Implementation of Seasonal Forecast SEAS5

#newfcsystem

Description of the upgrade

The fifth generation of the ECMWF seasonal forecasting system, in short SEAS5, will be introduced in the autumn of 2017, replacing System 4, which was released in 2011. SEAS5 includes updated versions of the atmospheric (IFS) and interactive ocean (NEMO) models and adds the interactive sea ice model LIM2. The IFS uses a new grid and horizontal resolution has been increased (details below).

Ocean horizontal and vertical resolution have also been increased. Ocean and land initial conditions have been updated, and the re-forecast ensemble size has been increased from 15 to 25. While re-forecasts span 1981 to 2016, the re-forecast period used to calibrate the forecasts when creating products will use the more recent period 1993 to 2016. SEAS5 highlights include a marked improvement in SST drift, especially in the tropical Pacific, and improvements in the prediction skill of Arctic sea ice.

⚠ Implemented: 5 Nov 2017

News

19.01.2018: Following the successful implementation of the SEAS5 system on 5 Nov 2017 and the parallel run of the old System 4 for 3 months, we will stop this latter on 8 Feb 2018, with the run based on 1 February 2018. May we remind all users to start using the SEAS5 system before System 4 is terminated.

08.11.2017: We are pleased to confirm that the SEAS5 system was successfully implemented in operations on 5.11.2017. System 4 will keep running for a limited time.

16.10.2017: The long range forecast documentation page has been updated, to include the SEAS5 user guide.

16.10.2017: Pre-operational SEAS5 charts are available under https://www.ecmwf.int/en/forecasts/charts/seasonal_system5/

11.10.2017: We now have modified the operational dissemination requirements to request SEAS5 data. Users can update their operational requirements, as needed. Any change made will be used for the first time in the SEAS5 run of November. Changes to the dissemination requirements for System 4 are no longer possible.

04.10.2017: The re-archiving of the problematic SEAS5 pressure level derived fields has completed last night and we have validated the data this morning.

03.10.2017: We have identified a problem with some archived pressure level fields for some derived fields associated with the real-time forecasts. The fields affected are type=hcmean from stream msmm, and types fcmean and em from stream mmsa. Pressure level fields from 925 hPa up to 1 hPa are affected, for dates from January to September 2017. Surface fields and 1000hPa pressure level fields are not affected.

<http://apps.ecmwf.int/mars-catalogue/?origin=ecmf&stream=msmm&levtype=pl&system=5&expver=1&method=1&year=2017&type=hcmean&class=od>

<http://apps.ecmwf.int/mars-catalogue/?origin=ecmf&stream=mmsa&levtype=pl&system=5&expver=1&method=1&year=2017&type=em&class=od>

<http://apps.ecmwf.int/mars-catalogue/?origin=ecmf&stream=mmsa&levtype=pl&system=5&expver=1&method=1&year=2017&type=fcmean&class=od>.

Note that the main monthly mean fields (stream=msmm, type=fcmean) are ***not*** affected. We will begin re-archiving the affected pressure level fields in MARS at 14:30UTC on the 3rd October, to correct the problem, and will confirm on this page when the re-archiving is complete. Please accept our apologies for any inconvenience caused.

Timeline of the implementation

The planned timetable for the implementation of SEAS5 is as follows:

Contents of this page

Date	Event
05 July 2017	Initial announcement. Data available in MARS
08 September 2017	Availability of test data in dissemination
05 November 2017	Date of implementation

The timetable represents current expectations and may change in light of actual progress made.

We acknowledge the contribution of the Copernicus Climate Change Service (C3S) in the production of SEAS5. C3S provided the computer time for the generation of the re-forecasts for SEAS5 and for the production of the ocean reanalysis (ORAS5), used as initial conditions for the SEAS5 re-forecasts. SEAS 5 will be the ECMWF contribution to the C3S multi-model seasonal forecast products, see paragraph 'SEAS5 and Copernicus services'.

Overview of SEAS5

With a few exceptions, SEAS5 is configured to be identical to the extended part of the ENS, as implemented with IFS Cycle 43r1. In particular, the same resolution is used for both the monthly and seasonal forecast ranges. However, while the ENS will be regularly upgraded over the next few years with each new cycle of the IFS, the SEAS5 will remain fixed at IFS Cycle 43r1. Previous seasonal forecast systems have had a lifetime of about 5 years, and although future upgrades of SEAS may happen more often there is not yet a planned date for the introduction of SEAS6.

The table below summarizes the upgrades in model components and initialization for SEAS5.

	System 4	SEAS5
IFS Cycle	36r4	43r1
IFS horizontal resolution	T_L255	$T_{CO}319$
IFS Gaussian grid	N128 (80 km)	O320 (35 km)
IFS vertical resolution (TOA)	L91 (0.01 hPa)	L91 (0.01 hPa)
IFS model stochastic physics	3-lev SPPT and SPBS	3-lev SPPT and SPBS
Ocean model	NEMO v3.0	NEMO v3.4
Ocean horizontal resolution	ORCA 1.0	ORCA 0.25
Ocean vertical resolution	L42	L75
Sea ice model	Sampled climatology	LIM2
Atmosphere initialization (Re-forecast/Forecast)	ERA-Interim/Operations	ERA-Interim/Operations
Land Initialization (Re-forecast/Forecast)	ERA-Interim land (36r4) /Operations	ERA-Interim land (43r1) /Operations
Ocean initialization	ORA-S4	ORS-S5
Forecast ensemble size	51 (0-7m) 15 (8-13m)	51 (0-7m) 15 (8-13m)
Re-forecast years	30 (1981-2010)	36 (1981-2016)
Re-forecast ensemble size	15 (0-7m) 15 (8-13m)	25 (0-7m) 15 (8-13m)

Related links

- News article
- Forecast User Guide
- SEAS5 user guide

All IFS cycles

- Terminology for IFS testing
- Implementation of IFS Cycle 48r1
- Implementation of IFS Cycle 47r3
- Implementation of IFS Cycle 47r2
- Implementation of IFS Cycle 47r1
- Implementation of IFS cycle 46r1
- Implementation of IFS cycle 45r1
- Implementation of Seasonal Forecast SEAS5
- Implementation of IFS cycle 43r3
- Implementation of IFS Cycle 43r1
- Implementation of IFS cycle 41r2
- Introducing the octahedral reduced Gaussian grid
- Horizontal resolution increase
- Boundary-Condition Programme ENS at 06 and 18 UTC
- Implementation of IFS Cycle 41r1
- IFS cycle upgrades pre 2015

Calibration period	1981-2010	1993-2016
Products Release Date	The 8th of each month at 12UTC	The 5th of each month at 12UTC

Meteorological content

Atmosphere model

The IFS has been upgraded from cycle 36r4 to 43r1. In this time many changes have been made to model physics (surface drag, boundary layer entrainment, shallow convection, vertical diffusion, orographic drag, surface climate fields, CO2/CH4 climatologies, convective detrainment, cloud scheme physical processes, introduction of a lake model, radiation-surface interactions, solar zenith angle calculations, freezing rain physics, cloud erosion, CAMS O3 climatology, boundary layer cloud) and to model numerics (revised semi-Lagrangian extrapolation, revised interpolation of moist variables, cubic truncation and octahedral grid, semi-lagrangian departure point iterations, spectral viscosity). Further details can be found in the documentation of the evolution of the IFS.

The configuration of the IFS used in SEAS5 is almost identical to that used in ENS, but there are a small number of differences. In order to allow a reasonable evolution of the QBO in the seasonal forecasts, the amplitude of the tropical non-orographic gravity wave drag forcing has been re-tuned to account for the enhanced level of resolved wave activity in the model stratosphere - the new high resolution cubic grid is much more active than the previous low resolution linear grid. The tropospheric sulphate aerosol climatology is not the default fixed version, but the time varying CMIP5 climatology as used in ERA5. Volcanic stratospheric sulphate aerosol continues to be treated as in System 4 - a simple specification of an initial value which then decays towards a climatological value. This is important to allow a representation of any future major volcanic eruptions in the operational forecasts. Although the methodology is the same, the GISS dataset used has been updated to the most recent version, which has a higher background level of stratospheric aerosol than before. Compared to System 4, note that the ozone is no longer radiatively interactive in the model - the default Cycle 43r1 climatology is used instead, just as in ENS. Ozone is thus included as an essentially passive variable (it has a very minor influence on the calculation of the vertical distribution of volcanic aerosol), and is calculated from a new ozone scheme.

Initial conditions for the IFS largely come from ERA-Interim for the re-forecasts and then from the operational analysis from 1 Jan 2017 onwards. The land surface initial state for the re-forecasts uses the same technique as in System 4 (an offline run of a matching version of the land surface model at the required resolution, forced by ERA-Interim). Unlike System 4, no GPCP correction was made to the ERA-Interim forcing because this has been shown to be unhelpful, especially over Europe. The real-time land surface is taken from the operational analysis. As in System 4, a limiter is used to prevent the real-time land surface values taking unrealistic values relative to those used in the re-forecasts. This is necessary as a safety constraint - the operational analysis is at a much higher resolution, and interpolating this to the lower resolution needed by SEAS5 can result in locally large differences compared to initial conditions prepared directly at the lower resolution. Future changes in the operational analysis may also introduce further incompatibilities in the land initial conditions, and the limiter will act as a safety constraint in these situations, too. As in System 4, ozone is initialized from climatology, although in SEAS5 the climatology is derived from a constrained run of the ozone model.

Ocean model: higher resolution and wave interaction

As for System 4, SEAS5 uses the NEMO (Nucleus for European Modelling of the Ocean) ocean model (Madec 2008), but with upgrades in the model version, ocean physics and resolution. The resolution has been increased from 1 degree and 42 layers in SEAS4 to 0.25 degrees and 75 layers in SEAS5. The vertical resolution is particularly refined in the uppermost part of the ocean, with an increase in the number of levels in the first 50 metres from 5 to 18. The increase in horizontal resolution improves the representation of sharp fronts and ocean transports. The vertical resolution increase means that the diurnal cycle of sea-surface temperatures (SST) is much better captured, with a 1-metre top level in the new configuration compared to the previous 10-metre top level.

The ocean model configuration is based on that developed by the DRAKKAR for the NEMO version V3.4 (SEAS4 used V3.2), and contains upgrades introduced at ECMWF regarding aspects of ocean-surface wave interaction (Breivik et al. 2015). These aspects include a momentum flux estimated from the dissipation term (accounting for the intensity of breaking waves) ; the surface boundary condition of the turbulent kinetic energy equation, which now account for the energy flux from breaking waves (Craig and Banner 1994); and the Coriolis-Stokes forcing term is introduced in the momentum equation.

Prognostic sea ice model

The interactive sea-ice model LIM2, the Louvain-la-Neuve Sea Ice Model developed at the Belgian Université Catholique de Louvain, has been implemented in SEAS5. LIM2 is part of the NEMO modelling framework also used at ECMWF to model the ocean. This is the first time that the ECMWF seasonal system includes a prognostic sea-ice model. In SEAS4, the sea-ice was prescribed by sampling the recent history of sea-ice occurrences. The prognostic sea-ice model allows sea-ice cover to respond to changes in the atmosphere and ocean states, and intends to capture inter-annual variability and trends in the sea-ice over. Therefore SEAS5 should be able to provide seasonal outlooks of sea-ice cover, which is a product of interest for users.

Ocean initial conditions: ensemble of ocean reanalyses

SEAS5 ocean and sea-ice initial conditions are provided by the new ocean analysis and reanalysis ensemble (ORAS5). ORAS5 uses the same ocean model and sea-ice as the couple forecasts in SEAS5, and consists on 5 ensemble members covering the period 1975 to the present. Compared to its predecessor ORAS4 (Balmaseda et al 2013), used to initialized SEAS4, ORAS5 has higher resolution, updated data assimilation and observational data sets, and most importantly, provides sea-ice initial conditions by assimilating sea-ice concentration.

ORAS5 has been developed based on Ocean Reanalysis Pilot 5 (ORAP5) (Zuo et al. 2015; Tietsche et al. 2015), using updated observational data sets. The ocean in-situ temperature and salinity comes from the recent quality-controlled EN4 (Good et al. 2013), which has higher vertical resolution and fuller spatial coverage than the previous version EN3 - used in ORAP5 and ORAS4. The altimeter sea-level data have also been updated to the latest version (DUACS2014) from CMEMS (Copernicus Marine Environmental Monitoring Services). The underlying SST analysis before 2008 has also been changed in ORAS5: it comes from the HadISST2 dataset, the same used in the currently ERA5 reanalysis. From 2008 onwards the SST and sea-ice are given by the OSTIA product, which is also used in the ECMWF NWP operational analysis.

The perturbation scheme used to generate the ensemble of reanalyses has also been modified. The scheme consists of two distinct elements: perturbations to the assimilated observations, both profiles and surface, and perturbations to the surface forcing fields. For details see Zuo et al 2017, Technical Memorandum 795.

Meteorological impact and evaluation

Pre-implementation testing showed that the model version planned for SEAS5 gives substantial improvements in SST bias in the tropical Pacific, with consequent improvements in ENSO forecast skill. A more comprehensive assessment of the meteorological impact based on analysis of the full set of SEAS5 re-forecasts is being made and will be given shortly. Assessments of mid-latitude forecast skill are subject to considerable sampling error, and the limited sample sizes available from pre-implementation testing are not considered reliable predictors of the eventual outcome of the SEAS5 re-forecast dataset.

The graphical products for SEAS5 show anomalies with respect to a **1993-2016 base period**, whereas System 4 used a 1981-2010 base period. Due to global warming, the use of a more recent base period results in significant changes to the plotted anomalies, particularly for temperature and geopotential height. Thus although the actual (calibrated) temperature forecast may be very similar, the plotted anomaly can look quite different. Users are encouraged to calibrate the forecasts according to their own needs by using the re-forecast data available in MARS. Re-forecasts cover 1981-2016 to maximize the data available for skill estimation and calibration.

New and changed parameters

Surface parameters added

Several new parameters have been added related to the lake model, 6h instantaneous stresses have been added to help user applications such as wave modelling, and top incoming solar radiation has been added with a 24 hour output frequency. Note also that surface and sub-surface runoff are now fully available (in System 4, these parameters were available for the real-time forecasts, but only a limited number of the re-forecasts).

paramId	name	frequency
26	Lake cover	Step 0 only
228007	Lake depth	Step 0 only
228008	Lake mixed layer temperature	24 hour
228014	Lake ice depth	24 hour

229	Instantaneous eastward turbulent surface stress	6h
230	Instantaneous northward turbulent surface stress	6h
212	Top incoming solar radiation	24h
8	Surface runoff	24h
9	Sub-surface runoff	24h

Surface fields output at additional timesteps

Some surface fields previously archived every 24 hours are now archived every 6 hours. As well as increased availability of synoptic data, this also changes the monthly means for the instantaneous fields such as SST and soil temperature. These are now calculated from 6 hourly data, and no longer have the diurnal cycle aliased into them. (For accumulated fields, the monthly mean rate of accumulation is independent of whether synoptic data is written at 6 or 24h intervals).

paramId	name	frequency
34	Sea surface temperature	6 hr
144	Snowfall	6 hr
139	Soil temperature level 1	6 hr
169	Surface solar radiation downwards	6 hr
175	Surface thermal radiation downwards	6 hr
228	Total precipitation	6 hr

Model level data

SEAS5 model level data are now produced to 6 months instead of 5 months for System 4.

Ocean waves parameters added

All fields are output every 24 hours

paramId	name
140220	Mean wave period based on the first moment
140221	Mean wave period based on the second moment
140244	Mean square slope of waves
140249	10 m wind direction (no calculation of monthly mean/max/min/SD)

Technical content

Changes to GRIB encoding

Model identifiers

The GRIB model identifiers (generating process identification number) for SEAS5 will be changed as follows:

GRIB 1 Section 1 Octets	GRIB 2 (only for SEAS5) Octets	grib_api/ecCodes key name	Component	Model ID	
				System 4	SEAS5
6	14 (in Section 4)	generatingProcessIdentifier	Atmospheric model	139	**147**

			Ocean wave model	107	**112**
52-53	18-19 (in Section 2)	systemNumber		4	**5**

GRIB 2 data

SEAS5 model level data is coded in GRIB 2, compared to GRIB 1 for System 4. The change to GRIB 2 for model level data was introduced in IFS Cycle 37r2 in 2011. See under User impact below for more information.

Use of the octahedral reduced Gaussian grid

SEAS5 introduces a new form of the reduced Gaussian grid, the **octahedral grid**, for the atmospheric (mostly) single level data. See Introducing the octahedral reduced Gaussian grid for further details.

Software

EMOSLIB version 443, GRIB API version 1.17.0 or ecCodes version 2.0.0 are the minimum versions recommended to manipulate all SEAS5 fields.

> ⚠ ecCodes has now replaced GRIB API on the ECMWF platforms.
>
> GRIBEX is no longer available and cannot decode GRB 2 data.

Increased field sizes

The size of the fields archived have increased by a factor 2 to 4. When retrieving data via MARS or dissemination, if no spectral truncation or grid resolutions are specified, fields are provided at the model resolution.

In particular, users should be aware of the increase in memory and CPU time needed to process the increased resolution fields and adjust their programs and batch scripts appropriately.

Availability of SEAS5 data

Re-forecast data in MARS

The SEAS5 re-forecast data can be accessed in MARS from:

- Daily data (stream MMSF) - example for May 2001
- Monthly mean data (stream MSMM) - example for 2001

Only registered users with access to MARS will be able to access the re-forecast data sets.

The re-forecast data for all 12 months in the year have been released.

Test SEAS5 Forecast data in MARS

SEAS5 technical test data are available in MARS with E-suite experiment version (expver) **9001** (MARS keyword EXPVER=9001) for the runs of May, June and July 2017 at 00UTC. The data can be accessed in MARS from:

- Atmospheric forecasts (class=od, stream=mmsf, expver=9001, system=5, method=1)
- Wave forecasts (class=od, stream=wasf, expver=9001, system=5, method=1)
- Atmospheric monthly means (class=od, stream=msmm, expver=9001)
- Wave monthly means (class=od, stream=swmm, expver=9001)
- Seasonal forecast monthly anomalies (class=od, stream=mmsa, expver=9001)

The SEAS5 Forecast beta release data are intended for testing technical aspects and should not be used for operational forecasting. Please report any problems you find with these data to User Support.

Release candidate SEAS5 data have been archived in MARS from January 2017 onwards with experiment version 0001:

- Atmospheric forecasts (class=od, stream=mmsf, expver=001, system=5, method=1)
- Wave forecasts (class=od, stream=wasf, expver=001, system=5, method=1)
- Atmospheric monthly means (class=od, stream=msmm, expver=001)
- Wave monthly means (class=od, stream=swmm, expver=001)
- Seasonal forecast monthly anomalies (class=od, stream=mmsa, expver=001)

Only registered users with access to MARS with permission to access real-time data will be able to access these test data sets.

Test real-time SEAS5 data in dissemination

SEAS5 test data are now available in dissemination for the run of August 2017 onwards. SEAS5 test dissemination files are queued into ECPDS in delayed (standby) mode. Users can trigger the transmission of wanted test products at their convenience by logging into the test ECPDS system at https://ecpds-xmonitor.ecmwf.int/ in the usual manner. Users can find the SEAS5 by selecting all the dates in the interface. In order to receive the test products, users will have to open their firewall to the relevant ECPDS Data Movers:

- Internet transfers: 193.61.196.104 (ecpds-xma.ecmwf.int) 193.61.196.105 (ecpds-xmb.ecmwf.int)
- RMDCN transfers: 136.156.8.132 (mspds-dm4.ecmwf.int)

SEAS5 test dissemination file names will have EXPVER '9001' as the last part of the file name, e.g. ALL0801000010_____9001, to distinguish with the operational file names ending with '1', e.g. ALL0801000010_____1. Note however that the GRIB messages in the SEAS5 test dissemination data will contain the key expver=0001. GRIB headers fully reflect the generating process (systemNumber=5, methodNumber=1).

At the moment, SEAS5 test data are generated based on the current (SYSTEM=4) dissemination requirements.

SEAS5 T319/O320 products can be requested in their original representation as well as in the previously supported representations in System 4. Supported latitude/longitude resolutions in the System 5 are:

- multiplies of 0.4/0.4 degrees (as the third leg of the monthly forecast)
- multiplies of 0.75/0.75 degrees, to provide seamless transition from the Seasonal System 4 (current resolution)

Where possible, we would advise users to request the native (Octahedral) resolutions.

On the day of SEAS5 implementation into ECMWF operations, due for 5 November 2017, no test requirements will be carried into the operational mainframe. Users wishing to make their modified test SEAS5 requirements operational on the implementation date can make these changes in the operational ECPDS system (https://ecaccess.ecmwf.int:9443/do/product/requirements) or will have to let ECMWF (Data Services) know two weeks prior to the announced implementation date.

Parallel run of System 4 and SEAS5

SEAS5 has run for May, June, July 2017 in beta testing (experiment=9001). SEAS5 will run in near real-time from September onwards. SEAS5 data will then become available shortly after the System 4 data have been released.

On the switch-over date, due for 5 November, SEAS5 will become the operational system. The SEAS5 dissemination file names will then end with EXPVER '1'. System 4 will continue to be run as a near real-time system, for a limited period of time. Data from System 4 will be available from MARS and, for those interested, through dissemination in delayed mode, on request. Those interested can transfer the System 4 files through the test ECPDS system (https://ecpds-xmonitor.ecmwf.int/) or should contact Data Services at ECMWF. On the implementation date of SEAS5, users who requested to keep getting System 4 data though dissemination will receive both the SEAS5 and System 4 files via ECPDS, with the System4 file names including EXPVER '9004', e.g. ALL1101000010_____9004.

The release date of these '9004' files in ECPDS will remain the 8th of each month at 12UTC.

We intend to stop running System 4 before March 2018. Users are advised to make sure that all their applications are switched to using SEAS5 data as soon as possible after the implementation.

Graphical display of SEAS5 test forecasts

Graphical products from the seasonal forecast system are displayed on the Forecast Charts pages of the ECMWF website. Pre-operational SEAS5 charts for Jan-Oct 2017 are available at https://apps.ecmwf.int/webapps/opencharts/?facets=%7B%22Range%22%3A%5B%22Long%20%28Months%29%22%5D%7D.

Time-critical applications

Member State users of the "Simple time-critical jobs" framework can test that their scripts will work with the SEAS5 test data by using the new 'event' set up.

Event ID	Event name	Description
1763	seasonal5_fc	At this stage, the system 5 Seasonal Forecast real time products have been updated.

Users are reminded to change the directive 'SYSTEM=5' in their MARS requests.

SEAS5 in EUROSIP

EUROSIP, the Multi-model seasonal forecast, will use SEAS5 data as soon as SEAS5 will have been implemented in operations.

SEAS5 and Copernicus services

The C3S is currently in a proof-of-concept phase and the data services for the Copernicus users are being developed. At the moment, for seasonal forecasts, graphical products only are available on the C3S web site (https://climate.copernicus.eu/seasonal-forecasts). In early 2018, it is expected that SEAS5 data on a 1-degree resolution grid will be freely available for download from C3S on the 10th of each month, 5 days after the SEAS5 products are available through the normal ECMWF dissemination mechanisms.

References

- Madec G (2008) NEMO ocean engine. Tech. rep., Institut Pierre-Simon Laplace (IPSL), URL https://www.nemo-ocean.eu/doc/
- Good, S. A., M. J. M., and R. N. A., 2013: EN4: Quality controlled ocean temperature and salinity profiles and monthly objective analyses with uncertainty estimates. J. Phys. Oceanogr., 118, 6704–6716, doi:10.1002/2013JC009067.
- Fichefet T,Maqueda MAM (1997) Sensitivity of a global sea ice model to the treatment of ice thermodynamics and dynamics. Journal of Geophysical Research 102(C6):12,609–12,646, DOI 10.1029/97JC00480,URL http://doi.wiley.com/10.1029/97JC00480
- Balmaseda MA, Mogensen K, Weaver AT (2013) Evaluation of the ECMWF ocean reanalysis system ORAS4. Quarterly Journal of the Royal Meteorological Society 139(674):1132{1161
- Steffen Tietsche, Magdalena a. Balmaseda, Hao Zuo, and Kristian Mogensen. Arctic sea ice in the global eddy-permitting ocean reanalysis ORAP5. Climate Dynamics, jun 2015. ISSN 0930-7575. doi: 10.1007/s00382-015-2673-3. URL http://link.springer.com/10.1007/s00382-015-2673-3.
- Hao Zuo, Magdalena A Balmaseda, and Kristian Mogensen. The new eddy-permitting ORAP5 ocean reanalysis: description, evaluation and uncertainties in climate signals. Climate Dynamics, 2015. doi: 10.1007/s00382-015-2675-1. URL http://link.springer.com/article/10.1007/s00382-015-2675-1.
- Zuo, H., M.A. Balmaseda, E. Boisseson and S. Hirahara, 2017: A new ensemble generation method for ocean reanalyses. ECMWF Technical Memorandum 795.
- Zuo et al 2018 (in preparation)
- SEAS5 user guide. Comments and feedback on this document can be submitted using this questionnaire.

Document versions

Date	Reason for update
05.07.2017	• Initial version • Availability of data in MARS
31.08.2017	• New release day for SEAS5 - 5th of each month at 12UTC • Preliminary information about SEAS5 data in dissemination

08.09.2017	• Release candidate testing ◦ Data in MARS and dissemination • SEAS5 in EUROSIP • SEAS5 and Copernicus Services
03.10.2017	• Re-archiving of some derived SEAS5 data. See Latest news.
04.10.2017	• Re-archiving of some derived SEAS5 data completed.
20.10.2017	• SEAS5 dissemination requirements available • SEAS5 release candidate charts available • SEAS5 User guide available
08.11.2017	• Confirmation of successful implementation of SEAS5.
19.01.2018	• Confirmation of termination date of old System