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VALIDATION TEAM MEETING
15–17 March 2021 | Virtual Event
Comparison of Masks of Fmask5, ATCOR and Sen2Cor
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Europe's eyes on Earth

Comparison of Masks of Fmask5, ATCOR and Sen2Cor

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Processor versions

Fmask 5: pythonfmask 0.5.4 (2019)[1]

Sen2Cor: 2.8 (2019) [2]

ATCOR: 9.3.0 (2019) [3]

Note: in order to make the comparison as fair as possible, only the original image data without external classification maps was used

1. Frantz, D.; Hass, E.; Uhl, A.; Stoffels, J; Hill, J. Improvement of the Fmask algorithm for Sentinel-2 images: separating clouds from bright surfaces based on parallax effects. Remote Sens. Environ. 2018, 215, 471–481.
2. Louis, J. Sentinel 2 MSI - Level 2A Product Definition. Issue 4.4. 2016-08-12. Available online: http://step.esa.int/thirdparties/sen2cor/2.8.0/docs/S2-PDGS-MPC-L2A-PDD-V14.5-v4.7.pdf (accessed March 1, 2021)
3. Richter, R.; Schläpfer, D. ATCOR Theoretical Background Document, DLR Report DLR-IB 564-03/2019, German Aerospace Center (DLR): Wessling, Germany, 2019. Available online:https://www.rese-apps.com/software/atcor/manual-papers.html , (accessed Feb. 26, 2021).

Brief characteristics of the 3 methods (input S2 L1C data)

- Common features:
  - spectral thresholds of TOA reflectance, band ratios, NDVI, NDSI …
  - cloud mask + geometric criteria to calculate cloud shadow

- Differences:
  - thresholds are set differently
  - criteria to define potential shadow
  - buffering of cloud, buffering of "holes" in cloud / cloud shadow

For details refer to the publications on previous slide.

- This study was performed for 20 test sites distributed over all continents (flat, mountains, different seasons & cloud covers) .
- Results for 5 selected sites are presented here.

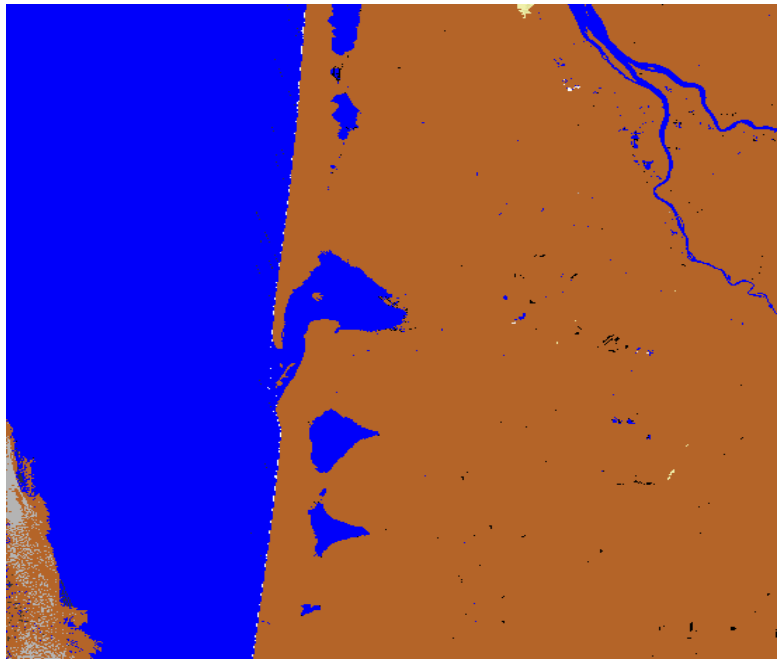
1. Arcachon – 2017.02.18

GRANULE:
L1C_T30TXQ_A008671_20170218T110125
L2A_T30TXQ_A008671_20170218T110125

Zenith angle = 58.27°
Azimuth angle = 159.92°

TOA_rho_20m (true color)

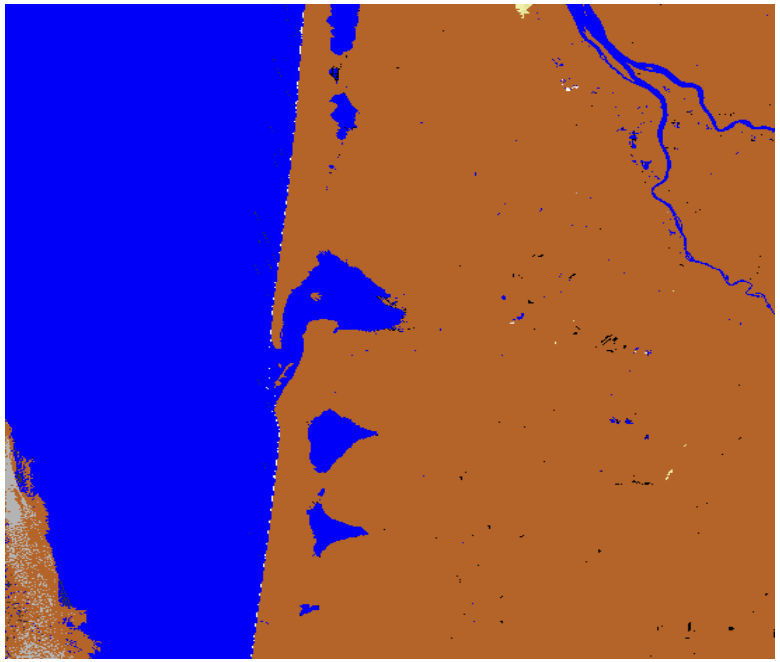
TOA_rho_20m_CIR



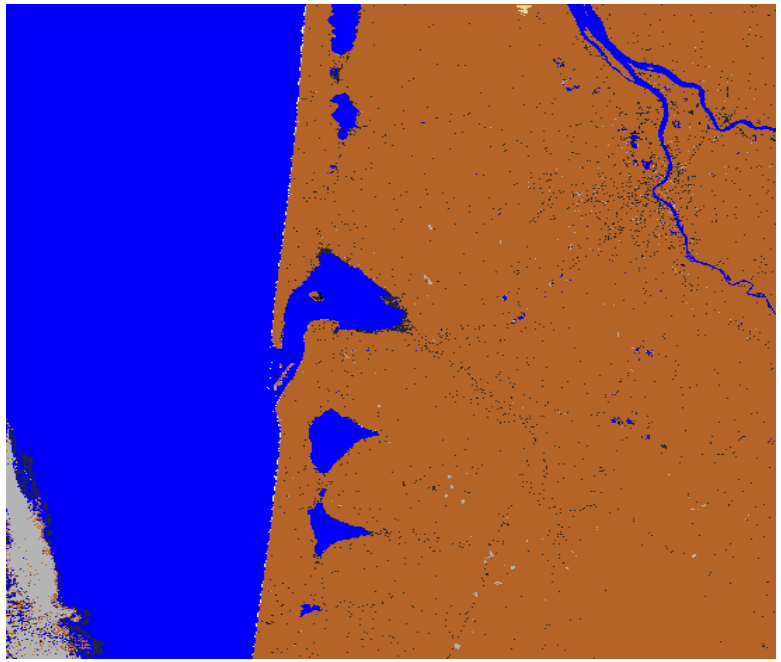
ATCOR_csw

Arcachon – 2017.02.18

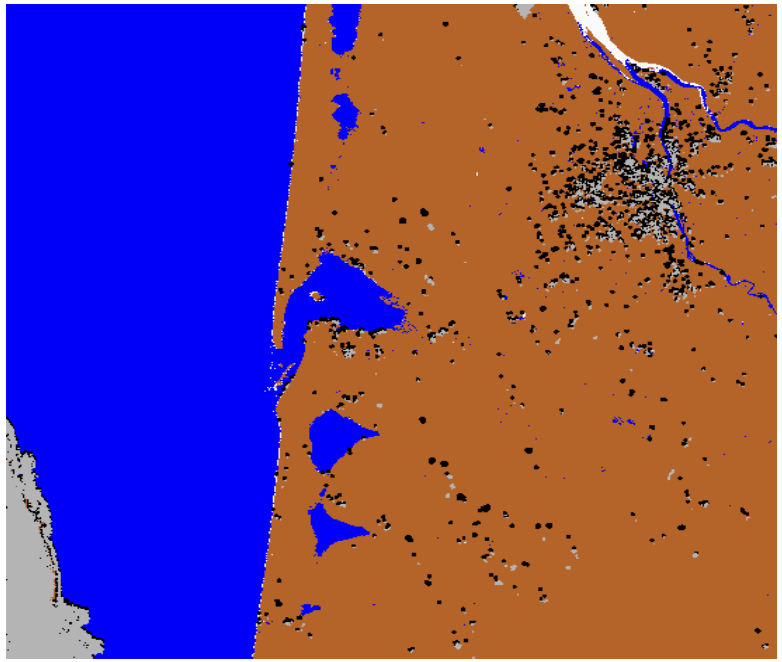
clear		cloud	
water		snow	
shadow		cirrus	



ATCOR_csw



Sen2Cor_SCL

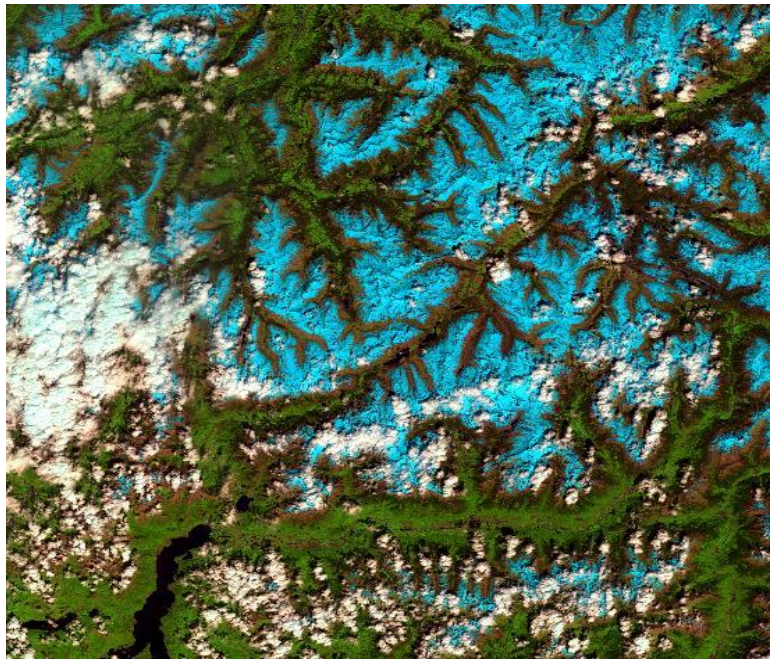


Fmask-5

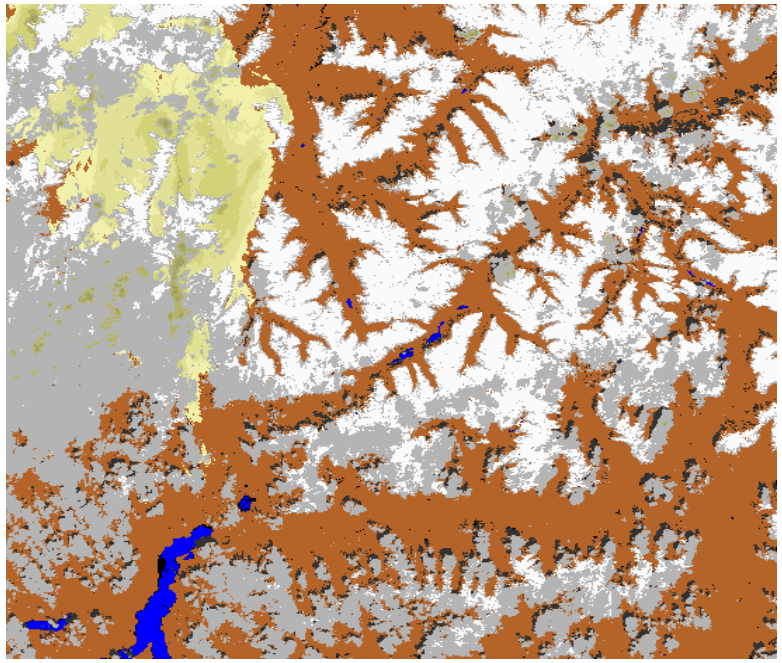
2. Davos – 2016.05.22

GRANULE:
L1C_TL_SGS__20160522T155047_A004781_T32TNS_N02.02

Zenith angle = 27.86°
Azimuth angle = 154.44°



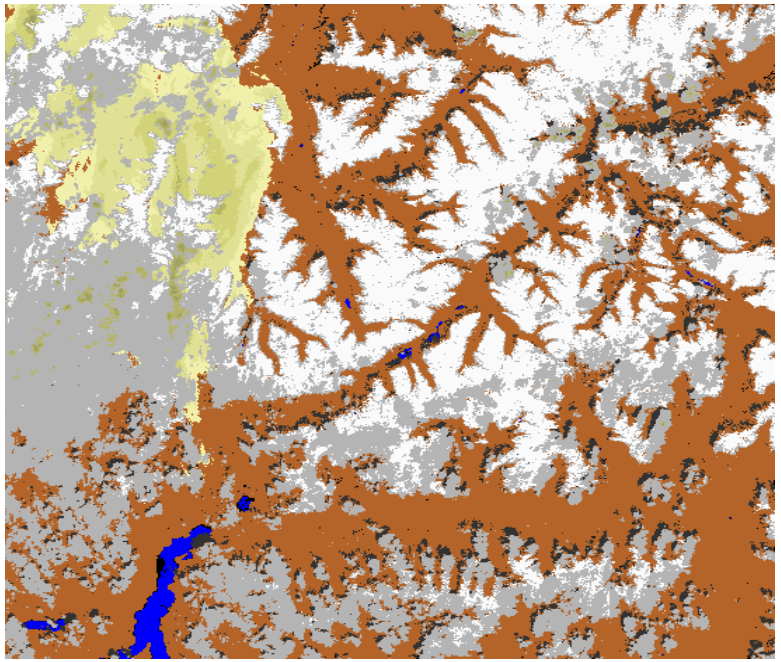
SWIR1_NIR_Red



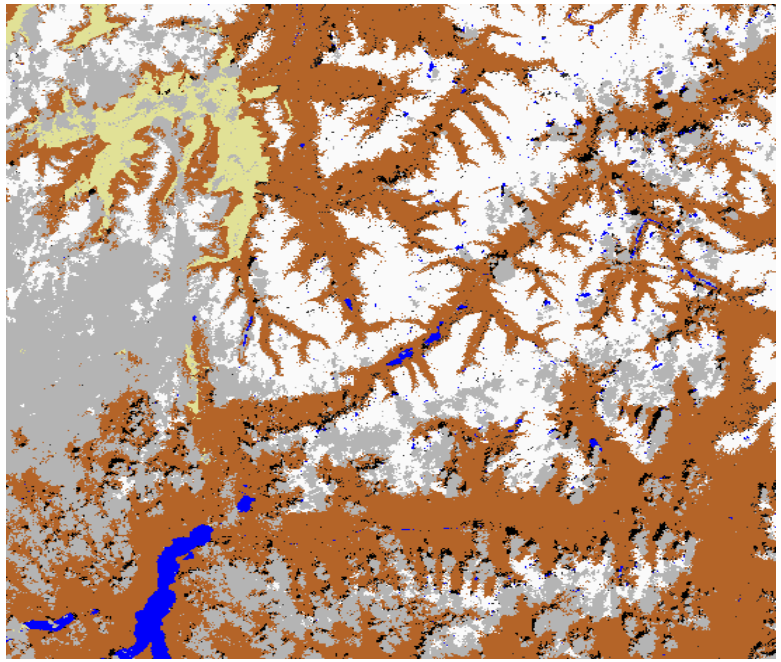
ATCOR_csw

Davos – 2016.05.22

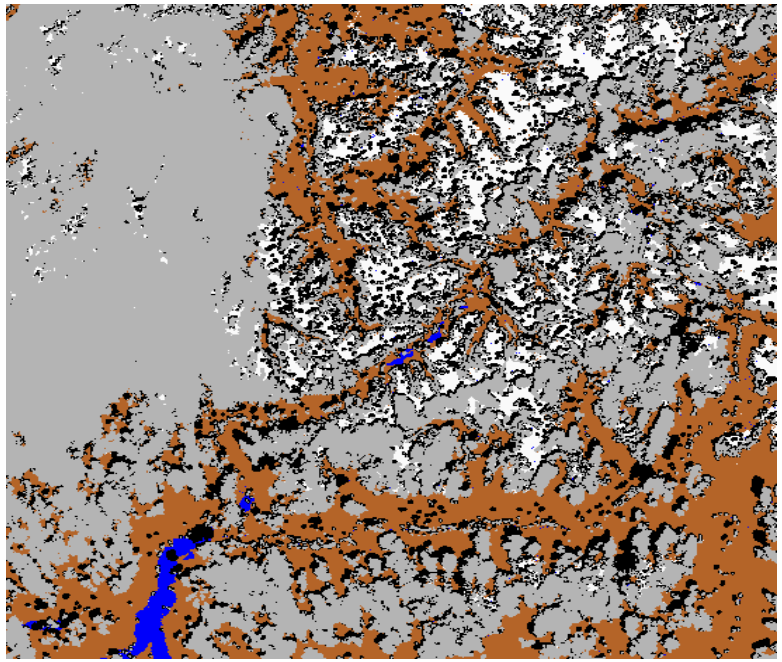
clear	cloud
water	snow
shadow	cirrus



ATCOR_csw



Sen2Cor_SCL

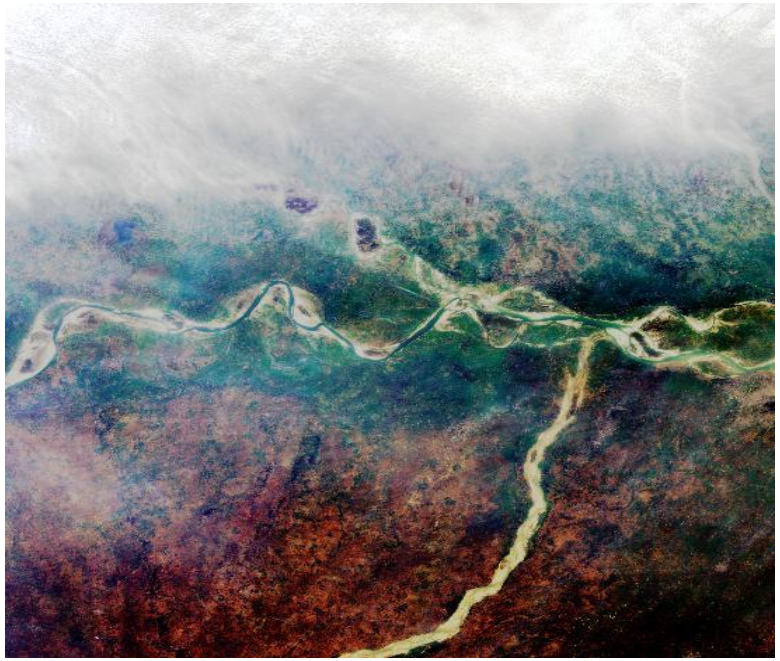


Fmask-5

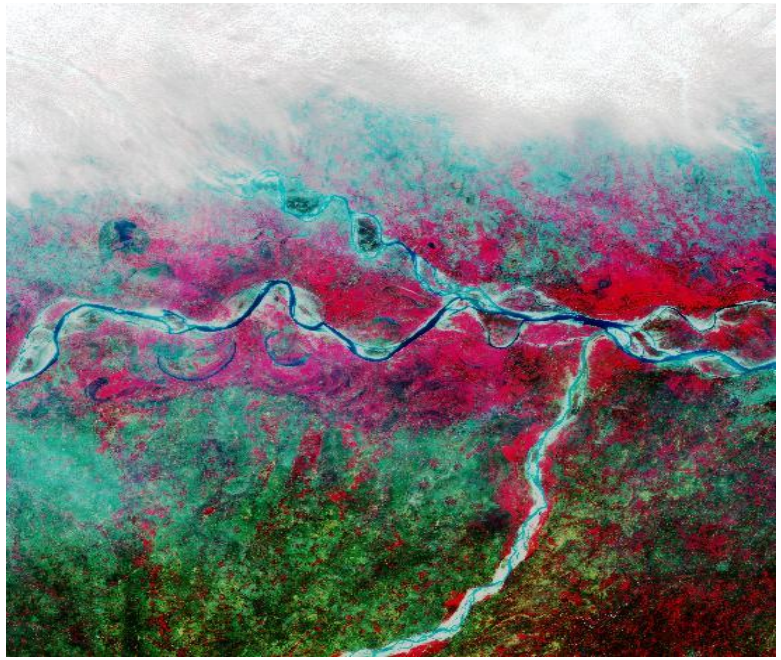
3. Delhi, Gandhi College – 2016.12.22

GRANULE:
L1C_T45RTJ_A007838_20161222T050600
L2A_T45RTJ_A007838_20161222T050600

Zenith angle = 51.89°
Azimuth angle = 159.79°



TOA_rho_20m (true color)



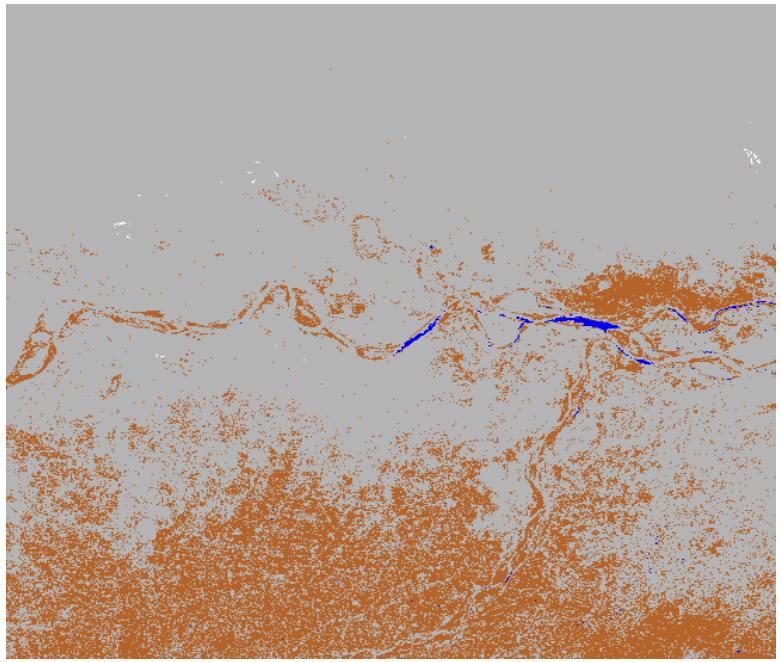
TOA_rho_20m_CIR

ATCOR_csw

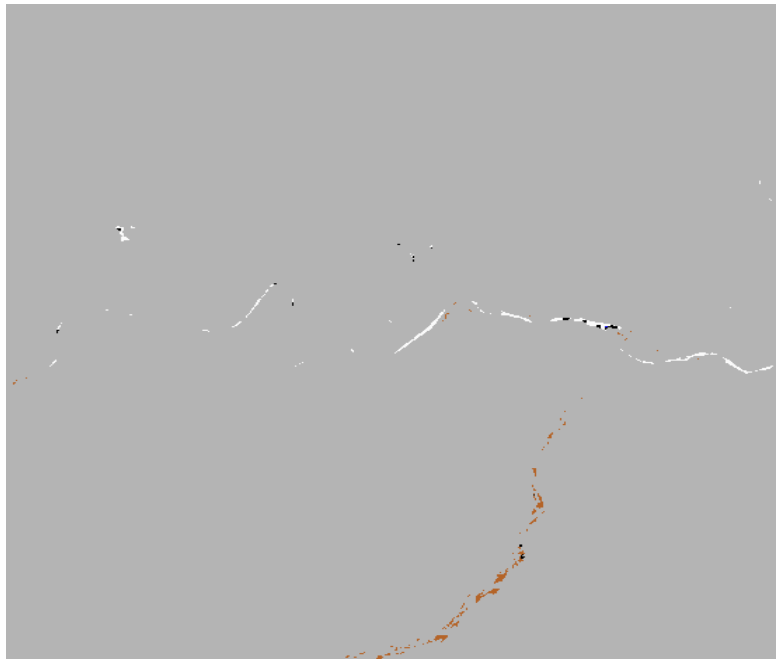
Delhi, Gandhi College – 2016.12.22

clear | cloud
water | snow

ATCOR_csw



Sen2Cor_SCL

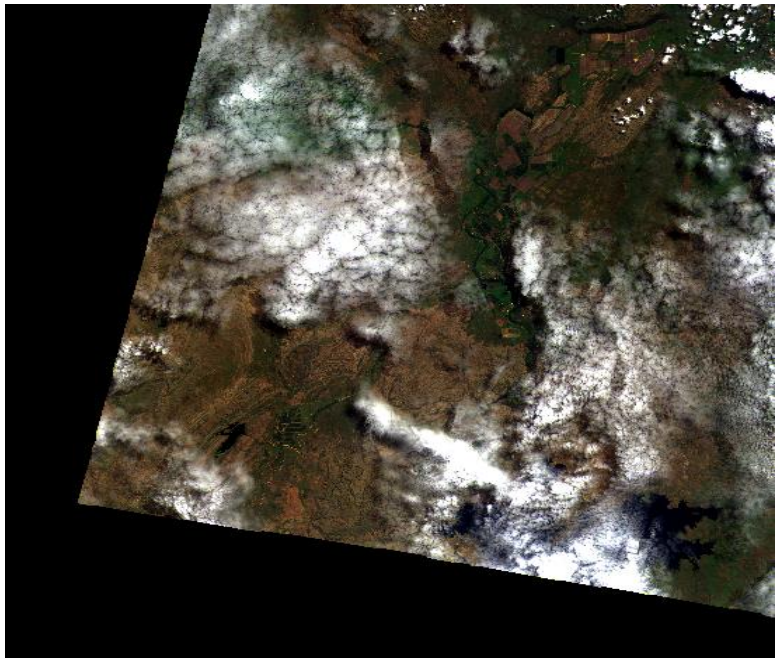


Fmask-5

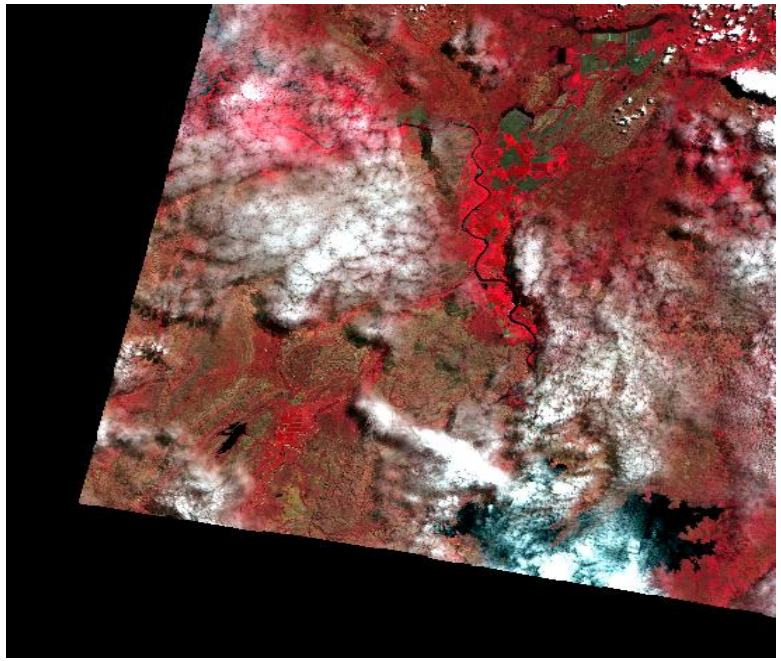
4. Lake Argyle (Australia) – 2017.03.26

GRANULE:
L1C_T52LDH_A009180_20170326T013706
L2A_T52LDH_A009180_20170326T013706

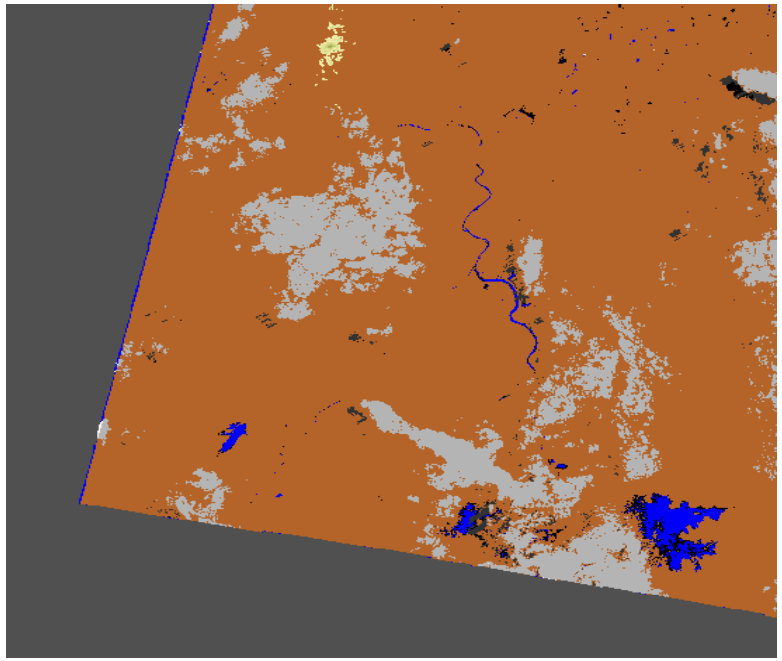
Zenith angle = 32.58°
Azimuth angle = 58.67°



TOA_rho_20m (true color)



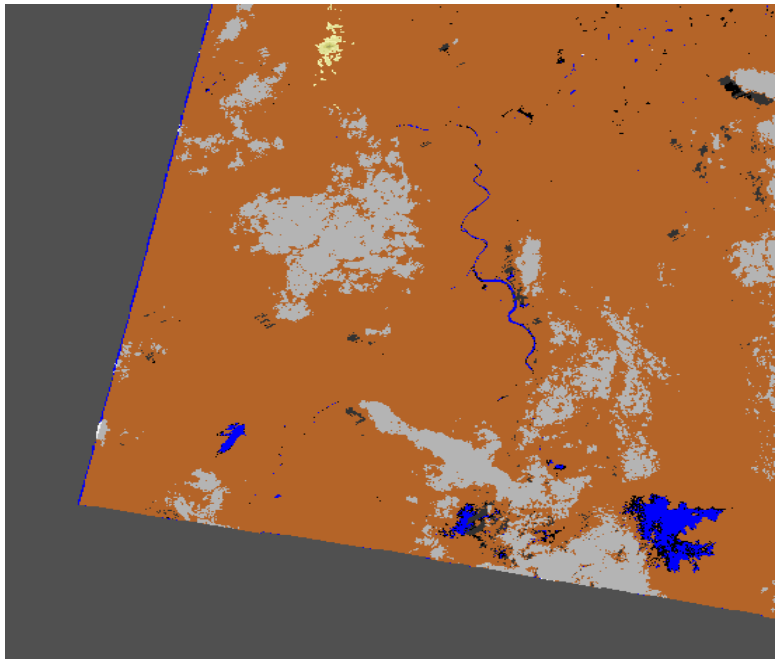
TOA_rho_20m_CIR



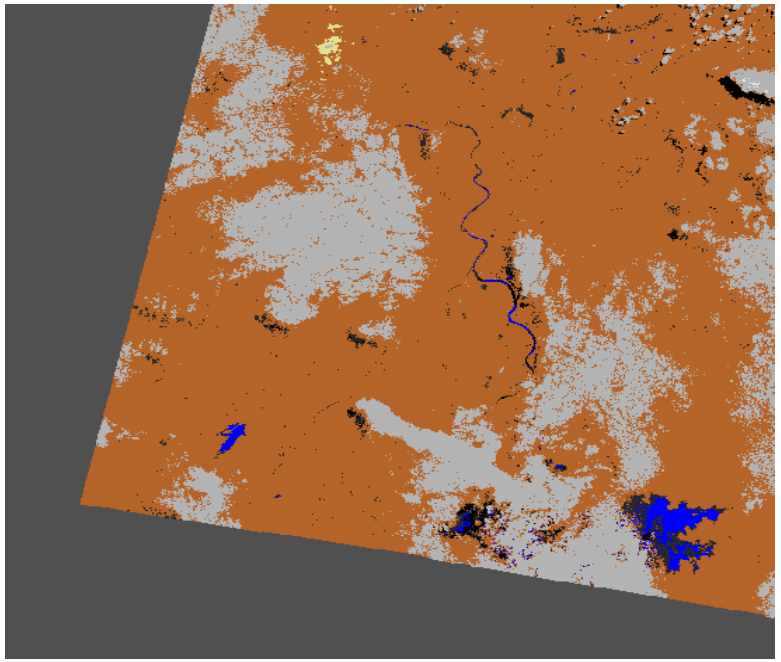
ATCOR_csw

Lake Argyle (Australia) – 2017.03.26

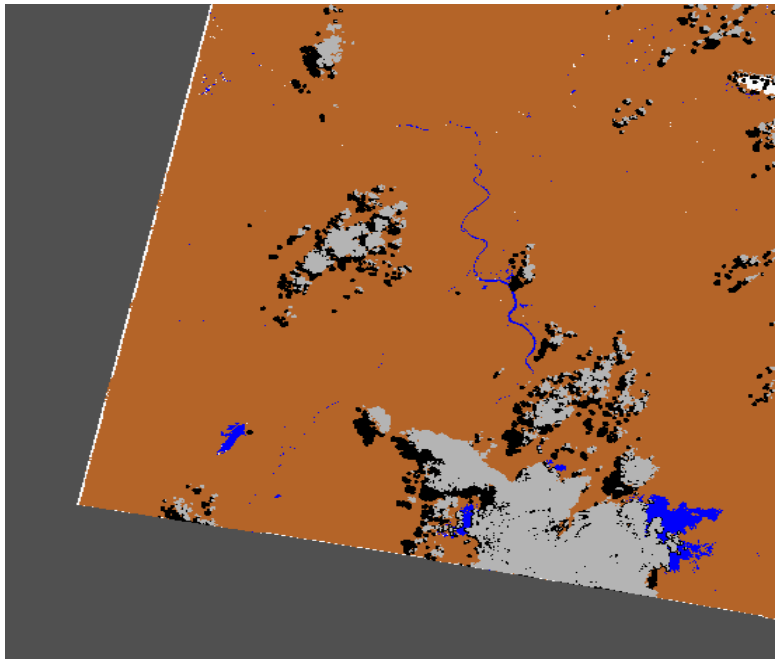
	clear		cloud
	water		snow
	shadow		cirrus



ATCOR_csw

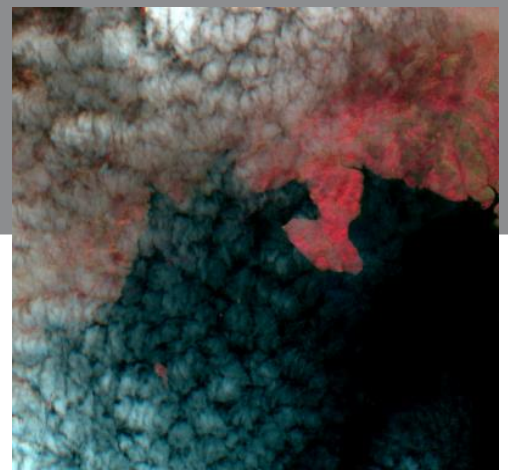


Sen2Cor_SCL



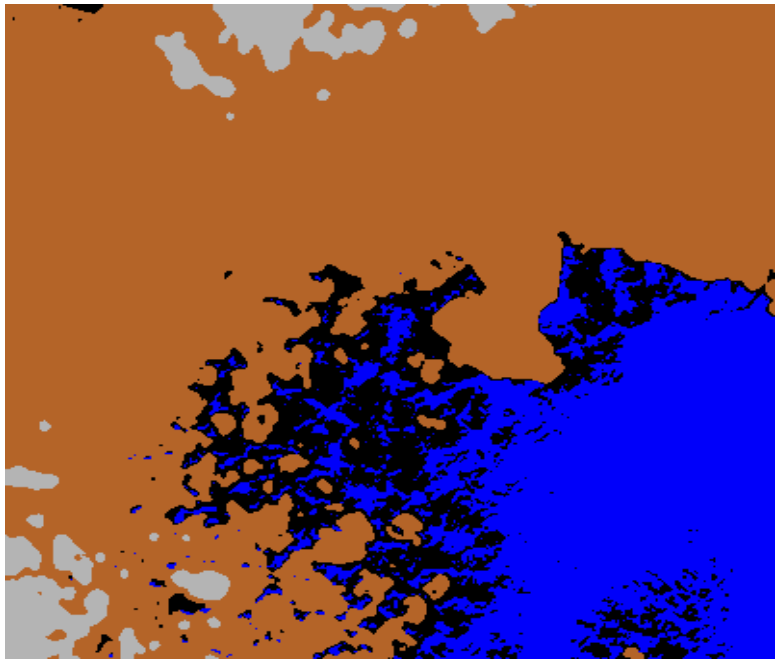
Fmask-5

Lake Argyle (Australia) – 2017.03.26
→ Example

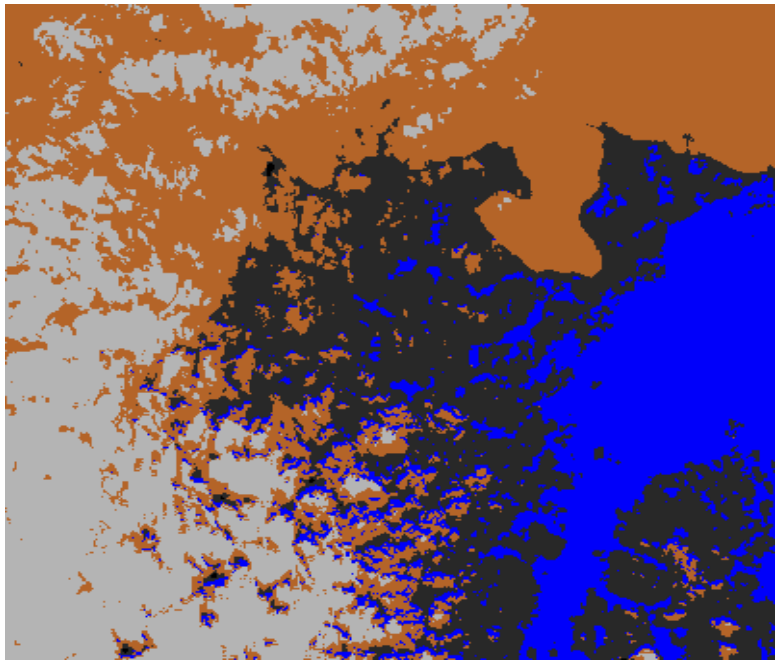


TOA_rho_20m_CIR

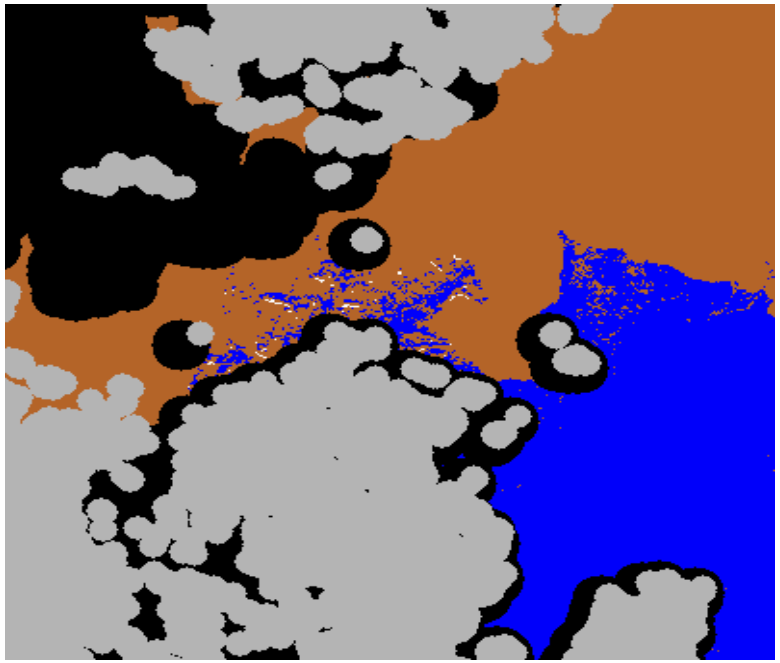
clear	cloud
shadow	water



ATCOR_csw



Sen2Cor_SCL

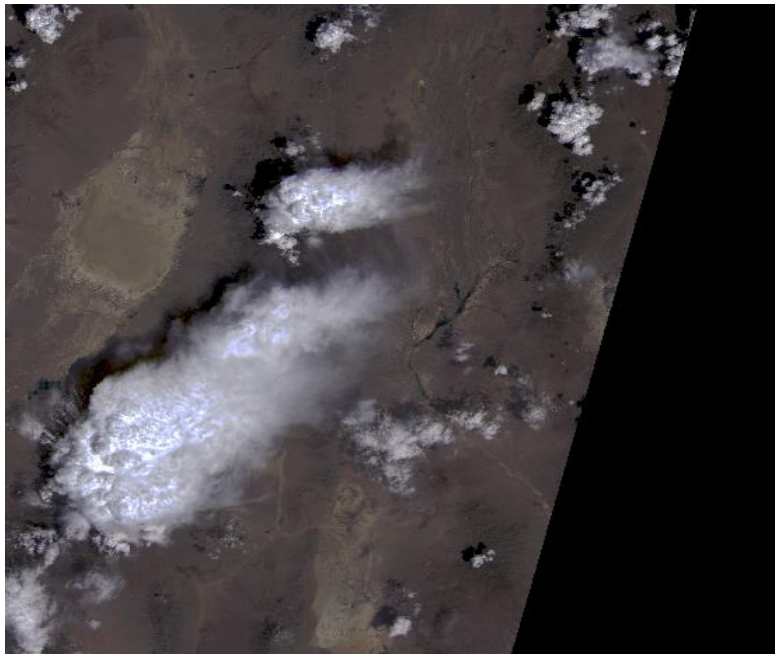


Fmask-5

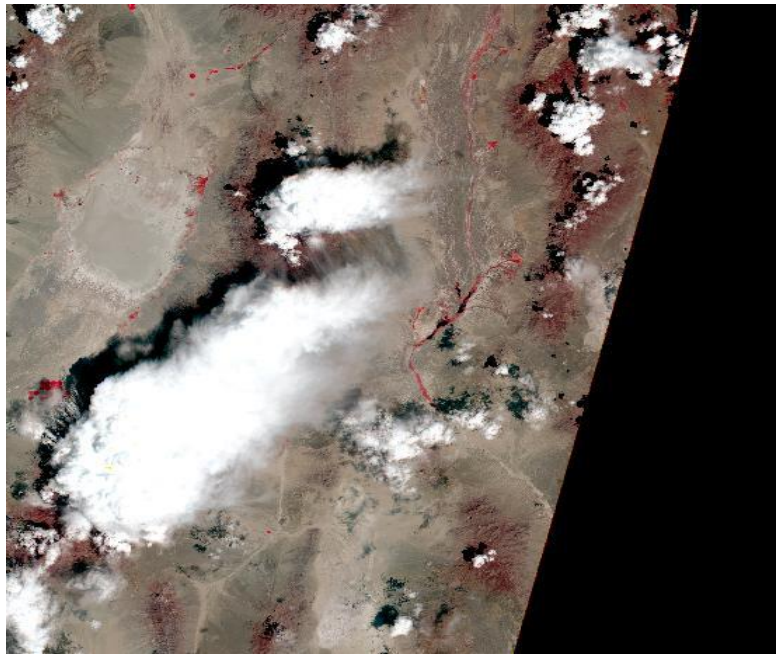
5. Railroad Valley – 2017.07.23

GRANULE:
L1C_T11SPC_A010892_20170723T184000
L2A_T11SPC_A010892_20170723T184000

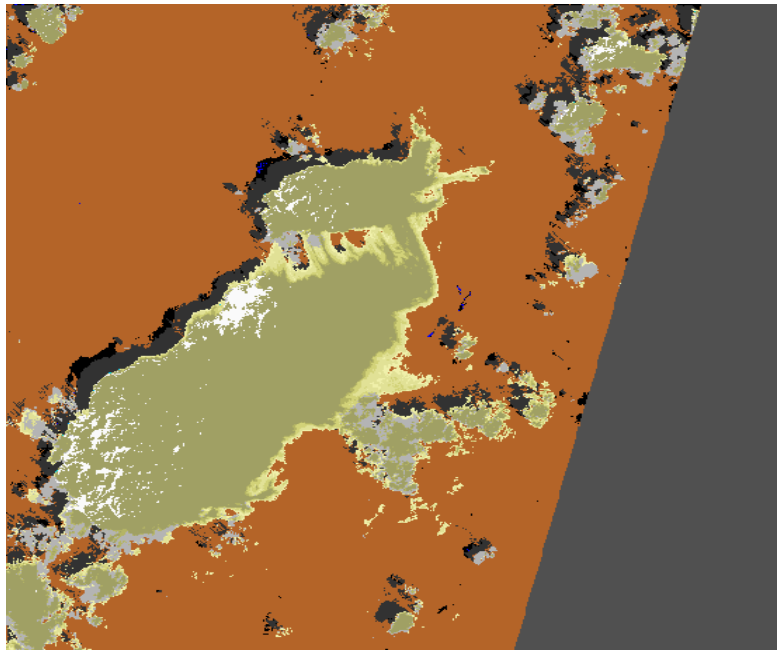
Zenith angle = 23.01°
Azimuth angle = 138.71°



TOA_rho_20m (true color)



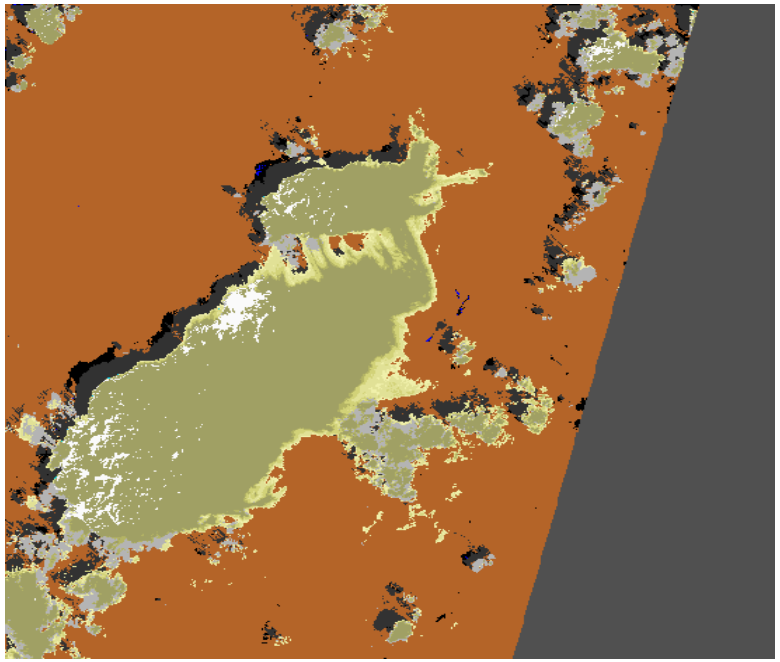
TOA_rho_20m_CIR



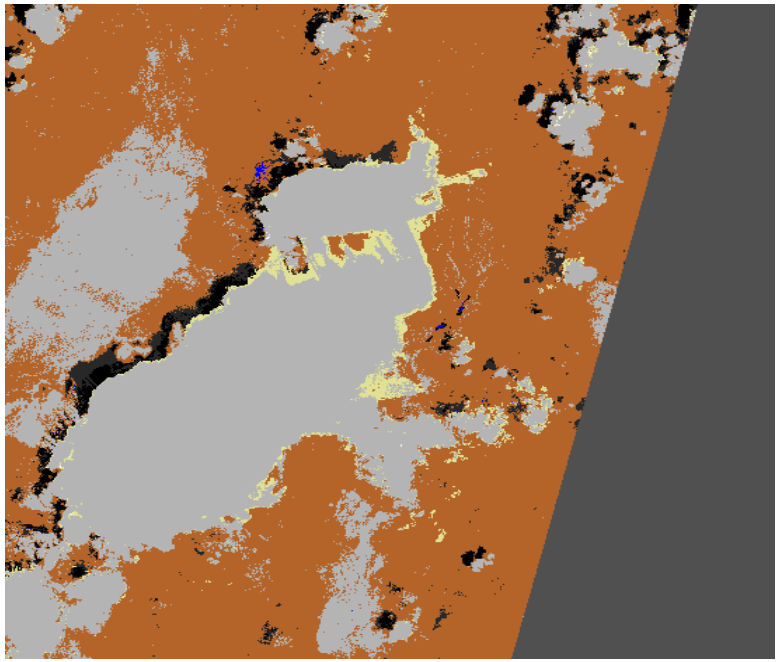
ATCOR_csw

Railroad Valley – 2017.07.23

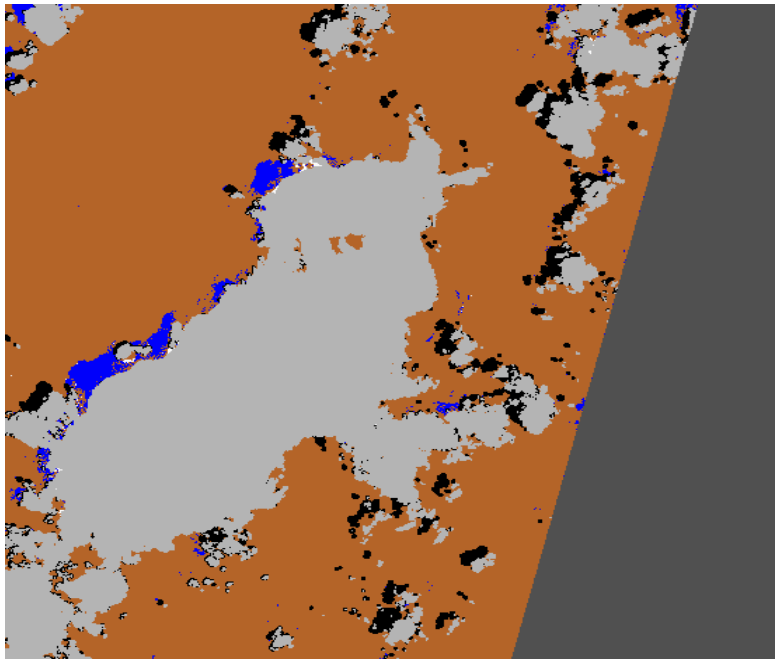
clear		cloud	
water		snow	
shadow		cirrus	



ATCOR_csw



Sen2Cor_SCL



Fmask-5

Summary

ATCOR **+**

- Robust classification
- Cloud mask: accurate (urban/arid/desert area)
- Accurate water mask (shadow over water: shadow preference)
- Adequate shadow mask

ATCOR **-**

- Conservative mask of water cloud (underestimates clouds)
- Conservative cloud shadow mask (underestimates cloud shadow)

Sen2Cor **+**

- Robust classification for all scenes
- Cloud mask: accurate in many cases (medium brightness scenes)

Sen2Cor **-**

- Cloud mask fails in urban areas and arid/desert areas cannot distinguish between bright ground object and cloud
- Cloud shadow mask consistently underestimates shadow

Fmask **+**

- Cloud mask is dilated to increase accuracy of clear pixels
- Cloud mask is adequate in desert/arid regions
- High User Accuracy for semitransparent cloud, water, topog. shadow

Fmask **-**

- Urban structures are usually classified as cloud
- Strange circular or elliptical blobs of cloud mask often appear
- Classifies bright water as snow/ice and often misclassifies snow/ice as cloud