VIIRS Surface Type algorithm refinement and preliminary validation

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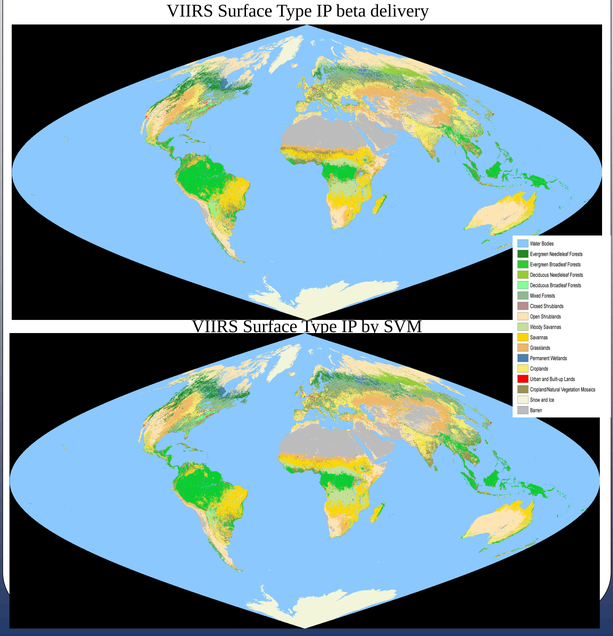
Introduction

VIIRS Surface Type Intermediate Product (IP) and Environmental Data Record (EDR) represent continuity with NASA EOS MODIS and NOAA POES AVHRR land cover products. After the beta delivery, VIIRS Surface Type algorithms are continuously evolving, and many improvements have been applied to the Surface Type IP, and then EDR. Among those improvements, results of a post-classification modeling on top of the original decision tree algorithm outputs, and a new classification algorithm Support Vector Machines (SVM) generated outputs are shown. The necessity of the new SVM in the ST algorithm refinement is that decision tree output requires intensive post processing while SVM may produce better direct output and needs less post processing. Comparisons of IGBP class agreements between SEED delivery and the delivered decision tree result, post-classification modelled result, and SVM result are presented. Preliminary validations performed by BU are also included.

VIIRS Surface Type IP beta delivery

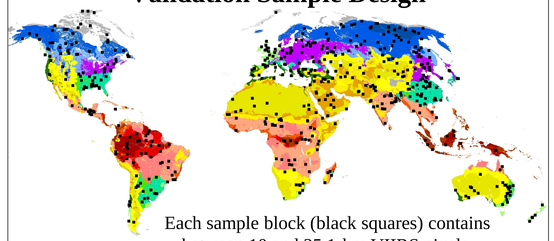


VIIRS Surface Type IP by SVM

Validations

The independent global validation dataset was based on a stratified random sample of 500 blocks, which included 17 IGBP classes. Each validation block contains between 10-35 VIIRS 1km pixels. The validation was performed by human interpretation in high resolution images using a tool built in Google Earth. Validation samples and comparisons of overall accuracies among different products are shown below.

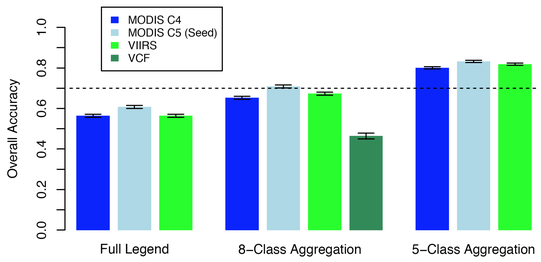
Validation Sample Design



Each sample block (black squares) contains between 10 and 35 1-km VIIRS pixels.

Tropical Rainforest, Tropical Seasonal Forest, Tropical Savannah, Desert, Steppe, Mediterranean, Temperate Evergreen Forest, Marine West-coast, Continental Forest, Boreal Forest, Tundra, Snow and Ice, Cold Boreal Forest, pTropical Rainforest, pTropical Seasonal Forest, pTropical Savannah, pDesert, pSteppe, pTemperate Evergreen Forest, pContinental Forest, Urban

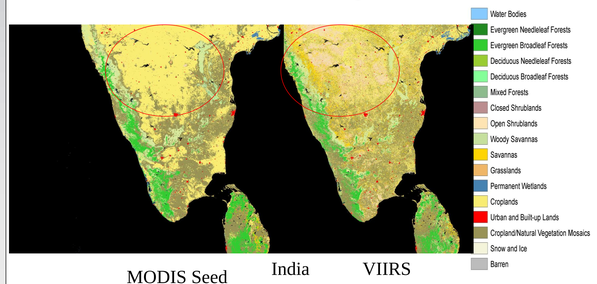
Overall Accuracies for Different Products



VIIRS QST IP overall accuracy is similar to MODIS C4 and C5 (Seed), and detailed visual interpretation and per-class analyses indicated that the VIIRS QST IP is compatible to MODIS C5 Land Cover product.

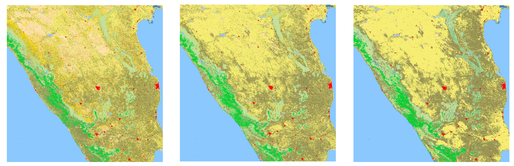
Refinement

The preliminary validation suggested the new VIIRS QST IP omitted some cropland pixels in India and misclassified some grassland or open shrublands into croplands in high latitude areas, such as southern Argentina.



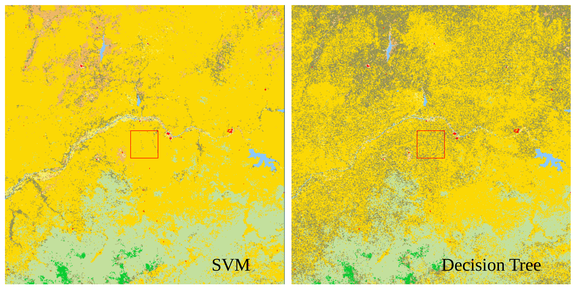
MODIS Seed India VIIRS

To improve the accuracy of croplands class, a crop probability product from global cropland extent project of South Dakota State University and an internal multiple products crop distribution agreement data are employed in a post-classification modelling.



Initial QSTIP QSTIP post-class MODIS Seed

Another refinement is the introduction of the SVM algorithm in the generation of QSTIP. Preliminary visual comparisons suggest the SVM yield less speckle noises than original decision tree. A west Africa case showed.



Agreement with MODIS C5

The initial decision tree generated global surface type IP, post-classification modelled QST-IP, and SVM generated QST-IP are compared to MODIS C5 (Seed) Land Cover, and agreements among those datasets are presented. The results indicated both decision tree and SVM are able to generate MODIS C5 compatible VIIRS surface type products, and their agreements are very similar.

17 Class IGBP agreement between SEED and Beta delivery QSTIP in percentage, overall agreement = 92.9841%

	ENF	EBF	DNF	DBF	MF	CS	OS	WS	S	G	PW	C	UB	CN	SI	B	WB
ENF	66.85	0.19	1.34	0.06	5.39	1.14	0.24	3.46	1.04	0.72	3.24	0.08	0	0.20	0	0	0.01
EBF	0.62	90.14	0.01	2.91	2.63	0.30	0	3.29	2.06	0.23	11.42	0.32	0	4.58	0	0	0
DNF	0.46	0	74.63	0	1.25	0.02	1.19	1.48	0.58	0.15	0.42	0.01	0	0.16	0	0	0
DBF	0	0.07	0	53.30	1.53	0.15	0	0.31	0.07	0.05	0.05	0.05	0	1.17	0	0	0
MF	18.18	1.44	9.86	11.44	75.44	5.95	0.24	4.66	0.42	0.95	2.89	0.44	0	4.64	0	0	0
CS	0.02	0	0	0.11	0.01	18.37	0.06	0.05	0.04	0.13	0	0.02	0	0.01	0	0	0
OS	0.74	0.01	3.07	0.10	0.13	18.30	81.89	2.51	4.29	23.45	8.73	3.09	0	0.63	1.23	5.99	0.02
WS	8.10	2.77	7.45	17.18	6.44	18.57	3.02	63.79	14.02	2.24	10.20	2.45	0	7.29	0.01	0	0.01
S	0.01	0.49	0.01	5.90	0.13	24.22	3.53	10.57	66.15	6.24	2.05	5.87	0	13.31	0	0.01	0
G	1.25	0.17	0.26	0.23	0.45	7.64	3.79	0.64	1.92	50.65	0.46	7.27	0	3.36	0.02	0.97	0
PW	1.43	0.23	1.80	0.12	0.31	1.11	1.49	0.82	1.13	0.23	48.78	0.23	0	0.22	0	0.02	0.01
C	0.78	0.23	0.23	0.75	1.84	4.72	1.34	2.30	0.90	6.19	3.85	70.32	0	10.13	0.02	0.05	0.01
UB	0	0	0	0	0	0	0	0	0	0	0	0	99.76	0	0	0	0
CN	0.57	4.23	1.24	7.89	4.33	2.14	0.70	5.99	7.34	3.40	4.21	9.80	0	54.17	0	0.02	0
SI	0.35	0	0.03	0	0.04	0.05	0.21	0.06	0.01	2.47	0.13	0	0	0	98.51	0.65	0
B	0.01	0	0	0	0	0.04	2.23	0	0	2.77	0.07	0.02	0	0.11	0.10	92.28	0
WB	0.63	0.02	0.08	0	0.09	0.07	0.08	0.08	0.02	0.15	3.50	0.03	0.24	0.01	0.11	0.02	99.93

17 Class IGBP agreement between SEED and Post-classification modelled QSTIP in percentage, overall agreement = 93.5068%

	ENF	EBF	DNF	DBF	MF	CS	OS	WS	S	G	PW	C	UB	CN	SI	B	WB
ENF	67.71	0.19	1.38	0.07	5.48	1.41	0.26	3.49	1.07	0.79	3.4	0.1	0	0.29	0	0	0.01
EBF	0.62	92.9	0.01	2.94	2.66	0.33	0	3.59	2.19	0.25	11.98	0.39	0	5.96	0	0	0
DNF	0.46	0	75.06	0	1.27	0.02	1.2	1.49	0.59	0.16	0.5	0.01	0	0.19	0	0	0
DBF	0	0.08	0	58.4	1.7	0.23	0	0.37	0.1	0.06	0.09	0.06	0	1.77	0	0	0
MF	18.32	1.48	10.32	12.51	79.43	7.35	0.27	5.23	0.55	1.1	3.38	0.66	0	6.74	0	0	0.01
CS	0.02	0	0	0.12	0.02	20.05	0.07	0.07	0.05	0.14	0.04	0.04	0	0.03	0	0	0
OS	0.76	0.01	3.14	0.12	0.15	18.5	82.8	2.57	4.34	23.65	8.92	1.85	0	0.64	1.23	5.99	0.02
WS	8.16	3.04	7.52	17.59	6.71	16.25	3.07	68.05	14.66	2.41	10.71	2.54	0	9.02	0.01	0	0.01
S	0.02	0.62	0.07	5.97	0.15	24.32	3.56	10.83	70.95	6.37	2.22	4.71	0	14.01	0	0.01	0
G	1.36	0.2	0.36	0.47	0.58	8.51	3.99	0.79	2.15	55.15	0.82	5.96	0	4.71	0.02	0.97	0
PW	1.44	0.31	1.84	0.13	0.35	1.17	1.5	0.87	1.17	0.25	51.92	0.29	0	0.34	0	0.02	0.01
C	0.07	0.05	0.04	0.16	0.53	1.2	0.66	0.98	0.31	3.08	1.34	74.14	0.7	8.44	0	0.03	0
UB	0	0	0	0.02	0.01	0.01	0	0.01	0.01	0.01	0.03	0.05	98.74	0.09	0	0	0
CN	0.05	1.1	0.14	1.48	0.82	0.5	0.1	1.52	1.84	1.19	0.94	9.14	0.33	47.62	0	0.01	0
SI	0.35	0	0.03	0	0.04	0.05	0.21	0.06	0.01	2.47	0.14	0	0	0	98.52	0.65	0
B	0.01	0	0	0	0	0.04	2.23	0	0	2.78	0.08	0.03	0	0.12	0.1	92.3	0
WB	0.63	0.02	0.08	0	0.09	0.07	0.08	0.08	0.02	0.15	3.51	0.03	0.24	0.01	0.11	0.02	99.93

17 Class IGBP agreement between SEED and SVM generated QSTIP in percentage, overall agreement = 92.6669%

	ENF	EBF	DNF	DBF	MF	CS	OS	WS	S	G	PW	C	UB	CN	SI	B	WB
ENF	67.03	0.26	1.14	0.06	5.07	0.39	0.19	6.25	1.38	0.66	2.72	0.05	0	0.1	0	0	0.01
EBF	1.1	92.74	0.01	3.03	3.43	0.29	0	4.72	2.87	0.3	9.9	0.23	0	8.47	0	0	0
DNF	0.78	0	78.9	0	1.12	0	1.88	3.87	0.89	0.12	0.96	0	0	0.13	0	0	0
DBF	0	0.1	0	46.85	2.06	0.39	0	0.54	0.12	0.06	0.12	0.12	0	3.03	0	0	0
MF	22.35	1.43	12.83	13.89	78.69	9.04	0.44	7.56	0.54	1.43	4.45	0.52	0	7.4	0	0	0.01
CS	0.01	0	0	0	0	0.35	0.01	0.01	0	0.01	0	0	0	0	0	0	0
OS	1.06	0.01	2.92	0.1	0.21	24.04	83.19	4.27	4.17	23.81	9.95	3.1	0	0.79	1.65	6.07	0.02
WS	2.45	2.17	1.31	27.47	3.42	19.56	1.24	52.43	14.56	1.78	5.15	0.9	0	6.69	0	0	0
S	0	0.44	0.02	3.68	0.13	32.76	2.98	10.19	65.93	6.45	2.1	5.07	0	17.02	0	0	0
G	0.81	0.09	0.27	0.23	0.35	7.07	3.94	0.75	2.72	50.9	0.42	8.16	0	4.73	0.08	1.03	0
PW	1.99	0.46	1.86	0.14	0.61	1.39	1.45	1.84	1.44	0.29	52.67	0.41	0	0.36	0	0.02	0.01
C	0.47	0.12	0.08	1.25	0.84	2.92	1.39	1.48	0.72	5.51	2.75	67.03	0	6.36	0.01	0.1	0.01
UB	0	0	0	0	0	0	0	0	0	0	0	0	99.76	0	0	0	0
CN	0.74	2.05	0.54	3.28	3.93	1.48	0.41	5.91	4.62	2.98	4.98	14.35	0	44.74	0	0.01	0.01
SI	0.58	0.12	0.03	0.01	0.07	0.2	0.32	0.1	0.01	2.89	0.21	0.01	0	0.01	98.09	0.71	0
B	0.01	0	0	0	0	0.03	2.49	0	0.01	2.65	0.12	0.02	0	0.16	0.04	92.04	0
WB	0.63	0.02	0.08	0	0.09	0.07	0.08	0.08	0.02	0.15	3.5	0.03	0.24	0.01	0.11	0.02	99.93