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The new era of SAR time series: Tackling big EO data analysis and visualization with Pangeo tools

Josef Kellndorfer, Ph.D.
EARTH BIG DATA LLC

PANGEO SHOWCASE Seminar Series
May 12th 2021

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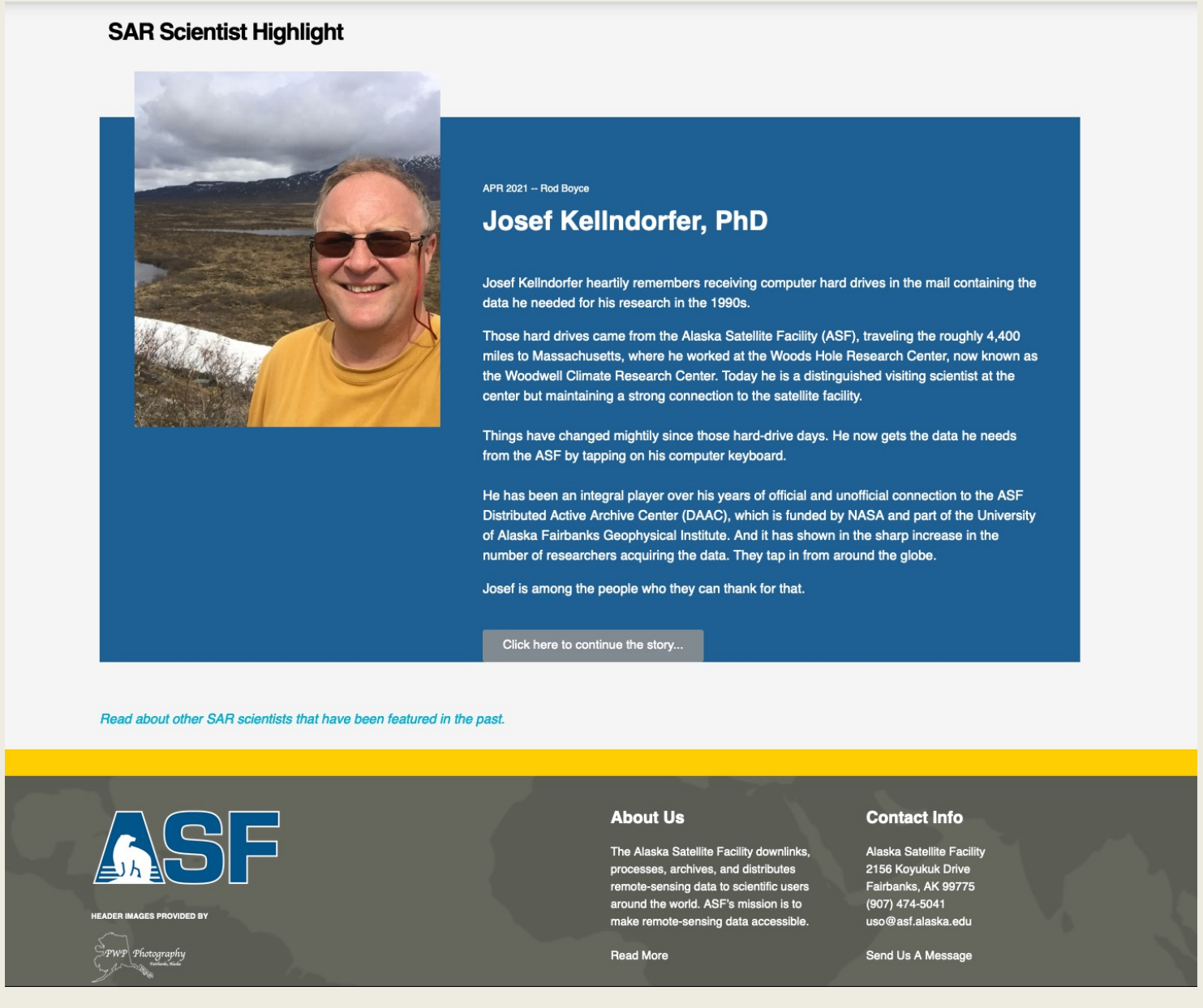
Background



Currently featured at the NASA SAR DAAC at the Alaska Satellite Facility

https://asf.alaska.edu

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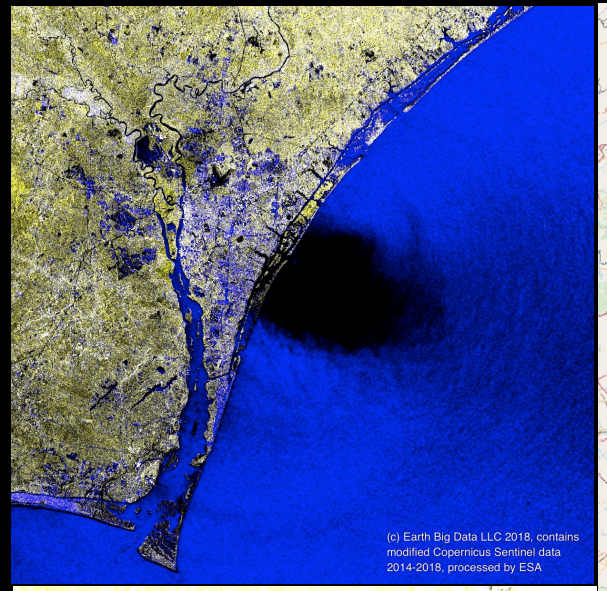
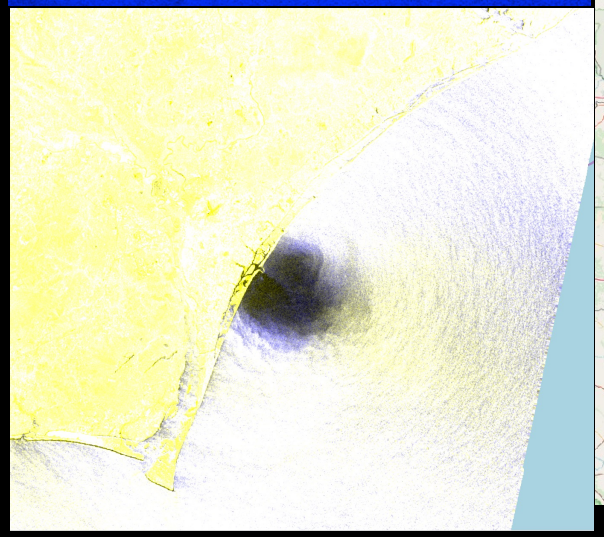
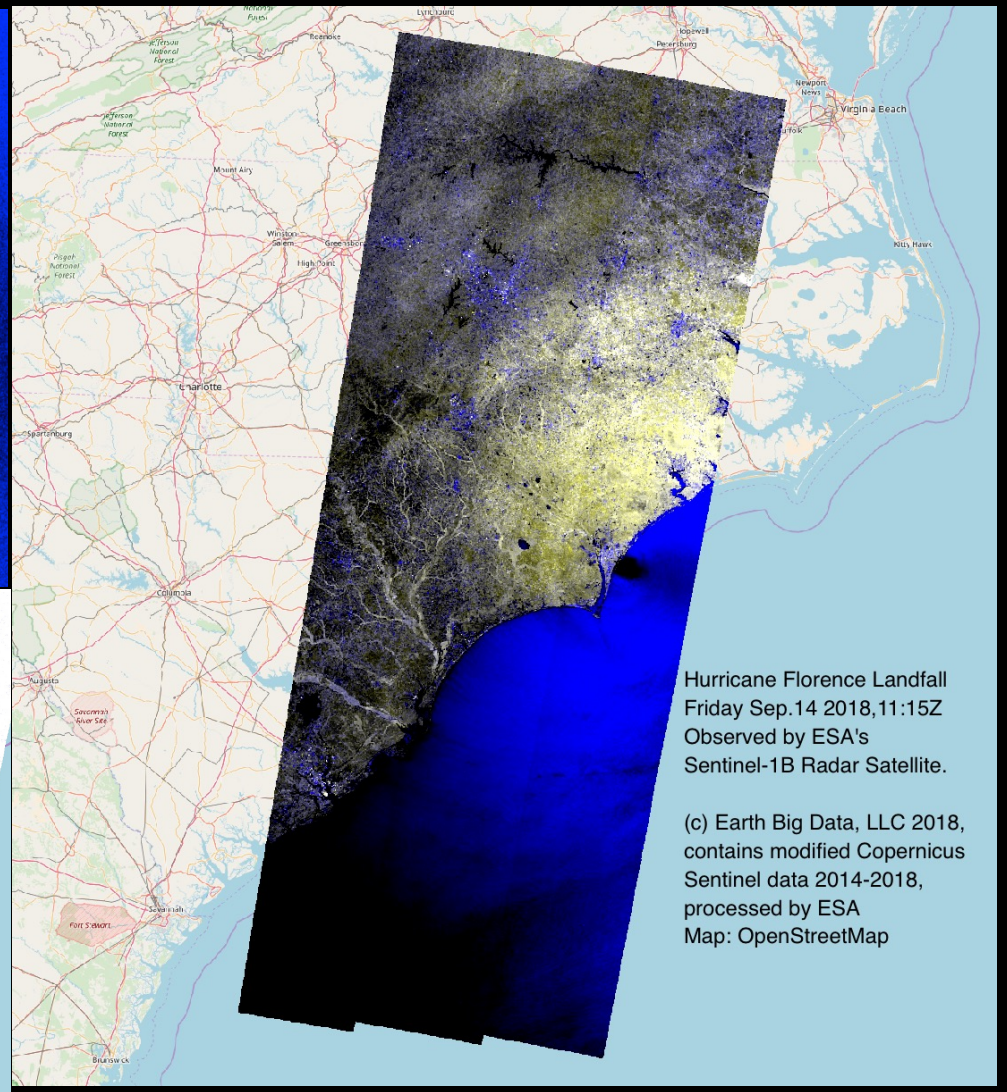
What makes SAR remote sensing so exciting?

- All-weather mapping of the planet (microwaves penetrate clouds)
- All-season monitoring (e.g., ice dynamics in Arctic and Antarctic winters)
- Fully coherent, active remote sensing technology:
  - Measurement of phase and magnitude of a signal -> interferometry, coherence, backscatter metrics
  - Can be accurately calibrated over space and time
- Consistency of measurements:
  - Signal changes relate to changes of the target, with same illumination geometry
  - Simplified: Changes in the signal are changes in **structure** or **moisture (dielectric)**
- **Invaluable tool for monitoring Earth. With applications in science, natural resource management, and policy decisions at local and global scale.**

Hurricane
Florence
Landfall
Sep 14th 2018







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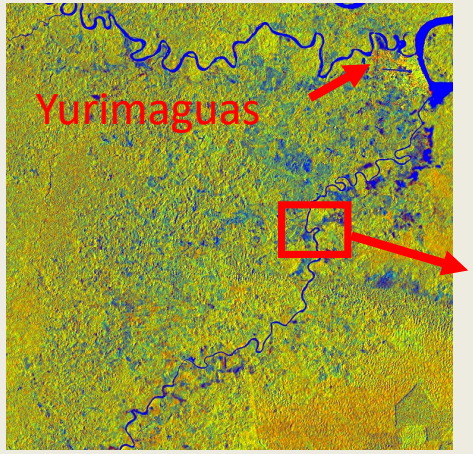
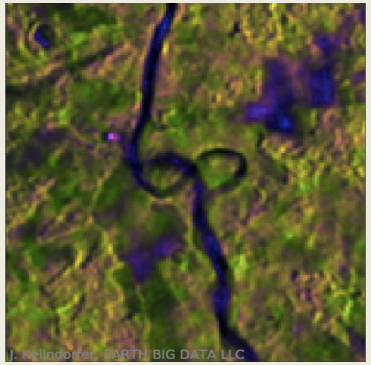
Birth of an Oxbow Lake in Yurimaguas, Peru, observed by Sentinel-1 (C-band)



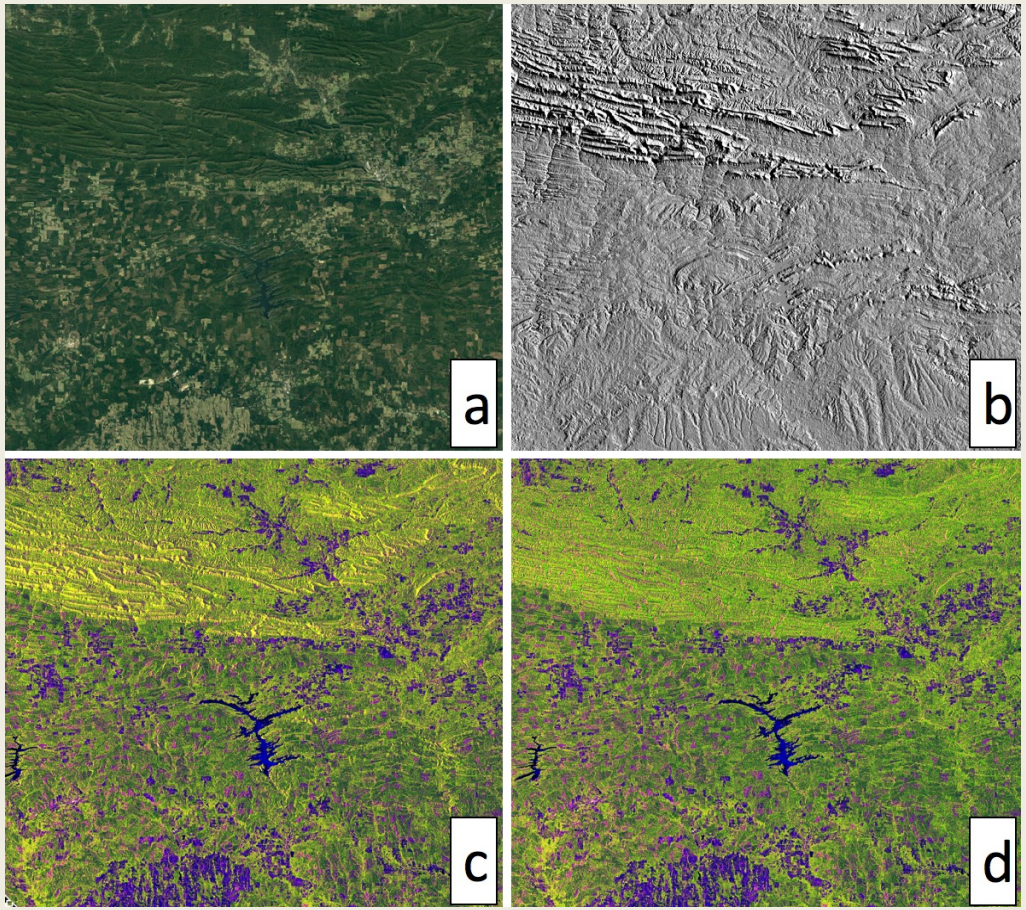
2017-01-09

2019-10-02



SAR Radiometric Terrain Correction and Time Series Generation

a) Optical
b) DEM
c) Sigma0
d) Gamma0 RTC



- Key to viable time series production:
  - Excellent geometric accuracy (processing with precision orbits and high quality DEMs) Follow the real estate principle: 'Location, location, location'!
  - Excellent radiometric calibration (noise floor subtraction, scattering area-based pixel calibration, incidence angle dependency accounting
- EBD has developed fully automated cloud-scalable processing chains addressing these criteria for all major Spaceborne and airborne SAR sensors

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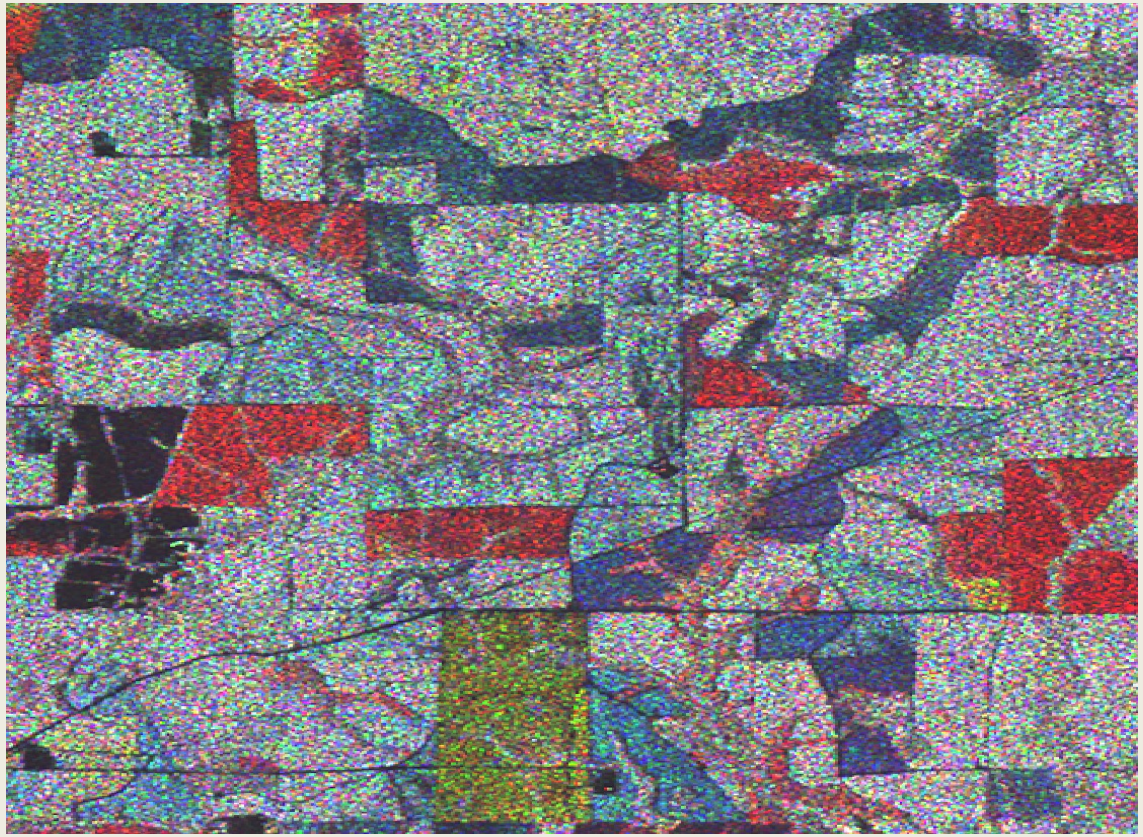
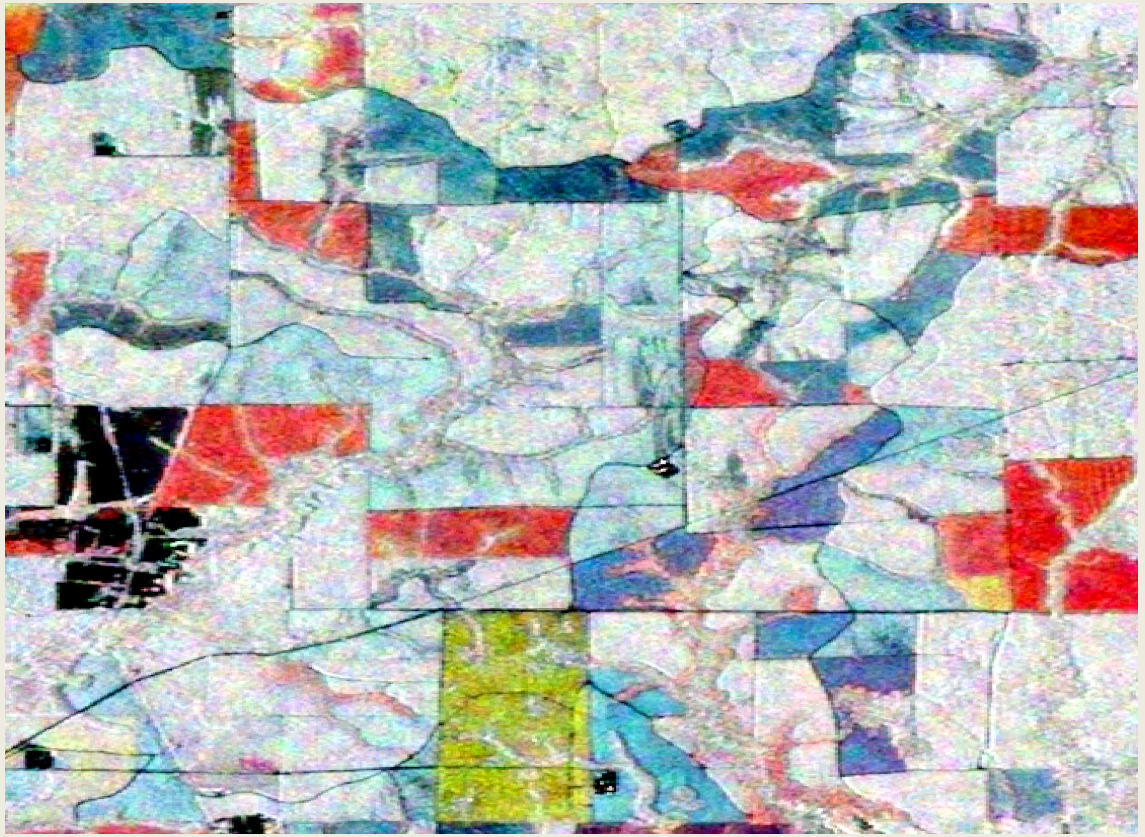
SAR Signal Enhancement: Multi-temporal Speckle Noise Filter

Before Filter Application



After Filter Application



J. Kellndorfer, 11/2015

ALOS-1 L-band HV RGB: 2007-07-03 2009-07-08 2010-07-11

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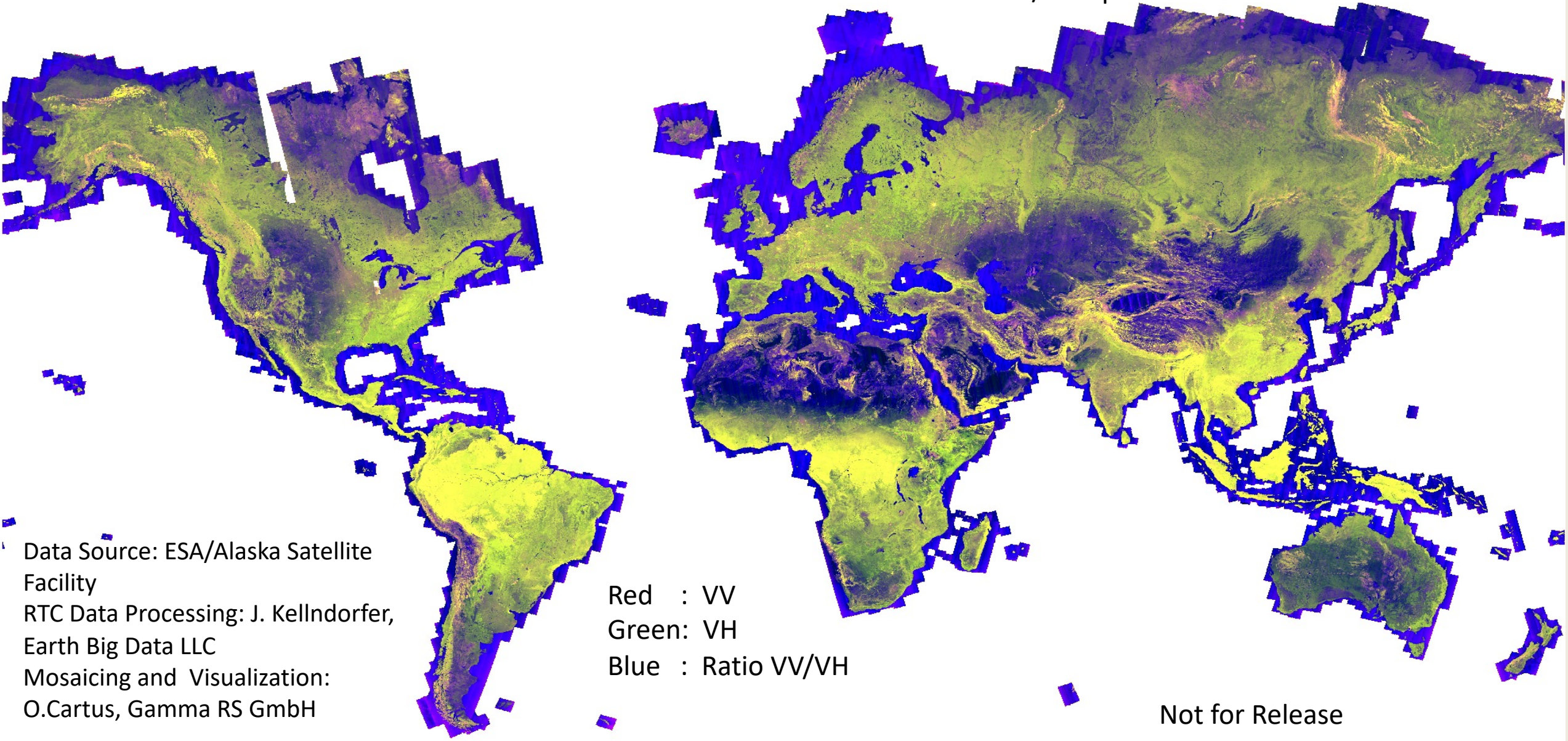
2017 Sentinel-1 Backscatter of Earth

Median backscatter in 2017 time series of all Sentinel-1 A/B acquisitions



Data Source: ESA/Alaska Satellite Facility
RTC Data Processing: J. Kellndorfer, Earth Big Data LLC
Mosaicing and Visualization: O.Cartus, Gamma RS GmbH

Red : VV
Green: VH
Blue : Ratio VV/VH

Not for Release

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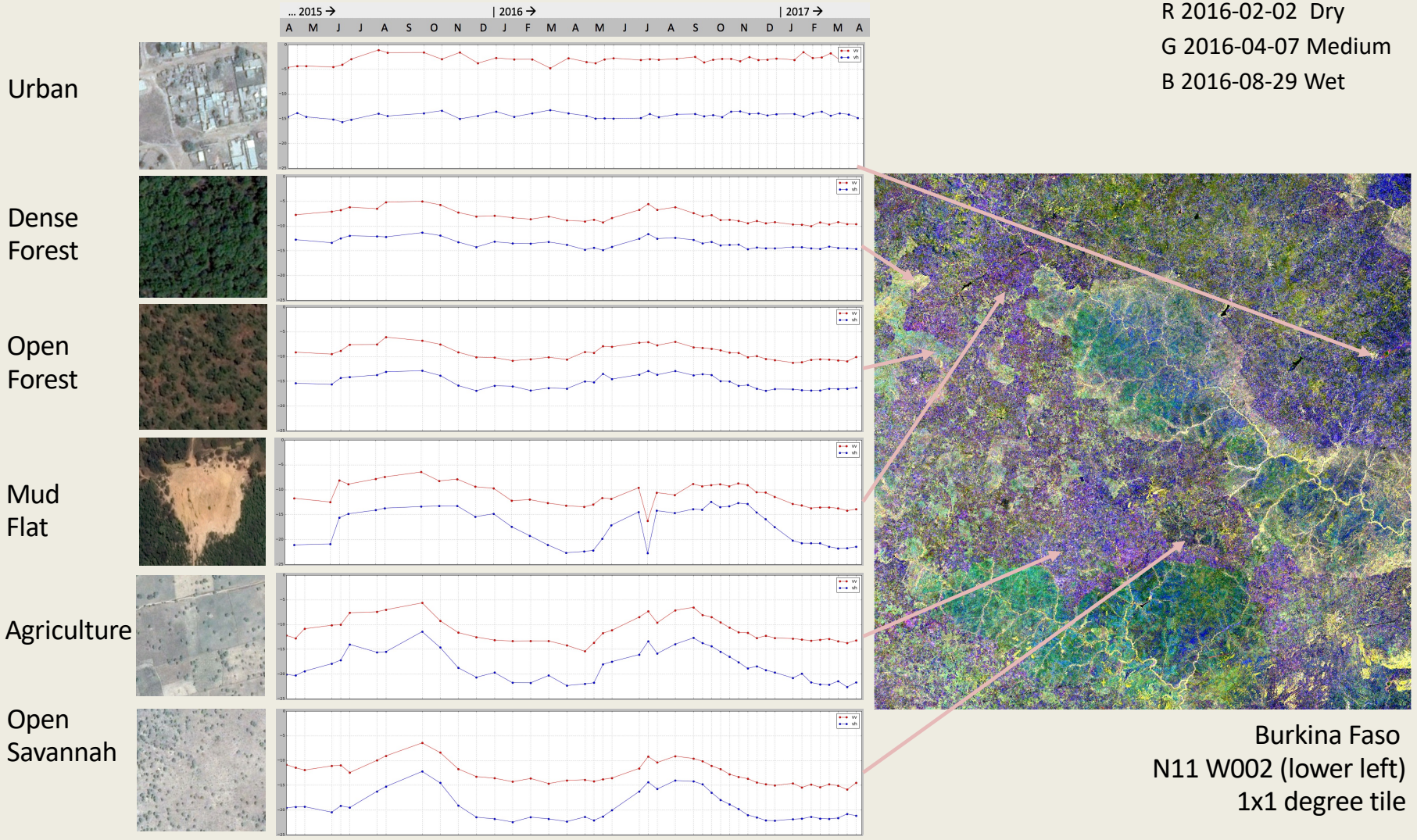
Sentinel-1 Time Series in Arid Environments

Multi-temporal composite
R 2016-02-02 Dry
G 2016-04-07 Medium
B 2016-08-29 Wet



Burkina Faso
N11 W002 (lower left)
1x1 degree tile

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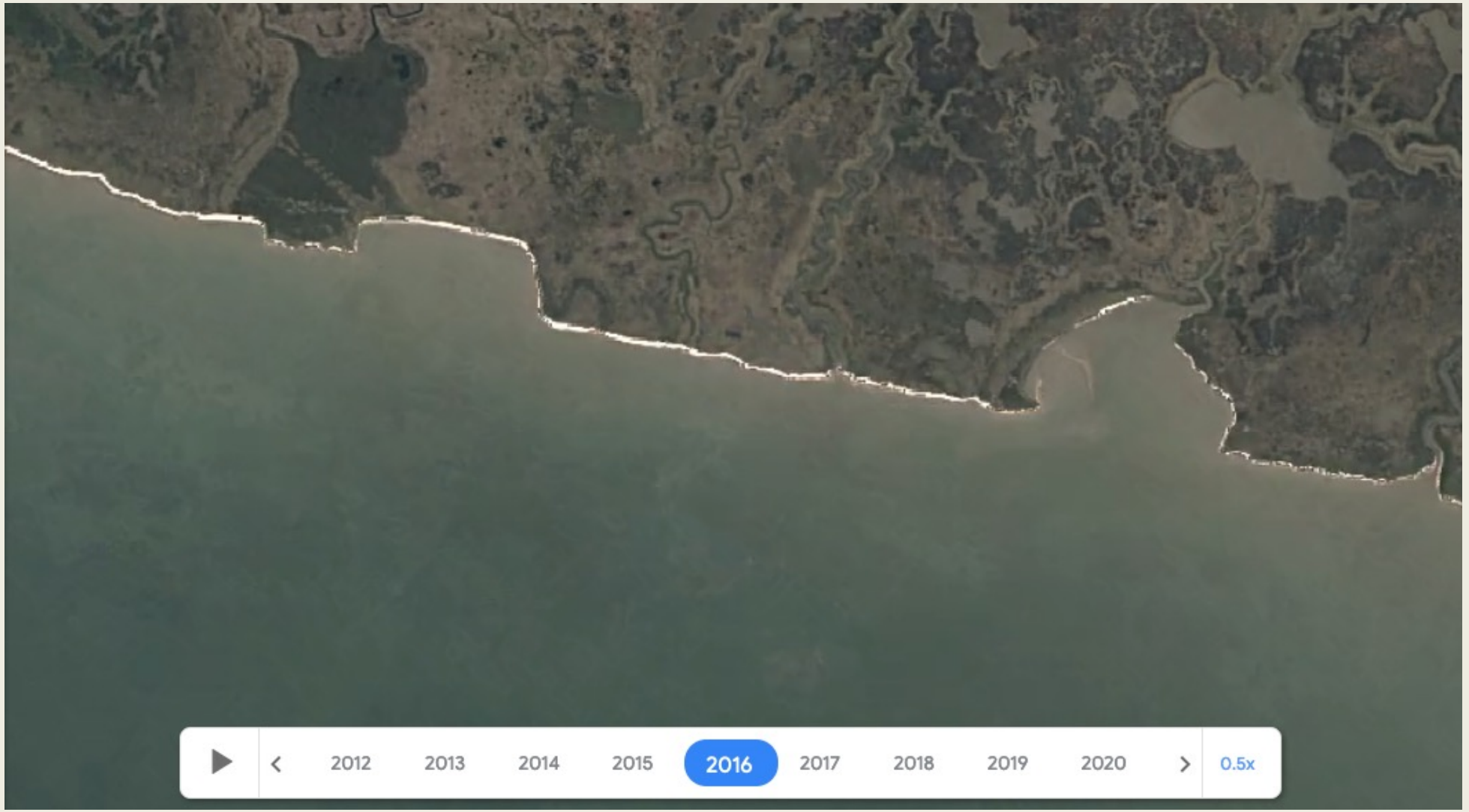
Gulf Coast Erosion



Source: https://earthengine.google.com/timelapse/

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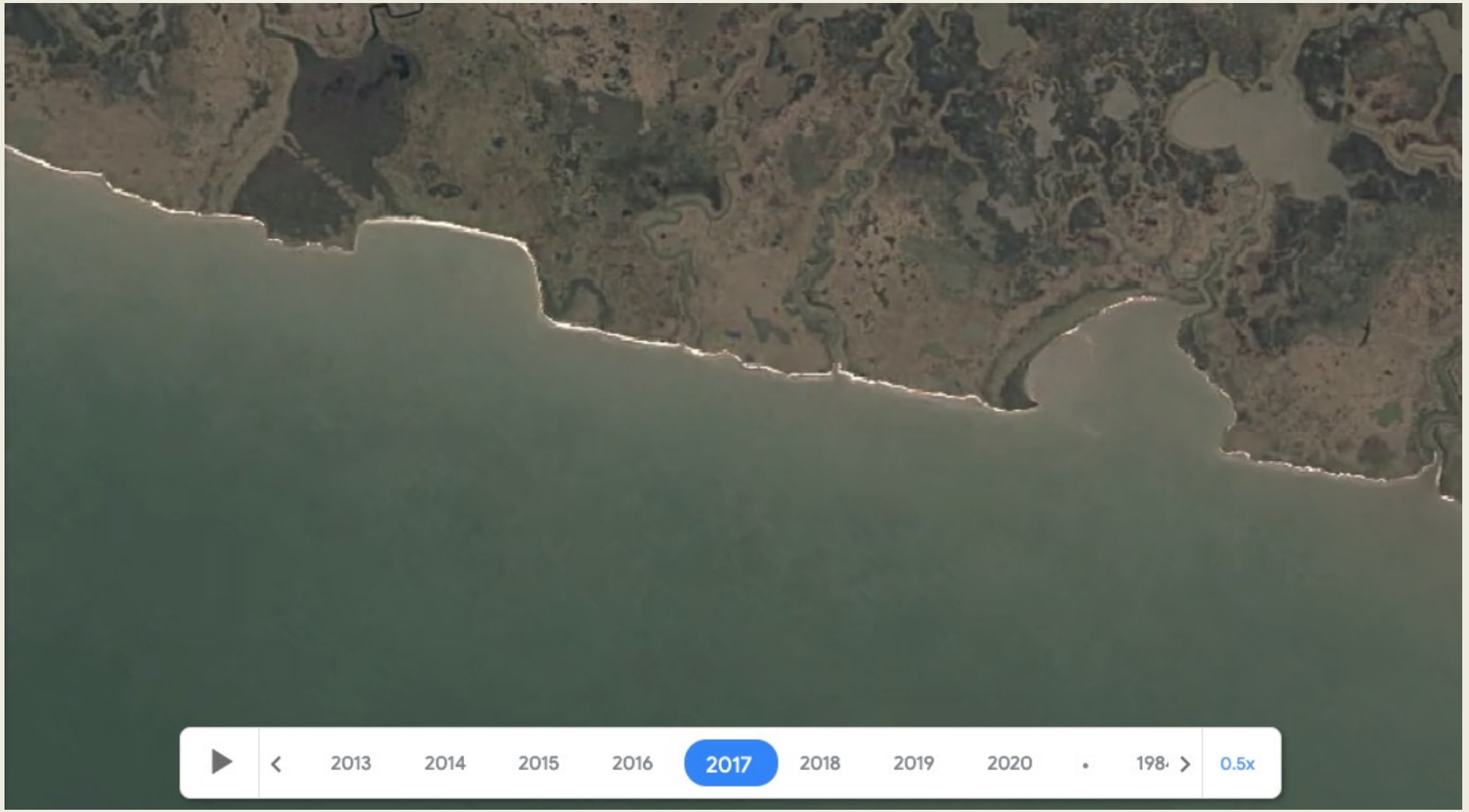

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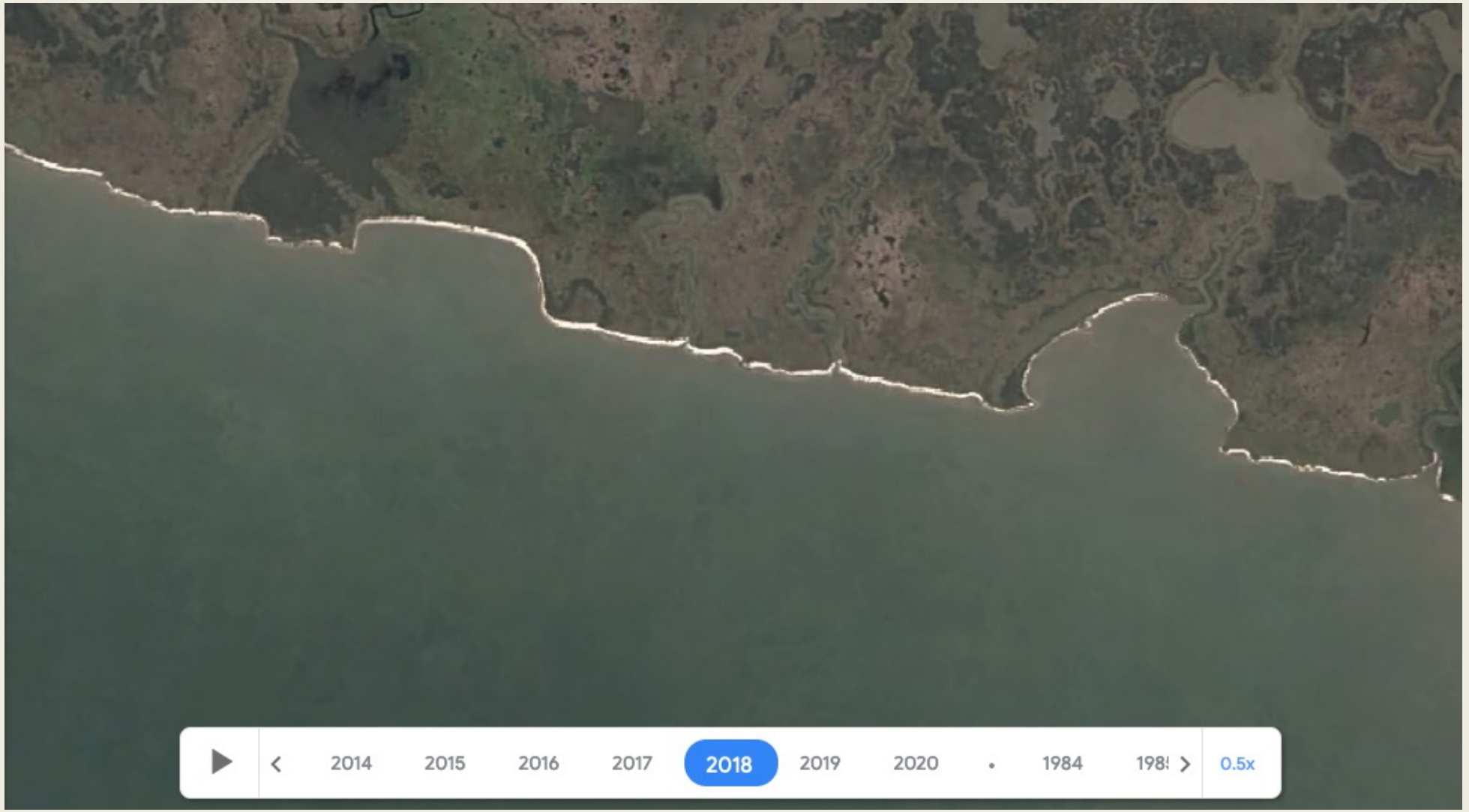

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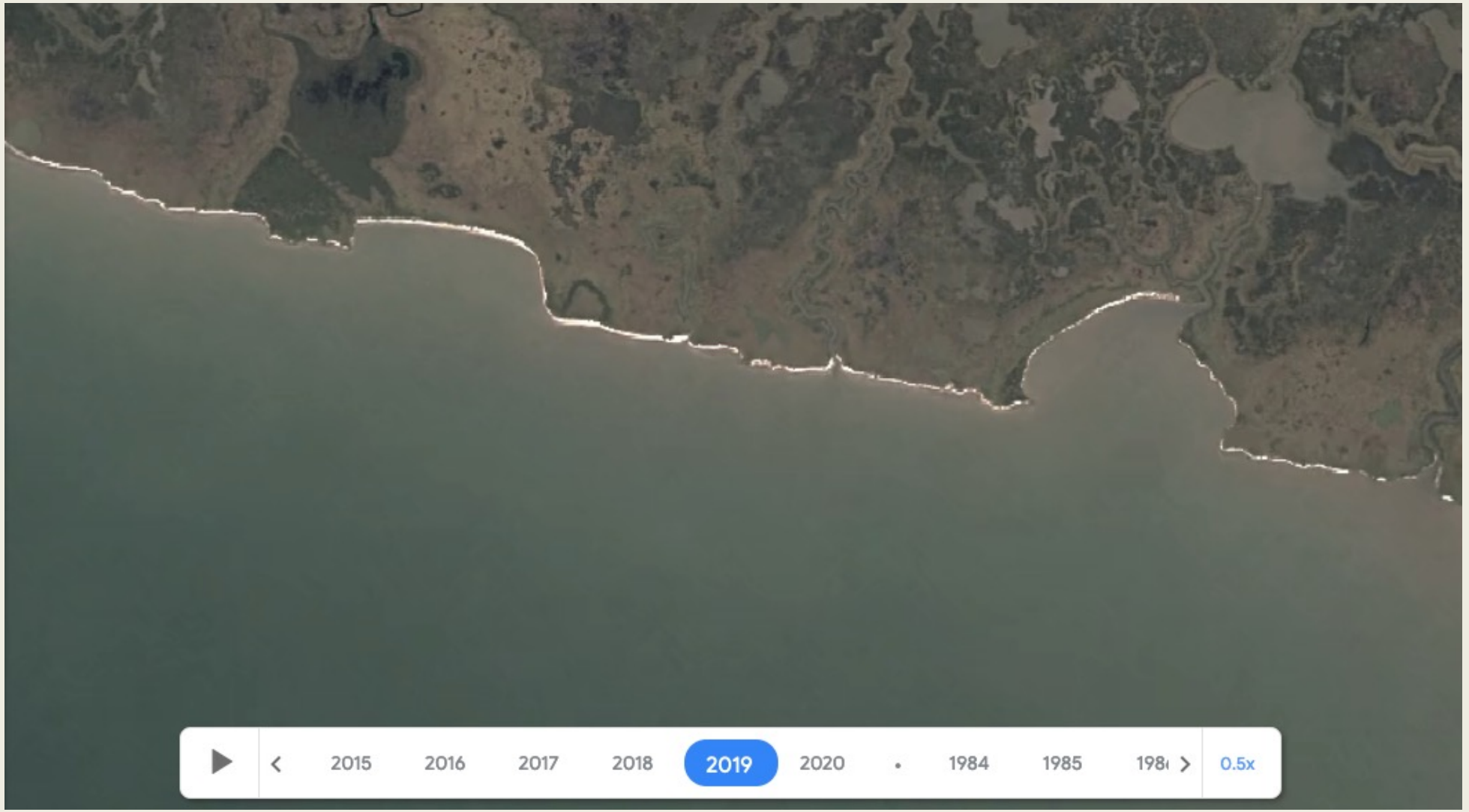

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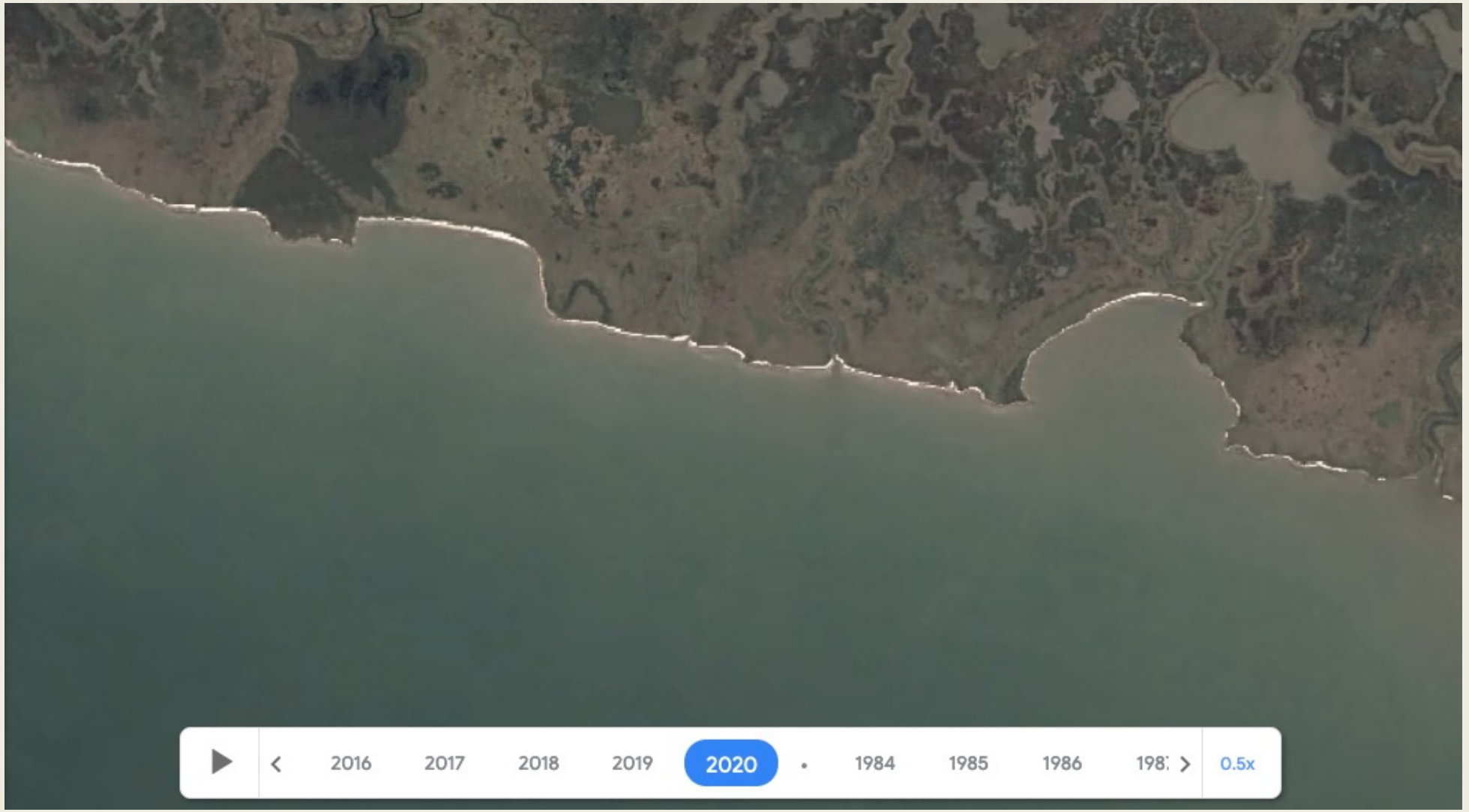

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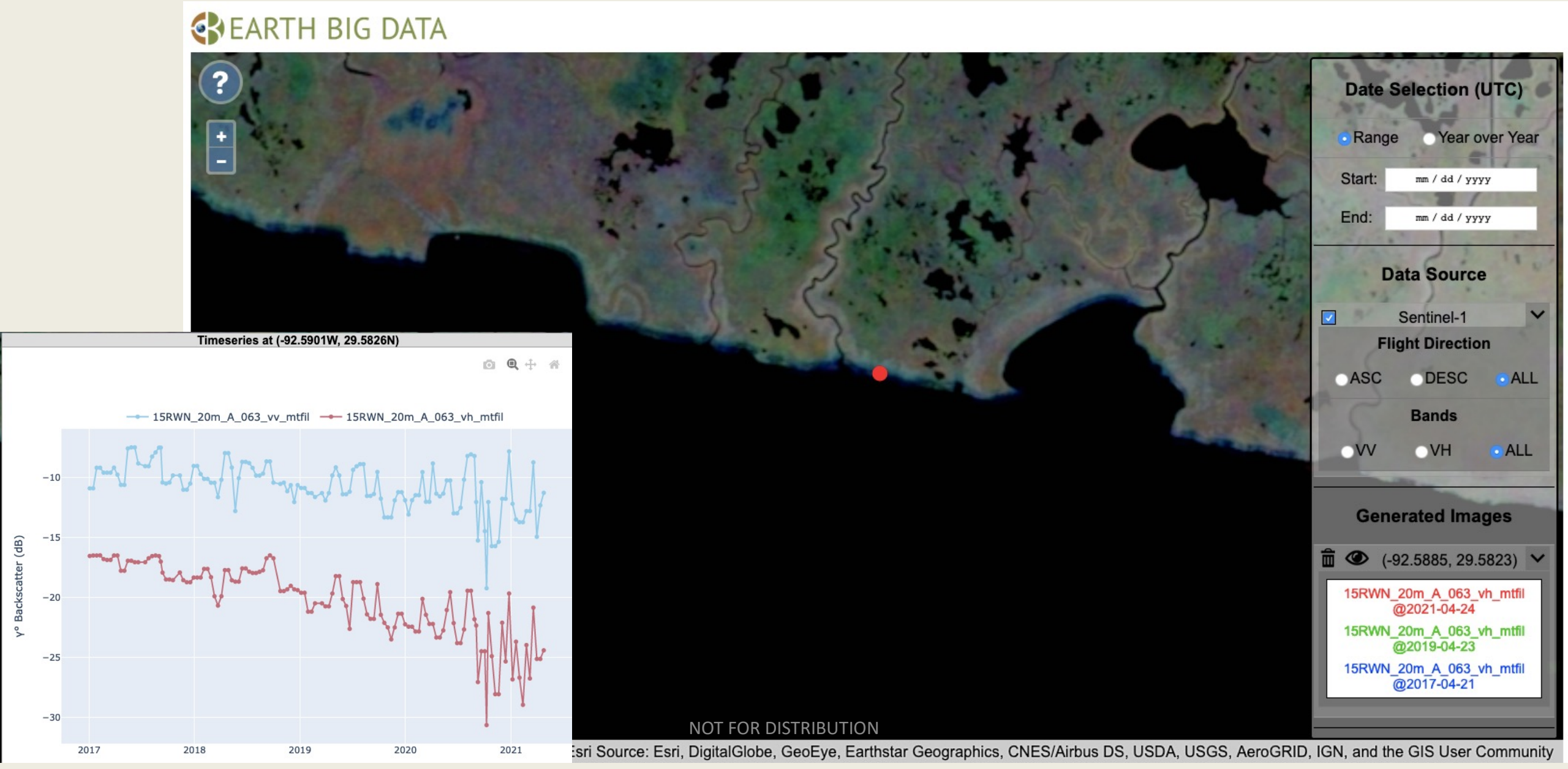
Sentinel-1 Observations



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Our Challenge

- SAR data availability is exploding (thanks to open data policies)
  - Sentinel-1 since 2014 with 6 to 12 day repeat coveage of the planet (delivers about 1.5 Pbyte/year or 4 TB/day in single look complex SAR format)
  - NISAR mission (launch 2022/2023) slated to deliver 100TB/day of science data
- Need cloud-based strategies for raw SAR data processing into Analysis Ready Data (ARD) streams
- Need visualization and analytic tools to reduce the high-spatio-temporal resolution data streams into meaningful presentation online and offline

-> Harness the excellent suite of open source tools developed by PANGEO, Qhub, and friends.

Further Reading

https://servirglobal.net/Global/Articles/Article/2674/sar-handbook-comprehensive-methodologies-for-forest-monitoring-and-biomass-estimation

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SAR Handbook: Comprehensive Methodologies for Forest Monitoring and Biomass Estimation

Published: Apr 09 2019

The SAR Handbook: Comprehensive Methodologies for Forest Monitoring and Biomass Estimation is the culmination of a two-year collaboration between NASA SERVIR and SilvaCarbon. Five trainings, led by six SAR subject matter experts, were held at hubs throughout the SERVIR network. The topics of these trainings included SAR basics, SAR for forest change detection, forest height estimation, biomass estimation, mangrove monitoring, and sampling design. Each of these training topics are covered in a SAR Handbook chapter, which includes the theoretical basics and applied exercises. You can download the entire SAR Handbook (PDF) below, or explore individual chapters, trainings and one-pagers.

Click the image above to download the entire SAR Handbook.

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Contact Info

Headquarters

Josef Kellndorfer
President

EARTH BIG DATA, LLC
P.O. Box 114
Woods Hole, MA 02543
p: +1-508-444-0885
e: josef@earthbigdata.com
w: https://earthbigdata.com

Latin America

Carlos Pedraza, MSc
Scientist

p: +57-313-348-5726
e: carlos@earthbigdata.com