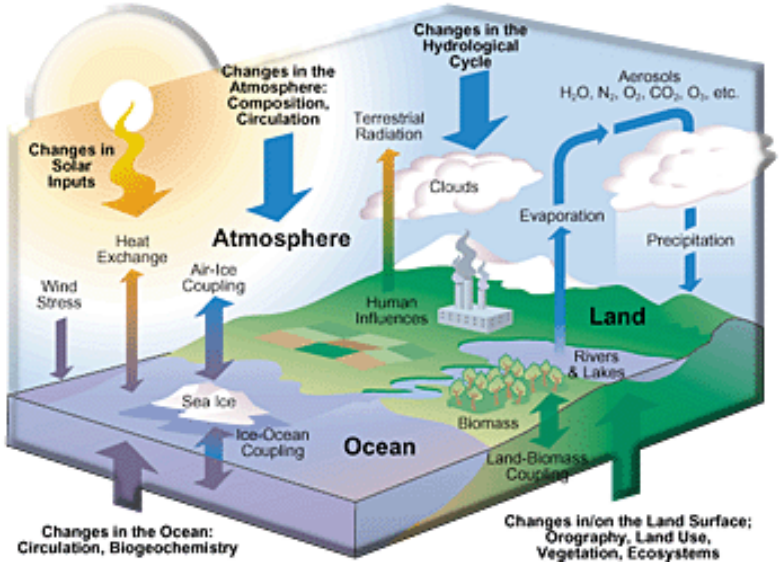
ERA-CLIM2
M36 Review Meeting

Roberto Buizza

European Centre for Medium-Range Weather Forecasts

The FP7 ERA-CLIM2 project (2014-2017)

Goal: Production of a consistent 20th-century reanalysis of the coupled Earth-system: atmosphere, land surface, ocean, sea-ice, and the carbon cycle



Main components:

- *Production of coupled reanalyses, for 20C and the modern era* *(WP1)*
- *Research and development in coupled data assimilation* *(WP2)*
- *Earth system observations for extended climate reanalyses* *(WP3)*
- *Evaluation of uncertainties in observations and reanalyses* *(WP4)*
- *Improving access to reanalysis data and input observations* *(WP5)*

The 3rd General Assembly: Wien 16-18 Jan 2017

Few numbers:

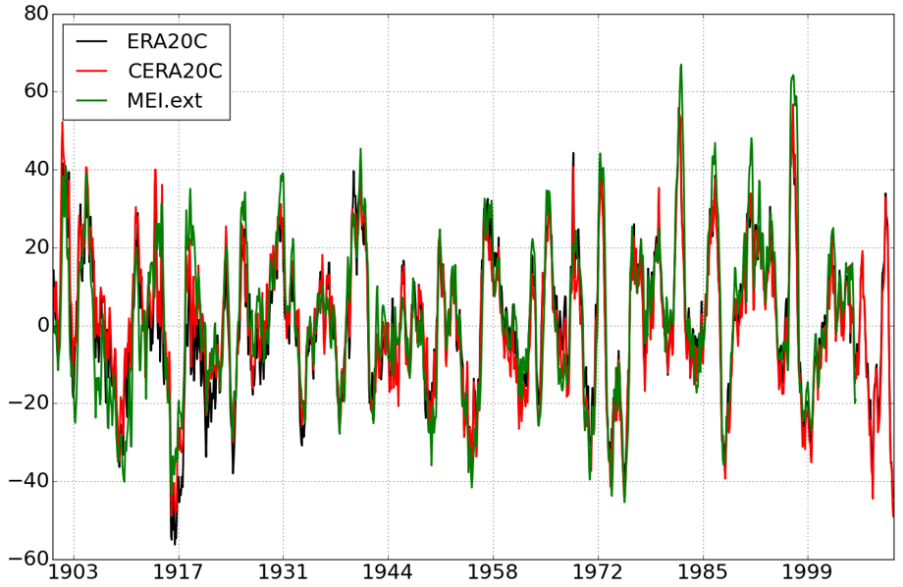
- Attended by 34 people, with 33 presentations from ERA-CLIM2 participants,
- WG discussions, External Adviser comments, discussions
- Deliverables: some delays in data re-processing (EUMETSAT) due to changes in computing environment

As a project coordinator, I think that the project has been progressing very well and mostly on-schedule with respect to the plan defined at the end of 2015:

- Very good overall interaction
- **CERA-20C is a great success: this is the 1st Coupled Reanalysis of the 20th Century**
- CERA-SAT is in production and plans to complete 8-10 years (2008-to-date)
- Rescued and post-processed observations are being fed into key data archives
- Newly developed methods are being integrated in software depositories to be tested for future use

Key achievements of past 9 months: WP1

- CERA-20C dataset is completed (1901-2010)
- CERA-SAT production has started (2008-2016)
- Ocean carbon reanalysis forced by ERA-20C completed
- Land carbon reanalysis based on ORCHIDEE forced by CERA-20C is completed
- Ocean carbon reanalysis forced by CERA-20C scheduled for 2017
- Consolidation of the ORCHIDEE model for land carbon reanalyses: land carbon reanalyses based on the consolidated ORCHIDEE, forced by CERA-20C and CERA-SAT scheduled for 2017



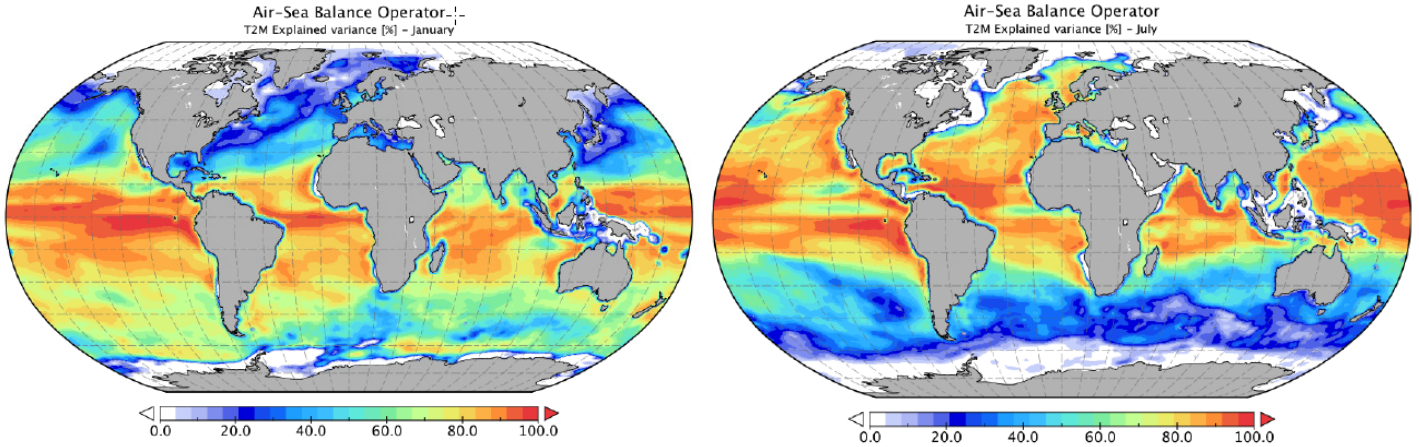
Timeseries of the multivariate ENSO index for ERA-20C, CERA-20C and the Wolter & Timlin observational product (MEI.ext)

The El Niño and La Niña events are captured by the two reanalyses

Key achievements of past 9 months: WP2

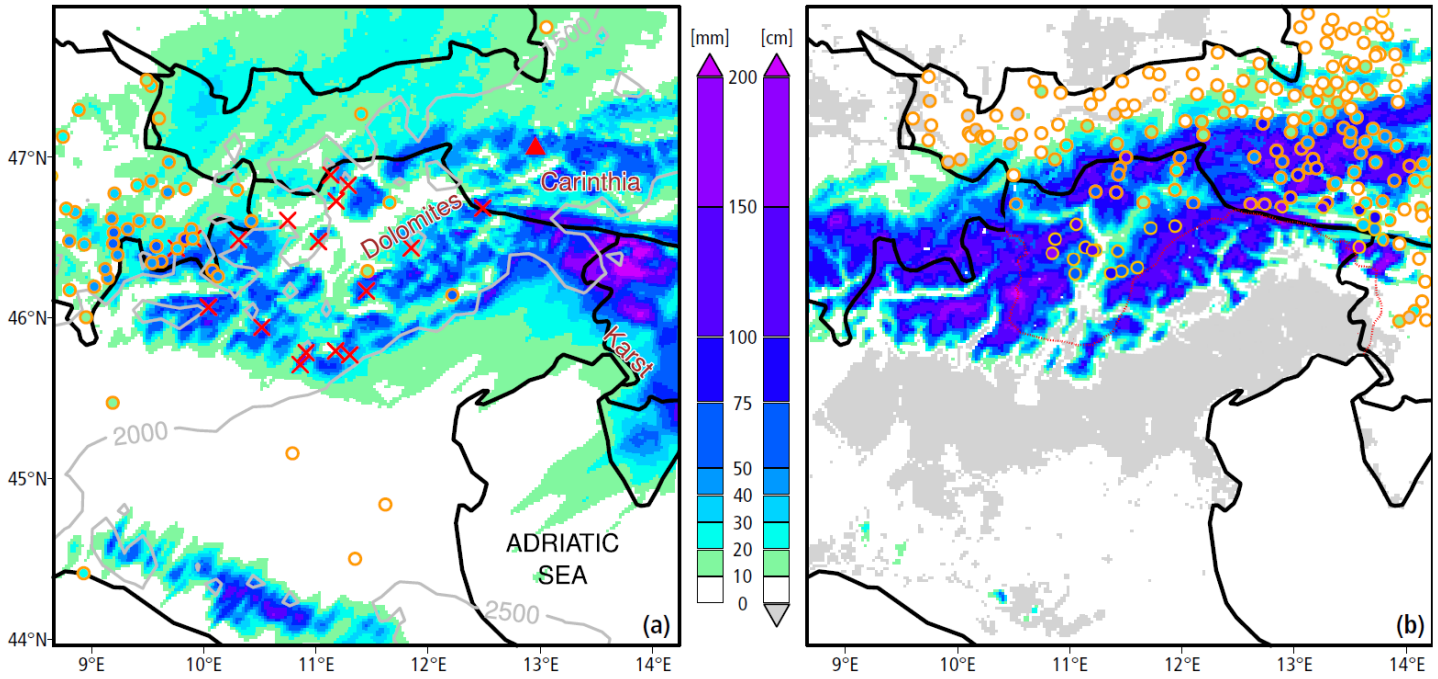
- Contributions to the WMO Coupled Data Assimilation Workshop in Toulouse, Oct 2016 (co-sponsored by ERA-CLIM2)
- Deliverable D2.4 completed by CMCC: “Strongly coupled data assimilation experiments with linearized ocean-atmosphere balance relationships and hybrid covariances”
- Paper published on carbon cycle assimilation (Peylin et al., GMD).
- Progress on other upcoming deliverables – see later presentations.

Towards strongly coupled DA: Variance explained for 2m air temp from a *linearised air-sea balance operator*



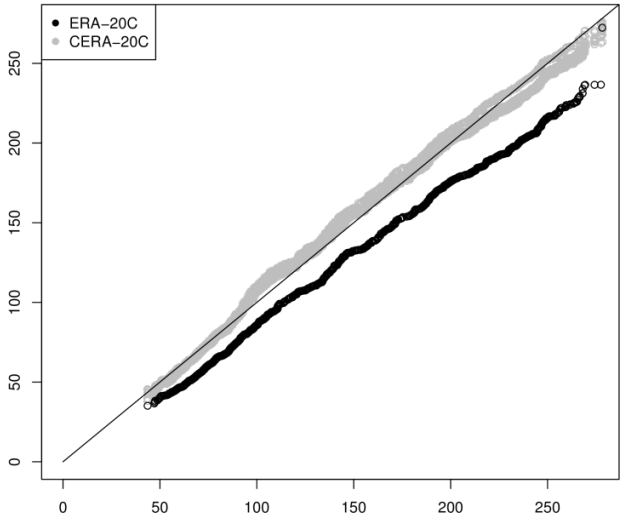
Key achievements of past 9 months: WP3

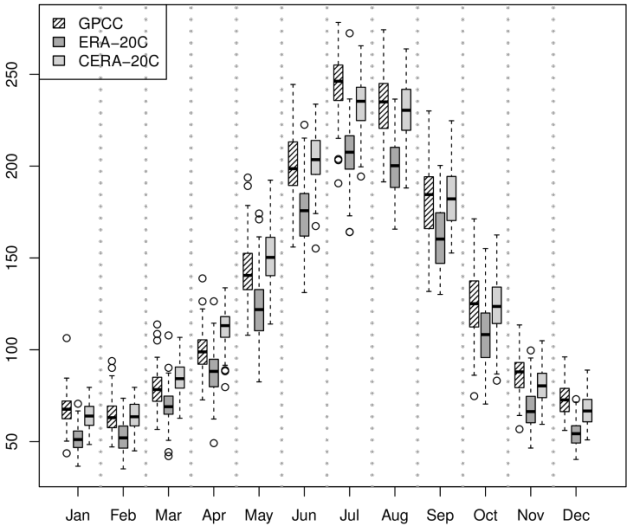
- Contributions to the Conference on 'Observations for Reanalyses' (22 June 2016, Maynooth, Ireland, together with ACRE meeting)
- Continuation of data rescue: Deliverable 3.4
- RTTOV updates and ocean database updates delivered, early satellite data almost
- Case study 'Avalanches during the winter of 1916'



Key achievements of past 9 months: WP4

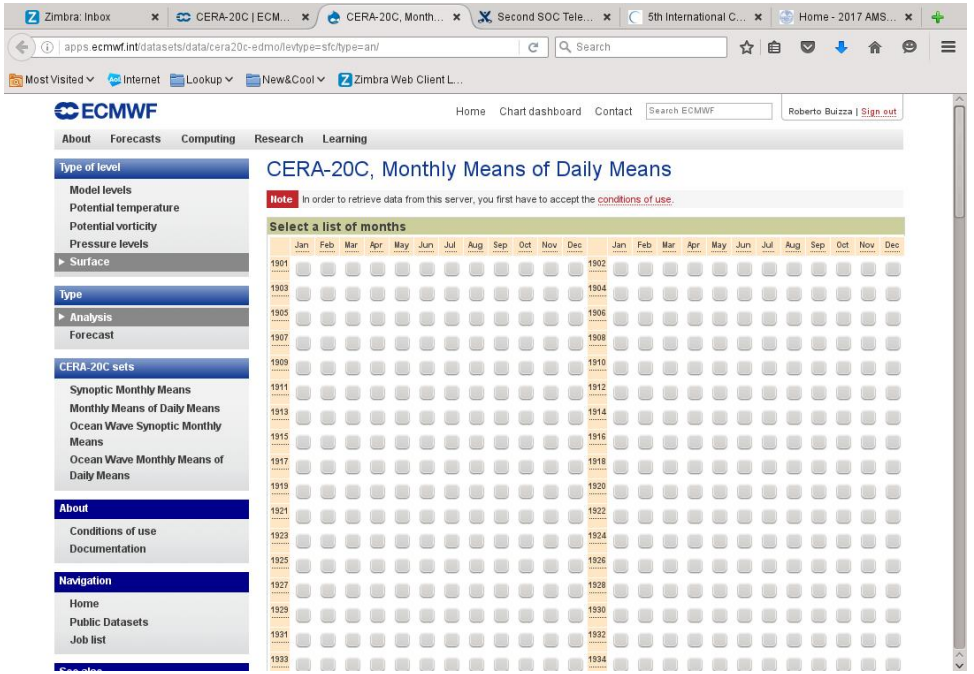
- Precipitation validation with DWD data has been progressing
- ERA-preSAT paper submitted
- Good progress in ‘coupled evaluation’ of oceanic and atmospheric reanalysis data
- Quality Control for newly digitised upper air, surface, snow data from Russia and other countries almost completed
- CHUAN v2.0 data merged with available data, feedback data for all time series calculated for various full and surface data only reanalyses
- Good progress in RS-T homogenization back to 1939, RS-H homogenization back to 1979





Key achievements of past 9 months: WP5

- Technical development in MARS to support archiving and retrieval of NetCDF format completed
- Consolidation of CERA-20C data into the user version has been progressing well:
  - Complete: Atmospheric and wave monthly means: 30 Tbytes. Available via the Public Data Server
  - In progress: Atmospheric and wave analysis (all members) and ensemble means and standard deviation: 200 Tbytes. Expected end Jan 2017
  - Followed by forecast (all members), observation feedback and ocean component: Over 1 Pbyte. Expected for month 42.



- We have extended the framework of the Public Data Server to report on registered users and access statistics, such as volume and fields retrieved. This has been done using other datasets, but the reporting will be available for the access to CERA-20C during 2017.

Project status: deliverables WP1

D1.1	CERA-20C	24	36	**Delivered.**
D1.2	CERA-20C/Carbon	36	48	Extension allows carbon reanalyses to use atmospheric forcings from ERA20C.
D1.3	CERA-SAT	36	48 (partially)	Extension allows to establish the CERA-SAT system, and run it for a a subperiod (number of years to be confirmed once system is up and running) between 1979 and 2016 depending of HPC resources and production speed
D1.4	CERA-SAT/Land	36	48 (partially)	Extension allows CERA-SAT/Land system to be implemented and run over a subperiod between 1979 and 2016 depending of HPC resources and production speed.
D1.5	Status report WP1	8	8	**Delivered**

Status:	Delivered	Delayed

Project status: deliverables WP2

D2.1	SST assimilation code (METO)	27	39	Extension allows more time for testing of developments
D2.2	Sea-ice assimilation code (MERCO)	27	39	Extension allows testing to be done in more recent version of system
D2.3	Ensemble B NEMOVAR code (CERFACS)	34	46	Extension allows higher quality deliverable
D2.4	Report on ensemble covariances in coupled DA (CMCC)	24	36	**Delivered**
D2.5	Report on 4D-Var tests (INRIA)	27	39	Extension allows higher quality deliverable
D2.6	Report on land carbon model optimisation (UVSQ)	34	46	Delay of the production of the climate reanalysis in WP1 puts some constraint on the C cycle reanalysis
D2.7	Report on ocean biogeochemical coupling methods (MERCO)	34	46	Extension allows higher quality deliverable
D2.8	Report on strengths/weaknesses of coupled DA (UREAD)	18	18	**Delivered**
D2.9	Report on coupled error covariances (METO)	18	18	**Delivered**
D2.10	Report on coupled model drift an bias correction (UREAD)	34	46	Extension makes it possible to deliver a high quality report
D2.11	Report on fully coupled DA (INRIA)	34	46	Extension allows higher quality deliverable
D2.12	Status report (METO)	8	8	**Delivered**

Status:	Delivered	Delayed

Project status: deliverables WP3

D3.1	Data catalogue (UBERN)	6	6	**delivered**
D3.2	Priorities for data rescue (UBERN)	6	6	**delivered**
D3.3	Meta-database update (UBERN)	36	48	continuous
D3.4	In-situ data for reanalysis (UBERN)	24	36	Spanish Ebro and North African upper air not in time
D3.5	In-situ data (other) (UBERN)	30	42	Chile data not in time
D3.6	Quality-controlled version of D3.4 (UBERN)	36	48	Shift in deadlines allows more data from French overseas, International days
D3.7	Quality-controlled version of D3.5 (UBERN)	33	48	Shift in deadlines allows more data from French overseas, International days
D3.8	RTTOV updates (METO)	36	36	**delivered**
D3.9	Early satellite data (METO)	36	36	To be submitted by end of January (METO);
D3.10	AVHRR polar winds (EUMST)	24	36	Expected in M48 - Delayed due to updates of operational EUMETSAT algorithm and delayed new compute environment at EUMETSAT; it will cause no other delays for the project;
D3.11	SSM/T2 and AMSU-B/MHS radiance data (EUMST)	24	24	Expected in M42 - EUMETSAT Climate Monitoring Satellite Application Facility (CM-SAF) did deliver an ATBD and a preliminary version of the data record but not the processor to EUMETSAT; furthermore, the early version of data had issues that resulted in the need to update the inter-satellite calibration method; it will cause no further delays to the project's deliverables;
D3.12	Geostationary radiance data (EUMST)	36	36	Expected in M42 - Recalibration of Meteosat IR channels is finished; what is still missing is the integration into the original image files, which is delayed due to the delayed delivery of the new compute environment at EUMETSAT; this will cause a delay in deliverable D3.13;
D3.13	AMV from MFG (EUMST)	36	42	Expected in M48 - This will be delayed due to dependence on D3.12; this will not cause any delay to other project's deliverables;
D3.14	Radio occultation data (EUMST)	36	36	Expected in M48 - Delayed due to error found in GRAS reprocessed data; a second processing of the GRAS mission data has been performed but other mission data are pending the processing.
D3.15	HadISST2 update (METO)	18	18	**delivered**
D3.16	Ice thickness data (METO)	12	12	**delivered**
D3.17	Ocean database update (METO)	24	30	**delivered**
D3.18	Snow data product (FMI)	24	36	Expected in M42 - FMI investigation on the optimum set of calculation parameters of SWE assimilation system is still going on (a detailed investigation needed in order to obtain an improved product when compared with the original GlobSnow SWE Climate Data Record).
D3.19	Quality controlled version of snow data base (in situ) (FMI)	36	48	Extension allows higher quality deliverable
D3.20	HadISD update (METO)	12	12	**delivered**

Status: **Delivered** **Delayed**

Project status: deliverables WP4

D4.1	RS bias adjustments (UNIVIE)	12	20	**delivered**
D4.2	Updated RS bias adjustments (UNIVIE)	36	48	ERA5 and a ERA-preSAT rerun are expected to be much better reference than previous reanalyses but are not available in month 36. Value of deliverable would be significantly degraded
D4.3	QC for obs from FFCUL (FFCUL)	36	48	FFCUL had difficulties in personnel recruitment and works hard on digitization of Chilean and other data. This has priority for now. QC aspect would improve a lot if 12 months more are available
D4.4	Visualization tool for QC (FFCUL)	12	12	**delivered**
D4.5	QC for upper-air, surface, and snow obs. (RIHMI)	36	36	To be delivered by end of Jan
D4.6	Methodology for quantifying obs error (UBERN)	36	36	**delivered**
D4.7	Verification of precipitation against GPCC (DWD)	36	48	Data set will be ready but validation of ERA5, CERA-20C would not be possible
D4.8	Global energy, water, carbon cycles (ECMWF,UNIVIE, UVSQ)	36	48	Evaluations without ERA5, CERA-20C would be much less innovative
D4.9	Upper air data qc (UBERN, RIHMI)	24	24	**delivered**
D4.10	Comparison with other reanalyses (UNIVIE; ECMWF)	36	48	Comparisons without ERA5, CERA-20C would be much less innovative
D4.11	Low frequency variability and trends (ALL)	36	48	Without completed ERA5, CERA-20C many evaluations would have to be based on data not created in ERA-CLIM2
D4.12	Uncertainty of input parameters for carbon budget (UVSQ)	12	20	**delivered**
D4.13	Confidence intervals on carbon fluxes (UVSQ)	36	48	Those would have to be based on existing ERA-20C, not new CERA-20C
D4.14	Comparison of CTESSEL, ORCHIDEE flux estimates (ECMWF, UVSQ, UNIVIE)	36	48	This could be done partly with unfinished CERA-20C but much value would be added if complete CERA-20C set were available

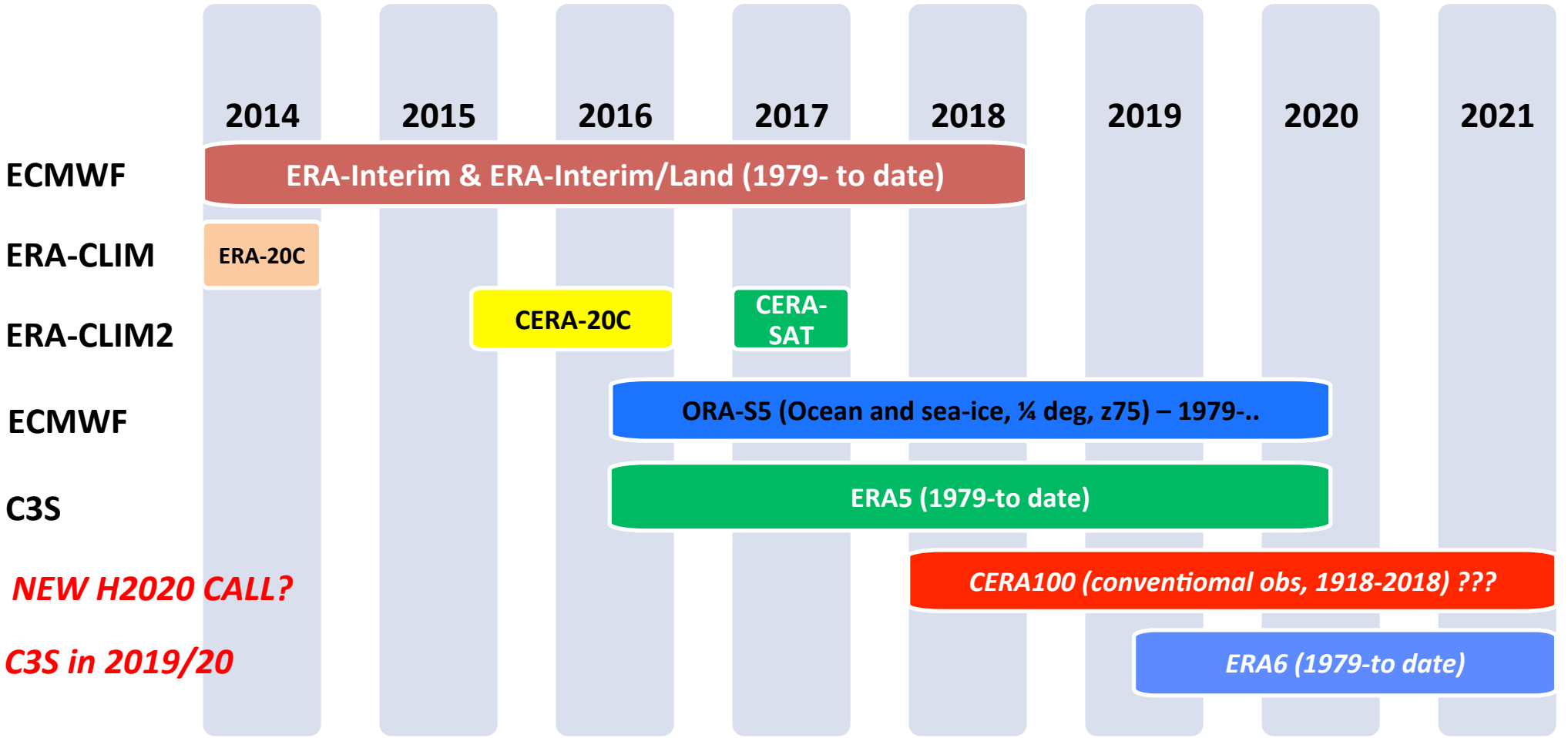
Status: **Delivered** **Delayed**

Project status: deliverables WP5-WP6-WP9

D5.1	NetCDF in MARS	12	30	Design, specifications and technical work completed.
D5.2	CERA data services	24	48	Consolidation of data into user version in progress. Monthly means released. Expected completion for month 48, as in revised plan and discussed during the M27 Review Meeting.
D5.3	Report on data services	24	48	Technical work complete based on ERA-20C. D5.3 will report on data services for year 2017. xpected completion for month 48, as in revised plan and discussed during the M27 Review Meeting.
D6.1	Project web site	10	10	**delivered**
D6.2	Project brief 1	12	12	**delivered**
D6.3	Workshop report 1	19	19	**delivered**
D6.4	Project brochure	22	36	Expected in M39
D6.5	Policy brief 2	24	36	To be delivered by end of Jan
D6.6	Workshop report 2	31	31	
D6.7	Policy brief 3	36	48	
D6.8	Dissemination plan	4	4	**delivered**
D6.9	Policy brief 4	n/a	48	
D9.1	Coordination plan	36	48	
D9.2	Common web page	6	6	**delivered**
D9.3	Common lessons learned	24	24	**delivered**
D9.4	Meeting minutes	36	48	

Status:	Delivered	Delayed

ECMWF, FP7 and C3S reanalyses production



Forthcoming ERA-CLIM2 meetings

ERA-CLIM2 WSs and GAs:

- 16-18 Jan 2017: ERA-CLIM2 3rd General Assembly (Univ. of Vienna)
- 19 Jan 2017: ERA-CLIM2 M36 Review Meeting (Univ. of Vienna)
- 12-14 Dec 2017 - ERA-CLIM2 4th General Assembly (Univ. of Bern; Switzerland)
- 15 Dec 2017 (am) - M48 Review Meeting (Univ. of Bern; Switzerland)

Related WSs/Seminars/Conferences:

- 97th AMS Annual Meeting (22-26 Jan 2017; Seattle, US)
- EGU Meeting (23-28 Apr 2017; Vienna, Austria)
- ECMWF Annual Seminar on 'Ensemble prediction: past, present and future' (Reading, UK)
- 5th International Conference on Reanalysis (ICR5; 13-19 Nov 2017; Rome, Italy)

M27 Review Meeting Recommendations

R1. Further articulate technically and thematically the relationship between ERA- CLIM2 capability & products and those of C3S – to optimize the current and future impact of R&D into operational services

- The ERA-CLIM2 Team is actively working with the C3S Team at a range of levels (knowledge and expertise exchanges; technical level; outreach).
- Data rescued/re-processed within ERA-CLIM and ERA-CLIM2 are used in the production of ERA5 (the new C3S reanalysis that will replace ERA-Interim) and/or will be used in ERA6
- CERA-SAT and ERA5 will be compared for the overlapping period (2008-2016), and will provide valuable indications for the next C3S reanalysis
- WARNING: there is a need for further H2020-funded R&D to prepare the next C3S re-analysis (data-rescue, data-processing, DA-methodologies, ..)

M27 Review Meeting Recommendations

R2. Consolidate the establishment of a continuous cycle for the production of reanalyses, emphasizing to the external world that R&D reanalysis (ERA-CLIM2) and operational reanalyses (C3S) are the two faces of the same coin, and that R&D is a fundamental prerequisite to operations

- Production consolidation *in-fieri (see eg earlier slide 14)*
- **H2020 R&D funding are needed to continue to progress in reanalysis production: without a continuous R&D activity, future operational (C3S) reanalyses will not continue to improve, neither in quality nor in scope**
- ERA5 and CERA-20C are hosted in the MARS system. The Public Datasets interface to the archive shows currently both entries, see: http://apps.ecmwf.int/datasets/ However! The interface for selection of fields will be different. For CERA-20C we will follow the same as previous re-analysis (ERA-Interim, etc...). For ERA5 the idea is to make it available via the Copernicus Climate Data Store (CDS). Once the CDS is available, we will remove the ERA5 entry from the Public Datasets interface.

M27 Review Meeting Recommendations

R3. Take relevant measures (e.g. involve external relations experts) to optimize communication about the nature of ERA2 products and their limitations and inherent uncertainties (for instance in the tropics). Develop text, diagrams, web interfaces as appropriate. Make sure there is guidance for users regarding which product should be used for which application.

- Work has been progressing well towards achieving these objectives, as documented by the GA3 presentations
- Now that CERA-20C start being available, publications are being planned to document the quality of CERA-20C (results presented at GA3 suggests that is superior to the other climate reanalyses (ERA-20C and NOAA-20CR)
- New diagnostics and validation tools are being developed
- A 'User Support' activity is being established at ECMWF to help access and data-retrival (synergies with C3S)

M27 Review Meeting Recommendations

R4. Reinforce essential international cooperation to take maximum stock of long-range reanalyses performed by other regions/countries in the past decade (regarding observation-rescue as well as coupled-assimilation-systems' development)

- Work to achieve this has been progressing
- ERA-CLIM2 funded reanalyses (CERA-20C and the forthcoming CERA-SAT) are being advertised at Conferences (e.g. European Geophysical Union General Meeting 2016 and 2017; European Meteorological Society Annual Meeting 2016; American Meteorological Society Annual Meeting 2016 and 2017; ..)
- Publications are being published and prepared both for peer-reviewed journals and for openly-available publications (eg ECMWF Newsletter, University Internal Reports, ..)
- International cooperation in communication/outreach activities:
  - ERA-CLIM2 co-sponsored the Int. Conf on Coupled DA
  - ERA-CLIM2 Coordinator has been asked to co-chair the Scientific Organizing Committee of the 5th International Conference in Reanalysis (Rome, Nov 2017; ICR4 was held at NOAA in 2012)

M27 Review Meeting Recommendations

R5. Sustain efforts (indirectly through international networks or directly through support to selected groups or individuals) to rescue data that is at risk of being lost. Identify which are the high risk observations on which to focus.

- ERA-CLIM2 has been involved in this work, but more has to be done
- **H2020 R&D funding are needed to continue both data-rescue activity and data re-processing activities: new data are continuously found, new problems (eg break points) in data series that are continuously discovered need to be addressed; new methods are being tested and could be used in the future: without a continuous activity, future reanalyses will not continue to improve (in quality and scope)**

M27 Review Meeting Recommendations

R6. Consider adding dynamically-meaningful variables (such as Potential Vorticity on relevant isentropic surfaces) to the list of metrics currently used to evaluate reanalysis products; Interact with research experts as appropriate.

- This type of variables have been added (PV and PT levels archived and available)