South Asian Meteorological Association (SAMA)
and
Advanced Center for Atmospheric Radar Research (ACARR)
Cochin University of Science and Technology (CUSAT), India

Jointly Organize
Weekly Online Lecture Series on

Radar Meteorology

With Special Focus on

"Principles & Applications of Doppler Weather Radar in Weather Forecasting & Research"

South Asian Meteorological Association (SAMA) is a professional non-profit international scientific society having HQ in India for the promotion of Meteorological and allied sciences and their application for the safety, well-being, and sustainable development of the citizens of the South Asian countries. Established on 3rd August 2020, it has more than 600 members from nine countries (Afghanistan, Bangladesh, Bhutan, India, Myanmar, Maldives, Nepal, Pakistan, and Sri Lanka), which is increasing day by day. SAMA has conducted more than 65 activities including 3 online training lecture series for 16-20 weeks each in Atmospheric Physics, Weather Research & Forecasting (WRF) modelling and Satellite Meteorology. About 2000 people from 60 countries across the world have attended the lecture series.

Cochin University of Science and Technology (CUSAT) was initially constituted as the University of Cochin through an Act of Kerala Government on 10th July 1971. The University of Cochin was re-constituted as Cochin University of Science and Technology (CUSAT) in February 1986, redefining its objectives as "promoting Graduate and Post-Graduate studies and Advanced Research in Applied Sciences, Technology, Industry, Commerce, Management and Social Sciences." CUSAT is now a world-ranking university that aims to develop higher education, emphasizing post-graduate studies and research in applied science, technology, industry, humanities, and commerce. CUSAT has consecutively been featured in the Times Higher Education World Ranking since 2017. The Times ranks around 1500 best universities worldwide annually with around 60 universities from India out of 967. CUSAT has also found a place in the QS World University Ranking and the National Institutional Ranking Framework (NIRF) of the India Government. Cast in the mould of a federal University, CUSAT is now a premier Science and Technology University in the country, re-accredited with NAAC 'A+' Grade in 3rd cycle.

Advanced Centre for Atmospheric Radar Research (ACARR) is a multidisciplinary research centre established by the Cochin University of Science and Technology (CUSAT). A state-of-the-art indigenously developed Stratosphere Troposphere (ST) wind profiler radar operating at 205 MHz frequency (which is the first wind profiler radar in the 200 MHz frequency range) is successfully functioning at CUSAT from (December 2016) onward. This versatile wind profiler radar provides high-resolution wind information from 315 m to 20 km in all weather conditions facilitating a better understanding of the dynamics and physics of the atmosphere and the weather systems. A variety of data are now available to support cutting-edge research in the field of atmospheric observations and modelling by using ST radar along with additional observational facilities installed at ACARR . In addition to the wind profiling Radar, the Radar Centre hosts a myriad of complementary remote sensing observations such as Radiosonde (for deriving atmospheric state variable profiles), Microwave Radiometer (temperature and water vapour measurement), Disdrometer (raindrop size distribution), Ceilometer (cloud height and macro-physical properties), Microrain radar (fall velocity of hydrometeors, bright band and radar reflectivity), Automatic Weather Stations (monitoring of surface weather parameter including soil temperature and heat fluxes), Pyranometer (solar radiation intensity), Athelometer, Optical and Aerodynamic Particle Sizer, SMPS etc. Compiled together, these advanced facilities are expected to cater to the needs of the advanced research in the field of atmospheric remote sensing and climate sciences.

About the Course:

This course will provide an introduction to radar systems, encompassing both theoretical and practical aspects. The objective of this course is to cultivate an extensive understanding of radar components, radar system design, and radar signal analysis. By applying these principles to specific applications in radar remote sensing within the fields of meteorology and weather forecasting, participants will enhance their quantitative insights. The field of radars encompasses a vast array of subjects, and this course will encompass a diverse variety of topics. The course is designed for individuals who possess a strong foundation in meteorology, physics, mathematics, as well as a comprehensive understanding of electromagnetic (E&M) waves, E&M propagation, digital signal processing, and signal analysis. It is open to graduate students, postgraduate students, and working professionals.

Radar has countless uses, including detecting meteorological objects and estimating their properties, movement, temperature, rate and type of precipitation, ionospheric plasma, surface conditions, and many more. Radar data have exciting potential for improving forecasts from numerical weather prediction (NWP) models by assimilation of Radar observations. With a focus on radar applications in weather analysis and forecasting, this course aims to give students a solid grounding in the operation, components, and remote sensing capabilities of radar systems as they pertain to meteorology.

Given the significance of radar meteorology, SAMA and ACARR-CUSAT are collaborating to host a weekly online lecture series on the subject every Saturday from April 27 to September 30, 2024, featuring specialists in the field. Senior Scientists, Professors, and other specialists from reputable institutions in this region will be giving lectures. Additionally, there will be some practical instruction (hands-on training). The intended audience for the lecture modules includes professionals, postgraduate students and research scholars, as well as curious non-meteorological individuals.

The three interrelated modules of theory, analysis, and synthesis will be used in this course to introduce radar systems. The theoretical component will encompass lectures that delve into the mathematical underpinnings and fundamental principles of radar systems. The aforementioned viewpoint pertains to the distribution and learning of essential radar knowledge required for a professional to comprehend the functioning of radar systems. The analysis portion will involve the processing and interpretation of actual radar observations obtained from stations located on the ground, in the air, and in space. This perspective utilizes theoretical knowledge to address practical atmospheric science challenges through the application of radar remote sensing techniques. The main component of this course will involve detailed discussion on the utilization of atmospheric radars for the purposes of weather research, analysis, and forecasting.

Upon completion of this course, participants will possess an in-depth understanding of the functioning of a radar system and its use in remote sensing within the field of meteorology. This course does not specifically address the construction of radars. Instead, it aims to educate participants on the utilization of radar systems for weather observation and the extraction of valuable information from these systems for the purpose of weather analysis and forecasting.

Syllabus:

Module 1:

Fundamentals of Radar Remote sensing:

Radar basics; pulsed radar; target ranging; range ambiguity; pulse-to-pulse motion; signal, noise and losses; target detection; receiver components and processing; Doppler radar; Doppler velocity ambiguity, EM propagation, radar antennas & Scattering Processes: Radiation and propagation of radio waves, radar antennas, directivity, gain, antenna patterns; aperture antennas; phased array antennas. Radar equation for point and distributed targets, derivation and application for point targets; Radar power equation for area targets; Radar power equation for volume targets; radar power losses; radio and receiver noise, Radar cross-section, Scattering processes.

Module 2:

Radar Signal Processing and Value-added Products:

Transmitter/signal generating characteristics; pulsed waveforms; continuous waveforms; pulse modulation and compression; complex signals; digital filtering; Doppler spectrum characteristics. I&Q,

moments of the power spectrum, ground clutter, attenuation, Radar Remote Sensing Applications in Meteorology, meteorological radars, incoherent scatter radar, synthetic aperture (SAR) radar, rainfall estimates using radar reflectivity and dual polarization radars, ground and satellite based precipitation radars, AI-ML techniques in radar signal processing.

Module 3:

Radars for Weather analysis, Forecasting and research:

Single- and dual-Doppler interpretation and analysis, polarimetric theory and applications, kinematics of convective storms (multi-cell, supercell, mesoscale convective systems, hurricanes, lightning) and their radar signatures, radar mozaiking, radar nowcasting, radar data assimilation, radar application in impact based forecasting.

Advisory Panel and Organizing Committee of the Lecture Series

S.N.	Advisory Panel	S.N.	Organizing Committee
1	Dr. Devendra Pradhan – Chairman Former ADGM, IMD	1	Dr. S. Abhilash – Coordinator Director, ACARR/ CUSAT, Host Institute
2	Dr. S. Abhilash – Coordinator Director, ACARR/ CUSAT, Host Institute	2	Dr. Sreekala P P, Member ACARR, CUSAT
3	Dr. T. Narayan Rao - Member Scientist/ Eng. – SG, NARL	3	Mr. Rakesh V, Member ACARR, CUSAT
4	Dr. G. Pandithurai – Member Scientist-G & Project Director	4	Dr. Swagata Payra, Member Assoc. Professor, BIT, Mesra & ECT Memb.
5	Dr. M. Rajasekhar – Member Scientist-SF, SHAR, ISRO	5	Dr. T. V. Lakshmi Kumar, Member Assoc. Professor, JNU, Delhi & ECT Memb.
6	Dr. Ashish Routray – Member Scientist-F, NCMRWF	6	Dr. Divya Prakash, Member Asst. Professor, PU, Jaipur & ECT Memb.
7	Dr. Gajendra Kumar – Member Scientist-F, IMD	7	Dr. Rohini Bhawar, Member Asst. Professor, SPPU, Pune & ECT Memb.
8	Dr. Jayanti Pal – Member Asst. Professor, CURAJ	8	Dr. Mili Ghosh nee Lala, Member Asst. Professor, BIT, Mesra & ECT Memb.
9	Mr. Shah Alam – Member Electronic Engineer, BMD, Bangladesh	9	Dr. Mohan Kumar Das, Member Exec. Director, NOAMI, Bangladesh & ECT
10	Dr. Than Naing – Member Asst. Director, DMH, Myanmar	10	Dr. Fatima Akter, Member Assoc. Prof. & Chair, DU, Bangladesh & ECT
11	Mr. Govind Jha – Member Asst. Meteorologist, DHM, Nepal	11	Dr. Madan Sigdel, Member Asst. Professor, TU, Nepal & ECT Member
		12	Dr. Poulomi Chakravarty, Member DST INSPIRE Fellow & ECT Member