PC compression news

- **Upcoming changes to the PC compressed IASI L1C data**
- **Ongoing studies**
- **MTG IRS L1 PC dissemination**

16 June 2021, ASWG ITSC-23, Tim Hultberg

Outline

- **Upcoming changes to the PC compressed IASI L1C data (Nov/Dec 2021)**
  - New PC basis, v2.01 to replace v1.04 operational since 22/02/2011
  - Introduction of the hybrid approach (5 additional local basis vectors for each granule)

- **Ongoing studies**
  - Use of reconstructed radiances for AC/AQ applications (ULB/LATMOS and SPASCIA/UNIBAS)
  - Use of reconstructed radiances for assimilation (ECMWF)

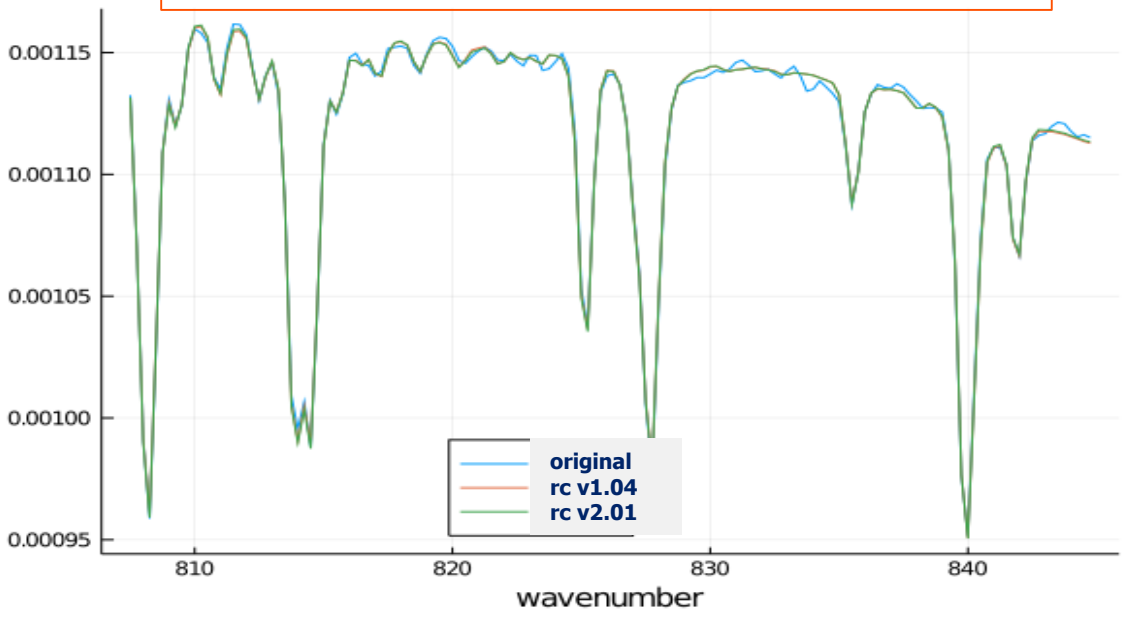
- **MTG IRS L1 PC dissemination**
  - IRS scanning sequence

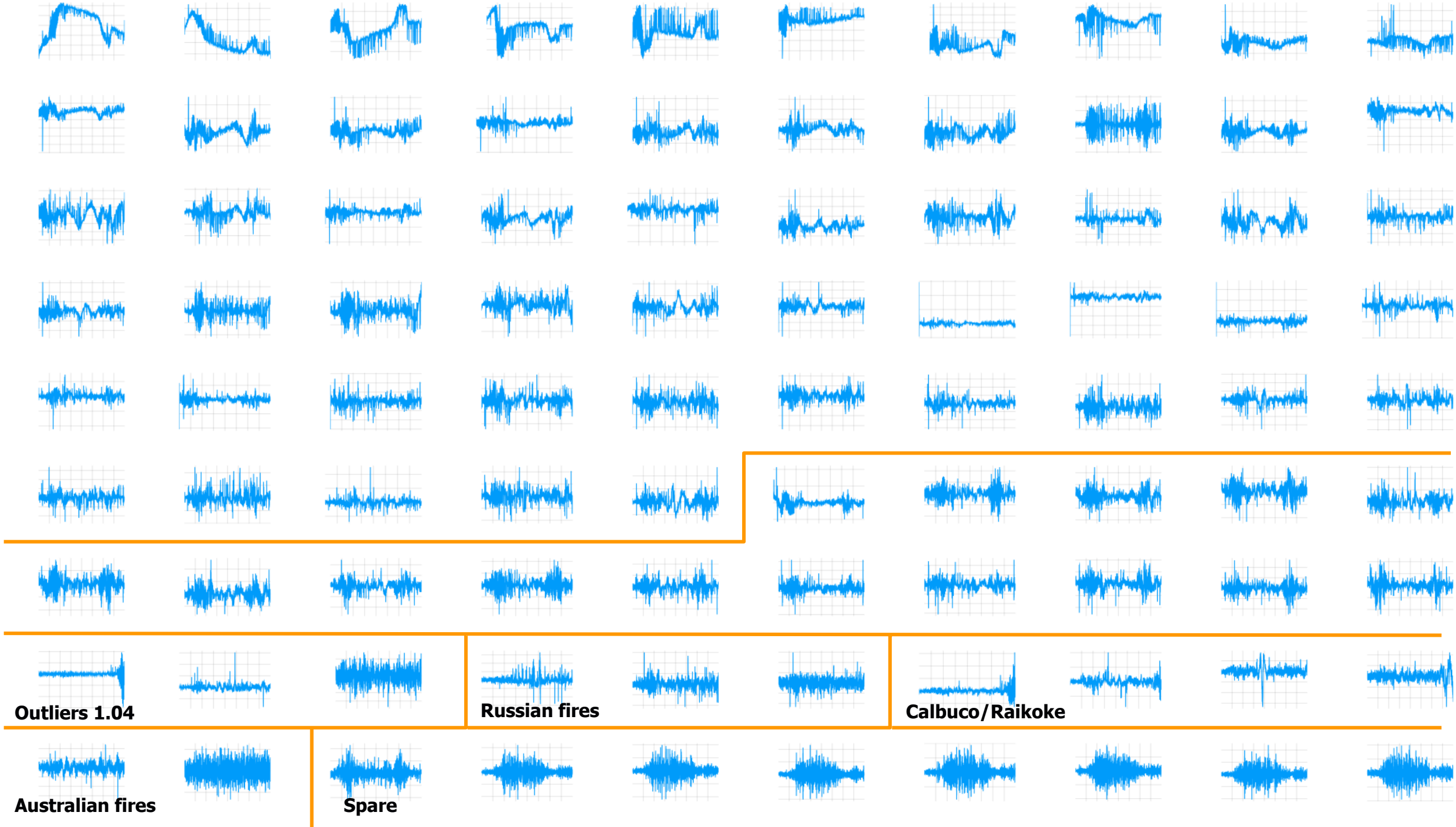
IASI PC Basis v2.01

- Full matrix noise normalisation
- **Optional** filtering of instrument artefacts not common to all satellites, pixels and CCDs
- Subspace (instead of affine subspace) – not centered around mean spectrum
- 153 million base spectra: 74 days of reprocessed IASI-A (2008-2019) 48 days of IASI-B (2013-2019)
- Adding directions from further events: Calbuco, Raikoke, Australian fires

	B1 [90]	B2 [120]	B3 [90]
Base common	**55**	**72**	**46**
Base artefacts	15	28	24
Outliers from v1.04	3	8	8
Russian fires	3	2	2
Calbuco+Raikoke	4	6	3
January2020	2	2	1
Spare	8	2	6

Despite being created very differently, the resulting radiances reconstructed from the two PC Bases are very similar




Outliers 1.04
Russian fires
Calbuco/Raikoke
Australian fires
Spare

The hybrid approach

What?

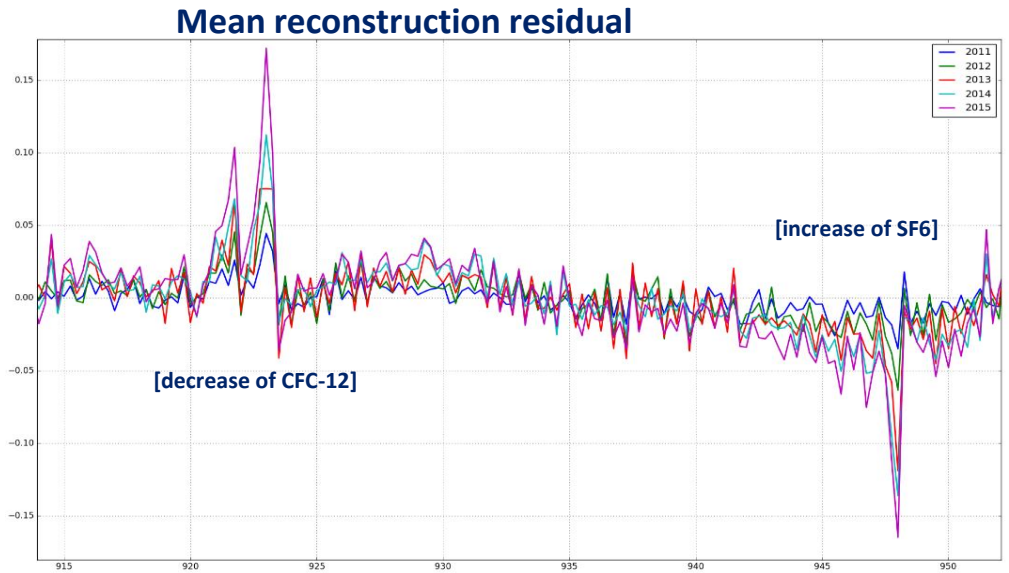
- 5 additional local PC scores based on the leading eigenvectors of the residual in each local granule

Why?

- To capture spectral features orthogonal to the subspace spanned by the global PC basis, which might originate from rare situations not fully captured by the global PC basis.
- To accommodate for atmospheric trends which can otherwise translate into trends in the reconstruction residuals

Limitations?

- A single outlier in a granule can not be distinguished from noise. We could modify the approach to use only 4 local eigenvectors and an additional PC basis vector based on the pixel with the highest remaining residual. [Transparent to users] [Global + Local + Superlocal]



Use of reconstructed radiances for AC/AQ applications

1. Apply existing retrieval algorithms to reconstructed radiances as well as original radiances and compare the performances against independent reference data.

2. Catalogue of rare but "*important*" spectral signatures. This might feed into the spare vectors of PC basis v2.01

3. They also looked at the hybrid approach: "

- Overall, the PCA, in most cases, does an excellent job in reconstructing the IASI spectra for exceptional events.
- However, residuals for these events regularly exceed by a large margin the IASI noise.
- The hybrid approach largely improves the reconstruction when the anomalies occur in several spectra (in a plume/ larger area)
- The hybrid approach does not help for isolated anomalies

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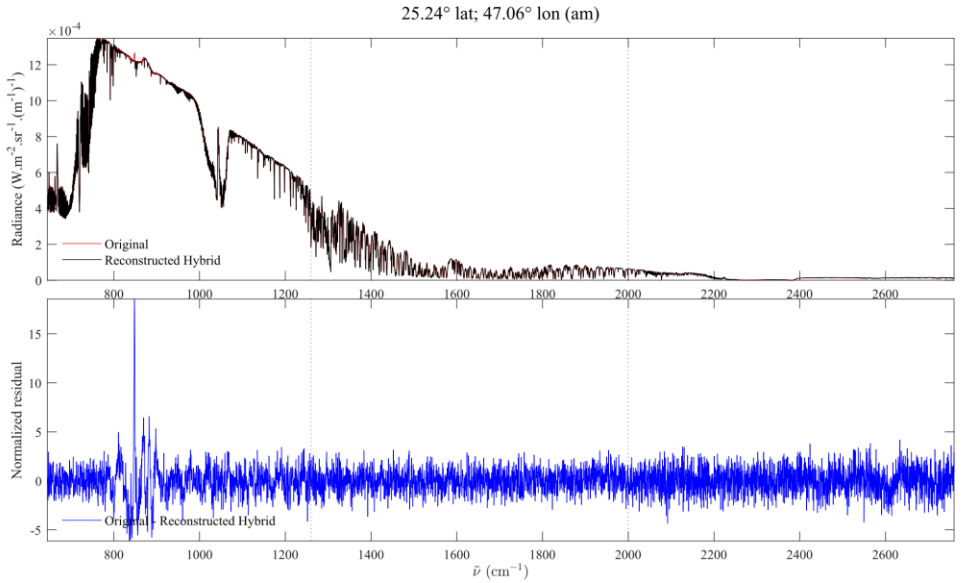

Noise normalised residual after hybrid approach for a single outlier

Use of reconstructed radiances for assimilation

Assimilation experiments in a depleted observing system show that the reconstructed IASI radiances have a positive impact similar to the original IASI radiances

- ➢ To be repeated in a full observing system

- ➢ Test an “on-the-fly” update of the PC basis (from v1.04 to v2.01)

See the ITSC-23 poster for more information

- ❑ No need to retune the assimilation when replacing original radiances with reconstructed radiances. (Only the part of the noise which is orthogonal to the directions of atmospheric information is removed)

ECMWF EUMETSAT

The assimilation of EUMETSAT reconstructed radiances for IASI data compression

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1 Introduction

Assume a situation where the EUMETSAT baseline dissemination system will only carry reconstructed-radiances data and the full Level-1 spectrum of conventional radiances will not be available in near real time. This study main aim is to establish if ECMWF (and by implication other NWP centres) could switch seamlessly to using the current EUMETSAT reconstructed radiance product with no modification of the data assimilation system.

The reconstructed radiances (RecRad) were generated locally at ECMWF using EUMETSAT PC compression basis (i.e., v1.04 and v2.01), applicable to all three MetOp IASI instruments.

The eigenvectors used for compression are characterized by: the noise normalisation matrix (e.g., v1.04 basis was derived using a diagonal noise-normalisation matrix applied to centred radiances; v2.01 basis was derived using a full noise-normalisation matrix and the radiances haven't been centred), the training set of spectra which consists of real L1C IASI spectra and the number of eigenvectors to retain (300 PC, regarded as an efficient encapsulation of the original data for transmission and assimilation).

Assimilation trials using reconstructed radiances equivalent of our IASI channels currently assimilated in ECMWF operations have been run, in an initial setup treating them similarly to conventional radiances (same observation error matrix and RTTOV). Their performance is presented here, in a depleted control system containing no active use of any infrared sounder radiances from polar orbiters.

2 Data and Experiments

Experiments for 1st Sept – 31st Dec 2020 and 1st Jan – 30 April 2021:

CTRL(depleted): similar to the ECMWF operational 4D-Var system, except for containing no active use of any IR sounder radiances from polar orbiters (3 IASI, 2 CrIS, 1 AIRS) and running at reduced horizontal resolution (TCo399, CY47R1.4)

Rad: As CTRL, but with MetOp-A/B/C IASI radiances added. IASI radiances are assimilated in clear skies and above low or overcast cloud.

RecRad v1.04: As CTRL, but with MetOp-A/B/C IASI reconstructed radiances added (i.e., generated using EUMETSAT v1.04 eigenvectors basis).

RecRad v2.01: As CTRL, but with MetOp-A/B/C IASI reconstructed radiances added (i.e., generated using EUMETSAT v2.01 eigenvectors basis).

We used the RecRad equivalent of our current operational IASI channels with no modification of observation error matrix (Fig.1) and RTTOV.

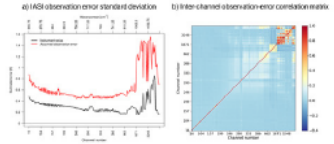


Fig. 1: a) Assumed observation error standard deviation for IASI. b) Inter-channel observation error correlations derived using the departure-based diagnostic methods (Bormann et al., 2010).

3 Impact on the data assimilation system

- A comparison between the mean and standard deviation of the background departures for original and reconstructed IASI radiances was performed (Fig.2). Reconstructed radiances show small differences in the mean, but marked reduction in the standard deviations of the background departures; the biases are generally unchanged; comparable data volumes passes the cloud detection algorithm;
- The RecRad and Rad experiments display very similar patterns of temperature and humidity analysis

3 Forecast Impact

- IASI Rad, as well as IASI RecRad provide statistically significant positive medium range forecast impact (Fig. 5)
- Humidity skill translates to wind skill (4D-Var tracing, Fig. 6)

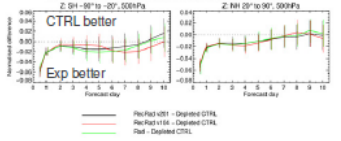


Fig.5: Normalised difference in RMSE of 500 hPa geopotential for Southern Hemisphere (left) and Northern Hemisphere (right). Negative values show an improvement from adding the IASI Rad (green) and IASI RecRad (v1.04 red and v2.01 black). Confidence range 95%. Each experiment has been verified against the operational analysis, with a total of 248 samples.

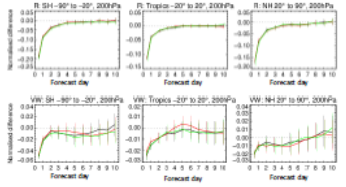


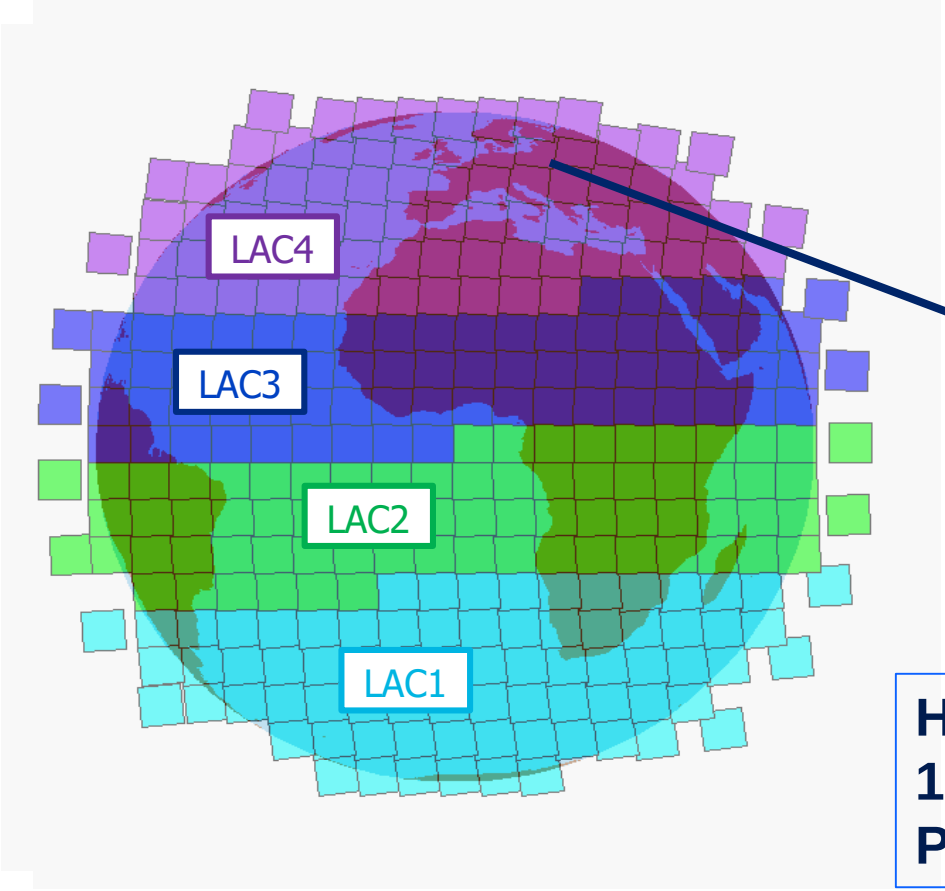
Fig.6: As above, but for humidity (top) and wind (bottom) at 200hPa over Southern Hemisphere (left), Tropics(middle) and Northern Hemisphere (right).

5 Conclusions

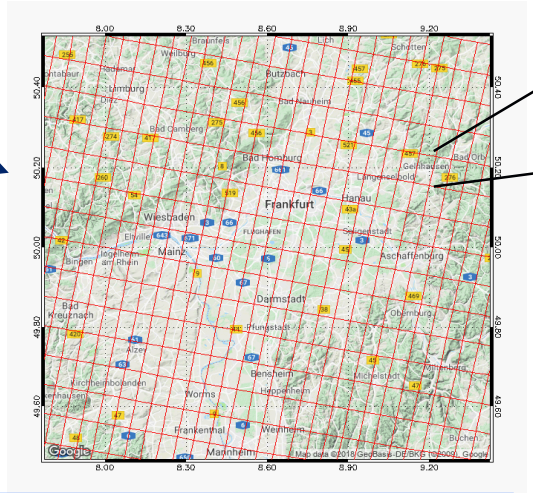
- The results obtained from the assimilation of IASI reconstructed radiances in a depleted

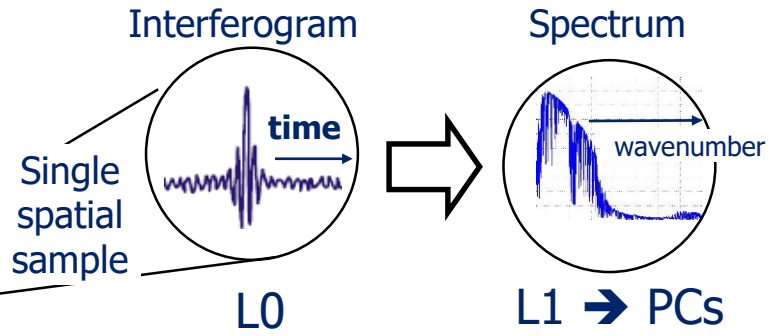
IRS scanning sequence and dissemination

- ✓ The Earth disk is split in 4 Local Area Coverage (LAC) zones, each of them covered in 15 min by a succession of “steps and stares” called dwells
- ✓ **LAC4** (northern mid-latitudes) will be covered **every 30 minutes**
- ✓ LAC1, 2, 3 will be alternatively viewed in-between



Each dwell consists of 160x160 pixels yielding a high spatial sampling





Hybrid PC approach
150 global and 5 local PC scores in each band

Dissemination of the PCs

- ✓**There are 12 LAC1, 12 LAC2, 24 LAC3 and 48 LAC4 per day**
- ✓**Size of a LAC is ~ 1.1G**

Conclusion

- www.eumetsat.int/changes-pc-compressed-iasi-l1c-data
  - IASI PC Basis v2.01
  - Hybrid PC compressed test data
  - Description of the planned changes

Hybrid PC approach will be used for dissemination of IRS L1 radiances

Hybrid PC approach to be introduced for PC compressed IASI L1C data

- Possibility to gain more experience for both EUMETSAT and Users

Coordination of possible refinements of the hybrid approach to better handle isolated outliers could be useful