

Elevation changes and X-band ice and snow penetration inferred from TanDEM-X data of the Mont-Blanc area

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Study region

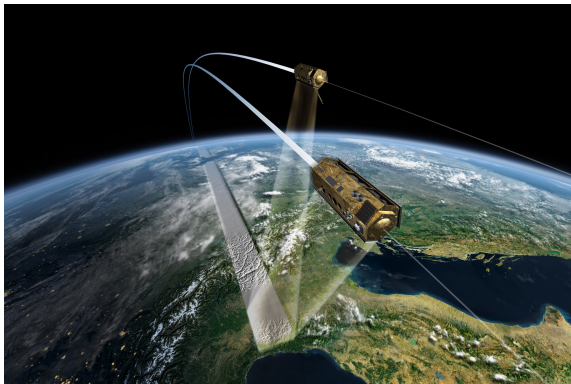


Study region



TanDEM-X

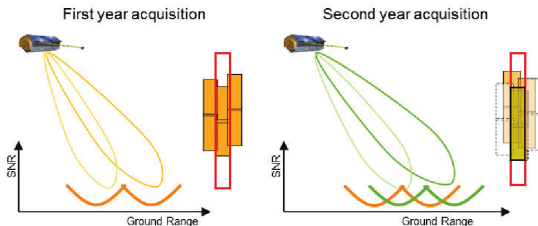
- 2 SAR satellites flying in close formation (250-500m baseline)
- primary objective : generation of a global DEM with vertical relative accuracy of 2m (4m slope >20%) and 12m posting



TanDEM-X

Achieved by a dual baseline processing :

- 2 acquisitions with heights of ambiguity of 25-30m and 35-40m
 - for difficult terrains, several acquisitions with different geometries (look direction, incidence angle...)
- ⇒ not suited for glaciological applications with rapid changes



Lachaise et al., 2012

Data

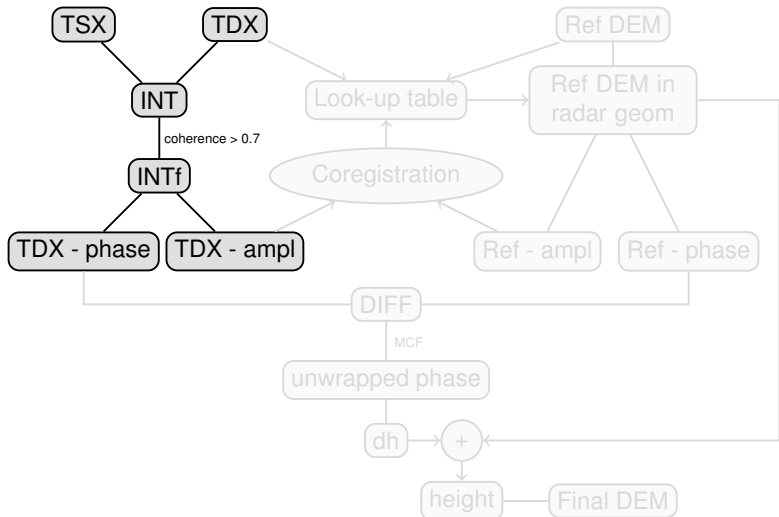
TABLE: Pairs of TanDEM-X images used in this study.

Date	Orbit	Bperp (m)	HoA (m)	Incidence
2012/05/13	Ascending	176.3	30.3	44°
2012/05/24	Ascending	170.8	31.0	44°
2013/02/01	Ascending	122.8	58.8	44°
2013/10/21	Descending	80.4	63.7	37°
2013/11/12	Descending	95.0	62.3	37°

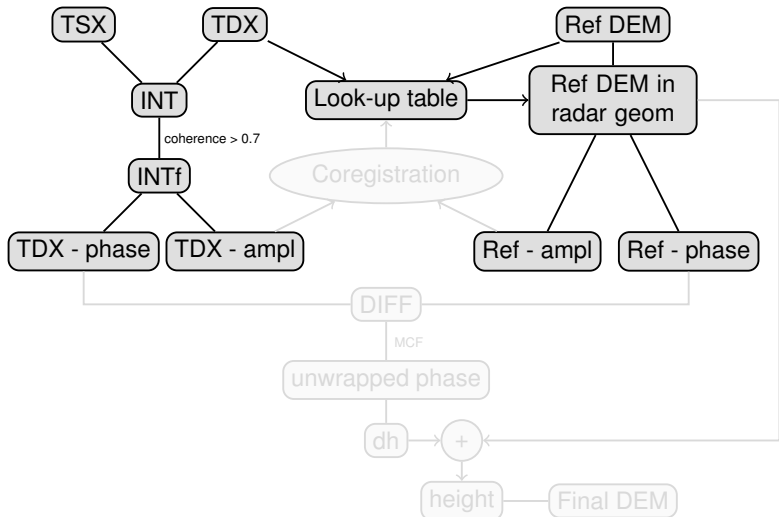
TABLE: Reference DEMs used in this study

Data/Mission	Date	Posting (m)
Pléiades	2012/08/19	4
Pléiades	2013/09/20	4
SRTM-C	Feb. 2000	30

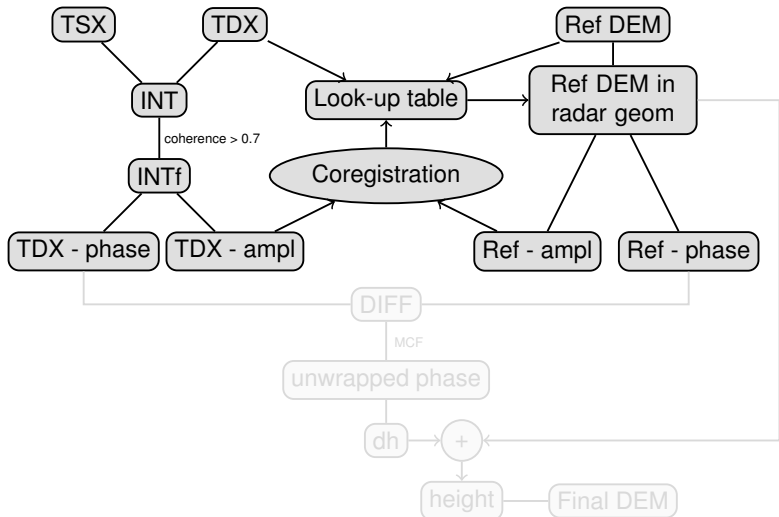
InSAR processing



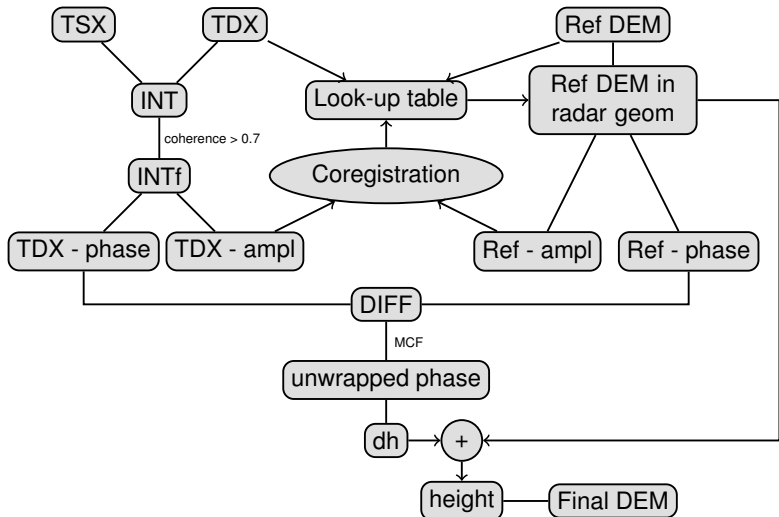
InSAR processing



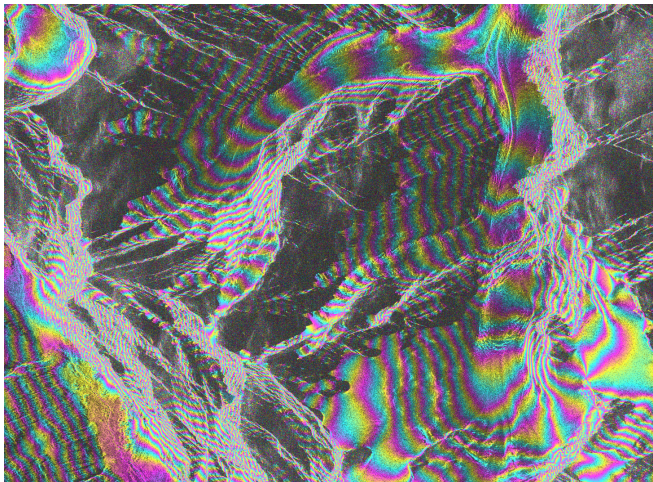
InSAR processing



InSAR processing

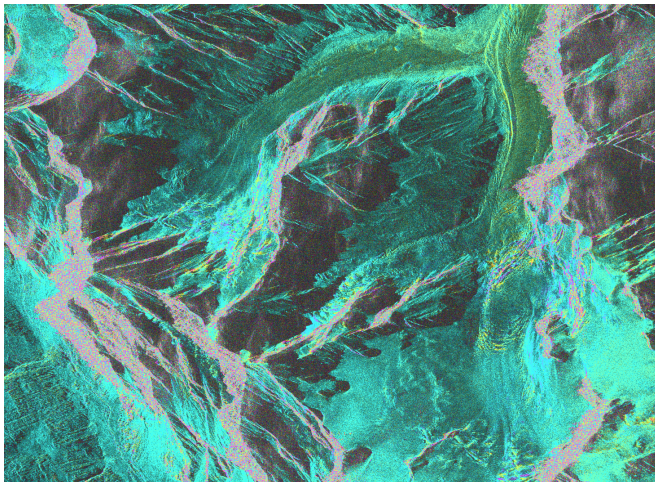


Need for a reference DEM



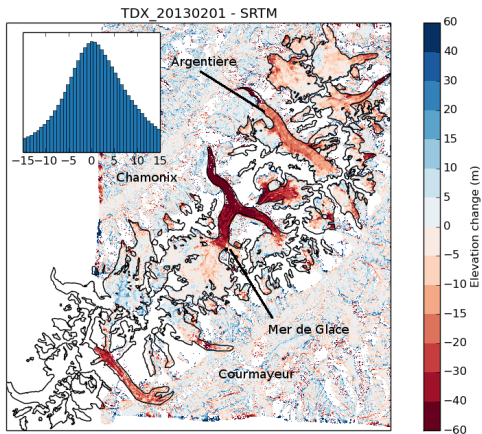
Interferogram - No reference DEM

Need for a reference DEM



Differential interferogram using Pleiades 2012

Decadal trends



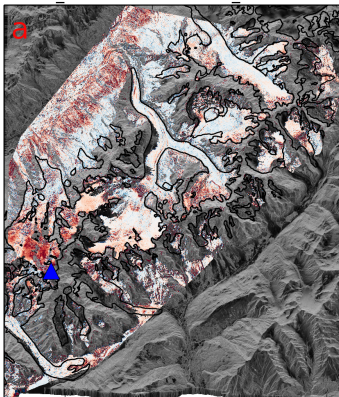
TDX (2013/02/01) - SRTM (Feb. 2000)

Uncertainty

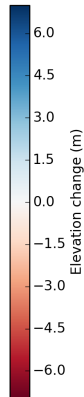
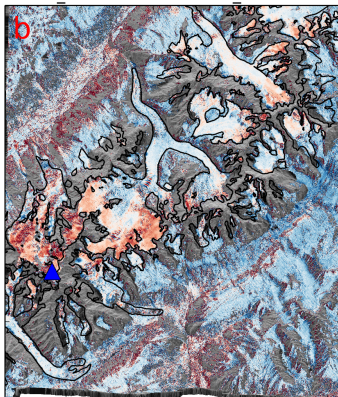
TDX Pair	Reference	Pléiades 2012/08/19		
		Mean (m)	Median (m)	MAD (m)
2012/05/13		1.41	1.88	3.10
2012/05/24		1.16	1.56	2.97
2013/02/01		0.83	1.94	2.65
2013/10/21		-1.14	-0.07	1.92
2013/11/12		-1.33	-0.14	1.99

Radar penetration

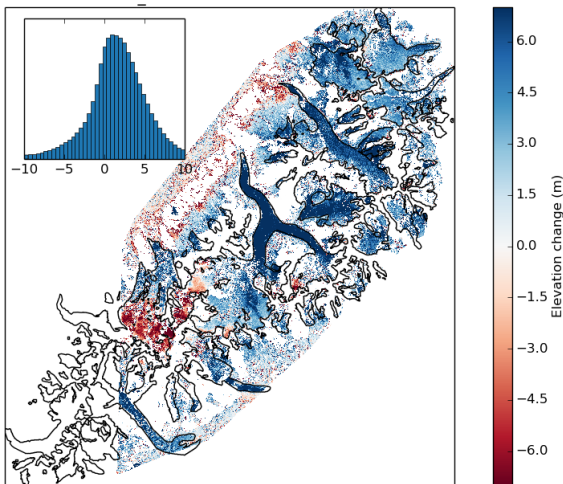
TDX_20131021 - Pleiades 20130920



TDX_20130201 - Pleiades 20120819

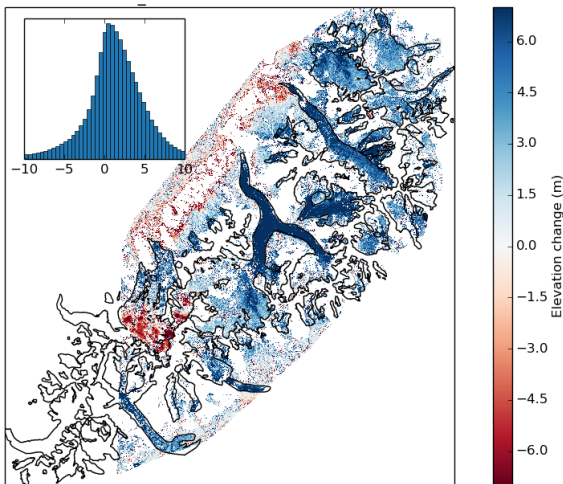


Seasonal elevation changes



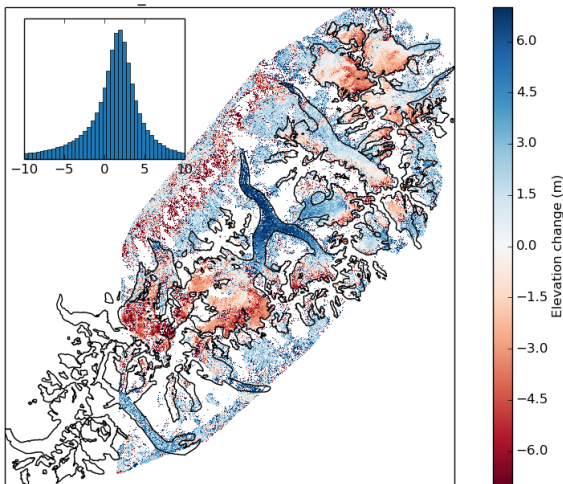
TDX 2012/05/13 - Pleiades 2013/09/20

Seasonal elevation changes



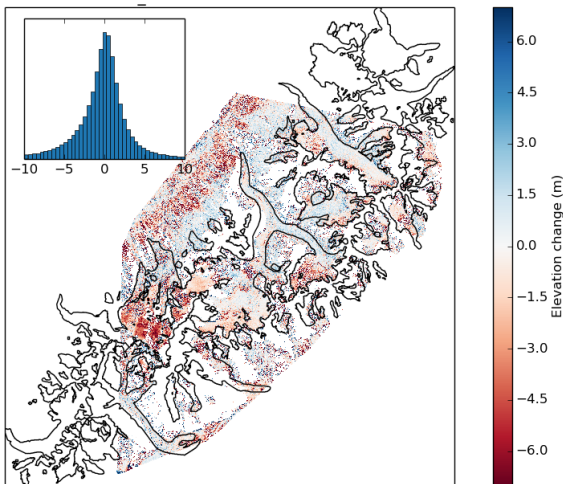
TDX 2012/05/24 - Pleiades 2013/09/20

Seasonal elevation changes



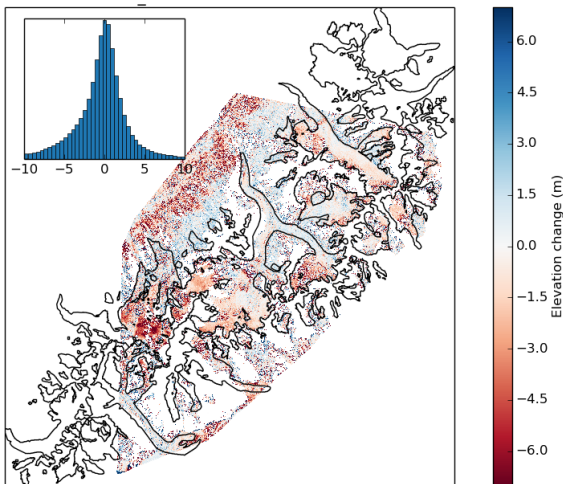
TDX 2013/02/01 - Pleiades 2013/09/20

Seasonal elevation changes



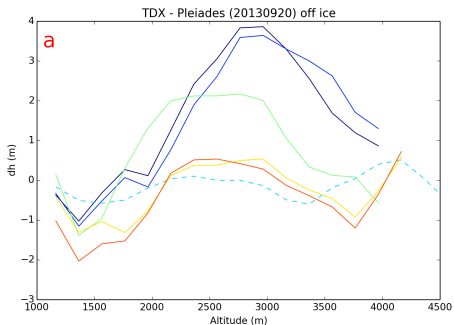
TDX 2013/10/21 - Pleiades 2013/09/20

Seasonal elevation changes

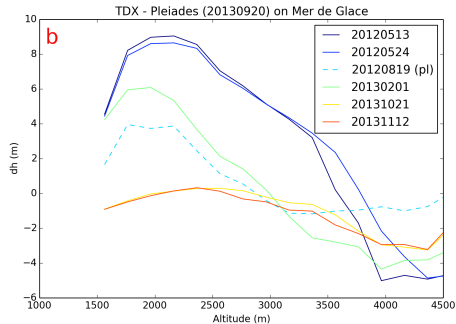


TDX 2013/11/12 - Pleiades 2013/09/20

Seasonal elevation changes

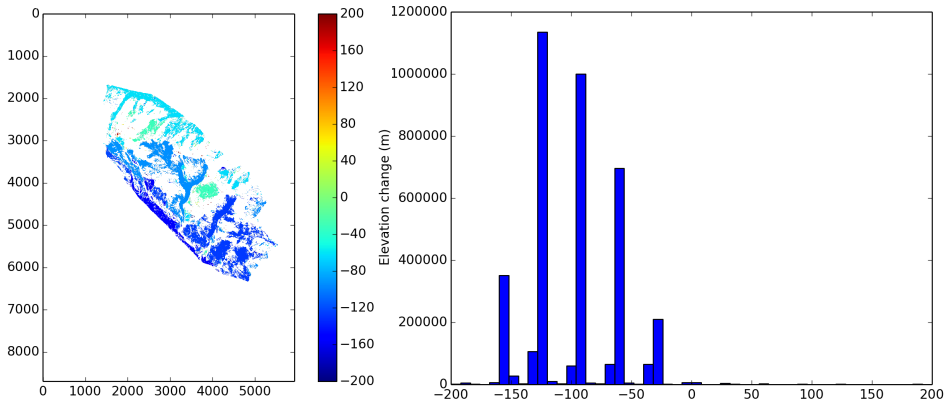


TDX - Pleiades 2013 off ice



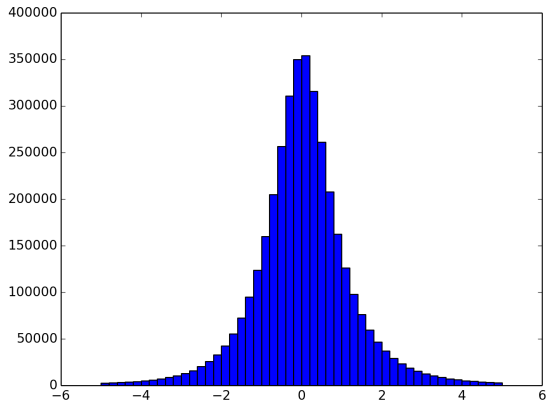
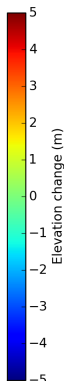
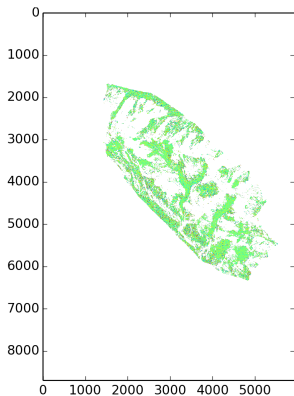
TDX - Pleiades 2013 on Mer de Glace

Impact of the reference DEM



TDX_Pleiades - TDX_SRTM, pair 20120524

Impact of the reference DEM

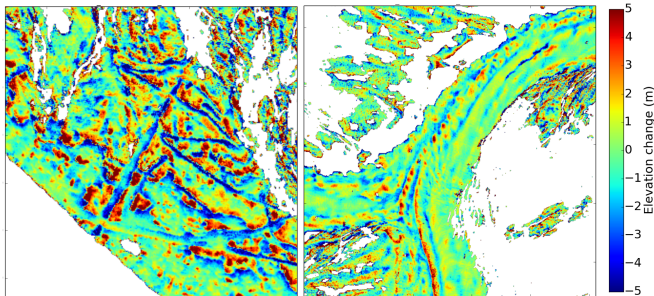


TDX_Pleiades - TDX_SRTM, pair 20120524

Impact of the reference DEM

TABLE: Elevation differences between the TDX DEMs obtained using Pléiades 2012 or SRTM as a reference for phase unwrapping.

	2012/05/13	2012/05/24	2013/02/01	2013/10/21	2013/11/12
Median (m)	0.02	0.02	0.01	-0.06	-0.05
MAD (m)	0.91	0.92	1.45	1.59	1.60
MAD/HoA	0.030	0.029	0.025	0.024	0.025



Conclusions

- single TanDEM-X pairs are suitable to derive DEMs in mountainous area with the use of a reference DEM
- uncertainties 2-3m similar to previous studies
- radar penetration can reach up to 7 m in high altitude (>3500m) but seems negligible below 2500 m
- the final DEM depends on the reference DEM within less than 3% of the Height of Ambiguity (HoA)
- if a coarse global DEM such as SRTM is used as a reference, many unwrapping errors occur

Perspective

- develop a method to help phase unwrapping from coarse, global DEMs
- compare elevation changes from radar (e.g SRTM-X + TDX) and optical (e.g SPOT + Pleiades) sensors to estimate penetration ⇒ Not in the Mt Blanc area



Thank you for your attention !