IDEAS-QA4EO Service
Cal/Val Workshop #2
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Ground-based sky-camera observations for cloud-mask validation in support to CMIX

Add-on: pixel collection for MERIS 4th RP cloud mask validation

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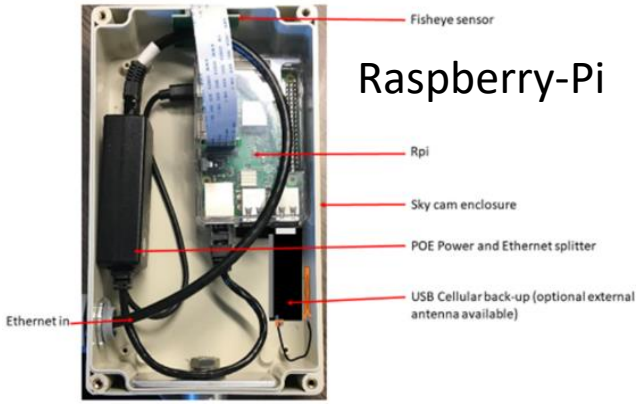
Project Objective

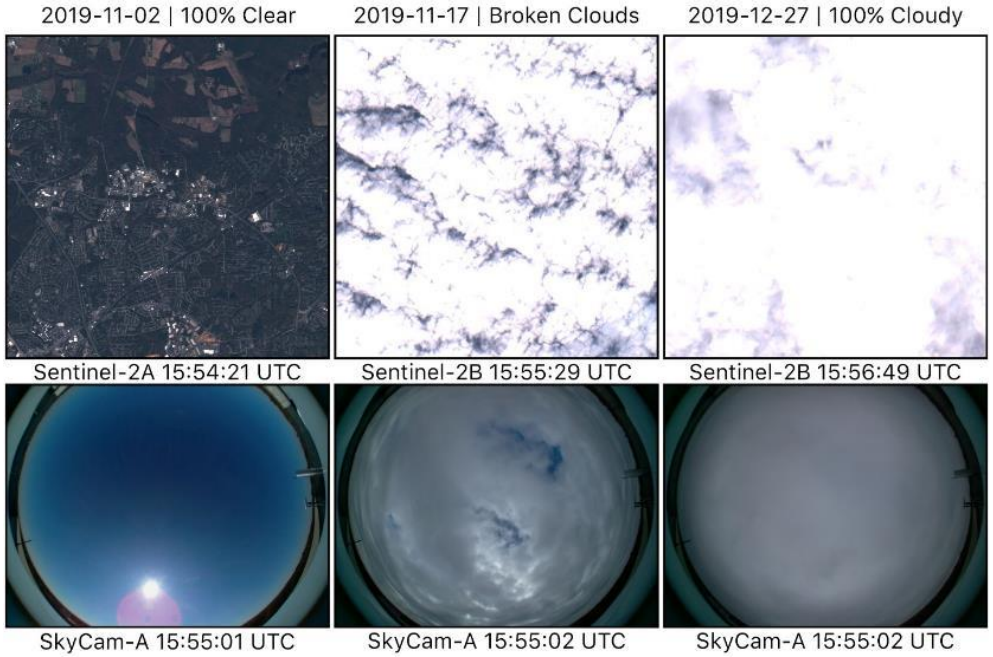
- Develop a global source for independent cloud mask validation of any remote sensing sensor operating in the visual domain (with focus on CMIX).
  - Prepare for establishing and operating a network of sky-camera (SC) based cloud mask validation sites.
  - Collect requirements for cloud mask validation and review instrumentation state of the art
  - Development algorithms for cloudiness index (SC) and validation.
  - Experimental operation of two test sites: Goddard Space Flight Center (US), La Sapienza University, (Italy)
  - Develop a roadmap

Cooperation with University of Maryland & La Sapienza University

SkyCam system @ NASA/GSFC -> La Sapienza

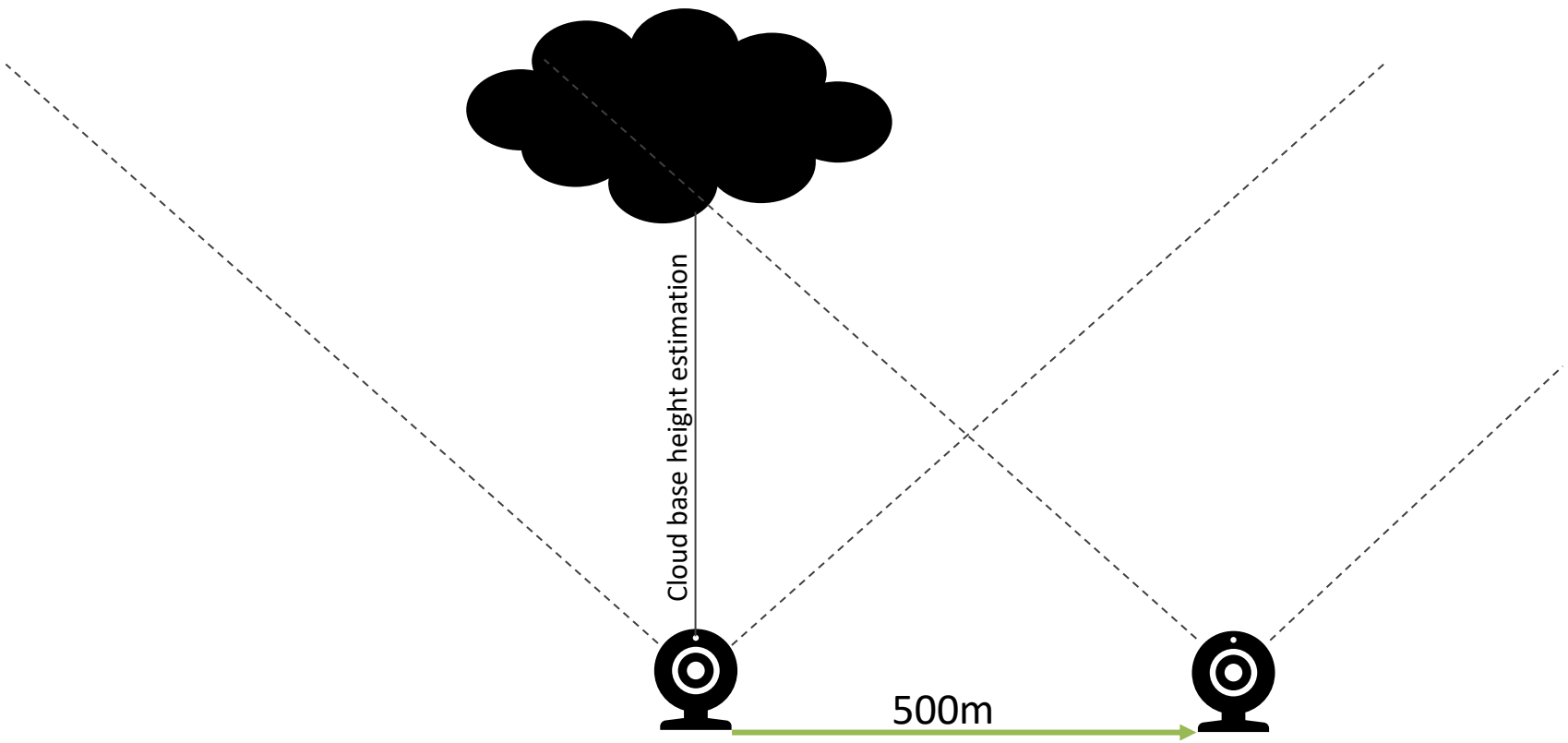
Omnivision OV5647 5 Megapixels
sensor fitted with a wide field-of-view lens





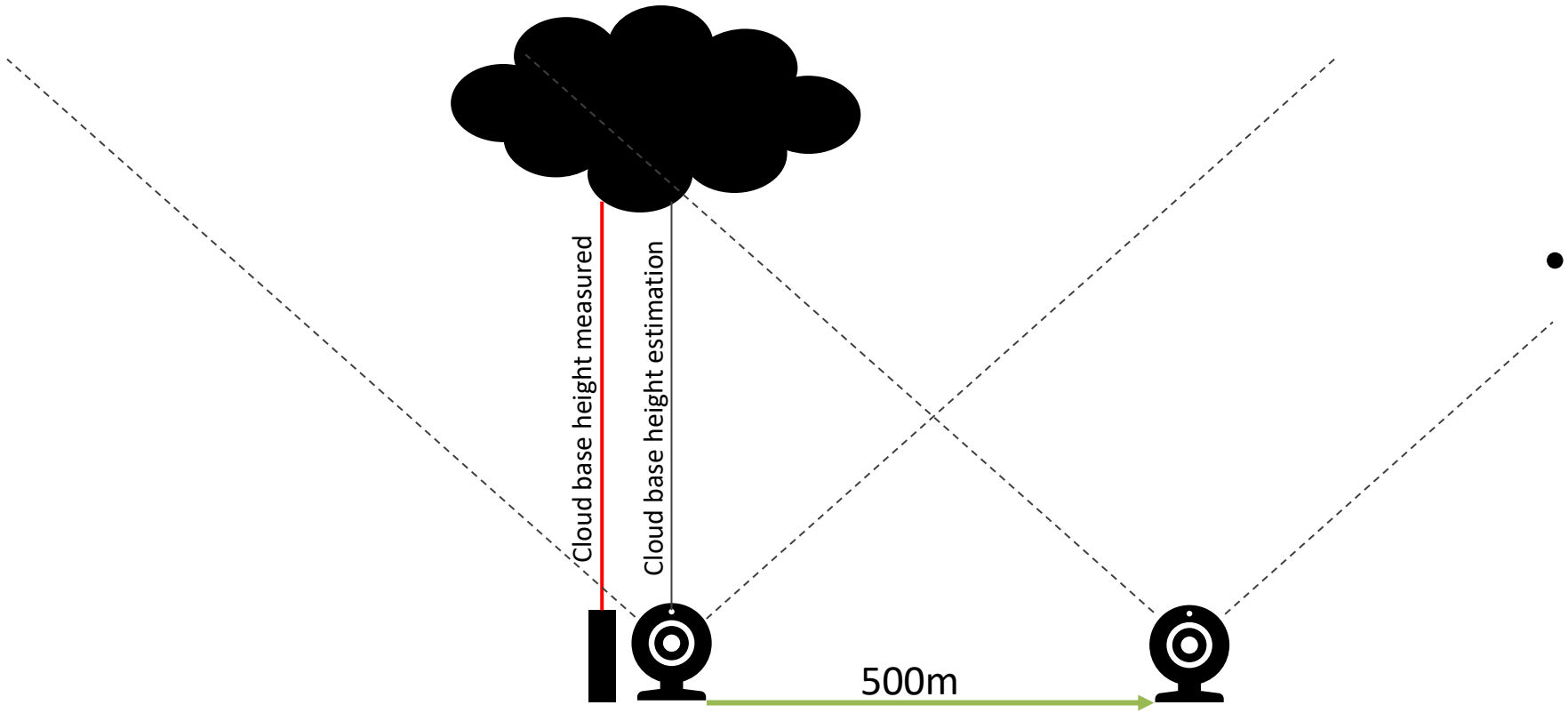
[Skakun et al., 2020]

SkyCam and Lidar setup @GSFC



- The modules are synchronized
- provide real-time cloud cover data every 5 min.
- during satellite overpasses: every 1 min.

SkyCam and Lidar setup @La Sapienza



- In dation to the Stereo SkyCams a Lidar is installed
- Lidar will be used to validate the estimated cloud base height

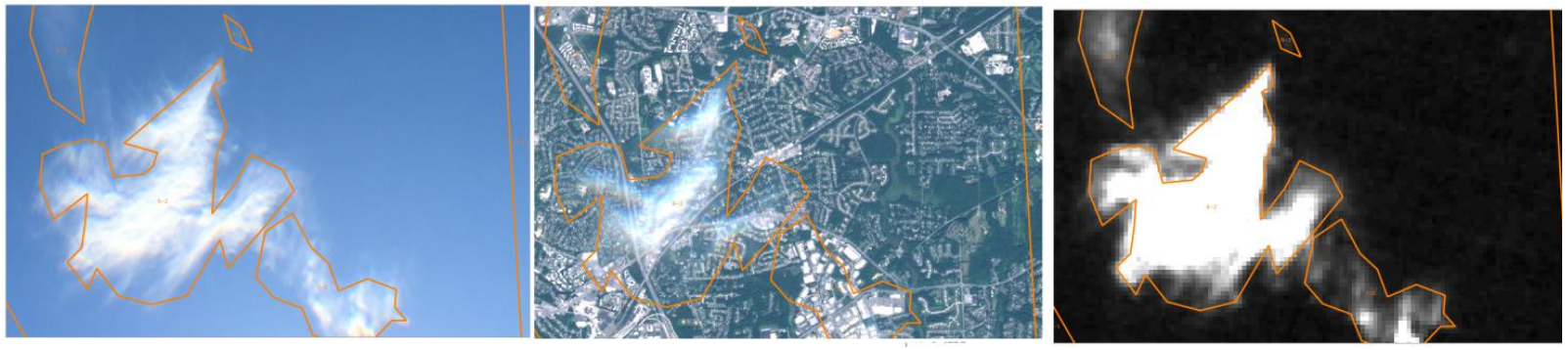
Method

- In a first attempt, clouds from the SkyCam have been mapped manually
- Now an automated classifier is in place
- The area between clouds and clear is not mapped

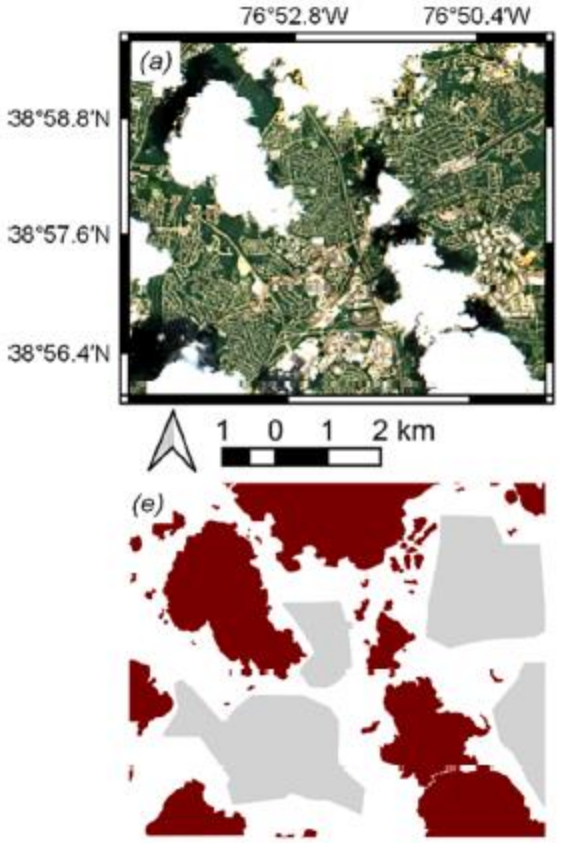
[Skakun et al., 2020]

Method

- The SkyCam image + classification is mapped onto the satellite image based on GCPs using the shape of clouds



[Skakun et al., 2020]



Project tasks and schedule

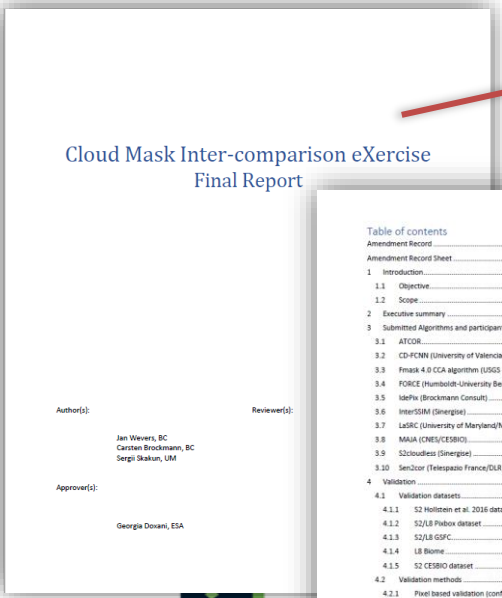
- Task 1: Requirement and state of the art analysis
- Task 2: Validation sites and methods preparation
- Task 3: Experimental operation
- Task4: Evaluation and conclusion

Task	Content	May 20	Jun 20	Jul 20	Aug 20	Sep 20	Oct 20	Nov 20	Dec 20
Task 1	Requirements and state of the art analysis								
Task 2	Validation sites and methods preparation	~~Planned shipment of the Skycam~~							
Task 3	Experimental operations		Corona		Pandemic				
Task 4	Evaluation and conclusion								
								D1	D2

D1: Roadmap - Plan for up-scaling
D2: Operations and Validation Report

What could be done

- Task 1: Requirements and state of the art analysis


Cloud Mask Inter-comparison eXercise
Final Report

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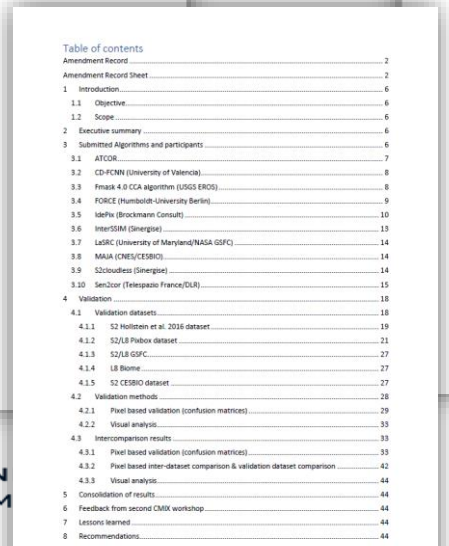
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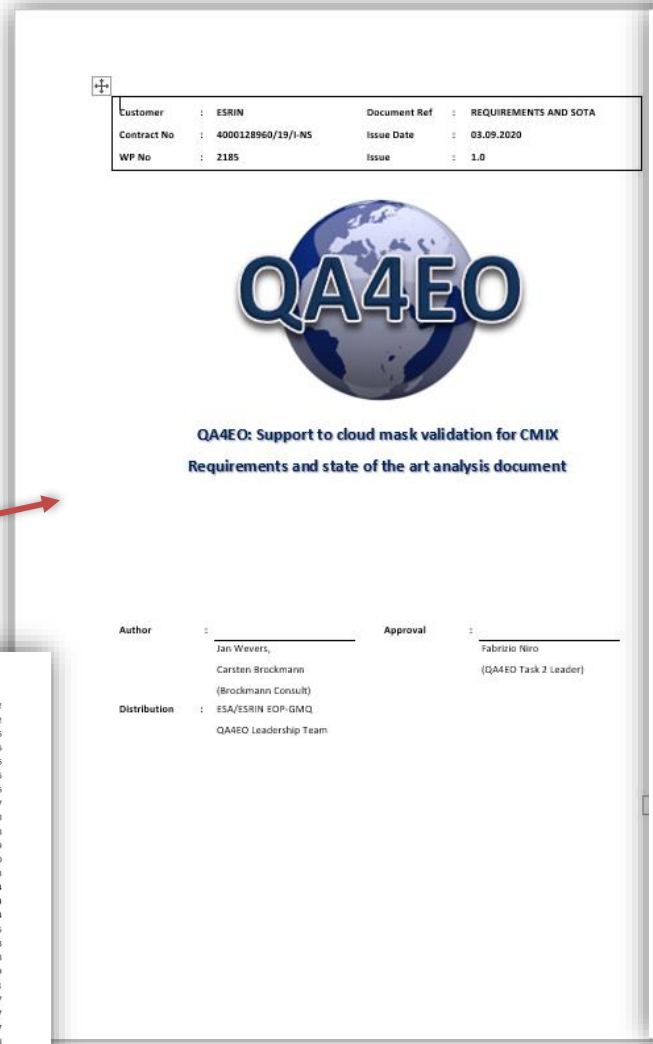

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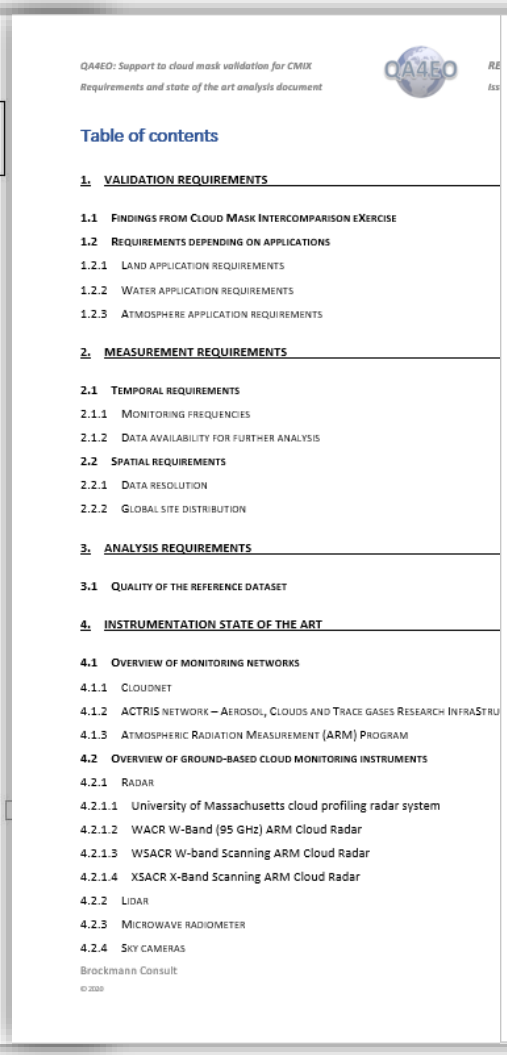
QA4EO: Support to cloud mask validation for CMIX

Requirements and state of the art analysis document

Author	: Jan Wevers, Carsten Brockmann (Brockmann Consult)	Approval	: Fabrizio Niro (QA4EO Task 2 Leader)
Distribution	: ESA/ESRIN EOP-GMQ QA4EO Leadership Team		



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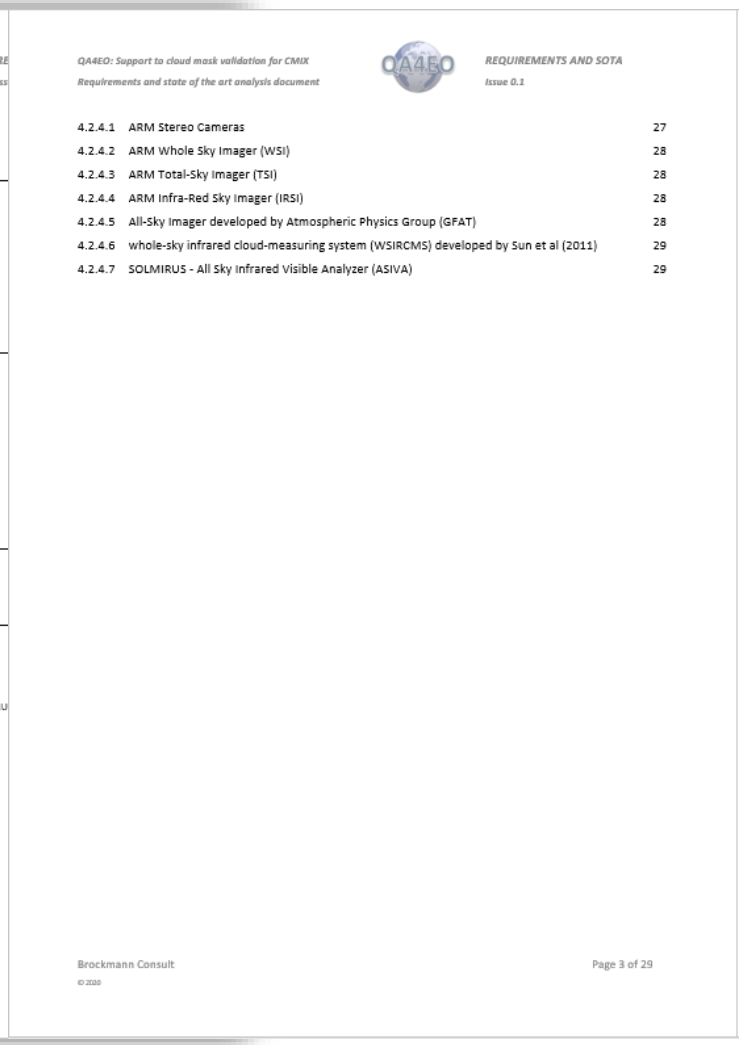

What could be done

- Task 2: Validation sites and methods preparation
- Some work was done for the US site:
  - Method development for automated classification at UoM
  - Method of Skakun et al. [2020] has been published most recently

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An experimental sky-image-derived cloud validation dataset for Sentinel-2 and Landsat 8 satellites over NASA GSFC

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ABSTRACT

Availability of a reliable cloud mask for optical satellite imagery is a prerequisite, when generating high-quality high-level geoinformation products. Creation of a reference (ground truth) cloud mask for moderate spatial resolution sensors, such as Operational Land Imager (OLI) aboard Landsat 8 and Multispectral Instrument (MSI) aboard Sentinel-2A/B satellites, is a challenging and time-consuming task. Existing reference datasets were mainly produced through photointerpretation of satellite images by an analyst, which can introduce subjectivity in detecting clouds. Therefore, other methods for generating cloud reference data shall be explored and evaluated that can complement existing datasets. In this paper, we document generation and provide the description of a new reference cloud dataset, named GSFC-Cloud, which is based on the extensive use of ground-based images of the sky. The dataset is collected over the same area, covers various cloud conditions, and is available for six Landsat 8 and twenty-eight Sentinel-2 scenes spanning the period of September 2017 to November 2018. The dataset is available in the vector format, so cloud masks at various spatial resolutions can be validated. We also describe a system to automate the process of ground-based data collection using low-cost off-the-shelf parts with the long-term objective to replicate this set-up in multiple locations around the world. We use the proposed dataset to validate and improve the Land Surface Reflectance Code (LaSRC) for cloud detection in Sentinel-2 imagery. We show that adding a parallax feature to estimate a subpixel shift between red and green bands with a phase correlation method can reduce overdetection of clouds and improve performance of LaSRC.

1. Introduction

Cloud cover is a limiting factor in exploiting data acquired by space-borne optical remote sensing sensors. The common approach to overcome this limitation is to filter out (mask) cloudy-affected pixels before any high-level processing steps. The accuracy of such masking can vary depending, among others, on the surface and clouds reflective properties, and on their mutual radiometric contrast. Remaining undetected clouds, due to inaccurate masking, can lead to artifacts in the resulting downstream applications, such as land cover land use change, agricultural monitoring, or monitoring of aquatic resources. Therefore, having a high-quality cloud mask is a prerequisite for the efficient use of optical imagery.

Data acquired by sensors aboard Landsat 8 (Operational Land Imager—OLI and Thermal Infrared Sensor—TIRS) and Sentinel-2 (Multispectral Instrument—MSI) satellites are widely used in many application domains thanks to their high quality, global coverage and free access policy (Drusch et al., 2012; Gascon et al., 2017; Wulder et al., 2019; Zhu et al., 2019). Combination of data from OLI and MSI sensors improves frequency of observations reaching the temporal revisit required for many land applications (Li and Roy, 2017), and multiple studies have shown efficiency of their combined usage (Bolton et al., 2020; Griffiths et al., 2019; Pahlevan et al., 2019; Roy et al., 2019; Skakun et al., 2019a). NASA's Harmonized Landsat Sentinel-2 (HLS) product (Claverie et al., 2018) is an example of harmonizing data from several complementary sensors into analysis ready dataset, as if data were acquired by a single sensor. In order to effectively combine data from OLI and MSI sensors it is crucial to perform an accurate cloud detection and screening.

Cloud detection in optical satellite imagery has been an area of active

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Project tasks and new schedule

- Caused by the pandemic and lock-down situation the shipment of the sky-cameras was delayed for 6 month.
- On 24th of November the SkyCams finally arrived in Rome
- As most of the work was depending on the operation of both sites (especially Rome – SkyCam + Lidar), the schedule had to be adjusted.

Task	Content	May 20	Jun 20	Jul 20	Aug 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21
Task 1	Requirements and state of the art analysis													
Task 2	Validation sites and methods preparation							Actual shipment of the Skycam						
Task 3	Experimental operations													
Task 4	Evaluation and conclusion													
													D1	D2

D1: Roadmap - Plan for up-scaling
D2: Operations and Validation

Highlight from additional activities under QA4EO Task 1

- Expert pixel collection (PixBox) for MERIS 4th RP FR data.
- 19000 pixels for cloud mask validation
- Validation will be conducted between Dec 2020 and Jan 2021
- Outcome will be summarized in a dedicated report. And can then be made available for the users.