

# Reanalysis and climate variability

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In a reanalysis, the weather observations collected in past decades are fed into a modern forecasting system. Reanalysis differs from the traditional climatological approach in that it processes a wide variety of observations simultaneously, using the physical laws embodied in the forecast model and estimates of the typical errors of forecasts and observations to interpret conflicting or indirect observations and to fill areas with poor observational coverage.

The quality of a reanalysis depends on both the observations and the data assimilation system. The data-assimilation system has since the first ECMWF reanalysis ERA-15 been reformulated both by improving the assimilating model and introducing the variational assimilation technique for the analysis. The radiance data are assimilated directly and more extensively and new schemes to handle biases between the observations and model background have been included. More information than before can be exploited from a given set of observations in a new reanalysis using an improved data assimilation system.

The observing system has from the International Geophysical Year 1958 evolved together with the development of operational forecasting requirements. The role of satellite observing systems increases through the period. In 1972 the first meteorological satellite was introduced. The increasing quality of the second generation ECMWF reanalysis ERA-40, 1957-2002, can be seen through better assimilation of the data and better quality 10-day forecasts specially in the Southern Hemisphere. A dramatic improvement in the analysis quality is seen from 1979 onwards, when an observing system with two polar orbiting and five geostationary weather satellites was introduced and further updated in 1987, 1991 and in 1998.

Reliable estimates on climate change can be obtained after 1979, while the reanalyses for pre-1979 period can be used with care considering the weaknesses of the global observing system particularly in the Southern Hemisphere. The evolution of ECMWF reanalyses ERA-15, ERA-40 and the current ERA-Interim are reviewed and assessed in terms of the detection of climate signals. The requirements and possibilities for future global reanalyses are discussed.