Evaluation of Variational Bias Correction Using Iterative Bias Correction with First Guess Update

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Introduction

In order to use radiance observation for data assimilation (DA), biases between observation and the radiance simulated from the model background must be corrected. A traditional static bias correction assumes that the average background over a period is unbiased. It is not true. The model prediction has a systematic bias, and it cannot be removed by time averages. Variational bias correction (VarBC) estimates biases and adjusts the BC coefficients to fit the analysis during the DA.

In this study, we propose another bias correction method that uses analysis to corrects observation biases.

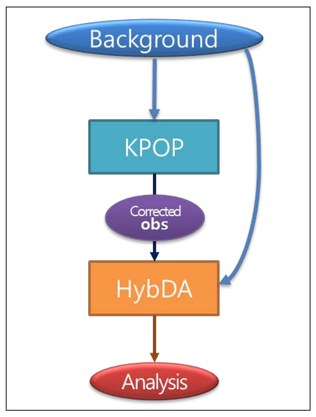
Data Assimilation at KIAPS

The Korea Institute of Atmospheric Prediction systems (KIAPS) has developed an operational Hybrid DA (HybDA) system for the cubed sphere grid global model called Korean Integrated Model (KIM). It assimilates most satellite radiance observations used in the Korea Meteorological Administration (KMA) DA system. The KIAPS has built their own observation processing system called KIAPS Package of Observation Processing (KPOP) to provide qualified real-time observations for the DA system.

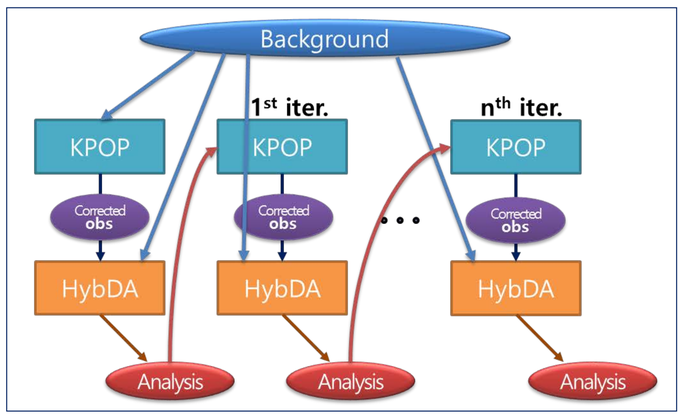
Recently the VarBC method is implemented in the KIAPS DA system, and it is applied for AMSU-A and MHS so far.

Iterative Bias Correction

Operational DA



DA with iterative bias correction



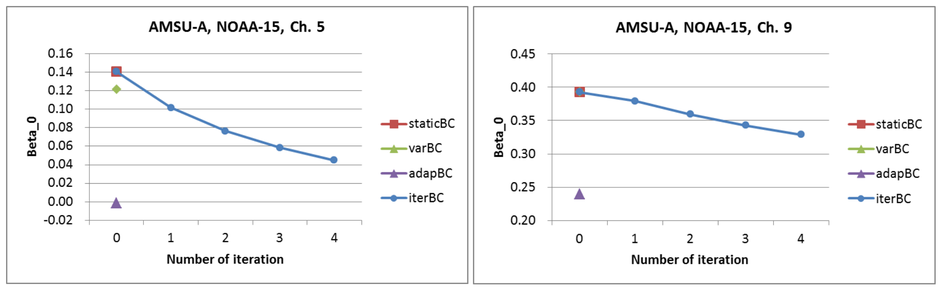
In the iterative BC method, HybDA repeats data assimilation with the same background and differently corrected observations .

Bias correction at KIAPS [air-mass bias (b_{air})]:

$$b_{air} = \beta_0 + \beta_1 P_1 + \beta_2 P_2$$

P_1:perturbation of 850-300 hPa thickness, P_2: perturbation of 200-50 hPa thickness

Bias coefficients β_0, β_1 and β_3 are calculated by a least-squares fit. β_0 is identical to a global offset of bias



StaticBC:
static coef. from three weeks data
VarBC:
VarBC (initial coef. = static coef.)
adapBC:
BC with the coef. calculated by only current background
IterBC:
Iterative BC
: static coef. at initial
calculated coef. from 1st iteration

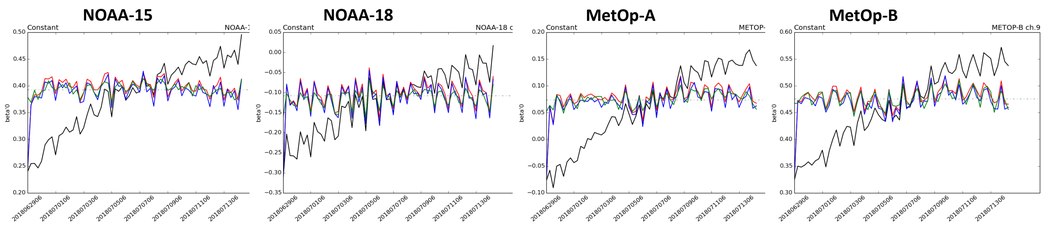
Bias coefficient $\beta_0$decreases with each iteration in iterative BC. The distance from staticBC to iterBC is greater than the distance from staticBC to VarBC. Works harder

Results in DA cycle

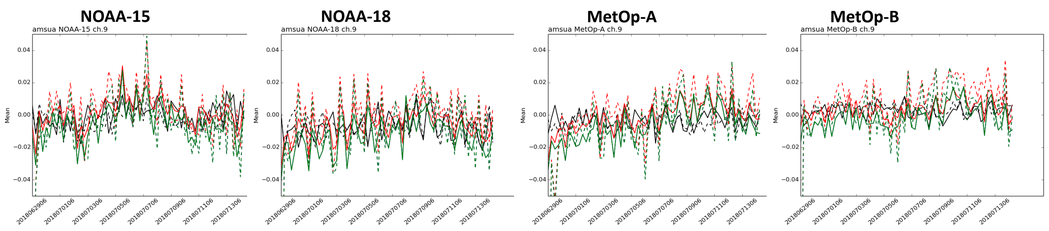
DA cycle with iterative BC . (DA method = 3DVar-FGAT, max. iter. = 1)

RMSE Comparison between different BC methods

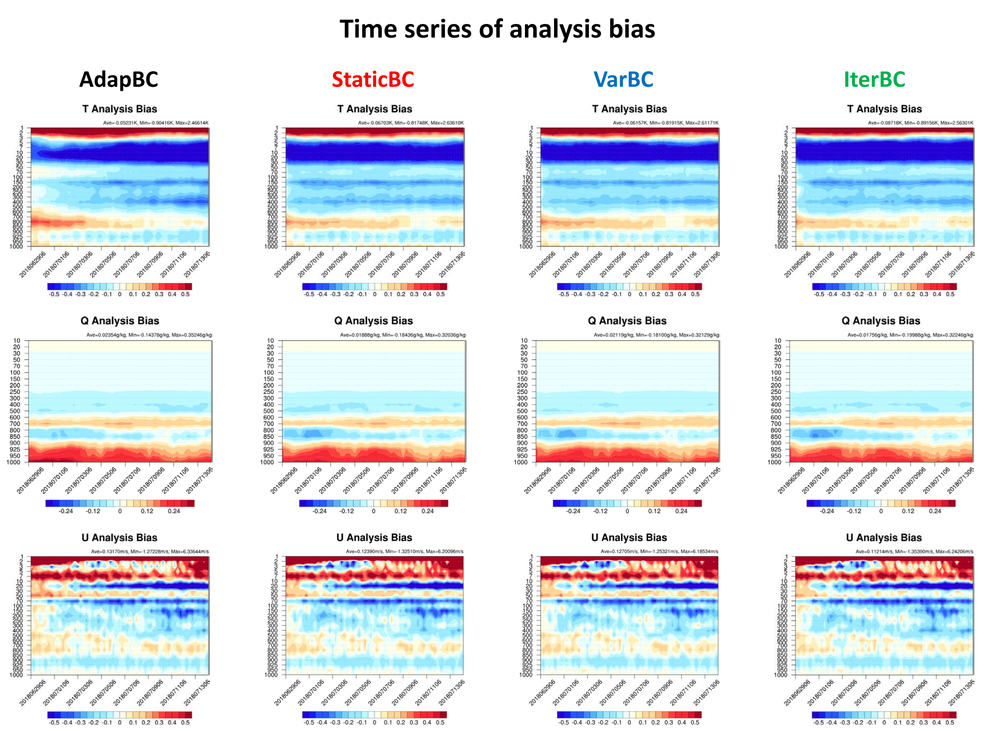
Time series of β_0



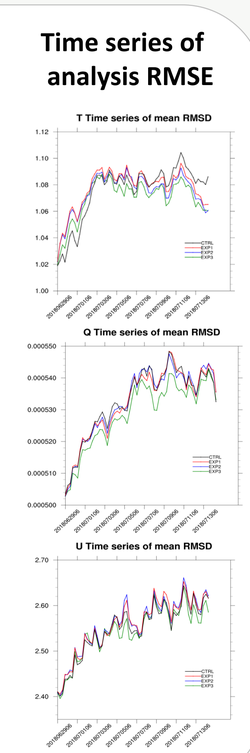
Time series of C-B & C-A (------- C-B, —— C-A)



Time series of analysis bias



Time series of analysis RMSD



Summary and Conclusions

The iterative BC method outperforms in the experiment because the radiance biases are adjusted to be consistent with other observations and fit the analysis. However, this method is not feasible to be operational in a real-time forecast system because of computational cost. The iterative BC method is relatively straightforward, so it can be a useful tool for evaluating VarBC. It turns out that the VarBC in KIAPS DA is not much sensitive to analysis. We will expand VarBC for every radiance assimilation and will diagnose the results using the iterative BC.