Multi-Sensor Approaches in Monitoring Ecosystem Dynamics: An Update

Garik Gutman, NASA HQ

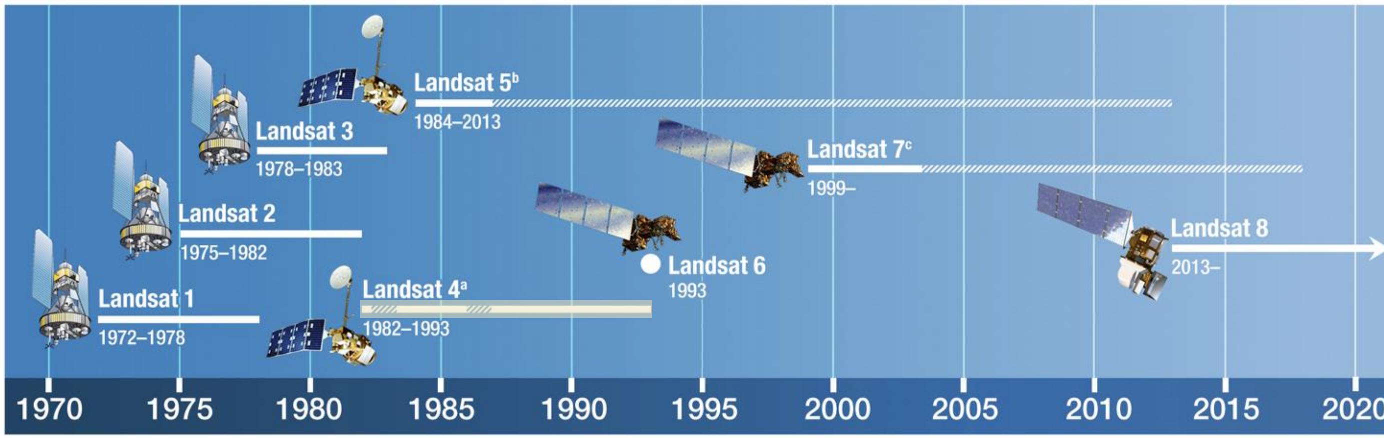
Washington, DC USA

Educational Component for E.Europe: NASA-ESA Trans-Atlantic Training

- Origin: after the training session for the LCLUC ST meeting, Latvia, 2010
- Concept: while visiting Karlov University in Prague, 2012
- NASA-ESA agreement
- Implementation: Prague, 2013
- Under careful supervision by a NASA Program Manager

TAT-1	2013, Prague, Czech Rep.
TAT-2	2014, Krakow, Poland
TAT-3	2015, Brašov, Romania
TAT-4	2016, Zvolen, Slovakia
TAT-5	2017, Pecs, Hungary
TAT-6	2018, Zagreb, Croatia
TAT-7	2019, Novi Sad, Serbia

Landsat



Landsat 9

[a]Limited data due to transmitter failure soon after launch. Only 45,172 Landsat 4 Thematic Mapper scenes from 1982–1993 available for science users—~10 scenes/day (vs 725 scenes/day from L8)

[b]Data coverage limited to Continental US (CONUS) and International Ground Station sites after a transmitter failure in 1987; Multispectral Scanner turned off in August 1995

[c]Degraded Performance due to Scan Line Corrector failure in May 2003

- The Landsat program began as the Earth Resources Technology Satellites Program in 1966, with Landsat 1 (ERTS) launched in July 1972
- NASA built and launched Landsats 1-5 and Landsats 7-8
- Thermal band added for Landsats 3 and beyond
- After launch, Landsat operations are transferred from NASA to USGS, and USGS collects, archives, processes, and distributes the image data via the internet at no cost to users
- Landsat 8 began as a data purchase and became known as the Landsat Data Continuity Mission (LDCM)
    - Although the thermal bands were originally not incorporated in the mission, they were added back into the Observatory’s capabilities following strong support from a variety of stakeholders

Landsat-8 Science Objectives

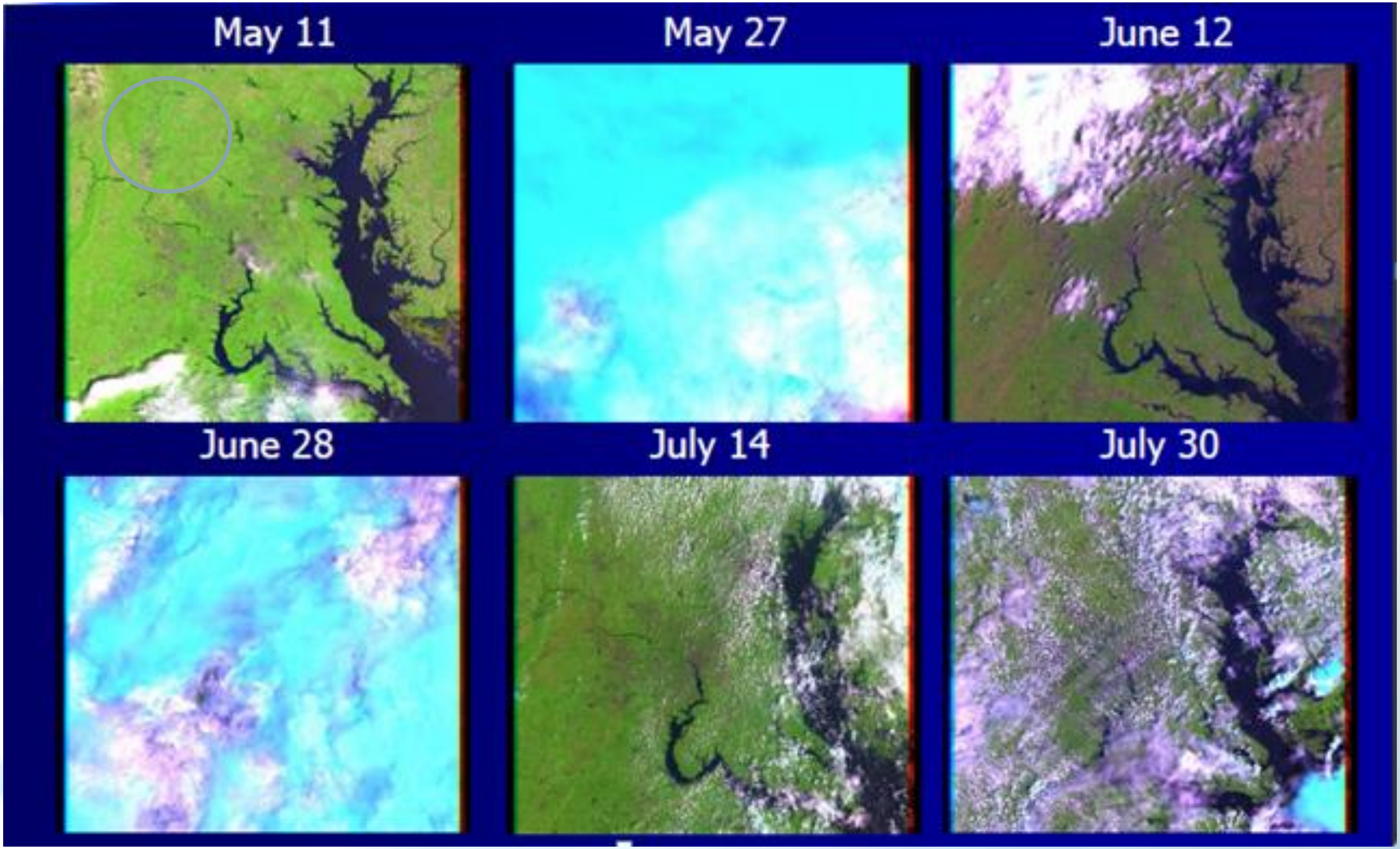
- Collect data sufficiently consistent with data from the earlier Landsat missions to permit studies of land cover and land use change over multi-decadal periods

- Continue Landsat tradition to collect multispectral digital image data providing seasonal coverage of the global land mass

Landsat

- Infrequent observations
  - One-Landsat system: 16-day revisit time
  - Two-Landsat system: 8 days
- Cost
  - Until 2010 expensive, free now!
  - Preferable (and now possible) continuous monitoring
- Cloud occurrence
  - 16-day repeat cycle in the areas with frequent cloud may not provide enough time series for monitoring seasonal changes in vegetation
  - Need daily observations like from coarse-resolution sensors

Single Landsat: Cloud Issue
16-day Repeat Coverage is insufficient



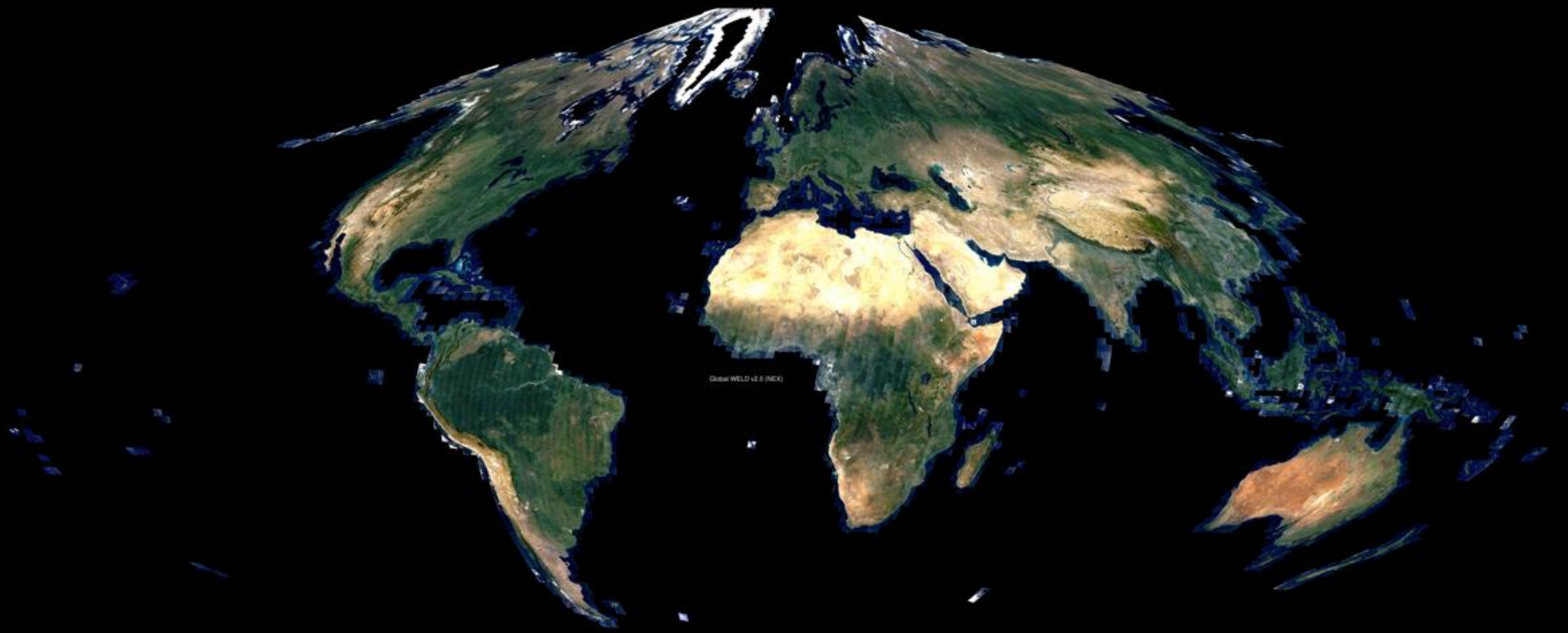
More frequent imaging is needed to maximize opportunity for cloud free observations particularly for rapidly changing phenomena: Fire, Flooding, Agriculture

Landsat Products and Applications

- Global Products
  - Forest Cover Change
  - Global composites
  - Global mangroves

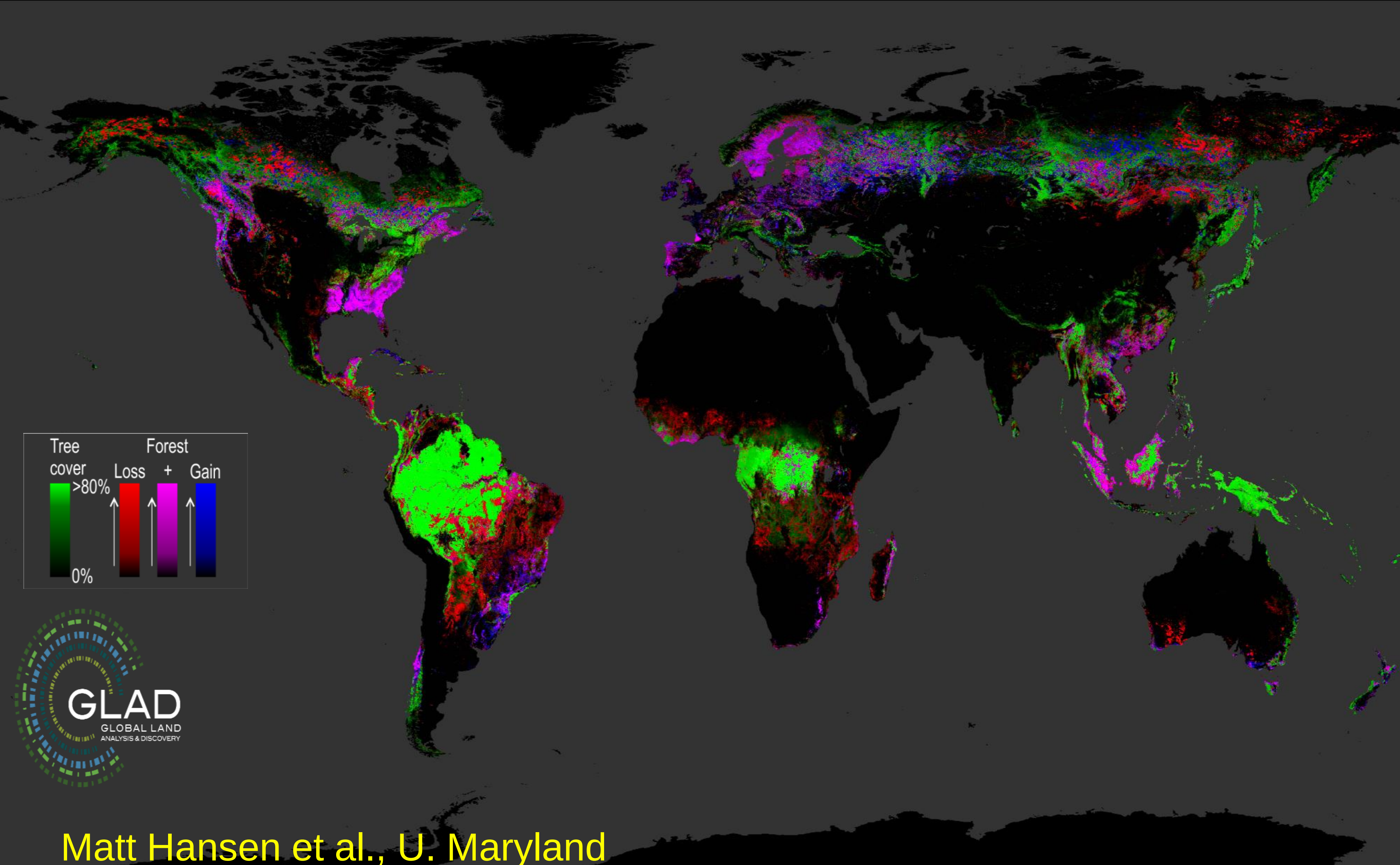
- Applications
  - Agriculture
  - Forestry
  - Range Resources
  - Urbanization
  - Geology
  - Hydrology
  - Coastal Resources
  - Environmental Monitoring

Global Composite Using Landsat-5 and -7: WELD mosaics



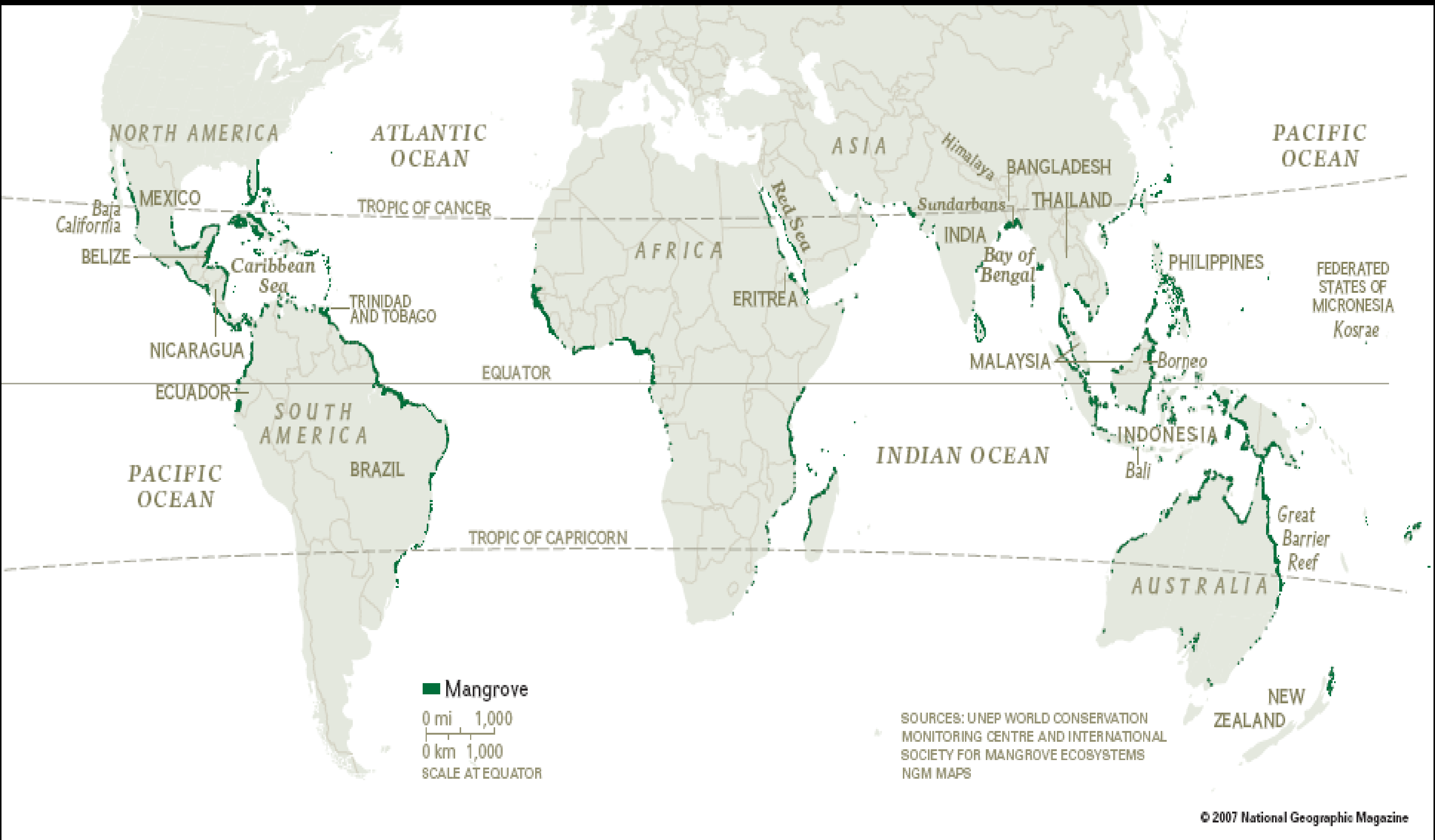
David Roy, Michigan State U. (formerly at South Dakota State U.)

Tree Cover Extent and Forest Loss and Gain: 2000-2014



Matt Hansen et al., U. Maryland

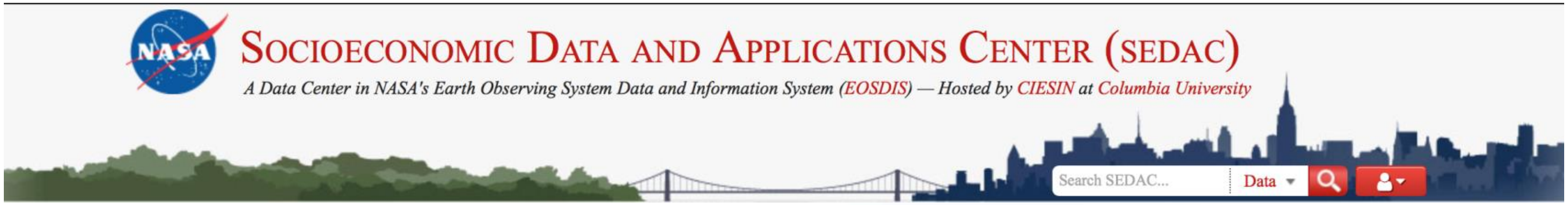
Mapping Global Mangrove Forest Cover



Global Impervious Surface Datasets

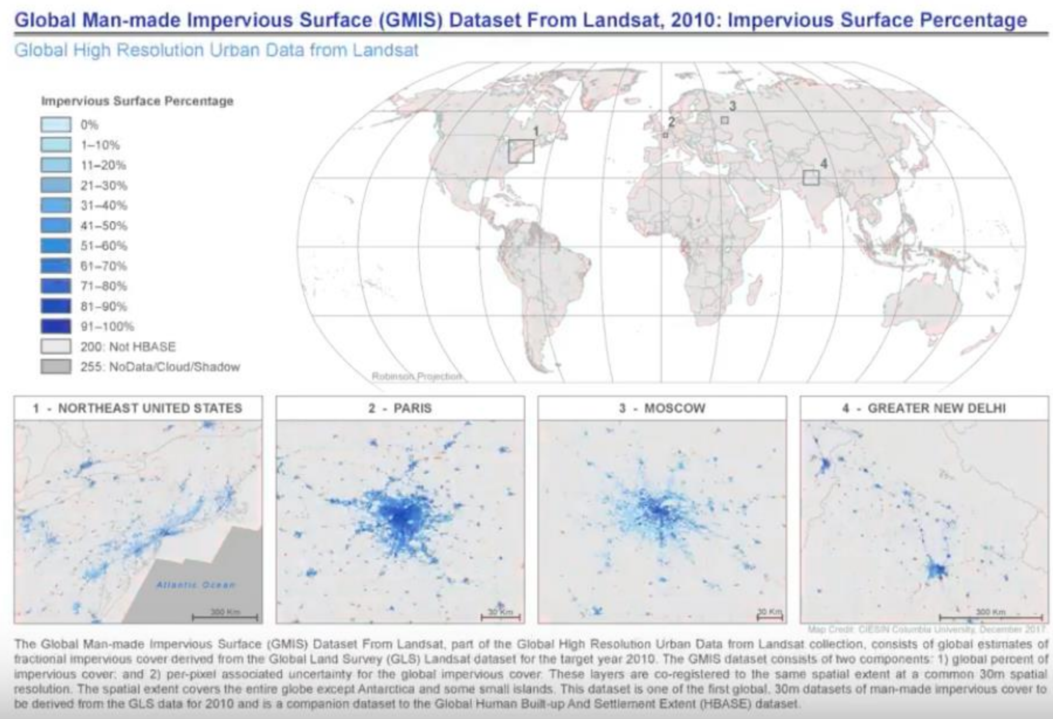
Global Man-made Impervious Surfaces; Global Human Built-up And Settlement Extent

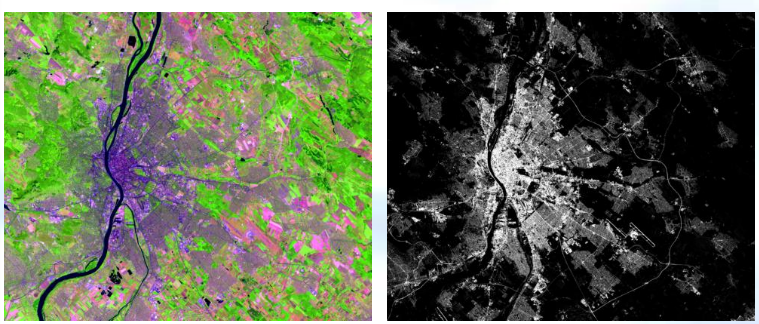
Brown de Colstoun (NASA GSFC) and Cheng Huang (U. Maryland)



From the Landsat Science News Digest for January and February 2019:

"The Global High Resolution Urban Data from Landsat data collection contains the two companion data sets produced by **NASA Goddard Space Flight Center (PI Brown de Colstoun) and University of Maryland (Cheng Huang)**"





Budapest from Landsat (2010)

- LCLUC Global Products (available since 2015)
  - Global Man-made Impervious Surfaces
  - Global Human Built-up And Settlement Extent

The ESA Sentinel Program

Sentinel-1

- Objectives Land and Ocean monitoring

* Composed of two polar-orbiting satellites with Radar operating day and night, acquiring data regardless of the weather.

* The mission provides an independent operational capability for continuous radar mapping of the Earth.

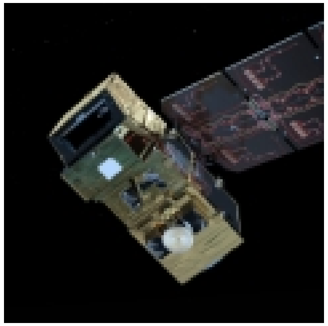
The first SENTINEL-1 satellite was launched in April 2014

https://sentinel.esa.int/web/sentinel/missions/sentinel-1

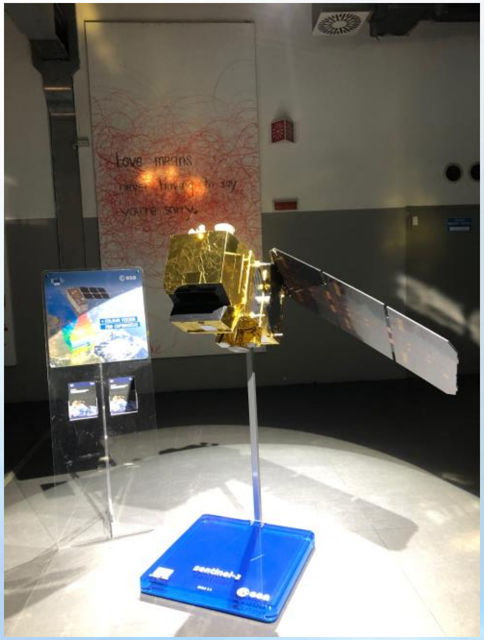
Sentinel-2

- Objectives: Land monitoring
- Composed of two polar-orbiting satellites of providing high-resolution optical imagery
- Vegetation, soil and coastal areas are among the monitoring objectives
- 13 spectral bands, 290 km swath width
- Revisit frequency: 10-day (for one S2) and 5-day (for two S2)

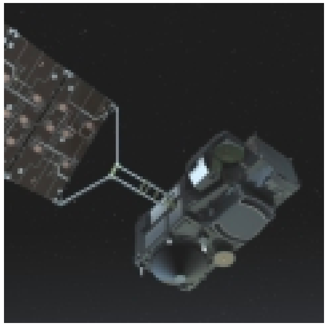
https://sentinel.esa.int/web/sentinel/missions/sentinel-2



The first SENTINEL-2(a) launched June 2015



Sentinel-3



- Objectives: marine observation, sea-surface topography, sea and land surface temperature, ocean and land color
- Composed of three satellites
- Primary instrument is a radar altimeter, but the polar-orbiting satellites will carry multiple instruments, including optical imagers
- agricultural practices, urban heat islands, fires
- Ocean and Land Colour Instrument

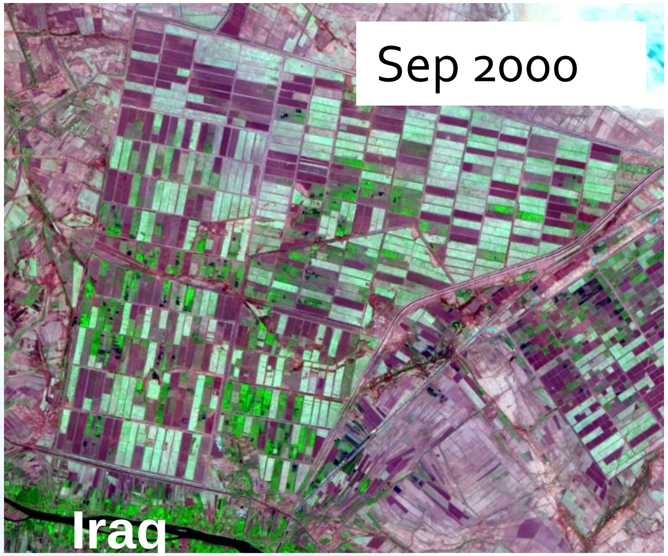
    1270 km and 21 spectral bands 0.5km
    (1 km for thermal IR)

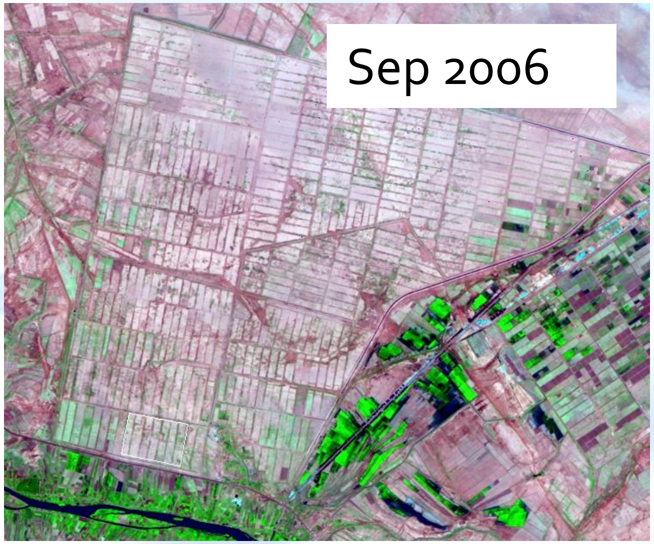
The first SENTINEL-3 satellite was launched in Feb 2016

https://sentinel.esa.int/web/sentinel/missions/sentinel-2

Combining Moderate and Coarse Resolution Sensor Data

Landsat images in Iraq 6 years apart





Long revisit time is not suitable for seasonal vegetation phenology monitoring or rapid surface changes

MODIS time series of Green Index

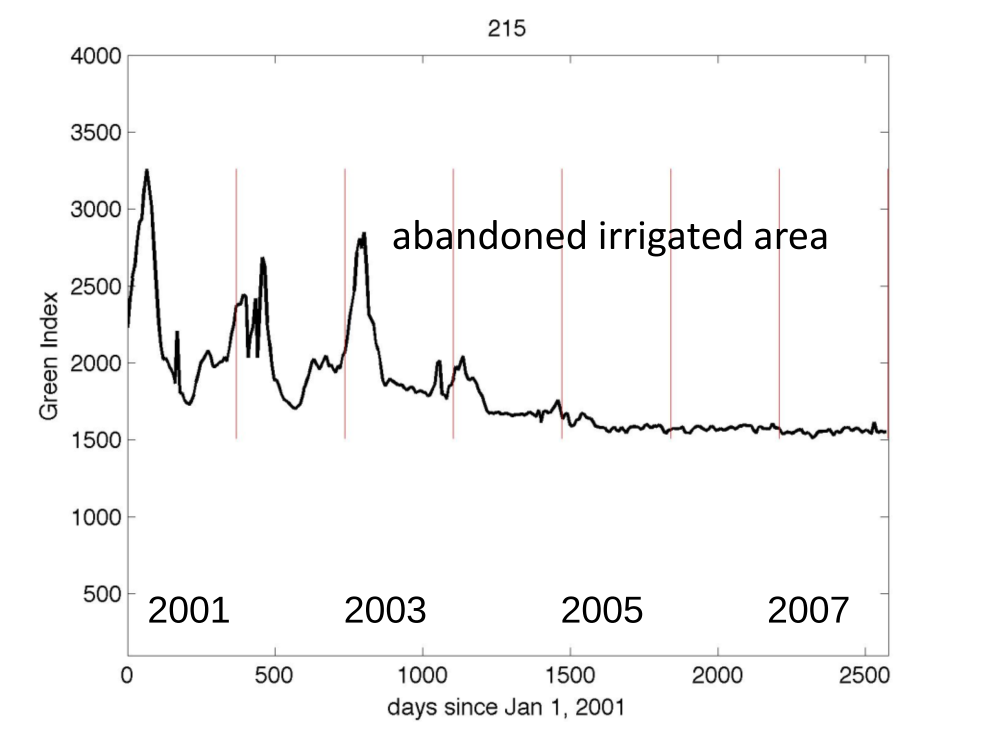
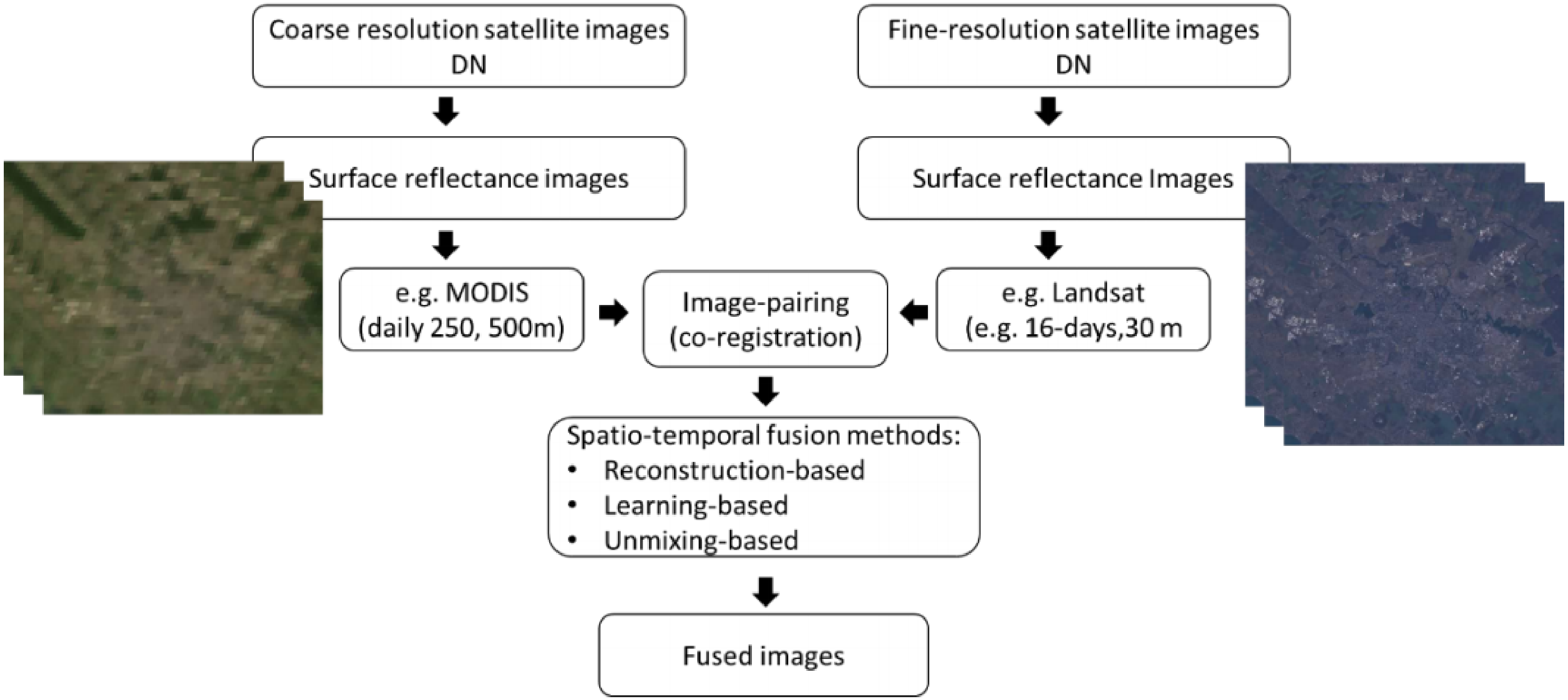


Image Fusion

- combining high and low-spatial resolution images from the same satellite system or different satellite systems
  - Landsat: 15m panchromatic images with 30m multispectral
  - SPOT 10m panchromatic with Landsat 30m multispectral images
  - Landsat 30m with Sentinel2 10m and 20m images
- combining optical and microwave remote sensing images
- combining microwave (passive) and microwave (active) sensors
- combining multispectral passive optical and active imagery (LiDAR)
- combining multispectral satellite imagery and hyperspectral data
- combining high-resolution, low-frequency images with low resolution, high-frequency images

Theoretical Workflow of Spatiotemporal Image Fusion



Belgiu and Stein, Remote Sensing, 2019 (A review)

Image Fusion (cont.)

- Important Issues for Data Fusion
  - Spectral responses of input images have to be unified
    - spectrally normalize the input sensors to common wavebands
  - Co-registration of multi-source input images
    - misalignments between Landsat and Sentinel-2 by several pixels
  - Atmospheric corrections
    - input images have to be radiometrically corrected before fusing them
- Performed at pixel-level, feature-level (e.g. land-cover classes of interest), and decision-level (e.g. purpose driven)
- Spatiotemporal image fusion methods
  - **Reconstruction-Based**
  - **Learning-Based**
  - **Unmixing-Based**

Some Important References for Spatiotemporal Image Fusion Methods

- 32. Gao, F.; Masek, J.; Schwaller, M.; Hall, F. IEEE Trans. Geosci. Remote Sens. 2006, 44, 2207–2218.
- 43. Hilker, T.; Wulder, M.A.; Coops, N.C.; Linke, J.; McDermid, G.; Masek, J.G.; Gao, F.; White, J.C. Remote Sens. Environ. 2009, 113, 1613–1627.
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- 12. Zhu, X.; Helmer, E.H.; Gao, F.; Liu, D.; Chen, J.; Lefsky, M.A. Remote Sens. Environ. 2016, 172, 165–177.

	Spatiotemporal fusion model	Categories
Gao, et al. [32]	Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM)	Reconstruction-based
Hilker, et al. [43]	Spatial-Temporal Adaptive Algorithm for mapping Reflectance Change (STAARCH)	Reconstruction-based
Zhu, et al. [44]	Enhanced spatial and temporal adaptive reflectance fusion model (ESTARFM)	Reconstruction-based
Hazaymeh and Hassan [45]	Spatiotemporal image-fusion model (STI-FM)	Reconstruction-based
Luo, et al. [46]	Satellite Data Integration (STAIR)	Reconstruction-based
Zhao, et al. [47]	Robust Adaptive Spatial and Temporal Fusion Model (RASTFM)	Reconstruction-based
Wang and Atkinson [48]	FIT-FC	Reconstruction-based
Chen, et al. [41]	Hierarchical Spatiotemporal Adaptive Fusion model (HSTAFM)	Learning-based
Huang, et al. [7]	Sparse representation based Spatio temporal reflectance Fusion Model (SPSTFM)	Learning-based model
Song and Huang [49]	One-pair learning image fusion model	Learning-based model
Wu, et al. [50]	Spatial and Temporal Data Fusion Approach (STDFA)	Unmixing-based
Huang and Zhang [51]	Spatio-Temporal Reflectance Fusion Model (U-STFM)	Unmixing-based
Gevaert, et al. [36]	Spatial and Temporal Reflectance Unmixing Model (STRUM)	Unmixing-based
Wu, et al. [52]	Modified Spatial and Temporal Data Fusion Approach (MSTDFA)	Unmixing-based
Zurita-Milla, et al. [53]	Constrained unmixing image fusion model	Unmixing-based
Zhang, et al. [54]	Spatial-Temporal Fraction Map Fusion (STFMF)	Unmixing-based
Zhu, et al. [12]	Flexible Spatiotemporal Data Fusion (FSDAF)	Hybrid

Reconstruction-Based Spatiotemporal Image Fusion Methods

- also called filter-based methods or weighted-function-based
- were successfully tested for fusing Landsat-MODIS images
- most popular STARFM[32]
- are used to generate synthetic spectral reflectance by means of the weighted sum of the neighboring similar pixels of the input image source
- assume the existence of co-temporal pairs of fine and coarse spatial resolution images
- Notes
  - Quality of the fused time series is dependent on the number of observations from the high temporal resolution images set and on the availability of cloud-free pair images of the matching dates
  - When no-matching dates images are found, the method starts searching for the closest image in the temporal domain to predict the value in the fine resolution output image

Learning-Based Spatiotemporal Image Fusion Methods

- allow fusion between images with different spectral values
  - As compared to reconstruction-based and unmixing-based methods which allow spatiotemporal fusion of images with unified spectral values
- use machine learning to predict finer temporal resolution images from coarse spatial resolution images
- learn the differences between fine spatial resolution images and high temporal coverage images by making use of a dictionary created from the image patches generated from the two image types
- consider phenology of vegetation and other disturbances caused by land-cover changes that might occur before the prediction date

Unmixing-Based Spatiotemporal Image Fusion Methods

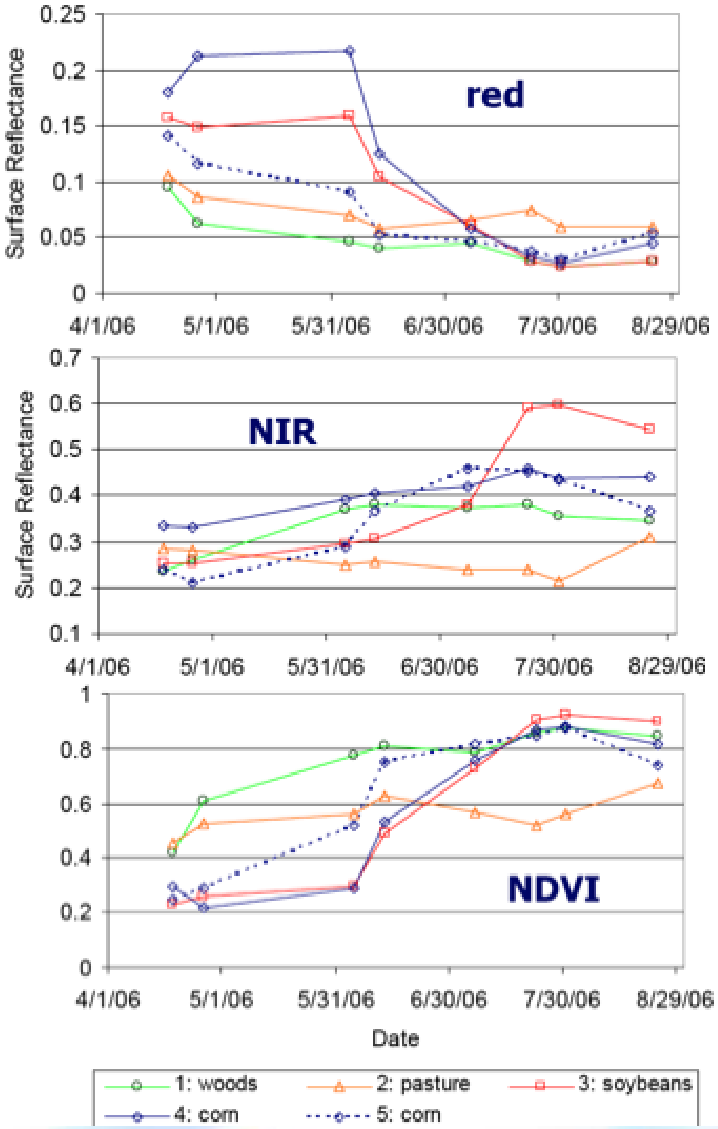
- used for very heterogeneous environments
- rely on the linear spectral mixture to extract endmembers and abundances, i.e. proportion, at the subpixel level
  - The number of endmembers and abundances is obtained from a high-resolution data set, and the spectral signature of the endmembers is unmixed from the coarse resolution images
- assume that the reflectance of each coarse spatial resolution pixel is a linear combination of the responses of each land-cover class contributing to the mixture
- Step 1: the classification of the image with high spatial resolution using unsupervised methods such as k-means (or fuzzy k-means)
- Step 2: spectral unmixing of the image with high temporal frequency by making use of the classification information obtained during the first step
  - up-to-date land-cover/land-use maps can be used to identify the endmembers

Other Advanced Methods for Spatiotemporal Image Fusion

- Hybrid Methods
  - Rely on predicting the fraction map of fine resolution images from the available coarse resolution fraction maps by making use of images acquired before and after the prediction dates
  - The fraction maps can be obtained using any available spectral unmixing model such as a linear spectral mixture model or multiple endmember spectral mixture analysis mode
- Fusing microwave and optical data –cloud problem mitigation
- "Deep learning" for data fusion
  - Liu, Y.; Chen, X.; Wang, Z.; Wang, Z.J.; Ward, R.K.; Wang, X. Deep learning for pixel-level image fusion: Recent advances and future prospects. Inf. Fusion 2018, 42, 158–173

Merging Data From Landsat-like Mid-Resolution Sensors Prior to ESA Sentinel Program

Land-cover phenology at 30 m



- Red reflectance, near-infrared (NIR) reflectance, and NDVI values for individual fields from central Illinois during the first half of the 2006 growing season

- Data are combined from **Landsat-5, -7, ASTER, and IRS**

Courtesy: Feng Gao, USDA

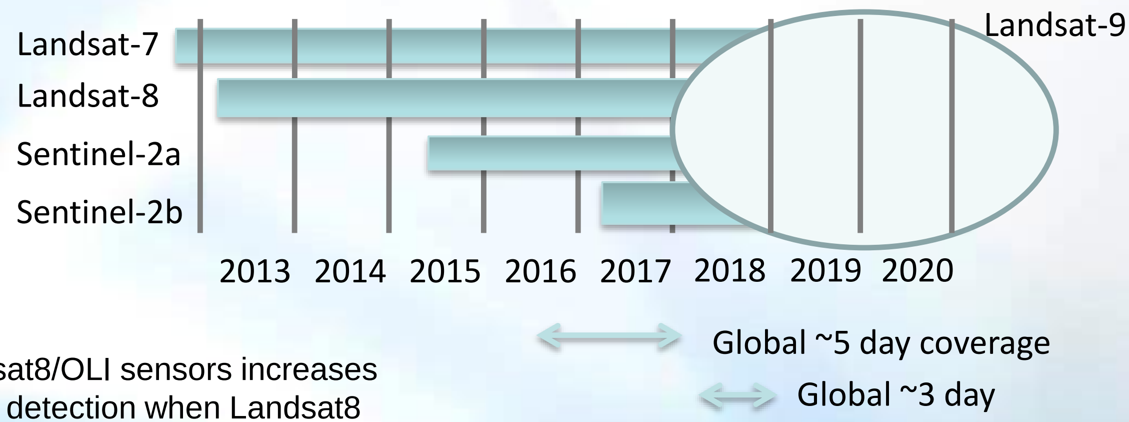
Sentinel + Landsat: the NASA MuSLI Program

- Sentinel-2a: launched in Jun 2015
- Sentinel-2b: launched in Mar 2017

- Landsat-7: launched in Apr 1999
- Landsat-8: launched in Feb 2013
- Landsat-9: planned for Dec 2020

Merging Sentinel-2 and Landsat data streams could provide < 5-day coverage required for Ag monitoring

- Both sensors have 10-30m coverage in VNIR-SWIR
- Satellite orbits complementary
  - Landsat-7 & -8 8 days out of phase
  - Sentinel-2a & 2b 5 days out of phase
  - Landsat and Sentinel sun synch orbits precess relative to each other

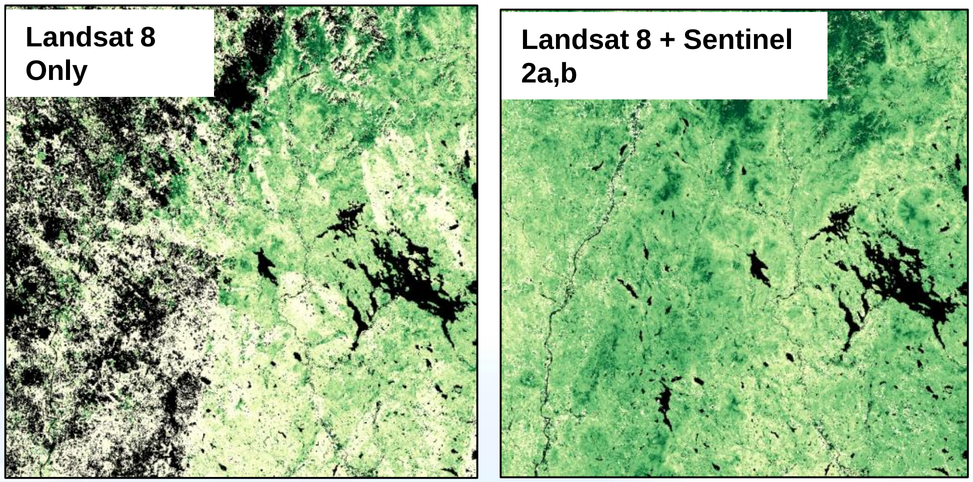


Fusing Sentiel2/MSI and Landsat8/OLI sensors increases accuracy of land-cover change detection when Landsat8 panchromatic band is used in the image fusion

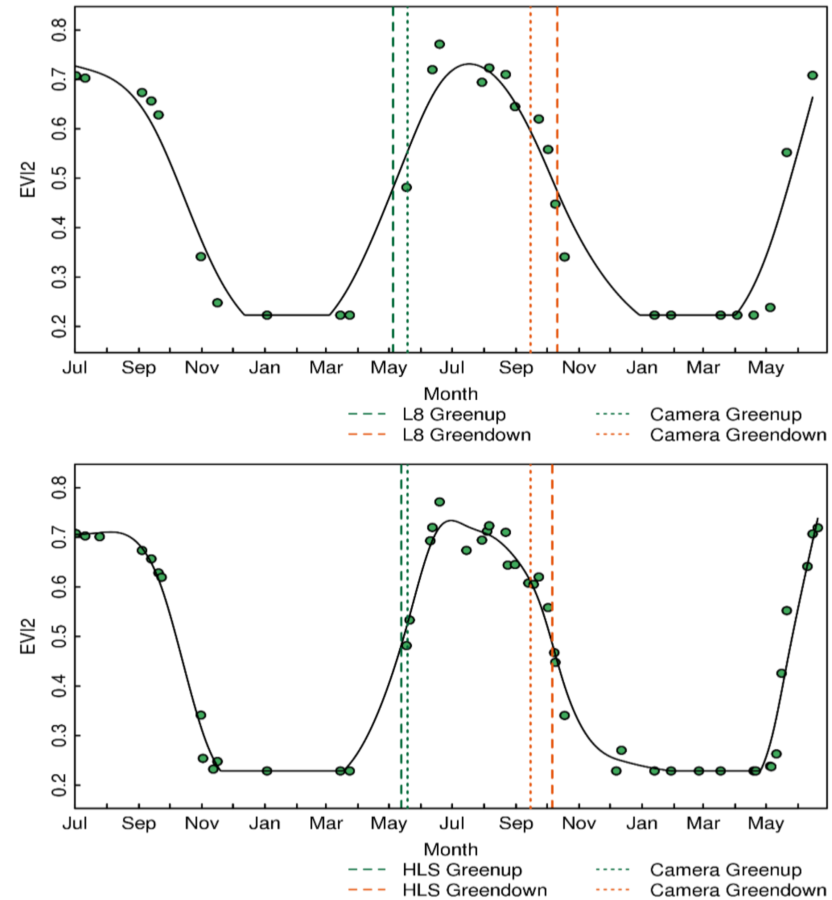
Wang, Q.; Blackburn, G.A.; Onojeghuo, A.O.; Dash, J.; Zhou, L.; Zhang, Y.; Atkinson, P.M. Fusion of landsat 8 oli and sentinel-2 msi data. IEEE Trans. Geosci. Remote Sens. 2017, 55, 3885–3899.

Satellite-Derived Greenup for Broadleaf Forests: New Hampshire

PI: Friedl, Boston U.



-- No prediction due to insufficient data density



Regression against PhenoCam greenup obs

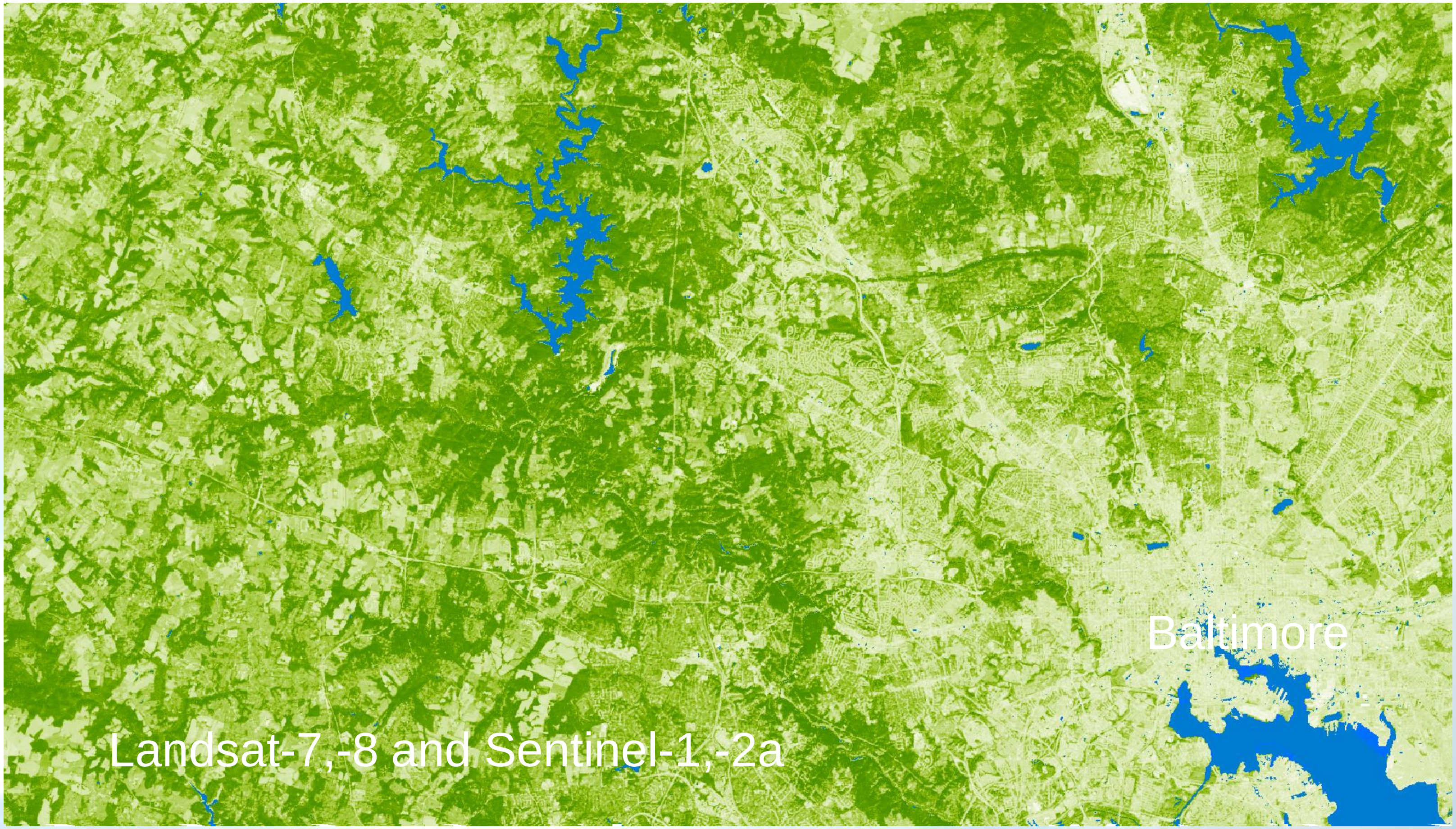
	Landsat	Sentinel	L8+S2
RMSE	12.6	17.0	8.4
R^2	0.62	0.32	0.81

Increased temporal density results in more complete and more accurate retrieval of phenology

Courtesy: Doug Bolton, BU

Tree Canopy Cover Estimated from Landsats and Sentinel-1, 2

PI: John Townshend, UMD, co-I: Joe Saxton



Courtesy: Saurabh Channan, UMD

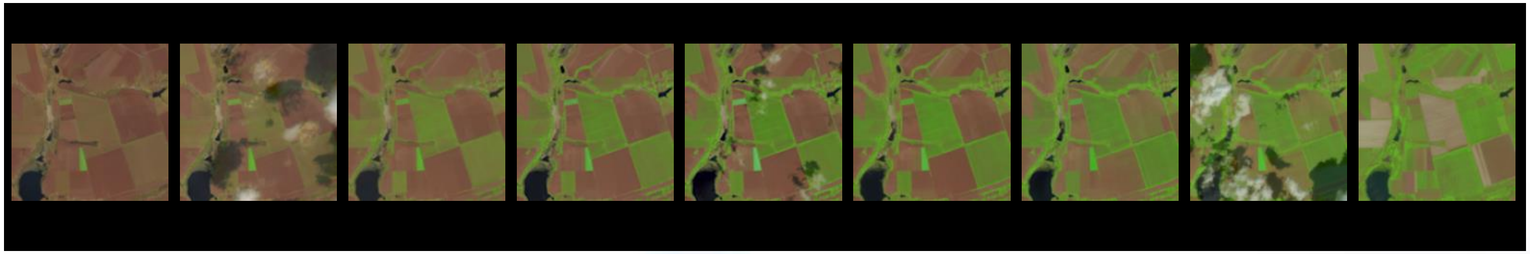
Landsat8 filled most of the gaps caused by SLC off, cloud, cloud shadow, but still some gaps remained.

Combining with Sentinel-1 and -2 removed the remaining gaps.

Crop Yield Assessment and Mapping from Landsat-8 and Sentinel-2 observations

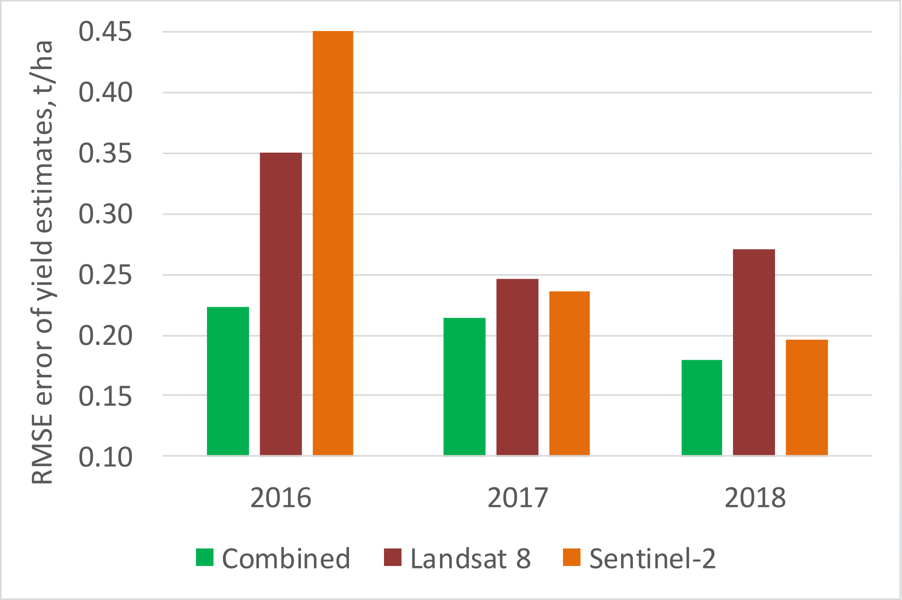
PI: Skakun, U. Maryland

Ukraine (Kirovograd obl.)



Root mean square error (RMSE) of the relationship between *crop yield* (ground data) and *cumulative satellite-derived vegetation index*

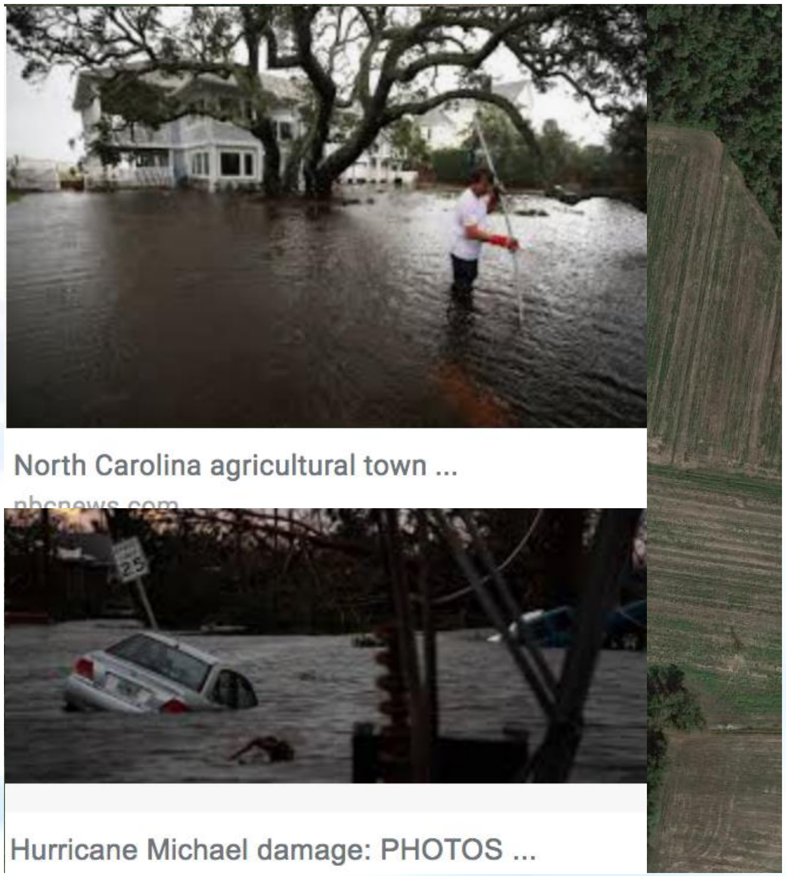
Multi-source (L8+S2) reduction in *RMSE* →

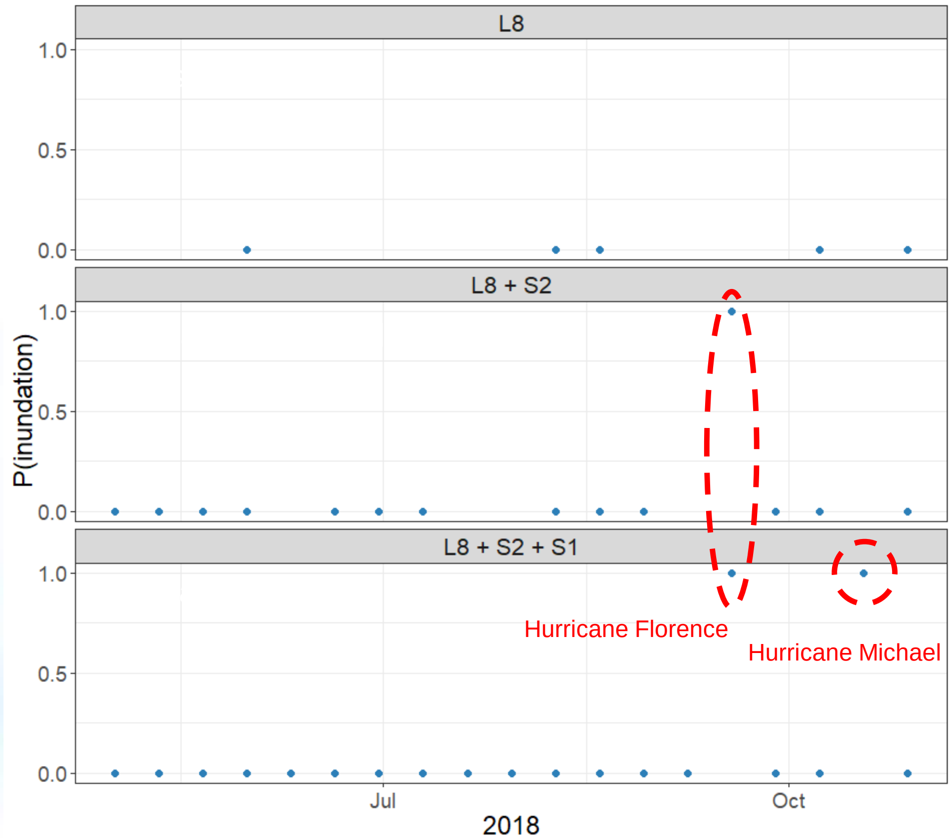


2016, 2017 – Sentinel 2a
2018 – Sentinel 2a,b

Merging Mid-Resolution Optical and Microwave (Radar) Data for Mapping Inundation in North America

PI: Cheng Huang, U. Maryland



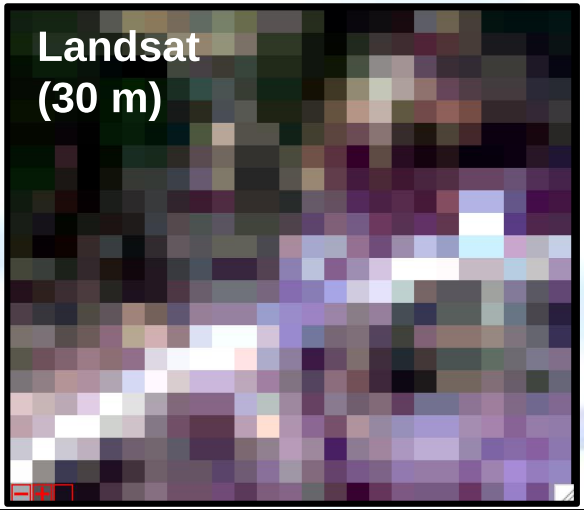


Two flooding events over crop fields in N. Carolina: 1) Hurricane Florence in Sep 2018 - captured by L8 + S2, 2) Michael in Oct 2018 Hurricane L8+S2+S1. These events are not captured by L8 data alone.

Mapping Smallholder Farm Characteristics Using VHR and Mid-Resolution Satellite Data

PI: Meha Jain, U. Michigan

	Accuracy		
	Planet	**Planet + Sentinel2**	**Planet + Sentinel2 + Sentinel1**
Random Forest (RF)	0.813	0.806	0.850
Support Vector Machine (SVM)	0.781	0.822	0.859
Artificial Neural Network (ANN)	0.795	0.759	0.840



Objectives

- How well do Sentinel-1, Sentinel-2, and Planet imagery perform in mapping field-level crop type
- How well can Planet imagery map wheat yields at the field and sub-field scale?

Conclusions

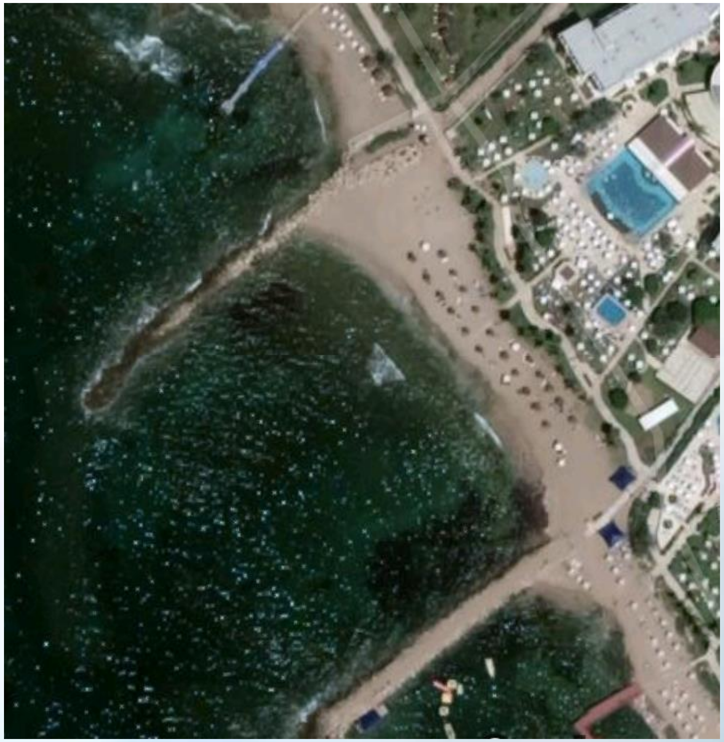
- Using multiple sensors (Sentinel-1, Sentinel-2, and Planet) increases accuracy when mapping field-level crop type in smallholder farms
- Micro-satellite data can be used to map field-level and sub-field level smallholder yields

Zooming In

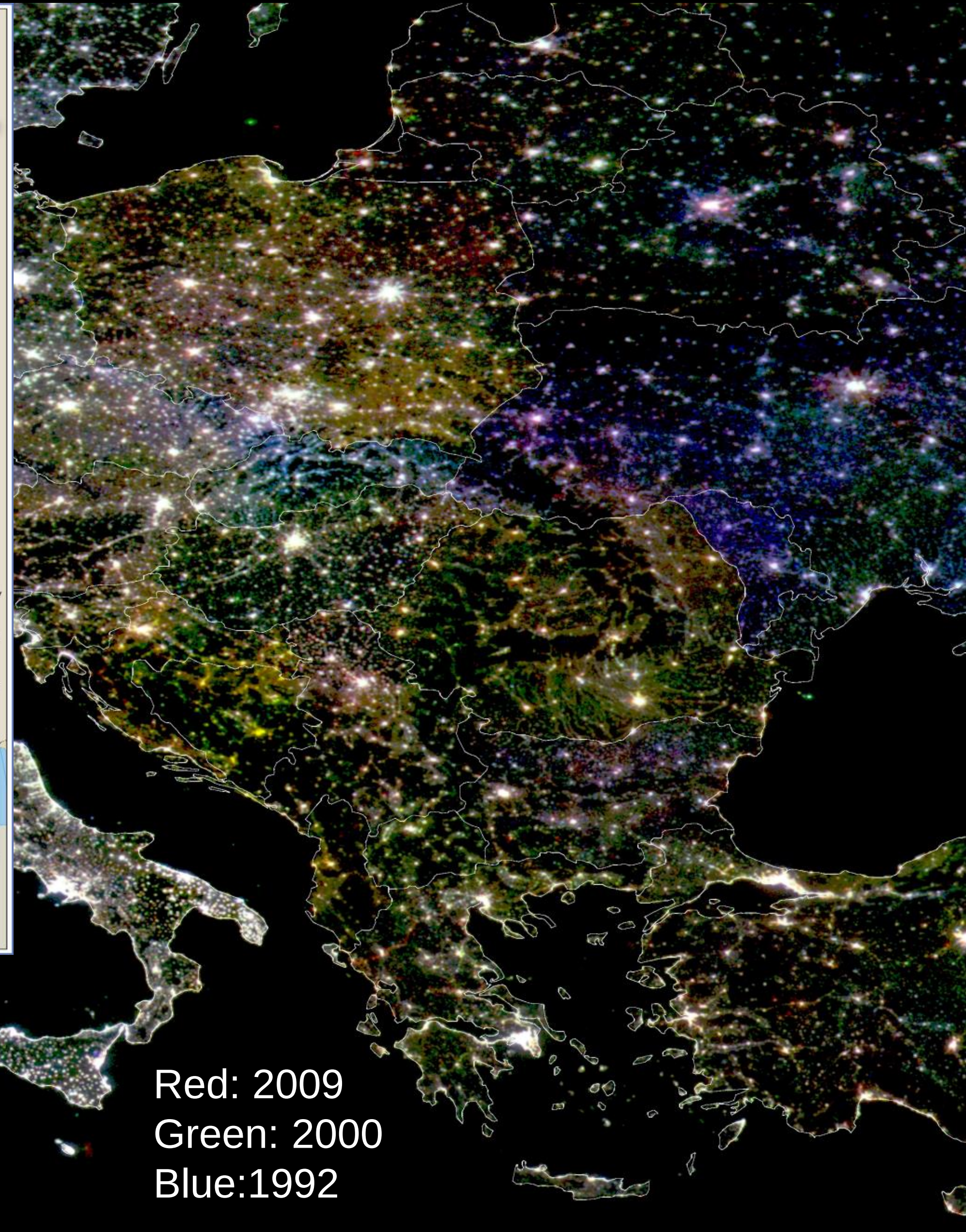
- Need very high resolution (VHR) images in both time and space
- Commercial satellites offer images at fine spatial scale and high temporal resolution
  - Planet Labs constellation acquire daily images of the Earth with a spatial resolution of about 3 m
    - Including 5m RapidEye (acquired by PlanetLab in 2015; first commercial satellite to include the Red-Edge band)
  - Digital Globe (WorldView satellite constellation)
    - Panchromatic band 0.3m
    - Multispectral bands 1.2m
    - SWIR, CAVIS
- Important in fusing Planet and WorldView images
  - inter-calibration: to reduce the magnitude differences in the reflectance values between the two input sensors products
  - co-registration: to align them to avoid mis-registration errors

Prospects for Using VHR Imagery

- Mid-resolution data from Landsat/Sentinel2 are fused with VHR imagery
- It is expected that NASA-affiliated investigators will have free access to a very rich, dense high spatial resolution dataset within the next couple of years from satellite constellations of both **Planet Lab** and **Digital Globe** over land including coastal zone and cryosphere
- Limited Planet datasets are available for free already now at Universities
- Next step: fusing the DG Worldview images having <u>higher spatial resolution but low revisit time</u> with Planet images having <u>lower spatial resolution but daily re-visit times</u>

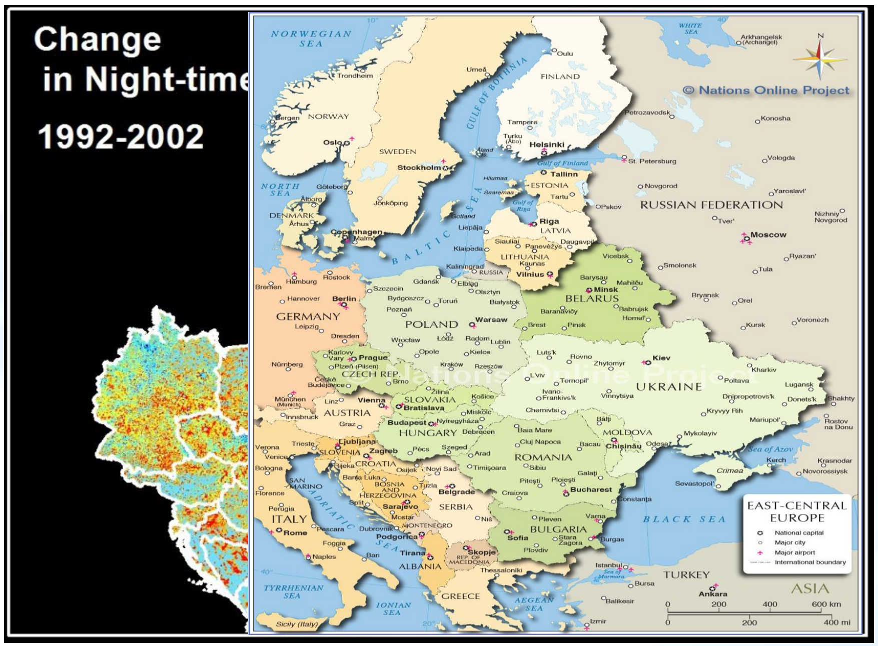


Earth Night Lights Observed by DMSP/OLI



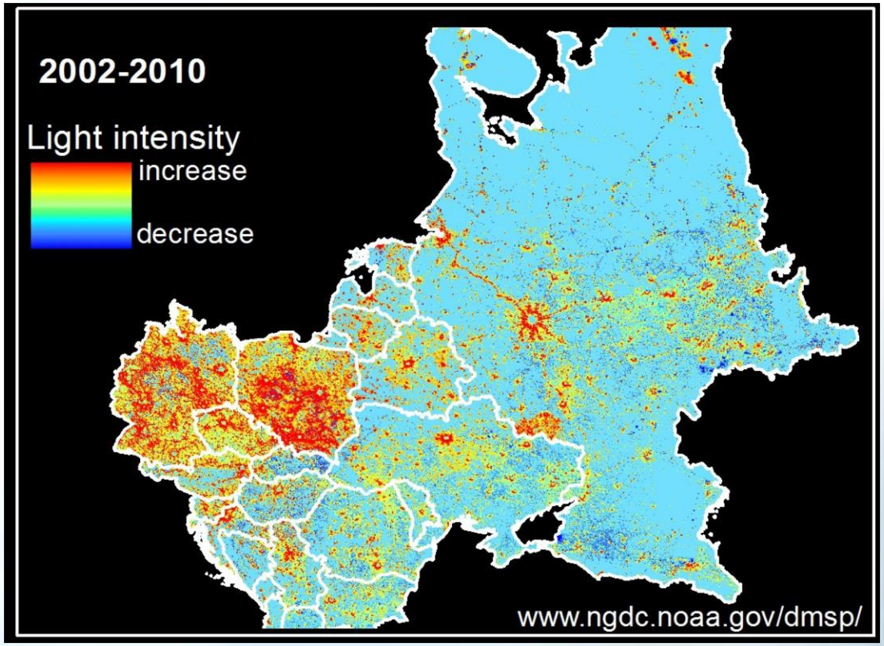
DMSP Night Lights Reflecting Changes in Economy

The Decade of Collapse



Deep Blue: Depressed Economies
(e.g. Ukraine & Moldova)
Red: Positive Economy Development

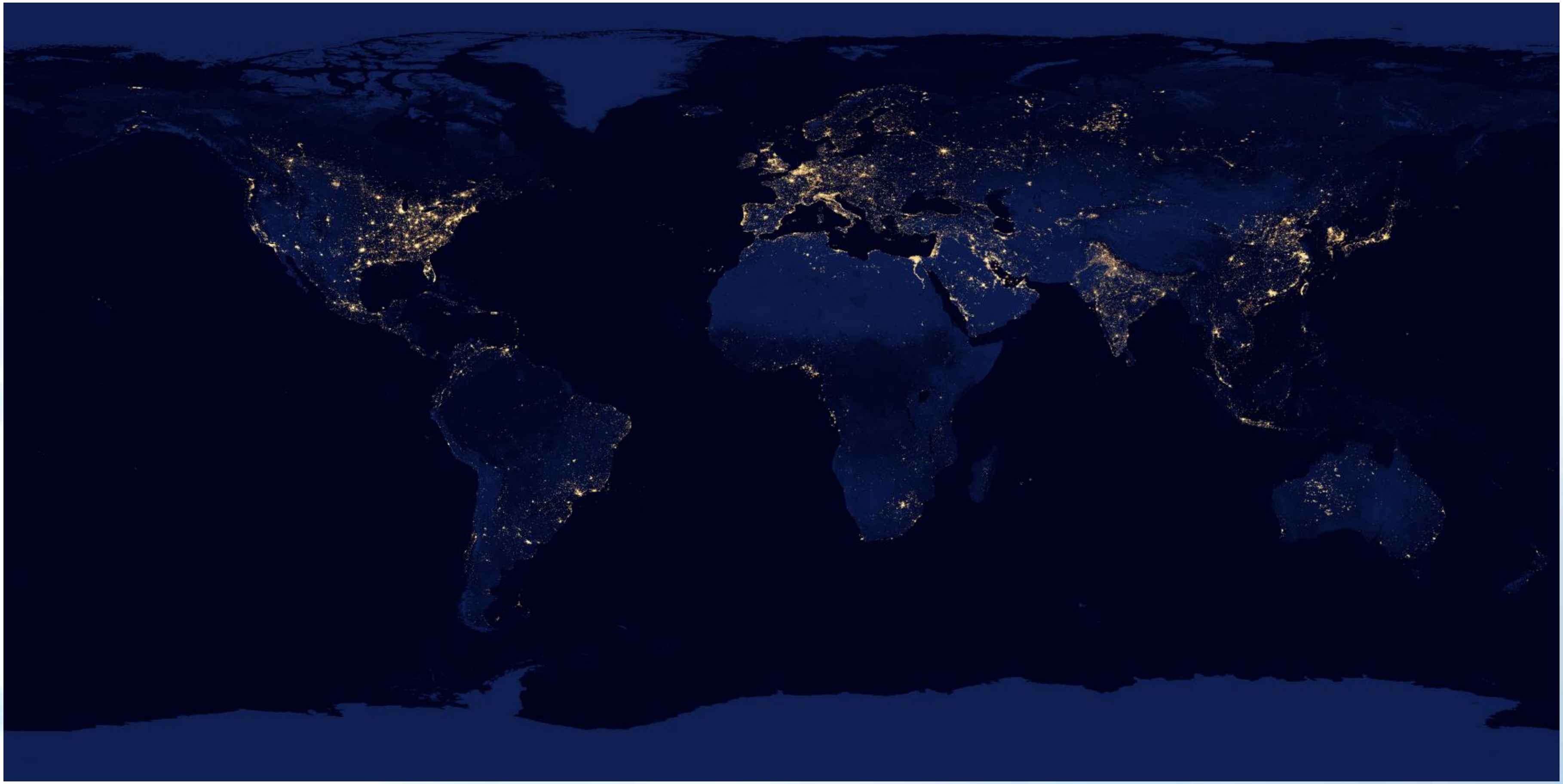
The Decade of Recovery



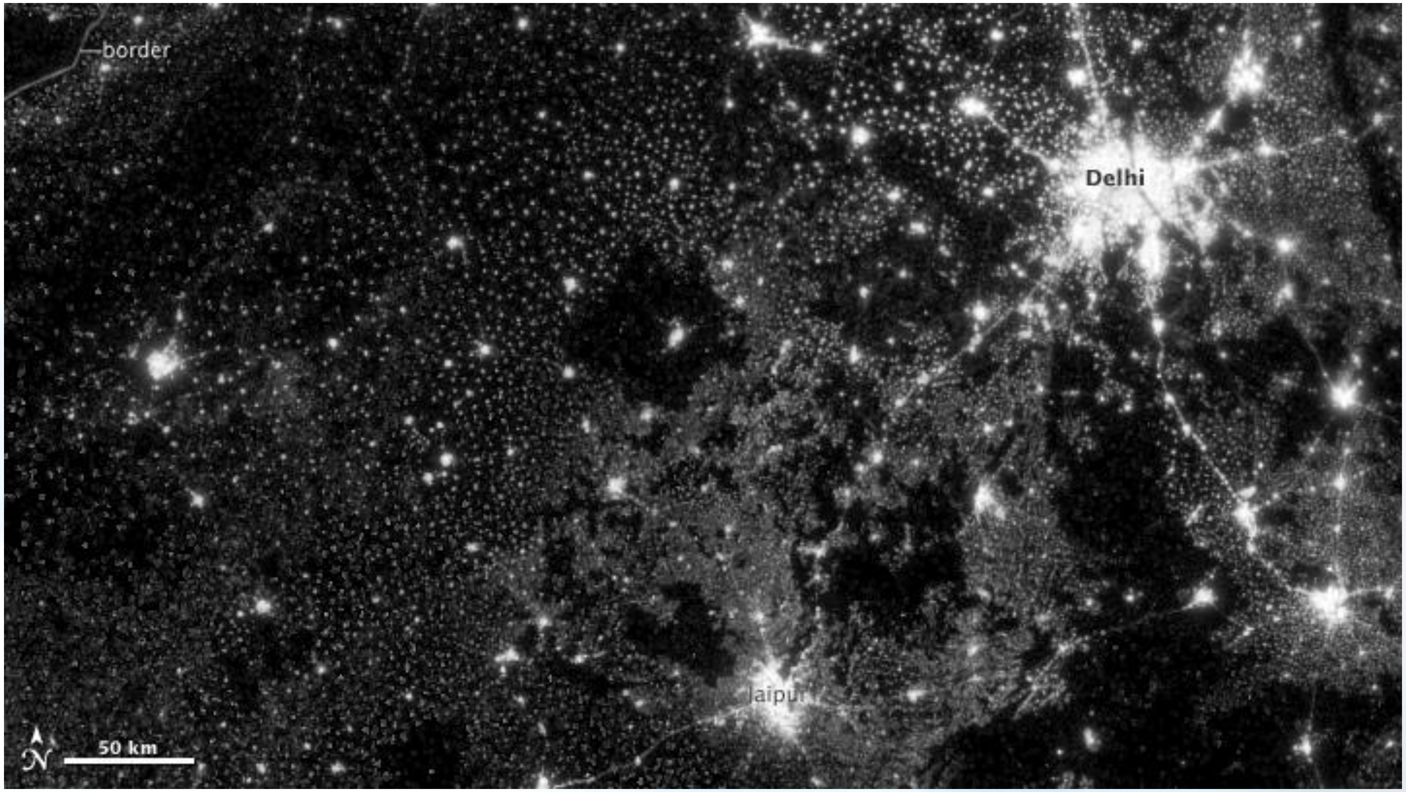
Light Blue: neutral (not much change)

Red: Economy and urban expansion (e.g. Moscow)

Earth Night Lights: A 2012 composite from data acquired by the
Suomi National Polar-orbiting Partnership (Suomi-NPP) satellite



NPP/VIIRS versus DMSP/OLS: Delhi, India

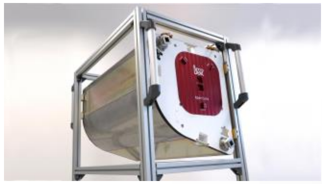


From OLS ($5km^2$/ 6 bits) to VIIRS(742 m^2 /14 bit)

New Sensors on the International Space Stations (ISS) for Land Observations

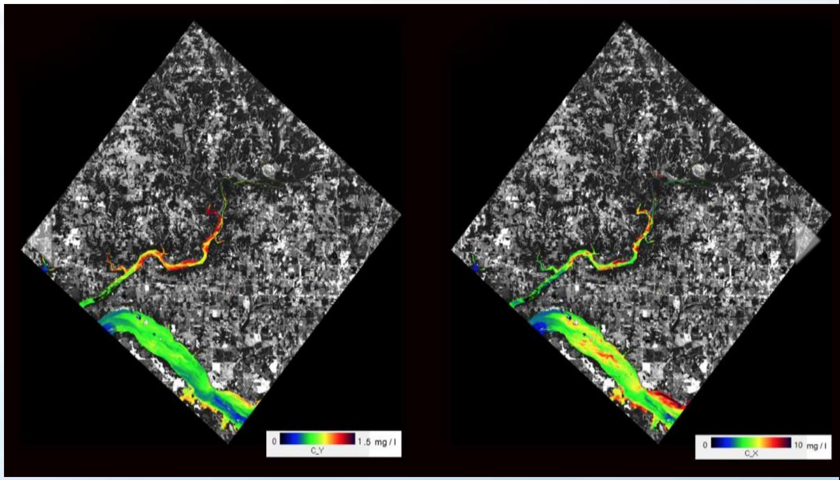
New: DLR Earth Sensing Imaging Spectrometer (DESIS) on ISS

- Launched to the International Space Station (ISS) from Cape Canaveral on **29 June 2018**
- Multiple User System for Earth Sensing (MUSES) platform, which can accommodate up to four Earth observation instruments.
- DESIS was deployed on the MUSES instrument platform in **Aug 2018** to observe the Earth and provide hyperspectral data to support scientific, humanitarian and commercial objectives
- DESIS has 235 spectral channels with ground res. 30m
- From their position on the ISS, DESIS and MUSES can point forwards, backwards and to the sides, allowing the instrument to respond with outstanding agility
- Data is becoming available



https://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10212/332_read-28665/#/gallery/30169

02 October 2018 water quality analysis

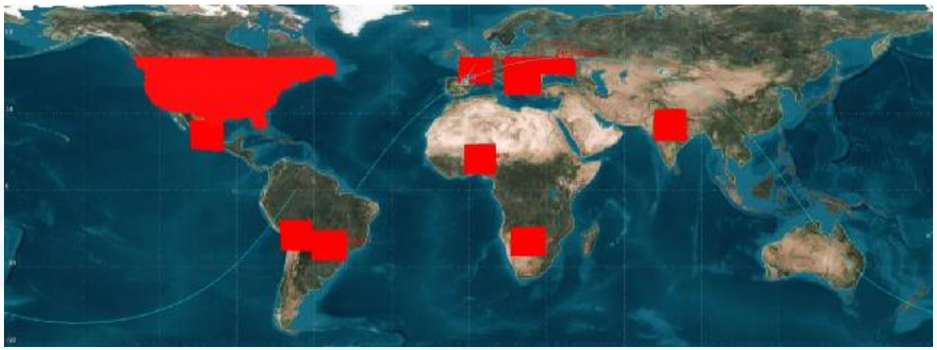


New: ECOsystem Spaceborne Thermal Radiometer Experiment on ISS (ECOSTRESS)

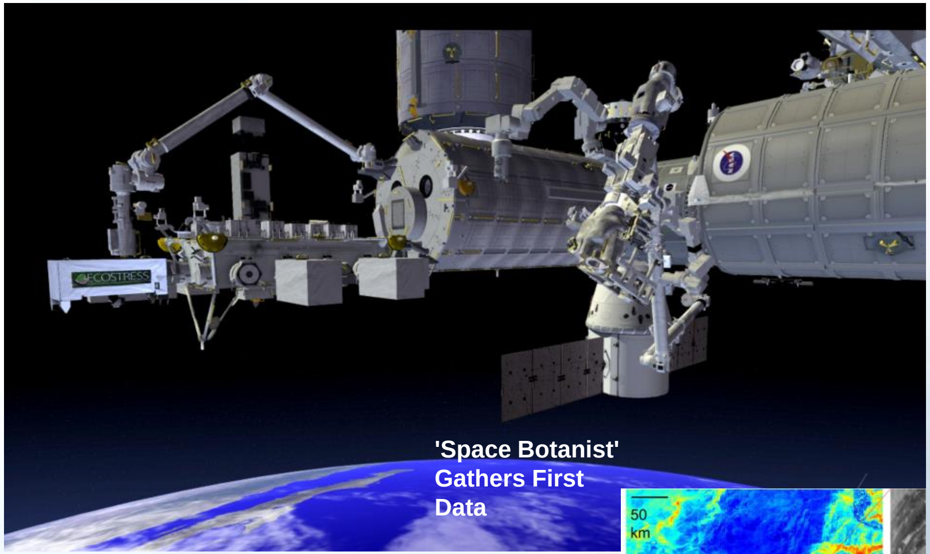
Credit: NASA/JPL-Caltech

https://ecostress.jpl.nasa.gov

Prototype HyspIRI Thermal Infrared Radiometer (PHyTIR):
5 spectral bands in the 8-12.5 µm range+1.6 µm (69m x 38m)

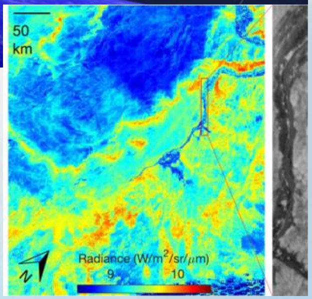


- Science objectives
  - Identify critical thresholds of water use and water stress in key biomes (e.g., tropical/dry transition forests, boreal forests)
  - Detect the timing, location, and predictive factors leading to plant water uptake decline and cessation over the diurnal cycle
  - Measure agricultural water consumptive use over CONUS at spatiotemporal scales applicable to improving drought estimation accuracy.

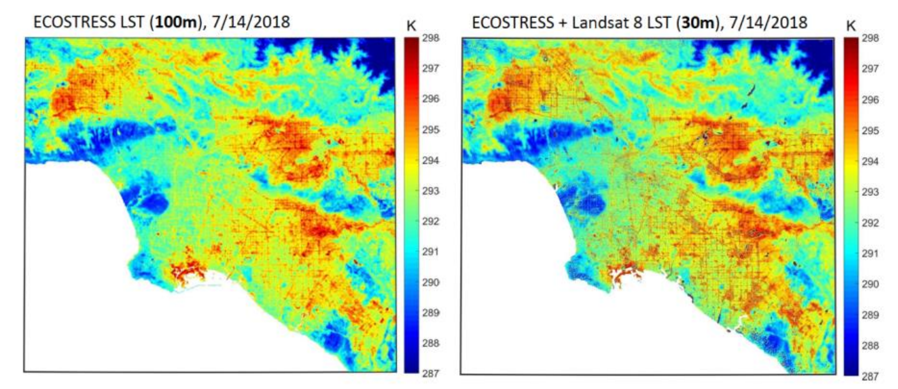


July 5: ECOSTRESS was removed from the Dragon spacecraft and robotically installed on the exterior of the space station's Japanese Experiment Module - Exposed Facility (JEM-EF) l

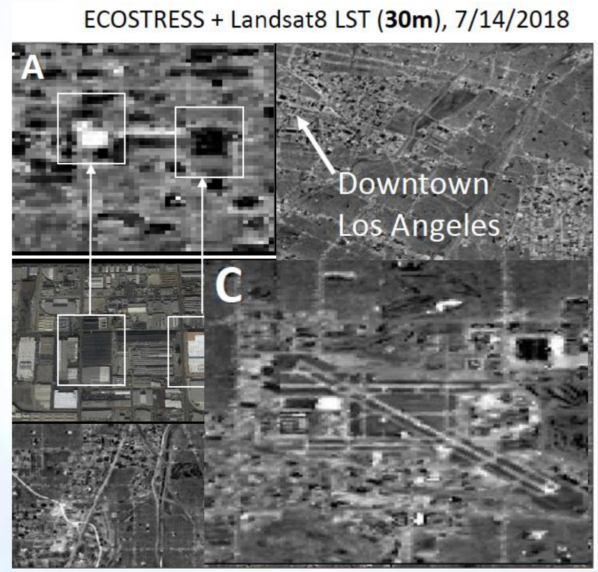
July 9 over Egypt



Sharpening of Coarse Resolution Thermal IR Images With Mid-Resolution Optical Images



ECOSTRESS Land Surface Temperature Imagery averaged into 100m cells and sharpened with Landsat 30m optical data for Los Angeles county, Ca



Distinguishing fine-scale thermal features of individual building roofs and transport network infrastructure (roads, runways)

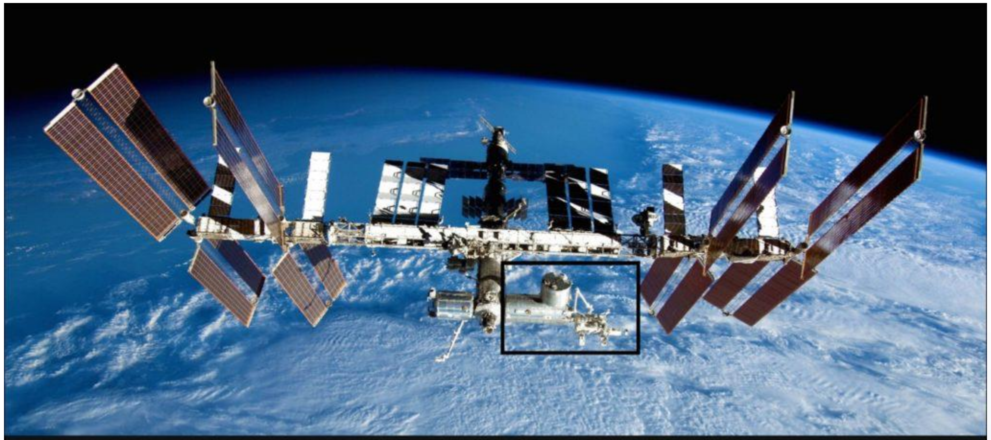
A: upper thermal image vs Google Earth image

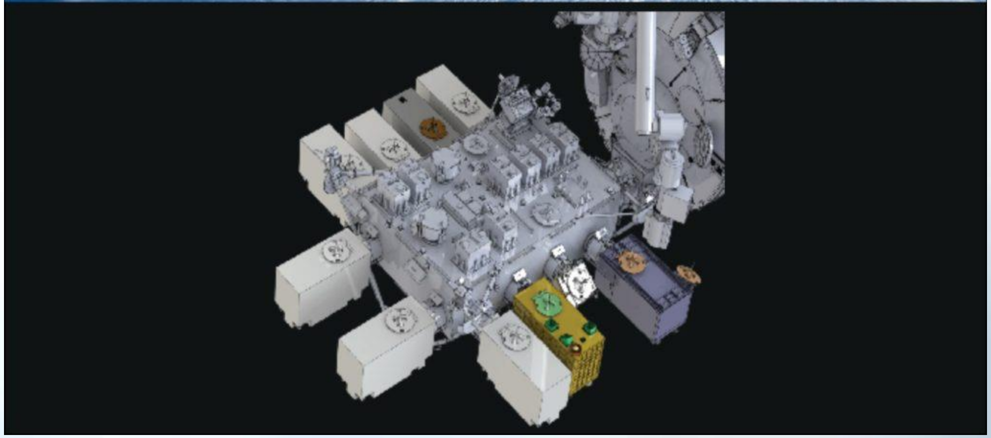
ECOSTRESS observations: throughout the diurnal cycle every week, while Landsat only the morning temperatures twice a month, at best

Courtesy: Glynn Hulley, NASA JPL

New: Global Ecosystem Dynamics Investigation (GEDI) Lidar on ISS

- Launched successfully on December 5, 2018
- GEDI was deployed on the the Japanese Experiment Module – Exposed Facility (JEM-EF) on Dec 13.
- Commissioning (at NASA GSFC) should be completed in February - once out of the commissioning phase, GEDI will begin collecting planned science data
- Makes precise measurements of forest canopy height, canopy vertical structure, and surface elevation
- Advances our ability to characterize important carbon and water cycling processes, biodiversity, and habitat
- Applications include weather forecasting, forest management, glacier and snowpack monitoring, accurate digital elevation models
- Primary science questions
  - What is the aboveground carbon balance of the land surface?
  - What role will the land surface play in mitigating atmospheric carbon dioxide in the coming decades?
  - How does ecosystem structure affect habitat quality and biodiversity?





- Produces high resolution laser ranging observations of the 3D structure of the Earth
- Each laser fires 242 times per second and illuminates a 25 m spot (a footprint) on the surface over which 3D structure is measured.
- Each footprint is separated by 60 m along track, with an across-track distance of about 600 m between each of the eight tracks.

"GEDI will provide a vertical record, not only of how tall trees are, but how much canopy material there is at any height,"

Take Away Messages

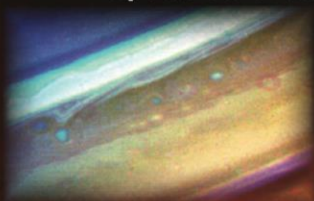
- Current trends in the LCLUC theme
  - multi-source land imaging using virtual constellation of available space assets with compatible characteristics, such as Landsat and Sentinel-2 systems
  - Long-term time series datasets, even with coarser resolution, are still useful for studying trends (e.g. DMSP/OLI)
  - intensification of using high-res. commercial data from vendors with constellations, such as Planet Lab and Digital Globe
- Advance science by fusing observations from
  - Optical at nested multi-spectral resolutions (300m→30m→3m→0.3m)
  - Optical mid-resolution (10-30m) from different sources, e.g. Landsat+Sentinel2
  - Optical and microwave (radar), e.g. Landsat & Sentinel-1
  - Hyperspectral optical and multi-spectral thermal infrared
    - Early Career Scientists should look into the NASA Surface Biology and Geology (SBG) mission to get engaged at the preparation stage

Opportunities at NASA for Early Career Scientists

NASA Postdoctoral Program

- One-year appointments
- Renewable up to three years
- Annual stipend
- Supplements for travel, relocation, and insurance

Space Science

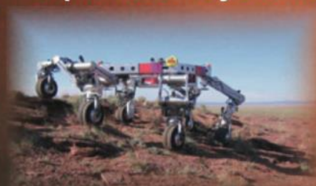


Earth Science

Aeronautics Research

Astrobiology

Exploration Systems



Space Operations

NASA Centers*

Ames Research Center
Dryden Flight Research Center
Glenn Research Center
Goddard Space Flight Center
Jet Propulsion Laboratory
Johnson Space Center
Kennedy Space Center
Langley Research Center
Marshall Space Flight Center
NASA Headquarters
Stennis Space Center
*Astrobiology Institute-Various Locations
NASA Goddard Institute for Space Studies

Administered by Universities Space Research Association

Eligibility

- Ph.D. completed
- U.S. Citizen or
- Lawful Permanent Resident (LPR) or
- J-1 Research Scholar

An H-1B status is not acceptable because the NPP is not an employment program. You are eligible to apply for the NPP while holding the F-1 status. However, if you are selected for an appointment, you must change your status to one listed above

Application

- Only ONE application for ONE research opportunity per application cycle
- REGISTER BEFORE YOU APPLY
- IDENTIFY A RESEARCH OPPORTUNITY
- Some opportunities are restricted to US citizens
- Apply either as a **Postdoctoral Fellow** or a **Senior Fellow** depending on your seniority
  - A Senior Fellow has held the doctoral degree for five or more years at the time of application

Useful links

- https://npp.usra.edu/
- https://www.giss.nasa.gov/edu/
- https://npp.usra.edu/about/faq/applicants/
- https://npp.usra.edu/about/faq/fellow/

Thank You Хвала

7 years later: interest to continue confirmed!