

# Filling Cloud Gaps on Optical Time-Series through Optical and SAR Data Fusion for Cropland Monitoring



Thomas Papadimos, Stelios Andreadis, Vasileios Sitokonstantinou, Alkiviadis Koukos, George Choumos, Ilias Gialampoukidis, Stefanos Vrochidis, Charalampos Kontoes, Ioannis Kompatsiaris

{papadimos, andreadist, heliasg, stefanos, ikom}@iti.gr  
{vsito, akoukos, g.choumos, kontoes}@noa.gr

Information Technologies Institute, Centre for Research and Technology Hellas,  
6th km Harilaou - Thermi, 57001, Thermi, Thessaloniki, Greece

## Challenge

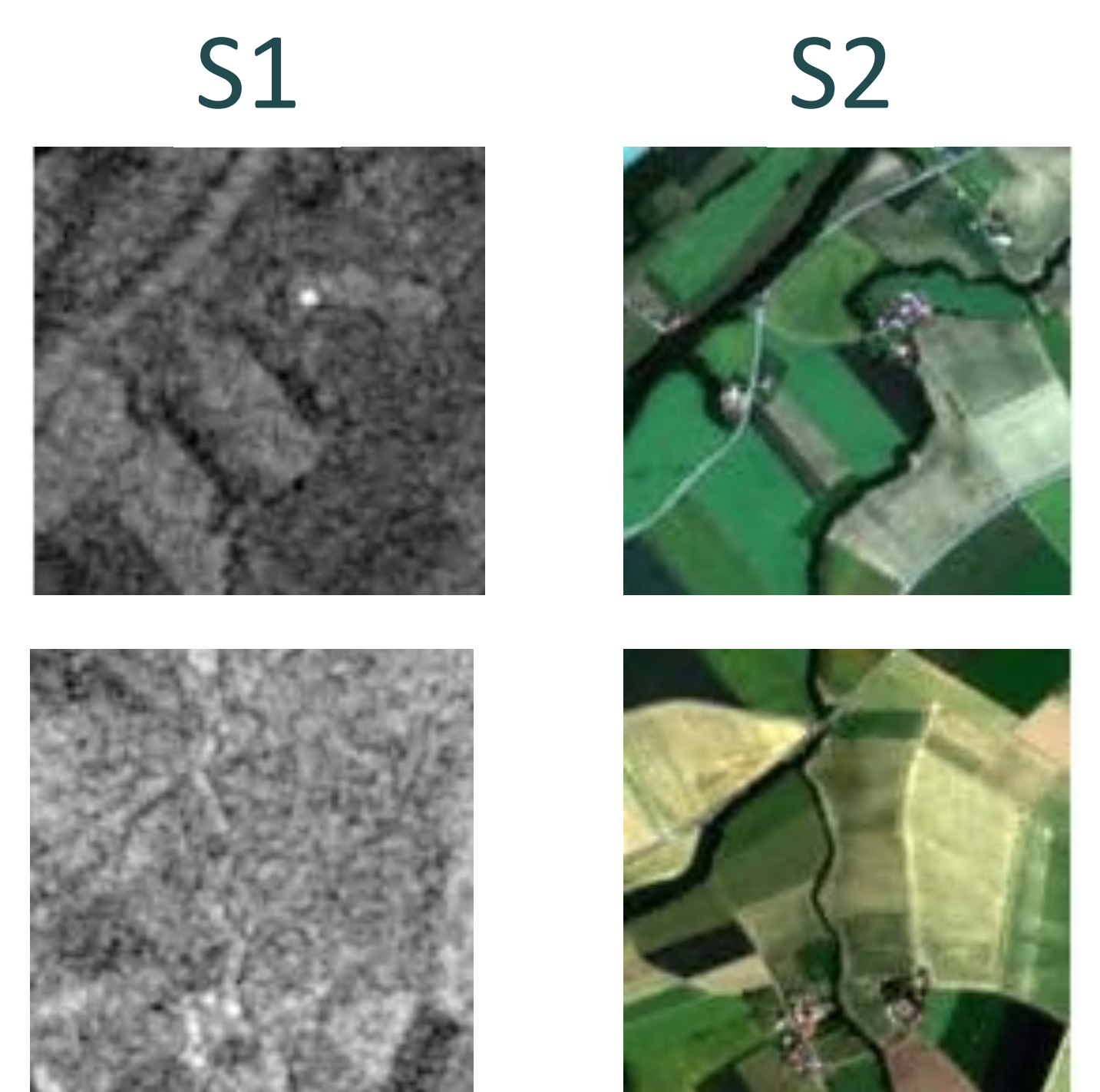
- In agricultural remote sensing, clouds can critically impact the utility of satellite images by completely covering the ground below, or distorting the measurements collected
- Images produced by the Sentinel-2 mission come with cloud occlusions
- There are no works focused on cloud gap filling in the agriculture
- SAR to optical translation is challenging in this sector due to the non-constant spatial resolution of the flora in crop types



## Data and Annotation

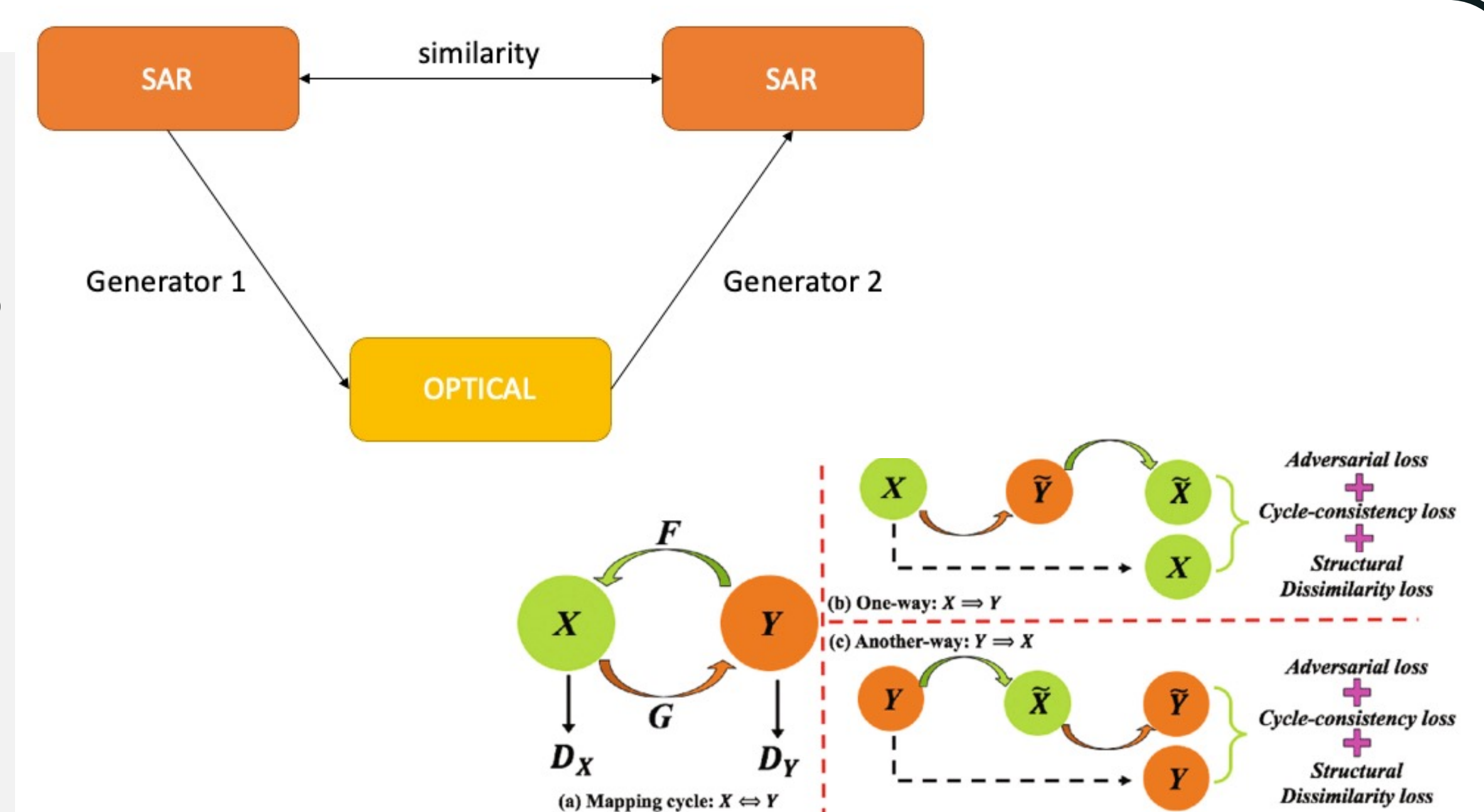
- Dataset:** BigEarthnet dataset consisting of 590,326 pairs of Sentinel-1 and Sentinel-2 image patches
- Each image patch was annotated by multiple land-cover classes
- We used patches that belong to the agriculture-related labels
- Bands 4,3,2 used for Sentinel-2 Images and VH polarization for Sentinel-1

BigEarthnet labels
Non-irrigated arable land
Permanently irrigated land
Rice fields
Vineyards
Fruit trees and berry plantations
Olive groves
Pastures
Sparsely vegetated areas
Natural grassland
Annual crops associated with permanent crops



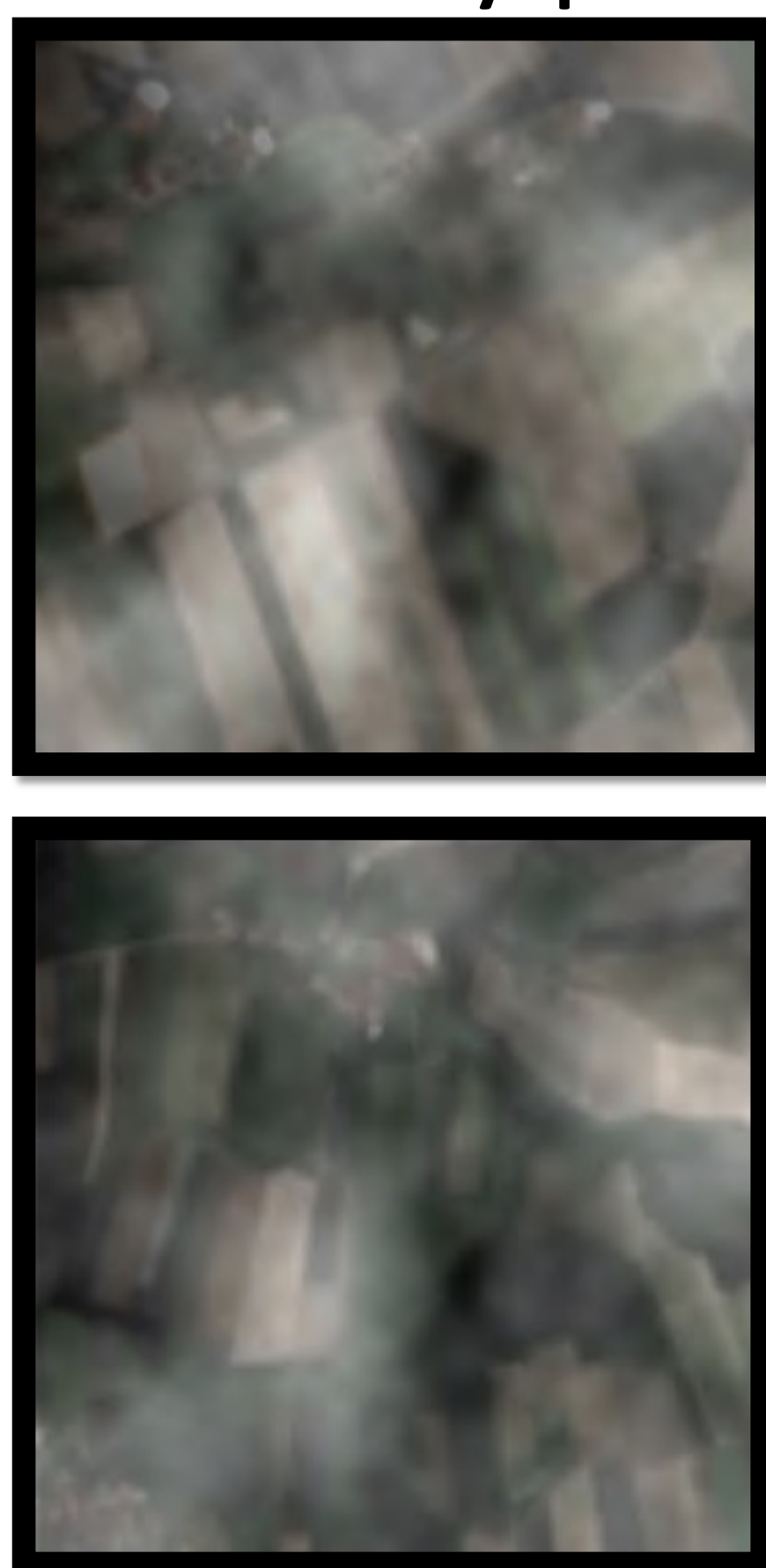
## Deep Learning

- Train of a GAN for SAR to Optical translation
- GAN type: CycleGAN, due to its capability to work with spatially uncoupled image pairs
- The translation is learned in two directions creating two generators and two discriminators
- Consistency: an image is processed through both generators whose result is expected to be the same as the input
- Experiments:
  - Monitoring of three losses: two for both GAN translations and one for consistency

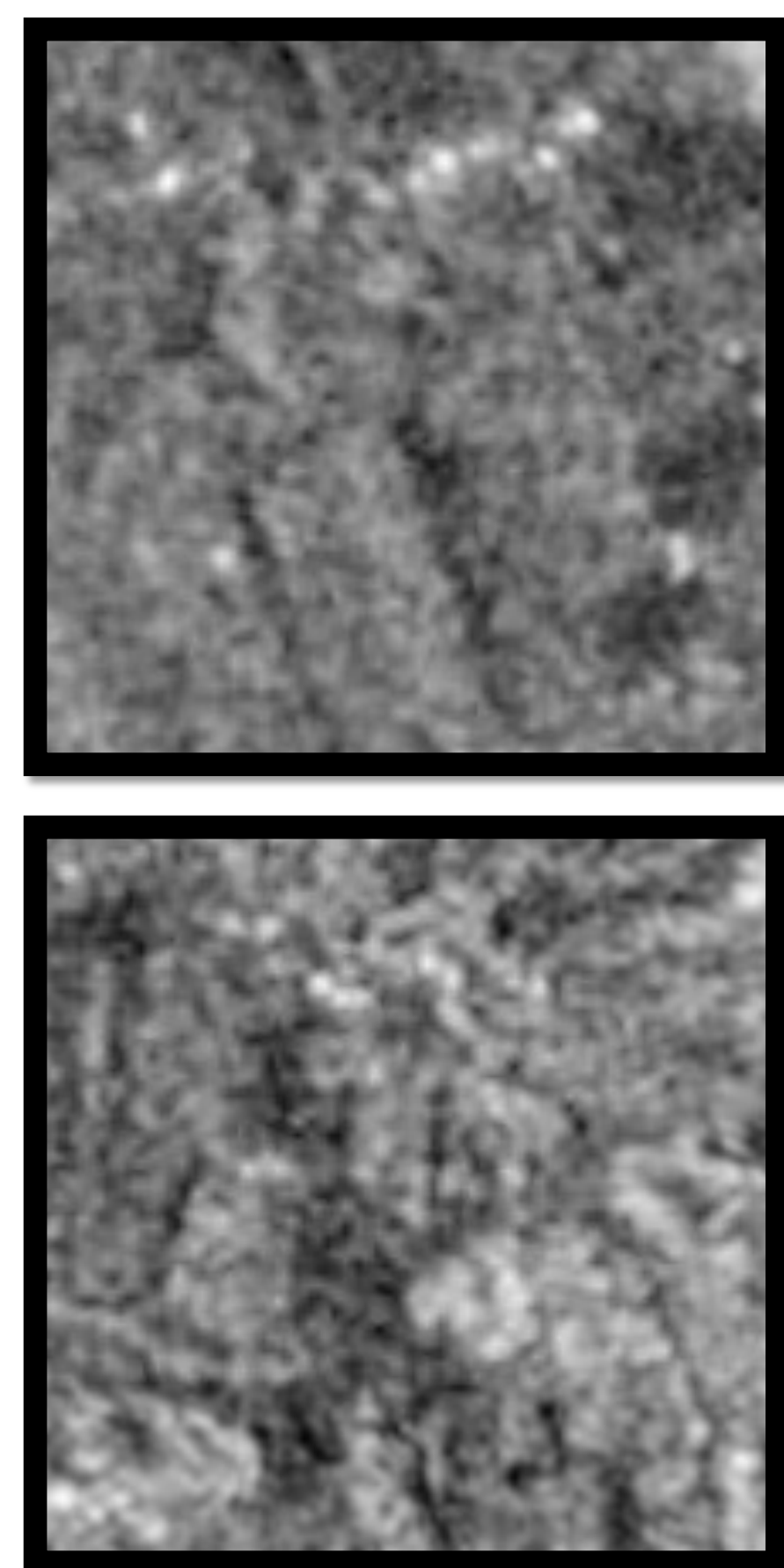


## Results

S2 – Cloudy patch



S1 - SAR



CycleGAN

Output



S2 – Cloud Free Original

