

# Validation of EarthCARE L2a MSI Aerosol Optical Thickness over Italy using AERONET and SKYNET photometers



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EUROPEAN SPACE AGENCY

## Introduction

This work presents a national-scale validation of EarthCARE Level-2a MSI Aerosol Optical Thickness (MSI-AOT) over Italy using coordinated ground-based observations from 16 AERONET (10 Land and 6 Coastal) and 3 SKYNET photometer stations (Fig. 1). The analysis is performed within the EVID11 activity and within the EC-ValMed.it project supported by the Italian Space Agency (ASI).



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## Methodology

EarthCARE MSI-AOT @ 670 nm was validated against relevant AOT @ 675 nm from AERONET and SKYNET photometers over Italy using a harmonized spatial-temporal matchup approach over the almost two-year period (July 2024-May 2026). Only MSI-AOT retrievals with quality status 0-1 (valid) and overpasses within 150 km from each station were considered. Fig. 2a shows the 2-year mean MSI AOT over Italy. For the validation, satellite AOT was spatially averaged over fixed windows of variable size (3x3, 9x9, 25x25, and 51x51 pixels, e.g. Fig. 2b), centered on station coordinates. AERONET (L1.5) and SKYNET (L2a) ground-based observations were temporally averaged within ±15, ±30, ±60, and ±120 min around the overpass time.



Fig. 1: AERONET (bullets) and AERONET/SKYNET (squares) sites used for the analysis. Different colors represent Land (orange) or Coastal (cyan) sites.

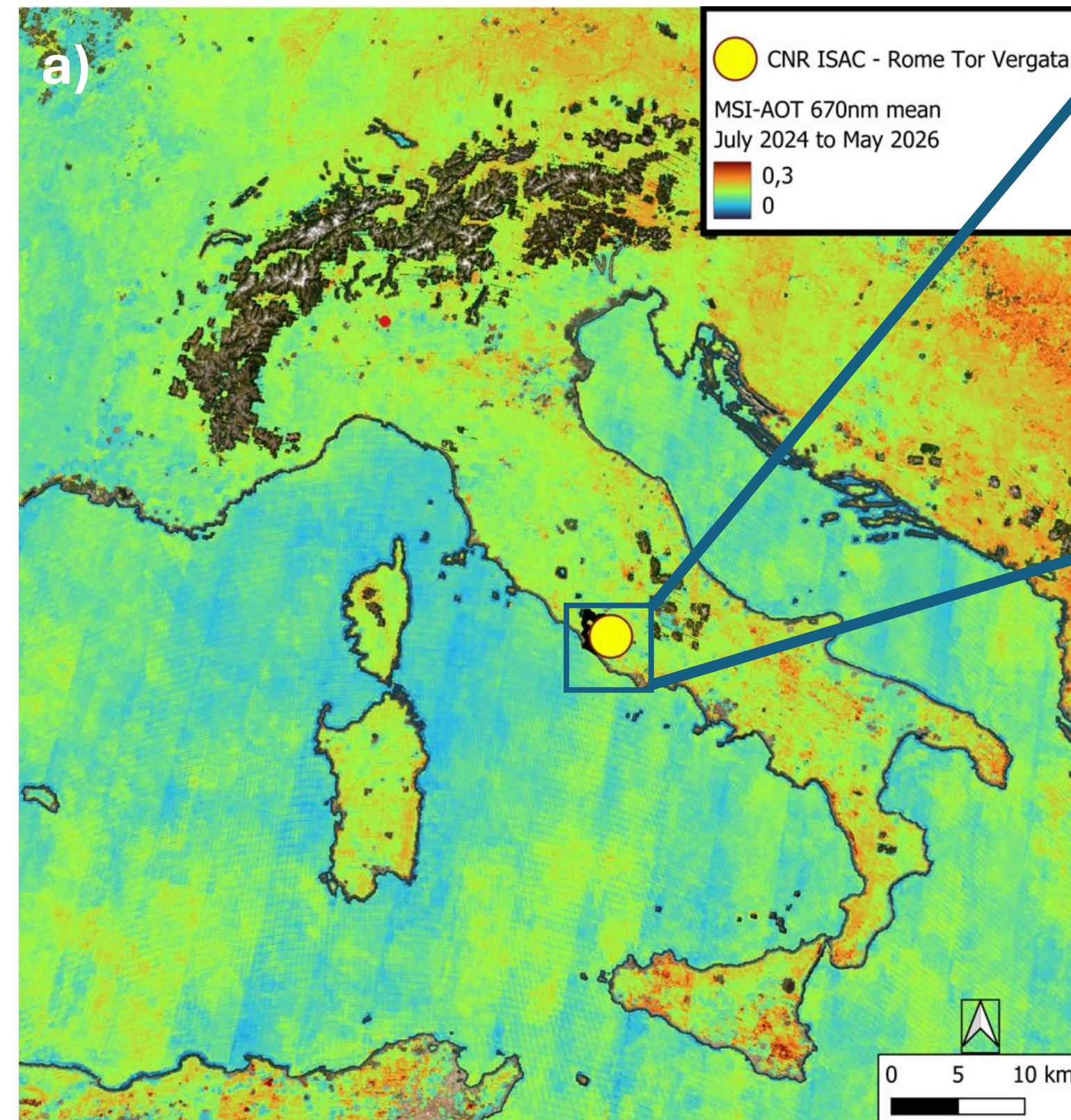


Fig. 2a: 2-year average (July 2024-May 2026) MSI-AOT @ 670nm over Italy

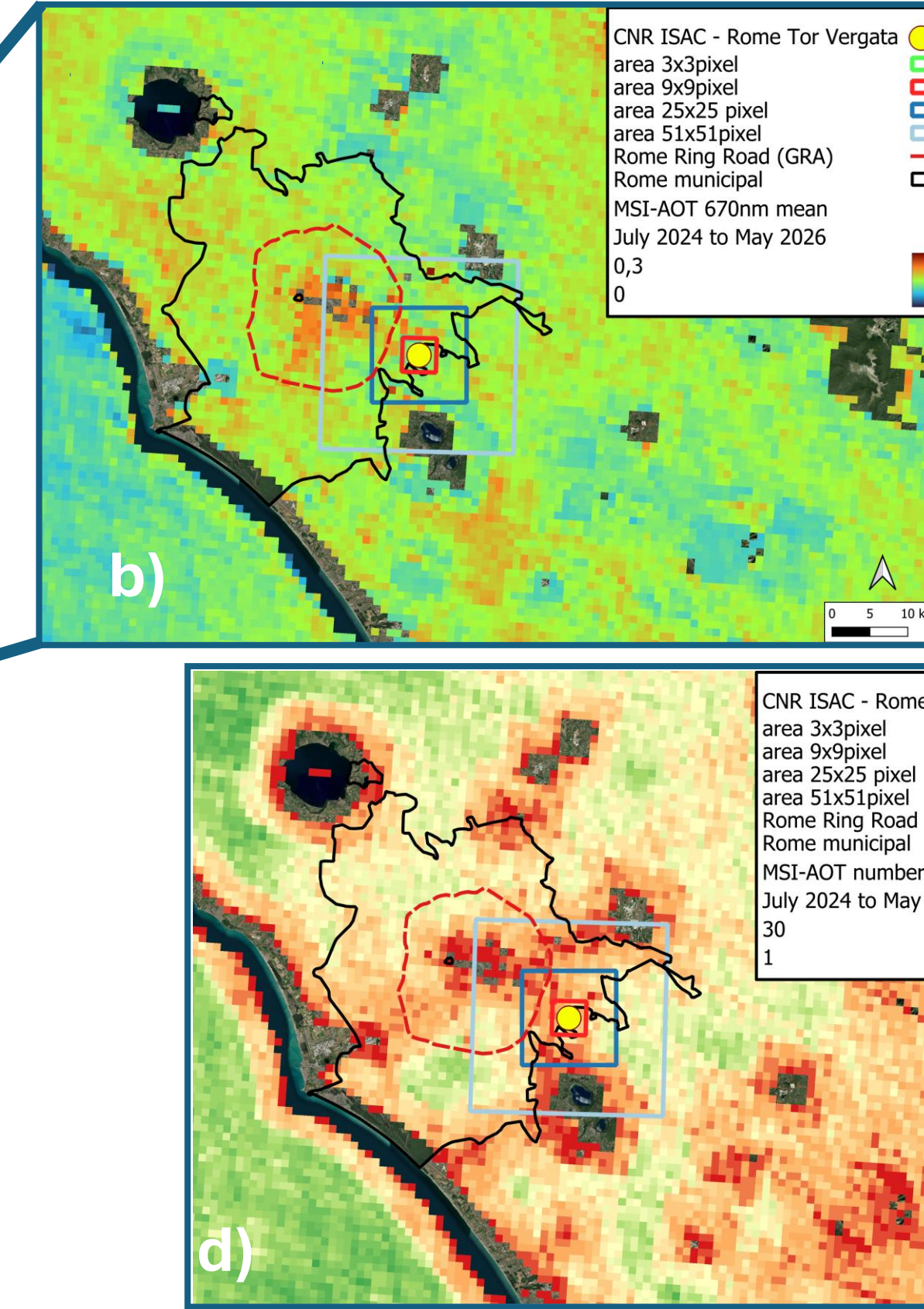


Fig. 2b & 2d: Zoom of Fig. 2a and Fig. 2c over the Rome area, and spatial windows used (from 3x3 to 51x51 pixels) for each matchup.

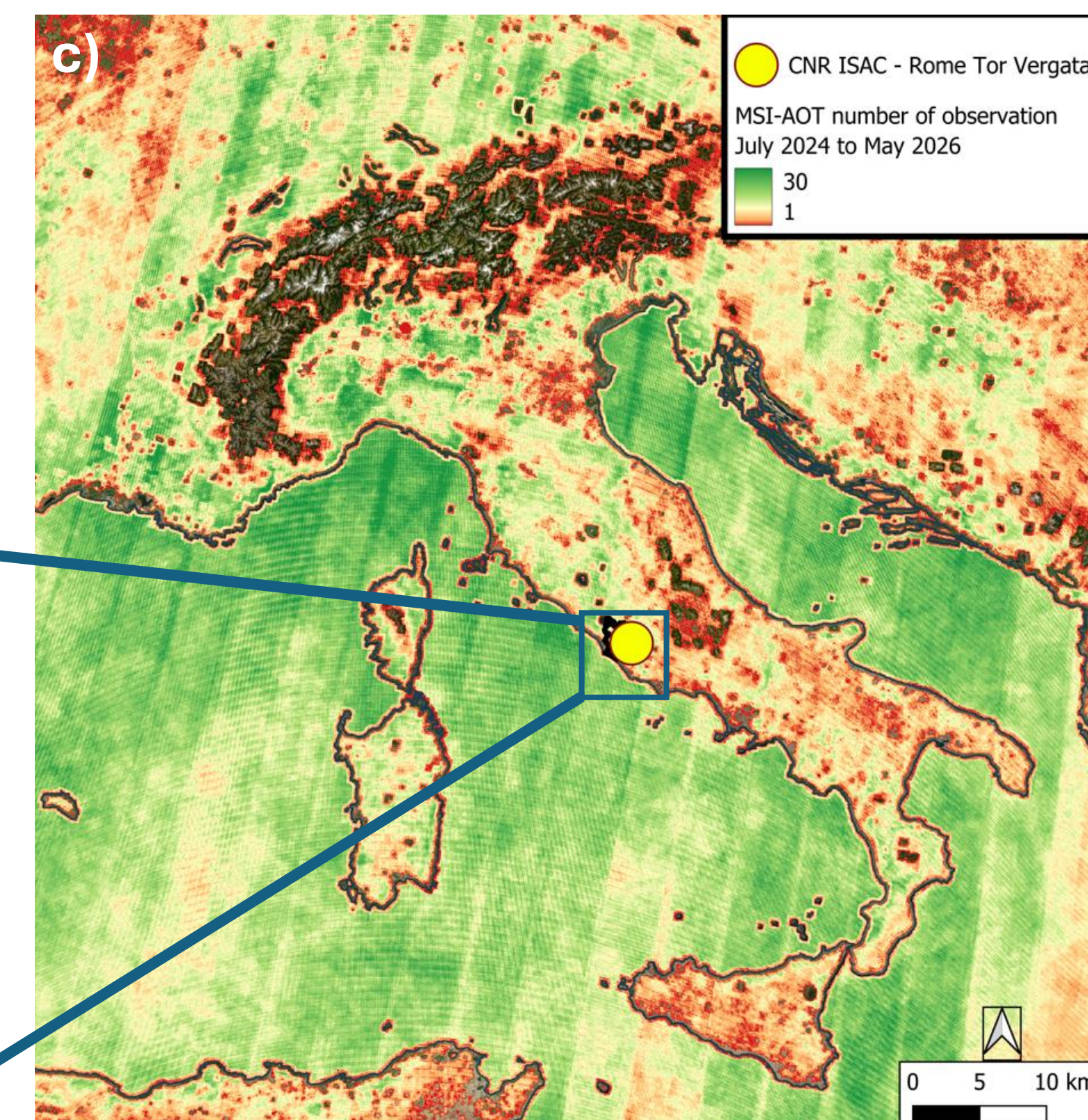


Fig. 2c: Pixel-resolved number of data included in the mean AOT reported in Fig. 2a. Blind areas (no data) are visible near coasts, water surfaces, and mountainous terrain.

## Scatter plots of MSI-AOT @ 670nm vs AERONET/SKYNET AOT @675nm over Italy

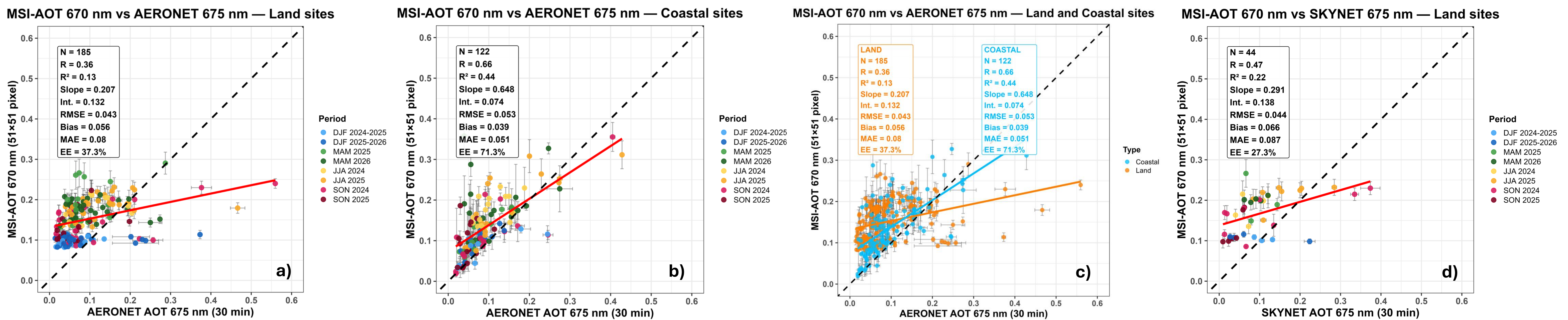


Fig. 3. Scatterplot of MSI-AOT @670 nm vs relevant AERONET data, over Land-sites (a), Coastal sites (b) and their combination (c). Fig. 3d is the same of Fig. 3a but for the 3 SKYNET sites available. Relevant data statistics are reported in the plots insets.

MSI-AOT shows poor correlation with AERONET over land ( $R = 0.36$ , Bias = +0.056, EE = 37.3%), with a regression line slope of 0.2. A similar result is obtained for the comparison with SKYNET. Over land, the MSI-AOT shows a clear bias as the AOT never reaches values below or  $\sim 0.1$ . No clear dependence of these results on season is evident (Fig. 3a, b). Agreement of MSI with ground based data markedly improves for sites in coastal areas (Fig. 3b, c,  $R = 0.66$ , Bias = +0.039, EE = 71.3%), likely due to the different retrieval algorithm with respect to the land one.

## Time variation of MSI and AERONET/SKYNET AOT

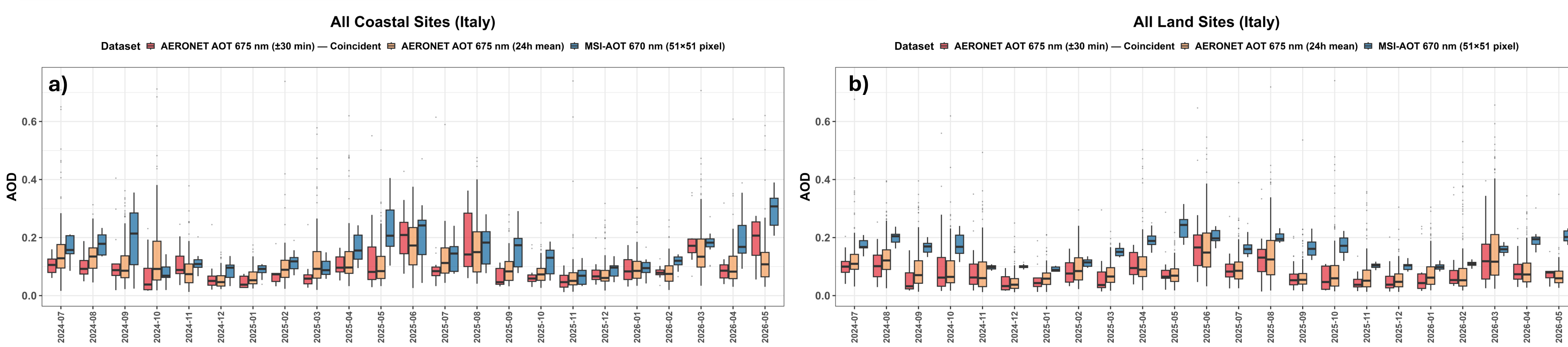


Fig. 4. Monthly-resolved statistics (median and 25-75% perc) of AOT from MSI (blue), and AERONET using both all available daily-mean AERONET data (yellow) or only those AERONET data coincident ( $\pm 30$  min) with the satellite overpasses. Fig. 4a shows the results for coastal sites while Fig. 4b for the land ones

## Key messages

- Number of MSI AOT data retrievals is still insufficient to draw main conclusions.
- Better performances of the AOT retrievals over Ocean are evident.
- Over Land, MSI AOT has a bias, well visible in both the scatter plots and the time series, which markedly affects its overall performances.
- This analysis is work in progress and run in parallel to the one with ATLID.