Combination of multi angular-polarimetric and SWIR spectrometric measurements for the simultaneous CO2, CH4 and aerosol retrieval in GRASP algorithm.

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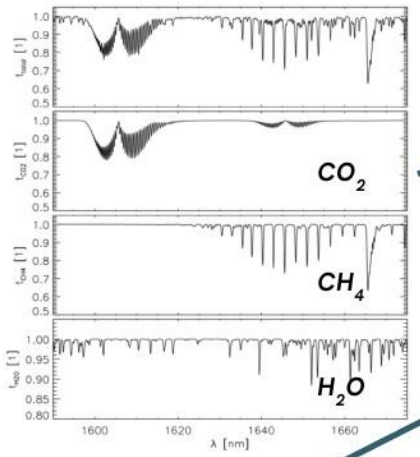
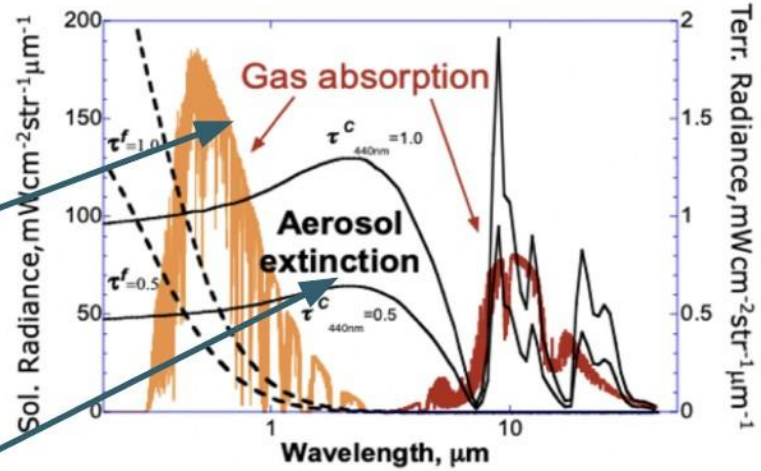
Objective

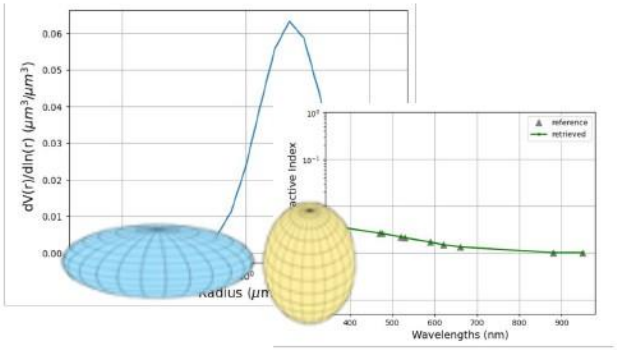
Develop a simultaneous retrieval of aerosol, surface, CO2 and CH4 properties from MAP and SWIR spectrometric measurements.

Gas

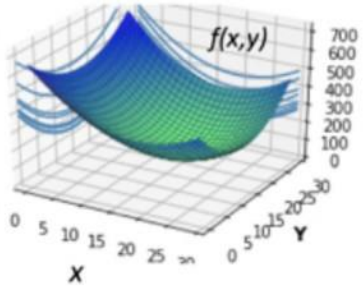




Aerosol



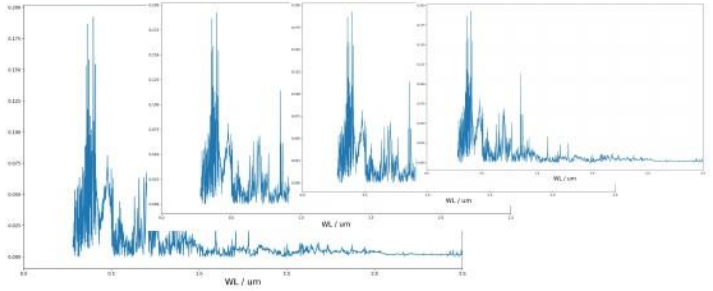
Surface



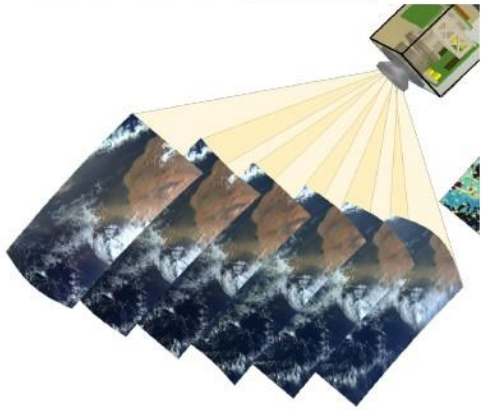
GRASP

Combined retrieval scheme

VIS-IR-SWIR spectrometric measurements



Multiangular multispectral polarimetric measurements (**MAP**)



$I(\lambda, \theta, \varphi)$
$U(\lambda, \theta, \varphi)$
$Q(\lambda, \theta, \varphi)$

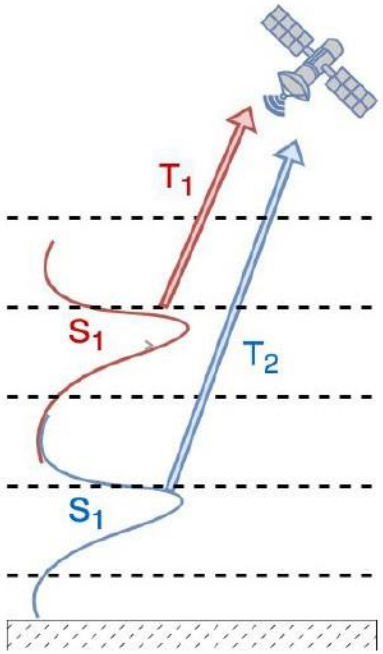
Different retrieval approaches

Proxy method	vs	Full physics retrieval
Atmospheric scattering elements ignored: $I(\lambda) = F_0(\lambda) A(\lambda) \frac{\mu_{\text{in}}}{\pi} \exp^{-\tau_{abs}(\lambda) \Big/ \tilde{\mu}}$ (Lu et al., 2022)		Complete radiative transfer: $\mathbf{S}(\tau, \mu, \varphi) = \frac{\omega(\tau)}{4\pi} \mathbf{P}(\tau, \mu, \varphi, \mu_0, \varphi_0) \mathbf{E}_0 \exp(\tau/\mu_0) + \frac{\omega(\tau)}{4\pi} \int_0^{2\pi} \int_{-1}^{+1} \mathbf{P}(\tau, \mu, \varphi, \mu', \varphi') \mathbf{L}(\tau, \mu', \varphi') \, d\mu' \, d\varphi'.$ (Lenoble et al., 2007)
Surface: Lambertian model		Surface: BRDF + BPDF
Only CO2 or CH4 can differ from the background		No a priori limitation
Accuracy dependency on aerosol load and aerosol layer height		No a priori limitation
Low computational cost and conceptually simple implementation.		Higher computational cost and conceptually complex.

Scattering elements: the influence of the optical path

Aerosol layer height (ALH) is a key parameter to achieve a successful gas concentration retrieval. It is not only enough to know the AOD (Sx), but uncertainties in the ALH can lead to important difference in the atmospheric transmittance.

Problem:



$S_1 = S_2$

$T_1 > T_2$

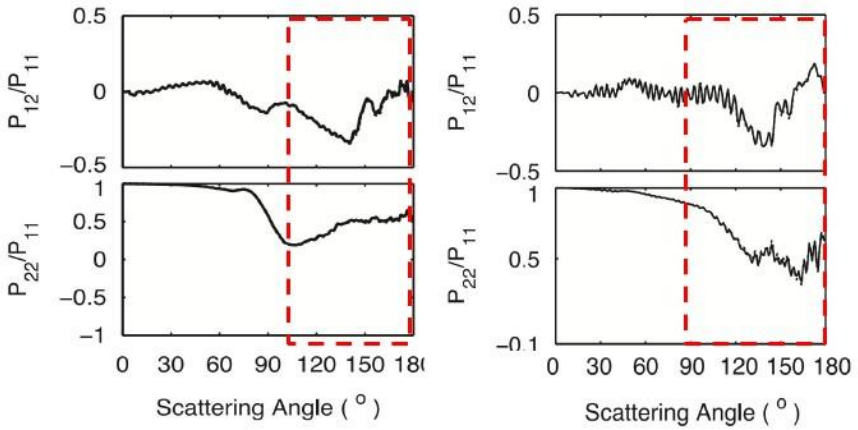
Uncertainties in ALH are propagated to gas concentrations

$$\mathbf{S}(\tau,\mu,\varphi) = \frac{\omega(\tau)}{4\pi}\mathbf{P}(\tau,\mu,\varphi,\mu_0,\varphi_0)\mathbf{E}_0 \exp\left(\frac{\tau}{\mu_0}\right) + \frac{\omega(\tau)}{4\pi}\int_0^{2\pi}\int_{-1}^{+1}\mathbf{P}(\tau,\mu,\varphi,\mu',\varphi')$$

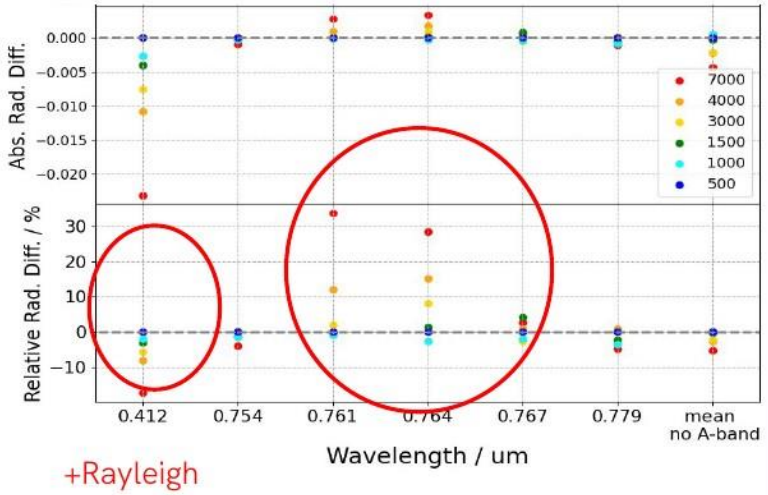
Solution: Addition of measurements with proper sensitivity to ALH

Multiangular Polarimeter + **Spectrometer**

Polarization state induced by aerosols

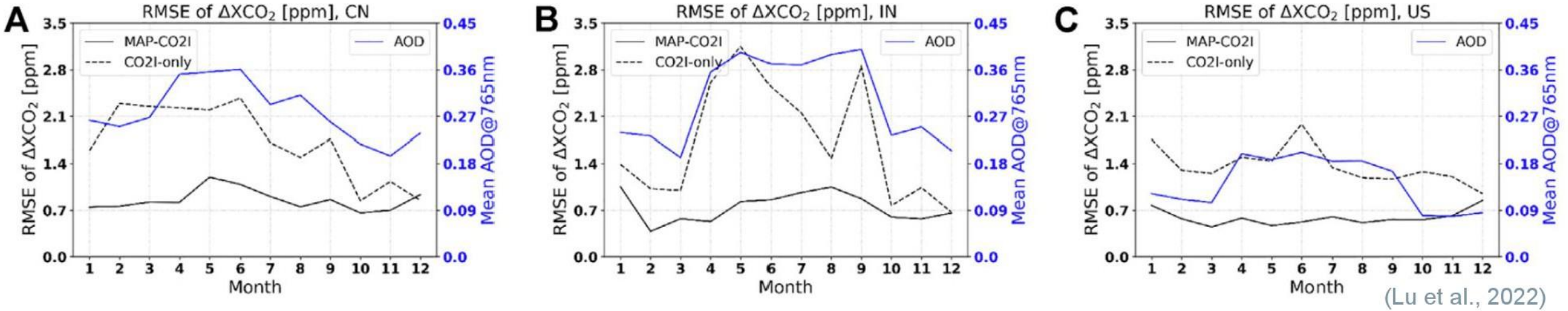


O2 A-band absorption

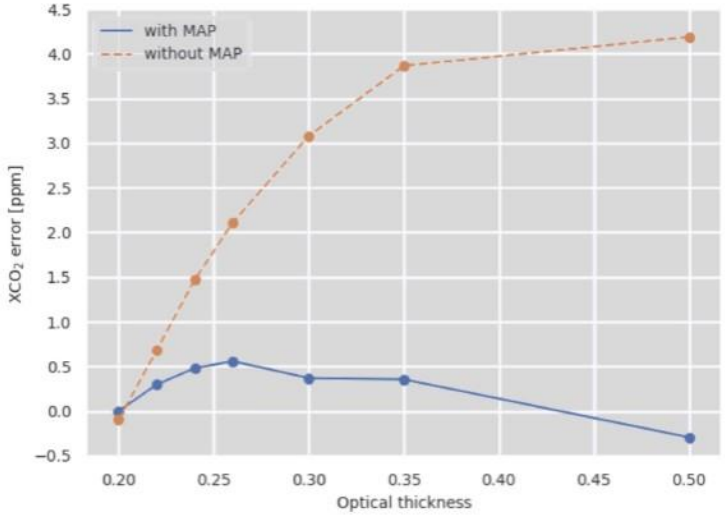


+Rayleigh

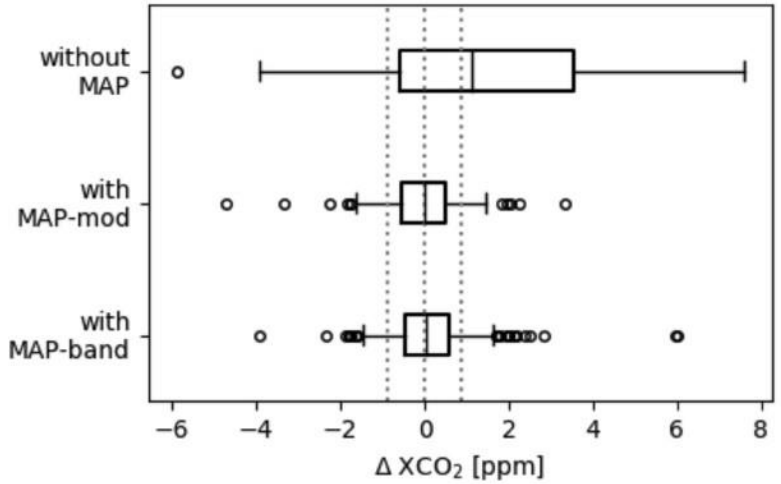
MAP vs no MAP



(Lu et al., 2022)



(Landgraf et al., 2020)



(Rusli et al., 2021)

OPERA-S5

OPEn platform for the Retrieval of Aerosol and CO2 from S5

Technical Goal:

Develop Open-Source Community Full-Physics XCO2 Retrieval Algorithm fully modular for Sentinel 5.

Scientific Goal:

Investigate experimental retrieval methods, aimed to improve existing uncertainty characterisation of CO2 and CH4 retrievals in the context of the challenging CO2M requirements.

OPERA-S5

GRASP SRON esa

OPEn platform for the Retrieval of Aerosol and CO2 from S5

THE PLATFORM

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Develop Open-Source Community Full-Physics XCO2 Retrieval Algorithm fully modular for Sentinel 5.

APPLICATIONS

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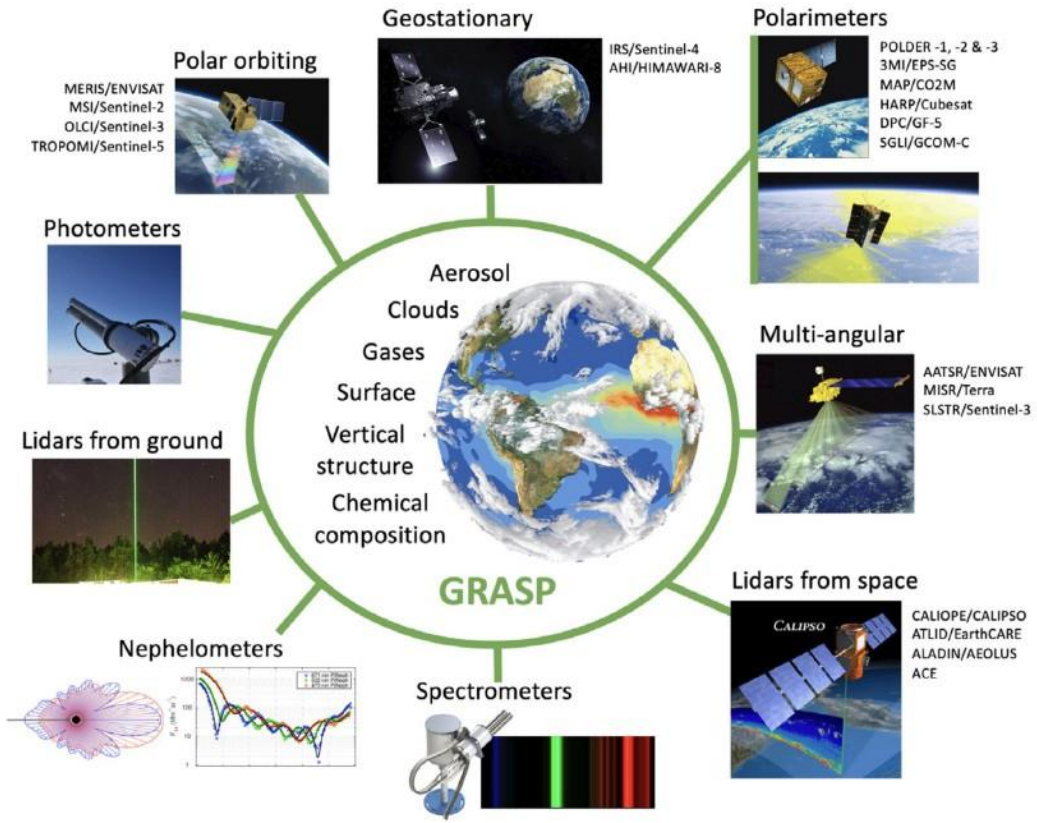
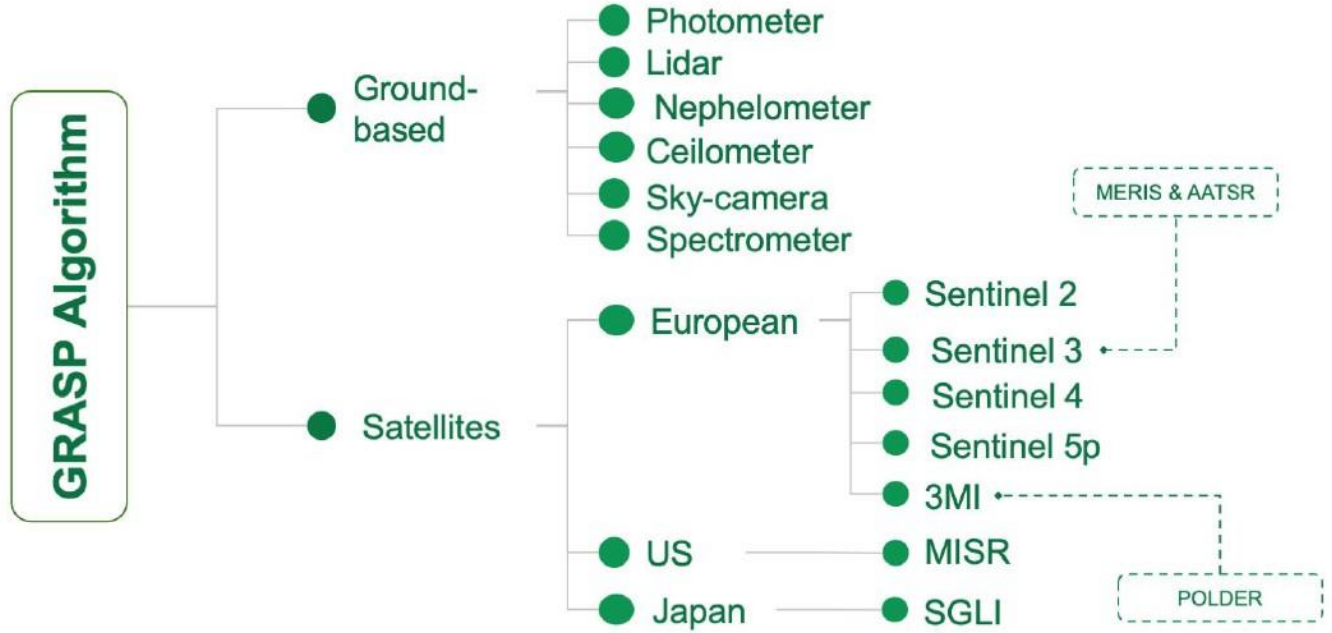
GRASP Algorithm

GRASP: Generalized Retrieval of Atmosphere and Surface Properties

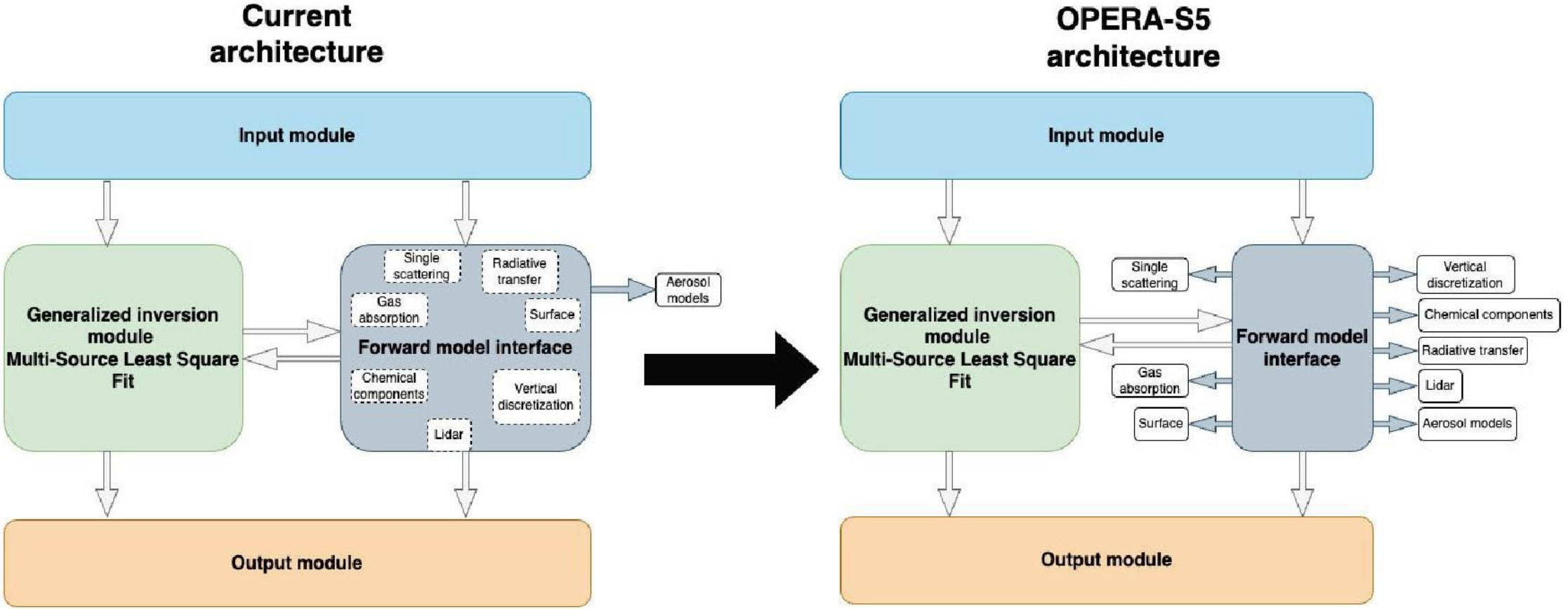
(Dubovik et al., 2021)



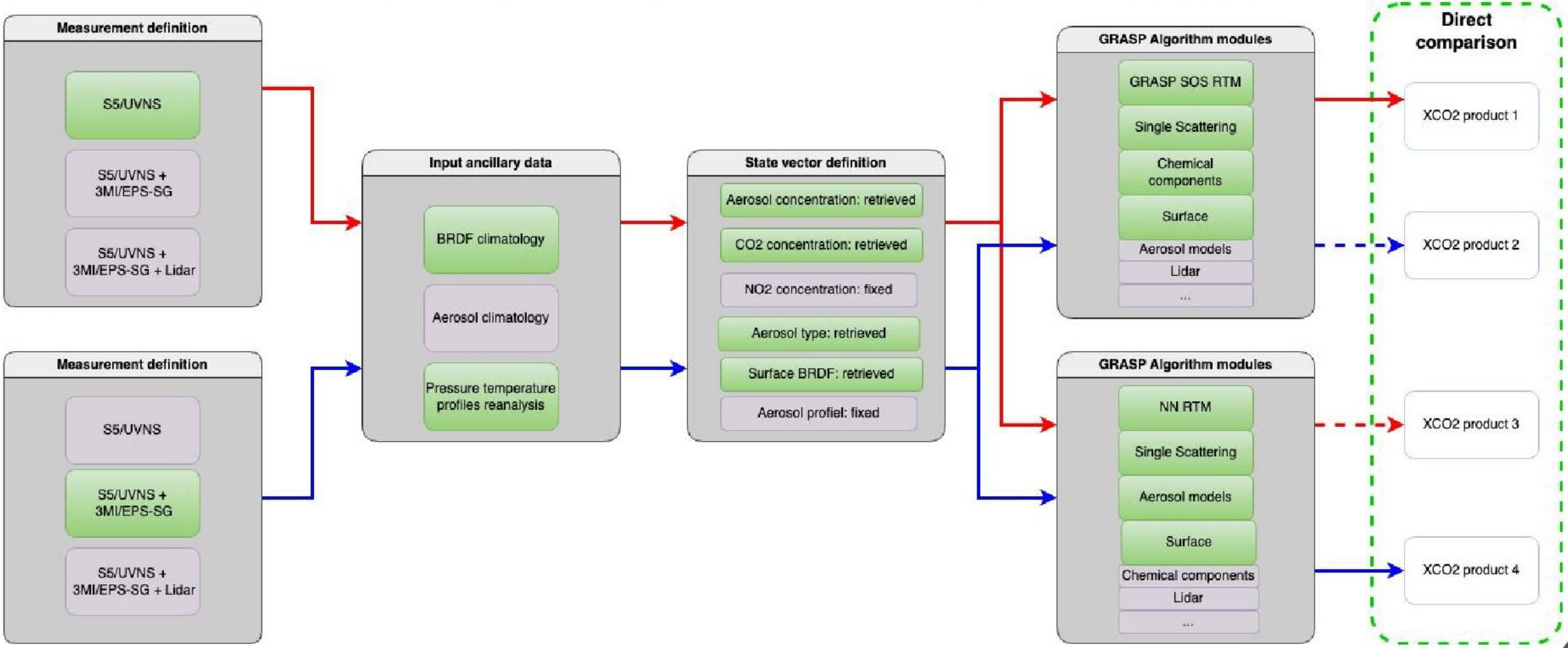


Platform Structure

Technical Goal: Develop Open-Source Community XCO2 Retrieval Algorithm for Sentinel 5



Retrieval possibilities



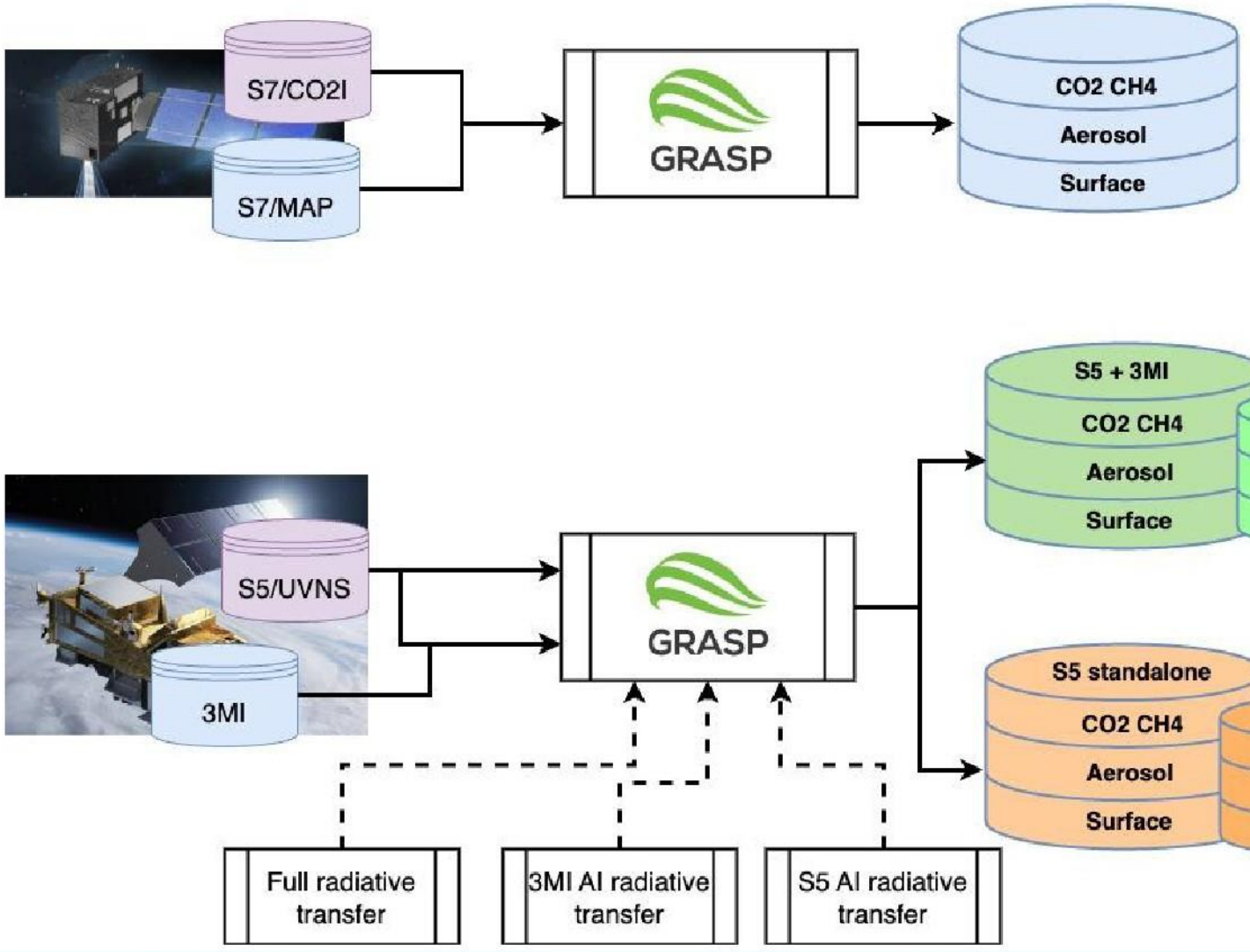
Fully modular approach = ~ Plug and Play

OPERA-S5 applications

Scientific Goals

Combination of S7CO2M/MAP and CO2I in GRASP retrieval algorithm

S5/UVNS and combination of 3MI and S5/UVNS in GRASP retrieval algorithm, with the inclusion of additional AI based modules for performance or quality assurance increase



Summary

- An Open Community XCO2 and aerosol retrieval algorithm for S5 it is going to be build with GRASP.
- Application to S7 CO2M/MAP+ S7 CO2M/CO2I
- Application to S5/UVNS and S5/UVNS + 3MI
- XCO2 + XCH4 + Aerosol + Surface simultaneous retrieval
- GRASP flexibility and high degree of generalization will enable the applications to any instrument combination or forward model approach.