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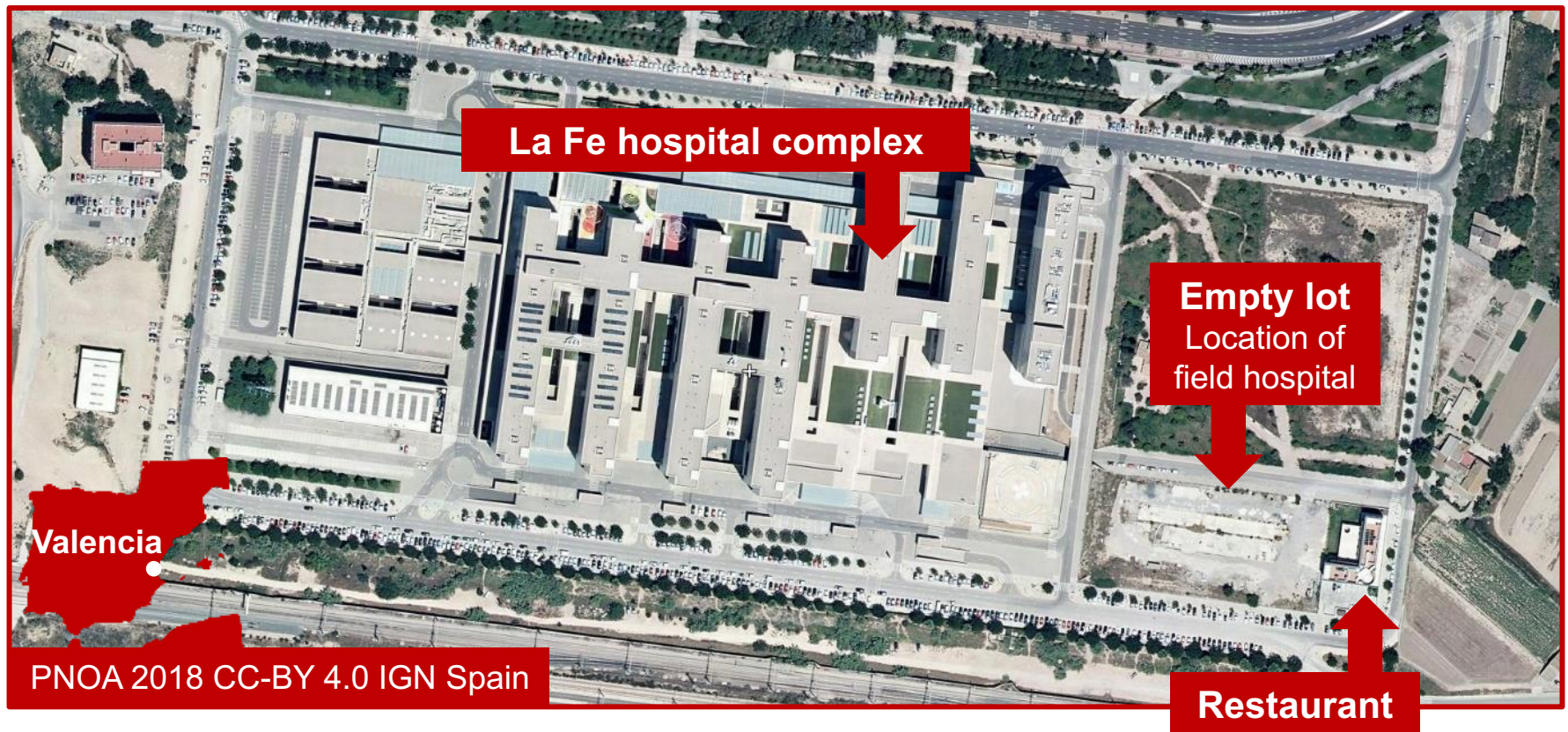
SAR for activity monitoring during COVID-19

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SAR for activity monitoring during COVID-19

- Example of COVID-related activity: **field hospital deployment**
 - Field hospital next to La Fe hospital complex in Valencia, Spain
 - Pre-event situation (hi-res photogrammetric flight):



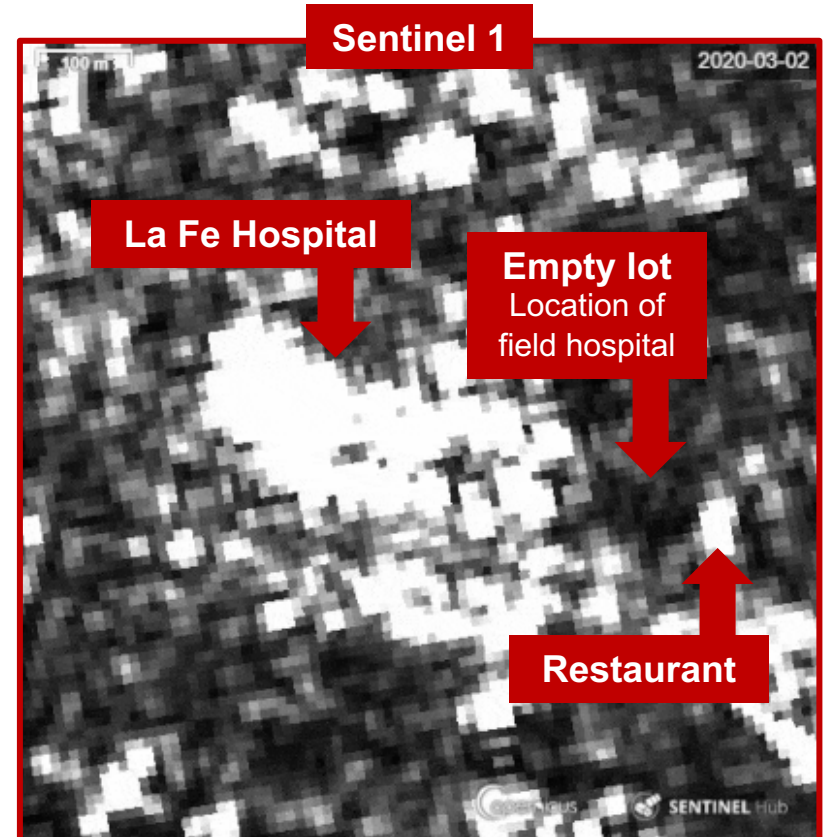
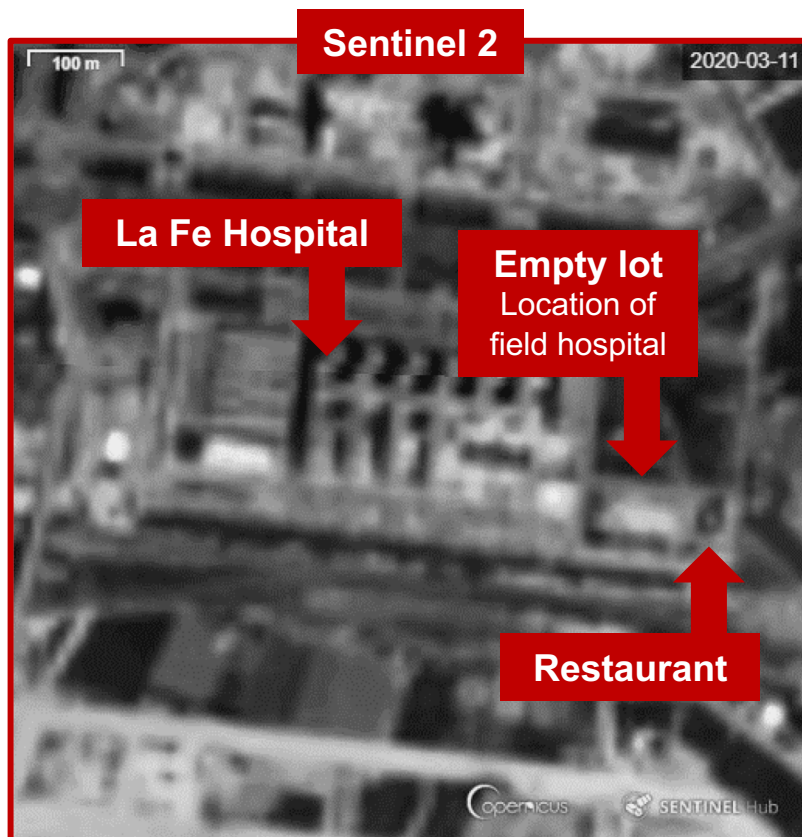
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- Time-sensitive situation: construction announced **March 19**
- Issue: optical imagery often obscured by clouds
 - **Sentinel-2**: several acquisitions with high cloud cover:



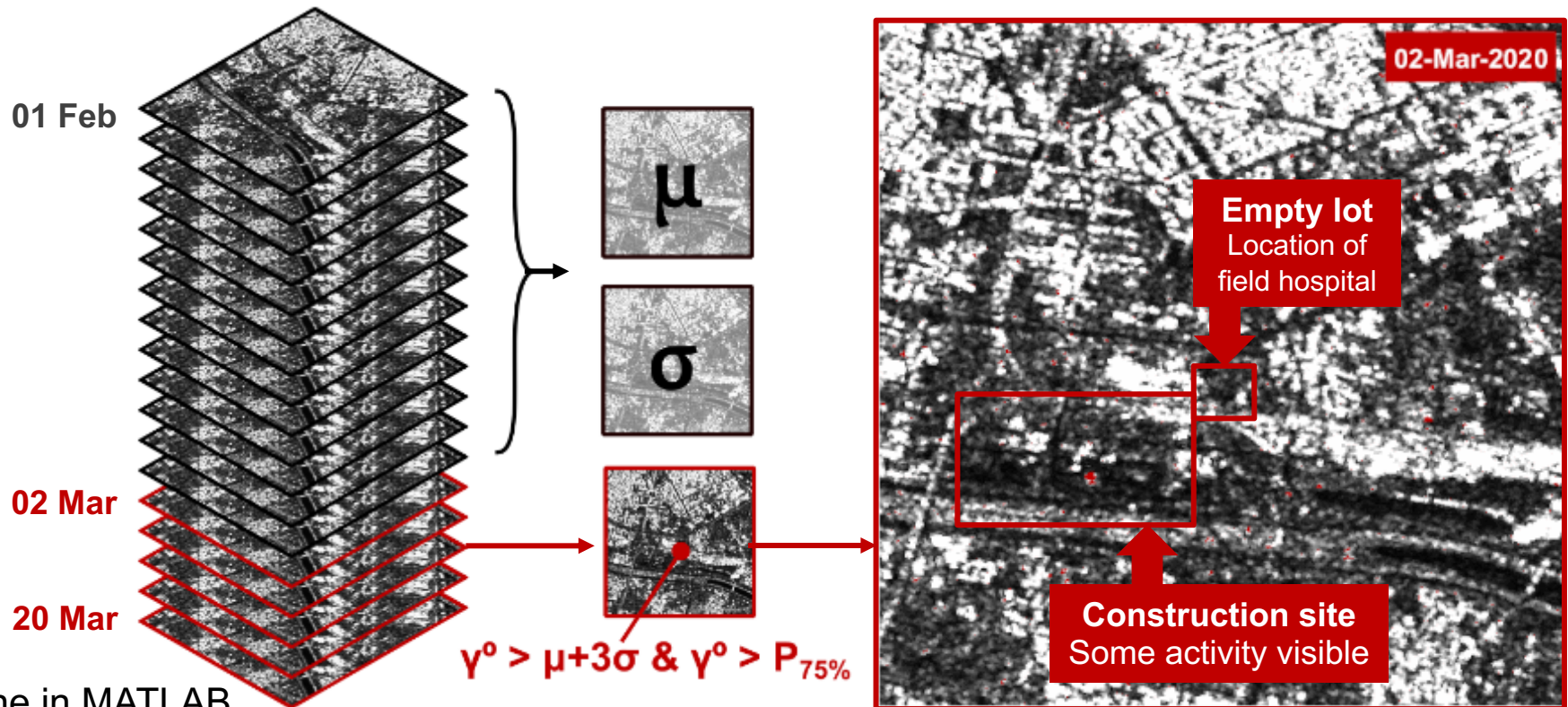
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- **SAR imagery:** Sentinel-1 orthorectified γ^0 (VV polarization)
 - Advantage: no cloud obscuring or day-to-day lighting variations
 - Smooth surface of empty lot enhances contrast vs buildings



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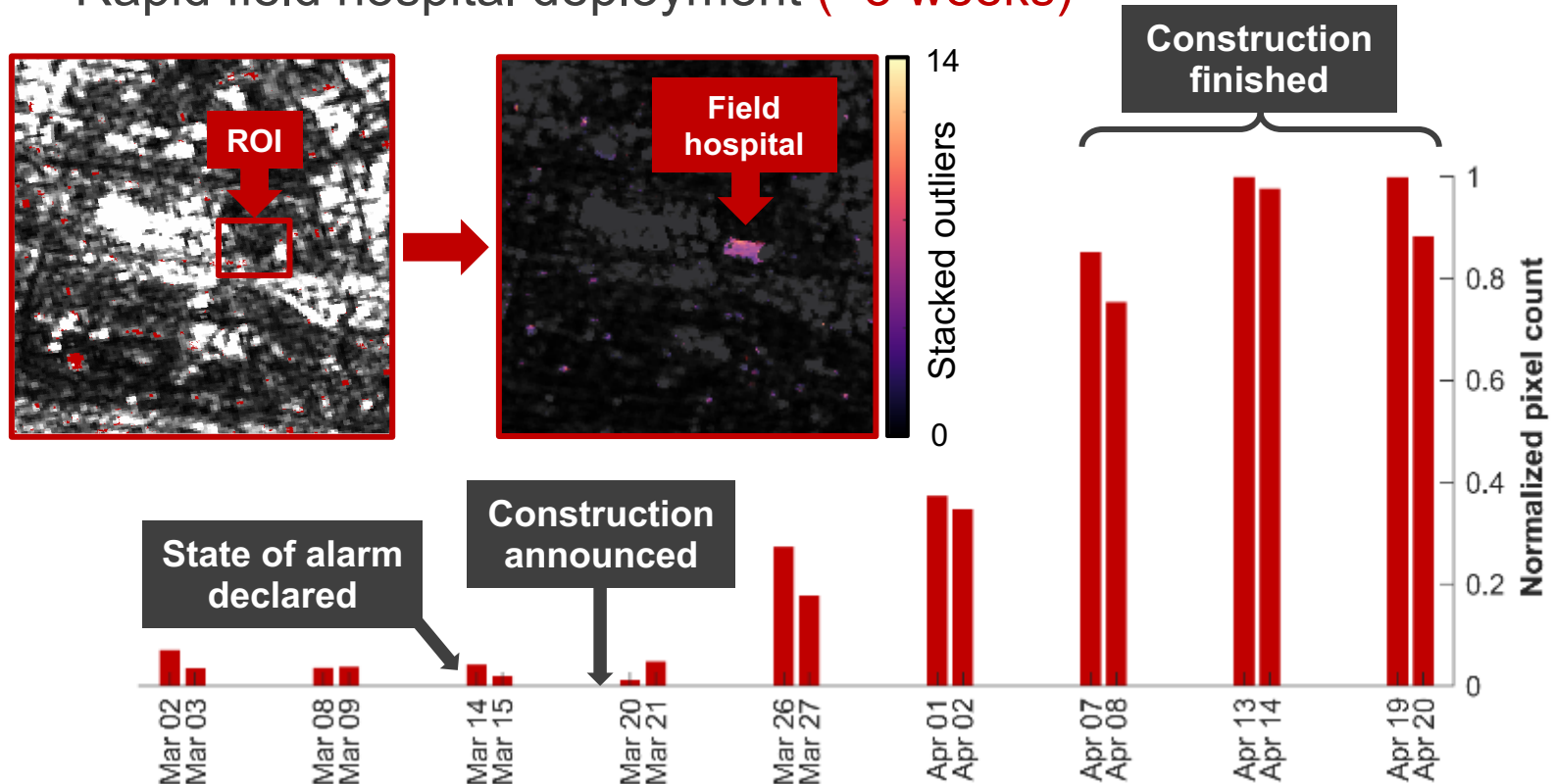
- Quantification: simple statistical analysis
 1. Compute¹ pre-event baseline of mean and standard deviation of γ^0
 2. Identify outlier pixels ($\gamma_i^0 > \mu_i + 3\sigma_i$) for each acquisition of interest
 3. Restrict to top-75% brighter outliers ($\gamma_i^0 > P_{75\%}$) of each frame:



¹ Done in MATLAB

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- Quantification: simple statistical analysis
 - Sum of outliers within a ROI allows tracking of construction progress
 - Stacking outliers highlights consistent, permanent structures
 - Rapid field hospital deployment (**~3 weeks**)



Agriculture

Agriculture

SAR for activity monitoring during COVID-19

- Quantification: simple statistical analysis
 - Economic activities are also tracked: ports, construction, agriculture...
 - Changes since the baseline period are highlighted
 - May allow i.e. rapid discovery of non-essential activity, etc.

Agriculture

Field hospital

Ships docking

Construction

Construction

Vehicle exports

Container movement

Modified Copernicus Sentinel data 2020

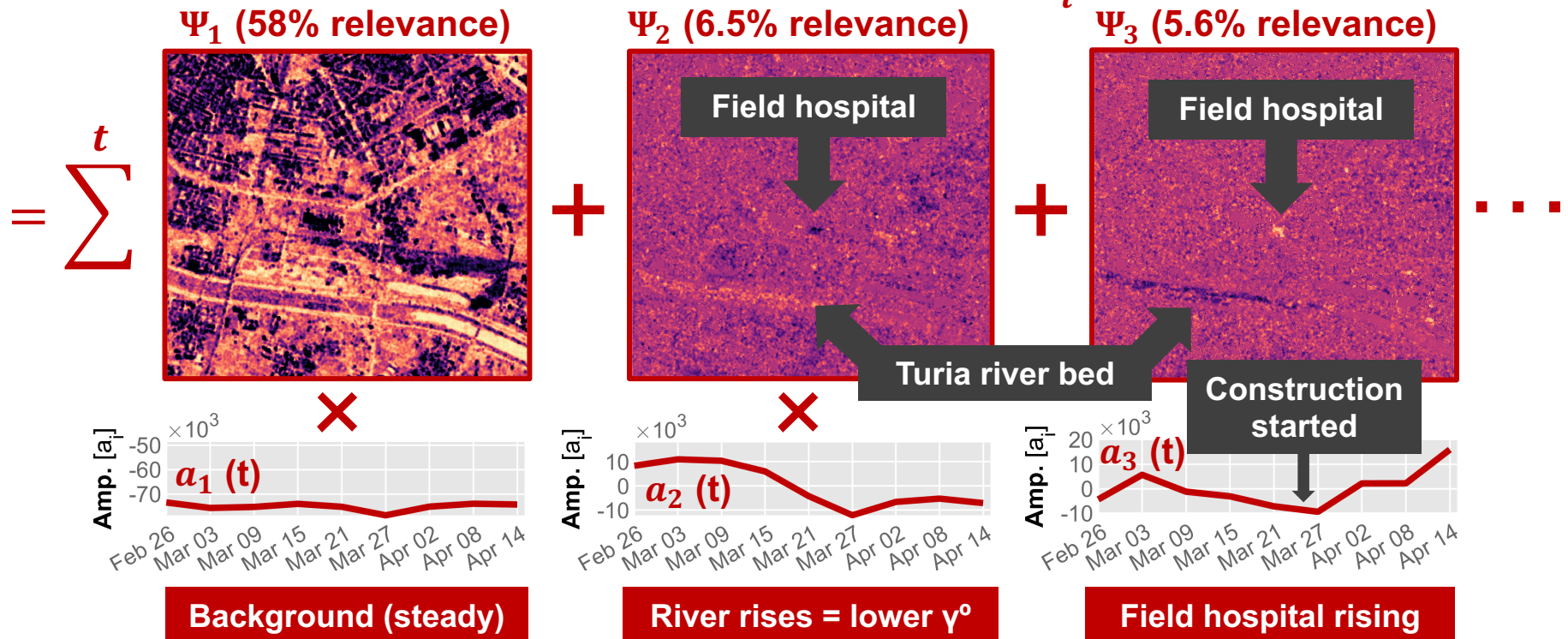


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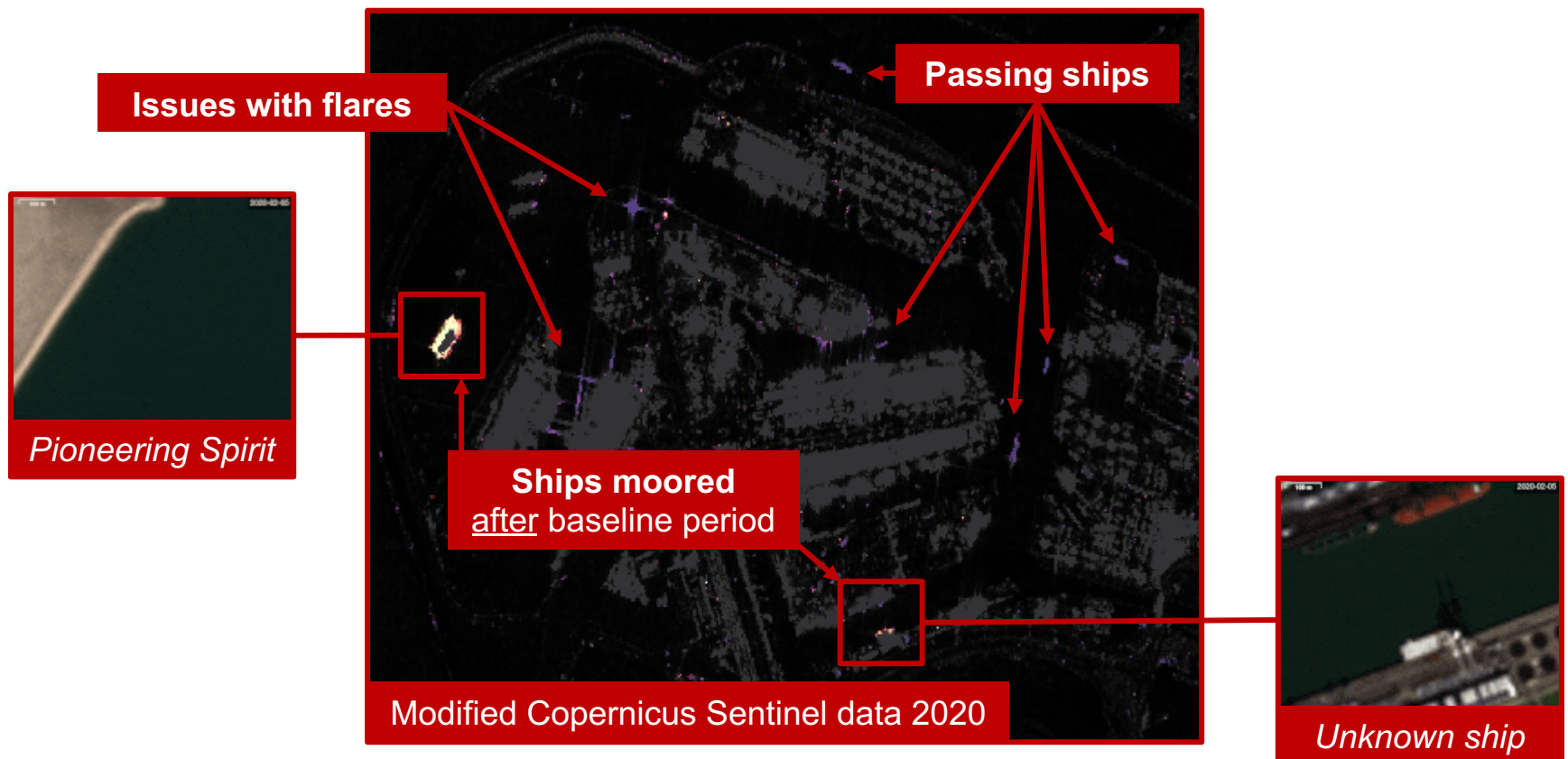
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- Quantification: data-driven modal decomposition methods
 - Example: **Proper Orthogonal Decomposition** (POD, also called PCA)
 - A process V is decomposed into spatial modes Ψ_i & time evolutions a_i
 - Here V is the time-evolution of $\gamma^0(x, y, t) = \sum_i \Psi_i(x, y) \cdot a_i(t) =$



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- Application of the simple statistical analysis in other region:
 - Economic activities during COVID-19: **ship movements in Rotterdam**
 - Shows **passing** (fewer stacked outliers) and **newly-moored** ships (higher)



SAR for activity monitoring during COVID-19

- **Methods:** MATLAB + Copernicus data through Sentinel Hub
- **Conclusions:**
 - Pandemic response monitoring is a very time-sensitive application
 - Optical imagery may present critical time gaps due to cloud cover
 - **SAR** helps track & quantify relevant emergency & economic activity...
 - ...through **simple statistical analysis**
 - **Pros:** extremely simple per-pixel algorithm, implementable in EO Browser, non-technical staff (or even concerned citizens) can monitor activity
 - **Cons:** does not consider neighboring pixels, issues with flares, requires tuning
 - ...through **data-driven modal decomposition methods**
 - **Pros:** hands-free, able to identify coherent spatial evolutions (not just pixels)
 - **Cons:** not implementable in EO Browser, modes can be difficult to interpret
- **Possible follow-up works:**
 - Implementation of simple statistical analysis as EO Browser evalscript
 - Use of higher resolution SAR imagery (TerraSAR-X, TDX, PAZ, etc.)

