All-sky infrared radiances assimilation of selected humidity sensitive IASI channels at NCEP/EMC

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Outline

• IASI humidity channel selection in all-sky conditions
• Introduction of cloud effect parameter
• Different cloud cover schemes discussion
• Preliminary results
• Summary and future work
IASI humidity channel selection

IASI Spectral With WV CH Selection

Brightness Temperature [K]

Wave Number [cm⁻¹]
IASI humidity channel selection

<table>
<thead>
<tr>
<th>Channel number</th>
<th>Wave number (cm(^{-1}))</th>
<th>Channel index</th>
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<tbody>
<tr>
<td>2889</td>
<td>1367</td>
<td>304</td>
</tr>
<tr>
<td>2958</td>
<td>1384.25</td>
<td>314</td>
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<td>1422.25</td>
<td>342</td>
</tr>
<tr>
<td>5381</td>
<td>1990</td>
<td>459</td>
</tr>
<tr>
<td>5399</td>
<td>1994.5</td>
<td>462</td>
</tr>
<tr>
<td>5480</td>
<td>2014.75</td>
<td>469</td>
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Prediction of O-B using the cloud effect parameter

(Geer et al, 2011; Okamato et al, 2014)

\[ CA_i = \frac{(|OB_i - FG_{clr,i}| + |FG_i - FG_{clr,i}|)}{2} \]

\[ FG_{clr} : \text{clear-sky FG, } i: \text{channel} \]

\[ CA_i = \frac{(|C_O| + |C_M|)}{2} \]

**O-B assuming overcast**

**O-B using model’s cloud fraction**
Set up new obs error based on cloud effect

```plaintext
do i=1,nchanl
  cclr_ir(304)=0.0_r_kind
  cclr_ir(314)=0.0_r_kind
  cclr_ir(321)=0.0_r_kind
  cclr_ir(322)=0.0_r_kind
  cclr_ir(330)=0.0_r_kind
  cclr_ir(340)=0.0_r_kind
  cclr_ir(342)=0.0_r_kind
  cclr_ir(459)=0.0_r_kind
  cclr_ir(462)=0.0_r_kind
  cclr_ir(469)=0.0_r_kind
end do

do i=1,nchanl
  ccld_ir(304)=10.0_r_kind
  ccld_ir(314)=10.0_r_kind
  ccld_ir(321)=10.0_r_kind
  ccld_ir(322)=10.0_r_kind
  ccld_ir(330)=10.0_r_kind
  ccld_ir(340)=10.0_r_kind
  ccld_ir(342)=10.0_r_kind
  ccld_ir(459)=5.0_r_kind
  ccld_ir(462)=5.0_r_kind
  ccld_ir(469)=5.0_r_kind
end do

<table>
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<th>sensor/instr/sat</th>
<th>chan</th>
<th>iuse</th>
<th>error</th>
<th>error_cld</th>
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<td>1</td>
<td>1.98</td>
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<td>...</td>
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<td>...</td>
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</tbody>
</table>
```
estimated observation error for low peak and high peak channels
Mixed channels: separate observation errors for clear sky channels and all sky channels.
O-B assuming overcast

O-B using model’s cloud fraction

PDFs obtained by including cloud effect and model’s cloud fraction are much closer to Gaussian distribution.
Check O-B with model cldfrac for other channels
Check O-B with model \text{cldfrac} for other channels
Analysis PDFs response well by including cloud effect and model’s cloud fraction
CRTM cloud cover option

Using Paul’s crtm_v2.3.0-alpha branch with cloud cover computation

• Offline cloud fraction computation vs. CRTM cloud cover computation
• Calculate the total cloud cover (TCC) using the four overlap schemes from the cloud fraction profile (Morcrette and Jakob, 2000)
• Apply computed TCC to calculate the all sky radiances:
  • Include all the points
  • In radiance space
  • Over the ocean

\[ \text{Radallsky} = (1-TCC) \times \text{Radclear} + TCC \times \text{Radcloudy} \]
Weighted cloud fraction verification

- Cloud cover scheme is implemented in GSI code
- Total cloud cover calculated from CRTM RT solution is verified against offline GSI cloud fraction calculation
  - $\text{rt\_solution}\%\text{total\_cloud\_cover} - \text{Offline\_GSI\_cloud\_cover}$
Radallsky = \((1-TCC)\times Radclear + TCC\times Radcloudy\)

**Example of weighted cloud fraction calculated from CRTM and O-B departure from average overlap**
Radallsky = (1-TCC)\text{Radclear} + TCC\text{Radcloudy}

Example of weighted cloud fraction calculated from CRTM and O-B departure from maximum overlap
All the points over ocean

All the points over ocean with QC

➢ O-B GSI stats (no bias correction) for different overlap assumptions:

**Avg:** 0.3981826  **Max:** 0.5500953  **Ran:** 0.6193535  **MaxRan:** 0.5777849
Results from parallel experiment: 2015052500-2015072400
Results from parallel experiment: 2015052500-2015072400

North

TEMPERATURE

South

Tropics

North America

prlRct solid
prlRexp dotted
24-hr fcst
48-hr fcst

prlRct solid
prlRexp dotted
00z10Jun2015 - 00z24Jul2015
Results from parallel experiment: 2015052500-2015072400
Results from Global radiances monitoring package for Ch2889

Smaller O-B and O-A departure compared to control
MHS channel 3 unbiased corrected mean O-B/O-A for control and experiment

From IRctl

Mean Not Bias-Corrected Departure O-B channel 3

Mean Not Bias-Corrected Departure O-A channel 3
MHS channel 3 unbiased corrected mean O-B/O-A for control and experiment

From IRexp

Mean Not Bias-Corrected Departure O-B channel 3

Mean Not Bias-Corrected Departure O-A channel 3

All sky IASI experiment reduce MHS channel O-B/O-A bias
Summary and future work

• Assimilating IASI water vapor sensitive channels in all-sky condition show slight positive/neutral impact.

• Four CRTM cloud cover schemes were tested in this study and the average overlap scheme was selected.

• IASI All-sky radiances assimilation reduced the bias of other satellite instrument.

• Start a new parallel experiment using CRTM REL-2.3.0.

• Use International Satellite Cloud Climatology Project (ISCCP) data to verify cloud signal.

• Prepare for operational implementation.

• Apply the same methods to CrIS FSR.
Future work: Ongoing ASCAT-B winds assimilation

- Assimilating MetOp ASCAT-A winds project was supported by JCSDA during FY07-FY08.
- The current ASCAT-B winds assimilation efforts are being supported by NCEP/EMC.

2015052800 – 2015060800 All the points after QC
ASCAT Histogram by OBS SPD Range

ASCAT Histogram by OBS SPD Range

ASCAT Histogram by OBS SPD Range

ASCAT Histogram by OBS SPD Range

ASCAT-A

ASCAT-B
References

