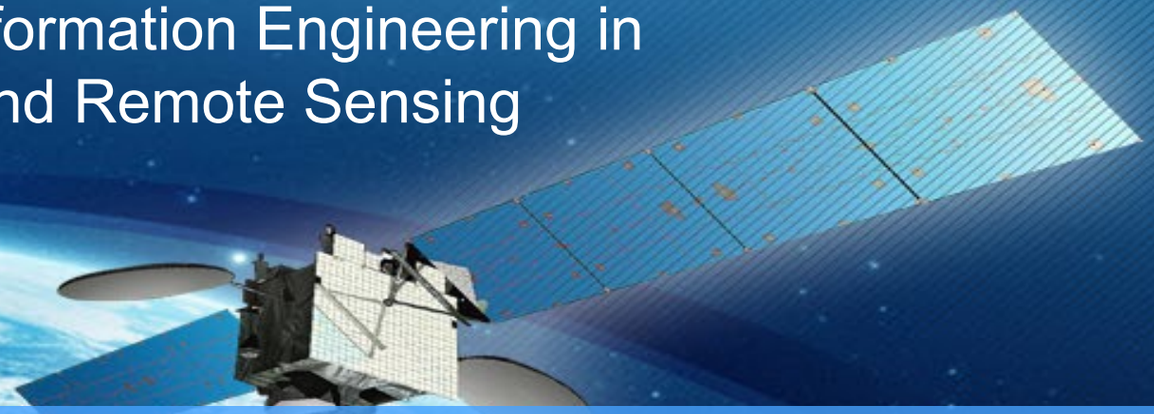
An object-oriented approach for generating clear-sky composite image based on time series analysis using FY-3D MERSI data

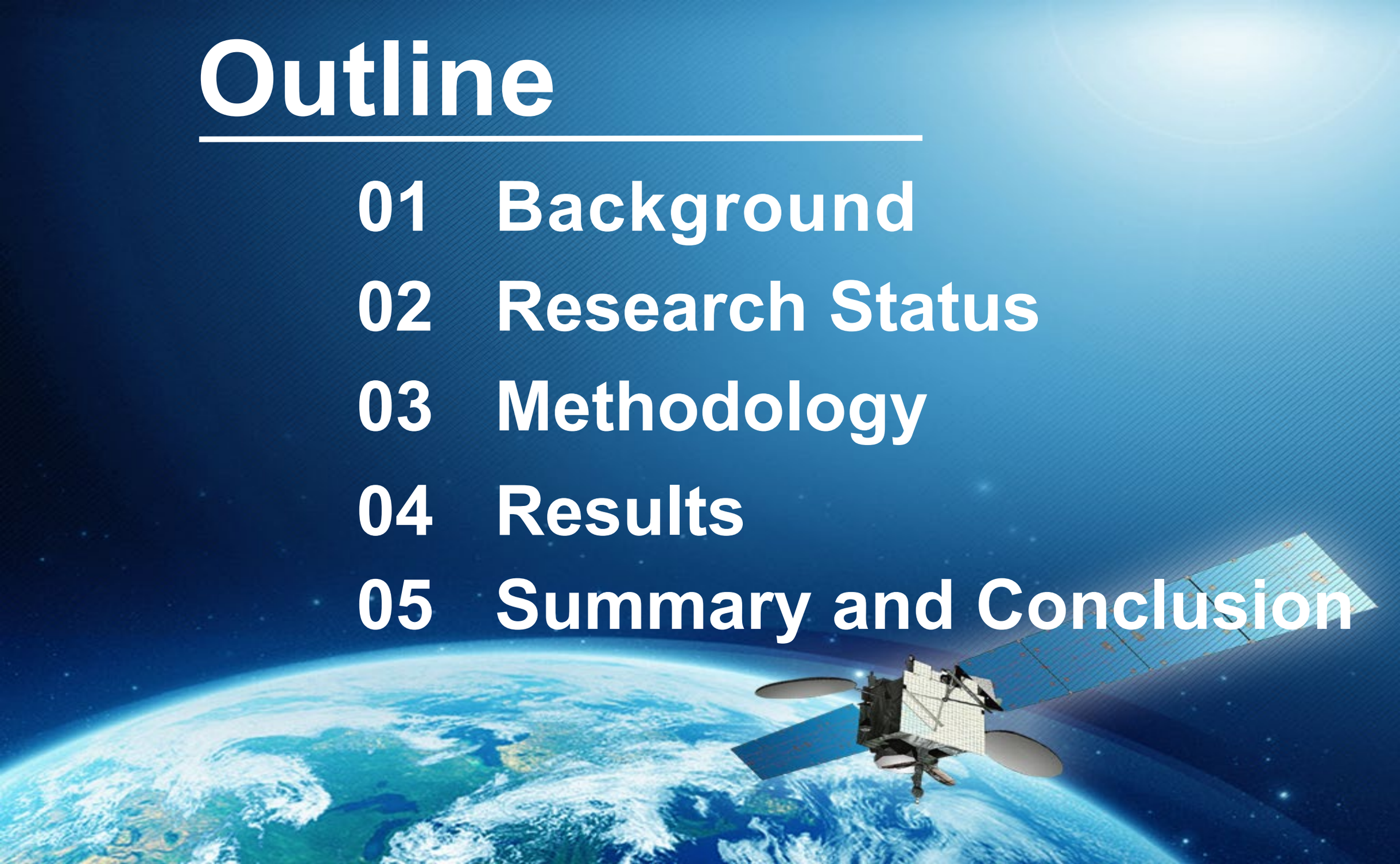
Prof. Kaimin SUN

Wuhan University

State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing

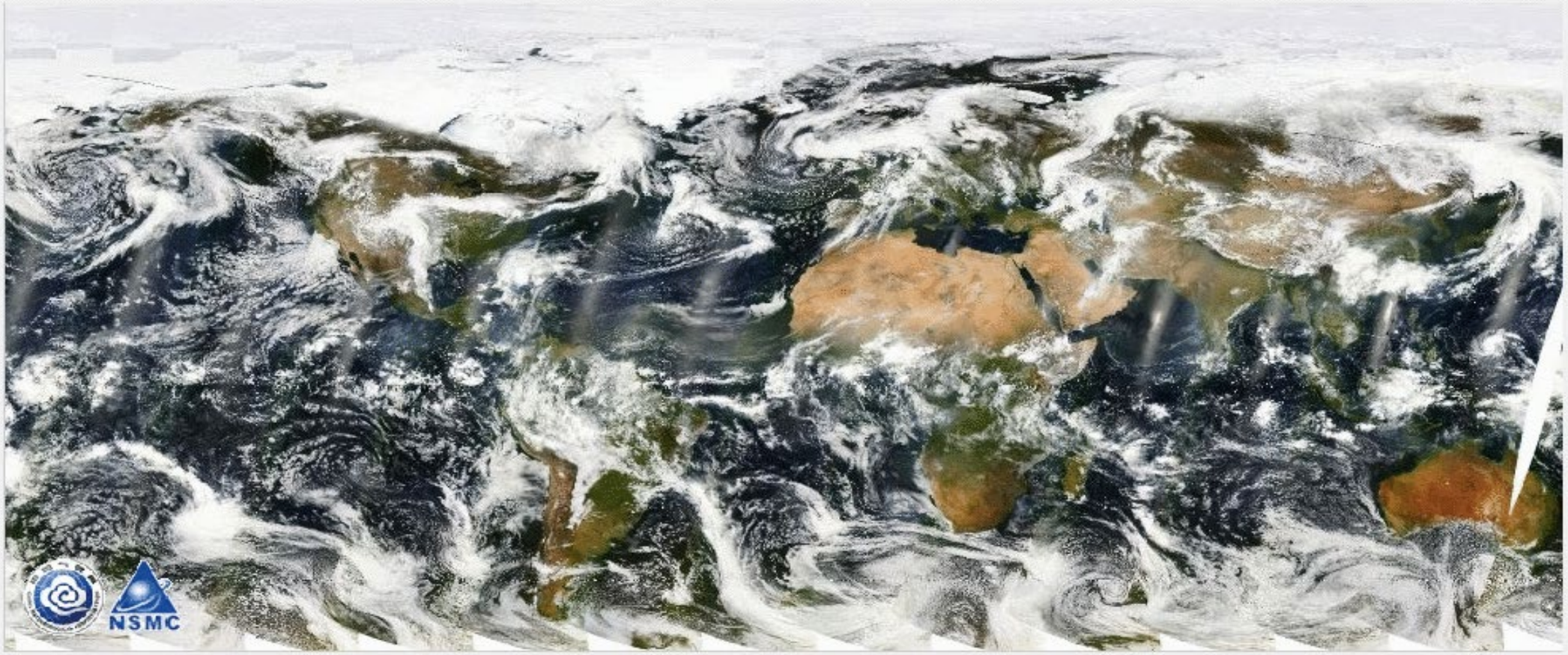


Outline



Background

- 66% global land surface covered by cloud
- Reduces the usage rate and hinders the follow-up interpretation
- Clear-sky composite image are widely used



Research Status

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Research Status

1、Existing two categories : substitution and interpolation;

2、Suffer from blurring details and radiometric inconsistency;

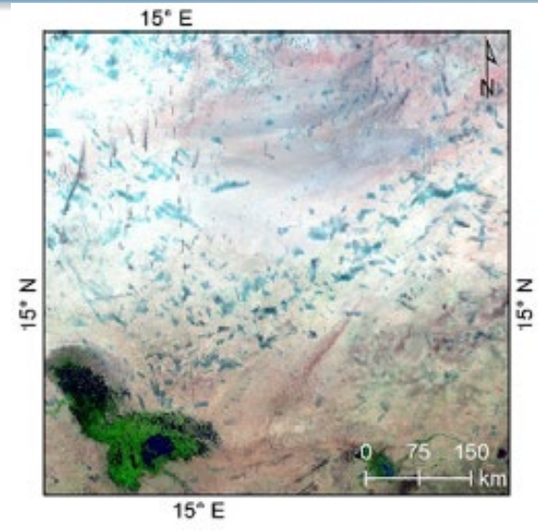
3、Limited by the type of underlying surface and the spatial temporal domain

Challenges

1、Detect clear-sky pixels based time series pattern;

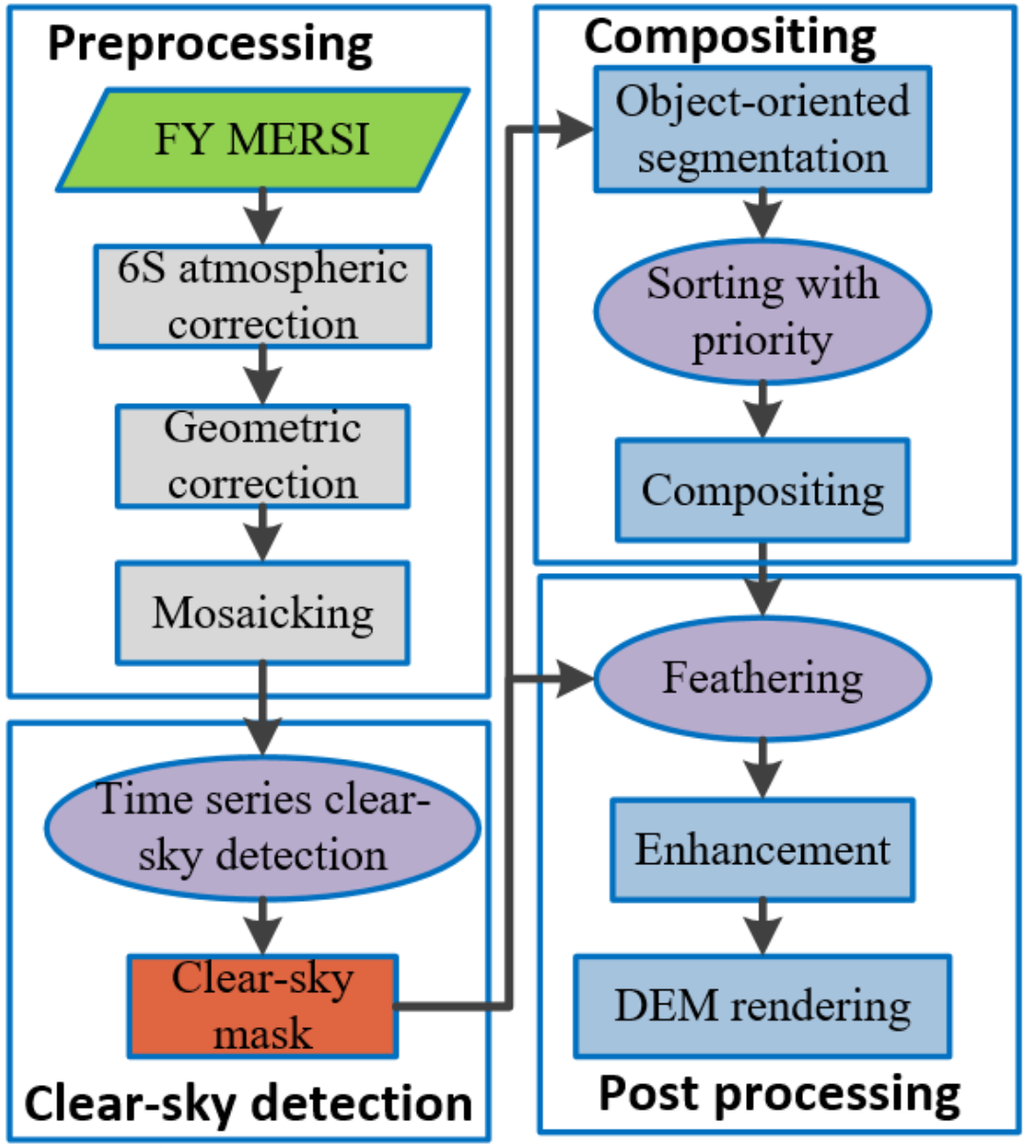
2、Improve radiometric consistency and visual quality;

3、Retain the quantitative application ability of composites.



Blurring Results

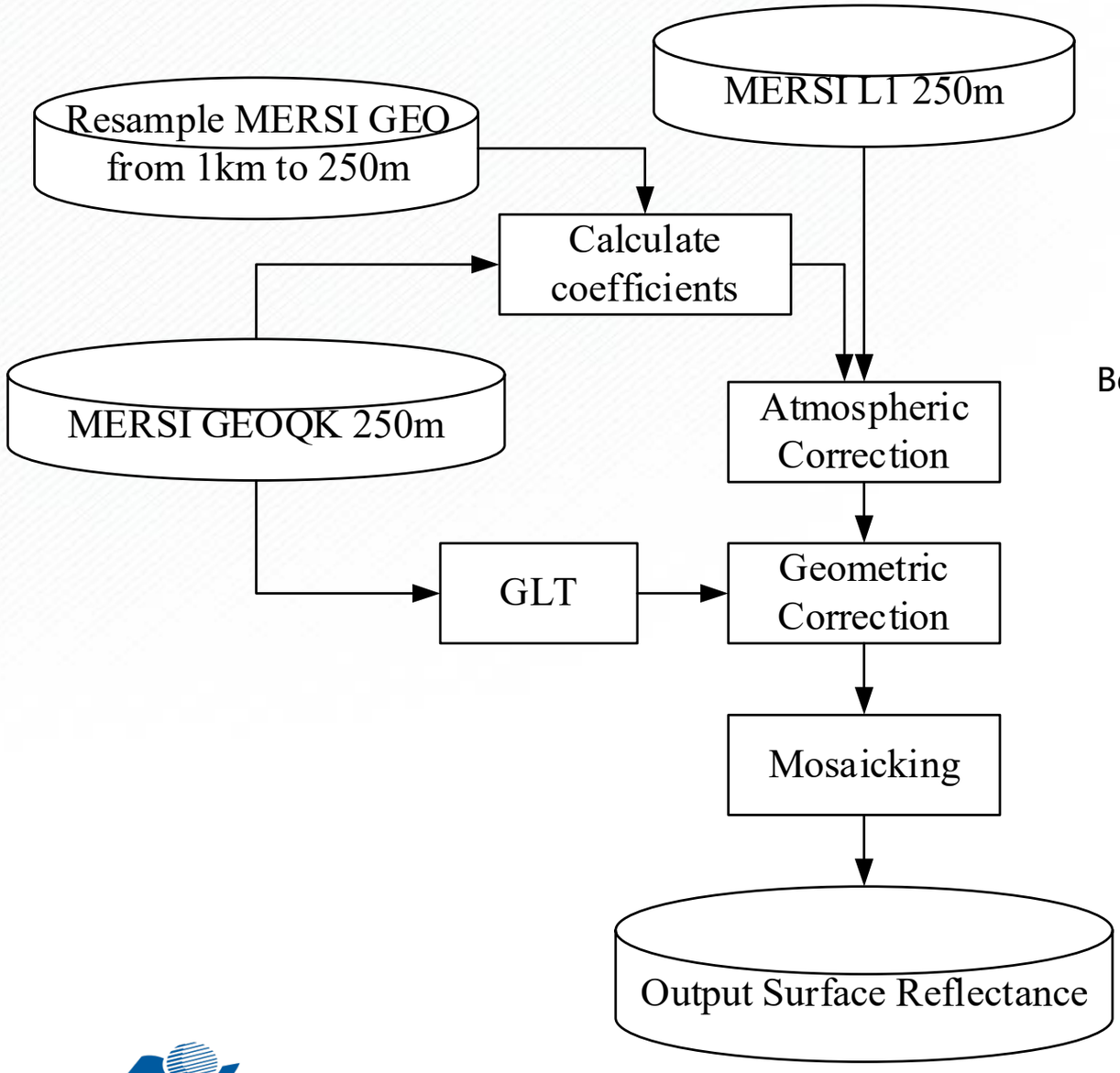
Methodology

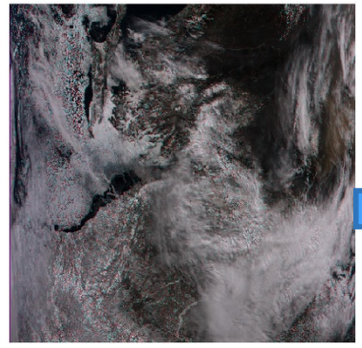


Input files for generating clear-sky composite

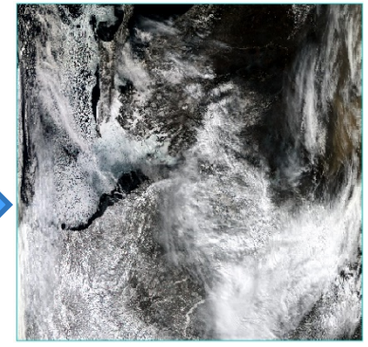
Number	Name	File Format	frequency	resources	Details
1	MERSI L1 250m	HDF	Daily	CNS-COSS	250m data for reflective solar and emissive Bands
2	MERSI GEO1km	HDF	Daily	CNS-COSS	Solar zenith and azimuth angle, sensor zenith and azimuth angle, DEM
3	MERSI GEOQK 250m	HDF	Daily	CNS-COSS	Latitude, longitude

Preprocessing



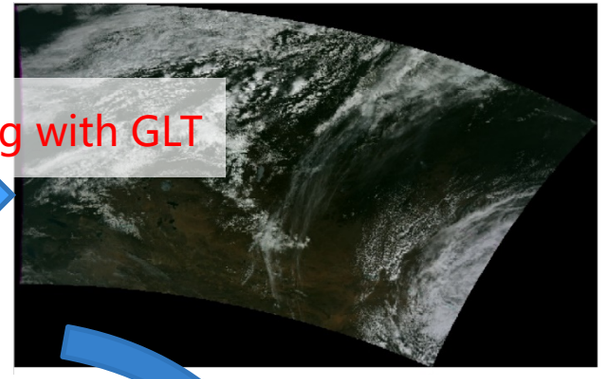


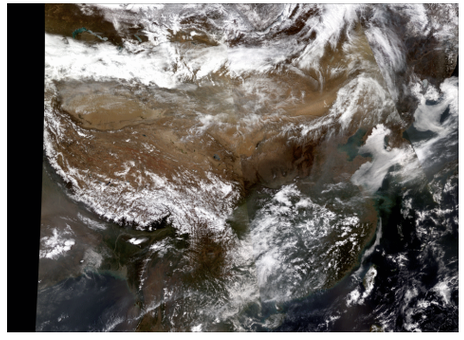
Before atmospheric correction



After atmospheric correction

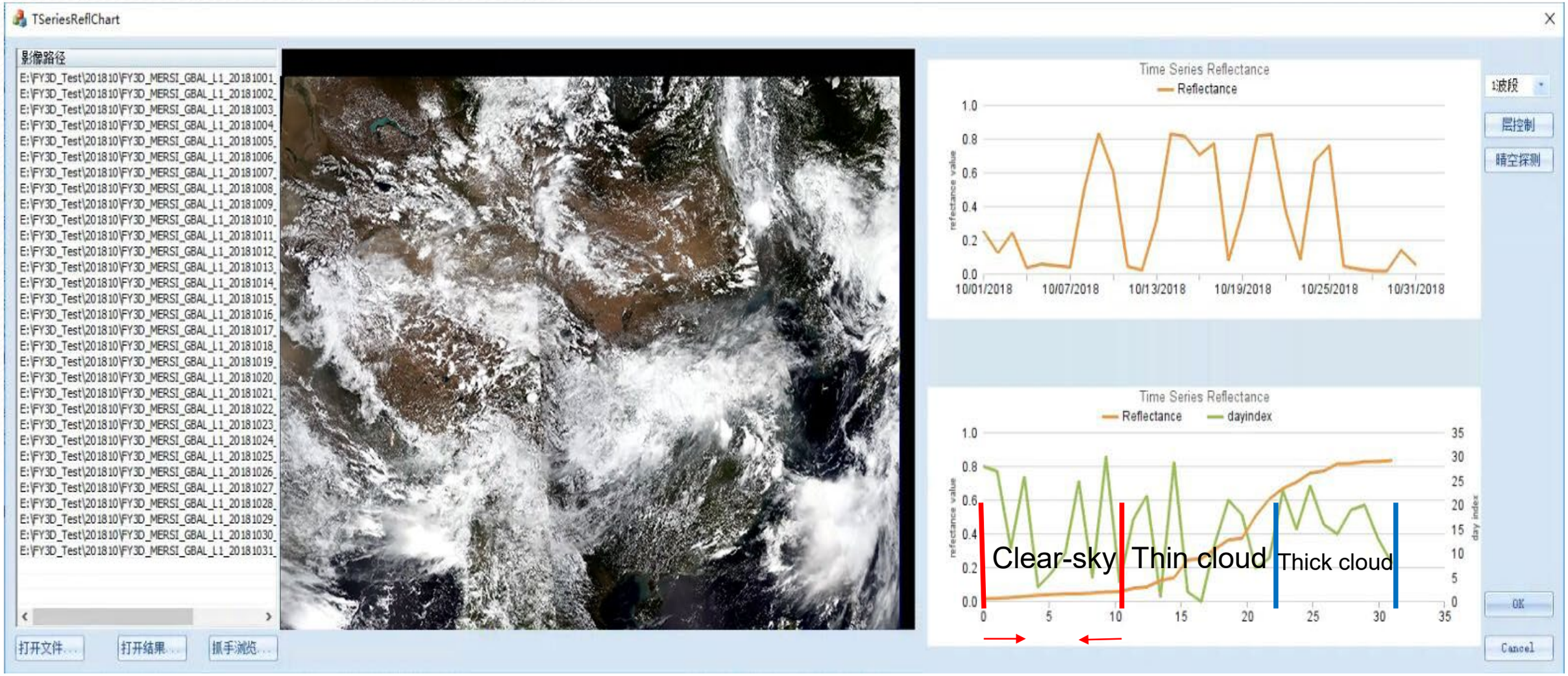
Georeferencing with GLT





Mosaic

Clear-sky/Cloudy pixels Detection



Generating Clear-sky Composite

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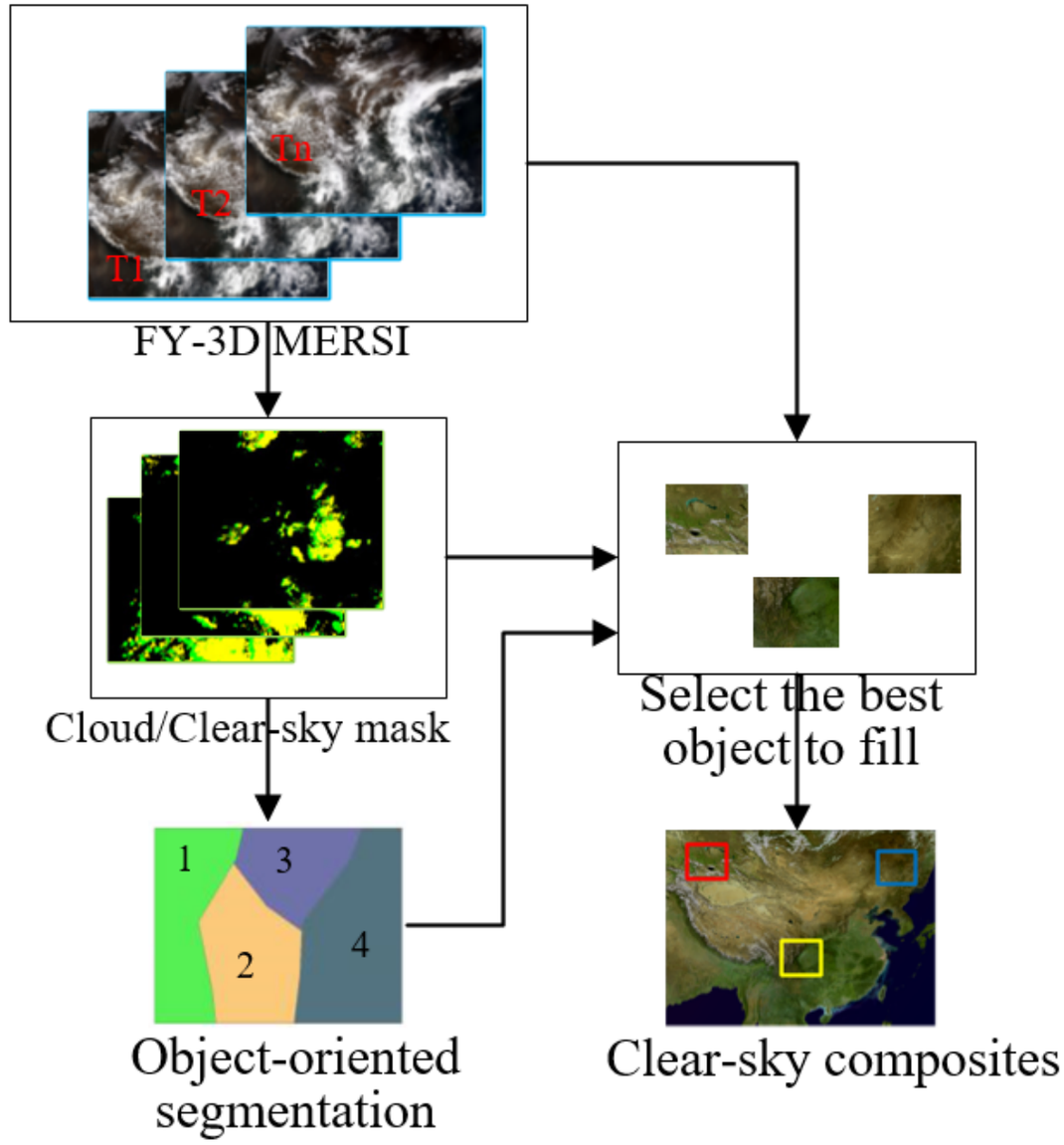
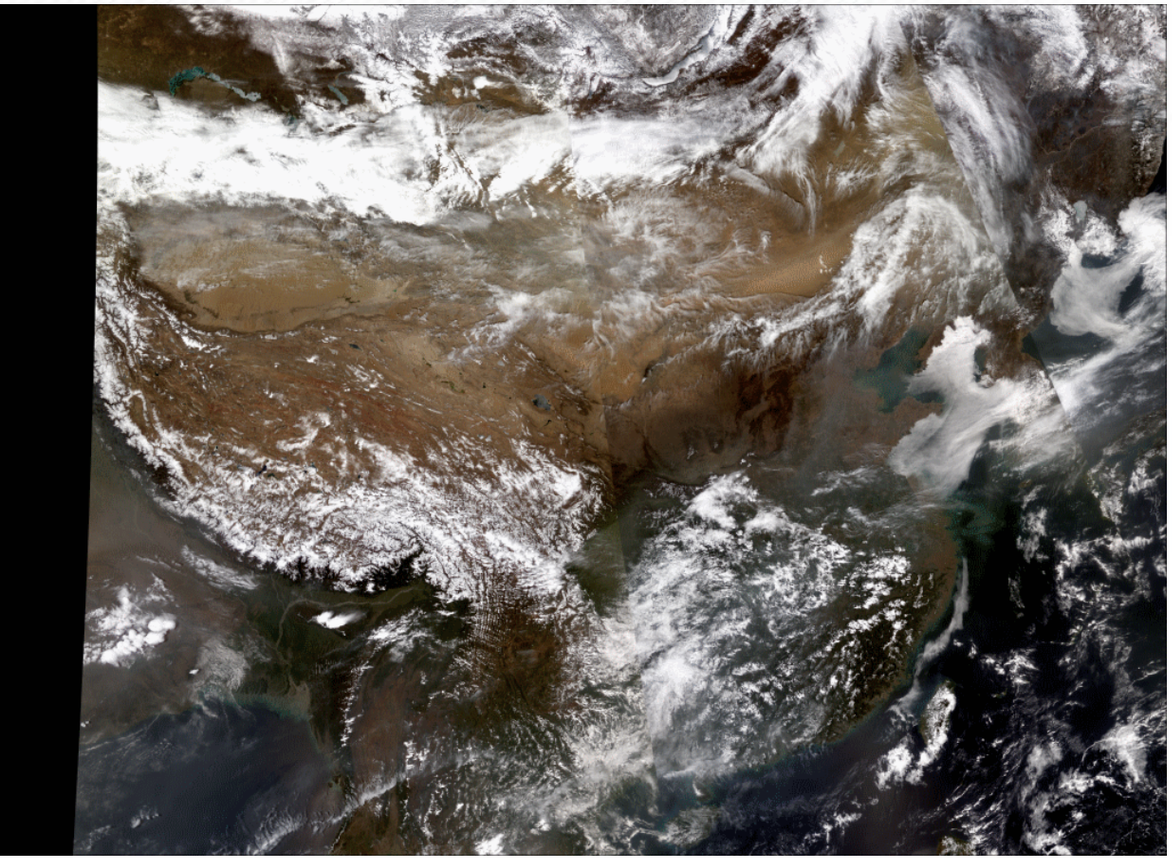
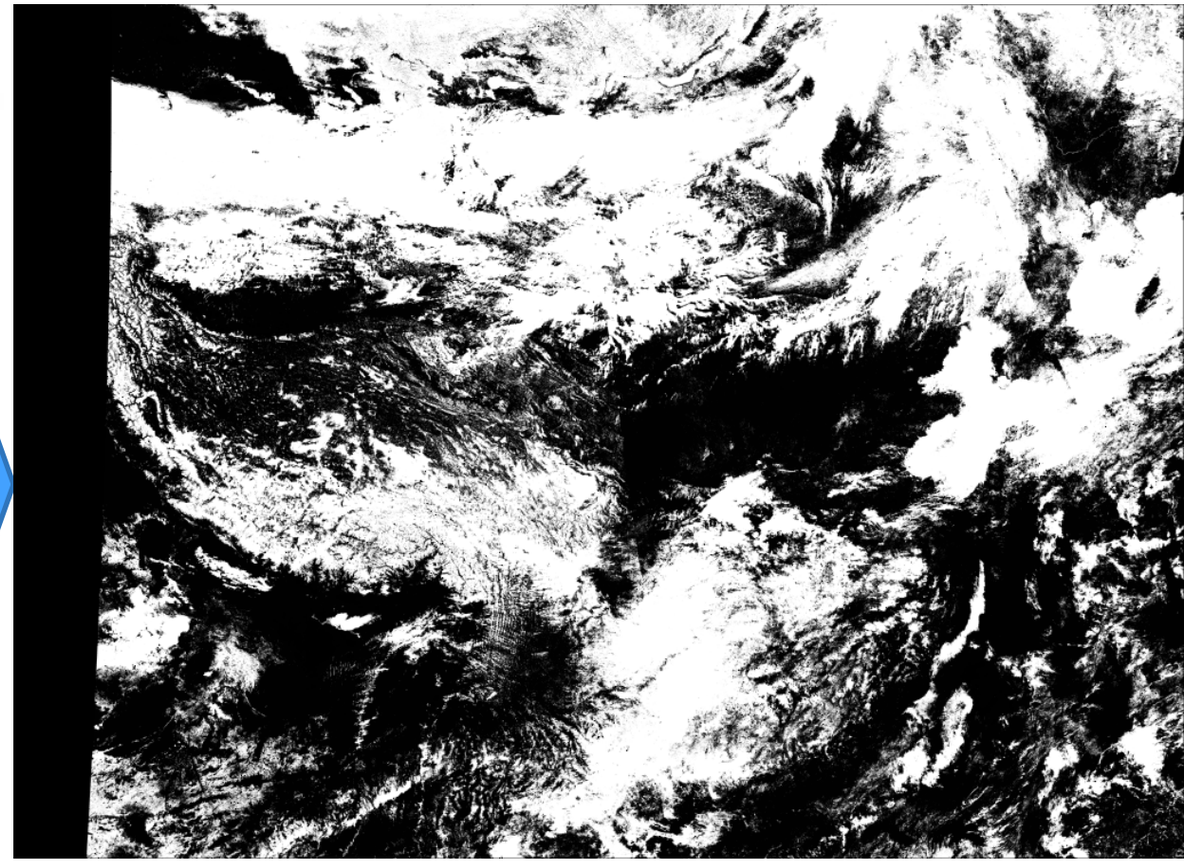
- From the surface reflectance time series, the best clear-sky object will selected to fill based on the mask.

- The selection criteria adopted include:
  - principle of time optimal
  - principle of quantity optimal
  - principle of quality optimal
  - ……

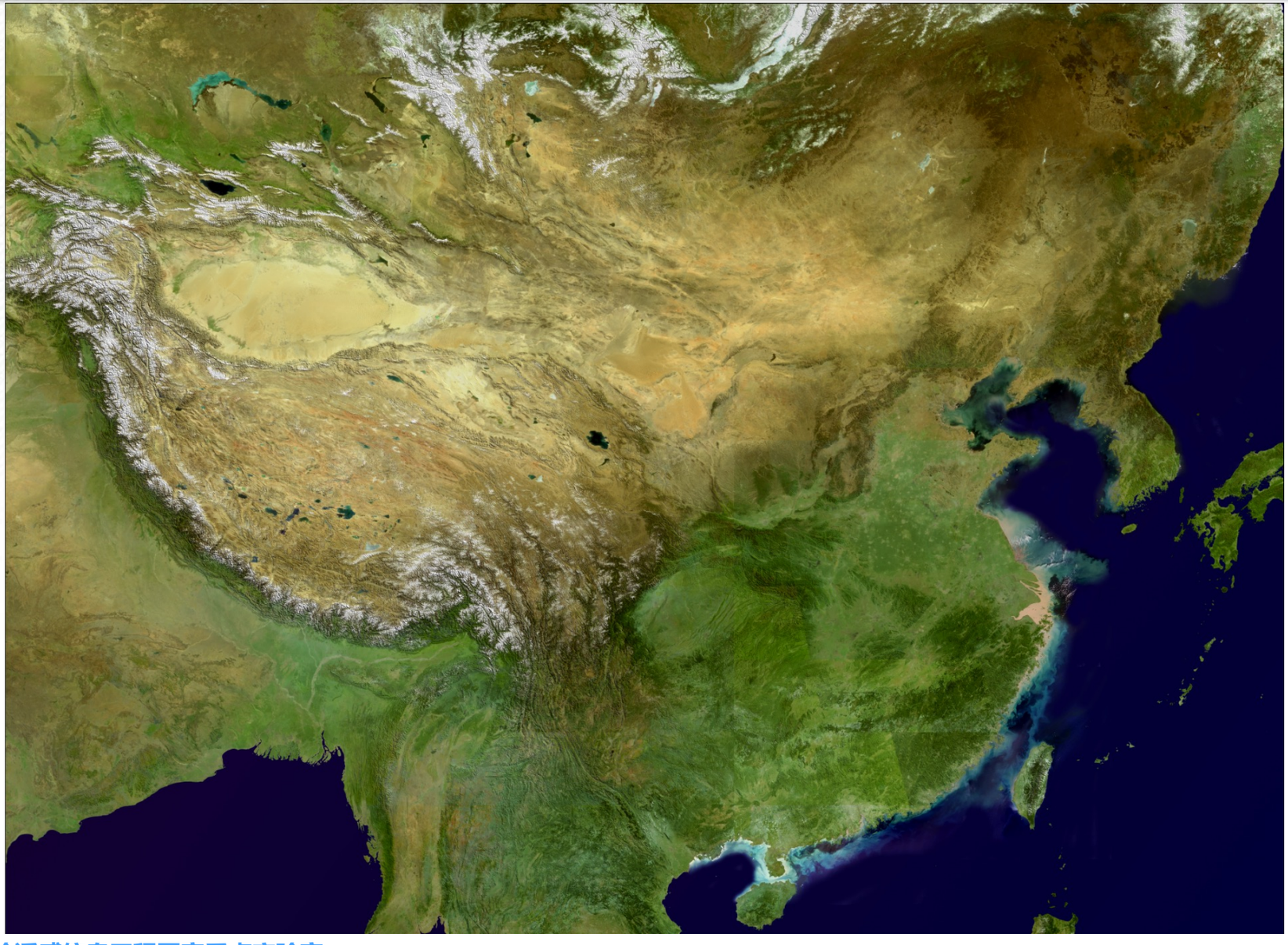


Results of clear-sky/cloud detection in China

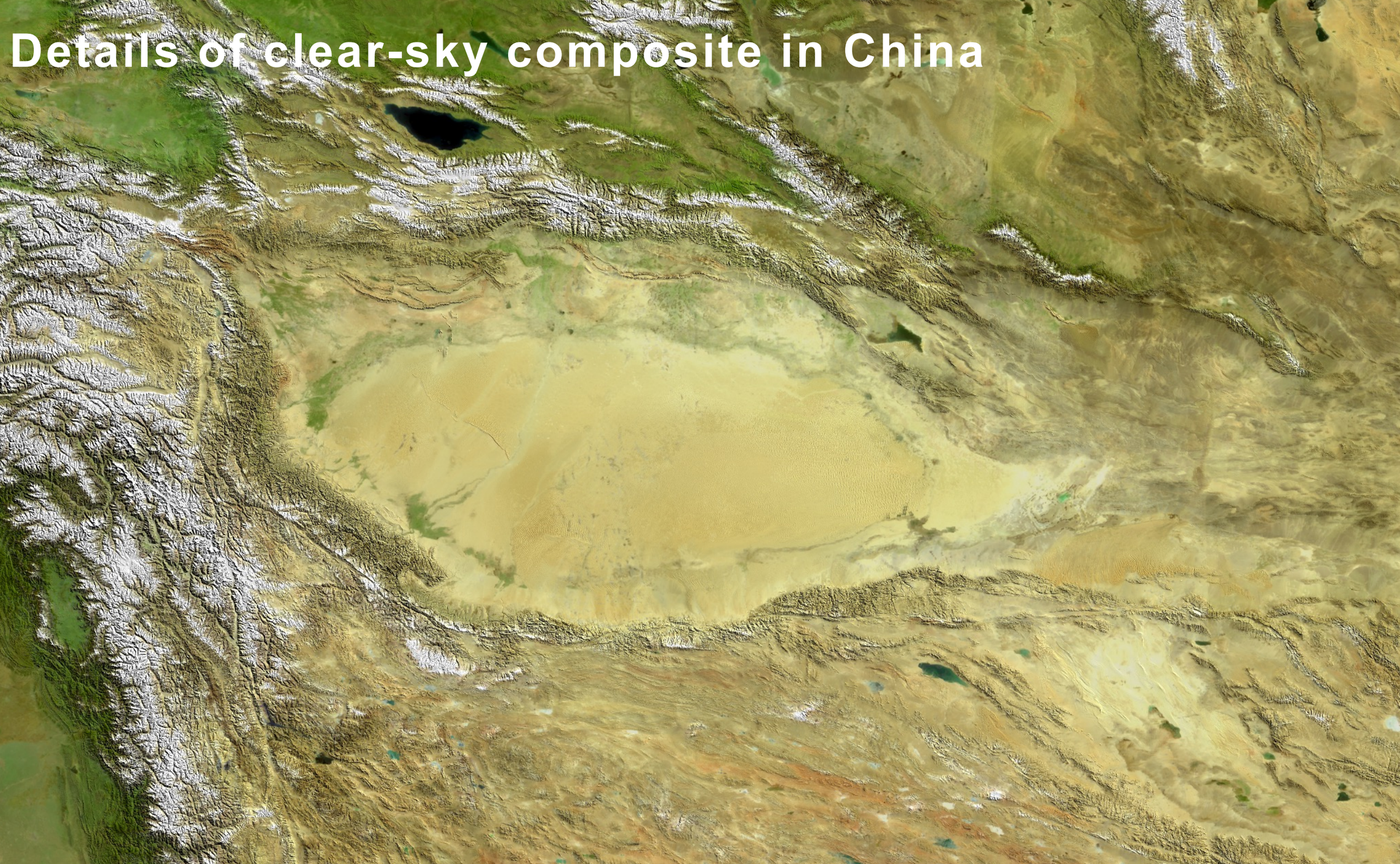


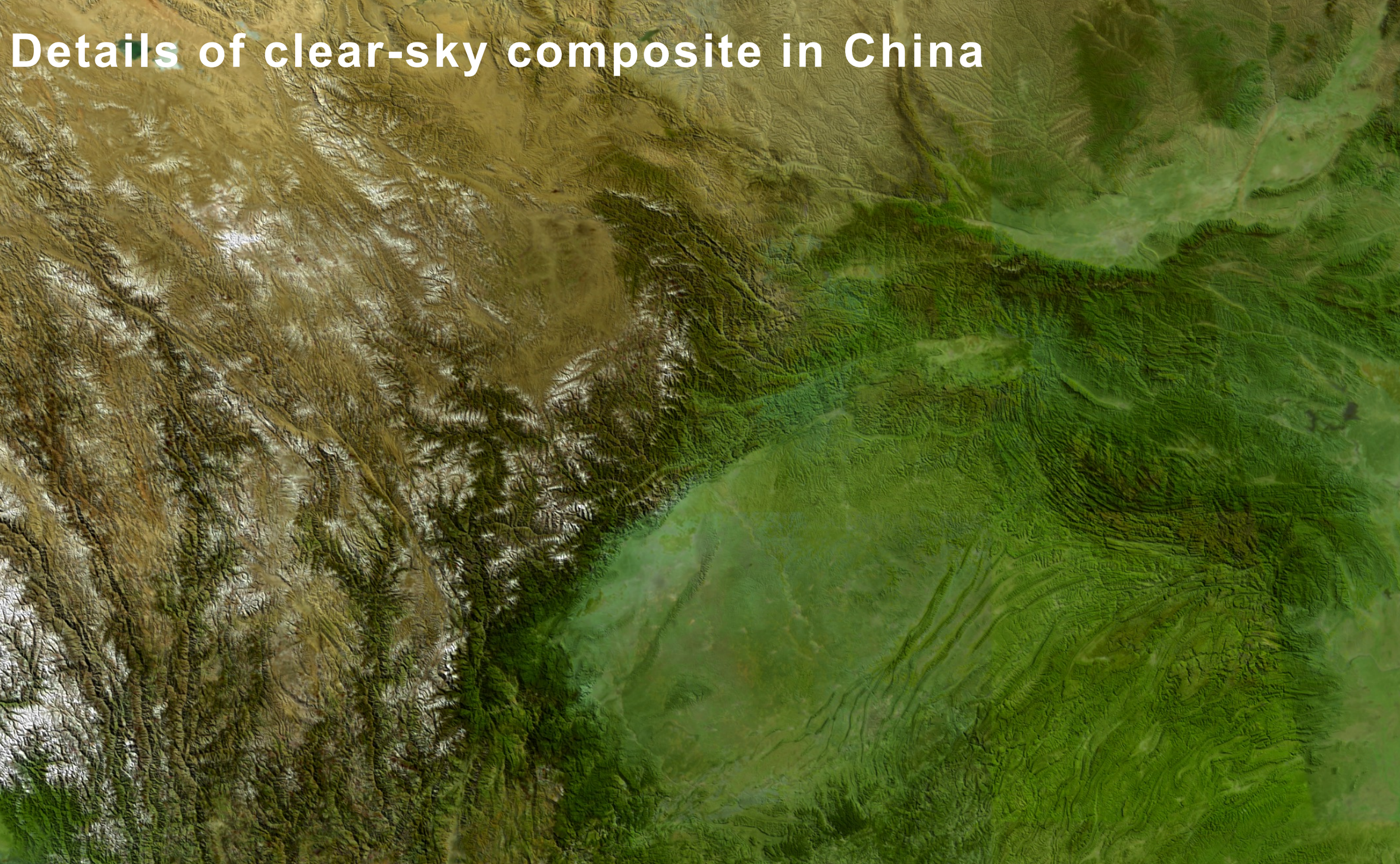


Results of clear-sky composite in China

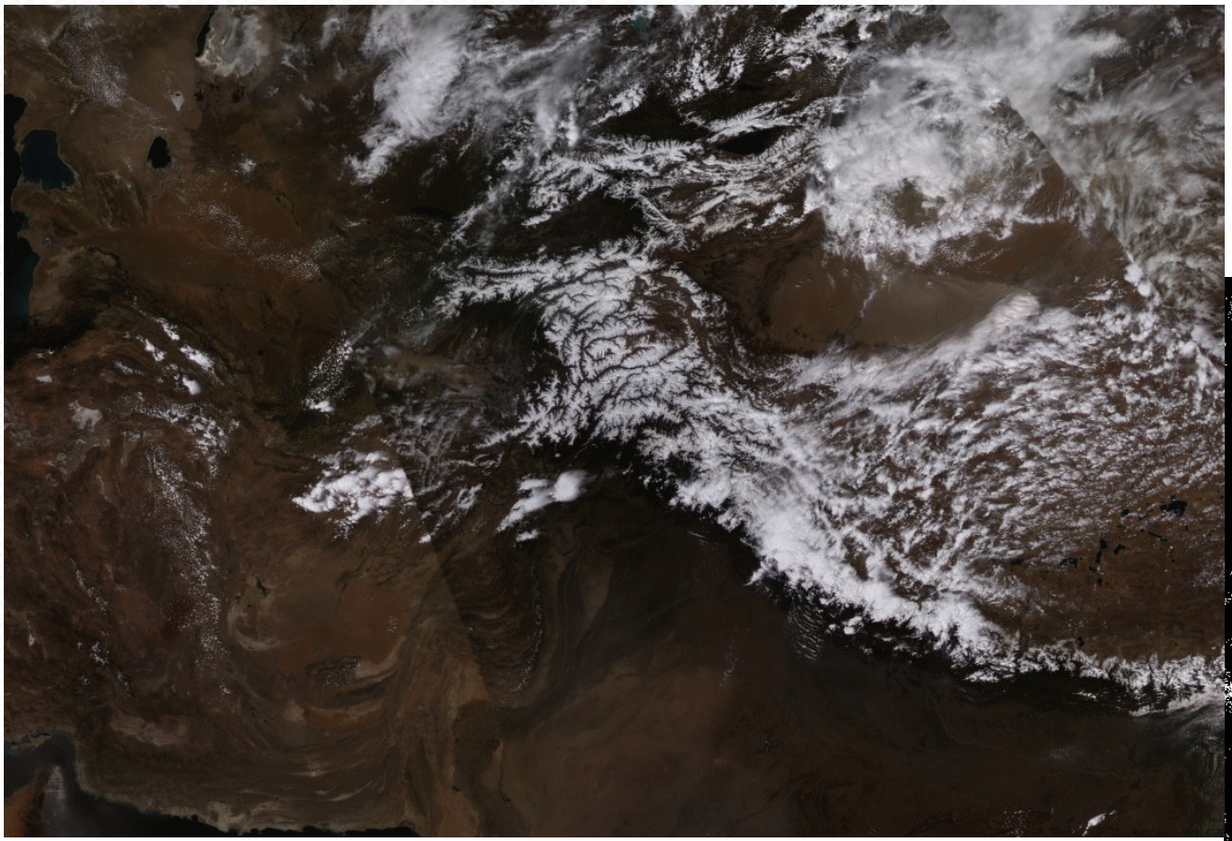


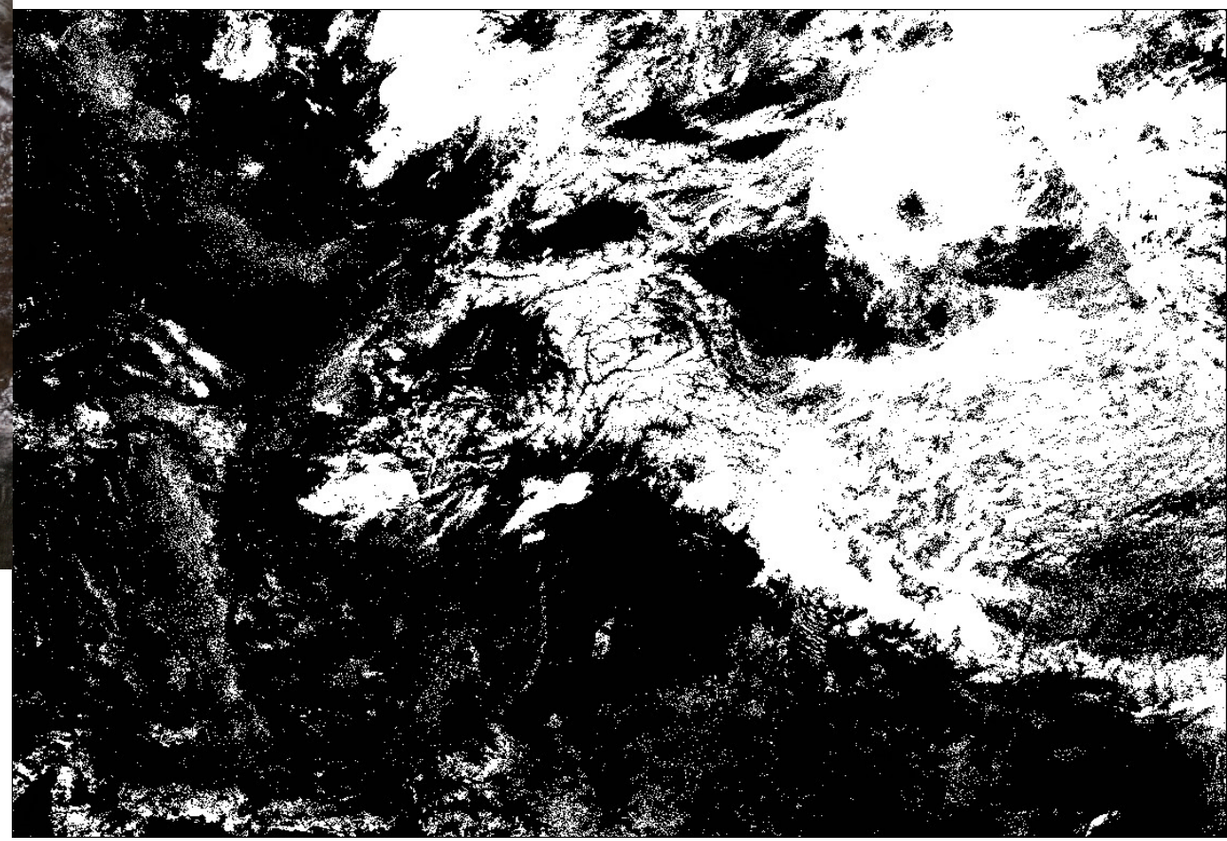
April
2018


Details of clear-sky composite in China


Details of clear-sky composite in China

Results of clear-sky detection in the eastern region of One Belt and One Road





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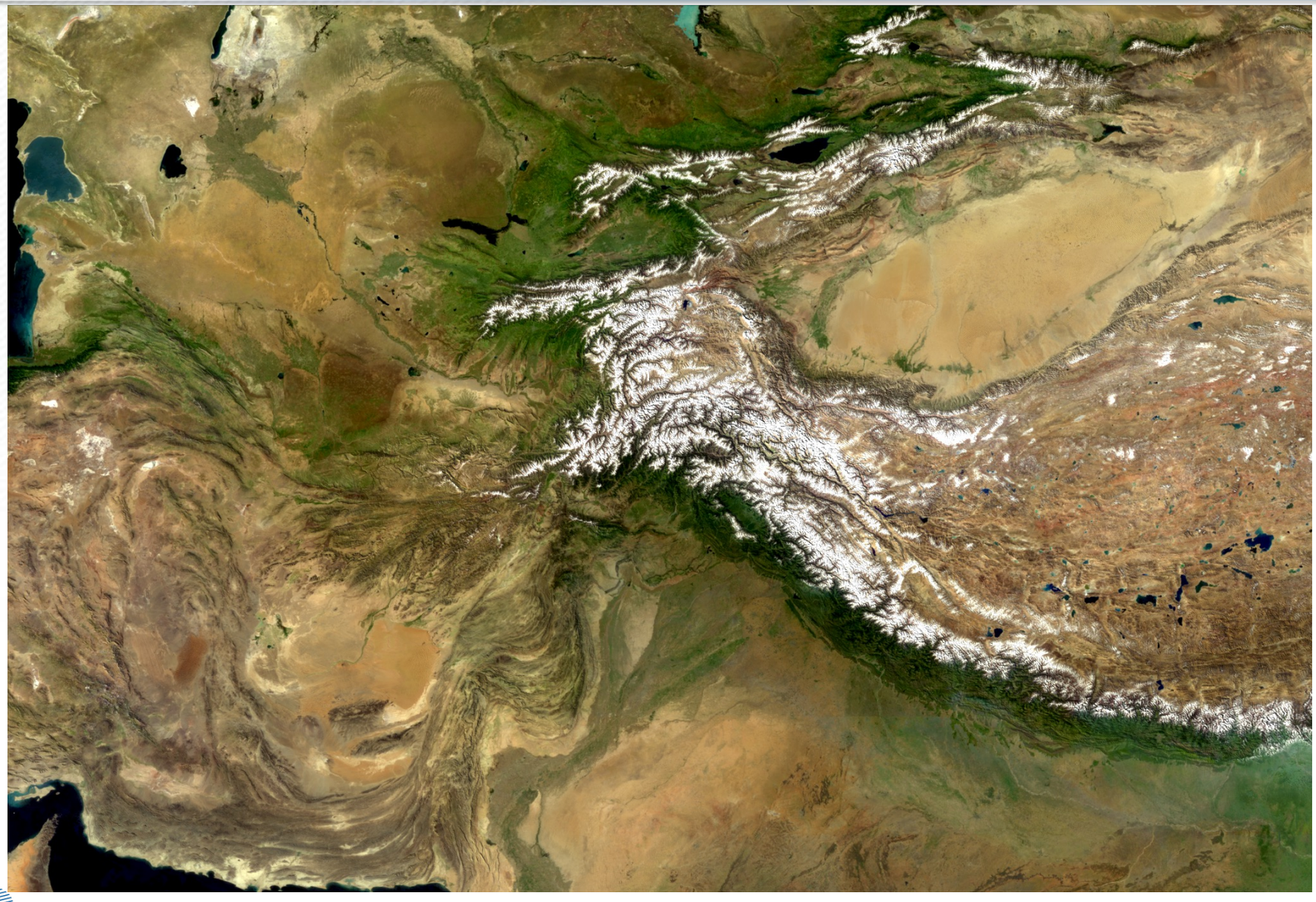
Results of clear-sky composite in the eastern region of One Belt and One Road



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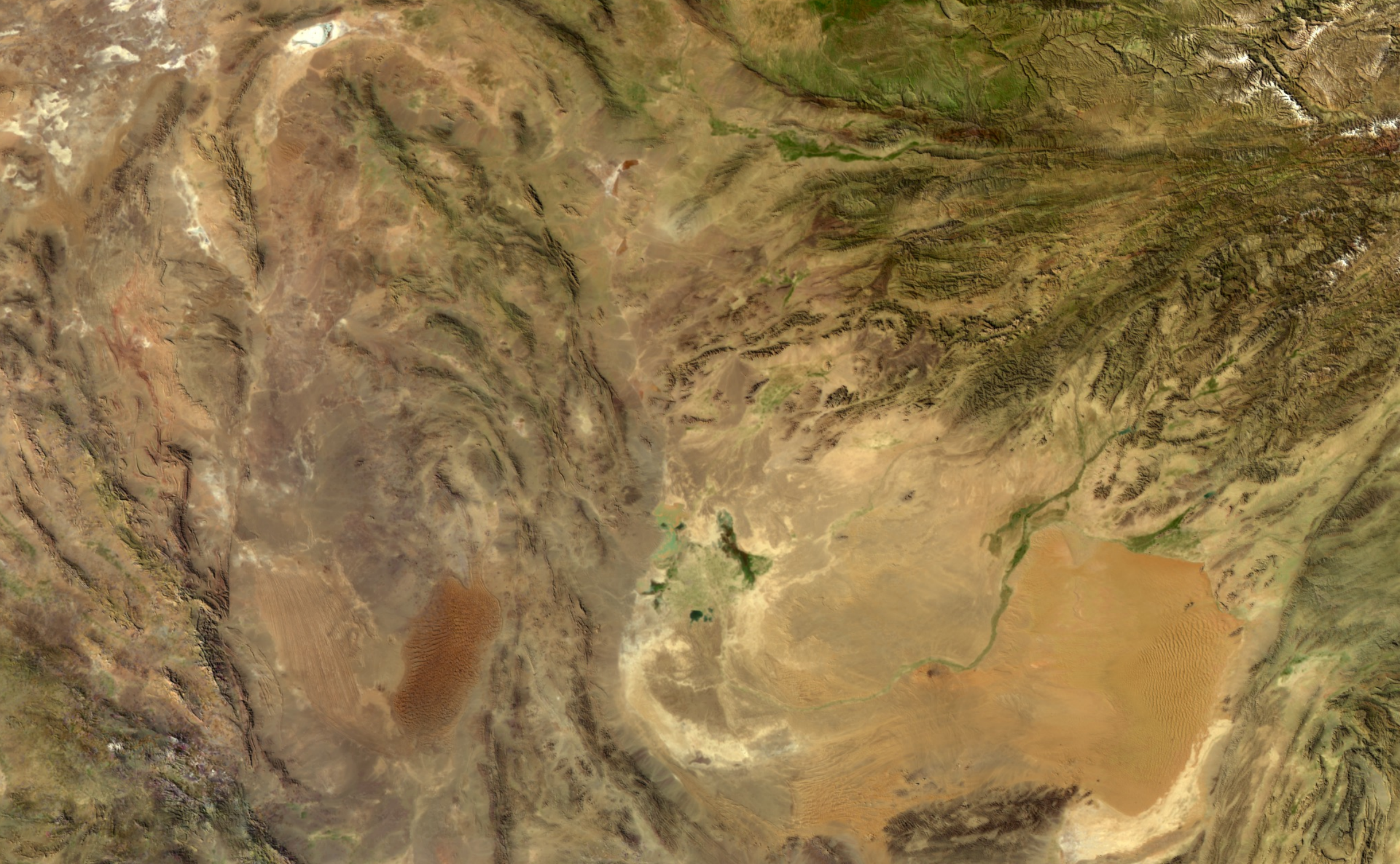
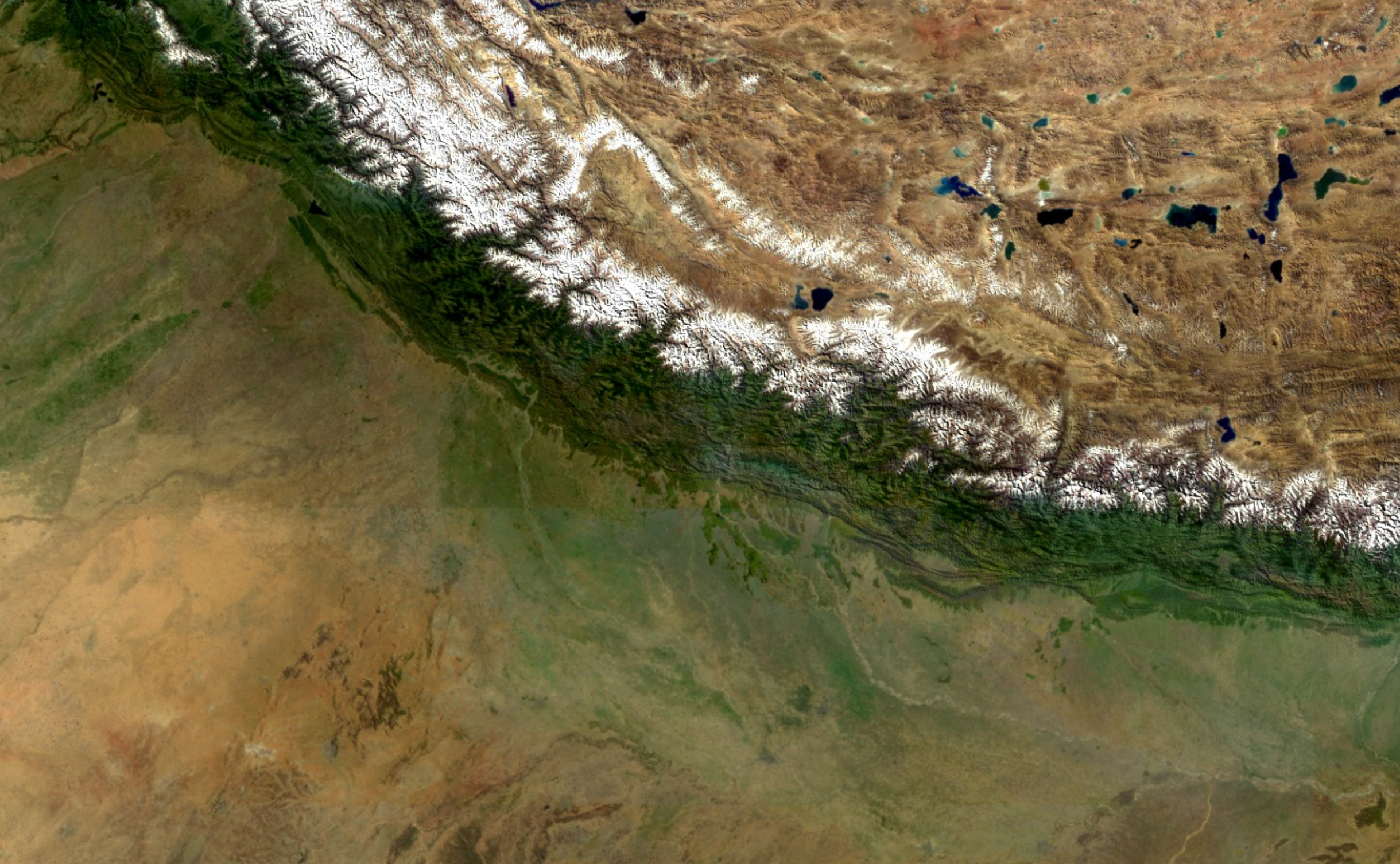
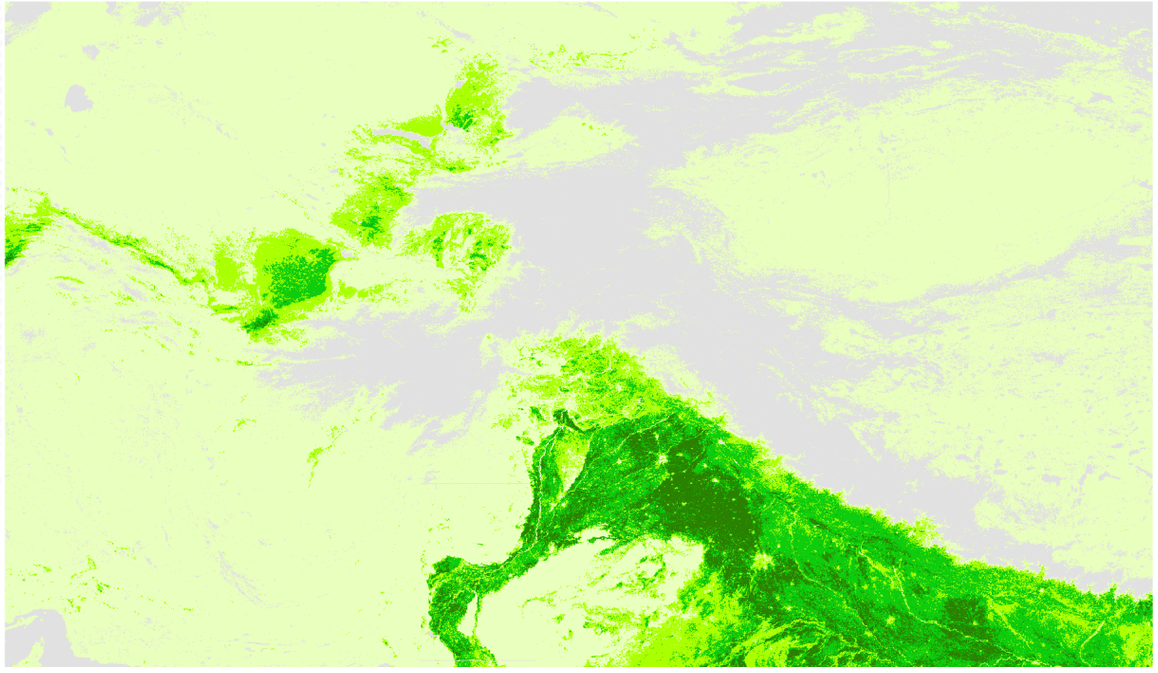
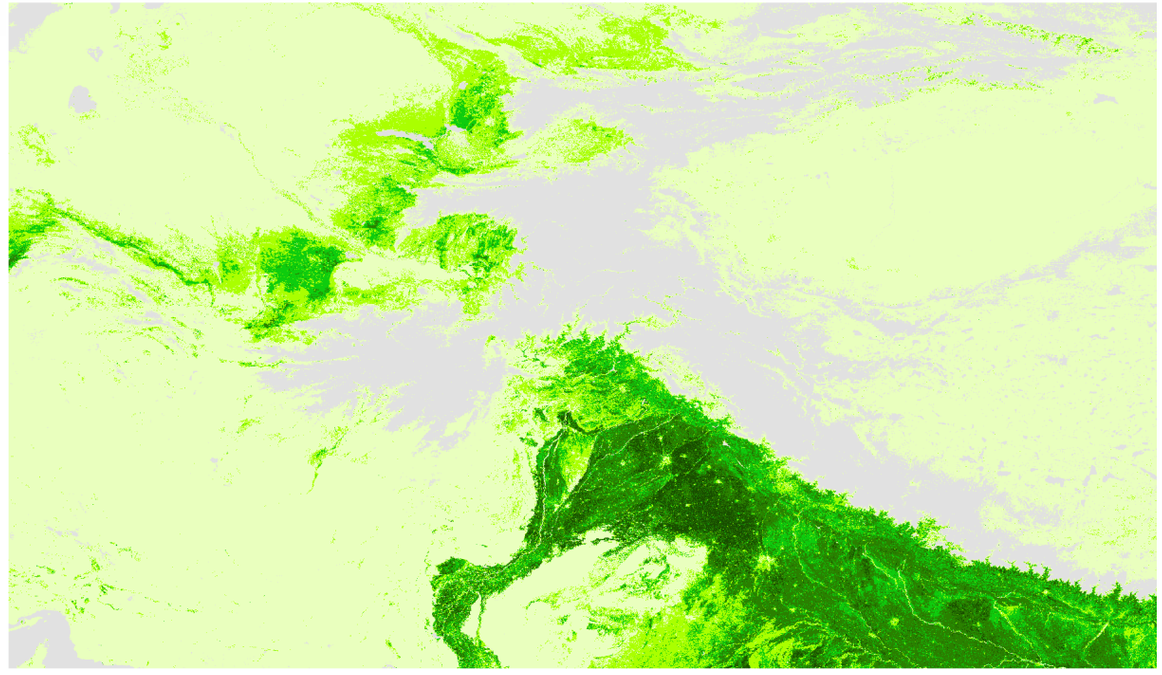




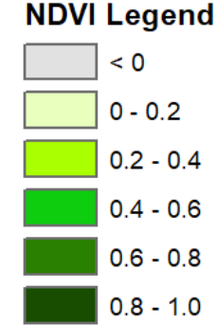
Comparison between FY-3D NDVI and MODIS NDVI in February 2019



FY-3D MERSI NDVI
(generated from FY-3D clear-sky composites)



MODIS NDVI



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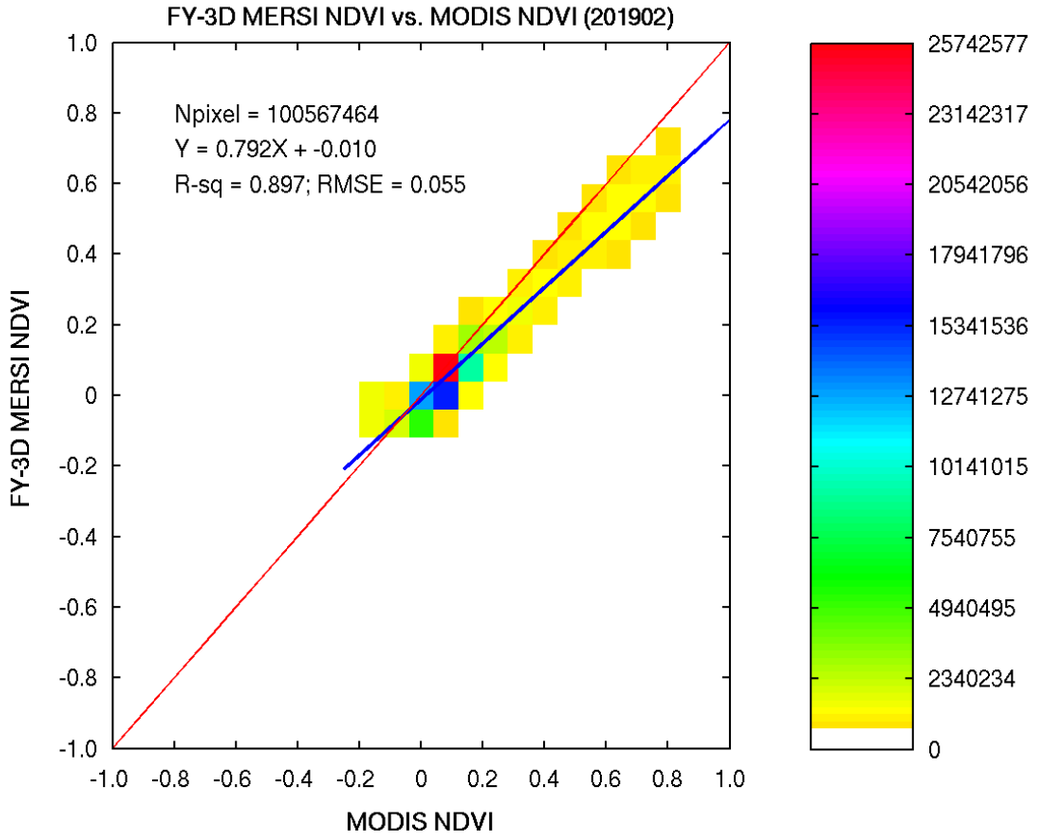
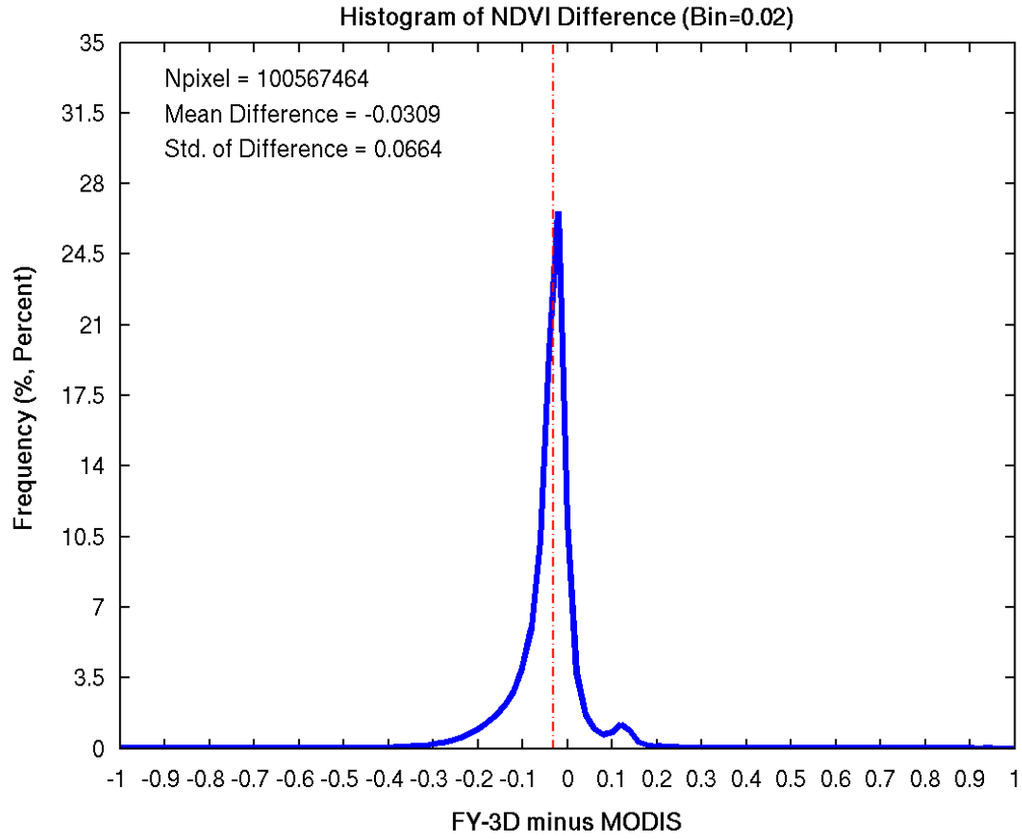
FY-3D NDVI and MODIS NDVI in February 2019 over the eastern region of One Belt and One Road





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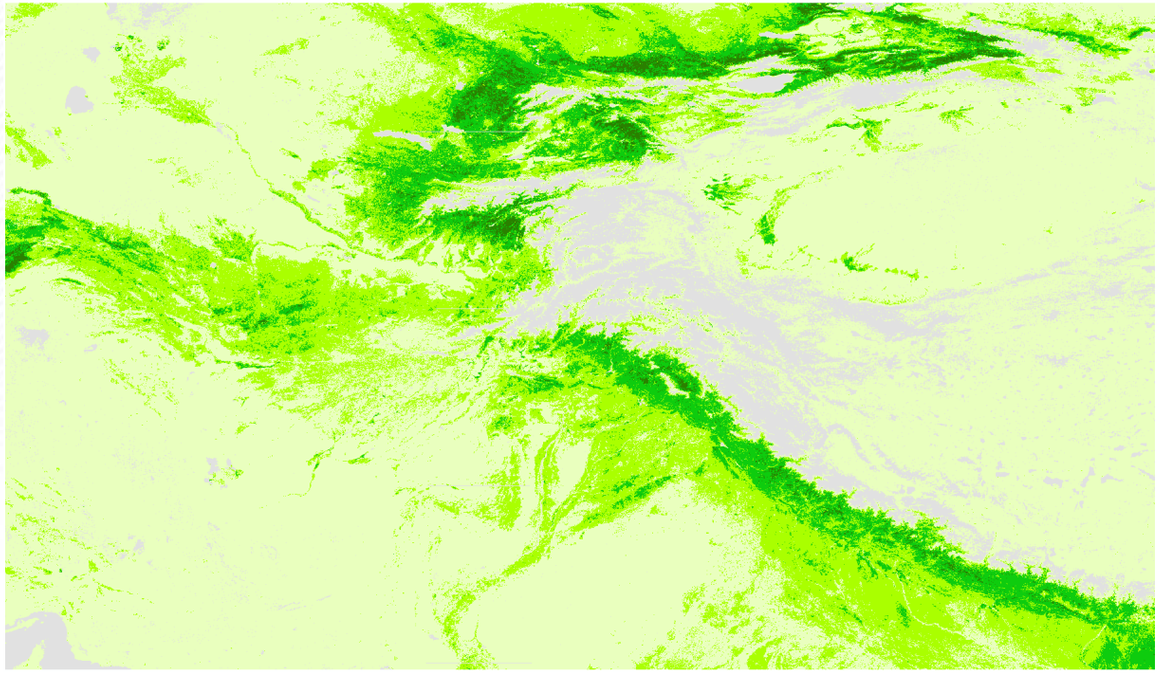
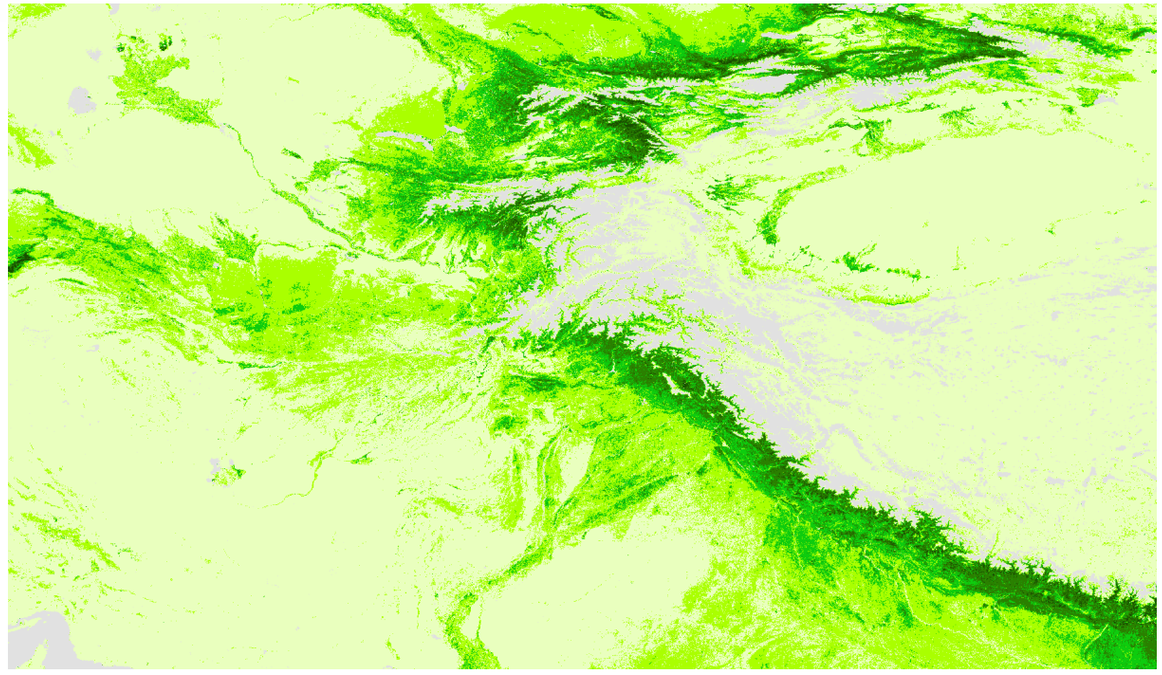
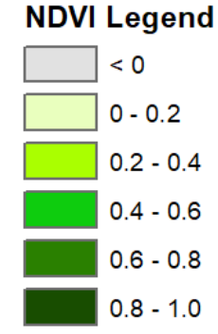


FY-3D MERSI NDVI
(generated from FY-3D clear-sky composites)



MODIS NDVI



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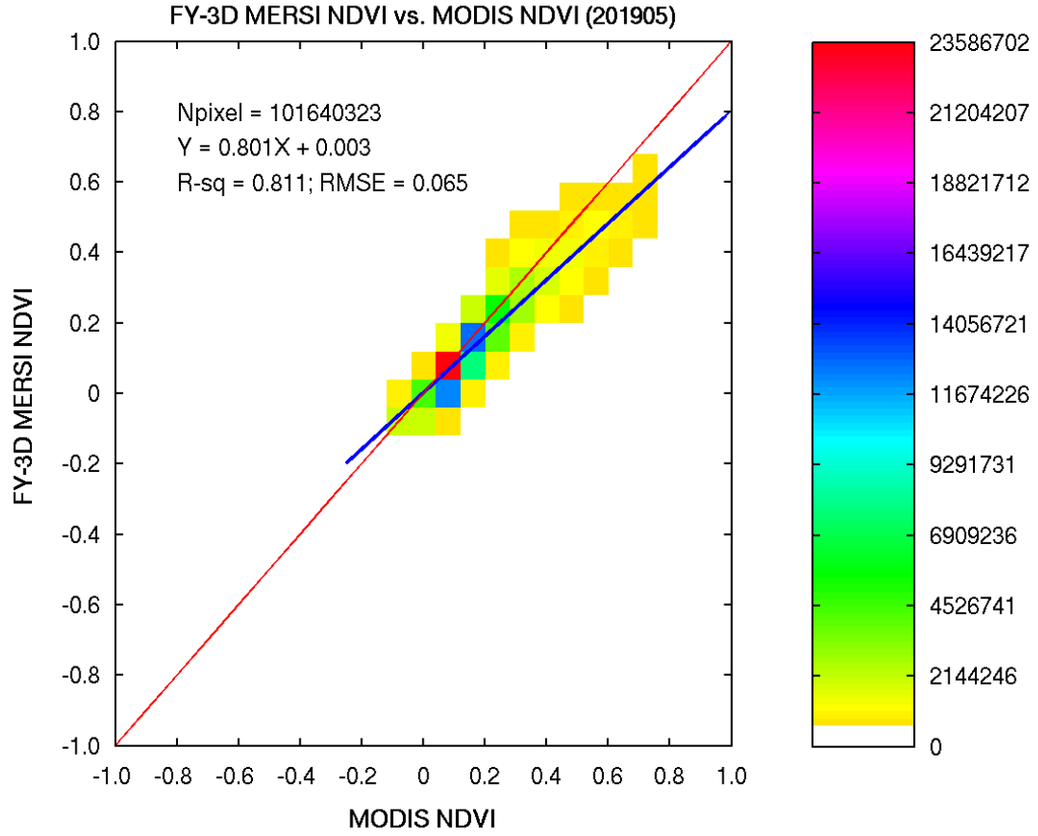
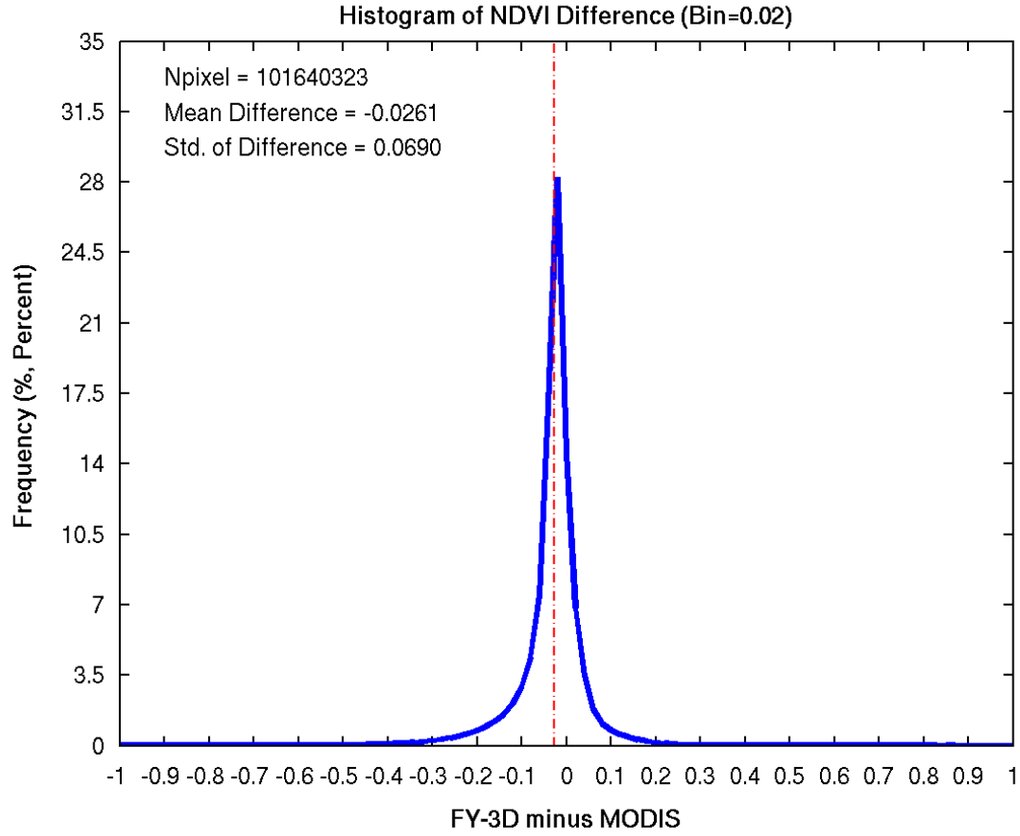
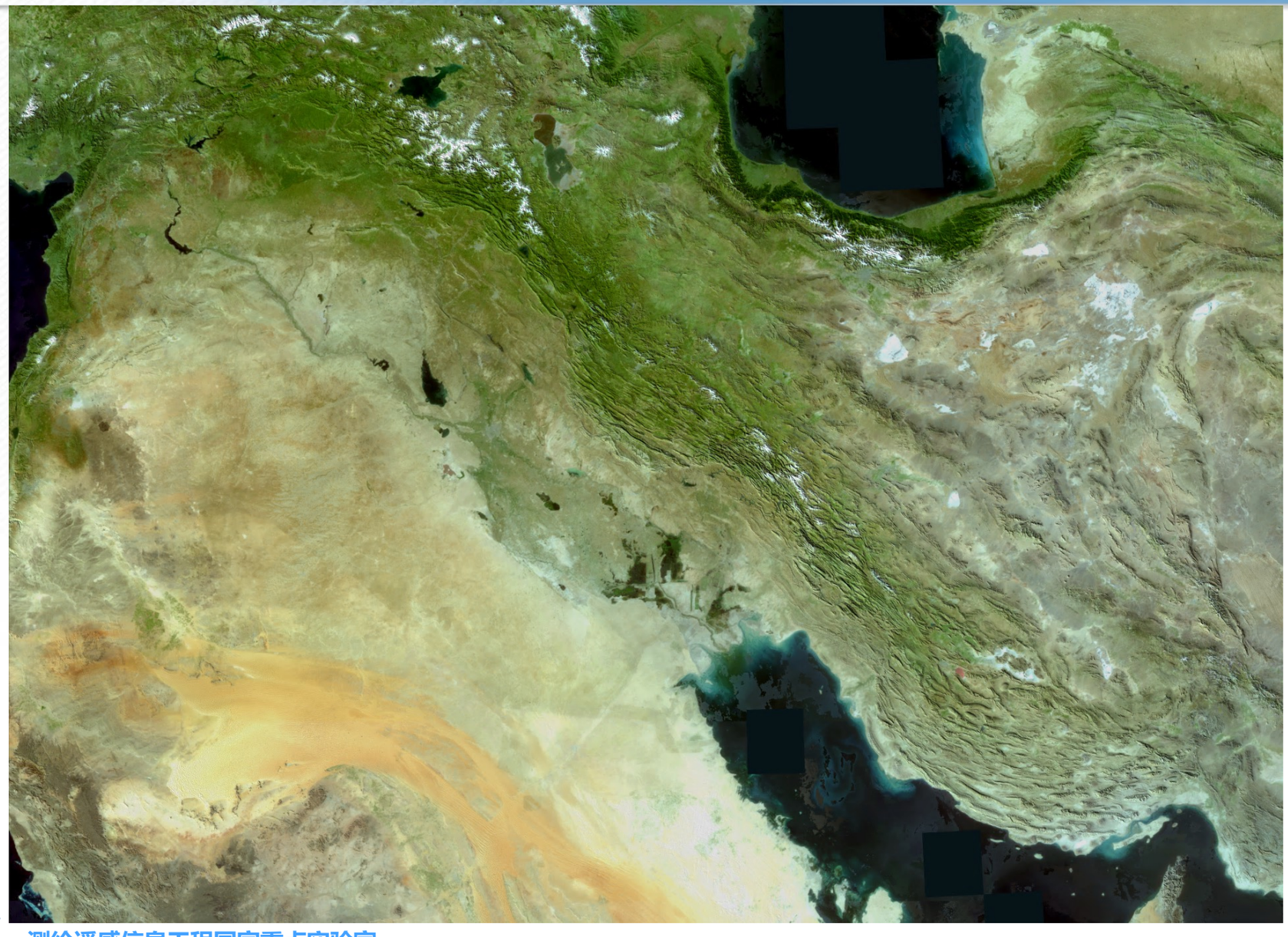
FY-3D NDVI and MODIS NDVI in May 2019 over the eastern region of One Belt and One Road





Results of clear-sky composite in the western region of One Belt and One Road



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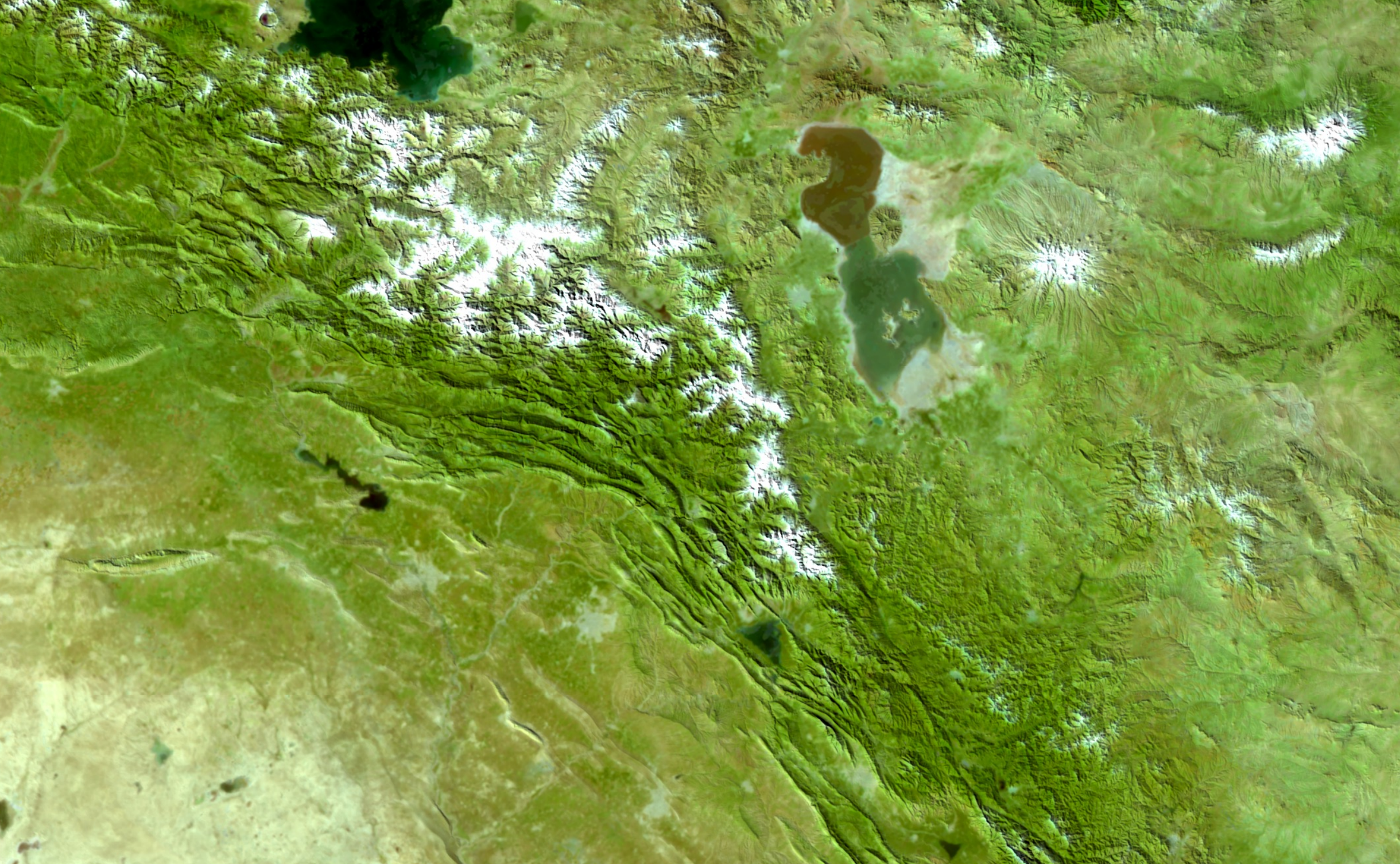
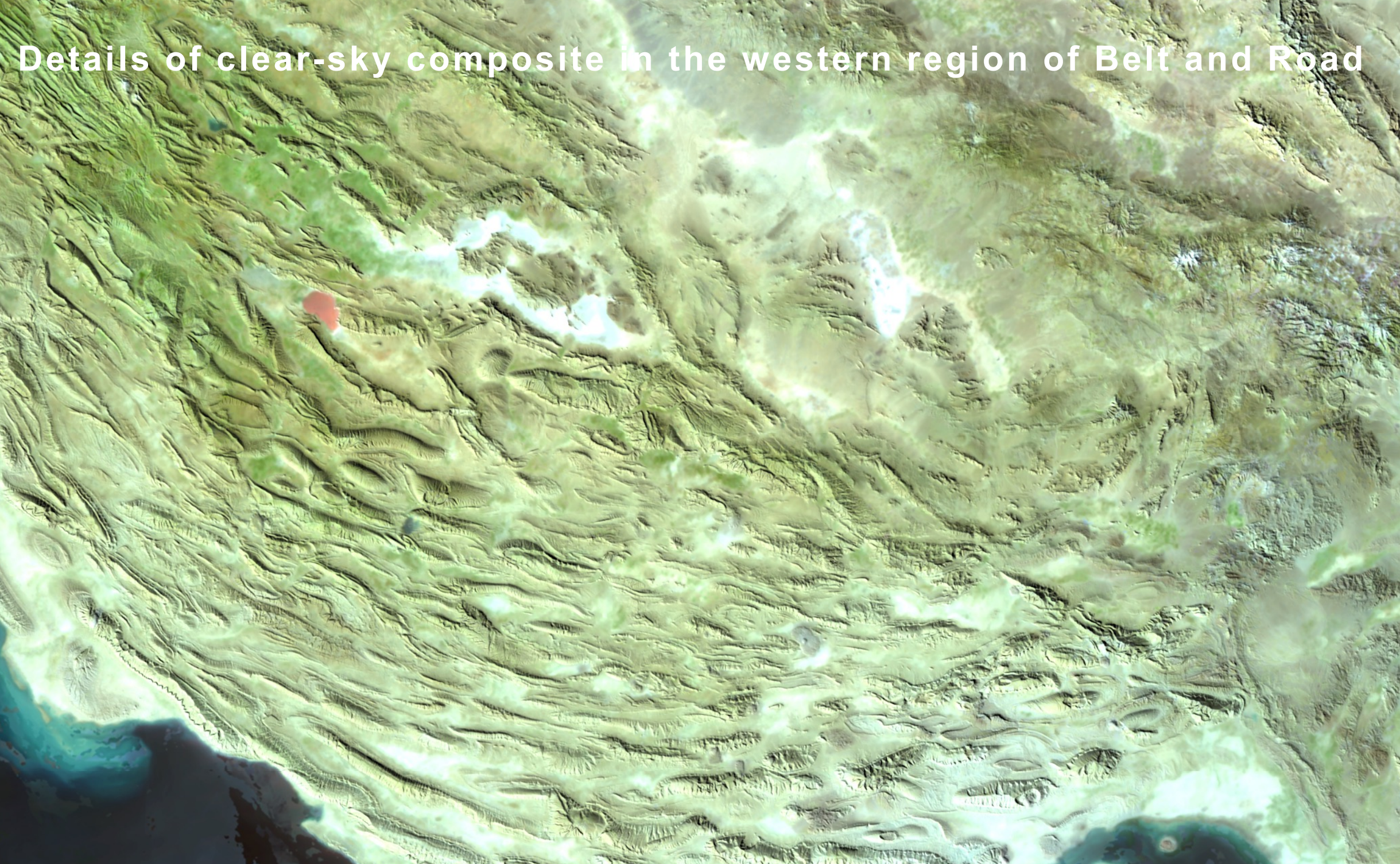
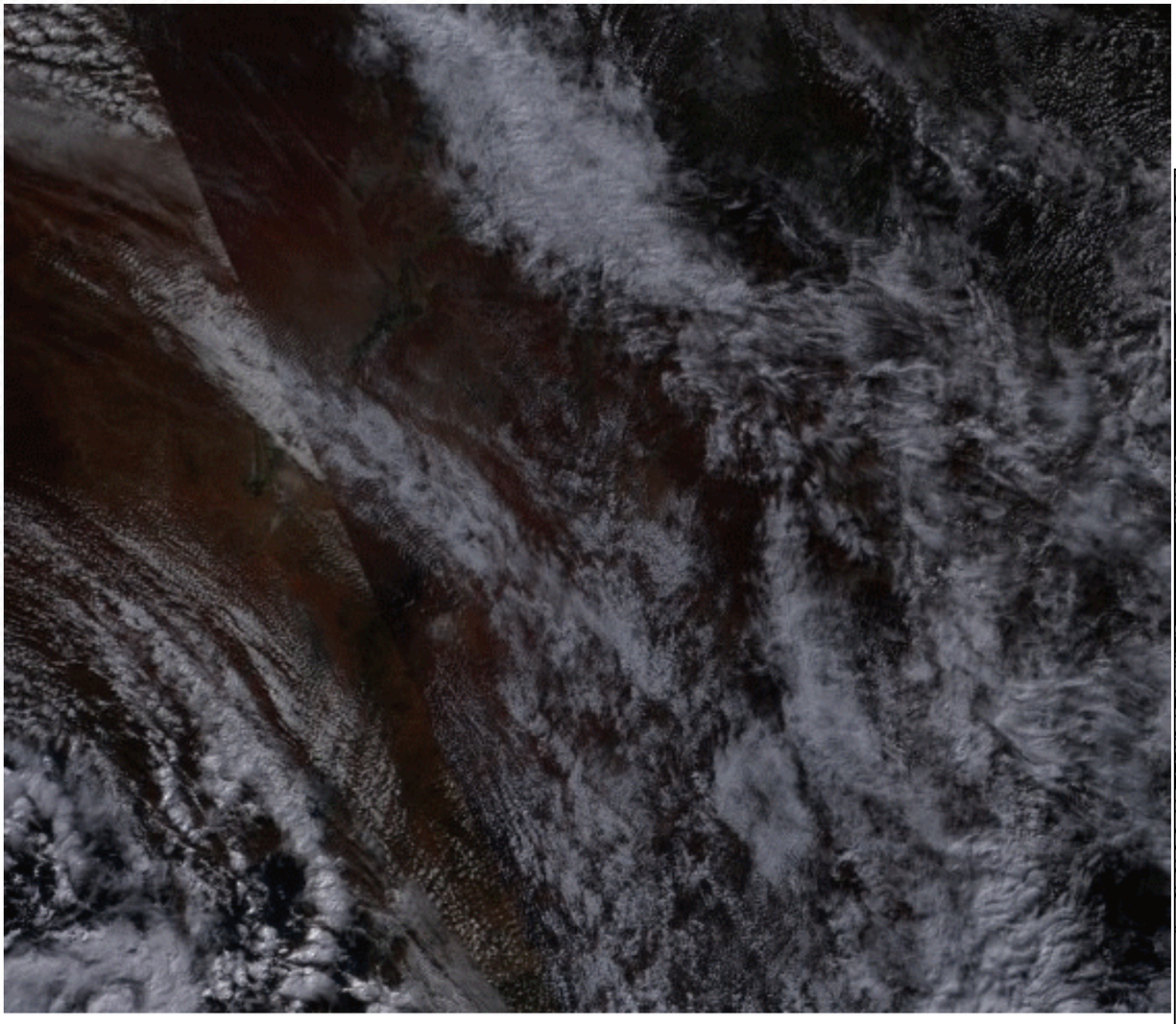
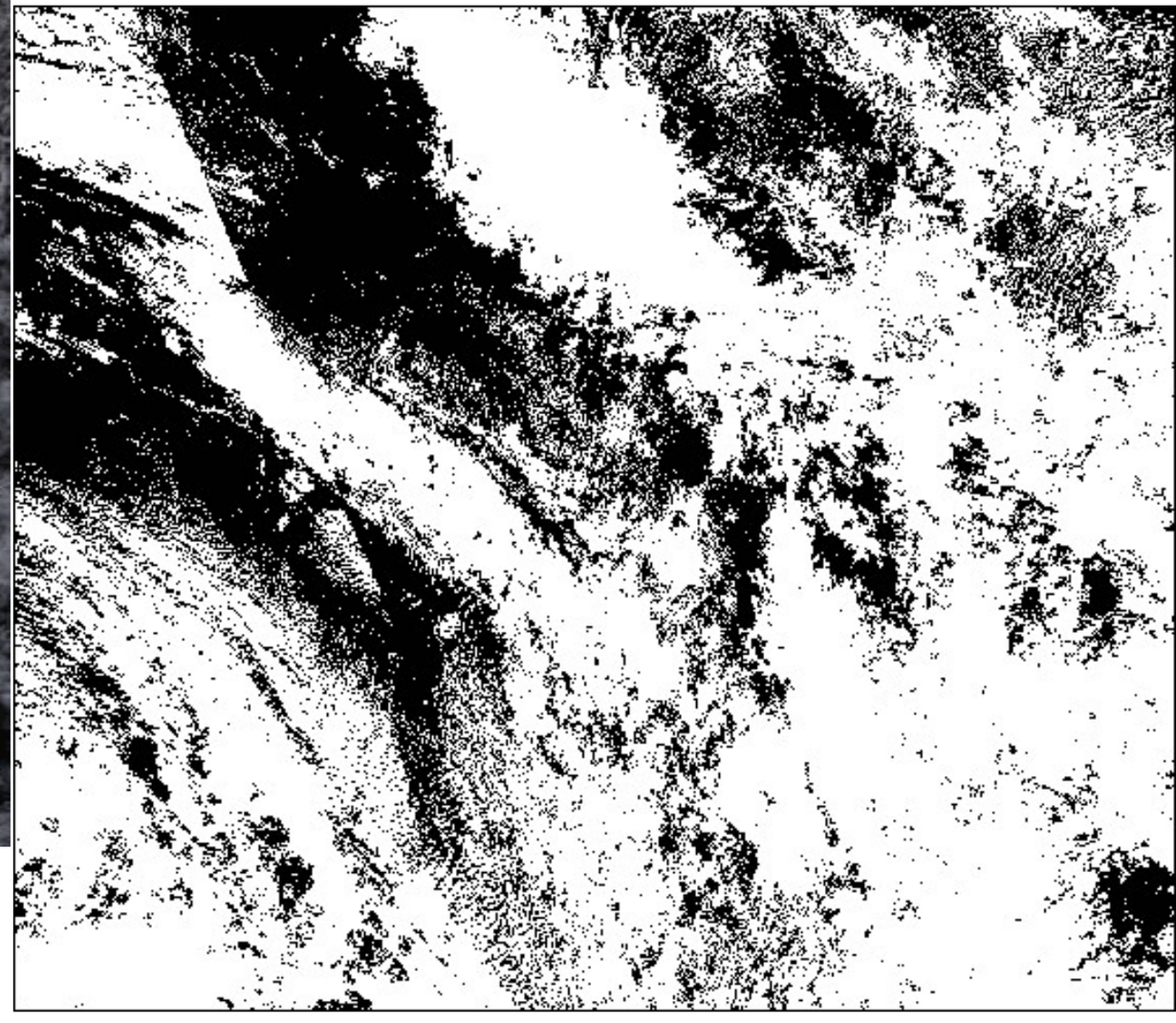



Details of clear-sky composite in the western region of Belt and Road


Details of clear-sky composite in the western region of Belt and Road

Results of clear-sky/cloud detection in Australia





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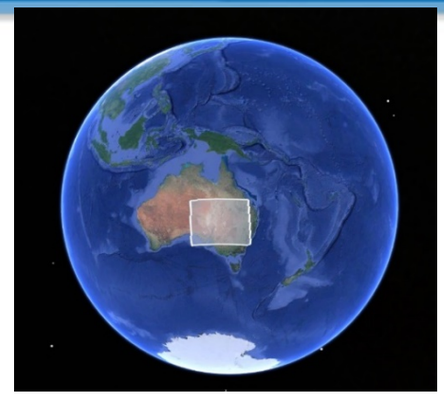
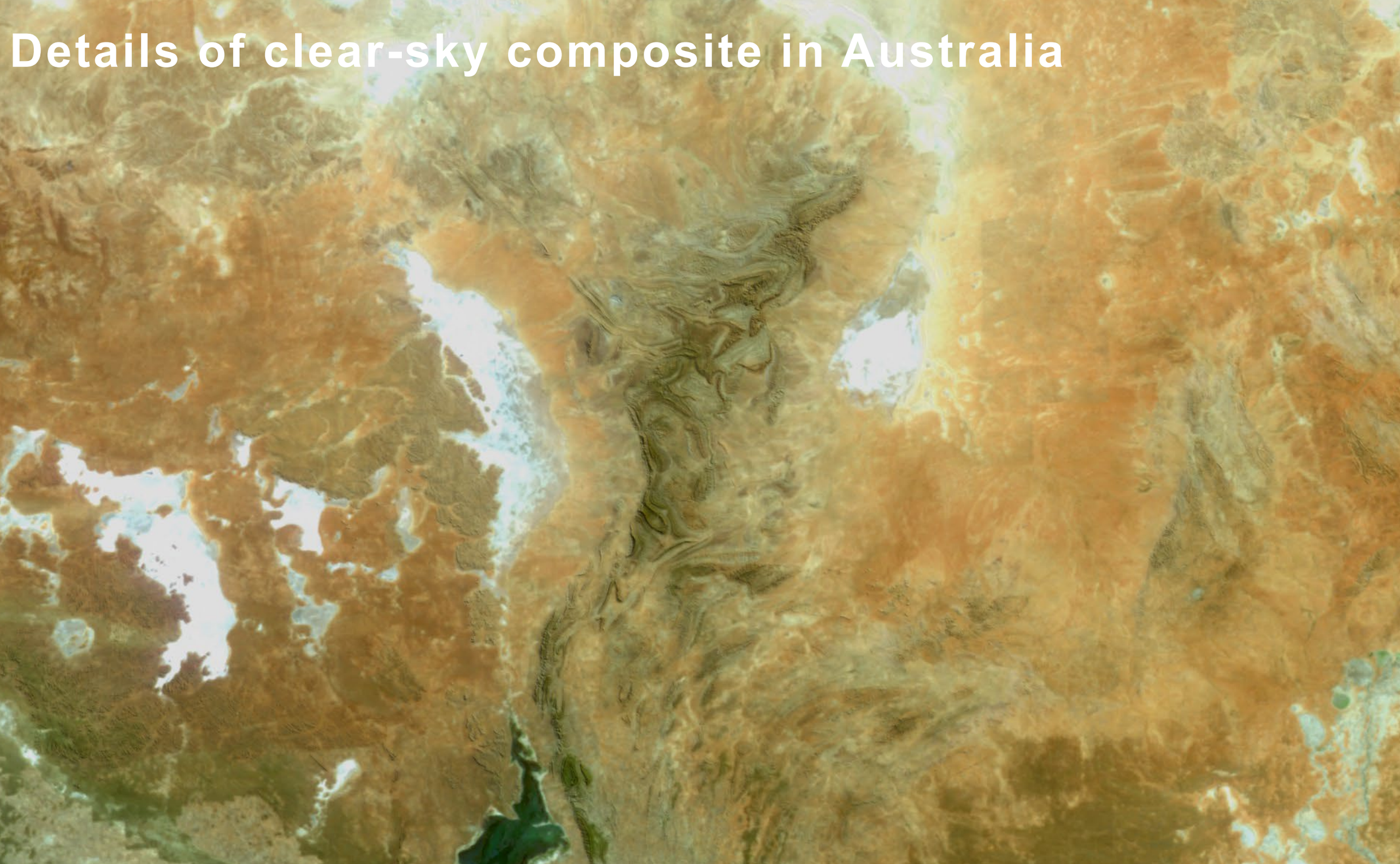
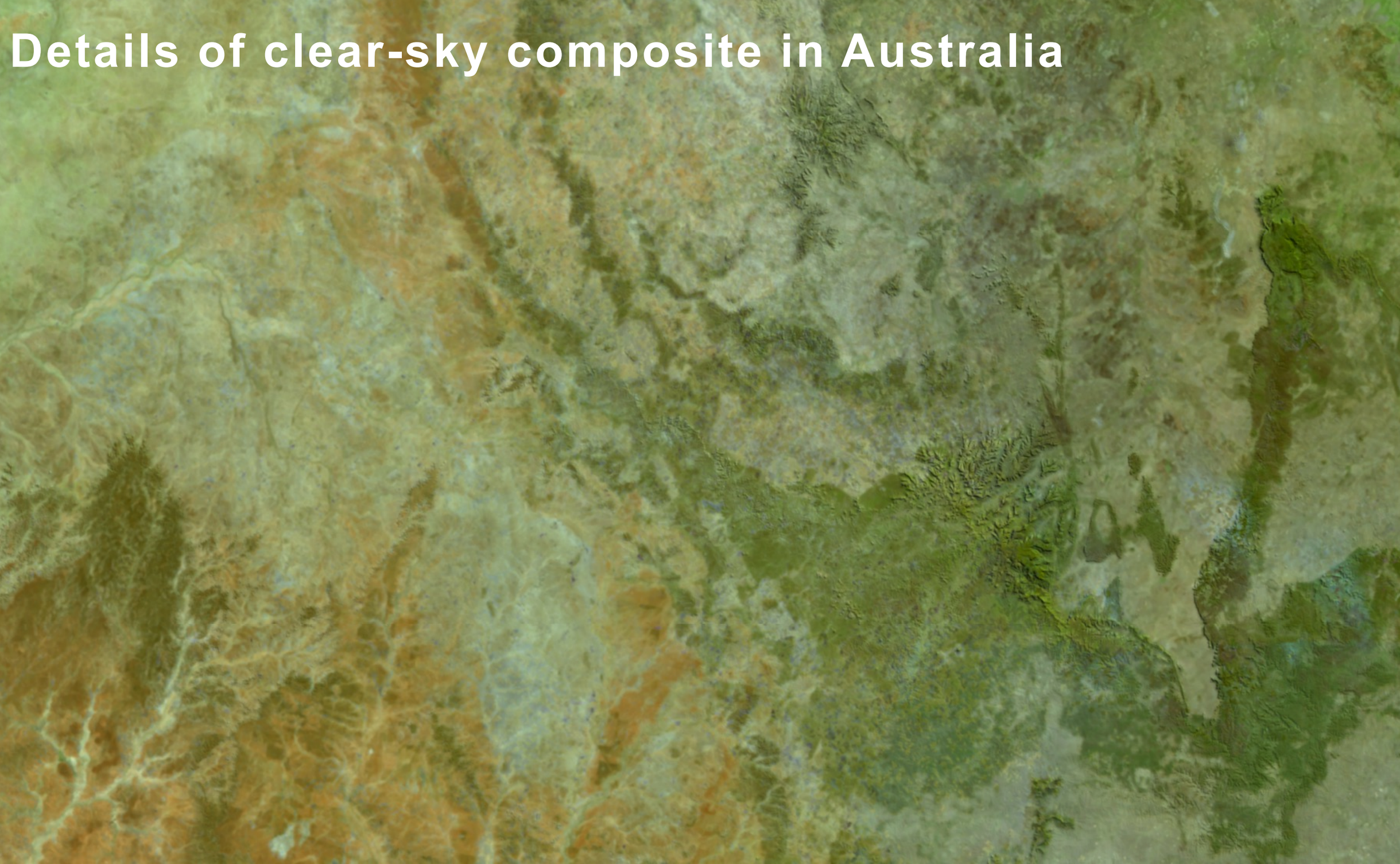
Results of clear-sky composite in Australia



Details of clear-sky composite in Australia




Details of clear-sky composite in Australia

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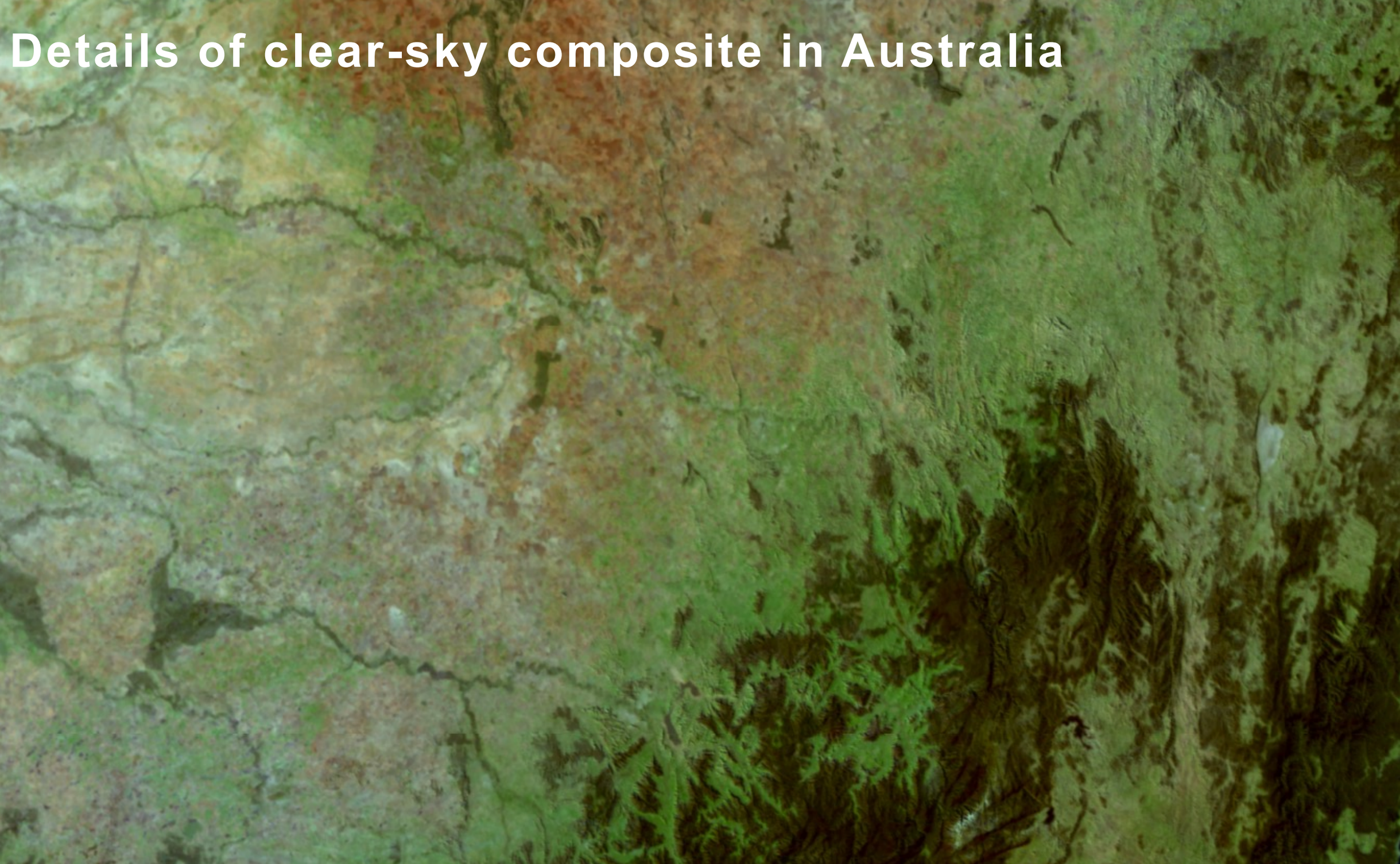
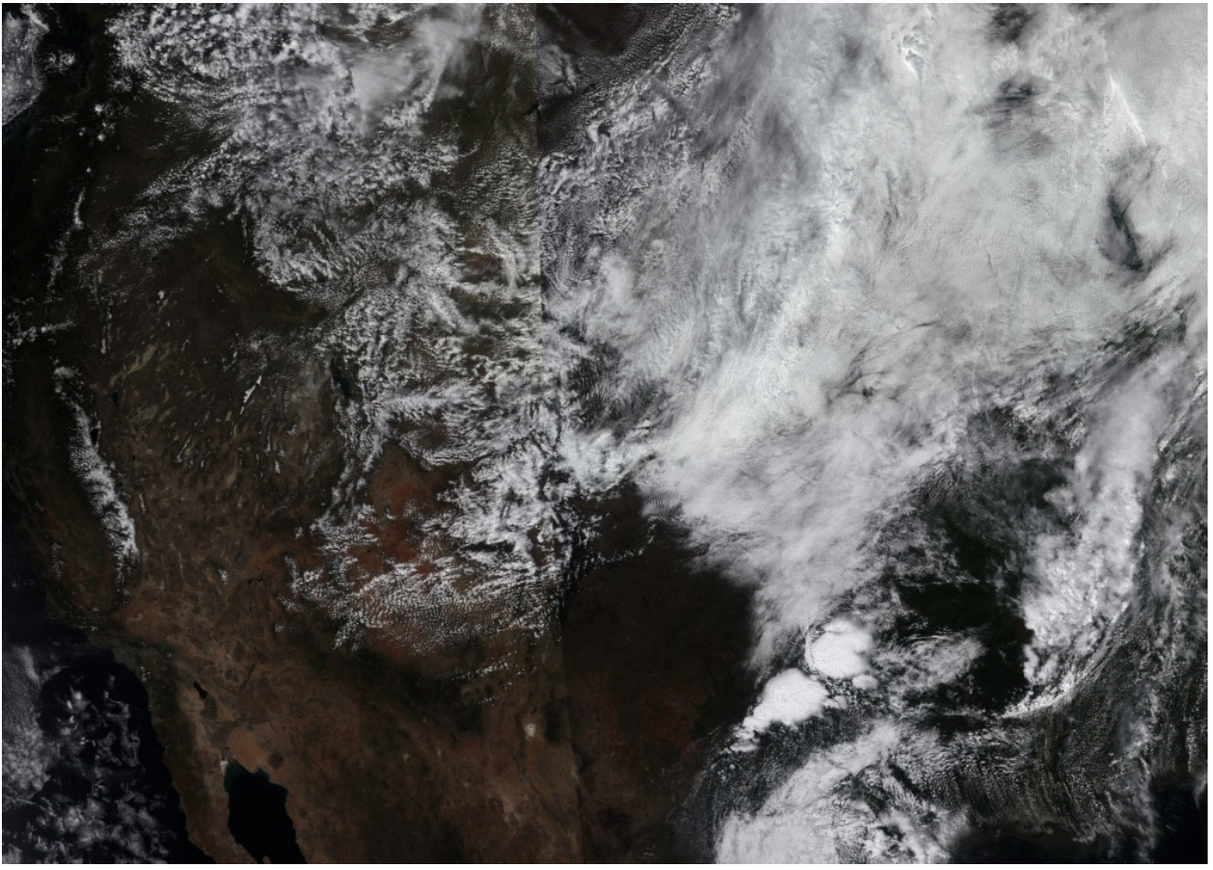
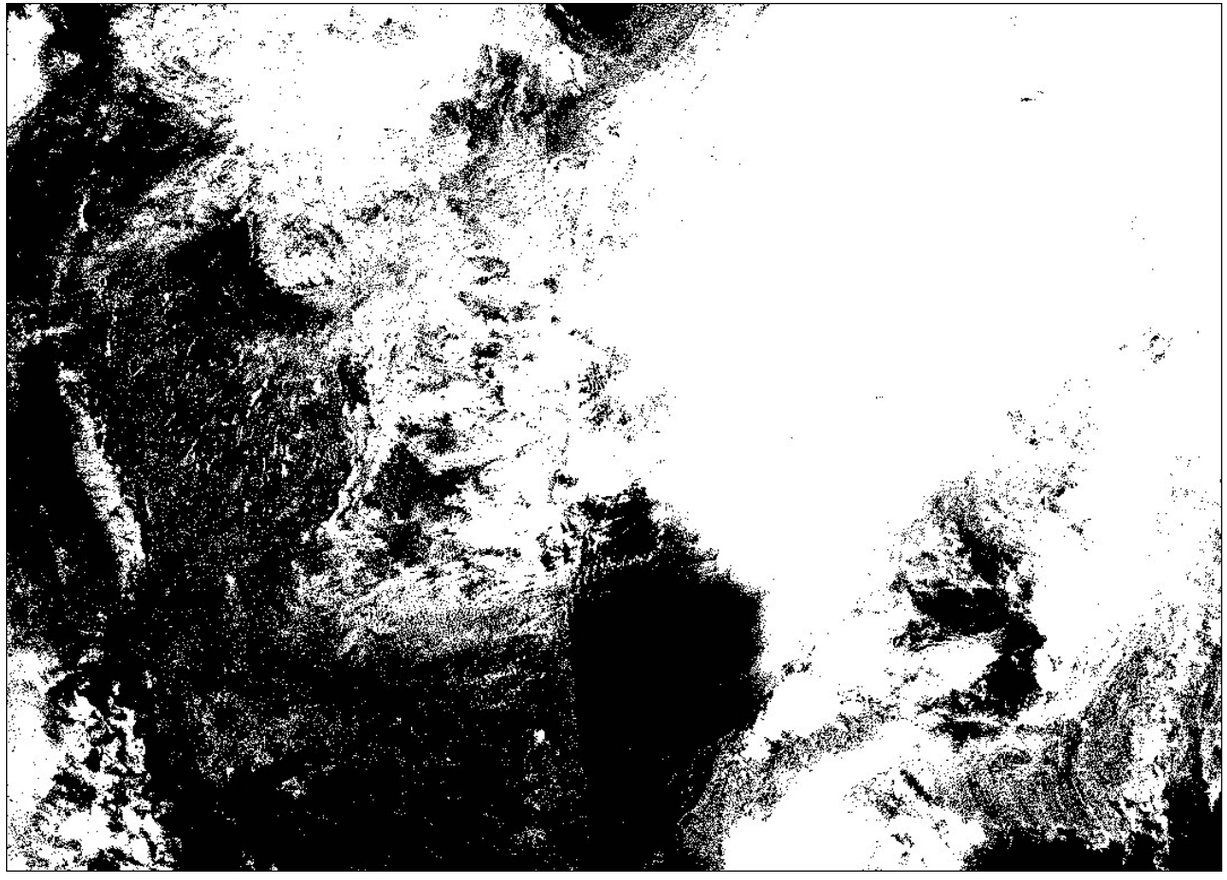


Results of clear-sky/cloud detection in North America





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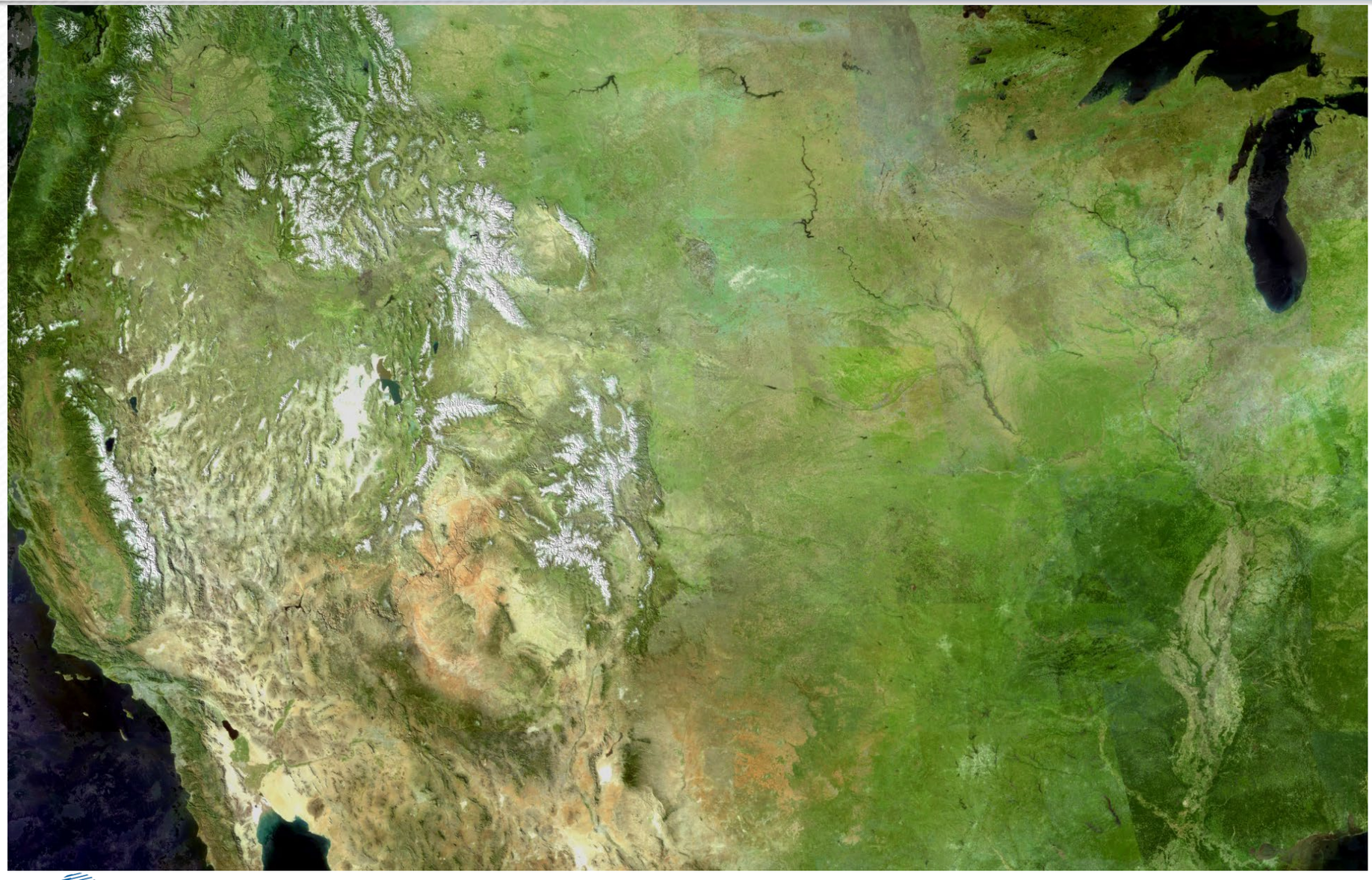
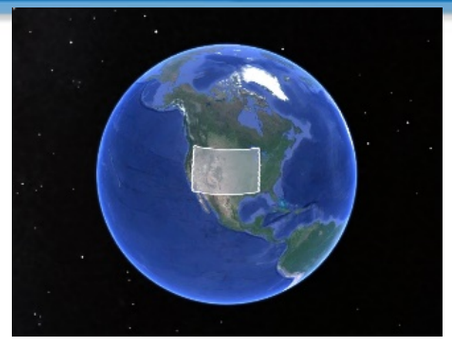
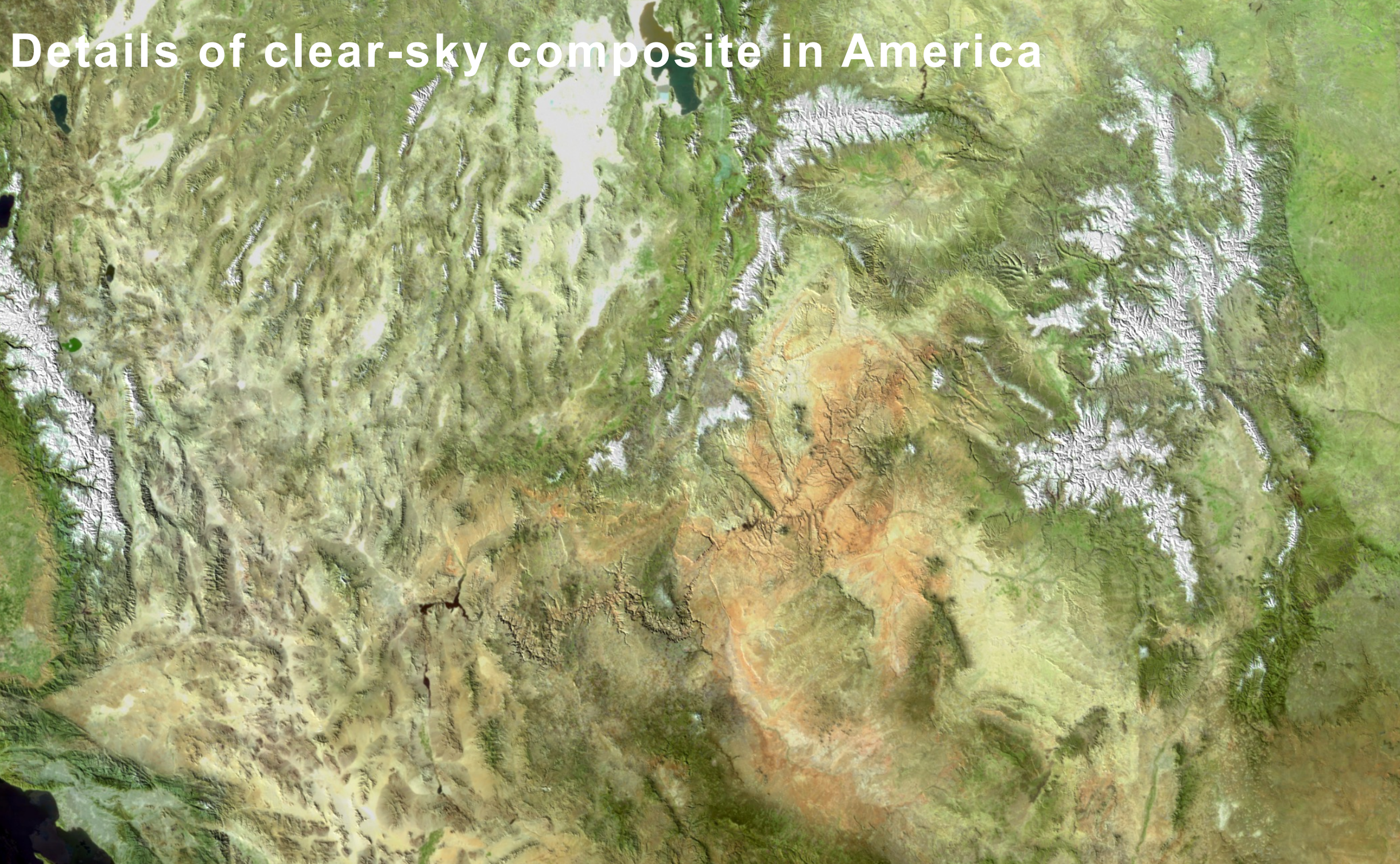
Results of clear-sky composite in North America





Details of clear-sky composite in America


Details of clear-sky composite in America


Details of clear-sky composite in America

NDVI over North America

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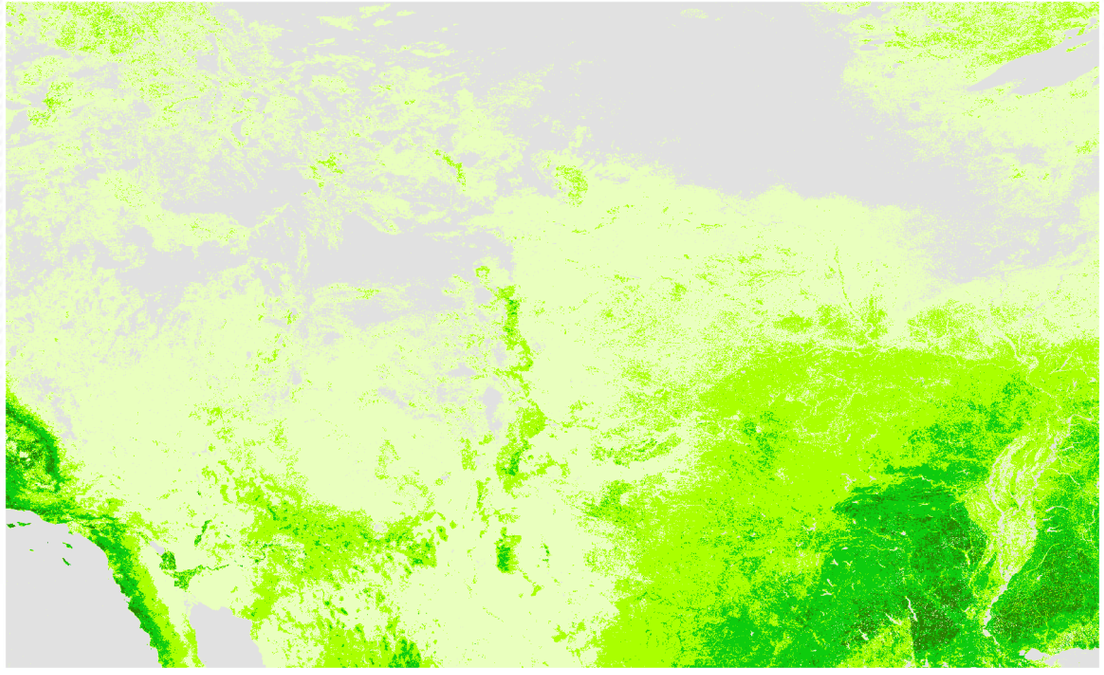
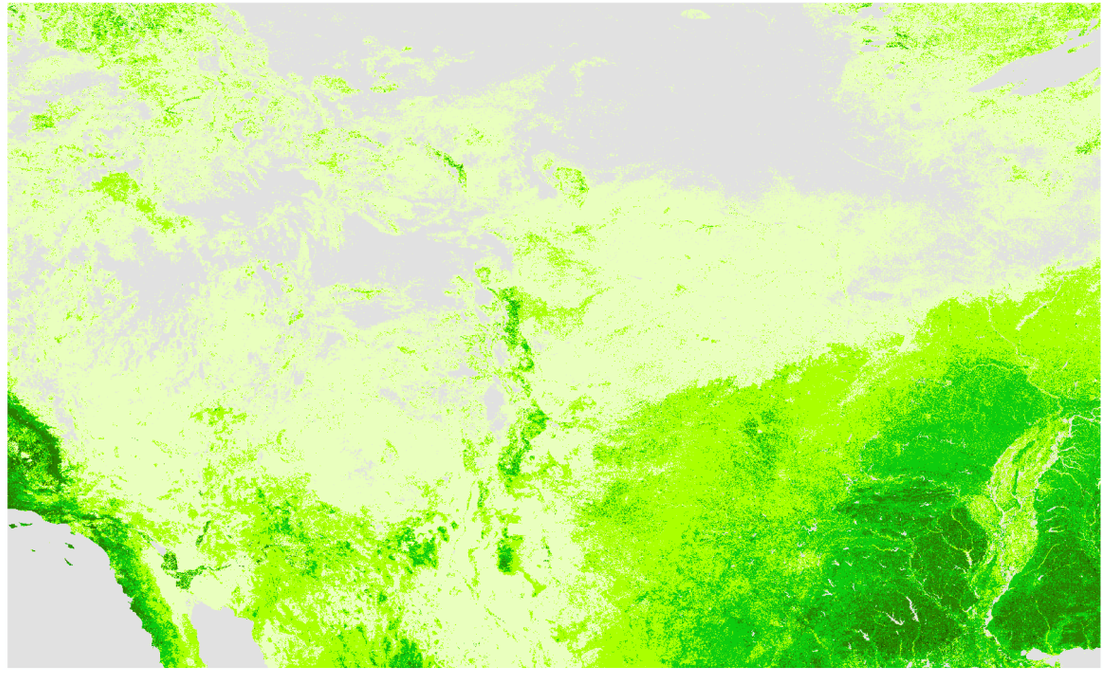
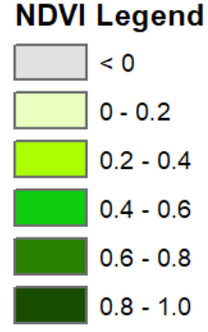
Comparison between FY-3D NDVI and MODIS NDVI in February 2019 over North America



FY-3D MERSI NDVI
(generated from FY-3D clear-sky composites)



MODIS NDVI



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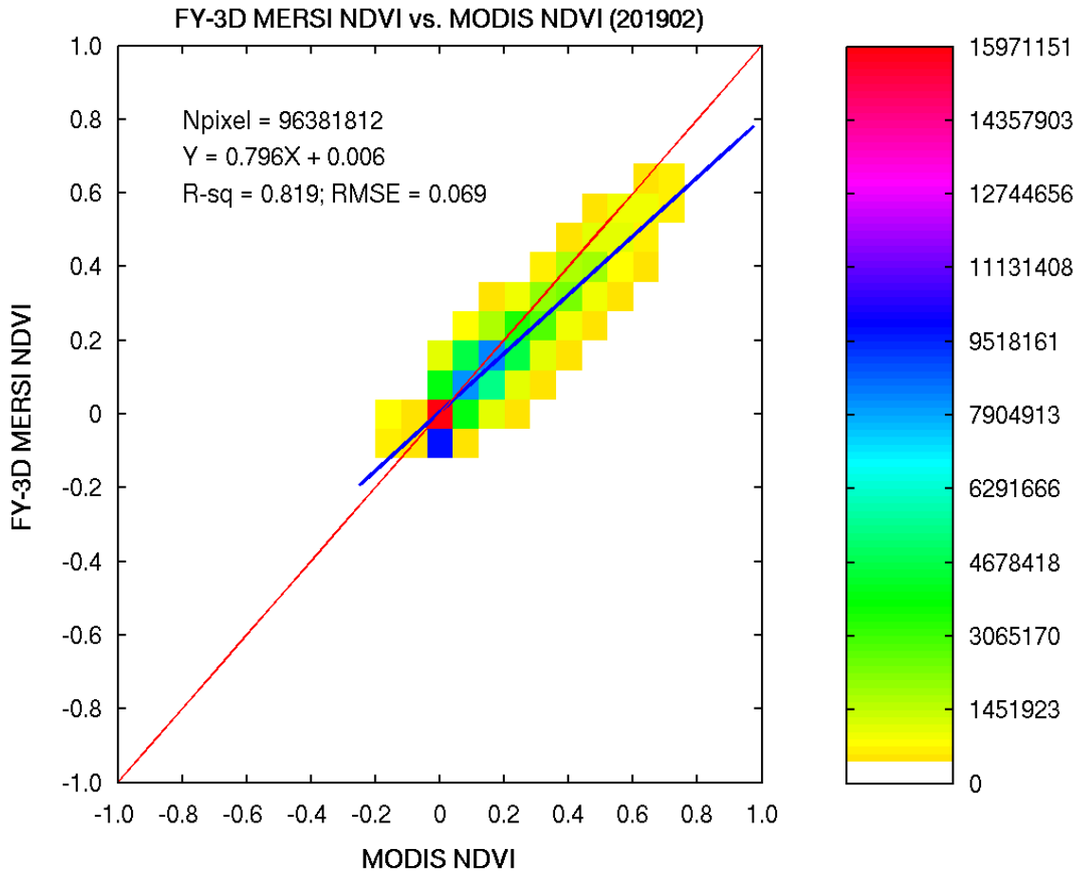
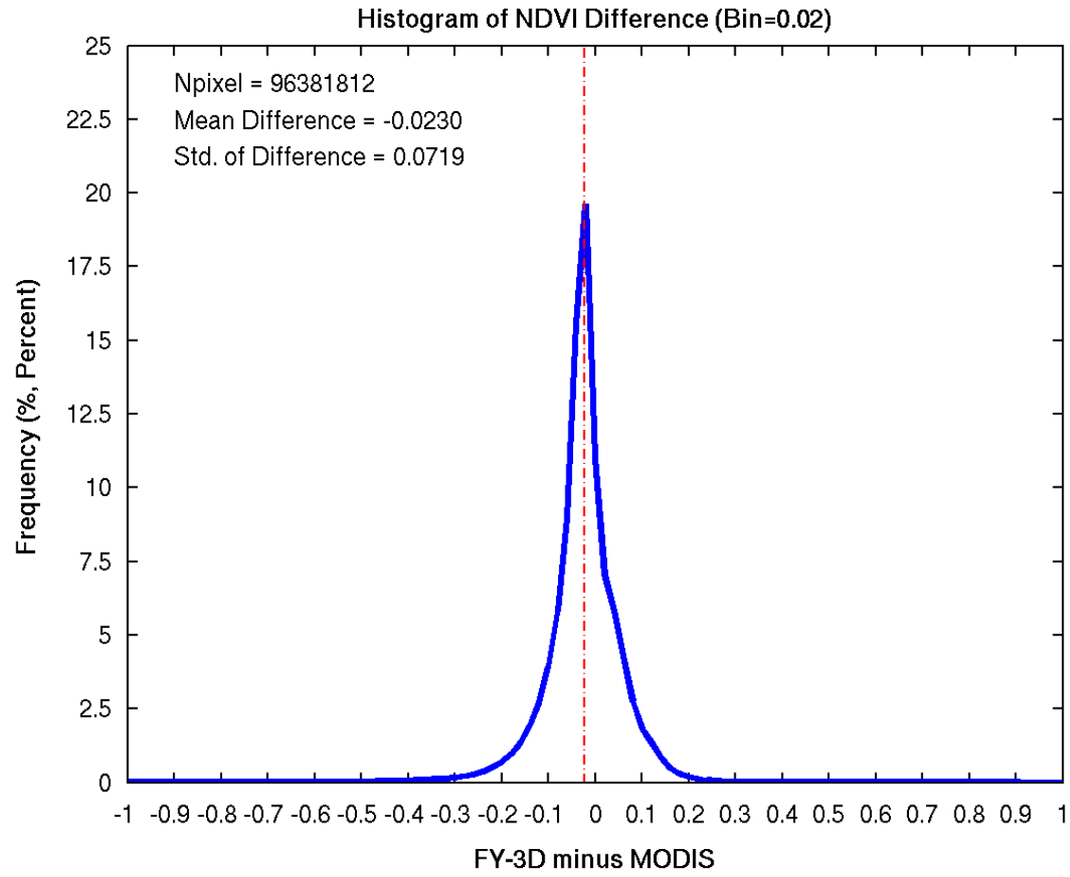
Quantitative Comparison

FY-3D NDVI and MODIS NDVI in February 2019 over North America





NDVI over North America

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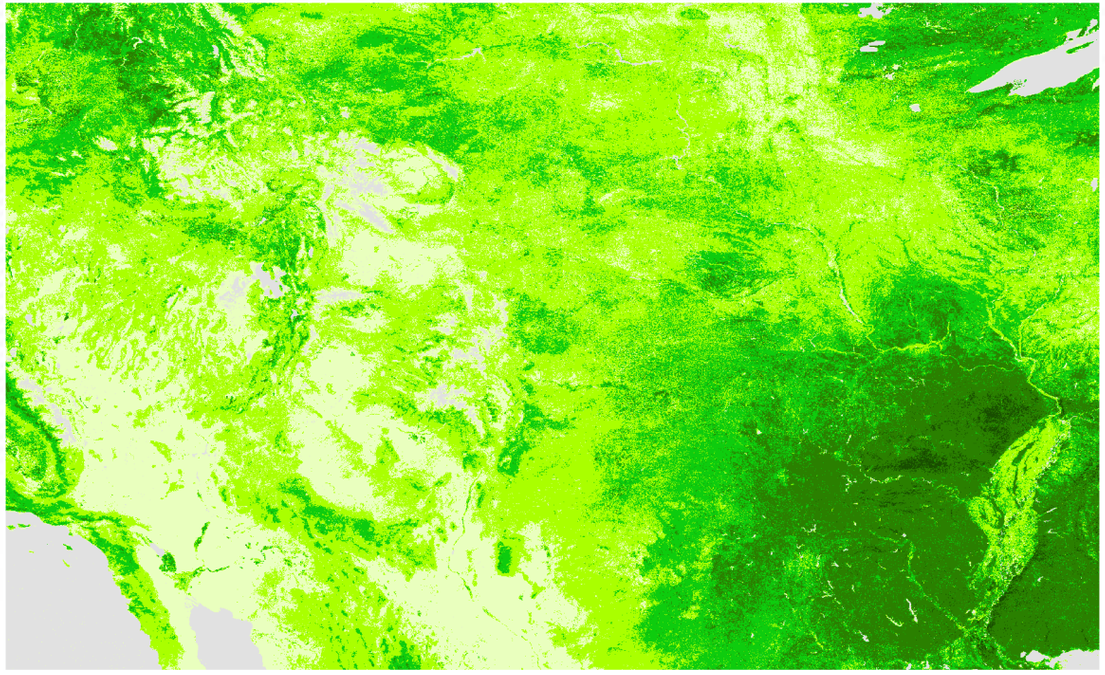
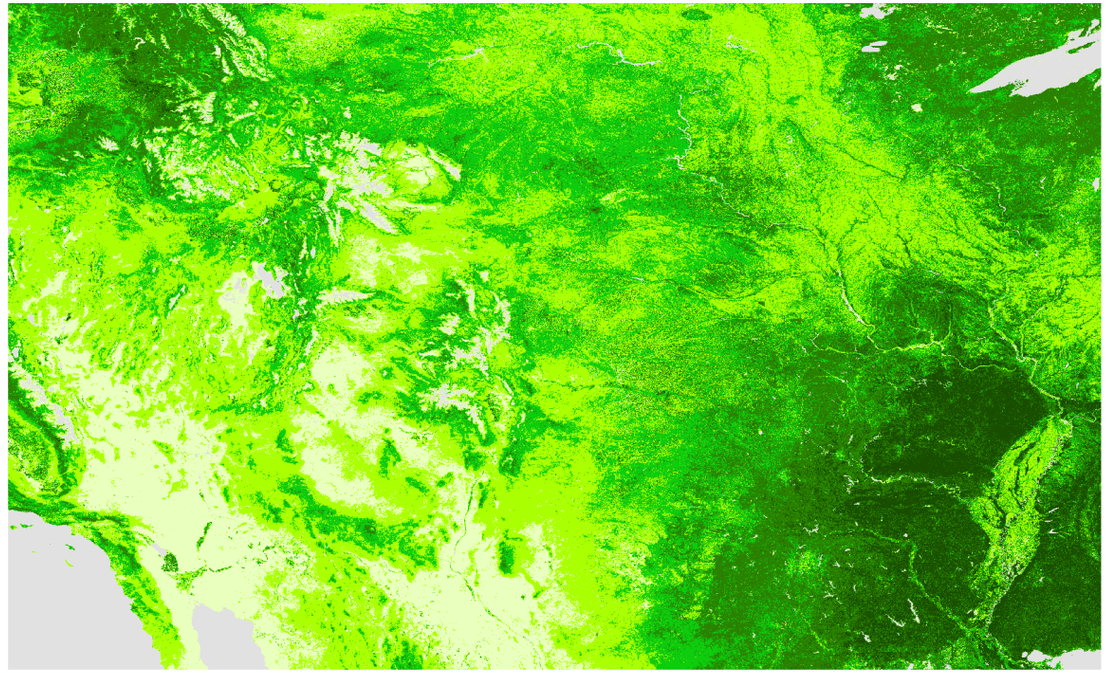
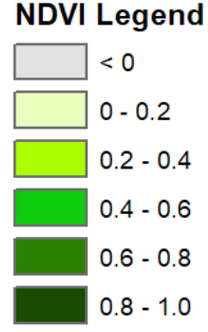
Comparison between FY-3D NDVI and MODIS NDVI in May 2019 over North America



FY-3D MERSI NDVI
(generated from FY-3D clear-sky composites)



MODIS NDVI



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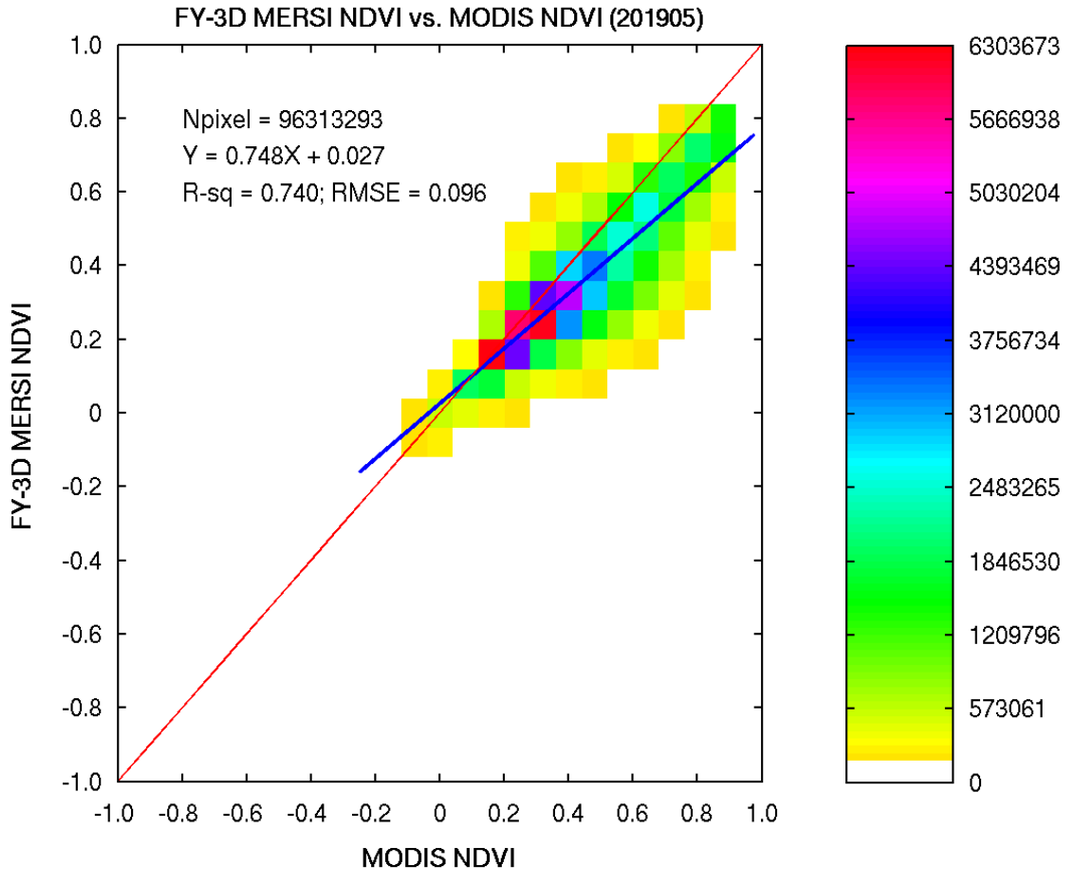
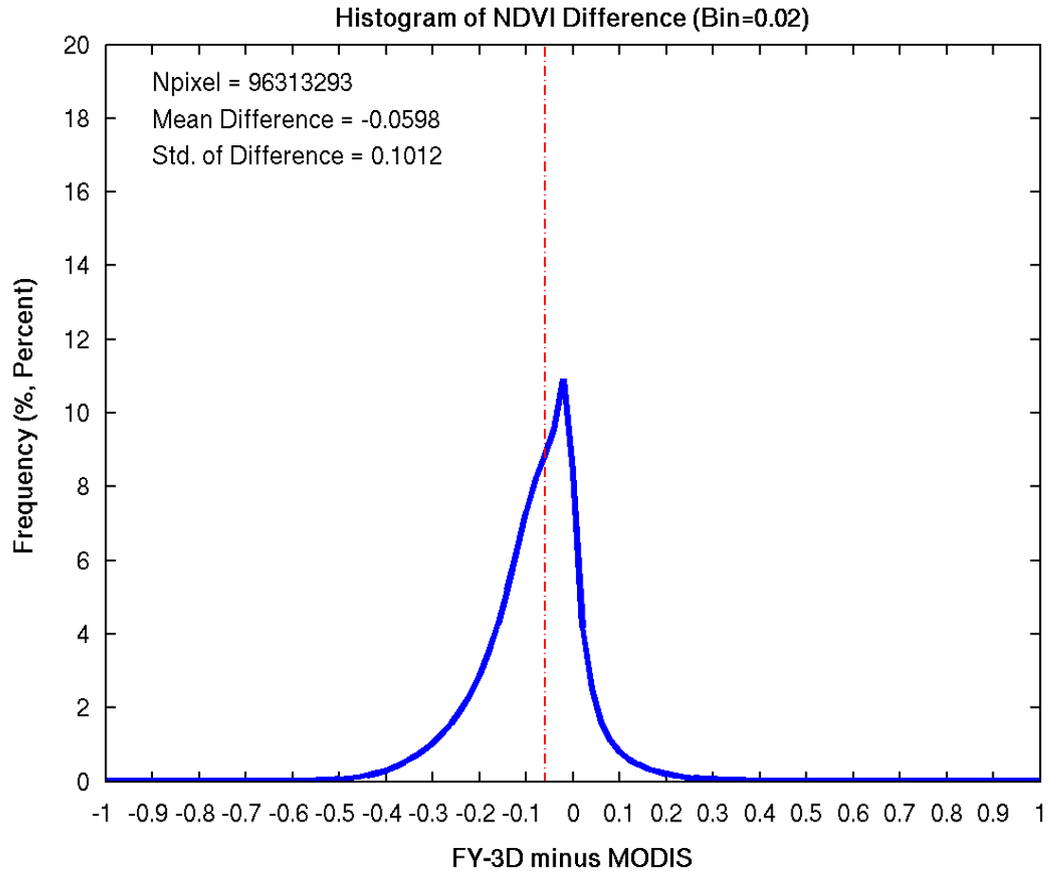
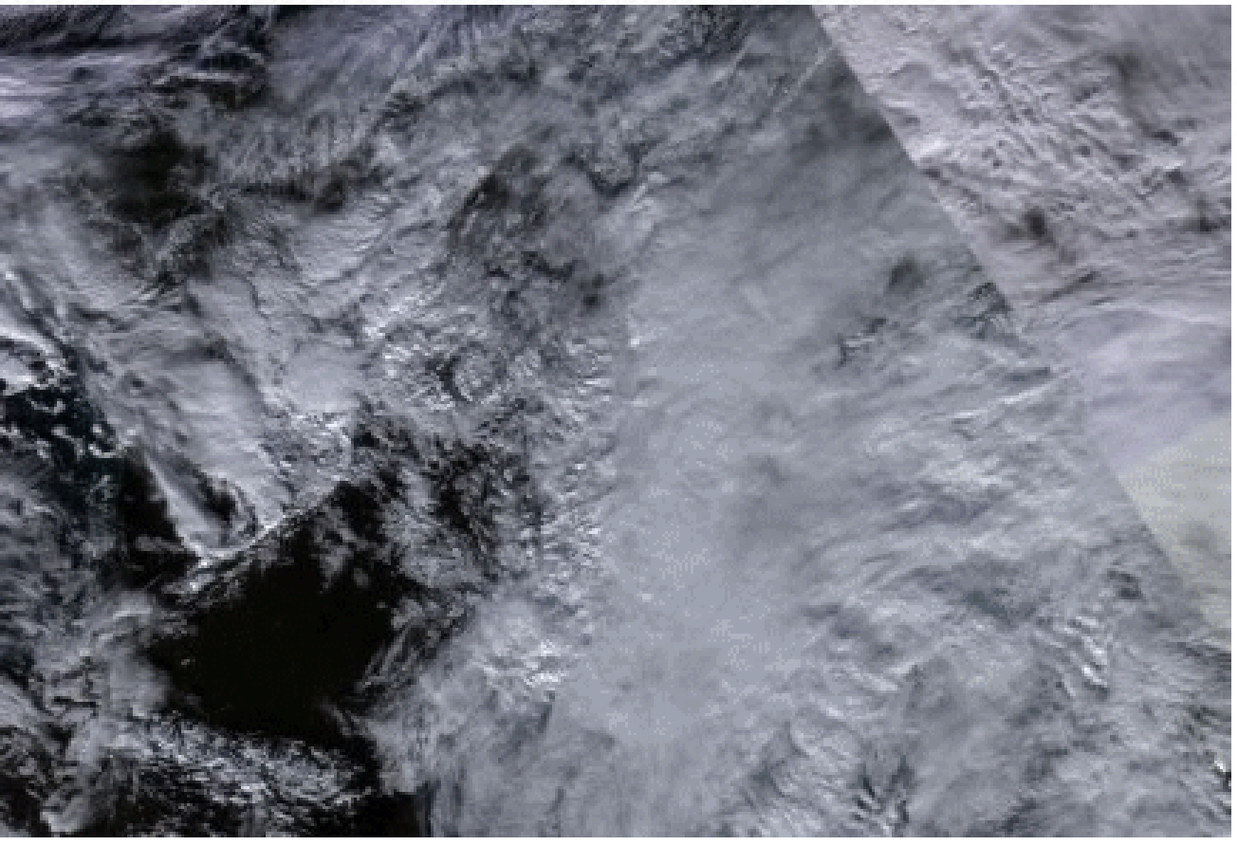
Quantitative Comparison

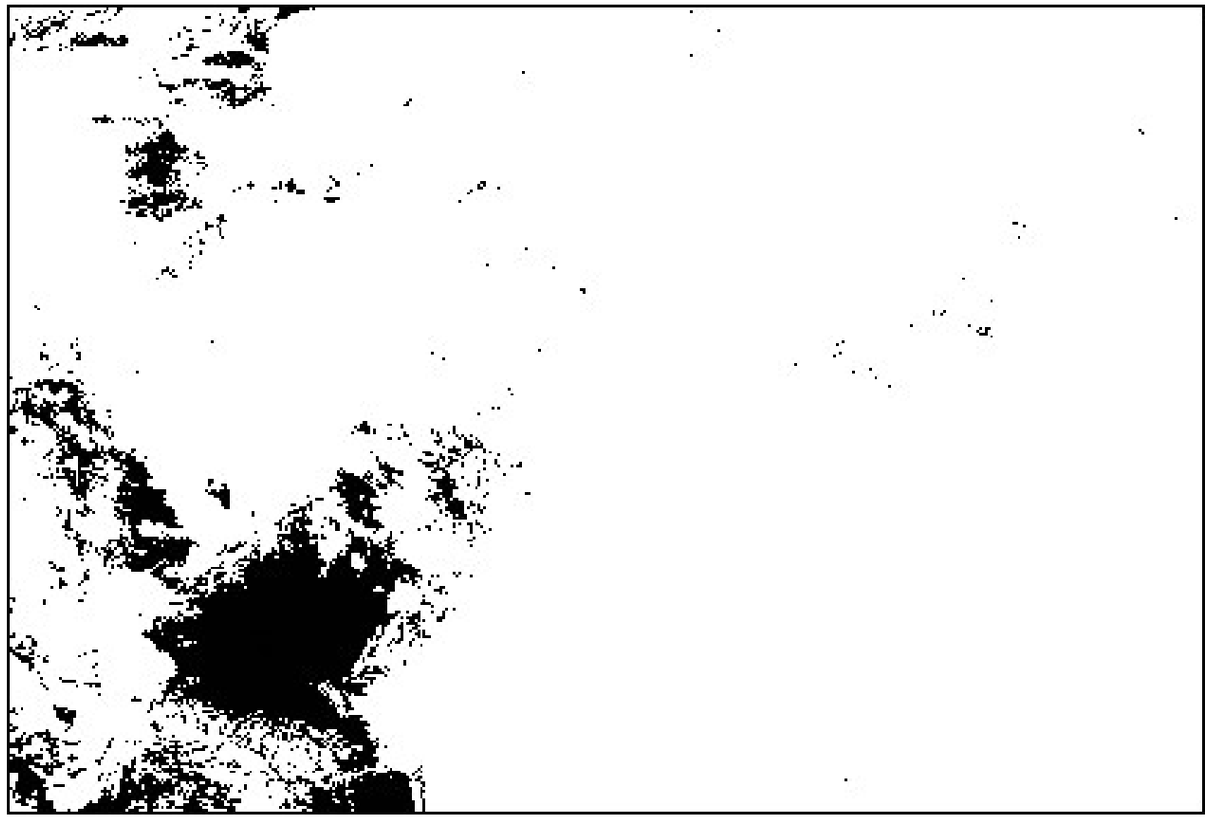
FY-3D NDVI and MODIS NDVI in May 2019 over North America





Results-case of cloud detection in Europe



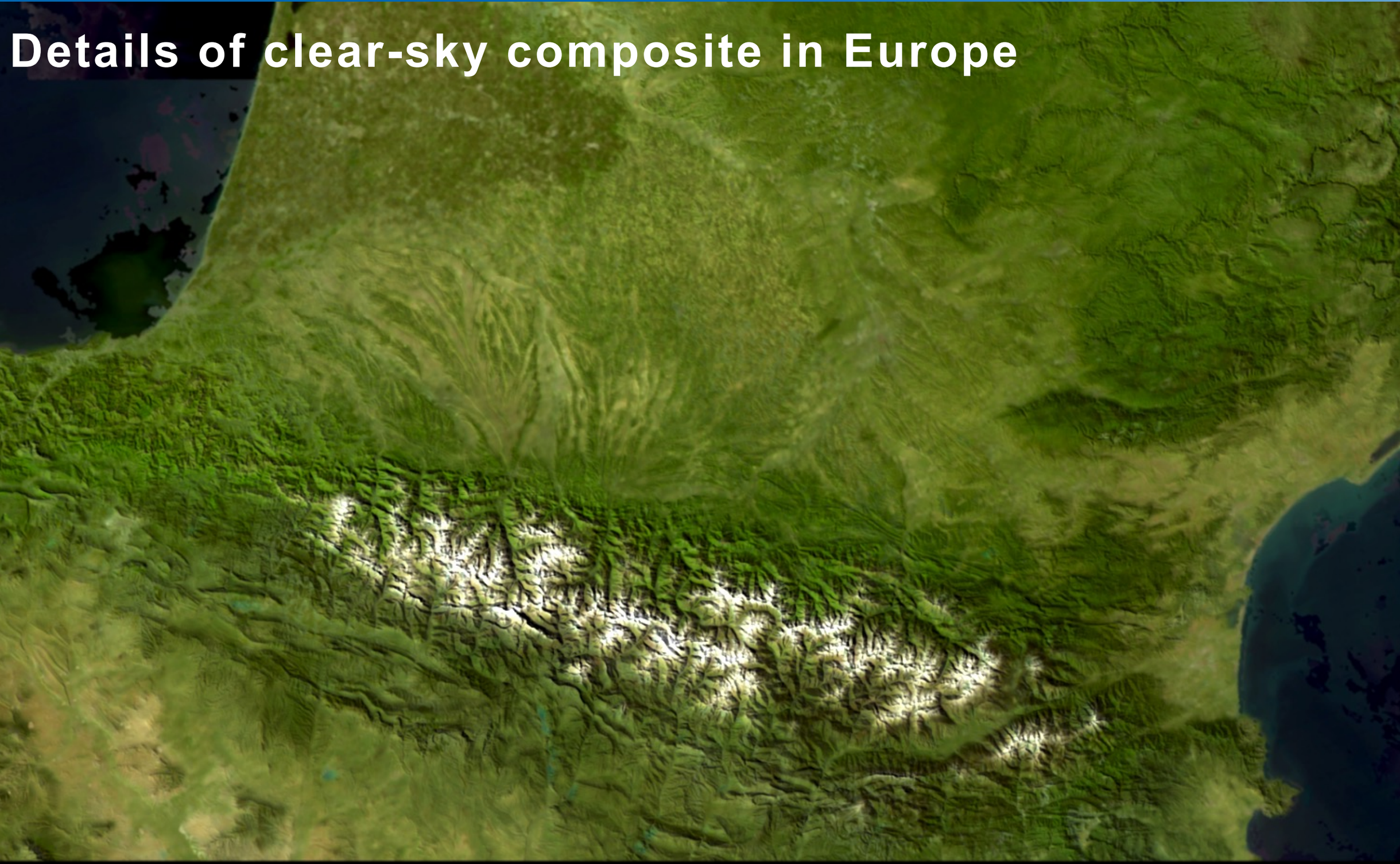


May 2019

Results of clear-sky composite in Europe

Details of clear-sky composite in Europe

Details of clear-sky composite in Europe



NDVI over Europe

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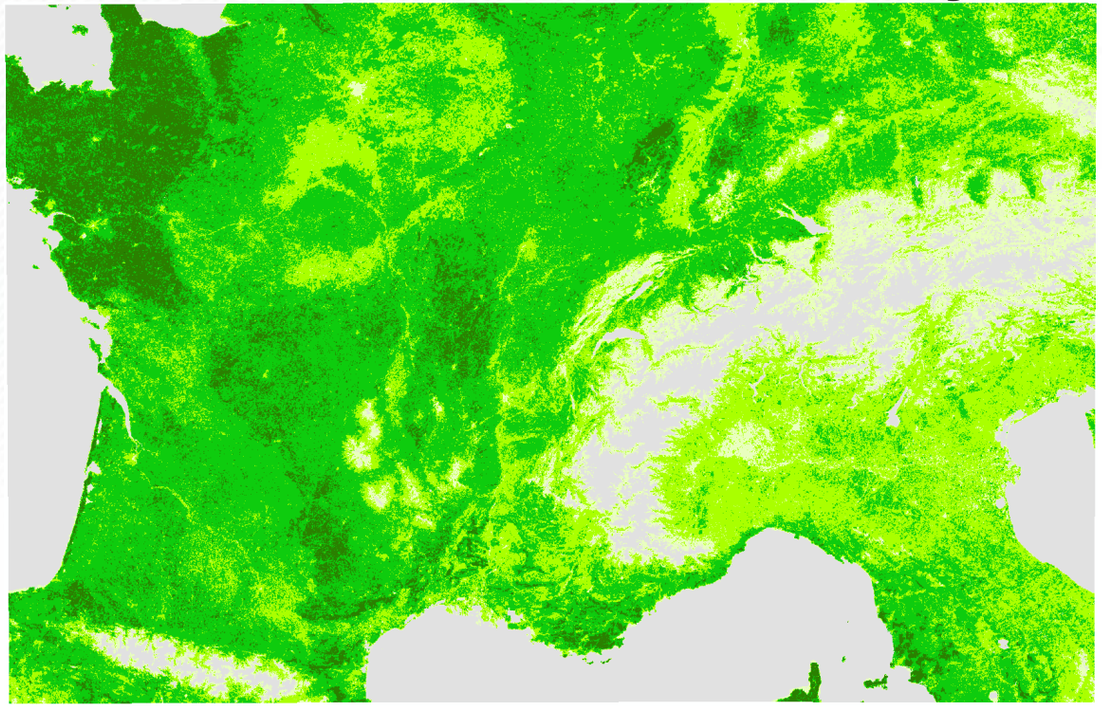
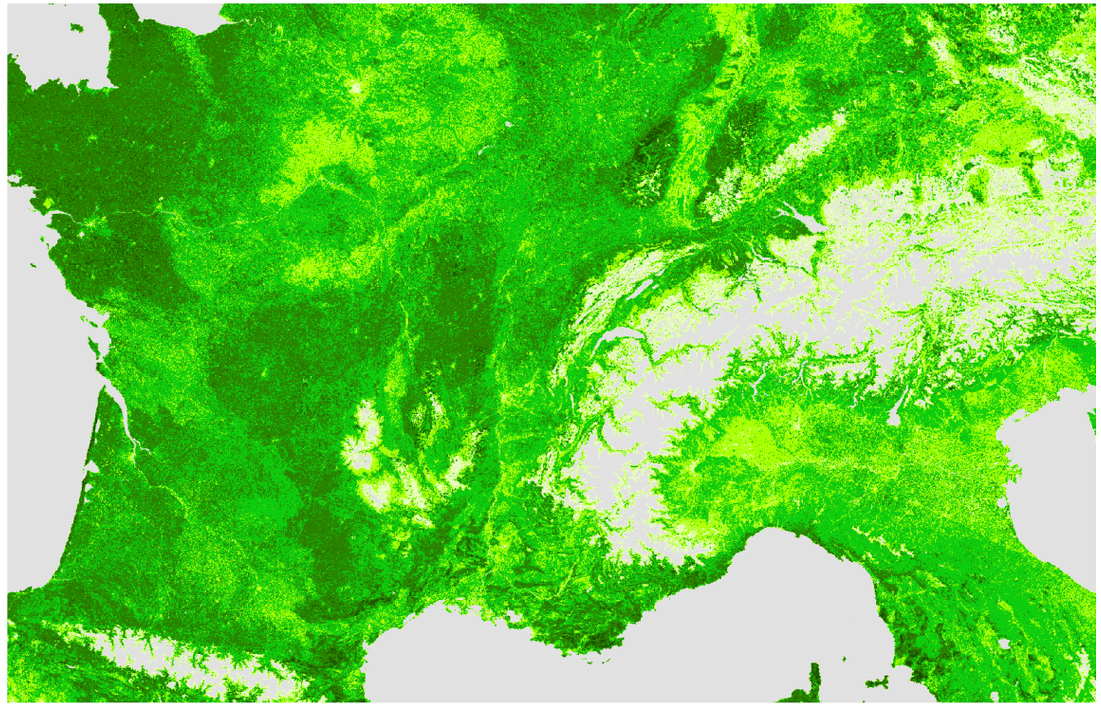
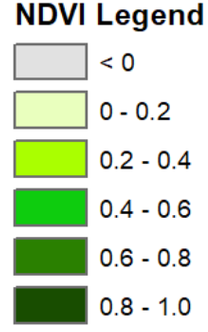
Comparison between FY-3D NDVI and MODIS NDVI in February 2019 over Europe



FY-3D MERSI NDVI
(generated from FY-3D clear-sky composites)



MODIS NDVI



FY-3D NDVI VS MODIS NDVI over Europe

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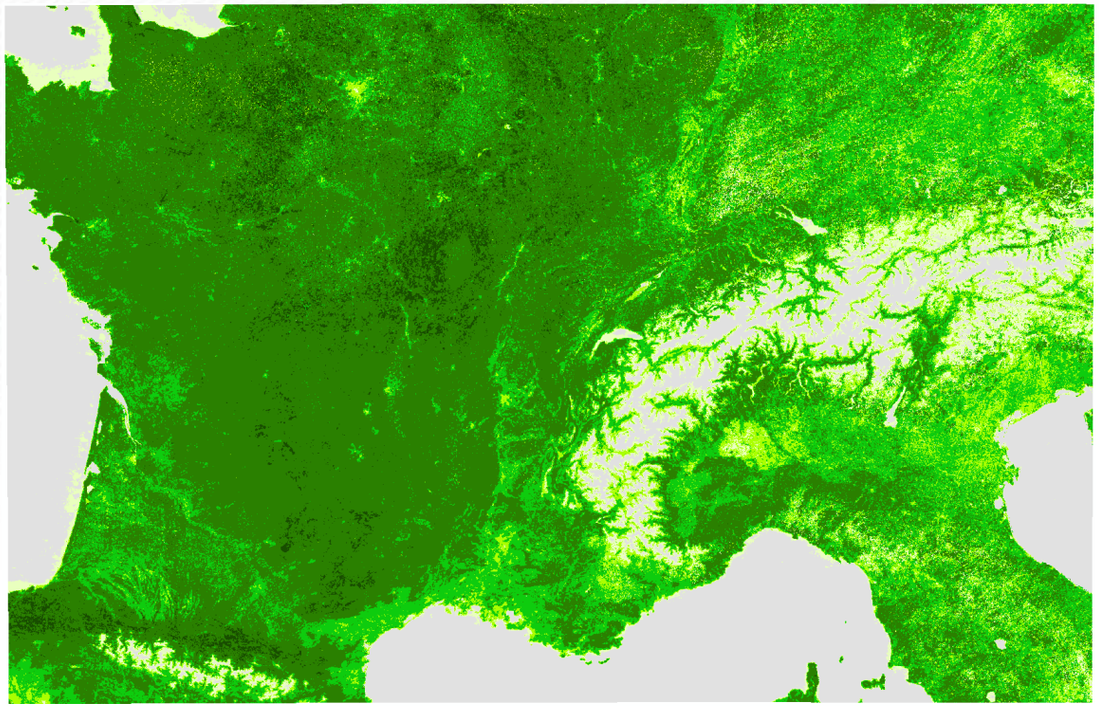
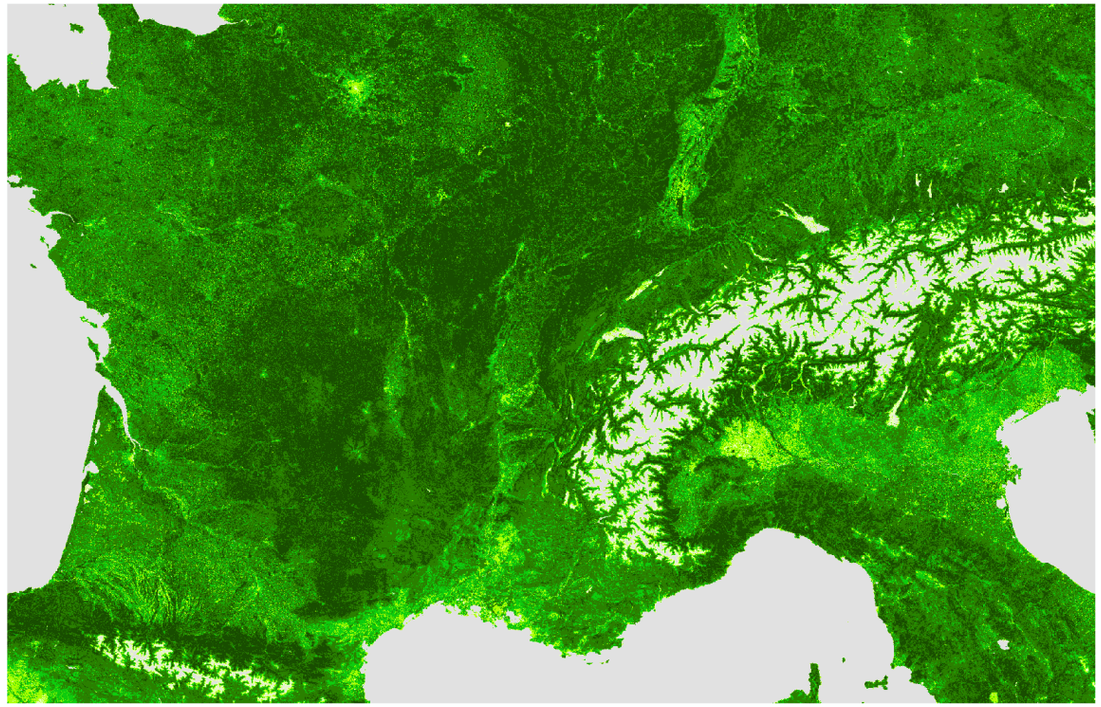
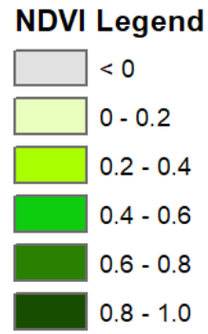
Comparison between FY-3D NDVI and MODIS NDVI in May 2019 over Europe



FY-3D MERSI NDVI
(generated from FY-3D clear-sky composites)



MODIS NDVI



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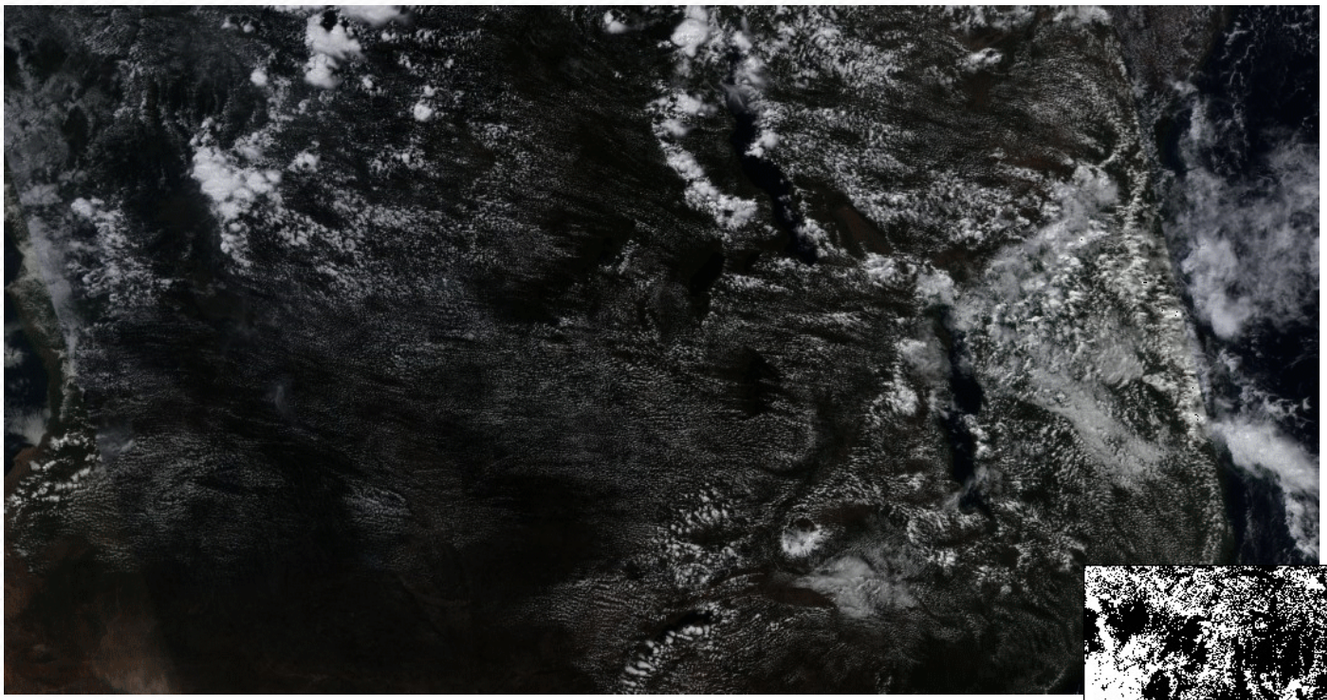
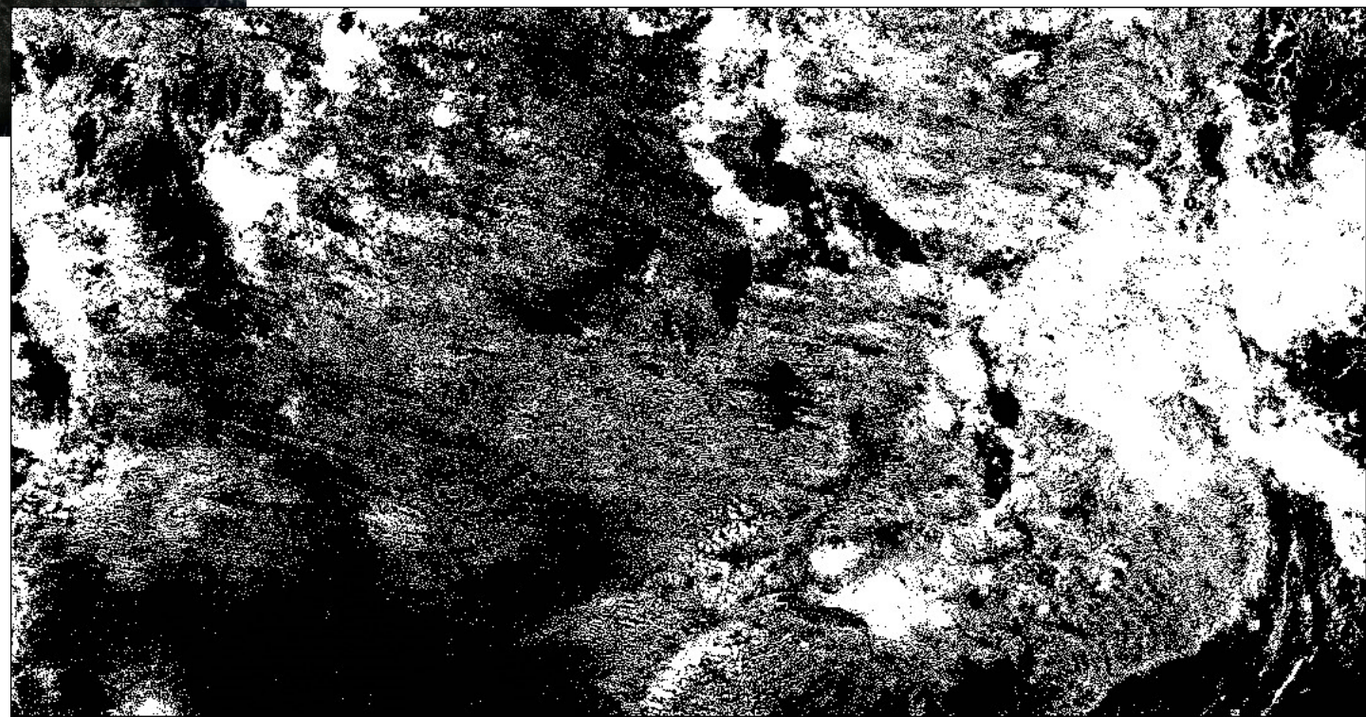
Results of clear-sky/cloud detection in Africa





May 2019

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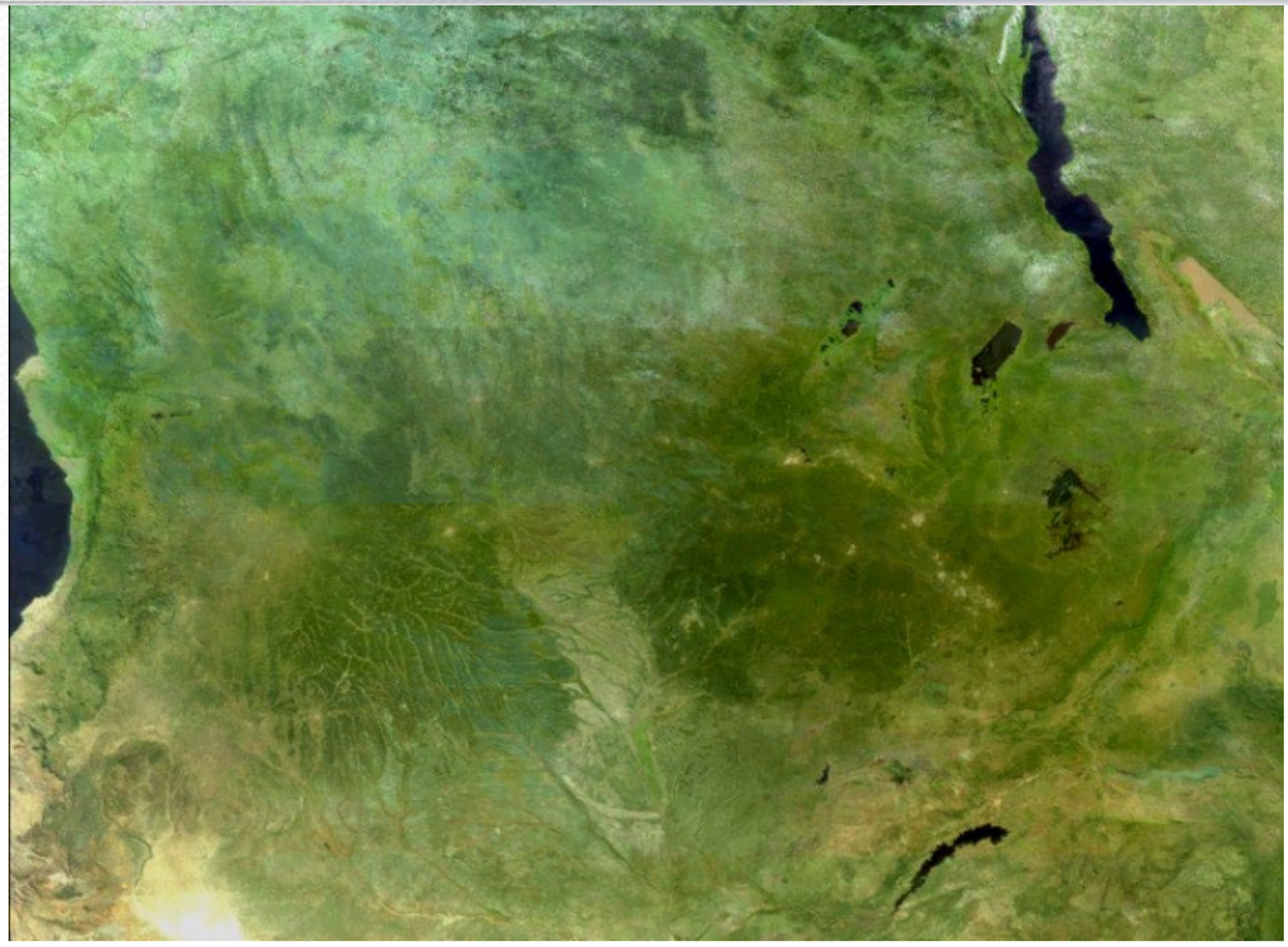
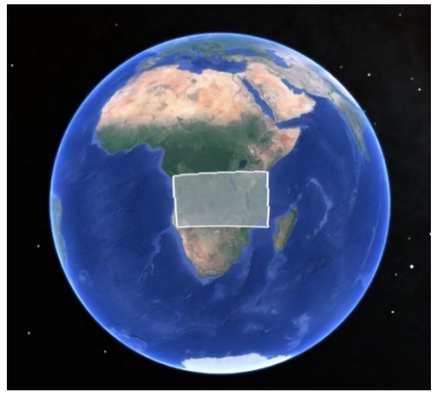
Results of clear-sky composite in Africa



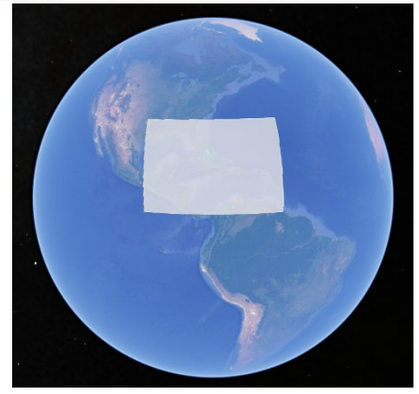



Details of clear-sky composite in Africa

Details of clear-sky composite in Africa

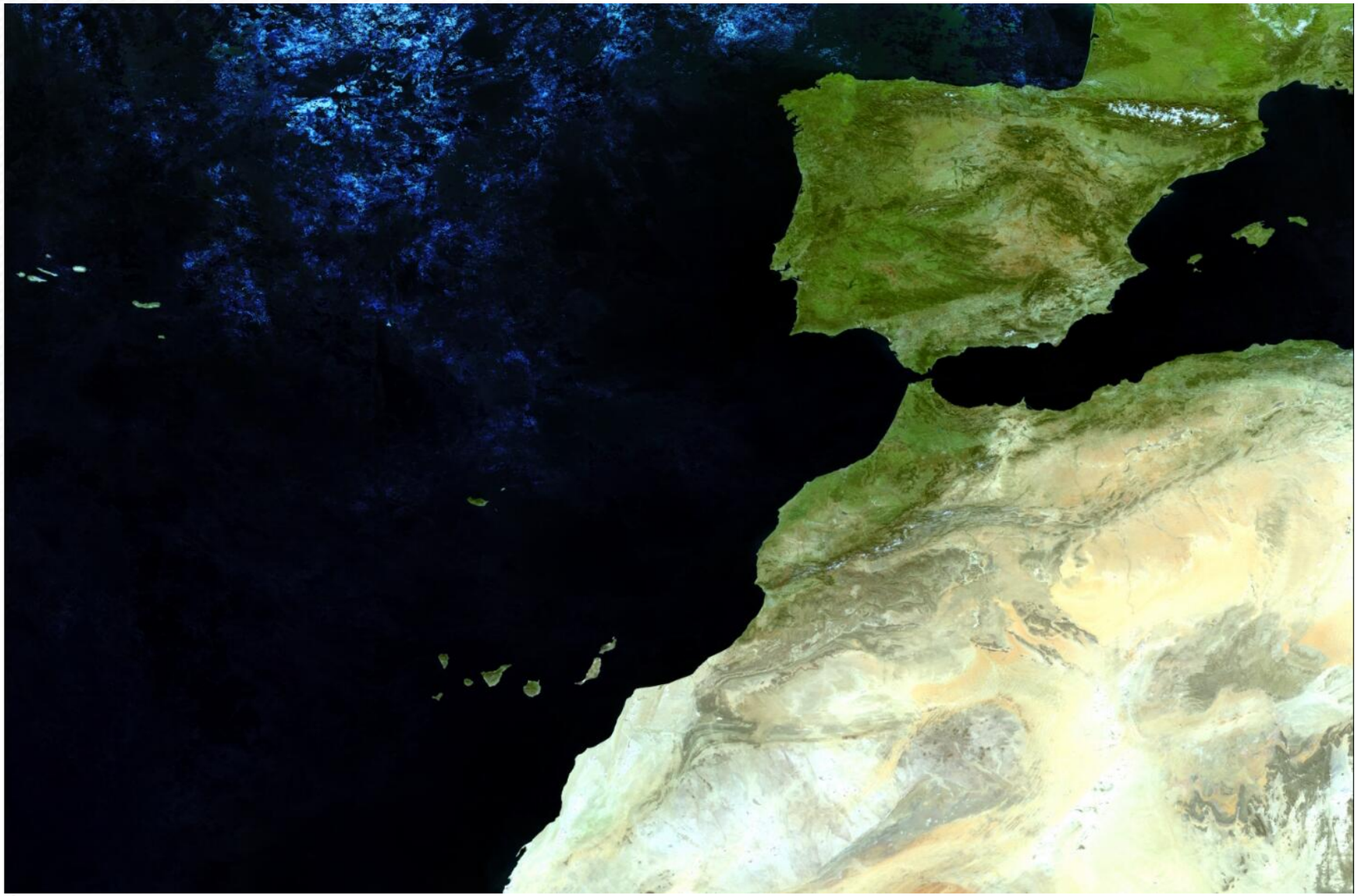

Details of clear-sky composite in Africa

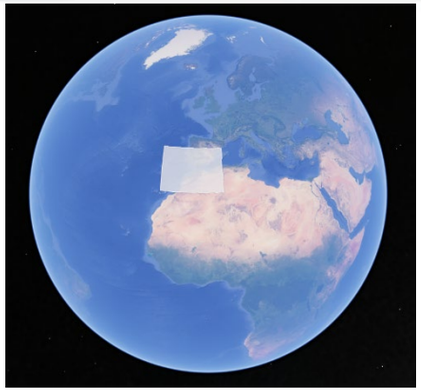
Results of clear-sky composite over Caribbean Sea



January
2019

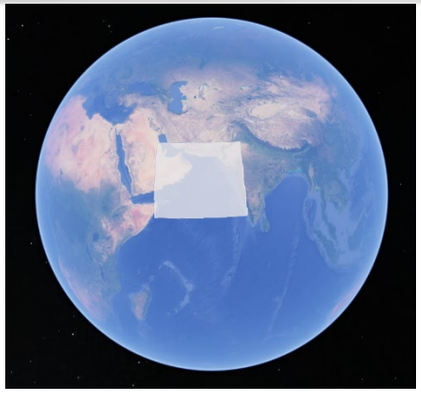
Results of clear-sky composite in Spanish Bay





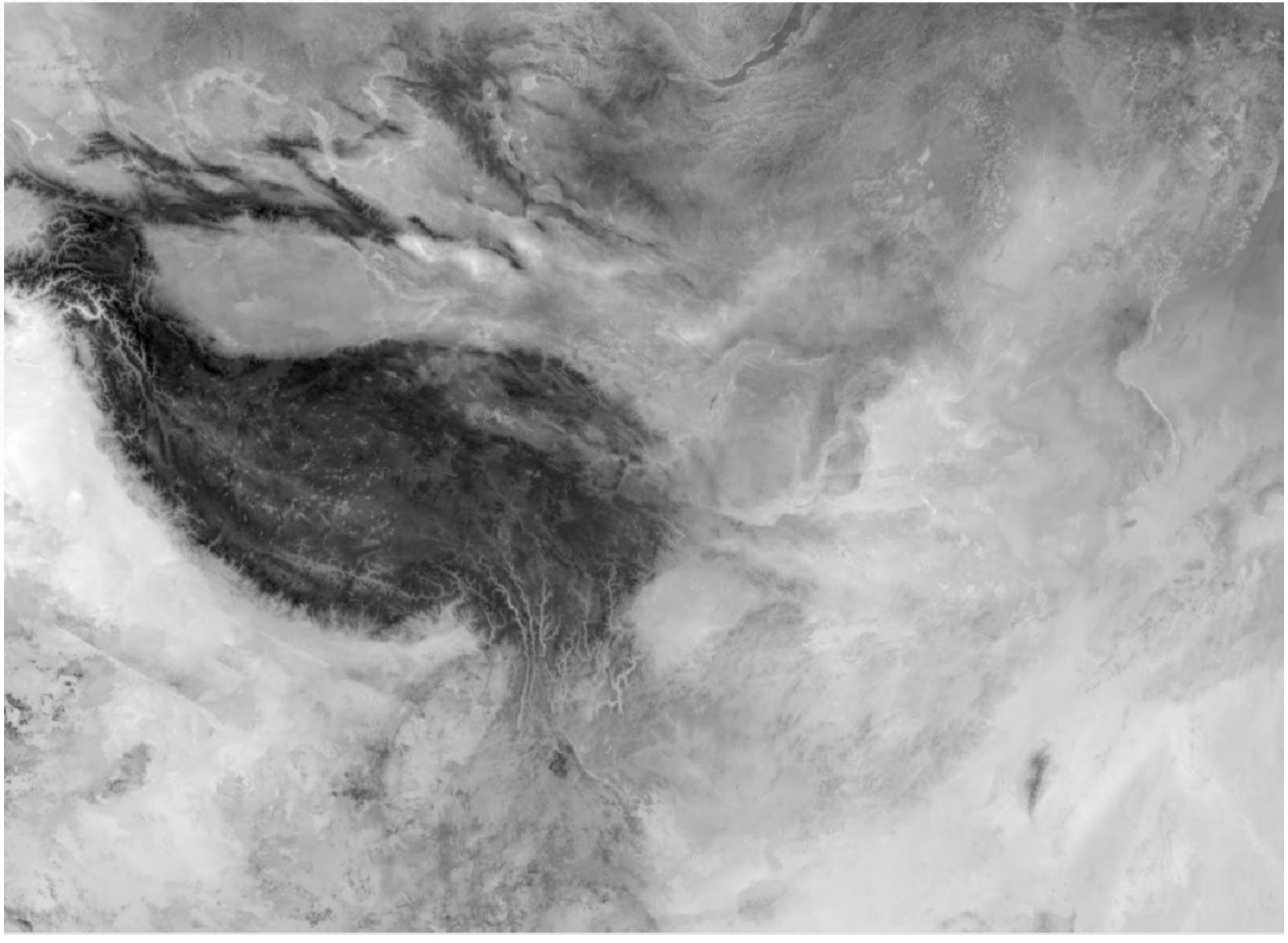
January
2019

Results of clear-sky composite in Persian Gulf



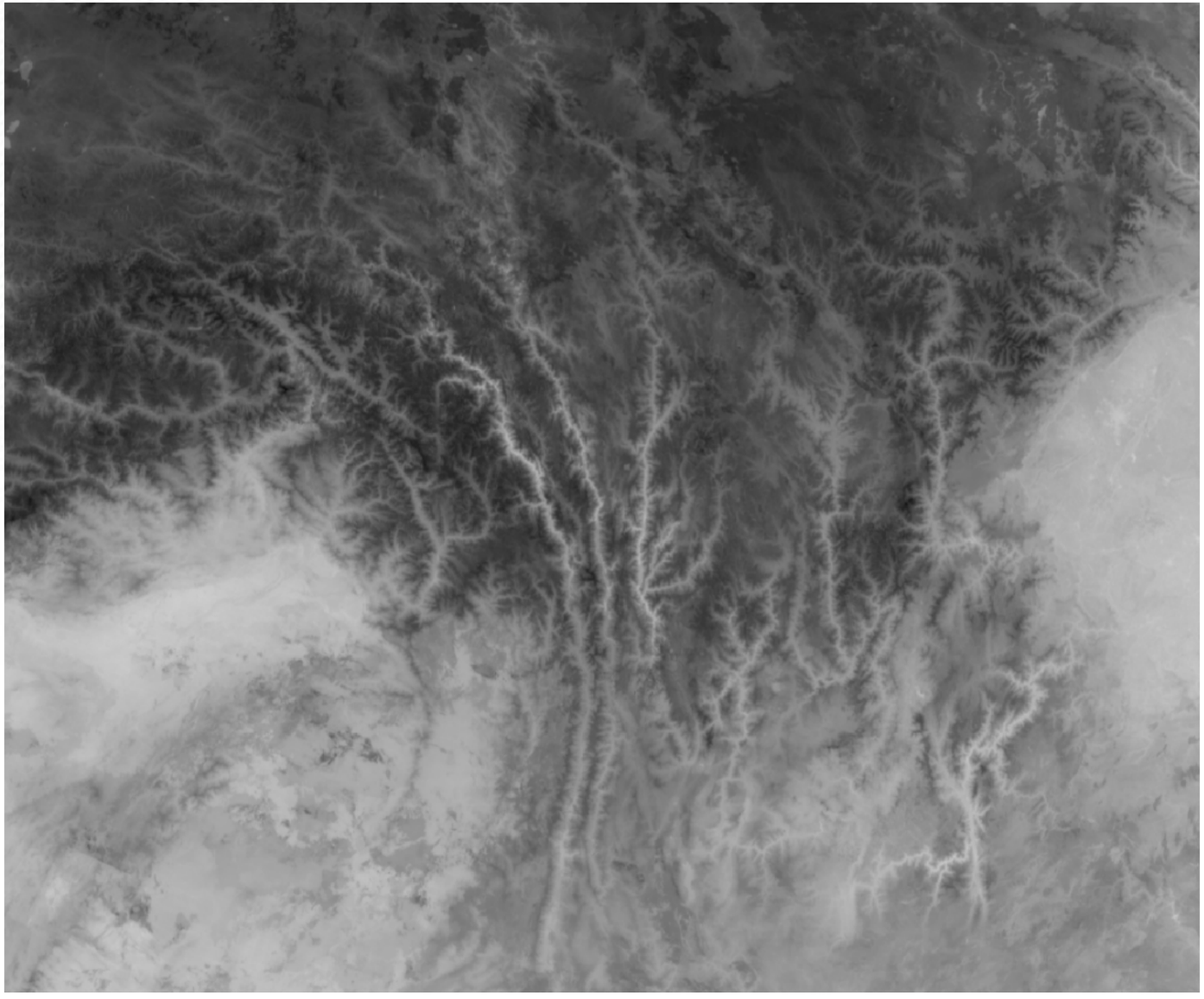
January
2019

Results of clear-sky composite of night time using thermal infrared band in China

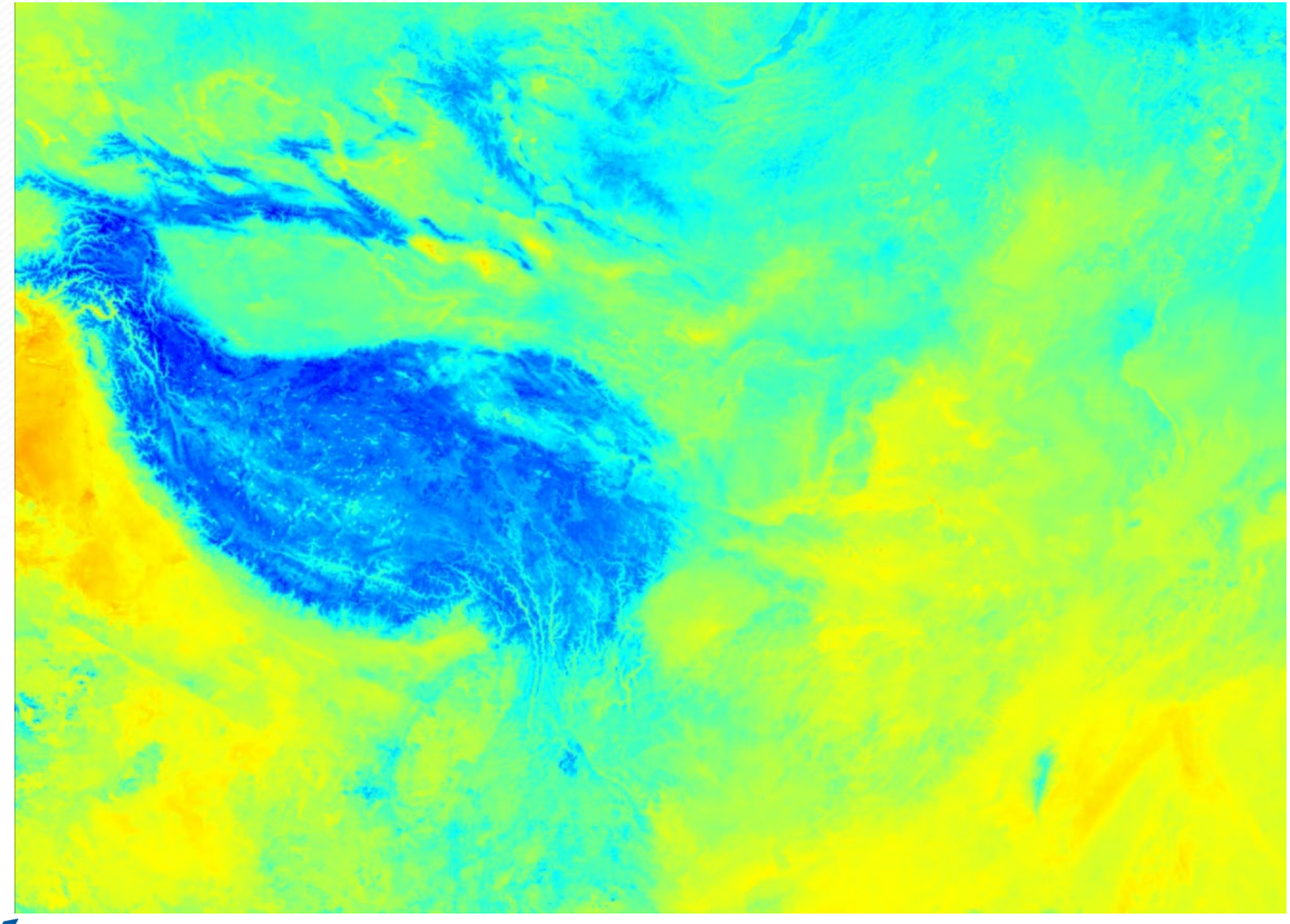


Night of
June 2018

Results of clear-sky composite of night time using thermal infrared band in China



Results of clear-sky composite of night time using thermal infrared band in China



Night of
June 2018

Efficiency

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Regions	Month	Data Volume	Time Consume	Outputs
The Eastern Region of Belt and Road	2019-02	474GB	12 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
The Eastern Region of Belt and Road	2019-05	474GB	12 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
The Western Region of Belt and Road	2019-02	280GB	7 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
The Western Region of Belt and Road	2019-05	284GB	7.5 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
Europe	2019-02	235GB	7 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
Europe	2019-05	235GB	7 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
America	2019-02	507GB	15 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
America	2019-05	507GB	15 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
Australia	2019-02	281GB	12 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
Australia	2019-05	281GB	12 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
Africa	2019-02	291GB	10.5 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask
Africa	2019-05	291GB	10.5 hours	RGB clear-sky composite / multi-channel clear-sky reflectance / cloud mask

Summary and Conclusions

- **Visual display of FY-3D MERSI clear-sky composites**
  - FY-3D MERSI clear-sky composites are radiometrically consistent with no cloud or obvious patch existing, showing reasonable seasonality;
  - The details like snow line on the mountain are clear. The objects, such as deserts, water, forests, etc., are conform to their actual characteristics in remote sensed images.
- **Capability of quantitative application FY-3D MERSI clear-sky products**
  - The NDVI products generated from FY-3D MERSI clear-sky composites are temporally and spatially agree with Terra MODIS NDVI products，showing similar distribution and seasonal trend；
  - The NDVI products generated from FY-3D MERSI clear-sky composites are highly correlated to Terra MODIS NDVI products. More than 85% of NDVI differences are within a small range. The results are similar to those from FY meteorological satellite center.

It could be concluded that FY-3D MERSI clear-sky composites meet the requirements for visual display, as well as the follow-up quantitative application.

Thank you for your attention