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Constrained adaptive bias correction for satellite radiances assimilation in the ECMWF 4D-Var

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Satellite radiance observations are typically affected by biases that arise from uncertainties in the absolute calibration, the radiative transfer modeling, or other aspects. These biases have to be removed for the successful assimilation of the data in NWP systems. Two key problems have been identified in bias correction: Firstly, bias corrections can drift towards unrealistic values in regions where there is strong model error and relatively few "anchor" observations, ie, observations that have little systematic error and therefore allow the separation between model and observation bias. Examples where this has been particularly problematic are channels sensitive to ozone or stratospheric temperature. Secondly, there is undesired interaction between the quality control and bias correction for observations where bias-corrected observation departures are used for quality control and where these departures show skewed distributions (e.g., in case of cloud detection).
In the study, we investigated potential solutions to these problems by providing further constraints using potential available information, such as constraints on the size of the bias correction and innovative bias correction metrics using uncertainty estimation from calibration and radiative transfer. This has been studied in the full ECMWF global 4D-Var system, using data from microwave sounders which are sensitive to stratospheric temperature. The resulting enhanced bias corrections was assessed in the context of other assimilated observations (in particular radiosondes and GPS radio occultation measurements), and through comparisons of MLS temperature retrieval data in stratosphere and mesosphere.
The constrained adaptive bias correction of AMSU-A stratospheric sounding channels reduces the biases in stratosphere and improves the medium range forecasts in both stratosphere and troposphere.