Cloud information in the IRS L1 product

A cloud retrieval algorithm based on supervised machine learning is included in the specifications to obtain cloud information in the IRS L1 product

- Cloud fraction [0 - 1]
- Cloud signal (K)

Outline:

1. Some details of the retrieval algorithm (not too many)
2. What is “Cloud signal”?
3. Validation results for cloud fraction retrieval from IASI (Comparison study by Stefan Stapelberg, 2018)
4. Conclusion

The specified PWLR algorithm

Ensemble of regressions where each instance follows these steps:

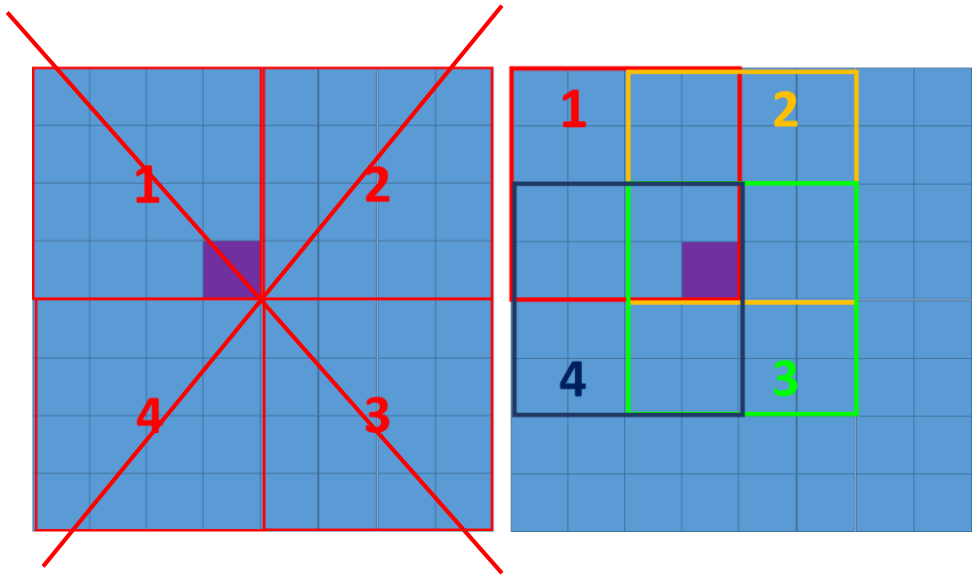
1. Split the input space into distinct classes (K-means clustering)
2. Apply first linear regression (LR) within each class
3. Split each regression class into further subclasses based on first LR retrieval
4. Apply final LR in each subclass

Separate coefficients for Day-Land, Day-Sea, Night-Land and Night-Sea

Predictors:

- Secant of satellite zenith angle
- Surface elevation
- IRS radiances in 16 (4 by 4) pixels (represented as PC scores)

Averaging of the instances
Two step computation of PC scores (2 by 2) => (4 by 4)
Handle missing pixels (for example at the edges of the disc)



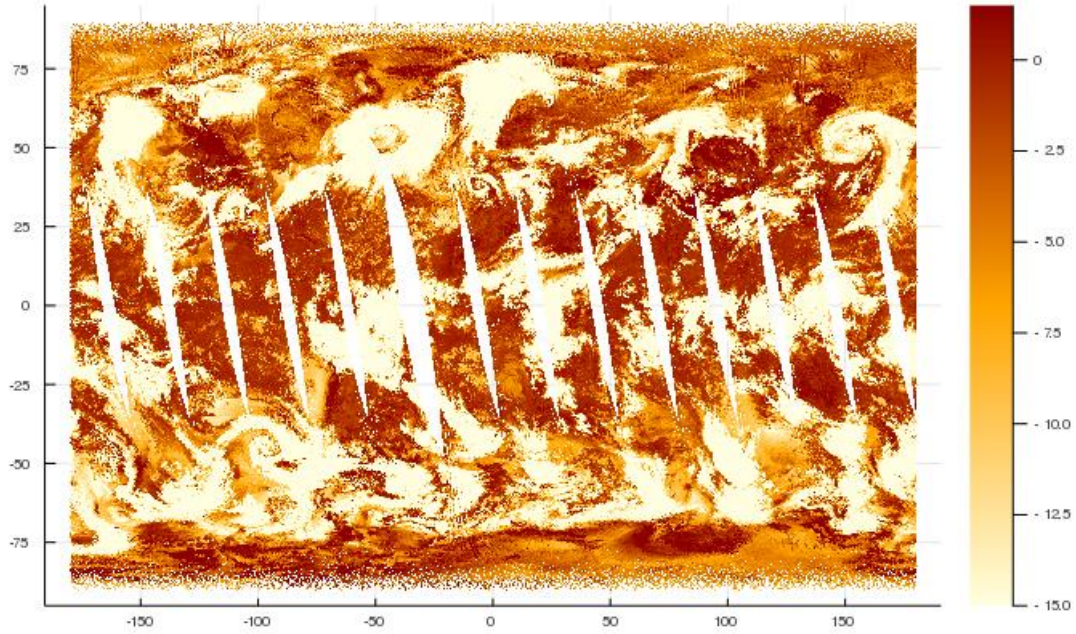
Cloud signal

the difference between the measured BT and the simulated clear sky BT (in a window channel)

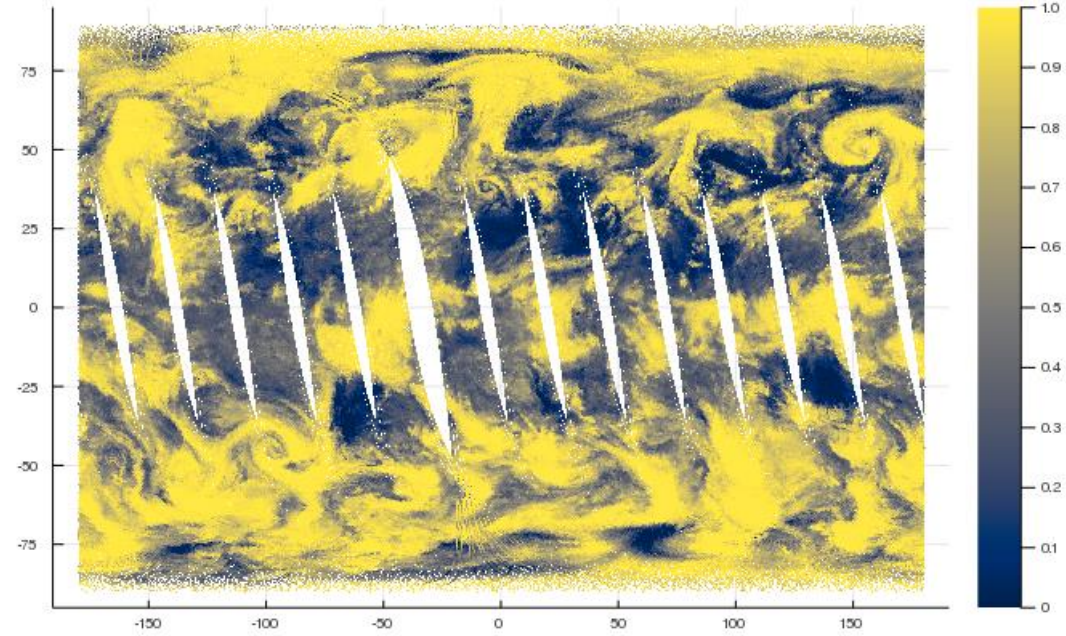
Offline	Online	
	OBS - RTTOV(FCT)	Traditional
Train $PWLR_1$(OBS) ~ ANA	OBS - RTTOV($PWLR_1$(OBS))	Better
Train $PWLR_2$(OBS) ~ OBS - RTTOV($PWLR_1$(OBS))	$PWLR_2$(OBS)	Even better and faster

Instead of a single window channel, we use the average of two channels at approximately 819.5 and 831.75 cm^{-1}

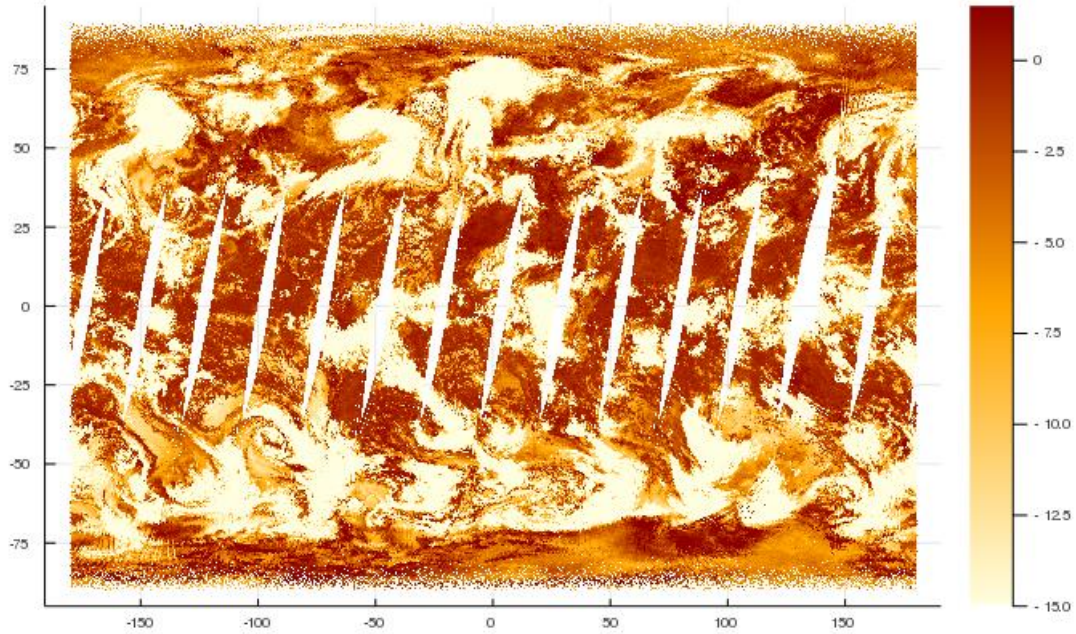
Cloud signal 20200321 Ascending



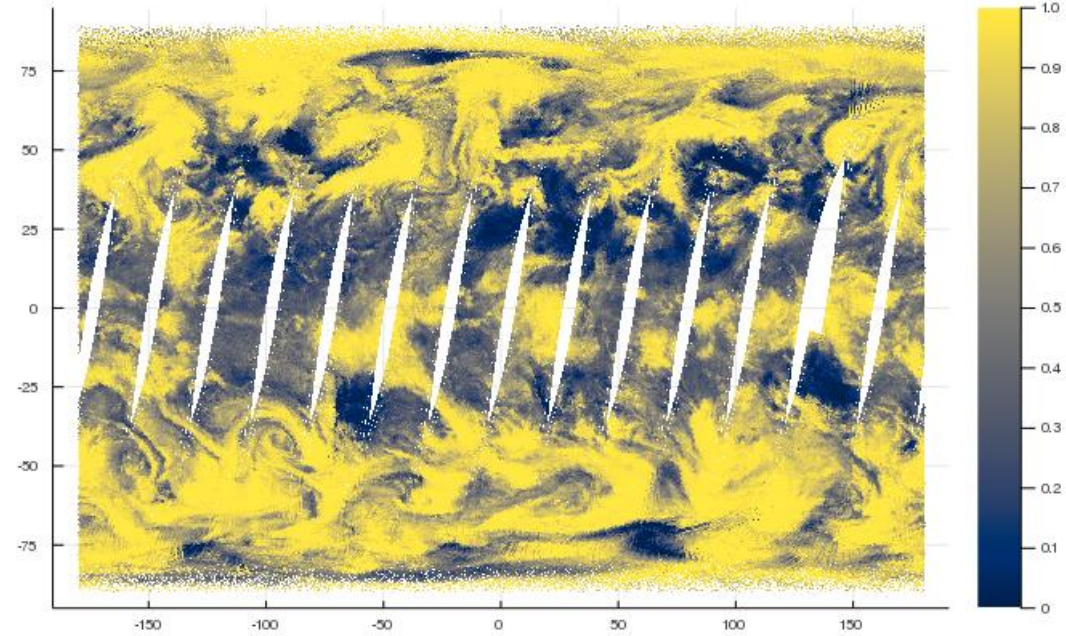
Cloud cover 20200321 Ascending



Cloud signal 20200321 Descending



Cloud cover 20200321 Descending



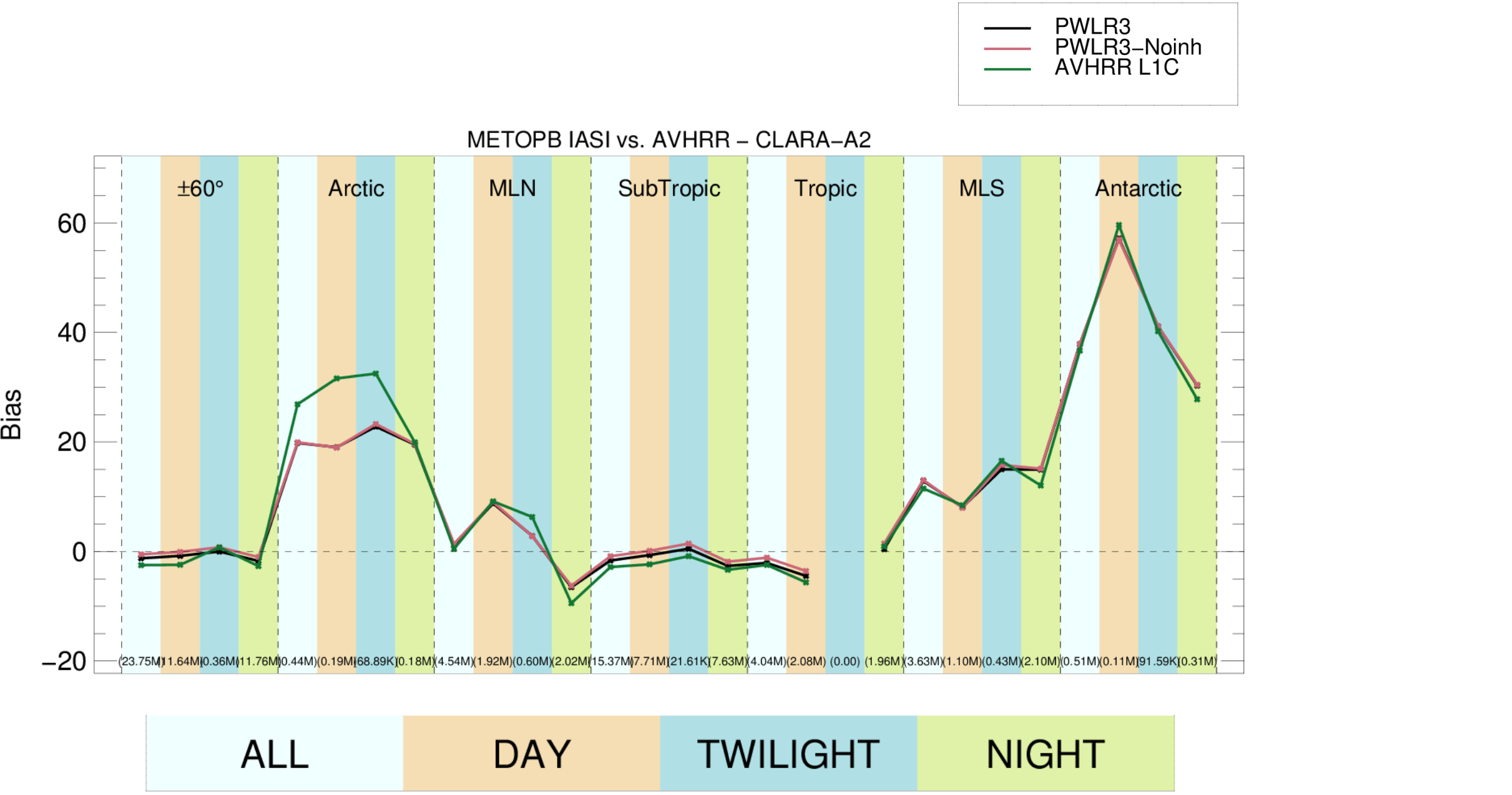
Cloud Mask Inter-Comparison / Validation Study by Stefan Stapelberg (2018)

To study the performance of PWLR cloud fraction retrieval.

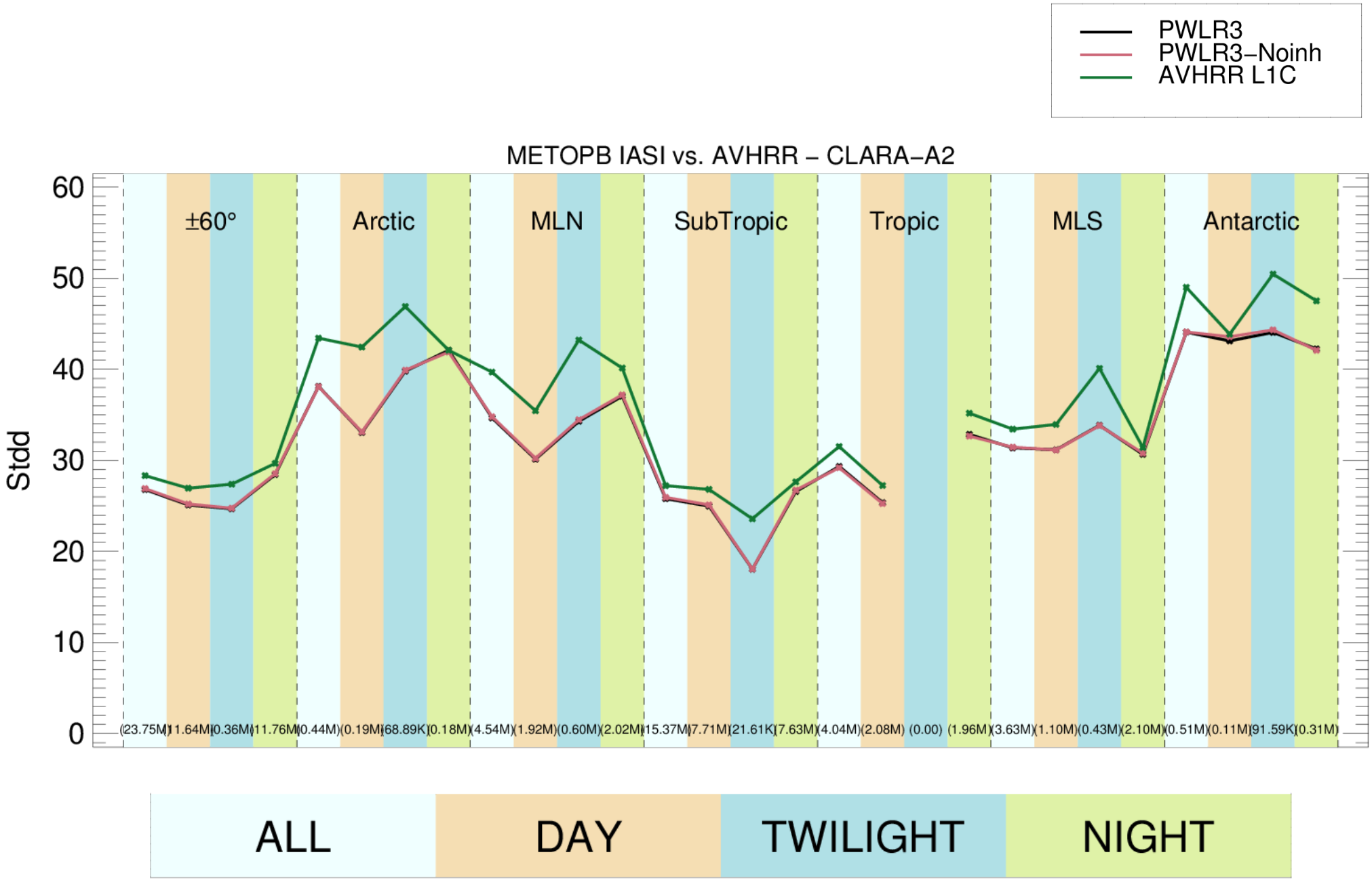
Training: IASI/Metop-B with AVHHR based cloud fraction from the IASI L1C products of 2017.

Applied to: 4 days per month of 2015

Compared with: CLAAS-2 (CM SAF) MSG-SEVIRI, CLARA-A2 (CM SAF) AVHRR, CC4CL (Cloud_cci) AVHRR, global SYNOP reports

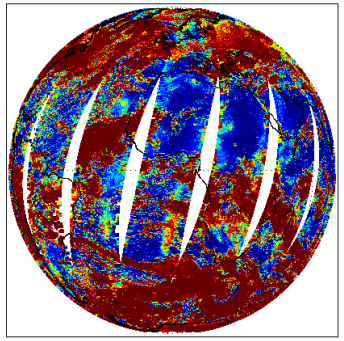


Stefan Stapelberg

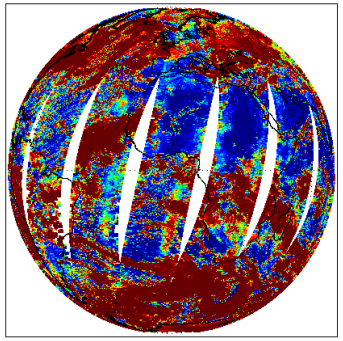


Stefan Stapelberg

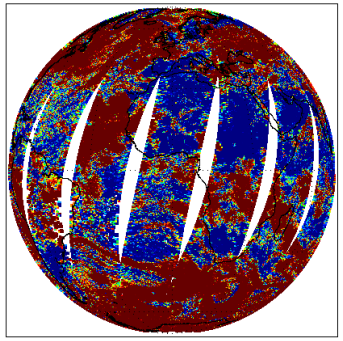
IASI PWLR_CF



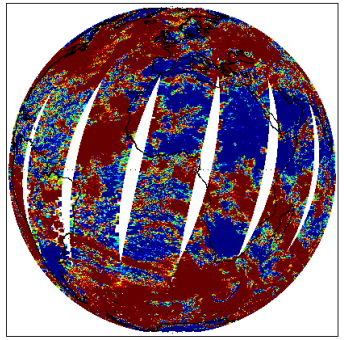
20150104 METOPA DESC IASI PWLR_CF-NOINH



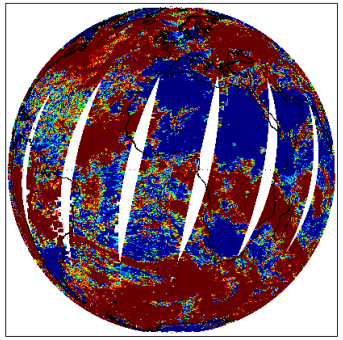
L1C_CF



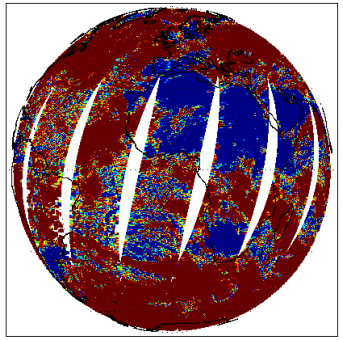
CIARA-A2



Cloud_cci



CLAAS-2

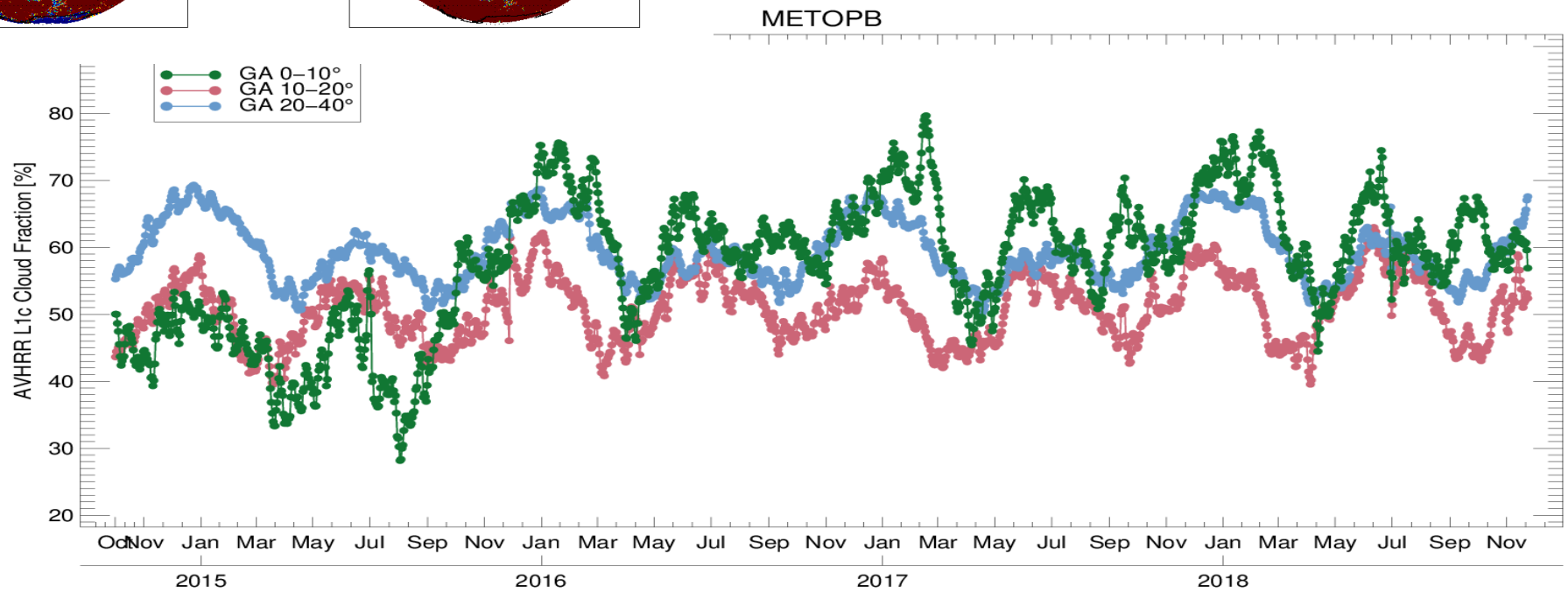


Cloud fraction is overestimated in sunglint areas by the PWLR retrieval.

The IASI L1C-AVHRR cloud fraction does not show problems in sunglint areas.
Before End-2015!

But PWLR was trained with data from 2017…

Stefan Stapelberg



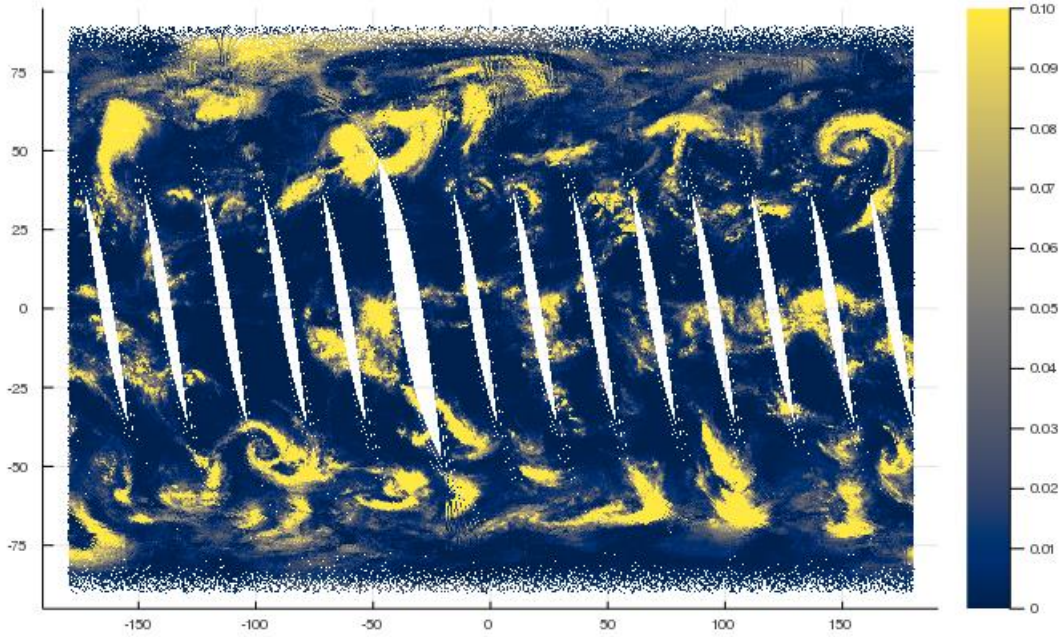
Conclusion of cloud fraction comparison study by Stefan Stapelberg

- The PWLR is a suitable cloud mask and compares well with AVHRR / SEVIRI and SYNOP based observations.
- In many cases PWLR performs even better than IASI L1C-AVHRR which was used for training, especially over sea ice at daytime.
- Issues like overestimation in sunglint areas and bright snow- or ice-covered surfaces at daytime are clearly imposed by the training dataset.

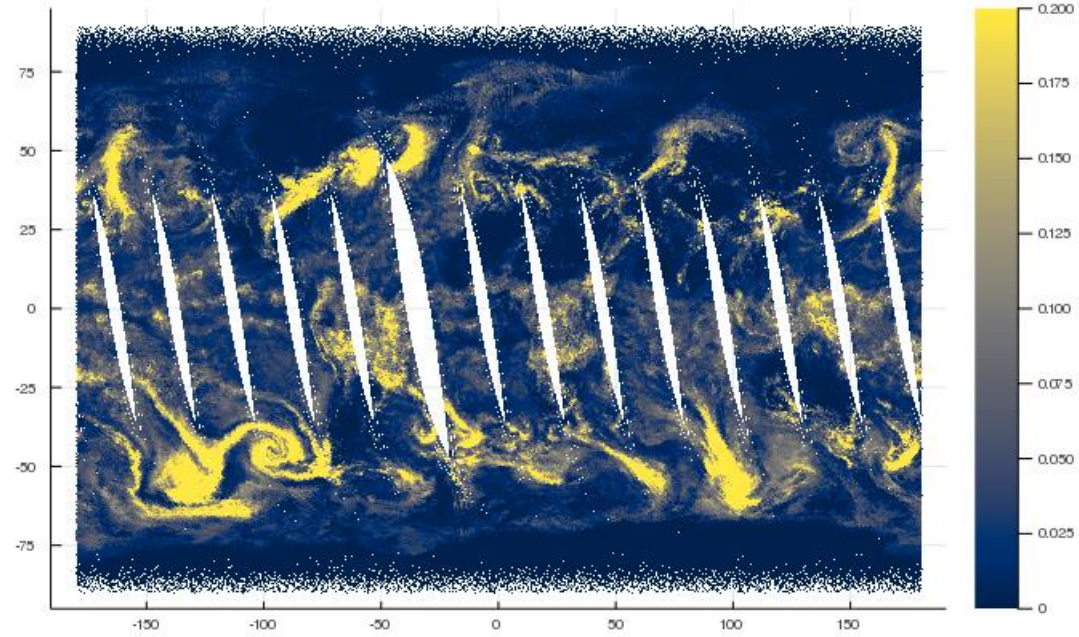
To avoid the systematic biases observed in the IASI L1C-AVHRR cloud fraction we plan to use ERA-5 as reference data.

ERA-5 also has TCIW and TCLW, which could be retrieved instead of cloud fraction and cloud signal.

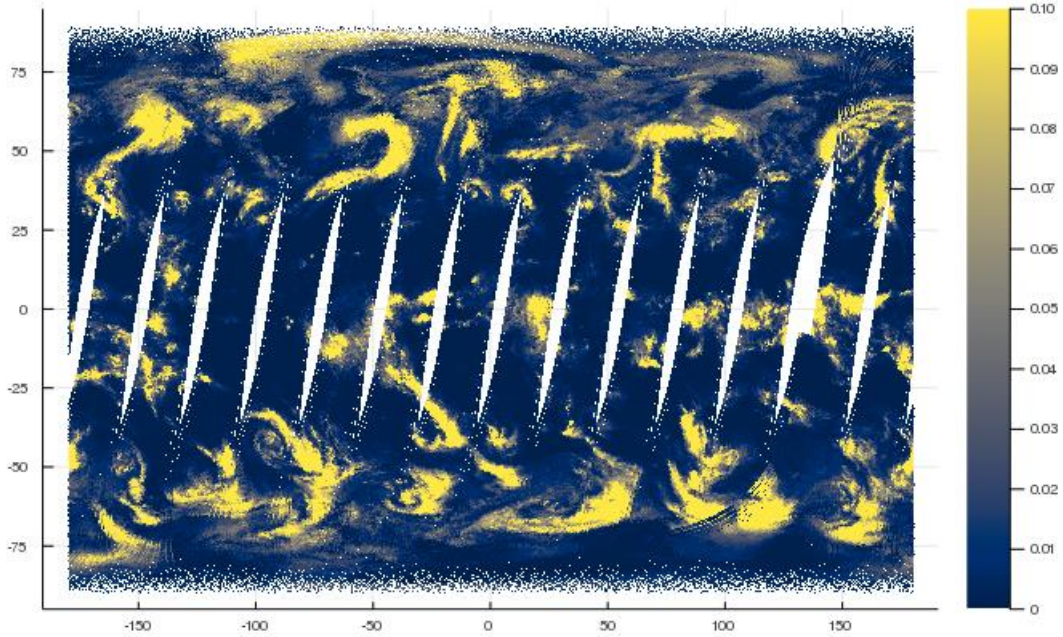
TCIW 20200321 Ascending



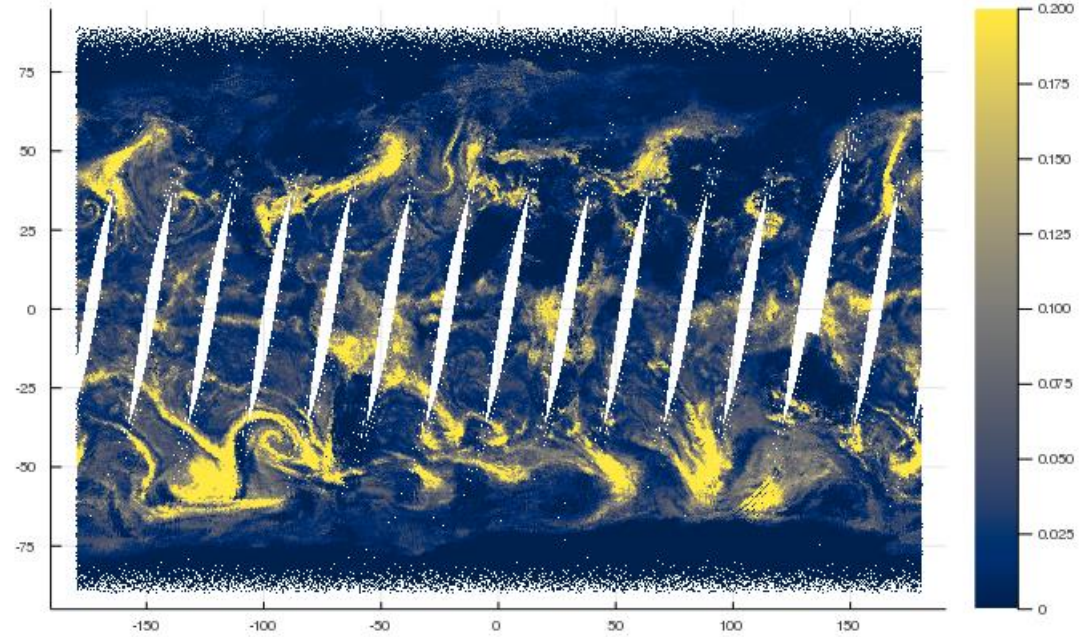
TCLW 20200321 Ascending



TCIW 20200321 Descending



TCLW 20200321 Descending



Conclusion

- Supervised machine learning is suitable for retrieval of cloud properties.
- What is most relevant for users, cloud fraction, cloud signal, TCIW, TCLW, … ?