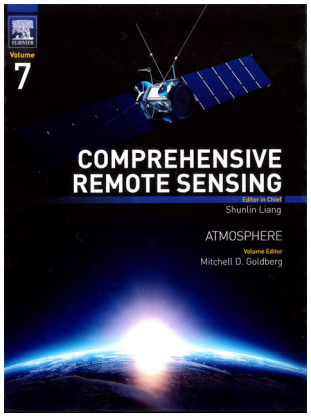
The chapter 11 by F. Sigmundsson (University of Iceland) and 19 others is all about how the movement of magma in VIPS affect the associated ground deformation and unrest. Different techniques such as Global Navigation Satellite System (GNSS) geodesy are shown to measure ground deformation caused by the magma transfer. Detailed illustrations from the volcanoes in Iceland at different time zones (2010 Eyjafjallajökull eruption, 2014–15 Bárðarbunga eruption) preceding several years of unrest have been provided.

The epilogue (chapter 12 by Steffi Burchardt) focuses on the future scope of the state-of-the-art techniques in our understanding of the VIPS, which till now depended on years of observation, measurements and experiments. Efforts made by International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), an international commission dedicated to the VIPS, are narrated in the chapter. The importance of multi-disciplinary approaches and advanced technical developments in enhancing our understanding of the processes that are associated with the magma plumbing systems is highlighted.

In summary, the book undoubtedly provides an easily understandable overview of the contemporary integrated and multi-disciplinary research being done on the VIPs. I have no hesitation in recommending it to be an invaluable companion of the curious young (and old) minds who are interested in embarking research on volcanic and igneous plumbing systems.

N. V. CHALAPATHI RAO

Mantle Petrology Laboratory,
Department of Geology,
Institute of Science,
Banaras Hindu University,
Varanasi 221 005, India
e-mail: nvcrao@bhu.ac.in



Comprehensive Remote Sensing, Volume 7: Atmosphere. Editor in Chief: Shunlin Liang, Volume Editor: Mitchell D. Goldberg. Elsevier, Radarweg 29, P.O. Box 211, 1000 AE Amsterdam, The Netherlands. 2018. xxii + 545 pages. Price: not mentioned.

Earth's atmosphere comprises layers of gases and dust and plays a major role in sustaining life on the planet by creating adequate pressure allowing liquid water to exist, warming surface through greenhouse gases and balancing diurnal temperature extremes. Presence of clouds changes the radiation budget of Earth's atmosphere. Observations from space-based satellites play a key role in global monitoring of atmospheric phenomena such as cyclones, extreme rainfall events (EREs), concentration of greenhouse gases (GHGs) and other pollutants, etc. Recently, assimilation of satellite data in Numerical Weather Prediction (NWP) models has shown immense potential for improving forecasts.

This book under review updates the understanding as to how satellite-based measurements and associated remote sensing techniques provide information on the states of various atmospheric parameters. Further, the book emphasizes on the evolution of various instruments and their characteristics that are used in remote sensing of aerosols, atmospheric gases, cloud microphysical properties and vertical sounding of temperature and water vapour, etc. There are specific chapters on advances in ozone sounding in ultra violet region, infrared and microwave sounding of temperature and humidity, detecting cloud vertical structures, advanced instrumentation and techniques for detection of aerosols and trace gases. The authors discuss principles involved in remote sensing, the challenges of measurements, calibration/validation and role of radiative transfer modeling in precise and accurate retrieval of geophysical parameters. Experts in the field of atmospheric remote sensing have contributed articles and their views represent the state-of-the-art in the field. Case studies on selected sensors, including their design, retrieval techniques for parameters and scientific applications to atmospheric studies make this book extremely valuable.

Instruments placed on satellite platforms are designed to measure the radiance from Earth and its atmosphere. Electromagnetic signal measured by satellite instruments in different spectral regions (UV, Visible) are produced by either scattered and reflected sun light or emission (infrared, microwave) from Earth with contribution from atmospheric aerosols, clouds and Earth's surface. Measurements are designed to be carried out at specific wavelengths depending upon sensitivity of atmospheric constituents of interest. That is why each instrument is designed for specific spectral window and required spectral resolving power. For example, the 313.3, 317.5, 331.1, 339.7, 360.0 and 380.0 nm wavelengths with spectral resolution of 1.0 nm were used in first global mission to produce daily maps of total column of ozone in TOMS in 1978 and similar philosophy was followed in GOME, SCIAMACHY and OMI instruments. Radiative transfer modelling is applied to retrieve the atmospheric parameter of interest. Sometimes, nonlinearity in the physics of radiative transfer and ill-posed nature of the inverse problem poses inevitable issues.

Depletion of ozone in the stratosphere has been of particular concern to the scientific community. Hyperspectral sensors such as GOME, OMI and SCIAMACHY have provided long-term records of ozone profile in the atmosphere. A dedicated chapter in this book provides description of Ozone Mapping and Profiler Suite (OMPS) for retrieval of ozone in different viewing modes. Nadir observations of total column ozone and low-vertical resolution ozone profile along with limb observation of high vertical resolution ozone profile are available from space-based sensors. The authors have emphasized the need to perform inter-calibration of sensors on polar and geostationary platforms to identify biases, improve product accuracy and

provide a robust system for monitoring the atmosphere using the new generation of hyperspectral UV/Vis instruments.

Aerosols and their distribution in the atmosphere have been an area of great interest to atmospheric, environmental and climate change studies. Along with their adverse health impacts, tropospheric aerosols affect the solar radiation budget and aid in the formation of cloud droplets. Aerosol optical depth and particle size distribution require multi-look and/or multi-spectral measurements for retrieval. This book deals with remote sensing of tropospheric aerosols from multi-spectral observations. It contains excellent review on aerosol characteristics and different methods for estimating aerosol optical thickness, which makes it highly useful.

Infrared and microwave sounders flown on weather-monitoring satellites provide crucial information on profiles of temperature, water vapour and trace gases. Fast radiative transfer algorithms have been used for assimilation of satellite-measured clear-sky radiances in weather forecasting models. Authors raise the issue that present radiative transfer calculations face challenges in cloudy conditions and need to include polarization and scattering from clouds for improving accuracy. Cross-track Infrared Sounder (CrIS) onboard SNPP is a Fourier transform spectrometer (FTS) providing vertical profiles of temperature, water vapour and trace gases like CO, CH_4, CO_2, O_3, etc. This book has a dedicated chapter which provides an overview of the CrIS system and mathematical description of applied calibration algorithms. Dual-regression approach for processing ultra-spectral measurements from Atmospheric Infrared Sounder (AIRS), Infrared Atmospheric Sounding Interferometer (IASI) and CrIS has provided high vertical resolution profiles. Assimilation of these high-resolution profiles (obtained from Aqua, Metop and SNPP) into various NWPs may improve the forecasts and create opportunity for research.

Assimilation of satellite measured microwave and infrared radiances into NWP models has helped improve forecasts. Case study on Polar Operational Environmental Satellite (POES) microwave observations and Geostationary Operational Environmental Satellites (GOES) infrared radiance observations in improving forecasts of tropical cyclones has been presented in the book. Although few studies have shown positive results, authors mention that these can be case-dependent and have scope for further improvement. Scatterometers have been designed to provide near-surface wind velocity over oceans and many agencies around the world have assimilated this information in their forecasting models. This book misses the opportunity of discussing scatterometers in detail and real-time assimilation of their data in various NWPs.

Retrieval of trace gases from satellites is crucial in monitoring the distribution of pollutants in the atmosphere. Most polyatomic molecules exhibit strong absorption and emission lines in thermal infrared region. Dispersive and Fourier Transform spectrometers are used to record these observations. Algorithm for measurement of trace gases from space-borne hyperspectral sensors usually requires an inversion process. Hyperspectral thermal infrared (TIR) observations are matched with forward simulations from a radiative transfer model to estimate concentration of trace gases. This book provides a brief overview of hyperspectral sensors like Interferometric Monitor for Greenhouse gases (IMG), Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), AIRS, Tropospheric Emission Spectrometer (TES), IASI and Thermal and Near infrared Sensor for carbon Observations–Fourier Transform Spectrometer (TANSO-FTS). Radiative transfer models form the core of retrieval of trace gases and errors in these models are propagated into the retrieved concentrations. Line-by-line models are the most accurate but computationally slow whereas fast RT models are usually less accurate but computationally efficient. Optimal estimation method then provides a statistically most probable solution based on observation and an a priori profile derived from climatology or recent forecasts. Space-based observations of trace gases usually suffer from multiple errors ranging from instrument noise, errors in RT model and a priori estimate, smoothing errors, etc. However, with improved spectrometers providing large spatial coverage, errors in concentration of trace gases are bound to reduce.

This book presents excellent articles on different dimensions of atmospheric remote sensing focusing on scientific principles and retrieval methods, including recent technological trends in this field, which make it worth reading both by the beginners and the specialists in this field.

R. P. SINGH*
ROHIT PRADHAN

Land Hydrology Division
(GHCAG/EPSA),
Space Applications Centre, ISRO,
Ahmedabad 380 015, India
**e-mail: rpsingh@sac.isro.gov.in*