Commencement of Joint Research on Long- and Mid-Term Weather Forecasting
—Proving early predictions of heat waves and cold waves and contributing to stable energy supply—

December 14, 2021
Kyoto University
Osaka Gas Co., Ltd.

On December 14, 2021, the Disaster Prevention Research Institute, Kyoto University (Director: Eiichi Nakakita; hereinafter "DPRI"), and Osaka Gas Co., Ltd. (President: Masataka Fujiwara; hereinafter "Osaka Gas") commenced a joint research project on long- and mid-term weather forecasting as an effort to further stabilize the energy supply.

The energy business is closely related to meteorological conditions, such as temperature, which causes changes in demands for gas/electricity, and weather, which affects the amount of electric power generated by solar panels. For example, a cold wave that hit Japan in January 2021 is considered as one of the factors behind the sudden surge in domestic demand for electricity.

Professor Takeshi Enomoto and his team members in the Climate Environment Laboratory, Research Division of Atmospheric and Hydrospheric Disasters, DPRI have been engaged in clarifying the mechanism of extreme weather events at hemispheric scales and have pursued research on the predictability of such weather and numerical weather prediction[*1] for many years. They yielded interesting results, such as the predictability of heat waves[*2] and clarification of teleconnection patterns[*3] when the El Niño phenomenon occurs[*4].

Osaka Gas has been working to predict gas demand and the sales of indoor gas heaters using temperature information. In 2008, the company started meteorological simulation using its original method, providing predictions of solar power generation by combining predictions on the quantity of incoming solar radiation and machine learning (AI) technology, and a service in which the date of the interruption of power generation[*6] by ENE-FARM Type S (hereinafter "Ene-Farm"), a self-sustaining[*5] fuel cell for home use, is moved up when an upcoming large typhoon is predicted. Moreover, in 2018, Osaka Gas was registered as a certified weather forecast provider[*7].

In this joint research project, we aim to predict phenomena that could affect our energy business, such as heat waves and cold waves, two weeks to several months before the actual events[*8] by analyzing atmospheric conditions at hemispheric scales . To do this, the research team will integrate Professor Enomoto's scientific knowledge on global weather dynamics and numerical weather prediction and Osaka Gas's know-how about meteorological prediction by combining weather simulation and machine learning technologies. In FY2021, we will conduct research on a method of detecting early signs of cold waves coming from the continent to Japan by analyzing weather patterns in the Northern Hemisphere. Furthermore, we will utilize the predicted results within the Daigas group and are considering provision of the data to external parties.

DPRI and Osaka Gas aim to contribute to stable energy supply as well as provision of useful services to a wide variety of industries by developing long- and mid-term meteorological prediction technology and providing the predictions of heat waves and cold waves early.

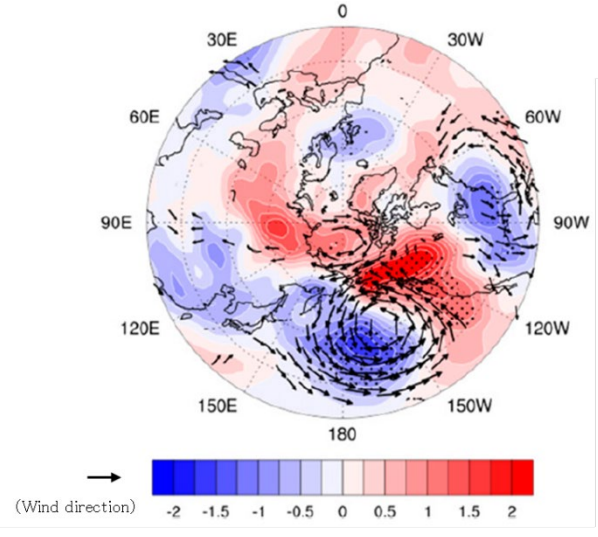
*1: A method of weather forecasting that predicts the future weather condition by numerically calculating change in the current atmospheric condition.
*2: Enomoto, T., H. Endo, Y. Harada, and W. Ohfuchi, “Relationship between High-Impact Weather Events in Japan and Propagation of Rossby Waves along the Asian Jet in July 2004”, Journal of the Meteorological Society of Japan. Ser. II, 87, 139–156 (2009)
*3: Modes of change in the factors of a weather condition in multiple geographically distant places, such as atmospheric flow, atmospheric pressure, temperature, and precipitation, while the factors have correlation with each other
*4: Shiozaki, M., T. Enomoto, and K. Takaya, “Disparate Midlatitude Responses to the Eastern Pacific El Niño”, Journal of Climate, 34, 773–786 (2021)
*5: If a power outage occurs while an Ene-Farm is generating electricity, the system will be independent of the electrical grid and continue generating electricity.
*6: Ene-Farm automatically shuts down at regular intervals to avoid the effects of the gas leakage detection feature of the gas meter. When a power outage is expected to occur due to a typhoon, the date of the interruption of power generation is moved up through remote operation using its IoT connection feature. Consequently, the Ene-Farm can avoid an overlap between the date of a power outage and the time when the system stops power generation and continue self-sustained operation when the grid-connected power fails due to the typhoon.
*7: On September 7, 2018, Osaka Gas announced that the company obtained permission to provide a weather forecasting service. (https://www.osakagas.co.jp/company/press/pr_2018/1273577_37838.html)
*8: We aim to find unknown new generation mechanisms of heat waves and cold waves and provide more reliable predictions earlier than before.

1. Long- and mid-term global weather prediction

The following are teleconnection patterns in the case of severe winter rather than a typical mild winter despite the El Niño phenomenon.

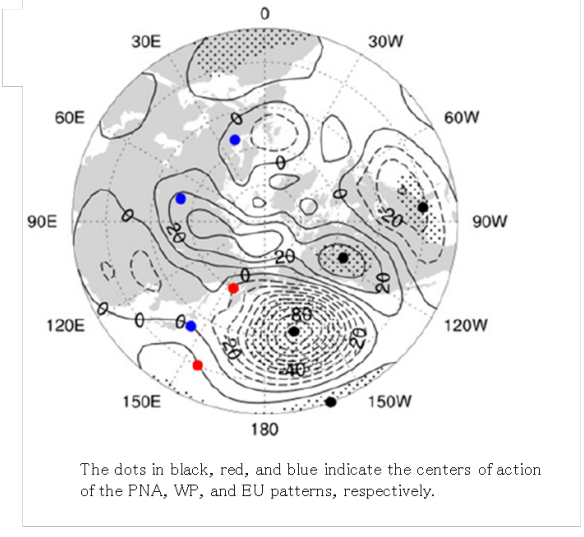
(Analysis results of past weather data)

<Temperature anomalies at an altitude of approx. 1500 m (850 hPa)>



(Temperature anomalies from the base line (Unit: K)))

<Height anomalies at an altitude of approx. 10000 m (250 hPa)>

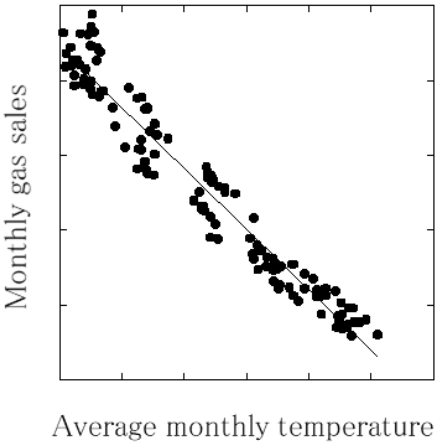


The dots in black, red, and blue indicate the centers of action of the PNA, WP, and EU patterns, respectively.

(Some information was added to the paper by Shiozaki, Enomoto and Takaya (2021).)

2. Relationship between energy business and weather

<Gas demand and temperature>



<Electric power demand and temperature>