

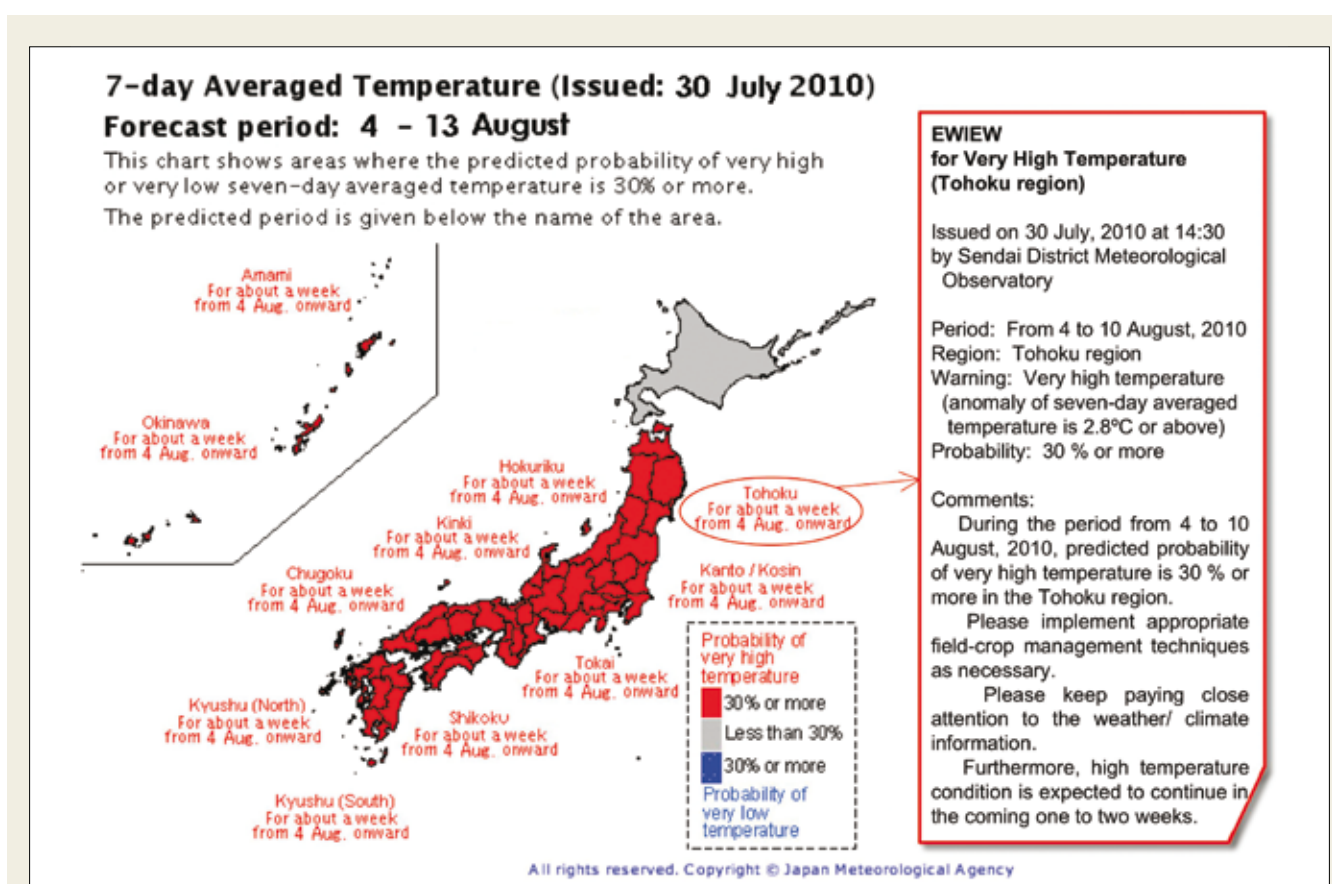
Early warning information on extreme events

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As recognized by the High-Level Taskforce on the Global Framework for Climate Services (GFCs), people around the world are affected by climatic conditions. This is particularly the case with extreme weather and climate events, which represent fundamental risks to climate-sensitive sectors. In this regard, early warning of extreme events, including periods of very high or very low temperatures, should be positioned as an important element in climate risk management. In Japan, there is demand for such information with a higher level of user-friendliness in the agricultural sector to complement the

development of effective measures against extreme temperatures. Other sectors, including those of health and energy, also require such information due to the high risk of heatstroke and possible power shortages caused by the increased use of air conditioners in hot summer conditions.

The Japan Meteorological Agency (JMA) has a long history of providing climate information, including climate monitoring, seasonal forecasts, El Niño moni-



An EWIEW map issued on 30 July 2010. EWIEW is in effect in the red and blue areas (with a 30 per cent or more probability of very high or low seven-day mean temperatures respectively). The box on the right shows text information issued for the Tohoku region (originally in Japanese)

Source: JMA

toring and outlooks, and climate change projections. Until recently, however, no climate information was supplied to specifically urge the implementation of appropriate measures against high temperatures and other extreme events. Based on the increased skill of seasonal forecasts and the above-mentioned social demand, JMA therefore commenced the operational provision of Early Warning Information on Extreme Weather (EWIEW) in March 2008 with the aim of contributing to meteorological risk management in climate-sensitive sectors. EWIEW is a probabilistic forecast highlighting the possibility of extreme events (such as very high or low temperatures) from one to two weeks ahead, and is issued to 11 regions in Japan.

EWIEW is provided in a number of ways. JMA makes the information widely available on its website¹ in map, table and text format indicating current nationwide issuance, and its local offices issue EWIEW in text form within their areas of responsibility. In addition to information for use by the general public on the website, EWIEW is also sent directly to national and local governmental organizations, media providers and private weather-related companies so that they can broadcast the warnings themselves and/or prepare and issue information tailored to users' needs. For example, local governments may send messages to farmers urging them to take measures against potential damage from high temperatures.

Scientific basis

JMA operates the Ensemble Prediction System (EPS) for one-month forecasts, using the Atmospheric Global Circulation Model, which provides one-month numerical prediction data on temperature and other conditions. EWIEW is based on predicted data for regional-scale seven-day mean temperatures (T7d) in individual regions for each day during periods of 5-14 days ahead. When a high probability (30 per cent or more) of a very high or very low regional-scale T7d anomaly is predicted for one or more regions of Japan, JMA issues EWIEW including:

- Estimates of predicted temperatures meeting the criteria for EWIEW issuance
- The relevant duration, region and a brief message on the possible social impacts of such high/low temperatures
- The predicted probability of the expected condition occurring
- Details of expected general weather conditions considered likely to induce extreme climate situations.

Criteria for announcing the probability of very high or low temperatures in EWIEW are calculated for each region using JMA's historical records of regionally averaged observed T7d values covering the 30-year period from 1981 to 2010. The criteria for very high and very low are the 90th and 10th percentiles

of these historical records, respectively. On Tuesdays and Fridays, JMA predicts whether temperatures will reach these criteria for each region and issues EWIEW accordingly. If an expected criterion is not met, the agency issues information to notify of a change in its outlook and reports on the progress of temperature conditions since the latest EWIEW.

JMA roughly estimated the skill of EWIEW based on 3,600 cases for all regions in Japan from March 2008 (when EWIEW was first issued) to January 2011. For the categories of very high and low temperatures, the hit ratios (that is, the number of occurrences of the predicted phenomenon against the number of EWIEW issuances) were 62 per cent and 57 per cent respectively. While there is certainly room for improvement in these rates, the information is well received and appreciated by various user sectors.

In addition to the four elements of EWIEW listed above, JMA also provides detailed probabilistic prediction products for individual regions through the same website independently of EWIEW issuance. These products show the scientific basis of EWIEW and provide users with information on probabilities within the range of their own threshold values. The products are:

- Daily tables of predicted T7d anomaly probabilities in five categories (very high, high, normal, low, and very low)
- Time sequences of these probabilities
- Cumulative probability functions (CPFs) and probability density functions (PDFs) of predicted T7d anomalies.

These data are provided not only for the 11 EWIEW regions but also for 152 stations where JMA performed observations from 1981 to 2010. The information is calculated using both numerical prediction data from EPS and regression coefficients estimated from hindcast experiments (re-forecasts) conducted using the same EPS for the 30-year period 1981-2010. The skill levels of these products were evaluated using hindcast experiment data and were found to be satisfactory in terms of probabilistic prediction metrics such as Brier skill scores. CPF and PDF graphs are considered to have high potential for possible future customized use of the scientific basics used to produce EWIEW. For example, JMA regularly provides the energy (electric power supply) sector with information on the most likely predicted T7d value together with more tailored information covering the period one week ahead, which can be estimated from its graph-form representation. Using this newly available data, operators in the sector can now estimate electric power demand for the coming two weeks more efficiently and reasonably.

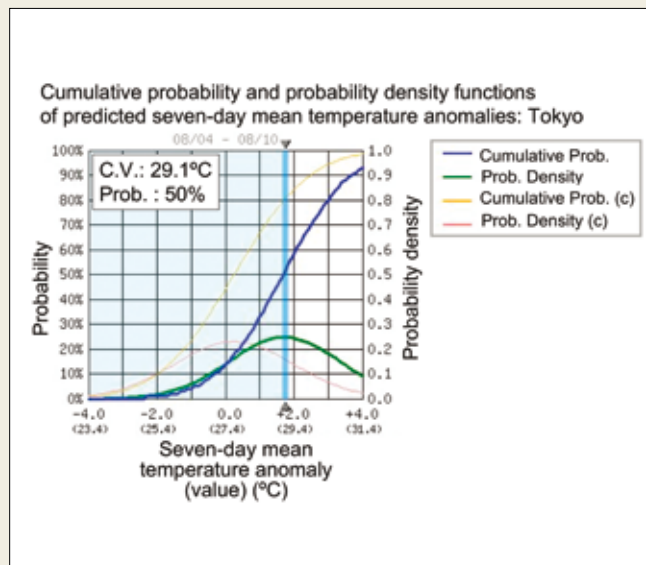
Use of EWIEW

EWIEW is expected to be used in a variety of fields in addition to its current main user sectors of agriculture and health. In one notable case, the information

Probability of predicted seven-day mean temperature anomaly for five categories for 4-10 August 2010, issued on 30 July for the Tohoku region (originally in Japanese)

Very Low	Low	Normal	High	Very High
-2.9 °C	-2.8 - -0.9 °C	-0.8 - +1.1 °C	+1.2 - +2.7 °C	+2.8 °C -
0%	3%	26%	41%	30%

Source: JMA



Cumulative probability function (CPF) and probability density function (PDF) of predicted T7d anomalies for 4-10 August 2010, issued on 30 July for Tokyo. The horizontal axis shows the T7d anomaly. The blue and green lines show the CPF and PDF for the prediction, while the yellow and pink lines show those for the occurrence of climatology values. Users can change the critical value (the light-blue line) on the website to see the cumulative probability applicable to the area shaded in light blue (originally in Japanese)

Source: JMA

led local agricultural organizations in Japan's northern Tohoku region to provide local farmers with guidance in relation to an extremely high-temperature event in April 2008. The Sendai District Meteorological Observatory responsible for the Tohoku region issued successive EWIEW on high local temperatures on 8, 11, 15, 22 and 25 April 2008, advising attention to farm product management. In response to the EWIEW issued on 8 April, the Aomori Prefectural Government in Tohoku issued special information for agricultural production on 11 April calling for frequent ventilation in greenhouses to avoid poor germination of rice crops, vegetables, flowers and ornamental plants due to soaring temperatures. The prefectural governments of Akita, Miyagi and Yamagata in Tohoku also called for similar measures against predicted high temperatures. Farmers use such special information to implement appropriate field-crop management techniques as necessary.

EWIEW is also efficiently used in the health sector. When very high temperatures are predicted and EWIEW is issued, relevant local governments inform the public of the increased potential risk of heatstroke as well as efficient countermeasures to be taken. As heatstroke can be prevented by appropriate behaviour, such caution is considered highly effective and important. Schoolteachers also use EWIEW to give appropriate guidance to pupils.

Future issues

In the last four years since JMA started providing EWIEW operationally, a number of governmental agricultural organizations in Japan have leveraged the information in their activities to provide farmers with agricultural technical guidance. JMA also promotes

the use of EWIEW in other sectors, and operators in various fields are expected to use the probabilistic prediction products provided on the JMA website in their climate risk reduction activities. An example of this may be the use of the information in creating plans for sales of commodities, which are sensitive to climate conditions. CPFs and PDFs are expected to support next-generation forecasting that will advise users of the probability of temperatures moving above or below their self-set threshold values.

JMA is currently working to address four major challenges regarding EWIEW:

Dissemination of EWIEW and strengthening of related interpretive activities

EWIEW is not yet widely known in Japan. As many potential users may be able to make good use of such information in their decision-making activities, JMA is seeking and exploring further opportunities for dialogue with such users in order to interpret the characteristics and usage of EWIEW. The provision of briefings to broadcasting-organization meteorologists and members of the press is also important. Such activities are expected to support the dissemination of EWIEW in Japan.

Addition of more meteorological elements to EWIEW

To complement the temperature information already provided, JMA is currently considering the addition of other meteorological elements as targets of prediction. In terms of prediction skill and the impact of such information on society, JMA plans to add data on expected snowfall for the Sea of Japan side of the country in winter.

Improvement of prediction techniques

To support better prediction of extreme events with greater accuracy, there is a need to develop and improve prediction tools and techniques such as the numerical atmospheric model and ensemble prediction techniques, application methods including calibration of numerical prediction results based on hindcast experiments, and approaches to downscaling.

Provision of seamless weather/climate information to users

Seamless information on weather and the climate will help users to prepare and take countermeasures using EWIEW in combination with analysis of current climate conditions and weekly forecasts.

In response to these challenges, JMA engages in activities in collaboration with research organizations on the user side with the aim of producing user-friendly climate information that supports decision-making. One such activity is a pilot project to promote the use of climate information in the agricultural sector in collaboration with Japan's National Agriculture and Food Research Organization Tohoku Agricultural Research Center.