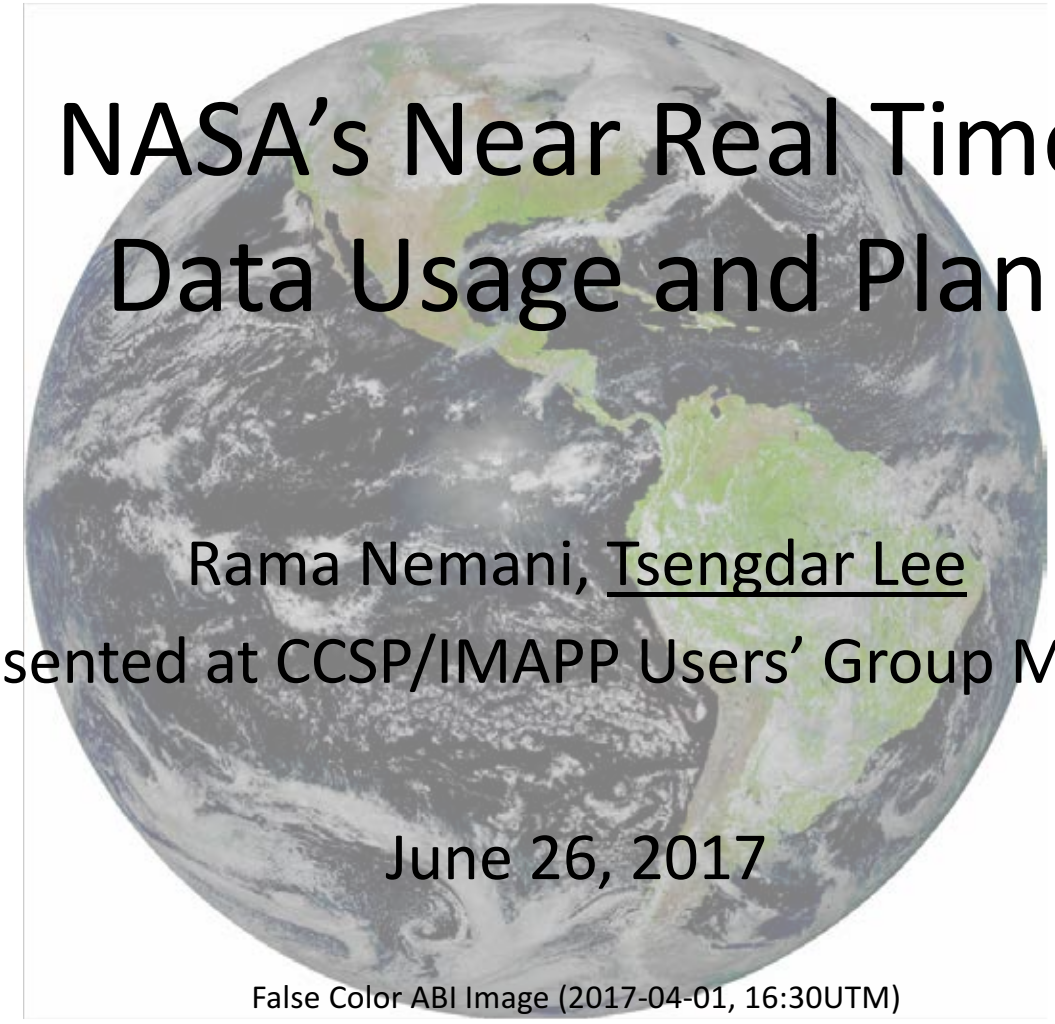
NASA's Near Real Time Data Usage and Plan

Rama Nemani, Tsengdar Lee

Presented at CCSP/IMAPP Users' Group Meeting

June 26, 2017



False Color ABI Image (2017-04-01, 16:30UTM)

Rayleigh scattering effects are removed using the EOS 6S radiative transfer code. **R: 1.61µm G: 0.865µm B:0.64µm**

NASA's Supports in Near Real Time Activities - Past and Future

- NASA has invested in IPOPP, LANCE, CSPP and IMAPP in the past many years.
- NASA uses NRT data to support weather research and transition research products to forecast operations.
- NASA's Disaster Program in Applied Science uses NRT data heavily.
- NASA currently does not have a plan to build Direct Broadcast systems in future satellite missions while the planned NOAA GOES and POES systems will be able to provide many EOS era developed products.
- Therefore, a new strategic direction for the NRT activities is needed to guide future investments.

Input by Steve Platnick and the Goddard Team

White paper on potential NASA-focused GOES-R research and applications

S. Braun[1], S. Platnick[1], J. McCorkel[1], D. Chesters[1],

and

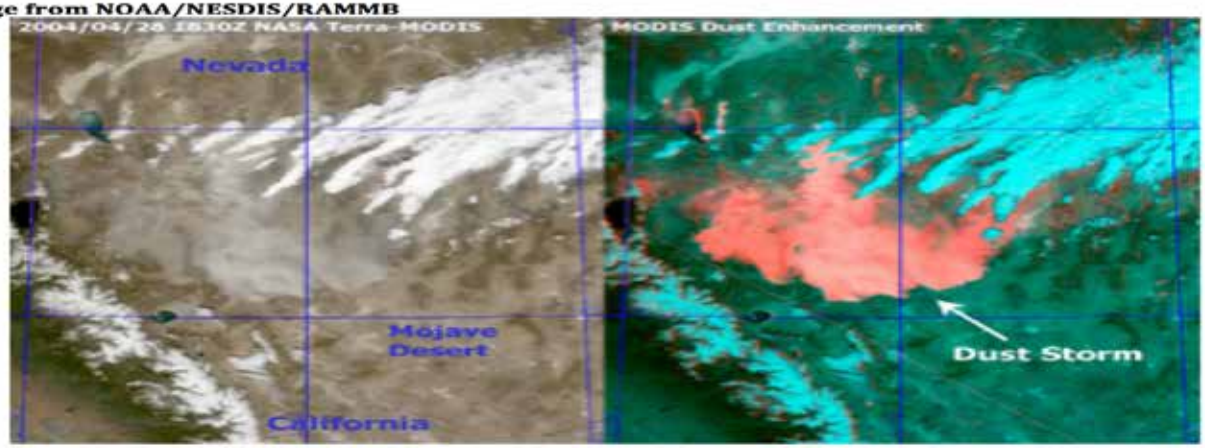
V. Buchard[5], S. Gasso[3], R. Levy[1], A. Lypustin[1], T. Matsui[2], L. Ott[1], N. Pahleven, K. Pickering[1], S. Zhang[4],

Affiliations:

[1]NASA GSFC; [2]U. of Maryland, College Park; [3]Morgan State University; [4]Science Applications International Corporation; [5]Universities Space Research Association

Presented to NASA's Earth Science Division: October 2016

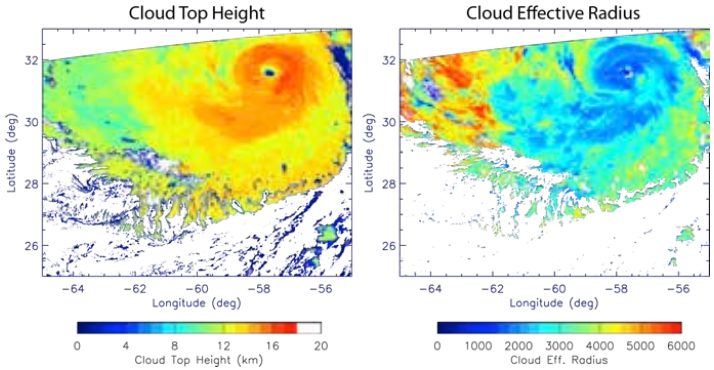
Image from NOAA/NESDIS/RAMMB



NASA GOES-R Focus Areas

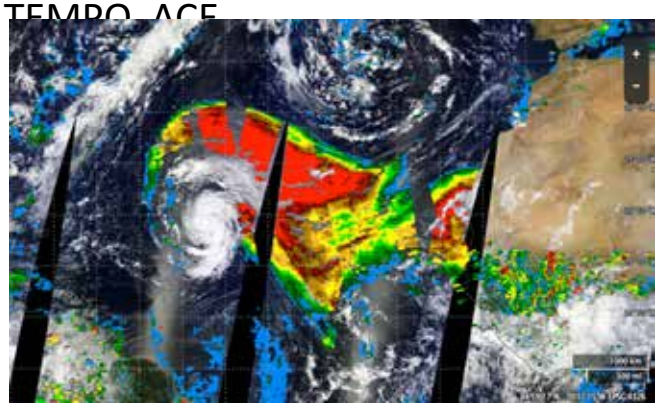
Weather

- New measurement capabilities (ABI, GLM)
- Hurricanes, severe local storms, MCS, atmos. rivers, ET cyclones:
  - Role of aerosols on storm morphology: cloud top microphysical evolution, lightning, diurnal cycle
  - Diurnal variability of cloud-top properties and lightning
- Strong synergy with GPM, CYGNSS, TROPICS, field campaigns



Atmospheric Composition

- Provides high temporal resolution of VIIRS-like cloud/aerosols properties, volcanic ash
- Lightning data valuable for NOx
- Information on local variability and transport
- Potential algorithm improvements
- Strong synergy with MODIS, VIIRS, TEMPO, ACE

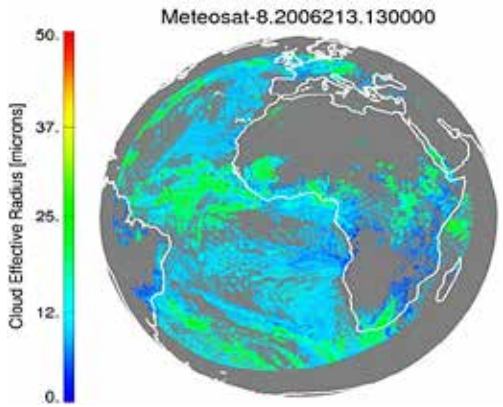


MODIS Clouds and AOD

NASA GOES-R Focus Areas

Clouds and Radiation

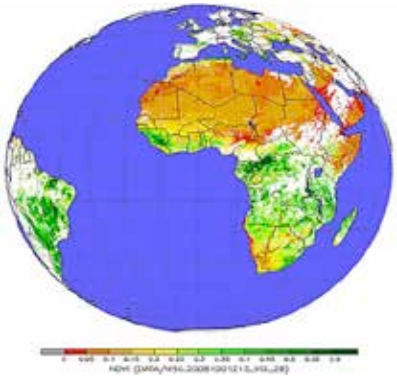
- Provides high temporal resolution of VIIRS-like cloud properties
- Diurnal evolution of cloud-top properties for a variety of cloud types/systems
- Development of consistent cloud climate data records from global constellation of GEO imagers
- Strong synergy with MODIS, VIIRS, ACE, DSCOVR



Terrestrial/Oceans

- Provides high temporal resolution for land surface properties: vegetation, surface temperature, fires, snow/ice, floods/standing water
  - Crop seasonal production models
  - Evapotranspiration/water cycle
- Exploring ocean color benefits
  - Improved atmos. correction
- Strong synergy with MODIS, VIIRS, SMAP, GeoCAPE

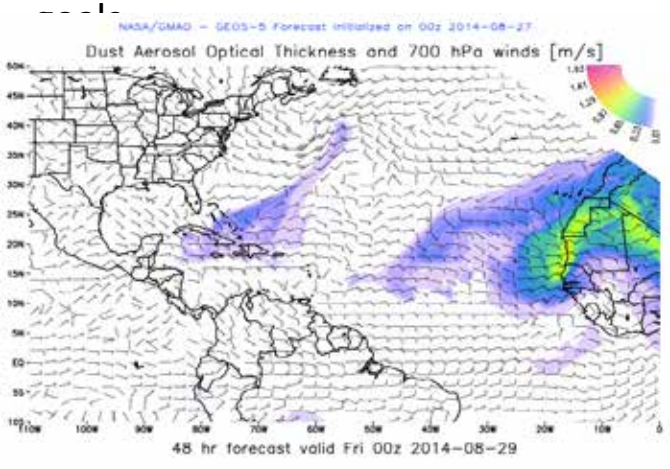
Vegetation index



NASA GOES-R Focus Areas

Modeling/data assimilation

- Provides high temporal resolution cloud/aerosol properties, lightning
- Focus on non-NOAA applications including aerosol, fire, lightning DA
- Validation of lightning model used for GEOS-5 chemistry
- Strong synergy with Modeling, Analysis, & Prediction program



GEOS-5 aerosol forecast

Climate Data Records

Requirements include:

- Well-calibrated and intercalibrated instrumental data
- Consistent, but evolving retrieval algorithms
- Capability for data reprocessing
- Communication and coordination among EOS and GOES-R instrument calibration, science, and data processing teams

Recommendations

• NASA should make strategic investments in either a GOES-R science team or GOES-R elements within other NASA science teams to conduct the diverse research described in the white paper.

• To produce consistent GEO and LEO data records:

1) Develop a consistent set of 2 and L3 science algorithms for use across GEO and LEO instrument records that are critical for establishing continuity of Climate & Earth Science Data Records (CESDRs);
2) establish an integrated instrument and L1 calibration team to conduct systematic evaluations of GEO imager performance and be responsible for L1B code that allows for reprocessing and forward-processing algorithm testing in data formats consistent with ESDIS and legacy algorithms;
3) expand the role of the LEO Science Investigator-led Processing System (SIPS) to include (re)processing, archiving, and distribution of NASA-funded GEO imager science team data products; and
4) establish independent discipline-specific NASA Validation Teams to assess the NASA-funded ABI (and other GEO imagers) CESDRs and work closely with the algorithm teams to ensure that validation findings inform algorithm refinement.

NASA EARTH EXCHANGE (NEX).

OVERVIEW

+ NEX is virtual collaborative that brings scientists together in a knowledge-based social network and provides the necessary tools, computing power, and access to bigdata to accelerate research, innovation and provide transparency.

VISION

To provide "science as a service" to the Earth science community addressing global environmental challenges

GOAL

To improve efficiency and expand the scope of NASA Earth science technology, research and applications programs

NEX Provides a Complete Work Environment "Science As A Service"

COLLABORATION

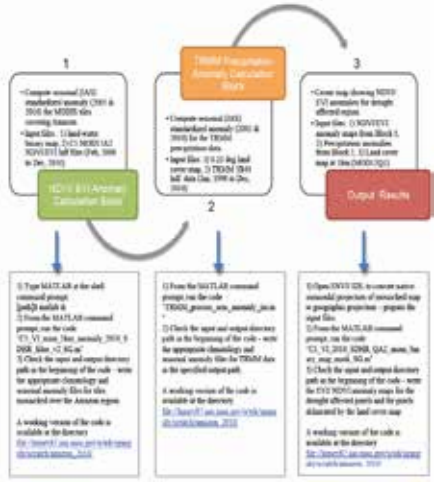
Over 400 Members

COMPUTING

Scalable
Diverse
Secure/Reliable

CENTRALIZED DATA REPOSITORY

Over 2.3 PB of Data



KNOWLEDGE

Workflows
Machine Images
Model codes
Re-useable software

NEX Resources

Portal

- Web server
- Database server
- 503 registered members (up from 420)

Sandbox

- 96-core server, 264GB memory, with 320 TB storage
- 48-core server, 128 GB, 163 TB storage

HPC

- 720-core dedicated queue + access to rest of Pleiades
- 181 users/44 active (153/40 last year)
- 2.3 PB storage (from 850TB)

Models/Tools/Workflows used by NEX User Community

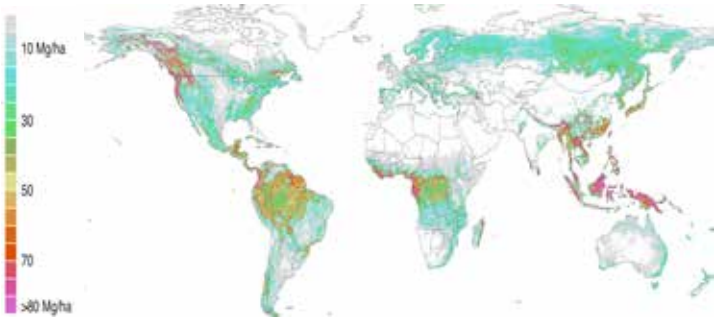
- GEOS-5
- CESM
- WRF
- RegCM
- VIC
- BGC
- LPJ
- TOPS
- BEAMS
- Fmask
- LEDAPS
- METRIC

…

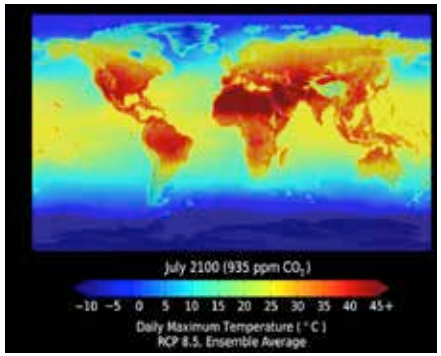
Data (>2 PB on & near-line)

- Landsat
- MODIS
- TRMM
- GRACE
- ICESAT
- CMIP5
- NCEP
- MERRA
- NARR
- PRISM
- DAYMET
- NAIP
- Digital Globe
- NEX-DCP30
- NEX-GDDP
- WELD
- NAFD-NEX

Science at NEX

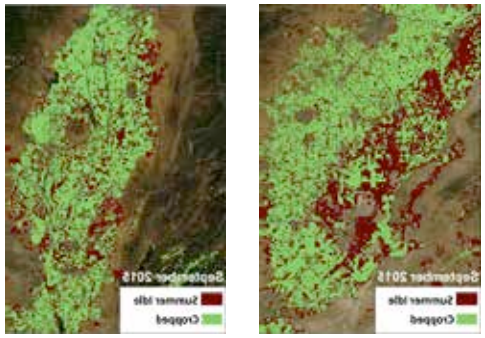


Global Vegetation Biomass at 100m resolution by blending data from 4 different satellites

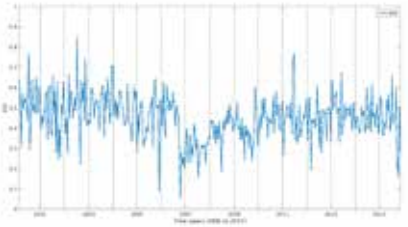


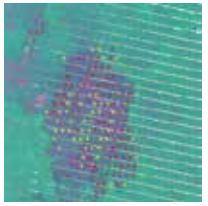
High resolution climate projections for climate impact studies

High resolution monthly global data for monitoring forests, crops and water resources



Mapping fallowed area in California during drought





Machine learning and Data mining – moving towards more data-driven approaches

OpenNEX – A private public partnership

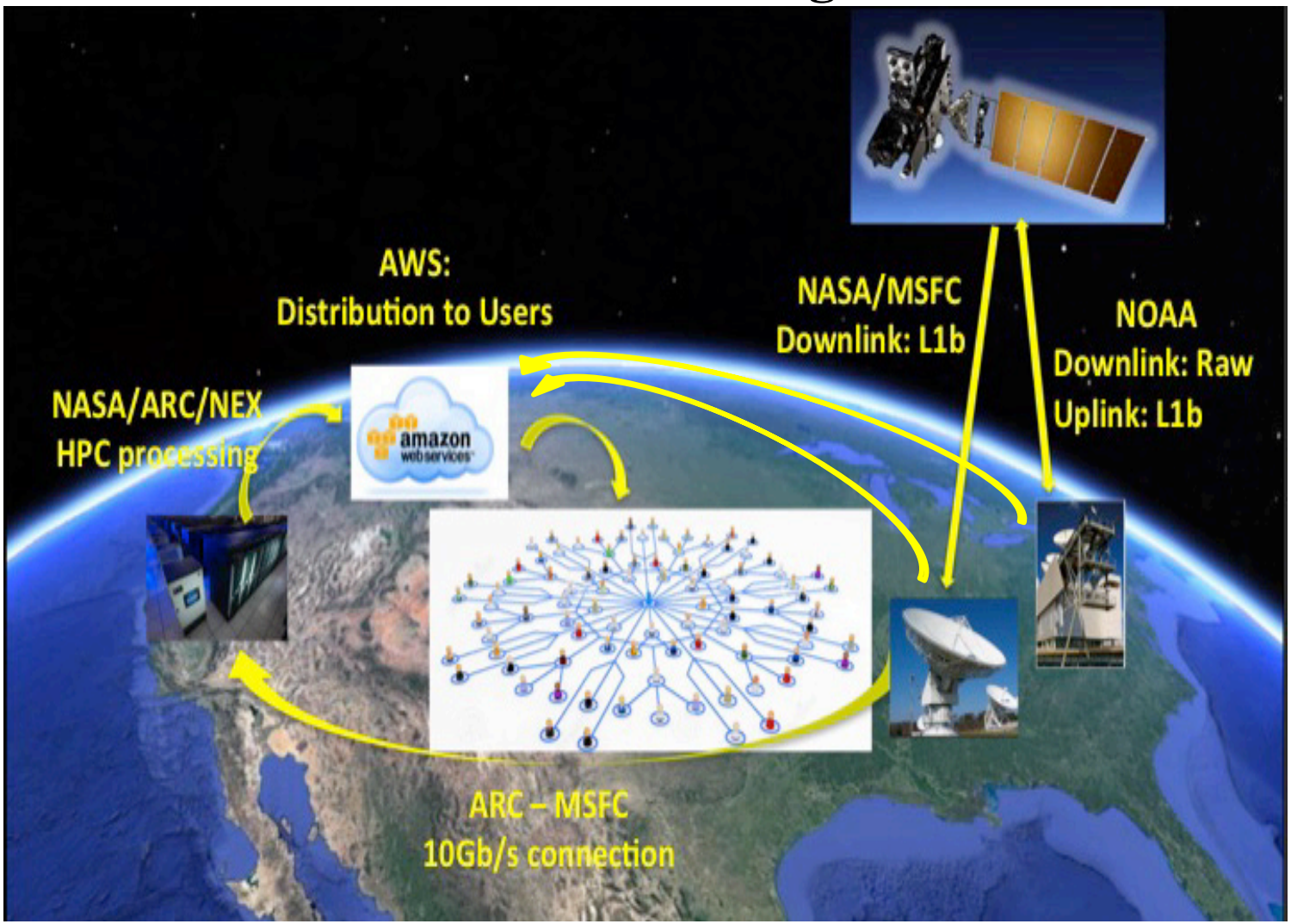
NASA Private Cloud

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

Commercial Public Cloud

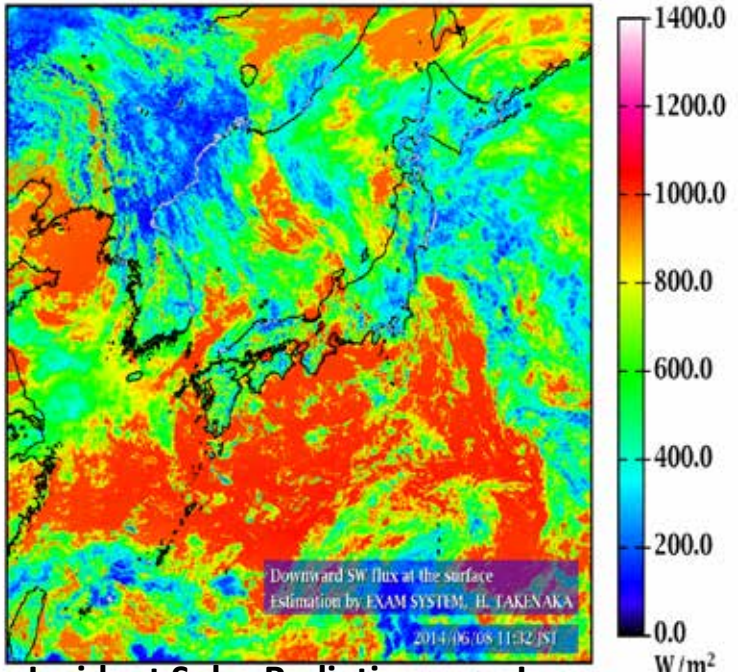
- Builds on NEX
- Open access
- User-funded
- Ideal for prototyping, exploration and community engagement

GOES-NEX Processing Plan



GOES-NEX Near Real-time Products

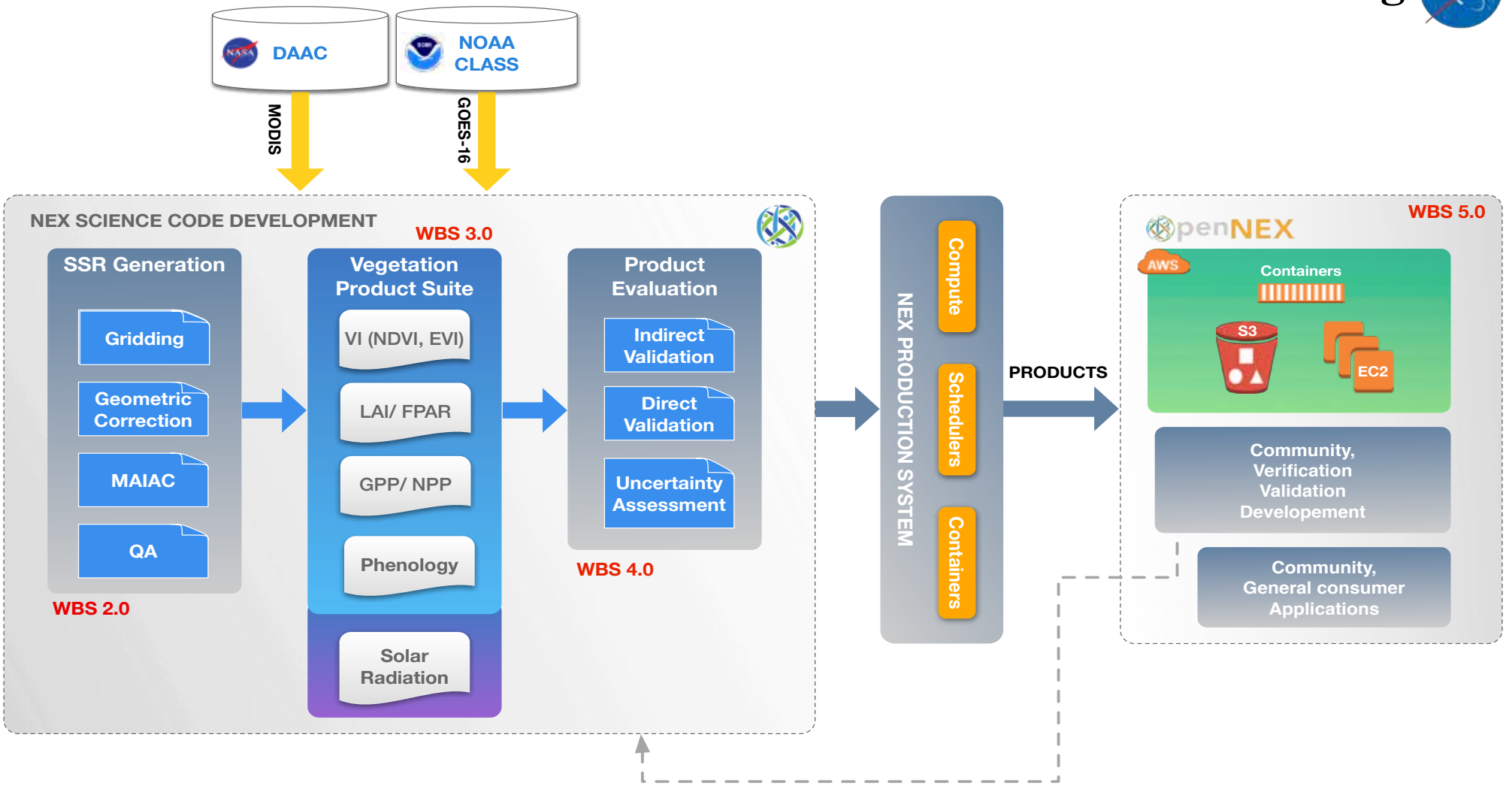
Product	Spatial Resolution	Frequency
Incident solar radiation, w/m2	1km	15 minutes
Photovoltaic Energy, kw/PV	1km	15 minutes
Photovoltaic Energy Forecast – 30 minutes, kw/PV	1km	30 minutes



Incident Solar Radiation over Japan derived from Himawari

GOES-16 from MSFC GRB Reception dish
Product generation at ARC/NEX
Product distribution on AWS, 7 day rotation
Algorithms from JAXA/Chiba University

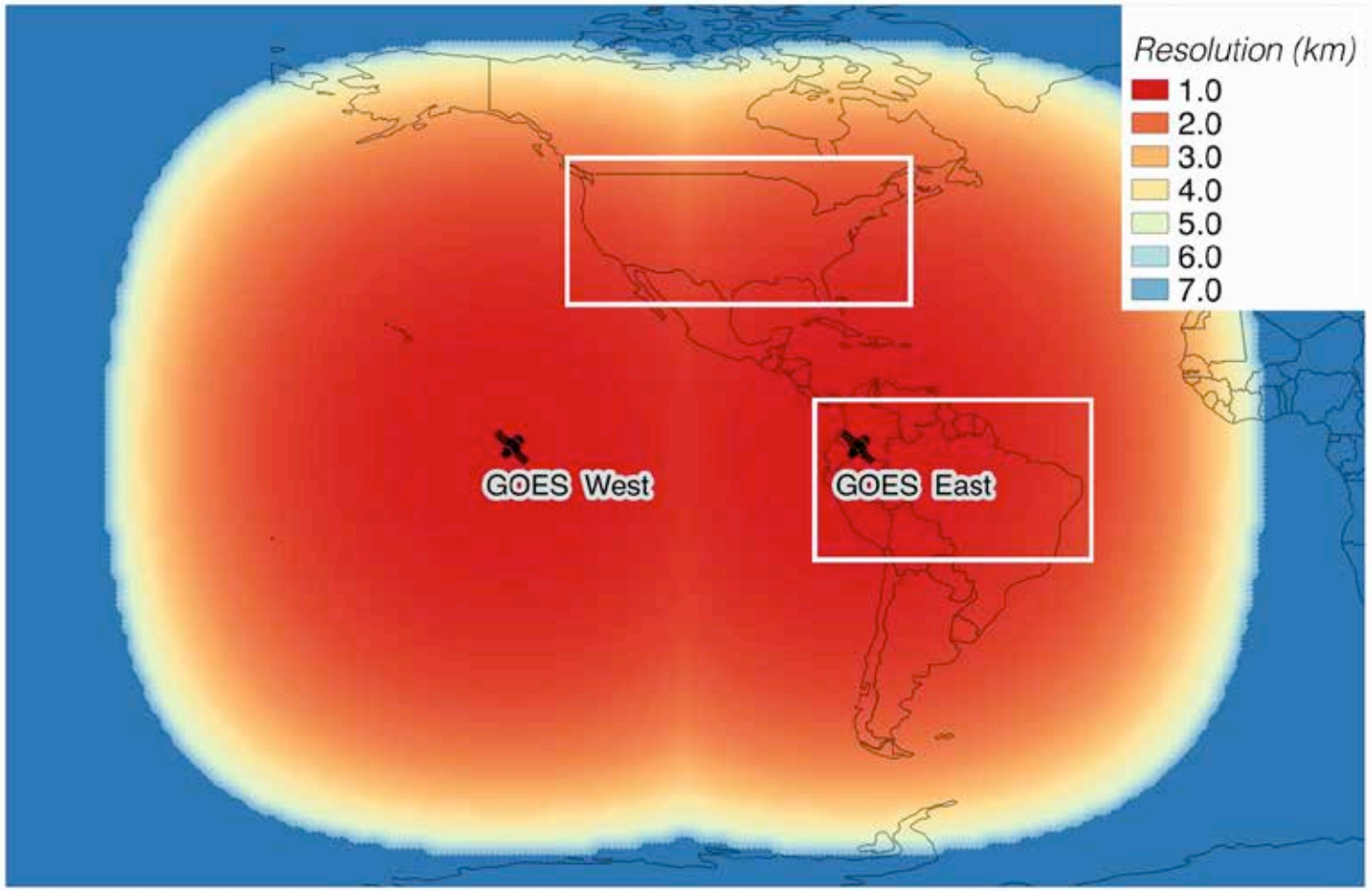
Planned GOES-NEX Land Products Processing



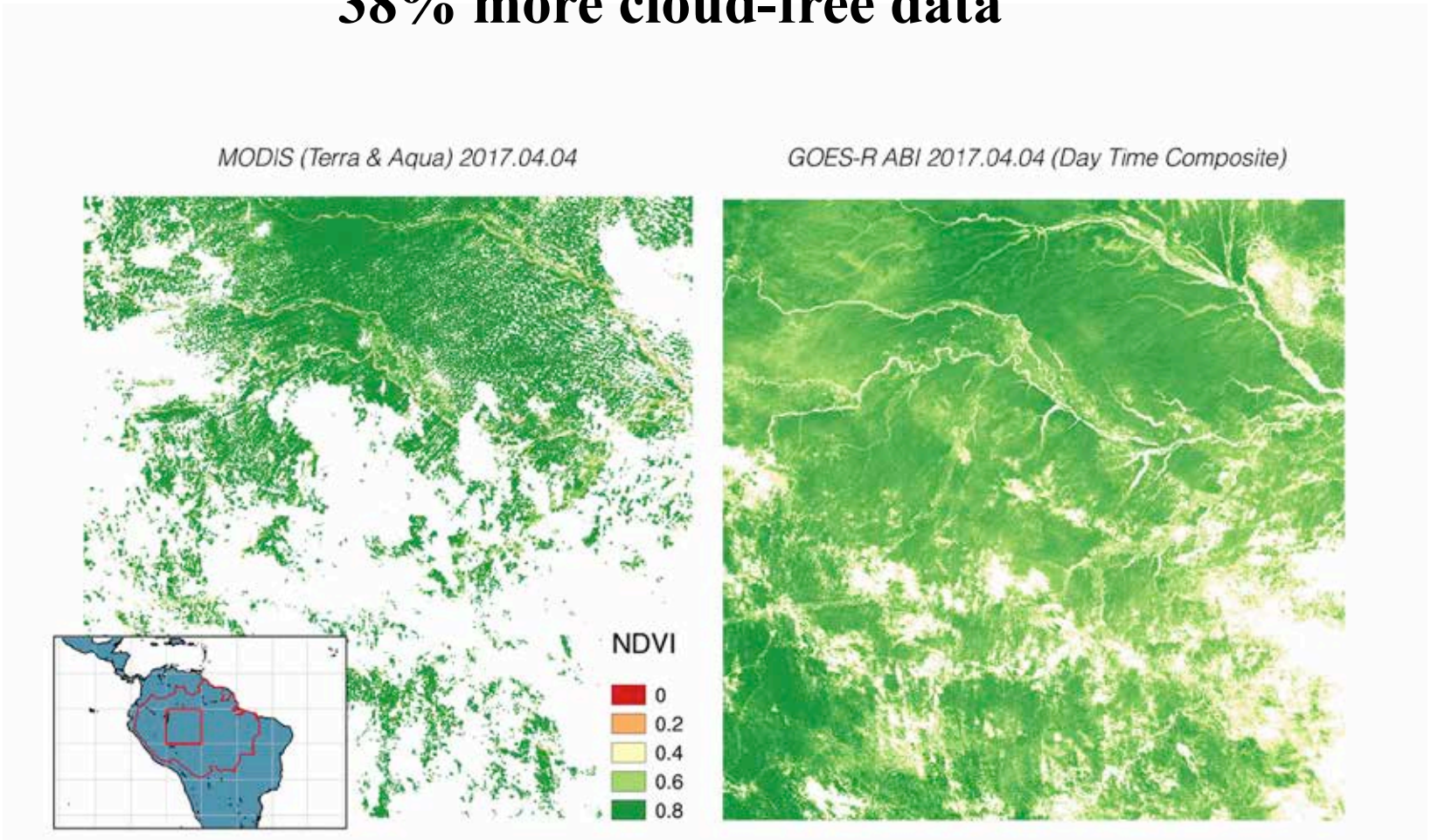
Planned GOES-NEX Land Products

Product	Algorithm	Current use	Frequency (all at 1km)	Remarks related to NOAA products
Surface Reflectances	MAIAC (Lyapustin et al., 2011)	MODIS/VIIRS	daily	NOAA has no plans
Solar Radiation	HIMAWARI (Takaneka et al., 2011)	AHI/HIMAWARI	daily	NOAA plans for 25km/50 km products
Vegetation Index (EVI/NDVI)	MOD13Q1 (Huete et al., 2002)	MODIS/VIIRS	daily/weekly	NOAA plans use top of atmosphere (TOA) data only
LAI/FPAR	MOD15A2 (Myneni et al., 2002)	MODIS/VIIRS	daily/weekly	NOAA has no plans
GPP/NPP	MOD17A2 (Running et al., 1999)	MODIS	hourly/daily/annual	NOAA has no plans
Phenology	MOD12Q2 (Ganguly et al., 2010)	MODIS/VIIRS	annual	NOAA has no plans
QA/QC*	All products	MODIS/VIIRS	daily/annual	

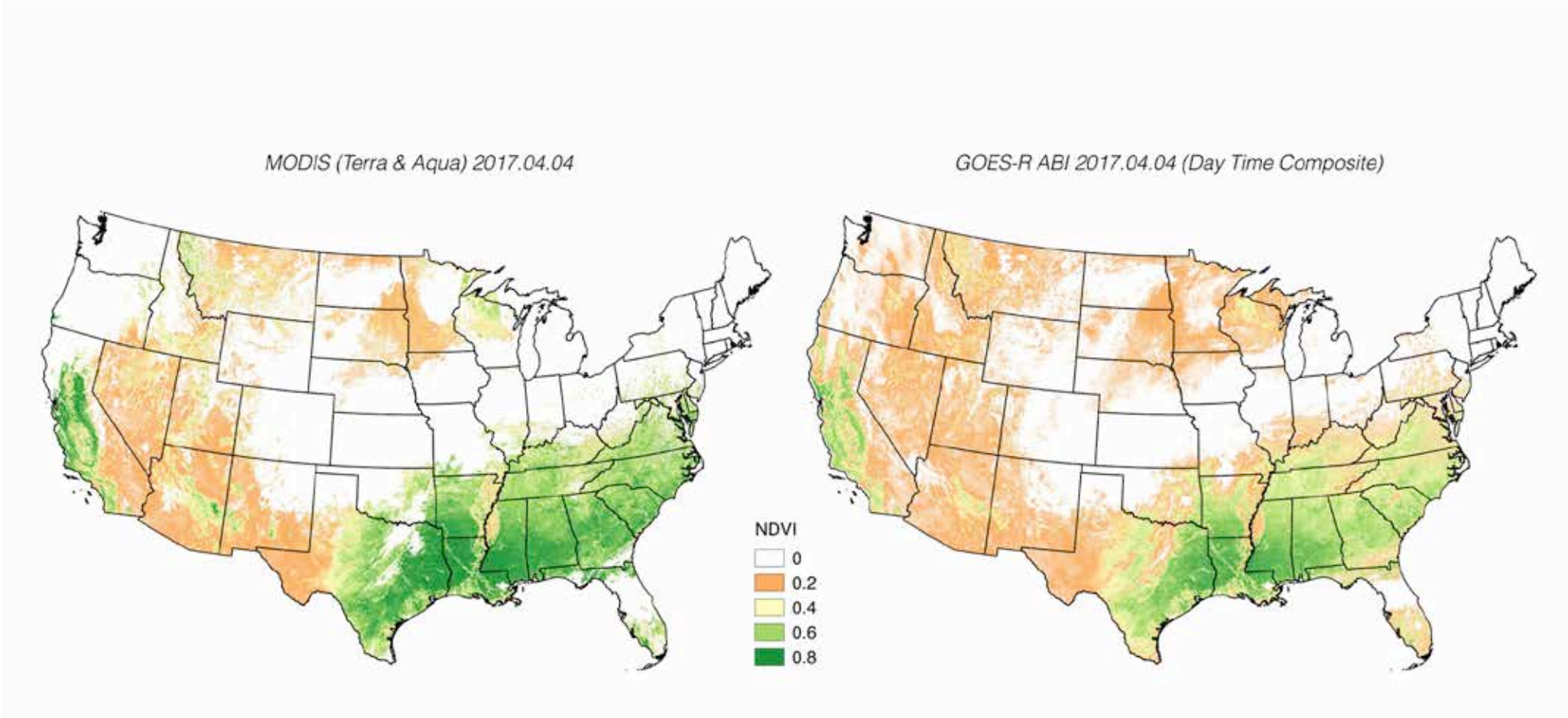
Planned GOES-NEX Land Products



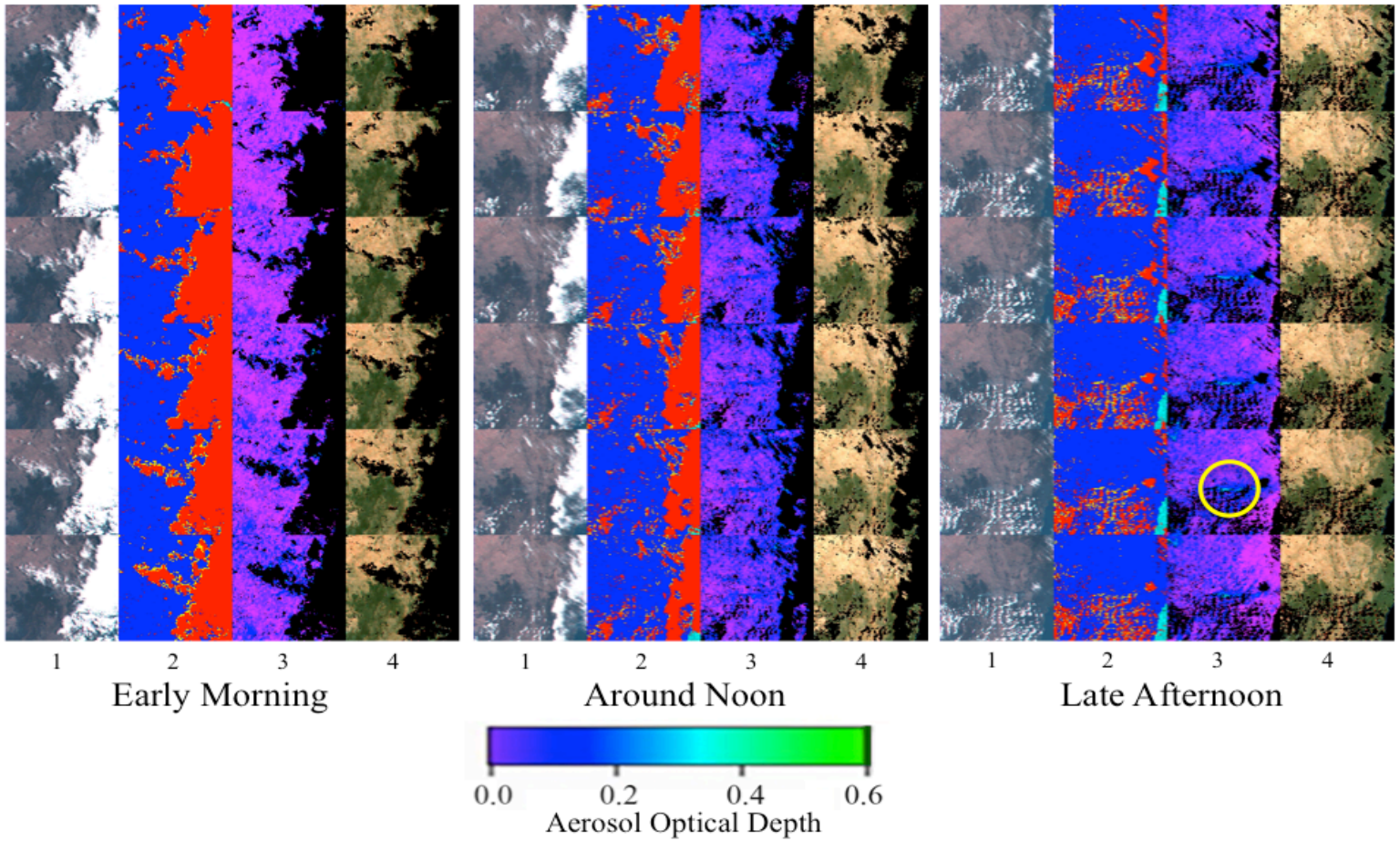
Advantages of GOES-NEX over MODIS, 38% more cloud-free data



Advantages of GOES-NEX over MODIS, 22% more cloud-free data



Multi-Angle Implementation of Atmospheric Correction (MAIAC)



Operational Implementation

Primary Outputs:
Surface Reflectances

Secondary Outputs:

Snow Cover
Cloud Cover
Aerosol Optical Depth
Albedo