ccast intro and overview

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introduction

CCAST takes level zero data from the Cross-track Infrared Sounder (CrIS), a Fourier transform spectrometer on the Suomi NPP and JPSS weather satellites, and produce high-quality calibrated radiances. It is written primarily in Matlab, allowing for easy interaction, modification, and data visualization. We give a brief overview of the design, implementation, and use.

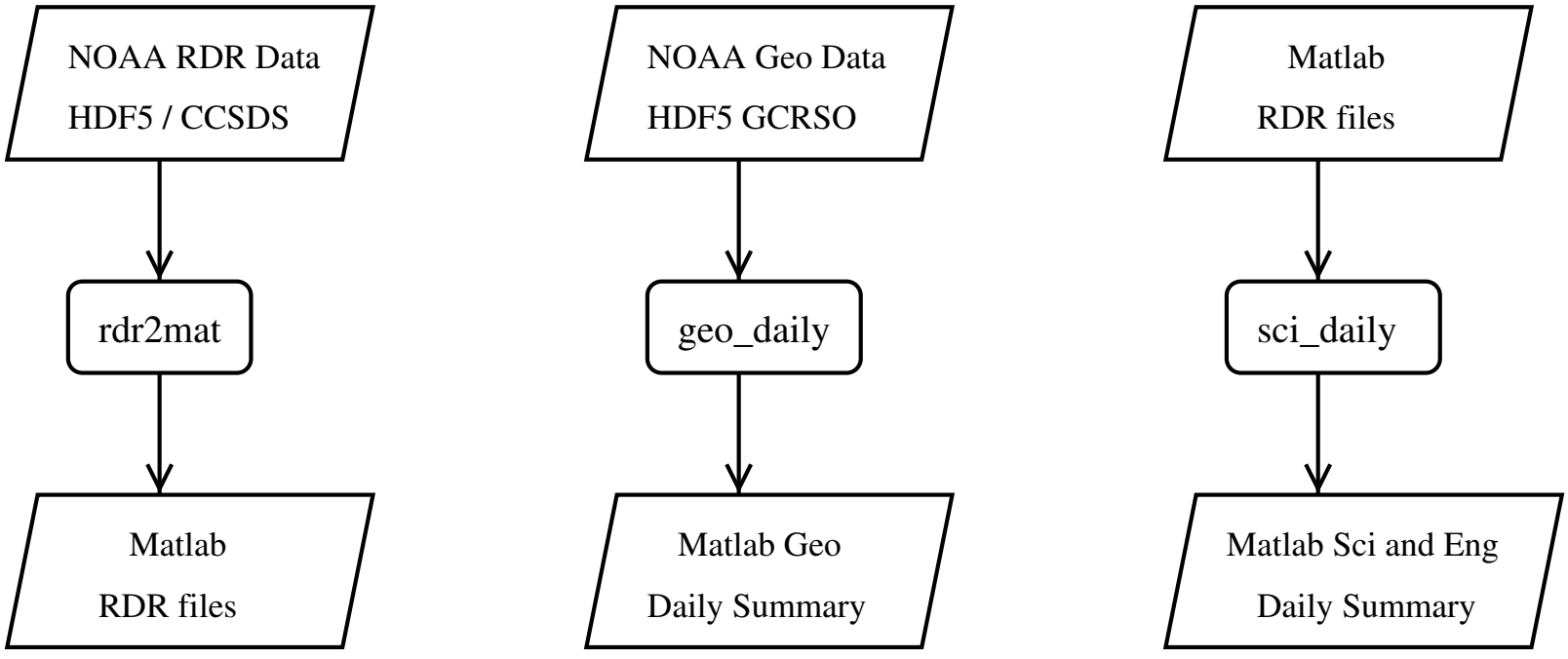
The authors of the UMBC CCAST are Howard E. Motteler, David Tobin, L. Larrabee Strow, and Dan Mooney, with interferometric parameters in spreadsheet form from Joe Predina.

CCAST is available as a GitHub public repository and is distributed under the terms of the GNU GPL v3.

history

- CCAST started as a collaboration between UMBC and UW in fall 2010, with major components from the 2007-2008 FM1 bench and TVAC tests.
- H. Motteler wrote the L1a processing, starting with Dan Mooney's RDR reader, and L. Strow, Dave Tobin, and H. Motteler all collaborated on the L1b
- this forked into a UW version with Fred Nagel's geo that got first light, and a UMBC version with NOAA geo that got the first high res obs a month later.
- in the summer of 2012 H. Motteler updated the UW code to run in the UMBC environment, and for some time maintained both versions while continuing to develop the UMBC branch.
- major portions of the UW branch, including ICT modeling and the non-linearity correction, were updated and merged into the UMBC branch.

preprocessing



main ccast processing

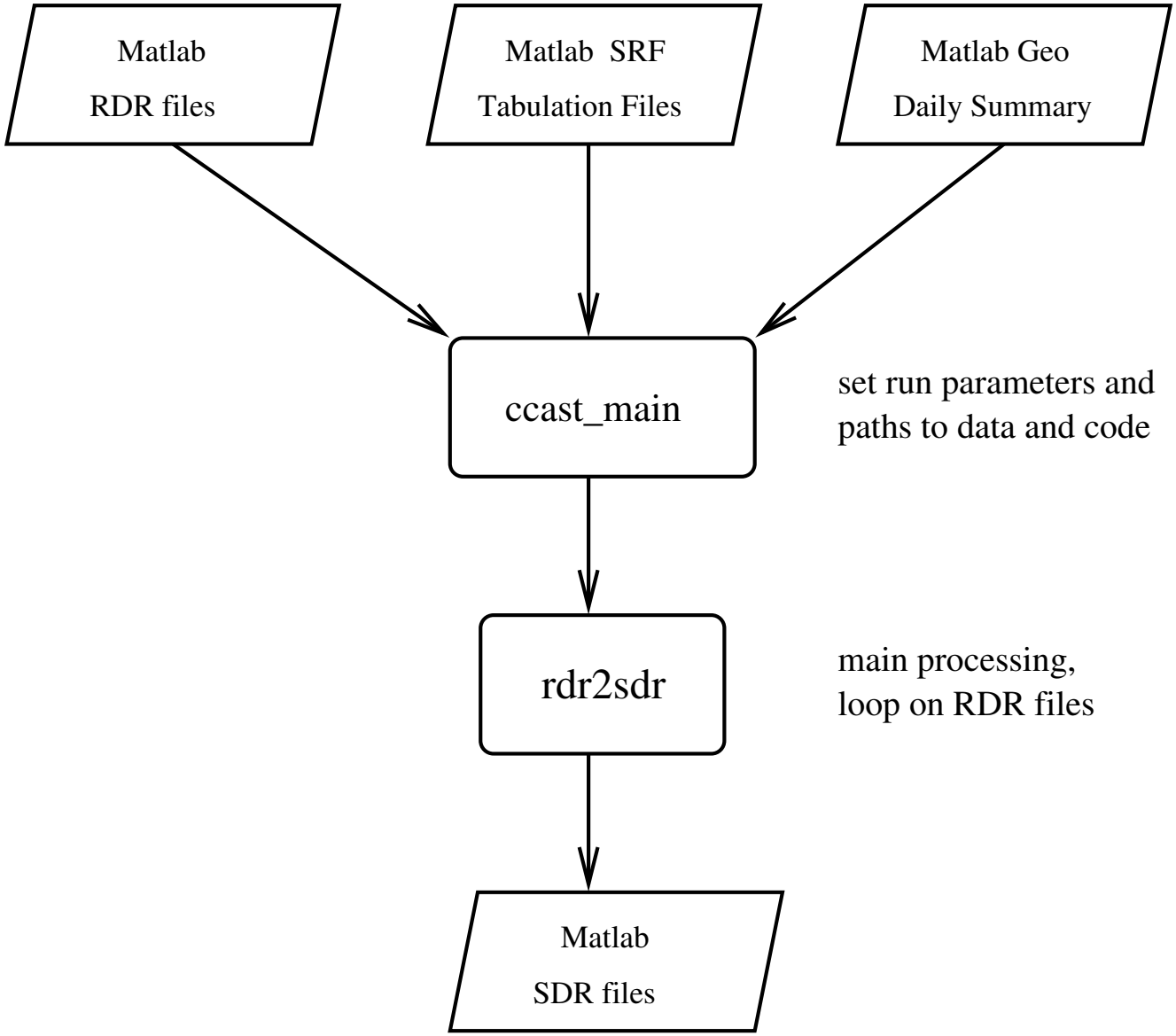
support

preprocessing

CCAST processing is done in two passes—the first takes HDF and CCSDS data to Matlab files, and the second takes those files to calibrated radiances. The top-level preprocessing script is ccast_prepro. The main steps are

- rdr2mat – read NOAA RDR files (CCSDS level 0 data with an HDF-5 wrapper) and produce Matlab RDR files, our working level 0 format.
- geo_daily – read NOAA GCRSO HDF-5 geo files and produce daily abstracts of CrIS geo data, as Matlab files.
- sci_daily – read Matlab RDR files and produce daily abstracts of "science" (8 second) and "engineering" (4 minute) support data, as Matlab files.

main processing



main processing

ccast_main sets parameters and paths and calls rdr2sdr, which loops on Matlab RDR files, typically one set per day. The main processing steps in rdr2sdr are

- checkRDR – validate and order the RDR data
- scipack – process sci and eng packet data
- inst_params – user and sensor grid parameters
- igm2spec – take interferograms to count spectra
- scanorder – group data into scans
- geo_match – match GCRSO and RDR scans
- movavg_app – calculate moving averages
- calmain – radiometric and spectral calibration

design notes

Some high-level design choices reflect past expedience and incremental development.

- there is no granule structure. Interferogram data is ordered by channel, FOV, and obs time and then grouped into scans.
- the intent was to facilitate a moving window design, and if desired add our own granule structure
- although we use NOAA GCRSO data, we do not use the NOAA granule structure. The RDR files can start and stop at any field of regard (FOR), and for now the ccast SDR files simply track this
- the use of geo summary files was originally meant to be temporary; the geo_match procedure could use GCRSO or other geo data directly

design notes

- interferometric and instrument parameters are set centrally, in the function inst_params
- the translation to count spectra should be done later, right before taking moving averages
- there is no explicit quality control for the final calibrated product. There is extensive low-level data QC, and most output and working arrays are initialized with NaNs as a sanity check on processing
- error logging is basic, and mainly from the L1a processing. These messages are merged with error or other messages from the Matlab interpreter
- control flow is transparent, with almost no use of control flags or global variables

performance

- CCAST produces high-quality calibrated radiancesm, and high resolution processing has been an option from the start
- although it borrows significantly from the NOAA ATBD, key features such as the ILS, SA interpolation, and the form of the calibration equation were developed independently and in some cases have been adopted by other groups.
- runtime performance is good. Running as a single task rdr2sdr takes just over a minute to processes a 60-scan file
- reliability is good. We have repeatedly reprocessed all data from mission start with no problems.

to-do list

- continue to improve the documentation.
- vectorize the non-linearity correction and set non-linearity parameters in inst_params.
- regularize the output and expand the draft matlab_sdr.txt into more user-friendly data definitions
- add file spanning moving averages. This was on hold pending possible lower level regularization or the addition of a granule structure.
- add some QC for the final calibrated product, including the residual complex component from the calibrated radiances
- consider switching to a faster RDR reader. Dan Mooney's reader (with some local mods) has been very reliable, but is idiosyncratic and slow relative to the rest of the processing.

getting started

- to download the ccast repo
  git clone https://github.com/strow/ccast.git
- to update a local copy of the ccast repo
  git pull origin master
- see ccast/README for info on installation and testing, and for URLS to test data and sample SRF tabulations
- see ccast/doc for
  - ccast_intro.pdf – this document
  - ccast_eqns.pdf – ILS and main calibration equations
  - matlab_sdr.txt – output data format and fields
  - finterp.pdf – notes on Fourier interpolation