Constrained Bias Correction for Satellite Radiance Assimilation in Limited Area Model

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ABSTRACT
Radiance bias correction is crucial to the successful assimilation of satellite radiance observations which 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. There are several issues in the implementation of the bias correction method in limited area models (LAMs) which was originally developed for global models. One of these important issues is how to separate the observation bias from the innovations if there are obvious model diurnal biases in LAMs using adaptive bias correction in 3D-Var. In this study, the constrained bias correction scheme is proposed and tested considering the estimate of radiometric uncertainties and the relative model diurnal bias. Enhanced cooperation between NWP and other ITWG groups are recommended for the validation and characterization of satellite radiance bias estimation.

1. Motivation
Bias correction is essential for successful use of satellite radiance

-obsolete view: BC could change the impact sign
-absolute calibration in radiance
-Model diurnal bias

Progress in RT and calibration uncertainty estimation[7]

2. Methodology
Constrained Bias Correction[4]
-Background term for bias estimation
-Use of uncertainty information of RT and calibration
\[
\frac{1}{2}(x - \bar{x})(x - \bar{x})^T \mathbf{B}^{-1}(x - \bar{x})
\]
-Physical-based impact model
-Priori uncertainty estimate of observation bias
-The time evolution of bias (cycle period of bias coefficients)
-Consideration of model bias (2,5)

3. Case Study: Bias correction of SSMIS imager channels[3]
Bias model for SSMIS imager channels
-Scan bias (Ascending and Descending)
-Bias predictor: LWP (liquid water contribution)

Spin-up of the bias coefficients

4. Validation of Bias Correction
H(x, e) - H(x, e) - H(x, e) - H(x, e)
Collocated independent unbiased obs.
-Model observation error to background space
Using observation operator H

5. Results and Discussion
-Background term for observation bias estimation
\[
\gamma (x_b - \bar{x}_b)^T \mathbf{B}^{-1} (x_b - \bar{x}_b)
\]
-Uncertainty of observation operator and calibration
-channel, scene temperature
-pre-launch and on-orbit
-Adaptive update of the bias correction coefficients

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Reference
4. Han W., 2014: Constrained variational bias correction for satellite radiance assimilation, 19th International TOVS Study Conference, 6 March – 1 April 2014, Jeju Island, South Korea.