The EO Processing Chain: Scatterometry As An Example
Simon Kok Lupemba
Junior remote sensing scientist
JuliaEO24 11/01/2024
Agenda

• Introduction to EUMETSAT.
• The EO processing chain, scatterometry as an example.
• How we use Julia in my team.
• My personal view on Julia for EO processing.
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An intergovernmental organisation with 30 member states

- Austria
- Belgium
- Bulgaria
- Croatia
- Czechia
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Italy
- Latvia
- Lithuania
- Luxembourg
- The Netherlands
- Norway
- Poland
- Portugal
- Romania
- Slovak Republic
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom
EUMETSAT mission

Primary objective:
Establish, maintain and exploit European systems of meteorological satellites.

Further objective:
Contribute to the operational monitoring of the climate and the detection of global climatic changes.
## EUMETSAT Mission Planning

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Scatterometer (SCA) – METOP Second Generation
Side looking radar
Data Processing Levels

- Used by NASA, ESA, EUMETSAT and more.
- Level 0: Raw instrument data
- Level 1: Radiometrically and geometrically calibrated geo-located data.
- Level 2: Derived geophysical variables.
Overview of processing chain

Level 0 → L1 Processor → Level 1 → L2 Processor → Level 2

Near Real Time Dissemination

Data Store and Archive
Level 0 – Instrument data

- Comes in data records.
- Contains antenna id, echo, noise measurements, internal temperatures and more.
- Only dimension is time from the internal clock.
- Everything is in unsigned integers. No units.
- Data rate.
  - ASCAT ~5 kB/s, ~20 MB/h (On board averaging)
  - SCA ~ 1.2 MB/s, ~ 4.25 GB/h (No on-board averaging)
**Level 1 – Geolocated backscatter**

**No wind**
- Sea surface is flat
- Most energy is reflected away from the sensor

**Light wind**
- Sea surface roughens
- Some energy is backscattered to sensor

**Strong wind**
- Sea surface roughness increases
- More energy is backscattered toward sensor

Credit: https://coastwatch.gitbook.io/satellite-course/lectures/ocean-surface-winds
Level 1 processing

- Geolocate using orbit state and data record timestamps (leap seconds matter).
- Use Aux files to convert echo to Radiometrically calibrated backscattering coefficients.
- Add quality flags.
- Compute resampled products.
SZR Makie demo

- \((R, G, B) = (\sigma_{for}, \sigma_{mid}, \sigma_{aft})\)
- Scaled from -36 dB to -10 dB
\[ \sigma_0 = gmf(V, \phi_{rel}, \theta) \]
Level 2 – Processing Wind

• Done by OSI-SAF.
• Estimate wind speed and direction based on level 1 backscatter.
• Only over ocean.
• Ambiguities corrections.
• Distance to model function.
• Quality flag.
Winds Makie demo
Soil moisture Makie demo
Beyond level 2

- Not my area of expertise.
- Fusion products.
- Interpolations.
- More complex products.
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What is Julia used for at EUMETSAT

- Julia is a niche at EUMETSAT
- Visualisation
- Monitoring of science data
- Tools for calibration
- Regression testing
- Prototyping

- Julia is not used in the operational processing chain
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My personal view on Julia for EO processing.

- Opportunities
  - High performance scientific computing.
  - Composability via package could improve reusability.
  - More open source.
  - Flexible data types.
  - Potential in the whole chain. From L0 processing to large weather models.

- Challenges
  - EUMETSATS is not a first mover (Long operational programs).
  - Awareness.
  - Industry uptake.
  - Maturity.
  - Open source vs proprietary information.
My personal view on Julia for EO processing.

• The road forward.
  • I hope to publish AscatData.jl.
  • Contribute to open source packages relevant for EUMETSAT.
  • Prove the value of Julia through non-operational tools.
  • Keep an eye out for first movers.
  • Advocate for Julia at EUMETSAT.
Engage

- Use the data. [https://data.eumetsat.int/](https://data.eumetsat.int/)
- EUMETSAT Meteorological Satellite Conference 2024
- I hope to see Julia users at the conference.
- Early Career Scientists Initiative (Under 32 and under 2 years work experience)
Thank you!
Questions are welcome.