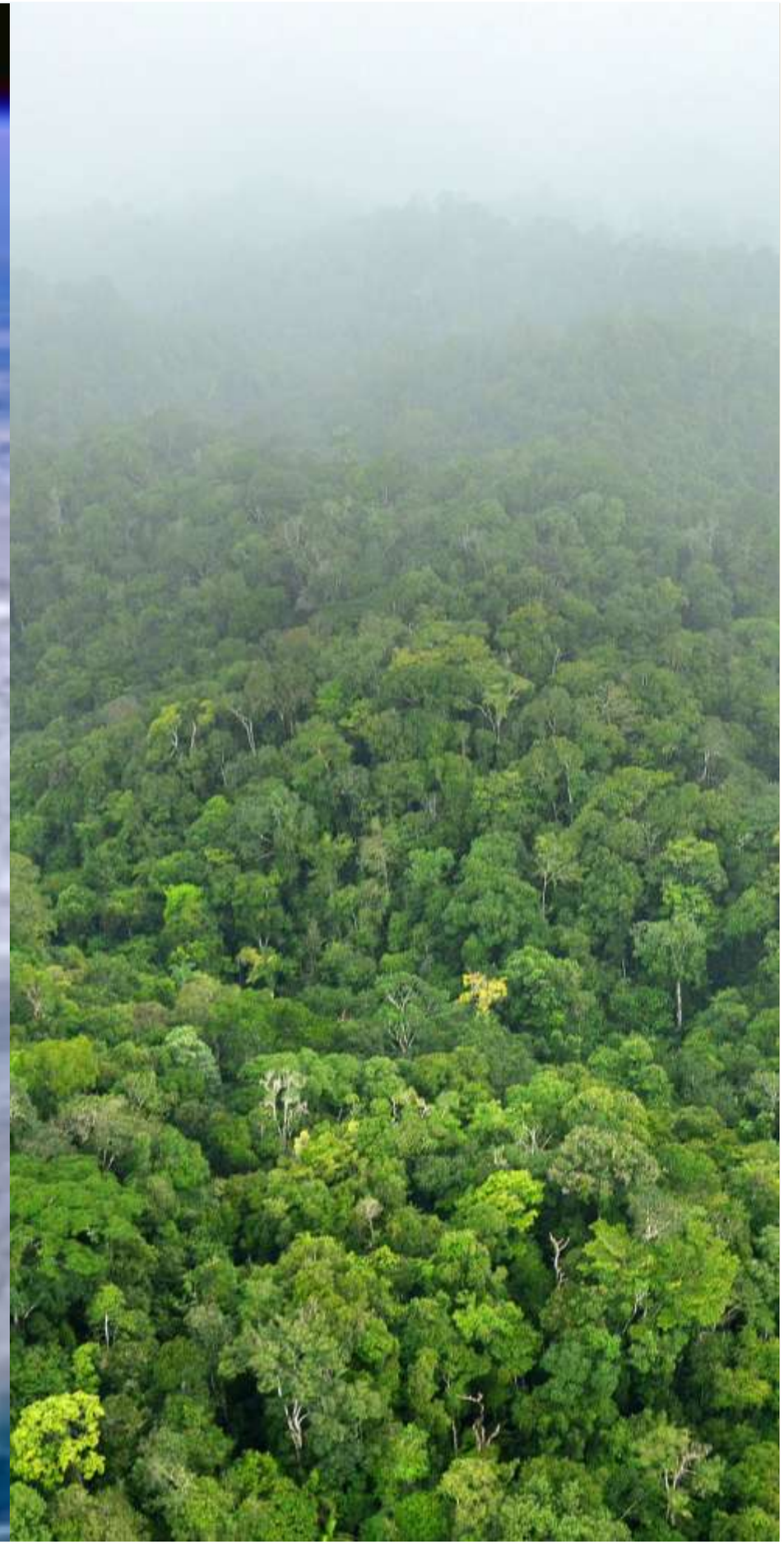

Atmospheric correction and cloud masking

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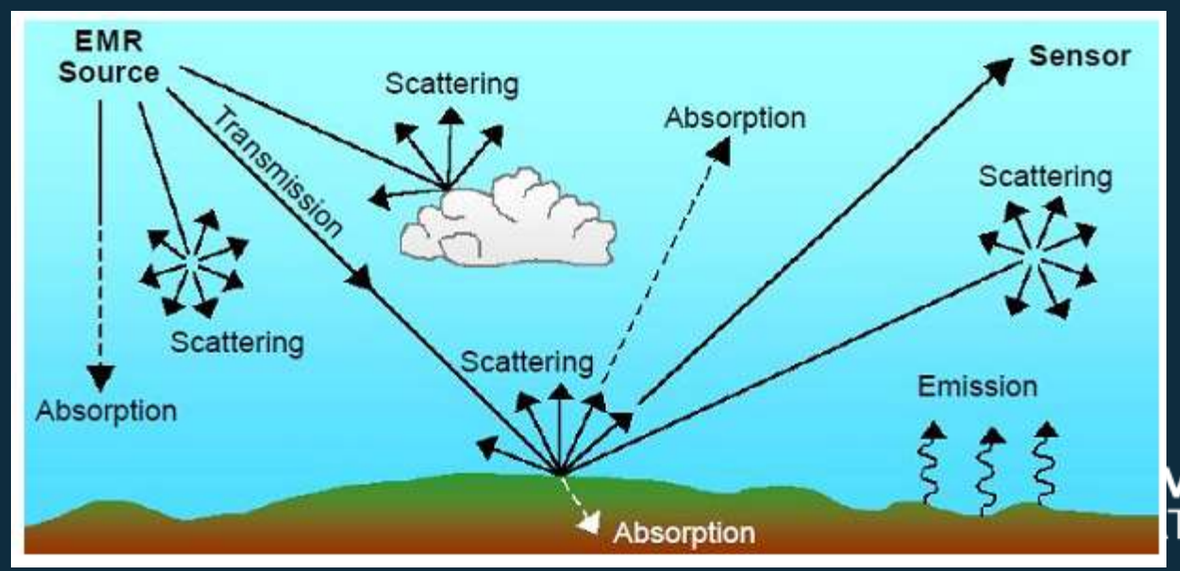
What is atmospheric correction?

- Atmospheric correction (sometime referred to as radiometric correction) is the process by which images are corrected to account for atmospheric contaminants, sensor viewing angle, and sun position.



Why is it important?

- Correcting for atmospheric contamination is important because it converts pixel values to “actual” surafce reflectance
- In general this will also lead to great contrast and depth in the values in the image
- Especially important when mosaicing or combining multiple images

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What are the methods?

- There are many methods for performing atmospheric correction and most software packages contain correction tools (EDRAS, IDRIS, ENVI)
- The method that is used at CI is called LEDAPS (Landsat Ecosystem Distrubance Adaptive Processing System)
- LEDAPS uses satellite image data, metadata, and daily atmospheric data to correct images and detect clouds
- LEDAPS processed TM5 and ETM+7 images can now be downloaded directly from the USGS Earth Explorer website as part of the Climate Data Record (CDR) dataset

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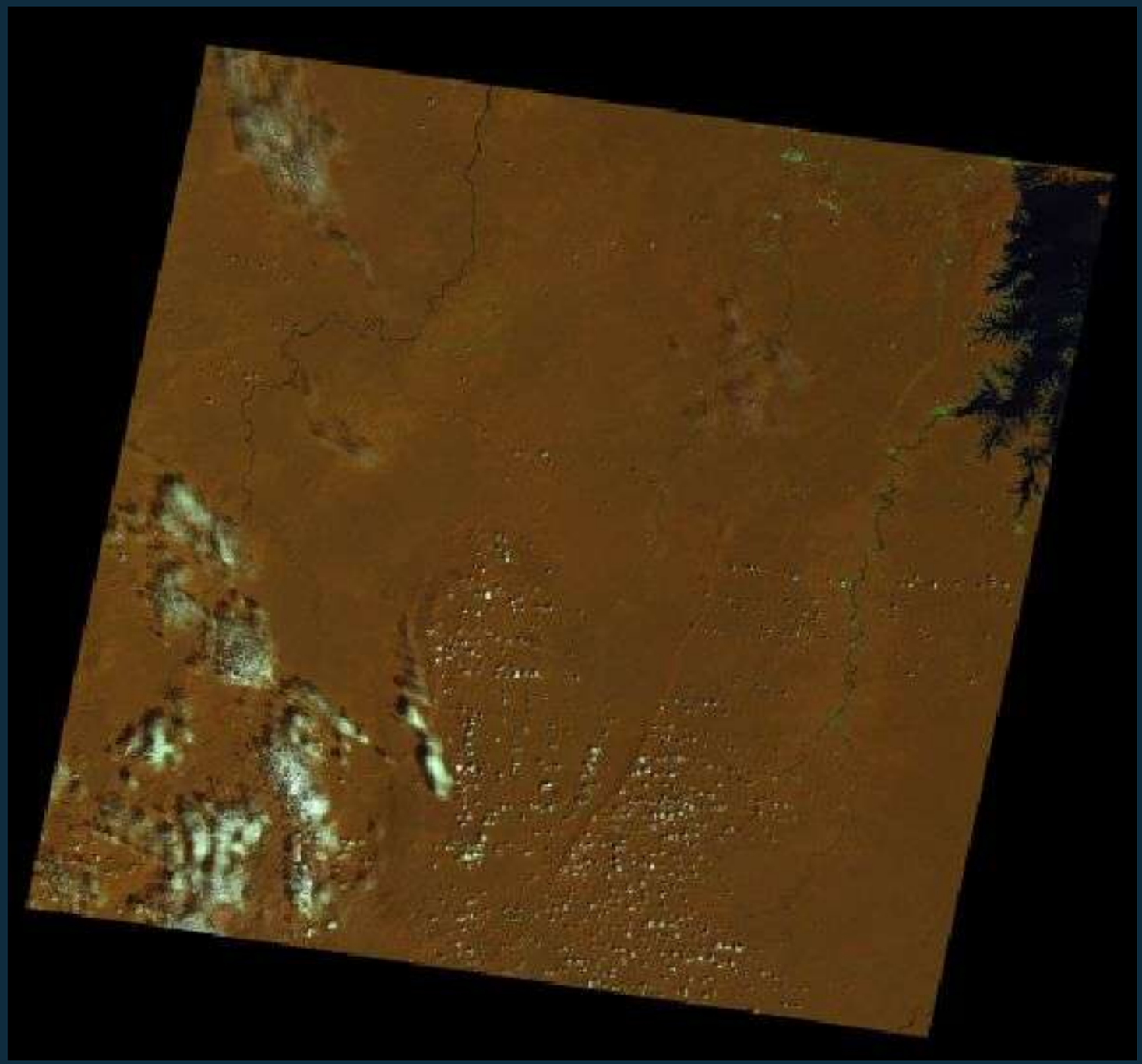
Before atmospheric correction



Landsat 5, path 229 row 57.
Image date 11/15/2009

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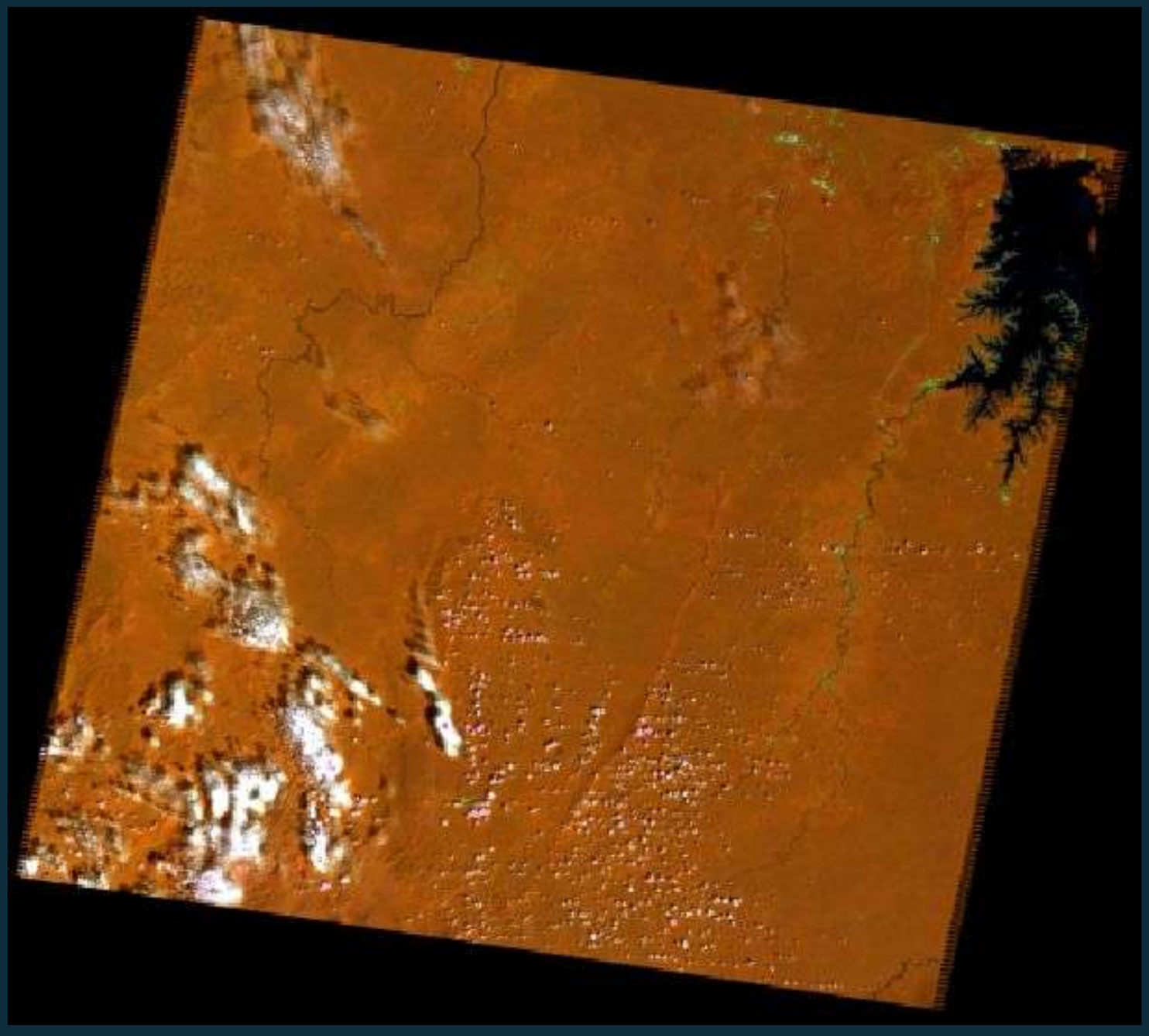
After atmospheric correction



Landsat 5, path 229 row 57.
Image date 11/15/2009

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Cloud masking

- One of the most important feature of LEDAPS pre-processing is that it can be used to generate cloud masks
- Masking the clouds from your image is useful because it lowers the amount of variability that you need to train on
- Removing clouds also tends to remove spectral outliers from the image

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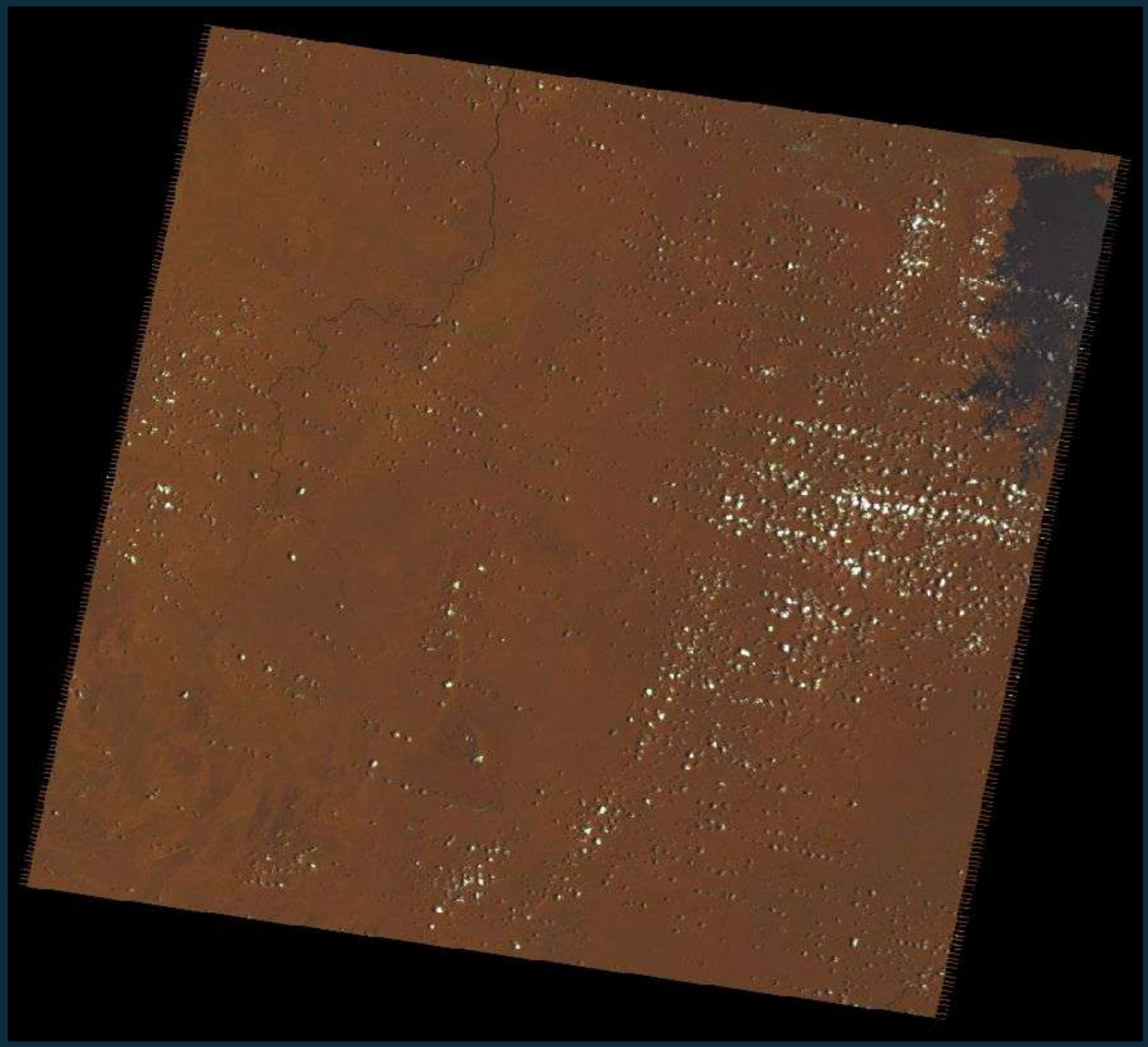
Atmospherically corrected image



Landsat 5, path 229 row 57.
Image date 9/28/2009

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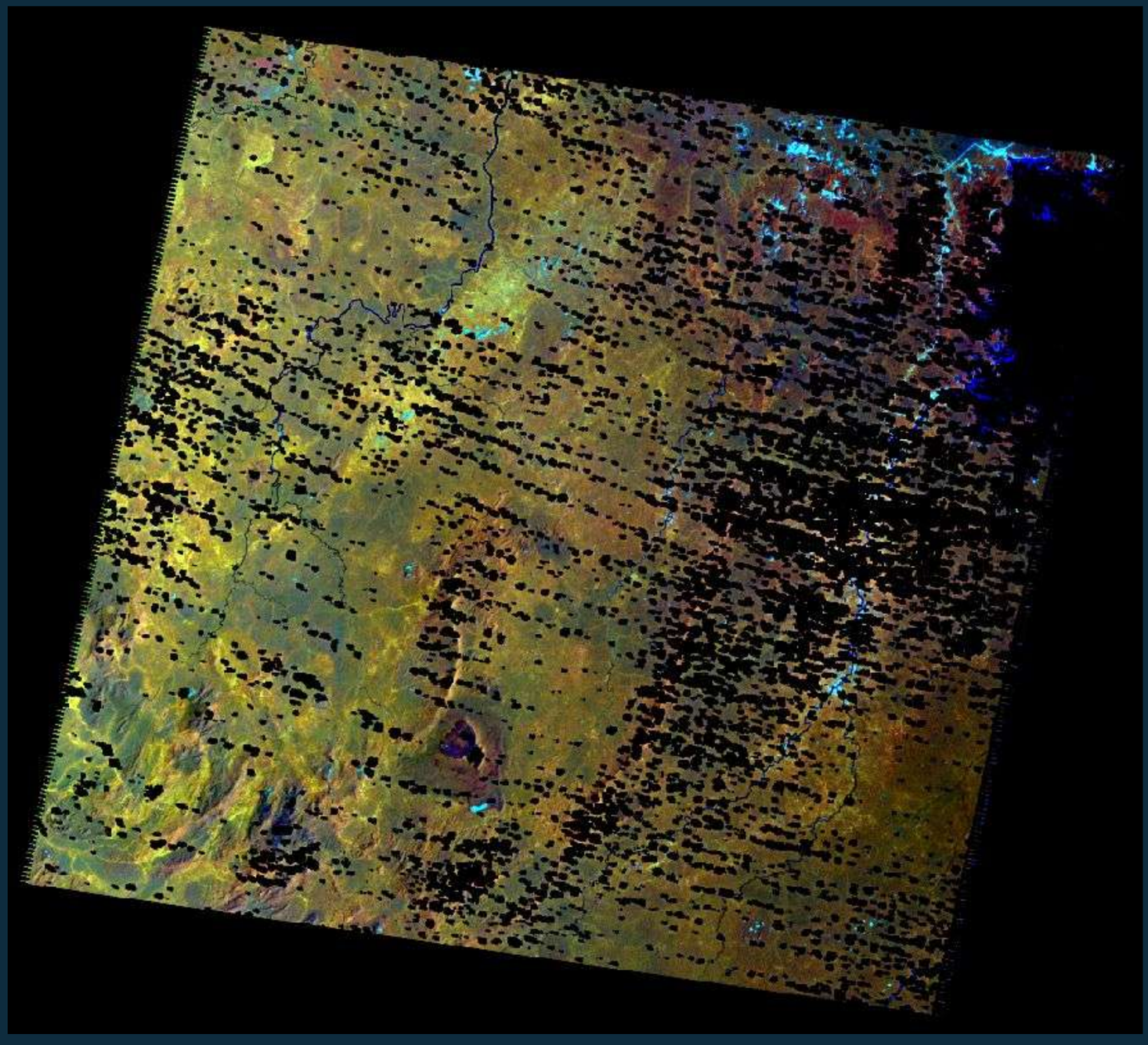
Cloud Masked Image



Landsat 5, path 229 row 57.
Image date 9/28/2009

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Gap-filling

Cloud-masking is important, but in may tropical regions that experience high levels of cloud-cover it may also be necessary to fill the cloud holes using additional imagery

Some things to consider when gap-filling:

- ✓ Seasonality!!
- ✓ Image dates
- ✓ Gap-filling order

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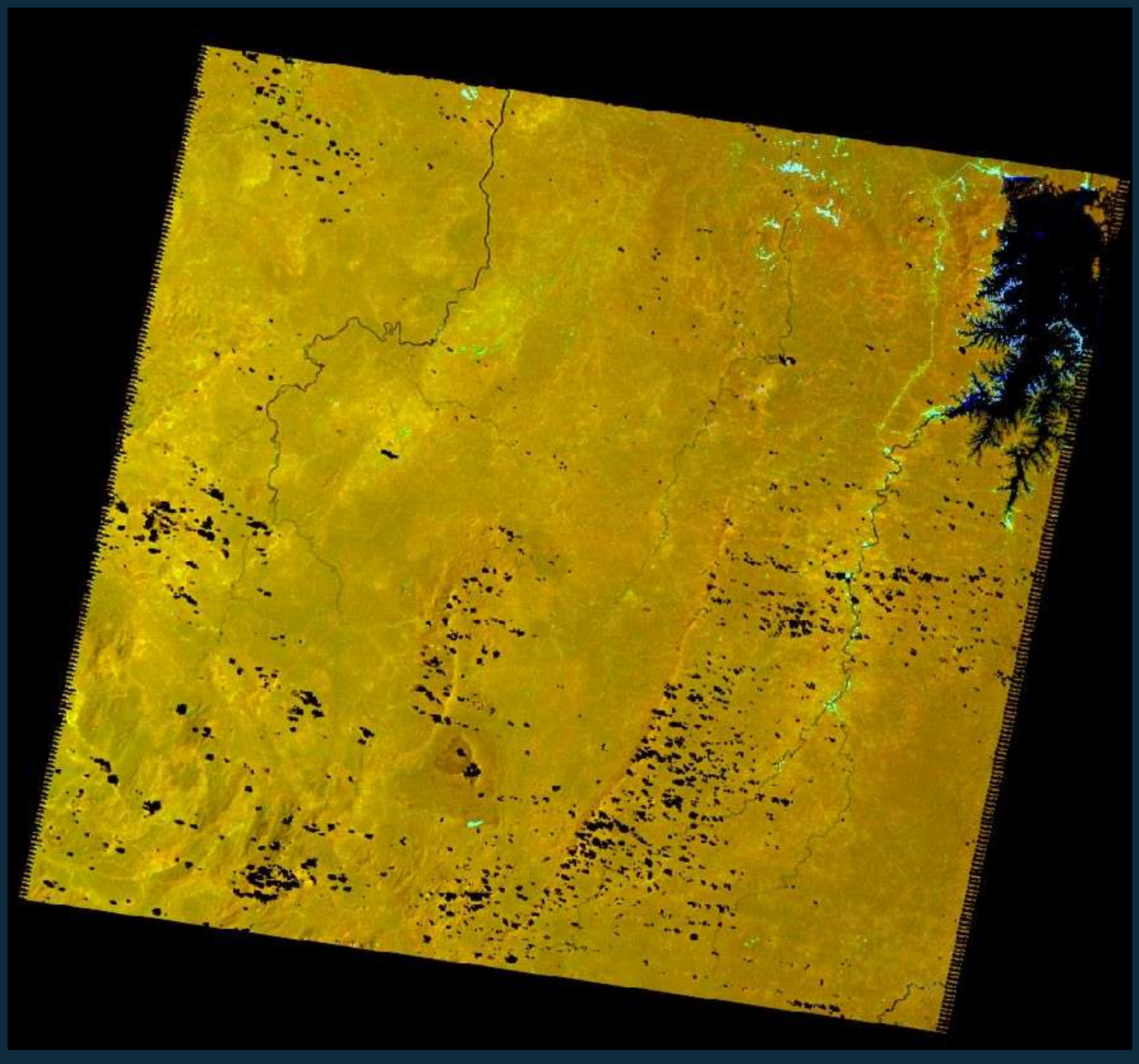
Gap-filled Image



Base image date: 9/28/2009
Fill image date: 11/15/2009

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Options for gap-filling

There are several methods for gap filling:

- In ERDAS the MosaicPro can be used for gapfilling images. A nice feature in MosaicPro is that you can use histogram matching to make the images blend better.
  - However, ths can change pixel values so analysts must use caution

- In IDRIS you can use the Concat module to combine images or the Overlay module to stack images that have been cloud-masked

- CI has also developed an IDL script that can be run in the IDL-VM that will gap-fill scenes with up to 5 images.

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Gap-filling with IDL-VM script

- The program uses the surface reflectance product from LEDAPS (or data from the CDR dataset)
- Converts Hierarchical Data Format (HDF) scientific datasets into geoTIFF images
- Calculates binary cloud and SLC-off mask from HDF using bit flags from clouds and shadows
- Mask clouds and shadows on each band
- Aligns multiple Landsat scenes into a common frame (using a slightly modified reframe.pro program from NASA)
- Fill the cloud and SLC-off gaps using fill images

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Correction in practice

A) shows an unstretched “true-color composite” The black lines are SLC-off data gaps.

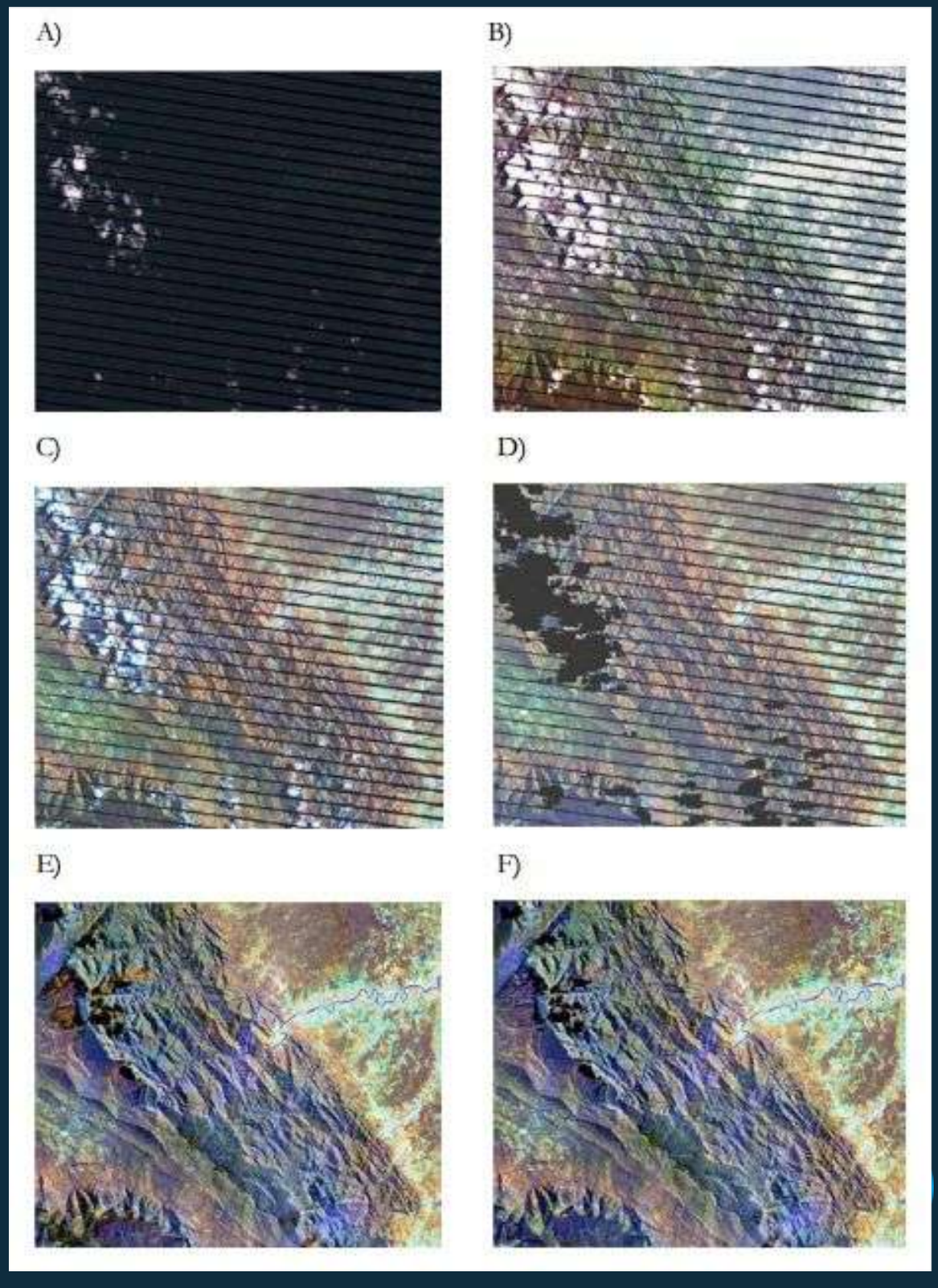
B) shows the same image, but a Gaussian stretch was applied to the data histogram.

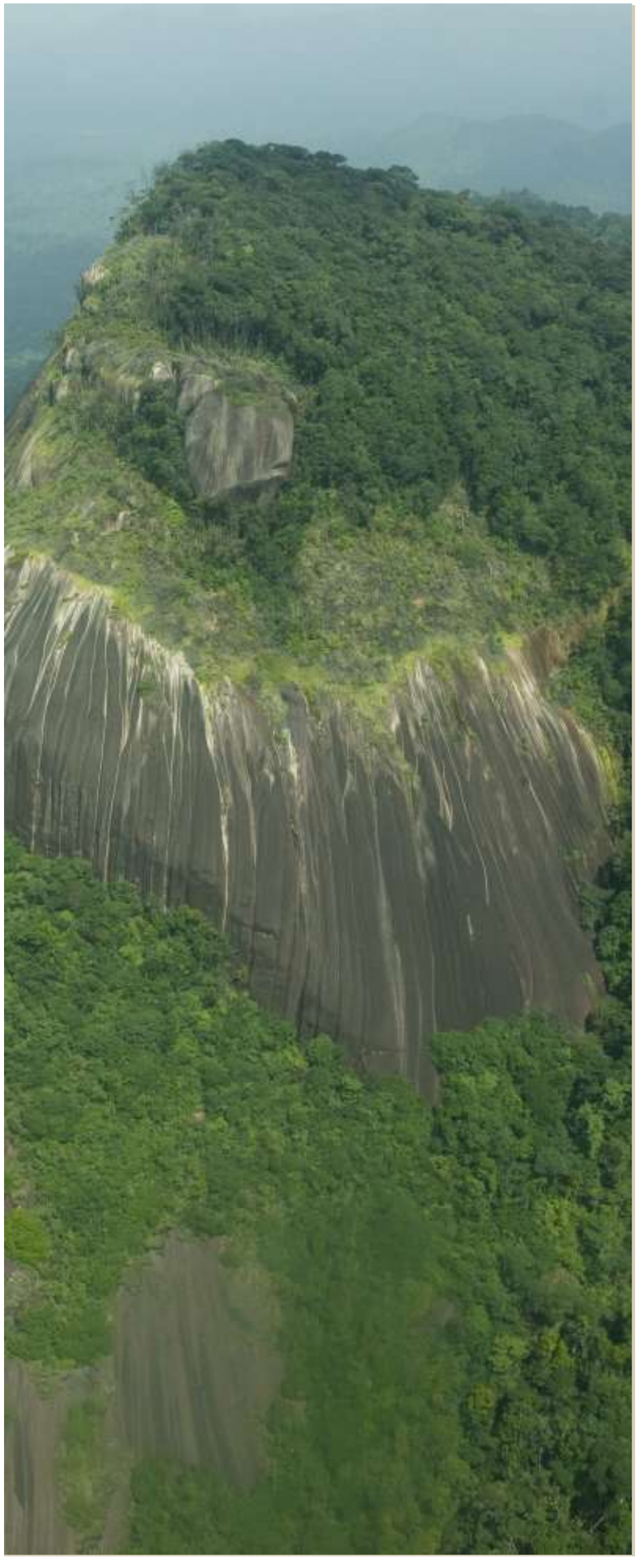
C) shows a common assignment for a “false-color composite” that allows visual exploration of the infrared data.

D) shows the same, but after atmospheric correction and a cloud / cloud-shadow mask have been applied using LEDAPS.

E) shows a mosaic of two atmospherically corrected images, but with no histogram matching between them applied; note the orange-tone artifacts that appear to the left of the remaining cloud gaps in the upper-left of the image.

F) shows the same two images combined into a mosaic image, but with histogram matching applied; note that the artifacts in E) are no longer visible.





Conclusions

- While not necessarily required for 2-date image classification, atmospheric correction is useful to enhance spectral characteristics of the imagery
- Cloud and shadow masking can save a lot of time later on when classifying images
- Gap-filling holes in the imagery to account for clouds and shadows provides much better coverage and it practically essential when working in areas of the tropics with persistent clod cover

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