A 35 GHz Mobile Doppler Radar and a Microwave Disdrometer Network for Meteorological Research

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MILLIMETER-WAVE DOPPLER RADAR

A mobile pulse Doppler radar system with dual polarization receive capability assembled at ISAC-CNR is described. To increase system sensitivity, separate antennas are used for the transmitter and receiver. All the transmitter waveguides are pressurized at 40 psi to prevent electrical arcs and breakdowns in the waveguide system.

The Magneton Transmitter pulse width is 250 ns with a duty cycle of 0.0005. The output of this transmitter can be coupled through a directional coupler to a receiver operating at 125.5 MHz. It is digitally controlled via a B13-232 bus and will accept several frequencies. The receiver has a high Q preamplifier with a low noise performance. The antenna is a 120 cm in diameter, case-grown parabolic reflector. The feed system uses scalar control horns and a hyperbolic sub-reflector. In the scalar horn, the direct radiation from the feed horn is reduced by introducing corrugations in the horn walls to increase the surface roughness and reduce the edge diffraction in the E-plane. The resulting horn radiation pattern has very low side-lobes (about 30 - 50 dB down from the peak of the main lobe) and the main lobe is about the same in the E and H planes. The use of a scalar horn instead of a conventional radiation-limited horn with a parabolic reflector allows polarization-diversity capability and it also yields higher aperture efficiencies, lower side-lobes and improved overall system noise temperatures. The overall antenna gain is about 50 dBi and the 3 dB beamwidth is about 0.5 degrees.

The transmitter polarization is fixed linear and the receiver antenna has an elliptical cross-section (EMS) that can be manually set to receive either both linear or circular polarizations. The radar, including all the transmitter and receiver components, is controlled from within the mobile unit. The documented use of the 35 GHz band is for precipitation detection and analysis. The system is highly adaptable for radar meteorological applications.

The radar is bistatic and uses two separate antennas for the transmitter and the receiver. The use of two separate antennas improves the radar receiver sensitivity by about 3-4 dB since this is the insertion loss of commercially available transmit-receive (TB) switches. There is an additional problem with the maximum peak power handling of this TB switch which is typically limited to 100 kW. The tube used in our transmitter is a LITTON L-4524 coaxial magnetron which has a peak power output of 146 kW with a pulse width of 250 ns. The transmitter is protected and a microwave processor checks all the parameters sequentially to make sure they are in the specified range and shuts the transmitter down if they are out of range. To increase the transmitter tube life, the transmitter Duty Cycle was limited to about 1/2000. In summary, the use of two separate antennas has improved the radar sensitivity by about 5 to 6 dB.

TECHNICAL DESCRIPTION

A configuration file in the computer controlling the radar allows the operator to set up and optimize scan parameters before a scanning sequence is initiated or while the radar is waiting and data are being collected. The using of the TITAN program allows, in addition to the meteorological parameters output, the optimization of clutter mitigation by computation of a clutter map from 30 to 40 volume scans of clear air regions when no reflector is present. The program will compute the median reflectivity for these clear air scans and store the data as a clutter map. The TITAN program will also help mitigating Antennal Propagation (AP) effects by looking at the gradients of vertical reflectivity between consecutive tilts of the radar beam.

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CALIBRATION PROCEDURE

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A mobile Ka band radar with advanced specifications is described. In addition to the advances in cloud microphysical characteristics determination, that we expect from this category of radars when operated alone, when in combination with microwave disdrometers we expect it will complement what a C band radar already exists with a similar network. Moreover satellite estimation methods for rain fall intensity can be improved.

The combination of Ka band radar and microwave disdrometers, individual or in network, is a promising addition also to the supertypes which are established for ground truth of spaceborne W band radars.

CONCLUSIONS

A network of Phidas microwave disdrometers under the mobile Ka Band radar described in this poster will be deployed. In this case the expected improvements concern the light precipitation characterization (drizzle, very light rain, etc.) due to the strong attenuation of the Ka band beam. This case the combination of Ka band radar data with surface microwave disdrometers network will allow us to fill the gap from the lowest useful elevation of the radar and the surface data from the disdrometers. This configuration may lead to a cloud physics complement using the complementary output of the Phidas radar and disdrometers obtained from it.