AOPC-29: IP Action C4

New and improved reanalysis products

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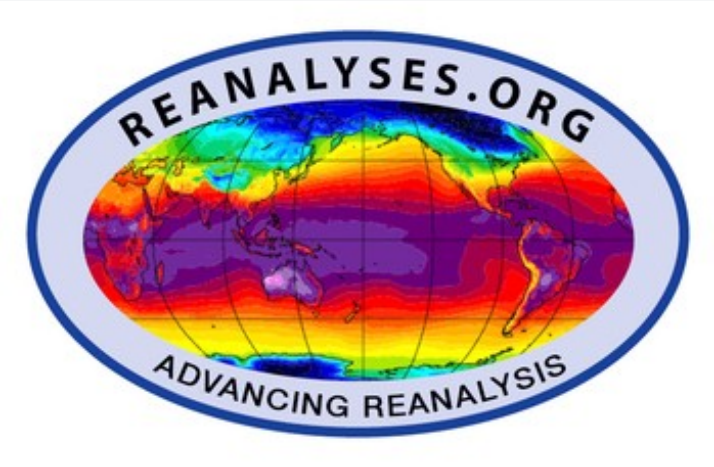
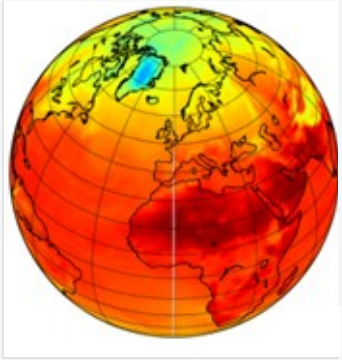


Reanalysis is a scientific method for developing a comprehensive record of how weather and climate are changing over time.

Reanalysis – Advantages



“Maps without gaps”

Gridded data

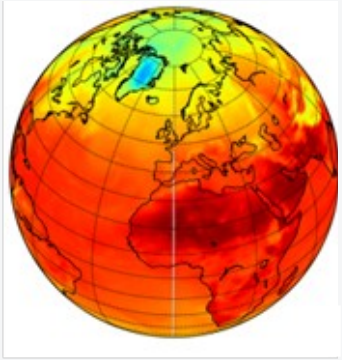
Based on observations

Incorporates model equations

Physically and dynamically coherent

Full set of meteorological fields

Reanalysis – Disadvantages



Very quickly gets “old”

Long production time

Dependent on good observations

Regional reanalyses need local observations

Quality not constant due to observations

Global Reanalysis – examples

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- ECMWF – ERA5
  - 1940-2024 (ongoing)
  - 31 km horizontal grid
  - 10 member ensemble (80km)

- JMA – JRA-3Q
  - 1947-2024 (ongoing)
  - 40 km

- NASA – MERRA-2
  - 1980-2017
  - 40 km

- NOAA – 20th-Century Reanalysis
  - 1836-2015
  - 75 km (latest version)
  - Only uses surface pressure observations
  - 56 member ensemble

Regional Reanalysis – examples

- Europe
  - CERRA – 1984-2021 (extension is ongoing), 5.5 km
  - COSMO REA6 and REA2 – 1995-2018 and 2007-2013, 6.2 and 2 km
- Arctic
  - CARRA – 1979-2021 (extension is ongoing), 2.5 km in 2 domains
- North America
  - NCEP NARR – 1979-2020, 32 km
- Australia/New Zealand
  - BARRA – 1990-2019, 12 km with four sub-domains of 1.5 km
- India
  - IMDAA – 1979-2018, 12 km

Plus several local reanalyses covering small regions

Upcoming reanalyses

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- ERA6

  14 km resolution, coupled, uncertainties addressed, known issues with ERA5 solved...

- NOAA

  Plans for a coupled global reanalysis. No details yet

- CARRA2

  Pan-Arctic reanalysis at 2.5 km reslution

- CERISE
  - European regional reanalysis focusing on surface data assimilation, coupling and uncertainty estimation. More research than production.

- CERRA-ML

  Down scaling of ERA5 to produce CERRA-like output. Only a limited set of parameters to start with.

Plus several local reanalyses covering small regions

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1. Implement new production streams using improved data assimilation systems and better collections of observations, particularly aiming at:
    a) Further increasing resolution;
    b) Improving handling of systematic observational and model biases;
    c) Providing (improved) estimates for the uncertainty in the mean state;
    d) Improving quality control in data sparse areas

Basically all planned reanalyses address these points

ECMWF has recently been nominated by WMO as a global lead centre for multiple climate reanalyses. This involves setting standards for data exchange and verification between global producing centres (NOAA, NASA, JMA, CMA and ECMWF).

Means of assessing progress: Publications
The problem with finding publications is that they are usually published when the production is done. Can conference presentations be ok?

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2. Develop couples reanalysis (ocean, land, sea-ice)
   Basically all new developments will include some sort of coupling.
   Several processes will improve, e.g. the diurnal cycle and the impact of ocean currents. Also boundary layer description will improve.
   Demonstrated benefits can be found in papers describing NWP developments. We can look for examples.

3. Improve the capability of sparse-input reanalysis that covers the entire 20th century and beyond
   For global it makes sense. For regional it would be like downscaling.
   See shared document for some comments on ERA6.

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4. Develop and implement regional reanalysis and other approached to regionalisation

Several initiatives are planned both through “traditional production”, traditional down scaling as well as down scaling using ML.

Examples:

- A pan-Arctic reanalysis, CARRA2 has just started. In addition,

- ML techniques for down scaling of ERA5, trained on CARRA/CERRA data will be explored in near future

- CERISE is a horizon Europe funded research project that will focus on surface data assimilation and coupling between surface and upper air. It will also address uncertainties. Developments will benefit a possible CERRA2 and ERA7.

5. Reduce data latency

Latency can be due to both operational aspects, since it is heavy to run, but also waiting time for input data, e.g. reprocessed observations or quality controlled precipitation observations.

The 6:th WCRP International Conference on Reanalysis

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