INTRODUCTION

I have great pleasure in presenting the Annual Report of the CSIR Centre for Mathematical Modelling and Computer Simulation (C-MMACS) for the year 1996-97. The report summarises its scientific achievements in the areas of climate and environmental modelling, geological modelling, industrial computational mechanics and dynamical systems. It also includes the current status of personnel and the computing environment, as well as lists of publications, lectures and visitors.

The R&D activities of the Centre are guided by a Research Advisory Committee chaired by the Director General of Council of Scientific and Industrial Research.

One of the long standing interests of the Centre has been in the area of climate modelling and prediction which requires an understanding of the coupled physical, chemical and biological aspects of the interactive atmosphere-ocean-lithosphere system. The concept of convective time lag which was introduced earlier has been further explored using a versatile in-house numerical model for tropical zone, and means and variances of the climate variabilities have been quantified. This has led to a satisfactory explanation of the structure and periodicities of interseasonal, intraseasonal and other oscillatory patterns in the observed fields in the Indian region. A cognitive network technique developed earlier has been used to forecast annual rainfall during this year's summer monsoon. Simulation studies of circulation in the Indian ocean using the Modular Ocean Model (MOM) have been further advanced. The sea surface height structure has been derived and these results compare reasonably well with the Topex/Poseidon altimeter data. The marine ecosystem model has been tuned with the Arabian sea JGOFS observations of marine productivity and thermal structure. These results are embedded in the MOM code system and numerical simulations of the coupled physical biological processes in the Indian Ocean have been carried out.

Another important area of interest of the Centre has been the quantification of geological hazards using GPS geodetic techniques and genesis and exploitation of natural resources. The repeat GPS observations of the southern Indian peninsula have further constrained its deformation and signatures of buckling/basin formation here have been delineated. Similarly, strain partitioning across the Himalayan convergence zone has also been constrained which would lead to a better understanding of probable earthquake hazards in the Himalayas. The efficiency of bioremediation processes to reduce hydrocarbon pollution of the groundwater occuring in the Assam region has been optimised by combining a coupled physical-chemical model simulations with field experiments.

In the area of industrial computational mechanics, the structure and breakdown of vortex on a delta wing have been simulated and compared with observations using the flow consistent embedded conical grids. Work has also started on defining the constitutive relationships of polymers by simulating the descent of cylindrical (spherical) bodies in inhomogeneous viscous fluids. Finite element analysis of elastic R C C frames and walls have been performed for constructing optimal design scenarios. The basement elastic response of road pavements relevant to Indian conditions have been simulated and compared with observations of Falling Weight Deflection data.

Mechanical strength variations of leather skins have been modelled for better design of shoes and other leather products.

Time series analysis techniques based on nonlinear dynamical system theory such as the Trans-Spectral Coherence have been used to analyse brain, heart and earthquake records to decipher premonitory patterns. Studies of nonlinear systems such as damped driven Toda lattice system and feedback pathways in cellular biochemical system have been carried out to develop insights about how nonlinearity manifests in physico-chemical systems.

The Local Area Network (LAN) at the Centre has been further expanded and several versatile softwares have been added. The total utilisation figure of the CONVEX supercomputer has crossed over 35,000 CPU hours during this year.

I would take this opportunity to thank Dr. R.A. Mashelkar, DGCSIR and Chairman of our Advisory Committee and its other members for providing guidance and support to the activities of the Centre. Dr. K.N. Raju, Director (Retd.) and Dr. T.S. Prahlad, Director, National Aerospace Laboratories have been most generous in providing guidance and intrastructural support to the Centre. I also thank Dr. A. Muthunayagam, Secretary, Department of Ocean Development and Prof. V.S. Ramamurthy, Secretary, Department of Science and Technology for extending support to the Centre's activities. I also take this opportunity to thank Dr. K.S. Yajnik, former Scientist-in-Charge of C-MMACS for giving me generous advice whenever I approached him.

I thank all the staff of C-MMACS for contributing in various ways to the preparation of this report. Special thanks are due to the secretarial and administrative staff of C-MMACS for organising this report and its publication.

R N Singh
Scientist-in-Charge