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

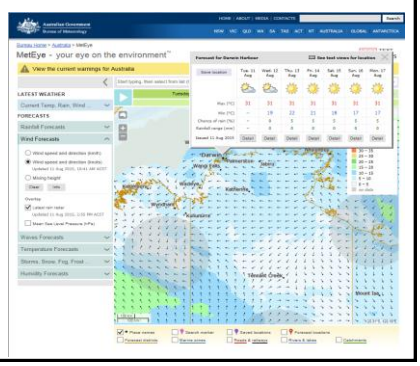
- Aviation forecasting
- Fire weather
- Public weather
- Severe weather
- Volcanic Ash Advisory Centre
- Tropical Cyclone Advisory Centre
- Climate
- Hydrology

Aviation Forecasting

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

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

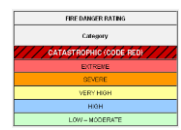
AUSTRALIAN GOVERNMENT - BUREAU OF METEOROLOGY VICTORIA

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.



Weather Basics

Weather Basics: Topics

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

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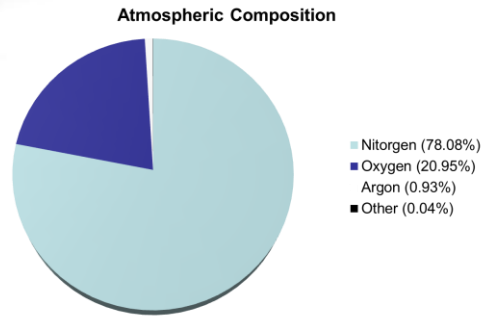
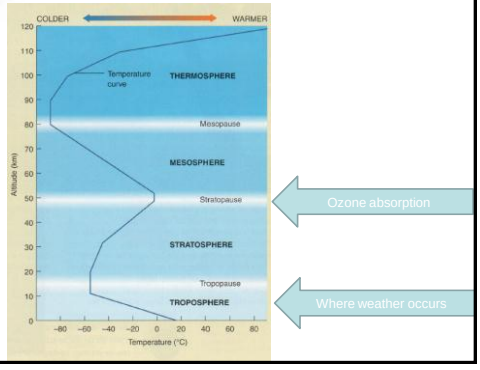
The Atmosphere



The Atmosphere



Weather Basics: Topics

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Air Pressure

- Why is air pressure important in meteorology?

Air Pressure

- Force = mass X acceleration
- F=ma

Air Pressure

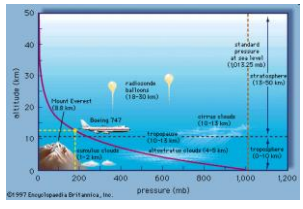
- Pressure: net force per unit area, P=F/A
  - Air has mass
  - Gravity pulls air down
  - Air Pressure is the force exerted by the column of air directly above you.
  - Measured by a barometer
    - In millibars (mb) =
    - hecto Pascals (hPa) = kg / ms^2
    - Sometimes inches of mercury

Air pressure and altitude

If you are standing at the top of Mt Everest, will the air pressure be less or more then 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

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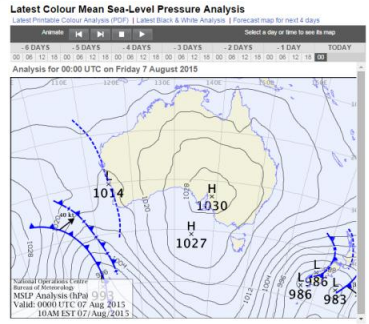
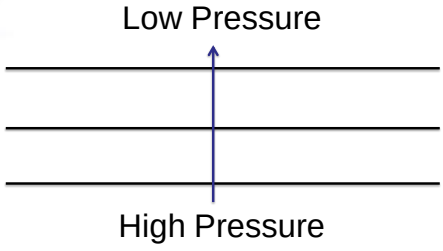
Air pressure and weather patterns – Horizontal motion



Horizontal Motion

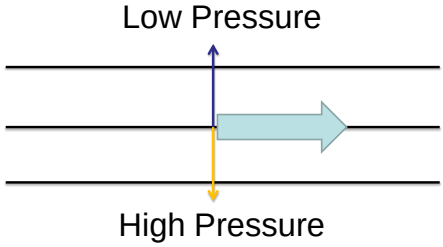


= Pressure Gradient Force

Coriolis Effect

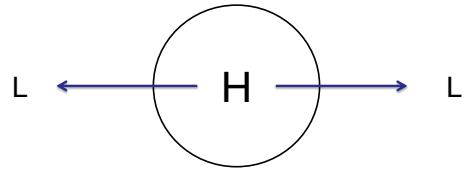
https://www.youtube.com/watch?v=_36MiCUS1ro

Horizontal Motion



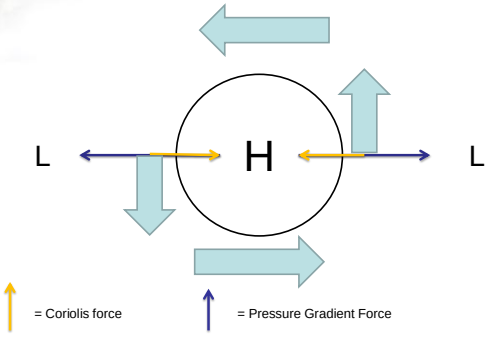
= Pressure Gradient Force = Coriolis force

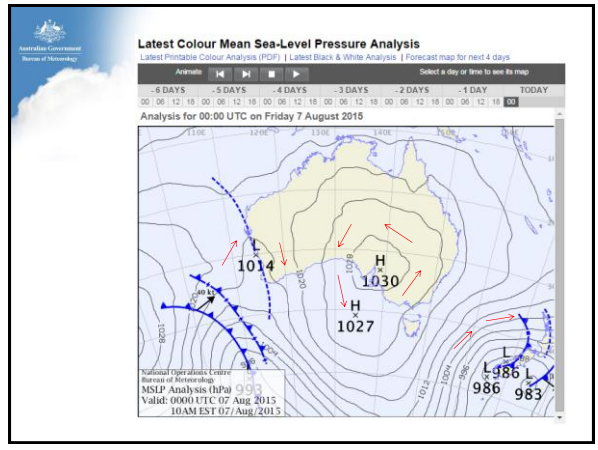
Horizontal motion



= Pressure Gradient Force

Horizontal motion





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

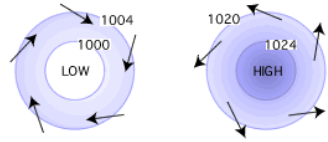
3. On land wind is given in kilometres per hour
   On water we use knots (nautical miles per hour).
   a) 1 knot = 1.85 km/h

Basics: Highs and Lows

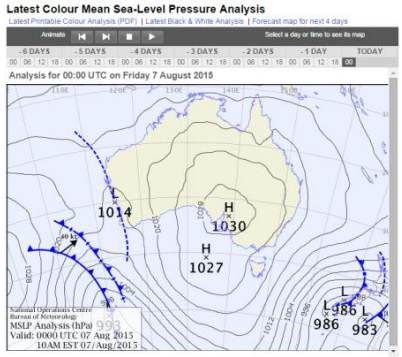
- In the Southern Hemisphere:

  Motion around a Low is Clockwise

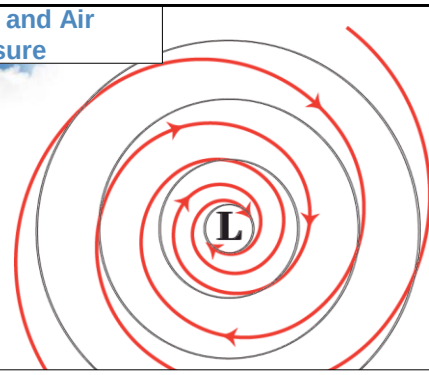
  Motion around a High is Anticlockwise



What about the tropics?



Wind and Air Pressure



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

Weather Basics: Topics

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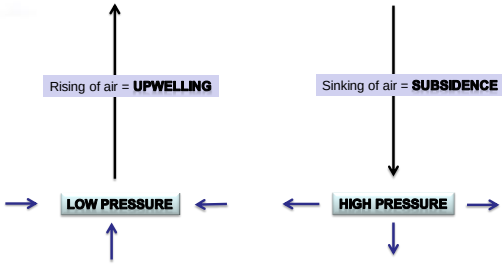
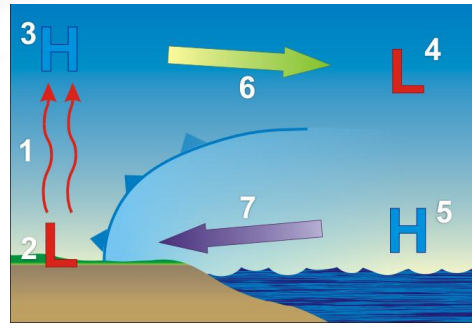
Air pressure and weather patterns – Vertical motion



Sea breeze



HOT Air Rises, but as it rises it

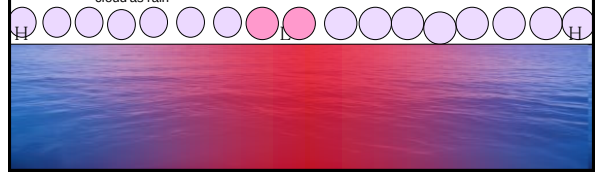
cools

and

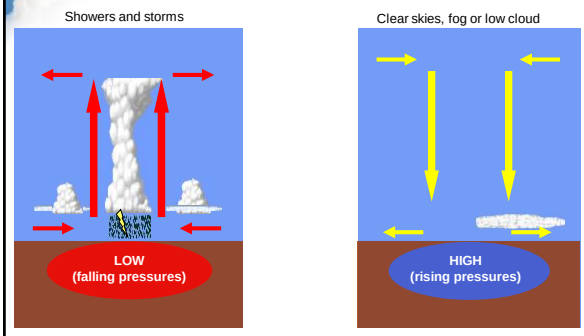
expands

Convection

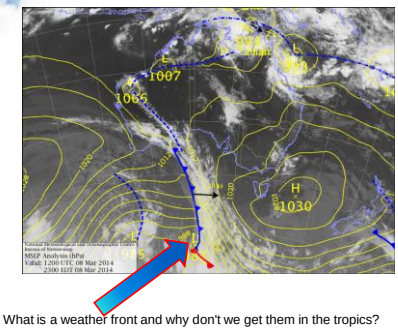
The water vapour in the air will condense into water droplets that form a cloud and can eventually grow into raindrops and fall from the cloud as rain



Basics: Highs and Lows



Where's the weather?



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

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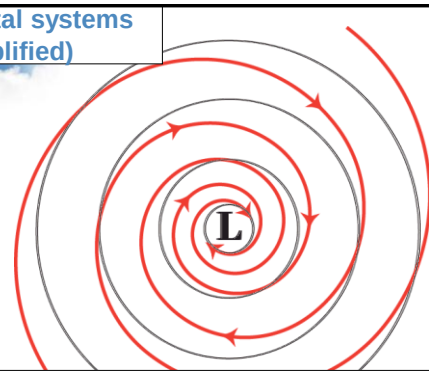
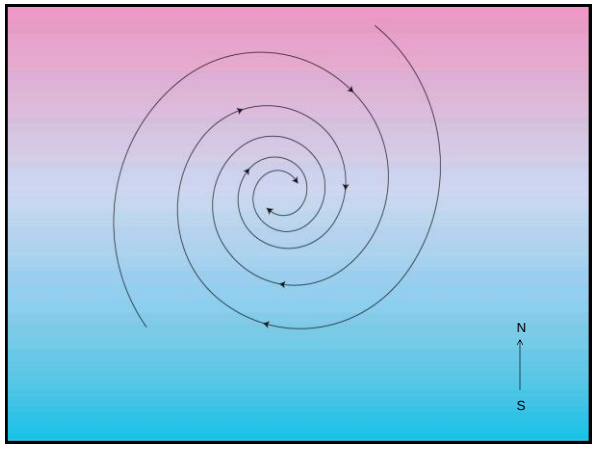
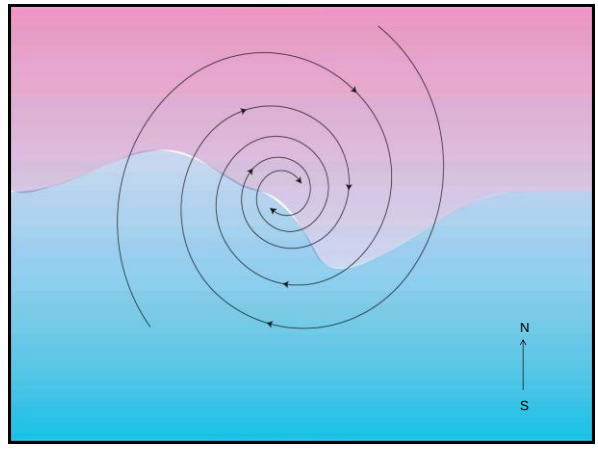
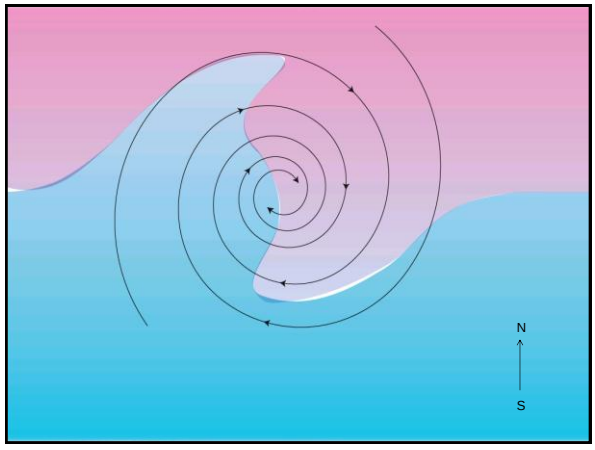
Frontal systems (simplified)

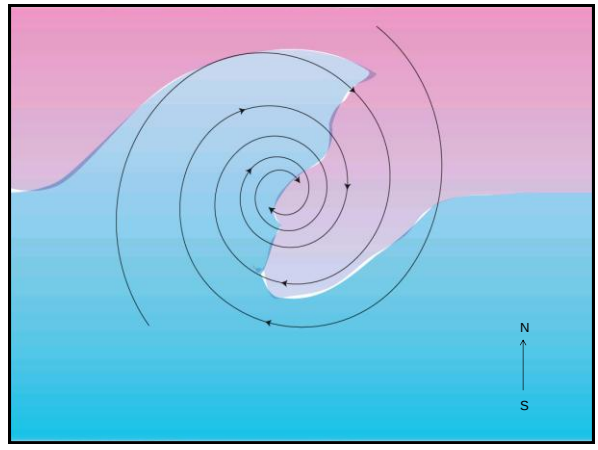


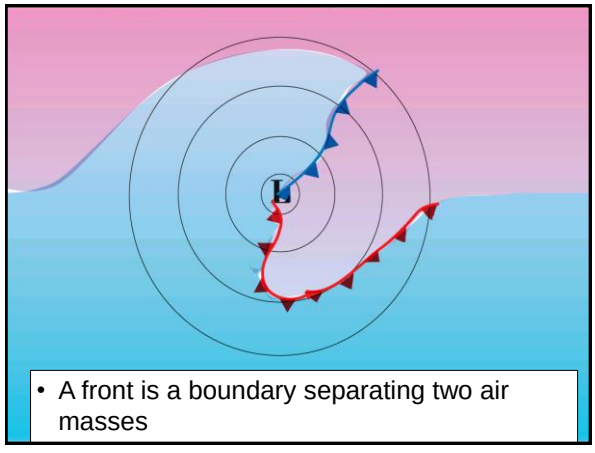
- A front is a boundary separating two air masses







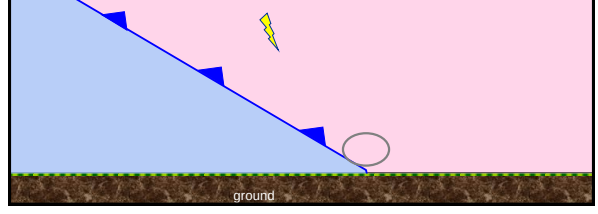




- A front is a boundary separating two air masses

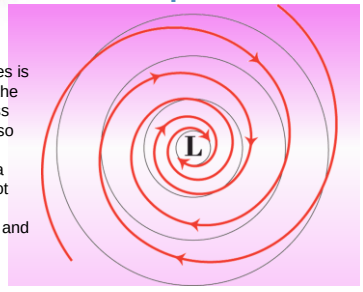
Cold fronts and weather

- 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.

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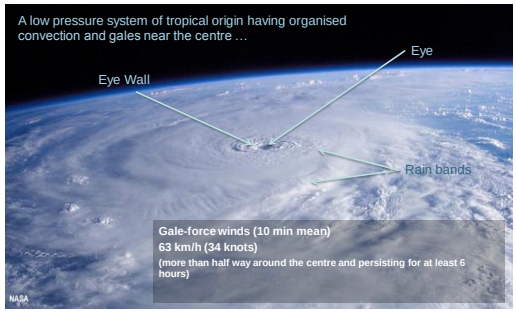
What is a Tropical Cyclone?



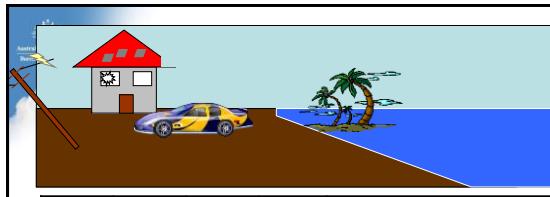
Super Typhoon Noul
Animated GIF: http://go.wisc.edu/0ii0lk

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

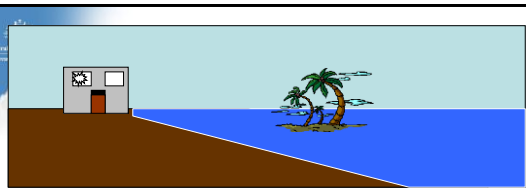
Category	Strongest Gust (km/h)	Average Maximum Wind (km/h)	Central Pressure (hPa)	Typical Effects
1	< 125	63 - 88	> 985	Negligible house damage. Damage to some crops, trees and caravans. Craft may drag moorings

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. *Winifred*)



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. *Tracy*, *Olivia*)



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. *Vance*)

Climatology Basics

Climatology Basics

- Definitions
- Global Energy Budget
- Global Circulation
- Monsoon

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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
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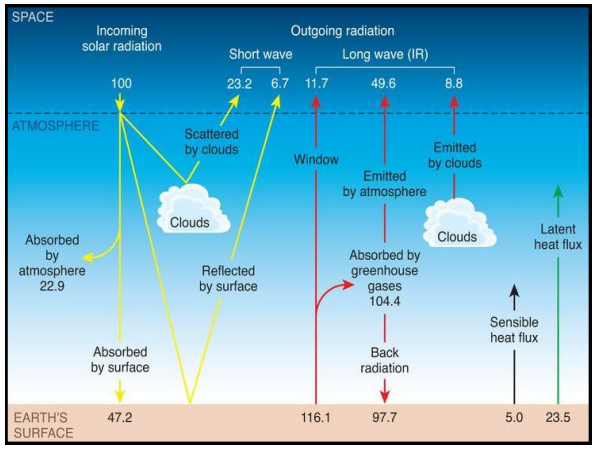
Global Energy Balance

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

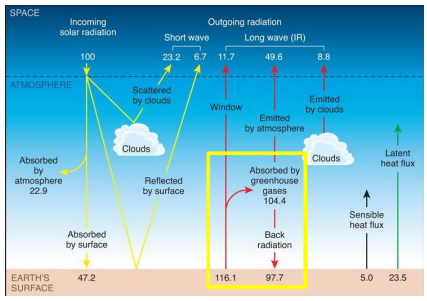
- Balance: Incoming energy = outgoing energy
- Energy in = shortwave radiation
  - Sun
- Energy out = longwave radiation
  - Earth's surface, atmosphere, ect



Why is this energy balance important to climate?

Greenhouse effect

Greenhouse Effect



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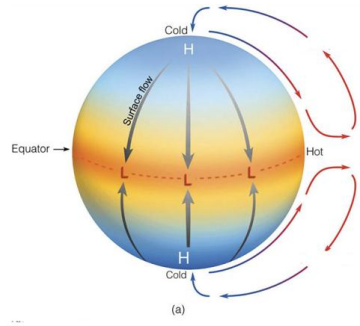
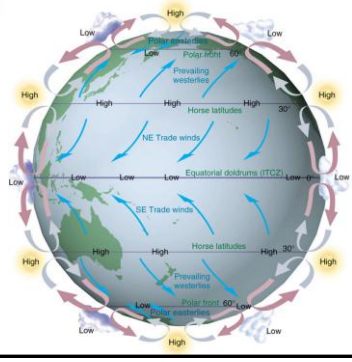
Global Circulation

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

Single Cell Model

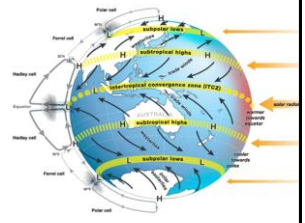


Three cell Model



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?



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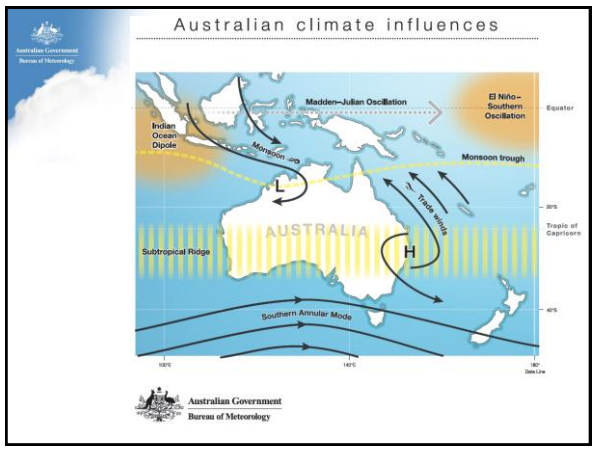
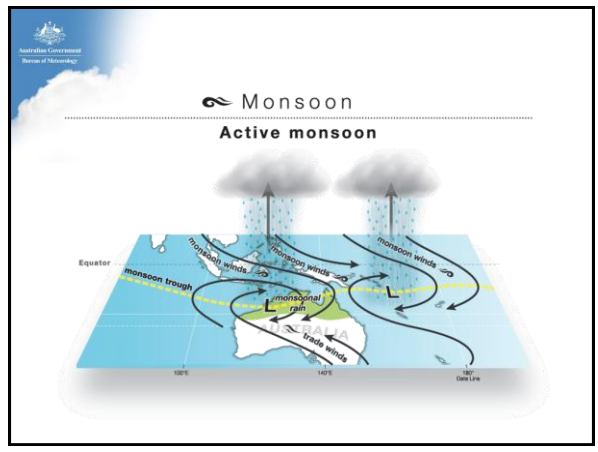
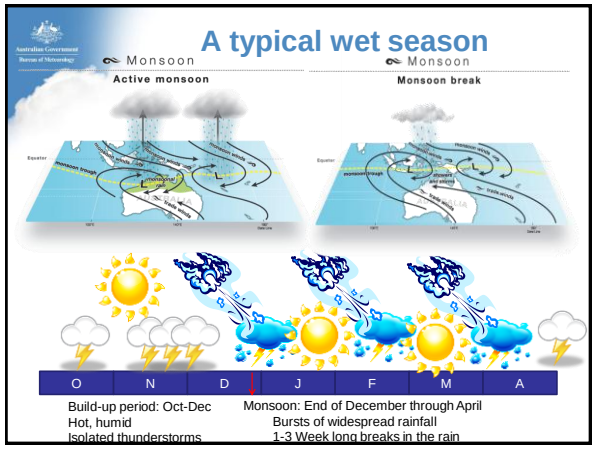
Definitions

- 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.







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

Thank you for your time

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