MICROCARB

# MicroCarb CNES microsatellite mission to characterize $CO_2$ surface fluxes:

# Sizing of the mission centre

2019 Conference on Big Data from Space: BiDS'19

CNES - Céline L'HELGUEN

# MicroCarb mission: in what context?

- **Objectives:**
  - Remotely measures $CO_2$ column integrated volume mixing ratios in the atmosphere
  - Helps to better assess carbon fluxes (the most important anthropogenic greenhouse gas)
- **Previous missions:**
  - JAXA: GOSat (2009)
  - NASA: OCO-2 (2014)
  - Chinese missions: TanSat ACGS, Feng Yun-3D GAS, Gaofen-5 GMI
- **The first European mission:**
  - Microsatellite Myriade
  - Launch scheduled in mid-2021, expected duration of 5 years


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# MicroCarb mission: contributors

- **Project led by CNES, the French Space Agency**
- **In partnership with:**
  - UKSA, UK manufacturers and science laboratories
  - the French science laboratories, in particular IPSL
  - EUMETSAT for the operation of the data processing centre
  - National and European industries
- **Funded by the French Government PIA (« Plan d'Investissement d'Avenir »)**


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# MicroCarb mission: major challenges

- **Expected data:**
  - estimation of $CO_2$ concentration gradients (a few ppm)
  - generation of $CO_2$ fluxes maps
- **Extremely high precision required:**
  - 1 ppm (0.25%) of random error
  - 0.1 ppm (0.025%) of regional bias
- **Scientific performances are crucial for the success of the mission!**
  - Drive performances on satellite, instrument and processing steps


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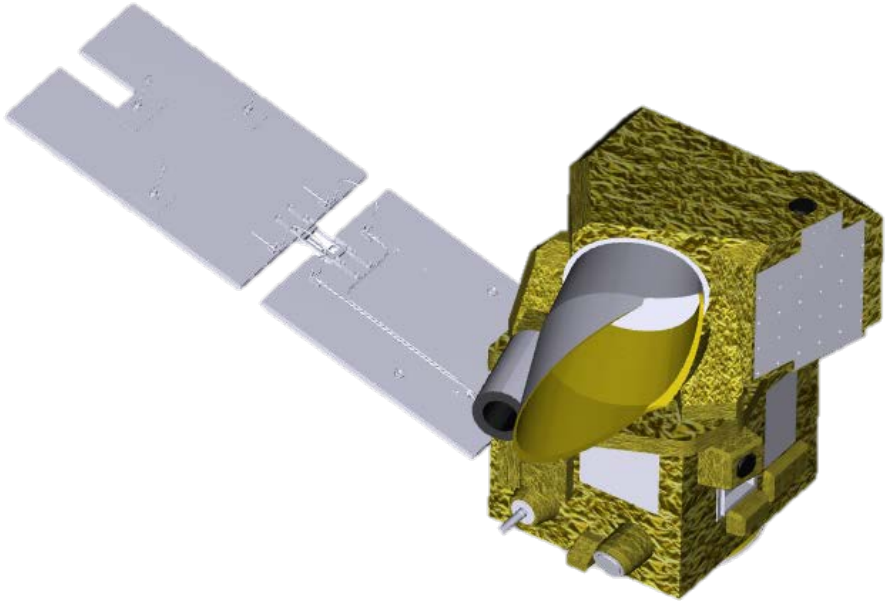
# Science objectives: instruments

- **Developed by Airbus Defense & Space**
- **Spectrometer:**
  - Oxygen ($0_2$ at 0.76 and 1.27 µm) to retrieve surface pressure
  - Carbon dioxide ($CO_2$ at 1.6 µm and 2.0 µm)
- **Imager:**
  - Improvement of the location precision
  - Detect clouds

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# A microsatellite…

# But a big ground segment!


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# PLOC – PayLoad Operations Centre - CNES



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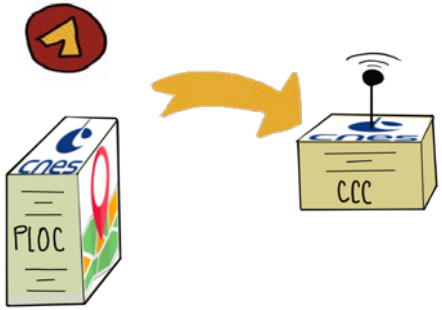
# CCC – Command-Control Centre - CNES





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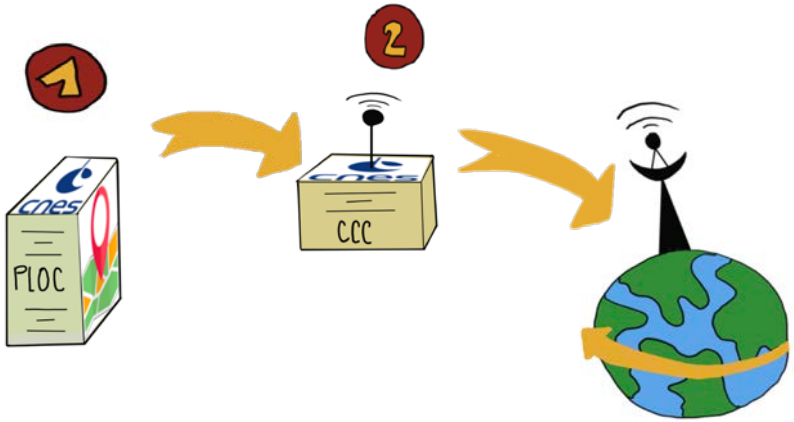
# Stations – CNES network





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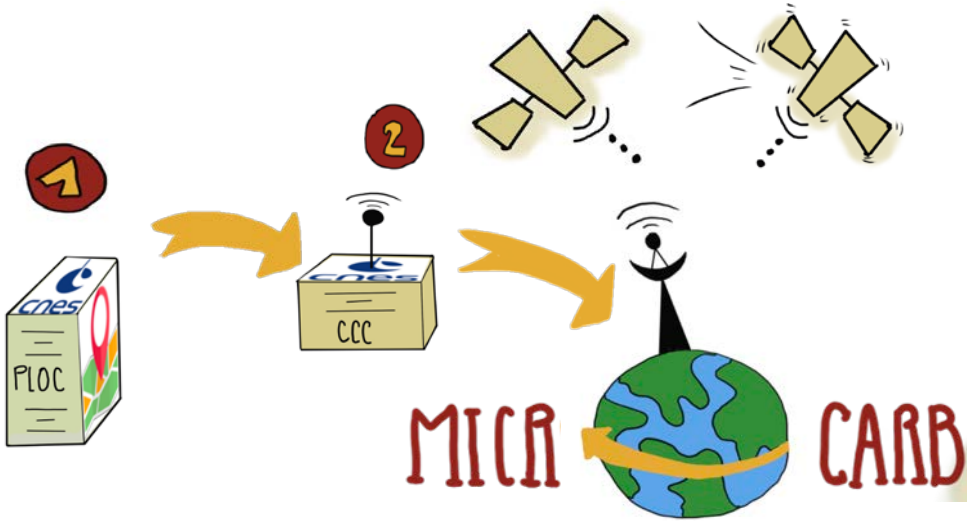
# MicroCarb satellite





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# PLDS – PayLoad Data Server - CNES



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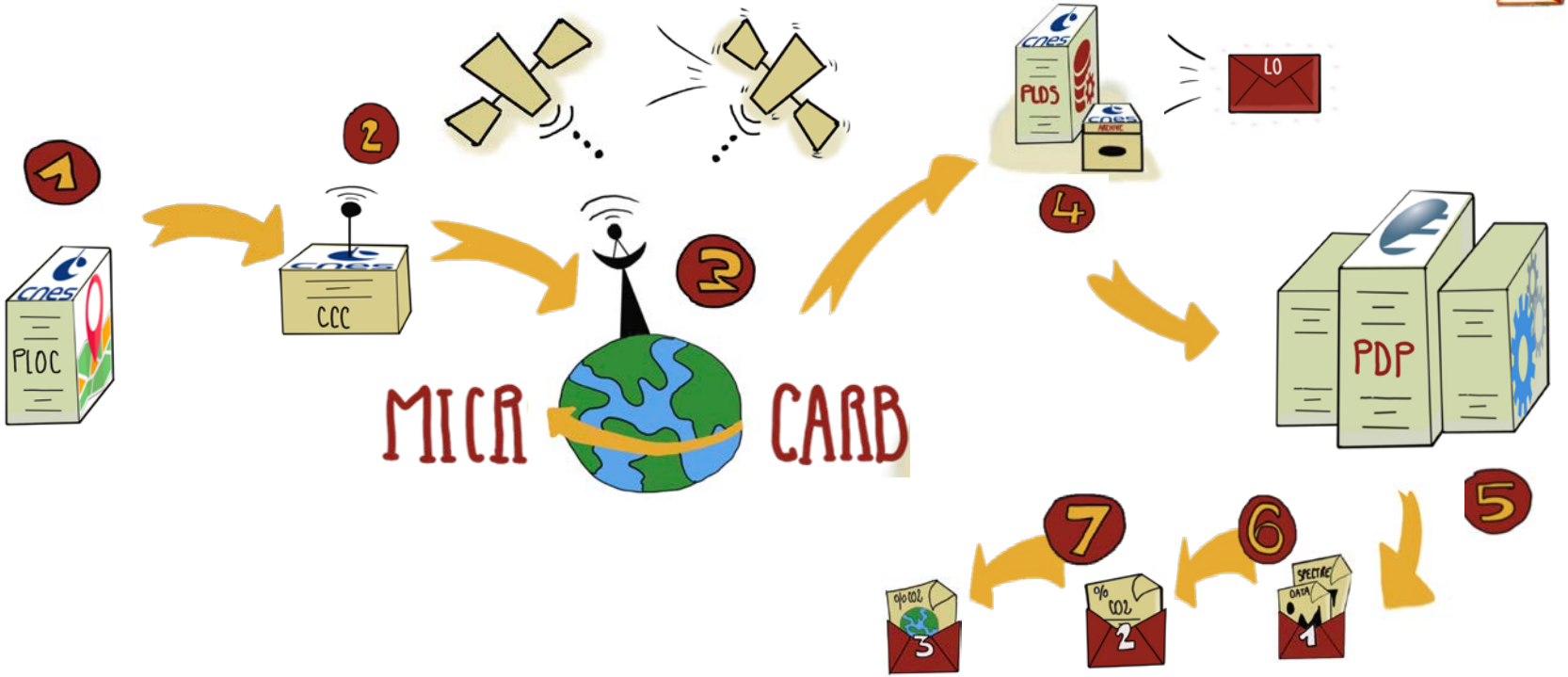
# PDP – Products Data Processing – EUMETSAT





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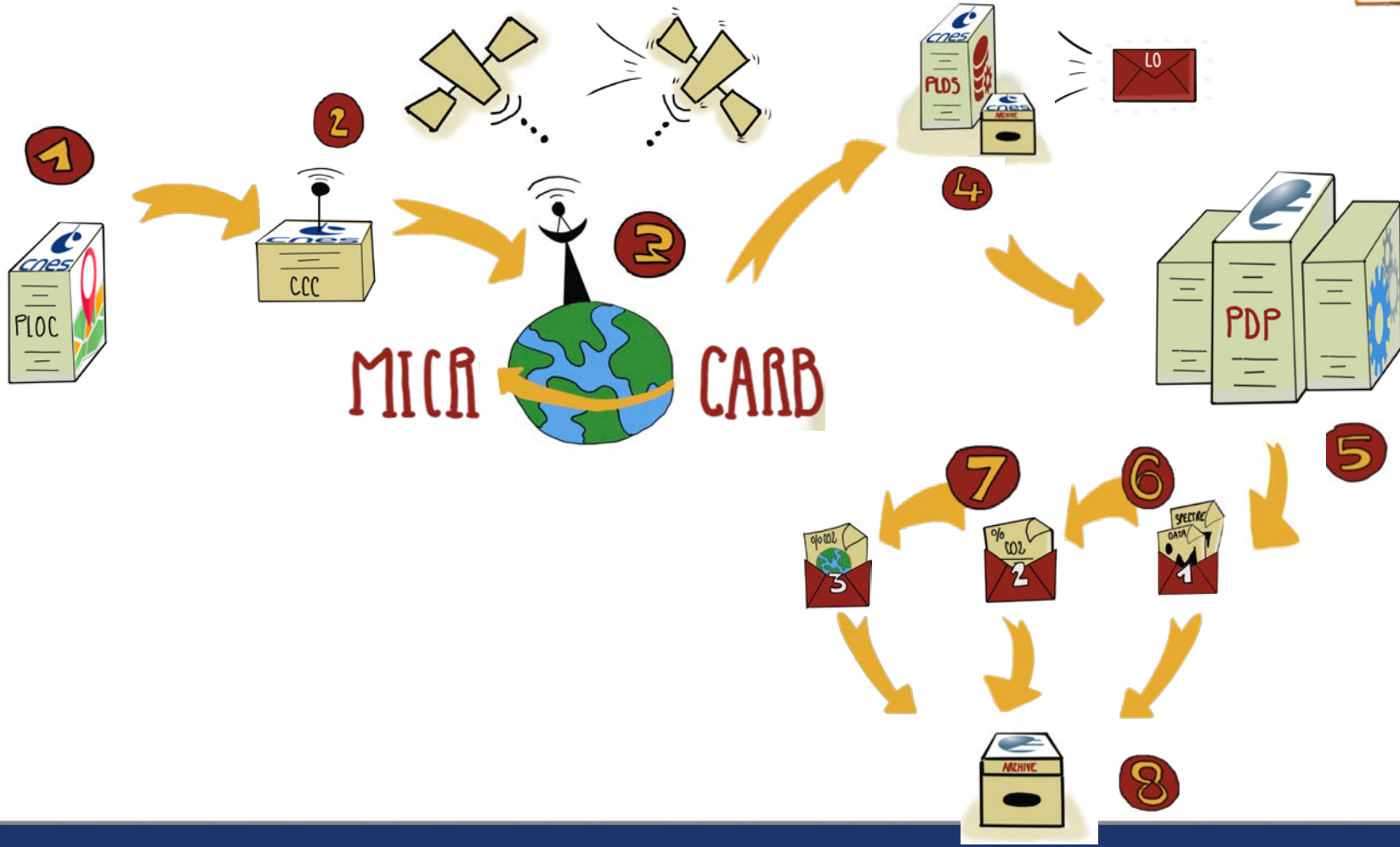
# Archival





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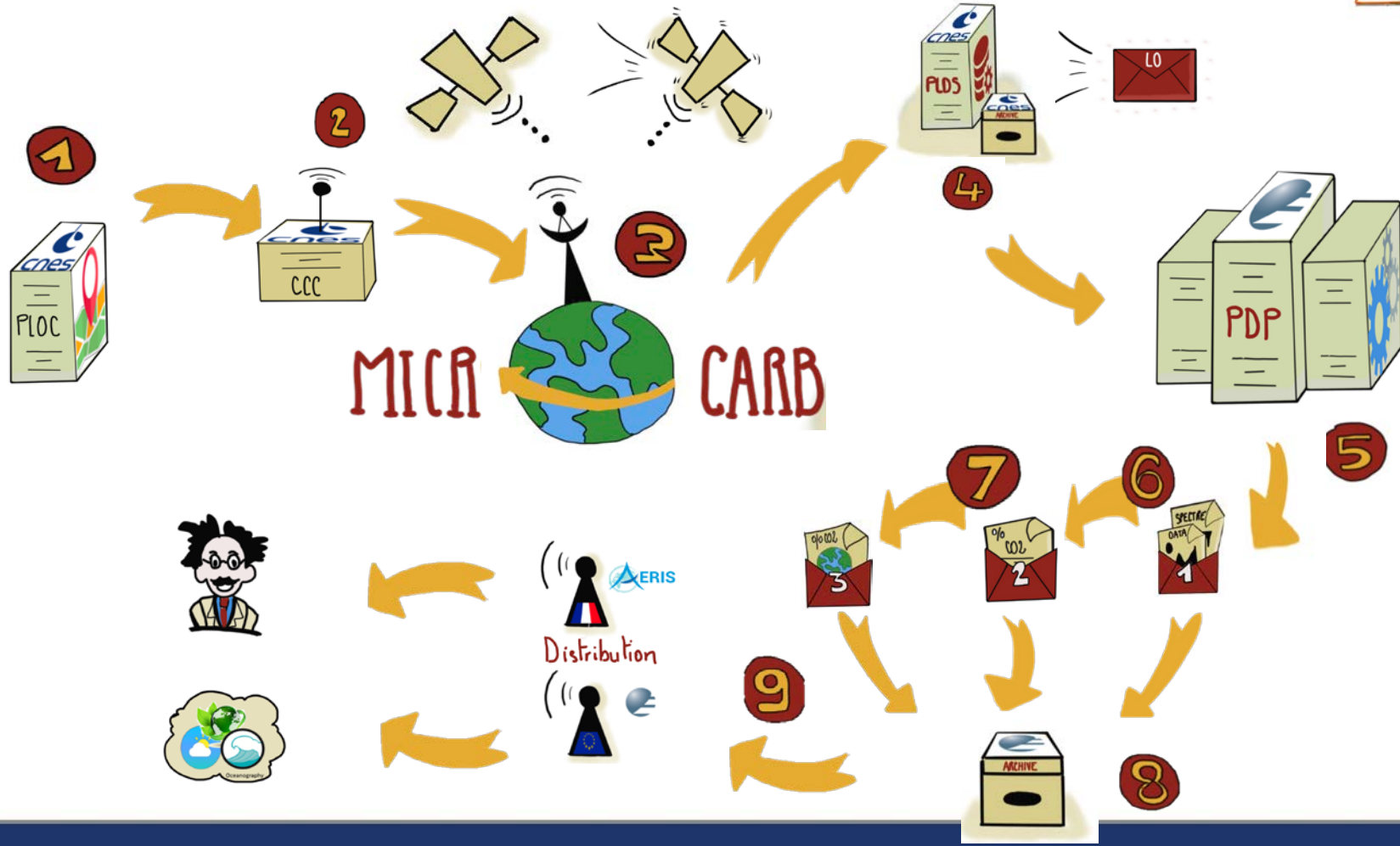
# Distribution





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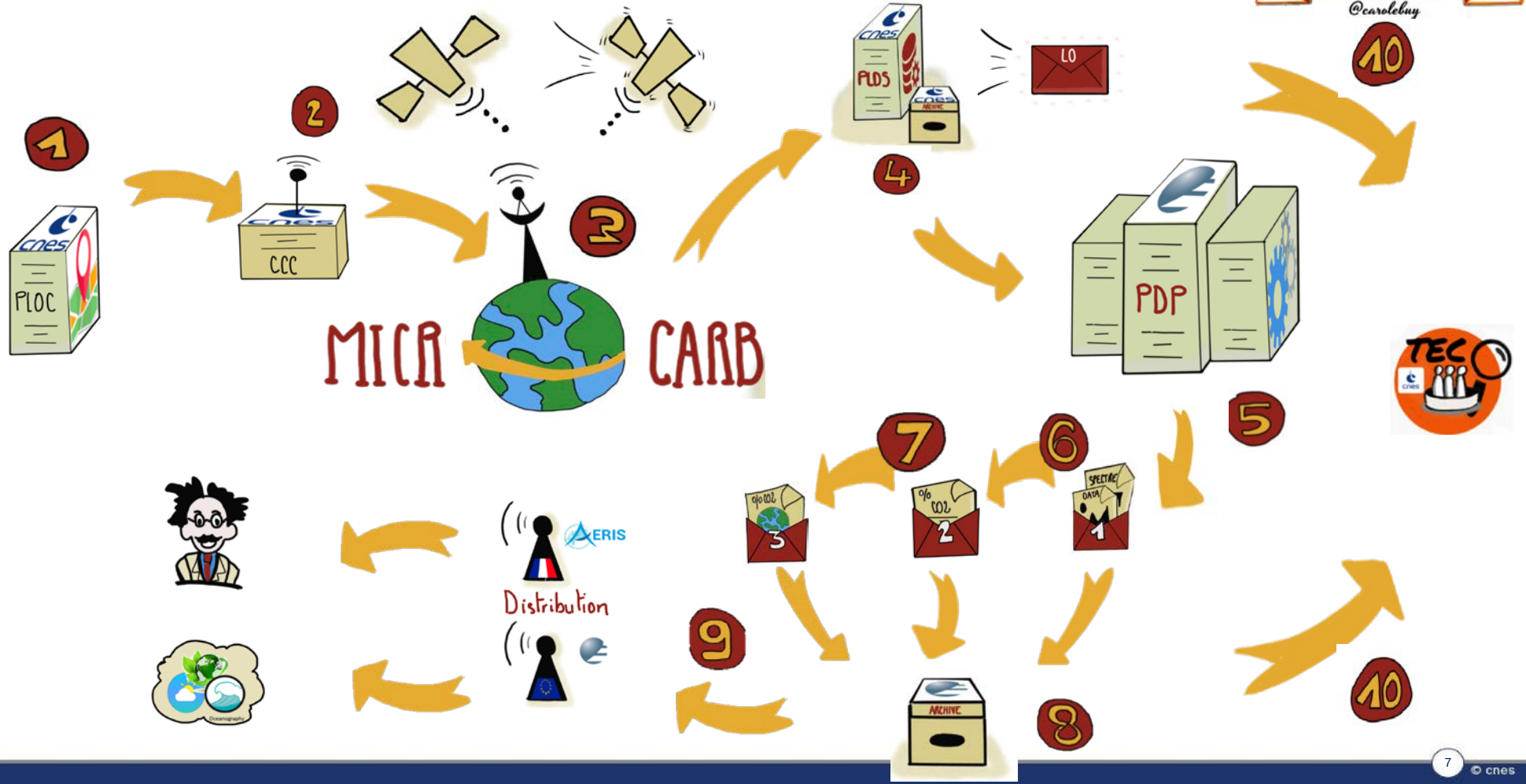
# TEC – Technical Expertise Centre - CNES





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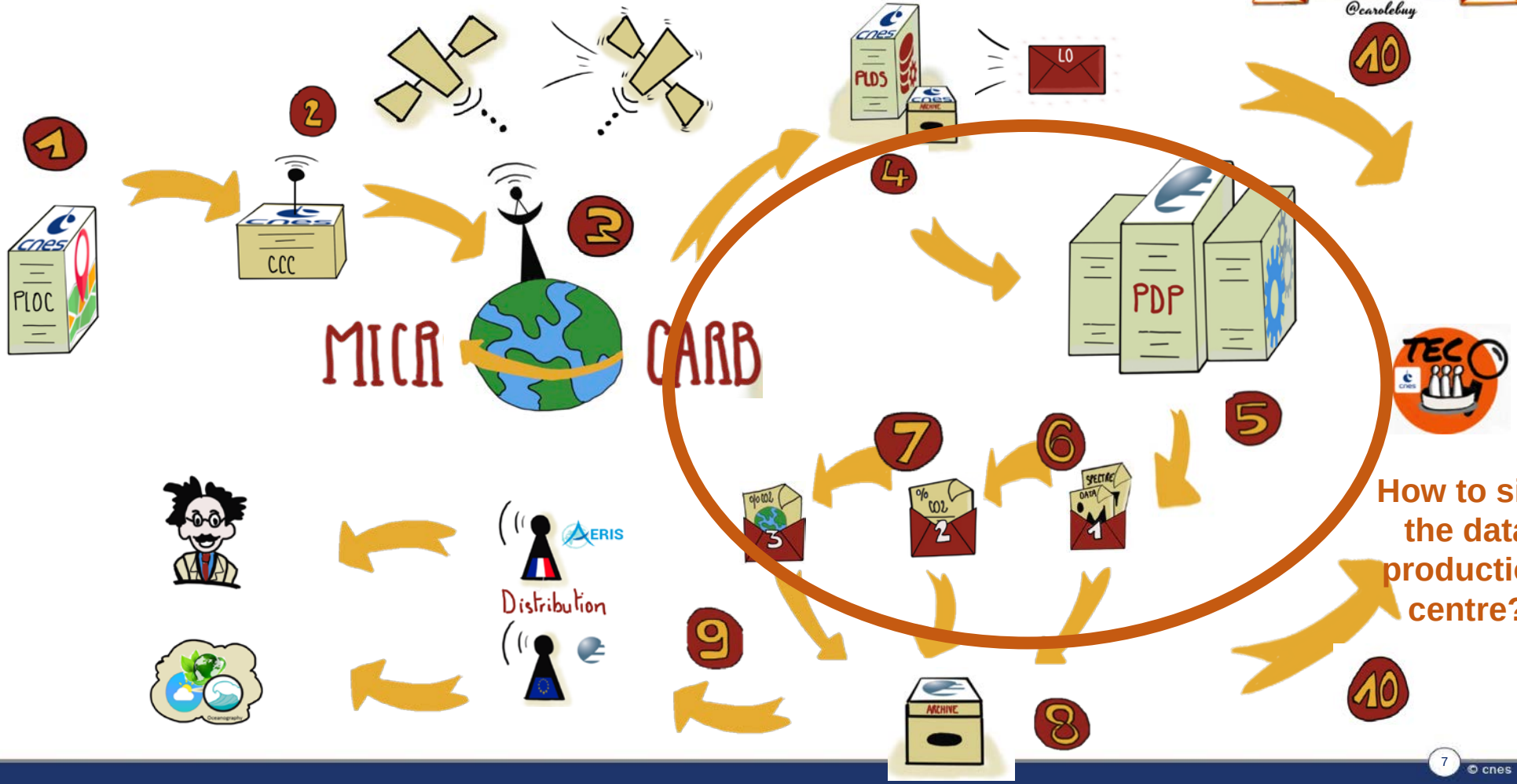
# MicroCarb PayLoad Ground Segment





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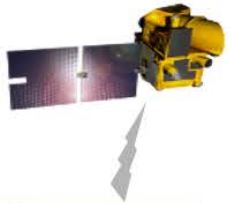
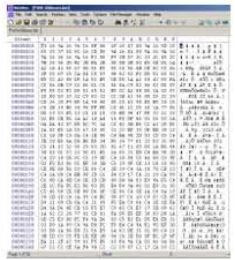
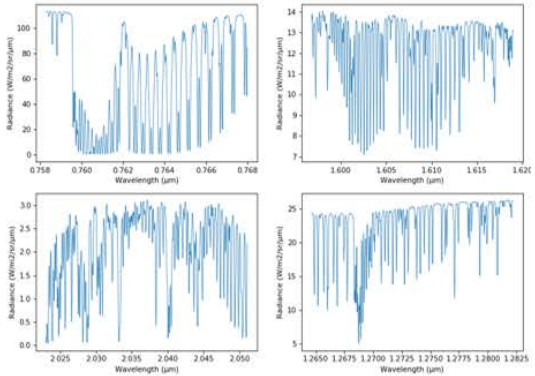
# MicroCarb levels of product





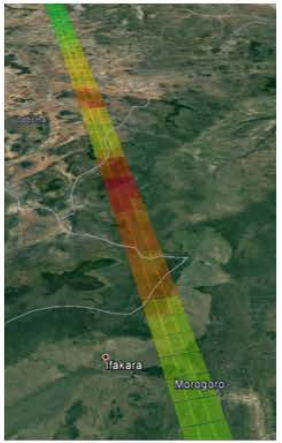
*Level 0*
= raw data

Calibration and binning



*Level 1* = calibrated spectra
(radiometry, spectrometry, geometry)

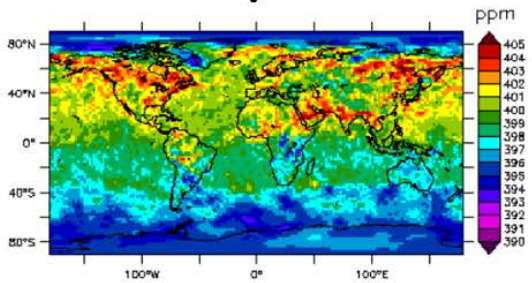
Inversion of the radiative transfer



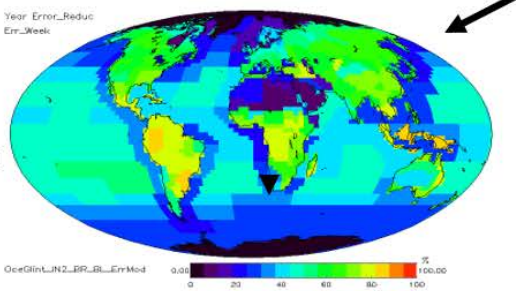

*Level 2*
= column integrated $CO_2$ volume mixing ratio

Spatio-temporal summation

*Level 3*
= $XCO_2$ maps




Atmospheric transport inversion



*Level 4*
= $CO_2$ sources and sinks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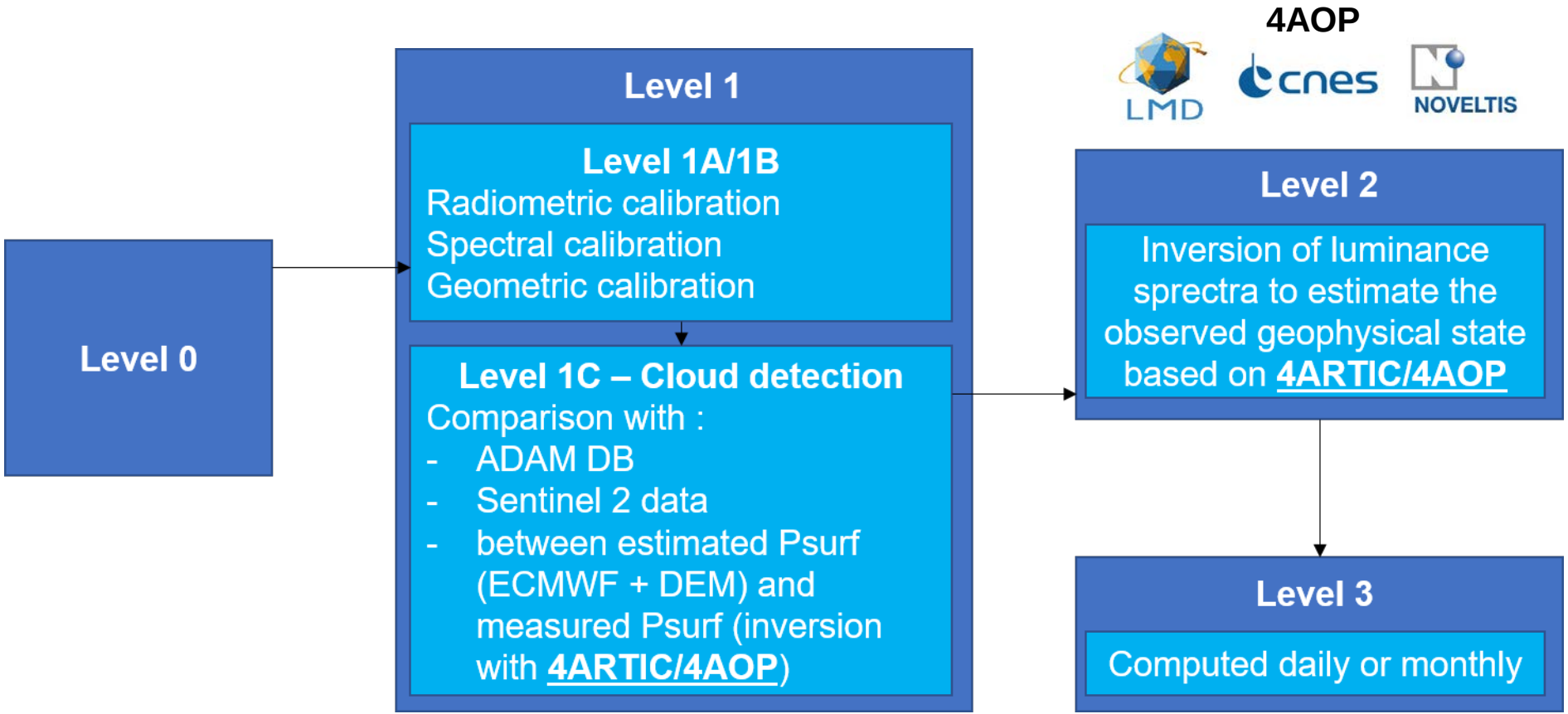
# MicroCarb levels of product - functions





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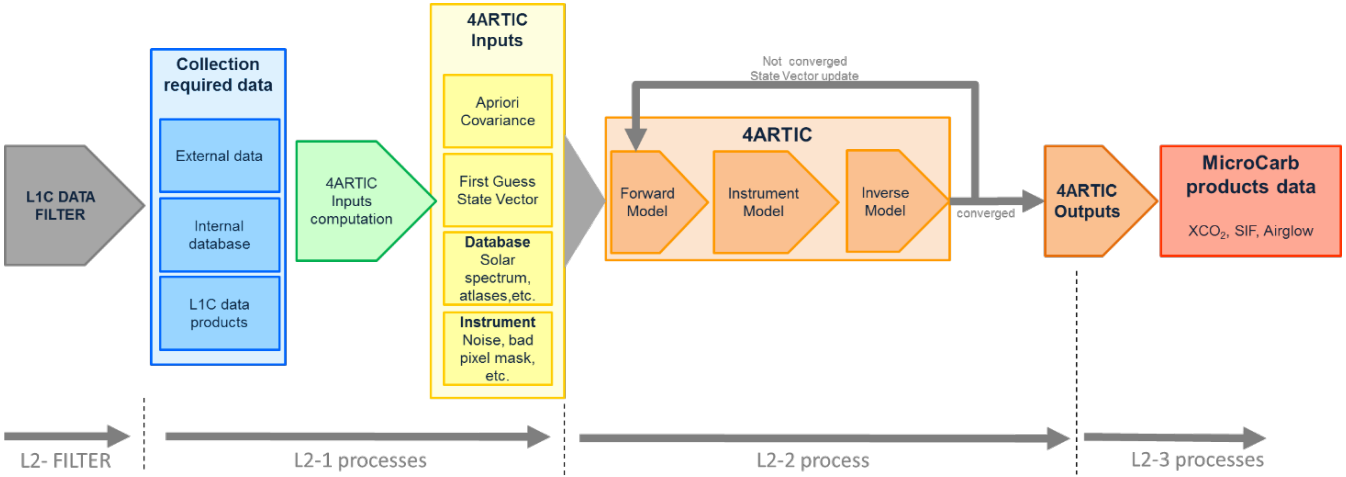
# MicroCarb algorithms: 4ARTIC computation of $CO_2$ concentration





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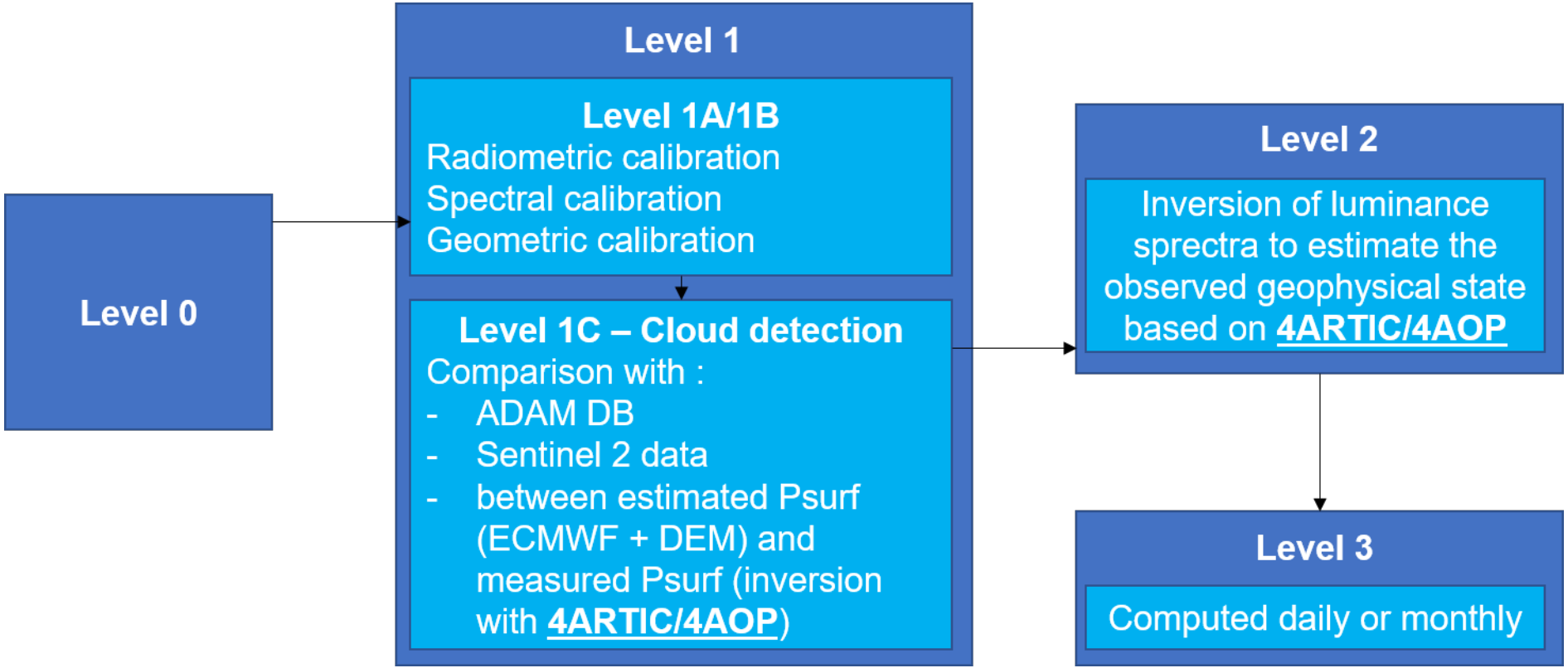



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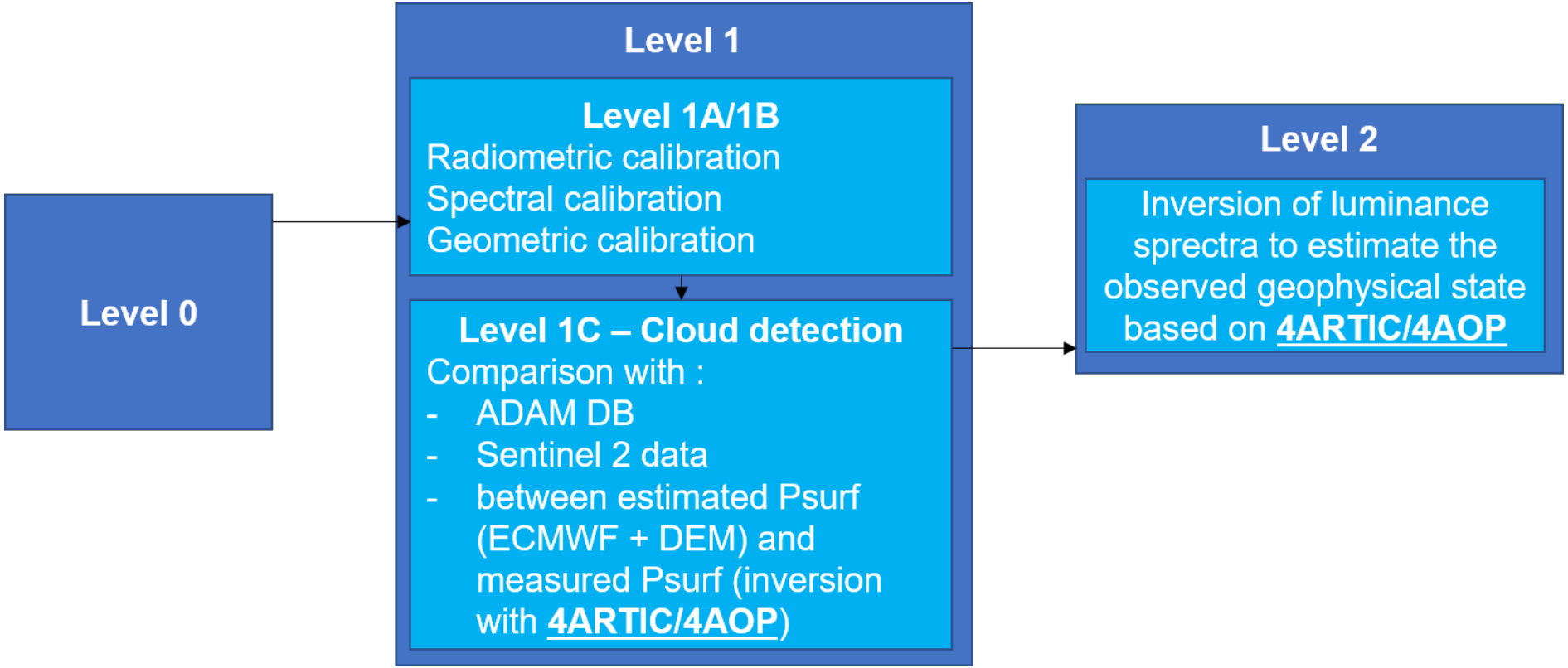



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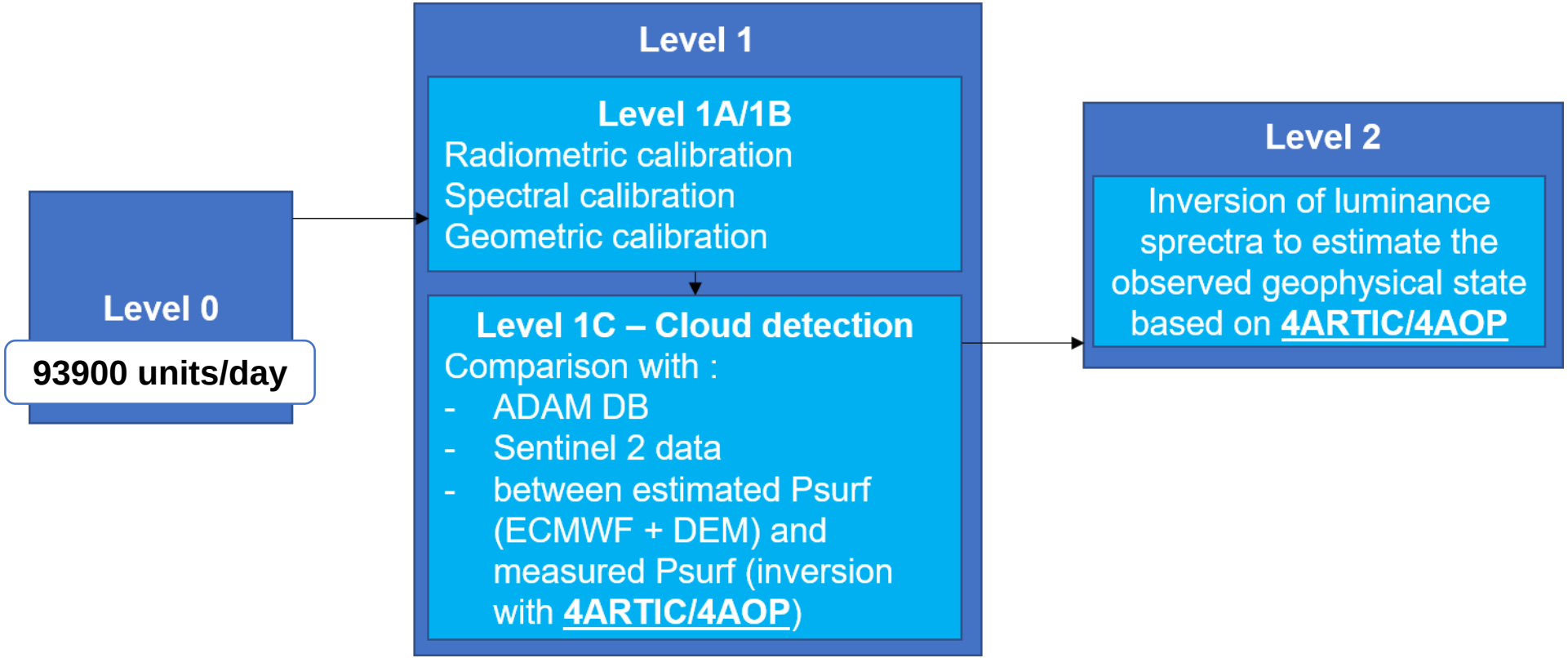
# MicroCarb levels of product - functions




Note : a unit is a Field Of View.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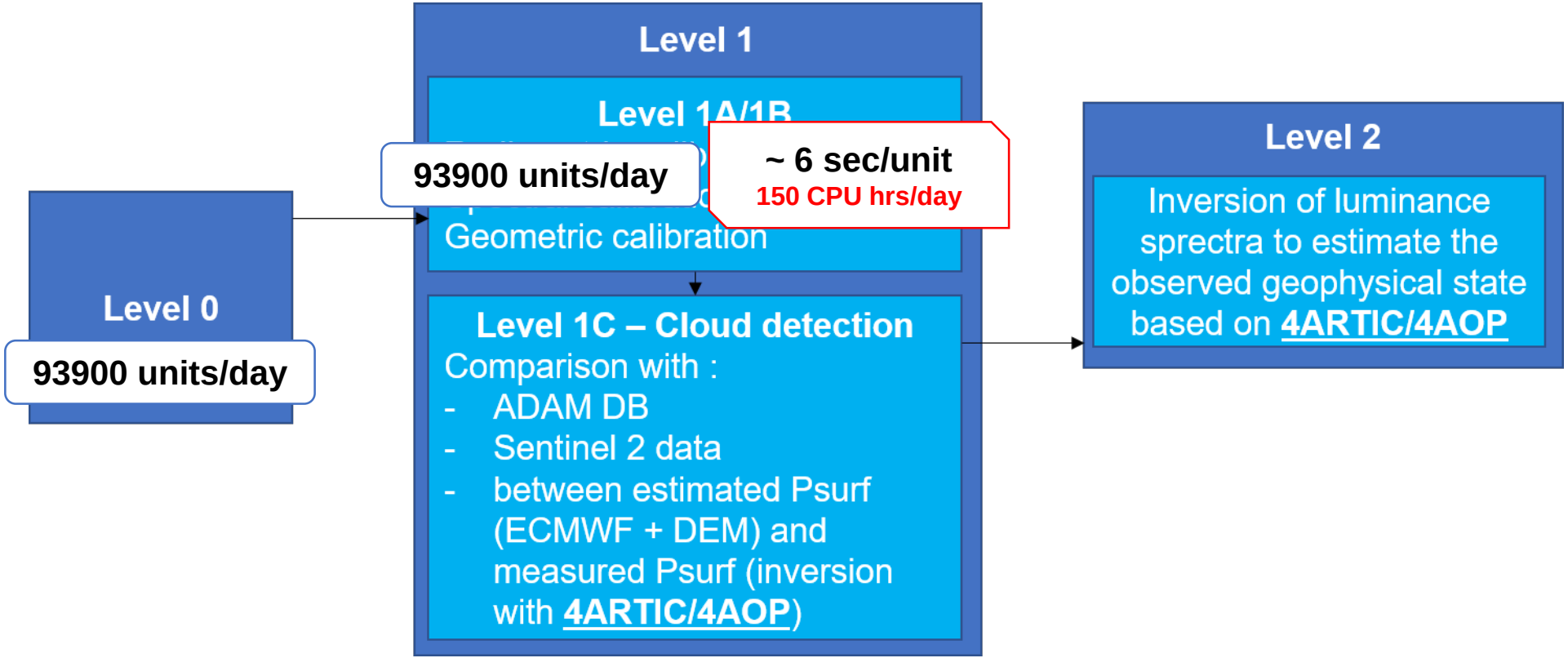
# MicroCarb levels of product - functions

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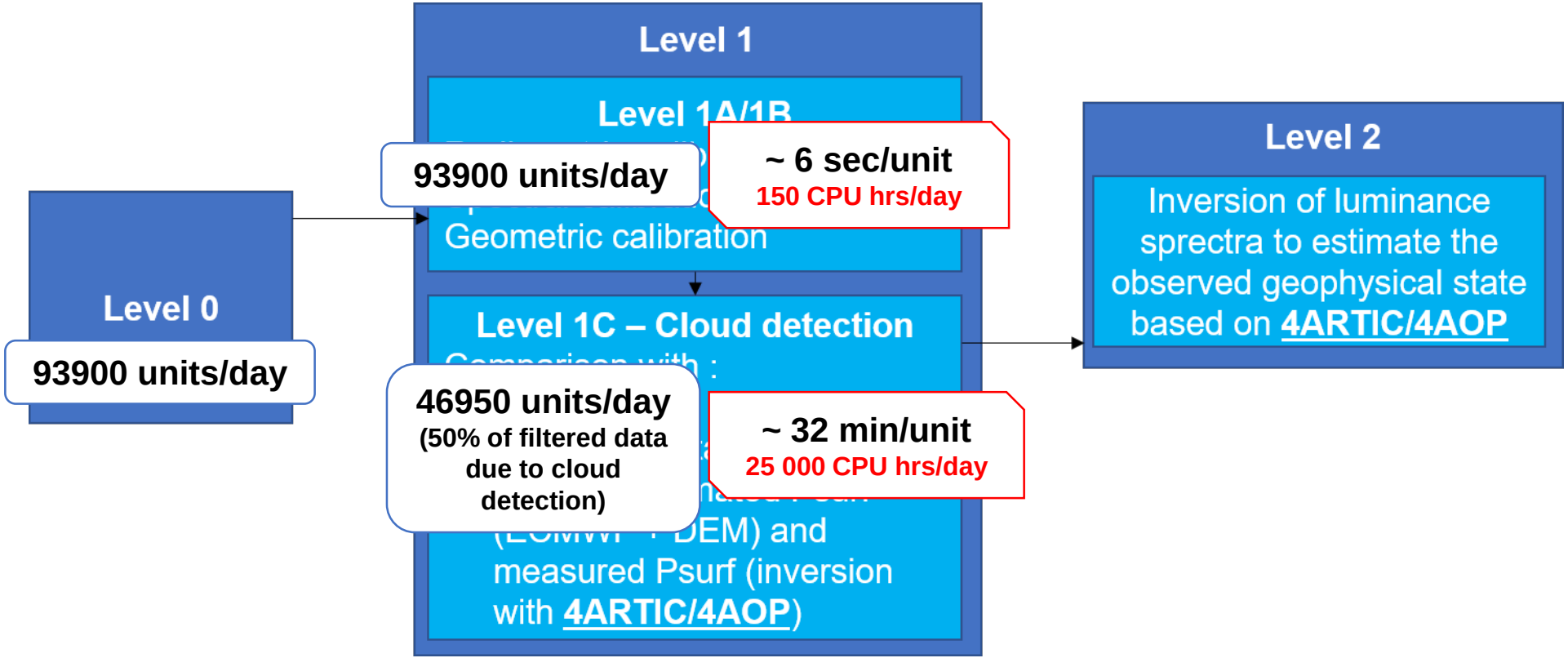


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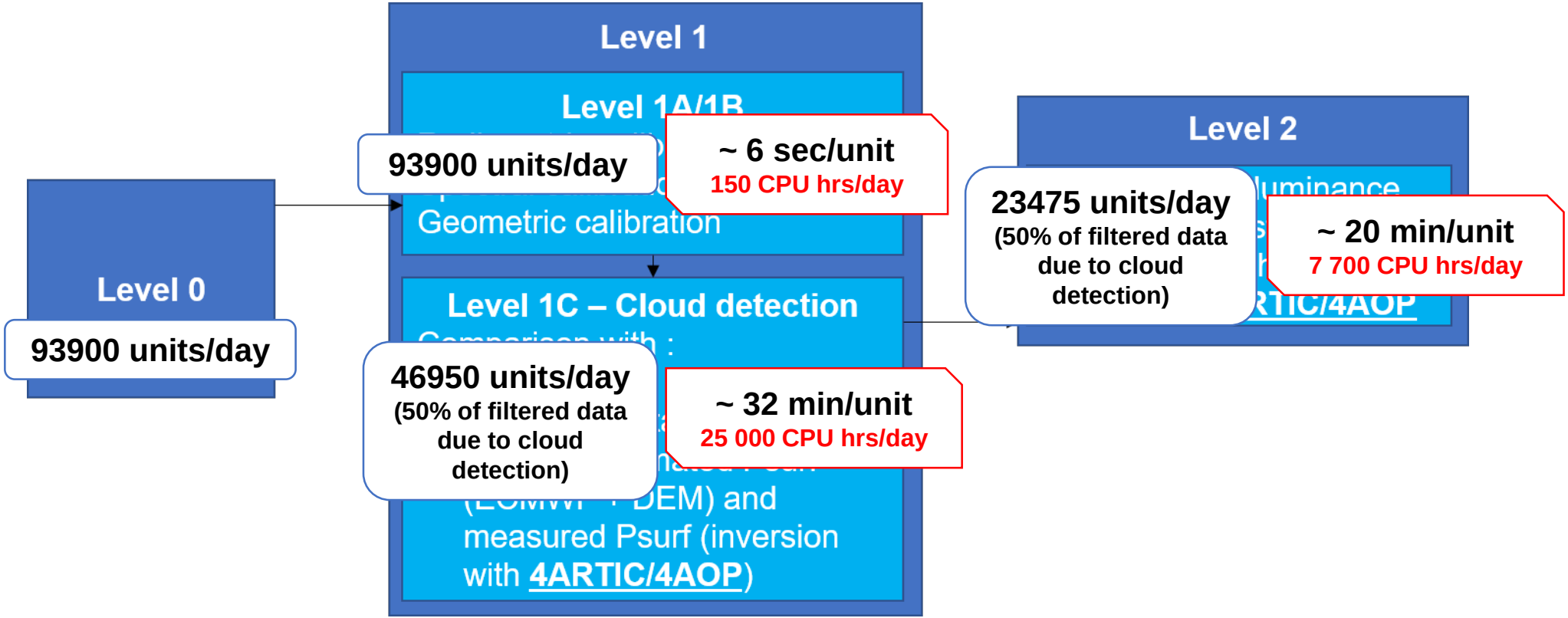


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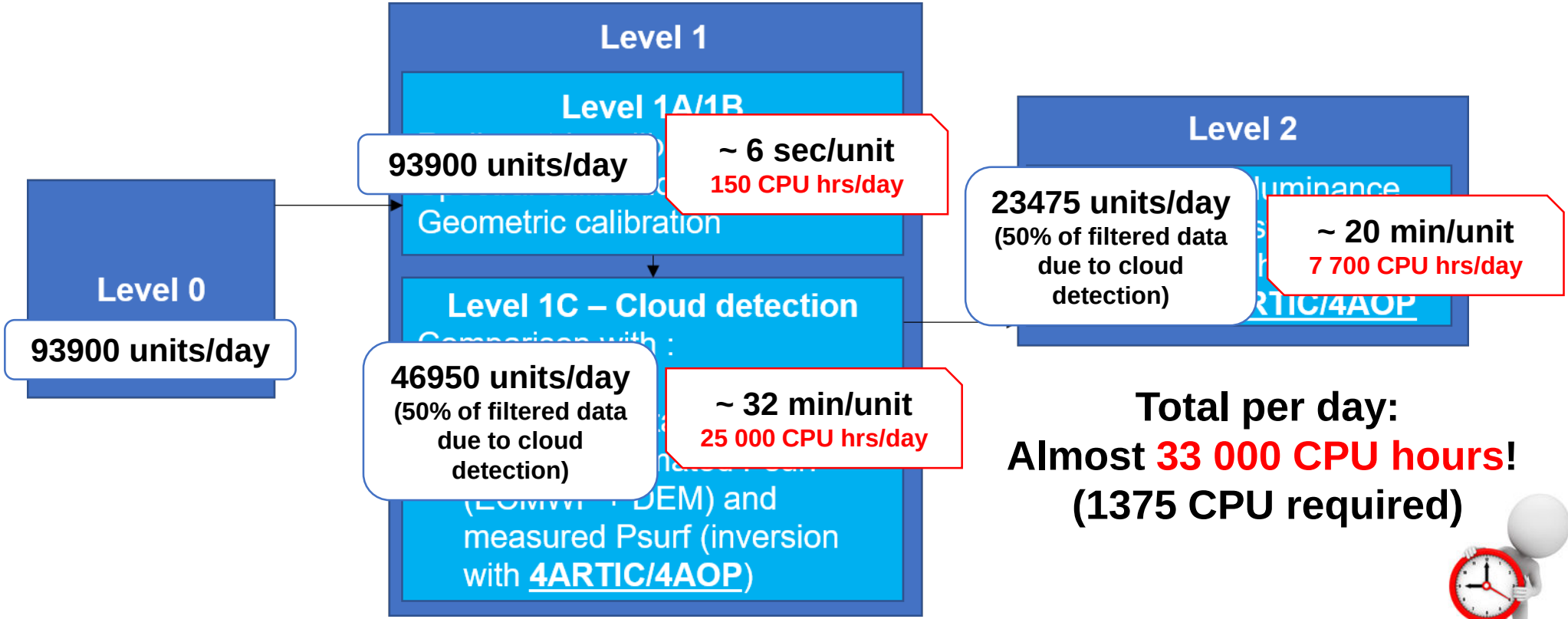


Note : a unit is a Field Of View.

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# EUMETSAT production centre IT sizing

- **For nominal processing: <u>3000 cores required</u>**
  - EUMETSAT IT architecture double for processing steps
  - To face possible delays and unavailability
  - To distribute Level 2 products in less than 7 days and hopefully in less than 48h
- **For reprocessing: <u>9000 cores required</u>**
  - 1 year of data shall be reprocessed in less than 2 months
  - 3 reprocessing campaigns during the first year
  - 1 reprocessing campaign per year afterwards


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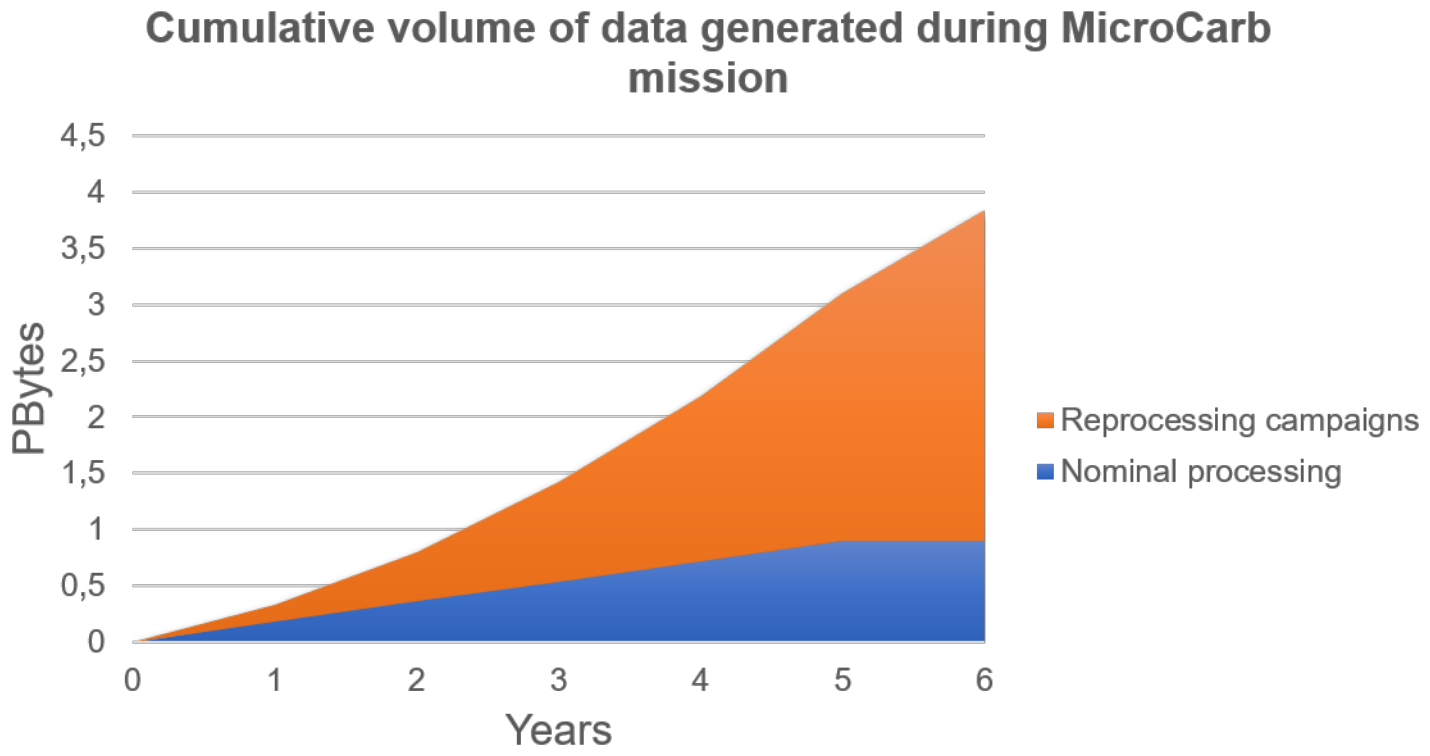
# Cumulative volume of produced data





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# Conclusion

- **EUMETSAT and CNES Invitations To Tender in progress**
- **MicroCarb: probationary project for CNES**
- **Small budget but large IT needs**
- **A major challenge to:**
  - Specify, Develop, Integrate the processing chains
  - Respect the schedule and the budget
  - Ensure high quality products for the science community.


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# Thank you


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