European Geoscience Union, General Assembly, Vienna, Austria, 7-12 April 2013

Satellite-based VIS/IR multispectral screening of precipitating clouds: A case study during summer at mid-latitudes

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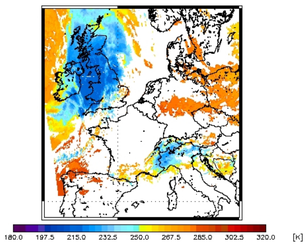
1. INTRODUCTION

✧ The detection of precipitating clouds from geostationary sensors provides a characterization on time scales consistent with the nature and development of precipitating systems and oriented to potential operational applications.
✧ The aim is to implement a precipitating cloud (PC) detection methodology based on MSG spectral channels and rain rates from the NIMROD radar network and to evaluate its performances against NIMROD data and other satellite based PC detection techniques.

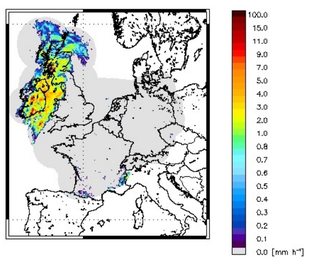
2. DATA SETS



MSG-SEVIRI DATA

17/06/2009 0630 UTC
BT at 10.8 μm

✧ Data from summer 2009 (JJA)
✧ Channels: 0.6, 1.6 (daytime), 3.9 (nighttime), 6.2, 8.7, 10.8, and 12.0 μm
✧ Cloudy pixel selection: CTTH and CEFFECT (PGE03) from SAF NWC (https://www.nwcsaf.org)
✧ Correction for parallax error: CTTH and routine elaborated by the Convection Working Group (http://www.convection-wg.org)



NIMROD c-band radar network: rain rate product
(http://badc.nerc.ac.uk)

17/06/2009 0630 UTC

✧ North-West Europe composite: 5 km spatial resolution, 15 min refresh time
✧ A matching method based on the distance between MSG and radar pixels was implemented to determine if a MSG pixel is covered by PC or not (rain rate > 0.1 mm h^{-1})

3. METHODOLOGY

(Thies et al., Atmos. Chem. Phys.,2008; Thies et al., Meteorol. Appl., 2008)

$$PI(x_1,...,x_n) = \frac{N_p(x_1,...,x_n)}{N_p(x_1,...,x_n) + N_{np}(x_1,...,x_n)}$$

Look-up tables of Probability Index (PI)

✧ July and August 2009 data sets
✧ $x_1,\ldots,x_n$: MSG spectral features, 0.6/1.6 (reflectances ratio, daytime), BTD(3.9-10.8) (nighttime), BT10.8, BTD(10.8-12), BTD(6.2-10.8), BTD(8.7-10.8)
✧ N_p and N_{np}: frequencies of PC and non-PC pixels having $x_1,\ldots,x_n$ values for the selected features

PC detection

$PI(x_1,\ldots,x_n) > PI_{th}$ with threshold values determined by maximizing the Equitable Threat Score (ETS)

4. RESULTS and CONCLUSIONS

The daytime approach is most effective in PC detection as shown by ETS, ACC, FAR, and POFD values.

	Day	Night	Twilight
ACC	0.88	0.76	0.84
BIAS	1.15	1.70	1.27
POD	0.60	0.66	0.48
FAR	0.48	0.61	0.62
POFD	0.08	0.21	0.11
ETS	0.33	0.21	0.20
HK	0.52	0.45	0.37

June 2009 – PC detection algorithm vs NIMROD rain rates

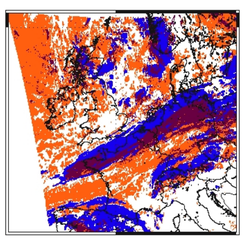
During nighttime, when the 0.6/1.6 spectral feature is substituted with BTD(3.9-10.8), the statistical parameters indicate a lower skill in PC detection, which further decreases in twilight conditions.

→ Overestimation of the raining areas

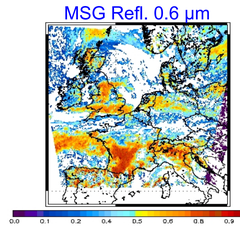
	mean	stdev
ACC	0.87	0.07
BIAS	1.45	1.89
POD	0.47	0.17
FAR	0.61	0.16
POFD	0.09	0.06
ETS	0.22	0.10
HK	0.38	0.15

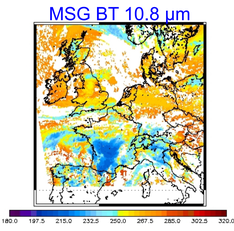
PGE04	mean	stdev
ACC	0.90	0.06
BIAS	0.80	0.69
POD	0.29	0.20
FAR	0.57	0.21
POFD	0.05	0.05
ETS	0.16	0.11
HK	0.24	0.17

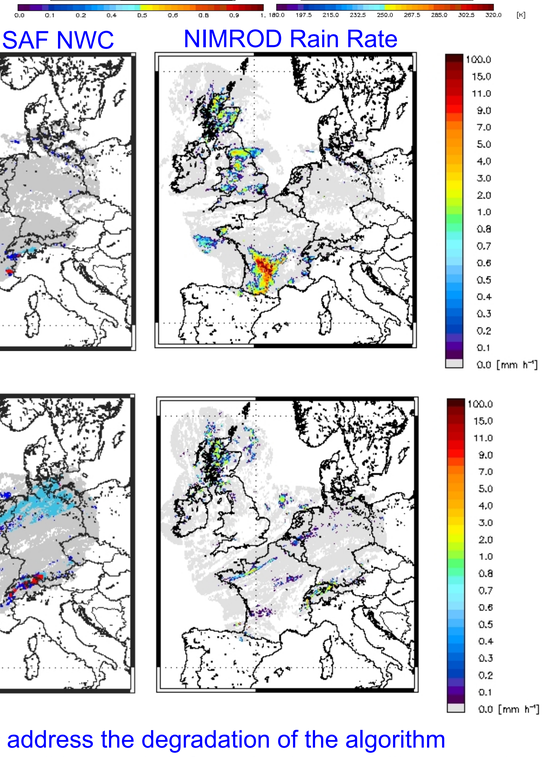
June 2009 – PC detection algorithm vs Precipitating Cloud product (PGE04) from the SAF NWC



CLOUD PHASE (PGE02) - SAF NWC
ice cloud
water cloud
undefined







05/06/2009 1615 UTC
ETS = 0.45, BIAS = 1.02, POD = 0.70, FAR = 0.32
misses → 0.63 mm h^{-1}

ability to detect PC with low rain rates (< 3mm h^{-1})

good skill in identifying PC with cold tops, optically thick, and associated to moderate-intense rain rates

19/06/2009 0115 UTC
ETS = 0.06, BIAS = 2.99, POD = 0.43, FAR = 0.86
misses → 0.73 mm h^{-1}

a wide cloud covered area is erroneously identified as precipitating

Future work:

✧ further investigations are needed to address the degradation of the algorithm performance when the illumination conditions switch from daytime to twilight and vice versa
✧ other periods of the year have to be considered to take into account the cloud variability due to seasons
✧ the method can be applied to other geographical regions from mid-latitude to tropical areas