Wind Field Extractions From SAR Sentinel-1 Images Using Electromagnetic Models

**Fig. 1: Iroise Coast**

![Map of Iroise Coast](image)

Fig. 1. Iroise Coast (France) with many meteorological observation stations (red circles) of Météo France. These stations located very close to the sea are expected to give similar measurements as in the open sea. The *in situ* measurements from these stations used to be compared with the retrieved wind direction and wind speed are collected at the website [http://www.infoclimat.fr/](http://www.infoclimat.fr/).

**Fig. 2: Wind Estimation on A Sample of VV-pol SAR Images**

Fig. 2 shows the estimated wind speed on a VV-pol sample image. It is acquired in the IWS mode on 15th Apr 2015, from 18:12:46 UTC to 18:13:15 UTC. The radar incident angles used to capture it (32.5°–45°) correspond to the domain of validity of the SPM. The color bar in Fig. 2 denotes wind scale from 0 to 12 m/s. The wind directions relative to radar look in this case are about 210°–220°. As expected, at $\theta = 32.5°–35°$, the SPM-estimated wind speed is higher than the results given by the CMOD.5 (about 2.5 m/s, in average). Likewise, at $\theta = 35°–40°$ the SPM-based wind speed is still overestimated but a little less (about 1.5–2 m/s, in average). At $\theta = 40°–45°$, the two studied models give the same estimations for moderate wind (5–8 m/s). For the low wind (below 5 m/s), the SPM-based wind speed seems to be slightly overestimated (about 1–2 m/s, in average). Compared to the *in situ* measurements, the wind speed estimated by the two models has quite good agreement. The deviation is only 1–2 m/s.
Fig. 2. Wind speed estimations using (a) the SPM (EM model) and (b) CMOD.5 (empirical model) on a VV-pol Sentinel-1 sample image (IWS mode) acquired on 15th Apr 2015 from 18:12:46 UTC to 18:13:15 UTC.

Fig. 3: Wind Estimation on Two Samples of HH-pol SAR Images

The wind speed estimations on the two samples of HH-pol SAR images are shown in Fig. 3. They are collected by the SM mode in the winter on 27th Nov 2014 and on 08th Jan 2015, at the same moment from 06:23:46 UTC to 06:24:15 UTC. One should know that the sea surface wind in Iroise Coast at that period is normally strong. The radar incident angles for the two images are from 42° to 46°. For the image acquired on 27th Dec 2014 (Fig. 3a), the wind directions relative to radar look are about 150°–160°. The SPM-based wind speed is significantly overestimated compared to the results of the CMOD.5 and in situ measurements (about 12–15 m/s). Likewise, in the second case (Fig. 3b) where the wind directions relative to radar look are 30°–40°, the wind speed estimated by the SPM is significantly higher than the other results (about 15 – 18 m/s).
Fig. 3. Wind speed estimations using (left) the SPM and (right) CMOD.5 on the two HH-pol Sentinel-1 sample images (SM mode) acquired on (a) 27th Dec 2014 and (b) 08th Jan 2015, from 18:12:46 UTC to 18:13:15 UTC.

REFERENCES


