Project of Strategic Interest NextData

Deliverable D2.2.1
Report on the in situ and satellite historical marine data and atmospheric parameters for building the Reconstruction-Reanalysis

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Contents

1. Introduction

The activity during the first year focused on the realization of a reference database of the historical marine and atmospheric data needed to produce the Reconstruction/Reanalysis (RR) of the Mediterranean Sea in the last 100 years. The activity mainly focused on reviewing and updating the available data sets in order to cover the entire 100-year period of the Mediterranean RR, as shown in Table 1.

The activity was done in close collaboration with WP1.3, which performed specific data quality control procedures, as described in D1.3.1. The objective is to create an extensive reference database in order to obtain the best RR quality.

	MedReanV2 (1985-2007)	MedReanV4(1985-2010)	RR(1912-2011)
Initial conditions	MedAtlas Climatology (obs 1995-1999) *(Maillard et al. 2005)*	SDNV2aa climatology (obs until1987)	SDNV2aa climatology (obs until1987)
Atmospheric forcings	ERA15 1.125° (1985-1992) ECMWF analyses 0.5° (1993-2007)	ERAInterim 0.75° (1985-2010)	AMIP1.125° (1912-1957) ERA40 1.125° (1958-1978) ERAInterim 0.75° (1979-2011)
Total Cloud Cover	NCEP–NCAR (1985–92) ECMWF analyses 0.5° (1993-2007)	ERAIinterim 0.75° (1985-2010)	AMIP 1.125° (1912-1947) NCEP–NCAR(1948-1978) ERAInterim 0.75°(1979-2011)
Precipitations	NCEP–NCAR (monthly climatology)	CMAP (monthly climatology)	AMIP (montly climatology) NCEP–NCAR (monthly climatology) CMAP (monthly climatology)
SST	SST reconstruction (1985-2007) *(Marullo et al.2007)*	SST reconstruction (1985-2007) *(Marullo et al.2007)* DT data (2008-2010)	HadISST (1912-1985) SST reconstruction (1985-2007) *(Marullo et al.2007)* MyOcean data (2008-2011)
SLA	ERS1, ERS2, EnviSat, TOPEX/Poseidon, Jason1 *(Pujol and Larnicol 2005)*	AVISO multisensor "UPD" data reprocessed in 2010	MyOcean multisensor "UPD" data reprocessed in 2012
XBT	<1999 MEDATLAS, MATER Ship of Opportunity *(Manzella 2007)* 2000-2007 MFS observations	SeaDataNet MFS observations (1985-2010)	SeaDataNet MFS - MyOcean observations (1912-2011)
ARGO	MedArgo Program 2001-2007 *(Poulain et al. 2007)*	All observations 2001-2010	All observations 2001-2011
CTD	MEDATLAS, MATER (<1999) 2000-2007 MFS observations (2000-2007)	SeaDataNet MFS observations (1985-2010)	SeaDataNet MFS - MyOcean observations (1912-2011)

Table 1. Historical datasets used in the Reconstruction/Reanalysis systems at INGV. The systems are described in D1.3.2.

The data sets archived to produce the RR are:

- Sea Surface Temperature (SST) observations;
- Satellite Sea Level Anomaly (SLA) observations;
- In situ temperature and salinity observations;
- Surface atmospheric variables;
- Gridded temperature and salinity fields.

2. Description of the datasets

2.1. SST observations

The creation of a SST dataset covering the whole RR period mainly focused on the analysis of the available data for the period preceding 1985. For the following period, specific SST products are already available for the Mediterranean Sea and they are characterized by horizontal maps which are optimally interpolated onto the RR model grid at 1/16 of a degree.

The SST data set starting from 1985 is a temporal concatenation of the following SST data:

- 1985-20080710: reconstruction data built from the most recent AVHRR Pathfinder SST time series (Marullo et al., 2007).
- 20080711-20111231: SST TAC/OSI TAC of MyOcean produce and disseminate Level 4 (L4) high resolution SST products. The L4 data correspond to daily (night-time) gridded super-collated (multi-sensor) and optimally interpolated satellite SST estimates at High spatial Resolution, i.e at 1/16 and 1/100 respectively.
  These products are based on all infrared data available (AATSR, METOP, AVHRR, MODIS, SEVIRI) and specific sensor bias corrections and interpolation procedures are applied (Buongiorno Nardelli et al, 2013). There are two kind of data, DT until 20100831 and then NRT which differ for time window used for statistical interpolation.

The Met Office Hadley Centre SST dataset (HadSST1) was archived for the period preceding 1985. This dataset consists in monthly SST on a regular grid of 1°x1° starting from 1870 (Rayner et all, 2003). This choice is consistent with the idea to use AMIP (Atmospheric Model Intercomparison Project – Gates, 1992) type of atmospheric forcing for the pre-ERA40 period, before mid-1957. AMIP data were obtained form ECHAM4 model simulations forced by HadSST1.

2.2. Satellite SLA observations

The SLA dataset was updated at the latest version released on April 2012 completing the time series till April 2012.
These data are produced and disseminated in the framework of Sea Level TAC of the MyOcean Project.
The dataset consists in altimeter satellite along-track sea surface heights computed with respect to seven-year means (http://catalogue.myocean.eu.org/static/resources/myocean/pum/MYO2-SL-PUM-008-001-005-v3.2.pdf).
All missions data are homogenized with respect to a reference mission, which is currently Jason-2. These data have been produced with an optimal and time centered computation time window (6 weeks before and after the date). They correspond to the up-to-date ("upd") data sets with up to four satellites observations at a given time. The "vfec" version was archived, i.e. validated, filtered, sub-sampled and LWE corrected with a spatial resolution of 14 km.
The time coverage depends on the duration of the missions and starts from 1992, since we did not take into consideration GEOSAT data (Figure 1):

- Jason 2: since October 2008
- Jason 1 (new orbit): since February 2009
- Jason 1: April 2002 - October 2008
- Envisat (new orbit): since October 2010

- Envisat: October 2002 - October 2010
- ERS-1: October 1992 - May 1995
- ERS-2: May 1995 - April 2003
- GFO: January 2000 – September 2008
- T/P (new orbit): September 2002 - October 2005
- T/P: September 1992 - April 2002

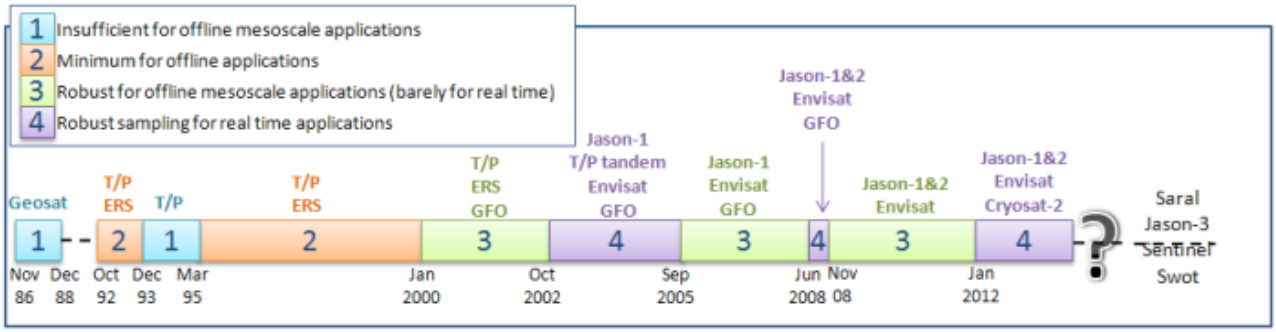

Figure 1. Altimetry sampling and satellite missions. Credits CLS (from AVISO website)

Each satellite has a repeated cycle and a ground track that guarantees a uniform coverage of the Mediterranean Sea. The Data Assimilation (DA) scheme needs the following information: time in Julian day since January 1950, longitude, latitude and sea level anomaly in meter.

2.3. In-situ temperature and salinity vertical profile observations

The in situ dataset is collected from three main sources:

1. SeaDataNet (SDN hereafter) infrastructure;
2. MEDAR-MEDATLAS dataset covering the period 1985-1999 (Maillard et al. 2005);
3. MFS and MyOcean In situ TAC.

The merging of these datasets was necessary due to missing data within the SDN infrastructure. Potential duplicates were identified and excluded from further use. From the annual data distribution of the amount of temperature and salinity observations within the SDN database (Figure 2) from 1990 to 2012, it is evident the decrease of the number of observations in recent years owing to a time lag between the sampling and the data insertion inside the database. This is a common problem of historical databases due to the more sophisticated Quality Control (QC) procedures implemented for historical observations than for NRT (Near Real Time) databases. Thus MFS operational observations were merged with the SDN dataset. Another check has been implemented to verify the presence of all MEDAR-MEDATLAS data within SDN, since *Adani et all* (2011) assimilated the whole MEDAR-MEDATLAS dataset. Missing data have been integrated to obtain the most extensive dataset available.

Figure 3 and Figure 4 show the annual distribution of the number of temperature and salinity profiles for the period 1959-1989 (Figure 3) and 1911-1958 (Figure 4). The time period 1911-1946 is characterized by very few observations

along the water column and in many years there are no observations at all. The availability of in situ observations starts and systematically increases from 1946.

The map distribution of the data for the three periods 1990-2012 (Figure 5), 1959-1989 (Figure 6), 1911-1958 (Figure 7) show a good coverage for the periods 1959-1989 and 1990-2012 with a quite homogeneous distribution of observation locations in all the basin, except for the Tunisian and Algerian coasts. For the first time period (1911-1958) observations are sparse with some data concentration close to Gibraltar, along the coast of Provence and Israel.

In-situ dataset includes bottles, CTD, XBT, ARGO and MBT measurements that have been quality controlled as described in deliverable D1.3.1. Vertical profiles were archived by years and by instruments type because the DA scheme applies to observations different instrumental error values. Daily files per instrument type were archived containing all the observations collected in that day. Each profile within the daily file includes a header with temporal and spatial location followed by depth, T and S records along the water column.

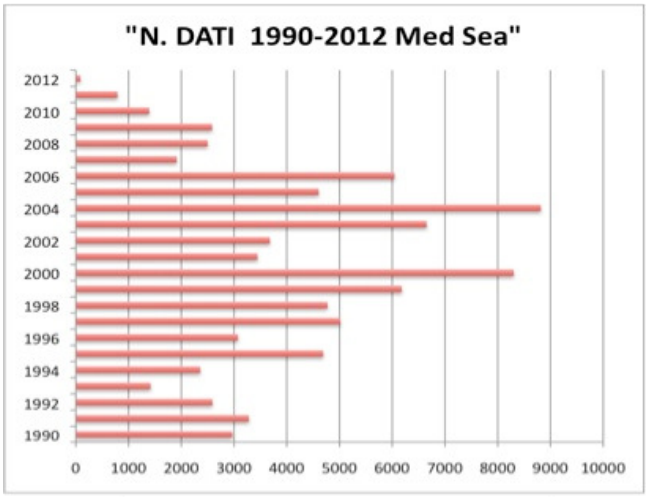

Figure 2. Annual distribution of T&S data for the period 1990-2012 in the SDN infrastructure for the Mediterranean Sea.

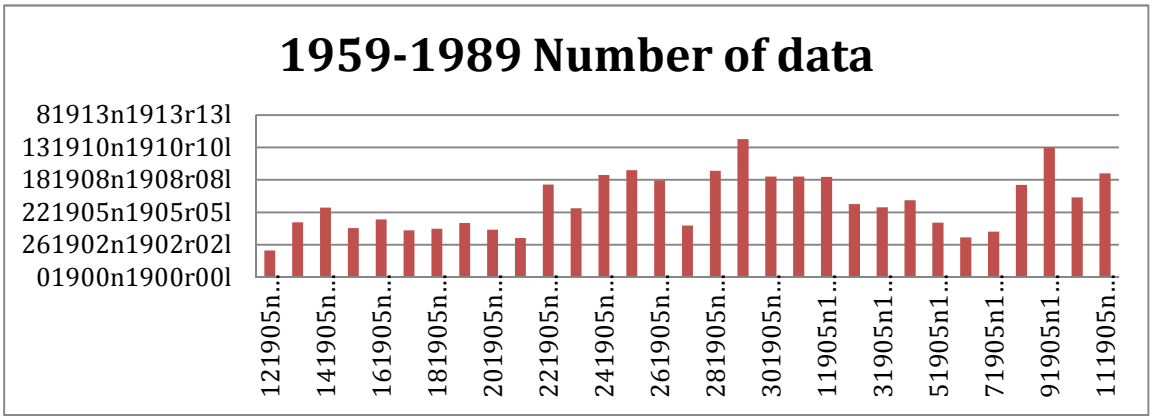

Figure 3. Annual distribution of T&S data for the time period 1959-1989 in the SDN infrastructure for the Mediterranean Sea.

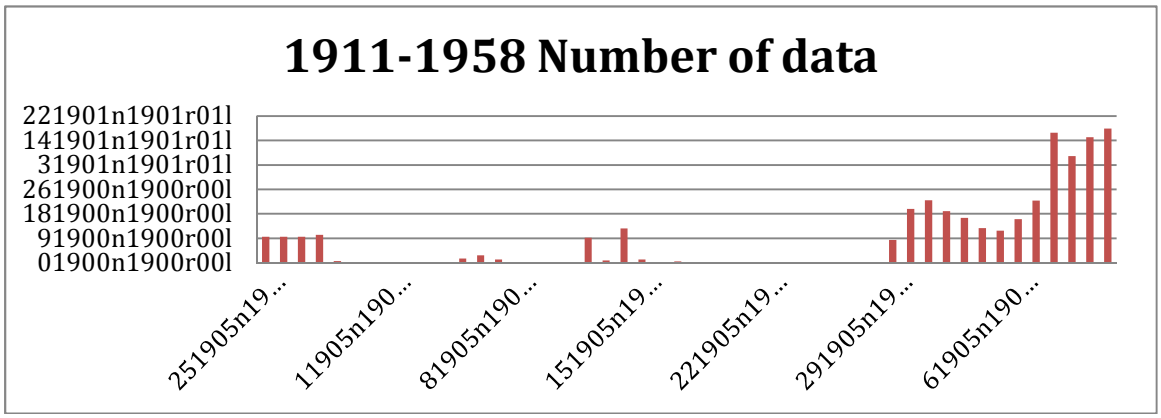

Figure 4. Annual distribution of T&S data for the time period (1911-1958) within the SDN infrastructure for the Mediterranean Sea.

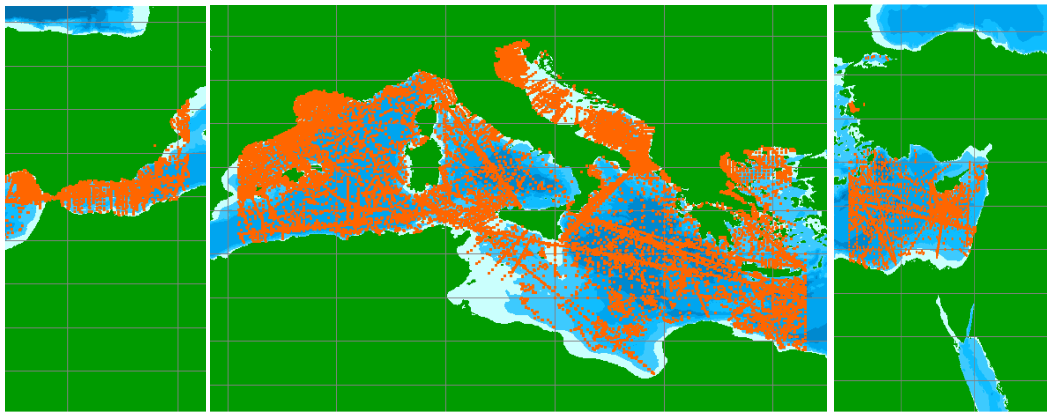

Figure 5. Horizontal distribution of T&S data for the period 1990-2012 in SDN infrastructure for the Mediterranean Sea.

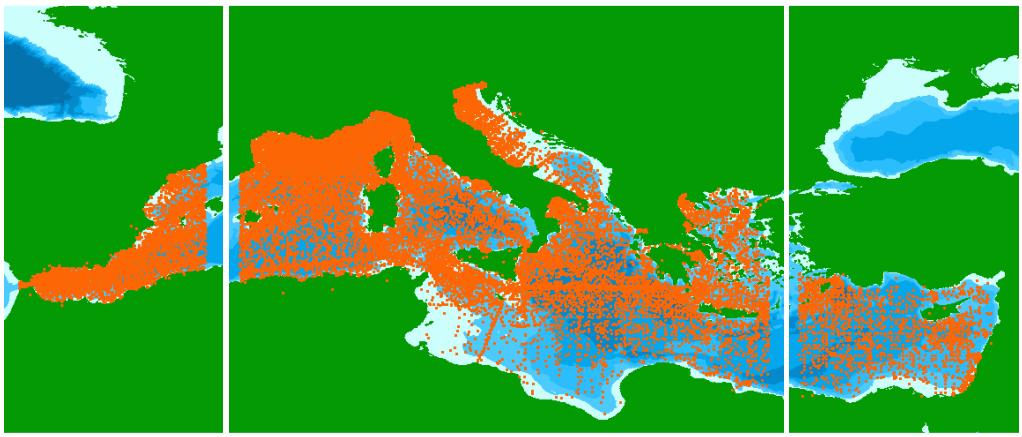

Figure 6. Horizontal distribution of T&S data for the period 1959-1989 in SDN infrastructure for the Mediterranean Sea.

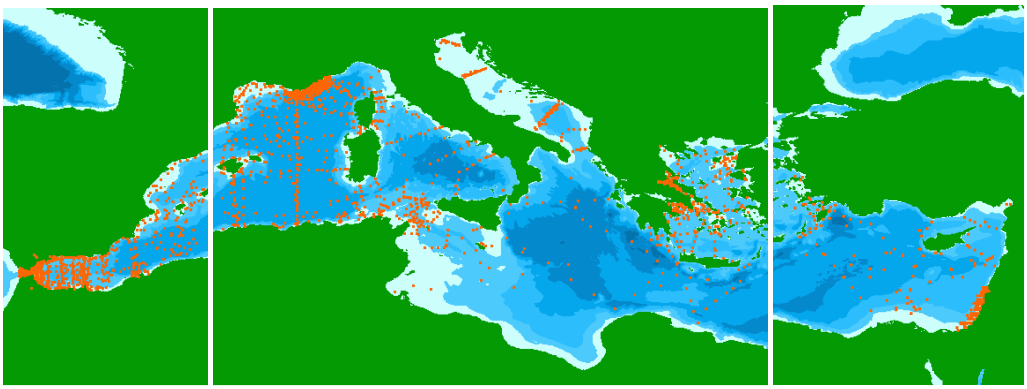

Figure 7. Horizontal distribution of T&S data for the period 1911-1958 in SDN infrastructure for the Mediterranean Sea.

2.4. Surface Atmospheric variables

The atmospheric data needed to force the RR are the following:

1. Mean Sea Level Pressure (MSLP)
2. 2m Temperature (T2m)
3. Zonal and Meridional wind components (U,V)
4. Total Cloud Cover (TCC)
5. 2m dew point temperature (D2m)
6. Precipitation (P)

In order to include all the variables and to cover the entire RR period, we considered different atmospheric datasets: AMIP, NCEP-NCAR, ERA-40, ERAINTERIM, CMAP, as shown in Table 1. We extracted the relevant variables (MSLP, U, V, TCC, T2m, D2m) from the original dataset and archived them in monthly or daily files containing all the variables at original temporal and spatial resolution. Space-time interpolation onto model grid is done on line inside the model before the surface fluxes computation through bulk formulas, as described in D1.3.2. Precipitation data were archived in monthly files already space-interpolated into the 1/16° model grid.

The original datasets (AMIP, NCEP-NCAR, ERA-40, ERAINTERIM, CMAP) are described in the following section.

AMIP

AMIP ("Atmospheric Model Intercomparison Project") is a standard protocol for global atmospheric general circulation models (AGCMs). It provides a community-based infrastructure to support climate model diagnosis, validation and intercomparison. This framework enables to analyze the AGCMs in a systematic fashion improving the climate model.

In AMIP experiments, the AGCM is forced by observed monthly averaged distribution of SST and sea ice as boundary conditions. This model configuration enables to focus on the atmospheric model without the added complexity of ocean-atmosphere feedbacks in the climate system. Archived AMIP data were produced using the ECHM4 AGCM, with SST interpolated from the HadSST1 (described before) (*Cherchi and Navarra, 2007*). We archived 7 experiment members with a spatial resolution of 1.125° providing MSL, TCC, U, V, T2m, D2m and P for the time period 1912 -

2003. These 7 realizations, as described in the WP1.3 Annual Report, will be analyzed and compared to ECMWF reanalysis in their overlapping period in order to select the best quality member to use in the RR.

NCEP-NCAR

From the NCEP-NCAR reanalysis dataset, total cloud cover (TCC) and precipitation fields were extracted for the time period 1948/1949 to 1979. Spatial resolution is 320 km.

ERA-40

The ERA-40 data cover the period 1958-1978 at a spatial resolution of 1.125° and are available with a 6 h temporal resolution.

ERA-Interim

The ERA-Interim data cover the period 1979-2011 with 0.75° spatial resolution and 6 h temporal resolution.

CMAP

The CPC Merged Analysis of Precipitation ("CMAP") is a technique which produces pentad and monthly analyses of global precipitation in which observations from rain gauges are merged with precipitation estimates from several satellite-based algorithms (infrared and microwave bands). The archived climatological monthly means are computed from monthly means starting from 1979 with a horizontal spatial resolution of 2.5°x2.5°, as described in D1.3.2.

2.5. Gridded temperature and salinity fields (Initial Conditions)

The gridded temperature and salinity fields consist in monthly climatologies computed as described in D1.3.1. Monthly temperature and salinity NetCDF files were archived. January monthly climatology of temperature and salinity will be used to initialize the RR system, while the whole monthly climatology will be used later in the project to assess the quality of the RR products.

Different RR input datasets are archived in a dedicated space disk as shown in Figure 8.

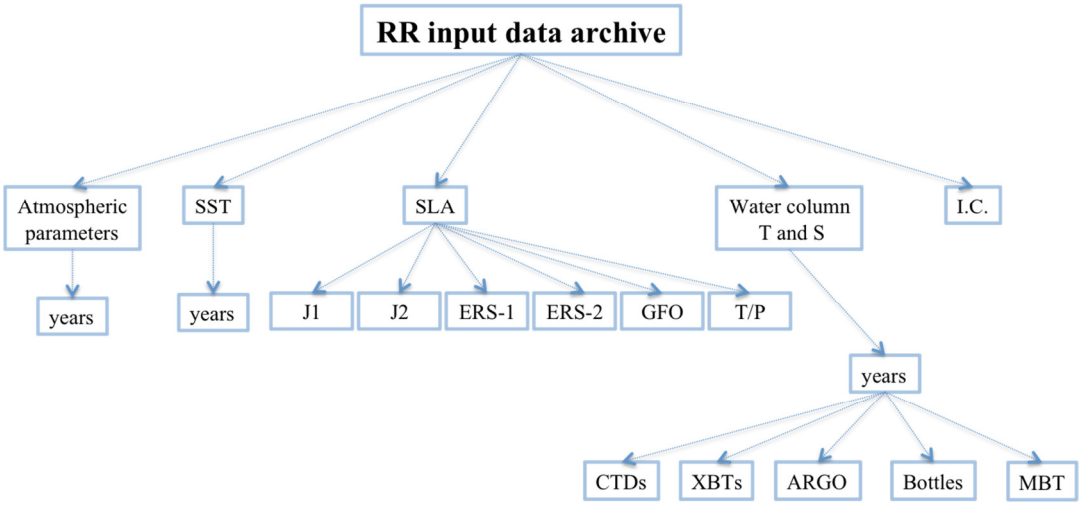

Figure 8. Archive directories organization of RR input data.

All the datasets are archived by years and/or instruments. The data are written with the format to be read from the OceanVar data assimilation scheme and from the numerical model:

- ASCII: temperature and salinity vertical profiles; satellite SLA observations;
- Binary: surface atmospheric variables;
- netCDF: SST observations; temperature and salinity initial conditions; precipitation.

3. Conclusion and future work

During the first year of the project, a dedicated observational dataset for the RR production was created. Future work will be devoted to updating the existing dataset.

References

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