



Climate Change

Copernicus Regional Reanalysis for Europe

2nd Baltic Earth conference, Helsingør, 15/06/2018
Semjon Schimanke, Per Undén, Martin Ridal,
Ludvig Isaksson and Lisette Edvinsson





Climate
Change

What's the service about?

- Operational production of a regional reanalysis (RRA) for Europe in near real-time
- Long series of freely available RRA
 - Starting 1961 with a horizontal resolution of 11km
- User support and guidance

SMHI

ECMWF

Copernicus
Europe's eyes on Earth

 European
Commission



Climate
Change

Overview

1. Introduction/Background
2. The RRA system and available data
3. Data quality and homogeneity
4. Summary



Climate
Change



1. Introduction/Background



Climate
Change

The pre-operational FP7 project



- UERRA: Uncertainties in Ensembles of Regional ReAnalysis
www.uerra.eu
- 12 European partners
- Three different RRA plus ensembles

SMHI

ECMWF

Copernicus
Europe's eyes on Earth

 European
Commission

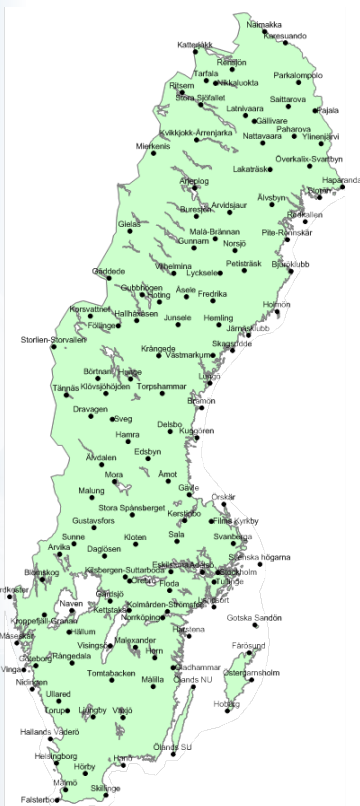


Climate
Change

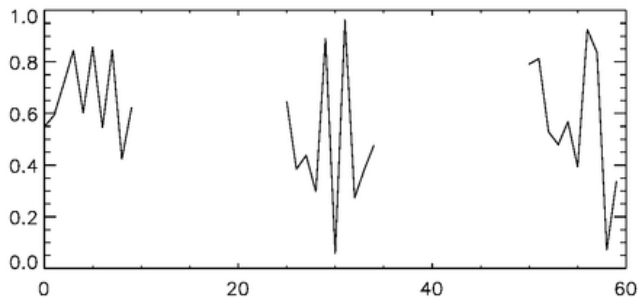
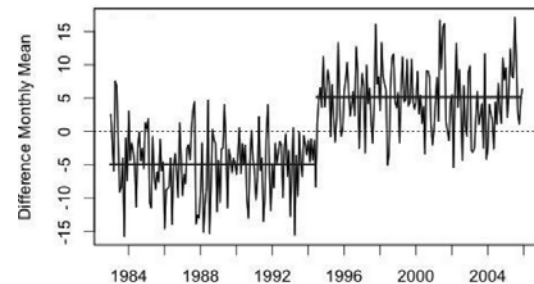
Why reanalysis?

Drawbacks of observations

- Gaps in space
- Breaks in time
- Inhomogeneous



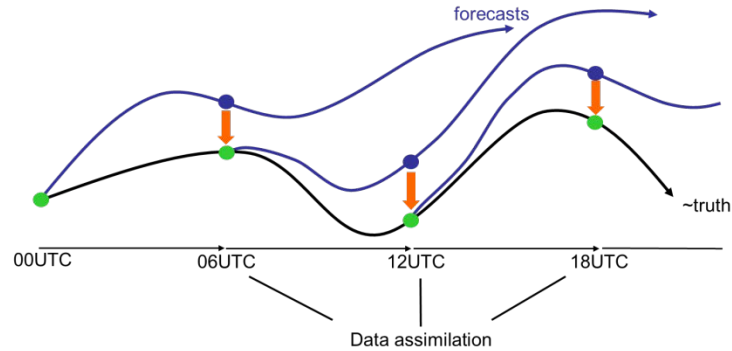
Swedens stations
network



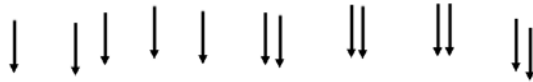


Climate
Change

The basics of reanalyses



Observations as complete as possible or improving



NWP model and analysis system remain fixed

Reanalysis quality remains the same or improving

1961

2018

- Usage of as many observations as possible including quality control
 - Usage of a fixed system for the entire period
- ➔ That's called a reanalysis.

Advantages:

- No gaps in room or time
- Complete parameter set
- Homogeneous in time

SMHI

ECMWF

Copernicus
Europe's eyes on Earth

European
Commission



Climate
Change

2. The RRA systems and available data

SMHI

ECMWF

Copernicus
Europe's eyes on Earth

 European
Commission



Climate
Change

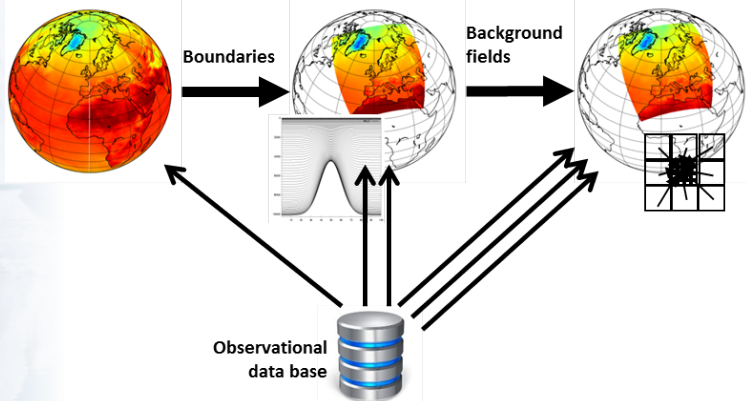
The system

Global Reanalysis → Regional Reanalysis → Surface Reanalysis

ERA40/ERA-Interim

UERRA-HARMONIE

MESCAN-SURFEX



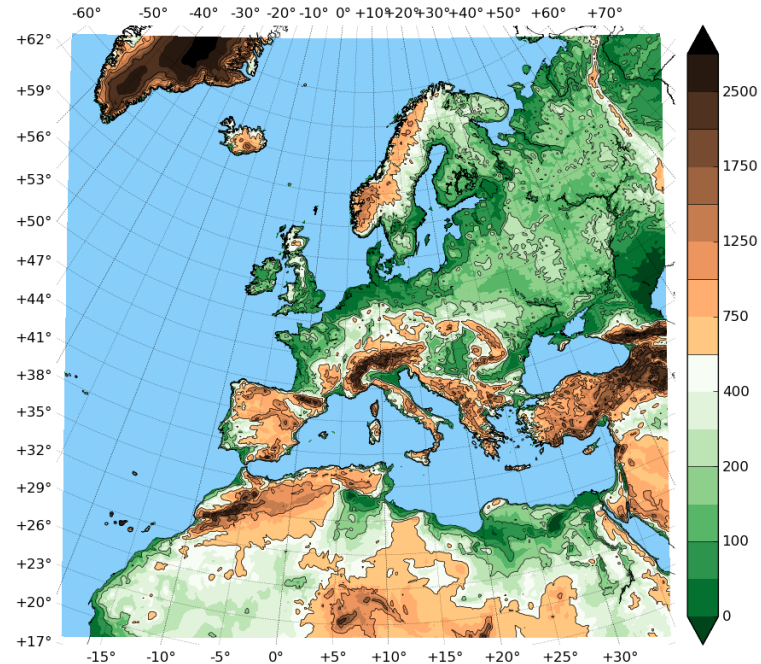
- UERRA system
 - HARMONIE cycle 38h1, ALADIN physics
 - ERA40/ERA-interim as lateral boundary
 - Assimilation of conventional observations
 - 3D-VAR data assimilation
 - 4 cycles per day, forecast lengths 6h and 30h
 - 11km resolution (565x565) and 65 vertical levels
- MESCAN-SURFEX
 - Optimal interpolation (OI)
 - 5.5km resolution



Climate
Change

Available data

- 11km horizontal resolution including entire Europe
- Period 1961-Feb. 2018 with monthly updates
- Hourly resolution (4 analysis per day and hourly resolution from the forecast model)
- 31 surface parameters, 9 parameters on pressure levels, 7 parameters on height levels, 4 parameters on model levels 2 parameters on soil levels
- Additional output from MESCAN-SURFEX (surface and soil)



Model domain illustrated with model topography and land-sea mask



Climate
Change

Data access

<http://apps.ecmwf.int/>

The screenshot shows the ECMWF MARS Catalogue interface. At the top, there is a navigation bar with links for Home, Chart dashboard, Contact, and a search box. The user is identified as Semjon Schimanke. Below this is a secondary navigation bar with categories like About, Forecasts, Computing, Research, and Learning. A left sidebar contains a 'Navigation' menu with links to Home, MARS Catalogue, MARS Activity, and Job list, and a 'See also...' section with links to FAQ, Accessing forecasts, and GRIB decoder. The main content area is titled 'MARS Catalogue' and shows the year '1961'. It includes a 'Choose the month:' section with a list of months from January to December, each with a right-pointing arrow. Below this is a 'Current selection:' section with various filters: 'year' (a long list of years from 1961 to 2015), 'type' (an, fc), 'stream' (enda, oper), 'origin' (edzw, egr, eswi), 'expver' (prod, test), and 'class' (a long list of codes like at, be, ch, co, cs, de, dk, dm, dt, e2, e4, ea, ei, el, em, en, ep, er, es, et, fr, ie, it, la, mc, me, ms, nl, no, nr, od, pt, pv, rd, rm, s2, se, te, ti, to, tr, uk, ur, yp, yt).

▲ Top of page

copyright © ECMWF

- All UERRA data is already freely available! (1961- Feb. 2018)
- All you need is to register!
- UERRA data 480 TB





Climate
Change



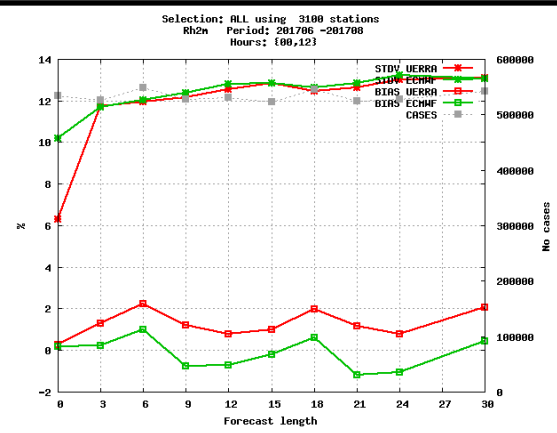
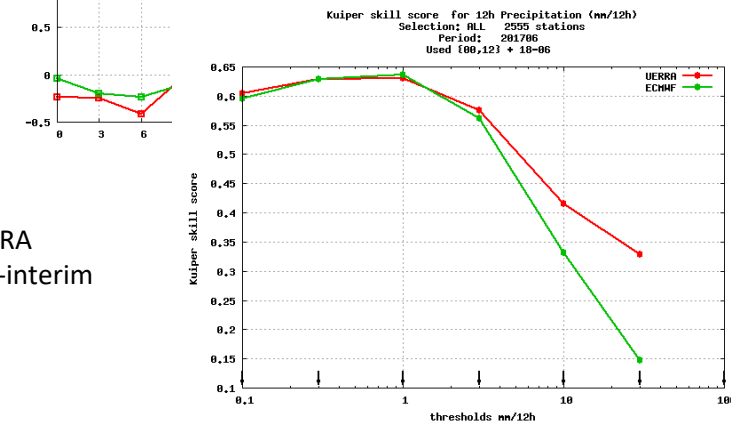
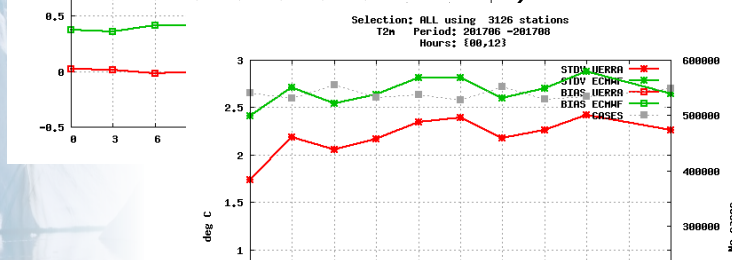
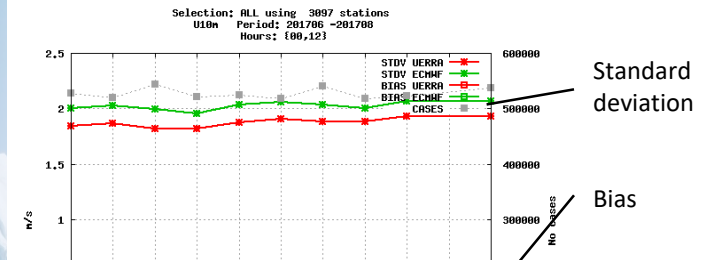
3. Data quality and homogeneity



Climate Change

Verification

- Verification tools are part of the quality control during the production
- Smaller bias and std than ERA-interim, e.g. T2m, wind speed, precipitation
- Some parameters not better than ERA-interim, e.g. RH2m



— UERRA
— ERA-interim





Climate
Change

Quality of wind speed

	ERA-interim	Downscaling with RCA	EURO4M	UERRA
RMSE	2.36	2.36	1.88	1.80
Correlation	0.79	0.75	0.83	0.85

Quality of wind speed at Swedish coastal stations based on 6 hourly data for a 10year period (1996-2005)

	Horizontal resolution	Resolution in time
ERA-interim	80 km	3 hourly
Dynamical downscaled with RCA	11 km	hourly
EURO4M	22 km	3 hourly
UERRA	11 km	hourly



Climate
Change

Homogeneity

Number of observations



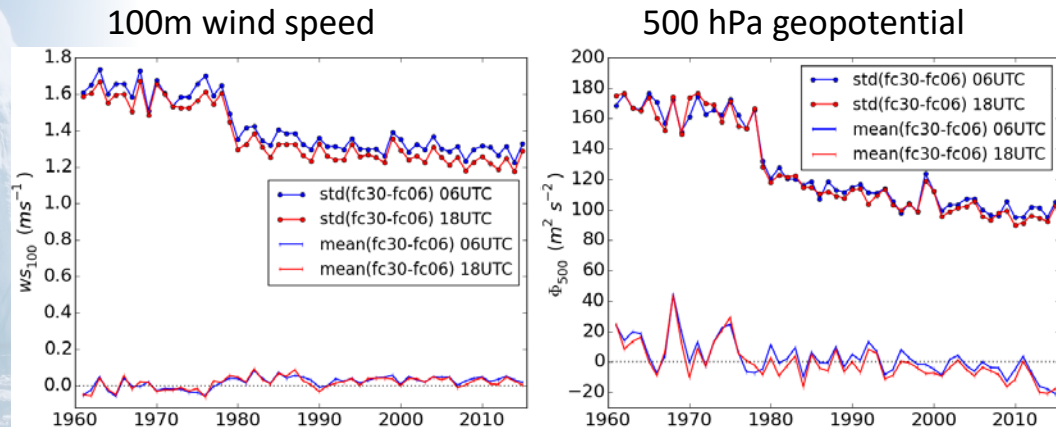
Risks for inhomogeneity

- Switch of lateral boundary data
 - 1961-1978 ERA40
 - 1979- ERA-interim
- Increasing numbers of observations in time, especially aircraft data



Climate
Change

Homogeneity



Yearly averages of the standard deviation and mean of the forecast difference fc30-fc06 during winter (DJF). Left: 100m wind speed. Right: 500 hPa geopotential. Curtesy Adam von Kraemer.

Investigations of the forecast skill (differences between fc30 and fc6):

- Forecast skill effects accuracy of the first guess and has herewith consequences on the data quality
- Increase of quality with the switch to ERA-interim and increasing numbers of observations (upper air)
- Less pronounced for surface parameters ([T2m](#))



Climate Change

User support

UERRA data user guide

Issued by: SMHI / S. Schimanke
Date: 31/05/2018
Ref: C3S_322_Lot1.4.1.2_UERRA_data_user_guide
Official reference number service contract: 2017/C

Copernicus Climate Change Service regional reanalysis for Europe

NEWS

- 22 May 2018 Air returns in Spain and Portugal
- 21 May 2018 Storms in western Spain since 18th
- 21 May 2018 Continuous contribution to healthier city living through UERRA reanalysis
- 18 May 2018 Copernicus to launch operational service for energy sector
- 11 May 2018 Member States to use Copernicus climate data

EVENTS

- 18 Jun 2018 COP24 (COP24) Industry ministers' meeting in Katowice
- 09 Jun 2018 Workshop: Climate data with Copernicus data
- 22 Mar 2018 Call for the study 2018

Global Reanalysis → Regional Reanalysis → Surface Reanalysis

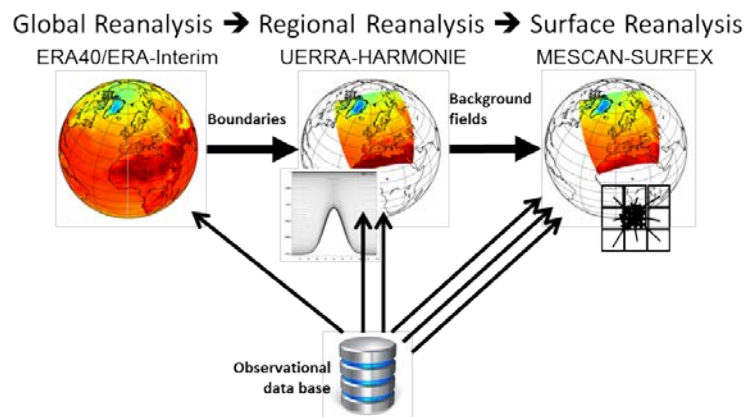
Figure 1: Three official stages of reanalysis: left) the Global Reanalysis ERA5 with the default boundary condition, middle) a 3D Regional Reanalysis, and right) a 2D Reanalysis for the near surface. The amount of observational data used for the regional and surface reanalysis increases from the global to the surface reanalysis as indicated by the arrows.

- User guide
- Homepage <https://climate.copernicus.eu/copernicus-climate-change-service-regional-reanalysis-europe>
- Git server with example scripts https://git.smhi.se/C3S_322_Lot1/C3S_322_Lot1_user_examples



Summary

- The service offers:
 - Based on the RRA from the FP7 UERRA project, hourly data at 11km resolution from 1961 to near real time for Europe
 - A comprehensive set of output parameters for the surface, the upper air, and the soil
 - User guidance and support
- Data quality improves compared to global products
- Some inhomogeneity due to the change from ERA40 to ERA-interim





Climate
Change

Time line of service and system details

2017

2018

2019

2020

2021

UERRA system in near real time
(11km resolution)

Development of the new system

New system in operational mode
(5.5km resolution)

EDA system (10 members at 11km
resolution)

- 11 km (565x565 grid points), 65 levels
- Surface downscaling analysis 5.5 km (MESCAN)
- Start in 1961 and operational from 2/2018

- 5.5 km (1100x1050 grid points), 100 levels
- Surface analysis at 5.5 km – no downscale
- Plus 10 ensemble members at 11km
- Will start in the early 1980s



Climate
Change

UERRA system

- HARMONIE cycle 38h1 (ALADIN physics)
- ERA40 and ERA-interim as LBC
- 4 cycles per day
- No satellite data

New system

- HARMONIE cycle 40.1h/42 (ALADIN physics)
- New soil model and analysis
- ERA5 as LBC
- 8 cycles per day
- Satellite radiances, e.g. IASI, SEVERI, MSU, AMSU
- Usage of ERA5 ODB files, e.g. blacklisting information
- More obs-data, e.g. GBGNSS



Climate
Change



2. Operational production



Climate
Change

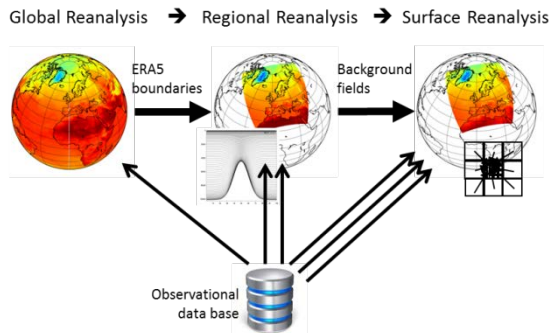
Challenges for operational production

- More automatization, e.g.
 - Checks of input data (LBC and observations)
 - Checks of output data (number of files, quality controls, etc.)
 - Automatic job submission
 - Notifications via mail in case of abnormality
- Continual quality control
 - Monthly quality checks, e.g. visual check of verification scores, observation usage, bias corrections, etc.
 - Team of 3-4 people will be involved in checks and production



UERRA system

- 11 km (565x565 grid points)
- 65 levels (10hPa)
- Surface downscaling analysis 5.5 km (MESCAN)



New system

- 5.5 km (~1100x1050 grid points)
- ~100 levels (1hPa)
- Surface analysis at 5.5 km as part of the system
- Plus 10 ensemble members at 11km and coupling to data assimilation



Climate
Change

Model systems: differences

UERRA system	New system
HARMONIE cycle 38h1 (ALADIN physics)	HARMONIE cycle 40.1h/42 (ALADIN physics)
SURFEX 7.3	SURFEX 7.3 with updates or SURFEX 8.0
ERA40 and ERA-interim as LBC	ERA5 as LBC
4 cycles per day	8 cycles per day
No satellite data	Satellite radiances, e.g. IASI, SEVERI, MSU, AMSU
---	Usage of ERA5 ODB files, e.g. blacklisting information
---	More obs-data, e.g. GBGNSS



Climate
Change

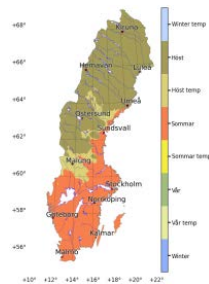
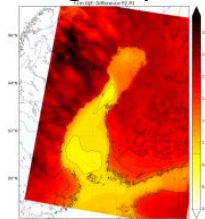


4. User guidance and support



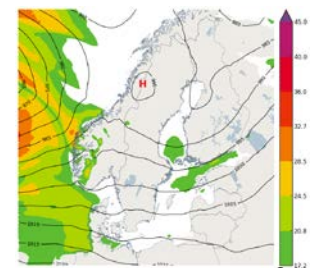
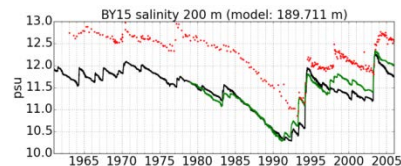
- Technical support will be available through CDS
- Training material as well as a collection of best practice examples
- There are plenty of possible usage ideas. However, we are looking for user!
- Two user workshops (first November 2018)

Regional climate
change reports



Climate related
products, e.g. season
maps

Forcing data for
models, e.g. regional
ocean models



Investigations of
historical storms



Climate
Change

Homogeneity

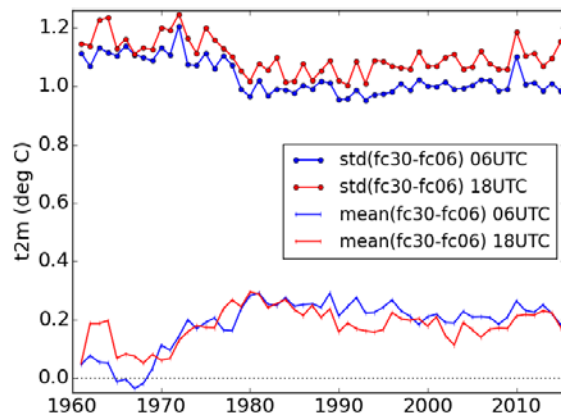
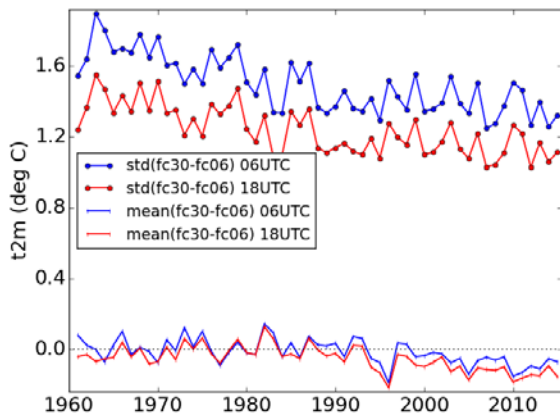
Adam von Kraemer: Temporal consistency of the UERRA Regional Reanalysis: Investigating the Forecast Skill

- T2m, wind speed at 100 meters, 500 hPa geopotential
- Land points only
- Comparison ERA40 vs. ERA-int
- Influence from observing system after 1979
- Difference between fc30 and fc6 (forecast skill)
- Forecast skill effects accuracy of the first guess and has herewith consequences on the data quality
- The data has lower quality in the beginning
- Largest change of forecast skill in 1979



Climate
Change

Forecast skill T2m

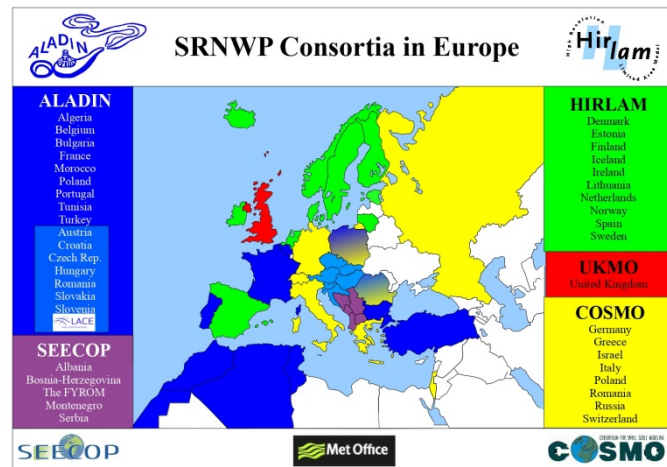




Climate
Change

Model systems: common base

- HARMONIE-ALADIN system
- 3D-VAR data assimilation
- Large scale constraint (J_k)
- Incremental digital filter initialization





Climate
Change

Time line of service and system details

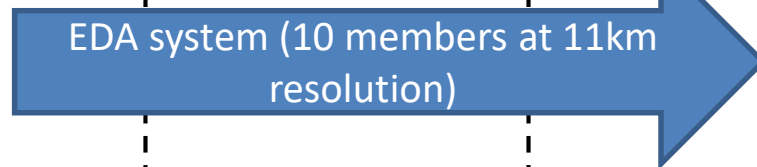
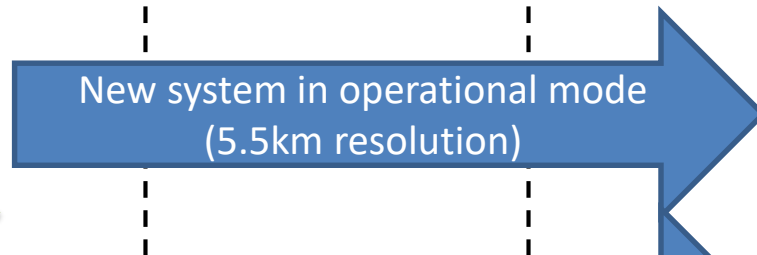
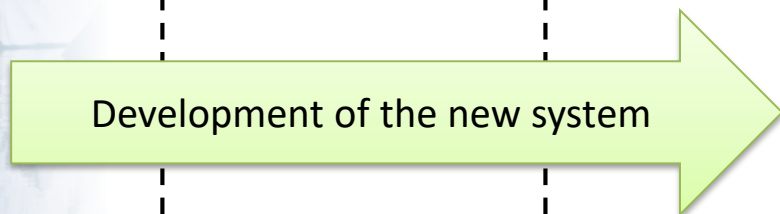
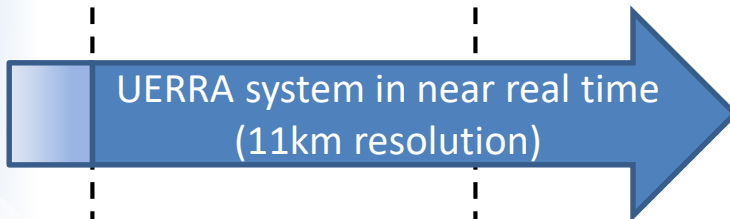
2017

2018

2019

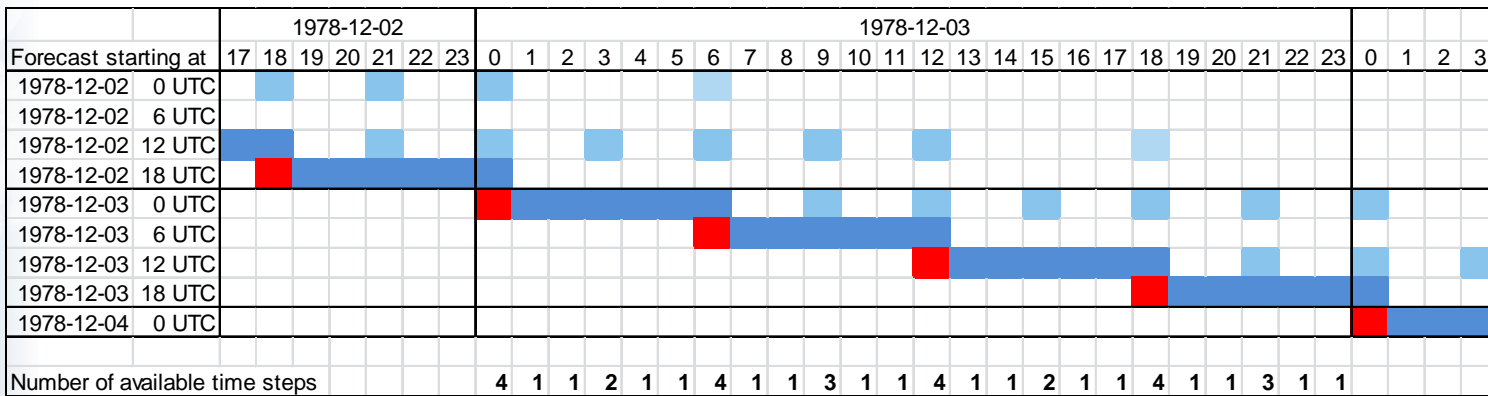
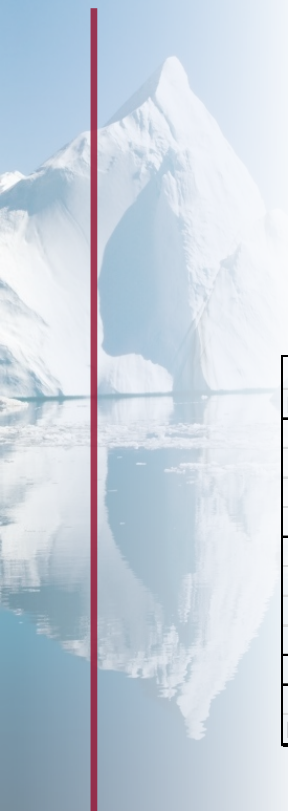
2020

2021





Climate
Change





Climate
Change

What's the service about?

- Operational production of a regional reanalysis (RRA) for Europe in near real-time
- Long series of freely available RRA
 - Starting 1961 with a horizontal resolution of 11km
 - Starting in the early 1980s with a resolution of 5.5km (under development)
- User support and guidance

SMHI

ECMWF

Copernicus
Europe's eyes on Earth

 European
Commission



Climate
Change

Time line of service and system details

2017

2018

2019

2020

2021

UERRA system in near real time
(11km resolution)

Development of the new system

New system in operational mode
(5.5km resolution)

EDA system (10 members at 11km
resolution)

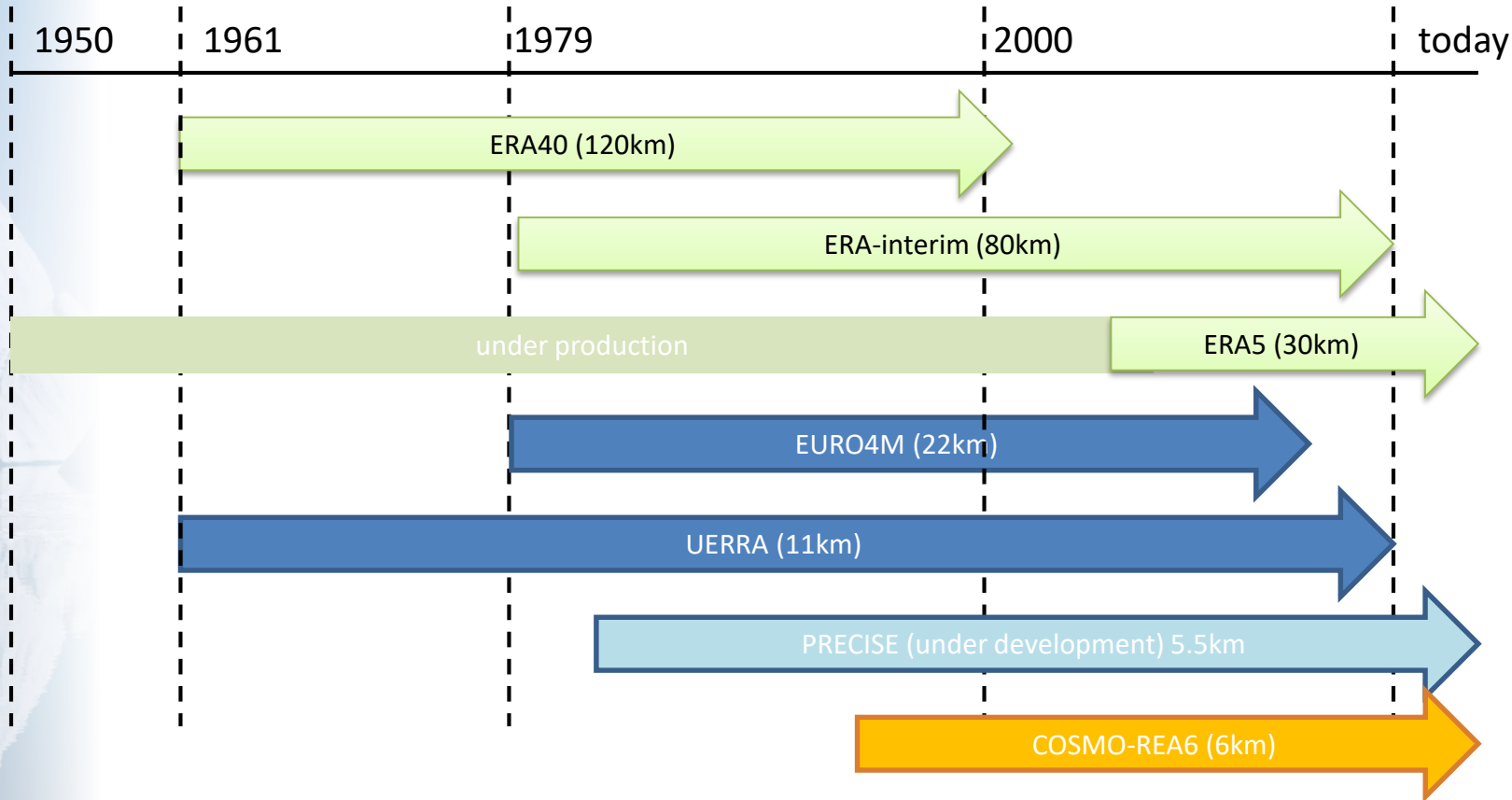
- 11 km (565x565 grid points), 65 levels
- Surface downscaling analysis 5.5 km (MESCAN)
- Start in 1961 and operational from 2/2018

- 5.5 km (1100x1050 grid points), 100 levels
- Surface analysis at 5.5 km – no downscale
- Plus 10 ensemble members at 11km
- Will start in the early 1980s



Climate
Change

Selection of reanalyses



SMHI

ECMWF

Copernicus
Europe's eyes on Earth

European
Commission