Application and verification of ECMWF products 2014

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1. Summary

In this contribution, a new product for a customer in the energy sector is presented and assessed. A first informal experiment had been carried out satisfactorily with the same customer during the winter 2012-2013. At this stage it is too early to draw firm conclusions on the quality of this product. Feedback from the customer has again been positive despite a lack of sharpness to anticipate cold events beyond two weeks.

2. Use and application of products

In 2014, the discovery of significant structural faults (micro cracks) and further (allegedly criminal) damage led to a forced shut-down of several nuclear reactors. There was deep concern that the resulting drop in power production might not be compensated fully through foreign import (mainly from France) in case of a cold winter, causing fears of blackouts and prompting the federal authorities to deliver a concrete plan for controlled power cuts.

The Belgian power grid operator Elia turned to the Royal Meteorological Institute of Belgium (RMIB) for assistance to assess the risk of cold snaps during the winter 2014-2015.

From 3rd Nov 2014 until 10th Feb 2015, long-range forecast guidance was emailed to the customer once to twice a week in the form of surface-temperature anomaly maps and critical discussions.

The products used were:

- For a horizon of up to one month: the ECMWF monthly forecast charts (mainly weekly 2-m temperature and SST anomalies + probabilities, stamp maps, 500-hPa geopotential anomalies and Hovmöller diagrams, MJO phase diagrams);
- For ranges beyond one month: the seasonal forecast charts (EUROSIP multi-model ensemble + ECMWF ensemble, mainly 2-m temperature and SST anomalies + probabilities, El Niño anomaly plumes). Combined dynamical and statistical forecast charts from the IRI (International Research Institute for Climate and Society) were also used.

Relevant teleconnections with Euro-Atlantic regimes were monitored closely using information from various global prediction centres:

- ENSO (El Niño – Southern Oscillation): moderate or weak El Niño increases the probability of cold snaps in Europe during the latter part of the winter (e.g. Norton and Rowlands, 2011);
- QBO (Quasi-Biennial Oscillation): easterly (negative) phase favours stratospheric warmings and cold intrusions in northern latitudes (e.g. Thompson et al., 2002);
- MJO (Madden-Julian Oscillation): the NAO (North Atlantic Oscillation), Atlantic ridges and Scandinavian blockings are influenced by the phase of the MJO (e.g. Cassou, 2012);
- Arctic sea-ice extent in autumn: a minimum may favour cold surges and increased snowfall (Liu et al., 2012).

Despite recent improvements, dynamical models can struggle to keep these features on track in their simulations, so comparing their predicted against actual evolution can give useful indications on the possibility that the models underestimate the risk of a cold event.

3. Verification of products

3.1 Objective verification

3.1.4 End products delivered to users

Given the short period considered (one winter) and the relatively low number of forecasts (maximum twice a week), the sample is far too small to compute statistics of any significance.

A basic verification of expected weekly mean surface temperature anomalies for Belgium is presented in Table 1 below. Please refer to the caption for a detailed description. The outcome for each week was formulated as one of 3 possible categories: above normal (A), below normal (B) or normal (N).

		Forecasts available on Friday															Forecasts available on Tuesday															Tan	Obs
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	[°C]	
1	45	A															A															1.0	N/A
2	46	A	A														A	X														2.6	A
3	47	A	A	A													A	X	A													2.2	A
4	48	N	A	A	A												N	X	N	A												1.8	N/A
5	49		A	A	A	N												X	N	N	B											-2.5	B
6	50			A	N	N	N												N	N	N	N										0.8	N/A
7	51				N	A	A	A												N	A	A	A									3.2	A
8	52					A	A	A	A												N	A	A	X								1.4	N/A
9	1						A	N	B	B												A	N	X	B							-0.9	N/B
10	2							A	N	N	X												N	X	A	A						1.4	N/A
11	3								A	A	X	X												X	A	A	A					2.1	A
12	4									N	X	X	B												A	A	B	B				-3.1	B
13	5										X	X	B	X												A	N	N	N			-0.6	N/B
14	6											X	N	X	X												N	N	N	B		-2.1	B
15	7												N	X	X	X												A	N	B	N	1.1	N/A
16	8													X	X	X													N	N	N	-0.8	N/B
17	9														X	X														N	N	1.1	N/A
18	10															X															N	0.9	N/A

Table 1 Weekly mean surface temperature anomalies for Belgium based on ECMWF extended-range products available online each Friday and Tuesday. The first column indicates the week number starting from 3rd November 2014 (week 1) until 8th March 2015 (week 18). The second column shows the corresponding week number of the year according to the ISO-8601 standard. For each week, the expected average surface temperatures over Belgium are expressed as 'above normal' (A), 'below normal' (B) or 'normal' (N). The label 'X' means that no forecast was made. The observed weekly mean anomalies over Belgium (Obs) and their values from synoptic measurements in Uccle (Tan, in °C) are shown in the last two columns. Significantly cold (warm) anomalies have been highlighted in blue (red).

Cold snaps of potential interest for the customer were observed during weeks 5 (49th week of 2014), 12 and 14 (4th and 6th weeks of 2015). It can be seen that these cold events were anticipated at best two weeks ahead, which is a bit disappointing, and that there was some more skill in the prediction of warm events than in the prediction of cold events.

The average surface temperature anomaly for the DJF winter (from week 5 to 17) turned out to be very close to climatology (N) with an observed value 0.1°C in Uccle, in agreement with the seasonal guidance provided.

3.2 Subjective verification

3.2.1 Subjective scores (including evaluation of confidence indices when available)

No scores were computed, but the customer confirms that the guidance provided had some practical value.

3.2.2 Synoptic studies

A winter with average surface temperatures close to climatology or slightly above had been predicted for Belgium. Models consistently and successfully developed a large pool of relatively cold water above the North Atlantic that was to moderate storm-track activity and hence the associated warming of the continent. There was no evidence in support of a particularly cold winter either. The Arctic sea-ice extent in autumn had increased significantly since the minimum of autumn 2012. However, the neutral to weak El Niño and easterly phase of the QBO were pointing to a good chance of a few cold events, which turned out to be the case. One must note, however, that these colder spells remained of relatively small amplitude and duration in the west of Europe compared to the east of North America, where the bulk of the cold discharges took place in the second half of the winter. .

4. References to relevant publications

Cassou, C., 2012: Sources of intraseasonal to interannual predictability over the North Atlantic/Europe region. *ECMWF Annual Seminar 2012*.

Liu J., **J.A. Curry**, **H. Wang**, **M. Song** and **R.M. Horton**, 2012: Impact of declining Arctic sea ice on winter snowfall. *Proceedings of the National Academy of Sciences of the United States of America*, **109**(11), 4074-4079.

Norton, **W.** and **D. Rowlands**, 2011: First impressions of seasonal forecasting system 4. *ECMWF User Meeting 2011.*

Thomson, **D.W.**, **M.P. Baldwin** and **J.M. Wallace**, 2002: Stratospheric connection to Northern-Hemisphere wintertime weather: implications for prediction. *J. Climate*, **15**, 1421-1428.