Buddy check for radiance with analysis error variance

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Introduction

The analysis error variances are calculated as the product of increment and analysis departure, so they should normally be positive value at each observation point. But the analysis error variances are negative when the given observation has different signal from other observations in the vicinity because the analysis does not exist between the background and the observation.

The process of eliminating observation with large negative analysis error variance is defined as buddy check in this study. The buddy check is adapted for satellite radiation data such as IASI, CrIS, AMSUA, ATMS, and MHS, after first outer loop in data assimilation process of Korea Institute of Atmospheric Prediction Systems (KIAPS)

Buddy check method

C. corrected observed TB
B. background TB, \( T_b \)
A. analysis TB, \( T_a \)
T. true TB, \( T_T \)
H. observation operator
X. model space
TB. brightness temperature, observation space

\[
\text{Observed error square (C-T)}^2 = (C-A)(C-A)
\]

\[
\text{Background error square (B-T)}^2 = (A-B)(B-A)
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\[
\text{Analysis error square (A-T)}^2 = (A-C)(A-C)
\]

Analysis exceeds observation

\[
(C-A) > 0
\]

Analysis is in the same level as the observation

\[
(C-A) = 0
\]

Analysis is less than the observation

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(C-A) < 0
\]

\[
\text{C and A are observed, B is background.}
\]

Application Buddy check to AMSUA ch. 10

Date: 2017.06.22 18UTC, Buddy check: (A-B)(C-A) < -0.1 * obs.err We applied a strict buddy check to clearly identify the effect.

Buddy check is not the outlier rejection on C-B. So the standard deviation of C-B is not reduce after buddy check.

Before buddy check: stddev of C-B = 0.239

After buddy check: stddev of C-B = 0.244

Buddy check reject the observation when its C-B is opposite the sign of many others

And also buddy check reject the observation when its C-B is smaller than the magnitude of many others

Short range forecast verification against Observations

Diag. -3.0 vs Diag. off

\[
\text{RMSD}_{\text{Diag off}} - \text{RMSD}_{\text{Diag -3.0}}
\]

Jul 2017

\[
\text{Diag. off vs Diag. off}
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\text{RMSD}_{\text{Diag off}} - \text{RMSD}_{\text{Diag off}}
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Jul 2017

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\text{AexB. -3.0 vs Diag. off}
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Jul 2017

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\text{RMSD}_{\text{Diag off}} - \text{RMSD}_{\text{AexB. -3.0}}
\]

Jul 2017

Summary

- Buddy check works well to remove the observations which have a different effect from most other observations.
- We have verified how removing the data with buddy check had an effect on short range forecast.
- There was a positive effect on temperature in the verification against observation and IFS analysis, especially AexB. -3.0 which reject only the observation when its C-B is opposite the sign of many others.
- Water vapor was strongly positive for the verification against MHS, ATMS and IASI. On the other hand, the verification against IFS analysis showed negative or neutral effect.

Future Works

- Fitting the threshold for each observation
- Investigation of removal data with buddy check to improve QC or blacklisting
- Setting large observation errors instead of removing the data

Settings

- Model: KIM 91L, ne120 (~25 km)
- Di: HydDA ne0 (50 km) without ensemble run
- Used data: Sonde, Aircraft, Surface, GFSC, AMSU, CrIS
- IAM, CrIS, AMSU, ATMS, MHS, COMS
- Period: 2017.06.22-07.31
- 6 hour forecast cycle run