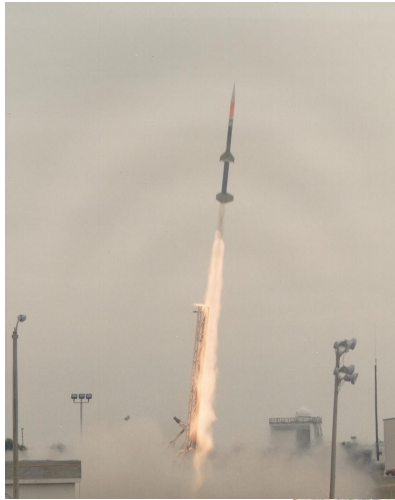


# Update on the Proposed Peru NASA Sounding Rocket Campaign



**Unprecedented, Preeminent Science  
at a Unique Observing Site**



Robert Pfaff  
NASA/Goddard Space Flight Center

CEDAR Workshop: “Discovery Science Near the Magnetic Equator”

June 25, 2020

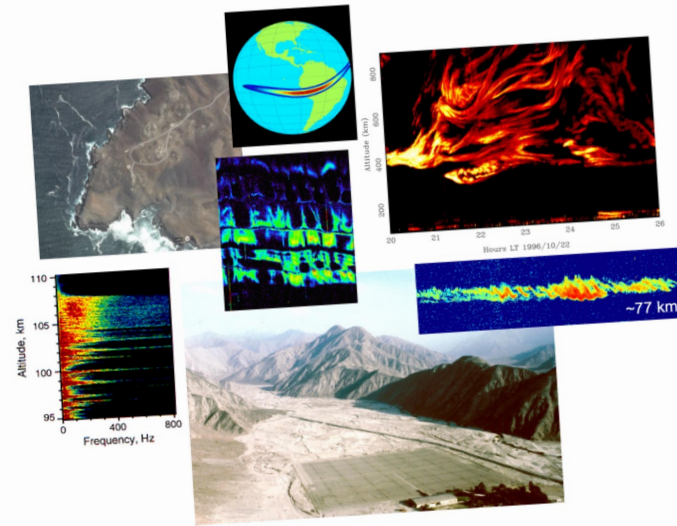
## Background

- For many, many years, Geospace community has been promoting and asking for a NASA rocket campaign in Peru
- Two community meetings took place at NSF Sponsored CEDAR meetings in summer 2016 and 2017 (w/NASA HQ present)
- A 38 page “White Paper” was submitted to NASA HQ (Dan Moses) on Jan. 25, 2018 →
- Paper was favorably received
- Wallops asked to study such a campaign and prepare to implement, if feasible!
- Third CEDAR meeting took place in 2018 with WFF present

Link to white paper:

<https://rscience.gsfc.nasa.gov/keydocs.html>

### A NASA Sounding Rocket Campaign in Peru -- Unprecedented, Preeminent Science at a Unique Observing Site



### A White Paper

Prepared by Members of the International Space Science Community

January 25, 2018

## Status of NASA Peru Campaign (June, 2020)

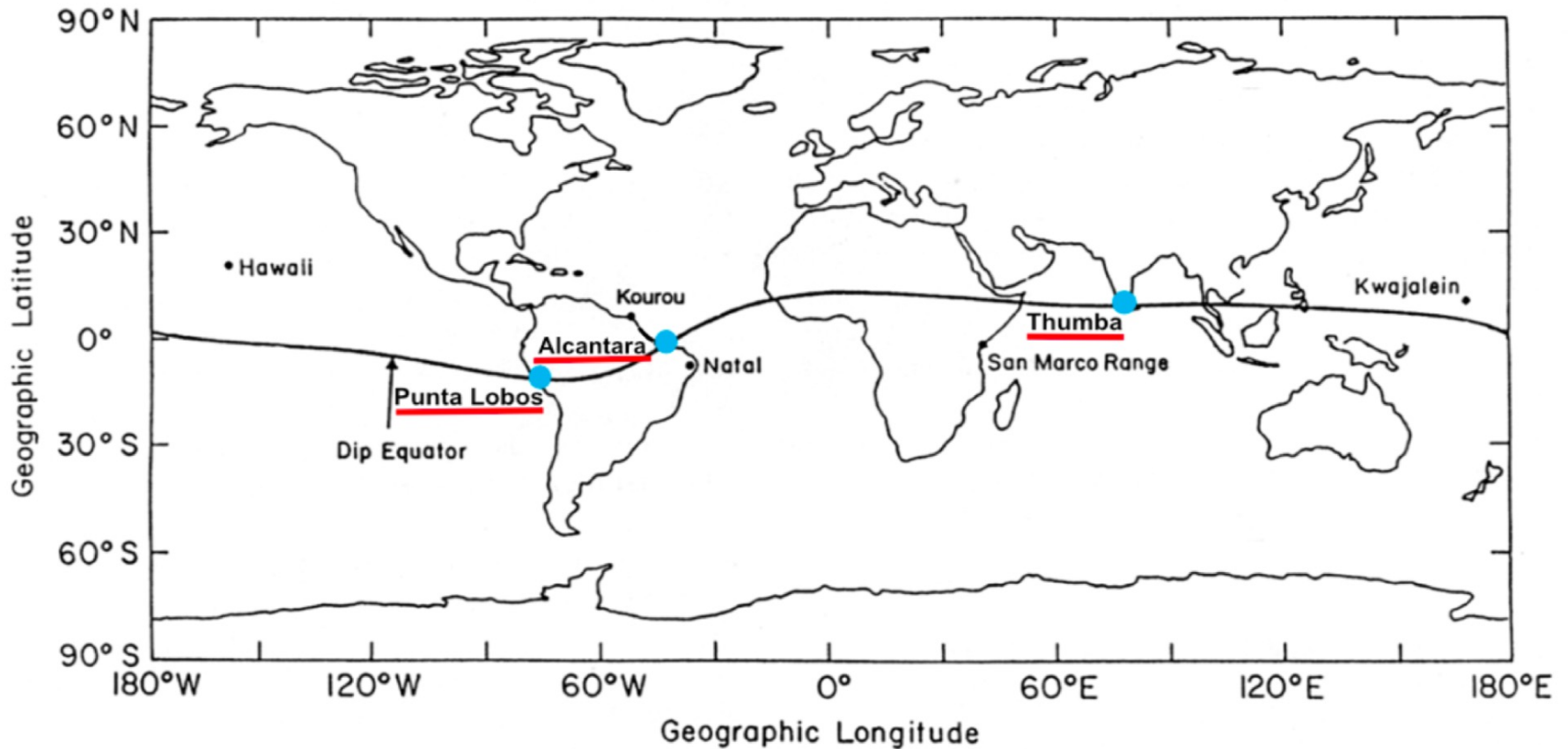
- White paper was received “very favorably” at NASA HQ in 2018
- Although NASA HQ (Dan Moses) directed the Sounding Rocket Program Office at Wallops to investigate a Peru campaign, studying what is needed, carry out a site visit, etc., it is currently “up in the air”
- NASA International Office is still extremely busy with Australia campaign which has slipped to summer, 2021.
- NASA International Office considers the Peru campaign a major undertaking and will not start working on Peru until Australia campaign and some Norway agreements are further along
- Covid-19 has not helped the situation
- NASA HQ is not sure if proposals will be accepted next year or the following year

# Background Material

From Previous Presentations  
On the Proposed Peru Sounding Rocket Campaign

(At CEDAR and SRWG Meetings in 2018)

## Launch sites at the magnetic “dip” equator



## NASA Sounding Rocket Campaigns at the Geomagnetic Equator

- 1964 India (Thumba) -- 4 rockets
- 1965 USS Croatan (off coast of Peru) -- 10 rockets
- 1970 India (Thumba) -- 6 rockets
- 1972 India (Thumba) -- 2 rockets (w/Germany)
- 1975 Peru (Punta Lobos) -- 19 rockets
- 1983 Peru (Punta Lobos) -- 18 rockets
- 1994 Brazil (Alcantara) -- 13 rockets
- 2024 Peru (Punta Lobos) -- ??

A sounding rocket campaign in Peru in 2024 will mark 30 years since NASA sounding rocket research has been carried out at the magnetic equator and 41 years since rockets have been launched in conjunction with the world-class Jicamarca Observatory in Peru.

## Previous Two NASA Campaigns at the Magnetic Equator

“Condor Campaign” -- 1983, Peru

18 Rockets (+ meteorological rockets)

“Guará Campaign” -- 1994, Brazil

13 Rockets (+ meteorological rockets)

**Each had a strong publication record and many Ph.D. theses**



# Punta Lobos Rocket Range, Peru



Satellite view of Punta Lobos  
rocket range, Peru



Peruvian "Paulet-1" rocket  
launched in 2006

(Additional information on range provided elsewhere)

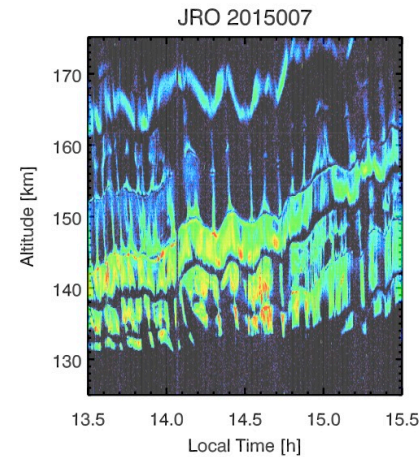
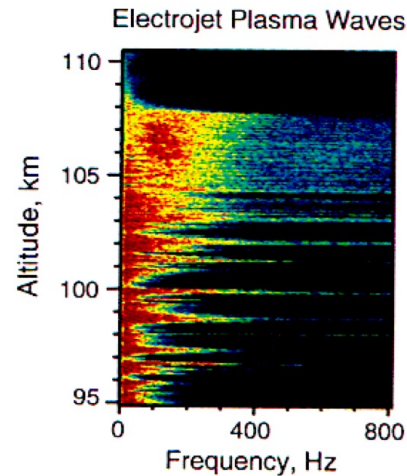


# Why launch sounding rockets from Punta Lobos, Peru?

- Unique, important scientific processes that only occur at the magnetic equator

## Examples:

Equatorial  
Electrojet

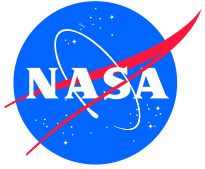


“150 km”  
echoes

- State-of-the-art, world-class NSF-funded incoherent scatter radar

Jicamarca  
Radio Observatory





NASA  
Sounding  
Rockets

## Possible Scientific Investigations

- Equatorial electrojet, particularly nighttime
- Daytime electrodynamics of 150-km valley region
- Equatorial Wind and Temperature Anomaly
- Sunset vortex electrodynamics and winds
- Spread-F electrodynamics, Turbulence
- Bottomside F-region electrodynamics
- Gravity wave “breaking” and electrodynamics
- Mesospheric turbulent processes
- Active experiments

# Jicamarca Radio Observatory



Main 50-MHz Incoherent Scatter Radar is a 290 m by 290 m array of 18,432 half-wave dipoles

Peak transmitter power greater than 1 MW

## **Lower power radars**

JULIA system - main array with low power transmitters

Yagi antenna array - large off-vertical pointing angle (approx. 45 degrees)

SOUSY - 600 kW peak power array, 15 degree off-vertical pointing

## **Additional Ground Science Instruments**

Fabry-Perot Interferometer - located at Arequipa

VIPIR, Digisonde, magnetometers at Jicamarca site

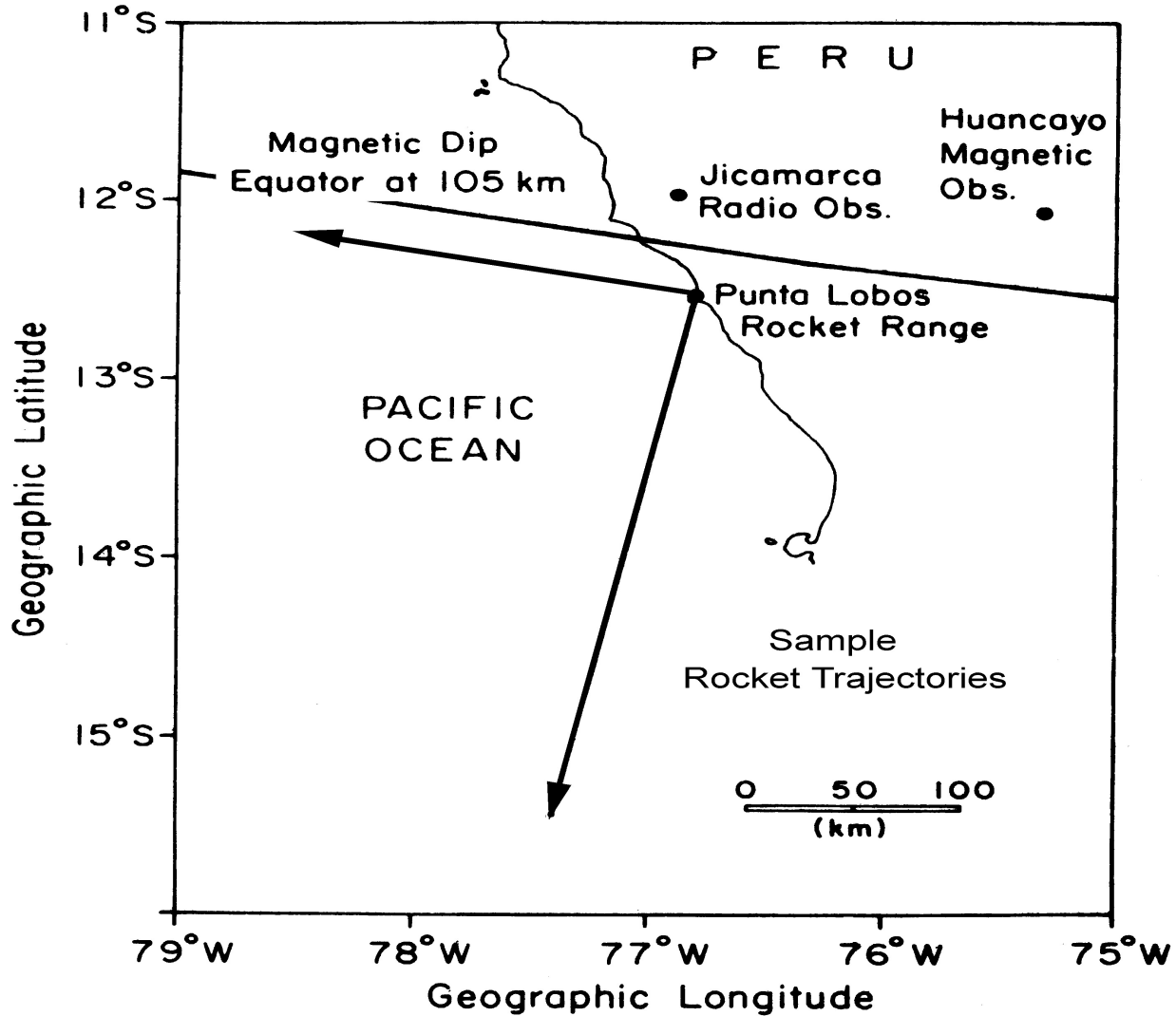
## Punta Lobos Launch Range, Peru

- Located ~30 mi. south of Lima
- Launch coordinates: 12.5 S 76.8 W
- Located on magnetic dip equator
- Site used for NASA campaigns in 1975 (Antarqui) and 1983 (Condor)
- Originally built for DoD “EQUINON” launch in 1971 w/UTD, Aerospace Corp.
- Peru uses range for internal rockets and research



Peruvian “Paulet-1”  
rocket launched in 2006

# Allowable Rocket Azimuths, Location of Jicamarca





**CNOIS (National Center of Operations of Satellite Images)  
is located near the Punta Lobos rocket range**



# Summary

- A rocket/radar campaign from Peru enables NASA/NSF researchers to explore space physics problems found **only at the magnetic equator**
- Science topics address **critical unknown processes in geospace** that exist only at the magnetic equator and which are particularly well-suited to be addressed by a dedicated sounding rocket/radar campaign.
- Rocket Campaign in Peru will be carried out with unique, preeminent scientific research in conjunction with the unique, **world-renowned NSF Jicamarca radar**
- **Existing rocket range at Punta Lobos** at the magnetic equator **provides the critical geophysical location required to carry out the scientific investigations**
- Punta Lobos has been used for **two major NASA rocket campaigns** (Antarqui, 1975; Condor, 1983) and easily accommodates standard NASA sounding rockets
- **Advances in instrumentation** with scientific instruments and payloads **promise significant scientific discoveries** since previous campaigns
- **Peruvian scientists**, primarily at the Jicamarca radar, **welcome the campaign** and would be fully engaged in the rocket/radar investigations
- **Could include Astrophysics missions** that seek to observe **southern hemisphere** celestial targets, with high altitude rockets (no recovery)