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DOCUMENT TITLE
METEOROLOGY FOR AUSTRALIA

CHAPTER 11 – THERMAL WINDS

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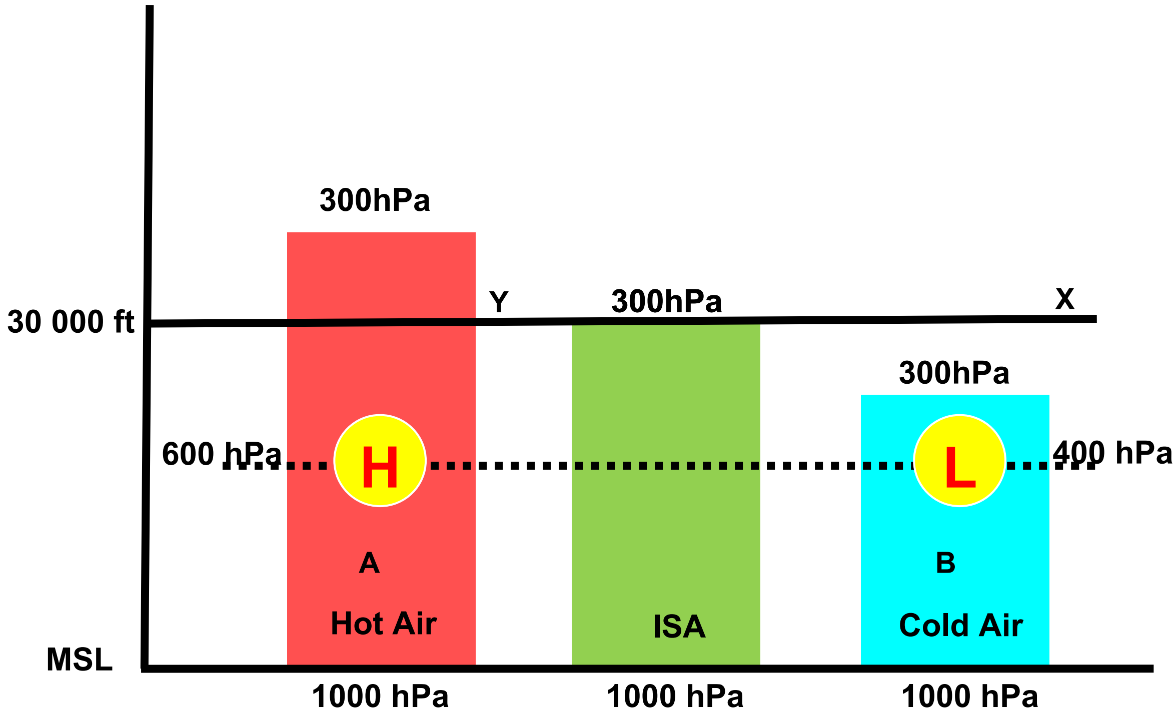
CONTENTS ....PAGE

THERMAL WINDS

INTRODUCTION

Consider the following situation:



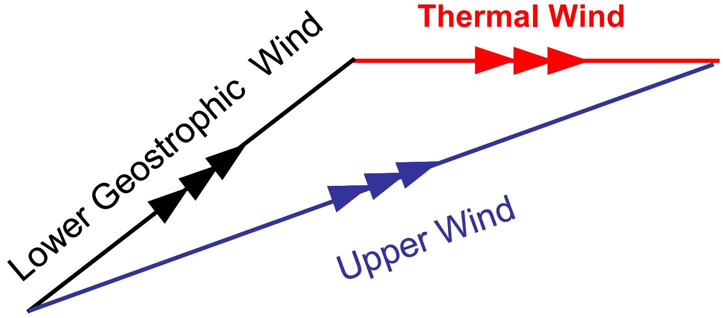
Pressure and Temperature

At the surface between A and B there is no pressure difference and therefore no wind (PGF is zero). However, cold air is denser than hot air, so that once we go above ground level, at any given level (positions X and Y above) there is a pressure difference. This pressure difference causes a wind to flow. This is called a thermal wind. The greater the temperature differential, the greater will be the pressure differential and the thermal wind component.

As with all winds, a thermal wind is subjected to geostrophic forces, so that it will flow parallel to the isotherms. In the Northern Hemisphere the cold (or low) temperature will be on the left and in the Southern Hemisphere it will be on the right. This, like Buys Ballot's Law, can be remembered by:

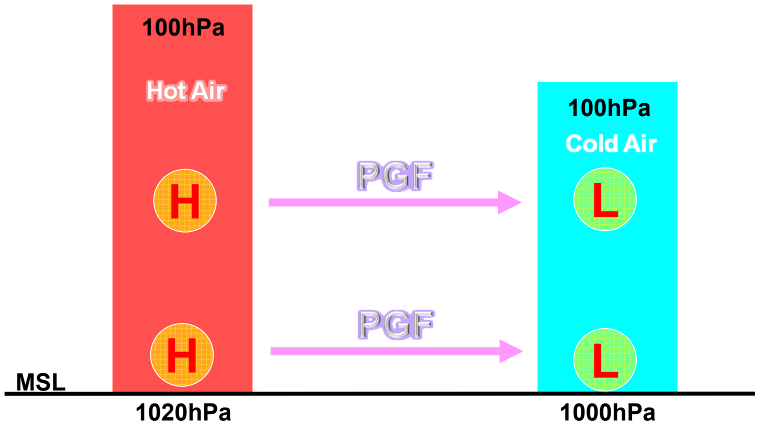
Back to the wind, low to the right (Southern Hemisphere) and vice versa in the Northern Hemisphere.

The resulting upper wind will be the vector result of the lower geostrophic wind and the thermal wind.

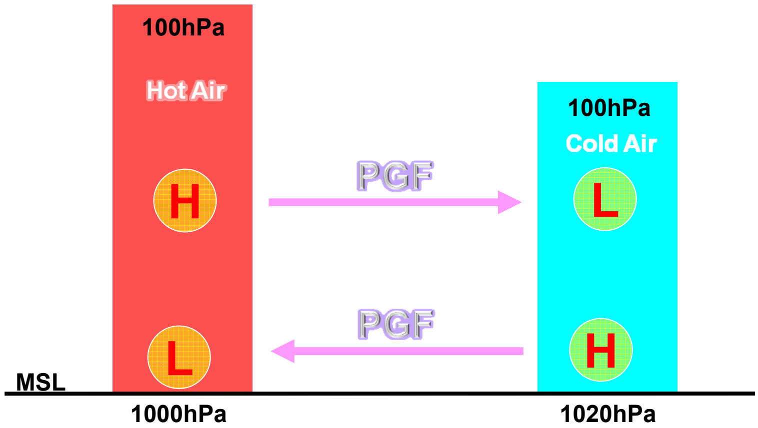


11.b Vector Diagram of Geostrophic, Thermal and Upper Winds

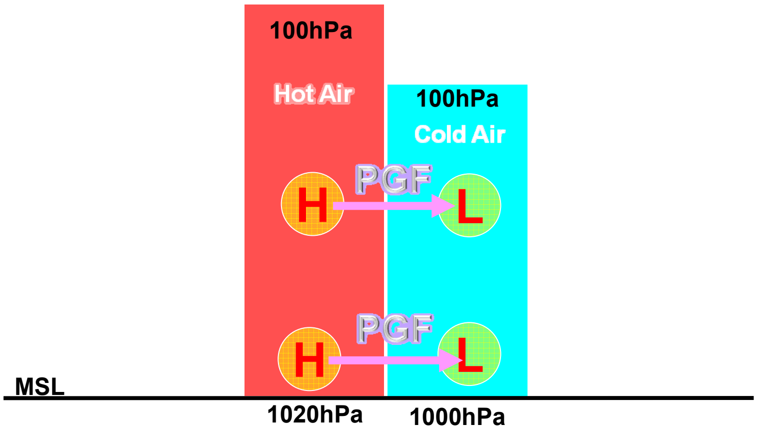
Look at the following examples



This shows a surface pressure gradient in the same direction as the upper pressure gradient. The result will be **strong** upper winds.



This shows a surface flow in one direction but the upper pressure gradient is in an opposite direction. The result will be **weak** upper winds.



Consider the situation where warm air is close to cold air. If the surface pressure gradient is steep and the upper pressure gradient is also steep, the result will be very strong upper winds known as a “jet stream” (which is discussed in more depth in a later in Chapter 23). This close proximity between cold and warm air usually be found at warm and cold fronts, but it can also be found globally, where polar and equatorial air masses meet.

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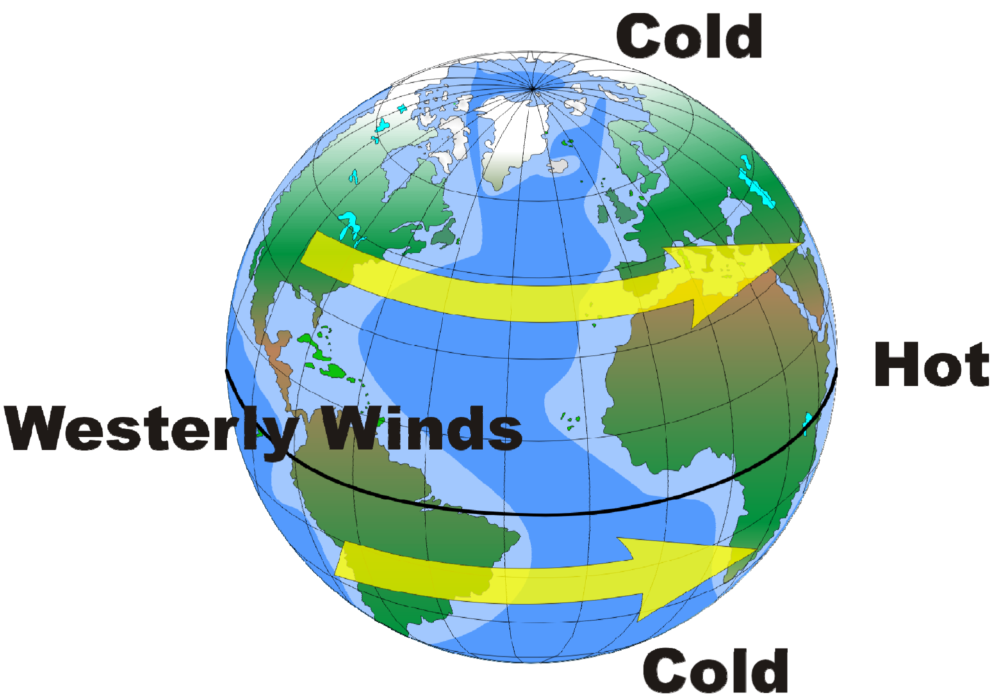
The temperature gradient of the earth increases from the poles to the equator so that in both the Northern and Southern Hemispheres, the thermal wind component will usually be westerly. This is borne out, as, in reality, winds usually do become more westerly with altitude. Exceptions to this are covered in Chapter 27.



Global Thermal Winds

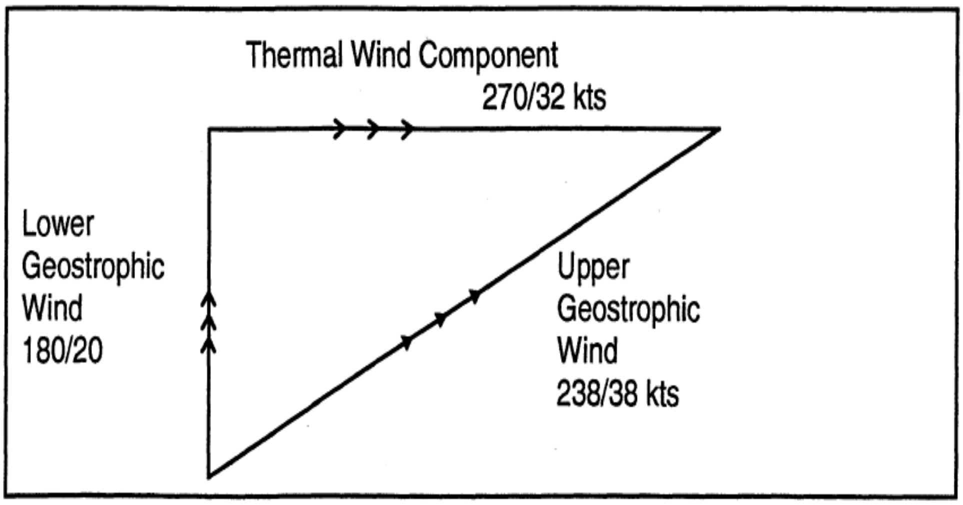
CALCULATION OF THE THERMAL WIND COMPONENT

The steeper the temperature gradient the stronger the wind. Also, because the pressure differential usually increases as height increases, the thermal wind component also increases with height. The strength can be obtained from the following equation.

Thermal Wind Component (in knots) = G x H

(where G is the mean temperature gradient in °C/100 nm and H is the height of the columns of air in 1000s of feet.

The upper wind is the vector addition of the lower wind and the thermal wind component, and is known as the Upper Geostrophic Wind. The lower geostrophic wind can be at any height, not just the surface, and the thermal wind component will be between that height and the height for which the upper geostrophic wind is required:



11.d. Calculation of Upper Geostrophic Wind

Upper geostrophic winds can be calculated by drawing a scale diagram and measuring the resultant vector. To ensure that there is no confusion when drawing the vector diagram, always start with the lower geostrophic wind and continue in the same direction with the thermal wind component. The resulting upper wind will then be a logical vector.