Supplementary Materials of:

AgroShadow: A new Sentinel-2 cloud shadow detection tool for precision agriculture

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The following pages include additional information concerning comparison among AgroShadow, Sen2Cor and MAJA tools (Tables S1 and S2).

Examples of TCI reference images and related classifications made by the three tools are also provided, showing site name and date.

Tables S3, S4 and S5 are the label codification used by Sen2Cor and MAJA tools for their classifications.

Table S1. Classification of false negative (missing shadows) of the three tools. CLM = clouds/cloud shadows classification mask; MG2 = geophysical mask.

	BLANK	DARK AREA	VEGETATED	NOT VEGETATED	WATER	UNCLASSIFIED	CLOUD MEDIUM PROBABILITY	THIN CIRRUS	ALL CLOUDS	Total
AgroShadow	NA	NA	**9255**	NA	NA	NA	NA	NA	NA	**9255**
Sen2Cor	NA	**5315**	**7291**	**2442**	**937**	**5089**	**815**	**21**	NA	**21910**
MAJA-CLM	**634**	NA	NA	NA	NA	NA	NA	NA	NA	**634**
MAJA-MG2	**634**	NA	NA	NA	NA	NA	NA	NA	**13322**	**13956**

Table S2. Classification of shadow and clouds over Rice-Alluvial plain scenes and classification of Snow, Fog and Concrete for the three tools. **Y**: correct classifications; **N**: misclassifications. Codifications of classes of Sen2Cor, MAJA-CLM and MAJA-MG2 are explained in Tables S3, S4 and S5 of these Supplementary Materials. CLM = clouds/cloud shadows classification mask; MG2 = geophysical mask.

	Fog		**Snow**		**Concrete**		**Rice-Alluvial**	
	Y	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**
AgroShadow	0	3186	172	24	769	0	14747	2239
Classes		**Vegetation**	**Snow**	**Vegetation**	**Concrete**		**Vegetation**	**Shadow**
Sen2Cor	3186	0	161	35	672	97	1958	15028
Classes	**L8**		**L11**	**L5, L7**	**L5, L7**	**L8, L9**	**L4**	**L2, L6, L7**
MAJA-CLM	3186	0	NA	NA	NA	NA	6528	10458
Classes	**ID139**						**Blank**	**ID11, ID27, ID33, ID43, ID59**
MAJA-MG2	3186	0	0	196	NA	NA		10458
Classes	**ID2**			**Blank**				**ID2, ID8, ID10**

Table S3. Codification of bits identifying MAJA-CLM classes.
(https://labo.obs-mip.fr/multitemp/sentinel-2/theias-sentinel-2-l2a-product-format/)

Label (bits)	Classes
ID11	clouds detected via multi-temporal thresholds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
ID15	clouds detected via multi-temporal thresholds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
	clouds detected via mono-temporal thresholds
ID27	thinnest clouds
	clouds detected via multi-temporal thresholds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
ID31	all clouds except the thinnest and all shadows
	all clouds (except the thinnest)
	clouds detected via mono-temporal thresholds
	clouds detected via multi-temporal thresholds
	thinnest clouds
ID33	cloud shadows cast by a detected cloud
	all clouds except the thinnest and all shadows
ID43	cloud shadows cast by a detected cloud
	clouds detected via multi-temporal thresholds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
ID47	cloud shadows cast by a detected cloud
	clouds detected via multi-temporal thresholds
	clouds detected via mono-temporal thresholds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
ID51	cloud shadows cast by a detected cloud
	thinnest clouds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
ID59	cloud shadows cast by a detected cloud
	thinnest clouds
	clouds detected via multi-temporal thresholds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
ID63	all clouds except the thinnest and all shadows
	all clouds (except the thinnest)
	clouds detected via mono-temporal thresholds
	clouds detected via multi-temporal thresholds
	thinnest clouds
	cloud shadows cast by a detected cloud
ID139	high clouds detected by 1.38 μm
	clouds detected via multi-temporal thresholds
	all clouds (except the thinnest)
	all clouds except the thinnest and all shadows
ID143	high clouds detected by 1.38 μm
	all clouds except the thinnest and all shadows
	all clouds (except the thinnest)
	clouds detected via mono-temporal thresholds
	clouds detected via multi-temporal thresholds

Table S4. Codification of bits identifying MAJA-MG2 classes.
(https://labo.obs-mip.fr/multitemp/sentinel-2/theias-sentinel-2-l2a-product-format/)

Label (bits)	Classes
ID2	All clouds (except the thinnest)
ID8	All shadows ("OU" des bits 5 et 6 du masque de nuages)
ID10	All clouds (except the thinnest)
	All shadows ("OU" des bits 5 et 6 du masque de nuages)

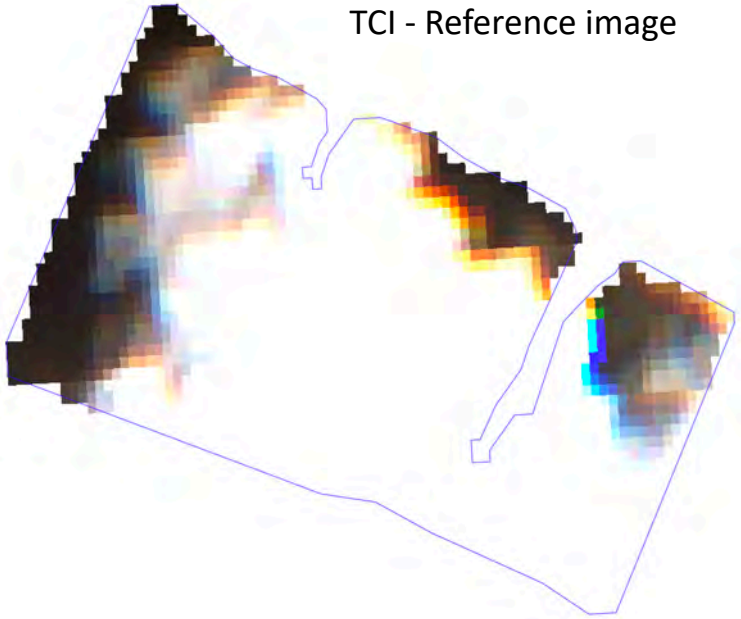
Table S5. Sen2Cor scene classification.
(https://dragon3.esa.int/web/sentinel/technical-guides/sentinel-2-msi/level-2a/algorithm)

Label	Classes
L0	No Data
L1	Saturated or Defective
L2	Dark Area Pixels
L3	Cloud Shadows
L4	Vegetation
L5	Not Vegetated
L6	Water
L7	Unclassified
L8	Cloud Medium Probability
L9	Cloud High Probability
L10	Thin Cirrus
L11	Snow

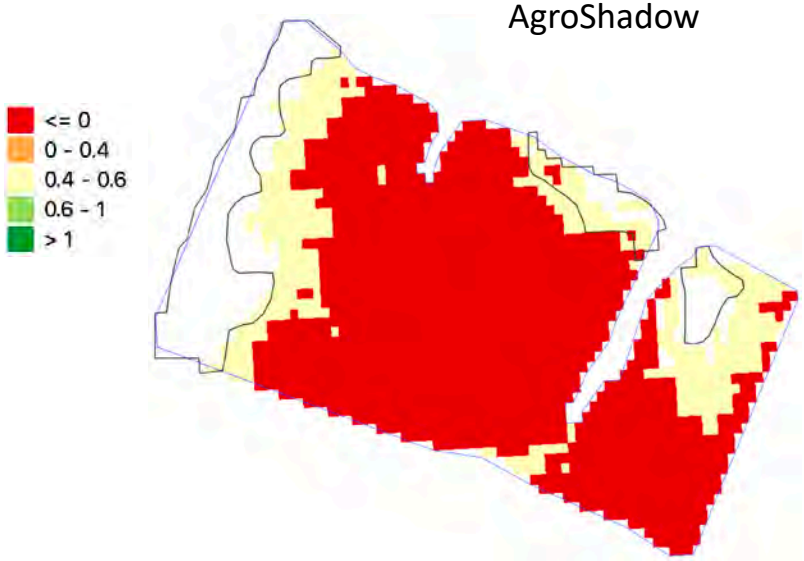
Comparison between TCI reference image, Agroshadow, Sen2Cor and MAJA shadow classifications

ENNA – T33SVB
(5 August 2020)

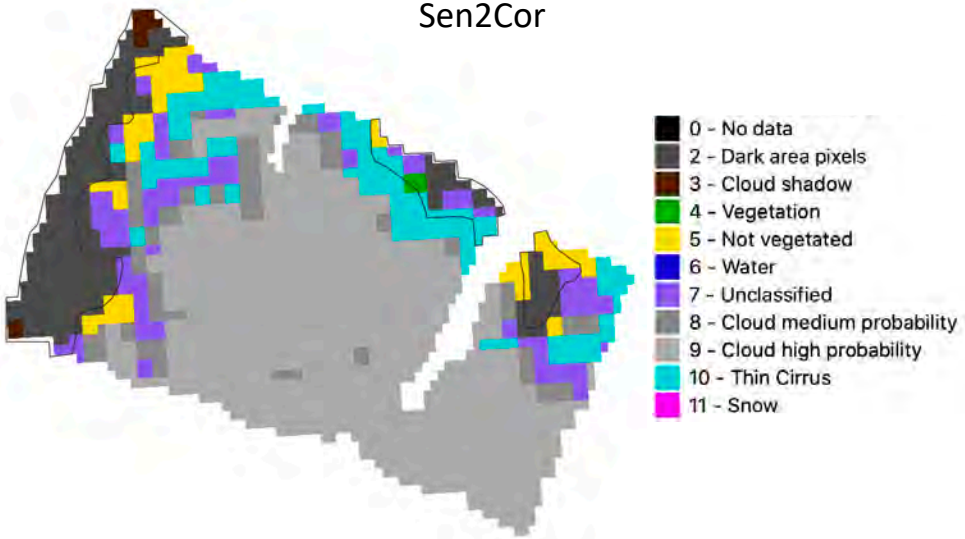
TCI - Reference image



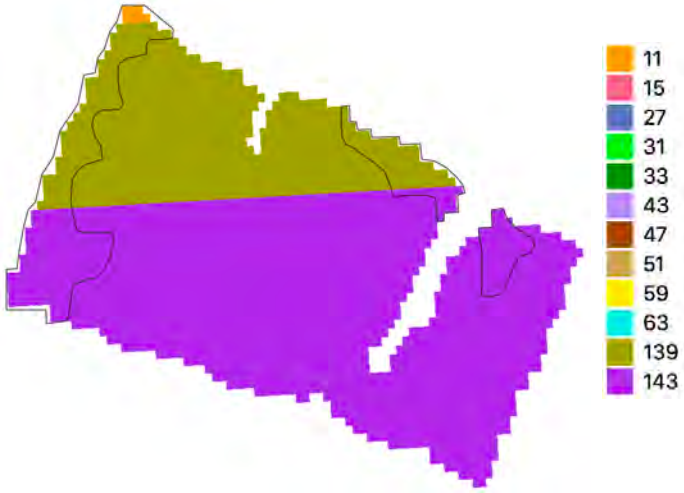
AgroShadow



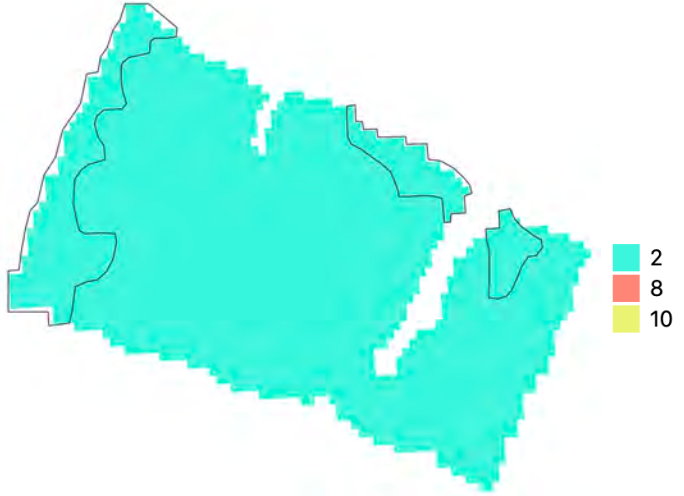
Sen2Cor



MAYA-CLM

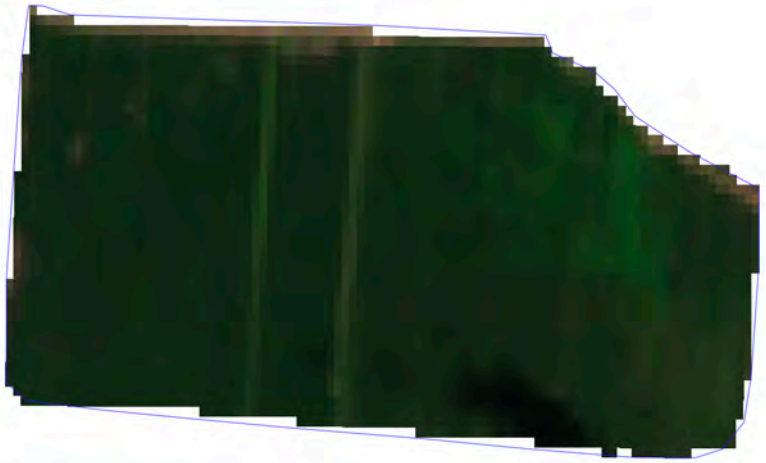


MAYA-MG2



ORISTANO – T32TMK
(3 September 2020)

TCI - Reference image



AgroShadow

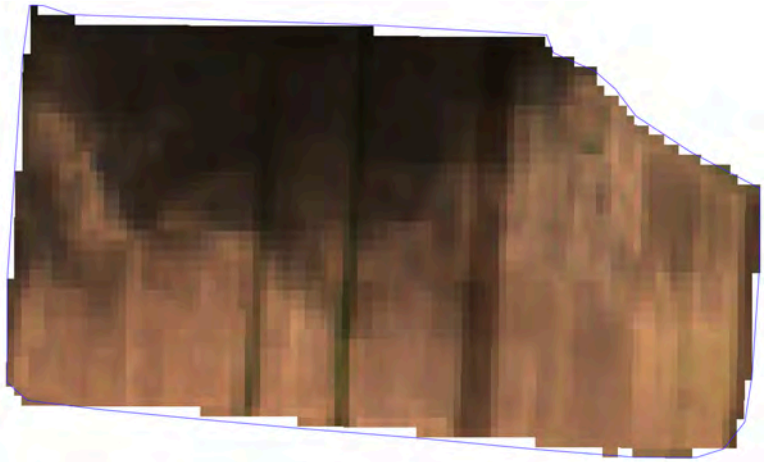
Sen2Cor

MAYA-CLM

MAYA-MG2

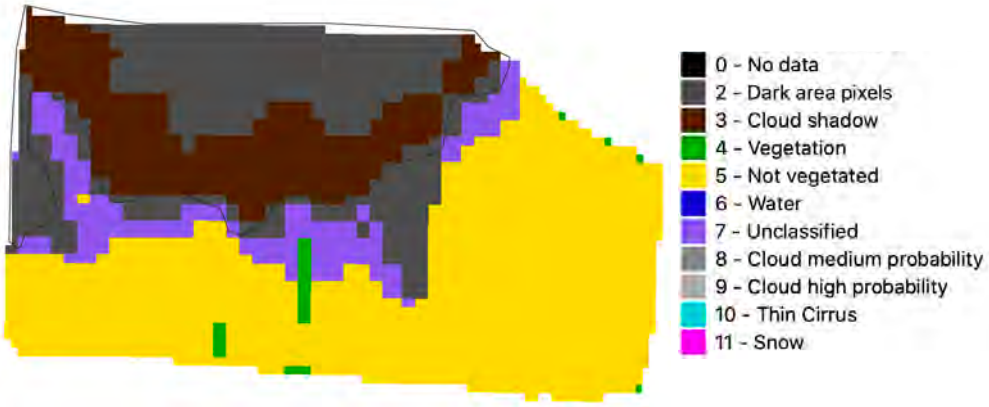
ORISTANO – T32TMK
(8 October 2020)

TCI - Reference image

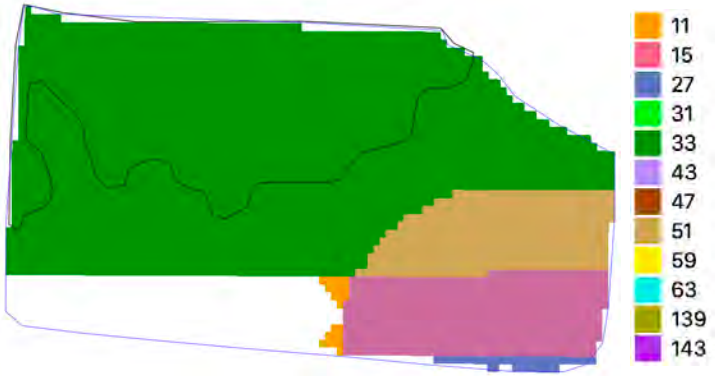


AgroShadow

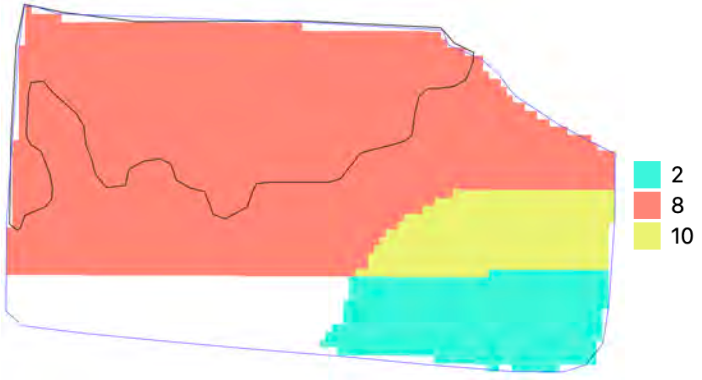
Sen2Cor



MAYA-CLM

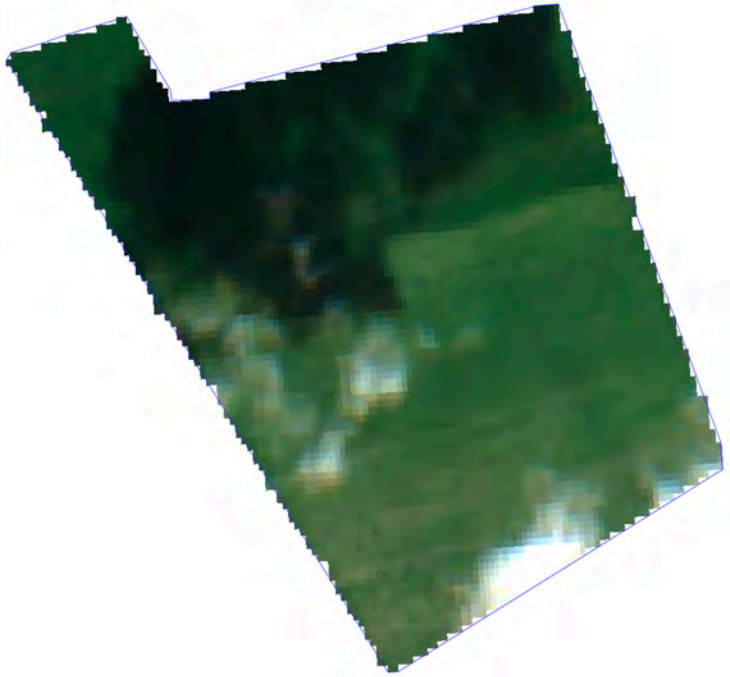


MAYA-MG2



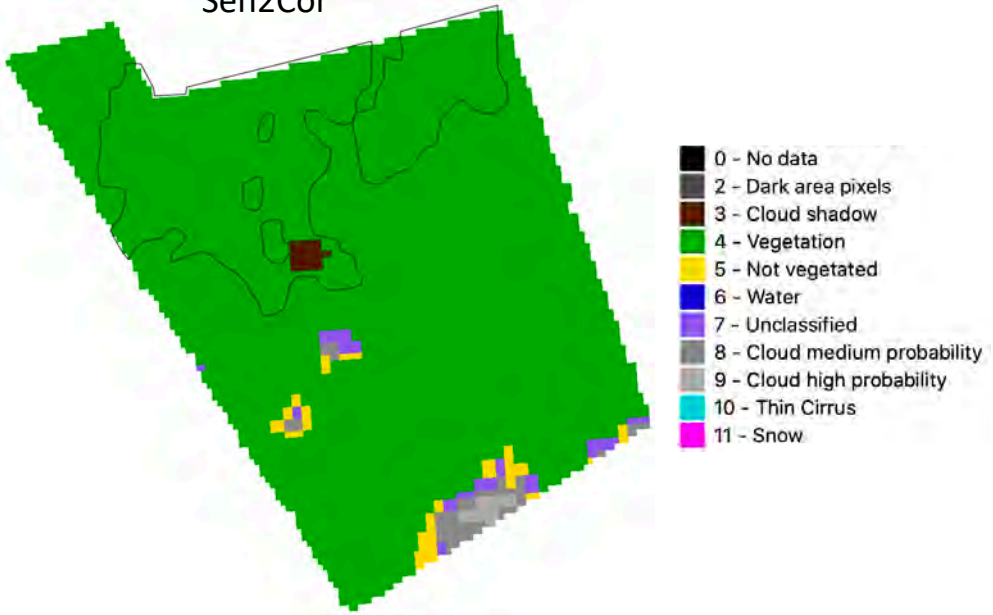
FOGGIA – T33TWF
(7 May 2020)

TCI - Reference image

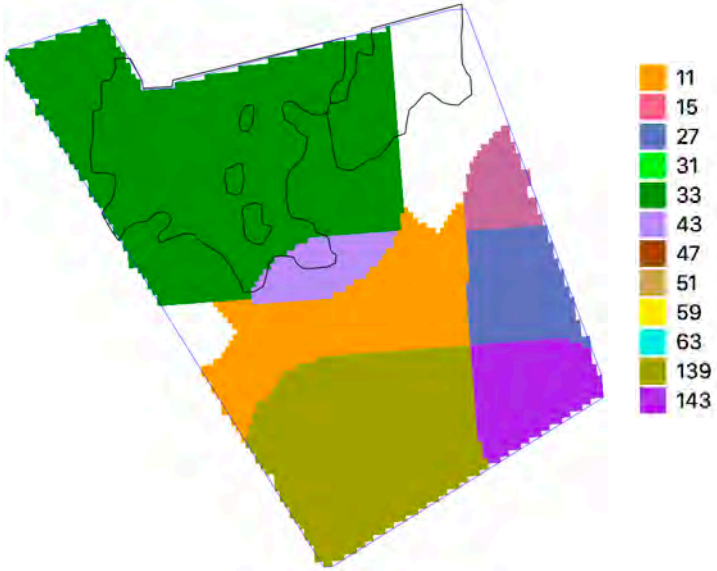


AgroShadow

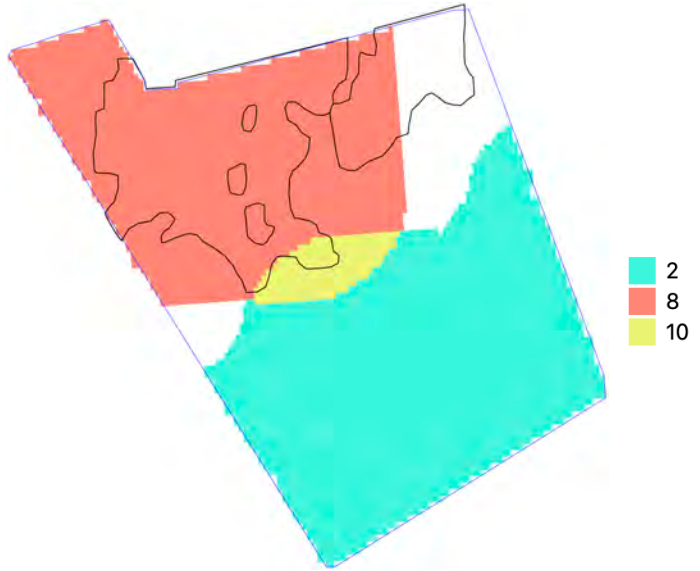
Sen2Cor



MAYA-CLM

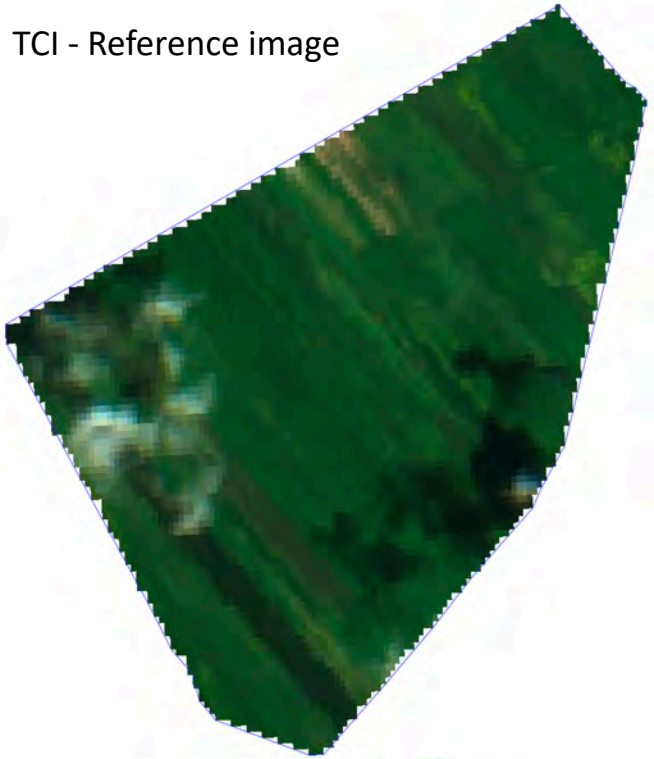


MAYA-MG2

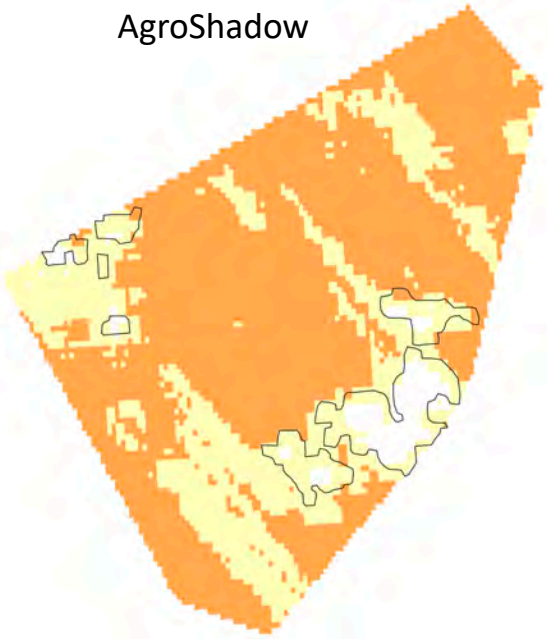


CASERTA – T33TVF
(27 April 2020)

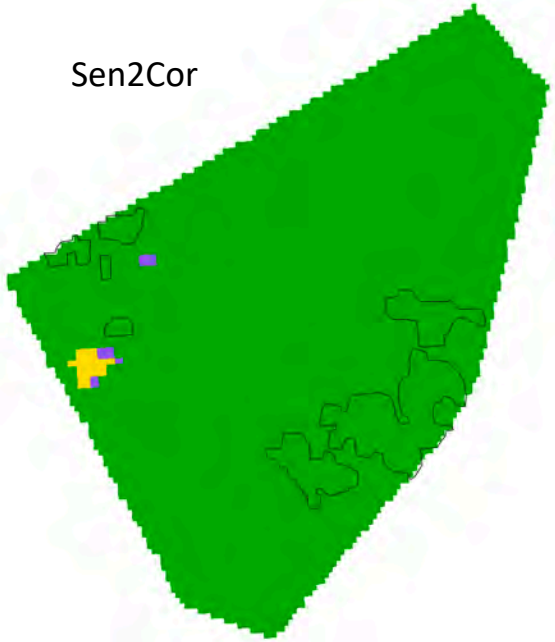
TCI - Reference image



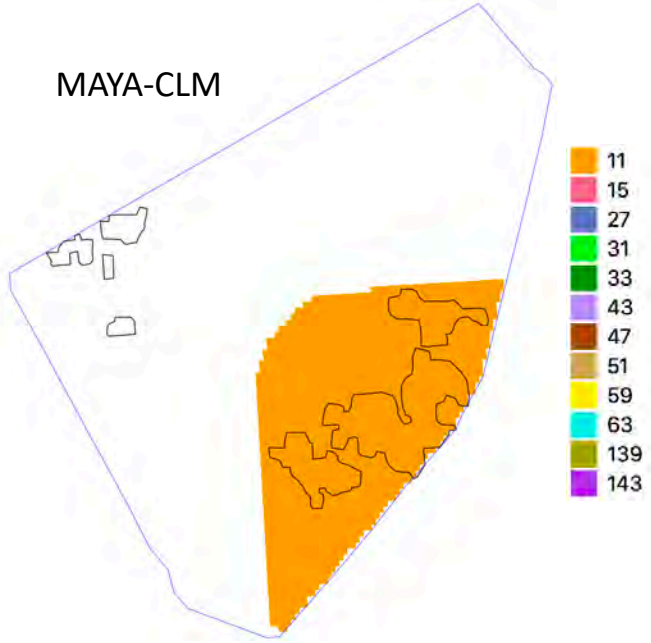
AgroShadow



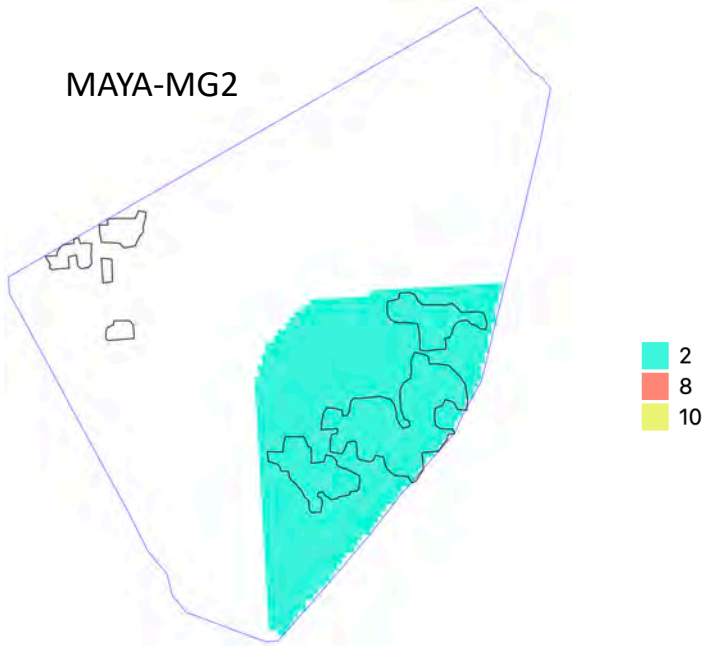
Sen2Cor



MAYA-CLM

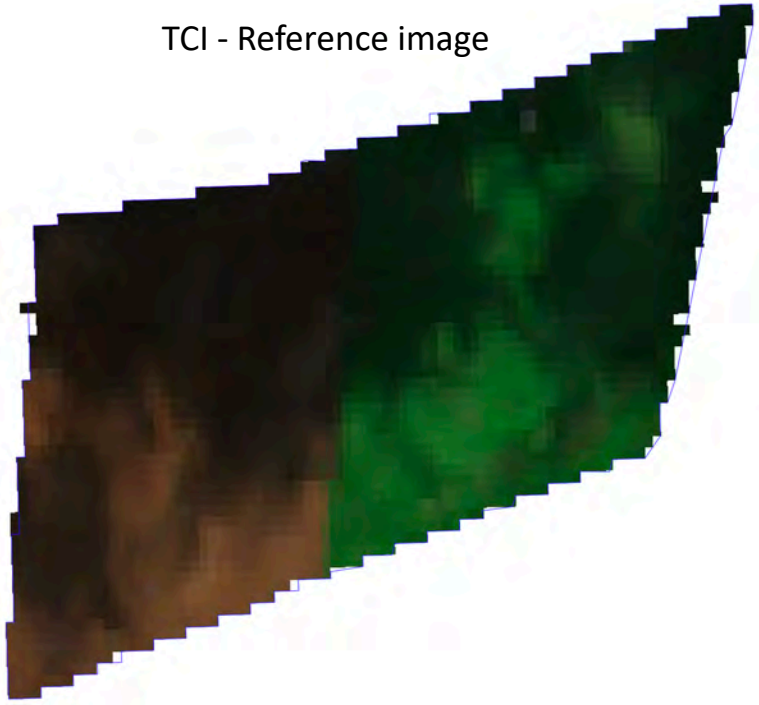


MAYA-MG2

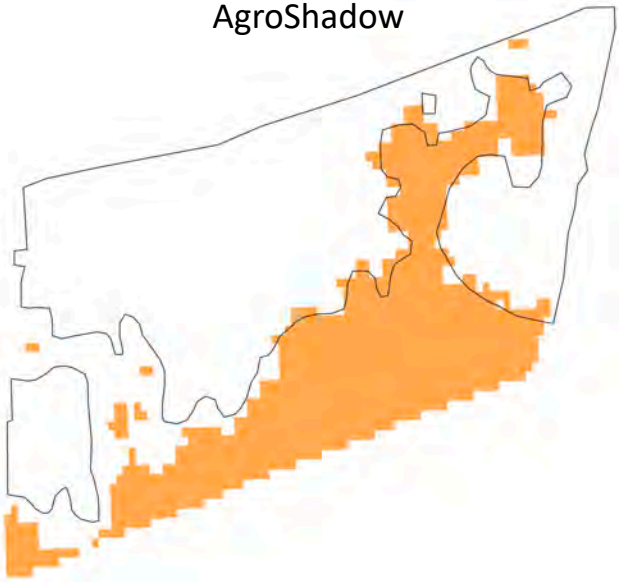


TUSCANIA – T32TQN
(22 October 2020)

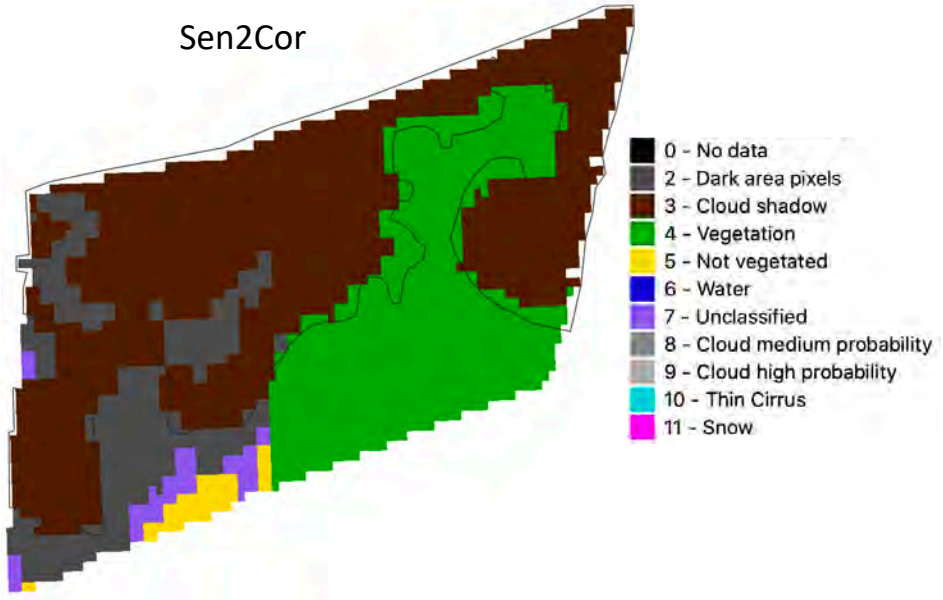
TCI - Reference image



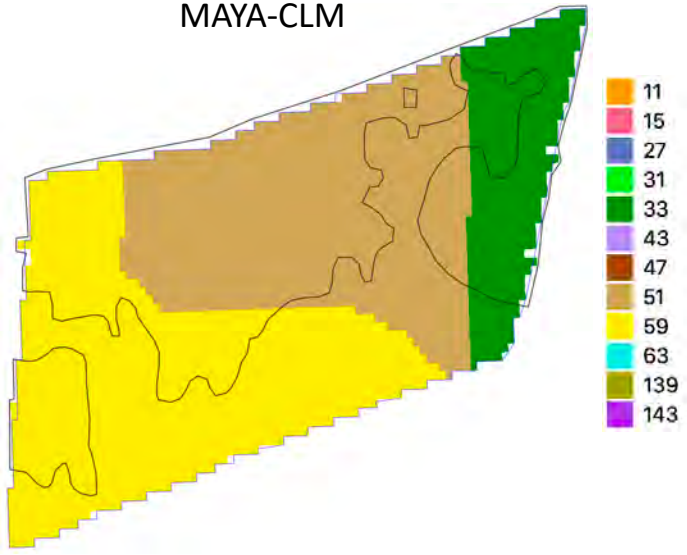
AgroShadow



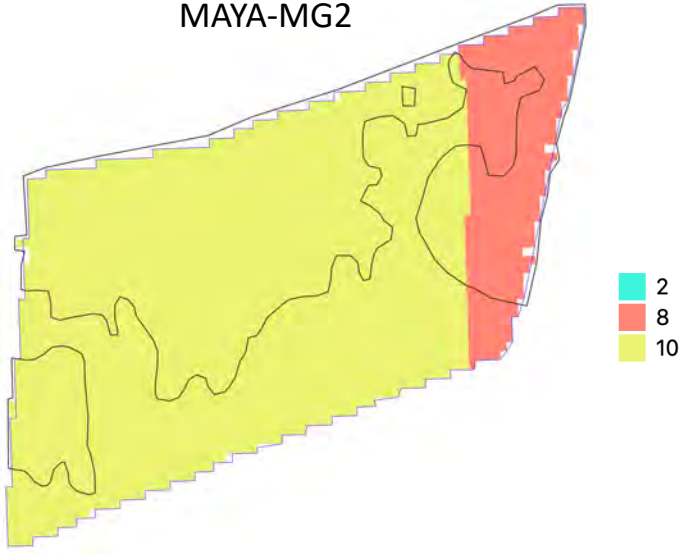
Sen2Cor



MAYA-CLM

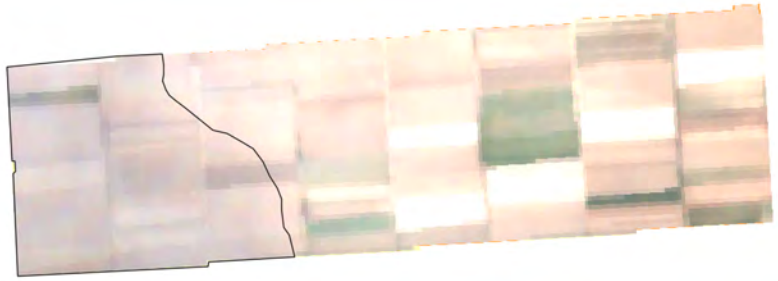


MAYA-MG2



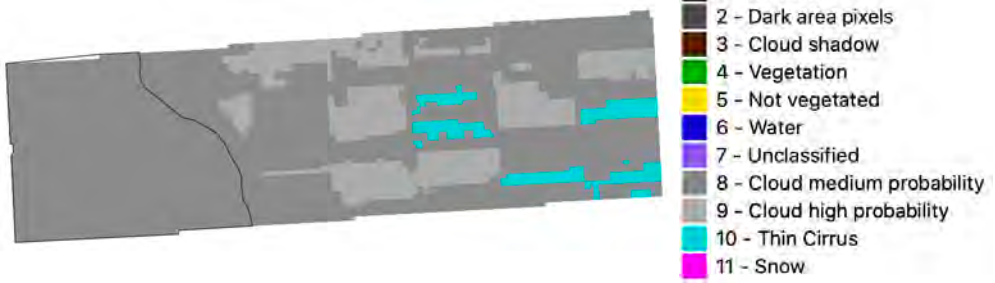
AVEZZANO (FOG) – T33TUG
(5 April 2020)

TCI - Reference image

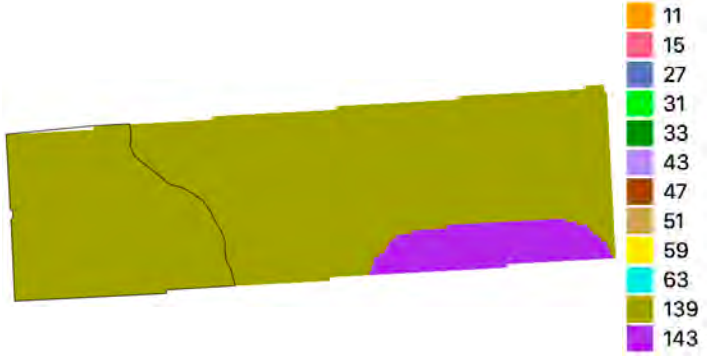


AgroShadow

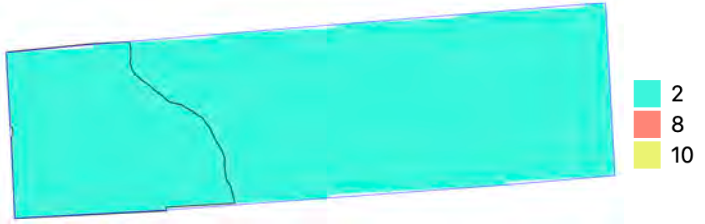
Sen2Cor



MAYA-CLM

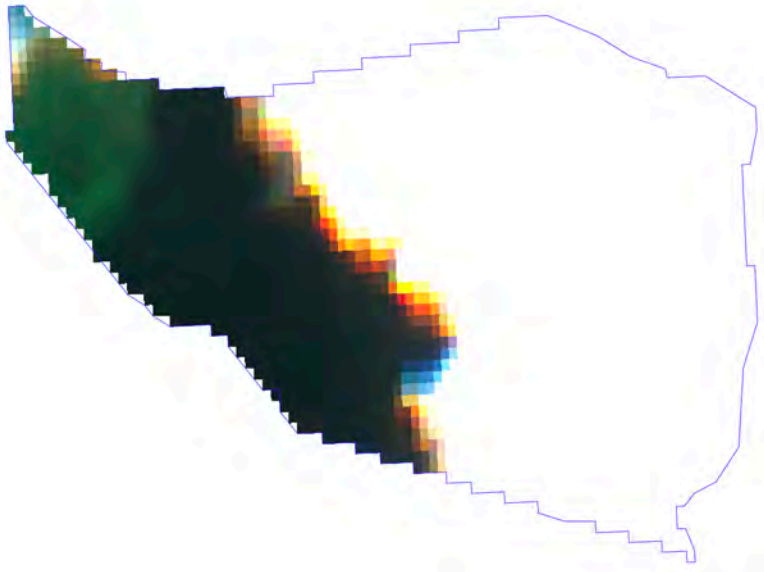


MAYA-MG2

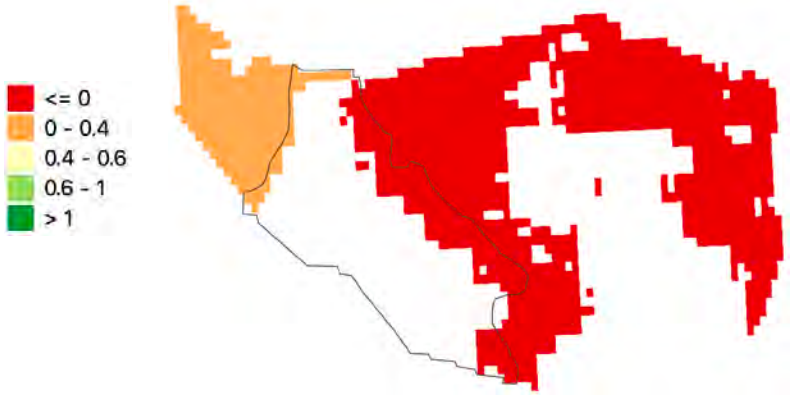


PESARO – T33TUJ
(30 April 2020)

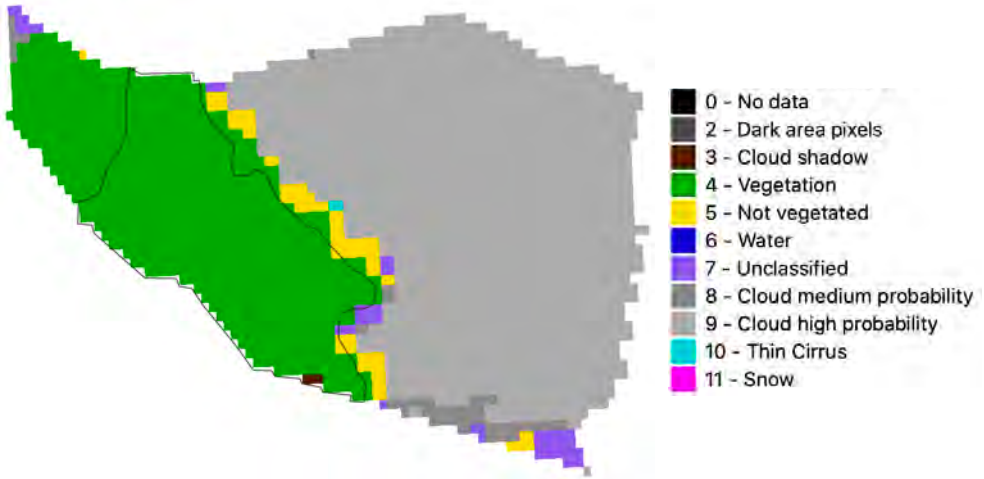
TCI - Reference image



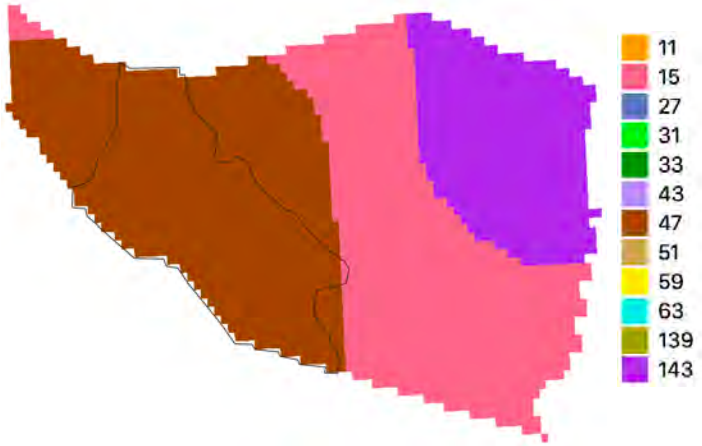
AgroShadow



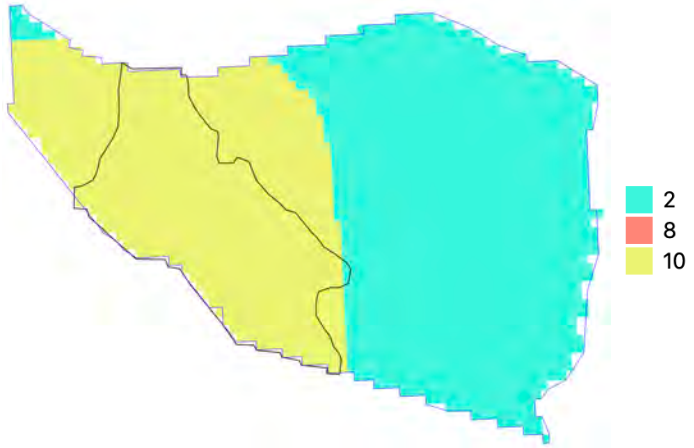
Sen2Cor



MAYA-CLM



MAYA-MG2

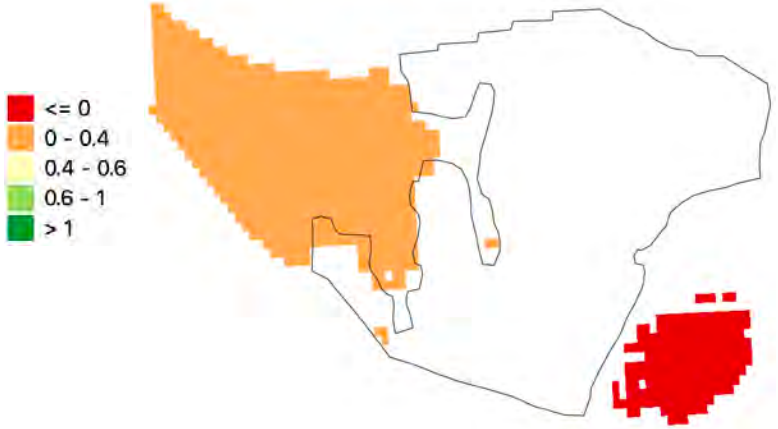


PESARO – T33TUJ

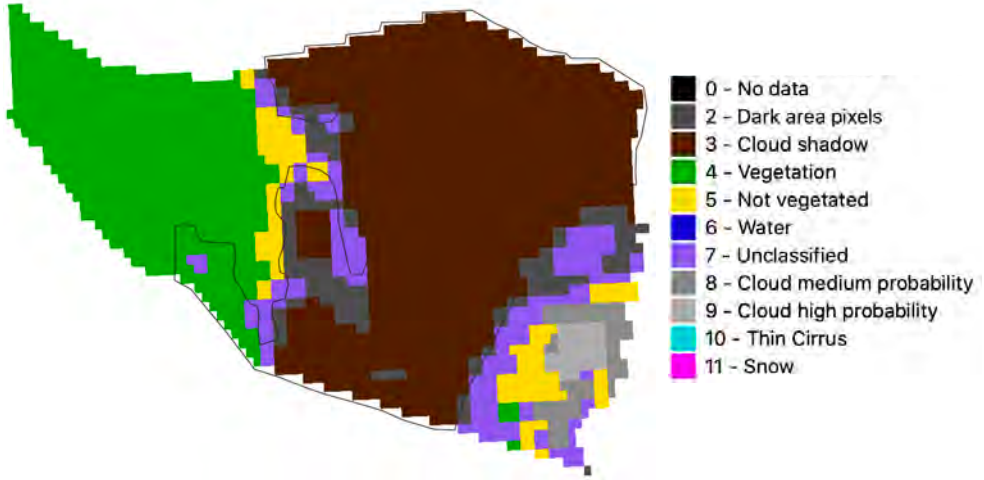
(24 July 2020)

TCI - Reference image

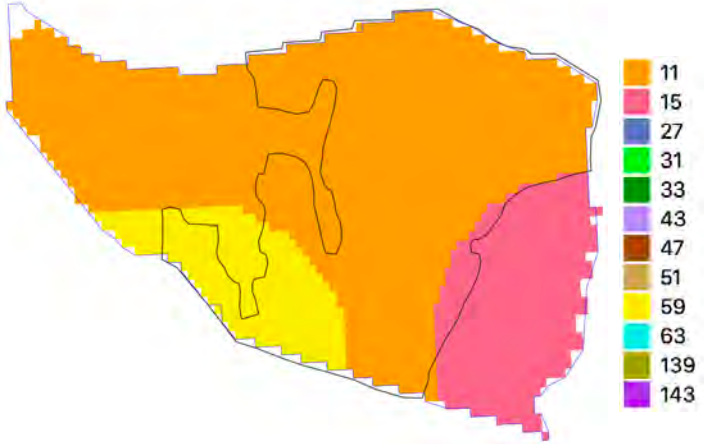
AgroShadow



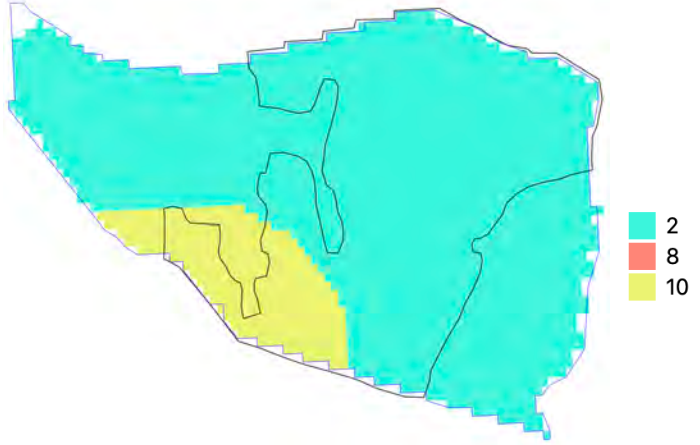
Sen2Cor



MAYA-CLM



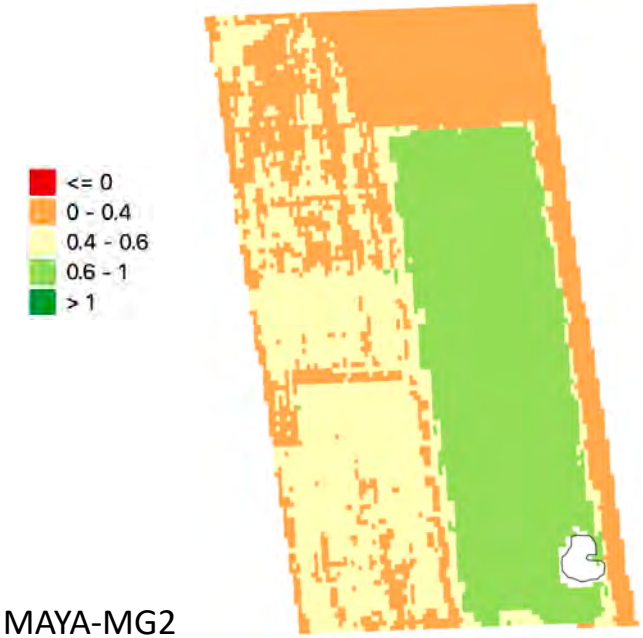
MAYA-MG2



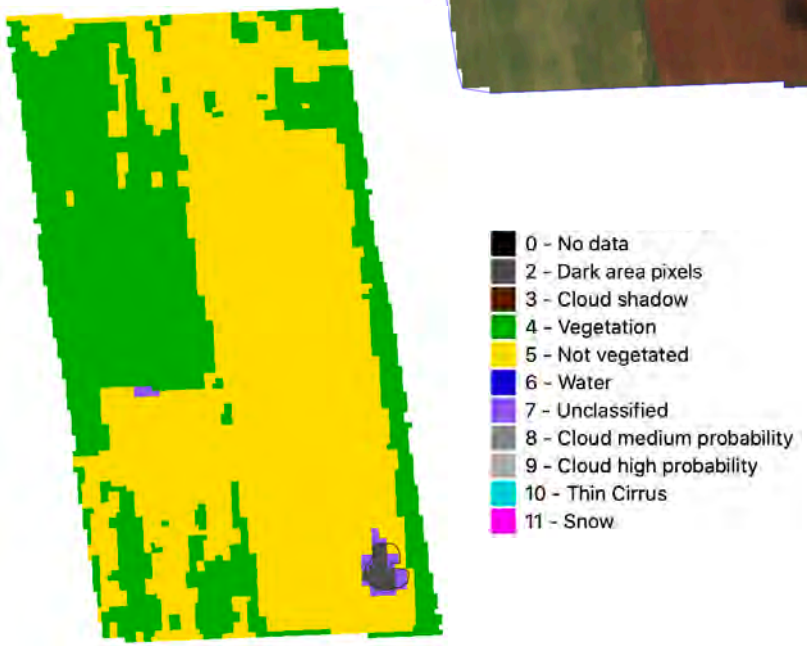
RAVENNA – T32TQQ
(12 June 2020)

TCI - Reference image

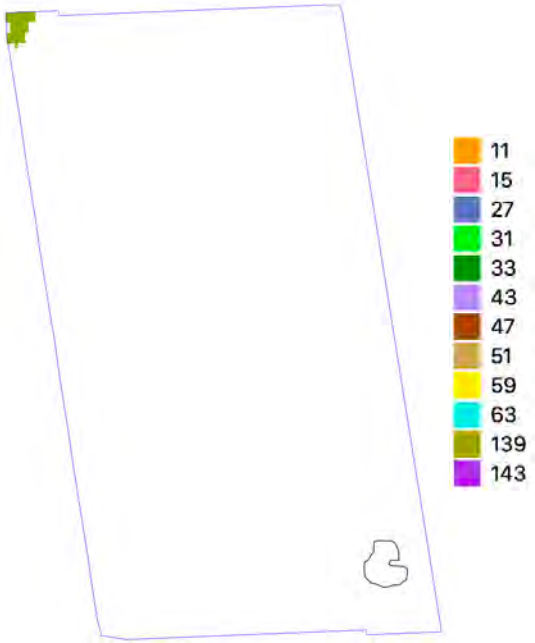
AgroShadow



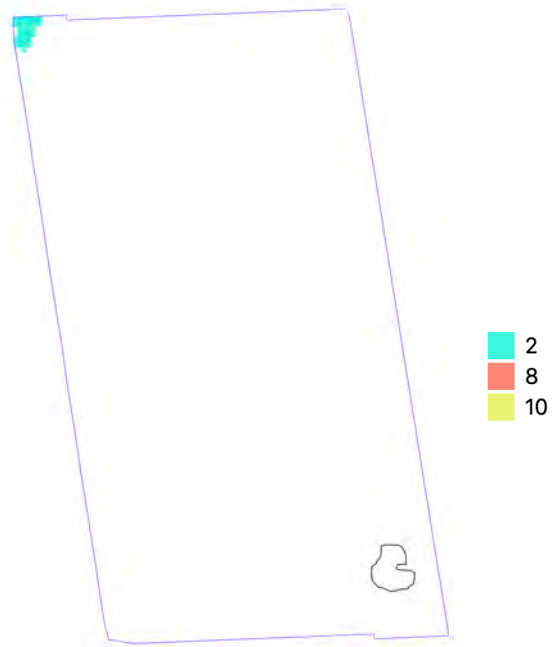
Sen2Cor



MAYA-CLM



MAYA-MG2

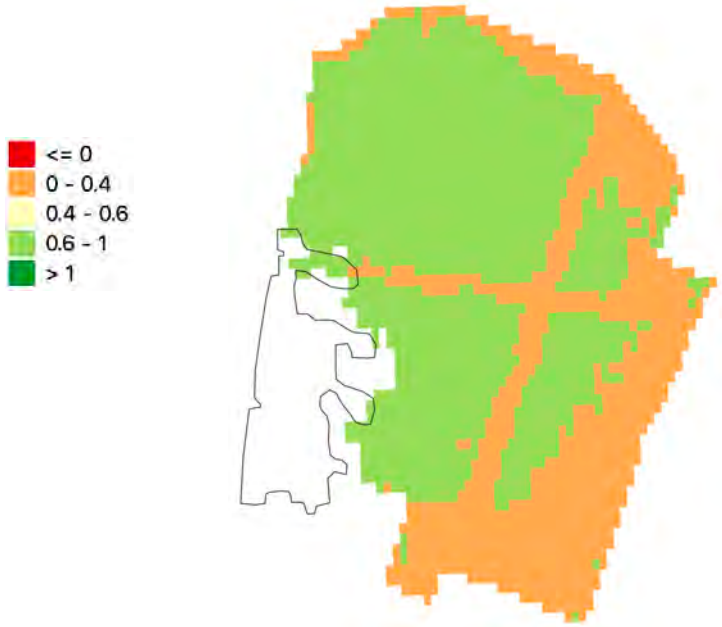


BOLOGNA – T32TPQ

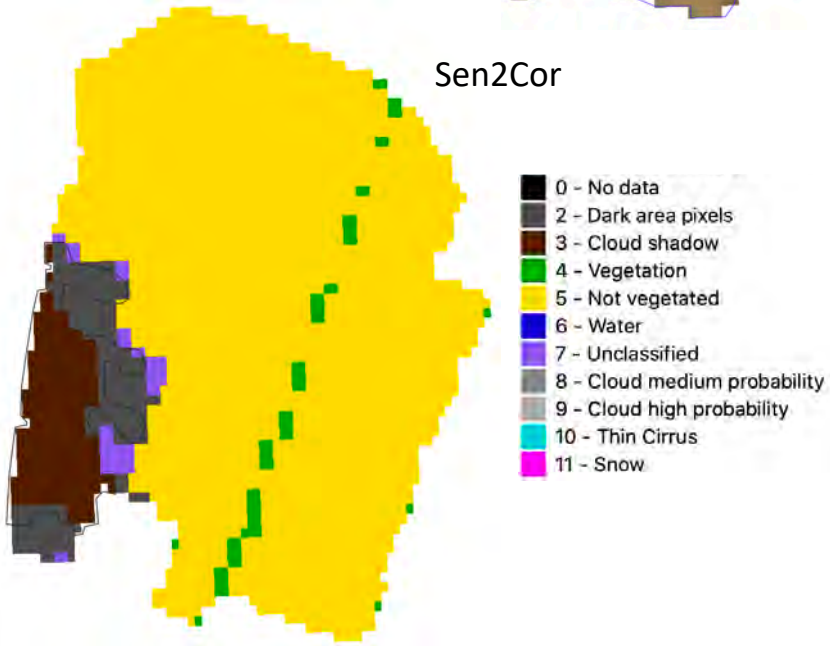
(6 August 2020)

TCI - Reference image

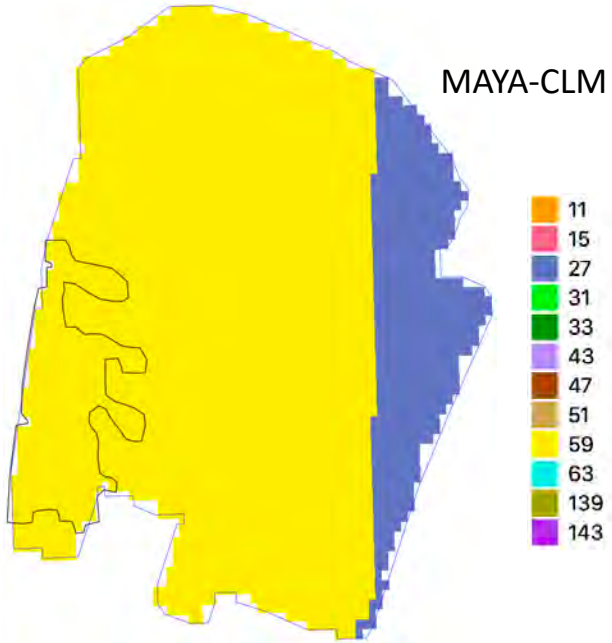
AgroShadow



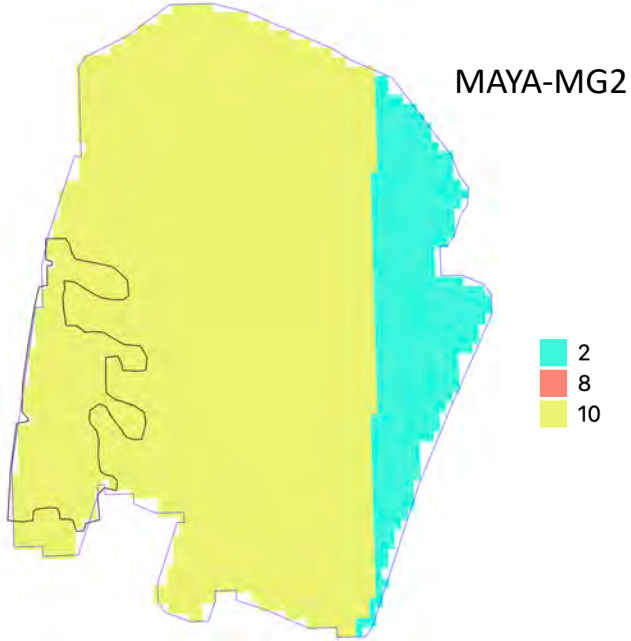
Sen2Cor



MAYA-CLM

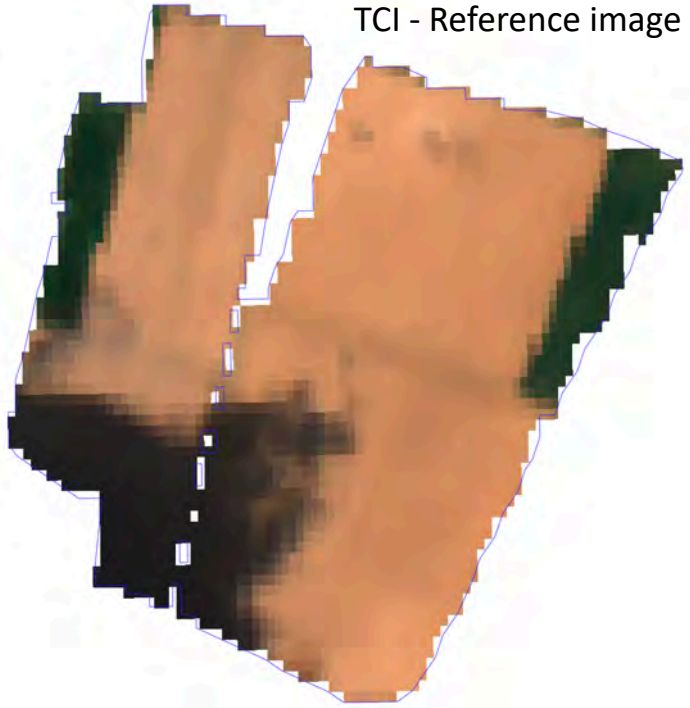


MAYA-MG2

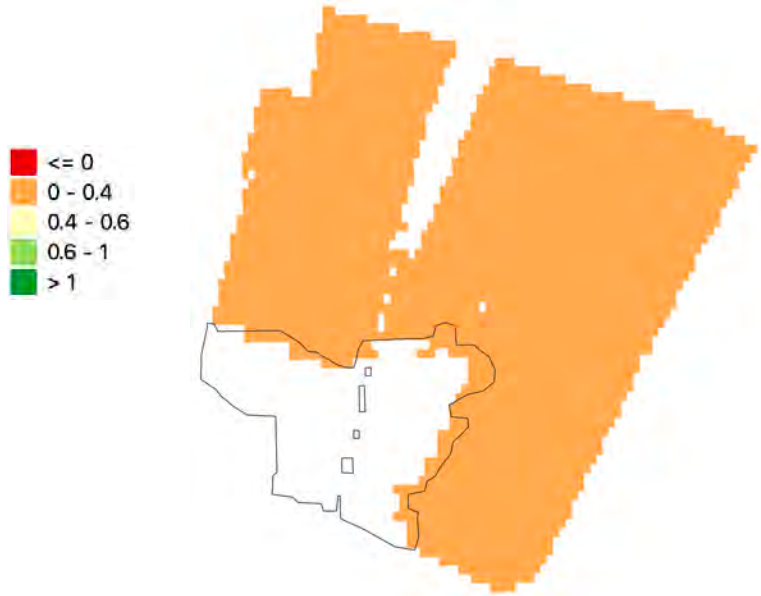


BRESCIA – T32TNR
(3 May 2020)

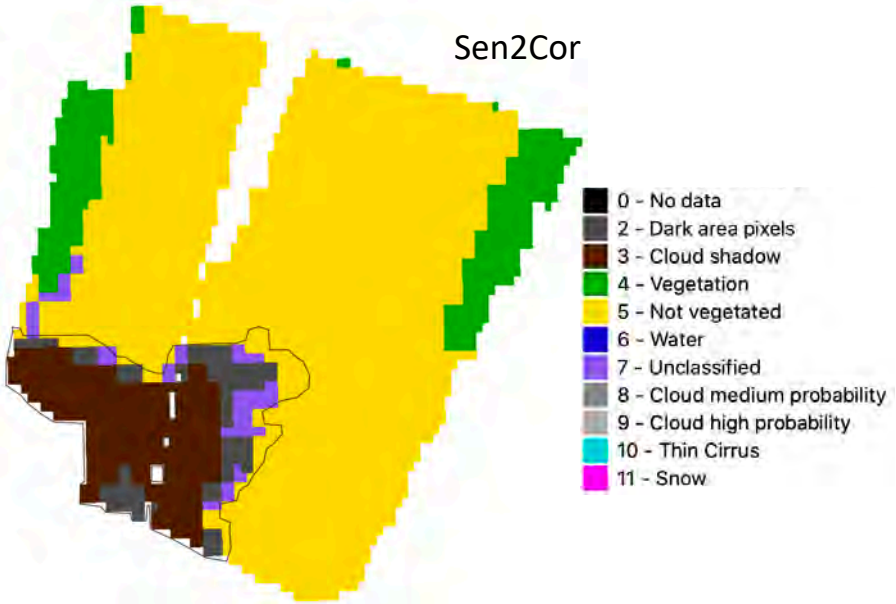
TCI - Reference image



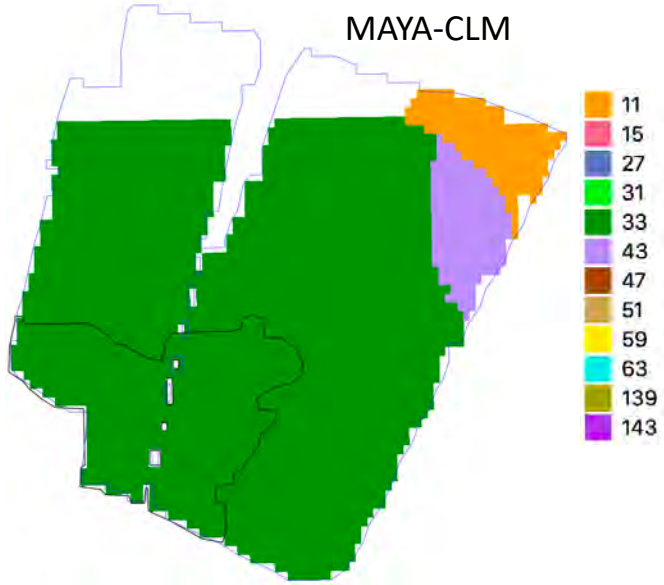
AgroShadow



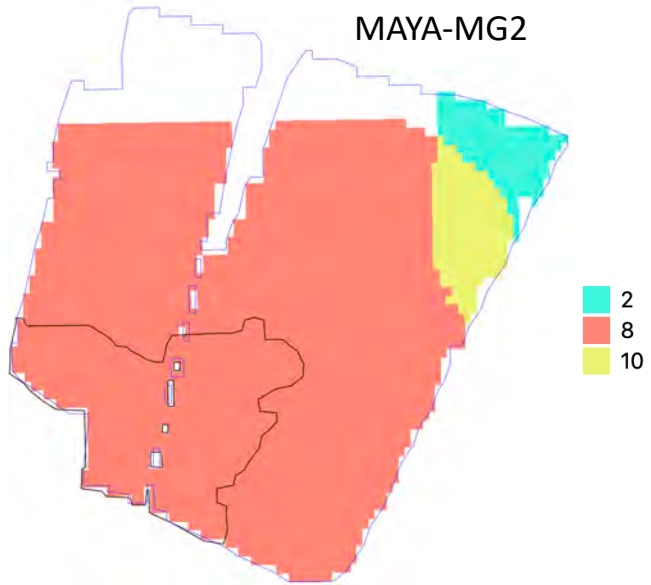
Sen2Cor



MAYA-CLM

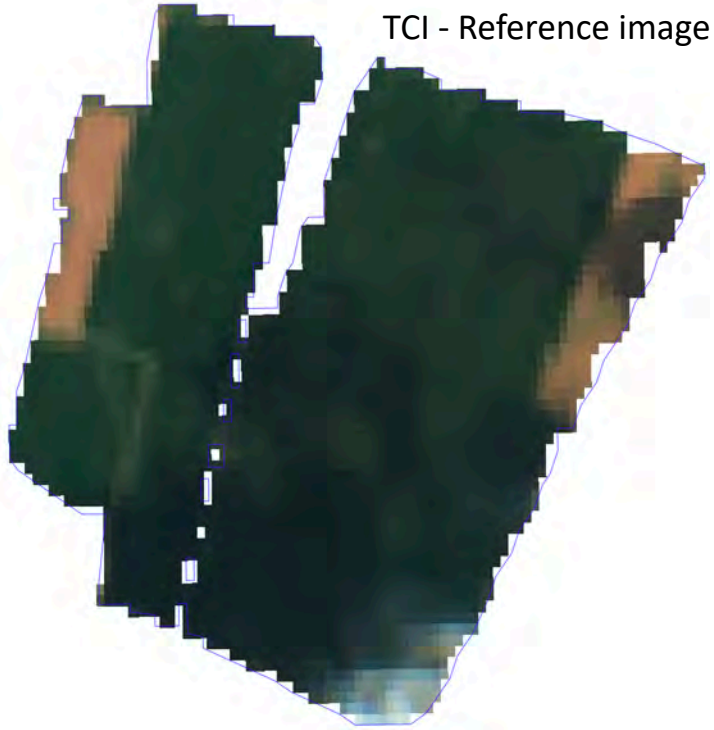


MAYA-MG2

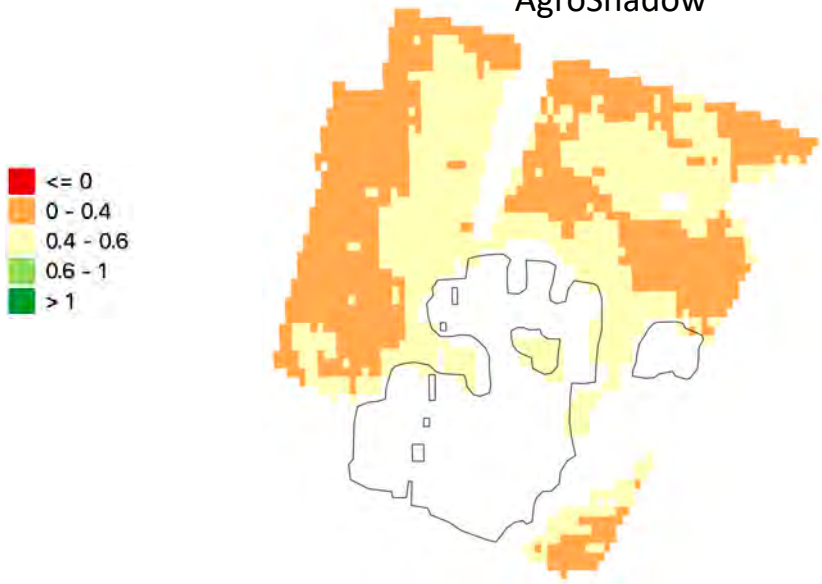


BRESCIA – T32TNR
(2 July 2020)

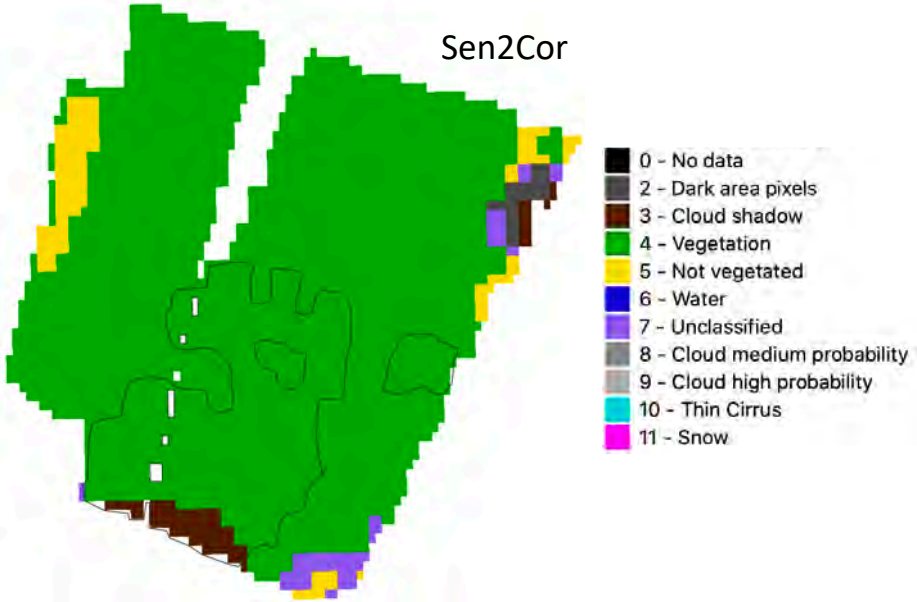
TCI - Reference image



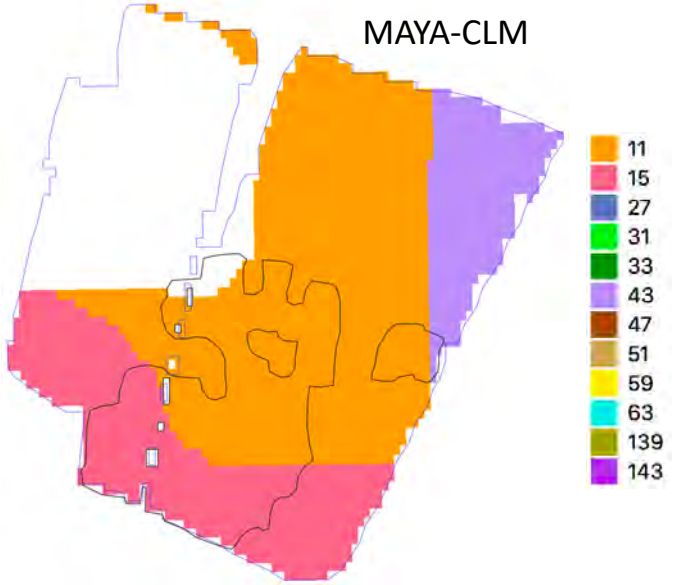
AgroShadow



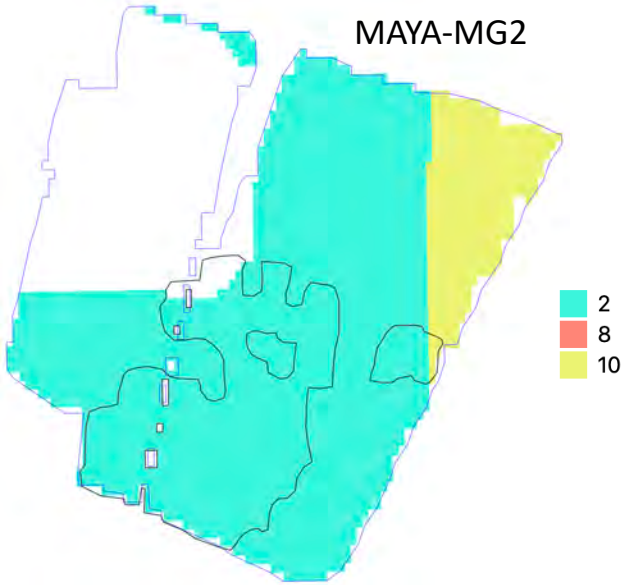
Sen2Cor



MAYA-CLM

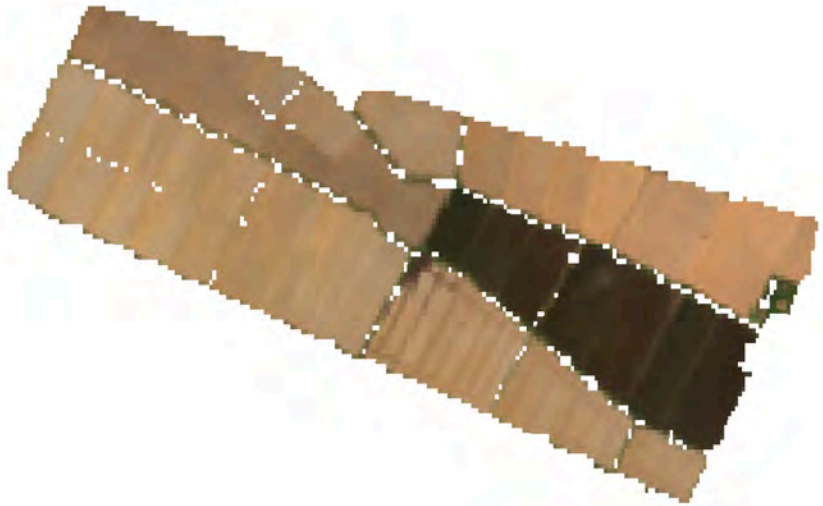


MAYA-MG2

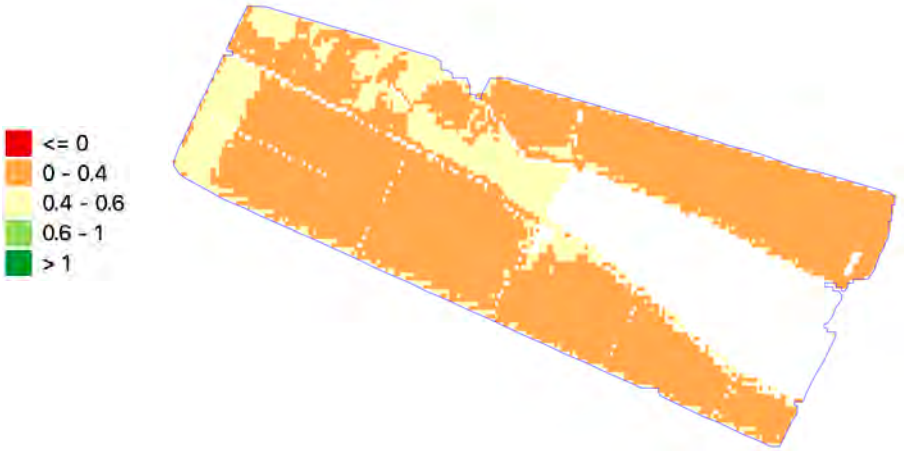


VERCELLI – T32TMR
(14 April 2020)

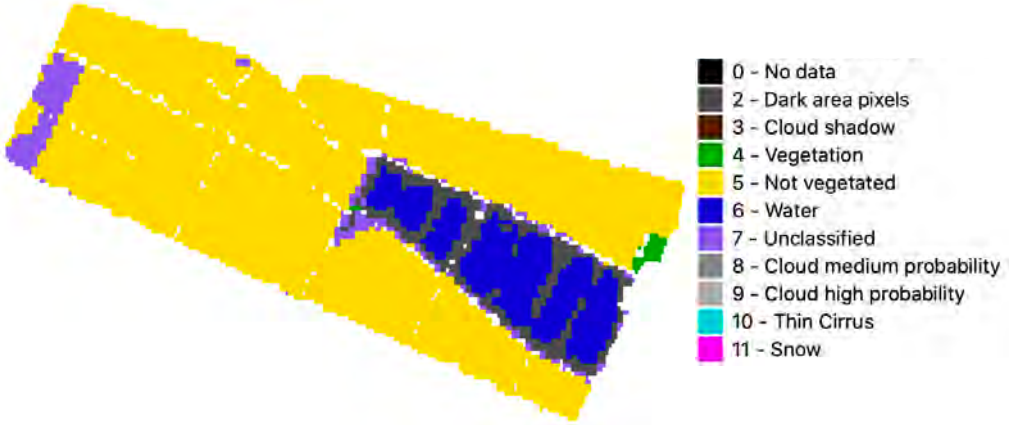
TCI - Reference image



AgroShadow



Sen2Cor



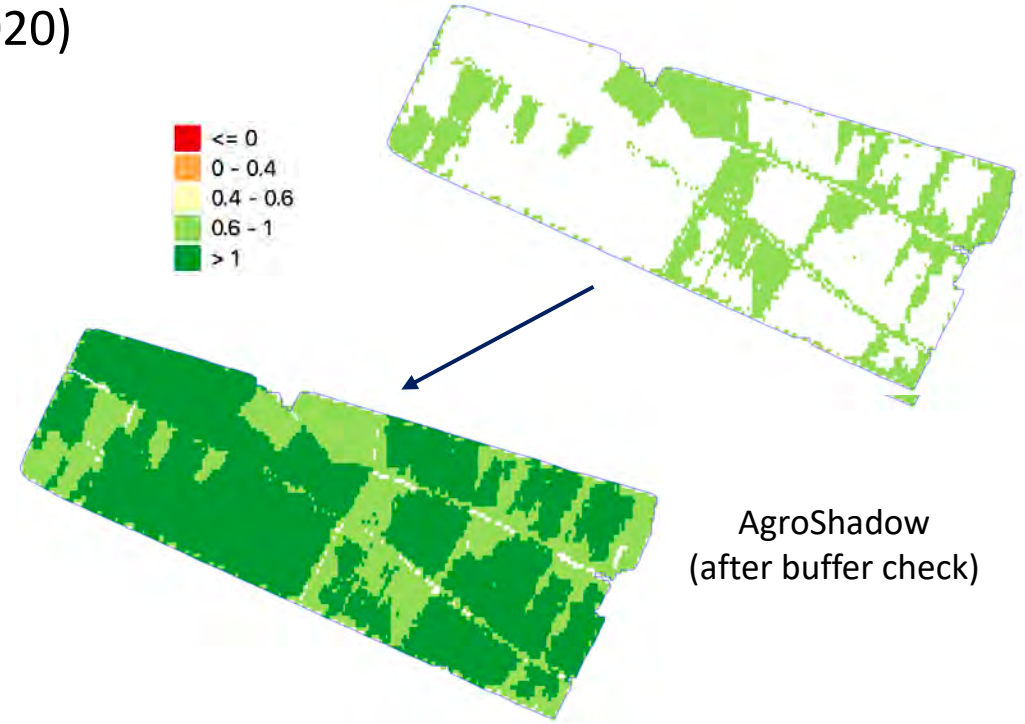
MAYA-CLM

MAYA-MG2

VERCELLI – T32TMR
(13 June 2020)

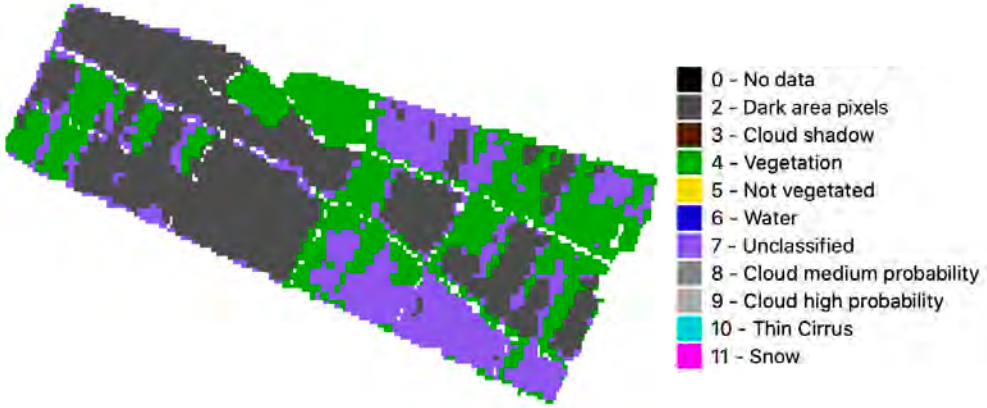
TCI - Reference image

AgroShadow (before buffer check)

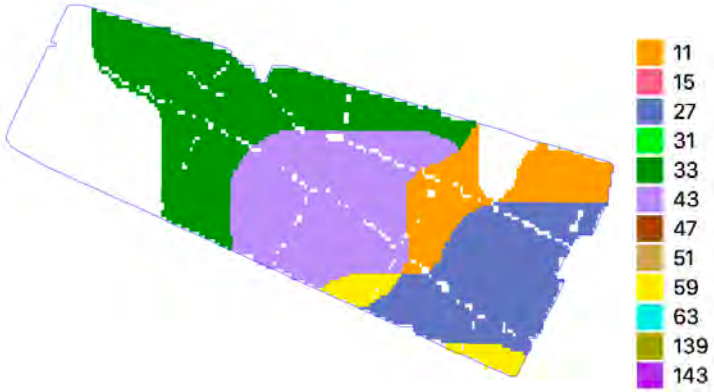


AgroShadow
(after buffer check)

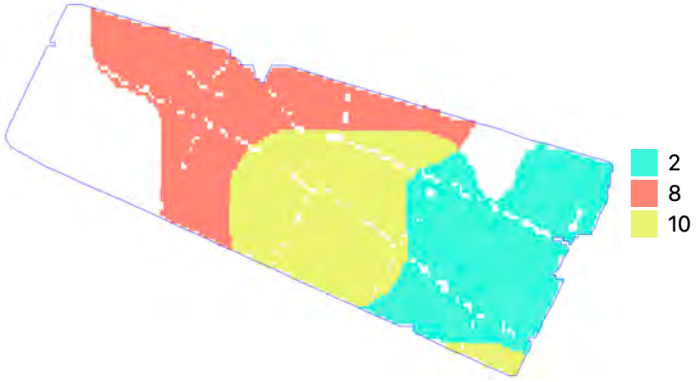
Sen2Cor



MAYA-CLM

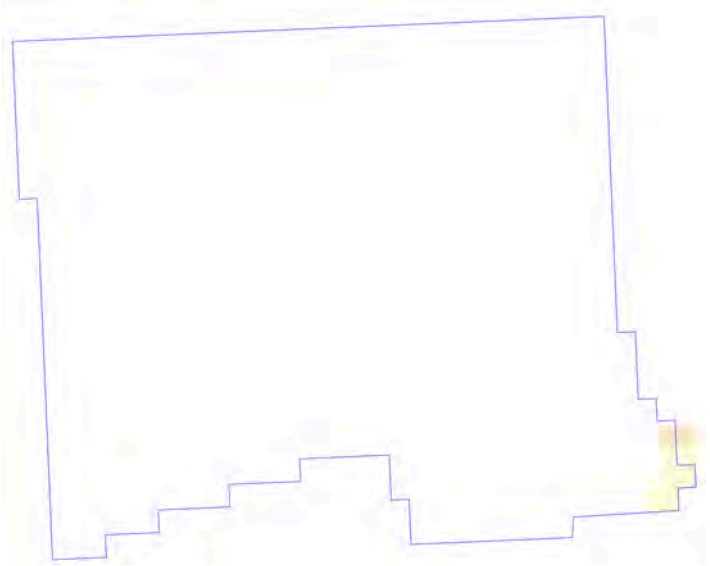


MAYA-MG2

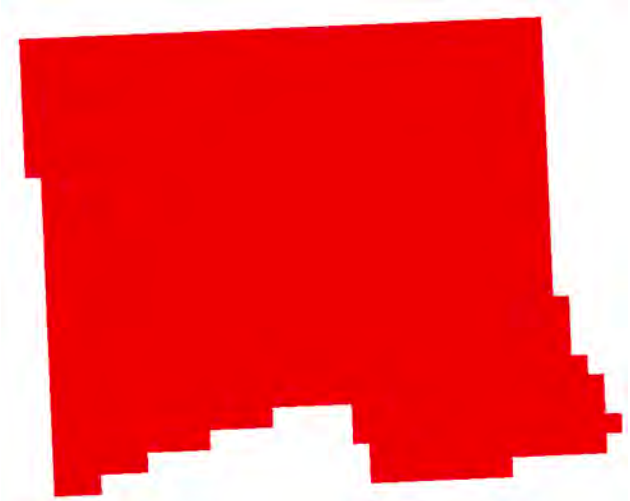


CRETTO DI BURRI (CONCRETE) – T33SUB
(17 March 2020)

TCI - Reference image

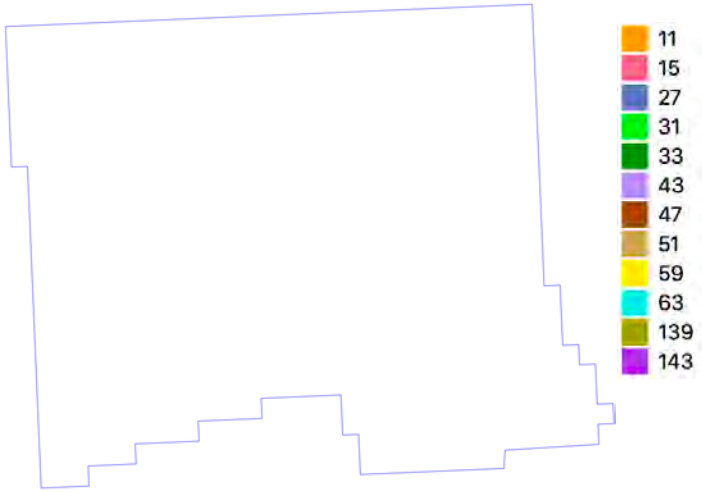


AgroShadow

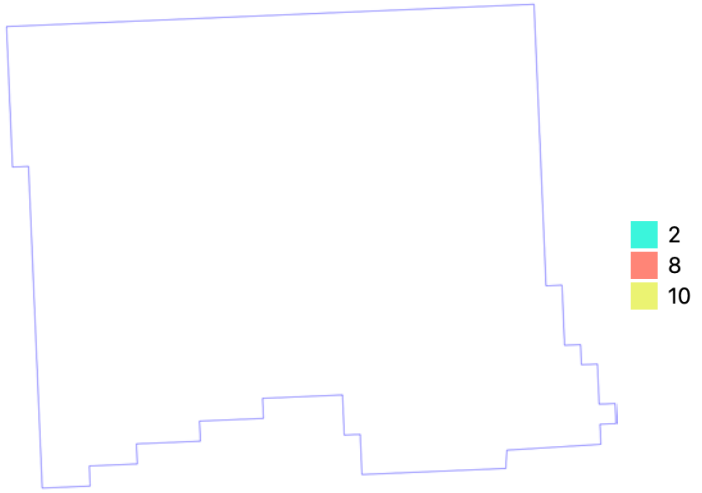


Sen2Cor

MAYA-CLM

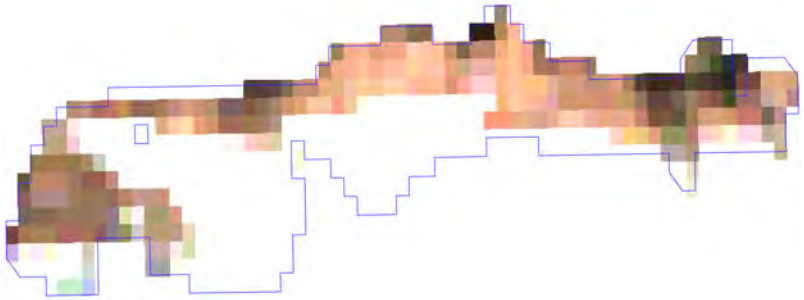


MAYA-MG2



SONDRIO (SNOW) – T32TPS
(29 October 2020)

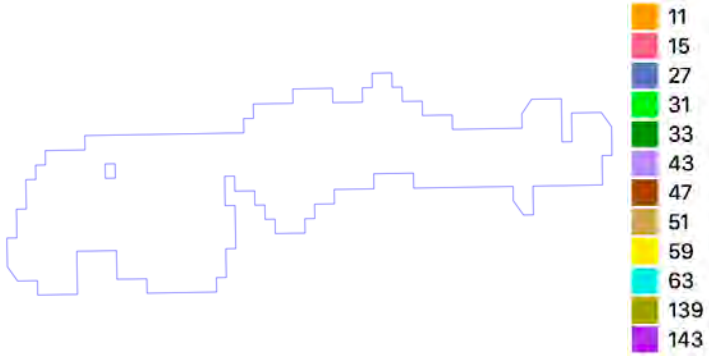
TCI - Reference image



AgroShadow

Sen2Cor

MAYA-CLM



MAYA-MG2