LEISA Atmospheric Corrector (AC)
on EO1

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LEISA Development History

- 1993 Selected for Pluto Express (PE) Mission under Advanced Technology Insertion Program
- 1993 Baseline IR spectral imager for Highly Integrated Pluto Payload System (HIPPS)
- 1994 Chosen for Small Satellite Technology Initiative (SSTI) Lewis Mission
- 1996 Chosen for New Millennium Program Earth Observing-1 (EO-1) Mission
- 1997 Space Act Agreement, participation in Field Studies with Boeing Commercial Space Company, Resource21
- 2001 Phase B development New Horizons for NASA Pluto-Kuiper Belt Mission
Instrument Characteristics

- Correct Atmospheric Effects in High Spatial Resolution Multispectral Imager Data
  - Hyperspectral Imager
  - Moderate Spectral Resolution (<10 nm)
  - Moderate Spatial Resolution (<300 meter)
  - Maximum Sampling Flexibility
  - Minimum Impact on Spacecraft Resources
Wedged Filter Operation
Sample Image  (Arid Lands Ecological Reserve)
Contribution to EO-1

- Validation of Wedged Filter Approach for Spacecraft Instrumentation
- Atmospheric Correction for ALI Multispectral Images.
- Atmospheric Correction for Landsat-7 Images (Formation Flying).
- Direct Study of Spatial Resolution Degradation (Cross-Comparison with Hyperion).
- Retrieved Atmospheric Parameters.
- Cross-Comparisons with MODIS.
AC Instrument Specifications

- Spectral Coverage: 0.89 - 1.58 μm; 256 Bands Selected for Optimal Correction of High Spatial Resolution Images
- Spectral Resolution 2 Filter Sections:
  - Section 1 ~35 cm⁻¹ (5 nm @ 1.2 μm, 9 nm @ 1.6 μm)
  - Section 2 ~55 cm⁻¹ (4 nm @ 0.9 μm, 8 nm @ 1.2 μm)
- Swath Width: ~185 km; Matches Landsat
- Spatial Resolution (pixel): 356 radian (250 meter @ 705 km)
- Three 256 x 256 Element InGaAs Arrays; TEC Stabilized (<285 K)
- Three 15 Degree FOV 3 Element Lenses
- Two Modules: “Bolt-on” Optics Module and Electronics Module
- Mass: 10.5 kg (EM, 4.4 kg; OM 3.9 kg; Cable 2.2 kg)
- Power: 48 W (Peak); <15 W (Orbit Average)
AC Linewidths
Optics Module Detail
In-Flight Calibration

- Solar Calibration
  - Radiometric Calibration (Relative and Absolute)
  - Radiometric Stability
  - Variable Light Level Response
  - “Fixed Pattern” Noise Correction
- Lunar Calibration
  - Radiometric Calibration
  - Image Quality
  - Extended Duration Dark Current Stability
- Surface Targets
  - Radiometric/ Spectral Calibration (Ground Campaigns)
- Dark Earth Looks
  - Dark Current Stability
‘Fixed Pattern’ Signal

SCANNING SOLAR CALIBRATION RESULTS FOR ROW 180

DIGITAL COUNTS

PIXEL NUMBER

FRAME 385

185

85
Extended Calibration

- “Fixed Pattern” Signal Apparent After Launch
  - Predominantly Additive Contribution
  - Constant in Position and Time
  - Reduced Accuracy in Low Illumination

- Modified Radiometric Correction Procedure
  - Requires Measurements Unaffected by Atmospheric Absorption, Use Scanning Solar Data
  - Scale Calculation Replaced by Calibration Lookup Table
Atmospheric Corrector Calibration System

ACCS

EO1 Level-0 Data ➔ EXTRACT ➔ REDUCE ➔ ARCHIVE ➔ DELIVER ➔ Level-1 Products

Temporary Storage

Permanent Database
Calibration System Software

• 150+ program modules
Processing Options

accs@fastie-bin-2  LAC_Option -l
  to_level  1R                  # 1R, 1G
  keepall_prod  yes            # no (highest only), yes
  eolq_execute  standard      # none, standard, extended
  null_calibration  no        # no, yes
  offset_source  local_dark   # default, local_dark
  scale_source  default       # default, extended, local_cal
  replace_bad  yes             # no, yes
  force_cal  no                # no, yes
  cal_matchkey  preset2        # preset2, facist3, preset1, anarchist0
  enhance_qlook  yes           # yes, no
  deliver_to  lacsend          # lacsend, tarsend, tape, null
  archive_file  lacstor        # lacstor, tape, null
  post_cleanup  yes            # no, yes
  do_tapels  both              # both, tape, eoltape, none
  mail_report  yes             # no, yes
  getsome_sleep  yes           # yes, no
  lookforward2_vacation  yes   # yes, no
Session Logs

- goACCS_E01###.log
- LAC_Extract/Reduce0/Deliver/Archive-YYYYMonDD@HHMMSS.log
- goClean.log

- dat3/dlt4_ACCS###.lst
- Scenes_Processed.lst
ACCS Performance

- > 1500 scenes processed
- 8.5 Gb of data per session
- 1.5 hrs/Gb total processing time* (Extract + Reduce + Archive)

* excepting extended calibration
HDF File Creation

Example

L0 = LACDATA+'/lac/20013010839_AKS/EO11520372001301112K0/’ + $ 
‘AC2001301054952_AKS_01.L0’

GENICAL, L0, /VERBOSE, /OFFSET, $ 
    MATCH={TYPE:1,TIME:1.0,ARRAY1T:10,ARRAY2T:10,ARRAY3T:10,STAT:'0111'}

GENHDF, L0, RUN_LABEL='2002Jan23@064222', /VERBOSE, /NON_INTERACTIVE

L1 = VERYGEN1R( L0 )

TIMEUPDT, L1

GEN1RSDS, L1

RDUPDT, L1, /NON_INTERACTIVE
Associated Files

- YYYY_DDD_lac/gps/acs.hdf
- 00indexEO1###
- ACYYYYDDDDHMMSS_RRR_##.L0_calcoeff.b4
  - " .L0_calpnotes.txt
- " .L0_stats
- " .L0_stats-M/S.bmp
- " .L0_trace0/C
- " .L0/1R_wint
- " .L0_update
- " .L1R_q-bands/frames.jpg
- " .L1R_geo
# Level-1 HDF Products

<table>
<thead>
<tr>
<th>Type</th>
<th><strong>Level-1R</strong></th>
<th><strong>Level-1G</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing Inputs</td>
<td>HDF v4 Grid</td>
<td>HDF-EOS v2.4 Swath</td>
</tr>
<tr>
<td></td>
<td>L0 Science, L0 Dark, scale coefficients, lac / gps / acs metadata</td>
<td>L1R Science, lac / gps / acs metadata, pointing map, wavelength map, corrected frame times</td>
</tr>
<tr>
<td>Key Attributes</td>
<td>Data Start Time, Level 1R: Dataset Type, Response SD: Filenames, Scale Factor</td>
<td>Spectra: Scale Factor</td>
</tr>
<tr>
<td>SD Structures</td>
<td>Offset, Response, Pixel_Map, Wavelength_Map, Level 1R (radiometrically calibrated, 768 x Nframes x 256)</td>
<td>Latitude, Longitude, Wavelength, Spectra (geo-located and band rectified, NY x NX x 256)</td>
</tr>
<tr>
<td>Associated Products</td>
<td>Raw frame/pixel statistics, quicklook images, ENVI header</td>
<td>Geo-location info</td>
</tr>
<tr>
<td>Usage</td>
<td>Modified ENVI input procedures (BSQ)</td>
<td>ENVI Generic HDF (BIP)</td>
</tr>
</tbody>
</table>
Science Data Formats

- instrument clock, header data
- pixel pointing map, filter frequency map
- spacecraft meta data (YYYY_DDD_lac/gps/acs.hdf)

\[ I_{i,j,t} \Rightarrow I_{x,y,\nu} \]
Band Alignment

Scan of Cuprite, NV 1200 frames
Cuprite, NV Mar. 1, 2001
red=1.32, green=1.03, blue=0.98 (μm)
Spectra

Cuprite, NV

March 1, 2001
Cuprite, NV
Scene-ID: EO10410342001060111PP

Lake Frome
Scene-ID: EO10970812001021111PP

Rochester, NY
Scene-ID: EO10160302001125111PP

Snake River
Scene-ID: EO10410342001060111PP

Suez Canal
Scene-ID: EO11760392001140111PP

Venice
Scene-ID: EO11920282001158112PP