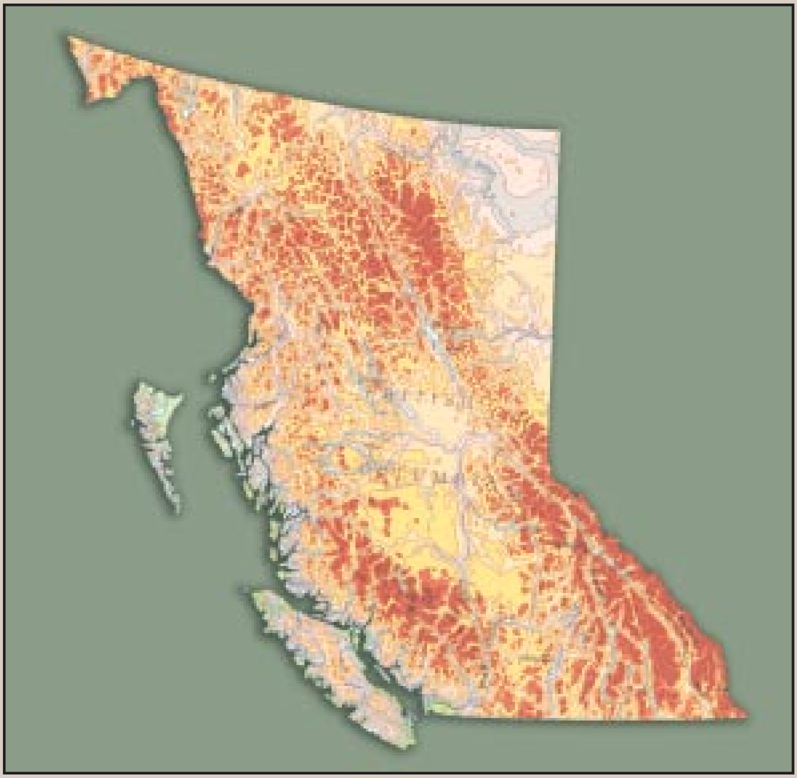
The Weather of British Columbia



Graphic Area Forecast 31

NAV CANADA

The Weather of British Columbia

Graphic Area Forecast 31

by

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NAV CANADA

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The Weather of British Columbia
Graphic Area Forecast 31 Pacific Region

Preface

For NAV CANADA's Flight Service Specialists (FSS), providing weather briefings to help pilots navigate through the day-to-day fluctuations in the weather is a critical role. While available weather products are becoming increasingly more sophisticated, and at the same time more easily understood, an understanding of local and regional climatological patterns is essential to the effective performance of this role.

This British Columbia Local Area Knowledge Aviation Weather manual is one of a series of six publications prepared by Meteorological Service of Canada (MSC) for NAV CANADA. Each of the six manuals corresponds to a specific graphic forecast area (GFA) Domain, with the exception of the Nunavut – Arctic manual that covers two GFA Domains. These manuals form an important part of the training program on local aviation weather knowledge for FSS working in the area and a useful tool in the day-to-day service delivery by FSS.

Within the GFA domains, the weather shows strong climatological patterns controlled either by season or topography. This manual describes the Domain of the GFACN31. This area offers beautiful open spaces for flying but can also provide harsh flying conditions. As most pilots flying the region can attest, these variations in weather can take place quiet abruptly. From the rocky coast to jagged mountain peaks, local topography plays a key role in determining both the general climatology and local flying conditions in a particular region.

This manual provides some insight on specific weather effects and patterns in this area. While a manual cannot replace intricate details and knowledge of British Columbia that FSS and experienced pilots of the area have acquired over the years, this manual is a collection of that knowledge taken from interviews with local pilots, dispatchers, Flight Service Specialists and MSC personnel.

By understanding the weather and hazards in this specific area, FSS will be more able to assist pilots to plan their flights in a safe and efficient manner. While this is the manual's fundamental purpose, NAV CANADA recognizes the value of the information collected for pilots themselves. More and better information on weather in the hands of pilots will always contribute to aviation safety. For that reason, the manuals are being made available to NAV CANADA customers.

Acknowledgements

This manual was made possible through funding by NAV CANADA, Flight Information Centre project office.

NAV CANADA would like to thank The Meteorological Service of Canada (MSC), both national and regional personnel, for working with us to compile the information for each Graphic Area Forecast (GFA) domain, and present it in a user-friendly, professional format. Special thanks also go to meteorologists Ross Klock and John Mullock, Mountain Weather Centre, Kelowna. Ross's regional expertise has been instrumental for the development of the Pacific GFA document while John's experience and efforts have ensured high quality and consistent material from Atlantic to Pacific to Arctic.

This endeavour could not have been as successful without the contributions of many people within the aviation community. We would like to thank all the participants who provided information through interviews with MSC, including flight service specialists, pilots, dispatchers, meteorologists and other aviation groups. Their willingness to share their experiences and knowledge contributed greatly to the success of this document.

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January, 2002

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TABLE OF CONTENTS

Introduction

Meteorology is the science of the atmosphere, a sea of air that is in a constant state of flux. Within it storms are born, grow in intensity as they sweep across sections of the globe, then dissipate. No one is immune to the day-to-day fluctuations in the weather, especially the aviator who must operate within the atmosphere.

Traditionally, weather information for the aviation community has largely been provided in textual format. One such product, the area forecast (FA), was designed to provide the forecast weather for the next twelve hours over a specific geographical area. This information consisted of a description of the expected motion of significant weather systems, the associated clouds, weather and visibility.

In April 2000, the Graphical Area Forecast (GFA) came into being, superceding the area forecast. A number of MSC Forecast Centres now work together, using graphical software packages, to produce a single national graphical depiction of the forecast weather systems and the associated weather. This single national map is then partitioned into a number of GFA Domains for use by Flight Service Specialists, flight dispatchers and pilots.

GFA Domains

This Pacific Local Area Knowledge Aviation Weather Manual is one of a series of six similar publications. All are produced by NAV CANADA in partnership with the MSC. These manuals are designed to provide a resource for Flight Service Specialists and pilots to help with the understanding of local aviation weather. Each of the six manuals corresponds to a Graphical Area Forecast (GFA) Domain, with the exception of the Nunavut - Arctic manual which covers two GFA Domains. MSC aviation meteorologists provide most of the broader scale information on meteorology and weather systems affecting the various domains. Experienced pilots who work in or around it on a daily basis, however, best understand the local weather. Interviews with local pilots, dispatchers and Flight Service Specialists form the basis for the information presented in Chapter 4.

Within the domains, the weather shows strong climatological patterns that are controlled either by season or topography. For example, in British Columbia there is a distinctive difference between the moist coastal areas and the dry interior because of the mountains. The weather in the Arctic varies strongly seasonally between the frozen landscape of winter and the open water of summer. These changes are important in understanding how the weather works and each book will be laid out so as to recognize these climatological differences.

This manual describes the weather of the GFACN31 Pacific. This area often has beautiful flying weather but can also have some of the toughest flying conditions in the world. Shifting dramatically from the dripping, fog-shrouded rain forests of the West Coast, through the parched valley bottoms of the Interior, to the majestic snow-capped peaks and glaciers of the Rocky Mountains, few places in the world offer more visual splendors for a pilot and passengers. At the same time, mountains also evoke rapidly changing weather conditions that all too often have contributed to a tragedy. Between 1976 and 1994, there were 419 flying accidents in British Columbia where weather has been identified as one of the contributing factors. In these accidents, 319 people were killed and 89 people injured seriously. Mountain flying itself is not inherently dangerous, rather it is the weather associated with these areas that tends to be unforgiving of the rash, the negligent and the unlucky.

This manual is “instant knowledge” about how the weather behaves in this area but it is not “experience”. The information presented in this manual is by no means exhaustive. The variability of local aviation weather in British Columbia could result in a publication several times the size of this one. However, by understanding some of the weather and hazards in these areas, pilots may be able to relate the hazards to topography and weather systems in areas not specifically mentioned.

Chapter 1

Basics of Meteorology

To properly understand weather, it is essential to understand some of the basic principles that drive the weather machine. There are numerous books on the market that describe these principles in great detail with varying degrees of success. This section is not intended to replace these books, but rather to serve as a review.

Heat Transfer and Water Vapour

The atmosphere is a "heat engine" that runs on one of the fundamental rules of physics: excess heat in one area (the tropics) must flow to colder areas (the poles). There are a number of different methods of heat transfer but a particularly efficient method is through the use of water.

Within our atmosphere, water can exist in three states depending on its energy level. Changes from one state to another are called phase changes and are readily accomplished at ordinary atmospheric pressures and temperatures. The heat taken in or released during a phase change is called latent heat.

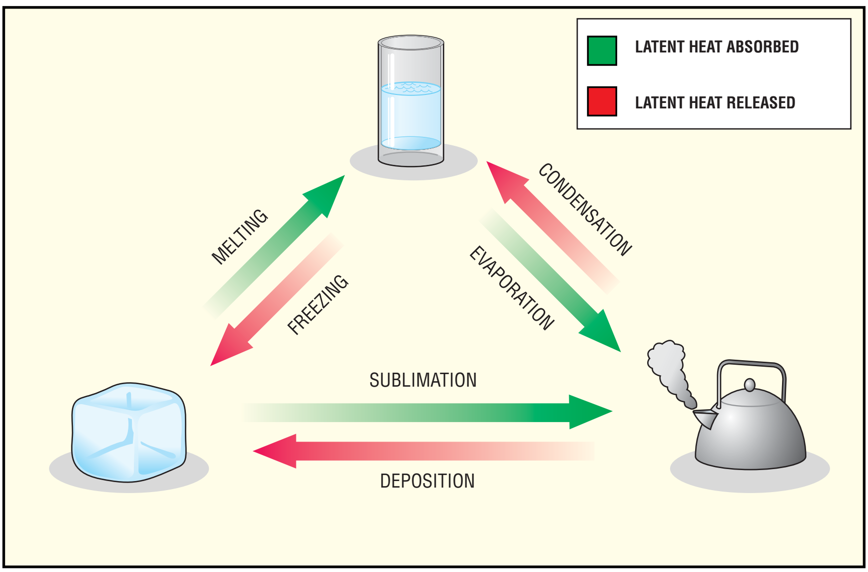


Fig. 1-1 - Heat transfer and water vapour

How much water the air contains in the form of vapour is directly related to its temperature. The warmer the air, the more water vapour it can contain. Air that contains its maximum amount of water vapour, at that given temperature, is said to be saturated. A quick measure of the moisture content of the atmosphere can be made by looking at the dew point temperature. The higher (warmer) the dew point temperature, the greater the amount of water vapour.

The planetary heat engine consists of water being evaporated by the sun into water vapour at the equator (storing heat) and transporting it towards the poles on the winds where it is condensed back into a solid or liquid state (releasing heat). Most of what we refer to as "weather," such as wind, cloud, fog and precipitation is related to this conversion activity. The severity of the weather is often a measure of how much latent heat is released during these activities.

Lifting Processes

The simplest and most common way water vapour is converted back to a liquid or solid state is by lifting. When air is lifted, it cools until it becomes saturated. Any additional lift will result in further cooling which reduces the amount of water vapour the air can hold. The excess water vapour is condensed out in the form of cloud droplets or ice crystals which then can go on to form precipitation. There are several methods of lifting an air mass. The most common are convection, orographic lift (upslope flow), frontal lift, and convergence into an area of low pressure.

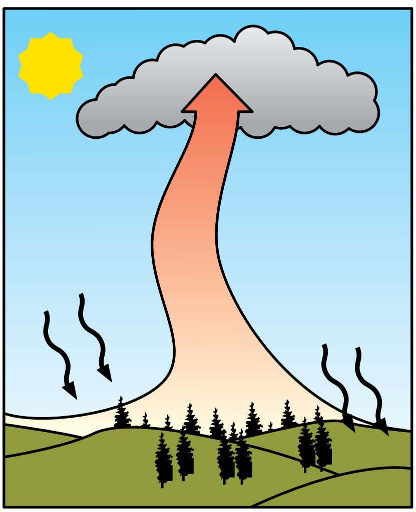


Fig. 1-2 - Convection as a result of daytime heating

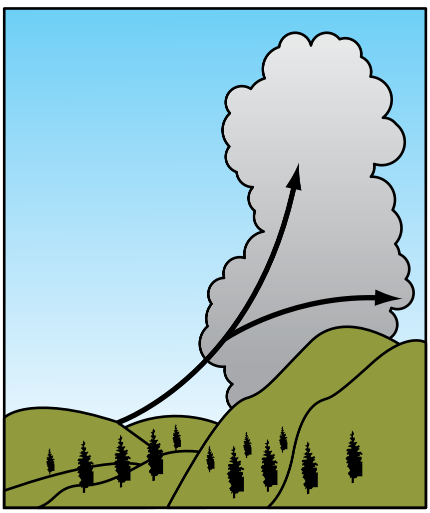


Fig.1-3 - Orographic (upslope) lift

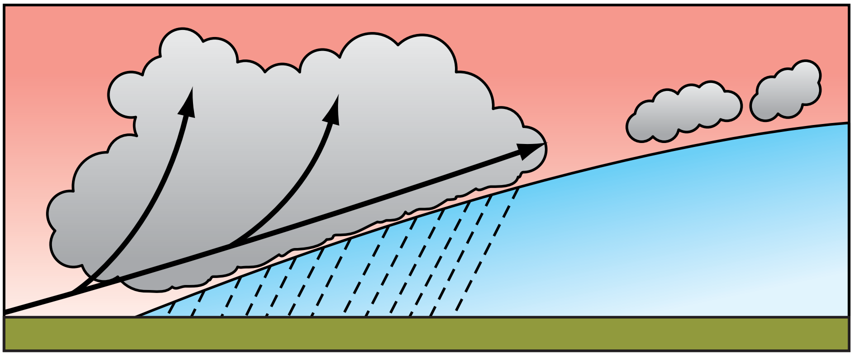


Fig.1-4 - Warm air overrunning cold air along a warm front

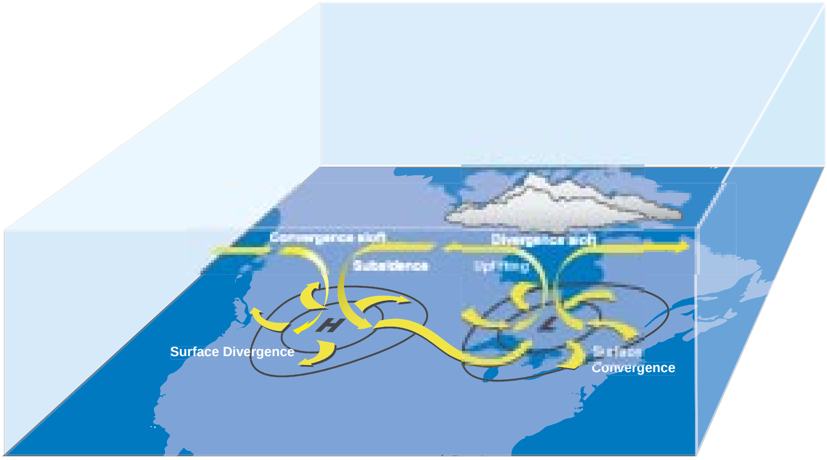


Fig. 1-5 - Divergence and convergence at the surface and aloft in a high low couplet

Subsidence

Subsidence, in meteorology, refers to the downward motion of air. This subsiding motion occurs within an area of high pressure, as well as on the downward side of a range of hills or mountains. As the air descends, it is subjected to increasing atmospheric pressure and, therefore, begins to compress. This compression causes the air's temperature to increase which will consequently lower its relative humidity. As a result, areas in which subsidence occurs will not only receive less precipitation than surrounding areas (referred to as a "rain shadow") but will often see the cloud layers thin and break up.

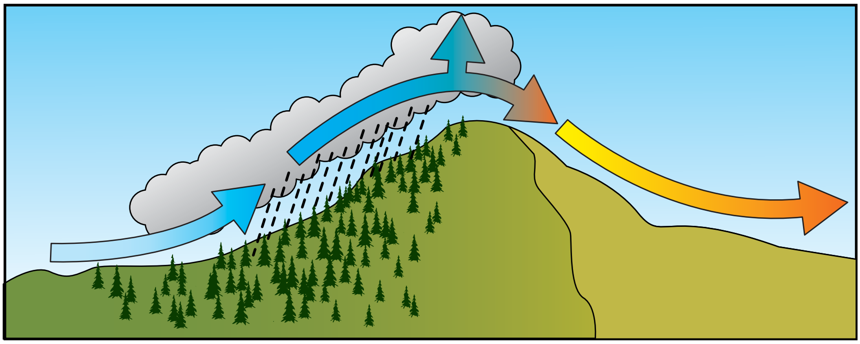


Fig.1-6 - Moist air moving over mountains where it loses its moisture and sinks into a dry subsidence area

Temperature Structure of the Atmosphere

The temperature lapse rate of the atmosphere refers to the change of temperature with a change in height. In the normal case, temperature decreases with height through the troposphere to the tropopause and then becomes relatively constant in the stratosphere.

Two other conditions are possible: an inversion, in which the temperature increases with height, or an isothermal layer, in which the temperature remains constant with height.

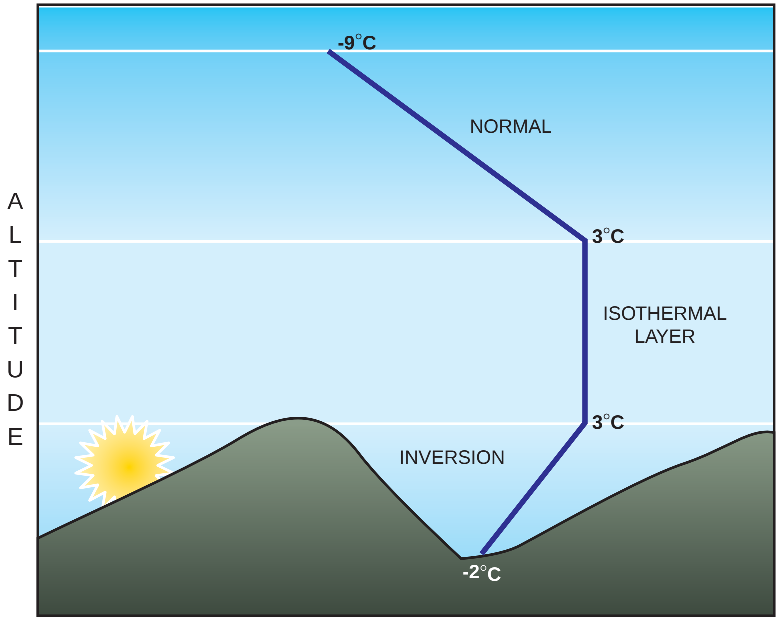


Fig. 1-7 - Different lapse rates of the atmosphere

The temperature lapse rate of the atmosphere is a direct measurement of the stability of the atmosphere.

Stability

It would be impossible to examine weather without taking into account the stability of the air. Stability refers to the ability of a parcel of air to resist vertical motion. If a parcel of air is displaced upwards and then released it is said to be unstable if it continues to ascend (since the parcel is warmer than the surrounding air), stable if it returns to the level from which it originated (since the parcel is cooler than the surrounding air), and neutral if the parcel remains at the level it was released (since the parcel's temperature is that of the surrounding air).

The type of cloud and precipitation produced varies with stability. Unstable air, when lifted, has a tendency to develop convective clouds and showery precipitation. Stable air is inclined to produce deep layer cloud and widespread steady precipitation. Neutral air will produce stable type weather which will change to unstable type weather if the lifting continues.

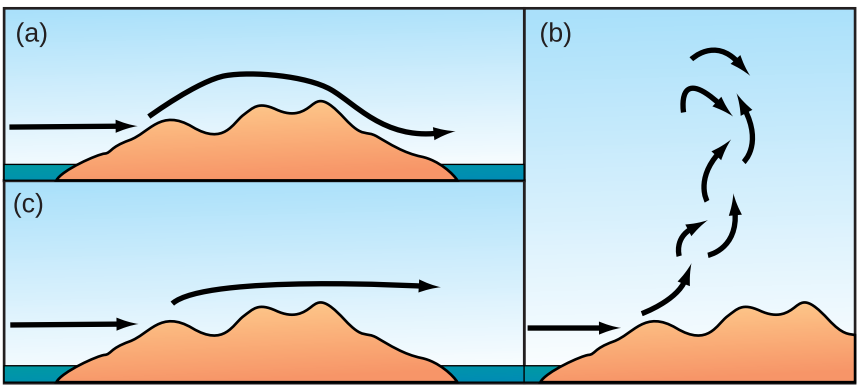


Fig. 1-8 - Stability in the atmosphere - (a) Stable (b) Unstable (c) Neutral

The stability of an air mass has the ability to be changed. One way to destabilize the air is to heat it from below, in much the same manner as you would heat water in a kettle. In the natural environment this can be accomplished when the sun heats the ground which, in turn, heats the air in contact with it, or when cold air moves over a warmer surface such as open water in the fall or winter. The reverse case, cooling the air from below, will stabilize the air. Both processes occur readily.

Consider a typical summer day where the air mass is destabilized by the sun, resulting in the development of large convective cloud and accompanying showers or thundershowers during the afternoon and evening. After sunset, the surface cools and the air mass stabilizes slowly, causing the convective activity to die off and the clouds to dissipate.

On any given day there may be several processes acting simultaneously that can either destabilize or stabilize the air mass. To further complicate the issue, these competing effects can occur over areas as large as an entire GFA domain to as small as a football field. To determine which one will dominate remains in the realm of a meteorologist and is beyond the scope of this manual.

Wind

Horizontal differences in temperature result in horizontal differences in pressure. It is these horizontal changes in pressure that cause the wind to blow as the atmosphere attempts to equalize pressure by moving air from an area of high pressure to an area of low pressure. The larger the pressure difference, the stronger the wind and, as a result, the day-to-day wind can range from the gentlest breeze around an inland airfield to storm force winds over the water.

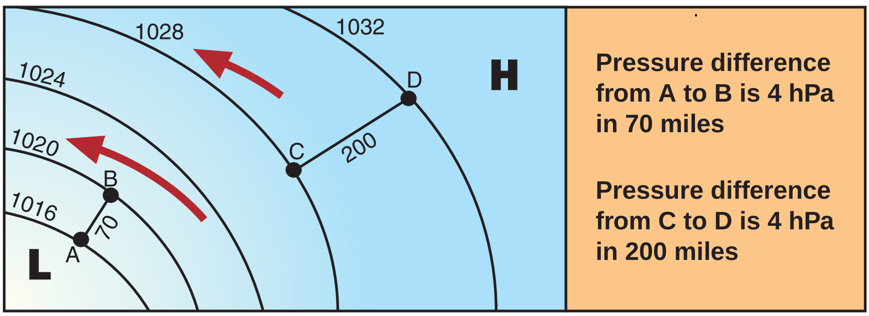


Fig. 1-9 - The greater pressure changes with horizontal difference, the stronger the wind

Wind has both speed and direction, so for aviation purposes several conventions have been adopted. Wind direction is always reported as the direction from which the wind is blowing while wind speed is the average steady state value over a certain length of time. Short-term variations in speed are reported as either gusts or squalls depending on how long they last.

Above the surface, the wind tends to be relatively smooth and changes direction and speed only in response to changes in pressure. At the surface, however, the wind is affected by friction and topography. Friction has a tendency to slow the wind over rough surfaces whereas topography, most commonly, induces localized changes in direction and speed.

Air Masses and Fronts

Air Masses

When a section of the troposphere, hundreds of miles across, remains stationary or moves slowly across an area having fairly uniform temperature and moisture, then the air takes on the characteristics of this surface and becomes known as an air mass. The area where air masses are created are called "source regions" and are either ice or snow covered polar regions, cold northern oceans, tropical oceans or large desert areas.

Although the moisture and temperature characteristics of an air mass are relatively uniform, the horizontal weather may vary due to different processes acting on it. It is quite possible for one area to be reporting clear skies while another area is reporting widespread thunderstorms.

Fronts

When air masses move out of their source regions they come into contact with other air masses. The transition zone between two different air masses is referred to as a frontal zone, or front. Across this transition zone temperature, moisture content, pressure, and wind can change rapidly over a short distance.

The principal types of fronts are:

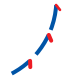
Cold Front - The cold air is advancing and undercutting the warm air. The leading edge of the cold air is the cold front.		
Warm front - The cold air is retreating and being replaced by warm air. The trailing edge of the cold air is the warm front.		
Stationary front - The cold air is neither advancing nor retreating. These fronts are frequently referred to quasi-stationary fronts although there usually is some small-scale localized motion occurring.		
Trowal - Trough of warm air aloft.		

Table 1-1

More will be said about frontal weather later in this manual.