A new seasonal forecast system for Météo-France: features and performances

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Since 2004 Météo-France has been part of the Eurosip consortium which builds up each month a 7-month numerical forecast based on several contributors (presently ECMWF, Met Office, NCEP, JMA and Météo-France). Each contribution provides hindcasts of at least 20 years for the 12 starting months. Each contributor updates from time to time his method to produce hindcasts/forecasts named "system". The numerical cost of a full hindcast, together with the time necessary to evaluate a new system, and the need of users for some stability, prevent frequent system upgrades. Météo-France system 5, developed in 2014 and early 2015, was introduced in Eurosip in June 2016. Since early 2016 a new system 6 has been developed. It has been launched in a parallel suite in March 2017 and should replace system 5 in 2018.

Météo-France system 6 upgrade corresponds to the migration from the CMIP5 version of the Météo-France climate model to the CMIP6 version. The so-called atmosphere diagnostic physics described in Voldoire et al. (2013) has been replaced by a prognostic physics in which the diabatic terms take into account the present as well as the past state of the atmosphere (Cuxart et al., 2000 for turbulence; Lopez, 2002 for micro-physics; Guérémy, 2011 for convection). The model components are.

- atmosphere: Arpege 6.0, T255, L91, Δt=15 min (system 5); Arpege 6.2, T359, L91, Δt=7.5 min (system 6)
- ocean: Nemo 3.2, 1°, L42 , Δt=1h (system 5); Nemo 3.6, 1°, L75 Δt=30 min (system 6)
- land surfaces: Surfex 7.3 (system 5); Surfex 8.1 (system 6)
- sea-ice: Gelato 5 (system 5); Gelato 6 (system 6)

For the sake of fair comparison, an additional hindcast experiment has been carried out with the two systems. It is based on 30 members starting on 1st February, 1st May, 1st August and 1st November and lasts 7 months. This hindcast spans the 1993-2015 period. Both ensembles are generated using the stochastic dynamics technique (Batté and Déqué, 2016)

Table 1 shows the root mean square (RMS) systematic error of seasonal average (months 2-4) for 500 hPa height (Z500) in the 30°N-90°N band, and for sea surface temperature (SST)in the 30°S-30°N band. This score, calculated against ERA-interim, measures the accuracy of the simulated climate in the first months of a coupled simulation starting from an observed state. The results show a systematic improvement of system 6 climate versus system 5 one.

	MAM		JJA		SON		DJF	
	Syst. 5	Syst. 6	Syst. 5	Syst. 6	Syst. 5	Syst. 6	Syst. 5	Syst. 6
Z500	34	10	20	15	37	19	45	18
SST	1.0	0.5	0.9	0.6	1.1	0.8	1.0	0.9

Table 1: RMS seasonal bias for 30°N-90°N Z500 (m) and for 30°S-30°N SST (K)

Table 2 shows, for the same variables as Table 1, the mean anomaly correlation coefficient (ACC). This score measures the predictive skill. System 6 is better than or equivalent to system 5, except for autumn northern latitudes circulation.

In winter (DJF), mid-latitude predictability can also be measured by the time correlation of circulation indices. These indices are derived by projecting model anomalies on the first mode of Principal Component Analyses performed with ERA interim data (1979-2012). The time correlations for system 5 / system 6 are:

- Arctic Oscillation (based on northern hemisphere mean sea level pressure): 0.69 / 0.66

- North Atlantic Oscillation (based on North Atlantic/Europe Z500): 0.52 / 0.61
- Pacific North America (based on North Pacific/North America Z500): 0.47 / 0.55

	MAM		JJA		SON		DJF	
	Syst. 5	Syst. 6	Syst. 5	Syst. 6	Syst. 5	Syst. 6	Syst. 5	Syst. 6
Z500	.27	.32	.10	.17	.26	.15	.34	.42
SST	.65	.65	.65	.68	.76	.77	.71	.74

Table 2: Seasonal ACC for 30°N-90°N Z500 and for 30°S-30°N SST

Tropical SST seasonal predictability is maximum in the Pacific Ocean. The skill is often measured by the time coefficient correlation of the SST average in the Nino 3.4 box (5°S-5°N by 170°W-120°W). Figure 1 displays the time correlation with respect to ERA-interim SST of the monthly means as a function of the lead time and shows the improvement brought by system 6, except in spring (MAM).

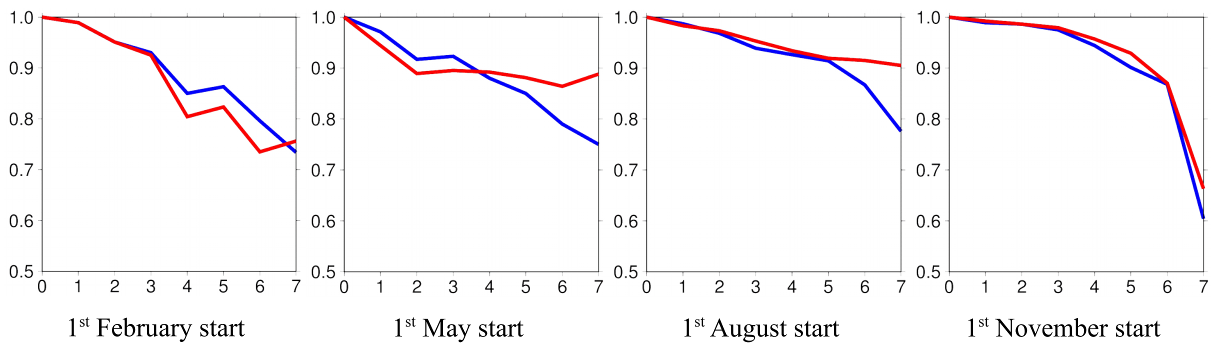

Figure 1: Nino 3.4 monthly SST correlation as a function of the lead time (month); system 5 (blue line) and system 5 (red line)

In conclusion, this new system has a more realistic climate and is in many aspects better than the previous one in terms of predictability. It will be implemented in the future European multi-model seasonal prediction developed in the framework of the Copernicus Climate Change Services (C3S).

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