

# Supplementary material: Land Cover Classification with Gaussian Processes using spatio-spectro-temporal features

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## I. COMPARISON OF DIFFERENT METHODS FOR THE SELECTION OF THE INDUCING POINTS

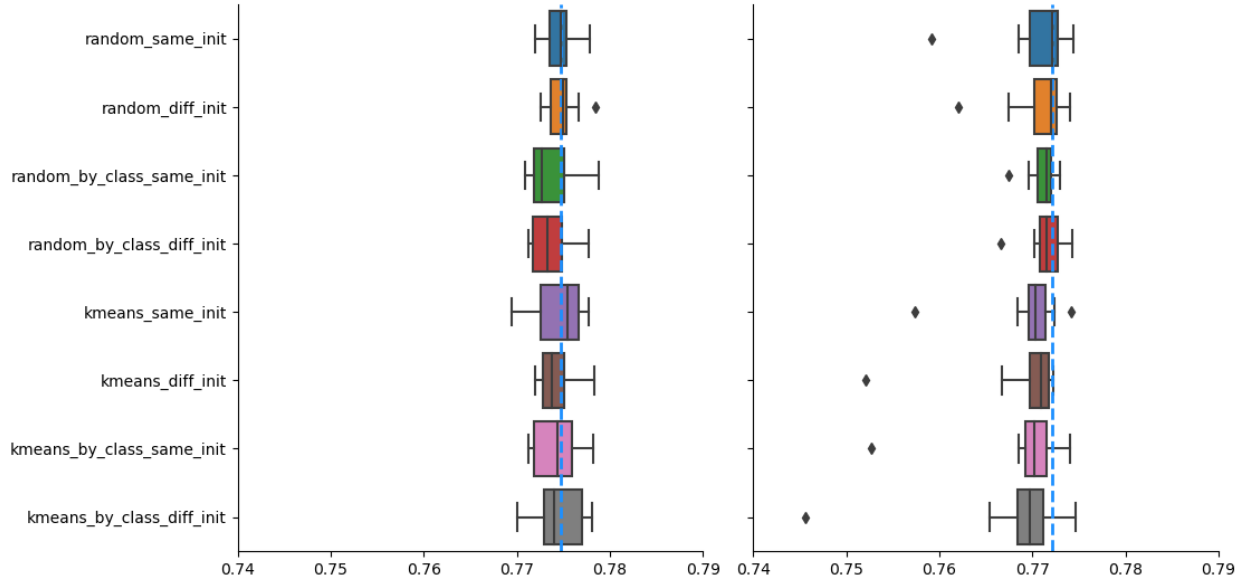


Fig. 1: Boxplot of the overall accuracy (computed over 11 runs) for different methods of the selection of inducing points. **random\***: random selection with no constraint, **random\_by\_class\***: random selection with the same number of pixels for each class, **kmeans\***: k-means clustering with no constraint, **kmeans\_by\_class\***: k-means clustering with the same number of pixels for each class, **\*same\_init**: same initialization for each latent process, **\*diff\_init**: different initialization for each latent process. Left: *stratification* configuration. Right: *global* configuration.

## II. SPATIAL REPARTITION OF THE LABELLED AND UNLABELLED PIXELS ON A BOUNDARY ZONE



Fig. 2: Labelled pixels are represented with  $\bullet$  and unlabelled pixels are represented with  $\bullet$ . These pixels are extracted from the  $2B = 2000m$  boundary zone between regions 4 and 7 in the T31TCJ tile.

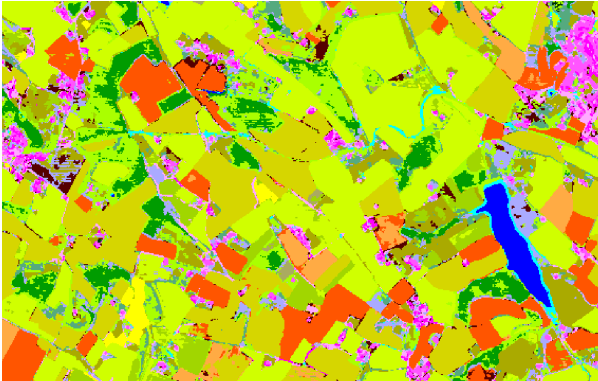


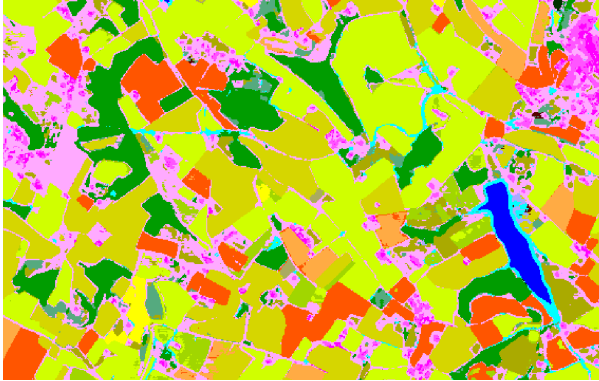


## III. QUANTITATIVE RESULTS: PERFORMANCE RESULTS IN THE SOUTHFRANCE AREA

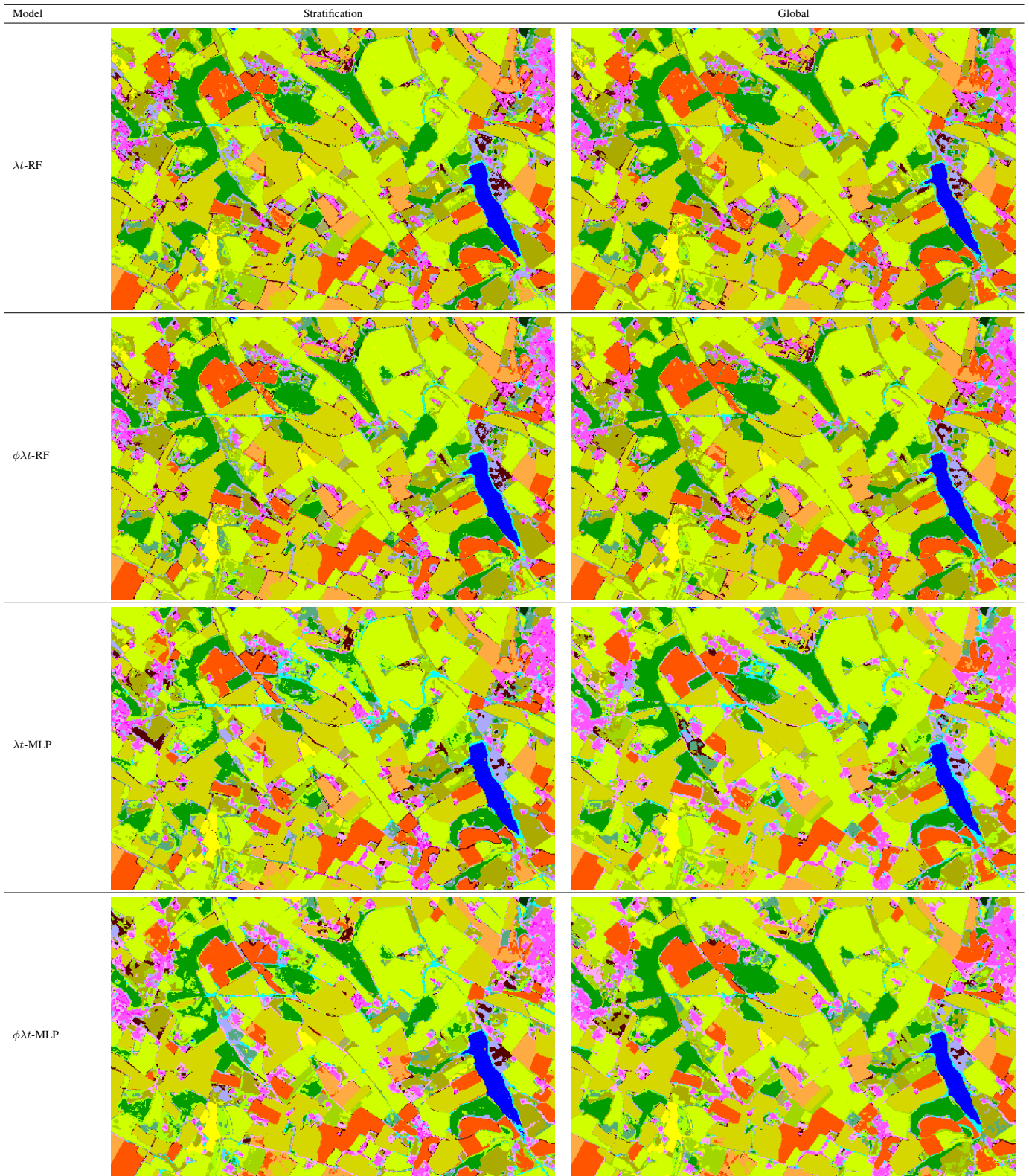
TABLE I: Averaged training (T) and prediction (P) times for each model and each region (mean in seconds computed with 11 runs). The white line corresponds to the data set DS-A and the gray line corresponds to the data set DS-B.

Region	Time	Model								
		$\lambda t$ -GP	$\phi\lambda t$ -GPSC	$\phi\lambda t$ -GPPC	$\lambda t$ -RF	$\phi\lambda t$ -RF	$\lambda t$ -MLP	$\phi\lambda t$ -MLP	$\lambda t$ -LTAE	$\phi\lambda t$ -LTAE
1	T	275	446	307	15	15	174	175	138	137
		862	1425	978	58	57	556	558	440	437
	P	22	25	22	1	1	1	1	1	1
		35	37	29	2	2	1	1	2	2
2	T	305	495	342	16	17	200	200	158	156
		1051	1740	1197	72	71	711	709	552	551
	P	25	31	25	1	1	1	1	1	1
		43	41	48	3	3	2	2	3	3
3	T	216	333	237	11	11	151	150	119	119
		662	1051	754	43	43	474	474	376	374
	P	20	24	20	1	1	1	1	1	1
		31	31	32	2	2	1	1	2	2
4	T	307	501	345	17	17	203	204	158	158
		1200	1987	1371	84	83	811	809	627	626
	P	27	33	27	2	1	1	1	2	2
		50	54	50	3	3	2	2	3	3
5	T	320	527	362	18	17	206	206	162	162
		1104	1829	1275	74	72	723	721	564	561
	P	26	32	26	2	1	1	1	1	1
		46	50	50	3	3	2	2	3	3
6	T	321	527	361	17	17	207	208	163	162
		1203	1972	1364	75	75	779	785	607	603
	P	28	34	28	2	2	1	1	2	2
		52	57	50	3	3	2	2	3	3
7	T	287	399	319	15	15	193	193	150	150
		1088	1538	1229	70	69	751	753	581	583
	P	24	28	24	1	1	1	1	1	1
		48	49	47	3	3	2	2	3	3
8	T	325	537	370	18	18	212	212	165	164
		1252	2069	1417	85	83	819	819	636	634
	P	29	34	28	2	2	1	1	2	2
		56	58	55	4	4	2	2	3	3
Global	T	2500	4118	2869	189	184	1988	1989	1346	1348
		8708	15411	10566	895	888	7540	7586	5012	5021
	P	170	233	216	18	17	11	11	14	14
		276	336	314	47	44	21	21	27	27

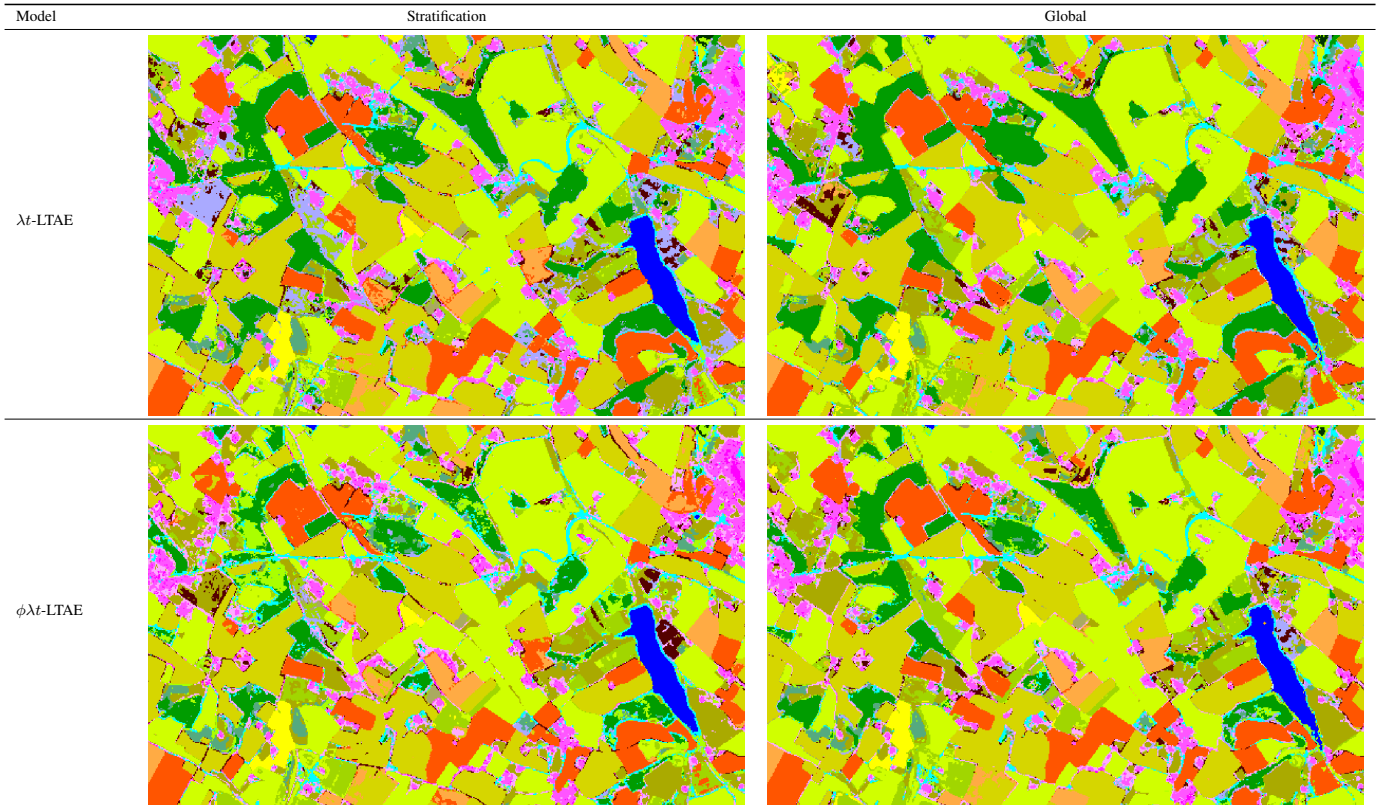
#### IV. QUALITATIVE RESULTS: PERFORMANCE RESULTS IN THE SOUTHFRANCE AREA

TABLE II: Comparison of the land cover maps obtained with each model in both configurations (stratification and global) on an agricultural area around Toulouse (tile *T31TCJ*). Topography informations (30-meter STRM) and Sentinel-2 image (RGB) (acquisition date: 15/05/18) of the specific zone are provided.

Model	Stratification	Global
$\lambda$ -GP		
$\phi\lambda$ -GPSC		
$\phi\lambda$ -GPPC		







## V. QUANTITATIVE RESULTS: CONTINUITY ANALYSIS IN BOUNDARY ZONES

TABLE III: Averaged percentage of agreement (between two borderer models) for different sizes of boundary zones ( $B \in \{100, 200, 500, 1000\}$ ) (mean %  $\pm$  standard deviation computed with 11 runs). Comparison between unlabeled pixels and labeled pixels correctly predicted.

$B$	Pixels	$\lambda t$ -GP	$\phi \lambda t$ -GPSC	$\phi \lambda t$ -GPPC	$\lambda t$ -RF	$\phi \lambda t$ -RF	$\lambda t$ -MLP	$\phi \lambda t$ -MLP	$\lambda t$ -LTAE	$\phi \lambda t$ -LTAE
100	unlabelled	66.3 $\pm$ 0.7	64.6 $\pm$ 1.0	66.2 $\pm$ 0.8	72.6 $\pm$ 0.5	72.1 $\pm$ 0.4	65.2 $\pm$ 0.6	64.4 $\pm$ 0.6	68.4 $\pm$ 0.6	66.0 $\pm$ 0.8
	labelled correctly predicted	66.6 $\pm$ 0.6	68.5 $\pm$ 0.6	69.8 $\pm$ 0.6	69.2 $\pm$ 0.4	70.5 $\pm$ 0.8	64.9 $\pm$ 0.4	65.6 $\pm$ 0.4	66.4 $\pm$ 0.4	68.2 $\pm$ 0.5
200	unlabelled	66.2 $\pm$ 0.7	64.7 $\pm$ 0.9	66.2 $\pm$ 0.8	72.6 $\pm$ 0.5	72.1 $\pm$ 0.3	65.1 $\pm$ 0.6	64.4 $\pm$ 0.6	68.3 $\pm$ 0.6	66.0 $\pm$ 0.9
	labelled correctly predicted	66.5 $\pm$ 0.6	68.3 $\pm$ 0.6	69.5 $\pm$ 0.6	69.2 $\pm$ 0.4	70.5 $\pm$ 0.4	64.9 $\pm$ 0.4	65.6 $\pm$ 0.4	66.3 $\pm$ 0.4	68.1 $\pm$ 0.5
500	unlabelled	66.0 $\pm$ 0.7	64.5 $\pm$ 0.9	66.1 $\pm$ 0.8	72.5 $\pm$ 0.5	71.8 $\pm$ 0.3	65.0 $\pm$ 0.5	64.2 $\pm$ 0.6	68.2 $\pm$ 0.6	65.9 $\pm$ 0.8
	labelled correctly predicted	66.6 $\pm$ 0.5	68.2 $\pm$ 0.5	69.4 $\pm$ 0.5	69.3 $\pm$ 0.4	70.5 $\pm$ 0.3	65.1 $\pm$ 0.4	65.8 $\pm$ 0.4	66.4 $\pm$ 0.4	68.2 $\pm$ 0.5
1000	unlabelled	65.8 $\pm$ 0.7	64.3 $\pm$ 0.9	65.8 $\pm$ 0.8	72.3 $\pm$ 0.5	71.8 $\pm$ 0.3	64.8 $\pm$ 0.6	64.0 $\pm$ 0.6	68.0 $\pm$ 0.6	65.7 $\pm$ 0.8
	labelled correctly predicted	66.9 $\pm$ 0.5	68.5 $\pm$ 0.5	69.7 $\pm$ 0.5	69.4 $\pm$ 0.4	70.8 $\pm$ 0.4	65.4 $\pm$ 0.3	66.2 $\pm$ 0.3	66.8 $\pm$ 0.4	68.6 $\pm$ 0.5

TABLE IV: Averaged overall accuracy (OA) computed on labeled pixels for different sizes of boundary zones ( $B \in \{100, 200, 500, 1000\}$ ) (mean %  $\pm$  standard deviation computed with 11 runs). Comparison between global configuration and stratification configuration.

$B$	Pixels	$\lambda t$ -GP	$\phi \lambda t$ -GPSC	$\phi \lambda t$ -GPPC	$\lambda t$ -RF	$\phi \lambda t$ -RF	$\lambda t$ -MLP	$\phi \lambda t$ -MLP	$\lambda t$ -LTAE	$\phi \lambda t$ -LTAE
100	global	77.1 $\pm$ 0.6	79.3 $\pm$ 0.7	79.9 $\pm$ 0.6	77.7 $\pm$ 0.1	78.7 $\pm$ 0.4	77.8 $\pm$ 0.2	78.8 $\pm$ 0.1	78.0 $\pm$ 0.4	80.6 $\pm$ 0.2
	stratification	74.6 $\pm$ 0.4	76.5 $\pm$ 0.4	77.3 $\pm$ 0.4	75.6 $\pm$ 0.2	76.8 $\pm$ 0.7	73.1 $\pm$ 0.3	74.0 $\pm$ 0.2	74.2 $\pm$ 0.3	76.2 $\pm$ 0.3
200	global	77.0 $\pm$ 0.6	79.2 $\pm$ 0.6	79.8 $\pm$ 0.6	77.6 $\pm$ 0.1	78.7 $\pm$ 0.1	77.8 $\pm$ 0.3	78.7 $\pm$ 0.1	78.0 $\pm$ 0.4	80.6 $\pm$ 0.2
	stratification	74.6 $\pm$ 0.4	76.5 $\pm$ 0.3	77.2 $\pm$ 0.3	75.6 $\pm$ 0.2	76.9 $\pm$ 0.2	73.2 $\pm$ 0.3	74.0 $\pm$ 0.2	74.1 $\pm$ 0.3	76.2 $\pm$ 0.3
500	global	77.3 $\pm$ 0.6	79.3 $\pm$ 0.7	79.9 $\pm$ 0.6	77.7 $\pm$ 0.1	78.7 $\pm$ 0.1	77.9 $\pm$ 0.2	78.9 $\pm$ 0.1	78.1 $\pm$ 0.3	80.6 $\pm$ 0.2
	stratification	74.8 $\pm$ 0.3	76.4 $\pm$ 0.4	77.2 $\pm$ 0.3	75.9 $\pm$ 0.2	77.0 $\pm$ 0.2	73.6 $\pm$ 0.2	74.4 $\pm$ 0.2	74.4 $\pm$ 0.3	76.4 $\pm$ 0.3
1000	global	77.5 $\pm$ 0.6	79.6 $\pm$ 0.7	80.1 $\pm$ 0.6	77.8 $\pm$ 0.1	79.0 $\pm$ 0.1	78.1 $\pm$ 0.2	79.1 $\pm$ 0.1	78.3 $\pm$ 0.3	80.9 $\pm$ 0.2
	stratification	75.4 $\pm$ 0.3	77.0 $\pm$ 0.4	77.7 $\pm$ 0.2	76.2 $\pm$ 0.3	77.5 $\pm$ 0.2	74.1 $\pm$ 0.3	75.0 $\pm$ 0.2	74.8 $\pm$ 0.3	76.8 $\pm$ 0.3



## VI. QUALITATIVE RESULTS: CONTINUITY ANALYSIS IN BOUNDARY ZONES

TABLE V: Comparison of the land cover maps obtained with each model in both configurations (stratification and global) on an boundary zone between two eco-climatic regions (tile  $T31TDJ$ ). Topography informations (30-meter STRM) and Sentinel-2 image (RGB) (acquisition date: 15/06/18) of the specific zone are provided.

Model	Stratification	Global
$\lambda$ -GP		
$\phi\lambda$ -GPSC		
$\phi\lambda$ -GPPC		

