Forecast Sensitivity to satellite observations in global and East-Asia

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1 Introduction

Evaluation methods of the observation impacts on NWP system

- Adjoint-based **FSO** (Forecast Sensitivity to Observations) method
  - Not necessary to add or remove observations from the assimilation to estimate their impacts
  - Reduces the computational costs of the observation impact calculations
  - Observation impact can be efficiently estimated for a set of observations or any subset of observations grouped by ***instrument type***, ***variable***, ***region***, ***vertical level***, etc
- What is FSO?

  Numerical forecast error reduction/increase due to the observation use
  - Use an adjoint technique in VAR system
  - Trace it back to the observations used in the analysis
  - Forecast error : **Energy Norm (J/kg)**
  - **Negative value** means error reduction → **good impact**
  - Impact of each observation type (sorted by **channel**, **location**, **variable**, vertical **level**, etc) written in a single ascii file

Object

- **Evaluation of satellite impacts** by using KMA FSO system
- Especially focused on…
  - Comparing the impact of **Global and East Asia area**
  - Detail analysis the results of **East Asia** FSO

2 Experiment Design

Observation Impact measure

Reduction in error variance **dry energy norm**, surface to ~150 hPa, for 24-hour forecast

NWP system

- **Met Office global Unified Model (UM) with 4D-Var**
  - **Version 7.9 PS28 – operational from 27 June 2013**
  - **Resolution: UM N512, 4D-Var N216**

Data period

- **June ~ August 2013 for summer**
- **December 2013 ~ February 2014 for winter**
- **6 hourly (00Z,06Z,12Z,18Z)**

Observation data used in KMA

- **Surface : Synop, Ship, Buoy, METAR, BOGUS**
- **Sonde : Radiosonde, PILOT, Wind profiler, DROPSONDE**
- **Aircraft : AMDAR, AIREP**
- **Scatwind : ASCAT (MetOp2-A, MetOp1-B)**
- **AMV (Atmospheric Motion Vector) : GOES, AVHRR, MODIS, COMS (KMA), MTSAT (JMA), Meteosat7, Meteosat10**
- **ATOVS : NOAA15, 18, 19, MetOp2-A, MetOp1-B**
- **IASI : MetOp2-A, MetOp1-B**
- **AIRS : AQUA**
- **CSR : COMS (KMA)**
- **GPSRO : GRAS, GRACE, COSMIC**

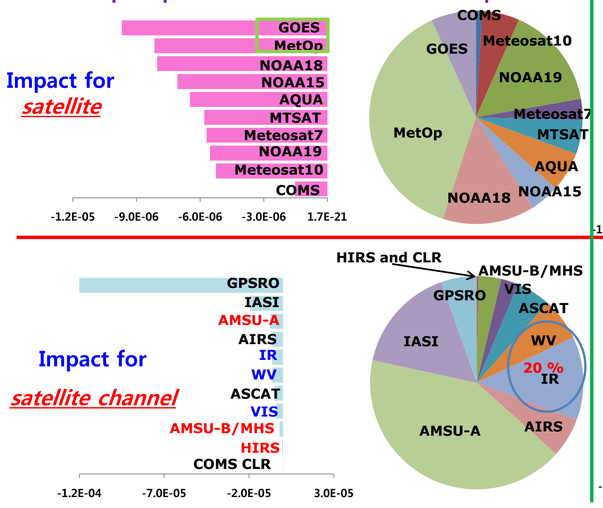
※ **KMA has been used the *MetOp1-B satellite* since *November, 2013***

3 Results – Global VS East Asia

summer

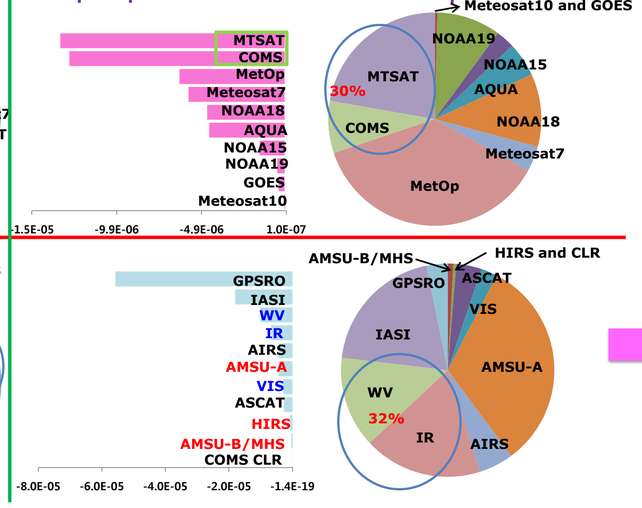
Impact for *Global*

Impact per observation / Total Impact



Impact for *East Asia*

Impact per observation / Total Impact

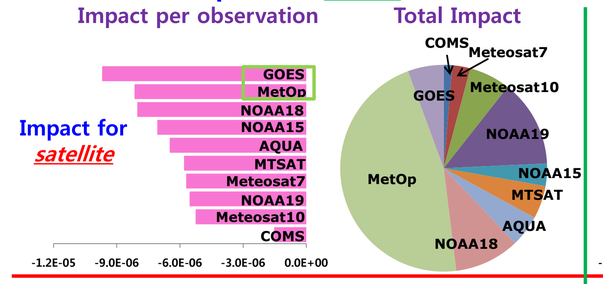


Impact for *satellite channel*

winter

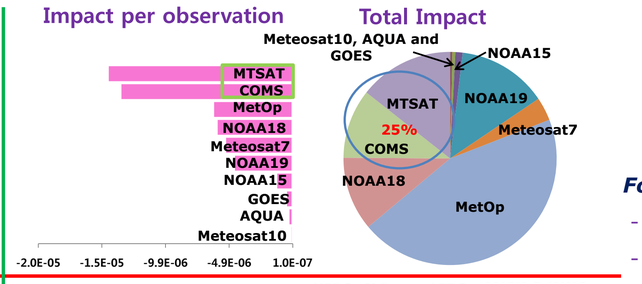
Impact for *Global*

Impact per observation / Total Impact

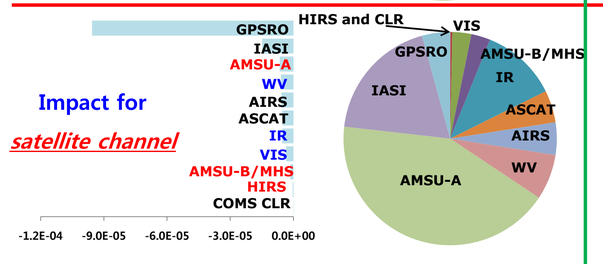


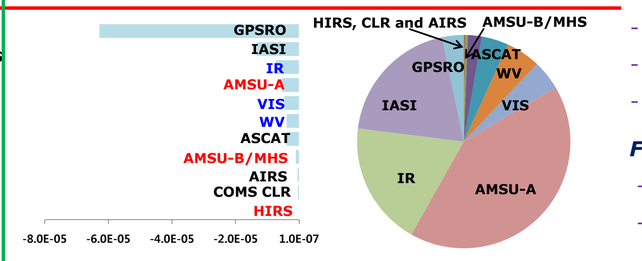
Impact for *East Asia*

Impact per observation / Total Impact



Impact for *satellite channel*





Similar pattern

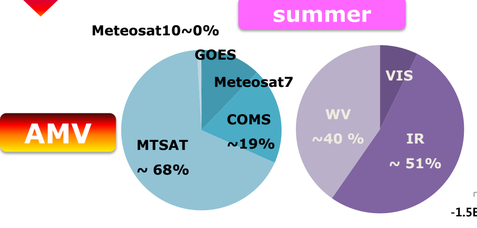
Impacts of **MetOp** satellite and **AMSU-A** channel are large
Impacts per observation are large in **GPS-RO** and **IASI**

Especially for East-Asia area

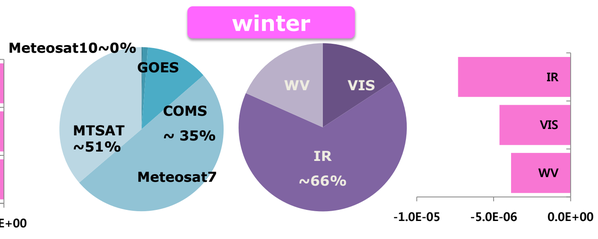
Impacts of **MTSAT** and **COMS** satellite (AMV) are large
- Due to the their mainly distribution

3 Results –East Asia

summer



winter

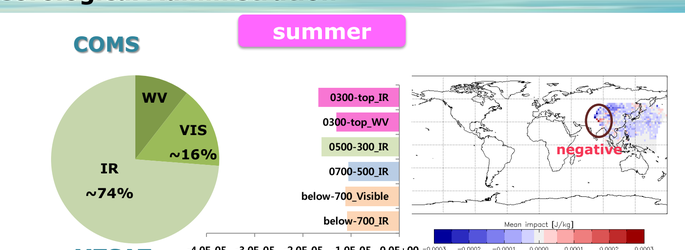


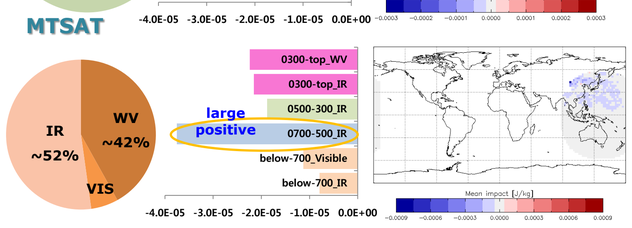
AMV

♣ MTSAT > COMS > Meteosat7 > GOES (+ Polar wind) > Meteosat10
♣ IR > WV > Visible channel for total impact

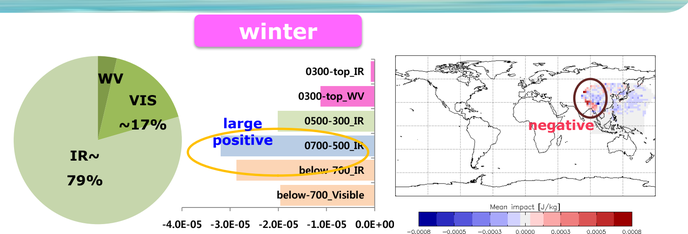
__- For summer/winter, impact per observation is largest in WV/IR channel

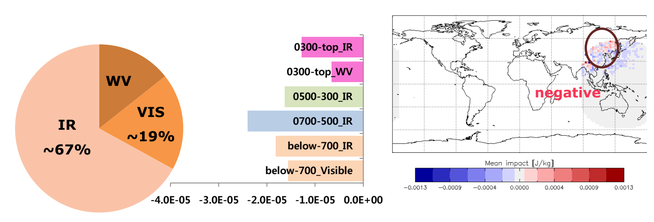
summer





winter





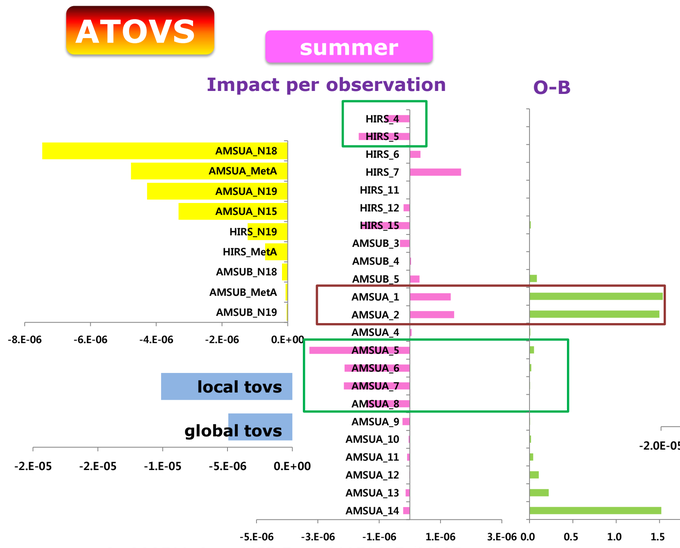
♣ ***IR channel*** gives largest impacts for both COMS and MTSAT
- Portion of IR impact decreased in winter for both COMS and MTSAT

♣ Negative impacts are shown in East China area
♣ For summer, MTSAT gives larger positive impacts at mid-low (700~500 hPa) levels than COMS
♣ For winter, impacts per observation of COMS are larger than MTSAT especially at low~mid. levels (~500 hPa)

ATOVS

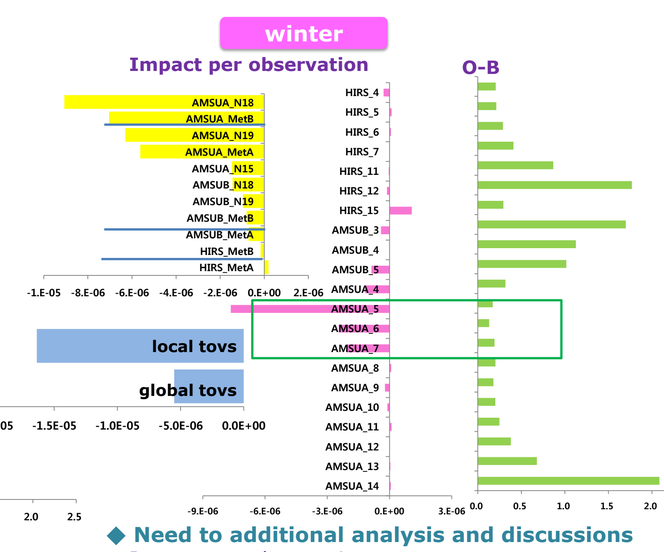
summer

Impact per observation / O-B



winter

Impact per observation / O-B

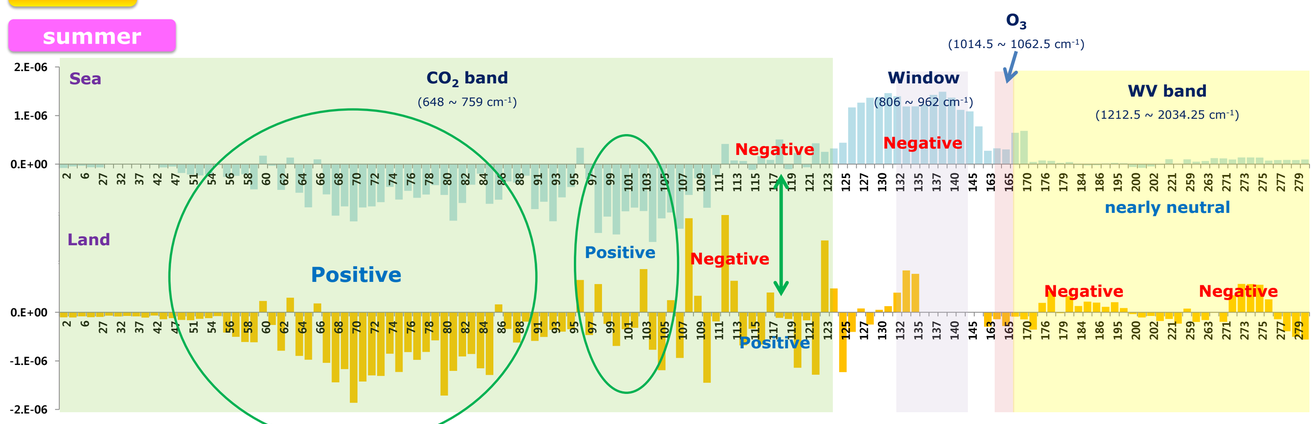


♣ AMSU-A > HIRS > AUSM-B/MHS
♣ NOAA18 > Metop > NOAA19 > NOAA15
♣ ***MetOp1-B*** gives large positive impacts

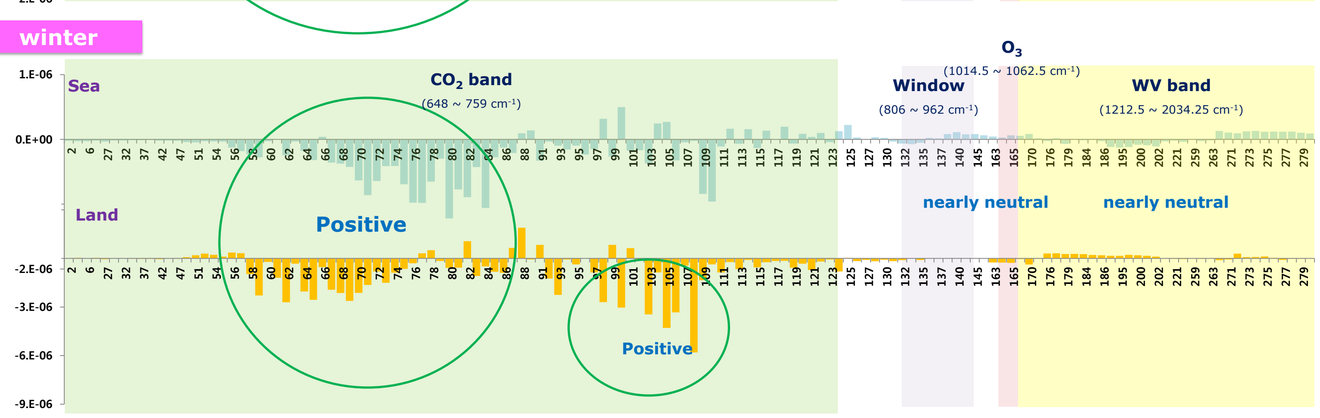
◆ **Need to additional analysis and discussions**
- Impact per observation
  : ***local ATOVS*** (RARS) > global ATOVS
- O-B increase ↔ negative impact increase

IASI

summer



winter



For summer
- There are generally positive impacts on **CO_2 band** for both Sea and Land (**Especially middle of troposphere**)
- There are negative impacts at lower stratosphere
- In window and O_3 band, IASI degrades the forecast skill
- There are *neutral impacts on WV band*
- Distinct differences between Land and Sea appear at lower stratosphere (some land channels give negative impacts)

For winter
- There are generally positive impacts on **CO_2 band** for both Sea and Land (**similar to summer**)
- Positive impacts are reduced/increased at middle-low troposphere on Sea/Land compared to summer
- There are *neutral impacts on Window, O_3 and WV band*

4 Conclusions and Future plan

- Impacts of ***MetOp*** satellite and ***AMSU-A*** channel among satellite observations are large for both global and East-Asia area
- Impacts of **MTSAT and COMS** satellite (AMV) are large for East-Asia area due to the their mainly distributions
- For ATOVS, mean impacts of ***NOAA18*** are largest among satellites and ***MetOp1-B*** (started to be used November 2013) gives positive impacts
- For IASI, there are generally positive impacts on **CO_2 band** for both Sea and Land
  - need to further analysis about channels which degrades forecast skill

◆ **Future Plan**
- Evaluation of each AIRS channel
- Development of local-area FSO to evaluate the observations for local-area