PICSCAR

WGCV/IVOS Working Group on

Pseudo Invariant Calibration Sites Characterization

- PICSCAR Summary IVOS#31 -
**Main objectives:**

- Sharing experience acquired on PICS by different ‘calibration’ teams
- Update PICS characterization, assess sites performance and display them on an open website
- Provide access to methods description and tools for calibration and cross calibration over PICS

First focus on Libya 4
PICSCAR activity since IVOS#30

Regular webex meetings:

- 22/05/2018
- 02/07/2018
- 18/09/2018
- 19/12/2018
- 08/02/2019

with: SDSU, CNES, JPL, Argans, ESA

+ Dedicated bilateral meetings (phone discussion)
PICSCAR IVOS#31 overview

PICSCAR Working Group Report:

• Overview of one year of PICSCAR activities
  • Spectral correction for intercalibration over PICS
  • Libya_4 stability assessment
  • PICSCAR intercalibration exercises
  • Set up of a multi ‘team’ Landsat_8 / Sentinel_2A intercalibration monitoring
• The PICSCAR WebSite

Presentation of complementary activities relative to PICS:

• Last results of the PICSAND study – ONERA/NOVELTIS/LSCE - ESA
• PICS quality assessment based on Sentinel_3A – CNES
• PICS trending analysis – USGS/SDSU
• Sentinel_2 / Landsat_8 intercalibration over PICS – Argans - S2MPC
Main conclusions about spectral correction

• Strong impact of spectral correction for intercalibration
  • Depends on spectral bands width and on position in the spectrum
  • Different methods:
    • Generic SBAF (Spectral Band Adjustment Fonction) computation
    • Direct spectral resampling using sensors measurements
    • Band to band comparison (no spectral correction)
  • Difference in SBAF computation according to:
    • Reference spectral profiles (Hyperion or…)
    • Spectral resampling and spectral bands shape assumptions
    • TOA or BOA
  • Direct spectral resampling
    • Only possible for multispectral reference sensor
  • Band to band comparison
    • Can induce 10% error…
• Major interest for a better spectral characterization
  • Laboratory measurements (PICSAND)
  • Hyperspectral sensors (AHSI, PRISMA…)

CEOS/WGCV/IVOS-31 - Picscar Workshop – CSIRO Perth – 2019 March 28th
Main conclusions about sites stability

• Through analysis of different sets of data (different sensors, different teams)
  • Good confidence in site stability for several PICS including Libya_4, Libya_1, Algeria_3, Algeria_5...
  • But… difficult to assess precisely this stability
    • Several interpretation for ‘stability’
    • Pertinent parameters to be defined and assessed
  • Top priority for the PICSCAR Working Group

• Through analysis of different calibration methods (different teams)
  • Site stability not always mandatory
    • Important for absolute calibration monitoring
    • Often little or less important for sensors cross calibration (site homogeneity may be more important)
    • BRDF stability to be considered
  • TOA or BOA stability?
Completion of intercalibration exercise #1

Calibration exercise #1:

• Comparison of calibration method using a common provided dataset
• Landsat 8 calibration vs Sentinel 2a calibration

Results are expressed as the ratio of band L8/S2A

<table>
<thead>
<tr>
<th>IC L8/S2A</th>
<th>Green</th>
<th>Red</th>
<th>NIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNES</td>
<td>1.005</td>
<td>0.997</td>
<td>0.996</td>
</tr>
<tr>
<td>SDSU</td>
<td>0.992</td>
<td>0.987</td>
<td>0.992</td>
</tr>
<tr>
<td>JAXA/EORC</td>
<td>0.991</td>
<td>0.972</td>
<td>0.989</td>
</tr>
<tr>
<td>PICSCAR</td>
<td>0.993</td>
<td>0.996</td>
<td>0.993</td>
</tr>
<tr>
<td>TPZ</td>
<td>1.007</td>
<td>0.973</td>
<td>0.997</td>
</tr>
<tr>
<td>Argans MPC</td>
<td>1.002</td>
<td>1.009</td>
<td>0.994</td>
</tr>
</tbody>
</table>

Results presented on the PICSCAR WebSite with calibration methods description
‘Multi team’ L8/S2A intercalibration monitoring over Libya_4

- Extension of PICSCAR exercise#1 for intercalibration monitoring over Libya_4
- Publication, every 6 months, of the L8/S2A intercalibration results over Libya_4 performed by the different PICSCAR teams
- Already accepted by 4 teams: SDSU, CNES, Argans/S2MPC, PICSCAR
- Results available through the PICSCAR Web Site

Calibration over Libya4

Intercomparison of S2A/MSI and L8/OLI

The monitoring of the ratio of equivalent bands of S2A/MSI and L8/OLI sensors is provided for the team involved in the E1 exercise. Results of different teams are provided.

<table>
<thead>
<tr>
<th>Band name</th>
<th>PICSCAR</th>
<th>CNES</th>
<th>SDSU</th>
<th>MPCS2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>( )</td>
<td>0.9925 (0.0080)</td>
<td>0.9841 (0.007)</td>
<td>( )</td>
</tr>
<tr>
<td>Blue</td>
<td>1.01104 (0)</td>
<td>0.9975 (0.0088)</td>
<td>1.0138 (0.0072)</td>
<td>( )</td>
</tr>
<tr>
<td>Green</td>
<td>0.995446555 (0)</td>
<td>1.0107 (0.0078)</td>
<td>1.001 (0.0064)</td>
<td>( )</td>
</tr>
<tr>
<td>Red</td>
<td>0.997983933 (0)</td>
<td>1.0021 (0.0065)</td>
<td>0.9931 (0.0053)</td>
<td>( )</td>
</tr>
<tr>
<td>NIR</td>
<td>0.995403573 (0)</td>
<td>0.9986 (0.0059)</td>
<td>0.9929 (0.0046)</td>
<td>( )</td>
</tr>
<tr>
<td>SWIR1</td>
<td>( )</td>
<td>0.9951 (0.0075)</td>
<td>0.994 (0.0055)</td>
<td>( )</td>
</tr>
<tr>
<td>SWIR2</td>
<td>( )</td>
<td>1.0075 (0.0161)</td>
<td>1.0029 (0.016)</td>
<td>( )</td>
</tr>
</tbody>
</table>
Pseudo invariant calibration sites have been widely and successfully used on-orbit radiometric trending of optical satellite systems for more than 20 years. At the IVOS 27 meeting in November 2015, a new initiative was established to facilitate coordination and help prioritise research on PICS and their usage to the benefit of the EO community as a whole.

A roadmap has been set up at IVOS 28 in March 2017 where the subjects have been identified and priorities given to:

- PICS’s BRDF characterization
- Spectral characterization
- Atmosphere properties
- Temporal stability
- Combining multiple sites calibration results
- Revisiting the sites

This page contains general and detailed information about 6 PICS. If you wish to also download the reflectance normalised to nadir Please register to have access to the document.

**First ‘draft’ version open after IVOS#30**

**New version available including exercise#1 results and L8/S2A intercalibration monitoring over Libya_4: ask to be registered**

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CEOS/WGCIVOS-31 - Picscar Workshop – CSIRO Perth – 2019 March 28th
• Laboratory spectral and directional characterization of many sand samples
  • Some CEOS PICS sites: Algeria_3, Algeria_4, Algeria_5
  • Other sandy areas over the world: Namibia, Morocco, Niger, Australia, Arabia, US…

• Determination of the physical properties of the sand samples

• Re-assessment of PICS
  • Rather good results for CEOS PICS sites
  • 2 new sites: Namibia, Arabia

• Climatology of the sites

• Directional behaviour of the sites using PARASOL collection

All results soon available through the Cal/Val Portal
PICS Quality Study using Sentinel_3 CNES

- PICS quality estimation through Sentinel_3A calibration results
- RMSE computation of elementary calibration results (April 2016 and January 2019): 87376 calibration points distributed over 20 sites

- Good score for some CEOS PICS sites: Libya_1 and _8, Algeria_3 and _5
- Bad score for Mauritania_1 and _2
- New potential good sites: Sudan_1, Egypt_1, Libya_2
• Validation of some sites stability using calibration monitoring of Landsat_8, Sentinel_2A and _2B
  • OK for Libya_1, Libya_4, Niger_1, Niger_2, Sudan_1
  • To be validated for Egypt_1…
• Temporal uncertainties for all bands are within 2.0%

• Cross calibration of Landsat_8, Sentinel_2A and Sentinel_2B over these sites
  • Agreement between all sensors is within 1%
  • Except blue-coastal band 2%

• Study of ‘patched’ african PICS using clustering method over North Africa
  • Very good results for calibration trending (even better than individual sites)
  • Probably more difficult to use for intercalibration (TBC)
• Main interests:
  • Image acquisition can be as frequent as every 1.5 days
  • Large number of acquisitions helps beat down uncertainties
  • Especially useful for quick commissioning and continually observing for short lived missions
• Main drawback: computation time
• 2 different methods applied
• Good consistency of the intercalibration results
  • Better than 1% for Red and NIR bands
  • 2% for the Green band
  • 2.5% for the Blue band
• Despite seasonal effects, discrepancies seems to be bias (low RMS error)
• No trend detectable

• To be continued in the frame of PICSCAR calibration monitoring over Libya_4
Main actions issued from this workshop

- Organise a PICSCAR webex meeting dedicated to sites stability
- Provide AHSI hyperspectral profile over CEOS PICS (at least Libya_4)
- Provide sand lab spectral measurement (compatible with Libya_4)
- Try to obtain sensors datasets over the new sites proposed through the PICSAND study
- Update site characterization with information provided by PICSAND study, but also CNES and SDSU studies
- Play PICSCAR Exercise#3 with the PICSAND BRDF model over Libya_4
- Open the PICSCAR web site to the CEOS community and work with Cal/Val portal team
- Extend the mailing list for PICSCAR webex meeting

Remark: Still one major LEO sensor missing in our Libya_4 dataset: VIIRS…
Way forward

- Finalize intercalibration exercises #2 and #3
- Finalize the set up of the L8/S2A intercalibration monitoring and open it to public
- Extend Libya_4 results to other sites
- Provide calibration community with consensually assessed performances
- Revisit the list of CEOS PICS according to recent results (PICSAND, CNES, USGS, S2MPC…)

Many thanks to PICSCAR Working Group members

PICSCAR Chu still to be caught…