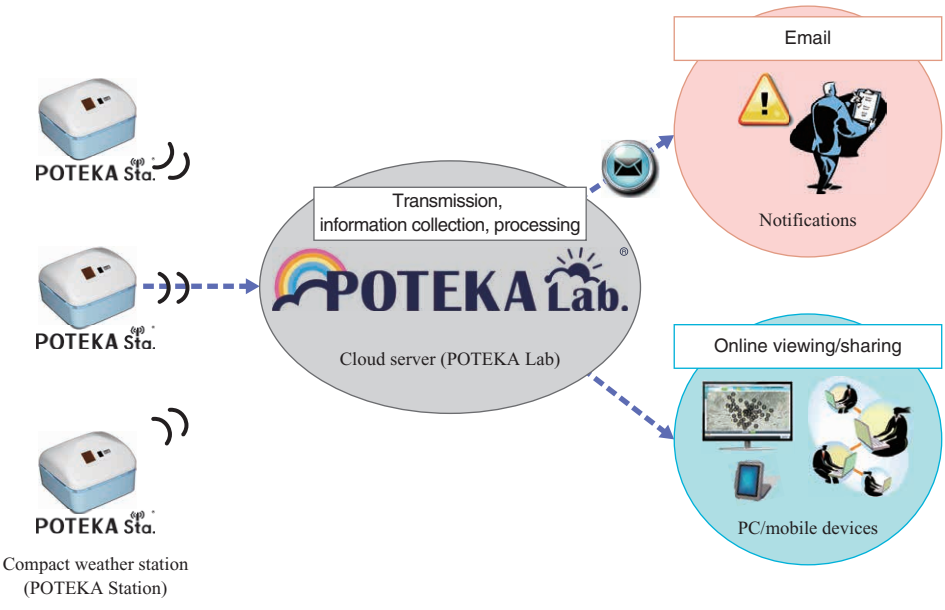
Protecting Life and Society with Street-Corner Weather Stations

The POTEKA Project: local disaster protection using a dense network of compact weather stations

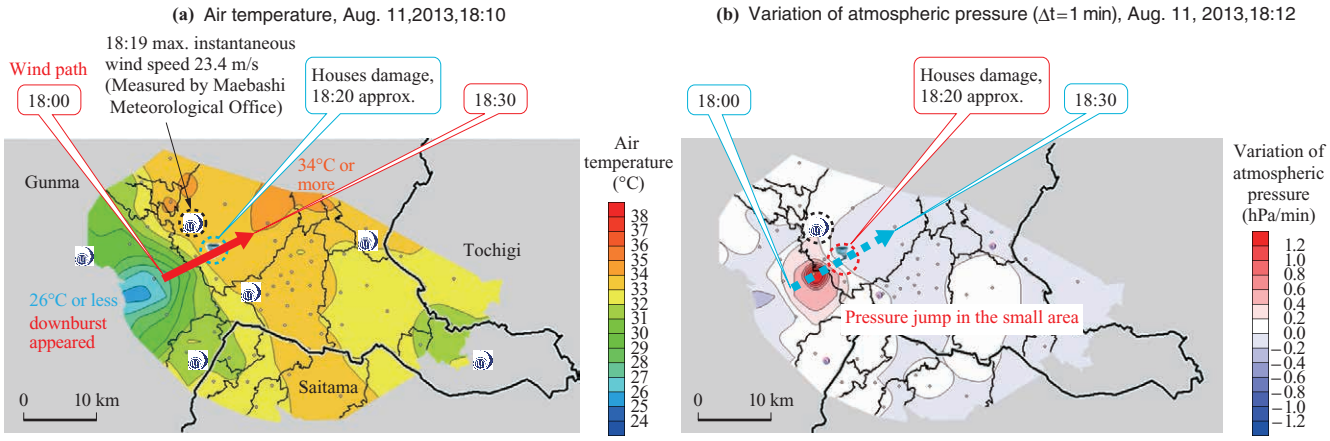
Predicting local, brief weather changes such as the recent increase in frequent torrential downpours, tornados, and squalls has reached a limit with conventional weather forecast technology. MEISEI ELECTRIC CO., LTD. has developed a low-cost weather station, and by installing a large number of these stations to form a dense observation network it becomes possible to conduct local observation by remote monitoring. Sharing this information will lead to new developments in disaster protection, daily living, and business activities.



POTEKA weather observation system

Point + Tenki (weather) + Kansoku (observation) = POTEKA

It happened on the evening of August 11, 2013. It was a hot, late-summer day, and temperatures exceeding 34°C were being recorded even into the evening around southern Gunma Prefecture, in cities such as Takasaki, Isesaki, and Maebashi. Cumulonimbus clouds then began to form and around 6:20 pm, sudden gusts of wind blew the rooftops off houses, toppled trees, and caused other damage from Takasaki to Maebashi. The Meteorological Agency issued a tornado warning for Gunma Prefecture at 6:29 pm, but by that time the squall had already passed. The Maebashi local weather observatory conducted an investigation of the affected area and on August 13, two days later, reported that the phenomenon was caused by a downburst. A downburst refers to strong downward air currents emanating from cumulonimbus clouds. A mass of cool air descends and collides with the ground level, and then spreads out in a circle. A downburst has a high possibility of creating strong,



(Note) : Meteorological observatory/AMeDAS

Steep temperature decrease and pressure increase at the downburst captured by POTEKA

sudden winds at the boundaries between warm and cool air.

In fact, however, the phenomenon on the evening of the 11th had already been correctly identified by the POTEKA project administered by MEISEI ELECTRIC CO., LTD. (hereinafter called MEISEI ELECTRIC), even before the announcement by the weather observatory. The POTEKA project is a field test of the compact weather stations (POTEKA Sta.) developed by MEISEI ELECTRIC. These POTEKA Stations are used to form a high-density ground observation network that provides data that is potentially useful for predicting local weather changes such as torrential downpour, tornados, and squalls. POTEKA may also help in efforts to combat heat stroke. The name POTEKA comes from the words "point", "tenki" (Japanese for "weather"), and "kansoku" (Japanese for "observation"), and was proposed by students at a local junior high school.

The POTEKA project started in 2013, and POTEKA Stations were installed at 54 locations, including elementary and junior high schools in Isesaki, Gunma, as well as "Save On" convenience stores mainly located in Gunma (but also including some in Saitama and Tochigi Prefectures). The POTEKA Stations are spaced 2-5 km apart. As a result, the POTEKA project creates a network that is much finer than the approx. 17 km spacing of the Automated Meteorological Data Acquisition System (AMeDAS) which observes weather data for daily weather forecasting.

The downburst appeared on the map

Returning to the story on August 11, the POTEKA observation network picked up a temperature change just after 6:00 pm. As viewed on the upper-left map, the downburst had already occurred in the southwest at exactly 6:00 pm, and the circular spread of cool air from that point was observed. Since wind blows in the areas of dense isotherms as air moves from a cooler region to a warmer region, the wind direction could be predicted from the isotherms observed by POTEKA, and the observations matched the conditions of a dangerous squall.

Besides just temperature, POTEKA also made detailed observations of the changes in air pressure at this point. By analyzing the data, it was determined that the local air pressure rose suddenly after 6:00 pm in an area near the border between Takasaki and Maebashi (upper-right map). It is all but certain that this rise in air pressure caused the squall. Meanwhile, with the conventional system the only air pressure observation point in Gunma Prefecture is the meteorological observatory near Maebashi, and air pressure changes over such a narrow range could not be detected. In fact, AMeDAS only measures four elements: temperature, hours of sunlight, precipitation, and wind direction/speed. Although not well-known, the changes in air pressure that accompany squalls, as well as humidity which serves as an indicator for heat stroke, are not observed elements in AMeDAS.

Low-cost installation in any location

The first POTEKA Stations were used for observation in 2013 were about as big as a large lunchbox. In addition to the observed elements of temperature, humidity, air pressure, and sunshine, each station is equipped with a precipitation detector, and is able to observe the time when rain starts to fall and the time when rain stops. Observation data is collected in a cloud server by wireless LAN communication, and users are able to obtain information by email or on a website. In 2014, an improved POTEKA Sta. 2 was introduced. The new stations enable observation of solar radiation and wind direction/speed in addition to temperature, humidity, air pressure, and precipitation, and optionally may be equipped with a rain gauge. In addition, a solar cell can be installed to enable observation even in locations lacking a power supply.

POTEKA achieved revolutionary success immediately after starting the field test, but also stands out for the compactness and simplicity of the devices compared to AMeDAS. Each AMeDAS station costs several million yen in equipment and installation fees, and a pole with a height of 5 m or more

POTEKA Station installed on roof of convenience store

must also be installed. On the other hand, a POTEKA Station can be easily installed in a corner of a schoolyard or on the roof of a convenience store.

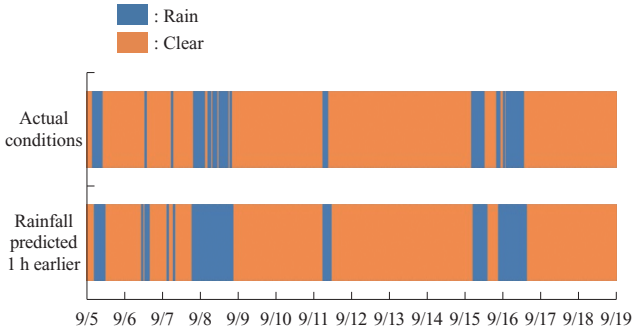
A project made possible by the link between manufacturing technology and the local community

The POTEKA project started in response to the need for countermeasures against heat stroke and for assisting in education at local elementary and junior high schools, but is currently expanding to help minimize the damage caused by local weather phenomena such as guerilla rainstorms, squalls, and tornados. The home of MEISEI ELECTRIC in Isesaki, Gunma Prefecture is surrounded by mountains and is an area where-particularly in the summer months-the temperature rises and often leads to cumulonimbus clouds, with accompanying thunder and lightning. As a result, local interest in weather information is high (in fact, people outside the company have remarked that it is located in a perfect place to develop weather equipment.) Currently, weather alerts such as thunderstorm advisories and tornado advisories are issued over a broad geographical range, such as for the entire prefecture, even though the weather phenomenon itself may actually be highly localized. By constructing a denser observation network and accumulating temperature, air pressure, and other data, localized prediction should be possible. In fact, there are groups carrying out field tests with such goals in various regions of Japan, but the strength of MEISEI ELECTRIC lies in its involvement with weather observation as a manufacturer of AMeDAS stations. In addition, MEISEI ELECTRIC has a long history of successfully producing equipment such as radiosondes (devices that send high-altitude weather data back to ground via radio), seismographs, and even sensors used for space development. On a technical level, MEISEI ELECTRIC possesses a wealth of engineering expertise in manufacturing compact weather observation stations at low cost. The valuable social contribution of the POTEKA field test was also recognized, enabling MEISEI ELECTRIC to foster ties between local businesses through the partnership with convenience stores, and from an educational perspective, obtain the cooperation of the Isesaki Board of Education.

Contributing to disaster prevention, health, business, and education

The capability to observe detailed weather information provided by POTEKA opens up a wide range of possibilities. First, as already discussed, since sudden changes in temperature and pressure can be observed in real-time, it is possible to predict phenomena such as local torrential downpour, tornados, and squalls within 10-60 minutes. For example, since the time when rain starts falling is known, by analyzing where the rain is coming from and at what speed, rain forecasts become more accurate (although the movement of rain clouds can be seen with existing weather radar, being underneath a raincloud does not necessarily mean that rain will fall). The diagram below illustrates a comparison between rainfall predicted one hour before versus actual conditions, and shows that the times of actual rainfall match the predicted times almost exactly. Additionally, from the relationship between temperature and humidity, it is possible to calculate and predict a Wet-Bulb Globe Temperature (WBGT) that acts as an indicator of heat stroke (often the WBGT is different just several km away as a result of the wind direction and geography). Being able to pinpoint affected regions more closely is not only useful for predicting abnormal weather, but additionally aids in the planning of outdoor activities, such as school events, construction, paint work, and agricultural tasks, while also helping stores rearrange their stock with respect to items that sell differently depending on the weather.

In 2013, testing was conducted to prove the effectiveness of the POTEKA system for heat stroke prevention. A WBGT calculated from POTEKA data was observed at each school where a POTEKA Station was installed (elementary and junior high schools in Isesaki), and a heat stroke warning email message was delivered on days that exceeded a "severe alert level". Additionally, as a result of counting the number of such days, it was noticed that differences in the WBGT occur even at schools only 2 km away from each other, demonstrating that more practical heat stroke prevention is possible. It is also possible to use such weather data for science education and research projects by young students. One example is the Yotsuba Gakuen in Isesaki,



Short-term rainfall prediction using dense weather data

POTEKA Sta. 2

where junior high school students decided topics themselves and conducted independent research projects related to the weather.

Compete, as an information business, instead of on product sales

Through POTEKA, MEISEI ELECTRIC aims to establish an integrated equipment manufacturing and information business that provides remote sensing, observation data collection and analysis, and output (information services) via the Internet. Instead of selling equipment to customers who then innovate to find ways of using it as in the past, MEISEI ELECTRIC will develop the equipment, information infrastructure, and analysis methods, and provide customers with requested data, as well as derived information and predictions. This is a completely new type of business deployment for MEISEI ELECTRIC, and deciding how to create business exploiting POTEKA data is a major challenge.

Accordingly, MEISEI ELECTRIC first surveyed companies and local governments within Gunma Prefecture in order to gather honest opinions about questions such as "If you had access to pinpoint observation data and predictions, how would it help you?" and "How would you want to view the data?". Even though the survey was purposefully conducted with no compensation to respondents, MEISEI ELECTRIC received replies from 216 organizations. These organizations included not only local government offices, but also convenience store chains, taxi companies, tourism-related businesses such as hotels, and disaster-related consulting companies. In the future, MEISEI ELECTRIC plans to visit interested companies, collect opinions, and research the best computational models that should be used to analyze data, as well as the best ways to present and deliver results.

Fostering a better community

In 2014, in addition to continuing the field test in Gunma Prefecture, MEISEI ELECTRIC also participated in a torrential downpour prediction experiment in Kobe. In 2008, a river in the Nada Ward of Kobe flooded suddenly and caused an accident that claimed the lives of five people, including elementary school students. In order to prevent similar accidents caused by torrential downpour in the future, a new type of weather radar was installed, with the goal of using the K supercomputer to process the data from the radar and predict, within 30 seconds after data acquisition, torrential downpour that will occur 30 minutes later. For this test, the POTEKA Sta. 2 was installed at seven elementary schools and the RIKEN research institute in order to observe temperature and pressure changes on the ground, and the effectiveness of a high-density ground observation network for local numerical weather forecasting was investigated.

In the future, there are plans for the POTEKA project to extend past local government boundaries such as municipalities and prefectures, and share weather data and disaster prevention information over the entire Tone River basin, for example. In order to accomplish this, the creation of an organization, such as a "Tone River Basin Meteorological Information Utilization Society," is also being considered. There are great expectations, from both within the company as well as the local community, that sharing weather information will lead to technologies and businesses that help create a safer and more disaster-resilient community.

Inquiries:
Meteorological & Air Traffic Control Systems Division,
Meteorological & Disaster Prevention Systems,
MEISEI ELECTRIC CO., LTD.
Phone: +81-270-32-1111
Website: www.meisei.co.jp/