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Editorial: Towards 2030: a remote sensing perspective on achieving sustainable development goal 13 – climate action

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Editorial on the Research Topic
Towards 2030: a remote sensing perspective on achieving sustainable development goal 13 - climate action

Climate change is already here, and we can see its impacts on the news more often than we would like to. Therefore, it is no wonder that people are demanding more actions to stop the warming trend and steer our trajectory toward a calmer future. However, sustainable action must be based on robust and trustworthy data to avoid jumping out of the frying pan and into the fire.

This motivated us to address the 13th Sustainable Development Goal: Climate Action–Take urgent action to combat climate change and its impacts. Specifically, we focused on how studies of atmospheric remote sensing could help us understand how to reverse the course of climate change, and how to reduce and minimize its impact on the population, their livelihood, and nature.

It can be argued that enough is already known about the physical basis of climate change and therefore, researchers should move their focus on supporting climate action with the data they produce. However, not everything is known—at least not accurately enough. Satellite data sets have sampling issues and biases that still need to be resolved (e.g., Chung et al., 2024; Magruder et al., 2024). Moreover, the modelling community is moving forward to regional analyses with high-resolution models, thus more detailed observations are needed for the development and validation of these new models. In addition, remote sensing data records are approaching climate-relevant time scales and offering invaluable information on the changes already caused by climate change. With novel algorithms and machine learning methods even more could be learned from these long data series. Furthermore, people's behavior and their emissions are constantly changing, thus accurate monitoring is needed also in the future. Especially, as the global average temperature will rise above 1.5°C which will take us to uncharted territory with an increasing possibility for abrupt changes and crossing of tipping points. Consequently, new and refined satellite retrievals will likely lead to new understanding and better support for climate action. This new and improved information will also be a crucial part of the seventh IPCC Assessment Report which is planned to be released in 2029.

To address the above-mentioned needs, this Research Topic includes six original research articles. All of them present novel methods and/or new atmospheric satellite products which will be beneficial for the scientific community and society at large.

Delgado-Bonal et al. used data from the Earth Polychromatic Imaging Camera (EPIC) aboard the Deep Space Climate Observatory (DSCOVR) satellite to analyze daily variability of cloud properties, especially cloud optical thickness and cloud height. The understanding of the diurnal cycle of clouds in different regions around the world is essential for improving climate models and predicting the impacts of climate change.

Kostinski et al. also used data from the EPIC instrument on-board the DSCOVR satellite. They analyzed the Earth's reflectance and produced temporally and conditionally averaged reflectance images on a fixed grid separated by surface types (land or ocean), and atmospheric conditions (cloudy or clear). These kind of reflectance maps can offer insights into climate science and diagnostic, as well as educational tools for the public.

Marshak et al. presented a novel method of spectral invariance for remote sensing of inhomogeneous clouds. The advantage of the new retrieval is that it does not assume cloud plane-parallel homogeneity. Enhancement of the accuracy of satellite-based cloud property measurements is crucial for atmospheric monitoring and for the improvement of atmospheric models.

Strahlendorff et al. developed a new soil moisture prediction tool by integrating advanced machine learning methods with satellite observations and weather forecasts. The new tool offered more refined and accurate information than the old version which relied solely on weather forecasts and reanalysis data. Long observational data sets were crucial for developing this societally relevant tool that can help people prepare and gradually adapt to changing climate conditions.

Wen et al. addressed the challenges of accurately measuring aerosol properties in the vicinity of clouds. They used a two-layer model to adjusts for the 3D radiative effects caused by the clouds, enhancing the precision of aerosol retrievals obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. More accurate observations of aerosols, particularly in cloudy regions, are imperative for studies of aerosol-cloud interaction.

Zubko et al. present a novel method for characterizing atmospheric aerosol with polarimetry and shadow hiding. The combination of these approaches reveals information on the size, shape and chemical composition of the aerosol. With this method they were able to identify the contributions of water-ice, mineral-dust and carbonaceous aerosols in their observations. The possibility to characterize the type of the aerosol is a valuable addition to atmospheric aerosol observations.

As the summaries of the articles in this Research Topic show, there is still room for improvement in our current satellite algorithms. However, the articles also provide potential solutions to the shortcomings of the operational algorithms, and essential knowledge for the development of atmospheric models. Satellite observations are vital for model evaluation, but it is good to keep in mind, that models can also be used to understand and evaluate the satellite observations. For example, Kokkola et al. (2024) used an ensemble of large eddy simulations to show that the satellite-based estimate of the relationship between cloud droplet number and cloud water is biased due to combination of spatial variability in cloud properties and instrumental noise. Nevertheless, the analysis implied that satellite data can provide robust results if the cloud cases are carefully selected from similar meteorological conditions. This example underscores how combining global satellite observations with models leads to more accurate insights and better answers to climate-related questions, ultimately helping us make sustainable decisions related to climate action.

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