

Annual Summary

**2022**

ARSET



# Table of Contents

*(Click to jump to section)*

<b>Introduction .....</b>	<b>3</b>
<b>Statistics .....</b>	<b>4</b>
<b>Climate Trainings .....</b>	<b>7</b>
<b>Disasters Trainings .....</b>	<b>9</b>
<b>Health &amp; Air Quality Trainings .....</b>	<b>11</b>
<b>Ecological Conservation Trainings .....</b>	<b>12</b>
<b>Water Resources Trainings .....</b>	<b>14</b>
<b>In-Person Trainings .....</b>	<b>16</b>
<b>Participant Comments .....</b>	<b>17</b>
<b>ARSET Team .....</b>	<b>18</b>
<b>Publications .....</b>	<b>19</b>
<b>Acknowledgements .....</b>	<b>20</b>





# Introduction

Welcome to the Applied Remote Sensing Training (ARSET) Program's 2022 Annual Report! Over this past year our instructors produced and delivered **18 new trainings** on a wide variety of topics. That's an average of 1.5 multi-session trainings per month! In this year's summary, you will get a glimpse of the impact of these 18 trainings through maps and graphs, as well as a detailed description of each with links to materials.

In 2022, ARSET covered new topics, such as humanitarian applications of remote sensing. We continued to add trainings to our newest application area, Climate & Resilience, and collaborated with a total of 61 guest speakers and contributors who brought their unique expertise to our trainings. In addition, we brought four new team members on board, including three trainers and a training coordinator, and started a quarterly newsletter, featuring newsworthy items, past and future training opportunities, and highlights of individual participants who have put their training to good use. This year also saw the return of in-person training workshops.

We would like to thank each and every one of you for your continued participation and support and hope you enjoy some of our highlights from the year.

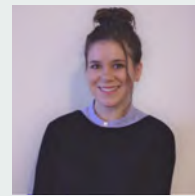
## The ARSET Team

## Climate Application Area

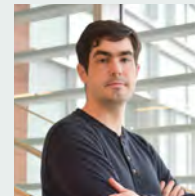


In 2021 we added our newest application area, Climate & Resilience. This year we added four Climate & Resilience trainings to our portfolio with more to come. To see the entire list of ARSET Climate & Resilience trainings, [click here](#).

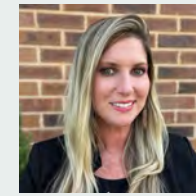
## A warm welcome to our new team members!



Britnay Beaudry



Carl Malings



Natasha Johnson-Griffin



Sarah Strode

## New Quarterly Newsletter

In 2022 we began distribution of the new ARSET Quarterly Newsletter, with an issue coming out on the first day of March, June, September, and December. To read past newsletters, [click here](#).

# Statistics

We reached

# 21,449

participants from  
159 countries

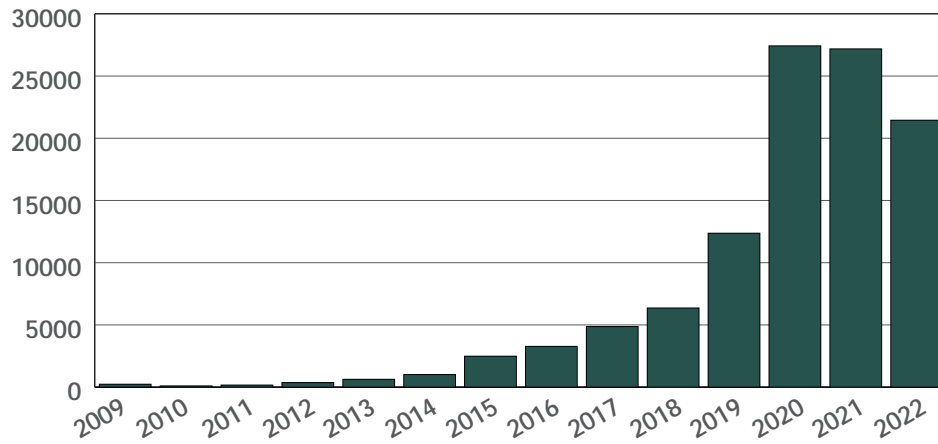
# 97.7%

of survey respondents  
said trainings met or exceeded  
their expectations

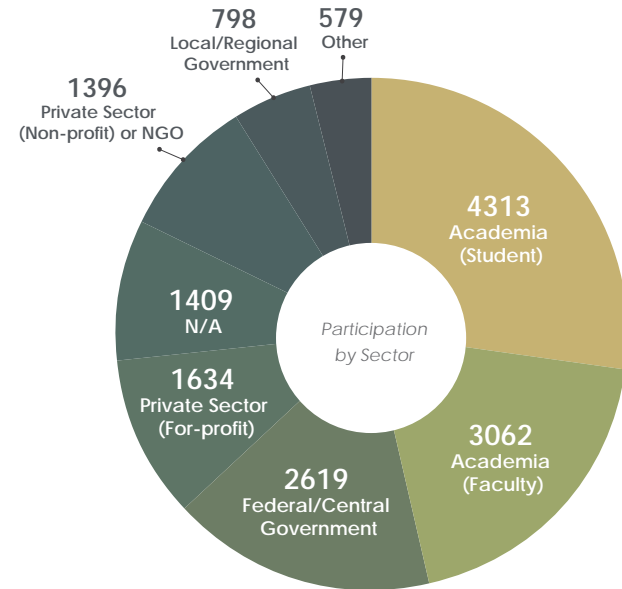
# 26

scientific and  
other publications  
mentioned an ARSET training

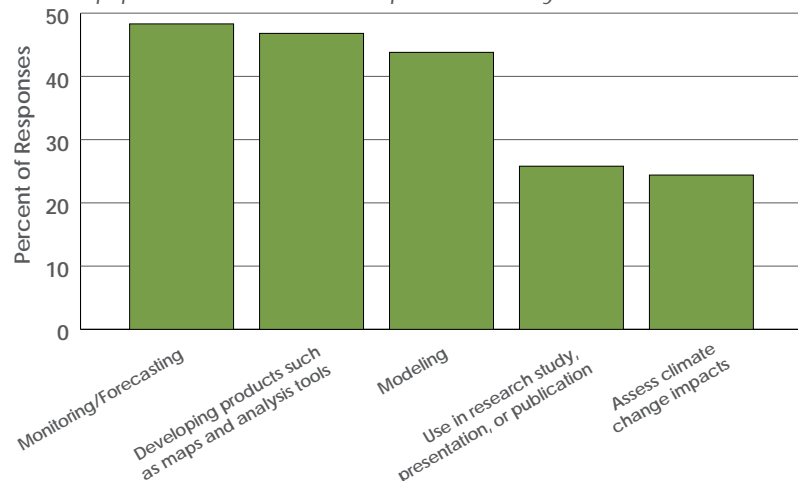
## Annual Participation in ARSET Trainings



During the Covid-19 pandemic our participation numbers surged. In 2022 we saw the numbers revert to the pre-pandemic trend of steady growth.



We asked participants how they plan to use what they learned in an ARSET training: nearly half responded that they intend to develop products such as maps and analysis tools.



We asked training registrants to rate their knowledge of remote sensing data products prior to the ARSET training:



When participants were asked **what skills/information were needed** to better use remote sensing data for their work responsibilities, **the top answer from every 2021 post-training survey report was more training.**

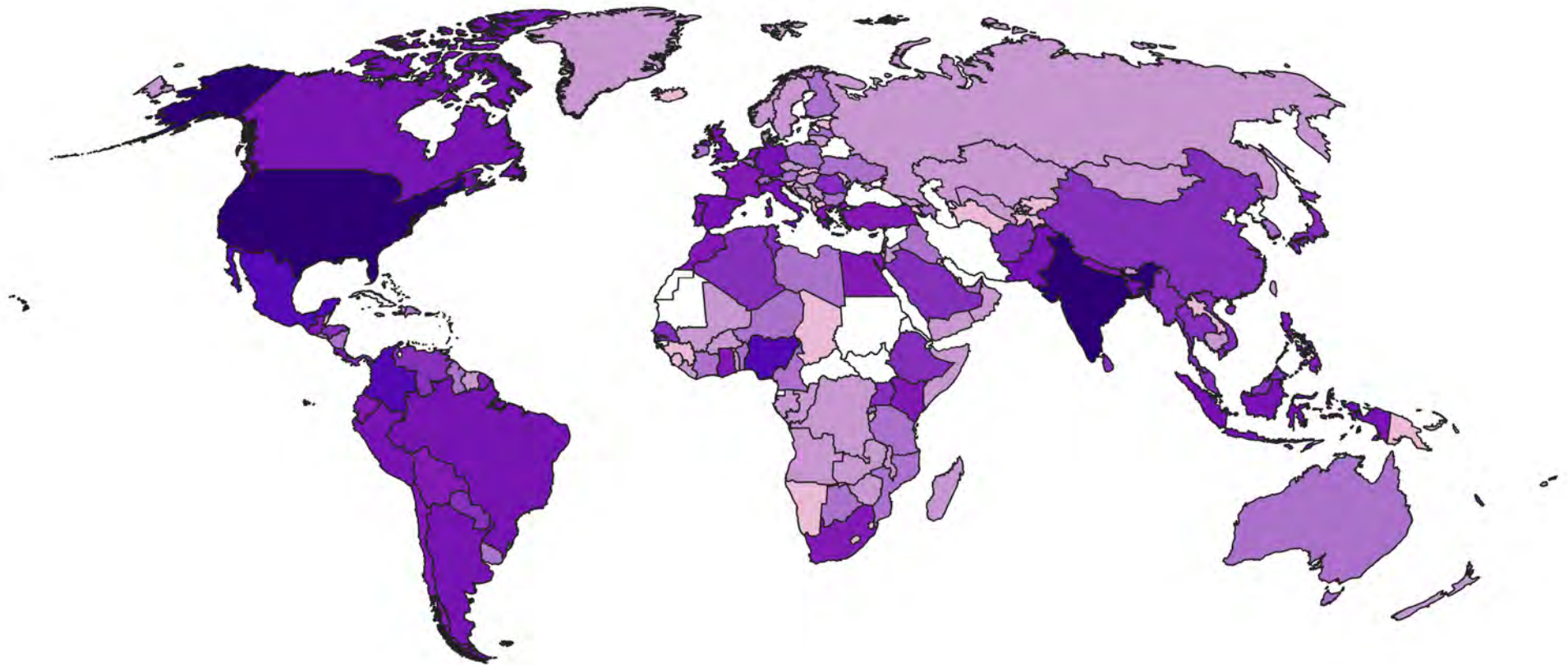
More than **25%** of participants attended **more than one training.**  
Seventeen participants attended every training in 2022.





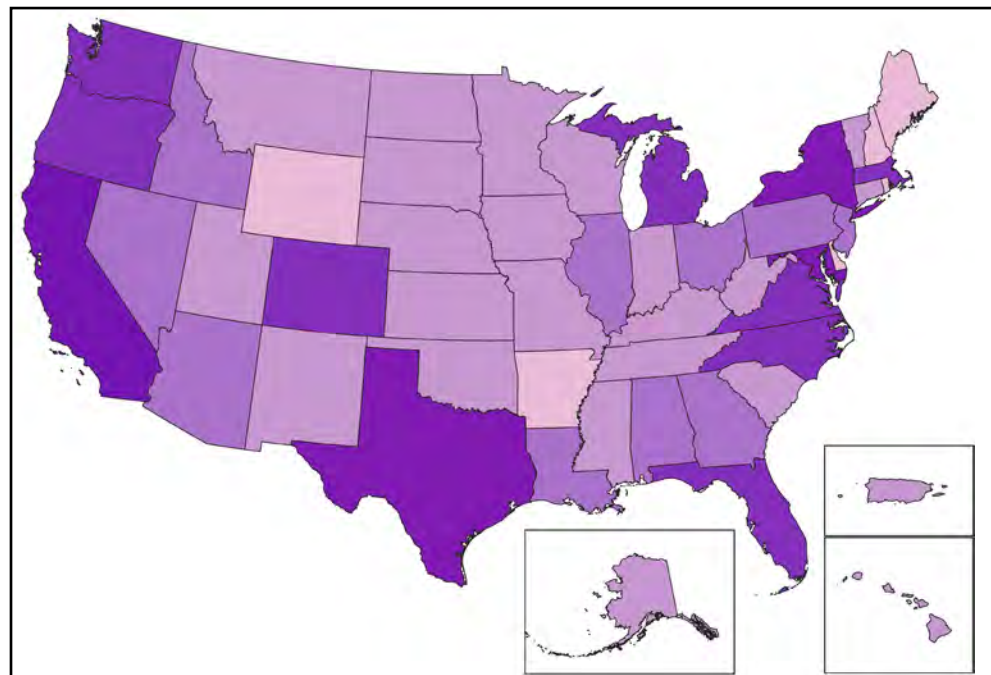
# Statistics - Participation Maps

ARSET trainings were attended by participants from 159 countries.



## Greatest participation came from:

1. United States - 2181
2. India - 2050
3. Colombia - 690
4. Mexico - 669
5. Nigeria - 503
6. Brazil - 409
7. Pakistan - 401

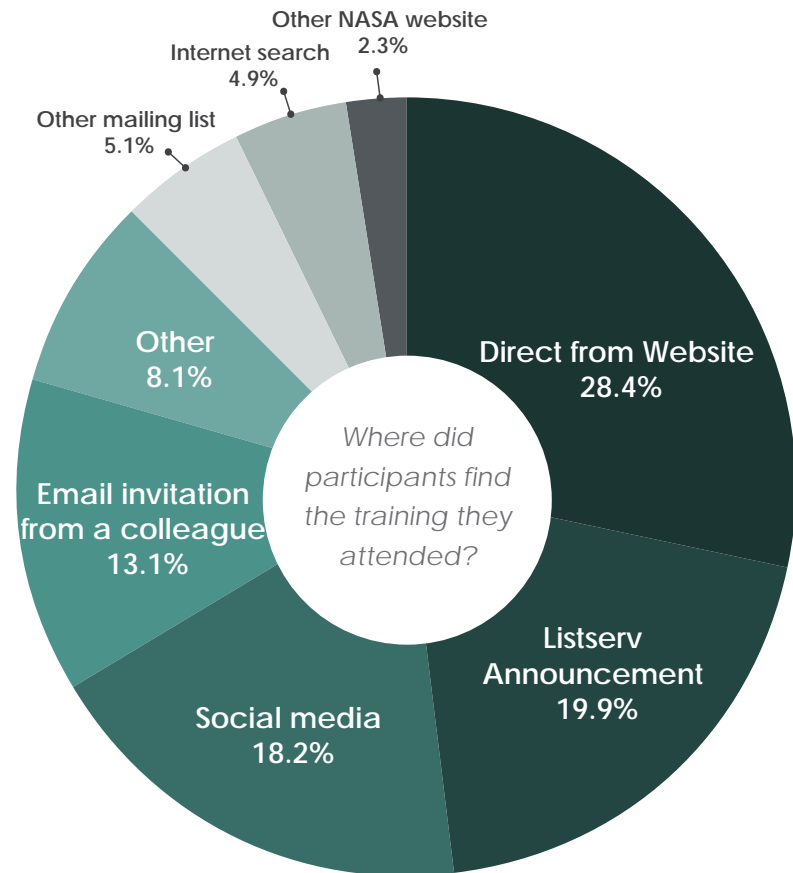
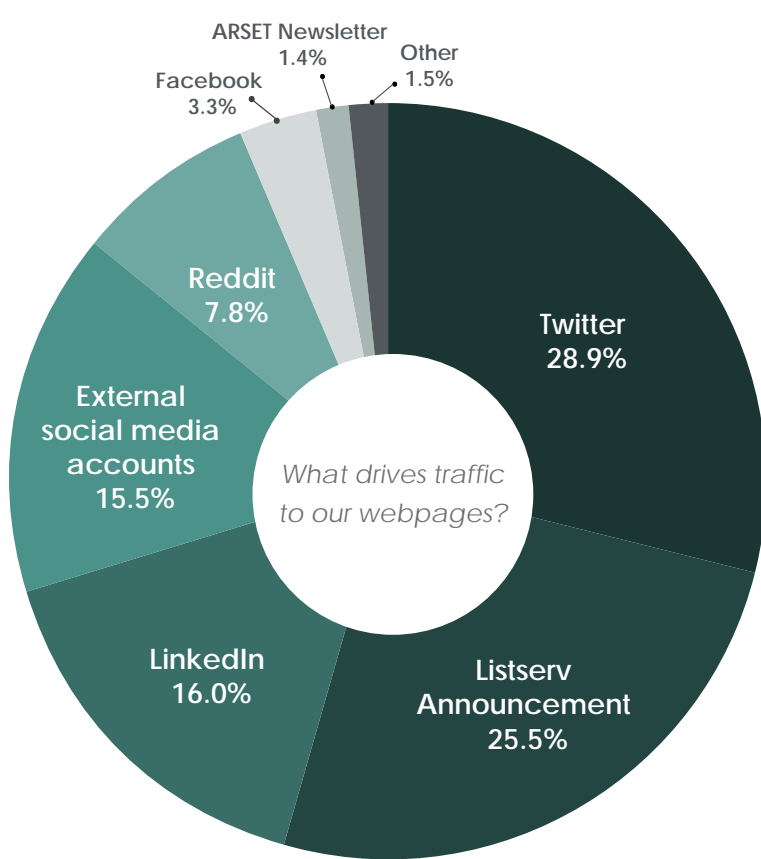


8 of 16 of ARSET's online trainings were presented live in both **English and Spanish**, including one training which was also presented in **French**. 1 of 2 of our in-person training activities was presented in **English, Spanish, and Portuguese**.



# Statistics - Social Media

We promote trainings via a variety of social media platforms, directed emails, and online message boards and forums. While social media drives the most traffic to our website, most of those who actually attend the trainings find them directly from the website and our email listserv.



Our social media presence continued to grow:

**13,800+**  
Twitter followers



**150,000+**  
YouTube views



**Top 5%**  
of Reddit  
karma earners





# Climate Trainings



## Earth Observations Toolkit for Sustainable Cities and Human Settlements

1,204 102 797

Participants Countries Organizations

January 27, February 3 & 10

**Level:** Introductory

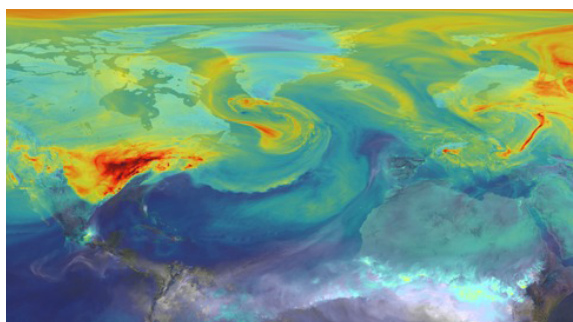
**Coordinator:** Brock Blevins

**Guest Speakers:** Argyro Kavvada (NASA, GEO Earth Observations for the Sustainable Development Goals EO4SDG), Cascade Tuholske (CIRESIN/Columbia University), Dennis Mwaniki (UN Habitat), Evangelos Gerasopoulos (National Observatory of Athens [NOA]), Nale Mudau (The South African National Space Agency [SANSA]), Rafael Monge (Ministerio de Ambiente y Energia e Costa Rica [MINAE]), Sandra Moreno (National Administrative Department of Statistics of Colombia [DANE]), Thomas Kemper (European Commission, Joint Research Centre [JRC])

**Languages:** English, Spanish

This 3-part, introductory webinar series provided an overview of the Earth Observations Toolkit for Sustainable Cities and Human Settlements, an online knowledge resource that shares ready-to-use Earth observation data sets and tools.

This training series was a collaboration between NASA's Applied Remote Sensing Training Program (ARSET), UN Habitat, Group on Earth Observations (GEO) EO4SDG initiative, GEO Human Planet initiative, and the CEOS Working Group on Capacity Building & Data Democracy (WGCapD).



## Atmospheric CO2 and CH4 Budgets to Support the Global Stocktake

620 92 460

Participants Countries Organizations

May 11, 18 & 25

**Level:** Introductory

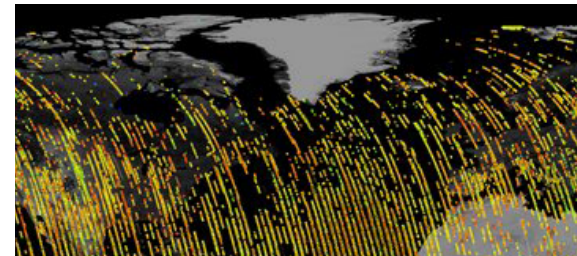
**Coordinators:** Melanie Follette-Cook, Brock Blevins, Mike Bosilovich, Sean McCartney

**Guest Speakers:** Abhishek Chatterjee (NASA Jet Propulsion Laboratory [JPL]), Brendan Byrne (JPL), Daniel Cusworth (University of Arizona), David Crisp (JPL)

**Language:** English

This three-part webinar series introduced bottom-up and top-down methods for tracking emissions and removals of carbon dioxide (CO2) and methane (CH4) from the atmosphere and explored how to combine this information to produce a more complete and transparent global stocktake.

Demonstrations were provided on how top-down atmospheric budgets of CO2 and CH4 can be derived. Participants were also introduced to pilot products and how information contained in these top-down atmospheric products can supplement bottom-up inventory products to assess the accuracy and completeness of emissions reports on regional, national, and local scales.



## Measuring Atmospheric Carbon Dioxide from Space in Support of Climate Related Studies

530 90 412

Participants Countries Organizations

May 24, 26, 31 & June 2

**Level:** Introductory

**Trainer:** Erika Podest

**Guest Speakers:** Abhishek Chatterjee (NASA Jet Propulsion Laboratory [JPL]), John Lin (University of Utah), Karen Yuen (JPL), Vivienne Payne (JPL)

**Languages:** English, Spanish

This introductory four-part webinar series provided an overview of atmospheric carbon dioxide measurements from space with the OCO-2 and OCO-3 sensors. It included a theoretical portion that described the instrument, how the measurement was made, and the characteristics, limitations and validation of the measurement. There was a discussion of the type of climate studies that such measurements can support. There was also a practical session where participants learned how to access, search, filter and display XCO2 data using Jupyter Notebook.





# Climate Trainings & Summary



**889** Participants   **106** Countries   **678** Organizations

**September 19 & 20**

**Level:** Introductory

**Coordinators:** Melanie Follette-Cook, Brock Blevins

**Guest Speakers:** Alex Ruane (*Goddard (Goddard Institute for Space Studies [GISS])*), Meridel Phillips (*Columbia University*)

**Language:** English

Climate projection sets begin with global climate model outputs and often include additional observational data to produce variables that are more relevant for certain applications. Different projection sets provide their own unique advantages but are often limited by tradeoffs shaped by resource constraints and the availability of supporting materials.

This training provided an overview of resources for choosing climate projection sets for mitigation, adaptation, and risk management applications. The webinar gave an overview of application areas, defined a list of distinguishing characteristics of climate projection sets, and highlighted the main benefits and drawbacks of different types of projection sets.

One year after the first ARSET climate training was offered in 2021, we surveyed participants to find out how they used the information from the training. **The majority of respondents reported that they use remote sensing data moderately or much more** for a variety of data applications, including **monitoring climate indicators**, and **responding to climate change through mitigation, adaptation, and resilience**. This feedback informed the selection of the climate trainings offered in 2022.

## Participant Feature

*Dr. Xolile Nciphha, South Africa, Federal/Central Government*



Dr. Xolile Nciphha is an atmospheric scientist at the South African Weather Service and research fellow with the University of South Africa. Xolile plans to use skills from “Measuring Atmospheric Carbon Dioxide from Space in Support of Climate Related Studies” and “Atmospheric CO<sub>2</sub> and CH<sub>4</sub> Budgets to Support the Global Stocktake” to update research he began on the distribution of carbon dioxide in South Africa and Southwest Indian Ocean islands using data from TES, or the Tropospheric Emission Spectrometer. He plans to use what he learned to support the South African national government in meeting obligations to the Paris Agreement.

## Participant Feature

*Elena Pilch, Michael Pazmino, Katera Lee, Lauren Webster, and Kathleen Lange, NASA's DEVELOP program, USA*



Lauren Webster, Elena Pilch, Katera Lee, Michael Pazmino, & node Fellow Kathleen Lange were members of the fall 2022 West Tennessee Water Resources DEVELOP project at JPL. They developed a code tutorial to share with their partner organization, Protect Our Aquifer, in collaboration with the University of Memphis Center for Applied Earth Science and Engineering Research (CAESER). The team used ECOSTRESS ET data, GPM IMERG precipitation data, and runoff data from NLDAS to highlight areas that may be water stressed within west Tennessee. The team processed their data and developed a code tutorial using instruction and scripts from ARSET's June 2022 evapotranspiration training.

Please note: Participant highlights illustrate how ARSET participants use remote sensing data in their work and are not an endorsement by NASA or ARSET.

**3,243**  
**Participants**





# Disasters Trainings



## Humanitarian Applications Using NASA Earth Observations

**590 101 446**

Participants Countries Organizations

June 14, 16, 21 & 23

**Level:** Introductory

**Coordinator:** Sean McCartney

**Guest Speakers:** Jamon Van Den Hoek (*Oregon State University*), Andrew Kruczkiewicz (*Columbia University*), Corey Scher (*City University of New York*), Hannah Friedrich (*University of Arizona*), Michael Owen (*Indufor North America*)

**Language:** English

This training focused on using NASA data products for monitoring human settlements and landscapes during armed conflict and forced displacement.

This ARSET training was the first dedicated to humanitarian applications of NASA satellite imagery with topics including monitoring urban damage, mapping refugee settlement dynamics, and gauging climate hazards at refugee settlements. We discussed relevant satellite sensors and methodologies, data access and analysis using Google Earth Engine, as well as assumptions, opportunities, and limitations of various remote sensing-based approaches in humanitarian applications.



## Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability Indices

**1,231 112 896**

Participants Countries Organizations

August 2, 4, 9 & 11

**Level:** Advanced

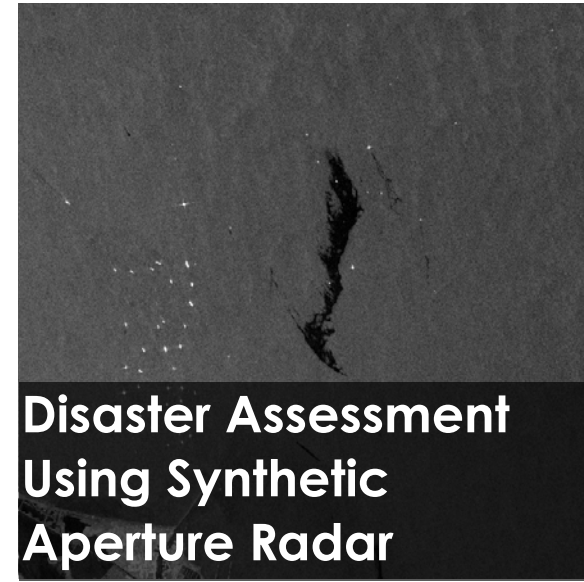
**Trainers:** Sean McCartney, Amita Mehta

**Guest Speakers:** Cascade Tuholske (*Center for International Earth Science Information Network [CIESIN]/Columbia University*), Evan Mallen (*Georgia Tech*), Kathryn Conlon (*University of California Davis*)

**Language:** English

Thermal mapping from satellites can be used to monitor land surface temperature (LST), while optical data collected from satellites can inform where and when land use and land cover have changed over time and can be used to approximate air temperatures. This four-part, advanced webinar built on ARSET's urban heat island training held in November 2020 with hands-on exercises for participants to measure UHI and construct HVIs for their areas of interest.

This webinar series is a collaboration between NASA's Applied Remote Sensing Training Program (ARSET) and the National Integrated Heat Health Information System (NIHHIS).



## Disaster Assessment Using Synthetic Aperture Radar

**1,304 111 860**

Participants Countries Organizations

October 19, 20 & 27

**Level:** Intermediate

**Trainer:** Erika Podest

**Guest Speakers:** Eric Fielding (*NASA Jet Propulsion Laboratory [JPL]*), Malin Johansson (*UiT - The Arctic University of Norway*)

**Languages:** English, Spanish

This intermediate, three-part webinar series focused on the use of Interferometric SAR to assess areas at risk from disasters due to landslides, characterize the extent of oil spills and their impacts, and characterize inundation extent. This training included theoretical portions for each disaster as related to the SAR signal interaction with surface conditions and demonstrations using Google Earth Engine, Jupyter Notebooks, and the SNAP Toolbox, all freely and openly available tools.



# Disasters Summary

*Humanitarian Applications Using NASA Earth Observations* was the **first ARSET training dedicated to humanitarian applications** of NASA satellite imagery.

*Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability Indices* was planned as a **direct result of participant feedback** and requests.

## Participant Feature

*Adina Renner, Switzerland, Private Sector*



Adina Renner is a visual journalist who specializes in data visualization. Adina works for Neue Zürcher Zeitung where she creates maps and uses satellite imagery to accompany investigative news articles. She also occasionally gives presentations about how journalists can use satellite imagery in their work. Adina found and attended “Disaster Assessment Using Synthetic Aperture Radar” in October 2022 after it was featured in remote sensing scientist Rafaela Tiengo’s newsletter. Adina sought to improve her foundational knowledge of SAR imagery after realizing she had gaps in their understanding of how the images were created. You can find some of Adina’s work here: [www.adinarenner.com](http://www.adinarenner.com)

## Participant Feature

*Lita Verduga, Ecuador, Federal/Central Government*



Lita Verduga works as an environmental management analyst for the PROMADEC program in the Ministerio del Ambiente, Agua y Transición Ecológica (Ministry of Environment, Water, and Ecological Transition) of Ecuador. Lita visits sites including water purification and waste treatment plants and landfills to anticipate and remediate potential environmental hazards with stakeholders before government intervention becomes necessary. She uses remote sensing techniques to assess impacts to the environment and sanitation after disasters, and to detect land cover change. Lita is also a professor at Pontificia Universidad Católica del Ecuador Sede Esmeraldas (PUCESE) and attends ARSET trainings to stay up to date on the latest applications of remote sensing.

Please note: Participant highlights illustrate how ARSET participants use remote sensing data in their work and are not an endorsement by NASA or ARSET.

**3,125**   
**Participants**





# Health & Air Quality Trainings & Summary



632 91 469

Participants Countries Organizations

February 22, 24 & March 1

**Level:** Advanced

**Trainers:** Melanie Follette-Cook, Pawan Gupta, Sarah Strode

**Guest Speakers:** Binita KC (NASA Goddard Earth Sciences [GES] Data and Information Services Center [DISC]/ADNET), Jennifer Wei (NASA's Earth Science Data and Information System [ESDIS] Project/ NASA GES DISC), Suhung Shen (George Mason University [GMU]/GSFC), Xiaohua Pan (ADNET)

**Language:** English

This advanced webinar series built the capacity to apply Python codes and other online tools to read, map, and analyze datasets from NASA Goddard Earth Observing System (GEOS) air quality forecasts as well as products from the second Modern-Era Retrospective analysis for Research and Application (MERRA-2) reanalysis.

The training had three two-hour sessions. The sessions included lectures and hands-on activities, including exercises, interacting with web-based and offline Python tools, and time to perform analyses.



860 102 611

Participants Countries Organizations

October 11, 18 & 25

**Level:** Intermediate

**Trainers:** Pawan Gupta, Melanie Follette-Cook, Sarah Strode

**Guest Speakers:** Aaron Naeger (TEMPO/Marshall Space Flight Center [MSFC]), Amy Huff (National Oceanic and Atmospheric Administration [NOAA]/National Environmental Satellite, Data, and Information Service [NESDIS]/STAR), Jhoon Kim (GEMS Science Team), Sujung Go (Goddard Space Flight Center [GSFC]/University of Maryland, Baltimore County [UMBC])

**Language:** English

This three-part webinar series was created in partnership with the National Oceanic and Atmospheric Administration (NOAA) and the National Institute Of Environmental Research (NIER, South Korea) on air quality (AQ) data analysis from geostationary satellites.

The series provided an overview of geostationary capabilities for monitoring air quality around the world; introduced geostationary aerosol datasets from GOES-East, GOES-West, Himawari 8, and GEMS; & presented data access & Python tools to read and analyze the datasets.

During the training *Tools for Analyzing NASA Air Quality Model Output*, ARSET trainers Pawan Gupta and Sarah Strode hosted live demonstrations with lab time. 76.1% of survey respondents found these 'extremely helpful,' and 19.5% found them 'moderately helpful.' Hands-on activities are an often requested item in post-training surveys.

1,492  
Participants



# Ecological Conservation Trainings



## Using Earth Observations for Pre- and Post-Fire Monitoring

1,028 107 698

Participants Countries Organizations

January 18 & 20

**Level:** Advanced

**Trainers:** Amber McCullum, Juan Torres-Pérez

**Contributors:** Britnay Beaudry (*Science Systems and Applications, Inc. [SSAI], DEVELOP*), Hayley Pippin (*SSAI, DEVELOP*)

**Languages:** English, Spanish

This training included two sessions with hands-on-exercises and “lab time,” where participants completed exercises with instructors online to answer questions as they arose. During the first session, we reviewed pre-fire risk assessment by investigating land surface variables (e.g., vegetation type and height, fuel regimes, fuel moisture, and topography) and climate variables (e.g., temperature and precipitation).

In the second session, we conducted post-fire mapping of burned area and burn severity using vegetation indices such as the Normalized Burn Ratio (NBR). Methods included the use of open-source tools, such as Google Earth Engine and NASA-supported platforms such as the SERVIR Global Service Catalog for analyzing imagery.



## Using the UN Biodiversity Lab to Monitor the Pulse of the Planet

958 121 686

Participants Countries Organizations

April 14, 21 & 28

**Level:** Intermediate

**Trainers:** Amber McCullum, Juan Torres-Pérez

**Guest Speakers:** Annie Virnig (*United Nations Development Program [UNDP]*), Casandra Llosa (*UNDP*), Di Zhang (*UNDP*), Lauren Weatherdon (*UN Environment Program World Conservation Monitoring Center [UNEP-WCMC]*), Marion Marigo (*UNDP*), Osgur McDermott-Long (*UNEP-WCMC*), Scott Atkinson (*UNDP*)

**Languages:** English, Spanish, French

This training focused on using remote sensing and geospatial data within the NASA-supported UN Biodiversity Lab (UNBL) to take action on national conservation and sustainable development priorities. With over 400 of the world's best global data layers on biodiversity, ecosystem services, and sustainable development, UNBL enables decision-makers and policymakers to access essential global data, upload national datasets, and calculate dynamic indicators for any area of interest - all without any background in remote sensing and GIS.



## Monitoring Aquatic Vegetation with Remote Sensing

813 95 612

Participants Countries Organizations

July 12, 14 & 19

**Level:** Introductory

**Trainers:** Juan Torres-Pérez, Amber McCullum

**Guest Speakers:** Roy Armstrong (*University of Puerto Rico- Mayaguez*), William Hernández (*University of Puerto Rico- Mayaguez*)

**Languages:** English, Spanish

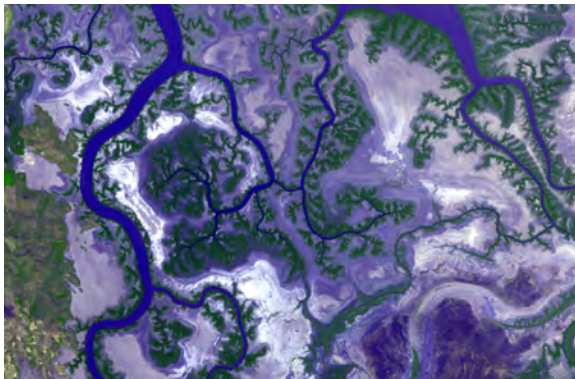
Aquatic vegetation (AV) provides a habitat for numerous small invertebrate and fish species. The presence of AV in coastal waters is a normal occurrence, as it is an important component of the natural marine environment. Nevertheless, in the last decades, the appearance of increasingly abundant mats of certain floating species in other coastlines has become a nuisance to local economies.

This training combined basic information on the remote sensing of AVs, spectrometry of aquatic/coastal vegetation, a demonstration of the NASA-funded Floating Forests citizen science tool, and the use of satellite and remote cameras for seaweed detection.





# Ecological Conservation Trainings & Summary



## Evaluating Ecosystem Services with Remote Sensing

**1,668** **120** **1105**

Participants Countries Organizations

**August 23, 25 & 30**

**Level:** Introductory

**Trainers:** Amber McCullum, Juan Torres-Pérez

**Guest Speakers:** Austin Troy (*University of Colorado, Denver*), Becky Chaplin-Kramer (*Stanford University*), Mehdi Heris (*Hunter College City University of New York*), Ken Bagstad (*US Geological Survey [USGS]*)

**Languages:** English

This training outlined the basics of ecosystem services and natural capital accounting. It provided an overview of how Earth Observations (EO) can be used to support global frameworks and initiatives such as standards set by the United Nation's System of Environmental Economic Accounting (UN-SEEA).

Participants received information on techniques and tools for using EO in natural capital accounting such as the use of land cover mapping, time series analysis, and modeling efforts conducted with the Natural Capital Project via the InVEST software, The Artificial Intelligence for Environment and Sustainability (ARIES) Project, and more. Case-study examples were provided.

Promotion of *Evaluating Ecosystem Services with Remote Sensing* drove the most traffic of any training to our website this year: our outreach resulted in **2,662 separate visits to its training page**.

In survey responses to our 2020 *Using the UN Biodiversity Lab to Support National Conservation and Sustainable Development Goals* training, **46% of respondents noted more training would help them increase their use of remote sensing data**. *Using the UN Biodiversity Lab to Monitor the Pulse of the Planet* was hosted almost exactly two years after the first UN Biodiversity Lab training.

### Participant Feature

**Eric Ferreol, France, Non-Governmental Organization**



Eric was one of the 20 participants who attended all of ARSET's trainings in 2021. Using satellite image analysis skills he gained from ARSET, Eric has previously developed a web application, leakbysat.com, using ALOS/PALSAR-2 images to detect treated water leaks from distribution networks. Now working for an NGO, Eric is focusing on biodiversity and agro-ecology and has developed an interactive website ([www.ceintureverteidf.net](http://www.ceintureverteidf.net)) using LANDSAT-8 and SENTINEL-2 imagery and Circuitscape and Graphab simulations to portray habitat fragmentation, focusing especially on foxes and blue chickadees, in and around Paris.

### Participant Feature

**Steve Hinton, Tribal/Indigenous Organization, USA**



Steve Hinton is a Conservation Scientist with the Tulalip Tribes, who are looking to implement a portion of their climate adaptation strategy that involves documenting current natural capital assets in the Snohomish River Basin in Washington State. Steve notes that they hope that using the current environmental conditions as a baseline, they can advocate for changes to local land use laws and management strategies that help to conserve, restore and adapt under changing climate conditions. Steve attended the ARSET Training "Evaluating Ecosystem Services with Remote Sensing" to gain insight into available resources and review case study projects on the topic while the Tulalip Tribes seek funding for this initiative.

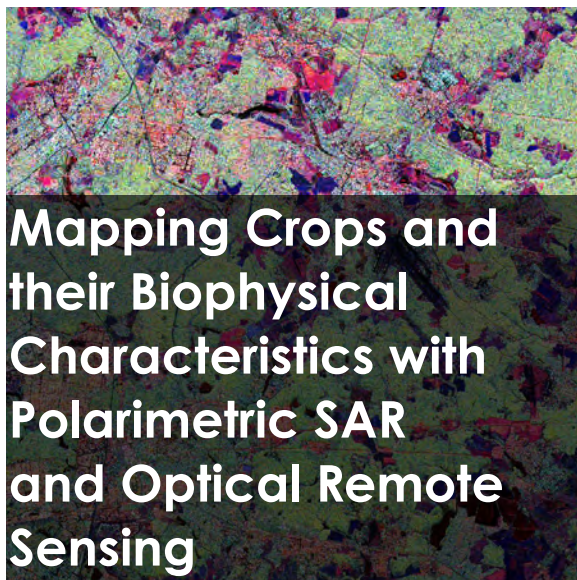
Please note: Participant highlights illustrate how ARSET participants use remote sensing data in their work and are not an endorsement by NASA or ARSET.

**4,467**  
**Participants**





# Water Resources Trainings



## Mapping Crops and their Biophysical Characteristics with Polarimetric SAR and Optical Remote Sensing

1,365 115 919

Participants Countries Organizations

April 12, 19, 26 & May 3

**Level:** Advanced

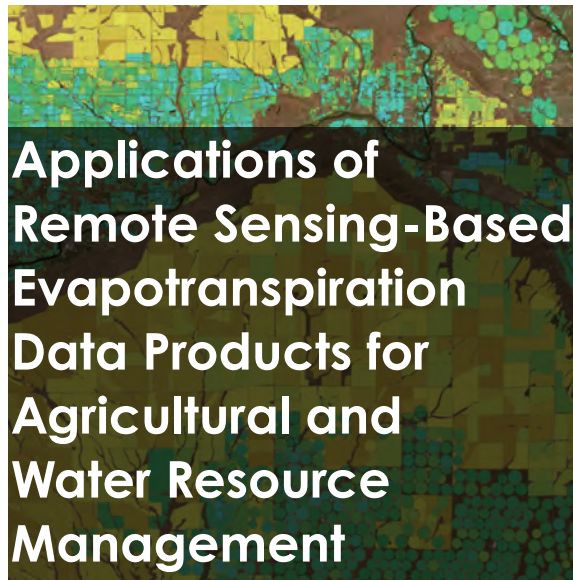
**Trainers:** Erika Podest and Sean McCartney

**Guest Speakers:** Amalia Castro Gomez (European Space Agency [ESA]), Armando Marino (University of Stirling), Fabrizio Ramoino (ESA), Heather McNairn (Agriculture and Agri-Food Canada), Laura Dingle Robertson (Agriculture and Agri-Food Canada), Pierre Defourny (Université catholique de Louvain [UCLouvain]), Sarah Banks (Environment and Climate Change Canada)

**Languages:** English, Spanish

This training built on the previous ARSET agricultural training. We presented advanced radar remote sensing techniques using polarimetry to extract crop structural information and Sen4Stat, an open source system for monitoring and reporting SDG targets related to agriculture.

This webinar series was a collaboration between ARSET, Agriculture and Agri-Food Canada (AAFC), European Space Agency (ESA), United Nations Office for Outer Space Affairs (UNOOSA), University of Stirling, Université Catholique de Louvain (UCLouvain), and the CEOS Working Group on Capacity Building & Data Democracy (WGCapD).



## Applications of Remote Sensing-Based Evapotranspiration Data Products for Agricultural and Water Resource Management

812 103 605

Participants Countries Organizations

June 1, 8 & 15

**Level:** Intermediate

**Trainers:** Amita Mehta

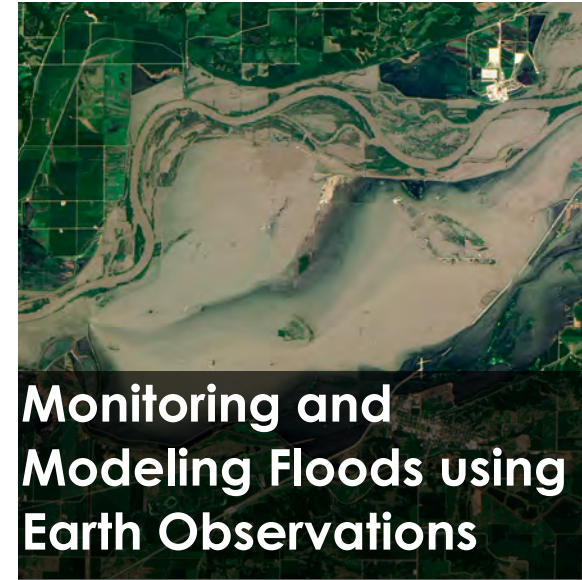
**Guest Speakers:** Forrest Melton (Ames Research Center [ARC]), Gregory Halverson (NASA's Jet Propulsion Laboratory [JPL])

**Language:** English

This three-part webinar series focused on introducing newly available ET products derived from remote sensing observations.

It specifically covered a web portal called OpenET (<https://openetdata.org/>), which includes ET products estimated by using six models as well as Landsat satellite observations. These ET products cover the western United States. In addition, information about global ET products derived from ECOsystem Spaceborne Thermal Radiometer Experiment on the Space Station (ECOSTRESS) were covered.

The webinar series provided details about OpenET and ECOSTRESS ET products, demonstrations and hands-on exercises for data access and analysis, and examples of applications of the data.



## Monitoring and Modeling Floods using Earth Observations

1,193 122 837

Participants Countries Organizations

September 14 & 21

**Level:** Intermediate

**Trainers:** Amita Mehta, Sean McCartney, Erika Podest

**Guest Speakers:** Augusto Getirana (Goddard Space Flight Center [GSFC]), Caroline Williams (DEVELOP, SSAI)

**Language:** English

Remote sensing observations from optical and Synthetic Aperture Radar (SAR) sensors are routinely used for detecting and mapping flooding. Empirical methodologies developed using remote sensing observations of rainfall, terrain, soil moisture, and landcover, as well as weather modeling data have been used for flood monitoring.

This two-part training focused on recent developments and updates in flood monitoring tools and flood modeling techniques. An overview of the Hydrological Modeling and Analysis Platform (HyMAP), a routing model used with NASA's Land Information System (LIS), and examples of flood modeling cases were presented in this training.





# Water Resources Summary

In response to participant feedback from the October 2021 training, *Agricultural Crop Classification with Synthetic Aperture Radar and Optical Remote Sensing*, the training *Mapping Crops and their Biophysical Characteristics with Polarimetric SAR and Optical Remote Sensing* was designed as a follow-up training.

## Participant Feature

**James Varghese, Canada, Private Sector/Nonprofit**



James Varghese is a Remote Sensing Analyst with Ducks Unlimited Canada, where he is working on mapping wetlands in the boreal regions of Canada using Object Based Image Analysis (OBIA) with Sentinel 2, DEM, Sentinel 1, and derived data products as well as field validation using Helicopter Surveys. He also has personal interest in wetland research: he hopes to use ECOSTRESS data to assess time-series trends to understand how different wetland types respond to changes in hydrological, biogeochemical, climatic and environmental conditions, including those resulting from human activities. You can learn more about James' and Ducks Unlimited Canada's work and the benefits of boreal wetlands here: <https://boreal.ducks.ca/how-duc-maps-boreal-wetlands/>

## Participant Feature

**Aikaterini Karagianni, PhD, Greece, Academia (Faculty)**



Aikaterini Karagianni, PhD, earned her PhD from the School of Civil Engineering of the Aristotle University of Thessaloniki in 2019, after completing her dissertation on applying remote sensing to civil engineering issues. Aikaterini is also a regional coordinator for the International Society for Photogrammetry and Remote Sensing (ISPRS) Working Group V/7. Here, she applies Earth Observation-based problem solving to engineering issues and increases geospatial literacy in the civil engineering and architectural fields through development of educational materials and presentations at workshops and symposiums with her team. You can find Aikaterini's scientific publications here: <https://orcid.org/0000-0003-3423-5265>

Please note: Participant highlights illustrate how ARSET participants use remote sensing data in their work and are not an endorsement by NASA or ARSET.

3,370   
Participants



# In-Person Training Activities



## Climate Change Monitoring and Impacts Assessment using NASA Earth Observations

34

Participants

22

States

21

Organizations

**October 24**

**Level:** Introductory

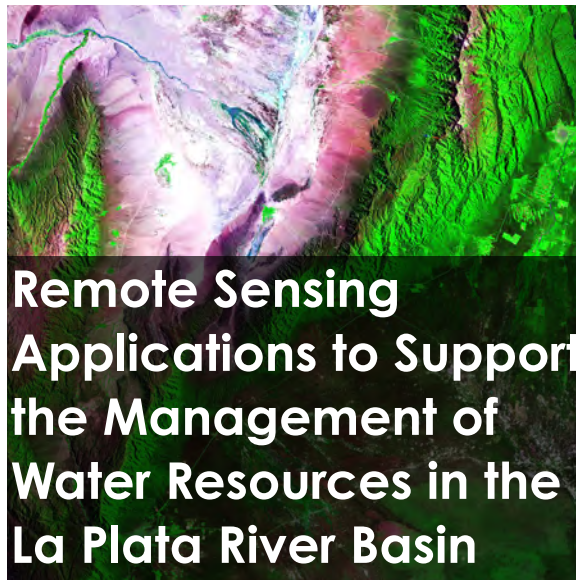
**Trainers:** Sean McCartney, Melanie Follette-Cook

**Language:** English

This workshop was held in-person in Denver, Colorado as a part of the Pecora 22 conference.

This four-hour workshop provided an overview of NASA resources for monitoring climate change and its impacts on various sectors such as extreme weather, water, food, and health. We defined the terminology and the role of Earth observations in climate change assessment, and provided an overview of NASA climate models suitable for emissions policy, impacts, risk, and resilience applications.

The workshop provided hands-on examples using open source tools to visualize and access information and data relevant to understanding and planning for climate change. The workshop also previewed NASA's Earth System Observatory.



## Remote Sensing Applications to Support the Management of Water Resources in the La Plata River Basin

49

Participants

5

Countries

**November 14 - 18**

**Level:** Introductory

**Trainers:** Sean McCartney

**Language:** English, Spanish, Portuguese

This week-long, in-person training workshop took place in Buenos Aires, Argentina and was organized and led by the Interagency Water Working Group Science and Applications Team (ISAT) to provide technical support to the Comité Intergubernamental Coordinador de los Países de la Cuenca del Plata (CIC) countries concerning water resource-related issues in the La Plata River Basin.

Technical support was provided for capacity building in data acquisition and model development/application. The three main topics for support include 1. Early warning systems for floods/droughts, 2. Sediment control, and 3. Water quality.

This year we resumed in-person training activities, hosting a four-hour workshop in **Denver, Colorado**, and contributing to a week-long workshop in **Buenos Aires, Argentina**.

83

Participants





# Participant Comments

We send surveys to participants to request their feedback immediately after, and approximately one year after each training. In these surveys, we allow for open ended responses so participants can share their comments.

★ **“I have more understanding of the work using RSD by researchers on my team to better guide them on the research especially on analysis and recommendations for policy.”** Survey comment, July 2022. Participant of ARSET Training “Introduction to Population Grids and their Integration with Remote Sensing Data for Sustainable Development and Disaster Management” (April 2021), Intergovernmental organization employee, Japan.

★ **“When I enrolled in this training last year I had very limited knowledge of the capabilities of remote sensing data for the energy sector. I am now at a far better position and have used various data sets for my own work and for research proposals. The training also prepared me to compare NASA/NOAA data with similar Copernicus products.”** Survey comment, July 2022. Participant of ARSET Training “NASA Earth Observations for Energy Management,” (July 2021) Private sector employee, Austria.

★ **“First of all, thank you for making these data and information available, they greatly help comprehensive land management and help to spread its usefulness, especially to indigenous peoples and communities. I require that these training sessions remain available online, they are a great help, and having sessions with more practical thanks.”** Survey comment, translated from Spanish, September 2022. Participant of ARSET Training “Satellite Observations and Tools for Fire Risk, Detection, and Analysis,” (May, 2021), NGO employee, Mexico.

★ **“These trainings are high quality and very relevant. I hope that you continue to provide these. Our agency budget can be limited when providing training and these free training opportunities are invaluable.”** Survey comment, September 2022. Participant of ARSET training, “Google Earth Engine Applications for Land Monitoring” (June 2021), Federal government employee, United States.

★ **“Please continue this valuable knowledge initiative for the world, you truly are a vehicle for high-quality, accessible learning. Many thanks from Medellin.”** Survey comment, translated from Spanish, July 2022. Participant of ARSET Training “Use of Solar Induced Fluorescence and LIDAR to Assess Vegetation Change and Vulnerability,” (March, 2021), Utility employee, Colombia.

★ indicates the response was received from a one-year post-training survey from a 2021 training

**“I think the continuous availability of such training will bolster our knowledge and practical applicability of these approaches, thanks to NASA, particularly for making the training accessible. Otherwise, from a developing country’s perspective, you have put us on a global level as far as knowledge in this thematic area is concerned. This is the true globalization of knowledge!!”** Survey comment, Participant of ARSET training, “Disaster Assessment Using Synthetic Aperture Radar” (October 2022) NGO employee, Uganda.

**“The training was excellent. Since I have always focused on environmental and ecosystem analysis in the urban environment, all the elements, themes, tools and methods covered in the training will allow me to perform more specific spatial analysis of environmental issues in large urban centers.”** Survey comment, Participant of ARSET training, “Earth Observations Toolkit for Sustainable Cities and Human Settlements” (January 2022) Researcher, Brazil.

**“ARSET has been putting so much effort into adapting to various learners abilities, needs, and also avoiding troubles in doing exercises for them. Thank you so much for your relentless efforts.”** Survey comment, Participant of ARSET training, “Using Earth Observations for Pre- and Post-Fire Monitoring” (January 2022) Student, New Zealand.

**“I just wanted to say, as a minimally-experienced coder, I really appreciated the very clear step-by-step explanation in the coding section. It was extremely well presented and helpful! Thanks! Excellent webinar!!”** Survey comment, Participant of ARSET training, “Using Earth Observations for Pre- and Post-Fire Monitoring” (January 2022) Academic Researcher, United States.

**“I just want to say I especially find the PM2.5 equation provided in the Review video and that Review in general extremely valuable. It is so empowering to see so many experts explaining topics and concepts (e.g: data assimilation, analysis, reanalysis) I normally don’t have the capacity to comprehend through reading.”** Survey comment, Participant of ARSET training, “Tools for Analyzing NASA Air Quality Model Output” (February 2022) Faculty, Vietnam.

**“All the material available by ARSET is very useful to generate curiosity and new knowledge.”** Survey comment, translated From Spanish, Participant of ARSET training, “Applications of Remote Sensing-Based Evapotranspiration for Agricultural and Water Resources Management” (June 2022) NGO Employee, Colombia.



# ARSET Team

## Disasters & Water Resources



Amita Mehta

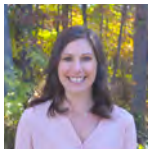


Erika Podest



Sean McCartney

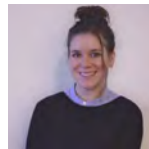
## Ecological Conservation



Amber McCullum



Juan Torres-Pérez



Britnay Beaudry

## Health & Air Quality



Pawan Gupta



Sarah Strode



Carl Malings

## Coordination & Communications



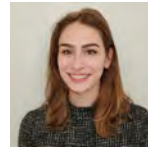
Brock Blevins



Selwyn Hudson-Odoi



Jonathan O'Brien



Sarah Cutshall



Natasha Johnson-Griffin



Annelise Carleton-Hug



David Barbato



Marines Martins

## Leadership

Melanie Follette-Cook



### Applications of Remote Sensing-Based Evapotranspiration Data Products for Agricultural and Water Resource Management

- Forrest Melton - Ames Research Center (ARC)
- Gregory Halverson - JPL

### Measuring Atmospheric Carbon Dioxide from Space in Support of Climate Related Studies

- Abhishek Chatterjee - JPL
- John Lin - University of Utah
- Karen Yuen - JPL
- Vivienne Payne - JPL

### Atmospheric CO<sub>2</sub> and CH<sub>4</sub> Budgets to Support the Global Stocktake

- Abhishek Chatterjee - JPL
- Brendan Byrne - JPL
- Daniel Cusworth - University of Arizona
- David Crisp - JPL

### Using the UN Biodiversity Lab to Monitor the Pulse of the Planet

- Annie Virnig - UNDP
- Casandra Ilosa - UNDP
- Di Zhang - UNDP
- Lauren Weatherdon - UNEP-WCMC
- Marion Marigo - UNDP
- Osgur McDermott-Long - UN Environment Program World Conservation Monitoring Center (UNEP-WCMC)
- Scott Atkinson - United Nations Development Program (UNDP)

### Mapping Crops and their Biophysical Characteristics with Polarimetric SAR and Optical Remote Sensing

- Amalia Castro Gomez - European Space Agency (ESA)
- Armando Marino - University of Stirling
- Fabrizio Ramoino - ESA
- Heather McNairn - Agriculture and Agri-Food Canada
- Laura Dingle Robertson - Agriculture and Agri-Food Canada
- Pierre Defourny - Université catholique de Louvain (UCLouvain)
- Sarah Banks - Env. & Climate Change Canada

### Tools for Analyzing NASA Air Quality Model Output

- Binita KC - GES DISC/ADNET
- Jennifer Wei - NASA's Earth Science Data and Information System (ESDIS) Project/ NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC)
- Suhung Shen - George Mason University (GMU)/GSFC
- Xiaohua Pan - ADNET

### Earth Observations Toolkit for Sustainable Cities and Human Settlements

- Argyro Kavvada - NASA, GEO Earth Observations for the Sustainable Development Goals EO4SDG
- Cascade Tuholske - CIESIN/Columbia University
- Dennis Mwaniki - UN Habitat
- Evangelos Gerasopoulos - National Observatory of Athens (NOA)
- Nale Mudau - The South African National Space Agency (SANSA)
- Rafael Monge - Ministerio de Ambiente y Energía e Costa Rica (MINAE)
- Sandra Moreno - National Administrative Department of Statistics of Colombia (DANE)
- Thomas Kemper - European Commission, Joint Research Centre (JRC)

## 2022 Guest Speakers & Contributors

Funding provided by: ● NASA's Earth Surface and Interior Focus Area ● NASA Applied Sciences Mission Applications  
● NASA Applied Sciences Disasters Program ● The DEVELOP Program ● NASA Applied Sciences Water Resources Program

### Using Earth Observations for Pre- and Post-Fire Monitoring

Hayley Pippin - Science Systems and Applications, Inc. (SSAI), DEVELOP  
Britnay Beaudry - SSAI, DEVELOP

### Disaster Assessment Using Synthetic Aperture Radar

- Eric Fielding - NASA Jet Propulsion Laboratory (JPL)/Caltech
- Malin Johansson - UiT - The Arctic University of Norway

### Accessing and Analyzing Air Quality Data from Geostationary Satellites

- Aaron Naeger - TEMPO/Marshall Space Flight Center (MSFC)
- Amy Huff - National Oceanic and Atmospheric Administration (NOAA)/National Environmental Satellite, Data, and Information Service (NESDIS)/STAR
- Jhoon Kim - GEMS Science Team
- Sujung Go - Goddard Space Flight Center (GSFC)/University of Maryland, Baltimore County (UMBC)

### Monitoring and Modeling Floods using Earth Observations

- Augusto Getirana - GSFC
- Caroline Williams - DEVELOP

### Selecting Climate Change Projection Sets for Mitigation, Adaptation, and Risk Management Applications

Alex Ruane - Goddard Institute for Space Studies (GISS)  
Meridel Phillips - Columbia University

### Evaluating Ecosystem Services with Remote Sensing

Austin Troy - University of Colorado Denver  
Becky Chaplin-Kramer - Stanford University  
Mehdi Heris - Hunter College City University of New York  
Ken Bagstad - US Geological Survey (USGS)

### Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability Indices

Cascade Tuholske - Center for International Earth Science Information Network (CIESIN)/Columbia University  
Evan Mallen - Georgia Tech  
Kathryn Conlon - University of California Davis

### Monitoring Aquatic Vegetation with Remote Sensing

Roy Armstrong - University of Puerto Rico-Mayaguez  
William Hernández - University of Puerto Rico-Mayaguez

### Humanitarian Applications Using NASA Earth Observations

Andrew Kruczkiewicz - Columbia University  
Corey Scher - City University of New York  
Hannah Friedrich - University of Arizona  
Jamon Van Den Hoek - Oregon State University  
Michael Owen - Indufor North America





# Publications

In 2022, ARSET was cited or mentioned a total of 27 times in scientific and other publications. These publications serve as some of the best indications we have of our ability to provide meaningful training opportunities.

## Citations in Peer-Reviewed Publications

- [Global Flood Mapper: a novel Google Earth Engine application for rapid flood mapping using Sentinel-1 SAR](#)
- [Integrating remote sensing with ecology and evolution to advance biodiversity conservation](#)
- [Integrating geographical information systems, remote sensing, and machine learning techniques to monitor urban expansion: an application to Luanda, Angola](#)
- [Cloud-based large-scale data retrieval, mapping, and analysis for land monitoring applications with google earth engine \(GEE\)](#)
- [Mapping cashew monocultures in the Western Ghats using optical and radar imagery in Google Earth Engine](#)

## Mentions in Peer-Reviewed Publications

- [Integrating Multiscale Geospatial Environmental Data into Large Population Health Studies: Challenges and Opportunities](#)
- [A bibliometric analysis on the visibility of the Sentinel-1 mission in the scientific literature](#)
- [Enhancing the Uptake of Earth Observation Products and Services in Africa Through a Multi-level Transdisciplinary Approach](#)
- [Integrating One Health topics to enhance health workers' leadership in health promotion activities](#)
- [NASA's Global Precipitation Measurement Mission: Leveraging stakeholder engagement & applications activities to inform decision-making](#)
- [Land-use changes by Old Colonies Mennonites in Mexico with Sentinel 2 and Trends Earth](#)

## Conference Proceedings

- [Air quality prediction using remote sensing](#)
- [Flood Mapping in Bosnia and Herzegovina: Role of Remote Sensing and GIS](#)
- [Detection of surface algae blooms using the Sentinel 2A: An algorithm of the best strip ratio for a freshwater lake](#)
- [Characterizing Wildfires in Western U.S.: A Cloud-based Case Study for Interdisciplinary Research using NASA Resources](#)

## Theses

- [Remote Sensing Methods for Assessing Abrupt Land Cover Change - A Case Study of the Central Luangwa Valley in Zambia](#)
- [Applying Remote Sensing to Assess Habitat Viability for the Western Monarch Butterfly \(\*Danaus plexippus plexippus\*\) in California](#)
- [A deep neural network for lake ice detection with Sentinel-1 data](#)
- [Investigating changes in Mangrove cover and conservation policy in the protected area of Yum Balam, Mexico, 1981-2020](#)

## Books

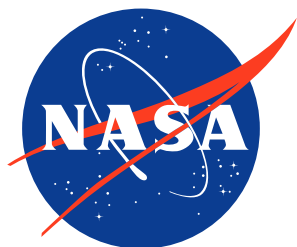
- [Cities and Their Environments](#)
- [Earth Observation Applications and Global Policy Frameworks](#)
- [Air Quality Prediction Using Machine Learning](#)

## Miscellaneous

- [NISAR Mission Overview and Updates on ISRO Science Plan](#)
- [Needs, Challenges, and Opportunities: A Review by Experts](#)
- [Earth Observation, Public Health, and One Health](#)
- [NASA Biological Diversity and Ecological Forecasting](#)



# Acknowledgements



**EARTH SCIENCE  
APPLIED SCIENCES**

We would like to thank Dr. Nancy Searby and everyone at NASA Earth Science Division's Applied Sciences Program for the continued funding, support, expertise, and guidance that makes our work possible.

We would also like to thank all of our partners, collaborators, and guest speakers. Your contribution was invaluable.



Committee on  
Earth Observation  
Satellites



Environment and  
Climate Change Canada



Agriculture and  
Agri-Food Canada



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STIRLING**



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