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EUMETSAT NWP SAF NUMERICAL WEATHER PREDICTION

Met Office

Adaptation of PARMIO for the fast model in passive microwaves

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1. Introduction

- In the context of a NWP SAF visiting scientist mission, a fast version of the PARMIO model has to be developed.
- It has to cover microwave frequencies from 500MHz to 700GHz.
- Here, we detail the selections and adaptations that have been done in the PARMIO model to cover this frequency range with limited errors.

2. Summary of the previous comparisons

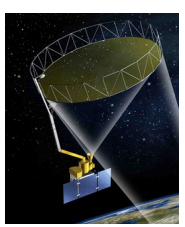
- 3 models have been compared...

LOCEAN a physical model
with parameters adjusted to L band measurements
FASTEM (FAST microwave Emissivity Model)
a fast parameterized model
RSS (Remote Sensing Systems)
an empirical model fitting satellite observations

RTM	Model type	Dielectric constant	Wave spectrum	Foam cover	Foam emissivity
LOCEAN Dinnat et al., 2003	Full physical model adjusted for L-band	Klein and Swift, 1977	Durden and Vesecky, 1985 with $a_0 \times 1.25$	Yin et al. 2016	Anguelova and Gaiser, 2013
FASTEM Liu et al., 2011	Parameterized and fast	Ellison et al., 1998 +Double Debye	Durden and Vesecky, 1985 with $a_0 \times 2$	Monahan and O'Muircheartaigh 1986	Kazumori et al., 2008 with Stogryn,1972
RSS Meissner and Wentz, 2012	Empirically fitted to observations	Meissner and Wentz, 2004 and 2012	Wind induced emissivity fitted to observations Meissner and Wentz, 2012 Meissner et al., 2014		

...with satellite observations from:

SMAP observations at 1.4GHz



AMSR2 observations from 6.9 to 89GHz

GMI observations from 10.6 to 166GHz

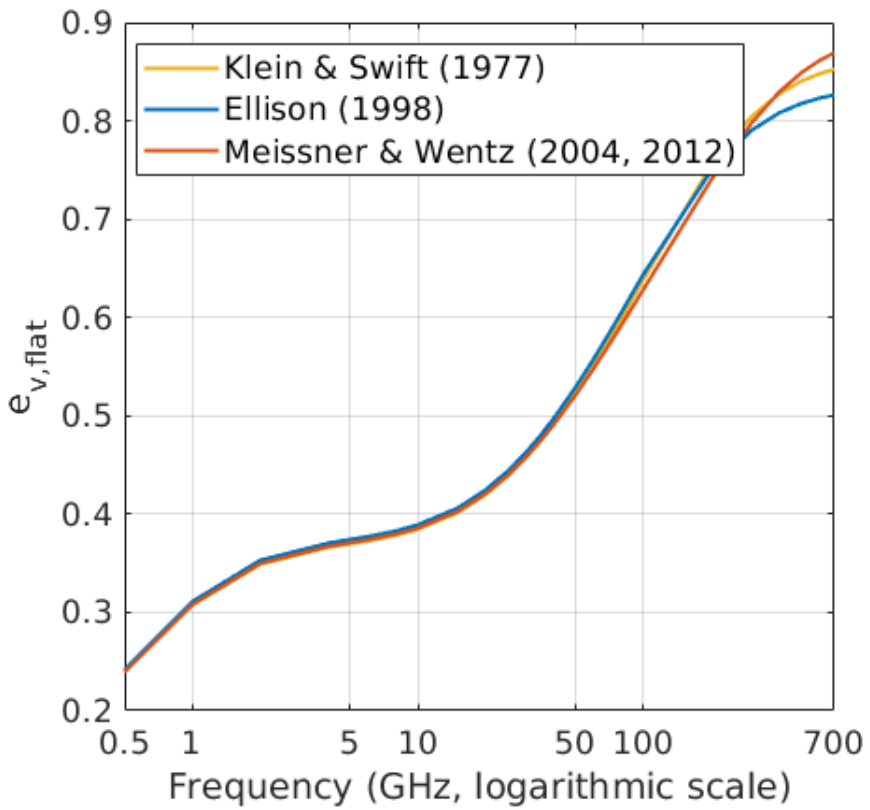
ATMS observations from 23.8 to 165.5GHz

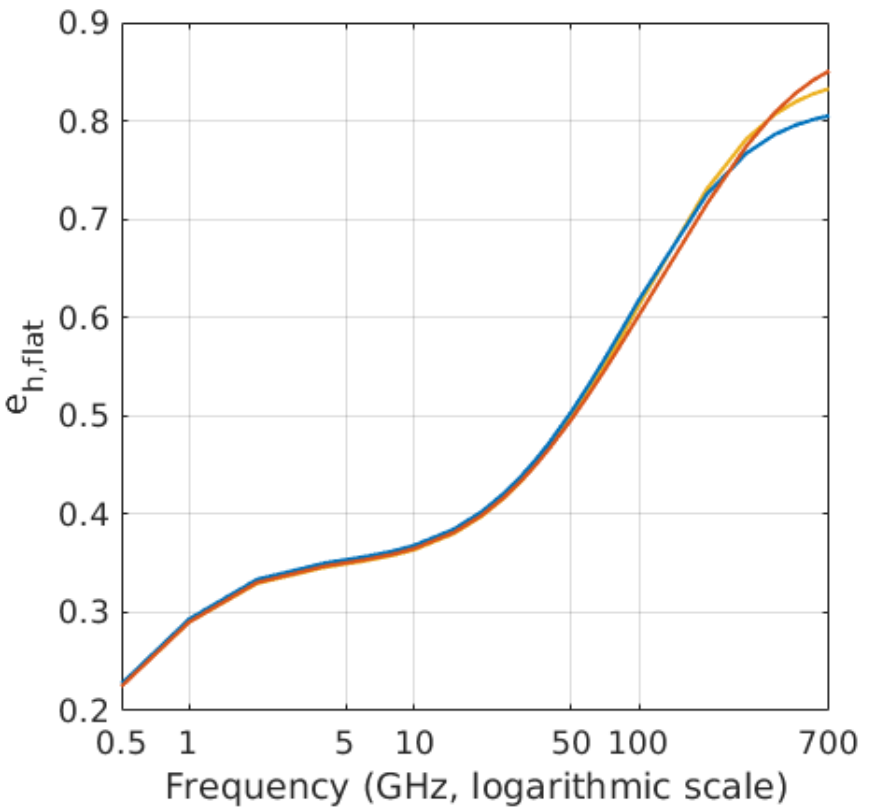
- We found discrepancies between the observations and the models for cold sea surface temperatures and high ocean wind speeds for frequencies beyond 6GHz.

- So our following choices in the PARMIO model aim to decrease these errors.

3. Selection of the dielectric constant model

- The dielectric constant model in PARMIO is the one from Meissner & Wentz (2004, 2012).
- We keep this dielectric constant model for the development of the fast version.
- Tests have been done to see if the model extrapolates well down to 500MHz and up to 700GHz.

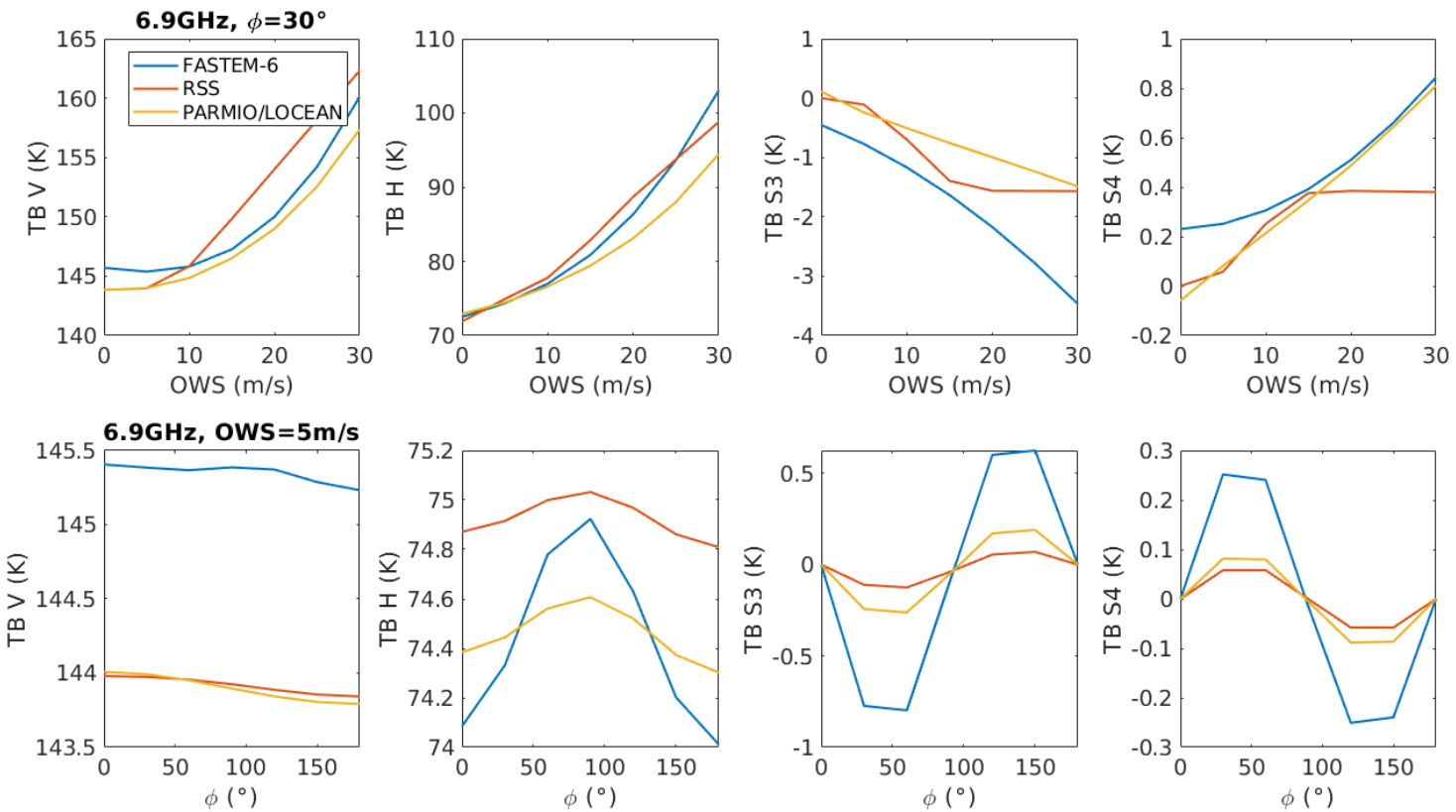




4. Selection of the wave spectrum model

- The wave spectrum from Durden & Vesecky, 1985 with an amplitude coefficient of 1.25 is selected in PARMIO. We keep this configuration that is the same than the LOCEAN model.

- Comparisons in active mode with this wave spectrum have also been done. (to be shown in the next presentation)



5. Development of a foam coverage

- In its default configuration, PARMIO uses the foam coverage model from Yin et al. (2016), but it has been shown that emissivities at OWS were underestimated at higher frequencies with this model.

- Foam coverages are mostly based on the power law: $Fc = b \times OWS^{c}$

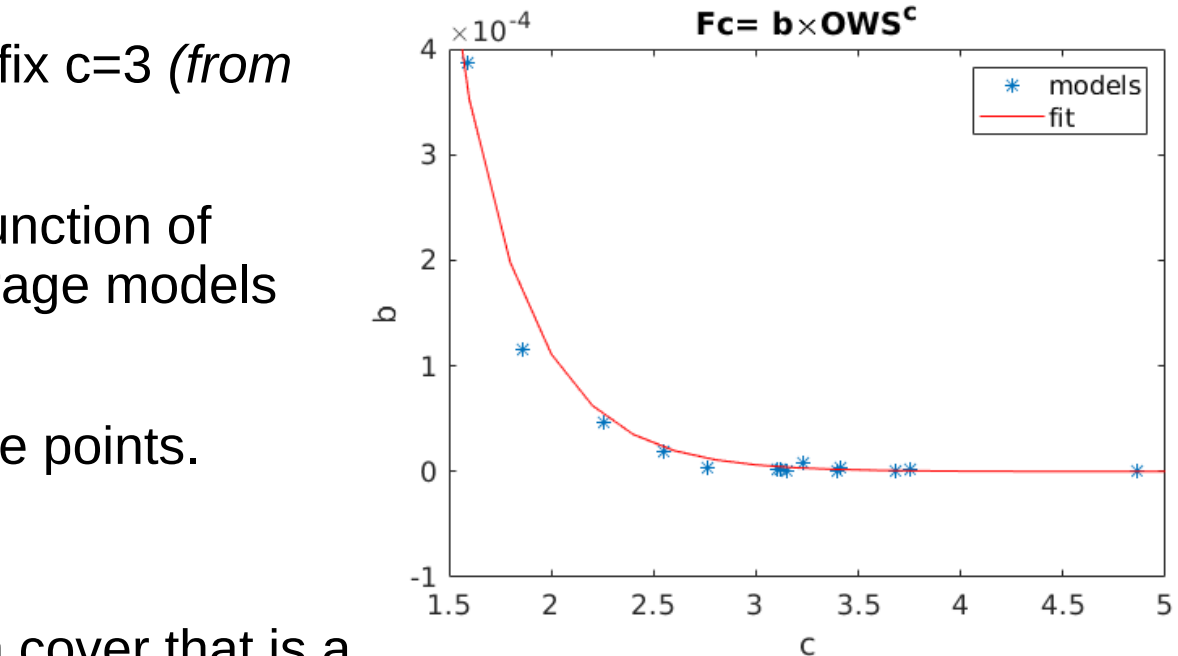
- For our new foam coverage, we fix c=3 *(from Wu, 1979 and 1992)*.

- Then we plot coefficient b as a function of coefficient c using all foam coverage models that use the power law.

- An exponential fit is applied to the points.

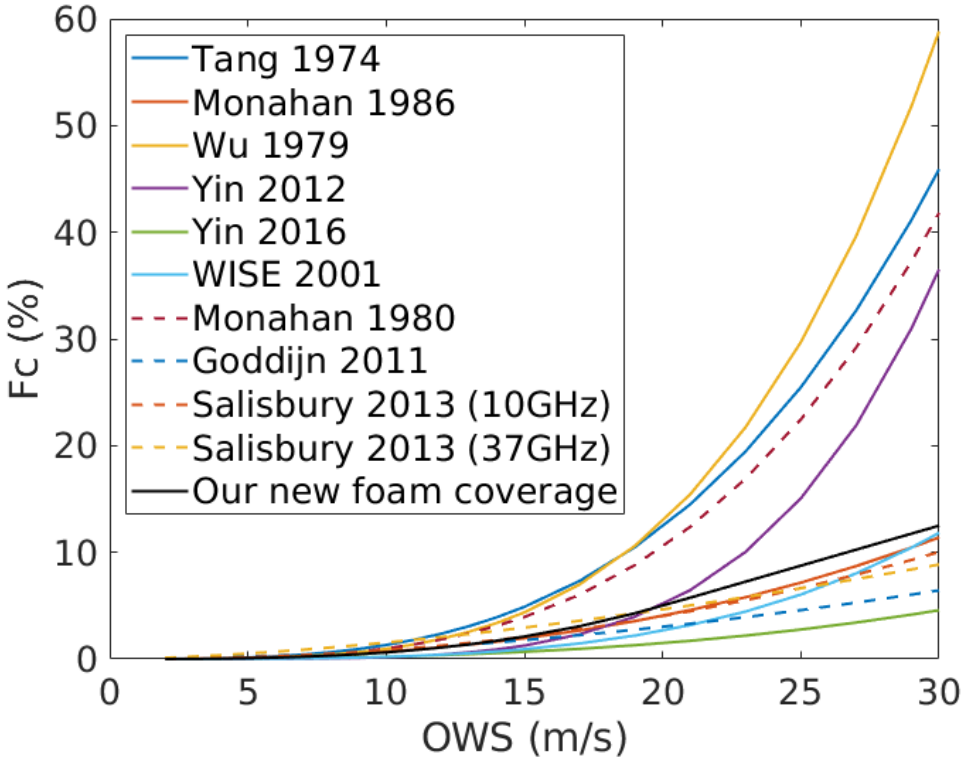
- We find $b=6.25e^{-6}$

- With this method, we find a foam cover that is a compromise between all the existing foam coverage models.



5. Development of a foam coverage

- By comparing TB_{rough} simulated with different models we note that the foam coverage should not be expressed as a power law beyond 20 m/s.
- Therefore beyond 20m/s it is the expression of the tangent curve that is taken.
- Our foam coverage model is expressed:



$$if\ OWS < 20$$

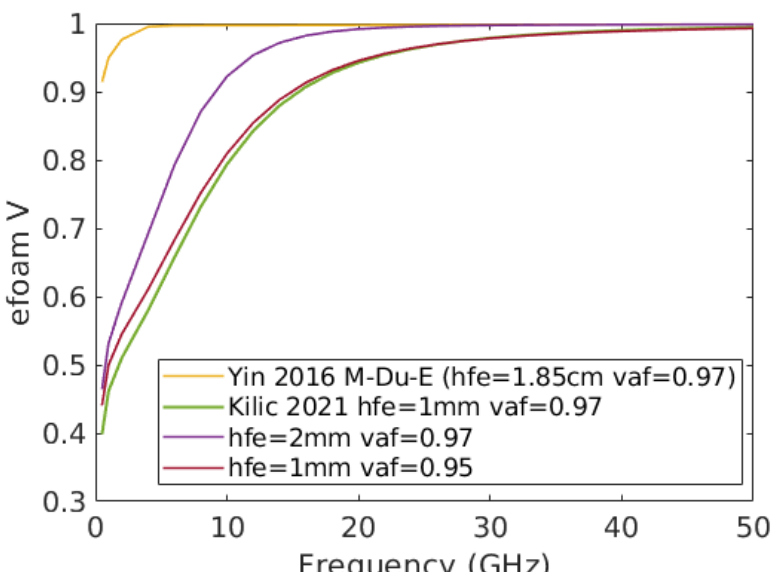
$$Fc = 6.25e^{-6} \times OWS^3$$

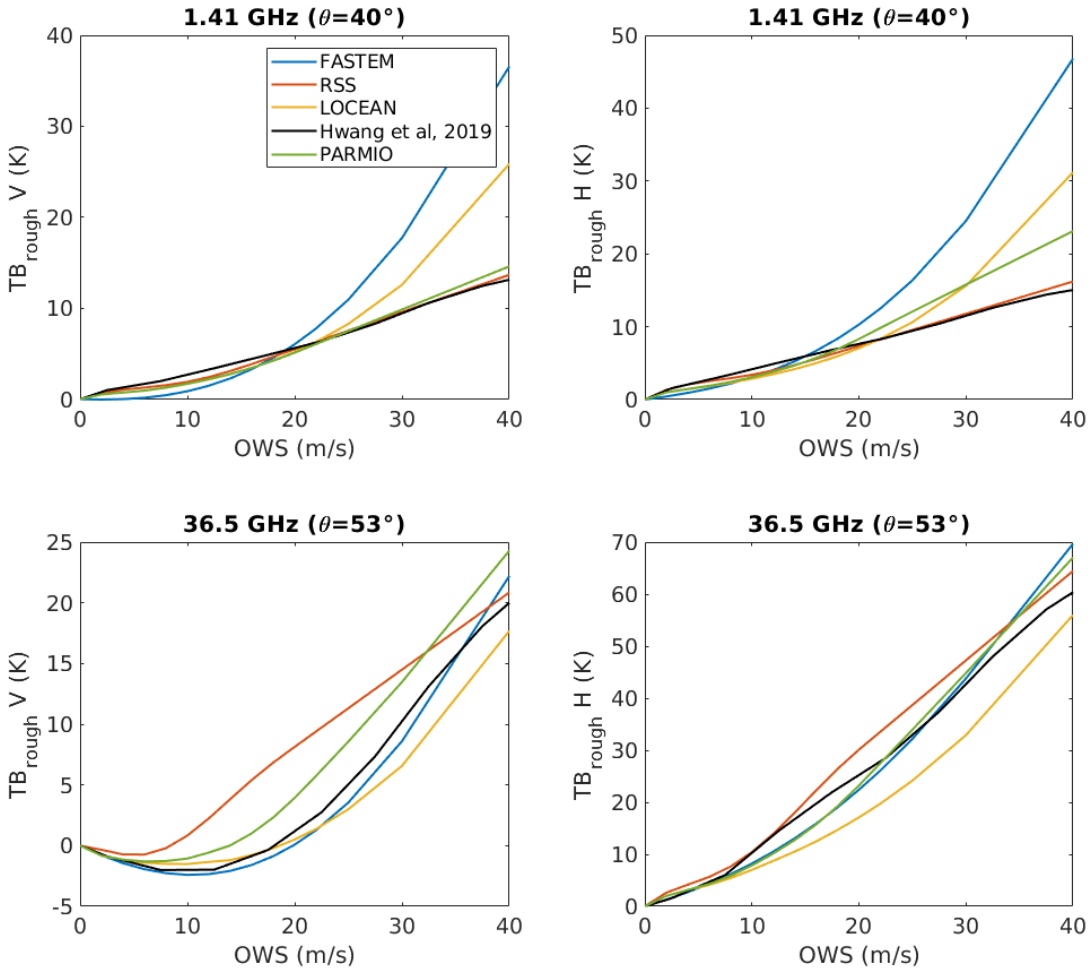
$$else$$

$$Fc = 3 \times 6.25e^{-6} \times 20^2 \times (OWS - 20) + 6.25e^{-6} \times 20^3$$

6. Adjustments of the foam emissivity

- For the foam emissivity, we use Anguelova & Gaiser, 2013 as it is described in Yin et al., 2016.
- We selected:
  - foam thickness hfe=2mm
  - Void fraction at air-foam interface vaf=0.97
- The other parameters are fixed like in Yin et al., 2016.





- Comparisons with Hwang et al., 2019 GMFs show good results of the PARMIO model even for high OWS up to 50 m/s with our foam models.

7. Conclusion

- Configuration of the PARMIO model has been adapted for better accuracy for frequencies from 500 MHz to 700 GHz.
- This configuration of the PARMIO model will be used to train the SURface Fast Emissivity Model (SURFEM).