S2S4E
Climate Services for Clean Energy

CASE STUDY #1

COLD SPELL AND WIND DROUGHT IN EUROPE

January 2017

BASIC FACTS

- **Area:** France and Western Europe
- **Season:** winter
- **Year:** 2017
- **Forecast range:** sub-seasonal
- **Main interest:** wind energy and electricity demand
- **Forecast variables:** wind speed, temperature and electricity demand

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WHAT happened

A cold wave over Europe led to extremely low temperatures, which increased electricity demand for heating. Lower than usual wind speeds also resulted in a decrease in wind power generation and caused a high risk of energy imbalance in the energy grid.

WHERE it affected

The cold spell mostly affected areas in Europe. France in particular faced a shortage in energy supply due to planned maintenance outages in several nuclear power plants that coincided at the same time as the cold spell.

WHEN it occurred

The anomaly was observed during winter 2016-17, and was particularly significant from January 17th to 23rd, 2017.

Analysis of the event

In January 2017, a cold wave over Europe (demonstrated in Figure 1) created a large increase in electricity demand, especially in France where a large portion of household heating is powered by electricity.

As seen in Figure 2, temperatures dropped significantly during the third week, resulting in an extremely low average close to 0°C, four degrees colder than the climatological mean.

In addition, from December 2016 to February 2017, low wind speeds occurred over Europe (Figure 3), which led to lower than normal renewable energy supply. Wind speeds were clearly under the climatological mean, leaving fossil fuel generation plants as the main means to balance the energy system.

In the same period, France shut down several nuclear power plants, under a planned request from the national regulation authority, in order to carefully check some components of the reactors. This programmed maintenance check created a significant risk of supply shortage.

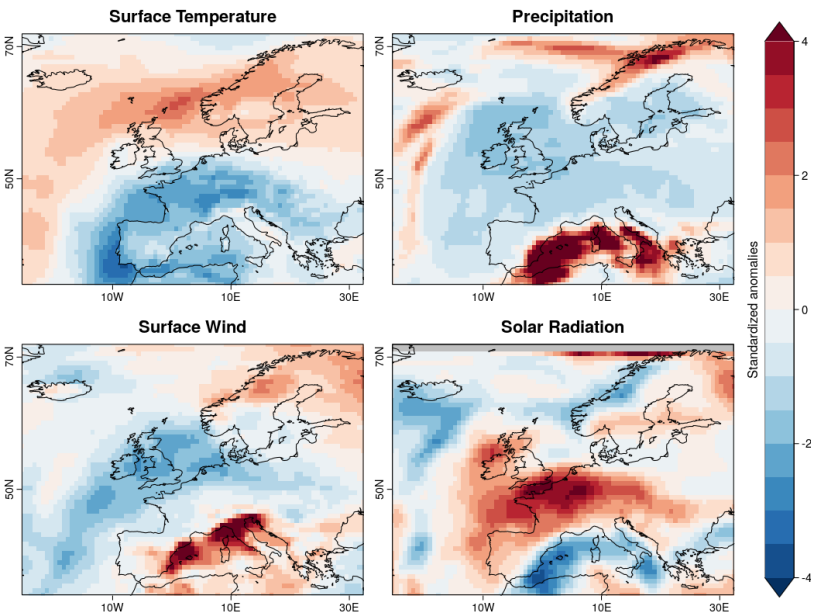

Figure 1. Standardized anomalies of temperature, precipitation, surface wind and solar radiation for December 2016 through February 2017. ERA-Interim reanalysis.

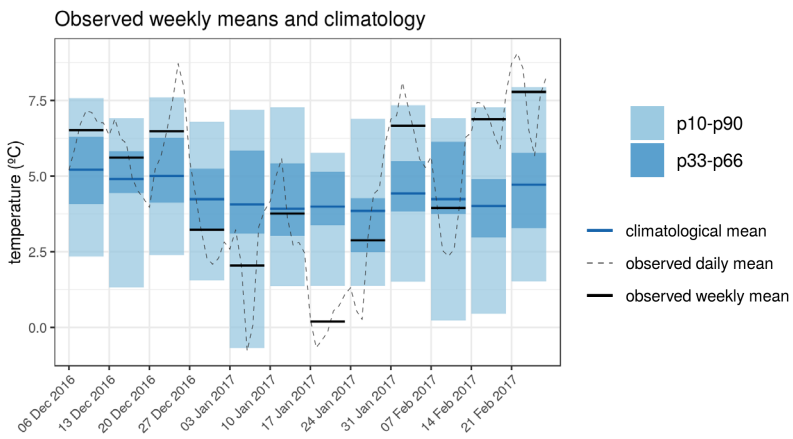

Figure 2. Observed temperature means for December 2016 through February 2017. ERA-Interim reanalysis.

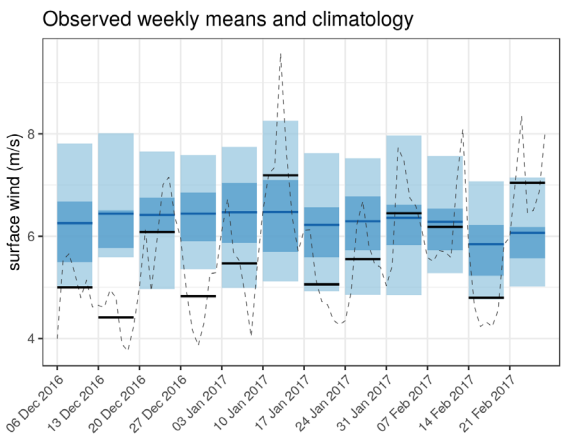

Figure 3. Observed wind speed means for December 2016 through February 2017. ERA-Interim reanalysis.

Available forecasts

S2S4E sub-seasonal forecasts of temperature and wind speed were produced for central Europe, while forecasts of electricity demand were produced for France. All forecasts used the ECMWF Monthly Prediction System.

The available forecasts for temperature (Figure 4) predicted the correct below normal tercile four to one week in advance (with a probability of 44%, 49%, 51% and 87% respectively). The forecasts four to three weeks before the event were less significant, however, because the above normal tercile was also predicted to be 42% in both cases (Fig.3A). The skill associated to the temperature forecasts were low for the longer lead times (Table 1), but grew to 0.37 the week before the event. For this forecast issued one week in advance, the ensemble members group closer, showing a higher certainty in the predicted outcome.

Electricity demand was also predicted to be above average for mid-January 2017 (Figure 5). The week before the target time, almost all members pointed to above normal demand conditions with 97% probability, which was in line with the real demand of the time. Skill for the electricity demand forecasts were high and positive starting at the two week lead times, scoring RPSS values of 0.187 two weeks before the event and 0.398 one week before the event (Table 2).

Table 1. Probability skill scores for temperature.

Skill (Temperature)	Forecast lead time			
	Days 26-32	Days 19-25	Days 12-18	Days 5-11
RPSS	0.13	0.06	0.12	0.37

Table 2. Probability skill scores for electricity demand.

Skill (Electricity demand)	Forecast lead time			
	Days 26-32	Days 19-25	Days 12-18	Days 5-11
RPSS	-0.19	0.08	0.19	0.40

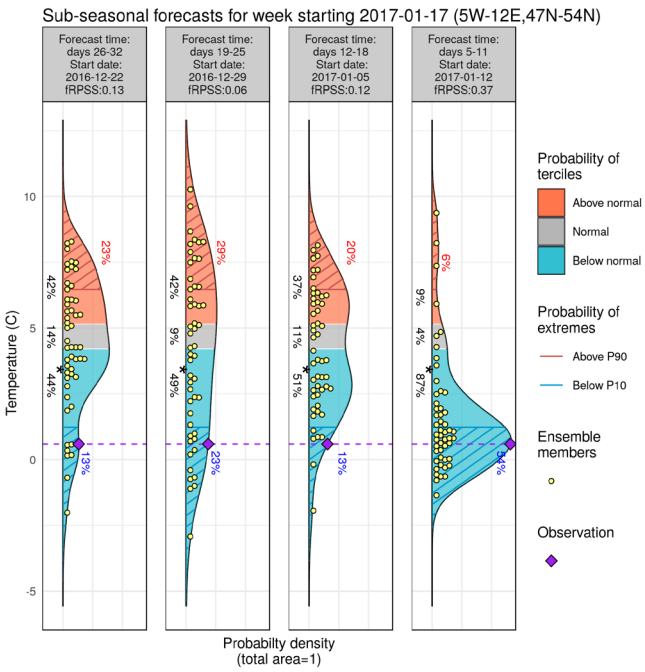

Figure 4. Sub-seasonal electricity demand forecasts for February 27th, 2018. Issued four, three, two and one week in advance.

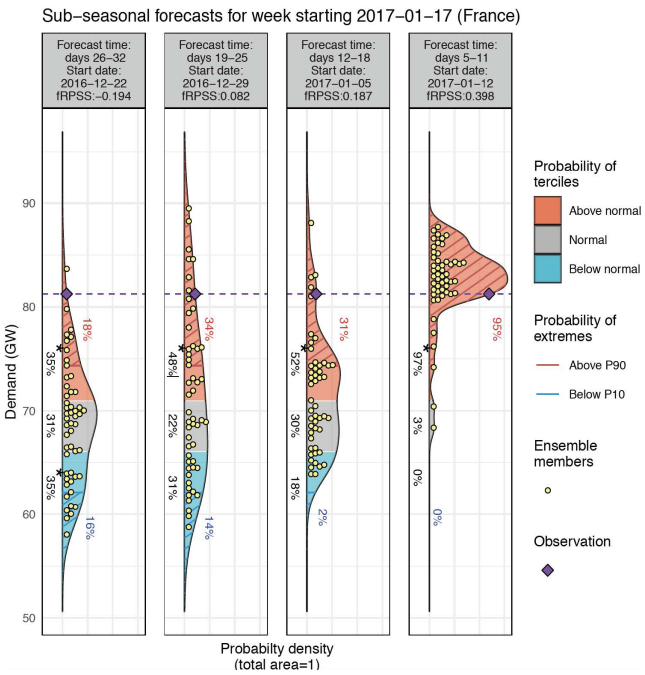

Figure 5. Sub-seasonal temperature forecasts for February 27th, 2018. Issued four, three, two and one week in advance.

Available forecasts

The wind drought, on the other hand, was much harder to predict (Figure 6). As shown in Table 3, the skill for the forecasts are quite low four and three weeks in advance (fRPSS: 0.03 and 0.02, respectively), but increase to high positive values two and one week before the event (fRPSS: 0.12 and 0.30, respectively). For this single event, all four forecasts generally predicted wind speed to be close to normal conditions (Fig.3B).There is a slight improvement in the forecast one week before the event, however, as it predicts 44% probability in the normal tercile and 41% probability in the below normal tercile.

Table 3. Probability skill scores for wind speed.

Skill (Wind Speed)	Forecast lead time			
	Days 26-32	Days 19-25	Days 12-18	Days 5-11
RPSS	0.03	0.02	0.12	0.30
BSS P10	0.07	-0.02	0	0.21
BSS P90	0.02	0.01	-0.01	0.19

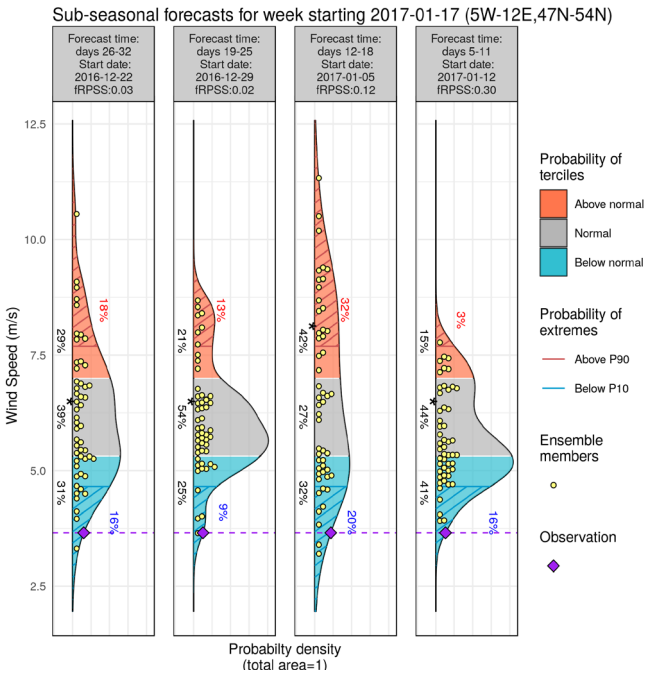

Figure 6. Sub-seasonal wind speed forecasts for February 27th, 2018. Issued four, three, two and one week in advance.

Conclusions

The fairRPSS values computed for the whole hindcast demonstrate that S2S4E sub-seasonal forecasts have skill for this time period and region in anticipating episodes of low temperature, especially two to one weeks in advance. This high skill highlights how subseasonal forecasts could be beneficial over the current practice of using climatological forecasts for decision-making in energy trading companies and within Distribution System Operators.

In this specific cold spell case study, the probabilities forecasted from 4 weeks ahead did indeed predict correctly temperatures in the below normal tercile and energy demand in the above normal tercile. For both forecasts, the probability of the correct tercile was very close to 100% one week before the event.

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