Supplementary material

Optimizing Near Real-Time Detection of Deforestation on Tropical Rainforests using Sentinel-1 Data

Supplementary material of Optimizing Near Real-Time Detection of Deforestation on Tropical Rainforests using Sentinel-1 Data

Table S1: Characteristics of the collected forest Time Series.

| Polarization | Period | Treatment | # Samples per treat. | Backscattering intensity (\(\gamma_0\)) |
|--------------|--------|-----------|----------------------|---------------------------------------|
|              |        |           | Total | Mean | Mean | Std. dev. |
| VHg0         | 1 yr   | harmon    | 139873 | 56.8 | 0.056 | 0.0219 |
|              |        | harmonf   |        |      | 0.0559 | 0.0072 |
|              |        | orig      |        |      | 0.0561 | 0.022  |
|              |        | origf     |        |      | 0.056 | 0.0074 |
|              |        | spatial   |        |      | 0.0561 | 0.0217 |
|              |        | spatialf  |        |      | 0.056 | 0.0066 |
|              | 2 yr   | harmon    | 212362 | 86  | 0.0567 | 0.022  |
|              |        | harmonf   |        |      | 0.0567 | 0.0073 |
|              |        | orig      |        |      | 0.0567 | 0.0075 |
|              |        | origf     |        |      | 0.0567 | 0.0219 |
|              |        | spatial   |        |      | 0.0567 | 0.0066 |
|              |        | spatialf  |        |      | 0.0567 | 0.0066 |
| VVg0         | 1 yr   | harmon    | 139893 | 56.8 | 0.2393 | 0.0898 |
|              |        | harmonf   |        |      | 0.2387 | 0.0291 |
|              |        | orig      |        |      | 0.2396 | 0.0905 |
|              |        | origf     |        |      | 0.239 | 0.0306 |
|              |        | spatial   |        |      | 0.2396 | 0.0892 |
|              |        | spatialf  |        |      | 0.239 | 0.0273 |
|              | 2 yr   | harmon    | 212371 | 86  | 0.2373 | 0.0888 |
|              |        | harmonf   |        |      | 0.2369 | 0.0289 |
|              |        | orig      |        |      | 0.2375 | 0.09 |
|              |        | origf     |        |      | 0.2371 | 0.0306 |
|              |        | spatial   |        |      | 0.2375 | 0.0886 |
|              |        | spatialf  |        |      | 0.2371 | 0.0271 |

Table S2: Characteristics of the collected deforestation Time Series.

| Polarization | Period | Treatment | # Samples | Backscattering intensity (\(\gamma_0\)) |
|--------------|--------|-----------|-----------|---------------------------------------|
|              |        |           | Total | Mean | Mean | Std. dev. |
| VHg0         | 1 yr   | harmon    | 149413 | 58  | 0.049 | 0.023 |
|              |        | harmonf   |        |      | 0.049 | 0.012 |
|              |        | orig      |        |      | 0.049 | 0.023 |
|              |        | origf     |        |      | 0.049 | 0.013 |
|              |        | spatial   |        |      | 0.049 | 0.022 |
|              |        | spatialf  |        |      | 0.049 | 0.011 |
| Polarization | Period | Treatment  | # Samples | Backscattering intensity ($\gamma^0$) |
|-------------|--------|-----------|-----------|-------------------------------------|
|             |        |           | Total     | Mean      | Std. dev. | Mean      | Std. dev. |
|             | 2 yr   | harmon    | 225265    | 88        | 0.052    | 0.023    |
|             |        | harmonf   |           |           | 0.052    | 0.012    |
|             |        | orig      |           |           | 0.052    | 0.023    |
|             |        | origf     |           |           | 0.052    | 0.012    |
|             |        | spatial   |           |           | 0.052    | 0.022    |
|             |        | spatialf  |           |           | 0.051    | 0.01     |
| VVg0        | 1 yr   | harmon    | 149792    | 59        | 0.211    | 0.092    |
|             |        | harmonf   |           |           | 0.212    | 0.044    |
|             |        | orig      |           |           | 0.212    | 0.093    |
|             |        | origf     |           |           | 0.212    | 0.048    |
|             |        | spatial   |           |           | 0.212    | 0.09     |
|             |        | spatialf  |           |           | 0.211    | 0.042    |
|             | 2 yr   | harmon    | 225514    | 88        | 0.217    | 0.092    |
|             |        | harmonf   |           |           | 0.217    | 0.041    |
|             |        | orig      |           |           | 0.217    | 0.092    |
|             |        | origf     |           |           | 0.217    | 0.044    |
|             |        | spatial   |           |           | 0.217    | 0.09     |
|             |        | spatialf  |           |           | 0.217    | 0.039    |

**Figure S1:** Box-plot of the coefficient of variation of the forest speckle-filtered time series, without stabilization (origf), with harmonic stabilization (harmonf) and with spatial stabilization (spatialf).

**Table S1:** Mean reduction of the variability of the time series, as measured by the coefficient of variation.
| Period | Polarization | Change Origf-Harmon (%) | Change Origf-Spatialf (%) |
|--------|--------------|-------------------------|--------------------------|
| 1 yr   | VHg0         | -2.83                   | -10.59                   |
| 1 yr   | VVg0         | -4.85                   | -10.20                   |
| 2 yr   | VHg0         | -3.30                   | -10.43                   |
| 2 yr   | VVg0         | -4.57                   | -10.10                   |

**Figure S2:** Results of the Shapiro-Wilk normality test applied to the treated and non-treated forested TS. orig – original Sentinel-1 backscattering samples, origf – original TS filtered, harmon – original TS stabilized using harmonic fitting, harmonf – original TS stabilized using harmonic fitting and then filtered, spatial – original TS stabilized using spatial stabilization, spatialf – original TS stabilized using spatial stabilization and then filtered.

**Table S4:** Results of the Shapiro-Wilk test for normality of Forest time series, in terms of number of TS passing the tests with a significance of 5%.

| Polarization | Period | Treatment | Shapiro-Wilk p>0.05 |
|--------------|--------|-----------|---------------------|
|              |        | Total     | %                   |
| VHg0         | 1 yr   | harmon    | 998                 | 40.29               |
|              |        | harmonf   | 2137                | 86.27               |
|              |        | orig      | 696                 | 28.10               |
|              |        | origf     | 2022                | 81.63               |
|              |        | spatial   | 735                 | 29.67               |
|              |        | spatialf  | 2084                | 84.13               |
|              | 2 yr   | harmon    | 430                 | 17.36               |
|              |        | harmonf   | 1989                | 80.30               |
| Polarization | Period | Treatment | KS p>0.05 | Total |
|--------------|--------|-----------|-----------|-------|
| VHg0         | 1 yr   | harmon    | 2476      | 100.0 |
| VHg0         | 1 yr   | orig      | 2475      | 99.9  |
| VHg0         | 1 yr   | spatial   | 2477      | 100.0 |
| VHg0         | 2 yr   | harmon    | 2475      | 99.9  |
| VHg0         | 2 yr   | orig      | 2475      | 99.9  |
| VHg0         | 2 yr   | spatial   | 2474      | 99.9  |
| VVg0         | 1 yr   | harmon    | 2475      | 99.9  |
| VVg0         | 1 yr   | orig      | 2472      | 99.8  |
| VVg0         | 1 yr   | spatial   | 2474      | 99.9  |
| VVg0         | 2 yr   | harmon    | 2476      | 100.0 |
| VVg0         | 2 yr   | orig      | 2473      | 99.8  |
| VVg0         | 2 yr   | spatial   | 2474      | 99.9  |

Table S5: Results of the Kolmogorov-Smirnoff test for gamma-distribution fitting of unfiltered Forest time series, in terms of the number of TS passing the tests with a significance lower than 5%.
Figure S3: Jeffries-Matsushita distance of the F/DF classes as computed by the finite mixture algorithm.

Figure S4: Density distribution of the values of the deforestation log-likelihood of the validation samples, by TS classes (DF= deforested time series, F= Forest time series).

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