# How are the precipitation and temperature maps in seNorge and Xgeo made?

The precipitation and temperature maps in seNorge and Xgeo are made by interpolating between measuring stations for precipitation and temperature.

This is how the precipitation map in seNorge and Xgeo can look like.
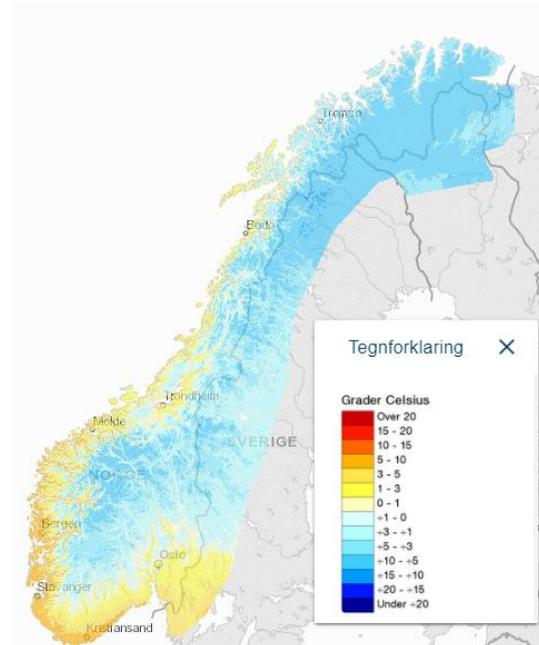
This is how temperature maps in seNorge and Xgeo can look.

Based on observations and the weather forecast

The precipitation and temperature maps can be divided into observation-based maps and forecast based maps. The observation-based maps show the weather as it has been, while the forecast-based maps are based on a weather forecast.

There are observation-based maps of precipitation and temperature from 1.1. 1957 until yesterday's date. The forecast-based maps are available for today and 9 days ahead.

Daily sum and daily average

Basically, it is the daily data that is displayed, i.e., the sum of how much precipitation that has come during the day, or expected through the day, and the average temperature for the day.

In xgeo.no, a three-hour map is also available that shows the sum of precipitation for three hours and a three-hour average temperature.

From observations to maps

The basis for the observation-based precipitation and temperature maps in seNorge and Xgeo are measurements of precipitation and temperature that are performed at various measuring stations around the country. The number of stations included in the interpolating has varied over time. The total number of available measurements are used in the interpolation. Using different interpolation routines, the measurements are interpolated to each square kilometer route in the country.

The precipitation- and temperature maps in seNorge and Xgeo are produced by MET.
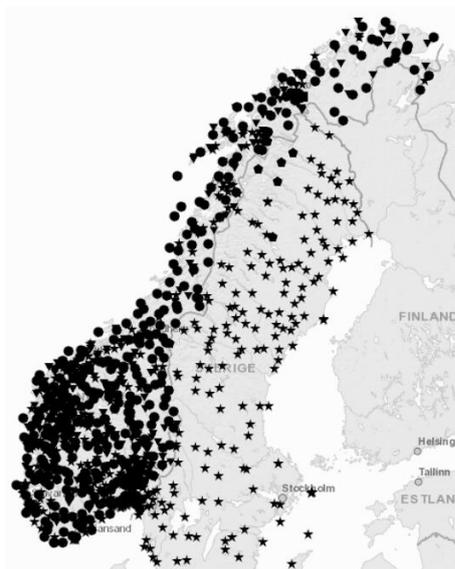
Map of precipitation stations in the country, sorted by owner.
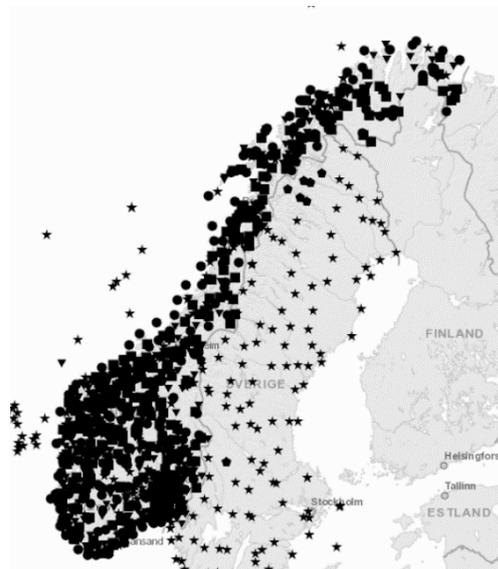
Map of temperature stations in the country, sorted by owner.

Prognosis and forecasts

The maps showing precipitation and temperature conditions in the future are based on the weather forecasts. The prognosis maps are made for 9 days in advance.

The prognosis of precipitation and temperature are based on a numerical weather forecast model that calculates precipitation and temperature in a grid across the country. The weather forecast

model is based on the weather as it is now and uses physical laws, empirical relationships, and mathematical modeling to calculate how the weather is going to be in the future.

The basis for the forecast maps for the next 2-3 days is the weather model MEPS (MetCoOp-Ensemble Prediction System) which is further refined and adapted to Norwegian conditions by MET (Metpp Nordic Forecast)

For the next 3-10 days, the maps are based on the weather model called ECMWF (ecmwf.org).

For Svalbard, the weather model AROME-Artic is used.

For experienced users

What time does the interpolation cover?

The observations of precipitation and temperature at the measuring stations are done at 7 am (8 am Summer time) every day.

Yesterday's map is based on measurements made at 7 (or 8) today. If the accumulated amount of precipitation is 10 mm from 7:00 yesterday to 7:00, it will give 10 mm in yesterday's map since most of the time from 7:00 yesterday to 7:00 is yesterday. If there is a lot of precipitation in the middle of the night during the night to day, you will find it in yesterday's map.

When will the various maps be updated

The observation-based maps

The observation-based maps are updated with the latest observations between 08 and 09 (09-10 summer time). Normally, what was a forecast map before the observations came in will be replaced by an observation-based map at this time. The users of the maps will recognize it by looking at the colored label in the legend.

As more observations are received through the day, several updates are performed in the observation-base. In addition to the "main update" in the morning, the maps are also updated in the evening (7 pm winter time, 8 pm summer time).

The forecast-based maps are updated every time a new weather forecast is launched. The number and letters in parentheses (00H, 06H, 12H, 18H) refer to the start time of the model run. 00H means it starts at midnight (UTC), 06 means at 06 (UTC), 12 means at 12 (UTC), while 18 means at 18 (UTC).

- ~ 5 am with new Met-pp (00H) weather forecasts

- ~ 10 am with EC (00H) weather forecasts

- ~ 11 a.m. with new Met-pp (06H) weather forecasts

- ~ 5 pm with new Met-pp (12H) weather forecasts

- ~ 10 pm with new EC (12H) weather forecasts

- ~ 11 pm with new Met-pp (18H) weather forecasts

Interpolation of temperature and precipitation (for experienced users)

The interpolation algorithm in seNorge version 2.0 is based on the Bayesian "Optimal Interpolation (OI)" method.

The interpolation is three-dimensional, which means that it considers that the precipitation and temperature not only vary from place to place (at a given altitude), but also with altitude. In most cases, the temperature decreases with increasing altitude, but sometimes there is an inversion and then the temperature increases with increasing altitude. The three-dimensional interpolation takes this into account and uses observations of precipitation and temperature from different altitudes to correct for changes in temperature with altitude. When we started making maps in seNorge in the 2000s, we used fixed altitude gradients, which could lead to large errors when, for example, the temperature increases with increasing altitude (inversion). Now a days, all the maps, including the maps back in time, are interpolated with the "OI" method.

Nevertheless, today's interpolation is not entirely flawless. In version 2.0, we do not correct precipitation observations for possible measurements errors, i.e. wind loss, that can occur especially during strong winds and snowfall.

MET has launched a newer version (v2018) of the interpolated grid data model which we are evaluating and that we are going to use in the future. In this new version, they use precipitation climatology from weather forecasting models in addition to observations when interpolating between stations. In this version of the model, we also correct for estimated wind loss.

The precipitation- and temperature maps based on the v2018 interpolation method are only available in Xgeo.

Here you can read more about the different versions:

Version 2.0

Lussana, C., Saloranta, T., Skaugen, T., Magnusson, J., Tveito, O. E. and Andersen, J.: seNorge2 daily precipitation, an observational gridded dataset over Norway from 1957 to the present day, *Earth Syst. Sci. Data, 10*, 235–249, https://doi.org/10.5194/essd-10-235-2018 , 2018a.

Lussana, C., Tveito, O. E. and Uboldi, F.: Three-dimensional spatial interpolation of 2m temperature over Norway, *Q. J. Roy. Meteor. Soc., 144*, 344–364, https://doi.org/10.1002/qj.3208 ,2018b.

Version 2018

Lussana, C., Tveito, O. E., Dobler, A. and Tunheim K.: seNorge_2018, daily precipitation, and temperature datasets over Norway, Earth Syst. Sci. Data, 11, 1531–1551, https://doi.org/10.5194/essd-11-1531-2019 , 2019.

Lussana, C.: seNorge observational gridded datasets (seNorge_2018, version 20.05), MET report No. 07/2020, The Norwegian Meteorological Institute, Oslo, Norway, https://www.met.no/publikasjoner/met-report , 2020.