

# living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE  
OF OUR PLANET FROM SPACE



## FLEX-E: The End-To-End Mission Performance Simulator for ESA's FLEX photosynthesis mission

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# FLEX-E: L2 End-to-End Mission Performance Assessment

- **FLEX-E L2 End-to-End Simulator (E2ES)** is the tool for the **assessment of FLEX Photosynthesis Mission Requirements** at L1 and L2.
- FLEX-E E2ES is intended to be used at all mission phases
- It is the baseline for the ground segment prototypes.
- FLEX-E contract started in 2017 and it will extend up to the FLEX-E commissioning phase (2025 TBC)
- FLEX-E main objectives are:
  - To evaluate the mission concept.
  - To evaluate the consolidation of the technical requirements of the system.
  - To validate the proposed processing algorithms.



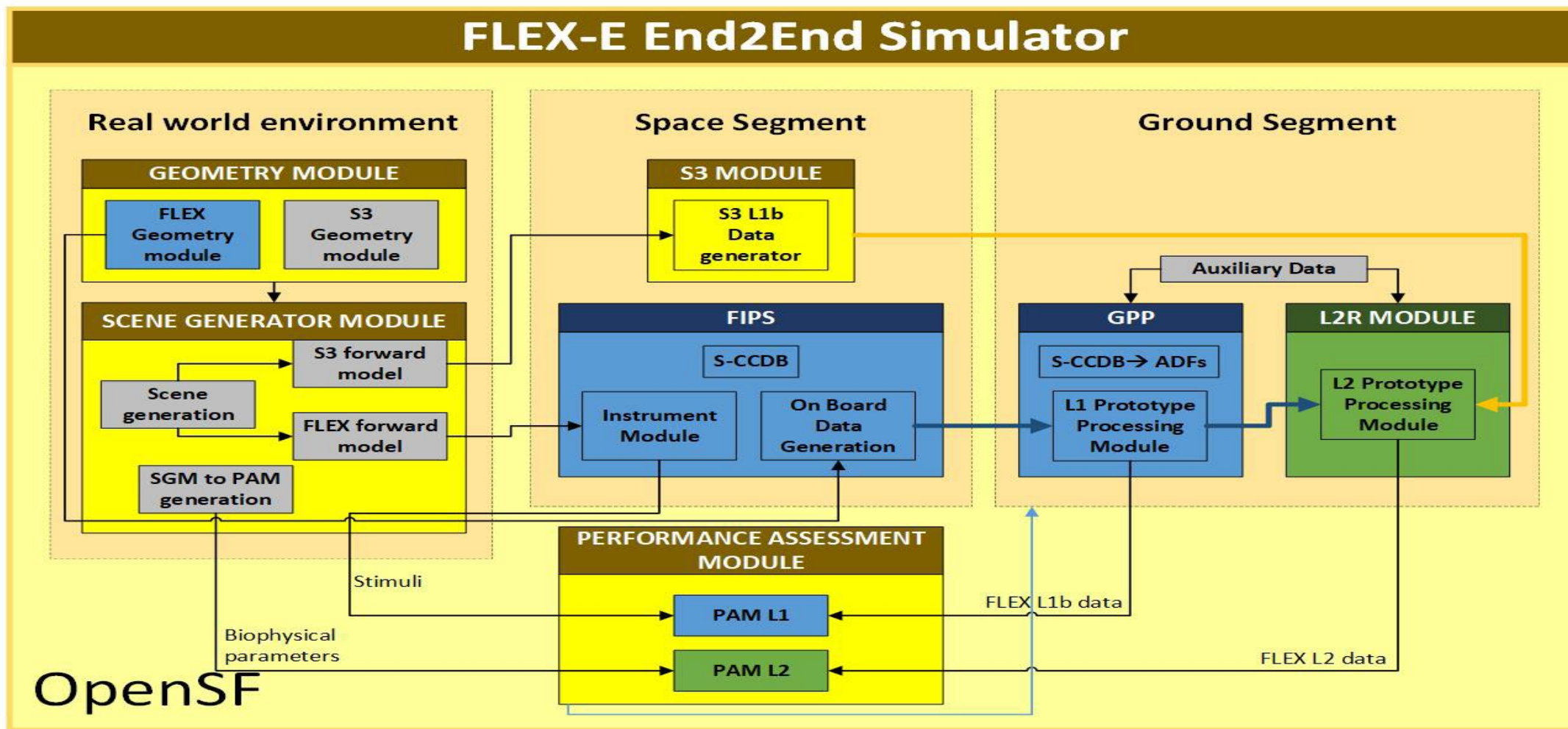
# FLEX-E Project Team



ESA Contract No. 4000119707/17/NL/MP

<https://leoipl.uv.es/l2e2es/>





FLEX-E contract

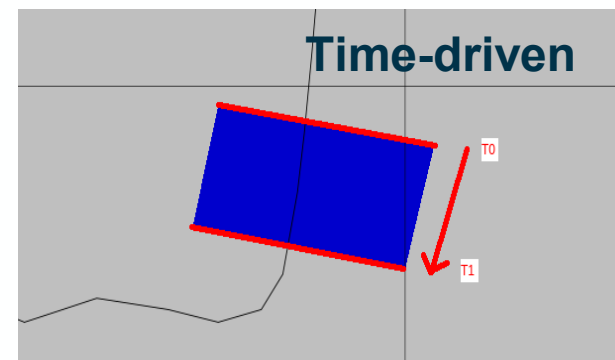
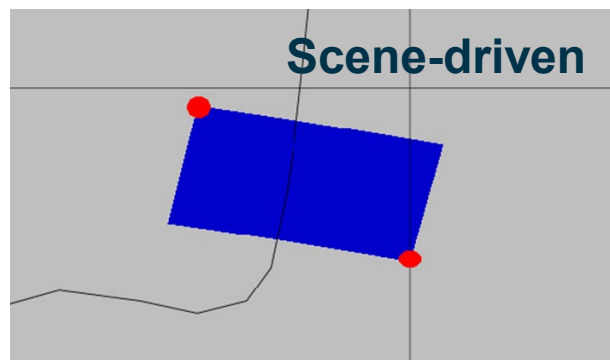
FIPS contract

L2 scientific studies

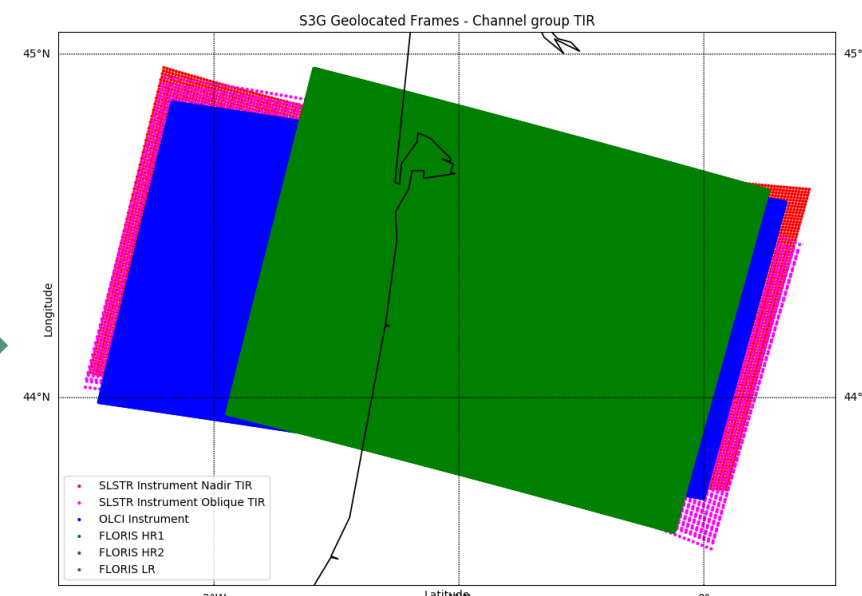
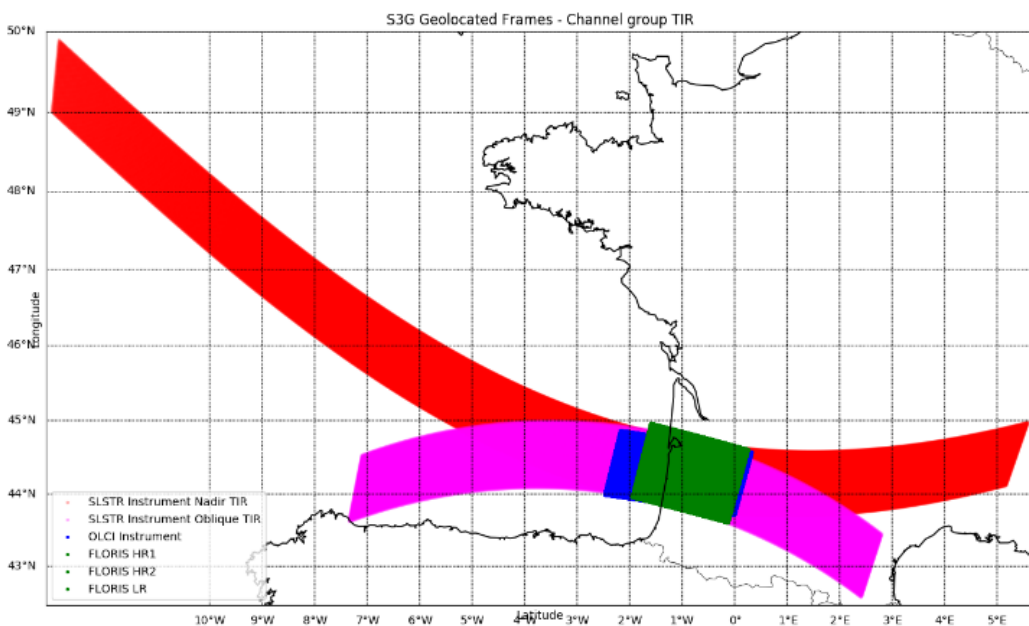


# FLEX-E scene configuration – geometry modules

Two operation modes



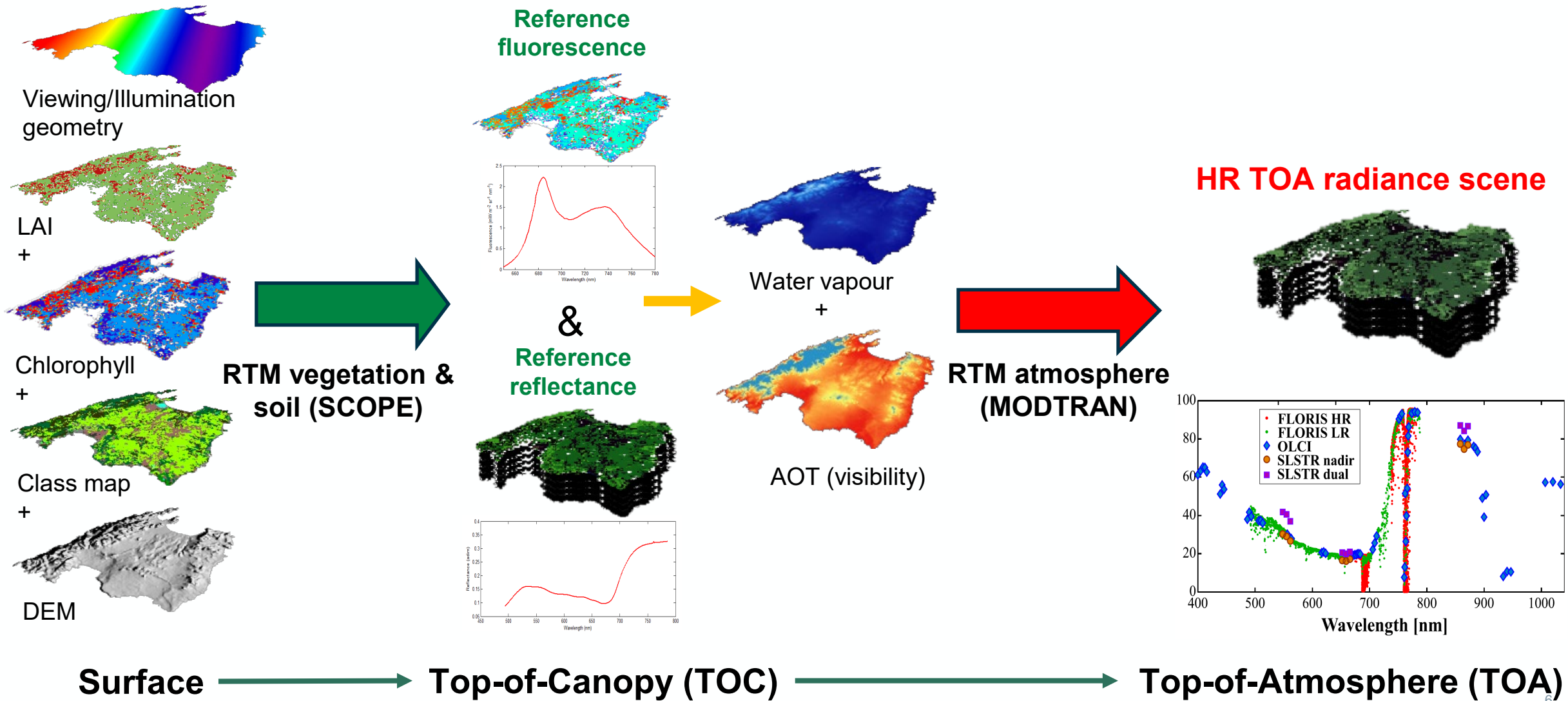
Data generated for the overlap region with FLORIS



Overlap of FLORIS HR-LR and Sentinel 3 (OLCI camera 4 + SLSTR nadir & oblique)



# FLEX-E Scene Generation Module (SGM)

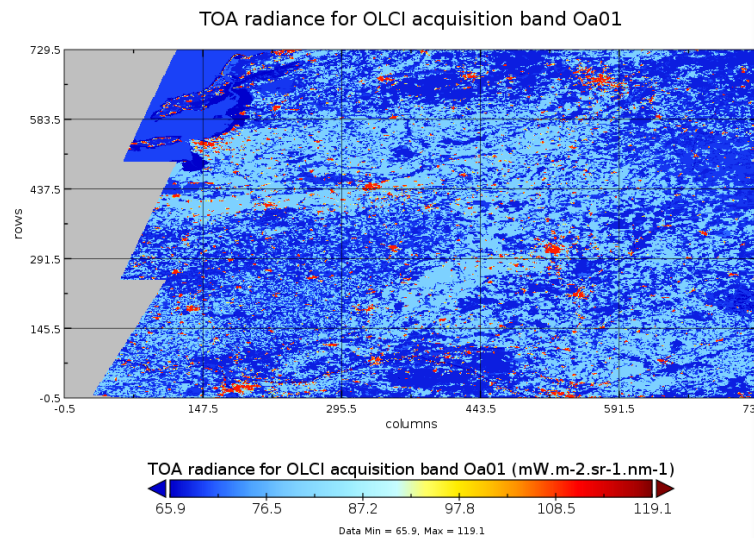
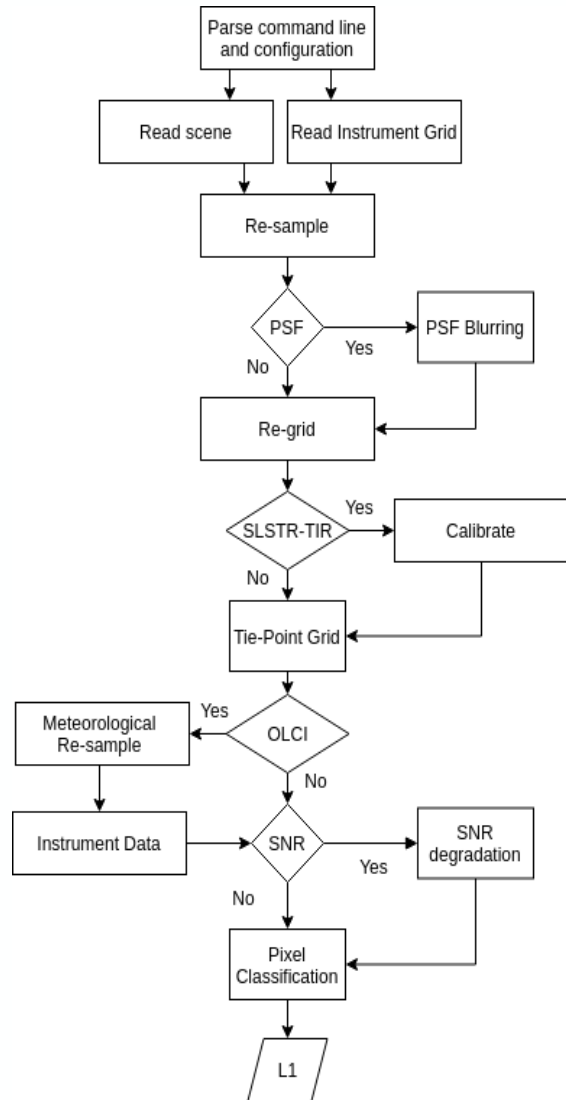


## Specific features for performance optimization:

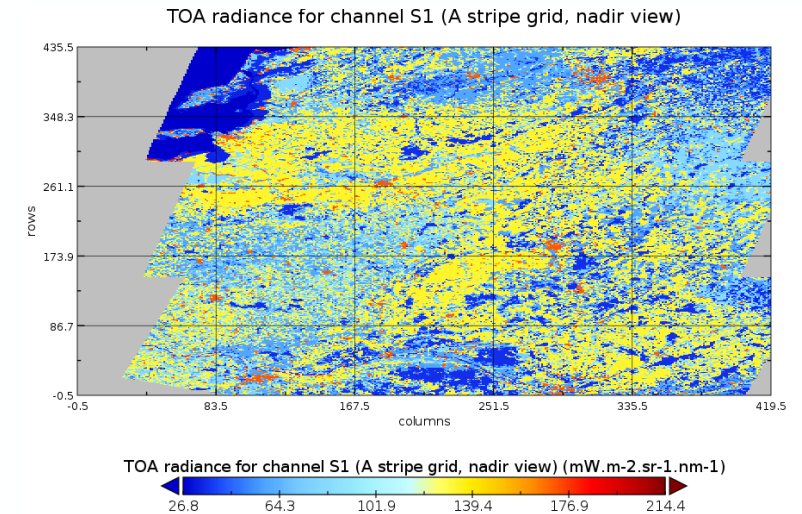
- From V2.2. on, fully coded in C++
- TOA outputs (to FIPS-ISM and S3M) divided in blocks
- Four operation modes:
  - **Full**: Calculates TOA radiance and the L2 products **by using the RTM SCOPE**. Intended to perform the **scientific validation of the L2RM**
  - **Fast L1**: Uses the **TOA radiance reference** data from Reference Spectra. Intended to generate **large scenes for geometric or performance testing up to L1**
  - **Fast L2**: Uses a **pre-created TOA radiance + L2 products database** to fill the SGM outputs. Intended to generate **large scenes for geometric or performance testing up to L2**
  - **Textures**: Calculates TOA radiance from a **Sentinel-2 reflectance image**. Intended to generate scenes containing realistic textures

Simplification of the S3 operational software radiometric chain :

- Simplified correction of the noises and instrumental effects added to the TOA radiance
- Output radiances with a (configurable) residual noise equivalent to the S3 mission SNR
- Simplified L1b image grids and re-gridding. Subsampled tie-points grid



OLCI's L1b Product for channel Oa01

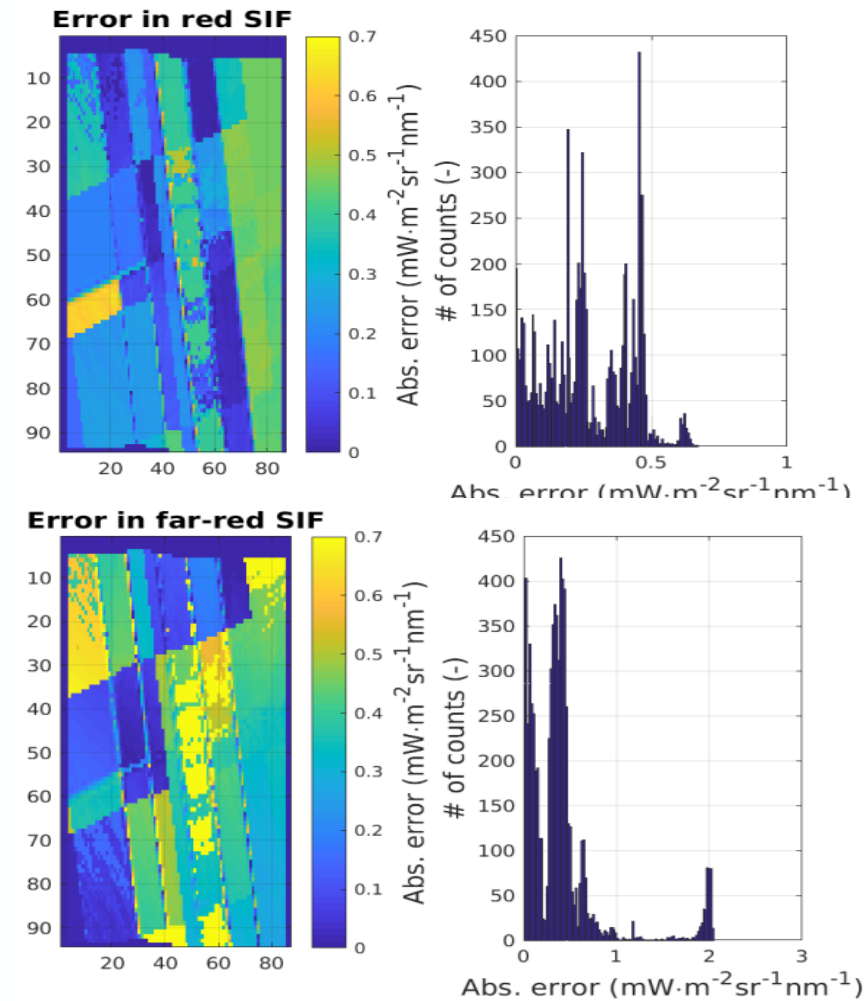


SLSTR's L1b Product for channel S1, Nadir view





- Developed in the L2RM project
- It compares, on a per-pixel basis, two datasets, projected to UTM tiles:
  - 1) The SGM reference data (TOC reflectance and fluorescence, reference maps for the L2C products)
  - 2) The L2B and L2C output products of the L2RM
- Generates an automatic report with the evaluation of all L2 MR



Example of plots for the assessment of MR-FLEX-020 (fluorescence peak values and positions)

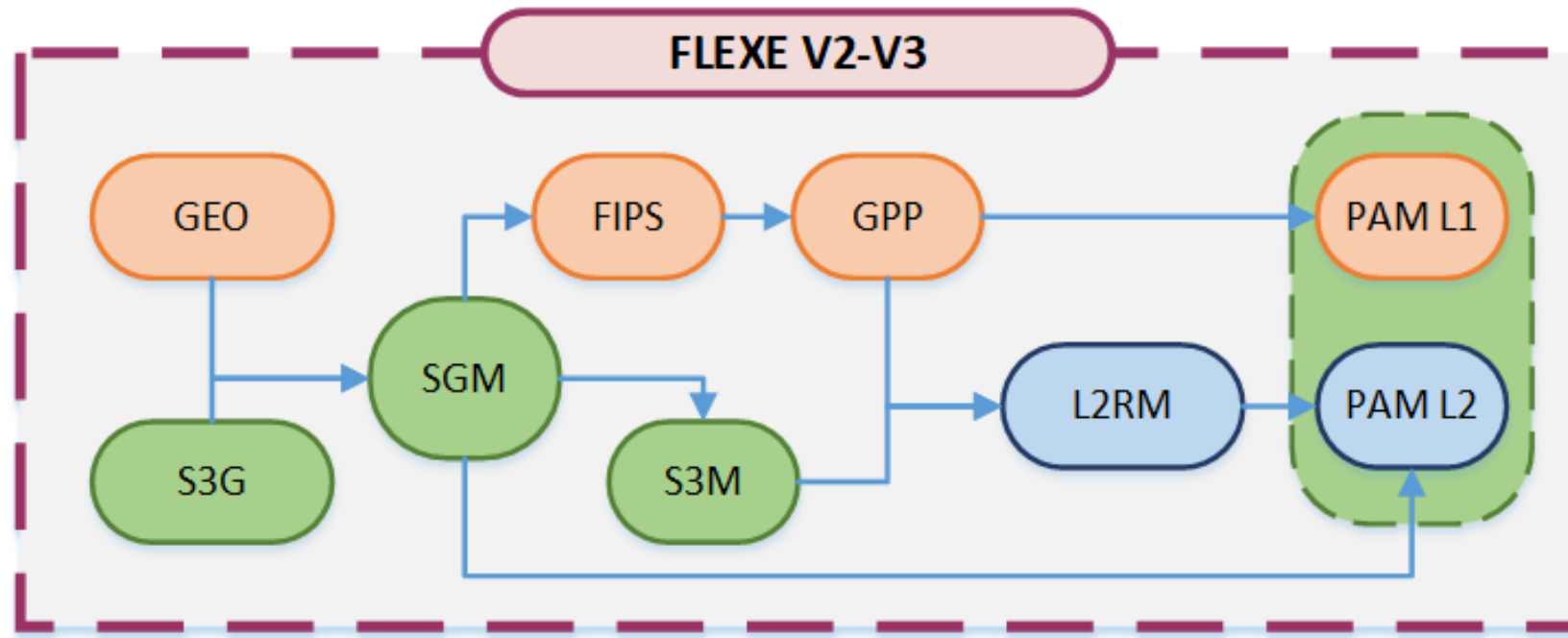


# FLEX-E L1 & L2 Mission Performance Assessment Report (MPAR)

- Ultimate goal of FLEX-E
- Latest full MPAR produced with FLEX-E V1.2 (2020)
- Next MPAR foreseen with FLEX-E V2.2 in 2022
- Results to be used for Mission Critical Design Review (M-CDR)

Test	MRD req.	Specific Description	Comments	Pass	Raised SPRs	
MPAP_01a	MR-FLEX-300	Temporal co-registration between FLEX and Sentinel-3 measurements		YES		
	MR-FLEX-110	Swath width		YES		
	MR-FLEX-130	Spatial Sampling Distance (SSD)	Across-track SSD complies, but along-track SSD does not. Possibly due to an excessive perturbation to the platform stability	NO		
	MR-FLEX-140	Spatial resolution (defined as the FWHM of the PSF)	An effective PSF has been provided by OSST v4 at selected points and wavelengths <b>It will be properly evaluated on V2</b>	YES (party)	<a href="#">36559</a>	
	MR-FLEX-310	FLORIS' swath falls within the swath of OLCI's nadir looking camera		YES		
	MR-FLEX-150	Spectral range covered by FLORIS spectrometers		YES		
	MR-FLEX-160	Spectral Sampling Interval (SSI)		YES		
		Spectral Resolution (SR) defined as the FWHM of the Instrument Spectral Response Function (ISRF)	An effective PSF has been provided by OSST v4 at selected points and wavelengths <b>It will be properly evaluated on V2</b>	YES (party)	<a href="#">36559</a>	
	MR-FLEX-170	Spectral Sampling Interval (SSI) downloaded without on-board binning		YES		
		Spectral Resolution (SR) downloaded without on-board binning	An effective PSF has been provided by OSST v4 at selected points and wavelengths <b>It will be properly evaluated on V2</b>	YES (party)	<a href="#">36559</a>	
	MR-FLEX-220	Intraband spectral co-registration, i.e. maximum difference in the position of ISRF's barycenter of any given spectral channel across the swath.	Smile effect is now included in OSST v4	YES	<a href="#">36481</a>	
		<b>In text, not numbered, Page30 Par2 of MRD v2</b>	Interband spectral co-registration, i.e. relative position of the ISRF's barycentre for consecutive spectral channels	Smile effect is now included in OSST v4	YES	<a href="#">36481</a>
	MR-FLEX-230	Intraband band-broadening, i.e. maximum FWHM difference of any given spectral channel across the swath	There is no band broadening present. It is not possible to evaluate this requirement. <b>It will be evaluated on V2</b>	NOT EVAL.	<a href="#">36481</a>	
	MR-FLEX-240	Interband band-broadening: The FWHM difference between two consecutive across-track pixels (FWHM regularity)	There is no band broadening present. It is not possible to evaluate this requirement. <b>It will be evaluated on V2</b>	NOT EVAL.	<a href="#">36481</a>	
MR-FLEX-180	Signal to noise ratio (SNR)	All bands comply with requirement within 1-sigma, except for a few bands in the LR red-edge region. Unbinned HR bands are estimated to comply.	YES (party)	<a href="#">36482</a>		
MR-FLEX-190 INS-480	Absolute radiometric accuracy		YES			

# FLEX-E evolution - V2 & V3 (2020-2023)



FLEX-E CONTRACT

FIPS CONTRACT

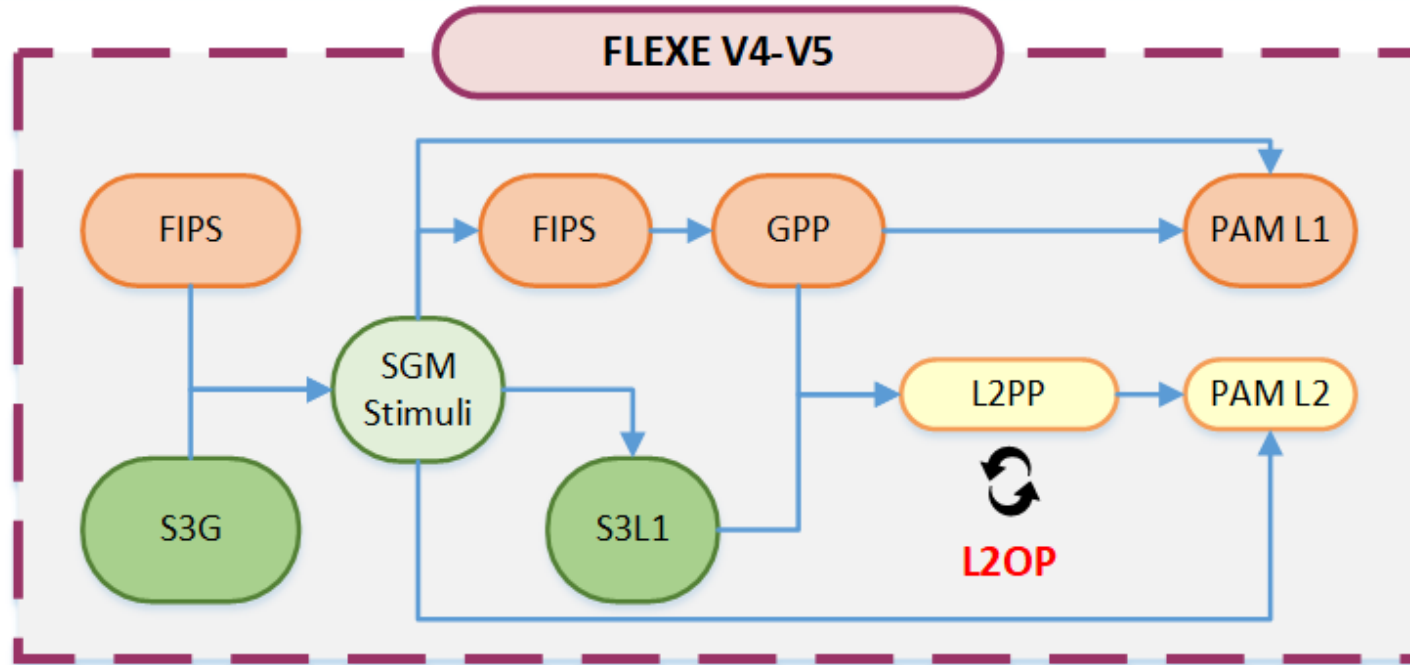
L2 SCIENTIFIC STUDIES

L2PP CONTRACT

**Current stage: V2.2**



# FLEX-E evolution – V4 & V5 (2024-2025)



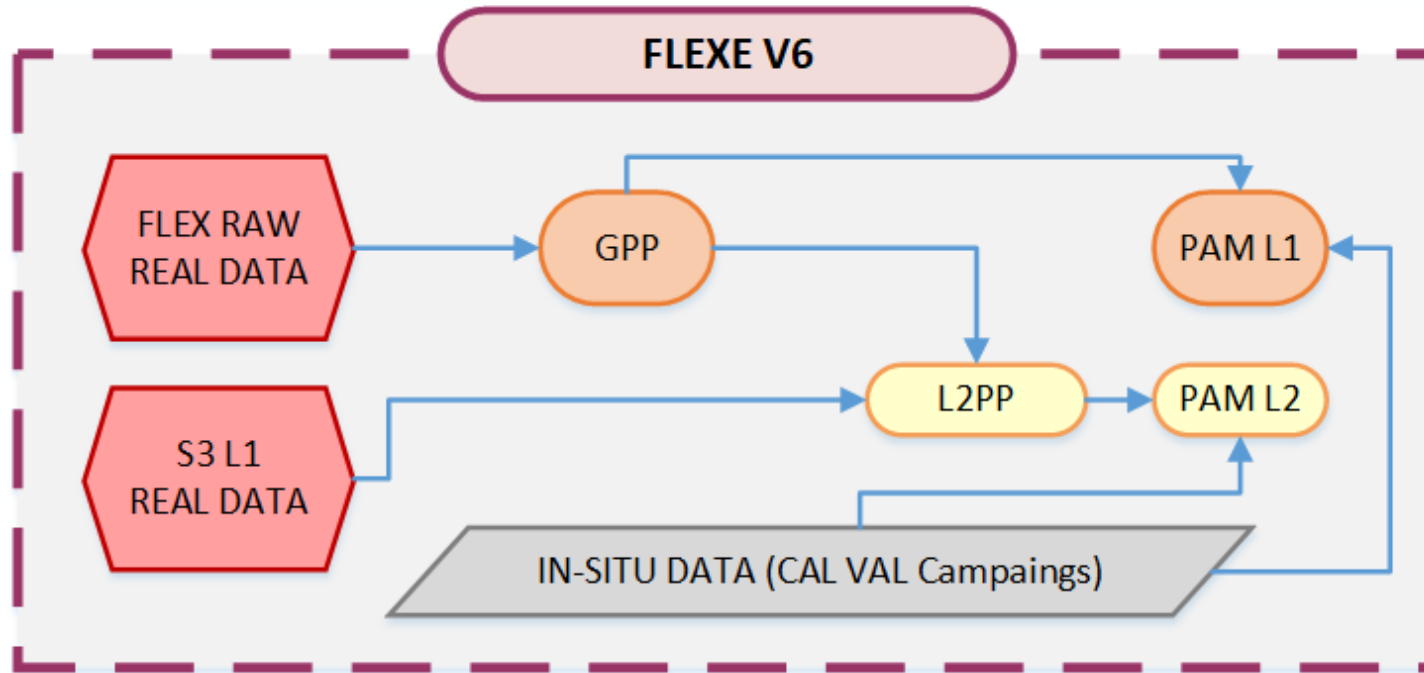
FLEX-E CONTRACT

FIPS CONTRACT

L2 SCIENTIFIC STUDIES

L2PP CONTRACT

# FLEX-E evolution - V6 (2025-2026)



FLEX-E CONTRACT

FIPS CONTRACT

L2 SCIENTIFIC STUDIES

L2PP CONTRACT



- FLEX-E is the FLEX L1/L2 end-to-end mission performance Simulator for ESA's FLEX Earth Explorer-8.
- It is the key tool to demonstrate the feasibility of the whole FLEX mission concept and the baseline for the mission Ground Segment.
- It is also a versatile scientific tool, allowing to simulate the variability of ground, atmospheric and observation conditions that the FLEX – Sentinel-3 tandem mission will face,
- It allows to test the impact, on the L2 scientific products, of the limitations or constraints imposed by the technical solutions adopted for the FLEX instrument/platform
- The current version of FLEX-E (V2.2), to be released in July 2022, will be used for Mission Performance Assessment at the incoming M-CDR milestone (2023)