



# Landslide detection

ESA–MOST China Dragon 4 Cooperation

**2019 ADVANCED INTERNATIONAL TRAINING COURSE IN LAND REMOTE SENSING**

中欧科技合作“龙计划”第四期 **2019**年陆地遥感高级培训班

18 to 23 November 2019 | Chongqing University, P.R. China



培训时间: 2019年11月18日-23日 主办方: 重庆大学

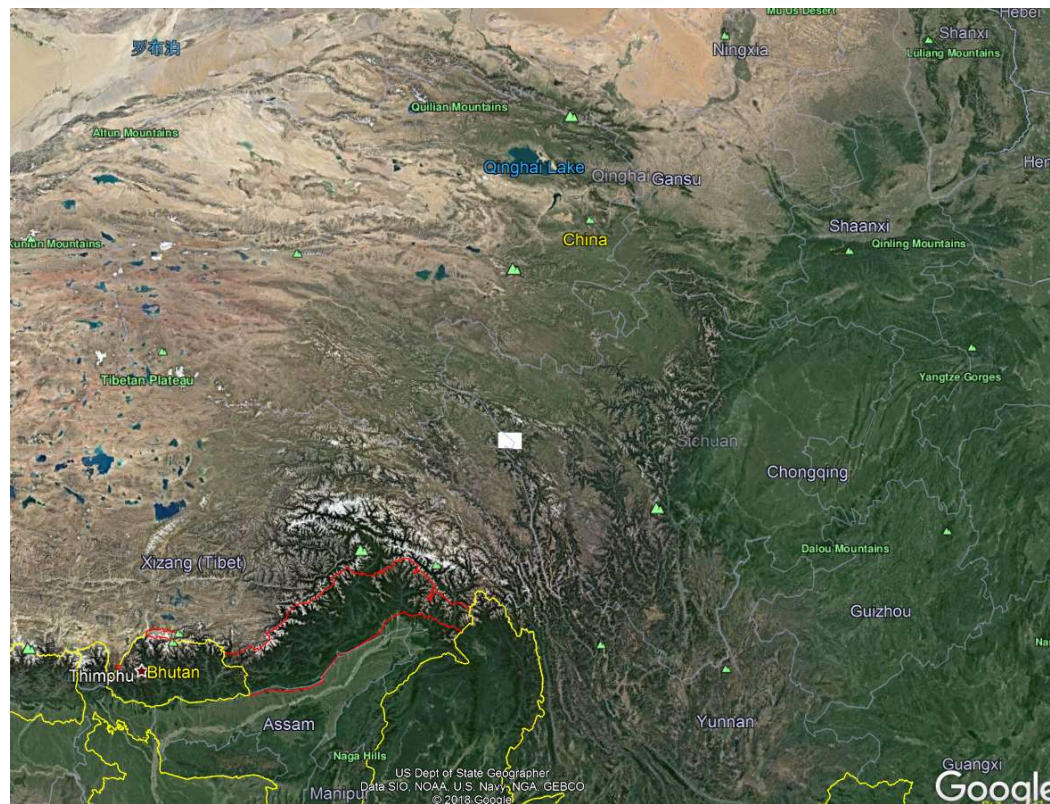
# Aims of the practical



- To visually observe landslide signals on InSAR measurements
- To detect landslide over large areas using high resolution InSAR measurements
- To understand the spatial-temporal landslide deformation feature on InSAR measurements



# Study area



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# Inputs



- A series of unwrapped Sentinel-1 interferograms

<input type="checkbox"/> 20170318-20170330.phs	<input checked="" type="checkbox"/> 20170318-20170330.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170330-20170411.phs	<input checked="" type="checkbox"/> 20170330-20170411.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input checked="" type="checkbox"/> 20170411-20170423.phs	<input checked="" type="checkbox"/> 20170411-20170423.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170423-20170505.phs	<input checked="" type="checkbox"/> 20170423-20170505.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170505-20170517.phs	<input checked="" type="checkbox"/> 20170505-20170517.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170517-20170529.phs	<input checked="" type="checkbox"/> 20170517-20170529.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170529-20170610.phs	<input checked="" type="checkbox"/> 20170529-20170610.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
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<input type="checkbox"/> 20170622-20170704.phs	<input checked="" type="checkbox"/> 20170622-20170704.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170809-20170821.phs	<input checked="" type="checkbox"/> 20170809-20170821.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170821-20170902.phs	<input checked="" type="checkbox"/> 20170821-20170902.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170902-20170914.phs	<input checked="" type="checkbox"/> 20170902-20170914.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170914-20170926.phs	<input checked="" type="checkbox"/> 20170914-20170926.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20170926-20171008.phs	<input checked="" type="checkbox"/> 20170926-20171008.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171008-20171020.phs	<input checked="" type="checkbox"/> 20171008-20171020.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171020-20171101.phs	<input checked="" type="checkbox"/> 20171020-20171101.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171101-20171113.phs	<input checked="" type="checkbox"/> 20171101-20171113.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171113-20171125.phs	<input checked="" type="checkbox"/> 20171113-20171125.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171125-20171207.phs	<input checked="" type="checkbox"/> 20171125-20171207.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171207-20171219.phs	<input checked="" type="checkbox"/> 20171207-20171219.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171219-20171231.phs	<input checked="" type="checkbox"/> 20171219-20171231.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20171231-20180112.phs	<input checked="" type="checkbox"/> 20171231-20180112.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20180112-20180124.phs	<input checked="" type="checkbox"/> 20180112-20180124.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20180124-20180205.phs	<input checked="" type="checkbox"/> 20180124-20180205.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20180205-20180217.phs	<input checked="" type="checkbox"/> 20180205-20180217.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20180217-20180301.phs	<input checked="" type="checkbox"/> 20180217-20180301.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20180301-20180313.phs	<input checked="" type="checkbox"/> 20180301-20180313.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20180313-20180325.phs	<input checked="" type="checkbox"/> 20180313-20180325.phs.rsc	2019/11/2 0:53	RSC 文件	1 KB
<input type="checkbox"/> 20180325-20180406.phs				



# Outputs



- Deformation velocity map of the study area
- Detected landslide locations
- Deformation time series of the detected landslides



# Part 1 Data and script preparation



- Download the data and the script from:
- Unzip to your preferred directory  
e.g. D:\workspace\
- After unzipping, you will have:



# Part 1 Data and script preparation



- Add the scripts to your matlab path (remember to change this path to your own):

```
>> addpath('D:\workspace\Dragon_Practical\scripts');
```

- Go to the practical path:

```
>> cd D:\workspace\Dragon_Practical\
```



## Part 2 Observing individual interferograms



- There are 64 interferograms covering from 20170318 to 20190612
- All the interferograms are in the same size
- There is a header file containing the geographic coordinate information of the interferograms



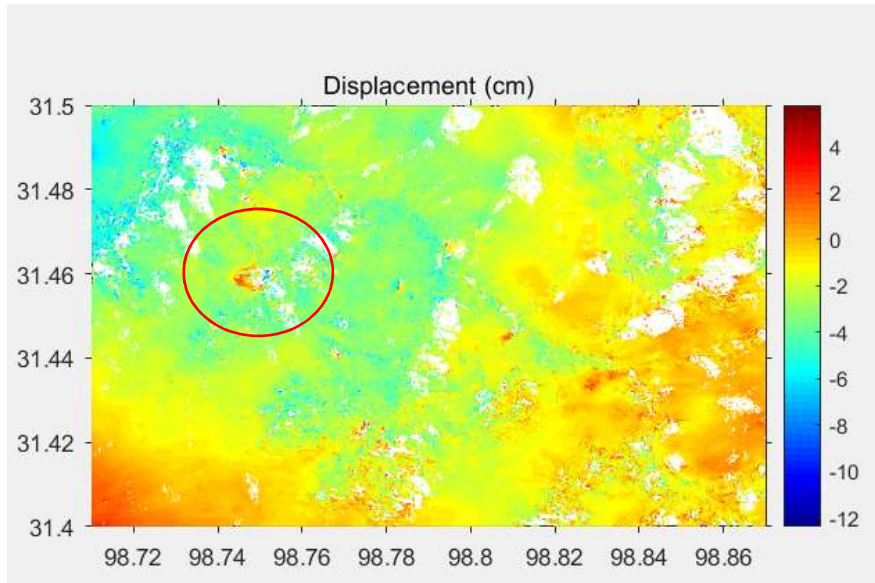


## Part 2 Observing individual interferograms



- Check interferograms - 20170926-20171008.phs

```
>> figure;plot_ifg('ifgs/20170926-20171008.phs','float',1,1,[],0,0,1); colormap(jet); colorbar;title('Displacement (cm)');
```

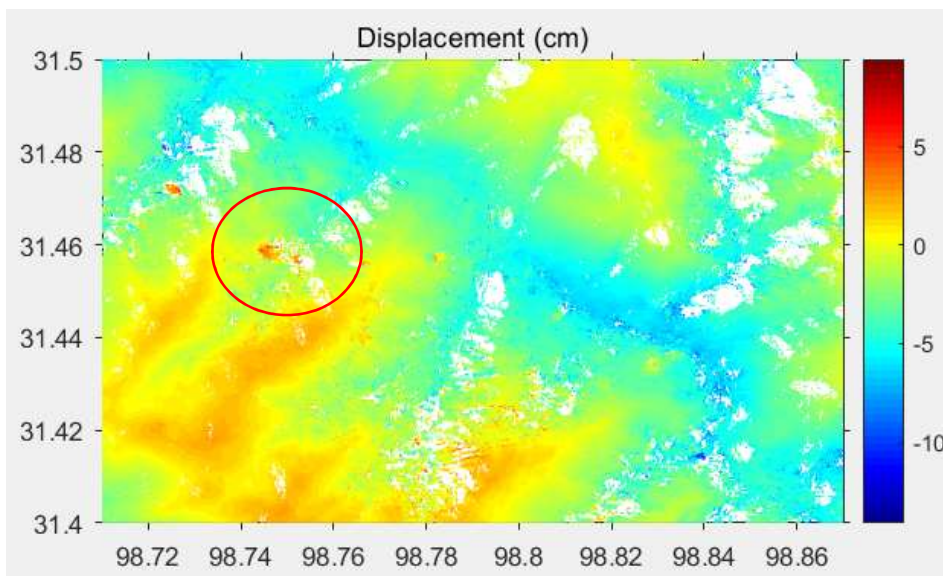


## Part 2 Observing individual interferograms



- Check interferograms - 20171008-20171020.phs

```
>> figure;plot_ifg('ifgs/20171008-20171020.phs','float',1,1,[],0,0,1); colormap(jet); colorbar;title('Displacement (cm)');
```



- ✓ This location has substantial displacements on multiple continuous interferograms, potentially implying a moving landslide.

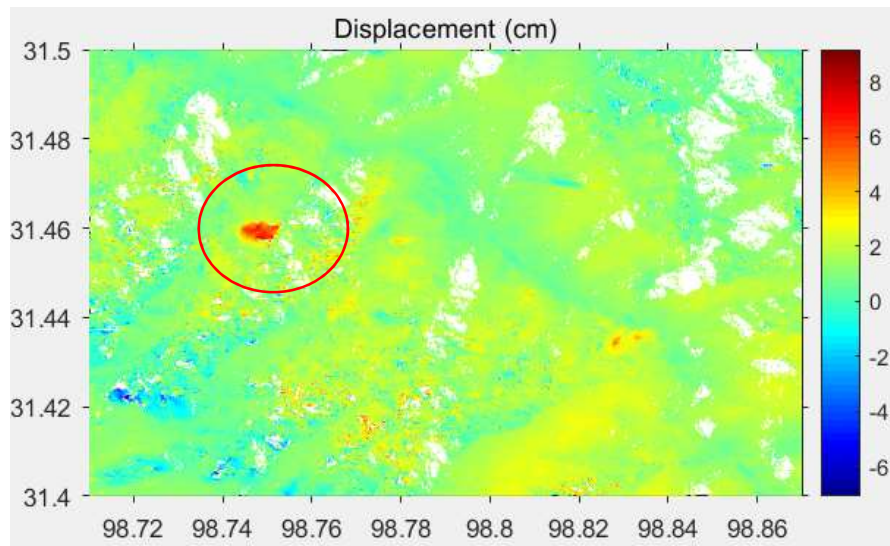


## Part 2 Observing individual interferograms



- Check interferograms - 20171207-20171219.phs

```
>> figure;plot_ifg('ifgs/20171207-20171219.phs','float',1,1,[],0,0,1); colormap(jet); colorbar;title('Displacement (cm)');
```



- ✓ This location has substantial displacements on multiple continuous interferograms, potentially implying a moving landslide.

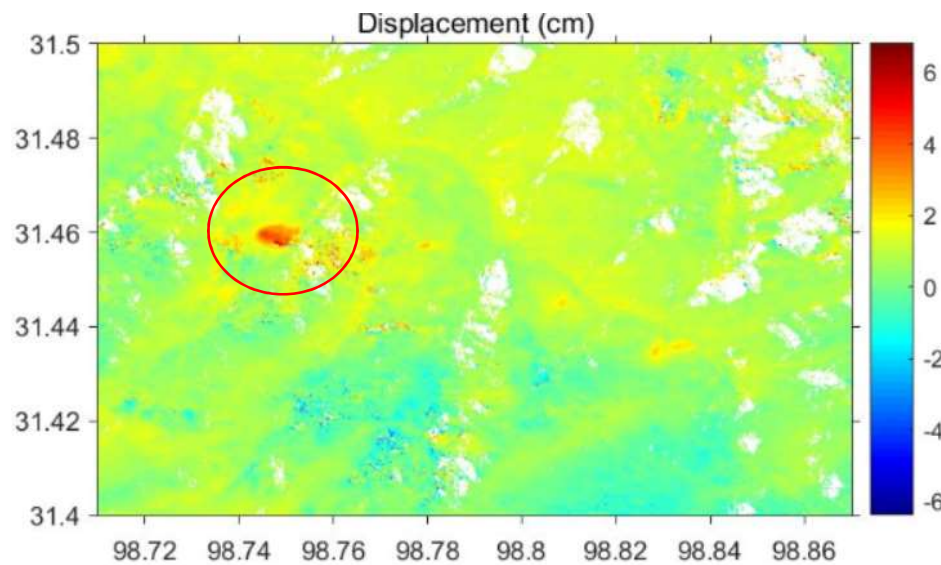


## Part 2 Observing individual interferograms



- Check interferograms - 20171219-20171231.phs

```
>> figure;plot_ifg('ifgs/20171219-20171231.phs','float',1,1,[],0,0,1); colormap(jet); colorbar;title('Displacement (cm)');
```



✓ It is possible to detect the landslide on a single interferogram if it moves fast enough



## Part 3 Generating mean velocity map



$$\text{ph\_rate} = \frac{\sum_{j=1}^N \Delta t_j \varphi_j}{\sum_{j=1}^N \Delta t_j^2} \quad \text{var}(\text{ph\_rate}) \approx \sum_{j=1}^N \left( \varphi_j - \frac{4\pi}{\lambda} \text{ph\_rate} \Delta t_j \right)^2 / \Delta t_j^2$$



## Part 3 Generating mean velocity



Go to your working space (remember to change this to you own path):

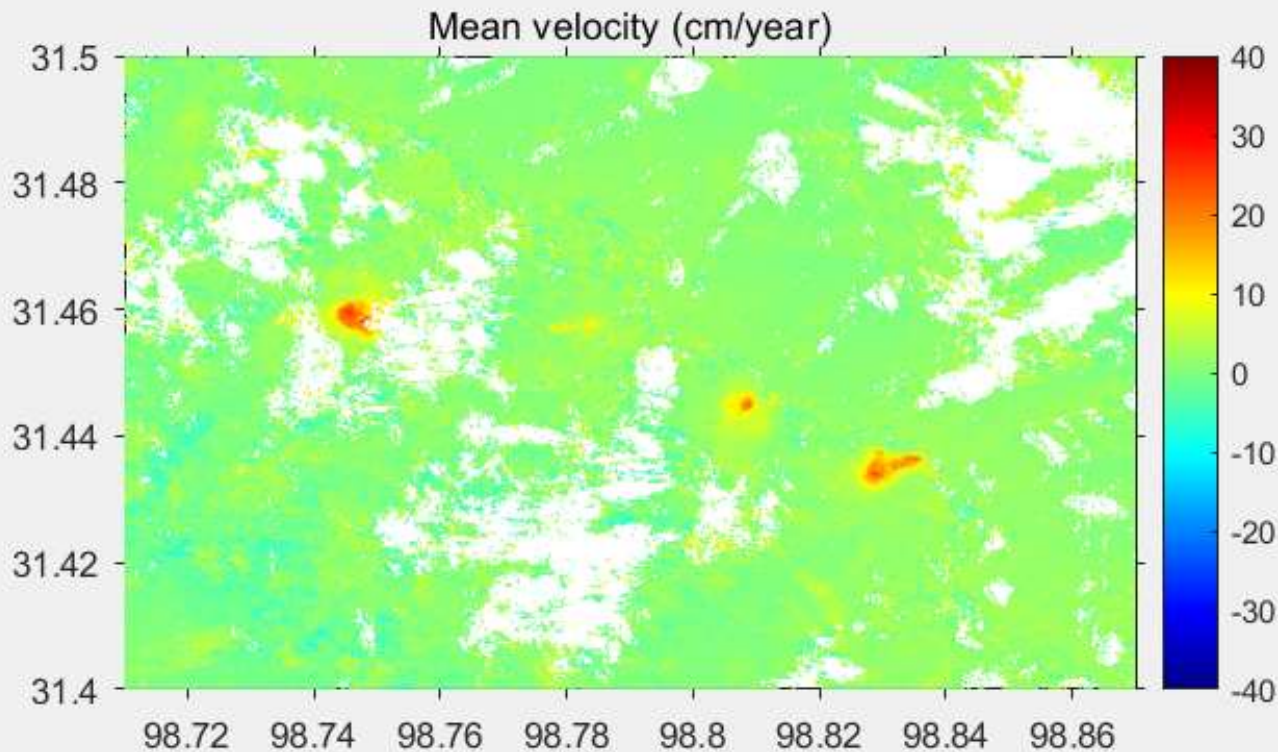
```
>> cd D:\workspace\
```

Run script to generate mean velocity:

```
>> stacking_mean_velocity
```



## Part 3 Generating mean velocity



- The reference point is set to (31.467, 98.817)



## Part 4 Generating displacement time series



- Go to your working space (change this to your own path):

```
>> cd D:\WORKSPACE
```

- Need to find the coordinate of the detected landslide



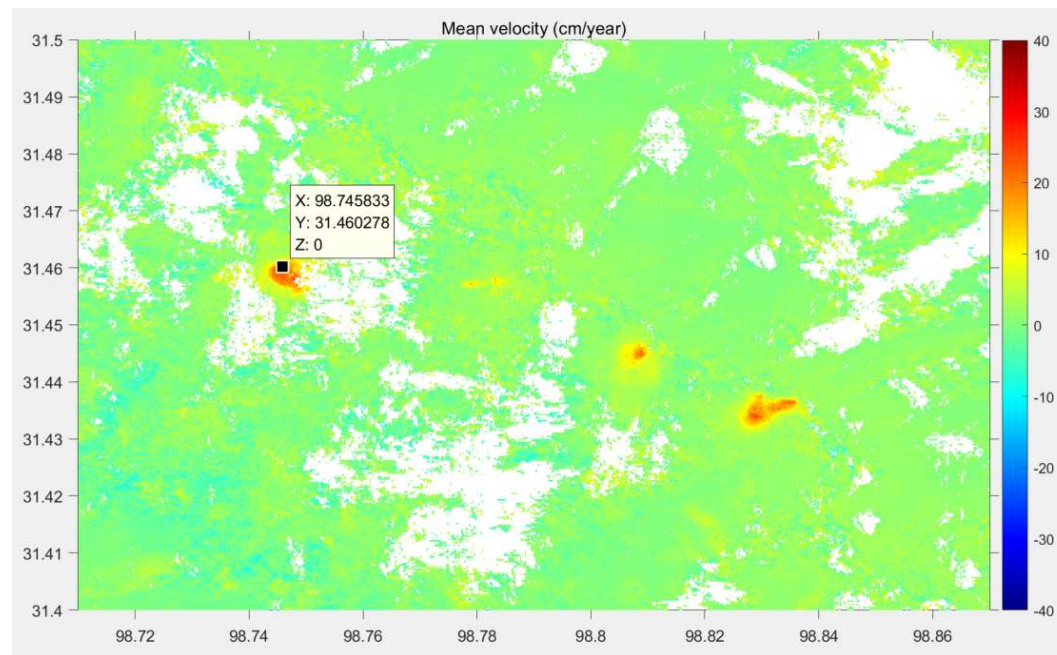


## Part 4 Generating displacement time series



- Checking point 1 on one of the landslide

```
>> stacking_point_time_series(31.459244, 98.745127);
```

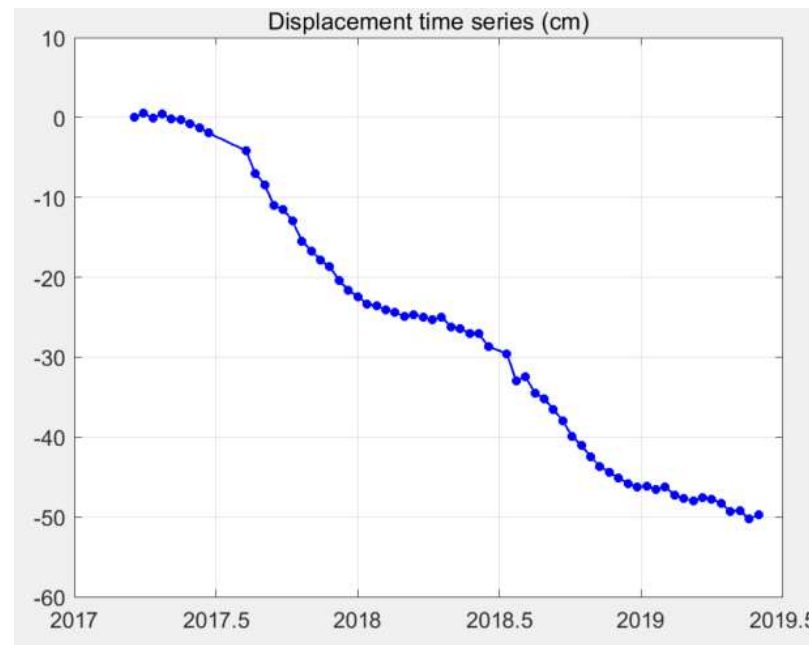


## Part 4 Generating displacement time series



- Checking point 1 on one of the landslide

```
>> stacking_point_time_series(31.459244, 98.745127);
```

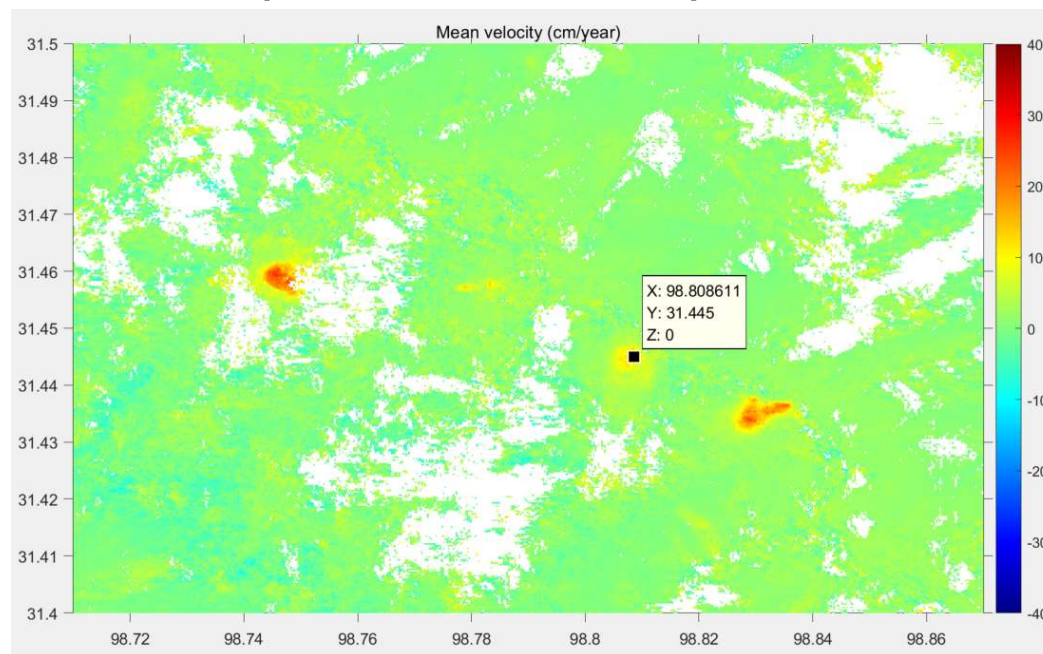


## Part 4 Generating displacement time series



- Checking point 2 on one of the landslide

```
>> stacking_point_time_series(31.445, 98.808611);
```

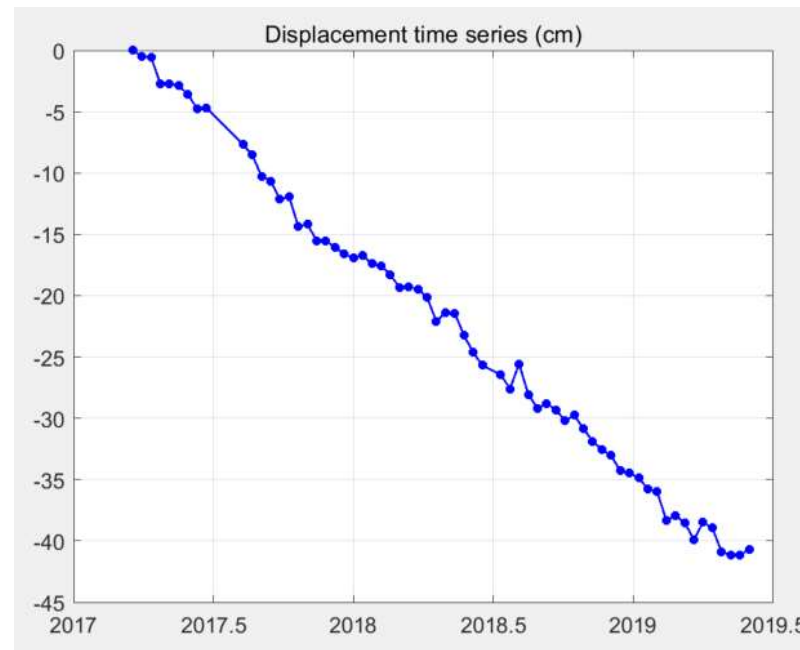


## Part 4 Generating displacement time series



- Checking point 2 on one of the landslide

```
>> stacking_point_time_series(31.445, 98.808611);
```

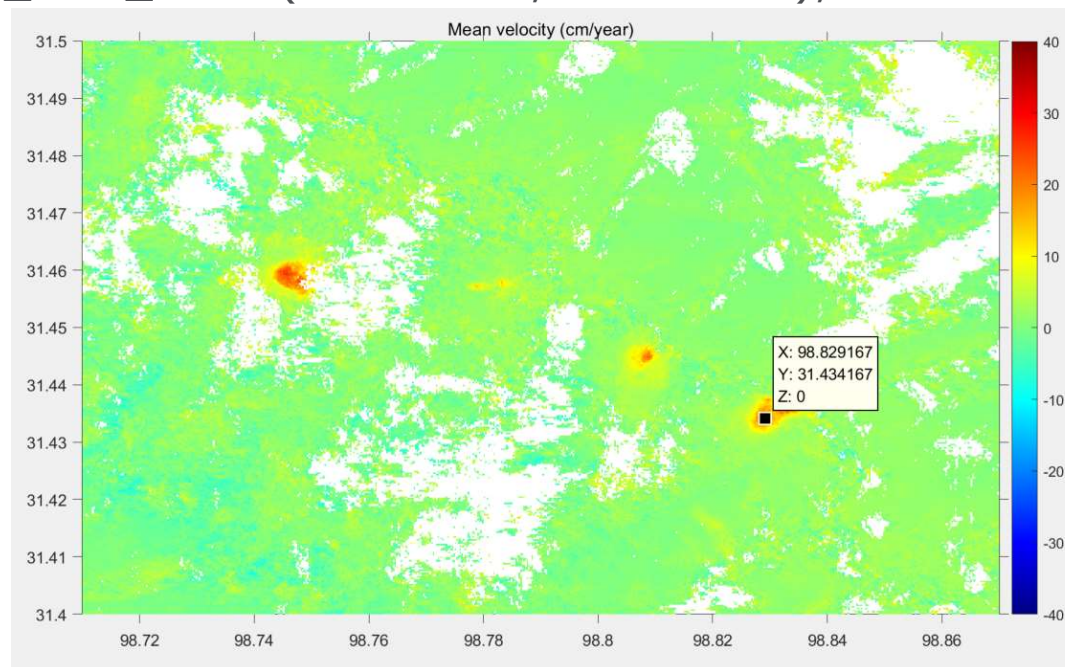


## Part 4 Generating displacement time series



- Checking point 3 on one of the landslide

```
>> stacking_point_time_series(31.434167, 98.829167);
```

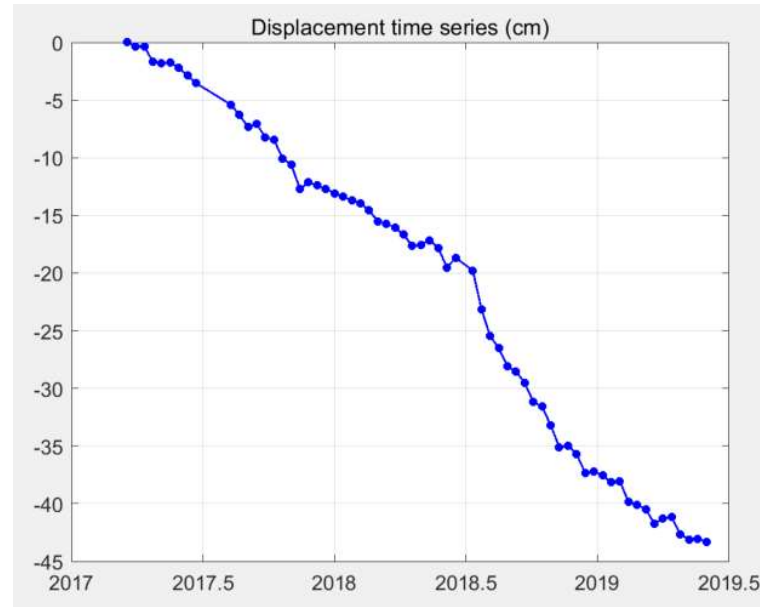


## Part 4 Generating displacement time series



- Checking point 3 on one of the landslide

```
>> stacking_point_time_series(31.434167, 98.829167);
```

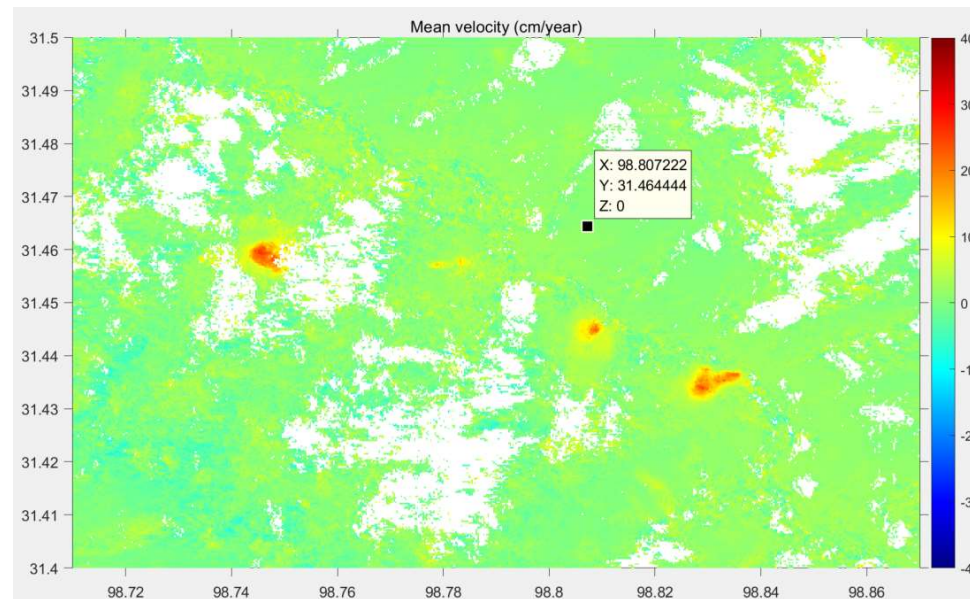


## Part 4 Generating displacement time series



- Checking point 4 in 'non-deforming area'

```
>> stacking_point_time_series(31.464444, 98.807222);
```

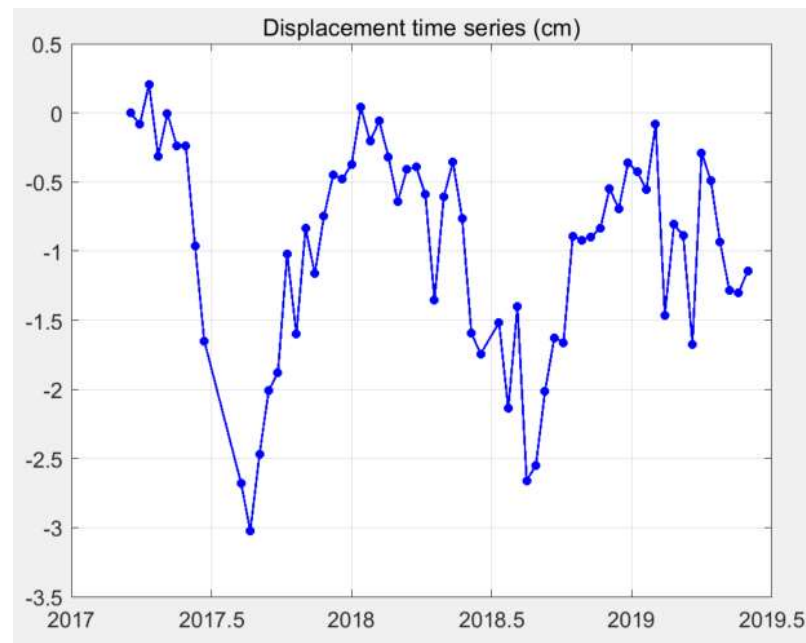


## Part 4 Generating displacement time series



- Checking point 4 in 'non-deforming area'

```
>> stacking_point_time_series(31.464444, 98.807222);
```

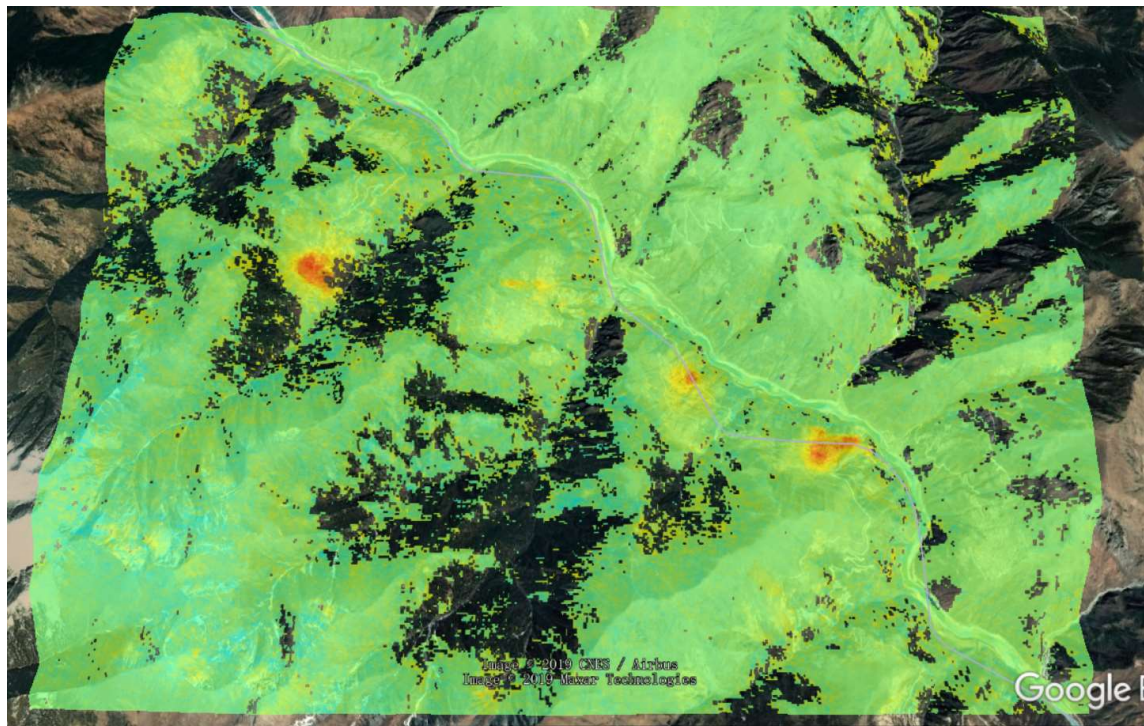




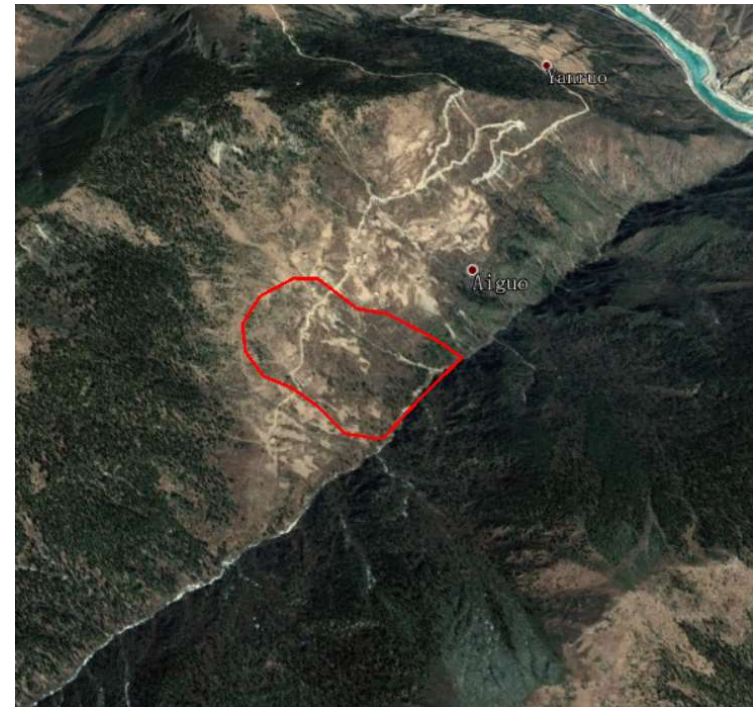
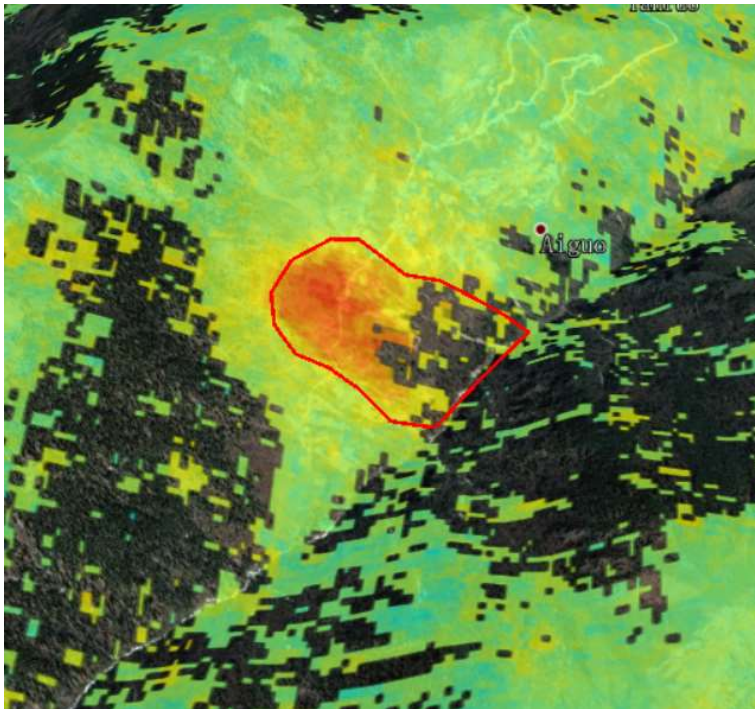
## Part 5 Flagging detected landslide



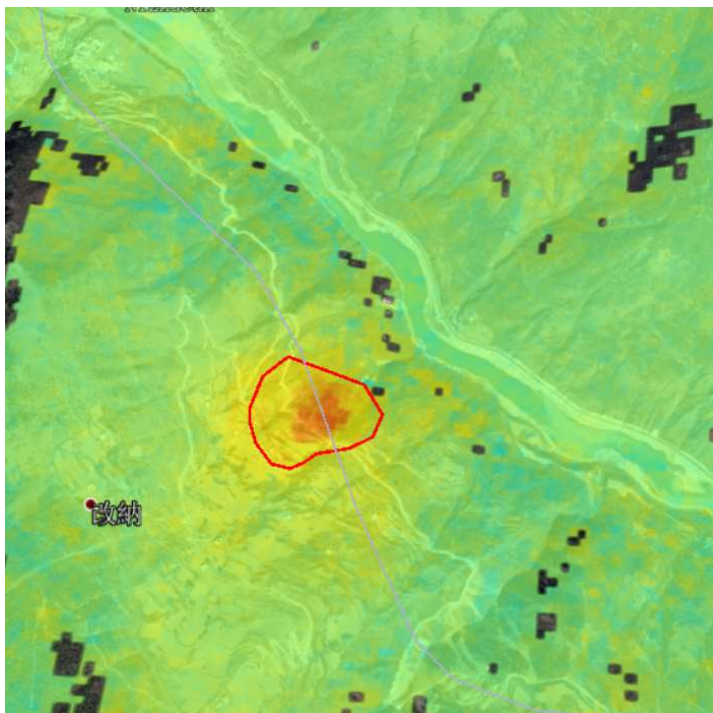
- Open D:\workspace\ifgs\mean\_velocity.kml



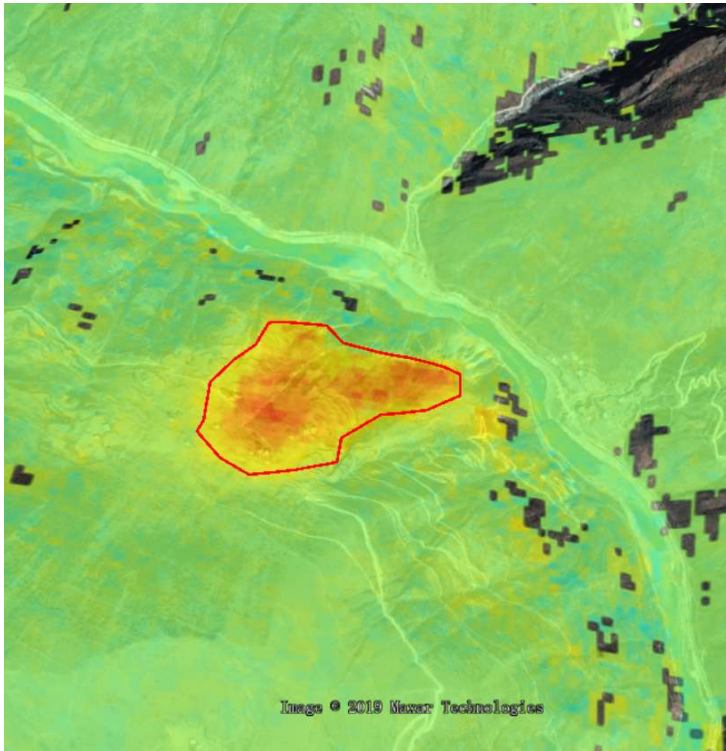
## Part 5 Flagging detected landslide



# Part 5 Flagging detected landslide



## Part 5 Flagging detected landslide





**Thank you!**

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