Toward a better retrieval of fine water vapor atmospheric structures using IASI

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Motivation behind this study

• The first results of humidity profile retrievals in low troposphere with IASI were disappointing: accuracy less good than expected from simulations done before the launch of IASI.

• Problems:
  – channels with WV sensitivity in low troposphere are mainly in CO2 band with high sensitivity to Temperature
  – Bg covariance matrices often don’t take into account all local structures
  – temperature and humidity retrievals compensate and add incorrect structures elsewhere
  – large Observation covariance matrices do not allow to leave the initialization

• Question: is it possible to retrieve fine atmospheric structures from IASI data which are not present in the initialization profile?

• This study, test of:
  – dynamic selection of channels at each new processed data
  – reduction of T,q retrieval compensations
Dynamic selection of channels

Method:
- 1DVar Levenberg-Marquardt method.
- Guess: ECMWF 12h and 18h forecasts. 0.5x0.5 resolution.
- ECMWF Background covariance matrix. Global.

Experiments:
1. Standard run: 178 pre-selected channels (used for ECMWF oper runs)
   \( R_{mat} = \text{constant values @280K (1K LW, 0.4K, 2K water vapor, 0.6K SWIR)} \)
2. 178 channels
   \( R_{mat} = \text{CNES NeDt (apodized level 1c) band matrix + RTTOV noise} \)
3. In-line selection of channels:
   Rodgers method weighted by \( \Delta t_b \) (forecast -Obs) ->150 channels in 366 ECMWF sub-set.
4. Same as 3) but in a sub-set of 1700 channels in bands 1,2 sensitive to T,q

Data:
- Jaivex campaign clear-sky and marine situations
- IASI / Radiosonde CMS matchup file
Tests on Jaivex campaign (1/5)

Example on the 29/04/2007: marine clear sky case near a cloud layer

Dropsonde 1 – nearest IASI obs A about 10mn and 20km departure

M=0.09  s=0.46
Tests on Jaivex campaign (2/5)

Water vapor fluctuations: Impact of dropsondes differences on IASI spectra

- **Context**
- **Method/Data**
- **Results**
- **Conclusion**

**Results**

- **RTTOV Bts departure. residuals@280K**
  - Dropsonde 1 - Dropsonde 2

- **Adiabatic constant removed**
- **Black: dropsonde**
- **Blue: Plog interp. on 43 rttov levels**

- About 10mn and 60-70km departure between dropsondes
Tests on Jaivex campaign (3/5)

**Test 1**: 178 channels. Rmat=Cst values

**Test 2**: 178 ECMWF channels. Rmat= CNES NeDt band matrix

(Ret – IASI) Obs A: \( M=0.28 \) \( s=0.56 \)

\( M=0.12 \) \( s=0.50 \)
Tests on Jaivex campaign (4/5)

Test 3: In-line Selection of 150 channels in the ECMWF set of 366 channels

Test 4: Selection of 150 channels in a set of 1700 channels

Method/Data

Results

Context

Conclusion

Test 3: In-line Selection of 150 channels in the ECMWF set of 366 channels

Test 4: Selection of 150 channels in a set of 1700 channels

M = 0.20, σ = 0.49

M = 0.15, σ = 0.49
Impact on Averaging kernels area for IASI Obs A

1. 178 channels
   Rmat=cstes
   DOFS: 0.65(T). 1.35(Q)

2. 178 channels
   Rmat=NeDt
   DOFS: 2.81(T). 3.04(Q)

3. 150 channels_in_366
   DOFS: 2.34(T). 4.16(Q)

4. 150 channels_in_1700
   DOFS: 1.88(T) 4.34(Q)
Colocation dataset of radiosonde and nearest IASI Observation with
Distance <50km, time difference < 1h.
Compilation since the 1th of June 2009

Standard retrieval:
- 114 channels in 366 ECMWF sub-set
- ECMWF global Bmat

Test:
• In line channels selection in the 366 ECMWF sub-set.
• 2 steps with modified Bmat
  1. Temperature profile + Ts only. 50 channels.
     Increased Bmat values near surface + correlation Ts / Ta near surface
     Purpose: to fix the T profile to reduce compensations of T and q retrievals
  2. T,q profiles. 100 channels.
     Increased Bmat values near surface for q
     Reduced Bmat values near surface for T
IASI / RS matchup file (2/2)

Preliminary results: example on the dataset first situation
Conclusions

• Water vapor fluctuations can change quickly in small distances with:
  – impact on the spectrum could be much larger than noise for distances <50km
  – necessity of doing the WV retrieval at the IASI ifov

• A dynamic in-line selection of channels weighted by $\Delta B_t(\text{guess-Obs})$ helps retrieving WV fluctuations

• Due to
  – T and Q profile retrieval compensations
  – local structures in Bmat not in global matrix
  – small sensitivity of IASI spectrum to low level humidity profile

preliminary tests indicate that a first “temperature alone” retrieval helps retrieving WV fluctuations

This work will be pursued on RS/IASI co registrations