

Preliminary Selection and Characterization of Pseudo-Invariant Calibration Sites (PICS) in Northwest China



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Outline



- Background
- Study area information
- Method
- Results
- Conclusions



- Cosnefroy et al. (1996) selected 20 desert sites located at Suadi Arabia of North African, and six of these have been endorsed by CEOS as standard reference sites for the post-launch calibration of optical satellite sensors.
- Helder et al. (2010) developed an algorithm for locating optimal sites which are spatially and temporally stable. They identified new sites in Egypt and Libya 4 as the most temporally stable of the Sahara Desert PICS.
- Bacour et al. (2019) revisited the list of desert PICS at the global scale and identified four new PICS: in Algeria, Sudan, Arabia and Namibia, based on temporal stability and spatial uniformity metrics at 20 km and at 100 km spatial scales.



- Sohn (2009) made the selection of desert targets for visible channel calibration in the Eastern Hemisphere including the Northwest China based on the several criteria of brightness, temporal stability, spatial uniformity, etc., using MODIS BRDF parameter products.
- ESA-PICS project (ESA, 2018) surveyed some possible areas suitable for vicarious calibration on the globe and identified other more possible calibration desert sites elsewhere in China.
- Previous research about PICS in China provides excellent demonstrations and useful reference for further works. But the selection procedure and characterization of these sites are not well explored and the application cases about these sites are also lacking.

2. Study area information



- Location: 32 46°N, 75 107°E of northwest China
- The terrain is mainly plateaus, basins and average elevation is over 1000 m.
- Precipitation is few and climate is arid and semi-arid.
- 1: TaklaMakan desert
- 2: Chaidamu basin
- 3: Badanjilin desert
- 4: Tegger desert



RGB clear sky composite map of the study area from FY-3D/MERSI-II in October

Atmospheric variables in the study area







- Low cloud fraction (<0.4) is found in the east of TaklaMakan, Badanjilin, and Tegger desert.
- AOD is less than 0.3 except the TaklaMakan desert.
- Water vapor is lower than 1.5 cm.



3. Data and methods



	NICD43A3-WSA	WCD43C3-WSA	Band	Bandwidth /nm	
Collection	6	5	1	620 - 670	R
Resolution	500 m	0.05°	2	841 - 876	NIF
Frequency	daily	everv 8 davs	3	459 - 479	
Period	July in 2002, 2007, 2012, and 2017	2008.1 – 2016.9	4	545 - 565	G
			5	1230 - 1250	
			6	1628 - 1652	
Usage	spatial uniformity assessment	temporal stability assessment	7	2105 - 2155 S	WIF
					_

• Four typical channels representing green, red, near-infrared and short-wave infrared, i.e., bands 4, 1, 2, and 7 were used.



Factors for target selection

- ✓ Spatial uniformity: CVs, in a moving 10 X 10 grid (5 X 5 km²) window
- ✓ Temporal stability: CVt, pixel by pixel (~ 5km)



CV: Coefficient of variation



4. Results - Spatial uniformity CVs



- Very homogeneous (<3 %): TaklaMakan, Badanjilin
- Homogeneous (< 5 %): West of Luobopu lake, Kumtag, Chaidamu
- Tegger: Mixed of Very homogeneous and Homogeneous



Temporal stability CVt



- Very Stable (< 3%): TaklaMakan, West of Luobopu lake, Badanjilin
- Stable (<5 %): TaklaMakan, Kumtag, Chaidamu, Tegger





35°N

80°E



Finally, 29 sites are selected as PICS according to the CV-based method and manual visual verification on Google Earth. Another 3 well known calibration sites of Dunhuang, Milan, and Luobupohu_South

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manual visual verification
Another 3 well known
Best Relative Good
Dunhuang, Milan, and are also included here.

PICS from Iteratively Reweighted Multivariate Alteration Detection (IR-MAD) method



Aqua/MODIS



457 467 367

- Data: FY3 VIRR (2010-2019) and Aqua MODIS (2013-2019).
- The IR-MAD method is to identify the invariant pixels from the image-pair data itself.
- It should be noted that the PICS identified by this method are truly temporally stable but may not spatially uniform.
- The selected PICS from CV method are also identified as invariant by the IR-MAD method.

Landsat OLI RGB composite maps of several typical PICS sites



Best Belative Good

Spectral characteristics of the selected PICS



- The brightness of PICS over Northwest China is lower that of Libya 4.
- WSA in 659 nm:
 - Weak (<0.25): 4 sites
 - Moderate (<0.3): 15 sites
 - Strong (>=0.3): 12 sites

Note: LBPO S is not listed here.

SHDBAN

DAZH_W MANY_S KUMTAG

DAZH_E XCDH_W

TAERDN



Vicarious calibration using the selected PICS

• Validation of Aqua MODIS L1B TOA reflectance



- Collection: V5. Period: Jun., Jul., Nov., Dec., 2012.
- TOA reference: simulation from 6SV
- Reflectance factor obtained in summer are twice that in winter. By jointly using calibration samples, increases the coverage of the sensor dynamic range.
- The RMSE in MODIS calibration is less than 0.05%, indicating that very small systematic bias exists using the PICS over Northwest China for Vicarious calibration.



Validation of FY3D MERSI-II L1B TOA reflectance



CW (nm)	Relative Bias (%)		RMSE (%)	
	MODIS	MERSI-II	MODIS	MERSI-II
650	3.04	3.87	0.04	0.05
865	-1.16	1.34	0.03	0.03
1640	1.41	-5.88	0.04	0.08

- Period: Jun., Jul., Dec., 2019 and Jan. 2020
- The relative bias and RMSE in the 650 nm and 865 nm of MERSI2 is comparable to that of MODIS, indicating sound calibration accuracy and precision in these two channels.



- MODIS surface BRDF products are used to identify the PICS over China through spatial and temporal CV.
- The long term data from Aqua MODIS and FY3 VIRR are investigated for the PICS selection using IR-MAD method.
- These PICS in China are located at high latitude area and their reflective radiance is easily affected by the incident solar irradiance and surface BRDF.
- The relatively low radiance of these sites in winter season provides good opportunity of the vicarious calibration for the ocean color bands.
- They also give the chance of evaluating the instrument nonlinear response by using the wider signal dynamic from the observation in different seasons.



Thanks for your attention!