Climate Change

Copernicus Regional Reanalysis for Europe

2nd Baltic Earth conference, Helsingør, 15/06/2018

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European Commission

ECMWF

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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

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Overview

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

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1. Introduction/Background

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The pre-operational FP7 project

UERRA
Uncertainties in Ensembles of Regional ReAnalyses

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

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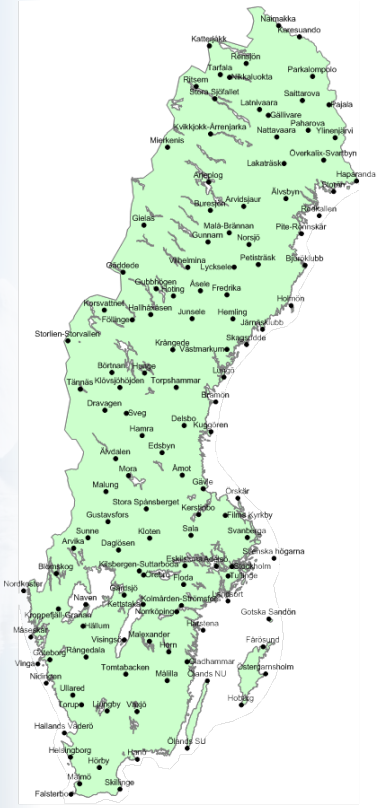
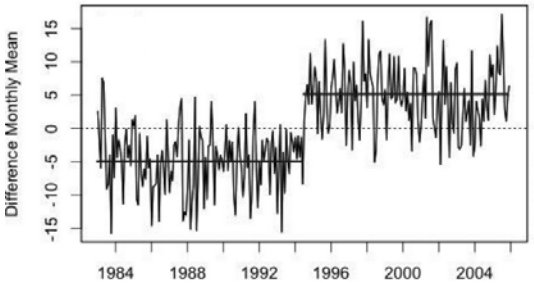
Why reanalysis?

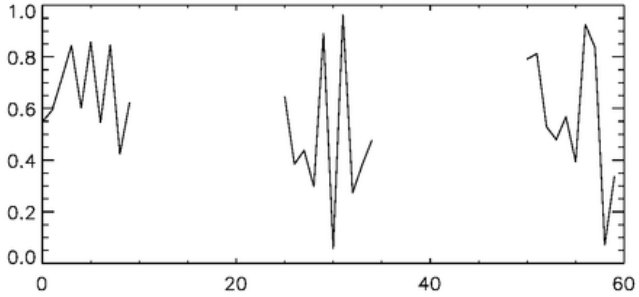


Swedens stations network

Drawbacks of observations

- Gaps in space
- Breaks in time
- Inhomogeneous





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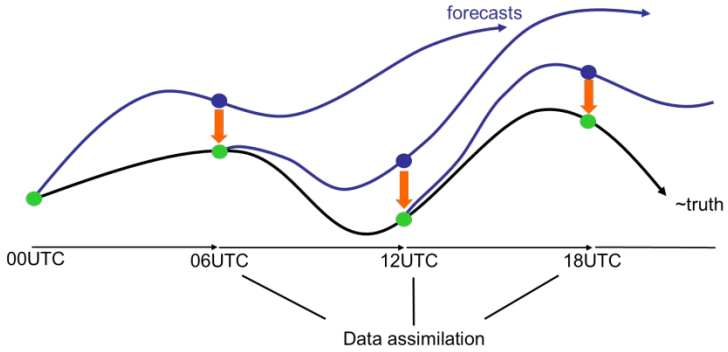
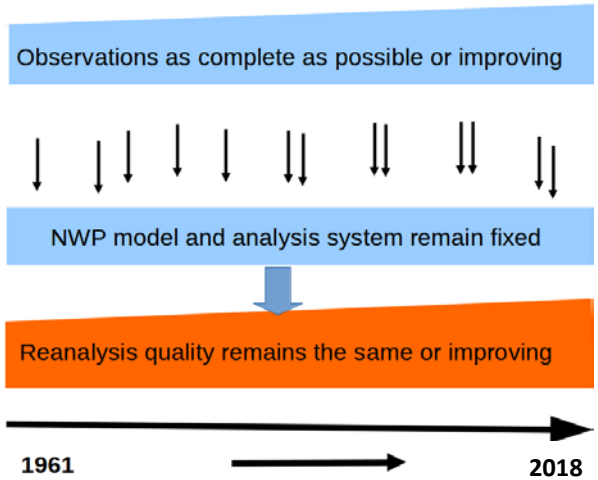
The basics of reanalyses





- 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

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2. The RRA systems and available data

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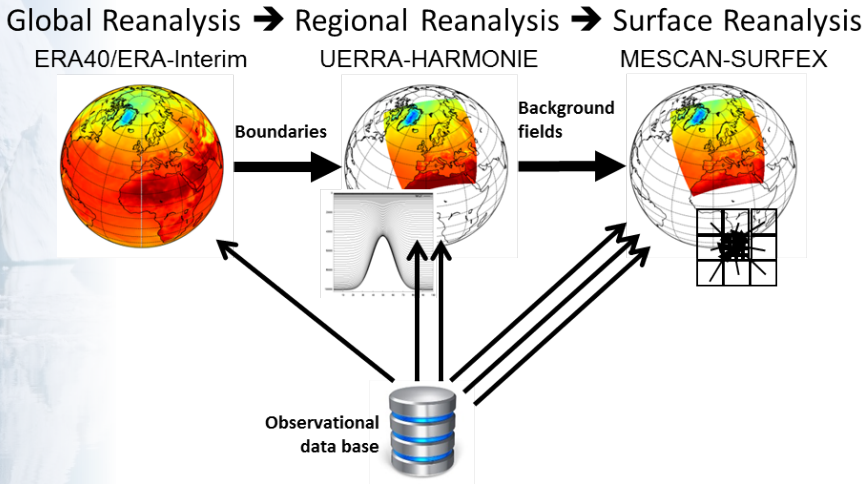
The system



- 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

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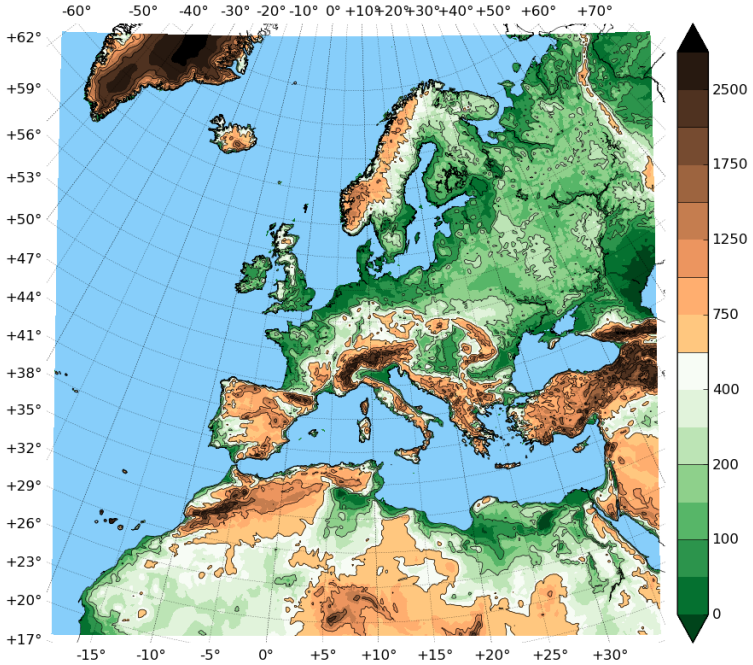
Available data

- 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

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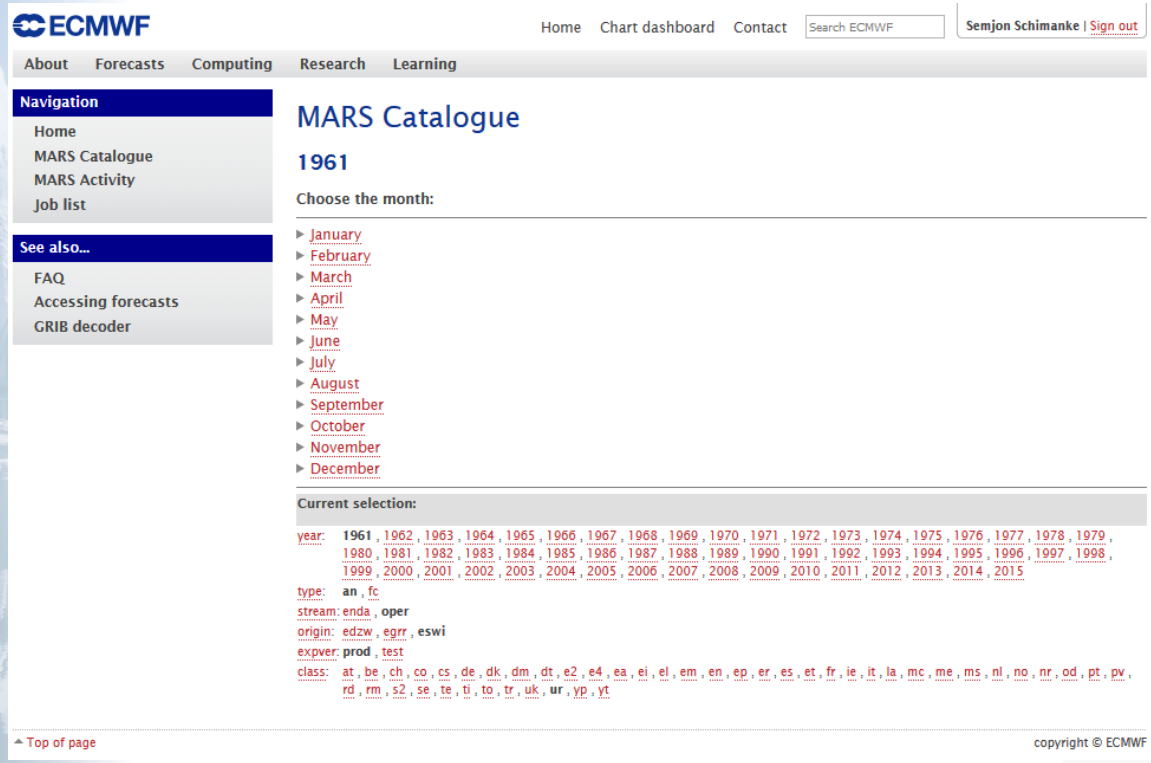
Data access

http://apps.ecmwf.int/



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

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3. Data quality and homogenity

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Verification

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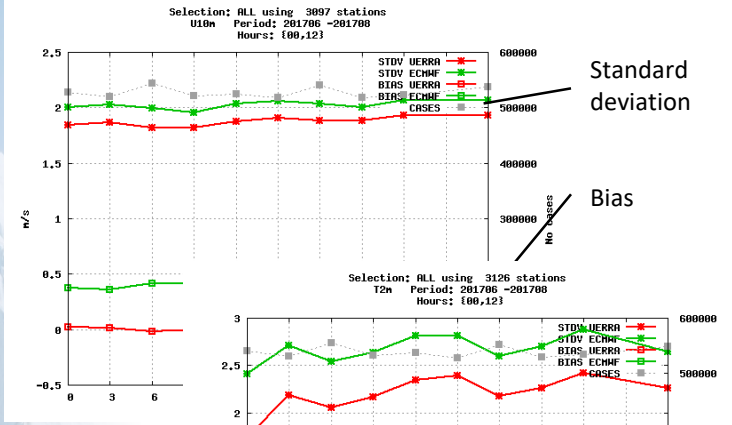
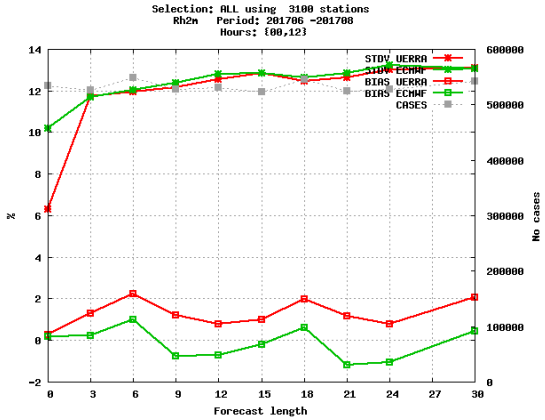


Standard deviation

Bias

- 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

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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

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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

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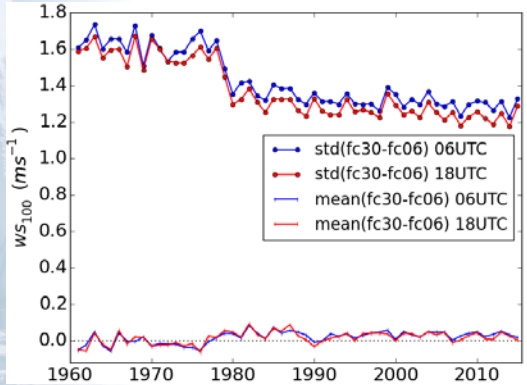
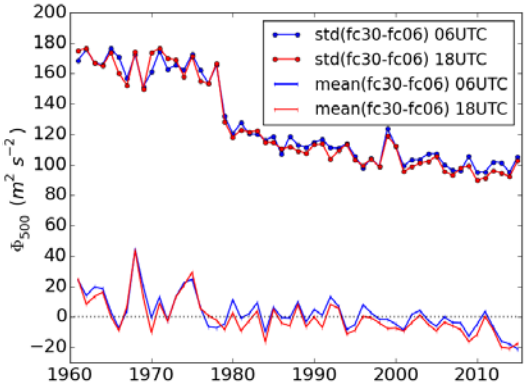
Homogeneity

100m wind speed



500 hPa geopotential



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)

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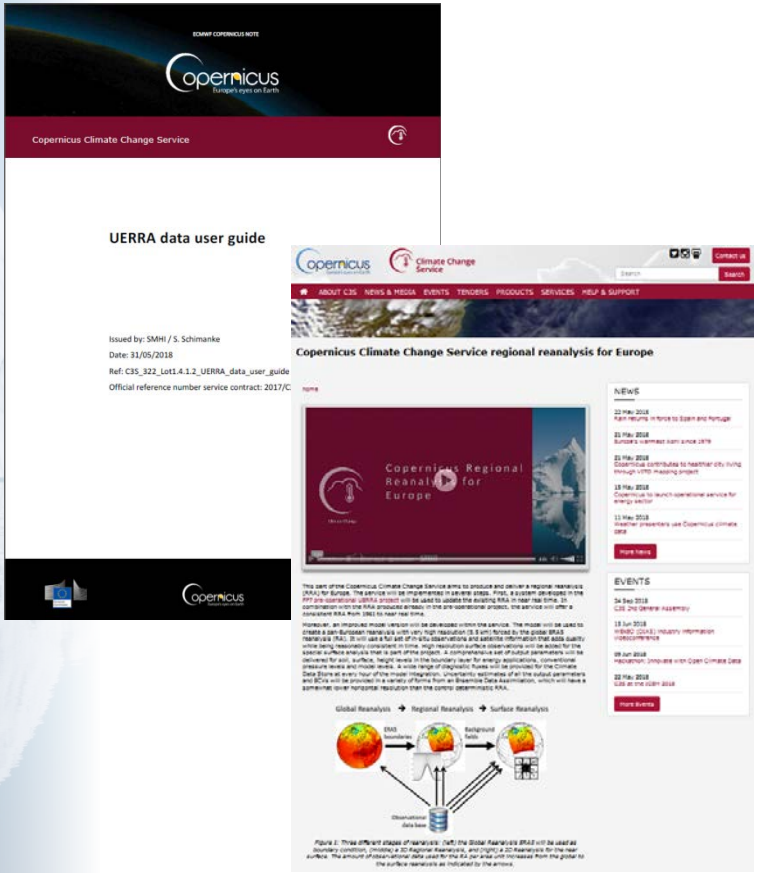
User support



- 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

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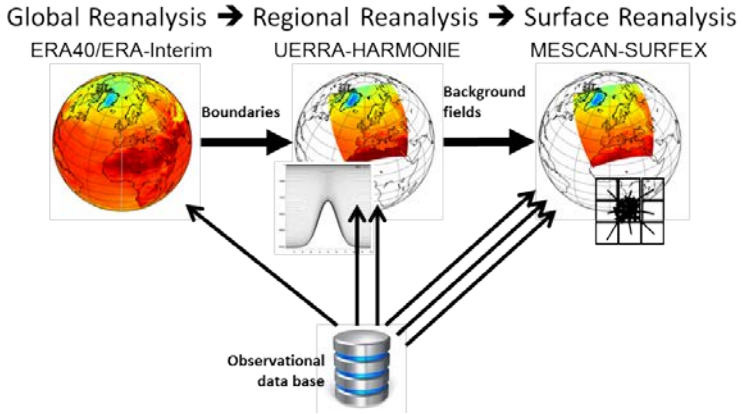
Summary

- 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



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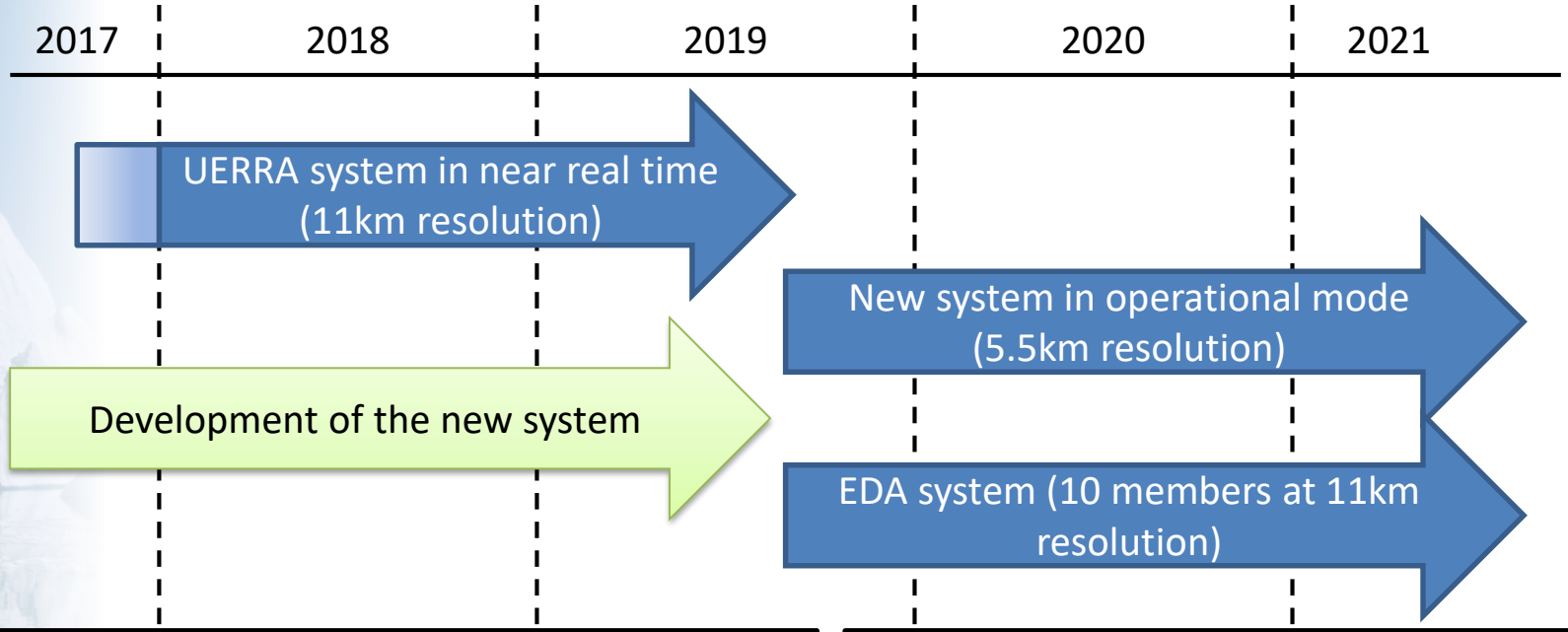
Time line of service and system details



- 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

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Model systems

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

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2. Operational production

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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

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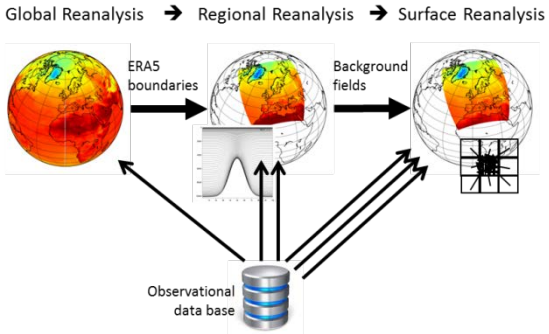
Model systems: differences

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

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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

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4. User guidance and support

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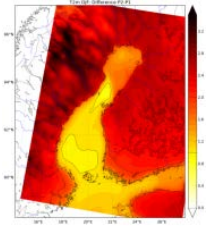
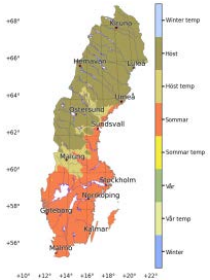
User support and guidance

- 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)

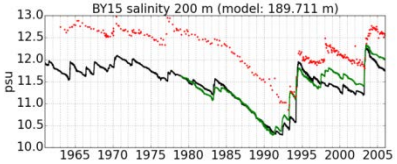
Regional climate change reports

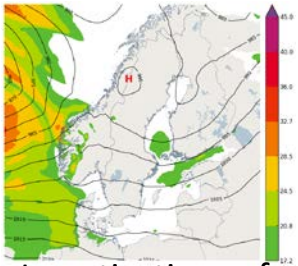




Climate related products, e.g. season maps

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





Investigations of historical storms

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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

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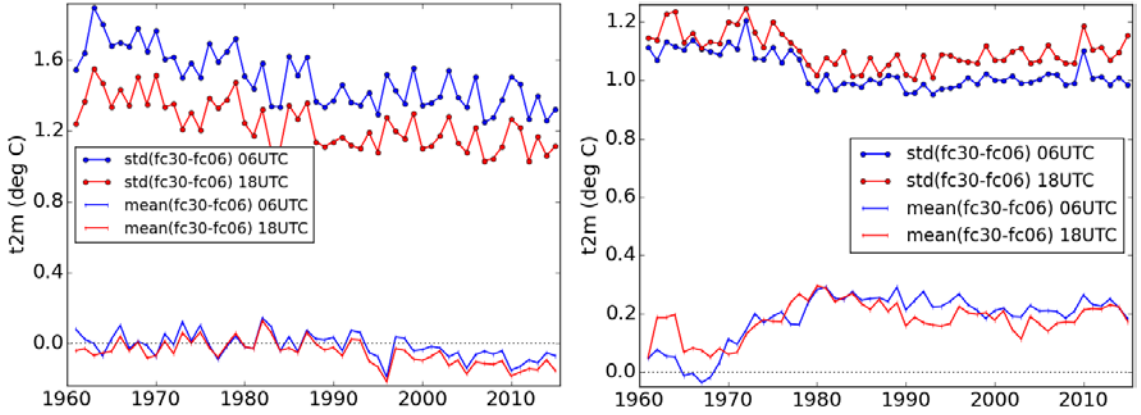
Forecast skill T2m



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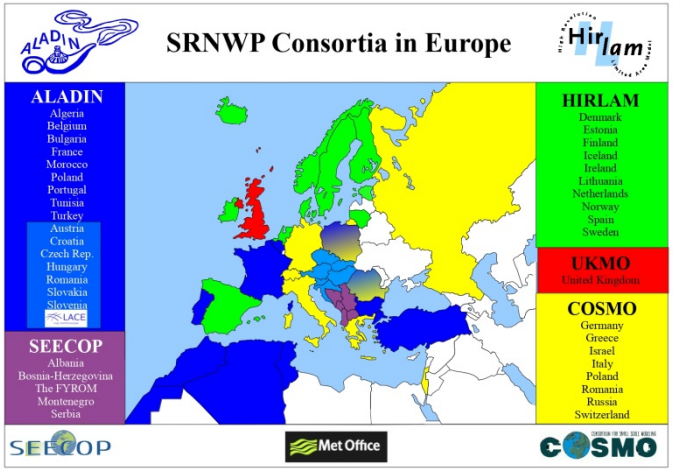
Model systems: common base

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



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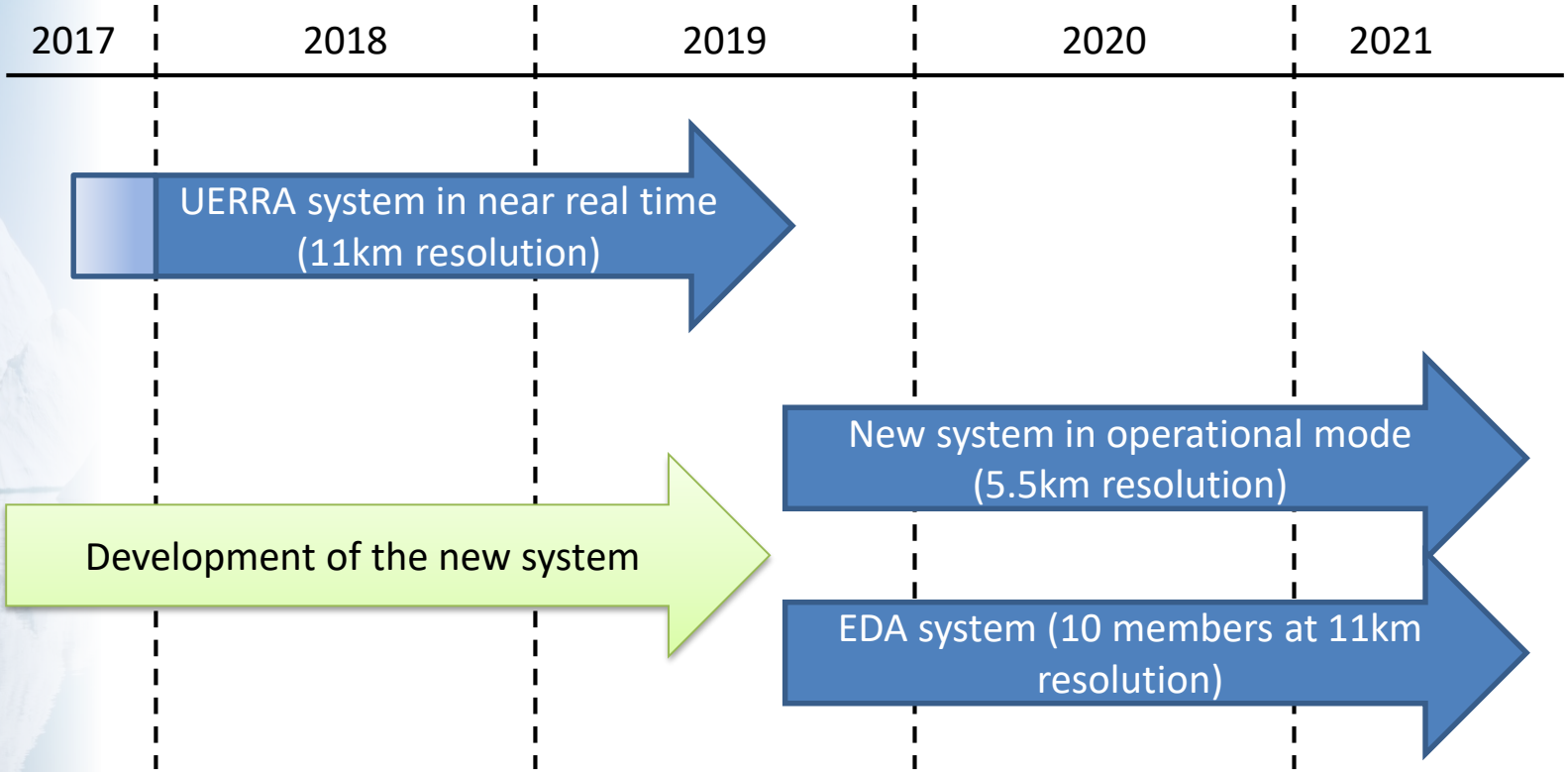
Time line of service and system details



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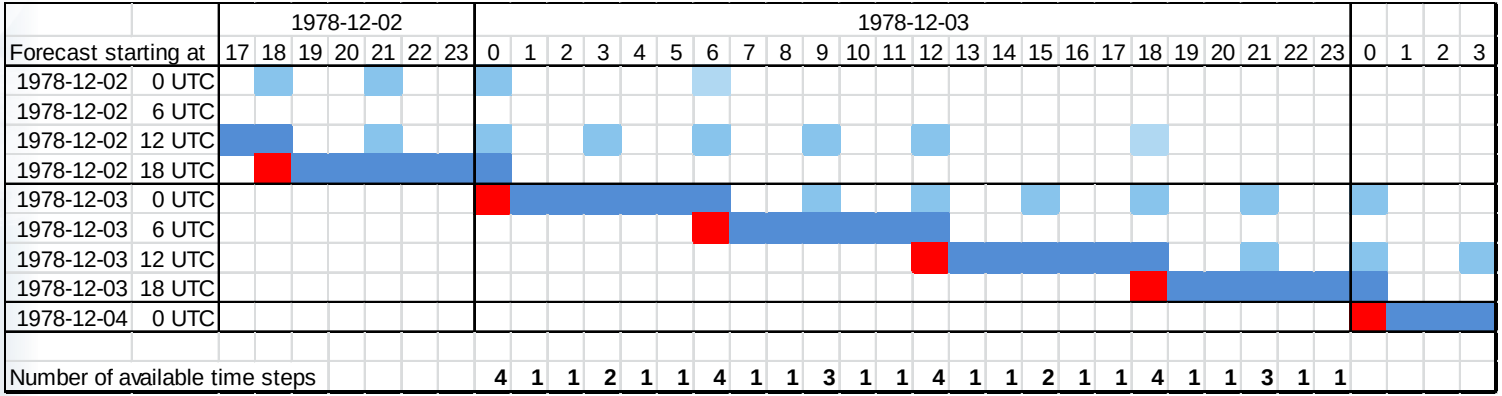

		1978-12-02							1978-12-03																								
Forecast starting at		17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3
1978-12-02	0 UTC																																			
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Number of available time steps									**4**	**1**	**1**	**2**	**1**	**1**	**4**	**1**	**1**	**3**	**1**	**1**	**4**	**1**	**1**	**2**	**1**	**1**	**4**	**1**	**1**	**3**	**1**	**1**				

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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

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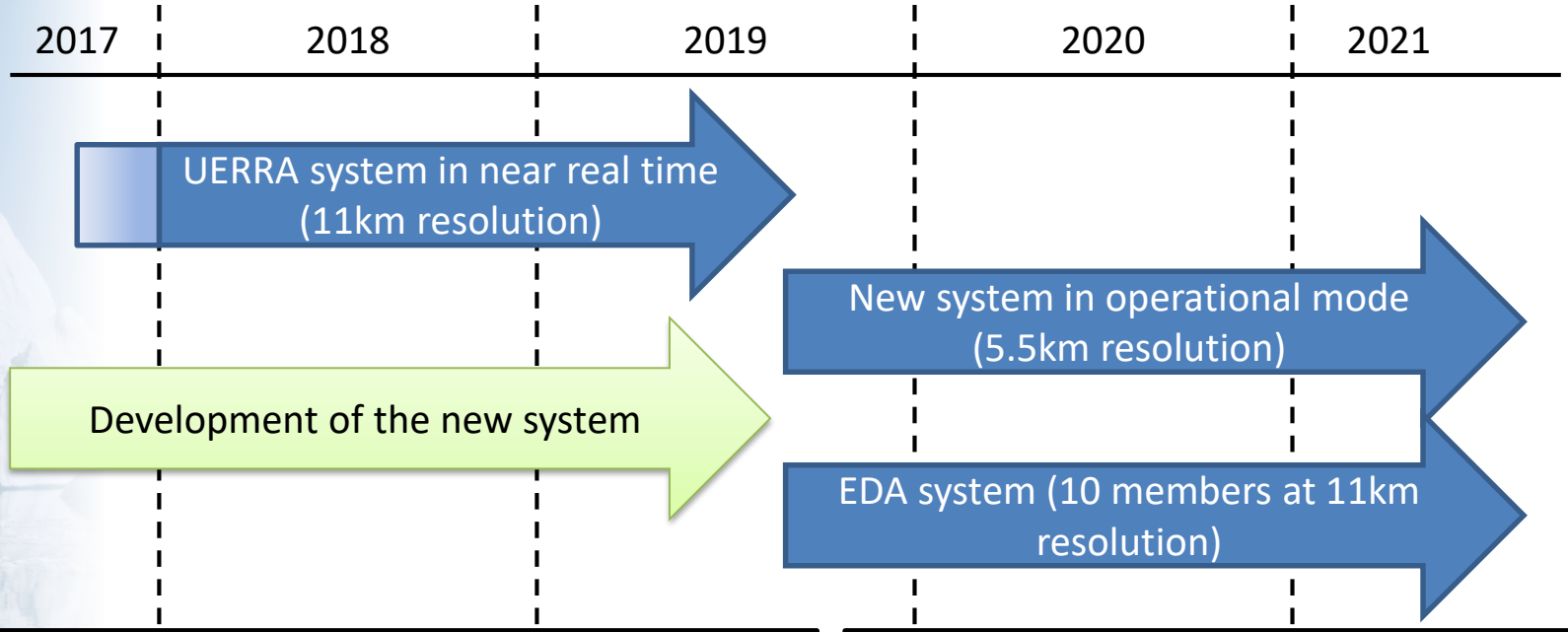

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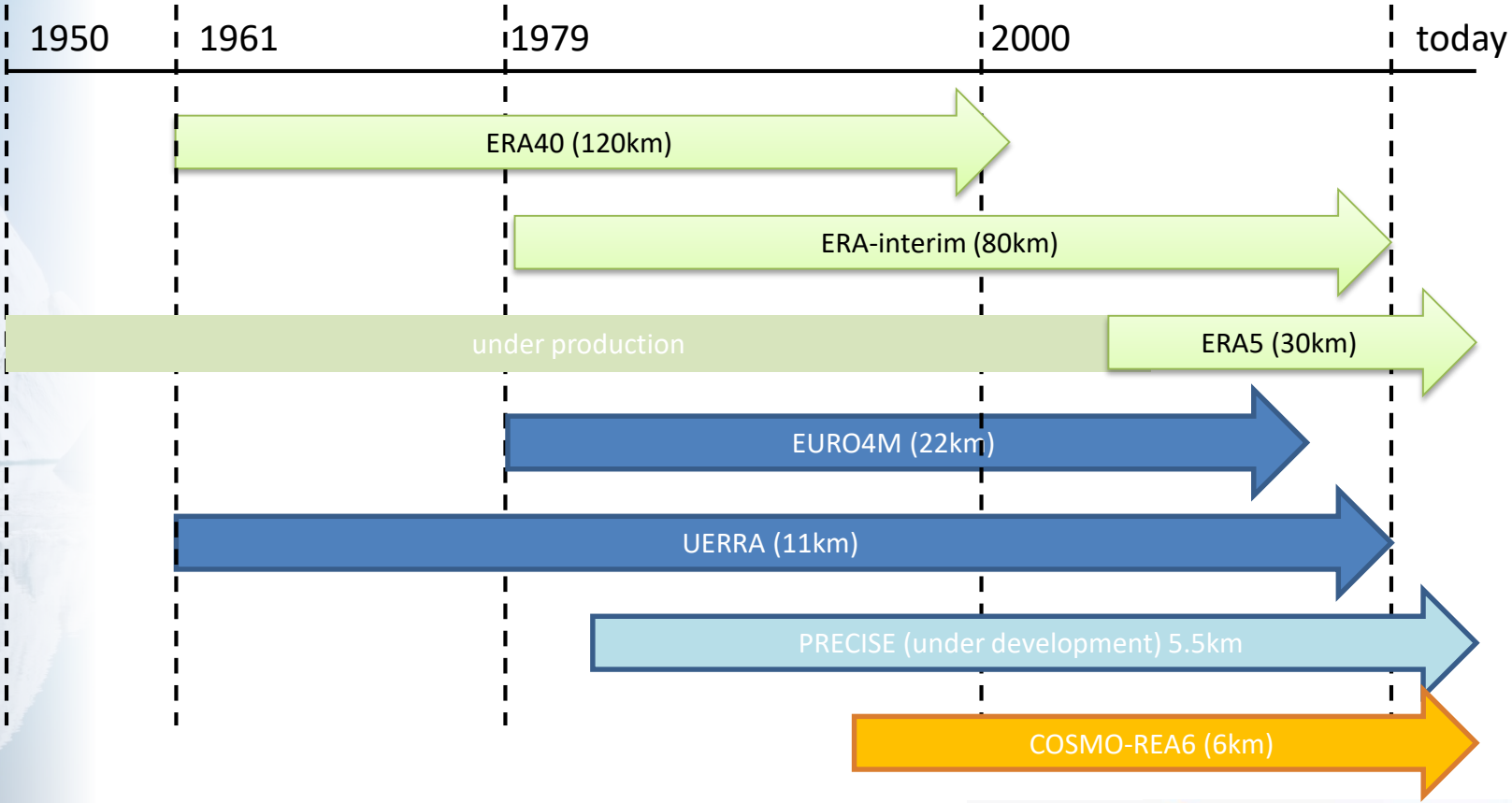
Selection of reanalyses



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