Cloud Masking

GlobSnow User WorkShop 1 – Innsbruck

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GlobSnow Snow Extent (SE) Product

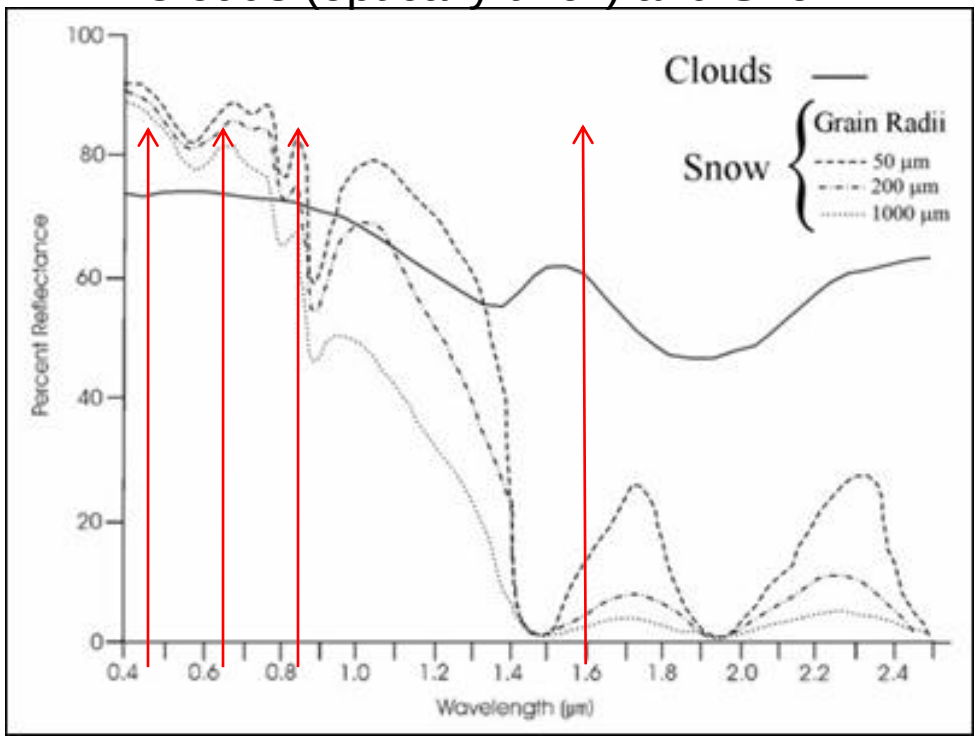
Robust Cloud / Snow discrimination is an important step towards hemispheric Snow Cover Products

OBJECTIVE

Investigate the performance of (A)ATSR cloud detection algorithms in the presence of snow

Snow and Clouds Spectral Signatures

Simplified spectral signature of
Clouds (optically thick) and Snow



AATSR Bands:
0.55 µm, 0.66 µm, 0.87 µm, 1.6 µm,
3.7 µm, 11 µm and 12 µm.

Available A(A)TSR Cloud Detection Algorithms

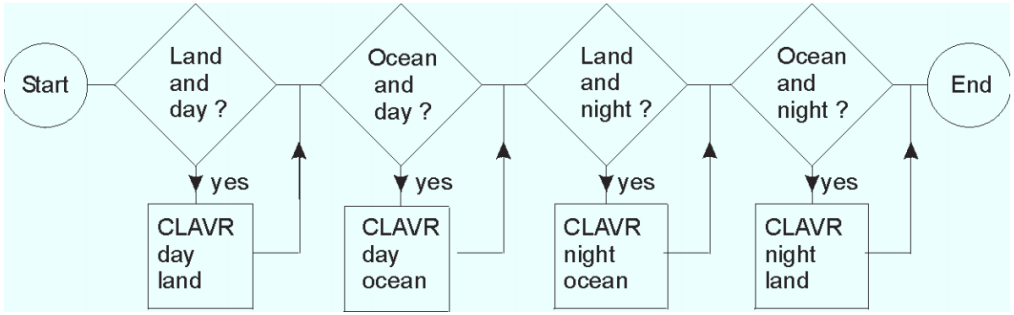
- **Operational (A)ATSR** cloud cover product:
  - based on the channels 12 µm, 11 µm, 3.7 µm, and 1.6 µm.
  - mainly dedicated to oceans; does not address explicitly the discrimination between snow and clouds.

- The SYKE cloud detection algorithm was adapted to AATSR data (**Simple (A)ATSR Algorithm**). The binary classifier is based on a multispectral decision tree. thresholds are adapted to the Alps by ENVEO.

- **NR (A)ATSR Algorithm**: uses K-Clustering; adapted to AATSR data in GLOBSNOW.

Operational (A)ATSR Algorithm

Overall Structure:



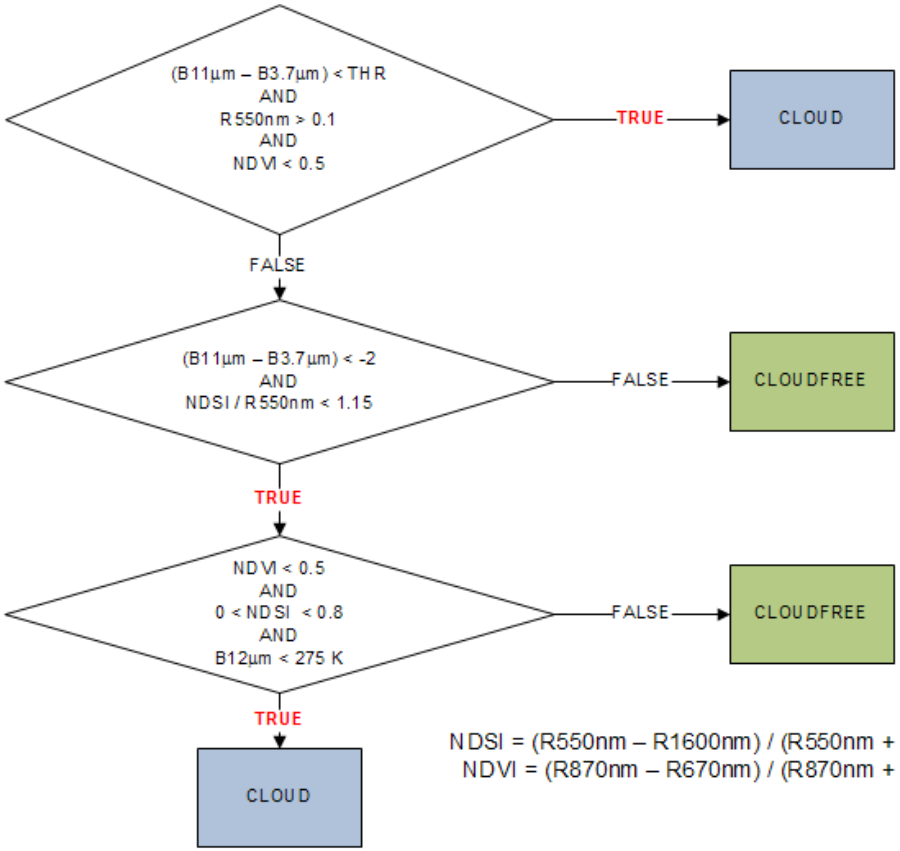
Operational AATSR Algorithm:

- Applied for land + ocean, but optimized for oceans
- Tends to underestimate cloud amount when it is large
- Tends over estimate when small

Test	Channels	Day		Night	
		Land	Ocean	Land	Ocean
Reflectance Gross Cloud	0.67 μm threshold	yes	yes	no	no
Reflectance Uniformity	0.67 μm spatial	yes	yes	no	no
Reflectance Ratio	0.87/0.67 μm	yes	yes	no	no
Channel 3 (3.7 μm) albedo	3.7, 11 and 12 μm	yes	yes	no	no
Thermal uniformity	11 μm	yes	yes	yes	yes
Four minus Five (11 12 μm)	11 and 12 μm	yes	yes	yes	yes
Thermal Gross Cloud	11 μm	yes	yes	yes	yes
Channel 3 (3.7 μm) Restoral	3.7, 11 and 12 μm	yes	yes	no	no
Thermal Uniformity	11 μm	yes	yes	yes	yes
Uniform Low Stratus	3.7, 11 and 12 μm			yes	yes
Cirrus	3.7 and 12 μm			yes	yes

Stowe et al. (1999)

Simple Cloud Detection Algorithm (SCDA)



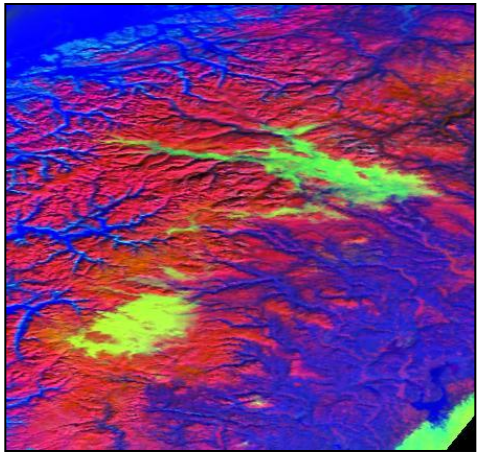
NDSI = (R550nm – R1600nm) / (R550nm + R1600nm)
NDVI = (R870nm – R670nm) / (R870nm + R670nm)

DATE	*THR*
2003-11-10	-7
2003-12-09	-7
2004-03-16	-10
2005-01-16	-10
2005-02-10	-7
2006-02-05	-7
2006-06-12	-10
2006-06-18	-10

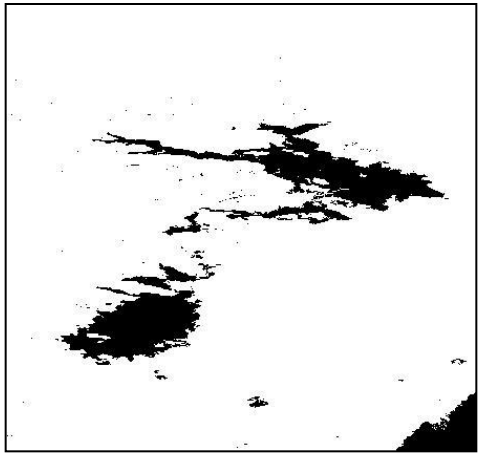
Syke Cloud Detection Alg. adapted to (A)ATSR

NR (A)ATSR algorithm: uses K-Clustering

- Based on k-Nearest Neighbour (k-NN)
- In a k-NN classifier a pixel, represented by a vector of band values, is assigned the class which is most relevant among the *k*-nearest labelled vectors from a reference set
- A k-NN classifier is an asymptotically optimum (Maximum Likelihood) classifier as the size of the reference set increases
- The classifier was trained using a set of AATSR images throughout a year where classes were assigned manually

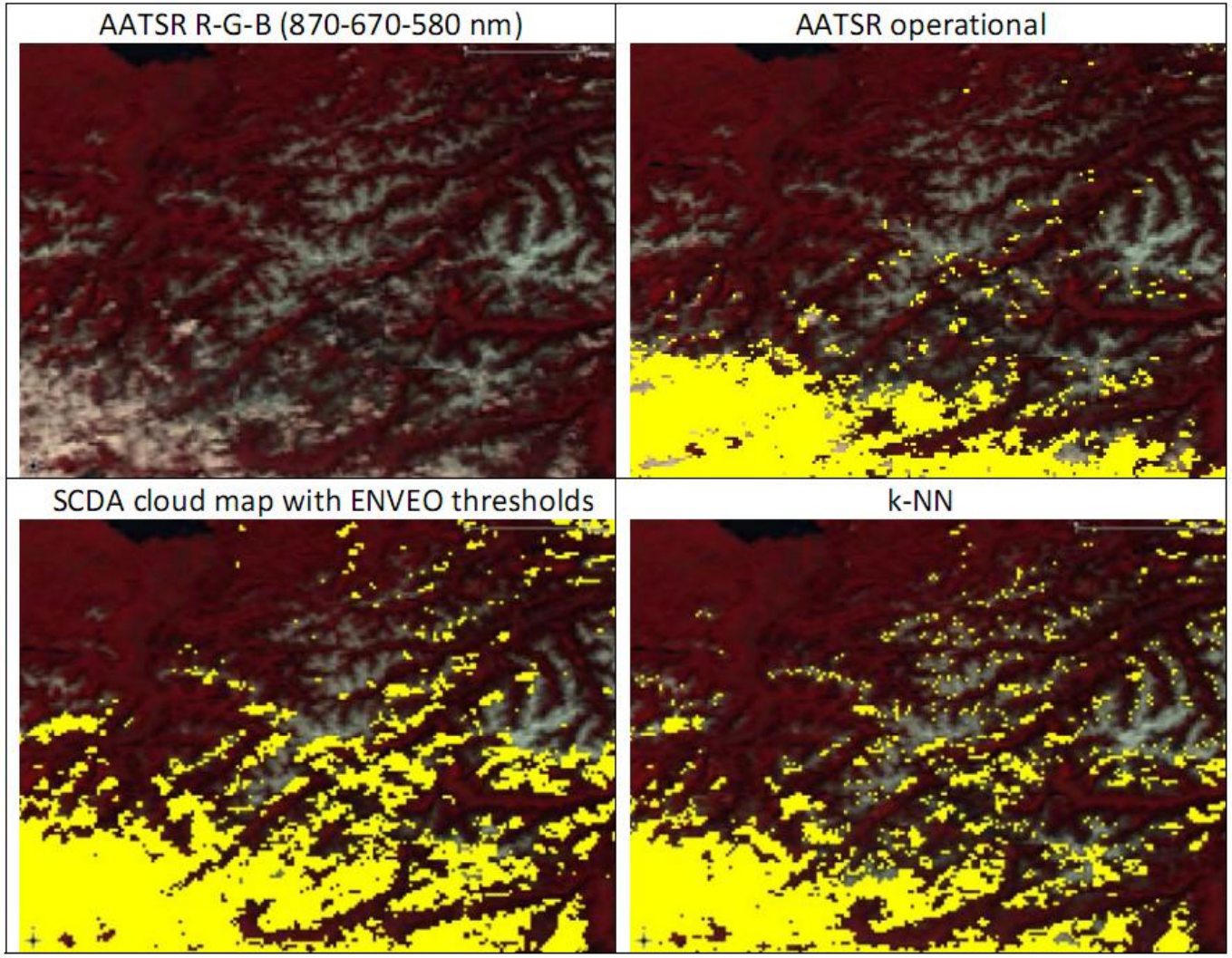


AATSR colour composite



Resulting cloud mask

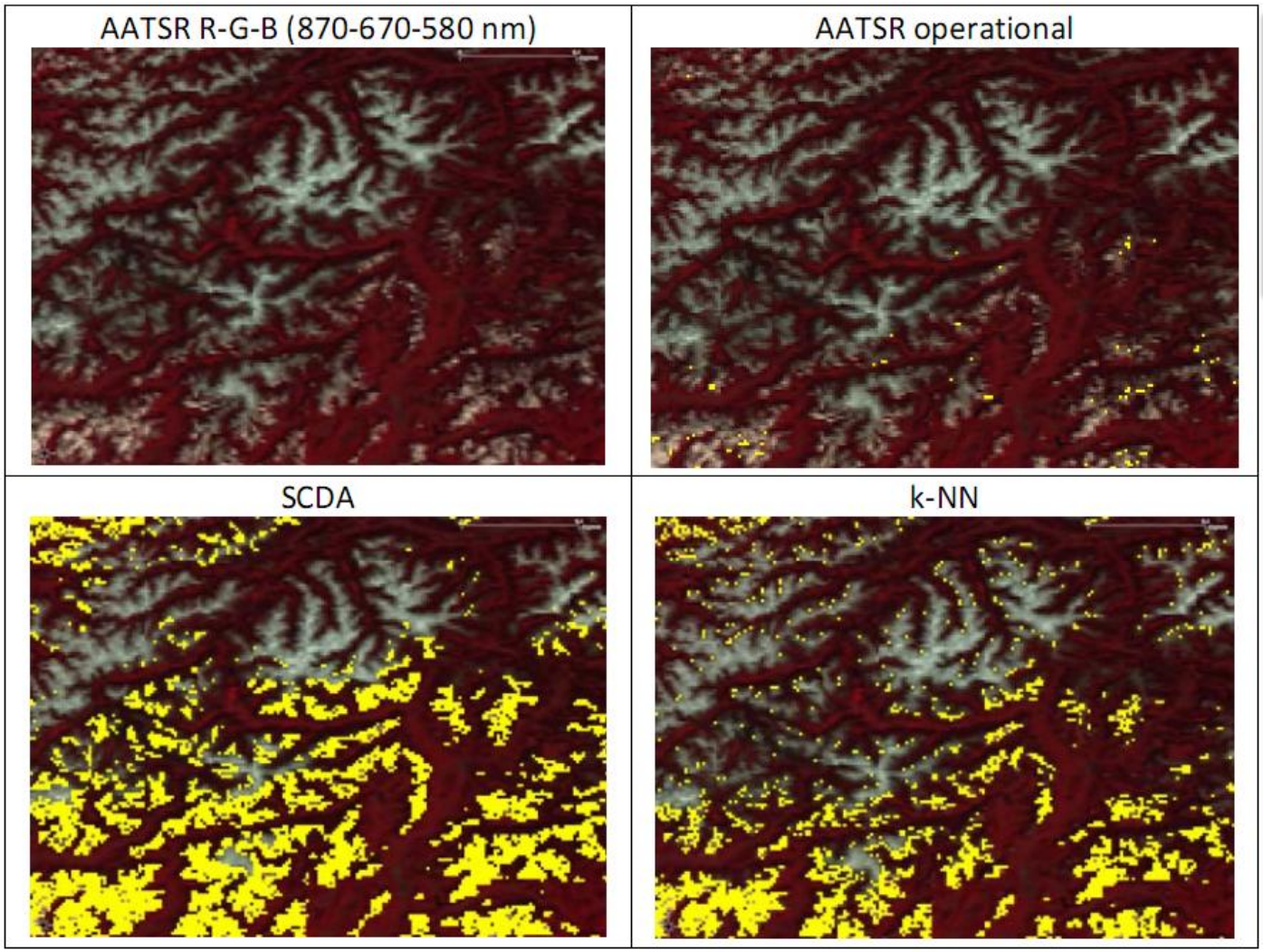
Comparison of Cloud Masks – Spring/Summer



Spring / Summer
2006/06/18

Cloud cover type
is mainly cumulus.

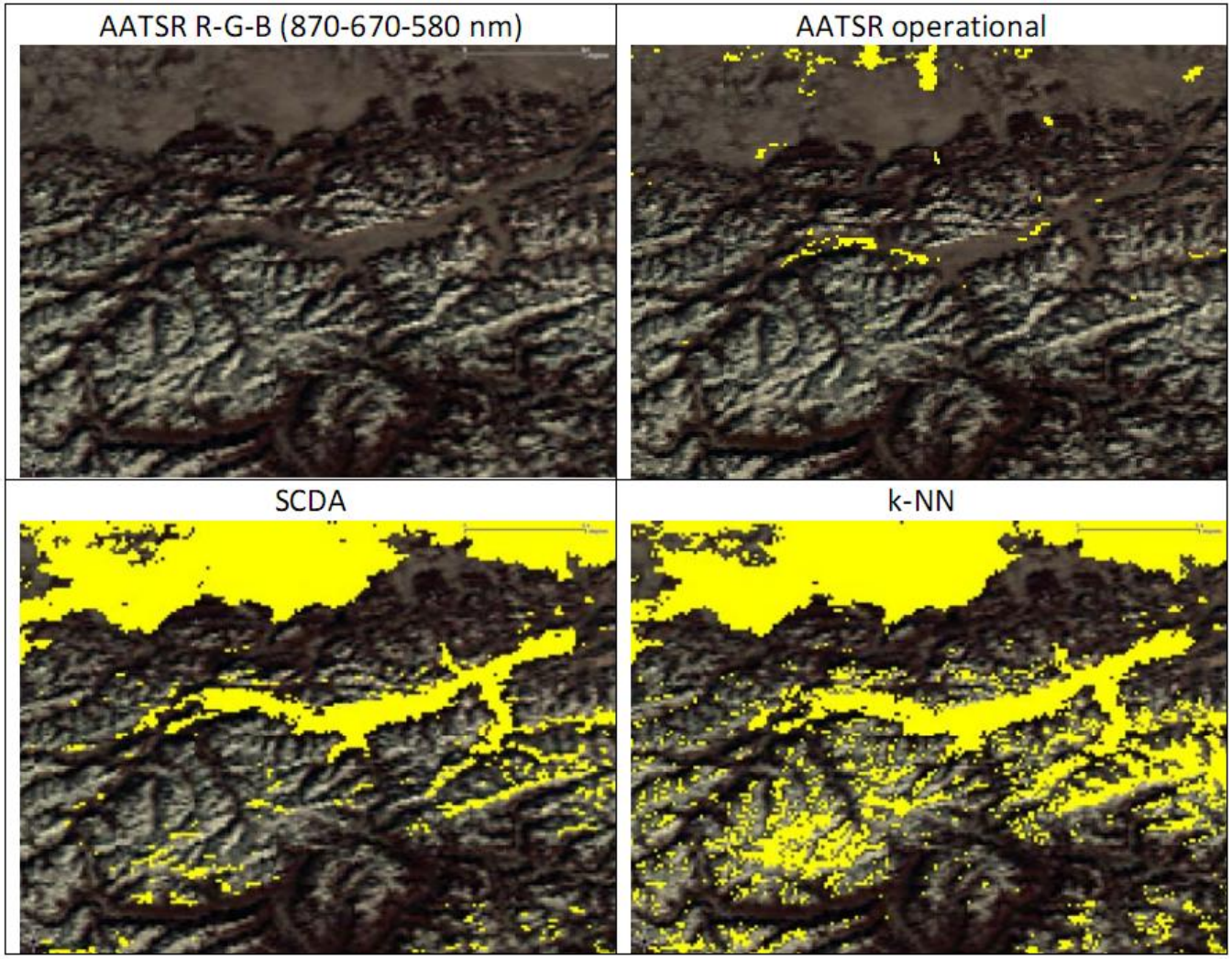
Comparison of Cloud Masks - Spring/Summer



Spring / Summer
2006/06/18

Cloud cover type
is mainly cumulus.

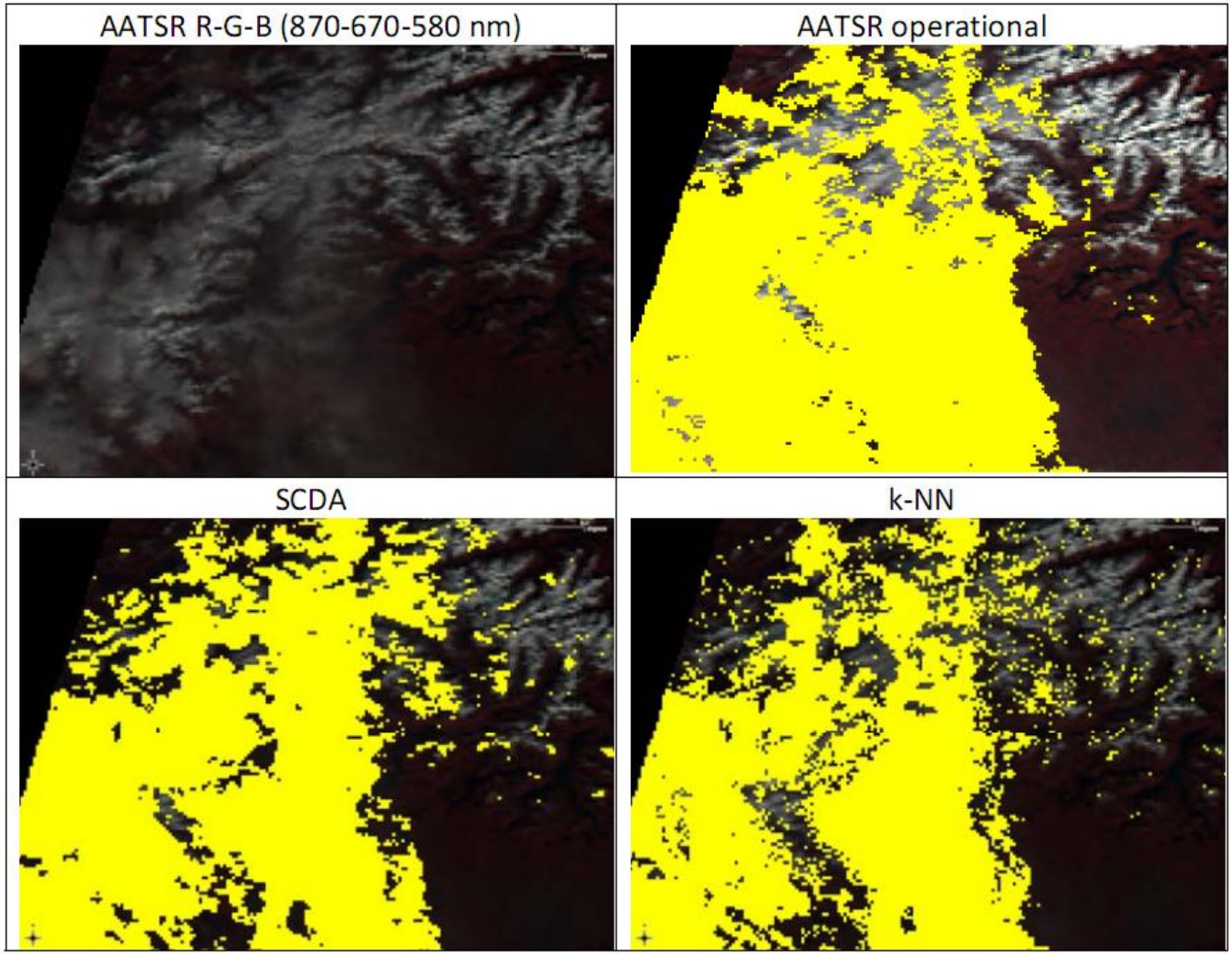
Comparison of Cloud Masks –Winter



2006/02/05

Cloud cover type is mainly fog in the valleys and low-lands.

Comparison of Cloud Masks – Winter



2003/11/10

Cloud cover type is mainly Cirrus and Altocumulus

Conclusions

- **Due to the wide variability of cloud characteristics (temporal, spatial, climate, etc.), the discrimination of snow and clouds on a hemispheric scale using only AATSR data is challenging.**
- **The (A)ATSR operational cloud product shows significant errors in the cloud / snow discrimination for various different cloud types and is therefore not recommended for GLOBSNOW. In particular, its performance in detecting low stratus clouds in winter is rather poor.**
- **The SCDA and K-Clustering cloud detection algorithm show similar performance over the Alps, but more detailed analysis would be needed to see the strengths and weaknesses of each of these algorithms.**
  - The SCDA cloud algorithm masks appears less patchy than K-Clustering
  - K-Clustering masks indicate problems in areas of mixed pixels at the boundary of the snow areas. This needs to be checked by comparison with high resolution images.
  - A major disadvantage of the Simple (A)ATSR loud detection algorithm is the need for adjustment of the cloud algorithm threshold, depending on season, cloud type, and region.
  - Computational costs for Simple (A)ATSR cloud detection algorithm are much lower than for K-Clustering Algorithms.

Selection of Cloud Detection Algorithm

The SCDA was selected for the GlobSnow SE processing line:

- Low computational costs
- Similar performance as K-Clustering

Needs:

- Development of a scheme for temporal and spatial (climate regions) adaptation of the thresholds (lookup table)
- Testing and verification of algorithm in other environmental and climate zones.