# IMPROVING THE LOWER AND MIDDLE ATMOSPHERIC OBSERVATION CAPABILITIES OF THE ARECIBO RADAR SYSTEM

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## Introduction

The Arecibo radar system is not your typical wind profiler. It has unique strengths and weaknesses. To list the weaknesses first, it cannot be used to:

(1) observe continuously year-round, due to competition for time with astronomers;

(2) observe below $\sim$ 5 km, due to ground clutter, transmitter limitations, and limited steering (for the bistatic system); and

(3) obtain high time-resolution 3-D winds, due to slow steering of the single beam.

To list some of the unique strengths, it can be used to:

(1) make measurements in three distinct frequency regimes: VHF (46.8 MHz), UHF (430 MHz), and S-band (2380 MHz) (more, in fact, if one counts the lidar system);

(2) take simultaneous, co-linear data with the VHF and UHF systems;

(3) make ultra-fine range resolution (20-m) measurements in the stratosphere; and

(4) make observations which require a narrow (300-m) radar beam throughout the troposphere and stratosphere.

In the future we would like to eliminate the major weaknesses while enhancing the unique capabilities. There is nothing to be done about item (1) on the weaknesses list unless all astronomers are mysteriously eliminated; however, we have plans and proposals which should take care of problems (2) and (3).

## Planned Improvements

Currently, the Arecibo Observatory is undergoing a $20-million upgrade. Items in the upgrade which will improve observational capabilities for the MST mode are:

(1) a ground screen around the perimeter of the 300-m dish which helps increase the sensitivity at large zenith angles (completed August, 1993);

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(2) the addition of an independent beam at 430 MHz which will enable high time-resolution measurement of horizontal winds;

(3) power upgrade of the 2380-MHz transmitter to 1 MW, CW;

(4) near-field focusing capability for the new 430-MHz beam, enabling gain enhancement at selected heights; and

(5) moving the Los Caños 30-m dish onto site.

Item (5) is especially important since it will extend the uniquely high-resolution capabilities of the bistatic FM-CW S-band system down to the lower troposphere ($\sim$ 2 km) and expand the simultaneous altitude coverage in the stratosphere from $\sim$ 600 m to $\sim$ 10 km (Fig. 1). Previously the minimum observation height with this system was 16 km due to the limited steering capability of both dishes. In other words, relocating the 30-m dish will help alleviate weakness (2). Also, with the upgraded power of 1 MW, CW, it may well become the most powerful cloud and precipitation radar in the world. We should also note that this bistatic system has a dual polarization capability and can be operated at 430 MHz.

## Proposed Improvements

There are several good ideas that are still looking for funding:

(1) A spatial-domain interferometer for the 430-MHz system. Originally proposed by Bob Palmer (U. Nebraska), Miguel Larsen, and Carl Ulbrich (Clemson U.), this would essentially be a "parasitic" add-on to the main radar consisting of three spaced antennas, receivers, and a data acquisition system. It would shore up weakness (2) and (3) by lowering the minimum observation height to $\sim$ 2 km and allowing the measurement of 3-D wind vectors with high time resolution. Furthermore, it would be able to detect scatterers within the angular resolution of the main radar beam.

(2) Additional beams for the 46.8-MHz system. Proposed by John Mathews (Penn. St. U.), this would also solve weakness (3) by enabling the measurement of 3-D winds. Also, a transmitter power upgrade to the megawatt range would allow the observation of the atmosphere throughout the entire MST range, including the "gap" region in the upper stratosphere and lower mesosphere.

(3) Purchasing a UHF boundary layer radar. A boundary layer radar would directly take care of weakness (2) and add to the uniqueness of Arecibo (availability of 4 radar frequency bands).

## Other Systems

The Arecibo Observatory also owns a 1.95-MHz spaced antenna radar located in Ramey, in the northwest corner of Puerto Rico. It is currently operated by the University of Puerto

Rico-Mayagüez and is used for wind measurements in the mesosphere. More extensive data comparisons with the main radar system is planned in the future.

Another independent source of wind measurements is our Nd:YAG Rayleigh lidar. Currently its daytime capabilities are being developed. The goal is to be able to make wind measurements in the "gap" region of the present radar system.

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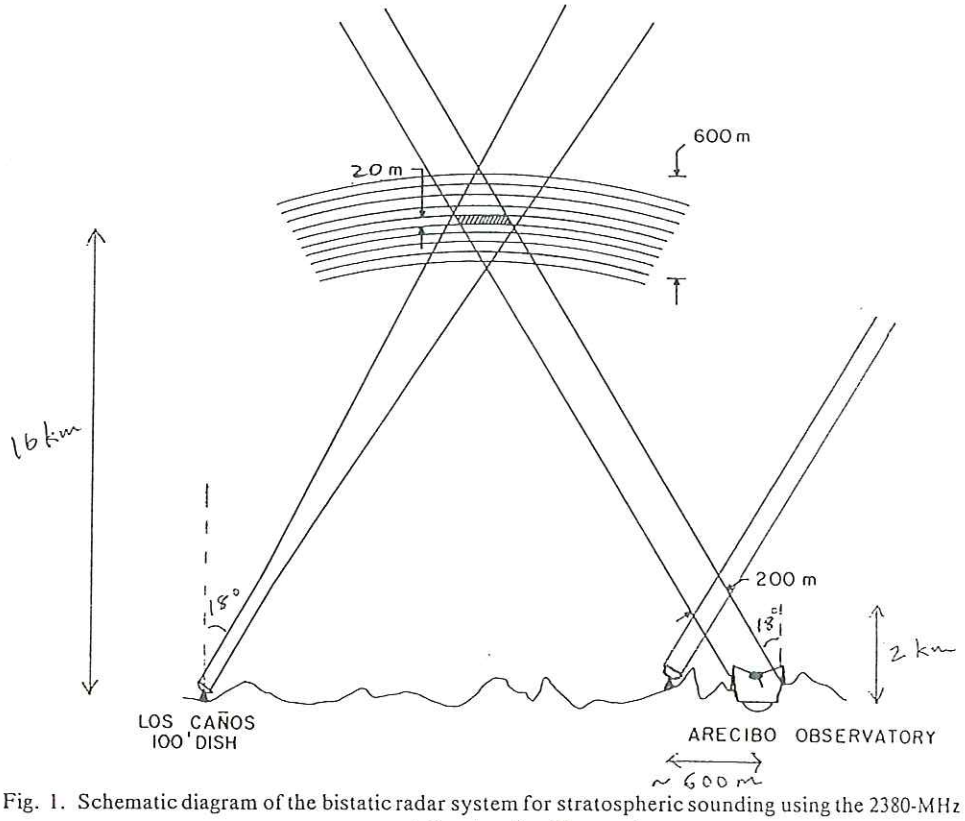


Fig. 1. Schematic diagram of the bistatic radar system for stratospheric sounding using the 2380-MHz at the Arecibo Observatory.