

A Rapid Cloud Mask Algorithm for Suomi NPP VIIRS Imagery EDRs

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Introduction

A cloud mask algorithm, adapted from a Landsat 7 automatic cloud cover assessment¹, has been developed for use with Suomi National Polar-orbiting Partnership (NPP) Visible Infrared Imager Radiometer Suite (VIIRS) Imagery Environmental Data Records (EDRs). Though the cloud mask algorithm produces results that are less accurate and less detailed than the VIIRS Cloud Mask (VCM) Intermediate Product², it has an advantage in that it can be quickly calculated from a VIIRS Imagery EDR and used to assess cloud cover at the EDR's 350 m nadir resolution.

The cloud mask algorithm

The algorithm exploits the similarity of the multi-spectral bands in Landsat-7 ETM+ and VIIRS Imagery.

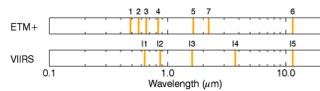
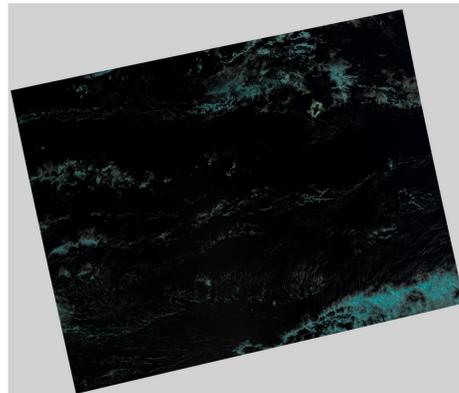


Figure 1. A comparison of the central wavelengths of the Landsat 7 ETM+ bands and VIIRS I-Bands.

The algorithm (hereafter VIBCM, for VIIRS I-Band Cloud Mask) consists of a sequence of six pixel-based tests that use thresholds on VIIRS top-of-atmosphere reflectances and brightness temperatures. Each test returns a binary (clear or cloudy) result. For a pixel to be classified as cloudy, it must pass all six tests:

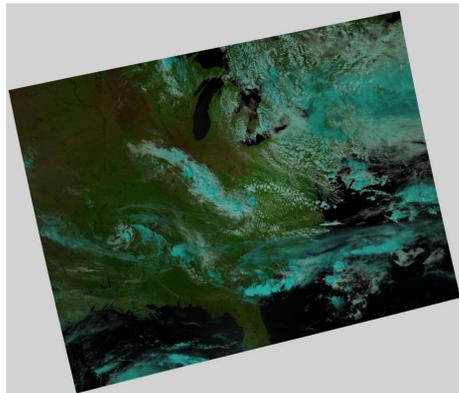
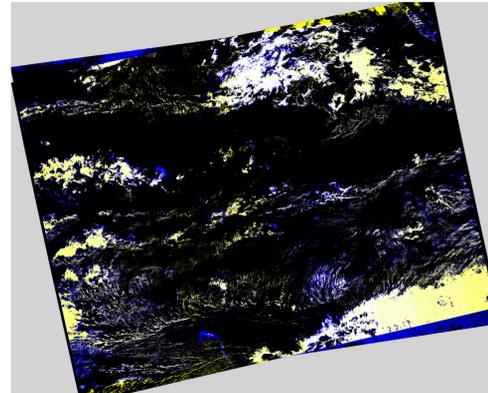
- Brightness threshold.** Pixels in I1 with a reflectance greater than 0.08 are classified as cloudy.
- Normalized difference snow index.** Pixels with an NDSI greater than 0.7 and an I2 reflectance greater than 0.11 are classified as cloudy.
- Temperature threshold.** Pixels in I5 with brightness temperatures less than 312 K are classified as cloudy.
- Band I3-I5 composite.** In the composite defined by $(\max(I3) - I3) * I5$, pixels less than 485 K are classified as cloudy.
- Band I2/I1 ratio.** In this vegetation index proxy, pixels less than a threshold value of 2.0 are classified as cloudy.
- Band I2/I3 ratio.** Useful in identifying rocky/sandy areas, pixels in this test with ratios greater than 1.0 are classified as cloudy.

VIIRS I3-I2-I1 false color composite

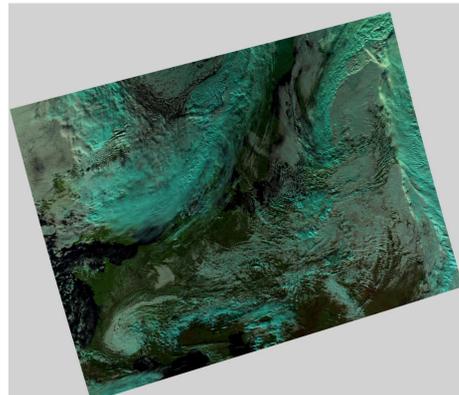
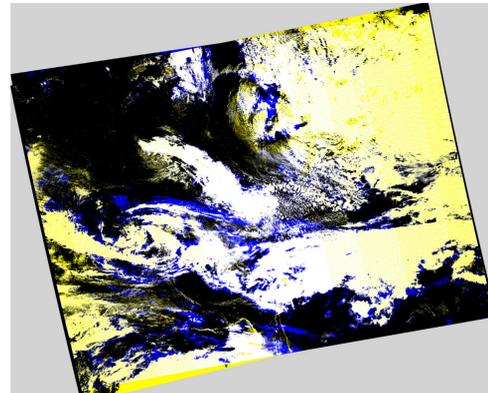


Scene 1: Hawaii

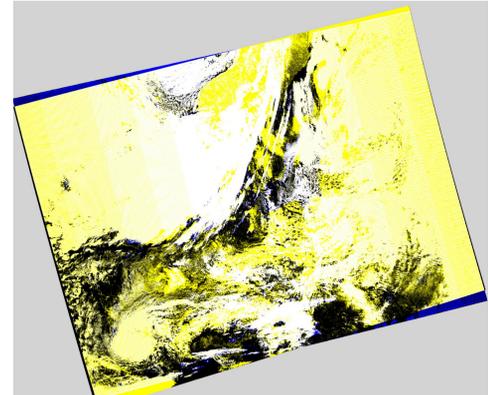
Cloud mask comparison



Scene 2: Eastern U.S.



Scene 3: Northern Europe



Contingency tables and statistics

Total pixels	Cloudy pixels		Cloud fraction			
	VCM	VIBCM	VCM	VIBCM		
49333671	8202646	8224509	0.1663	0.1667		
Cloud in VCM						
	Yes		No		(totals)	
Cloud in VIBCM	Yes	5484638	2739871	8224509		
	No	2718008	38391154	41109162		
	(totals)	8202646	41131025	49333671		
Bias	Hit rate	Accuracy	FA rate	CSI	HSS	KSS
1.0027	0.6686	0.8894	0.0666	0.5012	0.6014	0.6020

Total pixels	Cloudy pixels		Cloud fraction			
	VCM	VIBCM	VCM	VIBCM		
49365508	23158912	26102335	0.4691	0.5288		
Cloud in VCM						
	Yes		No		(totals)	
Cloud in VIBCM	Yes	19198933	6903402	26102335		
	No	3959979	19303194	23263173		
	(totals)	23158912	26206596	49365508		
Bias	Hit rate	Accuracy	FA rate	CSI	HSS	KSS
1.1271	0.8290	0.7799	0.2634	0.6386	0.5614	0.5656

Total pixels	Cloudy pixels		Cloud fraction			
	VCM	VIBCM	VCM	VIBCM		
49450355	27112336	41135502	0.5483	0.8319		
Cloud in VCM						
	Yes		No		(totals)	
Cloud in VIBCM	Yes	26447598	14687904	41135502		
	No	664738	7650115	8314853		
	(totals)	27112336	22338019	49450355		
Bias	Hit rate	Accuracy	FA rate	CSI	HSS	KSS
1.5172	0.9755	0.6895	0.6575	0.6327	0.3366	0.3180

Experiment

The VIBCM was tested against the VCM in three scenes: **Hawaii** (2012-Feb-06, orbit 1442), **Eastern United States** (2012-Jun-04, orbit 3127), and **Northern Europe** (2012-Nov-06, orbit 5322), shown at left. VCM pixels that are probably or confidently cloudy, with medium to high mask quality, are counted as cloudy for the comparison. The VCM, at 750 m resolution, was interpolated to the VIIRS Imagery Band resolution of 350 m by nearest-neighbor sampling and registered to the VIBCM. Contingency tables and their derived scores³ were constructed for the three scenes, with the VCM representing "observed" cloudy pixels and the VIBCM "forecast" cloudy pixels.

Results

The VIBCM compares favorably with the VCM in the tests, with accuracies near 80% and Heidke skill scores (HSS) above 0.5, even with bowtie deletion issues in the VCM. However, a more thorough comparison between VIBCM and the VCM, as well as with the MODIS Cloud Mask (MOD35), would be useful.

References

- Irish, R.R. (2000) Landsat 7 automatic cloud cover assessment, *Proceedings of SPIE*, **4049**, 348-355.
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- Stanski, H.R., L.J. Wilson, and W.R. Burrows (1989) Survey of common verification methods in meteorology, 114 pp., World Weather Watch Tech. Rept. No.8, WMO/TD No.358, WMO, Geneva.

Acknowledgments

I thank Exelis VIS for the time and freedom to independently pursue this research, as well my colleagues Ben Kamphaus, Dave Hulslander and Thomas Harris for helpful informal discussions on this project.