IRS MAG - Action M7.A12
Plans for assimilation of L2 in NWP

Thomas AUGUST

MTG IRS 8th MAG meeting

EUMETSAT HQ, Darmstadt, 18-19/11/2019

Background of M7.A12 – Status at 7th MAG

M5.A10: which NWP centers envisage to assimilate L2 in regional/convection resolving models?

Concluding bullets from 7th MAG M5.A10

- **Surveys conducted in 2014 (SWG), 2016 and 2019 (User Services)**
- **no operational assimilation of retrievals** from hyperspectral
- **Little to no plans to assimilate L2 operationally**
  - *esp. ECMWF, M-F, DWD, UKMO had expressed several times clear positions for radiances DA*
  - *UKMO exploring assimilation of "transformed state vector" (new concept: complexities & unknowns)*
- **Radiances are the overall baseline**, wherever sounder data assimilation is in place or planned.
- At Day-1, L2 sounding products more likely to be directly used as profiles to support forecaster NWC.

Next steps, building on recent EARS-IASI L2 regional service and experiments (in Europe, US)**:**

- Monitor/learn from studies using retrievals in NWP, assess operational potential for some NWP centres
- User Services to conduct broader consultation, both in targeted audience and scope of the survey (e.g. including potential direct use of L2 products for forecasting), in particular as part of MTG User preparation (e.g. MTG-Up…)

- **Action M7.A12**

Action M7.A12

To complete the questions raised to EUM centres individually, **EUMETSAT to contact the leading entities of European regional NWP consortia as well as NOAA to know about their plans to assimilate L2 products.** Summary to be presented at the next MAG

** the question was raised with a focus on hyperspectral, but opened to satellite-based geophysical products in general*

Balasz SZINTAI, OMSZ
C-SRNWP Manager

B. SZINTAI is the C-SRNWP manager, contact kindly advised by M-F colleagues
- C-SRNWP is the Coordination of Short-Range NWP Programme in Europe
- C-SRNWP is part of EUMETNet, the Network of European Meteorological Services

- At his level of visibility and coordination, there are no plans to assimilate Level 2 products in limited area models, as all groups are concentrating on the assimilation of Level 1 data.
- The question was forwarded to the Expert Team on Data Assimilation (this team has experts from all European limited area modelling consortia)

One answer from Florian Meier, NWP group at ZAMG, part of Aladin/LACE Consortium.
- IASI Level 2 data are routinely used in the remote sensing department, to:
  - ✓ Evaluate other satellite products derived from MSG (e.g. icing)
  - ✓ Support “manual” nowcasting by the forecasters
- L2 are not assimilated so far, and there are no plans to do so in the near future:
  - ➢ Because IASI radiances are directly assimilated into AROME LAM.
  - ➢ Focus on rapid (hourly) cycling on small domains, where **polar orbiting data is of minor interest**.
  - ➢ However, **MTG more interesting** for that purpose.
  - ➢ From the regular meetings within the LACE consortium (CZ, SK, AT, HU, SL, HR, RO), no other countries tried to assimilate L2 data so far in their NWP configurations.

Sid Boukabara, NOAA STAR (Sat. Appl. & Research) Principal Scientist for Strategic Initiatives

- **Renewed interest in the US** but not with operational NWP perspectives at this stage. The idea of assimilating L2 has been around for many years.
- If presented with a solid demonstration, using an actual NWP system, and backed up with mathematical basis of why this is legit, it will get serious (re)consideration.

- **Increasingly high data volume:** multiplication of missions, denser in spectral and temporal. Using the retrievals might be a way to do data compression if nothing else, also noting the L2 performances nowadays, as compared to early days of the HSIR missions.

- **Some scientific studies with L2** were done in the US as well – different setup and mixed conclusions. If done correctly, e.g. if L2 are provided with meaningful error estimates and AK *[which can be achieved with ML too]* to serve in the observation operator, L2 could add value to the system.

- **Interfering uncertainties limiting rad. DA:** In particular in regions/layers where radiance assimilation is still limited due to uncertainties interfering in the forward modelling, e.g. in land surface emissivity, skin surface temperature, undetected clouds…

- **Other geophysical retrievals are currently assimilated**: AMVs, wind speed…

- Especially MTG-IRS is expected to provide 3D-winds estimates. These type of retrievals would not have any resistance to be assimilated as such (just like AMVs currently are).

Dave Turner, NOAA/ESRL (Earth System Research Laboratory)
Lead, Model Assessment Section, Assimilation Development Branch

- Question forwarded to the individuals in charge of the ESRL's regional models, RAP (Rapid refresh) -North America- and HRRR (High-Resolution Rapid Refresh) - 3-km resolution, hourly updated, cloud-resolving, convection-allowing atmospheric model.
  ➔ no individual answers, summary view/status below:

- Current status: **no retrieved thermodynamic profiles assimilated in RAP/HRRR**. Instead, handful of channels from low-earth orbiting sounders (CrIS and IASI) are assimilated.
  - Radiances -**only cloud-cleared so far**- will remain baseline for several years.
  - Known **issues with the fast radiative transfer models** in different cloud scenes. Assimilating retrieved profiles have hence been suggested in the past, and again recently, but lower priority for the moment.

- Some experiments of assimilating geophysical quantities retrieved from ground-based observations took place in 2011 and more recently (2019 papers). Including vertical sensitivity functions in the observation operator was discussed during the International Symposium on Tropospheric Profiling held in May 2019 in Toulouse. Focus on improving the boundary layer.
  ➔ Possible mutual learning here, including points from M-F and ECMWF studies.

Andrew Collard, IMSG @ NOAA/NCEP National Center for Environmental Prediction

- **No plans to assimilate L2 products in NCEP** models
- **Assimilation of radiances** (perhaps of reconstructed one day) will remain the **paradigm**.

- However, it could be interesting to investigate the old idea of using the L2 surface parameters –especially emissivity- in support of the assimilation of radiances* to update the background atmospheric profiles. Investigate if/how they can help better than e.g. static land emissivity atlases or forecasted surface skin temperature.

** this idea was also discussed during ECMWF-EUM Technical Bilateral meetings. Sketch study in answer to Action ST2016.4. Study re-oriented to other priorities.*

** Using retrieved land Ts and emissivity in support to radiance assimilation is also actual at M-F, with their own retrievals (e.g. A. Vincensini and N.Boukachaba PhD theses + recent communications at ITSC-22…)*

Conclusion and proposed way forward

- **Radiance assimilation is the established baseline**
- Assimilating L2: only recent and limited experience, with simplified settings
  ➔ encouraging results however.
- No immediate plans of L2 in DA currently, little momentum in Europe (NL? UKMO transformed state)
- Known limitations of assimilating rads: RT physics, data density (spectral, spatial, temporal), CPU?

➢ **Close question for now**

➢ **Pursue scientific studies with L2** assimilation and the underlying necessary developments:
  - ML including error estimates and AK, generation and evaluation
  - Utilisation of surface parameters, of 3D winds… in a radiance DA context
  - Share of experience with US (joint experiments?)
  - Evaluate operational potential: practicalities, added-value… (also as compared to results & complexity of the “transformed states”)
  - Mutually beneficial in any case: feed-back on L2 quality, review of L1 assimilation practices

➢ Re-open the question at a later stage
  - In an informed manner, with consolidated results and possible practical way forward
  - Address all NMHS systematically, covering all geophysical parameters, including global and regional models, Polar/Geo missions