

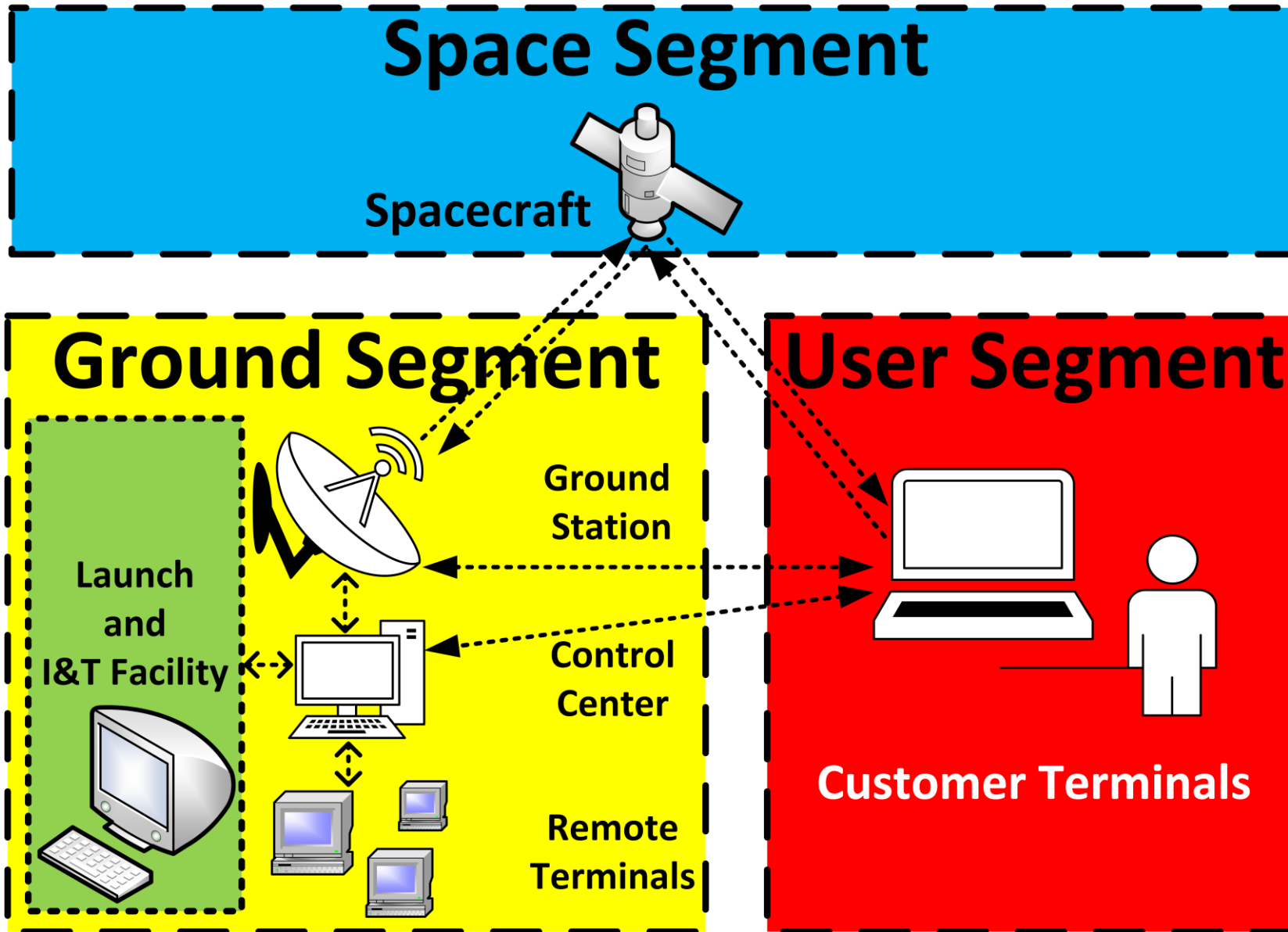
Processing levels of satellite data products

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ISMAR-CNR

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”



Ground & space segment



Product level: L0

Institution(s) typically responsible: Space agency (e.g. ESA, NASA) or meteorological agency responsible for satellite missions (e.g. EUMETSAT, NOAA)

Indicative content: Raw telemetry: timings, counts. Raw radiometric instrument data, Platform telemetry, etc

How produced: Downlinked to receiving stations and consolidated

Science application: Usually none

L0->L1 Processing

Inverse geometric model: From raw telemetry (satellite position, instrument sensor array position, etc) to geolocation (Lat and Lon) of each single measurement.

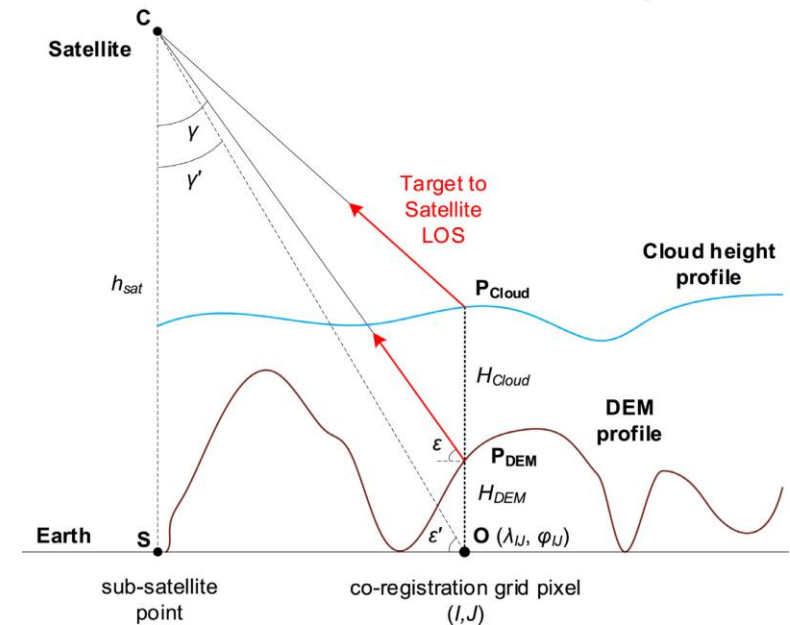
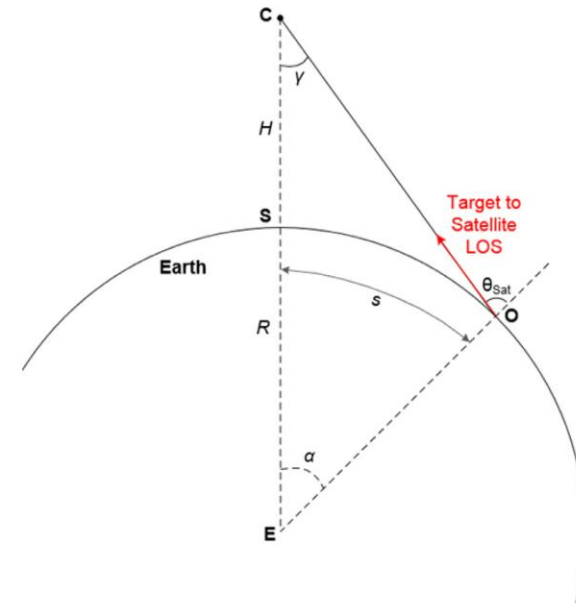
Inverse radiometric model: From raw radiometric counts to physical radiometric variable (Top Of Atmosphere Radiance/Reflectance/Brightness temperature)

Quality control/Data Flagging: Gives information on the quality of the data including cloud/sunlint contamination

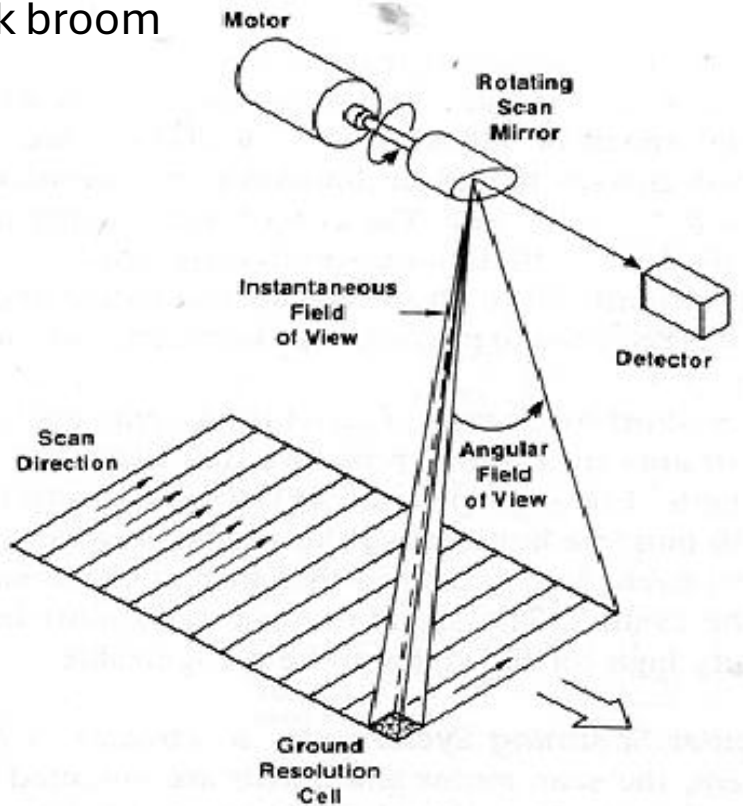
Inverse geometric model:

May include a parallax correction (e.g. for high level clouds or topography).

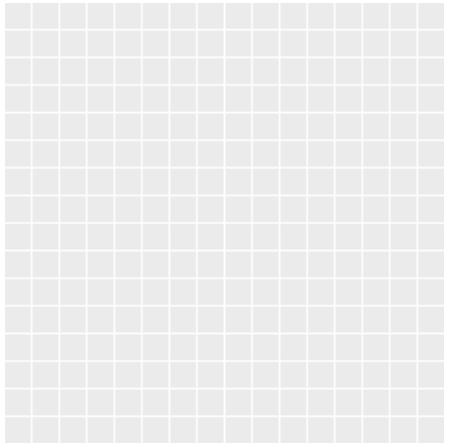
Include channel co-registration.



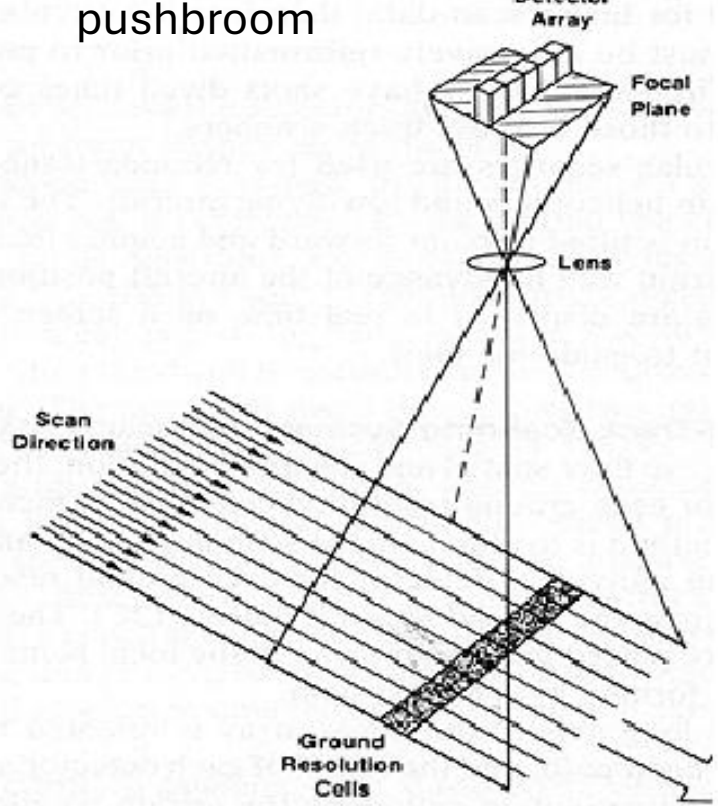
whisk broom



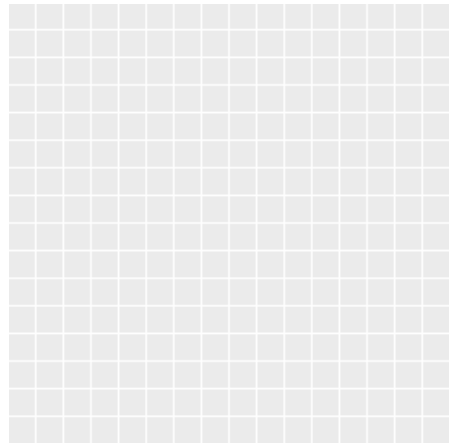
A. CROSS-TRACK SCANNER.



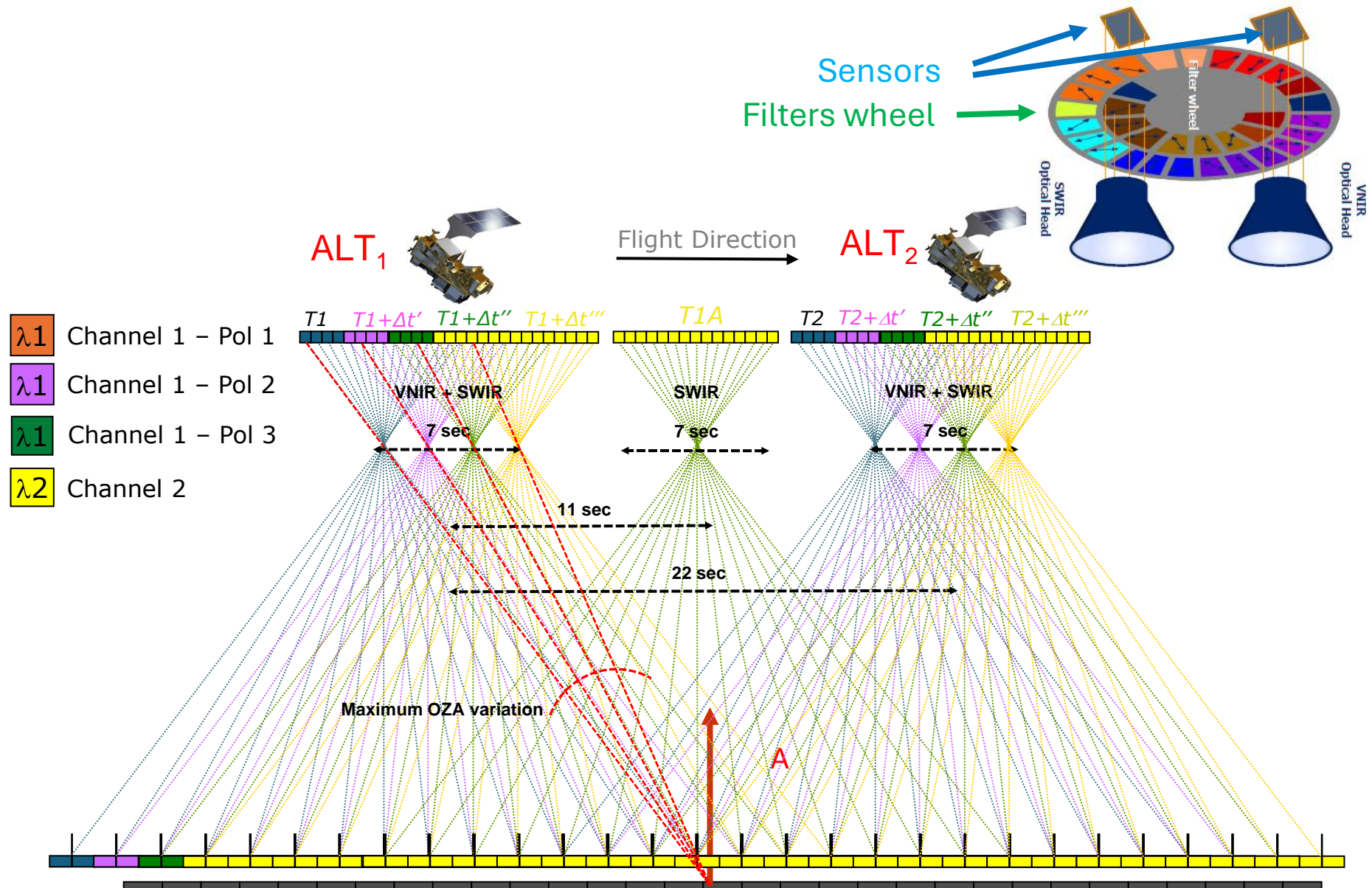
pushbroom



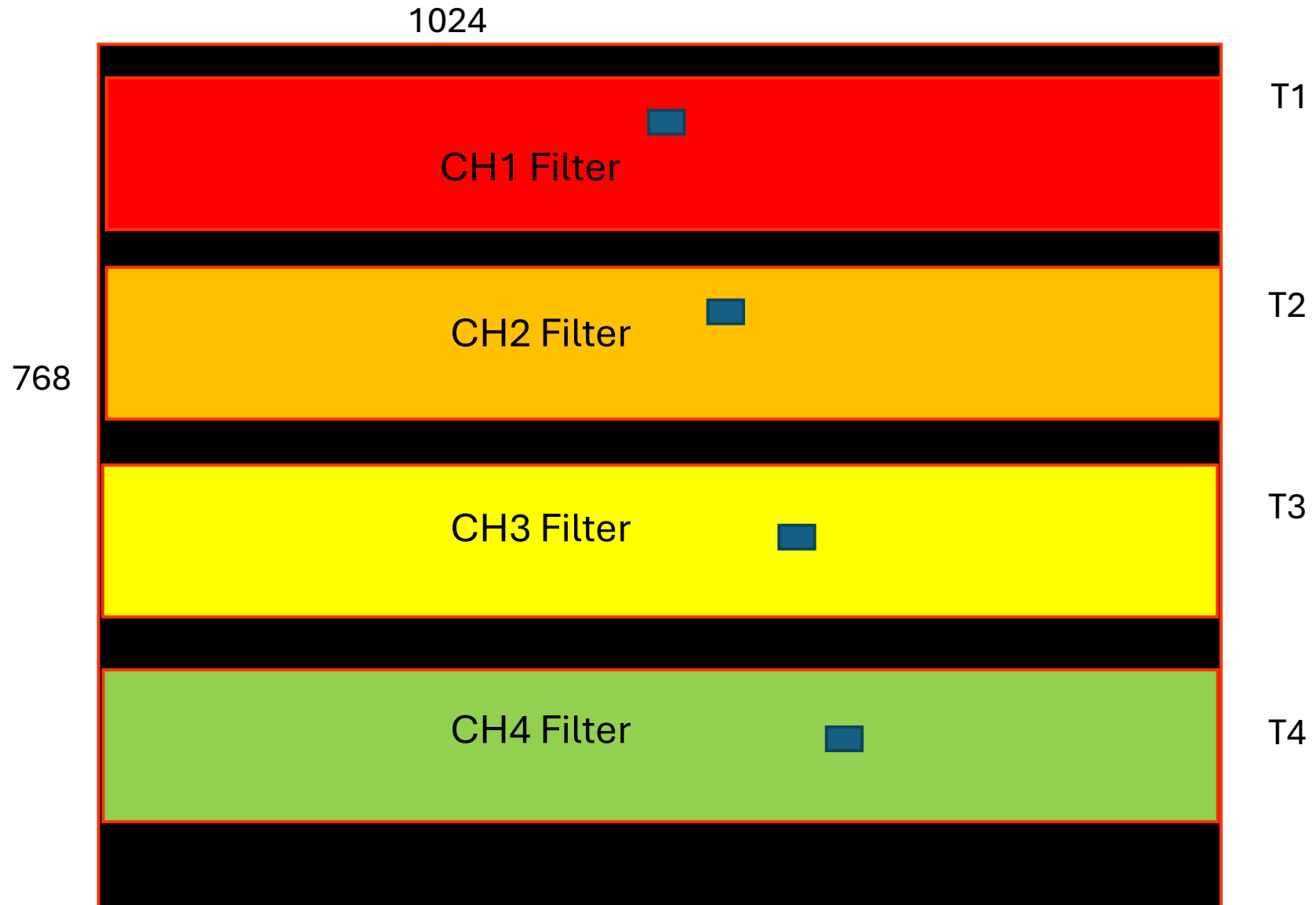
C. ALONG-TRACK SCANNER.



M V



SENSOR POSITION OF THE SAME LAT-LON AREA AT DIFFERENT ACQUISITION TIMES



Inverse Radiometric Model:

Calibration (on-board or vicarious)

Non-linearity corrections

Straylight corrections

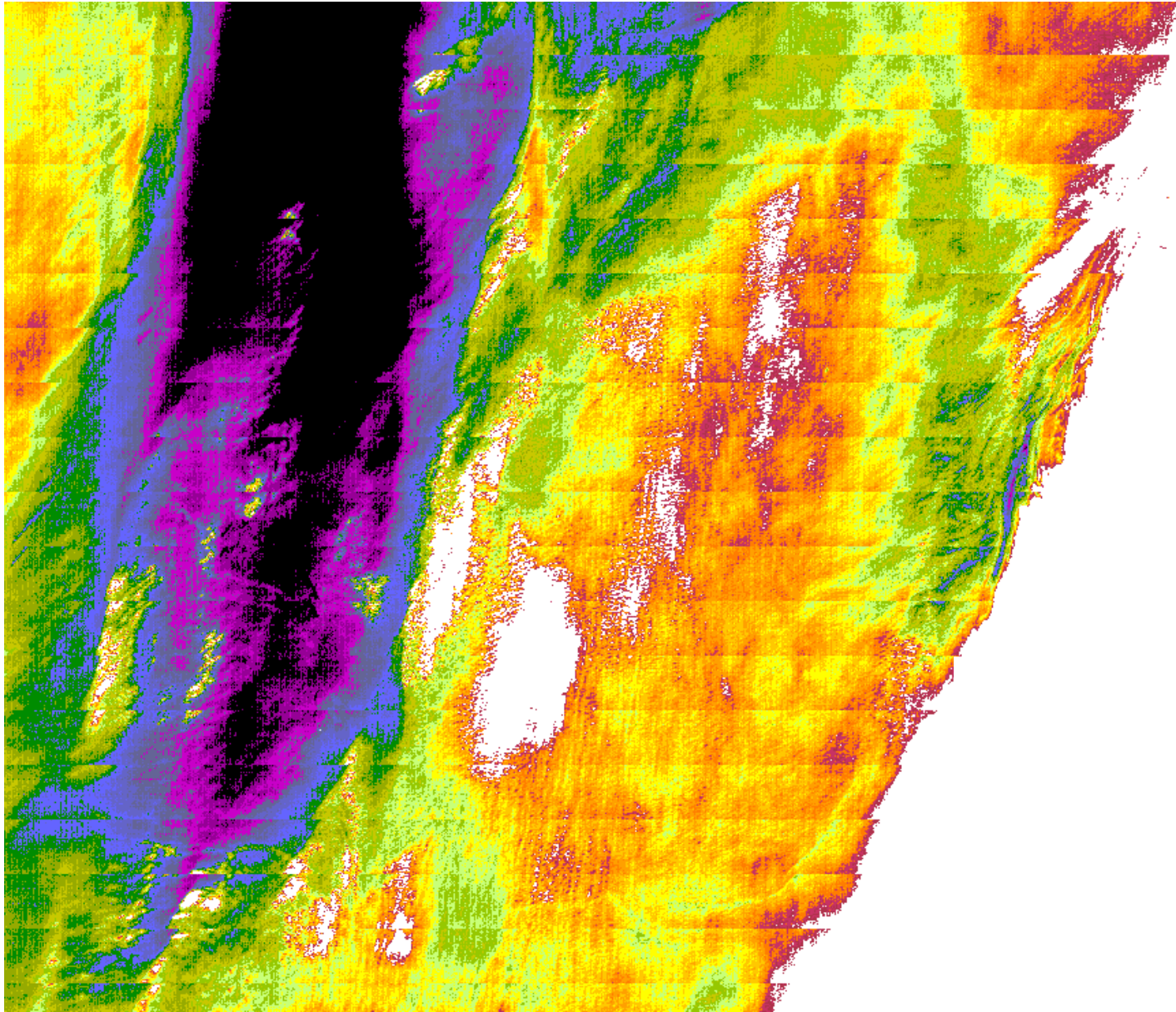
Smearing Correction

Bad pixel correction

Sensors homogenization

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Example of artefact due to different sensitivity in the pixels of the sensor array: to be corrected with the sensor homogenization



Quality control & Data Flagging:

Flagging of instrumental issues

Land/Sea/(Ice/Snow) masks

Tide flag

Cloud detection

Sun glint contamination

MSI-Sentinel 2: L0->L1 processing: geometric model

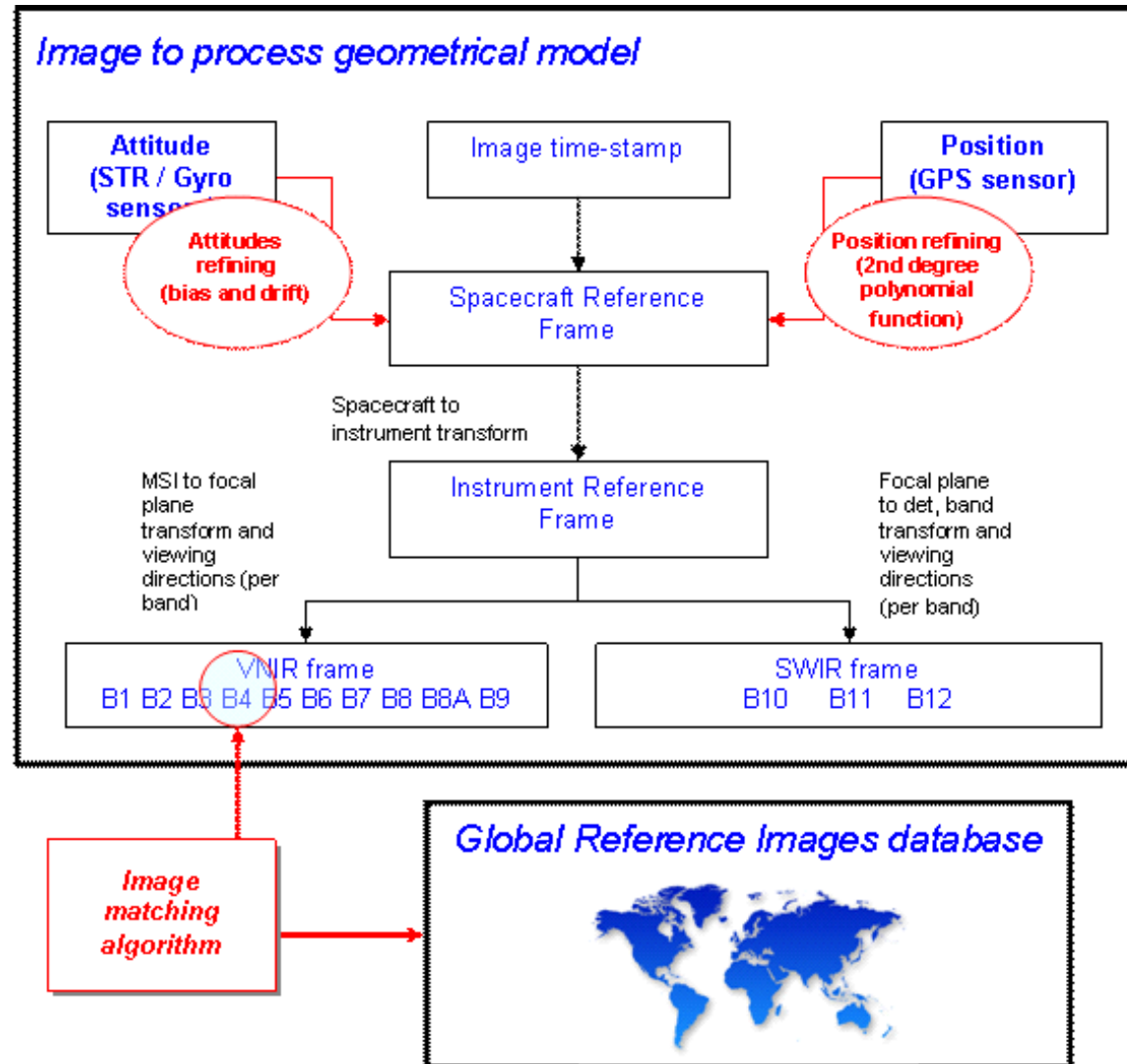
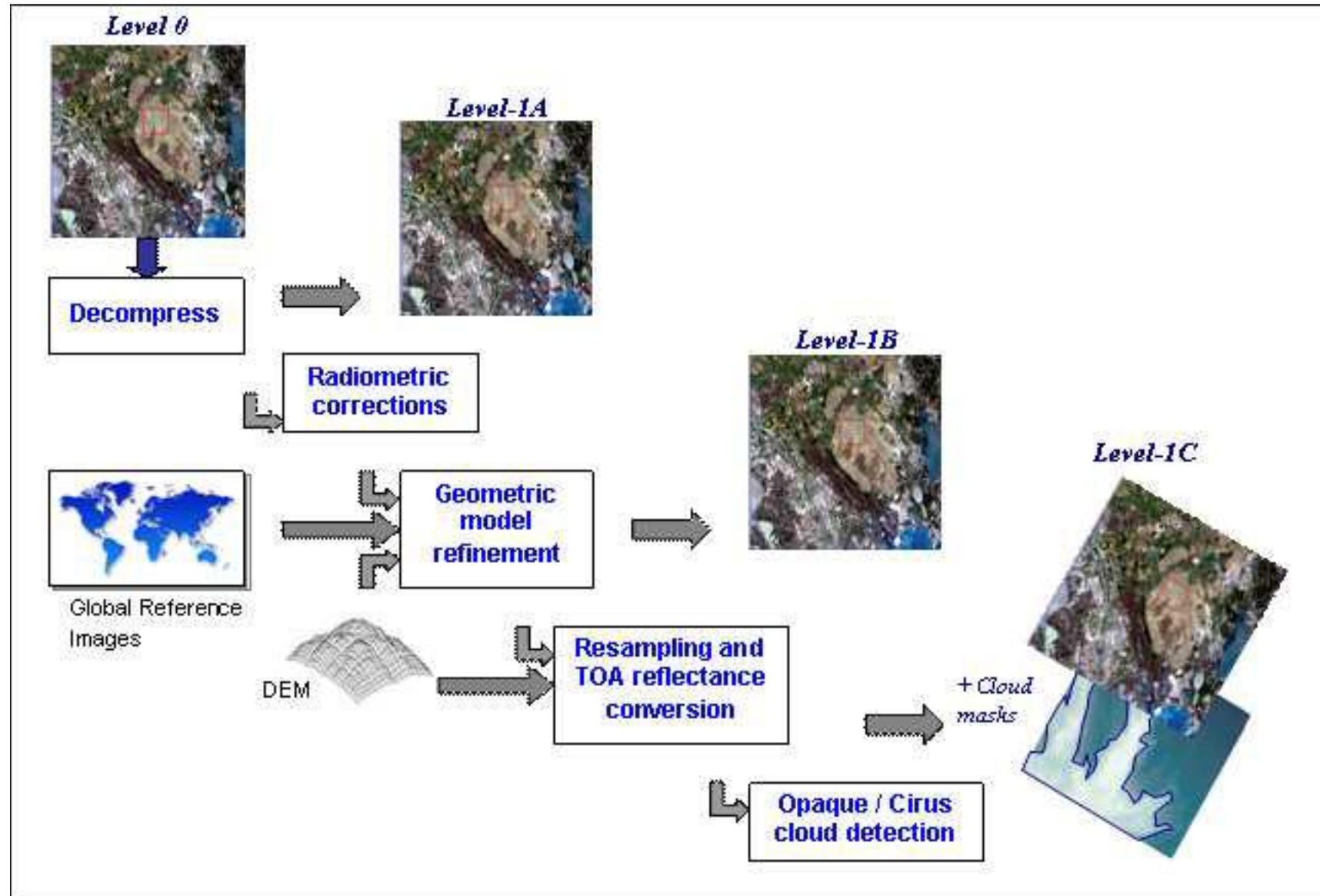




Illustration of the time-lag between detector bands B02 (blue), B03 (green) and B04 (red) by the different colors of the flying airplane at Capbreton, France. The time-lag between each band is 0.527 s.

<https://www.mdpi.com/2072-4292/11/16/1918>

MSI-Sentinel 2 L0->L1 processing



L0->L1 Processing Uncertainties

Inverse geometric model: Absolute geolocalization, channel coregistration

Inverse radiometric model: From raw radiometric counts to physical radiometric variable (Top Of Atmosphere Radiance/Reflectance/Brightness temperature)

Quality control/Data Flagging: Gives information on the quality of the data including cloud/sun glint contamination

Product level: L1

Institution(s) typically responsible: Space agency (e.g. ESA, NASA) or meteorological agency (e.g. EUMETSAT, NOAA)

Indicative content: Calibrated top of atmosphere radiances and/or reflectances and/or brightness temperature, with location (lat, lon), time, and viewing geometry. Quality control info/Flags.

How produced: Calculated from L0 using in-flight calibration results, and platform navigation

Science application: Basis for retrieval of geophysical variables

Product level: L2

Institution(s) typically responsible: Space agency (e.g. ESA, NASA) or meteorological agency (e.g. EUMETSAT, NOAA) research organisation, commercial

Indicative content: Estimates of geophysical variables on the spatio-temporal sampling pattern of the L1 radiances ('swath data'). For example: Sea/Land Surface Temperature, Surface Reflectance

How produced: Retrieved, combining radiances (may also exploit auxiliary datasets)

Science application: Full spatial resolution analyses of retrieved variable, e.g. for process study

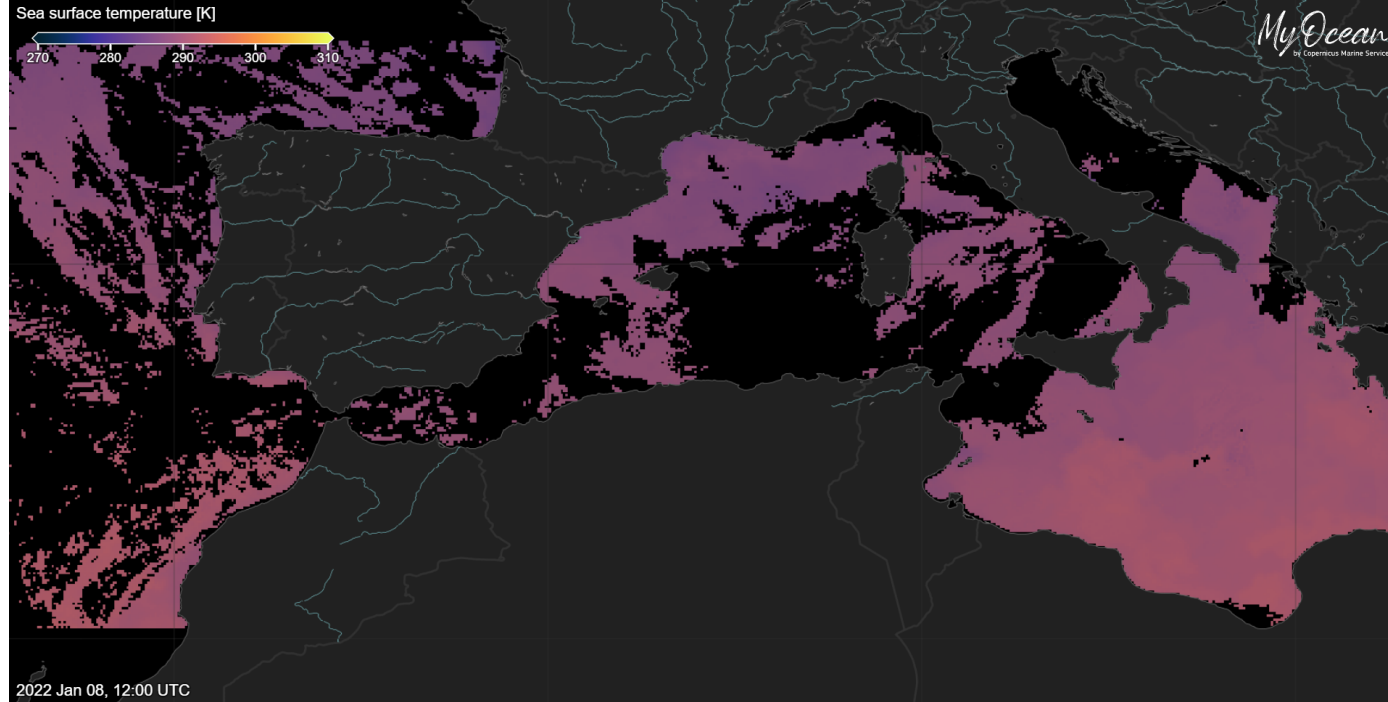
Product level: L3

Institution(s) typically responsible: Meteorological agency (e.g. EUMETSAT, NOAA) research organisation, commercial

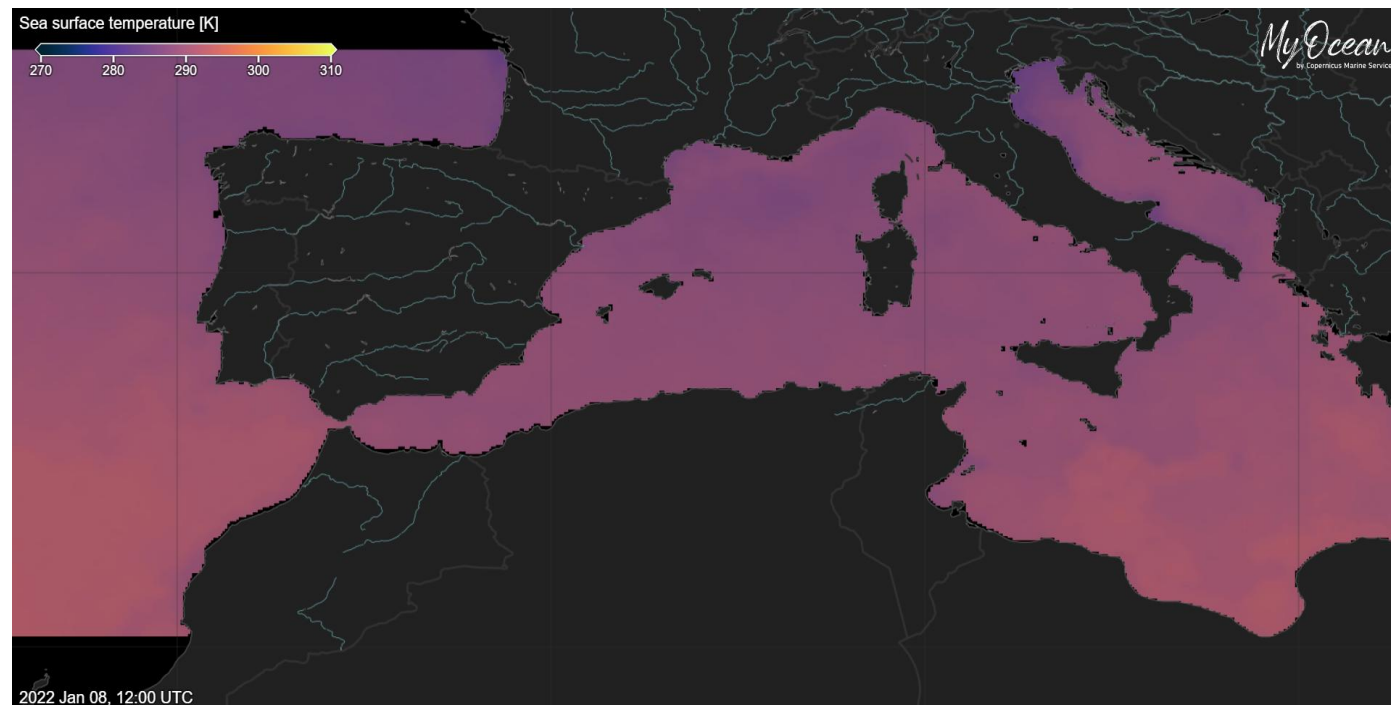
Indicative content: L2 data transformed to a fixed spatio-temporal sampling ('grid') often at reduced spatio-temporal resolution.

How produced: Aggregation in space and/or time, e.g. by averaging available L2 data within grid

Science application: Model testing, analysis of change and variability



L3->L4



Product level: L4

Institution(s) typically responsible: Meteorological agency (e.g. EUMETSAT, NOAA) research organisation.

Indicative content: Spatio-temporally complete fields on a regular grid

How produced: Gap (e.g. cloud contaminated) filling of L2 and/or L3 data by interpolation in space and/or time, perhaps combining data from more than one sensor

Science application: Model testing, prescribed field for simulations, convenient analysis of change and variability



THANKS!

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