

Preface

The new Springer book *Global Satellite Meteorological Observation (GSMO) Theory: Volume 1* presents in its introduction the development of radio and satellite communications including the history of satellite meteorological observation. The book includes major aspects of the space segment with satellite platforms and orbital mechanics, baseband signals and types of transmission systems, atmospheric electromagnetic radiation and radiative transfer, satellite meteorological parameters, main satellite meteorological instruments, and antenna systems with propagation.

Moreover, in *Global Satellite Meteorological Observation (GSMO) Applications: Volume 2*, topics about satellite meteorological networks, satellite imagery interpretation, satellite weather remote sensing, satellite meteorological applications, ground segments, user segments, and integrations in space meteorology will be introduced.

Today satellite meteorological instruments present as the “eyes from space,” which can “see” the Earth and its atmosphere with all weather phenomena and, from a global perspective, can send all necessary observations, data, and images via satellite onboard transponders to the ground Earth stations (GES) or readout stations for processing facilities. On the other hand, it is very important to realize the idea and possibility for the integration of a meteorological satellite service, such as geostationary Earth orbit (GEO), polar Earth orbit (PEO), and new high elliptical orbit (HEO) satellite systems, together with other space meteorological facilities, under one worldwide observation umbrella.

For basic and principal technical information, the author of this book has drawn heavily mostly on the following sources:

- Kidder S. Q. and Ham T. C., “Satellite Meteorology – An Introduction,” Academic Press, San Diego, CA, USA, 1995.
- Tan S. Y., “Meteorological Satellite Systems,” Springer, New York, 2014.
- Menzel P., “Remote Sensing with Meteorological Satellites,” University of Wisconsin Academic Press, Madison, WI, USA, 2012.

- Kelkar R. R., “Satellite Meteorology,” BS Publications, Hyderabad, India, 2007.
- Sportisse B., “Fundamentals in Air Pollution – From Processes to Modelling,” Springer, Dordrecht, Netherlands 2008.
- Liu G., “Satellite Meteorology,” Florida State University, Florida, 2005.
- Ilcev D. S., “Global Mobile Satellite Communications for Maritime, Land and Aeronautical Applications – Theory Volume 1,” Springer, Boston, 2016.
- Ilcev D. S., “Satellite Meteorological Observation System,” Manual, DUT, 2015.
- Ilcev D. S., “Global Aeronautical Communication, Navigation and Surveillance,” Theory Volume 1 and Applications Volume 2, AIAA, Reston, 2013.
- Ilcev D. S., “Space Meteorology,” Manual, SSC, DUT, 2017.
- NOAA/NESDIS, “User’s Guide for Building and Operating Environmental Satellite Receiving Stations,” Suitland, MD, USA, 2009.
- Eumetsat, “The Meteosat System – Satellite Ground Segment Mission and Global Coordination,” Darmstadt, Germany, 2000.
- Roscosmos/Russian Space Agency, “Status of Current and Future Russian Satellite Systems,” Roshydromet, Moscow, 2010.
- Group of Authors, “Radiowave Propagation Information for Predictions for Earth-to-Space Path Communications,” edited by C. Wilson and D. Rogers, ITU, Geneva.

Readers will find that this book has been written using up-to-date systems, techniques, and technology in satellite meteorological observation. The material has been systematized in such a way to cover developments in satellite meteorology space and ground segments, transmission systems, electromagnetic radiation in the atmosphere, radiative transfer, satellite meteorological parameters and instruments, antenna systems with practical solutions, and radio wave propagation.

The two volumes of this book were written in order to form a bridge between potential readers and current global satellite meteorological observation (GSMO) trends, system concepts, and transmission network architecture by using a very simple style with easily comprehensible technical information, characteristics, graph icons, figures, illustrations, and mathematical equations. The special approach in the two volumes of the GSMO books is the introduction of a complete space and ground segment with all significant segments introducing modern meteorological imaging systems on board satellites, transmission systems, and ground readout and processing facilities.

Volume 1 of this new book, nominated as “Theory,” consists of seven chapters on the following particular subjects:

Chapter 1, “Introduction,” depicts a background to the development of space systems and concepts of satellite communications in the function of transfer meteorological observation data and images. The special retrospective presents the evolution of space meteorological observations, history of early radio, evolution of satellite mobile and fixed communication systems, definition of VSAT broadcasting, international coordination organizations and regulatory procedures, space

systems and radio communication frequency assignment, and history of satellite meteorology.

Chapter 2, “Space Segment,” discusses the fundamental principles and theories of space platforms and orbital mechanics, laws of satellite motion, satellite parameters, new types of launching systems and station-keeping techniques, satellite orbits and geometric relations, spacecraft configuration, payload structure, types of orbits for meteorological and other satellite systems, meteorological satellite payloads on board satellite antenna systems, and components of a satellite bus.

Chapter 3, “Baseband and Transmission Systems,” gives an essential basic knowledge of baseband signals and processing techniques, analog and digital transmissions, modulation and demodulation, channel coding and decoding, error corrections, multiple access techniques, fixed and mobile DVB-RCS standards, MPEG multimedia standards, satellite audio and video broadcasting, direct-to-home and other satellite digital broadcast systems, transmission standards, and new DVB-S2/S3 architectures.

Chapter 4, “Atmospheric Electromagnetic Radiation,” presents all the fundamentals of atmospheric radiative transfer, energy emissions, radiative properties of matter, Earth’s atmosphere applications and radiative transfer equation (RTE) with prime of radiations for infrared and visible imaging, radiative budget for the Earth atmosphere system, solar constant and emission effective temperature, and energy budget for the Earth or atmosphere systems.

Chapter 5, “Satellite Meteorological Parameters,” explains very important satellite activities; such as, satellite weather observation, satellite meteorological instruments for observation and monitoring, parameters for temperature and trace gases, wind flow, clouds and aerosols, precipitation measuring technique, Earth radiation budget, measurements and monitoring of other Earth observation parameters with special review of hydrological analysis, sea waves and ocean dynamics, sea surface temperatures, pollution and ecosystem, cryosphere detection, agricultural and forestry, global land cover mapping, and desertification monitoring.

Chapter 6, “Satellite Meteorological Instruments,” introduces all weather instruments on board PEO satellite meteorological systems from space; such as, the US POES and European spacecraft. All types of meteorological instruments on board GEO satellites; such as, the US GOES, European Meteosat, Russian Electro, Chinese Fengyun, Indian INSAT, and Japanese GMS satellites are also discussed here.

Chapter 7, “Antenna Systems and Propagation,” includes research and introduction of current and new proposed prototypes of antenna solutions for satellite and other radio meteorological communications and broadcasting fixed, semi-fixed, and mobile systems: such as, low-gain omnidirectional antennas, medium-gain directional antennas, and high-gain directional aperture antennas. Moreover, this chapter introduces ground antennas for particular satellite meteorological systems: such as, directional antennas for PEO direct readout stations (DRS), multidirectional antennas for PEO DRS, directional antennas for GEO DRS, meteocast DVB-RCS GES antennas for GEO DRS, user shipborne antennas, and user vehicleborne antennas. This chapter also comprises all particulars about propagation effects significant for

satellite transmission requirements in meteorology and weather observation data: such as, propagation fundamentals, refraction, absorption and non-LOS radio propagation, sky wave propagation, atmospheric effects on propagation, sky noise temperature contributions, path depolarization causes, propagation effects important for space communications and broadcasting, and so on.

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The author is the chair of SSC, a research professor, and a supervisor at DUT for research and postgraduate studies. The author has a very important multinational project, the African Satellite Augmentation System (ASAS), for the entire African continent and Middle East and also many other proposals in radio and satellite CNS, digital video broadcasting-return channel via satellite (DVB-RCS), global radio and satellite tracking of mobiles and living beings, satellite SCADA (M2 M), stratospheric platform systems (SPS), and space solar power (SSP); he also had one significant GADSS project developed in 2000. He also would like to express his special appreciation to DUT for the generous contribution as a sponsor of this book.

The Durban University of Technology prides itself on the commitment to academic excellence.

The over 24,000 students who pass through the doors everyday are testament to a growing ethos of learning, research, and community engagement. DUT is a multi-campus university of technology at the cutting edge of higher education, renowned for technological training and academic prowess. The university is characterized by being research-driven with a focus on strategic and applied research that can be translated into professional practice. Furthermore, research output may be commercialized, thus providing a source of income for the institution. In striving to create a new and dynamic ethos, the university builds upon current strengths and celebrates the expertise of its staff. DUT is providing Web pages for its SSC for Research and Postgraduate Studies in Space Science at www.dut.ac.za/space_science – where the full study program, projects for instant developments, and research and supervisor staff are all presented.

The author is also very grateful to the group of authors for the various manuals, brochures, and pamphlets issued by IMO, ICAO, ITU, WMO, ESA, ETSI, ETRI, NOAA, Roscosmos, Roshydromet, China Meteorological Administration (CMA), ISRO, Japan Meteorological Agency (JMA) Sea Launch, Advantech Wireless,

Kongsberg, Dartcom, SeaSpace, Orbit, SCISYS, and other regulatory bodies and operators.

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Stojče Dimov Ilčev

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