

Image: Dedegöl Mountain  
Paleoglacier Model  
with PISM v0.7  
Temperature -10  
Precipitation x 1.75

# Reconstruction of Paleoglaciers with PISM, A case study Dedegöl Mountain

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April 17, 2017



# Content

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- ❖ Glaciers and Climate change
- ❖ How do they form?
- ❖ How do they move?
- ❖ Modeling and Reconstructions —> Paleoclimate
- ❖ Case Study: Dedegöl Mountain Paleoglaciers



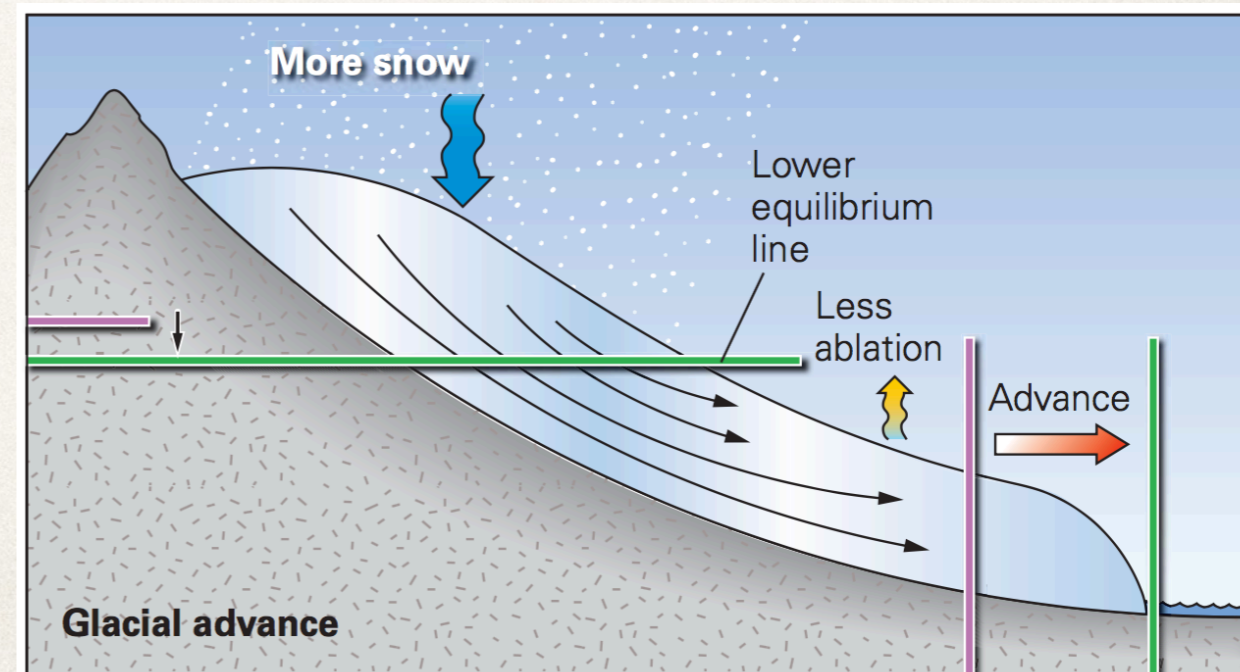
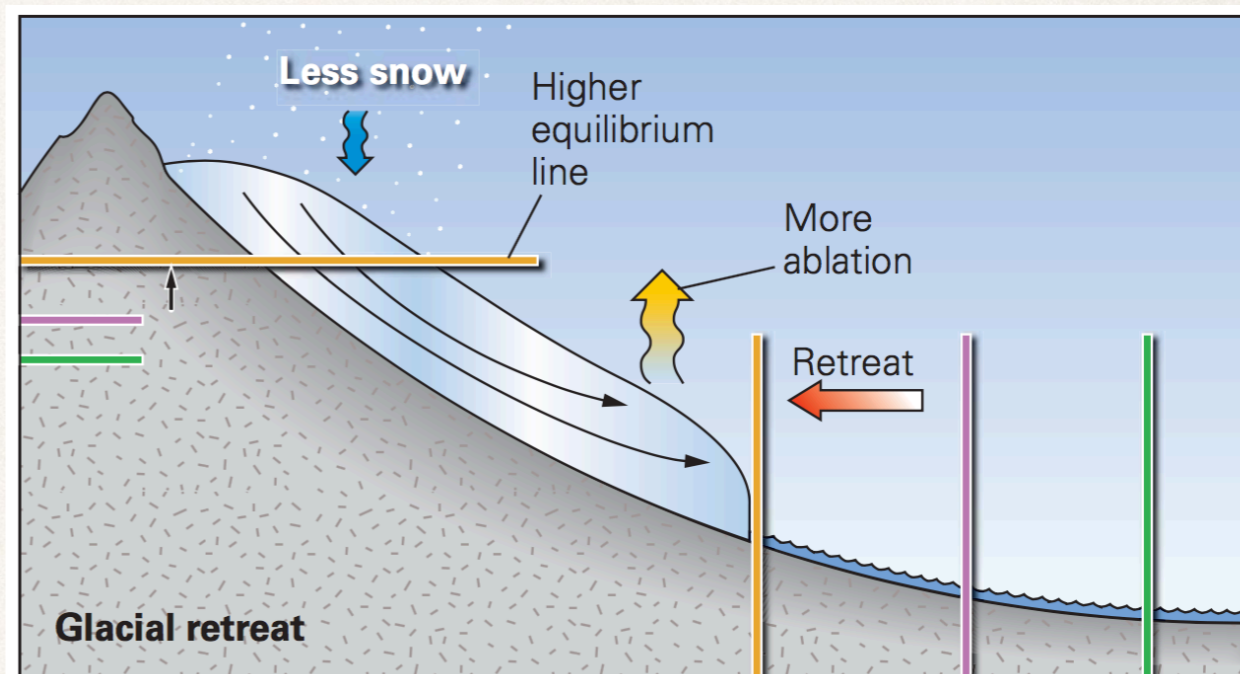
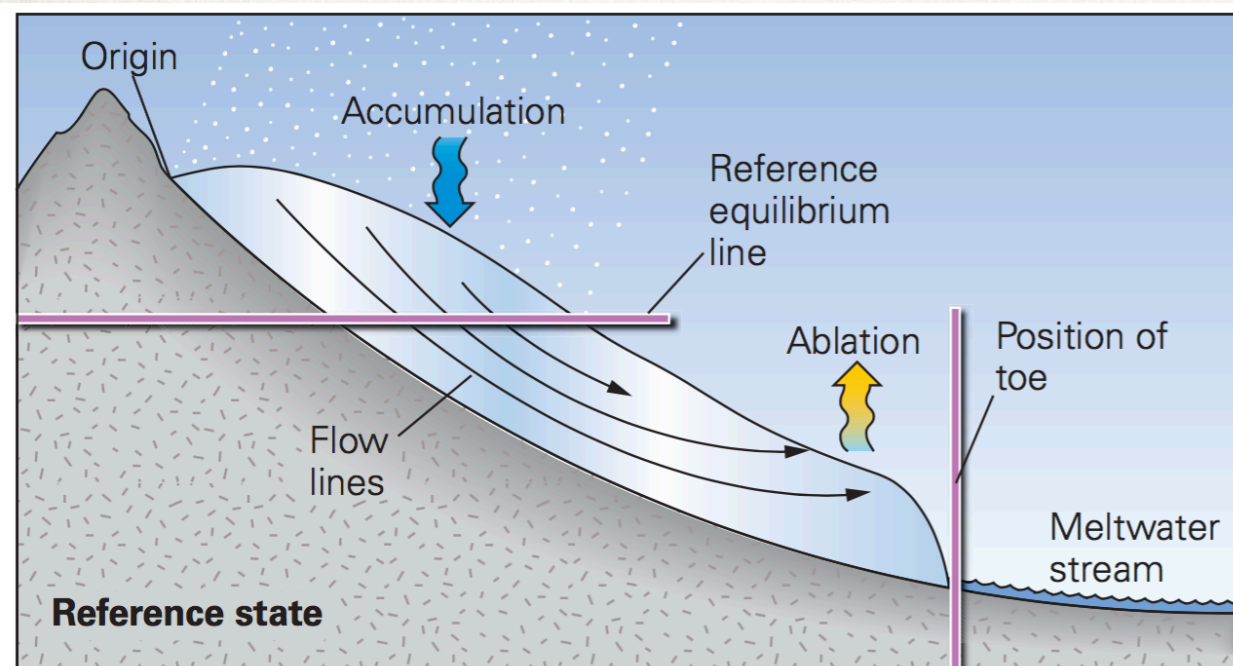
# Glaciers and Climate

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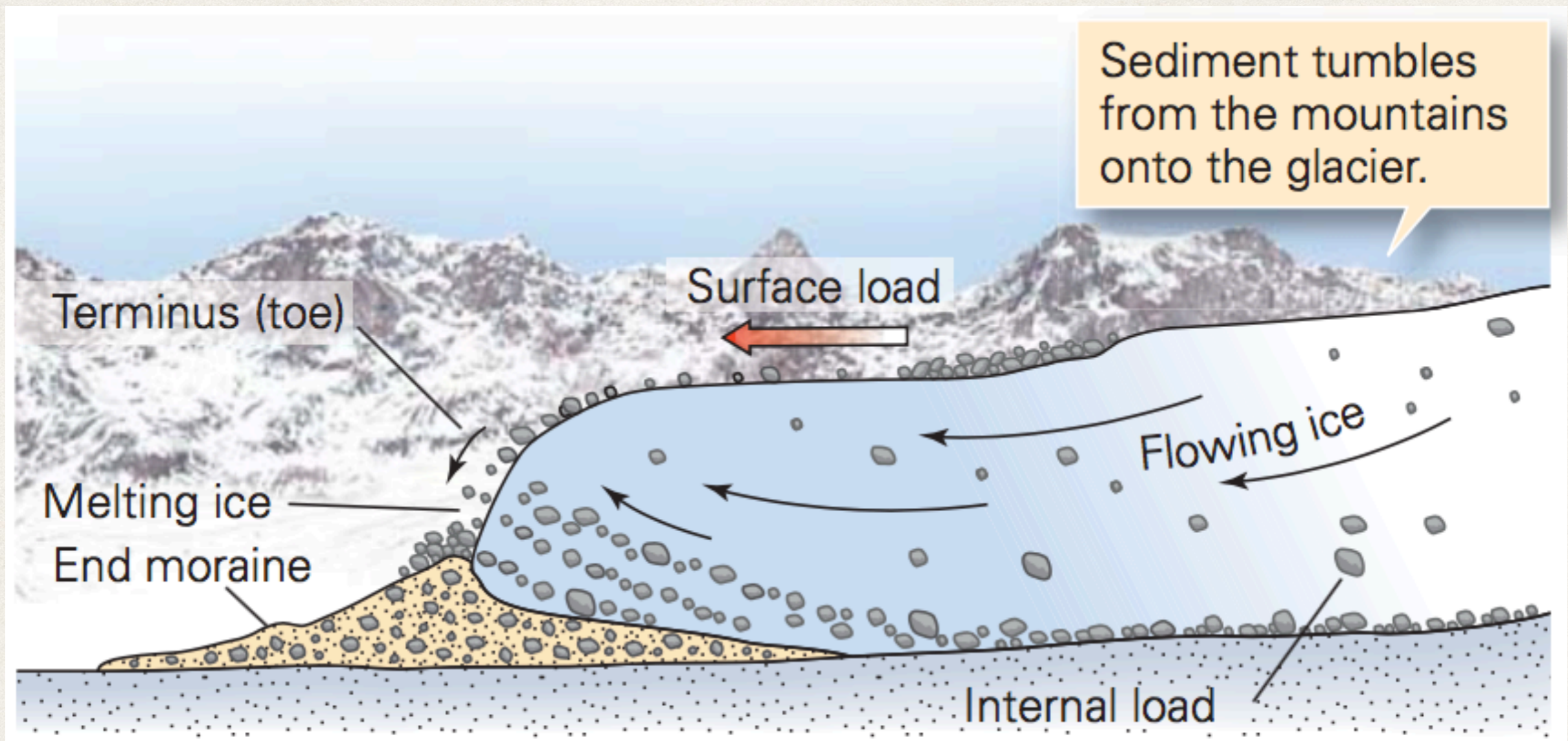
- ❖ Accumulation
- ❖ Ablation
- ❖ Equilibrium Line Altitude
- ❖ Advance x Retreat
- ❖ Mass Balance  $\longrightarrow$  Temperature and Precipitation



# Glacier Flow







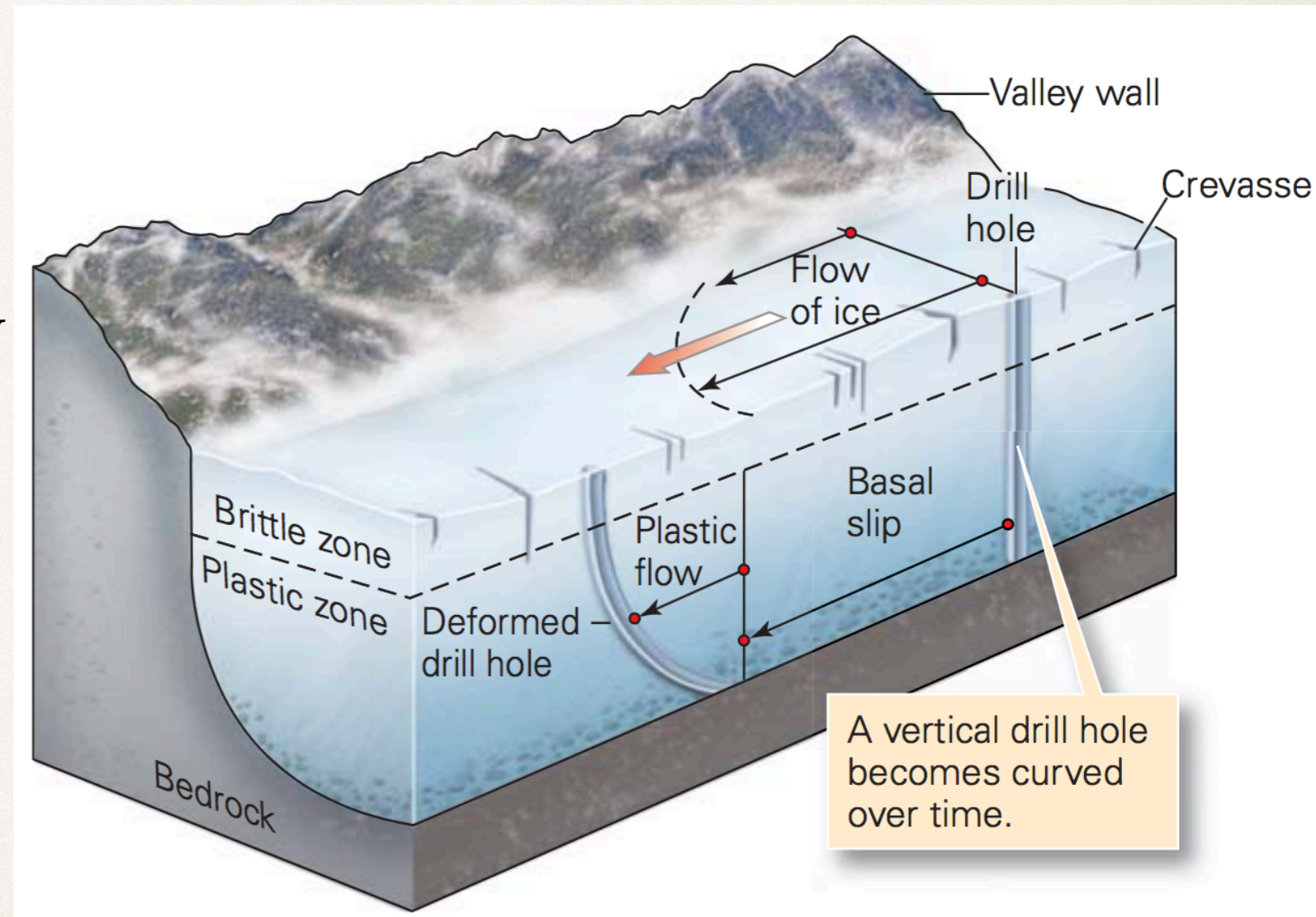
# Glacier Flow

- ❖ Abrasive effect —> Transportation

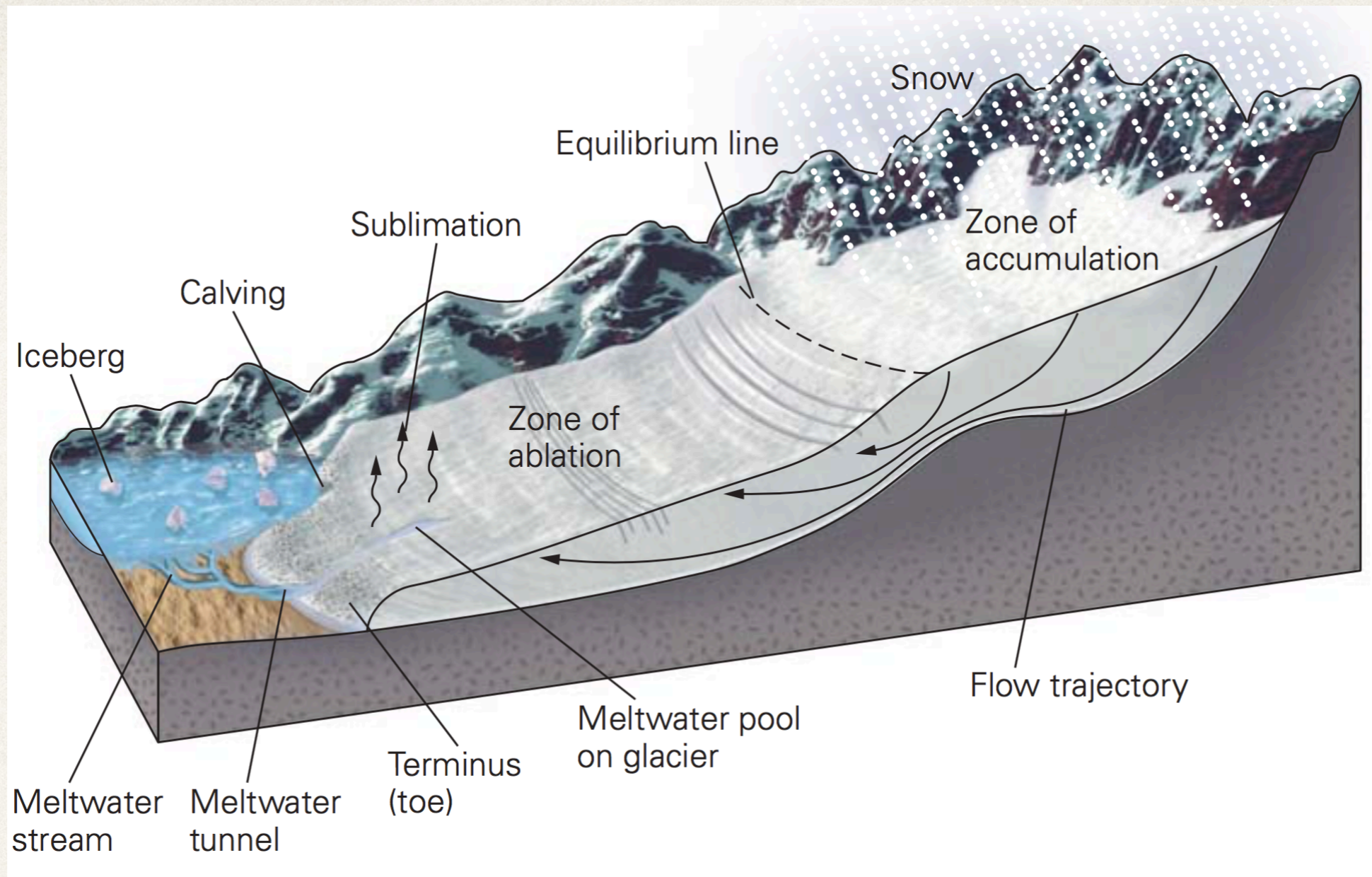


# Glacier Flow

- ❖ Valley Glacier's Flow
- ❖ Flow Models





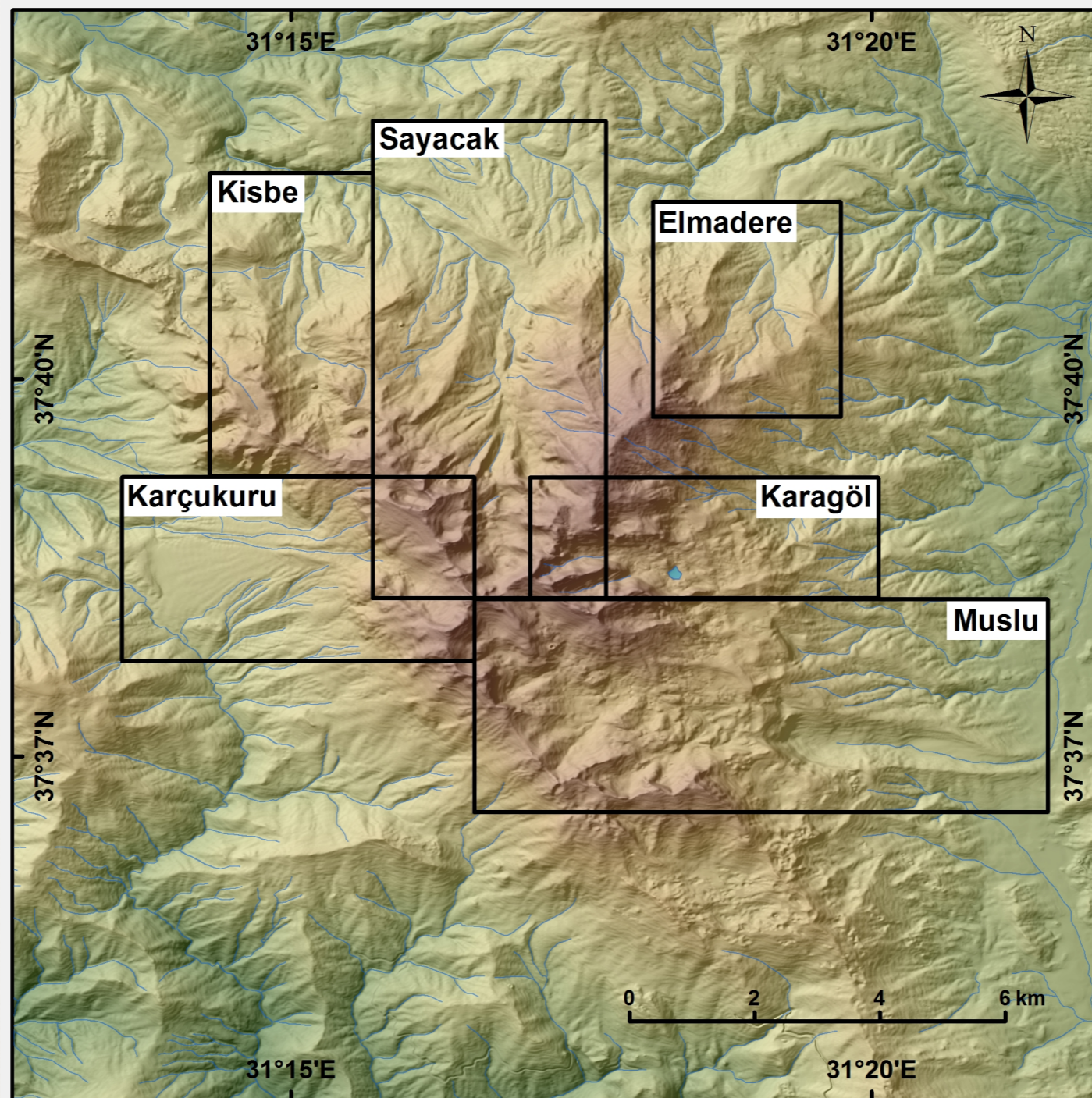


# Glacier Flow

❖ What are the inputs?

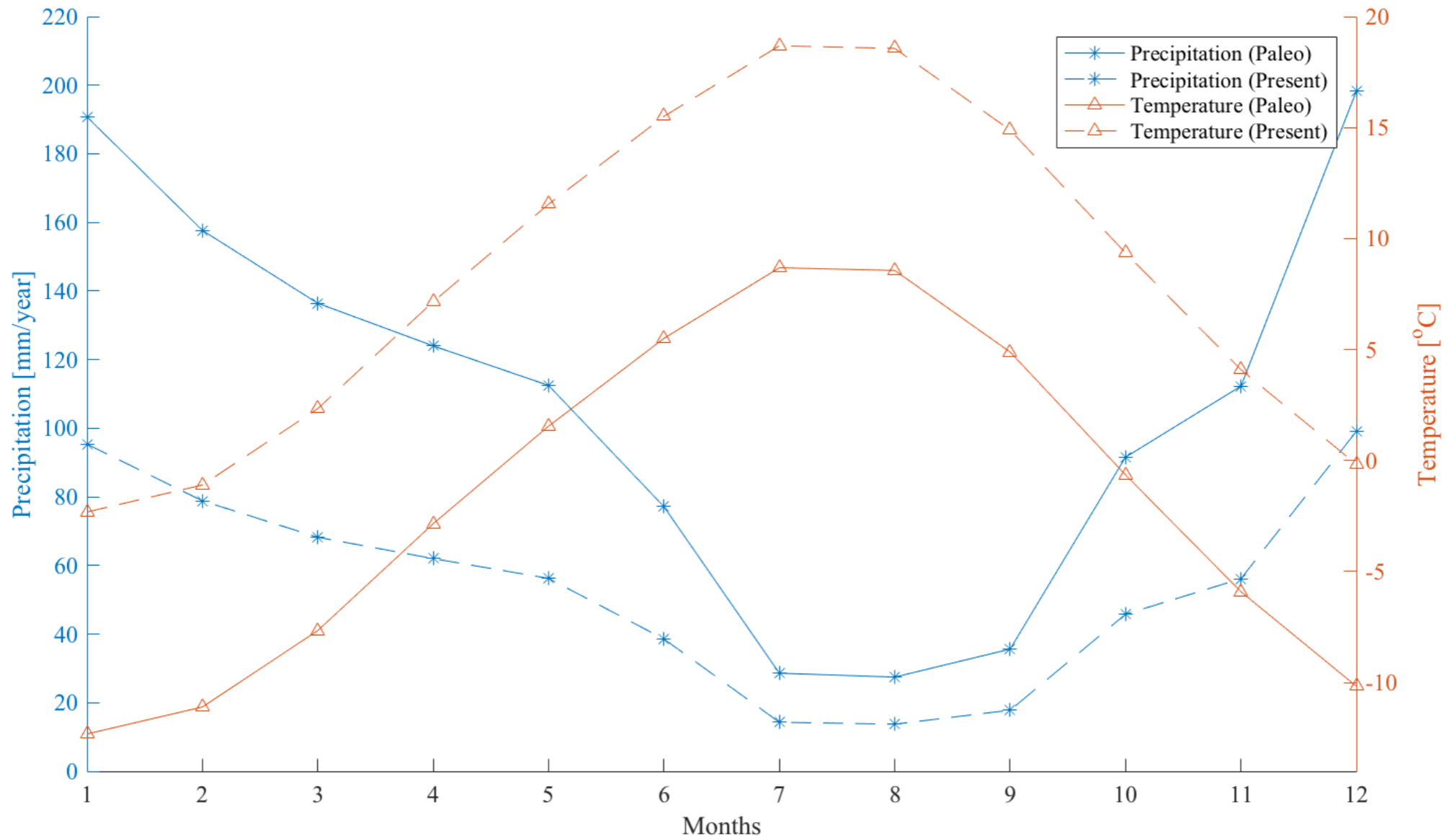


# Case: Dedegöl Mountain



from Oğuzhan  
Köse





# Climatic Inputs

Temperature -10    Precipitation x2

[www.worldclim.org](http://www.worldclim.org)



## Accumulation:

if  $T < 0$

Accumulation =

Ice equivalent precipitation

elseif  $0 < T < 2$

Accumulation linearly  
dependent to prec.

else  $T > 2$

Accumulation = 0

## Ablation:

Positive Degree Day

$$EPDD = \sigma \int_0^{12} 30.4 \left[ 0.3989 \exp \left( -1.58 \left| \frac{T_{mon}^{sur}}{\sigma} \right|^{1.1372} \right) + \max \left( 0, \frac{T_{mon}^{sur}}{\sigma} \right) \right] dt$$

Braithwaite, R.J., 1995

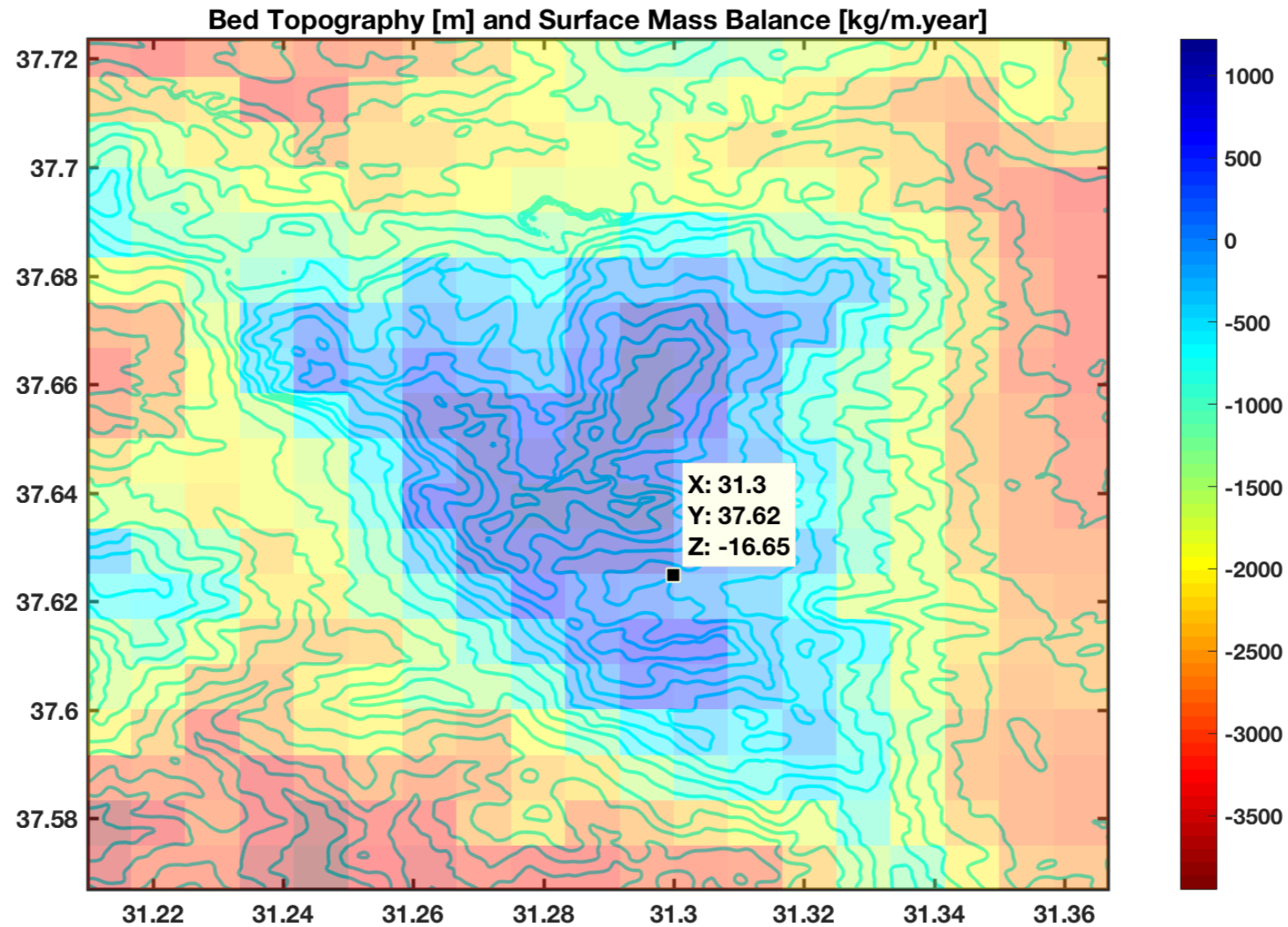
# Mass Balance = Accumulation - Ablation

Negative (-)   Zero (Stable)   Positive (+)

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North

Grid: 565 x 565  
 Resolution: 30 m  
 16.92 x 16.92 km

# Mass Balance

Negative (-)    Zero (Stable)    Positive (+)

*For Dedegöl Mount*



# Glacier Model



- ❖ Inputs: thk, mass balance, topography etc. \*.nc file

- ❖ [www.pism-docs.org](http://www.pism-docs.org)

Name	Long Name	Type
▼ pism_dedegol...	pism_dedegol_T1...	Local File
🌈 bheatflx	Basal Heat Flux	Geo2D
🌈 bmelt	Ice Basal Melt Rate	Geo2D
🌈 climatic_m...	Surface Mass Balan...	Geo2D
🌈 ice_surface...	Annual Mean Air T...	Geo2D
🌈 lat	Latitude	Geo2D
🌈 lon	Longitude	Geo2D
🌈 mapping	mapping	—
🌈 precipitation	Present Precipitation	Geo2D
🌈 thk	Ice Thickness	Geo2D
🌈 time	Time	—
🌈 topg	Bedrock Topography	Geo2D
🌈 x	Cartesian x-coordi...	1D
🌈 y	Cartesian y-coordi...	1D

```
:_FillValue = NaNf; // float

float thk(x=565, y=565, time=1);
:reference = "Initial. Cond.";
:grid_mapping = "mapping";
:long_name = "Ice Thickness";
:standard_name = "land_ice_thickness";
:units = "meters";
:coordinates = "lat lon";
:_FillValue = NaNf; // float

// global attributes:
>Title = "Pism input Data Set";
:Comments = "Created at EIES, Istanbul Technical University";
:input_code_example = "mpiexec -n 4 pismr -i pism_{location}_T
}
```



Find Files, Compare, Print, Go To, Find, Breakpoints, Run Section, Run and Time

Insert, Comment, Indent, Breakpoints

Current Folder

- input\_files
- bheatflx.m
- data\_importer.m
- dem.txt
- dem\_cut.txt
- edit\_moraine.m
- edit\_thk.m
- hfmap.mat
- kmlcreator.m
- pism\_dedegol\_T10\_P2.nc
- pism\_in\_gen.m
- results.kml
- runner\_dedegol\_T10\_P2.t...
- smb\_calc.m

```

1 %% data_importer.m
2 % imports topography, temperature, precipitation, and basal heat flux data from *.txt files,
3 % generates x,y,topg,lat,lon,thk and time series for the pism_in_gen function.
4 % runs function.smb_calc, function.pism_in_gen
5
6 %% Important Notes:
7 % Please add dem.txt, t(1,2,3,...), p1.txt, hfmap.mat, and pism_in_gen.m to the "input_files"
8 % (exported from ArcGis) and, hfmap.mat, and pism_in_gen.m to the "input_files" directory.
9 % Input file names have to be:
10 % bed elevation.....dem.txt
11 % temperature.....t1.txt
12 % precipitation.....p1.txt
13 % basal heat flux ...hfmap.mat
14
15
16 % First indices      Second indices
17 % i- input file      -dem- b... original file
18 % o- output          -lat- latitude -ml matlab file

```

Input variables

Study Area: dedegol

x axis [m]: 30

y axis [m]: 30

Temperature offset [C]: -10

Precipitation multiplier: 2

Model start year: -500

Model end year: 0

OK Cancel

```

- CheckData_mb
...
function.pism_in_gen
...
txt files
...s" directory.
...
(month)
...
(month)
...
d indices
... original file
... matlab file

```

Workspace

Name	Value
ax2surf	1x1 S
ax3	1x1 A
ax4	1x1 A
ax4surf	1x1 S
ax5	1x1 A
ax6	1x1 A
ax6surf	1x1 S
ax7	1x1 A
ax8	1x1 A
ax8surf	1x1 S
ax_o_lat_ml	1x56
ax_o_lon_ml	1x56
cb2	1x1 C
CheckData_bheatflx	1x56
CheckData_bmelt	1x56
CheckData_lat	565x
CheckData_lon	565x
CheckData_mb	1x56
CheckData_prec	1x56
CheckData_surtemp	1x56
CheckData_thk	1x56
CheckData_time	0
CheckData_topg	565x
CheckData_x	565x
CheckData_y	565x
defaultans	1x7 c
delimiterIn	''
dem_cut	565x

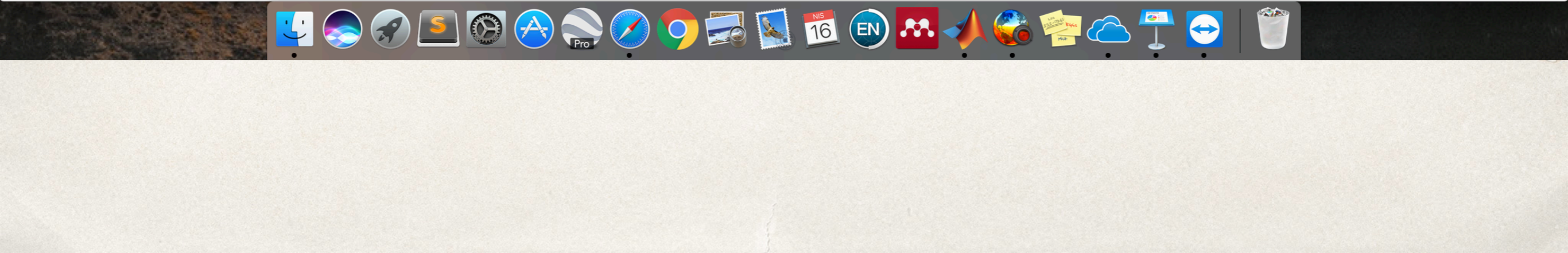
Command Window

This code calculates "Basal Heat Flux, Surface Mass Balance; creates pism input file (\*.nc)

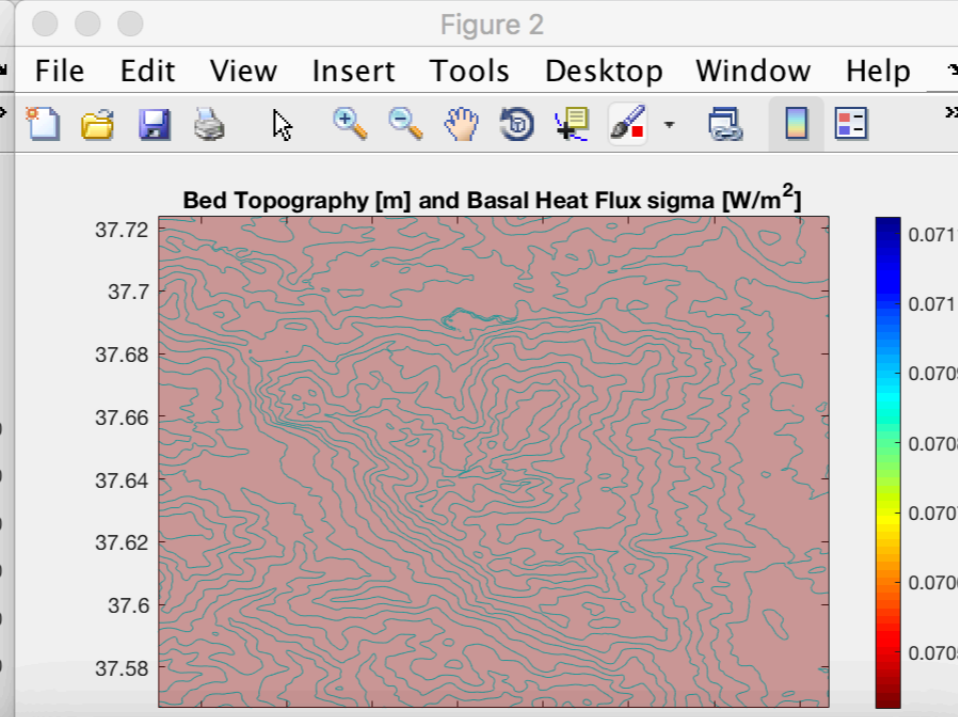
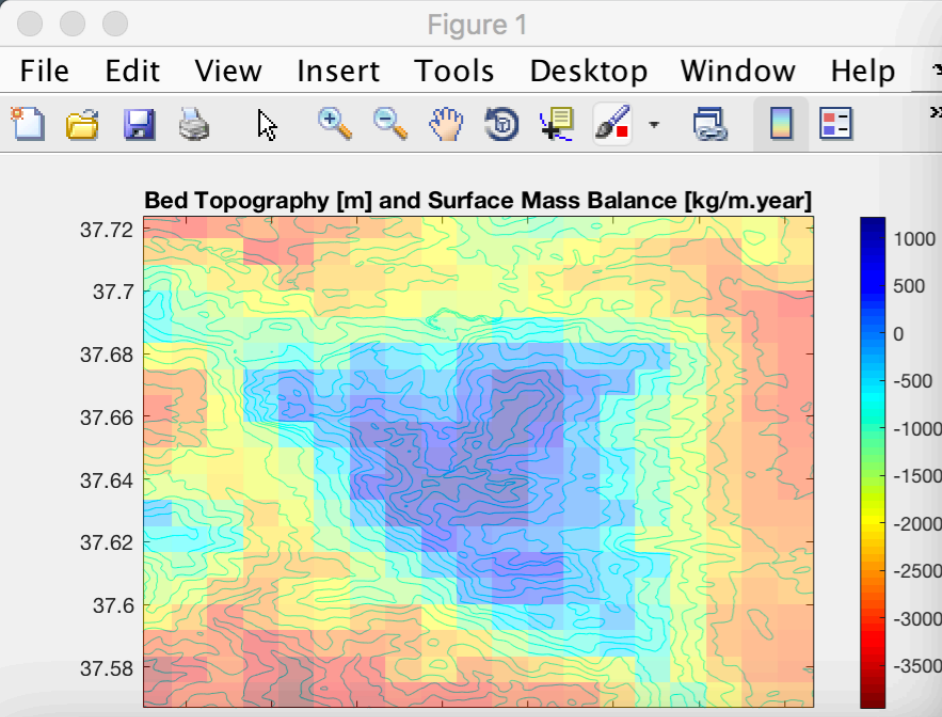
1- Defining the x,y axes grids distances.  
Please enter the distance between two x axis grids, Study Area

data\_importer.m (Scri...)

- data\_importer.m
- Important Notes:
- 1- Defining the x,y axe...
- 2- Importing dem.txt fi...
- 3- Latitude and longitu...
- 4- Calculating x and y ...





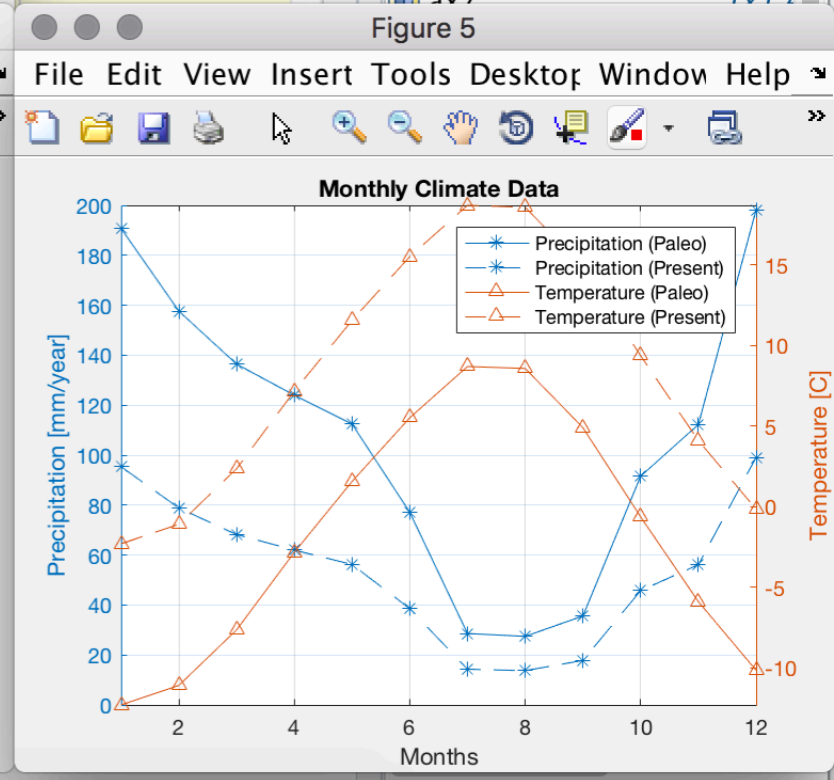
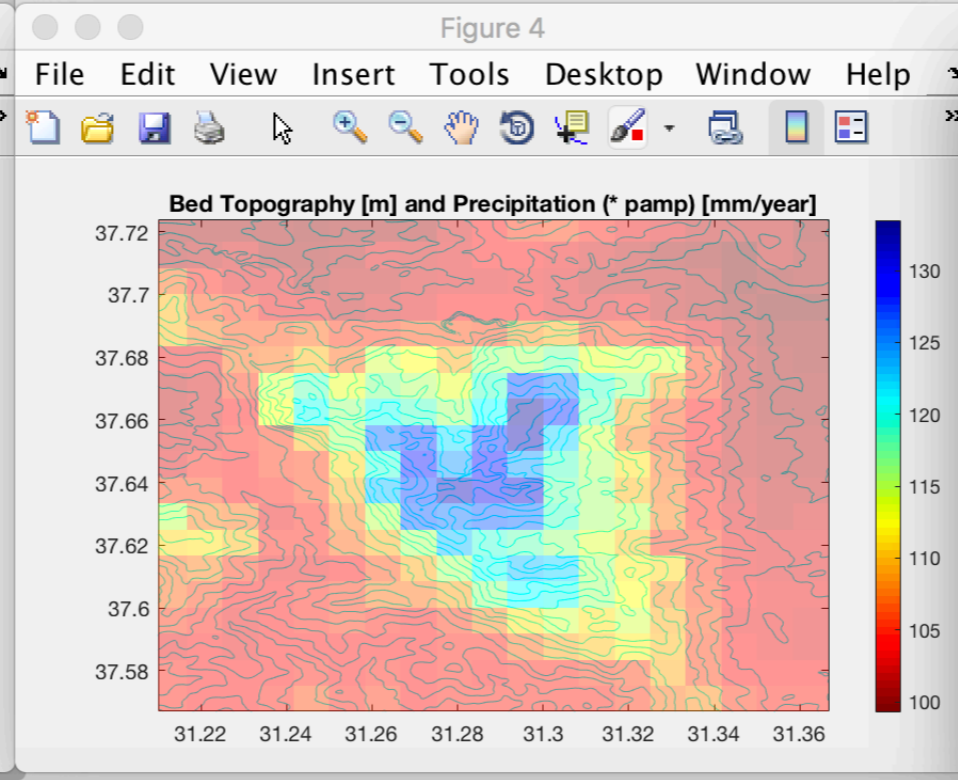
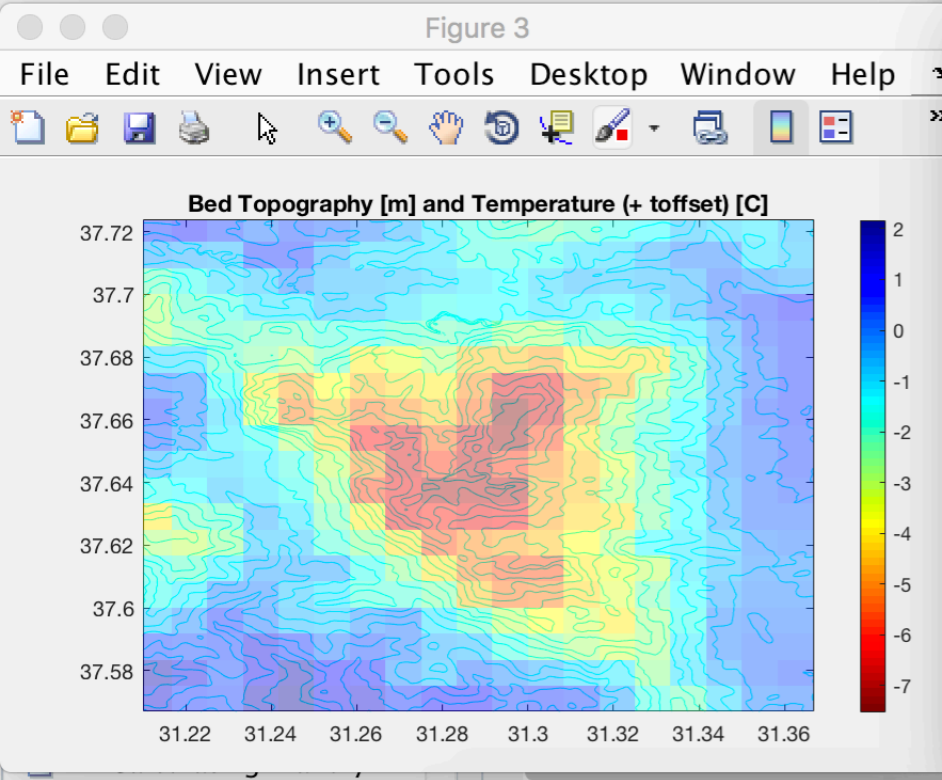


Search Documentation

Grid: 565 x 565  
Resolution: 30 m  
16.35 x 16.35 km

Workspace

Name	Value
ax2surf	1x1 S
ax3	1x1 A
ax4	1x1 A
ax4surf	1x1 S
ax5	1x1 A
ax6	1x1 A
ax6surf	1x1 S
ax7	1x1 A



script Ln 9 Col 31



```
mpirun -n 8 pismr -i pism_dedegol_T10_P2.nc -bootstrap -Mx 565 -My 565 -Mz 11 -Lz 600 -bed_smoother_range 0 -ys -500 -ye 0
-surface given -ts_file ts_dedegol_T10_P2.nc -ts_times -500:yearly:0 -extra_file ex_dedegol_T10_P2.nc -extra_times -500:5:0 -
extra_vars tempicethk_basal,bmelt,velsurf_mag,mask,thk,topg,lat,lon,usurf -o output_dedegol_T10_P2.nc &>
run_dedegol_T10_P2.txt &
```



Ncview 2.1.7 David W. Pierce 29 March 2016

Files ice thickness

frame 1/70 2-Jul-497 12:00:00 (2 bnds:1-Jan-499 00:00:00 -> 1-Jan-494 00:00:00)  
 displayed range: 0 to 227.993 m  
 Current: (i=441, j=23) 0 (x=31.3325, y=37.57339)

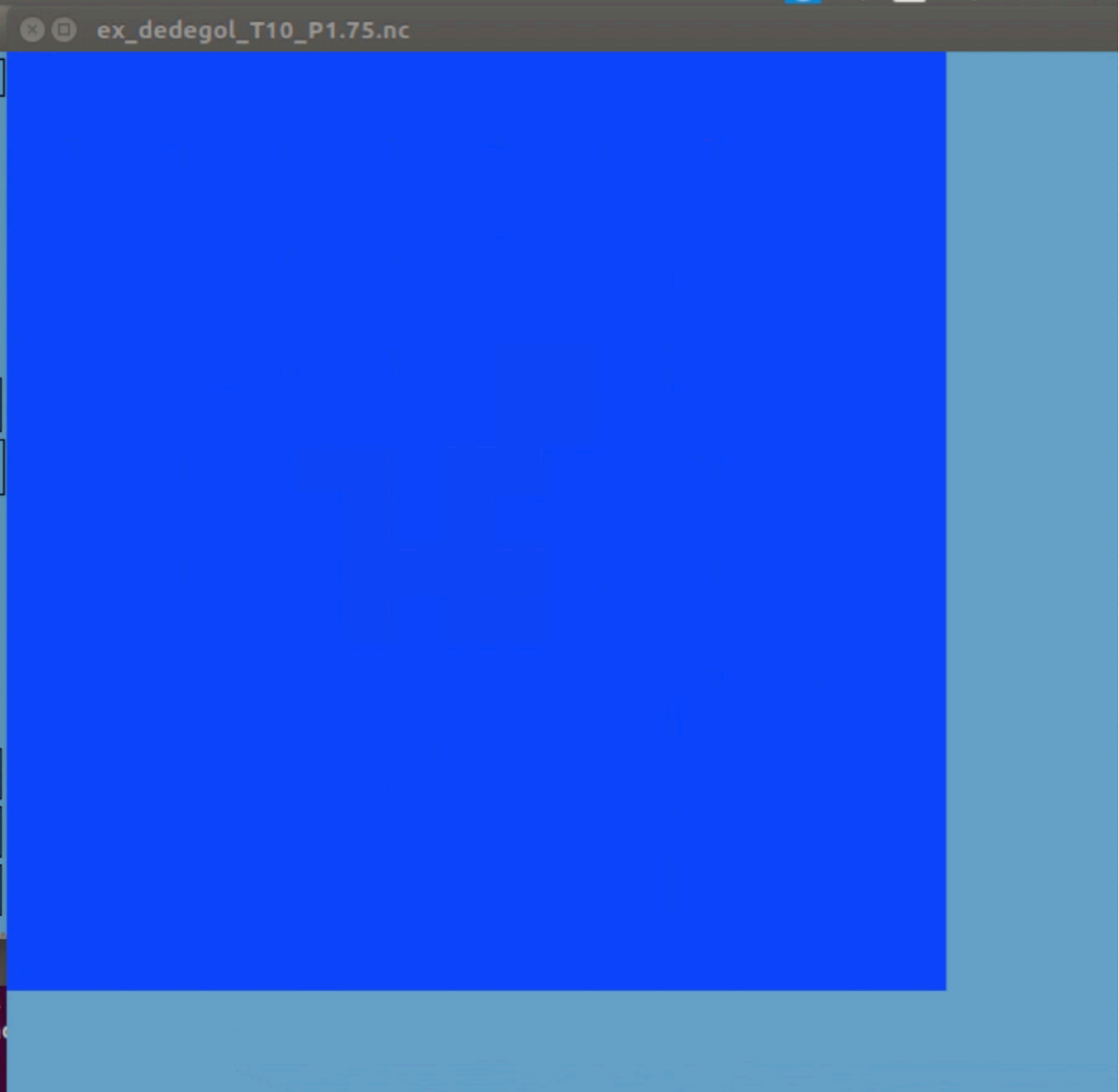
Quit ->1 << < || > >> Edit ? Delay: [ ] Opts

3gauss Inv P Inv C Mag X1 Linear Axes Range Bi-lin Print

0 50 100 150 200

Var: time\_bounds timestamp **bmelt** lat  
 lon mask tempicethk\_bas **thk**  
 topg usurf velsurf\_mag

Dim:	Name:	Min:	Current:	Max:	Units:
Scan:	time	-1.56892e+10	1-Jan-494 00	-4.80924e+09	seconds since
Y:	x	37.567	-Y	37.7237	m
X:	y	31.21	-X	31.3667	m



```

Terminal File Edit View Search Terminal Help
after 3309 requests (3309 known processed) with 0 events
captain@mountain:~/Documents/dedegol/master_thesis_adem/T10$ nc
10_P1.75.nc
Ncview 2.1.7 David W. Pierce 29 March 2016
http://meteora.ucsd.edu:80/~pierce/ncview_home_page.html
Copyright (C) 1993 through 2015, David W. Pierce
Ncview comes with ABSOLUTELY NO WARRANTY; for details type `ncview -w'.
This is free software licensed under the Gnu General Public License version 3; t
ype `ncview -c' for redistribution details.

calculating min and maxes for thk...
XIO: fatal IO error 11 (Resource temporarily unavailable) on X server ":0"
after 2859 requests (2859 known processed) with 0 events remaining.
captain@mountain:~/Documents/dedegol/master_thesis_adem/T10$ ncview ex_dedegol_T
10_P1.75.nc
Ncview 2.1.7 David W. Pierce 29 March 2016
http://meteora.ucsd.edu:80/~pierce/ncview_home_page.html
Copyright (C) 1993 through 2015, David W. Pierce
Ncview comes with ABSOLUTELY NO WARRANTY; for details type `ncview -w'.
This is free software licensed under the Gnu General Public License version 3; t
ype `ncview -c' for redistribution details.

calculating min and maxes for thk...

```

Grid: 565 x 565  
 Resolution: 30 m  
 16.92 x 16.92 km

**TeamViewer**  
 Free license (non-commercial use only)

Session list

Adem Candag (546 908 972)

www.teamviewer.com



# Paleoclimate Cases - Dedegöl Mountain

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	Mass Balance - <u>maximum</u> [mm/yr]						
	Temperature offset [°C]						
x P [mm/yr]	-8	-9	-10	-11	-12	-13	-14
0.50	-1141	-782	-476	-227	-2	188	287
0.75	-824	-447	-130	120	356	455	507
1.00	-507	-112	215	468	590	675	727
1.25	-189	223	562	696	804	895	947
1.50	128	557	807	905	1019	1115	1167
1.75	445	862	1045	1113	1233	1334	1387
2.00	762	1063	1222	1322	1448	1554	1606



# Dedegöl Mountain Paleoglaci- ers

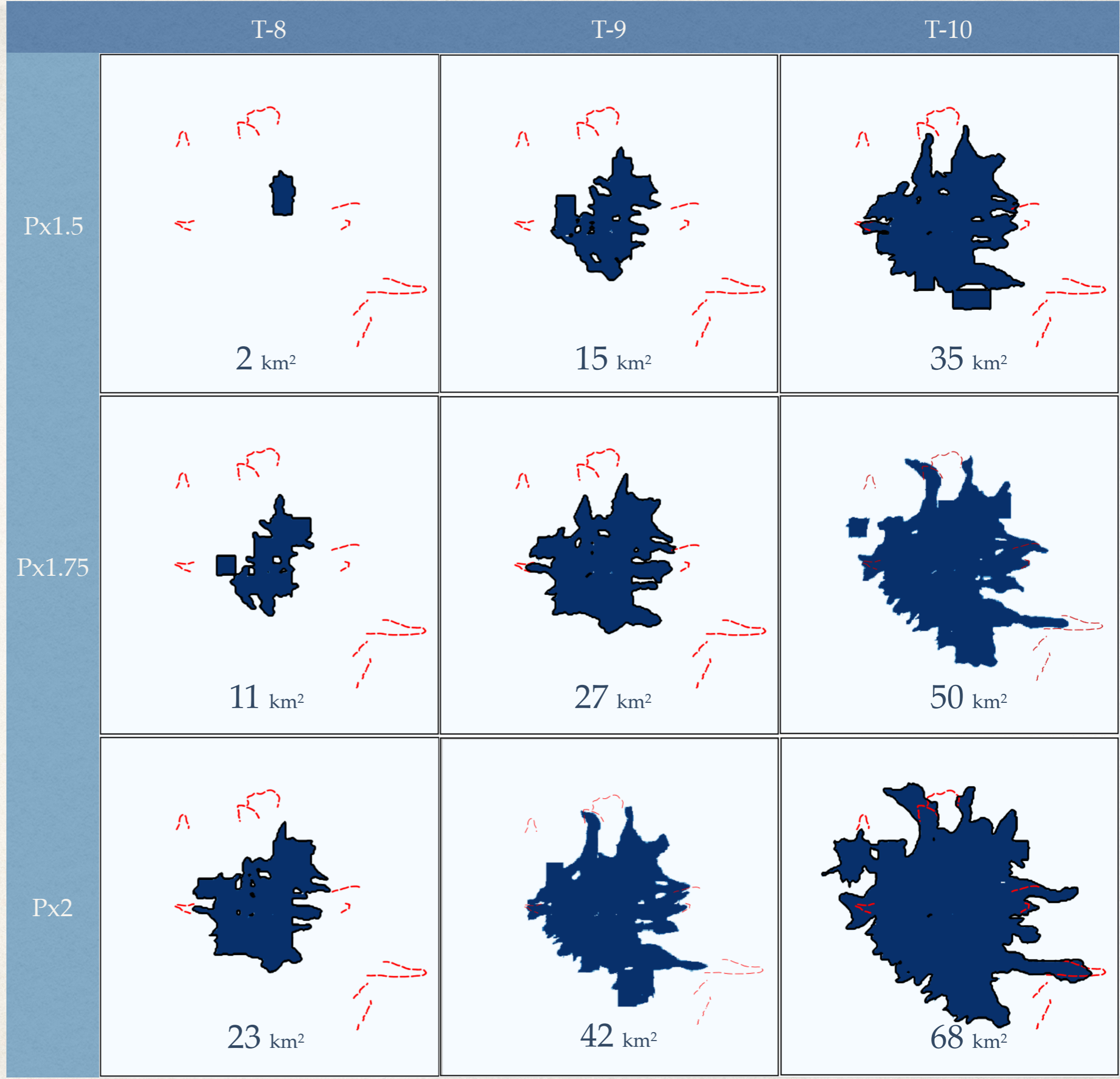
## Ice Area

T: Temperature  
Offset

P: Precipitation  
Multiplier

Grid: 565 x 565  
Resolution: 30 m  
16.92 x 16.92 km

North 





# Dedegöl Mountain Paleoglaciars

Px1.5

2

15

35

T: Temperature  
Offset

P: Precipitation  
Multiplier

Px1.75

11

27

50

Ice Area

Px2

23

42

68

T-8

T-9

T-10





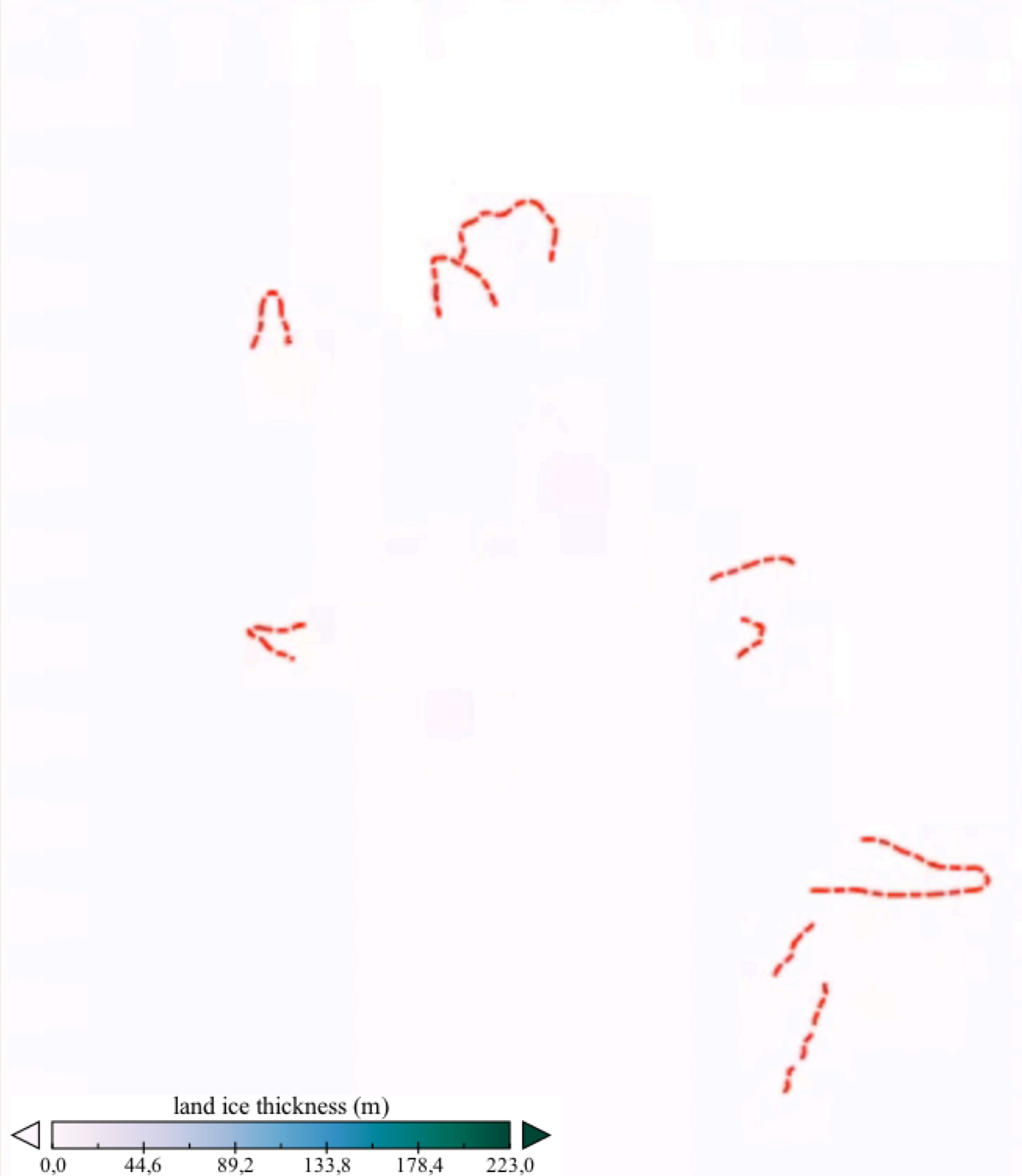
# Dedegöl Mountain

## Ice thickness

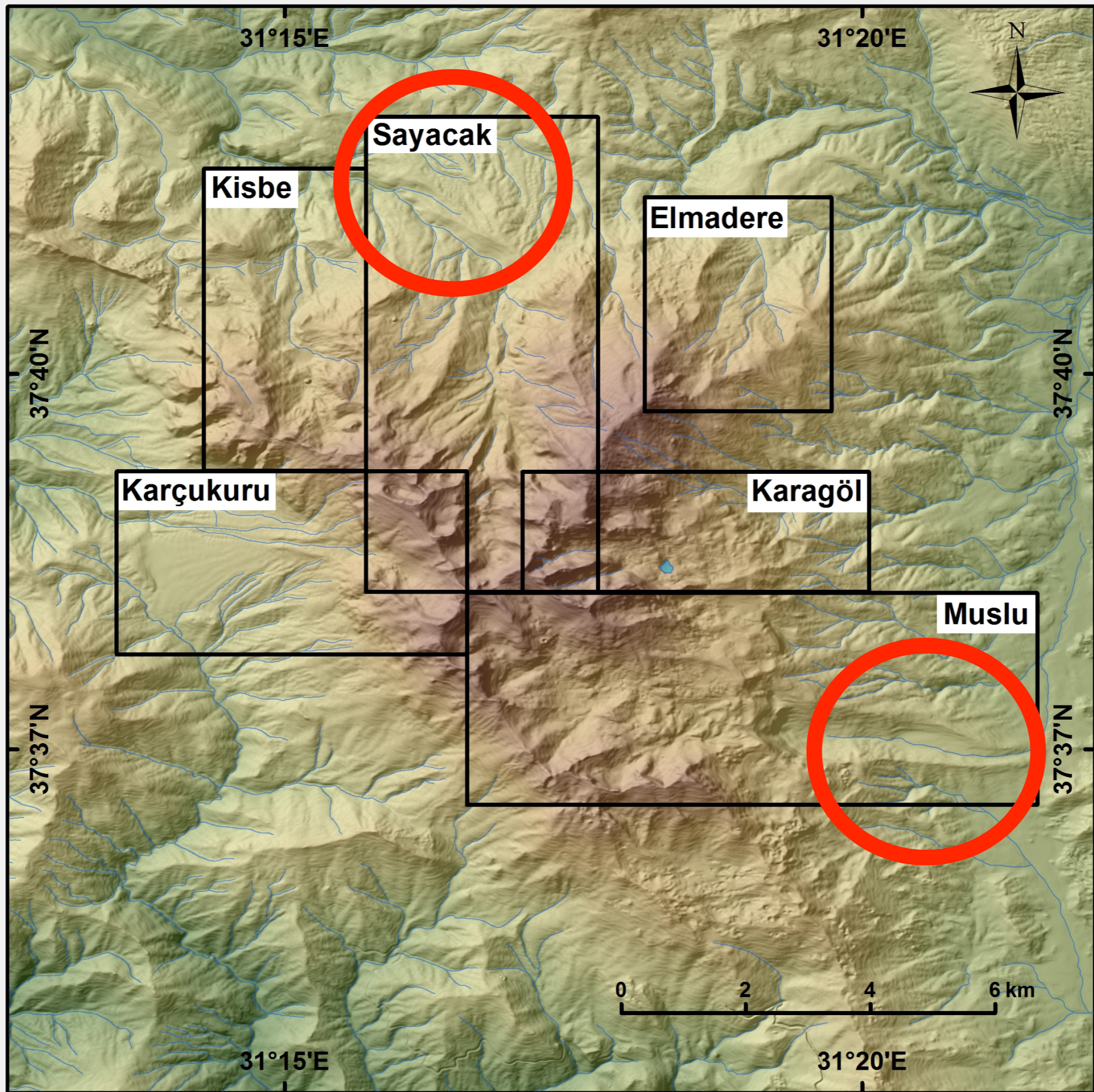
T -9 Px2

Grid: 565 x 565  
Resolution: 30 m  
16.92 x 16.92 km

North 







Sayacak and Muslu Valley - PISM



Sayacak Valley

Muslu Valley

Eldere

Kurucaov

© 2016 Basarsoft  
© 2016 Google  
Image © 2016 DigitalGlobe

Google Earth

4.50 km

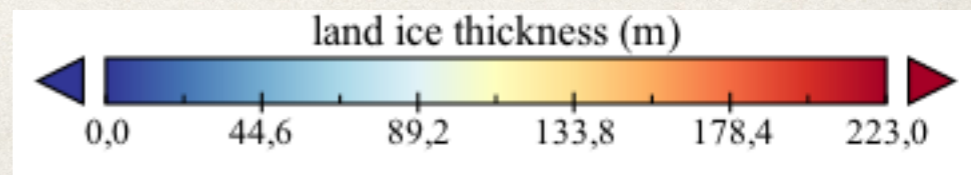
37°42'02.64"K 31°10'47.44"D yükseklik 1294 m göz hızası 20.67 km

Tur Rehberi

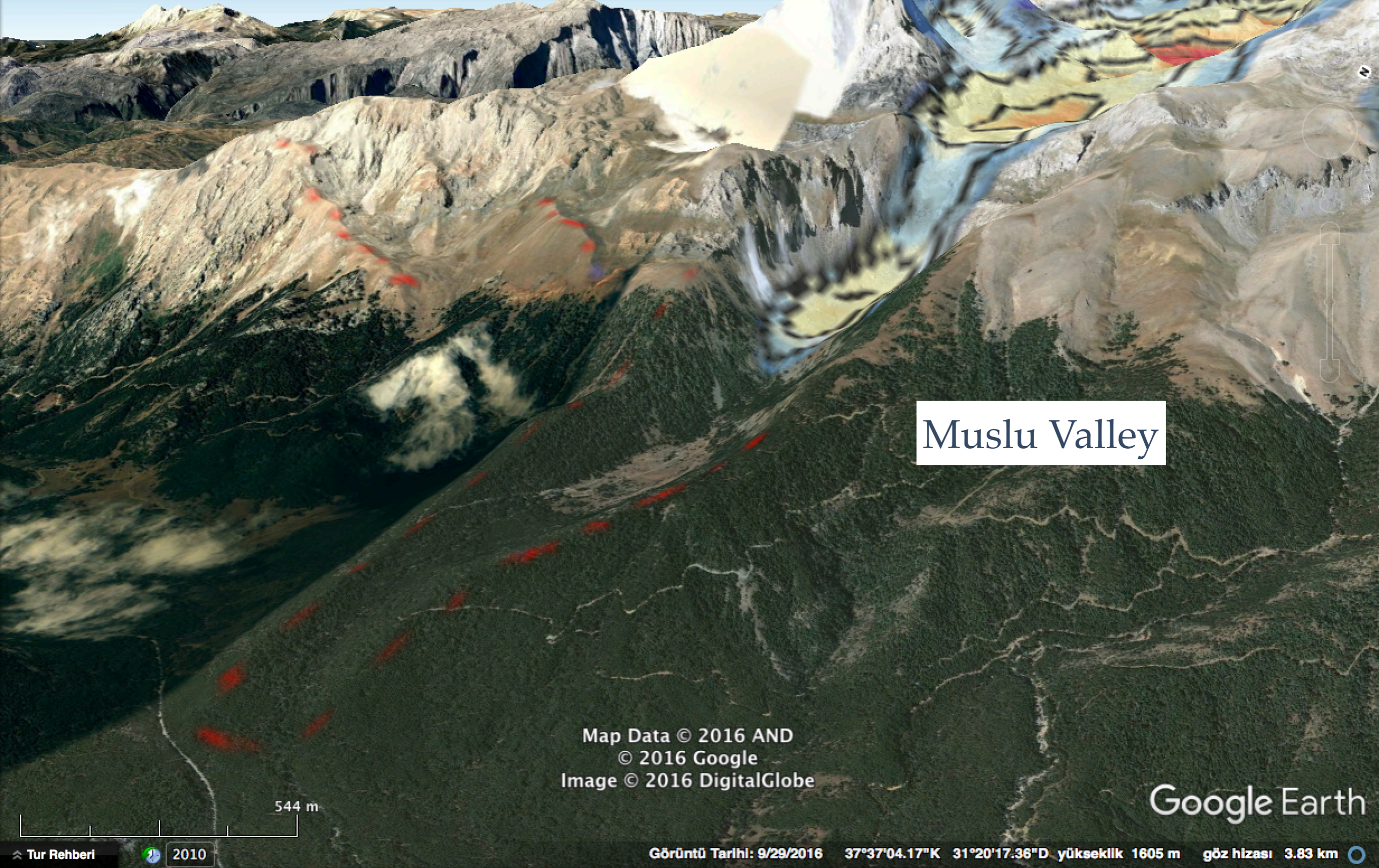
Güldallı

North 

T-9 Px2







# Muslu Valley

Map Data © 2016 AND  
© 2016 Google  
Image © 2016 DigitalGlobe

Google Earth

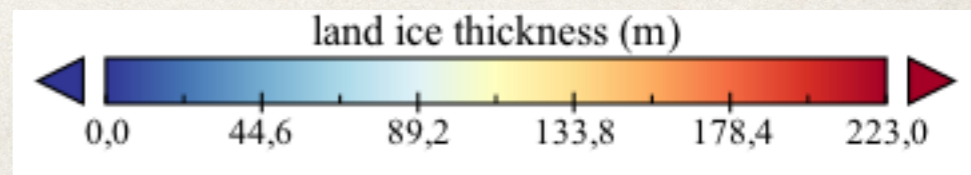
Tur Rehberi 2010

Görüntü Tarihi: 9/29/2016 37°37'04.17"K 31°20'17.36"D yükseklik 1605 m göz hizası 3.83 km

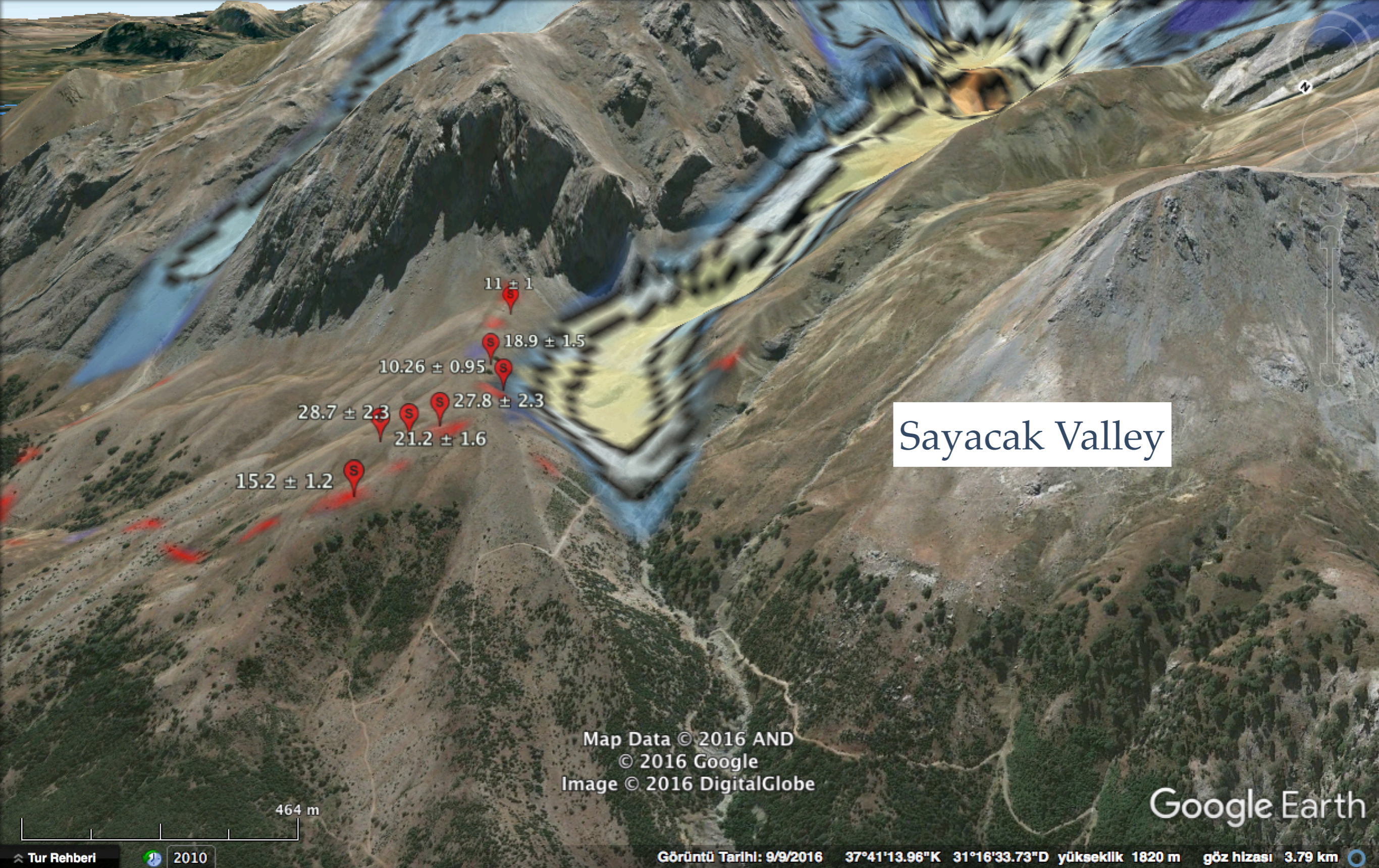
Zahno 2009:  $19.8 \pm 1.6$  ka  $17.7 \pm 1.4$  ka  $13.9 \pm 2.3$  ka

North 

## Muslu Valley: T-9 Px2

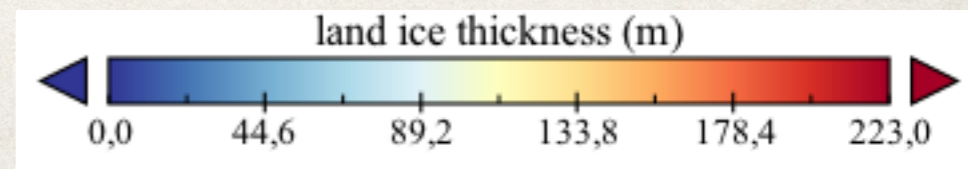




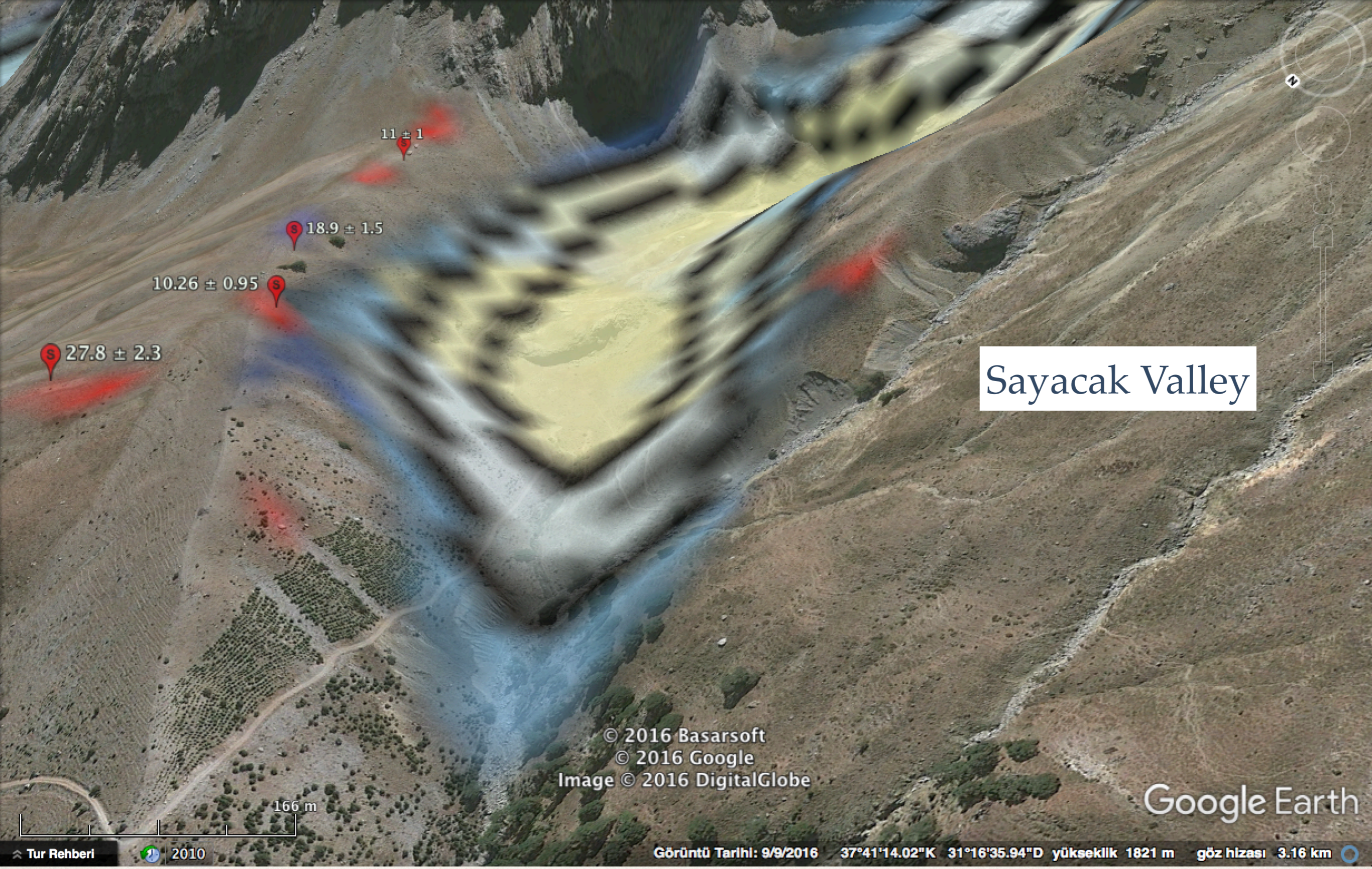


North 

## Sayacak Valley: T-9 Px2







# Sayacak Valley

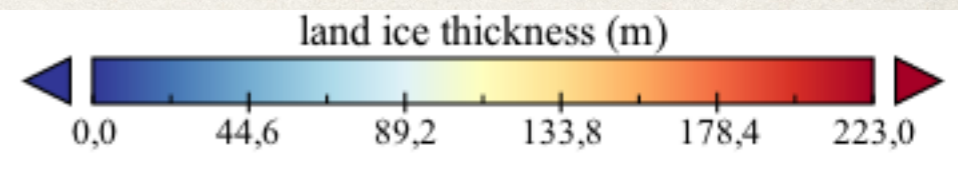
© 2016 Basarsoft  
© 2016 Google  
Image © 2016 DigitalGlobe

Google Earth

Tur Rehberi 2010 Görüntü Tarihi: 9/9/2016 37°41'14.02\"K 31°16'35.94\"D yükseklik 1821 m göz hızası 3.16 km

North 

## Sayacak Valley: T-9 Px2





# Conclusion

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- ❖ Sayacak Valley:  $T < -9$ ;  $P < x2$
- ❖ Muslu Valley:  $T < -9$ ;  $P > x2$
- ❖ Need to topographic correction
- ❖ Parallel Ice Sheet Modeling - PISM: jointly developed at the University of Alaska, Fairbanks the Potsdam Institute for Climate Impact Research: [www.pism-docs.org](http://www.pism-docs.org)
- ❖ Supported by Tübitak 114Y548 Project
- ❖ e-mail: [candas@itu.edu.tr](mailto:candas@itu.edu.tr)

