Extending the Use of Satellite Data for Reanalyses

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Satellite observations of the atmosphere and surface have been shown to be a valuable source of measurements in order to better define the atmospheric state and surface in reanalyses. For example, when MSU radiances were introduced in late 1978 in the ERA-40 reanalysis, the forecasts of 500hPa height over Australia/New Zealand improved dramatically. The infra-red radiances from the VTPR instrument, introduced in 1972, also improved the global moisture analysis. In fact, the meteorological "satellite era", as it is commonly called, starts in 1979 (with FGGE), and this is no coincidence why so many modern reanalyses today also go back to that year, and no further.

Yet, even before 1979, in the early years of meteorological satellites (late 1960's and 1970's), there were many instruments flown, though more to prove the concepts than to make long term measurements. These early observations represent an untapped observational resource from a climate point of view, and could possibly help extend the "satellite era reanalyses" back by a few years. Some of those early instruments were more successful than others, and some only operated for a short period. Before deciding to invest time and effort on recovering these data and learning how to best use them, a prior study assessing the early satellite datasets had to be undertaken.

For each dataset, the following factors were considered:

- Length of data record
- Access to datasets in a readable format and required level (e.g. level 1 for radiance)
- Estimated quality of dataset, including error estimates
- Added value over other established datasets such as used in ERA-40
- Availability and complexity of observation operator

The results of the study will be presented with recommendations for which sensor datasets to assimilate or use for validation in the ECMWF next-generation satellite era reanalysis, due to replace ERA-Interim in the next five years. The sensor types were grouped into infrared and microwave sounders, infrared and microwave imagers, active sensors such as scatterometers and GPS radio occultation, atmospheric motion winds, ozone and limb viewing instruments, and finally 1960's imagery for validation.

Several satellite datasets were identified as potentially providing significant value to future reanalyses. Flown on Nimbus-6, the HIRS-1 instrument could help improve the temperature and humidity analyses, and also the Pressure Modulator Radiometer (PMR), conceptually similar to the Stratospheric Sounding Unit (SSU), could improve the stratospheric temperature analyses in the mid 1970s. The early Defense Meteorological Satellite Program (DMSP) microwave sounders SSM/T2 (like AMSU-B) could extend the microwave humidity record back to 1994. The SMMR microwave imager, flown on Nimbus-7, could improve the low level humidity analyses over the ocean from 1978-1987, if a suitable, ideally reprocessed, level 1 radiance dataset could be located. Polar atmospheric motion winds from the Advanced Very High Resolution Radiometer (AVHRR), flown since 1978, could help constrain analyses in otherwise poorly observed polar regions, and are beginning to become available. The talk will highlight several other datasets, in addition to the above, which could be valuable for reanalyses. For example, satellite imagery from the 1960s could also be useful for validation of reanalyses and further assisting understanding cloud cover regional changes.

Overall results of this study should also attract attention on the importance of safeguarding raw satellite data, as well as ancillary and instrument information from Earth-observation experiments, for use by future generations, whether in reanalysis, climate monitoring or in any other context.

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