



**WELCOME TO
NASA APPLIED REMOTE SENSING TRAINING
(ARSET)
WEBINAR SERIES**

**INTRODUCTION TO REMOTE SENSING FOR
CONSERVATION MANAGEMENT**

**COURSE DATES: EVERY TUESDAY, MAY 5 – JUNE 2
TIME: 12:00 – 1:00 PM EDT (GMT-04:00)
OR
10:00 – 11:00 PM EDT**



Course Structure

- ❑ One lecture per week – every Tuesday May 5 to June 2
 - ❑ 12:00 – 1:00 PM EDT (GMT-04:00) (Session 1)
 - ❑ 10:00 – 11:00 PM EDT (Session 2)

- ❑ Webinar recordings, PowerPoint presentations, and homework assignments can be found after each session at:
<https://arset.gsfc.nasa.gov/ecoforecasting/webinars/introduction-remote-sensing-conservation-management>

- ❑ Certificate of Completion
 - ❑ Attend 4 out of 5 webinars
 - ❑ Assignment 1 and 2 – access from the ARSET Conservation Management webinar website (above)
 - ❑ You will receive certificates approximately 1 month after the completion of the course from:
marines.martins@ssaihq.com

- ❑ Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)



ARSET Conservation Management

The screenshot shows the ARSET (Applied Remote Sensing Training) website interface. At the top, there are navigation links for 'Earth Science Division', 'Applied Sciences', and 'ASP Water Resources'. The main header features the NASA logo and the text 'ARSET Applied Remote Sensing Training' with a search bar. Below the header is a navigation menu with tabs for 'DISASTERS', 'ECO FORECASTING', 'HEALTH & AIR QUALITY', and 'WATER RESOURCES'. The 'ECO FORECASTING' tab is active, showing a sidebar with 'Eco Forecasting' and 'Upcoming Training' sections. The 'Upcoming Training' section lists two courses: 'Ecoforecasting Introduction to Remote Sensing for Conservation Management' (05/05/2015 to 06/02/2015) and 'Disasters NASA Remote Sensing Observations for Flood Management' (06/08/2015 to 06/29/2015). The main content area displays the details for the 'Introduction to Remote Sensing for Conservation Management' course, including course dates (05/05/2015 to 06/02/2015), course objectives, course participants, and course agenda.

Earth Science Division Applied Sciences ASP Water Resources

NASA ARSET Applied Remote Sensing Training

DISASTERS ECO FORECASTING HEALTH & AIR QUALITY WATER RESOURCES

Eco Forecasting

- ▶ Eco Webinars
- Eco Personnel

Upcoming Training

Ecoforecasting
Introduction to Remote Sensing for Conservation Management
05/05/2015 to 06/02/2015

Disasters
NASA Remote Sensing Observations for Flood Management
06/08/2015 to 06/29/2015

Introduction to Remote Sensing for Conservation Management

05/05/2015 to 06/02/2015

Course Dates:

- Five 1-hour sessions, each session will be held two times a day to allow for national and international participation from different times zones.
- Each Tuesday from May 5 - June 2 at 12:00-1:00pm and at 10:00-11:00pm (GMT-04:00) Eastern Time (US and Canada)
- Please only sign up for and attend one of the session times.

Course Objectives:

- Provide an overview of remote sensing, details on how to access and visualize relevant NASA Earth science data, and how to use these data for conservation and biodiversity issues.
- Assist NGOs and land management professionals in decision-making through the use of NASA data, relevant tools, and assessment methods.

Course Participants:

- This course is intended for national and international NGOs and land managers at the local, state, and federal level, focused on conservation and biodiversity issues. **Space is limited. Preference will be given to the organization types listed above.**

Course Agenda:

Week 1 (May 5): Overview of remote sensing and conservation applications

Week 2 (May 12): Satellite sensors and aircraft platforms and access tools

Week 3 (May 19): Habitat monitoring

Week 4 (May 26): Animal movement

Week 5 (June 2): Near-real time monitoring

All training materials will be available in English and Spanish.

Certificates will be provided for those who attend 4 out of 5 weeks (of the same session time) and complete all homework assignments.

Register for one of the session times below:


[Click here to register for the 12:00-1:00pm \(EDT\) session](#)


<https://arset.gsfc.nasa.gov/ecoforecasting/webinars/introduction-remote-sensing-conservation-management>



Accessing the Recordings

ADOBE® CONNECT™ TimeZone (US/Pacific-New) ▼

ARSET
Applied Remote Sensing Training 



Event Info | **Event Registration**

RS for Conservation Management Week 2 Recording
In case you have not registered for this event before [please click here to register](#)

Login using Email

E-mail Address:

Login



You must register to access the recordings!
This is different from your webinar registration.



Your Course Instructors

- ❑ Cindy Schmidt (ARSET): cynthia.l.schmidt@nasa.gov
- ❑ Amber Kuss (ARSET): amberjean.m.kuss@nasa.gov
- ❑ Guest Speakers:
 - ❑ Walter Jetz – Yale University (week 3)
 - ❑ Jeff Cavner – University of Kansas (week 4)
 - ❑ Karyn Tabor – Conservation International (week 5)

General inquiries about ARSET: Ana Prados (ARSET)
aprados@umbc.edu



Course Outline

Week 1



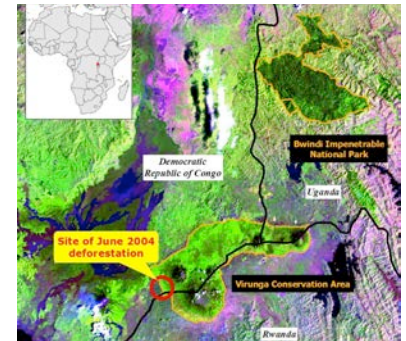
Overview of satellite remote sensing

Week 2



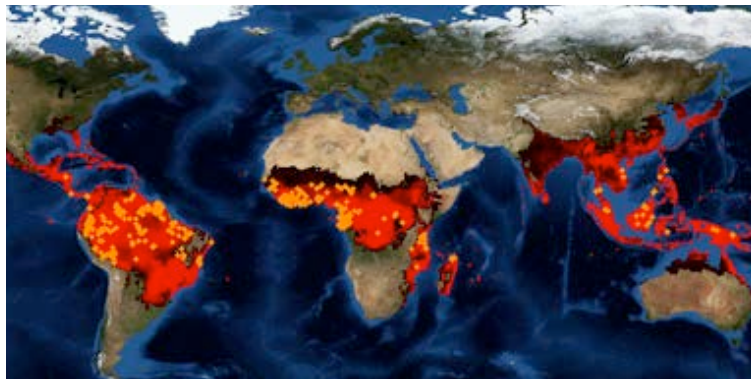
Platforms and sensors for conservation

Week 3



Habitat monitoring

Week 4



Animal movement

Week 5



Near-real time data



Week 4 Agenda

- ❑ Review of Week 3
- ❑ Overview of monitoring animal movement
- ❑ Remote sensing and animal movement
 - ❑ NDVI and Phenology
 - ❑ NDVI products
 - ❑ Examples
- ❑ Additional Resources
- ❑ Live demo
 - ❑ LifeMapper: Guest speaker Dr. Jeff Cavner, University of Kansas



Review of Week 3

Overview of Habitat Monitoring

- ❑ Used to assess the threat and conservation status of species and protected areas
- ❑ IUCN Red List key criteria:
 - ❑ Habitat extent
 - ❑ Fragmentation
 - ❑ Rate of Change



Image credit: E. De Merode

Land changes in the Virunga Conservation Area which provides habitat to approximately 380 mountain gorillas

Rapid deforestation occurred in June 2004 in the “Mikeno” section of the park

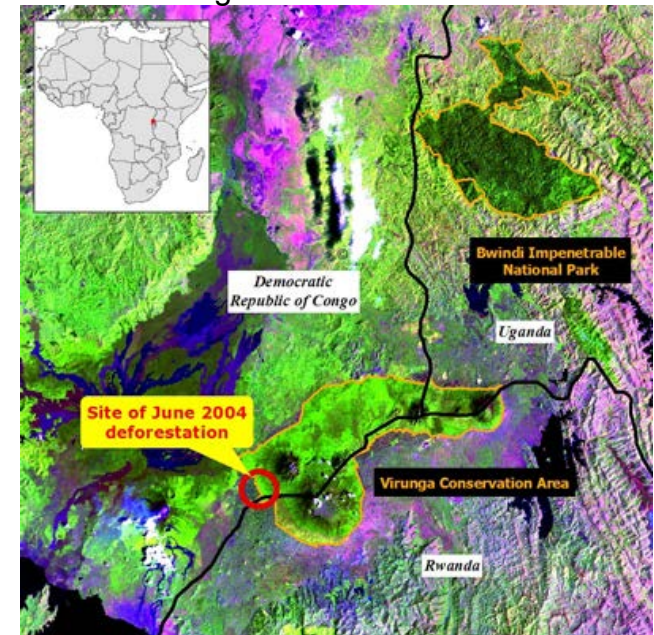
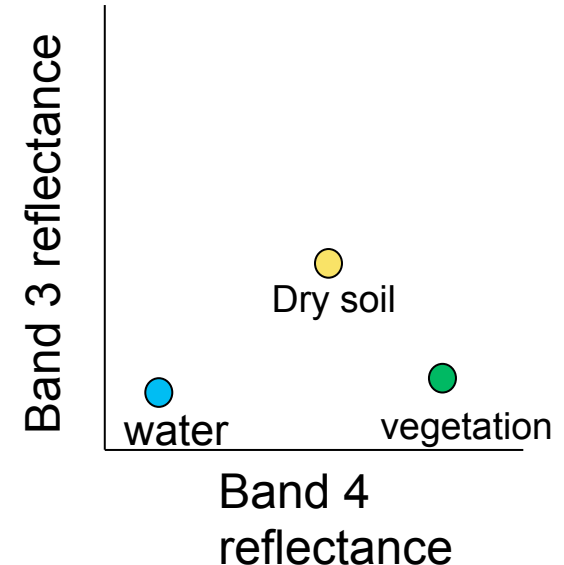


Image credit: Nadine Laporte/Tiffany Lin






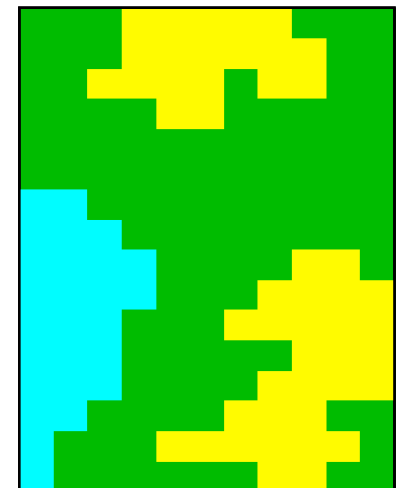
Land Cover Mapping Basics

- ❑ Using **Image Processing software**, image classification involves using n number of bands, not just 2.
- ❑ You specify the number of land cover classes that are in your study area.
- ❑ There are many methods, but two common ones are **Supervised** and **Unsupervised** classification



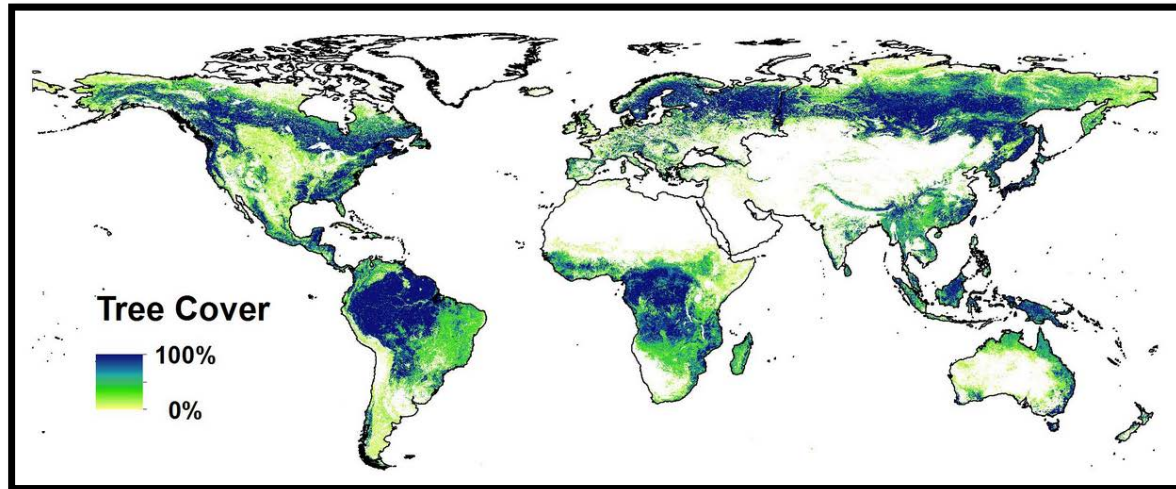
Legend:

-  Water
-  Vegetation
-  Dry soil





Global 1-km Consensus Land Cover

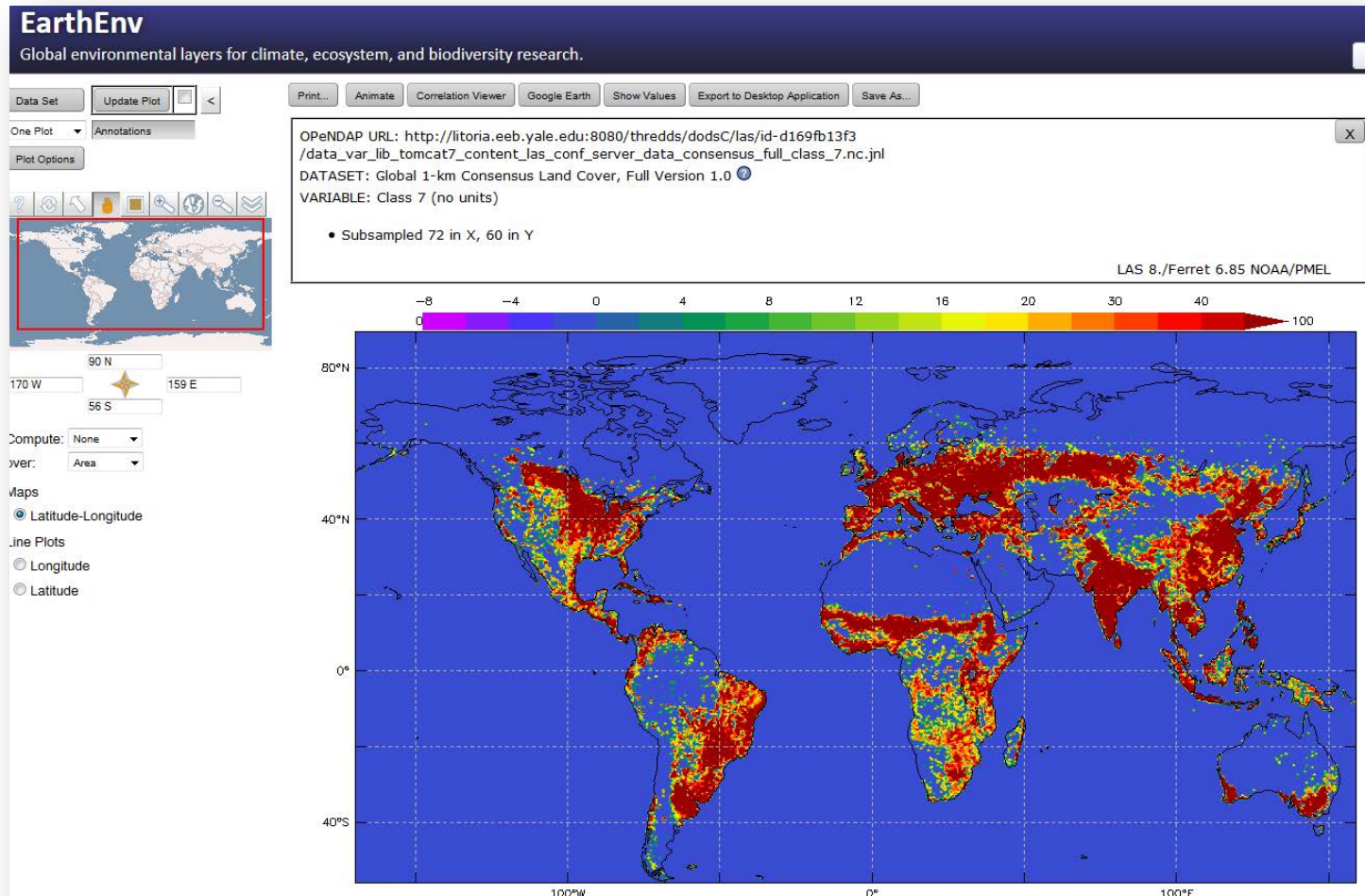


- ❑ Integrates multiple global remote sensing-derived land-cover products
- ❑ Includes 12 land cover classes at 1-km resolution
- ❑ Each land cover class is available as an individual layer for download in GeoTIFF format

www.earthenv.org/landcover.html



Global 1-km Consensus Land Cover



www.earthenv.org/landcover.html



Overview of Monitoring Animal Movement



Animal Movement

- ❑ Spatial and temporal animal movement patterns are a central focus of animal ecology.
- ❑ Four fundamental questions:
 - ❑ Why move?
 - ❑ How to move?
 - ❑ When and where to move?
 - ❑ What are the ecological and evolutionary consequences of movement?



Credit: Elizabeth Gordon



Credit: tanzaniaonfoot.com

Serengeti wildebeest migration

Animal Movement: Technologies

- ❑ Non-electronic tags (e.g. metal bands)
 - ❑ Requires capture and re-capture
- ❑ Radio or satellite tracking
 - ❑ Does not require re-capture
 - ❑ Sometimes have to follow animal, but sometimes not
 - ❑ Giving a complete, continuous picture of migration patterns



Credit: The Migratory Connectivity Project





Remote Sensing and Animal Movement: NDVI and Phenology



Remote Sensing and Animal Movement

- ❑ Animals interact with their environment at multiple spatiotemporal scales
- ❑ Remote sensing data can capture characteristics about the environment at different scales
- ❑ Animal locational data combined with remote sensing data can help determine why and where animals move



Credit: gallery.hd.org

This Burchells zebra is grazing on green grass in Addo Elephant Park, Eastern Cape, South Africa

Example: Wildebeest



- Between **December and April** the wildebeest are on the short grass plains in the southern Serengeti
- In **April and May** the rains stop and the plains in the south and east of the Serengeti dry out. The herd then moves north and west where there is more grass and water.
- In **June to July** is transitional between rainy and dry season. The herds push further north towards the Maasai Mara.
- Between **July and August** many thousands of wildebeest move to the Maasai Mara.
- We can use remote sensing (precipitation and vegetation green up) to determine when and where the wildebeest will migrate.





Remote Sensing and Animal Movement

- Paper: “Opportunities for the application of advanced remotely-sensed data in ecological studies of terrestrial animal movement”
Neumann et al., 2015, *Movement Ecology*
 - Studies of small-scale movement included data about land cover, infrastructure, and terrain
 - Studies of coarser-scale movement (e.g. migration) often used data on vegetation phenology, sometimes combined with climate, weather, and terrain data



Remote Sensing and Animal Movement

- Plants and animals have life cycles events that occur regularly every year that are dependent on temperature, precipitation and available sunlight.
- Vegetation information from satellite imagery is useful to study animal movement because **plant phenology** and **vegetation productivity** can often be linked to location of individuals.

Remote Sensing and Animal Movement

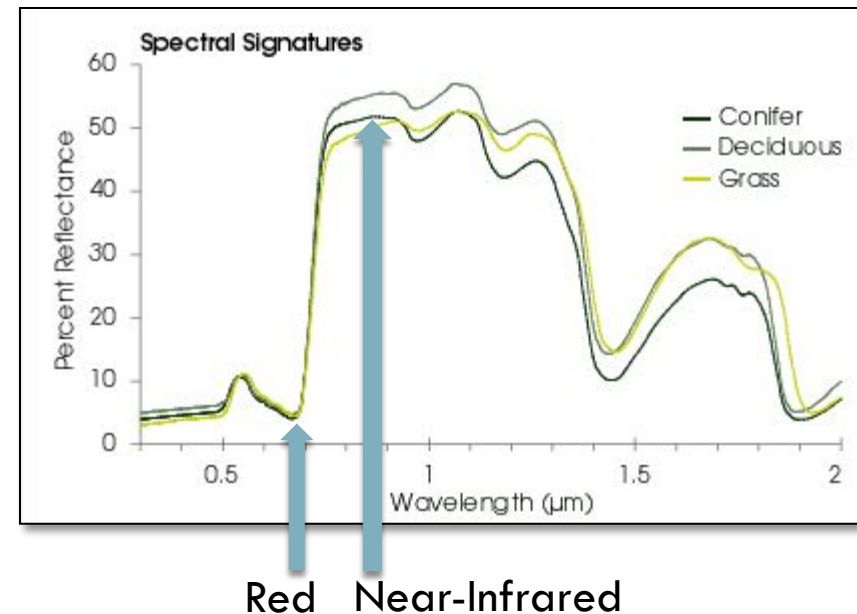
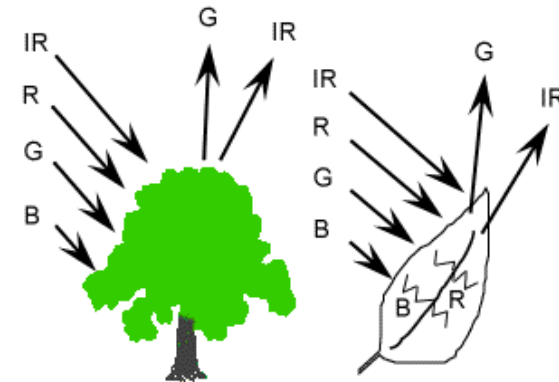
- RS information on vegetation productivity can be obtained through vegetation indices: Normalized Difference Vegetation Index (NDVI) or Enhanced Vegetation Index (EVI)
 - At coarser scales, shifts in relative NDVI distribution can explain movement to and from seasonal ranges
 - At finer scales, NDVI might explain the habitat choices of individuals at a particular point in time



Vegetation changes in Africa from March 2004 (top) to September 2004 (bottom)

What is NDVI?

- Normalized Difference Vegetation Index
 - Based on the relationship between red and near-infrared wavelengths.
 - Chlorophyll strongly absorbs visible (red)
 - Plant structure strongly reflects near-infrared



What is NDVI?

- NDVI formula:
$$\frac{\text{Near-Infrared} - \text{Red}}{\text{Near-Infrared} + \text{Red}}$$
- Values range from -1.0 to 1.0
 - Negative values to 0 mean no green leaves
 - Values close to 1 indicates the highest possible density of green leaves.

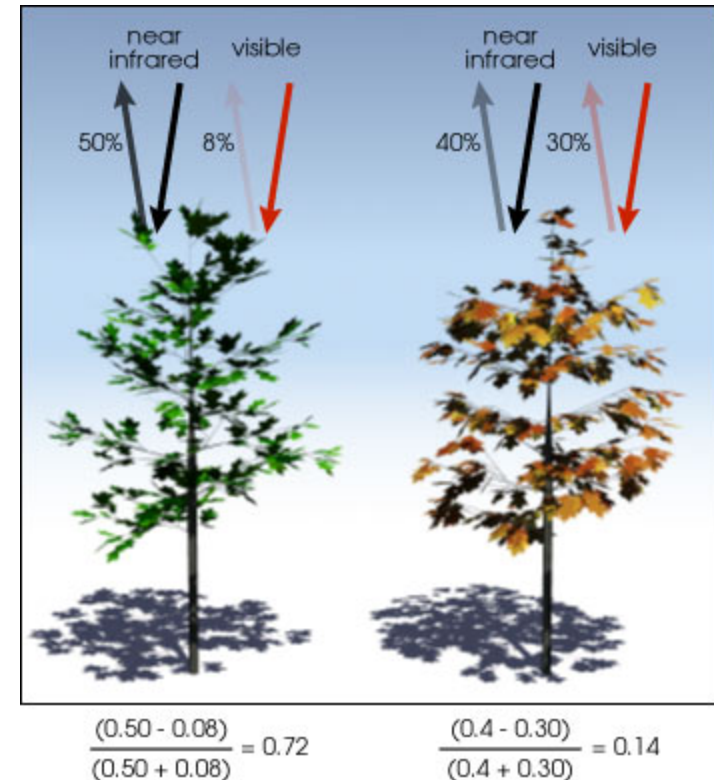


Image Credit: Robert Simmon

NDVI Example

This is Landsat NDVI image of the Panama Canal watershed

The darker green the area, the higher the NDVI value, the more green vegetation is present

This image was acquired in March 2000 during Panama's annual dry season.

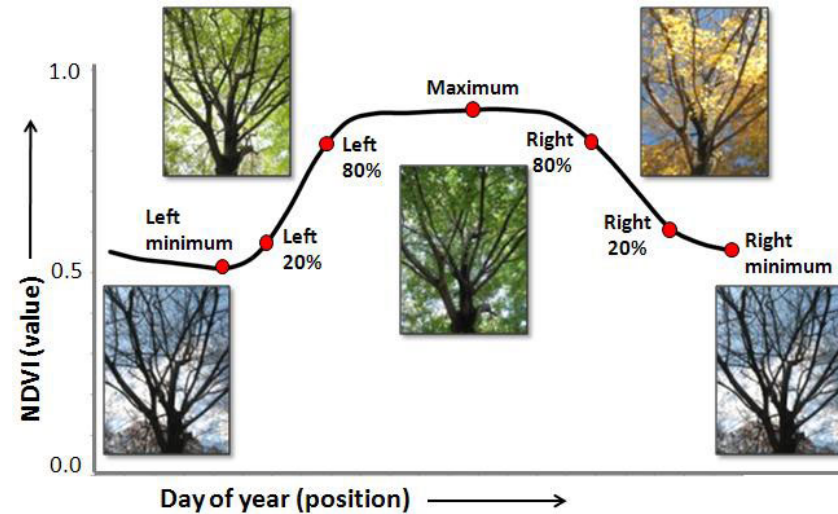


Normalized Difference Vegetation Index (NDVI)
-0.1 0.1 0.3 0.5 0.7 0.9

Source: <http://earthobservatory.nasa.gov>

NDVI: Phenology

- ❑ Remote sensing is used to track the seasonal changes in vegetation
- ❑ Monthly NDVI images from MODIS or Landsat can be used to monitor phenology



Credit: spacegrant.montana.edu

North America NDVI images in winter and summer



Remote Sensing and Animal Movement: NDVI and Phenology Products



MODIS Products

MODIS Name	Product Name	Spatial Resolution (m)	Temporal
MOD 09	Surface Reflectance	500	8-day
MOD 11	Land Surface Temperature	1000	Daily, 8-day
MOD 12	Land Cover/Change	500	8-day, Yearly
MOD 13	Vegetation Indices	250 – 1km	16 day
MOD 14	Thermal Anomalies/Fire	1000	Daily, 8-day
MOD 15	Leaf Area Index/Fraction of Absorbed Photosynthetically Active Radiation (FPAR)	1000	4-day, 8-day
MOD 16	Evapotranspiration		
MOD 17	Primary Production	1000	8-day, yearly
MOD 43	Bidirectional reflectance distribution function (BRDF)/Albedo	500-1000	16-day
MOD 44	Vegetation Continuous Fields	250	yearly
MOD 45	Burned Area	500	monthly



MODIS NDVI and EVI

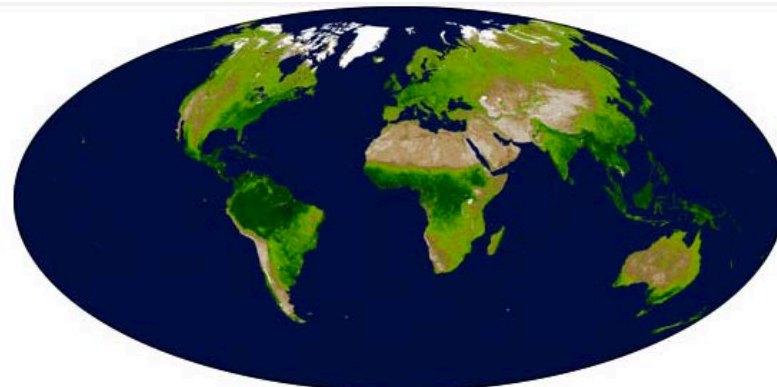
Composite	Spatial Resolution	Terra	Aqua
16-day	250 m	MOD13Q1	MYD13Q1
16-day	500 m	MOD13A1	MYD13A1
16-day	1km	MOD13A2	MYD13A2
16-day	.05 deg (~5.5 km)	MOD13C1	MYD13C1
Monthly	1km	MOD13A3	MYD13A3
Monthly	.05 deg (~5.5 km)	MOD13C2	MYD13C2

<http://reverb.echo.nasa.gov>

<https://mrtweb.cr.usgs.gov>

What is EVI?

- ❑ Enhanced Vegetation Index (MOD13Q1) – only from MODIS
 - ❑ Maintains sensitivity over dense vegetation conditions
 - ❑ Uses the blue band to remove residual atmosphere contamination caused by smoke and sub-pixel thin clouds





MODIS Products

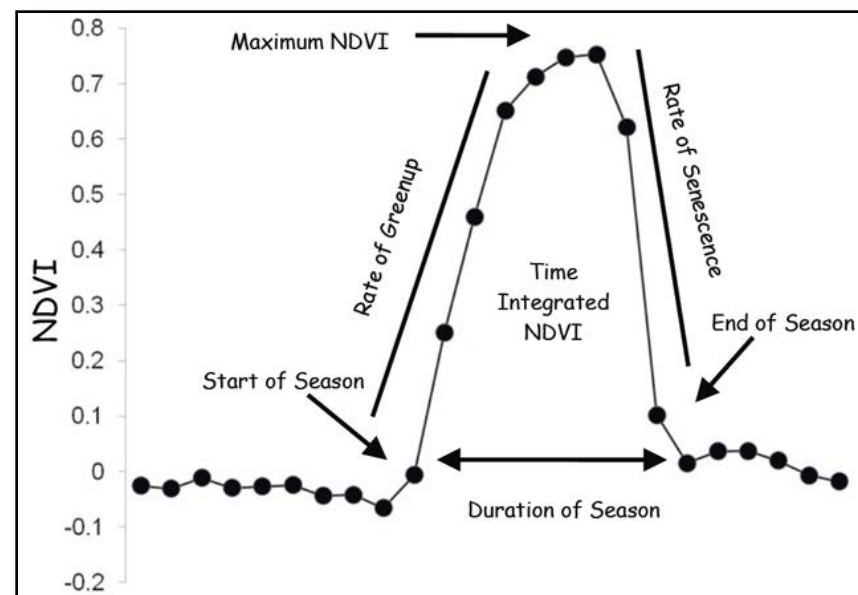
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MODIS Land Cover Dynamics (MCD12Q2)



MODIS Phenology (2001-2012)

- Start of season time/NDVI
- End of season time/NDVI
- Time of Maximum NDVI
- Length of growing season
- Maximum increase in canopy
- Photosynthetic activity across entire growing season



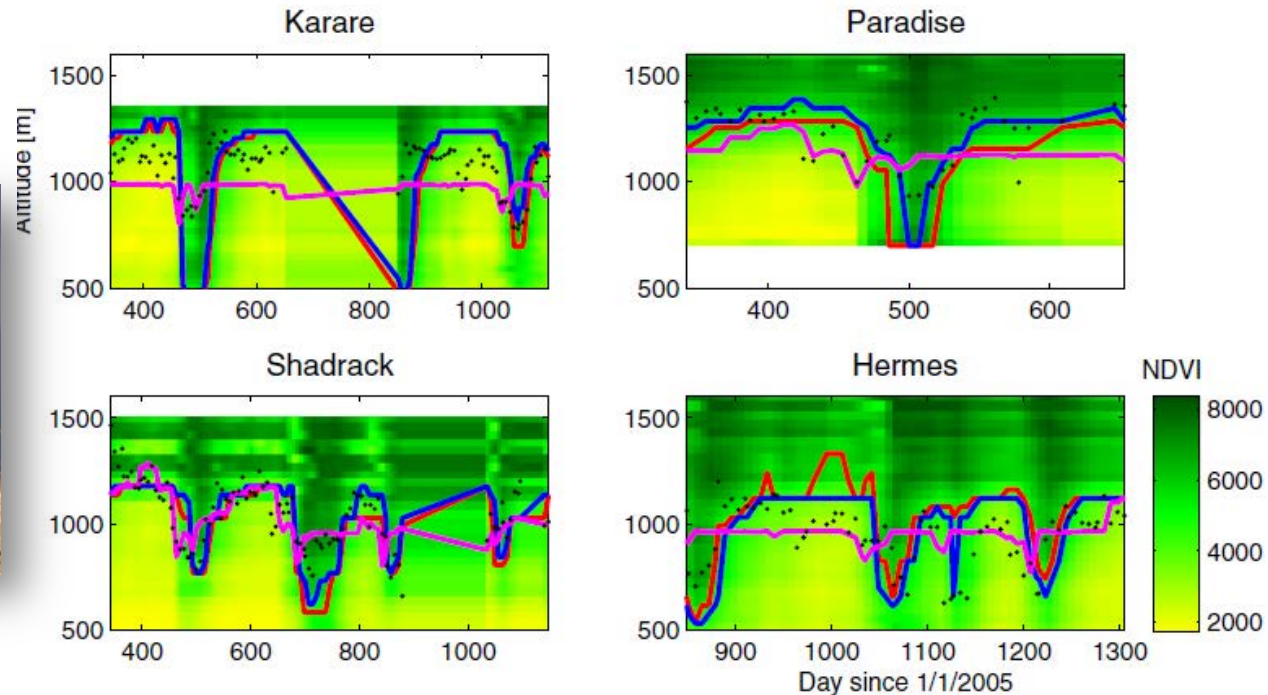
<http://reverb.echo.nasa.gov>



Some Examples

Use Case: Phenology and Elephants

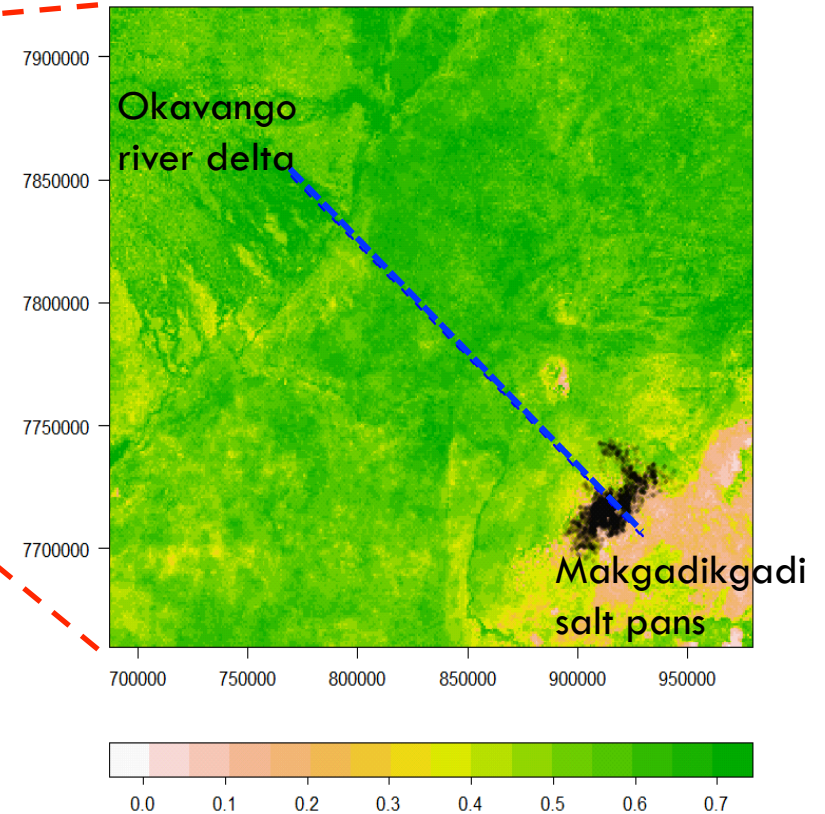
- Bohrer et al. (2014) found that the elevational migration of individual elephants closely matched the patterns of greening and senescing of vegetation in their home range.



Use Case: Zebras at the Okavango Delta: Moving to greener pastures



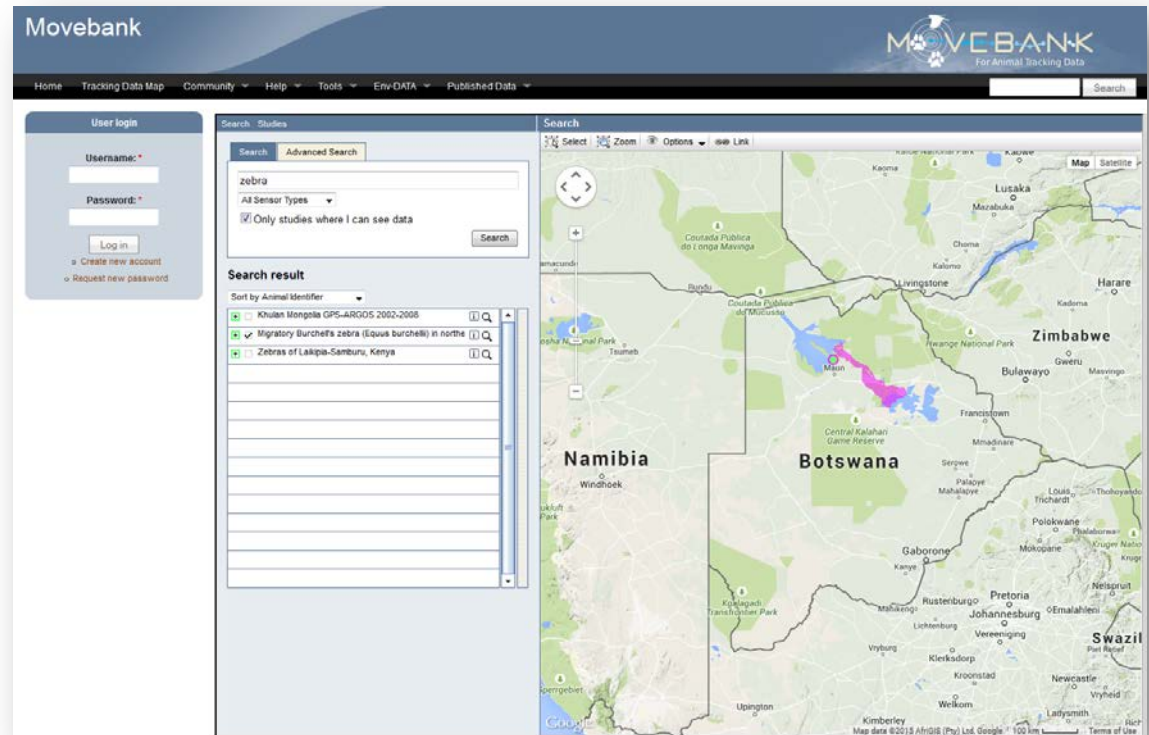
Bartlam-Brooks et al. (2014), JGR





Movebank

- Movebank is a free, online database of animal tracking data hosted by the Max Planck Institute of Ornithology.
 - Helps animal tracking researchers to manage, share, protect, analyze and archive their data.



This shows the web interface for Movebank. This example shows migratory path of Burchell's zebra in northern Botswana.

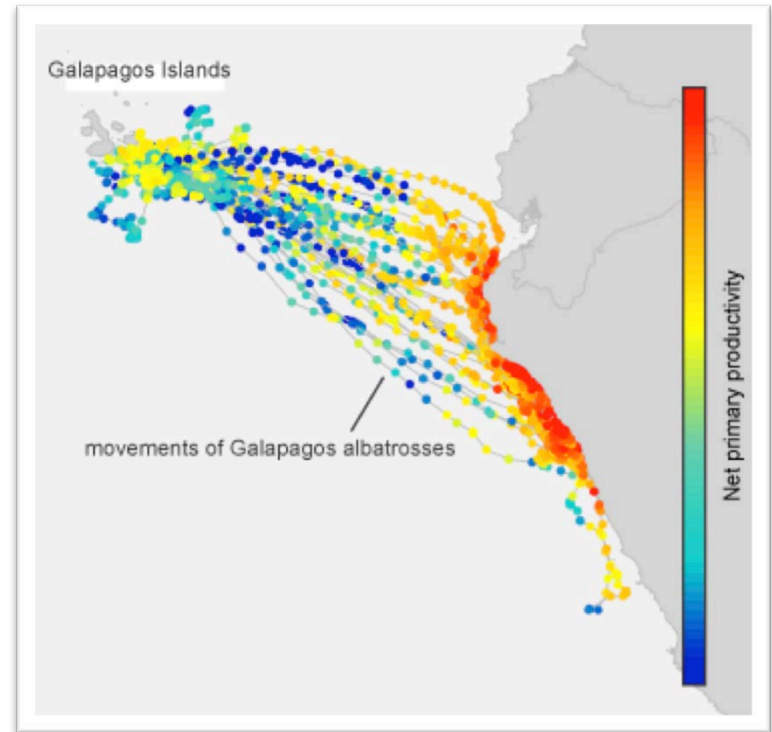
<http://www.movebank.org>



Movebank: The Env-DATA System

- Goals:
 - To streamline the co-registration of animal tracking data with a diverse range of environmental variables
 - To allow scientists to examine relationships between animal movement and ambient atmospheric observations and underlying landscape
 - For more information and tutorials go to:

<http://youtube.com/movebank>



This image shows 8-day ocean net primary productivity annotated to tracks of Galapagos albatrosses



Movebank: The Env-DATA System

- ❑ Automate the acquisition of data from open web resources of remote sensing and weather data
 - ❑ 50 large global datasets (>4000 variables)
 - ❑ NASA, NOAA, USGS, NCEP/NCAR and ECMWF weather reanalysis datasets
 - ❑ Complete list:
<https://www.movebank.org/mode/7471>

Datasets	Data Source	Temporal Coverage
Tropical Rainfall Measuring Mission (TRMM)	NASA http://trmm.gsfc.nasa.gov/	1998– present
AVHRR land NDVI	NASA http://glcf.umiacs.umd.edu/data/gimms/	1989–present, 1982–present
NCEP Global Reanalysis 2	NOAA http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis2.html/	1948–present
North American Regional Reanalysis	NOAA http://www.emc.ncep.noaa.gov/mmb/rrean/	1979–present
ECMWF Reanalysis	ECMWF http://www.ecmwf.int/	1979–present
MODIS Land	NASA https://lpdaac.usgs.gov/	2002–2012
MODIS Ocean	NASA http://oceancolor.gsfc.nasa.gov/	
MODIS Snow	NASA http://modis-snow-ice.gsfc.nasa.gov/	
Ocean productivity	http://www.science.oregonstate.edu/ocean.productivity/	1997–2009
ASTER GDEM	USGS http://asterweb.jpl.nasa.gov/gdem.asp	
SRTM	NASA http://www.cgiar-csi.org/data/srtm-90m-digital-elevation-database-v4-1/	
GlobCover	ESA http://dup.esrin.esa.it/prjs/prjs68.php	2009
Socioeconomic data	http://sedac.ciesin.columbia.edu/gpw/global.jsp	1990–2010
Ocean Surface Current Reanalysis (OSCAR)	NASA http://www.oscar.noaa.gov/	1993–present
ETOPO1	NASA http://www.ngdc.noaa.gov/mgg/global/global.html/	1940–2008



Additional Resources



List of Resources

- ❑ AniMove (www.AniMove.org)
 - ❑ Two-week intensive training course for studying animal movement
- ❑ EcoSens: Remote Sensing and GIS in Ecology and Conservation (www.ecosens.org)
 - ❑ Applied RS and GIS training for conservation and ecology
- ❑ Book: “Remote Sensing and GIS for Ecologists” (<http://book.ecosens.org>)
- ❑ Book: “Analysis and mapping of animal movement in R” (Amazon.com)

Live Demo: Life Mapper



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Range &
Diversity

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The Lifemapper Project

For more than 300 years, tens of thousands of biologists around the world, through rugged exploration of the planet's wild places, have strived to discover and document the diversity of life on earth.

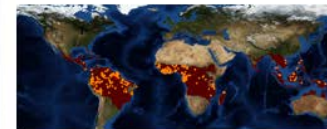
[Read More ...](#)



Scientific Impacts

Where will invasive species next attack? What geographic areas are most vulnerable to the plague? These questions are being answered by scientists who use Lifemapper to run predictive models.

[Read More ...](#)



Run a Model

The Lifemapper team has created an interactive web application that offers a glimpse of Lifemapper's approach to Species Distribution Modeling. Three interfaces offer a glimpse of our Modeling capabilities.

[Run a Model](#)

<http://lifemapper.org/>

Coming up next week!

Near Real-Time Monitoring



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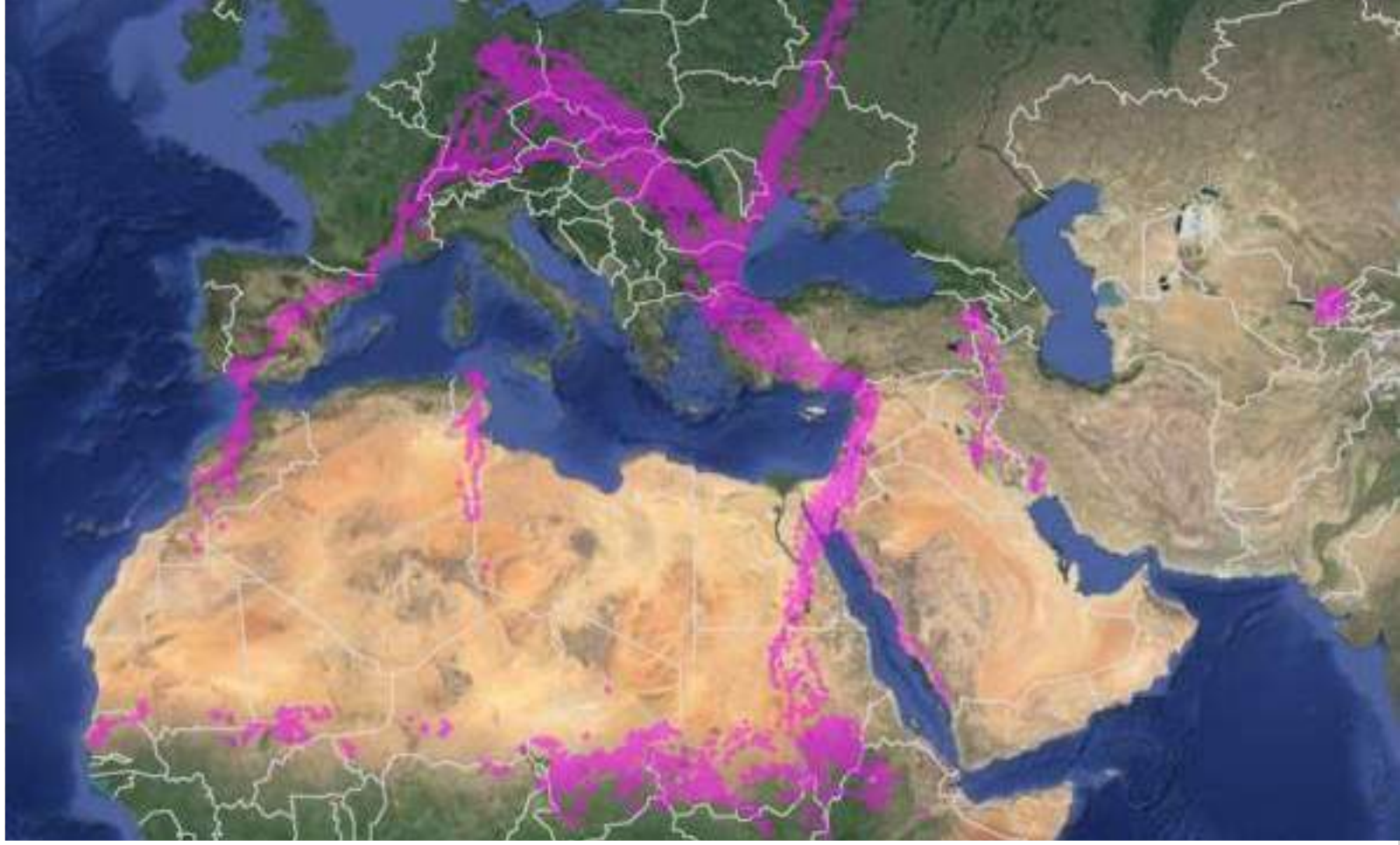
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- ❑ Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)

Please complete the webinar survey after Week 5!!!!

This image shows the migration routes for white storks. This is part of a large project to determine the effects of migration strategies on survival and fitness (PI: Wolfgang Fielder)



Thank You!!

Cindy Schmidt

Cynthia.L.Schmidt@nasa.gov