

# Deteção Remota Microondas 2024/2025 TP-02

## Aula laboratorial 2

Objectivo: Processamento interferométrico de imagens TSX e S1 Dados: Imagens TSX (Lisboa) e S1 (Portugal e Cabo Verde) (Tutorial: S1TBX TOPSAR Interferometry with Sentinel-1 Tutorial.pdf)

**Caso 1. Erupção de Cabo Verde** Erupção de 23 Novembro de 2014 a 8 Fev 2015

Imagens Sentinel-1 1. Ler as imagens:

> S1A\_IW\_SLC\_\_1SSV\_20141103T195043\_20141103T195056\_003122\_00395A\_B81E.zip S1A\_IW\_SLC\_\_1SSV\_20141127T195042\_20141127T195056\_003472\_004117\_D715.zip

Uma das imagens é 4 dias após a erupção.

2. Ver as imagens, escolher o swath
Ver as diferentes bandas: i (real), q (imaginário), intensity
Escolher swath = 3

## 3. Corregisto

\$Radar > S1 TOPS Coregistration > S1 TOPS Coregistration with ESD (~23 minutos)

Read1= imagem master Read2= imagem slave TOPSAR-Split = IW3; Bursts = 1:4 Apply-Orbit-File: Sentinel Precise (Auto Download) Back-Geocoding: SRTM 1Sec HGT Write: 20141103\_20141127\_Orb\_Stack.dim

(imagem com 6 bandas : 3 da imagem master + 3 imagem slave)

Referir o local onde são armazenados os dados auxiliares



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#### 4 Cálculo do interferograma



\$ Radar > Interferometric > Products > Interferogram Formation

Output: 20141103\_20141127\_Orb\_Stack\_ifg.dim

Atenção: ativar "Subtract topographic phase"



C Interferogram Formation	×
File Help	
I/O Parameters Processing Parameters	]
Subtract flat-earth phase	
Degree of "Flat Earth" polynomial	5 ~
Number of "Flat Earth" estimation points	501 ~
Orbit interpolation degree	3 ~
Subtract topographic phase	
Digital Elevation Model:	Copernicus 30m Global DEM (Auto Download) 🗸
Tile Extension [%]	100 ~
Output Elevation	
Dutput Orthorectified Lat/Lon	
☑ Include coherence estimation	
Square Pixel	Independent Window Sizes
Coherence Range Window Size	10
Coherence Azimuth Window Size	3
	Run Close

Ver as imagens criadas (amplitude, fase, coerência, elevação, latitude longitude) Fazer o histograma da fase e da amplitude

Fazer o cálculo manual do valor da fase e amplitude de um píxel.

```
Z_1=a_1+ib_1 \text{ (imagem 1)}
Z_2=a_2+ib_2 \text{ (imagem 2)}
S=Z1 \cdot Z2^* = a_3 + ib_3
intensidade = a_3^*a_3 + b_3^*b_3
fase = atan2(b_3, a_3)
```

## 5. Topo Deburst

Juntar os 4 debursts. Output: 20141103\_20141127\_Orb\_Stack\_ifg\_deb.dim

\$ Radar > Sentinel-1 TOPS > Sentinel-1 TOPS Deburst



### 6. Multilooking

> Radar > SAR utilities > multilooking

	Multilooking		×
	File Help		
	I/O Parameters Process	ng Parameters	
	Source Bands:	I. fg. JW3_W_03Nov2014_27Nov2014 q. fg_ JW3_W_03Nov2014_27Nov2014 Intensity , fg_ JW3_W_03Nov2014_27Nov2014 Phase_fg_ JW3_W_03Nov2014_27Nov2014 elevation orthorestified.at orthorestified.or	
<b>NAME</b>	GR Square Pixel	Independent Looks	
	Mean GR Square Pixel:	1 13.701493	
		Note: Detection for complex data is done without resampling.	
		Run	Close

## 7. Filtrar a fase

\$ Interferometric > Filtering > Goldstein (tem de se apagar a banda da fase) Para filtrar a fase. O filtro trabalha com números complexos.

#### 8. Terrain correction

\$ Geometric > Terrain Correction > Range Doppler Terrain Correction



Resultado do Terrain Correction (Fase)





## 9. Inserção em ArcMap

(converter as bandas virtuais em bandas reais, "convert band")



## Caso 2. Sentinel-1 Lisboa

Imagens Sentinel-1 1. Ler as imagens:

> S1A\_IW\_SLC\_\_1SDV\_20190116T063453\_20190116T063521\_025499\_02D3AC\_5C49 S1B\_IW\_SLC\_\_1SDV\_20190122T063400\_20190122T063427\_014603\_01B358\_A563

2. Ver as imagens, escolher o swath
Ver os diferentes swaths, escolher o swath.
Ver a localização das imagens S1A e S1B.
Área útil para o interferograma.

#### 3. Usar o Graph Builder

(abrir alguns exemplos para ver a estrutura e comandos)

📓 Graph	Builder : TOPSAR (	Coreg Interferogram	m.xml				×
File Gra	hs						
Re TOPSJ Apply-0 TOPSA Res	d 2. Split Irbit-File Back- Dit-File(2) Split(2) (2)	Geocoding -> In	terferogram 🛏	TOPSAR-Deburst	→ Write		
			_				~
C Doudl o	1/22 2020-00 0 1				a 1.a - 1		>
Source P	d(z) TOPSAK-Spi vduct	t TOPSAK-Split(2)	Apply-Orbit-Hie	Apply-Orbit+le(2)	Back-Geocoding	Interferogram	10(
Name:							
							~
Data Fo	mat: 🗸 🗸						
Source pro	ict not selected			<b>A</b>			
	Loa 🔛	d 🏷 Clear	A Note	Save Save	🕑 Help	> Run	

\$ Graphs > InSAR Graphs > Top SAR Coreg Interferogram ( 5 minutos, RAM=12Gbyte)

TOPSAR Split: IW3, VV BackGeocoding : DEM > SRTM 1 sec HGT Interferogram: Substract Topographic Phase (Copernicus 30 m) Output Elevation Output OrthoRectified Lat /Lon

#### 4. Multilooking

\$ SAR Utilities > Multilooking (4/1) Seleccionar todas as bandas Ver o tamanho da imagem em disco e comparar com a inicial.



## 5. Filtrar a fase

\$ Interferometric > Filtering > Goldstein Para filtrar a fase. O filtro trabalha com números complexos.

#### 6. Terrain correction

\$ Range Doppler terrain correction WGS/UTM, 14m, output complex data Calcular o valor da fase  $\phi = atan2(q,i)$ 





## Caso 3. Interferogram com TSX-POL

#### Usar as imagens TSX do Lab-1

TDX1\_SAR\_\_SSC\_\_\_\_\_SM\_D\_SRA\_20171208T064715\_20171208T064723.dim TDX1\_SAR\_SSC\_\_\_\_\_SM\_D\_SRA\_20171219T064714\_20171219T064722.dim

## 1. Ver as imagens

Ver as duas imagens

## 2. Usar o Graph Builder

Calcular um interferograma para cada polarização (VV e HH)

#### \$ Graph > INSAR Graphs > BandSelect-Coreg-Interferogram-Filter (cerca de 5 min)

BandSelect: VV, i\_VV, q\_VV, intensity\_VV Interferogram: Substract Topographic Phase (Copernicus 30m) Output Elevation Output OrthoRectified Lat /Lon

(Alternativa: Coregistration + interferogram + Goldstein)

## 3. Ver o interferograma

Analisar a região das Lezirias

## 4. Filtrar a fase

\$ Interferometric > Filtering > GoldsteinPara filtrar a fase. O filtro trabalha com números complexos.

Comparar os histogramas das duas imagens de fase Ver imagem de coerência Detetar alterações (ver imagens S2) Interpretação do interferograma





Interferogram das Lezirias TSX com filtro Goldstein

## Sequencia dos primeiros 6 interferogramas de 20171003 a 20171219





## Caso 4. Erupção de La Palma

Imagens:

S1B\_IW\_SLC\_\_1SDV\_20210928T071020\_20210928T071047\_028895\_0372CA\_0EAF.zip S1B\_IW\_SLC\_\_1SDV\_20210904T071019\_20210904T071046\_028545\_03680D\_CB52.zip



6.75 franjas \* 5.6/2= 18.9 cm uplift

Sentido de medição das franjas: do exterior para o centro da deformação as cores têm a sequencia, azul, verde vermelho, significa de acordo com a barra de cores sentido negativo. Ou seja, a distância ao sensor diminuiu e por isso houve "uplift".



## Caso 5. Crise Sismica de S. Jorge

#### Imagens:

#### Descendente

S1A\_IW\_SLC\_\_1SDV\_20220315T075739\_20220315T075806\_042329\_050BCA\_1825.zip S1A\_IW\_SLC\_\_1SDV\_20220327T075739\_20220327T075806\_042504\_0511BC\_4D8D.zip

#### Ascendente

S1A\_IW\_SLC\_\_1SDV\_20220309T194930\_20220309T194957\_042249\_05091A\_256B.zip S1A\_IW\_SLC\_\_1SDV\_20220321T194930\_20220321T194957\_042424\_050F06\_F7F3.zip



