

Landsat 8 Surface Reflectance Code (LaSRC)
U.S. Geological Survey (USGS)
Earth Resources Observation and Science Center (EROS)
Sioux Falls, South Dakota, U.S.A.
LaSRC Release Notes

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LaSRC 1.4.0 (March 7, 2018 – USGS EROS)

Overall

- Removed Pre-Collection processing code

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LaSRC 1.3.0 (October 5, 2017 – USGS EROS)

Overall

- Modified the aerosol inversion algorithm to produce the aerosol for a representative pixel in a 3x3 pixel window. This cuts down on the number of aerosol inversions and therefore allows the application to run in significantly less time. The remaining pixels in the 3x3 window are then interpolated using the surrounding/closest representative 3x3 window aerosol values. Special handling is in place for clouds, cloud shadows, and water.
- The ipflag values output in sr_aerosol have been updated to allow the clouds, shadows, water, and interpolated pixels to be masked.
- A bug in the routine which frees the RADSAT and SR_AEROSOL bits was fixed. This bug intermittently created core dumps.

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LaSRC 1.2.1 (July 5, 2017 – USGS EROS)

Overall

- Bug fix that was likely the cause of intermittent segfaults. The wv and oz variables were allocated as uint8* and int16* values instead of uint8 and uint16. This generated less memory than what was trying to be used by the uint16 array. This fix is only applied to the 'src' directory and not to the pre-collection directory, which is basically obsolete at the current time and will be deleted soon.

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LaSRC 1.2.0 (June 1, 2017 – USGS EROS)

Overall

- Updated the XML short_name to use a 4-digit instrument identifier.
- Merged the changes for LaSRC FORTRAN version 3.5.5. The main change is the if-check on the band1 and band2 ratios used for computing the slope and intercept used for the aerosol inversions.

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LaSRC 1.1.0 (May 9, 2017 – USGS EROS)

Overall

- Fixed broken links in the LAADS auxiliary Makefile.
- Fixed a compiler warning in the combine LAADS C code.
- Modified the LAADS update scripts to use the MODIS public http server - <https://ladsweb.modaps.eosdis.nasa.gov> instead of the ftp server <ftp://ladssci.nascom.nasa.gov>. This LAADS data has been moved to the public http site and allows all users of the update LAADS scripts to access the data without a username/password.
- Updated the application version number.
- Added –version command-line options for applications and scripts.
- Updated the LAADS scripts to allow Aqua-only CMG/CMA and/or Terra-only CMG/CMA for the situations when Terra or Aqua is not available.
- Removed the unused SDSs for the LAADS hdf_fused auxiliary products. Only the water vapor and ozone are used by LaSRC.
- Updated Makefiles to catch build errors in the for loops.

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LaSRC 1.0.1 (March 30, 2017 – USGS EROS)

Overall

- Fill value for the angle bands is -32768 instead of -9999.

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LaSRC 1.0.0 (March 10, 2017 – USGS EROS)

Overall

- Changes to the C version were made based on the new version 3.5.2 of the FORTRAN code, which is also included in this release. Changes to that FORTRAN code include the following:
 - subaeroret.f (and new subaeroretwat.f)
 - Modifications to how aerosol retrieval is handled. Modified the algorithm and added a new algorithm for retrieval over water. This routine is very similar to the

non-water retrieval, but the residual computations are different for the water pixels. There are also a couple of other minor differences in the two aerosol retrieval functions. (subaeroret.c contains subaeroret and subaeroretwat)

- LUTldcm_subr_v4.f
 - The atmospheric correction now uses the angstrom coefficient to modify the passed in roat550nm. This modified value is used in the atmospheric corrections versus the original value. (Affects atmcorlamb2 in lut_subr.c)
- possolp.f
 - Added a routine to compute the solar azimuth and zenith angles. These are computed for each pixel based on lat/long. (New possolp.c file)
- LDCMSR-v3.5.2.f
 - The overall algorithm now computes the lat/long for each pixel and then determines the solar azimuth and solar zenith angles by calling possolp for each pixel (sza, saa). The viewzenith and viewazimuth are also approximated. These per-pixel angles are used in the subaeroret computations. Note: the view zenith/azimuth corrections will be minor in the results due to the small view angle window of L8 (range of approximately 8 degrees). Fixed a bug in the do_lasrc.py script to correctly handle the new Collection naming convention.
 - The ratiob1, ratiob2, slpratiob1, slpratiob2, intratiob1, and intratiob2 values read from the ratiomapndwiexp.hdf file have changed which SDSs are used. In general, the b1 values have switched from using b3 to b10 in the HDF file. The b2 values have switched from using b8 to b9 in the HDF file. Eric indicated this change in SDSs provides a better match between the MODIS data in the HDF file as the Landsat imagery.
 - The four non-fill image corners are found and the scene center is computed from those four corners. The image rotation angle is computed using these corners as well. These corners and rotation angle are used in the approximation of the per-pixel view zenith angle and view azimuth angle. They are used to produce an index into the l8geom.hdf file which has a table of view zenith and view azimuth values.
 - The TOA reflectance corrections use the approximated solar zenith angle for the current pixel versus the solar zenith angle for the scene center.
 - Previously cirrus pixels were flagged as clouds if the value in band 9 was greater than $100.0 / tp[curr_pix] / 1013$. These pixels were not run through aerosol inversion. The new code does not flag these pixels and therefore aerosol inversion is run on all pixels.
 - If/then statements were changed for the slpratio and intratio processing. The values of intratiob1 and intratiob2 were changed from 327, 482 to 550, 600.
 - The actual call to subaeroret for the aerosol retrievals now uses a pressure, ozone, and water vapor value that was interpolated for the current pixel versus a constant value for each variable.
 - subaeroret is called three times with eps = 1.0, 1.75, and 2.5 for each pixel. The algorithm looks for the eps that minimizes the residual. Then that eps, residual, and roat are carried forward. Previously subaeroret was only called once, and the eps was not used.
 - The if-check on the model residual in relation to the aerosol impact has been modified.
 - The model residual is checked with several checks, including the NDVI check. Pixels failing are flagged as water. These pixels are then reprocessed for aerosol retrieval, using the new aerosol retrieval algorithm for water.
 - The aerosol interpolation is handled differently. The average taero and teps values in a surrounding 11x11 window are computed and used. In the event that

not enough valid values are available, the taeros is set to 0.05 and teps is set to 1.5 as the defaults.

- Cloud QA processing is now handled at the end of the algorithm, after the aerosol retrieval/interpolation and the surface reflectance corrections have been completed. Therefore, the algorithm is no longer reliant upon cloud QA information, and I confirmed that with Jean-Claude. I asked him if we could simply skip doing the cloud QA processing and he reconfirmed that the cloud QA is no longer needed. The C code will not run the cloud QA processing, since there are way better cloud algorithms in existence. This also means that the algorithm is no longer reliant upon the TIRS bands.
- The aerosol QA information has changed slightly and that QA band will now also include the aerosol QA confidence that used to be stored in the cloud QA band. This new band will be the "aerosol" band and it replaces the "cloud" and "ipflag" bands.
- ESPA Enhancements
 - For collection products, the per-pixel approximations for the solar and view angles have been replaced with the angle values from the Landsat per-pixel angle bands, which are generated from the Level-1 angle coefficient file. This makes the newly delivered l8geom.hdf file obsolete. There is a src directory and src_pre_collection directory under the c_code for LaSRC. The src_pre_collection source code still uses the original angle approximations, since pre-collection scenes don't have the angle coefficient file. The src directory contains the source code to be used for the collection products. do_lasrc.py has been modified to call the different versions of C-code, depending on whether the data is pre-collection or collection. NOTE: It will be necessary to re-download the l8sr_auxiliary.tar.gz file and install it in your L8_AUX_DIR. The .tar.gz file has been updated to contain the l8geom.hdf file which will be required to process pre-collection products.
 - Per-pixel angle bands are masked to match the band quality image extents, and therefore fill pixels in the band quality are masked as fill pixels in the per-pixel angle bands.

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LaSRC 0.9.0 (October 26, 2016 – USGS EROS)

Overall

- Modified the cloud QA to contain the cloud and aerosol information in one 16-bit band for Collection products. Pre-Collection products will continue to have two 8-bit QA bands, one for the cloud band and the other for the aerosol band.
- Fixed a bug in the do_lasrc.py script to correctly handle the new Collection naming convention.
- Modified how the bits are set in the cloud masks by using a bit shift and an OR with the existing bits.

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LaSRC 0.8.0 (July 29, 2016 – USGS EROS)

Overall

- Updated the valid_range to be a floating point versus long to match the new data type in the XML schema.
- Change scene_id to product_id in the output XML to match the new schema.
- Verified the code supports Albers for CONUS, Hawaii, and Alaska.
- Verified the code support for the new 4-character product type collection filenames.
- Fixed a bug in the per-pixel interpolation of the auxiliary input data. The pixel location in the CMG-level auxiliary products should not be rounded when going from Landsat pixel to CMG pixel. The interpolation of the auxiliary values is based on the pixel value being truncated versus rounded.

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LaSRC 0.7.0 (May 16, 2016 – USGS EROS)

Overall

- Updated the FORTRAN code to be the latest version (v3.0) of software received from NASA GSFC for LaSRC.
 - Band ratios are interpolated at the pixel level versus the CMG level, which helps solve the blockiness results from the previous algorithm.
 - Aerosols are not retrieved over cirrus pixels, however they are retrieved for all other non-fill pixels (including water). The results of the aerosol retrieval are tested and flagged if the retrieval does not meet residual and NDVI criteria. These flagged pixels are attempted to be interpolated via aerosol interpolation. Cirrus, cloud, and water pixels are not used as part of the interpolation. The aerosol interpolation process has changed and allows the results of the interpolation to be at the pixel level versus a block level. The final step is to perform the atmospheric correction based on the calculated or interpolated aerosols. This level of correction is not applied to cirrus or cloud pixels.
- Updated the C version of the LaSRC code to include the modifications delivered as part of v3.0 of the FORTRAN source code.
- Merged in changes from version 0.6.1 and 0.6.2 for the updatelads.py script.

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LaSRC 0.5.0 (March 02, 2016 – USGS EROS)

Overall

- Updated to support the new L1T file naming convention.
- Modified the LaSRC script to handle OLI-only scenes in addition to the OLI-TIRS scenes.

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LaSRC 0.4.0 (December 03, 2015 – USGS EROS)

Overall

- Updated scripts to use Python logging (originally print statements).
- Added a command-line option for specifying the username and password for updatelads.py. If the username and password are specified, then they are used. Otherwise the script tries to pull the username and password from our ESPA remote procedure calls (XMLRPC).
- Modified the interpolation code for ozone, water vapor, and DEMs to wrap around the dateline in the event the scene straddles -180, 180 line or -90, 90 pole.
- Removed --usebin from do_ledaps.py as the LEDAPS executables are expected to be in the PATH.
- Updated the Makefile.
- Updated RPM support.
- Provided top-level surface-reflectance script helper for ESPA processing.

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LaSRC 0.3.1 (September 28, 2015 – USGS EROS)

Overall

- Fixed a bug accessing the 9x9 window in the land/water mask array. We were accessing invalid memory if the window was on the edges of the scene.
- Fixed a bug accessing the CMG arrays for line+1 and sample+1. We were accessing invalid memory if the scene was at the right or bottom edge of the CMG array.
- Modified the update auxiliary files script (updatelads.py) to retry the file download in the event the wget fails. Cleaned up a few logger issues in this script as well.
- Float to integer conversions previously added 0.5 to the float before converting to integer. That was only correct for positive values. The source code now uses round to correctly round the floating point values up or down.

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LaSRC 0.3.0 (May 13, 2015 – USGS EROS)

Overall

- Updated to utilize the static land/water mask. This is only used for computing the surface reflectance. Thus it will not be used for OLI-only scenes.
- Updated the TOA reflectance and BT computations to use the radiance/reflectance/thermal constants and earth-sun distance from the XML file.

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LaSRC 0.2.0 (March 16, 2015 – USGS EROS)

Overall

- Modularized the L8 SR application to break up the code into more readable pieces. In particular, broke out the TOA reflectance calculations and the surface reflectance calculations.

- Isolated the SR-related memory allocations, read from lookup tables, and read of auxiliary data to the compute_sr_refl function. This should minimize the amount of time needed to process TOA (if only TOA is selected) due to no longer needing to read lookup tables and auxiliary data.
- Comparison between SR products generated with LaSRC 0.1.0 and 0.2.0 will show a small number of differences on the order of 10 or less (usually between -1 and 1), due to round-off differences. The variables are local to the function now and aren't passed in.
- Modified LaSRC to address a couple of issues with blockiness along the coastlines and within the forested regions. This includes treating adjacent water pixels as water until the ndvi < 0.1 check confirms it isn't water.
- Changed the aerosol interpolation to use a step x step window surrounding the current pixel vs. the step x step window to the southeast of the current pixel, where the pixel is the UL corner of the step x step window.

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LaSRC 0.1.0 (December 23, 2014 – USGS EROS)

Overall

- Converted original FORTRAN code to C.
- Modified the code to support ESPA raw binary file format for input and output image products.
- Added documentation to the source code.
- Made some modifications for efficiency in the code processing.
- All int16 bands use -9999 for the output fill value, which is a modification for most of the bands.
- Switched the use of xmus and xmuv in the calls to local_chand, since they were being sent in the incorrect order. This doesn't have much impact on the outputs, due to the nature of the algorithms and how those variables are used.
- Implemented modifications to achieve code speed-ups.
- Modified the code to allow the user to specify whether the TOA values should be output in addition to the SR values.
- Modified to stop after the TOA corrections if the sun angle is too low.
- Modified to stop after TOA corrections if this is an OLI-only scene.