Committee on Earth Observation Satellites

Agency Reports - NASA

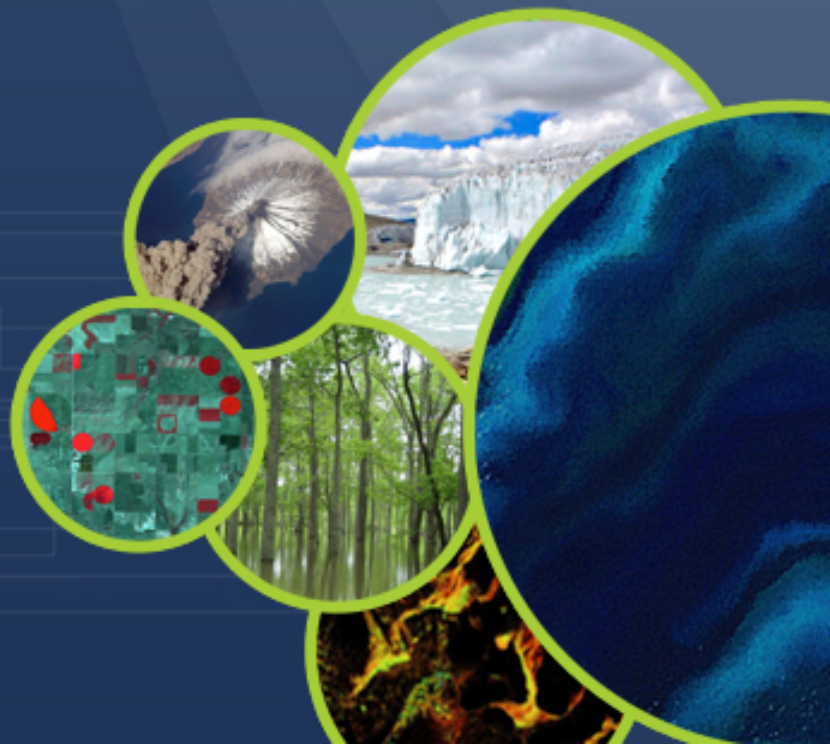
David B. Jarrett

Jeffrey G. Masek

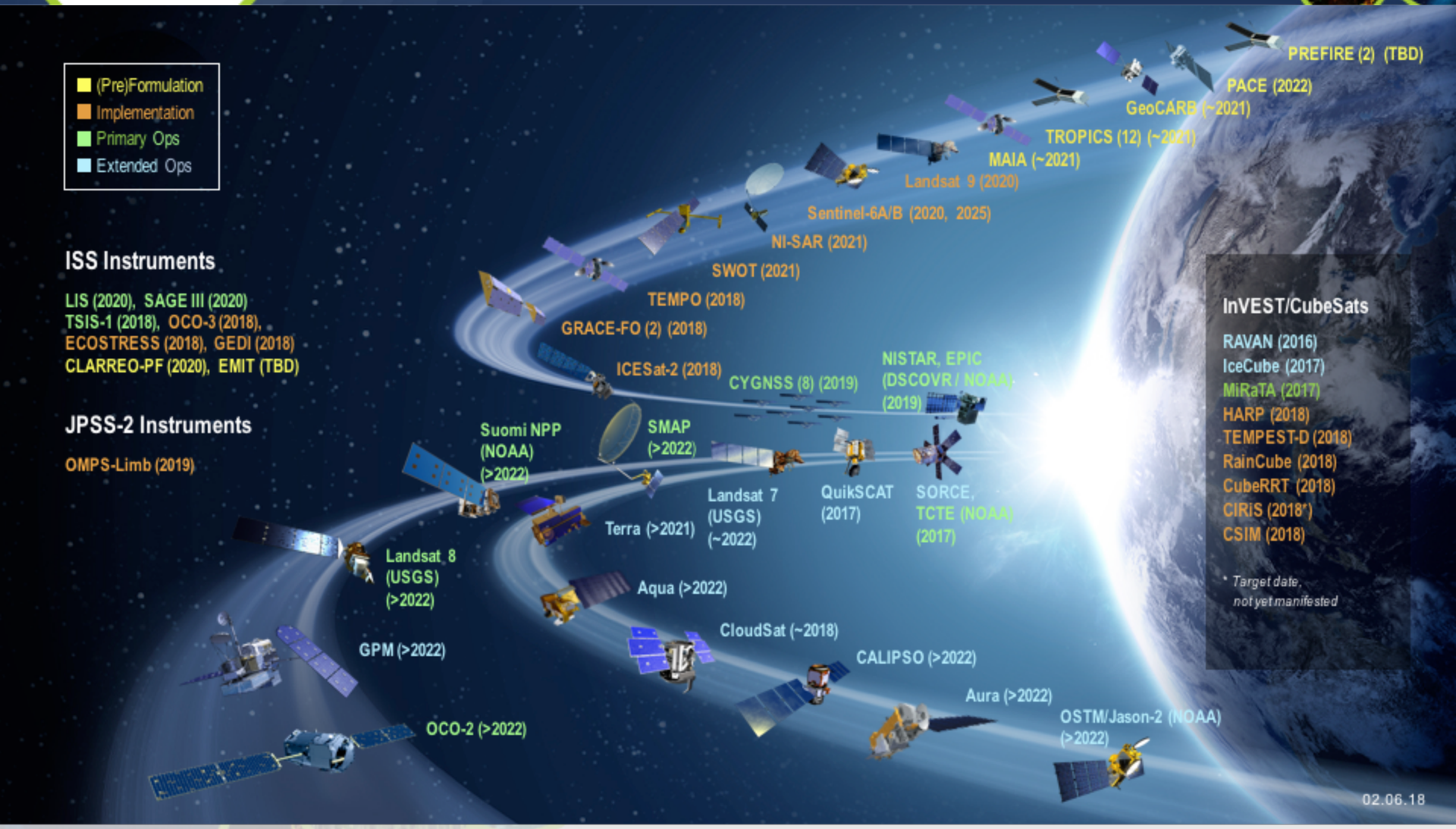
LSI-VC-5

Agenda Item #2-7

February 2018



NASA Earth Science
Missions: Present through 2023



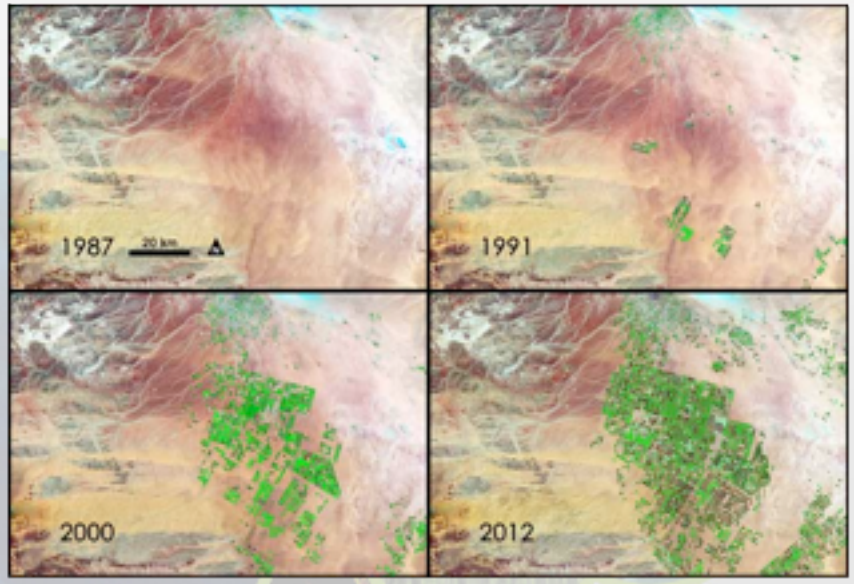
Landsat 9 Mission Overview

Mission Objectives

- Provide continuity in multi-decadal Landsat land surface observations to study, predict, and understand the consequences of land surface dynamics
  - Core Component of Sustainable Land Imaging Program

Mission Team

- NASA Goddard Space Flight Center (GSFC)
- USGS Earth Resources Observation & Science (EROS) Center
- NASA Kennedy Space Center (KSC)



Increase in pivot irrigation in Saudi Arabia from 1987 to 2012 as recorded by Landsat. The increase in irrigated land correlates with declining groundwater levels measured from GRACE (courtesy M. Rodell, GSFC)

Mission Parameters

- Single Satellite, Mission Category 1, Risk Class B
  - 5-year design life after on-orbit checkout
  - At least 10 years of consumables
- Sun-synchronous orbit, 705 km at equator, 98° inclination
- 16-day global land revisit
- Partnership: NASA & USGS
  - NASA: Flight segment & checkout
  - USGS: Ground system and operations
- Launch: FY 2021 (Targeting December 15, 2020), Category 3 Vehicle

Instruments

- Operational Land Imager 2 (OLI-2; Ball Aerospace)
  - Reflective-band push-broom imager (15-30m res)
  - 9 spectral bands at 15 - 30m resolution
  - Retrieves data on surface properties, land cover, and vegetation condition
- Thermal Infrared Sensor 2 (TIRS-2; NASA GSFC)
  - Thermal infrared (TIR) push-broom imager
  - 2 TIR bands at 100m resolution
  - Retrieves surface temperature, supporting agricultural and climate applications, including monitoring evapotranspiration

Spacecraft (S/C) & Observatory Integration & Test (I&T)

- Orbital ATK (OA)

Launch Services

- United Launch Alliance (ULA) Atlas V 401

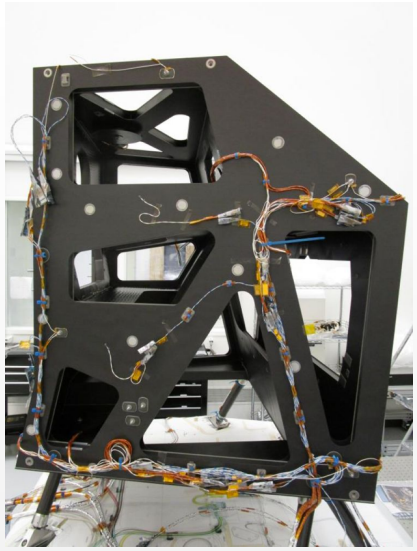
MOC and Mission Operations

- General Dynamics Mission Systems (GDMS)

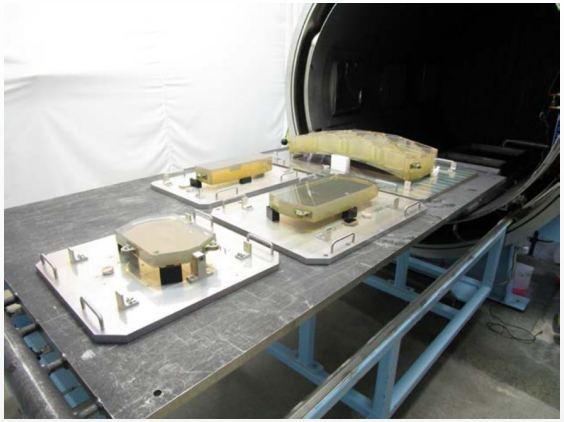
Landsat 9 Status

- Landsat 9 on schedule to launch December 2020
  - Successful Mission Preliminary Design Review (MPDR) was held in September 2017
  - United Launch Alliance Atlas-V was selected as Landsat 9 launch vehicle
  - Spacecraft and Mission Critical Design Reviews to be conducted in February and April 2018, respectively
- Operational Land Imager -2 (OLI-2) under development at Ball Aerospace
  - Focal plane and telescope are complete and tested
  - All indications are that performance will equal or surpass Landsat 8 OLI
- Thermal Infrared Sensor -2 (TIRS-2) under development at GSFC
  - Combined focal plane & telescope were recently characterized in the thermal/vacuum chamber
  - Performance appears very good – substantial improvement in stray light compared to Landsat 8 TIRS
- Ground system under development by USGS
  - Ground System Preliminary Design Review (PDR) to be held March 2018
  - Surface reflectance / temperature Analysis Ready Data (ARD) to be standard USGS Landsat 9 products

Landsat 9 Flight Hardware

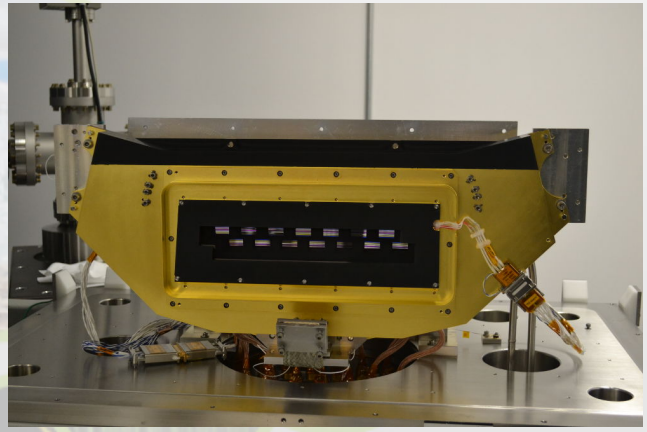


OLI-2 Optical bench

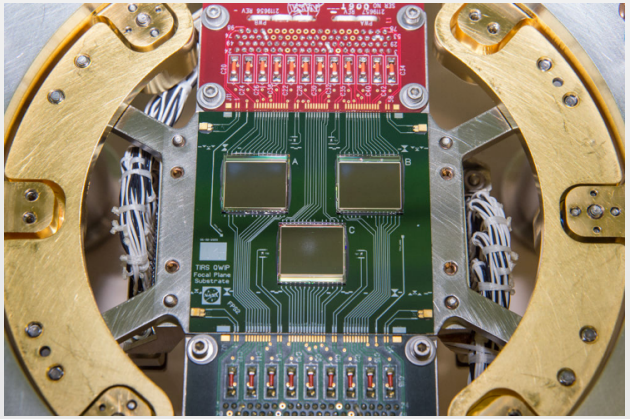


OLI-2 Mirror assemblies

Shimming the TIRS-2 Focal Plane



OLI-2 Focal Plane Assembly



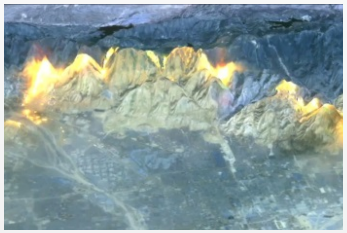
TIRS-2 Focal Plane

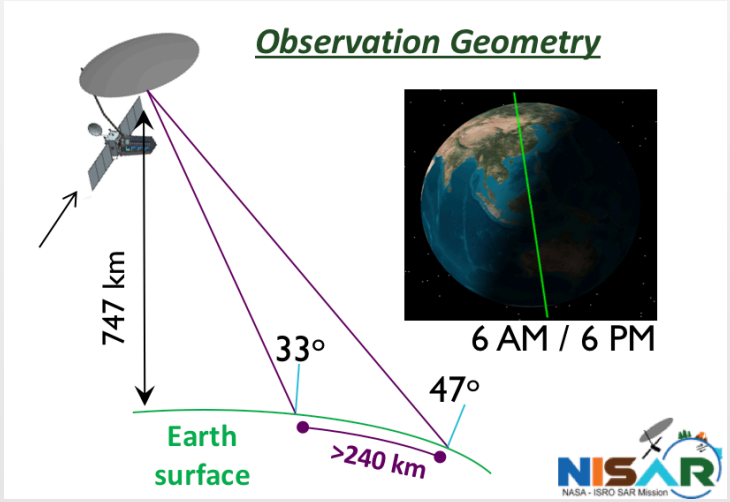
NISAR at a Glance

NISAR Characteristic:	Would Enable:
L-band (24 cm wavelength)	Low temporal decorrelation and foliage penetration
S-band (12 cm wavelength)	Sensitivity to light vegetation
SweepSAR technique with Imaging Swath > 240 km	Global data collection
Polarimetry (Single/Dual/Quad)	Surface characterization and biomass estimation
12-day exact repeat	Rapid Sampling
3 – 10 meters mode-dependent SAR resolution	Small-scale observations
3 years science operations (5 years consumables)	Time-series analysis
Pointing control < 273 arcseconds	Deformation interferometry
Orbit control < 500 meters	Deformation interferometry
> 30% observation duty cycle	Complete land/ice coverage
Left/Right pointing capability	Polar coverage, north and south

NISAR Will Uniquely Capture the Earth in Motion

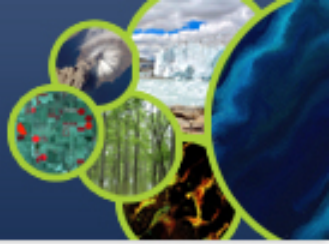




P. Siqueira – NISAR Ecosystems Lead

Multi-Source Land Imaging



- NASA Multi-Source Land Imaging (MuSLI) Team is a research program designed to advance use of multi-source remote sensing data for land monitoring
  - Solicited 2014 through NASA Land Cover/Land Use Change Program
  - Re-competed in 2017 for second three-year cycle
- MuSLI Objectives:
  - Develop algorithms and prototype products that make use of multiple satellite sources & time series approaches
    - *Emphasis on use of Landsat and Sentinel-1 & 2*
    - *Focus on evolving continental-scale products analogous to what is available from MODIS, but at moderate resolution (<100m)*
  - Understand challenges associated with algorithms & processing streams that incorporate multiple satellite systems

ESA-NASA Multi-Source Research Cooperation

Toward a Common US & European Research Community…

- Coordination of parallel research calls from ESA and NASA on land imaging (e.g. Multi-Source Land Imaging and DUE Innovator calls)
- MuSLI proposals strongly encouraged to have international collaboration
- Joint meetings for science exchange
  - ESA S2 for Science
  - NASA LCLUC meetings
  - EARSeL Land Cover
  - ESA Living Planet

2014-2017 MuSLI Projects

Project Title	PI	International Collaborators
Multisource Imaging of Seasonal Dynamics in Land Surface Phenology	Friedl/BU	Eklundh / Lund
Integrating Landsat 7, 8 and Sentinel 2 Data in Improving Crop Type Identification and Area Estimation	Hansen/UMD	Defourny / Louvain
Towards Near Daily Monitoring of Inundated Areas Over North America Through Multi-Source Fusion of Optical and Radar Data	Lang / UMD	Creed / Western
Prototyping a Landsat-8/Sentinel-2 Global Burned Area Product	Roy / SDSU	Chuvieco / Alcala; Tansey / Leicester
Operational Algorithms and Products for Near Real Time Maps of Rice Extent and Rice Crop Growth Stage Using Multi-Source Remote Sensing	Salas / Applied Geosystems	Hoekman / Wageningen; Le Toan / CESBIO
Multi-Source Imaging of Infrastructure and Urban Growth Using Landsat, Sentinel and SRTM	Small / Columbia U	Esch / DLR
Multi-Source Imaging of Time-Serial Tree and Water Cover at Continental to Global Scales	Townshend / UMD	Schmullius /Jena

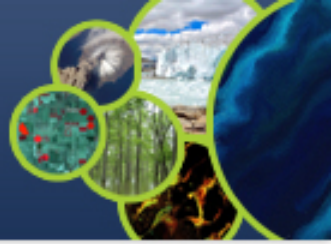
2018-2020 MuSLI Projects

Mark Friedl (Boston U)	An Operational Multisource Land Surface Phenology Product from Landsat and Sentinel 2
David Roy (South Dakota State U.)	Africa Burned Area Product Generation, Quality Assessment and Validation - Demonstrating a Multi-Source Land Imaging (MuSLI) Landsat-8 Sentinel-2 Capability
Crystal Schaaf (U. Mass - Boston)	Circumpolar Albedo of Northern Lands from Landsat-8 and Sentinel-2
Martha Anderson (USDA)	Characterizing Field-Scale Water Use, Phenology and Productivity in Agricultural Landscapes Using Multi-Sensor Data Fusion
Petya Campbell (U. Maryland - Baltimore County)	Prototyping MuSLI canopy Chlorophyll Content for Assessment of Vegetation Function and Productivity
Glynn Hulley (JPL)	A High Spatio-Temporal Resolution Land Surface Temperature (LST) Product for Urban Environments
Volker Radeloff (U. Wisconsin)	Monitoring Abandoned Agriculture, Fallow Fields, and Grasslands with Landsat and Sentinel-2
Sergii Skakun (U. Maryland - College Park)	Crop Yield Assessment and Mapping by a Combined use of Landsat-8, Sentinel-2 and Sentinel-1 Images

Type 1: Continental-scale products

Type 2: Regional-scale prototypes

Analysis Ready Data



- NASA directly supports data products from one operational, moderate-resolution imaging system (ASTER on Terra) and three operational coarse-resolution systems (Terra MODIS, Aqua MODIS, NPP VIIRS).
  - ASTER: Surface reflectance (AST07) and Surface Temperature (AST08) data products are available in UTM projection, with a variety of QA-relevant metadata.
  - MODIS: MODIS surface reflectance and surface temperature products are available operationally, with full QA metadata, and gridded as sinusoidal tiles at 250m, 500m, and 1000m resolutions. They are compliant with the CEOS ARD Spec.
- Beginning in 2022 (TBR), NASA will also begin distributing data from the NISAR L-band instrument.

NASA Research Products

- In addition, NASA has supported generation of research products that advance ARD capabilities, for example:
  - Web-Enabled Landsat Data (WELD) products (D. Roy, South Dakota State U) – gridded, tiled reflectance products composited from “Best clear” Landsat observations on weekly, monthly, and seasonal basis. Sinusoidal projection.

- Harmonized Landsat/Sentinel-2 (HLS) products (NASA GSFC) – gridded, tiled reflectance products derived from both Landsat 8 and Sentinel-2, with corrections applied to minimize sensor-specific differences.