Preparation of Next Generation Hyperspectral Radiometric Validation Networks for Water and Land Surface Reflectance - the HYPERNETS project

presented by Kevin Ruddick (RBINS)

H2020/HYPERNETS

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The HYPERNETS project is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 775983.
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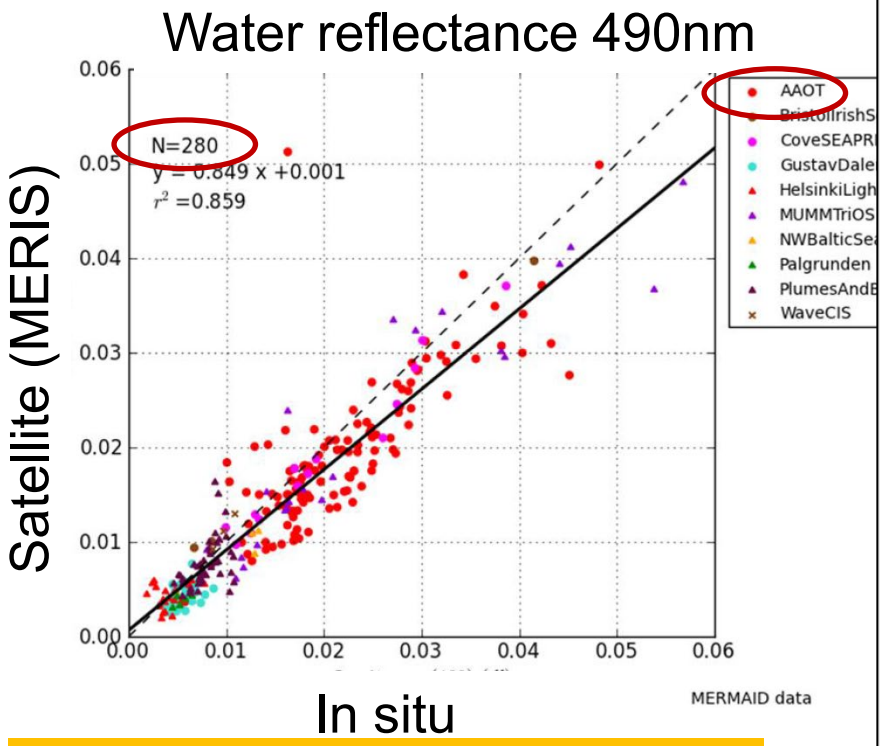
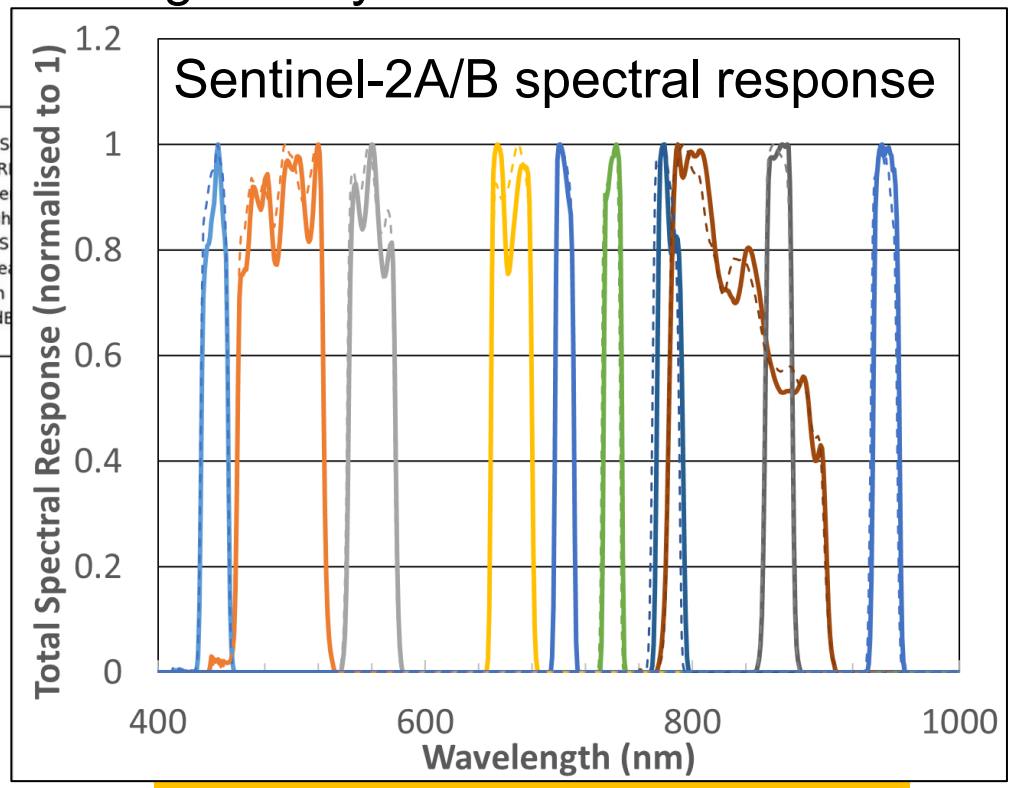
The Motivation for automated hyperspectral

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





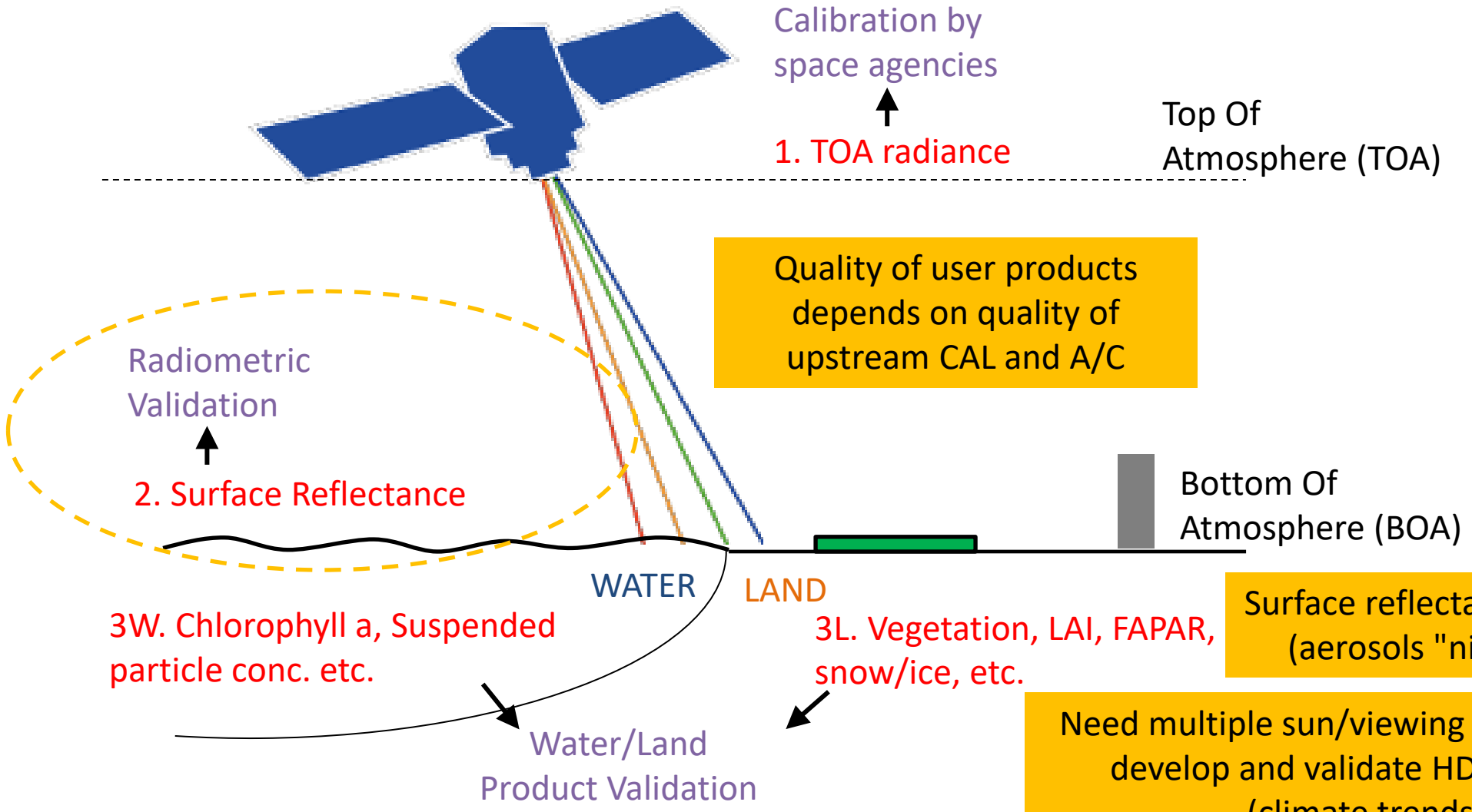
Data acquisition must be **AUTOMATED**

Instrument must be **HYPERSPECTRAL**

Sites preferably **NETWORKED**

[MERIS 3rd reprocessing data va
Data courtesy of PIs (D. McKee,
Zibordi, G. Schuster, S. Kratzer,
atzer) and AERONET-OC PIs (G.
MERMAID

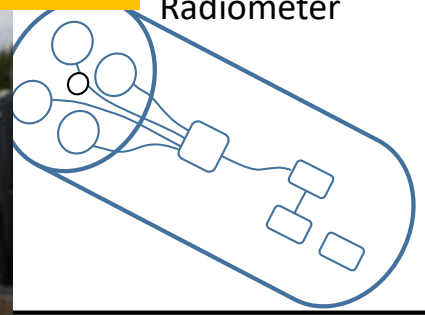
Motivation for radiometric validation



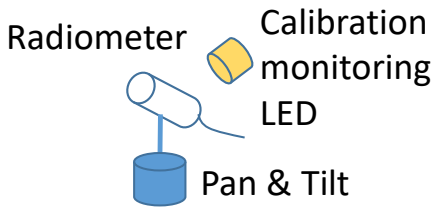
The H2020/HYPERNETS project

14 prototypes produced!!!
17 more in prep!!!

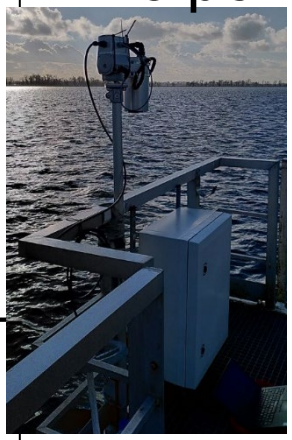
HYPERNETS multi-head hyperspectral Radiometer



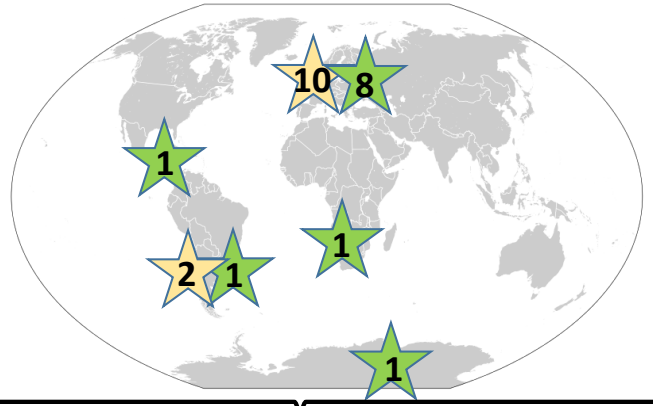
HYPERNETS Autonomous System



Host system inc pointing



HYPERNETS water validation network



HYPERNETS land validation network

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

[HYPERNETS Proposal, 2017]

[2022 update]
+PlanetDoves
+L9
+...
+PACE+SBG
+MTG+GLIMR
+CHIME
+Newspace
+...

HYPSTAR® instrument spec (XR=land version)

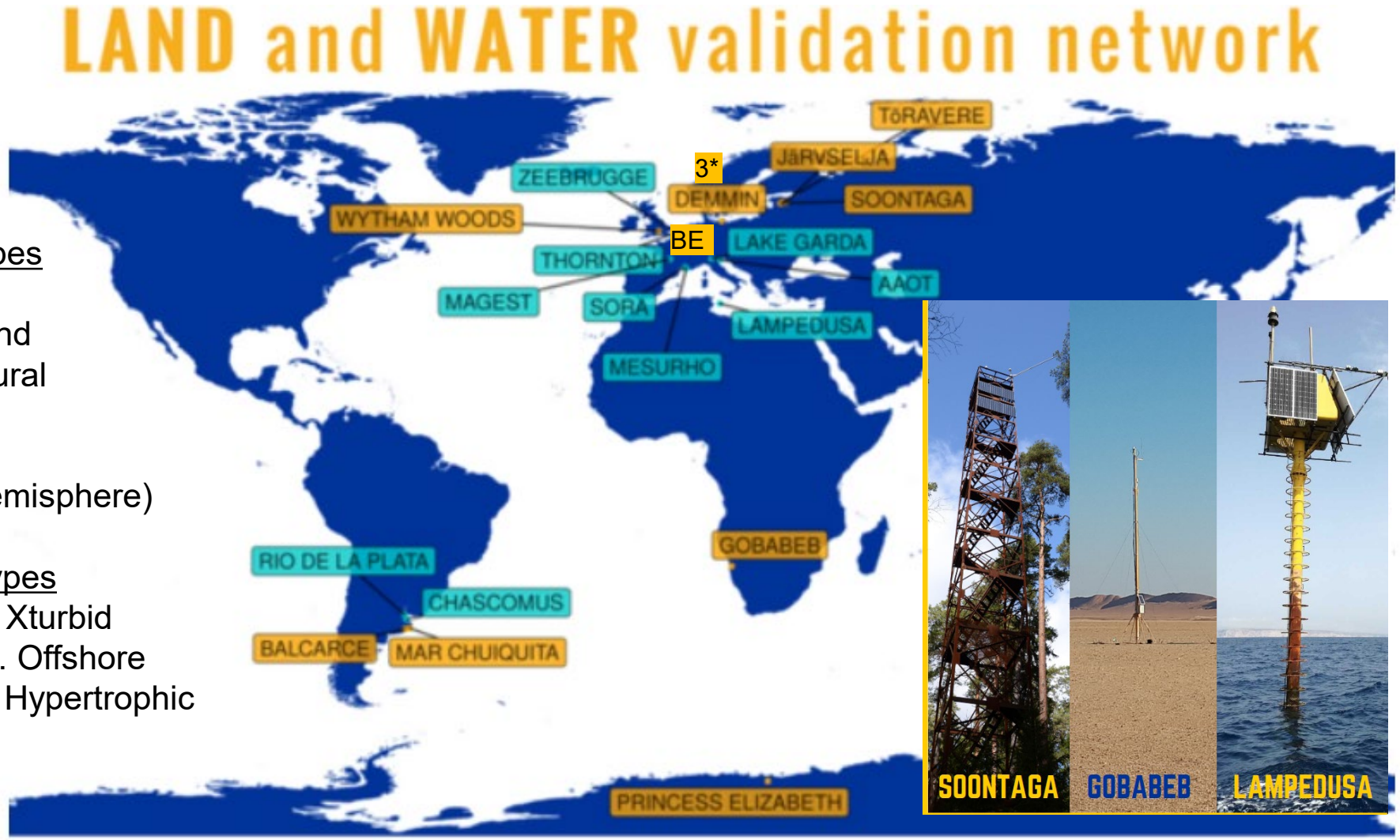
Parameter	HYPSTAR-XR radiometer
Measured quantity	Radiance and irradiance (multiplexed)
Field of view	5° (radiance), 180° (irradiance)
Detector array	2048 px Si, 256 px InGaAs
Spectral range	380 ... 1700 nm
Spectral sampling interval	0.5 nm (VNIR), 3 nm (SWIR)
Spectral resolution	3 nm (VNIR), 10 nm (SWIR)
ADC resolution	16 bit
Integration time	1...65535 ms
Shutter	Internal
Target camera	5 Mpx, RGB
Communication interface	RS485, half duplex, 115.2 ... 8000 kbps
Housing material	Anodised marine grade aluminium
Dimensions (DxL)	ø110.3 x 434 mm
Weight	3 kg
Power supply	8 ... 18 V DC, 2 A
Environmental protection	IP67
Operating temperature	-25 ... +45 °C
Storage temperature	-35 ... +70 °C

SR=water version
VISNIR (380-900nm),
2° FOV

[www.hypstar.eu]

Typically measuring every 15 mins during daytime for a year before recalibration

Validation Test sites

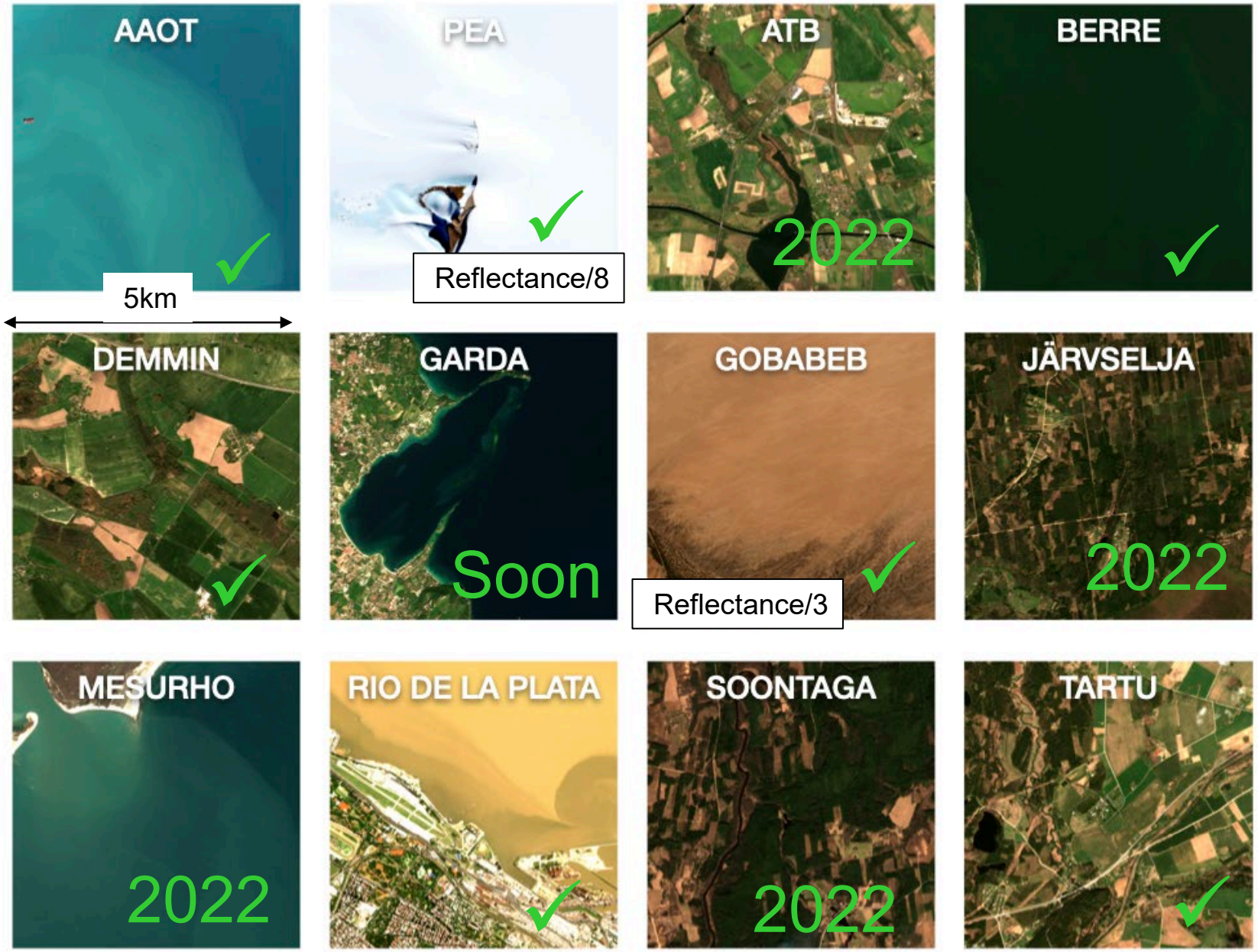


Land types
Forest
Grassland
Agricultural
Desert
Snow
(N+S hemisphere)

Water types
Clear ... Xturbid
Inland ... Offshore
Oligo ... Hypertrophic

Sentinel-2 imagery of test sites (1/2)

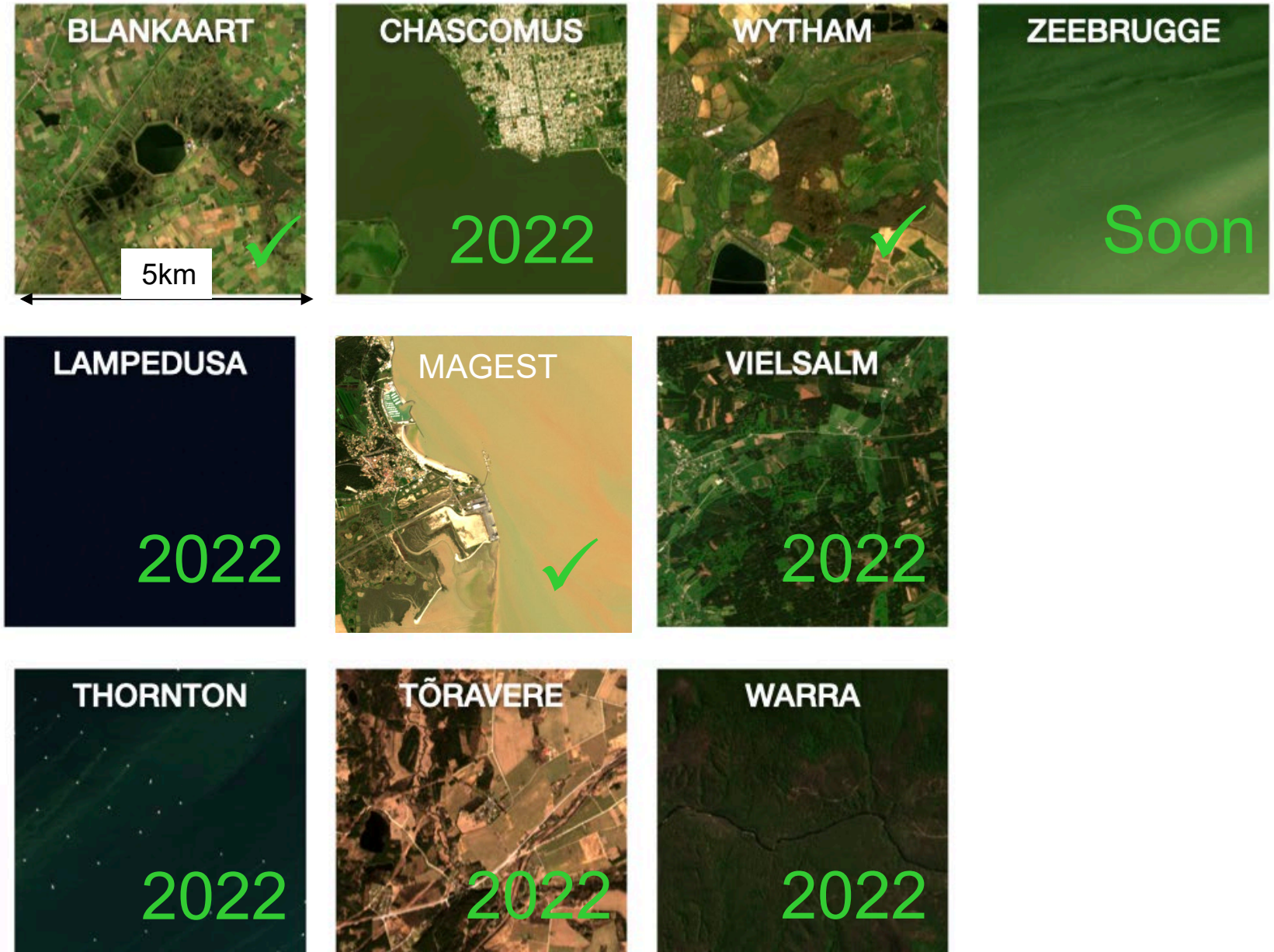
[S2 Data from ESA/EU]



(not all functioning ctsly)

Sentinel-2 imagery of test sites (2/2)

[S2 Data from ESA/EU]



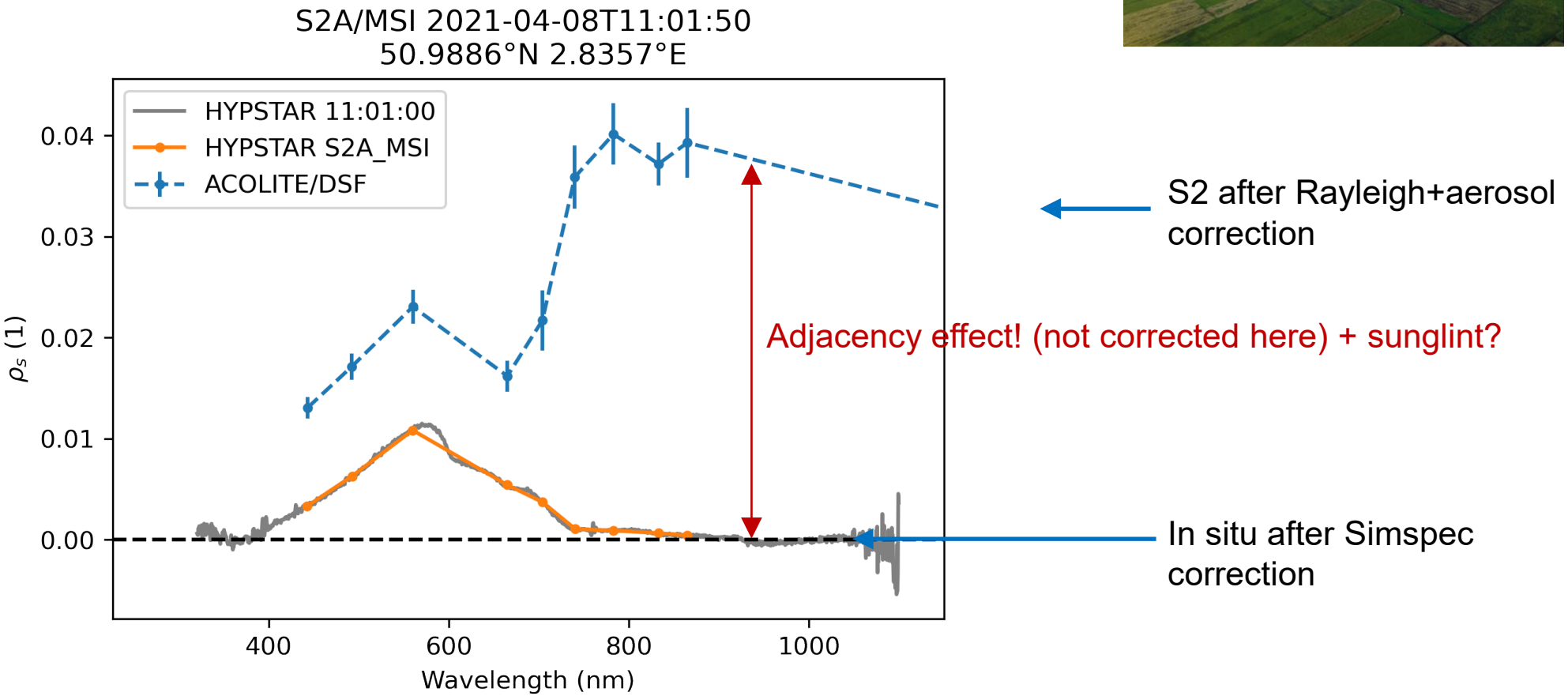
(not all functioning ctsly)

Blankaart reservoir - example matchup, HYPSTAR® prototype

RBINS HYPSTAR® deployment and S2 processing

Also used for validation of L8, L9, PlanetDoves, ...

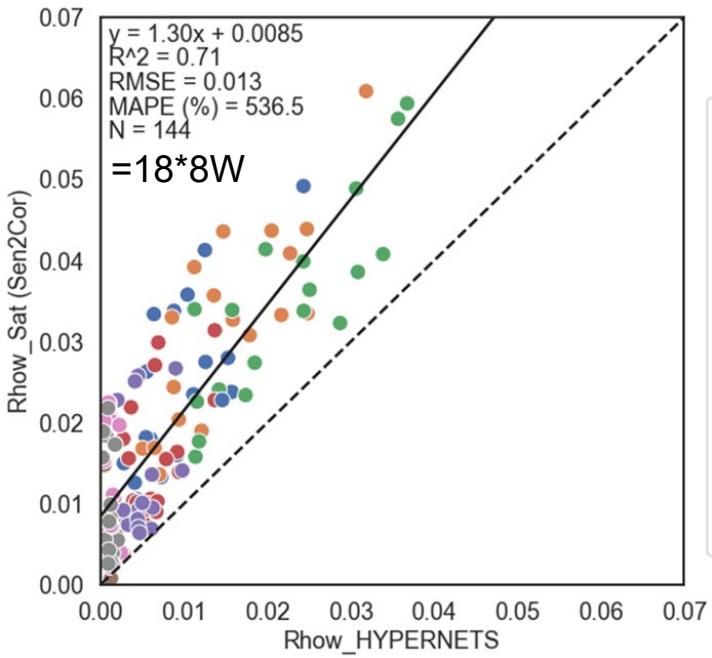
Good site for difficult adjacency effects!

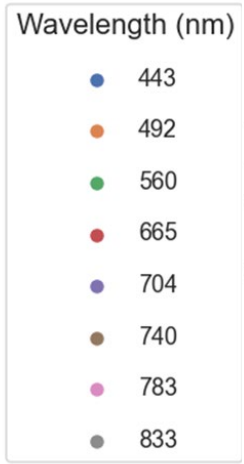


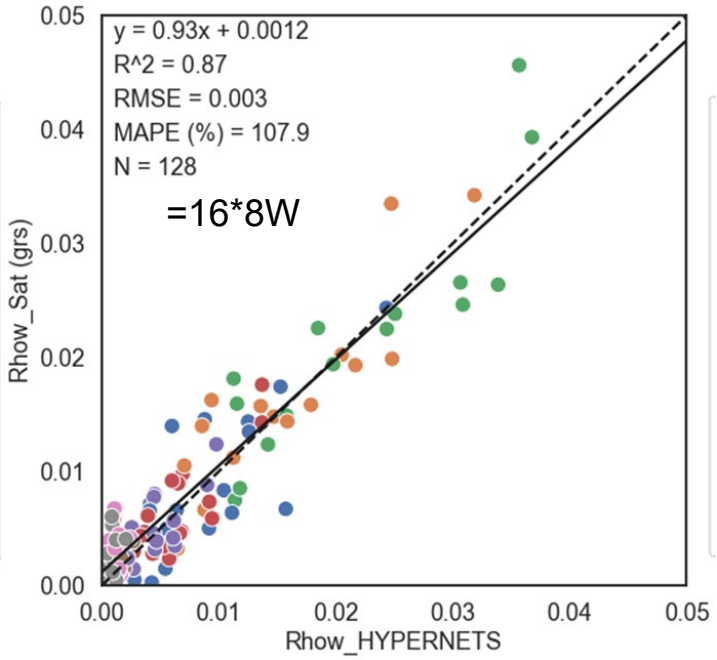
Etang de berre - 1 year matchups, HYPSTAR® prototype

LOV HYPSTAR® deployment and S2 processing
Feb 2021 - Feb 2022
SAT: no cloud, spatial heterogeneity<20%, RHOw>0
Matchup window = +/- 1 hour
18 matchups out of 60 potential
Algos: Sen2cor, GRS, C2RCC,
Also used for validation of L8 and OLCI

Good site for difficult sunglint!
(full talk: Doxaran Tues 11:25!)







Early results:

- C2RCC performs well: (good A/C and Glint)
- Conclusions may be different in productive/turbid parts of lagoon)

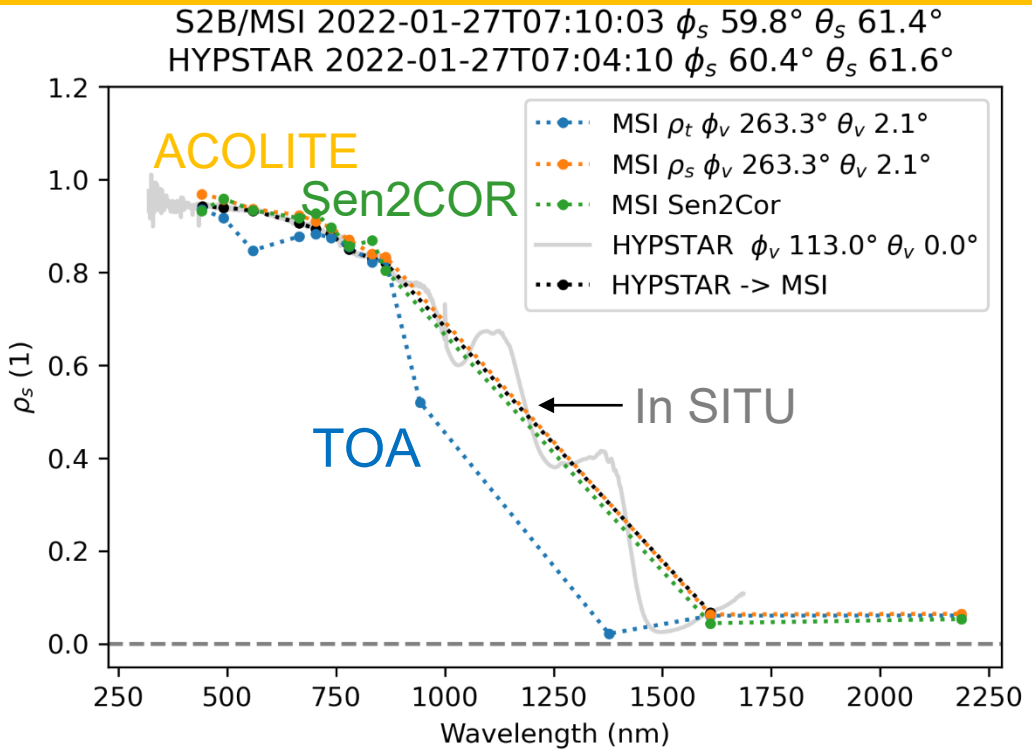
BE Antarctica base (IPF) - example matchup, HYPSTAR® prototype

RBINS HYPSTAR® deployment and S2 processing

Also to be used for validation of L8, L9, OLCI, ...

Jan-Feb 2022

Good site for snow properties, HDRF, cloud detection over snow, vcal?, user interest ...

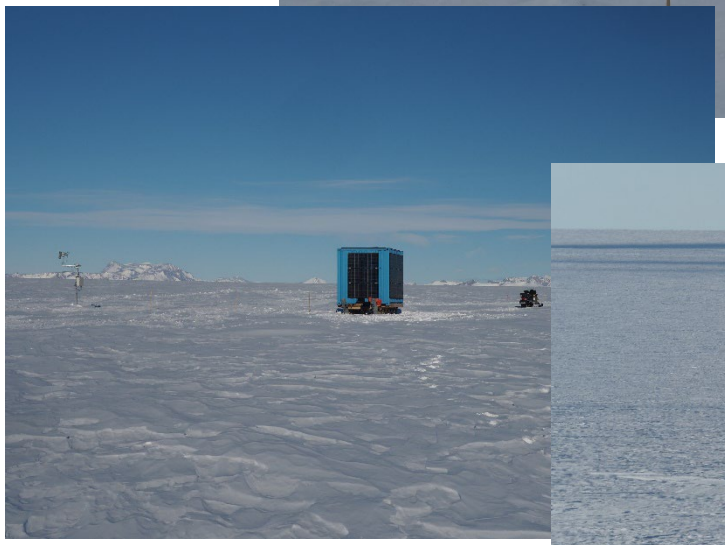


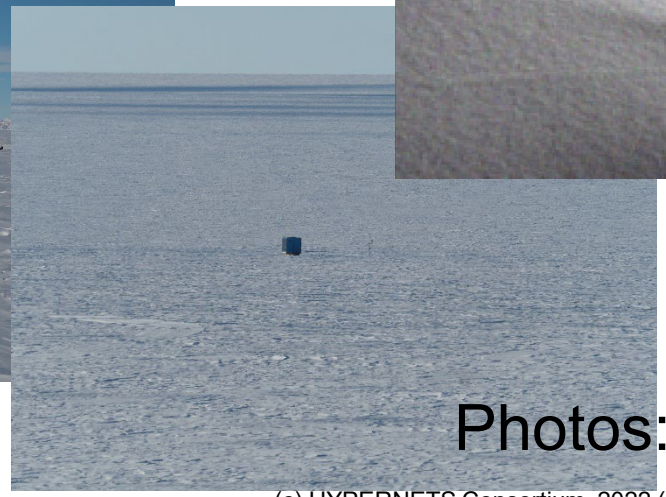
S2B/MSI 2022-01-27 07:10:03
ρ_s RGB

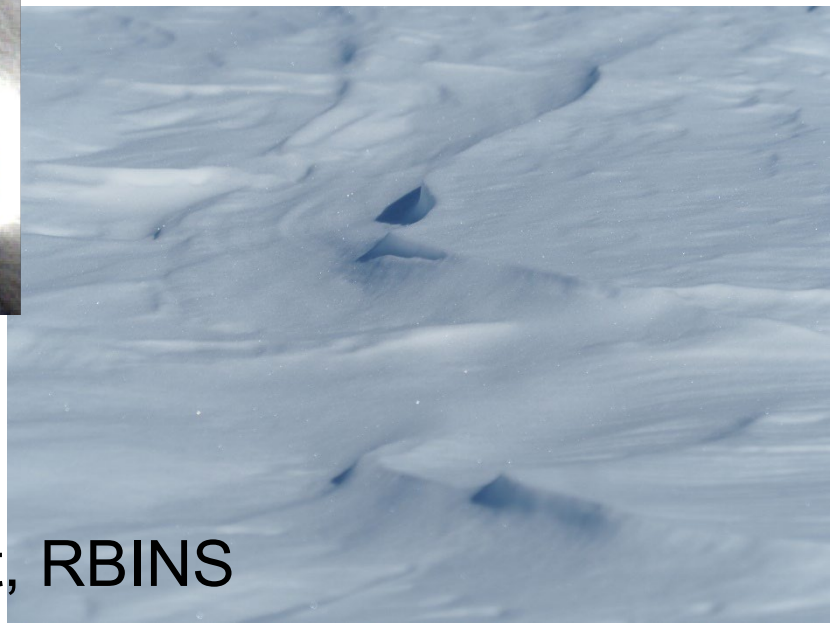
~3km

Spin-off: high potential for snow properties

S2 contrast enhanced (~3km)





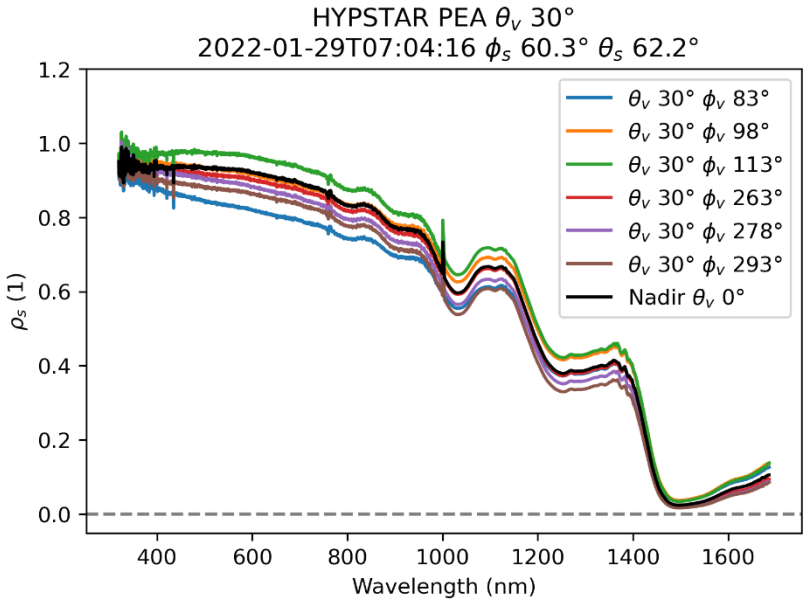


Photos: Q.Vanhellemont, RBINS

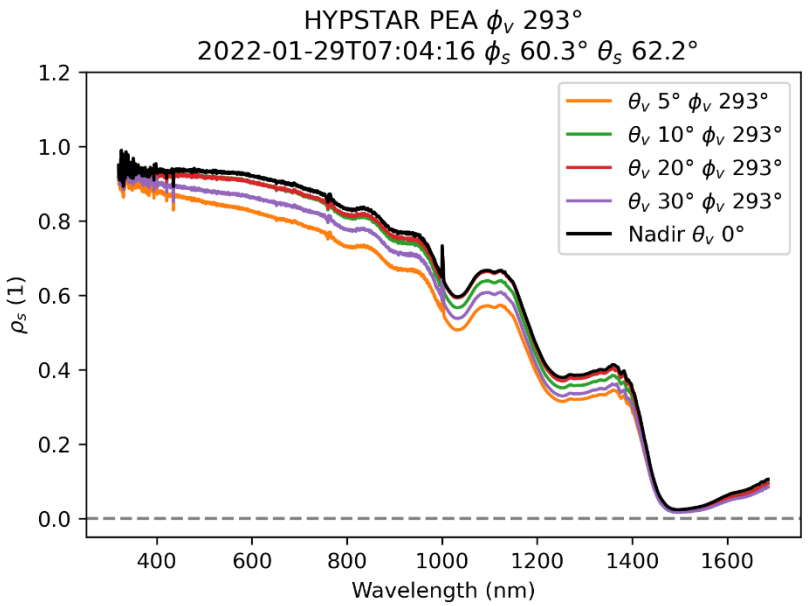
BE Antarctica base - multi-angular, HYPSTAR® prototype

[Q.Vanhellemont]

VZA=30°, 6 different VAA



VAA=293°, 5 different VZA



1. Data acquisition protocol currently designed for sat val (cross-track azimuthal viewing), but could do full HDRF ...
2. Might become a RADCALNET vcal site ...
3. Also UMaryland dual skycam for clouds ...

More sites recently started ...

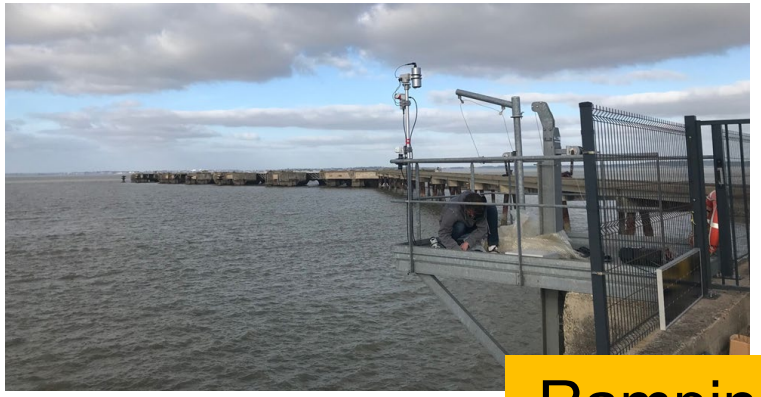
+ all LAND: see poster 63770!)

NPL: Wytham Woods

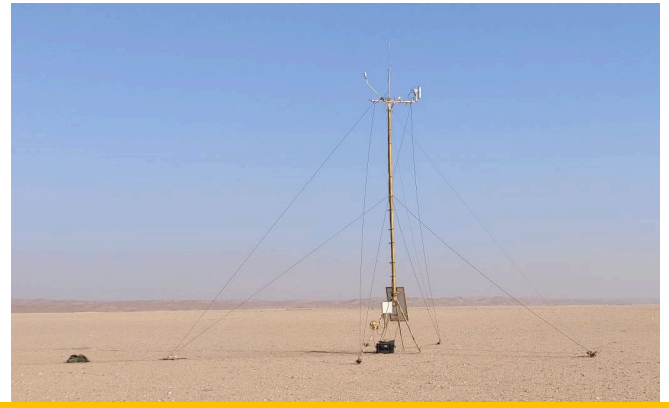
GFZ: DEMMIN (see poster 63529!)

CNR: Acqua Alta (see poster 62731!)

LOV: Gironde (talk Tues 11:25!)



NPL: GOBABEB!



CONICET: La Plata (see poster 64004!)

Ramping up to 12 WATER + 12 LAND by Dec 2022 ...

FOLLOW US on https://twitter.com/Hypernets_H2020 !

Conclusions

Surface reflectance data is essential for water and land product validation

Autonomous hyperspectral network is most cost-effective (multi-mission context)

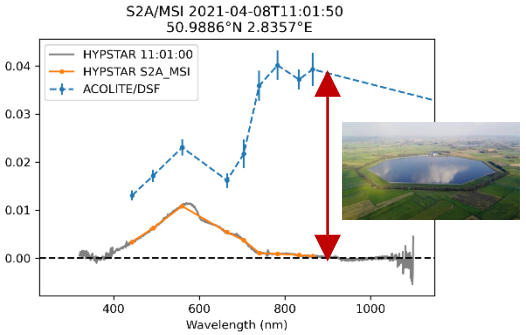
Zenith- and azimuth-pointing enables full HRDF for land and extra scenarios for water (as well as "parking" to protect)

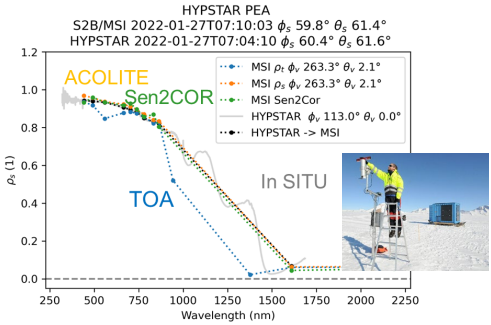
Useful for other applications (not just sat val) ...

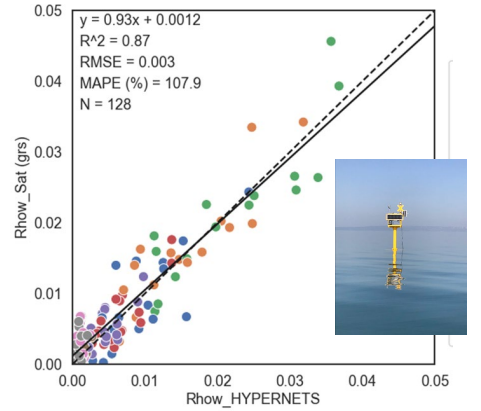
Early prototype HYPSTAR® data looks very useful ...

Diverse water and land HYPERNETS validation sites should provide good basis for validation of S2A&B

(and L8&9 and S3A&B and CHIME and PRISMA and ENMAP and NewSpace and ...)

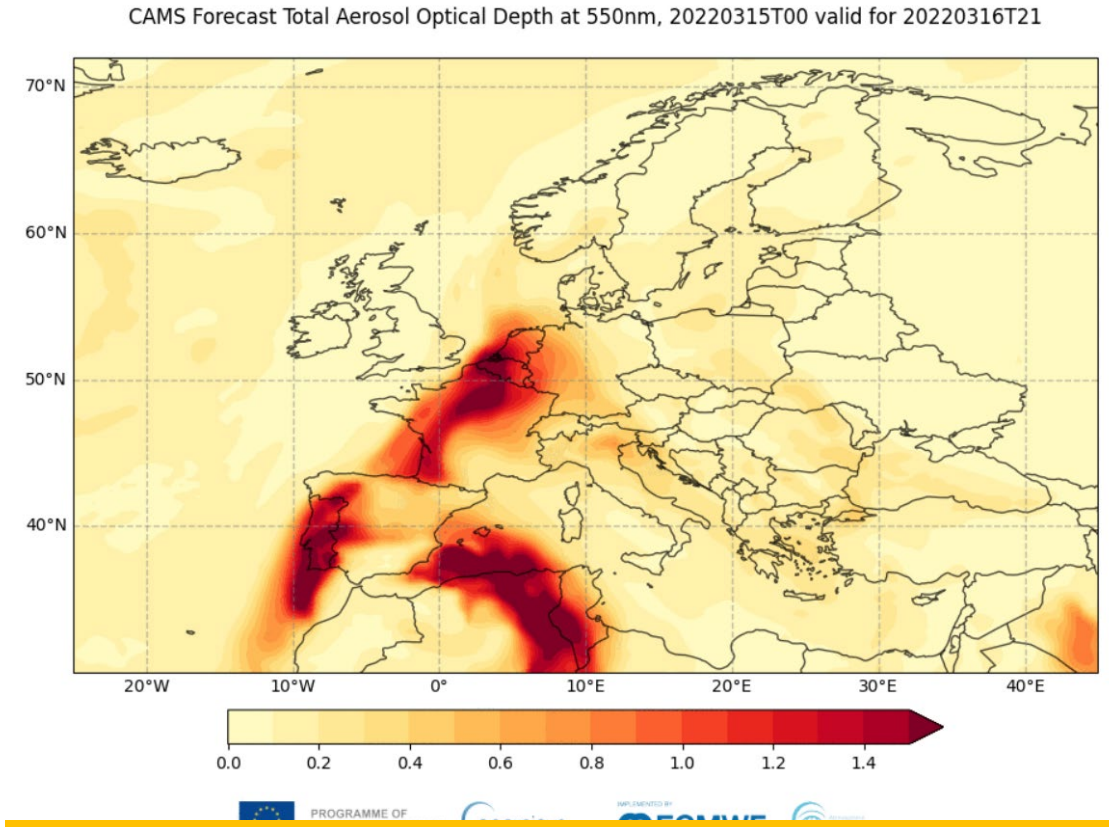






CHALLENGE : Foreoptics contamination [experiment by F.Ortenzio, RBINS]

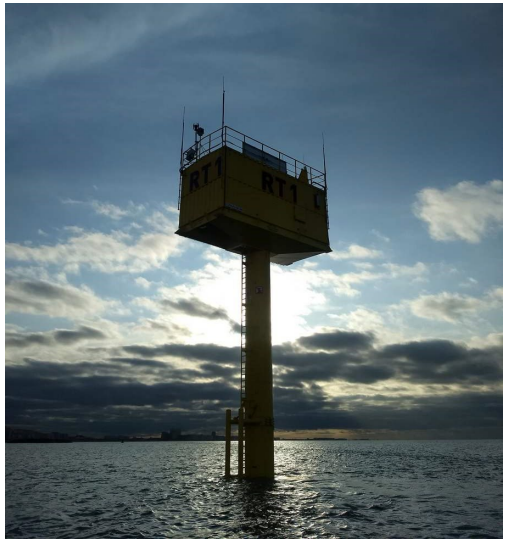
First week of Deployment

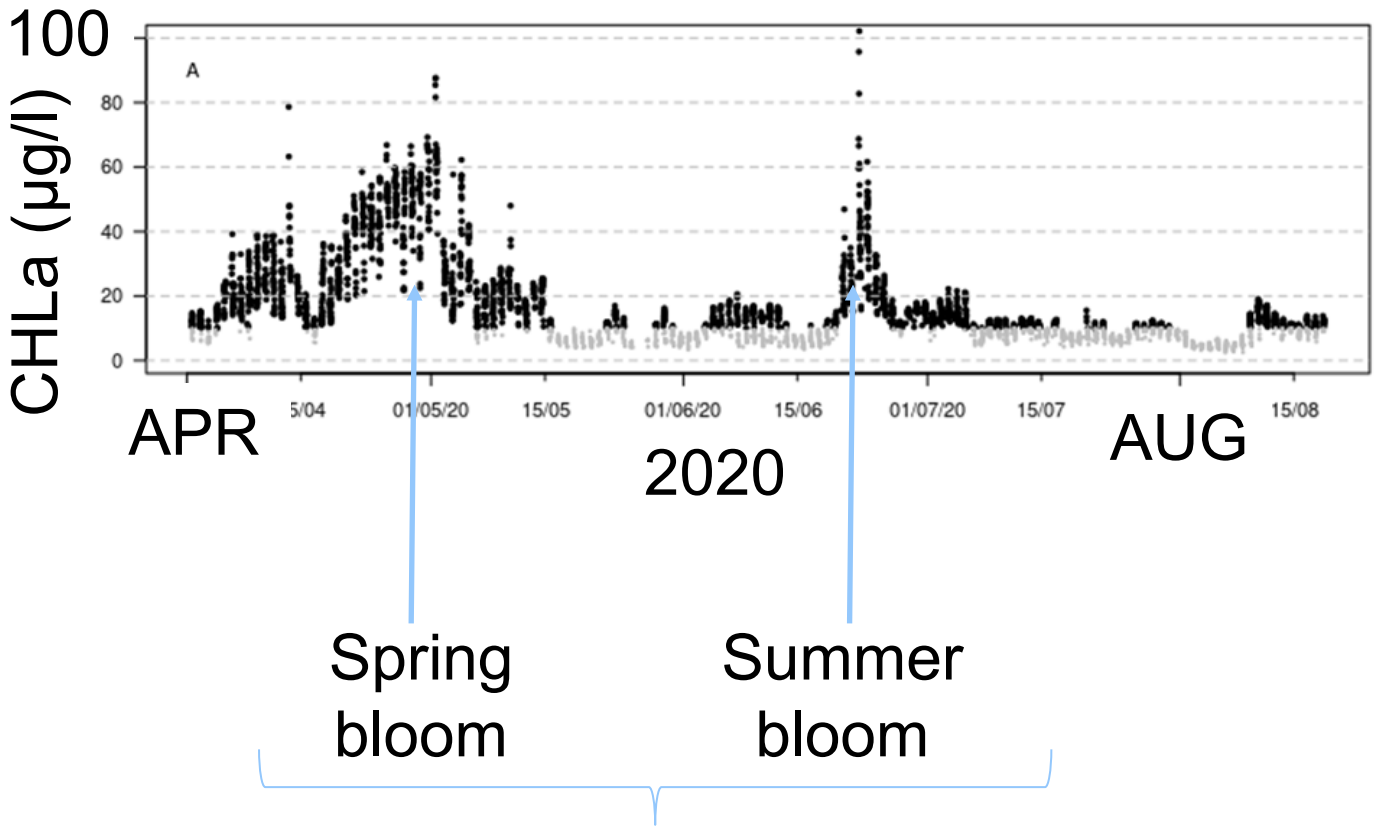


1. Experiment to understand contamination processes
2. Parking downwards to protect (+rain sensor)
3. Continuous cal monitoring : LED, Rayleigh sky, ...

BONUS: hyperspectral radiometry is not just sat val

PANTHYR system
[Vansteenwegen et al, 2019]
on RT1/Oostende (VLIZ)





Different species [Lavigne et al, subm] ...

Colocation of HYPERNETS radiometry with other water/land/aerosol instruments very powerful ...