# A MATLAB function for 3-D and 4-D topographical visualization in geosciences

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Vrije Universiteit Brussel

Research Foundation Flanders
Opening new horizons

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Outstanding Student Poster & PICO Contest

## What?

A freely available and user-friendly MATLAB function to make 3-D and 4-D visualizations of landscapes

## Why?

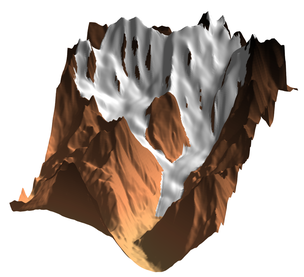
- In geosciences: often 2-D visualizations used to represent spatially varying variables. When combining this with topographical information (elevation) visualizations tend to become packed with information and difficult to interpret
- Numerical computing environment MATLAB is widely used, but has limited 3-D+ visualization options. Here an easy-to-use function is presented that can be used to produce high-quality figures and animations

## How?

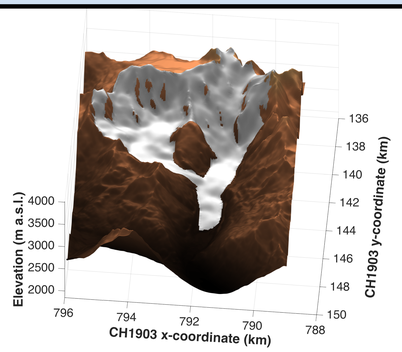
- Function deals with technicalities that make it a time-consuming and complex task to make 3-D+ and 4-D visualizations in MATLAB
- Problem of combining different colour schemes within one figure, which is not possible with standard implemented MATLAB functions (e.g. 'surf'), is dealt with and by means of some technical operations the correct colour bar is displayed and the labelling is adapted accordingly
- User is not confronted with these technicalities. Needs to call the function (TopoZeko), with only 2 mandatory fields (bedrock and surface elevation). Can be complemented with 40 optional input parameters to adapt the figure to the specific needs.

## Examples of 3-D+ visualizations for the Morteratsch glacier complex (Switzerland)

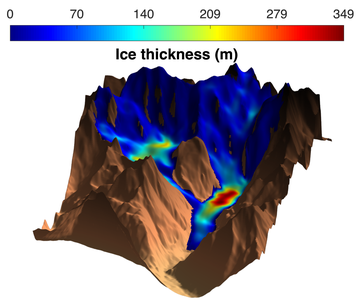
Topography and data based on Zekollari et al. (2013, 2014) and Zekollari and Huybrechts (2015)



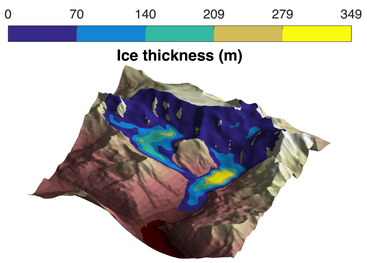
```
TopoZeko(BED, SUR, 'view_orientation',[-159.5 40]);
```




```
TopoZeko(BED, SUR ,'axes','on', 'bed_colormap_flipud','off',
'label_size',18, 'light_orientation',[-90 90],
'view_orientation',[-175 64], 'xlabel','CH1903 x-coordinate
(km)', 'xlabel_rotation',-3, 'xvalues',[789 796],
'ylabel','CH1903 y-coordinate (km)', 'ylabel_rotation',85,
'yvalues',[137.025 149], 'zlabel','Elevation (m a.s.l.)');
```

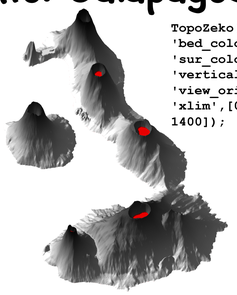



```
TopoZeko(BED, SUR,
'extra_dimension','on',
'view_orientation',[-159.5 40]);
```




```
TopoZeko(BED,SUR, 'bed_colors',20,
'bed_colormap','pink','bed_colormap_flipud','off',
'cbar_colors',5, 'D4_colormap','parula',
'extra_dimension','on', 'vertical_scaling',0.5,
'view_orientation',[-151 53]);
```

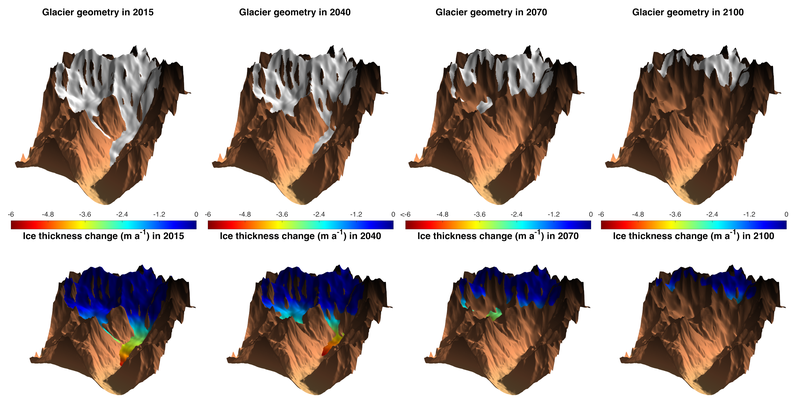
## Other example of 3-D+ visualization (for Galapagos Islands)



```
TopoZeko(BED, SUR,
'bed_colormap','gray',
'sur_color',[1 0 0],
'vertical_scaling',0.7,
'view_orientation',[0 80],
'xlim',[0 1400], 'ylim',[0
1400]);
```

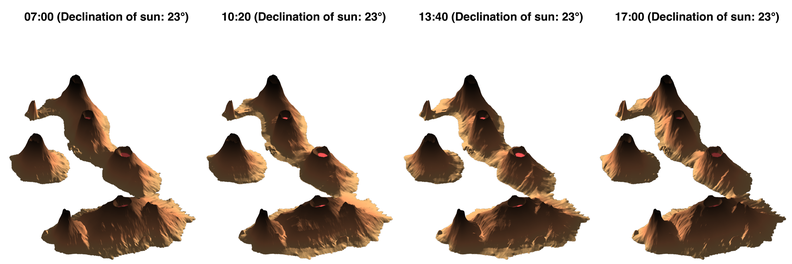
Retreat based on simple parameterization, with most of the change occurring at the glacier front and a warming of around +4°C at the end of the century (vs. 2015)

Scan QR code to see animation




Scan QR code to see animation

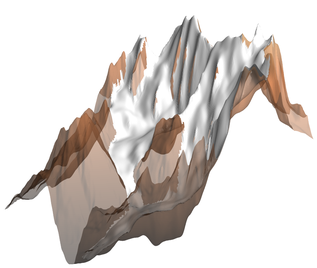
## Visualization obtained from function are very suited to make time-dependent animations (movies)



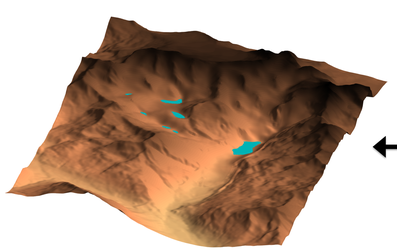

Position of the sun is calculated with simple function (also available online at zekollari.be/topozeko2016) given the geographic location and the declination of the sun.

Scan QR code to see animation

## Examples of 4-D visualizations for the Morteratsch glacier complex (Switzerland)

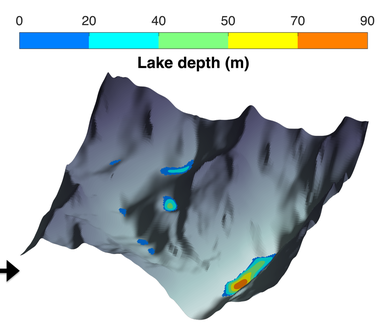


```
TopoZeko(BED, SUR, 'bed_colormap_flipud','off',
'bed_trans',0.5, 'view_orientation',[-113 15],
'xlim',[50 280], 'ylim',[0 350]);
```



```
TopoZeko(BED, SUR_LAKE, 'sur_color',[0
206/255 209/255], 'vertical_scaling',0.25,
'view_orientation',[-159.5 40]);
```

Examples in which all ice is removed and all bedrock depressions are filled with water (possible future lakes if glacier dissapears)




```
TopoZeko(BED, SUR_LAKE,
'bed_colormap','bone',
'cbar_colors',5,
'extra_dimension','on',
'view_orientation',[-159.5 40],
'xlim',[50 250], 'ylim',[130 260]);
```

## Function availability

- All functions and data (used to make figures) presented here are available online at zekollari.be/topozeko2016
- Manuscript presenting and documenting the function is under review. If you are interested in this or any other information, do not hesitate to contact me!

## References

Zekollari, H., Huybrechts, P., Fürst, J.J., Rybak, O., Eisen, O., 2013. Calibration of a higher-order 3-D ice-flow model of the Morteratsch glacier complex, Engadin, Switzerland. Ann. Glaciol. 54, 343–351

Zekollari, H., Fürst, J.J., Huybrechts, P., 2014. Modelling the evolution of Vadret da Morteratsch, Switzerland, since the Little Ice Age and into the future. J. Glaciol. 60, 1155–1168

Zekollari, H., Huybrechts, P., 2015. On the climate–geometry imbalance, response time and volume–area scaling of an alpine glacier: insights from a 3-D flow model applied to Vadret da Morteratsch, Switzerland. Ann. Glaciol. 56, 51–62

**Zekollari, H., TopoZeko: A MATLAB function for 3-D and 4-D topographical visualization in geosciences (under review)**

## Information, questions, remarks, suggestions?

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