

Automated Cloud Mask Ensemble

Dr. François G. F. Smith
Radiant Solutions

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- Submitting an experimental method
- Not “official” Radiant Solutions method
- Haze is not extracted
- Processing performed at 30m resolution
- Originally designed to recreate the CFMASK for S-2 imagery
- Highly accurate automated cloud/cloud shadow mask is crucial to our production

- Works for Landsat or Sentinel-2 imagery
- TOA
- S-2 imagery is resampled to 30m resolution
- For both Landsat and S-2
 - 6-bands layerstacked
 - B,G,R,NIR, SWIR1, SWIR
 - Also uses a thermal band if Landsat
- Output is CFMASK classification
 - 0 = Clear
 - 1 = Water
 - 2 = Cloud Shadow
 - 3 = Snow/Ice
 - 4 = Cloud
 - 255 = No Data

Pre-processing Steps

- TOA
- Terrain Normalization
- Mask Ocean from coastal scenes
- Water mask
- Snow/Ice mask
- ISODATA
 - Stretch imagery
 - Threshold for albedo
- Blue Shift
 - Shadow extraction
- Cirrus band threshold
- Cloud Ratios
 - B/SWIR1 (or thermal if Landsat)
 - NIR/SWIR1
 - NDVI
- Tasseled cap transformation

- Cross Correlation Analysis (CCA)
- Statistical approach measuring variation of late-date DN values from strata means where strata are derived from the early-date imagery
- No direct comparison of imagery
- Output is a 16-bit Z-score layer correlated to probability of change
- Usually threshold layer to create binary change using an empirically derived universal coefficient

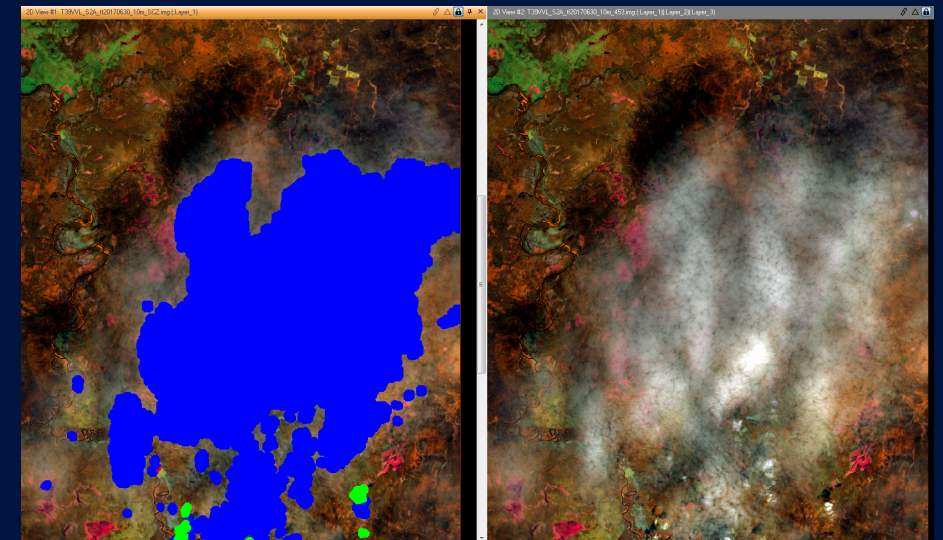
- CART Classification
- Training modeled from derived layers
 - Cloud
 - Z-scores
 - ISODATA – high albedo
 - Cloud ratios
 - Remove snow/ice
 - Shadow
 - Z-scores
 - Blue-shift
 - ISODATA – low albedo
 - Remove water
- Independent variables derived from imagery,
 - Tasseled cap transformation
 - Band Ratios
 - Z-scores

- Ruleset #1 to refine cloud and cloud shadow layer
- Cloud/Cloud shadow matching algorithm based on solar elevation and azimuth to refine cloud shadow mask
- Ruleset #2 to refine those results and build CFMASK classification
- Morphological filters

- False positives:
 - High albedo sandy shoreline, bare soil, or urban structures confused with cloud
 - Terrain and building shadow, asphalt, and deep dark water confused with cloud shadow
- False negatives:
 - Small clouds and shadows get filtered out and missed
 - Cloud shadow gets missed regularly
- Cloud accuracy is higher than shadow accuracy

Potential issues to think about as a group

- Where to draw the line?
- Boundary of a cloud extent?
- If you can see features through hazy cloud, leave it?
- If any pixels are impacted, should they be removed?
- Do we care if we miss cloud shadow over water?
- Many approaches are tunable and can be adjusted to fit desired output
- Parameters depend on application
 - Land cover, often best to undercall
 - Change detection, best to overcall



Thank You



- Contact info:
 - Dr. François G. F. Smith
 - Francois.smith@radiantsolutions.com
 - 240-833-8262