

60th Anniversary Jicamarca Radio Observatory Workshop Report

D. L. Hysell, M. A. Milla, and D. Scipion

September, 2022

1 Introduction

The 60th Anniversary Workshop of the Jicamarca Radio Observatory was convened to highlight the importance of the 60 years of contributions to space physics and aeronomy research from the observatory and to commemorate and acknowledge the important role of the facility, its users, and its staff, both past and present.

Jicamarca has been an incubator for discoveries in aeronomy, space physics, and radar techniques since its inception in the early 1960s, and the 60th anniversary was an occasion worth marking. However, the motivation for the workshop was not driven purely by the calendar. Rather, the motivation comes from a number of exciting, recent developments in equatorial aeronomy, space physics, and space weather. Furthermore, Jicamarca has been undergoing a number of upgrades, and the workshop was an opportunity to describe and demonstrate some of them and to familiarize the user community with the new capabilities available to them for their research.

The venue for the workshop was the Courtyard Hotel in Miraflores, Lima, Peru, with one day of the workshop also being held at the observatory. The workshop was convened from July 25th to 27th, 2022, when a partial break in the busy summer conference schedule in geospace science presented itself. An excursion around Lima was also hosted on July 24th, the Sunday prior to the workshop, and a group dinner was held on Monday, July 25.

A keynote address recalling some of the most significant early findings from Jicamarca was given by Prof. Cesar La Hoz during the Jicamarca visit. The address touched on a number of broader themes on the interactions between science, technology, and education.

The comprehensive workshop website at <https://www.igp.gob.pe/eventos/internacional/2022/workshop60th-jicamarca/> presents more details about the event including the agenda and the list of speakers.

2 Organization

The workshop was organized with the help of a number of co-conveners and science leads who are named below. Early input from the conference participants was also used to shape the program. There were five sessions:

1. Distributed Sensors around Jicamarca (convened by Anthea Coster, Jade Morton, and Cesar Valladares)
2. MLT-X Research (convened by Jorge Chau and Erhan Kudeki)
3. F-region Instability and Irregularities (convened by Fabiano Rodrigues and Claudia Stolle)
4. Incoherent Scatter and Equatorial Aeronomy (convened by David Hysell and Marco Milla)
5. Research and Technology Developments in Peru (convened by Marco Milla and Danny Scipion)

These reflect some of the main interests of the Jicamarca and the broader community as well as the kinds of problems Jicamarca is best suited to address. The first session highlighted the fact that the Jicamarca Radio Observatory is at the center of a distributed network of instruments that includes the LISN network of sounders and magnetometers, the SIMONE MIMO meteor radar network, numerous peripheral radar and radio systems, an HF beacon network, a network of GPS receivers, and regional FPIs and optical imagers.

The second session pointed to the rich science associated with the equatorial D, E, and valley regions which contain the equatorial electrojet, so-called “150-km echoes,” nighttime valley echoes, persistent mesospheric neutral echoes (PEMEs), and meteor head and trail echoes which can be studied with a number of modalities at Jicamarca.

The third session had to do with research surrounding the phenomenon “equatorial spread F,” the cause célèbre of space weather in the low latitude ionosphere. ESF was discovered in the 1930s at the Huancayo observatory with early sounders that constituted some of the earliest operational pulsed radars in the world. ESF was first correctly interpreted as a manifestation of ionospheric interchange instability at Jicamarca. Nowadays, forecast studies are underway utilizing various Jicamarca systems (e.g. the AMISR-14) and data products along with large-eddy and direct numerical simulations of the underlying plasma instabilities.

The fourth session concerned incoherent scatter, the mainstay of research methods at Jicamarca. ISR presents special challenges and opportunities at Jicamarca which operates at VHF frequencies and which steers very close to perpendicular to the geomagnetic field. Incoherent scatter theory in this limit is incomplete, but exciting work is underway to close the gap and to fully flesh out ISR theory in this limit for the first time.

Finally, the fifth session underscores the fact that Jicamarca is owned and operated by the Geophysical Institute of Peru (IGP) which is responsible for a broad portfolio of projects and subject areas comparable to the Geosciences Directorate at NSF. Over the years, Jicamarca has become a laboratory for electronics and instrumentation development in support the main radar and other instruments near the observatory. Our experience now benefits a variety of development projects spanning other science areas at IGP.

The final program as well as the individual presentations are available at the following link: https://www.igp.gob.pe/eventos/internacional/2022/workshop60th-jicamarca/event_schedule.php.

3 Demographics

The workshop was attended by 52 individuals including representatives from the Geophysical Institute of Peru, the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and researchers from different universities and institutes from around the world. Recruiting early-career scientists was emphasized throughout workshop planning. Travel support was made available to five visitors to Peru with preference given to early-career scientists.

Origin	Total	Early Career
International	35	4
Peru	17	8

Table 1: Meeting demographics.

Photographs from the event are available at https://www.igp.gob.pe/observatorios/radio-observatorio-jicamarca/?page_id=10838. This document is also hosted at <https://landau.geo.cornell.edu>.

4 Outcomes

Discussions regarding the present and future state of aeronomy, space physics, and space weather took place throughout the workshop, culminating in an open discussion mini-session at the conclusion of the program. While no specific resolutions emerged from the discussion, a number of themes came forward. These are summarized below.

- The research underway at Jicamarca remains at the center of the interests of the international equatorial aeronomy community. The workshop was a great opportunity to “catch up” with that community and to take stock with present and anticipated research needs and trends. Many of the most pressing needs pertain to longer operations, operations over larger geographic regions, and improved support for spacecraft, from cubesats to major missions.
- There was special interest in maintaining complementary (to ISR) networks of instruments to monitor the equatorial region including small but flexible radars (AMISR), meteor radar networks (SIMONe), Fabry-Perot interferometers, ionosondes, magnetometers, HF sounders, and GNSS receivers. This points to a community need for comprehensive regional measurements to support realistic modeling and simulation studies. These networks, however, are too often deployed and maintained on an ad hoc basis. The logistical and financial challenges of distributed networks require more planning going forward.
- Even after 60 years, the need to improve and refine experimental methods and to introduce new measurement techniques persists. For example, simultaneous observations of incoherent and coherent scatter in a common volume have led to important

findings in the past, and ways of expanding this capability should be prioritized. Likewise, radar imaging, pioneered at Jicamarca, has proven itself to be an incisive tool for understanding ionospheric stability and plasma dynamics but can benefit from the expansion of multistatic reception arrays, inclusion of multiple transmitters, adoption of MIMO methods, and exploitation of polarimetry and multi-frequency capabilities.

- The importance of community participation in planning exercises such as the ongoing NASEM Decadal Survey was stressed by several conference participants. A recurring problem with these exercises is the lack of a mechanism for incorporating ground-based instrumentation into NASA missions. The agencies were urged to continue to search for such a mechanism.
- The submission of white papers concerning additions to the Geospace facilities to the Survey was specifically encouraged.
- Finally, the importance of the Jicamarca Radio Observatory to the education and training of the next generation of geospace scientists and engineers was highlighted by workshop participants.