

# Dynamics and controls of a tropical slow moving landslide measured by remote sensing: the study case of Grand Éboulis, Réunion Island

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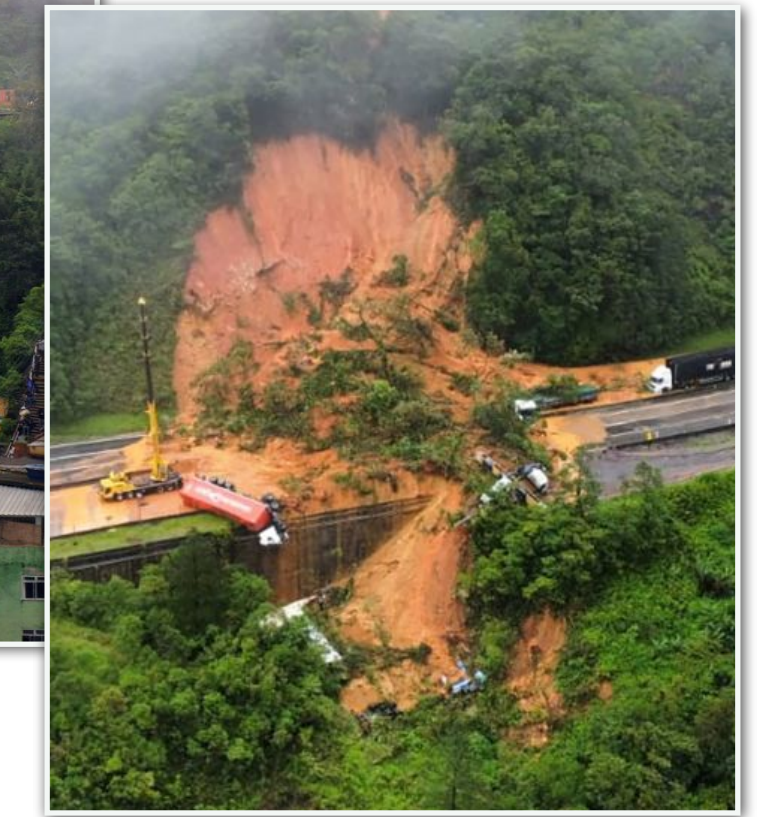
1. Université Paris Cité, Institut de Physique du Globe de Paris, CNRS, France
2. Laboratoire GéoSciences Réunion, Université de La Réunion, France
3. European Center for Geodynamics and Seismology, Luxembourg



# INTRODUCTION

## LANDSLIDES

- Efficient erosion processes
- Natural hazards



Brazil

# INTRODUCTION

## LANDSLIDES

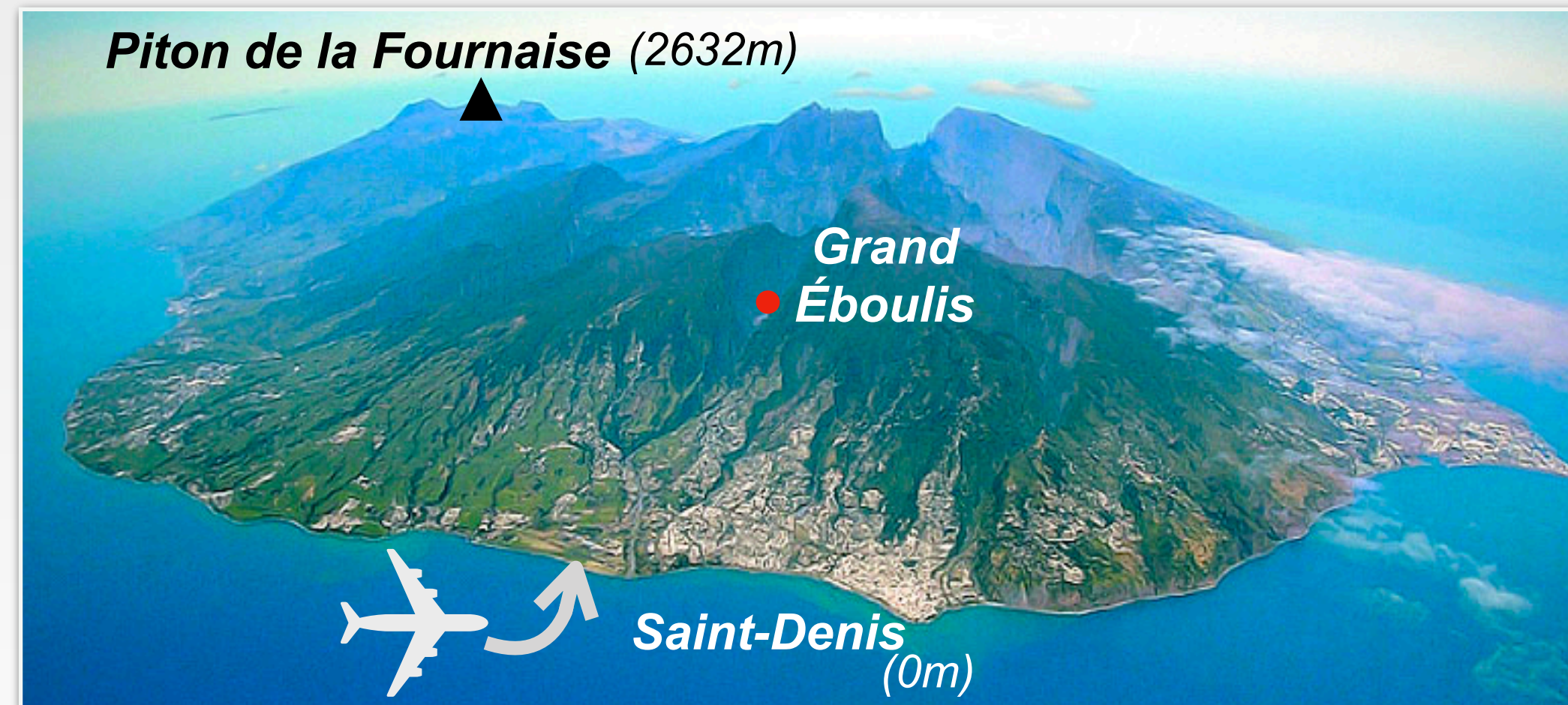
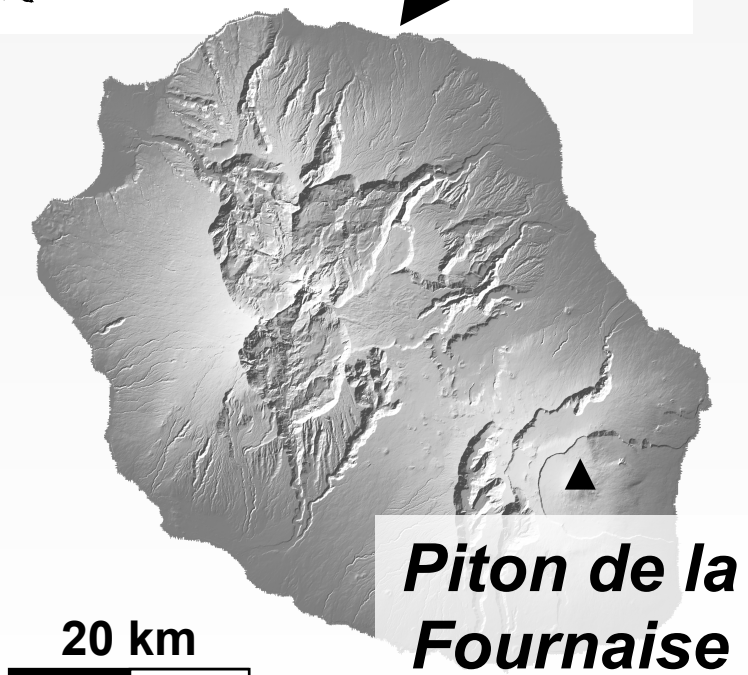
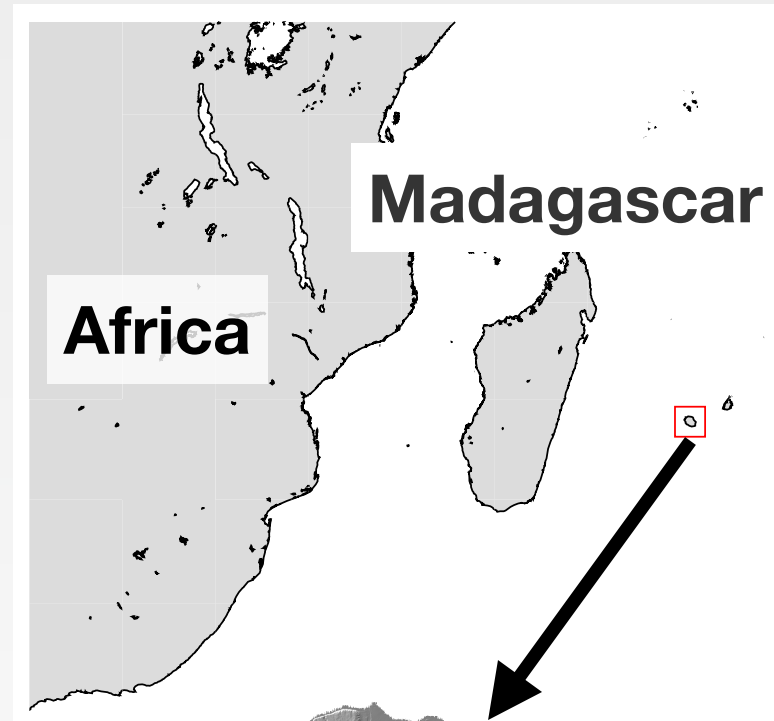
- Efficient erosion processes
- Natural hazards



Brazil



## LA RÉUNION

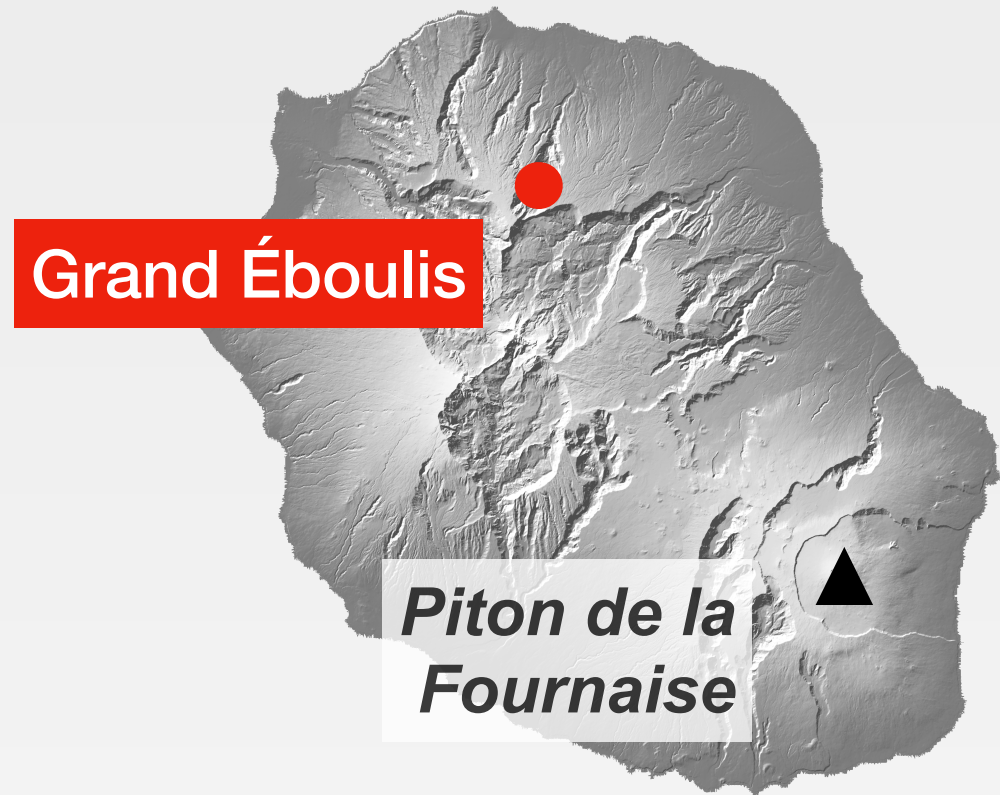


- High standing island
  - Frequent landsliding
  - Variability of precipitation
- Natural laboratory

➤ **Dynamics of Grand Éboulis & meteorological control**

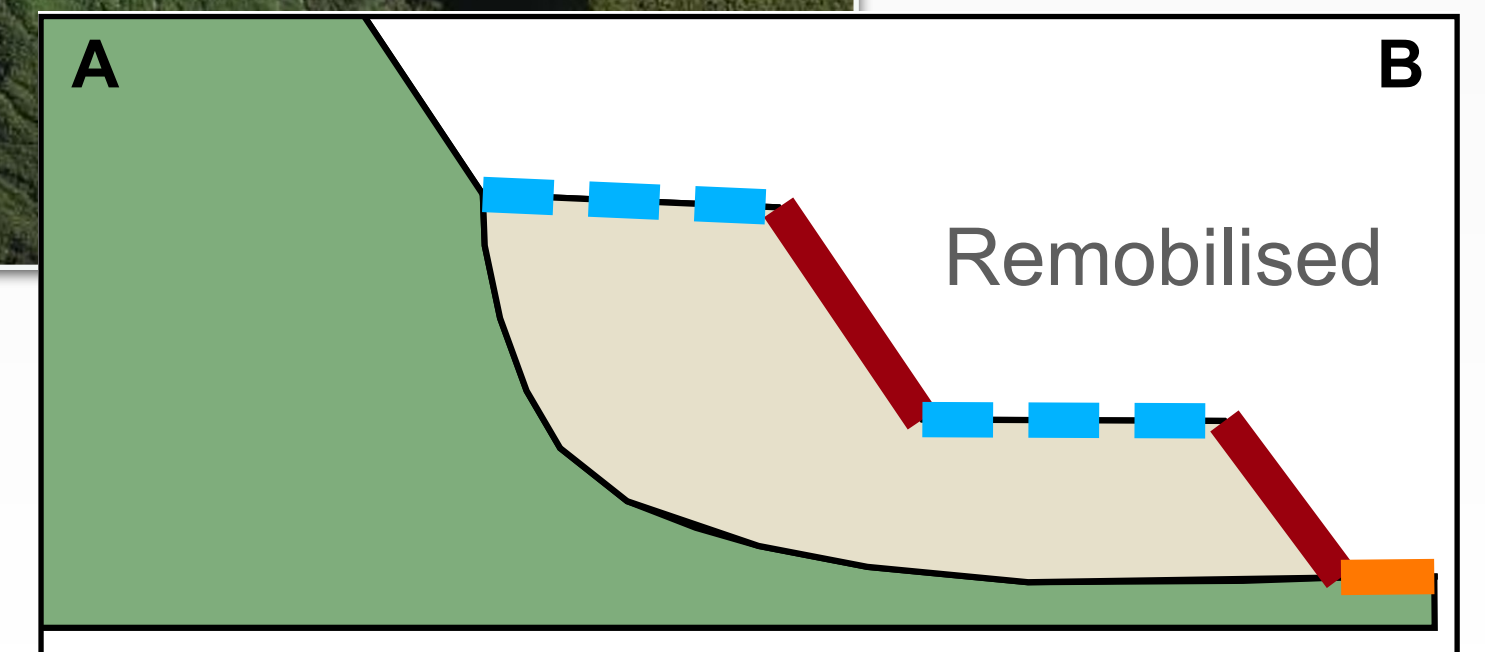
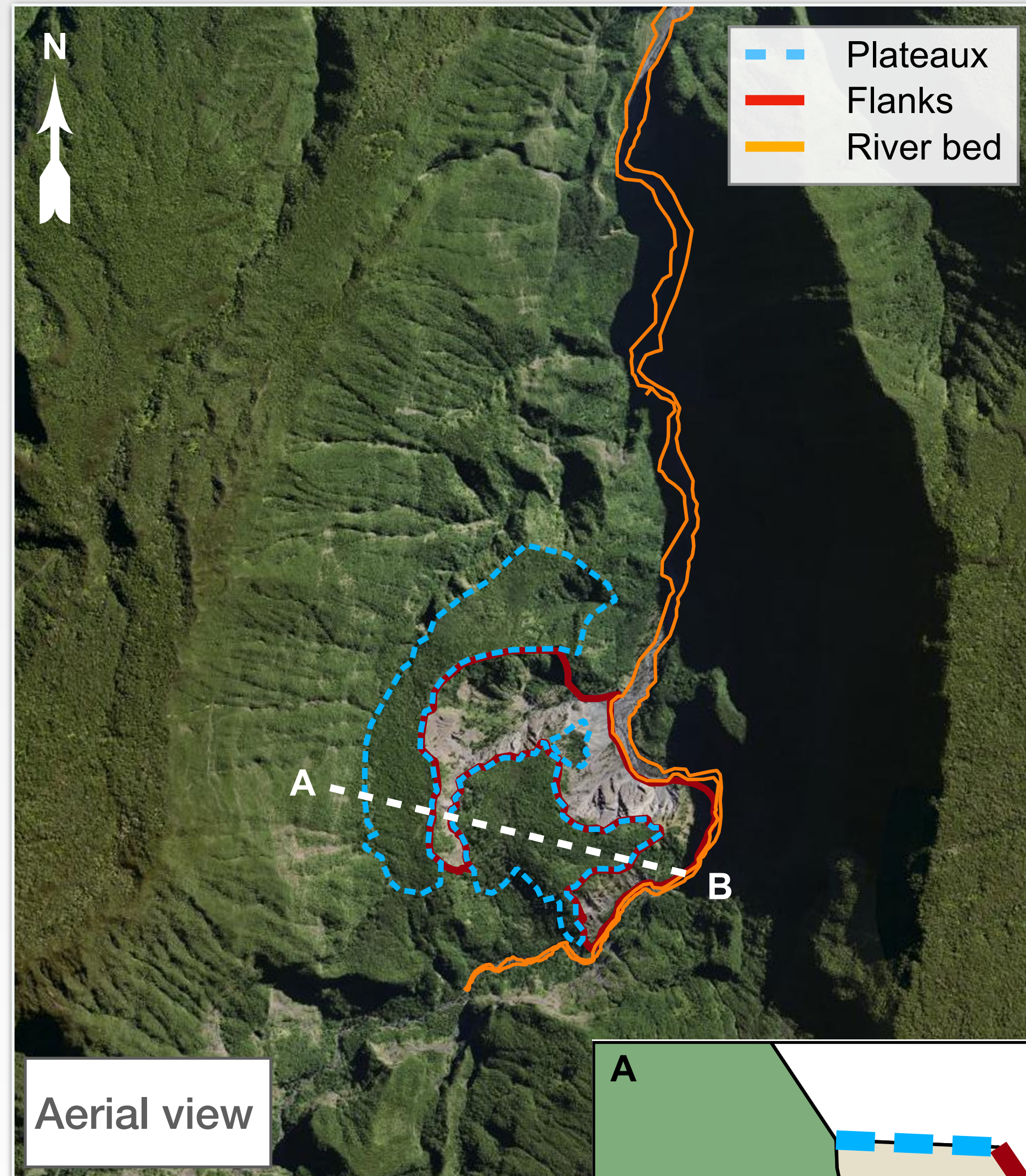
# GRAND ÉBOULIS

## LOCATION

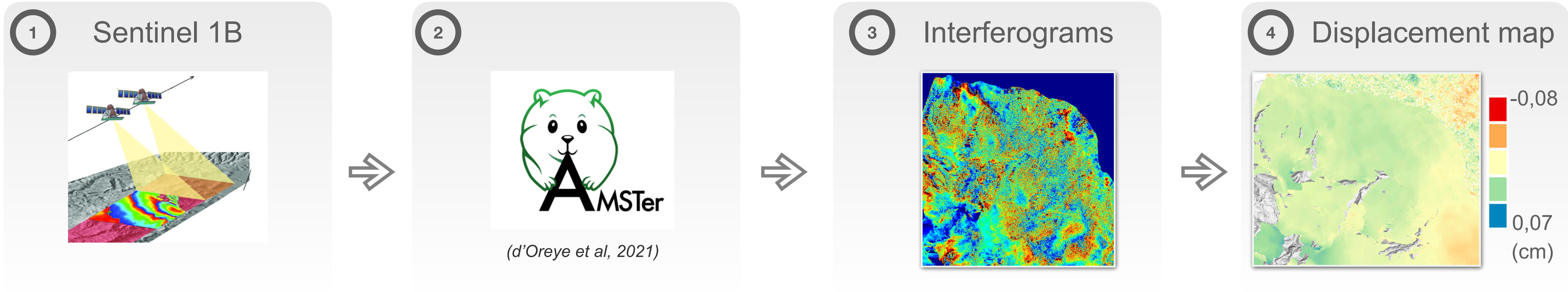


● Mountainous watershed

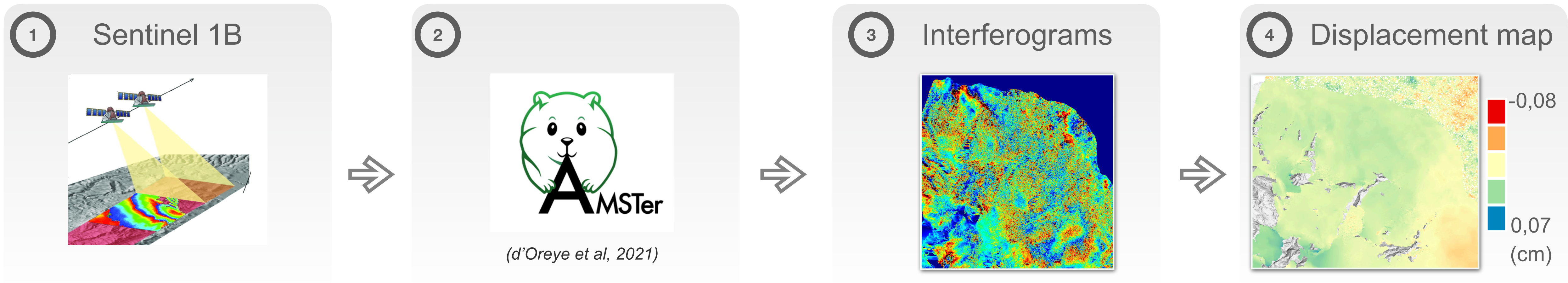
## MORPHOLOGY



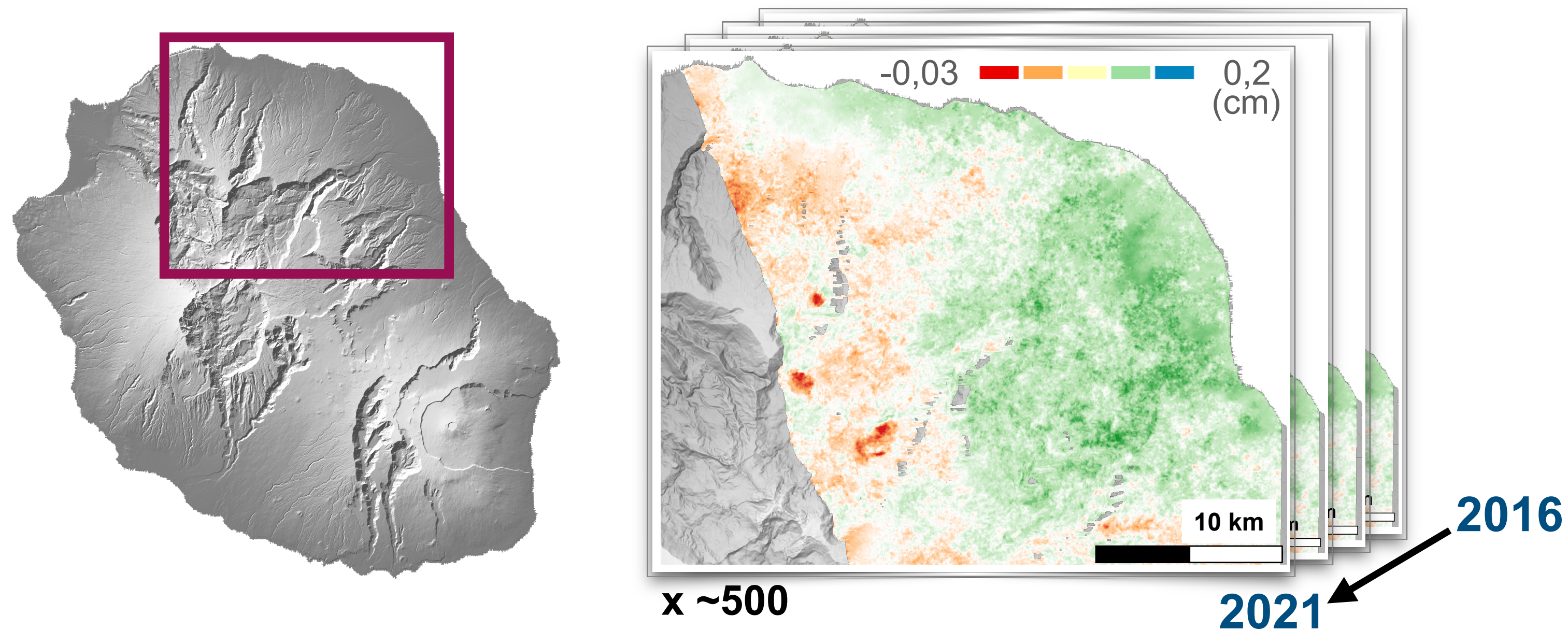
# BI-MONTHLY DYNAMICS: RADAR INTERFEROMETRY



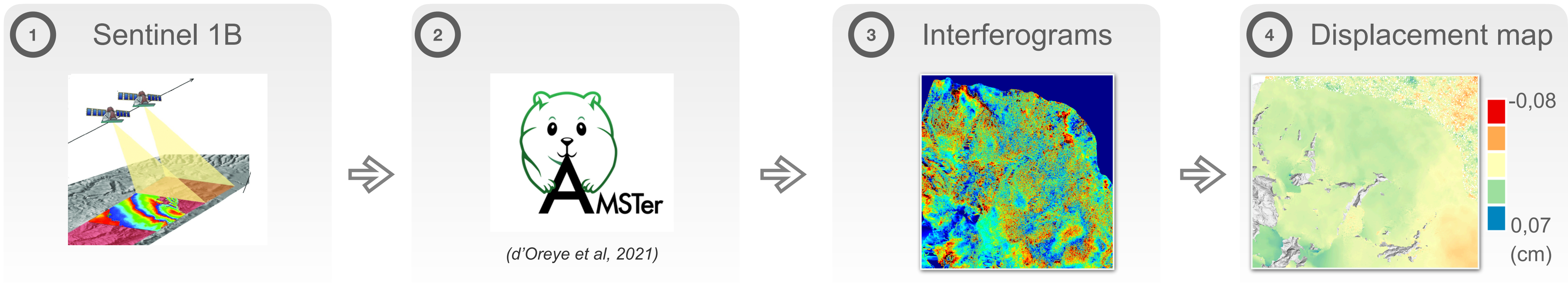
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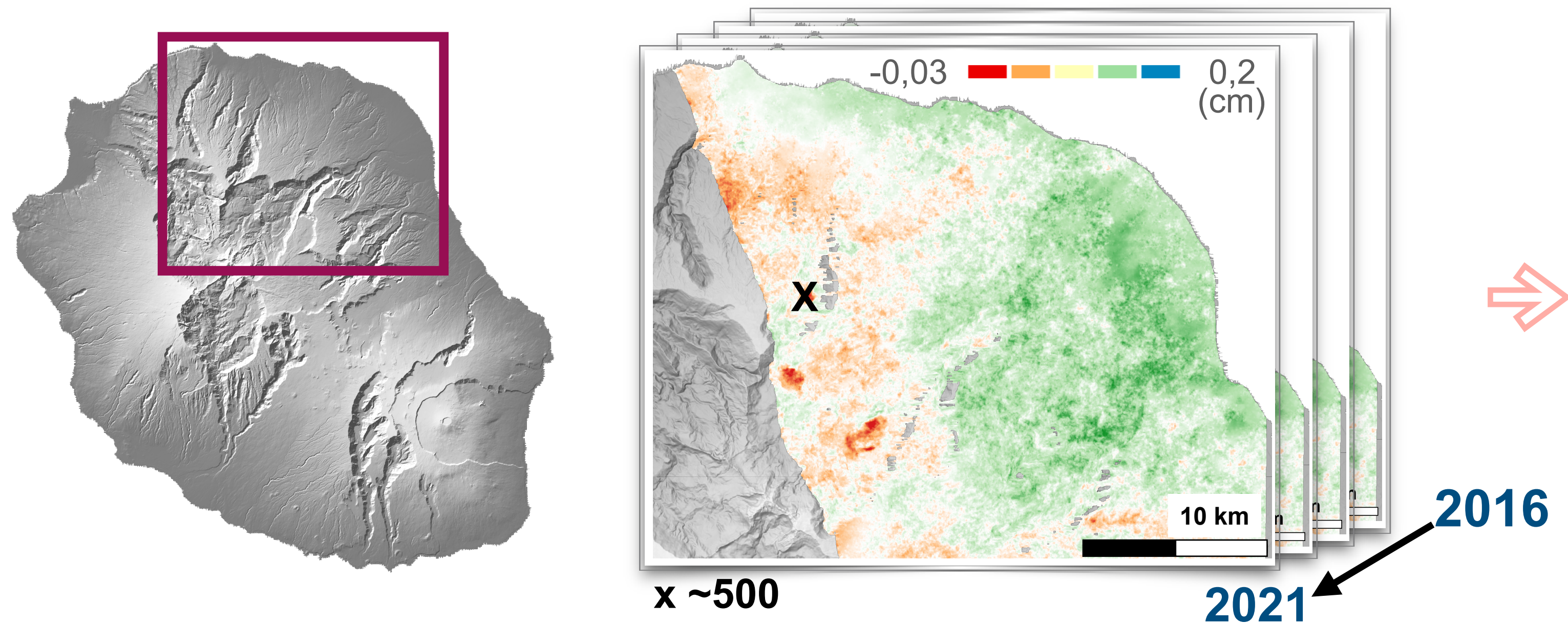
## Cumulated displacement maps (LOS)



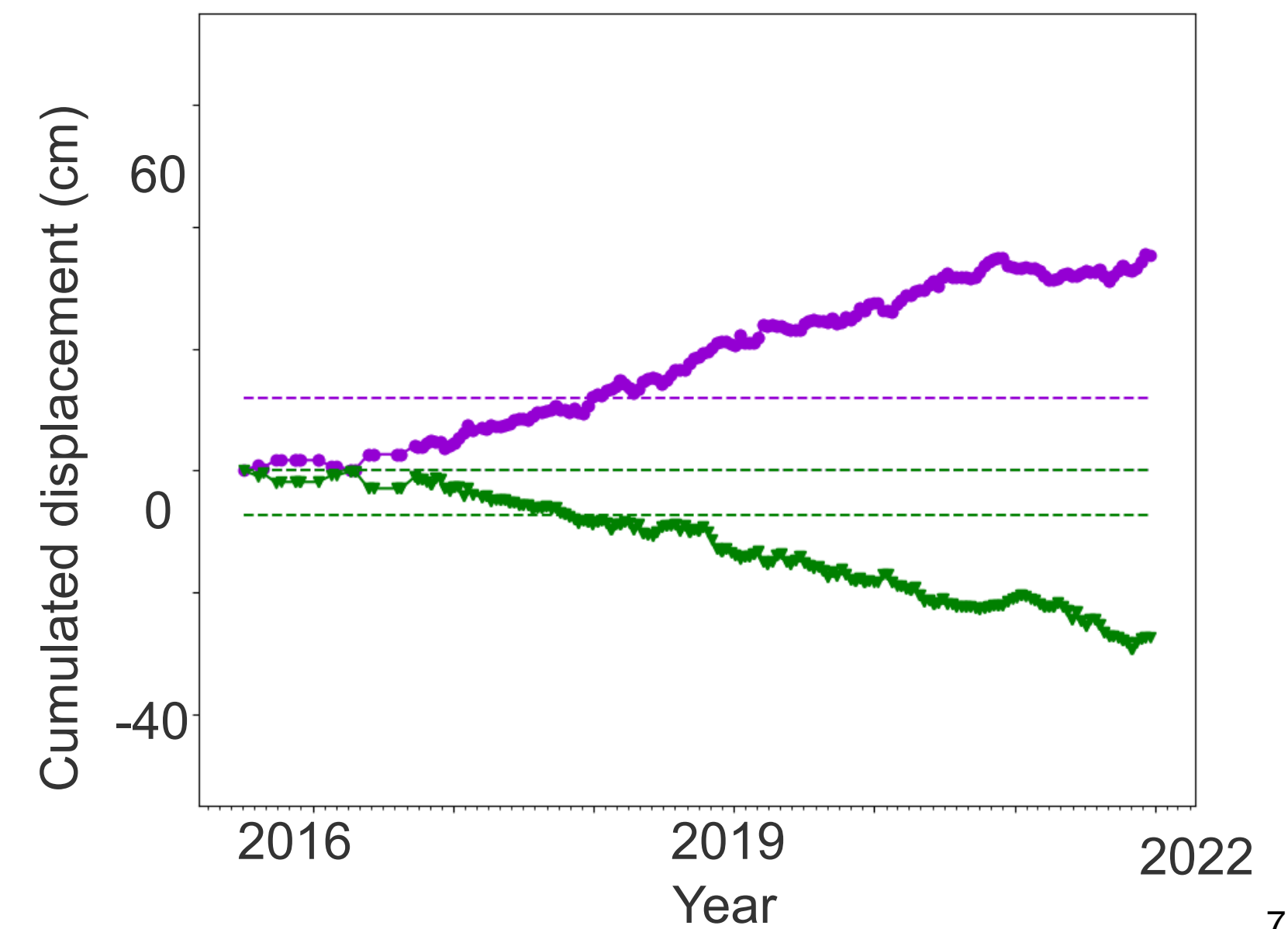
# BI-MONTHLY DYNAMICS: RADAR INTERFEROMETRY



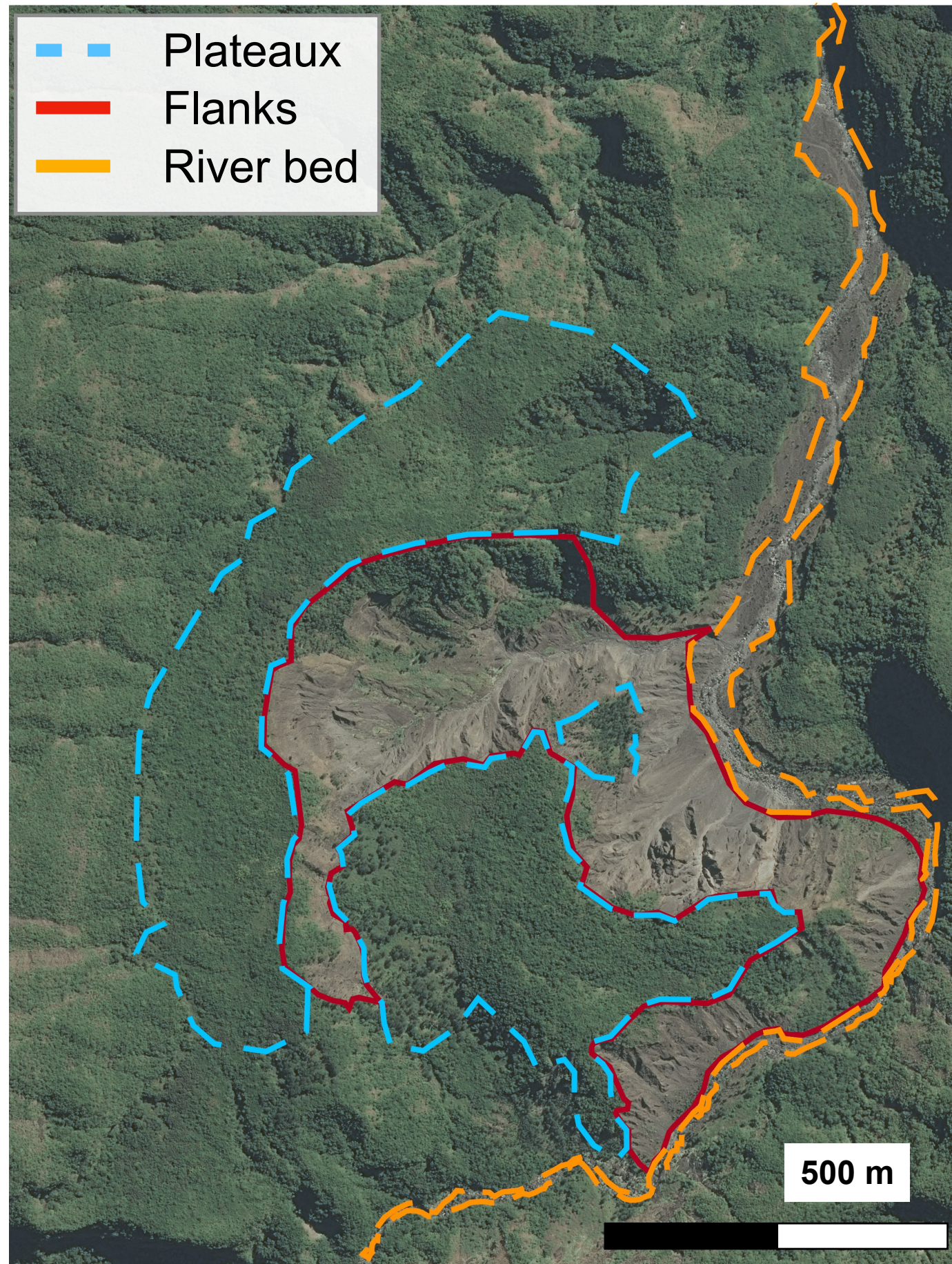
## Cumulated displacement maps (LOS)



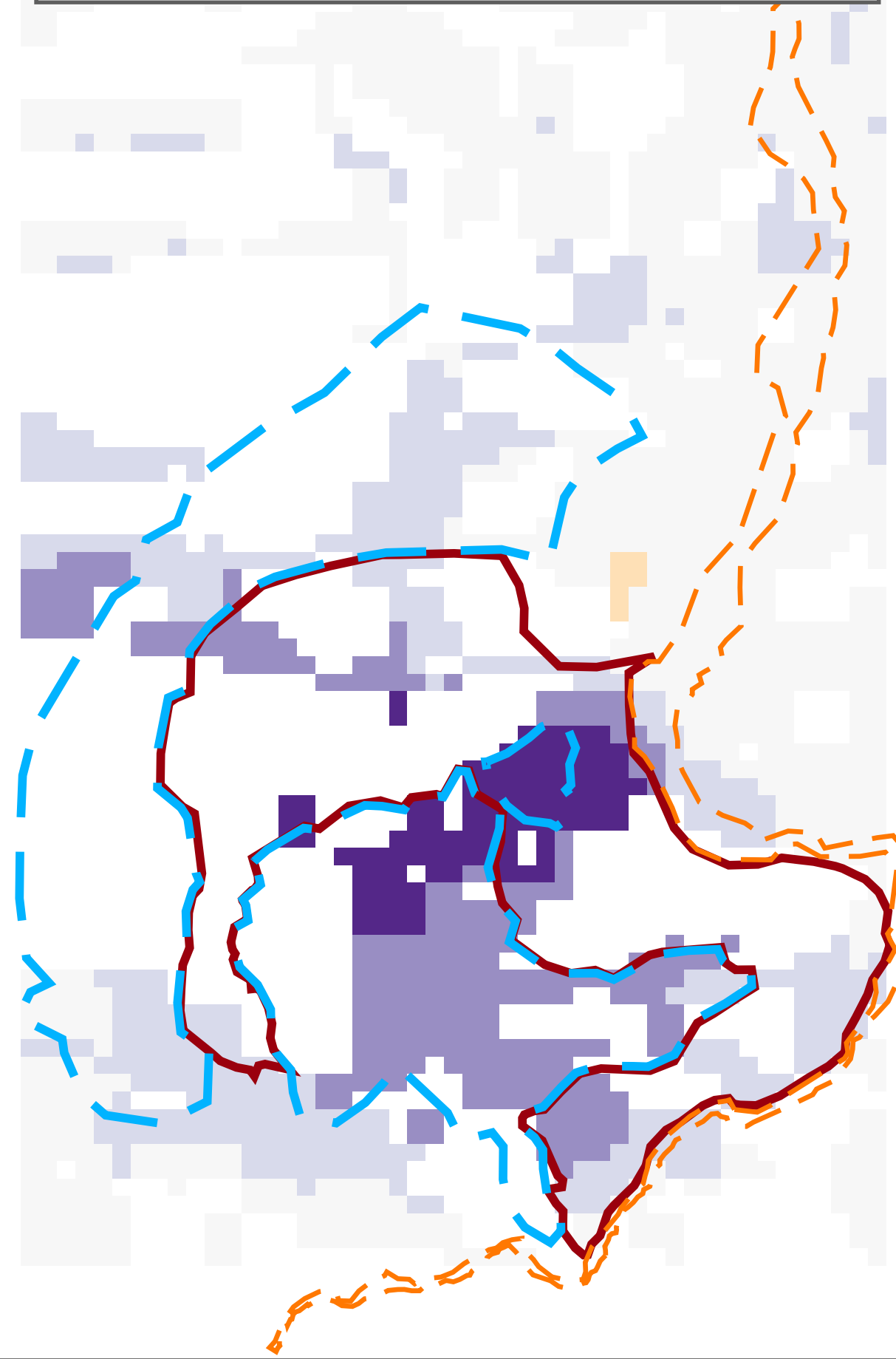
## Time series



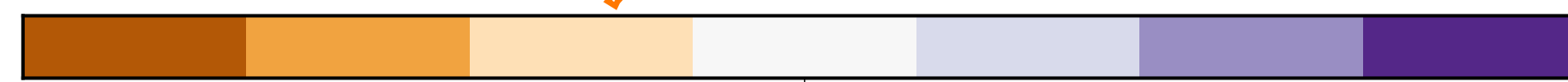
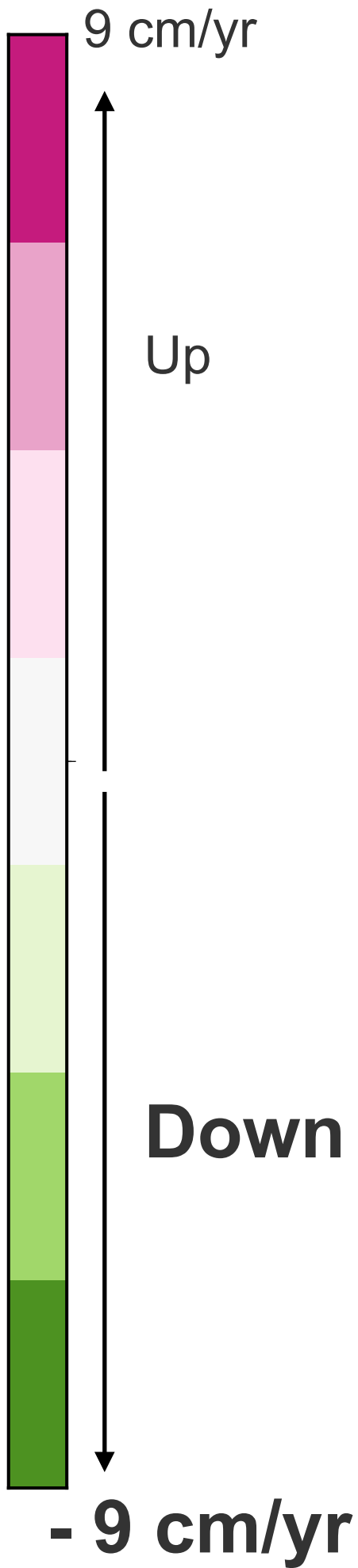
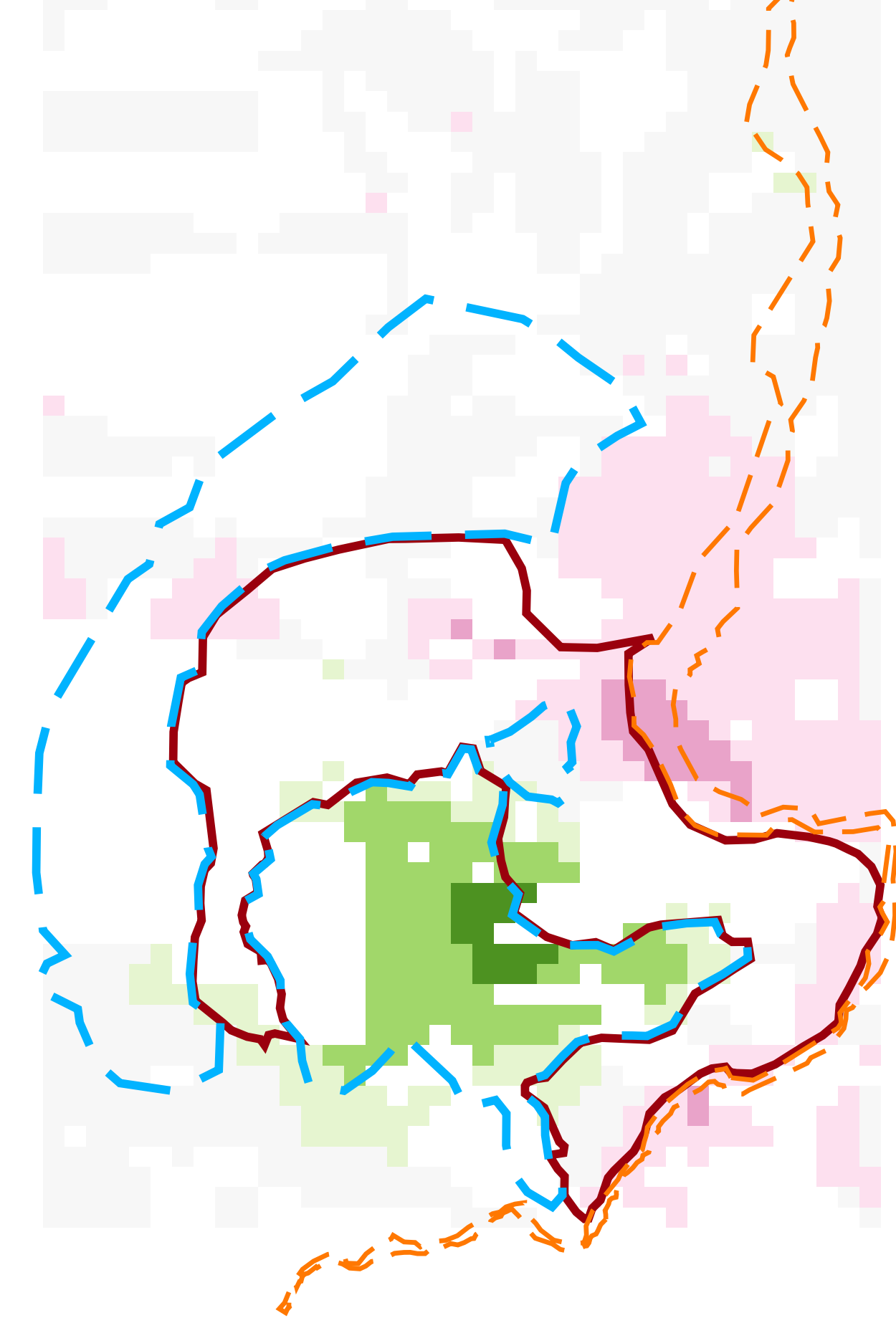
# BI-MONTHLY DYNAMICS: SPATIAL DISPLACEMENT



Average displacement EW



Average displacement V



- 14 cm/yr

West

East

14 cm/yr

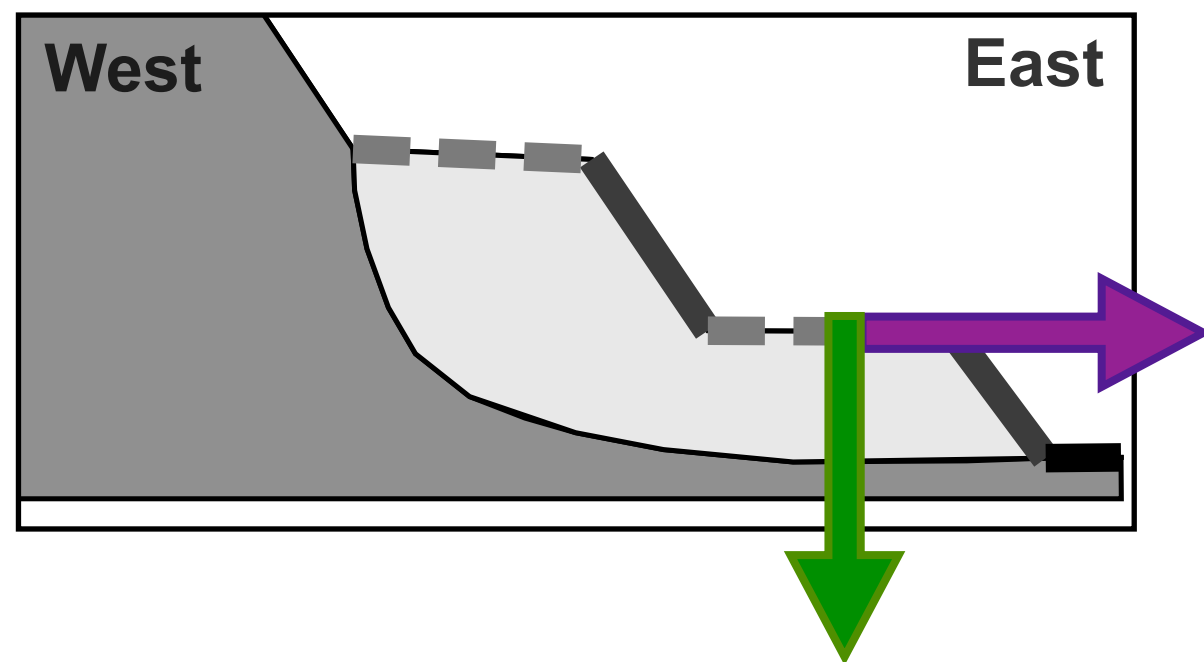
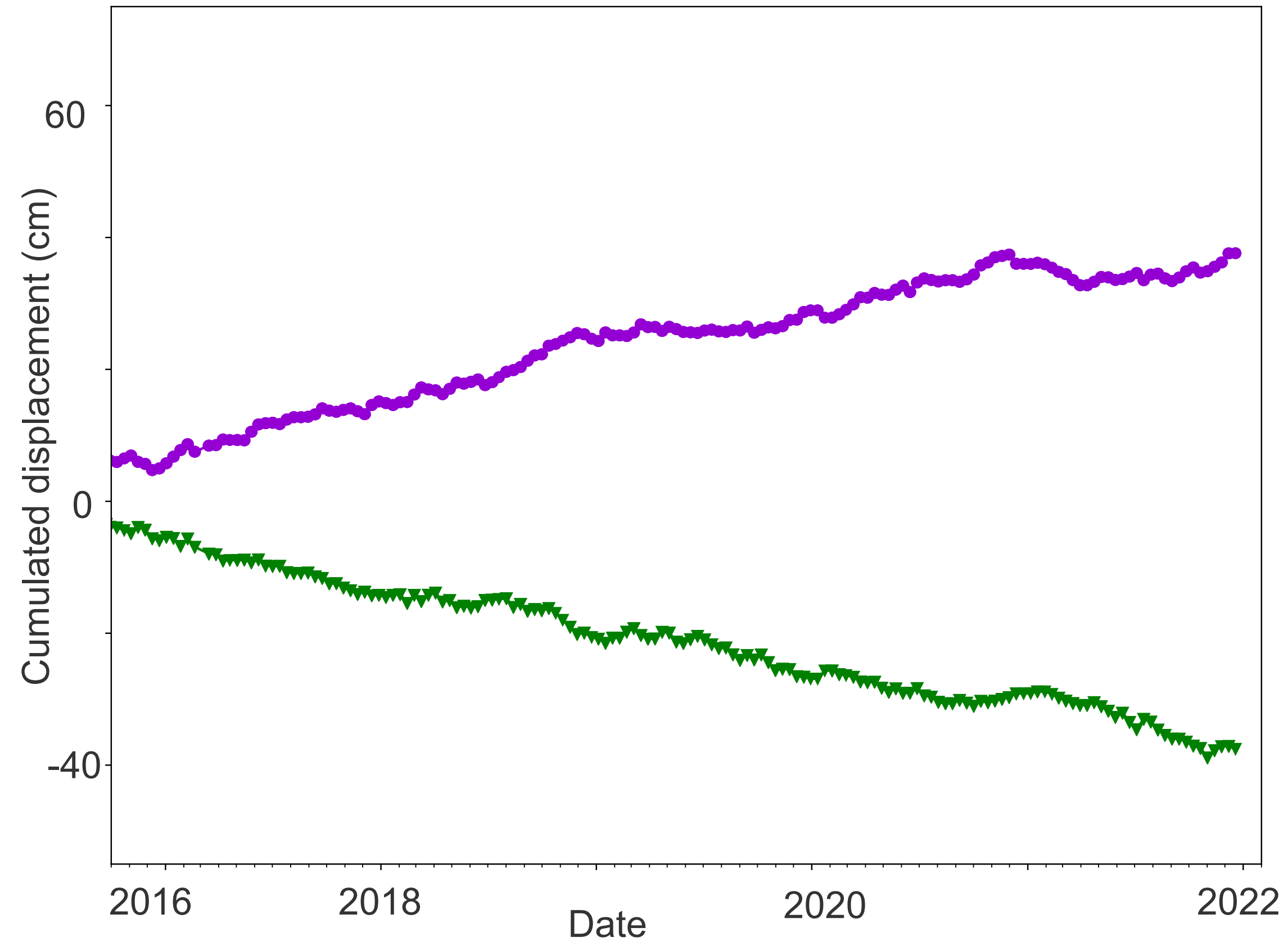
East-West & vertical displacement

➔ *Slow landslide*



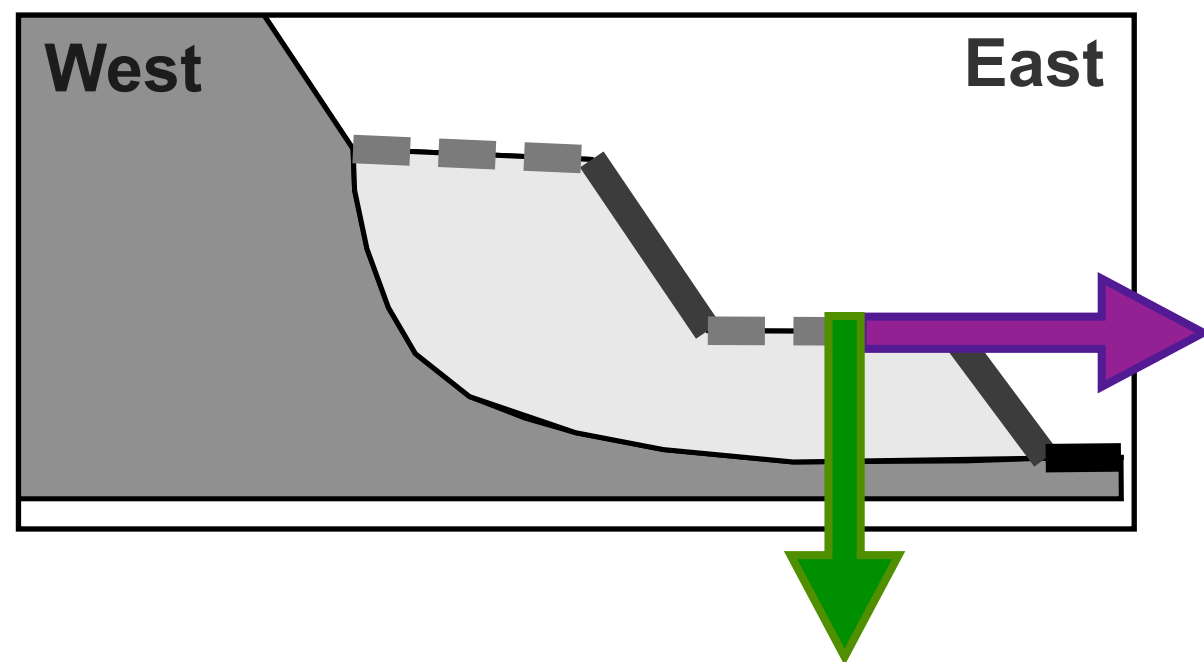
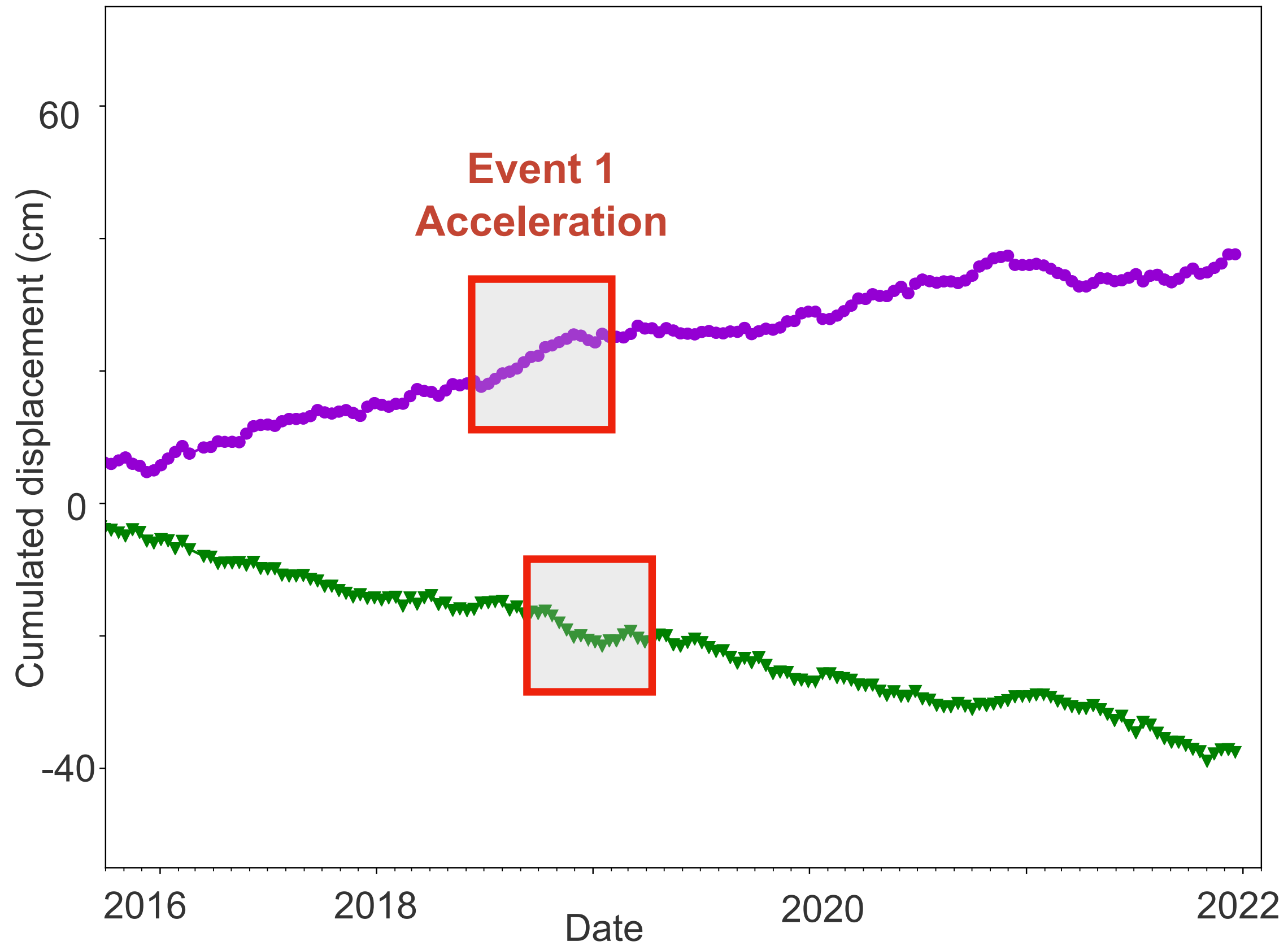
# BI-MONTHLY DYNAMICS: TEMPORAL DISPLACEMENT AND CONTROL

Cumulated displacement time series



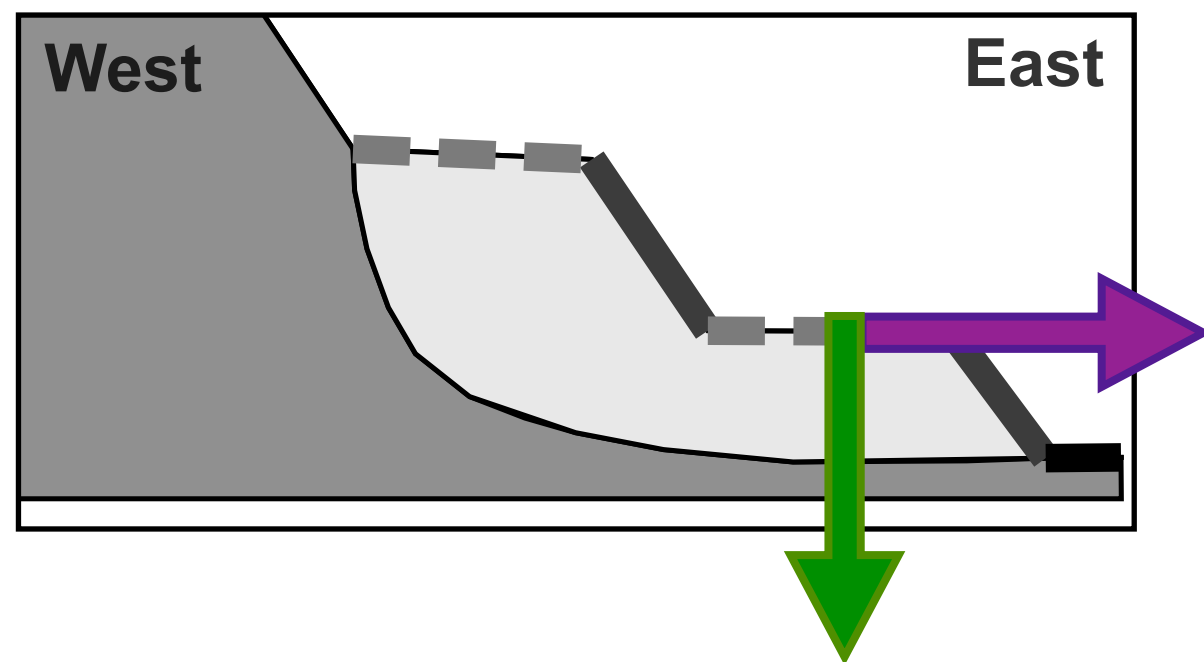
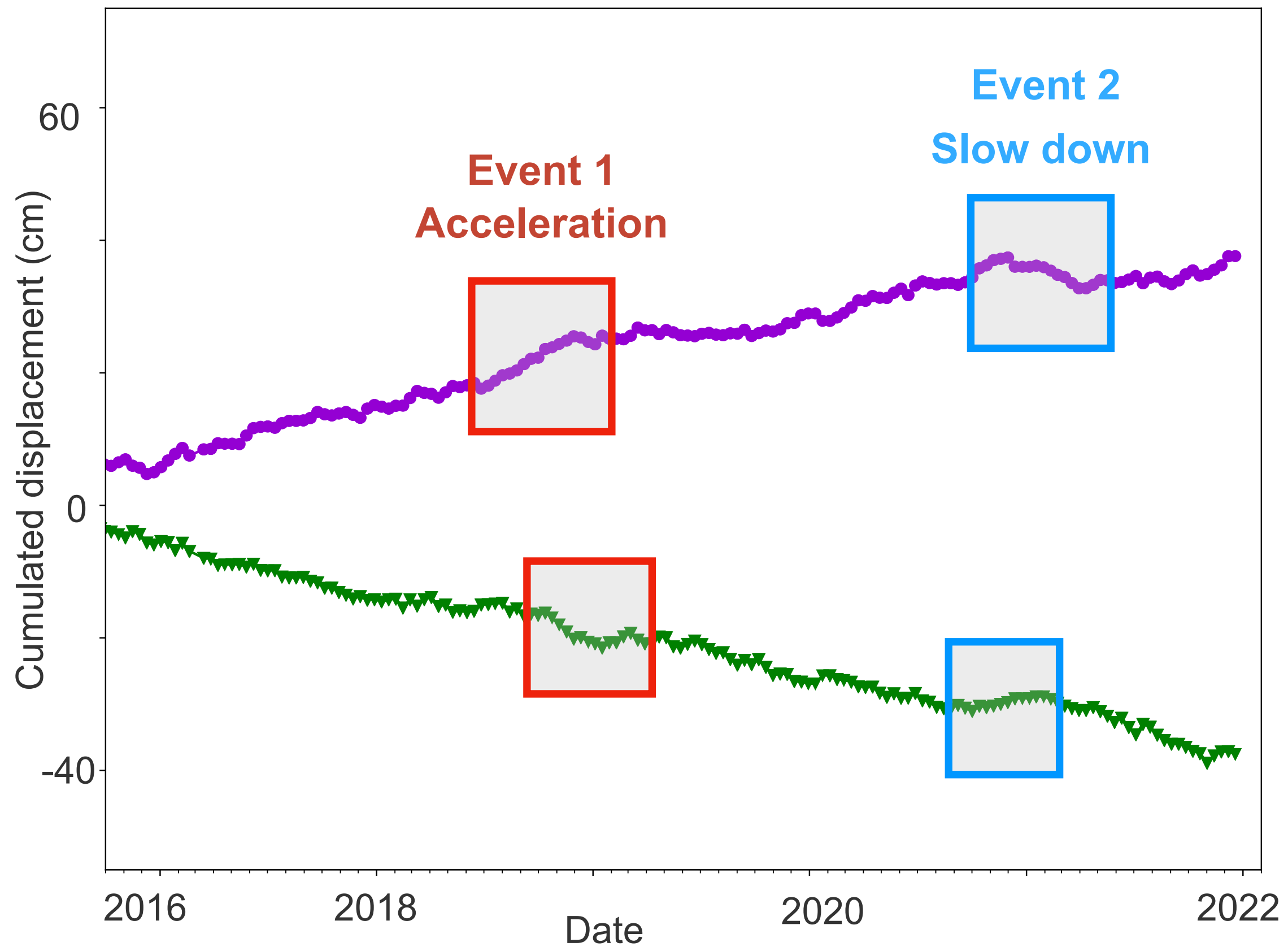
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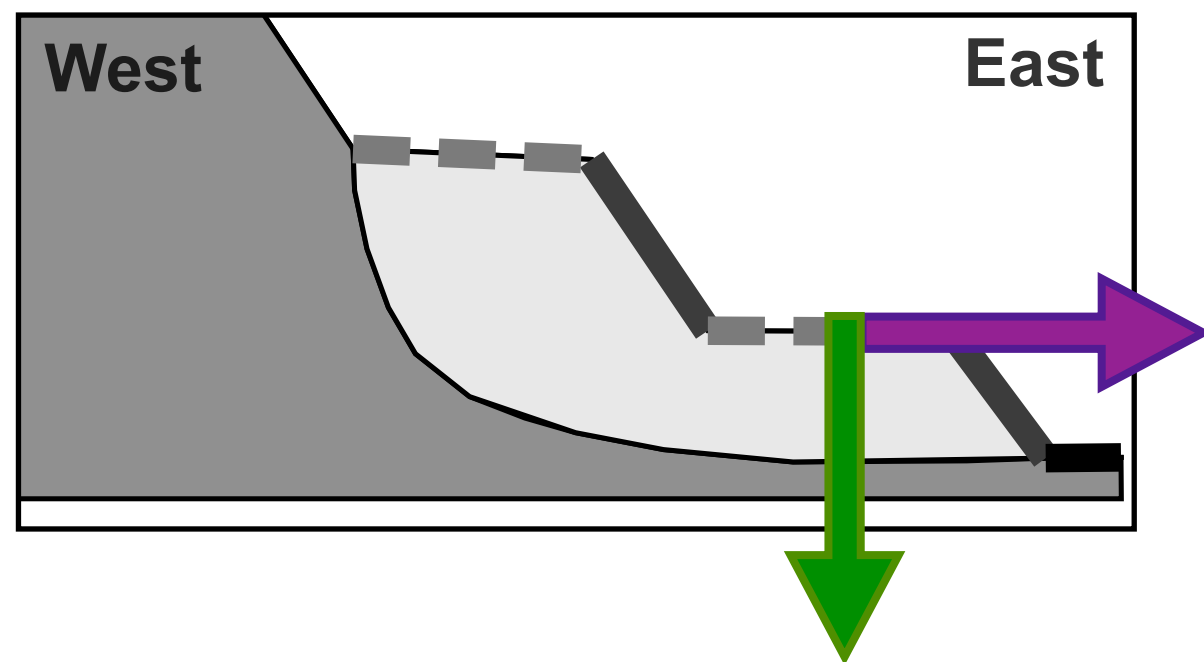
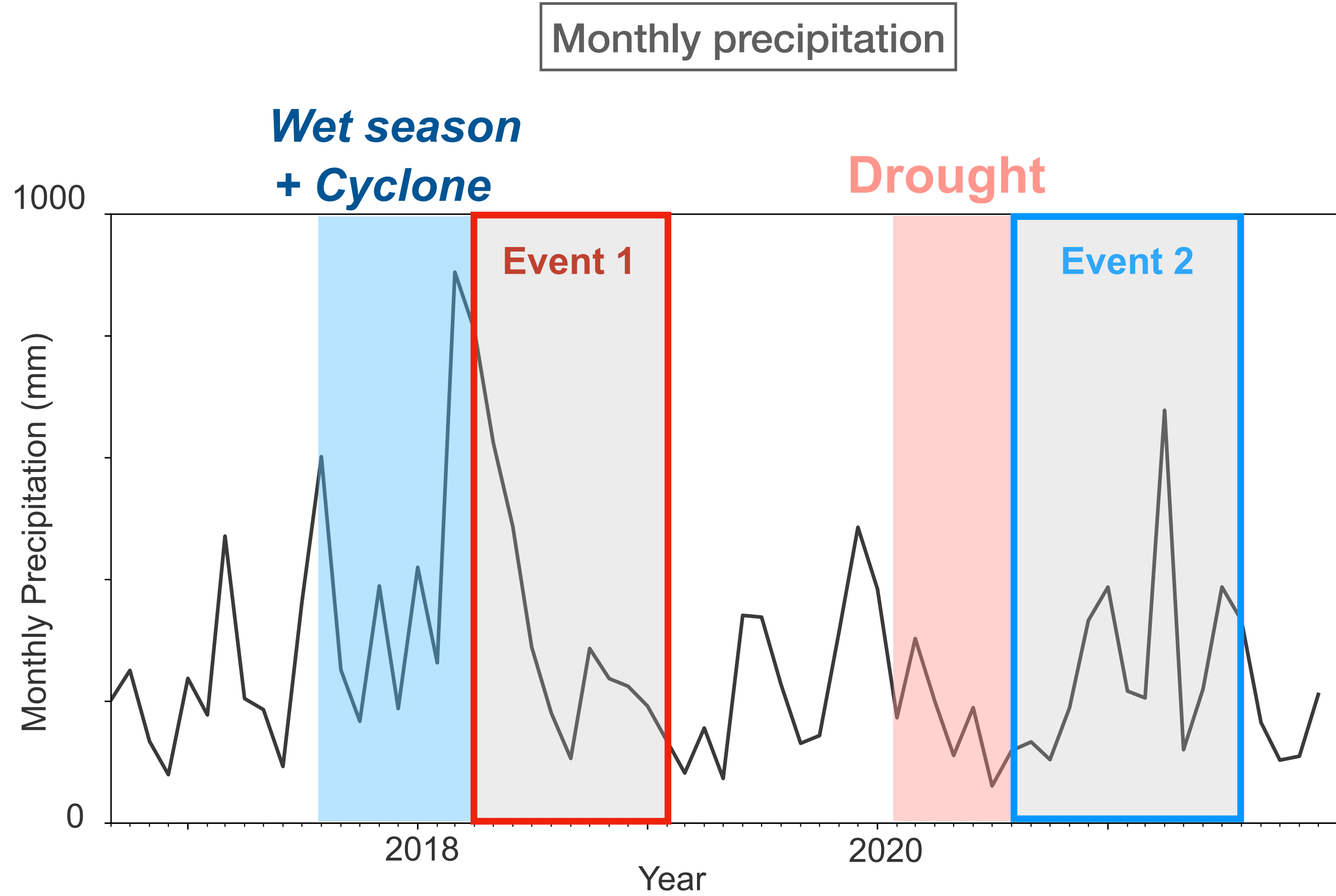
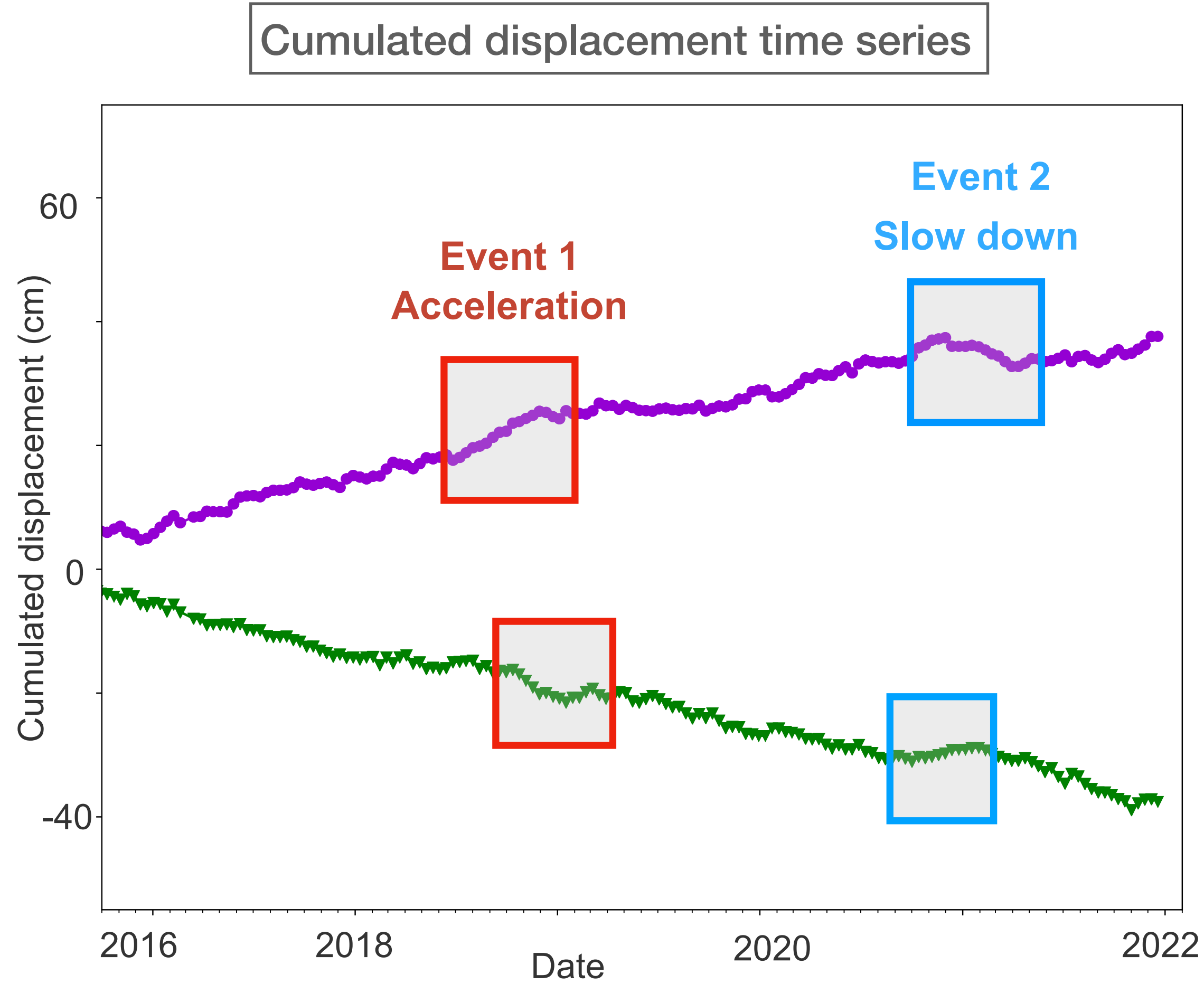


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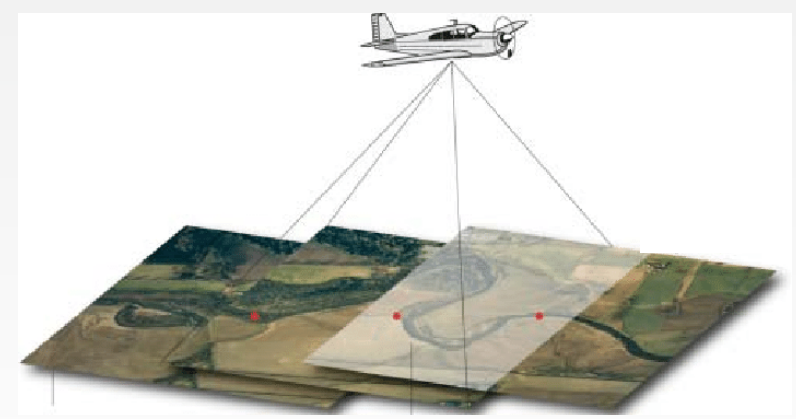


# BI-MONTHLY DYNAMICS: TEMPORAL DISPLACEMENT AND CONTROL

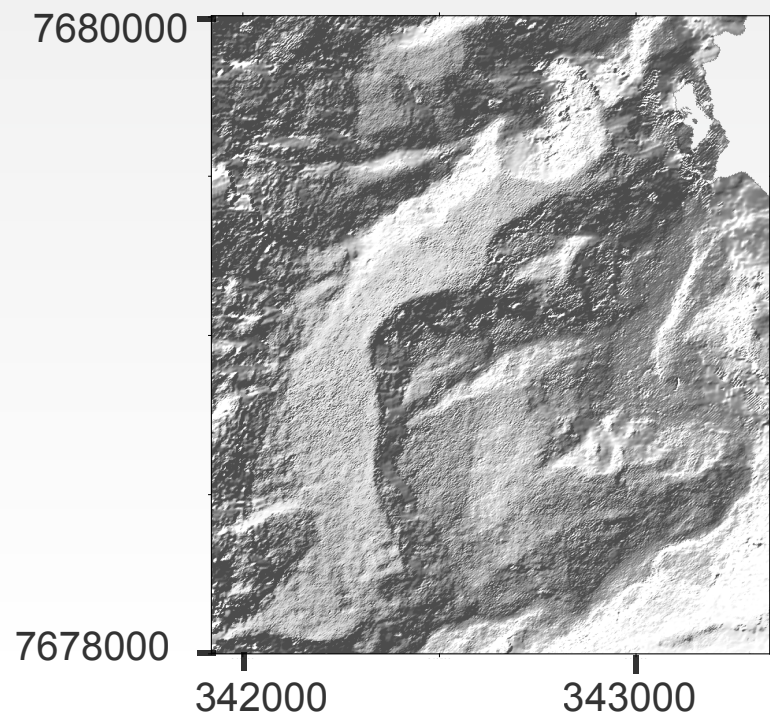


# PLURI-ANNUAL DYNAMICS : PHOTOGRAMMETRY (Lucas and Gayer, 2022)

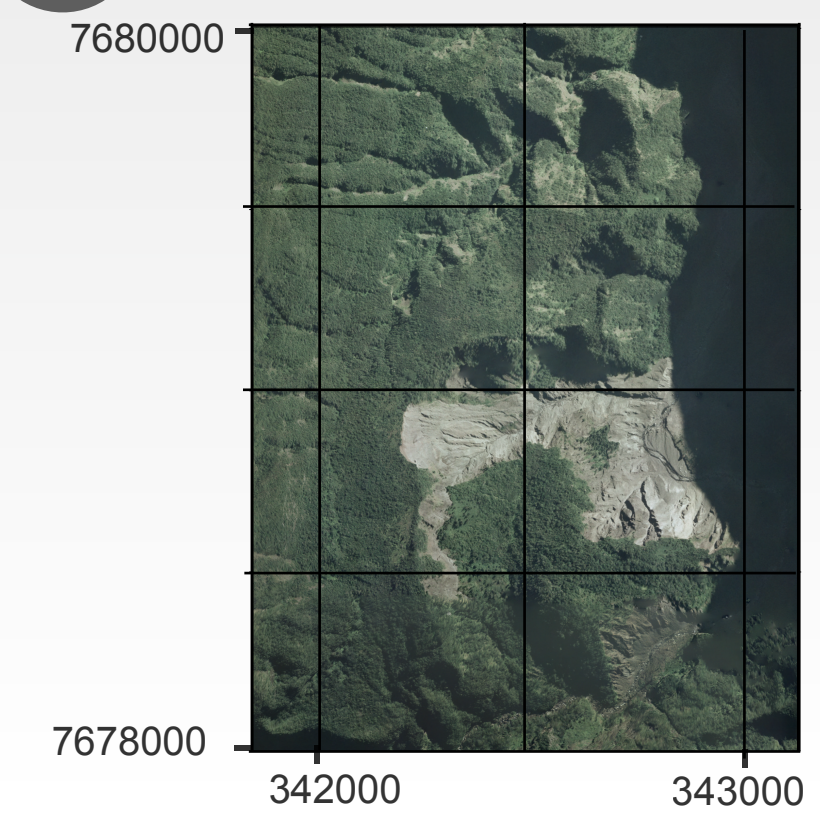
1 Historical aerial photographs (IGN)



2a Digital Surface Models (DSM)

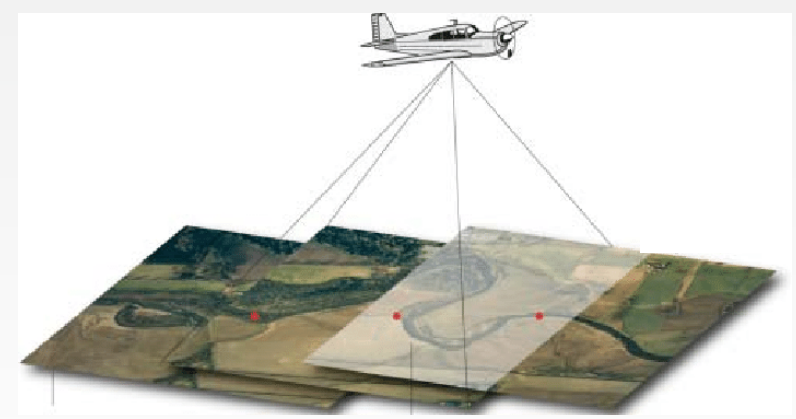


2b Orthoimages

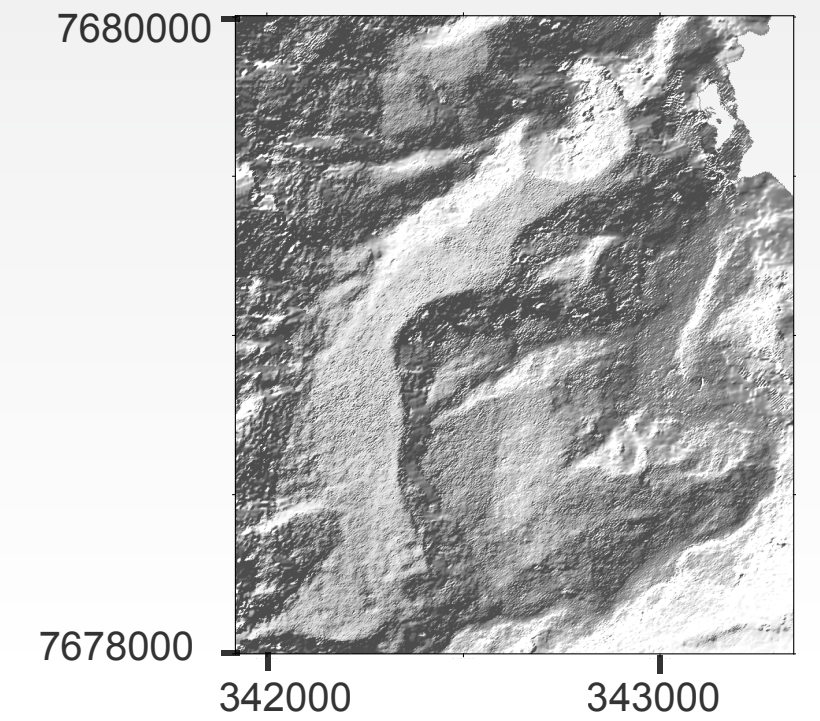


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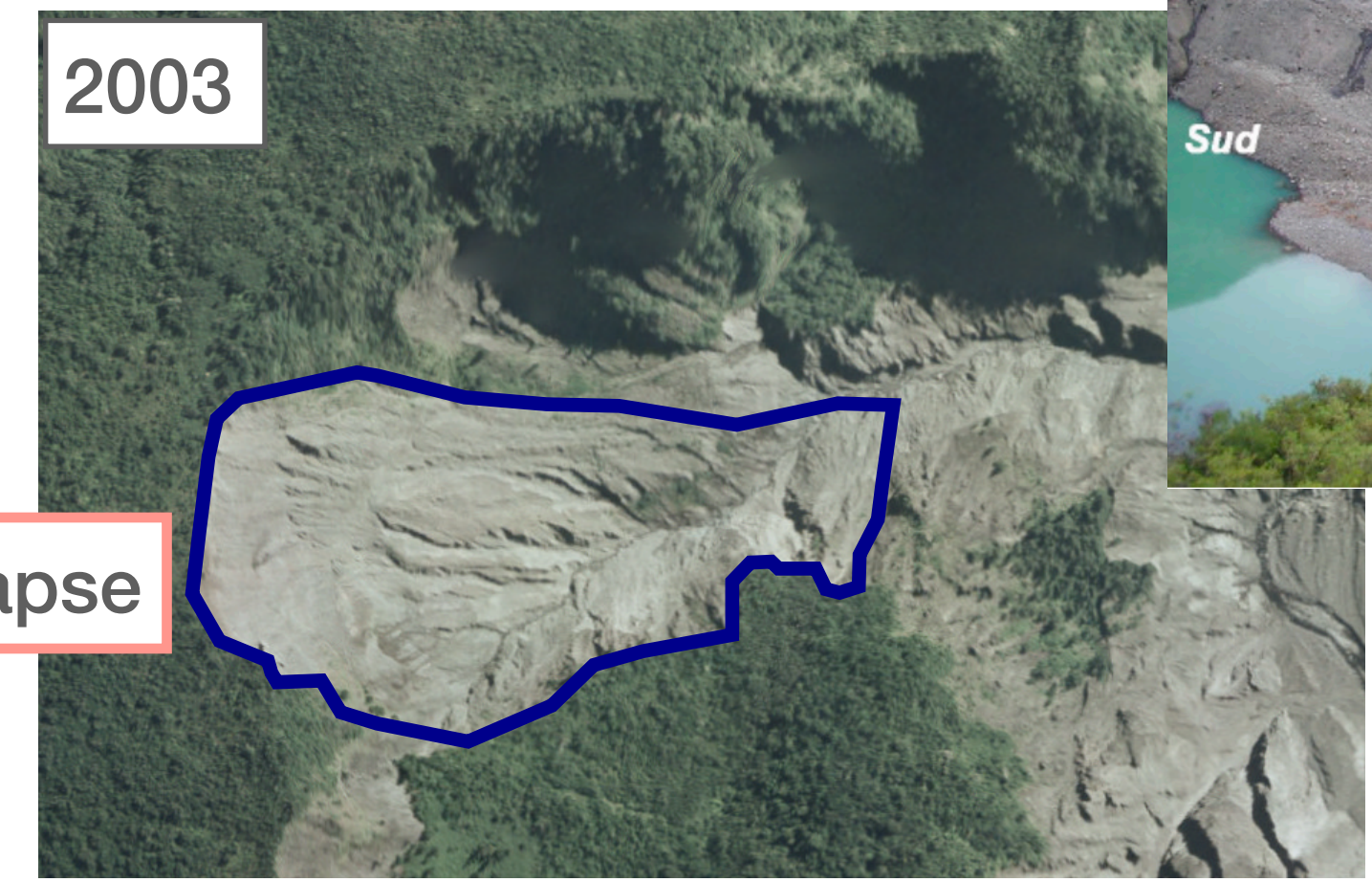
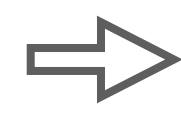
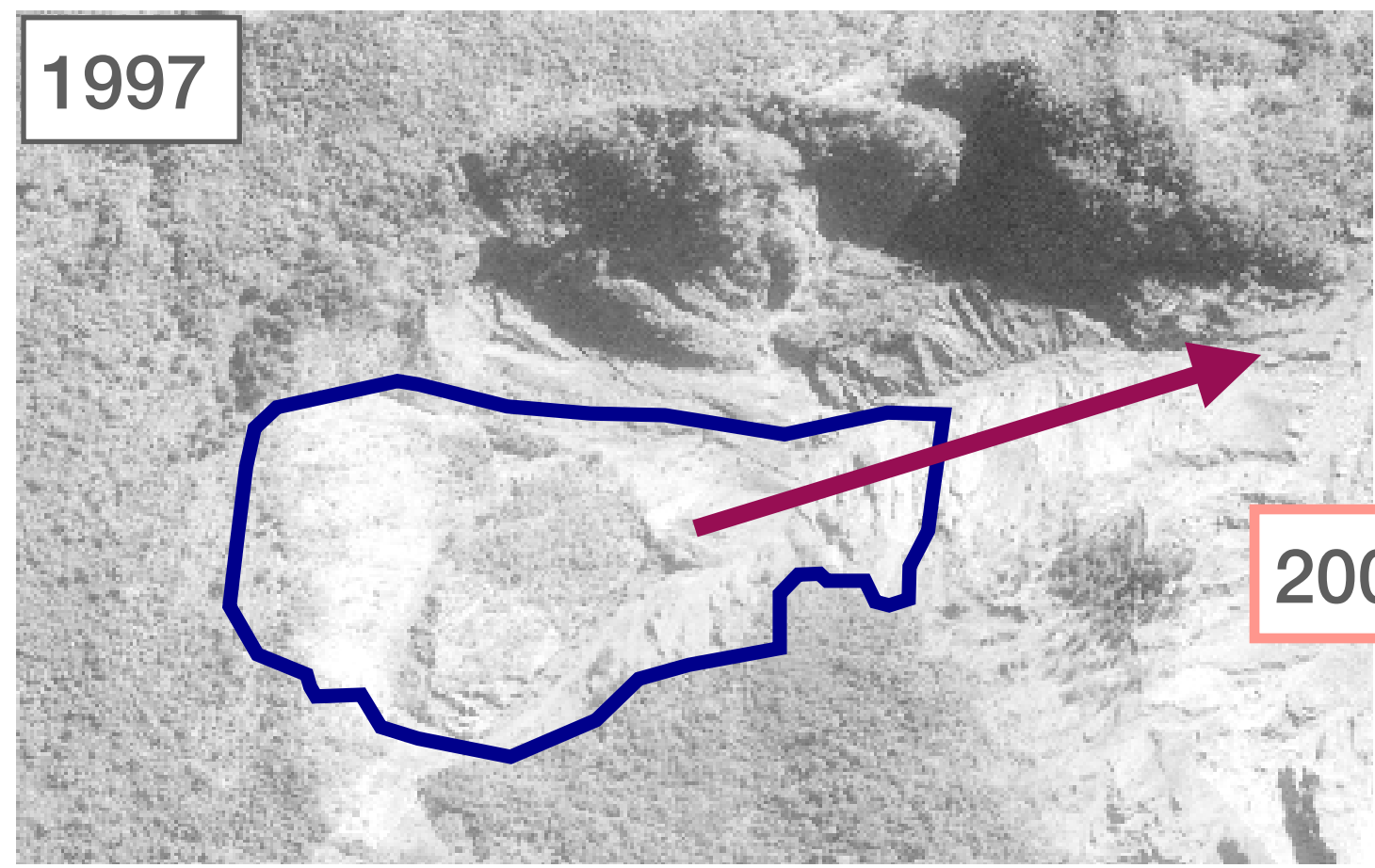
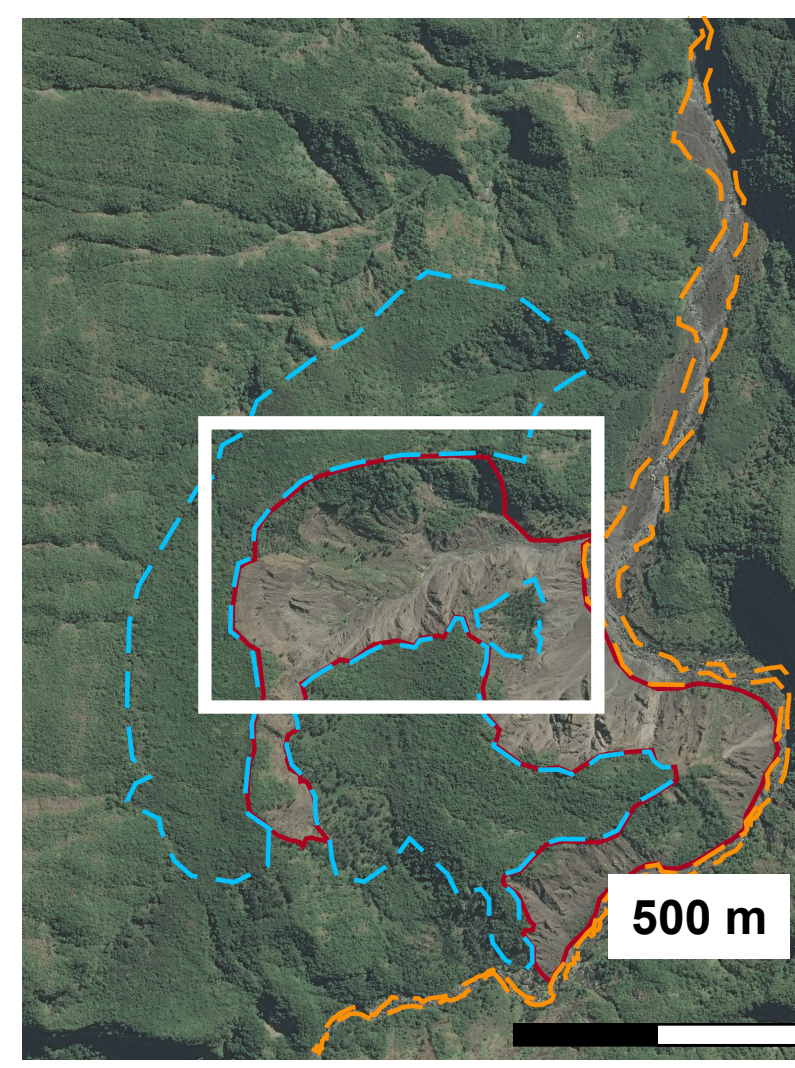
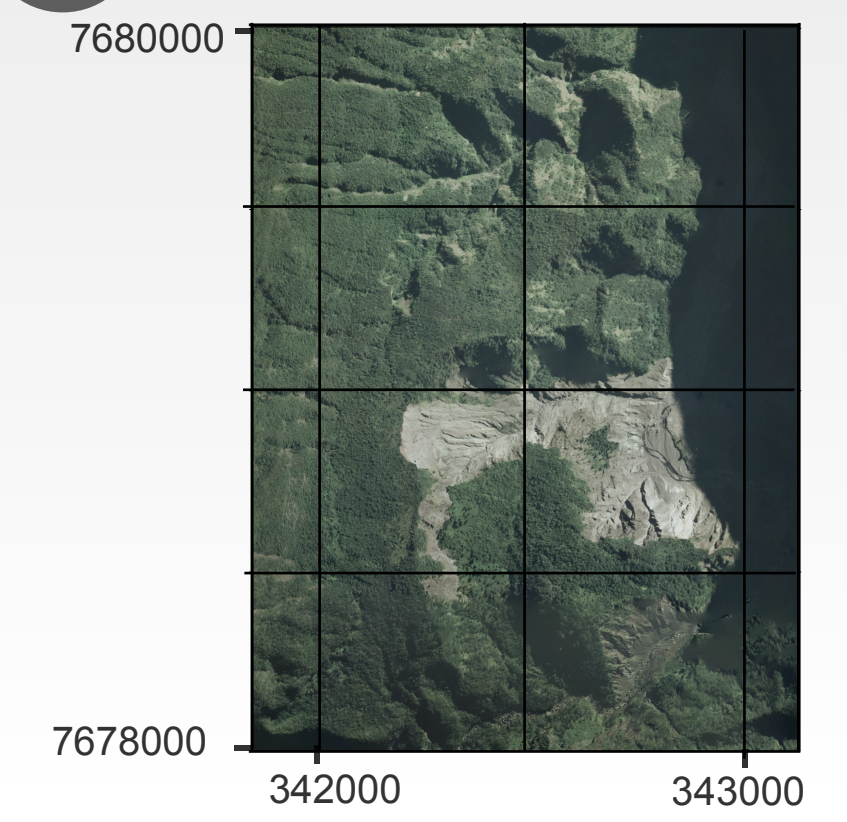
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2a Digital Surface Models (DSM)



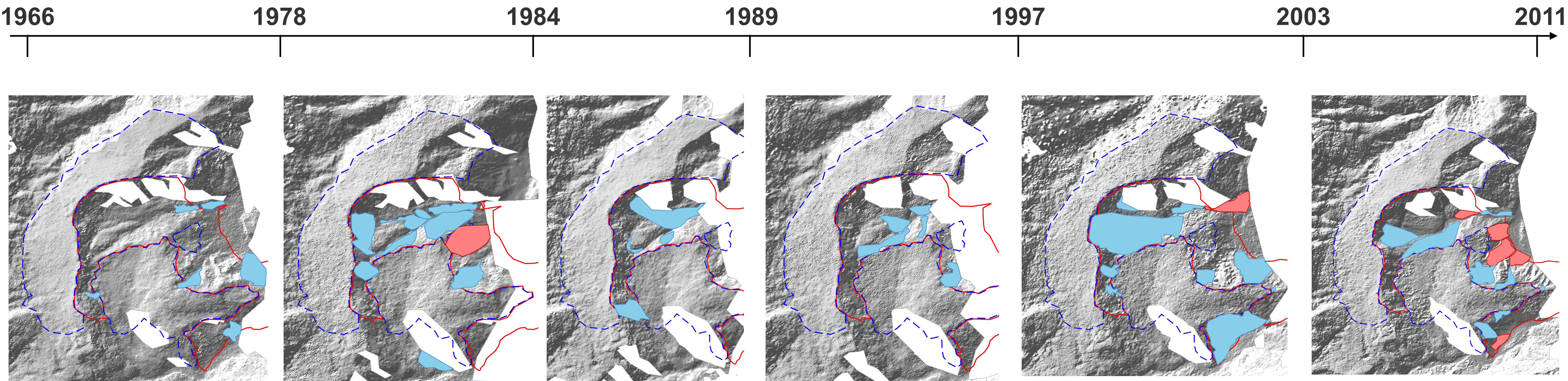
2b Orthoimages



(Fèvre, 2005)

Sediment remobilisation ⇒ Collapse/Deposit cartography

# PLURI-ANNUAL DYNAMICS: COLLAPSE AND DEPOSIT



Total volume:

- 0.4 Mm<sup>3</sup>

- 0.3 Mm<sup>3</sup>

- 0.3 Mm<sup>3</sup>

- 0.1 Mm<sup>3</sup>

- 1.7 Mm<sup>3</sup>

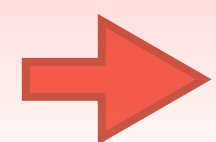
- 0.6 Mm<sup>3</sup>

Total volume of sediments: - 3 Mm<sup>3</sup>



Export rate: 76 000 m<sup>3</sup>/year

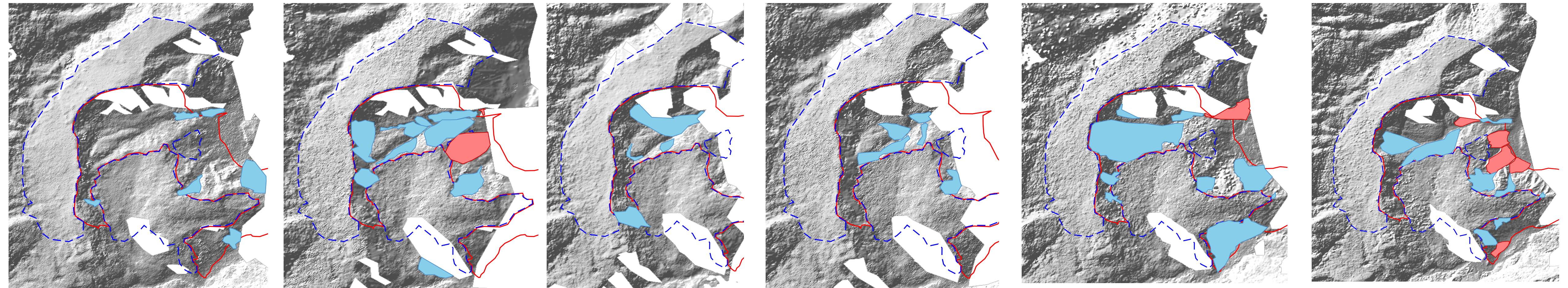
*Pluri-annual*



*Sediment remobilisation w/ high export rate*

# PLURI-ANNUAL DYNAMICS: COLLAPSE AND DEPOSIT

1966 1978 1984 1989 1997 2003 2011



Total volume:

- 0.4 Mm<sup>3</sup>

- 0.3 Mm<sup>3</sup>

- 0.3 Mm<sup>3</sup>

- 0.1 Mm<sup>3</sup>

- 1.7 Mm<sup>3</sup>

- 0.6 Mm<sup>3</sup>

Cyclone occurrences

5 cyclones

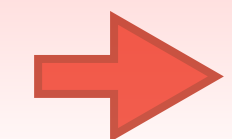
2 cyclones

3 cyclones

2 cyclones

5 cyclones

1 cyclone

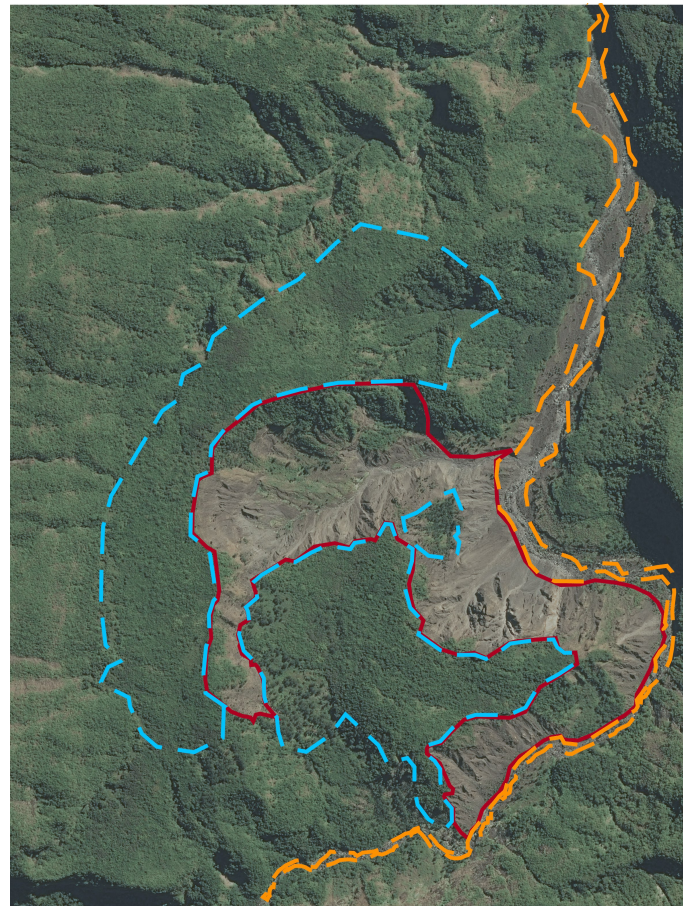


***Extreme precipitation influence ?***



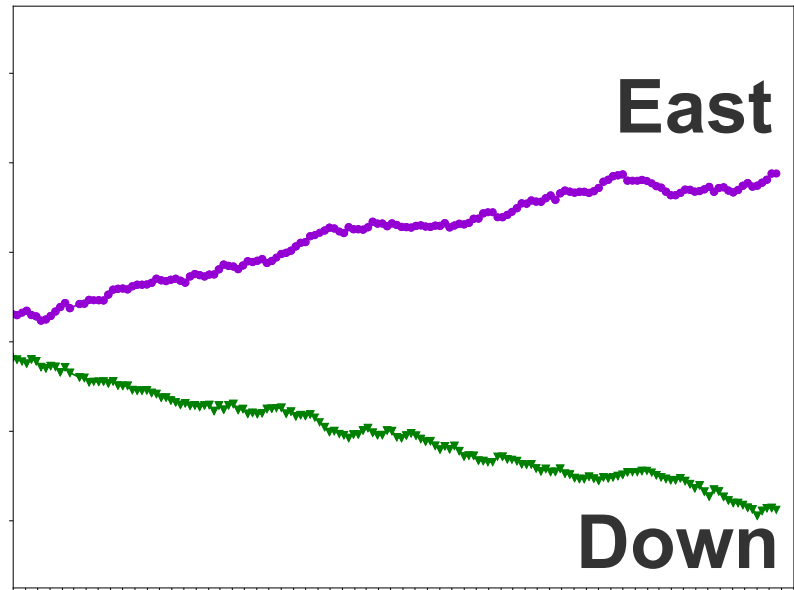
# GRAND EBOULIS DYNAMICS

1

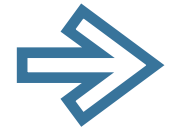
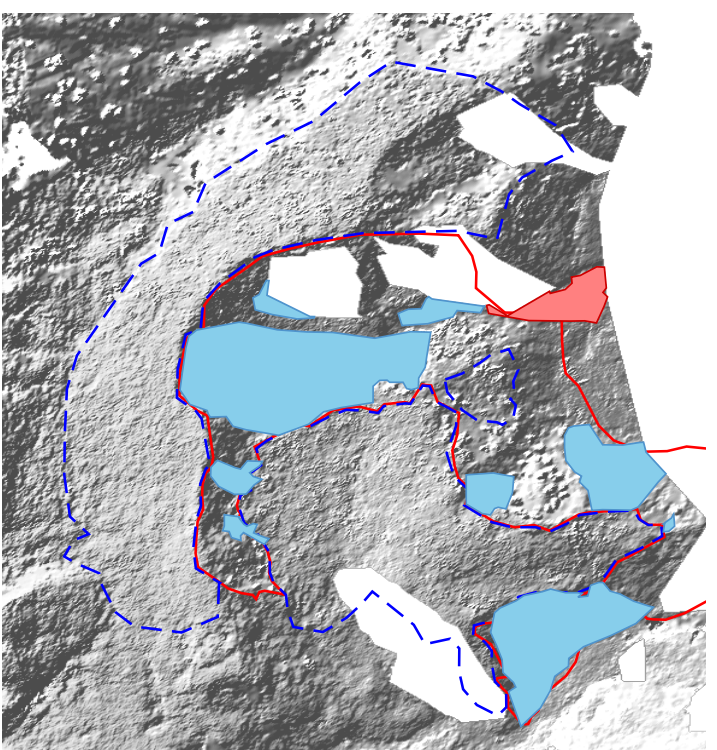


- **BI-MONTHLY**  
**Slow landslide**

- **PLURI-ANNUAL**  
**Remobilisation**



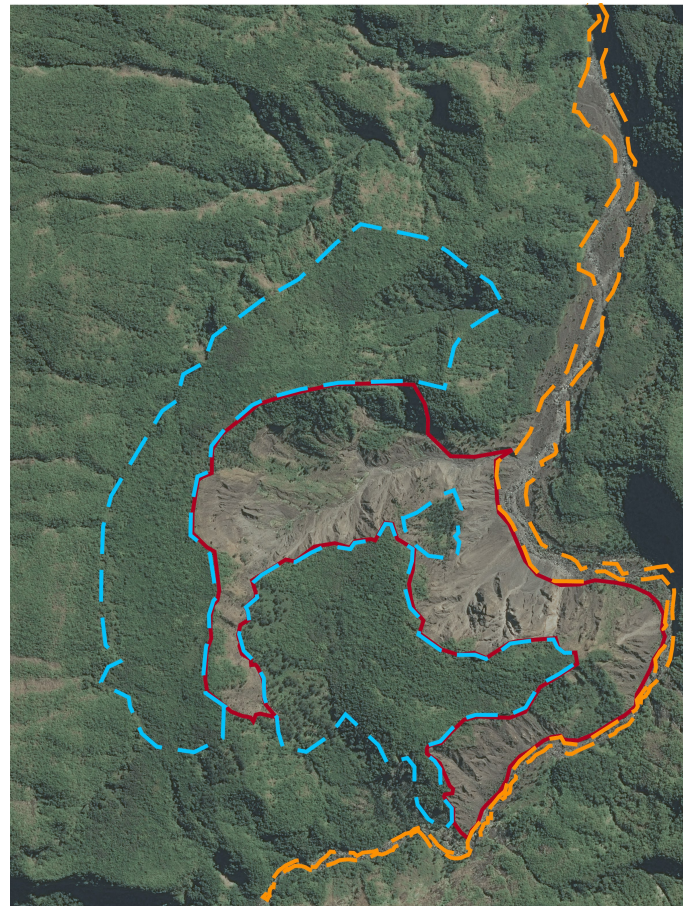
**Extreme meteorological events**



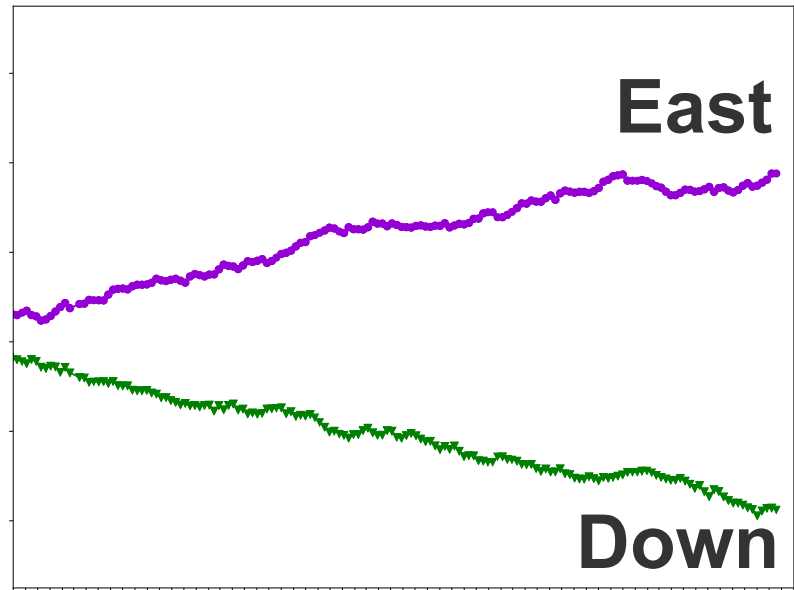
**Extreme precipitation ?**

# GRAND EBOULIS DYNAMICS

1

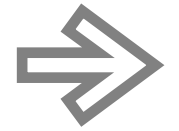
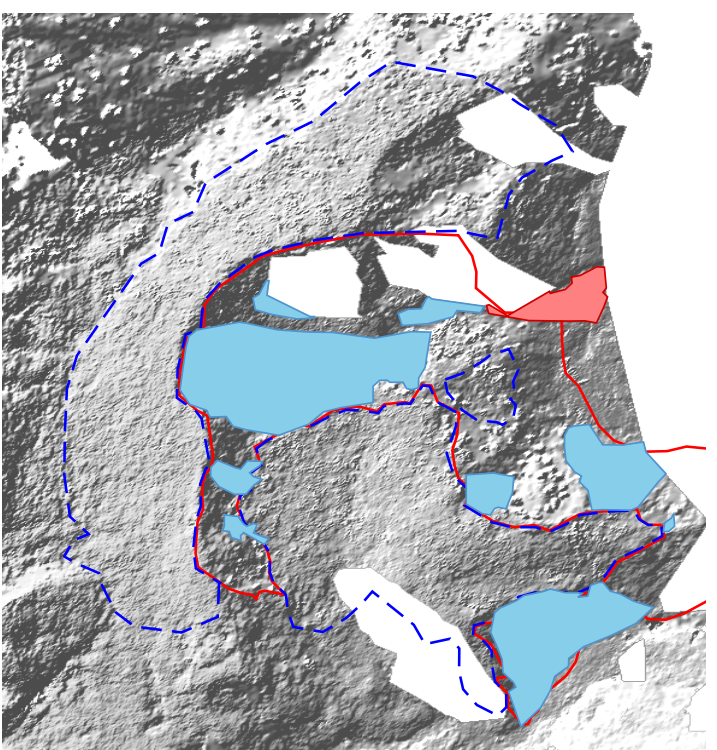


- **BI-MONTHLY**  
Slow landslide



**Extreme meteorological events**

- **PLURI-ANNUAL**  
Remobilisation

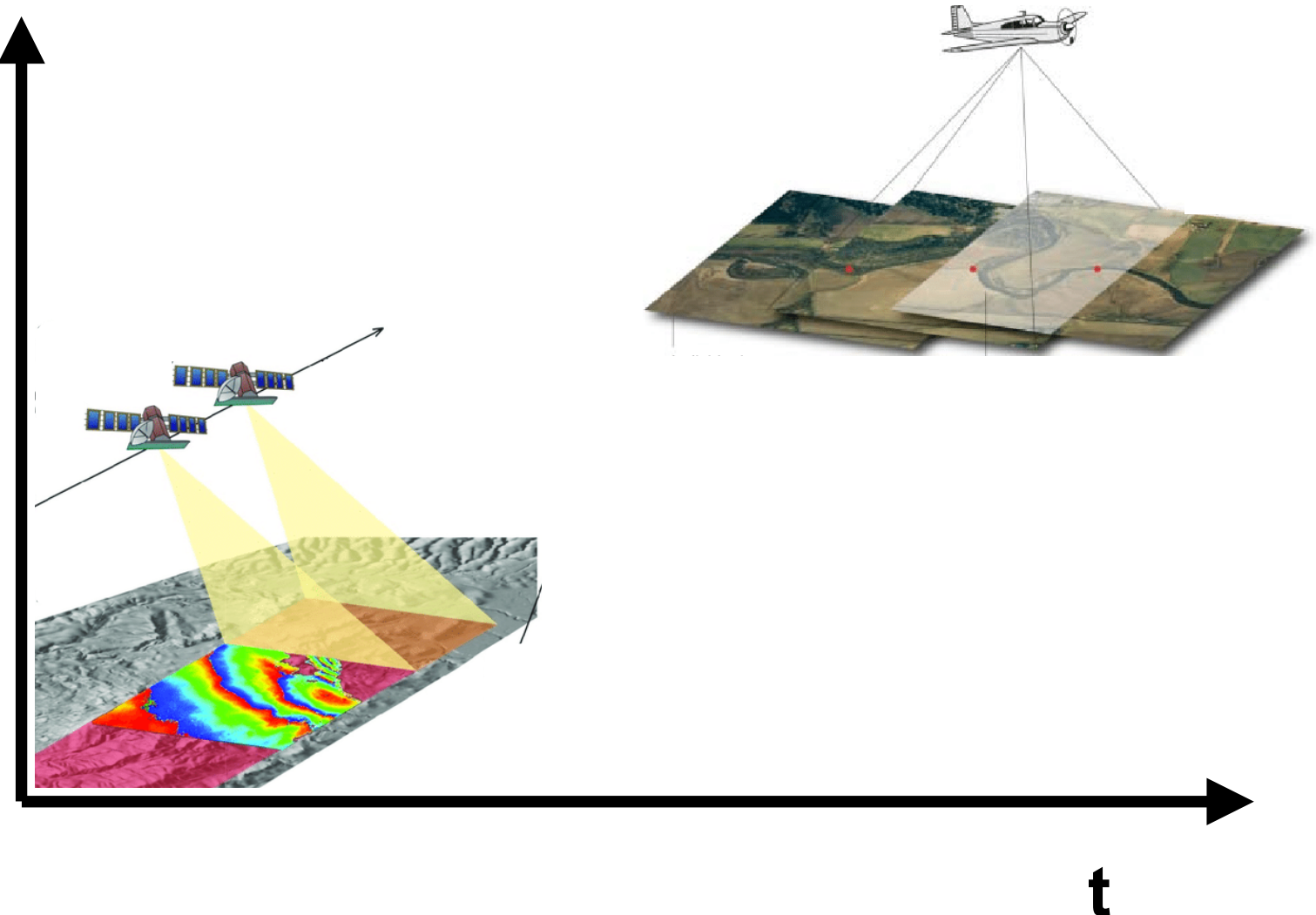


**Extreme precipitation ?**

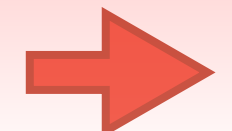
2

**Photogrammetry**

**InSAR**



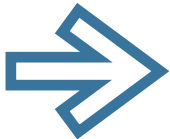
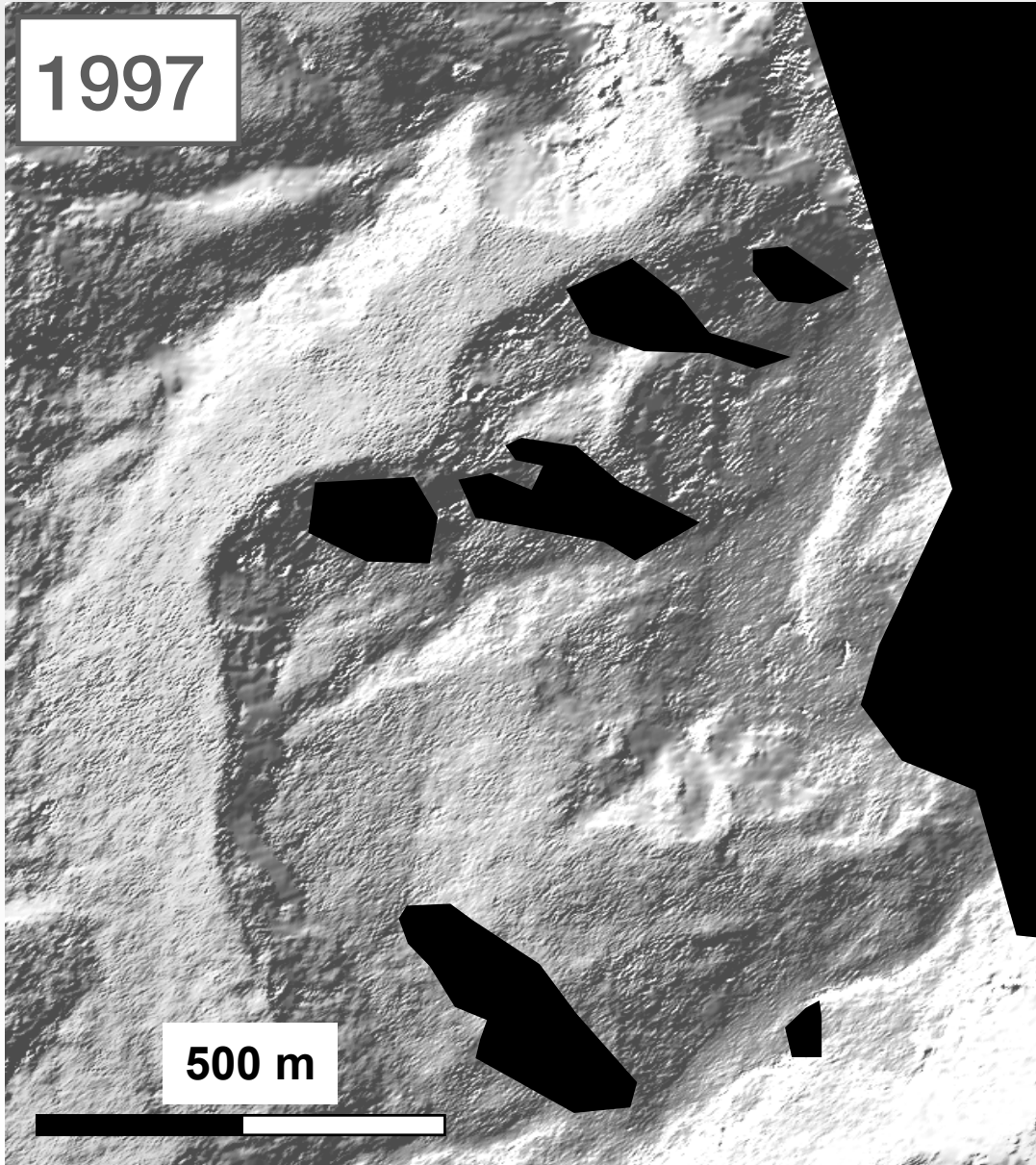
- **Watershed dynamics**
- **Sediment pulses**
- **Response to extreme meteorological events**



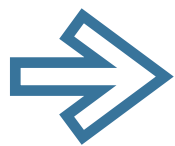
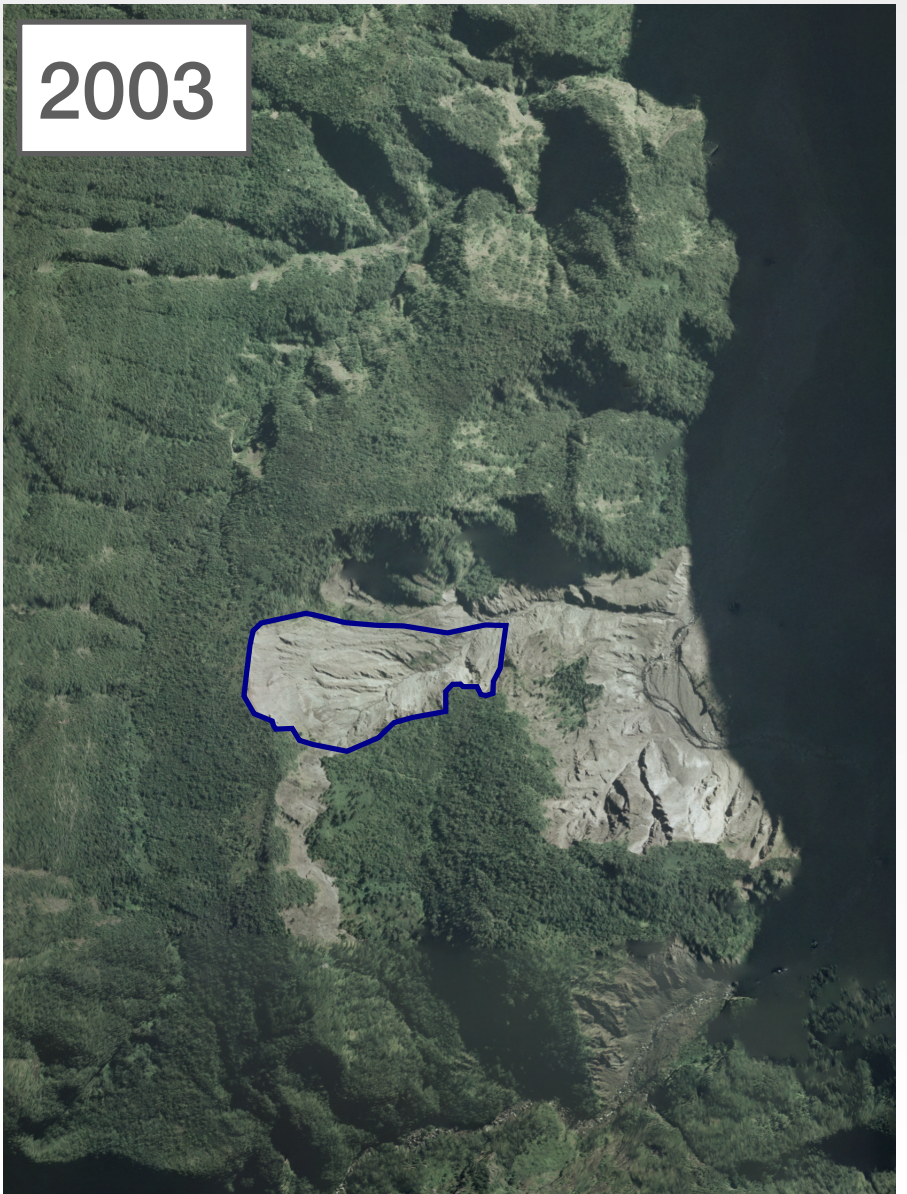
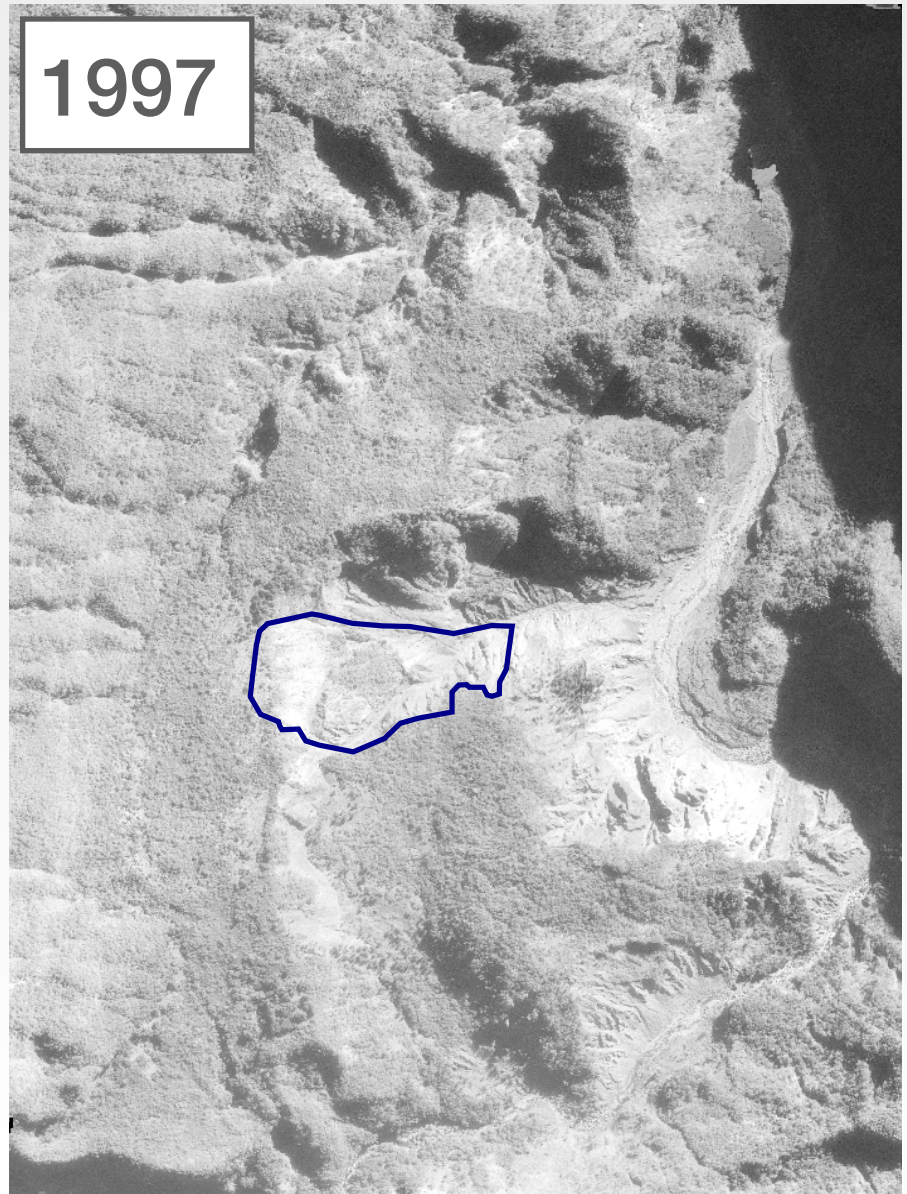
**Mountainous settings**

# Appendix PLURI-ANNUAL DYNAMICS: MNS INTERPRETATION

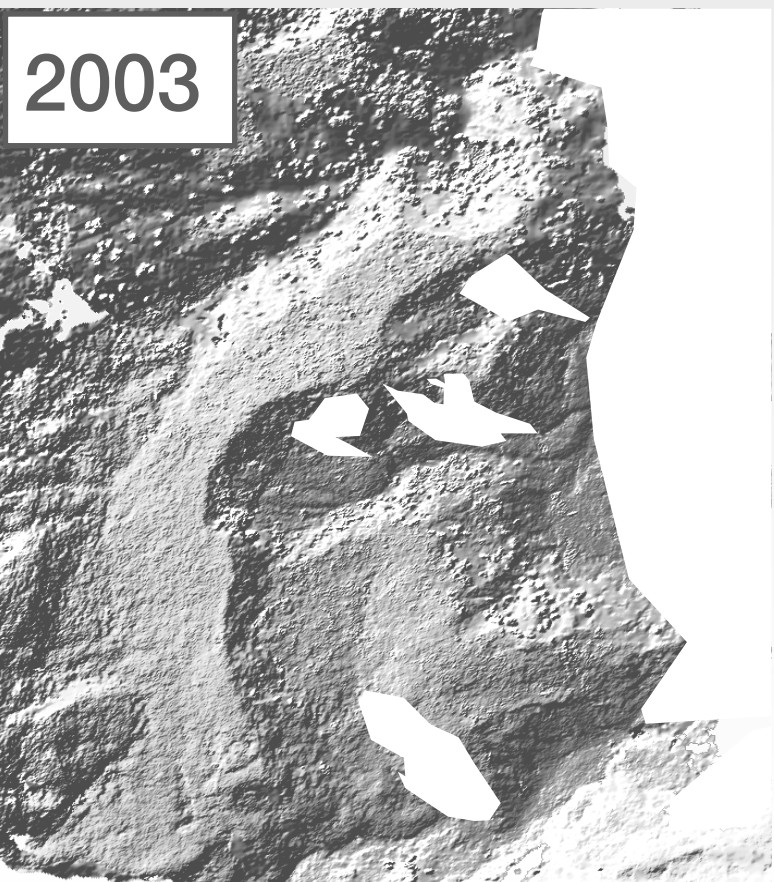
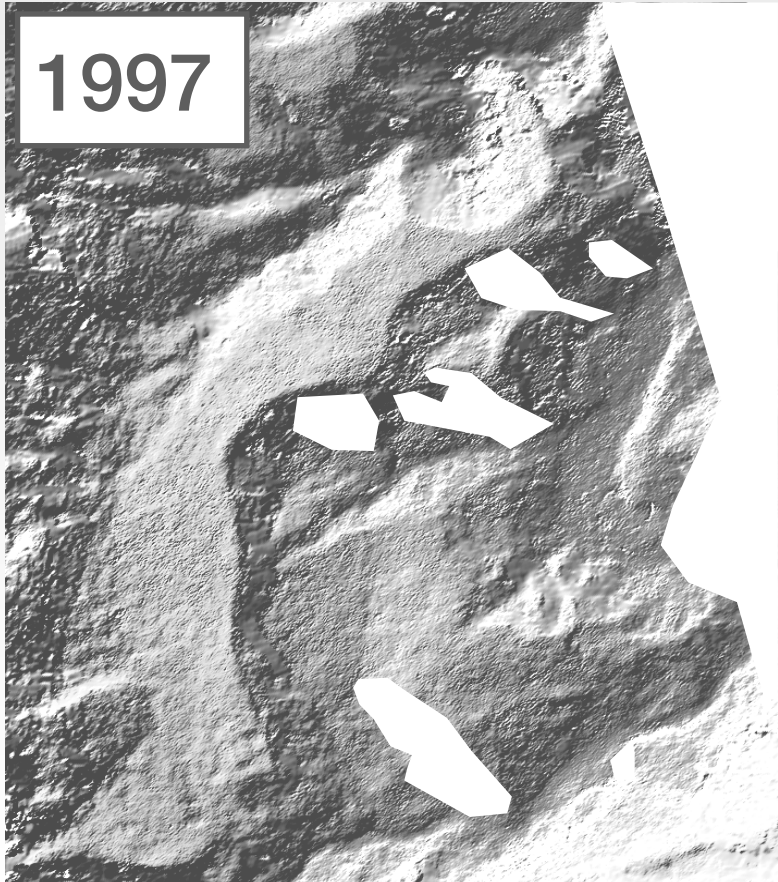
## 1 Shadow correction



## 2 Collapse cartography



## 3 Volume calculation



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