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Mr. Trygve Aspenes, Mr. Janne Kotro, Mr.  
Adam Dybbroe and Mr. Lorenzo Clementi  
STG-OPSWG Representatives for Norway,  
Finland, Sweden and Switzerland respectively

STG-OPSWG Members

Your reference  
Votre référence

Your letter dated  
Votre lettre du

9 October 2015

Our reference  
Notre référence

EUM/OPS/LET/15/830281

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18 November 2015

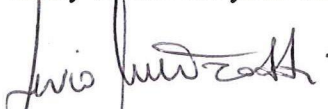
**Subject: Response to letter from Nordic & Swiss STG-OPSWG Members on FCI Level 1 Format**

Dear STG-OPSWG Members,

As announced during the 67<sup>th</sup> STG meeting, the Secretariat has prepared a response to the letter received from the STG-OPSWG representatives for Norway, Finland, Sweden and Switzerland concerning the FCI Level 1 data format.

The response can be found in the following pages. The Secretariat has the intention of reporting on the comments received on the FCI Level 1 test data set and Users Guide at the Spring 2016 STG-OPSWG. We are always open to answer questions and arrange discussions on the format and test data with the Delegates and welcome the feedback received so far.

Many thanks for your continued interest.



Livio Mastroddi  
Director of Operations and Services to Users

## Response to letter from Nordic & Swiss STG OPS-WG members on FCI Level 1 Format

Extracts from the delegation letter are indicated in bold italic, followed by the Secretariat response.

### 1 Data compression and decoding on the user side

***“The essence of the answer given to Sweden above by the Secretariat is that standard netCDF libraries will not be able to decode and read the data.”***

The Secretariat would like to highlight that the content is readable with standard netCDF-4 libraries that decode the data by calling HDF5 routines and will encapsulate the decompression software calls as described below. However, additional processing is required to:

- a. add geolocation information  
The location of the data chunk within the fixed grid together with a pointer to the coordinates of the fixed grid is provided in the dataset.
- b. convert the encoded radiances values  
CF compliant software may handle this for all channels apart from IR3.8. However; the use of the scale\_factor and add\_offset attributes is part of the netCDF best practices, but is not always part of standard netCDF libraries. For example standard C netCDF libraries do not apply scale\_factor and add\_offset automatically so packed integers require decoding.
- c. piece together chunks to form a complete repeat cycle image  
The data is transmitted as chunks in order to meet the timeliness requirements

For each of the points above, the Secretariat has the intention to provide example code fragments to illustrate how the data can be handled.

***“Has EUMETSAT considered other compression algorithms already available in the HDF5 library, but not (yet) in the netCDF4 API, and how do they compare to charLS, for instance SZIP?”***

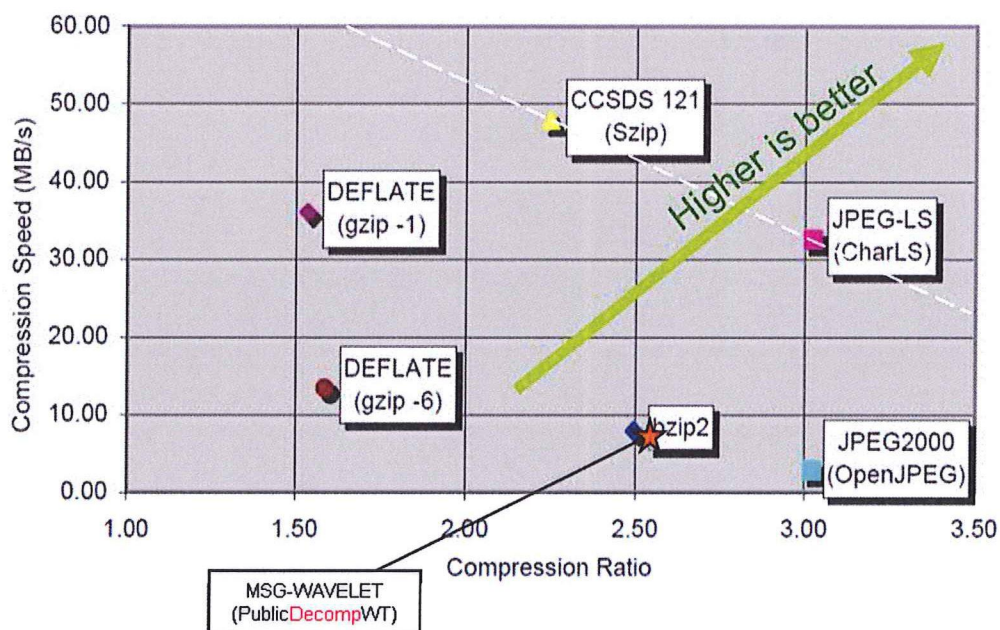
- ***How much bandwidth is saved using the proposed method compared to the gzip compression available today in netCDF?***
- ***How much bandwidth is saved compared to other HDF5 built in compression algorithms?”***

A EUMETSAT study using standard compression techniques on netCDF/HDF (gzip, slib, ...) was run in 2013. The results of the study are given in CMP-13-NT-1056-117, “LOSSLESS DATA COMPRESSION OF LEVEL 1 FCI DATASETS”, with the relative performance of the studied compression options given in Figure 1. The choice of the compression option to be adopted was based on the priority to reduce the data volume. Thus the compression ratio was considered as the most important element, followed by compression/decompression speed and then other items such as licensing arrangements and whether the technique was in common usage. From Figure 1 it can be seen that CharLS performs better than its two closest competitors when considering the compression ratio and compression/decompression speed. Further the compression offered by szip was not deemed sufficient to meet the MTG needs.



Note that compiling with szlib is optional for building HDF5/netCDF-4 so it is possible that using szip would have meant recompilation for a number of users.

	bzip2	JPEG-LS (CharLS)	CCSDS 121 (Szip)	JPEG2000 (OpenJPEG)	DEFLATE (gzip -1)	DEFLATE (gzip -6)	MSGWAVELET (PublicDecompWT_2.06)
Compressed Data Volume (MB)	111.82	<b>92.35</b>	124.28	92.35	181.90	175.94	109.46
Compression Ratio	2.50	<b>3.02</b>	2.25	3.02	1.53	1.59	2.55
Compression Time (s)	35.27	8.59	<b>5.83</b>	99.22	7.75	20.81	-
Compression Speed (M/s)	7.91	32.49	<b>47.87</b>	2.81	36.01	13.41	-
Decompression Time (s)	11.38	4.68	5.14	83.57	<b>3.26</b>	3.35	32.31
Decompression Speed (M/s)	24.52	59.64	54.30	3.34	<b>85.61</b>	83.31	8.64



Note: This provides an indication of the relative performance that could be expected from these implementations. The actual performance of the compressor with FCI scenes will depend on scene and instrument characteristics, including instrument noise

Figure 1 Compression performance of several lossless image compression tools tested on the 12 channels of a High Rate SEVIRI level 1.5 image.

***“What is the plan for EUMETSAT in the long term? Can it be expected that the modification to the library will be integrated upstream, so that it will be available in standard ways in the future?”***

The decompression works as a HDF5 Dynamically Loaded Filter (see <https://www.hdfgroup.org/HDF5/doc/Advanced/DynamicallyLoadedFilters/HDF5DynamicallyLoadedFilters.pdf>). Thus the user needs the HDF5 Dynamically Loaded Filter plug-in as well as the relevant CharLS (de)compression library. The Secretariat has the intention of registering the CharLS filter with the HDF5 group (see <https://www.hdfgroup.org/services/contributions.html>), hence the usage of CharLS should be as easy as any other compression technique supported by the HDF5 Dynamically Loaded Filter.

***“Considering that compression efficiency is so crucial, has EUMETSAT considered using the HDF5 file format, rather than netCDF, and thus having direct access to several efficient compression methods?”***

netCDF-4 uses HDF-5 as the underlying file storage format and the decompression filter is accessed in the way that is standard for HDF-5 files.

## **2 Format specification and CF conformance:**

***“How is EUMETSAT interacting with the CF community?”***

Beyond involvement in the CF discussion groups and mailing lists, EUMETSAT have yearly meetings with the netCDF team at UNIDATA.

***“Has the current format proposals been submitted for review to the cf-metadata mailing list as should be done with any dataset aspiring to CF compliance? The current proposal looks actually quite far away from CF conventions and more specifically from the work done by the cf-satellite group.”***

The current FCI level 1 format has been discussed with the netCDF team at UNIDATA; however the dataset is currently unable to be compliant with the CF Conventions as they apply only to netCDF-3 and do not consider netCDF-4 enhanced features (although we are aware of the work initiated on the CF convention 2.0). The work of the CF-satellite group is noted, but again is focussed on the netCDF-3 implementation and is incomplete for the purposes of FCI. However; there are some items that can be considered for inclusion in the FCI level 1 format, such as the use of the standard names suggested.

***“What is EUMETSAT’s engagement in the creation of CF 2.0?”***

During the interactions with the netCDF team and the postings placed on the mailing list it has become obvious that development work on the CF convention 2.0 is very slow. The Secretariat will continue to be involved with the CF convention; however an alternative approach is proposed, see §3.

***“Why is this document not mentioning the grid mapping in the CF conventions (<http://cfconventions.org/Data/cf-conventions/cf-conventions-1.6/build/cf-conventions.html#grid-mappings-and-projections> ) since the projection described here is the “geos”/“geostationary” projection available in proj. 4 and the cf conventions 1.7?”***



The Secretariat is aware of the various grid mappings. However; the published version 1.6 CF conventions has no appropriate GEOS projection (the vertical\_perspective projection is not appropriate). There have been discussions upon adding a GEOS projection as a separate mapping (CF Trac Ticket #72 from 2011) but this is not currently in the 1.7 draft convention, existing only as a proposal. Once the definition is available, the Secretariat will check it is appropriate for the FCI L1C reference grid projection and will then be able to make use of it. We would propose also keeping the necessary values for users to construct their own geolocated reference grids for those who are not using CF aware tools or in the case that the release of the CF 1.7 does not leave time for CF aware tools to be updated to handle the GEOS projection before we start making updated FCI datasets available.

### **3 Way forward regarding data conventions**

The Delegates' letter correctly highlights the need to investigate the creation of conventions for satellite data and the need for a strong EUMETSAT representation within the HDF/netCDF community. In the CGMS context (*i.e.* in response to CGMS action A42.05), focal points have been nominated to analyse, *i.e.*, the impact of new file format standards on the satellite data dissemination. The Secretariat will, within the scope of this CGMS activity, propose a coordinated approach to the development of conventions or profiles to be used for imager data. A first meeting of the CGMS group may be proposed for the EUMETSAT User Conference in 2016.

In parallel, the Secretariat will continue to investigate any synergies between the EUMETSAT LEO and GEO imager data formats currently being developed, in order to provide input to the CGMS activities.

Naturally, this work will extend to the other instruments for which EUMETSAT generate formatted data, and will highlight differences and similarities between the LEO and GEO instruments' data.

Finally, with respect to the CF conventions for netCDF, the Secretariat will continue to discuss the future versions of a convention, based on agreements reached with CGMS partners, with the target of obtaining a netCDF-4 inclusive version of a convention with which our datasets can be compatible.