

Vortices and related phenomena

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ABSTRACT

The terms 'whirlwind' (Indonesian *pusaran angin*, *angin puyuh*) and 'whirlpool' (Indonesian *pusaran air*) usually show up as definitions in our indigenous language dictionaries. However both the English and Indonesian terms can be ambiguous. In this paper I mention more than a dozen different natural phenomena that involve wind or water rotating about an axis—from tornadoes to fire whirls, from tidal maelstroms to river eddies—with the aim of helping us to write clearer, more precise definitions.

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Vortices and related phenomena ¹

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The terms *pusaran angin* and *angin puyuh* ‘whirlwind’ as well as *pusaran air* ‘whirlpool’ often show up as definitions in the dictionaries that we help compile for local languages. However both the English and Indonesian terms can be ambiguous. Does the local term that we gloss as ‘whirlwind’ include tornadoes or waterspouts? Typhoons? Dust devils? Does the local term that we have defined as *pusaran air* cover both whirlpools and eddies? Unfortunately our dictionaries can be, and often are, silent on such matters.

This guide looks at several different kinds of vortices or similar phenomena, with the aim of helping us to be more precise when writing definitions. I hope it will also lead you to investigate local terms for phenomena that you might otherwise not have thought about.

Tropical cyclones

A tropical cyclone is a type of large, rotating storm system with a low pressure center. They are characterized by their large size, high winds, heavy rains, and, when they make landfall, storm surge. Consequently they are some of the most destructive storms known to man. The term ‘tropical cyclone’ covers all of the following: tropical depression (winds up to 39 miles per hour), tropical storm (winds 40 to 74 miles per hour) and hurricane, typhoon, or cyclone (winds 75 miles per hour or above).

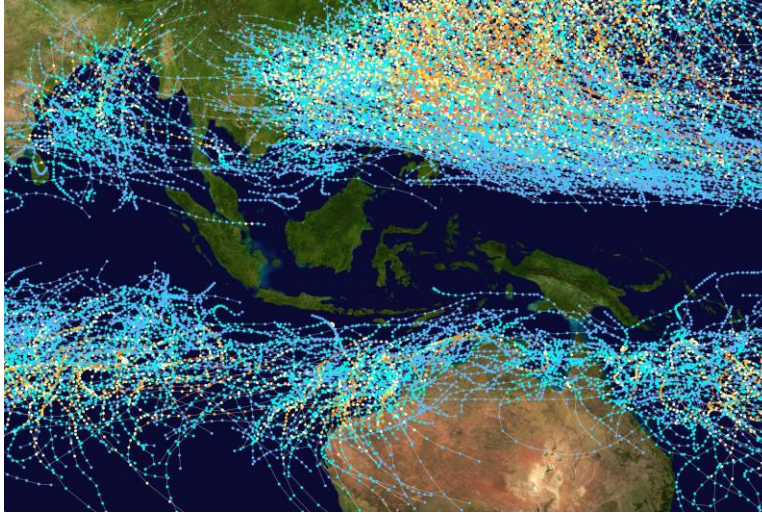


Pacific Ocean, September 15, 2007. Public Domain (NASA).

Tropical cyclones need warm sea water (80° F or above) to propagate, therefore it makes sense that they would form near the equator. However tropical storms also require a deflection effect from the earth’s rotation (called the coriolis force) to impart rotation, and this force is generally too weak within about four degrees of the equator. The image below, excerpted from “Map of the cumulative tracks of all tropical cyclones during the

¹ I want to thank Launa Maier, meteorologist, whose invaluable notes and enthusiastic response gave me the confidence to finish this paper. Any remaining errors are solely my responsibility.

1985–2005 time period,”² shows that, as expected, Indonesia remained (and remains) largely free of tropical cyclones. However tropical cyclones were doubtless known to Malay sailors and others who ventured westward to India, northward to the Philippines and China, or southward to Australia.



Excerpt from “Map of the cumulative tracks of all tropical cyclones during the 1985–2005 time period” Public Domain (NASA).

The Indonesian terms *siklon tropis* and *badai tropis* (and Malay *ribut tropika*) refer specifically to tropical cyclones. Other terms include *angin taufan*, *angin topan* and *badai topan*.³ Tropical cyclones can even be referred to in a general way as a *pusaran angin* and *angin puyuh*, although these terms are used as well of other kinds of weather phenomena.

Tornadoes

A funnel cloud is a high-velocity vortex that descends out of a cloud, and is associated with a strongly rotating core within the cloud itself. When the funnel cloud reaches land it becomes a tornado. The Indonesian term for both funnel clouds and tornadoes is *angin puting beliung*, or simply *puting beliung*. The literal reference of the term *puting beliung* is to the slender, tapering tang of the blade of a rotatory adze. Apparently in the shape of the tang Indonesians see a resemblance to funnel clouds.

² The full map can be viewed on the page “Always Something Brewing Year ’Round on NASA’s Hurricane Web Page” https://www.nasa.gov/mission_pages/hurricanes/features/hurricane_brew.html (accessed April 11, 2017).

³ English ‘typhoon’ as well as the Indonesian terms *topan* and *taufan* originate from Arabic *tūfān* ‘flood, inundation, deluge,’ but as used in the Indian Ocean referring to large cyclonic storms. The related Arabic verb *tāfa* means ‘to go about, make a circuit, circumambulate,’ said for example of the circumambulation (*tawāf*) of the Kaaba in Mecca. While Hakka *tai fung* and Cantonese *daai fung* both mean ‘big wind,’ these languages have rarely (and only lately) donated words to Malay or Indonesian. The Arabic origin is more secure.



Public Domain (NOAA).

The peak season for tornadoes in Indonesia is the month of January. For example for the period January 1 to February 12, 2016, the National Board for Disaster Management in Indonesia reported 103 tornado incidences, spread across seventeen different provinces (BNPB 2016). The following map,⁴ prepared in 2010, indicates the likelihood that an area of Indonesia might experience a tornado event.

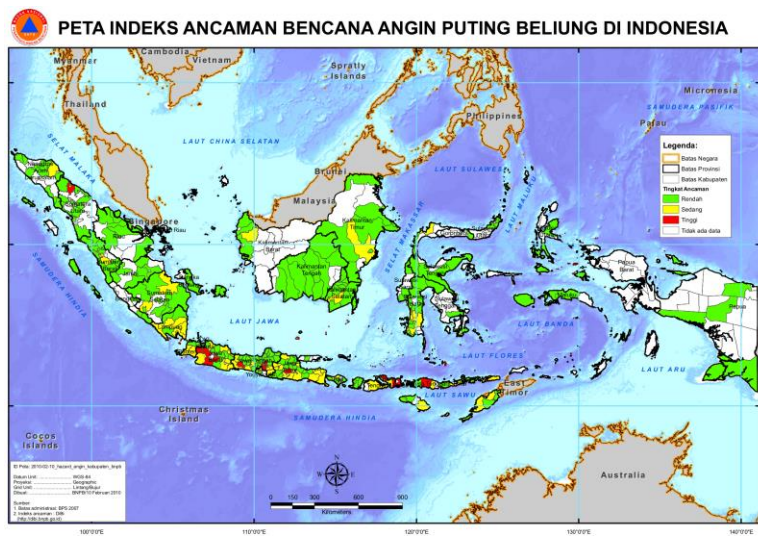


Image Credit: Badan Nasional Penanggulangan Bencana (BNPB).

Waterspouts

A common belief is that a waterspout is a tornado over water. Indeed some waterspouts are tornadic in nature, formed when a funnel cloud reaches the water's surface.

⁴ Online URL: http://geospasial.bnpb.go.id/wp-content/uploads/2010/02/2010-02-10_hazard_angin_kabupaten_bnpb.pdf (accessed April 14, 2017).



Tornadic waterspouts, Lake Michigan, September 12, 2013.
Photo Credit: Officer Michael Madsen, Kenosha Police Department.

However not all waterspouts are produced this way. In fact by far the more common type—called a fair-weather waterspout, non-tornadic waterspout, or true waterspout—usually forms along the leading edge of a line of towering cumulus clouds.



Non-tornadic waterspouts near the Hague, the Netherlands. © 2006
by Skatebiker at English Wikipedia. Released to the Public Domain.



Non-tornadic waterspout near Florida. Photo by Dr. Joseph Golden. Public Domain (NOAA).



Non-tornadic waterspout, Florida. Punta Gorda Police
Department via the U.S. National Weather Service (NWS).

A fair-weather waterspout first appears as a light-colored disc on the surface of the ocean surrounded by a darker area, indicating the end-point of an invisible funnel.⁵ This spot then develops into a donut-shaped spray ring. When wind speeds become strong enough the column itself begins to form. However what is thought to be water being sucked up from the surface is actually water from the (humid) atmosphere that is being condensed as the air rises and cools. Consequently the column of a fair-weather waterspout may appear hollow. Fair-weather waterspouts last from five to twenty minutes, and die away when cold air or rain descending from the storm overtakes the base of the waterspout, cutting off its supply of warm air. Wind speeds in fair-weather waterspouts can reach from 80 to 120 mph. However because of their compact wind field, short lifespan, occurrence over water, and (usually) slow forward motion, they only have a slight potential for doing damage.

Two Indonesian terms for waterspouts are *belalai air*, literally ‘water trunk, water snout,’ and *sengkayan*. Whether these terms can be matched to tornadic and fair-weather waterspouts is not known to me. Sometimes waterspouts are called *puting beliung*, that is, the same word used for ‘tornado’ (see above).

Landspouts

In 1985 the term ‘landspout’ was coined to describe phenomena similar to waterspouts that occur over land (Bluestein 1999:561). Not all landspouts are visible, and when they are they may have a hollow or translucent look. For this reason they are sometimes called dust-tube tornadoes. I do not know of a particular Indonesian term for landspouts.



Landspout near North Platte, Nebraska on 22 May 2004. Public Domain (NOAA).

Landspouts are associated with cloud fronts, and as such they should not be confused with dust devils (described below), which are a phenomenon of clear, sunny days.

⁵ The description of waterspout formation in this paragraph is summarized from Golden (1974).

Gustnadoes

Gustnadoes are short-lived whirlwinds that form along the gust front of a thunderstorm (or less commonly on the rear flank of a supercell). They are usually observed by the dust or other debris that they raise. Unlike landspouts (dust-tube tornadoes) and waterspouts, however, gustnadoes do not form a condensation funnel.



A gustnado in Jefferson County, Kansas on April 3, 2011. Public Domain (NWS).



A gustnado in southeastern Wisconsin on October 4, 2002. Public Domain (NOAA).

The English term gustnado is blended from ‘gust’ and ‘tornado.’ However gustnadoes have little in common with (supercellular) tornadoes either in terms of formation, longevity, or destructive force, although a few might cause light or moderate damage.

Gustnadoes (strong enough to damage houses) as well as smaller whirlwinds can be called *pusaran angin* and *angin puyuh*. From dictionaries note also *angin limbubu*, *angin selebubu* and *halimbubu*, although these may be regional terms.

Supercells

You could think of a supercell as an extremely well-organized thunderstorm. At its heart is a deep, persistent, tilted, rotating updraft (called a mesocyclone), which allows a supercell to self-propagate and potentially last for several hours.⁶ Supercells are associated with severe weather, including high winds, hail, and destructive tornadoes. From the ground a

⁶ When researching this topic, I appreciated Mersereau’s (2014) explanation of supercells, written for a general audience.

supercell may look like a large mass of rotating dark clouds.⁷ In Indonesian, a supercell could be described as *badai petir yang berputar*.



Supercell. Public Domain (NWS).



© 2005 by Ian Armstrong. CC BY-SA 2.0 Generic.

A question I had was, are all tornadoes associated with supercells? The answer is, it depends on how you define ‘tornado.’ And here there seems to be a mismatch between how the term is popularly used versus how it is defined by meteorologists. Going by the book, tornadoes can be broken down into two broad classes:

supercell tornado (also supercellular tornado) : associated with a strong rotation in the mid-level atmosphere, consequently they are relatively long lasting with high winds, and are well known for their destructive effects. These are the ‘tornadoes’ of popular imagination and the object of storm chasers. This category also includes tornadic waterspouts.

non-supercell tornado (also non-supercellular tornado, NST) : has low-level rotation only, a cover term for fair-weather waterspouts, landspouts, gustnadoes and dust devils. These are relatively short-lived phenomena that rarely have destructive effects (at most only F1 on the Fujita Tornado Damage Scale). Because they lack a clear radar signature, non-supercell tornadoes have also been more difficult to study.

⁷ For additional images there is no dearth of supercell videos on YouTube.

Hail

While on the topic of supercells, it seems best to make a small diversion and mention hail. Hail is produced in thunderstorms with strong updrafts. The Indonesian term for ‘hail’ is *hujan batu* or *hujan batu es*.⁸



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Although hail is less common in the tropics than in temperate zones, and hailstones are smaller (and may melt quickly), nonetheless we should probe whether the local language has a term for it. Michael Martens writes (January 18, 2014:pers.comm.):

I would never have guessed that Indonesian languages would have a term for ‘hail.’ But Uma does: *uda wua*’ literally ‘fruit rain.’ It hails in Kantewu about once every twenty years. I have also heard stories of hail in the Behoa area. I have found no other Kaili-Pamona language with a cognate, but there is Napu *uda au mawua* ‘rain that has fruit.’ So I reconstruct Proto Kaili-Pamona **uja-wua* ‘hail’ < PMP **quzan-buaq* ‘hail; hailstone.’

Although hail is more common in the tropical highlands, it can also occur at sea level.⁹

Downbursts

We are all familiar with the cycle of a thunderstorm as it builds up, the sky darkens, and finally the clouds unleash their rain. A downburst is a blast of rain-cooled air that descends from a thunderstorm during its dissipation phase.¹⁰ As it hits the ground the downburst spreads out in all directions. A strong downburst can produce damaging winds. A difference between a downburst and a tornado, however, is that damage from a downburst radiates outward, while damage from a tornado radiates inward, toward the center.

⁸ Next to *hujan es*, *hujan butiran es* ‘sleet’ and *pembekuan hujan* ‘freezing rain.’

⁹ See Frisby and Sansom (1967). For example in June 2016 a hail-producing storm hit Kuala Lumpur: *Sinar Harian Online* “KL dan Selangor Dilanda Hujan Batu” <http://www.sinarharian.com.my/semasa/kl-dan-selangor-dilanda-hujan-batu-1.528456> (accessed April 11, 2017).

¹⁰ Without going into detail, supercells have a different life cycle, and can produce a downburst without dissipating; see Mersereau (2014).



Downburst damage. Public Domain (NOAA).

I do not know of a specific term for ‘downburst’ in Indonesian. It could be described as *hembusan angin dingin dari awan*. A somewhat lengthy but more precise description might run *udara yang didinginkan oleh hujan turun terhempas ke bumi lalu menyebar ke semua arah menyebabkan angin kencang*.

Foehn winds

A foehn wind, also föhn wind, *angin fohn*, is a dry and relatively hot wind that flows down off the slopes of mountains. Foehn winds result when humid air drops its moisture as it ascends the windward slope of a mountain range, then descends, drier and hotter, on the leeward side. The so-called chinook winds of the western U.S. and Canada are a type of foehn wind.

Foehn winds are relatively straight winds, without rotation. The reason I mention them in this guide is because during certain times of the year foehn winds are also prone to occur in Indonesia. The name given to such winds often has a local flavor, for example:¹¹

angin bohorok (Deli, North Sumatra)
angin kumbang (Cirebon, West Java)
angin gending (Pasuruan, East Java)
angin brubu (Makassar, South Sulawesi)
angin wambraw (Biak, Irian Jaya)

Besides *angin fohn*, this kind of wind could be further described in Indonesian as *angin yang bertiup kuat dan kering serta panas*.

Dust whirls

Dust whirls are rotating columns of air that are visible mainly because of the dust they send swirling into the air. They are created on clear, calm, sunny days when hot ground

¹¹ Wikipedia *Ensiklopedia Bebas*, s.v. “Angin fohn” https://id.wikipedia.org/wiki/Angin_fohn (accessed April 11, 2017).

heats the air immediately above it, creating a column of warm, rising air. Dust whirls range from ten to a hundred feet wide, and are rarely dangerous or destructive.



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A particularly strong, vigorous dust whirl can be called as dust devil. The usual Indonesian term for dust whirls and dust devils is *pusaran debu*.



Dust devil in Arizona. Public Domain (NASA).

Fire whirls

A fire whirl, *pusaran api*, is a whirlwind created by heat rising from a fire, sometimes in combination with surface winds. A fire whirl can also include smoke and ash, and can suck in burning debris.



Public Domain (United States Marine Corps).

Fire whirls are also colloquially known in English as fire devils, fire twisters, firenadoes, and fire tornadoes, although the last term is technically incorrect.

Wind eddies

A wind eddy or eddying wind is wind that swirls around on the sheltered side of an obstruction such as a building or rough terrain. The size of the eddy is proportional to wind speed and the size of the obstruction.¹² Although I don't have a picture of a wind eddy, think for example of walking down a city street on a blustery day, and seeing wind pick up leaves or other bits of debris and swirl it around.¹³

I have not come across a specific term for such wind eddies in Indonesian. They could perhaps be described as *pusaran angin kecil* or *putaran angin*. The same terms used to describe gustnadoes (see above) could probably also be used for wind eddies.

Smoke swirls

I was unable to discover a specific Indonesian term that describes the lazy, wispy swirls of smoke that rise from, say, a burning cigarette in a still room, but it could be described as *asap yang bergerak ke atas secara rawak*. The swirls are formed by turbulence as the hot fumes attempt to change places with the cooler air above it.



Public Domain (Pixabay).

The terms *gumpalan asap* and *asap berkepul-kepul* refer more to billowing smoke rather than gentle swirls.

¹² This kind of eddy is the result of a localized pressure irregularity. Wind eddies can develop from other factors, such as temperature contrasts or variations in wind currents. Even ocean currents can produce wind eddies. However many of these eddies occur on a large scale and/or in the atmosphere, and thus are usually invisible to the unaided human observer.

¹³ For a nice example, see the YouTube video “Detik-detik terjadinya Angin puyuh menyerang aksi 4 desember 2016” posted at https://www.youtube.com/watch?v=XUd_HWc4vCI (accessed April 11, 2017).

Eddies

The Indonesian term *pusaran air* is ambiguous, referring to eddies in rivers, to small whirlpools such as may be formed in a draining container, and to large tidal whirlpools, also called maelstroms. If you use the term *pusaran air* you should be careful to further define it.

An eddy is a reverse current that is formed when the water of a fast-flowing stream or river flows past an obstacle. As water flows into the void behind the obstruction it creates a swirl in which the water reverses course and flows toward the back of the object. Eddies are common along banks. If an obstruction is located in the middle of the river, eddies will be formed on both sides.



Swirling eddy, Clackamas River, Oregon. Photo courtesy of <http://eng.namonitor.ru>. Used with permission.

Indonesian terms that I've encountered for eddies include *pusaran air*, *pusaran arus*, *arus olakan*, *air berolak*, *air berpusing*, and *kisaran air*.

For the same reasons, eddying may also be observed on shorelines where rocks or other obstructions impede incoming or outgoing waves, but these eddies and swirls are more temporary in nature.



© 2012 by Francis Gimenez. CC BY 2.0Generic.

The Indonesian term *gelora* (verb form *bergelora*) refers to seething turbulence and by extension to violent passion.

Maelstroms

The word maelstrom¹⁴ refers to a powerful eddy or whirlpool produced by the interaction of tidal currents and certain geographic features such as a confined strait or a peculiar shape of the seabed. Although the size and effects of maelstroms have been exaggerated in literature and film, they nonetheless can pose dangers to small boats.



The Corryvreckan Whirlpool. © 2011 by Walter Baxter. CC BY-SA 2.0 Generic.

One of the most famous maelstroms is the Moskstaumen, which forms off the northwestern coast of Norway and was the subject of Edgar Allen Poe's short story, "Descent into the Maelstrom." In the Bird's Head of western New Guinea, Indonesia, the narrow channel that connects Arguni Bay to the sea is known for its dangerous whirlpools that form regularly as tide waters enter and exit. I was surprised to learn that people of northern Buton Island knew of maelstroms in their area. Dangerous whirlpools form rarely, they told me—only during times of heavy flooding on land—and can capsize boats.

In Indonesian, a maelstrom could be defined as *pusaran air laut*, *arus laut yang berpusar dan bahaya*.

Whirlpools

Small-scale whirlpools can be observed in kitchen sinks and bathtubs. Somewhat larger ones may be seen in ponds or lakes when excess water drains through a pipe or culvert. Unlike eddies and most maelstroms, these whirlpools are true vortex phenomena, since there is an actual downward flow (downdraft) of fluid.

¹⁴ The term was coined by Dutch sailors from *maalen* 'to grind, whirl' and *stroom* 'stream, current,' originally in reference to a mythical whirlpool in the arctic ocean.



A small whirlpool in a pond. © 2011 by Shutinc. CC BY-SA 3.0 Unported.

Hair whorls

A hair whorl is a natural part of human anatomy. It is the point or axis on the back of the head around which hairs change direction. In English it is also known as a cowlick. In Indonesian it can be defined as *unyeng-unyeng*, *pusaran rambut di atas kepala*. In some languages of Indonesia, the local word for whirlwind or whirlpool also includes hair whorls in its reference.



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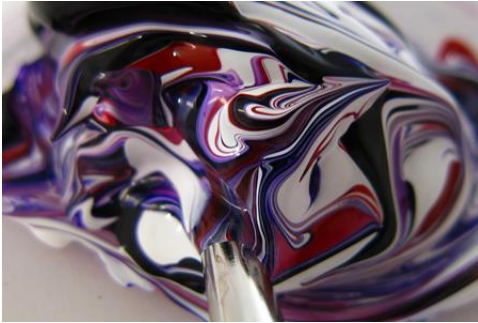
When eliciting this term, you may also want to check whether there are beliefs about persons that have more than one hair whorl. At the same time it would be good to contrastively elicit related terms such as fontanelle (the soft spot on top of a baby's head, later closed by bone, Indonesian *ubun-ubun*, *bagian lunak di atas kepala bayi*), crown (topmost part of the head, Indonesian *ubun-ubun*, *bagian puncak kepala*, *mercu kepala*), and hair bun (*sanggul*, *gelung rambut perempuan di atas kepala*).

Swirl (pattern)

We have all seen swirl patterns—for example when a batter is mixed or a pot is stirred. In the pictures below, the swirl pattern is enhanced by mixing different colors.



Swirly cake batter. © 2011 by Selena N. B. H. CC BY 2.0 Generic.



Acrylic paints swirling together as they are mixed.
© Nikki L. at Flickr. CC BY 2.0 Generic.



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Spiral (pattern)

Finally, you may wish to investigate terms that describe a spiral pattern or shape (*pilin*, *lingkaran spiral*). Here are three examples of spiral-shaped objects from nature, one from art, and two from manufacturing.



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Public Domain (Pixabay)



Spiral patterns on a Torajan *tongkonan* house. © 2005 by Kars Alfrink. CC BY 2.0 Generic.



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