



# Summer School in InSAR, time series processing and deformation modelling

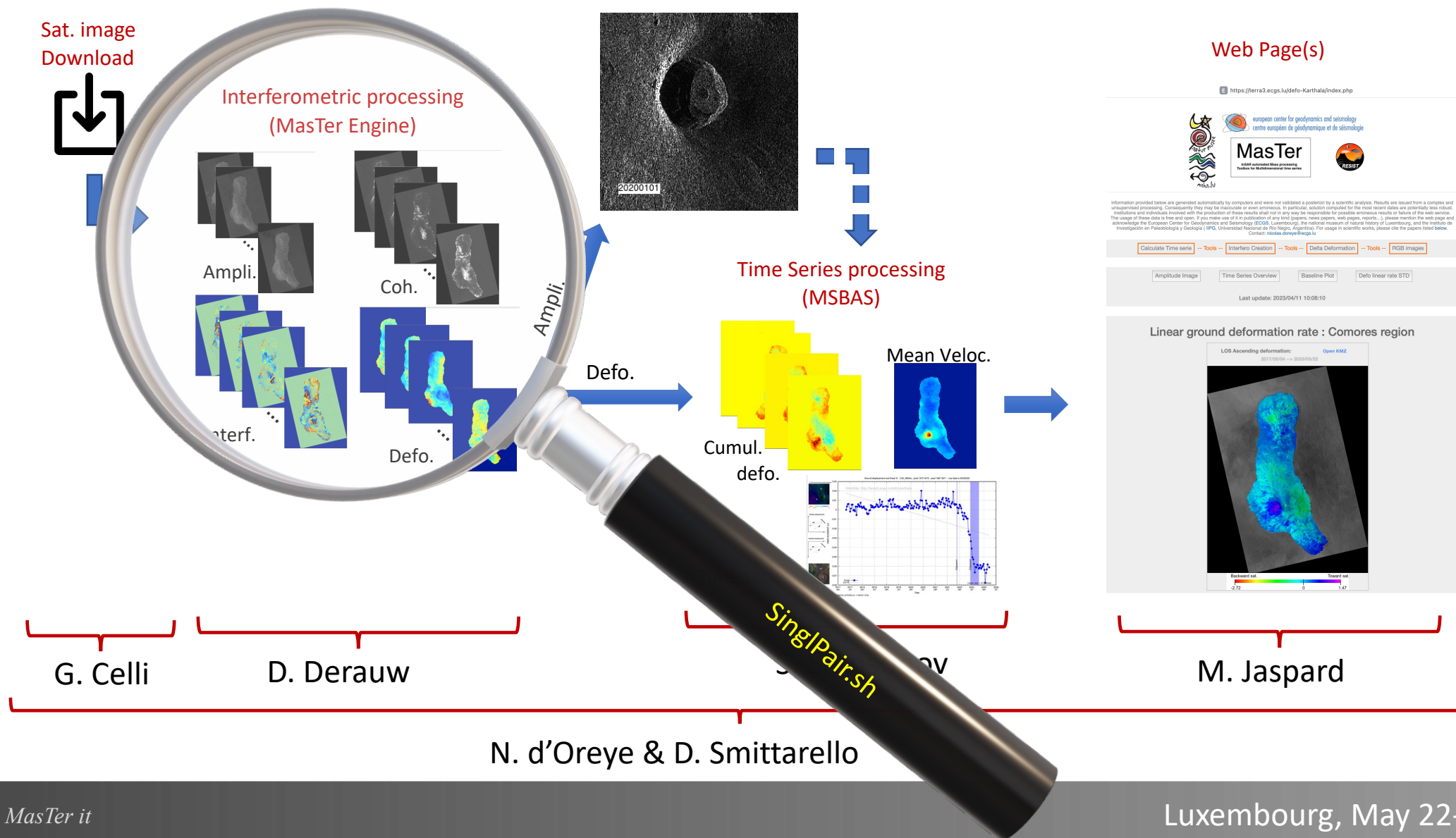


## Hands-on exercise 1:

## Single Pair processing for defo or topo.

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# MasTer Toolbox





# Exercise 1

## Plan:

### Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- **Prepare the data:**
  - Prepare a kml (or get it from 1650)
  - Prepare the DEM (or get it from DataSAR)
  - Get the raw data e.g. from ESA SciHub portal (or get it from 3600)
  - Get the orbits & Read the S1 SM data (Réunion Island) with *Read\_All\_Img.sh*
- **Prepare the parameters file**
- **Execute *SinglePair.sh***
- **Make a mask for water body**
- **Reprocess with mask**

### Exercise part 2: TOPO mode using TDX in pursuit/bistatic mode using CIS unwrapping – Virunga or CSK using snaphu unwrapping

- **Prepare the data:**
  - Get the raw data from 3600
  - Read the data with *Read\_All\_Img.sh*
- **Prepare the parameters file**
- **Execute *SinglePair.sh***



# Exercise 1 – part 1 (defo)

## Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:

- Prepare a kml (or get it from [.../1650/kml/Reunion/Reunion\\_Island.kml](#))  
Prepare/check with Google Earth....

→ OK?

- Prepare the DEM (or get it from [.../DataSAR/SAR\\_AUX\\_FILES/DEM/SRTM30/ALL/Reunion](#))  
→ OK?

- Get the raw data e.g.  
from ESA SciHub portal <https://scihub.copernicus.eu/dhus/#/home> (need login!)  
or ONDA (cfr MasTer Engine function **ONDA\_S1DataDownloader**)  
(or get it from [.../3600/SAR\\_DATA/S1/S1-DATA-REUNION\\_SM-SLC.UNZIP\[\\_FORMER\]](#))

→ OK?



# Exercise 1 – part 1 (defo)

## Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:

- Get the orbits & Read the S1 SM data (Réunion Island) with **Read\_All\_Img.sh** (See **manual §2**):

**Read\_All\_Img.sh** *DirWhereRaw DirWhereCSL/NoCrop SAT PATH/kml POL [WhereRESAMP WhereMassProces ForceAllYears]*

where: *DirWhereRaw* = .../SAR\_DATA/S1/S1-DATA-REUNION\_SM-SLC.UNZIP

*DirWhereCSL/NoCrop* = .../SAR\_CSL/S1/PF\_SM/NoCrop (**will be created; beware to end with NoCrop !**)

*SAT* = S1

*PATH/kml* = .../kml/Reunion/Reunion\_Island.kml

*POL* = VV (see e.g. /annotation/\*.xml file)

➔ OK? ☒ (~5 min?) 

See in .../SAR\_CSL/S1/PS\_SM\_A\_144/NoCrop

- Notes:**
- add “-n” to skip updating the orbits
  - add “**ForceAllYears**” to read data older than 6 months (if already read once, ie not anymore in 3600/SAR\_DATA/S1/**S1-DATA-REUNION\_SM-SLC.UNZIP**)
  - *WhereRESAMP* & *WhereMassProces* can be ignored here because no mass process is performed
  - Only the **3 first parameters must be provided in the right order**



# Exercise 1 – part 1 (defo)

## Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:
- Prepare the parameters file:
  - Copy `.../SAR/MasTerToolbox/SCRIPTS_MT/___V20230828_LaunchMTparam.txt`  
in `.../DataSAR/Param_files_SuperMaster/S1/PF_SM_A_144`  
and name it as something useful, e.g.  
`LaunchMTparam_S1_SM_Asc_144_Zoom1_ML8_Defo.txt` (name should help to assess what it is supposed to do)
  - Edit it and change appropriate values
    - Line 18: TRKDIR must be set to `PF_SM_A_144` (because that is where data are in `.../SAR_CSL/S1/`)
    - Line 22: ignore for now
    - Line 27: DEMNAME must be set to `Reunion` (because that is the name of your DEM)
    - Line 29: if RECOMPDEM is set to KEEP but DEM in master slant range geometry does not exist yet, it will compute it. If it exists, it will skip that step. If you need to force recomputing the DEM in slant range (e.g. if you change the DEM), then set it to FORCE.  
DEM in slant range is in `.../SAR_CSL/S1/PF_SM_A_144/YourCrop/master.csl/Data/externalSlantRangeDEM`
    - Line 35: set CROP to `CROPyes` then provide the coordinates in lines 36-39 resp.: `55.2, -21.41, 55.85` and `-20.85`
    - Line 40: keep zoom 1 (unless you want to oversample the data e.g. to reduce speckel in amplitude images)
    - Line 41: provide with a name that explains your (cropped) region as it will be used in dir naming, e.g. `Reunion`



# Exercise 1 – part 1 (defo)

## Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:
- Prepare the parameters file:
  - Edit it and change appropriate values (continue)
    - Lines 45 to 60 can remain as it is. These default parameters should be ok
    - Line 64: PROCESSMODE must be set to **DEFO**
    - Line 65: INITPOL is VV (cfr e.g. .../SAR\_CSL/S1/PF\_SM\_A\_144/NoCrop/*YourImg*.cs1/Info/[SLCImageInfo.txt](#))
    - Lines 66-67 can be ignored (only when using e.g. ALL2GIF.sh; see manual)
    - Line 69: INTERFML can be set to **8**  
(you can try higher resolution by setting it to less; remember to change the name of your param file accordingly)
    - Lines 68-69 are for the filtering. **1** and **1** should be OK (stronger may introduce artifacts)
    - Line 72: COHESTIMFACTOR must be similar to INTERFML when small and not higher than 5 or 7. Try **4** here.
    - Line 77: set **APPLYMASKno** if you do not have one yet (or **APPLYMASKyes** if you want to use the one provided and which you will provide with the full path at the next line, e.g.  
[.../DataSAR/SAR\\_AUX\\_FILES/MASKS/WaterBodies/Reunion/Reunion\\_mask\\_Byte](#))
    - Line 82: SKIPUW: set it to **SKIPno** if you want to unwrap and compute the deformation map,  
or **SKIPyes** if you want a quick computation e.g. to get the material to compute a mask. Try **SKIPyes** first.
    - Lines 84-115 can be kept by default most of the time when performing unwrapping.



# Exercise 1 – part 1 (defo)

## Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:
- Prepare the parameters file:
  - Edit it and change appropriate values (continue)
    - Line 117: INTERPOL can be set to **BOTH** when performing unwrapping. Useless if no unwrap.
    - Line 118: REMOVEPLANE: can be set to **DETREND** when performing unwrapping. Useless if no unwrap.
    - Line 123: GEOCMETHD: set it to **Closest** to get the coordinates of the geocoded products (size of geocoded pixels will be as close as possible as in slant range on flat topo; corners will be adjusted to extend of image). Ignore lines till 144. When performing time series, use **Forced** and set below the size of the geocoded pixels and corners of image accordingly.
    - Set the paths in the last lines:
      - Where do you want to perform the computation (e.g. .../PROCESS)
      - Where are the data in CSL format
      - Where is the DEM
      - Where is **FUNCTIONS\_FOR\_MT.sh**
      - Where are the RESAMPLED images (that is the coregistered on a Super Master) (if applicable)
      - Where are stored the results of the Mass Processing (if applicable)
  - When done, if needed, compare your [LaunchMTparam\\_S1\\_SM\\_Asc\\_144\\_Zoom1\\_ML8\\_Defo.txt](#) with existing example in .../SAR\_AUX\_FILES/Param\_files\_SuperMaster/S1/PF\_SM\_A\_144/





# Exercise 1 – part 1 (defo)

## Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:
- Prepare the parameters file
- Execute **SinglePair.sh**:  
*SinglePair.sh DateMas DateSLV ParamFile Comment [SuperMaster]*

where: *DateMas* = the date (or S1 name) of the Master image, i.e. 20210330 (or S1B\_144\_20210330\_A)  
*DateSLV* = the date (or S1 name) of the Slave image, i.e. 20210411 (or S1B\_144\_20210411\_A)  
*ParamFile* = path to your parameter file ([LaunchMTparam\\_S1\\_SM\\_Asc\\_144\\_Zoom1\\_ML8\\_Defo.txt](#))  
*Comment* = for dir naming (useful when performing several tests...), e.g. *\_Closest\_NoUnwrap*

**Notes:** - it will talk and ask you if you want spare time by benefitting from possible coregistration on a super master. Answer “n” because you have no coregistration on a super master yet. If you wanted to benefit from that option, you must have provided the 5th param with the date of the Super Master

### Notes:

- See the file naming of results in slant range and geocoded
- Can't run twice a process
- Beware of path when moving results
- Possible to make iterative unwrapping

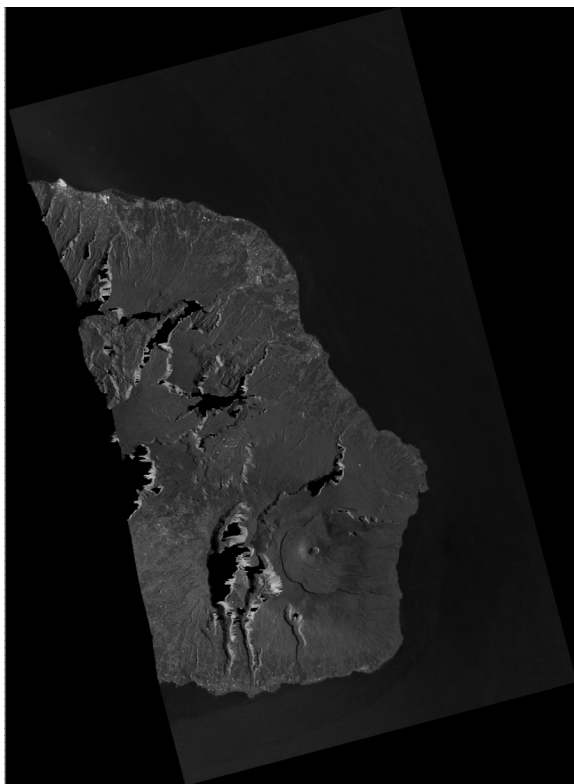
➔ OK? ☒ (~ 3 min for DEM + 15 min)  
See in .../PROCESS/S1/PS\_SM\_A\_144/

# Exercise 1 – part 1 (defo)

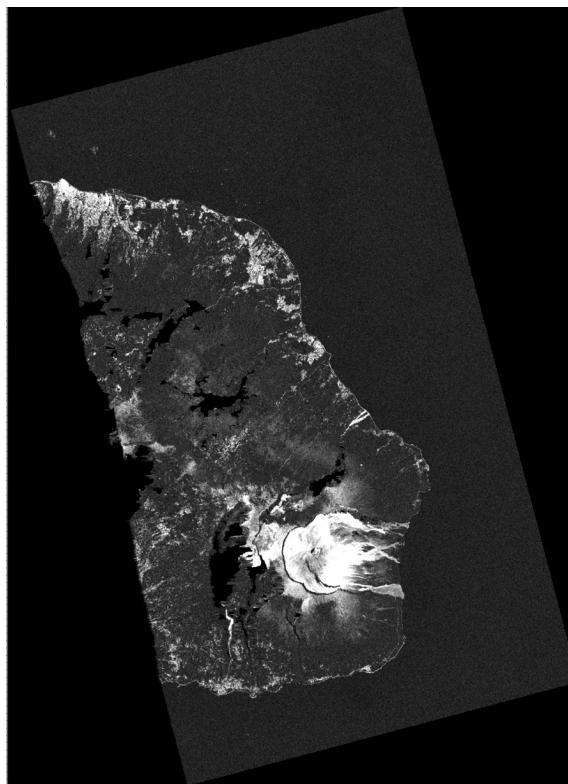
## Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:
- Prepare the parameters file
- Execute *SinglePair.sh*:

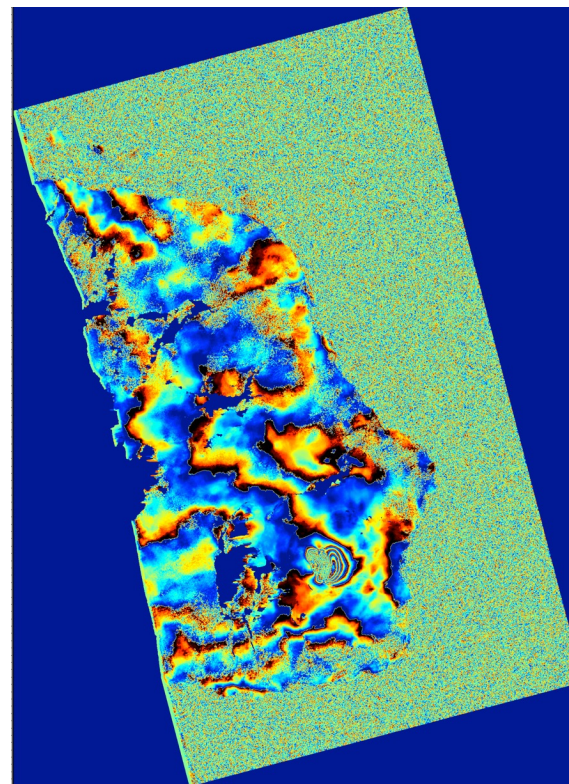
Results:



Ampli



Coh



Filtered interf.



# Exercise 1 – part 2a (topo TDX with CIS)

## Exercise part 2: TOPO mode using TDX in pursuit/bistatic mode – Virunga

- Prepare the data:

- Get the raw data from [.../3600/SAR\\_DATA/TDX/RDC\\_NYIGO\\_NYAM\\_StMp\\_Desc92\\_Bistat\\_150Mhz/](#)
- Read the data with ***Read\_All\_Img.sh*** (See [manual §2](#)):

***Read\_All\_Img.sh*** *DirWhereRaw DirWhereCSL/NoCrop SAT*

where: *DirWhereRaw* = [.../3600/SAR\\_DATA/TDX/RDC\\_NYIGO\\_NYAM\\_StMp\\_Desc92\\_Bistat\\_150Mhz](#)  
*DirWhereCSL/NoCrop* = [.../SAR\\_CSL/TDX/RDC\\_NYIGO\\_NYAM\\_StMp\\_Desc92/NoCrop](#)  
(will be created; beware to end with NoCrop !)  
*SAT* = TDX

➔ OK? ☒ (~2 min)

See in [.../SAR\\_CSL/TDX/.../NoCrop](#)

**Notes:** - Data will be saved as TX and RX in dedicated directories

[.../SAR\\_CSL/TDX/RDC\\_NYIGO\\_NYAM\\_StMp\\_Desc92\\_150Mhz\\_BS\\_D\\_003\\_RX](#)

[.../SAR\\_CSL/TDX/RDC\\_NYIGO\\_NYAM\\_StMp\\_Desc92\\_150Mhz\\_BS\\_D\\_003\\_TX](#)



# Exercise 1 – part 2a (topo TDX with CIS)

## Exercise part 2: TOPO mode using TDX in pursuit/bistatic mode – Virunga

- Prepare the data:
- Prepare the parameters file
  - Copy `.../SAR/MasTerToolbox/SCRIPTS_MT/___V20230828_LaunchMTparam.txt`  
in `.../DataSAR/Param_files_SuperMaster/TDX/RDC_NYIGO_NYAM_StMp_Desc92_Bistat_150Mhz`  
and name it as something useful, e.g.  
`LaunchMTparam_TDX_SM_Desc_92_Bis_Nyigo_Nyam_Full_Zoom1_ML20_TOPO_CIS.txt`  
(name should help to assess what it is supposed to do)
  - Edit it and change appropriate values
    - Line 18: TRKDIR must be set to `RDC_NYIGO_NYAM_StMp_Desc92_150Mhz_BS_D_003_TX` (because data are in such a dir)
    - Line 22: ignore for now
    - Line 27: DEMNAME; **although it is computing topo, it will need an external DEM to geocode it (and assist its unwrapping)**
    - Line 35: set CROP to `CROPno` `Copernicus_DSM_E27-31_S00-04.tif_flip0.BIL_CorrGeoid`
    - Line 40: keep zoom 1 (unless you want to oversample the data e.g. to reduce speckle in amplitude images)
    - Line 41: provide with a name that explains your (full) region as it will be used in dir naming, e.g. `Full_Nyigo_Nyam`
    - Line 64: PROCESSMODE must be set to `TOPO`
    - Line 65: INITPOL is VV (cfr e.g. `.../SAR_CSL/TDX/YourMode/NoCrop/YourImg.csl/Info/SLCImageInfo.txt`)
    - Line 69: INTERFML can be set to `20` (or higher if you want...)
    - Line 72: COHESTIMFACTOR must be similar to INTERFML when small and not higher than 5 or 7. Try `7` here.



# Exercise 1 – part 2a (topo TDX with CIS)

## Exercise part 2: TOPO mode using TDX in pursuit/bistatic mode – Virunga

- Prepare the data:
- Prepare the parameters file
  - Edit it and change appropriate values (continue)
    - Line 77: set **APPLYMASKno** if you do not have one yet or do not want one.  
To mask water bodies, set it to **APPLYMASKyes** and provide with the full path at the next line, e.g. the provided one:  
[.../DataSAR/SAR\\_AUX\\_FILES/MASKS/WaterBodies/DR Congo/LakeKivu\\_LatLong](#).
    - Line 82: SKIPUW: set it to **SKIPno**
    - Line 83: UWMETHOD, try **CIS**
    - Lines 84-115 can be kept by default most of the time when performing unwrapping.
    - Line 117: it is not advised to process interpolation when computing DEM, hence set INTERPOL to **NONE**
    - Line 118: REMOVEPLANE: it is not advised to process a detrending when computing DEM. Set it to **DETRENDno**
    - Line 123: GEOCMETHD: set it to **Closest**
    - Set the paths in the last lines as before...
  - When done, if needed, compare your  
[LaunchMTparam\\_TDX\\_SM\\_Desc\\_92\\_Bis\\_Nyigo\\_Nyam\\_Full\\_Zoom1\\_ML20\\_TOPO\\_CIS.txt](#) with existing example in  
[.../DataSAR/Param\\_files\\_SuperMaster/TDX/RDC\\_NYIGO\\_NYAM\\_StMp\\_Desc92\\_Bistat\\_150Mhz](#)





# Exercise 1 – part 2a (topo TDX with CIS)

## Exercise part 2: TOPO mode using TDX in pursuit/bistatic mode – Virunga

- Prepare the data:
- Prepare the parameters file
- Execute *SinglePair.sh*

*SinglePair.sh* *DateMas* *DateSLV* *ParamFile* *Comment* [*SuperMaster*]

where: *DateMas* = the date of the Master image, i.e. 20140912  
*DateSLV* = the date of the Slave image, i.e. 20140912  
*ParamFile* = path to your parameter file  
([LaunchMTparam\\_TDX\\_SM\\_Desc\\_92\\_Bis\\_Nyigo\\_Nyam\\_Full\\_Zoom1\\_ML20\\_TOPO\\_CIS.txt](#))  
*Comment* = for dir naming (useful when performing several tests...), e.g. *\_CIS\_Unwrap*

**Notes:**

- Note how SLV was renamed with dummy name (year 9000) to avoid conflict with same name as MAS image. A link was also created from RX to TX with the dummy date for processing infrastructure requirements
- geocoded DEM is named “[slantRangeDEM.VV-VV.UTM.40x40.bil\\_TDX\\_RDC\\_NYIGO\\_NYAM...](#)”
- remember to track errors or warnings by looking at lines that do not start with “//”. You can ignore the errors about flipped or flopped mod file not found.

→ OK? ☒ (~ 1 min for DEM + 8 min)  
See in .../PROCESS/TDX/...

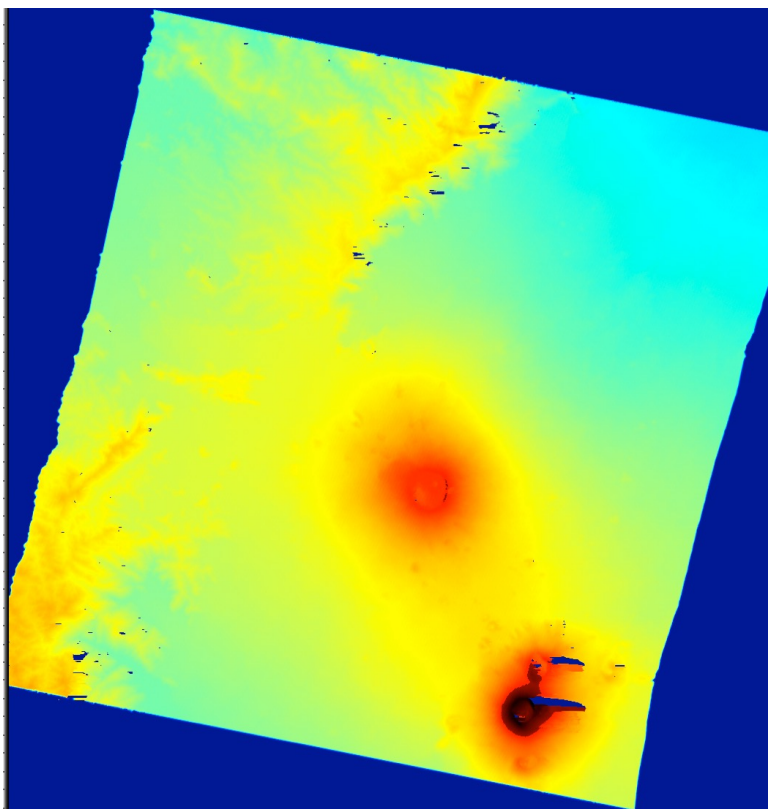
# Exercise 1 – part 2a (topo TDX with CIS)

## Exercise part 2: TOPO mode using TDX in pursuit/bistatic mode – Virunga

- Prepare the data:
- Prepare the parameters file
- Execute *SinglePair.sh*

Results:

Slant Range DEM



# Exercise 1 – part 2b (topo CSK with snaphu)



## Exercise part 2: TOPO mode using CSK – Virunga

- Prepare the data:

- Get the raw data from [.../3600/SAR\\_DATA/CSK/VVP/](#)
- Read the data with ***Read\_All\_Img.sh*** (See [manual §2](#)):

***Read\_All\_Img.sh*** *DirWhereRaw DirWhereCSL/NoCrop SAT PATH/kml*

where: *DirWhereRaw* = *.../3600/SAR\_DATA/CSK/VVP*

*DirWhereCSL/NoCrop* = *.../SAR\_CSL/CSK/Virunga\_Asc/NoCrop*

(**will be created; beware to end with NoCrop !**)

*SAT* = CSK

➔ OK? ☒ (~2 min)

See in *.../SAR\_CSL/CSK/.../NoCrop*

- Notes:**
- name *Virunga\_Asc* is arbitrary. We knew here it was ascending mode and targetting the Virunga, so it made sense to call it like that.
  - Choose carefully your pair of images to get an appropriate baseline ! Watch the altitude of ambiguity.





# Exercise 1 – part 2b (topo CSK with snaphu)

## Exercise part 2: TOPO mode using CSK – Virunga

- Prepare the data:
- Prepare the parameters file
  - Copy `.../SAR/MasTerToolbox/SCRIPTS_MT/___V20230828_LaunchMTparam.txt`  
in `.../DataSAR/Param_files_SuperMaster/CSK/Virunga_Asc`  
and name it as something useful, e.g.  
`LaunchMEparam_CSK_Virunga_Asc_Zoom1_ML30_snaphu_TOPO.txt`  
(name should help to assess what it is supposed to do)
  - Edit it and change appropriate values
    - Line 18: TRKDIR must be set to `Virunga_Asc` (because data are in such a dir)
    - Line 22: ignore for now
    - Line 27: DEMNAME; although it is computing topo, it will need an external DEM to geocode it (and assist its unwrapping)
    - Line 35: set CROP to `CROPno`
    - Line 40: keep zoom 1 (unless you want to oversample the data e.g. to reduce speckel in amplitude images)
    - Line 41: provide with a name that explains your (full) region as it will be used in dir naming, e.g. `Full`
    - Line 64: PROCESSMODE must be set to `TOPO`
    - Line 65: INITPOL is HH (cfr e.g. `.../SAR_CSL/CSK/Virunga_Asc/NoCrop/YourImg.csl/Info/SLCImageInfo.txt`)
    - Line 69: INTERFML can be set to `30` (or higher if you want...)
    - Line 72: COHESTIMFACTOR must be similar to INTERFML when small and not higher than 5 or 7. Try `7` here.

# Exercise 1 – part 2b (topo CSK with snaphu)



## Exercise part 2: TOPO mode using CSK – Virunga

- Prepare the data:
- Prepare the parameters file
  - Edit it and change appropriate values (continue)
    - Line 77: set **APPLYMASKno** if you do not have one yet or do not want one.  
To mask water bodies, set it to **APPLYMASKyes** and provide with the full path at the next line, e.g. the provided one:  
[.../DataSAR/SAR\\_AUX\\_FILES/MASKS/WaterBodies/DR Congo/LakeKivu\\_LatLong](#).
    - Line 82: SKIPUW: set it to **SKIPno**
    - Line 83: UWMETHOD, try **SNAPHU**
    - Lines 84-115 can be kept by default most of the time when performing unwrapping.
    - Line 117: it is not advised to process interpolation when computing DEM, hence set INTERPOL to **NONE**
    - Line 118: REMOVEPLANE: it is not advised to process a detrending when computing DEM. Set it to **DETRENDno**
    - Line 123: GEOCMETHD: set it to **Closest**
    - Set the paths in the last lines as before...
  - When done, if needed, compare you [LaunchMEparam\\_CSK\\_Virunga\\_Asc\\_Zoom1\\_ML30\\_snaphu\\_TOPO.txt](#) with existing example in  
[.../DataSAR/Param\\_files\\_SuperMaster/CSK/Virunga\\_Asc](#)



# Exercise 1 – part 2b (topo CSK with snaphu)

## Exercise part 2: TOPO mode using CSK – Virunga

- Prepare the data:
- Prepare the parameters file
- Execute *SinglePair.sh*

*SinglePair.sh* *DateMas* *DateSLV* *ParamFile* *Comment* [*SuperMaster*]

where: *DateMas* = the date of the Master image, i.e. 20210928

*DateSLV* = the date of the Slave image, i.e. 20210929

*ParamFile* = path to your parameter file

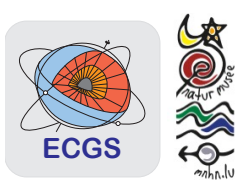
([LaunchMEparam\\_CSK\\_Virunga\\_Asc\\_Zoom1\\_ML30\\_snaphu\\_TOPO.txt](#))

*Comment* = for dir naming (useful when performing several tests...), e.g. *\_snaphu\_Unwrap*

**Notes:** - answer no when it offers you to gain time by using possible results from a coregistration on a super master...

→ OK? ☒ (~ 1 min for DEM + 25 min)  
See in .../PROCESS/CSK/...

# Exercise 1 – part 2b (topo CSK with snaphu)

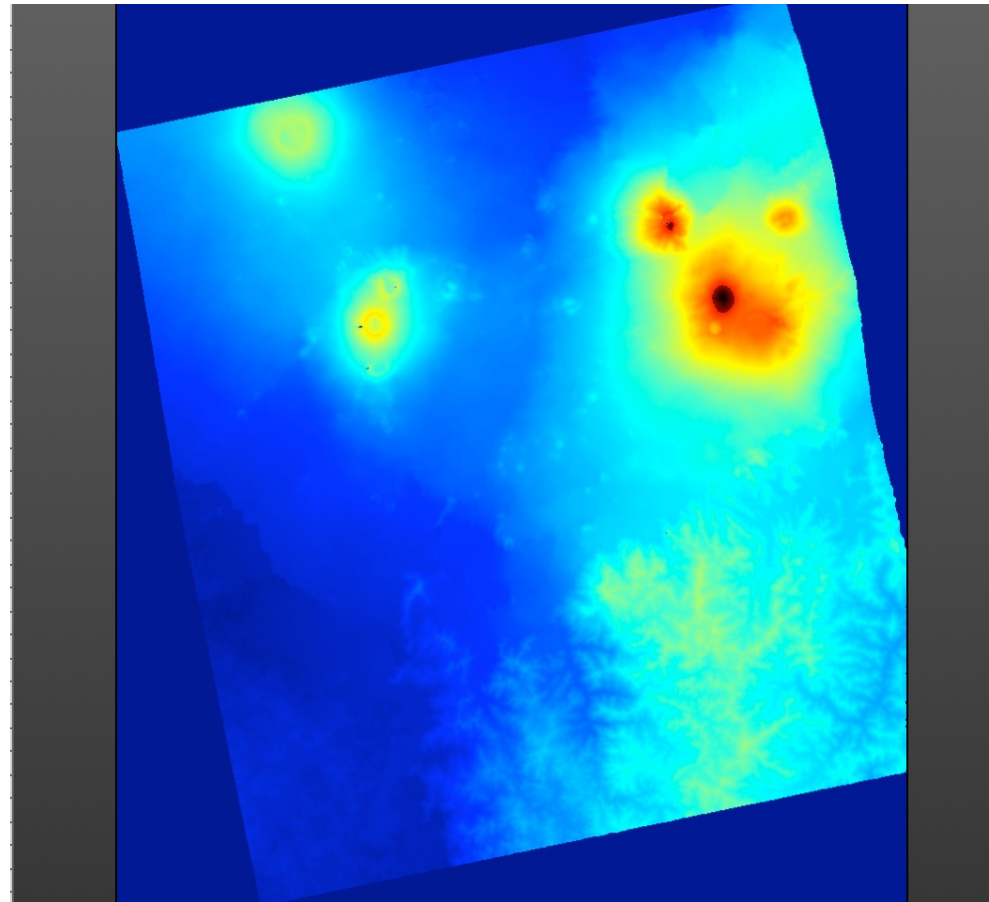


## Exercise part 2: TOPO mode using CSK – Virunga

- Prepare the data:
- Prepare the parameters file
- Execute *SinglePair.sh*

Results:

Slant Range DEM



# Exercise 1

## Plan:

### Exercise part 1: DEFO mode using Sentinel-1 data in StripMap mode – Piton de la Fournaise

- Prepare the data:
  - Prepare a kml (or get it from 1650)
  - Prepare the DEM (or get it from DataSAR)
  - Get the raw data e.g. from ESA SciHub portal (or get it from 3600)
  - Get the orbits & Read the S1 SM data (Réunion Island) with *Read\_All\_Img.sh*
- Prepare the parameters file
- Execute *SinglePair.sh*
- Make a mask for water body
- Reprocess with mask

- DONE ! -

### Exercise part 2: TOPO mode using TDX in pursuit/bistatic mode using CIS unwrapping – Virunga or CSK using snaphu unwrapping

- Prepare the data:
  - Get the raw data from 3600
  - Read the data with *Read\_All\_Img.sh*
- Prepare the parameters file
- Execute *SinglePair.sh*