





Hands-On Field Spectroscopy Training and Data Skills Workshop – An

Introduction to NASA Satellite and Airborne Optical Sensors

Cape Town, South Africa

Juan Torres-Pérez (NASA Ames), Sativa Cruz (BAERI/NASA Ames), and Justin Fain (BAERI/NASA Ames)



October 7-11, 2024

Training Learning Objectives

275

By the end of this training, participants will:

- Familiarize with legacy, current, and upcoming NASA satellite missions useful for studying land and aquatic ecosystems.
- Familiarize with airborne sensors flown during the 2023 BioSCape Campaign, particularly the optical sensors (AVIRIS-NG and PRISM).





Applications and Sources of Airborne VSWIR Data



NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop

Adapted from: Wilson, A., Hestir, E., Slingsby, J., Cardoso, A. (2022). Biodiversity Survey of the Cape (BioSCape).



Applications of Airborne VSWIR Data

- Hyperspectral visible to shortwave infrared imaging spectroscopy data can be used to monitor and measure a wide array of environmental parameters such as climate variability, land cover distribution, seasonal cycles, and much more.
- Common sources of this data include AVIRIS-NG and PRISM.



Source: NASA JPL





Overview of Commonly Used NASA Satellite Sensors



National Aeronautics and Space Administration

EARTH FLEET

Key

Invest/CubeSats

- NACHOS 2022 🕋 CTIM 2022 🕋
- NACHOS-2 2022
 - **MURI-FD 2023**
 - SNOOPI* 2024 HYTI* 2024
- ARGOS* 2024

JPSS Instruments

- OMPS-LIMB 2022 +--- 9 LIBERA 2027 +---- 📟 OMPS-LIMB 2027 +----OMPS-LIMB 2032 +----
- 2015 NISTAR, EPIC 🗐 🔷 SMAP 🔷 🛛 International Partners 6 0CO-2 U.S. Partner 🛄 CORD-ISS Instrument II+II JPSS Instrument +-GPM @ Cubesat 😭 Launch Date TBD * Earth System **Observatory Mission** Landsat 8 🕮 🔷 (Pre) Formulation P Implementation (e) Operating Extended



INCUS ()

NASA

04.10.2024

CRISTAL @

TIL



AOS Sky* @ () () **AOS Storm** PolSIR* @ GRACE-C* @ O @ +PMM*@ O @ Landsat Next* 🗐 🌒 SBG* (I) (I) TINT MISSIONS

2030

Landsat Series

- First Landsat launched in 1972
- NASA created and launched
- USGS maintains data
- Passive Sensor Obtains values of reflectance from Earth's surface
- 30-meter pixels
- Image of the entire Earth every 16 days

Applications:

- Vegetation Health
- Deforestation
- Fires
- Agriculture
- Species Habitats
- Water Quality





Moderate Resolution Imaging Spectroradiometer (MODIS)

- Spatial Resolution:
 - 250 m, 500 m, 1 km
- Temporal Resolution:
 - Daily, 8-day, 16-day, monthly, quarterly, yearly
 - 2000 Present
- Data Format:
 - Hierarchical Data Format Earth Observing System Format (HDF–EO8)
- Spectral Coverage:
 - 36 bands (major bands include blue, green, red, IR, NIR, MIR)

Bands 1-2: 250 m Bands 3-7: 500 m Bands 8-36: 1000 m







9

Visible Infrared Imaging Radiometer Suite (VIIRS)

- A sensor onboard the Suomi National Polar-Orbiting Partnership (NPP)
- Data available globally from January 2012 to present
- Revisit Time: 1 day
- Spatial Resolution: 375 m and 750 m
- Similar to MODIS (with some differences)
- Visible, near-infrared channels (reflectance)
- Shortwave and longwave infrared (brightness temperature)
- Products:
 - Surface Reflectance
 - Vegetation Indices
 - Thermal Anomalies





Suomi NPP satellite (above); Global vegetation map (left). Image Credit: NASA/NOAA)



NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop



Commonly Used NASA Airborne Optical Sensors

Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)

- Objective: Identify, measure, and monitor constituents of Earth's surface and atmosphere based on molecular absorption and particle scattering signatures
- Sometimes referred to as AVIRIS-C "Classic"
- Flown in North America, Europe, portions of South America, and Argentina
- Flown on Four Aircraft Platforms: NASA's ER-2 Jet, Twin Otter International's Turboprop, Scaled Composites' Proteus, and NASA's WB-57
- Active since 1986





Source: <u>Lu et al., 2020</u>



Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)

AVIRIS: Key West, Florida 921119 Red= 646.7 nm Green= 547.6 nm Blue= 449.1 nm



Source: <u>NASA JPL</u>

- 224 continuous spectral bands
- Spectral Coverage: 380 to 2500 nm
- Bandwidth: < 10 nm
- Pixel size based on altitude:
 - 20 km Above Ground Level (AGL) for 20 m pixel resolution
 - 4 km AGL for 4 m pixel resolution



Accessing and Using AVIRIS-C Data

S AVIRIS Data Portal 2006-2021





- 2006 2021 data is available to download from • AVIRIS Data Portal
 - Many filtering options _
 - Each flightline uses a specific base filename prefix
- To access pre-2006 data, users must fill out a request form
- Data Types: •
 - .KML
 - .JPEG
 - .dat
- Compatible with ENVI, QGIS, ESRI products, etc. ۲
- Preprocessing tutorial is provided .



Previous AVIRIS Campaigns

2006–2021 Campaigns





NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop

NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop

Flown on Several Aircraft Platforms: NASA's ER-2 Jet, the

- Twin Otter Turboprop, B200 King Air, and NASA's Gulfstream III and V
- Flown in North America, Europe, and India, and South Africa
- Active since 2009

Airborne Visible InfraRed Imaging Spectrometer – Next Generation (AVIRIS-NG)

Objective: To support NASA science and applications by measuring spectra as images that record the interaction of light with matter. These spectra are used to identify, measure, and monitor constituents of the Earth's surface and atmosphere.











Airborne Visible InfraRed Imaging Spectrometer – Next Generation (AVIRIS-NG)







Source: NASA JPL

- 481 contiguous spectral bands
- Spectral Coverage: 380 to 2510 nm
- Spectral Resolution: 5 nm ± 0.5 nm
- Pixel Size Based on Altitude:
 - 6,500 ft AGL for 2 m pixel resolution
 - 13,000 ft AGL for 4 m pixel resolution
 - 20,000 ft AGL for 6 m pixel resolution



AVIRIS-NG Data Products



NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop



Accessing and Using AVIRIS-NG Data



AVIRIS-NG Data Portal 2014-2021

		1	
	:	1	
n.		1	
+			
÷	- ST		
-			
÷			
		10883-008-0.ND	
	N.		
	1		
	Ale a		
	12		
	10		
and the second	1		
. 2			
10 1			
10. 1. 10.			
	1 A.		
CONTRACTOR OF STREET, STRE		Ar. HE Serve	Red value adds (122
arritrant ADA, Laparia by Yolan: 2014, 2015.	2018.2017.2018.2018.2024.2021		
			thank to
ata Table			
ata Table			
ata Table Solt the War sum is War solution Source File & Deemland in Joint	interv.		
ata Table Celt Re Vier son to Vier columns Colore P. A Demoked to som a toor Color tille is not atoms			
ata Table Sidi ilia War sun ti War silama Sissa Pita ili Constanti la Isaa Sina taba di una atalan			
ata Table Det Re Res son to Res silvers Des alle d'art d'articles Det alle d'art d'articles Artifici Aci Fign Lives - Artifici	NO Flattunes as		
ata Table Dati ha Yao sun is Yao silama Data Péré Denting to sun a tau Cast data a una antana Artifis Ad Fight Dies - Artifis Fig. Est. Yao - Yaon - Yaon -	ng Page Unio - m Ing Tage Design - mg		ter are
Ata Table Cot the Var such is Ner schume Course Pole + Operating is such as its loss Course Pole + Operating is such as its loss Course Variant Annual State Variant Tarray -	nonen Alla Pagin Linea - an Jere - Sale - Science - Malj		ter Fr
Ata Table Cell Re Ver non is Her silvers Cell Re Ver non is Her silvers Cell Ver a Question is to so a silver Cell Ver a Cell Version Ro Rot Status Rot Rot Non Seat Funda 1 (Cell Version (Cell Version) (Cell Version)	noon NG Fight Lines as Ten Tana Dominin way		Ber Red
Ata Table	NG FlightUnes as bee face (control we)		iter Feet
Ata Table Cold Be War such is Her schumes Cold Be War such is Her schumes Cold Be War such is Her schumes Cold Be War and State State Cold Be War and State State Cold Be War and State Cold Be War an	AG Flight Lines as less flags dimension weg		Barr Spell
Ata Table Cell Re Har son is Her stimmer Chan Re Ver and the Her son is her son in the Her son is her son is her the Her son is her son is her the Her son is her	NG Flight Lines as bes "task Energiese weg standinger Relate Cases 41 - 10 Hord Cases - Do Relate Cases - 10 Hord Cases - Do	9 1. no isocri-101 - 10 nov-Consta - 103 ng 1. no isocri-101 - 7 no t-Consta - 103 ng	Stars Spot
ata Table See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War such (s Her suburne) See the War suburne) See the War such (s Her suburne) See the War suburne) See the War suburne) <td>NG Flight Lines as bee face foremone weg managem Rate Gase as 1 (1999-2000) - 100 Rate Gase as 1 (1999-2000) - 100 Rate Gase as 1 (1999-2000) - 100 Rate Gase as 1 (1999-2000) - 100</td> <td> A model of the second se</td> <td>These Control of the second se</td>	NG Flight Lines as bee face foremone weg managem Rate Gase as 1 (1999-2000) - 100 Rate Gase as 1 (1999-2000) - 100 Rate Gase as 1 (1999-2000) - 100 Rate Gase as 1 (1999-2000) - 100	 A model of the second se	These Control of the second se
Ata Table Cold the View control to New coloures Cold the View control to New coloures Cold the View coloures Cold to Cold the View Cold to Cold to Cold the View Cold to	AG Flight Lines as an fair former weg an fair former and former		These Type II
Ata Table Staf Be War sun is War solution To	NG Flipf LDes. as be face Energies Note Taxes Energies Note Taxes 0-4 (1999-004) - De Robert Taxes 0-4 (1999-004) - De Robert Taxes 0-4 (1999-004) - De Robert Taxes 0-9 (1999-004) - De	a not see to the set of the se	These Page 10
ata Table Set Table Set Table War sum (s Her suburns) Set Table Set Tables Set Table Set Tables Set Table Set Tables Set Table Set Tables Set Table Set Tables AddRS Add Fright Lines - AddRS Set Tables AddRS Add Fright Lines - AddRS Set Table - Tables Image: Set Tables Set Table - Tables Image: Set Tables Set Table - Tables Image: Set Tables Set Tables Tables Image: Set Tables S	AG Flight Lines as the flight Lines as flight Lines as flight Lines as flight Lines (as flight Lines (as) flight Lines (a	4 In the fame in 100° + 10 server Chronite + 100 seq is instance in 100° + 71 net to Chanton + 100 seq is not near in 100° + 71 net to Chanton + 100 seq is not near in 100° + 100 rest of Chanton + 100 seq is not near in 100° + 100° + 100° + 100° + 100° + 100° and is not near in 100° + 100° + 100° + 100° + 100° + 100° and is not near in 100° + 100° + 100° + 100° + 100° + 100° is not near in 100° + 100° + 100° + 100° + 100° + 100° + 100° is not near in 100° + 100°	Toppicses
Ata Table Cold the View counts is New solutions Counts And a Count is New solutions Counts And a Count is New solutions Counts And a Count is New solutions Counts And	AG Flight Lines as be fast Sciences weg State Sciences weg Science Sciences Science Sciences Sciences Science Sciences	8 a nai kanani kata ing ang ang ang ang ang ang ang ang ang a	الله الله الله الله الله الله الله
ata Table Star David Star David Mar Hum () Hinr Humma Star David Mar Hum () Hinr Humma Star David Mar Hum () Hinr Humma Star David Mar Humma Star David Mar Humma Star David Mar Humma Star David Ma	NG Flight Lines as the flight	• * * * * * * * * * * * * * * * * * * *	These Provide State Stat
Atta Table Dath the Ware scale is Normal Schwares Dath the Ware scale is Normal Schwares Data the Ware scale is Normal Schwares Private Scale is Normal Schwares Private Scale is Normal Schwares Data Schwares </td <td>AG Flight Lines as AG Flight Lines as And Flight Lines as And</td> <td>4 s no description 2014 - 10 series Constants - 103 seg s in transmission 2014 - 71 no tra-Constants - 103 seg s in transmission 2014 - 71 no tra-Constants - 103 seg s in transmission 2014 - 71 no tra-Constants - 104 seg no transmission 2014 - 71 no tra-Constants - 104 seg no transmission 2014 - 104 seg constants - 104 seg no transmission 2014 - 104 seg constants - 104 seg no constants - 2014 - transmission 2014 seg not constant - 2014</td> <td>Dates Supple Fappings august and august</td>	AG Flight Lines as AG Flight Lines as And	4 s no description 2014 - 10 series Constants - 103 seg s in transmission 2014 - 71 no tra-Constants - 103 seg s in transmission 2014 - 71 no tra-Constants - 103 seg s in transmission 2014 - 71 no tra-Constants - 104 seg no transmission 2014 - 71 no tra-Constants - 104 seg no transmission 2014 - 104 seg constants - 104 seg no transmission 2014 - 104 seg constants - 104 seg no constants - 2014 - transmission 2014 seg not constant - 2014	Dates Supple Fappings august and august
Atta Table Cost the Ware scale is Ware scales Cost the Ware scale is Ware scales Cost the Ware scale is Ware scales Cost the Ware scale sca	AG Fight Lines as the fight Lines as the fight Lines (a) - (1) -	F a tod kannet (= 0.000 km = 1.000 km = 1.0000 km = 1.000 km = 1.0000 km = 1.00000	There Figure 1 Applications applications
ata Table Cont the War sum is Nor subwars Cont the War sum is Nor subwars Containe Nor subwars Containe Nor subwars Containe Nor subwars Containe Nor subwars Containe Normality AutHS Act Flight Lines - AutHS File State Normality Normality Containe Normality Normality Normality Normality Normality Normality Normality Normality Normality Normality Normality Normality	AG Fight Lines as an fact from the set of	4 a no famelo dal + al sero-Denasto + tal aqui to have been dal + a no ben-Danasto + tal aqui to ano tano e dal + a no ben-Danasto + tal aqui to ano tano e dal + a no e denasto + tal aqui to tana e dal tano e dal tano e dal parto + tal aqui to tano e dal + a no e dal parto + tal aqui to tano e dal + a no e dal parto + tal aqui to tano e dal + a no e dal parto + 1 da to tano e dal + dan tano + danasto + 1 da to tano e dal + dan tano + danasto + 1 da to dal + dan tano + danasto + 1 da to dal + dan tano + danasto + 1 da to dal + dan tano + danasto + 1 da to dal + dan tano + danasto + 1 da to dal + dan tano + danasto + 1 da to dal + dana + dan tano + danasto + 1 da to dal + dan tano + dana tano + danasto + 1 da to dal + danasto + danasto + danasto + 1 da to dal + danasto + danasto + dal + danasto to dal + danasto + danasto + dal + danasto tano + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + dal + danasto tano + dal + danasto + danasto + danasto + dal + danasto tano + dal + danasto + danasto + danasto + dal + danasto tano + dal + danasto + danast	Papertone -
ata Table Cont. Brie Ware points: Ware poin	AG Fight Lines (a) Total Environment (eV)	9 a noi kanoni oldi i di tarto-Chanto - titi kap a tarta kanoni oldi i 7 in to-Chanto - titi kap a to-tarto - 100 - 11 to to-Chanto - titi kap a to-tarto - 100 - 11 to to-Chanto - titi kap a to-tarto - 100 - 11 to to-Chanto - 100 kap an tarto-to-Chanto - 100 - to to-chanto - 100 kap an tarto-to-Chanto - 100 - to to-chanto - 100 kap to-Chanto - 200 - to to-to-chanto - 100 kap to-Chanto - 200 - to-to-chanto - 100 kap to-Chanto - 200 - to-to-chanto - 100 kap to-Chanto - 200 - to-chanto - 100 kap to-chanto - 200	تلدین المحافظ المحافظ محولة محافظ المحافظ المح محولة محافظ المحافظ المحافظ ومحافظ المحافظ الم

- 2014–2021 data is available to download from <u>AVIRIS-NG Data Portal</u>
 - Many filtering options
 - Each flightline uses a specific base filename prefix
- Data Types:
 - .KML
 - .JPEG
 - .dat
- Compatible with ENVI, QGIS, ESRI products, etc.



Portable Remote Imaging SpectroMeter (PRISM)

- Application: To serve as a UV-NIR (350 nm to 1050 nm) Coastal Ocean Science Instrument.
- Flown on Four Aircraft Platforms: NASA's ER-2 Jet, Twin Otter Aircraft, Gulfstream GIII and GV
- Flown in Western United States, South America, the Southern Ocean, and South Africa
- Active since 2012



Source: NASA JPL

NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop

Portable Remote Imaging SpectroMeter (PRISM)





- Pushbroom imaging spectrometer with 246
 contiguous spectral bands
- Spectral Coverage: 350–1050 nm
- Spectral Resolution: 3.5 nm
- Two short wave infrared (SWIR) bands at 1240 and 1610 nm
 - Bandwidth: 22 nm and 56 nm
- The spatial resolution depends on the altitude and plane speed, but ranges from 0.3 to 16 m.



PRISM Data Products



Source: NASA JPL

Product Name	Product Description
L1B	Resampled calibrated data in units of spectral radiance as well as observational geometry and illumination parameters.
L2	Orthocorrected and atmospherically corrected reflectance data (32-bit floating point quantities from 0 to 1) as well as retrieved column water vapor and optical absorption paths for liquid H2O and ice.

L1B Data Products

Grass Line, FL - View quicklook | Download data (4.5 GB) Island Line, FL - View quicklook | Download data (4 GB) Elkhorn, CA - View quicklook | Download data (9 GB) Elkhorn, CA - View quicklook | Download data (10 GB) Elkhorn, CA - View quicklook | Download data (10 GB)

L2 Data Products

Grass Line, FL - View quicklook | Download data (4.8 GB) Island Line, FL - View quicklook | Download data (4.1 GB) Elkhorn, CA - View quicklook | Download data (7.4 GB) Elkhorn, CA - View quicklook | Download data (8.2 GB) Elkhorn, CA - View quicklook | Download data (8.1 GB)

Accessing and Using PRISM Data



cap use rate (Automation	
Chilan rei prippia to pri lig	in the delete trubuling communit toke, HGU subdivoke, and NALe
Copperd real-balanti ("ww" must	is hate and above leaves by your (NOTE ADDITION Providered search and The betwee serving area.)
plant * warmed in common to service	
Additional responses i search in	of War balance ran be front from Variation to the Centerio lab and extern the Alternov.
No. of Concession, Name	a Rinh Data
Contraction of the second second	
PROH FIGHT	
of all the failed regregation that be har Encounter, and in during	
in a second s	
int .	C ALCON AND A AND
as a	
- faire -	chant parant strategies and a second
And X-1	
	And and a state of the second state of the sec
	and the second s
	Contra and a second sec
	had be the series that a shiple
	The Test and
	dama atta
	a search because where a first
	AP, NER, SPART, DR. PROVIDE APRIL PROVIDE APRI
	Bad to be
Data Table	
CAR for him to him only	
Channel Prin - Described in to	ne el longi sugo
Quel Mile in here marging	
PRIM PLANTING	
Ba Art Van man	farm has been and
6 11 G . Class	A
a il nara	
-	
A property defined to the	in the linear statistical and the statistical
a post-orient does	and second an interview with the second s
a production from the second	ne 18 Dennes Man Lawbrer gestinder for andre in gestinder to den
a construction from them.	in 17 December 18 + 12 above and ball of the second s

- 2014–2018 data is available to download from
 <u>PRISM Data Portal</u>
 - Many filtering options
 - Each flightline uses a specific base filename prefix
- Data Types:
 - .KML
 - .JPEG
 - .dat
- Compatible with ENVI, QGIS, ESRI products, etc.



Comparing Airborne Systems: Specifications



AVIRIS-C:

- Active since 1986
- 224 continuous spectral bands
- Spectral Coverage: 380 to 2500 nm
- Spectral Resolution: 10 nm
- Spatial Resolution: 4–20 m



AVIRIS-NG:

- Active since 2009
- 481 contiguous spectral bands
- Spectral Coverage: 380 to 2510 nm
- Spectral Resolution: 5 nm
- Spatial Resolution: 2–6 m



PRISM:

- Active since 2012
- 256 contiguous spectral bands and 2 SWIR bands: 1240 and 1610 nm
- Spectral Coverage: 350 -1050 nm
- Spectral Resolution: 3.5 nm
- Spatial Resolution: 0.3 to 16 m



Comparing Airborne Systems: Access and Use



AVIRIS-C:

- Data Access:
 - Data portal
 - 2006-2021
 - Pre-2006 form
- Data Products:
 - Up to Level 1B for 1993 to 2012
 - Up to Level 2 for data collected 2013 to present
- Data Types:
 - .KML
 - .JPEG
 - .dat

AVIRIS-NG:

- Data Access:
 - Data portal
 - 2014-2021
- Data Products: Level 1B and L2
- Data Types:
 - .KML
 - .JPEG
 - .dat



- PRISM:
- Data Access:
 - Data portal
 - 2014-2018
- Data Products: Level 1B and L2
- Data Types:
 - .KML
 - .JPEG
 - .dat





Upcoming Mission Highlights

Paving the Way for Future Missions

The design and data from these airborne instruments have been essential in the development of upcoming satellite missions and future science initiatives.

• Mission objectives and spectrometer specifications are based off the successful implementation of previous airborne campaigns.



Imagery from HyTES, AVIRIS-NG, AVIRIS-C, and PRISM campaigns used for the development of NASA's SBG mission. Credit: <u>Cawse-Nicholson, et al., 2021</u>.

Plankton, Aerosol, Cloud, and Ocean Ecosystem (PACE)

PACE is NASA's next great investment in

hyperspectral earth imagery and multi-angle polarimetry.

- Launch Date: Feb 8, 2024
- 3-year design life; 10-year propellant
- Hyperspectral Imager: Ocean Color Instrument
 (OCI)
 - Spectral Resolution: UV to SWIR (340-890 nm every 2.5 nm, with 940, 1038, 1250, 1378, 1615, 2130, & 2250 nm)
 - Temporal Resolution: 2 days
 - Spatial Resolution: 1-km2 at nadir
- Two Multi-Angle Polarimeters
 - HARP-2: Wide swath, hyper-angular, 4 bands across the VIS & NIR
 - SPEXone: Narrow swath, hyperspectral (UVNIR), 5 viewing angles











Spectral Range Goal of 320-865 @ 5 nm

Improve our understanding of how aerosols influence ocean ecosystems & biogeochemical cycles and how ocean biological & photochemical processes affect the atmosphere.

CE Moving from Multispectral Radiometry to Spectroscopy

1978-1986 1997-2010 1999-pres. 2012-pres.





Signals from the ocean are small & differentiating between constituents requires additional information relative to what we have today.



NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop

— 1 mm — 🗕

PACE: Interdisciplinary Applied Science Objectives



PACE "First Light" Image – South Africa Feb 28, 2024!!





Surface Biology and Geology (SBG) Mission

https://sbg.jpl.nasa.gov/

- In development via guidance from the <u>2018</u>
 <u>Decadal Survey</u>
- Potential Parameters:
 - Visible to Shortwave Infrared Bands:
 - Spectral Range: 350 or 400–2,500 nm
 - Spectral Resolution: 10 nm or better
 - Global with 2- to 16-day revisit times
 - Thermal Bands:
 - Spectral Range: 8,000–12,000 or 3,000–5,000 nm
 - Spectral Resolution: Greater than 5 bands
 - Global with 1- to 70-day revisit times



Mount Kilimanjaro Image Credit: JPL SBG



33

SBG Mission



SBG Potential Applications; Image Credit: JPL SBG

NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop

Resources

- <u>https://airbornescience.nasa.gov/</u>
- <u>https://aviris.jpl.nasa.gov/</u>
- <u>https://prism.jpl.nasa.gov/</u>
- <u>https://www.bioscape.io/</u>
- <u>https://airbornescience.jpl.nasa.gov/campaign/coral</u>
- <u>https://sbg.jpl.nasa.gov/</u>
- <u>https://pace.gsfc.nasa.gov/</u>





Summary

Summary



- The increased spectral resolution from hyperspectral data can provide users with additional data that multispectral data cannot measure.
- Airborne Visible/Infrared Imaging Spectrometer (AVIRIS), Airborne Visible InfraRed Imaging Spectrometer Next Generation (AVIRIS-NG), and Portable Remote Imaging SpectroMeter (PRISM) airborne campaigns provide us with hyperspectral VSWIR data.
- Recent and future hyperspectral missions include Plankton, Aerosol, Cloud, and Ocean Ecosystem (PACE), Airborne Visible InfraRed Imaging Spectrometer 3 (AVIRIS-3), and Surface Biology and Geology (SBG).







Thank You!

NASA ARSET – Hands-On Field Spectroscopy Training and Data Skills Workshop

