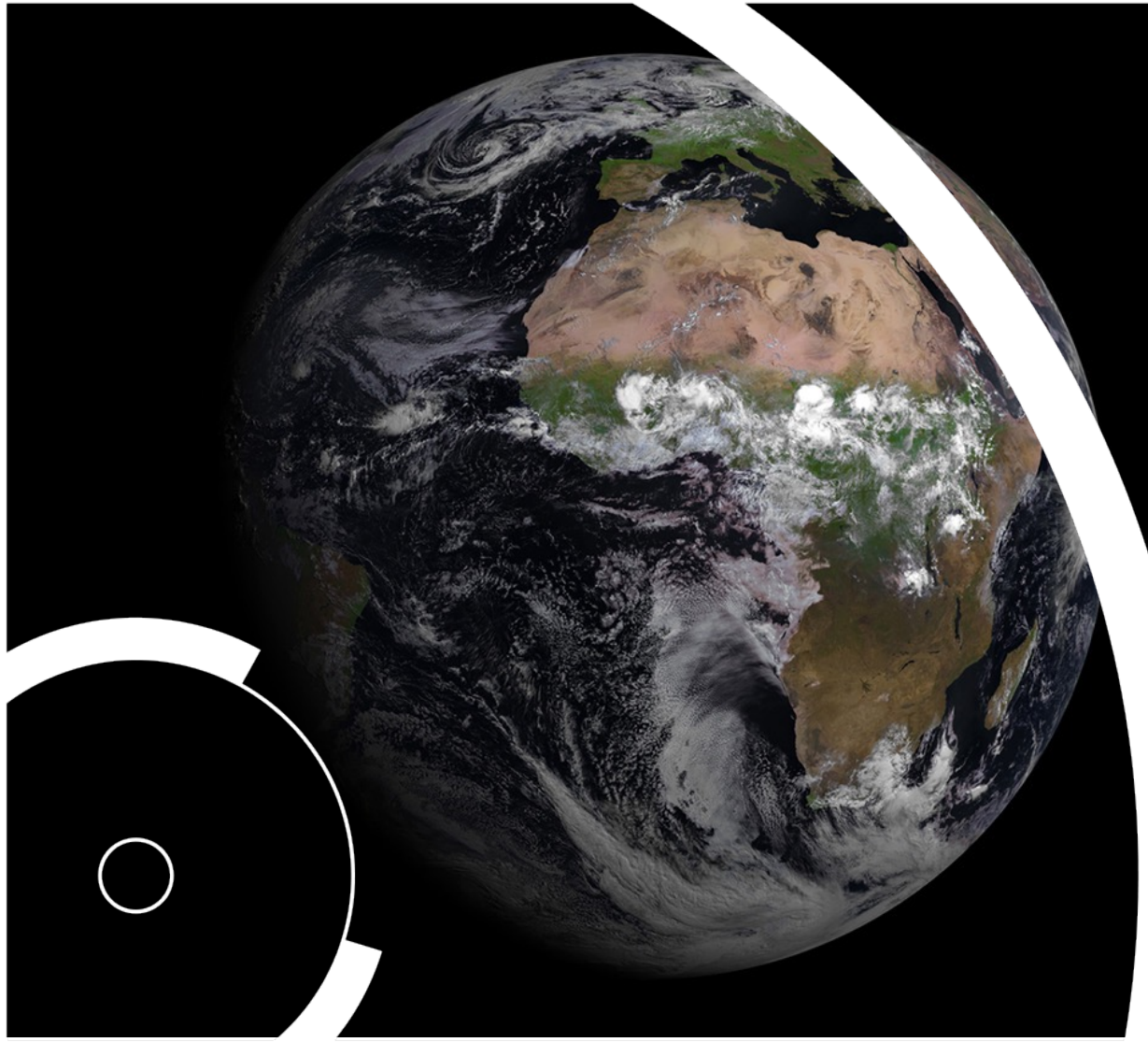


A New Paradigm for the Derivation of LEO AMVs Without Wind Guess

Kevin Barbieux, Régis Borde

Kevin.Barbieux@eumetsat.int

International Winds Workshop 16 – 9 May 2023

Why should we design a new AMV algorithm ?

- The use of the wind guess in the LEO AMV derivation scheme makes the AMVs inherently dependent on the forecast model which they are supposed to improve. We aim to design a method not reliant on the guess.

- We have doubts on the quality of the current AMVs considering the lack of robustness of the current tracking method. In particular, as explained in our poster yesterday[1] and in a future publication[2], this method is responsible for the tropical and mid-latitudes speed biases on AVHRR and SLSTR.

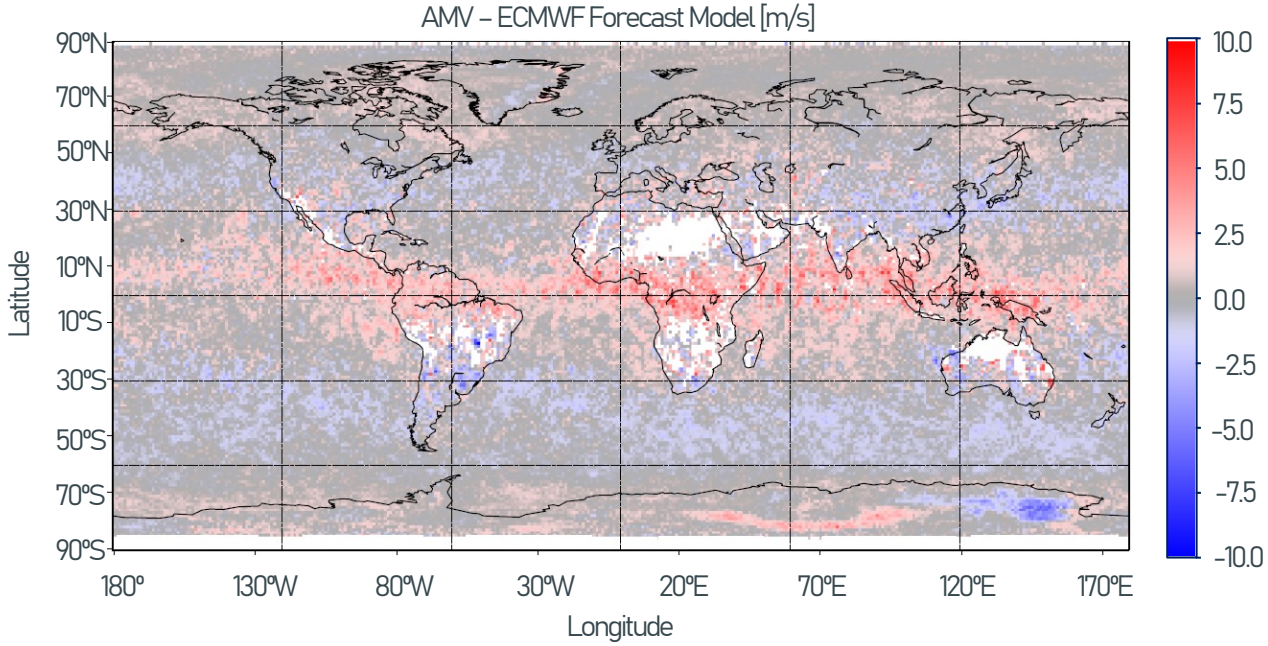
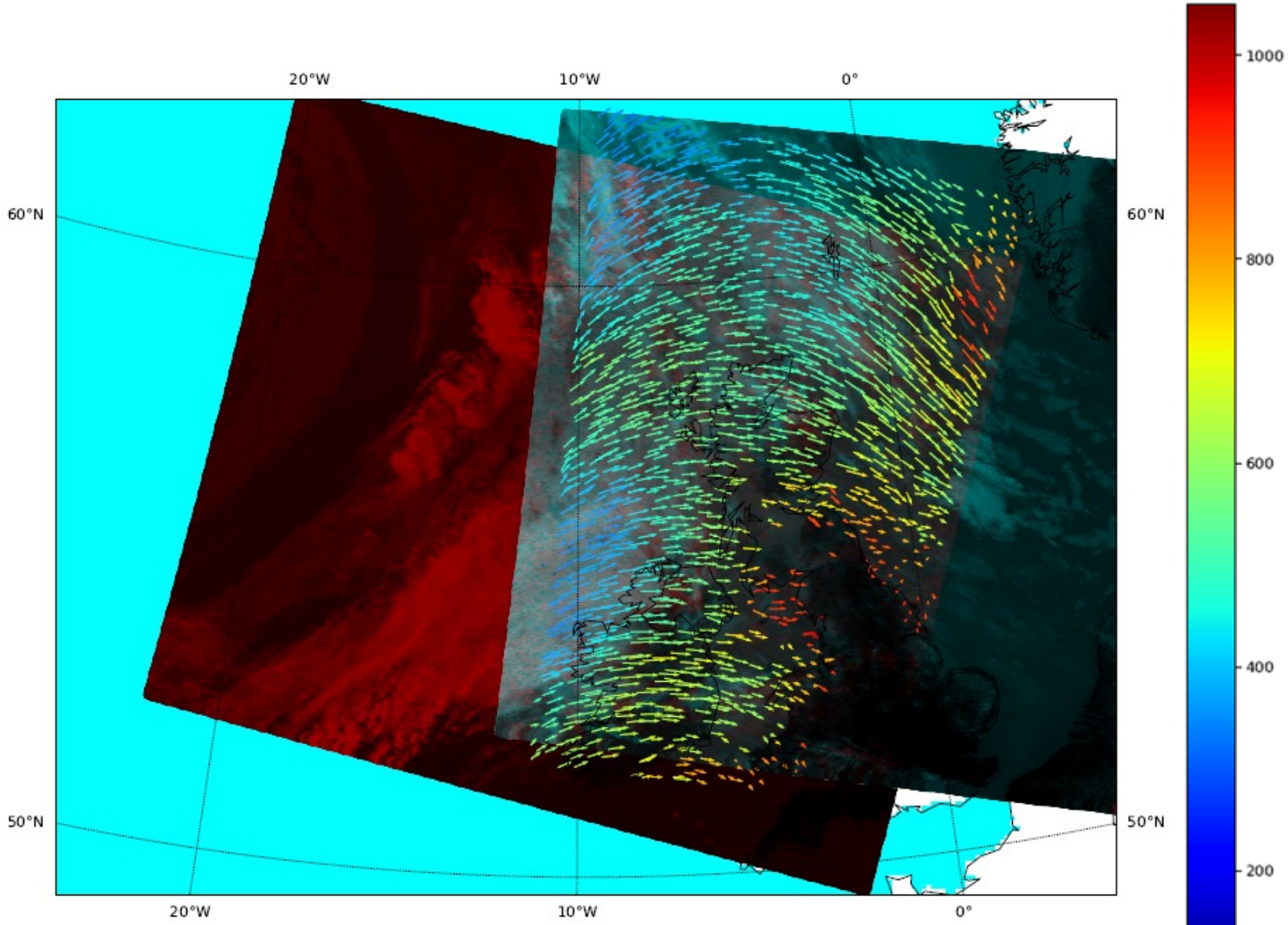


Figure: biases of S3A SLSTR AMVs against the ECMWF forecast model for the period 22 April 2021 to 21 May 2021. Only AMVs faster than 2.5 m/s and whose QIs are greater than 60 are used. Cells in which fewer than 5 fitting AMVs were derived are left blank.

[1] Barbieux, K. and Borde, R. The EUMETSAT AVHRR and SLSTR AMV tropical speed biases pattern explained. Poster presented at the IWW16 on 8 May 2023.
[2] Barbieux, K., and Borde, R. The reason behind the tropical and extratropical atmospheric motion vectors speed biases from EUMETSAT's low Earth orbit satellites. Accepted, to be published in *Remote Sensing Letters*.

Overview of the proposed tracking method

- Co-Registration via Projection
- Detection of Corners
- Matching via descriptors
- Height Assignment
- Filtering of matches via consensus
- Rematching following the consensus

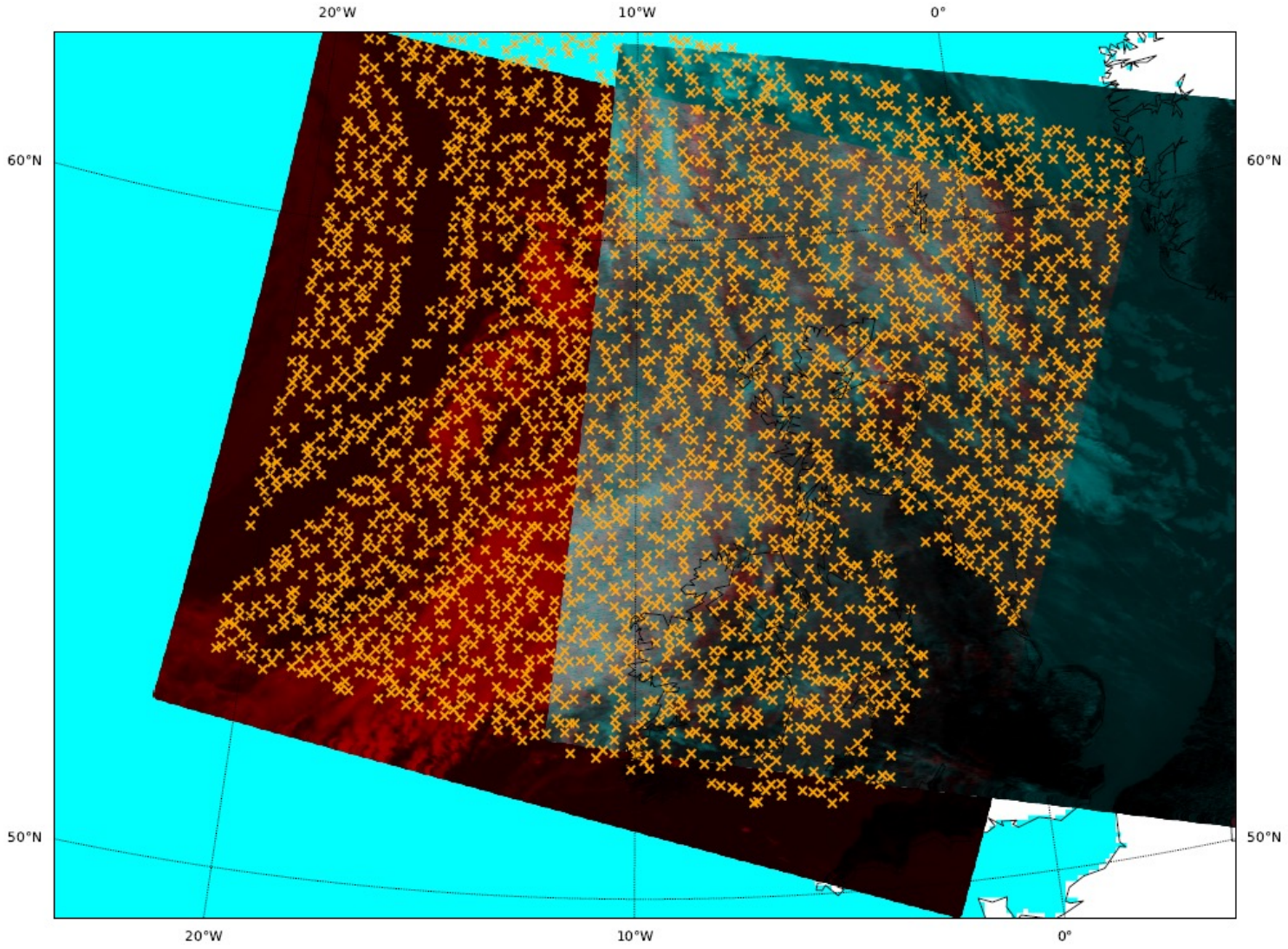


This derivation method is (tentatively) called Feature Matching and Consensus (FMC) and the corresponding AMVs, FMC-AMVs.

Detectors

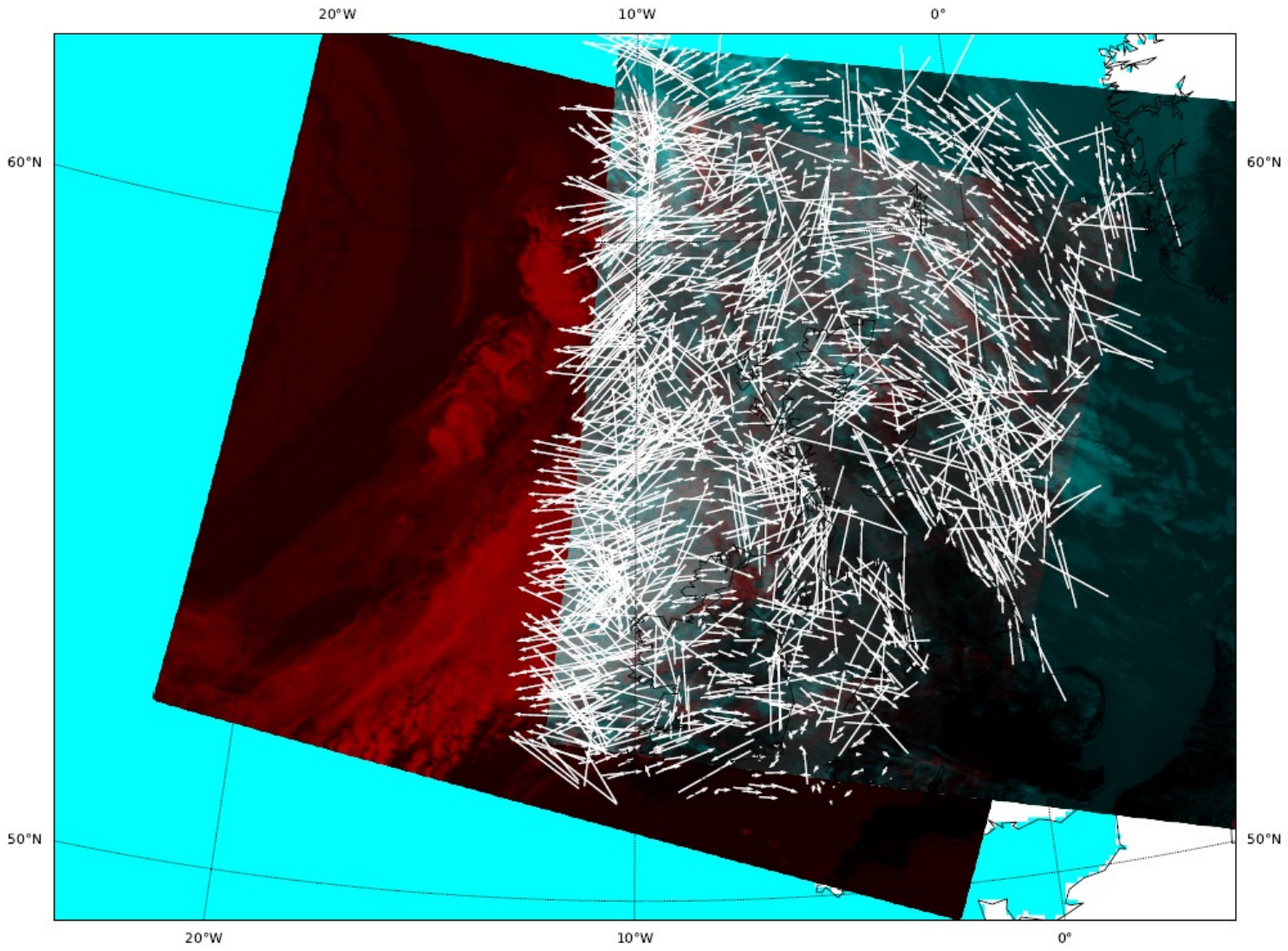
- The paradigm of grid does not exist anymore. We detect corners where they are the most salient.

- A time-efficient non-maximum suppression allows the reduction of the overlap between features.



Descriptors

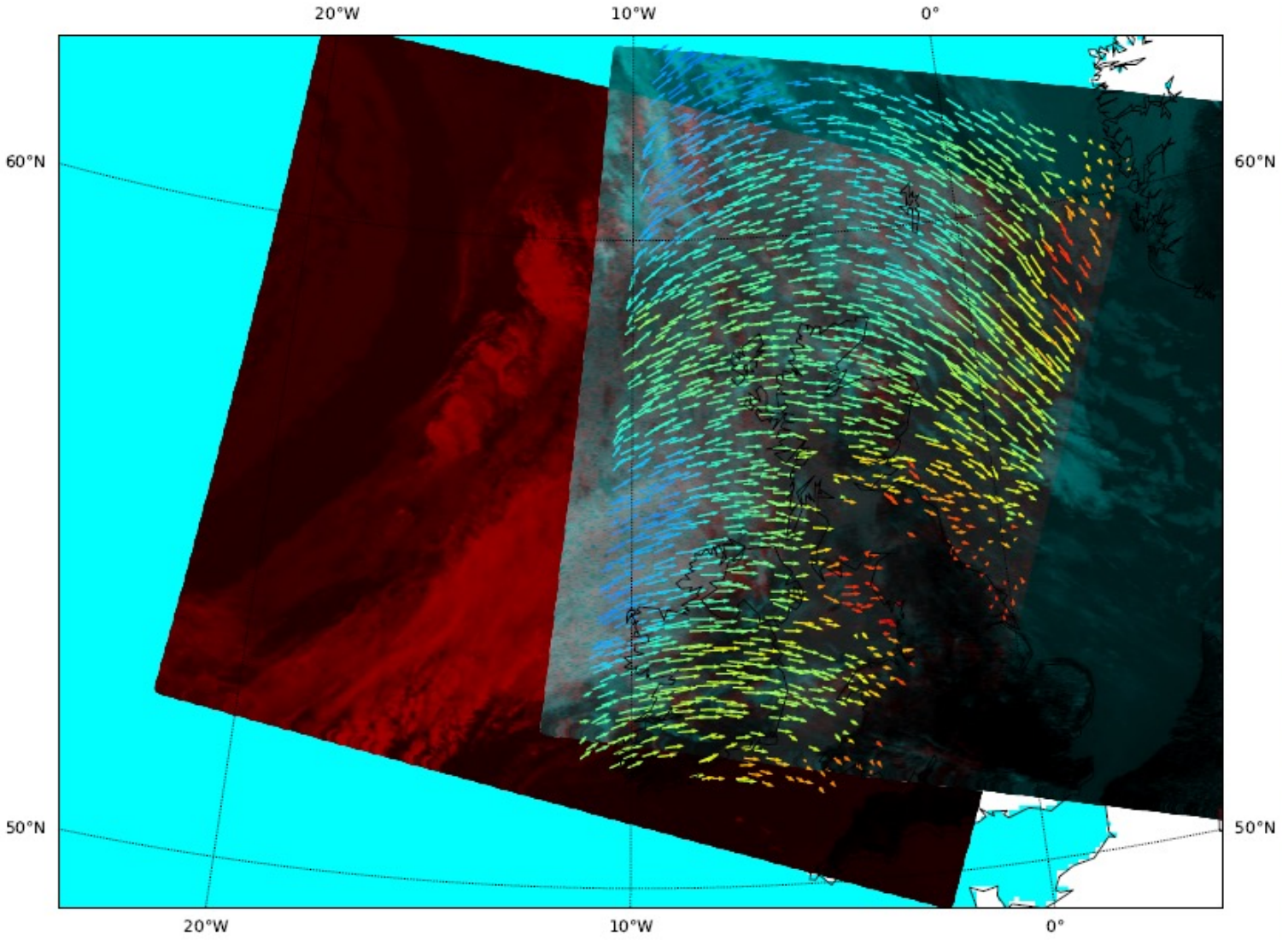
- Features are not described (and matched) by the target of radiance values, but by modern computer vision descriptors like Scale Invariant Feature Transform (SIFT)[1].



[1] Lowe, D. G. (1999, September). Object recognition from local scale-invariant features. In Proceedings of the seventh IEEE international conference on computer vision (Vol. 2, pp. 1150-1157). IEEE.

Consensus and Rematching

- We then find the best consensus among subsets of vectors. Vectors not fitting to the consensus are discarded.
- Height assignment is performed beforehand so that vectors at different heights do not influence each other.
- Discarded matches can be rematched by following the consensus.

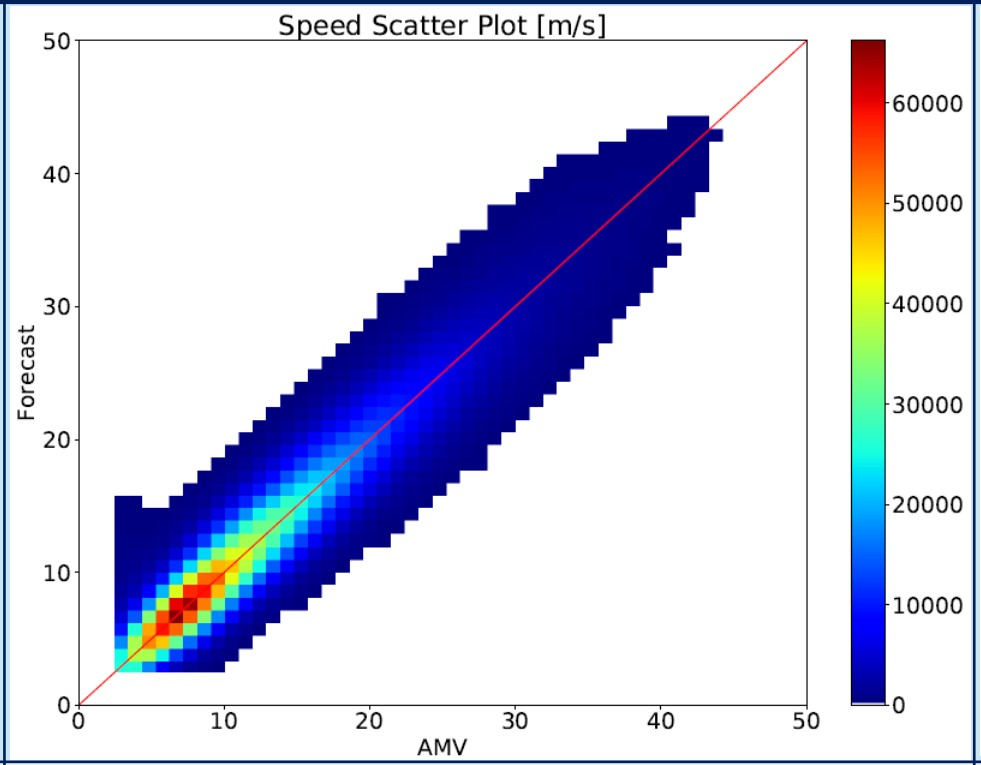
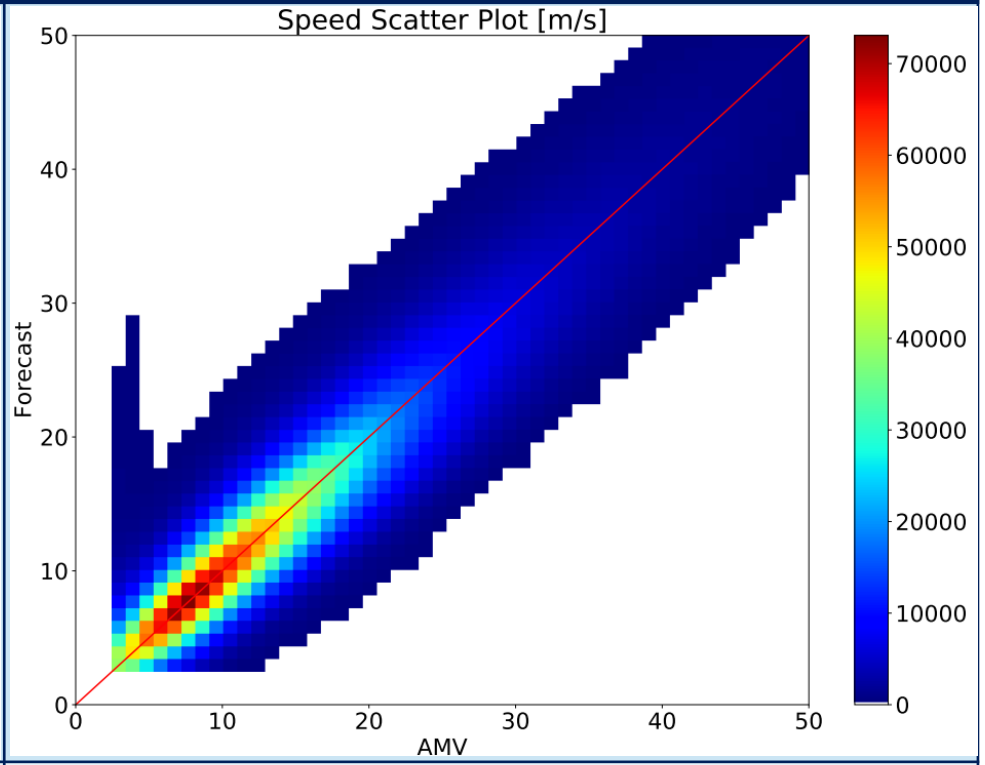


Quality Index

The QI is redesigned to take the specific features of the FMC method into account. It includes:

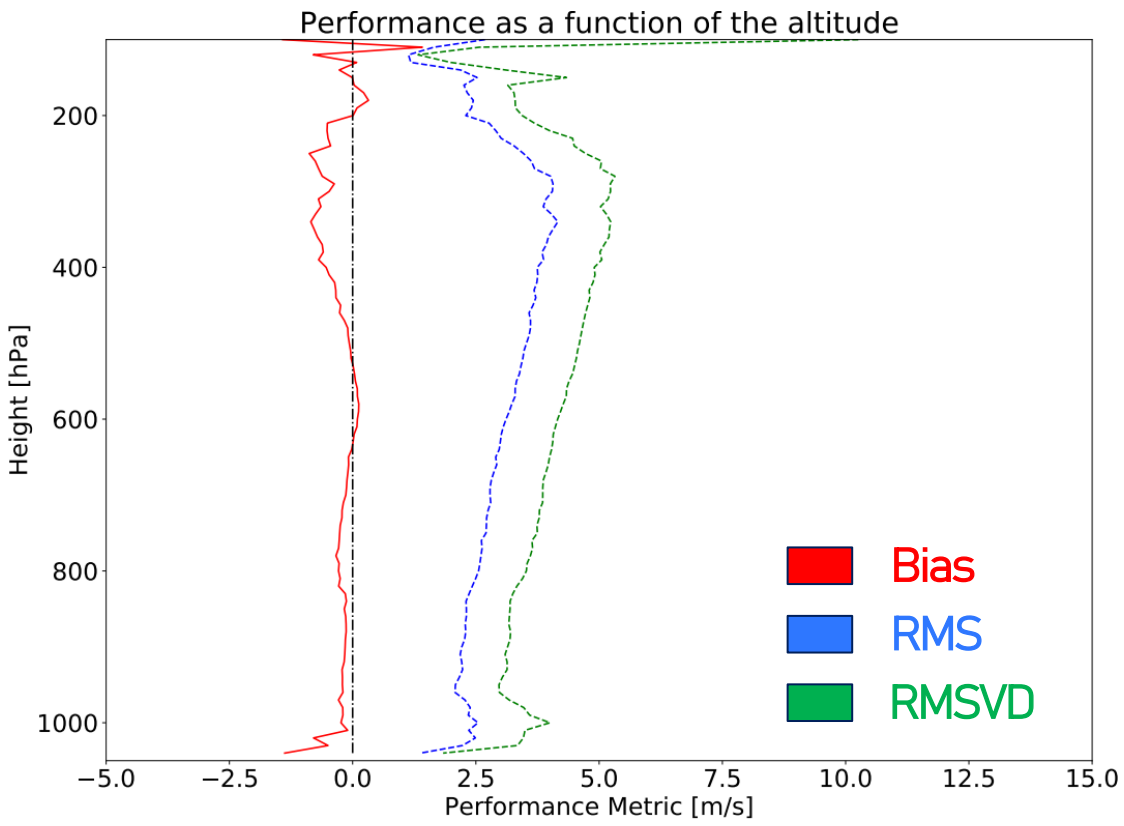
- The match score of each vector
- The overall quality of the consensus
- The quality of the consensus locally around each vector
- The agreement of each vector to the consensus

Results – SLSTR, 8 March – 7 April 2023, QI/FMCQI>60, speed > 2.5 m/s

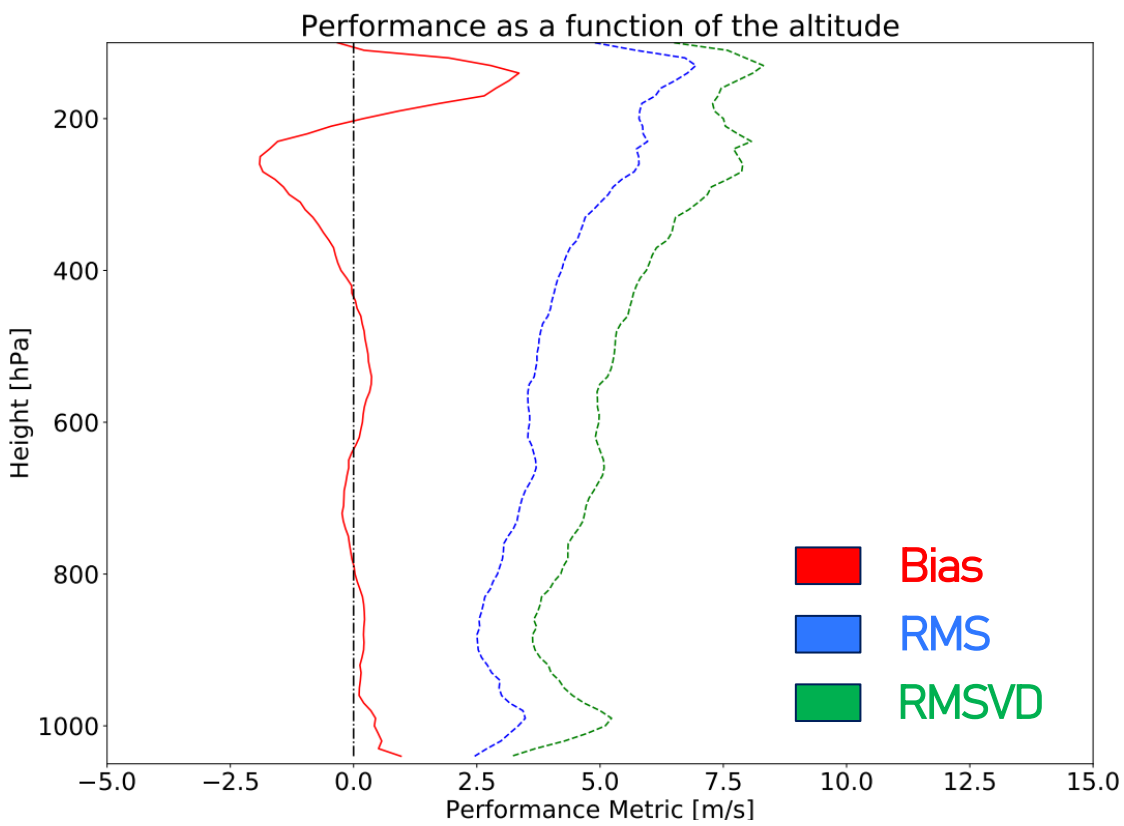
	FMC	Current Method
Speed Scatter Plot VS Model		
RMS [m/s]	3.5	3.9
RMSVD [m/s]	4.8	5.6
Bias [m/s]	-0.2	-0.1
Number of AMVs	5'678'872	8'863'116

Profiles - SLSTR, 8 March – 7 April 2023, QI/FMCQI>60, speed > 2.5 m/s

FMC

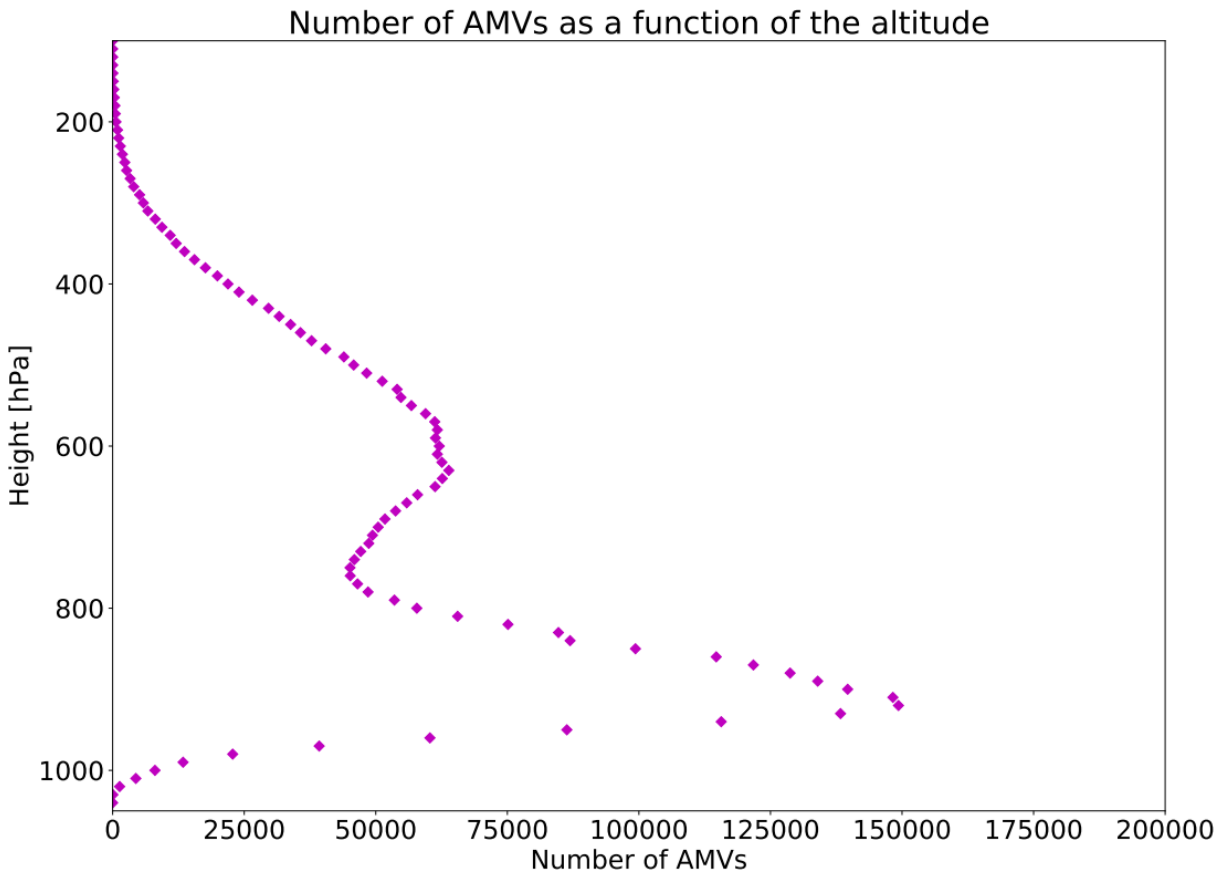


Current Method

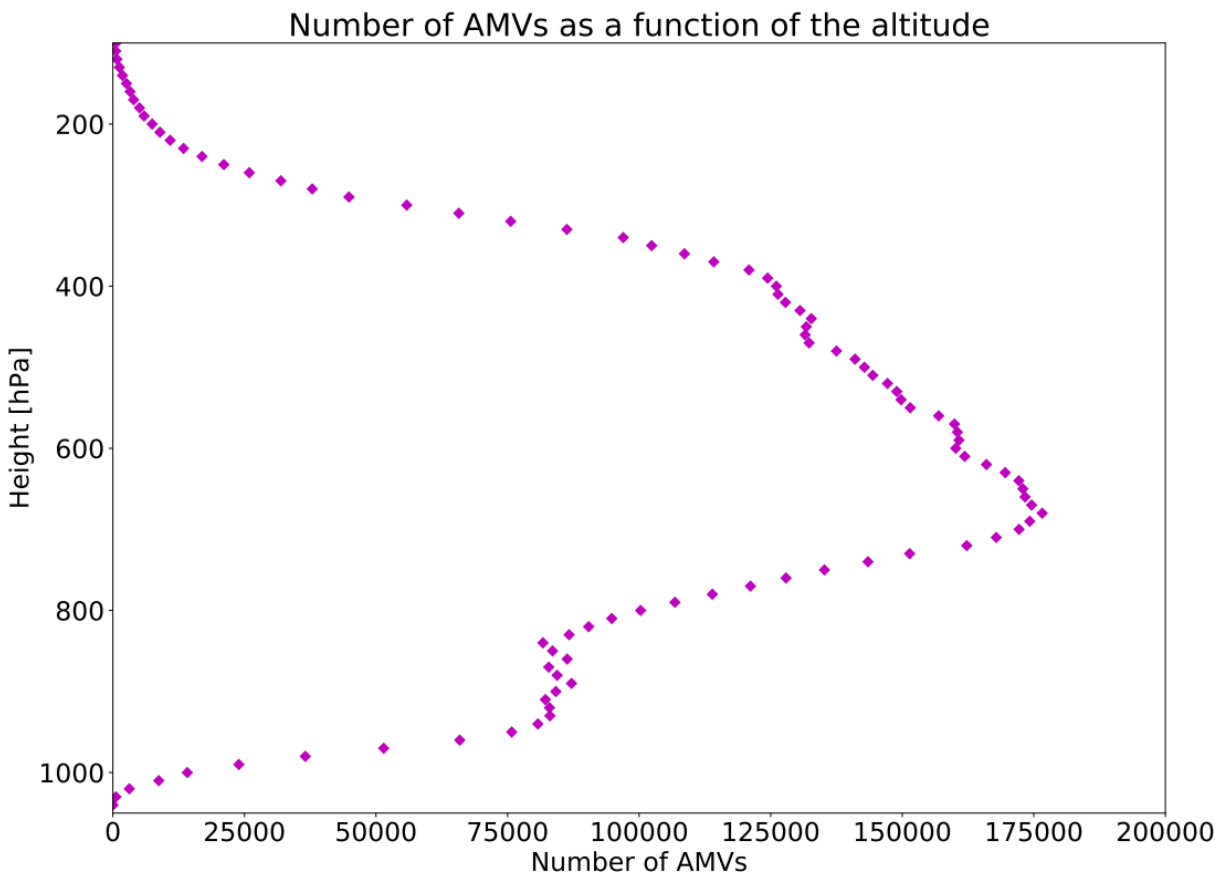


Number of AMVs - SLSTR, 8 March – 7 April 2023, QI/FMCQI>60, speed > 2.5 m/s

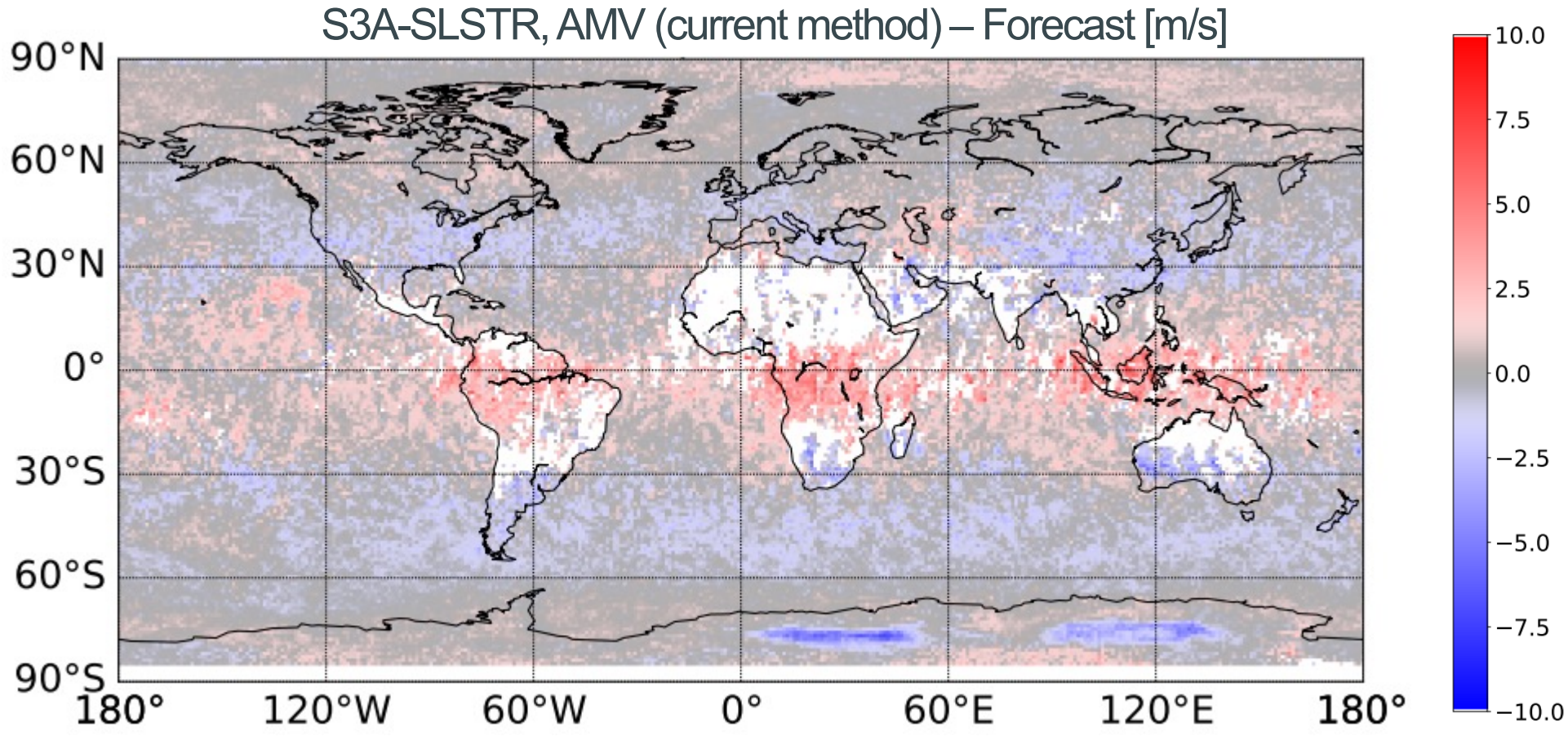
FMC



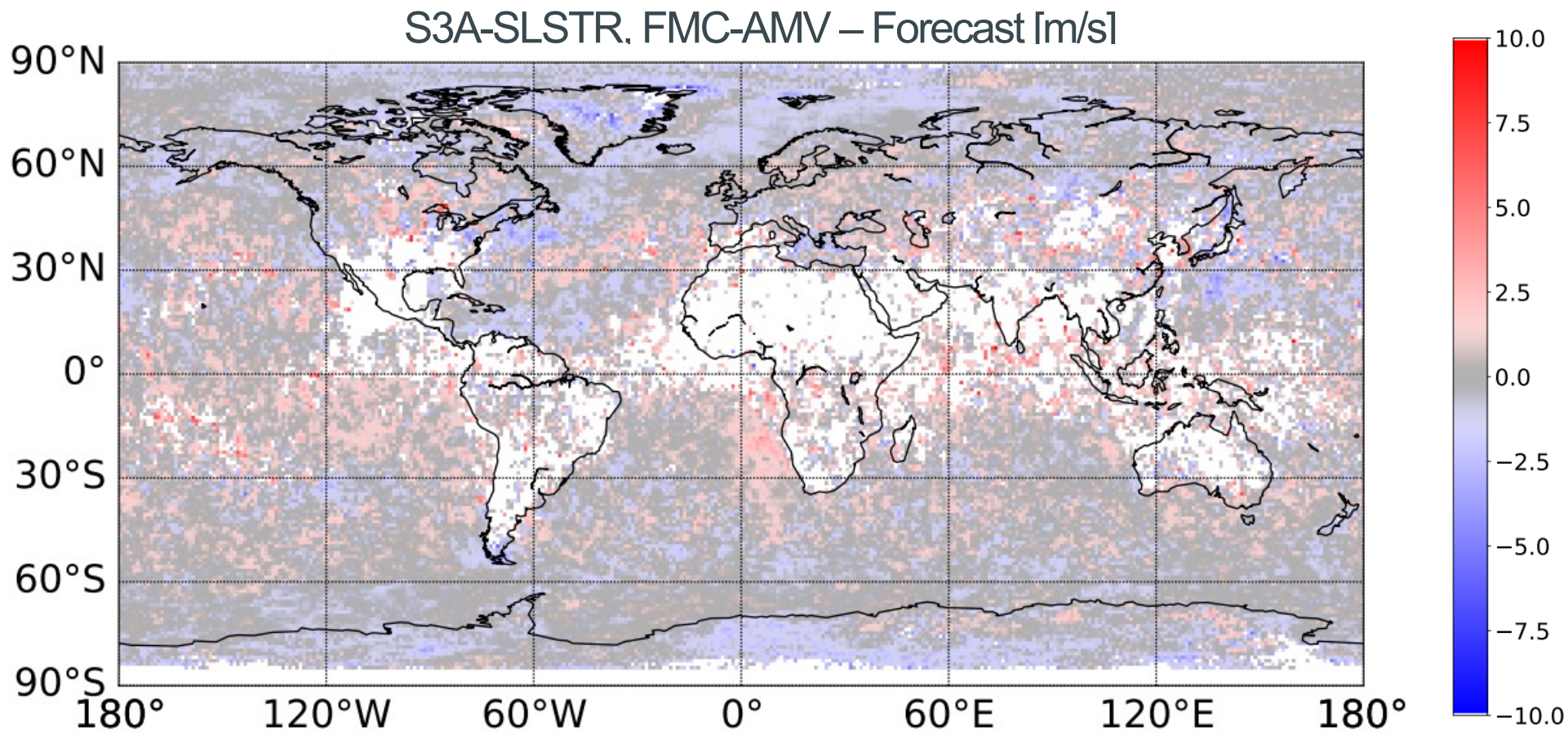
Current Method



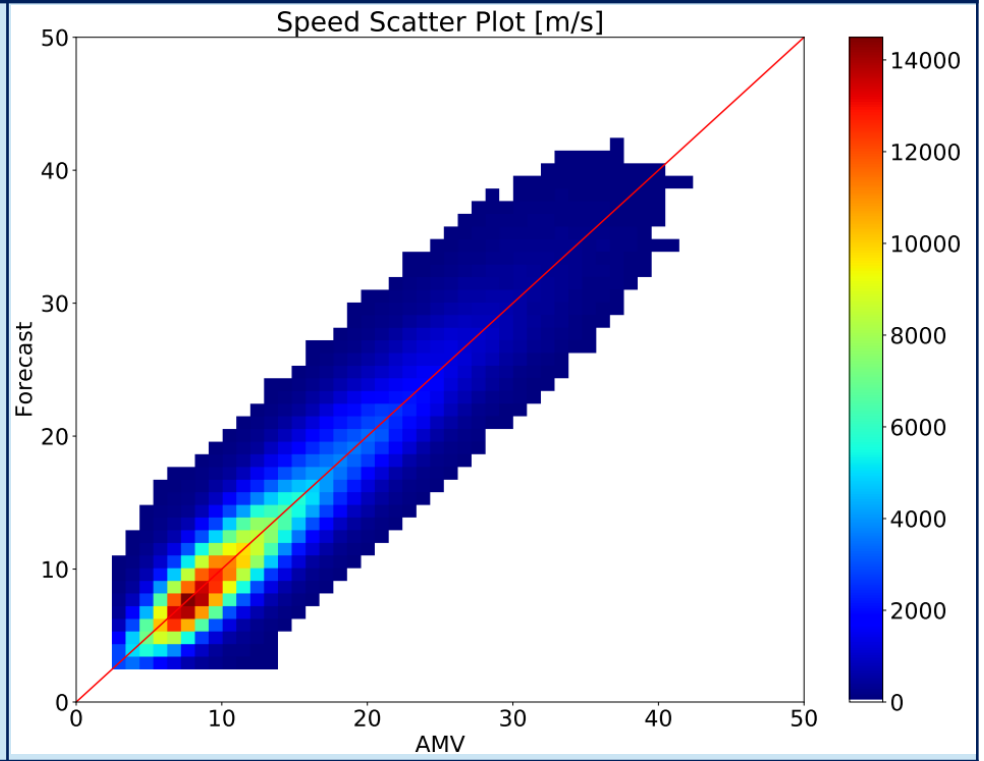
Biases Map - SLSTR, 8 March – 7 April 2023, QI>60, speed > 2.5 m/s



Biases Map - SLSTR, 8 March – 7 April 2023, FMCQI>60, speed > 2.5 m/s



Results – AVHRR, 1 – 3 March 2023, FMCQI>60, speed > 2.5 m/s

	FMC
Speed Scatter Plot VS Model	
RMS [m/s]	3.0
RMSVD [m/s]	4.2
Bias [m/s]	-0.1
Number of AMVs	1'065'109

Conclusion

- The FMC AMV algorithm is, as far as we know, the only existing LEO imager AMV algorithm independent of the wind guess.

- FMC significantly outperforms the cross-correlation method (15% reduction of the RMSVD), at the cost of producing 30 to 50% fewer AMVs.

- Production of AVHRR and SLSTR AMV datasets starting soon, with availability expected by the end of the year. Contact us (kevin.barbieux@eumetsat.int, regis.borde@eumetsat.int) if you are interested.

Thank you!

Questions are welcome.