INTERNATIONAL SPACE SCIENCE INSTITUTE

l'Observatoire de Paris — LERMA

EUMETSAT NWP SAF NUMERICAL WEATHER PREDICTION

Met Office

ISSI team meeting
18 may 2021

Comparison of the existing radiative transfer models with ATMS observations, and tests with radar backscattering.

Lise Kilic, Catherine Prigent
and the ISSI team

Outline

1)Summary

2)Comparisons of the models with ATMS

3)Start to code a fast version of the reference model

4)Comparisons of the backscattering simulated with the reference model with geophysical model functions.

1) Summary of the previous comparisons

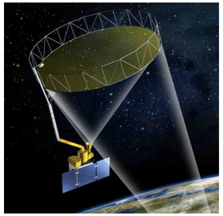
- 3 models have been compared...

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

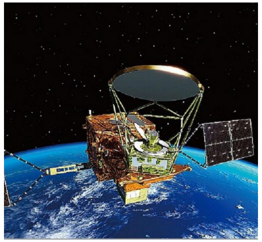
RTM	Model type	Dielectric constant	Wave spectrum	Foam cover	Foam emissivity
LOCEAN Dinnat et al., 2003	Full physical model adjusted for L-band	Klein and Swift, 1977	Durden and Vesecky, 1985 with $a_0 \times 1.25$	Yin et al. 2016	Anguelova and Gaiser, 2013
FASTEM Liu et al., 2011	Parameterized and fast	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

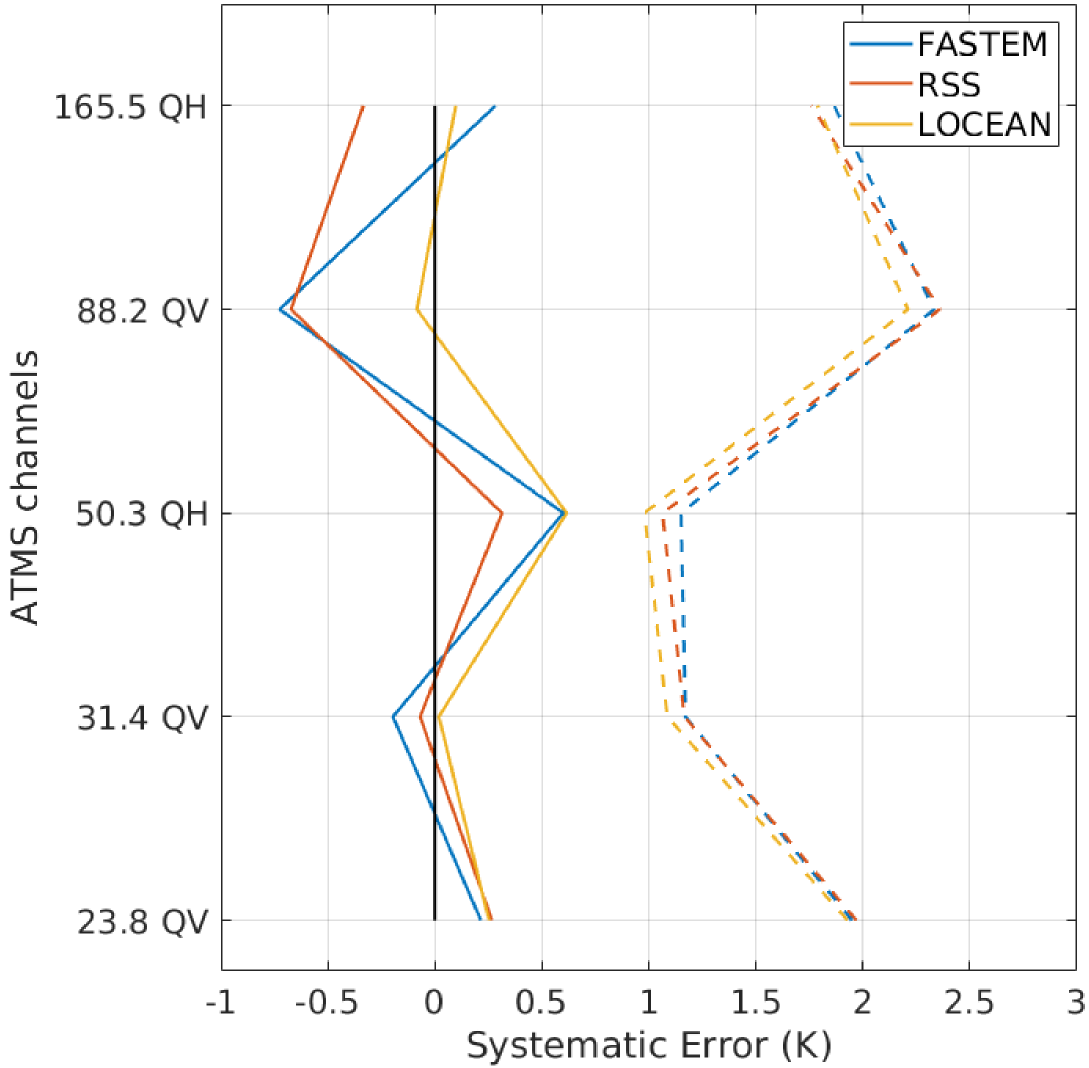
- We found discrepancies between the observations and the models for cold sea surface temperatures and high ocean wind speeds.

- Now, we compare the models with ATMS observations to evaluate the errors as a function of the incidence angle.

2) Comparisons with ATMS

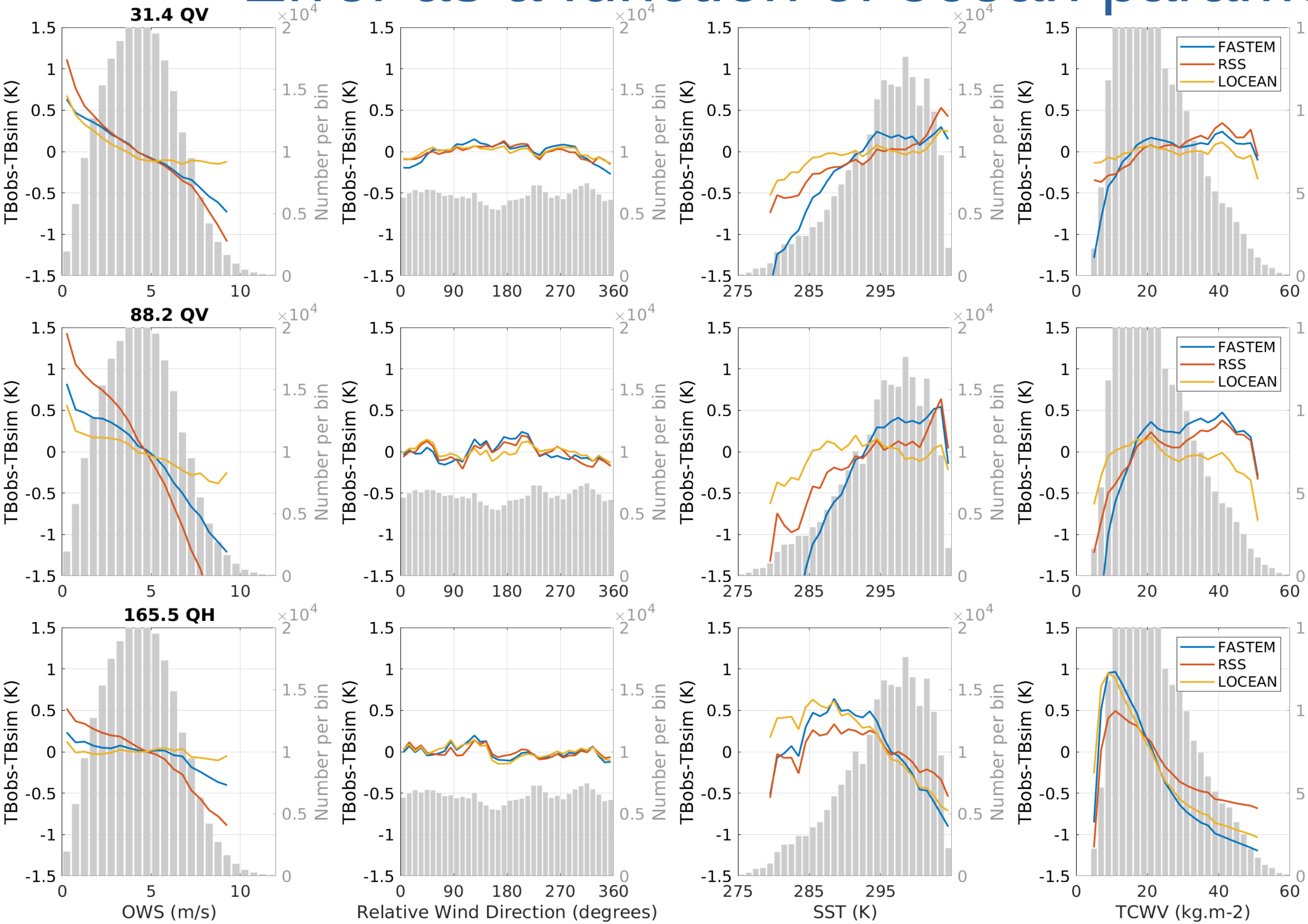
- We selected 23.8QV, 31.4QV, 50.3QH, 88.2QV, 165.5QH channels.
- ERA-5 data + Mercator salinity as inputs for the models
- Atmospheric radiative transfer model of Rosenkranz (we take into account the bandwidth of ATMS channels)
- Cloud filtering using Cloud liquid water from Grody et al., 2001
- Sea ice filtering with ERA-5 sea ice fraction.
- LOCEAN model updated with Meissner and Wentz dielectric constant.
- Wind direction has been taken into account for the 3 models.

Biases with ATMS



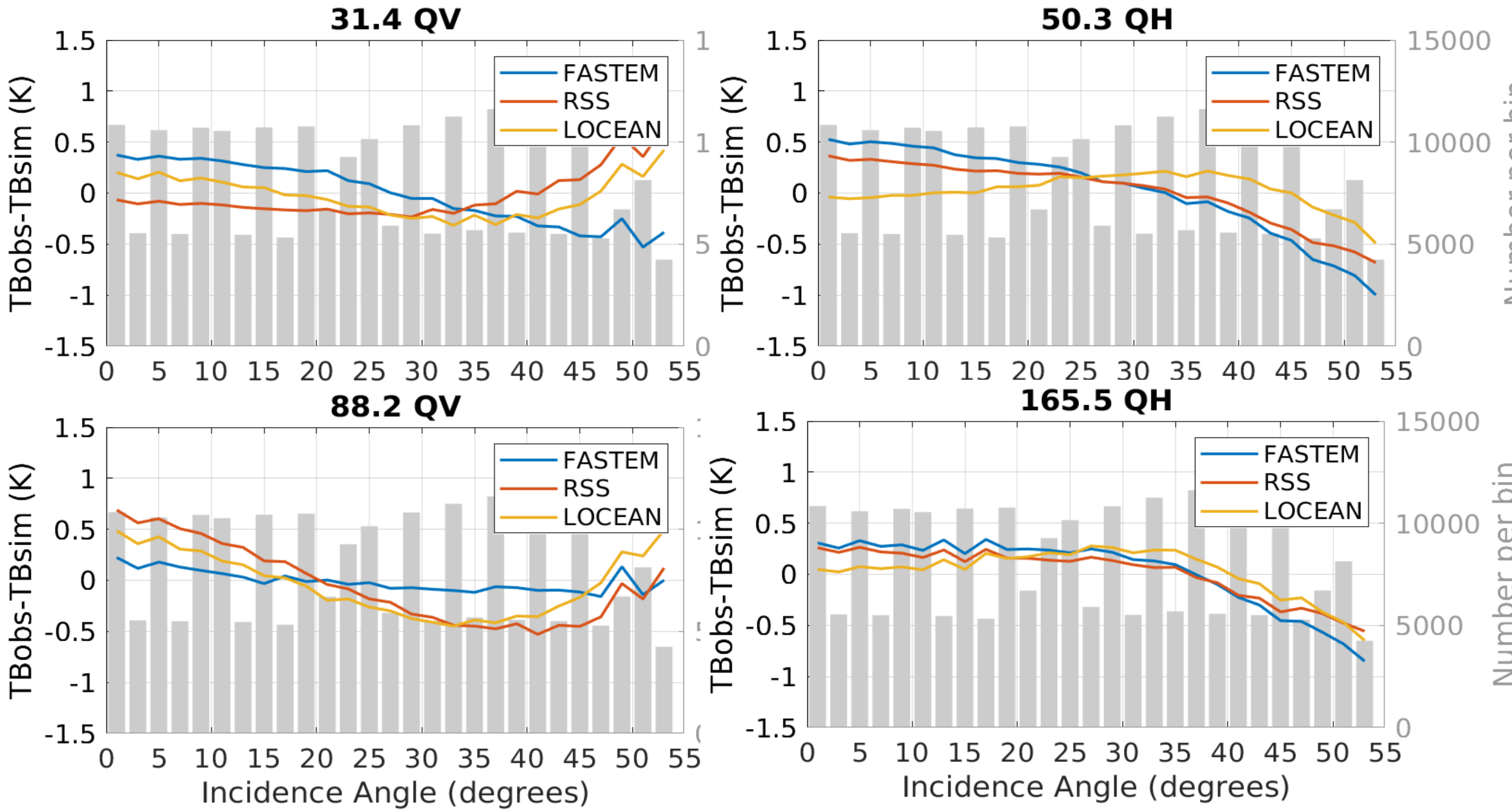
- We found very low biases between the simulations and ATMS observations
- Here the biases are computed mixing all the incidence angles.
- We should compute these biases only for incidence angle close to 55° to compare them with our previous results from GMI and AMSR2.

Error as a function of ocean parameters



- Dependence to SST is improved at high frequencies for LOCEAN model with Meissner & Wentz dielectric constant.
- No obvious sign of errors related to the wind direction. (but if not taken into account we can see the difference)
- Still errors as a function of OWS
- Correlation between TCWV errors and SST errors

Error as a function of the incidence angle



- Errors as a function of incidence angle (theta) are limited (less than 0.5K for LOCEAN)
- The larger errors are for high angles (> 35°).
- Which amount of these errors is due the atmosphere?

3) Development of the fast version

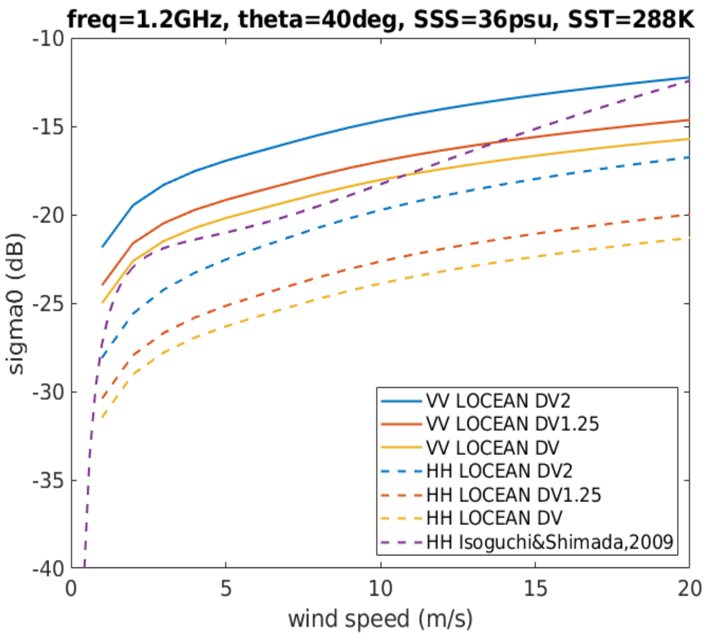
- After this meeting we will start to code the fast version of the model for NWP SAF
- Development of a database to test quickly the model with the observations (use of the previous work done with SMAP, AMSR2, GMI and ATMS comparisons).
- Need the parameter updates for foam coverage and foam emissivity to work on the large range of frequencies.

4) Comparisons of the backscattering

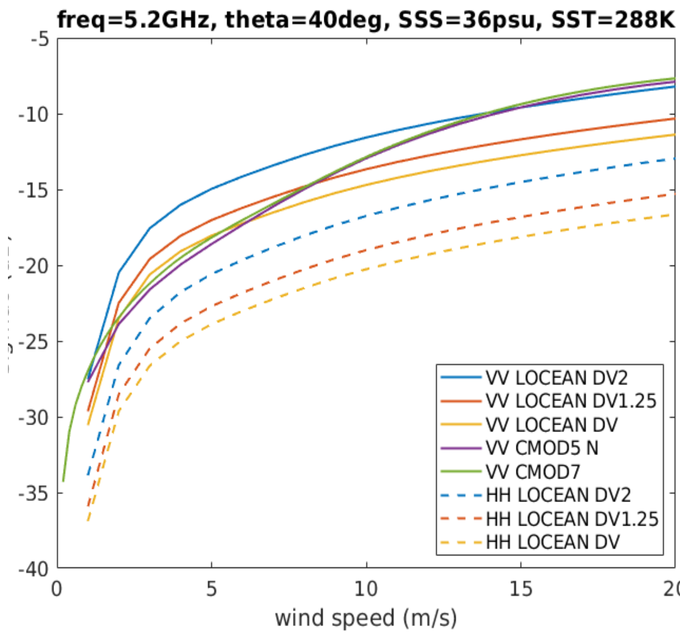
- We compared the reference model simulations with geophysical model functions (GMFs) at L, C and Ku-bands.
- Tests with different wave spectrums, cut-off numbers, and amplitude coefficient of the wave spectrum of Durden&Vesecky have been done.
- Note that in the passive mode we use the reference model with Durden&Vesecky wave spectrum with an amplitude coefficient of 1.25 and a cut-off wave number of k/4.

Backscattering as a function of OWS

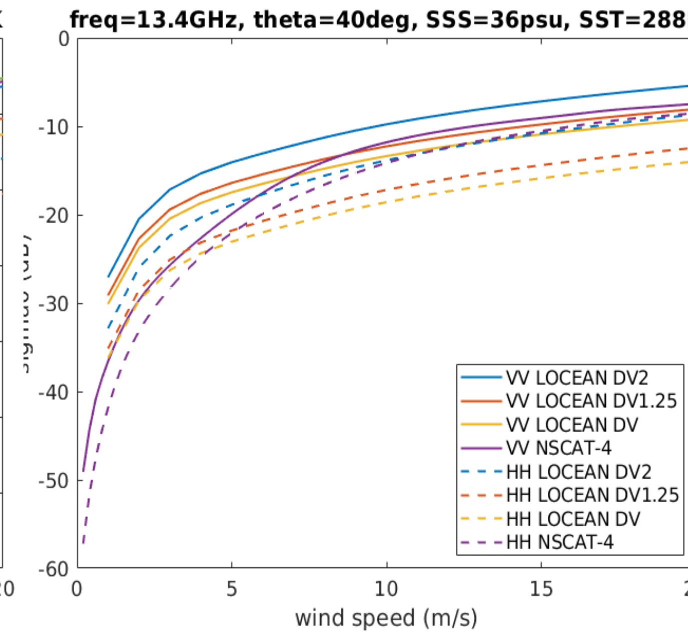
L-band



C-band

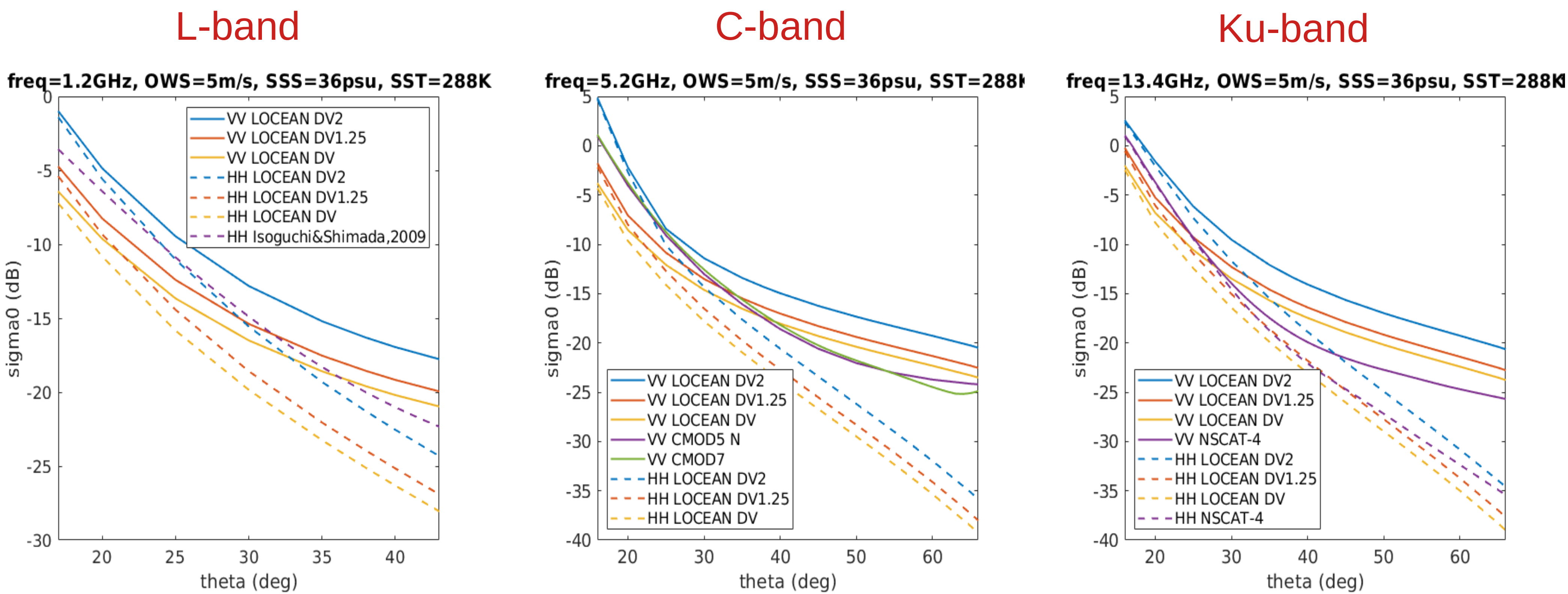


Ku-band



- Results calculated at L, C and Ku-band
- Inconsistency in the wind speed dependence for low winds between the model and the GMFs.

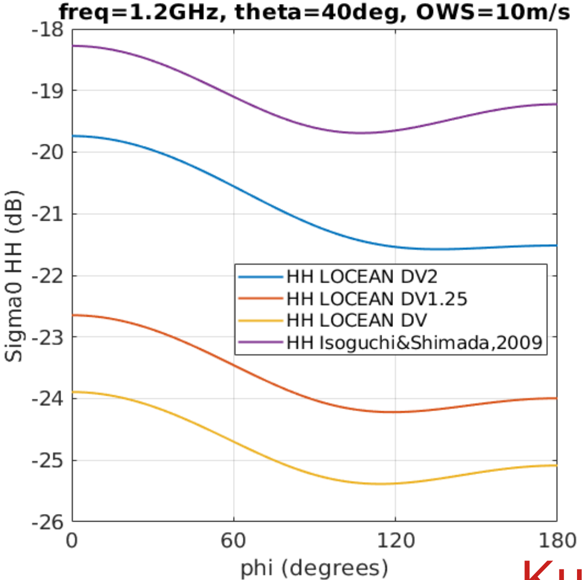
Backscattering as a function of the incidence angle



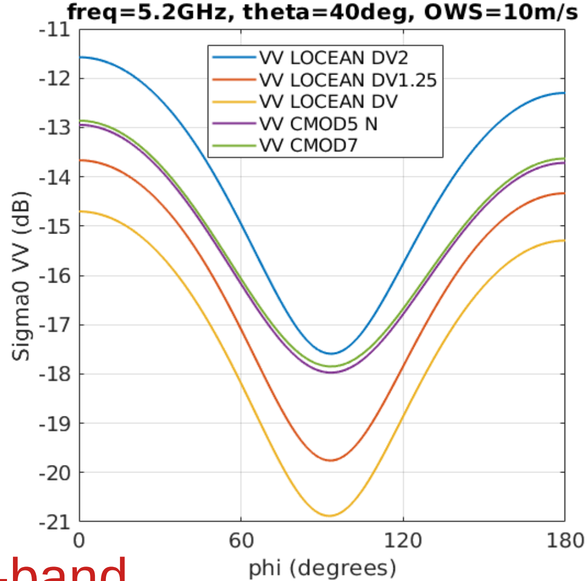
- Isoguchi and shimada very linear as a function of theta
- Discrepancies between the model and the GMFs.

Backscattering as a function of the wind direction

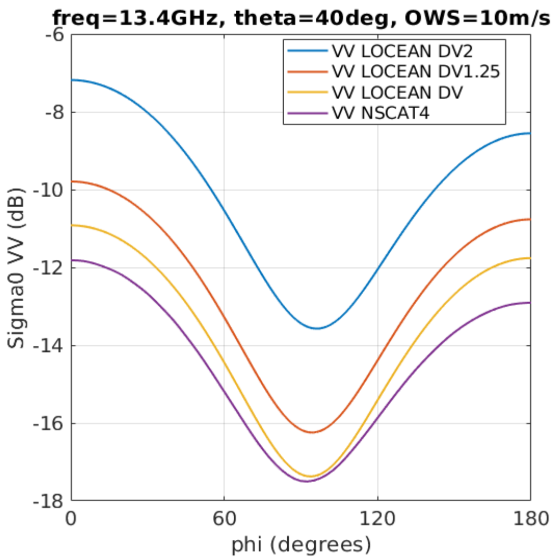
L-band

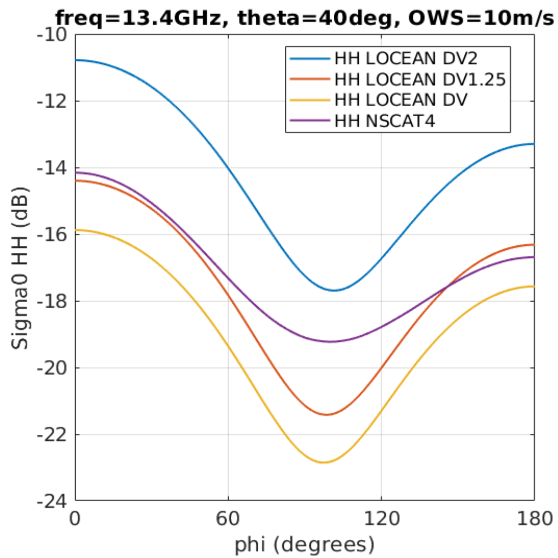


C-band



Ku-band





- Shape of the model simulations as a function of the relative wind direction (phi) looks good.
- The amplitude of the sinusoid with the model is ok for VV but not that good for HH.

Other tests for the backscattering

- Kudryavtsev wave spectrum does not show the good phi dependence
- Test with cut-off number from k/3 to k/4 have been done. It does not change the results.
- With which parameters of the radiative transfer model can we play to change the dependence (as a function of OWS, theta, phi)?