
Supplementary information

Initialized Earth System prediction from subseasonal to decadal timescales

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Supplementary Table 1. Main characteristics of the 18 currently used S2S initialized

prediction models. Modeling center acronyms are described in the Appendix. Origin refers to the model originating in either the climate community (C) or from Numerical Weather Prediction (NWP). Ops. Vs. research refers to whether the model is an operational (O) or research (R) model. Approximate atmospheric and ocean model horizontal resolution (current) is provided in either degrees, kilometers, or begins with ‘T’ for spectral models; the number of vertical levels begins with ‘L’. The existence of ocean and sea-ice coupling is indicated by ‘Y’ (yes) or ‘N’ (no). Model components initialized with a state representative of observations are indicated by ‘A’ for the atmosphere, ‘L’ for land, ‘O’ for ocean, and ‘I’ for sea-ice. Initialization type refers to either ‘Full-field’ (FF) or ‘Anomaly’ (A). Initialization frequency for real time forecasts and reforecasts is indicated separately and often in different time units. ‘# Ens’ indicates the number of ensemble members for real time forecasts and reforecasts (Rfc). Forecast length is specified in number of days. Superscripts in the modeling center column depict the following: ¹ indicates models included in the international S2S database, ² indicates models included in the SubX project, * indicates that the full CFSv2 data (6 hourly initializations) are provided to the S2S

25 database. The SubX version is a subset based on the SubX protocol (weekly initialization). For
 26 models that have used multiple versions and/or configurations, most recent configuration is
 27 described. Note, the table offers a general survey of S2S and is not intended to provide detailed
 28 documentation of each model. EnOI, Ensemble optimum interpolation scheme for oceanic
 29 analysis; OI, optimum interpolation; EnKF, Ensemble Kalman Filter.

Model center	Model name	Origin	Ops. vs research	Atmos. res. /levels	Ocean res./Levels	Ocean/sea ice coupling	Components initialized	Init. Type	Data Assimilation	Initialization frequency (real time/Rfc)	# Ens (real time/Rfc)	Forecast length (days)
Models Providing Real Time Forecasts and Reforecasts												
BoM ¹	ACCESS-S1	C	O	N216, L85	0.25° / L75	Y/Y	A, L, O, I	FF	Nudging from 4dVar	Daily, 4 per month	33/11	42
CMA ¹	BCC-CSM2-HR	C	O	T266, L56	0.25° / L50	Y/Y	A, O, I	FF	Coupled DA (ocean: EnOI; sea ice: OI; atmos: nudging)	Daily/Daily	4 /4	60
CNR-ISAC ¹	GLOBO	C	O	0.8° x 0.56°, L54	N/A	N/N	A, L	FF	N/A	weekly/every 5 days	41/1	31
ECCC ^{1,2}	GEPS, GEM	NWP	O	0.45°x0.45° / L40	N/A	N/N	A, L	FF	EnKF	weekly/weekly	21/4	32

ECMWF ¹	ECMWF	NWP	O	0.25°x0.25° (days 0-10), 0.5°x0.5° (after day10) / L91	0.25° / L75	Y/N	A, L, O	FF	4D Var (atmosph ere; 3D VAR (ocean/se a-ice)	2 per week/2 per week	51/11	46
HMCR ¹	SLAV	NWP	O	1.1°x1.4° / L28	N/A	N/N	A	FF	3D Var	Weekly/weekl y	20/10	61
JMA ¹	JMA GEPS, GSM	NWP	O	0.5°x0.5° / L60	N/A	N/N	A, L	FF	hybrid 4DVar- LETKF	4 per week/3 per month	25/5	33
KMA ¹	GloSea5-GC2	C	O	0.5°x0.5° / L85	0.25° / L75	Y/Y	A, O, I	FF	4D Var	daily/4 per month	4/3	75 or 240
Meteo France ¹	CNRM-CM	C	O	0.7°x0.7° / L91	1° / L42	Y/Y	A, L, O, I	FF	4D Var	weekly/2 per month	51/15	61
NASA GMAO ²	GEOS	C	R	0.5°x0.5° / L72	0.5° / L40	Y/Y	A, L, O, I	FF	EnOI	Every 5 days	4/4	45
NAVY ²	ESPC	C	R	T359 / L50	0.08° / 41L	Y/Y	A,L,O,I	FF	4DVAR	4 per week/4 per week	4/4	45
NOAA EMC ²	GEFS	NWP	O	T574 (days 0-8), T382 (days 8-35) / L64	N/A	N/N	A,L	FF	EnKF	weekly/weekl y	21/11	35

NOAA ESRL ²	FIM	NWP	R	~ 60 km / L64	~ 60 km /L32	Y/Y	A,L,O,I	FF	N/A	weekly/weekl y	4/4	32
NOAA NCEP ^{1,2}	CFSv2	C	O	T126 / L64	0.25° Eq, 0.5° global / L40	Y/Y	A, L, O, I	FF	3Dvar	6 hourly*/6 hourly*	16/1	45
RSMAS ²	CCSM4	C	R	0.9°x1.25° / L26	0.25° Tropics /1° global/ L60	Y/Y	A, L, O, I	FF	N/A	weekly/weekl y	9/4	45
UKMO ¹	GloSea5	C	O	0.5°x0.8° / L85	0.25° / L75	Y/Y	A, L, O, I	FF	4D Var	Daily/4 per month	4/7	45
Models Providing Reforecasts Only												
NCAR	30LCESM1	C	R	0.9°x1.25° / L30	0.25° Tropics /1° global/ L60	Y/Y	A, L, O, I	FF	N/A	weekly	NA/10	45
NCAR	46LCESM1	C	R	0.9°x1.25° / L30	0.25° Tropics /1° global/ L60	Y/Y	A, L, O, I	FF	N/A	weekly	NA/10	45

32 **Supplementary Table 2. Main characteristics of the 14 S2I initialized prediction models.** As
33 in Supplementary Table 1, but for S2I and with forecast length in months. ³ and ⁴ indicates
34 models participating in the NMME and contributing to the Copernicus Climate Change Service,
35 respectively. Note, the table offers a general survey of S2I and is not intended to provide detailed
36 documentation of each model.

Model Center	Model Name	Origin	Ops. vs research	Atmos. res. /levels	Ocean res./levels	Ocean/s ea ice coupling	Components initialized	Init. Type	Data Assimilation	Initialization frequency (real time/Rfc)	# Ens (real time/Rfc)	Forecast length (months)
BOM	ACCESS-S1	C	O	N216/L85	0.25° /L75	Y/Y	A,L,O,I	FF		Daily/4 per month	11/11	7
CMCC	CMCC-SPS3 ⁴	C	O	1° / L46	0.25° /L50	Y/Y	A, L, O, I	FF		1 st of the month	50/40	6
DWD	MPI-ESP ⁴	C	O	T127 / L95	0.4° Eq / L40	Y/Y	A, L, O, I	FF		1 st of the month	50/30	12
ECCC	CanCM4i ³	C	O	T63 / L35	.94°Eq / L40	Y/Y	A, L, O, I	FF		1 st of the month	10/10	12

ECCC	GEM-NEMO ³	NWP	O	1.4° / L79	0.33°Eq /1°global / L50	Y/Y	A, L, O, I	FF		1 st of the month	10/10	12
ECMWF	SEAS54	NWP	O	TCo319 (36km)/L91	0.25° /L75	Y/Y	A, L, O, I	FF		1 st of the month	51/25	7(13 from Feb/May/ Aug/Nov)
GFDL	CM2.1 ³	C	R	2x2.5° / L24	2x2.5° / L24	Y/Y	A, L, O, I	FF		1 st of the month	10/10	12
GFDL	CM2.5 ³	C	R	C18 (50 km) / L32	0.3°Eq/ 1° Polar/ L50	Y/Y	A, L, O, I	FF		1 st of the month	10/10	12
JMA/ MRI	CPS24	C	O	T159/L60	0.3°Eq/L 52	Y/Y	A, L, O, I	FF		12-13 mem every 5 days/5 mem every 15 days	51/10	12
Météo- France	System 7 4	C	O	TL359/L91	0.25° /L75	Y/Y	A, L, O, I	FF		1 st of the month	51/25	7
NASA	GEOSS2S ³	C	R	0.5°/ L72	0.5°Eq/ L40	Y/Y	A, L, O, I	FF		1 mem ev 5 days; 6 members on last day of month	10/10	10
NCAR	RSMAS- CCSM4 ³	C	R	0.9x1.25° / L26	0.25° Eq/L60	Y/Y	A, L, O, I	FF	N/A	1 st of the month	10/10	12

NCEP	CFSv2 ^{3,4}	C	O	T126 / L64	.25° Eq/L40	Y/Y	A, L, O, I	FF		4 members every 5 days	24/24	10
UKMO	GloSea5 ⁴	C	O	0.5°x0.8°/L 85	0.25° /L75	Y/Y	A, L, O, I	FF		2 per day/7 4 times per month	62/28	7

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38 **Supplementary Table 3. Main characteristics of the 14 S2D initialized prediction models.**

39 The table provides a general survey of S2D, and is not intended to provide detailed documental

40 of each model. As in Supplementary Table 1, but for S2D and with forecast length in years.

41 Initialization frequency and ensemble size are used for research except as “operations” denoted

42 via the WMO Lead Centres. Note, the table offers a general survey of S2D and is not intended to

43 provide detailed documentation of each model.

Model Center	Model Name	Origin	Ops vs research	Atmos. res./Levels	Ocean res. /Levels	Ocean/Sea Ice Coupling	Components initialized	Initialization Type	Initialization frequency	# Ens	Forecast length (years)
CCCma	CanESM5	C	R,O	2.8° / L49	1°, L45	Y/Y	A, L, O, I	FF	End of each year	40	10

CCSR/UT/ JAMSTEC/ NIES	MIROC6	C	R	1.4° / L81	1°, L62	Y/Y	A, O, I	A for Ocean; FF for Ice	Nov of each year	10	10
CMCC	CMCC-CM2- SR5	C	R	1° / L30	1° / L 50	Y/Y	A, L, O, I	FF	Nov of each year	10	10
CMA	BCC_CSM_ MR	C	R	1° / L 46	1° / L40	Y/Y	O	A	Nov of each year	10	10
CSIRO	CAFE	C	R	2o / L 24	1o /L506	Y/Y	A,O	FF	Each month	11	2
European EC-earth consortium	EC-Earth3 (BSC)	NWP	R	1° / L91	1° / L75	Y/Y	A, L, O, I	FF	Nov of each year	10	10
European EC-earth consortium	EC- Earth3(BSC/S MHI/DMI)	C	R, O	1° / L91	1° / L75	Y/Y	A, L, O, I	Two versions: FF (BSC) and AI (SMHI/DMI) with A for Ocean/Ice; FF for Atm/Land	Nov of each year	10	10
INM	INM-CM5	C	R	2° / L73	0.5° / L40	Y/Y	A, O	A	Nov of each year	10	10
LASG/IAP	FGOALS-g3	C	R	2° / L26	1°, L30	Y/Y	O	FF	Nov of each year	10	10
LASG/IAP	FGOALS-f3	C	R	1° / L32	1°, L30	Y/Y	O	A	Nov of each year	10	10

MPI	MPI-ESM-HR	C	R, O (via DWD)	1° / L95	0.4° /L40	Y/Y	A, L, O, I	A for Ocean/Ice; FF for atm	Nov of each year	10	10
MRI	MRI-ESM2	C	R	1° / L80	1x0.5°/ L60	Y/Y	O	A	Nov of each year	10	10
NCAR	CESM1	C	R	0.9°x1.25° / L30	0.25° Tropics /1° global/ L60	Y/Y	O	FF	Nov of each year	40	10
NCC	NorCPM1	C	R	2° /L26L	1° / L53	Y/Y	O	A	Nov of each year	10	10
UKMO	DePreSys4	C	R,O	0.5°x0.8°/L 85	0.25° /L75	Y/Y	A, O, I	FF	Nov of each year	10	10

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46 **Modeling center names and countries**

47 **BoM:** Bureau of Meteorology, Australia

48 **CCMA:** Canadian Centre for Climate Modelling and Analysis, Canada

49 **CCSR/UT/JAMSTEC/NIES:** Center for Climate System Research (CCSR), University of
50 Tokyo, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and the National
51 Institute for Environmental Studies (NIES), Japan

52 **CMA:** China Meteorological Administration, China

53 **CMCC:** Euro-Mediterranean Center on Climate Change, Italy

54 **CNR-ISAC:** Institute of Atmospheric Sciences and Climate of the National Research Council,
55 Italy

56 **CSIRO:** Commonwealth Scientific and Industrial Research Organization, Australia

57 **DWD:** Deutscher Wetterdienst, Germany

58 **ECCC:** Environment and Climate Change Canada, Canada

59 **ECMWF:** European Centre for Medium-Range Weather Forecasts, United Kingdom

60 **HMCR:** Hydrometeorological Centre of Russia, Russia

61 **INM:** Institute of Numerical Mathematics of the Russian Academy of Sciences, Russia

62 **JMA:** Japan Meteorological Agency, Japan

63 **KMA:** Korean Meteorological Administration, Korea

64 **LASG/IAP:** Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical
65 Fluid Dynamics (LASG), the Institute of Atmospheric Physics (IAP) of the Chinese Academy of
66 Sciences, China

67 **MPI:** Max Planck Institute, Germany

68 **Meteo France:** Meteo France, France

69 **MRI:** Meteorological Research Institute, Japan Meteorological Agency, Japan

70 **NASA GMAO:** National Aeronautics and Space Administration, Global Modeling and
71 Assimilation Office, United States

72 **NAVY:** United States Navy, United States

73 **NCAR:** National Center for Atmospheric Research, United States

74 **NCC:** Norwegian Climate Center, Norway

75 **NOAA EMC:** National Oceanic and Atmospheric Administration, Environmental Modeling
76 Center, United States

77 **NOAA ESRL:** National Oceanic and Atmospheric Administration, Earth System Research
78 Laboratory, United States

- 79 **NOAA NCEP:** National Oceanic and Atmospheric Administration, National Centers for
80 Environmental Prediction, United States
- 81 **RSMAS:** Rosenstiel School for Marine and Atmospheric Science at the University of Miami,
82 United States
- 83 **UKMO:** United Kingdom Met Office, United Kingdom