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Federal Department of Home Affairs FDHA
**Federal Office of Meteorology and Climatology MeteoSwiss**

**MeteoSwiss**

*Climate* CH2025

# Switzerland's Future Climate

ETH zürich

C2SM
Center for Climate
Systems Modeling

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

**National Centre for Climate Services NCCS**

## Imprint


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# Switzerland’s future climate

Heat warnings in summer, increased droughts, winters with little snowfall, and more intense and frequent heavy rainfall with flooding: the impacts of climate change are becoming more pronounced and occurring at a faster rate. The effects are clear to see, most notably in the form of glacier melt. As an alpine country, Switzerland is affected by these changes. How can we plan for them and what action can we take?

To answer these questions, we need to have reliable and up-to-date information. The *Climate* CH2025 climate scenarios developed by the Federal Office of Meteorology and Climatology (MeteoSwiss) in collaboration with ETH Zurich and the Center for Climate Systems Modeling (C2SM) provide this vital scientific basis. The new scenarios indicate how and in which regions climate change is having an impact, and provide a more accurate picture of Switzerland’s future climate.

In line with the Paris Agreement, under which signatory states have committed to cutting their greenhouse gas emissions, Switzerland has set itself clear targets: halving emissions by 2030 compared with 1990 levels, and reducing them to net zero by the middle of the century. This means that from 2050 Switzerland should not emit more greenhouse gases into the atmosphere than can be absorbed by additional natural and artificial sinks. These emission reductions are essential to mitigate the effects of climate change on biodiversity, our economy, our health and society.

The Climate and Innovation Act, approved by the electorate in 2023, is an important step towards achieving this. By taking proven measures in transport, construction, industry and agriculture, the Federal Council aims to continue the transition towards a low-emission Switzerland. Switzerland’s greenhouse gas emissions can be reduced through increased use of renewable energy, carbon-neutral mobility and enhanced efficiency. However, to achieve these ambitious and necessary climate goals, everyone – policymakers, businesses and the public – must play their part. The climate scenarios show how vulnerable Switzerland is to the effects of global warming. They also clearly demonstrate what we have to gain from decisive and consistent climate protection at regional, national and international levels.

Elisabeth Baume-Schneider
Federal Councillor, Head of the Federal Department of Home Affairs

# Key messages of *Climate* CH2025 at a glance

Climate change is reality. This is confirmed by long-term climate observations in Switzerland and worldwide. Global warming is clearly caused by man-made greenhouse gas emissions. It has already triggered noticeable changes, which will continue to intensify in the future.

## Switzerland is severely affected

**Swiss average temperature**

until 1991–2020: **+2.0 °C** since pre-industrial

in addition: **+2.9 °C** in a 3-degree world

Climate change is particularly evident in Switzerland

**Pages 6 and 7**

## Less snow

## More frequent and more intense heavy precipitation

**Intensity of a 1-day precipitation event with 50-year return period**

until 1991–2020: **Increase confirmed**

in addition: **+11 %** in a 3-degree world

Heavy precipitation is becoming more frequent and more intense

**Pages 12 and 13**

## More extreme heat

**Warmest night of the year**

until 1991–2020: **+3.2 °C** since 1901

in addition: **+3.8 °C** in a 3-degree world

Extreme heat is becoming more frequent and more intense

**Pages 8 and 9**

The overview shows the observed development up to 1991–2020 (above, in grey) and the expected development from 1991–2020 to a 3-degree world* (below, in red). The numbers are Swiss averages. Under the measures currently planned to reduce emissions, the world is heading for an increase of around 3 °C by the end of the century.

**Average zero-degree line in winter**

until 1991–2020: **+480 m** since 1901

in addition: **+550 m** in a 3-degree world

Precipitation is falling more often as rain instead of snow

**Pages 14 and 15**

## Every tenth of a degree counts




Many effects of climate change can be avoided or reduced through climate mitigation

**Pages 16 and 17**

## Drier summers

**Summer drought**

until 1991–2020: **Increase confirmed**

in addition: **+44 %** in a 3-degree world

Soils in Switzerland are drying out increasingly in summer

**Pages 10 and 11**

## Global warming levels

The climate scenarios show possible futures for Swiss climate based on different levels of global warming

**Page 6**

## In-depth information

Detailed information on various aspects of climate change in Switzerland

**Pages 18 to 21**

## Always the latest climate scenarios

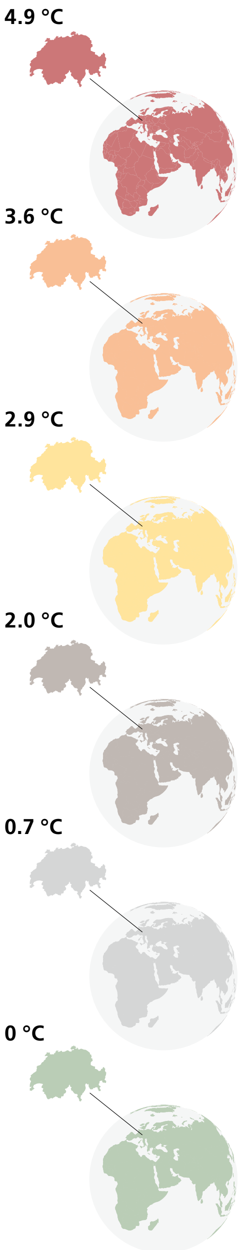
A look behind the scenes at how climate scenarios are created

**Pages 22 and 23**

* Average global temperature increase of 3 °C compared to the pre-industrial period.
More information on **page 6**

# Climate change is particularly evident in Switzerland

Climate change is particularly evident in Switzerland and is already having a significant impact. In the future, the rise in temperature in Switzerland will continue to be much more pronounced than the global average.




**3-degree world**

Average global temperature increase of 3 degrees Celsius compared to the pre-industrial period

**2-degree world**

Average global temperature increase of 2 degrees Celsius compared to the pre-industrial period

**1.5-degree world**

Average global temperature increase of 1.5 degrees Celsius compared to the pre-industrial period

**Reference period 1991–2020**

Central year 2005, corresponds to a 0.9-degree world

**WMO reference period 1961–1990**

Central year 1975, corresponds to a 0.4-degree world

**Pre-industrial period 1871–1900**

corresponds to a 0-degree world

Approximation of temperatures at pre-industrial levels

**Reading aid**

By the reference period 1991–2020, the global average temperature had already increased by 0.9 °C. A 3-degree world therefore reflects the climatic changes expected from a further 2.1 °C of global warming.

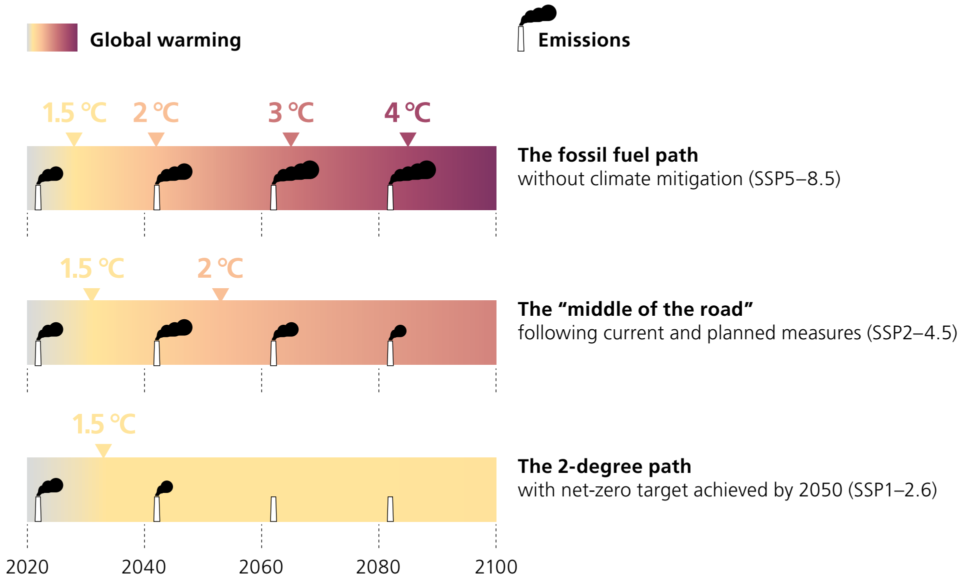
All temperature changes are rounded to one decimal place.

Globally, temperature has risen by 0.9 °C since pre-industrial times up to the reference period 1991–2020. Global temperatures have continued to rise since 1991–2020 and are currently 1.3 to 1.4 degrees above pre-industrial levels – already approaching the agreed climate targets. Effects of global warming vary widely from region to region. Across almost all continents, the observed temperature increase since pre-industrial times is significantly higher than the global average. The main reason for this is that land warms up faster than oceans.

Switzerland, with its diverse topography, is one of the regions particularly affected by global warming. The observed warming in Switzerland is around 2 °C up to the reference period 1991–2020 and around 2.9 °C by 2024. In addition to an above-average rise in temperature, extreme events such as heavy precipitation, heatwaves, and droughts have also become more frequent. Furthermore, snow and ice cover have decreased significantly.

Climate scenarios show that the changes observed to date will continue in the future and that Switzerland will continue to warm faster than the global average. In a 1.5-degree world, the average warming in Switzerland will be 2.9 °C compared to pre-industrial times (for more details, see page 18). In a 3-degree world, the average warming in Switzerland will be 4.9 °C compared to pre-industrial times and 2.9 °C compared to 1991–2020. This significant warming will have far-reaching consequences in Switzerland.

**Time of reaching a global warming level**




The climate scenarios show the possible future of the Swiss climate for different global warming levels. They show the climate conditions that will prevail in Switzerland once the global average temperature has risen to 1.5 °C, 2 °C or 3 °C above the pre-industrial temperature of 1871–1900. The approach follows the methodology of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change IPCC[1] and allows the results to be linked to the climate targets in the Paris Agreement*.

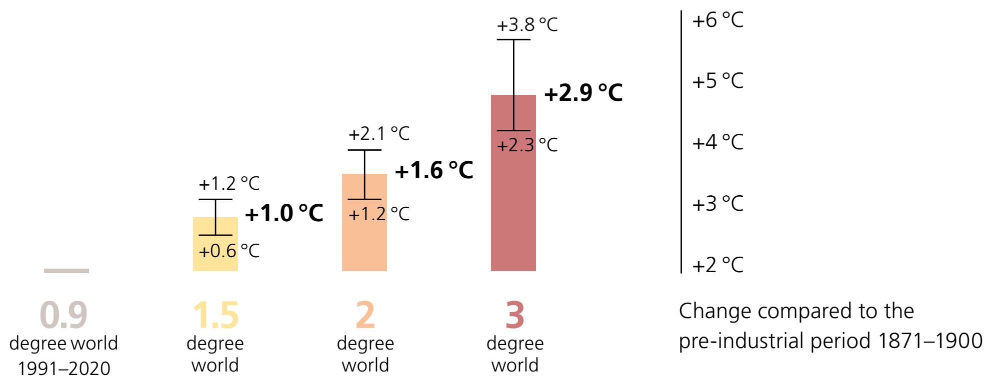
Global warming levels make it possible to show the effects of global temperature rise on Swiss climate, independently of emissions scenarios and therefore independently of the rate of global warming. The rate and thus also the point in time at which a certain warming level is reached depends fundamentally on the respective emission scenario used.

A 1.5-degree world is practically unavoidable due to past and current global greenhouse gas emissions and is expected to be reached in the next 5 to 15 years. A 2-degree world would be reached at around 2050 with current and planned climate mitigation (SSP2-4.5) or at around 2040 if we continue to rely on using fossil fuels without implementing further climate mitigation measures (SSP5-8.5). A 3-degree world would become reality around 2065 if we continue to rely on using fossil fuels without implementing climate mitigation measures (SSP5-8.5). Based on the measures currently planned for global emissions reduction, the world is heading for a temperature rise of around 3 °C by the end of the century.[1,2]

* The Paris Agreement commits all Parties to reducing greenhouse gas emissions.

**Average annual temperature in Switzerland**

Change in average annual temperature in Switzerland compared to the reference period 1991–2020 and compared to the pre-industrial period 1871–1900.



# More extreme heat

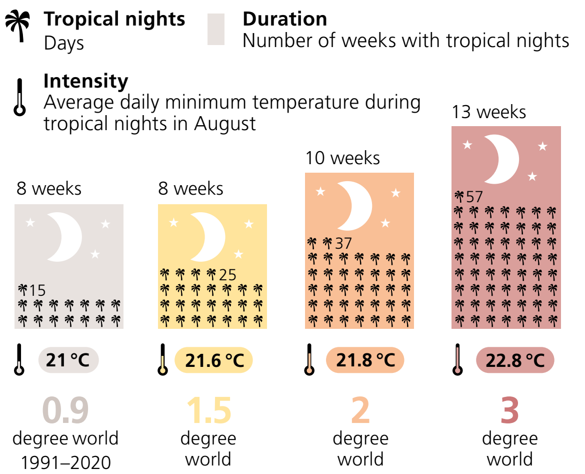
Maximum temperatures in Switzerland are rising markedly faster than average temperatures. Extreme heat events are becoming more frequent and more intense. The impacts of extreme heat have already increased significantly, particularly at low elevations and in urban areas. These trends are set to continue in the future.

The sharp rise in temperatures in Switzerland has been accompanied by an increase in extreme heat and the setting of new heat records. Temperatures that used to be very rare and extreme are now occurring much more frequently. Over the last century, the highest daytime and highest night-time temperatures have both risen significantly. Hot days (when temperatures reach at least 30 °C) have become far more frequent than in the last century. Other heat indicators such as tropical nights (when the temperature does not fall below 20 °C) are also on the rise. The warmest nights have warmed significantly more than the hottest days. Heat stress is particularly pronounced in urban areas (see page 20), as the heat island effect further reduces night-time cooling. This effect plays a central role in increased risk of extreme heat stress affecting urban areas.

In the future, Switzerland must expect significantly more frequent and more intense heat events. The increase in extreme heat in Switzerland is substantially greater than the average temperature increase in summer. Annual maximum temperatures will rise significantly as global warming increases.

**Tropical nights in Lugano**

Number of tropical nights, their seasonal duration and intensity in Lugano. Values show the expected change (median of all simulations).



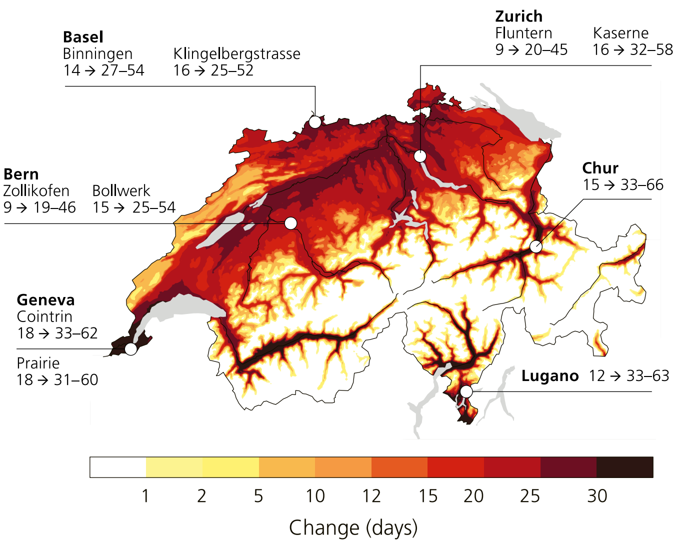

In a 1.5-degree world, the hottest day of the year in Switzerland will be 1.5 °C warmer than in the reference period 1991–2020. In a 3-degree world, the hottest day will be 4.4 °C warmer. For example, in a 3-degree world, this means a daily maximum temperature at the Basel (Binningen) monitoring station of 38.8 °C instead of 34.4 °C measured in the reference period 1991–2020.

The frequency and intensity of extreme temperatures will increase significantly. Extremely hot days, which currently only occur once every 50 years, will become approximately 2.6 times more frequent in a 1.5-degree world and around 16.7 times more frequent in a 3-degree world.

As warming increases, hot days and tropical nights will occur much more frequently than before. Low-lying and urban areas will be particularly affected (see page 20). However, regions in the Alps and Pre-Alps, where no tropical nights or hot days have been observed to date, will also be affected by heat in the future. If a heat event coincides with a severe drought, it can lead to further challenges.

**Hot days**

Expected change in the number of days per year with temperatures of at least 30 °C. Shown are the mean values measured in the reference period 1991–2020 and the possible range in a 3-degree world.



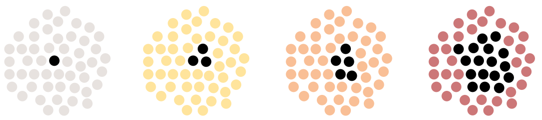


Geneva, 2012

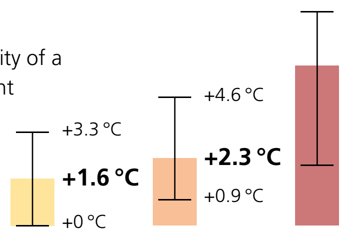
**Extremely hot days**

Change in frequency (above) and intensity (below) of extremely hot days that occur once every 50 years in the reference period 1991–2020 in Switzerland. The expected value (median of all simulations) and the possible range (spread of the simulations) are indicated.

**Frequency**
Per 50 years




**Intensity**
Increase in intensity of a 50-year heat event




Extreme heat during the day and a lack of cooling at night put strain on the body and affect health, especially among older people and young children. Physical and mental work is made more difficult during heatwaves, dense urban development exacerbates these effects.[3]

**Average summer temperature, hottest day and warmest night of the year**

Changes compared to the reference period 1991–2020. Shown are the expected values along with the possible ranges of change.

| | 1.5-degree world | 2-degree world | 3-degree world |
|---|---|---|---|
| Average summer temperature | **+1.3 °C** (0.5 to 1.9 °C) | **+2.1 °C** (1.3 to 2.8 °C) | **+3.6 °C** (2.4 to 5.1 °C) |
| Hottest day of the year | **+1.5 °C** (0.6 to 2.7 °C) | **+2.4 °C** (1.0 to 3.5 °C) | **+4.4 °C** (2.4 to 6.8 °C) |
| Warmest night of the year | **+1.1 °C** (0.6 to 2.3 °C) | **+2.1 °C** (1.1 to 2.8 °C) | **+3.8 °C** (2.3 to 5.1 °C) |

# Drier summers

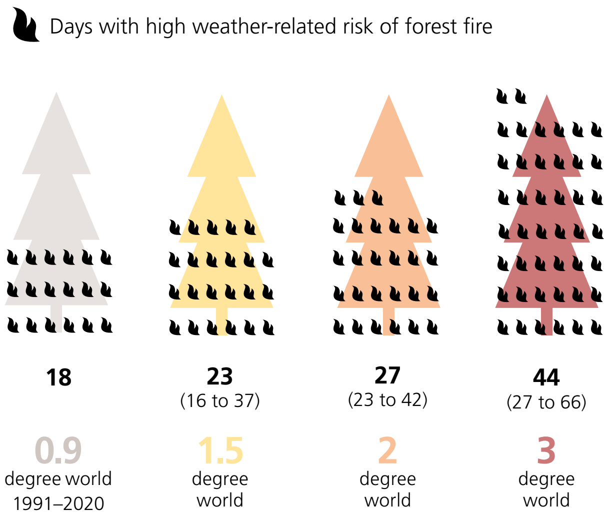
Over the past three decades, soils in Switzerland have become increasingly dry in summer. The causes include higher temperatures, increased evaporation, and decreasing summer precipitation. Summer drought and weather-related forest fire risk will continue to increase with climate change.

In Switzerland, summer soil moisture has decreased by around 5 to 10 percent since the early 1980s, according to observation-based datasets. This change is due to several factors, one of the most important being a decrease in summer precipitation, which has also been observed since the early 1980s. This trend is consistent with predictions for the future. In addition, rising temperatures cause more water to evaporate. Both solar radiation and sunshine duration have increased since the early 1980s, further stimulating evaporation. These changes accelerate summer soil drying and increasingly affect water supply, agriculture, and ecosystems.

In the future, the trend towards drier summers will intensify. This is due to both a further expected decline in average summer precipitation and faster soil drying caused by warmer and drier air. These long-term changes are overlain by significant natural year-to-year fluctuations, which are more pronounced than temperature variations. Humid summers will therefore still occur, though less frequently. On average, summers will become drier, and already dry summers will become even more extreme. Calculations show that in a 1.5-degree world, a summer drought* that occurred once every 10 years in the reference period 1991–2020 would occur about 1.6 times as often, and in a 3-degree world about 3.1 times as often. Such a drought would also be 17 percent drier in a 1.5-degree world and up to 44 percent drier in a 3-degree world.

**Weather-related forest fire risk**

Number of days per year with a high weather-related forest fire risk** in Sion. The expected value (median of all simulations) and the possible range (spread of the simulations) are indicated.




Increasing drought will significantly raise the risk of forest fires. Over the past 60 years, the potential for forest fires to start and spread has already increased in Switzerland. With even hotter and drier summers expected, weather-related risk** of forest fires will continue to rise. In a 3-degree world, the number of days with high weather-related fire risk will increase compared to the reference period 1991–2020, for example in Sion from 18 to 44 days.

* Defined by the water balance in summer: rainfall minus the water that evaporates back into the air. If the result is negative, the soil dries out.

** Days with a fire weather index higher than 95 percent of the days in the period 1991–2020.

> Due to the long dry spell, I have to continue watering my fields, so that at least part of the harvest can be saved. How much water do I have left?
>
> Valérie, Vegetable Farmer

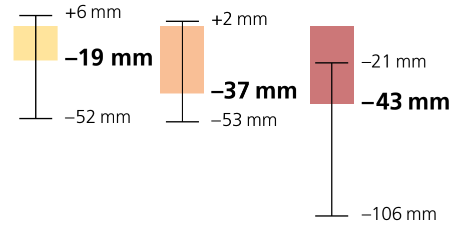
Ermatingen, 2025

## Summer drought

Change in frequency (above), water balance (middle), and intensity (below) of a summer drought* that occurs once every 10 years in the reference period 1991–2020 in Switzerland. The expected value (median of all simulations) and the possible range (spread of the simulations) are indicated.

**Frequency**
Per 10 years


**Water balance**
Change in water balance of a 10-year summer drought




**Intensity**

Relative change in the intensity of a 10-year summer drought. Here, an increase in intensity corresponds to an increasingly negative water balance. Shown are the expected values along with the possible ranges of change.

| | 1.5-degree world | 2-degree world | 3-degree world |
|---|---|---|---|
| Relative change | **+17 %** (–5 to +43 %) | **+28 %** (–2 to +47 %) | **+44 %** (+14 to +86 %) |

Drought leads to yield losses in agriculture, impairs forest health, increases the risk of forest fires, causes water shortages in reservoirs and restricts water supply. In addition, drought can intensify and prolong heatwaves.[3]

# More frequent and more intense heavy precipitation

Heavy rainfall events are occurring more frequently and are more intense to-day than in the first half of the 20th century. With climate change, Switzerland must expect a further increase in heavy rainfall across all seasons in the future.

In Switzerland, an increase in the intensity and frequency of heavy rainfall was observed during the 20th century. This increase was particularly noticeable in summer. The intensity of short-duration events (e.g., lasting around ten minutes) increased more than longer-duration events. The intensity of the heaviest 10-minute precipitation in summer has increased by around 20 percent since the 1980s, whilst the heaviest 3-hour precipitation has increased by around 10 percent. The rise in air temperature largely explains the increasing intensity of heavy rainfall. For every degree of warming, the air can hold 6 to 7 percent more water. Accordingly, this additional moisture can contribute to heavy rainfall becoming more intense.

As temperatures rise, both the intensity and frequency of heavy precipitation events will increase in all seasons. In a 3-degree world, the strongest 1-day precipitation events of the year are expected to increase by around 9 percent compared to the reference period 1991–2020. The shorter the duration of precipitation events, the greater the increase in intensity.

Increases in intensity of up to 30 percent can be expected, particularly for 1-hour precipitation events. Development of heavy precipitation events varies greatly in terms of time and space and can deviate from the long-term trend over longer periods. Overall, however, the models show a consistent increase. A single-day precipitation event that occurs once every 50 years in the reference period 1991–2020 will occur twice as often in a 3-degree world. In summer, the increasing intensity of individual precipitation events is likely to be more frequently associated with thunderstorms and hailstorms.

More intense precipitation in summer does not rule out a simultaneous decrease in total precipitation. Although it may rain fewer times per season in the future, individual events that produce large amounts of rain in a short period of time can still occur. Heavy precipitation can cause significant damage, for example through flooding or mudslides. In addition, the rise in the snow line in winter (see page 14) increases the proportion of liquid precipitation and consequently the volume of water entering river systems.

**Heavy precipitation**

Change compared to the reference period 1991–2020. Shown are the expected values along with the possible ranges of change.

| | 1.5-degree world | 2-degree world | 3-degree world |
|---|---|---|---|
| Maximum daily precipitation (total over a year) | **+3.5 %** (–0.2 to +5.9 %) | **+4.7 %** (–0.5 to +9.4 %) | **+9.0 %** (+5.2 to +15.2 %) |
| Intensity of a 50-year one-day event (total over a year) | **+2.8 %** (–3.8 to +10.6 %) | **+5.1 %** (–1.5 to +12.5 %) | **+11.1 %** (+4.3 to +21.6 %) |

> Heavy rainfall is becoming more frequent and intense. Do I need to plan further protective measures?
>
> Urs, Homeowner

Ticino, 2024

Sudden flash floods or hail can cause property damage and business interruptions. People's safety can also be swiftly compromised.[3]

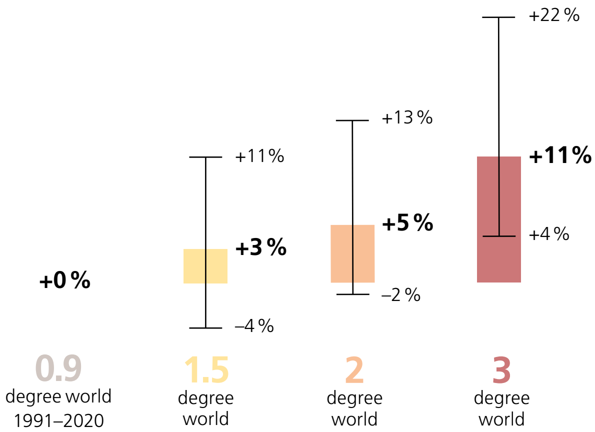
**Extreme heavy precipitation events**

Change in frequency (above) and intensity (below) of an extreme 1-day heavy precipitation event that occurs once every 50 years in the reference period 1991–2020 in Switzerland. The expected value (median of all simulations) and the possible range (spread of the simulations) are indicated.

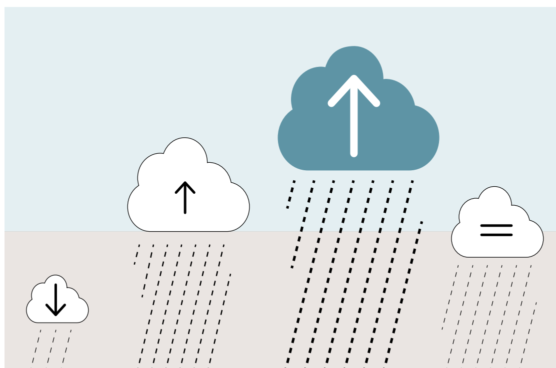
**Frequency**
Per 50 years

| | | | |
|---|---|---|---|
| **Once** | **1.2 times** (0.8 to 1.9) | **1.4 times** (0.9 to 2.3) | **1.9 times** (1.4 to 3.6) |
| 0.9 degree world 1991–2020 | 1.5 degree world | 2 degree world | 3 degree world |

**Intensity**
Increase in intensity of a 50-year heavy precipitation event




**Change in average precipitation and extreme precipitation**



| | | | |
|---|---|---|---|
| **Mean Summer precipitation** (decrease) | **Mean Winter precipitation** (increase) | **Extreme precipitation** (increase) | **Yearly mean precipitation** (no change) |

# Less snow

Since the beginning of the 20th century, the zero-degree line in Switzerland has risen sharply. At high elevations, precipitation increasingly falls as rain rather than snow. As a result, snow cover is decreasing and the melting of snow and ice is accelerating. This trend will continue to intensify in the future.

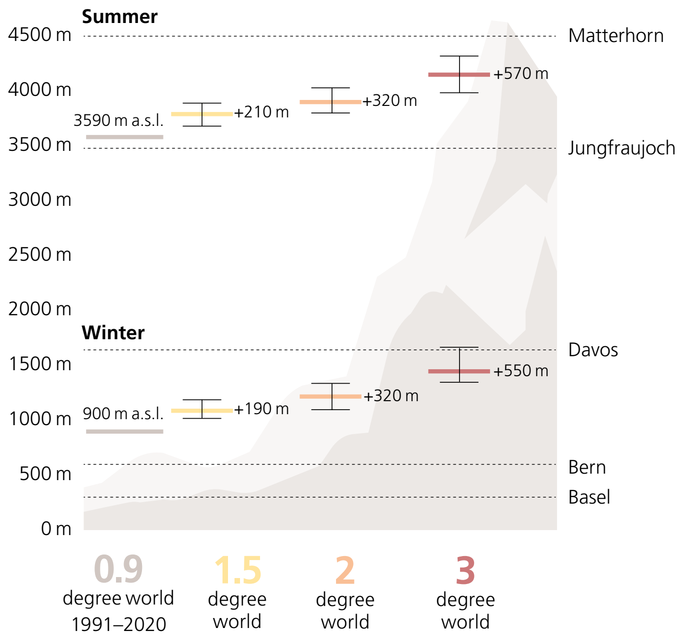
Rising temperatures have visibly changed the winter landscape in Switzerland over the past century. Around 1900, the winter zero-degree line was still at the average elevation of Zurich, about 420 meters above sea level. In the reference period 1991–2020, it had already risen to the elevation of Einsiedeln (900 m a.s.l.). With continued warming, the winter zero-degree line will rise by another 200 metres in a 1.5-degree world, slightly above the elevation of Gstaad (1050 m a.s.l.), and by a further 550 metres in a 3-degree world, reaching approximately the elevation of Andermatt (1450 m a.s.l.). The zero-degree line will also rise significantly in summer, accelerating the melting of snow and ice even on the highest Alpine peaks.

Depending on the extent of further global warming, climate models project an increase in winter precipitation of 11 to 14 percent. As temperatures rise, a growing share of this precipitation will fall as rain instead of snow, especially at lower elevations. The proportion of snow in winter precipitation, which has already declined significantly in Switzerland, will continue to decrease with further warming. In a 3-degree world, the snowfall share will drop by around 25 percent, while rainfall will almost double. As a result, snowfall amounts will decline markedly despite higher overall precipitation. The snow-to-rain ratio is strongly elevation-dependent.

The rising zero-degree line will also affect snowmelt, which will occur much earlier at all elevations. This will substantially shorten the snow season. With further warming, snowmelt will begin earlier, reducing the capacity of snow cover to store water. Consequently, meltwater will increase in the winter half-year but decrease in the summer half-year, leading to lower river discharge in summer.

**Zero-degree line**

Average elevation of the zero-degree line in winter (below) and summer (above) in Switzerland. The expected value (median of all simulations) and the possible range (spread of the simulations) are indicated.



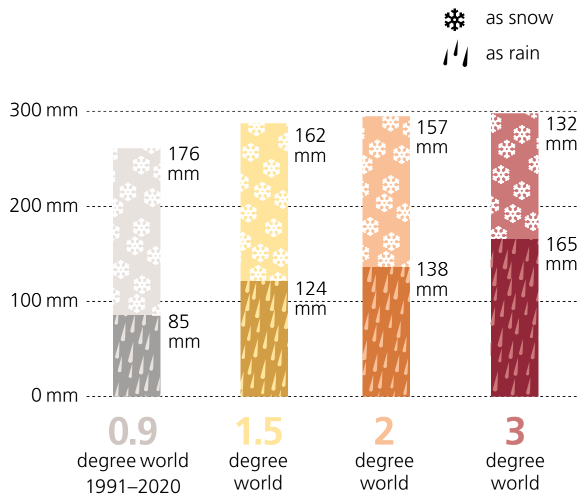
Over recent decades, many winters have seen little snow. What will our beautiful winter landscapes look like in the future?

Gian, Snowboarder

Valais, 2024

### Contribution of snow and rain

Average winter precipitation (in mm) and its form (proportion of snow and rain) in Switzerland. The expected values (median of all simulations) are shown.




Alpine habitats for plant and animal species are under pressure. The natural snow season is getting shorter, which is having a negative impact on winter tourism and may exacerbate summer drought. Thawing permafrost and melting glaciers can lead to unstable slopes. The water cycle may be disrupted.[3]

### Snowpack water storage

Relative change (%) in snow water equivalent (water stored in the snowpack) compared to the reference period 1991–2020. Swiss average between September and May depending on the elevation. Shown are the expected values along with the possible ranges of change.

| | 1.5-degree world | 2-degree world | 3-degree world |
|---|---|---|---|
| 2000 to 2500 m | **–19 %** (–39 to 0 %) | **–28 %** (–50 to –10 %) | **–44 %** (–57 to –28 %) |
| 1500 to 2000 m | **–34 %** (–63 to –19 %) | **–44 %** (–76 to –31 %) | **–63 %** (–82 to –47 %) |
| 1000 to 1500 m | **–51 %** (–76 to –29 %) | **–61 %** (–86 to –40 %) | **–78 %** (–92 to –65 %) |
| 500 to 1000 m | **–57 %** (–81 to –36 %) | **–63 %** (–86 to –42 %) | **–80 %** (–92 to –71 %) |

# Every tenth of a degree counts

How much and how quickly the climate continues to change depends on future human greenhouse gas emissions. To meet agreed climate targets, the international community must reduce its emissions rapidly and significantly. Every reduction lessens the impacts, including those in Switzerland. At the same time, adaptation to ongoing changes is essential, with the severity of impacts guiding the scale of measures taken.



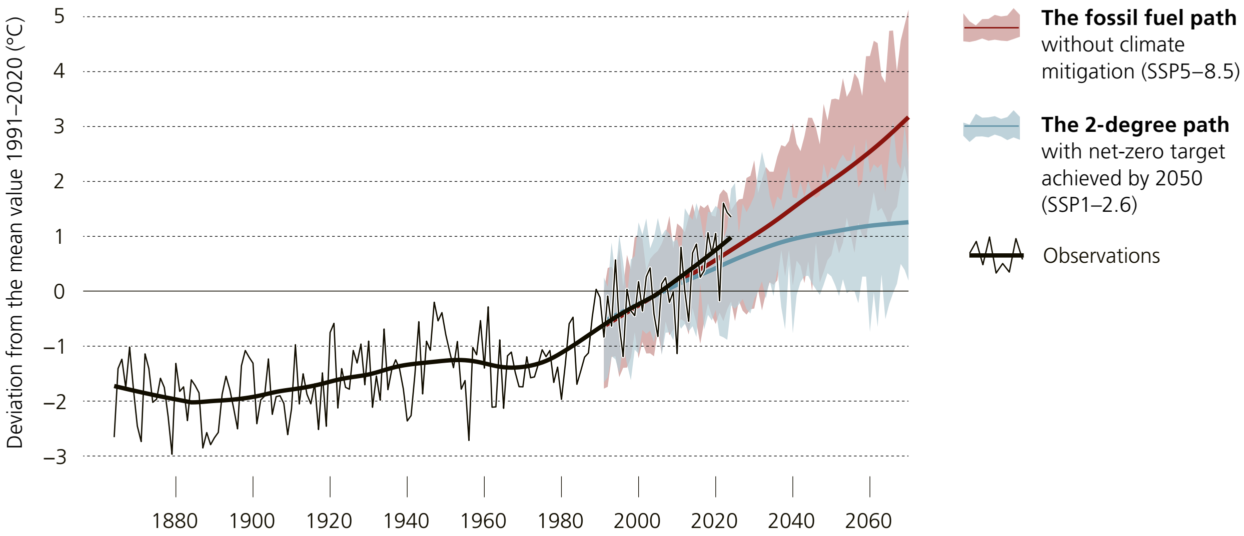

**Climate change and international climate targets**
Humans are primarily responsible for climate changes over the past 150 years. These changes result mainly from emissions of greenhouse gases, particularly carbon dioxide, methane, and nitrous oxide. In Switzerland, warming over the last 50 years has been at least three times greater than natural fluctuations. Every additional emission of greenhouse gases causes further temperature increases. Since most greenhouse gases persist in the atmosphere for decades, centuries, or even millennia, their effects accumulate over time. To halt global warming, net emissions must eventually be reduced to zero.

Switzerland ratified the Paris Climate Agreement in 2017 and, through the Climate and Innovation Act, committed to achieving net-zero greenhouse gas emissions by 2050, aiming to limit global temperature rise to well below 2 degrees Celsius above pre-industrial levels. Achieving climate targets requires both global action and national contributions.

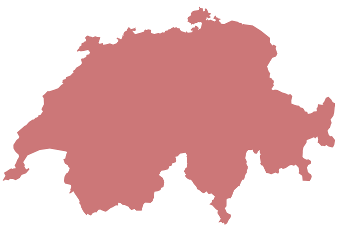
**Climate scenarios as a basis for adaptation**
The *Climate* CH2025 scenarios illustrate how Switzerland's local climate has changed in the past and how it is expected to evolve in the future. The temperature increase is particularly pronounced in Switzerland, with warming significantly exceeding the global average. In addition to rising temperatures, precipitation patterns are also changing, increasing the risk of regional droughts as well as more frequent heavy rainfall. The extent of these impacts is a direct consequence of global temperature rise and depends entirely on future global emissions. With ambitious climate mitigation measures and global net-zero emissions by 2050, most long-term warming and many of the resulting impacts could be avoided.

Recent data indicate that global warming of 1.5 degrees Celsius will be reached within a few years. The effects of climate change are already visible and will intensify in the future. Every fraction of a degree avoided contributes measurably to climate protection and reduces the adaptation efforts required. Nevertheless, adaptation to climate change is becoming increasingly important. Switzerland has had a climate change adaptation strategy since 2012, which is regularly revised to incorporate the latest findings. The new climate scenarios from *Climate* CH2025 will provide an important basis for the next revision of the adaptation strategy. This strategy supports policymakers and society in reducing risks and making climate-adapted decisions.

**Annual mean temperature evolution in Switzerland**




Shown are the observations for the period 1864–2024 (thin black line) and the development of the climate average (thick black line). The coloured lines show the expected future development of the climate mean for the emission scenarios SSP1–2.6 (the 2-degree path with net zero around 2050, blue line) and SSP5–8.5 (the fossil fuel path without climate mitigation, red line). The colour shading shows the uncertainty range (bandwidth of the simulations).



Many of the impacts that have already occurred are irreversible. However, every degree of avoided warming – even as little as a tenth of a degree – provides a measurable benefit for climate mitigation and reduces the need for adaptation.

Summers are becoming increasingly stressful for me, but I know that consistent climate mitigation can curb further increases in hot days and tropical nights.

Drought is forcing me to water my crops more and more. But I realise that consistent climate mitigation can prevent further increases in summer drought.

Heavy rainfall is becoming more frequent and intense and can cause significant damage. But we can do something about it: effective climate mitigation can prevent heavy rainfall from becoming even more frequent and intense.

Snow is increasingly absent in winter and snowmelt is occurring earlier. This is changing the water balance and affecting ecosystems. But effective climate mitigation helps reduce the future decline in snow cover.

# Understanding the Key Messages

In-depth analyses provide insights into the observed temperature increase and urban heat stress, as well as new findings on changes in extreme precipitation, circulation patterns and other aspects of climate change.

**Why is it not a contradiction that Switzerland is already as warm today as expected in a 1.5-degree world?**
By 2024, Switzerland has already warmed by around 2.9 degrees Celsius compared with pre-industrial levels (1871–1900). Even in a 1.5-degree world, climate models project a warming of about 2.9 degrees for Switzerland. Globally, however, the temperature increase remains just below the 1.5-degree threshold, at around 1.3 to 1.4 degrees Celsius. How does this fit together? The answer lies in the uncertainties surrounding both current measurements and future projections. The present estimate of 2.9 degrees Celsius could in fact lie between 2.6 and 3.2 degrees Celsius. Likewise, a 1.5-degree world corresponds to a similar range of 2.6 to 3.2 degrees Celsius. This shows that Switzerland is already experiencing conditions comparable to those expected in a 1.5-degree world. In addition to the direct effects of global warming, natural fluctuations in the weather patterns also play a role. Certain atmospheric conditions can temporarily amplify warming. Understanding how significant these effects are, and whether they are persistent or short-lived, remains an active area of research.

**Observed warming is significantly greater than natural fluctuations**
The climate system can fluctuate considerably from year to year. Numerous natural processes may overlap, amplifying or dampening each other. Experts refer to these fluctuations as internal variability. In a climate without external influences, variations would occur around a constant mean value. However, when external factors such as human-induced greenhouse gas emissions act on the climate, this mean value gradually changes over time.

When creating climate scenarios and analysing past changes, it is essential to distinguish between internal variability and external influences. Numerous studies show that the observed global warming of the last 50 years exceeds natural climate variability by a factor of three. Only by accounting for anthropogenic climate change can the observed rise in air temperature be explained. A purely natural warming of the atmosphere of the observed magnitude can therefore be ruled out.

**Change in large-scale circulation patterns**
Large-scale circulation patterns influence weather over several days. Examples include high-pressure systems which bring heat in summer, and low-pressure systems, which cause heavy precipitation in winter. The frequency of these patterns is part of natural variability and depends on the season. Currently, there are no clear indications for Switzerland as to whether the frequency of circulation patterns will change in the future, as natural fluctuations remain significant even in a warmer climate. At the same time, the intensity of weather phenomena associated with certain conditions is expected to increase due to climate change. Even if the frequency of these patterns does not change, high-pressure systems in summer will for example produce more intense heat waves, and low-pressure systems will bring heavier precipitation.

**Changes in other parameters and processes**
In summer and autumn, climate scenarios indicate a slight decrease in relative humidity in Switzerland, particularly in the Alps and Ticino. This increases the risk of heat and drought during these seasons and reduces the frequency of cloud formation and rainfall. At the same time, more solar radiation reaches the Earth's surface in summer, especially north of the Alps, which can further exacerbate warming. In winter and spring, solar radiation decreases slightly, somewhat dampening warming during these seasons. Average wind speeds are projected to change little. However, it is unclear how well the scenarios capture changes in regional and local winds, so no conclusion can be drawn about regional wind systems such as the Föhn and Bise. The frequency of fog and high fog on the Swiss Plateau has decreased significantly in some areas over the past few decades. The reasons for this are not yet fully understood, and future changes remain uncertain. Many of these small-scale processes require more detailed climate models than those currently available for the climate scenarios, but with continued support for model development and climate research in Switzerland, breakthroughs in understanding will follow.

## Seasonal and regional differences in temperature and precipitation changes

Changes in temperature and precipitation across Central Europe exhibit clear seasonal and regional differences. For example, temperatures rise more in summer than in winter. In summer, Switzerland experiences stronger warming influenced by the Mediterranean region, whereas in winter, warming is weaker in Switzerland but significantly stronger in Northern and Eastern Europe.

Average precipitation decreases in summer and increases in winter. Over the course of the year, these opposing trends largely balance out, so that annual average precipitation changes very little. Switzerland is part of a broader European pattern, which shows a significant decrease in summer precipitation in southern Europe and an increase in winter precipitation in northern and eastern Europe.

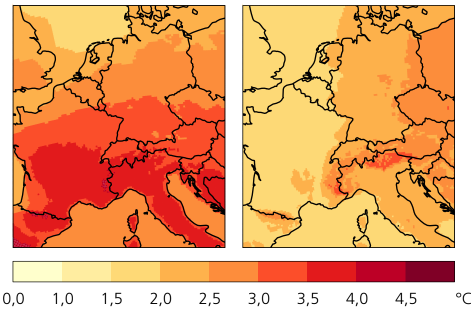
Within Switzerland, regional differences in temperature change are relatively small. Warming tends to be slightly stronger at higher elevations, particularly in spring and summer, although this elevation dependence should not be overinterpreted, as scenarios may slightly overestimate the effect. Regional differences in precipitation within Switzerland are also minor. Southern Switzerland shows somewhat stronger signals of change, with larger increases in winter and stronger decreases in summer.

**Seasonal changes**

Spatial change in mean temperature and mean precipitation in summer and winter compared to 1991–2020, in a 3-degree world.

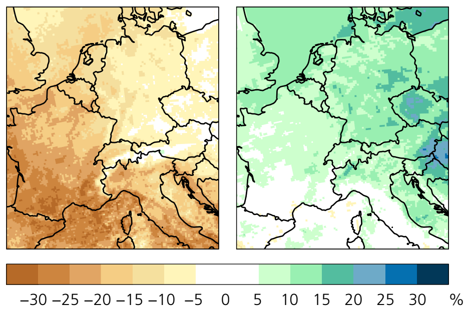
**Temperature**

Summer Winter




**Precipitation**

Summer Winter

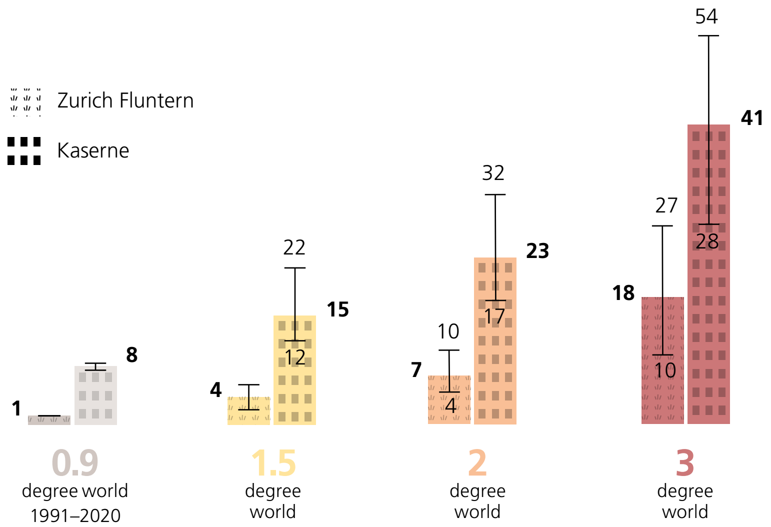


## Strong increase in heat stress in urban areas

Urban areas influence the local climate. Due to the high proportion of sealed surfaces, cities heat up faster and more intensely during the day than their rural surroundings, and they cool down more slowly at night. As a result, urban areas experience more intense heat. This so-called heat island effect is most pronounced in summer and at night. Between 1991 and 2020, for example, an average of 8 tropical nights per year was observed at the Zurich Kaserne urban measuring station, compared with only one at the less centrally located Zurich Fluntern. In a 3-degree world, Zurich Fluntern would experience an average of around 18 tropical nights per year, while Zurich city centre could see as many as 41 – more than five times the number in the reference period. Heat stress can also vary greatly within a city. A case study for the city of Bern illustrates this clearly: between 2018 and 2024, almost no tropical nights were recorded in the surrounding areas, whereas up to 5 occurred in the city centre. In a 3-degree world, up to 10 tropical nights per year would be expected in Bern's green areas and up to 21 in the city centre.

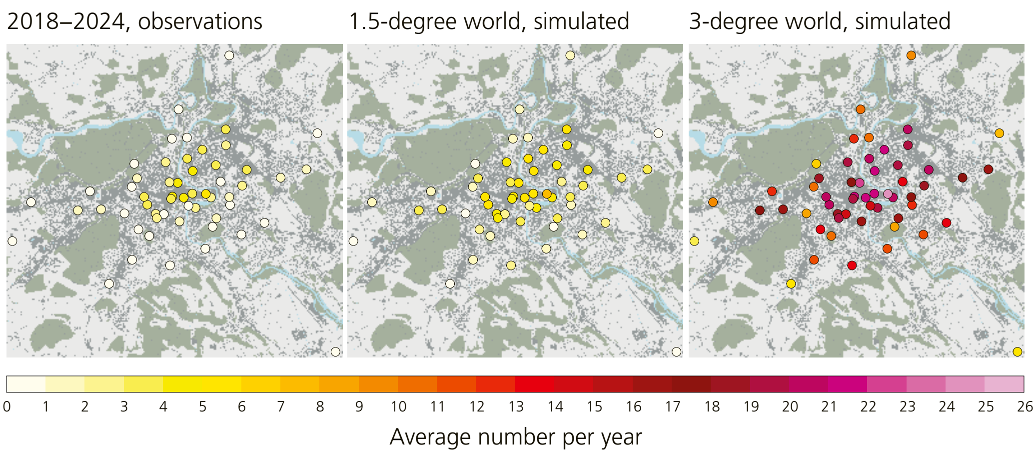
**Tropical nights in the City of Zurich**

Number of tropical nights per year in Zurich. The values show the expected value (median of all simulations) and the possible range (spread of the simulations).




**Tropical nights in the City of Bern**

Number of tropical nights per year in Bern in today's climate and future climate.
The values show the expected value (median of all simulations).



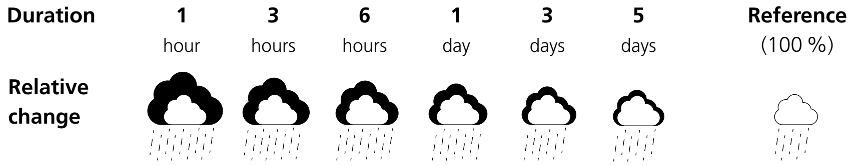
## Significant change in short-term heavy precipitation

In Switzerland, short-duration heavy precipitation events, such as those that occur during thunderstorms, have increased in intensity in recent decades. Measurements show a statistically significant rise in 10-minute and 1-hour heavy precipitation events, particularly in summer. High-resolution climate models project a further intensification of these events as warming continues. The increase is more pronounced for short-term precipitation than for longer-duration events.

A warmer atmosphere can hold more water vapour and store more energy. During thunderstorms, this energy is released, sometimes forming hail. Initial studies for Switzerland suggest that both the frequency and size of hail could increase significantly with warming, especially on the northern side of the Alps. This could lead to greater hail-related damage to buildings, as indicated by damage simulations.

**Short-duration precipitation becomes more intense.**

Relative change of heavy precipitation intensity depending on the duration.

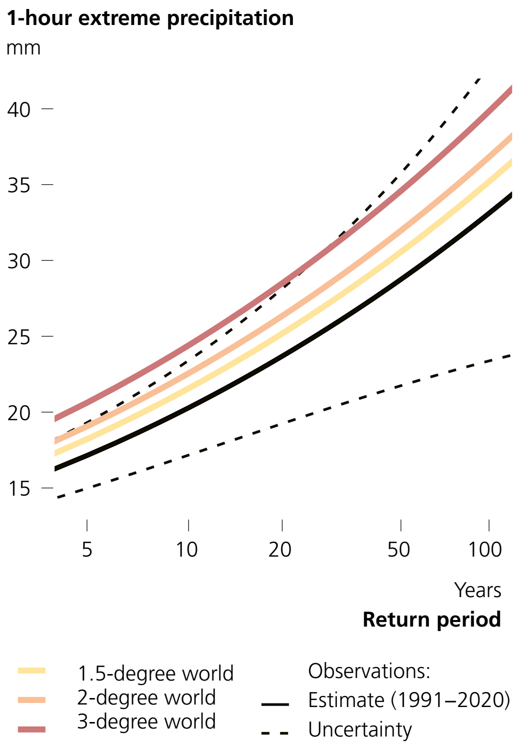



## Extreme precipitation scales up with increasing warming

The intensity of extreme precipitation events is estimated using statistical methods. Future projections can be refined further by incorporating additional physical principles. A key concept is the Clausius-Clapeyron relationship: with each degree of warming, air can hold roughly 6 to 7 percent more water vapour. During heavy rain events, higher temperatures can lead to increased precipitation, particularly during thunderstorms. Observations and high-resolution climate models confirm this relationship, especially for short, intense rainfall over a few hours. The Clausius-Clapeyron relationship provides a basis for estimating how much rainfall can increase with rising temperatures. Future increases generally lie at the upper end of today's uncertainty range, which can guide practical decisions for climate adaptation.

**Scaling of extreme precipitation**

Intensity and return period of 1-hour precipitation events with a return period of 50-years (across a whole year, averaged over Switzerland).



# Always the most up to date climate scenarios

The results from *Climate* CH2025 provide detailed information for understanding climate change in Switzerland and support informed decision-making on climate mitigation and adaptation. Regular updates are essential to incorporate the latest scientific findings. Further information and datasets are available at: www.climate-scenarios.ch.

**Why new climate scenarios?**

Based on the Federal Council's mandate and as part of Switzerland's strategy for adaptation to climate change, the Federal Office of Meteorology and Climatology, MeteoSwiss, regularly provides up-to-date climate scenarios that are freely available for all applications. MeteoSwiss develops these scenarios in collaboration with ETH Zurich and other partners under the umbrella of the National Centre for Climate Services (NCCS). At the global level, the latest scientific findings on climate change are published regularly by the Intergovernmental Panel on Climate Change (IPCC). These are then downscaled for Switzerland within the framework of the Swiss climate scenarios, using the latest scientific methods and explicitly taking use needs into account.

**What is new about *Climate* CH2025?**

The previous CH2018 climate scenarios already showed clear climate trends: more extreme heat, more frequent heavy precipitation, drier summers and winters with less snow. Since then, the climate itself, science, and user needs have continued to evolve. A key objective of *Climate* CH2025 was to better link observational data and model-based scenarios. This enables consistent and application-oriented information to be provided, for example, through the introduction of global warming levels. These allow political climate targets to be directly compared with climatic impacts.

*Climate* CH2025 builds on CH2018 and expands the work with longer measurement series, improved process understanding and information from new, high-resolution and convection-permitting climate simulations. In addition, the current MeteoSwiss reference period 1991–2020 is used. Detailed information on heavy precipitation and heat in urban areas is also compiled. In line with the rapid warming observed, the new scenarios show higher warming than previous projections. In a 3-degree world, this corresponds to approximately 10 to 15 percent more warming than reported in CH2018.

**How are the results obtained?**

A large number of climate simulations are used to estimate Switzerland's future climate. These climate projections are based on internationally agreed scenarios of how the world might develop in the future – for example, in terms of energy consumption, population growth and technological development pathways. Assumptions about socio-economic development are described using Shared Socioeconomic Pathways (SSPs), from which a specific range of possible greenhouse gas emissions is derived. Experts refer to these ranges as Representative Concentration Pathways (RCPs). The RCPs make it possible to estimate how the future socio-economic developments and associated greenhouse gas emissions will affect the climate.

Global climate models use the SSP-RCP scenarios and, through climate simulations, derive comprehensive information on possible climate conditions worldwide. However, they are not accurate enough to make statements about individual regions. The EURO-CORDEX initiative (Coordinated Regional Climate Downscaling Experiment – European Domain) of the World Climate Research Programme refines global climate simulations for Europe using regional climate models. These models use a grid size of approximately 12 kilometres. Compared with previous scenarios, the *Climate* CH2025 model results have been expanded and updated to include findings from the latest IPCC Assessment Report. Developing the *Climate* CH2025 scenarios highlights the vital role of international cooperation, especially within Europe. Reliable climate scenarios for Switzerland are only possible through shared data, expertise, and modelling.

Statistical methods are used to further refine results of regional climate simulations. Data from long-term, reliable measurements from MeteoSwiss are used for this purpose; the quality and continuity of which are ensured by the National Climate Observation Programme (GCOS-CH). This enables statements to be made for specific meteorological measurement locations and comprehensive maps with a resolution of one kilometre – for example, for both temperature as well as precipitation. Results of these analyses are supplemented with information from high-resolution, temporally and spatially detailed climate models that allow for convection. These models depict local processes, such as heavy precipitation, thunderstorms, and hail in a considerably more realistic way, thereby contributing to a better understanding of the processes and providing new foundations for practical application. Due to the high computational effort involved, climate simulations of these models are currently only calculated for short periods of time, but their importance will increase in the future.

An important methodological innovation in *Climate* CH2025 concerns the presentation of the results. The climatic impacts in Switzerland are described using global warming levels. Three warming levels are examined in more detail: the 1.5-degree world, the 2-degree world and the 3-degree world. These describe the state of the atmosphere when the global average ground-level temperature deviates by 1.5 degrees, 2 degrees and 3 degrees Celsius from the pre-industrial average. This approach makes it possible to analyse climate change in Switzerland specifically for certain global warming levels – regardless of when these are reached. This allows the scenarios to be directly linked to international climate targets and applied in a more practical manner. It is possible to assign global warming levels at the time they occur, but this depends on the emissions scenario (SSP-RCP) selected in each case.

**Further research supports adaptation to climate change**

The new *Climate* CH2025 scenarios reflect the current state of climate science and are based on the latest concepts in climate communication. Both subject areas, as well as many related disciplines, are developing rapidly. The Climate Scenario Consortium closely monitors these developments, actively participates in relevant discussions, and continuously advances new methods and knowledge bases. As before, new findings are regularly incorporated into the current climate scenarios to reflect the expanding needs of users. On the scientific side, this often requires further development in process understanding and improved representation of relevant climate processes in models. This involves, for example, closing existing gaps in knowledge about weather and climate extremes. Better understanding of the advantages of high-resolution climate simulations is also important. In addition, possible changes in large-scale circulation patterns should be assessed more reliably. Another objective is to harness the potential of artificial intelligence for modelling and post-processing the results. These and many other areas will further advance Swiss climate scenarios, helping to create an even stronger scientific basis for climate change adaptation in Switzerland.

More products and information can be found at:
**www.climate-scenarios.ch**