Chapter 1

Introduction

The history of satellite remote sensing began in 1959 when the first satellite with a meteorological instrument, Vanguard 2, was launched. However, its data was unusable. It was soon followed by Explorer 7, which carried the first successful meteorological instrument. The first satellite completely dedicated to remote sensing for meteorological purposes was TIROS 1, which was launched in April 1960. Since then, a long series of earth observation satellites was brought into space. Scientific and technical development has led to numerous improvements in many aspects. More and more instruments were launched on different platforms allowing faster and more regular observations of the entire globe. And although for many people the good old“view” at the planet is still the most appealing remote sensing technology, the“eyes” of the satellite instruments have also undergone a tremendous development allowing now observations not only in the visible part of the solar spectrum but also measurements ranging from ultra-violet wavelengths over the visible into the infrared and microwave spectral range. This was necessary in order to fulfill the demand of data-users who required more than plain images of the earth searching for more specific and detailed information on e.g. individual atmospheric and oceanic constituents or the exact shape of the earth. It was in 1985 when public attention was brought towards the results from satellite remote sensing for the first time. In this year, the ozone hole was first observed from the ground by scientists of the British Antarctic Survey at the Halley station in the Antarctic.

Shortly afterwards measurements of the TOMS[1] instrument illustrated its large spatial extent. Legend wants that by that time the software which created ozone measurements from satellite observations first discarded the results as instrument errors, as the resulting ozone amount was so low! However, since then different satellite instruments allow for a regular monitoring of the atmospheric ozone content.

In this context, one can see the advantage of measurements not only in the visible spectral range. Ozone is not visible for the human eye but is strongly absorbing solar radiation in the UV, thus observations in spectral ranges, where ozone is optically active, allow measurements of its atmospheric content.

But ozone is only one of the atmospheric gases which satellite based remote sensing is possible and reasonable for. Attention was also drawn towards the constant observation of atmospheric water vapour. Water vapour is optically active in the solar as well as in the terrestrial spectrum, thereby strongly affecting the atmospheric energy transfer and the earth-atmosphere energy budget. In fact, water vapour is the strongest of all greenhouse gases.

Due to its important role for atmospheric energy transfer water vapour is one of the key variables in the set of prognostic variables in numerical weather prediction models. At the same time, atmospheric water vapour shows a very high spatial and temporal variability making accurate measurements on a high resolution an essential prerequisite for the initialisation of weather prediction models and a critical information during the assimilation process.

This work describes the development, application and validation of algorithms for the remote sensing of atmospheric water vapour from space using two new satellite instruments, the MERIS[2] instrument on board the European Envisat platform and the U.S. American MODIS[3] instrument on two platforms, Terra and Aqua. These measurements are then used within the assimilation framework of an operational weather prediction model.

[1] Total Ozone Mapping Spectrometer
[2] Medium Resolution Imaging Spectrometer
[3] Moderate Resolution Imaging Spectroradiometer