National Environment Agency

Our Environment - Sustain and Enjoy

WEATHERWise Singapore

Cover Page Photograph by Wong Chee Ming

Cloud iridescence seen atop a developing cumulonimbus in Singapore, possibly a pileus (cap) cloud.

In a developing cumulonimbus cloud, sometimes strong updrafts could throw a section of air out and above the rest of the cloud. When moisture in the air section condenses and freezes, a pileus is formed. Iridescence is caused by coronal refraction between cloud (ice) droplets that are nearly uniform in size.

Contents

Introduction

Weather is the mix of atmospheric events involving temperature, rainfall, humidity and others that happen daily while climate generally refers to the average weather pattern over many years. Although public information on weather and climate is available, it is often not specific to Singapore. This booklet gives readers an overview on local weather and climate in relation to the wind and weather of the region.

It will begin with an introduction on cloud and rain formation which is central to the understanding of weather, followed by a chapter on *Regional Wind and Weather Patterns* describing the seasonal environment of the region. This will help in the understanding of the specific weather types in the following chapter.

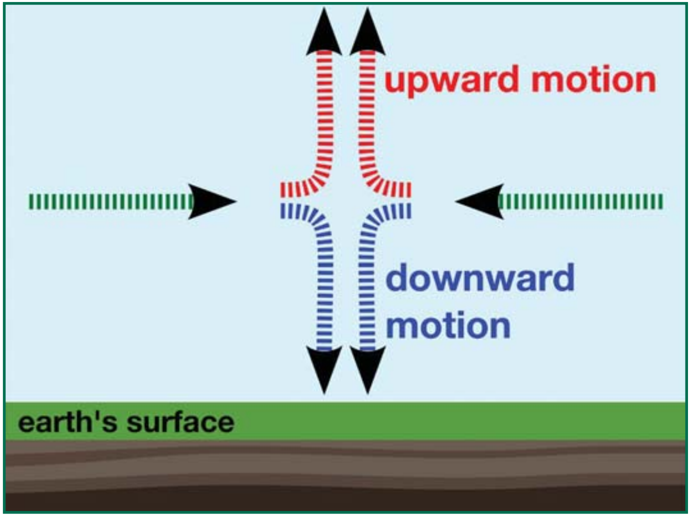
The remaining 3 chapters are for references:

- *Seasonal Weather Features:* Summary of weather features of the monsoon seasons and the transition periods.
- *Monthly Weather Highlights:* Description of the average weather conditions for each month
- *Monthly Statistics of Climate Data:* Monthly averages of wind, temperature, rainfall and thunder and lightning days.

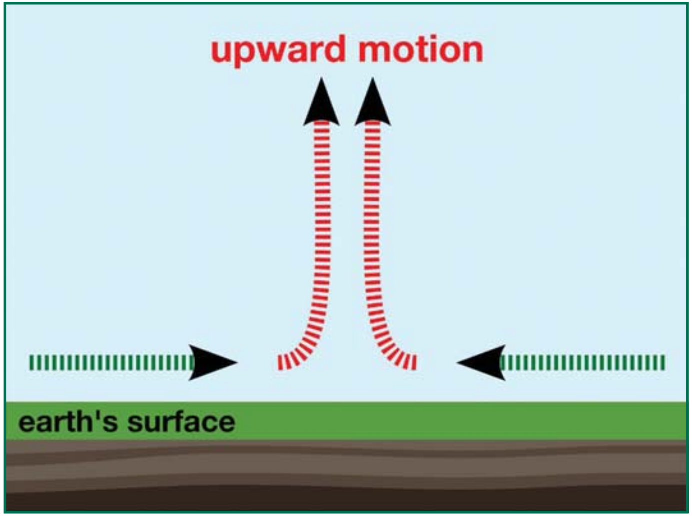
The Meteorological Services Division is a division of the National Environment Agency. It provides weather information and forecasts. We are pleased to produce this educational booklet which we hope will help you better understand and appreciate the value of these meteorological services and products.

Cloud & Rain Formation

How do cloud and rain form? The basic idea is simple. When different air streams meet and bump against each other (convergence), air parcels from the streams may be forced to move vertically. At low levels (say within 1 km from the surface) convergence can only produce upward motion of air. With lower pressure at higher altitudes, rising air expands and cools. Eventually, water vapour condenses into water droplets to form clouds. The continued growth of clouds leads to more and larger water droplets (or ice crystals) which eventually fall off the clouds as rain.



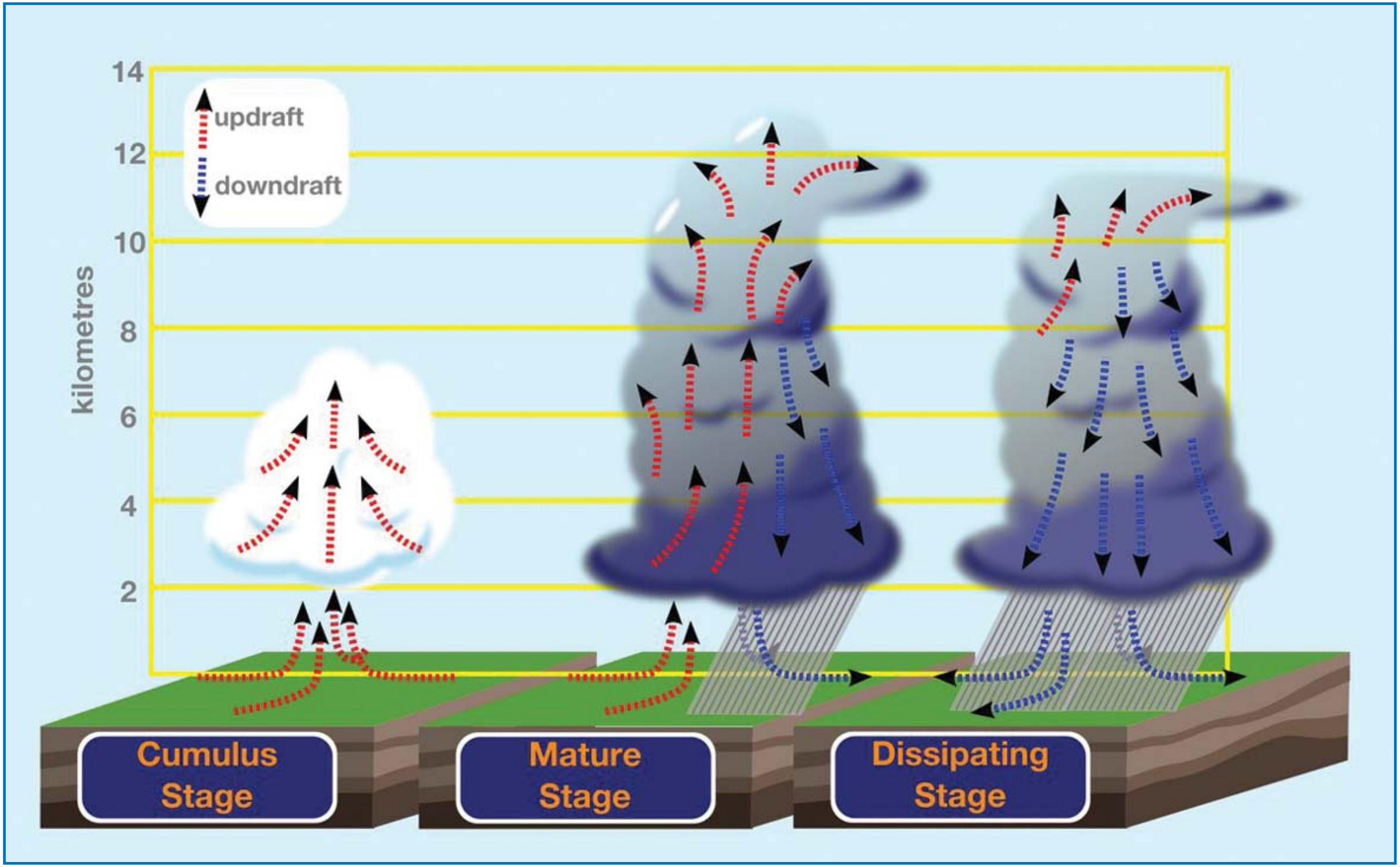
Convergence of air streams above the earth's surface



Convergence of air streams near the earth's surface

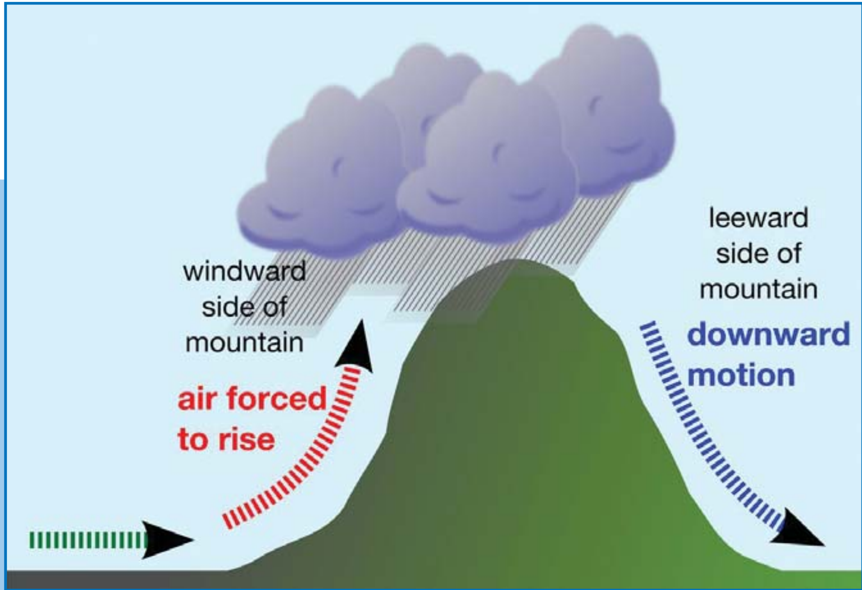
With sufficient convergence, air can rise to great heights. A typical thunderstorm cloud (cumulonimbus) in Singapore can grow to a height of between 8 and 12 km. A mature thunderstorm cloud (a cell) is characterised by vigorous updrafts and downdrafts. Updrafts are associated with inflow of humid air from the base of the cloud. When a thunderstorm matures, the falling of raindrops drags and pushes air downwards causing downdrafts. These downdrafts eventually spread throughout the entire cloud, cutting off the feed of moisture by updrafts. The thunderstorm cell then goes into the dissipating stage. A single thunderstorm cell typically lives for less than an hour. Meanwhile, when convergence is present in a large area, new cells may form in the vicinity, prolonging the episode of thunderstorm. In some cases, a dissipating cloud may spread horizontally into a layer (stratiform cloud) giving rise to continued rain.

Meteorologists often make a distinction between *showers* which come from clouds of large vertical extent (cumulo-form clouds) and *rain* which comes from clouds in layers (stratiform clouds). Thunder and lightning are not likely to be associated with rain. However, many times in Singapore, the distinction is not always clear because both tall and layered clouds are present simultaneously.

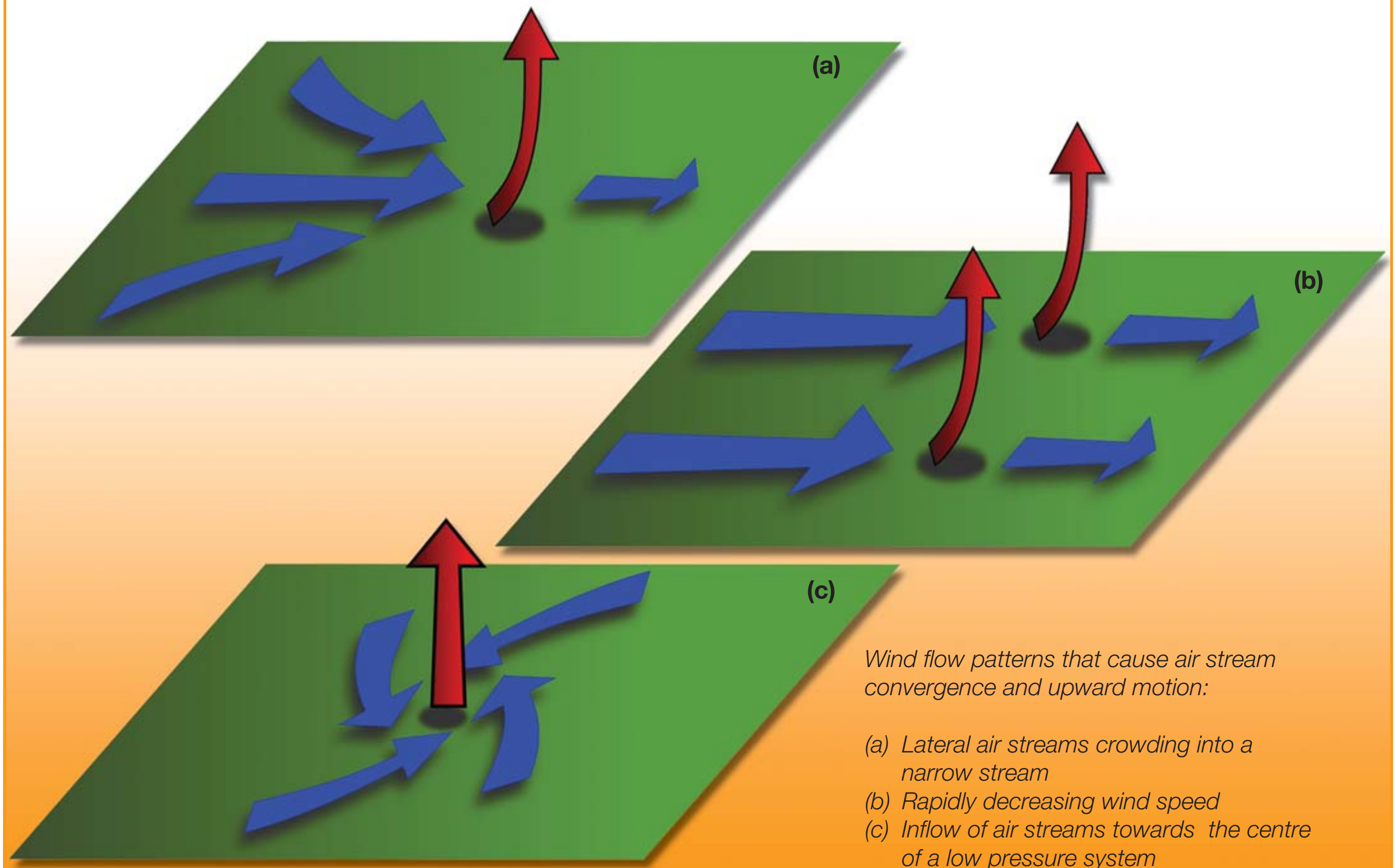


Life cycle of a single-cell thunderstorm

There are other ways air may be forced to rise. One obvious example is when high terrain obstructs onward flow of air. This mechanism is responsible for high rainfall in many places on the windward side of mountains. It is also common knowledge that afternoon convection can give rise to showers. On a hot afternoon, the sun heats the ground which in turn heats the immediate layer of air. Hot air then rises to produce convective clouds. However, intense thunderstorms occurring in the afternoon are usually due to a combination of factors. One of the factors may be the presence of the monsoon rain-belt in the vicinity.



Rain on windward side of mountain due to orographic lifting



Wind flow patterns that cause air stream convergence and upward motion:

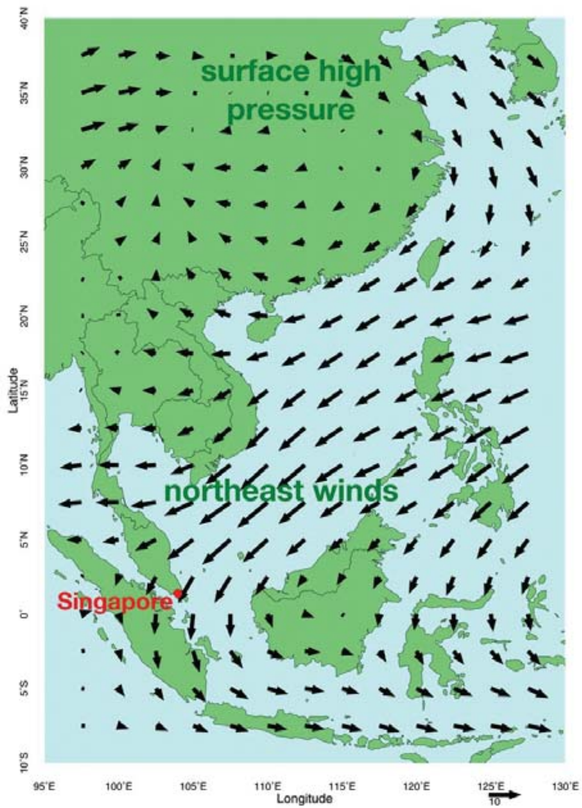
(a) Lateral air streams crowding into a narrow stream
(b) Rapidly decreasing wind speed
(c) Inflow of air streams towards the centre of a low pressure system

Regional Wind and Weather Patterns

Monsoons in Southeast Asia

Apart from occasional felled trees during thunderstorms, wind in Singapore is rarely an important factor in our daily lives. However, the pattern of wind-flow, especially that in the lowest 1 km from the surface of the earth (low-level wind) does play a critical role in weather. In fact, one of the major challenges in forecasting weather for the tropics is to be able to discern changes in light winds, amid inherent errors in observational data.

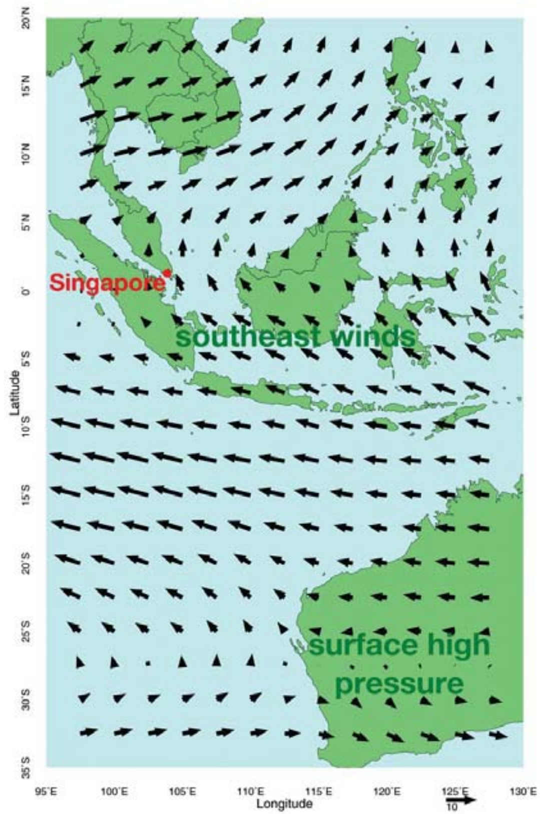
Uneven solar heating of the earth is the fundamental drive for air motion. In the northern winter (December through early March) Central Asia is a huge storehouse of cold air. From time to time, the air rushes out of Central Asia to blow across East Asia and towards the warmer tropical oceans and Australia (which is in summer). The wind chart for January depicts the average flow pattern.



Average low-level (800 m) wind flow for January

In July, the wind reverses. Relatively cold air moves out of Australia (then in winter) towards the warmer tropical ocean and the Asia continent. A place is said to experience *monsoon* if its low-level winds persist in one direction for a period of several months and then switch direction for another period within the year. Much of Southeast Asia is within the monsoon regime.

In Singapore, the wind usually blows from north or northeast between December and early March and from the south or southeast between June and September.

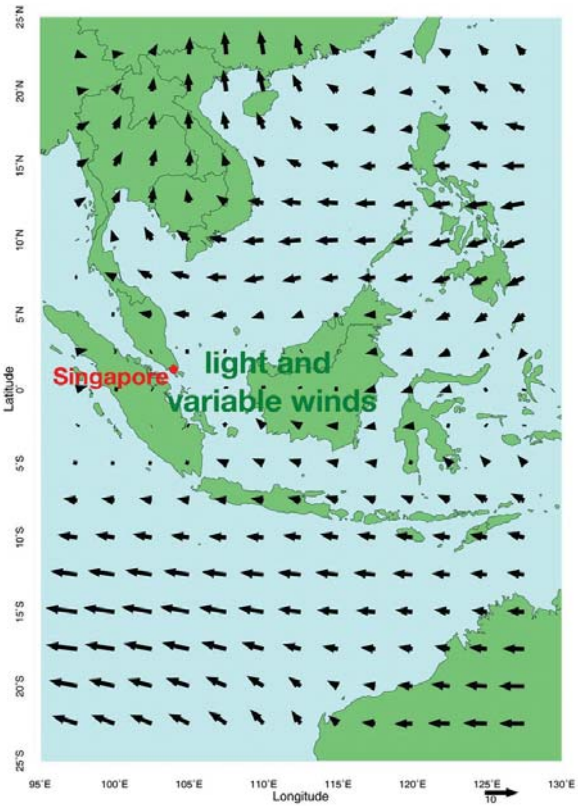


Average low-level (800 m) wind flow for July

Singapore's weather is traditionally classified into 4 periods according to average prevailing wind directions:

a) Northeast Monsoon Season (December to Early March)
b) Inter-monsoon Period (Late March to May)
c) Southwest Monsoon Season (June to September)
d) Inter-monsoon Period (October to November)

The transitions between the monsoon seasons occur gradually, generally over a period of 2 months. The winds during these transitions or Inter-monsoon Periods are usually light and tend to vary in direction daily.



Average low-level (800 m) wind flow for April

Weather in Southeast Asia

Monsoon Rain-belt

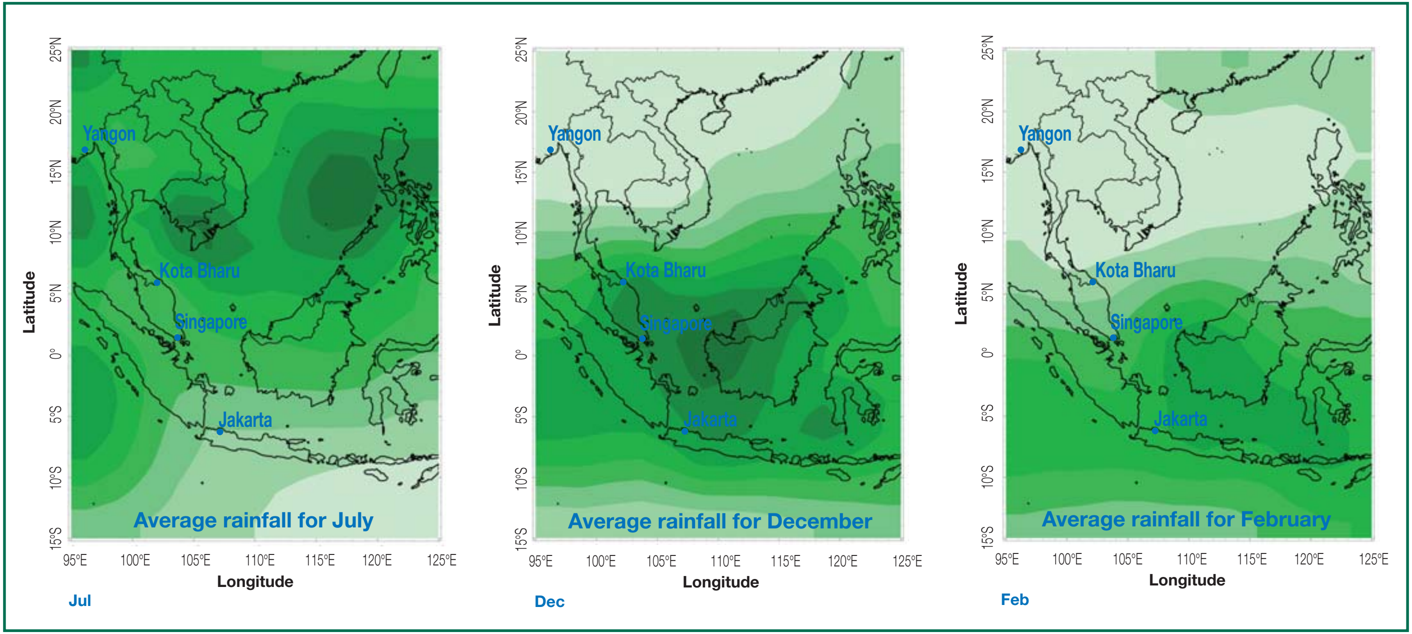
Frequent travellers may be aware that different parts of Southeast Asia experience their wet seasons at different times of the year. The table below illustrates this point:

City	Wettest month of the city
Yangon (Myanmar, 16.8 N, 96.2E)	July/August
Kota Bharu (Malaysia, 6.2N, 102.3E)	November/December
Singapore (Singapore, 1.3N, 103.8E)	December
Jakarta (Indonesia, 6.2S, 106.8E)	January/February

Wet weather apparently moves southward from Yangon in July/August to Jakarta in January/February. For anyone interested in looking at rainfall patterns in detail, the World Meteorological Organization website (http://worldweather.wmo.int/) has a large depository of climate data.

Conventional rainfall records are only available for land weather stations. In sea areas, rainfall is normally estimated using remote sensing techniques. The website http://ingrid.ldeo.columbia.edu/maproom, hosted by the International Research Institute for Climate and Society (IRI), is a treasure house for weather data. The charts for average rainfall for the months of July, December and February are adapted from the site. The high rainfall zone, sometimes called the "monsoon rain-belt", affects the region progressively from north to south.

The wind and rainfall patterns discussed so far are average conditions. On a day-to-day basis, the patterns may have large deviations from the average.

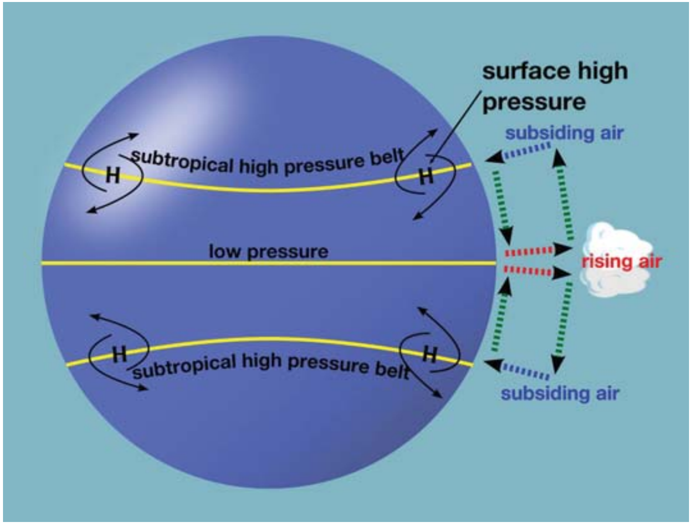


Progressive north-to-south migration of the monsoon rain-belt in the South China Sea during the period of July-February. The darker shades of green indicate higher rainfall.

Subtropical High Pressure System

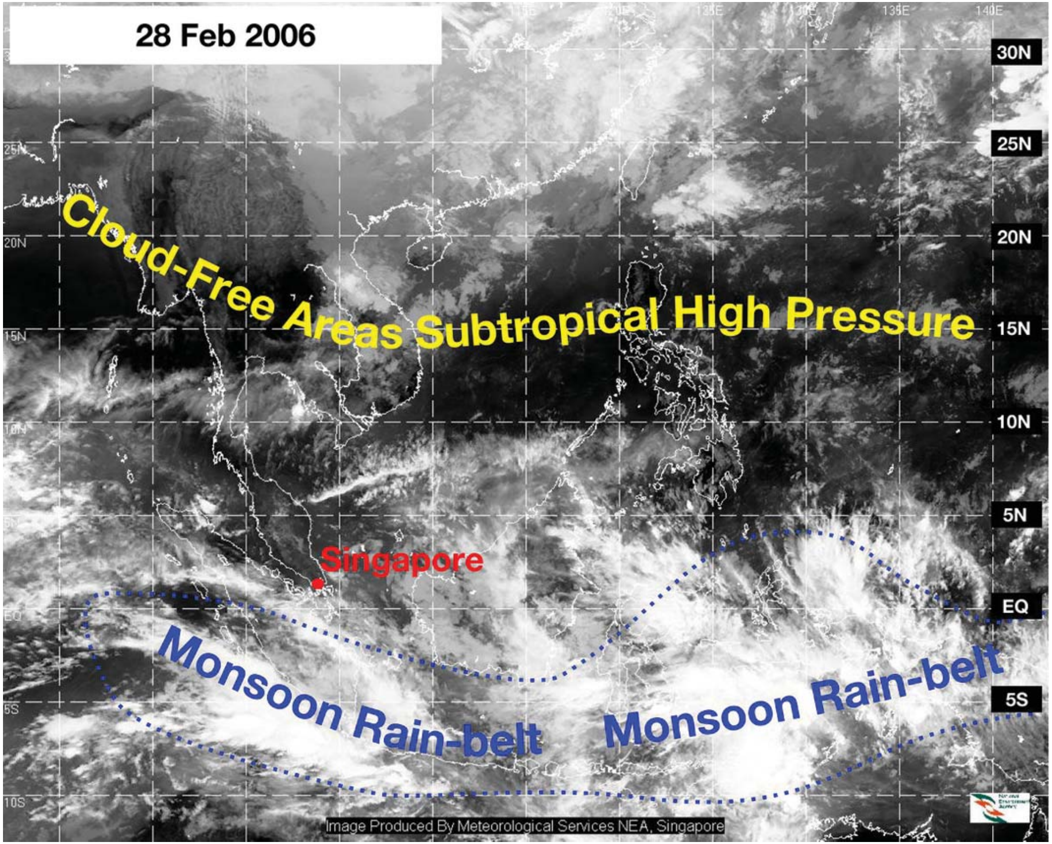
The troposphere contains 75% of the atmosphere's mass and almost all its weather activities. Rising air motion associated with thunderstorms or rain in the monsoon rain-belt contributes to a net transport of air to the top layer of the troposphere (about 15 km in the tropics). The air then moves towards the poles.

If you place 2 fingers on a globe and move them along the longitude lines towards a pole, they will come closer to each other. In a similar manner, pole-ward moving air converges. Coupled with cooling by radiation, the air subsides (sinks) around the subtropics (around 20°-30° N and S). Subsidence inhibits the rising of air, which is needed to produce cloud and rain. Pressure at the surface is basically the weight of the vertical air column per unit area. Surface pressure here is higher than the surrounding because of the relatively cool air above around the top of the troposphere. The subsiding air eventually diverges out of the high pressure system.



Average vertical circulations (Hadley cells) are shown on both sides of the equator. The downward arms are associated with the subtropical high pressure belts and fine weather.

This presence of the belt of subtropical high pressure is the fundamental reason for the occurrences of dry seasons in the subtropics. In the Asia Pacific region, the belt may be around 35°N in the summer and may move as far south as 15°N in winter. The outflow of the stable (with subsidence) air could further extend the dry weather towards the equator.



Satellite image showing the subtropical high pressure belt at around 15°N and the monsoon rain-belt. Note the extension of dry weather towards the equator affecting Singapore.

Weather and Climate in Singapore

Northeast Monsoon Surges

December is usually the wettest month of the year in Singapore. A few heavy rain spells normally contribute to most of the rainfall in the month. A rain spell may last for a few days or in some cases for more than a week. Most of these rain spells are caused by surges of Northeast Monsoon winds in the South China Sea.

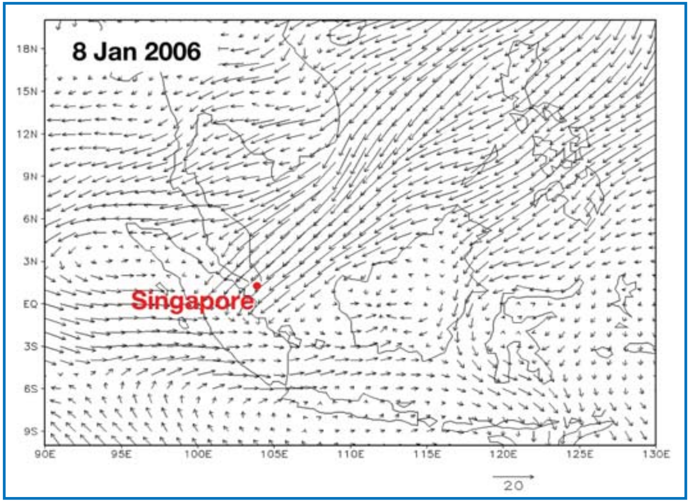
During the period of December through early March, the heartland of Asia including Siberia experiences very low temperatures. From time to time, air rushes out of Central Asia, bringing a sudden chilling to the East Asia region such as China and the Korean peninsula.

This *cold air outbreak* is more severe in the north but even in southern China, a fall of 5°C degrees within a day is common. Often, such a *cold air outbreak* is also accompanied by the formation of a high pressure system in China. The pressure difference sets forth an abrupt increase in northeasterly wind (speed) in the South China Sea blowing towards the warm tropics where pressure is lower. The sea warms and moistens the overlaying wind and in turn the wind eventually converges to bring about widespread rain in the tropics.

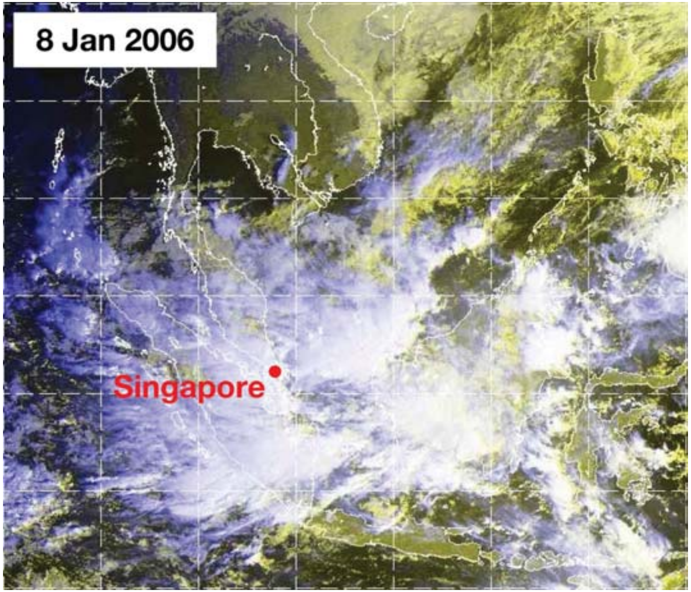
October	November	December	January	February	Early March
Inter Monsoon		Early Northeast Monsoon		Late Northeast Monsoon	
Wet season				Relatively dry period	

Monsoon is defined by wind. On average, rainfall in Singapore begins to increase in October, peaking in December

In December and January, the monsoon rain-belt resulting from convergence of wind is likely to be close to Singapore.



Wind-flow on 8 Jan 2006. Length of arrows denotes speed. Rapidly decreasing wind speed downstream implies the convergence of air.



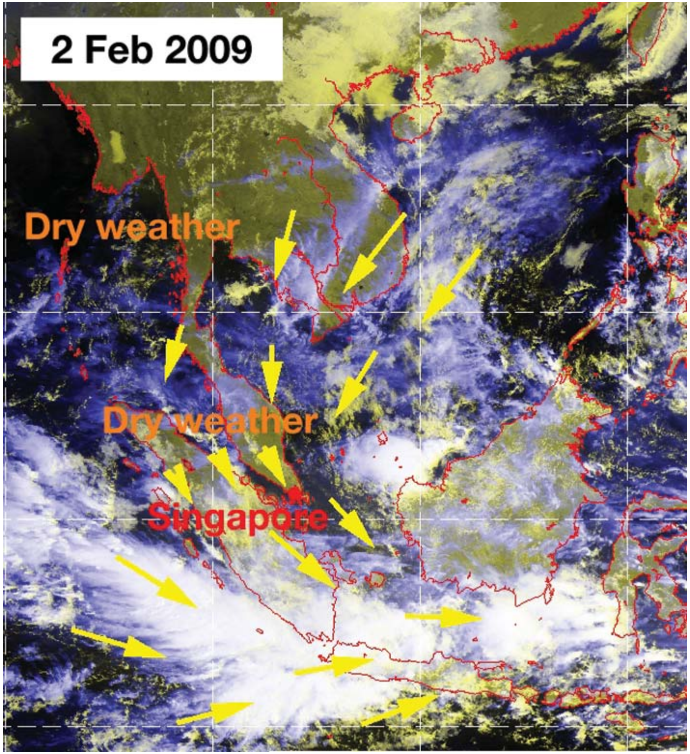
Satellite image showing widespread monsoon rain affecting Sumatra, Peninsular Malaysia, Singapore and Borneo

Dry Weather in the Late Northeast Monsoon

Most people associate the word *monsoon* with the rainy season. However, *monsoons* are more often defined by wind. Singapore experiences its Northeast Monsoon Season with winds blowing from the north or northeast during the period of December to early March. However, the monthly rainfall does not coincide with the monsoon wind exactly. Rather, increasingly wet weather is observed from October, peaking in December. The last phase of the Northeast Monsoon from February to early March often sees a sharp drop in rainfall and the number of rain-days in Singapore.

Dry spell has a specific meaning in meteorology. It refers to a period with more than 14 consecutive non-raining days. Days with less than 1 mm of rain are considered non-raining. Most of the dry spells in Singapore fall in the late Northeast Monsoon Season. The longest dry spell of 40 days occurred between 18 January and 26 February 2005.

What causes a dry spell? During the early part of the monsoon, the rain-belt is more likely to be positioned close to Malaysia and Singapore. Later, between February and early March, the rain-belt tends to move south to affect Java in Indonesia or northern Australia. The prevailing northeasterly wind actually extends the dry condition associated with the Subtropical High Pressure System towards the equator.



Monsoon rain-belt associated with the Northeast Monsoon affecting Java and southern Sumatra. A relatively dry area lies to the north of this rain-belt.

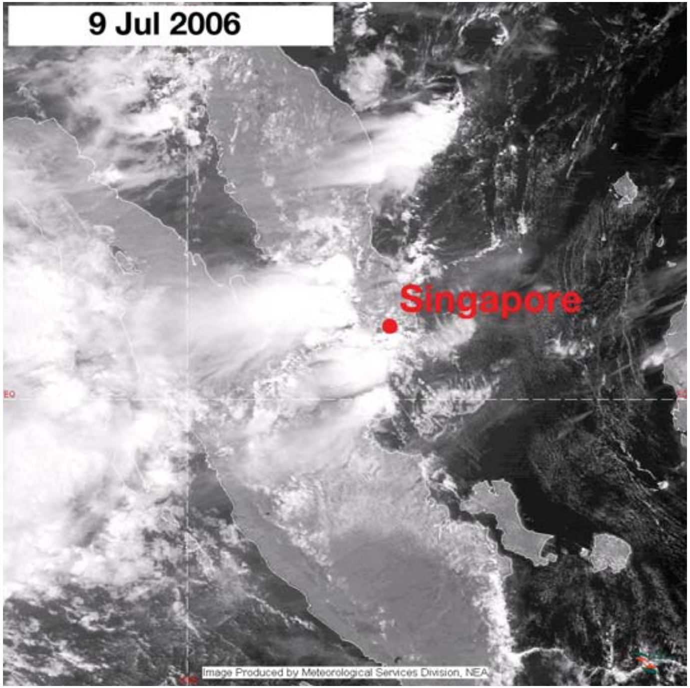
Sumatra Squall

An isolated thunderstorm cell has a short lifespan, usually less than an hour. Sometimes, a number of units or cells of thunderstorms may be organized by wind pattern or by terrain into a line. A thunderstorm line, also known as a *squall line (or squall)* moves and behaves collectively and can have a longer lifespan.

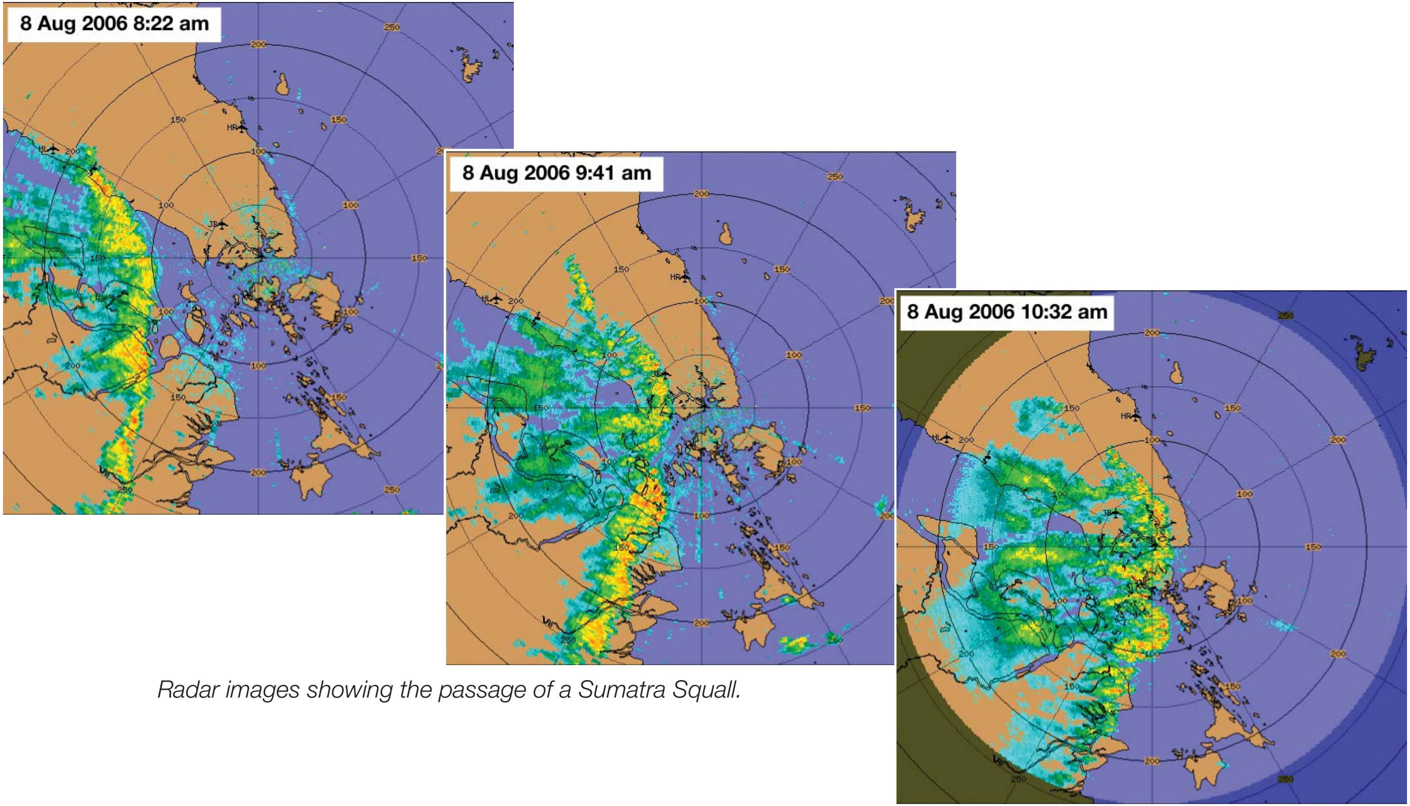
A *Sumatra Squall* is such an organised thunderstorm line that develops over Sumatra Island in Indonesia or the Straits of Malacca, often overnight, and then moves eastward to affect Peninsular Malaysia and Singapore. In a typical case, the squall line can bring about one to two hours of thundery showers. Often this happens in the predawn hours or morning. Some Sumatra Squalls are also accompanied by wind gusts of 40 to 80 km/h. Gusts are short-duration bursts of wind. Occasionally, such gusts are strong enough to uproot trees.

A Sumatra Squall approaching eastern Singapore on 4 July 2005

Sumatra Squalls can develop at any time of the year, but are uncommon during the Northeast Monsoon Season. Convergence of air streams at low levels (height of less than 1 km) over a large area is a pre-requisite for the development of a Sumatra Squall. Additionally, a general westerly wind above (between 2 to 4 km) blowing from Sumatra Island towards Singapore is needed to steer the squall line forward.



A satellite image showing a Sumatra Squall affecting Singapore and southern Peninsular Malaysia

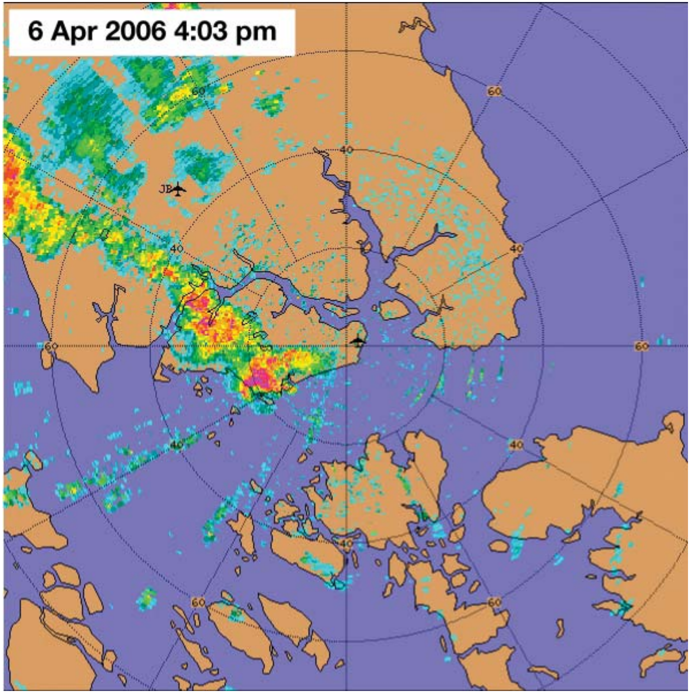


Radar images showing the passage of a Sumatra Squall.

Sea Breeze Induced Thunderstorms

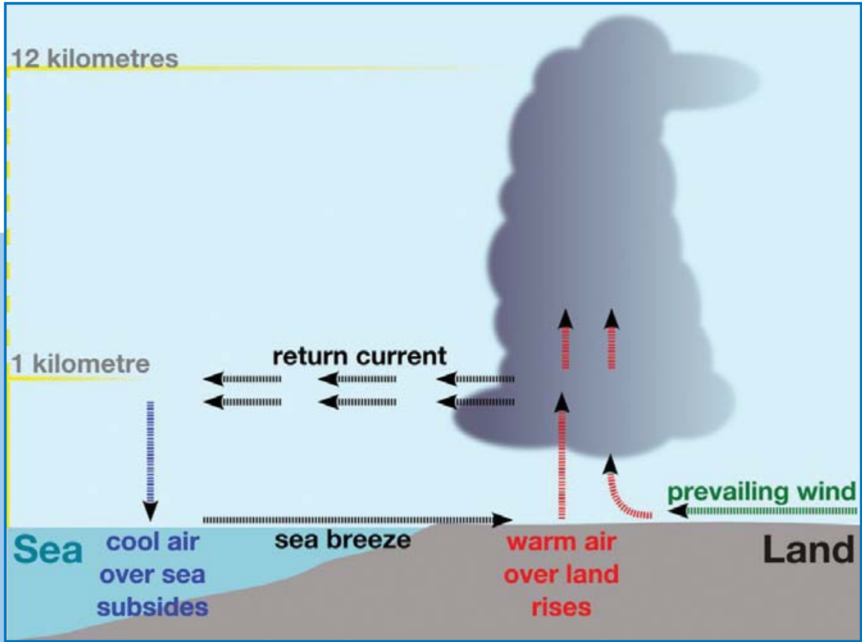
Sea breezes are winds formed as a result of temperature differences between land and the adjoining sea. As the day progresses, the land gets heated rapidly by the sun. Sea surface temperature increases less as water has a large heat capacity and heat absorbed is being mixed downwards. When hot air rises over the land, cool air immediately above the sea moves inland to fill the void. Above, typically at a height of half to one kilometre, air returns seaward and cools. Finally the air subsides. The sea breeze circulation is then complete.

The strength of a sea breeze depends directly on the temperature difference between the land and the sea. It is common for sea breezes to penetrate 40 to 80 km inland. One may expect sea breezes to form daily given the hot climate in Singapore, but this is not the case. The presence of a prevailing surface wind of more than 15 km/h is usually enough to overcome the formation of sea breezes. During the Inter-monsoon Periods when winds are light, sea breezes are more common.

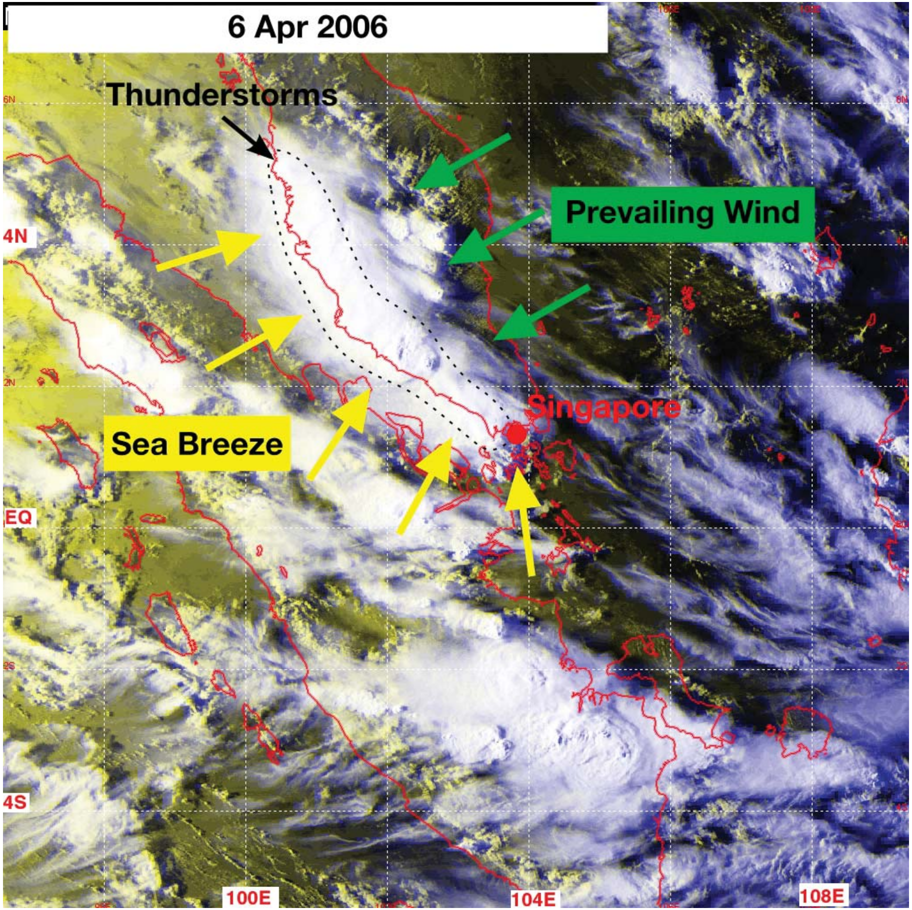


Radar image showing sea breeze induced thunderstorms over Singapore

Sea breezes can sometimes induce thunderstorms. The sea breeze and opposing light prevailing wind could collide or converge to initiate a vigorous uplift of air. As sea breezes are perpendicular to the coastline, the induced thunderstorms usually align roughly with the coastline. In Singapore, this mechanism contributes to produce some of the most severe thunderstorms in the late afternoon.



The collision of sea breeze and the prevailing wind helps to initiate thunderstorms.

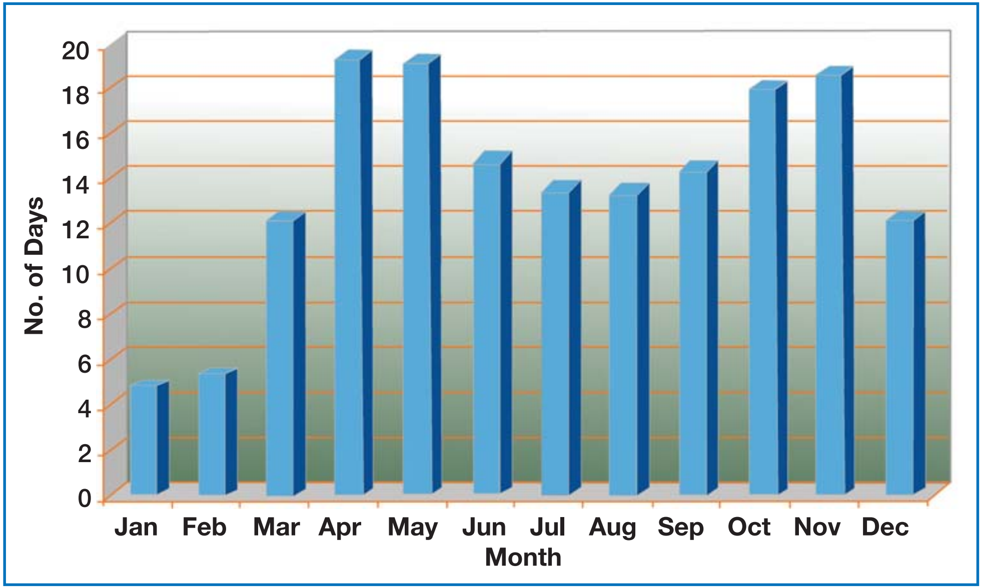


Satellite image showing sea breeze induced thunderstorms forming a "front" aligned along the western coast of Peninsular Malaysia and Singapore

Lightning

Lightning is the visible discharge produced by a thunderstorm. Cloud-to-cloud lightning can occur between two separate clouds (inter-cloud lightning) or within a single cloud (intra-cloud lightning). Intra-cloud lightning is the most frequently occurring type of lightning. The second most common type of lightning is cloud-to-ground lightning, which poses the greatest threat to life and property.

At any given moment, there can be as many as 2000 thunderstorms occurring across the globe. Singapore has one of the highest rates of lightning activity in the world. For the 27 year period from 1982 – 2008, the monthly distribution of mean thunder days shows a peak in April/May and October/November, with at least 18 thunder days each. January and February are the months with the least number of thunder days.



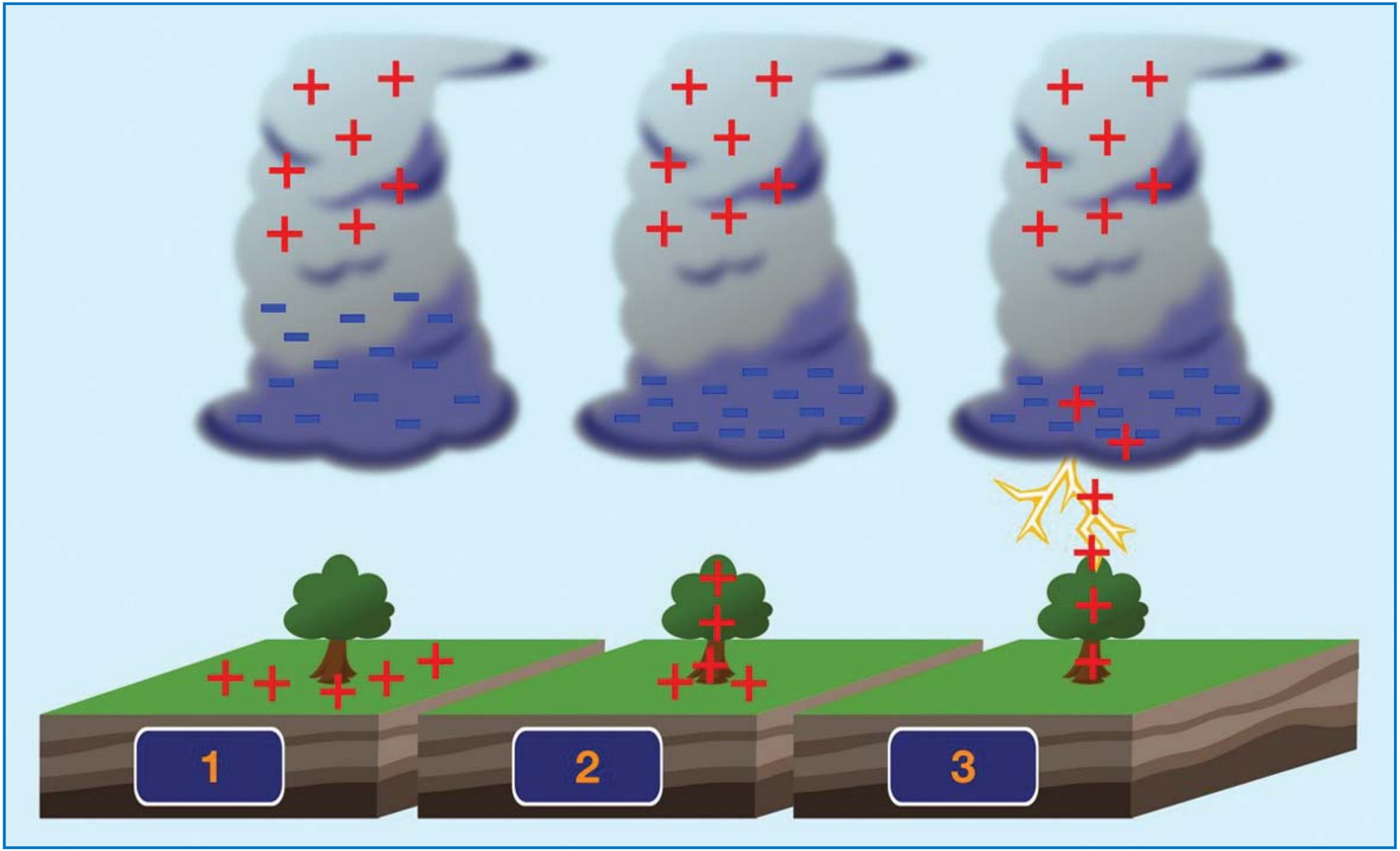
Average number of thunder days for the 27 year period 1982 – 2008. Thunder day: a day when thunder is heard at least once.

Most of the cloud-to-ground lightning is initiated by downward moving negative charges. The formation process of negative-stroke lightning is as follows:

1) Due to the action of rising and descending air as well as the distribution of water and ice particles, the charges in a thunderstorm are separated such that positive charges are at the top and negative charges are below. The negative charge at the bottom of the cloud induces a positive charge on the ground.

2) Once the negative charge at the bottom of the cloud gets large enough to overcome air resistance, lightning occurs. A channel of negative charge, called a "stepped leader", will descend from the bottom of the cloud towards the ground. The positive charges of the ground are attracted to this stepped leader. Upward moving charges or streamers from some elevated point on the ground move up to meet the stepped leader, opening a channel for flow of charges.

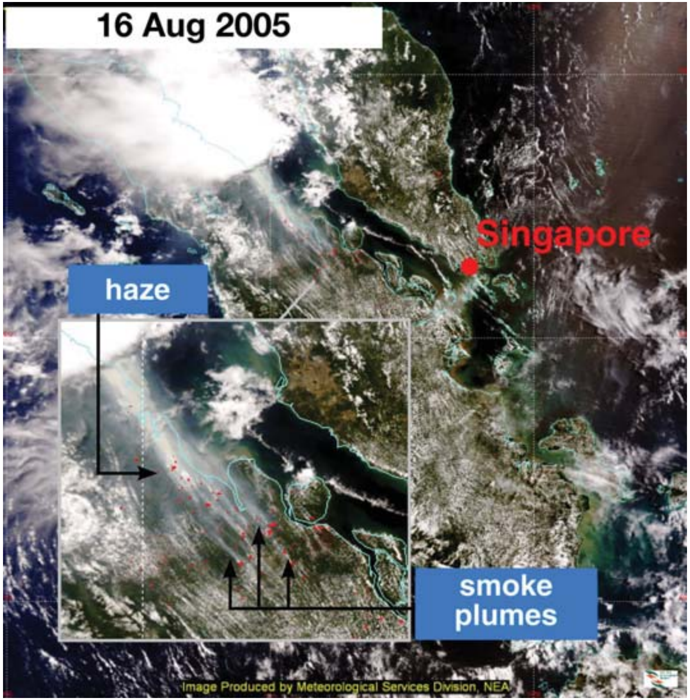
3) A large current wave propagates as a bright pulse up the channel – return stroke. The combination of the leader and the return stroke is known as a stroke. A cloud-to-ground flash may consist of one or up to a few tens of strokes passing the same channel.



Formation of a negative-stroke lightning flash. (A small percentage of lightning is due to positive strokes.)

Smoke Haze

The subtropics are generally dry because of the presence of the subtropical high pressure and associated subsiding air (see Subtropical High Pressure section). During the period of May to September, the southern Southeast Asia normally experiences its dry season. The southeasterly winds prevailing during this period originate from the dry subtropics in the southern hemisphere. Under this dry condition, isolated forest fires are common. Sometimes, smoke haze from the fires can be carried by the wind to places quite far away.



Satellite image showing smoke/haze. The inset is a zoom-in view showing "hot spots" and smoke plumes.

The phenomenon *El Niño* involves both the ocean and the atmosphere. Historically, it has occurred at irregular intervals of 2-7 years. Each episode may last for 1 to 2 years. During El Niño years, rainfall over the tropical eastern Pacific Ocean is enhanced because of abnormally warm waters. In contrast, rainfall in the tropical Western Pacific such as Indonesia is subdued.

During El Niño years, the dry season normally occurring between May and September in the region becomes more severe as experienced in the years 1994 and 1997, leading to more extensive forest fires.

A day with moderate haze (visibility about 4000 m) in Singapore.

Waterspout

A waterspout is a short-lived weather phenomenon seen occasionally over the coastal waters of Singapore. They are small, with an average size of 10 to 100 metres wide. They are awesome, similar in appearance to its more intense cousin the *tornado*. Tornadoes can occur over both land and sea but waterspouts only form over the sea. They usually dissipate rapidly on reaching the coast. The lifespan of a waterspout varies from a few minutes to perhaps half an hour. While the thin column or funnel appears to be sucking water up, it is actually water droplets in a rotating vortex of air. As the air rotates and rises, the humid air cools and vapour condenses, making the whirling mass visible.

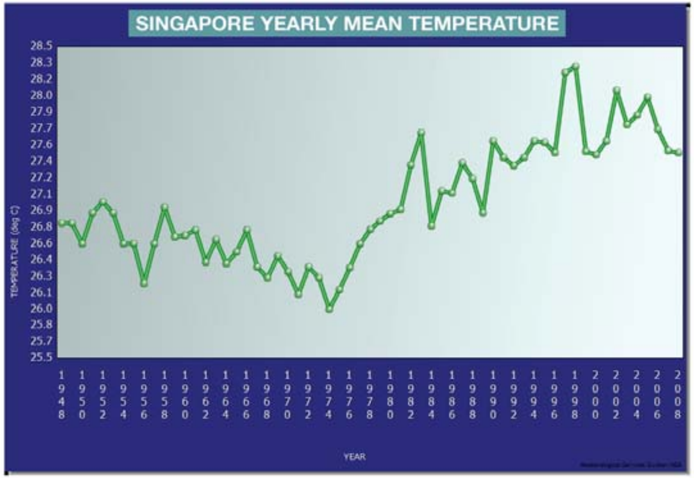
Waterspouts typically form beneath rapidly developing tall cumulus or cumulonimbus clouds over warm coastal waters just before the showers begin. They are often seen coming down from the clouds. Some do not seem to reach sea and they are known as funnel clouds. There has not been any direct measurement of the wind speeds of the waterspouts seen in Singapore. However, based on indirect estimate by radar, a wind speed of 100 km/h is possible in some cases. Much higher wind speeds have been reported for waterspouts occurring elsewhere.

A waterspout seen from a high-rise building, looking towards the south.

Warmer Climate

Singapore has become warmer since the 1940s. The plotted mean yearly temperature for Singapore for the period 1948 – 2008 shows an increase of 0.25 degrees Celsius per decade. This change is in tandem with the increase in temperature recorded in many places around the world – a phenomenon known as global warming. Global warming has been attributed to the increase of greenhouse gases (e.g. carbon dioxide) in the atmosphere, which is largely due to human activities such as the burning of fossil fuels.

Apart from global warming, urbanisation is also a factor contributing to warmer climate in Singapore. Urban built-up areas absorb more heat during the day than vegetated rural places.



Air temperature measurements were made hourly. All hourly measurements made in a year are averaged to give the yearly mean temperature.

At night, concrete high-rises in an urban area limit the view of the sky from the ground, making cooling by radiation to the sky less effective. Furthermore, while heat may be transported upwards by convection in the day, a stable layer of air may form near the earth's surface at night, thereby trapping heat in.

Seasonal Weather Features

Period	Prevailing Winds	Weather Features
Northeast Monsoon Season (December – early March)	Northerly to northeasterly winds 6 – 10 km/h	◆ Monsoon Surges cause widespread continuous moderate to heavy rain, at times with 25 – 35 km/h winds in the first half of the season. ◆ Rapid development of afternoon and early evening showers. ◆ Windy and relatively dry in the later part of the season.
Inter-monsoon Period (Late March – May)	Light and variable, interacting with land and sea breezes	◆ Thunderstorms, at times severe, occur in the afternoon and early evening. ◆ Hot afternoons are common (maximum temperature above 32°C).
Southwest Monsoon Season (June – September)	Southerly to southwesterly winds 6 – 10 km/h	◆ Occasional "Sumatra Squalls" with wind gusts of 40 - 80 km/h occuring between the predawn hours and midday. ◆ Short duration showers/thunderstorms in the afternoon are common.
Inter-monsoon Period (October – November)	Light and variable, interacting with land and sea breezes	◆ Thunderstorms, at times severe, occur in the afternoon and early evening. ◆ Generally wetter than the Inter-monsoon Period earlier in the year.

Monthly Weather Highlights

Month	General Weather Features
January	January can be very wet in some years and dry in others. It all depends on when the Northeast Monsoon transitions into the late (or dry) phase of the monsoon. *Wettest January : 818.6 mm (January 1893)* *Driest January : 15.4 mm (January 1997)* Average monthly rainfall is high. Still at the peak of the Northeast Monsoon, January is windy with winds blowing mainly from the north or northeast.
February	February is a relatively dry month in the year. A typical February still accumulates about 160 mm of rain on average. Occurrence of Northeast Monsoon surges during this month often results in rain to the south away from Singapore. February is generally windy, similar to January.
March	This month sees the transition of the Northeast Monsoon into the Inter-monsoon Period. Surface wind becomes increasingly light and showers/thunderstorms more frequent in the later part of the month. March may be noted for its hot afternoons. The climate-station's highest temperature of 36.0°C was recorded on 26 March 1998. Light winds, cloudless skies and more direct solar radiation are some of the contributing factors.

Month	General Weather Features
April	Winds are generally light and variable. Solar heating and sea-breezes aid in the development of some thundery and heavy showers in the afternoon. Occasionally, when wind changes to blow from the southeast or southwest, *Sumatra Squalls* may develop bringing widespread showers with gusty winds in the predawn hours and early morning. Like March, April is a relatively hot month.
May	Winds are generally light and variable, with increasingly persistent southeasterly winds. As in April, afternoon showers/thunderstorms are common with occasional occurrences of *Sumatra Squalls*.
June	The Southwest Monsoon Season is usually quite established by this month. Surface winds usually blow from the south or southeast. *Sumatras Squalls* are significant rain-bearing systems in June contributing to rainfall in the predawn hours and morning. Scattered showers and thunderstorms still occur in the afternoon occasionally. Overall rainfall for the month is usually less than that for April and May. Short periods of slightly hazy conditions may occur.

Month	General Weather Features
July	July is a relatively dry month in the year. There is still about 160 mm of monthly rain on average. General weather is similar to June.
August	The Southwest Monsoon is at its peak. A southerly or southeasterly wind of about 15-20 km/h is sometimes experienced in the afternoon (e.g. blowing onshore at East Coast). Weather pattern remains similar to June and July.
September	This is the last month of the Southwest Monsoon Season with generally weaker southeasterly/southerly wind compared to August. There is an increase in frequency of afternoon showers.

Month	General Weather Features
October	October is the beginning of the second Inter-monsoon Period of the year. It often marks the beginning of the rainy season which may last till January the following year. Monthly rainfall jumps more than 20 mm on the average from the September value. However, this is not Northeast Monsoon yet. Surface winds remain mostly light with afternoon thundery showers contributing to most of the rainfall. In some years, when *dry weather in the region persists* into October, episodes of hazy conditions may occur.
November	November is the second wettest month of the year. Winds are light initially and may turn temporarily to northwesterly or northeasterly. Heavy thunderstorms in the afternoon may extend into the evening. Though less common, monsoon rain may sometimes happen in November.
December	December is the wettest month of the year. Heavy thunderstorms occurring in the afternoon are common. In addition, surges of northeasterly monsoon winds may bring about windy conditions with widespread heavy rain. The rain may be continuous, lasting from a few days to more than a week.

Monthly Statistics of Climate Data

Temperature

Month	Mean Daily Min[1] (°C)	Daily Mean[2] (°C)	Mean Daily Max[3] (°C)
January	23.9	26.5	30.3
February	24.3	27.1	31.6
March	24.6	27.5	32.0
April	25.0	27.9	32.3
May	25.4	28.3	32.1
June	25.4	28.3	31.9
July	25.1	27.9	31.4
August	25.0	27.8	31.4
September	24.8	27.6	31.4
October	24.7	27.6	31.7
November	24.3	27.0	31.1
December	24.0	26.4	30.2

[1] Calculated by averaging the daily minimum temperature for each month for the 27 year period (1982 – 2008)
[2] Calculated by averaging the daily temperature for each month for the 27 year period (1982 – 2008)
[3] Calculated by averaging the daily maximum temperature for each month for the 27 year period (1982 – 2008)

Rainfall

Month	Mean Total Raindays[4]	Occurrence of highest hourly mean[5] (hrs)	Monthly mean[6] (mm)
January	13.8	1500	255.8
February	8.1	1700	107.4
March	12.7	1500	171.0
April	14.0	1700	151.2
May	13.2	1300	163.9
June	12.7	1400	132.3
July	13.2	1300	150.0
August	13.7	1300	151.9
September	13.3	1400	157.3
October	14.7	1400	158.8
November	18.0	1500	262.4
December	18.5	1700	329.5

[4] Calculated by averaging the total number of raindays for each month for the 27 year period (1982 – 2008)
[5] Time of day for which the mean rainfall occurs for each month for the 27 year period (1982 – 2008) is the highest
[6] Calculated by averaging the monthly total rainfall for each month for the 27 year period (1982 – 2008)

Surface Wind

Month	Direction	Mean speed (m/s)	Max gust speed (m/s)
January	N/NE	2.6	20.3
February	N/NE	2.8	17.8
March	N/NE	2.1	21.9
April	Variable	1.4	23.9
May	S/SE	1.5	18.1
June	S/SE	1.9	21.4
July	S/SE	2.3	23.9
August	S/SE	2.4	21.9
September	S/SE	1.9	21.4
October	Variable	1.4	20.3
November	Variable	1.3	21.1
December	N/NE	1.9	17.2

1 m/s = 1.94 knots = 3.6 km/h

Thunderstorms and Lightning

Month	Mean thunder days[7]	Mean lightning days[8]
January	4.8	5.9
February	5.3	5.0
March	12.1	13.9
April	19.4	22.4
May	19.2	22.1
June	15.0	17.4
July	13.6	14.5
August	13.5	12.3
September	14.6	13.5
October	18.0	19.6
November	18.7	23.5
December	12.3	15.7

[7] Calculated by averaging the total number of days thunder is heard for each month for the 27 year period (1982 – 2008)
[8] Calculated by averaging the total number of days lightning is detected for each month for the 27 year period (1982 – 2008)

Credits

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Rainfall charts

CAMS-OPI precipitation dataset:
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Wind flow charts

NCEP/NCAR Reanalysis wind data:
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Printed on recycled paper
Design and Layout by P D Addison

Location Address
Meteorological Services Division, NEA
Singapore Changi Airport
Passenger Terminal Building 2, South Finger,
#048-033
Singapore 819643

Mailing Address
Director-General,
Meteorological Services Division, NEA
PO Box 8, Singapore Changi Airport
Singapore 918141