763.526

LIGHTNING IN AUSTRIA

ANNUAL REVIEW 2015

UBIMET WEATHER MATTERS

EXECUTIVE SUMMARY

In 2015, there were 763.526 lightning strikes in Austria detected by UBIMET's lightning detection system powered by nowcast. The hot spot was Styria, where approximately 30% of all lightning strikes were registered. Here, you can also find the area with the most thunderstorms over the course of the year; Graz and its surrounding villages. The peak of the thunderstorm season was in summer, with July being the most thundery month. The most intense lightning strike of the year hit Kramsach in Tyrol, and it reached a current rating of 399.000 ampere.

In total, there were

>760.000

lightning strikes in Austria

In total, it was thundery on 142 days in Austria. Tyrol was the leading province with days of thunder, followed by Carinthia and Styria.

Styria

is the province with the most lightning strikes in 2015

Province	Days of thunder
Tyrol	88
Carinthia	88
Styria	86
Salzburg	78
Lower Austria	75

Comparing the number of lightning strikes in 2015 with the number of strikes from past years since 2009 shows that 2015 was an average year. For example, looking back at 2014 shows that only 442.303 lightning strikes were registered, while the most intense years of 2009 and 2012 hit the 1-million mark. Interestingly, in 2009 more than 350.000 lightning strikes were registered just in Styria which is nearly the total number of strikes registered from the whole country in 2014.

Year	Number of Lightning Strikes in Austria
2015	763.526
2014	442.303
2013	452.167
2012	1.067.930
2011	665.570
2010	939.570
2009	1.003.171

A

Most intense lightning strike in Tyrol with nearly

399.000

AMPERE

LIGHTNING STRIKES IN AUSTRIA: DETAILS 2015

In the time from the 1st of January to the 31st of December 2015, exactly 763.526 lightning strikes hit the Austrian national territory. The lightning hot spot was the mountainous area within Styria. Since 2009, Styria has been the province with the most lightning strikes recorded. Almost one third of all lightning strikes in 2015 were registered here, followed by Tyrol with 160.000 lightning strikes. In contrast, only 223 lightning strikes were registered in Vienna. "Thus, together with Weinviertel and Burgenland, the capital is Austria's least active thunderstorm region", says UBIMET-meteorologist Josef Lukas. The reason for a less active thunderstorm season in the flatlands is a result of high pressure which dominated the area during the summer months. As a consequence, there was a lack of thunderstorms in the lowlands. "In the mountains, warm and partly humid air of Mediterranean origin caused several thunderstorms, some of which were accompanied by flash floods and big hail", says Lukas. As a result of the stronger thunderstorms, flash floods and landslides were the consequence, for example on the 8th of June in the Tyrolian Sellrain and Paznaun Valley, where big parts of the valleys were devastated.

Province	Number of lightning strikes
Styria	224.247
Tyrol	166.624
Carinthia	97.294
Upper Austria	87.197
Salzburg	84.149
Lower Austria	55.080
Vorarlberg	32.692
Burgenland	16.020
Vienna	223

LIGHTNING DENSITY*

Province	Density
Styria	13,67
Tyrol	13,18
Vorarlberg	12,53
Salzburg	11,76
Carinthia	10,20
Upper Austria	7,28
Burgenland	4,04
Lower Austria	2,87
Vienna	0,54

* Number of lightning strikes per km²

Another way to interpret lightning data is to look at lightning density, which is the number of lightning strikes per square kilometer. The lightning density statistics for Styria show that province was at the top with nearly 14 lightning strikes per square kilometer, followed by Tyrol with 13. The region with the least lightning strikes per square kilometer is once again Vienna, where only every 2nd square kilometer was hit by a lightning strike.

"This method has the added advantage to take into account the size of the provinces; therefore, this value is more realistic for a direct comparison", says Lukas. Compared with the more active year of 2009, the number of 13.67 lightning strikes per square kilometer in Styria is relatively low. In 2009, 21 lightning strikes per square kilometer were monitored. "These facts manifest once more how different a year of thunderstorms can be", mentions Lukas.

+++ ADDITIONAL INFORMATION +++

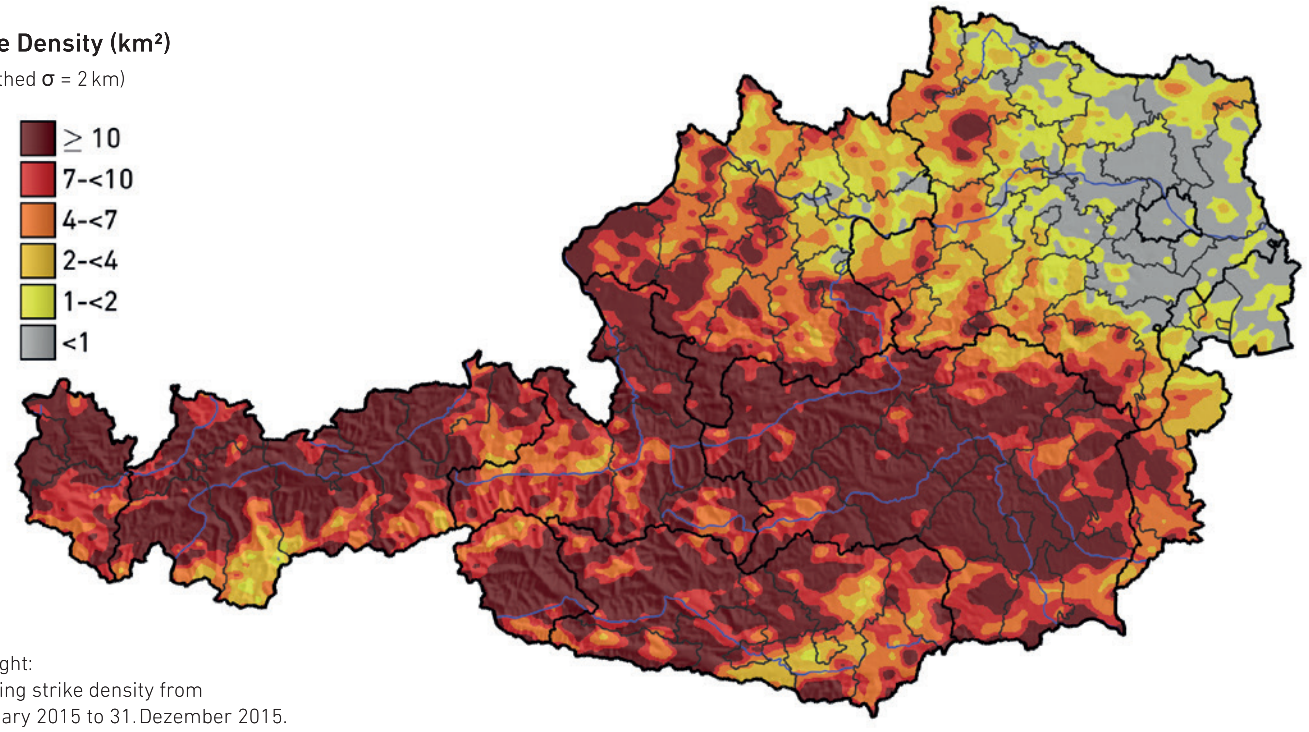
GRAZ AREA 2015

THUNDERSTORM HOT SPOT AUSTRIA

The leading district with a total of 21 lightning strikes per square kilometer is Graz-Umgebung, followed closely by the city Graz itself with 19 lightning strikes per square kilometer. "This means that the surrounding area of Graz was the thunderstorm hot spot in 2015", according to Lukas. Looking at the number of lightning strikes per district, Liezen is ahead with 46,131 lightning strikes. In second is the province Spittal, but with almost 10,000 less lightning strikes than in Graz.

Strike Density (km²)

(smoothed σ = 2 km)



Map right:
Lightning strike density from
1.January 2015 to 31.Dezember 2015.
(Source: UBIMET)

420.000 LIGHTNING DISCHARGES IN SUMMER

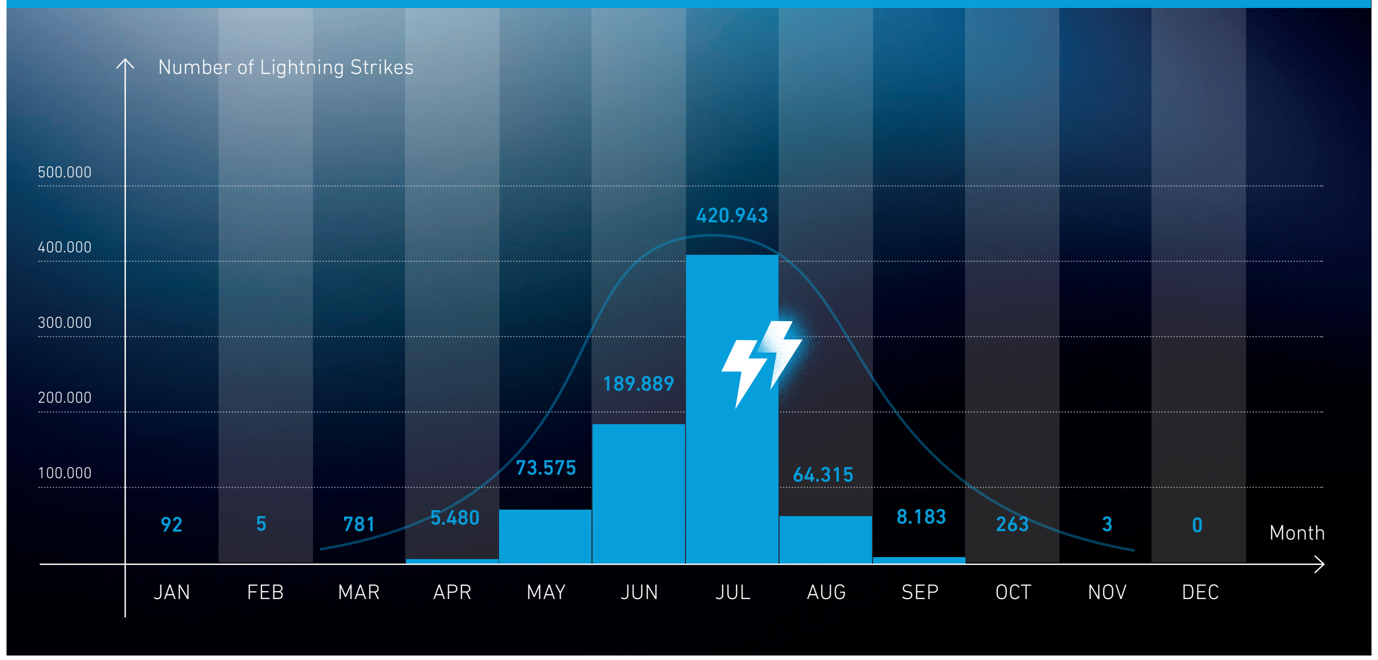
Like every year, the peak of thunderstorm activity was during the summer time. 420.000 lightning strikes were registered in just July across Austria. "Thus, closely as many lightning strikes were registered in July 2015 as in 2014 overall", says Lukas. "At that time, the in house lightning detection system registered about 440.000 lightning strikes." Compared to July 2015, August was relatively calm. Only a few thunderstorms developed in the typical severe weather regions at the eastern edge of the Alps. However, in nearly every month of 2015 there were lightning discharges measured. The only exception was in December when no lightning strikes were detected. Compared to previous years, this is not an unusual trend.

Historically, November to February is the calmest time period for thunderstorm activity. A shorter duration of sunshine, often wintry temperatures, snow cover and a low solar altitude all contribute to mitigate the development of thunderstorms. Is this happening though, it is often connected with the passage of an intense cold front or with strong snow, rain or graupel showers.

July

was the month with most lightning strikes in 2015

NUMBER OF LIGHTNING STRIKES IN 2015 – SPLIT BY MONTH



Hail

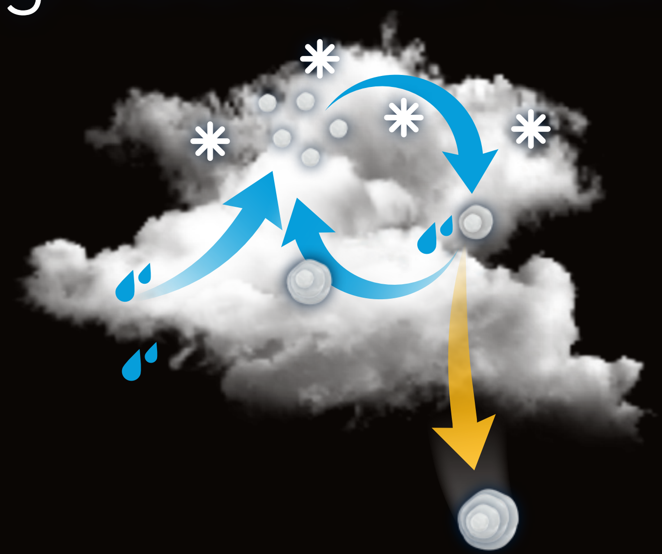
BACKGROUND KNOWLEDGE

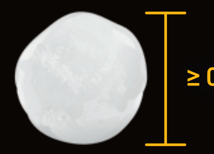
Hail is nearly inseparably linked to severe thunderstorms in summer. The so called hail hot spots are located across the southern and eastern parts of Styria, the southern and central parts of Burgenland and the northern foothills of the Alps. In general, hail is possible anywhere in Austria and may cause immense damage especially to agriculture.

A hailstone can grow to a size of a few centimeters of diameter, and only very rarely do hailstones get bigger than five centimeter in the alpine region. The biggest hailstone ever recorded in Austria dates back to the evening of the 23rd of July 2009 in the Salzburgian Flachgau. Hailstones with diameters up to 8cm fell and caused immense damage, including injuries to people.

Big hailstones can have speeds up to 120 kph on their way down to earth. Strong thunderstorms containing large and ruinous hail depend on the weather environment that the thunderstorm has formed over. Quite often, large hail occurs in long living and severe thunderstorms which grow in humid and hot air rich of energy. While much more infrequent, big hail with a diameter of more than 3 cm is typically connected to organized, fast moving thunderstorm lines that also contain the threat of damaging winds.

What are the Ingredients for Hail?



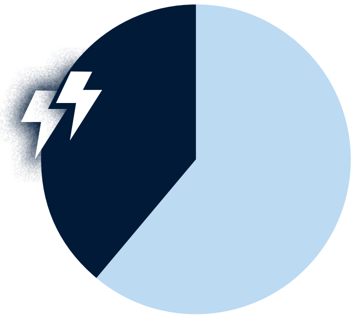


Hail is frozen precipitation that usually contains a diameter bigger than 0.5 cm. Turbulence in the inner part of a thunderstorm results in fast up-and-down circulation of precipitation particles. Alternating freezing and thawing processes and collisions with other water droplets or hailstones result in growing of a hailstone. This process continues until the hailstone becomes too heavy to remain in the cloud and it can no longer be drawn back up through a cloud. Thereafter, the hailstone falls to the ground.

DAYS WITH LIGHTNING STRIKES

With 142 days of lightning strikes, 2015 is a lower midrange year. 130 to 180 thunderstorm days are normal in Austria over a given year. Carinthia and Tyrol were the provinces with the most days of thunder, followed by Styria. Once more, Vienna saw the least number of thundery days with just 14.

142 / 365



Days of thunder (Austria, 2015)

Province	Days of thunder*
Carinthia, Tyrol	88
Styria	86
Salzburg	78
Lower Austria	75
Upper Austria	72
Vorarlberg	56
Burgenland	55
Vienna	14

* X out of 365 in the year 2015

INTENSITY OF LIGHTNING STRIKES

The intensity of lightning strikes is measured by amperage with its units being the ampere. "In 2015 the most intense lightning strike was registered on the 6th of June in Kramsach, Tyrol with nearly 399.000 ampere, approximately 25.000 times more than the amperage of a commercial plug socket with 16 Ampere", say UBIMET's expert.

In this correlation, it is important to mention that not every lightning strike causes such a high amperage. The Austrian mean amperage of a lightning strike in 2015 is comparatively low at 7.540 ampere. The intensity of lightning strikes depend on the polarity, which may be positive or negative. A negative poled lightning strike conducts negative charging from the bottom of a cloud to the ground, while a positive poled lightning strike transports positive charging. The latter occurs in only 5 percent of cases, but it can reach amperage up to 300.000 ampere. "That's why a positive lightning strike is much more dangerous than a negative one", explains Lukas. "Quite often you can determine a positive lightning strike by its long lasting and strong discharging from ground to cloud." Negative strokes are much less powerful and seldom exceed an amperage of 20.000 ampere. "Regarding the mean absolute amperage of a stroke of 7.540 ampere, it can be concluded that negative lightning strikes are much more frequent", say Lukas.

How do Lightning Strikes form?

BACKGROUND KNOWLEDGE

1. Essentially, lightning strikes are the result of voltage releases between the cloud and the ground. The high voltage originates from the friction of ice crystals in the upper part of the cloud and water droplets a bit lower in the atmosphere. Thus, ice crystals become positive and water droplets negatively loaded. This difference of voltage ends up in a further growth of voltage, which releases in the form of lighting.

2. Lightning strikes occur both within a cloud and from a cloud to the ground. The procedure for each strike is always the same. First, an invisible channel establishes where the lightning strike is able to propagate within parts of a second. Then just before hitting the ground, a so called fishing amperage (German: Fangladung) approaches from the ground. The lightning strike then heats the surrounding air up to 30.000 degrees Celsius which then results in a shock wave. The shock wave is heard as thunder.

3. Lightning and thunder always occur at the same time, but due to the different velocities of light and sound, an observer notices the lightning strike first before hearing the thunder. "This fact can be used as a measurement for the distance of the thunderstorm", says the meteorologist. "The general rule is: for every second between lightning and thunder the distance grows 333 m." For example 18 seconds between a lightning strike and a clap of thunder means that the thunderstorm is 6 km away from the observer.

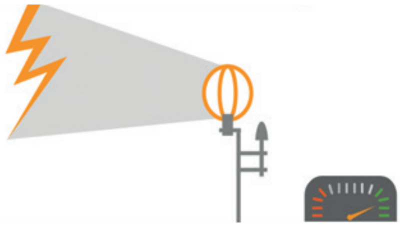
Hazards & Code of Conduct

A lightning strike is life-threatening. Not only do the the hazards of burns and cardiac arrhythmia exist, but in the worst case a cardiac arrest can occur. Even a low amperage of 0.03 to 0.08 ampere can lead to a ventricular fibrillation and more than 3 ampere already cause burns. Therefore, a lightning strike often leads to death. **The best protection against lightning strikes is the inside of cars or buildings. Open and exposed locations** like hills or mountain tops should be **avoided** when lightning is near. The same applies to water or swimming pools. Because the lightning always takes its shortest path, care should be taken to **minimize the step voltage and the contact area to the ground.** Therefore, the best position is to put your feet together, crouch down, put the arms close to your body and come up on your toes.

LIGHTNING DETECTION FROM UBIMET POWERED BY NOWCAST

In general, lightning detection is based on electromagnetic waves. Once the electromagnetic waves organize above a specific intensity threshold, the measurement system registers the lightning strike. The lightning detection system of UBIMET powered by nowcast detects lightning strikes already from an amperage of 3 Ampere. A lightning strike is gathered from multiple sensors, and a mathematical algorithm calculates the position right up to within 75 meters of the actual strike. As a result, this system is one of the most accurate worldwide. Additionally, it is able to detect even small discharges whereas other lightning detection systems cannot. "This precise lightning information is vital for the prediction of severe storms", explains Lukas. "The more precise the lightning information, the better the forecast of intensity, track and speed of storms and corresponding warnings will be." Additionally, the UBIMET lightning detection powered by nowcast distinguishes between cloud-to-cloud and cloud-to-ground lightnings with a patented 3-D technology. The cloud-to-cloud lightning takes place within a cloud or between clouds, whereas the cloud-to-ground lightning occurs between the earth's surface and the bottom of the cloud. www.nowcast.de

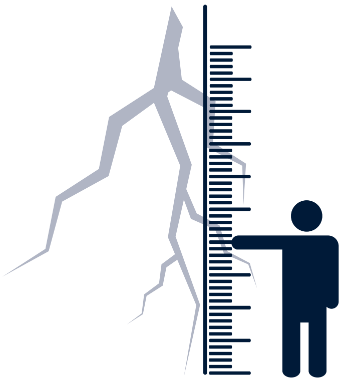
Top: Working nowcast technology; Below: nowcast antenna design (Source: nowcast GmbH)



HEIGHT OF THE LIGHTNING

To judge the strength and characteristics even better, the UBIMET lightning detection system gathers the height of the lightning as well. A basic principle applies: the higher the lightning, the stronger the thunderstorm and the higher the likelihood there is of being hail.

In 2015, the mean lightning height was 1.95 kilometer. The average height of a negative charged lightning strike in the mid latitudes amounts to between one and two kilometer. Positive charged lightning strikes can reach up to more than ten kilometers.



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