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Configuration Assessment of Deter-RT: a New SAR-Based Automated Deforestation Detection System in the Amazon

Avaliação da Configuração do Deter-RT: um Novo Sistema Automatizado de Detecção de Desmatamento Baseado em SAR na Amazônia

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Abstract: Deter-RT is a new system for automatic deforestation detection in the Amazon, offering high customization to user needs. This study compared nine system configurations combining three values of a factor regulating spatial optimization across ecoeregions and three scenarios of morphological filter application. Results were evaluated using the indices omission, commission, number of intersections, and format. Tests (2022–2023) showed that higher factor values increased omission and reduced commission errors, while the filter improved polygon geometry indices. The preferred configuration uses empirically estimated factors and a newly proposed morphological filter (T8). Two other scenarios, one with a different filter (T5) and one with more conservative factor values (T7), produced similarly good results.
Keywords: Synthetic Aperture Radar. C-band. Change detection. Near real-time monitoring.

Resumo: O Deter-RT é um novo sistema para detecção automática de desmatamento na Amazônia, com alta capacidade de personalização conforme as necessidades do usuário. Este estudo comparou nove configurações do sistema, combinando três valores do fator que regula a otimização espacial entre ecorregiões e três cenários de aplicação de filtros morfológicos. Os resultados foram avaliados pelos índices omissão, comissão, número de intersecções e formato. Os testes (2022–2023) mostraram que maiores valores do fator aumentaram os erros de omissão e reduziram os de comissão, enquanto o filtro melhorou os índices de geometria dos polígonos. A configuração preferida adota valores do fator empiricamente estimados e o novo filtro morfológico proposto (T8). Outros dois cenários, um com diferenças no filtro (T5) e um com fatores mais conservadores (T7), apresentaram resultados de qualidade semelhante.
Palavras-chave: Radar de Abertura Sintética. Banda C. Detecção de mudanças. Monitoramento em tempo quase-real.

1 INTRODUCTION

Timely and accurate information regarding forest status is essential for proposing policies and actions to curb deforestation and degradation of Amazon rainforests (Assunção et al., 2019). Brazil, holding nearly two-thirds of the Amazon forest, has a comprehensive governmental program to monitor this region in near-real time (i.e., as soon as images are acquired): the Daily Monitoring of Suppression and Degradation of Native Vegetation, also known as Deter. Deter was proposed in 2004, as part of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm). Its original objective was to detect disturbance events in forest areas within the Brazilian Legal Amazon. Since then, Deter has evolved into a family of systems that monitor distinct disturbance classes within various vegetation types and biomes, including the non-forested areas of the Amazon, Cerrado, and Pantanal. Currently (as of August 2025), all Deter systems in operation are based on the visual interpretation of optical remote sensing (RS) imagery (Almeida et al., 2025).

Optical RS usually has limitations regarding cloud cover, which can be a pervasive problem for the Amazon from November to April (Mas & Araújo, 2021). Synthetic Aperture Radar (SAR) images, which are less susceptible to atmospheric conditions, are often regarded as a suitable substitute for optical data for detection under clouds or smoke (Paradella et al., 2005; Sano et al., 2020). However, the processing and interpretation of SAR images are usually more complex than optical imagery. Moreover, SAR images were not available at no cost with adequate frequency up to 2014. The launch of the C-band SAR Sentinel-1 (S1) satellites, followed by distribution hubs and platforms, enabled the distribution and standardized processing of SAR data and the creation of SAR-based near real-time deforestation detection systems such as TropiSCO (Mermoz et al., 2021), Radar for Detecting Deforestation (RADD) (Reiche et al., 2021), and the recently discontinued Deter-Radar (Deter-R) (Doblas et al., 2022). Other recent initiatives were reviewed by Bottani et al. (2025).

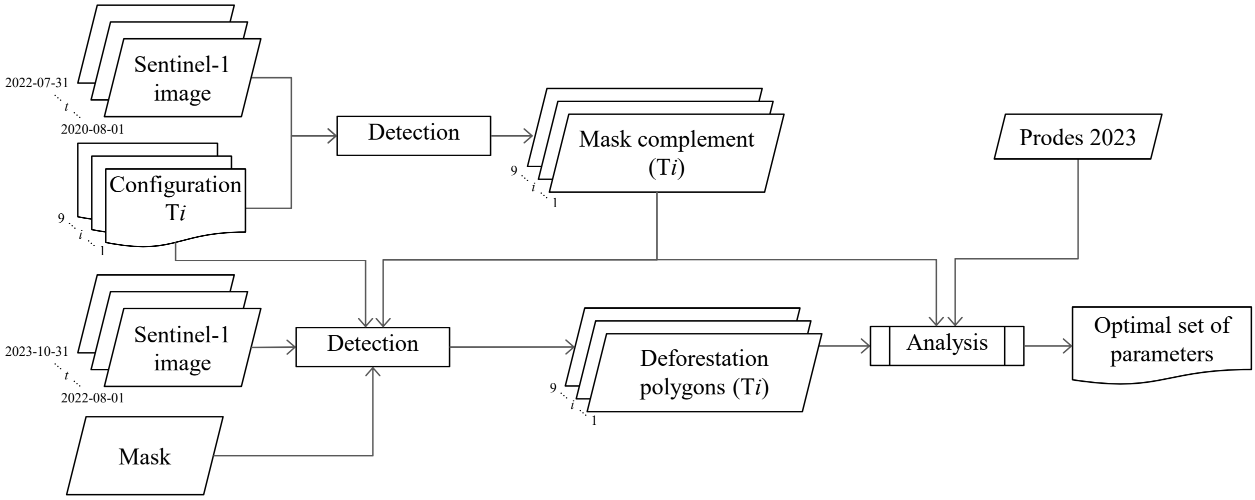
RADD is based on the Bayesian updating approach (Reiche et al., 2015), which fits either optical or SAR data. TropiSCO and Deter-R focus on detecting known drops in the backscatter in deforested areas when considering C-band images with different but complementary approaches. TropiSCO first locates changes in the shadows projected by trees of a given height over deforested areas (Bouvet et al., 2018), followed by the delimitation of the deforested area based on thresholding the aforementioned decrease in backscatter values. Both processes are done based on the Radar Change Ratio (RCR) index. Deter-R used an approach called Adaptive Linear Thresholding (ALT) (Doblas et al., 2020). ALT flags differences in backscatter values between a recent image and the median of a previous period as forest disturbances if they are higher than a given threshold. This threshold varied spatially as a function of the distance to past deforestation events to incorporate the knowledge that isolated deforestation events within largely untouched forests are somewhat rare in the Brazilian Amazon. Deter-R was the only fully automatic near real-time monitoring system in Deter's family based on SAR images, and was discontinued due to its dependency on Google Earth Engine.

To fill the gap left by Deter-R's discontinuation, Doblas et al. (2024) proposed a new system called Deter-Radar-TropiSCO (Deter-RT). This system combines the main advantages of the Deter-R and TropiSCO methodologies with a few novel features, such as the spatial optimization of thresholds, to improve deforestation detection. Deter-RT was designed as a highly customizable near real-time monitoring system for forested areas within the Brazilian biomes. Along with other Deter systems, its main objective is to deliver expedited and accurate deforestation alerts to monitoring agencies within the Brazilian government. As such, its operationalization demands a delicate process of parametrization to balance detection accuracy, false alarm rates, and operational feasibility. In this study, we evaluated nine configurations of Deter-RT in selected pilot areas to determine the configuration to be used during the first steps of operation. Besides adjusting key parameters for detection, we also implemented and tested the use of morphological filters to improve deforestation detection within the context of Deter systems. More details are provided in Section 2. This paper is an extended version of Reis et al. (2025), presented at the XXV Brazilian Symposium on Geoinformatics (GEOINFO 2025).

2 MATERIAL AND METHODS

For this study, we evaluated the results of different configurations of Deter-RT in selected areas and dates, as illustrated by Figure 1. Section 2.1 briefly overviews the Deter-RT structure, and Section 2.2 presents the selected test areas. The inputs and computational resources used in this study are detailed in Section 2.3. Section 2.4 presents the tested configurations and analyses.

Figure 1 – Methodological flowchart



Source: The authors (2025).

2.1 Deter-RT

Deter-RT was proposed by joint research conducted by the National Institute for Space Research (INPE), the *Centre National d'Études Spatiales* (CNES), Global Earth Observation (GlobEO), and the *Centre d'Etudes Spatiales de la Biosphère* (CESBIO). As previously mentioned, this system combines the primary characteristics of Deter-R and TropiSCO, as illustrated in Figure 2, along with some newly proposed features. The typical main steps of Deter-RT are (Doblas et al., 2024):

1. **Image selection:** selection of Sentinel-1 (S1) images acquired in Interferometric Wide Swath (IW) mode hosted and processed by the *Portail d'information et d'accès aux données spatiales "Observation de la Terre"du CNES* (GEODES). Similar to Deter-R and TropiSCO, only VH polarization is considered in Deter-RT since i) selecting a single polarization allows the definition of a single set of values for the thresholding of backscatter values and ii) previous studies indicate that VH characterizes deforestation events better than VV for Sentinel-1 data (Doblas Prieto, 2023);

2. **Preprocessing:** the orthorectification, normalization, and filtering of the selected images, processed and clipped into the Sentinel-2 tiling system using the 'S1Tiling' library (Koleck et al., 2024). These data are then used to calculate the RCR index, per subset of sequential images, and its sliding window minimum value (RCRmin);

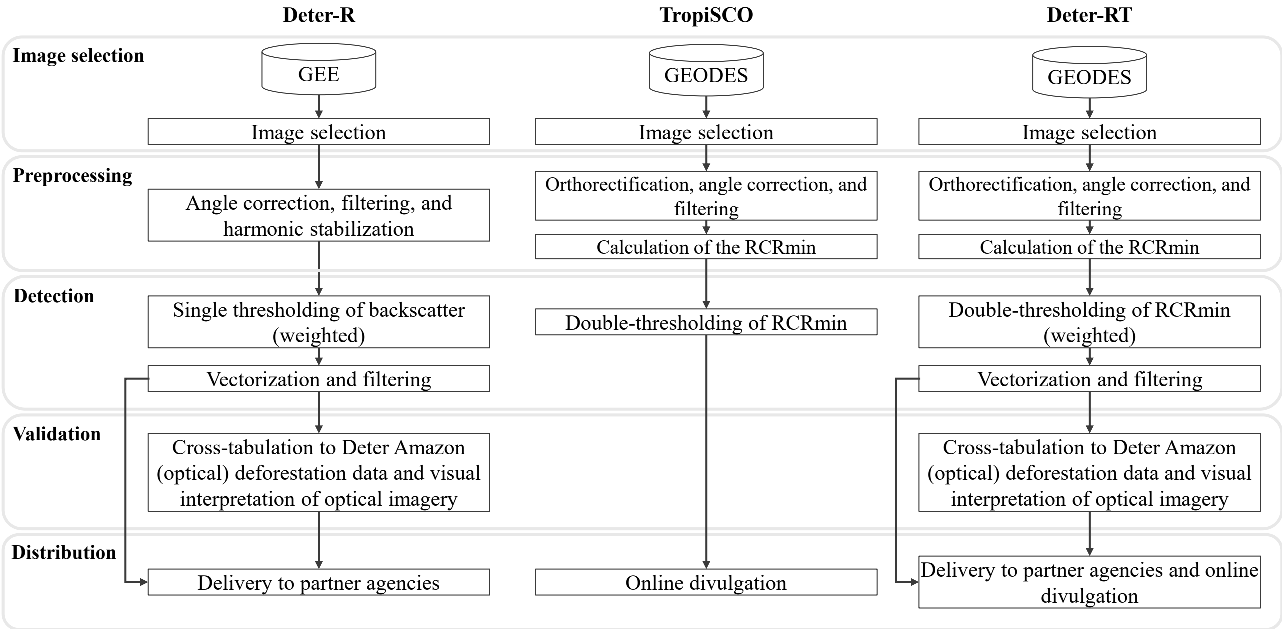
3. **Detection:** a double-thresholding based on RCRmin, one to detect tree shadows projected on the newly deforested area and one to delimit the deforested area. These thresholds are weighted according to the distance from previously deforested areas and ecoregion-dependent parameters, followed by the vectorization of alerts. Ecoregions represent large terrestrial areas with similar biogeographic characteristics and are defined in Deter-RT following Olson et al. (2001). The system includes this information in its calculation considering a factor defined as "alpha near" (Doblas et al., 2024). As a new feature tested in the present study, we also have the option to apply an opening and closing morphological filter (with the same number of pixels). This filter creates a buffer of a set size around flagged pixels to

merge alerts to better represent the phenomenon seen in the field. It is possible to set an Intermediate Minimum Mapping Unit (IMMU) prior to the filtering process, to avoid the inclusion of very small detections caused by speckle or other variations of no interest;

4. **Validation:** emitted alerts are validated by their cross-tabulation with Deter Amazônia (optical) results and/or visual interpretation of optical images. The selection of validation methodology (e.g., adequate imagery, legends, interpretation keys) is ongoing research;

5. **Distribution:** delivery of results to partner agencies and online publication on the Deter official repository (https://terrabrasilis.dpi.inpe.br/). This step has not yet been implemented. We expect publication policies to follow those of other Deter projects, meaning data will be delivered to partner agencies first and openly published after a few days.

Figure 2 – Comparison of main steps of Deter-Radar (Deter-R), TropiSCO, and Deter-Radar-TropiSCO (Deter-RT). In which GEE = Google Earth Engine, GEODES = *Portail d'information et d'accès aux données spatiales "Observation de la Terre"du CNES* and RCRmin = minimal value of the Radar Change Ration index



Source: Adapted from Doblas et al. (2024).

Box 1 summarizes the main technical differences between Deter-RT and related systems, Deter-R and TropiSCO. Note that a comparison of performance between Deter-R and TropiSCO, as well as other state-of-the-art deforestation monitoring systems, has been performed by Doblas et al. (2023). As Deter-RT is not yet fully operational, it is not currently possible to properly estimate how it will compare to these systems.

Box 1 – Main technical aspects of Deter-RT in comparison to related systems

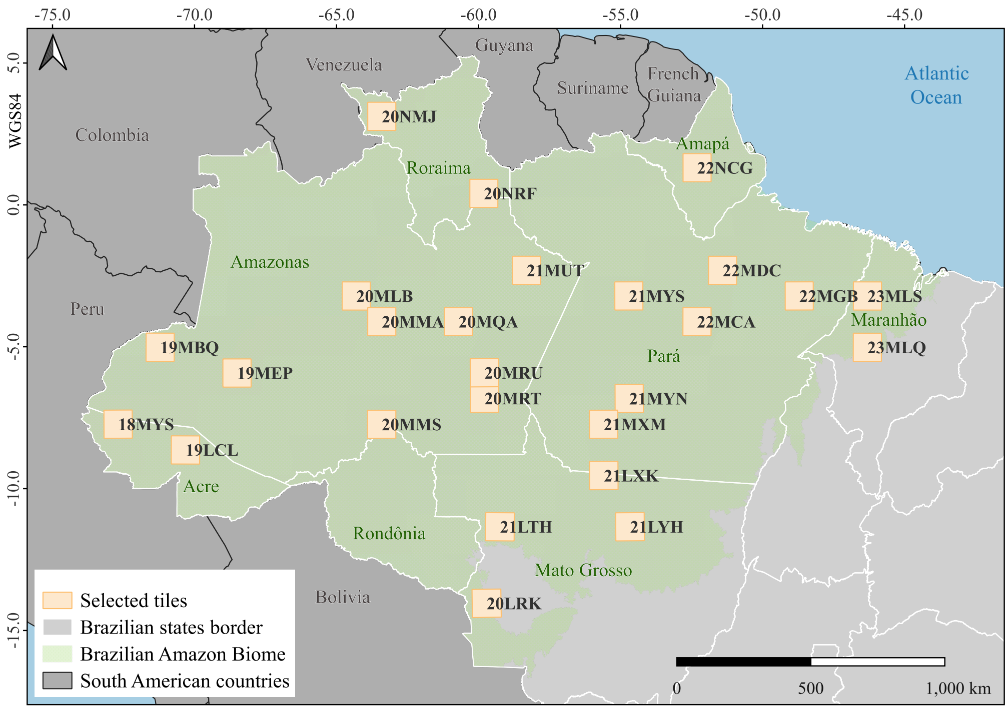
Aspect	**Deter-RT**	**Deter-R**	**TropiSCO**
Base algorithm	Doblas et al. (2024)	Doblas et al. (2022)	Bouvet et al. (2018)
Minimum Mapped Area	0.4 ha	1.0 ha (Collection 1) and 0.4 ha (Collection 2)	0.1 ha
Spatial coverage	Forested areas in the Brazilian Amazon Biome (projected)	Forested areas in the Brazilian Amazon Biome	Tropical forests in South America, Africa, and Southeast Asia
Period of operation	In development	2021-2024	Since 2022 (data available from 2018)

Source: The authors (2025).

2.2 Pilot test areas

This study was conducted in the 26 validation areas selected by Doblas et al. (2024) and illustrated in Figure 3. Here, the Deter-RT monitoring area excludes areas previously classified as deforested by Prodes 2022 and areas not originally covered by forests. The latter includes areas masked as non-forest natural vegetation or hydrography by the Prodes project (National Institute for Space Research, 2025b), wetlands (Hess et al., 2015), water masses (Pekel et al., 2016), and other flooded/beach areas (Brazilian Institute of Geography and Statistics, 2018). Within the first thresholding process (detection of tree shadows), we also omit areas with slopes higher than 15° (Copernicus Digital Elevation Model, 2023). This last step aims to avoid the detection of radar shadows caused by the terrain, which are often unrelated to deforestation events.

Figure 3 – Validation areas



Source: Adapted from Doblas et al. (2024).

2.3 Data sets and computational resources

The data sets used in this study are:

1. **Prodes 2023:** new deforestation increments detected by Prodes 2023, including those smaller than 6.25 ha (National Institute for Space Research, 2025b);

2. **Sentinel-1 images:** all Sentinel-1 IW images acquired between August 1, 2020, and October 31, 2023, as archived and processed by the *Plateforme d'Exploitation des Produits Sentinel* (PEPS) (before substitution by GEODES). These dates were chosen to allow the detection up to the date of the last used image in Prodes 2023 (October 11, 2023), while avoiding the detection of residues not mapped within the used masks due to differences in project resolution and imagery;

3. **high-resolution optical images:** the monthly Planet mosaics available through the Norway's International Climate & Forests Initiative (NICFI) (NICFI, 2021). Although we focused our analysis on mosaics from August 2022 to February 2024, any available image from this dataset may have been consulted.

All processes of mask calculation and deforestation detection were executed using the computational capabilities of the *Centre National d'Études Spatiales* High-Performance Computing (CNES-HPC), with the Slurm Workload Manager as the orchestrator of the required tasks and Dask as the main parallelization library.

2.4 Detection and analysis

Both the spatial optimization of thresholds due to ecoregions, regulated by the alpha near factor, and the use of morphological filters are features not included in TropiSCO or Deter-R systems. As such, there is no default value for alpha near, and the impact of using or not using the morphological filters is unknown. To set the alpha near value and decide on the use of the filter, we tested nine Deter-RT configurations, illustrated in Box 2. Besides varying the values of alpha near and using or not using the morphological filter, we also tested the inclusion of an IMMU of 0.1 ha within the morphological filter or not. The estimated alpha near values depicted in Box 2 were calculated for each ecoregion, as a balance between the results from Doblas et al. (2024) and further empirical analysis.

Box 2 – Definition of Deter-RT tested configurations. In which IMMU= Intermediate Minimum Mapping Unit

Configuration	**Alpha near**		
	Estimated - 0.1	Estimated	Estimated + 0.1
No morphological filter	T1	T2	T3
Filter 1 (Closing = 2 pixels, IMMU = 0.0 ha)	T4	T5	T6
Filter 2 (Closing = 2 pixels, IMMU = 0.1 ha)	T7	T8	T9

Source: The authors (2025).

We first ran the Preprocessing and Detection algorithms of Deter-RT over the S1 images from 2020-08-01 to 2022-07-31, to detect older changes not included in the mask, where new deforestation events are not to be detected. This step generated the so-called mask complement and was done separately for each proposed configuration, resulting in nine different masks. A second Preprocessing and Detection step, considering images from 2022-08-01 to 2023-10-31, results in the deforestation polygons for each configuration. These were evaluated based on four proposed indices: (i) omission, (ii) commission, (iii) number of intersections, and (iv) format.

The omission index measures the proportion, in area or number of polygons, of the deforestation polygons from the reference not seen by a given configuration of Deter-RT. We consider one polygon in the reference to be seen if there is at least 50% of geometric superposition between this polygon and a given configuration of Deter-RT.

The commission index, also calculated using area and number of polygons separately, describes the proportion of polygons detected by Deter-RT that do not correspond to deforestation events that can be detected in the period of the analysis. Due to differences in MMU for Deter-RT and Prodes, it is not possible to derive the commission rate by directly comparing the two datasets. To solve this problem, we opted to visually assess the commission error rate of randomly selected Deter-RT polygons not mapped by Prodes 2023, using the monthly Planet mosaics. This analysis has three main steps:

1. **Sample selection:** first, we select all Deter-RT alerts with less than a conservative 10% superposition with Prodes 2023, which are the ones considered to have the highest potential to be commission errors. We performed a random selection of alerts over this set for visual interpretation assessment, stratified based on the number of overlaps among polygons. Here, an overlap is defined by one superposition of at least 50% between two polygons of different configurations of Deter-RT, which we assumed depicted the same deforestation event. Values vary from 1 (one overlap with itself, no overlaps in different configurations) to 9 overlaps (overlaps in all configurations). We randomly selected up to 10 polygons with 1 to 8 overlaps for each configuration and tile, plus up to 10 polygons with 9 overlaps per tile in any configuration. This process was done without repetition, totaling up to 100 polygons per tile (10 polygons in 9 configurations plus 10 polygons with 9 full overlaps) and 2,547 in total (since some strata did not have 10 polygons);
2. **Assessment:** sampled polygons were assessed based on the visual interpretation of monthly Planet mosaics in the four classes described in Box 3, using the process detailed in Figure 4;
3. **Generalization of results:** given the high superposition of polygons between different configurations of Deter-RT, we augmented our sample size by attributing the class of a validated polygon to a non-validated

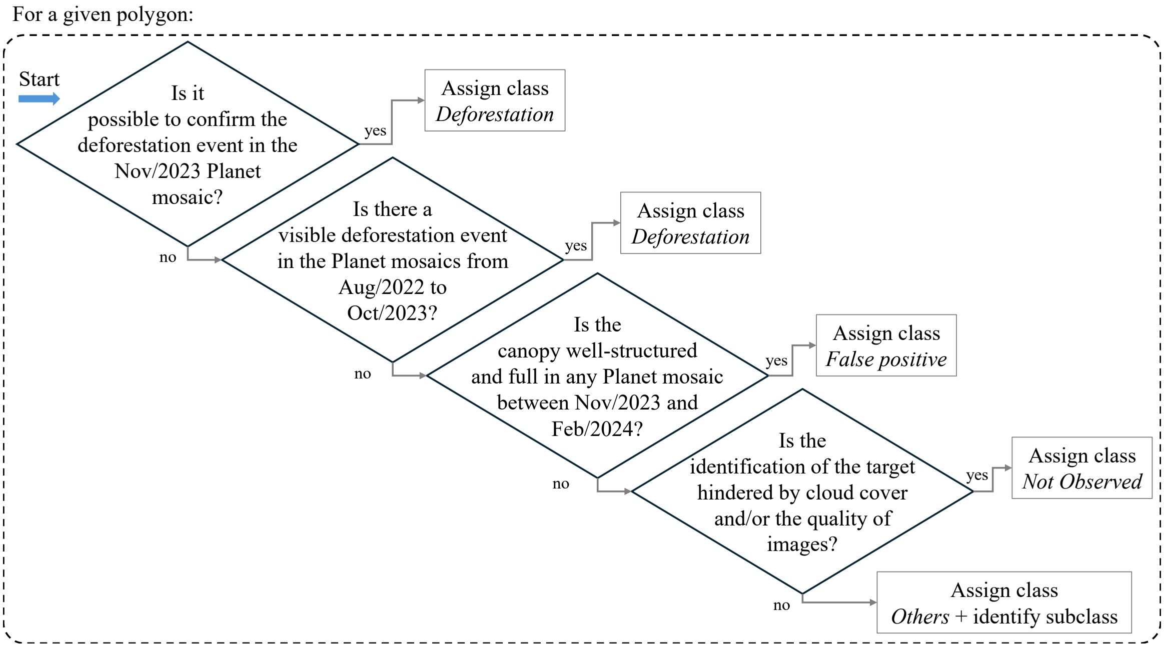
one if there is an overlap of at least 90%. There were no conflicting labels on superposed validated polygons. With this process, we were able to gather 10,858 validated Deter-RT polygons (16,514.89 ha) used to calculate the set of Commission indices, with 5 (3.34 ha) to 76 (318.26 ha) validated polygons per configuration/tile (median value of 47 polygons or 58.46 ha).

Box 3 – Assessment classes

Class	**Definition**
Deforestation	Tree cover removal through clear-cutting or progressive degradation resulting in canopy discontinuity between 2022-08-01 and 2023-10-31, followed or not by natural regeneration of the tree cover
False positive	Areas covered by forest that did not suffer a deforestation event between 2022-08-01 and 2023-10-31. This class includes forest degradation events that were not severe enough to cause the loss of canopy continuity
Not observed	Areas that could not be evaluated due to lack of adequate observations (cloud cover or lack of images)
Others	Areas that do not pertain to forests or that changed due to phenomena unrelated to deforestation events, including natural loss of forest cover (e.g. due to blowdowns or landslides)

Source: The authors (2025).

Figure 4 – Visual assessment process to validate selected Deter-RT polygons



Source: The authors (2025).

The number of intersections depicts how many polygons in the reference are intersected by a given polygon in Deter-RT. Here, we assumed an ideal 1:1 ratio between the number of polygons issued by a given configuration of Deter-RT necessary to represent a deforestation event mapped by Prodes 2023. Therefore, we computed, for each tested configuration of Deter-RT, the mean number of intersections between Prodes 2023 and each polygon from Deter-RT (ignoring those with no intersections).

Finally, the Format index prioritizes the compactness of deforestation alerts and is given by:

$$\sum_{i=1}^{n} \frac{perimeter(pol_i)}{\sqrt{area(pol_i)}} / n, \tag{1}$$

in which *perimeter* and *area* denote, respectively, the perimeter (m) and the area (m^2) of a given polygon i from the n total number of polygons.

We synthesized the indices results using a weighted ranking approach. First, we ranked the tested configurations (draws share the same rank) for each of the 26 tiles and six indices (omission and commission each yielding two values). We then summed the positions for all tiles to obtain one value per configuration/index, ranging from 26 (best-ranked in all tiles) to 234 (worst-ranked in all tiles). Finally, we computed a configuration score by summing the weighted values of the six indices, with the weights given in Table 1. These were assigned considering that minimizing commission errors is crucial to avoid the costs of deploying a regulatory team to a disturbed (or in this case, non-disturbed) area, whereas reducing omission improves the chances of curbing a forest disturbance in progress. For conservative systems like Deter (Doblas et al., 2022), low commissions are substantially more important than low omissions, which in turn outweigh the number of intersections or format of polygons. The lowest final value indicates the best-ranked configuration.

Table 1 – Weights per index

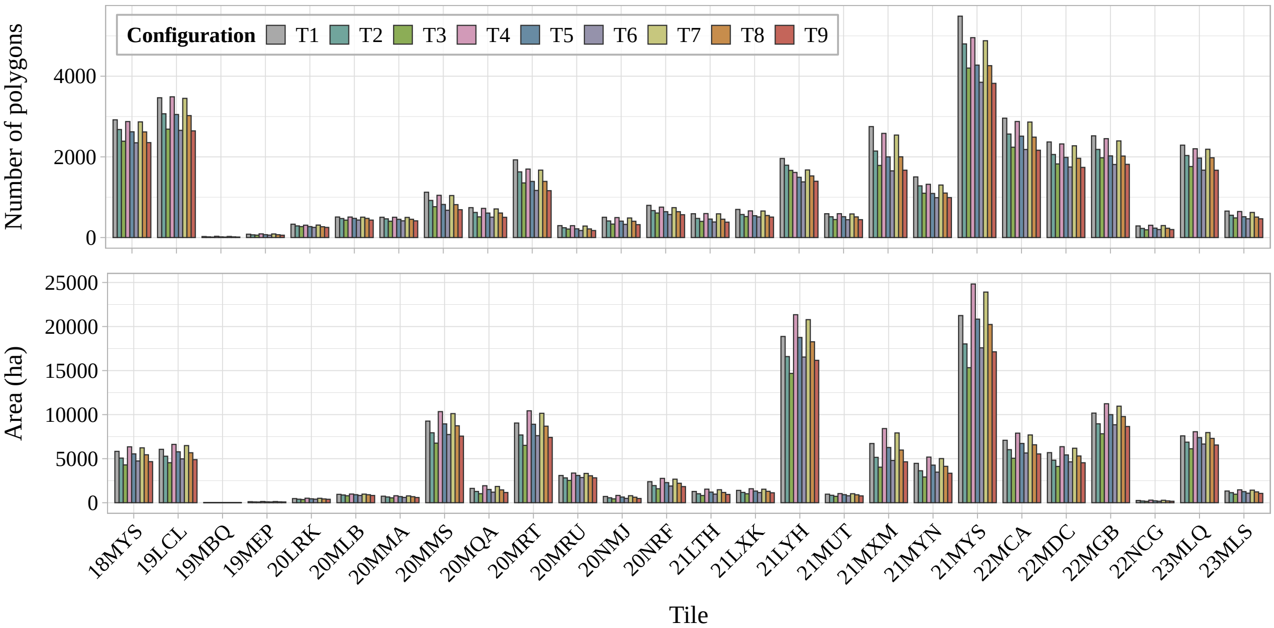
Index	Weight	Relative weight (%)
Omission (area)	1	25.0
Omission (number of polygons)	1	
Commission (area)	2	50.0
Commission (number of polygons)	2	
Number of intersections	1	12.5
Format	1	12.5

Source: The authors (2025).

3 RESULTS

Deter-RT detected 285,777 deforestation alerts across the 26 tiles and nine tested configurations. The number and area of alerts, per tile and configuration, are depicted in Figure 5. As expected, lower values of alpha near (T1, T4, and T7) tend to result in a higher detected area, whereas filtering tends to reduce the number of polygons. From these alerts, 193,063 presented less than 10% superposition with Prodes 2023 and were eligible for visual interpretation.

Figure 5 – Number and area of deforestation detections per tile and configuration of Deter-RT



Source: The authors (2025).

Figure 6 depicts the box plots containing the values for each index for each tested configuration and the 26 tiles of the pilot area. Despite the visible superposition of value ranges in all indices for the majority of Deter-RT configurations, these results confirm some expected patterns. For instance, decreasing the values of alpha near leads to lower omission but higher commission rates. Additionally, the use of morphological

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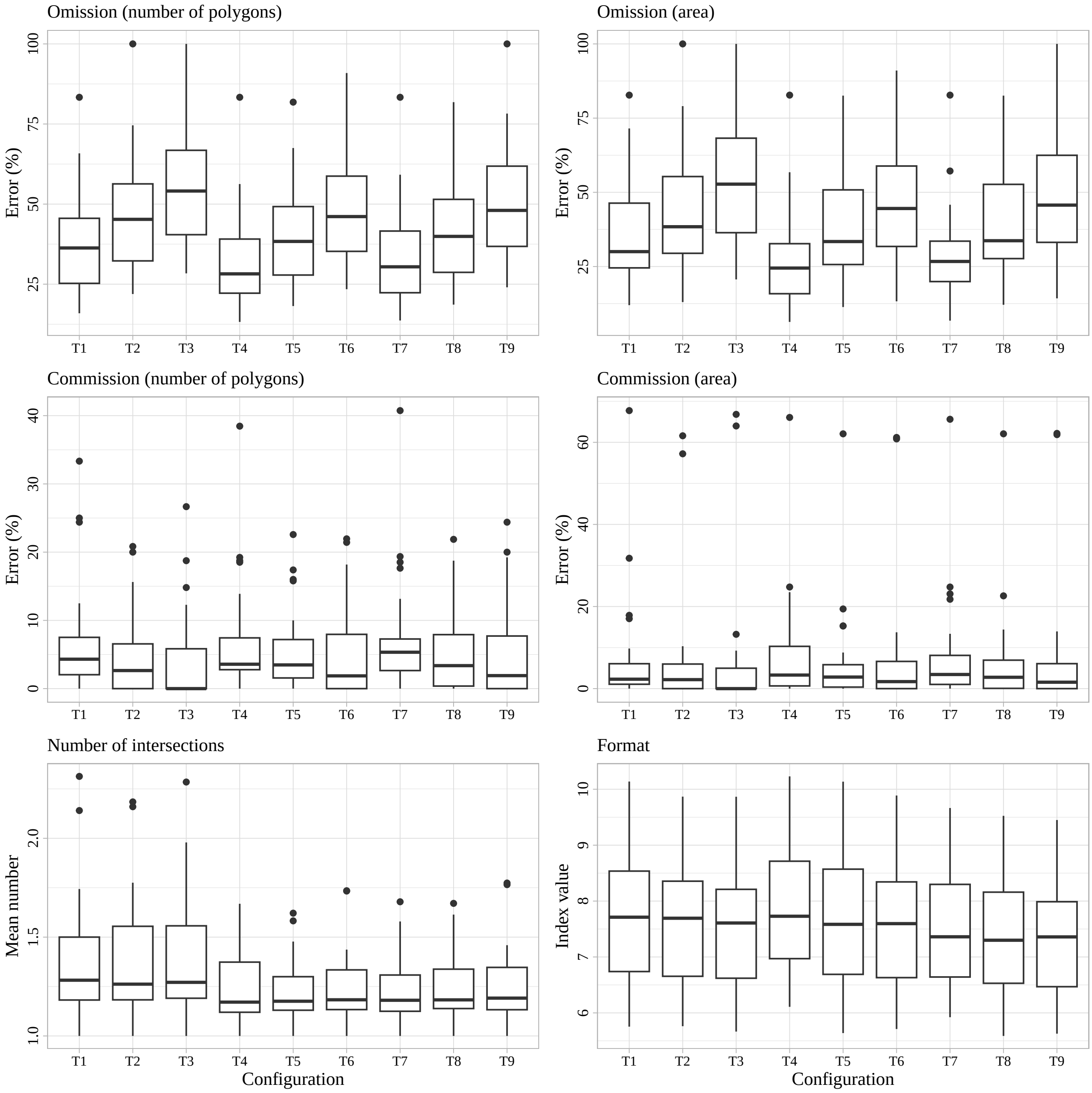
filters also appears to reduce the mean number of intersections between Deter-RT polygons and Prodes. The improvement of such filters on the format index is less pronounced.

Figure 6 – Indices values for the tested configurations of Deter-RT. Each box contains the calculated values for all tiles



Source: The authors (2025).

Table 2 presents the results of the ranking process. Different configurations return the best results for each index, with T4 and T3 consistently best-ranked for, respectively, lowering omission and commission errors. After weighing the positions, the best-ranked configuration is T8.

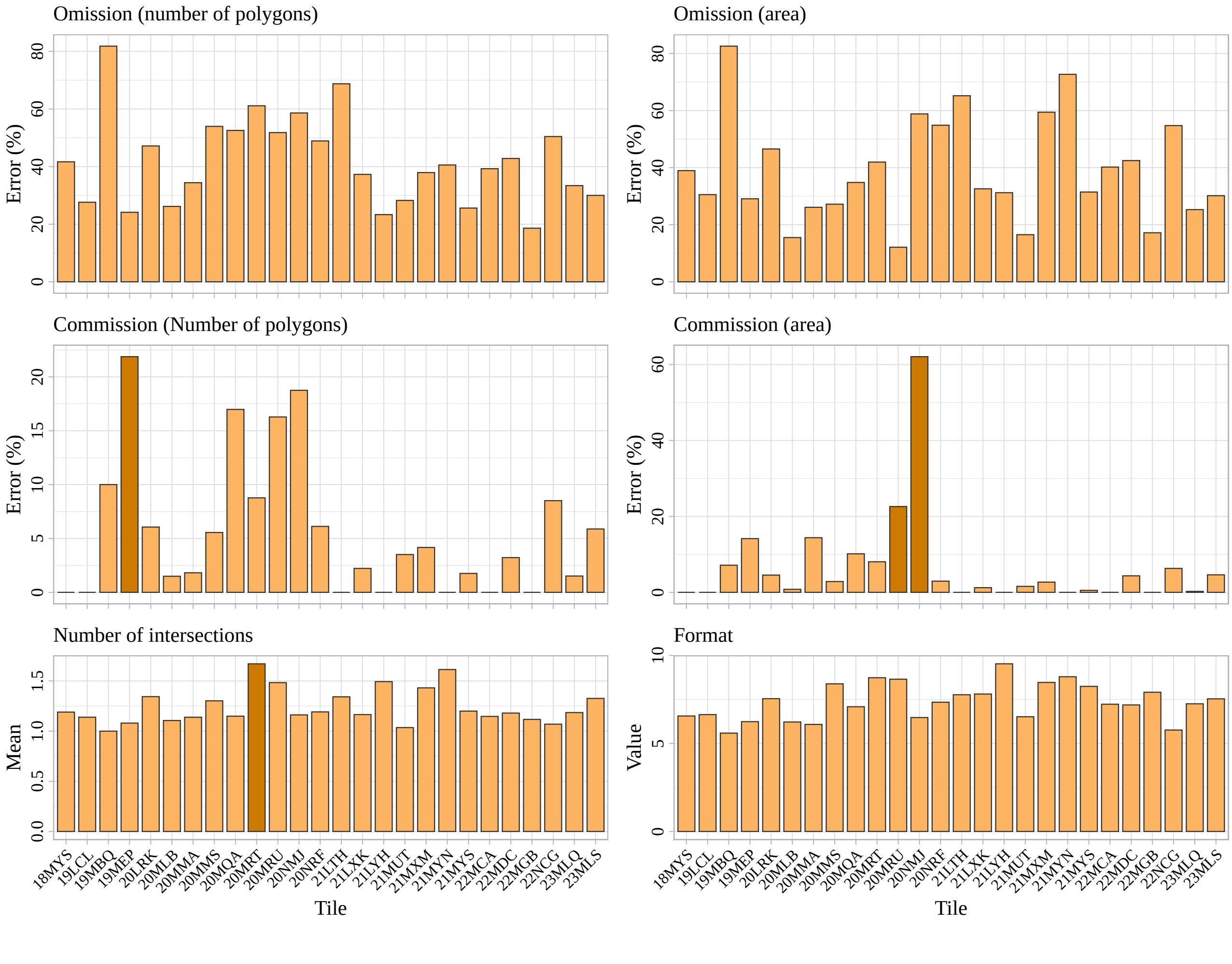
Table 2 – Results of the ranking process. The best ranking position for each index is highlighted in bold font

Index	Weight	Configuration								
		T1	T2	T3	T4	T5	T6	T7	T8	T9
Omission (area)	1	74	153	219	**28**	93	165	48	120	195
Omission (number of polygons)	1	73	147	218	**28**	94	169	48	119	194
Commission (area)	2	106	**73**	**73**	131	89	88	130	93	84
Commission (number of polygons)	2	101	81	**76**	109	90	84	113	85	82
Number of intersections	1	179	184	182	74	**65**	85	86	100	100
Format	1	188	152	123	217	161	126	107	56	**40**
Weighted total	-	928	944	1040	827	771	889	775	**751**	861

The authors (2025).

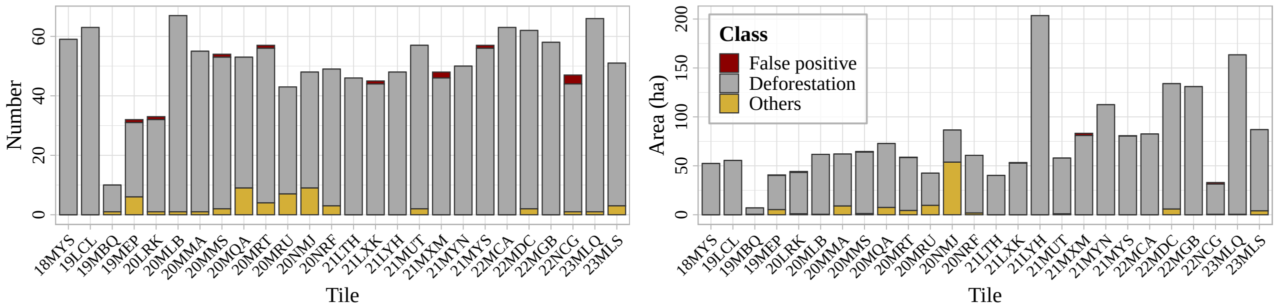
Figure 7 presents the values of calculated indices for each tile, using this configuration. In this figure, values of the omission and commission indices are of particular note. Although Omission values across tiles did not present any outliers, tile 19MBQ, for instance, achieved almost 80% of omission when compared to Prodes 2023, both in number of polygons and area. Using more permissive values of alpha near can reduce the omission error, but causes a spike in commission values. Commission errors in results based on the T8 configuration are particularly high in tiles such as 19MEP (in number of polygons), 20MRU (in area), and 20NMJ (in area). These errors are mainly caused by alerts labeled as "Others", as illustrated in Figure 8. False positives are relatively rare for the majority of tiles and represent a small proportion of the total alerted area.

Figure 7 – Indices values per tile for the selected configuration (T8). Outliers are highlighted in darker colors



Source: The authors (2025).

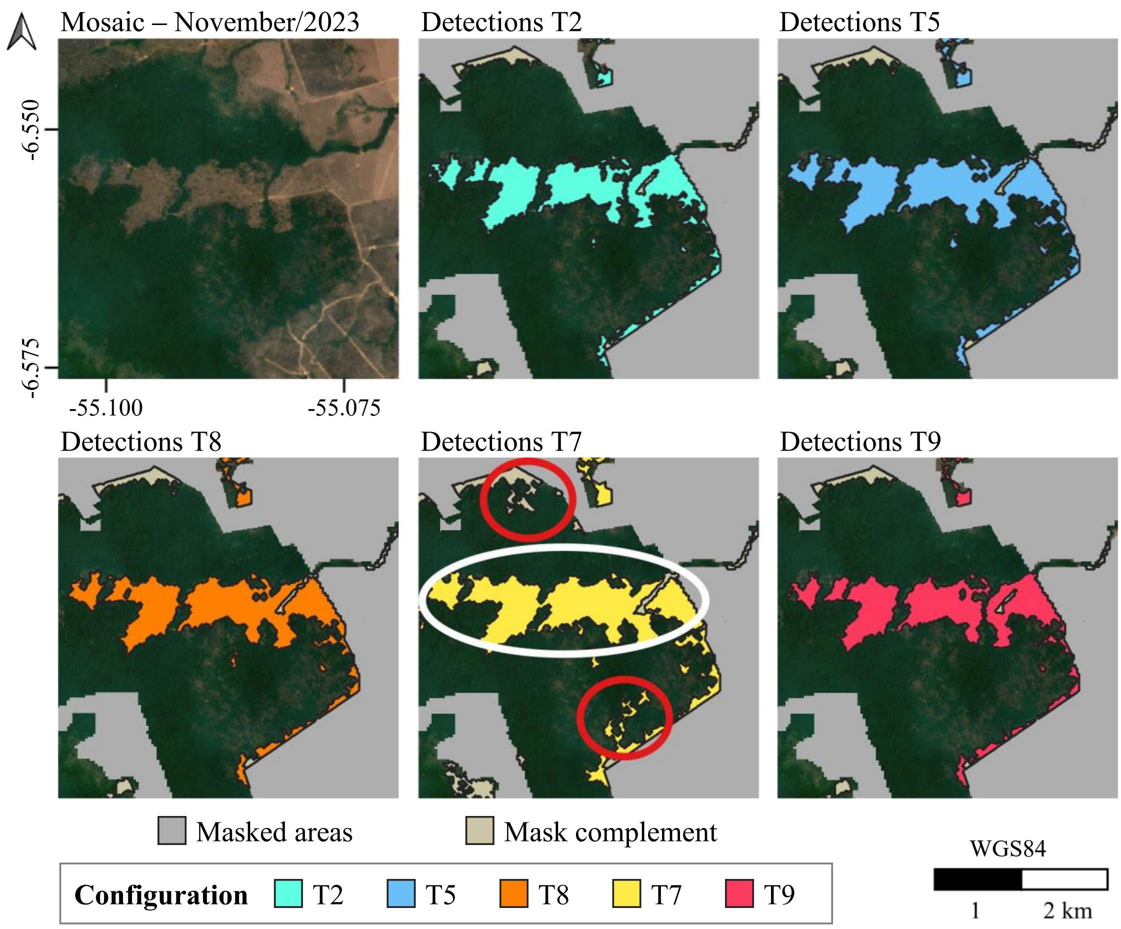
Figure 8 – Number and area (ha) of validated alerts produced by Deter-RT using the T8 configuration



Source: The authors (2025).

The differences between T8 and other configurations are illustrated in Figure 9. This figure presents a detection example using the selected configuration (T8) and those obtained by varying only one of the two parameters: different configurations of the morphological filter (T2 and T5) or variations in the alpha near value (T7 and T9). In this figure, the white ellipse highlights a set of polygons that are merged due to the application of the morphological filter. The red ellipses show areas detected as mask complement or new alerts only when using lower values of alpha near, showcasing the expected feature of detecting more polygons when using more permissive values for this parameter.

Figure 9 – Example of detections of Deter-RT over a subset of the Planet mosaic from November 2023. Red and white ellipses are areas highlighted to showcase differences in alpha near values and morphological filters, respectively



Source: The authors (2025).

4 DISCUSSIONS

This study evaluated the results of nine configurations of Deter-RT in 26 selected tiles, from 2022-08-01 to 2023-10-31. This detection period is expected to cover the deforestation events that occurred in the Prodes year of 2023, when we consider the need for at least three Sentinel-1 images to calculate an RCRmin value. Prodes 2023 was, at the time of processing, the most recent Prodes product covering the forested areas of the entire Amazon biome. Our results, however, should be interpreted considering a few limitations regarding the types of deforestation events that are visible in Sentinel-1 images, particular circumstances in the Amazon during the period of analysis, and the selected ranking method.

In Deter's systems, deforestation is usually defined as the complete removal of the forest cover due to anthropogenic processes (Almeida et al., 2022). Whereas the loss of forest cover can be directly mapped using RS imagery, the drivers of this change cannot. Deter analysts will consider characteristics such as feature format, variation over time, and landscape context to assess if an alert had an anthropogenic or natural driver (Almeida et al., 2022). Deter-RT mimics this behavior by incorporating the distance to previously deforested areas and ecoregions in the definition of thresholds. As the natural world does not respect hard-defined limits, we noticed that the majority of commission errors in Deter-RT detections are usually due to changes in non-forested areas, natural forest loss, and fires that do not completely remove the forest cover, thus corresponding to forest degradation events. Using our current data set, it is not possible to quantify the proportion of alerts caused by these changes. Deter's team is currently developing the operational validation methodology, as an improved version of the one adopted in Deter-R (Doblas et al., 2022). This method is expected to enable the differentiation of various classes of natural forest loss, forest degradation, and land cover changes in non-forested areas, as well as old/new deforestation events, and false positives not caused by forest disturbances.

Nonetheless, changes in non-forested areas and natural losses of forest are a minor concern in this stage of Deter-RT development. High rates of change in non-forested areas indicate problems with our forest/non-forest mask. An updated mask is expected as a product of Prodes' recent endeavors to produce a landmark map of deforestation for the Amazon up to December 2020, considering a MMU of 0.5 ha (Soler et al., 2025). Natural forest losses can occur near consolidated areas and present very similar backscatter drops to deforestation events. As such, parametrization changes that would hinder the detection of the relatively rare natural loss of forest cover would also preclude the emission of deforestation alerts.

Forest degradation by fire, on the other hand, is expected to play a major role in Deter-RT performance. The Amazon has experienced an extreme drought since 2023 (Espinoza et al., 2024; Marengo et al., 2024), which can exacerbate the forest's susceptibility to fire events, especially in already degraded areas (Andrade et al., 2020). Soil and vegetation humidity impact the dielectric properties of targets, which can cause variation in backscatter values and increase the detection rate of systems such as Deter-RT. Alternatively, INPE's monitoring systems have already detected a sharp increase in forest degradation events in 2024. Deter Amazon (optical) registered 50,662 km^2 of burn scars in 2024, whereas the maximum area mapped as this class in a year between 2016 and 2023 was 20,720 km^2 (mapped in 2016) (National Institute for Space Research, 2025a). Moreover, deforestation rates calculated by Prodes have been decreasing from 2021 to 2024 (National Institute for Space Research, 2025b). As such, shifts in Amazon forest dynamics (Mataveli et al., 2025) could cause an increased proportion of alerts caused by forest degradation events in analyses that include data from 2024 or 2025.

We also noted that some deforestation events detected by Prodes are not detected in Deter-RT due to local management practices. The conversion from forest to pasture, for instance, causes changes in color and texture in optical data that can be visually interpreted (Almeida et al., 2022). In C-band SAR images, however, changes in backscatter and texture are more visible in the so-called slash-burn processes, and up to six months after the deforestation event (Doblas et al., 2020). Changes in the C-band imagery may not be noticeable if there is vegetation remaining in the deforested area or after the growth of pasture or crops. We will also miss a deforestation event in Deter-RT if the forest along the borders of the feature is degraded enough to hinder shadow projection over the deforested area.

Furthermore, we highlight that our methodology does not allow us to consider the selected configuration as the optimal one for Deter-RT. A common constraint of studies based on the construction of weighted quality indices is that changing the weights can change the results. We also did not consider the magnitude of a given index value during the ranking process. As such, both small and great differences in values can have the same impact on the position of a configuration. Our analysis is also constrained to a specific time interval in a constantly changing study area. Therefore, T8 was selected as the preferred candidate for further analyses, but the final configuration of Deter-RT can be changed during operation if needed. In this sense, we highlight that T5 and T7 presented similarly high weighted totals as T8, and are also good candidates for future runs of the system. T7, in particular, was obtained using a more permissive alpha near value and may be used in case high omission rates are identified in future analyses.

5 CONCLUSIONS

This study compared the results of nine configurations of the newly implemented Deter-RT in pilot areas and considering the Prodes year of 2023. This comparison was made using four indices: omission, commission, number of intersections, and format, to test the impacts of varying the alpha near parameter and of the inclusion of a newly proposed morphological filter to improve polygon geometry.

Overall, increasing the alpha near values increases omission errors and decreases commission errors. Including a morphological filter, as expected, improved the values of the number of intersections and format indices. Our results indicate that further Deter-RT analyses in the Amazon could maintain the alpha near values previously estimated, while benefiting from applying the newly proposed morphological filter, parameterized using closing = 2 pixels and Intermediate Minimum Mapping Unit = 0.1 ha.

Deter-RT has been in operation in pilot areas, using the selected configuration, since July of 2025. It retroactively generated deforestation alerts from 2023-08-01 to 2024-06-30, which have been updated daily using automatic processes that involve both CNES and the computational resources of INPE's Georeferenced Information (BIG) program. We are currently developing robust validation methods to ensure that Deter-RT can be expanded for the Amazon biome in a suitable configuration.

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Conflicts of Interest

There are no conflicts of interest.

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