Chin. Sci. Bull. (2014) 59(14):1483–1484
DOI 10.1007/s11434-014-0313-7

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www.springer.com/scp

Editorial

Atmospheric Science

Preface

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Published online: 2 April 2014

It is well known that the increases in atmospheric CO_2 and CH_4 (long-lived greenhouse gases; GHGs) owing to anthropogenic activity are the dominant processes driving global climate change. Space-based measurements of GHGs with high precision, resolution, and global coverage are urgently needed to characterize the geographic distribution of their sources and sinks, and to quantify their roles in the atmospheric CO_2 budget. Over the past 10 years, the European Space Agency (ESA), the National Aeronautics and Space Administration (NASA), and the Japanese Aerospace Exploration Agency (JAXA) have initiated different satellite missions to achieve these goals, including the Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY), the Orbiting Carbon Observatory (OCO), and the Greenhouse Gases Observing Satellite (GOSAT). All these missions contributed to a tremendous improvement in satellite measurement capabilities. For example, since the launch of GOSAT in 2009, a measurement precision of 1.5 ppm in the column-averaged CO_2 dry-air mole fraction (XCO_2) has recently been achieved, while the regional CO_2 flux has been estimated using both GOSAT and ground-based CO_2 observations [1, 2].

As a large developing country, China has the highest levels of GHG emissions. The Chinese government seeks to meet the needs of sustainable development, and hence, is committed to reducing its GHG emissions. In 2011, the Chinese Academy of Sciences began a 5-year program known as the Strategic Priority Research Program of the Chinese Academy of Sciences—Climate Change: Carbon Budget and Relevant Issues (Carbon Budget). It aims to provide a scientific basis for scientific and economic policy decisions, and to formulate new development plans to meet the demands of climate change and the carbon budget. Satellite measurements of GHG emissions are a key component of this program. In the same year, a National High Technology Research & Development Program—Chinese Carbon Dioxide Observation Satellite mission (TanSat) was sponsored by the Ministry of Science and Technology of China. TanSat will carry two instruments into space: a hyperspectral grating spectrometer for CO_2 and a moderate-resolution polarization imaging spectrometer for cloud and aerosol observations (CAPI) [3, 4]. Both programs promote the development of theory, technology, and applications of GHG measurements from space.

The main focus of this special topic is the remote sensing theory behind XCO_2 retrievals, inverse CO_2 flux methods, satellite data applications, and the validation of satellite measurements. Nine research articles accepted for publication on this special topic provide a theoretical basis for the TanSat mission. These articles address: the optimal design of spectral sampling rate and range of CO_2 absorption bands for TanSat hyperspectral spectrometers, surface pressure retrieval from hyper-spectral measurements in the oxygen A band, CH_4 retrieval in the short-wave infrared and thermal infrared bands, aerosol retrieval from polarization reflectance, XCO_2 retrieval from ground-based high-spectral-resolution solar absorption measurements, observations and modeling of CO_2 diurnal variations, the Carbon Cycle Data Assimilation System (Tan-Tracker), and finally China's sizeable and uncertain carbon sink: A perspective from GOSAT. We believe it is very

SPECIAL TOPIC: Greenhouse Gas Observation From Space: Theory and Application

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important for Chinese scientists to strengthen their collaborations in all aspects of research related to GHGs, including satellite design, XCO_2 retrieval, inverse flux modeling, in situ surface measurements, and validation techniques, to build up an integrated ground-air-space network for GHG measurements in the near future.

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