Starlink: the 2025A release

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Abstract. Starlink is an open-source collection of software for astronomy containing tools for data reduction, analysis and visualization. It is currently maintained by the East Asian Observatory to support processing of data from the James Clerk Maxwell Telescope. Recent development has focused on handling problematic data, bug fixes and improving the "summit" pipelines used by the telescope operators.

1. Introduction

With its origins in the UK-based Starlink Project, the Starlink software collection is currently maintained by the East Asian Observatory, primarily to support data from the James Clerk Maxwell Telescope (JCMT). The software is open source and available from GitHub[1] with release packages available from the Starlink website.[2] Starlink releases also include StarJava applications (such as TOPCAT, Taylor 2005) and the ORAC-DR pipeline (Jenness & Economou 2015).

2. The 2025A and 2023A Releases

The 2025A and 2023A releases include the last four years of developments since Starlink was last presented at ADASS XXXI (Bell et al. 2024). While much of the work of preparing the releases went into bug fixes and updates for modern compilers, we present some of the more notable updates in the following sections.

2.1. Developments for Modern Systems

Starlink is now available via Flatpak[3] for easy installation on a variety of Linux distributions. Flatpak is an application packaging and sandboxing system where software is built for a particular standardized platform. The system installs the platform and application and can then run them in an isolated environment. Since the intention of Flatpak

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

[2]`https://starlink.eao.hawaii.edu/`

[3]`https://flatpak.org/`

is to distribute desktop applications, a single command to run is required — it was decided to simply make this a shell (running in a terminal) with the Starlink environment set up. An optional extension containing StarJava is also available.

Various scripts were converted from `csh` to `sh` to allow usage on systems without `csh` installed. Python scripts were changed to specify the interpreter as `python3` instead of the unversioned `python` command as this is no longer present on all systems.

Multi-threading has been added to more applications: the GaussClumps method of the CUPID clump finding package and the BLOCK image smoothing application of the KAPPA package. There were various bug fixes related to multi-threading in the NDF and ARY libraries.

2.2. Improved Support for MOC and HiPS

Support for IVOA MOC (Multi-Order Coverage) maps has been improved in the AST library allowing small features to be added to lower resolution MOCs. The outline tracing routine has been made more reliable with the addition of a backtracking algorithm, allowing GAIA (image / data cube viewer) to plot more complex MOCs. An example is shown in Figure 1. GAIA also now only attempts to draws the relevant part of a MOC by first computing the intersection with the area of the current plot. Finally a new command MOCGEN was added to the KAPPA package to create a MOC of the region covered by an image.

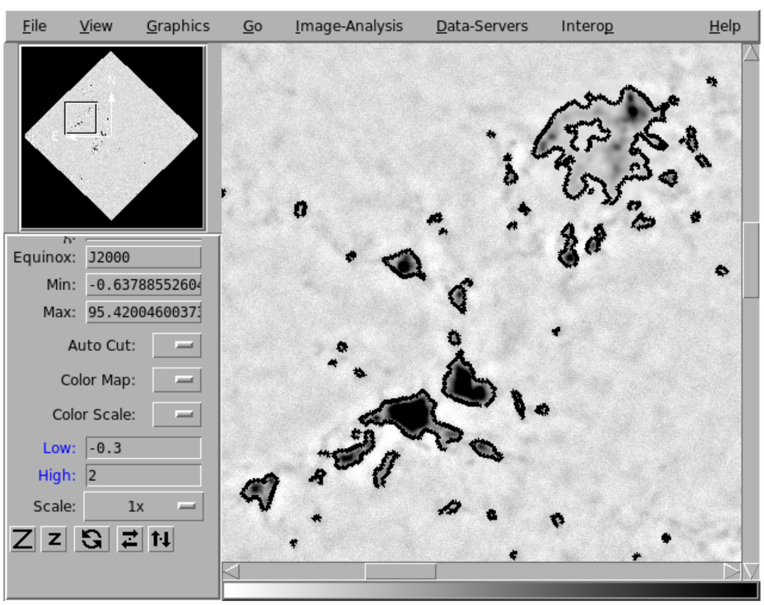

Figure 1. The GAIA image viewer showing a SCUBA-2 map with a MOC of detected emission outlined in black.

The PICARD MAKE_HIPS recipe for constructing HiPS (Hierarchical Progressive Survey, Fernique et al. 2015) structures has been made more efficient and can now take “JSA tiles” (tiles with a HEALPix projection as used in the SCUBA-2 legacy release) as input.

2.3. Updates to JCMT Data Processing

The SCUBA-2 (Holland et al. 2013) and heterodyne pipelines have been updated to produce preview images for pointing, focus and noise observations. While this functionality is available to anyone running the pipelines, it is most useful in the context of the observatory's WORF (WWW Observing Remotely Facility, Jenness et al. 1997) system, which now collects images from the real-time pipelines and makes them available immediately to observatory staff and members of related observing projects. Example preview images are given in Figures 2 and 3.

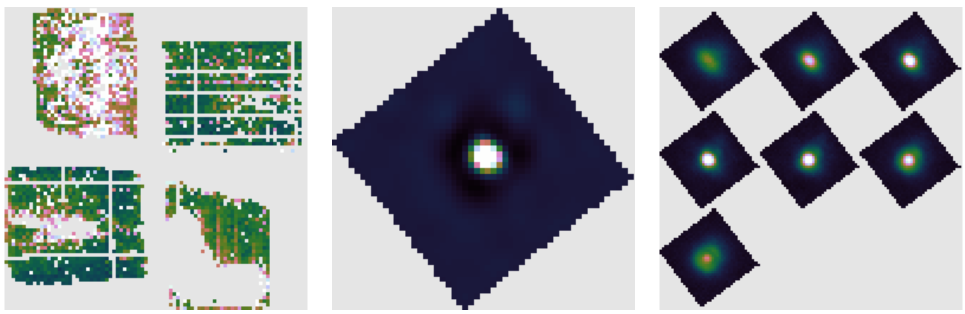

Figure 2. Preview images created by the ORAC-DR "summit" pipeline for SCUBA-2. *Left:* a noise map. *Center:* a small region extracted around a pointing source. *Right:* thumbnails generated by pasting together the planes of a focus cube where each was observed at a different position of the secondary mirror.

Figure 3. Preview images created by the ORAC-DR "summit" pipeline for heterodyne instruments. *Left:* a representative spectrum from a pointing observation. *Center:* a map showing the 5-point pattern used for pointing observations. *Right:* a graph showing the result of adjusting the position of the secondary mirror (SMU) in a focus observation.

A new routine was added to validate the telescope position by comparing the actual and demand positions found in the `JCMTSTATE` extension. This is used by the heterodyne reduction application MAKECUBE allowing the exclusion of individual samples which are out of position.

A number of new recipes were added to the Wesley (Bell et al. 2025) pre-processing pipeline. This software has proven to be a successful way of handling problematic raw data. The new recipes are listed below:

CLEAR_HEADER_SIMULATE Clears the `SIMULATE` header, for use with data known to have been incorrectly flagged as observed with telescope systems in simulation mode.

COPY_BLANK_HEADERS Attempts to fill blank headers using values from other files of the same observation.

FILTER_DOME_OPEN Selects only files where the headers indicate that the telescope dome was fully open. This is useful when the telescope operator was forced to close the dome due to worsening weather conditions but was not able to abort an observation in progress.

FIX_HEADER_IFFREQ Rewrites the `IFFREQ` header if it was written with insufficient precision based on the OCS (Observatory Control System) configuration XML included in the raw data files.

FIX_HEADER_LST Corrects the `LSTSTART` and `LSTEND` headers using the times stored in the `JCMTSTATE` extension of the raw data files.

FIX_HEADER_STEPTIME Sets the `STEPTIME` header from the OCS configuration XML included in the raw data files.

FIX_INCONSISTENT_OBJECT Makes the `OBJECT` headers of all files in a group the same. This is to avoid issues when the data reduction software merges the headers of the input data files. Headers that differ unexpectedly are removed, but the `OBJECT` header is required when archiving the group products.

REMOVE_NAN_VALUES Removes floating-point 'Not a Number' (NaN) values from raw data files, replacing them with the appropriate Starlink bad values.

3. Conclusion

The 2025A release brings the Starlink software collection to a variety of modern systems, including via Flatpak on Linux. It also includes useful updates for JCMT data processing and handling of MOC maps.

References

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