Airborne Research of the Earth System (ARES)
CWIS-II Imaging Spectrometer

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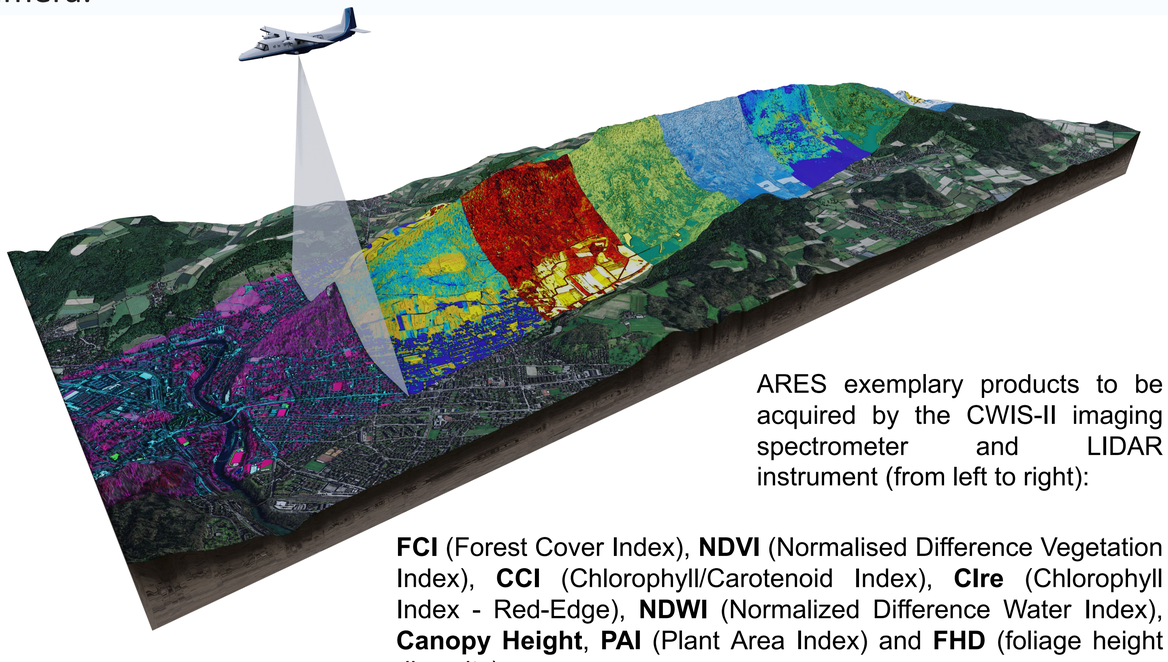
Introduction

ARES is a brand-new, state of the art airborne Earth observation system. It features three different sensors in its standard configuration: a) an imaging spectroradiometer, b) a full waveform LIDAR, and c) a photogrammetric camera.

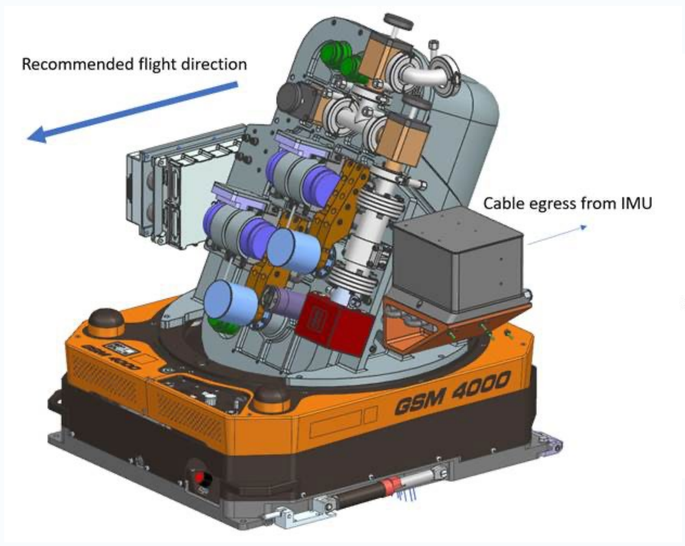


ARES exemplary products to be acquired by the CWIS-II imaging spectrometer and LIDAR instrument (from left to right):

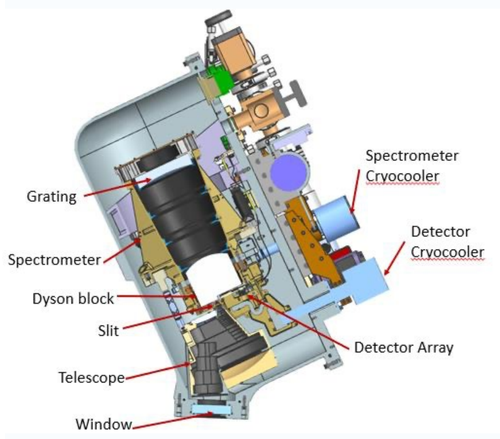
FCI (Forest Cover Index), **NDVI** (Normalised Difference Vegetation Index), **CCI** (Chlorophyll/Carotenoid Index), **CIre** (Chlorophyll Index - Red-Edge), **NDWI** (Normalized Difference Water Index), **Canopy Height**, **PAI** (Plant Area Index) and **FHD** (foliage height diversity)

CWIS-II – The ARES Imaging Spectrometer

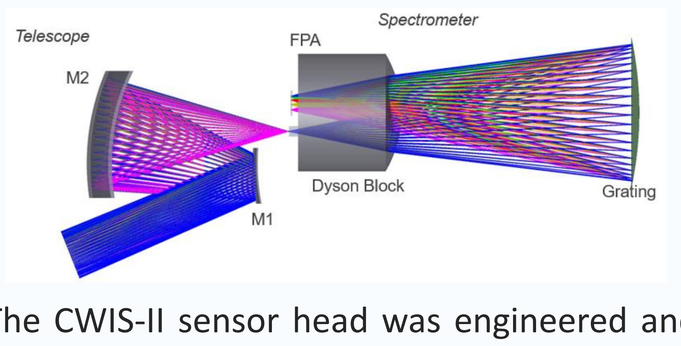
CWIS-II is based on a Dyson design, optimising the light-throughput of the optical chain and massively improving the uniformity of the imaged data in spectral and geometric space.



CWIS-II CAD drawing, showing the sensor placed in the GSM 4000 stabilising platform.



CWIS-II instrument major parts [2]



CWIS-II optical design with a two-mirror telescope and a full VSWIR Dyson spectrometer [2].

The CWIS-II sensor head was engineered and built by NASA/JPL [1, 2] while the flight hardware and software was developed by ZHAW and UZH.

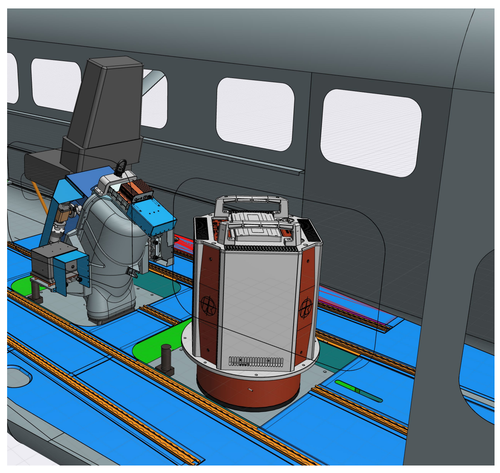
CWIS-II is the successor of the APEX airborne imaging spectrometer. APEX was developed by UZH and VITO and operated from 2009 till 2019. APEX is superseded by CWIS-II with regular operations planned for 2024.

CWIS-II offers unprecedented radiometric and spectral stability by being operated within a vacuum vessel and thermally regulated to within 100 mK.

Parameter	APEX	CWIS-II	Improvement Factor
Signal to Noise	~650	>2000	3
Frown	< 0.16 pixels	< 0.03 pixels	5
Smile	< 0.2 pixels	< 0.02 pixels	10
Sampling Range	400-2498 nm	400-2490 nm	-
Spectral Bands	299 (533)	327	-
VNIR Spectral resolution	2.6-13.5 nm	7.4 nm	-
SWIR Spectral resoliution	5.6-9.9 nm	7.4 nm	-
Field of View	28°	39.5°	1.2
Acrosstrack pixels	1000	1240	1.2
Smallest Ground Sampling Distance	1.7 m	0.3 m	6
Frames per second	30	215	7

Combined Sensor Operations

CWIS-II is integrated into a Cessna Caravan EX aircraft operated by Swiss Flight Services (SFS). Two hatches custom-designed for survey payloads allow a combined operation of CWIS-II and a laser scanner such as the RIEGL VQ-1560 II-S featuring an integrated medium format photogrammetric camera. A single overflight can produce spectroscopy data cubes, LIDAR point clouds and high-res RGB data that can be fused in a post-processing step to allow complex ecosystem studies.



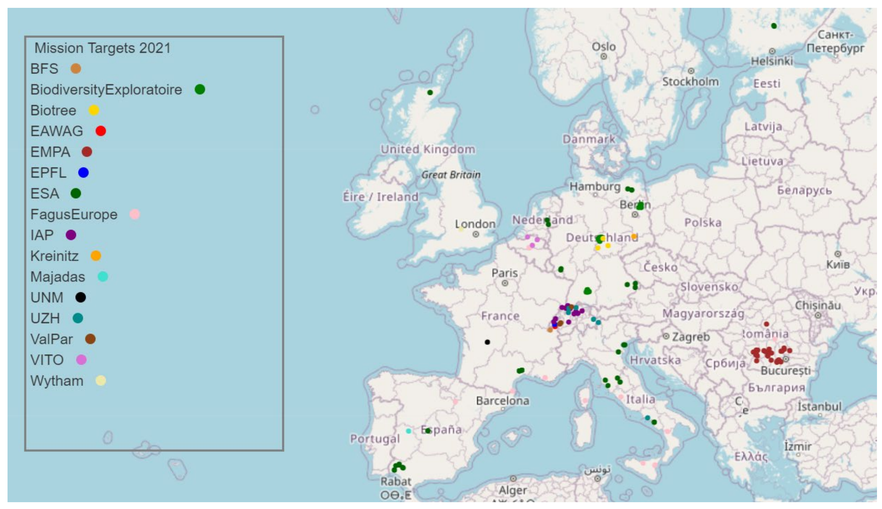
Cabin layout of the HB-TEN aircraft, showing CWIS-II installed in the forward hatch and the Riegl scanner occupying the aft hatch.

Swiss Flight Services HB-TEN aircraft, acting as the standard carrier for ARES [3].

Flight Mission Management

The ARES flight operations team has a multi-year experience in planning and conducting complex missions across multiple countries within highly dynamic environments.

Our automated weather assessment procedures and standardized daily communication protocol keeps everyone involved in the loop and helps us achieving optimal imaging within given flight budgets.



Mission target areas of the 2021 Europe Flight Mission for the CHIME and SBG future satellite missions, carried out in cooperation with NASA/JPL on behalf of the European Space Agency (ESA). Third party missions were added to this multi-months campaign.

Overall mission mangement by ARES Flight OPs team.

Acknowledgement

References

[1] Gorp, B. V., Mouroulis, P., Wilson, D. W., Green, R. O., Rodriguez, J. I., Liggett, E. and Thompson, D. R. (2016). Compact Wide swath Imaging Spectrometer (CWIS): alignment and laboratory calibration. SPIE Optical Engineering + Applications, SPIE.

[2] Green, R. O., Schaepman, M. E., Mouroulis, P., Geier, S., Shaw, L., Hueni, A., Bernas, M., McKinley, I., Smith, C., Wehbe, R., Eastwood, M., Vinckier, Q., Liggett, E., Zandbergen, S., Thompson, D., Sullivan, P., Sarture, C., Gorp, B. V. and Helmlinger, M. (2022). Airborne Visible/Infrared Imaging Spectrometer 3 (AVIRIS-3). 2022 IEEE Aerospace Conference (AERO).

[3] https://www.jetphotos.com/photo/10195217

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