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DOCUMENT TITLE

METEOROLOGY FOR AUSTRALIA

CHAPTER 15 – AIR MASSES AND FRONTS

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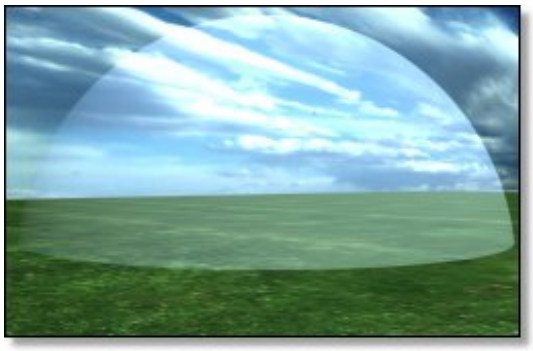
AIR MASSES

INTRODUCTION

An air mass is a large body of air with uniform characteristics of temperature and humidity throughout. Air masses acquire these properties by being in contact or passing over large distances of land or water. They are classified according to their origin and their importance is in bringing these characteristics to the areas to which they move. Their origins are classified by temperature and humidity.



The source region of an air mass is always an area of stability within a H.P. This is because in order to acquire its uniform characteristics of temperature and humidity the air has to remain stationary or slow moving for several days. Once an air mass leaves its source region it may then be modified by the surface over which it passes.

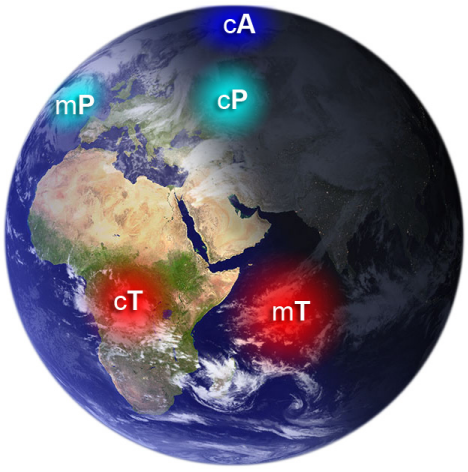
AIR MASS CLASIFICATION

Air masses are classified by their temperature as:

Arctic (**A**)	(very cold)
Polar (**P**)	(cold)
Tropical (**T**)	(warm)

by their humidity as:

Maritime (**m**)	(humid)
Continental (**c**)	(dry)
Equatorial (E)	Used occasionally in Asia (both warm and humid)



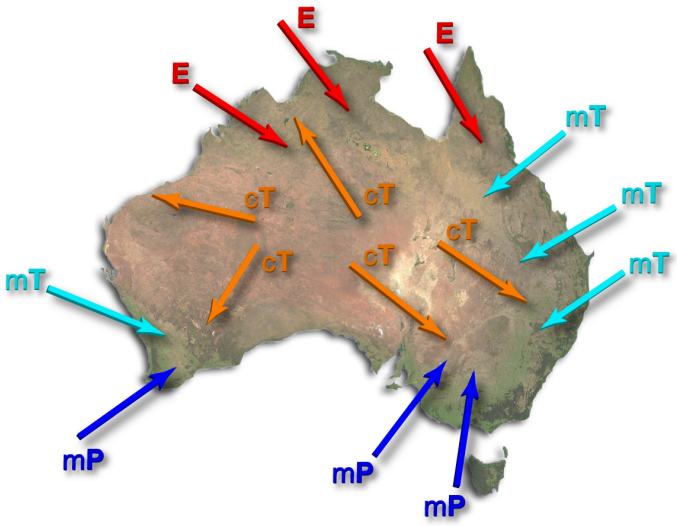
The results are air masses such as Polar Maritime (Pm) (cold and humid) or Tropical Continental (Tc) (warm and dry).

AIR MASS MODIFICATION

When an air mass moves over a warmer surface it is warmed from below which increases the Environmental Lapse Rate, resulting in greater instability. This may produce Cu and Cb cloud. For example, in Australian southern states, in a Polar Maritime air mass Cu clouds are likely to form.

When an air mass moves over a colder surface, the air is cooled from below which decreases the Environmental Lapse Rate and results in greater stability. This may produce Stratus, Stratocumulus, drizzle or advection fogs, for example, a Tropical Maritime air mass moving southwards.

AIR MASS MOVEMENT AROUND AUSTRALIA



Air Masses Affecting Australia

MOVING NORTH ACROSS AUSTRALIA:

- **Cold streams:** Cold and moist which becomes unstable as it moves over a warmer surface. The cloud is Cu and Cb, and the weather is showers, low temperatures and even thunderstorms and hail. Usually occurs in winter.
- **SE Trades:** In winter the SE Trade winds blow across Queensland and the Northern Territory. Although showers may occur along the Queensland coast, they bring hot dry conditions elsewhere.

MOVING SOUTH ACROSS AUSTRALIA:

- **Continental:** In summer the southern parts of Australia are influenced by hot dry Tc air flowing from inland areas.
- **Monsoons:** In summer, Tm air blows in from the Indian Ocean. The NW monsoons result in Cu, Cb, heavy rainfall and hot, humid condition.

SUMMARY OF AIR MASS CHARACTERISTICS AFFECTING AUSTRALIA

The properties of an air mass on arrival are a combination of the original source region properties, and the modification experienced en route.

Air Mass	Source Region [1]	Stability (on arrival)	Cloud Forms	Visibility	Precipitation	
Pm	Southern Ocean South Indian Ocean	Unstable	Broken Cu or Cu/Cb	Good, except in showers	Showers	Showers on exposed coasts. Often good clearances inland especially at night
Pc	Not applicable	-	-	-	-	-
direct Pm (winter only)	Southern Ocean	Very unstable	Broken Cu/Cbs	Good, but very poor in snow	Heavy showers or snow showers	Often associated with Polar Air depression giving heavy showers and falls of snow on the higher grounds
Tc	Central Australia	Stable	Nil	Haze	Nil	Gives rise to very high temperatures. Clear skies. Haze. Dust.
Tm	Timor Sea Coral Sea	Unstable	Cu, Cb, Ns	Poor in rainfall. Good away from rainfall	Tropical showers. Monsoonal rainfall.	

[1] All air masses are stable at their source region form in H.P. stable regions

FRONTS

INTRODUCTION

A front is the boundary between two air masses of different density (temperature). Fronts are named after the actively moving air mass.

If cloud forms, its type depends on the speed of the front and the stability of the air.

Cold front → **cold air moves in**

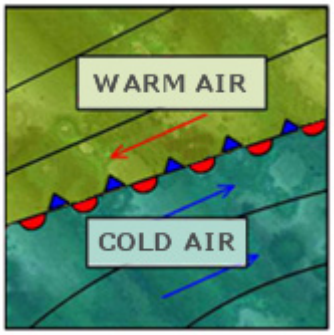
Warm front → **warm air moves in**

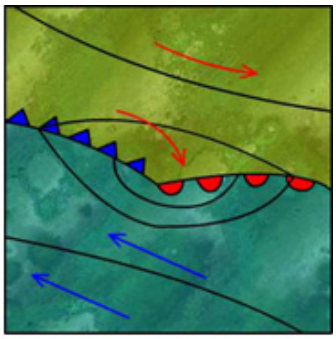
If the rising air is dry, no cloud forms and a change in wind direction, a drop in temperature and a rise in pressure may be the only indication of the passage of the front.

DEVELOPMENT OF FRONTS

Stationary Front

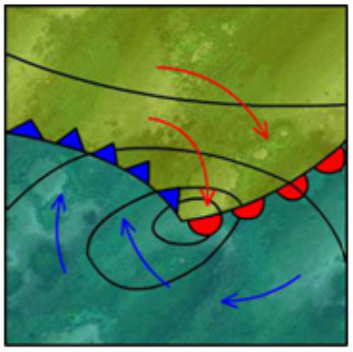
Falling pressure and converging lower winds bring air masses together to produce a well marked and active front. The boundary between polar and tropical air is called the Polar Front.

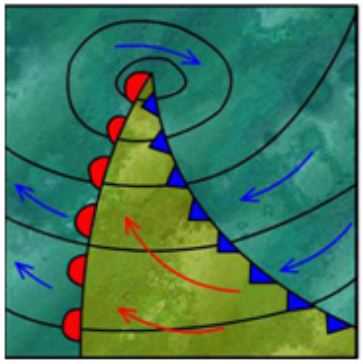




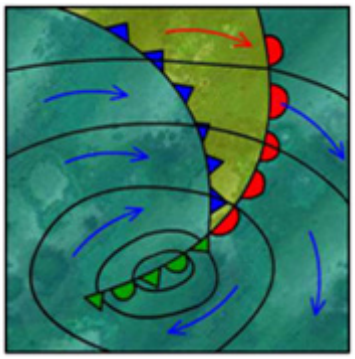
As pressure falls, air from both sides of the front starts to move towards the low, sharpening the contrast between the two air masses. After some hours, Coriolis force will deflect the wind to the left (in the southern hemisphere) causing the cold dense air to undercut the warm air on the western flank of the depression.

On the eastern side, the less dense warm air will ride up over the cold air. The warm air forced to rise in this way contributes to the further deepening of the depression by releasing latent heat.





This shows the state of development reached 36–48 hours later, with the warm air confined to a Vee-shaped wedge at the surface.



A warm front travels at 2/3 the gradient wind speed; a cold front travels at the gradient wind speed. Therefore a cold front may catch up to a warm front. This is called an occlusion. A ”cold” or a “warm” occlusion may form (see later note).

Once the occluding process is well under way, the depression slows down and the centre of the low tends to become stationary.

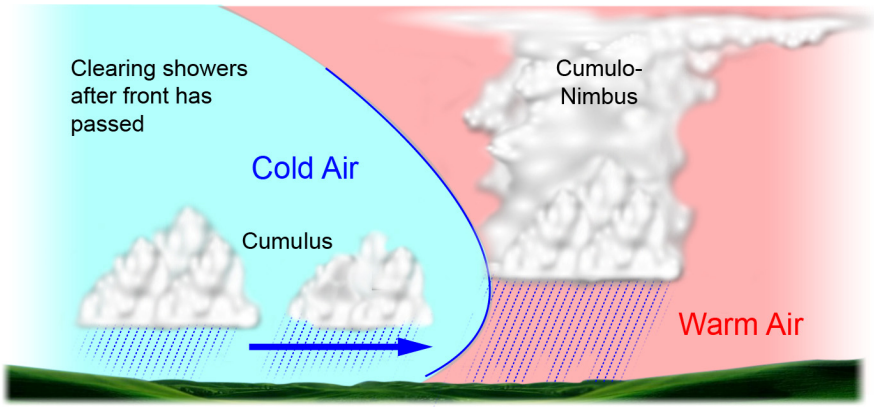
Cold Front
Warm Front
Occluded Front

COLD FRONT

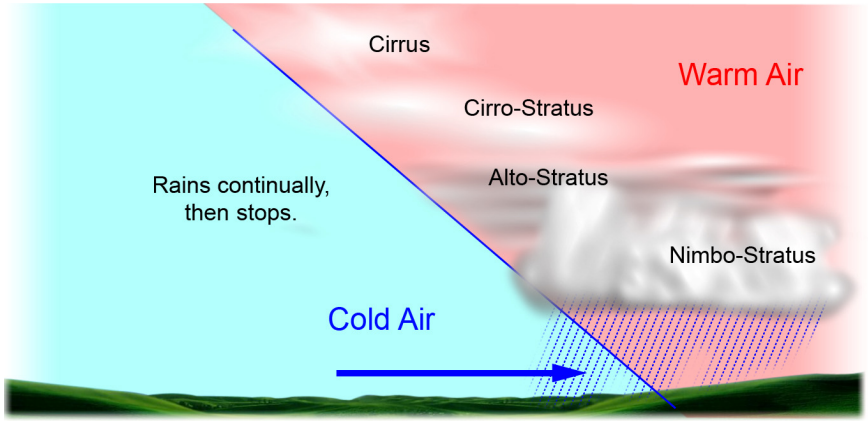
A cold front is the boundary between an actively moving cold air mass and the warm air mass it is displacing at the surface.

A cold front is wedge shaped as it slides under and displaces the warm air. The slope of the boundary is approximately 1:50.

Cold fronts may be subdivided into fast moving or slow moving fronts. Unless stated, the “normal” cold front is a fast moving cold front.

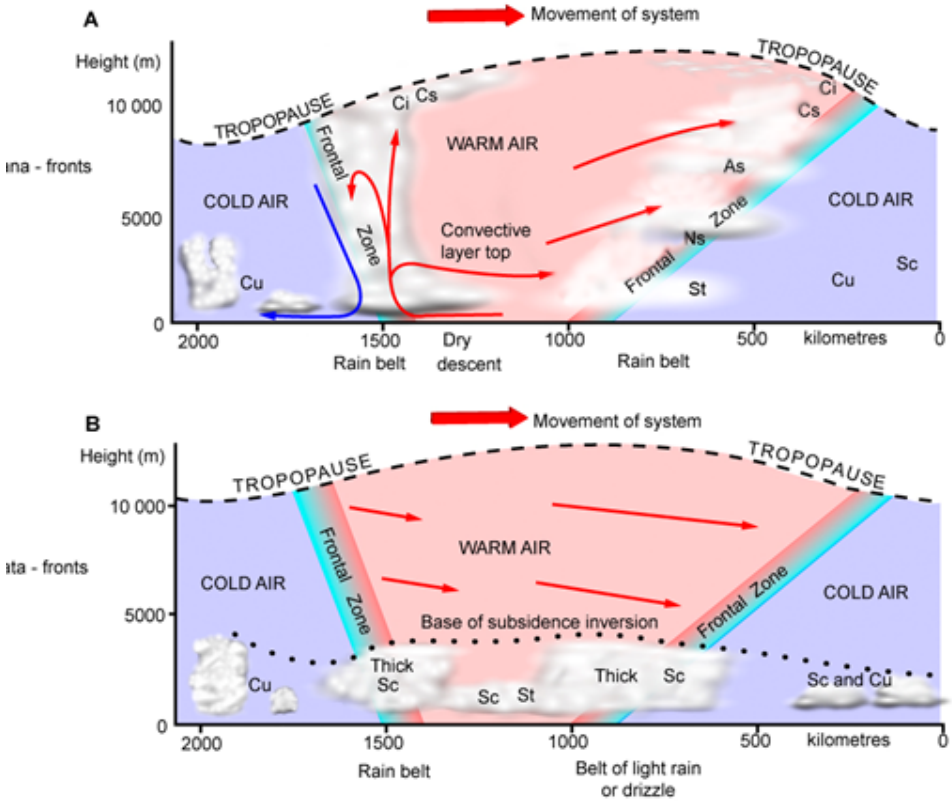


Fast-Moving Cold



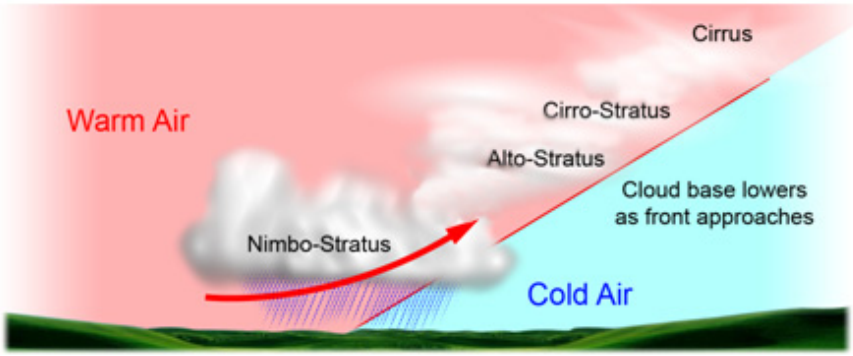
Slow-Moving Cold

A further subdivision of cold fronts is describing the front as either an “ana-front” or as a “kata-front”. Ana-fronts occur where the warm air in the warm sector is rising relative to the frontal zone and the fronts are consequently very active and generally well marked. Kata- fronts are accompanied by subsidence of air in the warm sector relative to both the cold air mass and frontal zone. Because of the subsiding air they are less intense and are usually associated with a subsidence inversion. Frontal activity may even be absent.



WARM FRONT

A warm front is the boundary between an actively moving warm air mass and the cold air mass it is displacing.



Warm Front

A warm front is wedge shaped as it moves over the colder air. The slope is approximately 1:125.

OCCLUDED FRONT

A warm front travels at 2/3 the gradient wind speed; a cold front travels at the gradient wind speed. Therefore, a cold front may catch up to a warm front.

If the air behind the occluded front is colder than the air in front, it is a cold occlusion. If the air behind the occluded front is warmer than the air in front, it is a warm occlusion.

STATIONARY FRONT

Two air masses are side by side and are not interacting. Winds (if any) are blowing parallel to the front.