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NWC SAF Convection Initiation product: recent improvements as a preparation to MTG

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CI at a glance

Probability for a pixel to become a thunderstorm

First version: v2016 (DEMONSTRATIONAL STATUS)

- Adaptation of **SATCAST methodology** (*Best Practice Document, 2013, for EUMETSAT Convection Working Group, Eds J.Mecikalski, K. Bedka and M. König*)
- **Visiting Scientist Activity** (*Karagiannidis, A., 2016, Final Report on Visiting Scientist Activity for the validation and improvement of the Convection Initiation (CI) product of NWC SAF v2016 and v2018, Visiting Scientist Activity followed in Nowcasting Department of Météo France, Toulouse, France Period June-December 2016)*

Then v2018 (PRE-OPERATIONAL status) and now v2018.1

Input:

- Satellite data (multiple channels), Numerical Weather Prediction data, other NWC SAF products: Cloud Products (CT, CMIC), HRW

Output:

- NetCDF pixel-based product, with 4 classes of probability (very low, low, medium, high) and 3 forecast periods (30, 60 and 90 minutes)

V2018 improvements:

- Use of CMIC and Cloud Type for the identification of areas of interest
- New tuning. Daytime and nighttime input data (and thus tuning) different
- Tracking improvement, forecast horizon extension, parallelization capabilities
- Validation improvement with quantitative approach (Associate Scientist work by TROPOS from Leibnitz institute)

2020 ESSL* testbed: feedback on NWC SAF CI (1)

**** European Severe Storm Laboratory***

4 sessions organized between June and July 2020

37 participants from 15 countries

Testbed Data Interface to evaluate meteorological data, including convection products (RDT-CW and CI) from NWC SAF v2018.1 software version operated with MSG rapid-scan mode data

Feedback collected from:

- direct discussion during Testbed
- answers to the survey, sent to MF by ESSL

Product usefulness rated on a scale from 1 to 5: **2.6** for **CI** (**4** for **RDT-CW)**

2020 ESSL* testbed: feedback on NWC SAF CI (1)

**** European Severe Storm Laboratory***

Many false alarms detected

- *CI produced with MSG Rapid-Scan Service data displays more false alarms than CI from MSG Primary Service data*

Day / night variability

Non detections when thin Cirrus layer is present

Unbalance in CI output between the 4 different levels of probability

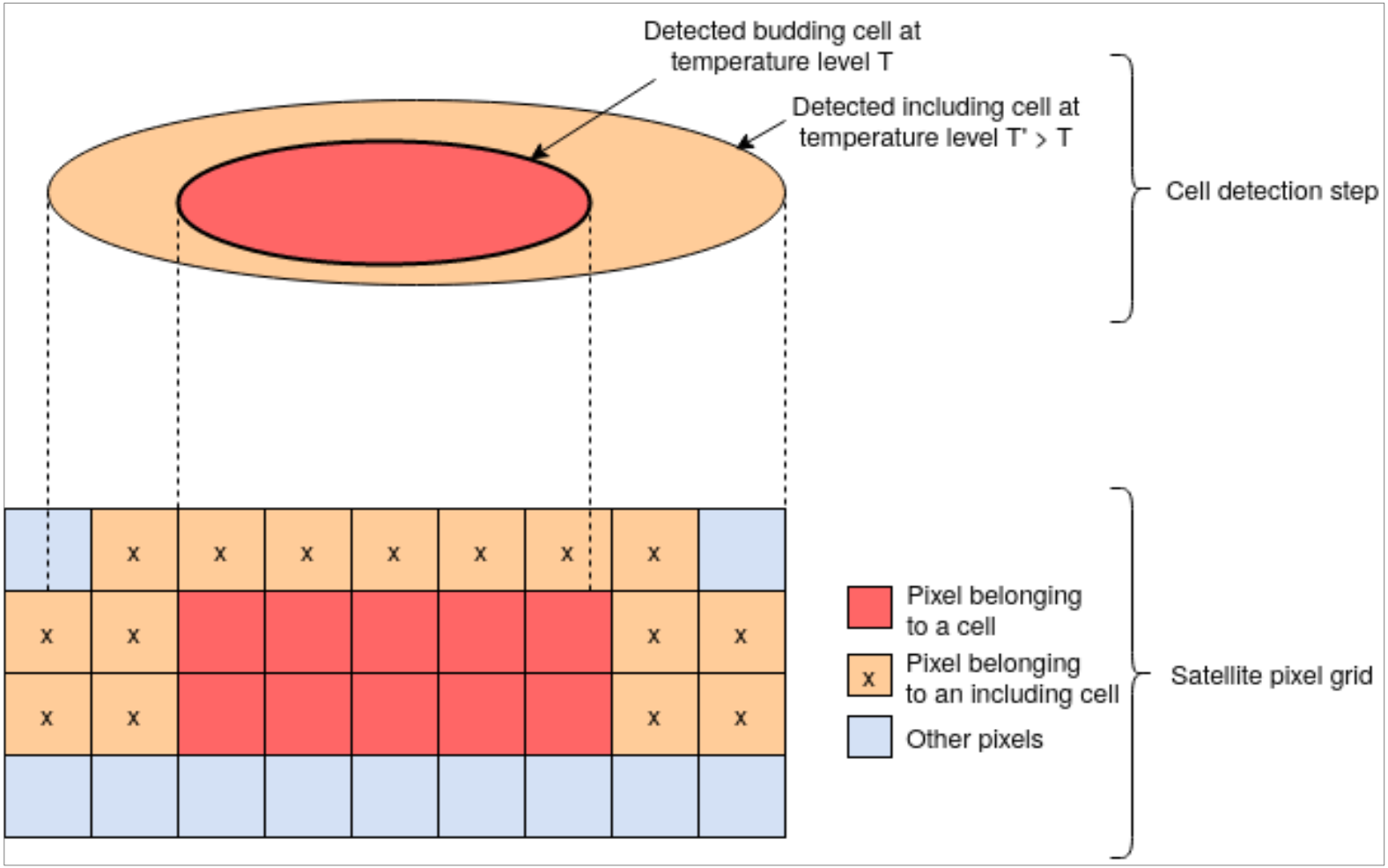
1. Pixel filtering improvement

Additional pixel filtering after cell detection step (1)

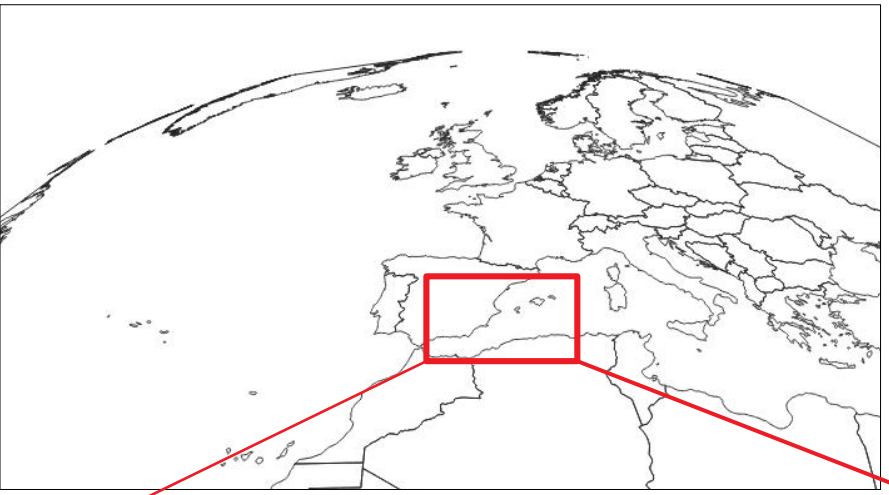
Observation: numerous false alarms at the edge of cold mature convective systems

Adaptation:

- Better description of convective cloud cells in the cell detection step by inclusion of cold levels
- Pixels belonging exclusively to the including cell are removed from further analysis (orange pixels in the diagram below), warmer pixels are kept.



Additional pixel filtering after cell detection step (2)

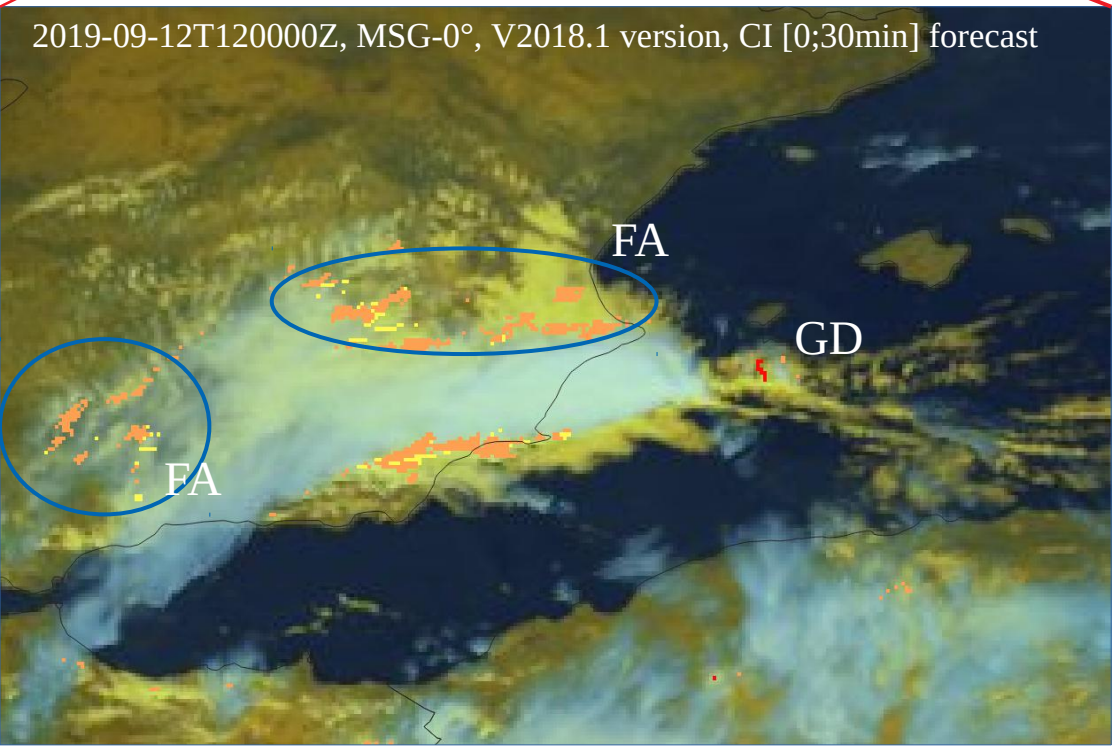


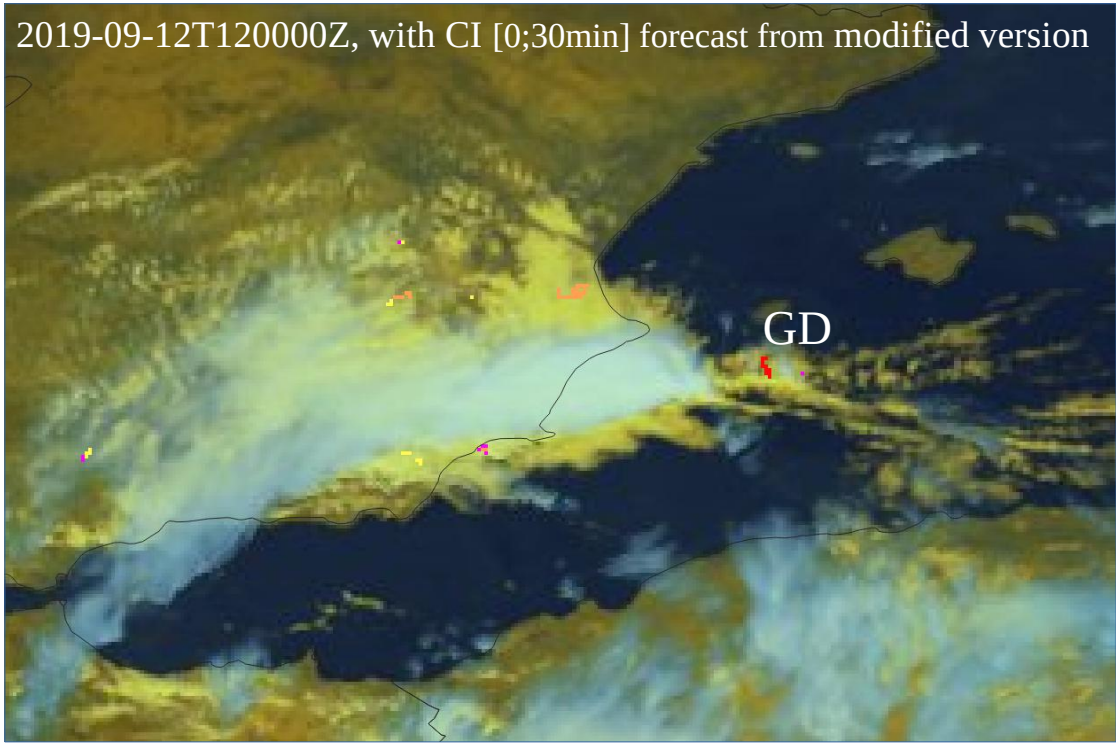
No CI
[0%,25%] CI probability
[25%,50%] CI probability
[50%,75%] CI probability
[75%,100%] CI probability

Heavy precipitation event over south-eastern part of Spain

In v2018.1 version, numerous FA (false alarms) in the vicinity of the main convective system

Good detection (GD) occurrences in the convergence area over Mediterranean sea with both version





2. Trends computation

Trends in CI diagnosis

Parameter trends used in CI diagnosis are included in the ‘Growth’ category

- IR10.8 BT* trend
- (WV6.2-IR10.8) BTD** trend

* Brightness Temperature

** Brightness Temperature Difference

The ‘Growth’ category is the most important one in CI decision tree

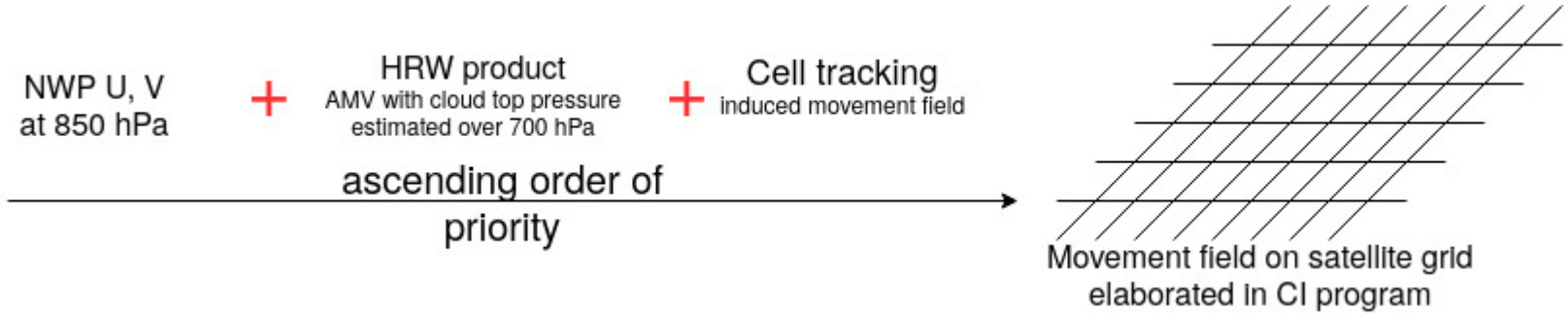
Number of Growth Relevant parameters (over 4)	***Nb of Glaciation Relevant parameters (over 3)***	***Nb of Height Relevant parameters (over 4)***	***CI DIAGNOSIS***
≥ 3	≥ 3	≥ 4	HIGH PROB
		≥ 3	MOD PROB
	≥ 2	≥ 4	LOW PROB
≥ 2	≥ 3	≥ 4	MOD PROB
		≥ 3	LOW PROB
	≥ 2	≥ 4	VERY LOW PROB
>=1	≥ 3	≥ 4	VERY LOW PROB
Other cases			NO PROB

Trends computation in CI product: principle

Different trends are computed:

- Pixel trends and cell trends
- Short-time trends and long-time trends

For pixel trend computation, pixel position at previous slot is retrieved from the movement field elaborated in CI program through retro-advection process.



Trends computation in CI product: main improvement

The improvement relies on (see diagram):

- going beyond the current pixel trend computation based on the previous slot whatever the satellite scan frequency
- selecting the adequate slots, according to satellite scan frequency, to compute short-time (15-min) and long-time (30-min) trends

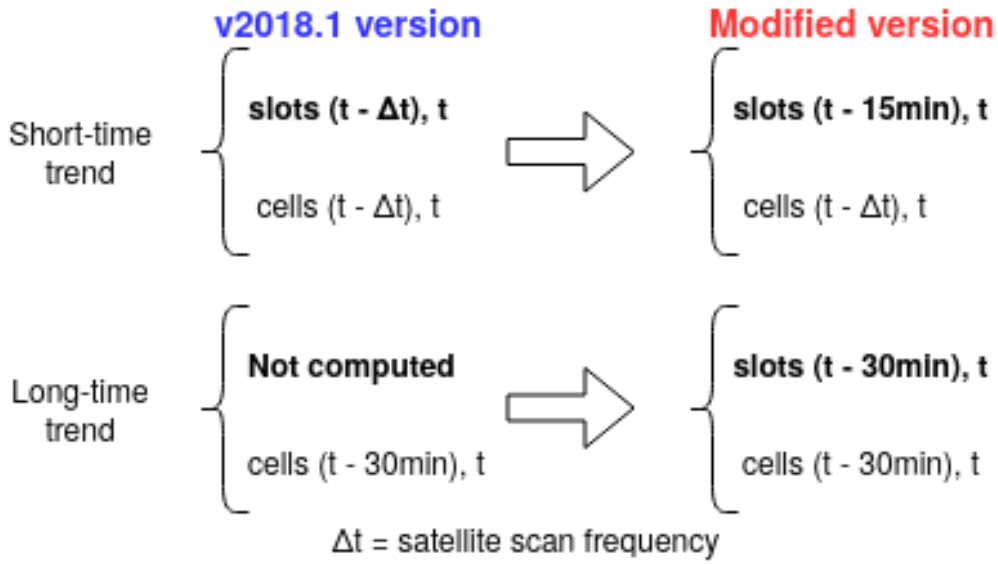


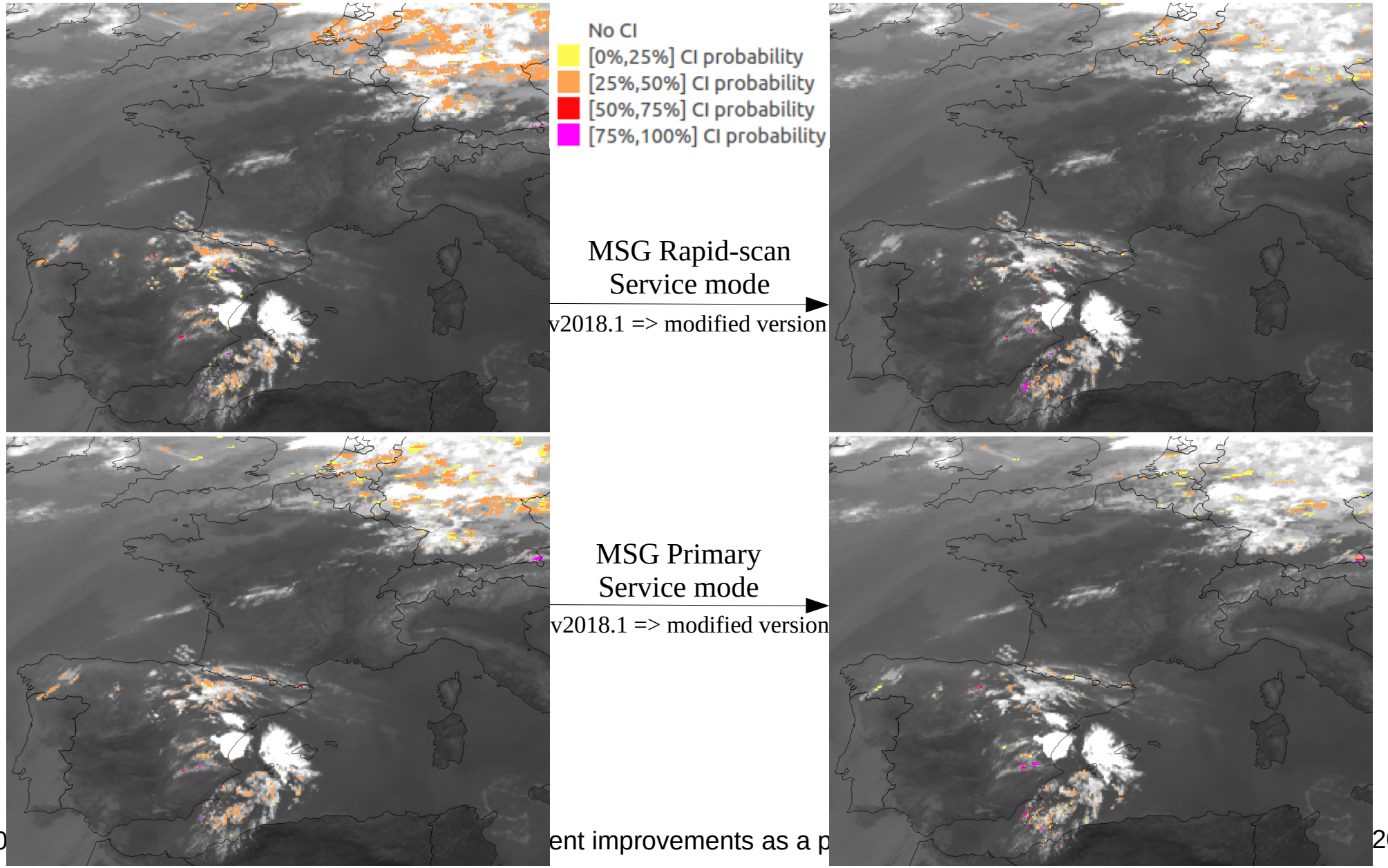
Table below sums up the modification in the trend computation for each satellite mission

Satellite mission	Scan frequency	Short-time trend	Long-time trend
MSG-0° / MSG-IODC	15 min	15 => 15 min	30* => 30 min
MSG-RSS	5 min	5 => 15 min	10* => 30 min
GOES16 / GOES17 / HIMAWARI08 / *MTG-I1*	10 min	10 => 10 min	20* => 30 min
HIMAWARI08	20 min	20 => 20 min	40* => 40 min

** trends computed only for pixels belonging to a cell*

False alarms reduction thanks to improvement in trends computation

Case Study from ESSL testbed: 2020-07-09T064500Z. IR 10.8µm combined with CI forecast for next 30 minutes.
It highlights false alarms (more with rapid-scan mode) and the unbalance between CI levels of probability

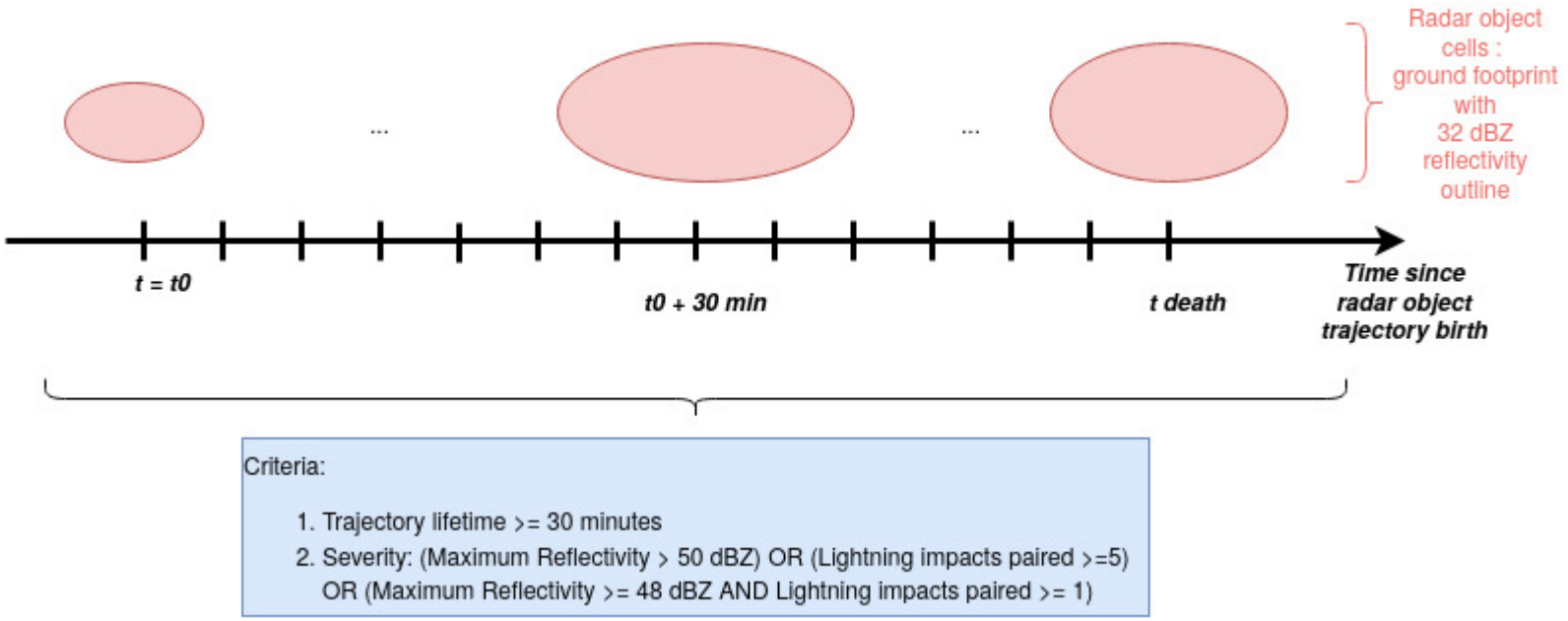


3. NWC SAF CI quantitative validation

NWC SAF CI: Validation framework

Ground Truth definition

- Derived from Météo-France radar-based objects delineating convective cells (outline: 32 dBZ reflectivity) and including cell tracking (identification of trajectory of cells).
- Definition of radar-derived convective initiation: footprint of the first cell belonging to a trajectory. The entire trajectory has to meet requirements in terms of severity and lifetime.



NWC SAF CI: Validation framework

Methodology and scores

- NWC SAF CI product and ground truth considered as binary events

- Neighborhood-based contingency tables including errors compensation
  Stein and Stoop, 2018
  - To offset double penalties

- Fraction Skill Score (FSS)

  Roberts and Lean, 2008
  - Originally used for quantitative precipitation forecasts
  - High-resolution numerical weather prediction models
  - Spatial behaviour

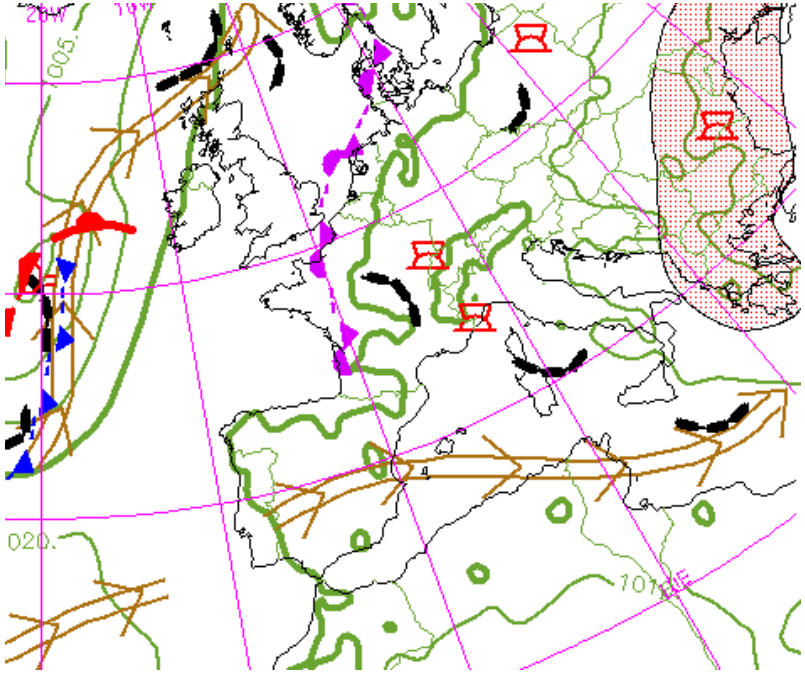
- Bootstrap technique
  - score significancy

NWC SAF CI: Validation framework on a specific case study (1)

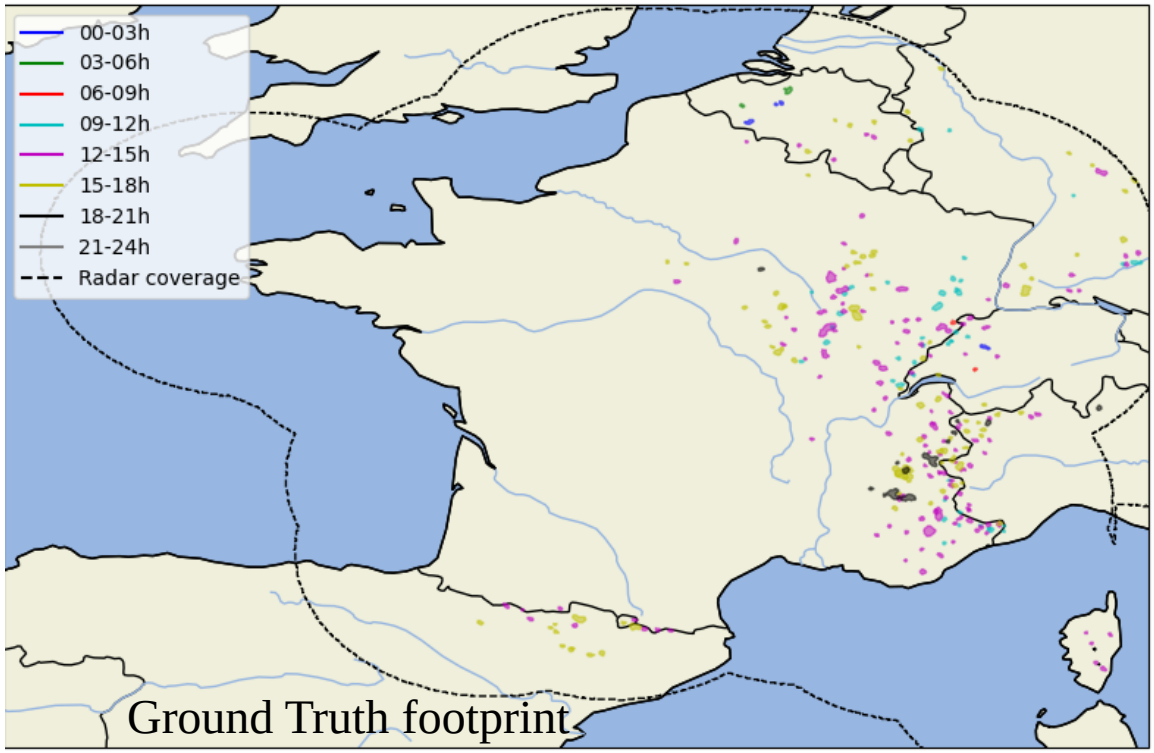
July 25th, 2018 Case study specificity: triggering of diurnal convection over eastern part of France. Mainly over mountains, then at the end of the day, moving over plains

To validate NWC SAF CI:

- focus on steps between 0800Z and 1545Z
- ground truth and CI as binary events



2018-07-25T120000Z Anasyg

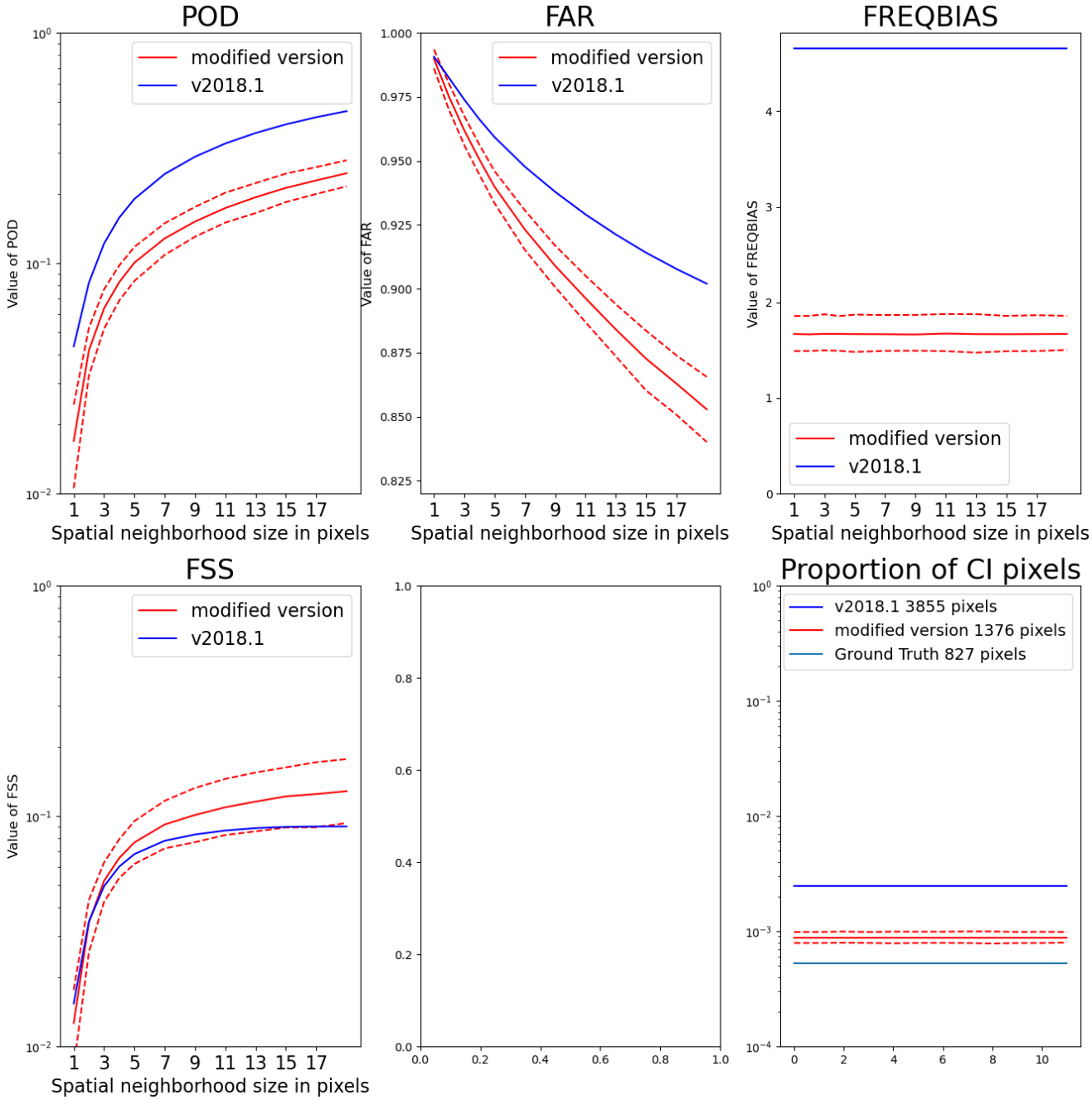


Ground Truth footprint

NWC SAF CI: Validation framework on a specific case study (2)

Results when CI operated with **MSG Primary Service (MSG4)**:

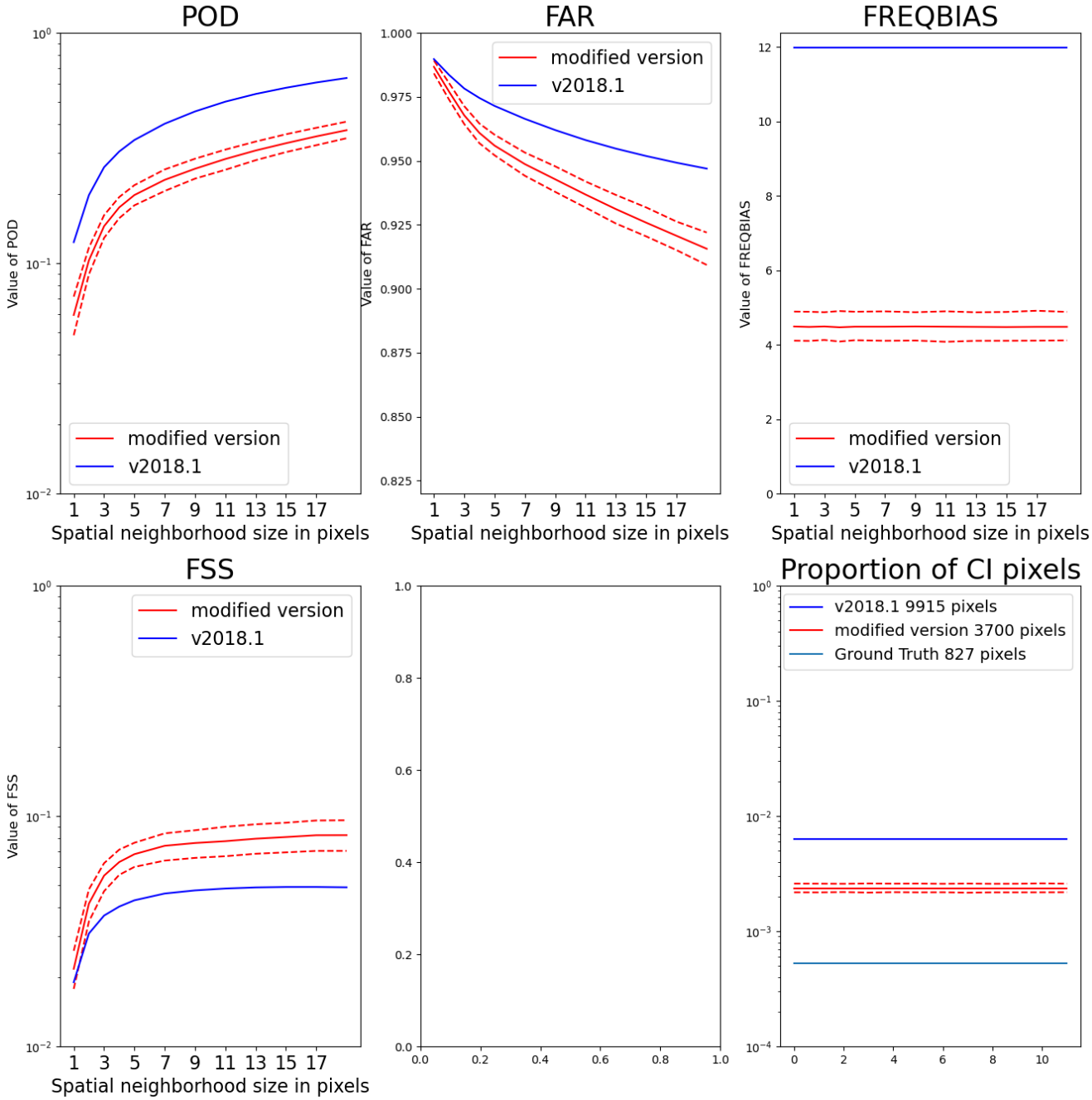
- CI is a rare event
- Low POD, high FAR
- Frequential bias quite good, particularly with modified version
- POD: modified version < v2018.1 version
- FAR: modified version < v2018.1 version
- FSS: no significant change between the two versions



NWC SAF CI: Validation framework on a specific case study (3)

Results when CI operated with **MSG Rapid-Scan Service (MSG2) compared to MSG4**:

- Higher frequential bias
- Better POD
- Higher FAR
- FSS: asymptotic curve reached for smaller neighborhood sizes.
- FSS: significant change between the two versions



4. Conclusion and perspective

From ESSL Feedback on NWC SAF CI to the perspective of development as a preparation to MTG

Feedback from ESSL

- **Too many false alarms**

  MSG RSS > MSG PS

- Day / night variability

- Non detections when thin Cirrus layer is present

- Unbalance in CI output between the 4 different levels of probability

Development already coded, tested, validated and ready to be implemented

- False alarms reduction:
  - Trends computation
  - Pixels filtering on including cells

  => To be delivered in next NWC SAF official version

Perspective of development for next CDOP4 phase

- **Ground Truth database derived from radar convective objects**
- **Improved tuning algorithm.**
- Use of stratiform / cumuliform flag from Cloud Type product
- Use of night cloud microphysical properties from CMIC product