DESIS and Copernicus Sentinel-2 Surface Reflectance, AOT and WV Products compared to measurements on ground

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DESIS web page @ DLR

Sentinel-2 web page @ ESA

Introduction

PACO atmospheric correction software is implemented in the DESIS L2A processor providing Bottom-Of-Atmosphere (BOA) ground reflectance spectral image cube together with aerosol optical thickness (AOT) and integrated water vapour (WV) maps. PACO can also be applied to Sentinel-2 data providing equivalent outputs.

This presentation will rely on reference measurements of SR, AOT and WV which had been performed on ground in parallel to DESIS acquisitions in August 2019 and 2020. Microtops photometers are used for measurements of the atmospheric parameters and SR measurements on ground used a hyperspectral SVC spectroradiometer covering the spectral range from 380 nm to 2.5 µm. There are Sentinel-2 overpasses over the same area at the same day. Both DESIS and Sentinel-2 data were be processed with PACO and then compared to the available reference measurements.

Data

22.08.2019: Test site: Meadow near Wesenberg (53.27°N, 12.97°E)

Fig1 Test site Wesenberg and DESIS natural color image

06.08.2020; Test site: harvested corn field in Potsdam (52.42°N, 13.04°E)

Fig2 Test site Potsdam and DESIS natural color image

Table 1: DESIS and Sentinel-2 data products

Date	Sensor	overpass	Solar zenith	Sensor tilt	Azimith difference	
22.08.2019	DESIS	10:08	43.3°	29.9°	60.4°	DESIS-HSI-L2A-DT0354896744_002-20190822T100731-V0203-SPECTRAL_IMAGE-SZA43.3
	Sentinel-2	10:11	42.9°	11.4°	49.2°	S2A_MSIL2A_20190822T101031_N0213_R022_T32UQE_20190822T143621
06.08.2020	DESIS	14:27	52.2°	9.9°	156.7°	DESIS-HSI-L2A-DT0483953296_005-20200806T142658-V0213-SPECTRAL_IMAGE
	Sentinel-2	10:11	37.7°	9.1°	61.1°	S2A_MSIL2A_20200806T101031_N0214_R022_T33UUU_20200806T115620

BOA comparison

❖ BOA processing doesn't accounted for BRDF-effects. (PACO DESIS processor [1] [2] , Sen2Cor 2.8 [3])

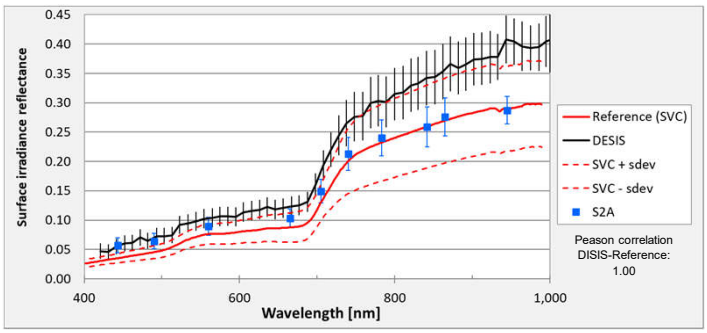

Fig 3: SR spectra over vegetation: Comparison of PACO outputs wiht reference measurements on ground.
Uncertainty of reference measurements is dominated by natural variability of test area.
Plotted uncertainty of DESIS retrieval doesnt accounted for increased AOT retrieval uncertainty due to distortion by thin clouds (see Fig. 5)

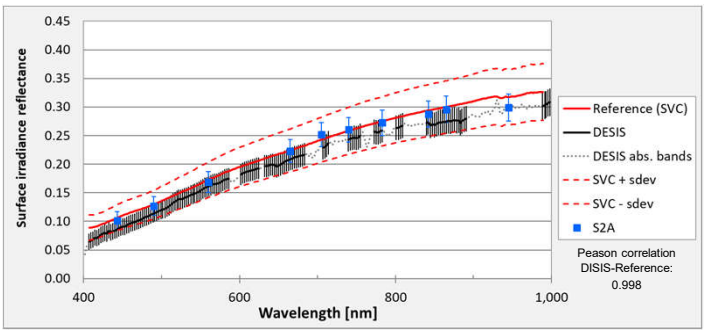

Fig 4: SR spectra over soil: Comparison of PACO outputs wiht reference measurements on ground.
Uncertainty of reference measurements is dominated by natural variability of test area.

AOT and WV comparison

Reference measurements: Microtops Ozonometer + Sun Photometer
(PACO DESIS processor [1] [2] , Sen2Cor 2.8 [3])

AOT_{550nm} (Median ±sdev)		22.08.2019	06.08.2020
Sunphotometer	time avg. ± 15 min	**0.23** ± 0.01	**0.07** ± 0.00
DESIS (PACO)	area avg. 9x9 km²	0.42* ± 0.00	0.09 ± 0.02
Sentinel-2 (Sen2Cor)	area avg. 9x9 km²	0.17 ± 0.01	0.09 ± 0.00

WV (Median ±sdev) [cm]		22.08.2019	06.08.2020
Sunphotometer	time avg. ± 15 min	**1.4** ± 0.0	**1.3** ± 0.0
DESIS (PACO)	area avg. 9x9 km²	2.1* ± 0.1	2.1 ± 0.0
Sentinel-2 (Sen2Cor)	area avg. 9x9 km²	1.7 ± 0.2	1.4 ± 0.1

Table 2: AOT and WV retrieval from DESIS and Sentinel-2 data compared to sun-photometer measurements.
(* Note distortion by thin clouds on 22.08.2019 short before Sentinel-2 overpass

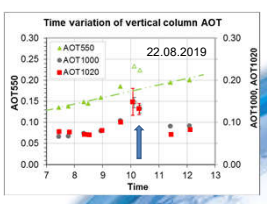

Figure 5: Time variation of AOT on 22.08.2019; The arrow marks the overpass times.

Conclusion

- SR within / (at boarder) of 1-sigma of reference measurements for both DESIS and Sentinel-2 without taking into account BRDF-effects
- Analysis has to be improved correcting BRDF-effects and uncertainty estimation
- High spectral correctness: Pearson correlation ≥ 0.998
- More and better SR reference measurements are necessary with uncertainty lower than uncertainty of retrieval from satellite data.
- Lesson learnt: Permanent observation of incoming light variations is necessary around overpass time.

Knowledge for Tomorrow

[1] de los Reyes, R. et al, 2020, PACO: Python-Based Atmospheric Correction, Sensors, 20, 1428

[2] de los Reyes, R. et al, 2022, The DESIS L2A processor and validation of L2A products using AERONET and RadCalNet data, The international Archives of the Photogrammetry, Remote Sensing and Spatial Information, XLVI-1/W1-2021, 9-12.

[3] S2 Level-2A Algorithm Theoretical Baseline Document (ATBD) version 2.10, https://step.esa.int/thirdparties/sen2cor/2.10.0/docs/S2-PDGS-MPC-L2A-ATBD-V2.10.0.pdf (accessed 17.06.2022)

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