stisblazefix Documentation

Release 1.1

Malinda Baer, Charles Proffitt

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> **Warning:** Please note that AURA/STScI is not responsible for any damages resulting from the use of this software.

The `stisblazefix` python module is designed to empirically correct STIS echelle data for misalignment in the blaze function. It does this by shifting the overall sensitivity curve applied to each order to find the shifts that make the measured flux in the wavelength overlap of adjacent echelle orders most consistent, under the assumption that the shift to be applied to each echelle order is a linear function of the order number.

Once installed, the `fluxfix` function of the module can be run by supplying a list of STIS echelle *x1d* FITS file names, as well as an output name to be used for the PDF diagnostic plots produced. For example:

```
stisblazefix.fluxfix(['ocb6i2020_x1d.fits', 'ocb6f2010_x1d.fits'], 'example.pdf')
```

This will produce as output the files *ocb6i2020_x1f.fits* and *ocb6f2010_x1f.fits* with corrected values for the extracted flux and error vectors, as well as a PDF file with a diagnostic plot for each exposure showing changes made to the data.
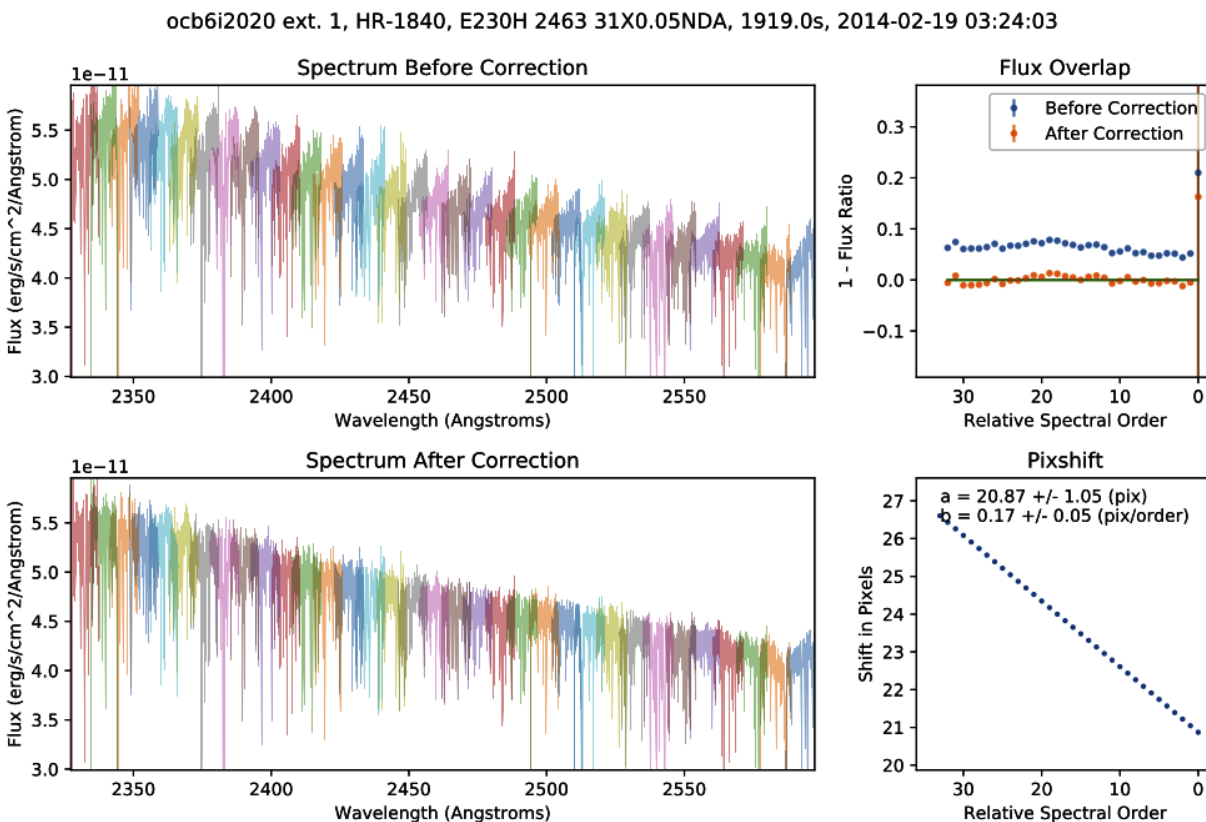

Fig. 1: Example blaze correction to HST/STIS E230H dataset OCB6I2020.

See also:

See STIS ISR 2018-01 for details on the correction.

INSTALLATION

1.1 Dependencies

The `stisblazefix` package is designed to run in the AstroConda environment. After installation, launch it via:

```
source activate astroconda
```

`LMFIT` is required, but is not currently in the standard `AstroConda` distribution. It can be added to an Anaconda environment by first activating the desired environment and then running:

```
conda install -c conda-forge lmfit
```

> **Warning:** Requires at least numpy 1.13, bugs occur with numpy 1.12.

Note: If it is necessary or desirable to install this module in a conda environment that does not include the AstroConda software channel, it may be possible as long as compatible versions of Astropy and Matplotlib are available.

1.2 Conda Installation

Once `LMFIT` is installed, install the `stisblazefix` module via:

```
conda install -c sean-lockwood stisblazefix
```

1.3 Manual Installation

Alternatively, you may download and manually install `stisblazefix` via:

```
python setup.py install
```

PYTHON API

Most users will be interested in the `fluxfix` function.

This module contains the following functions:

- `findshift` : calculates the shift to the blaze function that best aligns the spectrum.

- `fluxcorrect` : takes a shift to the blaze function and recalculates the flux and error.

- `fluxfix` : takes a list of *x1d* fits files and generates corrected *x1f* files and diagnostic plots.

- `generateplot`: takes an old and corrected spectrum and generates a diagnostic plot.

- `plotblaze` : plots the sensitivity curves for an extracted spectrum.

- `residfunc` : wrapper for lmfit minimizer.

- `residcalc` : calculates the flux residuals for the overlapping regions of an echelle spectrum.

stisblazefix.**findshift** (*filedata*, *guess*, *iterate=True*)
    Find pixshift that best aligns spectral orders.

    Use *lmfit* to calculate the pixshift (to apply to the blaze function) as a linear function of relative spectral order that minimizes the flux overlap residuals as calculated in *residcalc*.

- `filedata`: the data attribute of an *x1d* FITS file.

- `guess` : a tuple containing the starting parameters for the fit.

- `iterate` : Boolean that determines whether the function iterates to find the best fit.

    Returns *pixshift*, the error in the *pixshift*, and the final parameters.

stisblazefix.**fluxcorrect** (*filedata*, *pixshift*)
    Recalculate and return corrected flux and error vectors, based on shifted blaze function.

- `filedata` is the data attribute of an *x1d* fits file.

- `pixshift` is a 1D vector with length equal to the number of orders in the echelle spectrum. It contains the shift of the blaze function in pixels as a function of relative spectral order.

stisblazefix.**fluxfix** (*files*, *pdfname*, *guess=None*, *iterate=True*, *nxplot=1*, ***kwargs*)
    Corrects STIS echelle spectra by aligning the sensitvity function to compensate for shifts in the blaze function.

    This routine will iterate over a list of STIS echelle *x1d* files and for each exposure in each file it will find the shifts of the sensitivy curves for the spectral orders that maximize the flux consistency in the overlap between orders. Corrected flux and error vectors are then calculated and saved to new output files where *_x1d.fits* is replaced with *_x1f.fits*.

    It assumes that amount by which the sensitivity curve for each spectral order needs to be shifted is a linear function of the order number. The optimal shifts for each exposure to minimize the flux inconsistency in the overlapping regions of the spectral orders are found. Each exposure is treated independently.

Args:

> `files` (list of str): A list of file names corresponding to STIS echelle x1d files. All file names should end in *_x1d.fits* and should contain extracted and flux calibrated STIS echelle spectra output from CalSTIS.

> `pdfname` (str): Name for the output PDF file.

> `guess` (tuple of two floats): Contains a starting guess for the linear relation used to shift the blaze function. Should be in the form (a, b), where the blaze shift for each spectral order *x* will be *a + b*x*. Defaults to *None*, which then substitutes a suitable guess supplied in the code.

> `iterate` (bool): When set to *True* the code will iterate to find the values for *a & b* that minimimize the inconsistency in the flux ovelap regions. When set to False, the code will use the values supplied in Guess without iterating. Defaults to True.

> `nxplot` (integer): default 1. When set to a value > 1 will add extra plot pages, each comparing the original and corrected spectrum over approximately 1/nxplot of the wavelength range, but allowing a slight wavelength overlap between the plots.

Returns: A list of dictionaries, one for each exposure found in the *x1d* files. Each list element contains:

- `pixshift` : array of pixel shift values applied to sens curve
- `acof` : offset applied to sens curve of lowest order
- `bcof` : change in offset per order
- `acoferr` : formal error in the value for acof
- `bcoferr` : formal error in the value for bcof
- `oldresids` : vector of residual flux differences in order overlaps of original data
- `oldresiderr` : error vector for oldresids
- `newresids` : vector of residual flux differences in order overlaps of corrected data
- `newresiderr` : error vector for newresids
- `filename` : input file name
- `extno` : extension number of input file for this exposure

Produces:

- A new copy of each *x1d* file with the fluxes and errors corrected for the new shift of the sensitivity vector. The new files replace *x1d* in the file names with *x1f*.
- A multipage PDF file with diagnostic plots for each exposure.

`stisblazefix.`**`generateplot`**(*origdata*, *newflux*, *newerr*, *pixshift*, *params*, *paramerr*, *oldresids=None*, *oldresiderr=None*, *ntrim=5*)
Generate a diagnostic plot for a corrected spectrum.

Plot spectrum and residuals before and after correction to blaze function, and pixshift vs relative spectral order. Return a figure object.

- `origdata`: the data attribute of an *x1d* FITS file. This should contain the original flux.
- `newflux` : the corrected flux.
- `newerr` : the corrected error.
- `pixshift`: a 1D vector with length equal to the number of orders in the echelle spectrum.

> **kwargs:**
>
> - `oldresids` : the residuals for the uncorrected data.
>
> - `oldresiderr` : the error in the residuals for the uncorrected data.
>
> - `ntrim` : the cut made to the edges of the orders to avoid various edge problems. Defaults to 5.

If neither `oldresids` or `oldresiderr` is passed, they will be calculated from `origdata`.

`stisblazefix.`**`plotblaze`**(*filename*, *pdfname*, *ntrim=7*)
Plot the blaze function for each order of a STIS echelle spectrum.

`stisblazefix.`**`residcalc`**(*filedata*, *flux=None*, *err=None*, *dq=None*, *ntrim=5*)
Calculate and return the flux overlap residuals and weighted error.

Flux residuals are calculated by summing the flux in the overlapping region in adjacent orders, taking the ratio, and subtracting from one.

`filedata` is the data attribute of an *x1d* FITS file.

> **kwargs:**
>
> - `flux` : flux vector the same size as the *flux* in filedata.
>
> - `err` : error vector the same size as the *error* in filedata.
>
> - `dq` : data quality vector the same size as the *dq* in filedata.
>
> - `ntrim`: cut made to the edges of the orders to avoid various edge problems. Defaults to 5.

> If either `flux` or `error` is passed, they will be used to calculate the residuals. Otherwise, the *flux* and *error* arrays from `filedata` will be used.

`stisblazefix.`**`residfunc`**(*pars*, *x*, *filedata*)
Wrapper for *lmfit* minimizer. Return weighted residuals for a given pixshift.

- `pars` : a tuple containing *lmfit* parameters.

- `x` : the input variable, in this case relative spectral order.

- `filedata`: the data attribute of an *x1d* FITS file.

RELEASE HISTORY

- *v1.0a1*: Initial pre-release of stisblazefix package. Additional updates are pending.

- *v1.0a2*: Improved handling of divide-by-zero warnings. Reduced *conda* package size.

- *v1.1*: Fixed bug in lmfit dependency call when iterate=False.

SUPPORT

For support, please contact the STScI help desk at help<at>stsci<dot>edu.