Impact assessment of IASI temperature and humidity retrievals in the ECMWF system with scene dependent observation operators

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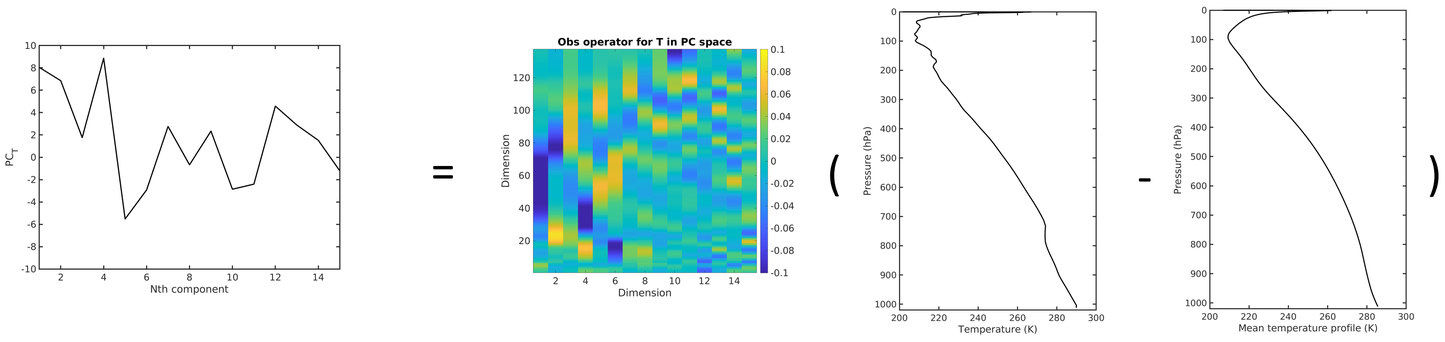
Introduction

EUMETSAT is producing forecast independent statistical retrievals of atmospheric temperature (T) and humidity (q) from IASI hyperspectral infrared radiances. This is done in preparation for the future product generation from MTG-IRS. Novelty of the product, provided in PC space, is to include scene dependent observation operators characterizing the vertical resolution of the retrieval information. The quality of the retrievals has been investigated and an impact assessment over sea has been performed in the ECMWF system, in depleted and in full observing system framework.

IASI all-sky retrievals

- Piecewise linear regression machine learning approach
- PC representation
- Scene dependent observation operators H_{scene} applied to the model background T/q profiles to obtain the model counterparts $x_{bg,PC}$.
- Normalised by retrieval errors, i.e. theoretical observation error for the retrievals is 1.

$$X_{bg,\,PC} = H_{scene}\,(x_{bg} - x_{mean})$$

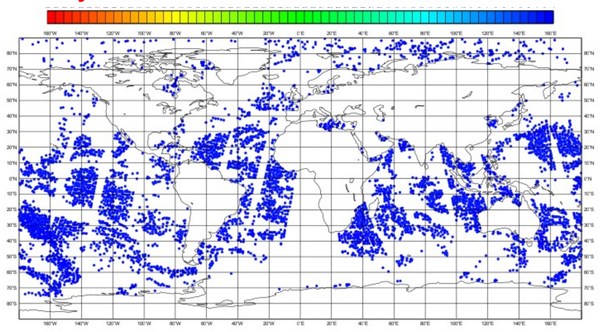


Impact assessment

Experiment setup, period 1.12.2019– 28.2.2020

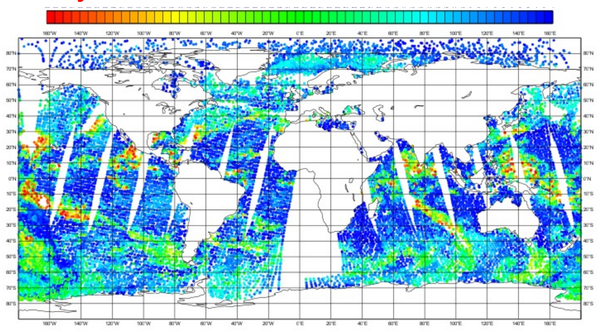
- **Baseline depleted**: conventional observations + AMSU-A (**100% line** in depleted observing system impact figures)
- **Baseline full**: All operationally used observations except IASI radiances (**100% line** in full observing system impact figures)
- **Radiance**: Baseline + Metop-C IASI radiances used over sea (**grey line**)
- **L2 clear sky**: Baseline + PC_T and PC_{lnq} retrievals from Metop-C over sea in clear sky scenes (**black line**), observations errors 1.5 for PC_T and 0.9 for PC_{lnq}
- **L2 all sky**: Baseline + PC_T and PC_{lnq} retrievals from Metop-C IASI over sea in clear and cloudy scenes (**blue line**), observations errors 1.5 for PC_T and 0.9 for PC_{lnq}

cloudy clear



12-hour sample coverage for active retrievals in clear sky (left) and in all-sky (right). Using data in all-sky more than triples the number of used profiles.

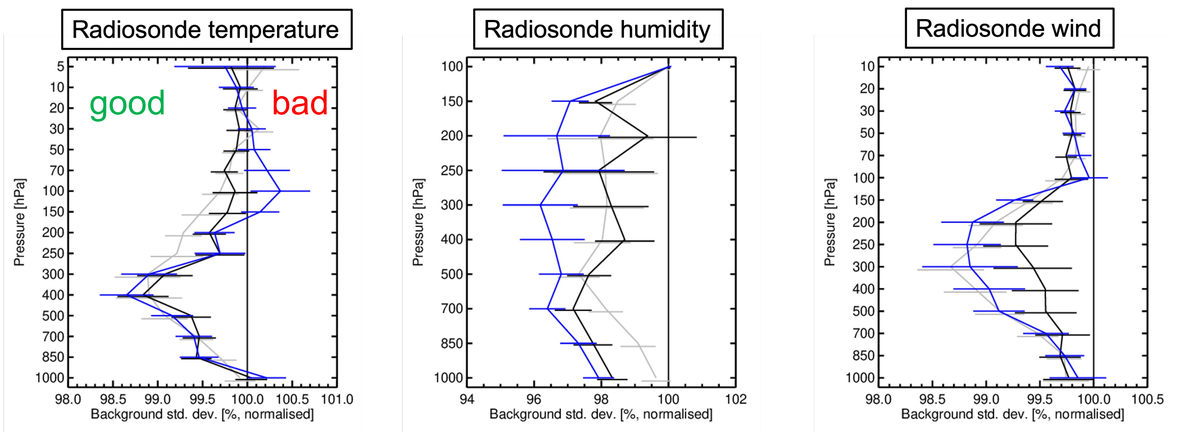
cloudy clear



Depleted observing system

In clear sky scenes the retrieval assimilation brings very similar information into the system to that of the radiance assimilation, especially for humidity, while the impact for temperature and wind is slightly smaller.

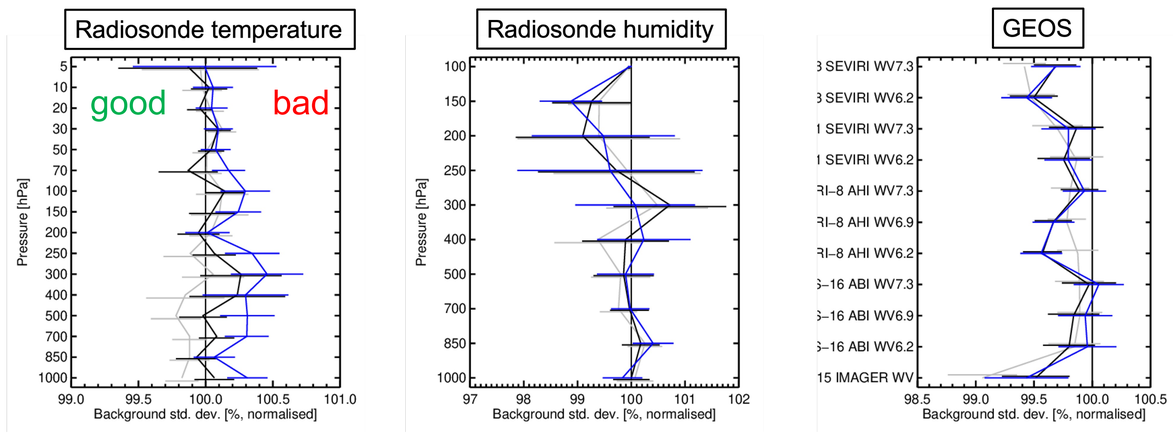
When the retrievals are assimilated in all-sky scenes the magnitude of the impact becomes comparable, for humidity the retrieval assimilation even outperforms the radiance assimilation impact. Some degradation is seen for temperature above 250 hPa.



Full observing system

The results indicate positive impact on humidity, similar to radiance assimilation, while the impact on temperature is mainly neutral when the retrievals are used in clear scenes.

In all-sky experimentation the humidity impact is positive, similar to impact from clear scenes. The temperature forecasts are currently degraded which would require further investigations and fine tuning the quality control and used observation errors.



Summary

The scene dependent observation operators, taking into account the vertical resolution of the retrievals, play a key role in order to achieve positive impact from the retrieval assimilation. The results in depleted observing system are extremely positive. In full observing system the impact is still more mixed and further investigations would be needed to exploit the full potential of the retrievals.