Weather Flying

Robert N. Buck
Robert O. Buck

Fifth Edition

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In winter, the lee of the Great Lakes has snow and stratus, because the wind blows air across the lakes, where it picks up moisture. Then the air rises as it is blown up the slope of the Allegheny Mountains. The result is zero-zero, with snow and clouds on the mountains; the clouds are full of ice, and it takes 9,000 to 14,000 feet to get on top.

Cities are a part of terrain-weather thinking. Cities make smoke and pollution, and those microscopic particles are something on which fog forms. Smoke and air pollution make the formation of fog easier, and a wind carrying pollution toward an airport is a setup for poor visibility. That's terrain, human made, but still terrain.

Wind

Another important factor in weather is wind, which plays a major role in a pilot's life. It affects us from the moment we take the airplane out of the hangar until we secure it for the night. Wind tells us how we must handle an airplane on the ground and during takeoff; it tells us how we must think and act while flying close to uneven terrain; it tells us how short we can take off and land and what up and downdrafts we can expect. Wind affects the performance of our airplane. A big jet weighing 290,000 pounds can take off from a certain runway in calm conditions; a 10-knot headwind can increase the gross to 300,000 pounds, but with a 5-knot tailwind, the gross is reduced to 280,000 pounds. The same rules apply for a Cessna 172 too; only the numbers are different.

Wind is also important when thinking about large-scale weather. First, on a weather map we notice, almost automatically, that if the isobars are jammed together like tracks in a railroad yard, it tells us the wind will be strong, or if they are wide apart, the wind will be lazy.

Then we look at direction. East winds may bring bad weather, west winds sunshine. Wind from a sea such as the Gulf of Mexico brings moisture that can create bad weather. Knowing what the wind is, or catching its changes in velocity or direction, can give us good weather clues.

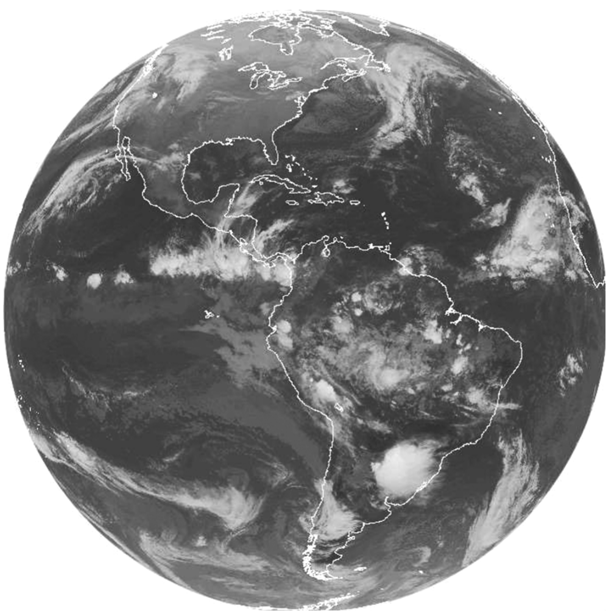
Wind is layered and blows differently aloft than it does on the ground. The wind up high tells a pilot about speed for a trip, and therefore, the required fuel and reserves. Wind just above the ground, within the first 1,000 feet, tells about shear and its hazards during takeoff and landing. While the wind may be calm on the ground, especially true in valleys and at night, it can be blasting along at high speed only a few hundred feet above the ground, which can be devastating to a climb rate as you suddenly fly into an unexpected tailwind. Part of preflight weather gathering should be a close inspection of the gradient wind; the wind above the surface out of the earth's friction layer. (Another term for this is PBL, which means planetary boundary layer; a fancy name for what we've always called the friction layer.)

The tremendous force of wind drove this board (measuring 10 feet × 3 inches × 1 inch) through a palm tree in Puerto Rico during a hurricane. (NOAA PHOTO)

An important part of wind action is convergence or, more simply, places where winds from opposite directions bang into each other and pile up. The idea of convergence and what happens because of it is difficult to pinpoint, and the actions it causes are complicated. A convergence area can be very big, like the Intertropical Front, also know as the Intertropical Convergence Zone (ITCZ), where northeast trade winds run into southeast trades and create an area of large cumulus and thunderstorms. Convergence can also be tiny, where a sea breeze meets inland air and forms a miniature front of no special consequence, except for a line of clouds a little way in from a coastline. These are called sea breeze fronts and generally are mild, but just to keep alive the realization that weather's ability can surprise us, thunderstorms occasionally will develop along such fronts. Fronts are a demonstration of convergence, and so are low-pressure areas. The important point is that almost any time convergence is present, there will be some sort of weather associated with it, because of the process of air being lifted and cooled.

Divergence is the opposite of convergence. Air flows down and away, which again, in going back to the adiabatic process, heats up and generally gives good weather. A high-pressure area is a large-scale divergence, a mass of sinking air. This sinking air in a high, and the rising air in a low, affect flight more than we realize.

When I (RNB) began flying the first 747s in 1970, a flight plan filed from New York's JFK to Europe made it important to note whether we would be climbing through a high or low pressure area. That would determine what altitude to file with Air Traffic Control (ATC) for crossing Nantucket, a checkpoint about 176 miles from JFK. If climbing in a low, the airplane could reach 33,000 feet, because the converging, rising air would help the climb.



The biggest convergence zone: the Intertropical Front, shown in this satellite picture. Thunderstorms show on South America's northwest coast westward into the Pacific. It's less active eastward until the central South Atlantic toward Africa. This is temporary as it strengthens and weakens because of activity or time of day. If you fly between the Northern and Southern Hemispheres, you will have to cross this area and its big thunderstorms—tops into the 60,000-foot range—and heavy rains. (NOAA IMAGE)

However, climbing through a high, with its diverging and settling air, the climb would be slower, with 29,000 feet at Nantucket. About all those early, low-powered versions of the airplane could comfortably handle.

Of course this effect works on any airplane. No doubt many pilots—especially those flying small, lower-powered aircraft cross-country in a fresh high-pressure area—have noticed how the airplane seemed to fly somewhat slower and worked harder to keep normal cruising speed. This is even worse in mountainous regions, but that's for another reason—waves—which we'll talk about later in the chapter on turbulence.

A good pilot is wind conscious, aware of its direction and velocity, knowing how it smells and feels, sensitive to a warm, humid wind or a crisp, cold one, where it came from, and what kind of weather it will bring. A good pilot awakes in the morning, looks out the window, sees where the surface wind is coming from, looks up at the clouds, checks which way they are drifting, and learns the wind aloft. All through the day, that pilot is subconsciously aware of the wind, and if it changes, they sense it, then contemplates what this may mean. Any weather-wise pilot puts the wind and flying together, visualizing it tumbling over trees or buildings near the approach end of a runway and what that will do to the airplane. Our pilot tries to "see" the downdraft on a sharp mountainside and relates wind to aircraft performance, as well as to the weather. The good pilot is animal-like in sensitivity to the wind, feeling and understanding its motions by instinct.

Clouds

A pilot literally looks at the weather to see what it's up to. One of the main things observed is clouds. They tell a big story.

There are two cloud types, cumulus and stratus, and all cloud designations are some combination of them. There are three classifications: cirrus, nimbus, and alto. *Cirrus* are high-altitude clouds, and because they occur in high, cold air, they are made of ice crystals; but they still follow the cumulus and stratus designations. *Nimbus* is simply a name given to clouds when precipitation starts to come from them—like cumulonimbus and nimbostratus. *Alto* simply designates height; it means a cloud is at medium height, somewhere between 7,000 and 25,000 feet, and again it is used with the basic cloud forms, as altostratus, altocumulus. You never hear "altocirrus," because cirrus by itself is high.

The important part about the two basic cloud types is their action and this, in turn, tells how they were made. Cumulus clouds are bouncy clouds. They were born of instability, born in air that once it starts up, wants to keep on going—for that's all instability is. Stratus clouds are smooth and flat, or almost flat; their air is basically stable.

Heavy precipitation comes from unstable clouds; steady, light rain or drizzle, comes from stable clouds. Said another way, ceilings and visibilities will be high enough to land during unstable conditions, except we may briefly have heavy rain or snow showers, causing the visibility to be near zero, the runway slick from rain or even flooded, with stopping difficult. Precipitation from stable clouds means low ceilings. Light precipitation can bring zero ceiling, or near it, with the condition widespread and of long duration.

So fluffy white clouds are cumulus, and flat, layered ones are stratus. To make it more confusing, they can be in combinations, as stratocumulus, for instance, which is a layer of clouds containing some instability. The precipitation from the clouds of slight instability can be light.

The stories clouds tell are varied. Cumulus clouds are generally thought of as pretty, fluffy white things floating in a blue sky. They mean good weather. But they are not all the same. We know that any cumulus-decorated sky will have choppy air underneath the clouds and smooth air on top. If we look at the clouds more closely, we can get an idea of how choppy it will be underneath. If the clouds have a shredded look, like cotton that's been pulled apart, it's probably rough; you are slapped around the sky, and it's a good bet that the surface winds are strong and gusty. When we fly gliders in these conditions, the rising thermals are generally chopped up and difficult to stay in.

If, however, cumulus clouds are bulbous and fat, the choppy air will not be so choppy, and the up and downdrafts will be better defined. You rise and descend more like a boat in swells at sea. We also look at these fat cumulus clouds with more suspicion, because they are the kind that may grow large and turn into thunderstorms.

We can tell without even looking at a weather map, merely from the type of cumulus present, a lot about the synoptic situation. The first type, the shredded kind, are in an air mass that's close behind a low, and a front has gone by with fresh, vigorous air flowing into the area. We're in for a few days of good weather. The fat cumulus clouds say that we are deeper into a high, perhaps on the back side of it, and warmer unstable air is coming in. Somewhere to the west a cold front is probably starting our way.

Stratus clouds tell a different yarn. We may be flying in a mountainous area, such as the New England states. There is a high overcast made of altostratus; the visibility is good. Our destination, in the mountains farther south, is reporting 8,000 feet and 5 miles visibility with light rain—good enough. We know there's a rain area, a warm front approaching, but the forecasts do not make our destination really bad until long after our arrival. We fly on and notice rain on our windshield. The visibility drops some, but there's enough. We are happy, even though it rains a little harder. But then, looking down in a valley, we see a wisp of stratus below, just a little thin glob of cloud floating along by itself. That should be a red flare signal! Things are happening; enough rain has fallen into the lower air to raise its dewpoint, and stratus is forming; stratus is the cloud low ceilings are made of. It's forming faster than the forecasts indicate; the next thing we know our destination will have about a 300-foot ceiling or less. We review our fuel, check the alternate

Three layers of clouds and the stories they tell. Looking south, from 32,000 feet, we are flying west. We've passed through the jet stream, under which is a cold front—we're on the back side, the front moving east. Up high is cirrus cloud, the thick band from the jet stream: it was flowing from 221° at 155 knots. Below the jet stream is an altostratus deck, around 20,000 foot. Down low and left is the front's back and cumulonimbus clouds. To right and behind the front are typical post frontal cumulus and stratocumulus cloud, with average tops about 12,000 feet. It's November, so maybe there's ice in the cumulus. Position: mid-ocean, North Atlantic—50° north and 40° west at 1649Z, November 10, 2005. (PHOTO BY ROBERT O. BUCK)

and destination weather, which is going down, and wish we could hurry and get there before it socks in. All this was told to us by a little piece of stratus.

We are flying westward on a summer day, on top in clear air with excellent visibility; below, it's hazy and difficult to see. Way west of us there's a cold front, which is forecast to arrive at our destination long after we do. But suddenly our eye catches a different shading in the high sky far ahead. We take off our sunglasses to see it better, but we can't; we put them on and squint a little, trying to pick it out. We fly on and look some more. Then we're certain. The western sky holds solid cirrus, white and innocent looking, but it's a sign that says let's check that front; it may be moving faster than we thought, or a prefrontal line squall may be developing.

These are a few examples of the many things clouds tell us; they are an entire weather story placed in the sky for us to read. We can study for a long time and never know the whole story, but it is profitable and interesting to try.