

GRASHEEM COLLEGE

Cloud removal in Sentinel-2 imagery using a deep residual neural network and SAR-optical data fusion

RUFAI BALOGUN

VITORIA FERREIRA



Research Topic and Applications

- Cloud cover affects temporal and spatial availability of surface observation (data gaps)
- Cloud Removal approaches are useful when consistent time series are needed, e.g. agricultural monitoring, or where a certain scene must be observed at a specific time, e.g. disaster monitoring

Objectives

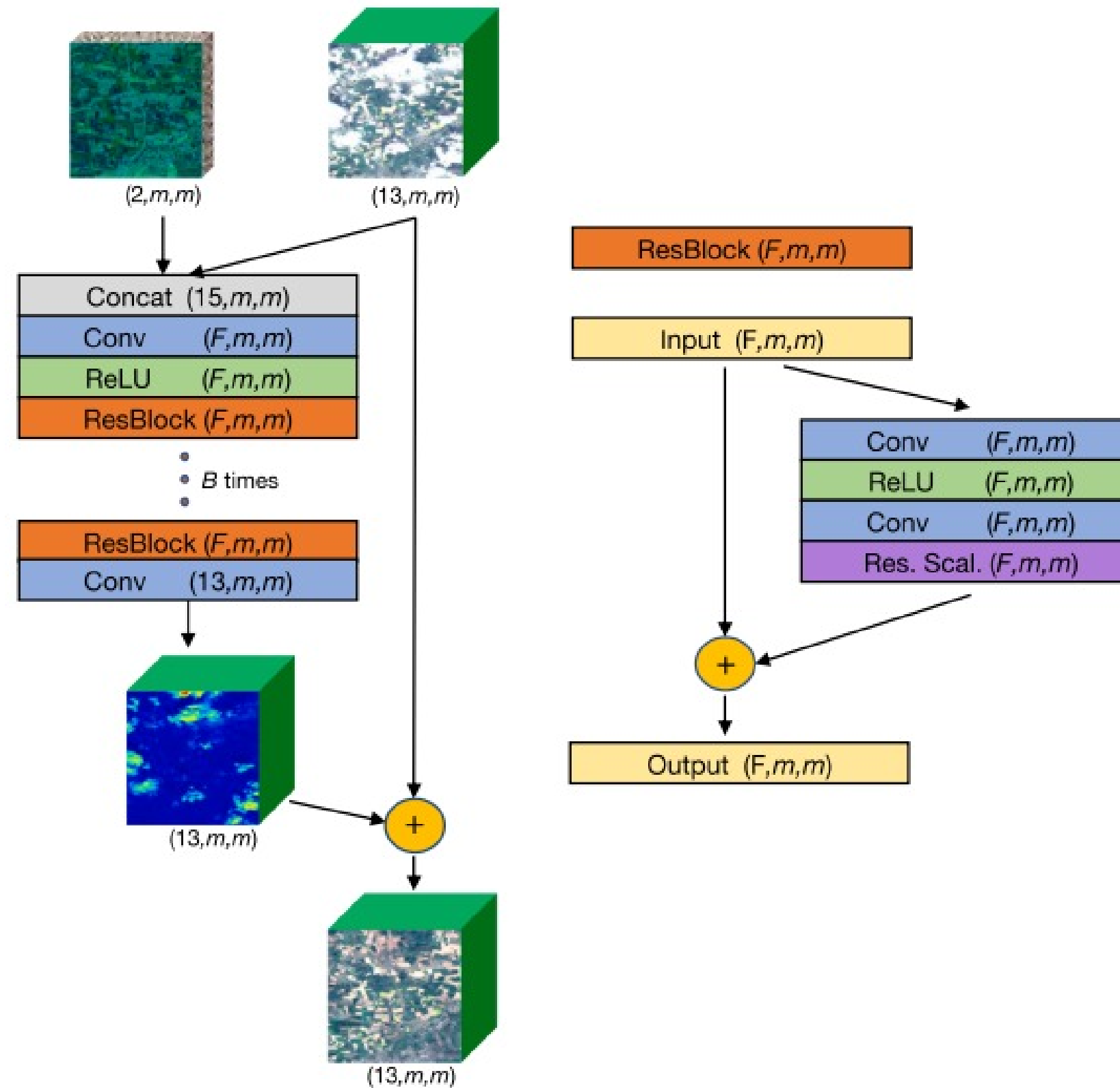
- Design a deep residual neural network architecture to remove clouds from multispectral Sentinel-2 imagery. SAR-optical data fusion is used to exploit the synergistic properties of the two imaging systems to guide the image reconstruction.

Dataset

- Sentinel - 2 (all 13 bands)
- Sentinel - 1
- SEN12MS-CR



METHODOLOGY - DSEN2-CR



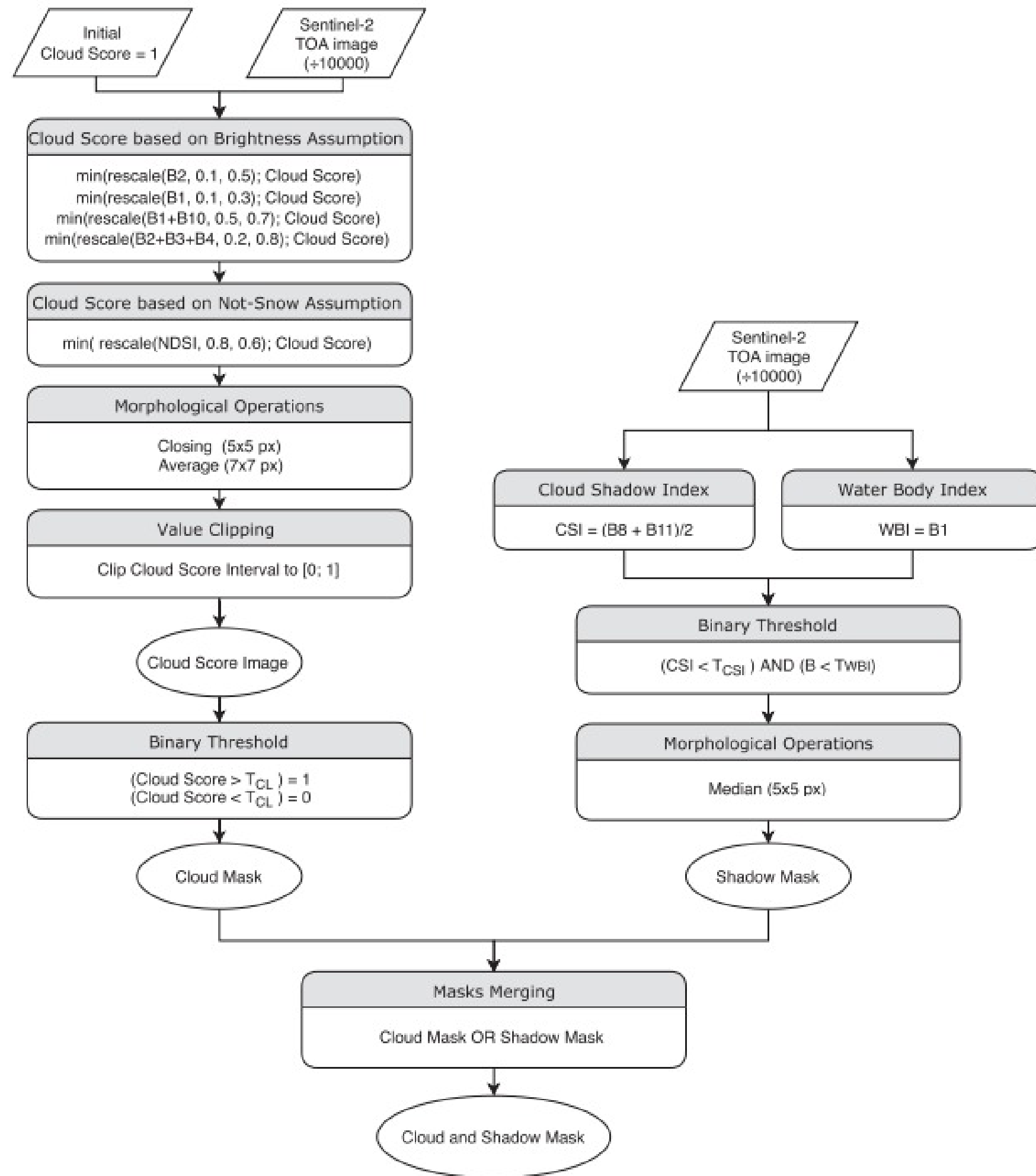


Fig. 5. Flowchart of the cloud (left stream) and shadow (right stream) detectors employed for the mask creation used in the $\mathcal{L}_{\text{CARL}}$ loss.

Evaluation Metrics

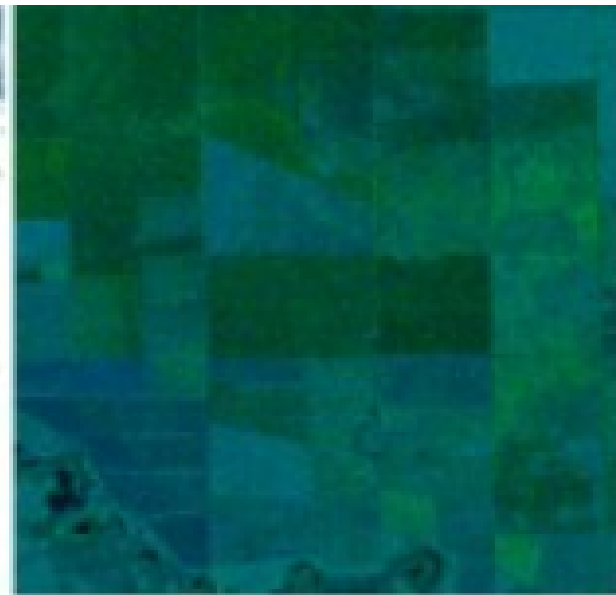
Method	MAE (ρ_{TOA})			RMSE (ρ_{TOA})	PSNR (dB)
	Target	Reprod	Recon	Target	Target
DSen2-CR on $\mathcal{L}_{\text{CARL}}$	0.0290	0.0204	0.0266	0.0366	28.7
DSen2-CR on \mathcal{L}_{T}	0.0270	0.0398	0.0266	0.0343	29.3
DSen2-CR on $\mathcal{L}_{\text{CARL}}$ w/o SAR	0.0306	0.0188	0.0282	0.0387	27.6
DSen2-CR on \mathcal{L}_{T} w/o SAR	0.0284	0.0389	0.0281	0.0361	28.8
<i>pix2pix</i>	<i>0.0292</i>	<i>0.0210</i>	<i>0.0274</i>	<i>0.0424</i>	<i>28.2</i>

(b) Test results on spectral and structural fidelity metrics.

Method	SAM (°)			SSIM
	Target	Reprod	Recon	Target
DSen2-CR on $\mathcal{L}_{\text{CARL}}$	8.15	3.94	8.04	0.875
DSen2-CR on \mathcal{L}_{T}	8.07	6.33	8.13	0.878
DSen2-CR on $\mathcal{L}_{\text{CARL}}$ w/o SAR	8.98	3.86	8.97	0.870
DSen2-CR on \mathcal{L}_{T} w/o SAR	8.97	6.17	9.05	0.873
<i>pix2pix</i>	<i>13.68</i>	<i>13.93</i>	<i>12.67</i>	<i>0.844</i>



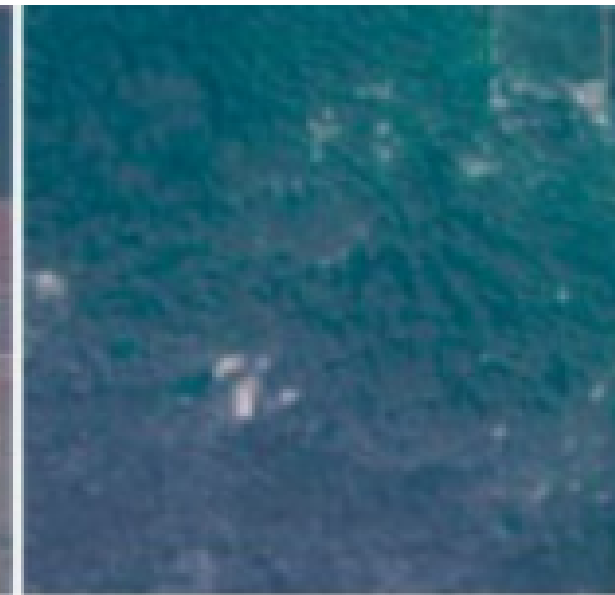
(a)



(b)



(c)



(d)



(e)

