Experience with seasonal forecasting at the Bulgarian weather service

Ilian Gospodinov

National institute of meteorology and hydrology, Bulgaria

UEF2015, ECMWF, 8-10 June 2015, Reading, UK

Introduction

Seasonal forecasting has recently advanced significantly both in terms of theoretical ground and operational production based on dynamical or statistical models. An experimental seasonal forecast was first issued by the Bulgarian weather service in the autumn of 2005 giving prediction for the winter season of 2005-2006. It followed the example of the winter seasonal outlook of the UK MetOffice published on their website at the time. The Bulgarian weather service has been issuing ever since seasonal outlook for the country targeting the general public. It makes 9 years of experience which allows for measuring the skill of the forecast. This presentation illustrates mainly how the uncertainty associated with the seasonal forecast is quantified and communicated to the public.

Method and data

Data from about 30 Bulgarian weather stations evenly distributed in the country are involved in the monitoring of temperature and precipitation at the seasonal time scale. Most of them have continuous records since 1951 and they have been used for some basic statistical analysis and the production of a national index.

The Bulgarian seasonal forecast is mostly a subjective evaluation of probability maps provided by some of the global production centers (GPCs) under the umbrella of the WMO as well as other entities (ex. IRI). The centers have been first chosen based on the availability of their seasonal outlook products on the web. However their number has recently been reduced based on some knowledge for the advancement of their models. The forecast is currently based on products of the following centers (Fig. 1):

ECMWF (including EUROSIP), MetOffice, NCEP, IRI, JMA.

The maps are evaluated subjectively and a certain value is assigned (see “index” bellow). All values from all centers are averaged which makes up the forecast. Weights can apply based on the skill of the models (see “skill” bellow).

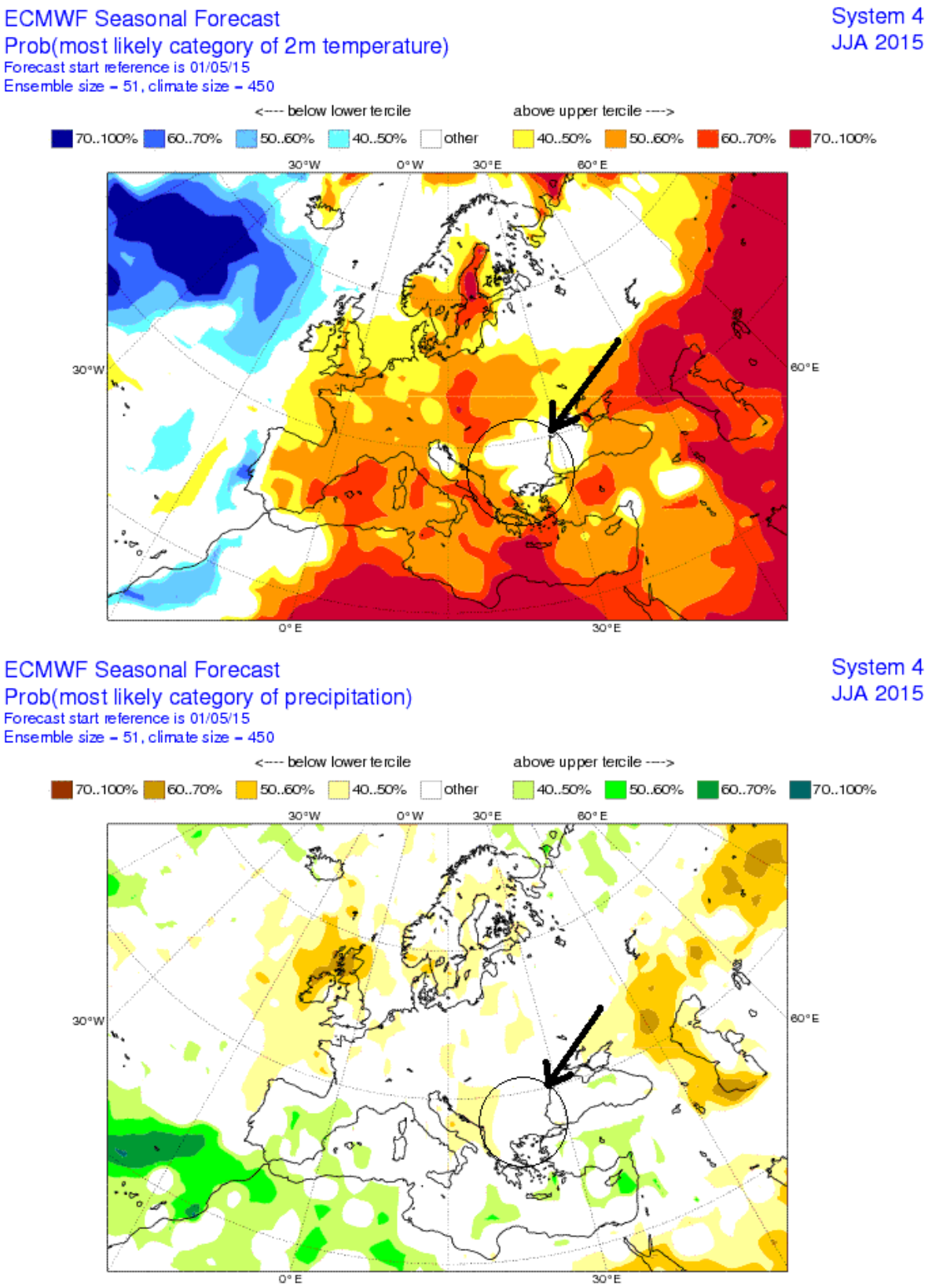

Figure 1: Example of online maps used for the national seasonal outlook: Latest 1-month lead time probability maps for temperature and precipitation for JJA 2015 (ECMWF).

Other products are considered as well like for example: ENSO and teleconnection indices forecast. Additionally, some knowledge of the current state of the global climate system helps to construct a view on how a given season would evolve. The bulletins of some of the GPCs (Meteo France, NCEP) regularly give thorough overview of the current state. The regional climate outlook forums (COFs), organized by the WMO, help to bring up the expertise in seasonal forecasting at national level in its less advanced or smaller members.

At the end of the process arbitrary subjective judgment takes place based on knowledge of the current state of the climate and other materials like for example consensus statements of COFs. Thus, the final forecast contains, from one side, the effect of the objective skill of the models and the quality of their online output maps and, from the other side, the personal judgment of the author based on knowledge (or luck of it) and experience.

The forecast numbers attributed to all used models for all predicted seasons have been archived since 2007. The 8-year records allow for doing some statistics and determining the skill of the subjective forecast both for the final product and the individual models part of the ensemble.

Measuring the seasons with a national index

There are 2 reasons for building a national index. Firstly, Bulgaria is a relatively small country. The atmospheric objects of synoptic scale usually influence the entire country within their lifetime. The country has a homogeneous response to all large scale atmospheric influences at the seasonal time scale which can be illustrated with figures 2 and 3. Secondly, the natural predictability in the region is theoretically low and the skill of the dynamical or statistical models reflects this weakness.

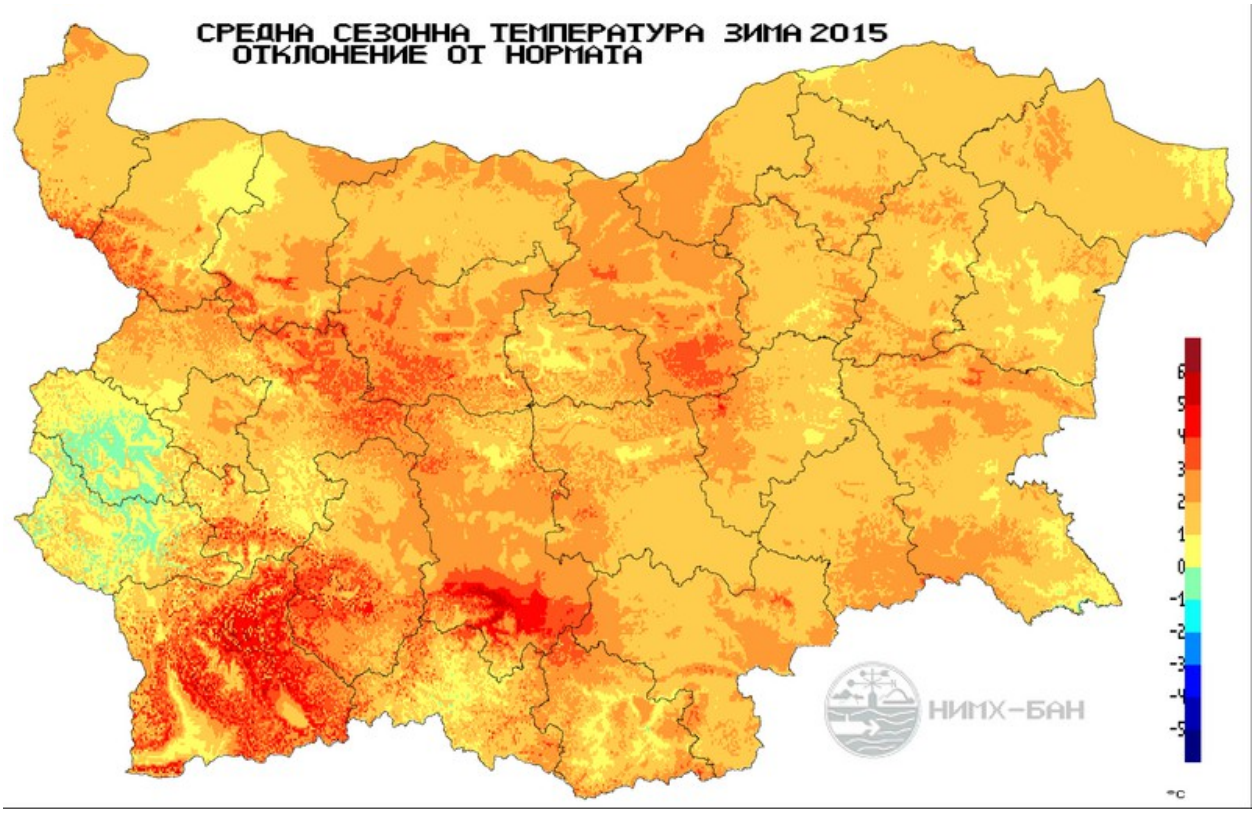

Figure 2: Departure of mean seasonal temperature from normal, DJF 2014/15 (Reference period 1961-1990).

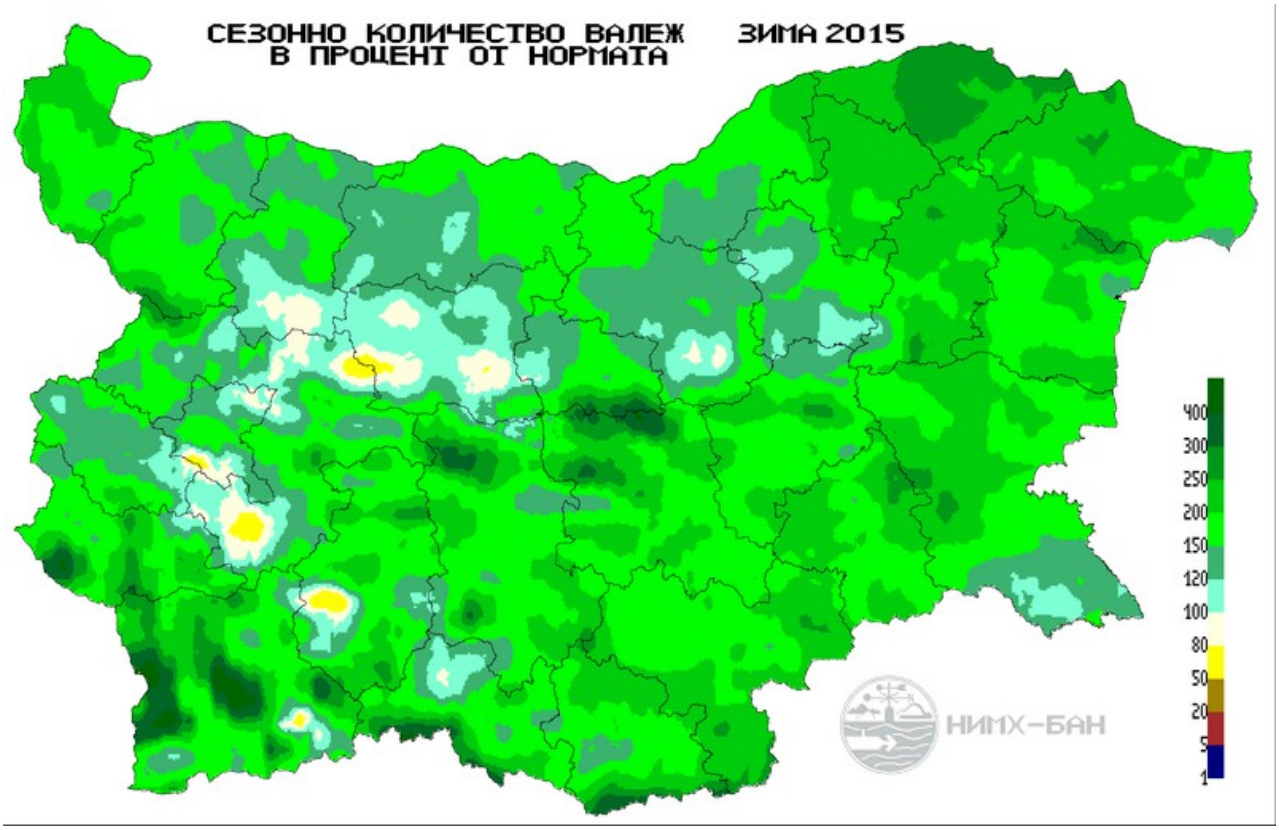

Figure 3: Seasonal precipitation amount in percent of normal, DJF 2014/15 (Reference period 1961-1990).

The climate of temperature or precipitation at a given location predicts that the value of these parameters for a given season would fall with equal probability of one third in one of the three tercile categories: below, around, or above normal. However the tercile intervals are large and often a single value can fall near the threshold which can be unpleasant for the evaluation of skill. The division of the probability distribution in terciles also lacks information for the extremes. The choice made for the construction of a Bulgarian national index was to divide the probability distribution in 7 equal parts which corresponds to interval width of about 14.3% and therefore accounts for the extremes and smoothes out the problem with values near the

threshold (Fig. 4). Index varying from -2 (very cold/dry) to +2 (very warm/wet) is assigned to a value falling in a given interval. The obtained indices for all monitored 30 weather stations are averaged and the result makes up a national index. The index itself also spans from -2 (very cold/dry everywhere) to +2 (very warm/wet everywhere). Figure 6 illustrates how all data from the monitored stations fall in probability intervals which cover most often 1 or 2 neighbor tercile categories. There are practically no cases with cold and warm parts of the country within one season. There can be only a very small part of the country falling in the opposite precipitation tercile category compared to the larger part.

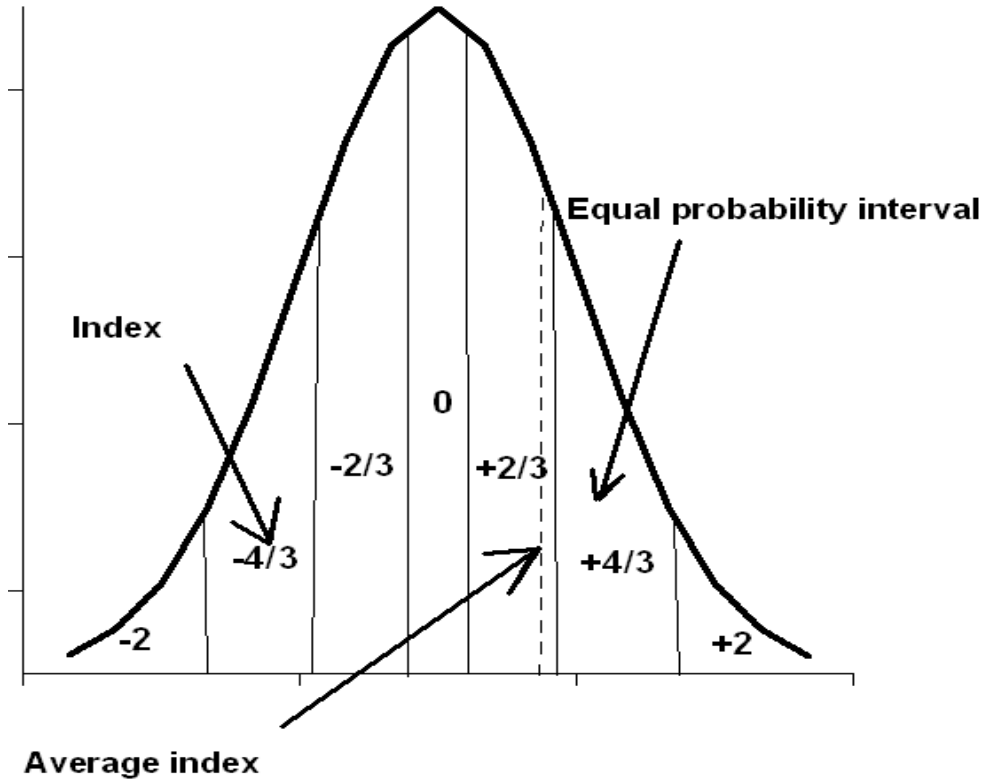

Figure 4: Constructing a national index: schematic representation.

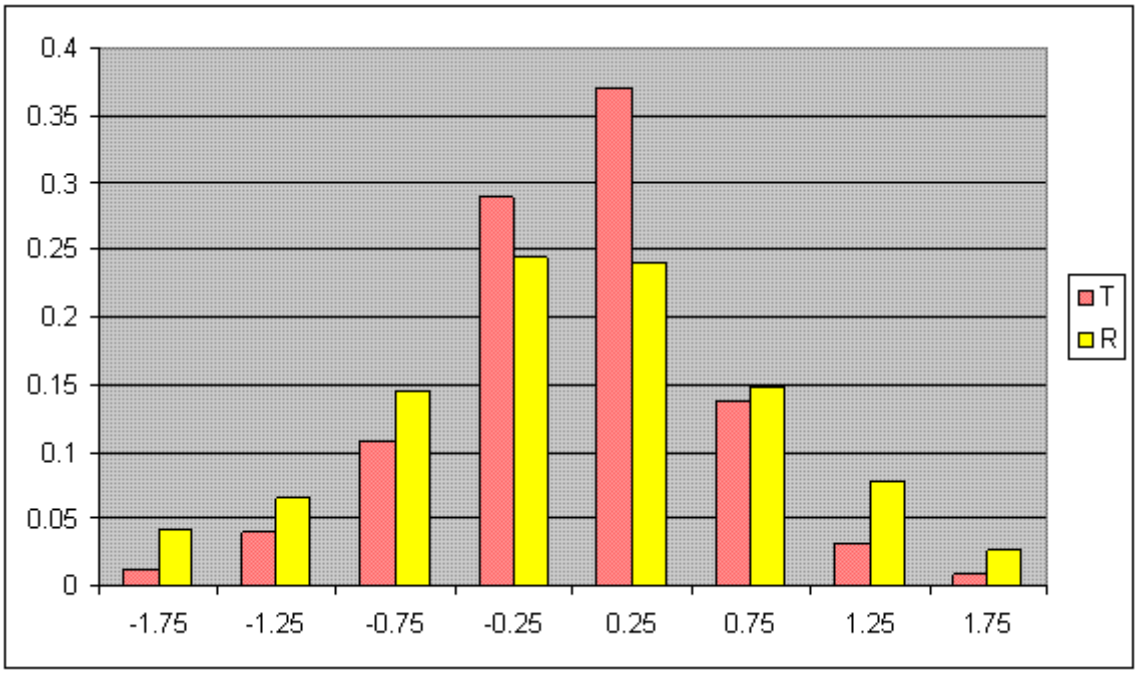

Figure 5: Probability for departure of the individual station indices from the national average. "T" – temperature; "R" – precipitation. Bottom axis - departure, Left axis – probability.

Skill of the subjective forecast

The seasonal probability maps are evaluated subjectively and are being assigned with a forecast index from -2 to +2. The forecast values assigned to the individual members of the ensemble of models are averaged. The final forecast is a number arbitrarily chosen based on the result from the overview of the models and personal judgment. All individual values of the models and the final forecast are archived. The departure of the forecast index from the actual index based on data is a measure of the skill of the forecast. Tables 1 and 2 summarize the skill of the ensemble of models and the ECMWF as an individual model. Figures 6 and 7 show the evolution of the scores of the forecast based on the ensemble of models and the

ECMWF as an individual model. A random choice of a single hypothetical forecast value is also presented for comparison. The random value has been chosen to be 0 (around normal) for precipitation and 1 (near or above normal) for temperature to account for the global warming trend. It can be seen that the random choice scores better than the subjective forecast based on the ensemble of models and the ECMWF model as an individual source of prediction both for temperature and precipitation. It is therefore not advisable to rely on the Bulgarian seasonal forecast yet. However there is an upward trend of the skill of the temperature forecast and the ECMWF scores slightly better than the ensemble of models. It is therefore advisable to use the ECMWF temperature forecast as a single source of prediction rather than the ensemble of models. For precipitation however the ensemble of models scores better than the ECMWF and it is advisable to use the ensemble for precipitation. The downward trend of the ECMWF precipitation forecast with longer lead times reflects a recent deterioration of their score during the 1-year long wet period from March 2014 to April 2015 (see author for details).

Table 1: Skill of the subjective seasonal forecast, ensemble of models.

			Temperature				Precipitation			
	ensemble		1-month	2-month	3-month	random	1-month	2-month	3-month	random
0	poor	false	0.17	0.26	0.36	0.16	0.23	0.23	0.22	0.19
1	reasonable	climate	0.03	0.01	0.06	0.00	0.04	0.03	0.04	0.00
2	good	-1.5 : +1.5	0.18	0.19	0.13	0.05	0.17	0.16	0.13	0.23
3	very good	-1 : +1	0.41	0.39	0.30	0.47	0.31	0.29	0.28	0.25
4	excellent	-0.5 : +0.5	0.21	0.16	0.14	0.32	0.25	0.30	0.33	0.33
		average	2.46	2.17	1.81	2.77	2.32	2.51	2.46	2.54

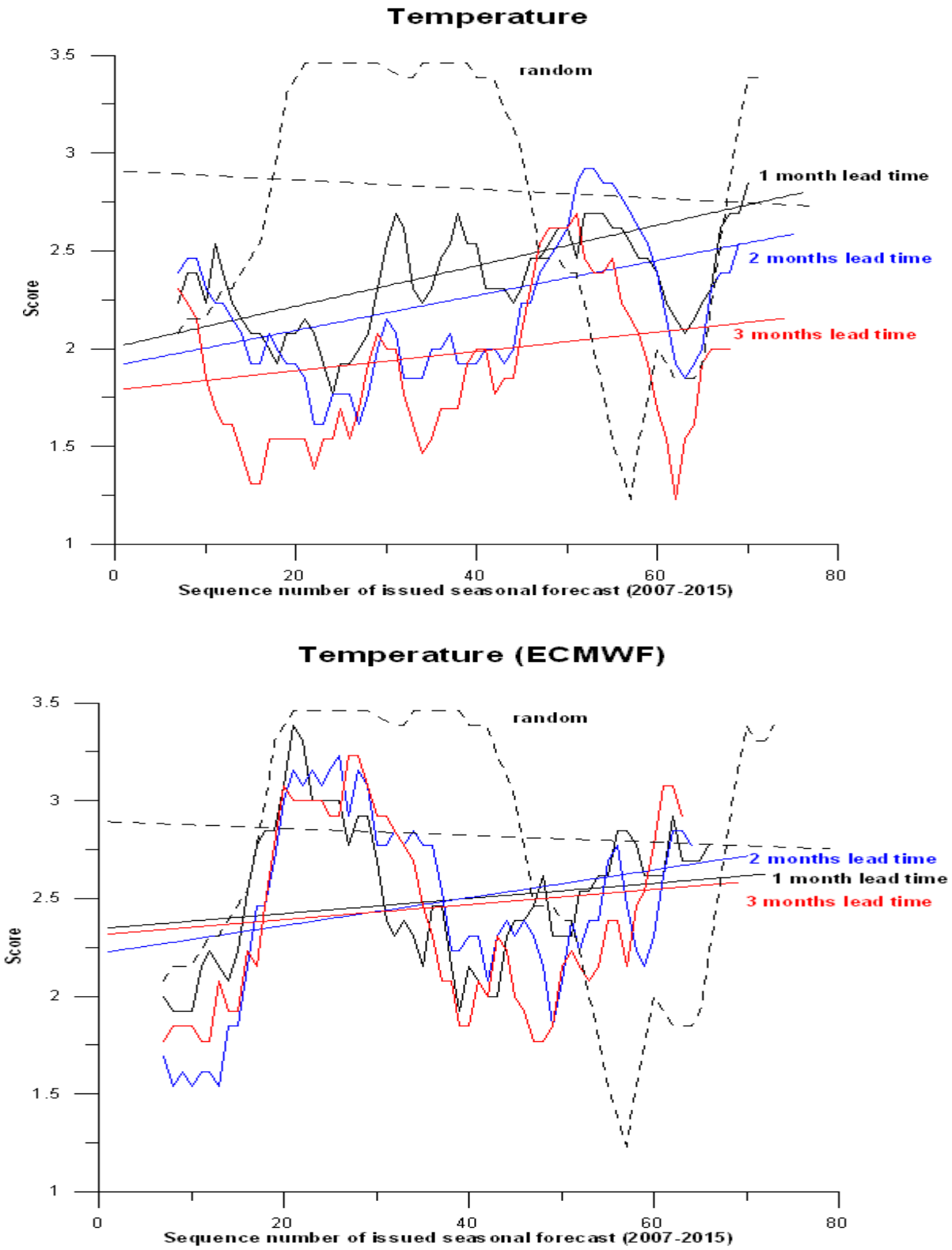

Figure 6: Scores of temperature forecast – evolution 2007-2015. Continuous curves/lines: 13-month running average and linear trend. Dashed curve/line: Random choice (always warm or normal). Upper plot – ensemble of models, lower plot – ECMWF.

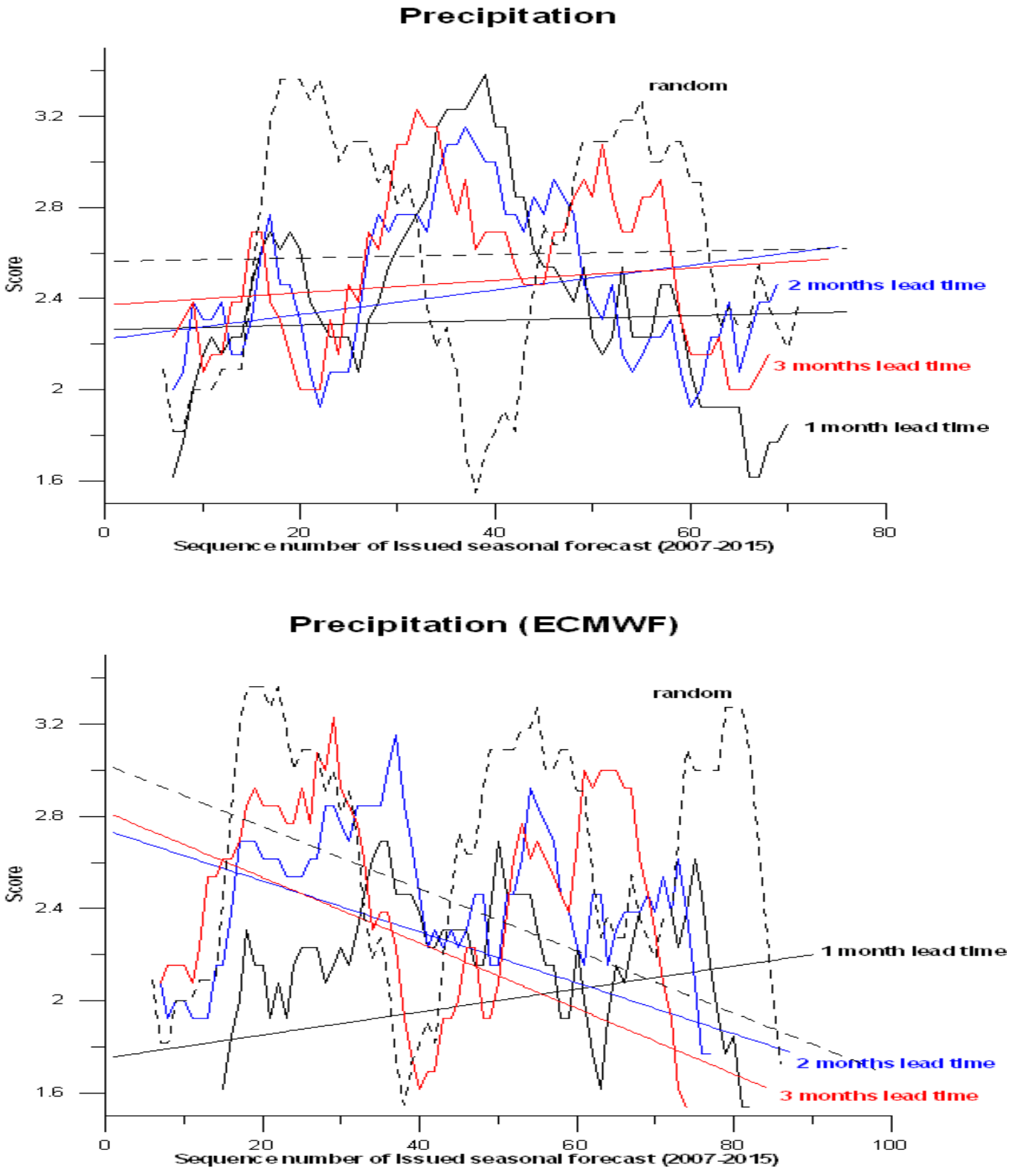

Figure 7: Scores of precipitation forecast – evolution 2007-2015. Continuous curves/lines: 13-month running average and linear trend. Dashed curve/line: Random choice (always normal). Upper plot – ensemble of models, lower plot – ECMWF.

Table 2: Skill of the subjective seasonal forecast, ECMWF.

			Temperature				Precipitation			
	ECMWF		1-month	2-month	3-month	random	1-month	2-month	3-month	random
0	poor	false	0.25	0.26	0.27	0.16	0.33	0.27	0.29	0.19
1	reasonable	climate	0.00	0.01	0.02	0.00	0.02	0.01	0.00	0.00
2	good	-1.5 : +1.5	0.08	0.06	0.13	0.05	0.20	0.19	0.17	0.23
3	very good	-1 : +1	0.31	0.34	0.26	0.47	0.24	0.27	0.30	0.25
4	excellent	-0.5 : +0.5	0.36	0.32	0.33	0.32	0.21	0.27	0.24	0.33
		average	2.54	2.45	2.35	2.77	1.99	2.26	2.20	2.54

Communicating uncertainty

As it has been shown the seasonal forecast for Bulgaria is not yet skillful enough. However the availability of seasonal forecast materials on the web and the facility to communicate around the world make the seasonal predictions very often a subject of public debate or speculation through media. The national weather service should provide guidance in these circumstances even though the forecast is not sufficiently skillful. This is the reason staying behind the decision of the Bulgarian weather service to maintain seasonal weather prediction for the general public. It is published on the website but it is not advertised widely. The document consists of 3 parts: seasonal outlook for the current and the coming calendar seasons in text and tables; short explanation on how to interpret the seasonal forecast; and information on how the forecast for the same seasons from the last year scored. One of the latest issues of the document (in Bulgarian) is posted at the end of this presentation for illustration. Tables 3 and 4 show an example of how the scores of the seasonal outlook for summer 2014 was measured and communicated.

Table 3: Scores of the seasonal forecast of mean seasonal temperature for summer 2014.

Temperature	Forecast			Index	Score		
	Month-1	Month-2	Month-3		Month-1	Month-2	Month-3
June	0		0	-0.76	3	1	3
July	-1	0		0.02	2	4	1
August	0	0	0	0.93	3	3	3
Summer	0		1	0.18	4	1	3

Table 4: Scores of the seasonal forecast of seasonal amount of precipitation for summer 2014.

Precipitation	Forecast			Index	Score		
	Month-1	Month-2	Month-3		Month-1	Month-2	Month-3
June	1		1	1.48	4	1	4
July	1	1		1.16	4	4	1
August	0	0	1	0.47	4	4	3
Summer	1		0	1.6	3	1	0

Conclusions

Seasonal forecasting will inevitably progress significantly in the coming years. It is not yet skillful for the region of Bulgaria though and it is not yet advisable to rely on it. However a modern weather service has to respond to the public interest by building and maintaining capacity for seasonal forecasting at the national level. The ECMWF model scores better than ensemble of models for temperature seasonal outlooks and it is advisable to rely on it as a single source of prediction for this parameter. It is however still advisable to use an ensemble of models for precipitation forecast with the ECMWF model being a part of it.

ilian.gospodinov@meteo.bg

Сезонна прогноза за България за сезон лято 2015

Национален институт по метеорология и хидрология, БАН

Последно обновяване на 29 май. Следващо обновяване на 27-30 юни.

Лято (юни-юли-август): Със средни сезонни температури близки до нормалните или по-високи и сезонни количества валеж близки до нормалните. Може да се очаква лято 2015 да е подобно или по-топло от лято 2014, но да е с по-малко валежи.
Юни: Със средни месечни температури близки до нормалните или по-високи и месечни количества валеж близки до нормалните. Може да се очаква юни 2015 да е по-топъл и с по-малко валежи от юни 2014.
Юли: Със средни месечни температури близки до нормалните или по-високи и месечни количества валеж близки до нормалните. Може да се очаква юли 2015 да е подобен или по-топъл от юли 2014, но да е с по-малко валежи.
Август: Със средни месечни температури и месечни количества валеж близки до нормалните. Може да се очаква август 2015 да е подобен на август 2015.

Таблица 1

Температура	Десетдневие	Месец	Лято
Юни	01-10		
	11-20		
	21-30		
Юли			
Август			

Таблица 2

Валеж	Десетдневие	Месец	Лято
Юни	01-10		
	11-20		
	21-30		
Юли			
Август			

Кратко обяснение:
Не повишена вероятност за събитие под, над или около нормата е 33%. Така може да се очаква, че средно климатично, сезоните попадат с еднаква вероятност (33%) в една от трите категории: около нормата, под нормата и над нормата. Целта на сезонните прогнози е да провери чрез различни статистически и числени методи дали има повишена вероятност предстоящ сезон да се окаже в някоя от трите категории за съответния елемент. Възможно е да не може да се даде предпочитание на нито една от трите категории и тогава не може да се направи специфична прогноза. Възможно е също да се окаже, че две съседни категории, а не само една, са с повишена вероятност (>33%) за реализация, например над нормата и около нормата. Категориите под, над или около нормата, използвани за целите на тази сезонна прогноза, се определят спрямо норма за периода 1980-2009. Малките пространствени мащаби на България в сравнение с мащабите на климатичните структури, които определят характера на сезоните, както и неопределеността в сезонните прогнози, ни карат да предпочитаме да издаваме сезонна прогноза за България под формата на индекс. Този индекс е валиден както за отделните места, така и за страната като цяло. Индексът е с възможни стойности от -2 (относително студено или сухо в цялата страна) до +2 (относително топло или мокро в цялата страна). В таблица 1 (температура) и таблица 2 (валеж) са посочени установените индекси за изтеклите или изтичащите месеци от текущия сезон и прогноза на индекса в интервал за предстоящите три месеца както и за текущия и предстоящия сезон. За сравнение, в таблица 3 са посочени установените индекси за същите месеци и сезони от миналата година както и успеваемостта на издадените за тях прогнози. Прогнозата по десетдневия за първия предстоящ месец е само в категории. Не се изработва и не се посочва десетдневен индекс.

Използвани са следните качествени градации:

топло	мокро
топло или нормално	мокро или нормално
нормално	нормално
студено или нормално	сухо или нормално
студено	сухо

и трите категории са еднакво вероятни
няма издадена прогноза

Таблица 3

		Издадена прогноза (1,2 или 3 месеца предварително)				Оценка на издадената прогноза		
2014 г.	Месец сезон	-1	-2	-3	Индекс	-1	-2	-3
Температура	Пролет	1	1	0	1.36	4	4	2
	Лято	0		1	0.18	4	1	3
	Март	1	1	1	1.93	3	3	3
	Април	0	0	1	0.56	3	3	4
	Май	0	0	0	-0.42	4	4	4
	Юни	0		0	-0.76	3	1	3
	Юли	-1	0		0.02	2	4	1
	Август	0	0	0	0.93	3	3	3
Валеж	Пролет	1	0	0	1.9	3	0	0
	Лято	1		0	1.6	3	1	0
	Март	0	0	-1	1.65	0	0	0
	Април	0	1	0	1.09	2	4	2
	Май	1	0	0	1.73	3	0	0
	Юни	1		1	1.48	4	1	4
	Юли	1	1		1.16	4	4	1
	Август	0	0	1	0.47	4	4	3

Оценка:
0 – незадоволителна; 1 – задоволителна; 2 – добра; 3 – много добра; 4 - отлична

Използвани са сезонни прогнози на следните чуждестранни метеорологични институти:

Европейски център за средносрочна прогноза на времето, Рединг, Обединено Кралство
Британска метеорологична служба, Ексетър, Обединено Кралство
Френска метеорологична служба, Тулуза, Франция
Център за прогнозиране на климата, Национална служба за времето, САЩ
Международен изследователски институт за Земята и обществото, Колумбийски университет, Ню Йорк, САЩ
Японска метеорологична служба

За контакти:
ilian.gospodinov@meteo.bg