Reanalysis

What is reanalysis?

Reanalysis data provide the most complete picture currently possible of past weather and climate. They are a blend of observations with past short-range weather forecasts rerun with modern weather forecasting models. They are globally complete and consistent in time and are sometimes referred to as 'maps without gaps'.

Why is reanalysis important?

To understand climate change and current weather extremes, it is important to have observations of the Earth system going back as far as possible in time. However, observations have always been unevenly distributed, and they come with errors. Even in the satellite era, observations alone cannot provide a complete and accurate picture of the state of the Earth system across the globe at a given point in time. Reanalyses fill the gaps in the observational record, and they do so in a way that is consistent in time, thus minimising any spurious signals of change.

How are reanalyses produced?

Reanalysis combines past short-range weather forecasts with observations through data assimilation. The process mimics the production of day-to-day weather forecasts, which use an analysis of the current state of the Earth system as their starting point. The analysis is a physically consistent blend of observations with a short-range forecast based on the previous analysis. Reanalyses are usually produced at lower resolution than current weather forecasts, and they use the same modern data assimilation system and forecasting model throughout the reanalysis period. Prior to the production of a new reanalysis, work is carried out to improve the quality and availability of past observational

data, for example by digitising old paper-based records and reprocessing existing satellite records. Careful quality control is carried out as reanalyses are produced, and their reliability is assessed by comparison with reanalyses produced at other institutes.

How can users access ECMWF reanalysis data?

The latest ECMWF reanalyses are being produced through the EU-funded Copernicus Climate Change Service (C3S), which is implemented by the Centre. They are freely available through the C3S Climate Data Store. The most recent ECMWF reanalysis dataset is the ERA5 Back Extension, a preliminary release to be further updated in 2021 that provides data from 1950 to 1978 and sits alongside the main established ERA5 dataset (1979 to present day). ERA5 provides data from the Earth's surface to the top of the atmosphere, for variables such as air temperature, wind, rainfall, sea-surface temperature and ocean wave height. ERA5 data are available within 5 days of real time. ERA5 also provides information about uncertainty: data from areas or periods where observations are sparser are likely to be less certain.

How are reanalysis data being used?

Reanalysis data are being used by a wide range of applications: monitoring climate change, research, education, policy-making and business, in sectors such as renewable energy and agriculture. ERA5 is a very popular dataset among users of the C3S Climate Data Store. It forms the basis for monthly C3S climate bulletins and is also used in the World Meteorological Organization's annual assessment of the State of the Climate presented at the Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC).

How will ECMWF reanalyses develop in the future?

Various datasets based on ERA5 are being produced in collaboration with European partners. These provide greater detail, for example for the land surface or for specific regions, such as Europe or the Arctic. Planning for a successor to ERA5, which will exploit the latest advances in Earth system modelling, is already well under way. ERA6 will be a coupled reanalysis, using both atmospheric and ocean observations. This approach accounts for interactions between the atmosphere and the ocean and has the potential to generate an even more balanced and consistent Earth system climate reconstruction.

Surface air temperature anomaly for January 2020 relative to 1981-2010
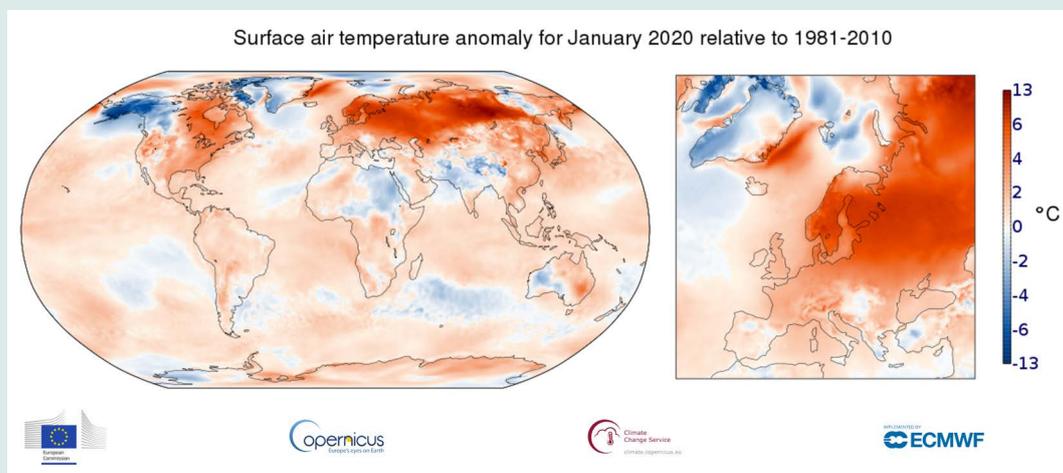
Data source: ERA5. Credit: Copernicus Climate Change Service/ECMWF.