A new hyperspectral radiometer integrated in automated networks of water and land bidirectional reflectance measurements for validation of Sentinel-3ABCD (and all other optical missions) - The HYPERNETS Project

and Landsat-8/9

and Sentinel-2ABCD

and PROBA-V

Kevin Ruddick, Joel Kuusk, Vittorio Brando, Ana Dogliotti, David Doxaran, Nigel Fox, Daniel Spengler, Davide Dionisi, Claudia Giardino, Clémence Goyens, Francisco Grings, Luis Guanter, Edouard Leymarie, Tiia Lillemaa, Christophe Penkerc'h, Anu Reinart, Rosalia Santoleri, Karl Segl, Dimitry Vanderzande, Quinten Vanhellemont, Riho Vendt

and ENMAP

and PRISMA

and MODIS-AQUA/TERRA

and nanosatellites

1. Royal Belgian Institute for Natural Sciences (RBINS), Brussels, Belgium
2. Tartu Observatory (TO), Tartu, Estonia
3. Consiglio Nazionale delle Ricerche (CNR), Rome, Italy
4. Instituto de Astronomía y Física del Espacio, Consejo Nacional de Investigaciones Científicas y Técnicas (IAFE, CONICET/UBA), Buenos Aires, Argentina
5. Laboratoire Océanographique de Villefranche, Université Pierre et Marie Curie – Paris 6 (UPMC/LOV), Villefranche-sur-mer, France
6. National Physical Laboratory (NPL), Teddington, United Kingdom
oltz Zentrum Potsdam DeustschesGeoforschungszentrum (GFZ), Potsdam,
8 Consiglio Nazionale delle Ricerche (CNR-IREA), Milan, Italy

and Pléiades

and VIIRS and SABIAMAR

and PACE

The HYPERNETS Project is funded by the European Union under the H2020 Program

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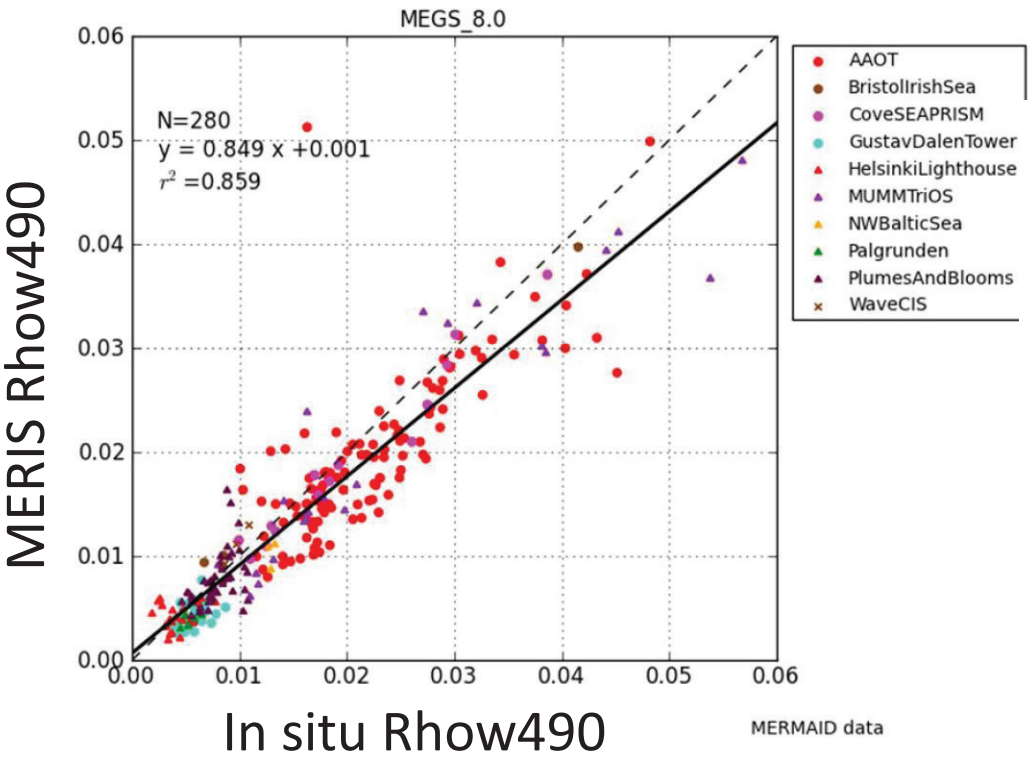
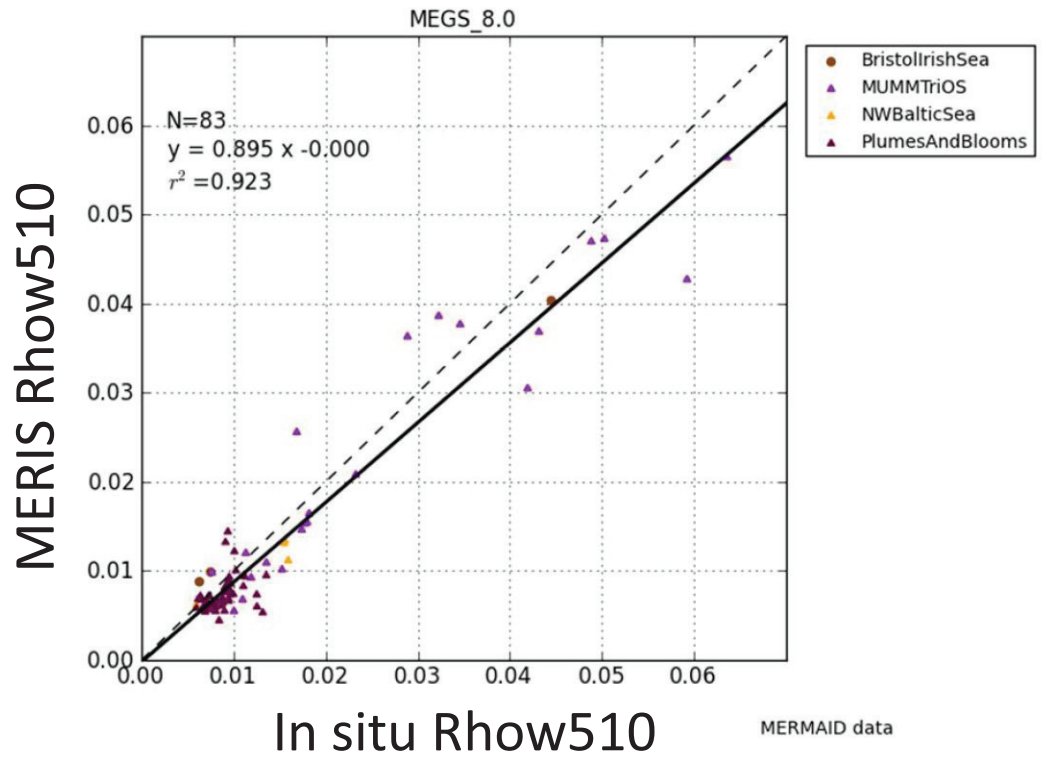
10 years of MERIS validation data, including a few years of AERONET-OC…





- AERONET-OC stations produce significantly more matchups
- AND have standardised calibration, processing and Quality Control
- BUT do not cover all wavelengths

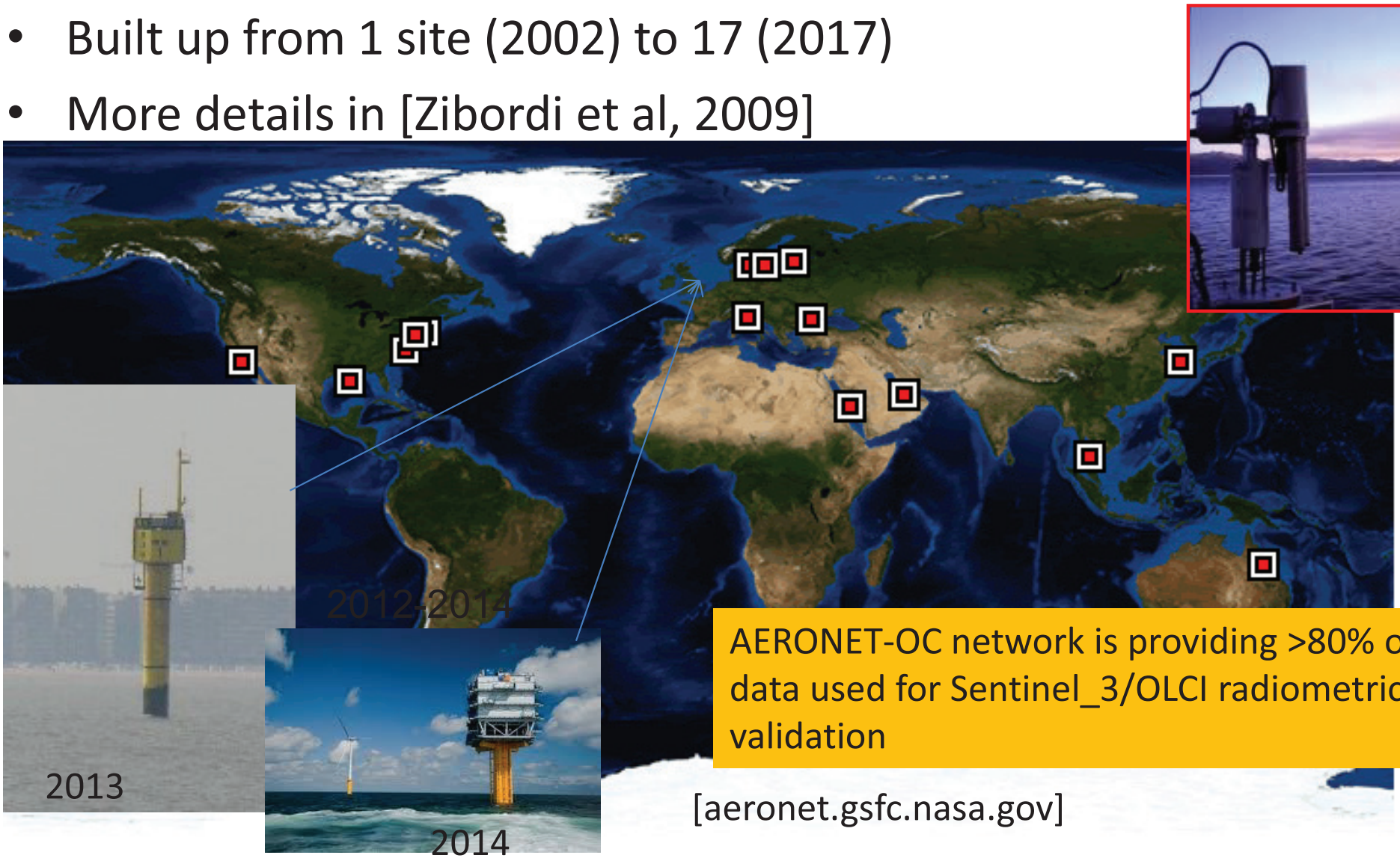
S3VT/MPC:
"No validation data for some red bands"

[MERIS 3rd reprocessing data validation report, ACRI, 2012]

Data courtesy of PIs (D. McKee, K. Ruddick, D. Siegel, S. Kratzer) and AERONET-OC PIs (G. Zibordi, G. Schuster, S. Kratzer, B. Gibson), matchup using MERMAID

Heritage: NASA/JRC AERONET-OC

- Federated network of instrumented sites for ocean color validation, spawned from larger AERONET network
- Built up from 1 site (2002) to 17 (2017)
- More details in [Zibordi et al, 2009]



AERONET-OC network is providing >80% of data used for Sentinel_3/OLCI radiometric validation

[aeronet.gsfc.nasa.gov]

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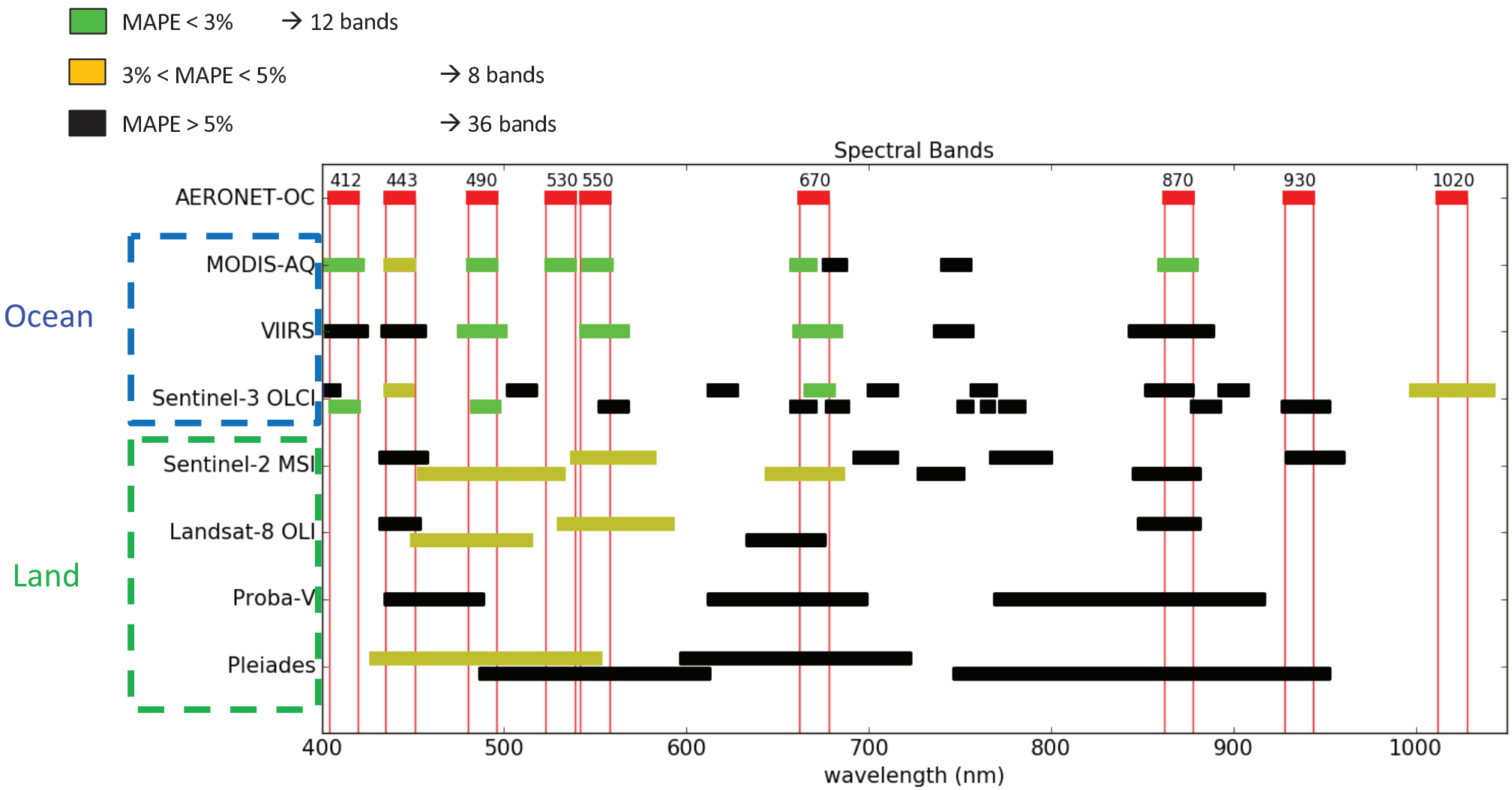
Multi-Mission Validation

[Van der Zande, Ruddick et al. Validation of Landsat-8/OLI for ocean colour applications with AERONET-OC sites in Belgian coastal waters (2016) Ocean Optics, Victoria, BC]



[a new version of CIMEL/SEAPRISM is now available with more OLCI bands]

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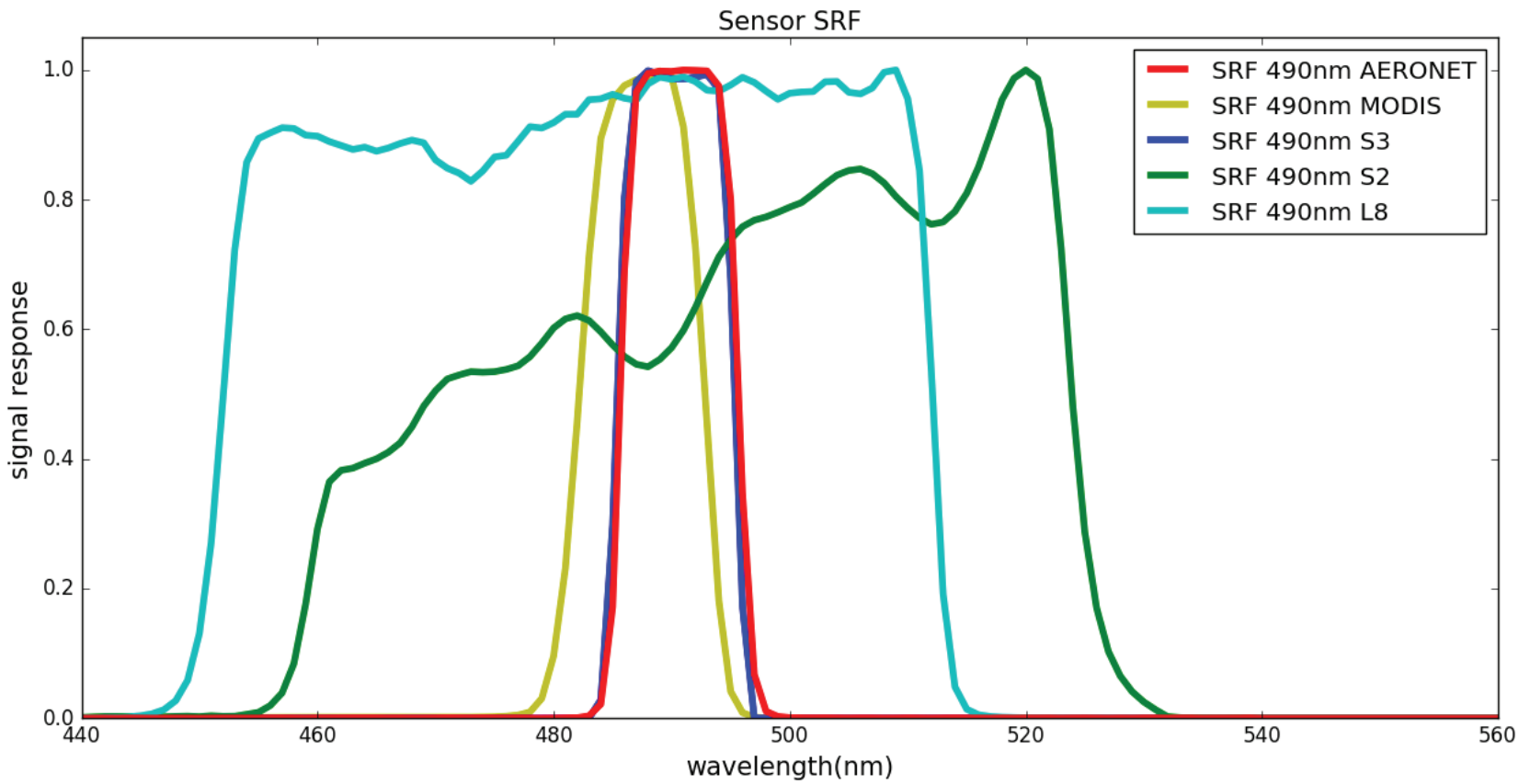
e.g. “490nm” spectral band of MODIS, S3/OLCI … L8/OLI and S2/MSI (and AERONET-OC)

Need hyperspectral to fit all these with low uncertainty



[new SRF function now available for S2A]

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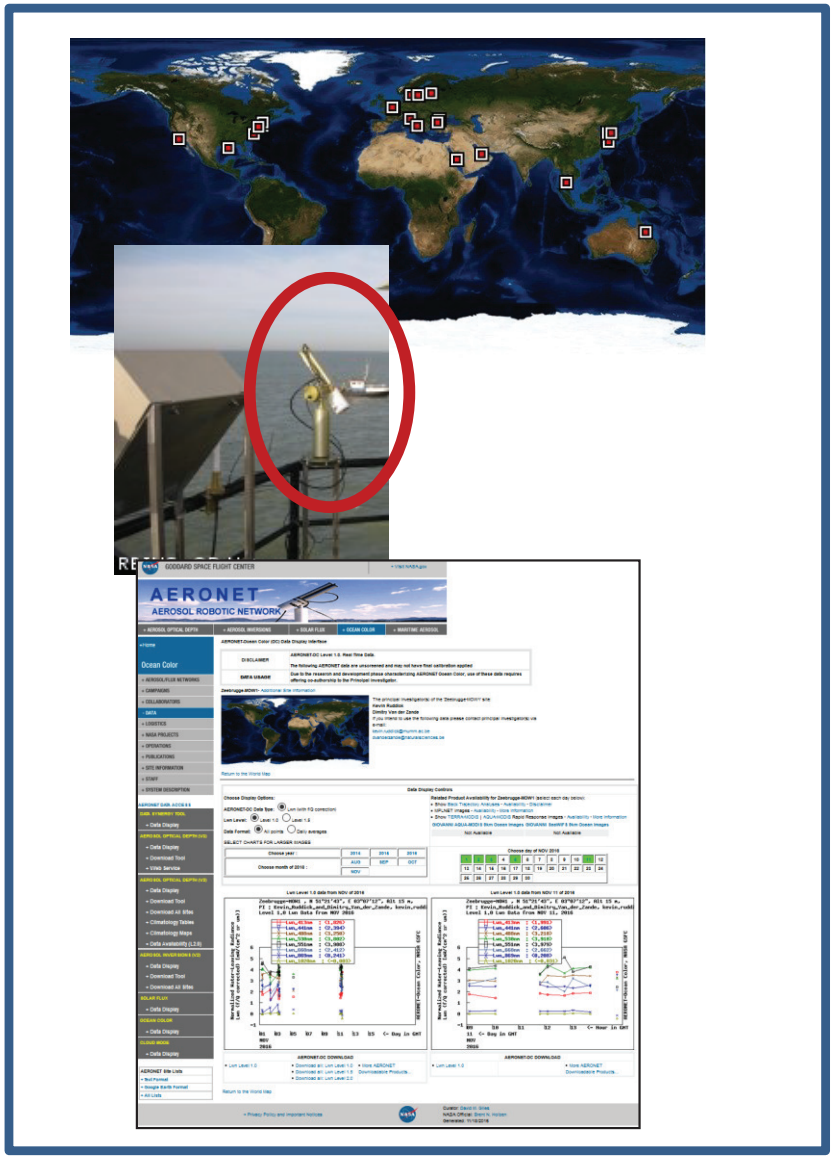
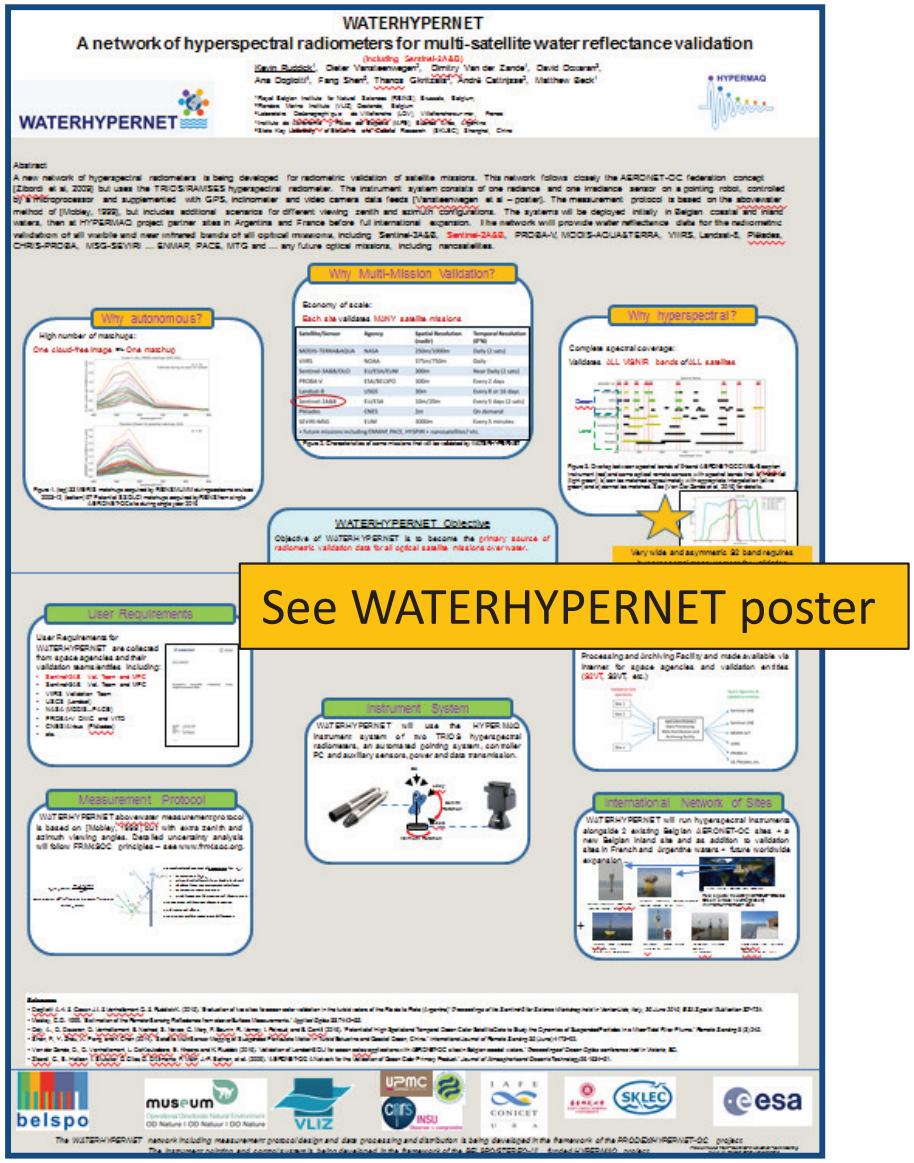
inspired new network
based on TRIOS/RAMSES
hyperspectral radiometer
(testing in 2018)

NASA/JRC-AERONET-OC → WATERHYPERNET





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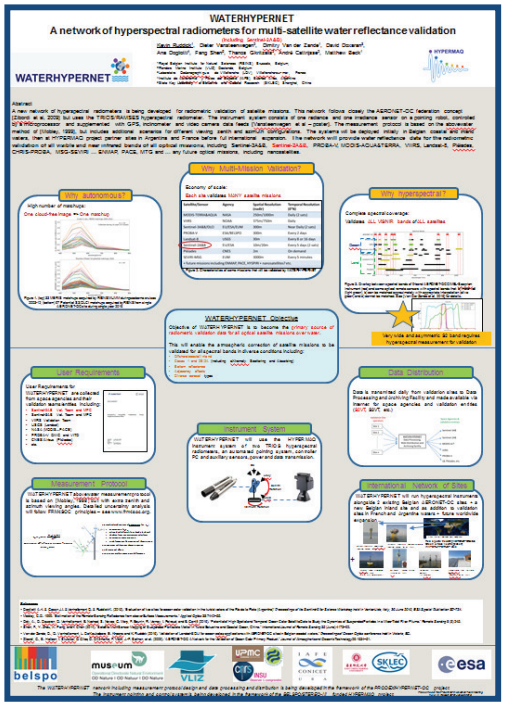
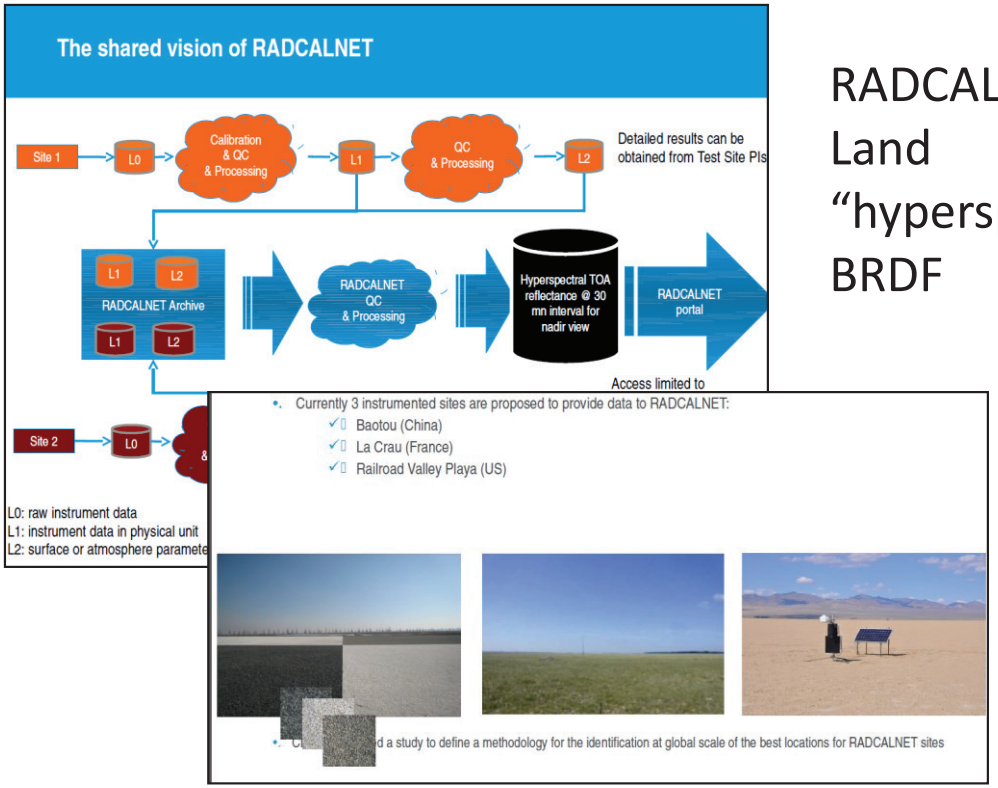
WATERHYPERNET





RADCALNET
Land
"hyperspectral"
BRDF

H2020/HYPERNETS project

"instrument"

New low-power, low-weight, low-cost hyperspectral radiometer
Wifi/GPRS, etc.
Inclinometer, GPS, etc.

+

"system(s)"

Azimuth and zenith pointing for
Water and Land BRDF
LED calibration source
+ extras

+

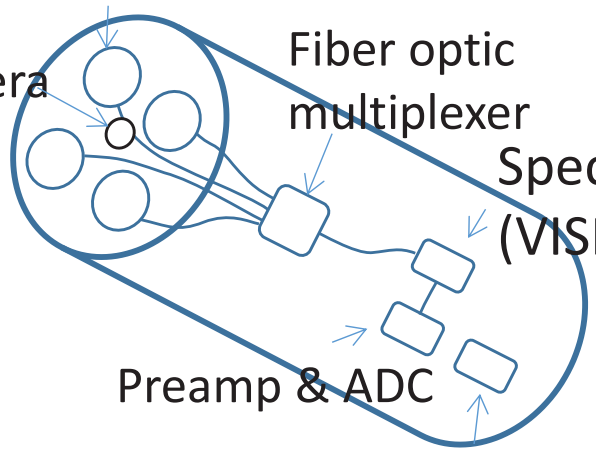
"networks"

AERONET-OC and RADCALNET style data portals

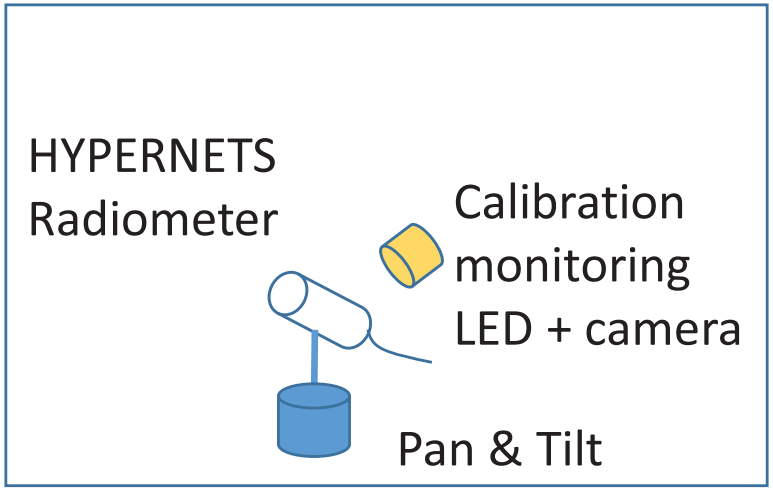
(c) HYPERNETS Consortium (RBINS, TARTU, LOV, CNR, NPL, GFZ, CONICET)

HYPERNETS
Radiometer

Multiplexed multi-head foreoptics
(radiance, irradiance, optional polarized
radiance, etc)



HYPERNETS
System



+

Site-dependent auxiliary equipment
e.g. Power (solar/wind), Data acquisition PC,
Transmission antenna, Mounting frame/mast,
Transmission antenna, heating/cooling, monitoring/anti-theft cam, protection from elements and animals, etc.
and complementary instruments (sunphotometers, flux towers, etc.)

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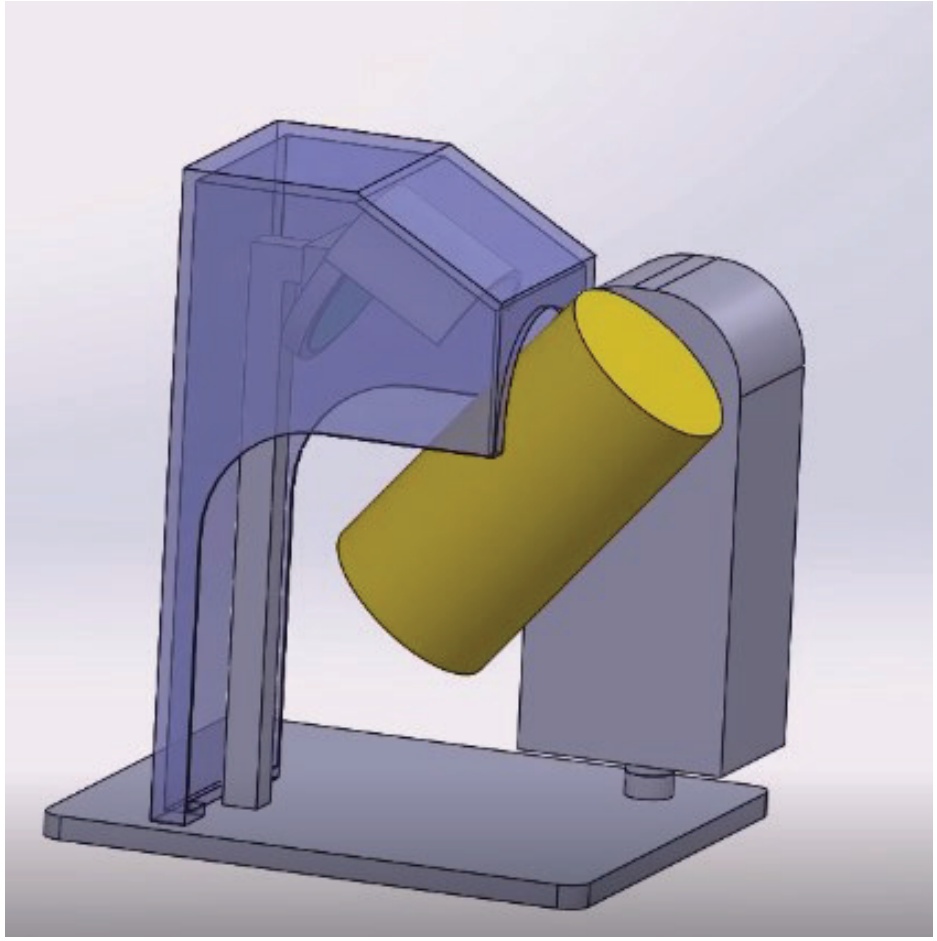
Preliminary idea for system design



[Edouard Leymarie, LOV]

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Sites (water, land)

- RBINS:
  - A-OC/Zeebrugge, A-OC/Thornton, BE/inland
  - Antarctica + BE/land
- LOV/Doxaran
  - MESURHO/Rhône, SORA/Rhône, MAGEST/Gironde
- CNR/Brando
  - Lampedusa buoy, Adriatic/Aqua Alta platform, Garda Lake
- Tartu/Kuusk
  - Temporary deployments (lakes, etc.)
  - Toravere, Soontaga, Jarvselja (forests)
- GFZ/Spengler
  - TERENO, ATB (agricultural)
- NPL/Fox
  - RADCALNET/Namibia, Wytham Woods, Tropical forest, Multiple temp
- CONICET
  - Rio de La Plata, Chascomus Lake
  - INTA Castelar Agricultural

(c) HYPERNETS Consortium (RBINS, TARTU, LOV, CNR, NPL, GFZ, CONICET)

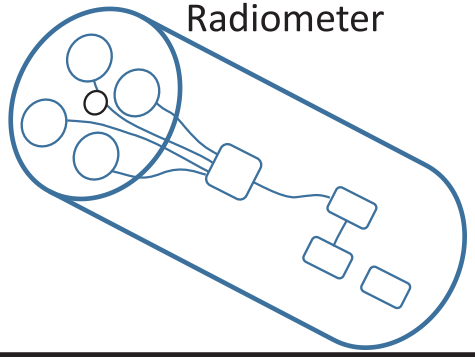
HYPERNETS Project overview

- Duration=48 M, Feb 2018 - Jan 2022
- Budget 5M€ (inc. ~0.9M€ for components)
- Partners:
  - RBINS, TARTU, UPMC, CNR, NPL, GFZ, CONICET
  - 12 water, 12 land test sites (from Antarctica to Namibian desert)
- Key dates
  - 2019/04, 2019/10, 2020/07: Prototype instruments
  - 2019/10, 2020/07, 2021/01: Systems for field testing
  - 2022/02: Commercialisation of instrument

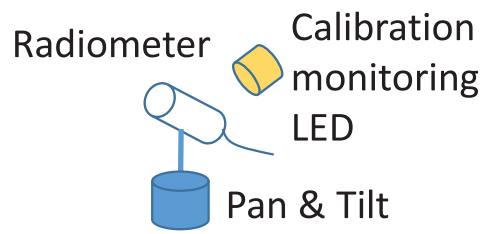
(c) HYPERNETS Consortium (RBINS, TARTU, LOV, CNR, NPL, GFZ, CONICET)

Conclusion

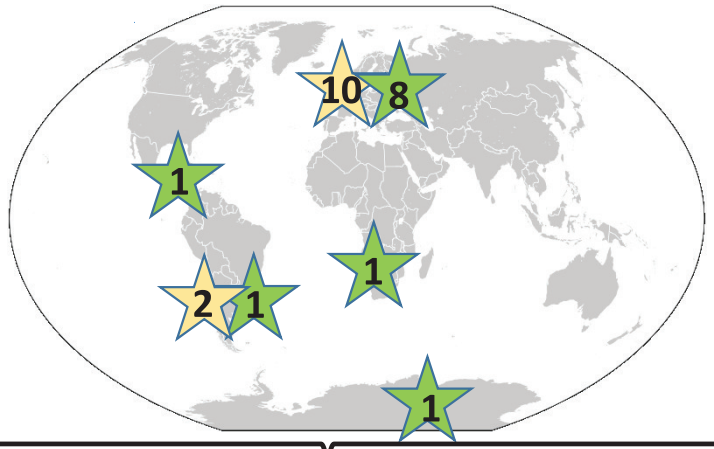
HYPERNETS multi-head hyperspectral Radiometer



HYPERNETS Autonomous System



HYPERNETS water validation network phase 1



HYPERNETS land validation network phase 1

Validation of surface reflectance at <u>all spectral bands</u> of <u>all optical missions</u> inc. Sentinel-2A&B, Sentinel-3A&B, MODIS-A&T, VIIRS, Landsat-8, Pléiades-2A&B, PROBA-V, CHRIS, ENMAP, PRISMA, SABIAMAR, etc. ... + nanosats

Spectral range and resolution?

Azimuth/zenith pointing range and accuracy?

Other instrument or system features?

Q for S3VT scientists: What would you like to have in a future hyperspectral radiometer?
Q for ESA/EUM: What data do you want from future hyperspectral networks?

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