Assimilation of satellite observations in global reanalysis: a double-edged sword

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Satellites collecting Earth observations have supported the development of global weather forecasts achieving unprecedented accuracy. In global reanalyses, these same satellite observations have also helped create atmospheric datasets with an unprecedented quality, of interest to qualify and quantify the past weather, its variability and its predictability.

However, new challenges come with using a large number of satellite observations covering large regions of the globe. These essentially all relate to ever-present biases in the observations, in the underlying Earth-system model in which they are assimilated, and in the mapping procedures between the two (so-called observation operators). Consequently, sudden changes in satellite observation coverage modulate biases in one or several of the three. The net results can be large-area, and sometimes global, but spurious and unphysical changes in reanalysis products. It is well known, for example, that changes in the mean climate signal in global reanalysis products are typically found around 1979-1980, when large amounts of satellite sounding observations start being regularly available.

These changes in quality relentlessly raise questions on the interpretation of inter-annual variability and trends drawn from reanalysis. For that reason, this invaluable, yet recent, observation source is often questioned for its use in reanalysis to generate climate-quality products.

First, a review of the use of satellite observations in recent reanalyses of the satellite era will be given, not restricted to ERA-Interim. Common problems in time consistency will be pointed out, some supporting the critics' points. However, interestingly enough, these reanalyses use similar input observations. Yet, these reanalyses differ in their details, regarding satellite data assimilation. These details sometimes trace to the timing and nature of time-series breaks.

We will then report on recent improvement in satellite data assimilation. These advances address known issues with using micro-wave and infra-red radiance satellite observations, and should eventually increase the consistency between observations and underlying models.

Finally we will explore the impact of a single micro-wave instrument on the quality of reanalysis products. These results suggest that efforts on early satellite data recovery could potentially help improve our knowledge of the 1970s via reanalysis.

In the end we will question the accepted view that satellite data are the odd ones out, needing bias correction, when other observations supposedly don't.

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