The NASA LCLUC Program Update to the FIRST In-Person Joint SCERIN-MedRIN meeting

GARIK GUTMAN,
LAND-COVER/LAND-USE CHANGE PROGRAM MANAGER,
NASA HEADQUARTERS
WASHINGTON, DC

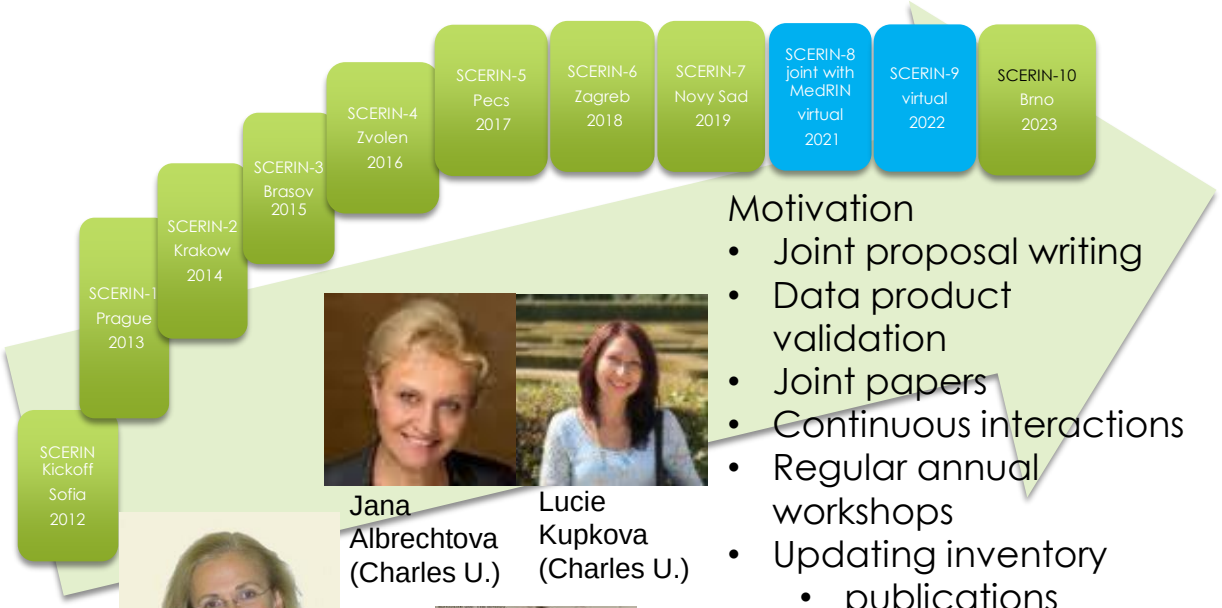
Crete – Κρήτη - *Kríti*

- The largest and most populous of the Greek islands
- The center of Europe's first advanced civilization, the Minoans, from 2700 to 1420 BC (Minos - son of Zeus and Europa)
- Greece → Rome → the Byzantine Empire → Andalusian Arabs → the Venetian Republic → the Ottoman Empire
- Achieved independence from the Ottomans in 1898
- Part of Greece since December 1913

More on Crete

- Record highest temperatures ever recorded in Europe during October-February from World Meteorological Organization stations
- Effects of tourism:
  - 1960 to 1970 positive: modern developments, e.g., running water and electricity onto the largely rural countryside
  - Since 1970s negative: overuse of natural resources
- Air-space connection: Icarus and Daedalus were held captives by King Minos, then crafted wings to escape → first attempts in air gliding → didn't finish well...

South/Central Eastern Europe Regional Information Network (SCERIN)



Jana Albrechtova (Charles U.)

Lucie Kupkova (Charles U.)

Petya Campbel (NASA/UMD)

Olga Brovkina (Czech Globe)

Motivation

- Joint proposal writing
- Data product validation
- Joint papers
- Continuous interactions
- Regular annual workshops
- Updating inventory
  - publications
  - projects
  - funding
- Educational component
  - Trans-Atlantic Training adjacent to SCERIN workshops

SCERIN: March Over the Old Empire

Mediterranean Regional Information Network (MedRIN)

MedRIN Kickoff Chania 2018

MedRIN-1 Paphos, Cyprus 2019

MedRIN-2-SCERIN joint virtual 2021

MedRIN-3 Paphos, Cyprus 2022

MedRIN-4 Paphos, Cyprus 2023

MedRIN-5-SCERIN Joint, Chania 2024

Vince Ambrosia (NASA, emeritus)

Florian (Max) Schwander (NASA Ames)

Ioannis Gitas (**Aristotle U. Thessaloniki**)

Diofantos Hadjimitsis (**Cyprus** U. Technology)

Motivation

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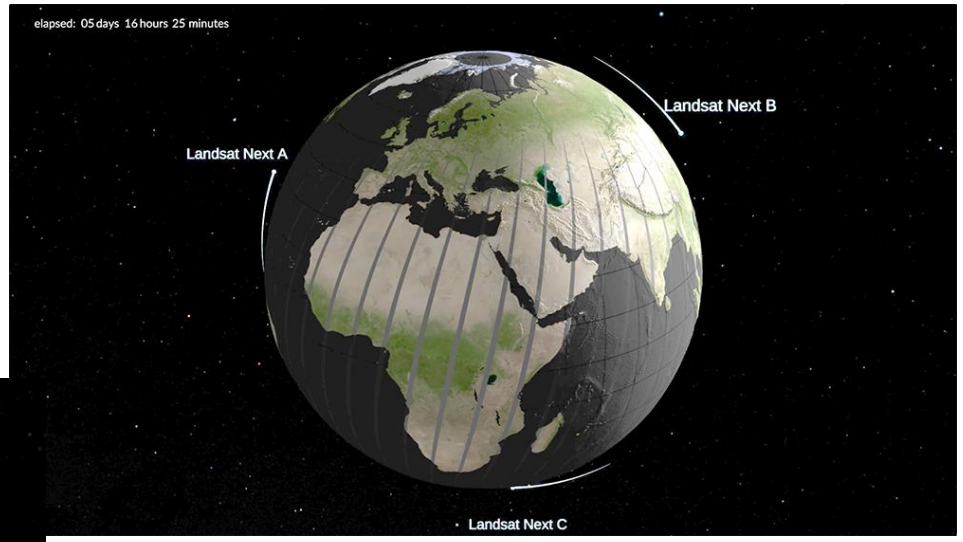
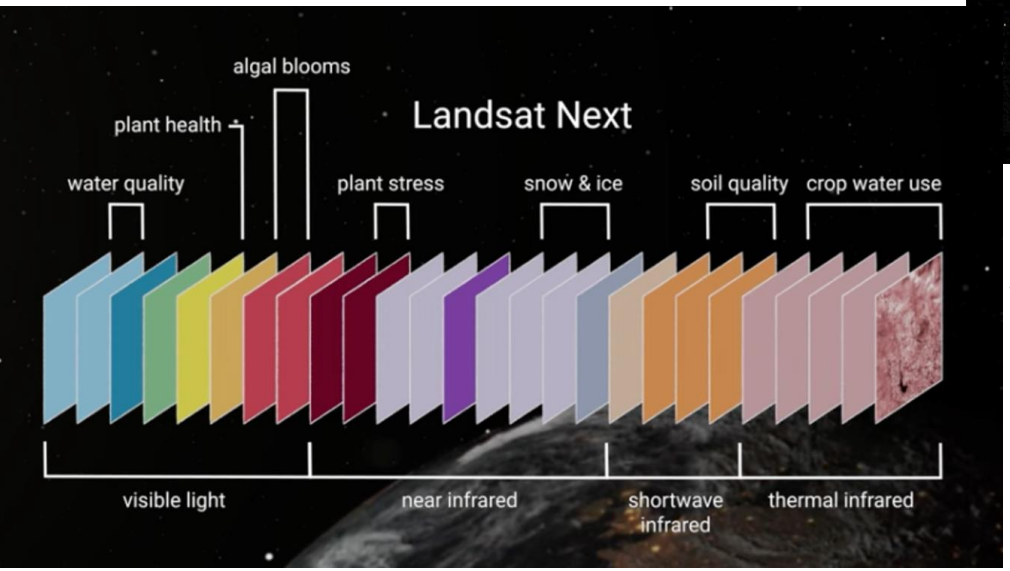
MedRIN: March Over the Hellenistic World

NASA Operating Missions in the Past 25 years

Landsat Next

- Constellation of 3 small satellites
- 26 wavelengths bands
- More frequent and finer resolution
- Launch late 2030





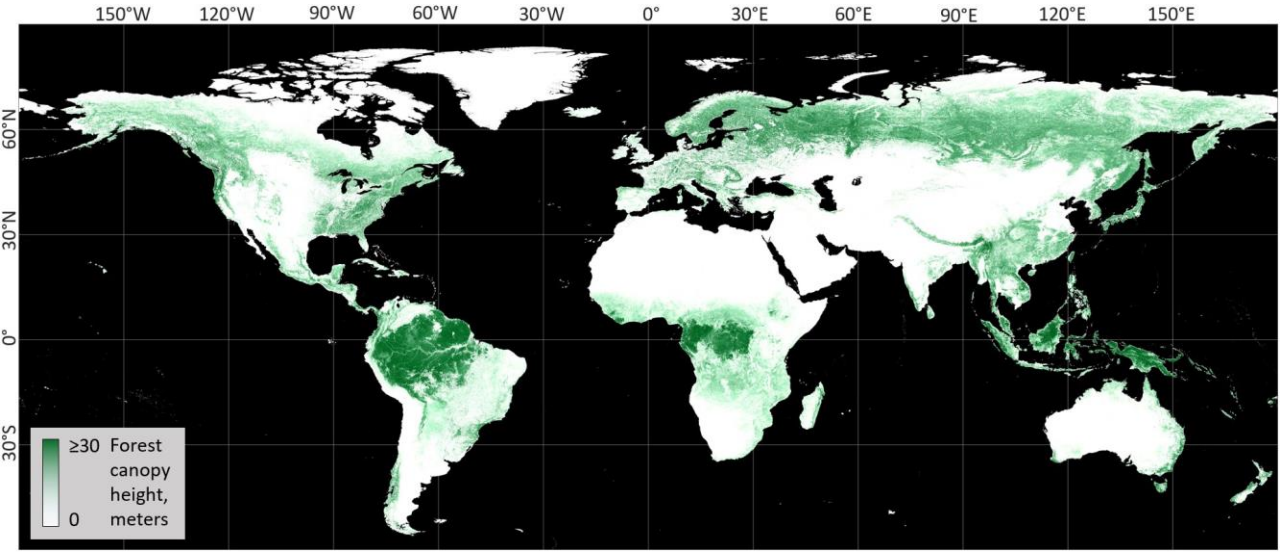
Landsat Next constellation of three spacecraft will provide finer spatial resolution (10-20m) and expanded spectral (26 band) imaging capabilities every six days (at the equator)

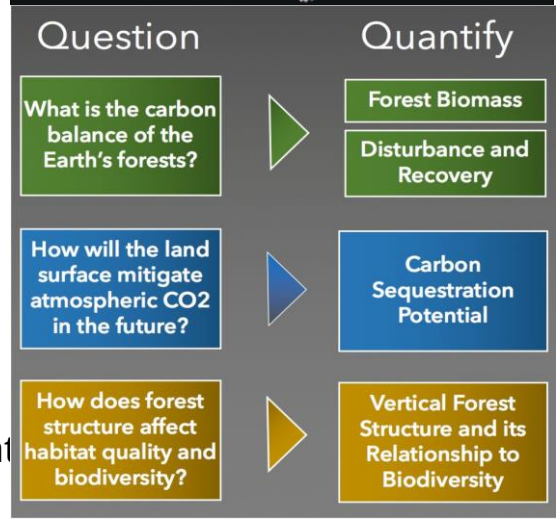
Global Ecosystem Dynamics Investigation
NASA GEDI instrument on ISS

- High resolution laser ranging observations
  - Launched June 29, 2018
  - three lasers produce eight parallel tracks of observations
  - each laser fires 242 times per second and illuminates a 25 m spot (a footprint) on the surface

GLAD Global Land Analysis & Discovery

Global Forest Canopy Height: 2019



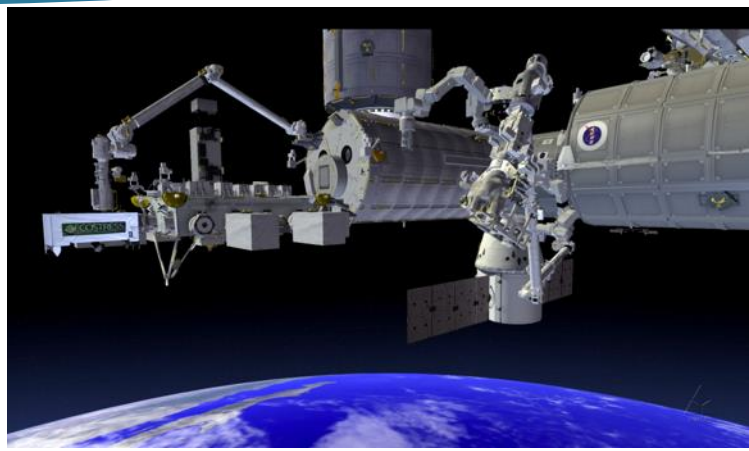


Integration of the GEDI lidar forest structure measurements and Landsat analysis-ready data time-series

ECOSTRESS: NASA Instrument on ISS

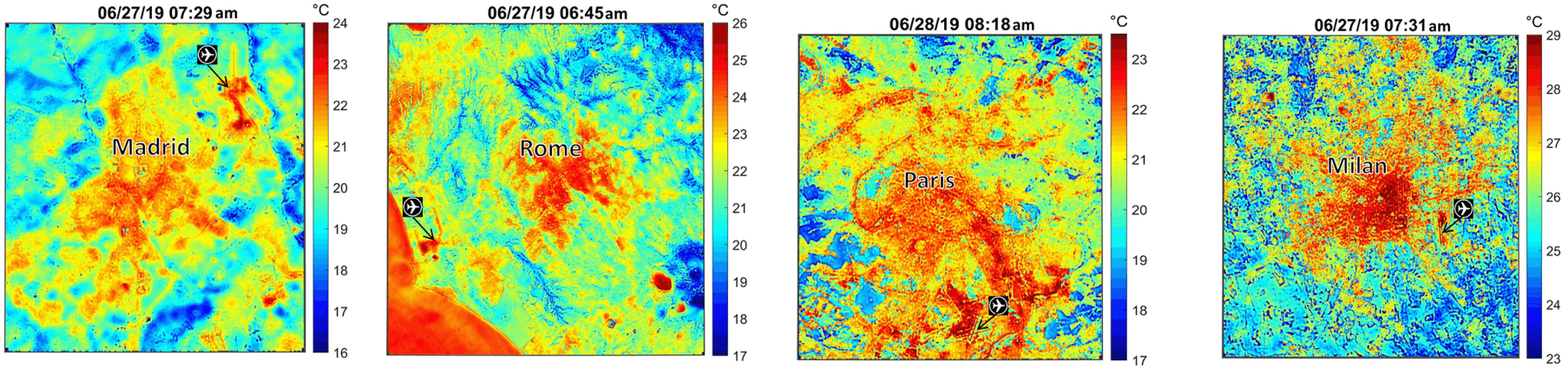
ECOsystem Spaceborne Thermal Radiometer Experiment on the International Space Station (ISS)

- Prototype HyspIRI **Thermal Infrared** Radiometer
  - Launched June 29, 2018
  - 5 spectral bands in the 8-12.5 μm range +1.6 μm
  - Spatial resolution ~70 m
  - **Advantage** over ASTER (on TERRA) – more frequent revisit



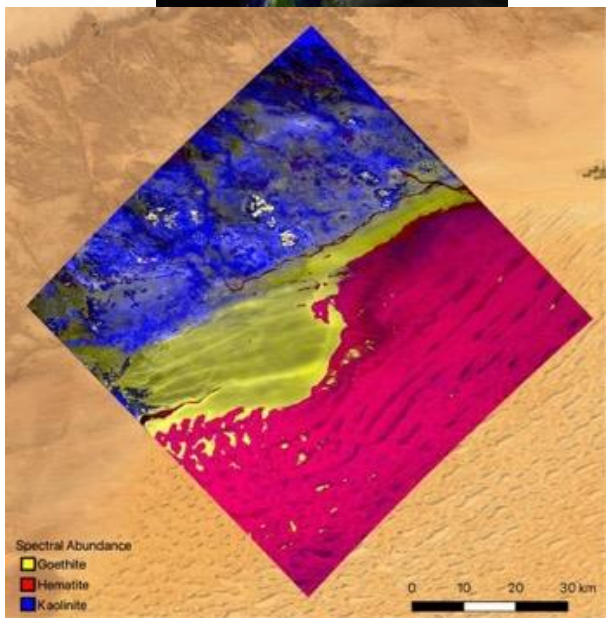
Credit: NASA/JPL-Caltech

Heatwave over Europe: June 2019



EMIT on ISS
Earth Surface Mineral Dust Source Investigation

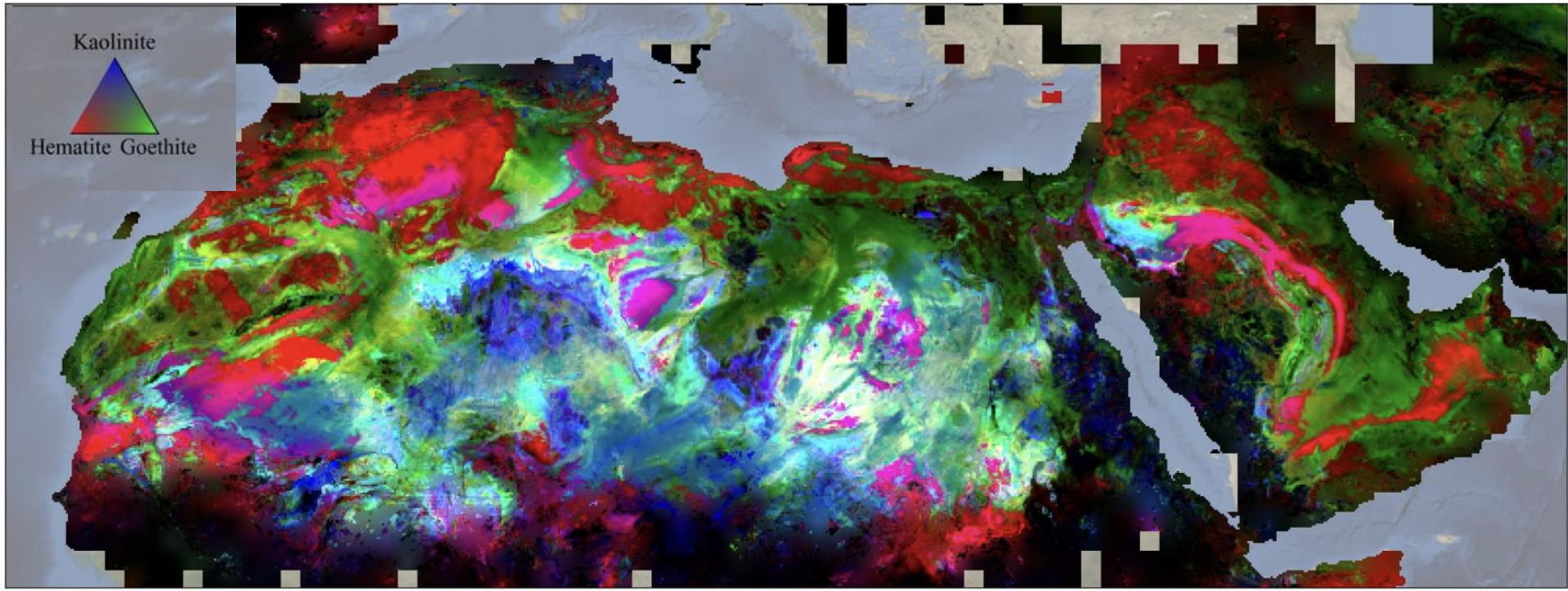
- Launched in July 2022
- Advanced imaging spectrometer with spectral range: 380-2500 nm
- **Primary applications: mineral dust, its heating and cooling effects in the atmosphere**
- **Potential other applications**
  - **natural hazards (** flood extent, ecosystem impacts, and surface water sediment load)
  - **environmental pollution (**oil spills, ocean plastics, acid mine drainage, etc.)
  - **coastal waters and harmful algal blooms (**ocean phytoplankton, harmful algal bloom biomass and composition, coral presence and bleaching events, and the health of coastal ecosystems)



EMIT first light: The mineral map in southwestern Libya in the Sahara Desert

Credit: JPL

Mineral Composition of North Africa and Middle East



NASA's EMIT produced its first global maps of hematite, goethite, and kaolinite in Earth's dry regions using data from the year ending November 2023. The mission collected billions of measurements of the three minerals and seven others that may affect climate when lofted into the air as dust storms

NASA-CNES Surface Water and Ocean Topography (SWAT)

- SWOT's 120-km-wide swath with overlaps over most of the globe with an average revisit time of 11 days
- Launched Dec 16, 2022
- On land, it will collect data on lakes and reservoirs larger than 62,500 m^2 and rivers wider 100 m with 50-m spatial and 10-cm height resolutions
- All weather - penetrate cloud cover and the dark of night

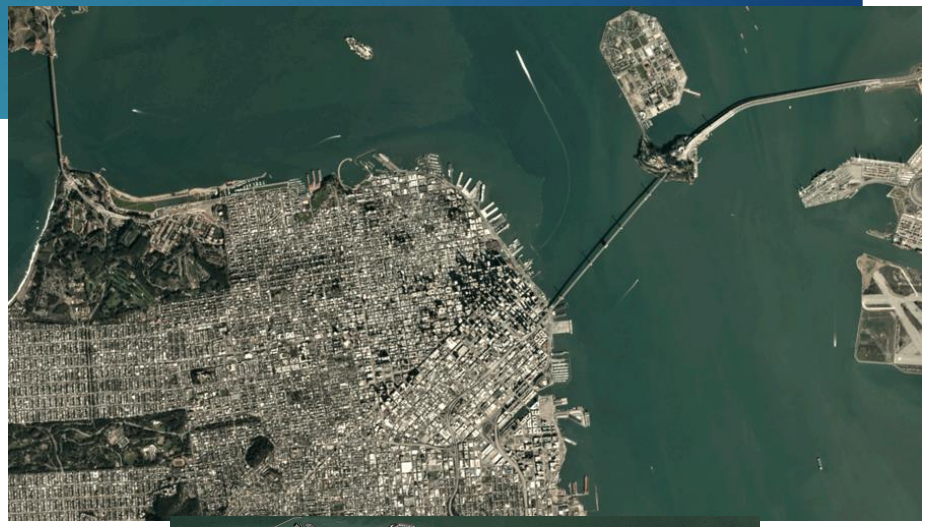
SWOT will survey nearly all water on Earth's surface for the first time with Ka-band Radar Interferometer (KaRIn, frequency between 26.5 and 40 GHz)

NASA-ISRO SAR (NISAR)

- Will observe Earth's land and ice-covered surfaces globally with 12-day repeat cycle
- Swath of 242 km
- Resolution 3–48 m for L-band
- Resolution of 3-24 m for S-band
- Planned Launch Date: 2024
- Will observe the distribution of vegetation and biomass to better understand ecosystems' responses to disturbance and recovery
- Will map above-ground woody biomass density for estimating carbon emissions from land-use change with much more accuracy

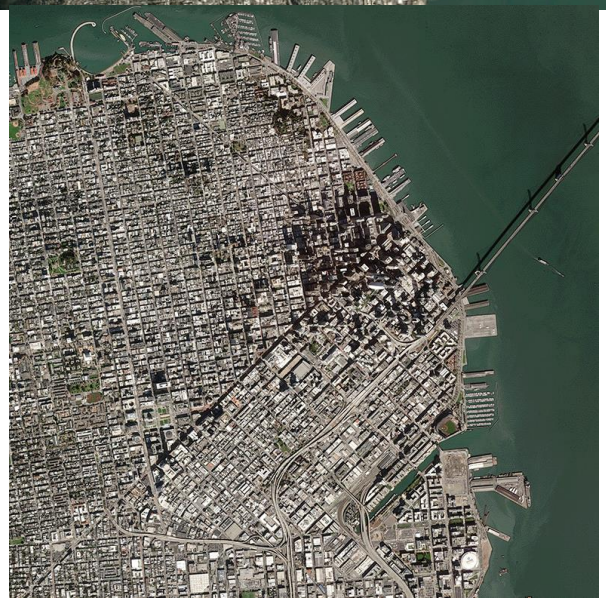
L-band (24 cm) and S-band (12 cm) polarimetric SAR

Using Very High- Resolution Observations



Commercial satellites offer images at fine spatial scale and high temporal resolution

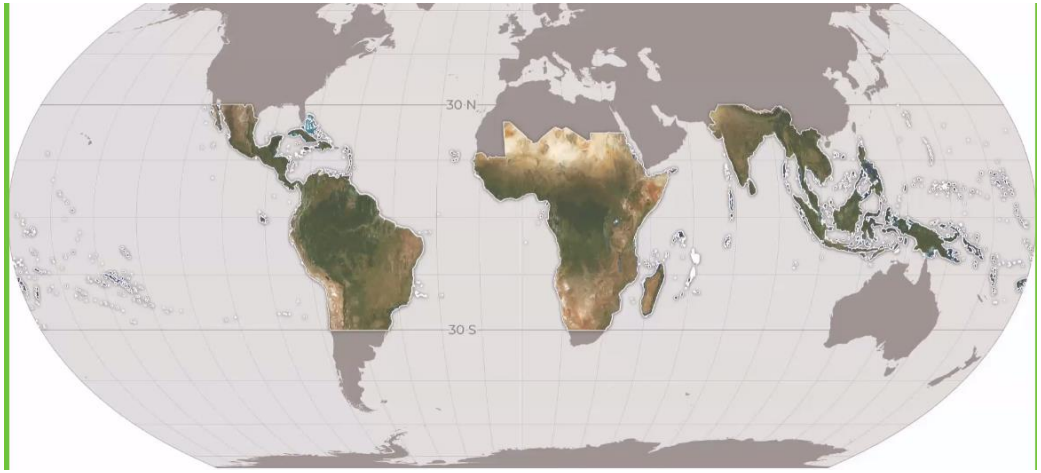
- The first NASA Data Buy 2003 – Ikonos
- Planet Labs constellation (>200 sats) acquire daily images of the Earth with 3-m resolution
- Maxar (Digital Globe, WorldView) with 1m resolution



- NASA Commercial Smallsat Data Acquisition (CSDA)
- Limited Planet datasets are available for free at Universities
- Wall-to-wall VHR data over tropics purchased by the government of Norway (to tackle tropical deforestation)
- **Special Issue in Remote Sensing (2020) on applications of VHR data in LCLUC studies**

VHR Data Availability: the Good News

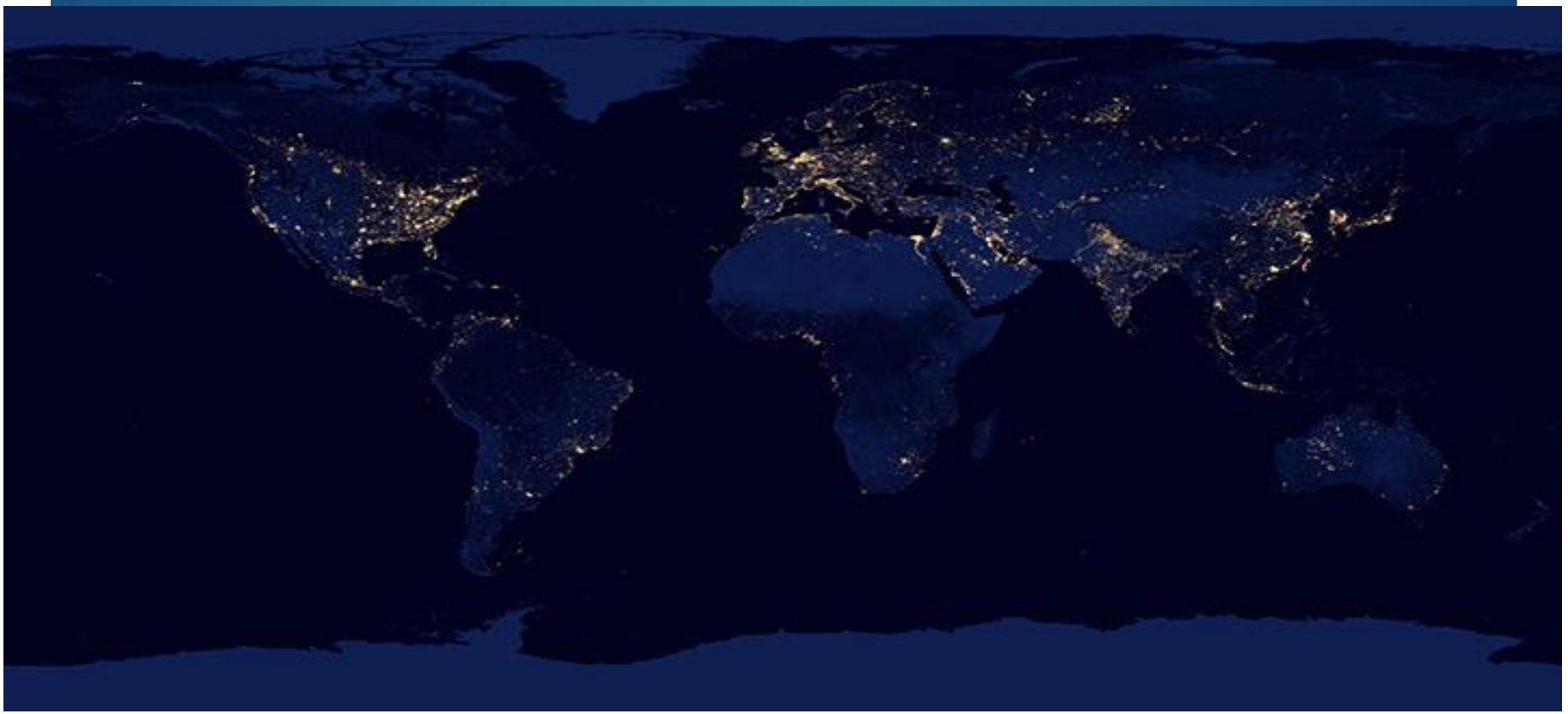
- Norway's International Climate and Forest Initiative (NICFI) 30°N-30°S mosaics (<5m) based on Planet data
  - Monthly mosaics: Sep 2000- end of 2024
  - Bi-annual mosaics: Dec 2015 – Aug 2020
- Access: www.planet.com/nicfi
- Bezos Earth Fund announced a new partnership with NICFI to continue providing the world with free access to high-resolution satellite data to support efforts to stop the destruction of the world's rainforests.



The partnership adds to the USD 43 million previously granted by NICFI to establish the NICFI Satellite Data programme and complements the Bezos Earth Fund's investments in protecting tropical forests and enhancing data, monitoring and accountability.

Global Forest Watch Project https://www.globalforestwatch.org

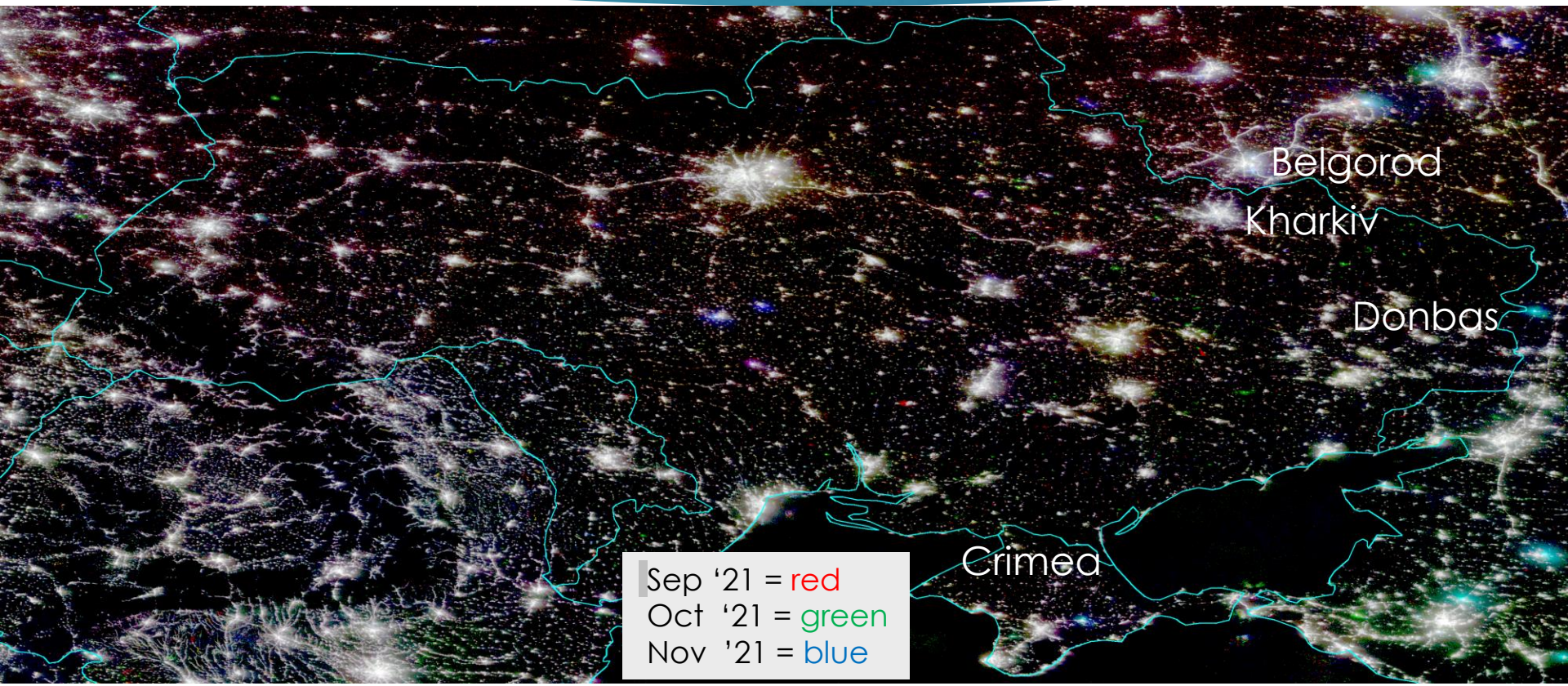
Global Night Lights: VIIRS/Suomi-NPP



VIIRS (742 m^2 /14 bit as compared to Suomi-NPP OLS 5km^2/ 6 bits)

The Night Lights composite assembled from data acquired by the Suomi National Polar-orbiting Partnership (Suomi-NPP) satellite over nine days in April 2012 and thirteen days in October 2012.

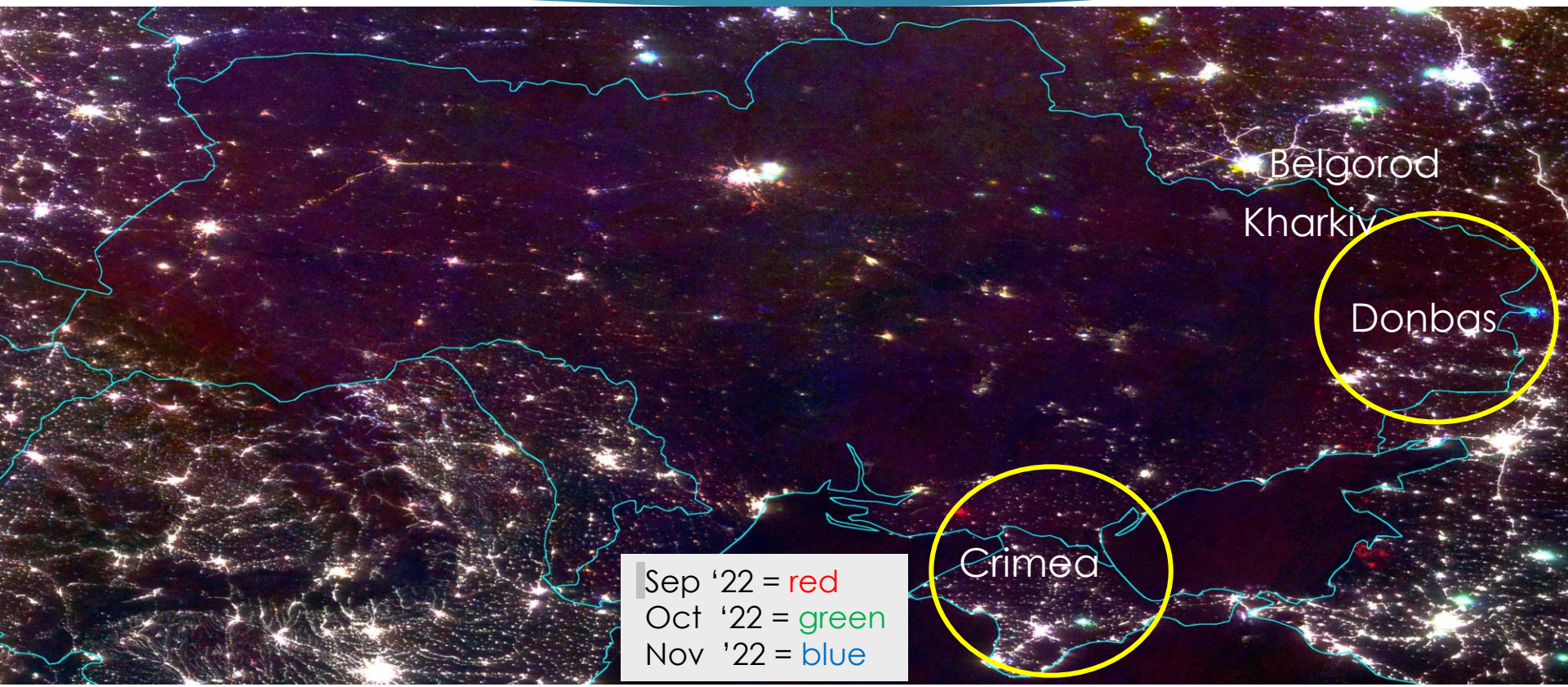
2021 Pre-war Condition: Ukraine



2021 VIIRS nighttime lights red-green-blue composite: Sep = red, Oct = green, Nov = blue. The white tones indicate the brightness of lighting is near equal in all three months.

Courtesy: Chris Elvidge (School of Mining)

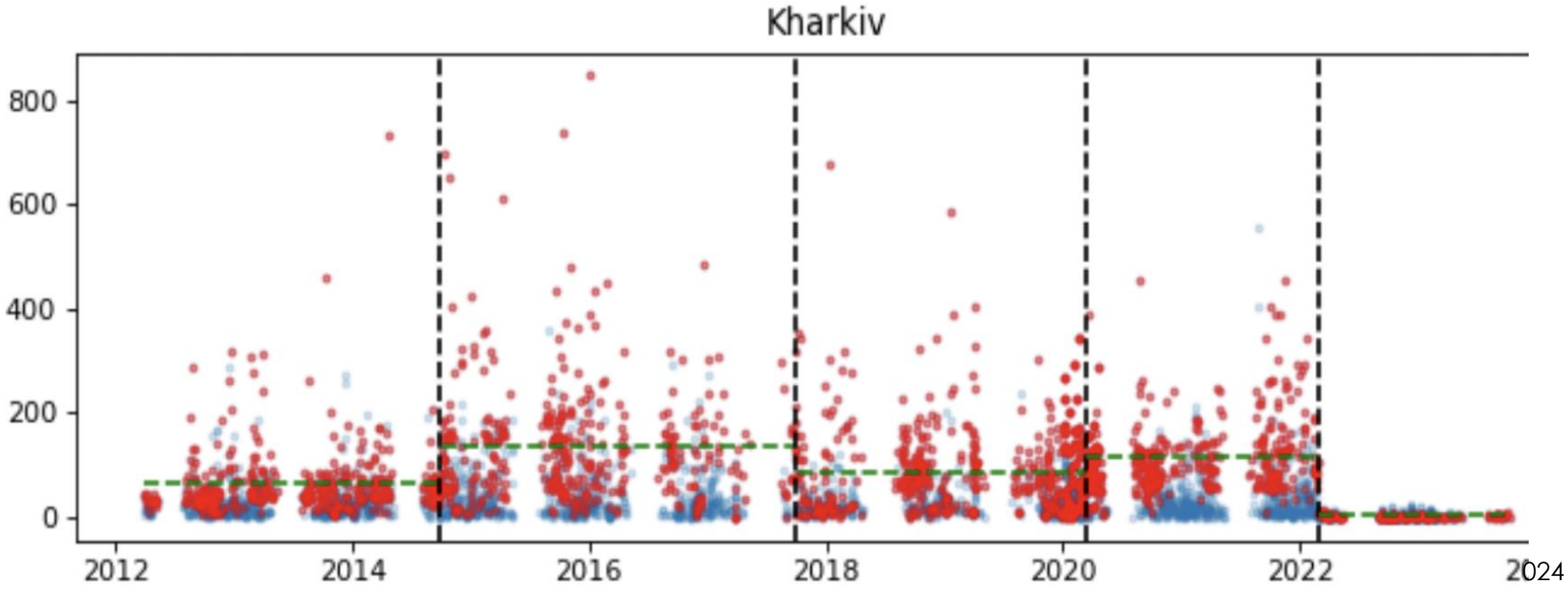
2022 War Impacted Condition



2022 VIIRS nighttime lights red-green-blue composite: Sep = red, Oct = green, Nov = blue. The white tones indicate the brightness of lighting is near equal in all three months in Russia-controlled areas.

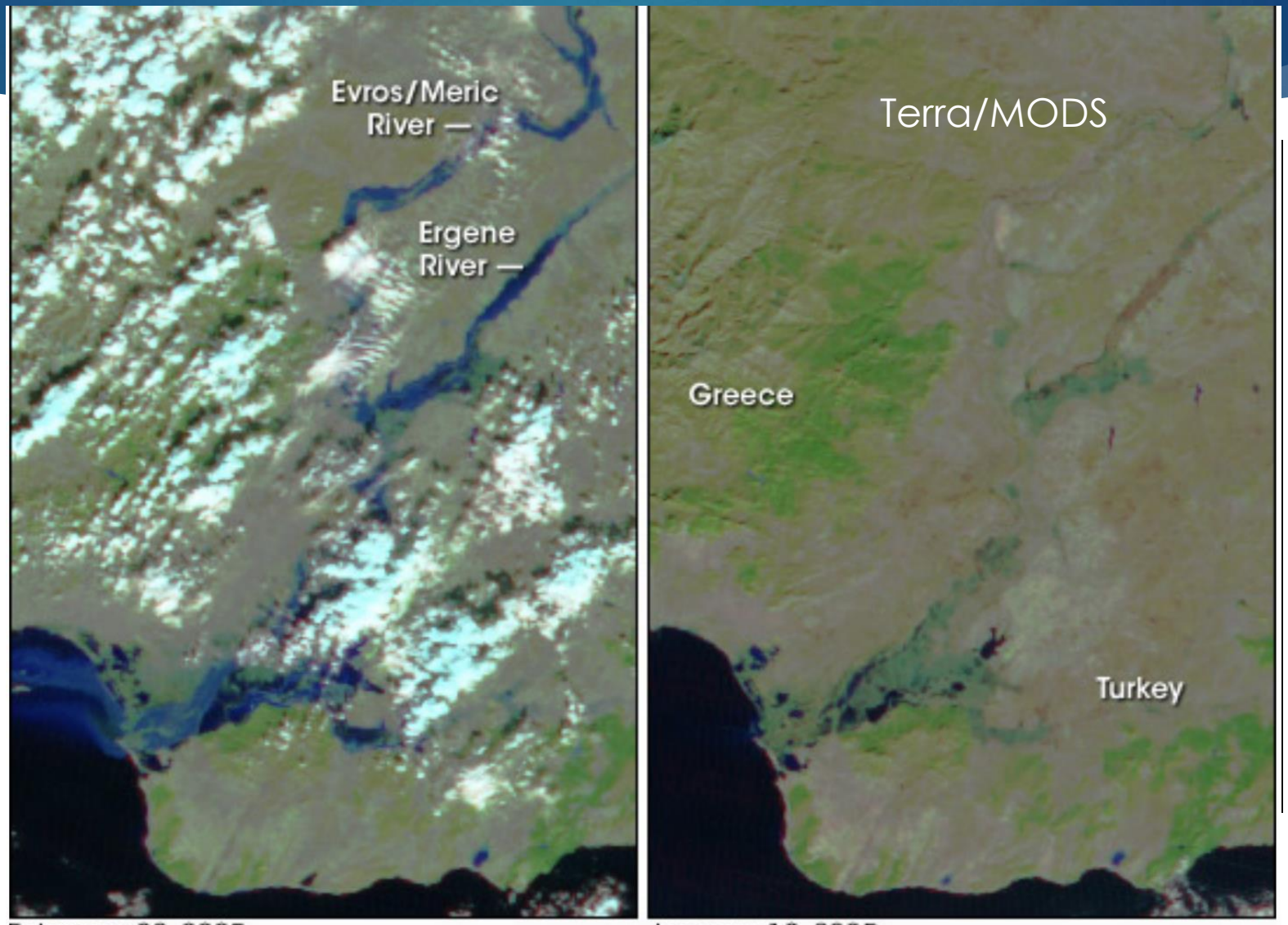
Courtesy: Chris Elvidge (School of Mining)

Kharkiv's VIIRS Nighttime Lights Through Years



red dots – clear
Blue dots - cloudy

Floods Don't Know Borders



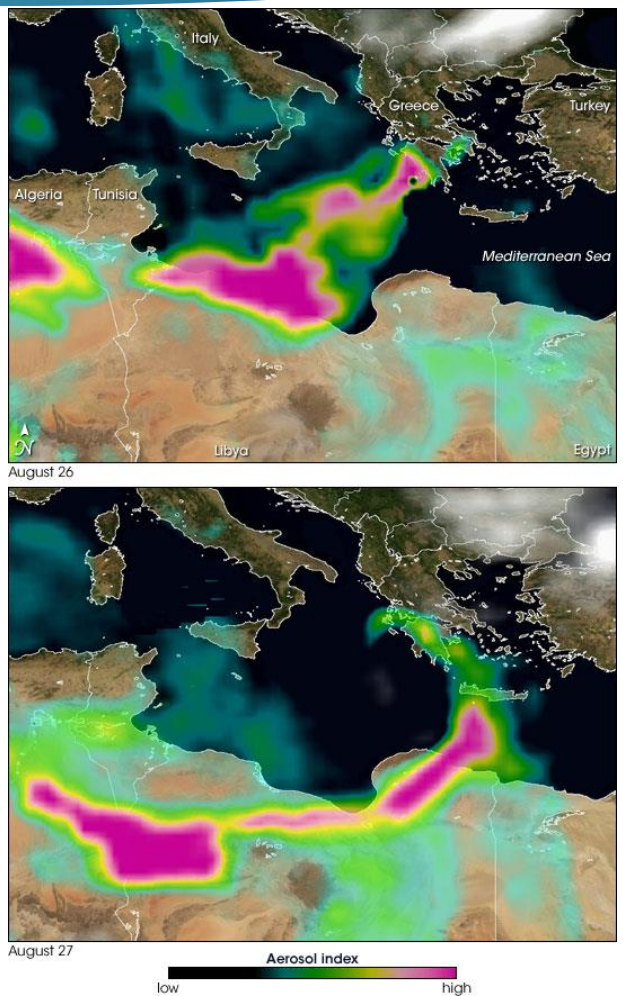
Fires in the Mediterranean

August 3, 2021
Aqua/MODIS

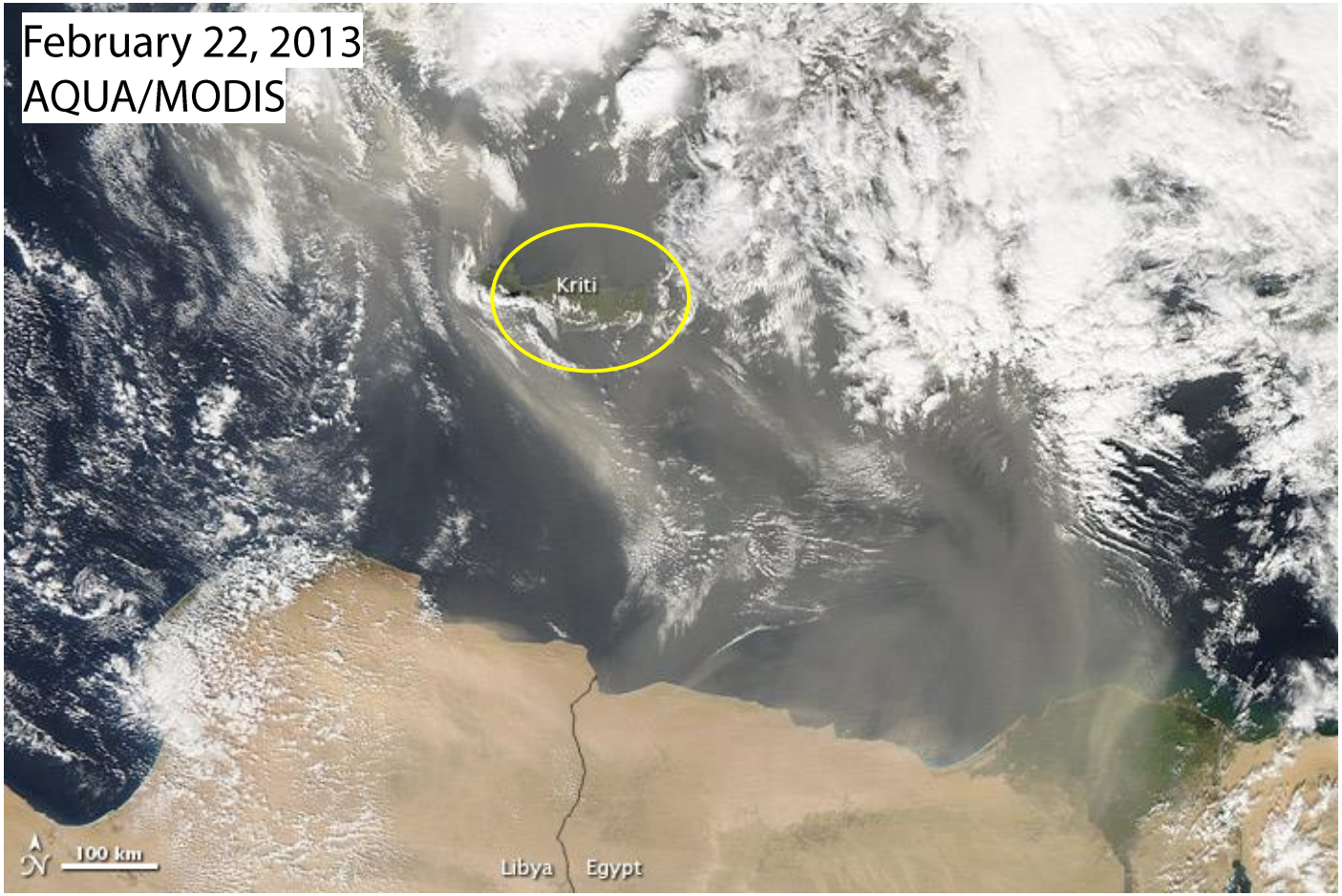
August 22, 2023
S-NPP/VIIRS

Smoke Aerosols Don't Know Borders

- Fires burning in Greece in August 2007 released pollutants that traveled across the Mediterranean Sea and into Africa.
- Aerosols from the fires on the southwestern coast of Greece and smoke emitted from fires burning in Algeria over a long stretch of the coastal Atlas Mountains.
- Observed by the Ozone Monitoring Instrument (OMI) on NASA's Aura satellite
- Aerosol index with OMI data: amount of ultraviolet (UV)scattered light compared to the amount of UV light if it were clear.



Dust Storms Don't Know Borders



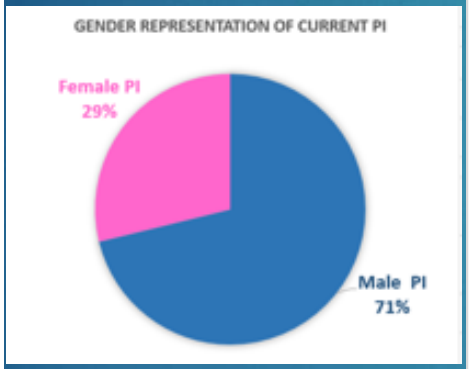
LCLUC Program at a Glance

Program stats since its inception:

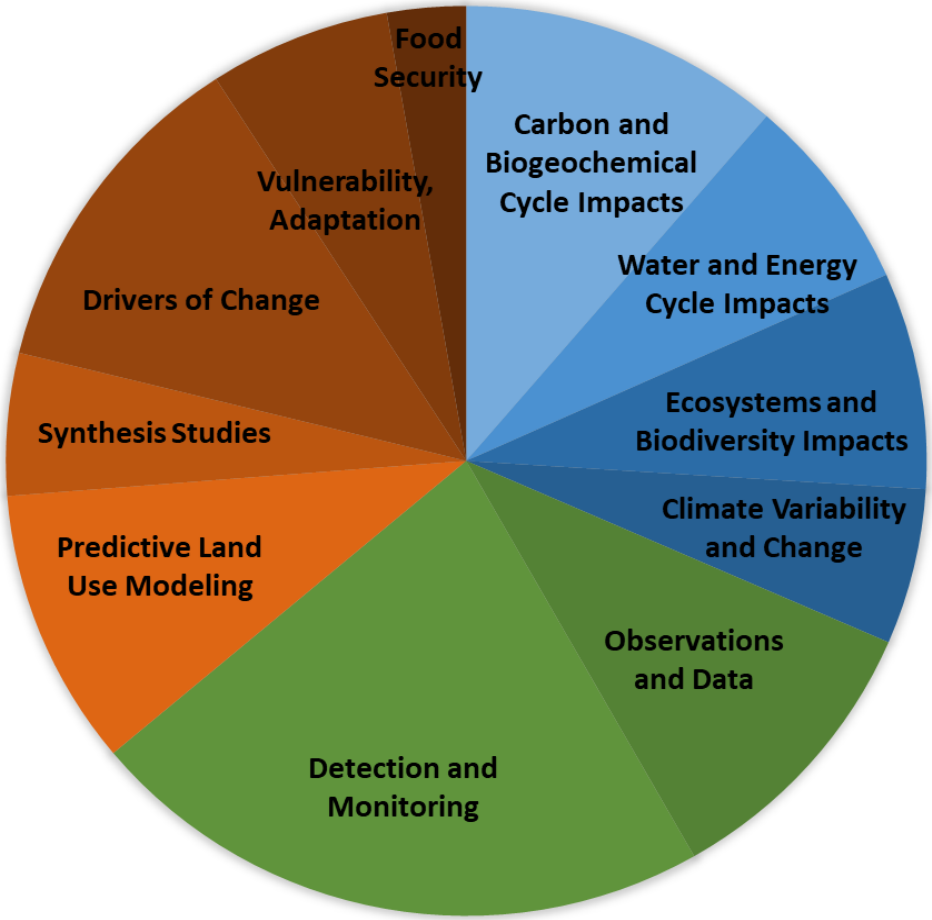
>350 projects
- 30-40 ongoing

>940 researchers
- >40 post-docs
- >80 grads

>1100 publications



Monitoring - 1/3 (green)
Impacts - 1/3 (blue)
Modeling - 1/3 (brown)



http://lcluc.umd.edu

LCLUC-24 Solicitation: Two Sub-elements

- Land Use for Digital Twins (LCLUC)
  - incorporation of land-use datasets as boundary conditions in regional short-range weather forecast models and evaluation of the impact on the quality of forecasts
  - incorporation of land-use datasets as boundary conditions as a function of time, e.g. on annual basis, in multiannual climate model runs for the last decade or longer and comparison of the hindcast results with the observed climate variables
- Technology Innovations for Land Digital Twins (ESTO/AIST)
  - developing software and information systems technology that will contribute to the development of the future L-ESDT
  - taking advantage of advanced Artificial Intelligence (AI)/ Machine Learning-based methods, Big Data Analytics, and powerful computational and visualization capabilities

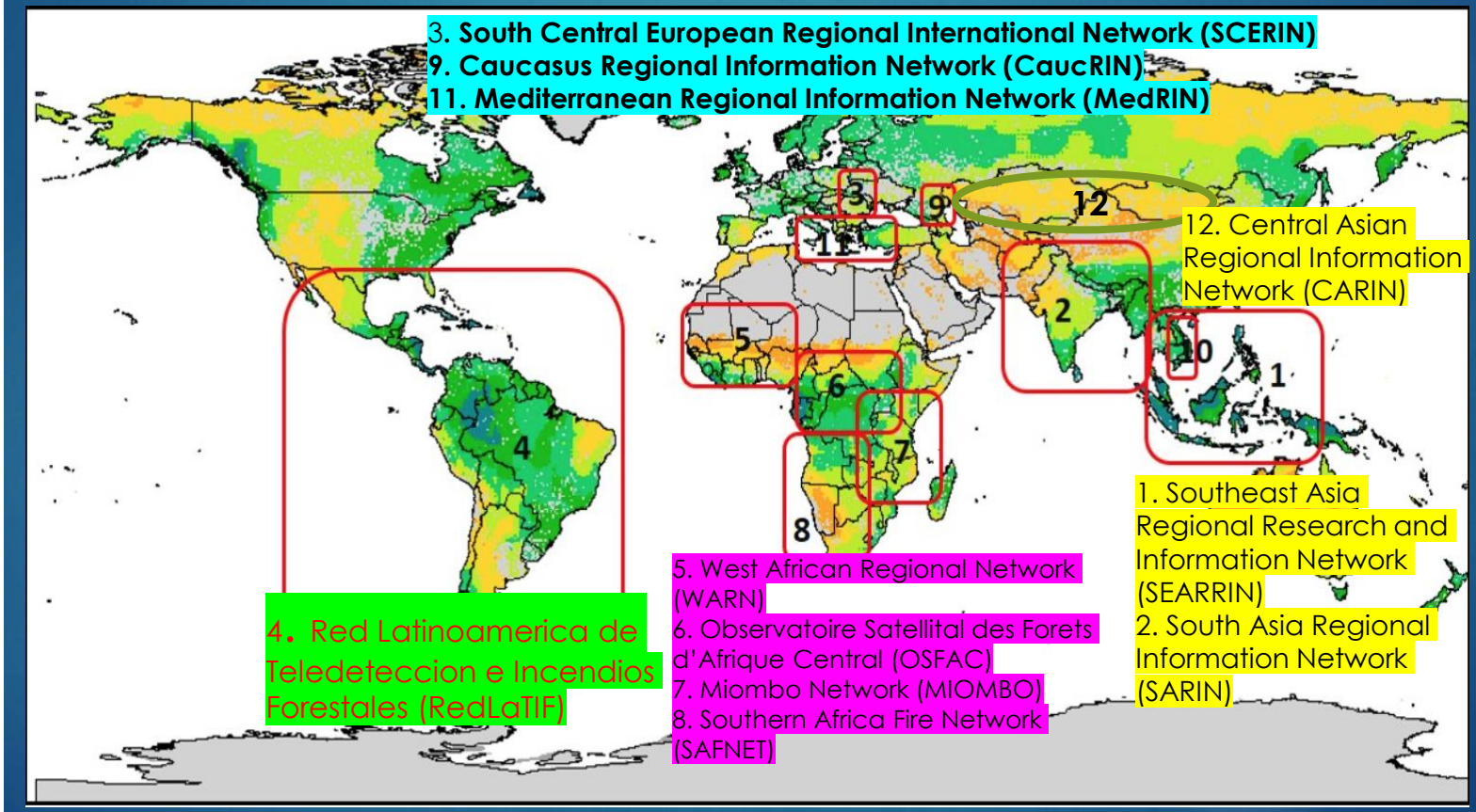
LCLUC-24 Submissions

- 32 proposals
  - 5 NASA (2 JPL, 1 GSFC, 2 ARC)
  - 1 UCAR
  - 1 private company
  - 25 Academia
- Models to be used:
  - NOAH-MP
  - NCAR-CESM
  - CLM-FATES
  - NU-WRF
  - MONAN
  - other

Models Short Description

- **NOAH**
  - **N**: National Centers for Environmental Prediction (NCEP); **O**: Oregon State University (Dept of Atmospheric Sciences ; **A**: Air Force (both AFWA and AFRL - formerly AFGL, PL); **H**: Hydrology Lab - NWS (formerly Office of Hydrology - OH
  - The community open-source Noah-MP (Multiparameterization) land surface model (LSM) is one of the most widely used and cited LSMs in the world widely used in both numerical weather prediction and decadal global/regional climate simulations
- **CESM**
  - The NCAR **C**ommunity **E**arth **S**ystem **M**odel is a fully-coupled global climate model developed in collaboration with colleagues in the research community
  - CESM consists of seven geophysical models: atmosphere (atm), sea-ice (ice), land (lnd), river-runoff (rof), ocean (ocn), land-ice (glc), and ocean-wave (wav - stub only), plus a coupler (cpl) that coordinates the geophysics models time evolution and passes information between them
- **FATES**
  - The **F**unctionally **A**ssembled **T**errestrial **E**cosystem **S**imulator, which is a vegetation demographic model, and needs a "Host Land Model" (HLM) to run, such as, e.g., Community Land Model of the Community Terrestrial Systems Model (CLM-CTSM)
  - A next-generation numerical terrestrial ecosystem model that simulates and predicts growth, death, and regeneration of plants and subsequent tree size distributions
  - Primarily supported by the Department of Energy (DOE)'s Office of Science, through the Next Generation Ecosystem Experiment - Tropics (NGEE-T) project
- **NU-WRF**
  - NASA-**U**nified **W**eather **R**esearch and **F**orecasting model - an observation-driven regional earth system modeling and assimilation system at satellite-resolvable scale
- **MONAN**
  - **M**odel for **O**cean-la**N**d-**A**tmosphere Predictio**N**) is a community model of the Unified Earth System, which aggregates efforts from several Brazilian national institutions and managed by INPE

LCLUC Worldwide Capacity Building: GOFC-GOLD Regional Networks



Self-Organization of a GOFC-GOLD Network

- Develop a roadmap: timeline and milestones
- Plan for two years at least
  - annual meetings
  - Inter-network interactions, e.g., joint network workshops
  - Topical meetings and interactions of focus groups
  - Capacity building
- Validation and inter-comparison studies
- Joint proposals and peer-reviewed papers
- Socio-economic component
- Inventory of projects, publications on a network page
- Maintaining a network page @gofcgold.org

LCLUC Ongoing Projects for SCERIN

- Water Scarcity in the Serbian Danube: Agricultural Land Use Change and Irrigation
  - Collaborator– Oskar Marko, Novy Sad, Serbia
- High-Impact Hot Spots of Land Cover Land Use Change: Ukraine and Neighboring Countries
  - Collaborators - Andrii Shelestov, National Technical University of Ukraine , Kyiv Ukraine and Nataliia Kussul, Space Research Institute NAS Ukraine & SSA Ukraine, Kyiv
- Institutional Forcings on Agricultural Landscapes in Post-Socialist Europe: Diachronic Hotspot Analysis of CAP Influences on Agricultural Land Use in Romania 2002-2023
  - Collaborators - Igor Sîrodoev, Ovidius Universityof Constantza, Romania, and Ioan Ianoş, University of Bucharest, Romania

Sean Woznicki, Grand Valley State U., MI

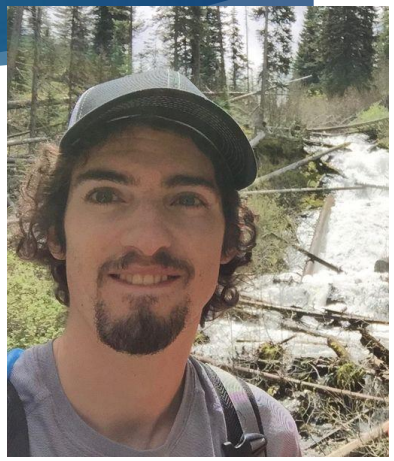
Sergii Skakun, U. Maryland

Geoff Henebry, Michigan State U.

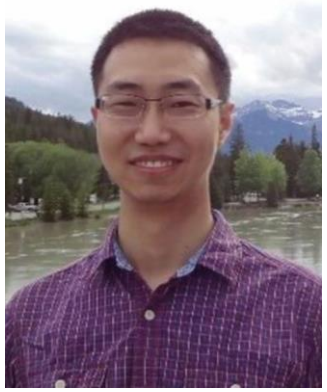
LCLUC Ongoing Projects for MedRIN

- Understanding the socio-economic drivers of agricultural land abandonment and associated fire risk in Greece

- The Syrian civil war affecting croplands – soon to be announced



Aaron Sparks,
U. Idaho



He Yin,
Kent State U., Ohio

Thank You - ευχαριστώ