

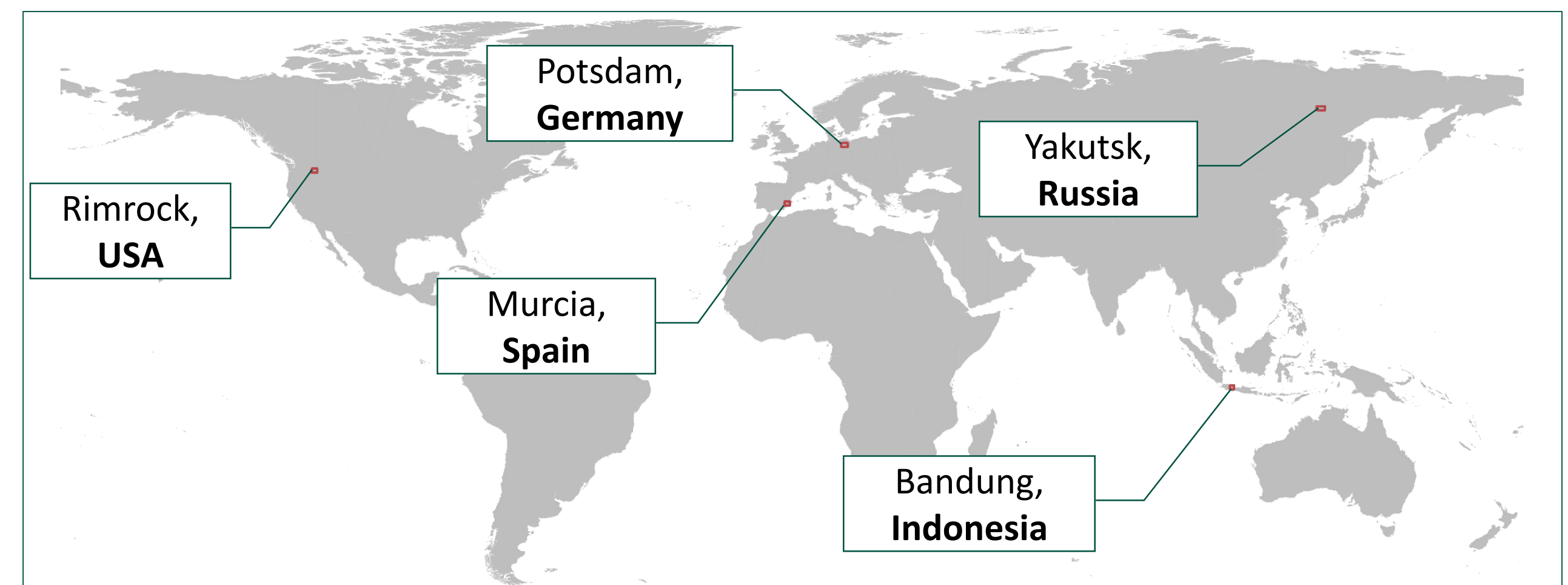
Validation of the Copernicus Sentinel-2 Sen2cor Scene Classification Products

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INTRODUCTION

- Sen2cor processed Sentinel-2 from the Top-Of-Atmosphere (TOA) Level 1C products to Level 2A products in the form of surface reflectance (Bottom-of-Atmosphere, BOA), Aerosol Optical Thickness (AOT), Scene Classification (SCL), and Water Vapor (WV)
- We investigated the performance of Sen2Cor 2.11 SCL on Sentinel-2 **Processing Baseline (PB) 04.00** products (25 January – 5 December 2022) in separating clear pixels from cloudy and shadowed pixels
- In order to generate reference pixels, we utilized **Sen2val** tools that were developed within the frame of the Level-2A Expert Support Laboratory (ESL) of the **Sentinel-2 Optical Mission Performance Cluster (OPT-MPC)**
- A time series of scenes from five globally distributed test sites in Germany, Spain, United States, Russia, and Indonesia were selected during the span of the PB 04.00
- The criteria of scene selection are cloud cover nearest to 20% and no data pixels of less than 30%



Northern latitude season	winter	spring	summer	fall
Yakutsk	T52VEP Febr.		July	
Potsdam	T33UUU	March		August
Rimrock	T11TMM	April		Sept.
Murcia	T30SKH		May	Oct.
Bandung	T48MZT		June	Nov.

METHODOLOGY

Validation basis

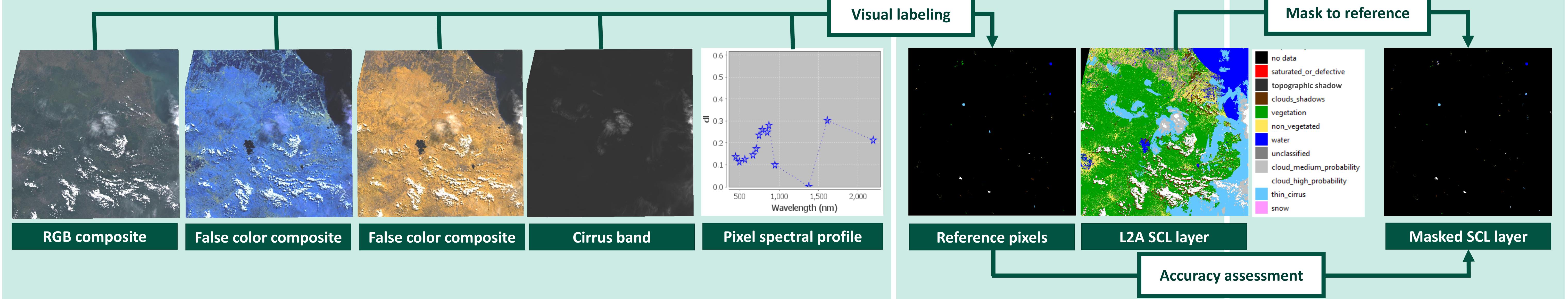
- Sentinel-2 band composites:
 - Red (B4) – green (B3) – blue (B2): to help differentiate vegetation, dark features, and shadows
 - SWIR (B12) – SWIR (B11) – NIR (B8A): to help differentiate water, clouds, and snow
 - NIR (B8A) – NIR (B6) – NIR (B5): to help differentiate vegetation, clouds, and shadows
- Pixel spectral profiles
- L1C cirrus band

Stratified random sampling

- Randomized subset selection
- Drawing polygons of homogeneous pixels to assign them into an SCL class
- Number of labeled pixels per class controlled to be stratified

Accuracy assessment

- Confusion matrix
- Overall accuracy (OA)
- Producer and User accuracy (PA, UA)
- Omission and Commission error (OE, CE)



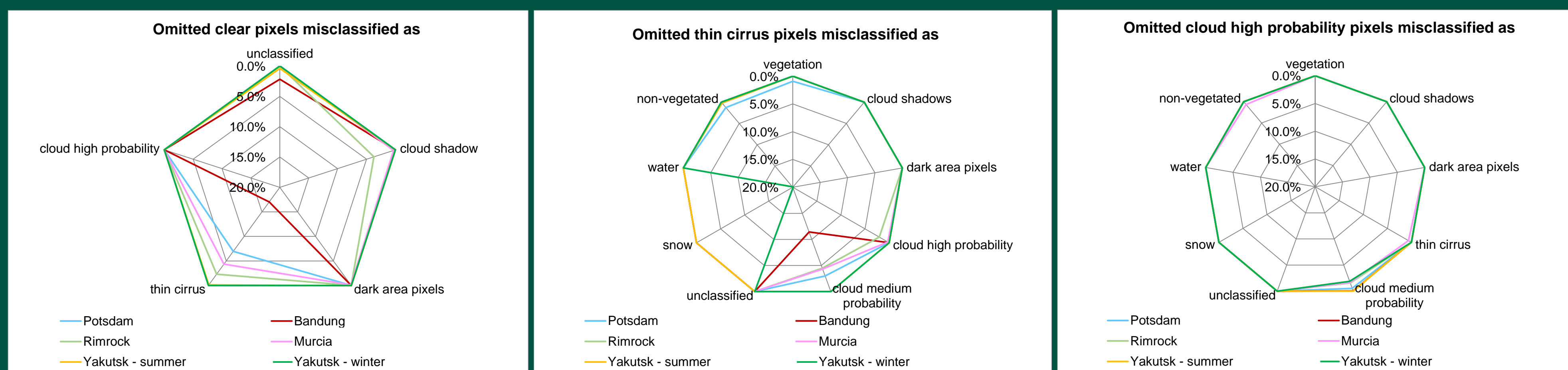
RESULTS

SCL accuracy scores are reported separately for **products without snow cover** and **with snow cover**

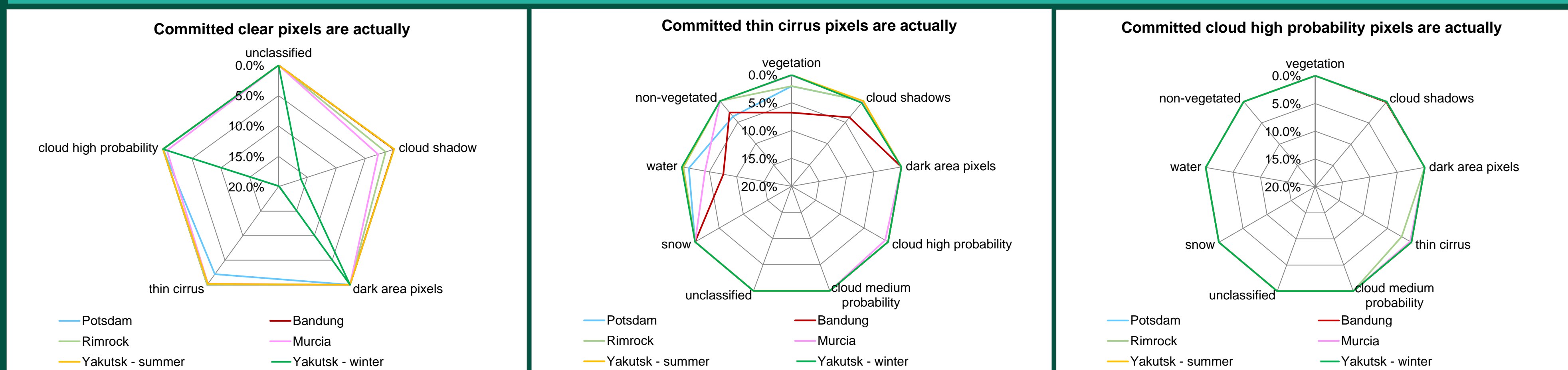
Products without snow cover						
	Clear pixels	Cloud pixels	sum	UA	CE	OA
Clear pixels	54%	2%	56%	97%	3%	90%
Cloud pixels	9%	35%	44%	80%	20%	
sum	63%	37%	100%			
						Balanced OA
PA	86%	95%				92%
OE	13.6%	5.1%				

Products with snow cover						
	Clear pixels	Clouds pixels	sum	UA	CE	OA
Clear pixels	45%	36%	81%	55%	45%	63%
Clouds pixels	1%	18%	19%	95%	5%	
sum	46%	54%	100%			
						Balanced OA
PA	98%	33%				77%
OE	1.9%	66.8%				

Class omission error



Class commission error



CONCLUSIONS

- Sen2cor performed SCL on **scenes without snow cover relatively better** than on scenes with snow cover
- On snow covered scenes, thin cirrus pixels are often misclassified as snow due to **similarity in spectral profiles**
- Cloud shadow pixels on snow are also often misclassified as clear pixels due to its **brighter reflectance compared to cloud shadow on land without snow cover**
- Balanced overall accuracy of scenes without snow cover is **92%**, as for scenes with snow cover **77%**

