

Are ECMWF winds a reliable auxiliary data source for SMOS salinity retrievals over rainy regions?

The European Centre for Medium-range Weather Forecasts (ECMWF) 10-m equivalent neutral wind data are used as auxiliary information in the SMOS operational Level 2 processing to improve the Sea Surface Salinity (SSS) retrievals. Errors in the auxiliary parameters (i.e., SSS climatology, Reynolds SST, and ECMWF wind) are known to propagate onto the SSS estimation in the cost function minimization step. In particular, high wind areas (above 12 m/s), where ECMWF wind uncertainty is higher, are usually flagged in the SSS retrieval. In this post, the ECMWF wind uncertainty under rainy conditions is assessed. It is shown that ECMWF does not well resolve the rain-induced wind variability and as such the wind uncertainty substantially increases in both rainy areas and their vicinity. It is therefore concluded that ECMWF winds should not be used to retrieve SSS under such conditions.

It is clear from Figure 1 that the ECMWF wind flow (top) shows no perturbation under rain conditions. In contrast, the Advanced Scatterometer (ASCAT) derived winds (bottom) show increased wind variability over the rainy regions. This is expected since convective rain cools the air below and reinforces downdraft near convective cells. These downdrafts often hit the ocean surface and cause outflow over the ocean, leading to variable wind speeds and directions. Although some rain contamination effects are expected in the ASCAT-derived field, recent work shows that under light and moderate rain rates, the rain contamination effect is minor in C-band scatterometers such as ASCAT (see reference below).



Fig 1. (top) ECMWF wind field collocated with the (bottom) ASCAT derived wind field observed over the tropical Pacific on September 24, 2008 at 20:32 UTC. The colours correspond to the collocated Tropical Rainfall Measuring Mission's (TRMM) Microwave Imager (TMI) rain rate values.

Figure 2 shows two different buoy wind and rain time series, together with the collocated ECMWF forecasts for the period of ± 24 hours of the ASCAT satellite overpass time. The first case (top) shows an important rain event with its associated high wind variability pattern, including downdrafts. It is clear that ECMWF does not resolve such high resolution wind pattern, since it varies rather smoothly over this period. The second case (bottom) shows again a case of high wind variability. Although no significant rain was recorded by the buoy, the downdraft-like wind pattern suggests the presence of rain cells in the vicinity. Again, the ECMWF wind pattern is rather smooth. In contrast, ASCAT is well resolving these high wind variability cases, as indicated by its good agreement with the collocated buoy wind (at the satellite overpass time). Further details on the ECMWF wind quality under rain conditions can be found in the reference below.



Fig. 2. Time series of buoy winds and rain, and ECMWF wind forecasts for the period of ± 24 hours of the ASCAT satellite overpass (see legend). The black circle represents the ASCAT retrieved wind speed. The first time series (top) corresponds to buoy 52003 [8°S, 165°E] and is centered on August 10 2007 at 22:00 UTC. The second time series (bottom) corresponds to buoy 52007 [5°N, 165°E] and is centered on July 5 2007 at 10:00 UTC.

In summary, small-scale wind variability appears to increase

with rain occurrence. ECMWF does not well resolve the air flow near rain and is rather smooth. In contrast, C-band and lower frequency scatterometers provide more reliable wind information under such conditions, e.g., in the Inter Tropical Convergence Zone (ITCZ). In particular, the L-band scatterometer onboard Aquarius is indeed a valuable auxiliary wind data source for improving SSS estimates from the Aquarius radiometer brightness temperature data. In SMOS, since no simultaneous scatterometer data are available, it is suggested to test whether neglecting ECMWF wind auxiliary data over rainy areas (i.e., using no wind constraint) does improve SSS retrieval quality.

This post is based on the following publication: Portabella, M., Stoffelen, A., Lin, W., Turiel, A., Verhoef, A., Verspeek, J., and Ballabrera-Poy, J., "Rain effects on ASCAT retrieved winds: towards an improved quality control," IEEE Trans. Geosci. Rem. Sens., 50 (7), pp. 2495-2506, doi:10.1109/TGRS.2012.2185933, 2012.