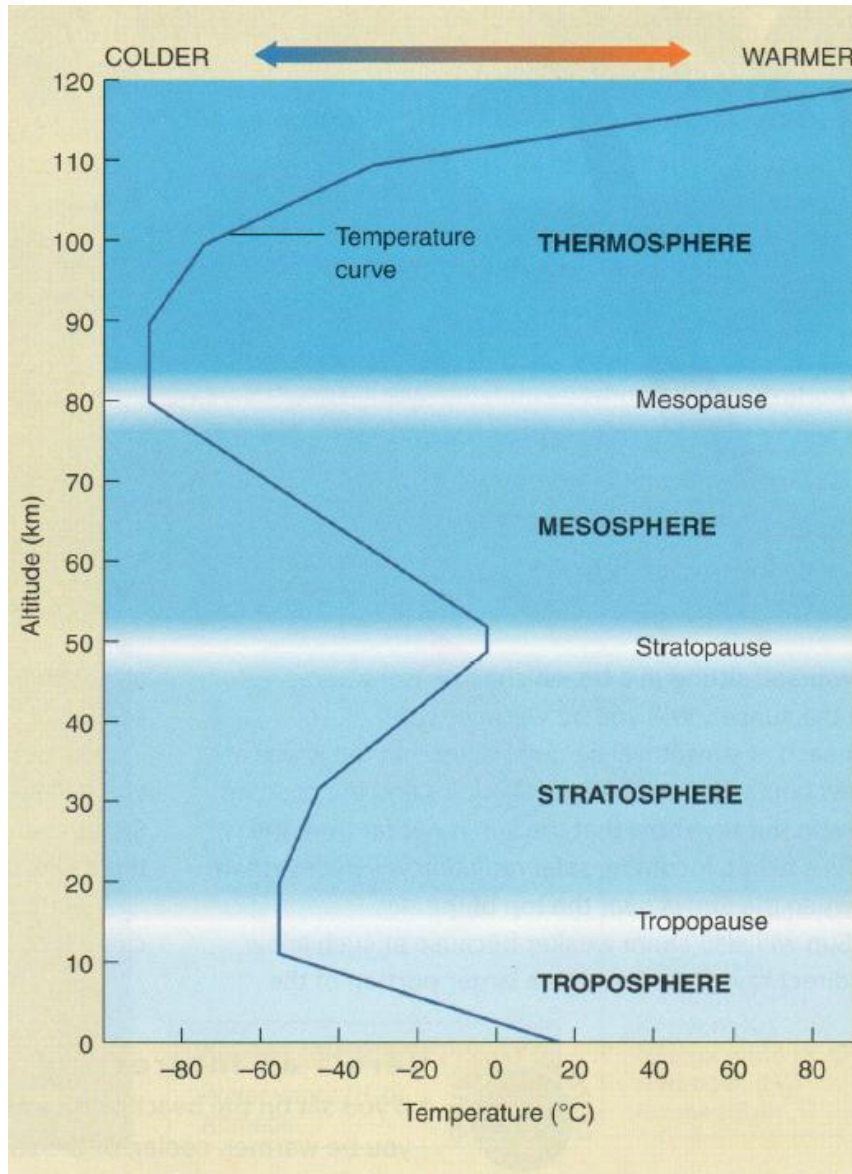
- The atmosphere
- Air pressure
- Horizontal motion
- Vertical motion
- Cold fronts
- Tropical cyclones

The Atmosphere

Atmospheric Composition



The Atmosphere



Ozone absorption

Where weather occurs



Weather Basics: Topics

- The atmosphere
- Air pressure
- Horizontal motion
- Vertical motion
- Cold fronts
- Tropical cyclones



Air Pressure

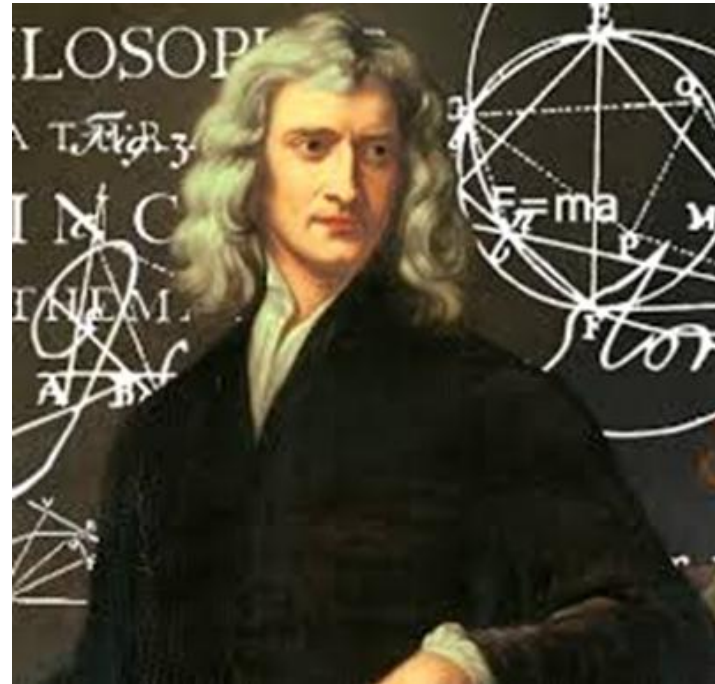
- Why is air pressure important in meteorology?





Air Pressure

- Force = mass X acceleration
- $F=ma$



Air Pressure

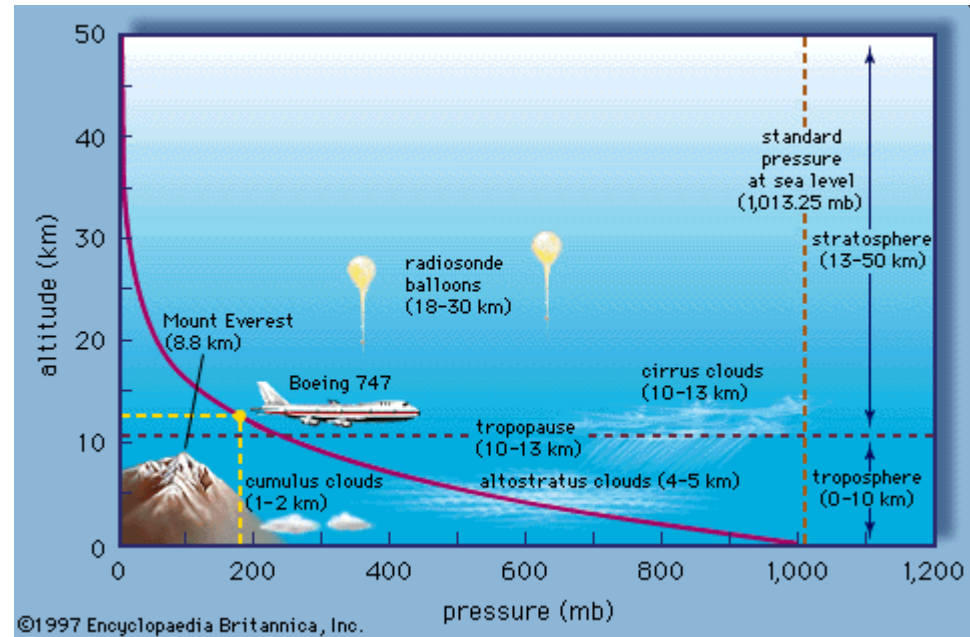
- Pressure: net force per unit area, $P=F/A$
- Air has mass
- Gravity pulls air down
- Air Pressure is the force exerted by the column of air directly above you.
- Measured by a barometer
 - In millibars (mb) =
 - hecto Pascals (hPa) = kg / ms^2
 - Sometimes inches of mercury

Air pressure and altitude

If you are standing at the top of Mt Everest, will the air pressure be less or more than when you were standing at base camp?

Air pressure and altitude

- If air pressure is weight of air above you
- Then less air above you means lower air pressure



Air pressure and its importance

- How does air pressure relate to weather patterns?
 - Horizontal motion
 - Vertical motion



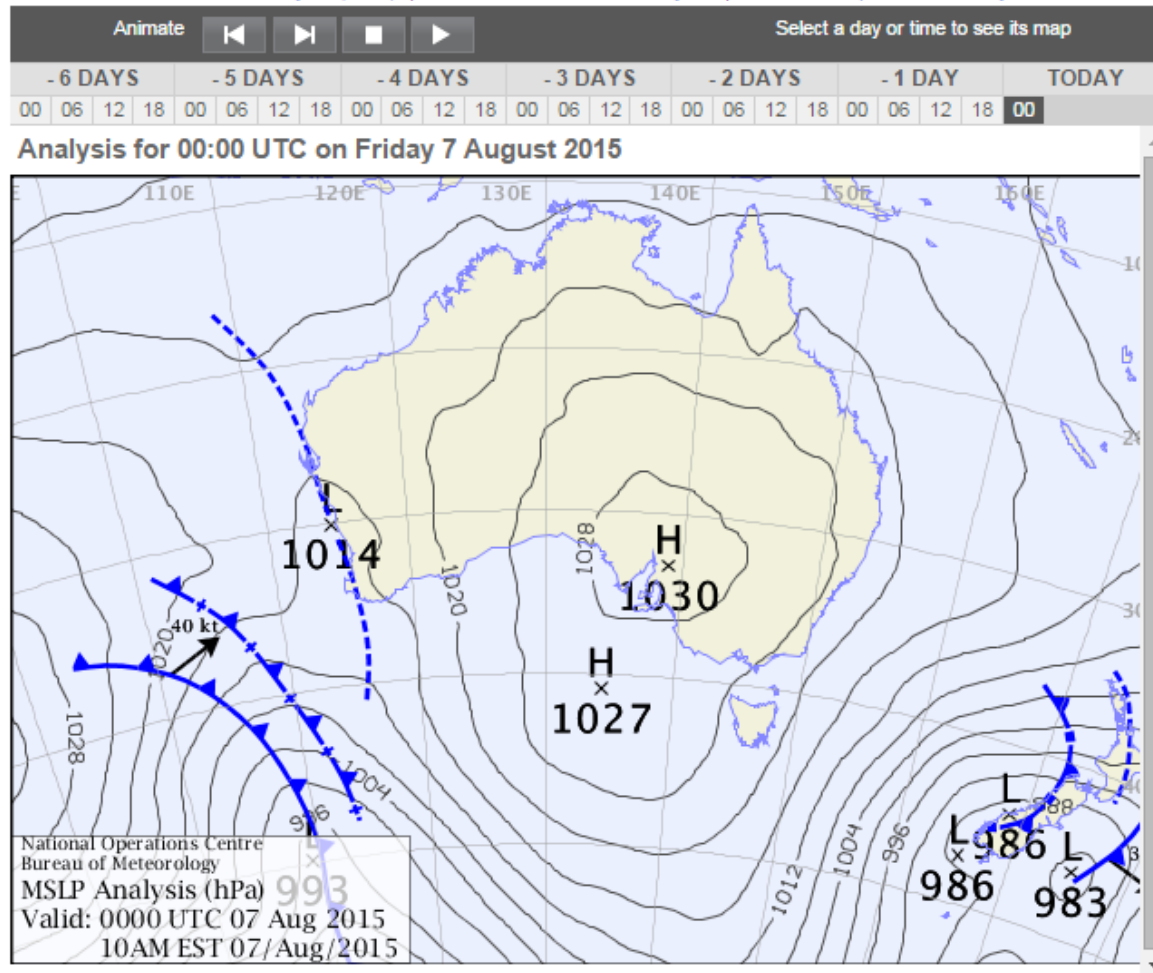
Weather Basics: Topics

- The atmosphere
- Air pressure
- Horizontal motion
- Vertical motion
- Cold fronts
- Tropical cyclones

Air pressure and weather patterns – Horizontal motion

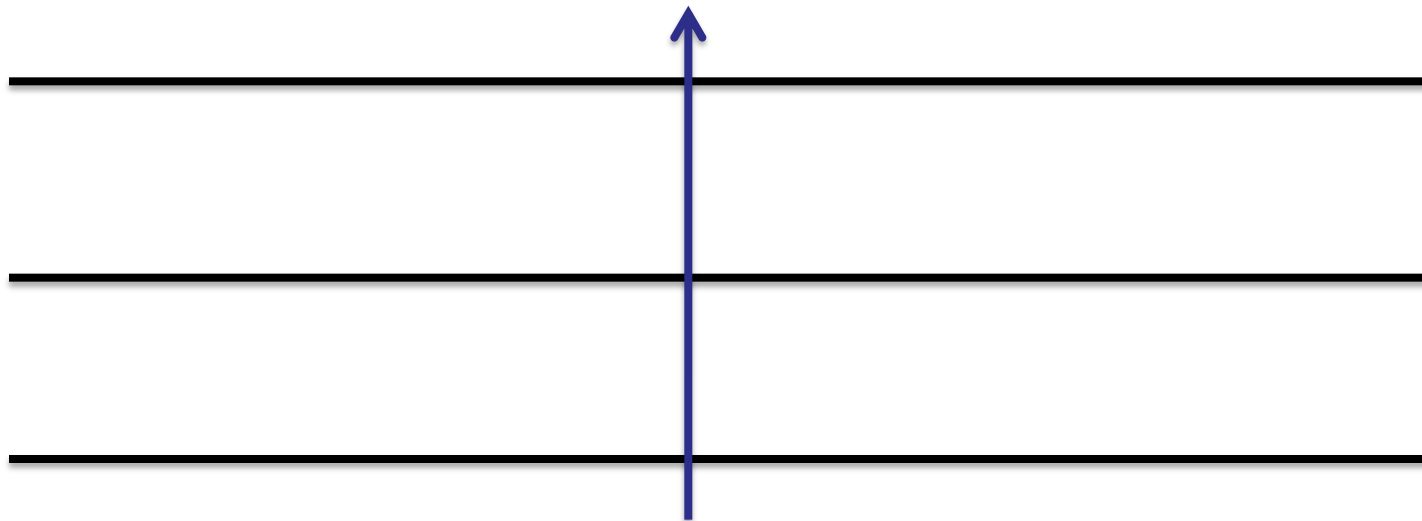
Latest Colour Mean Sea-Level Pressure Analysis

[Latest Printable Colour Analysis \(PDF\)](#) | [Latest Black & White Analysis](#) | [Forecast map for next 4 days](#)



Horizontal Motion

Low Pressure



High Pressure



= Pressure Gradient Force



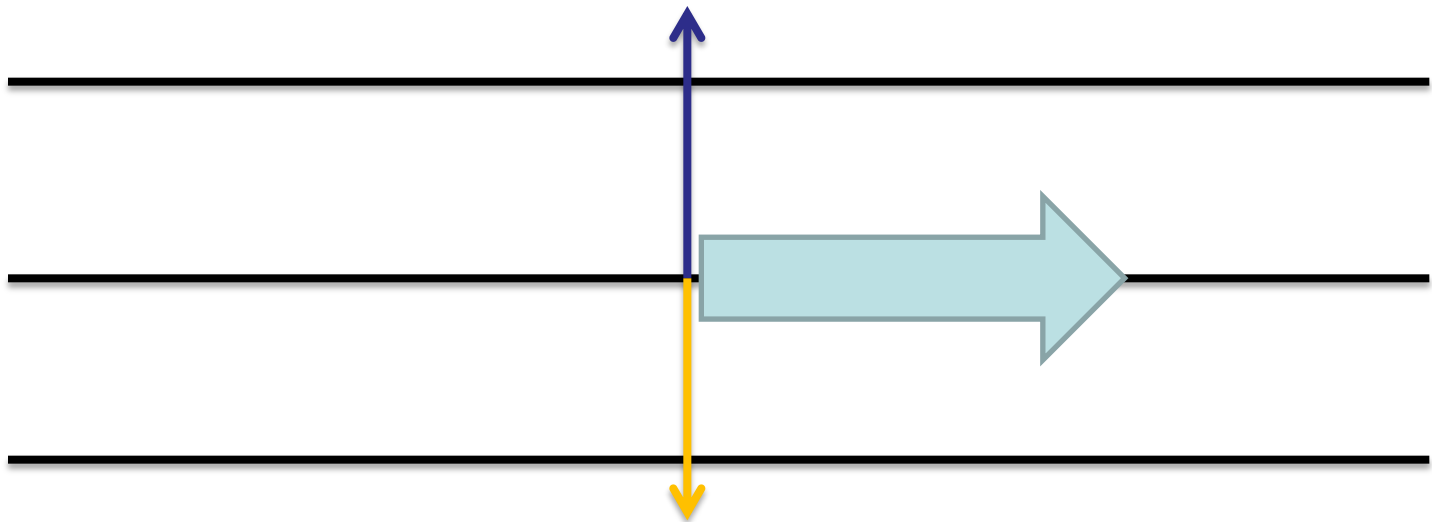
Australian Government
Bureau of Meteorology

Coriolis Effect

https://www.youtube.com/watch?v=_36MiCUS1ro

Horizontal Motion

Low Pressure



High Pressure

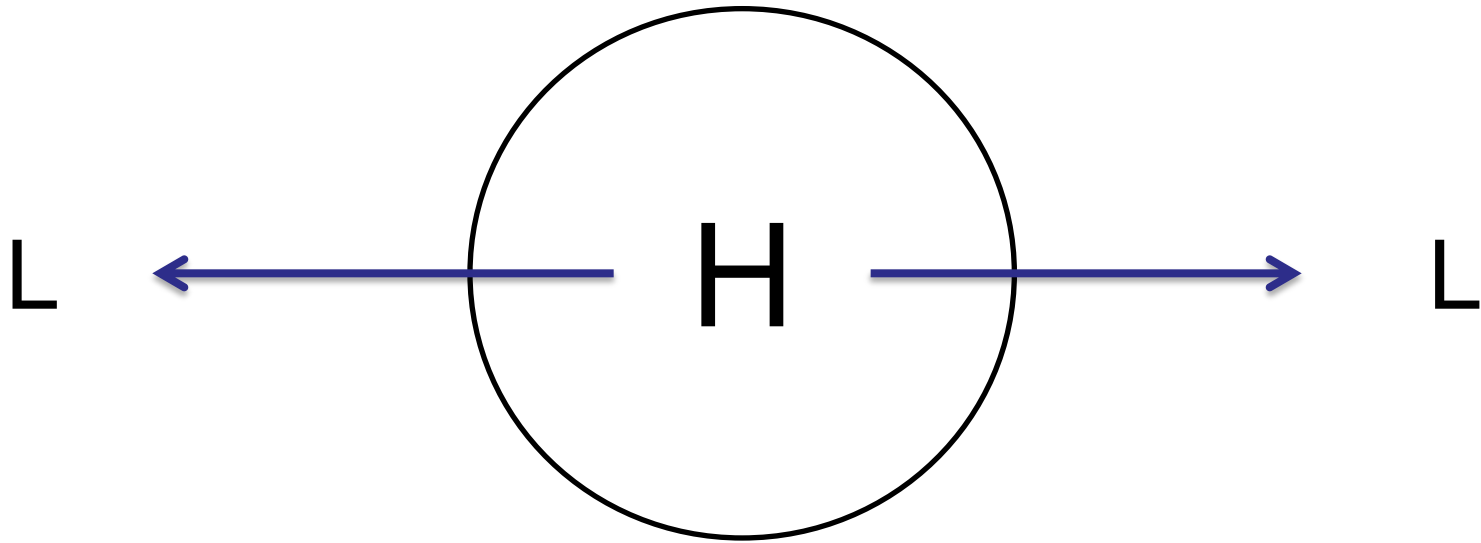


= Pressure Gradient Force



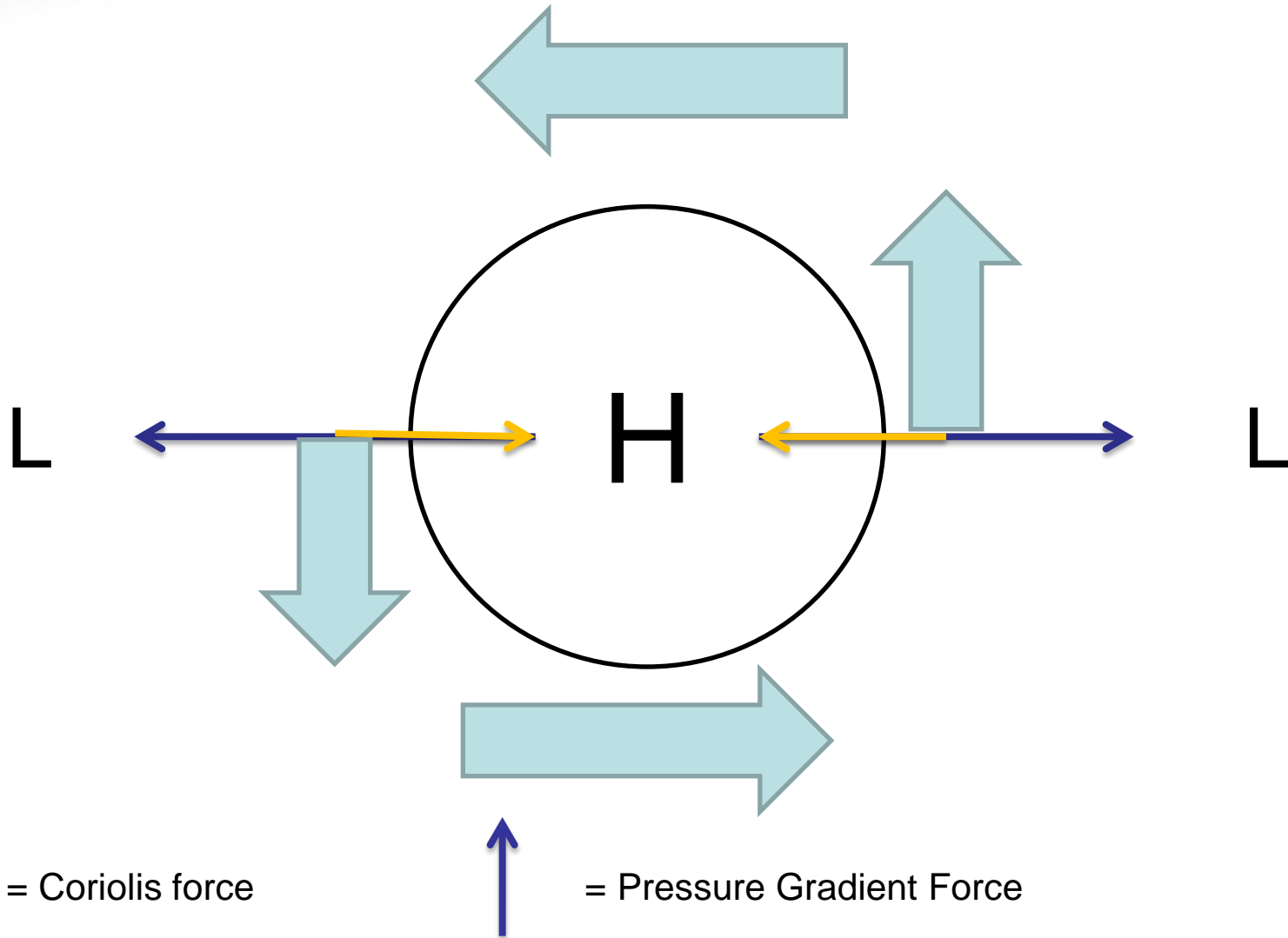
= Coriolis force

Horizontal motion



= Pressure Gradient Force



Horizontal motion





Latest Colour Mean Sea-Level Pressure Analysis

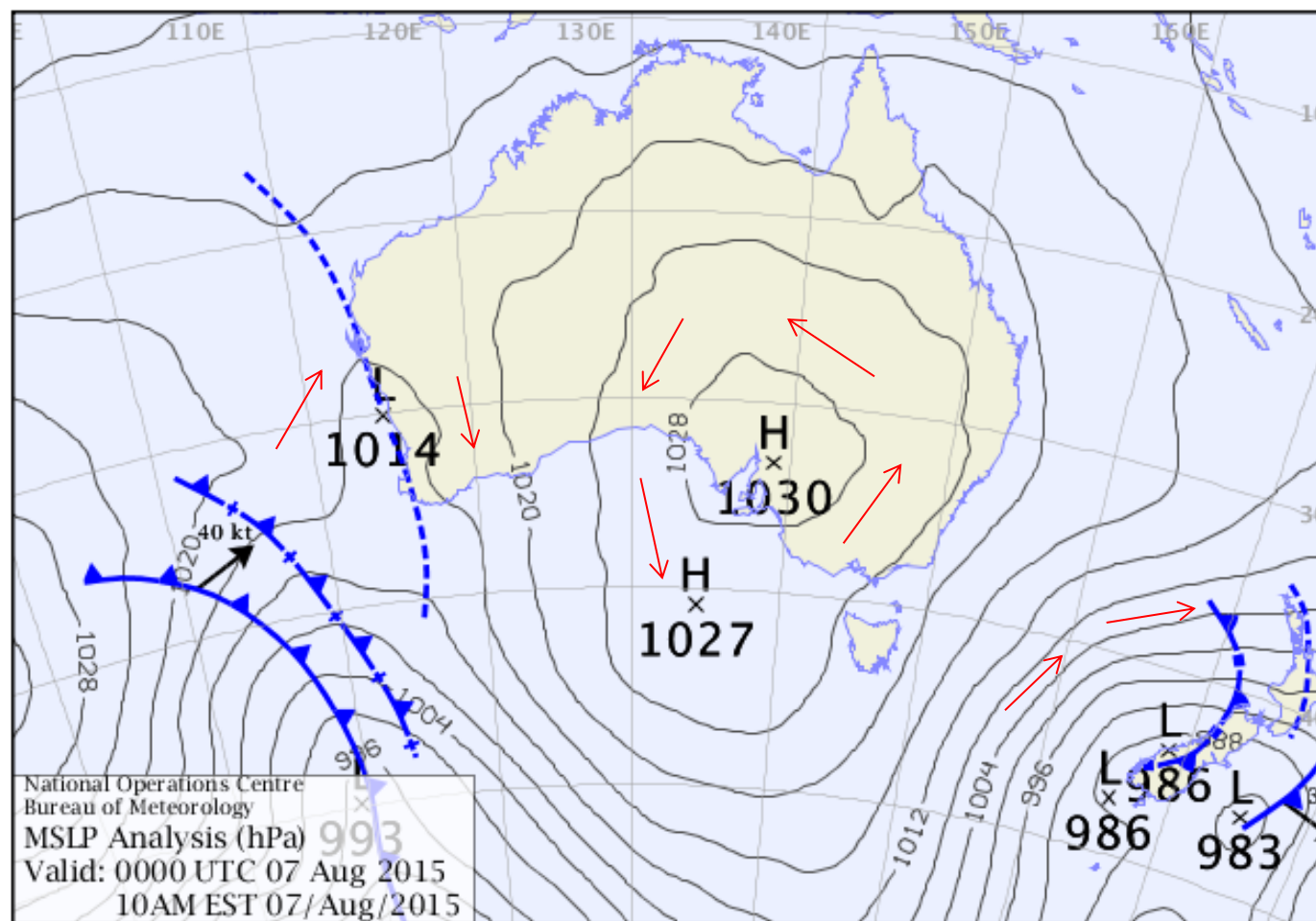
[Latest Printable Colour Analysis \(PDF\)](#) | [Latest Black & White Analysis](#) | [Forecast map for next 4 days](#)

Animate    

Select a day or time to see its map

- 6 DAYS				- 5 DAYS				- 4 DAYS				- 3 DAYS				- 2 DAYS				- 1 DAY				TODAY	
00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00	06	12	18	00	

Analysis for 00:00 UTC on Friday 7 August 2015



Important things to remember about wind:



1. It's described (or named) using the direction it is coming from
 - a) southeast winds are coming FROM the southeast.

2. Wind speed is constantly changing:
 - a) Gusts are a short increase in wind speed

The Bureau of Meteorology reports wind as a 10 minute mean of wind speed or direction.

Wind gusts are the highest instantaneous wind speed measured within that 10 minute mean

3. On land wind is given in kilometres per hour
On water we use knots (nautical miles per hour).
 - a) 1 knot = 1.85 km/h



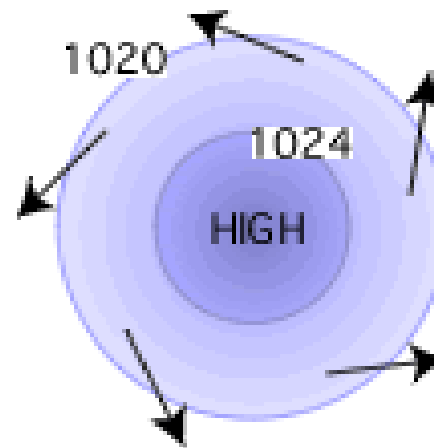
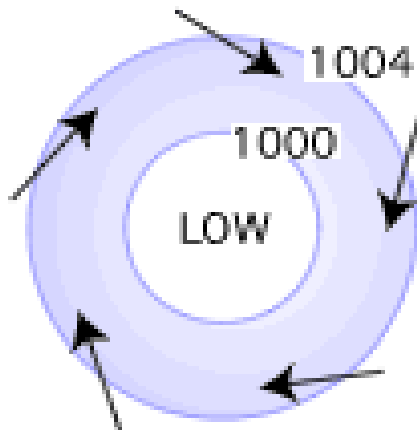


Basics: Highs and Lows

- In the **Southern** Hemisphere:

Motion around a **Low** is **Clockwise**

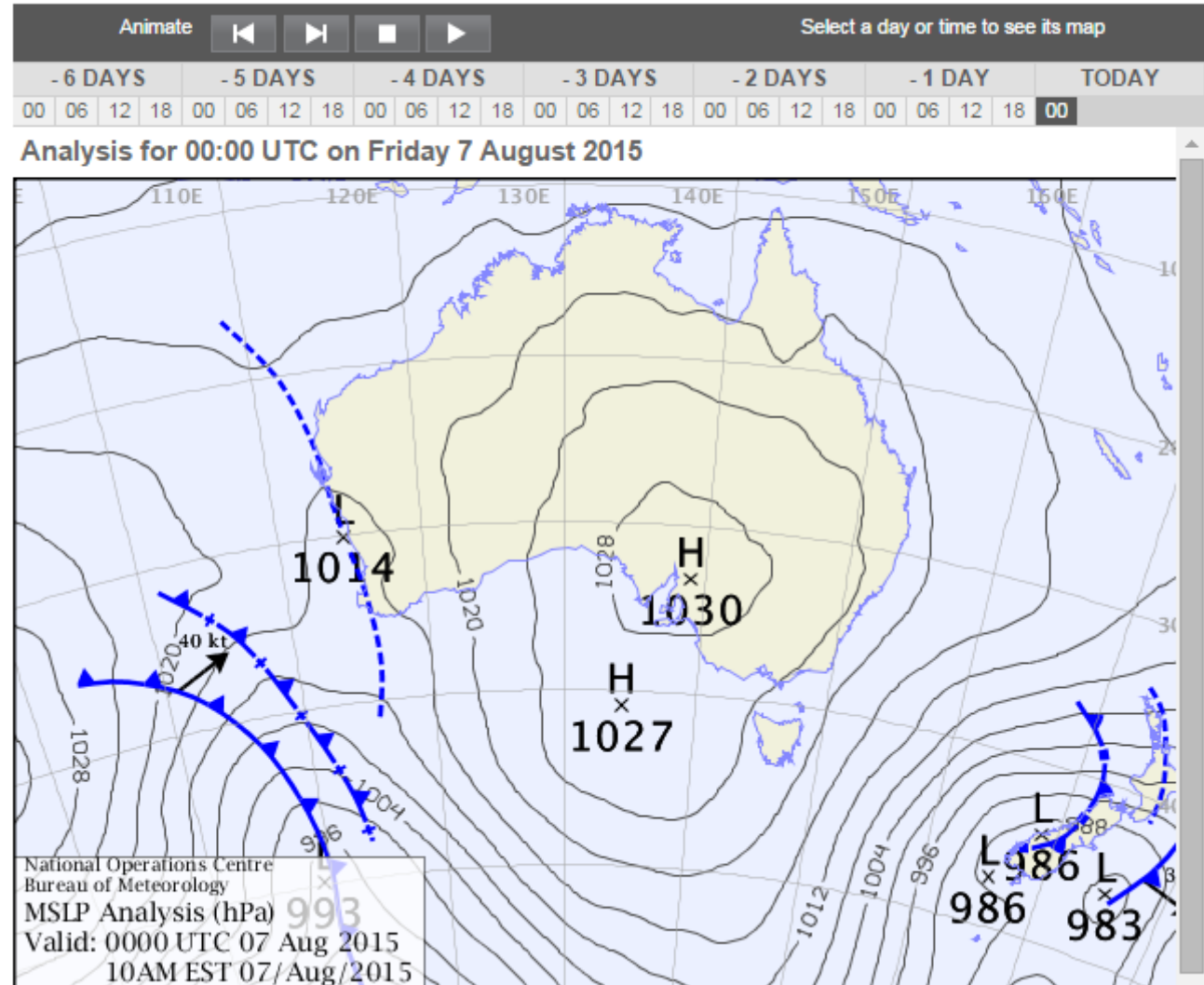
Motion around a **High** is **Anticlockwise**



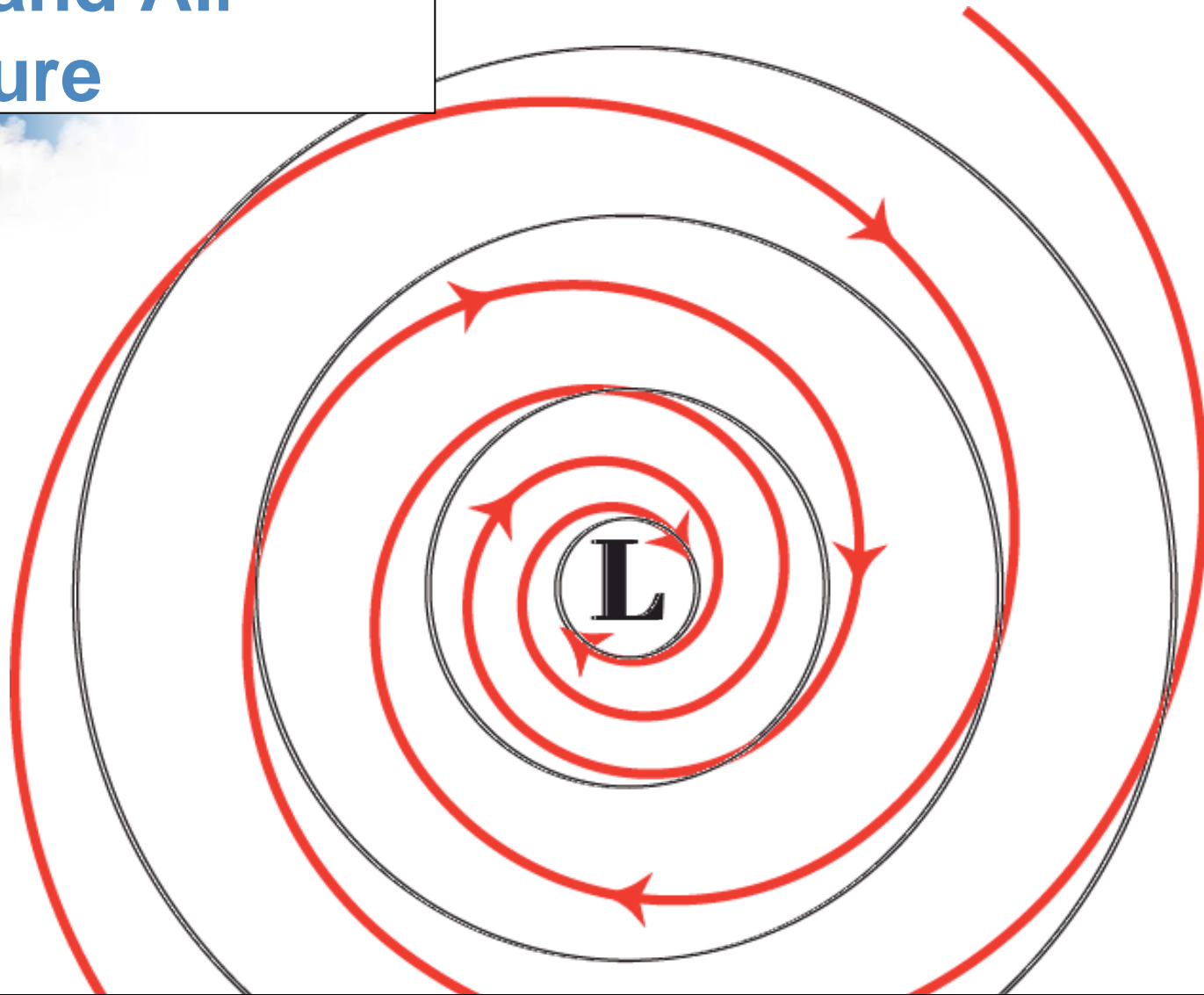
What about the tropics?

Latest Colour Mean Sea-Level Pressure Analysis

[Latest Printable Colour Analysis \(PDF\)](#) | [Latest Black & White Analysis](#) | [Forecast map for next 4 days](#)



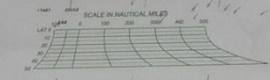
Wind and Air Pressure



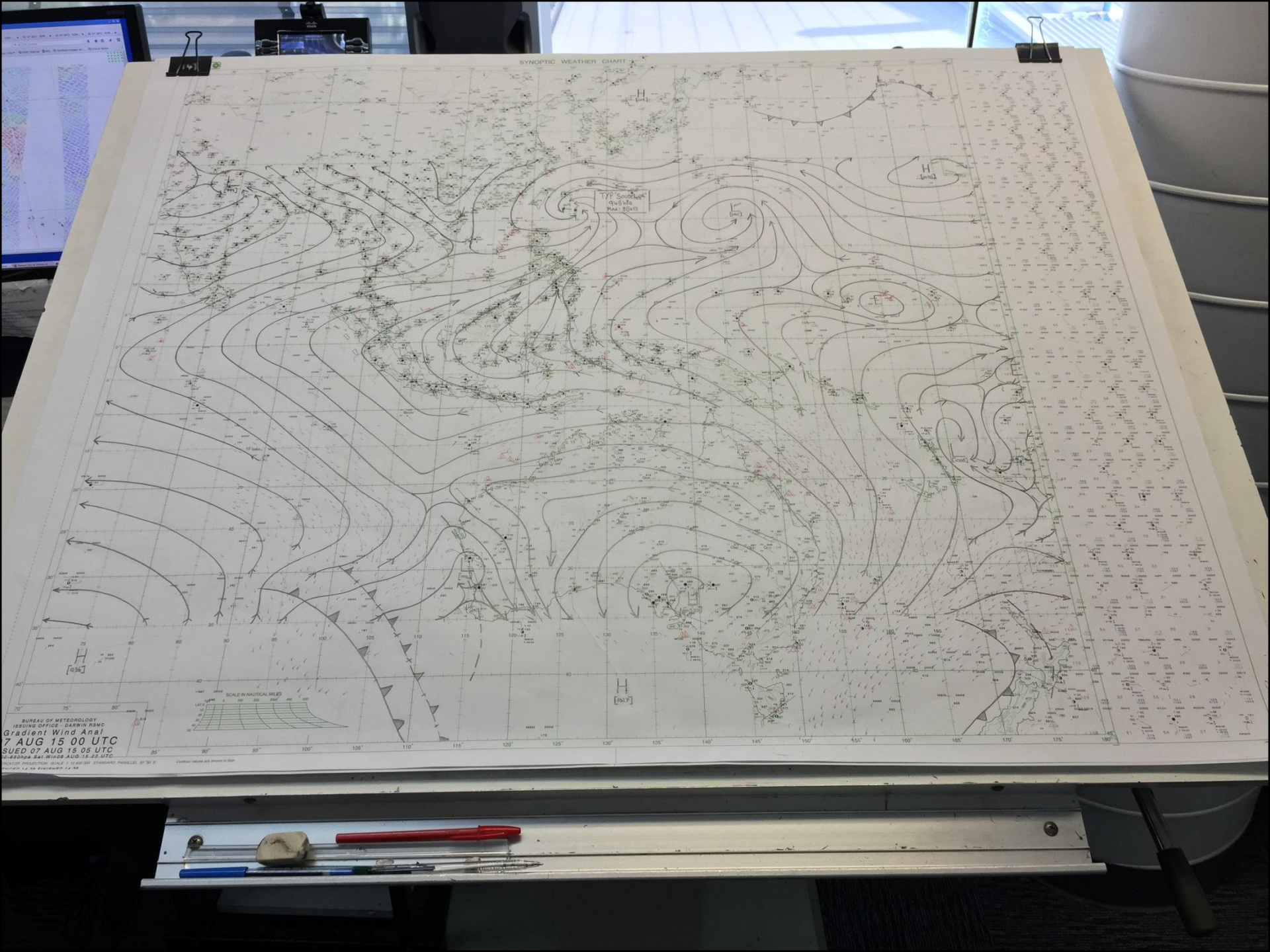
- We can draw the wind fields around the pressure systems to analyse the weather

SYNOPTIC WEATHER CHART

BUREAU OF METEOROLOGY
ISSUING OFFICE: DARWIN RSMC
Gradient Wind Anal
7 AUG 15 00 UTC
SUEO 07 AUG 15 05 UTC
10-8200pa, 841 WINDS AUG 15 23 UTC
PROJECTION: PROJECTION SCALE 1:10 000 000 STANDARD PARALLEL 30°30' S
PAPER: 14 x 20 INCHES 14-504



TYP. SOUTHERN
9-5 Sta
Mar 2013

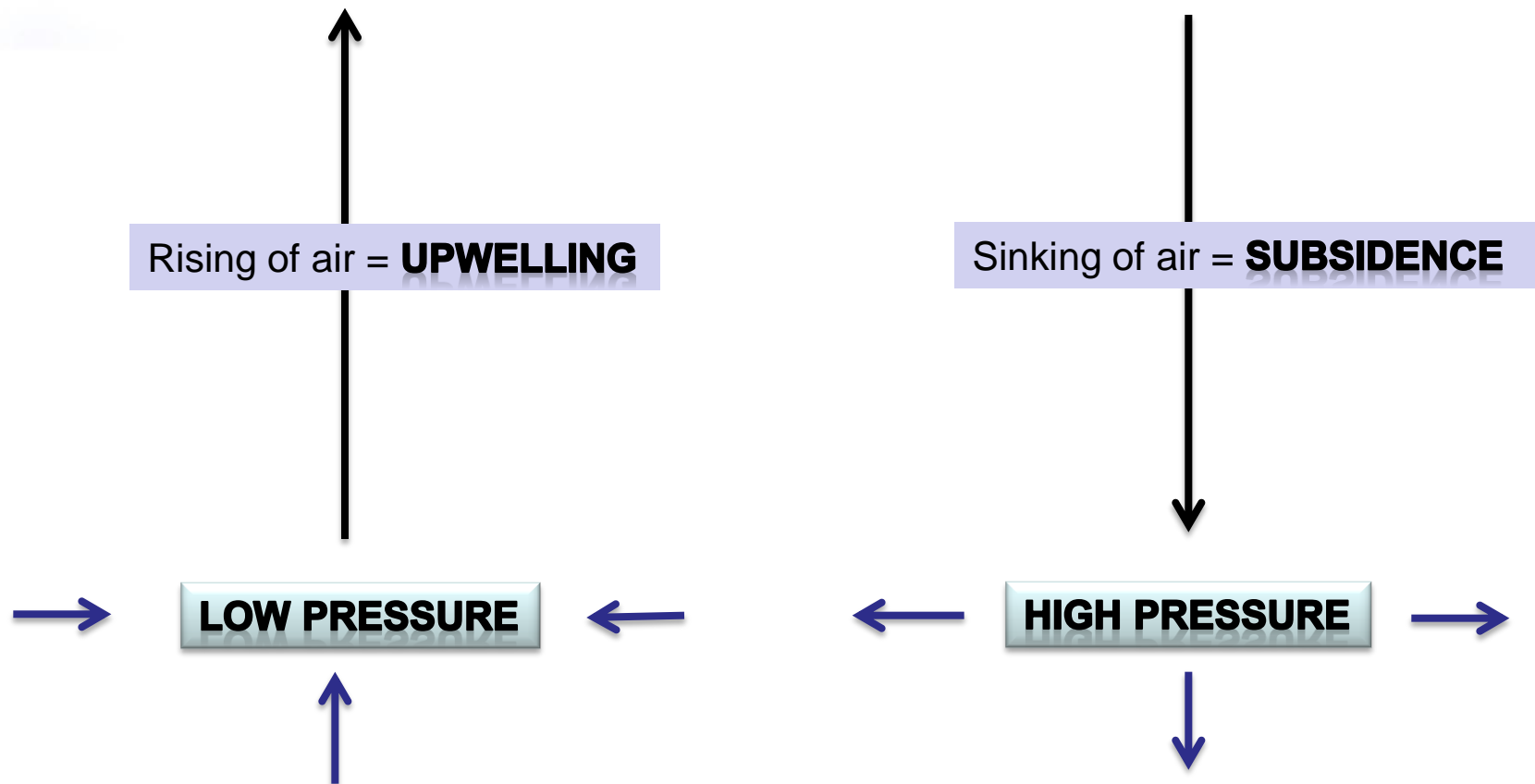




Weather Basics: Topics

- The atmosphere
- Air pressure
- Horizontal motion
- Vertical motion
- Cold fronts
- Tropical cyclones

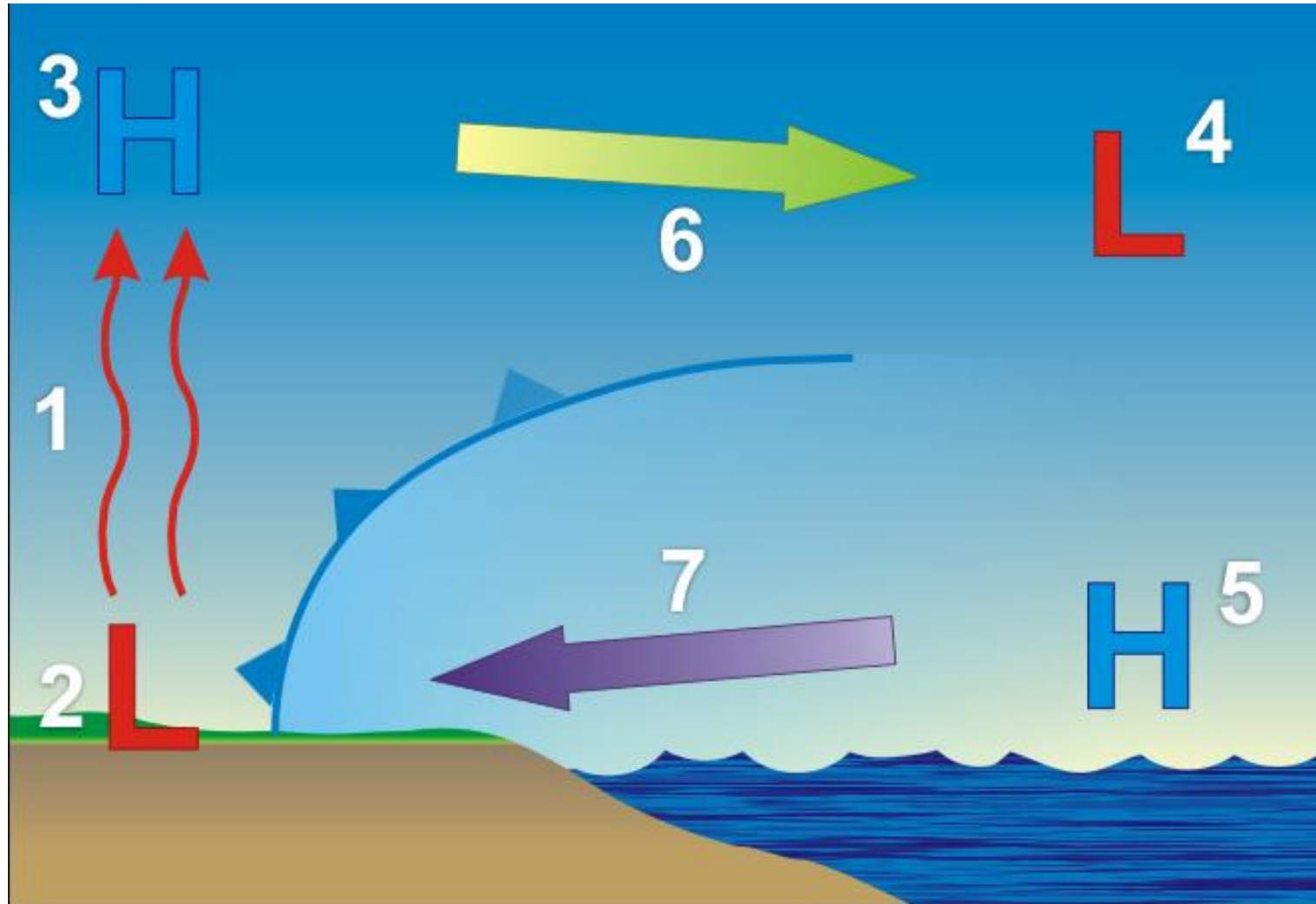
Air pressure and weather patterns – Vertical motion





Australian Government
Bureau of Meteorology

Sea breeze



HOT

Air Rises, but as it rises it

cools

and

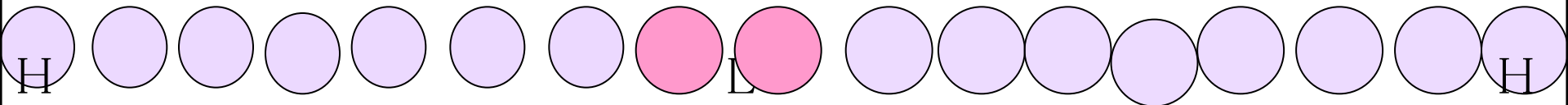
expands





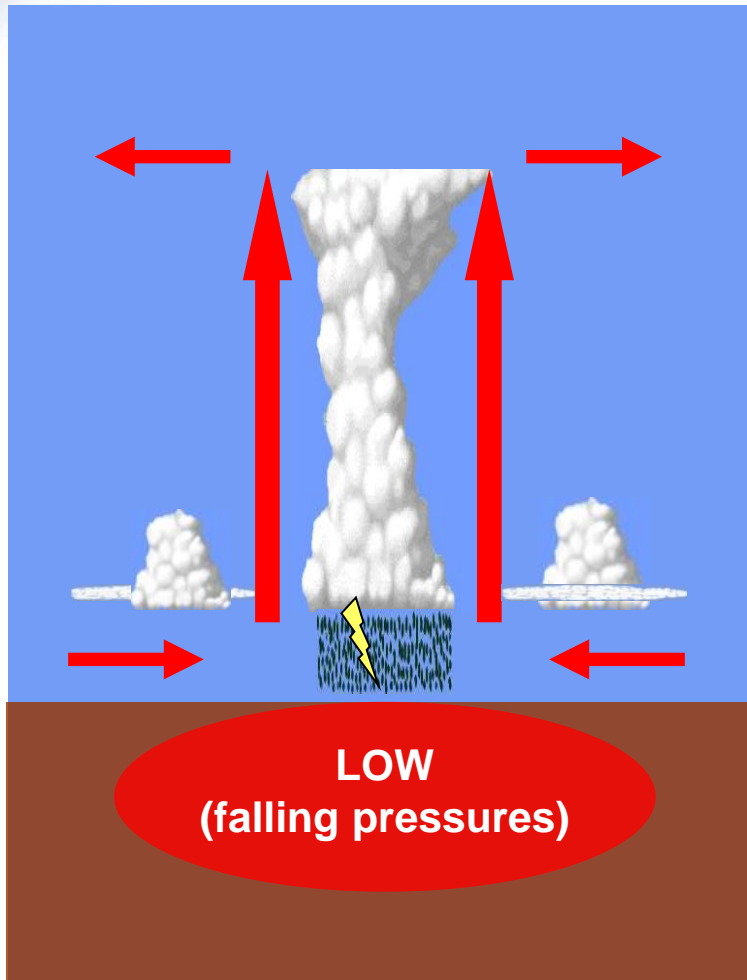
Convection

The water vapour
in the air will
condense into
water droplets
that form a cloud
and can
eventually grow
into raindrops
and fall from the
cloud as rain

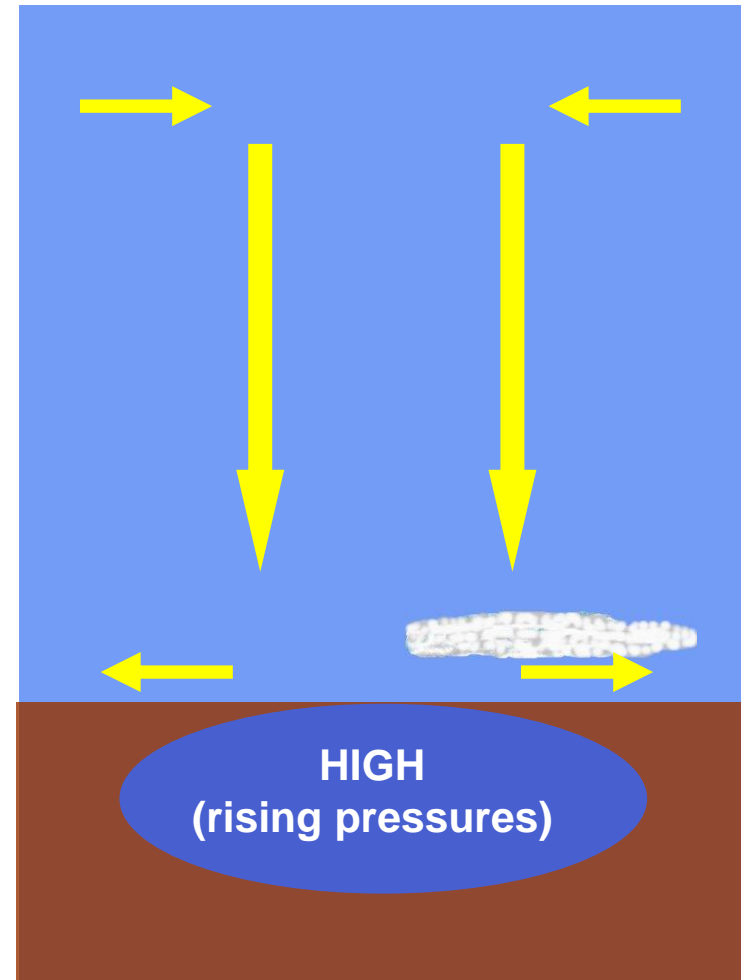


Basics: Highs and Lows

Showers and storms

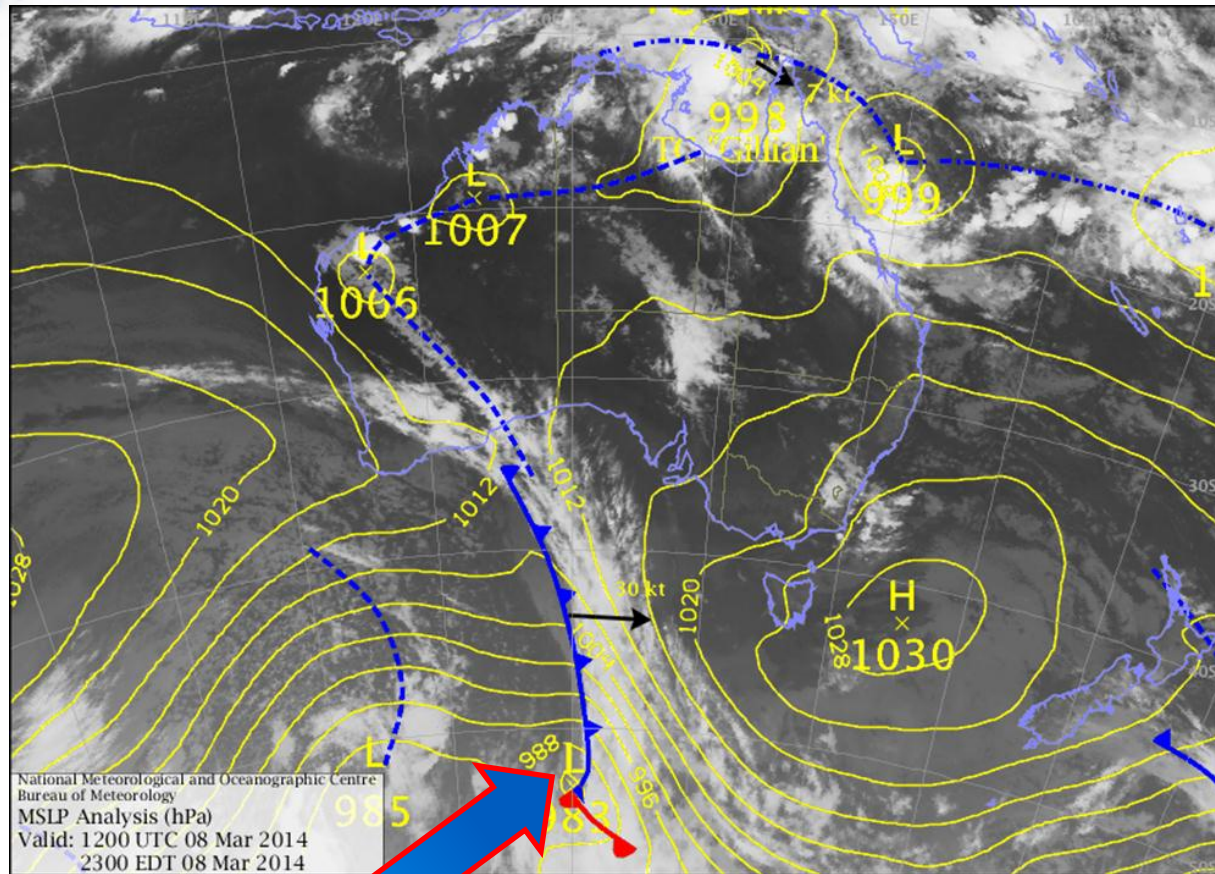


Clear skies, fog or low cloud





Where's the weather?



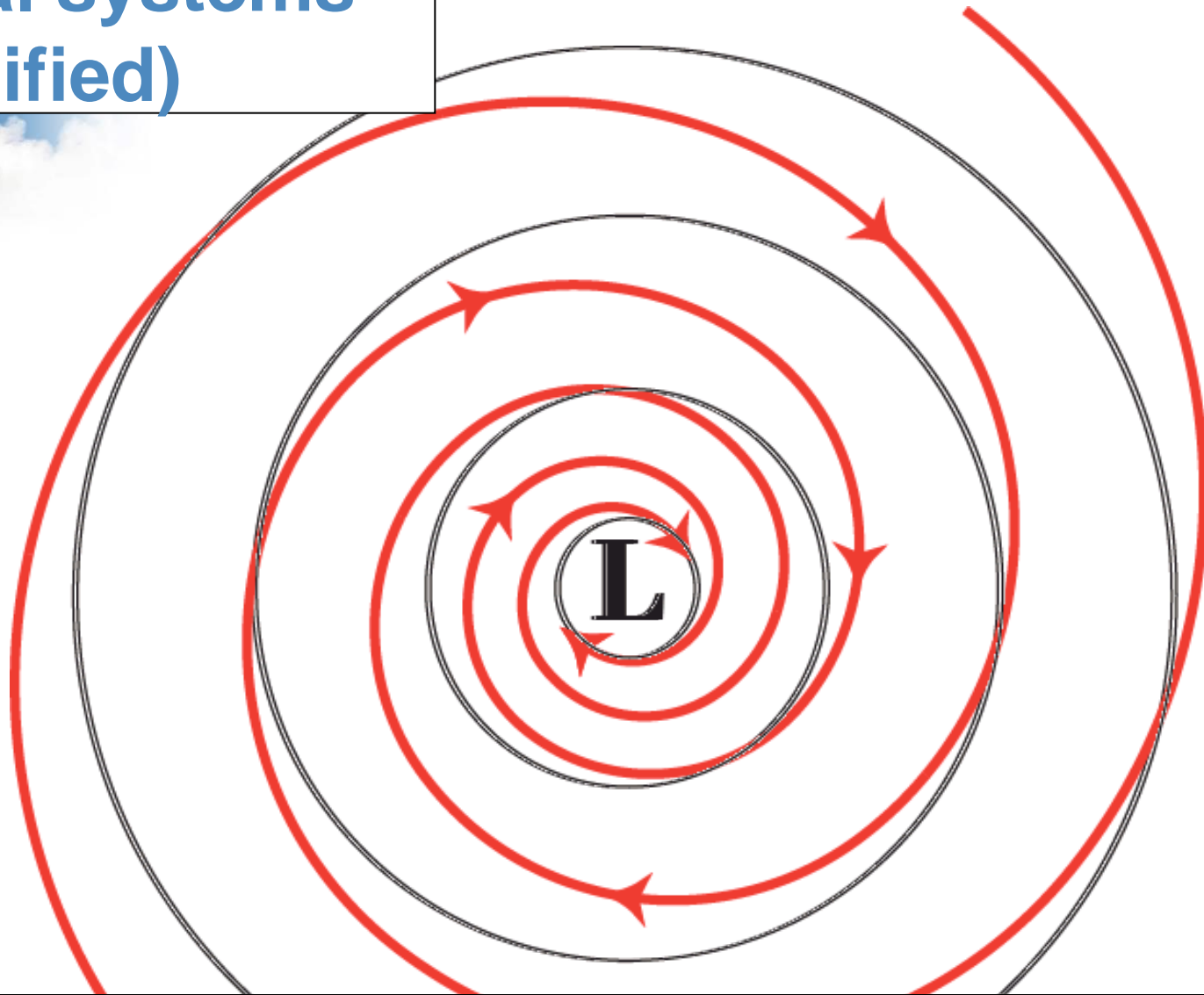
What is a weather front and why don't we get them in the tropics?



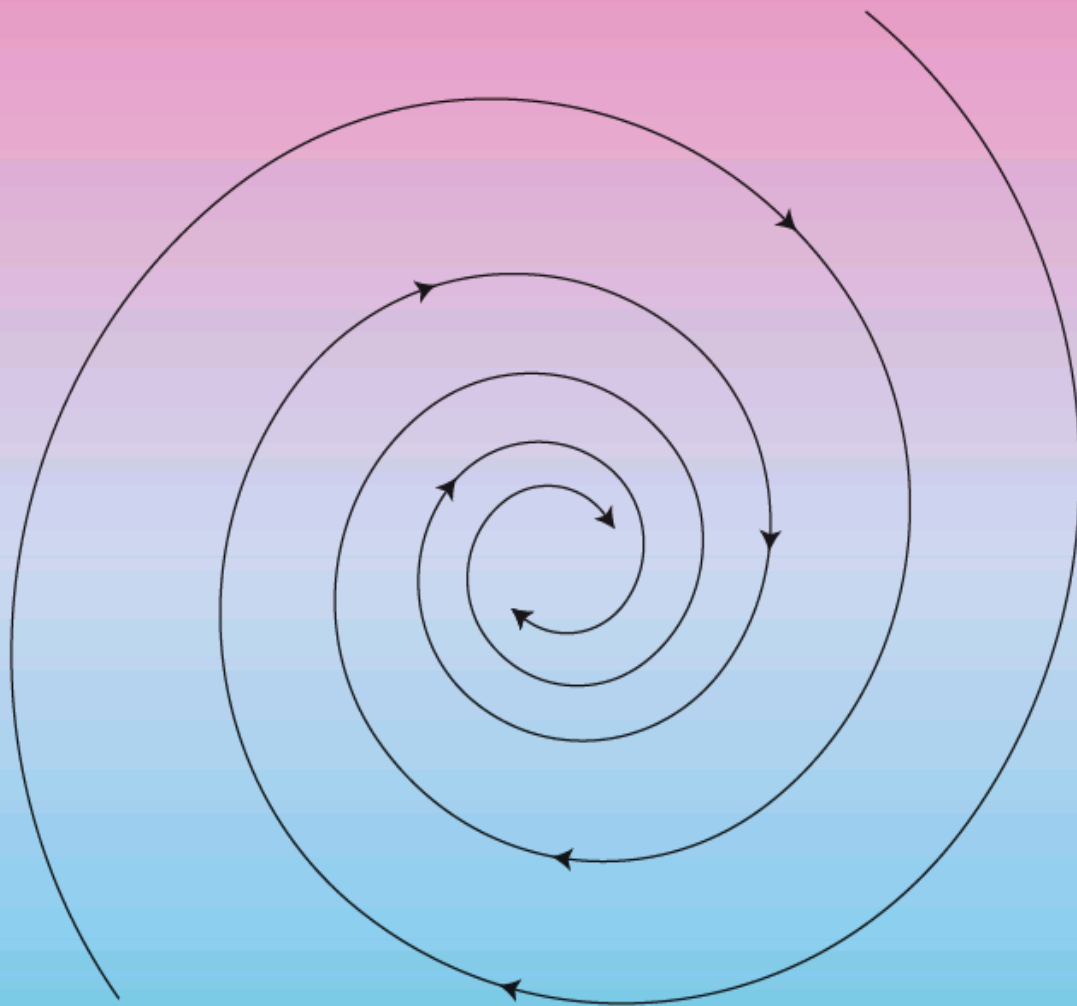
Weather Basics: Topics

- The atmosphere
- Air pressure
- Horizontal motion
- Vertical motion
- Cold fronts
- Tropical cyclones

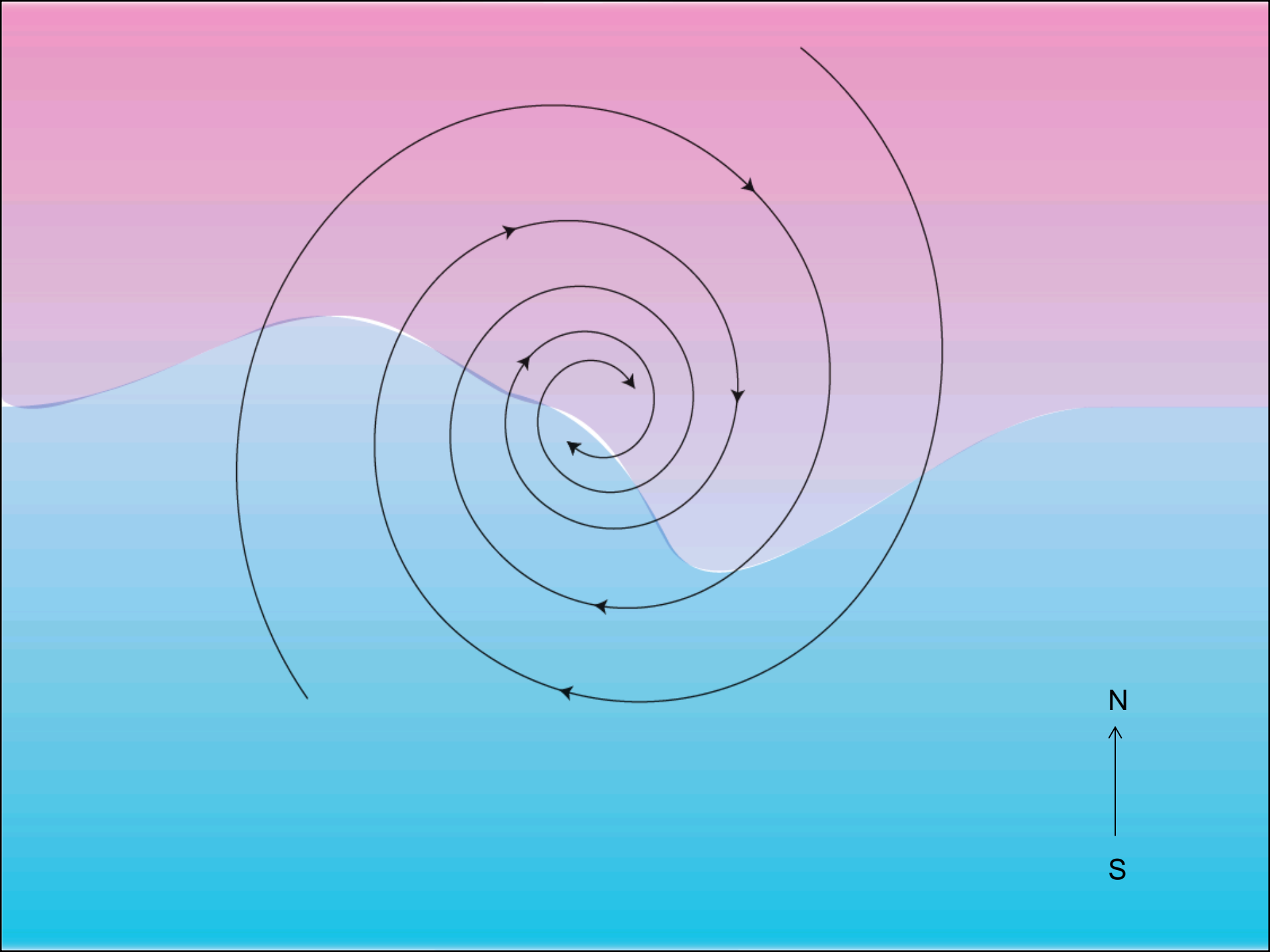
Frontal systems (simplified)

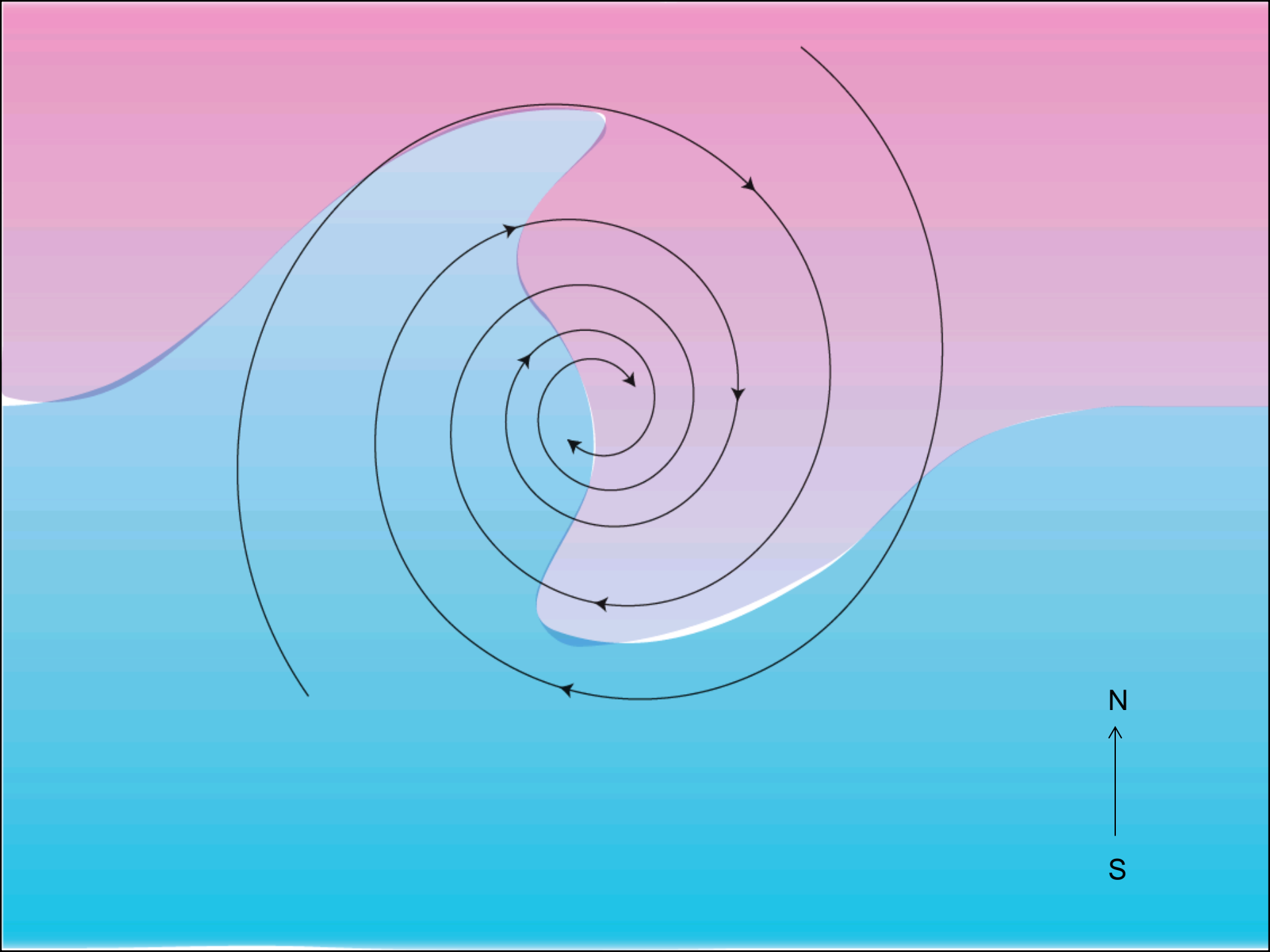


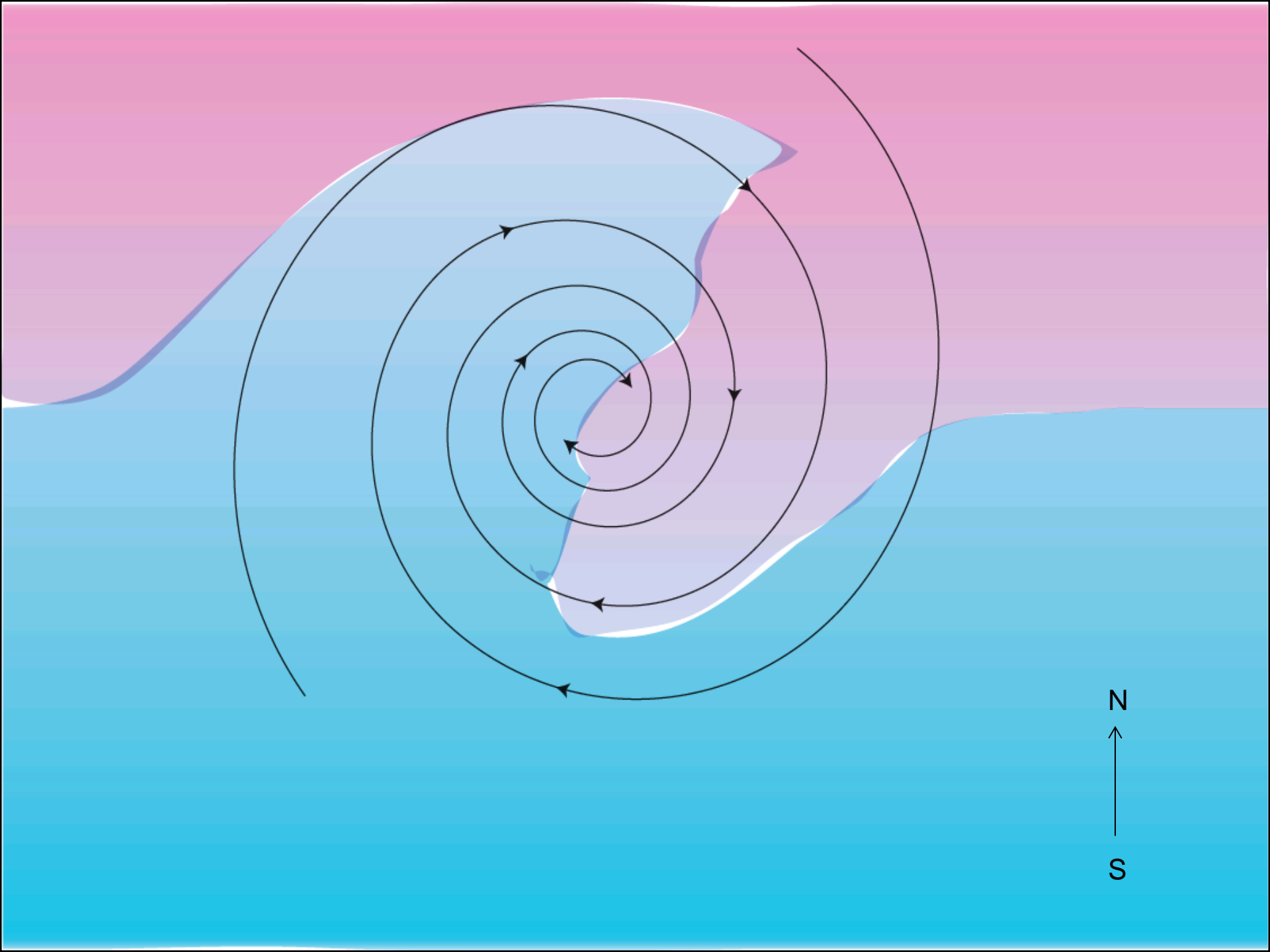
- A front is a boundary separating two air masses

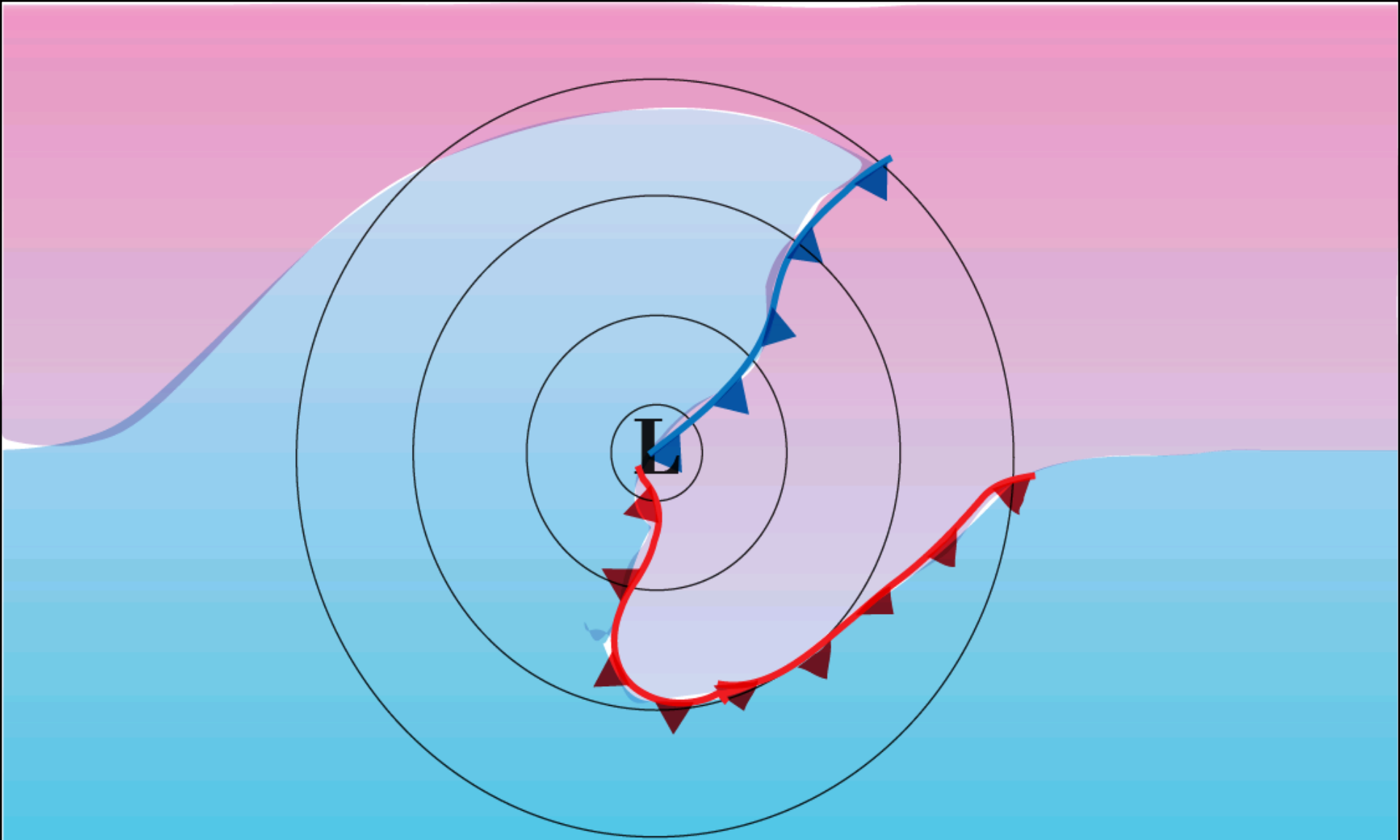


N
↑
S





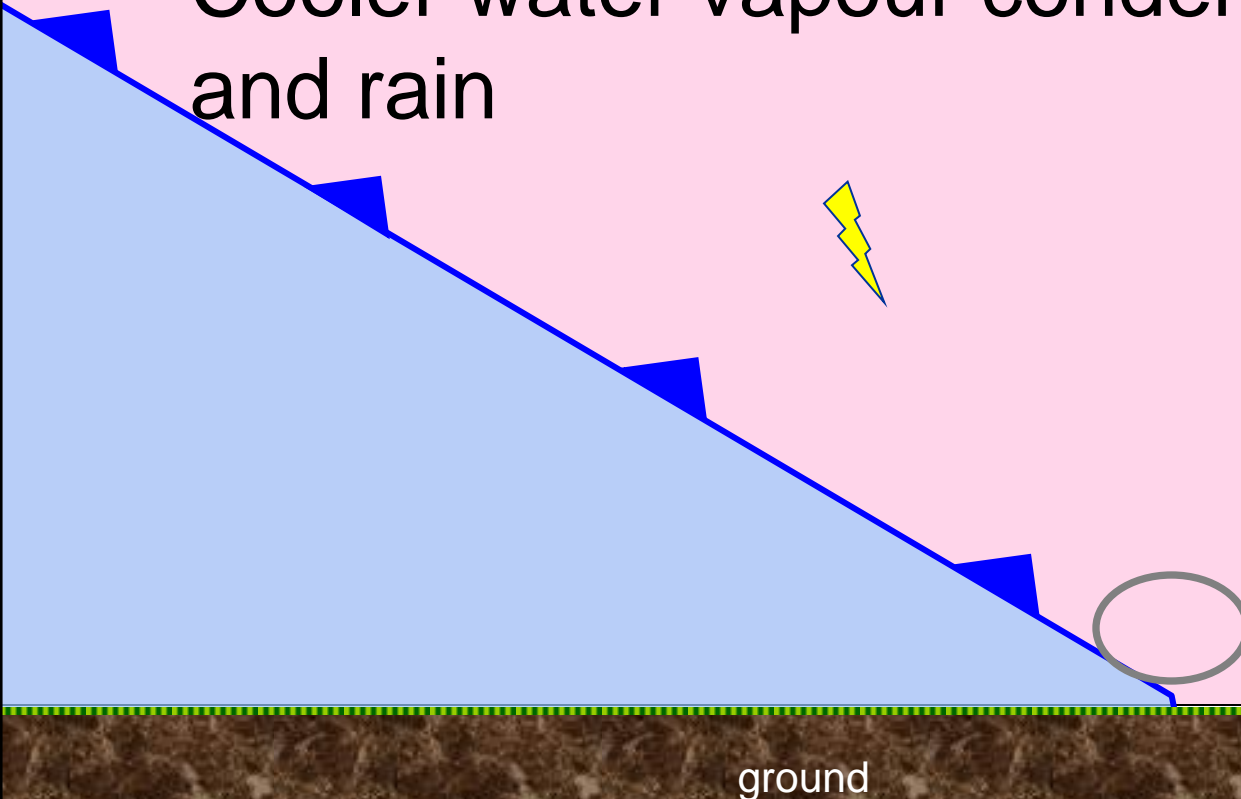




- A front is a boundary separating two air masses

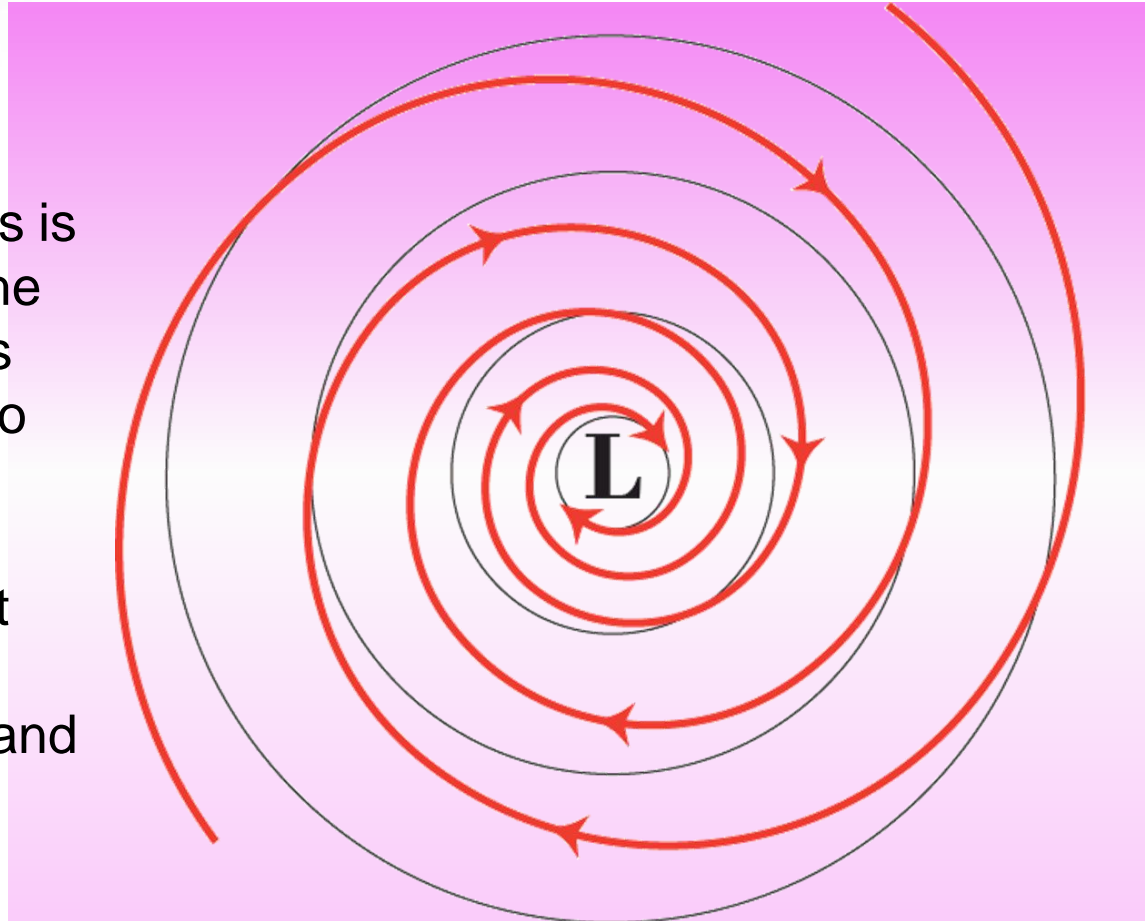
Cold fronts and weather

- Cold fronts cause warm air to rise and cool.
- Cooler water vapour condenses into cloud and rain



Why don't we get fronts in the tropics?

The temperatures is the mostly the same across the tropics so that air circulating a low does not develop boundaries and or fronts



Instead we get tropical lows & tropical cyclones.





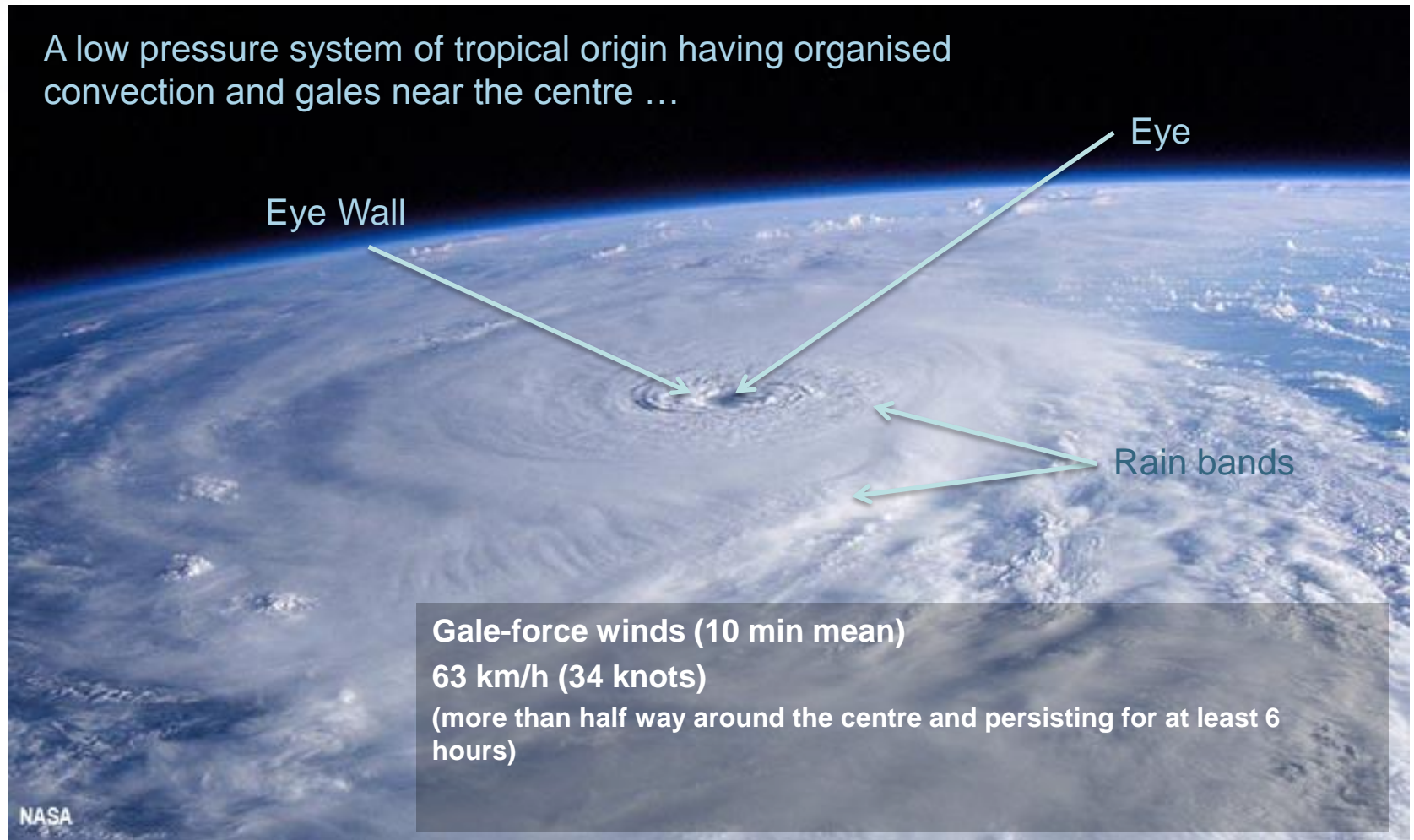
Weather Basics: Topics

- The atmosphere
- Air pressure
- Horizontal motion
- Vertical motion
- Cold fronts
- Tropical cyclones



What is a Tropical Cyclone?

A low pressure system of tropical origin having organised convection and gales near the centre ...



Gale-force winds (10 min mean)
63 km/h (34 knots)
(more than half way around the centre and persisting for at least 6 hours)



Australian Government
Bureau of Meteorology

Super Typhoon Noul

Animated GIF: <http://go.wisc.edu/0ii0lk>

MP4 movie file: <http://go.wisc.edu/s60k77>



Category	Strongest Gust (km/h)	Average Maximum Wind (km/h)	Central Pressure (hPa)	Typical Effects
1	< 125	63 - 88	> 985	Negligible house damage. Damage to some crops, trees and caravans. Craft may drag moorings



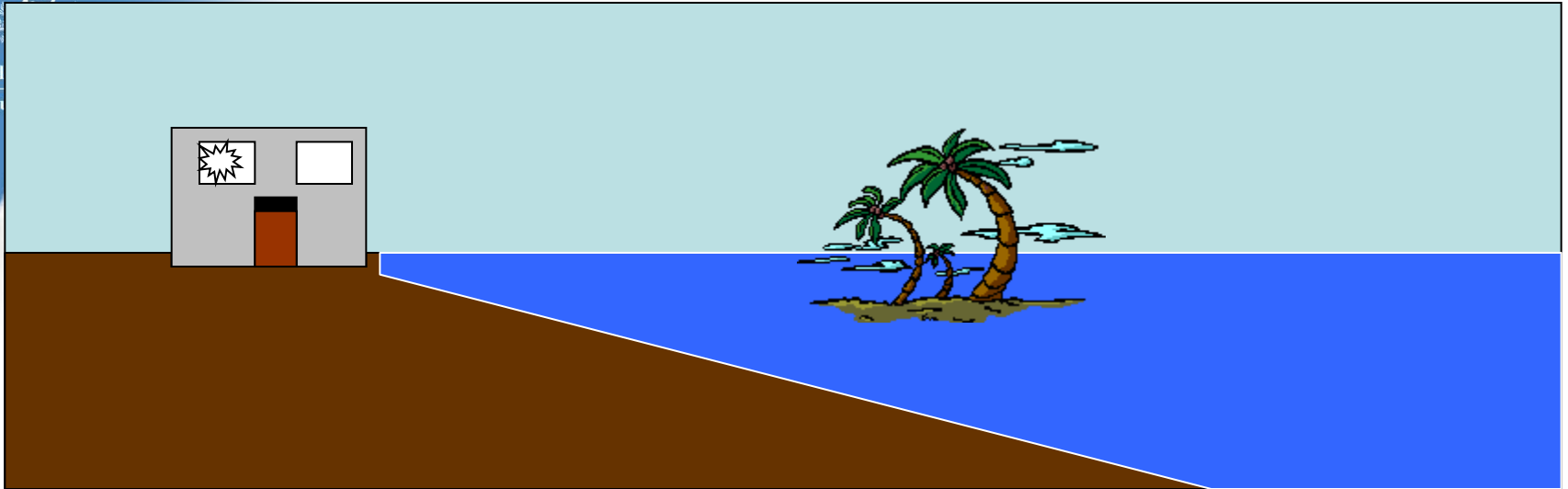
Category	Strongest Gust (km/h)	Average Maximum Wind (km/h)	Central Pressure (hPa)	Typical Effects
2	125 - 164	89 - 117	985 - 970	Minor house damage. Significant damage to signs, trees and caravans. Heavy damage to some crops. Risk of power failure. Small craft may break moorings.



Category	Strongest Gust (km/h)	Average Maximum Wind (km/h)	Central Pressure (hPa)	Typical Effects
3	165 - 224	118 - 159	970 - 955	Some roof and structural damage. Some caravans destroyed. Power failures likely. (e.g. <i>Winifred</i>)



Category	Strongest Gust (km/h)	Average Maximum Wind (km/h)	Central Pressure (hPa)	Typical Effects
4	225 - 279	160 - 199	955 - 930	Significant roofing loss and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures. (e.g. <i>Tracy, Olivia</i>)



Category	Strongest Gust (km/h)	Average Maximum Wind (km/h)	Central Pressure (hPa)	Typical Effects
5	> 279	> 200	< 930	Extremely dangerous with widespread destruction. (e.g. <i>Vance</i>)



Australian Government
Bureau of Meteorology

Climatology Basics

Climatology Basics

- Definitions
- Global Energy Budget
- Global Circulation
- Monsoon

Climatology Basics

- Definitions
- Global Energy Budget
- Global Circulation
- Monsoon

What is the difference between weather and climate?

- Weather: “The current state of the atmosphere...the short-term (minutes to days) variations in the atmosphere” AMS Glossary of Meteorology
- Climate: “The slowly varying aspects of the atmosphere-hydrosphere-land surface system” AMS Glossary of Meteorology
 - “The climate is what you expect, the weather is what you get”

Climatology:

average conditions and anomalies

- Climate: “The slowly varying aspects of the atmosphere-hydrosphere-land surface system”
 - AMS Glossary of Meteorology
 - Often taken as a 30 year average
- Climate variability: “any variations of the atmosphere/ocean system around a mean state”
 - AMS Glossary of Meteorology
 - Why are some years wetter than others?
 - What drives changes from season to season?
- Climate Change: “Any systematic change in the long-term statistics of climate elements sustained over several decades or longer”
 - AMS Glossary of Meteorology

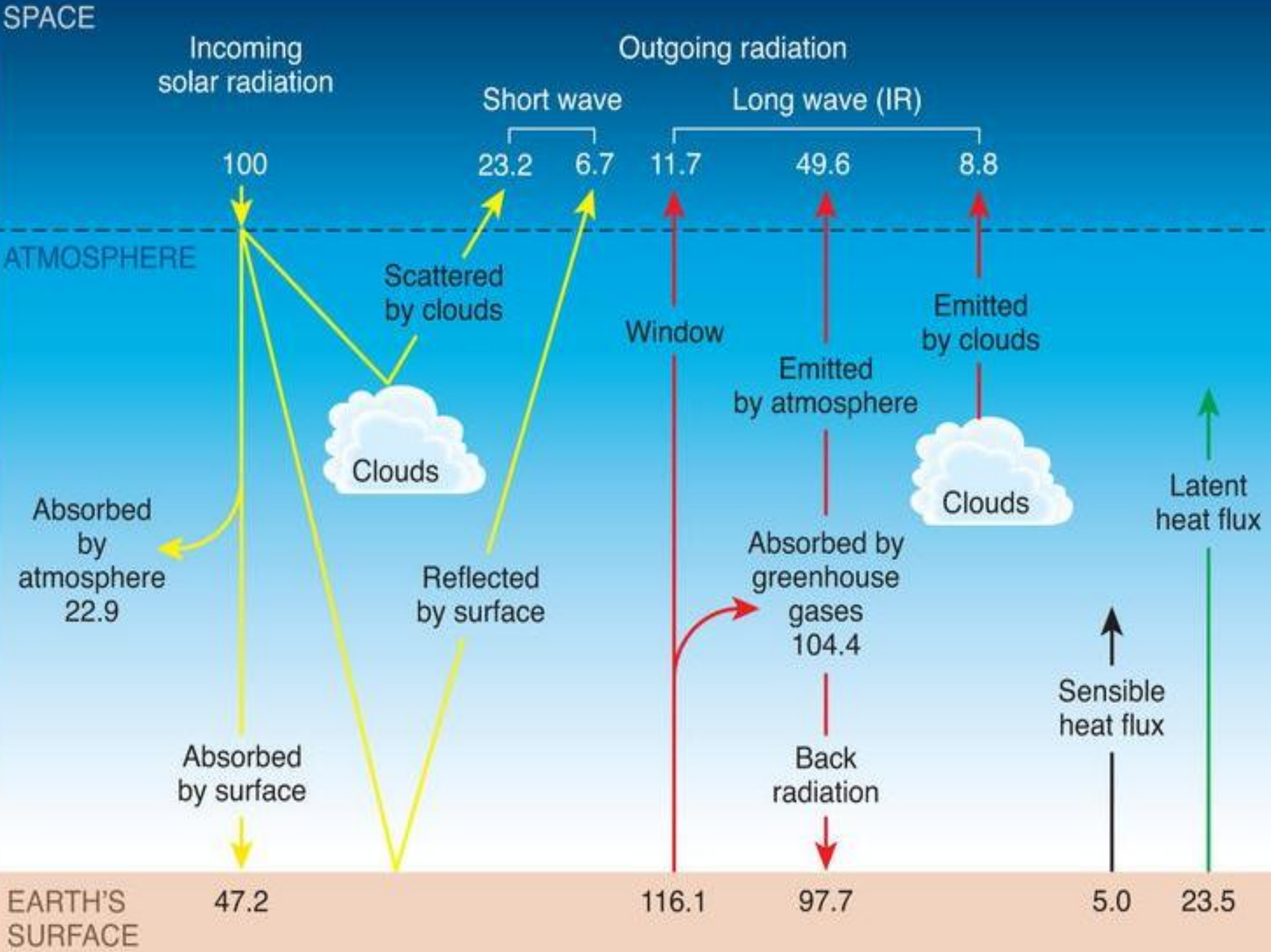
Climatology Basics

- Definitions
- Global Energy Budget
- Global Circulation
- Monsoon

Global Energy Balance

How much energy comes into the Earth's climate system from the sun and what happens to this energy

- Balance: Incoming energy = outgoing energy
- Energy in = **shortwave** radiation
 - Sun
- Energy out = **longwave** radiation
 - Earth's surface, atmosphere, ect





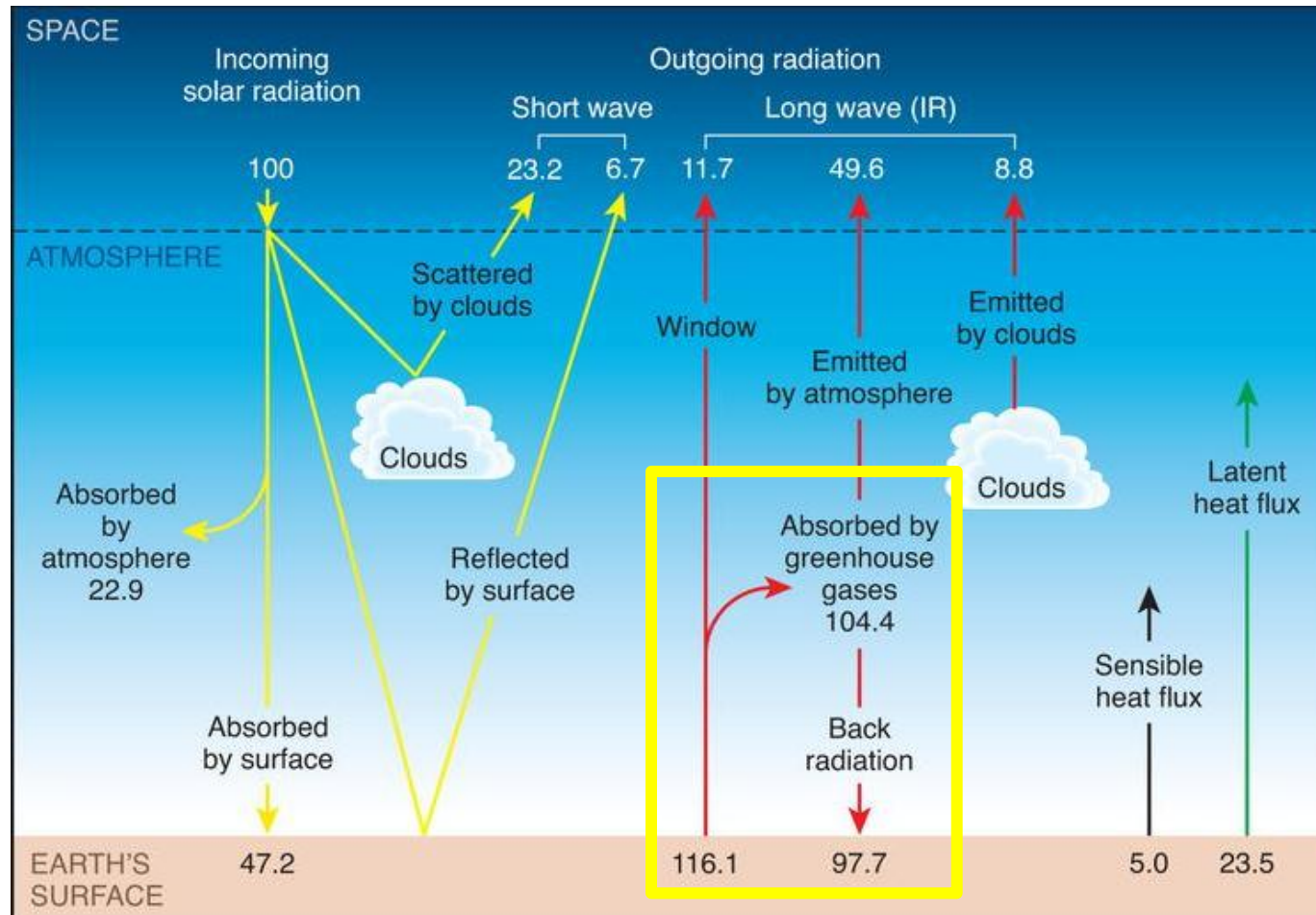
Australian Government
Bureau of Meteorology

**Why is this energy balance
important to climate?**

Greenhouse effect



Greenhouse Effect



Climatology Basics

- Definitions
- Global Energy Budget
- Global Circulation
- Monsoon

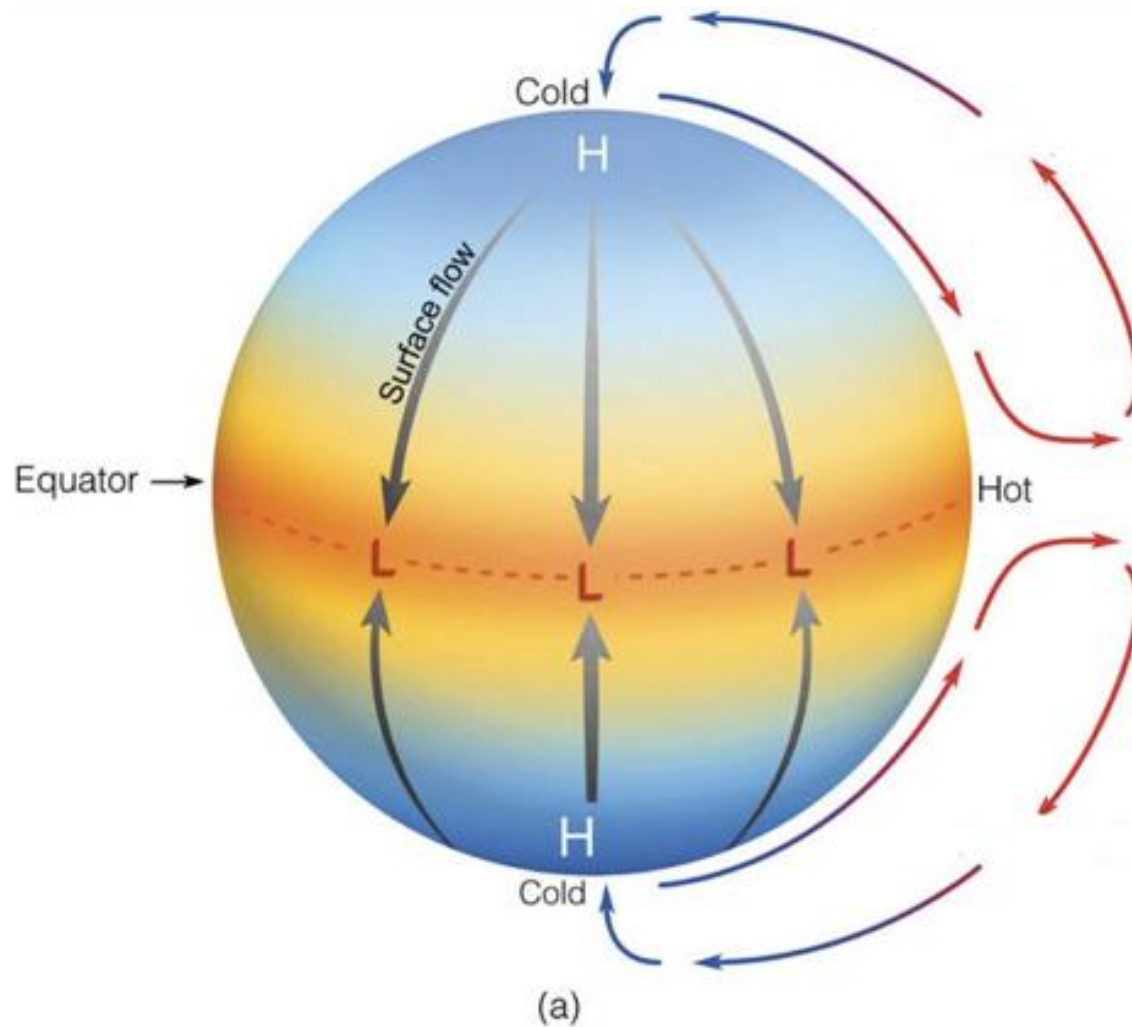


Global Circulation

Even though synoptic patterns (highs/lows) effect winds, there is also a global circulation occurring on a much larger scale.

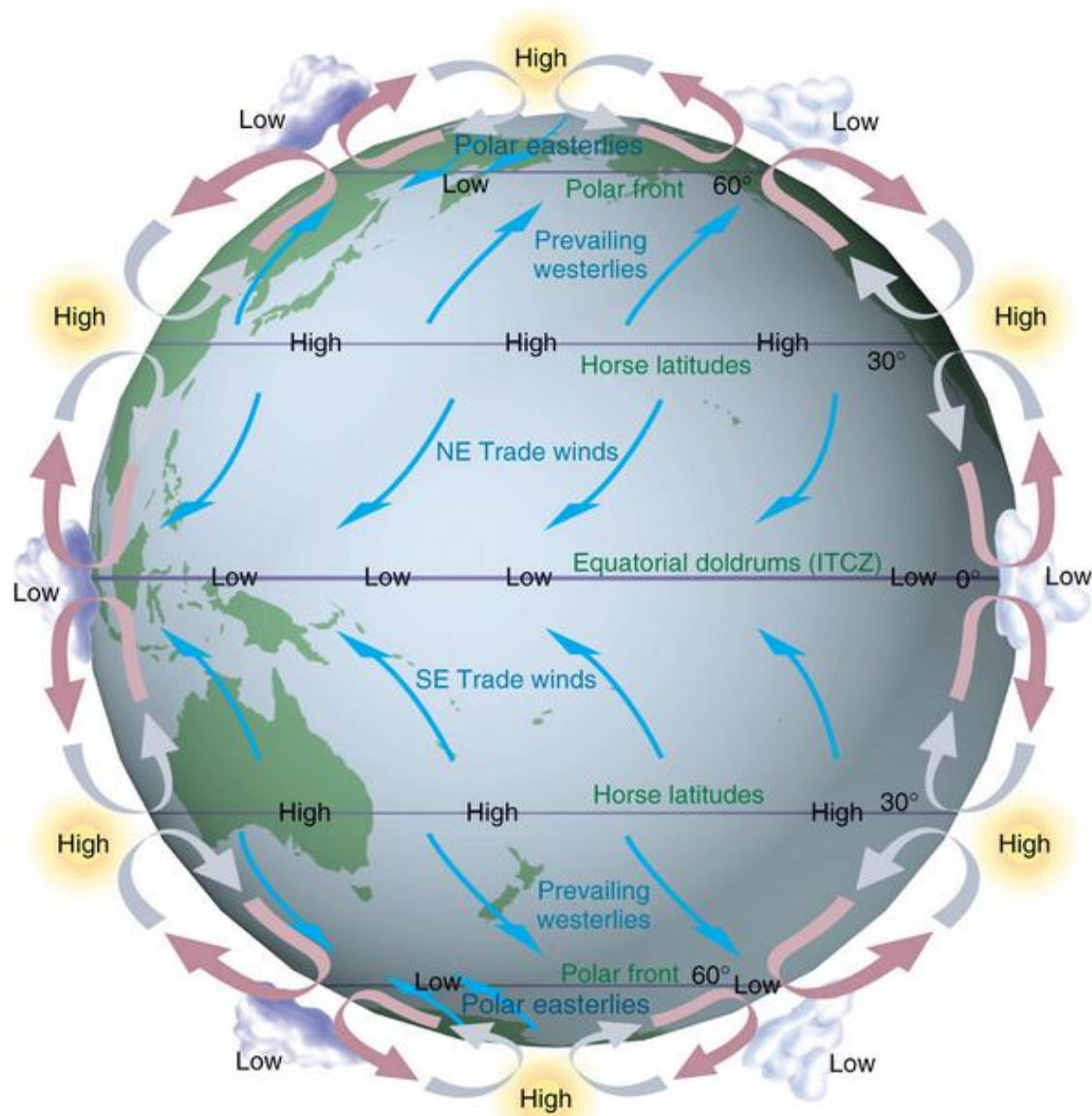


Single Cell Model



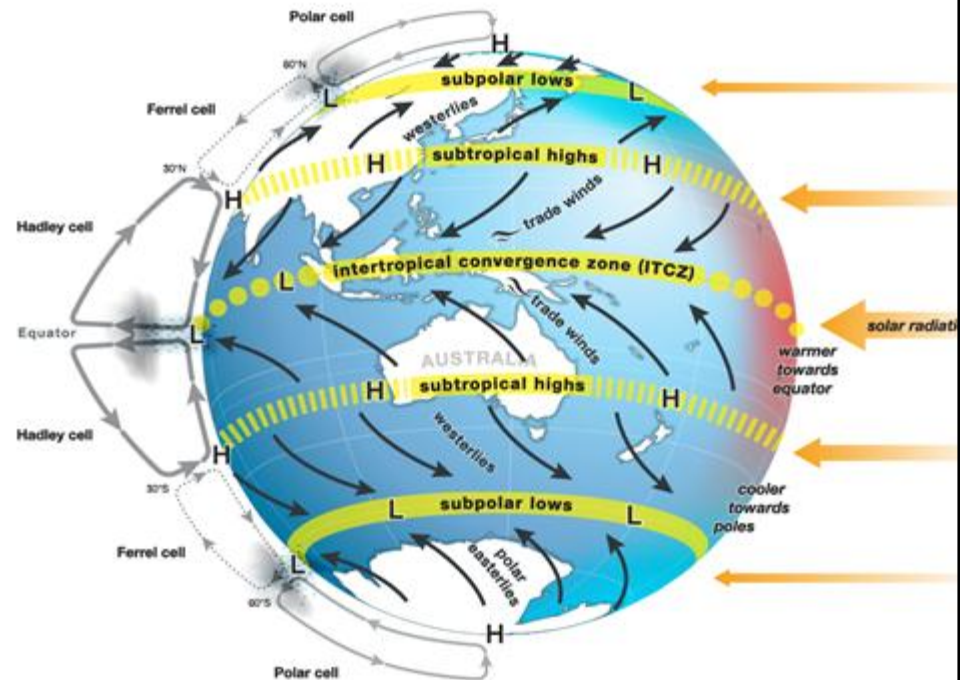


Three cell Model



How does global circulation effect Darwin?

- Trade winds
 - South-easterly flow across the Northern Territory
 - Brings dry air from central Australia
 - How does this explain monsoons/wet season?



Climatology Basics

- Definitions
- Global Energy Budget
- Global Circulation
- Monsoon

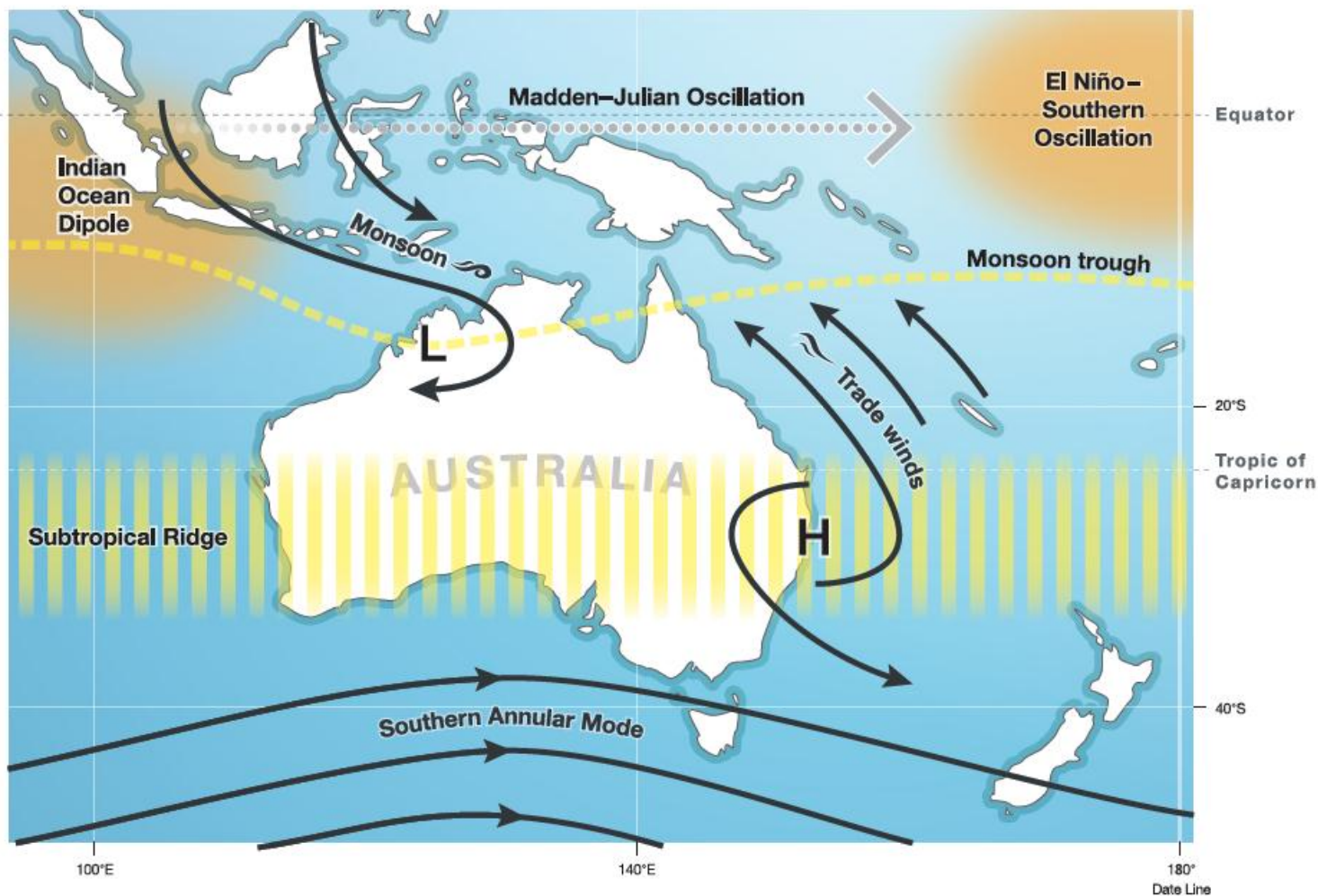
Definitions

- Wet Season: The wetter part of the year.
Runs from 1 October to 30 April
- Monsoon: derived from the Arabic word "mausam", meaning season. It is used to describe the **seasonal reversal of winds** that occurs over parts of the tropics.



Australian Government
Bureau of Meteorology

Australian climate influences

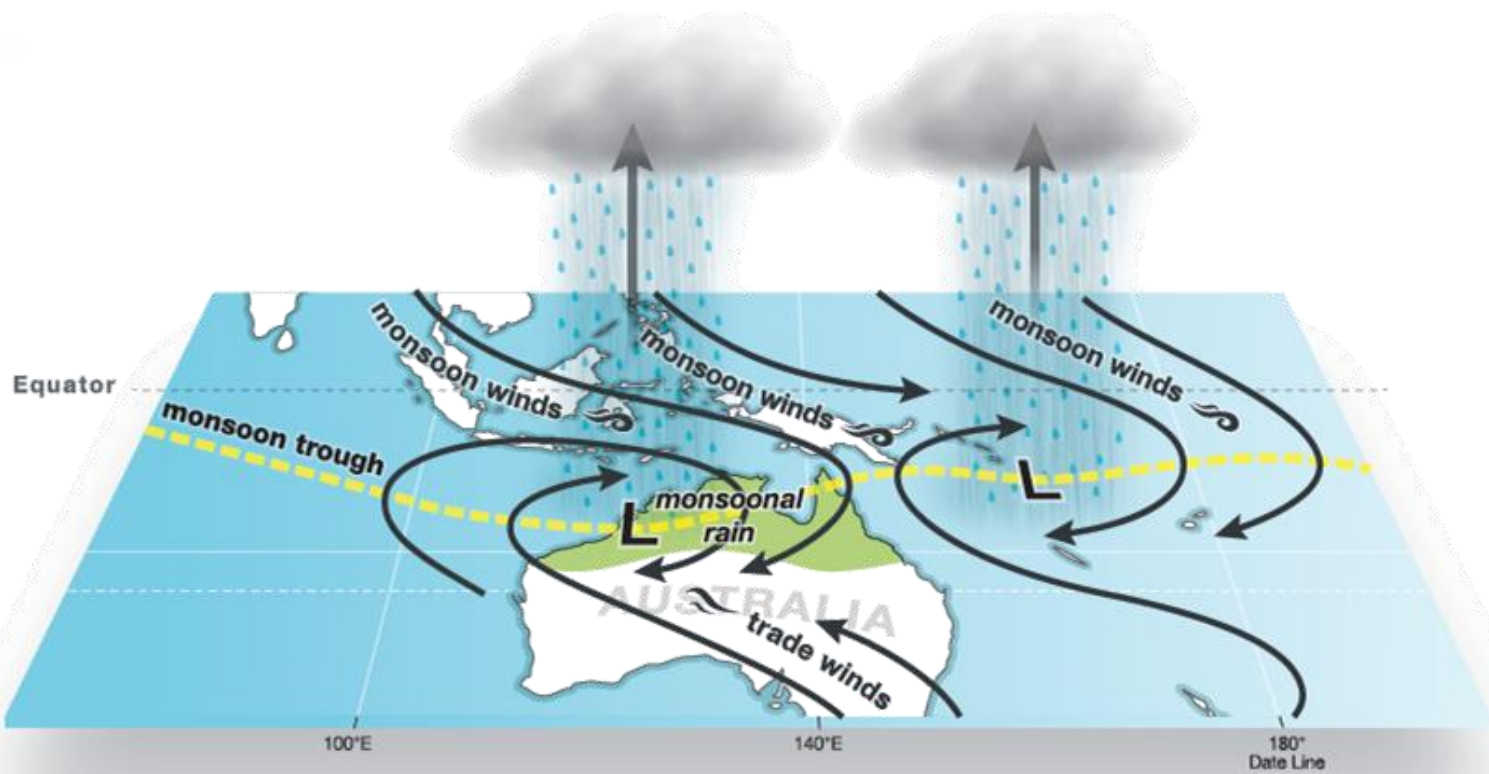


Australian Government
Bureau of Meteorology



Monsoon

Active monsoon



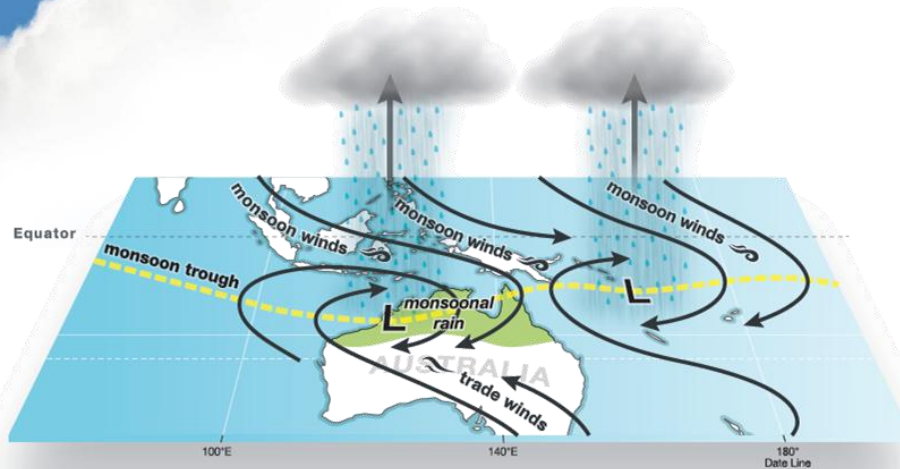


Australian Government
Bureau of Meteorology

A typical wet season

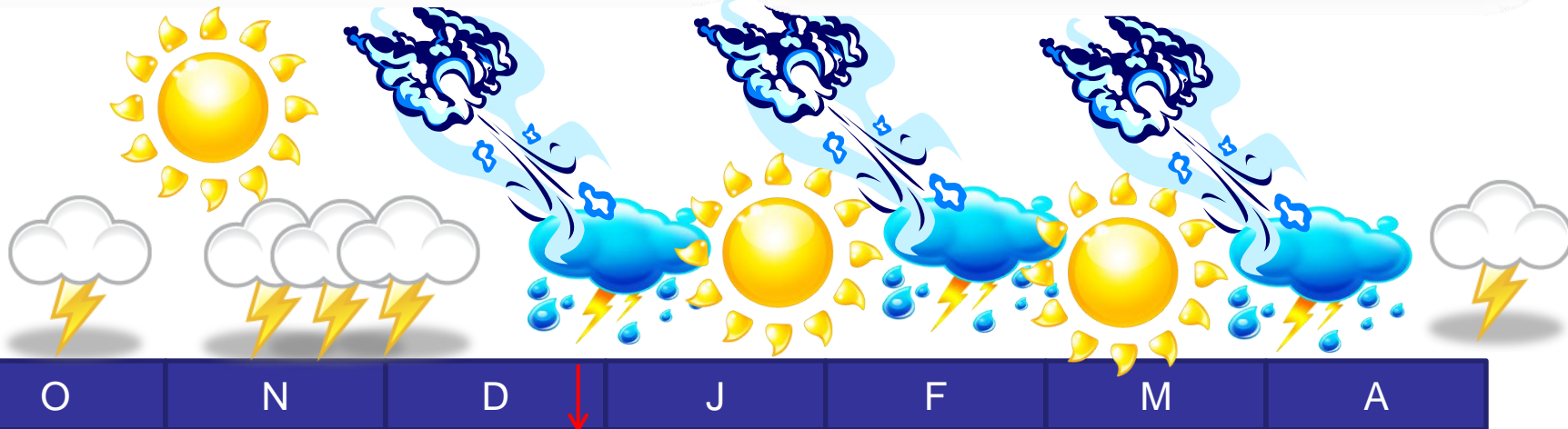
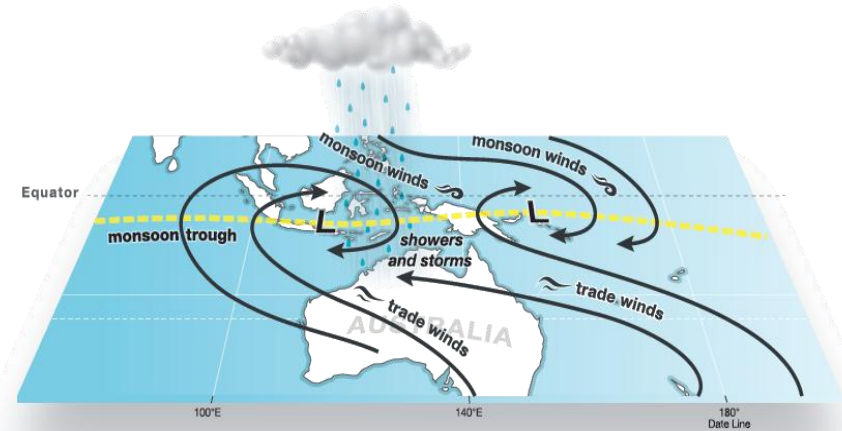
☞ Monsoon

Active monsoon



☞ Monsoon

Monsoon break



Build-up period: Oct-Dec
Hot, humid
Isolated thunderstorms

Monsoon: End of December through April
Bursts of widespread rainfall
1-3 Week long breaks in the rain



Bureau of Meteorology

- Graduate program
- Prerequisites: A degree, with a major in a physical science or mathematics
- <http://www.bom.gov.au/careers/grad-met.shtml>



Australian Government
Bureau of Meteorology

Thank you for your time

Questions? Feel free to email
L.Boekel@bom.gov.au