



Supplement of

Model output statistics (MOS) applied to Copernicus Atmospheric Monitoring Service (CAMS) O₃ forecasts: trade-offs between continuous and categorical skill scores

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Table S1. Evaluation of the different forecast methods on continuous metrics, at D+1 (and D+4 into parenthesis), at the d/dd/d1max/dd1max/d8max/dd8max time scales.

Time scale	Forecast	nMB	nRMSE	PCC	slope	nMSDB	N
d	GBM	-1% (-1%)	16% (18%)	0.91 (0.88)	0.84 (0.80)	-7% (-9%)	295617
	AN(10)	0% (0%)	16% (19%)	0.90 (0.86)	0.78 (0.73)	-13% (-15%)	295617
	KF(RMSE)	0% (-0%)	15% (18%)	0.91 (0.88)	0.85 (0.80)	-7% (-9%)	295617
	QM	3% (2%)	20% (22%)	0.86 (0.84)	0.91 (0.87)	5% (4%)	295617
	MA(1)	-0% (-1%)	16% (22%)	0.91 (0.82)	0.92 (0.81)	1% (-2%)	295617
	PERS(1)	0% (0%)	20% (29%)	0.85 (0.70)	0.85 (0.70)	-0% (-0%)	295617
	RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617
dd	GBM	0% (0%)	17% (19%)	0.89 (0.87)	0.80 (0.76)	-10% (-12%)	288026
	AN(10)	1% (1%)	17% (19%)	0.90 (0.86)	0.79 (0.74)	-11% (-14%)	288026
	KF(RMSE)	0% (-1%)	15% (18%)	0.92 (0.87)	0.87 (0.81)	-5% (-7%)	288026
	QM	3% (3%)	20% (21%)	0.86 (0.84)	0.86 (0.84)	0% (-0%)	288026
	MA(1)	-0% (-1%)	16% (22%)	0.91 (0.83)	0.92 (0.82)	1% (-2%)	288026
	PERS(1)	0% (1%)	20% (29%)	0.85 (0.70)	0.85 (0.70)	0% (-0%)	288026
	RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.51)	-28% (-30%)	288026
d1max	GBM	-8% (-8%)	16% (18%)	0.86 (0.83)	0.80 (0.75)	-8% (-10%)	295617
	AN(10)	-4% (-4%)	15% (17%)	0.86 (0.82)	0.74 (0.70)	-14% (-15%)	295617
	KF(RMSE)	-3% (-4%)	13% (15%)	0.89 (0.85)	0.81 (0.77)	-8% (-10%)	295617
	QM	-1% (-1%)	17% (18%)	0.82 (0.80)	0.83 (0.80)	1% (-0%)	295617
	MA(1)	3% (2%)	15% (18%)	0.86 (0.79)	0.87 (0.77)	1% (-2%)	295617
	PERS(1)	0% (0%)	17% (23%)	0.82 (0.67)	0.82 (0.67)	-0% (-1%)	295617
	RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617
dd1max	GBM	0% (0%)	15% (16%)	0.86 (0.83)	0.74 (0.70)	-13% (-15%)	288980
	AN(10)	1% (1%)	14% (16%)	0.87 (0.83)	0.74 (0.69)	-15% (-17%)	288980
	KF(RMSE)	0% (-0%)	13% (15%)	0.90 (0.86)	0.83 (0.78)	-7% (-9%)	288980
	QM	1% (1%)	16% (17%)	0.83 (0.80)	0.80 (0.77)	-4% (-5%)	288980
	MA(1)	-0% (-0%)	15% (18%)	0.87 (0.80)	0.88 (0.79)	2% (-1%)	288980
	PERS(1)	0% (0%)	17% (23%)	0.82 (0.67)	0.82 (0.67)	0% (-1%)	288980
	RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.51)	-28% (-30%)	288980
d8max	GBM	-4% (-5%)	15% (17%)	0.89 (0.86)	0.83 (0.79)	-7% (-8%)	295617
	AN(10)	-1% (-2%)	15% (17%)	0.88 (0.85)	0.78 (0.73)	-12% (-14%)	295617
	KF(RMSE)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.85 (0.81)	-7% (-8%)	295617
	QM	1% (2%)	17% (19%)	0.85 (0.83)	0.88 (0.84)	3% (1%)	295617
	MA(1)	1% (0%)	15% (18%)	0.89 (0.83)	0.89 (0.81)	0% (-2%)	295617
	PERS(1)	0% (0%)	18% (24%)	0.84 (0.70)	0.84 (0.70)	-0% (-1%)	295617
	RAW	7% (7%)	21% (22%)	0.79 (0.76)	0.57 (0.54)	-27% (-29%)	295617
dd8max	GBM	0% (0%)	15% (17%)	0.88 (0.85)	0.78 (0.74)	-11% (-13%)	286803
	AN(10)	1% (1%)	15% (17%)	0.89 (0.85)	0.77 (0.72)	-13% (-15%)	286803
	KF(RMSE)	0% (-0%)	13% (15%)	0.92 (0.88)	0.86 (0.81)	-6% (-8%)	286803
	QM	2% (1%)	17% (18%)	0.86 (0.84)	0.83 (0.81)	-3% (-4%)	286803
	MA(1)	-0% (-1%)	15% (18%)	0.89 (0.83)	0.90 (0.82)	1% (-2%)	286803
	PERS(1)	0% (1%)	18% (24%)	0.84 (0.71)	0.84 (0.70)	0% (-0%)	286803
	RAW	7% (7%)	21% (22%)	0.79 (0.77)	0.57 (0.54)	-28% (-30%)	286803

Table S2. Evaluation on continuous metrics of the Persistence (PERS) forecast method for different configurations (different windows in d), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	nMB	nRMSE	PCC	slope	nMSDB	N
h	PERS(10)	0% (0%)	32% (34%)	0.77 (0.74)	0.65 (0.62)	-16% (-16%)	7067085
	PERS(9)	0% (0%)	32% (34%)	0.78 (0.74)	0.65 (0.62)	-16% (-16%)	7067085
	PERS(8)	0% (0%)	32% (34%)	0.78 (0.74)	0.66 (0.63)	-15% (-15%)	7067085
	PERS(7)	0% (0%)	32% (34%)	0.78 (0.74)	0.66 (0.63)	-15% (-15%)	7067085
	PERS(6)	0% (0%)	32% (34%)	0.77 (0.73)	0.67 (0.63)	-14% (-14%)	7067085
	PERS(5)	0% (0%)	32% (35%)	0.77 (0.73)	0.67 (0.63)	-13% (-13%)	7067085
	PERS(4)	0% (0%)	32% (36%)	0.77 (0.72)	0.68 (0.64)	-11% (-12%)	7067085
	PERS(3)	0% (0%)	33% (37%)	0.77 (0.71)	0.70 (0.64)	-10% (-10%)	7067085
	PERS(2)	0% (0%)	33% (38%)	0.76 (0.69)	0.71 (0.64)	-6% (-7%)	7067085
	PERS(1)	0% (0%)	36% (42%)	0.75 (0.65)	0.75 (0.65)	0% (-0%)	7067085
	RAW	18% (17%)	38% (39%)	0.75 (0.72)	0.53 (0.50)	-29% (-30%)	7067085
d	PERS(10)	0% (0%)	22% (24%)	0.81 (0.76)	0.70 (0.66)	-13% (-13%)	295617
	PERS(9)	0% (0%)	22% (24%)	0.81 (0.76)	0.71 (0.66)	-13% (-13%)	295617
	PERS(8)	0% (0%)	22% (25%)	0.81 (0.76)	0.71 (0.66)	-12% (-12%)	295617
	PERS(7)	0% (0%)	22% (25%)	0.81 (0.76)	0.72 (0.67)	-11% (-12%)	295617
	PERS(6)	0% (0%)	22% (25%)	0.81 (0.75)	0.73 (0.67)	-11% (-11%)	295617
	PERS(5)	0% (0%)	22% (25%)	0.82 (0.75)	0.74 (0.67)	-10% (-10%)	295617
	PERS(4)	0% (0%)	21% (26%)	0.82 (0.74)	0.75 (0.68)	-8% (-9%)	295617
	PERS(3)	0% (0%)	21% (26%)	0.83 (0.73)	0.77 (0.68)	-6% (-7%)	295617
	PERS(2)	0% (0%)	21% (27%)	0.83 (0.72)	0.80 (0.69)	-4% (-4%)	295617
	PERS(1)	0% (0%)	20% (29%)	0.85 (0.70)	0.85 (0.70)	-0% (-0%)	295617
	RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617
d1max	PERS(10)	-6% (-6%)	19% (20%)	0.79 (0.74)	0.68 (0.64)	-13% (-14%)	295617
	PERS(9)	-6% (-6%)	18% (20%)	0.79 (0.74)	0.69 (0.64)	-13% (-13%)	295617
	PERS(8)	-5% (-5%)	18% (20%)	0.79 (0.74)	0.70 (0.65)	-12% (-12%)	295617
	PERS(7)	-5% (-5%)	18% (20%)	0.79 (0.74)	0.70 (0.65)	-11% (-12%)	295617
	PERS(6)	-5% (-5%)	18% (20%)	0.79 (0.73)	0.71 (0.65)	-10% (-11%)	295617
	PERS(5)	-5% (-5%)	18% (21%)	0.80 (0.73)	0.72 (0.66)	-9% (-10%)	295617
	PERS(4)	-4% (-4%)	18% (21%)	0.80 (0.72)	0.74 (0.66)	-8% (-8%)	295617
	PERS(3)	-4% (-4%)	18% (21%)	0.81 (0.71)	0.76 (0.66)	-6% (-7%)	295617
	PERS(2)	-3% (-3%)	17% (22%)	0.81 (0.69)	0.78 (0.67)	-4% (-4%)	295617
	PERS(1)	0% (0%)	17% (23%)	0.82 (0.67)	0.82 (0.67)	-0% (-1%)	295617
	RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617
d8max	PERS(10)	-2% (-2%)	19% (21%)	0.81 (0.77)	0.72 (0.68)	-11% (-11%)	295617
	PERS(9)	-2% (-2%)	19% (21%)	0.81 (0.77)	0.73 (0.69)	-11% (-11%)	295617
	PERS(8)	-2% (-2%)	19% (21%)	0.82 (0.77)	0.73 (0.69)	-10% (-11%)	295617
	PERS(7)	-2% (-2%)	19% (21%)	0.82 (0.77)	0.74 (0.69)	-9% (-10%)	295617
	PERS(6)	-2% (-2%)	19% (21%)	0.82 (0.76)	0.75 (0.69)	-9% (-9%)	295617
	PERS(5)	-2% (-2%)	18% (21%)	0.82 (0.76)	0.76 (0.70)	-8% (-8%)	295617
	PERS(4)	-2% (-2%)	18% (22%)	0.82 (0.75)	0.77 (0.70)	-7% (-7%)	295617
	PERS(3)	-2% (-2%)	18% (22%)	0.83 (0.74)	0.79 (0.70)	-5% (-6%)	295617
	PERS(2)	-1% (-1%)	18% (23%)	0.83 (0.73)	0.81 (0.70)	-3% (-4%)	295617
	PERS(1)	0% (0%)	18% (24%)	0.84 (0.70)	0.84 (0.70)	-0% (-1%)	295617
	RAW	7% (7%)	21% (22%)	0.79 (0.76)	0.57 (0.54)	-27% (-29%)	295617

Table S3. Evaluation on categorical metrics of the Persistence (PERS) forecast method for different configurations (different windows in d), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	H	F	FB	SR	CSI	PSS	AUC	N
d8max>60	PERS(10)	0.18 (0.14)	0.01 (0.01)	0.35 (0.35)	0.52 (0.41)	0.15 (0.12)	0.17 (0.13)	0.91 (0.88)	295617
	PERS(9)	0.19 (0.15)	0.01 (0.01)	0.37 (0.37)	0.51 (0.39)	0.16 (0.12)	0.18 (0.14)	0.91 (0.88)	295617
	PERS(8)	0.20 (0.15)	0.01 (0.01)	0.40 (0.40)	0.52 (0.39)	0.17 (0.12)	0.20 (0.14)	0.91 (0.87)	295617
	PERS(7)	0.22 (0.16)	0.01 (0.01)	0.42 (0.42)	0.52 (0.38)	0.18 (0.13)	0.21 (0.15)	0.91 (0.87)	295617
	PERS(6)	0.24 (0.17)	0.01 (0.01)	0.46 (0.46)	0.51 (0.37)	0.19 (0.13)	0.23 (0.16)	0.91 (0.87)	295617
	PERS(5)	0.26 (0.19)	0.01 (0.02)	0.51 (0.51)	0.50 (0.36)	0.21 (0.14)	0.25 (0.17)	0.91 (0.86)	295617
	PERS(4)	0.29 (0.20)	0.01 (0.02)	0.57 (0.57)	0.50 (0.35)	0.22 (0.14)	0.28 (0.18)	0.92 (0.86)	295617
	PERS(3)	0.33 (0.22)	0.01 (0.02)	0.65 (0.66)	0.51 (0.33)	0.25 (0.15)	0.32 (0.20)	0.93 (0.85)	295617
	PERS(2)	0.40 (0.24)	0.02 (0.02)	0.77 (0.77)	0.52 (0.30)	0.29 (0.15)	0.38 (0.21)	0.94 (0.85)	295617
	PERS(1)	0.51 (0.27)	0.02 (0.03)	1.00 (1.00)	0.51 (0.27)	0.34 (0.15)	0.49 (0.23)	0.95 (0.84)	295617
RAW	0.17 (0.13)	0.01 (0.01)	0.37 (0.30)	0.45 (0.41)	0.14 (0.11)	0.16 (0.12)	0.90 (0.88)	295617	
dd8max>60	PERS(10)	0.21 (0.17)	0.01 (0.01)	0.43 (0.43)	0.49 (0.40)	0.17 (0.13)	0.20 (0.16)	0.91 (0.88)	286803
	PERS(9)	0.23 (0.17)	0.01 (0.01)	0.46 (0.45)	0.49 (0.38)	0.18 (0.14)	0.21 (0.16)	0.91 (0.87)	286803
	PERS(8)	0.24 (0.18)	0.01 (0.01)	0.48 (0.48)	0.50 (0.38)	0.19 (0.14)	0.23 (0.17)	0.91 (0.87)	286803
	PERS(7)	0.26 (0.19)	0.01 (0.02)	0.52 (0.51)	0.50 (0.37)	0.20 (0.14)	0.24 (0.17)	0.91 (0.87)	286803
	PERS(6)	0.27 (0.20)	0.01 (0.02)	0.55 (0.55)	0.49 (0.36)	0.21 (0.15)	0.26 (0.18)	0.91 (0.87)	286803
	PERS(5)	0.29 (0.21)	0.01 (0.02)	0.60 (0.60)	0.48 (0.35)	0.22 (0.15)	0.27 (0.19)	0.92 (0.86)	286803
	PERS(4)	0.31 (0.22)	0.02 (0.02)	0.65 (0.66)	0.48 (0.34)	0.23 (0.16)	0.30 (0.20)	0.92 (0.86)	286803
	PERS(3)	0.36 (0.24)	0.02 (0.02)	0.73 (0.74)	0.49 (0.32)	0.26 (0.16)	0.34 (0.22)	0.93 (0.85)	286803
	PERS(2)	0.42 (0.25)	0.02 (0.03)	0.83 (0.85)	0.50 (0.30)	0.29 (0.16)	0.40 (0.22)	0.94 (0.84)	286803
	PERS(1)	0.51 (0.27)	0.02 (0.04)	1.01 (1.03)	0.50 (0.27)	0.34 (0.16)	0.49 (0.24)	0.95 (0.84)	286803
RAW	0.14 (0.11)	0.01 (0.01)	0.32 (0.26)	0.45 (0.42)	0.12 (0.09)	0.14 (0.10)	0.89 (0.88)	286803	
d1max>90	PERS(10)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.88 (0.82)	295617
	PERS(9)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.89 (0.82)	295617
	PERS(8)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (-0.00)	0.89 (0.82)	295617
	PERS(7)	0.00 (0.00)	0.00 (0.00)	0.01 (0.01)	0.33 (0.00)	0.00 (0.00)	0.00 (-0.00)	0.90 (0.82)	295617
	PERS(6)	0.01 (0.00)	0.00 (0.00)	0.02 (0.02)	0.33 (0.00)	0.01 (0.00)	0.01 (-0.00)	0.90 (0.82)	295617
	PERS(5)	0.02 (0.01)	0.00 (0.00)	0.05 (0.05)	0.31 (0.17)	0.01 (0.01)	0.02 (0.01)	0.91 (0.82)	295617
	PERS(4)	0.03 (0.01)	0.00 (0.00)	0.07 (0.06)	0.39 (0.12)	0.03 (0.01)	0.03 (0.01)	0.93 (0.81)	295617
	PERS(3)	0.03 (0.02)	0.00 (0.00)	0.12 (0.12)	0.22 (0.12)	0.02 (0.01)	0.03 (0.01)	0.94 (0.81)	295617
	PERS(2)	0.04 (0.02)	0.00 (0.00)	0.30 (0.30)	0.14 (0.05)	0.03 (0.01)	0.04 (0.01)	0.94 (0.81)	295617
	PERS(1)	0.12 (0.06)	0.00 (0.00)	1.01 (0.98)	0.12 (0.06)	0.07 (0.03)	0.12 (0.06)	0.95 (0.82)	295617
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.00 (0.00)	-0.00 (0.00)	0.93 (0.92)	295617	
dd1max>90	PERS(10)	0.00 (0.00)	0.00 (0.00)	0.02 (0.02)	0.00 (0.00)	0.00 (0.00)	-0.00 (-0.00)	0.91 (0.86)	288980
	PERS(9)	0.00 (0.00)	0.00 (0.00)	0.03 (0.03)	0.00 (0.00)	0.00 (0.00)	-0.00 (-0.00)	0.91 (0.86)	288980
	PERS(8)	0.00 (0.00)	0.00 (0.00)	0.04 (0.04)	0.11 (0.11)	0.00 (0.00)	0.00 (0.00)	0.92 (0.86)	288980
	PERS(7)	0.01 (0.00)	0.00 (0.00)	0.05 (0.05)	0.23 (0.08)	0.01 (0.00)	0.01 (0.00)	0.92 (0.86)	288980
	PERS(6)	0.01 (0.01)	0.00 (0.00)	0.07 (0.07)	0.18 (0.12)	0.01 (0.01)	0.01 (0.01)	0.92 (0.85)	288980
	PERS(5)	0.02 (0.02)	0.00 (0.00)	0.10 (0.10)	0.21 (0.26)	0.02 (0.02)	0.02 (0.02)	0.93 (0.85)	288980
	PERS(4)	0.04 (0.03)	0.00 (0.00)	0.19 (0.17)	0.23 (0.17)	0.04 (0.03)	0.04 (0.03)	0.94 (0.85)	288980
	PERS(3)	0.07 (0.02)	0.00 (0.00)	0.30 (0.30)	0.23 (0.05)	0.05 (0.01)	0.07 (0.02)	0.94 (0.85)	288980
	PERS(2)	0.06 (0.02)	0.00 (0.00)	0.45 (0.47)	0.14 (0.05)	0.05 (0.02)	0.06 (0.02)	0.94 (0.84)	288980
	PERS(1)	0.13 (0.06)	0.00 (0.00)	1.05 (1.07)	0.12 (0.06)	0.07 (0.03)	0.13 (0.06)	0.95 (0.84)	288980
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.91)	288980	

Table S4. Evaluation on continuous metrics of the Moving Average (MA) MOS method for different configurations (different windows in d), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	nMB	nRMSE	PCC	slope	nMSDB	N
h	MA(10)	0% (-1%)	26% (28%)	0.86 (0.83)	0.78 (0.74)	-9% (-10%)	7067085
	MA(9)	0% (-1%)	26% (29%)	0.86 (0.82)	0.78 (0.74)	-9% (-10%)	7067085
	MA(8)	0% (-1%)	26% (29%)	0.86 (0.82)	0.78 (0.74)	-9% (-10%)	7067085
	MA(7)	0% (-1%)	26% (29%)	0.86 (0.82)	0.78 (0.74)	-8% (-10%)	7067085
	MA(6)	0% (-1%)	26% (29%)	0.85 (0.82)	0.79 (0.74)	-8% (-9%)	7067085
	MA(5)	0% (-1%)	26% (29%)	0.85 (0.81)	0.79 (0.74)	-7% (-9%)	7067085
	MA(4)	-0% (-1%)	27% (30%)	0.85 (0.81)	0.79 (0.74)	-7% (-8%)	7067085
	MA(3)	-0% (-1%)	27% (31%)	0.84 (0.80)	0.80 (0.74)	-5% (-7%)	7067085
	MA(2)	-0% (-1%)	28% (32%)	0.83 (0.78)	0.81 (0.75)	-3% (-5%)	7067085
	MA(1)	-0% (-1%)	31% (36%)	0.81 (0.74)	0.82 (0.75)	2% (0%)	7067085
RAW	18% (17%)	38% (39%)	0.75 (0.72)	0.53 (0.50)	-29% (-30%)	7067085	
d	MA(10)	0% (-1%)	16% (18%)	0.91 (0.87)	0.85 (0.80)	-6% (-8%)	295617
	MA(9)	0% (-1%)	16% (18%)	0.91 (0.87)	0.85 (0.80)	-6% (-8%)	295617
	MA(8)	0% (-1%)	16% (18%)	0.91 (0.87)	0.85 (0.80)	-6% (-8%)	295617
	MA(7)	0% (-1%)	16% (18%)	0.91 (0.87)	0.86 (0.81)	-6% (-7%)	295617
	MA(6)	0% (-1%)	16% (18%)	0.91 (0.87)	0.86 (0.81)	-5% (-7%)	295617
	MA(5)	0% (-1%)	16% (19%)	0.91 (0.87)	0.86 (0.81)	-5% (-7%)	295617
	MA(4)	0% (-1%)	16% (19%)	0.91 (0.86)	0.87 (0.81)	-4% (-6%)	295617
	MA(3)	0% (-1%)	16% (20%)	0.91 (0.85)	0.88 (0.81)	-3% (-5%)	295617
	MA(2)	0% (-1%)	16% (20%)	0.91 (0.84)	0.89 (0.81)	-2% (-4%)	295617
	MA(1)	-0% (-1%)	16% (22%)	0.91 (0.82)	0.92 (0.81)	1% (-2%)	295617
RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d1max	MA(10)	-3% (-3%)	13% (15%)	0.89 (0.85)	0.82 (0.78)	-7% (-9%)	295617
	MA(9)	-3% (-3%)	13% (15%)	0.89 (0.85)	0.82 (0.78)	-7% (-9%)	295617
	MA(8)	-3% (-3%)	13% (15%)	0.89 (0.85)	0.83 (0.78)	-7% (-8%)	295617
	MA(7)	-3% (-3%)	13% (15%)	0.89 (0.85)	0.83 (0.78)	-7% (-8%)	295617
	MA(6)	-2% (-3%)	13% (15%)	0.89 (0.85)	0.83 (0.78)	-6% (-8%)	295617
	MA(5)	-2% (-3%)	13% (16%)	0.88 (0.85)	0.83 (0.78)	-6% (-7%)	295617
	MA(4)	-2% (-2%)	14% (16%)	0.88 (0.84)	0.84 (0.78)	-5% (-7%)	295617
	MA(3)	-1% (-2%)	14% (16%)	0.88 (0.83)	0.85 (0.78)	-4% (-6%)	295617
	MA(2)	0% (-0%)	14% (17%)	0.88 (0.82)	0.86 (0.78)	-2% (-5%)	295617
	MA(1)	3% (2%)	15% (18%)	0.86 (0.79)	0.87 (0.77)	1% (-2%)	295617
RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d8max	MA(10)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.86 (0.81)	-6% (-7%)	295617
	MA(9)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.86 (0.82)	-6% (-7%)	295617
	MA(8)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.86 (0.82)	-5% (-7%)	295617
	MA(7)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.86 (0.82)	-5% (-7%)	295617
	MA(6)	-1% (-2%)	13% (16%)	0.91 (0.87)	0.86 (0.82)	-5% (-6%)	295617
	MA(5)	-1% (-2%)	13% (16%)	0.91 (0.87)	0.87 (0.82)	-5% (-6%)	295617
	MA(4)	-1% (-2%)	14% (16%)	0.91 (0.87)	0.87 (0.82)	-4% (-6%)	295617
	MA(3)	-1% (-1%)	14% (16%)	0.90 (0.86)	0.88 (0.82)	-3% (-5%)	295617
	MA(2)	-0% (-1%)	14% (17%)	0.90 (0.85)	0.88 (0.81)	-2% (-4%)	295617
	MA(1)	1% (0%)	15% (18%)	0.89 (0.83)	0.89 (0.81)	0% (-2%)	295617
RAW	7% (7%)	21% (22%)	0.79 (0.76)	0.57 (0.54)	-27% (-29%)	295617	

Table S5. Evaluation on categorical metrics of the Moving Average (MA) MOS method for different configurations (different windows in d), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	H	F	FB	SR	CSI	PSS	AUC	N
d8max>60	MA(10)	0.42 (0.32)	0.01 (0.01)	0.59 (0.50)	0.72 (0.65)	0.36 (0.27)	0.41 (0.31)	0.96 (0.95)	295617
	MA(9)	0.43 (0.32)	0.01 (0.01)	0.60 (0.50)	0.71 (0.64)	0.37 (0.27)	0.42 (0.31)	0.96 (0.95)	295617
	MA(8)	0.43 (0.32)	0.01 (0.01)	0.62 (0.50)	0.70 (0.64)	0.37 (0.27)	0.43 (0.31)	0.96 (0.94)	295617
	MA(7)	0.44 (0.33)	0.01 (0.01)	0.63 (0.52)	0.70 (0.63)	0.37 (0.28)	0.43 (0.32)	0.96 (0.94)	295617
	MA(6)	0.45 (0.33)	0.01 (0.01)	0.65 (0.54)	0.69 (0.62)	0.37 (0.28)	0.44 (0.32)	0.96 (0.94)	295617
	MA(5)	0.46 (0.34)	0.01 (0.01)	0.68 (0.56)	0.68 (0.60)	0.38 (0.27)	0.45 (0.33)	0.96 (0.94)	295617
	MA(4)	0.48 (0.34)	0.01 (0.01)	0.72 (0.60)	0.66 (0.57)	0.38 (0.27)	0.47 (0.33)	0.96 (0.94)	295617
	MA(3)	0.51 (0.35)	0.01 (0.01)	0.78 (0.64)	0.65 (0.55)	0.40 (0.27)	0.49 (0.34)	0.96 (0.94)	295617
	MA(2)	0.55 (0.36)	0.01 (0.02)	0.88 (0.71)	0.63 (0.51)	0.42 (0.27)	0.54 (0.35)	0.97 (0.93)	295617
	MA(1)	0.62 (0.39)	0.02 (0.02)	1.07 (0.88)	0.57 (0.44)	0.42 (0.26)	0.59 (0.36)	0.96 (0.92)	295617
RAW	0.17 (0.13)	0.01 (0.01)	0.37 (0.30)	0.45 (0.41)	0.14 (0.11)	0.16 (0.12)	0.90 (0.88)	295617	
dd8max>60	MA(10)	0.45 (0.35)	0.01 (0.01)	0.64 (0.55)	0.70 (0.63)	0.37 (0.29)	0.44 (0.34)	0.97 (0.95)	286803
	MA(9)	0.45 (0.35)	0.01 (0.01)	0.65 (0.55)	0.69 (0.63)	0.38 (0.29)	0.44 (0.34)	0.97 (0.95)	286803
	MA(8)	0.45 (0.35)	0.01 (0.01)	0.66 (0.55)	0.69 (0.62)	0.38 (0.29)	0.45 (0.34)	0.97 (0.94)	286803
	MA(7)	0.46 (0.35)	0.01 (0.01)	0.67 (0.57)	0.68 (0.62)	0.38 (0.29)	0.45 (0.34)	0.97 (0.94)	286803
	MA(6)	0.47 (0.35)	0.01 (0.01)	0.69 (0.58)	0.68 (0.61)	0.38 (0.29)	0.46 (0.34)	0.97 (0.94)	286803
	MA(5)	0.47 (0.36)	0.01 (0.01)	0.71 (0.60)	0.66 (0.59)	0.38 (0.29)	0.46 (0.34)	0.97 (0.94)	286803
	MA(4)	0.49 (0.36)	0.01 (0.01)	0.75 (0.63)	0.66 (0.57)	0.39 (0.28)	0.48 (0.35)	0.97 (0.94)	286803
	MA(3)	0.51 (0.37)	0.01 (0.01)	0.80 (0.67)	0.65 (0.55)	0.40 (0.28)	0.50 (0.35)	0.97 (0.94)	286803
	MA(2)	0.55 (0.37)	0.01 (0.02)	0.88 (0.73)	0.63 (0.51)	0.42 (0.28)	0.54 (0.36)	0.97 (0.93)	286803
	MA(1)	0.60 (0.38)	0.02 (0.02)	1.02 (0.83)	0.59 (0.46)	0.42 (0.26)	0.58 (0.36)	0.97 (0.92)	286803
RAW	0.14 (0.11)	0.01 (0.01)	0.32 (0.26)	0.45 (0.42)	0.12 (0.09)	0.14 (0.10)	0.89 (0.88)	286803	
d1max>90	MA(10)	0.03 (0.01)	0.00 (0.00)	0.04 (0.01)	0.70 (0.67)	0.03 (0.01)	0.03 (0.01)	0.96 (0.95)	295617
	MA(9)	0.03 (0.01)	0.00 (0.00)	0.05 (0.02)	0.64 (0.75)	0.03 (0.01)	0.03 (0.01)	0.96 (0.95)	295617
	MA(8)	0.03 (0.01)	0.00 (0.00)	0.05 (0.01)	0.64 (1.00)	0.03 (0.01)	0.03 (0.01)	0.96 (0.95)	295617
	MA(7)	0.04 (0.01)	0.00 (0.00)	0.07 (0.02)	0.58 (0.60)	0.04 (0.01)	0.04 (0.01)	0.96 (0.95)	295617
	MA(6)	0.06 (0.02)	0.00 (0.00)	0.09 (0.03)	0.62 (0.57)	0.05 (0.01)	0.06 (0.02)	0.96 (0.95)	295617
	MA(5)	0.06 (0.01)	0.00 (0.00)	0.11 (0.03)	0.53 (0.29)	0.06 (0.01)	0.06 (0.01)	0.96 (0.95)	295617
	MA(4)	0.08 (0.02)	0.00 (0.00)	0.14 (0.04)	0.57 (0.36)	0.07 (0.01)	0.08 (0.02)	0.96 (0.95)	295617
	MA(3)	0.10 (0.02)	0.00 (0.00)	0.23 (0.05)	0.42 (0.43)	0.09 (0.02)	0.10 (0.02)	0.96 (0.95)	295617
	MA(2)	0.14 (0.03)	0.00 (0.00)	0.52 (0.13)	0.27 (0.26)	0.10 (0.03)	0.14 (0.03)	0.95 (0.95)	295617
	MA(1)	0.24 (0.08)	0.00 (0.00)	1.15 (0.59)	0.21 (0.13)	0.12 (0.05)	0.24 (0.07)	0.96 (0.94)	295617
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.00 (0.00)	-0.00 (0.00)	0.93 (0.92)	295617	
dd1max>90	MA(10)	0.06 (0.01)	0.00 (0.00)	0.08 (0.02)	0.74 (0.60)	0.06 (0.01)	0.06 (0.01)	0.96 (0.95)	288980
	MA(9)	0.06 (0.01)	0.00 (0.00)	0.09 (0.02)	0.71 (0.60)	0.06 (0.01)	0.06 (0.01)	0.96 (0.95)	288980
	MA(8)	0.08 (0.01)	0.00 (0.00)	0.11 (0.02)	0.76 (0.50)	0.08 (0.01)	0.08 (0.01)	0.96 (0.95)	288980
	MA(7)	0.09 (0.02)	0.00 (0.00)	0.13 (0.04)	0.71 (0.56)	0.09 (0.02)	0.09 (0.02)	0.96 (0.95)	288980
	MA(6)	0.10 (0.02)	0.00 (0.00)	0.16 (0.05)	0.61 (0.50)	0.09 (0.02)	0.10 (0.02)	0.96 (0.95)	288980
	MA(5)	0.11 (0.03)	0.00 (0.00)	0.18 (0.05)	0.58 (0.58)	0.10 (0.03)	0.11 (0.03)	0.96 (0.95)	288980
	MA(4)	0.14 (0.04)	0.00 (0.00)	0.27 (0.07)	0.51 (0.53)	0.12 (0.04)	0.13 (0.04)	0.96 (0.95)	288980
	MA(3)	0.15 (0.05)	0.00 (0.00)	0.37 (0.12)	0.41 (0.46)	0.12 (0.05)	0.15 (0.05)	0.96 (0.95)	288980
	MA(2)	0.19 (0.07)	0.00 (0.00)	0.56 (0.21)	0.33 (0.31)	0.14 (0.06)	0.19 (0.07)	0.96 (0.95)	288980
	MA(1)	0.25 (0.06)	0.00 (0.00)	1.06 (0.54)	0.24 (0.11)	0.14 (0.04)	0.25 (0.06)	0.96 (0.94)	288980
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.91)	288980	

Table S6. Evaluation on continuous metrics of the Kalman Filter (KF) MOS method for different configurations (different metrics to optimize internally), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	nMB	nRMSE	PCC	slope	nMSDB	N
h	KF(AUC-90)	0% (-0%)	25% (28%)	0.86 (0.83)	0.78 (0.74)	-10% (-11%)	7067085
	KF(AUC-60)	0% (-1%)	26% (29%)	0.86 (0.82)	0.78 (0.74)	-9% (-10%)	7067085
	KF(PSS-90)	0% (-0%)	25% (28%)	0.86 (0.83)	0.78 (0.74)	-10% (-11%)	7067085
	KF(PSS-60)	-0% (-1%)	29% (33%)	0.83 (0.78)	0.81 (0.74)	-3% (-4%)	7067085
	KF(CSI-90)	0% (-0%)	25% (28%)	0.86 (0.83)	0.78 (0.74)	-10% (-11%)	7067085
	KF(CSI-60)	0% (-1%)	27% (31%)	0.84 (0.79)	0.80 (0.74)	-5% (-7%)	7067085
	KF(SR-90)	0% (-0%)	25% (28%)	0.86 (0.83)	0.78 (0.74)	-10% (-11%)	7067085
	KF(SR-60)	0% (-0%)	26% (29%)	0.86 (0.82)	0.77 (0.73)	-10% (-11%)	7067085
	KF(RMSE)	0% (-0%)	25% (28%)	0.86 (0.83)	0.78 (0.74)	-10% (-11%)	7067085
RAW	18% (17%)	38% (39%)	0.75 (0.72)	0.53 (0.50)	-29% (-30%)	7067085	
d	KF(AUC-90)	0% (-0%)	15% (18%)	0.91 (0.88)	0.85 (0.80)	-7% (-9%)	295617
	KF(AUC-60)	0% (-0%)	15% (18%)	0.91 (0.87)	0.85 (0.80)	-6% (-8%)	295617
	KF(PSS-90)	0% (-0%)	15% (18%)	0.91 (0.88)	0.85 (0.80)	-7% (-9%)	295617
	KF(PSS-60)	0% (-1%)	16% (20%)	0.91 (0.85)	0.89 (0.81)	-2% (-4%)	295617
	KF(CSI-90)	0% (-0%)	15% (18%)	0.91 (0.88)	0.85 (0.80)	-7% (-9%)	295617
	KF(CSI-60)	0% (-1%)	15% (19%)	0.91 (0.86)	0.88 (0.81)	-3% (-6%)	295617
	KF(SR-90)	0% (-0%)	15% (18%)	0.91 (0.88)	0.85 (0.80)	-7% (-9%)	295617
	KF(SR-60)	0% (-0%)	16% (18%)	0.91 (0.87)	0.84 (0.79)	-8% (-9%)	295617
	KF(RMSE)	0% (-0%)	15% (18%)	0.91 (0.88)	0.85 (0.80)	-7% (-9%)	295617
RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d1max	KF(AUC-90)	-3% (-4%)	13% (15%)	0.89 (0.85)	0.81 (0.77)	-8% (-10%)	295617
	KF(AUC-60)	-3% (-3%)	14% (16%)	0.88 (0.84)	0.82 (0.77)	-7% (-9%)	295617
	KF(PSS-90)	-3% (-4%)	13% (15%)	0.89 (0.85)	0.81 (0.77)	-8% (-10%)	295617
	KF(PSS-60)	0% (-0%)	14% (17%)	0.87 (0.81)	0.86 (0.78)	-1% (-4%)	295617
	KF(CSI-90)	-3% (-4%)	13% (15%)	0.89 (0.85)	0.82 (0.77)	-8% (-10%)	295617
	KF(CSI-60)	-1% (-1%)	14% (16%)	0.88 (0.82)	0.85 (0.78)	-3% (-6%)	295617
	KF(SR-90)	-3% (-4%)	13% (15%)	0.89 (0.85)	0.82 (0.77)	-8% (-10%)	295617
	KF(SR-60)	-3% (-3%)	14% (16%)	0.88 (0.84)	0.80 (0.75)	-9% (-11%)	295617
	KF(RMSE)	-3% (-4%)	13% (15%)	0.89 (0.85)	0.81 (0.77)	-8% (-10%)	295617
RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d8max	KF(AUC-90)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.85 (0.81)	-7% (-8%)	295617
	KF(AUC-60)	-1% (-2%)	13% (16%)	0.91 (0.87)	0.85 (0.81)	-6% (-8%)	295617
	KF(PSS-90)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.85 (0.81)	-7% (-8%)	295617
	KF(PSS-60)	-0% (-1%)	14% (17%)	0.90 (0.85)	0.88 (0.81)	-2% (-4%)	295617
	KF(CSI-90)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.85 (0.81)	-7% (-8%)	295617
	KF(CSI-60)	-1% (-1%)	13% (16%)	0.91 (0.86)	0.88 (0.81)	-3% (-5%)	295617
	KF(SR-90)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.85 (0.81)	-7% (-8%)	295617
	KF(SR-60)	-1% (-2%)	13% (16%)	0.91 (0.87)	0.84 (0.79)	-8% (-9%)	295617
	KF(RMSE)	-1% (-2%)	13% (15%)	0.91 (0.88)	0.85 (0.81)	-7% (-8%)	295617
RAW	7% (7%)	21% (22%)	0.79 (0.76)	0.57 (0.54)	-27% (-29%)	295617	

Table S7. Evaluation on categorical metrics of the Kalman Filter (KF) MOS method for different configurations (different metrics to optimize internally), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	H	F	FB	SR	CSI	PSS	AUC	N
d8max>60	KF(AUC-90)	0.40 (0.29)	0.01 (0.01)	0.54 (0.44)	0.74 (0.67)	0.35 (0.26)	0.39 (0.29)	0.97 (0.95)	295617
	KF(AUC-60)	0.42 (0.30)	0.01 (0.01)	0.60 (0.48)	0.70 (0.63)	0.36 (0.25)	0.41 (0.29)	0.97 (0.94)	295617
	KF(PSS-90)	0.40 (0.29)	0.01 (0.01)	0.54 (0.44)	0.74 (0.66)	0.35 (0.25)	0.39 (0.29)	0.97 (0.95)	295617
	KF(PSS-60)	0.57 (0.36)	0.02 (0.02)	0.93 (0.75)	0.62 (0.49)	0.42 (0.26)	0.56 (0.35)	0.97 (0.93)	295617
	KF(CSI-90)	0.40 (0.30)	0.01 (0.01)	0.55 (0.45)	0.74 (0.66)	0.35 (0.26)	0.40 (0.29)	0.97 (0.95)	295617
	KF(CSI-60)	0.53 (0.35)	0.01 (0.01)	0.80 (0.64)	0.65 (0.54)	0.41 (0.27)	0.51 (0.33)	0.97 (0.94)	295617
	KF(SR-90)	0.40 (0.30)	0.01 (0.01)	0.55 (0.45)	0.73 (0.66)	0.35 (0.26)	0.40 (0.29)	0.97 (0.95)	295617
	KF(SR-60)	0.39 (0.28)	0.01 (0.01)	0.54 (0.44)	0.71 (0.64)	0.33 (0.24)	0.38 (0.27)	0.96 (0.94)	295617
	KF(RMSE)	0.40 (0.30)	0.01 (0.01)	0.54 (0.44)	0.74 (0.67)	0.35 (0.26)	0.39 (0.29)	0.97 (0.95)	295617
RAW	0.17 (0.13)	0.01 (0.01)	0.37 (0.30)	0.45 (0.41)	0.14 (0.11)	0.16 (0.12)	0.90 (0.88)	295617	
dd8max>60	KF(AUC-90)	0.46 (0.34)	0.01 (0.01)	0.66 (0.54)	0.71 (0.62)	0.39 (0.28)	0.46 (0.33)	0.97 (0.95)	286803
	KF(AUC-60)	0.48 (0.33)	0.01 (0.01)	0.70 (0.57)	0.68 (0.58)	0.39 (0.27)	0.47 (0.32)	0.97 (0.94)	286803
	KF(PSS-90)	0.46 (0.34)	0.01 (0.01)	0.66 (0.54)	0.71 (0.62)	0.39 (0.28)	0.46 (0.33)	0.97 (0.95)	286803
	KF(PSS-60)	0.53 (0.35)	0.01 (0.01)	0.81 (0.65)	0.66 (0.54)	0.41 (0.27)	0.52 (0.34)	0.97 (0.93)	286803
	KF(CSI-90)	0.46 (0.34)	0.01 (0.01)	0.66 (0.54)	0.71 (0.62)	0.39 (0.28)	0.46 (0.33)	0.97 (0.95)	286803
	KF(CSI-60)	0.52 (0.35)	0.01 (0.01)	0.78 (0.64)	0.66 (0.55)	0.41 (0.27)	0.51 (0.34)	0.97 (0.94)	286803
	KF(SR-90)	0.46 (0.34)	0.01 (0.01)	0.66 (0.54)	0.71 (0.62)	0.39 (0.28)	0.46 (0.33)	0.97 (0.95)	286803
	KF(SR-60)	0.43 (0.32)	0.01 (0.01)	0.61 (0.51)	0.69 (0.62)	0.36 (0.26)	0.42 (0.31)	0.97 (0.94)	286803
	KF(RMSE)	0.46 (0.34)	0.01 (0.01)	0.66 (0.54)	0.71 (0.62)	0.39 (0.28)	0.46 (0.33)	0.97 (0.95)	286803
RAW	0.14 (0.11)	0.01 (0.01)	0.32 (0.26)	0.45 (0.42)	0.12 (0.09)	0.14 (0.10)	0.89 (0.88)	286803	
d11max>90	KF(AUC-90)	0.02 (0.01)	0.00 (0.00)	0.08 (0.02)	0.30 (0.50)	0.02 (0.01)	0.02 (0.01)	0.96 (0.95)	295617
	KF(AUC-60)	0.04 (0.01)	0.00 (0.00)	0.11 (0.04)	0.36 (0.18)	0.04 (0.01)	0.04 (0.01)	0.96 (0.95)	295617
	KF(PSS-90)	0.03 (0.01)	0.00 (0.00)	0.08 (0.03)	0.36 (0.43)	0.03 (0.01)	0.03 (0.01)	0.96 (0.95)	295617
	KF(PSS-60)	0.17 (0.06)	0.00 (0.00)	0.74 (0.33)	0.24 (0.17)	0.11 (0.04)	0.17 (0.06)	0.96 (0.95)	295617
	KF(CSI-90)	0.03 (0.01)	0.00 (0.00)	0.09 (0.03)	0.39 (0.43)	0.03 (0.01)	0.03 (0.01)	0.96 (0.95)	295617
	KF(CSI-60)	0.12 (0.02)	0.00 (0.00)	0.39 (0.14)	0.31 (0.11)	0.10 (0.01)	0.12 (0.01)	0.96 (0.95)	295617
	KF(SR-90)	0.06 (0.02)	0.00 (0.00)	0.16 (0.05)	0.37 (0.36)	0.05 (0.02)	0.06 (0.02)	0.96 (0.95)	295617
	KF(SR-60)	0.01 (0.00)	0.00 (0.00)	0.04 (0.01)	0.18 (0.50)	0.01 (0.00)	0.01 (0.00)	0.95 (0.95)	295617
	KF(RMSE)	0.02 (0.01)	0.00 (0.00)	0.03 (0.01)	0.50 (1.00)	0.01 (0.01)	0.02 (0.01)	0.96 (0.95)	295617
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.00 (0.00)	-0.00 (0.00)	0.93 (0.92)	295617	
dd11max>90	KF(AUC-90)	0.07 (0.02)	0.00 (0.00)	0.12 (0.03)	0.57 (0.57)	0.06 (0.02)	0.07 (0.02)	0.96 (0.95)	288980
	KF(AUC-60)	0.08 (0.01)	0.00 (0.00)	0.19 (0.05)	0.40 (0.17)	0.07 (0.01)	0.08 (0.01)	0.96 (0.95)	288980
	KF(PSS-90)	0.09 (0.02)	0.00 (0.00)	0.17 (0.05)	0.55 (0.36)	0.09 (0.02)	0.09 (0.02)	0.96 (0.95)	288980
	KF(PSS-60)	0.14 (0.02)	0.00 (0.00)	0.42 (0.14)	0.32 (0.17)	0.10 (0.02)	0.13 (0.02)	0.96 (0.95)	288980
	KF(CSI-90)	0.09 (0.02)	0.00 (0.00)	0.17 (0.05)	0.55 (0.36)	0.09 (0.02)	0.09 (0.02)	0.96 (0.95)	288980
	KF(CSI-60)	0.11 (0.00)	0.00 (0.00)	0.28 (0.06)	0.41 (0.07)	0.10 (0.00)	0.11 (0.00)	0.96 (0.95)	288980
	KF(SR-90)	0.07 (0.02)	0.00 (0.00)	0.13 (0.04)	0.55 (0.50)	0.07 (0.02)	0.07 (0.02)	0.96 (0.95)	288980
	KF(SR-60)	0.04 (0.00)	0.00 (0.00)	0.07 (0.02)	0.59 (0.00)	0.04 (0.00)	0.04 (-0.00)	0.96 (0.95)	288980
	KF(RMSE)	0.09 (0.02)	0.00 (0.00)	0.13 (0.03)	0.68 (0.50)	0.09 (0.02)	0.09 (0.02)	0.96 (0.95)	288980
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.91)	288980	

Table S8. Evaluation on continuous metrics of the Analogs (AN) MOS method for different configurations (different number of analogs), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	nMB	nRMSE	PCC	slope	nMSDB	N
h	AN(30)	0% (0%)	27% (29%)	0.84 (0.81)	0.70 (0.67)	-17% (-18%)	7067085
	AN(25)	-0% (0%)	26% (29%)	0.85 (0.82)	0.71 (0.67)	-16% (-17%)	7067085
	AN(20)	-0% (0%)	26% (29%)	0.85 (0.82)	0.72 (0.68)	-15% (-17%)	7067085
	AN(15)	0% (0%)	26% (28%)	0.86 (0.82)	0.73 (0.69)	-14% (-16%)	7067085
	AN(10)	0% (0%)	26% (28%)	0.86 (0.82)	0.75 (0.70)	-13% (-15%)	7067085
	AN(5)	0% (0%)	26% (29%)	0.85 (0.81)	0.76 (0.71)	-11% (-13%)	7067085
	AN(1)	0% (0%)	33% (37%)	0.79 (0.73)	0.78 (0.72)	-0% (-1%)	7067085
	RAW	18% (17%)	38% (39%)	0.75 (0.72)	0.53 (0.50)	-29% (-30%)	7067085
d	AN(30)	0% (0%)	18% (20%)	0.87 (0.84)	0.73 (0.69)	-16% (-18%)	295617
	AN(25)	0% (0%)	18% (20%)	0.88 (0.84)	0.74 (0.70)	-16% (-17%)	295617
	AN(20)	0% (0%)	17% (20%)	0.89 (0.85)	0.75 (0.71)	-15% (-17%)	295617
	AN(15)	0% (0%)	17% (19%)	0.89 (0.86)	0.77 (0.72)	-14% (-16%)	295617
	AN(10)	0% (0%)	16% (19%)	0.90 (0.86)	0.78 (0.73)	-13% (-15%)	295617
	AN(5)	0% (0%)	16% (19%)	0.90 (0.86)	0.80 (0.75)	-11% (-13%)	295617
	AN(1)	0% (0%)	17% (20%)	0.89 (0.84)	0.83 (0.76)	-7% (-9%)	295617
	RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617
d1max	AN(30)	-5% (-5%)	17% (18%)	0.83 (0.80)	0.69 (0.65)	-18% (-19%)	295617
	AN(25)	-5% (-5%)	16% (18%)	0.84 (0.80)	0.70 (0.66)	-17% (-18%)	295617
	AN(20)	-5% (-5%)	16% (17%)	0.85 (0.81)	0.71 (0.67)	-16% (-17%)	295617
	AN(15)	-5% (-5%)	15% (17%)	0.85 (0.82)	0.73 (0.68)	-15% (-16%)	295617
	AN(10)	-4% (-4%)	15% (17%)	0.86 (0.82)	0.74 (0.70)	-14% (-15%)	295617
	AN(5)	-2% (-2%)	14% (17%)	0.86 (0.82)	0.76 (0.71)	-12% (-13%)	295617
	AN(1)	6% (6%)	17% (20%)	0.83 (0.77)	0.77 (0.71)	-7% (-8%)	295617
	RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617
d8max	AN(30)	-2% (-2%)	16% (18%)	0.86 (0.82)	0.72 (0.69)	-15% (-16%)	295617
	AN(25)	-2% (-2%)	16% (18%)	0.86 (0.83)	0.74 (0.70)	-15% (-16%)	295617
	AN(20)	-2% (-2%)	16% (17%)	0.87 (0.83)	0.75 (0.71)	-14% (-15%)	295617
	AN(15)	-2% (-2%)	15% (17%)	0.88 (0.84)	0.76 (0.72)	-13% (-14%)	295617
	AN(10)	-1% (-2%)	15% (17%)	0.88 (0.85)	0.78 (0.73)	-12% (-14%)	295617
	AN(5)	-1% (-1%)	14% (17%)	0.89 (0.85)	0.80 (0.74)	-11% (-12%)	295617
	AN(1)	1% (1%)	16% (18%)	0.87 (0.82)	0.81 (0.75)	-7% (-9%)	295617
	RAW	7% (7%)	21% (22%)	0.79 (0.76)	0.57 (0.54)	-27% (-29%)	295617

Table S9. Evaluation on categorical metrics of the Analogs (AN) MOS method for different configurations (different number of analogs), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	H	F	FB	SR	CSI	PSS	AUC	N
d8max>60	AN(30)	0.22 (0.17)	0.00 (0.00)	0.30 (0.25)	0.74 (0.67)	0.20 (0.16)	0.21 (0.16)	0.94 (0.92)	295617
	AN(25)	0.24 (0.18)	0.00 (0.00)	0.32 (0.27)	0.74 (0.68)	0.22 (0.17)	0.23 (0.18)	0.94 (0.93)	295617
	AN(20)	0.26 (0.20)	0.00 (0.00)	0.34 (0.30)	0.75 (0.68)	0.24 (0.18)	0.25 (0.20)	0.95 (0.93)	295617
	AN(15)	0.28 (0.22)	0.00 (0.00)	0.38 (0.33)	0.74 (0.67)	0.25 (0.20)	0.27 (0.22)	0.95 (0.93)	295617
	AN(10)	0.31 (0.24)	0.01 (0.01)	0.42 (0.37)	0.73 (0.66)	0.28 (0.22)	0.30 (0.24)	0.95 (0.94)	295617
	AN(5)	0.36 (0.27)	0.01 (0.01)	0.51 (0.44)	0.71 (0.62)	0.31 (0.23)	0.35 (0.27)	0.96 (0.94)	295617
	AN(1)	0.47 (0.36)	0.02 (0.02)	0.81 (0.76)	0.58 (0.48)	0.35 (0.26)	0.45 (0.34)	0.95 (0.92)	295617
	RAW	0.17 (0.13)	0.01 (0.01)	0.37 (0.30)	0.45 (0.41)	0.14 (0.11)	0.16 (0.12)	0.90 (0.88)	295617
dd8max>60	AN(30)	0.26 (0.21)	0.00 (0.01)	0.37 (0.33)	0.71 (0.63)	0.24 (0.19)	0.26 (0.20)	0.95 (0.93)	286803
	AN(25)	0.28 (0.23)	0.01 (0.01)	0.40 (0.35)	0.71 (0.64)	0.25 (0.20)	0.28 (0.22)	0.95 (0.93)	286803
	AN(20)	0.30 (0.24)	0.01 (0.01)	0.43 (0.38)	0.71 (0.64)	0.27 (0.22)	0.30 (0.24)	0.95 (0.93)	286803
	AN(15)	0.33 (0.27)	0.01 (0.01)	0.46 (0.42)	0.70 (0.64)	0.29 (0.23)	0.32 (0.26)	0.95 (0.94)	286803
	AN(10)	0.36 (0.29)	0.01 (0.01)	0.52 (0.46)	0.69 (0.62)	0.31 (0.25)	0.35 (0.28)	0.96 (0.94)	286803
	AN(5)	0.40 (0.32)	0.01 (0.01)	0.61 (0.56)	0.66 (0.58)	0.33 (0.26)	0.39 (0.31)	0.96 (0.93)	286803
	AN(1)	0.48 (0.39)	0.02 (0.03)	0.99 (0.97)	0.48 (0.40)	0.32 (0.24)	0.45 (0.36)	0.94 (0.90)	286803
	RAW	0.14 (0.11)	0.01 (0.01)	0.32 (0.26)	0.45 (0.42)	0.12 (0.09)	0.14 (0.10)	0.89 (0.88)	286803
d1max>90	AN(30)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.89)	295617
	AN(25)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.90)	295617
	AN(20)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.93 (0.90)	295617
	AN(15)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.94 (0.91)	295617
	AN(10)	0.00 (0.00)	0.00 (0.00)	0.01 (0.00)	0.50 (1.00)	0.00 (0.00)	0.00 (0.00)	0.95 (0.91)	295617
	AN(5)	0.01 (0.01)	0.00 (0.00)	0.02 (0.01)	0.60 (1.00)	0.01 (0.01)	0.01 (0.01)	0.95 (0.92)	295617
	AN(1)	0.11 (0.06)	0.00 (0.00)	0.81 (0.73)	0.14 (0.09)	0.07 (0.04)	0.11 (0.06)	0.95 (0.92)	295617
	RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.00 (0.00)	-0.00 (0.00)	0.93 (0.92)	295617
dd1max>90	AN(30)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.95 (0.92)	288980
	AN(25)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.95 (0.93)	288980
	AN(20)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (nan)	0.00 (0.00)	-0.00 (0.00)	0.95 (0.93)	288980
	AN(15)	0.00 (0.01)	0.00 (0.00)	0.01 (0.01)	0.00 (1.00)	0.00 (0.01)	-0.00 (0.01)	0.96 (0.93)	288980
	AN(10)	0.02 (0.01)	0.00 (0.00)	0.03 (0.01)	0.67 (1.00)	0.02 (0.01)	0.02 (0.01)	0.96 (0.93)	288980
	AN(5)	0.05 (0.02)	0.00 (0.00)	0.08 (0.05)	0.67 (0.55)	0.05 (0.02)	0.05 (0.02)	0.96 (0.94)	288980
	AN(1)	0.13 (0.14)	0.00 (0.00)	0.81 (0.73)	0.16 (0.19)	0.08 (0.09)	0.13 (0.14)	0.94 (0.93)	288980
	RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.91)	288980

Table S10. Evaluation on continuous metrics of the Gradient Boosting Machine (GBM) MOS method for different configurations (different set of features and/or weighting strategies), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	nMB	nRMSE	PCC	slope	nMSDB	N
h	GBM(noO,W3)	-4% (-4%)	29% (32%)	0.84 (0.81)	0.86 (0.82)	3% (2%)	7067085
	GBM(noO,W2)	-3% (-4%)	28% (30%)	0.85 (0.82)	0.84 (0.81)	-1% (-1%)	7067085
	GBM(noO,W)	-2% (-3%)	26% (29%)	0.86 (0.83)	0.81 (0.78)	-5% (-6%)	7067085
	GBM(noO)	-0% (-1%)	25% (28%)	0.87 (0.84)	0.75 (0.72)	-13% (-14%)	7067085
	GBM(W3)	-4% (-5%)	29% (32%)	0.84 (0.80)	0.86 (0.82)	3% (2%)	7067085
	GBM(W2)	-4% (-4%)	28% (31%)	0.85 (0.81)	0.85 (0.81)	-0% (-1%)	7067085
	GBM(W)	-2% (-3%)	26% (29%)	0.86 (0.83)	0.82 (0.77)	-5% (-6%)	7067085
	GBM	-0% (-1%)	25% (28%)	0.87 (0.83)	0.75 (0.71)	-13% (-15%)	7067085
RAW	18% (17%)	38% (39%)	0.75 (0.72)	0.53 (0.50)	-29% (-30%)	7067085	
d	GBM(noO,W3)	-4% (-4%)	19% (21%)	0.88 (0.85)	0.93 (0.89)	6% (5%)	295617
	GBM(noO,W2)	-3% (-4%)	18% (20%)	0.89 (0.86)	0.91 (0.88)	3% (2%)	295617
	GBM(noO,W)	-2% (-3%)	17% (19%)	0.90 (0.87)	0.89 (0.85)	-1% (-2%)	295617
	GBM(noO)	-1% (-1%)	16% (18%)	0.90 (0.88)	0.84 (0.80)	-7% (-8%)	295617
	GBM(W3)	-4% (-5%)	20% (22%)	0.88 (0.85)	0.94 (0.90)	7% (6%)	295617
	GBM(W2)	-4% (-4%)	18% (21%)	0.89 (0.86)	0.93 (0.88)	4% (3%)	295617
	GBM(W)	-2% (-3%)	17% (19%)	0.90 (0.87)	0.90 (0.85)	-0% (-2%)	295617
	GBM	-1% (-1%)	16% (18%)	0.91 (0.88)	0.84 (0.80)	-7% (-9%)	295617
RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d1max	GBM(noO,W3)	-5% (-6%)	18% (19%)	0.83 (0.80)	0.90 (0.86)	8% (7%)	295617
	GBM(noO,W2)	-6% (-6%)	17% (19%)	0.84 (0.81)	0.87 (0.84)	4% (3%)	295617
	GBM(noO,W)	-7% (-7%)	17% (18%)	0.85 (0.82)	0.84 (0.80)	-1% (-2%)	295617
	GBM(noO)	-8% (-8%)	17% (18%)	0.86 (0.83)	0.78 (0.75)	-9% (-10%)	295617
	GBM(W3)	-6% (-6%)	18% (20%)	0.83 (0.80)	0.91 (0.87)	10% (9%)	295617
	GBM(W2)	-6% (-6%)	17% (19%)	0.84 (0.81)	0.89 (0.84)	6% (4%)	295617
	GBM(W)	-7% (-7%)	17% (18%)	0.85 (0.82)	0.85 (0.81)	-0% (-2%)	295617
	GBM	-8% (-8%)	16% (18%)	0.86 (0.83)	0.80 (0.75)	-8% (-10%)	295617
RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d8max	GBM(noO,W3)	-3% (-3%)	18% (19%)	0.86 (0.84)	0.95 (0.92)	11% (10%)	295617
	GBM(noO,W2)	-3% (-3%)	17% (18%)	0.87 (0.84)	0.93 (0.89)	6% (6%)	295617
	GBM(noO,W)	-3% (-3%)	16% (17%)	0.88 (0.85)	0.89 (0.85)	1% (-0%)	295617
	GBM(noO)	-4% (-4%)	15% (17%)	0.89 (0.86)	0.82 (0.79)	-7% (-8%)	295617
	GBM(W3)	-3% (-3%)	18% (20%)	0.86 (0.84)	0.97 (0.93)	13% (11%)	295617
	GBM(W2)	-3% (-3%)	17% (19%)	0.87 (0.84)	0.95 (0.90)	8% (7%)	295617
	GBM(W)	-3% (-4%)	16% (18%)	0.88 (0.85)	0.91 (0.86)	2% (1%)	295617
	GBM	-4% (-5%)	15% (17%)	0.89 (0.86)	0.83 (0.79)	-7% (-8%)	295617
RAW	7% (7%)	21% (22%)	0.79 (0.76)	0.57 (0.54)	-27% (-29%)	295617	

Table S11. Evaluation on categorical metrics of the Gradient Boosting Machine (GBM) MOS method for different configurations (different set of features and/or weighting strategies), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	H	F	FB	SR	CSI	PSS	AUC	N
d8max>60	GBM(noO,W3)	0.40 (0.35)	0.01 (0.01)	0.68 (0.66)	0.59 (0.53)	0.31 (0.27)	0.39 (0.34)	0.94 (0.93)	295617
	GBM(noO,W2)	0.38 (0.33)	0.01 (0.01)	0.63 (0.60)	0.61 (0.56)	0.31 (0.26)	0.37 (0.32)	0.94 (0.93)	295617
	GBM(noO,W)	0.35 (0.30)	0.01 (0.01)	0.55 (0.51)	0.65 (0.59)	0.30 (0.25)	0.34 (0.29)	0.94 (0.93)	295617
	GBM(noO)	0.28 (0.24)	0.01 (0.01)	0.39 (0.36)	0.71 (0.66)	0.25 (0.21)	0.27 (0.23)	0.94 (0.93)	295617
	GBM(W3)	0.41 (0.35)	0.01 (0.01)	0.70 (0.67)	0.59 (0.52)	0.32 (0.26)	0.40 (0.33)	0.94 (0.93)	295617
	GBM(W2)	0.40 (0.33)	0.01 (0.01)	0.65 (0.60)	0.62 (0.55)	0.32 (0.26)	0.39 (0.32)	0.94 (0.93)	295617
	GBM(W)	0.37 (0.30)	0.01 (0.01)	0.58 (0.50)	0.65 (0.60)	0.31 (0.25)	0.36 (0.29)	0.95 (0.93)	295617
	GBM	0.30 (0.23)	0.01 (0.01)	0.41 (0.35)	0.72 (0.67)	0.27 (0.21)	0.29 (0.23)	0.95 (0.93)	295617
RAW	0.17 (0.13)	0.01 (0.01)	0.37 (0.30)	0.45 (0.41)	0.14 (0.11)	0.16 (0.12)	0.90 (0.88)	295617	
dd8max>60	GBM(noO,W3)	0.44 (0.39)	0.02 (0.02)	0.84 (0.79)	0.52 (0.49)	0.31 (0.28)	0.42 (0.37)	0.94 (0.93)	286803
	GBM(noO,W2)	0.43 (0.38)	0.02 (0.02)	0.78 (0.73)	0.56 (0.52)	0.32 (0.28)	0.42 (0.36)	0.94 (0.93)	286803
	GBM(noO,W)	0.42 (0.37)	0.01 (0.01)	0.71 (0.65)	0.59 (0.56)	0.33 (0.29)	0.41 (0.36)	0.95 (0.94)	286803
	GBM(noO)	0.39 (0.33)	0.01 (0.01)	0.59 (0.55)	0.65 (0.61)	0.32 (0.28)	0.38 (0.32)	0.95 (0.94)	286803
	GBM(W3)	0.45 (0.40)	0.02 (0.02)	0.87 (0.82)	0.51 (0.48)	0.31 (0.28)	0.43 (0.38)	0.94 (0.93)	286803
	GBM(W2)	0.44 (0.38)	0.02 (0.02)	0.80 (0.75)	0.55 (0.51)	0.32 (0.28)	0.42 (0.37)	0.94 (0.93)	286803
	GBM(W)	0.43 (0.37)	0.01 (0.01)	0.72 (0.68)	0.59 (0.55)	0.33 (0.29)	0.41 (0.36)	0.95 (0.94)	286803
	GBM	0.39 (0.33)	0.01 (0.01)	0.60 (0.55)	0.65 (0.60)	0.32 (0.27)	0.38 (0.32)	0.95 (0.94)	286803
RAW	0.14 (0.11)	0.01 (0.01)	0.32 (0.26)	0.45 (0.42)	0.12 (0.09)	0.14 (0.10)	0.89 (0.88)	286803	
d1max>90	GBM(noO,W3)	0.05 (0.01)	0.00 (0.00)	0.07 (0.05)	0.67 (0.25)	0.04 (0.01)	0.05 (0.01)	0.94 (0.93)	295617
	GBM(noO,W2)	0.03 (0.00)	0.00 (0.00)	0.04 (0.02)	0.70 (0.00)	0.03 (0.00)	0.03 (-0.00)	0.94 (0.93)	295617
	GBM(noO,W)	0.03 (0.00)	0.00 (0.00)	0.03 (0.00)	0.88 (1.00)	0.03 (0.00)	0.03 (0.00)	0.94 (0.94)	295617
	GBM(noO)	0.00 (0.00)	0.00 (0.00)	0.01 (0.00)	0.50 (nan)	0.00 (0.00)	0.00 (0.00)	0.93 (0.93)	295617
	GBM(W3)	0.06 (0.02)	0.00 (0.00)	0.08 (0.03)	0.76 (0.50)	0.06 (0.01)	0.06 (0.02)	0.94 (0.93)	295617
	GBM(W2)	0.05 (0.01)	0.00 (0.00)	0.06 (0.01)	0.76 (0.67)	0.05 (0.01)	0.05 (0.01)	0.94 (0.93)	295617
	GBM(W)	0.02 (0.00)	0.00 (0.00)	0.03 (0.00)	0.86 (nan)	0.02 (0.00)	0.02 (0.00)	0.94 (0.93)	295617
	GBM	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.00 (nan)	0.00 (0.00)	0.00 (0.00)	0.93 (0.92)	295617
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.00 (0.00)	-0.00 (0.00)	0.93 (0.92)	295617	
dd1max>90	GBM(noO,W3)	0.09 (0.03)	0.00 (0.00)	0.14 (0.09)	0.65 (0.33)	0.09 (0.03)	0.09 (0.03)	0.95 (0.94)	288980
	GBM(noO,W2)	0.10 (0.03)	0.00 (0.00)	0.14 (0.08)	0.73 (0.37)	0.10 (0.03)	0.10 (0.03)	0.95 (0.95)	288980
	GBM(noO,W)	0.10 (0.03)	0.00 (0.00)	0.16 (0.08)	0.62 (0.37)	0.09 (0.03)	0.10 (0.03)	0.96 (0.95)	288980
	GBM(noO)	0.05 (0.02)	0.00 (0.00)	0.10 (0.05)	0.54 (0.55)	0.05 (0.02)	0.05 (0.02)	0.96 (0.95)	288980
	GBM(W3)	0.10 (0.03)	0.00 (0.00)	0.14 (0.09)	0.68 (0.38)	0.09 (0.03)	0.10 (0.03)	0.95 (0.94)	288980
	GBM(W2)	0.08 (0.04)	0.00 (0.00)	0.13 (0.09)	0.63 (0.43)	0.08 (0.04)	0.08 (0.04)	0.96 (0.95)	288980
	GBM(W)	0.07 (0.03)	0.00 (0.00)	0.12 (0.07)	0.61 (0.41)	0.07 (0.03)	0.07 (0.03)	0.96 (0.95)	288980
	GBM	0.07 (0.02)	0.00 (0.00)	0.12 (0.02)	0.57 (0.67)	0.06 (0.02)	0.07 (0.02)	0.96 (0.95)	288980
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.91)	288980	

Table S12. Evaluation on continuous metrics of the sensitivity tests on Gradient Boosting Machine (GBM) and Analogs (AN) MOS methods for different meteorological input data (HRES and ERA5), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	nMB	nRMSE	PCC	slope	nMSDB	N
h	GBM(ERA5)	-1% (-1%)	24% (26%)	0.88 (0.86)	0.78 (0.75)	-11% (-13%)	7067085
	GBM	-0% (-1%)	25% (28%)	0.87 (0.83)	0.75 (0.71)	-13% (-15%)	7067085
	AN(10,ERA5)	0% (0%)	25% (27%)	0.86 (0.84)	0.75 (0.72)	-13% (-14%)	7067085
	AN(10)	0% (0%)	26% (28%)	0.86 (0.82)	0.75 (0.70)	-13% (-15%)	7067085
	AN(5,ERA5)	0% (0%)	26% (28%)	0.86 (0.83)	0.77 (0.73)	-11% (-12%)	7067085
	AN(5)	0% (0%)	26% (29%)	0.85 (0.81)	0.76 (0.71)	-11% (-13%)	7067085
	AN(1,ERA5)	1% (0%)	32% (35%)	0.79 (0.75)	0.79 (0.75)	-1% (-1%)	7067085
	AN(1)	0% (0%)	33% (37%)	0.79 (0.73)	0.78 (0.72)	-0% (-1%)	7067085
RAW	18% (17%)	38% (39%)	0.75 (0.72)	0.53 (0.50)	-29% (-30%)	7067085	
d	GBM(ERA5)	-1% (-1%)	15% (17%)	0.91 (0.89)	0.86 (0.82)	-6% (-8%)	295617
	GBM	-1% (-1%)	16% (18%)	0.91 (0.88)	0.84 (0.80)	-7% (-9%)	295617
	AN(10,ERA5)	0% (0%)	16% (18%)	0.90 (0.87)	0.79 (0.75)	-13% (-14%)	295617
	AN(10)	0% (0%)	16% (19%)	0.90 (0.86)	0.78 (0.73)	-13% (-15%)	295617
	AN(5,ERA5)	0% (0%)	16% (18%)	0.91 (0.87)	0.81 (0.77)	-11% (-12%)	295617
	AN(5)	0% (0%)	16% (19%)	0.90 (0.86)	0.80 (0.75)	-11% (-13%)	295617
	AN(1,ERA5)	1% (0%)	16% (19%)	0.90 (0.86)	0.83 (0.79)	-8% (-9%)	295617
	AN(1)	0% (0%)	17% (20%)	0.89 (0.84)	0.83 (0.76)	-7% (-9%)	295617
RAW	18% (17%)	30% (30%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d1max	GBM(ERA5)	-6% (-7%)	15% (17%)	0.87 (0.85)	0.79 (0.76)	-9% (-11%)	295617
	GBM	-8% (-8%)	16% (18%)	0.86 (0.83)	0.80 (0.75)	-8% (-10%)	295617
	AN(10,ERA5)	-4% (-4%)	15% (16%)	0.86 (0.83)	0.74 (0.71)	-14% (-14%)	295617
	AN(10)	-4% (-4%)	15% (17%)	0.86 (0.82)	0.74 (0.70)	-14% (-15%)	295617
	AN(5,ERA5)	-2% (-2%)	14% (16%)	0.87 (0.83)	0.76 (0.73)	-12% (-13%)	295617
	AN(5)	-2% (-2%)	14% (17%)	0.86 (0.82)	0.76 (0.71)	-12% (-13%)	295617
	AN(1,ERA5)	6% (7%)	17% (19%)	0.83 (0.79)	0.78 (0.73)	-7% (-7%)	295617
	AN(1)	6% (6%)	17% (20%)	0.83 (0.77)	0.77 (0.71)	-7% (-8%)	295617
RAW	2% (2%)	19% (19%)	0.76 (0.74)	0.55 (0.52)	-28% (-29%)	295617	
d8max	GBM(ERA5)	-3% (-4%)	14% (16%)	0.90 (0.88)	0.84 (0.80)	-7% (-9%)	295617
	GBM	-4% (-5%)	15% (17%)	0.89 (0.86)	0.83 (0.79)	-7% (-8%)	295617
	AN(10,ERA5)	-1% (-1%)	15% (16%)	0.89 (0.86)	0.78 (0.75)	-12% (-13%)	295617
	AN(10)	-1% (-2%)	15% (17%)	0.88 (0.85)	0.78 (0.73)	-12% (-14%)	295617
	AN(5,ERA5)	-1% (-1%)	14% (16%)	0.89 (0.86)	0.80 (0.76)	-10% (-11%)	295617
	AN(5)	-1% (-1%)	14% (17%)	0.89 (0.85)	0.80 (0.74)	-11% (-12%)	295617
	AN(1,ERA5)	1% (1%)	15% (17%)	0.88 (0.84)	0.82 (0.77)	-7% (-8%)	295617
	AN(1)	1% (1%)	16% (18%)	0.87 (0.82)	0.81 (0.75)	-7% (-9%)	295617
RAW	7% (7%)	21% (22%)	0.79 (0.76)	0.57 (0.54)	-27% (-29%)	295617	

Table S13. Evaluation on categorical metrics of the sensitivity tests on Gradient Boostin Machine (GBM) and Analogs (AN) MOS methods for different meteorological input data (HRES and ERA5), at D+1 (and D+4 into parenthesis).

Time scale	Forecast	H	F	FB	SR	CSI	PSS	AUC	N
d8max>60	GBM(ERA5)	0.32 (0.25)	0.01 (0.01)	0.45 (0.37)	0.71 (0.67)	0.28 (0.22)	0.31 (0.24)	0.95 (0.94)	295617
	GBM	0.30 (0.23)	0.01 (0.01)	0.41 (0.35)	0.72 (0.67)	0.27 (0.21)	0.29 (0.23)	0.95 (0.93)	295617
	AN(10,ERA5)	0.31 (0.26)	0.01 (0.01)	0.42 (0.39)	0.74 (0.67)	0.28 (0.23)	0.30 (0.26)	0.96 (0.94)	295617
	AN(10)	0.31 (0.24)	0.01 (0.01)	0.42 (0.37)	0.73 (0.66)	0.28 (0.22)	0.30 (0.24)	0.95 (0.94)	295617
	AN(5,ERA5)	0.36 (0.29)	0.01 (0.01)	0.51 (0.46)	0.71 (0.64)	0.31 (0.25)	0.35 (0.29)	0.96 (0.94)	295617
	AN(5)	0.36 (0.27)	0.01 (0.01)	0.51 (0.44)	0.71 (0.62)	0.31 (0.23)	0.35 (0.27)	0.96 (0.94)	295617
	AN(1,ERA5)	0.46 (0.38)	0.01 (0.02)	0.78 (0.73)	0.59 (0.52)	0.35 (0.28)	0.45 (0.36)	0.95 (0.93)	295617
	AN(1)	0.47 (0.36)	0.02 (0.02)	0.81 (0.76)	0.58 (0.48)	0.35 (0.26)	0.45 (0.34)	0.95 (0.92)	295617
RAW	0.17 (0.13)	0.01 (0.01)	0.37 (0.30)	0.45 (0.41)	0.14 (0.11)	0.16 (0.12)	0.90 (0.88)	295617	
dd8max>60	GBM(ERA5)	0.39 (0.34)	0.01 (0.01)	0.59 (0.52)	0.66 (0.65)	0.33 (0.29)	0.38 (0.33)	0.95 (0.94)	286803
	GBM	0.39 (0.33)	0.01 (0.01)	0.60 (0.55)	0.65 (0.60)	0.32 (0.27)	0.38 (0.32)	0.95 (0.94)	286803
	AN(10,ERA5)	0.36 (0.30)	0.01 (0.01)	0.52 (0.48)	0.69 (0.63)	0.31 (0.26)	0.35 (0.30)	0.96 (0.94)	286803
	AN(10)	0.36 (0.29)	0.01 (0.01)	0.52 (0.46)	0.69 (0.62)	0.31 (0.25)	0.35 (0.28)	0.96 (0.94)	286803
	AN(5,ERA5)	0.40 (0.33)	0.01 (0.01)	0.61 (0.57)	0.66 (0.58)	0.33 (0.27)	0.39 (0.32)	0.96 (0.94)	286803
	AN(5)	0.40 (0.32)	0.01 (0.01)	0.61 (0.56)	0.66 (0.58)	0.33 (0.26)	0.39 (0.31)	0.96 (0.93)	286803
	AN(1,ERA5)	0.48 (0.39)	0.02 (0.03)	0.98 (0.96)	0.49 (0.41)	0.32 (0.25)	0.46 (0.37)	0.94 (0.91)	286803
	AN(1)	0.48 (0.39)	0.02 (0.03)	0.99 (0.97)	0.48 (0.40)	0.32 (0.24)	0.45 (0.36)	0.94 (0.90)	286803
RAW	0.14 (0.11)	0.01 (0.01)	0.32 (0.26)	0.45 (0.42)	0.12 (0.09)	0.14 (0.10)	0.89 (0.88)	286803	
d1max>90	GBM(ERA5)	0.00 (0.00)	0.00 (0.00)	0.01 (0.00)	0.33 (nan)	0.00 (0.00)	0.00 (0.00)	0.94 (0.92)	295617
	GBM	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.00 (nan)	0.00 (0.00)	0.00 (0.00)	0.93 (0.92)	295617
	AN(10,ERA5)	0.01 (0.00)	0.00 (0.00)	0.02 (0.00)	0.50 (1.00)	0.01 (0.00)	0.01 (0.00)	0.95 (0.92)	295617
	AN(10)	0.00 (0.00)	0.00 (0.00)	0.01 (0.00)	0.50 (1.00)	0.00 (0.00)	0.00 (0.00)	0.95 (0.91)	295617
	AN(5,ERA5)	0.02 (0.01)	0.00 (0.00)	0.03 (0.02)	0.62 (0.50)	0.02 (0.01)	0.02 (0.01)	0.95 (0.92)	295617
	AN(5)	0.01 (0.01)	0.00 (0.00)	0.02 (0.01)	0.60 (1.00)	0.01 (0.01)	0.01 (0.01)	0.95 (0.92)	295617
	AN(1,ERA5)	0.11 (0.09)	0.00 (0.00)	0.77 (0.74)	0.15 (0.12)	0.07 (0.05)	0.11 (0.09)	0.95 (0.93)	295617
	AN(1)	0.11 (0.06)	0.00 (0.00)	0.81 (0.73)	0.14 (0.09)	0.07 (0.04)	0.11 (0.06)	0.95 (0.92)	295617
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.00 (0.00)	-0.00 (0.00)	0.93 (0.92)	295617	
dd1max>90	GBM(ERA5)	0.08 (0.02)	0.00 (0.00)	0.13 (0.03)	0.63 (0.57)	0.08 (0.02)	0.08 (0.02)	0.96 (0.95)	288980
	GBM	0.07 (0.02)	0.00 (0.00)	0.12 (0.02)	0.57 (0.67)	0.06 (0.02)	0.07 (0.02)	0.96 (0.95)	288980
	AN(10,ERA5)	0.02 (0.02)	0.00 (0.00)	0.04 (0.02)	0.56 (0.67)	0.02 (0.02)	0.02 (0.02)	0.96 (0.94)	288980
	AN(10)	0.02 (0.01)	0.00 (0.00)	0.03 (0.01)	0.67 (1.00)	0.02 (0.01)	0.02 (0.01)	0.96 (0.93)	288980
	AN(5,ERA5)	0.05 (0.03)	0.00 (0.00)	0.08 (0.05)	0.58 (0.54)	0.04 (0.03)	0.05 (0.03)	0.96 (0.94)	288980
	AN(5)	0.05 (0.02)	0.00 (0.00)	0.08 (0.05)	0.67 (0.55)	0.05 (0.02)	0.05 (0.02)	0.96 (0.94)	288980
	AN(1,ERA5)	0.13 (0.07)	0.00 (0.00)	0.73 (0.63)	0.18 (0.11)	0.08 (0.05)	0.13 (0.07)	0.94 (0.92)	288980
	AN(1)	0.13 (0.14)	0.00 (0.00)	0.81 (0.73)	0.16 (0.19)	0.08 (0.09)	0.13 (0.14)	0.94 (0.93)	288980
RAW	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	nan (nan)	0.00 (0.00)	0.00 (0.00)	0.92 (0.91)	288980	

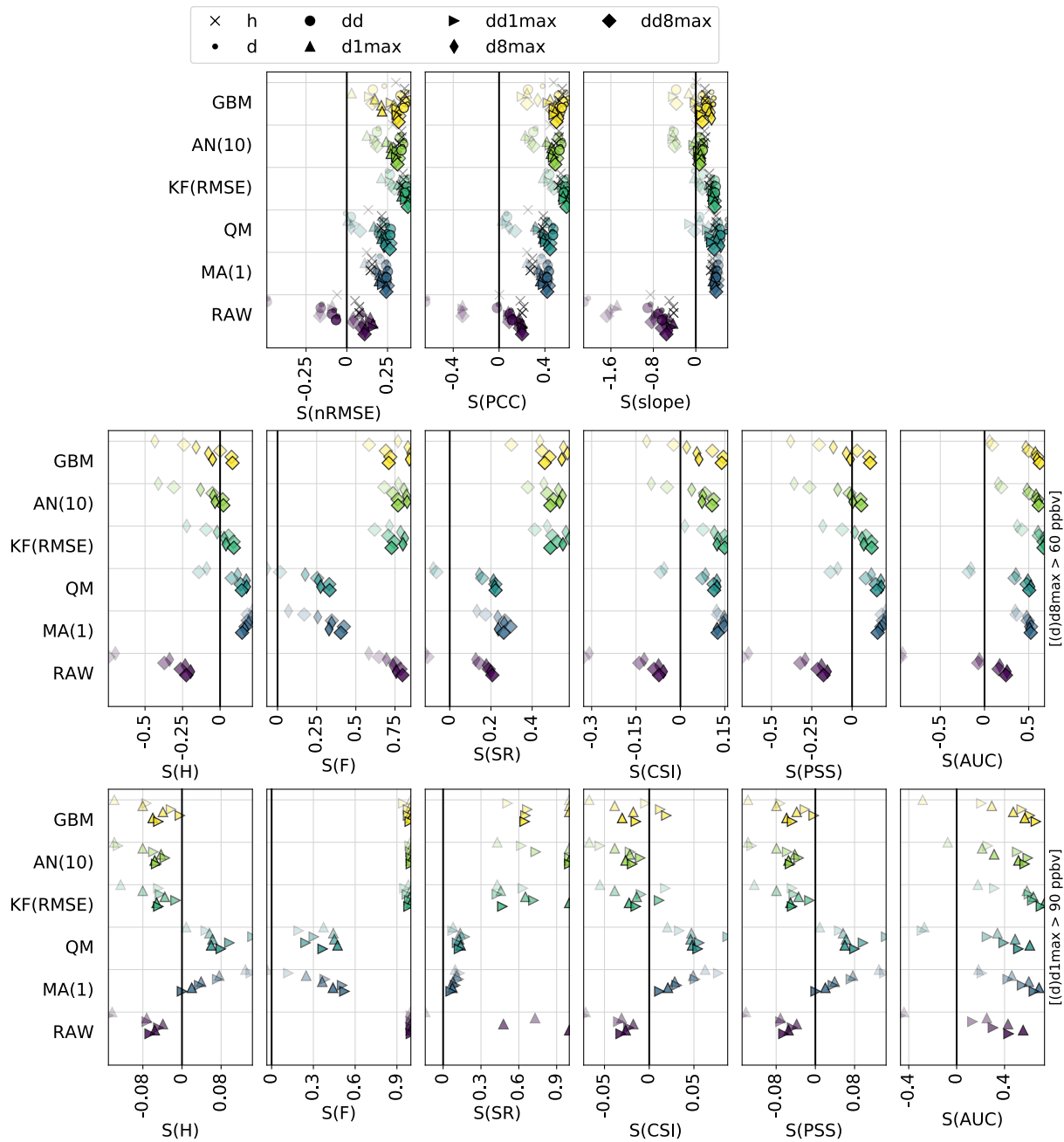


Figure S1. Skill scores of the RAW and MOS-corrected CAMS O₃ forecasts for continuous metrics (top panels) and categorical metrics related to the exceedance of the target (intermediate panels) and information threshold (bottom panels). The different symbols depict results obtained at different time scales (h: hourly; d: daily mean; d1max/dd1max: daily 1-hour maximum; d8max/dd8max: daily 8-hour maximum). In each panel, results are shown for the different methods (each with a given color). The overlaying symbols of decreasing transparency show the results at the different lead days from D+1 (most transparent) to D+4 (most opaque). See Sect. 2.4 and 2.5 for details on time scales and metrics, respectively. This figure is the same as Fig. 4, but showing the entire range of skill score values.