Better weather forecasts with a map showing atmospheric vapour

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Weather forecasts, satellite navigation in cars and the inspection of dikes or natural gas fields: these applications using satellite data would all be even more accurate if we knew more about the distribution of water vapour in our atmosphere, according to Roderik Lindenbergh from Delft University of Technology (TU Delft, The Netherlands).

He carried out research using the satellite instrument MERIS, which is on board the European environmental satellite Envisat. His research was supported by the Dutch space organisation NSO.

We are now completely used to the fact that our TomTom sat nav system shows us where to drive and that the weather forecaster tells us if it will be cloudy or sunny later on today. However, we never give a thought to the error margins in these two applications. Lindenbergh: "Satellite navigation in cars is accurate only to a few metres. That box on your dashboard does not know if you are driving on the main road or the access road next to it. The same is true of predicting thunder storms, which is really difficult. Even the best of weather forecasters will not be able to tell you whether a thunderstorm is going to make the main act in the Pinkpop music festival a washout ".

Water vapour ruins everything. GPS satellites send radio signals to us but these become scattered or delayed by water vapour in the atmosphere. The same is true of signals from the ASAR instrument on board the European Earth observation satellite Envisat. This radar instrument sends signals to Earth and later picks them up again. In their passage to Earth

and back, the signals are influenced by water vapour in the atmosphere, and this leads to deviations which can affect any measurements taken of ocean currents, ice caps and the topography of land masses.

Lindenbergh used another instrument on Envisat, the Medium Resolution Imaging Spectrometer (MERIS), to investigate how water vapour is distributed in the atmosphere. Using data from two wavelength areas, it is possible to estimate the quantity of water vapour present in the space between the satellite and Earth. "We are unable to see exactly how much water vapour there is at any particular height, but it is better to know just a little than nothing at all".

A second way of measuring water vapour is to use GPS ground stations. By taking into account the position of the various GPS satellites, the height of the ground station and the signal delay, it is possible to create a map showing the water vapour distribution in the atmosphere. In addition to MERIS, Lindenbergh used 25 GPS stations all over the Netherlands. These maps are less detailed than the MERIS maps but they are more up-to-date. They continually supply measuring data, whereas MERIS requires three days to map the whole earth. "Thanks to this research, we are now able to enhance the accuracy of the GPS and ASAR measurements with MERIS data. At the same time, we can enhance MERIS with the aid of GPS data", Lindenbergh explained. "This is the first time we have mapped the distribution of water vapour from two perspectives: from the ground and from space".

These more accurate water vapour data are not just useful for meteorology and satellite navigation. Climate researchers are really keen to use them too because water vapour is the most significant greenhouse gas in the atmosphere. In addition, many land survey applications are nowadays based on satellite measurements. Buildings, gas extraction locations and dikes are monitored from space. Lindenbergh: "Our method of estimating water vapour using satellite data can be used in

many different applications. This leads to much more accurate data".

Source: Delft University of Technology