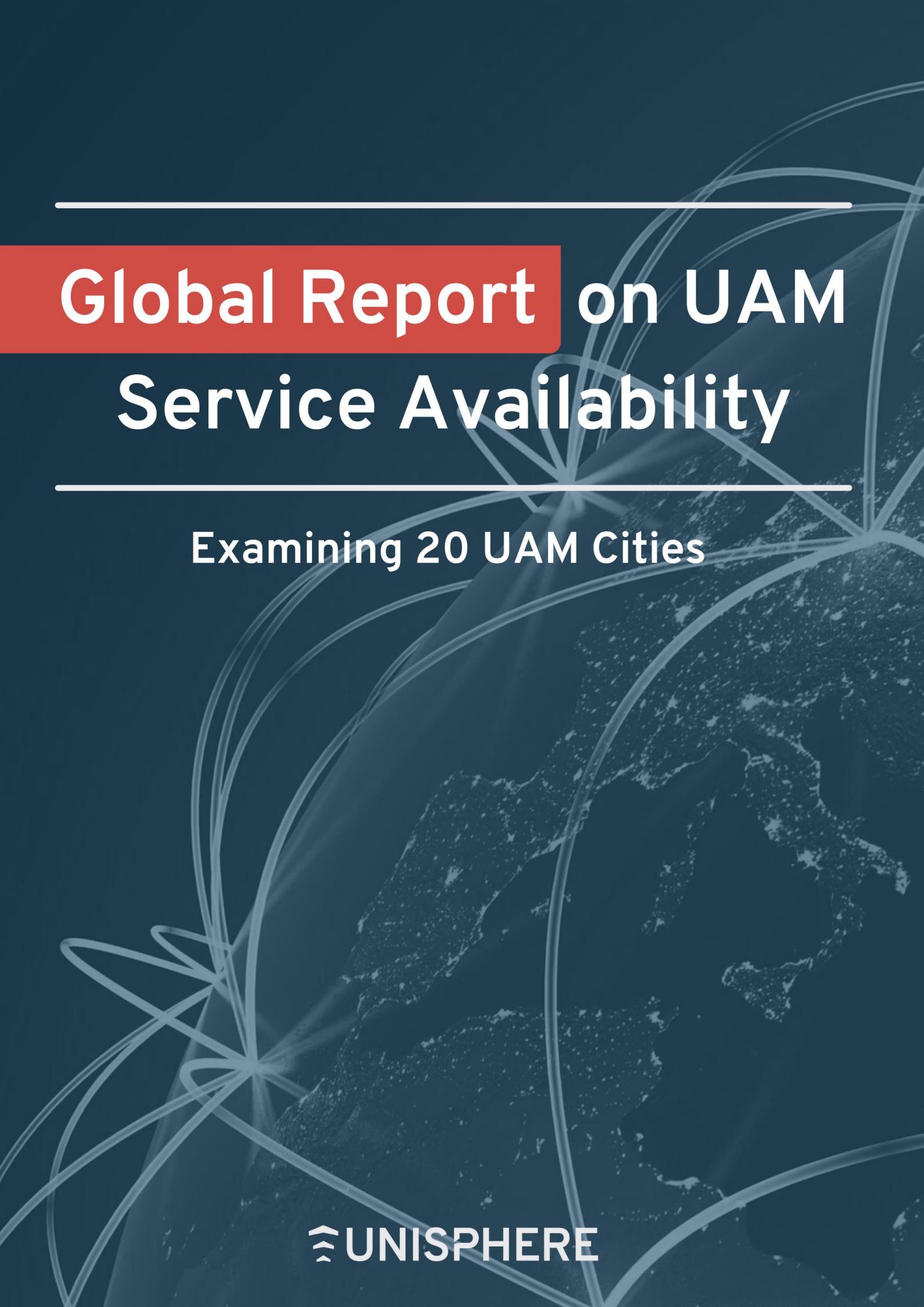
Global Report on UAM Service Availability

Examining 20 UAM Cities



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Content

1. Motivation for undertaking this analysis

The emergence of electrically powered aircraft is leading to a transformation in aviation – in addition to reducing emissions from air traffic, new use cases are emerging in urban environments, such as transit from a city center to an airport.

During the past years, air taxi manufacturers have raised multiple billion Euros funding and are on the way towards type certification. To create new markets for urban transportation, an ecosystem is needed that includes not only aircraft manufacturers and operators, but also systems for an increasingly digitalized airspace and infrastructure to support the daily flight operations.

Based on the positive feedback that we have received on the whitepaper, which was published in October 2021, we have extended the scope of our study to cover a more global reach with different cities from around the world.

The aim of this study is to create awareness for the operational conditions that have a strong impact on the future services, the design of route networks, the placement of vertiports as well as on the overall success of business cases which are not only depending on the demand but also the overall service availability.

If you are interested in contributing to this discussion, we are happy to receive your feedback! Just email us at UAManalytics@unisphere.de.

2. Study scope – analyzing 20 global UAM cities

Locations studied

The global report covers a selection of 20 cities around the world, which are active in the field of Urban Air Mobility. The cities are marked in Figure 2.

Within each city, the study used the location of the main train station since they represent a connecting point for mobility and a uniform selection could be made for all 20 cities. The exact location coordinates are listed in the apendix.

Weather data & models

For the analysis, historic weather model data of different weather models were used. Together with our weather partner, a downscaling of the horizontal resolution to a spatial resolution of 90m is achieved. This is done by applying high-resolution land usage data, soil, terrain data, astronomical computations and other sources.

A *mixed model approach* was selected, using the weather models listed in Table 1. Depending on the position of the point of interest (POI),the mixed model selects the most accurate weather model available at the respective POI.

ECMWF-IFS	European Center Medium-Range Weather Forecast Integrated Forecasting System
NCEP-GFS	Global Forecasting System by the National Centers for Environmental Prediction
UKMO-EURO4	European model by the UK MetOffice
DWD-ICON-EU	German Weather Service DWD
MF-AROME	Meteo France
MM-SWISS1k	High-resolution model for Switzerland designed by Meteomatics
CMC-GEM	Global Environmental Multiscale model by the Canadian Meteorological Center

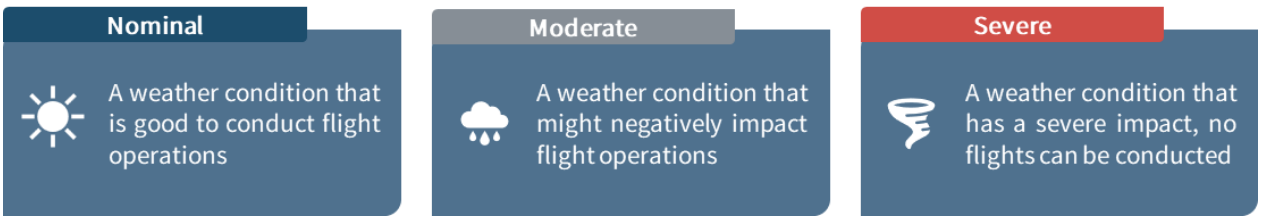
Table 1: Weather models that are the basis for the mixed model which is used for this study

Using weather models instead of weather recorded with weather stations has some disadvantages and advantages: It gives the flexibility to study every coordinate on the globe and at any given altitude. Weather stations in remote areas are rare and installed on the surface only, making it difficult to judge weather conditions at e.g. 150m AGL, nor do they provide accurate information of winds, humidity, temperature, and icing potential at altitude.

For this study, weather data was used that is based on weather models that are calibrated using the actual observation data of multiple weather station measurements nearby. That way, high accuracy and flexibility in the investigation at any point on the globe can be achieved.

Weather parameters & classification

For assessing the UAM service availability 16 weather parameters were analyzed over the past three years (2018-2020), using historic weather data. The parameters were classified into *nominal*, *moderate*, and *severe* conditions, which are defined as follows:



The 16 parameters are clustered into six groups of parameters, which are (1) Visibility, (2) Wind, (3) Temperature, (4) Precipitation, (5) Icing, and (6) Dangerous Phenomena. Below, the classification limits for each parameter can be found:

WX Group	Parameter	Nominal	Moderate	Severe
Visibility	Visibility	> 5000 m	5000-1500 m	< 1500 m
	Ceiling	> 500 m	500-150 m	< 150 m
Wind	Mean Wind speed	< 15 kn	15-20 kn	> 20 kn
	Gust Factor	< 10 kn	10-15 kn	> 15 kn
Temperature	OAT range	-20 to +40 °C	-30 to -20 / +40 to +50 °C	<-30/>+50 °C
Precipitation	Rain amount	< 2.5 mm/h	2.5-7.6 mm/h	>7.6 mm/h
Icing[1] (new)	General Icing	Always classified as severe		
Dangerous Phenomena	Thunderstorm	Always classified as severe		
	Sand- or dust storm			
	Funnel clouds			
	Freezing rain			
	Squall			
	Ice pellets			
	Hail			
	Fog			
	Smoke/volcano ash			

[1] General Icing is a combined parameter of high humidity and low temperatures. Intermediate steps of icing, as well as design and aerodynamic effects (e.g. venturi effect) favoring ice creation, are not differentiated explicitly in this analysis.

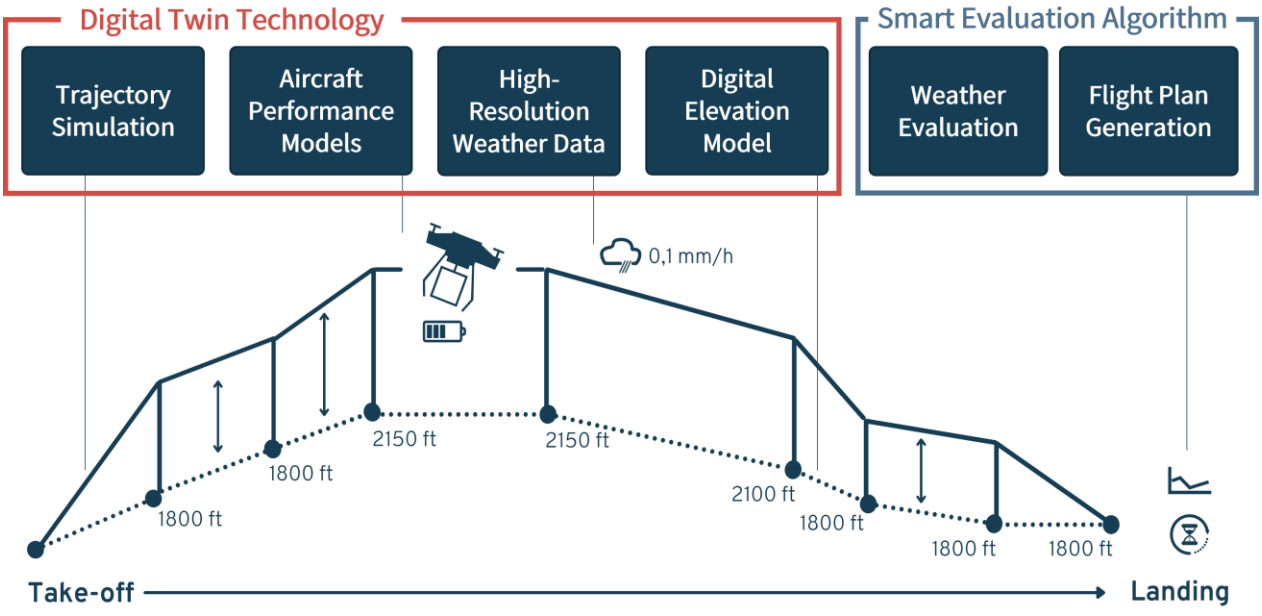
Operational Analysis – Method & technology

The weather data were evaluated on an hourly basis for the years 2018, 2019, and 2020. Given the timeframe and number of parameters around 400.000 data points were analyzed for each location. If in a given hour one of the parameters e.g. gust factor, was beyond the limit of *Nominal* it was considered as *Moderate* or *Severe*.

The operational conditions were analyzed at a height of 10m above ground level (AGL) for the wind conditions and 2m AGL for the remaining weather parameters. Based on the digital surface model SRTM-30 (Shuttle Radar Topography Mission, 30m date). However, it is clear that the placement of vertiports on different heights of the actual installment, e.g. on rooftops or at ground level, must be considered to correctly model weather effects.

In contrast to our Whitepaper of UAM Service Availability, icing conditions as an additional parameter were added to the analysis to create a more comprehensive understanding of the respective weather conditions.

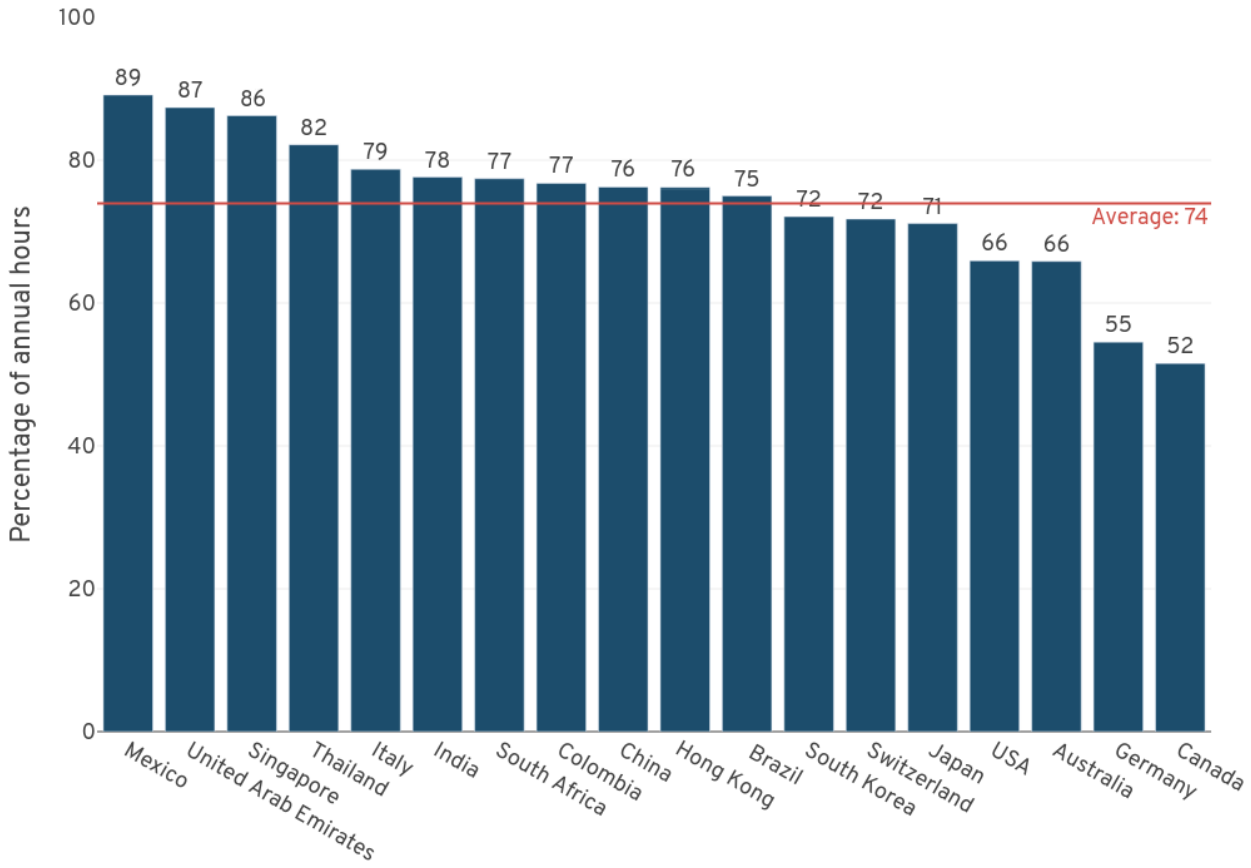
For the analysis, we used elements of our Smart 4D Trajectory technology (see figure below), which allows an automated evaluation of weather conditions and their impact on the air taxi flight feasibility.



Reference cases – Operational availability by country

As a baseline and in order to create a common basis for the evaluation of the cities, the respective countries were also analyzed. For the country analysis, the 20 most populated cities of each country[2] were analyzed for their operating conditions (based on 2018, 2019, and 2020 weather data). In total, 311[3] cities were analyzed in this way.

To obtain a reference value for each country, the results were averaged for all cities within a country. The 311 cities also serve as a basis for ranking the 20 cities analyzed in our global report.



With 89% of nominal conditions, the best operational conditions over a year can be found in Mexico, whereas Canada ranks last with only 52% of nominal hours. The country values are used to better contextualize the results of a particular city within the overall context of the country.

[2] Population data by NGIA, US Geological Survey, US Census Bureau, and NASA, 2021
[3] The unequal number of 311 cities can be expaind by the fact that some countries such as Singapore or UAE have less than 20 large cities.

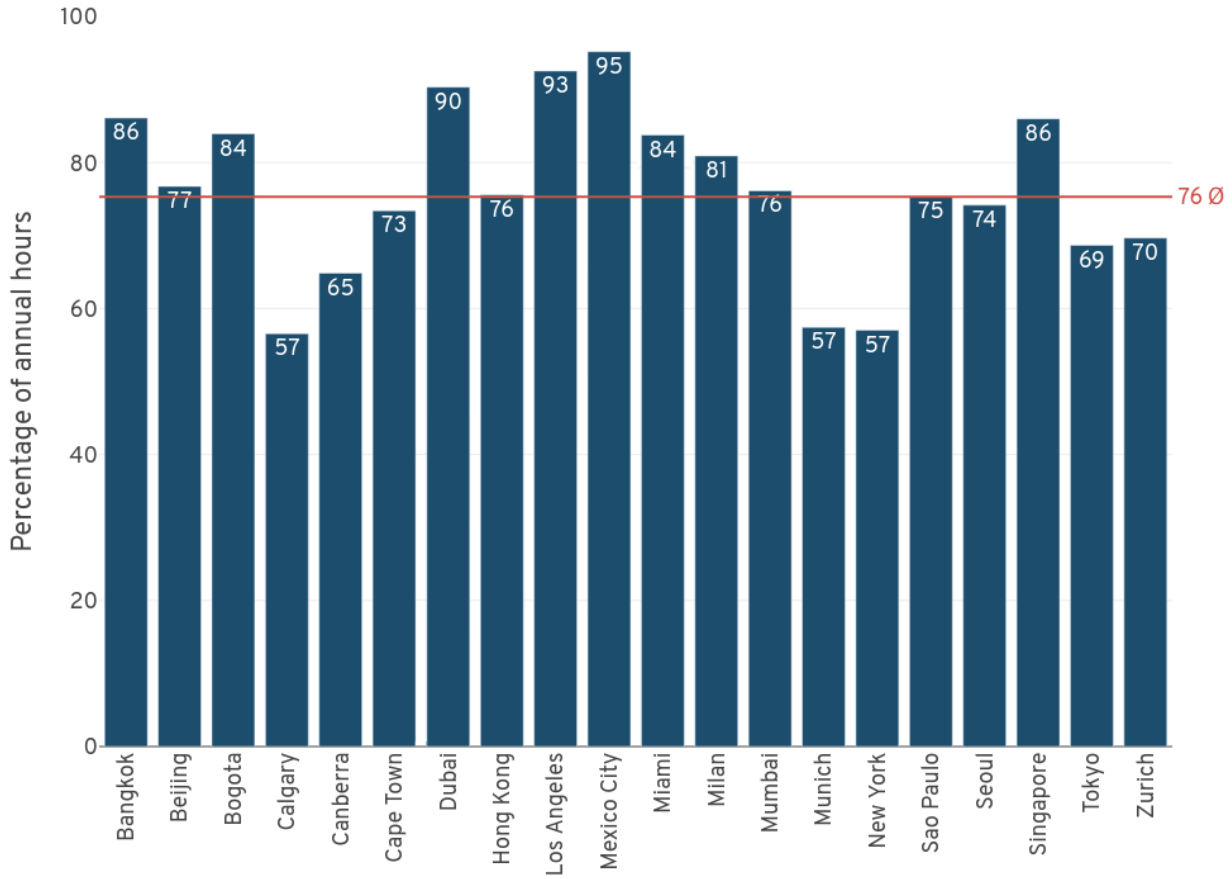
3. Results

In this section, we will provide detailed insights into the operating conditions of the 20 cities studied in this report. Each of the cities will be described with the following diagrams.

1) **Overall availability:** Pie chart describing the overall distributions of the weather conditions according to the classification into nominal, moderate, and severe – information on weather parameters causing the main severe conditions to understand the reason for non-availability.
2) **Monthly breakdown:** A bar chart distinguishing different weather conditions by month to better understand the impact of possible seasonal effects.

City comparison

The overview below shows the overall results of all 20 cities and the percentage of time the conditions were classified as nominal. Mexico City and Los Angeles are leading the ranking with 95% and 93%, whereas Calgary, New York, and Munich show only 57% of the time as nominal conditions.

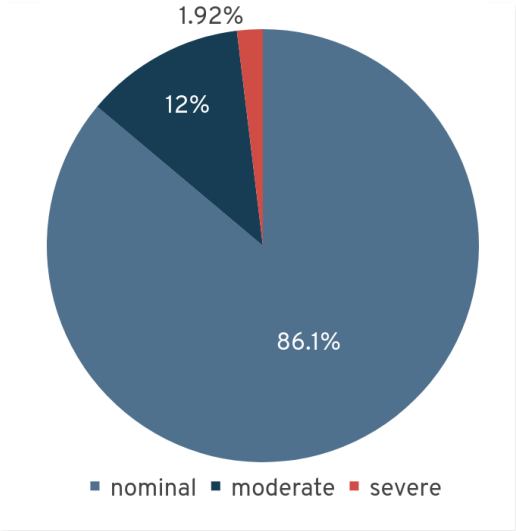


Bangkok

For the city of Bangkok, 86.1% of the weather conditions are classified as nominal. Bangkok is thereby 4.1% points above the national average of Thailand, which is 82%.

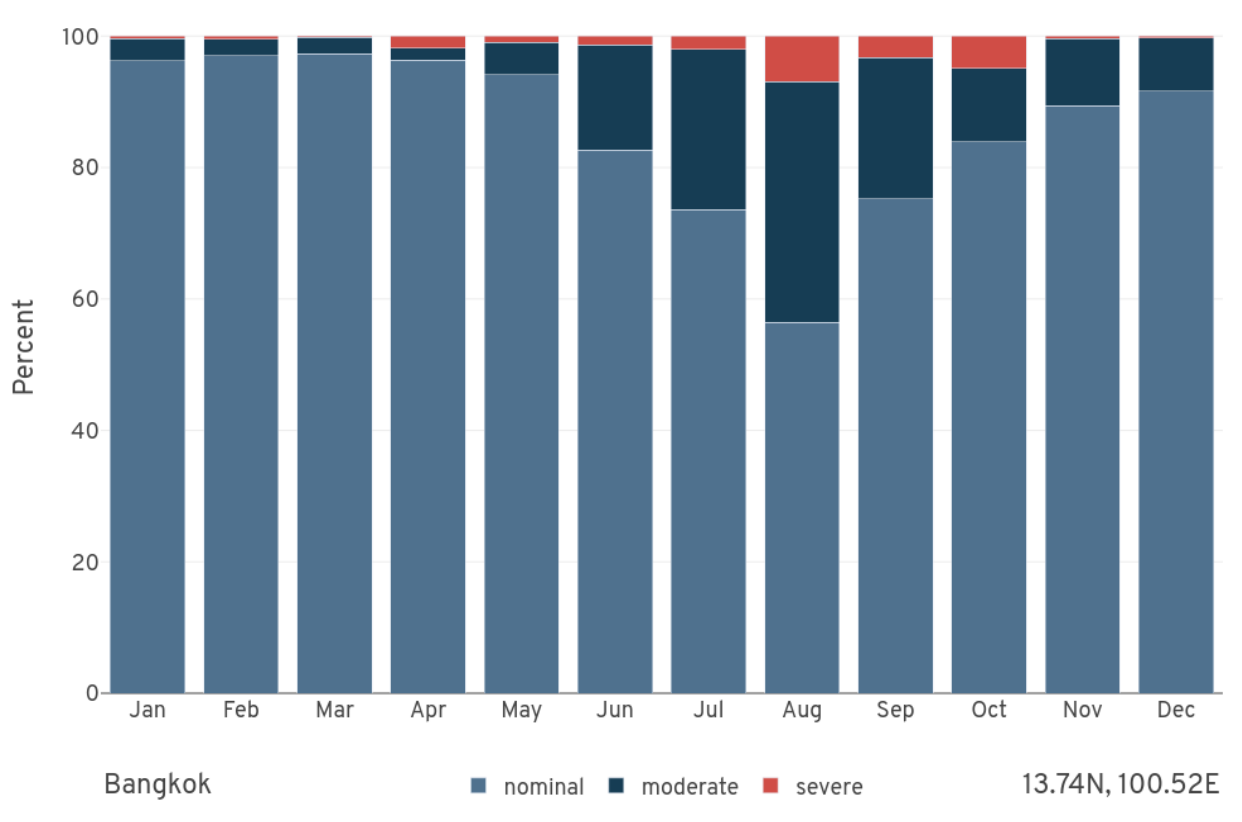
In total, 1.92% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Bangkok ranks number 42.

The predominant reason why weather conditions are classified as severe in Bangkok is the weather parameter “visibility” with 63%, followed by “gust factor” causing 32% of the severe conditions over the year.



Monthly operational conditions for Bangkok

The bar chart below shows the operational conditions per month. It reveals a strong seasonal variation in terms of severe and nominal conditions. Between June and October, a higher percentage of moderate and severe conditions occurs whereas from November to May there are mainly nominal conditions.

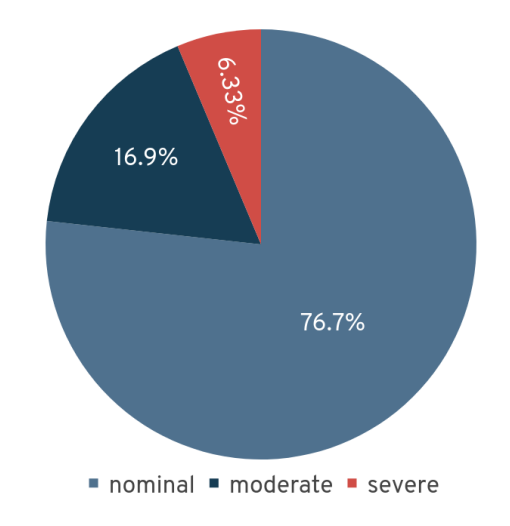


Beijing

For the city of Beijing, around 76.7% of the operational conditions are classified as nominal. Beijing is thereby 0.7% points above the national average of China with 76%.

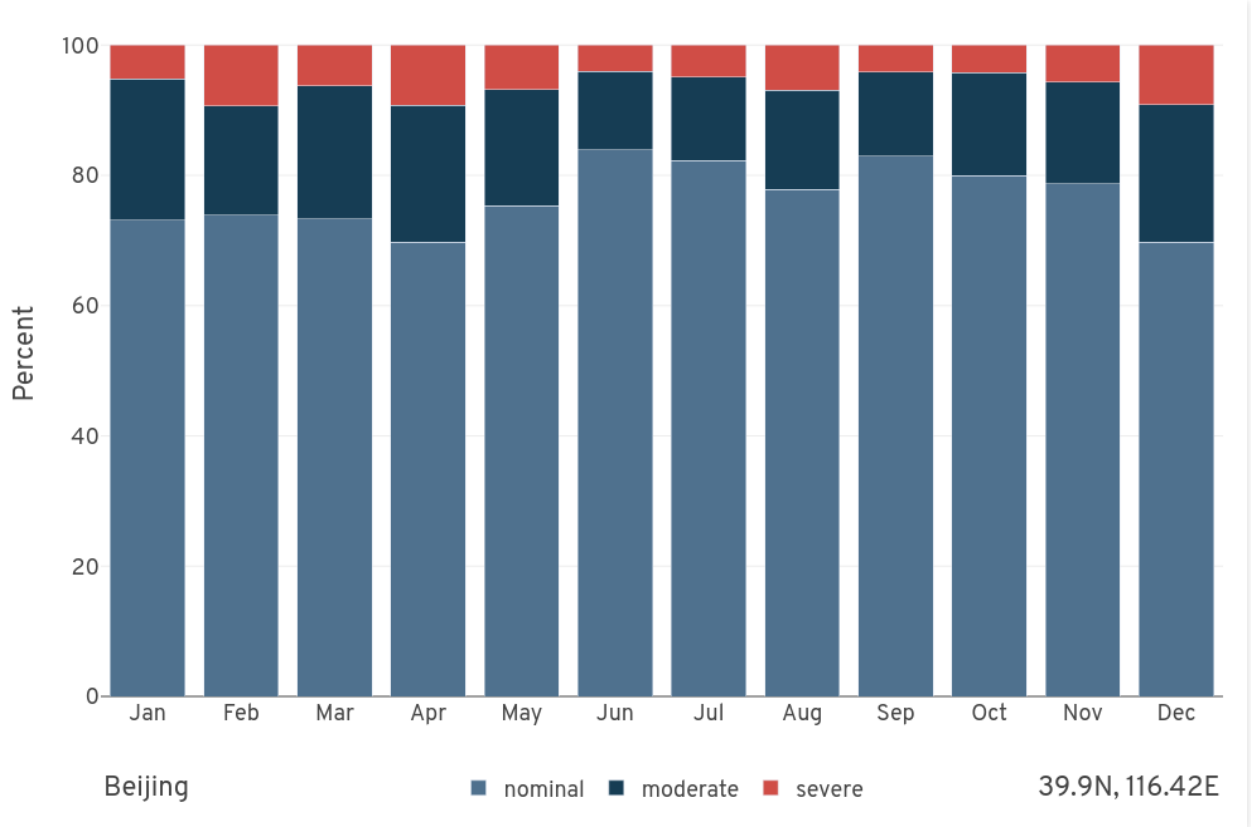
In total, 6.33% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Beijing ranks number 126.

The predominant reason why weather conditions are classified as severe in Beijing is the weather parameter “gust factor” with 56%, followed by “icing” causing 22% of the severe conditions over the year.



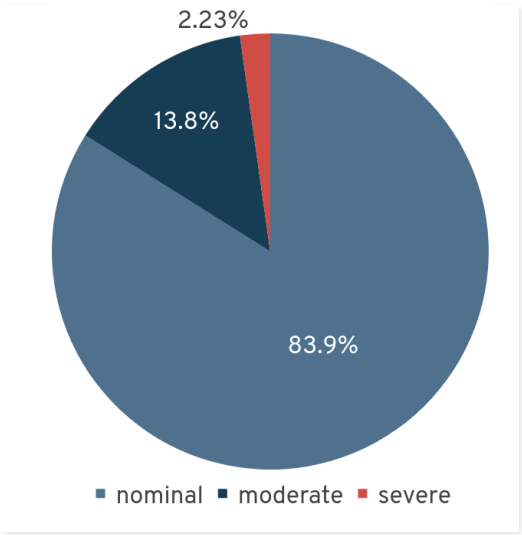
Monthly operational conditions for Beijing

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. February and April are the months with the highest percentage of severe conditions and June is the one with the highest percentage of nominal conditions.



Bogota

For the city of Bogota, around 83.9% of the operational conditions are classified as nominal. Bogota is thereby 6.9% points above the national average of Columbia, which is 77%.

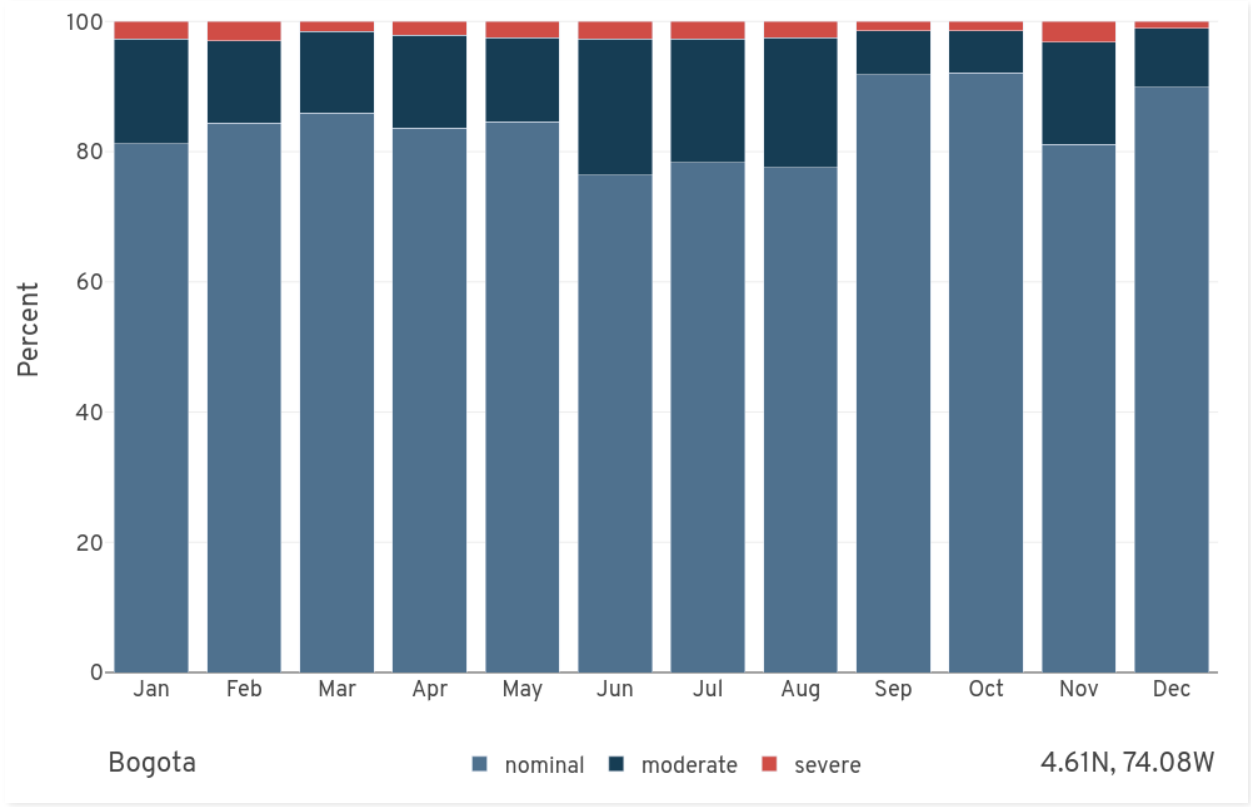


In total, 2.23% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Bogota ranks number 62.

The predominant reason why weather conditions are classified as severe in Bogota is the weather parameter “visibility” with 69%, followed by “cloud ceiling” causing 31% of the severe conditions over the year.

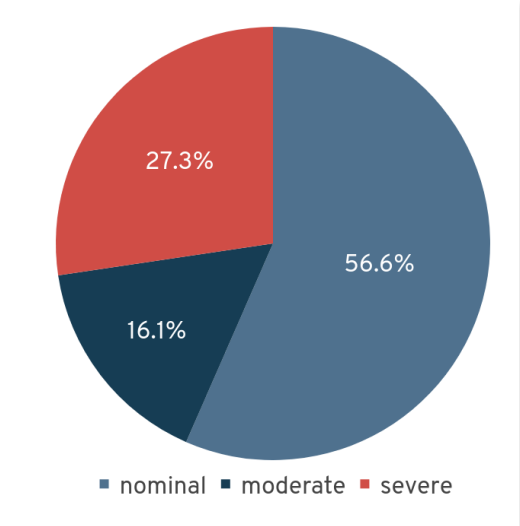
Monthly operational conditions for Bogota

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. November is the month with the highest percentage of severe conditions and October is the one with the highest percentage of nominal conditions.



Calgary

For the city of Calgary, around 56.6% of the operational conditions are classified as nominal. Calgary is thereby 4.6% points above the national average of Canada, which is 52%.

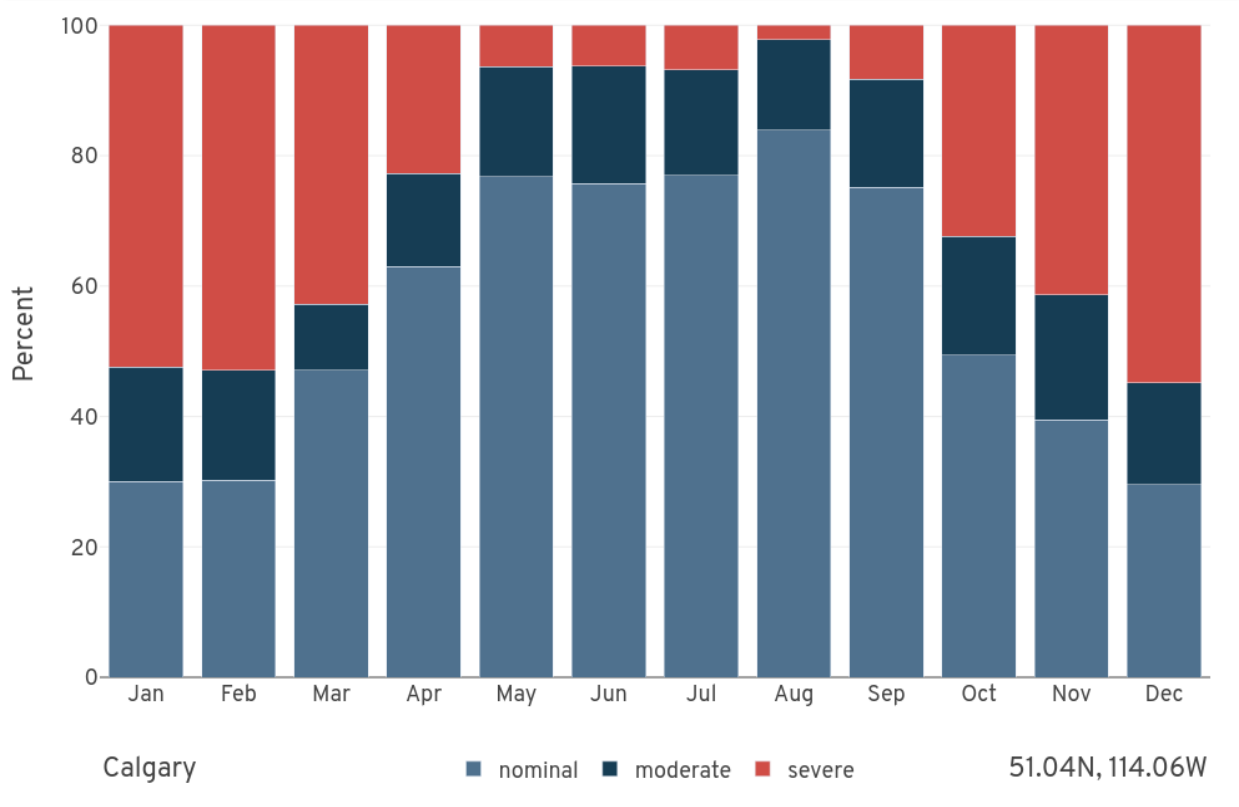


In total, 27.3% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Calgary ranks number 275.

The predominant reason why weather conditions are classified as severe in Calgary is the weather parameter “icing” with 67%, followed by “gust factor” causing 29% of the severe conditions over the year.

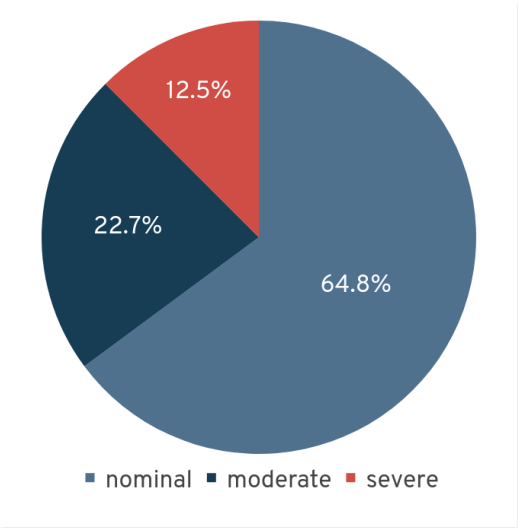
Monthly operational conditions for Calgary

The bar chart below shows the operational conditions per month. It reveals a strong seasonal variation in terms of severe and nominal conditions. December is the month with the highest percentage of severe conditions and August is the one with the highest percentage of nominal conditions.



Canberra

For the city of Canberra, around 64.8% of the operational conditions are classified as nominal. Canberra is thereby 1.2% points below the national average of Australia, which is 66%.

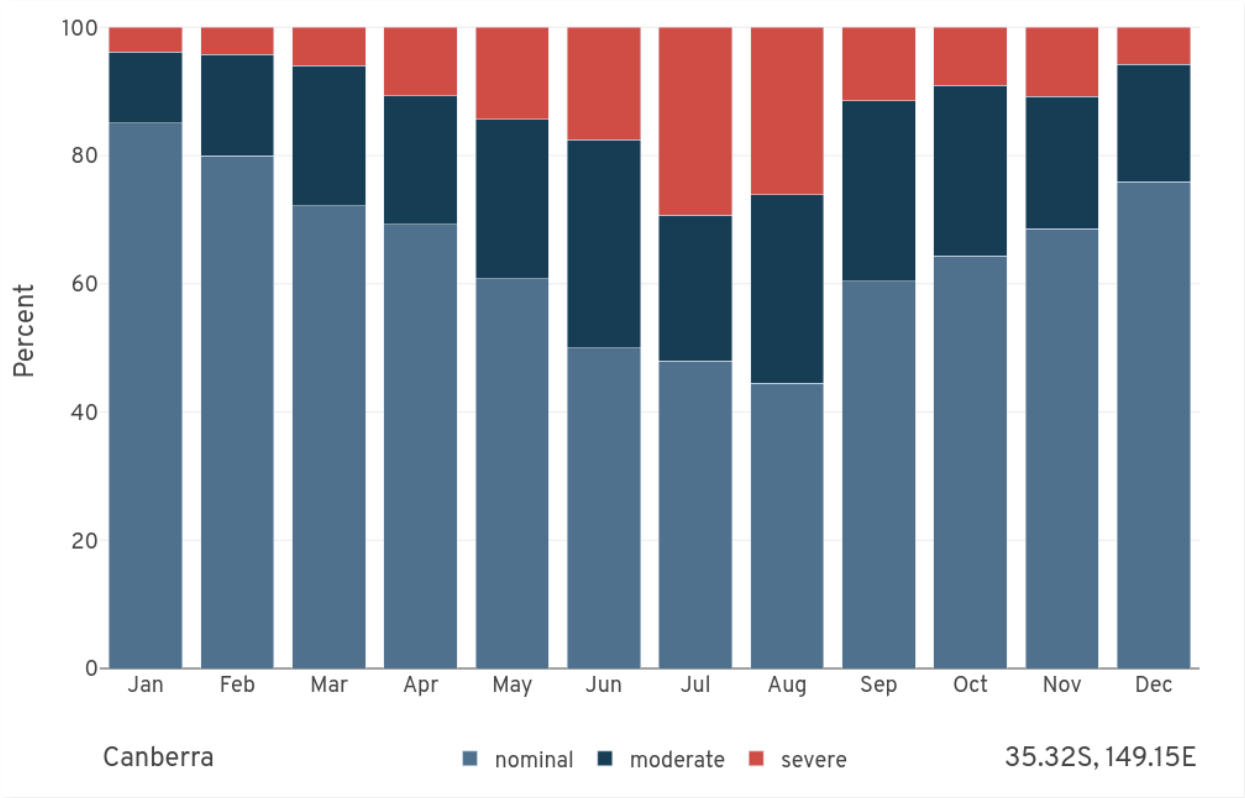


In total, 12.5% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Canberra ranks number 239.

The predominant reason why weather conditions are classified as severe in Canberra is the weather parameter “gust factor” with 57%, followed by “cloud ceiling” causing 21% of the severe conditions over the year.

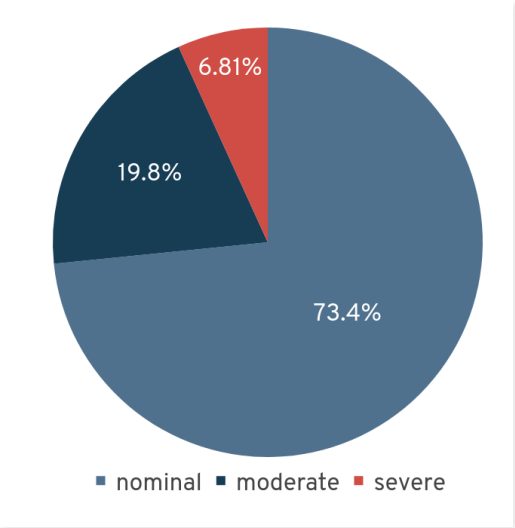
Monthly operational conditions for Canberra

The bar chart below shows the operational conditions per month. It reveals a strong seasonal variation in terms of severe and nominal conditions. July is the month with the highest percentage of severe conditions and January is the one with the highest percentage of nominal conditions.



Cape Town

For the city of Cape Town, around 73.4% of the operational conditions are classified as nominal. Cape Town is thereby 3.6% points below the national average of South Africa, which is 77%.

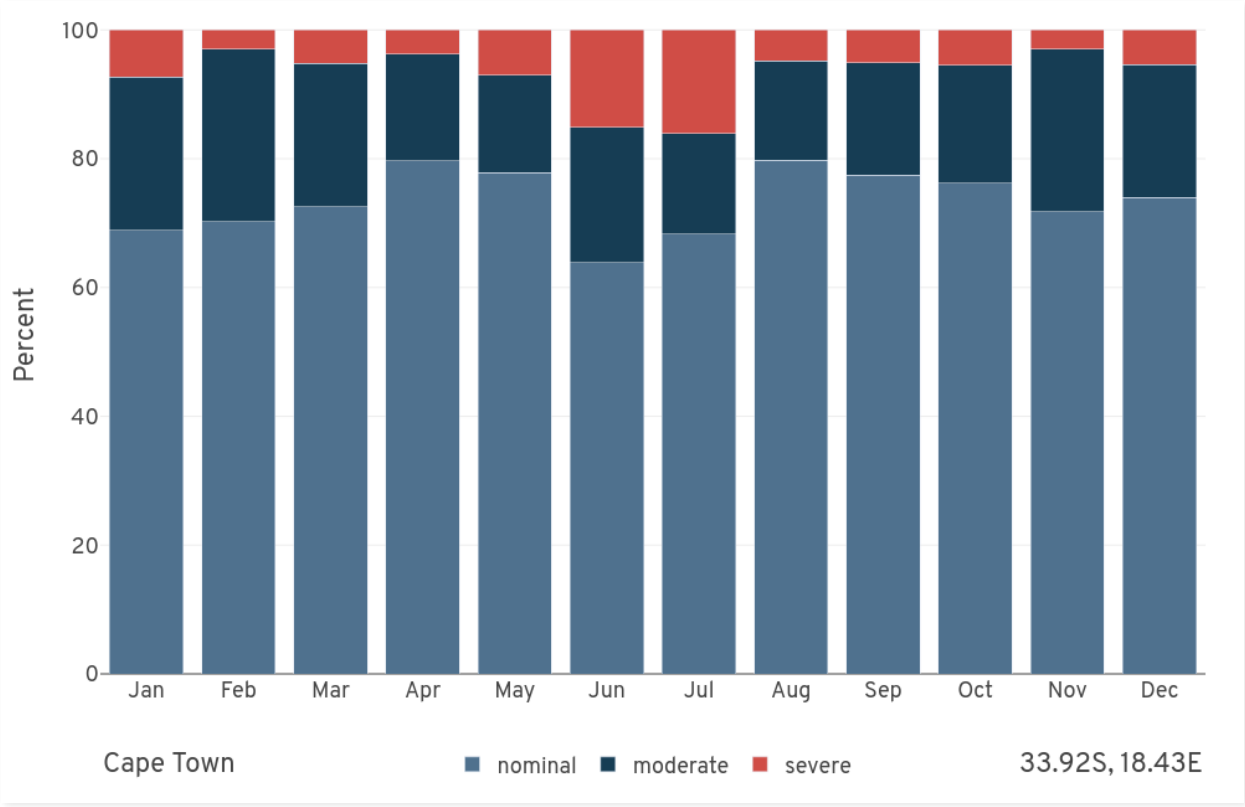


In total, 6.81% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Cape Town ranks number 168.

The predominant reason why weather conditions are classified as severe in Cape Town is the weather parameter “gust factor” with 40%, followed by “wind speed” causing 35% of the severe conditions over the year.

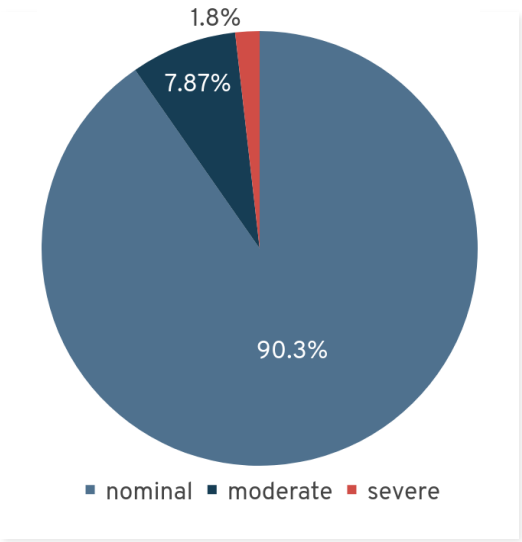
Monthly operational conditions for Cape Town

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. July is the month with the highest percentage of severe conditions and April is the one with the highest percentage of nominal conditions.



Dubai

For the city of Dubai, around 90.3% of the operational conditions are classified as nominal. Dubai is thereby 3.3% points above the national average of the United Arab Emirates, which is 87%.

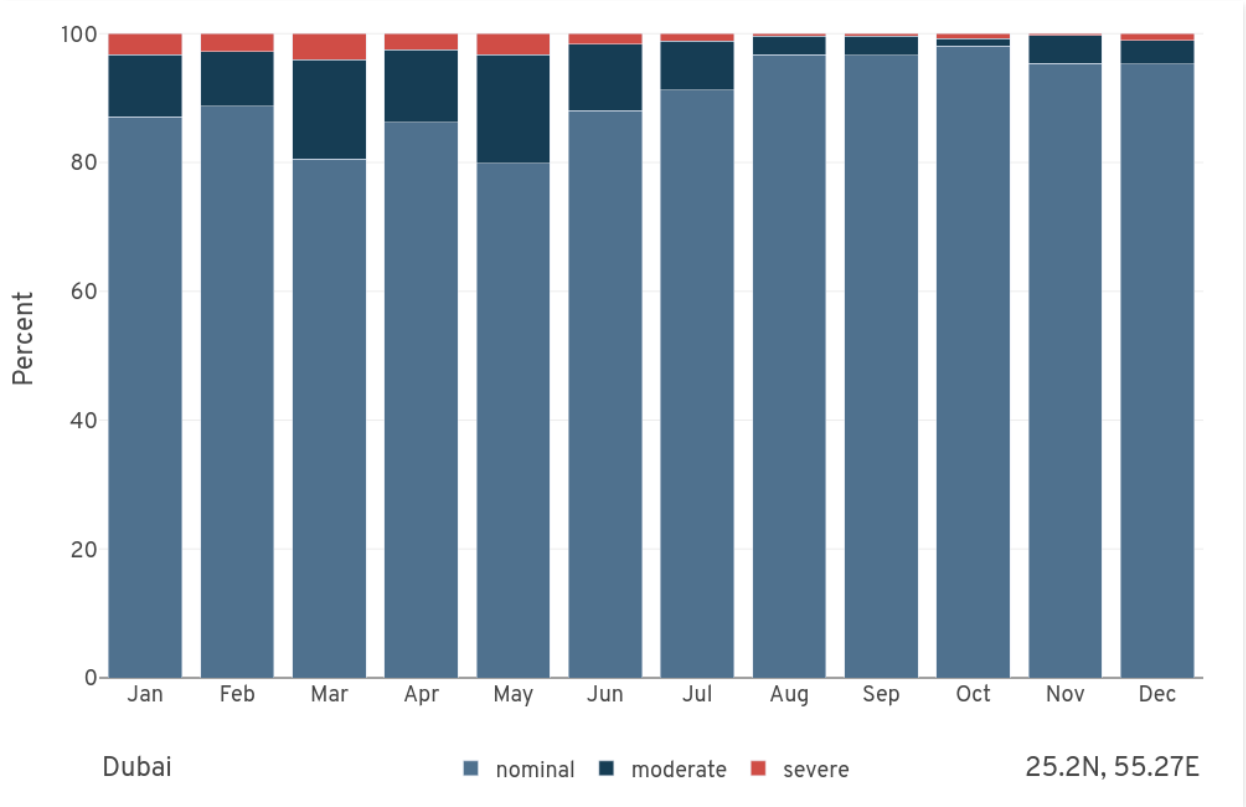


In total, 1.8% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Dubai ranks number 18.

The predominant reason why weather conditions are classified as severe in Dubai is the weather parameter “gust factor” with 38%, followed by “dangerous phenomena” causing 37% of the severe conditions over the year.

Monthly operational conditions for Dubai

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. March is the month with the highest percentage of severe conditions and October is the one with the highest percentage of nominal conditions.

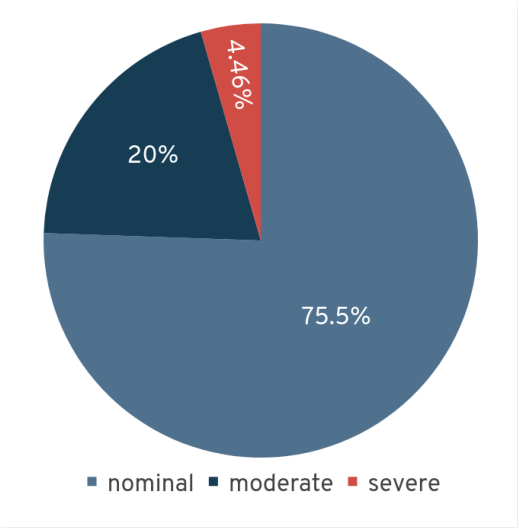


Hong Kong

For the city of Hong Kong, around 75.5% of the operational conditions are classified as nominal.

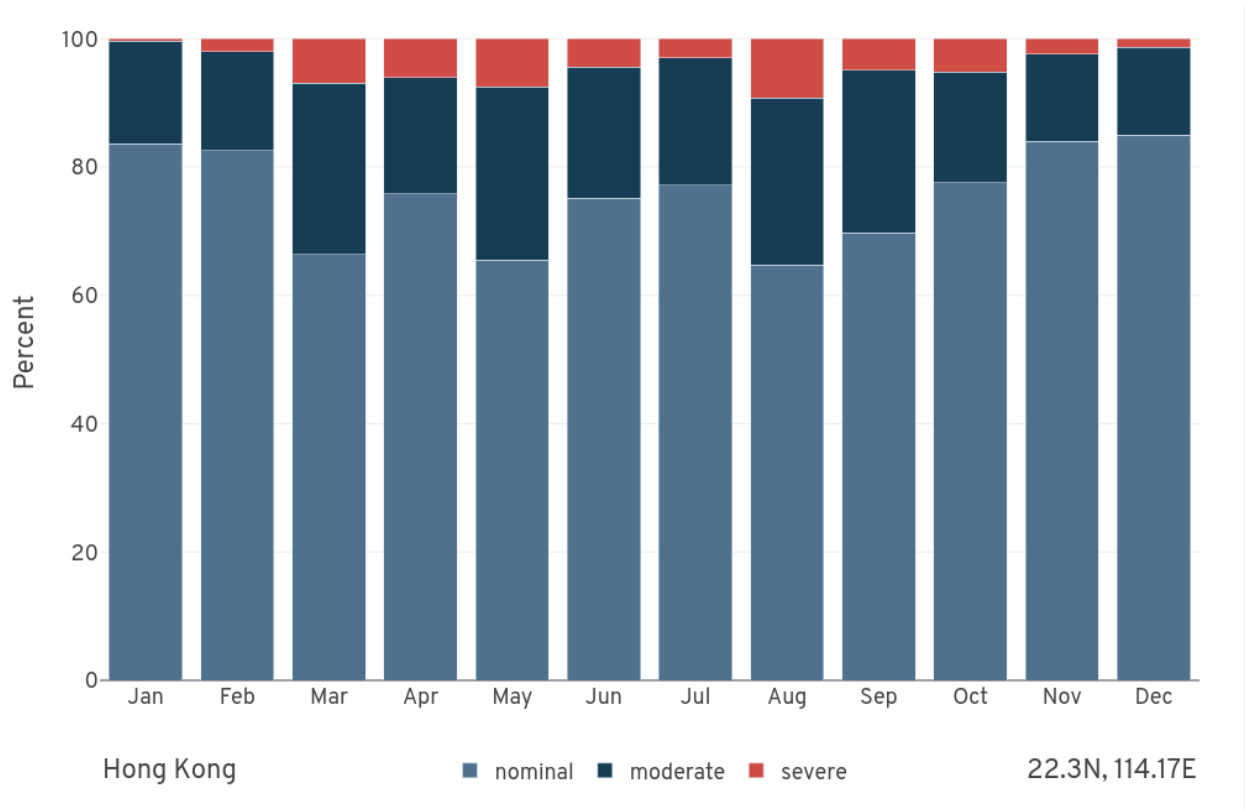
In total, 4.46% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Hong Kong ranks number 141.

The predominant reason why weather conditions are classified as severe in Hong Kong is the weather parameter “visibility” with 77%, followed by “gust factor” causing 18% of the severe conditions over the year.



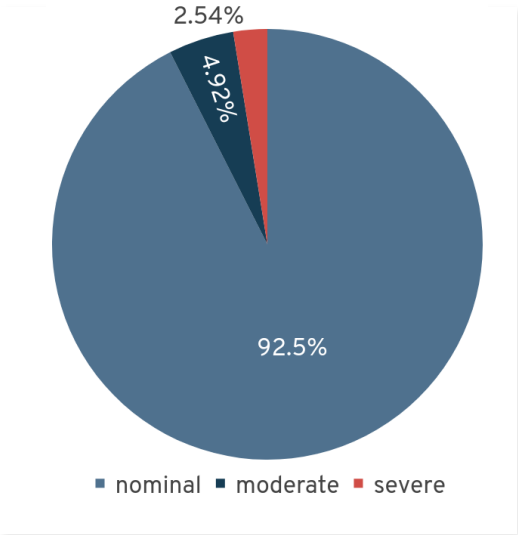
Monthly operational conditions for Hong Kong

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. August is the month with the highest percentage of severe conditions and December is the one with the highest percentage of nominal conditions.



Los Angeles

For the city of Los Angeles, around 92.5% of the operational conditions are classified as nominal. Los Angeles is thereby 26.5% points above the national average of the USA, which is 66%.

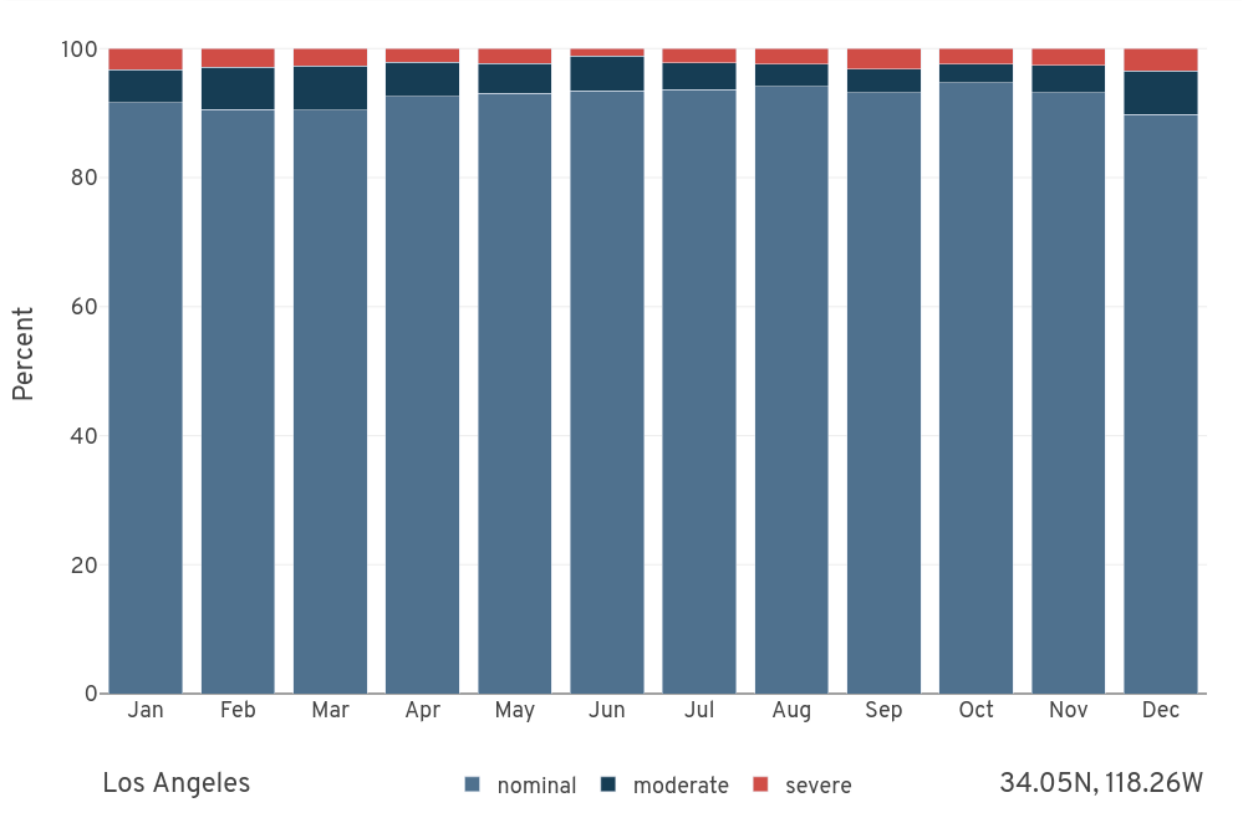


In total, 2.54% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Los Angeles ranks number 11.

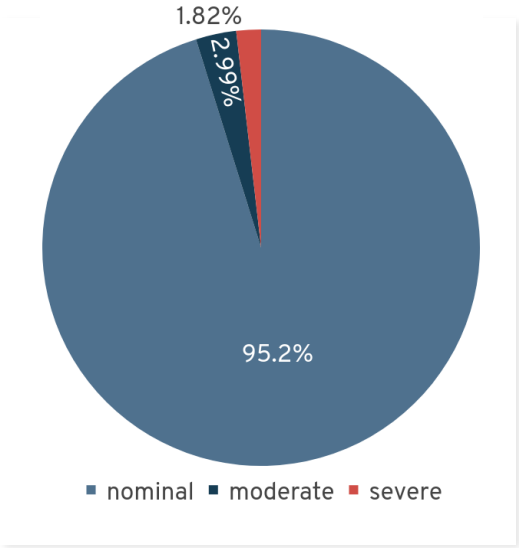
The predominant reason why weather conditions are classified as severe in Los Angeles is the weather parameter “cloud ceiling” with 48%, followed by “visibility” causing 43% of the severe conditions over the year.

Monthly operational conditions for Los Angeles

The bar chart below shows the operational conditions per month. It reveals a very smooth seasonal variation in terms of severe and nominal conditions. December is the month with the highest percentage of severe conditions and October is the one with the highest percentage of nominal conditions.



Mexico City



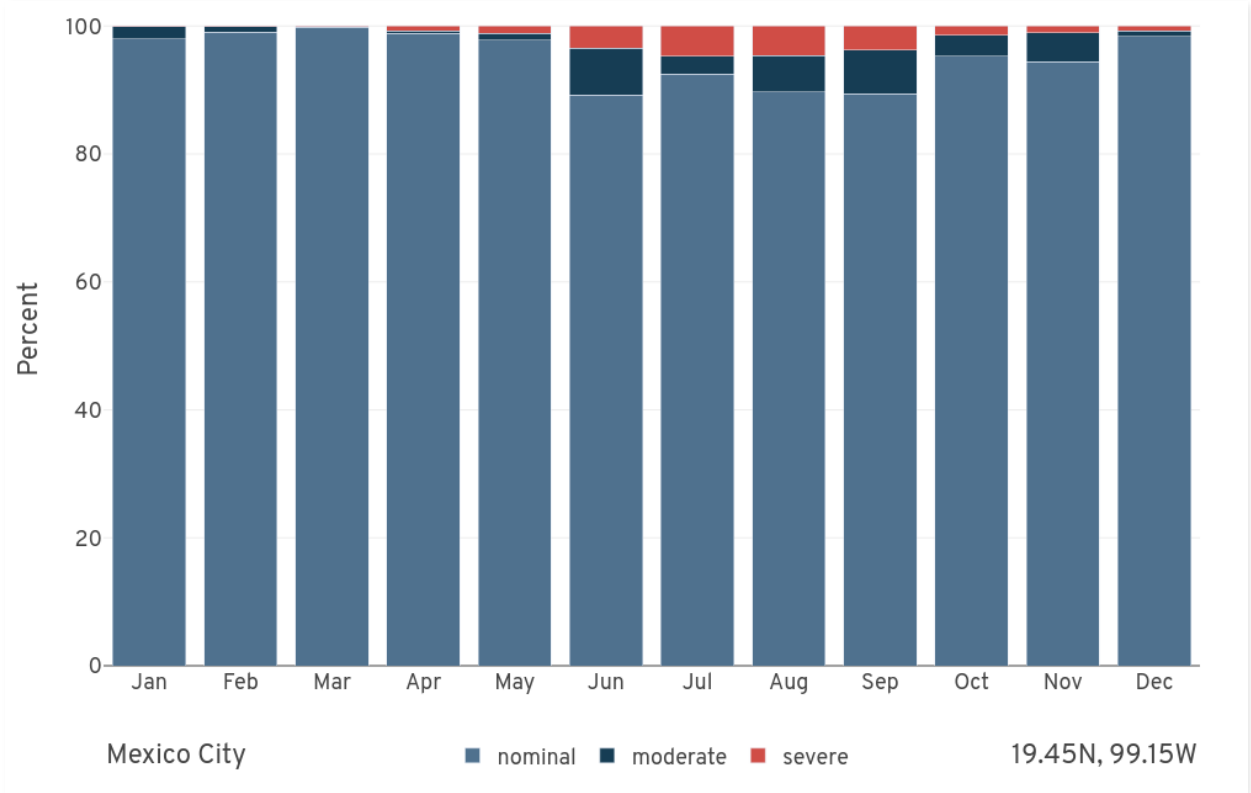
For the city of Mexico City, around 95.2% of the operational conditions are classified as nominal. Mexico City is thereby 6.2% points above the national average of Mexico, which is 89%.

In total, 1.82% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Mexico City ranks number 5.

The predominant reason why weather conditions are classified as severe in Mexico City is the weather parameter “dangerous phenomena” with 73%, followed by “visibility” causing 24% of the severe conditions over the year.

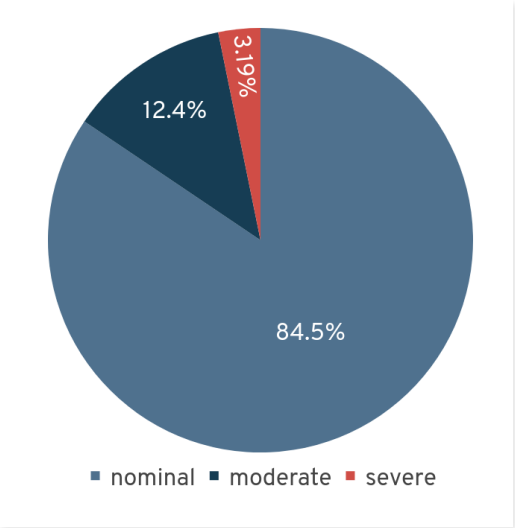
Monthly operational conditions for Mexico City

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. Between June and November, a slightly higher percentage of moderate and severe conditions is present whereas during the rest of the year there are mainly nominal flight conditions.



Miami

For the city of Miami, around 84.5% of the operational conditions are classified as nominal. Miami is thereby 18.5% points above the national average of the USA, which is 66%.

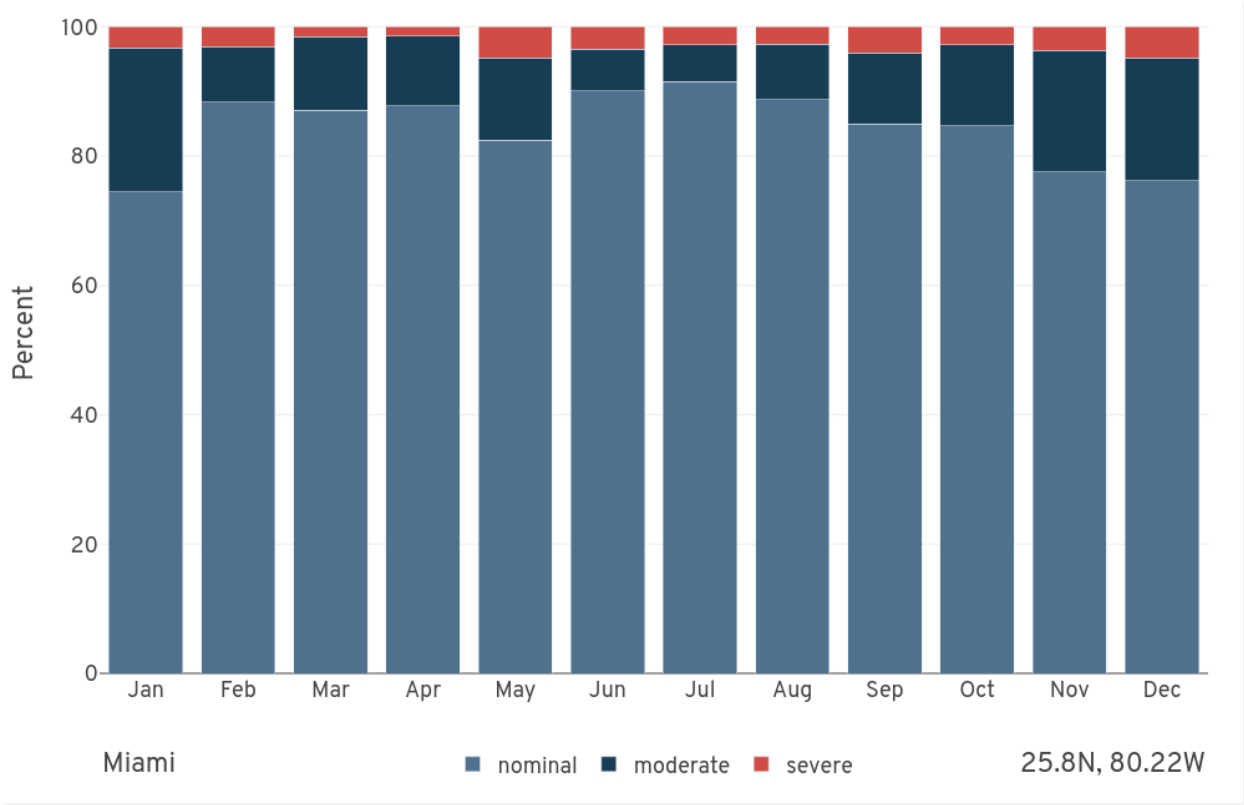


In total, 3.19% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Miami ranks number 57.

The predominant reason why weather conditions are classified as severe in Miami is the weather parameter “visibility” with 54%, followed by “dangerous phenomena” causing 35% of the severe conditions.

Monthly operational conditions for Miami

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. December, along with May are the months with the highest percentage of severe conditions and July is the one with the highest percentage of nominal conditions.

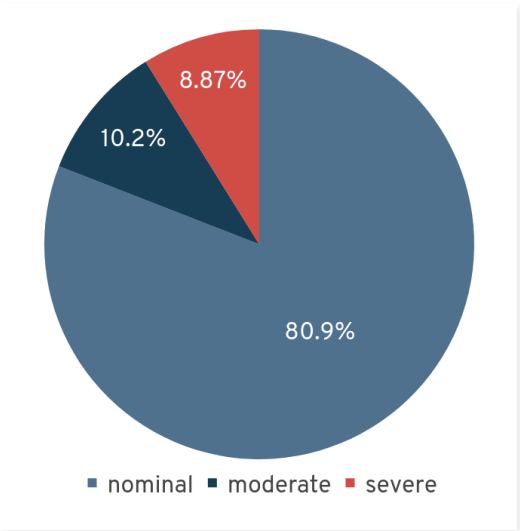


Milan

For the city of Milan, around 80.9% of the operational conditions are classified as nominal. Milan is thereby 1.9% points above the national average of Italy, which is 79%.

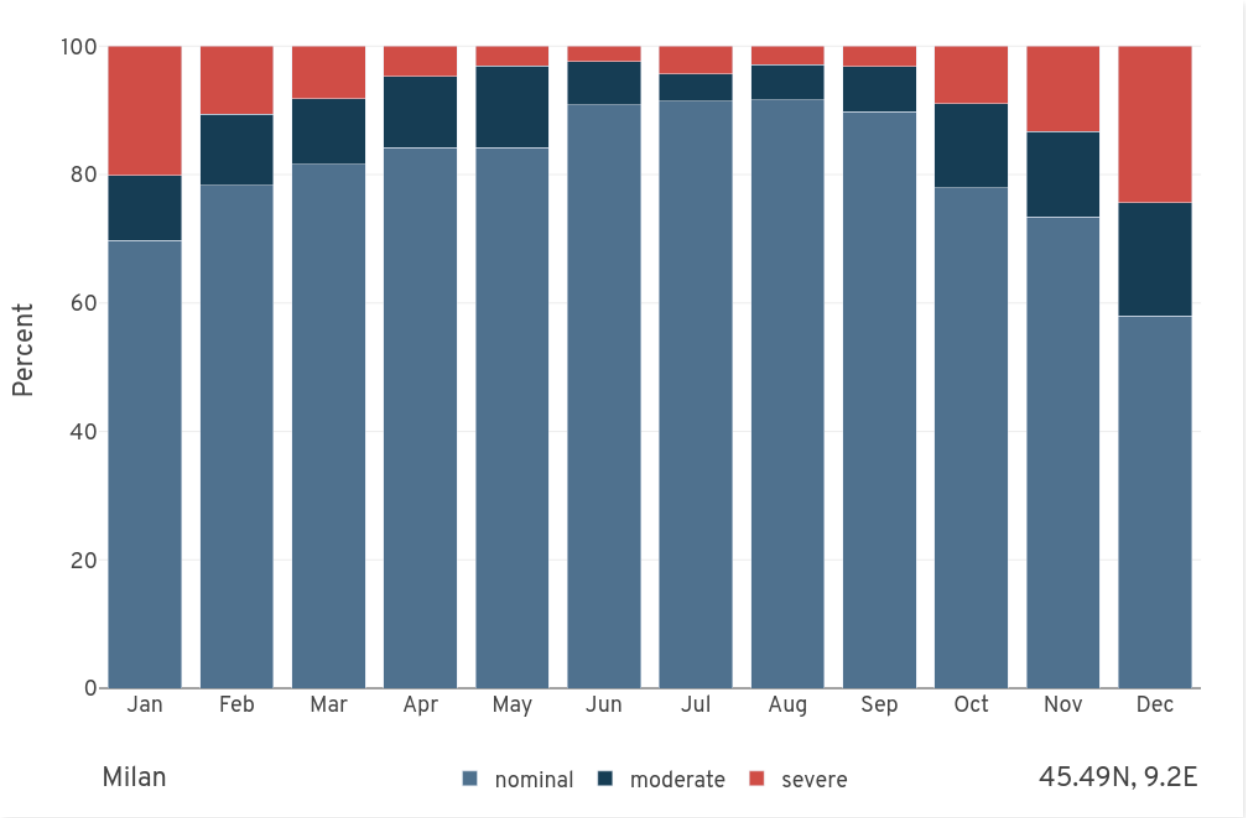
In total, 8.87% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Milan ranks number 90.

The predominant reason why weather conditions are classified as severe in Milan is the weather parameter “visibility” with 36%, followed by “icing” causing 33% of the severe conditions over the year.



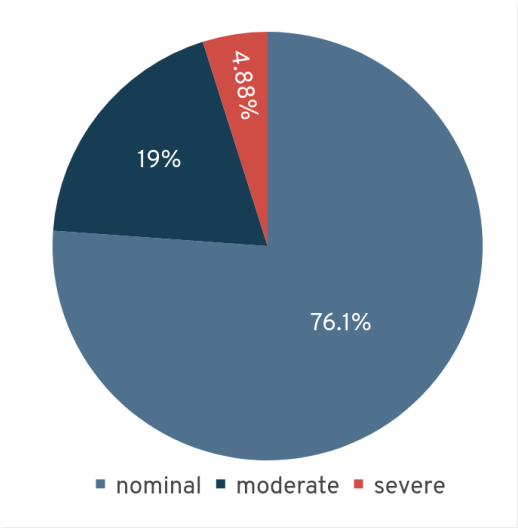
Monthly operational conditions for Milan

The bar chart below shows the operational conditions per month. It reveals a moderate seasonal variation in terms of severe and nominal conditions. December is the month with the highest percentage of severe conditions and August is the one with the highest percentage of nominal conditions.



Mumbai

For the city of Mumbai, around 76.1% of the operational conditions are classified as nominal. Mumbai is thereby 1.9% points below the national average of India, which is 78%.

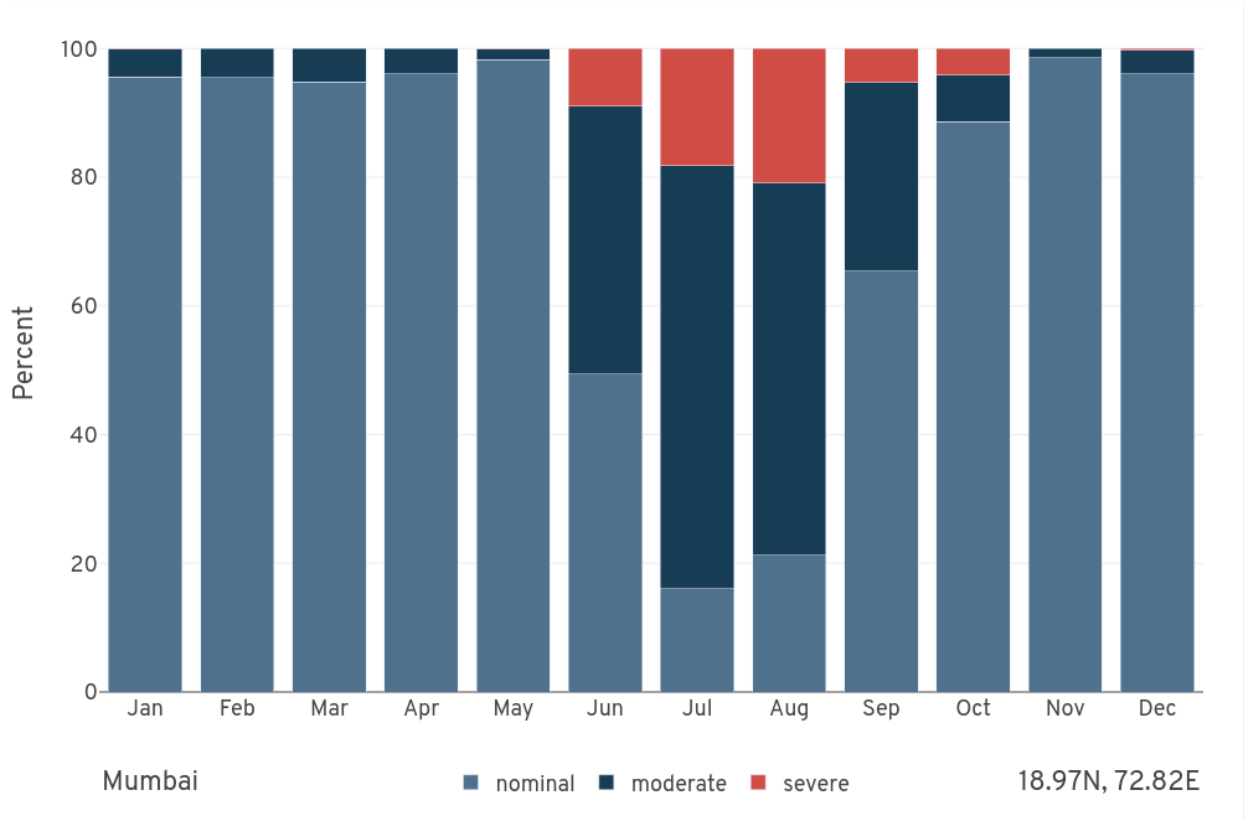


In total, 4.88% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Mumbai ranks number 132.

The predominant reason why weather conditions are classified as severe in Mumbai is the weather parameter “visibility” with 82%, followed by “wind speed” causing 25% of the severe conditions over the year.

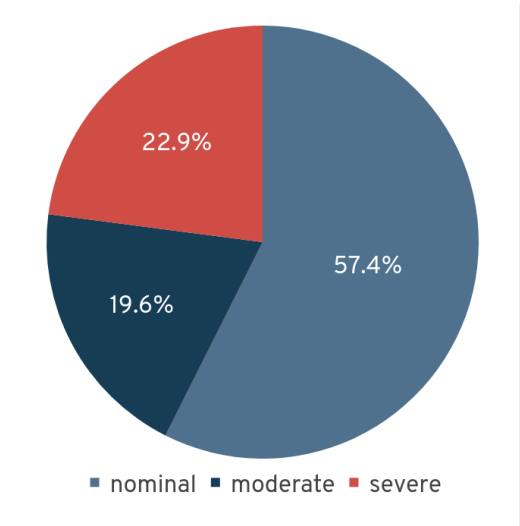
Monthly operational conditions for Mumbai

The bar chart below shows the operational conditions per month. It reveals a strong seasonal variation in terms of severe and nominal conditions. Between June and October, a higher percentage of moderate and severe conditions occurs whereas from November to May there are mainly nominal conditions.



Munich

For the city of Munich, around 57.4% of the operational conditions are classified as nominal. Munich is thereby 2.4% points above the national average of Germany, which is 55%.

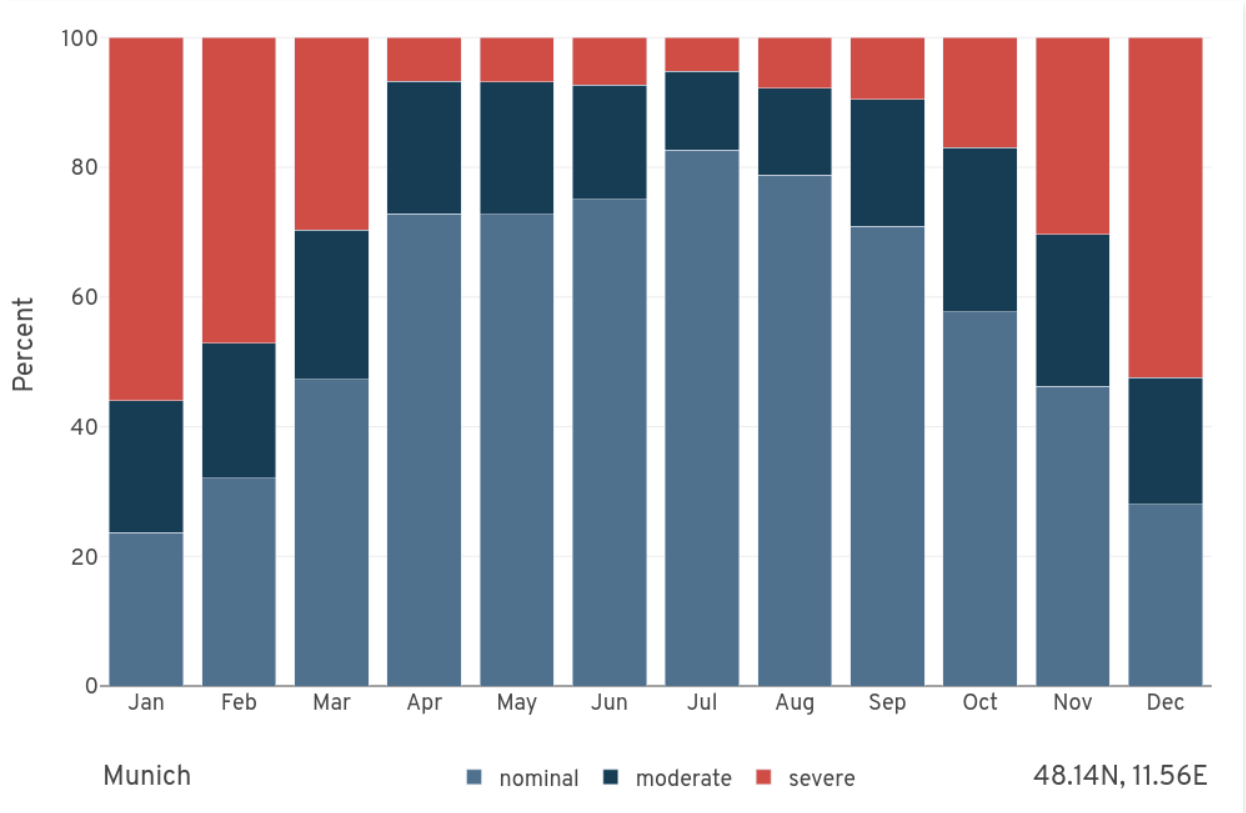


In total, 22.9% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Munich ranks number 266.

The predominant reason why weather conditions are classified as severe in Munich is the weather parameter “gust factor” with 53%, followed by “icing” causing 34% of the severe conditions over the year.

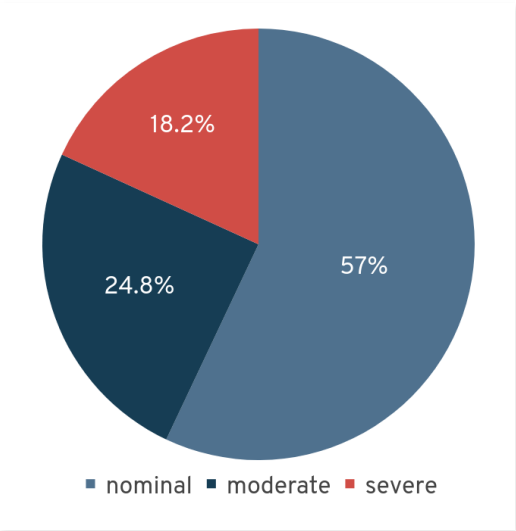
Monthly operational conditions for Munich

The bar chart below shows the operational conditions per month. It reveals a significant seasonal variation in terms of severe and nominal conditions. January is the month with the highest percentage of severe conditions and July is the one with the highest percentage of nominal conditions.



New York

For the city of New York, around 57% of the operational conditions are classified as nominal. New York is thereby 9% points below the national average of the USA, which is 66%.

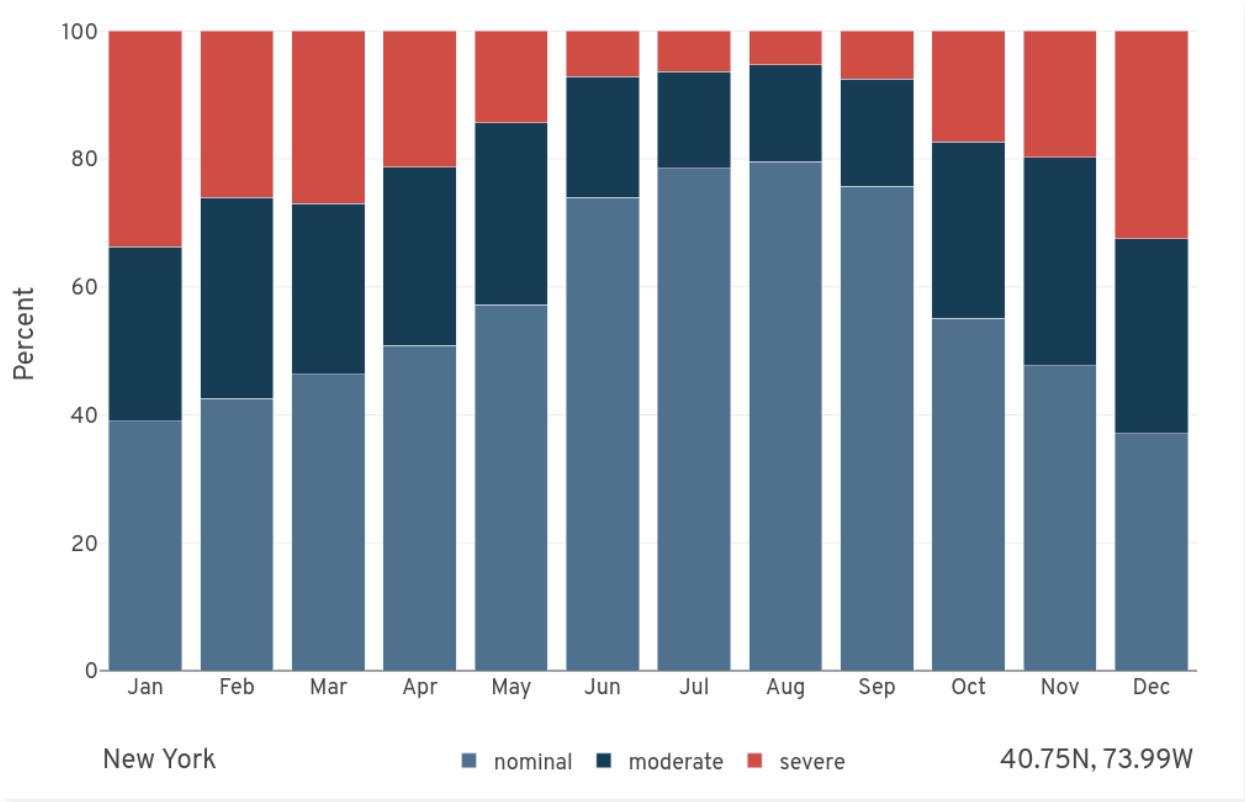


In total, 18.2% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, New York ranks number 270.

The predominant reason why weather conditions are classified as severe in New York is the weather parameter “gust factor” with 68%, followed by “visibility” causing 22% of the severe conditions over the year.

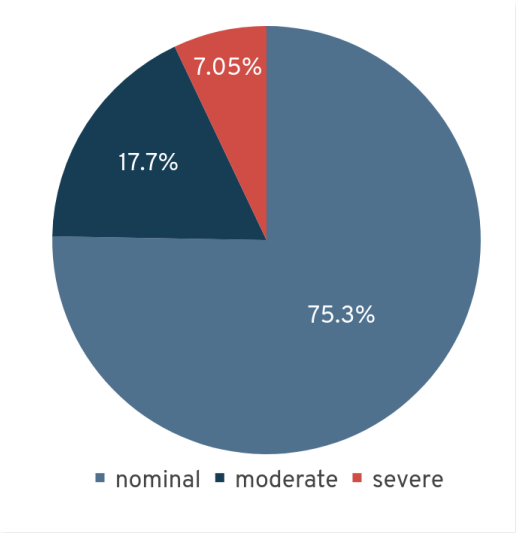
Monthly operational conditions for New York

The bar chart below shows the operational conditions per month. It reveals a major seasonal variation in terms of severe and nominal conditions. January is the month with the highest percentage of severe conditions and August is the one with the highest percentage of nominal conditions.



Sao Paulo

For the city of Sao Paulo, around 75.3% of the operational conditions are classified as nominal. Sao Paulo is thereby 0.3% points above the national average of Brazil, which is 75%.

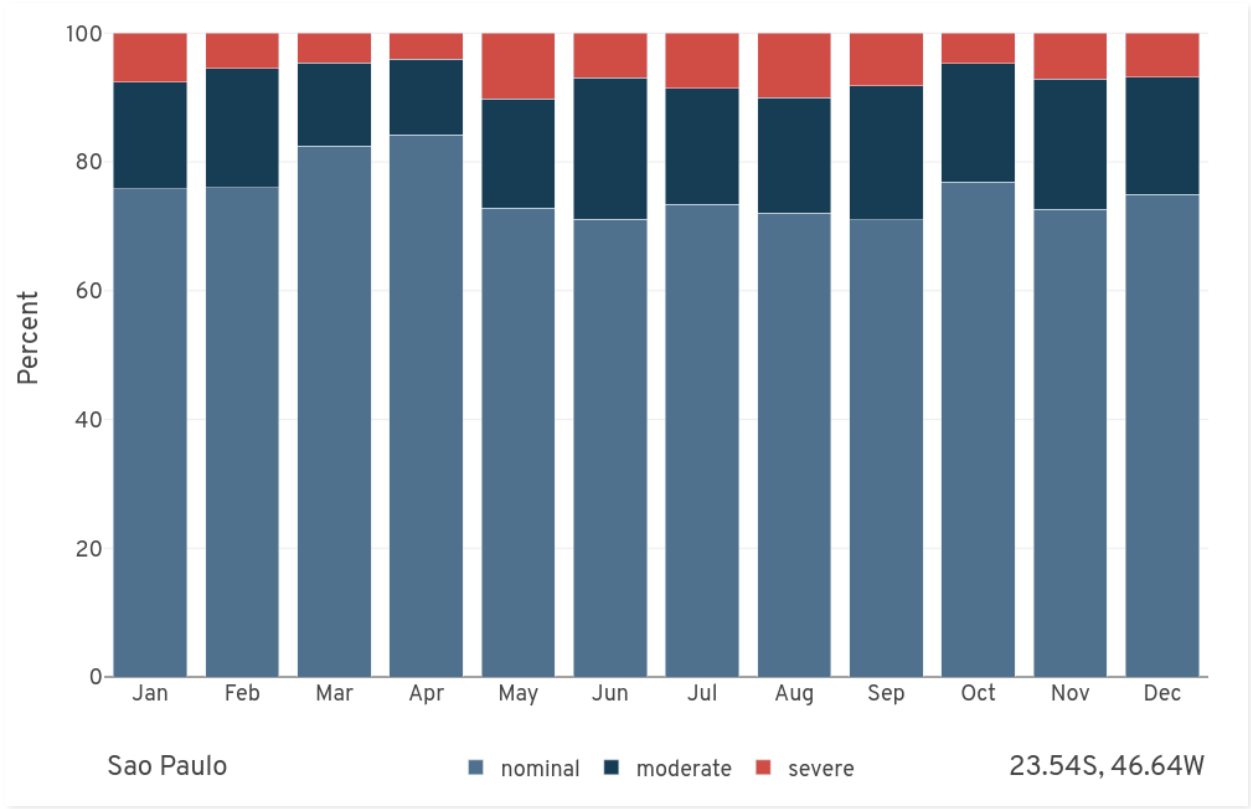


In total, 7.05% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Sao Paulo ranks number 145.

The predominant reason why weather conditions are classified as severe in Sao Paulo is the weather parameter “visibility” with 44% and “dangerous phenomena” causing 39% of the severe conditions over the year.

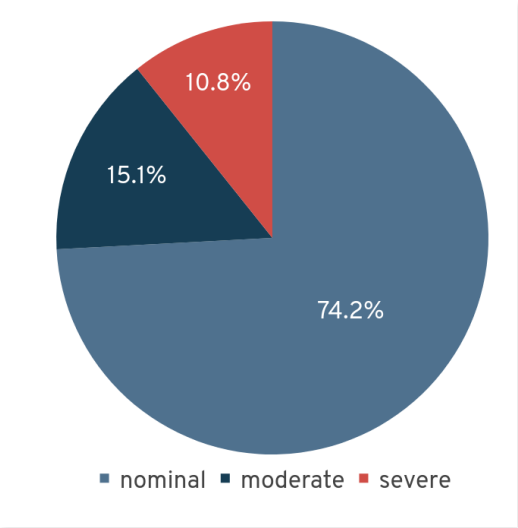
Monthly operational conditions for Sao Paulo

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. May is the month with the highest percentage of severe conditions and April is the one with the highest percentage of nominal conditions.



Seoul

For the city of Seoul, around 74.2% of the operational conditions are classified as nominal. Seoul is thereby 2.2% points above the national average of South Korea, which is 72%.

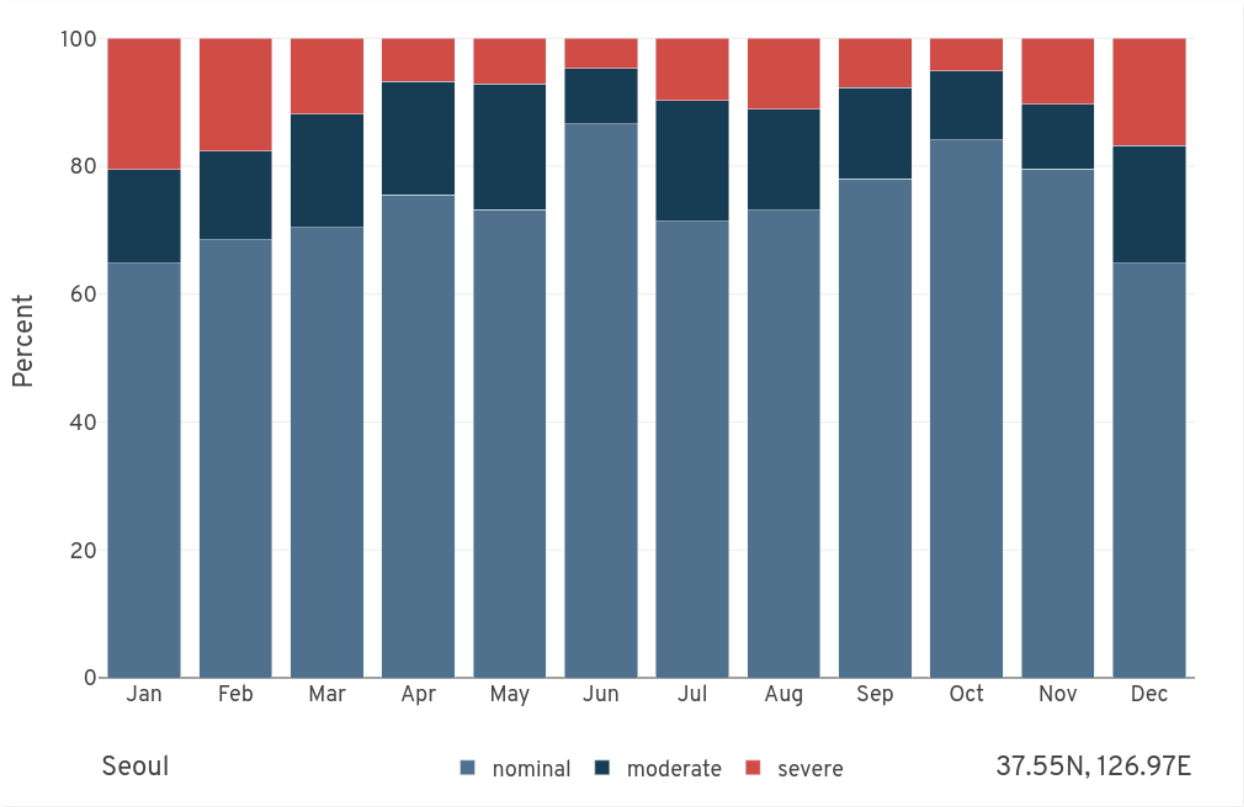


In total, 10.8% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Seoul ranks number 155.

The predominant reason why weather conditions are classified as severe in Seoul is the weather parameter “icing” with 40%, followed by “gust factor” causing 35% of the severe conditions over the year.

Monthly operational conditions for Seoul

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. January is the month with the highest percentage of severe conditions and June is the one with the highest percentage of nominal conditions.

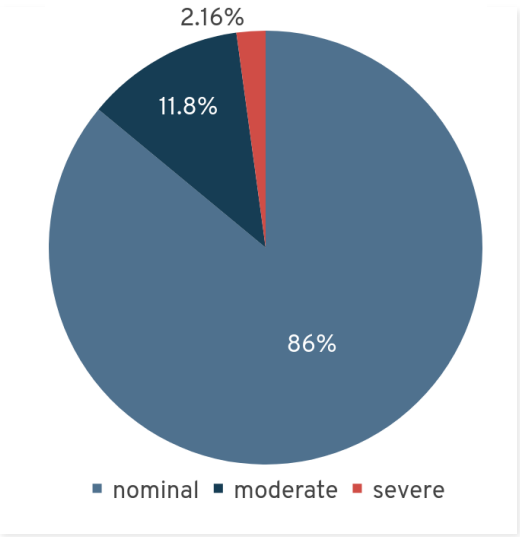


Singapore

For the city of Singapore, around 86% of the operational conditions are classified as nominal.

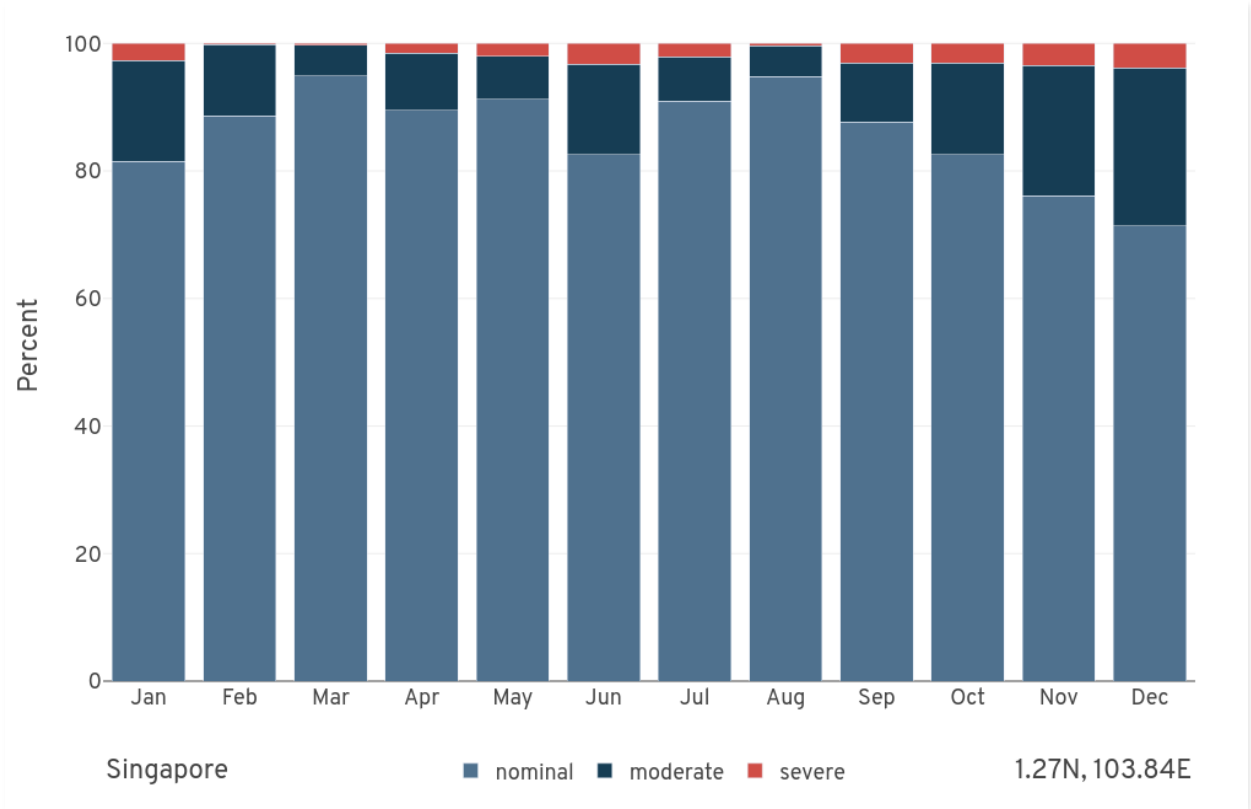
In total, 2.16% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Singapore ranks number 45.

The predominant reason why weather conditions are classified as severe in Singapore is the weather parameter “visibility” with 98%, followed by “rain amount” causing 9% of the severe conditions over the year.



Monthly operational conditions for Singapore

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. December is the month with the highest percentage of severe conditions and March is the one with the highest percentage of nominal conditions.

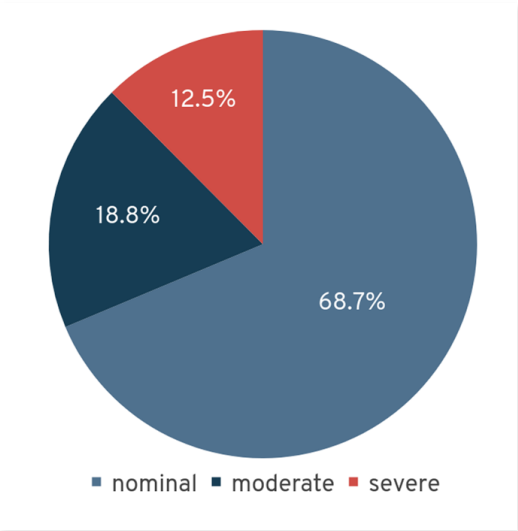


Tokyo

For the city of Tokyo, around 68.7% of the operational conditions are classified as nominal. Tokyo is thereby 2.3% points below the national average of Japan, with 71%.

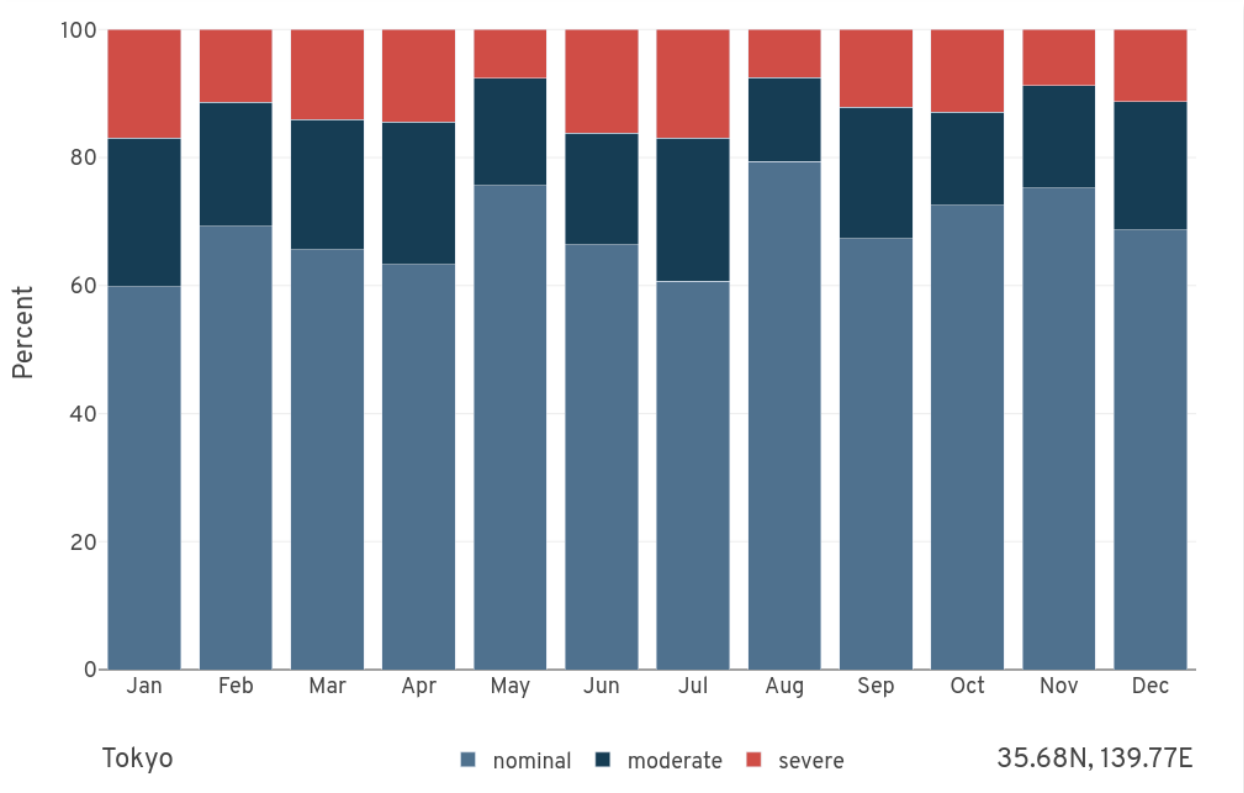
In total, 12.5% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Tokyo ranks number 219.

The predominant reason why weather conditions are classified as severe in Tokyo is the weather parameter “gust factor” with 47%, followed by “visibility” causing 38% of the severe conditions over the year.



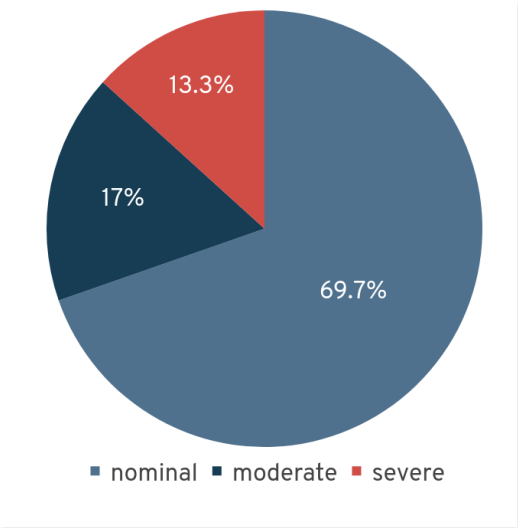
Monthly operational conditions for Tokyo

The bar chart below shows the operational conditions per month. It reveals a smooth seasonal variation in terms of severe and nominal conditions. January, together with July are the months with the highest percentage of severe conditions and August is the one with the highest percentage of nominal conditions.



Zurich

For the city of Zurich, around 69.7% of the operational conditions are classified as nominal. Zurich is thereby 2.3% points below the national average of Switzerland, which is 72%.

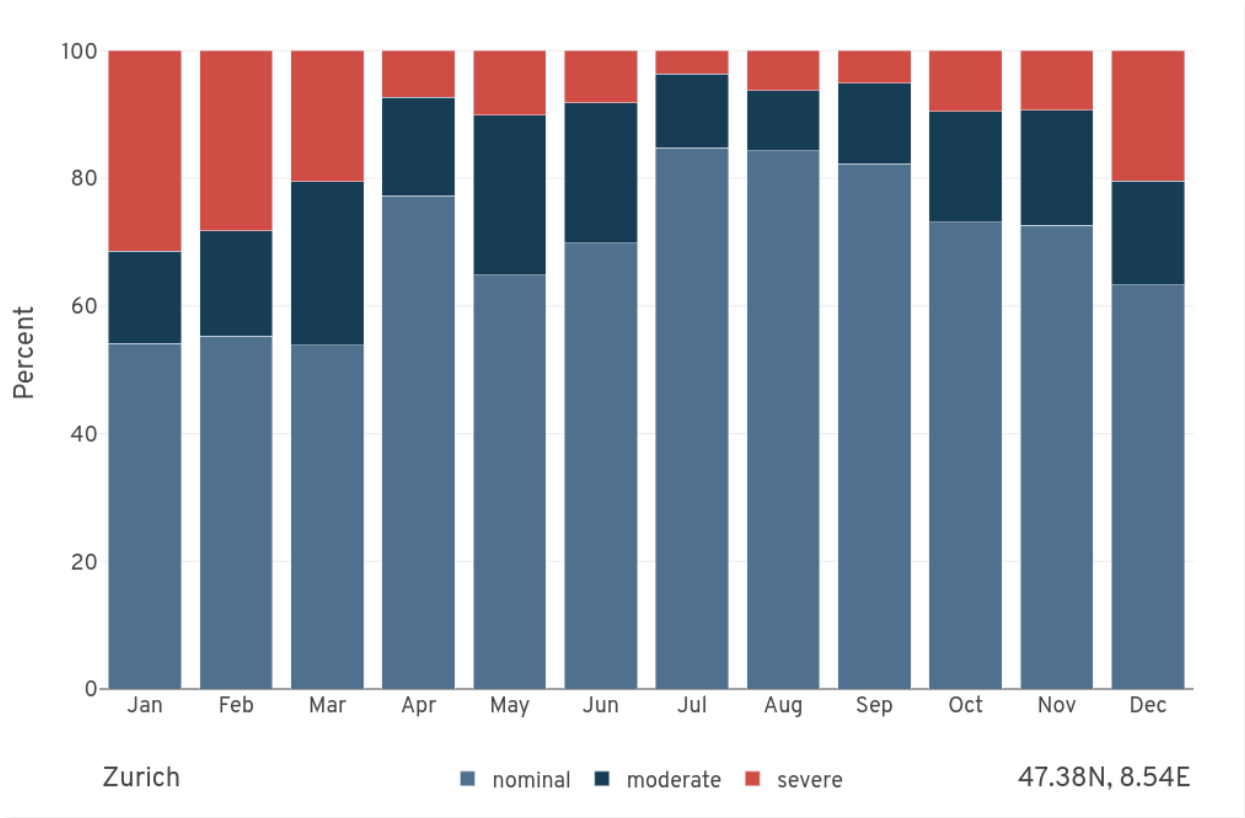


In total, 13.3% of the operational conditions are classified as severe. Out of 311 cities analyzed worldwide, Zurich ranks number 209.

The predominant reason why weather conditions are classified as severe in Zurich is the weather parameter “gust factor” with 46%, followed by “cloud ceiling” causing 28% of the severe conditions over the year.

Monthly operational conditions for Zurich

The bar chart below shows the operational conditions per month. It reveals a moderate seasonal variation in terms of severe and nominal conditions. January is the month with the highest percentage of severe conditions and July is the one with the highest percentage of nominal conditions.



4. Summary

The results of the global report show that there are strong differences in prevailing operational conditions depending on the geographic region in which cities are located. Mumbai and Bangkok, for example, show significant seasonal variations that can be explained by the monsoon season, which reduces service availability from June to the end of September. Furthermore, taking Calgary as an example, one can see that in countries with cold winters, service availability is strongly influenced during the winter months, especially by the parameter icing, which is a new addition to our analysis.

Depending on the aircraft characteristics, the results might vary strongly, i.e. an aircraft type that has an anti-icing system would show a much higher service availability in northern countries throughout the year. For aircraft without such a system it might be questionable if an air taxi service is viable the full year or can only be offered during summertime.

The top 5 parameters that show the most negative impact on the service availability are the following (in descending order):

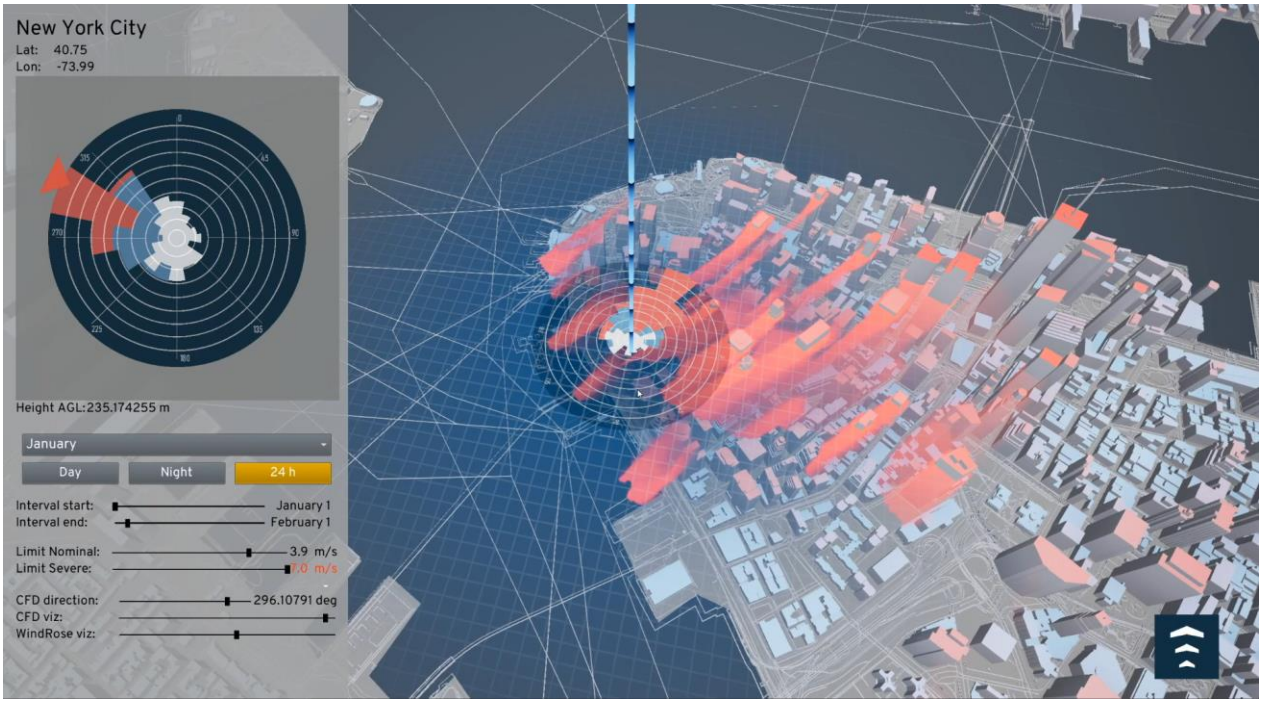
- **Gust factor** - The gust factor is defined as the difference between the peak wind gust of a 1-hour interval and the mean wind speed in the same period of time
- **Visibility** – For the analysis, the visibility on the ground was considered. Fog conditions occur if the visibility is less than 1km.
- **Icing conditions** – General Icing is a combined parameter of high humidity and low temperatures. Intermediate steps of icing as well as design and aerodynamic effects (e.g. venturi effect) favoring ice acretion are not differentiated excplicitly in this analysis.
- **Dangerous phenomena** – covers different extreme weather phenomena such as thunderstorms or hailing (full list see Section 3, parameter table).
- **Cloud ceiling** - The cloud ceiling is defined as the height of the lowest cloud layer covering more than half of the sky.

5. Outlook – New analysis types for designing flight procedures

In addition to the general service availability analyzed in this report, a more detailed examination of wind conditions and their impact on vertiport placement and design appears to be of great importance.

To determine the most appropriate approach and departure paths, prevailing wind conditions over the past 3 to 5 years can be used as a baseline to design flight procedures. In some situations seasonal effects might require alternative paths to ensure safe flight operations throughout the year.

In this context Unisphere is working on an interactive tool to create a comprehensive understanding of the situation locally by combining the dataset created by operational analytics and geospatial, buildings, obstacles, standard arrival and departure routes of nearby airports. That way the communcation between stakeholders involved is more comprehensive than a conventional report. Second, it allows to study multiple locations to be looked at without any further re-analysis.



The technology-based approach allows analyzing the wind conditions at different altitude levels to provide a holistic understanding. It furthermore supports decision-making for safety-critical aspects during vertiport planning and ensures the highest possible service availability to end customers, which is essential for a commercially viable business case.

6. Limitations of the analysis

This global report shows the benefits of using historic weather data in combination with the operational limitations of eVTOL to quantify operational availability. It is held generic by intention and can be quickly adjusted to the needs of stakeholders in the UAM ecosystem.

Like every study, there are a few limitations that must be considered regarding the results of this report:

- In this study, typical performance and limitation characteristics of eVTOL multi-rotor aircraft were considered. Depending on the aircraft type, there may be different thresholds for the parameters, e.g., a lift & cruise concept could potentially be more sensitive to a crosswind component. This means that the results are not generalizable to all eVTOL types in the same way.
- The analysis is limited to locations on the ground (10m AGL) and does not reflect conditions in the approach and departure path of an eVTOL. For example, nocturnal low-level jets (LLJ) with wind speeds up to 45 kts could cause disturbances during the approach phase. Such phenomena are not considered in the study but are assessable with a local analysis considering wind conditions at multiple levels in high granularity.
- Furthermore, the study does not explicitly differentiate between visual/instrument meteorological conditions (VMC/IMC) whereas most eVTOL operations are planned according to Visual Flight Rules (VFR). For such kinds of analyses, further information on visibility, cloud base, ceiling, and coverage should be considered.

7. About Unisphere

Unisphere is a specialist for smart software solutions to automate the flight operations of drones and air taxis. The software platform is used by leading BVLOS drone operators and supports both piloted and fully automated flight operations based on its unique simulation technology. Our data-driven analytics solutions enable vertiport and air taxi companies in the design and decision-making process for Urban Air Mobility services. Unisphere was founded in 2017 and is situated in Konstanz, Germany.

For more information, please visit: www.unisphere.de

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Chief Technological Officer

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We hope you enjoyed reading this whitepaper. Please let us be part of your thoughts and send your feedback to UAManalytics@unisphere.de

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8. Appendix

Coordinates that were used for 20 cities

Name City	Name Railway Station	Latitude	Longitude
Bangkok	Bangkok Railway Station	13.7389° N	100.5167° E
Beijing	Beijing Railway Station	39.9020° N	116.4201° E
Bogota	La Sabana Railway Station	4.6073° N	74.0832° W
Calgary	Calgary Tower Centre	51.0441° N	114.0631° W
Canberra	Canberra Railway Station	35.3192° S	149.1492° E
Cape Town	Cape Town Railway Station	33.9222° S	18.4264° E
Dubai	Dubai Metro Burj Khalifa	25.2014° N	55.2694° E
Hong Kong	West Kowloon Railway Station	22.3036° N	114.1650° E
Los Angeles	Los Angeles Metro Center Station	34.0475°N	118.2588° W
Mexico City	Buenavista Railway Station	19.4478° N	99.1522° W
Miami	Miami Metrorail Station	25.7959° N	80.2153° W
Milan	Milano Centrale Railway Station	45.4861° N	9.2036° E
Mumbai	Mumbai Central Railway Station	18.9697° N	72.8194° E
Munich	Munich Central Station	48.1402° N	11.5600° E
New York	Pennsylvania Station	40.7506° N	73.9939° W
Sao Paulo	Luz Station	23.5351° S	46.6359° W
Seoul	Seoul Station	37.5547° N	126.9708° E
Singapore	Singapore Railway Station	1.2727° N	103.8380° E
Tokyo	Tokyo Station	35.6811° N	139.7670° E
Zurich	Zurich Central Station	47.3778° N	8.5403° E