SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2019
Project Title:	SPHERA (Special Project: High rEsolution ReAnalysis over Italy)
Computer Project Account:	SPITCERE
Principal Investigator(s):	Ines Cerenzia, Tiziana Paccagnella
Affiliation:	ARPAE Emilia-Romagna, SIMC, Viale Silvani, 6 Bologna, Italy
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Andrea Montani
Start date of the project:	01/01/2018
Expected end date:	31/12/2020

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		**Current year**	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	50.240.000	42.730.000	9.340.000	5.548.000
Data storage capacity	(Gbytes)	55.000	56.165	60.000	63.835

Summary of project objectives (10 lines max)

The SPHERA special project aims at developing a high resolution atmospheric regional reanalysis over Italy (convection permitting resolution of 2.2km), performed with the COSMO non-hydrostatic Limited Area Model. SPHERA is performed by means of a dynamical downscaling of the ERA5 global reanalysis and by employing the observational nudging during the model integration. Three-dimensional hourly model output are produced. At the end of the project, SPHERA will cover 25 years, from 1995 to 2020. The main purposes of SPHERA are:

- to provide a high resolution, space and time consistent, description of the past decades climate (statistics for extreme events, specific-site series, application in scenarios)
- to provide a COSMO model validation based on long term performance, to be used as a reference for the operational forecast and to calibrate the COSMO based forecasting systems.

Summary of problems encountered (10 lines max)

Due to some revisions and technical/scientific issues (details are in the application for additional resources for 2019), the production of the SPHERA dataset accumulated few months of delay and required more in terms of computing units. Among the causes, the most relevant point was the necessity to use the COSMO model in double precision instead than in single precision as initially proposed. Indeed, after the proposal submission severe bugs have been evidenced in the model code when running in single precision. In total, the decision to use double rather than single precision model version caused largest part of the increment of the simulation cost (70% higher than estimated) and of the time required to simulate each day (more than doubled), see Table 1.

	Estimated in the proposal of June 2017	Real use in the production
Computing time required to simulate 1 day (hours)	0.5	1.3 (+ 0.4 average time in queue)
High Performance Computing Facility (SBU) for 1 day	4400	7500
Accumulated data storage (Gb) for 1 day	5.5	10.5

Table 1. First estimate and real use in terms of simulation time, memory storage and computing time requirements for 24hours of SPHERA reanalysis.

Due to the delays, it was not possible to produce the entire period foreseen for 2018, but only a part of it. According to the proposal submitted in June 2017, almost the entire period was expected to be produced in 2018. Consequently, the majority of resources were allocated for 2018, and much less for 2019 and 2020. However, in 2018 not all the SBU had been used, while in 2019, the low amout of SBU allocated allowed to bring forward the production only up to 57% of the period 2003-2017.

Summary of plans for the continuation of the project (10 lines max)

The additional resources required for 2019 will allow to reach 81% of the period 2003-2017. In this way, SPHERA will be completed for the interval 2011-2017, plus other non-continuous periods between 2003-2010. The rest of the period to be produced will include: 2.9 years to fill the gaps in the period 2003-2010, 2 years of forward extension (2018-2019) and 8years of past extension from 1995 to 2002 plus 2 times 6 months of spin-up (for 2 production trances). These intervals would be produced in 2020 if the amend to the original proposal will be approved.
At the same time with the production, the assessment of the SPHERA performance will be continued as well. The comparison of the surface and near surface variables with the in-situ observations will be performed with the verification tool box (configured ad hoc in 2018). Moreover, an intercomparison study with other high resolution reanalyses covering the Italian domain is currently ongoing and it will be extended to several near surface variables and several years. It aims at analyzing pros/drawbacks of different reanalysis archives, all driven by ERA5, but based on diverse limited area models, using different assimilation methods.

List of publications/reports from the project with complete references

2017/11. Poster with title "SPHERA: High rEsolution ReAnalysis over Italy. Plan and setup" (Ines Cerenzia , Tiziana Paccagnella, Andrea Montani, Arpae-Emilia Romagna, HydroMeteoClimate Service, Bologna, Italy) presented at the 5th International Conference on Reanalysis

2018/07. Oral presentation with title "SPHERA (High Resolution REAnalysis over Italy): system setup and tests" (Ines Cerenzia, Tiziana Paccagnella, Andrea Montani, Arpae-Emilia Romagna, HydroMeteoClimate Service, Bologna, Italy) presented at the 1st International Symposium on Regional Reanalysis

2018/09. Poster with title "SPHERA: High rEsolution ReAnalysis over Italy" (Ines Cerenzia , Tiziana Paccagnella, Andrea Montani, Arpae-Emilia Romagna, HydroMeteoClimate Service, Bologna, Italy) presented at the 1st AISAM (Italian Association for the Atmosphere Science and Meteorology) Conference

2018/09. Oral presentation with title "SPHERA(High Resolution REAnalysis over Italy): development of the system and first assessments" (Tiziana Paccagnella, Ines Cerenzia, Andrea Montani, Arpae-Emilia Romagna, HydroMeteoClimate Service, Bologna, Italy) presented at CLIMETECH

2019/03. Oral presentation with title "SPHERA(High Resolution REAnalysis over Italy): development of the system and first assessments" (Ines Cerenzia[1], Tiziana Paccagnella[1], Andrea Montani[2], 1. Arpae-Emilia Romagna, HydroMeteoClimate Service, Bologna, Italy, 2. ECMWF Reading, UK) presented at the Iccarus (**I**CON- **C**OSMO-**C**LM-**AR**T **U**SER **S**EMINAR**).**

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

1. Introduction

ARPAE Emilia-Romagna, SIMC is developing a high resolution atmospheric regional reanalysis over Italy, SPHERA, performed with the COSMO non-hydrostatic Limited Area Model. COSMO is developed in the framework of the COSMO (COnsortium for Small scale MOdelling, Schättler et al., 2011) consortium cooperation. It is used in the operational NWP suites in Italy, as well as in several other ECMWF Member States (Switzerland, Germany, Greece) and Co-operating States (Romania, Israel).

SPHERA is performed by means of a dynamical downscaling of ERA5 global reanalysis and by employing observational nudging during the model integration. SPHERA will cover 25 years (1995-2020) and will produce three-dimensional hourly model output.

At the time of submitting this project, the idea was to feed SPHERA with the initial and boundary conditions from COSMO-REA6 reanalysis archive: a regional reanalysis dataset covering Europe with a 6km resolution, based on the COSMO model and forced by Era-Interim. However, at the first stage of the special project, it was decided to force SPHERA with ERA5, the global reanalysis currently under production at ECMWF. The intent was to provide SPHERA with a more complete, accurate and up-to-date set of initial and boundary conditions . It was hypothesised that ERA5 could provide more accurate information than Era-Interim (up-to-date IFS code, newly reprocessed observation dataset that could not be ingested in Era-Interim, 31km horizontal resolution, hourly output) and even more precise and consistent than a regional reanalysis archive based on Era-Interim (COSMO-REA6 is based on a COSMO version of 2012). Furthermore, the timetable of ERA5 production was quite coherent with the one of the SPHERA production. Therefore, the activity was in part reviewed in order to follow this new project development.

The late special project SPHERA-PRE (lasting from July 2017 to December 2017) dealt with some of the preliminary steps required to SPHERA production. In particular, (I) the set up of the SPHERA production suite using XCDP package, (II) the development of a verification and monitoring tool box and (III) the definition of the data to be ingested into the assimilation process, (IV) the definition of the COSMO configuration and (V) the preparation of one of the tests needed to define the SPHERA configuration (in particular for the definition of the nesting modality in ERA5). Results of points I, II and III are detailed in the SPHERA-PRE final report. The configuration of COSMO (point IV) is summarized in Table 2. Finally, the test about the nesting modality (point V) was accomplished during the SPHERA project in 2018 and the results are reported extensively in the SPHERA progress report 2018. A summary and additional results are reported in the following paragraph 2.1. After the definition of the nesting modality, the following question regarded the definition of the deep soil temperature to assign to SPHERA. Deep soil signal are relevant in long lasting simulation since small inaccuracies at the soil level can trigger systematic errors associated to the soil hydrological cycle and surface fluxes balance. The experimentation performed to answer this point is reported in paragraph 2.2. Finally in September 2018, the production of SPHERA started. Paragraph 3 reports details about the temporal workflow of the production and about the operational monitoring tool. The assessment of SPHERA performance for the period already produced against near surface observations and in comparison with other regional reanalysis is in paragraph 4.

	SPHERA setup
Initial condition	ERA5
Boundary condition	ERA5, updated every hour
Nesting modality	1-way nested, directly nested in ERA5 (see paragraph 2.1)
Sea Surface Temperature	Interpolated from ERA5 every day

Deep soil temperature	Parametrized using ERA5 soil temperature (see paragraph 2.2)
Deep soil moisture	Free percolation at depth -1.62m (see paragraph 4.1)
Observations assimilated	SYNOP (not temperature at 2m and precipitation), SHIP (not temperature at 2m and precipitation), TEMP, PILOT and AIREP
Code version	INT2LM 2.04 (pre-processing) COSMO 5.05 in double precision
Domain	38N, 5.7W- 53N,18.2W
Resolution	2.2km horizontal, 65vertical levels (0-22km), 7 soil level (0-14.58m)
Physical schemes:	
Radiation	δ two-stream scheme after Ritter and Geleyn, 1992
Turbulence	Prognostic turbulent kinetic energy closure at level 2.5 including effects from subgrid-scale condensation and from thermal circulation (Raschendorfer 2001)
Transfer	Surface layer scheme coupled with the turbulence scheme (Raschendorfer)
Land-Surface	Multi-layer soil after Jacobsen and Heise (1982)
Convection	Only shallow convection (reduced Tiedtke 1989)
Microphysics	Grid scale cloud and precipitation scheme (3 categories ice scheme) and a statistical scheme for sub-grid clouds (Sommeria and Deardorff, 1977)
Subgrid scale Orography	Lott and Miller, 1997
Lake	Two-layer bulk model after Mironov (2008)
External parameters	
Orography	GLOBE
Land cover	Global Landcover 2000 Database
Soil type	Digital Soil Map of the World (FAO/UNESCO)

Table2. SPHERA setup

2. Main questions about SPHERA setup

2.1. Definition of the nesting modality in ERA5

One of the main questions tackled during the setting up process regarded the selection of the modality by which COSMO is nested into the driver dataset ERA5. As a general practice, high resolution runs are nested in coarser resolution integration of the same model, in order to ensure a ratio of spatial resolution between 2:1 and 5:1 (e.g. Warner et al. 1997, Denis et al. 2001). However, some recent studies (Marsigli et a. 2013) and experiences in the operational chain building-up (Arpagaus, MeteoSwiss, pers. comm.) demonstrated a neutral or improved performance of the high resolution run, when the intermediate step with the coarser resolution model was avoided.

Regarding this choice, two options had been considered for SPHERA:

- 2step: COSMO-2.2km was one-way nested in COSMO-10km (a COSMO model configuration with horizontal resolution of 10km, domain covering the whole Mediterranean Sea and convection parameterized by Tiedtke scheme, Tiedtke, 1989), which in turn was one-way nested in ERA5. The ratios of spatial resolutions between COSMO-

2.2km, COSMO-10km and ERA5 were respectively 5:1and 3 :1, in agreement with the traditional practice.

- 1step: COSMO-2.2km was directly one-way nested in ERA5, with a resolution step of 15:1. The integration domain is enlarged by 16 grid points at the border in each direction with respect to the one used in SPHERA-2step, in order to dump the border effects potentially associated to a nest using a large ratio between model resolutions.

These two configurations were tested on two parallel suites over one year (2015), plus 6 months of initialization used to spin up the model soil fields. The comparison between the two configurations was performed in terms of (I) temporal trend of the domain average of some specific surface variables (daily accumulated precipitation, surface pressure, mean surface pressure, noon and midnight temperatures at 2m), (II) verification against observations for daily accumulated precipitation and temperature at 2m. Details are reported in the SPHERA progress report 2018.
Main results were that:

1. SPHERA-1step outperforms SPHERA-2step, both in terms of total precipitation (almost at every threshold and especially during summer) and of temperature at 2m (small differences)
2. SPHERA-1step presents generally less precipitation than SPHERA-2step, especially at the end of summer and during autumn (Figure 1a).

A subsequent analysis evidenced that this difference is in large part due to the deep convection scheme, active only in COSMO-10km in the chain of SPHERA-2step. In particular, from May to September all the difference between SPHERA-2step and 1step (at 2.2km) originates in the intermediate integration domain of 2step (i.e. COSMO-10km), see Figure 1a. It is likely the deep convection scheme that produces more precipitation during this warm period. Then, the moister soil of COSMO-10km is interpolated down to the soil of COSMO-2.2km (Figure 1b), where it likely trigger more precipitation. From September to January only a small component of the precipitation difference originates in COSMO-10km (Figure 1a), but the soil of SPHERA-2step resuts the same moister than the one of 1step (Figure 1b). Therefore, the higher moisture stored in the soil in 2step could still be responsible of a higher precipitation during those months. Vice versa, from January to May no moisture difference is present, but SPHERA-2step appears the same wetter than 1step. Therefore, some other not-yet-identified process is at work in these months.

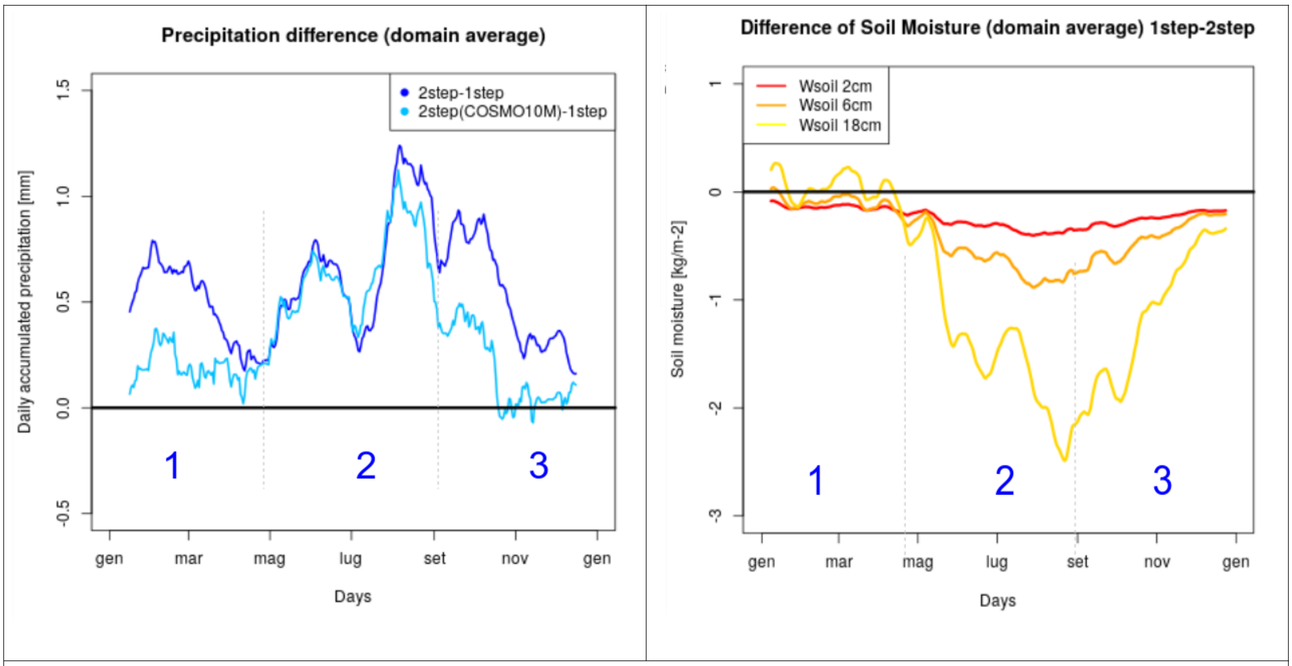

Figure 1. Difference of the domain-averaged (a) daily accumulated precipitation (b) soil moisture at different depths (as indicated in the label) simulated by SPHERA-2step, SPHERA-2step (COSMO-10km) and SPHERA 1-step, plotted against the integration time

In conclusion, the experiment clearly identified that the 1step nesting modality overcomes the traditional mode for the specific SPHERA environment. Therefore, SPHERA is set up to use the 1step nesting modality.

2.2 Definition of the deep soil temperature for SPHERA

The second relevant question tackled regarded the definition of the deep soil temperature to apply in a long term simulation, as a regional reanalysis dataset. In literature, this issue is very marginally treated, mainly for the lack of deep soil observations to validate the results. Nevertheless, the large soil inertia has the potential to trigger differences at the surface level and in the atmosphere on a long time scale. In general, the deep soil temperature in the regional reanalysis is interpolated from the deepest temperature of the driving model/reanalysis. However, since the deepest soil level in ERA5 is located at 1.954m of depth, while the lowest one in COSMO goes down up to 14.58m, a simple interpolation cannot be applied.

In order to estimate a consistent COSMO-2.2km deep temperature, three different parameterization approaches have been considered. They all are based on the simplified analytic solution of the heat transfer equation in soil (assuming sinusoidal yearly wave of temperature and a vertical homogeinity of soil thermal properties.. They were compared against observations on specific sites over Europe where soil measurements at a depth larger than 0.5m (Cardington, Fauga-Mauzac, Lindenberg, San Pietro Capofiume and Potsdam) are available. The study, reported in detail in the SPHERA progress report 2018, evidenced the best performance for the parameterization using the three-yearly running mean of the ERA5 deepest level, with a time delay defined using the soil thermal conductivity and the simplified analytic solution in which the thermal diffusivity is derived by the phase method. Values estimated with this approach have been used to to reconstruct the deep soil temperature for SPHERA.

Two parallel test runs were performed over two years (plus 6 months of initialization), the first using a constant deep temperature, equal ERA5 at -1.9m at the start of the model integration(standard option in COSMO when run in forecast mode), and the second one using a deep temperature parameterized as described above thus providing a time evolving deep temperature, dependent on the soil features in each grid point. Figure 2 shows that the domain average difference at -14.58m is about 1K (but in single grid-point it is larger than 5K). This deviation depends on the month of initialization (i.e. on the phase of the temperature wave of ERA5 at the initialization time) and on the soil type. Moreover, the temperature difference is propagated upward, and after 12months (+6months) it reaches -0.5m. The analysis for the second year of parallel simulation has not be done yet, and it will evidence to which level the signal will be propagated and the potential effect on the atmosphere.

3. Production of SPHERA

SPHERA takes the initial and boundary conditions from ERA5 (Table 2). For simplicity, the simulation is organized in a sequence of 24h-long runs: at the first day (the real start of the model integration) , the initial fields are interpolated from ERA5, while afterwards warm initialization is applied (the 24h forecast is used as Initial condition for the following run) in order to reproduce a continuous run. The lateral boundary conditions are updated every hour and the sea surface temperature is updated (interpolated from ERA5) every day.

In order to employ at best the resources allocated for 2018, the production period was sliced in four production trances of 4 years each (Figure 3), which could run at the same time. The trances are for (1) 2003-2006, (2) 2007-2010, (3) 2011-2014 and (4) 2015-2018. Each trance was preceded by 6 months of rerun needed for the soil spin-up. Years from 1995 to 1999 were not included because in September 2018 ERA5 had not been released yet for this interval. Due to the same reason, it was not possible to produce neither the years between 2000 and 2002, because it was not possible to reconstruct the deep soil temperature to provide as bottom boundary condition to COSMO (see paragraph 2.2). In 2018, SPHERA was produced for about two years (or a bit less) plus the 6-months spin-up for each trance. In 2019, the production of SPHERA was continued along all the four trances. The production advancement is reported in Figure 3.

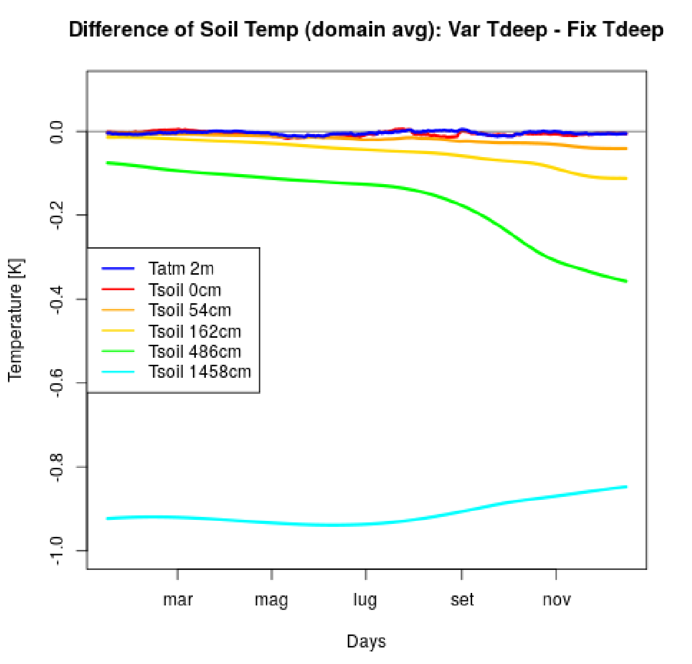

Figure 2. Difference of the domain-averaged soil temperature at different depths (as indicated in the label) simulated by SPHERA-VarTdeep (using the parametrized deep temperature) and SPHERA-FixTdeep (using the constant deep temperature), plotted against the integration time

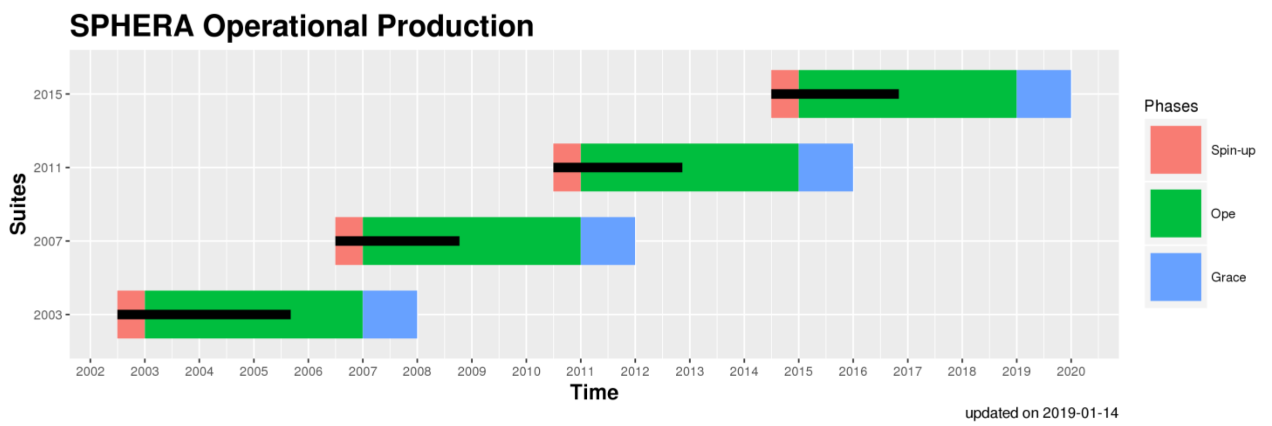

Figure3. Production advancement for the SPHERA dataset updated at 14/01/201. Black line indicates the periods already produced, while the other colors represent the production phases ('Ope' stays for operational and indicates the production of final data, 'spin-up' indicates the initialization period, while 'Grace' indicates an optional rerun, only for comparison purposes).

At the current state, approximately 6.5 years are missing to close the gaps between the trances and fully cover the period 2003-2017. The remaining years (2.9 years to fill the gaps in the period 2003-2017, 2 years of forward extension (2018-2019) and 8years of past extension from 1995 to 2002) will be produced following the same methodology (production trances 4years-long preceded by 6months of spin-up).

In addition the XCDP monitoring screenshot, a monitoring tool has been prepared to routinely check up the production advancement and the status of the data assimilation.
Regarding the first point, everyday an informative mail reports the updated plot of the production advancement (as Figure 3) and the number of days simulated by each production trance in the last

24hours. This was a useful way to identify stop or, less evident, slowing down of the production, which could be tempestively solved. Regarding the monitoring of data assimilation, it considers the number of observations assimilated during each simulation (24hours-long) subsetted per observation type. It was meant to: (I) control that data assimilation is properly working, (II) evidence sudden variations of the number of assimilated observations (which is suspect), (III) evidence long term trend in the ratio between assimilated and rejected data (indication of a suspect departure from the observation state), (IV) show the expected increment in time of the total number of observations per type. In the example reported in Figure 4 for SYNOP observations, it is possible to see some sudden decrements of the total number of data (point II), which eventually resulted to be a problem of the monitoring script that is now solved, the variation of the ratio between rejected and active data during 2015 (point III), which was not an issue since it corresponds to a net increase of the total number of ingested observations (point IV).

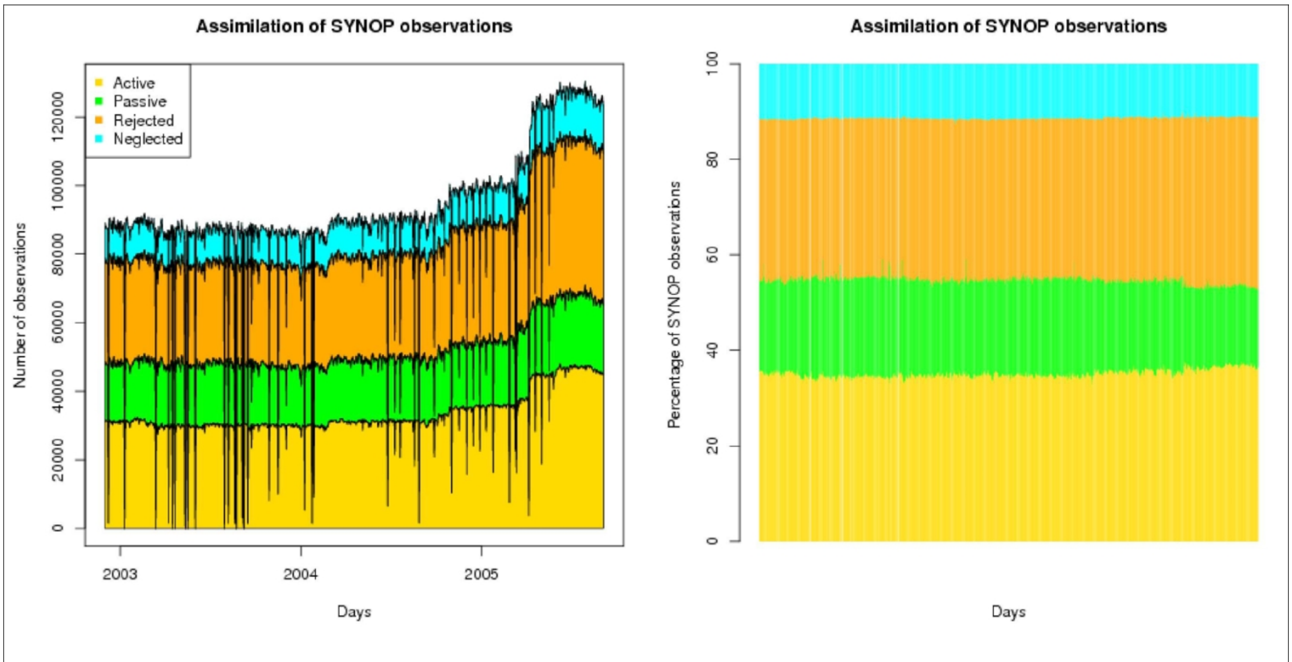

Figure 4. Temporal evolution of the total number and relative percentanges of SYNOP observations divided per status in the SPHERA data assimilation. This example is for the production trance 2003-2006.

4. Performance assessment

4.1. Analysis of trends

A potentially critical issue on long continuous simulations is the development of unrealistic temporal trends.. This is particularly relevant for the soil, due to its large inertia, as seen for the deep soil temperature study (paragraph 2.2). For the soil moisture, SPHERA applies a “free percolation” condition at a depth of -1.62m.

This might cause a lack of humidity in the soil and a consequent drift in the soil and surface temperatures. For this reason, the time evolution of the soil fields at different levels was compared with both in-situ observations (from San Pietro Capofiume station, Figure 5) and ERA5 domain-averages (Figure 6). The analysis evidenced a high temporal coherence with both in-situ observations and ERA5 for both soil moisture and temperature and the absence of significant trends along the production trances. Therefore, the “free percolation” condition does not cause any significant soil drying on these long time scale runs. Vice versa, SPHERA shows a time-constant wet bias at all depths against both the observations and ERA5 domain-average. However, the representation of soil can be considered satisfactory, taking into account the low constrains (e.g. no soil moisture analysis, only atmospheric input) given to the soil moisture.

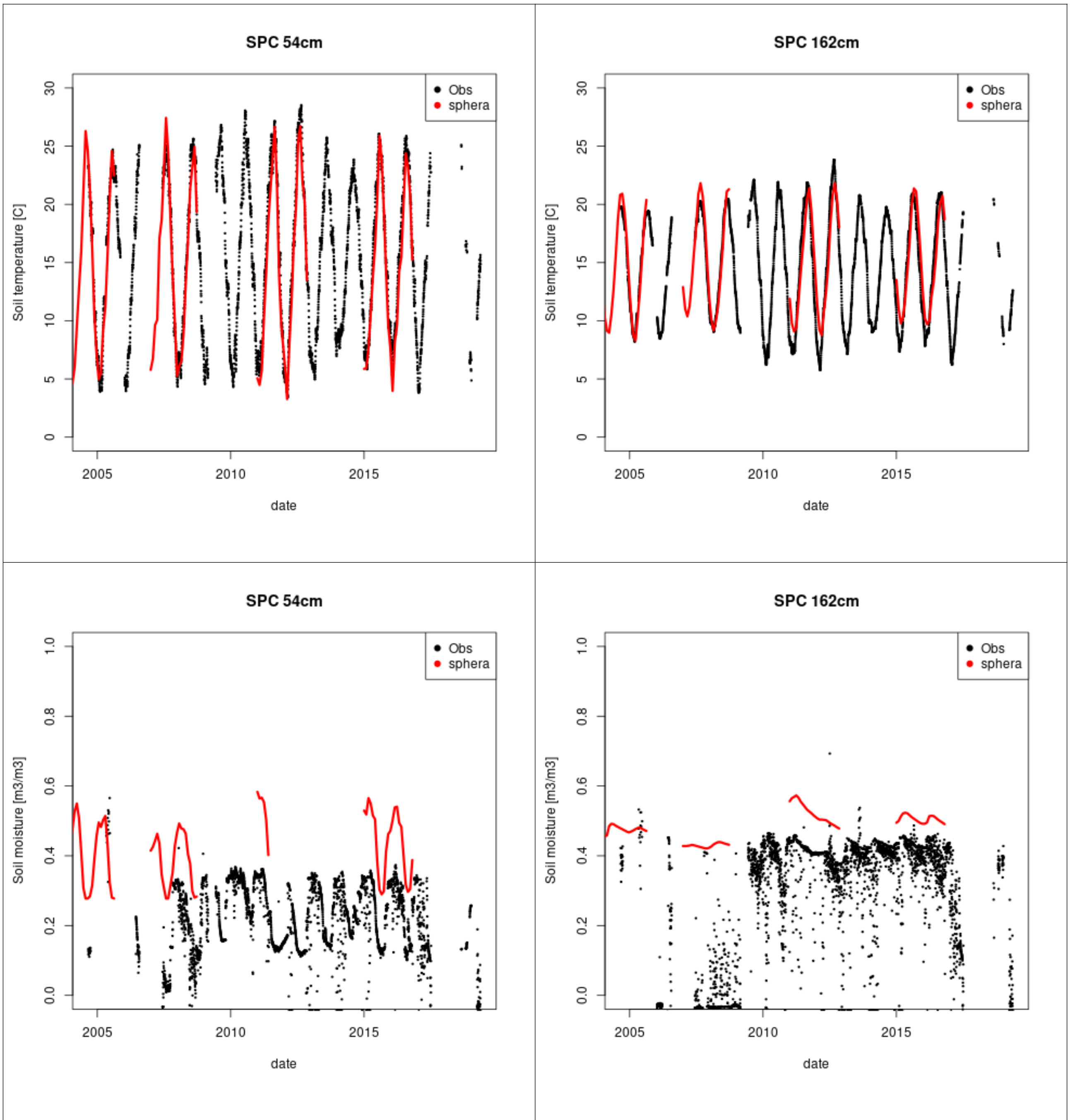

Figure 5. Time series of the soil temperature (top row) and moisture (bottom row) at different depths for SPHERA and observations at San Pietro Capofiume station

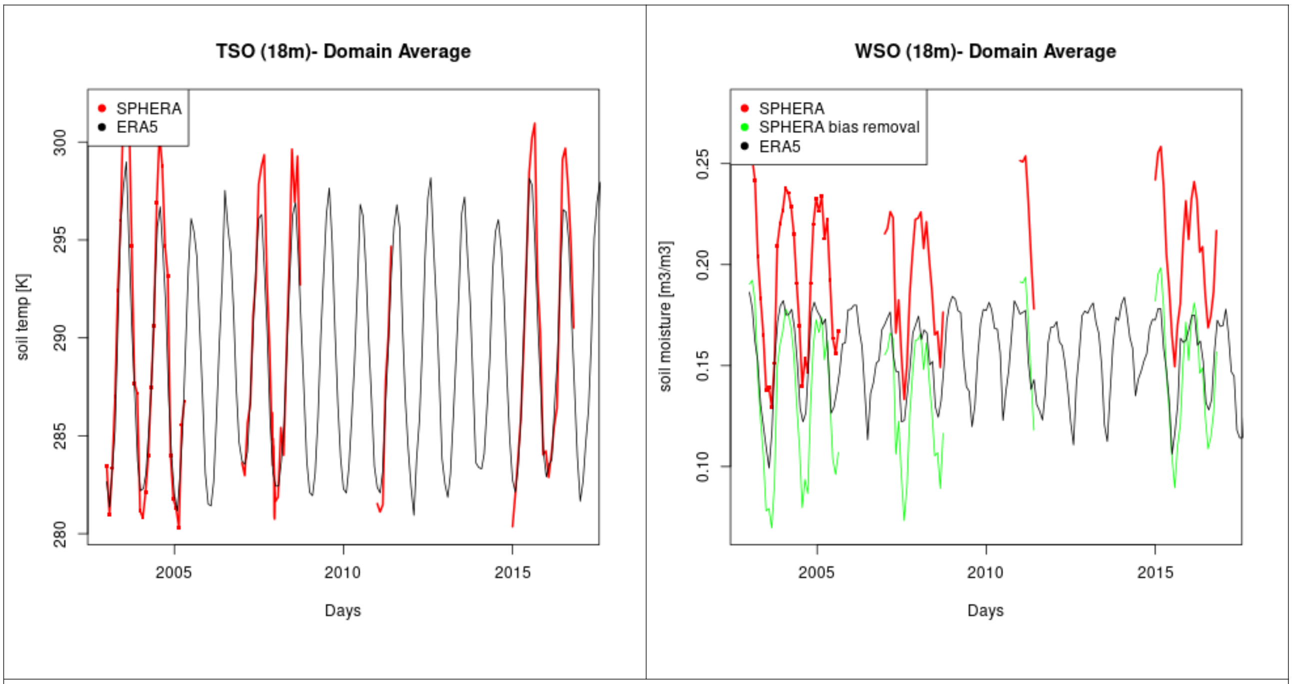

Figure 6. Time series of the domain averages of the soil temperature (left) and moisture (right) at -18cm of depths for SPHERA and ERA5. On the left the green line shows SPHERA without a wet bias of 0.05m³/m³.

4.3 Intercomparison with other regional reanalysis

The analysis of the SPHERA performance against the near surface observations has been done until now for the total precipitation and temperature at 2m for the production year 2015.
Additionally, for the same period and using the same data and verification techniques, the SPHERA dataset has been compared with other reanalysis datasets covering the italian domain. They are:

- COSMO-REA6: a 6km-resolution reanalysis performed using COSMO driven by ERA-Interim (Bollmayer et al. 2015),
- MERIDA: a 7km-resolution reanalysis performed using WRF driven by ERA5 (Bonanno et al. 2019)
- BOLAM/MOLOCH: two mesoscale models employed in cascade at 7km and 2km resolution respectively for this hindcast experiment (ie no data assimilation) driven by ERA5.

The intercomparison has been performed using the observations from the Italian Civil Protection network (http://www.mydewetra.org/). This activity was part of a collaboration with LaMMA Toscana (producer of BOLAM/MOLOCH reanalyses) and RSE S.p.A. (producer of MERIDA).

For the temperature at 2m (Figure 7), the verification has been performed using a bilinear interpolation of the models over the station and calculating the scores every three-hours. Height altitude correction was not applied. For SPHERA, these data were not ingested by the data assimilation procedure. Vice versa, MERIDA assimilated a small partion of this dataset.
SPHERA shows the smallest RMSE and MAE almost at every hour. A good performance is reported also by MERIDA, and both behave better than the driver ERA5. Larger errors are instead shown for the other ERA5-driven dataset, i.e. BOLAM/MOLOCH, likely because no assimilation was applied for this reanalysis. Interestingly, over the italian domain the 6km-reanalysis COSMO-REA6 is already outperformed by the 31-km resolution ERA5, which indicates the improvements accomplished by ECMWF with the new global reanalysis against the old ERA-Interim (i.e. driver for COSMO-REA6). In terms of BIAS, the datasets based on the COSMO model (i.e. SPHERA and COSMO-REA6) present the same diurnal cycle of error, which is a well known feature of COSMO.

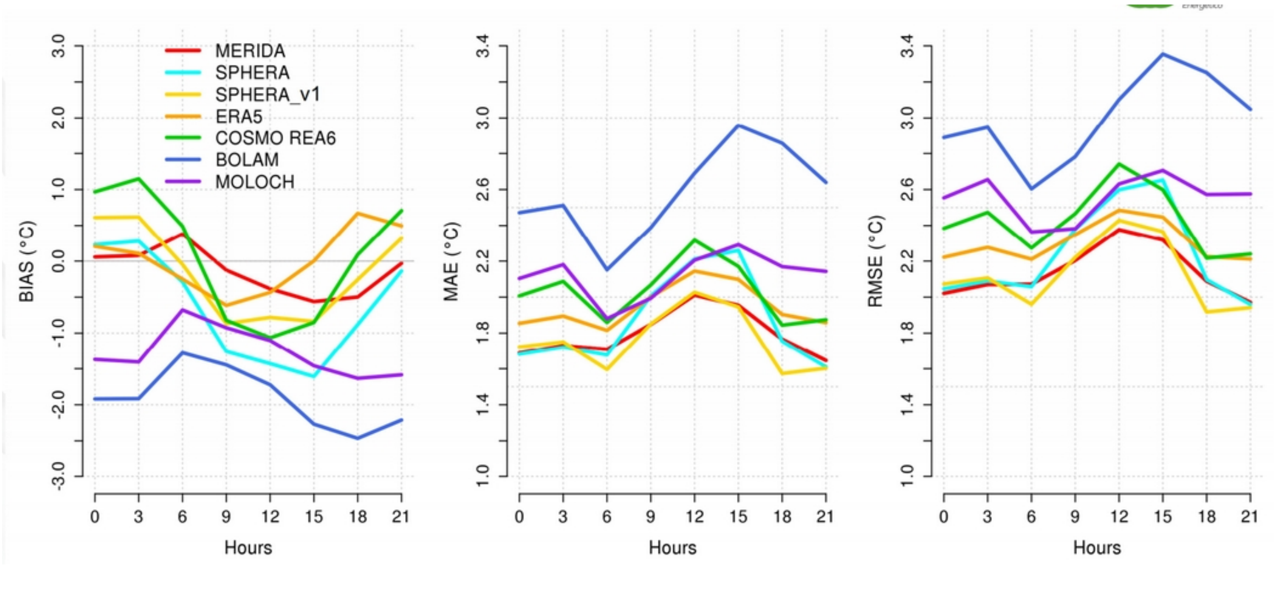

Figure 7. BIAS, MAE and RMSE of tempearature at 2m in SPHERA(labelled "SPHERA_v1"), , MERIDA, COSMO-REA6, BOLAM, MOLOCH and ERA5 averaged on the day hours for the months from March to December 2015

Regarding the daily precipitation, the verification is done over 0.4°x0.4° boxes comparing the 95 percentile in each box between model and observations (Figure 8). The performances appear dependent on the reanalysis resolutions for the HK score (POD-POFD), with better scores for the finer resolution cases, while FAR results clustered between global an regional reanalyses. In general at low threshold (5mm in Figure 9), the thread scores are similar for all the datasets. At increasing thresholds, the dependency on the model horizontal resolution (especially for POD) becomes more evident. Best performances are for MOLOCH and SPHERA, particularly at high threshold.

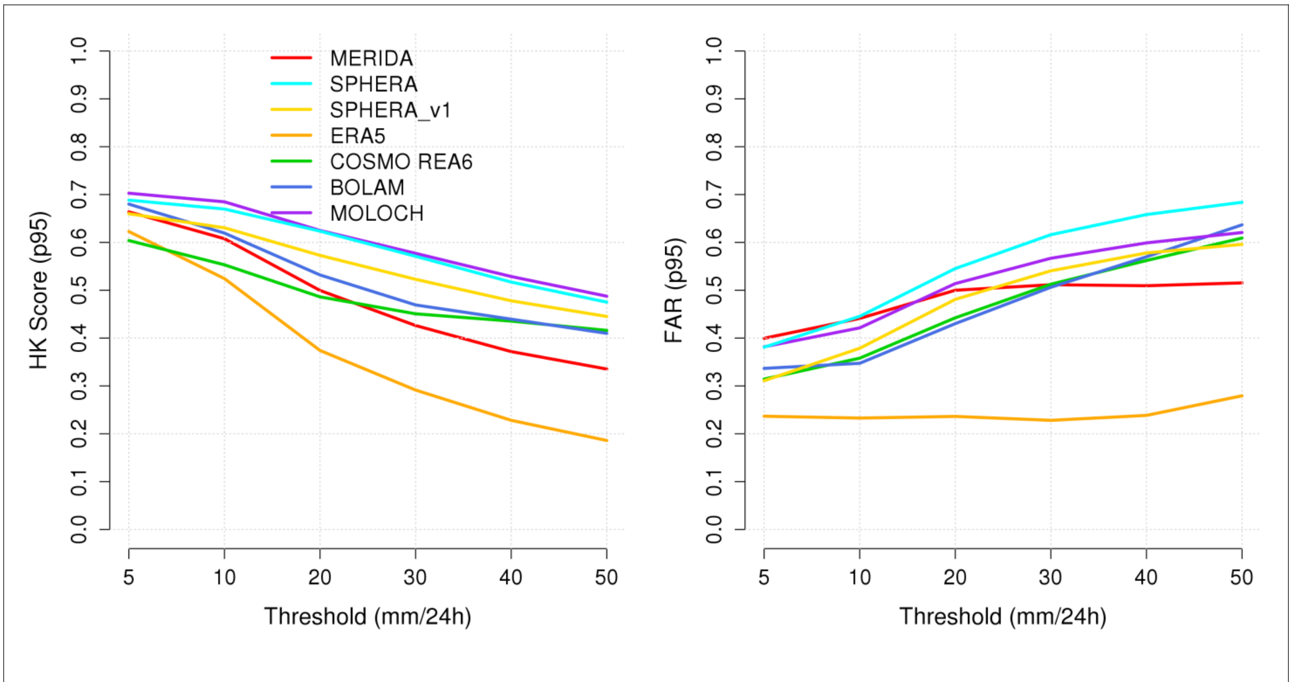

Figure 8. Hanssen and Kuipers score and False Alarm Ratio of the daily accumulated precipitation plotted as a function of threshold for SPHERA (labelled "SPHERA_v1"), MERIDA, COSMO-REA6, BOLAM, MOLOCH and ERA5 for the months from March to December 2015

The verification of the SPHERA dataset for other variables and for longer period will be performed along 2019.

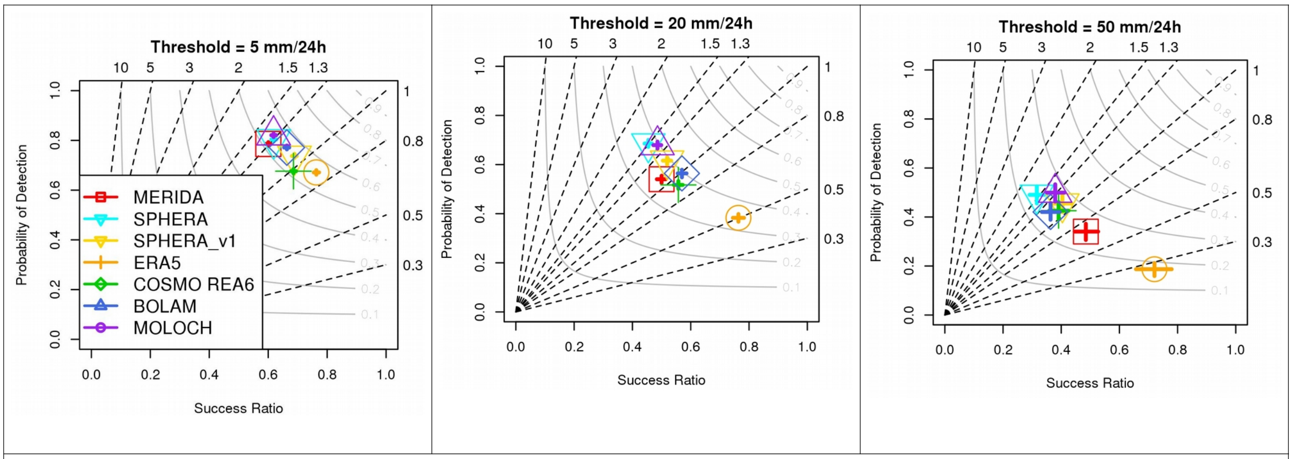

Figure 9. *Performance diagrams of the daily accumulated precipitation at different thresholds for SPHERA (labelled "SPHERA_v1"), MERIDA, COSMO-REA6, BOLAM, MOLOCH and ERA5 for the months from March to December 2015*

Conclusions

The SPHERA dataset is in production. Currently about 35% of its final extent (from 1995 to 2019 included) has been already produced and if the amend proposal for 2020 will be approved, it will be fully covered within 2020. The preliminary tests indicated that a direct nest of COSMO (at 2.2km of resolution) into ERA5 (at 31km of horizontal resolution) improved the scores of temperature at 2m and of precipitation with respect to a traditional 2steps nest (passing through an intermediate resolution COSMO run). Moreover, the standard use of a time-constant deep temperature as bottom boundary condition for COSMO was revised in favour of a time-evolving and site-dependent field.
The analyses performed over the already produced periods evidenced the absence of any significant anomalous temporal trend along the production trances. Moreover, in comparison with other regional reanalyses over the Italian domain, SPHERA resulted the best performing one in term of temperature at 2m and with satisfactory scores in terms of daily precipitation.

References

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