IRES-Peru Track I: Manifestations of Climate Change in Extreme Events

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School of Electrical Engineering and Computer Science
The Pennsylvania State University

60th Anniversary Jicamarca Radio Observatory Workshop, July 24 – 27, 2022

Penn State:

Julio Urbina (Electrical Engineering), Jose Fuentes (Meteorology), Rachel Brennan (Environmental Engineering), Alfonso Mejia (Hydrology), Chris Forest (Climate Dynamics), and Heather Randell (Rural Sociology)

Geophysical Institute of Peru:

Jose Luis Flores, Luis Suarez, Rene Estevan Arredondo

Jairo Valdivia, Valeria Llactayo, and David Guizado

Universidad Nacional de Ingenieria:

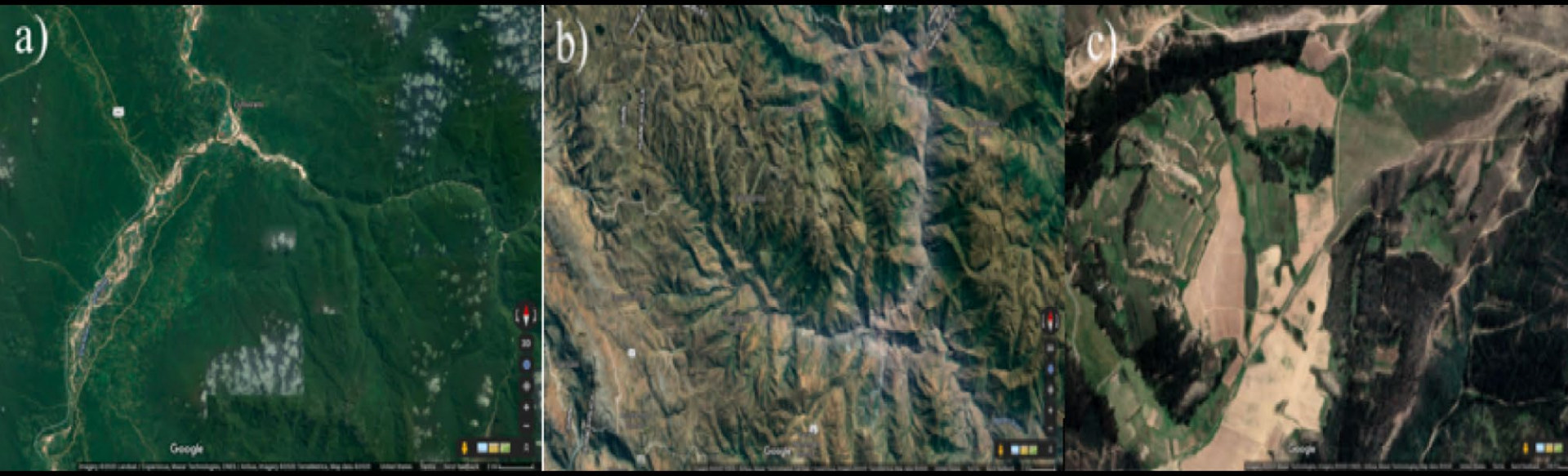
Jose Oliden (Mechantronics Engineering), Julio Kuroiwa (Civil Engineering)

iRES 2022 students:

Antonio DeMarchis (Penn State), Wilnelia Barea (Ana G. Mendez University), Jaishree Gupta (University of North Carolina at Chapel Hill), and Tarang Shah (Worcester Polytechnic Institute)

NSF IGP Instituto Geofísico del Perú PennState College of Engineering ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Photographs near Huancayo, Peru: a) Aerial view of the Mantaro Valley, surrounding Huancayo; b) Huancayo Observatory lodging facilities; and c) Huancayo Observatory showing many local RF instruments and atmospheric sensors.



Aerial map showing three sample locations near Huancayo Observatory where drone path will be conducted to study research addressing climate changes related to a) Forests, b) Andes Mountains, and c) Croplands.

Photographs of Santa Eulalia, Northern Lima, after el Niño Costero in 2017: a); and b), c), and d) damage caused by huaycos (landslide).

Research Activities

1. **Development and integration of technologies** *(Urbina, Fuentes, and Oliden).*

2. **Regional budgets of greenhouse gases (carbon dioxide and water) across different landscape types (croplands, pastures or grassland, forests, and the Andean Mountain (Native people in Peru))** *(Fuentes and Forest)*

   (i) Climate modeling with the NCAR Single Column Atmospheric Model.
   (ii) Data assimilation using the Single Column Atmospheric Model.

3. **Regional distribution and budget of air pollutants (ozone)** *(Fuentes, Forest, and Silva)*

4. **Mitigation of El Niño Phenomena** *(Mejia and Kuroiwa)*
5. **Drawdown Solutions for Climate Change** *(Brennan, Oliden, and Urbina)*
6. **Social Adaptation to extreme events** *(Randell, Castro, and Vidal)*

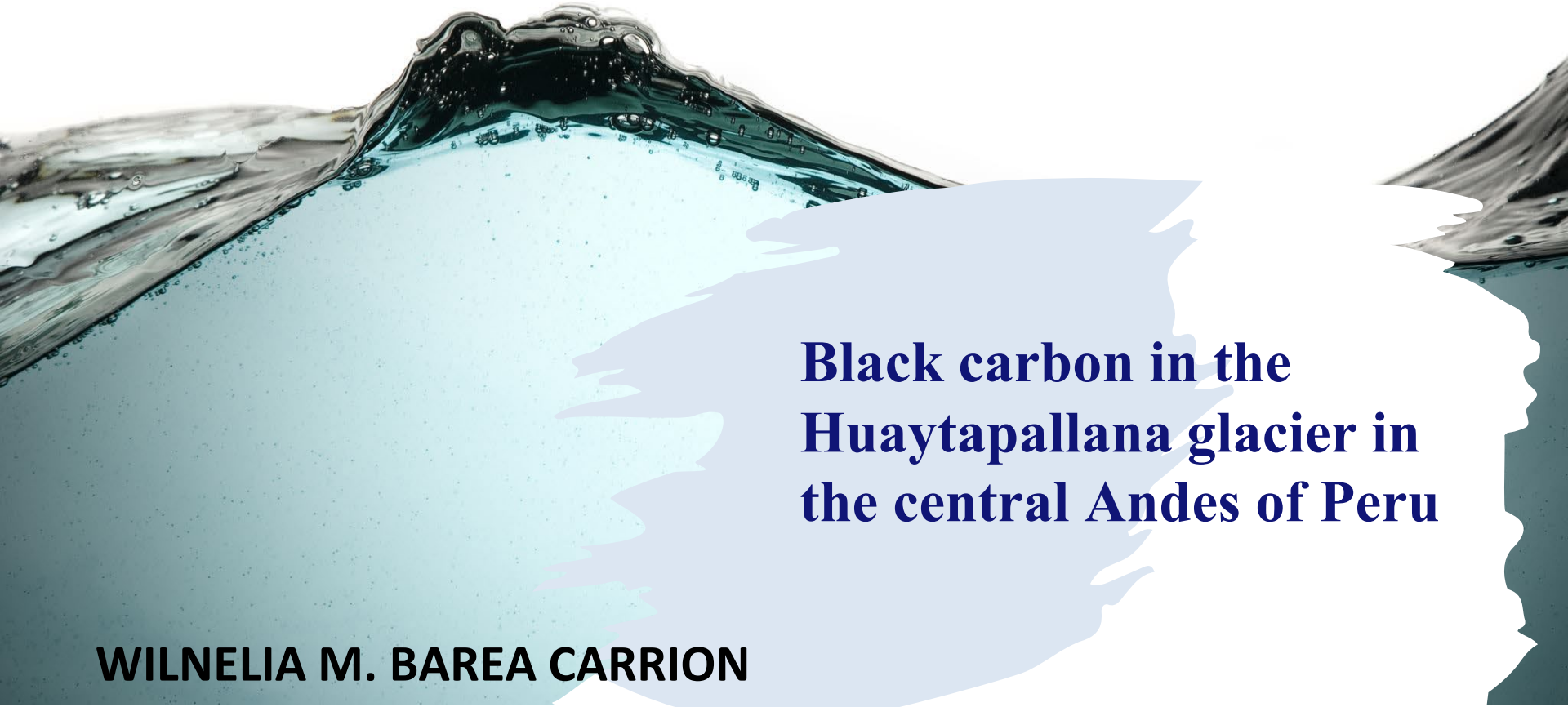
YEAR 1 PROJECTS

Developing a Portable Station to Assess Climate and Air Quality Parameters in the Central Peruvian Andes

Antonio DeMarchis
Penn State University

Acute Respiratory Infections in Central Andean Populations due to Aerosols

Jaishree Gupta
University of North Carolina at Chapel Hill



Black carbon in the Huaytapallana glacier in the central Andes of Peru

WILNELIA M. BAREA CARRION

ANA G. MENDEZ UNIVERSITY

Can Solar Cookers Address the Rising Costs of Fossil Fuel Dependency?

Tarang Shah
Worcester Polytecnnic Institute

Climate Change Workshop at Huayao and Sicaya Communities

NEXT YEAR

Pollinators in a Changing World – NSF iREU

Dr. M. Lopez-Uribe

Dr. Jose Fuentes

Dr. Julio Urbina

Dr. Alfonso Mejía

Dr. Luis Duque

NSF

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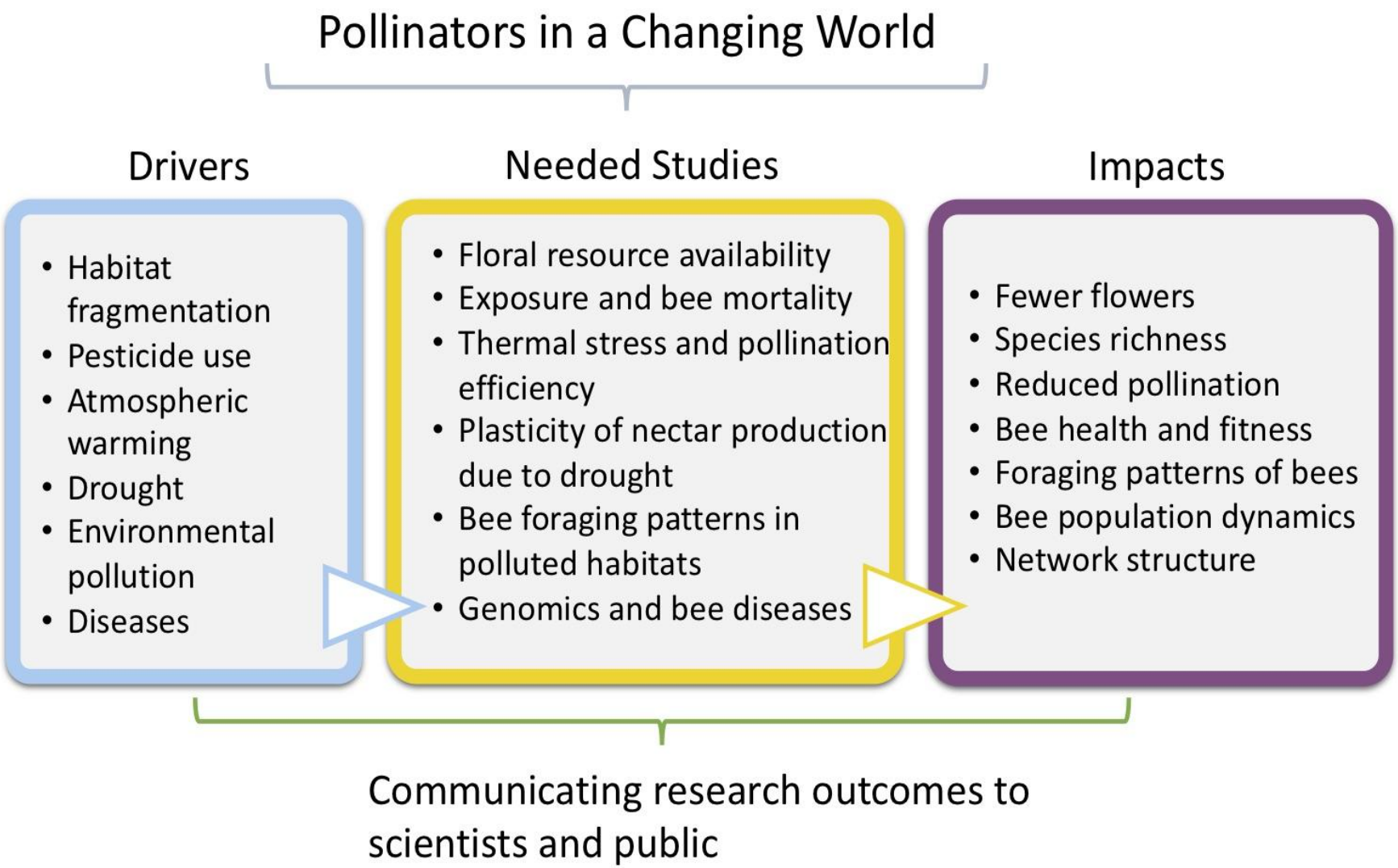
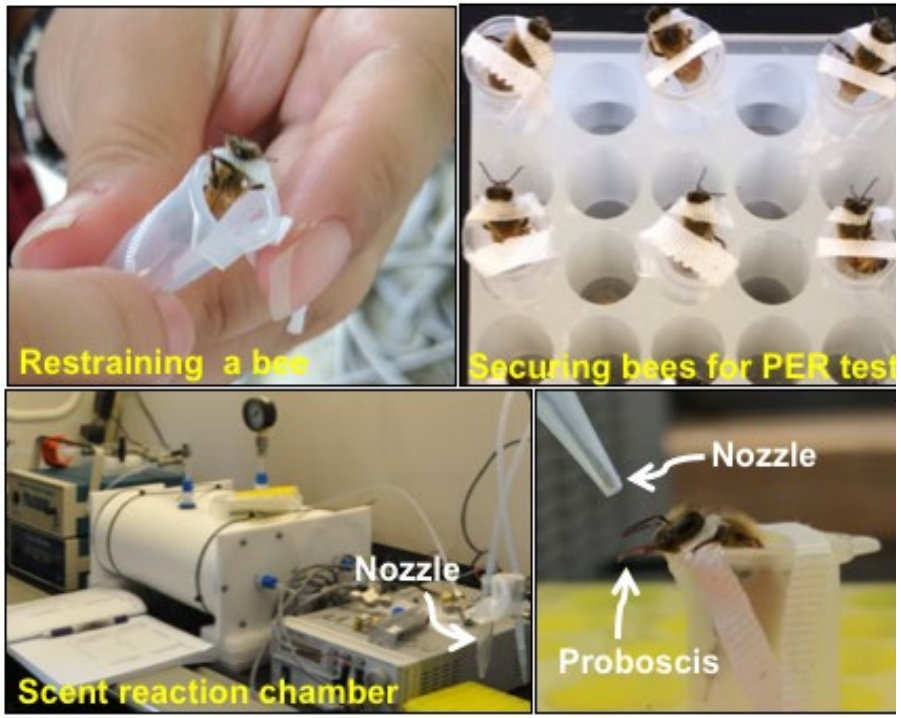
Pontificia Universidad Católica del Perú

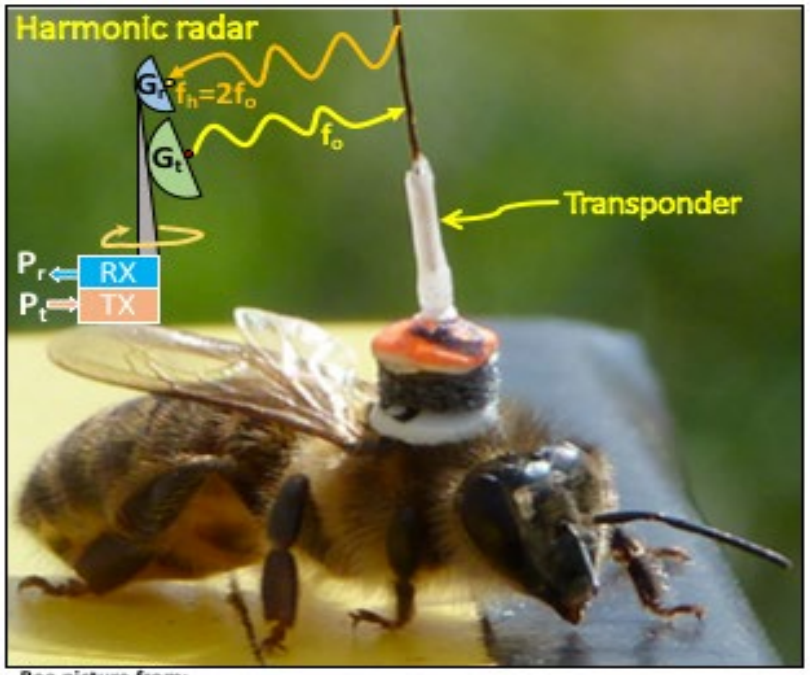

MONGABAY

Pollinators in a Changing World – NSF iREU



Effects of climate warming on plant-insect interactions





Bee picture from:
http://www.qmul.ac.uk/media/news/items/se/images/item181277.jpg

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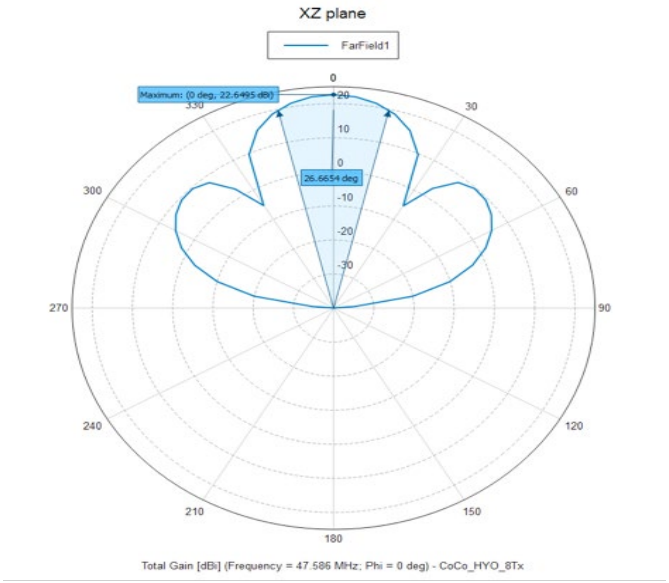
CIRI at Huancayo

- Operating Frequency of 47.586 MHz
- Four lines of Coaxial-Collinear (Co-Co) Antennas
- 2 Channels (East – Channel 1, West – Channel 2)
- 15 kW Peak Power
- 26.6° Beamwidth, 22.6 dBi Gain



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Radar Imaging


NSF


NASA


Applied Signal Processing and Instrumentation Research Laboratory
ASPIRL


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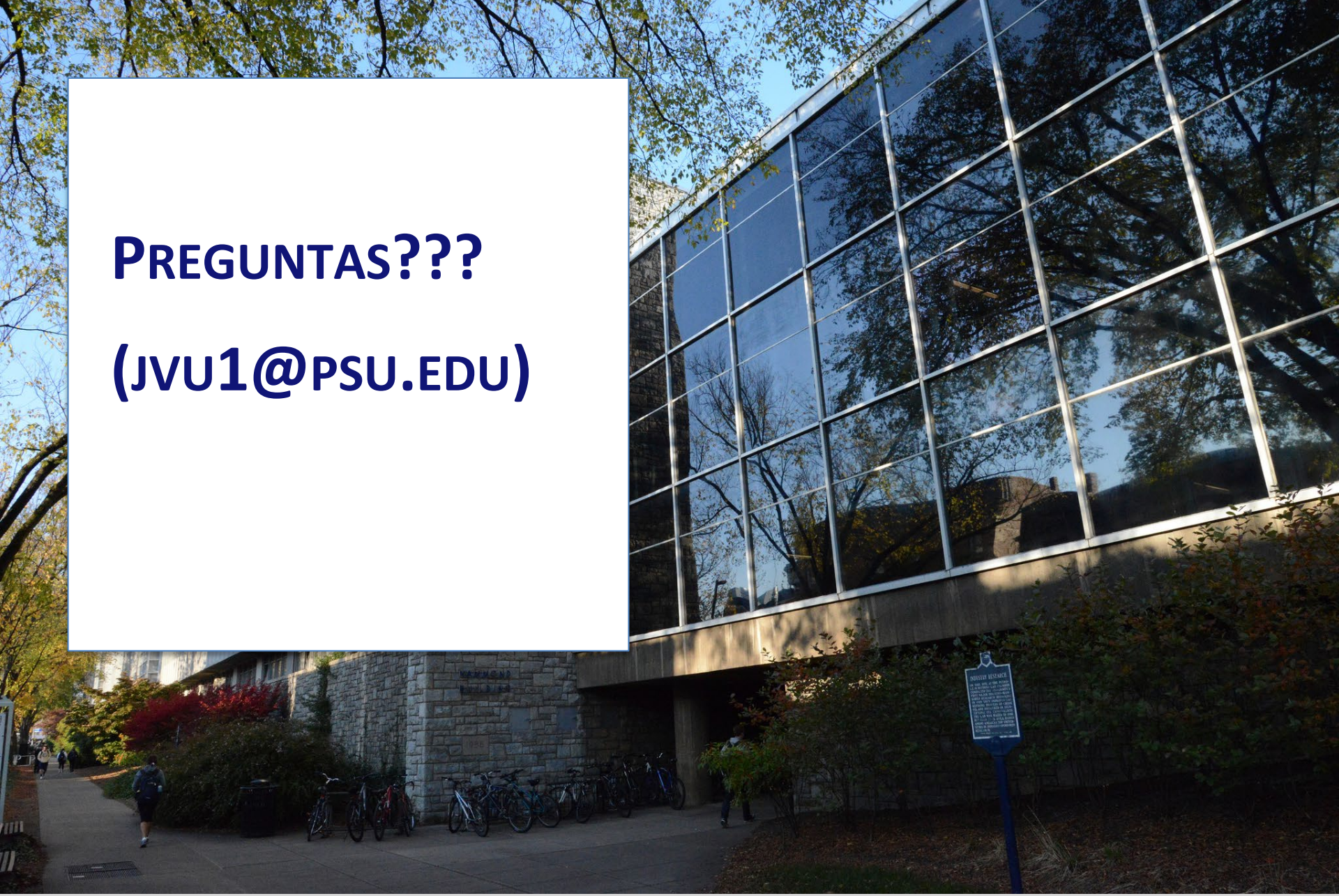
FULBRIGHT



PREGUNTAS???

(JVU1@PSU.EDU)

EM Spectrum Currently used by radar systems

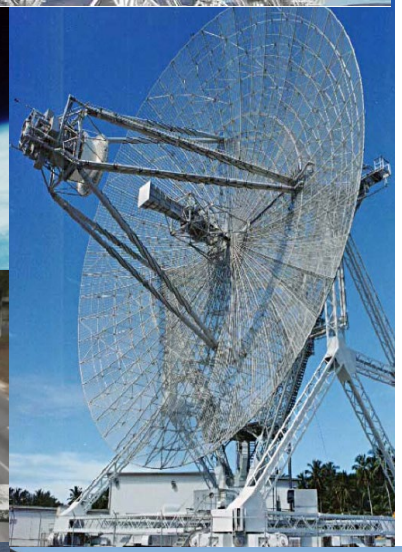


Table 1 Radar frequency band and its typical usage.

IEEE Band Designation	Frequency Range	Typical Usage and Characteristics
HF	3-30 MHz	Over the horizon surveillance; *low range and low resolution*
VHF	50-330 MHz	Long range (Line of Sight) surveillance, Foliage penetration (FOPEN), counter-stealth, ground penetrating; *low/medium resolution*
UHF	300-1000 MHz	Long range surveillance, FOPEN; *low/medium resolution*
L	1-2 GHz	Long range surveillance, Long-range air traffic control; *medium resolution and small weather effects*
S	2-4 GHz	Moderate-range surveillance, terminal air traffic control, long-range weather observation, airborne early warning (AEW); *moderate weather effect in heavy precipitation*
C	4-8 GHz	Long-range tracking, weather observation, weapon location; *increased weather effect in light/medium rain*
X	8-12 GHz	Short-range tracking, missile guidance, mapping marine radar, airbone intercept, battlefield surveillance, weapon location; *reduce to short range operation in rain*
Ku	12-18 GHz	High-resolution mapping, satellite altimetry, man-portable/unmanned air vehicle (UAV) radar; *short range due to water vapor absorption*
K	18-27 GHz	Police radar; *very limited use due to high water vapor absorption*
Ka	27-40 GHz	Short-range very high-resolution mapping, airport surveillance; *short range due to water vapor absorption*
V	40-75 GHz	Scientific remote sensing; *high water vapor absorption*
W	75-110 GHz	Automobile cruise control (77 GHz), missile seekers, very high-resolution imaging (94 GHz); *high water vapor absorption elsewhere in the band*
Mm	110-300 GHz	Experimental; *limited to short range due to high water vapor absorption*

From Bruder at al., 2003

Research Areas

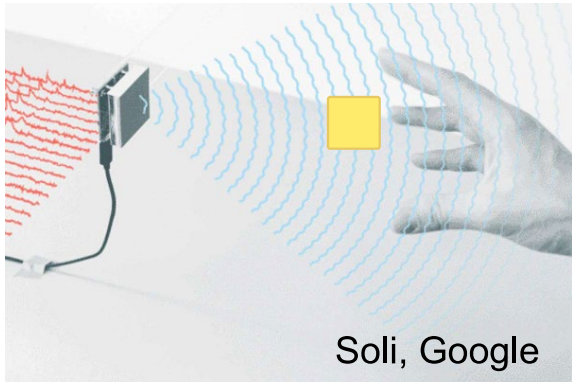
1. Noise Radar
2. Passive Radar
3. Through-Barrier Radar
4. Harmonic Radar
5. Radar Holography
6. Radar for Landmine Detection
7. Radar Micro-Doppler
8. Multimodal Radar
9. Multifunctional Radar-Communications Systems
10. Radar Tags
11. Indoor Radar Clutter
12. Image Analysis
13. Quantum Radar
14. Radar Applications of Sudoku Sequences
15. Noise-Based Communications
16. Cognitive Radar
17. Spectrum Sensing
18. Compressive Sensing
19. Trilateration
20. Medical Radar
21. Ultrawideband Radar
22. Materials
23. Other Applications

4. Future Technologies:

Waves in Communication/Sensing/IOT

- Mobile network

- Radar sensor

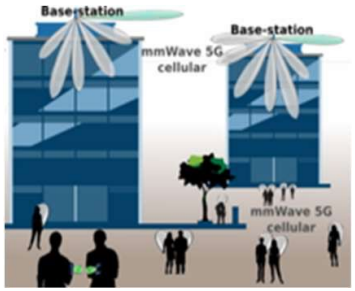


- Wireless power transfer

How to make waves deliver **higher data rate, higher radar resolution,** and **more focused energy**?

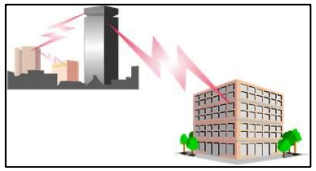
Existing and Emerging mmWave Application

5G radio access

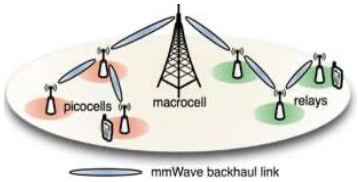


WiGig[1]

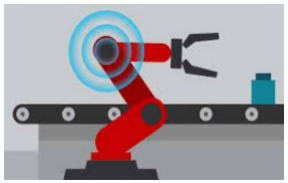
Licensed pt.-to-pt. link



Back-haul

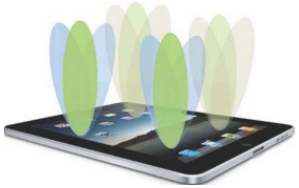


Short-range radar[2]



Automotive radar[3]

Gesture sensor[4]



Emerging application

- Ultra-broadband communication
- THz imaging
- Spectroscopy
- High resolution radar

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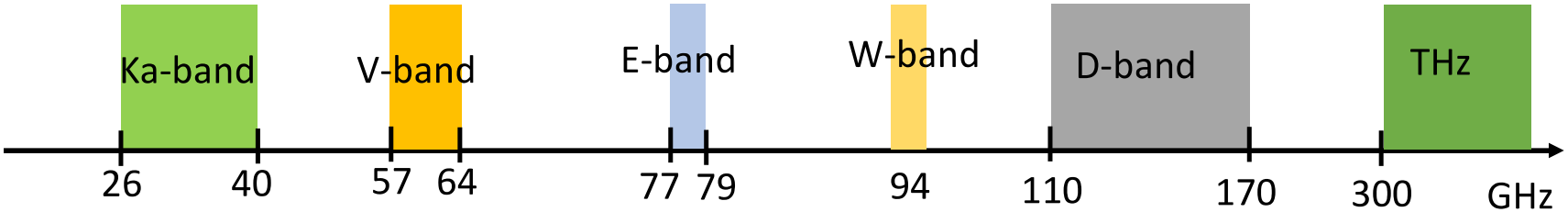
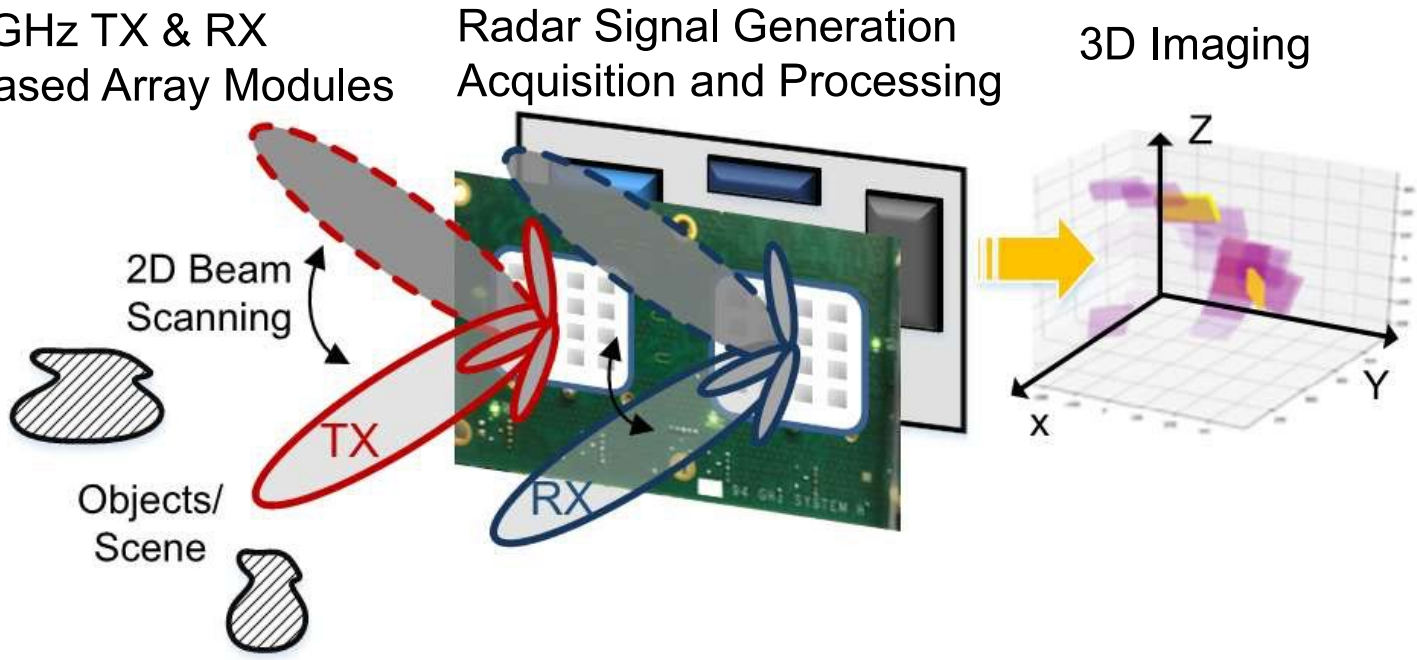


[1]G. Prophet, eeNews analog, Apr 2017
[2]D. Manners, Electronicsweekly, Nov 2018
[3]S. Bush Electronics Weekly, Jan 2017
[4]A. Arbabian, et al., IEEE JSSC, April 2013

Courtesy of Dr. Wooram Lee

3-D Imaging Radar Using Phased Array



- Application- automotive radar, gesture recognition, industrial radar, security.

Other Projects: United States Fulbright Scholar 2015 at Universidad Nacional de Ingenieria (UNI) – Lima, Peru

Open Source Radars
Software-Defined Radars

https://ocw.mit.edu/resources/res-ll-003-build-a-small-radar-system-c...-range-doppler-and-synthetic-aperture-radar-imaging-january-iap-2011/

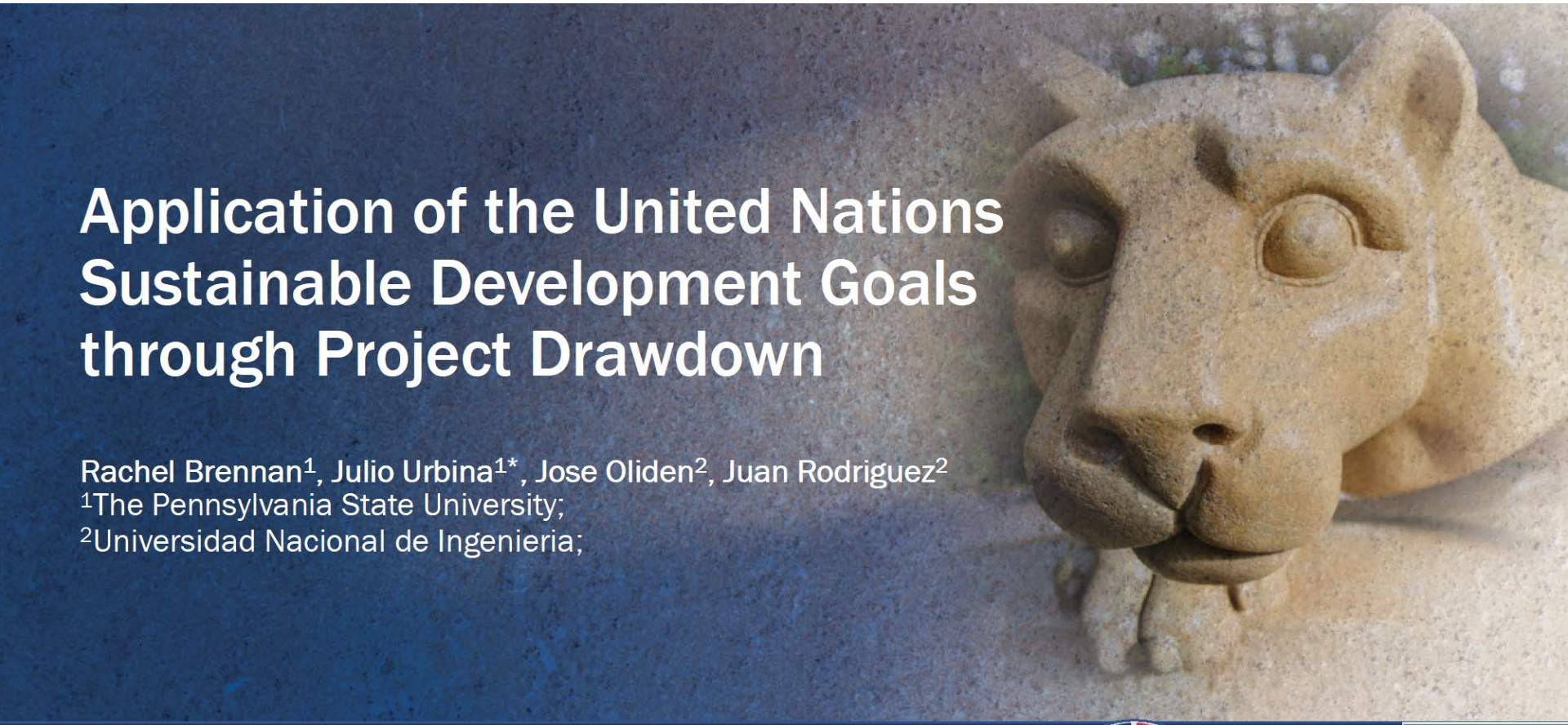
Experience-Based Learning in Global Engineering Culture and Society

Julio Urbina[1], José Oliden[2], Patrick Tunno[1], Akhlesh Lakhtakia[1], Juan Rodriguez[2], Miguel Estrada[2], Esther Obonyo[1], Sarah Zappe[1], Christine Masters[1*], and Fernando Fonseca[3]

1. The Pennsylvania State University
2. Universidad Nacional de Ingeniería
3. Lycoming College

Application of the United Nations Sustainable Development Goals through Project Drawdown

Rachel Brennan[1], Julio Urbina[1*], Jose Oliden[2], Juan Rodriguez[2]
[1]The Pennsylvania State University;
[2]Universidad Nacional de Ingenieria;



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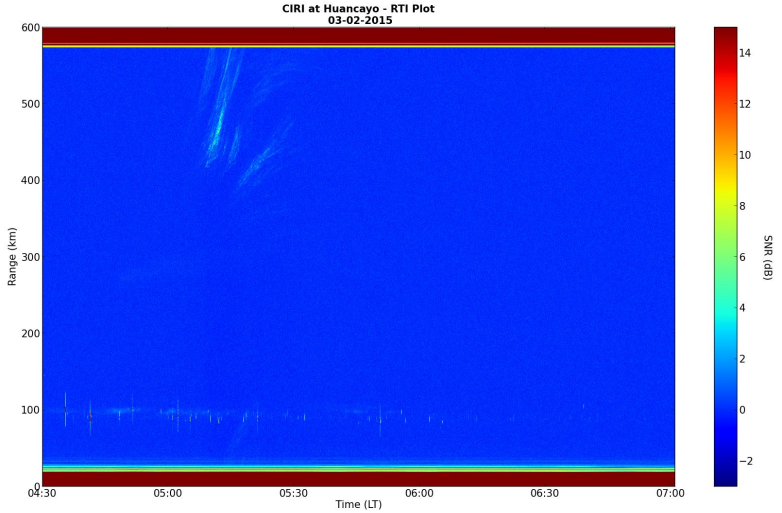
PennState College of Engineering

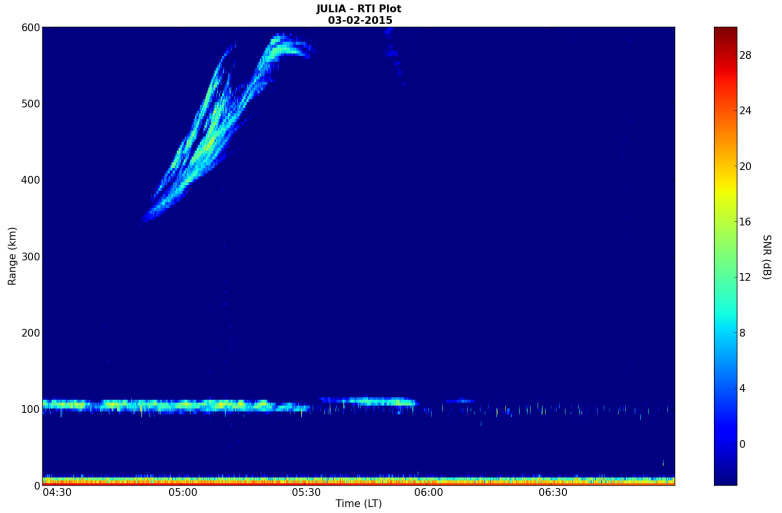
ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

IGE: Stakeholder-Driven Sustainable Development Experiences for Enhancing STEM Graduate Education

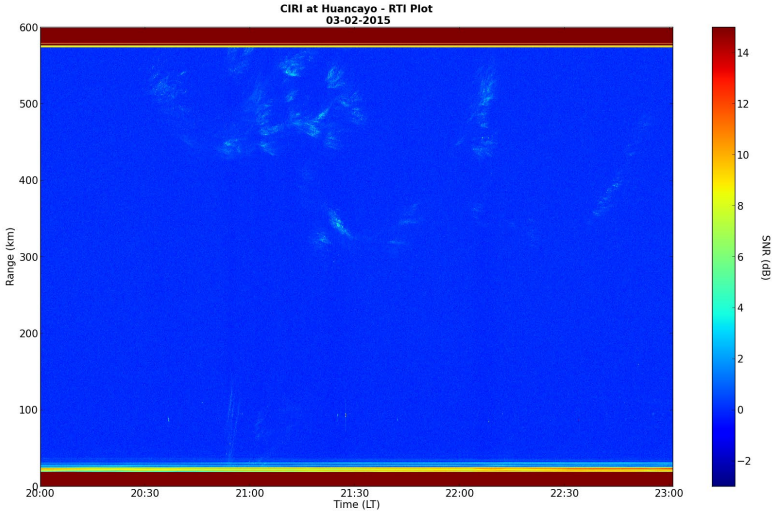
Project Launch Meeting
June 29, 2021

Comparisons with Jicamarca





Comparisons with Jicamarca



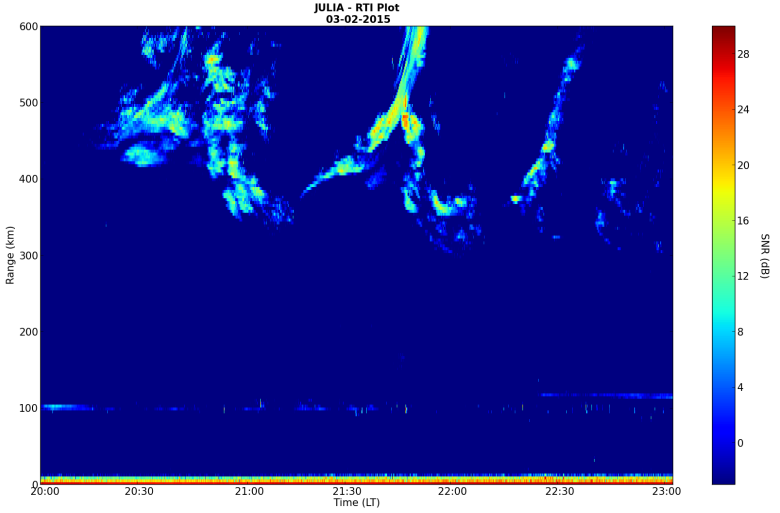


Table 1. Names, research areas, and project contributions of each of the faculty mentors that will lead th proposed international research program.

Faculty Member	Research Area	Contribution to Research Projects
Julio Urbina (PSU)	Data acquisition, system integration, RF remote sensing	Training of students on system integration and experimental design. Faculty advisor on projects related to the integration of sensors and data sensing, retrieval, and archival for further processing and interpretation.
Rachel Brennan (PSU)	Food-energy-water nexus challenges; water purification; waste valorization and upcycling into feed, fertilizers, and biofuels	Training of students on experimental design and Drawdown strategies for reversing global warming. Faculty advisor on projects related to Drawdown solutions.
Jose D. Fuentes (PSU)	Biosphere-atmosphere interactions, and climate change impacts on ecosystems	Guide student research involving data gathering with sensors on the drones , data analysis and interpretation, and publication of results (with students).
Chris E. Forest (PSU)	Climate dynamics, climate modeling, data analysis for assessing regional impacts	Guide student research on modeling local and regional climate, analysis of local climate data, and modeling greenhouse gas budgets for the regions.
Alfonso Mejia (PSU)	Analysis and prediction of floods and droughts, and their potential impact on inundation areas and water supplies	Guide student research in the analysis of data for extreme events, and modeling of flood and drought events.
Heather Randell (PSU)	Sociology and demography, health and social impacts of climate change	Guide student research involving social science data collection and analysis.
Julio Kuroiwa (UNI)	El Niño mitigation methods and hydrology modeling	Faculty mentor on mitigation of el Niño phenomena. Logistics support to students and researchers during field trips to Northern Lima.
Jose Oliden (UNI)	On the fly hardware and software development and integration, IoT, signal quality	Mentoring and training of students on open-source tools, cultural training with local students. Logistics support for the duration of the program in Peru.
Yamina Silva (IGP)	Climate dynamics of the Mantaro Valley	Huancayo Observatory facility management and mentor in local climate dynamics.