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Starlink Software in 2013

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Abstract. Although the Starlink Project was closed in 2005, Starlink software continues to be developed and supported by the Joint Astronomy Centre for its data-reduction requirements. This paper summarises new features added since the *Kapuahi* release in 2012, with emphasis on the reduction of sub-millimetre data, illustrated with SCUBA-2 continuum images demonstrating improved fidelity, and STC-region support in the GAIA visualization tool.

1. Introduction

The Starlink Software Collection (ascl:1110.012) is an open-source software project hosted on github[1] that has been in constant development since 1980 (Disney & Wallace 1982).

2. Main Changes since the Kapuahi Release

The *Hikianalia* release was made in April 2013. The key changes relative to the previous *Kapuahi* release (Berry et al. 2013) and subsequent changes are detailed below.

64-bit Integer Support

Data sets have continued to grow in size and the need for 64-bit integers has become more important. The *Herschel* telescope generates data products with 64-bit integers and people attempted to convert these files into Starlink NDF format (see Economou et al. 2014, for an overview of NDF), with little success. Historically we had been reticent regarding the addition of support for 64-bit integers given varied Fortran compiler support for the `INTEGER*8` data type and requiring C99 compilers for a guaranteed 64-bit data type in C (`int64_t`). With modern compilers this is no longer an issue and type

[1]`https://github.com/Starlink`

_INT64 was added to the Starlink file format (HDS) and the application code dealing with multiple types was consistently modified to use code automatically generated by the G application. This required that many generic source files were re-generated from the derived files which had been committed during the switch to a unified revision control system back in 2005 (Gray et al. 2005).

Application Updates

Applications such as C , C and KAPPA all automatically received the ability to process data with 64-bit integers.

GAIA. A new toolbox was added for overlaying STC-S regions on an image.

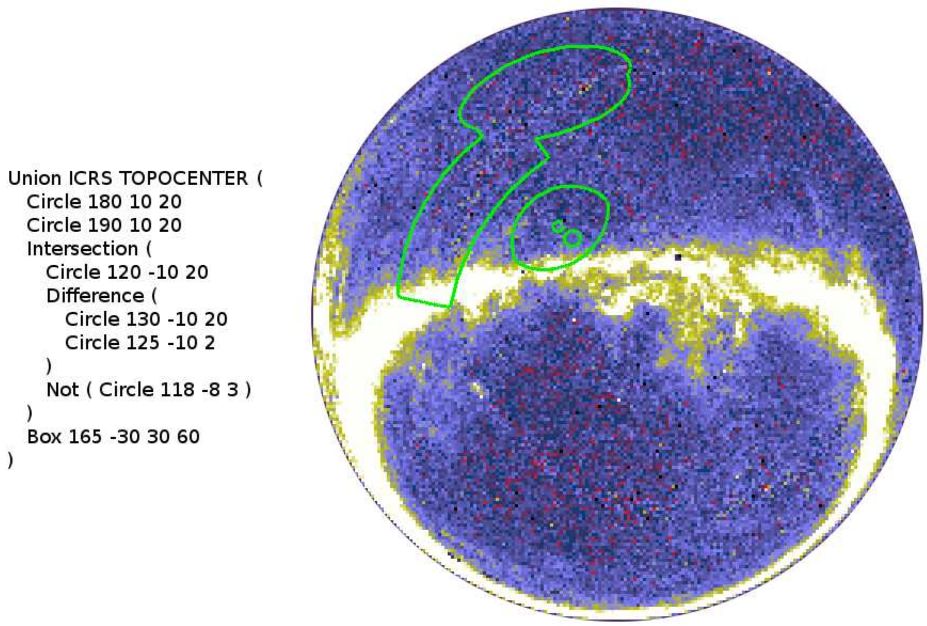

Figure 1. Capture of GAIA displaying an all-sky COBE image with the shown STC region overlaid.

KAPPA. Commands were added to report values of configuration parameters from a text file (using the standard configuration format supported by the G library) or NDF file history, and also to expand file lists.

Features were added to many commands including , , , , , , , , , and .

SMURF. The main focus of the *Hikianalia* release was to support the reduction of data from SCUBA-2 (Chapin et al. 2013). In particular a new approach to map-making was developed whereby all data are involved in each iteration rather than iteratively processing small chunks and coadding them all at the end. An example of this so-called *Skyloop* is presented in Figure 2.

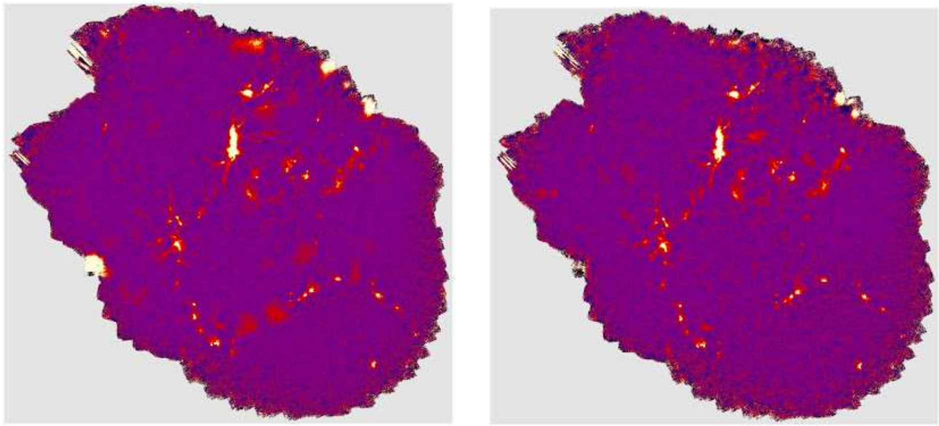

Figure 2. The left panel shows an example reduction of a SCUBA-2 continuum image without the Skyloop technique. The right panel shows the same data after application of Skyloop. Notice many diffuse false-emission blooms now disappear.

POLPACK. A new command has been added to rotate the reference direction of a pair of Q and U images.

SPLAT. Improved support for SSAP queries, with server grouping and new metadata parameters (see Dolensky & Tody 2004, for a protocol introduction).

Library Updates

AST. The AST library (see Berry & Jenness 2012, and references therein) can now read FITS headers that use the SAO convention for representing a distorted TAN projection, and can now handle missing `CNPIX1` and `CNPIX2` keywords in DSS headers. There were also modifications to flux conservation and normalisation in the rebinning routines.

NDF. The NDF library will now limit the maximum size of an NDF section. There have also been efficiency improvements in the way that provenance information is stored.

ORAC-DR

ORAC-DR (Cavanagh et al. 2008, ascl:1310.001) is the object-oriented perl pipeline used and developed at the Joint Astronomy Centre, but also used at other observatories such as Las Cumbres (Brown et al. 2013) and AAO for optical, infrared, and submillimetre data reduction.

Heterodyne. Further improvements to the detection of bad spectra (Currie 2013) include automatic emission detection or user-defined regions to excise emission from non-linear baseline detections, a filter to identify spectra with ringing (the same oscillation pattern appears in varying strength over tens of contiguous time series). Different options are now available to determine the receptor-to-receptor flat field.

The ACSIS/HARP pipeline can now process most data from the earlier DAS backend, arising in part from better merging of hybrid data, instrument-specific quality assurance criteria, and baseline correction in line forests.

Although the goal is to provide high-quality results automatically for the JCMT Science Archive, many new tailoring recipe parameters, such as to control memory requirements and the creation of a longitude-velocity image, have been added.

SCUBA-2 & PICARD. A number of data-quality analysis recipes have been added that allow an assessment of the properties of SCUBA-2 data.

- Instrumental noise—This helps identify excessively noisy data that can be excluded from the map-maker (`ASSESS_DATA_NOISE`).
- Calibration consistency—Calculate flux-conversion factors and beam sizes of standard sources to check calibration quality (`SCUBA2_CHECK_CAL`). This includes fitting of the source peak for FCF calculations now attempts to fit two Gaussian components for high (100) signal-to-noise ratio images of calibrators.
- Output map noise—Calculate the noise and NEFD from the map, compare with those derived from noise calculations and the SCUBA-2 integration-time calculator (`SCUBA2_CHECK_RMS`). Calculate the spatial power spectrum and determine noise power on scales up to a high-pass filtering scale (`SCUBA2_MAP_PSPEC`).

Documentation

Documents are now created as PDFs instead of PostScript. Further details of the changes can be found on the Starlink web site. (`http://www.starlink.ac.uk`)

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