Earth, Planets and Space

PREFACE

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Special issue "Recent Advances in MST and EISCAT/Ionospheric Studies – Special Issue of the Joint MST15 and EISCAT18 Meetings, May 2017"

Mamoru Yamamoto[1*], Wayne K. Hocking[2], Satonori Nozawa[3], Juha Vierinen[4], Huixin Liu[5] and Nozomu Nishitani[3]

Introduction

The Fifteenth Workshop on Technical and Scientific Aspects of MST Radar (MST15) and the Eighteenth EISCAT Symposium (EISCAT18) were jointly held in Tokyo, Japan, at the National Institute of Polar Research (NIPR) during May 26–31, 2017. The MST workshops have a long history of being the primary international meetings on the applications and development of mesosphere–stratosphere–troposphere (MST) radars. The MST workshop has been historically focusing on the atmospheric dynamics but is now including topics related to ionospheric applications of radars. The EISCAT Symposium, on the other hand, is the biennial conference for EISCAT-related radar research and science which is hosted by member institutions of the EISCAT Scientific Association.

This joint MST15/EISCAT18 meeting was a timely opportunity for close and extensive interactions of the middle-atmosphere and ionospheric radar scientists in our era of rapid technological changes and computational advances. The joint meeting was successfully attended by 182 participants from 19 countries/areas and hosted 233 presentations. These numbers were the maximum level ever for either conferences.

This special issue gathered 15 papers from this joint meeting, consisting of ten full papers, three frontier/express letters and two technical reports. The flexible publication style of *Earth, Planets and Space* benefitted us to cover easily both scientific and technical aspects of the research field. In the following, we categorize the articles into several groups and review them briefly.

Contents of the special issue

Study of atmospheric turbulence

One of important topics of the MST radars is atmospheric turbulence. In this special issue, there are three papers from the same research group who conducted joint experiment of the atmospheric turbulence by remote sensing with the MU radar and by direct measurement with an unmanned aerial vehicle (UAV) that flew nearby to the radar. Luce et al. (2018a) showed a case study of Kelvin–Helmholtz instability (KHI) at the bottom of clouds. The KHI billow structures were successfully observed by the MU radar while a fish-eye lens camera on the ground captured the same event. The authors suggested that this is the first simultaneous detection of KHI from ground-based camera and a radar. Luce et al. (2018b) is the study of concurrent measurement of atmospheric turbulence by the MU radar and a UAV. The UAV measured turbulence kinetic energy (TKE) dissipation rate (ε_U) by a low-noise Pitot tube, and the MU radar showed turbulence intensity by the spectral width (σ). The paper first confirmed same-volume observation by both techniques, and statistically studied empirical relationship between ε_U and σ. The result is $\varepsilon_U \propto \sigma^3$ that is different from previously expected $\varepsilon_U \propto \sigma^2$ relationship. Kantha et al. (2018) conducted

*Correspondence: yamamoto@rish.kyoto-u.ac.jp
[1] Research Institute for Sustainable Humanosphere (RISH), Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan
Full list of author information is available at the end of the article

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further study of this ε_U and σ relationship based on the same database as Luce et al. (2018b). They discussed the validity of the previous theoretical expression of the ε_U and σ relationship. After pointing out missing considerations in the past theories, they proposed a new numerical model described as a MATLAB code for later practical use by the radar community.

Study of polar mesospheric echoes

There are three papers on the study of polar mesospheric echoes. Rauf et al. (2018) conducted a statistical study of influence of particle precipitation on the polar mesospheric summer echoes (PMSE) with the EISCAT VHF radar. They showed that particle precipitation is not a necessary condition for PMSE to exist. However, particle precipitation still affects PMSE when they both occur simultaneously. Reid et al. (2018a) used PMSE echo data for the measurement of momentum flux and found reasonable results compared to previous studies with meteor radars and medium frequency (MF) radars. Belova et al. (2018) conducted a case study of polar mesospheric winter echoes (PMWE) using the tristatic EISCAT radar. Echo duration of the measured PMWE was only 6 min. Then, they found that the presence of patchy negatively charged small-sized dust might explain the observations.

Introduction of new radar facilities

Development of new radar facilities is important for the research field. There are three papers in this category. Ding et al. (2018) showed a newly developed incoherent scatter (IS) radar in Qujing, China (25.6°N, 103.8°E). This is the first IS radar in China that operates at 500 MHz with 2 MW peak envelope power (PEP). The antenna system is 29-m steerable parabolic dish. System description and some preliminary results are reported. Dolman et al. (2018), on the other hand, reported installation of wind profiling radar network over Australian continent. Australian Government Bureau of Meteorology added five more radars. Then, the network now consists of 19 radars (14 operational radars and 5 radars for research). Wind data are included in major models and contribute to more accurate weather forecast. Another paper by Garbanzo-Salas and Hocking (2019) reported a study on 1-year data from the first VHF wind profiler radar in Costa Rica. The radar frequency is 46.6 MHz, and measures wind profiles in the height range of 1–6 km with height resolution of 100 m. They successfully showed behavior of the planetary boundary layer in the low-latitude region.

Study of radar measurement techniques

The accuracy in wind estimation is a very important technical topic for the radar. There are three papers related to this. Hocking (2018) studied possible error from multistatic meteor radar observations. The network of several meteor radars benefits us to diagnose horizontal wind field over the network. This paper points out possible error from such simultaneous measurement of winds from different locations and proposes software to show the error estimation. Reid et al. (2018b) carried out wind comparisons between meteor radars and MF radars at middle- and high-latitude regions in the southern hemisphere. They showed that the winds from MF radars are underestimated and the problem is enhanced above 80 km. They suggested correction factors to mitigate the problem. Renkwitz et al. (2018) carried out wind comparison study between different wind estimation techniques. The study is based on the Saura MF radar (69.1°N, 16.0°E) that is an MF radar but can conduct the Doppler beam swinging (DBS) wind estimation with narrow beams. They showed that the wind estimation suffers from underestimation and suggested optimum combination of methods for better estimation of winds.

New observations and survey for new experiment

It is important to explore new observation methods in any research fields. There are three papers (one frontier letter and two technical reports) in this category. Sato et al. (2018) reported measurement of horizontal structures of the ionosphere from Synthetic Aperture Radar (SAR) measurement aboard the Advanced Land Observation Satellite 2 (ALOS2). This is a very interesting method as the information of azimuth shifts of the SAR image is used for the measurement of horizontal gradient of ionospheric plasma density. They used the EISCAT radar as a reference of observations. There are two more technical reports by Tsuda et al. (2018a, b). They surveyed conditions for artificial aurora experiment with ionospheric heating facility and the IS radar at EISCAT Tromsø site. One report (Tsuda et al. 2018a) suggests the case where they use 4 MHz radio wave for ionospheric heating. However, the chances of possible observations are not high and mostly hopeless during the solar minimum period. In the following report (Tsuda et al. 2018b), they surveyed the possibility of artificial aurora experiment if they can use 2.7 MHz radio wave for heating. They suggested that, by decreasing the frequency of the heating radio wave from 4 to 2.7 MHz, the chance of experiment is much larger and becomes possible even during the solar minimum period.

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Authors' contributions
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The authors declare that they have no competing interests.

Author details
[1] Research Institute for Sustainable Humanosphere (RISH), Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan. [2] Department of Physics and Astronomy, University of Western Ontario, 1151 Richmond St. North, London, ON N6A 3K7, Canada. [3] Institute for Space-Earth Environmental Research, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan. [4] Department of Physics and Technology, University of Tromsø, The Arctic University of Norway, Hansine Hansens Veg 18, 9037 Tromsø, Norway. [5] Department of Earth and Planetary Sciences, Graduate School of Sciences, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka 819-0395, Japan.

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