

The ERA5 Global Atmospheric Reanalysis at ECMWF as a comprehensive dataset for climate data homogenization, climate variability, trends and extremes.

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At the European Centre for Medium-Range Weather Forecasts (ECMWF), reanalysis is a key contribution to the Copernicus Climate Service (C3S) that is implemented at ECMWF on behalf of the European Commission.

The role of reanalyses in climate monitoring applications is now widely recognized. ECMWF's reanalysis ERA-interim is periodically used, together with other datasets, as input to the World Meteorological Organization (WMO) annual assessment of the State of the Climate, routinely presented at the Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC). ERA-interim is also a resource for the production of Essential Climate Variables (ECVs) and Climate Indicators recommended by the Global Climate Observing System (GCOS). By optimally combining observations and models, reanalyses indeed provide consistent "maps without gaps" of ECVs and strive to ensure integrity and coherence in the representation of the main Earth system cycles (e.g. water, energy).

This presentation focuses on the new ECMWF reanalysis ERA5, providing global estimates of the atmosphere, ocean waves and land surface quantities. It is produced at considerably higher resolution than ERA-Interim: hourly products are available at a horizontal resolution of 31 km on 137 levels in the vertical. ERA5 is publicly available from 1979 via the C3S Climate Data Store. A pre-extension back to 1950 is currently in production.

Vast numbers of observations are assimilated using 4D-Var, both in situ and from satellites, that, jointly, are sensitive to a wide range of geophysical quantities throughout the atmosphere. In contrast to ERA-Interim, ERA5 follows the evolution of greenhouse gases, volcanic eruptions, ozone and aerosols as recommended by CMIP5. It uses a consistent reconstruction for sea-surface temperature and sea ice. ERA5 data products also include information about uncertainties, which is provided by a lower-resolution 10-member 4D-Var ensemble.

Updates close to real time are provided, which allows for an accurate and up-to-date climate monitoring, and provides information on climate variability, trends and extremes. As such, C3S provides monthly-updated climate bulletin (<https://climate.copernicus.eu/climate-bulletins>), incorporating a global and European monitoring report covering surface air temperature, sea-ice and hydrological climate variables.

The assimilation method includes a variational method for estimating observation biases that respects the heterogeneity within the observing system. This on one hand provides ERA5 products that are less sensitive to inhomogeneities and biases in its input data. On the other hand, the resulting bias estimates also provide a path to more homogeneous long-term observational records.