frontiers | Frontiers in Remote Sensing

TYPE Editorial
PUBLISHED 13 October 2022
DOI 10.3389/frsen.2022.1040835

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Satellite Missions,
a section of the journal
Frontiers in Remote Sensing

RECEIVED 09 September 2022
ACCEPTED 16 September 2022
PUBLISHED 13 October 2022

CITATION
da Silva AM, Kato S, Baker H, Redemann J, Posselt D, Ferrare R and Lebsock M (2022), Editorial: Remote sensing of cloud, aerosols, and radiation from satellites.
Front. Remote Sens. 3:1040835.
doi: 10.3389/frsen.2022.1040835

Editorial: Remote sensing of cloud, aerosols, and radiation from satellites

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KEYWORDS

clouds, aerosols, convection, precipitation, radiation, satellite, satellite missions

Editorial on the Research Topic
Remote sensing of cloud, aerosols, and radiation from satellites

Planning a research satellite mission involves a careful study phase in which science objectives are defined and the measurements necessary to achieve these objectives are identified, which then determine instrument and other mission requirements. Obtaining the necessary geophysical variables with the required accuracies necessitates suitable retrieval algorithms and methods to assess how well the objectives can be realized, all within a well-defined budget and schedule. The pre-launch objective assessment phase represents a crucial and invaluable step for defining and justifying a mission. Yet, despite their importance, these algorithms and assessments are generally not readily accessible to researchers who are not involved directly in this mission study phase. This volume aims to add some transparency to this process.

The goal of this research topic is to document some of the pre-launch studies being conducted for NASA's Atmosphere Observing System (AOS, formerly ACCP–Aerosols, Cloud, Convection and Precipitation) and the ESA/JAXA EarthCARE satellite programs. The primary scientific focus of these missions is to elucidate the multifaceted interactions between aerosols, clouds, convection and precipitation at the process level.

Aerosols interact with radiation directly and indirectly *via* perturbations to macro- and micro-physical properties of clouds. The resulting impacts on regional and global weather and climate can perturb radiative forcing induced by changing greenhouse gas concentrations, determine cloud feedback strengths, and their impacts on the dynamics and thermodynamics of the atmosphere. Observing how clouds and aerosols influence atmospheric radiative transfer, thermodynamics and the atmospheric circulation is a key element in understanding how Earth will respond to climate change with far reaching consequences for the hydrosphere, cryosphere and the hydrological cycle of the planet.

In order to infer the vertical properties of aerosol, clouds, precipitation and their impact on the Earth's climate, multiple instruments are required to make simultaneous and synergistic measurements. Specifically, the combination of new active and passive sensors, combined with sensors from the Program of Record (those satellites currently in space or planned for launch in the coming years) can facilitate a paradigm-shift in observing and understanding the roles of clouds and aerosols in weather and climate.

In the first paper in this volume, Stephens et al. introduces the *Atmosphere Observing System* (AOS, formerly known as ACCP, the Aerosols, Cloud, Convection and Precipitation study) being developed by NASA in response to the 2017 Decadal Survey (National Academies of Sciences, Engineering, and Medicine, 2018). With a suite of measurements spanning radars, lidars, polarimeters and microwave radiometers, the AOS mission will provide the next big step in space measurements of aerosol, clouds, convection and precipitation. Stephens et al. describes the science objective of AOS and key science questions it promises to elucidate.

The calculation of aerosol single scattering properties is a computationally challenging task that is at the core of any algorithm that retrieves aerosol microphysical parameters. In *Improved Lorenz-Mie Look-Up Table for Lidar and Polarimeter Retrievals*, Chemyakin et al. explore recent advances in computational resources to develop a novel and improved Lorenz-Mie look-up table of light scattering properties using an ensemble of isotropic spheres at arbitrary wavelengths from ultraviolet to the shortwave infrared part of the spectrum. In addition to the look-up tables proper, the author make freely available all the software used for the calculations.

Machine learning is fast becoming an indispensable tool in many areas of atmospheric remote sensing. In Hu et al., a neural network model informed by CALIOP measurements is developed to retrieve vertically resolved macro and microphysical properties of water clouds. A 14 + yearlong global dataset of cloud properties is developed and validated against airborne measurements and other measurements from the Program of Record.

While great emphasis is placed on measurement accuracy and instrument design when developing a space mission, other mission design aspects such as orbit geometry, solar geometry and swath width can have a profound impact on the resulting datasets. With a focus on polarimetry, in Thompson et al., the authors examine the distribution of scattering angles associated with the inclined and polar orbits being considered for the AOS mission. Their thorough calculations, which explore the sensitivity to elements such as orbit inclination and swath width, provide critical information for the design of the AOS mission.

The concept of delta-t or tendency measurements–measurements provided by a pair of microwave radiometers separated by several tenths of seconds–have received considerable interest as an affordable approach for gaining insights on the dynamics of convective storms. Brogniez et al. provides an overview of the *Convective Core Observations through MicrOwave Derivatives in the TrOpics* (C^2OMODO) concept, and explore the information content provided by such measurements. In *Deep Convection as Inferred From the C^2OMODO Concept of a Tandem of Microwave Radiometers*, Auguste and Chaboureau use numerical simulations of two deep convective events, and an detailed instrument simulator, to derive very useful relationships between the "measured" brightness temperature, its time derivative and key geophysical quantities such as vertical ice momentum, vertical ice velocity and ice water path. Such measurements provide a novel approach to derive geophysical properties that are usually accomplished with active sensors.

Spaceborne measurements of vertical air velocity by Doppler radars is a critical component of emerging satellite missions aiming to elucidate the dynamics of clouds and convective storms. In *Mind the Gap–Part 3: Doppler Velocity Measurements from Space*, Kollias et al. present comprehensive forward simulations for assessing the advantages and drawbacks of six Doppler radars being considered by major space agencies around the world.

Polarized radiative transfer modeling is a foundational tool for the development of cloud and aerosol algorithms based on polarimetric measurements. Lin et al. give us a detailed description of several important upgrades to the Vector Discrete Ordinate Radiative Transfer (VDISORT) model, a polarized (vector) radiative transfer model that can be applied to a range of earth system retrievals. This paper provides very valuable information for developers of retrieval algorithms that seek to understand the internal works of a radiative transfer model.

Finally, the benefits of synergistic lidar-polarimetry measurements is a topic of great relevance to missions such as NASA's Atmosphere Observing System (AOS). In *Polarimeter + Lidar–Derived Aerosol Particle Number Concentration*, Schlosser et al. propose a simple and effective method for deriving vertically-resolved aerosol particle number concentration (N_a) based on active lidar measurements and passive polarimetric measurements. By using airborne observations from the NASA ACTIVATE campaign in the western Atlantic, the authors demonstrate that that the vertically resolved N_a represent a significant improvement over other existing remote sensing estimates.

In summary, the papers presented in this volume provide an excellent overview of some of the upcoming space missions to study aerosols, clouds, convection and precipitation and the candidate measurements that promise to revolutionize the next decade of earth observations.

Author contributions

AS drafted the initial editorial with contributions and review from co-authors.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

National Academies of Sciences, Engineering, and Medicine (2018). *Thriving on our changing planet: A decadal strategy for Earth observation from space*. Washington: DC: The National Academies Press. doi:10.17226/24938