somebody make a fancy title page

Introduction

somebody write an introduction
somebody fix the references

- here is where we got the matlab file from: `http://www.seaice.dk/exercises/task3/Matlab/FW_funktion2_is.m` (forward model by Dorthe Hofman-Bang)
- description of reference data: `http://www.seaice.dk/undervisning/Sotiris/SICCI_RRDB_Manual_v2.01_20170717.docx`

1 Validation of Forward Model

The forward model computes from a set of ocean and atmosphere parameters the brightness temperatures expected to be measured by a satellite radiometer. The input parameters are listed in Table 1, and the output parameters include values for both horizontal and vertical polarization at 6.93 GHz, 10.65 GHz, 18.70 GHz, 23.80 GHz, and 36.50 GHz.

	Forward Model		Reference Data	
	Abbrev.	Unit	Abbrev.	Unit
Ice concentration	C_is	fraction	ci	fraction
MY-fraction	F_MY	fraction		
Ice temperature	T_is	K	istl	K
Water vapour	V	mm (columnar)	tcwv	kg/m^2
Cloud liquid water	L	mm (columnar)	tclw	kg/m^2
Wind speed	W	m/s	ws	m/s
Sea surface temperature	T_ow	°C	sst	K

Table 1: Atmosphere and ocean parameters entered into the forward model

This forward model was validated by comparing its results to reference data from ESA's "Sea Ice Climate Change Initiative". The reference data consists of brightness temperatures at the relevant polarizations and frequencies as measured by the AMSR2 radiometer onboard the GCOM-W1 satellite. The measured data is paired with numerical wheather predictions for the atmospheric and oceanic parameters at the same geocoded locations at near simultaneous time. There are two different data sets: one with an ice concentration of 0, the other one with an ice concentration of 1. The relative error of the modelled brightness temperatures with respect to the reference data was computed using the following formula:

$$e = \frac{T_{\text{brightness, modelled}} - T_{\text{brightness, reference}}}{T_{\text{brightness, reference}}} \tag{1}$$

To save computation time, these errors where only computed for the first 100 reference data points. The errors for the no ice condition are shown in Figure 1, and those for the ice condition are shown in Figure 2. When evaluating the differences between the modelled and reference brightness temperatures, some systematic error sources must be observed. These are discussed

in the following paragraphs.

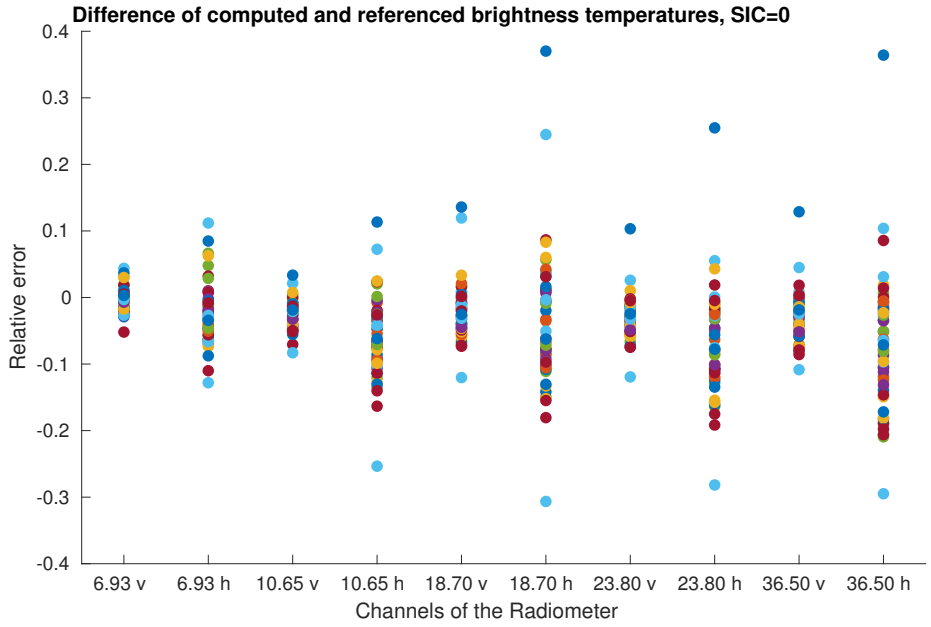

Figure 1: meaningful and informative caption

Firstly, the forward model was developed for the AMSR-E instrument. By using the numerical wheather predictions as input in the forward model in order to compare the output with the AMSR2 measured brightness temperatures, we assume that any calibration differences between AMSR-E and AMSR2 are negligible.

Secondly, the reference data does not contain information about all geophysical paramters needed as input in the forward model. The multi-year ice fraction cannot be found in the reference data and should therefore be determined by other means. The reference data is divided into two parts, one contains only datapoints from areas of open water for which the ice concentration is zero in which case the MY fraction is also zero. It is therefore possible to test the forward model for the open water datapoints. The other part of the reference data contain datapoints from areas of high ice concentration for which the MY fraction is unknown. We will still attempt to test the forward model for the high ice concentration areas by making an estimate of the MY fraction through a process of trial and error. The idea is to select a location where we have prior information about the MY fraction(...).

Thirdly, the wind speed is given in the NWP reference data as a u-component, v-component, and as a composite of the two. (comment/question: where u and v denote zonal and meridional directions respectively?) We have used the composite value for the wind speed as the input in our forward model. (Argumentation!?) (-backscatter as a result of wind speed direction (upwind, downwind, crosswind) sensitive to azimuth angle [4])

In order to use the reference data in the forward model it was necesarry to perform unit conversions for the parameters water vapour and cloud liquid water, which were given in the columnar units of $1\,\mathrm{kg/m^2}$ in the reference data, and have now been converted to $1\,\mathrm{mm}$, indicating the

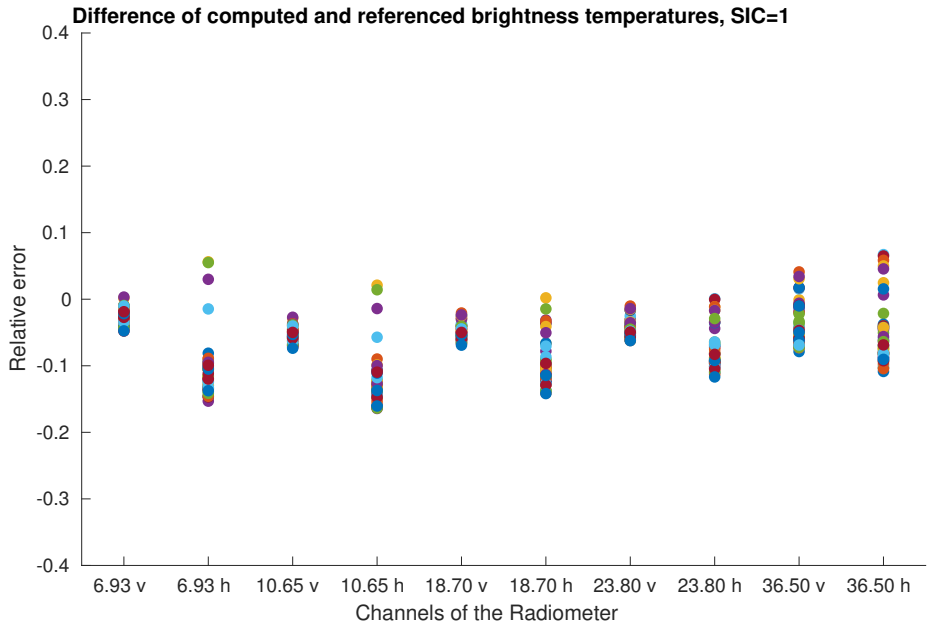

Figure 2: very relevant caption

height of water vapor or cloud liquid water if condensed uniformly across the column [3].

References

[1] Dorthe Hofman-Bang, Forward algorithm, September 2003. `http://www.seaice.dk/exercises/task3/Matlab/FW_funktion2_is.m` [accessed: 18/11/2017]

[2] Round Robin Data Package Manual, Version 2.0/, July 2017. Ref: SICCI SIC RRDP-07-17. `http://www.seaice.dk/undervisning/Sotiris/SICCI_RRDB_Manual_v2.01_20170717.docx` [accessed: 18/11/2017]

[3] (unit conversion) `http://www.remss.com/measurements/atmospheric-water-vapor/` [accessed: 18/11/2017]

[4] C. Elachi, Introduction to the Physics and Techniques of Remote Sensing. John Wiley and Sons, 1987. (section 6.5+7.3)