The NASA Blue Marble

Spatio-Temporally Consistent Satellite Composites

Options for Enhancing the Realism of Google Maps?

Reto Stöckli (reto.stockli@gmail.com)

MeteoSwiss

Blue Marble Research, NASA/GSFC, CSU and ETH

The Original Blue Marble

Photograph taken on board Apollo 17

- 7 December 1972
- 45’000km away from earth
- 70mm Hasselblad, 80mm lens

Credits

Eugene Cernan, Ronald Evans and Jack Schmitt

Blue Marble 2000

False color satellite data visualization

- September 1997
- Satellite Sensors:
  - NOAA GOES-10
  - NOAA AVHRR
  - SeaWiFS
- 5km spatial resolution

Credits

Reto Stöckli, Alan Nelson and Fritz Hasler

Blue Marble 2002

True color satellite data visualization

- June-August 2001
- MODIS (TERRA)
- 1km spatial resolution
  - land
  - ocean
  - sea-ice
  - clouds
  - lights

Credits

Reto Stöckli, Rob Simmon and MODIS science team

Blue Marble Next Generation

Numerical satellite data processing and visualization

- 500 m global, land
- seasonal dynamics
- spatial consistency with temporal statistics
- widely applied in media, exhibitions, education ...
- freely available

Credits:

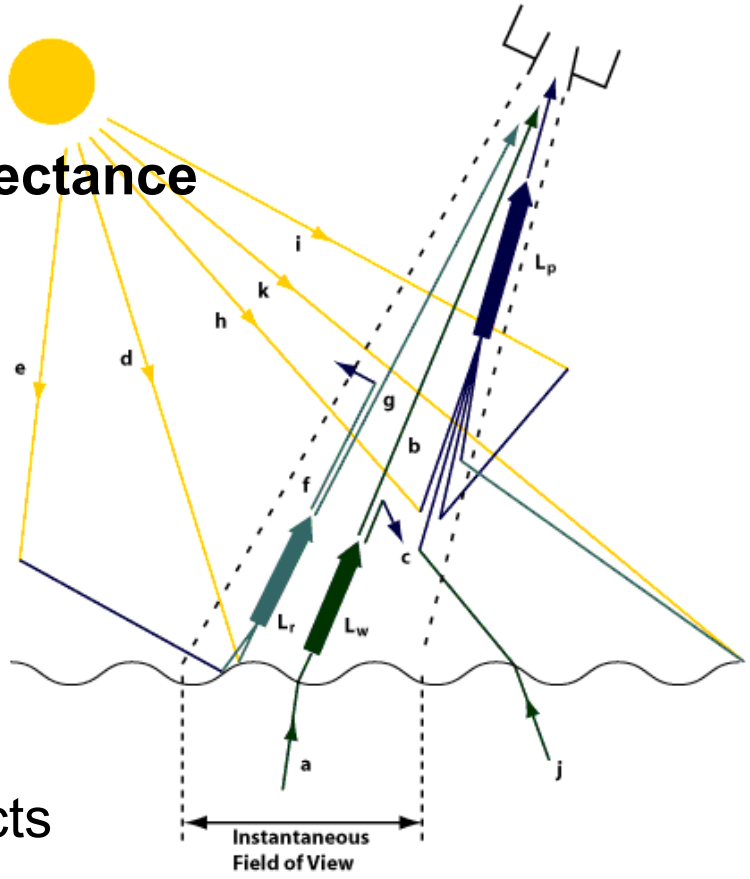
Reto Stöckli, Rob Simmon, Eric Vermote, MODIS Science Team

Scene Processing

Achieve cloud-free surface reflectance

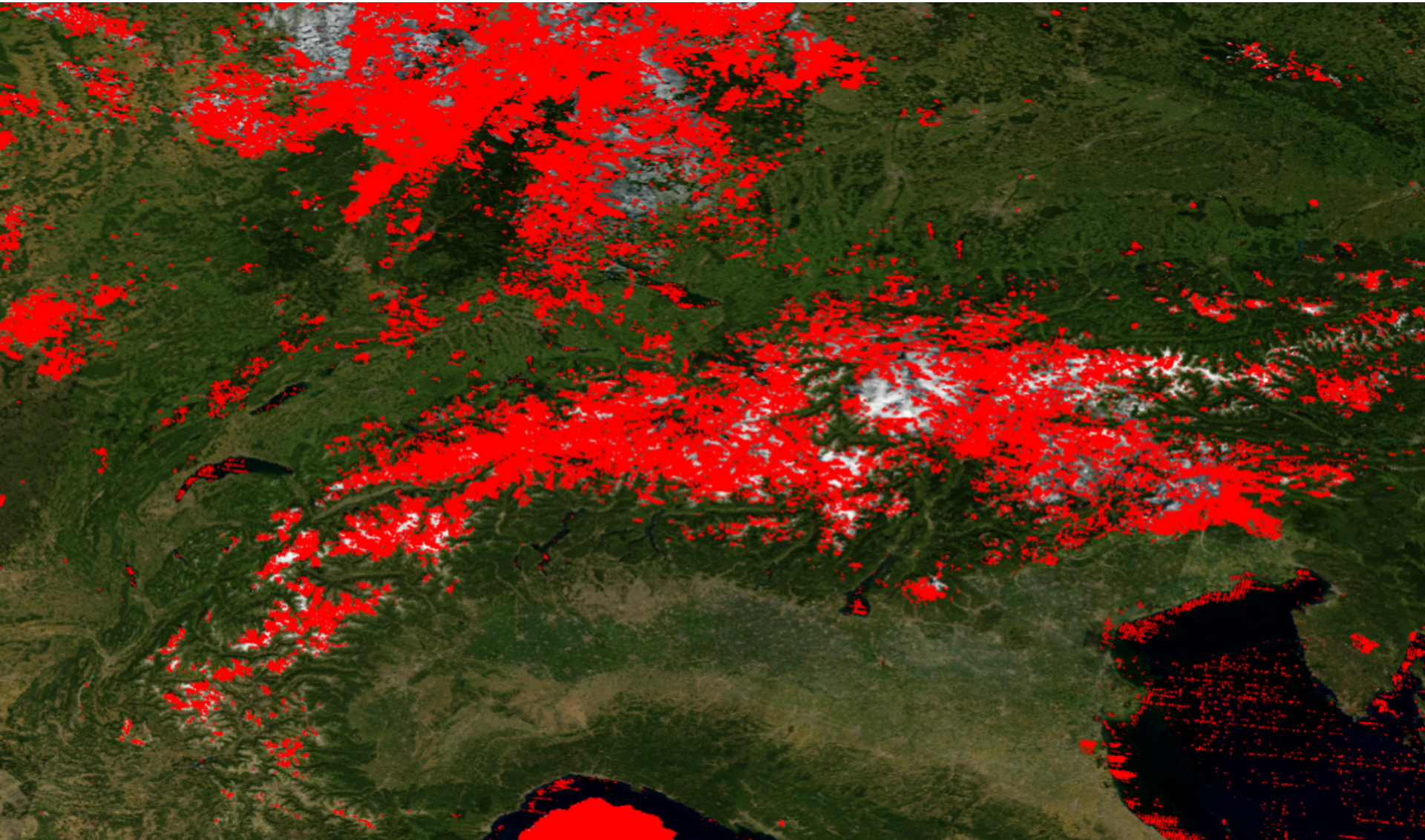
Mandatory for each scene:

- registration & navigation
- removal of artifacts
- orthorectification
- radiance (inter-) calibration
- cloud masking
- spectral conversion
- correction of atmospheric effects

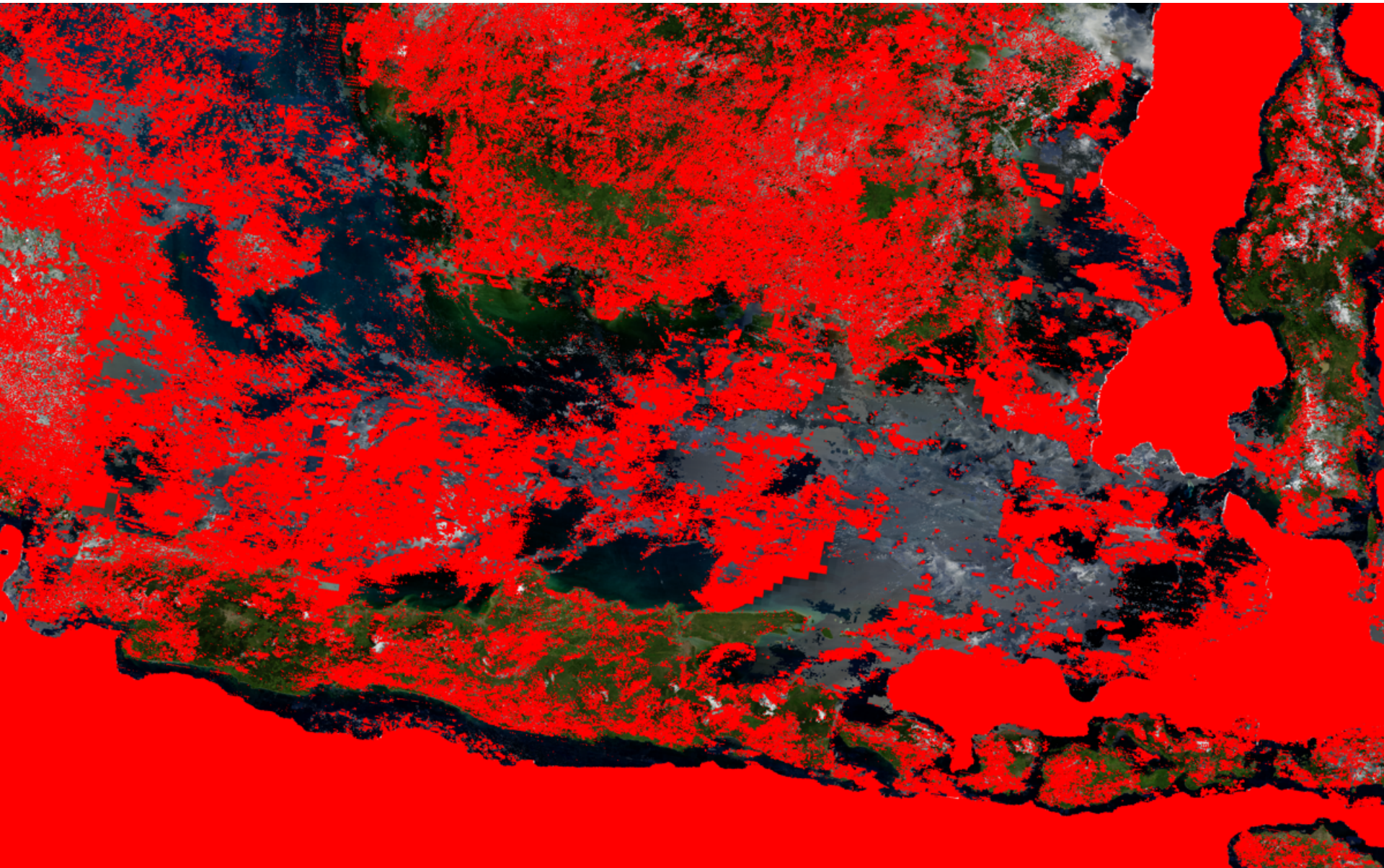


- **applicable to Google Maps (incl. Landsat and Ikonos)**
- computationally expensive, mature algorithms available
- requires Image metadata and physical retrieval models

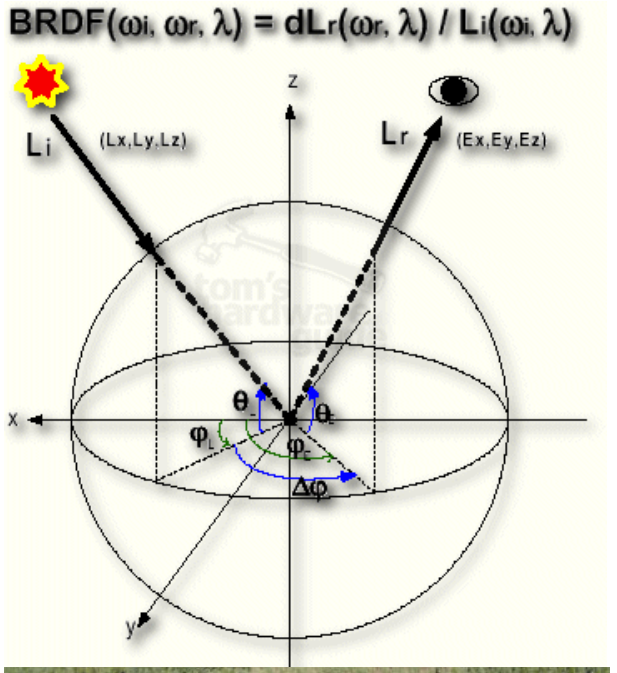
Screening & Correction of Atmospheric Effects and Cloudiness



Tropics ... where is the clear sky?



Scene Compositing



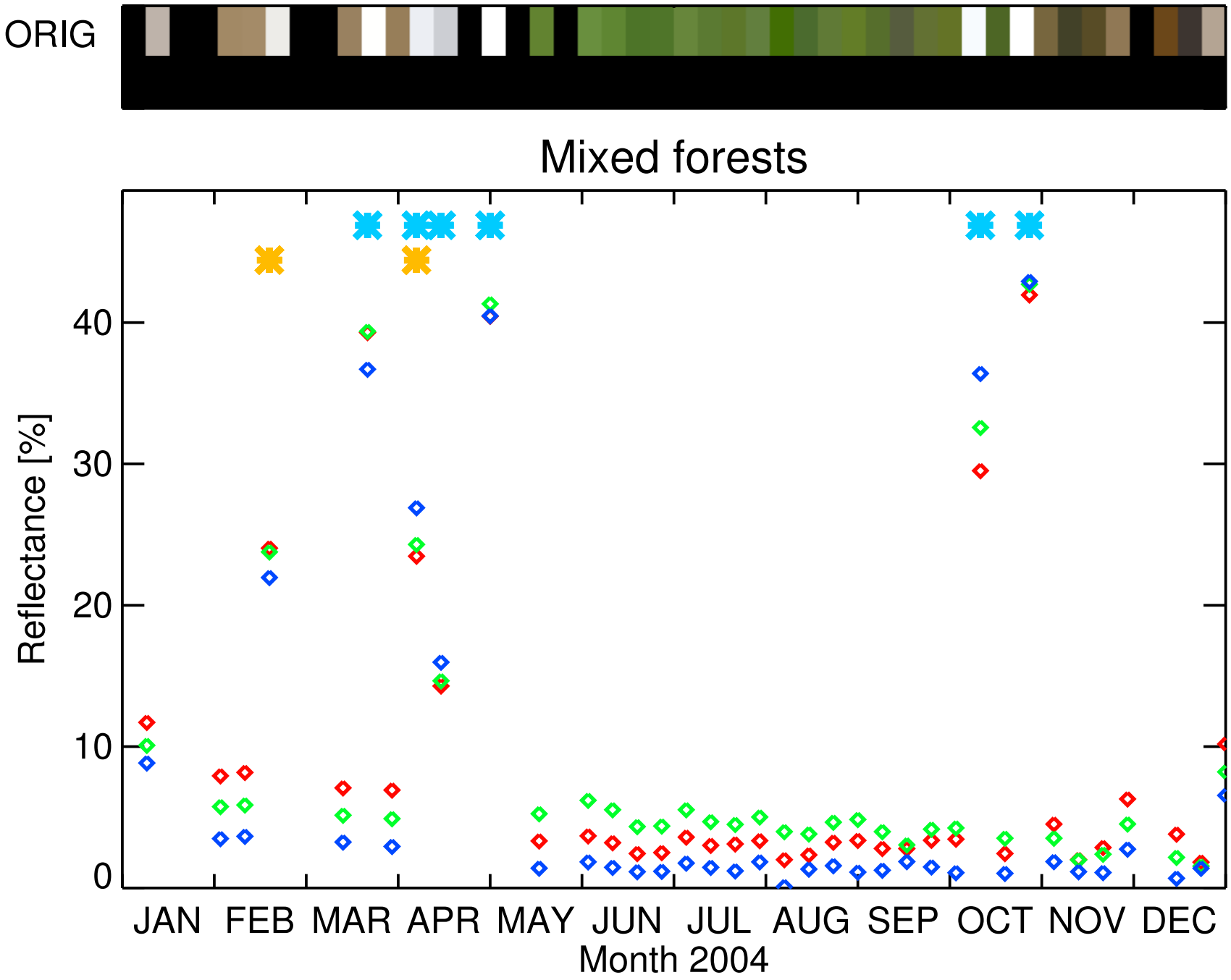
Achieve spatial consistency

- remove surface BRDF effects
- seasonal dynamics of vegetation
- remove gaps by temporal compositing

Possible solutions (model inversion)

- fit 2nd and 3rd order fourier series
- bayesian data assimilation
- multi-sensor parameter estimation

- **maybe applicable to Google Maps**
- requires “high” temporal coverage (Landsat? EO-1?)
- development of new algorithms, scientific innovation!


ORIG
Mixed forests
Reflectance [%]
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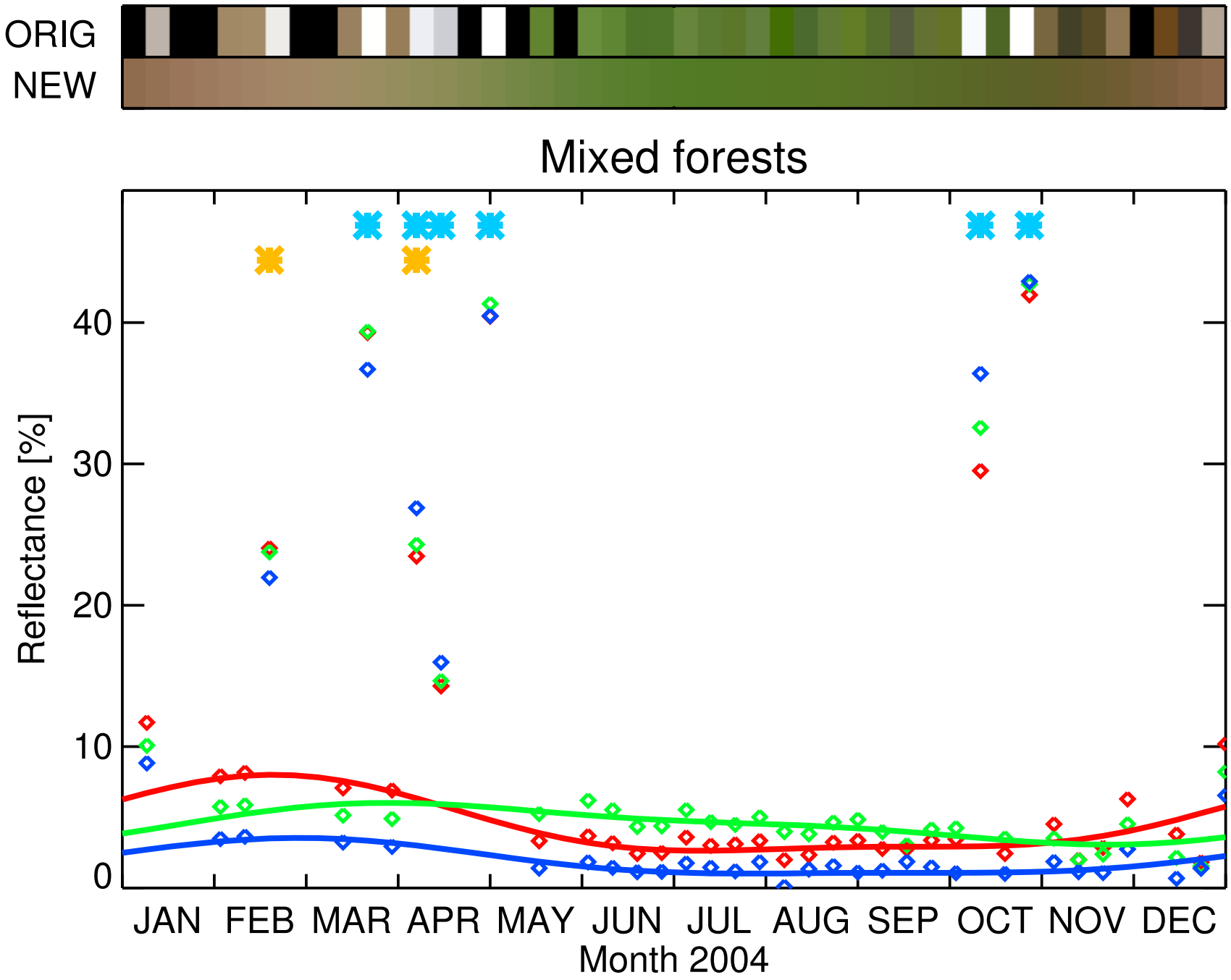
Month 2004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Mixed forests
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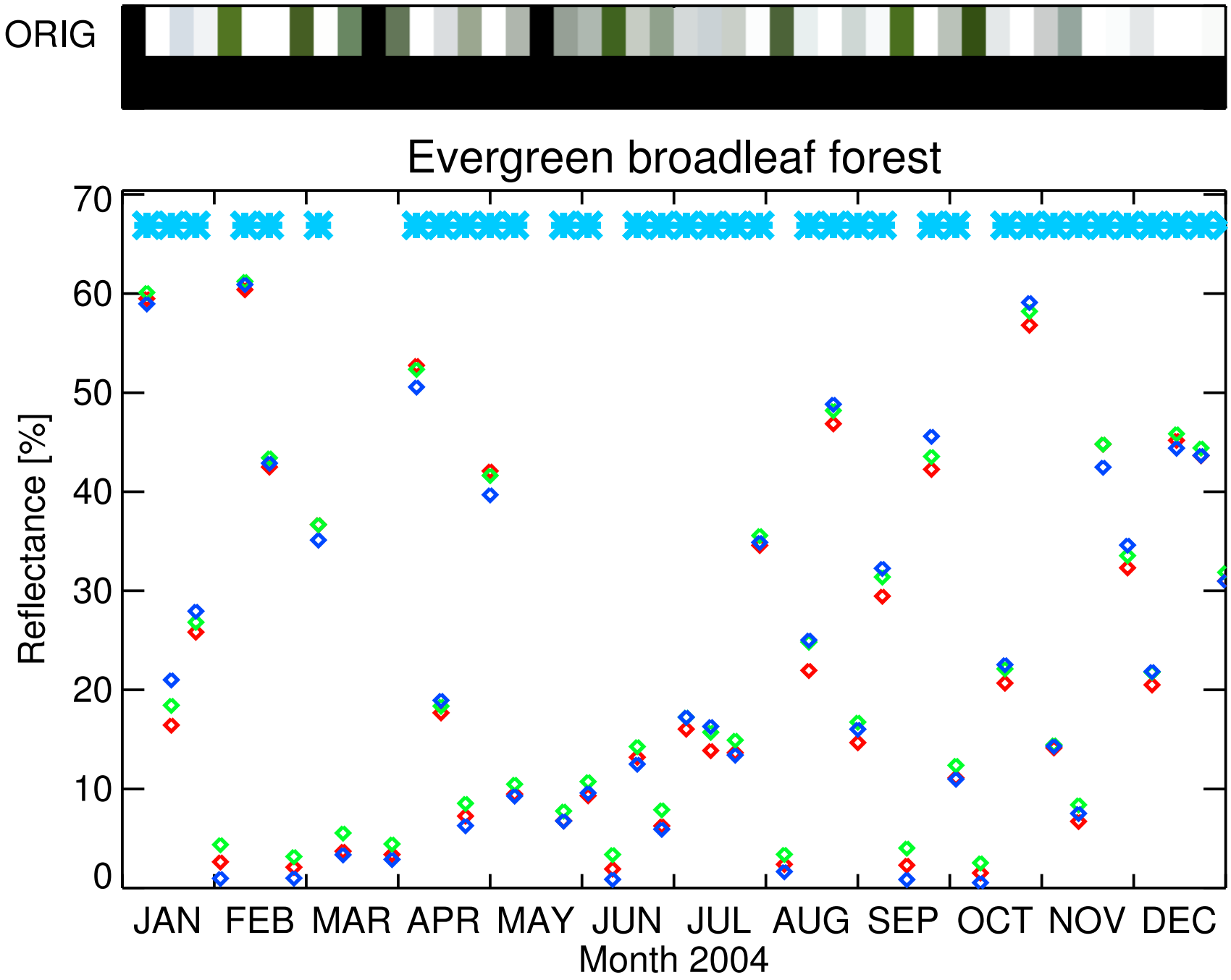
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Evergreen broadleaf forest
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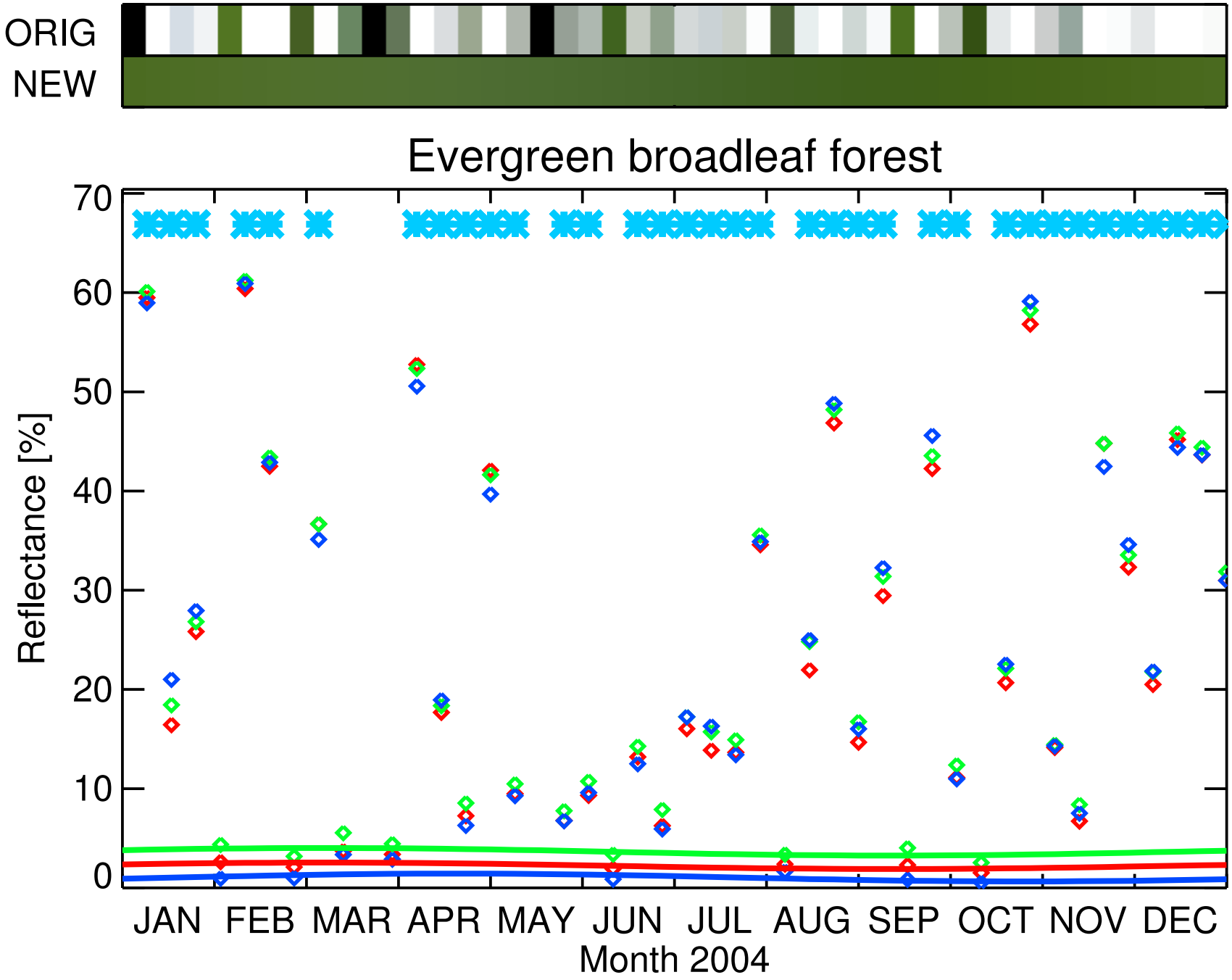
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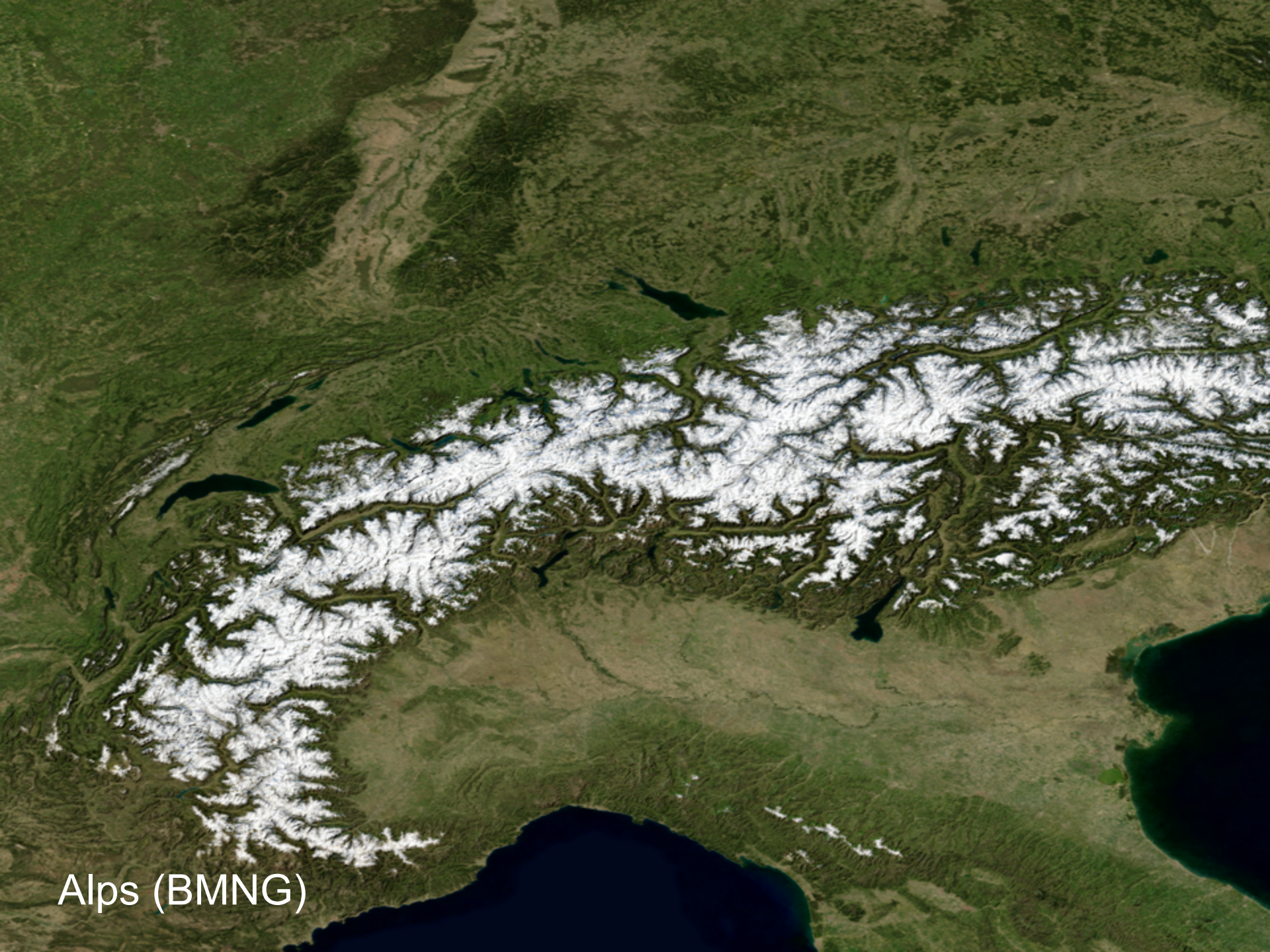
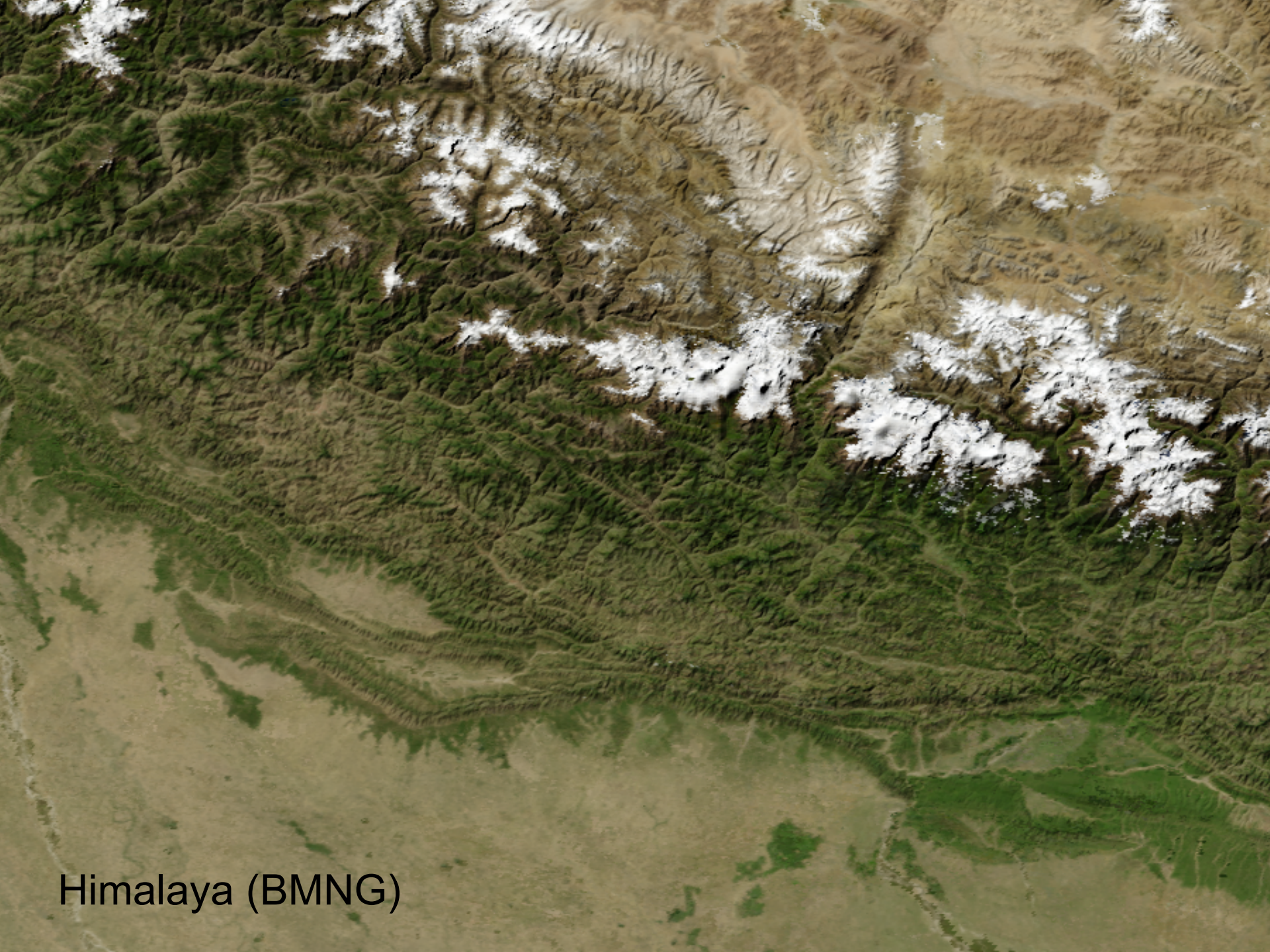
Mt Kenya
Nairobi

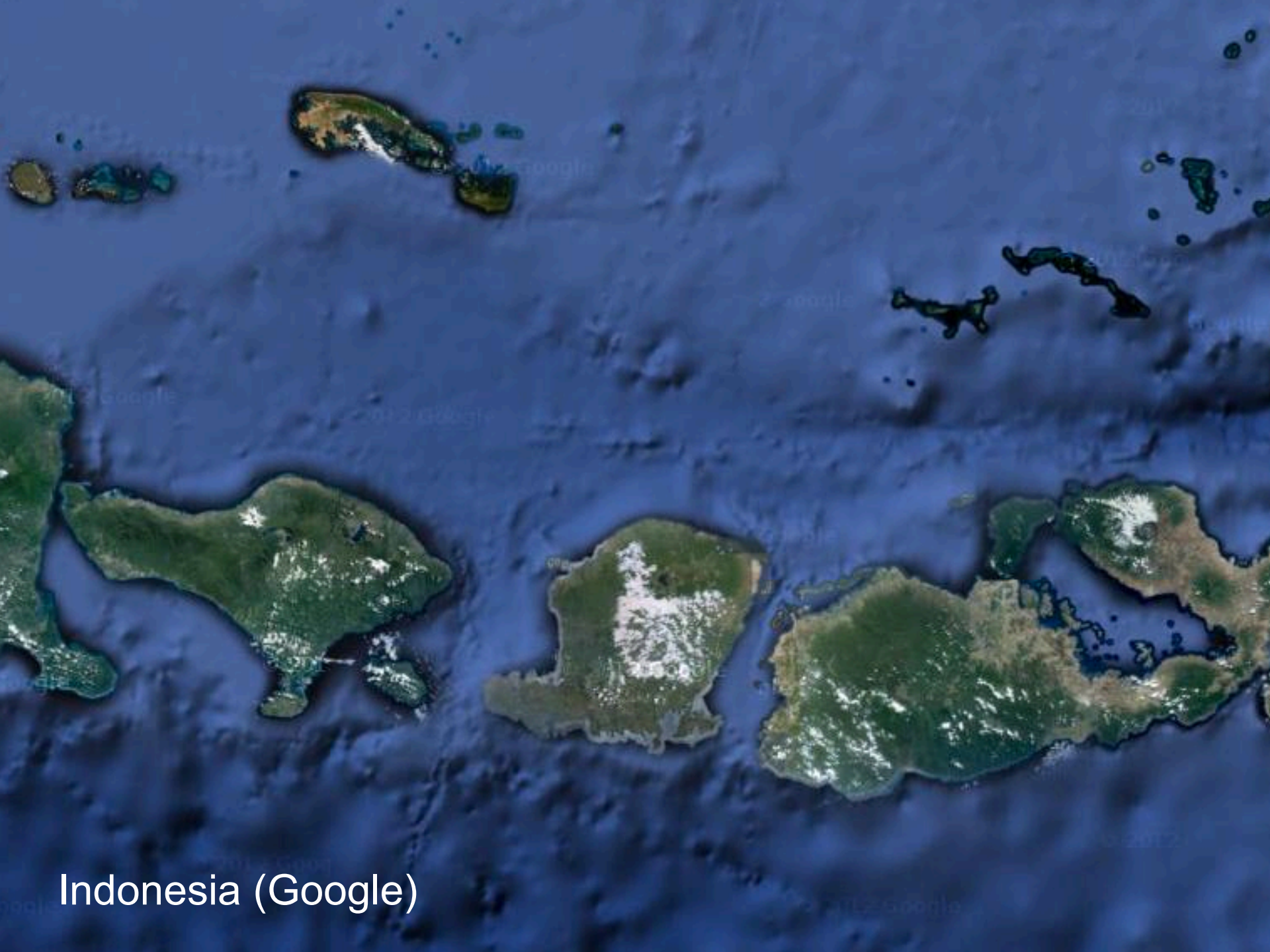

Alps (BMNG)


Alps (Google)

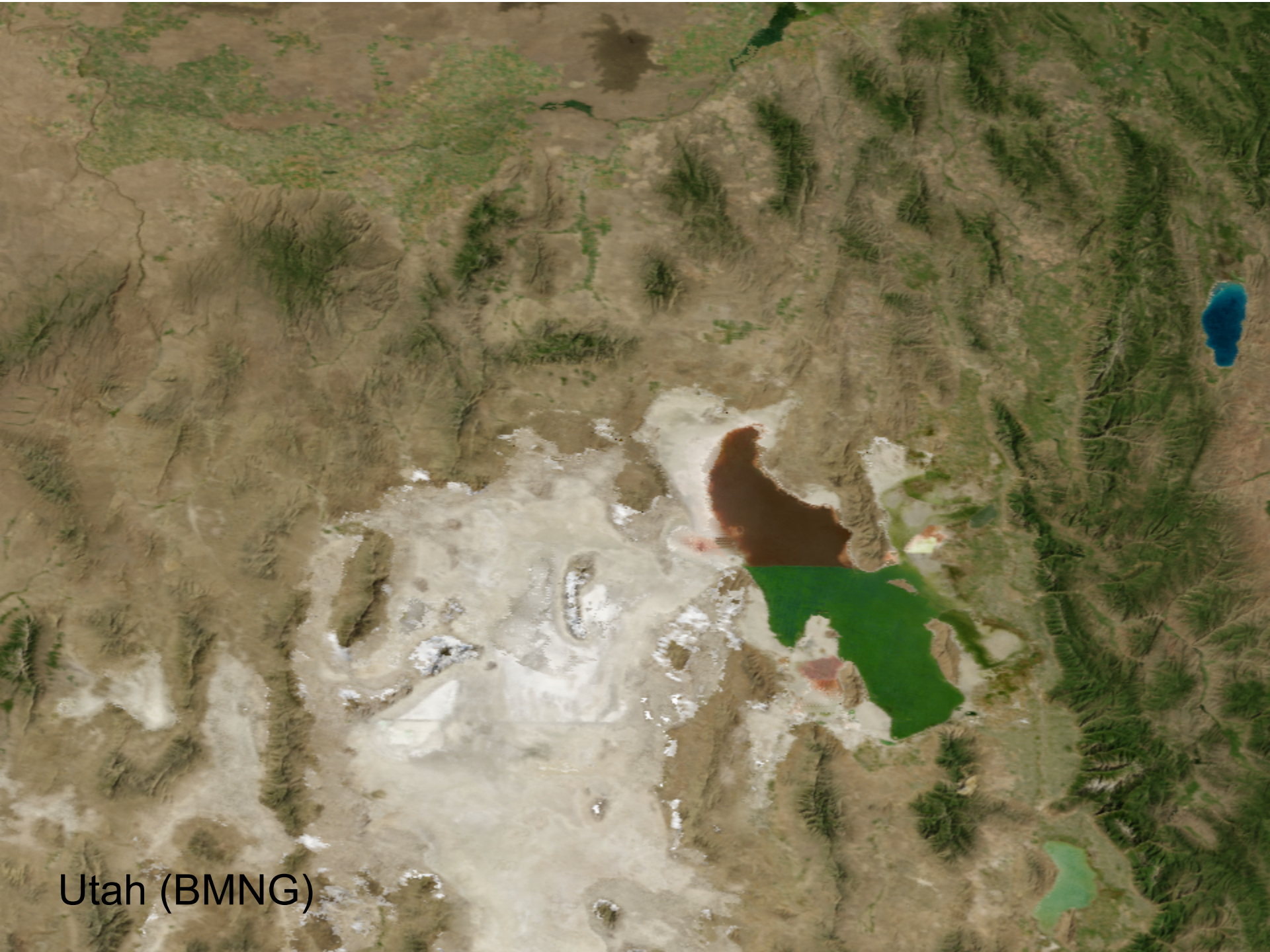

Himalaya (BMNG)

Himalaya (Google)

Indonesia (BMNG)



Indonesia (Google)


Utah (BMNG)

Utah (Google)