

# Latest update on C2 Cloud Mask and Extension to PV-CC

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ESA Proba-V QWG #12  
October 27-28, 2020

# Outline

Last QWG meeting:

1. Final CM trained (UV), implemented (VITO) and validated (BC) at 100m, 333m and 1km
2. Better cloud detection results than C1
3. Consistent results between the C2 CM at all scales

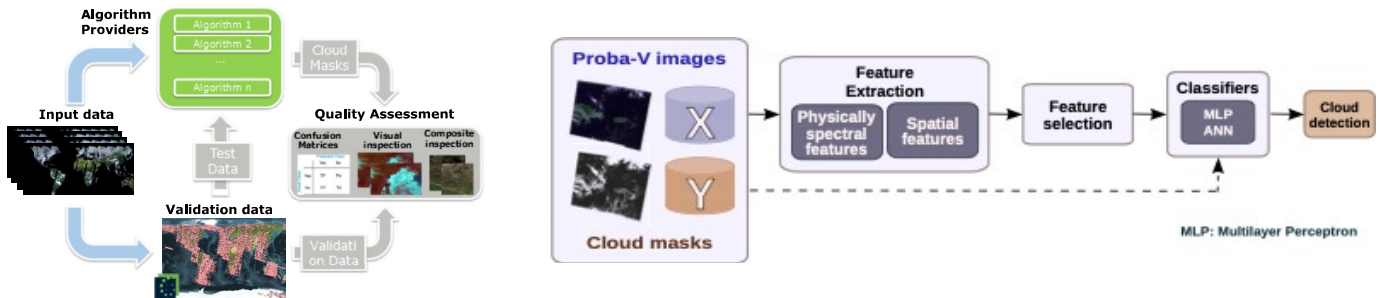
Outline:

1. Summary of the C2 Cloud Mask Approach
2. Extension to Proba-V Cubesat Companion

Proba-V C2 Cloud Mask

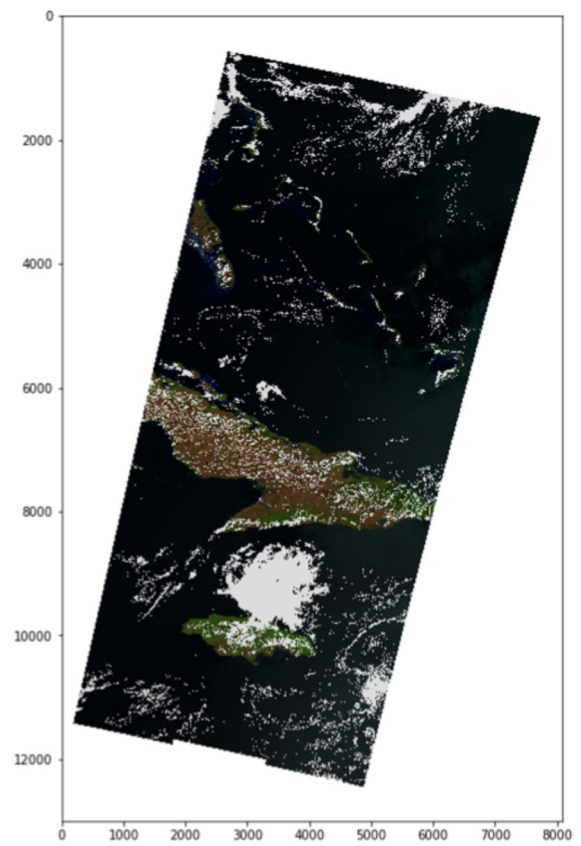
# Cloud Mask Approach

- Cloud detection approached as a complex binary classification
- Statistical machine learning methods directly learn from data:
  - Manual Ground Truth
- Available training set determines the quality of the results:
  - Number of samples, accurate labels, comprehensive cases



# Final Implemented Prototype

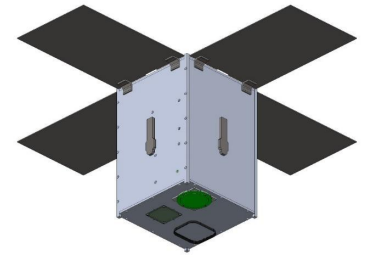
- Single global model
  - No ancillary data required
  - No multitemporal information
  - Simple input features in small patches
  - Fast simple implementation
    - MLP NN models



# Proba-V Cubesat Companion

# PVCC: Proba-V Cubesat Companion

- Optical VNIR-SWIR camera identical to the one on Proba-V
  - Re-use of PROBA-V ground segment
  - Cross calibration of PROBA-V and PV-CC
- Application Objectives
  - Different observation geometry (view and sun angles)
  - Harmonization of datasets captured by different platforms, in a different orbit, but with the same sensor
  - Calibration / Validation for small satellites



# PVCC: Proba-V Cubesat Companion

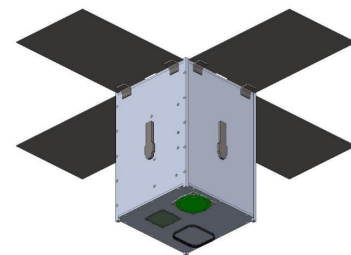
- Optical VNIR-SWIR camera identical to the one on Proba-V
  - Re-use of PROBA-V ground segment
  - Cross calibration of PROBA-V and PV-CC

## **Transfer learning from Proba-V CM to PV-CC**

- Application Objectives


- Different observation geometry (view and sun angles)
- Harmonization of datasets captured by different platforms, in a different orbit, but with the same sensor
- Calibration / Validation for small satellites

## **Domain Adaptation between Proba-V and PV-CC**










# PVCC: Proba-V Cubesat Companion




ISPRS Journal of Photogrammetry and Remote Sensing  
Volume 160, February 2020, Pages 1-17



## Transferring deep learning models for cloud detection between Landsat-8 and Proba-V

Gonzalo Mateo-García , Valero Laparra , Dan López-Puigdollers , Luis Gómez-Chova 

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**Transfer learning from Proba-V CM to PV-CC**

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## Cross-Sensor Adversarial Domain Adaptation of Landsat-8 and Proba-V images for Cloud Detection

Publisher: IEEE [Cite This](#) [PDF](#)

Gonzalo Mateo-Garcia; Valero Laparra; Dan Lopez-Puigdollers; Luis Gomez-Chova [All Authors](#)

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**Published in:** IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing ( Early Access )

**Page(s):** 1 - 1 **DOI:** 10.1109/JSTARS.2020.3031741

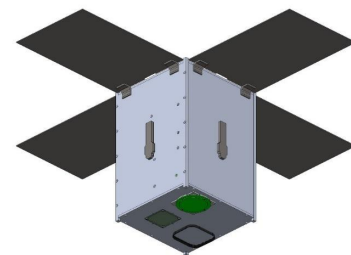
**Date of Publication:** 21 October 2020  **Publisher:** IEEE

<https://doi.org/10.1109/JSTARS.2020.3031741>

**Domain Adaptation between Proba-V and PV-CC**

# PVCC: Proba-V Cubesat Companion

- Launch: Q2 2020 → Q1 2021 → **Q4 2021**
  - *“The risk that the launch of PVCC will happen only in Q4 2021 is quite high, so there is the possibility that we don't have at all **simultaneous acquisitions** of Proba-V and PVCC within Oct 2021”* – Roberto Biasutti



## **Transfer learning from Proba-V CM to PV-CC**

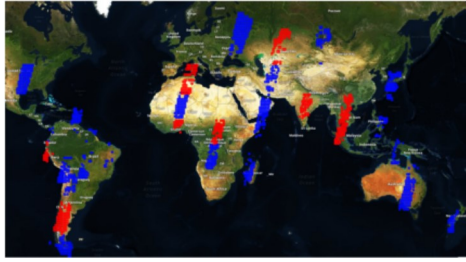
- Model trained on Proba-V data could be directly used

## **Domain Adaptation from PV-CC to Proba-V**

- DA transformation can be learned from unpaired images (no coregistered/simultaneous acquisitions required)

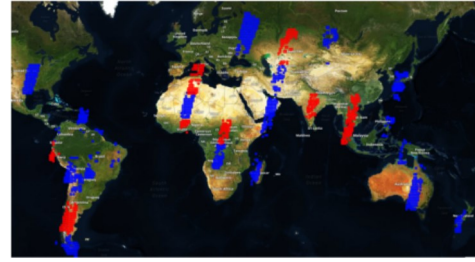
# Transfer learning of cloud detection models

1 RR@100m: (34) 25 train 9 test



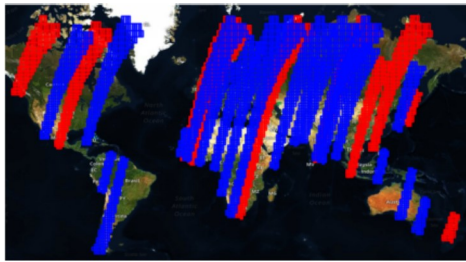
GT100m

2 RR@300m: (34) 25 train 9 test



GT300m  
@100m

3 Ext30@100m 20 train 10 test



ensemble  
NN300m

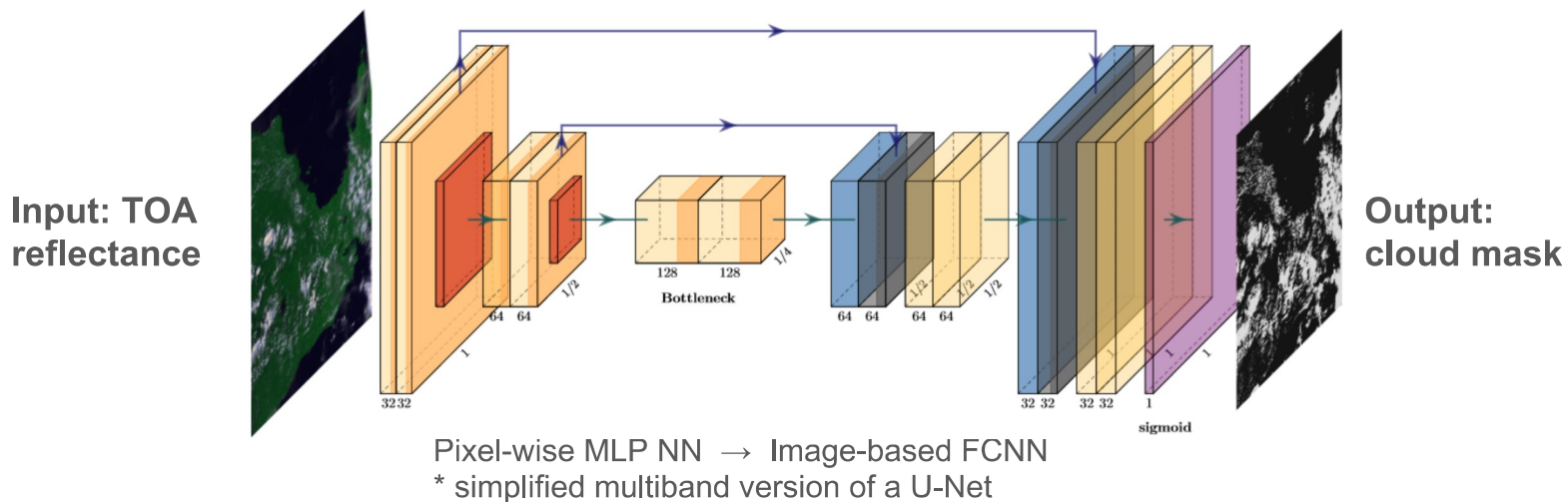
4 UCL@100m: 22 900x900 validation



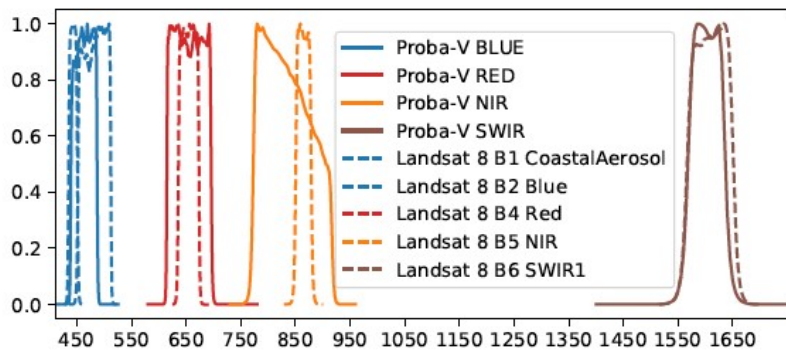
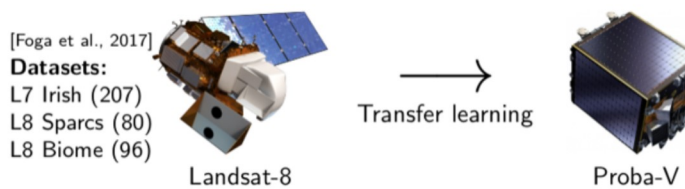
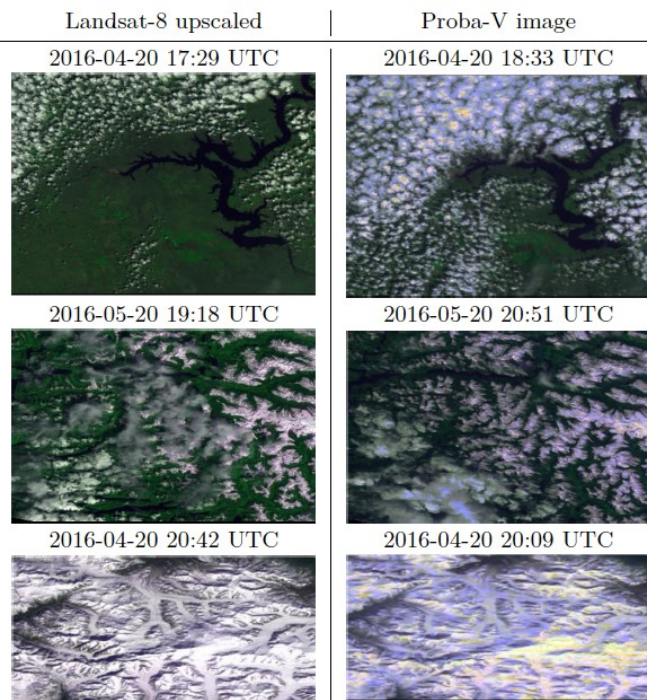
UCL100m

# Transfer learning of cloud detection models

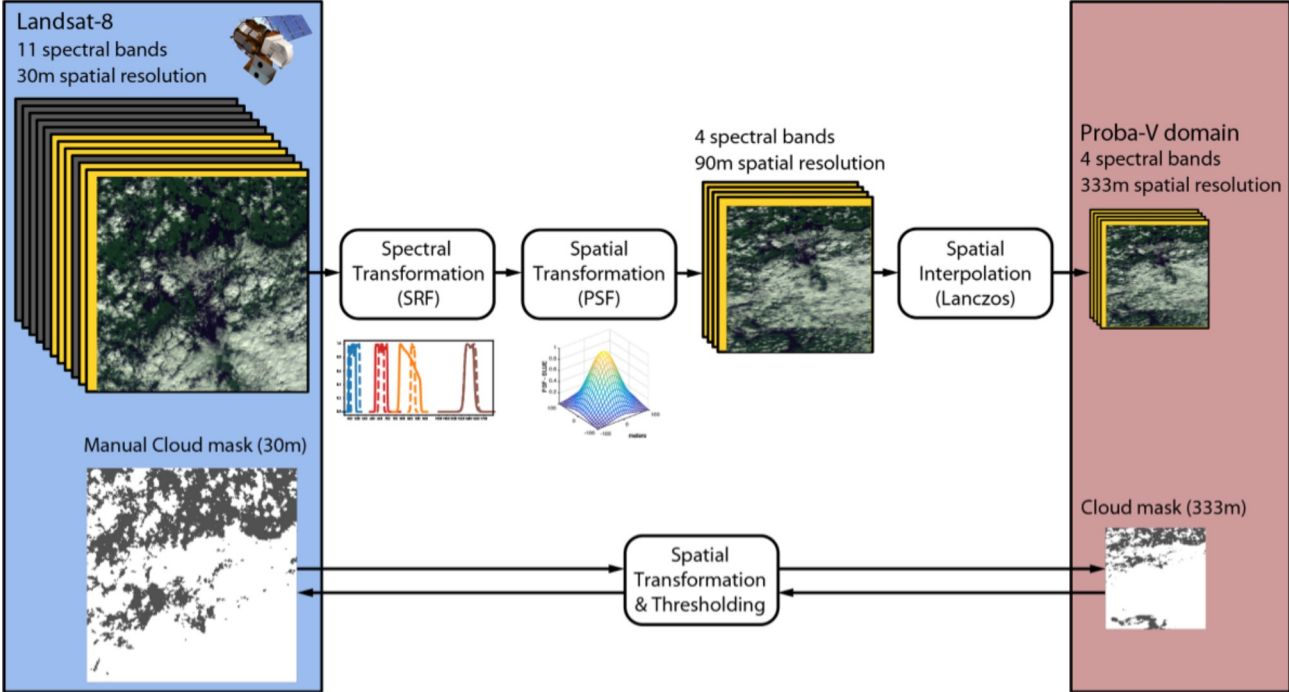
- Fully Convolutional Neural Networks (spectral and spatial information)



# Domain adaptation across similar sensors

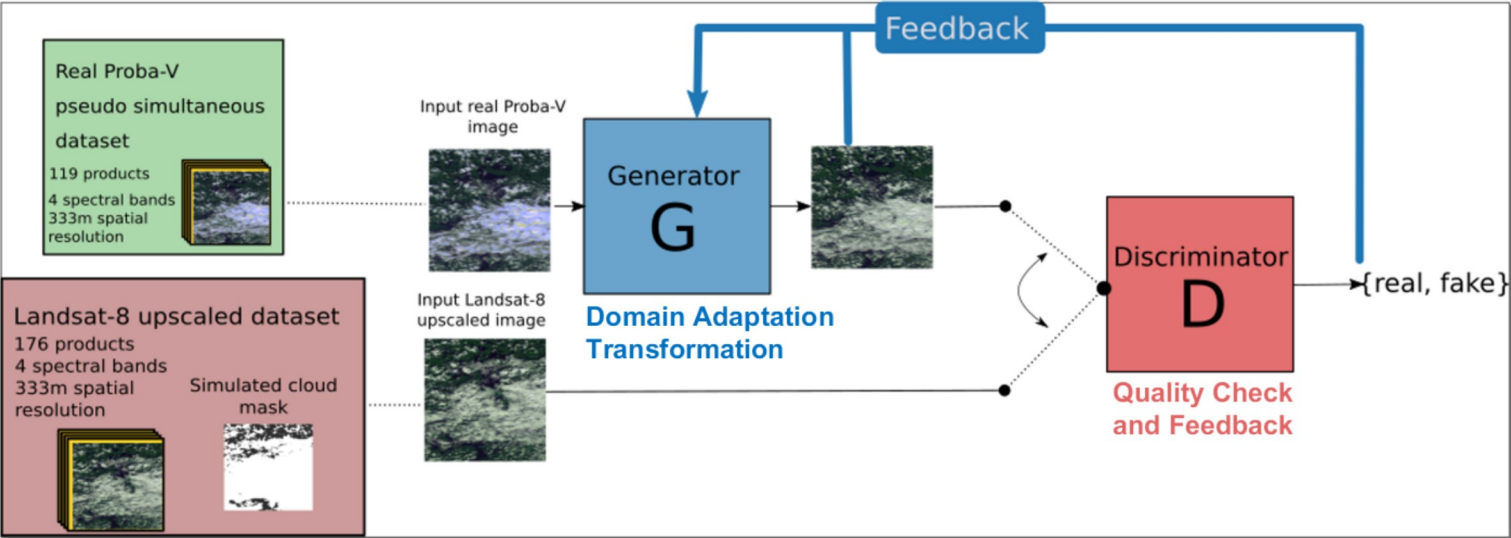


# Domain adaptation across similar sensors



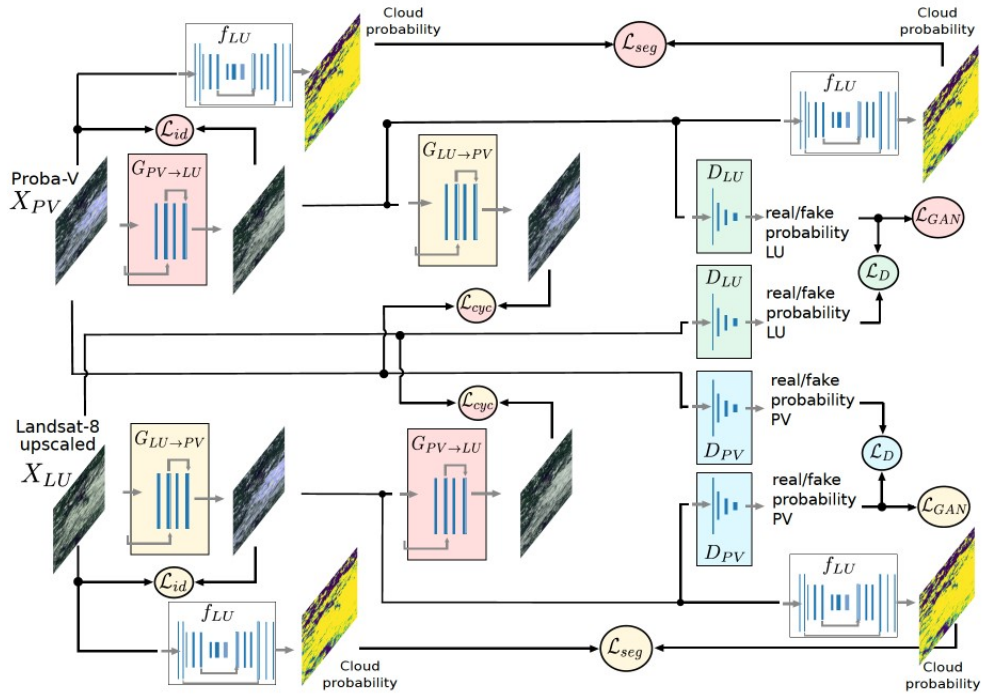
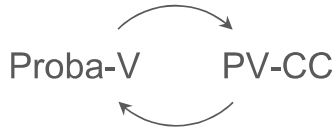
# Domain adaptation across similar sensors

- Generative Adversarial Domain Adaptation using GANs



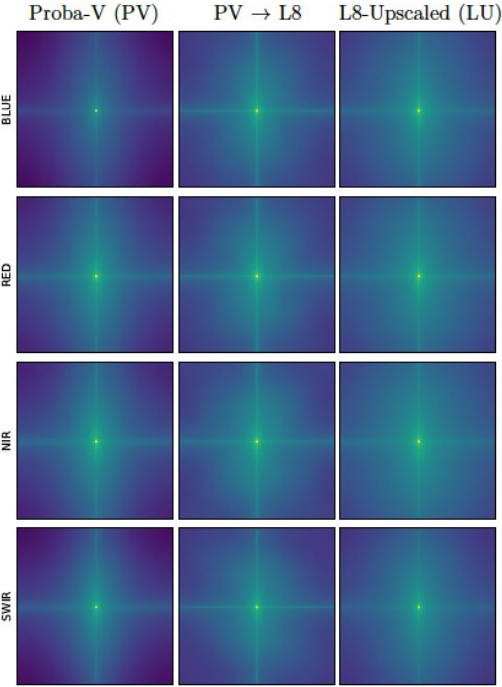
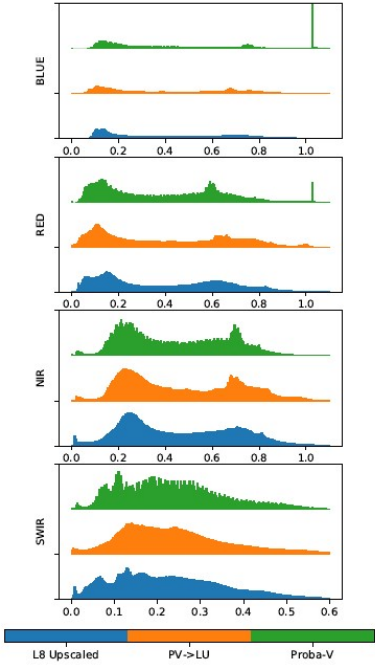
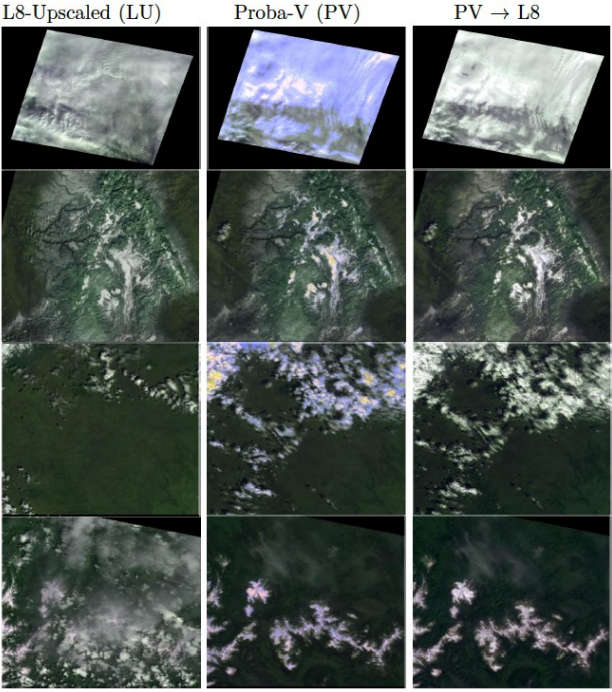
# Domain adaptation across similar sensors

CycleGANs:

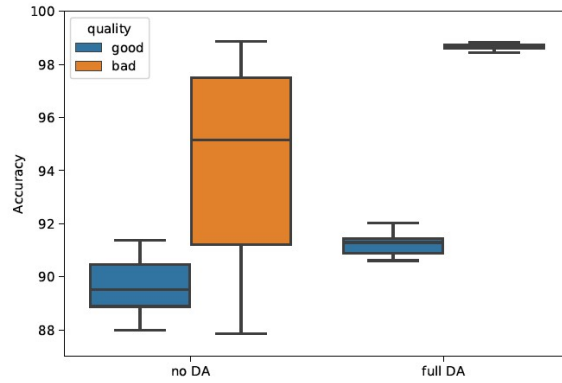
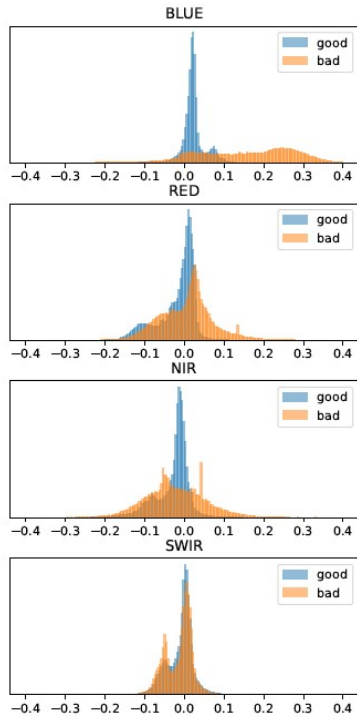




# Domain adaptation across similar sensors



# Domain adaptation across similar sensors



**“bad pixels”** of the Proba-V products quality flag:

- Different radiometric and cloud detection discrepancies
- Quality flags were not used for training models
- High adaptations can be used to find calibration issues (Proba-V vs PV-CC, Proba-V vs S3)
- Adaptation ratios can be used to validate calibration factors

# Summary and Next Steps

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## C2 Cloud Mask Summary:

- CM models trained (UV), implemented (VITO) and validated (BC)
- Better cloud detection results than C1
- Consistent results between the C2 CM at all scales

## Next steps:

- Preparation of a paper summarizing the Proba-V C2 CM
- Transfer learning from Proba-V to PV-CC using FCNNs
- Domain Adaptation from PV-CC to Proba-V using GANs

## Contribution to PV-CC:

- PV-CC Cloud Mask from the first acquisition and further improvements
- Cross calibration and harmonization of PROBA-V and PV-CC datasets

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