GEONEX

A NASA-NOAA collaboration in using geostationary satellites for land monitoring

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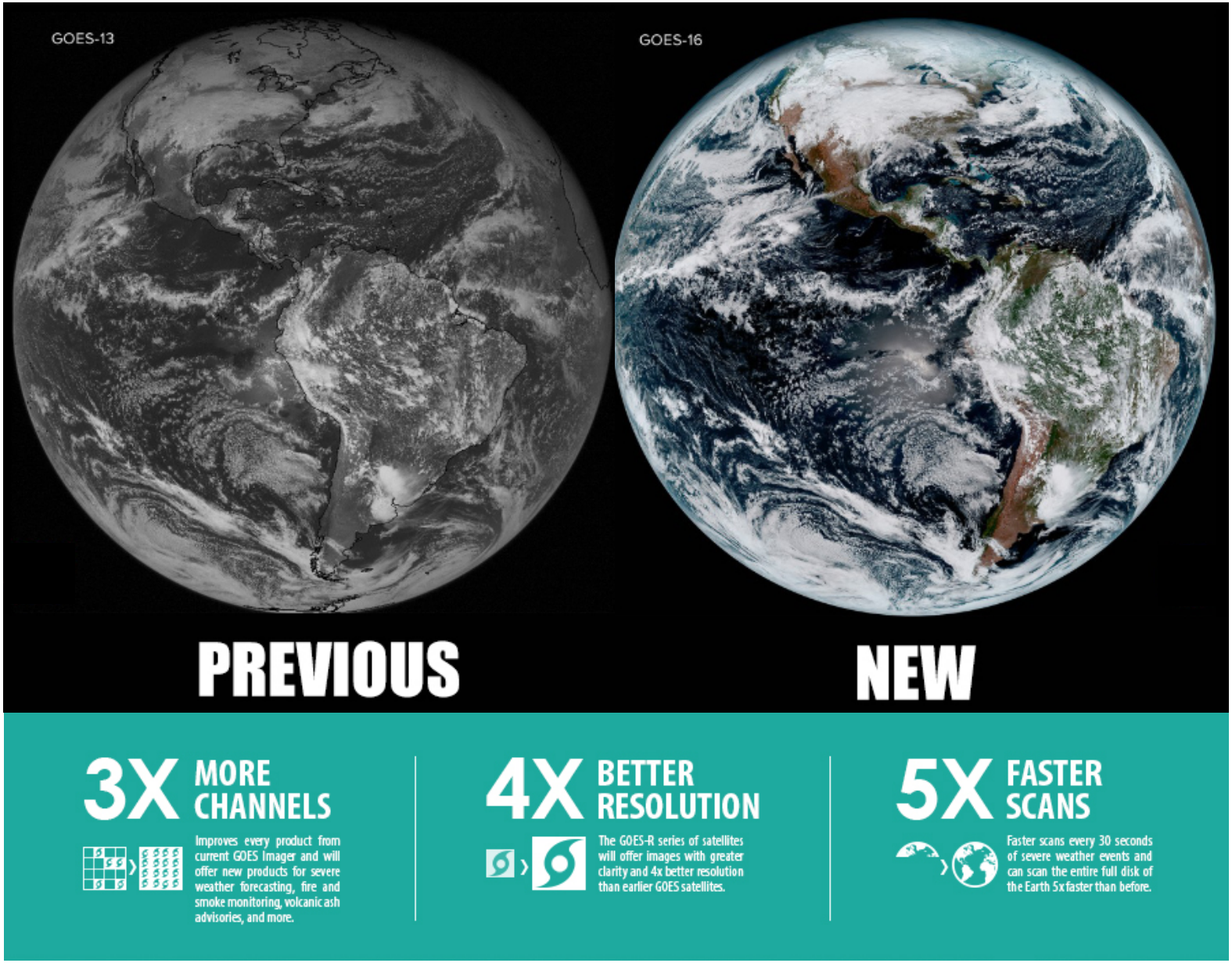
MODIS/VIIRS Science Team Meeting, October 17, 2018

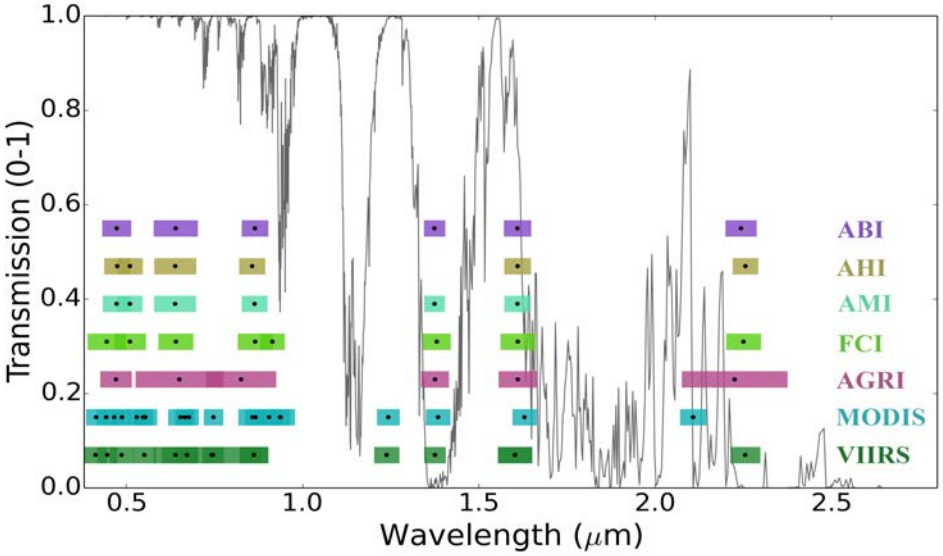
Outline

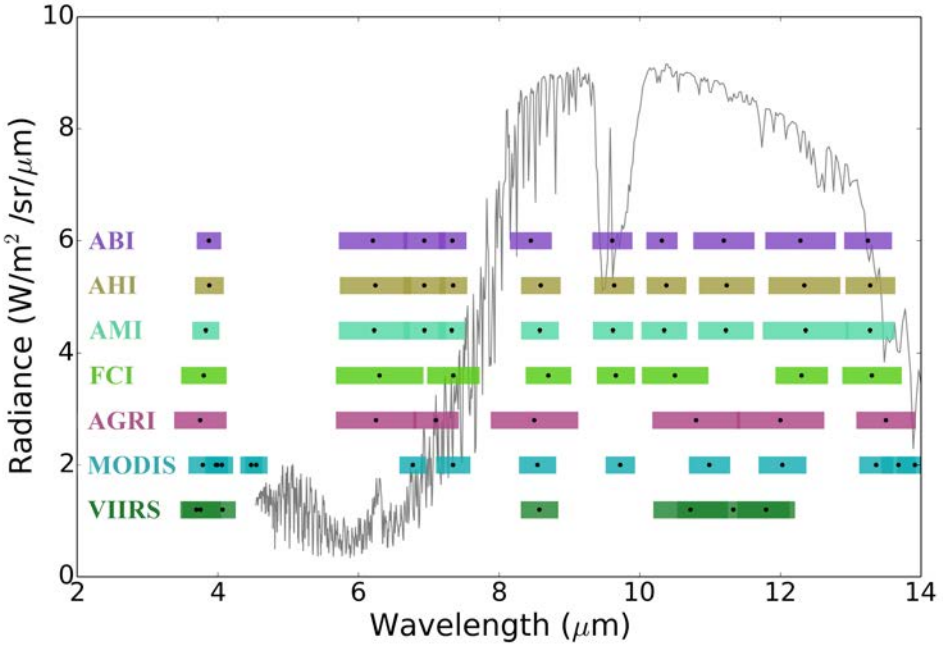
- A generational shift in geostationary satellites
- New opportunities for land monitoring
- Leveraging NEX / OpenNEX compute platforms
- GEONEX Processing system
- Adapting existing EOS/NOAA algorithms
- Preliminary products from GEONEX
- Community engagement on the cloud
- Outreach
- Summary



A generational shift in geostationary satellites

New generation geostationary platforms offer capabilities similar to MODIS for Land Monitoring





ABI – Advanced Baseline Imager on GOES-R/T

AHI – Advanced Himawari Imager on Himawari

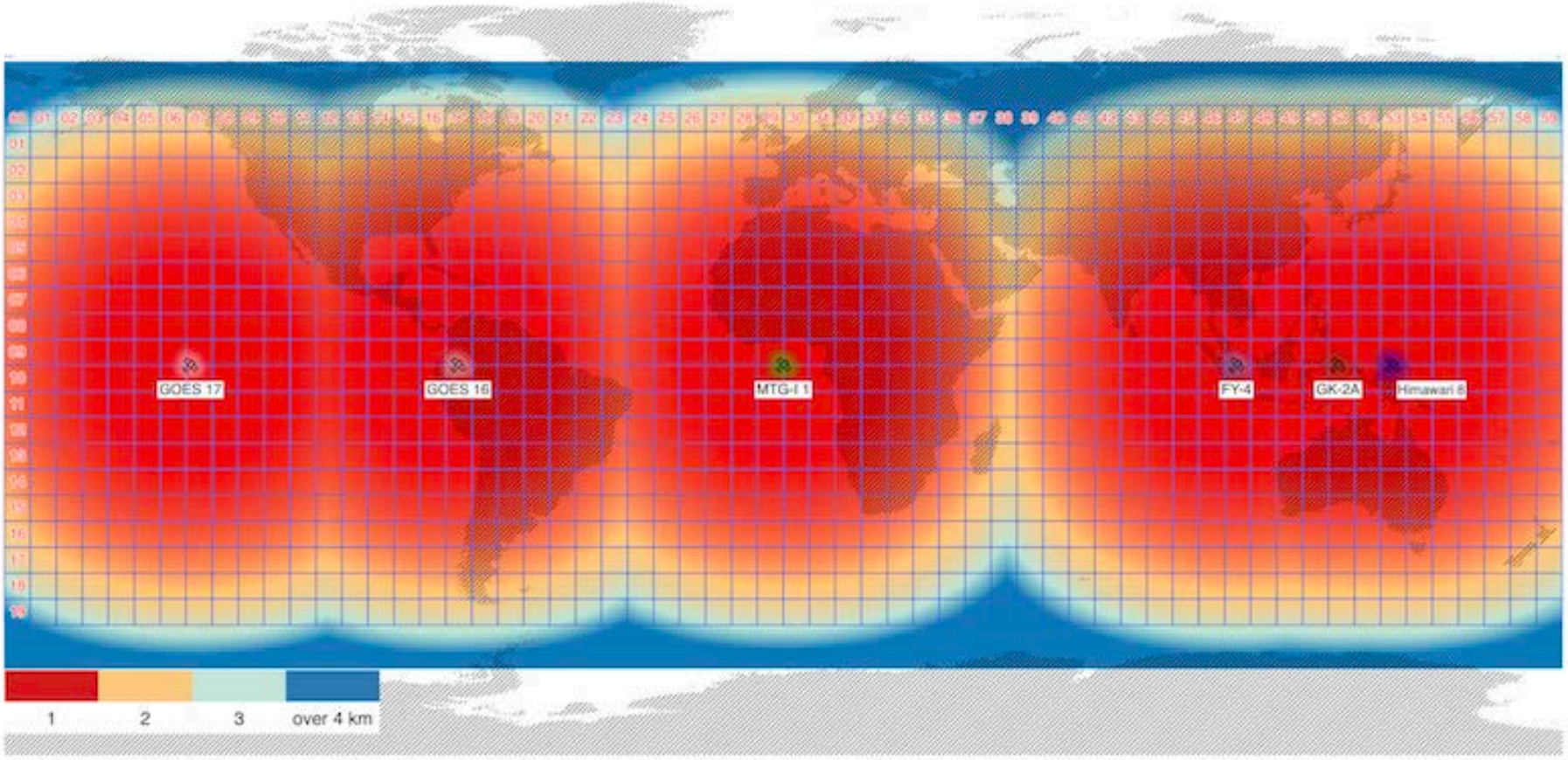
AMI – Advanced Meteorological Imager on GEO-KOMPSAT2

FCI – Flexible Combined Imager on MTG

AGRI – Advanced Geosynchronous Radiation Imager on Fengyun-4

A generational shift in geostationary satellites

1-2km coverage for large portions of the Earth at 5-15 minute interval



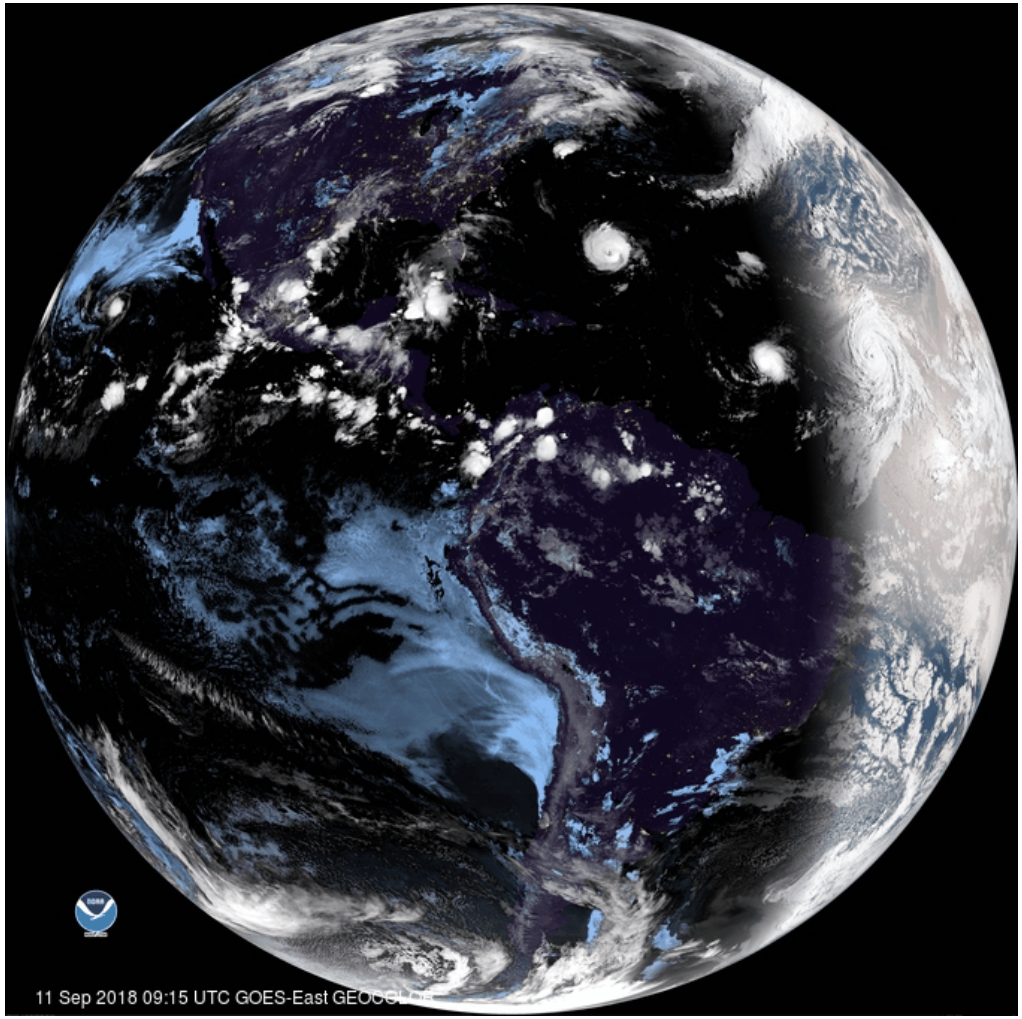
GEO-KOMPSAT2 is scheduled to be launch in December 2018

MTG-FCI is scheduled for 2021

MTG/IOC or Kalpana follow-on are still needed

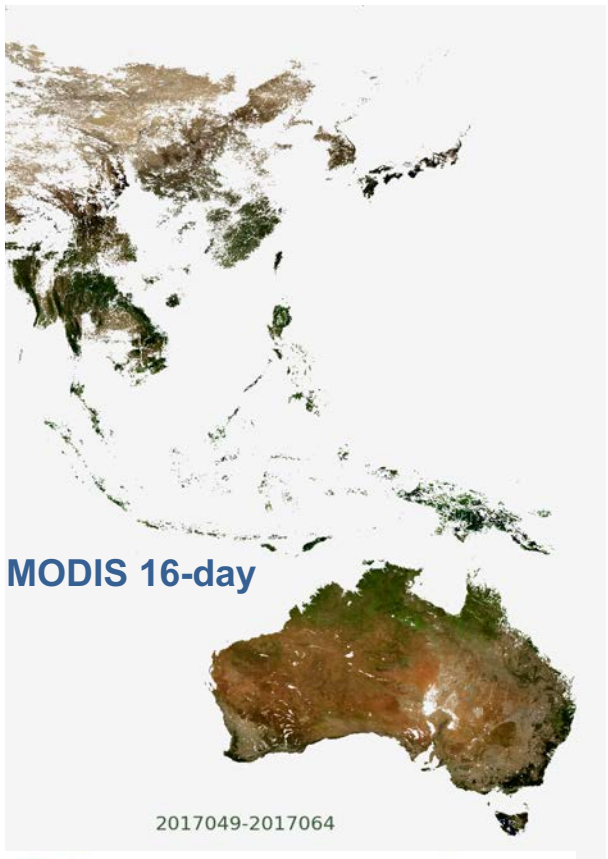
A generational shift in geostationary satellites

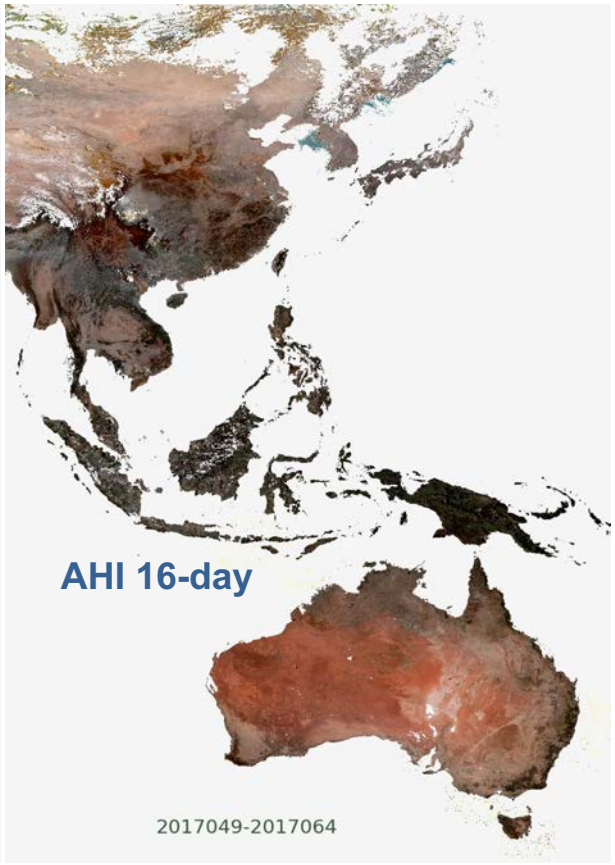
Improved Weather Forecasting

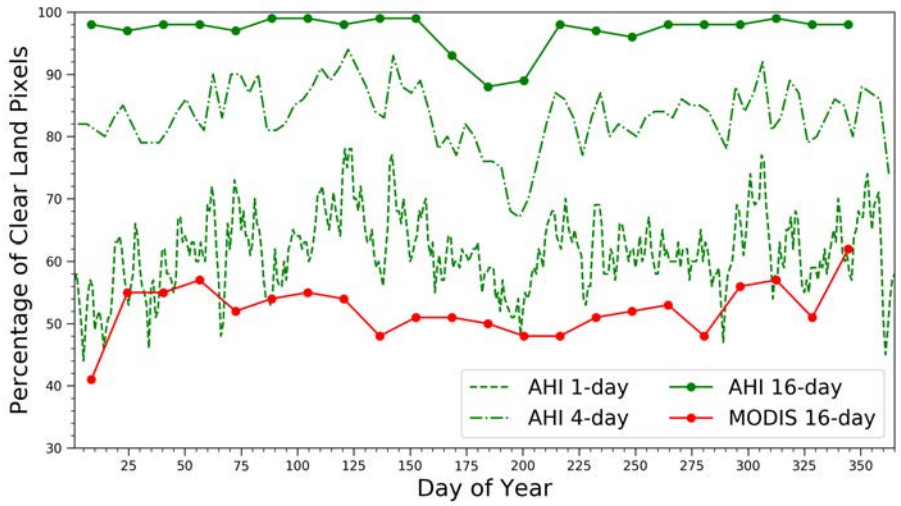


What can they do to improve land monitoring?

Increase in Cloud Free Observations



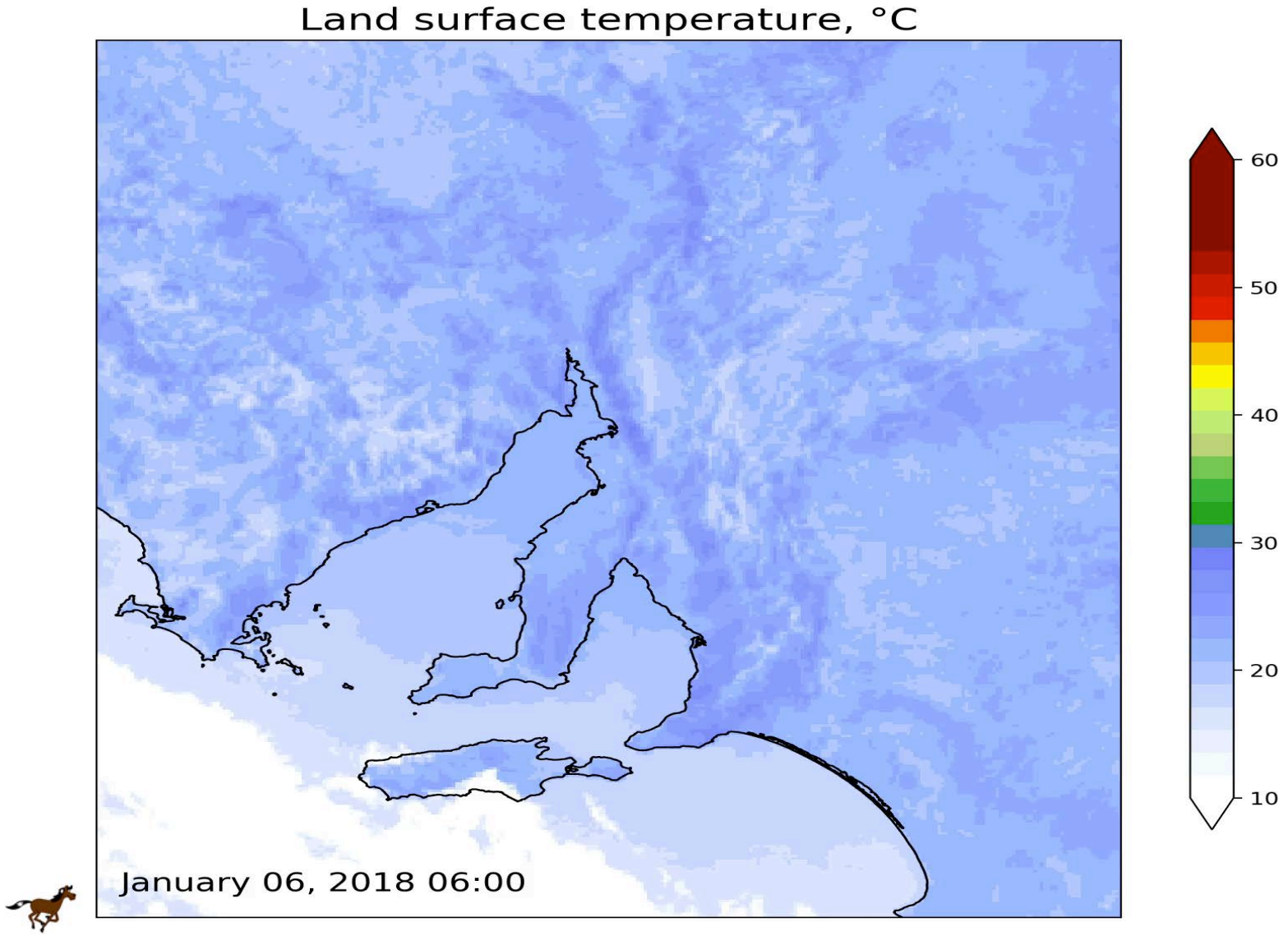




Geostationary satellites may provide daily cloud-free coverage that may take 16 or more days for polar orbiters.

New opportunities for land monitoring

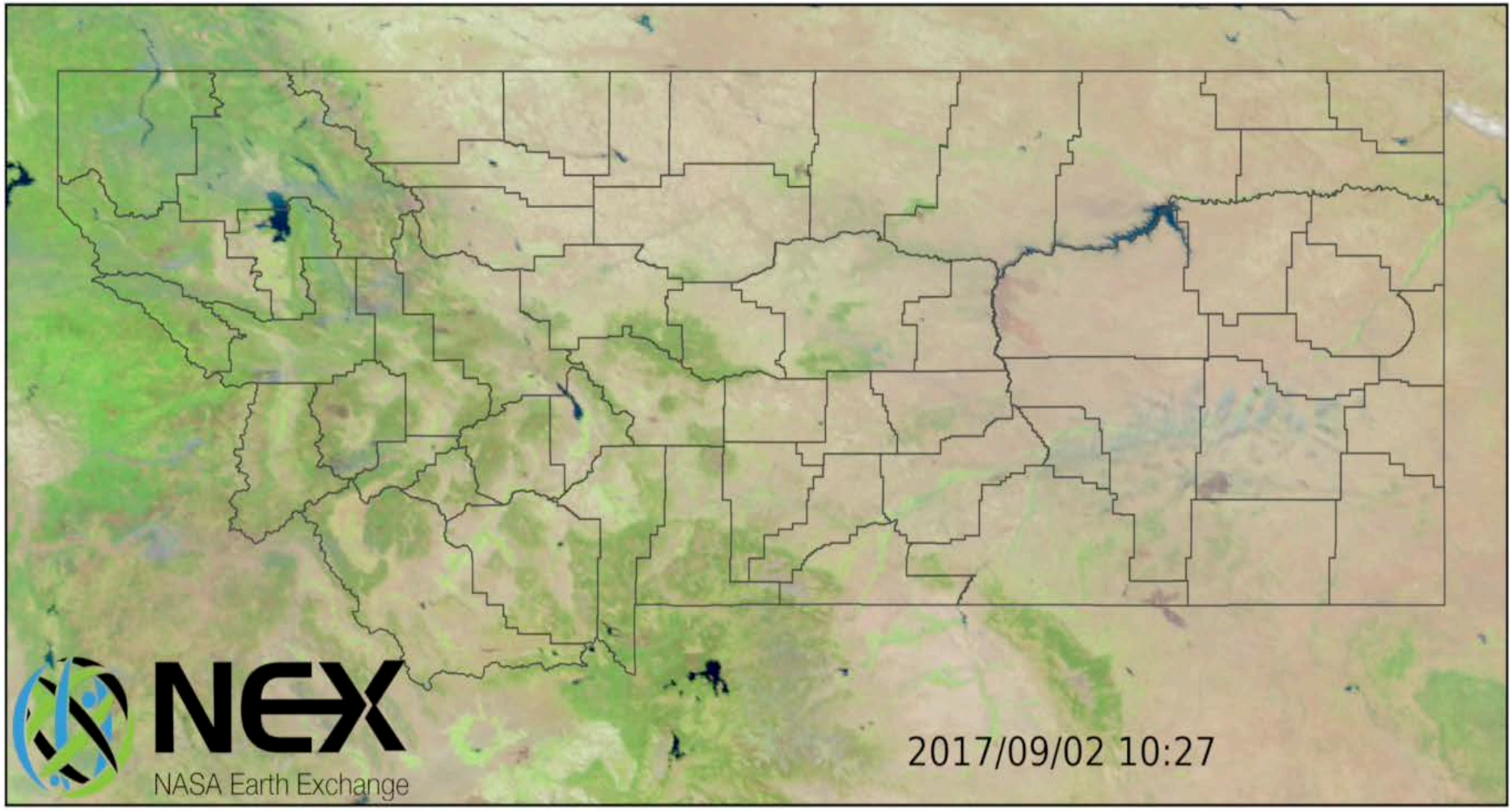
Eye on the heat wave, Adelaide, Australia



For a few hours during the early afternoon,
vehicles were not able to drive on paved roads

New opportunities for land monitoring

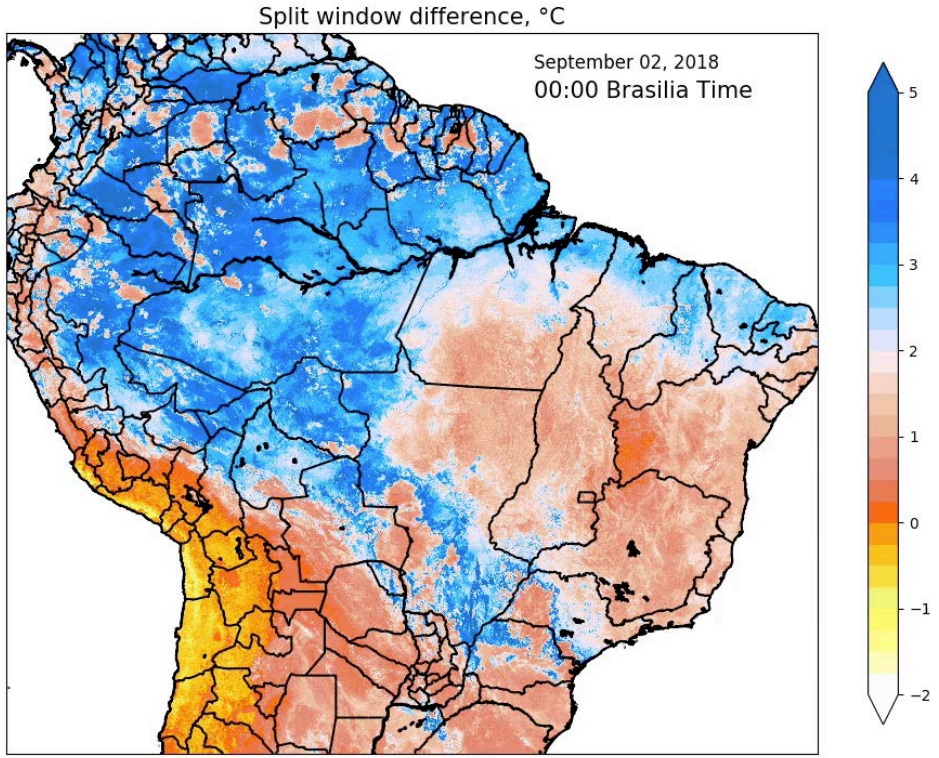
Diurnal wildfire dynamics, Montana, US

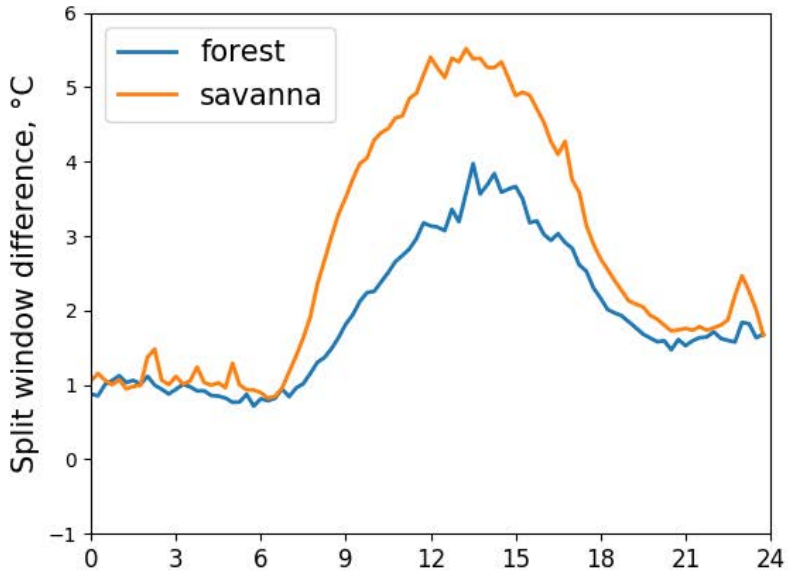


By early afternoon, the fires create local circulations and break out.

New opportunities for land monitoring

Real-time land-atmosphere dynamics, Amazon



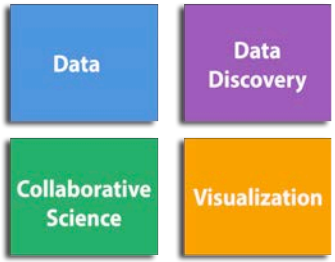


Strong gradients in SWD over short distances create ideal conditions for horizontal wind convergence at the surface leading to convective clouds and local storms.

New opportunities for land monitoring

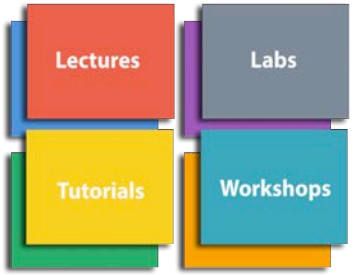
NASA Earth Exchange (NEX) - OpenNEX
A Private-Public Compute Infrastructure

NEX



NASA Private Cloud

OpenNEX



Commercial Public Cloud

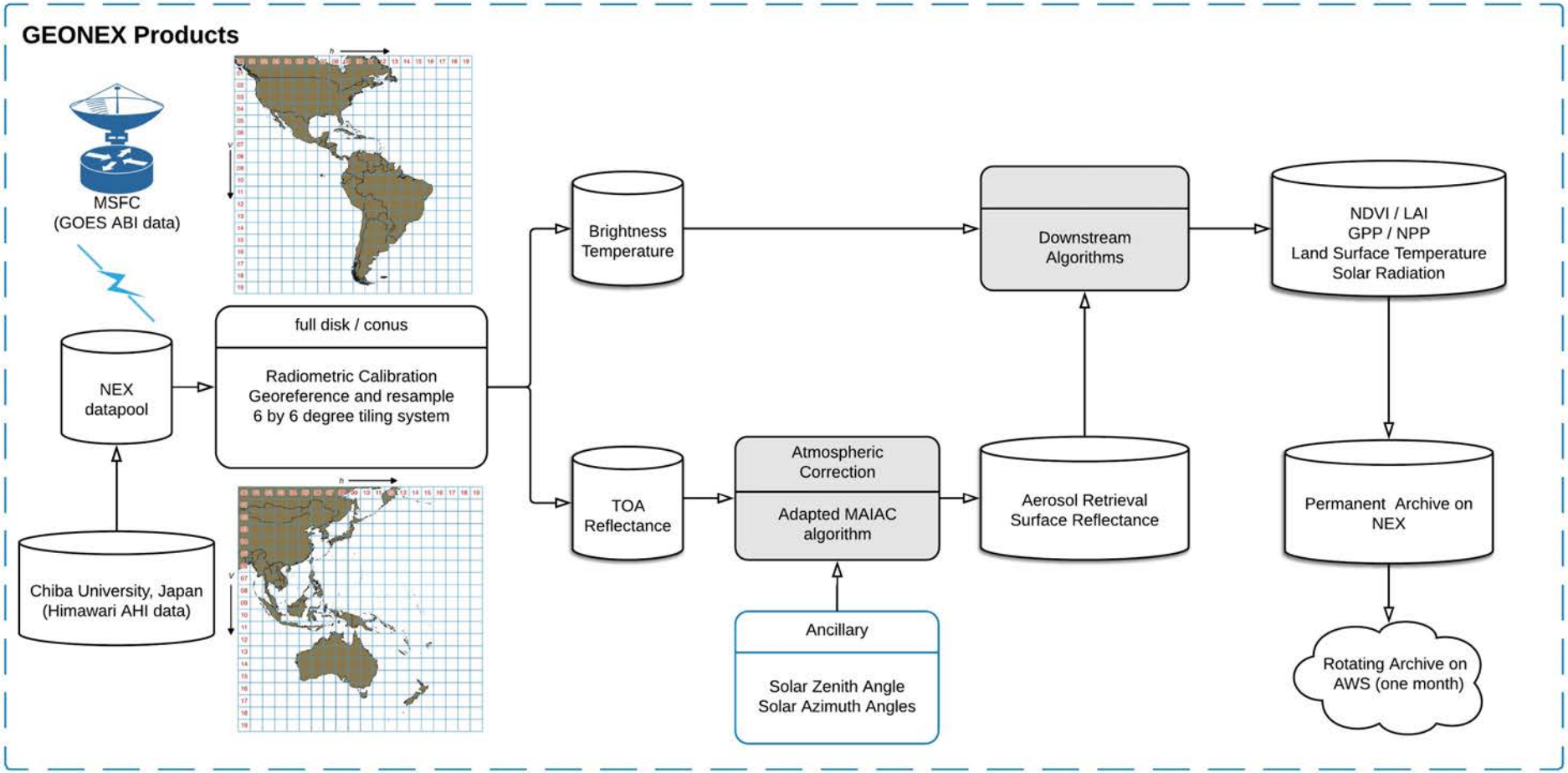
- Restricted access
- NASA funded
- Focus on large-scale modeling and analysis
- Ideal for producing research quality/reproducible results

- Builds on NEX
- Open access
- User-funded
- Ideal for prototyping, exploration and community engagement

Given the data volumes (0.5TB/day per sensor), we will not be able to execute GEONEX pipeline without leveraging existing infrastructure

Leveraging NEX-OpenNEX platforms

Current configuration of GEONEX processing system



GEONEX Processing system

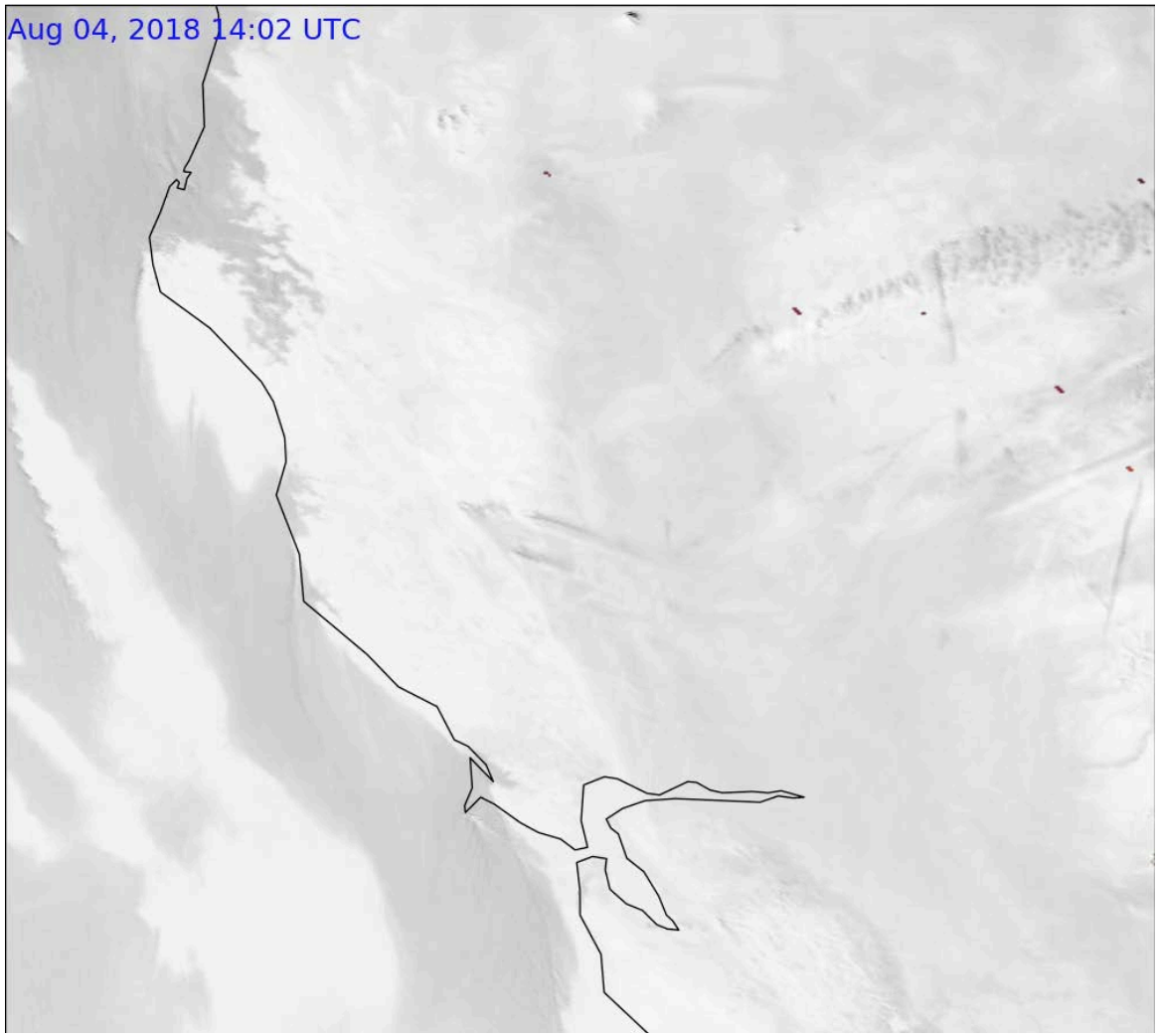
Potential land surface products from geostationary sensors and corresponding algorithms

Product	Algorithm	Current use	Resolution/Frequency
Surface Reflectances	MAIAC (Lyapustin et al., 2011)	MODIS/VIIRS	1km, daily
Fire	Schimdt et al., 2010	GOES/ABI	2km, daily
Vegetation Index (NDVI/EVI)	MOD13Q1 (Huete et al., 2002)	MODIS/VIIRS	1km, daily
LAI/FPAR	MOD15A2 (Myneni et al., 2002)	MODIS/VIIRS	1km, daily
Land Surface Temperature	Yu et al., 2010	GOES/ABI	2km, hourly
Solar Radiation	HIMAWARI (Takaneka et al., 2011)	AHI/HIMAWARI	1km, hourly
GPP/NPP	MOD17A2 (Running et al., 1999)	MODIS	1km, hourly/daily/annual
Evapotranspiration	MOD16A2 (Mu et al., 2007)	MODIS	1km, hourly/daily/annual
Phenology	MOD12Q2 (Ganguly et al., 2010)	MODIS/VIIRS	1km, annual
Snow cover	Cline et al., 2010	GOES/ABI	2km, daily

Prototyped | Getting There | Working on | Initial Stage

Adapting existing EOS/NOAA algorithms

OpenNEX (AWS)-adapted NOAA WFABBA (Fire) Algorithm

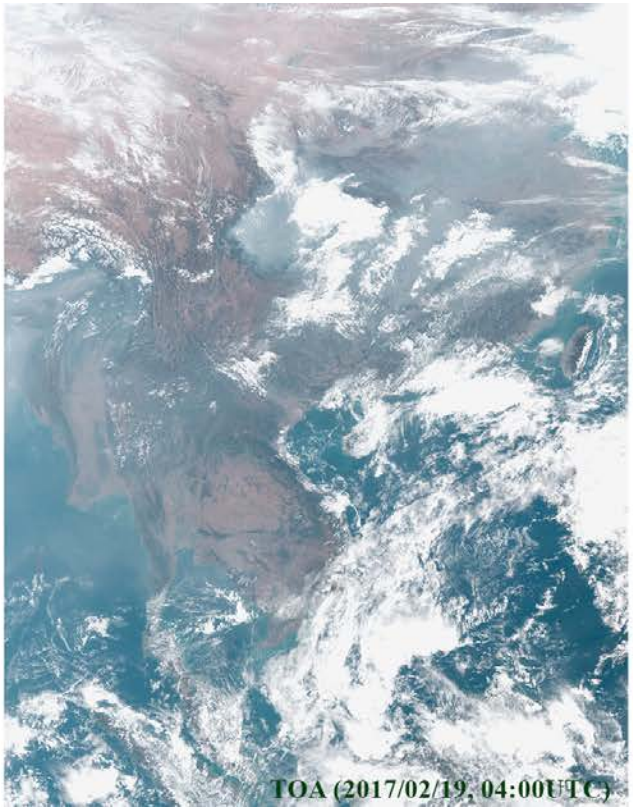


Mendocino complex fire in Northern California, detected by the algorithm over several 5 minute scans. For each scan, the overall product latency is 2.5 minutes from data acquisition.

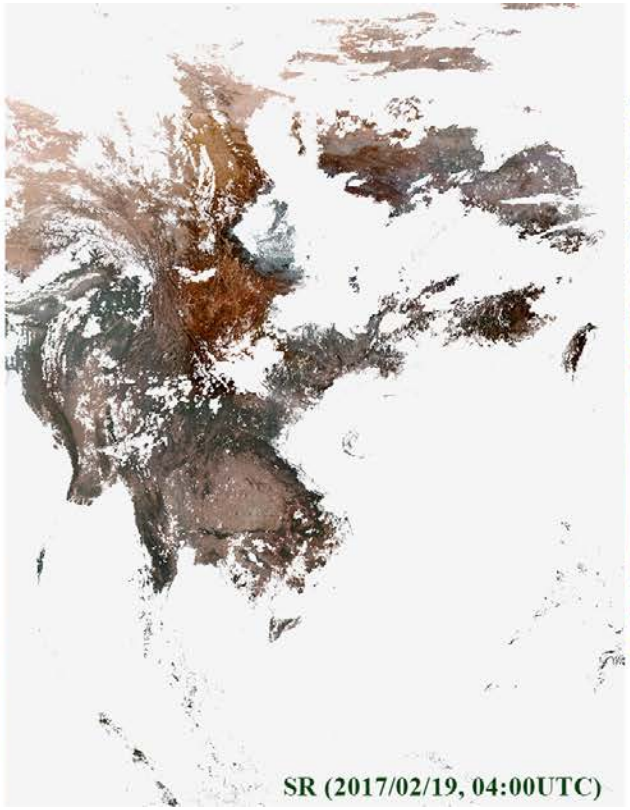
Example products from GEONEX

Adapting MAIAC Algorithm for GEONEX

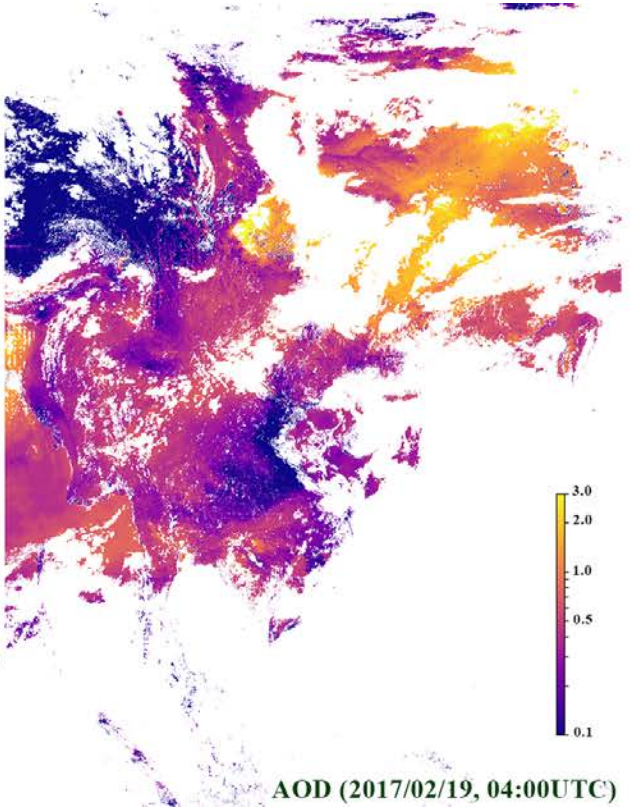
Top-of-Atmosphere



Surface Reflectance



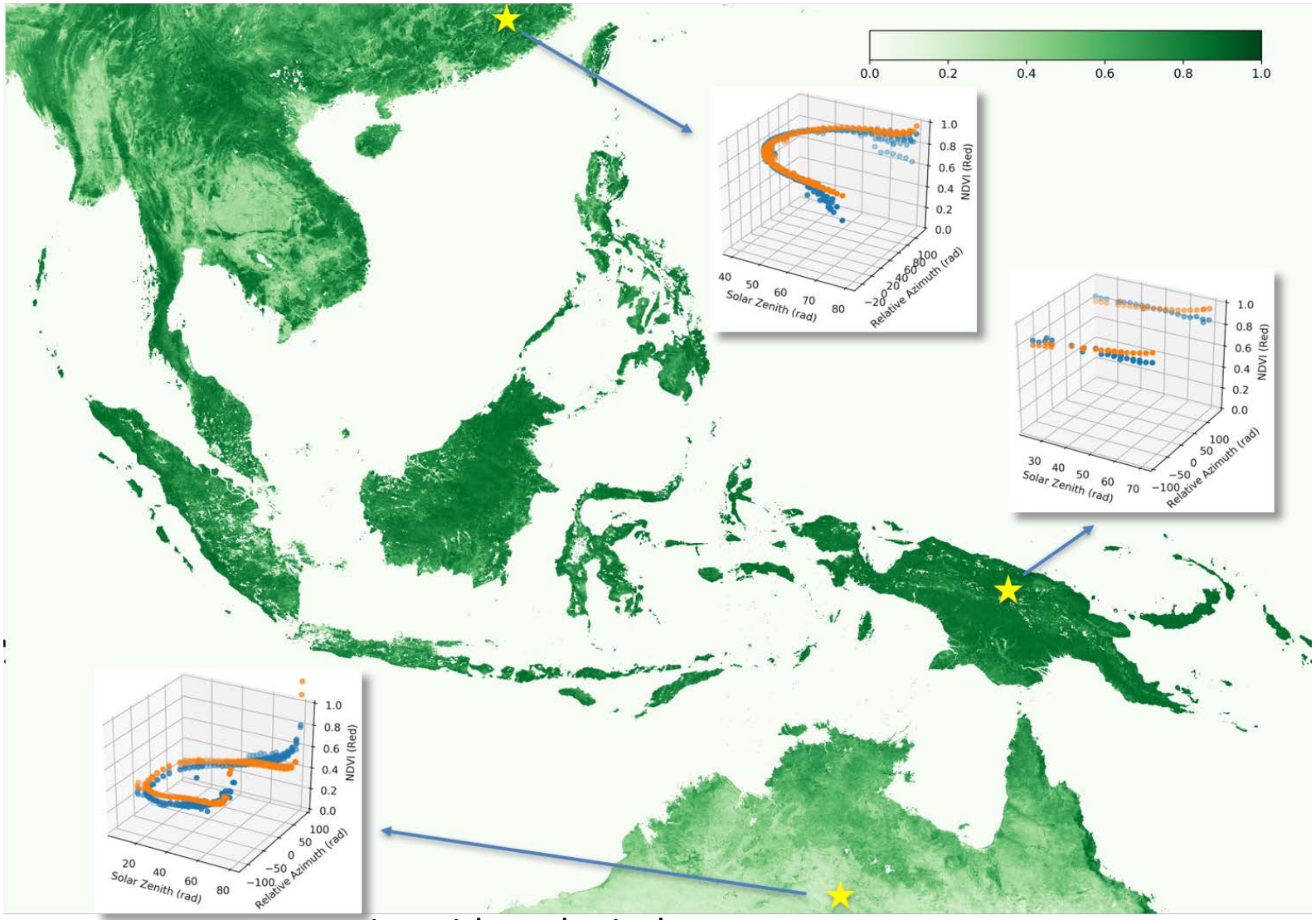
Aerosol Optical Depth



We are able to leverage existing algorithm and produce promising results from AHI. More work is needed for other sensors such as ABI with slightly different band configuration.

Preliminary products from GEONEX

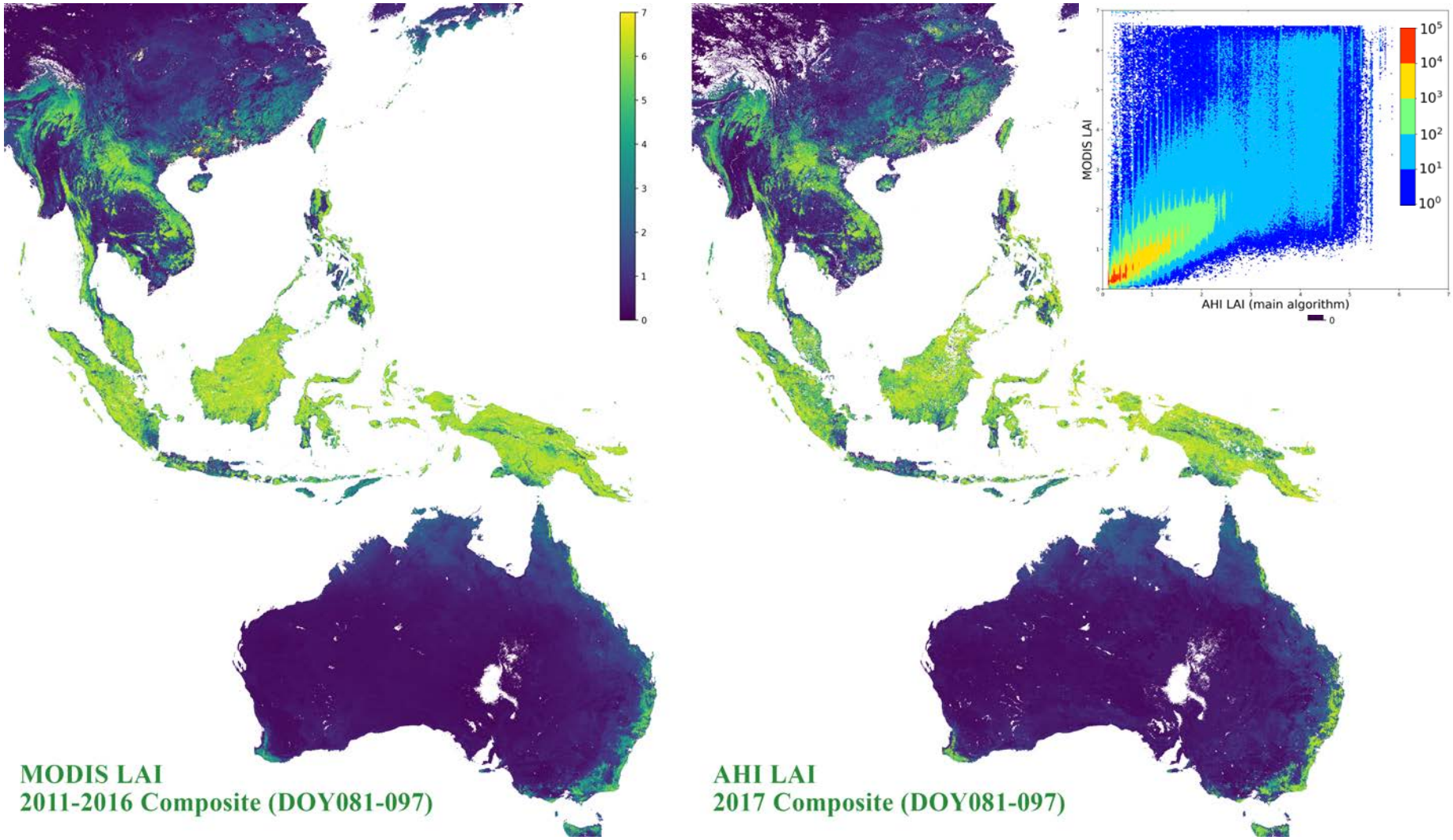
Vegetation Index from GEONEX/Angular Effects



The sun-sensor geometry varies with each pixel across the domain. Consequently, extracting meaningful information should account for the angular effects.

Preliminary products from GEONEX

Adapting MOD15 LAI/FPAR Algorithm for GEONEX



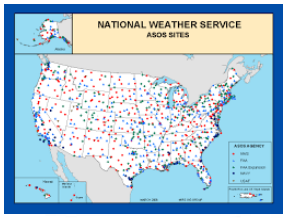
More work is needed in customizing the Look-Up-Tables and to explore machine learning algorithms to generate MODIS-consistent results

Preliminary products from GEONEX

Creating Near Real-time Surface Meteorology

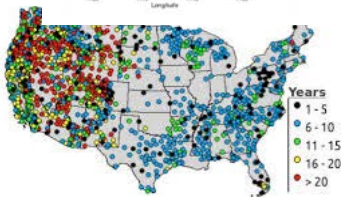
HOURLY INPUT DATA

ASOS

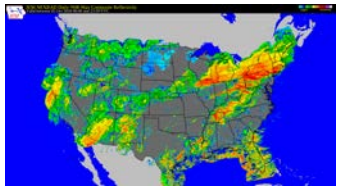


SNOTEL

MESONET



RADAR

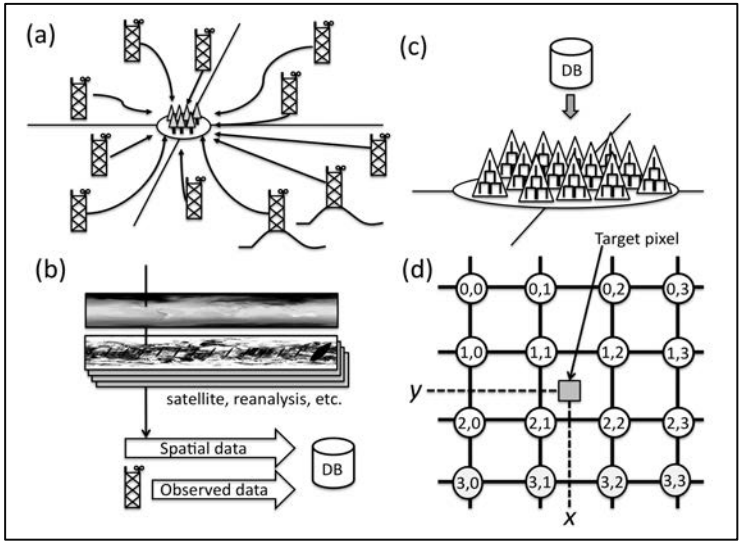


GOES

NASA EARTH EXCHANGE (NEX)

GRIDDED HOURLY METEOROLOGY (DHM)

MACHINE-LEARNING BASED DATA ASSIMILATION

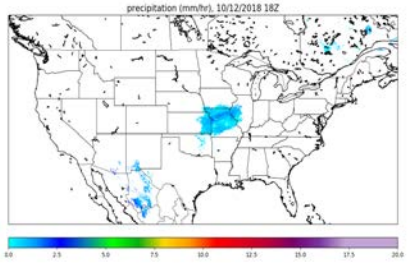


HISTORICAL DATA: 1979 – 2018
FREQUENCY: DAILY

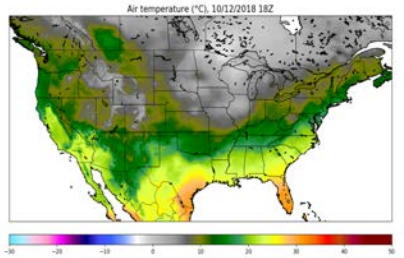
OPERATIONAL: HOURLY WITH
30-60 MINUTES DELAY

HOURLY OUPUT DATA

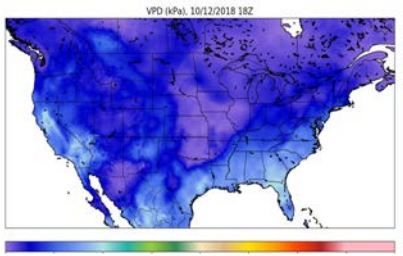
PRECIP



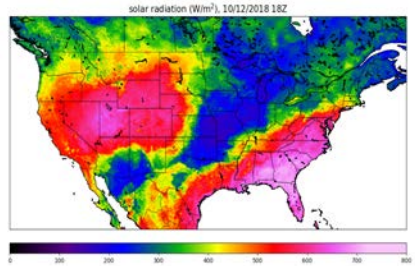
TAIR



VPD



RADIATION

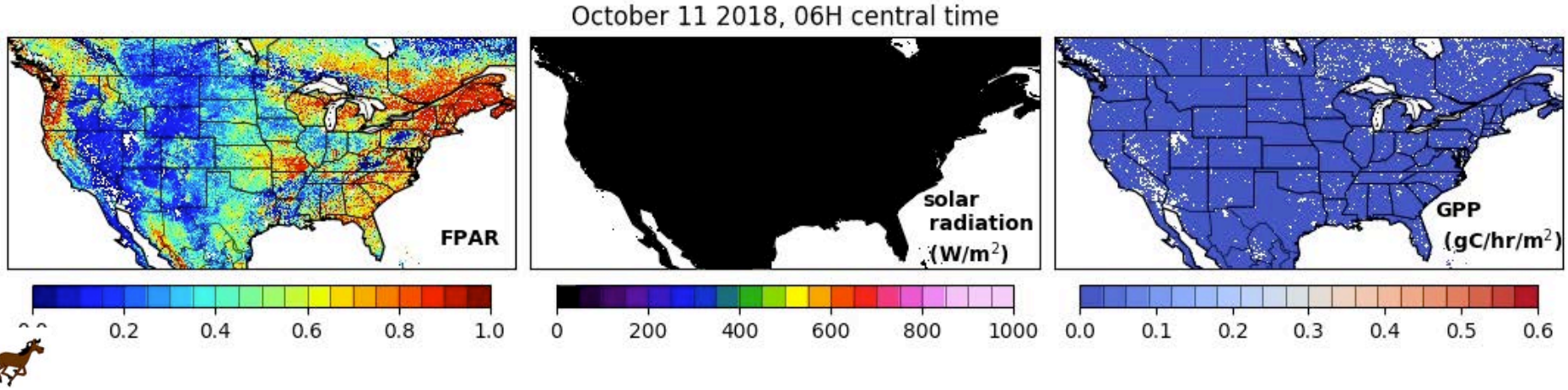


Our long-term interest is supporting the National Climate Assessment in the US

Preliminary products from GEONEX

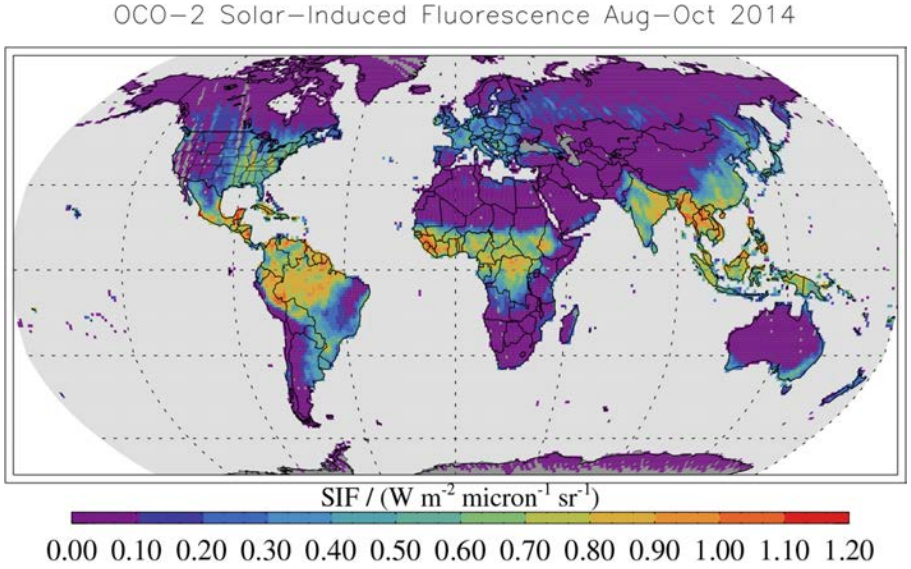
Adapting MOD17 GPP Algorithm for GEONEX

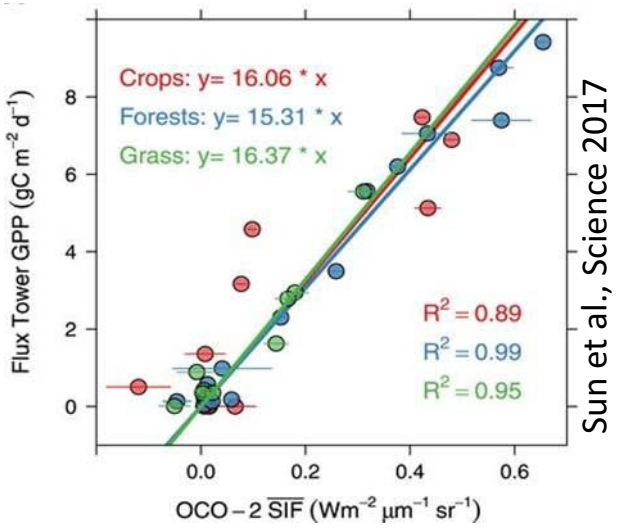
1km, hourly GPP estimates



Potential synergy with OCO-2 and GEOCARB for calibrating GPP algorithm

SIF under clear skies from OCO-2 is highly correlated with GPP from Flux towers

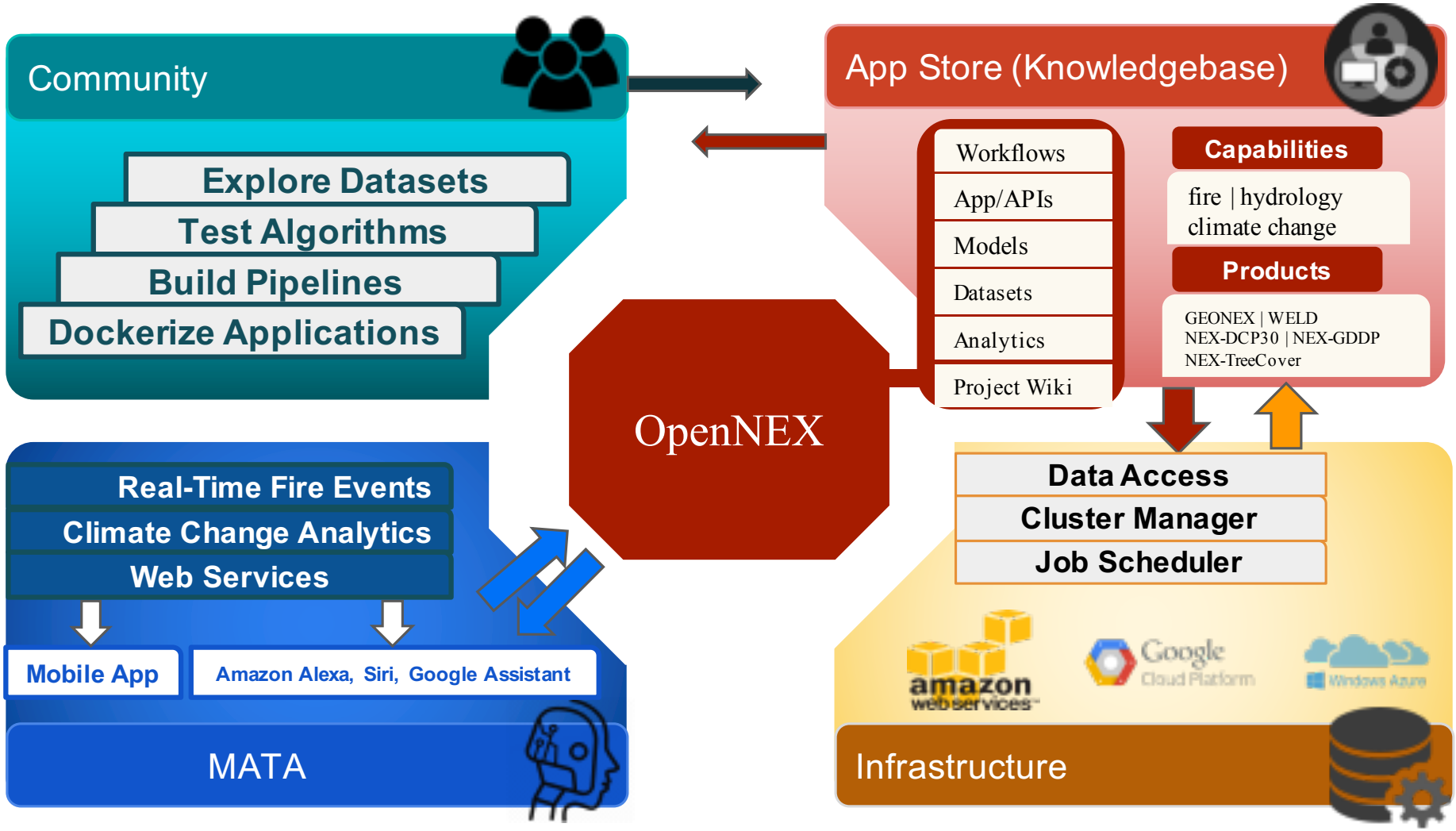




Sun et al., Science 2017

Preliminary products from GEONEX

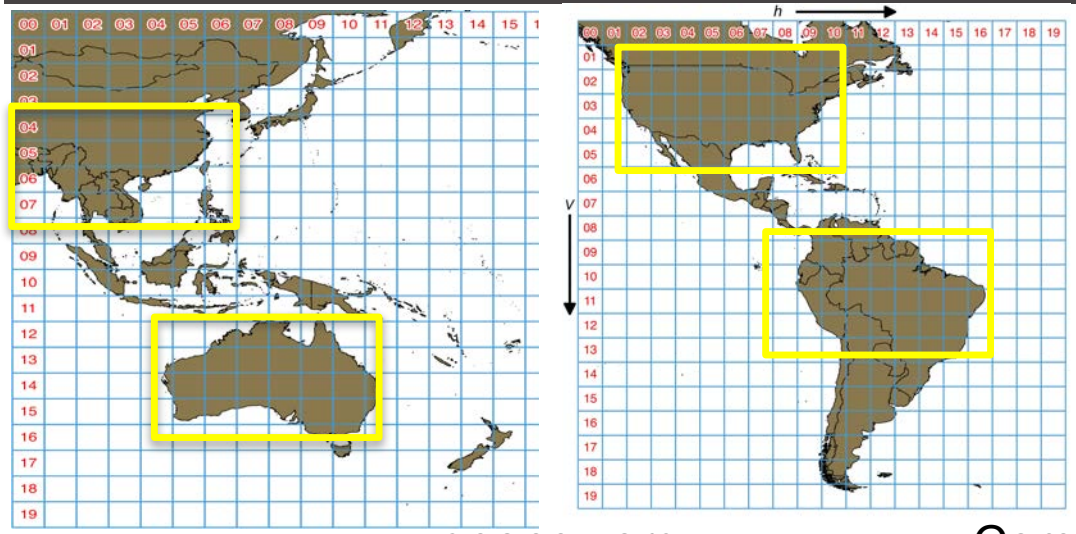
Cloud Deployment of GEONEX



The software stack we built for OpenNEX in support of the National Climate Assessment where community members accessed, analyzed and visualized the downscaled climate projections produced on NEX, is being re-used for GEONEX.

Community engagement on the cloud

GEONEX website provides sample data and products

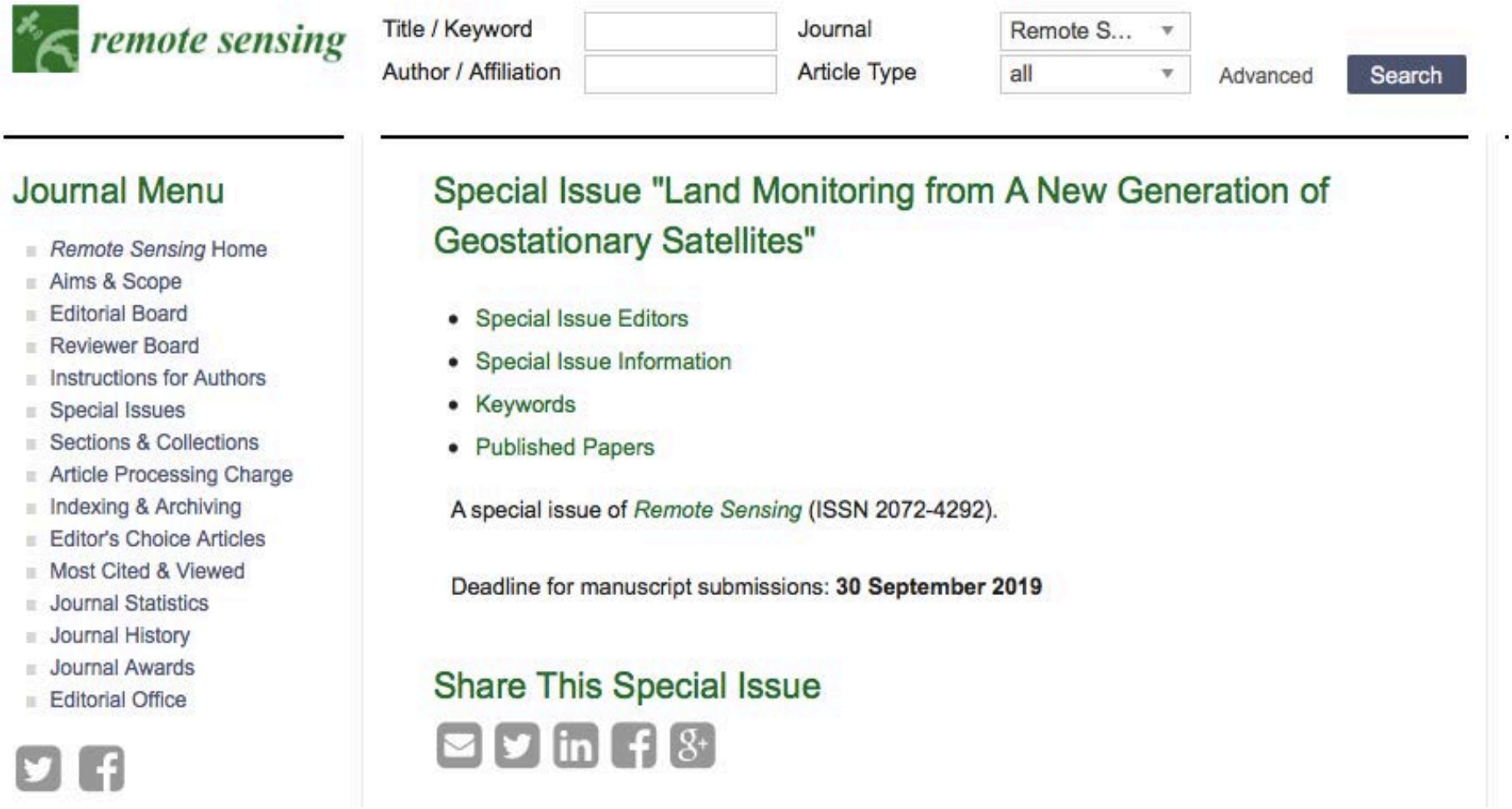


GEONEX products along with co-located MODIS data and tools for accessing, compositing and visualizing the data will be provided to the community.

www.geonex.org

Community engagement on the cloud

Special Issue is open to receive manuscripts



All publications for which authors share the codes will be containerized and made available on OpenNEX

Community engagement

New opportunities for land monitoring

- Studies of diurnal land-atmosphere dynamics
- Data-Model integration at a new level
- From states to fluxes
- GEO-LEO integration (**GOES, GEMS, GeoCARB, OCO, GCOM-C, MODIS/VIIRS**)

Community Engagement / Cloud Computing

- Rapid prototyping and deployment
- Low latency product generation
- Ready-to-deploy containers using building blocks
- Data-driven products from machine learning