

Compendium of Good National Practices for Public-Private Engagement

Integrating private sector observations in operational weather forecasting in Norway

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The weather app Yr builds on a demand-driven approach to services based on the idea that a weather forecast is not complete before it is received (exchangeable information) and understood (usable information) by the end-user, and meets a need in a decision process (useful information). Here we present how a public-private collaboration can facilitate an innovative scientific approach to address the growing need for accurate and reliable weather predictions, integrating private sector observations from Netatmo's network of Smart Weather Stations in the value chain structure operational at the Norwegian Meteorological Institute (MET Norway).

Climate change presents new challenges but also new needs and application areas for weather forecasting. Current weather is more frequently outside of historical climate statistics, which nature and society have adapted to for a long time. Rapid climate and environmental changes have triggered an immediate need for research advances to improve weather prediction. For instance, the forecasting and monitoring of extreme rainfall are challenged by its short predictability and inadequate density of observations. In the summer of 2019, we may for the first time have really seen what climate change can bring for European weather - heat waves and temperature records side by side with extreme rainfall in weather systems that we have not been used to in Europe. In Norway, cities were flooded and in [Jølster](#) heavy precipitation released a fatal landslide.

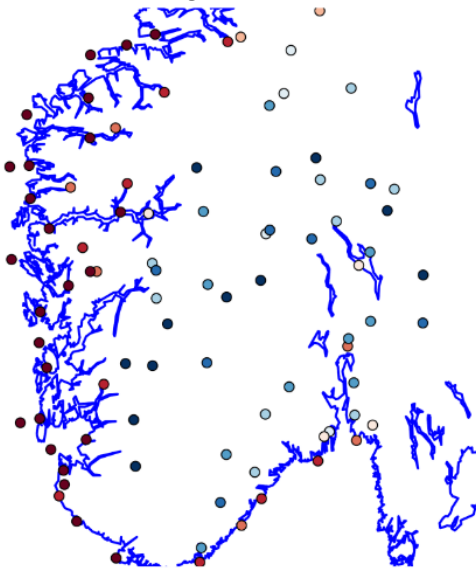
Research is a basic necessity for strengthening all parts of the weather forecast value chain, and is required to be able to improve performance and harness new opportunities. We are guided by the scientific hypotheses that (i) emerging observation systems and improved use of existing observation systems and (ii) new ways to identify observation errors, i.e. novel quality control approaches, enable advances in weather forecasting. Our approach has been to develop new methods to correct for biases in atmospheric models and at the same time increase the granularity of the weather forecasts.

Forecasting temperature is often a major challenge in Norway due to frequent inversion conditions and strong coastal gradients that are poorly represented even in the best state-of-the-art NWP models. Forecast errors exceeding 10°C is not uncommon. Conventional observation networks are not dense enough to capture very local, large gradients, while these gradients are very important from the citizen's point of view. Netatmo's Weathermap on the other hand, is the largest personal crowdsourced weather community. The Weathermap provides highly accurate ultra-local weather data, measured using Netatmo's Smart Home Weather Stations. The Netatmo community has important advantages through its large volume of data and its wide geographical coverage.

Real-time observations from Netatmo Weather Stations have given MET Norway the opportunity to post-process its weather forecasts to provide localized forecasts to the end-users. This is done by a statistical approach that detects the local forecast bias in real-time and makes a correction forward in time. The network has allowed us to reduce the large forecast errors by a factor of three. The sensor quality of the Weather Stations is sufficient to support this application. The main issue we are faced with when using Netatmo's network of Smart Weather Stations, is when instruments are poorly located. To get around this, we have developed a quality-control system that considers stations as part of a network and not as individual sites. As a result, more than 80% of the Netatmo Smart Weather Stations contribute to the improvement of the forecasts.

The quality-control developed by MET Norway has been directly integrated into the Netatmo Weathermap, a freely accessible map that incorporates the weather stations of users who share their weather observations. Not only has this partnership between Netatmo and MET Norway enhanced the value of the map itself but it has demonstrated the scientific value of the Netatmo weather station. Such partnerships strengthen the weather community by getting the information value from different partners into the final forecast in an optimal manner, increasing the value of the weather analysis and forecast for everybody.

WMO-compliant network



Netatmo Network

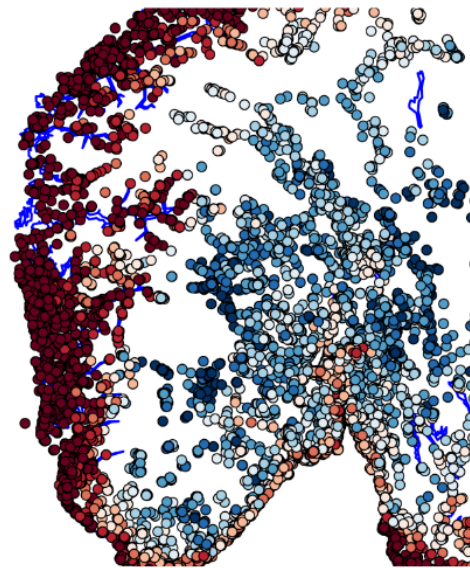


Fig. 1: Comparison of Network coverage for Southern Norway

The common denominator is the general weather enthusiasm of the public and their willingness to invest in private weather observations and make them available in real-time through the Internet. Both Netatmo and MET Norway serve well-developed weather interested and dependent communities. By working together, we harness the synergies. For instance, MET Norway receives several hundred detailed user feedback and having access to Netatmo's observations has enabled us to verify these user reports in areas where we do not have any stations of our own, thereby improving our capacity to satisfy user needs.

To summarize: Quality control is essential to extract as much value as possible from the observation network, methods using the citizen network must take into account observation uncertainty, and the data (observations and forecasts) should be easily accessible in near real time through APIs (as part of enabling technologies). Having "lateral thinkers" - people that are not only digging into their own, traditional expertise but are competent in the full value chain and how they help to build it, have been important for the successful collaboration and the resulting improved forecast quality. Our experience from this collaboration makes Netatmo and MET Norway believe that growing a relationship over time through a balanced give-and-take interaction, trust and mutual respect (or an enabling culture), will develop both in the private and public sector. Both partners need to be "hands-on" and over time have a direct benefit of what is being developed.

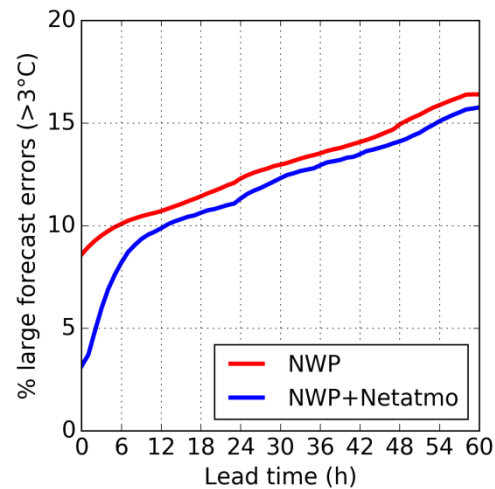


Fig. 2: Netatmo’s observations greatly reduce the frequency of large temperature forecast errors.

Factboxes

About Netatmo: Netatmo is a leading smart home company creating simple, beautiful smart solutions for a safer and more comfortable home. Since 2012, Netatmo has launched thirteen devices and accessories to meet the main demands of the smart home industry. The company offers different solutions to automate the home and make life easier, from its first product in 2012 to today. In addition to its main product range, Netatmo collaborates with key industrial leaders with its “with Netatmo” program to expand its reach and continue to grow strategically with smart integrated solutions that fit in your home’s infrastructure. Thanks to this strategy, Netatmo can bring simpler, easier and better home experiences. In November 2018, Netatmo joined the Legrand Group, the global specialist in electrical and digital building infrastructures. In 2012, Netatmo created its first product, the Smart Weather Station. The device measures the indoor and outdoor environment in real-time and sends alerts to the user’s smartphone, for instance when it detects changes in air quality. The user can also track changes in the environment over time by accessing the long-term data history.

About Yr: Yr is an open weather and climate service delivered on web (yr.no and yr.no/nb) and app (Android and iOS), in Norwegian and English language with about 100 million unique users per year. In this collaboration



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between the Norwegian Meteorological Institute (MET Norway) and the Norwegian Broadcasting Corporation (NRK), both parties are equal: MET Norway has the meteorological responsibility, and NRK has editorial responsibility and the chief editor for the service. MET Norway is a government agency under the Ministry of Climate and Environment with responsibility for the public meteorological service for civil and military purposes in Norway. All weather data are made available as open data. NRK is a non-commercial, politically independent public broadcaster, and makes its decisions on an editorial basis. Yr is without advertising, but partners are credited for their contributions. Yr does not have exclusivity to the weather data from MET Norway.