How the geometry of acquisition impacts our ability to retrieval aerosol properties

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Introduction

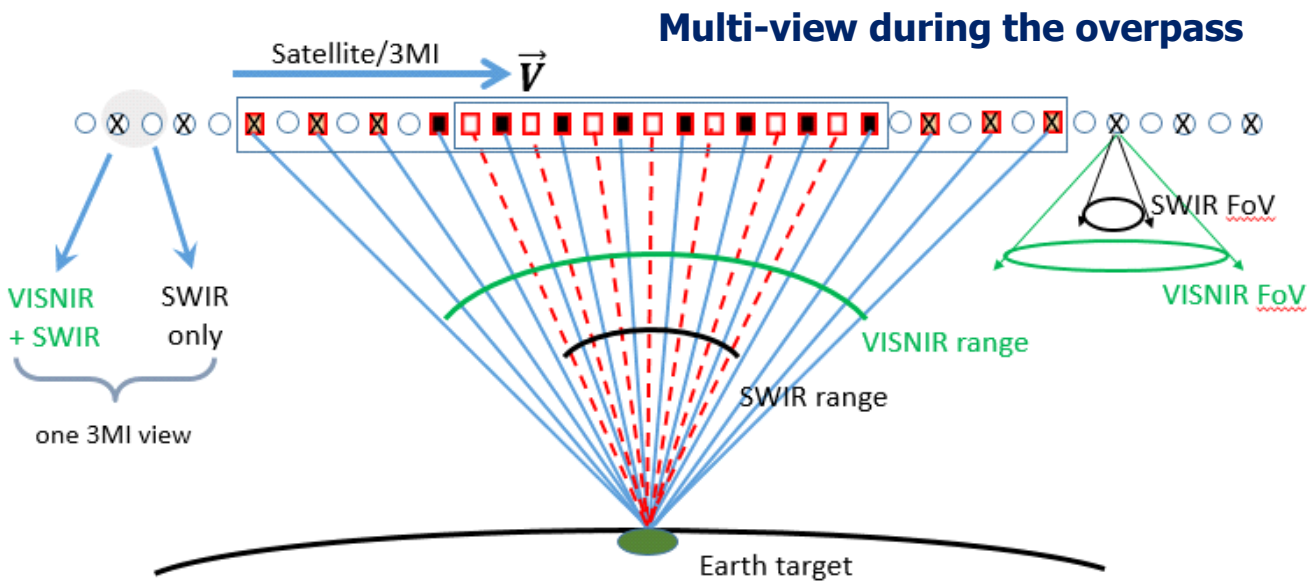
- Developments on EPS/PMAp, EPS-SG/3MI, S3/SLSTR and S3/OLCI – different types of retrieval
- Need to better describe the information content to understand some behaviours of the retrievals
- One major part of the information content is the geometry of observation
- The geometry allows or prevents the ability of the algorithm to retrieve some of the parameters (aerosol and/or surface)
- It is crucial to document this aspect
- 3MI was used to derive a first description of this impact

→ Fougnie, B., J. Chimot, M. Vazquez-Navarro, T. Marbach, and B. Bojkov, "Aerosol Retrieval from Space – How the Geometry of Acquisition Impacts our Ability to Characterize Aerosol Properties," *J. Quant. Spectr. Rad. Transf.*, APOLO special issue, No. 256, 2020.

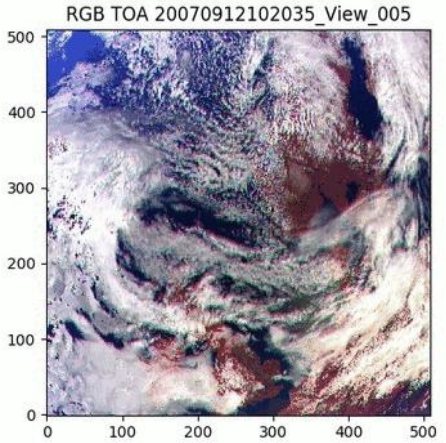
EPS-SG/3MI on an nutshell

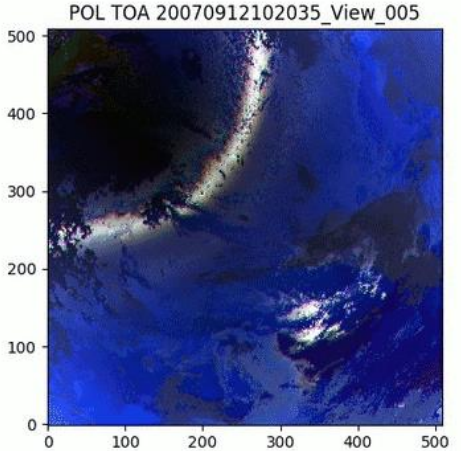
- The instrument relies on a very simple concept
  - 2 wide field-of-view optics (VISNIR + SWIR)
  - 2D detectors at focal planes (CCD for VISNIR, and CMOS for SWIR)
  - 1 filter wheel inc. polarizer (12 bands from 410 to 2130nm with I/Q/U)

(see Fougnie et al., 2018 in JQSRT APOLO'17)



Natural light



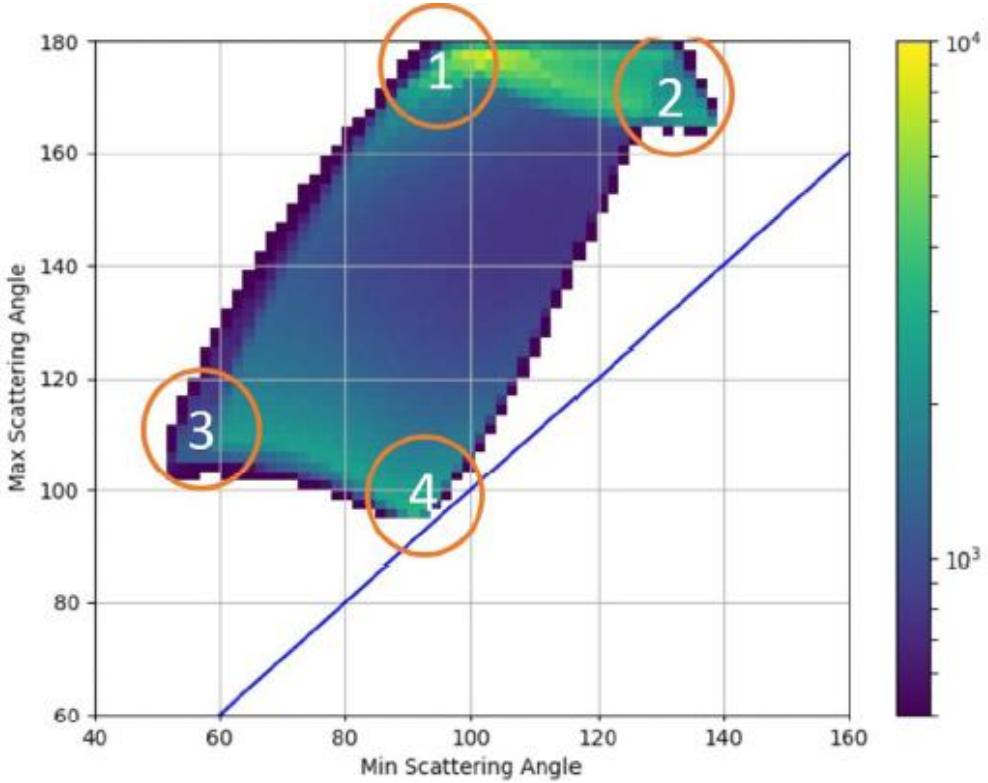


Polarized light

- GRASP was adopted for an optimal simultaneous retrieval of the surface and aerosol (configuration for operational processing, and optimisation of the performance for the aerosol retrieval)

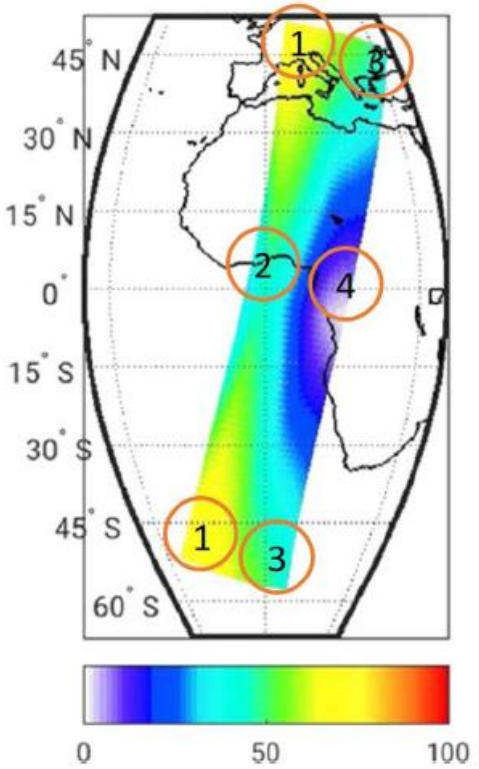
3MI and associated geometries

- 14 views, 12 bands and 3 polarisation for every targets but….. Same performance everywhere ?
- Surface type, aerosol type… usually refer to spectral capabilities
- What's the contribution of the viewing geometry ?
- Description through the Scattering Angle Range Distribution (ScARD)
  - Reports for every pixel, the MAX versus MIN scattering angles



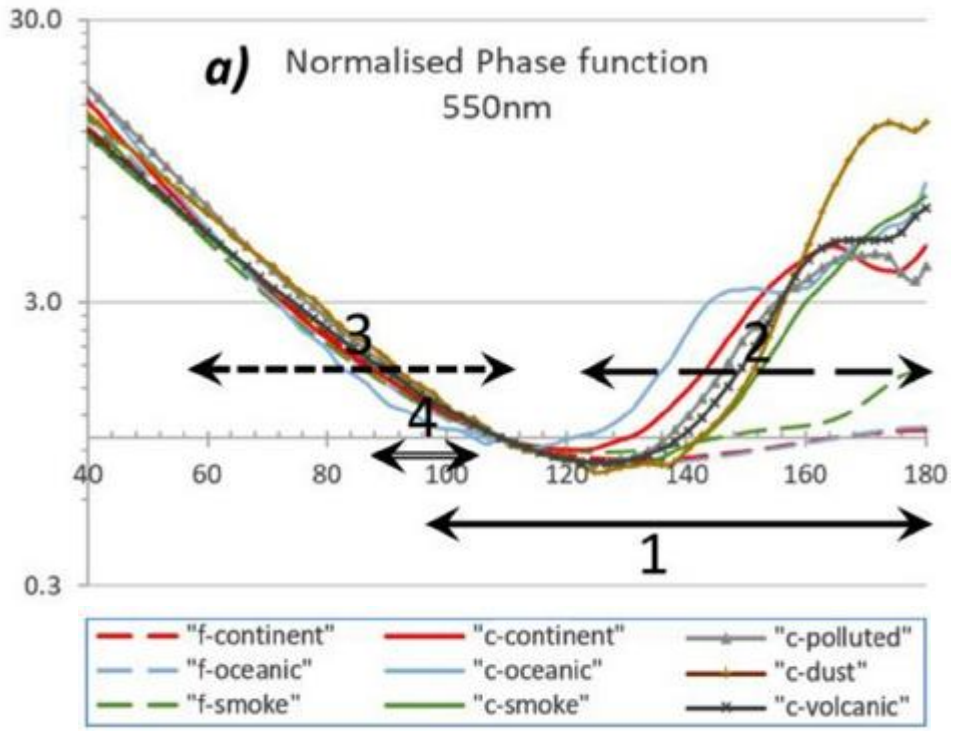
Scattering Angle Range Distribution (ScARD)

3MI orbit

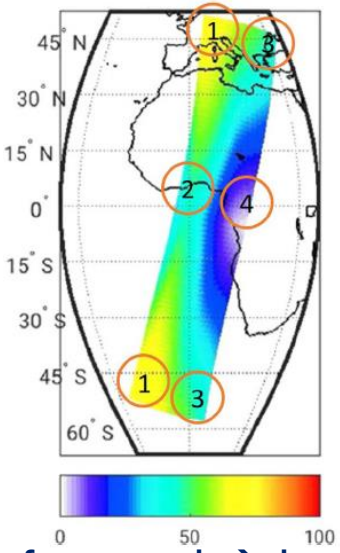


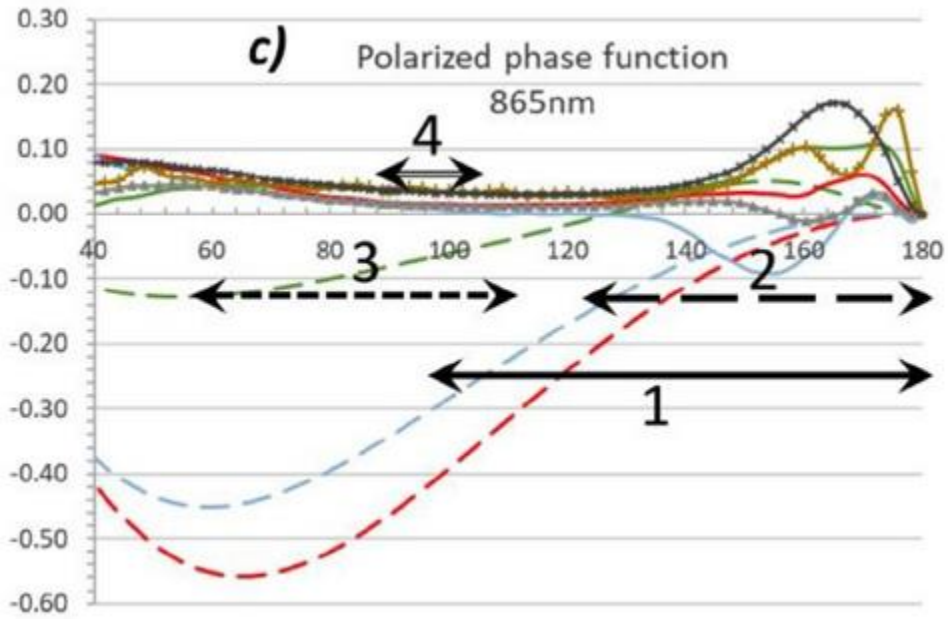
Scattering angle range

Information content : Aerosol & Geometry



Associated Information Content (aerosol)





$$R_{aer} = \frac{\omega_o . AOD . P_a}{4 . \mu_s . \mu_v}$$

From rich to poor information for the distinction of aerosol → impacts mechanically the retrieved AOD
Should be considered on:

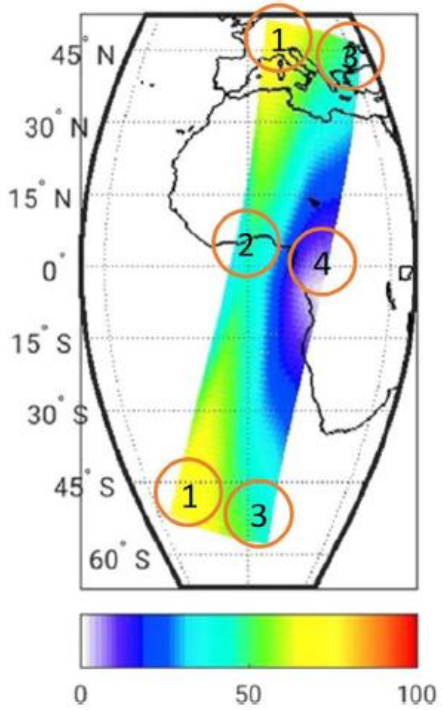
- the retrieval: add constraint or limit the number of free parameter
- the pixel error: the error parameter should reflect this
- the validation: the performance should be checked for every classes

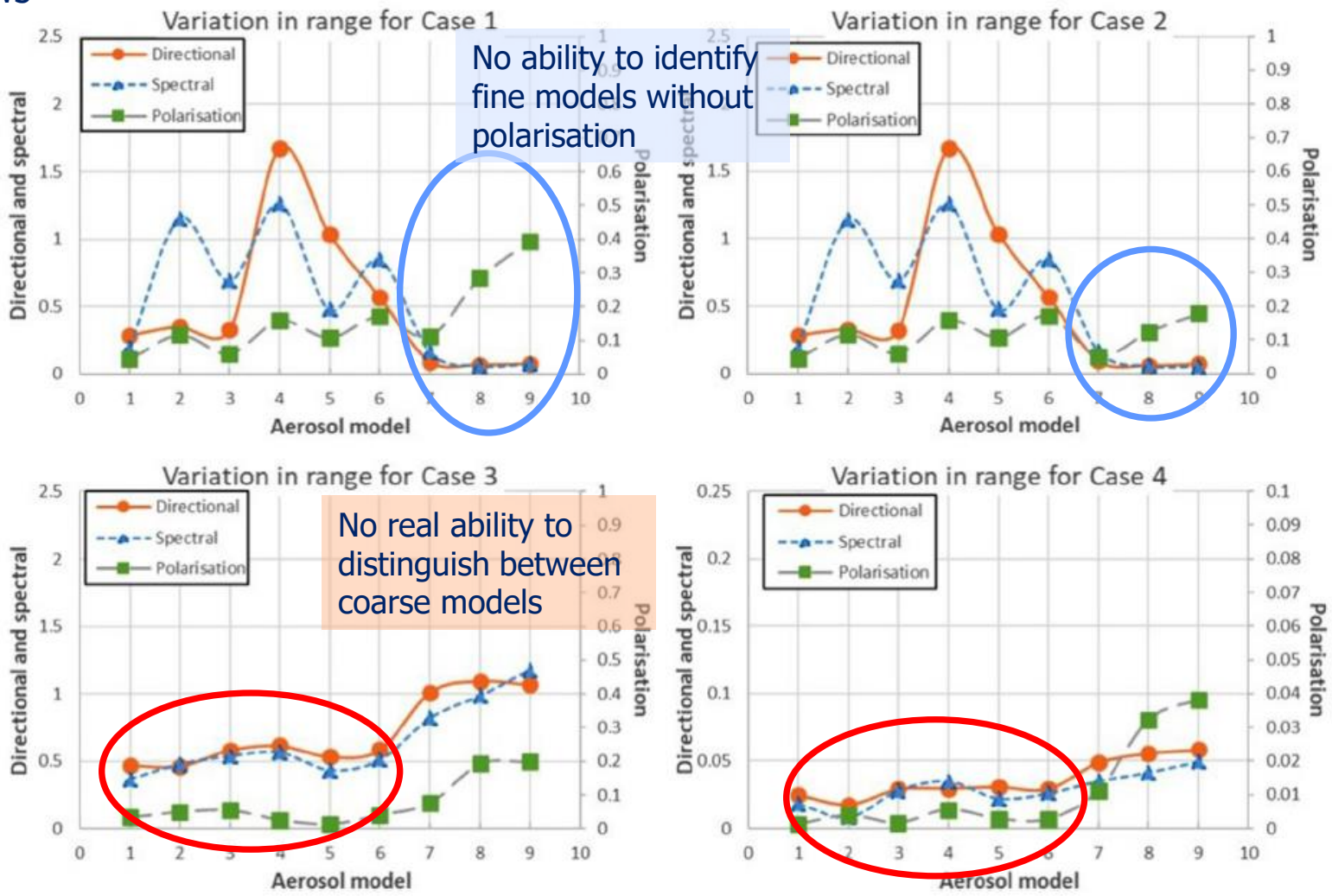
Geometry, spectrum, and polarisation

Associated Information Content

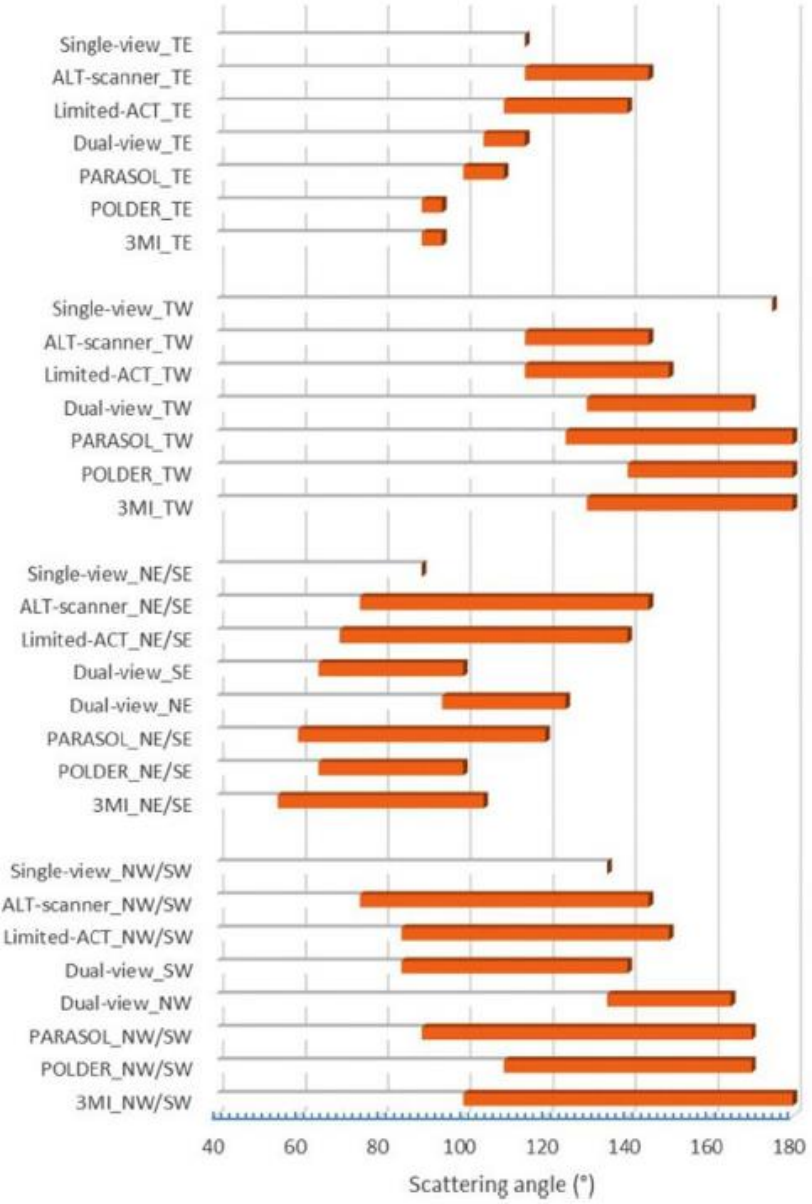
Variation of the phase function over the 14 views
- Directional at 865nm
- Spectral over 443-1650nm
- Polarised

1 "c-polluted"
2 "c-oceanic"
3 "c-continent'
4 "c-dust"
5 "c-smoke"
6 "c-volcanic"
7 "f-smoke"
8 "f-oceanic"
9 "f-continent'

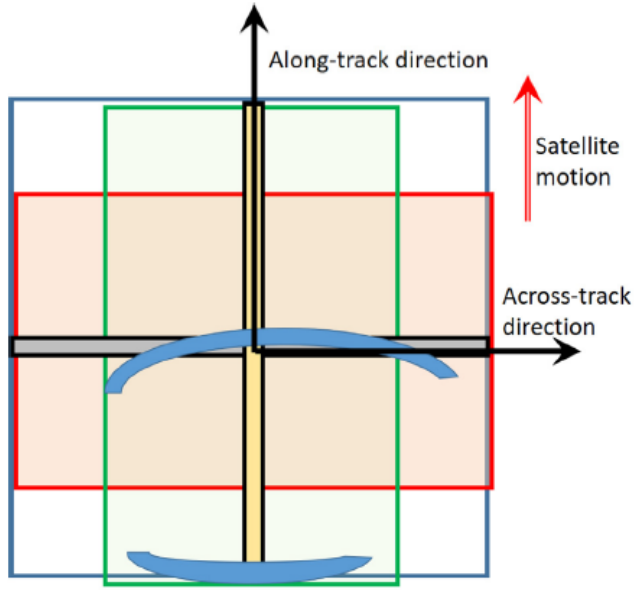


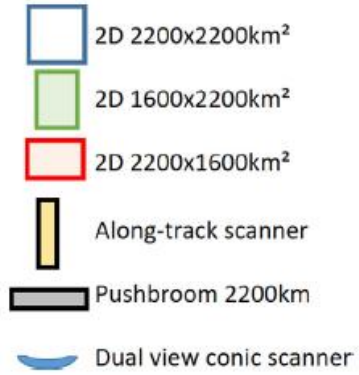


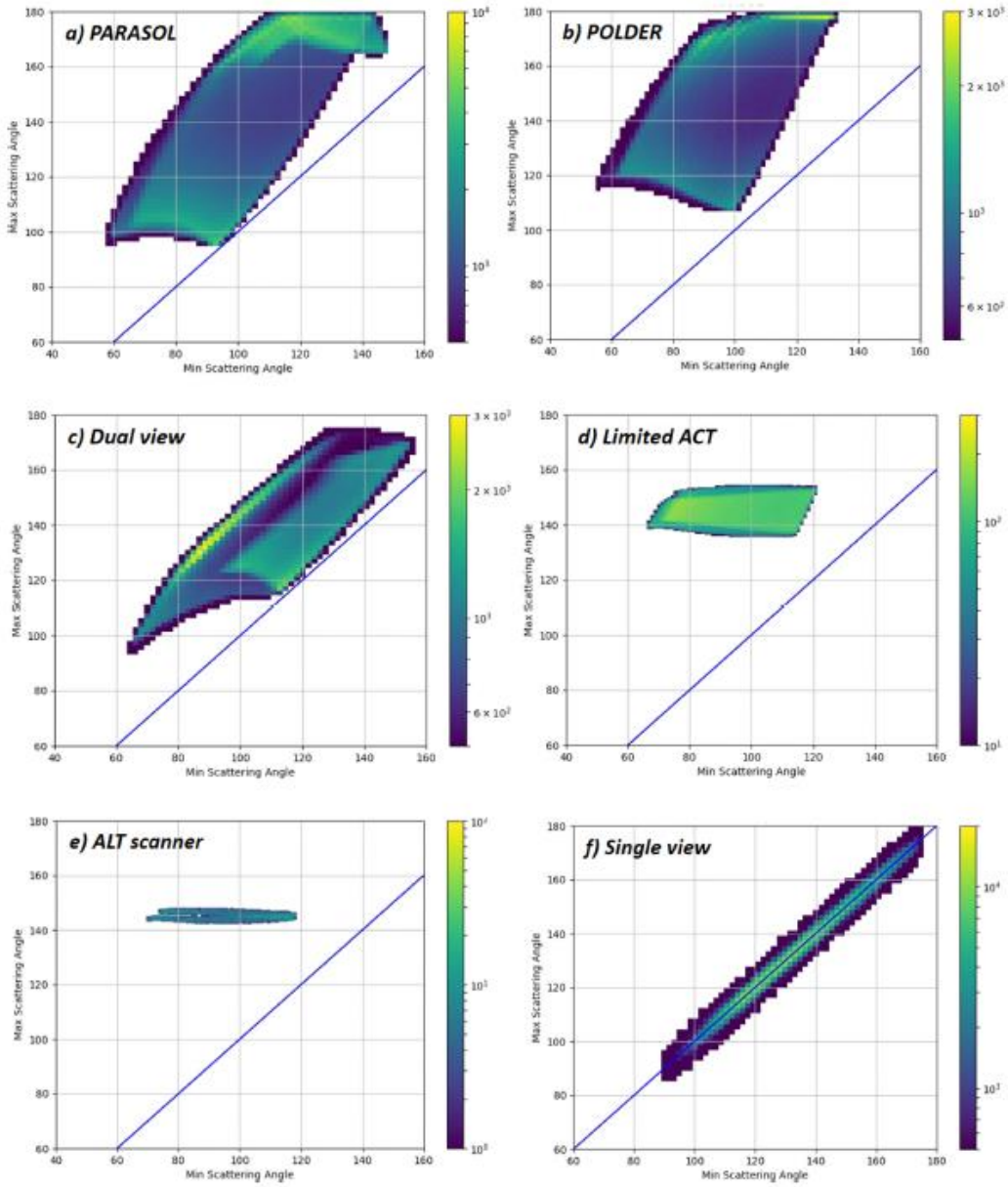
Generalisation to other type of sensors



Cross-comparison







Classification

Recommendations

The geometry of acquisition must be better consider

- When analysing the information content before going into the retrieval
  - Describe the geometry versus scan and along orbit (e.g. ScARD)
  - Assess the geometry among others (e.g. spectral, polarisation)
- When developing the retrieval
  - Identify where/when there is no ability to distinguish aerosol model
  - Consider this on the optimisation (add constraint, reduce free parameters….)
- When documenting the performance
  - Pixel quality index should reflect this aspect
- When validating the result
  - Identify classes of geometry and check the performance for each
- When developing new space system
  - Selection of instrument design, orbit…