Microwave Remote Sensing Lab (MRSLab), IIT Bombay

1/23/2021

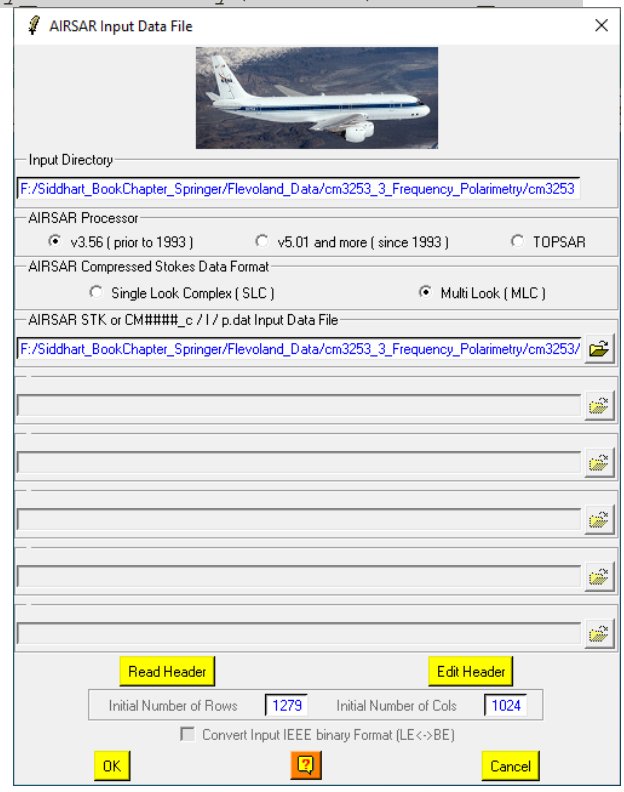
Feature set generation in PolSARpro

We use PolSARpro[1] toolbox to generate polarimetric features from AIRSAR multi-frequency data. AIRSAR Data is provided by ASF in compressed Stokes product format for each individual frequency band. The following Figure indicates C, L and P band data in *.dat files.

cm3253	29-12-2004 12:06 PM	GIF File	1,088 KB
cm3253_c.dat	29-12-2004 12:06 PM	DAT File	12,826 KB
cm3253_l.dat	29-12-2004 12:06 PM	DAT File	12,826 KB
cm3253_meta.airsar	29-12-2004 12:06 PM	AIRSAR File	3 KB
cm3253_p.dat	29-12-2004 12:06 PM	DAT File	12,826 KB

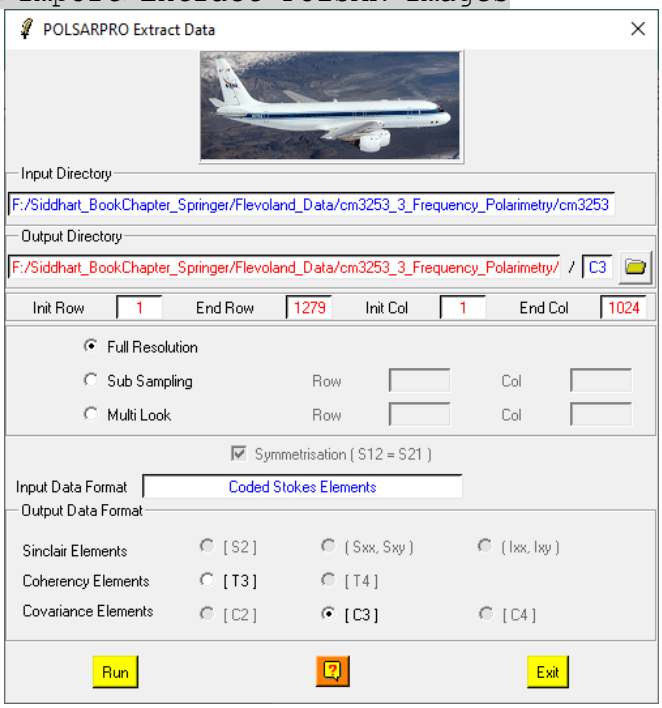
User Guide:

- We kept these files in the `F:\Siddhart_BookChapter_Springer\Flevoland_Data\cm3253_3_Frequency_Polarimetry\cm3253` directory.
- Open PolSARPro v.6 and set the Environment to this folder path.
- From menu bar Import>Airborne Sensors>Airsar; Select AIRSAR Processors, Data format, and provide path to *.dat file associated with specific band (e.g. `F:\Siddhart_BookChapter_Springer\Flevoland_Data\cm3253_3_Frequency_Polarimetry\cm3253\cm3253_c.dat` for C-band)

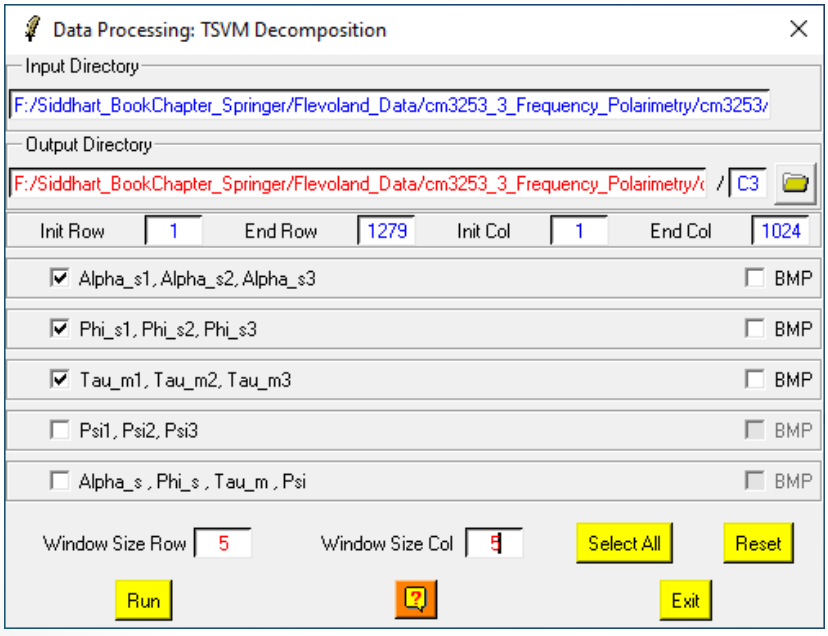


[1] PolSARpro download link: https://earth.esa.int/web/polsarpro/home

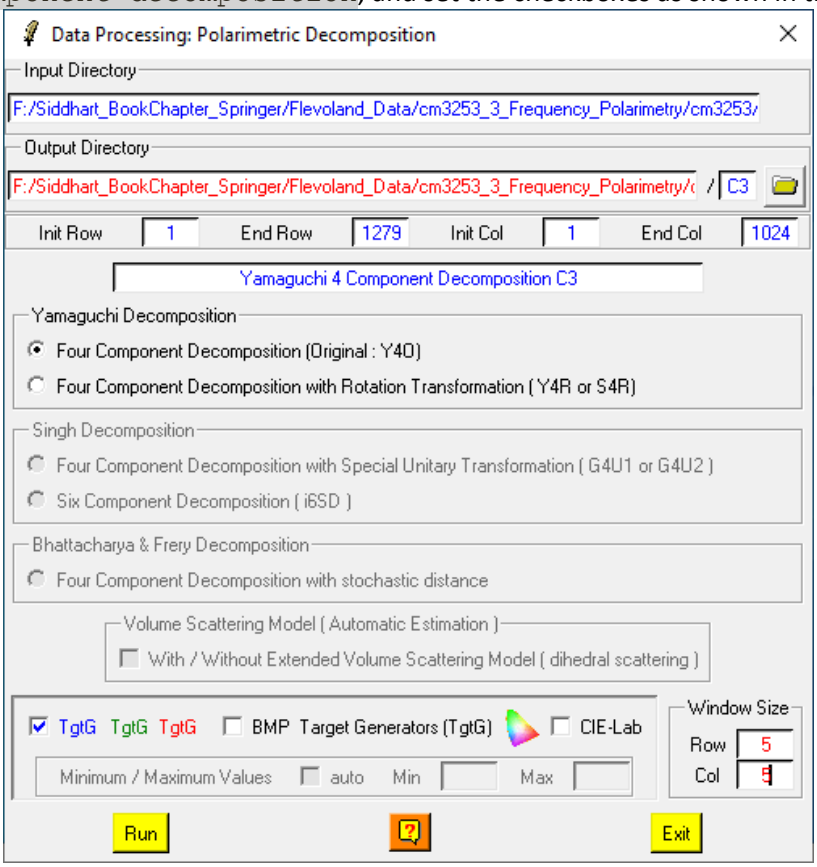
- Then click on 'ReadHeader' and then Ok.
- Now, we need to extract the data to generate 3x3 covariance matrix C3 by `Menubar>Import>Extract PolSAR Images`



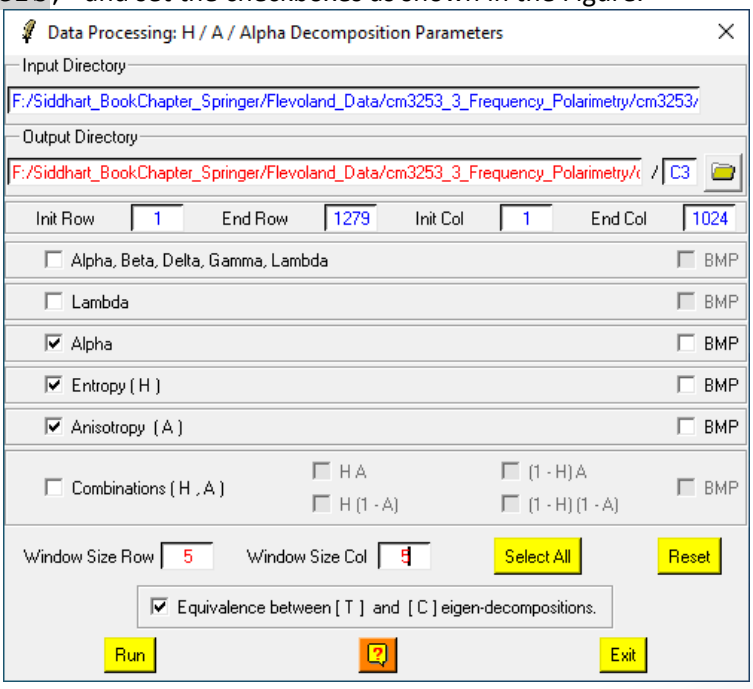
- Now, optionally we can run a polarimetric speckle filtering operation on C3 matrix if required.
- Next we generate Touzi decomposition parameters from menubar as `Process>Polarimetric Decompositions>TSVM:Touzi Decomposition`, and set the checkboxes as shown in the Figure.



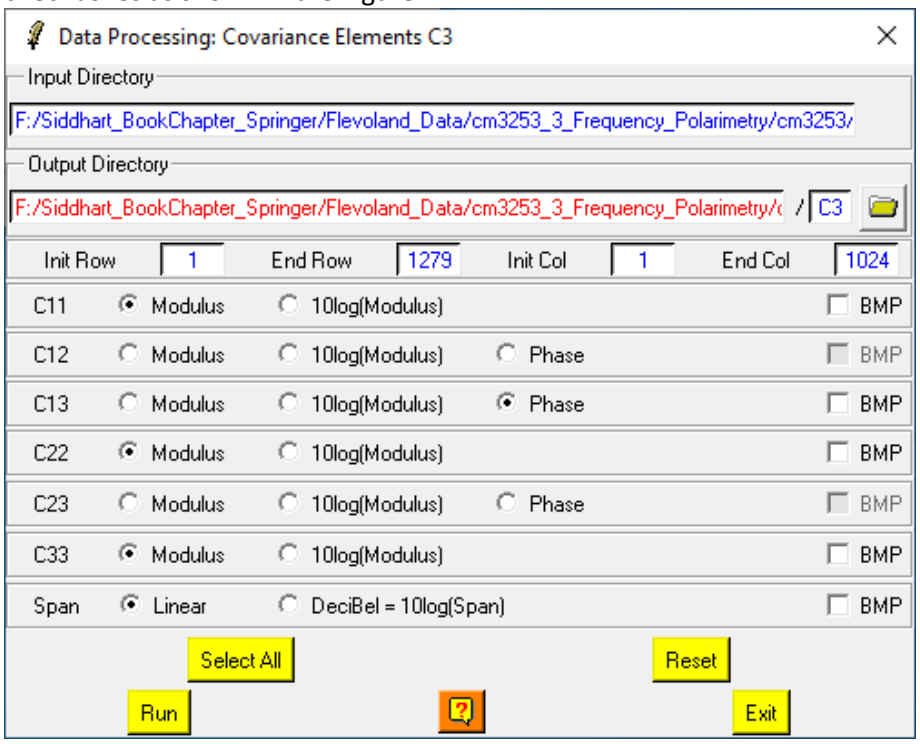
- To generate Yamaguchi 4 component decomposition from menubar go to `Process>Polarimetric Decompositions>YAM4: Yamaguchi 4 component decomposition`, and set the checkboxes as shown in the Figure.



- To generate Cloud-Pottier H/A/alpha decomposition from menubar go to `Process> H/A/alpha decomposition >Decomposition Parameters`, and set the checkboxes as shown in the Figure.

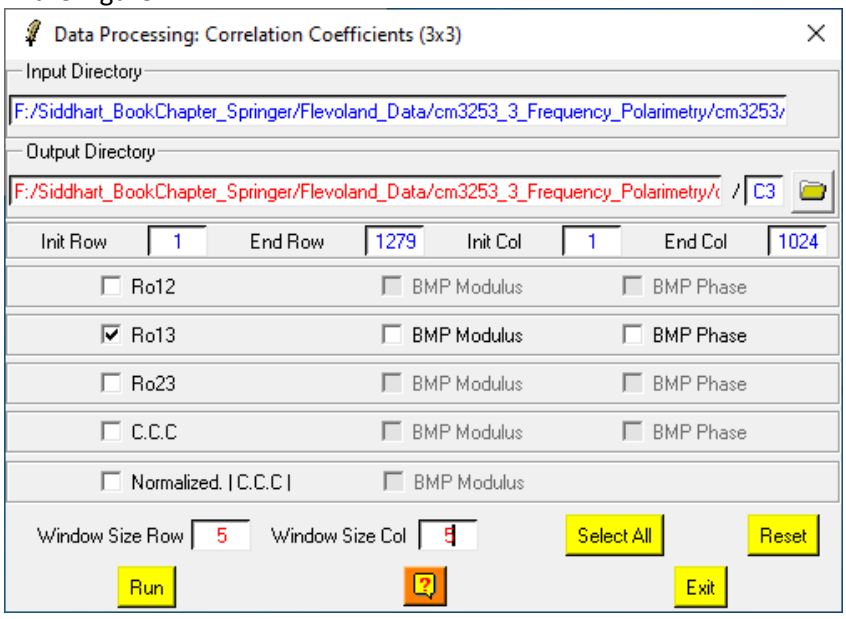


- For non-decomposition parameters, first we generate C11, C22, C33, ϕHH-VV, and Span. From menubar go to `Process> Matrix elements`, and set the checkboxes as shown in the Figure.

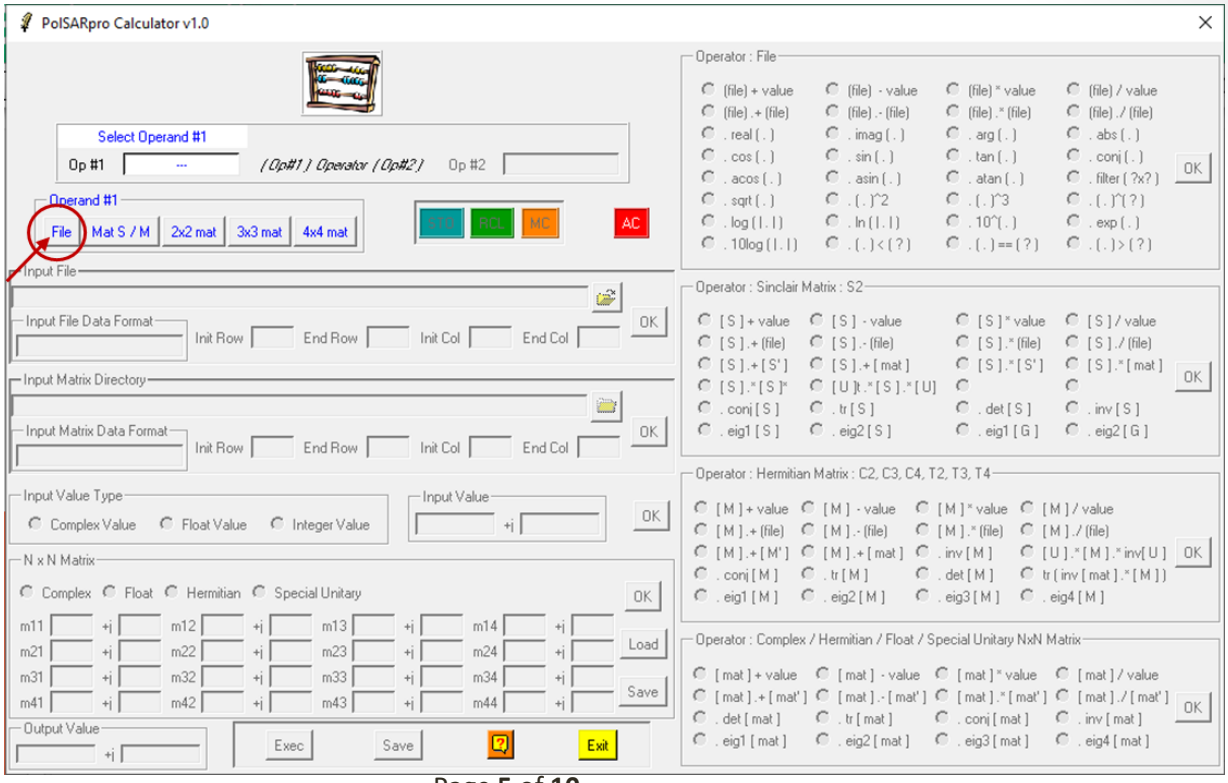


The phase of C13 element is equivalent to the ϕHH-VV.

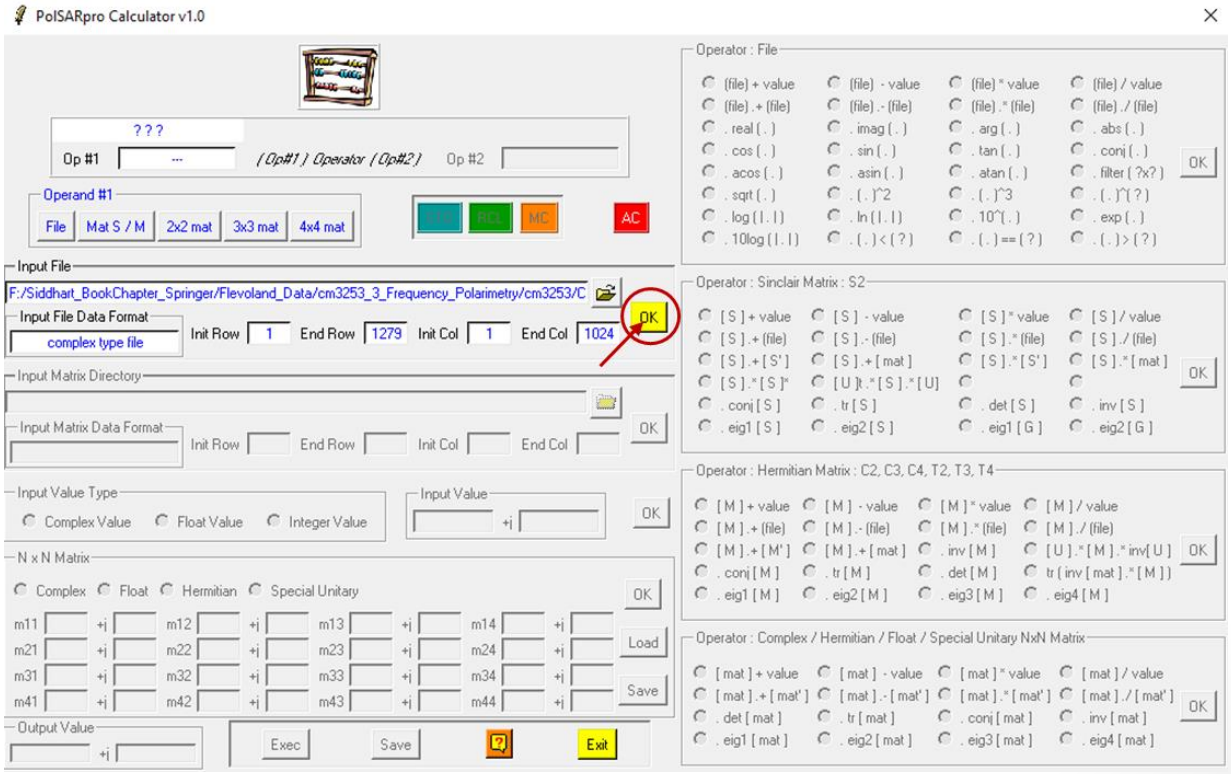
- For the co-pol correlation amplitude ρHHVV feature, we first need to create the ρHHVV complex image from elements of C3 matrix. From menubar go to `Process> Correlation Coefficients`, and set the checkboxes as shown in the Figure.



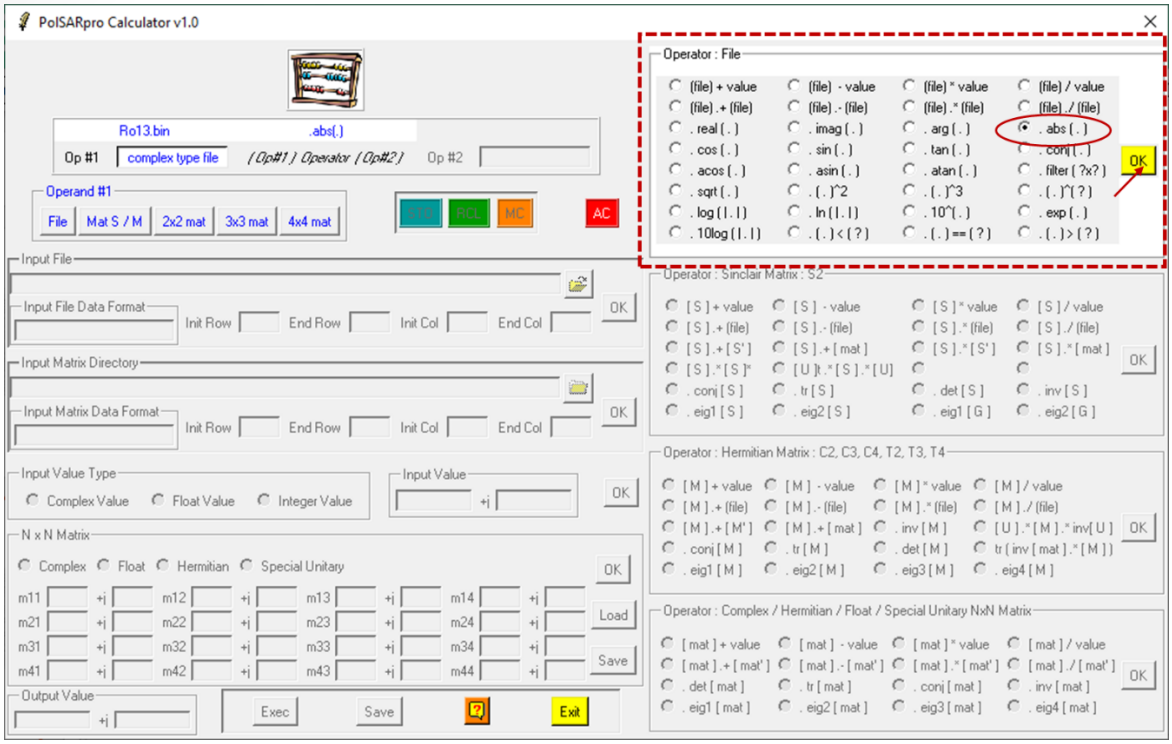
Now, we use PolSARPro Calculator to generate amplitude image from the complex Ro13.bin. From menubar go to `Utilities>PolSARPro-Calculator`.



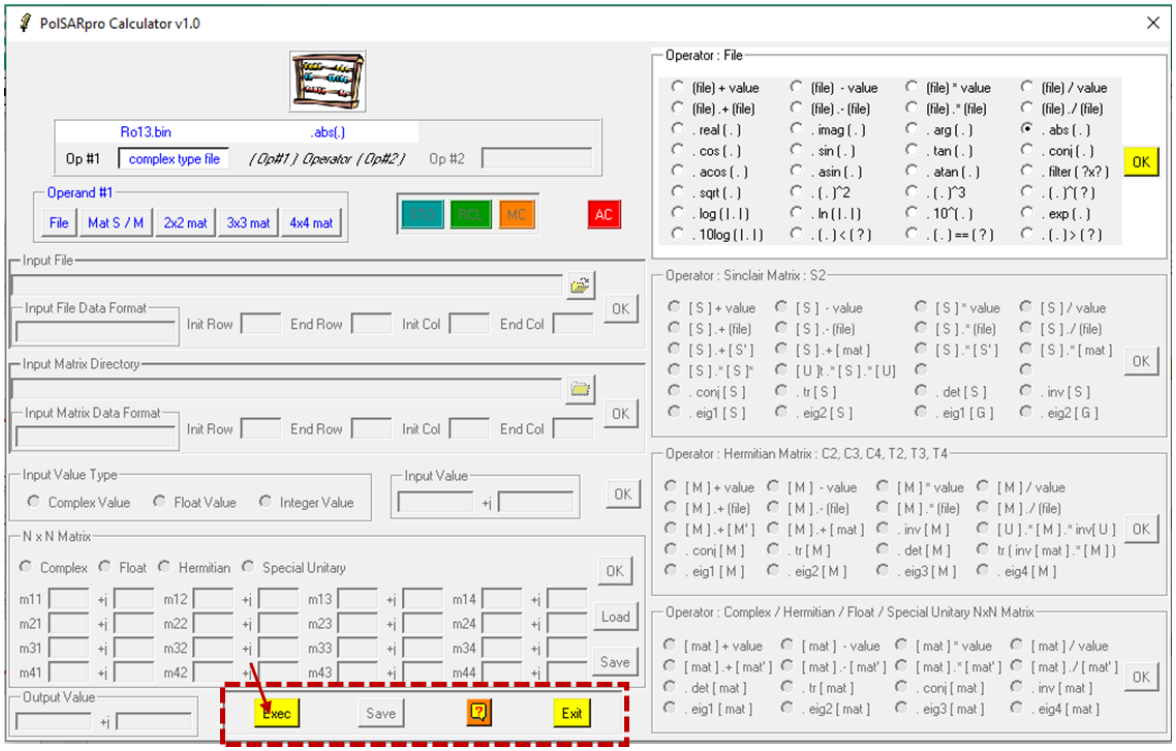
First load the rho13.bin file in the Operand#1 from File. Then click OK button.



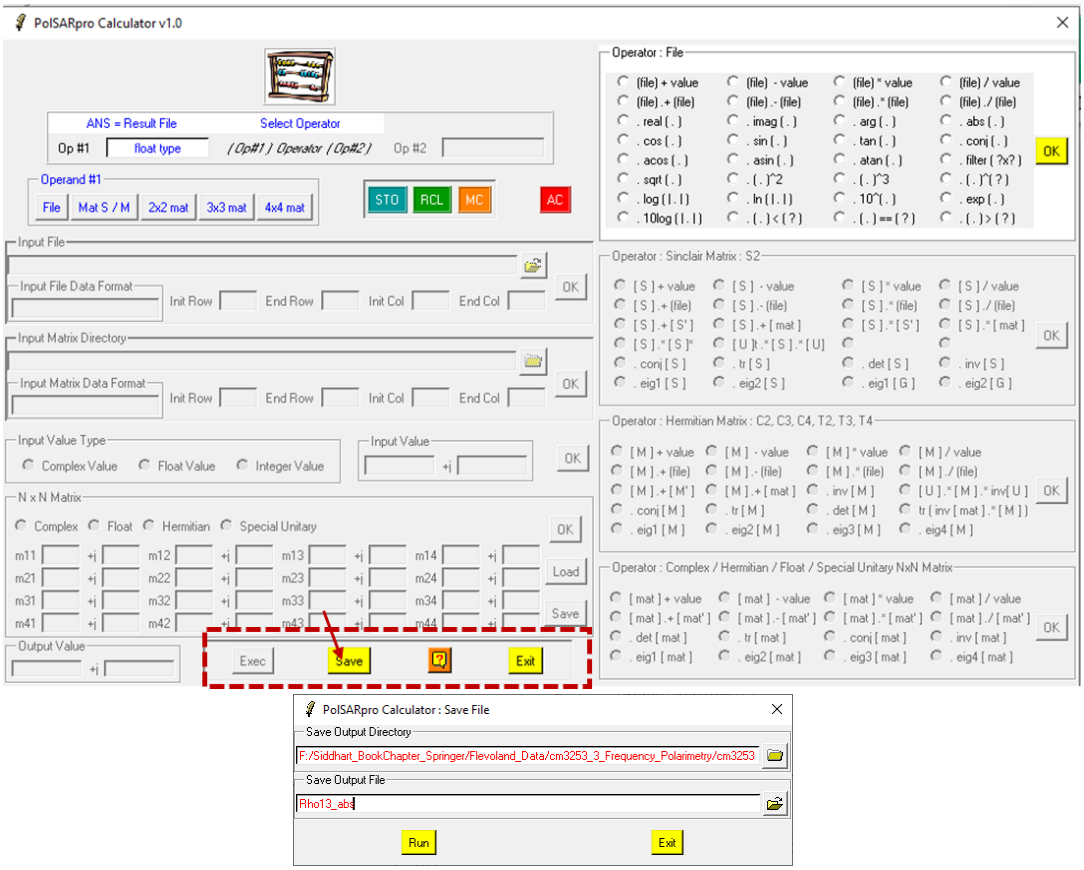
Then in the Operator file (Right side tab, shown in red dashed line), check on the abs[.] operator and click OK.



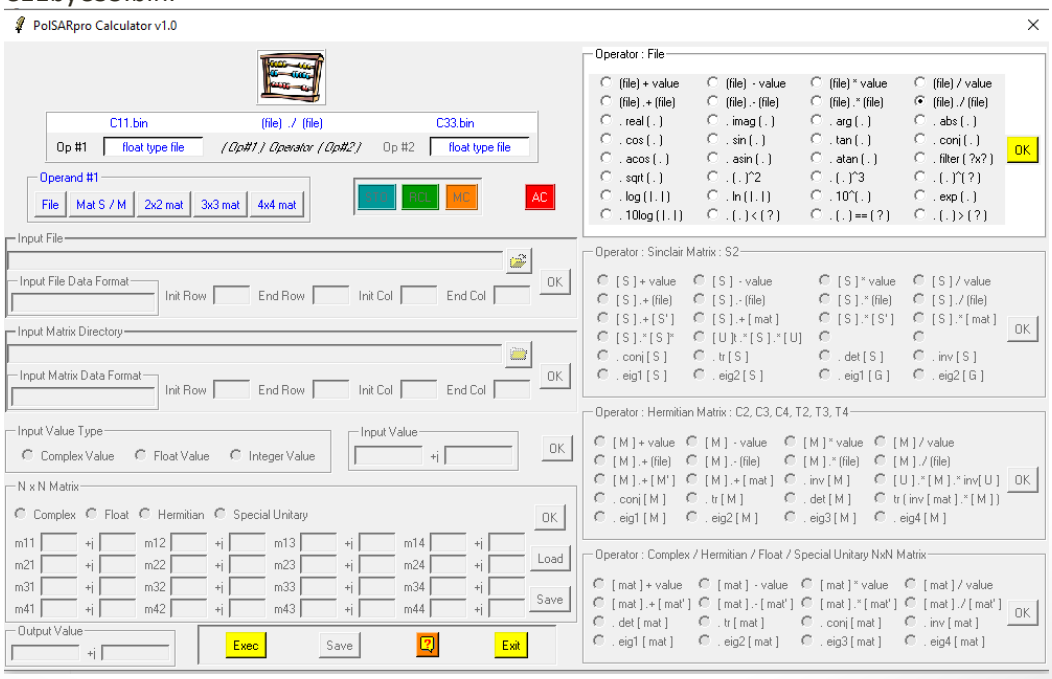
Then Execute the operation by clicking on Exec button.



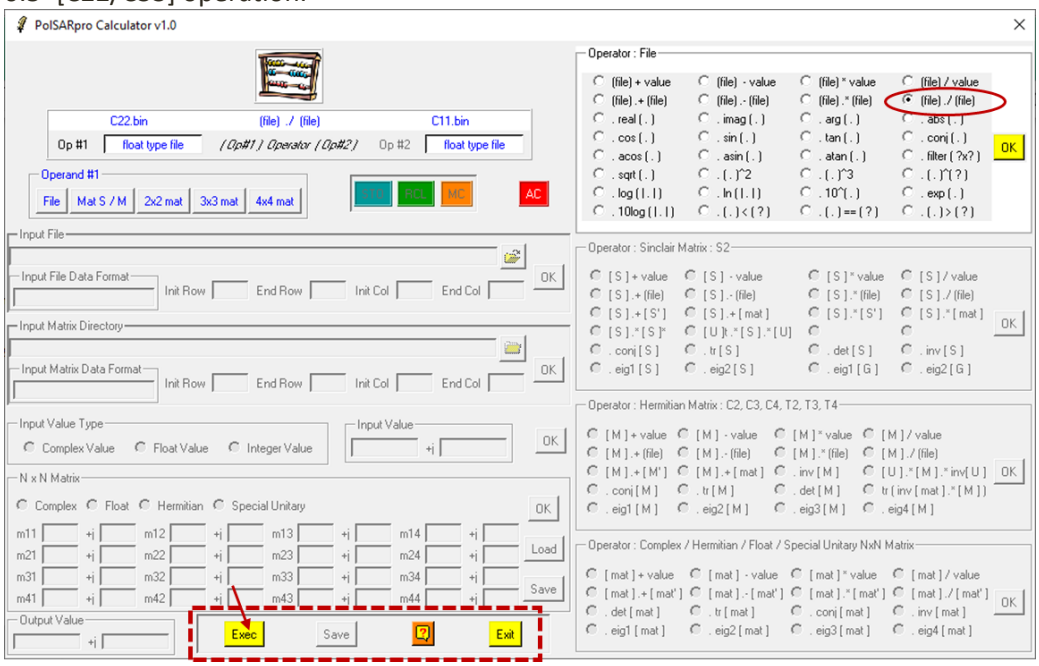
And finally save the image output after processing as Rho13_abs.bin.



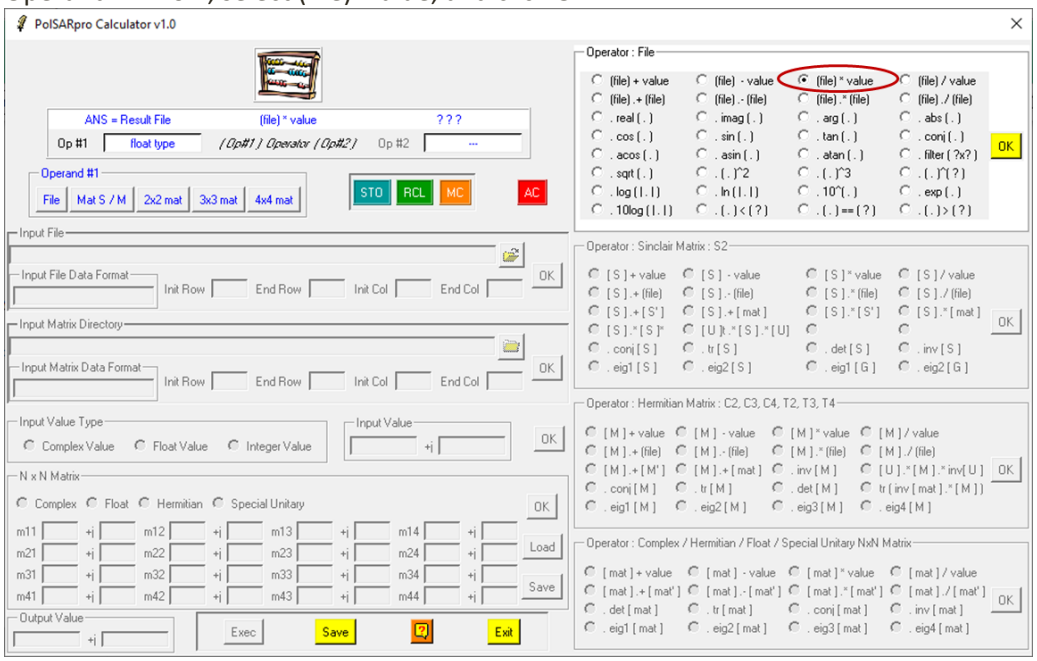
- For the co-pol and cross-pol ratio features we again have to use the PolSARPro-Calculator. For co-pol ration ($\sigma^{\circ}_{HH}/\sigma^{\circ}_{VV}$), we need to do C11/C33 operation. First load C11.bin in operand#1, then select (file)./(file) and click Ok. Again select C33.bin as input file to operand#2. Finally Execute the process and save the file as C11byC33.bin.



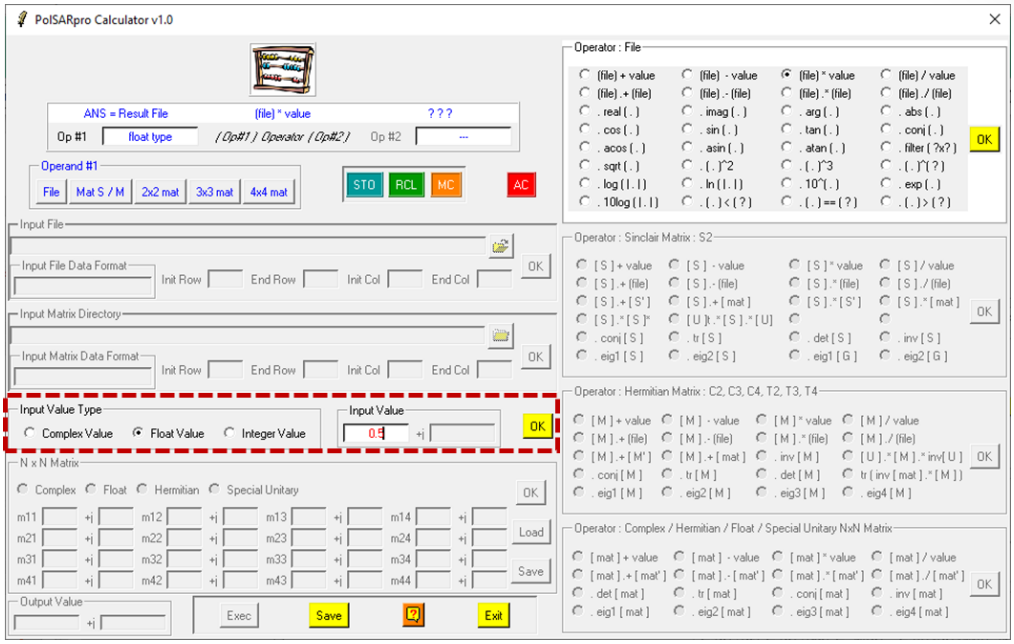
- For the cross-pol ratio $\sigma^{\circ}_{HV}/\sigma^{\circ}_{HH}$ and $\sigma^{\circ}_{HV}/\sigma^{\circ}_{VV}$, we need to do 0.5*[C22/C11] and 0.5*[C22/C33] operation.



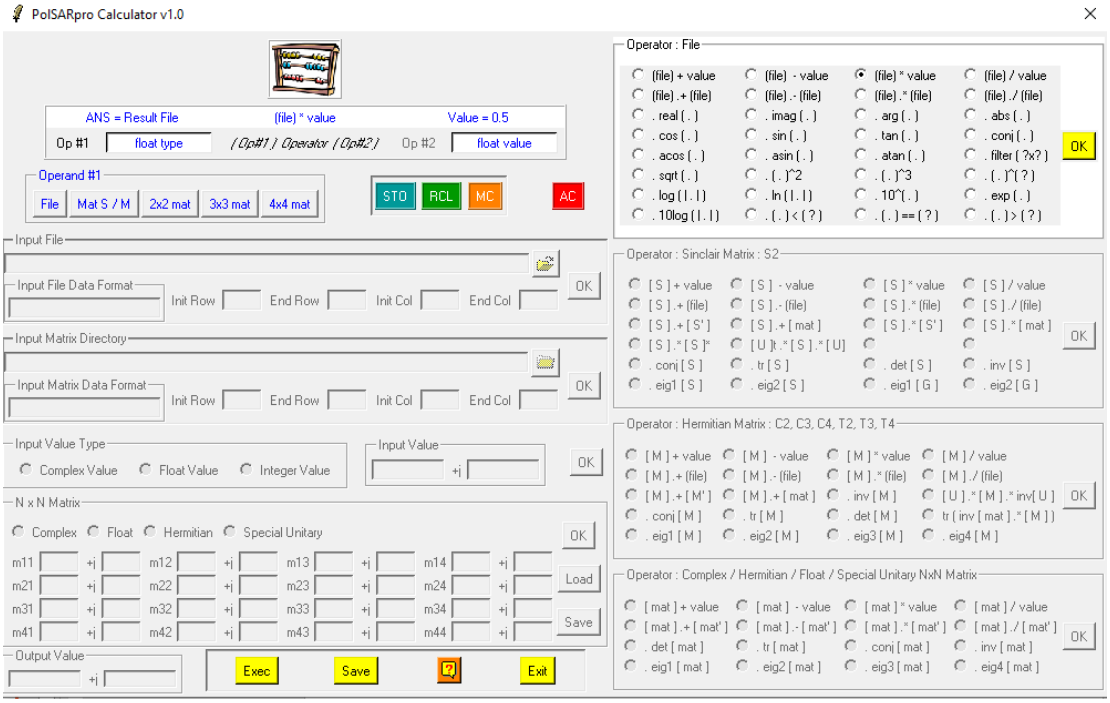
We don't have to save the C22/C11 operator output. It is already stored in Ans as Operand#1. Now, select (file)*value, and click OK.



Then put 0.5 in the input values in the following Figure. And click OK.

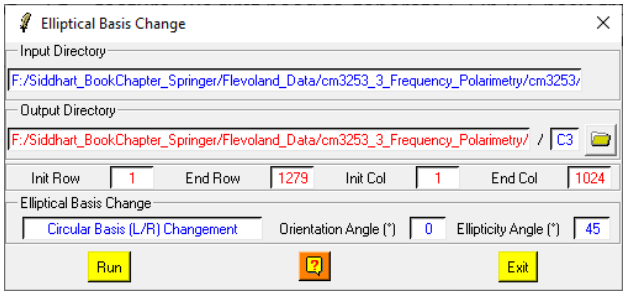


Finally execute the program and save the output as HVbyHH.bin file.



Similar approach can be performed for $\sigma^{\circ}_{HV}/\sigma^{\circ}_{VV}$.

- For the $\sigma^{\circ}_{RR}/\sigma^{\circ}_{RL}$ feature, we first need to generate C3 in R-L basis from the H-V basis. It can be executed from menubar `Process>Elliptical Basis Change>Circular (L/R)` option.



Then from the previous step, we can generate $\sigma^{\circ}_{RR}/\sigma^{\circ}_{RL}$ by 0.5*[C11/C22] operation.

Note:

The 3x3 covariance matrix elements:

$$\langle[\mathbf{C}]\rangle = \langle \mathbf{\Omega} \cdot \mathbf{\Omega}^{*T} \rangle$$

$$= \begin{bmatrix} \langle |S_{\mathrm{HH}}|^2 \rangle & \sqrt{2}\langle S_{\mathrm{HH}} S^*_{\mathrm{HV}} \rangle & \langle S_{\mathrm{HH}} S^*_{\mathrm{VV}} \rangle \\ \sqrt{2}\langle S_{\mathrm{HV}} S^*_{\mathrm{HH}} \rangle & 2\langle |S_{\mathrm{HV}}|^2 \rangle & \sqrt{2}\langle S_{\mathrm{HV}} S^*_{\mathrm{VV}} \rangle \\ \langle S_{\mathrm{VV}} S^*_{\mathrm{HH}} \rangle & \sqrt{2}\langle S_{\mathrm{VV}} S^*_{\mathrm{HV}} \rangle & \langle |S_{\mathrm{VV}}|^2 \rangle \end{bmatrix}$$