Report on 'Open Issues' discussion from former MIST/MIMAG group

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Background & Aim of reporting on previous list of ‚Open Issues'

- Bring some discussions from previous MIST/MIMAG group to the attention of the new IRS-MAG
  - Issues around IRS L1 and L2 products for different application areas
  - Highlights areas with need for further discussion and/or research activity (perspective of ~2012-2014)

➢ Status on some issues has evolved in the mean time
➢ Some issues are worthwhile to revisit (e.g. for new L2 retrieval approach)

Following report is based on the status at the time

➢ Summary presentation given to SWG in March 2014

IRS Repository of Open Issues

Christina Köpken-Watts (DWD)

as member of former MTG-IRS Science Team (MIST)

Members: S. Haan de, Ch. Köpken-Watts, A. Vocino, C. Serio, E. Pavelin, F. Friedl-Vallon, G. Camps-Valls, L. Lavanant, M. A. Martinez, P. Antonelli, P. Pascal, F. Rabier, N. Bormann, S. Tjemkes, R. Stuhlmann.

Contents

- Introduction and History of document
- Review of issues by application area
- Summary recommendations

Introduction

Aim of presentation:

- Report on state of discussion within MIST of open issues related to IRS and the resulting current recommendations prepared for 35th SWG (status of July 2013)
- Discussion of these recommendations within SWG
  – possibly leading to suggestions for further actions

History of the ‚Open Issues repository' document:

- Discussion on issues related to new MTG – IRS and planned L2 retrievals
  → Discussion paper at 30th SWG (J. Eyre, N. Bormann, E. Pavelin. F. Rabier and L. Stewart) :
  "Elaboration of user requirement for MTG-IRS products and implications for data processing methods: a discussion paper"

- Recommendation by SWG:
  → MTG-IRS Science Team (MIST) was invited to take discussion further to confirm and establish user requirements in all application areas
  → In developing MTG-IRS T/q products priority should be given to NWC/VSRF requirements.

Introduction

Discussion within MIST:

I) At several meetings with all members
II) Input from sub-groups and external experts for the different application areas

- **Global NWP and AMVs**:
  MetOffice (J. Eyre, E. Pavelin), ECMWF (N. Bormann), DWD (Ch. Köpken-Watts), MeteoFrance (F. Rabier)

- **Regional NWP**:
  MetOffice (J. Eyre, E. Pavelin), DWD (Ch. Köpken-Watts), MeteoFrance (F. Rabier)
  → In this area the MIST membership did not represent all users, discussions have therefore not reached conclusive stage for most open issues, wider input still needed.

- **Atmospheric chemistry**:
  MACC community, P. Prunet (Noveltis)

- **NWC**:
  NWC-SAF/AEMET (M. Martinez), MeteoFrance (L. Lavanant, J.-M. Moisselin, P. Santurette), DWD (Ch. Köpken-Watts), CNMCA (A. Vocino), MetO (J. Eyre)
  EUMETSAT NWC workshop (July 2013)

Open Issues - related to data compression

Spatial/temporal resolution: (NWPg.1,NWPr.1 NWPc.1, AMV.1,NWC.2,AC.2;Priority 1)

- L1: Aim for single product serving global to conv.-scale NWP and NWC, AC
  → full resolution, thinning to be done at user side
- L2 retrievals of T/q:
  → only for LAC4 (initially), potentially to be extended to full disk for AMVs
- L2 retrievals of atm. trace gases: full disk, best possible resolution

Spectral resolution for L1: (CR.1, AC.1, NWC.1, NWPg.1, **Priority 1**)

- PC compression is EUMETSAT baseline (~ 300 PC scores)
- Methods of lossless compression reviewed and discussed, compression ratios very likely not sufficient

Issues:

- **Preservation of** atmospheric, chemistry signals, PBL **signals**
  → EUMETSAT studies: vast majority of signal is preserved,
  noise reduction should be advantageous
  → Further analysis & application trials necessary to confirm this for all areas
- **Many scientific & technical implications** especially for data assimilation

Open Issues : Assimilation of PC compressed data

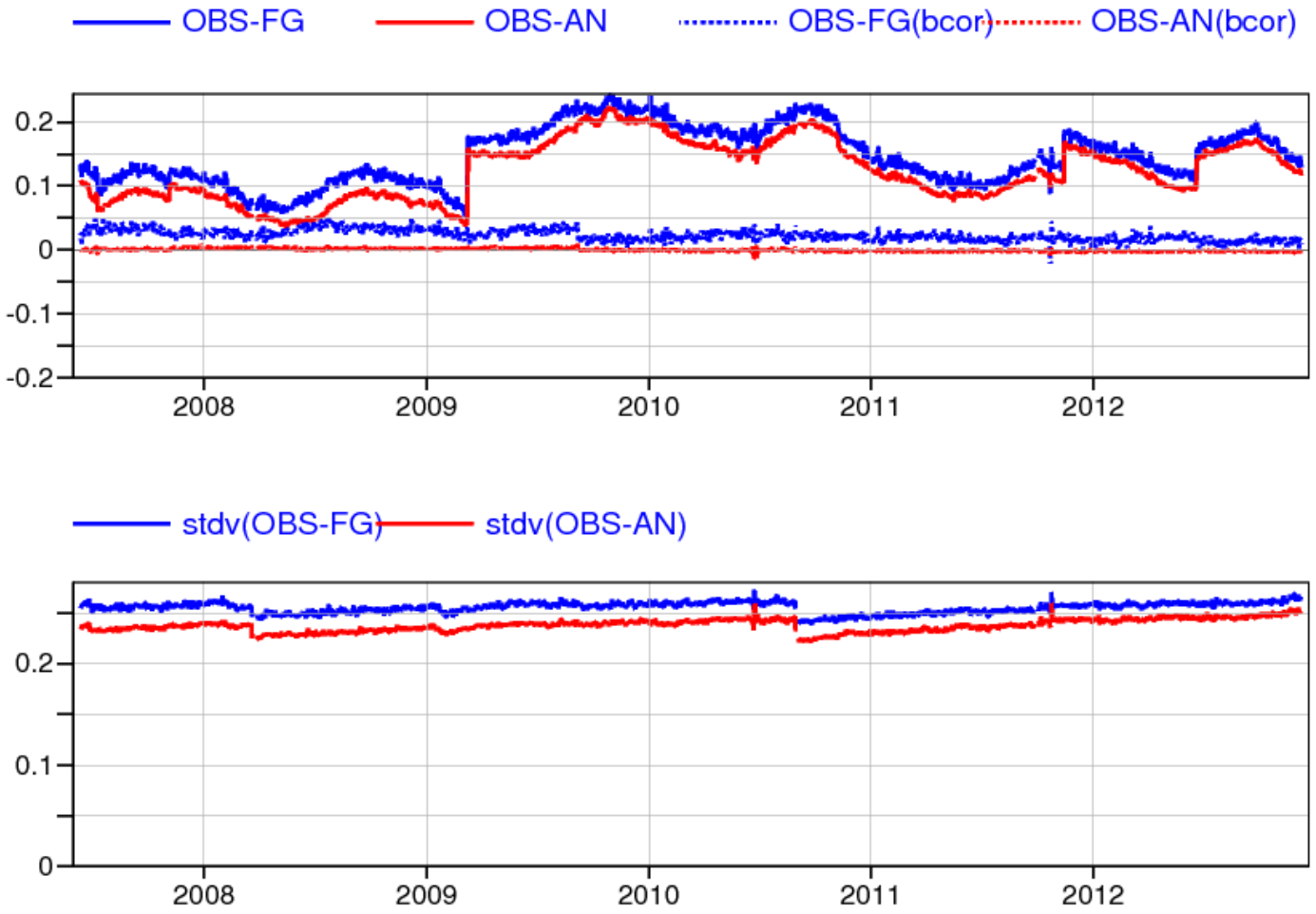
→ See also 36th SWG / DOC-14
(Discussion at ECMWF/EUM NWP-SAF workshop, Nov. 2013)

Technical issues, like:

- Specification of processing setup at EUM for PC generation,
  PC training dataset,
  Time needed to produce stable dataset after launch
- Need and coordinated mechanism for PC base updates
  (ensure correct PC base used)
- Monitoring at NWP centres → use reconstructed radiance space ?

Long-term monitoring

e.g., IASI channel 246, 14.159 µm



(Courtesy, N. Bormann)

Open Issues : Assimilation of PC compressed data

Assimilation issues: e.g.

- Error characteristics and their stability (e.g. volcanic events, slow drifts)
- Bias correction implementation
- Dealing with cloudy situations; potential spreading of cloud signal in reconstructed radiances through PC decomposition

- Evaluation of assimilation options: **PC scores or Reconstructed radiances**

  → No operational experience with any of these options (studies ongoing)

  → Need for further studies at NWP centres:

  - Confirm whether proposed L1 product specification allows successful use in NWP
  - Quantify potential deficiencies (also relative to other plausible PC representations)
  - Develop method and operational readiness for assimilation of PC scores or reconstructed radiances

Open Issues: Assimilation of L2 products (I)

Global NWP: (NWPg.3, Priority 1)

- Currently no interest in L2 product for direct assimilation
- May be needed internally for AMV generation

Regional / convective scale NWP: (NWPr.2, **Priority 1**)

- Potential users to confirm interest in this product
- Prior information: confirm that NWC applications are driving L2 requirements, (use of NWP background profile)

Issues for assimilation of L2: (NWPr.3, Priority 3)

- Appropriate use of L2 product in NWP implies

  - Dissemination of BG profile in addition to retrieval,
  - Dissemination of some information on the BG error cov. or averaging kernels

  → Discussion with identified users needed (considering volume limitations)

  → Studies on retrieval assimilation are ongoing

Open Issues: Assimilation of L2 products (II)

Issues for assimilation of L2: (NWPr.4, NWPr.5, NWPr.6, NWPr.7 **Priority 1 or 2**)

- **Horizontal error correlations** in L2 product:
  - Need to be assessed
  - Need to be addressed in assimilation: e.g. thinning, explicit treatment of errors (correlation both of OBS, and OBS with BG !)

  → Further studies and development of methods necessary

- **Biases in L2 product** need to be understood and require treatment
- Several bias sources:
  - Background profile, radiative transfer, radiances

- Improved use in NWP through dissemination of more **processing and quality indicators** with the product

Open Issues: AMVs

Area (AMV.1, Priority 1)

- Feature tracking probably requires retrieved humidity fields at full resolution

→ Suggestion: use NWC product for AMV derivation (LAC4 only at day 1) ;
If methods proves successful, extend L2 product and AMVs to LAC2/3/4

Method and error characteristics (AMV.2, **Priority 1**)

- Simulate AMVs and error characteristics, do they represent true winds most of the time ?
- Is direct radiance assimilation preferred to extract dynamical information ?
- Note: Interest in AMV product also from NWC

→ More research needed - and by whom ?, resources ?

Background dependence of AMVs (AMV.3, Priority 2)

- Evaluation of error characteristics needed

Open Issues: Atmospheric chemistry (MACC feedback)

L1 product: (AC.1, Priority 1)

- Interest (from MACC) stated for time horizon 2020
- Concern that atmospheric chemistry signals are preserved in PC-based dataset

L2 products: (AC. 2, AC.3, AC, **Priority 1**)

- Interest for day-1: CO, O3, NH3, also SO2; preferentially as profiles (some quality requirements indicated)
- Product list and retrieval density need to be confirmed in discussion with users
- Background information to be used: as close as possible to MACC-II system

L2 product use: (AC. 4, AC.5, **Priority 2**)

- Assimilation foreseen at both global and regional scale
- Dissemination also of background profile used and some information on BG error covariance or averaging kernels (not necessarily all for every profile and in NRT)
- Biases and horizontal error correlations need to be assessed and characterized

Open Issues: NWC + VSRF (I)

L1 data: (NWC.1, **Priority 1**)

- Interest in radiance product
- Focus on particular lines, potential PBL humidity signatures
- Tools for easy and efficient data use needed (e.g. conversion of PCs to radiances, different formats, compression issues, dwell concatenation, reprojection,…)

→ Interaction with NWC users needed
→ Research into how to best use high spectral information (radiance, PC space)

L2 retrievals: (NWC.3, **Priority 1**)

- Use of NWP background recommended
- Dissemination: also background profile (or increments) required
  Metadata about ECMWF forecast used (e.g. FC lead time)

Open Issues: NWC + VSRF (II)

L2 retrievals: (NWC.2, **Priority 1**)

- T, q profiles, but also e.g. Tsurf, cloud parameters, stability indices, integrated quantities, tropopause level, …
  → List needs to be established with NWC users
  → Which processing to be done where ?
  (at CAF? NWC-SAF? NWSs using centrally developed processing tools?)
- Discontinuity of fields problematic: interest in retrievals over cloud
- Multi-instrument products (e.g. IRS+FCI)

Accuracy versus timeliness: (NWC.4, Priority 2)

- Very stringent L2 timeliness requirement (before release of VSRF)
- Approaches may have to be investigated to meet **timeliness and high quality requirements** (e.g. Annex 2 of discussion paper Eyre et al.)

Need for training of NWC users (NWC.5, Priority 2)

Updated recommendations : Level 1 – PC product

Recommendation 1 (NWPg.2, NWPr.1, NWPc.1, NWC.1):

MIST recommends that the MTG-IRS **level 1 PC product** is to be generated and disseminated at **full horizontal and temporal resolution**, with selection and thinning to be conducted by users. In the interest of global NWP, this product should cover **all LACs**.

Recommendation 2 (NWPg.1, CR.2, CR.4, AC.1, NWC.1):

MIST recommends **early preparation of a more detailed specification of the level 1 PC product**, including options for a PC training dataset, a **specification of the processing** to generate this product, and a **specification of a mechanism for updating the PC basis in operations**. The specification of these aspects shall ensure adequate representation of atmospheric **chemistry signals** and potential signals **of low level/boundary layer atmospheric structures**.

Action: EUMETSAT to prepare an proposal for the technical and communications procedure to be followed if an update of the global PC basis is necessary in IRS operations. The proposal should be circulated to IRS-MAG members for feedback.

Updated Recommendations : L2 - assimilation

Recommendation 3 (NWPr.2-7, NWPc.2):
MIST recommends that EUMETSAT establishes **which NWP centres envisage to assimilate retrievals for regional or convective NWP.** These groups should confirm **whether they agree that NWC needs are driving the requirements for level 2** temperature and humidity retrievals for LAC4. Also, these identified users should work together with EUMETSAT to clarify **which additional ancillary information** is needed and on studies addressing issues related to the assimilation of retrievals.

Action: EUMETSAT to establish which NWP centres envisage to assimilate retrievals for regional/convection resolving NWP.

Action: NWP centres with interest in L2 retrieval assimilation should work together with EUMETSAT to specify which ancillary information is needed in the L2 products, decide on any additional necessary studies to address unresolved L2 assimilation issues and confirm whether NWC needs should drive L2 retrieval configuration, esp. w.r.t the choice of used a-priori profiles.

Recommendation 4 (NWPr.5-6, NWC.4):
MIST recommends that attention is given to **the treatment of biases,** in the **derivation and use of the level 2** data. Biases are expected to be present, for instance, in the background, radiative transfer, and other ancillary data.

Updated Recommendations : Atm. Chemistry products

Recommendation 5 (AC):

MIST recommends that the **potential and characteristics of a CO, O3, NH3, and Aerosol Optical Depth product** from MTG-IRS be consolidated, and be **considered for day 1 product generation,** in consultation with the MACC community.

Action: EUMETSAT to establish, with users, e.g. the CAMS community, the potential to retrieve atmospheric composition products (like CO, O3, NH3 and Aerosol Optical Depth) from MTG-IRS and consider whether this can be added as a Day-1 product.

Updated Recommendations : AMVs

Recommendation 6 (AMV.2, AMV.3):

MIST recommends that **EUMETSAT assesses current research in the area of deriving AMVs from humidity retrievals** and **to identify additional research needed**, including who should do it and how it might be resourced.

Recommendation 7 (AMV.1):

MIST recommends that the **standard MTG-IRS level 2 product, at full resolution, shall be used to generate AMVs for LAC4.** If the AMV product proves to be successful, the L2 temperature/humidity product should be extended to the other LACs to support the generation of AMVs in these LACs.

Updated Recommendations : NWC - L2 products

Recommendation 8 (NWC.2, NWC.3):
MIST recommends that a **NWP background is used for the Level-2 retrievals.** Additionally to the retrieval result, the **dissemination of retrieval increments (or first guess)** is needed to indicate to the forecasters the information coming from NWP and satellite, respectively. Also, additionally to temperature and humidity profiles, **surface temperature, and a number of derived 2D quantities like stability indices are of interest as well as quality information. The exact list** and specifications need **to be established in interaction with NWC users.**

The NWC community also considers a **wind product** derived from IRS as a very high priority.

Action: EUMETSAT to establish with NWC centres/NMSs:
- Is the NWP background still the preferred choice for L2 retrievals?
- Which additional retrieved parameters are needed (stability indices, integrated quantities) ?
- Which additional information is needed (quality indicators, used background profile, metadata)?
- Should some parameters be retrieved independently of a NWP background a-priori (e.g. surface parameters, stability)?

Recommendation 9 (NWC.2):
MIST notes that NWC applications prefer continuous fields and that therefore there is an **interest in the availability of retrieval results also above cloud top**. Additionally, **cloud parameters** are of interest to the NWC community.

Updated Recommendations : NWC - processing aspects

Recommendation 10 (NWC.1, NWC.2):
MIST recommends that for overall efficiency some **additional processing tools** should be developed and provided centrally (through CAF or SAFs), particularly for the **conversion of PC scores to radiances** and for the **derivation of additional products based on the Level-2 products.** Users should work together with EUMETSAT to establish which tools and end formats are needed.

Action: NWC-SAF and NWP-SAF to circulate their list of planned tools for IRS to IRS-MAG and NMSs to solicitate feedback on their plans and input for any additionally needed tools.

Recommendation 11 (NWC.4):
MIST notes that **fast delivery of products is crucial for NWC** and may conflict with the also high accuracy requirements. Therefore, possible approaches for speeding up the retrieval process probably need to be investigated (noting that a **latency of 15 min. should be aimed at** and that a latency of 60 min. will decrease its applicability for nowcasting purposes).
Recommendation: IRS-MAG welcomes the changes in the IRS dissemination baseline plans (15 min. latency for L1, 30 min. for L2 products). However, it is noted that NWC requirements are even more stringent (aim of 15 min. for L2), so that any additional options to further improve the latency of L1 and L2 products should be explored since this will increase the usefulness of the data.

Updated Recommendations : NWC - need for training

Recommendation 12 (NWC.5):

MIST notes that **specific and timely training of forecasters is needed** to ensure efficient use of **Level-1 and Level-2 products** in NWC and VSRF. MIST recommends that these training needs are taken into account for future **EUMETSAT training plans**.

Discussion: some thoughts…

→ further cooperative action required for several issues

- More user feedback needed, best way to collect this ?
- Which further studies may be needed ? Support necessary ?
  (→ e.g. AMVs)
- Interaction between EUMETSAT and key users – who are the best contact points at EUMETSAT and user side to carry issues forward ?
  (→ e.g. technical issues linked to PC scores product specification)
- Processing tools around L1 and L2 products for NWC
  (→ if this idea is supported, where should they be defined/developed?)
- Is it useful to review the status of the open issues in the table from time to time in SWG ?

Background from MIST discussion (summary N. Bormann)

Open NWP questions continued:

For assimilation of reconstructed radiances:

- RR will have inter-channel error correlations.
  Will they also have significant horizontal and temporal error correlations ?
- How to deal with these error correlations in assimilation – do they matter?
- Potential spreading of cloud information in RR?

Preliminary studies with RR for AIRS/IASI have been performed at ECMWF and MetO, but they did not address the above questions.

Relevant studies regarding error correlations of raw radiances at MetO, ECMWF, MF.

For PC scores assimilation:

- Benefits/additional issues for WV band?
- How do we deal with PC scores and clouds?

To be covered as part of Marco Matricardi's study at ECMWF.

What is better/more practical – assimilation of RR or PC scores?

- Simpler error covariances for PC scores?

No dedicated study yet.