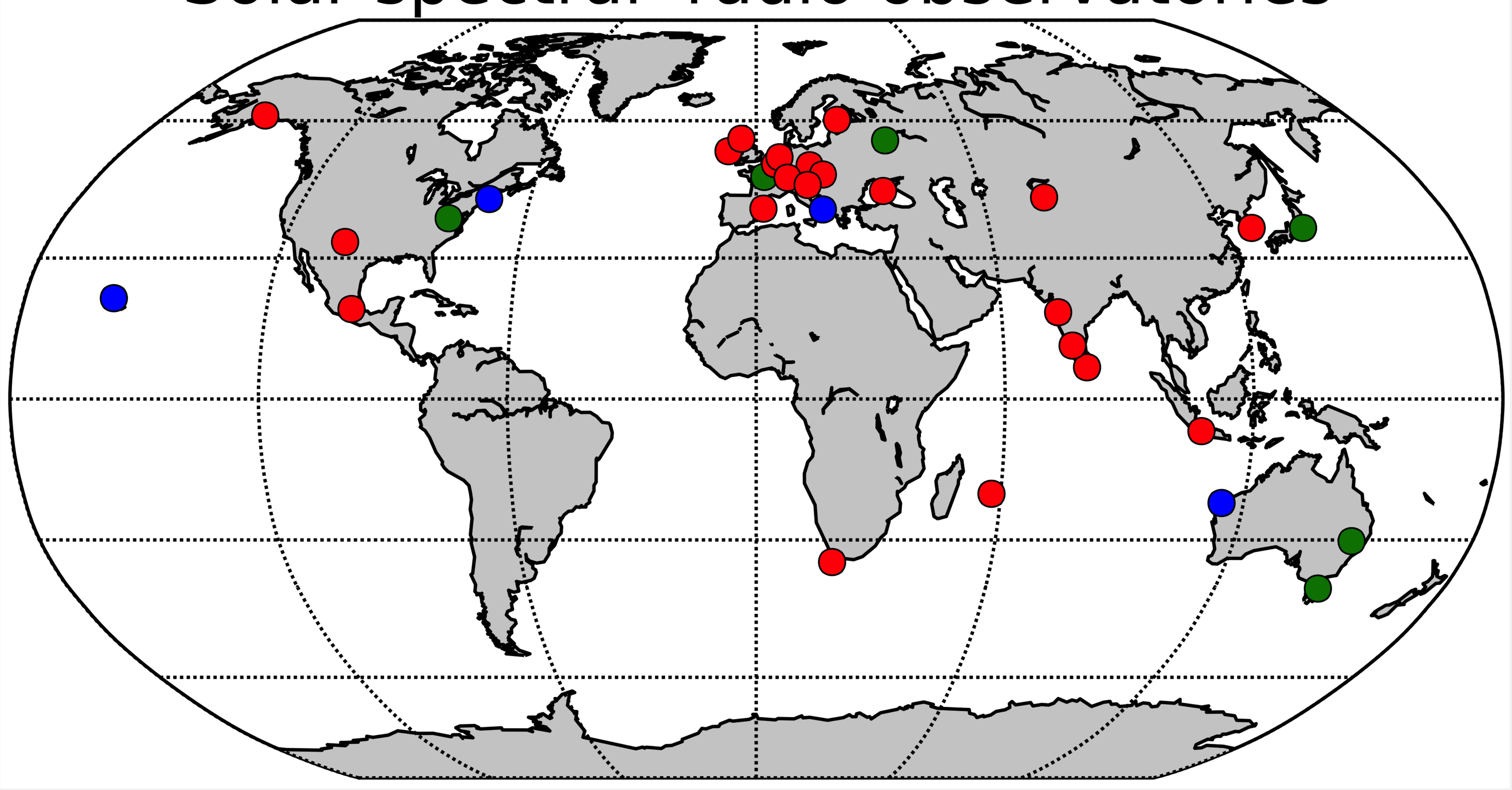
The Need for a Standardized Data Format for Solar Radio Spectrograms

C.Marqué[1], B. Bourgoignie[1]

Abstract: Solar radio spectrometers are a key element for the monitoring of the solar activity, providing information on flare-accelerated particles and shock waves propagating in the corona or the interplanetary medium. For historical reasons, each observatory operating such instruments (ground-based or space-based) has developed his own data format, sometimes proprietary, sometimes derived from international data formats (FITS, CDF,...). Even in the case international formats are used, this is done without much coordination, therefore hampering the possibility to easily combine these data together. We review here the current situation, discuss which information is needed for a better integration and propose some solutions.

Current situation

Solar spectral radio observatories



- RSTN network (US Air force), binary files
- E-callisto network, FITS files (non standard)
- Other observatories, binary files, FITS files, netCDF, IDL-sav

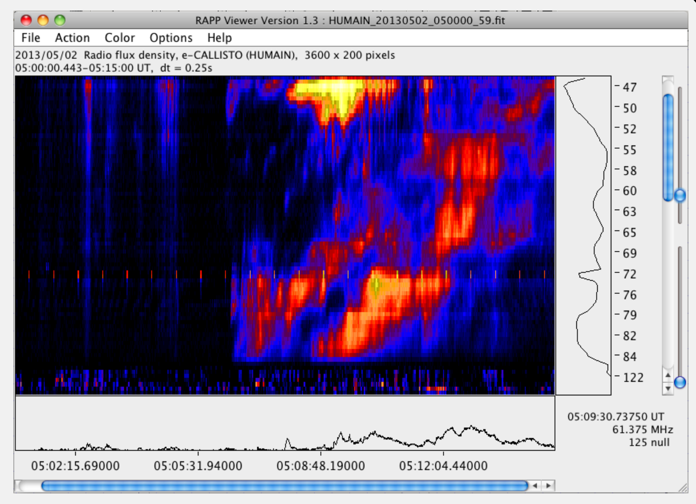
Non standard way of storing radio spectra (which axis is frequency, which is time), time & frequency array format, units and sub-units

Typical applications

Data analysis

- detecting radio burst time, duration, frequency range
- speed estimate for shock signatures (type II bursts)

Require interactive display of information (frequency, time)

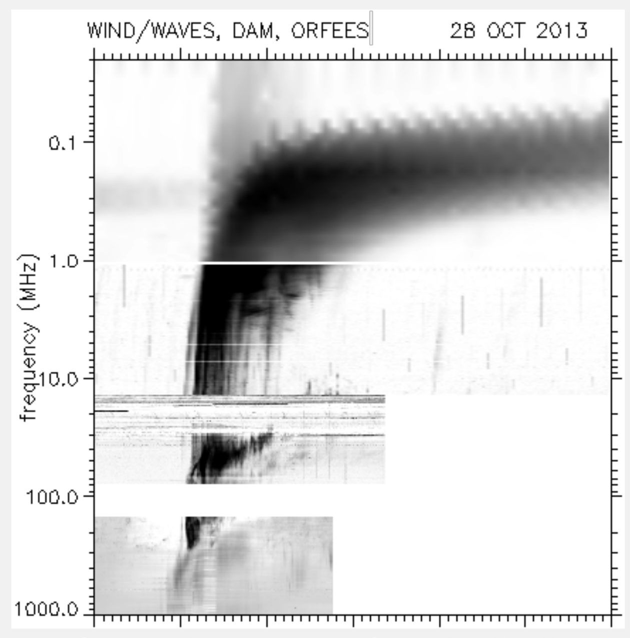


FITS viewer for e-Callisto (Courtesy ETH Zürich)

Composite spectra

- Solar radio bursts can occur in a very wide range of frequencies (especially for complex events)
- Interferences can be reduced by selecting "clean" frequencies

Time is expressed with different reference, frequencies are in different units



Composite spectrum from the Radio Monitoring page [1]

Monitoring of Solar Activity

With the current observatories, we could already have a 24 hours coverage of solar activity in radio. **The lack of common software and format is the only obstacle**

Possible solutions

Existing formats

- Different standards exist to store & share astronomical data
- FITS and HDF are the ones considered here as they are not linked to any proprietary software

HDF5

- Developed & maintained by U. of Illinois
- Designed to handle large & complex (heterogeneous) data sets
- Wide-spread use in Earth observations
- Large software support

HDF 5 format is the primary file format used by the LOFAR radiotelescope. The LOFAR consortium has defined a draft for dynamic spectra [2].

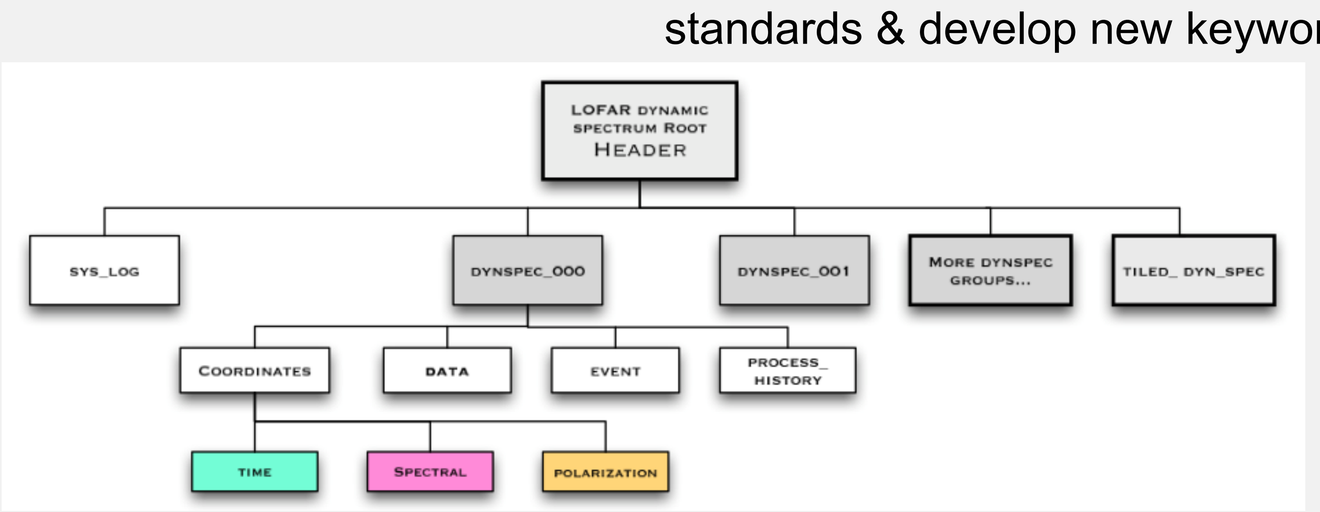
FITS

- Supported by IAU & NASA
- De facto standard for data format in astronomy (images)
- Expandable to different kind of data (timelines, interferometry visibilities ...)
- Broad software support

FITS is widely spread in the solar physics community.

Pro & Cons

- HDF5 is mainly designed to handle large datasets, and is probably not the best format for data exchange and easy manipulation
- FITS, being a known standard is probably the best choice for ground-based solar spectrographs, but an effort is needed to follow current standards & develop new keywords



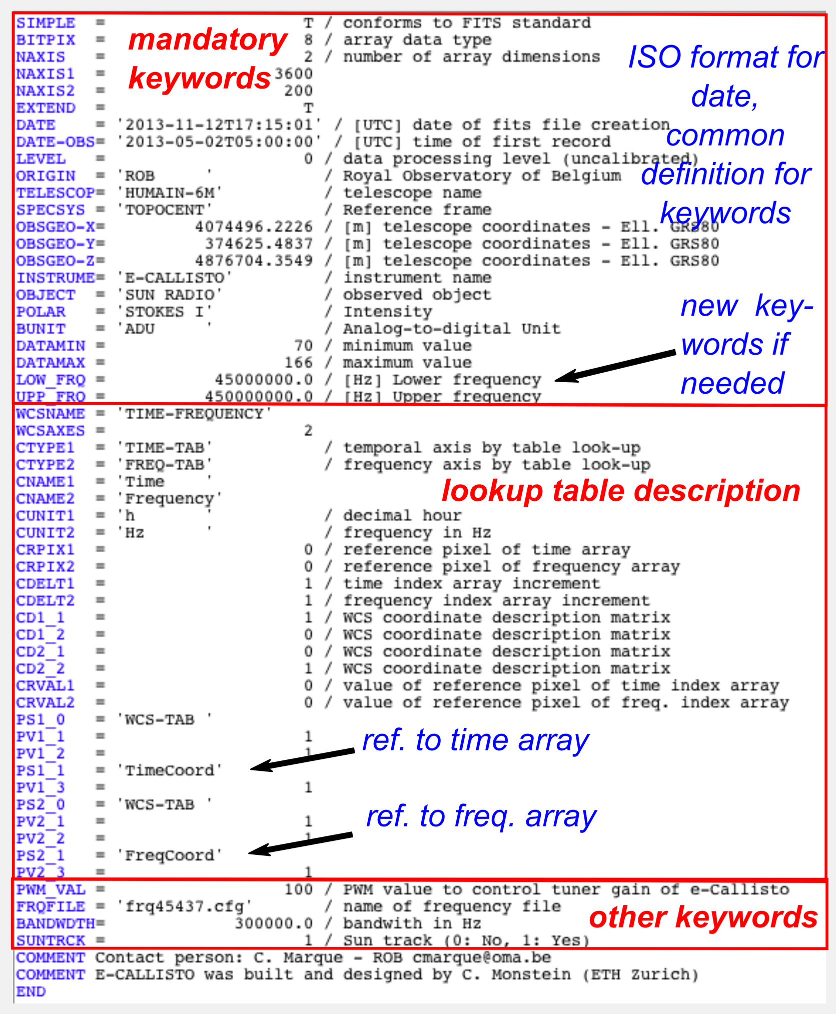
LOFAR data structure for dynamic spectra from [2]

A new FITS format for radiospectrograms

- Dynamic spectra are not classical image data
- How to store the time and frequency information related to each data axis?

Using existing FITS standards

- Greisen et al. paper [3] defines the official FITS standard for spectral data
- It allows to store non-standard coordinates in look-up tables, within the World Coordinate System (WCS)
- Primary header contains the keywords needed to identified the tables, stored in binary tables



Example of primary FITS header with lookup table related keywords

Conclusion

- A standardized format would allow a better sharing of relevant information for space weather and scientific applications
- Current FITS standards are readily available for such a step
- Little change required for existing softwares

- Different data levels can be foreseen to handle this information and extra keywords linked to meta-data

- The authors of this poster call for a white paper gathering all solar radio spectra providers to better define such a format.

Contact

Royal Observatory of Belgium
Ringlaan 3
1180 Ukkel
Belgium
cmarque@oma.be
bram.bourgoignie@oma.be

References & affiliations

(1) STCE - Royal Observatory of Belgium
[1] http://secchirh.obspm.fr
[2] LOFAR-USG-ICD-006.pdf, available at http://lus.lofar.org
[3] *Representations of spectral coordinates in FITS* Greisen, E. W. et al. A & A, 446, 747-771, 2006