Foreword: Global Environment and ICT (Information and Communications Technology)

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1 The safety and security of society — Approaching global environmental issues with info-communications technologies

The Ministry of Internal Affairs and Communications (MIC) and the National Institute of Information and Communications Technology (NICT) presently bear the bulk of R&D efforts in information and communications technology (ICT) in the public sector. Measurement technology using electromagnetic waves forms one of the major focuses of the R&D of ICT carried out by NICT, and this technology has proven significantly effective in the input of real-world information into ICT systems. It is widely assumed that among the challenges facing advanced ICT systems in the future, one of the most important issues will be to integrate the network virtual space (i.e., "cyberspace") with the real world. In such an age, technologies designed to protect the safety and security of society must not only ensure safe info-communications networks in cyberspace, but must also be aimed at ensuring safety and security in the overall ICT environment in which people acquire, process, and use information.

Although many factors threaten the safety and security of society, the most basic and fundamental issue we face is the problem of global environmental change, since such changes on a global scale are expected to have a serious impact on society, property, and human life. What's more, such changes will affect not only human society, but in fact may have an impact on the safety and security of all life on earth. Thus this issue is one of the most pressing political and economic topics of our time. Any approach to this serious matter using ICT will likely first of all require solutions enabling access to actual environmental data, followed by feedback of this data to the real world.

One way that ICT approaches the real world is through "sensor network" technology, an attempt to create powerful tools by directly connecting relatively simple and small sensor devices to a communication network. In a similar vein, "remote sensing" technologies have produced significant results using measurement systems consisting of single or several sensors, although these applications have been limited (e.g., to national land monitoring, meteorological applications, flood disasters, and global environmental monitoring, among others). It is hoped that the full exploitation of information collected by the "small sensors" for "sensor network" systems, along with information collected by the "large sensors" for remote sensing, which generate valuable information (albeit at high cost), will enhance the value of information overall and make society safer and more secure. To accomplish this goal, we must develop a range of ICT sensing technologies — including information-acquisition technologies that will make use of all available sensors, small and large alike — with the needed complementary func-

tions, and that we then combine these sensing methods with information-distribution technologies and technologies for the processing and management of environmental database information.

2 The present issue: Sensing of the middle and upper atmospheric environments

NICT has received high acclaim from the international research community for its achievements in radio science and in practical applications involving electromagnetic wave propagation in space, particularly its remote-sensing technologies aimed at acquiring information from targets. These technologies can be aimed at targets in the global environment, an essential focus that will help ensure greater safety and security for all. The present issue will present the results of R&D projects on observation technologies for the middle and upper atmosphere (i.e., an altitude range of approximately ten to several hundred kilometers), as part of our R&D efforts into these basic technologies. The present report generally describes our achievements from the perspective of a wide range of technology developments, and thus includes overviews on the know-how involved in system use, as well as results of validation experiments on the application of our systems in the earth sciences, examining the effectiveness of the device, component, and system/system design technologies developed under the auspices of the present projects.

The middle and upper atmospheric regions are located very far from the ground, and the air is extremely thin compared to conditions on ground. However, although thinly distributed, the atmospheric components in these regions protect the global environment and living organisms from the hazardous conditions of outer space, and so these regions play important roles in maintaining the delicate balance of the Earth. Accordingly, the results of studies on these regions will have a significant effect on our approach to the global environment and to the anticipated global changes which humans must survive in the future. However, substantial uncertainties still remain regarding electromagnetic-wave propagation and scattering characteristics in the middle and upper atmospheric regions due to the distance of these regions from the ground as well as from the unresolved properties of these areas. Further, the atmosphere and its components (the targets of measurement) are extremely thin in these regions, rendering them difficult to observe. These regions may thus be regarded as testbeds for the use of electromagnetic wave technologies, especially for those focused on measuring distant targets using electromagnetic waves.

The present issue compiles reports on two remote-sensing projects. The first is called the "Alaska Project", which consists of development and validation programs for atmospheric environment measurement technologies. The other is the "SMILES" (Submillimeter-Wave Limb-Emission Sounder) project and results of associated research, which we are fortunate to have seen emerge in Japan. The value and importance of both projects are appreciated in the international community, and NICT has good reason to be proud of its advanced technologies and research capability. However, both have now completed their respective first stages or are otherwise facing turning points for various reasons. We have attempted to compile the achievements of these projects at this point, in the belief that they will in any case set the benchmark for future research activities in these fields.

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Remote Sensing of Atmosphere, Middle Atmosphere Dynamics