KNMI Data Assimilation and physic developments

Siebren de Haan, Gert-Jan Marseille, Wim de Rooy and Sibbo vd Veen

1. Mode-S EHS data portal

Upper air atmospheric wind and temperature information is crucial for numerical weather prediction (NWP) and nowcasting. A novel method to measure wind and temperature is related to tracking and ranging by an enhanced surveillance (EHS) air traffic control (ATC) radar.

Until now only data from local sources were available in the Netherlands, made available through the Luchtverkeersleiding Nederland (LVNL). This meant that only a small area of our HIRLAM and HARMONIE model domains were covered by these dense observations. Now a project has started to collect and make available as much Mode-S data as possible.

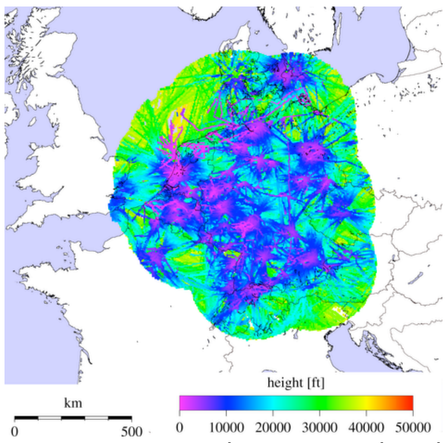

Figure 1: Coverage and minimum height of Mode-S EHS observations on 12-09-2013

The first result of this project is that the data from MUAC (Maastricht Upper Area Control Centre for EUROCONTROL) has become available. This Mode-S EHS derived meteorological information can be used by other NMHS, after signing a Non-Disclosure Agreement. The data is processed with all necessary corrections:
- Magnetic to true heading correction
- Heading corrections
- Airspeed corrrections

The data will be delivered every 15 minutes with a delay of 10 minutes and become available in three formats: BUFR, NetCDF and ASCII. The data coverage of one single day is shown in figure 1. The number of observations acquired over one week is shown in figure 2. It shows that there is a significant increase in available observations due to the addition of the EUROCONTROL data.
Please contact mode-s@knmi.nl for inquiries on data access or look at http://mode-s.knmi.nl for more information.

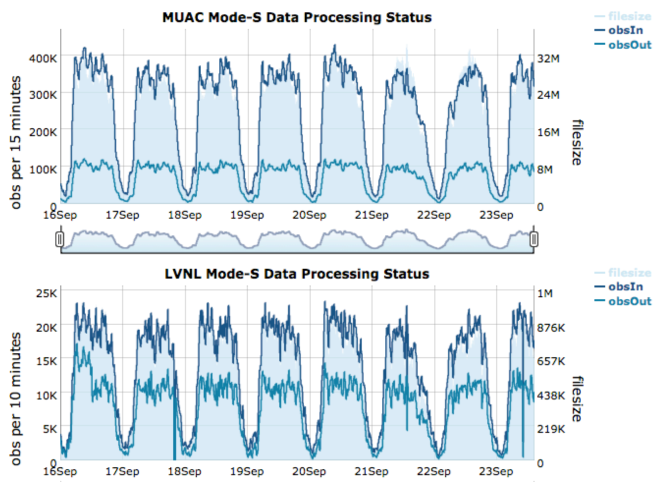

Figure 2: Number of observations per 15 minutes for MUAC and LVNL data

2. ASCAT assimilation in HARMONIE

NWP models are used in the Netherlands to calculate the water levels and storm surges at the Dutch coast. In the case of extreme storm surges water defenses should keep the low-lying parts of the Netherlands from becoming inundated. But as the closure of the Maeslant storm surge barrier has a big impact on the port of Rotterdam, the closures have to be kept to a minimum and accurate water level forecasts are of critical importance.

The wind over the sea therefore is very important to forecast correctly. As many observations as possible should therefore be included in the data assimilation, especially over the sea where data is relatively scarce. One such data source is scatterometer winds.

Figure 3: The Maeslant storm surge barrier.

At KNMI experiments have been performed with HARMONIE including scatterometer winds from ASCAT and Quikscat, for a number of windy periods. One of these periods included the first, and until now only, time that the Maeslant storm surge barrier (see figure 3) was closed due to forecasted high water levels.

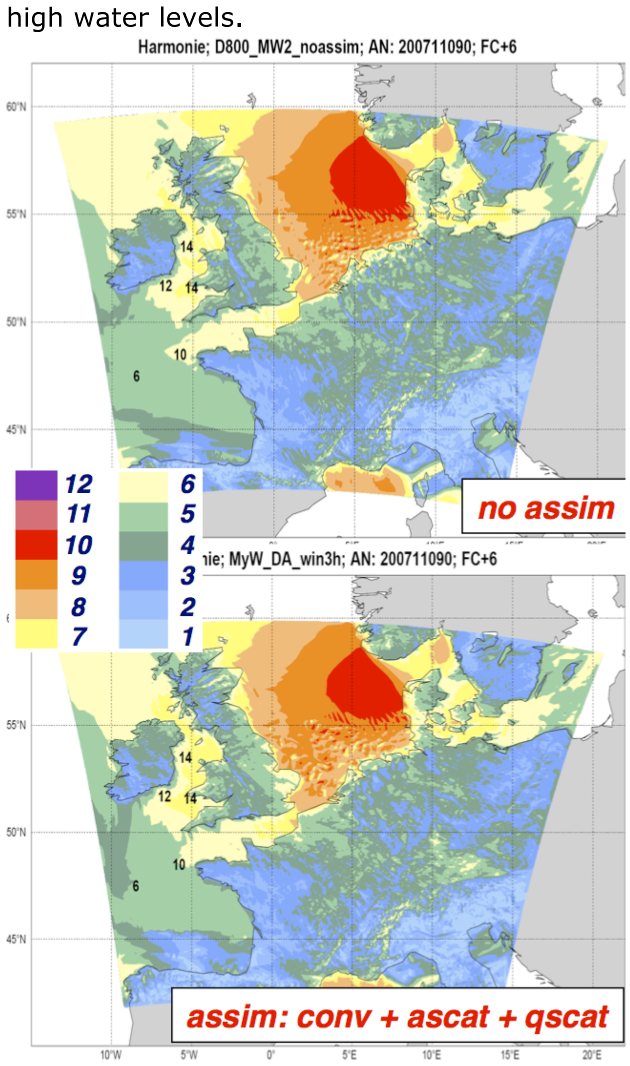

Figure 4: HARMONIE +06h wind speed (Beaufort) without (top) and with data-assimilation on 9 November 2007, 06 UTC.

Figure 4 shows the impact of the observations in the data assimilation. Especially over the sea this impact is significant with a decrease in the area with 10 Beaufort.

Figure 5 shows the verifying wind field as observed by Quikscat. HARMONIE does not show a significant bias over the sea, as opposed to ECMWF that has a significant negative wind speed bias (not shown here). Figure 4 and 5 also show that the wind field can be quite noisy in areas with convective activity, in this case over the southern half of the North Sea. One of the challenges will be to use the observations in a meaningful way in the HARMONIE data-assimilation in these areas.

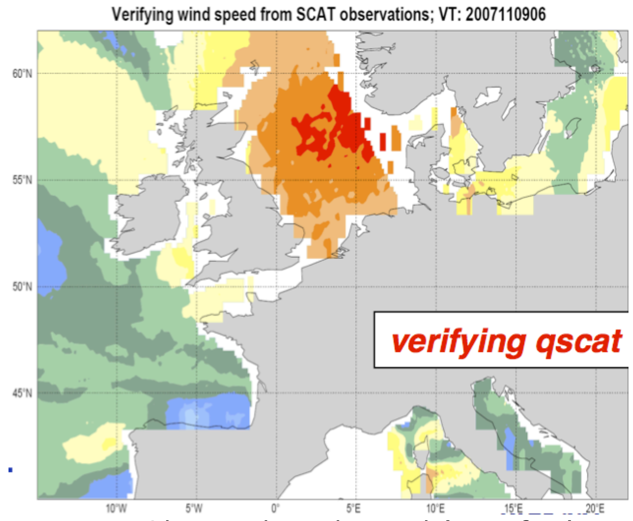

Figure 5: Observed wind speed (Beaufort) as diagnosed from Quikscat observations around 9 November 2007, 06 UTC.

3. Hunt for the solution of Erroneous sea-fog problem in HARMONIE

Last year we already mentioned the problems that HARMONIE has with fog over the sea in stable conditions. During Spring and Summer the seas under high pressure areas sometimes fill up with fog and low clouds, even when none are observed. This is one of the most important problems with the current HARMONIE system.

Compared to last year several significant results have been achieved. First it was found that the entrainment at the top of the boundary layer (or a fog layer) is too small, leading to too dense fog. This too small entrainment also leads to too shallow and moist boundary layers, causing fog to form earlier over land (see figure 6).

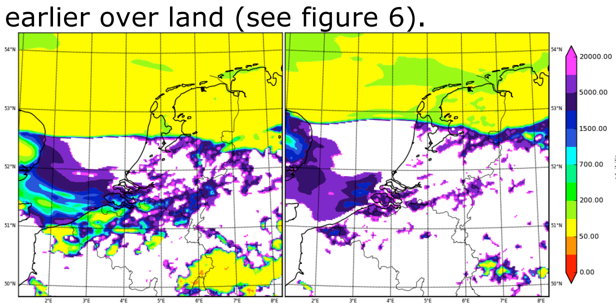

Figure 6: +17h forecasted visibility on 23 March 2012 05 UTC without (left) and with (right) additional entrainment.

A second reason for the development of too much fog may come from the evaporation over land. The Bowen ratio may be too small, due to a too large evaporation, also leading to a too moist boundary layer over land. When this too moist air is advected over a cold sea fog will also form too quickly. The question is what causes the too strong evaporation. Apparently the soil moisture of the top soil layer in HARMONIE is much higher than in the same surface scheme in ARPEGE (result from Yann Seity). Applying the ARPEGE top soil moisture decreased the fog problems considerably.

Finally, adjusting water vapour in analyzed model fields, based on satellite and cloud-base observations, improves the clouds much more when applied over a large domain than when the boundaries are dominant in a small domain.