

Domain adaptation and synergistic exploitation of PV-CC in combination with S-2/S-3

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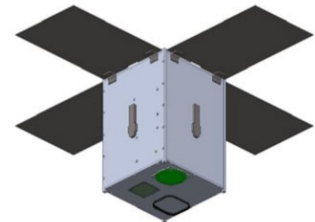
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ESA Proba-V QWG #13
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PV-CC: Proba-V Cubesat Companion

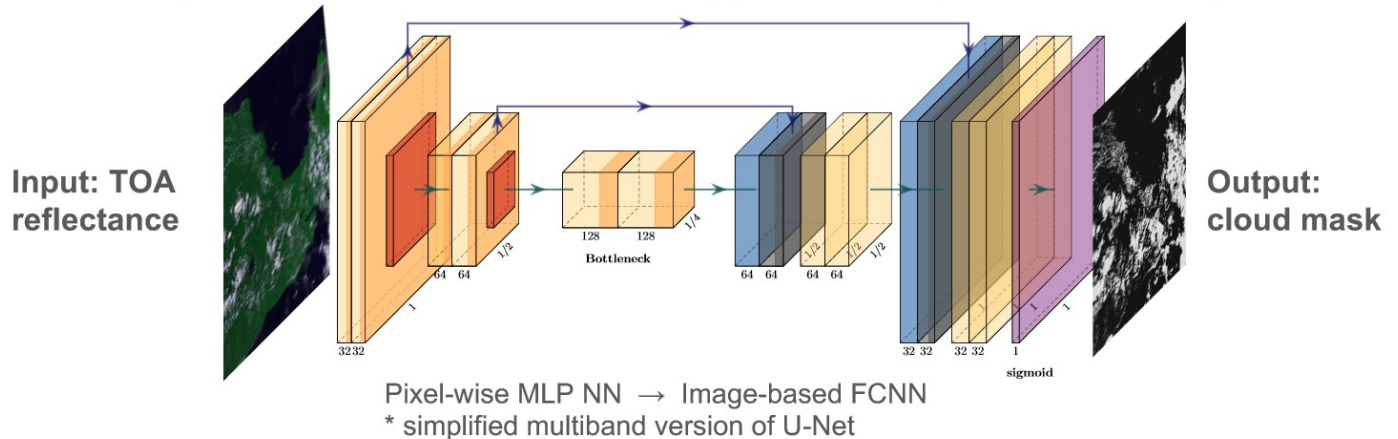
- PV-CC VNIR-SWIR camera identical to Proba-V
 - Launch Jan 2022 / March 2022? (no simultaneous acquisitions)
 - Ground Sampling Distance ~70m
 - Expected revisit of 13 days
- PV-CC Exploitation Plan
 - Re-use of PROBA-V ground segment
 - Cross calibration of PROBA-V and PV-CC (few months?)
- Exploitation opportunities using Deep Learning
 - 1 **Transfer learning** from Proba-V Cloud Mask to PV-CC
 - 2 **Cross-sensor Domain Adaptation** to assess the consistency of PV-CC products
 - 3 **Fusion of PV-CC and Sentinel** products: spatial and temporal sampling enhancement



1


Transfer learning from Proba-V CM to PV-CC

- Re-use of PROBA-V ground segment (Collection 2 CM based on MLP NN)
- Transfer learning: Models trained on Proba-V data could be directly used
- Fully Convolutional Neural Networks (spectral and spatial information)



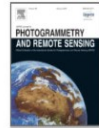
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Transfer learning from Proba-V CM to PV-CC










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

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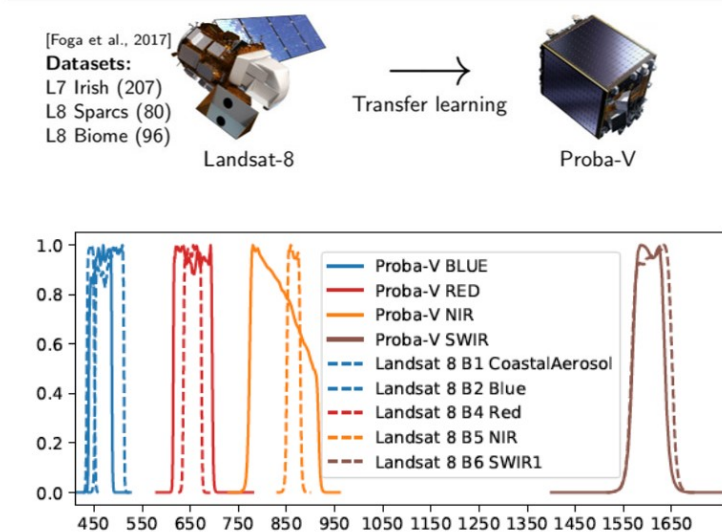
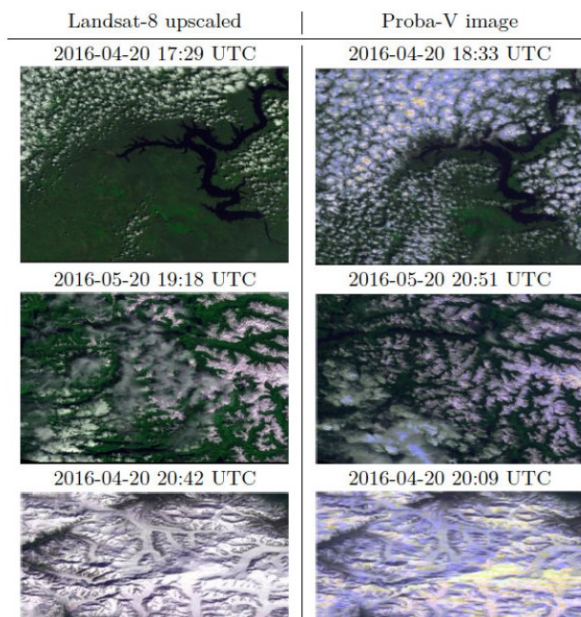
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Domain adaptation across similar sensors

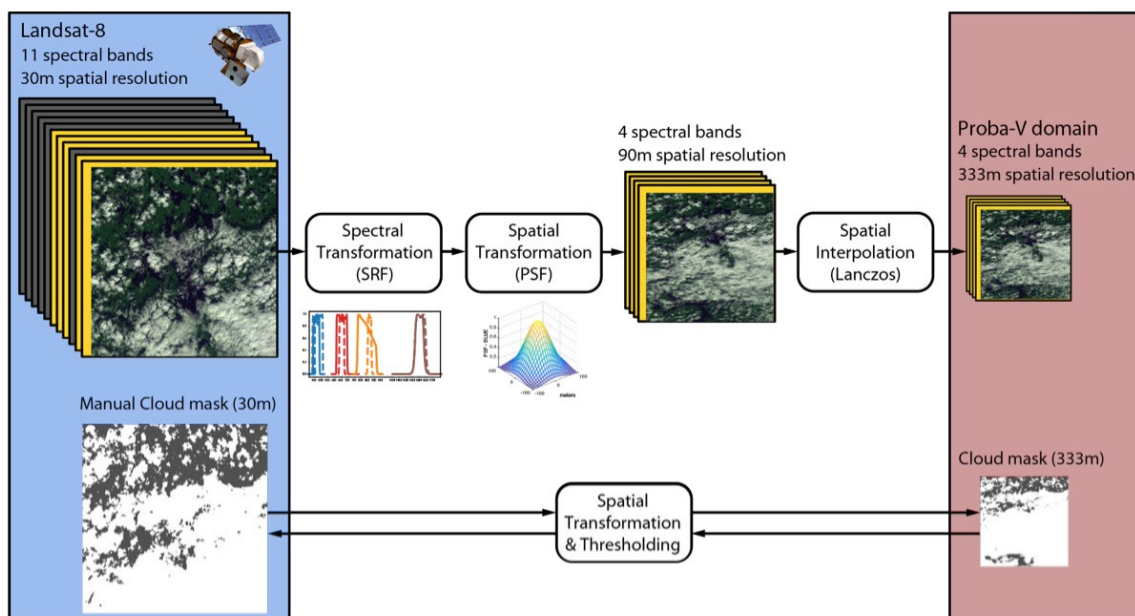
- Domain Adaptation from PV-CC to Proba-V
 - Cross calibration of PROBA-V and PV-CC (no close in time images)
 - Domain Adaptation between PV-CC and Sentinel-3 & Sentinel-2
 - Harmonization of datasets captured by different platforms
 - Validation of calibration for small satellites such as PV-CC
- Generative Adversarial Domain Adaptation using GANs
- Learned from unpaired images (no co-registered/simultaneous acquisitions)
 - Useful for any general purpose cross-sensor application
 - PROBA-V archive can be used as a proxy of PV-CC data

Domain adaptation across similar sensors



2

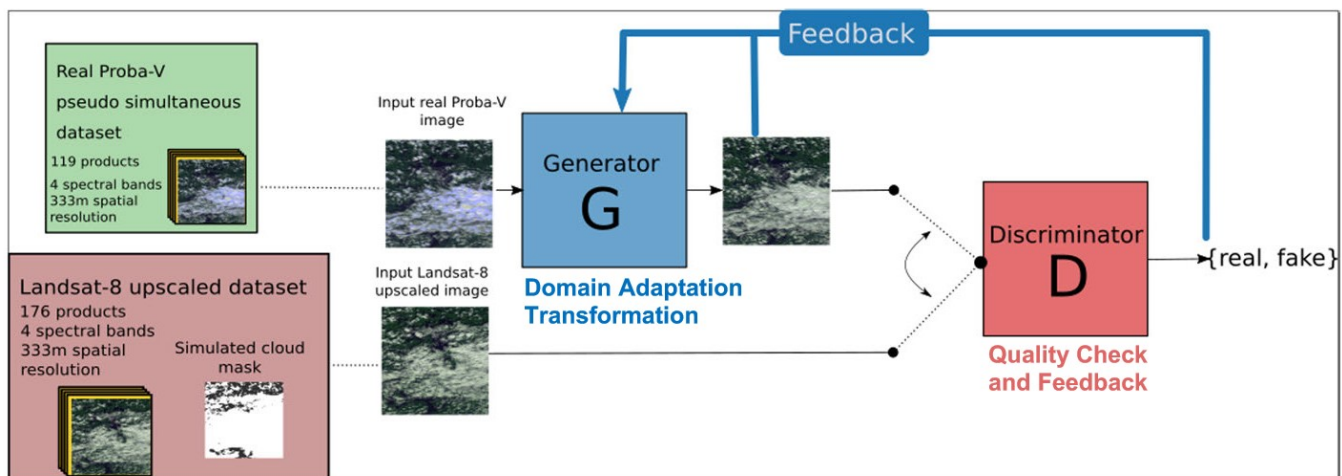
Domain adaptation across similar sensors



2

Domain adaptation across similar sensors

- Generative Adversarial Domain Adaptation using GANs



2

Domain adaptation across similar sensors

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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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2

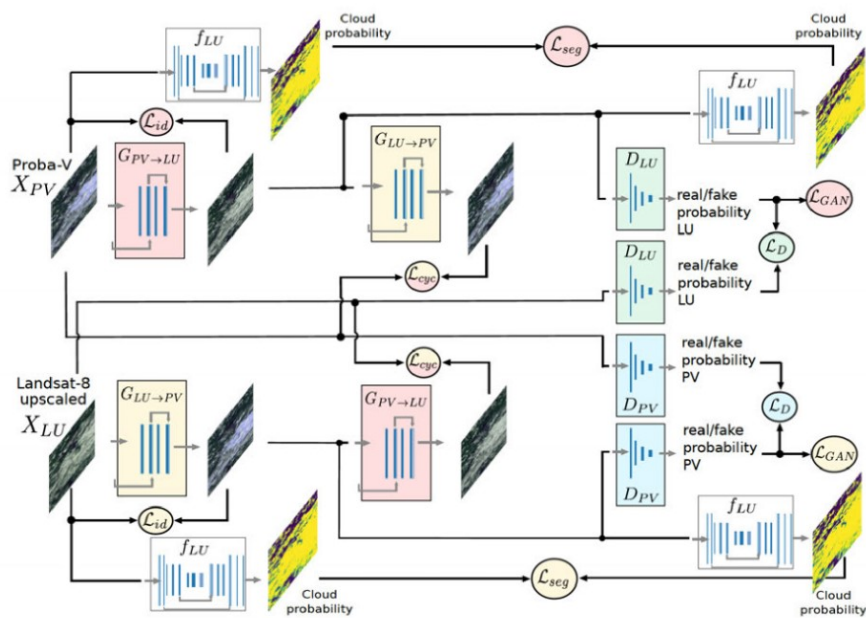
Domain adaptation across similar sensors

CycleGANs:

Both directions:

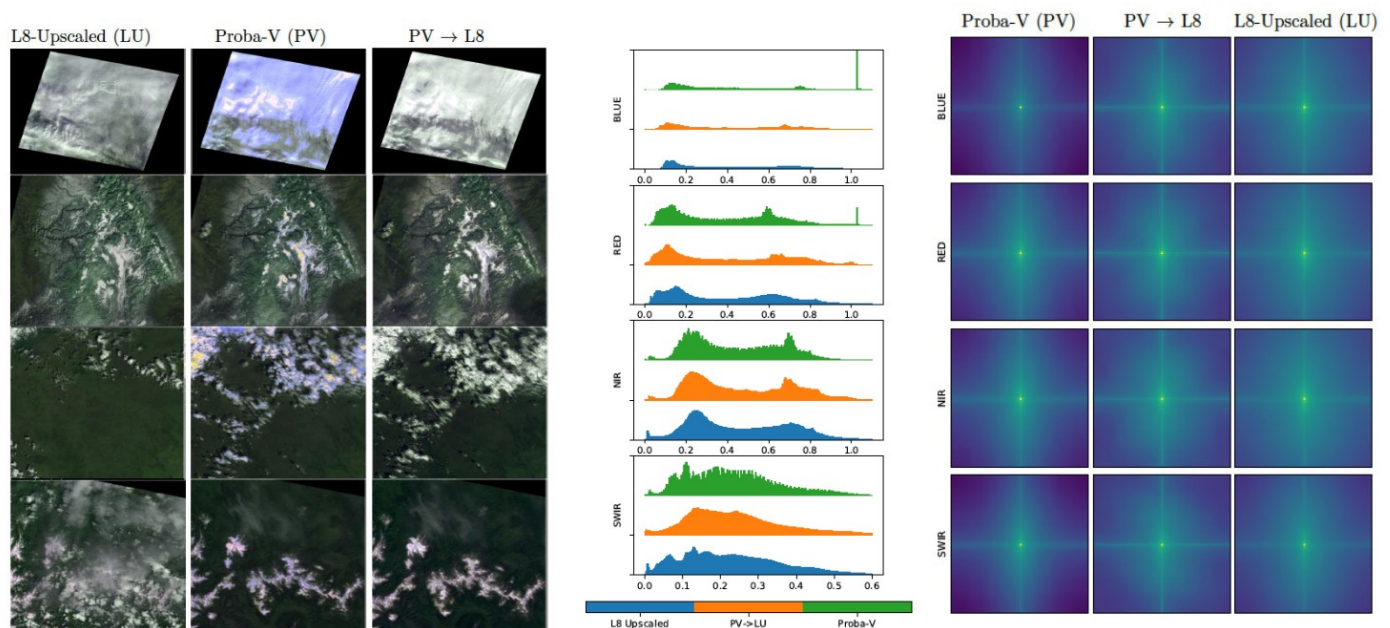
PV-CC \leftrightarrow Sentinel-3

Application oriented:
e.g. cloud detection



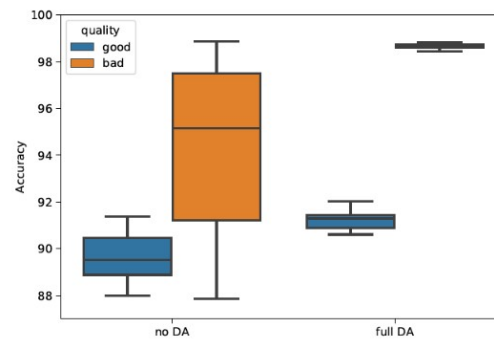
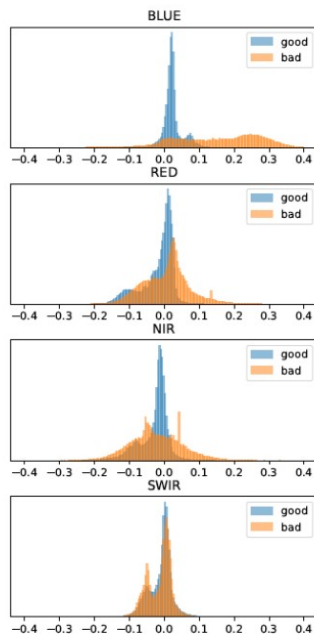
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Domain adaptation across similar sensors



2

Domain adaptation across similar sensors



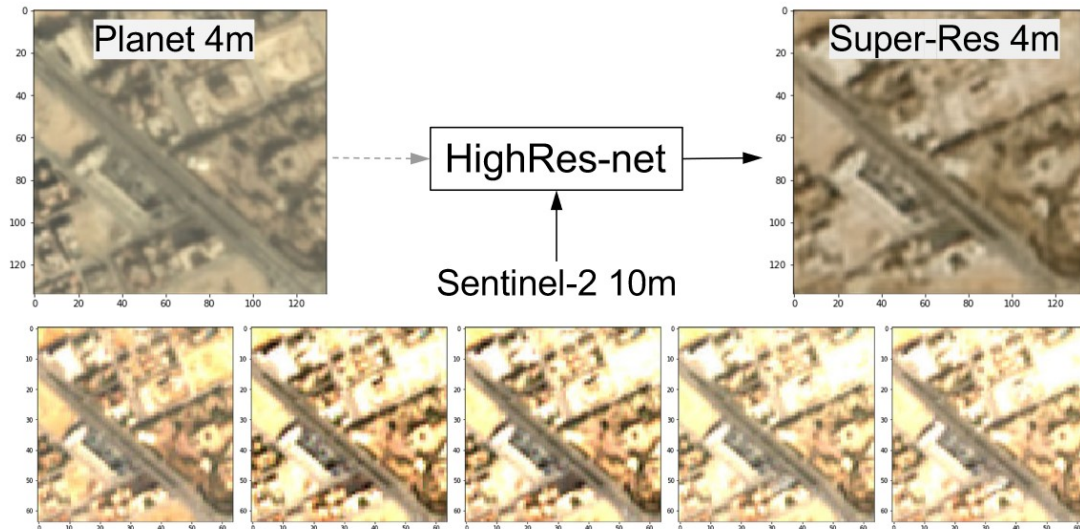
“bad pixels” of the Proba-V products quality flag:

- 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, PV-CC vs S3)
- Adaptation ratios can be used to validate calibration factors

3

Deep learning for fusion of PV-CC & Sentinels

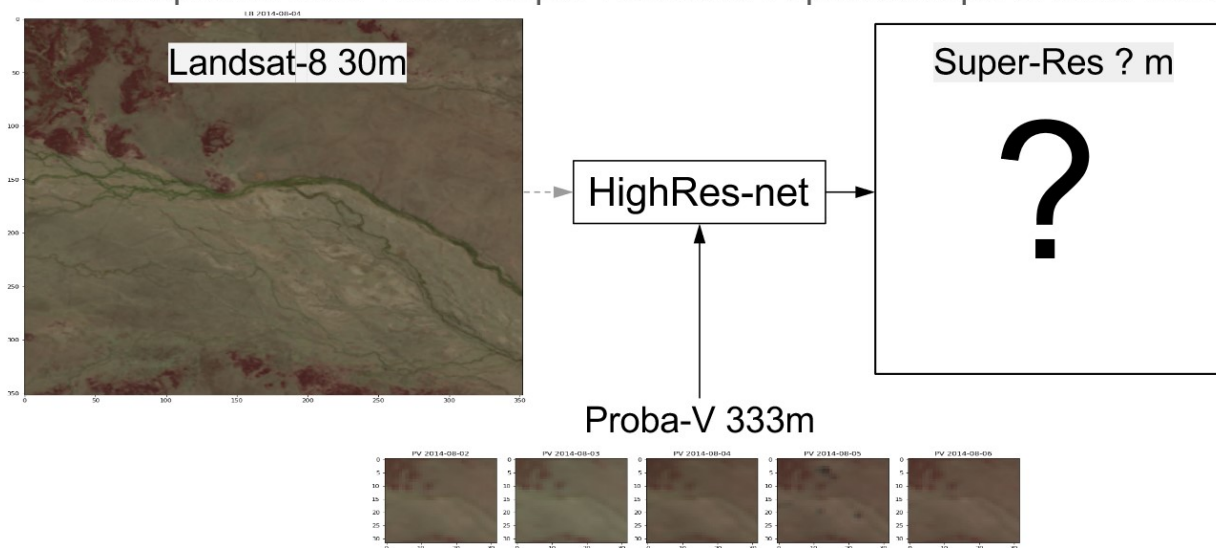
- Multispectral Multi-Frame Super-Resolution: spatial/temporal enhancement



3

Deep learning for fusion of Proba-V & Landsat-8

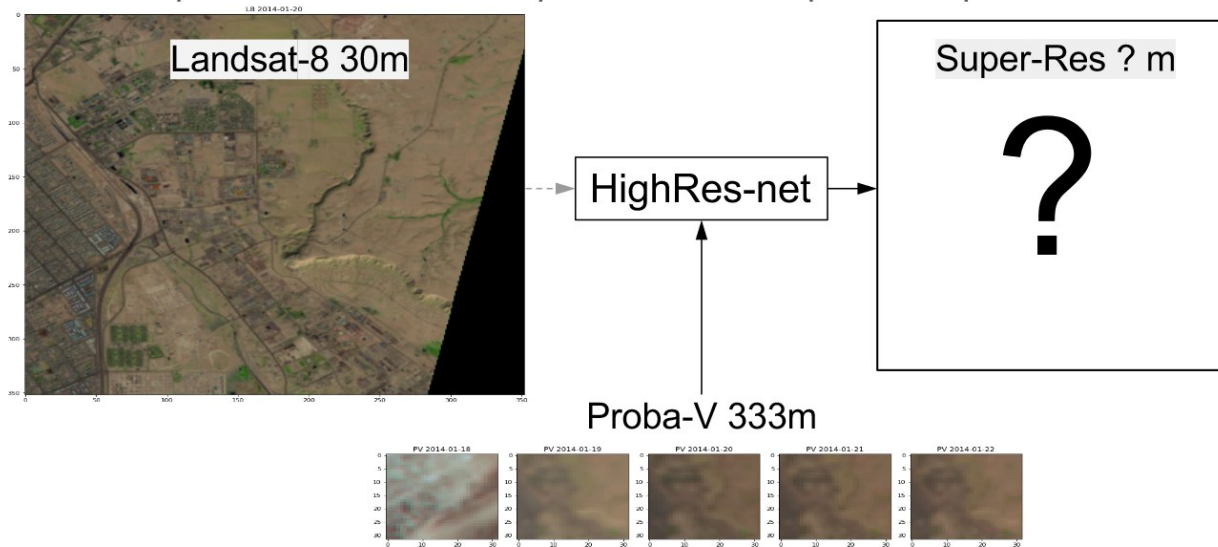
- Multispectral Multi-Frame Super-Resolution: spatial/temporal enhancement



3

Deep learning for fusion of Proba-V & Landsat-8

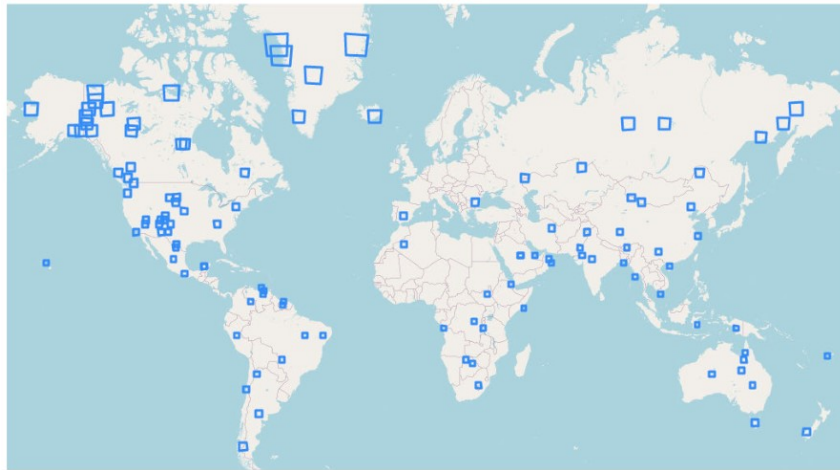
- Multispectral Multi-Frame Super-Resolution: spatial/temporal enhancement



3

Deep learning for fusion of Proba-V & Landsat-8

- Multispectral Multi-Frame Super-Resolution: spatial/temporal enhancement



Dataset: 65637 pairs of Landsat-8/Proba-V patches from 115 different locations

Summary: PV-CC Exploitation using Deep Learning

- 1 **Transfer learning** from Proba-V to PV-CC
 - Exploiting spatio-spectral information with CNN
- 2 **Cross-sensor Domain Adaptation** to assess consistency
 - Calibration: Linear/polynomial models (bias correction, calibration coefficients)
 - Multiband nonlinear adaptation model:
 - Provides different adaptation depending on the radiance/surface
 - Analysis of discrepancies between original and adapted images \Rightarrow instrumental factors, radiometric calibration L1 TOA, atm. correction L2 TOC, geographical patterns, consistent time series
 - Consistency assessment between PV-CC and Sentinel-3
- 3 **Fusion of PV-CC and Sentinel** products (super-resolution)
 - Spatial and temporal sampling enhancement & homogeneity in derived products
 - PV-CC \Rightarrow Sentinel-2 or Sentinel-3 \Rightarrow PV-CC

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