REMOTE SENSING INFORMATION ON CONVECTIVE PRECIPITATION IN POLAND

radar and ATS data sets as a validation sources for H-SAF satellite precipitation products – convective case study analysis.

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The EUMETSAT Network of Satellite Application Facilities

H SAF Support to Operational Hydrology and Water Management

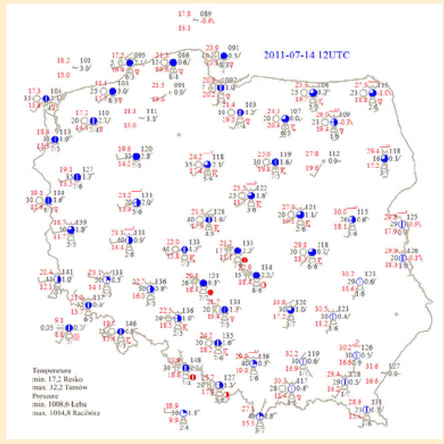
INTRODUCTION

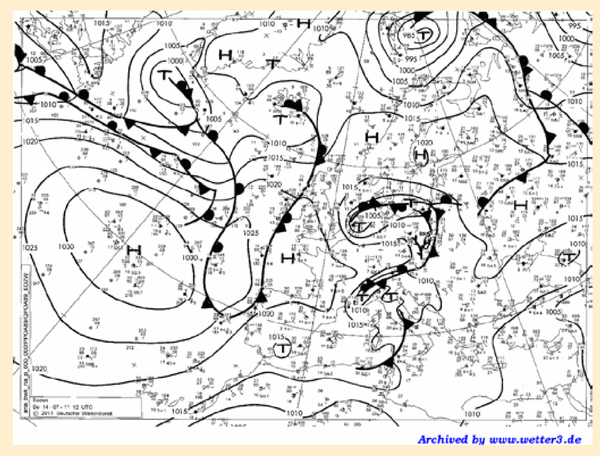
Proper understanding, interpretation and application of various precipitation information sources is crucial for human economy. Precipitation events inflicting water management and resulting in flood danger are more and more common in Poland as we are facing progressing climate changes. Correct recognition and validation of satellite precipitation products is in focus of attention for both meteorologists and hydrologists.

Network of over a thousand Automatic Telemetric Stations (ATS) collects precipitation information from all over the country in the near-real-time mode. Meteorological radar network consists of eight devices covering whole Poland and providing unified precipitation field using different precipitation products from which Surface Rainfall Intensity (SRI) is used on operational basis. Both systems provide quality spatial and temporal distribution of information for purposes of scientific studies as well as operational meteorology.

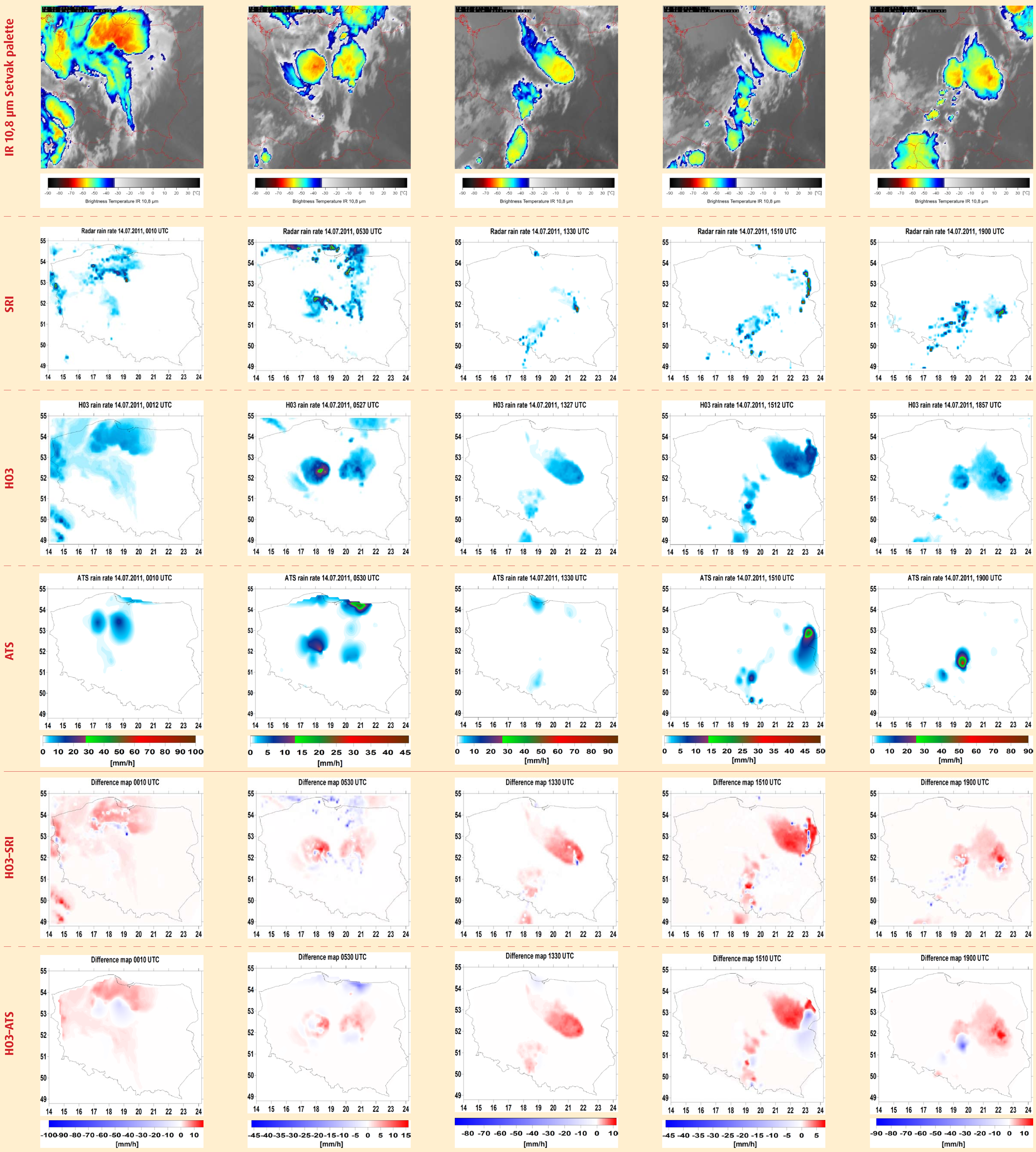
The main goal of EUMETSAT Satellite Application Facility in Support to Operational Hydrology and Water Management (H-SAF) is to provide satellite products in near real time mode to be useful for operational hydrology. Among them, the pre-operational precipitation products based on both passive microwave sensors (conical and cross track scanning) and IR sensors calibrated by MW have been available since 2009 for cooperating teams for detailed validation before release of operational products. One of the products, PR-OBS-3, is to be validated with use of both radar and ATS datasets.

In the presentation, the ability of the H-SAF PR-OBS-3 product to reproduce the convective precipitation patterns is discussed on the base of quantitative and temporal relations with radar and ATS precipitation information datasets (as ground based sensors) within chosen case analyses. Radar precipitation information used for the very first time to validate H-SAF satellite product in Poland is introduced. Finally, the quality of the satellite products in estimation of convective precipitation accuracy is presented.



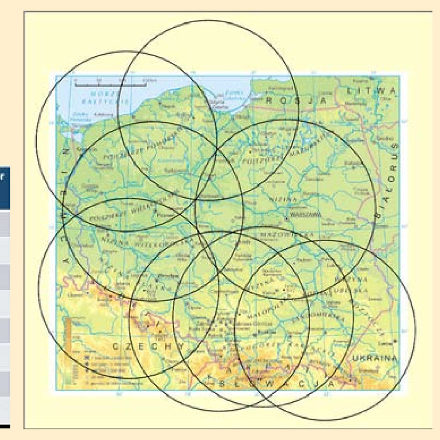


Low level pressure centre formed a few days before 14th of July 2011 over Bay of Biscay after a cold frontal wave incident travels its way through Europe in NE direction deepening and gaining in strength because of thermal contrast between its warm sector filled in with hot tropical air and cold, rear part which sucks cold air masses from N and NE. That thermal contrast is decreasing in time due to impediments in cold air masses alimentation and also spatial development of the Low itself. Cold front connected with mentioned above Low moving from SW to NE over Poland and subsequent big thermal contrast (12° C) created good initial conditions for storm supercells development and significant precipitation events throughout whole day in Poland. Numerous rainfalls of amount over 40 mm/h were recorded sometimes connected with local tornadoes (ex. near city of Łódź, and locality of Radzanów). During that day numerous Cumulonimbus clouds were passing over Poland merging in supercell formations. As a result, Cb type clouds joined in complexes by their anvils created local and self-reliant circulation what effected in heavy but local precipitation events in the late afternoon and evening.



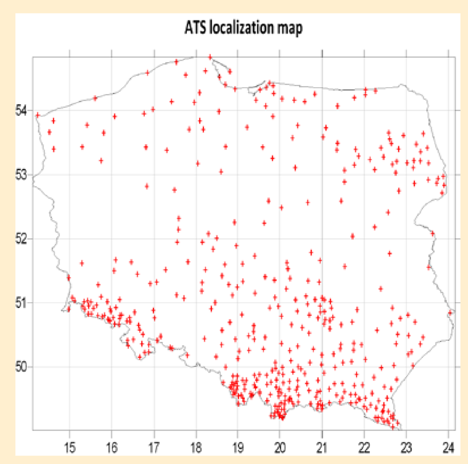
RADAR DATA SET

Location	Geographic coordinates		Antenna height (a.t.l)	Radar type	Transmitter type
Ramża	50°09'06"	18°43'36"	32 m	METEOR 360AC	magnetron
Pastewnik	50°52'58"	16°02'23"	22 m	METEOR 360AC	magnetron
Legionowo	52°24'01"	20°55'53"	29 m	METEOR 1500C	klystron
Rzeszów	50°06'51"	22°00'09"	30 m	METEOR 1500C	klystron
Poznań	52°24'35"	16°49'56"	35 m	METEOR 500C	magnetron
Świdwin	53°47'25"	18°27'22"	30 m	METEOR 500C	magnetron
Gdańsk	54°23'03"	18°27'22"	20 m	METEOR 1500C	klystron
Brzuchania	50°23'39"	20°04'47"	35 m	METEOR 500C	magnetron



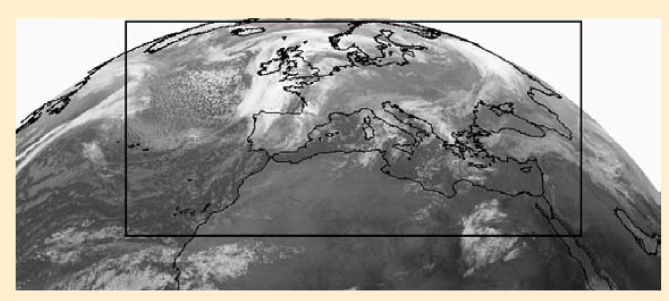
Polish meteorological radar network (POLRAD) consists of 8 radars. SRI (Surface Rainfall Intensity) is a 'hydrological' product which covers whole country by using so called 'composite radar map of Poland'. The SRI generates an image of the rainfall intensity [mm/h] in a user-selectable surface layer (SRI level). The SRI data are processed on this terrain-following layer, i.e. at a constant height above ground. The ground heights are calculated from an orographical map (DEM model). This map is also used to check for regions, where the user-selected surface layer is not accessible to the radar beam. The SRI algorithm can be applied on multiple-elevation polar volume reflectivity (dBZ or dBuZ) data.

ATS DATA SET



ATS – network of Automatic Telemetric Stations consists of 475 precipitation posts. Each post is equipped with two gauges: heated and non-heated, what enables some quality control of data. For validation purposes, readings from both gauges were compared in order to eliminate the cases of clogged instruments. If both gauges worked properly, higher values were taken into account. Telemetric posts are alocated all over the country. The network density increases in the mountainous regions of Poland, where the flood danger is higher. The measurements time resolution was set up in time step of 10 minutes, what allows estimating the rain rate with reasonable quality.

H03 DATA SET

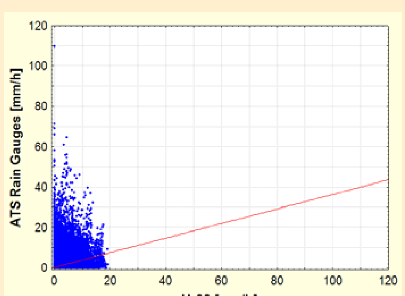


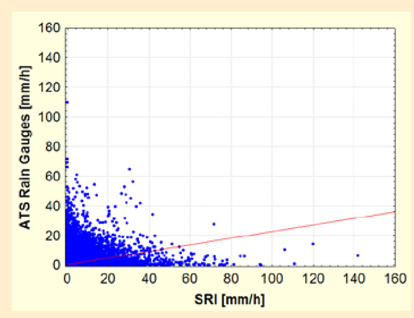
H-SAF PR-OBS-3 (H03) - Precipitation rate at ground by GEO/IR supported by LEO/MW. Product H03 is based on the IR images from the SEVIRI instrument onboard Meteosat satellites. The equivalent blackbody temperatures (TBB) are converted to precipitation rate by lookup tables updated at intervals by precipitation rate generated from MW instruments (in this case: H01 and H02). The product is generated at the 15-min imaging rate of SEVIRI, and the spatial resolution is consistent with the SEVIRI pixel. The processing method is called "Rapid Update".

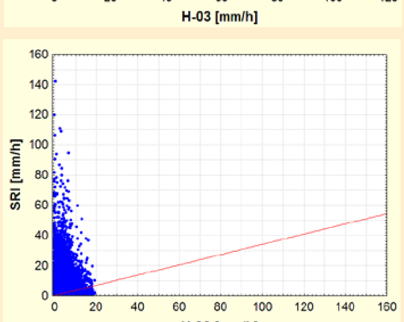
STATISTICS

All the data used in this study were interpolated to the same, common grid with the 0,1° fixed resolution. Obtained values were used to draw precipitation maps with Natural Neighbour spatialisation algorithm. The Natural Neighbour interpolation algorithm uses a weighted average of the neighbouring observations, where the weights are proportional to the Thiessen polygon. This method does not extrapolate contours beyond the convex hull of the data locations. Statistical parameters derived from the radar and ATS data sources were calculated by collation with H03 satellite precipitation information.

Although chosen time pace of presented maps depicts only very distinctive moments of storms evolution over Poland at that day, all the statistical indices were calculated using whole day precipitation data from 14th of July 2011. Continuous statistics table indices refer only to the precipitation amounts bigger that 0.25 mm.







Continuous stat.	ATS	Radar (SRI)
Number of cases	65642	63765
Max Ground	109.7	141.9
Max H03	19.3	19.3
Mean Ground	2.3	2.9
Mean H03	1.9	2.3
ME	-0.4	-0.6
St. Dev.	4.2	5.6
MAE	2.4	3.0
RMSE	4.2	5.6

Categorical stat.	ATS	Radar (SRI)
POD	0.58	0.67
False Alarm Ratio	0.5	0.62
Bias	1.16	1.75
ACC	0.83	0.85
CSI	0.1	0.08
Odds ratio	10	13.71
HSS	0.43	0.4

CONCLUSIONS

The objective of this study is to investigate the relation between liquid precipitation fields calculated from ground based networks (ATS and meteorological radar) and satellite sensor datasets (H03 product) within arbitrary chosen storm day recorded in Poland.

On the basis of presented material it can be stated that:

- Peak values are more pronouncedin radar precipitation maps than in ATS or relevant H03.In H03 case derived precipitation field is more diffused (also homogenous) and covers larger area because of precipitation retrieval method - H03 field reassembles related cloud structures (use of MSG/SEVIRI);
- Radar derived information adds more adequate and precise information on precipitation (microstructures and intensity) in comparison with ATS data (not dense enough network and subsequent interpolation faults);
- H03 tends to underestimate the 'ground truth' - especially extremely big values on precipitation. However low precipitation values are at the same time overestimated. Radar data show more of these local and medium scale events than ATS network which results in wider spread in comparison with H03 (see difference maps);
- Differences between H03, radar and ATS precipitation fields are related to nature of relevant measurement techniques. Interpolated point measurements of ATS ≠ H03 and radar precipitation field retrievals. Two physically different methods of precipitation information retrievals done by radar and ATS network are reflected in scatterplot showing two completely different data set structures - hoverer resulting (in comparison with H03 data set) with some similar statistical results.

In conclusion it may be stated that despite evident faults, radar precipitation measurements (SRI product) seems to be a good tool for satellite precipitation (H03 product) validation.

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