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ABSTRACT

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Forest loss is a global issue that requires real-time surveillance to prevent further vegetation loss. This study presents an unsupervised SAR-based technique that leverages Bayesian inference and infinite state Markov chains to identify forest loss, overcoming the limitations of current methods. Our approach significantly improves accuracy and reduces false alarm rates compared to existing Near Real-Time (NRT) forest loss monitoring systems and enlarges the conditions of operability.

Keywords: Forest Loss, Change Detection, Bayesian Inference, Sentinel-1, Time-Series.

1. INTRODUCTION & OBJECTIVES

Forests globally are undergoing substantial changes due to forest loss, highlighting the urgent need for prompt forest surveillance [1]. Traditional forest monitoring has relied on optical imagery [2], which is significantly limited by cloud coverage. Synthetic Aper-

4. METHOD

Bayesian Online Changepoint Detection (**BOCD**) is a statistical method that partitions a time series of Sentinel-1 data into segments by tracking the posterior distribution over the most recent change point, thus inferring the run length, r_t , of the current segment [5]. As the time series can be partitioned in infinite ways, the model resembles an infinite state Markov chain.







Filtering hampering small-scale detections

Monitoring of seasonality-prone areas

2. STUDY AREA





Savanna 20% of Brazil

Under-monitored

Figure: Study area with focus on two distinct biomes. The Cerrado experiences pronounced seasonal variations.

3. VALIDATION DATA





Figure: Small-scale forest disturbance for 2020 generated by BOCD over the Amazon (**left**) and the Cerrado (**right**), in comparison with MapBiomas Alerta reference data. Optical background image from Google Earth (©2023 Google)



Figure: Validation data and relative characteristics.

7. CONCLUSIONS

This work offers some key contributions:

- 1. A novel method for NRT forest loss detection with better detection and fewer false alarms;
- 2. Method application in the seasonally sensitive Cerrado biome, showing adaptability;
- 3. A filtering-free approach that maintains spatial resolution and reduces overestimation.



6. COMPARISON WITH OTHER NRT SYSTEMS & DISCUSSION

Performance metrics were assessed for the BOCD method across different configurations, each representing varying levels of conservatism, and compared with existing operational NRT systems; GLAD-L ([2], optical-based), RADD ([3], SAR-based), and GFW (an ensemble of optical and SAR-based alerts).



Figures: Normalized true positives vs normalized false positives of the different systems for the Amazon (**left**) and the Cerrado (**right**) biomes. The labels C1, C2, C3, and C4 denote various configurations the BOCD method, each representing distinct degrees of conservatism.

	BOCD-C1	BOCD-C4	GFW		BOCD-C1	BOCD-C4	GLAD-L
F1, thr=75%	69.6%	87.4%	74.1%	F1, thr=75%	39.5%	58.5%	23.6%
F1, thr=30%	91.6%	97.9%	92%	F1, thr=30%	85.3%	93.1%	66.9%
F1, thr=10%	92.7%	97.3%	93.1%	F1, thr=10%	91.7%	97.4%	75.5%

Tables: F1-score comparison between systems for varying evaluation thresholds. (left) Amazon, (right) Cerrado.

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Figure: Example of small-scale deforestation overestimation of existing NRT systems compared to BOCD. [1] Vancutsem et al. Long-term (1990–2019) monitoring of forest cover changes in the humid tropics. Sci. Adv., 2021.

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