On application of Extended Probabilistic Cloud Mask algorithm to SPOT-5 Take5 data

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Introduction

Fast and accurate cloud screening complemented with associated uncertainties is crucial for numerous satellite data analyses. It allows for an error budget estimation of consecutive products and gives flexibility in terms of cloud mask adjustment. Within this scope the Probabilistic Cloud Mask (PCM) algorithm suited for AVHRR imagery was developed (Musial et al., 2014a), that generates classification probabilities for three categories: cloudy, clear, and snow. Recently, its functionality have been extended to other cloud products (e.g. cloud optical depth and radius) and other sensors. The presented feasibility study was performed to assess the applicability of the xPCM algorithm to SPOT-5 data.

Data & Methods

In the study 93 SPOT-5 Take-5 L2A PENTE images (Figure 1) collected over 5 sites in Poland were used. 70 randomly selected scenes were used for training and 23 scenes were used for validation. The premise of the xPCM is based on a multidimensional matrix that contains cloud probability estimates. Each dimension corresonds to reflectances of 4 spectral channels of the HRG sensor. The matrix is further reduced to a Look-Up Vector (LUV) using step functions proposed by (Musial et al., 2014b), where reflectances are combined into a single value using bitwise operations. During the algorithm training, for each value within the LUV a total counts of cloudy and clear pixels are derived. The cloud probability is computed as a ratio of cloudy pixels to total pixel counts. Within the xPCM retrieval reflectances are combined into a single value using bitwise operation. These values are located within the LUV using a binary search algorithm and cloud probability estimates are retrieved. The binary cloud mask is generated using the 50% probability threshold.

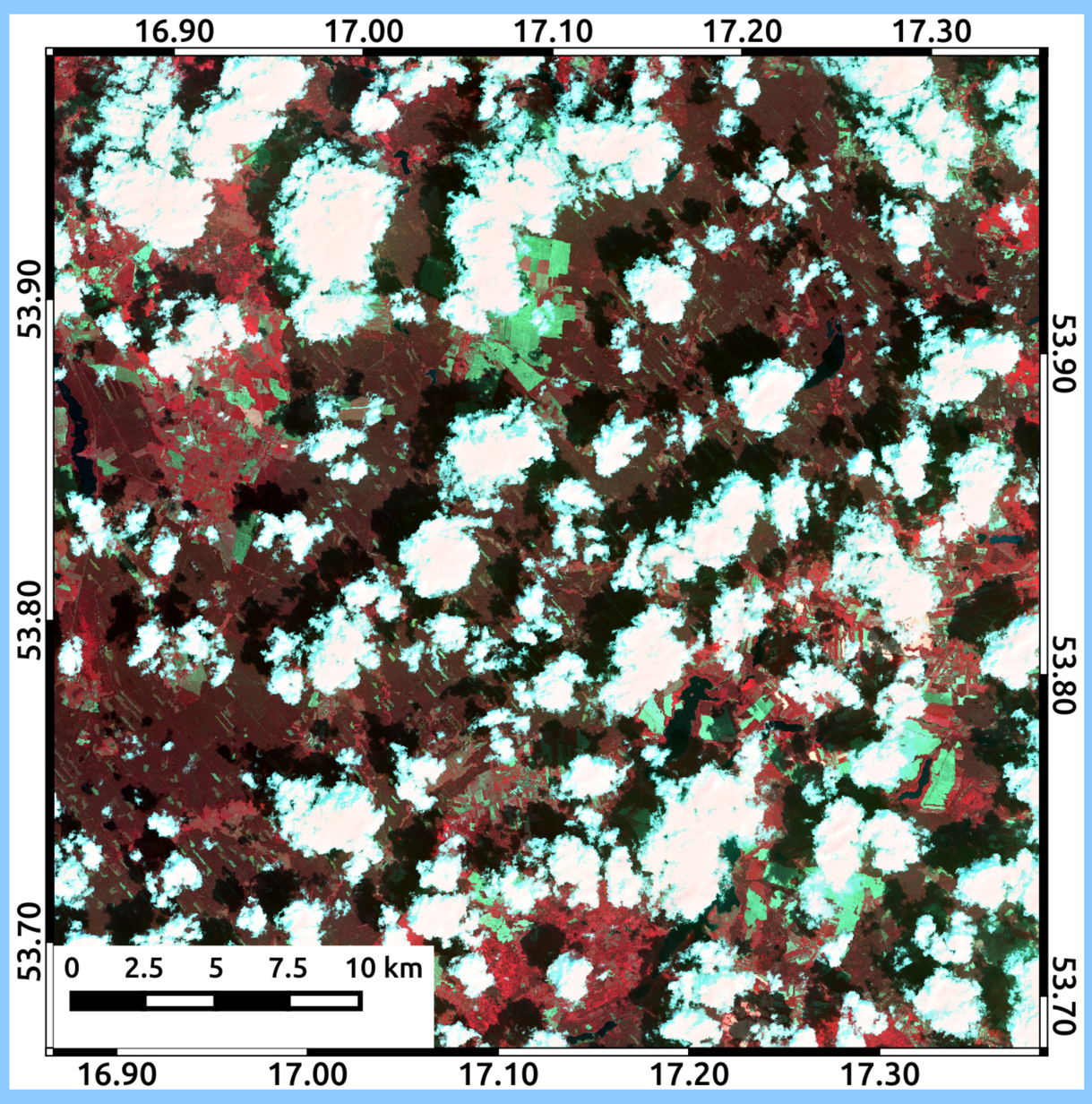


Fig.1: SPOT5 image 22.05.2015 (R: 835 nm G: 645 nm B: 545 nm)

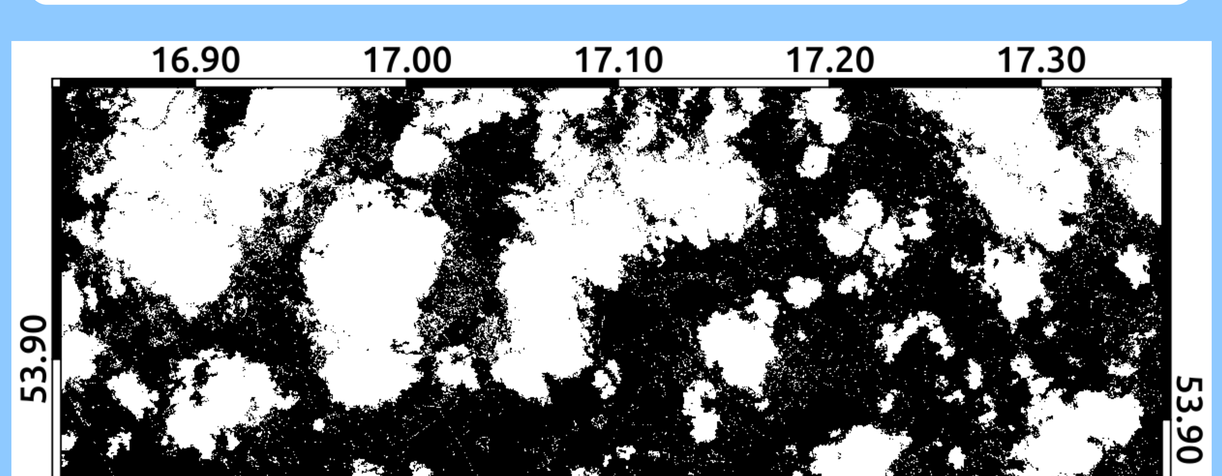


Fig.2: Binary cloud mask derived as xPCM cloud probability > 50 %

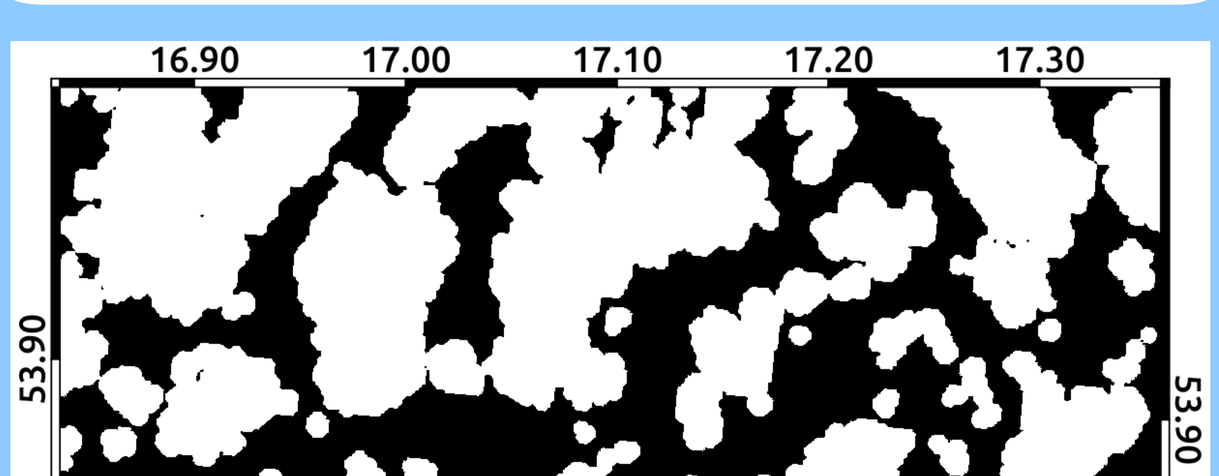


Fig.3: Standard SPOT-5 cloud mask embeded in NUA product (bit 1)

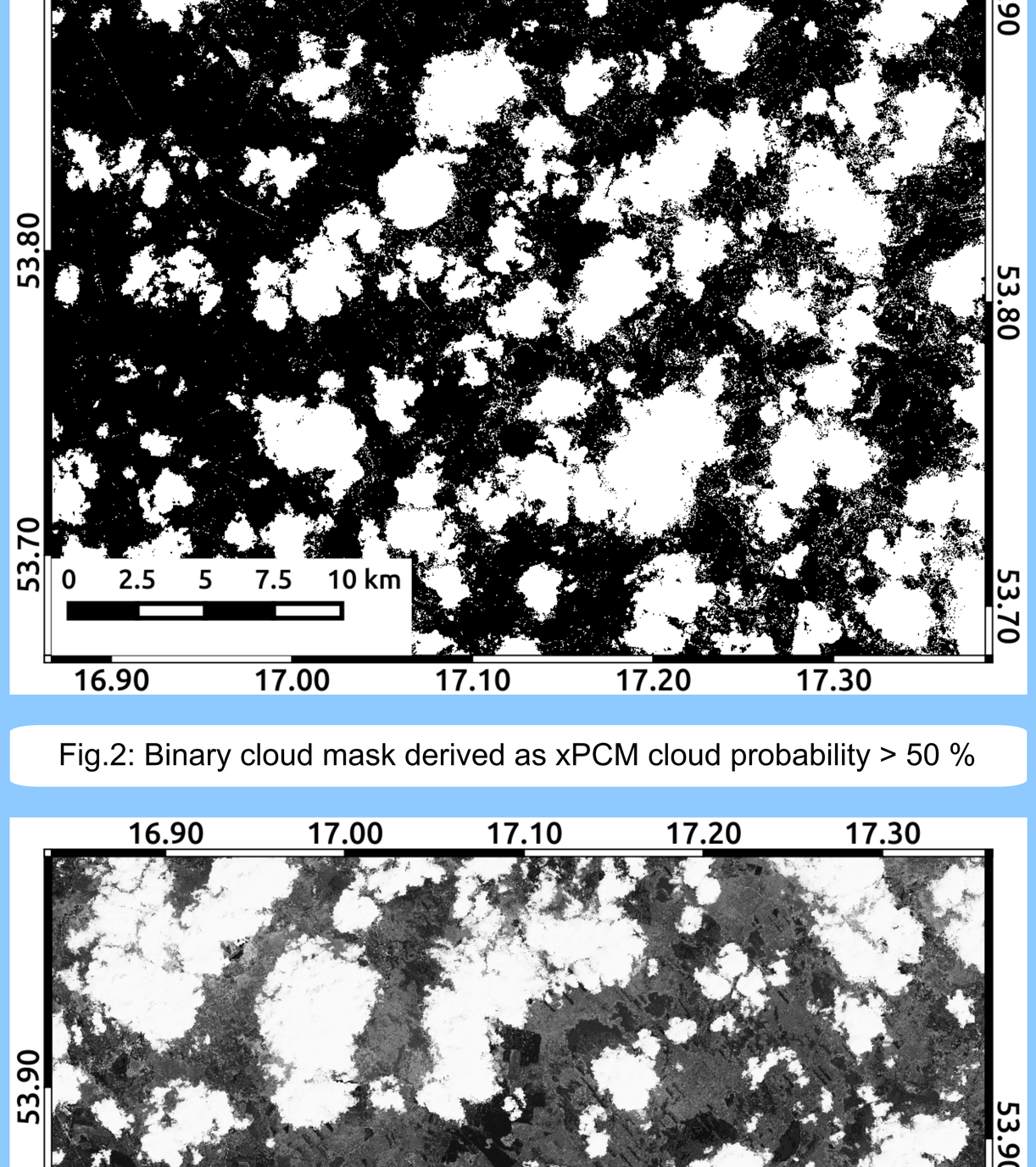
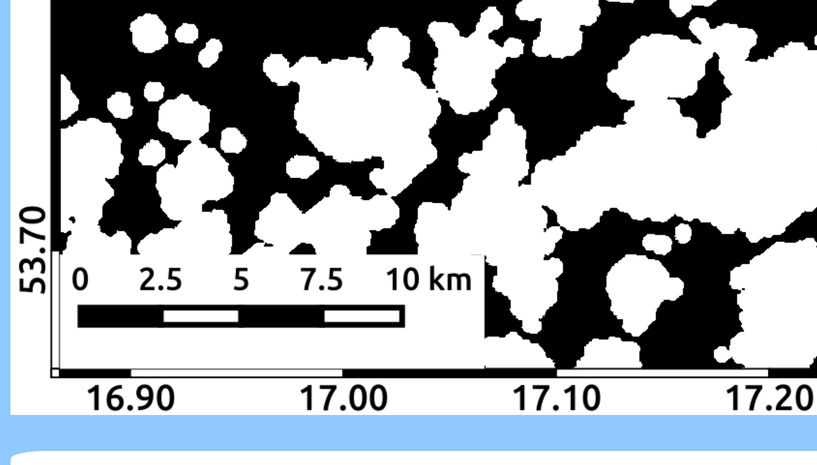


Fig.4: xPCM probabilistic cloud mask

Results

The xPCM was applied to 23 randomly selected SPOT-5 scenes. Example of generated products are presented on Figures 2 & 4. Overall agreement with the SPOT-5 cloud mask (Figure 3) is good with few misclassified pixel covering bright objects such as roads and barren fields. The results of 23 binary xPCM cloud mask were validated against matching SPOT-5 products. The derived skill scores: Probability of Detection (POD), False Alarm Rate (FAR), Hit Rate (HR) and Kuiper Skill Score (KSS) prove high accuracy of the xPCM classification. Further, the cloud probability distribution was computed (Figure below) which features characteristics U shape, with majority of pixels confidently classified as clear or cloudy.



Skill scores

POD_{cloud} = 0.76
POD_{clear} = 0.96
FAR_{cloud} = 0.09
FAR_{clear} = 0.12
HR = 0.89
KSS = 0.72

References

Musial, J. P., Hüsler, F., Sütterlin, M., Neuhaus, C., & Wunderle, S. (2014a). Probabilistic approach to cloud and snow detection on Advanced Very High Resolution Radiometer (AVHRR) imagery. Atmospheric Measurement Techniques, 7(3), 799-822.

Musial, J. P., Hüsler, F., Sütterlin, M., Neuhaus, C., & Wunderle, S. (2014b). Daytime low stratiform cloud detection on AVHRR imagery. Remote Sensing, 6(6), 5124-5150.