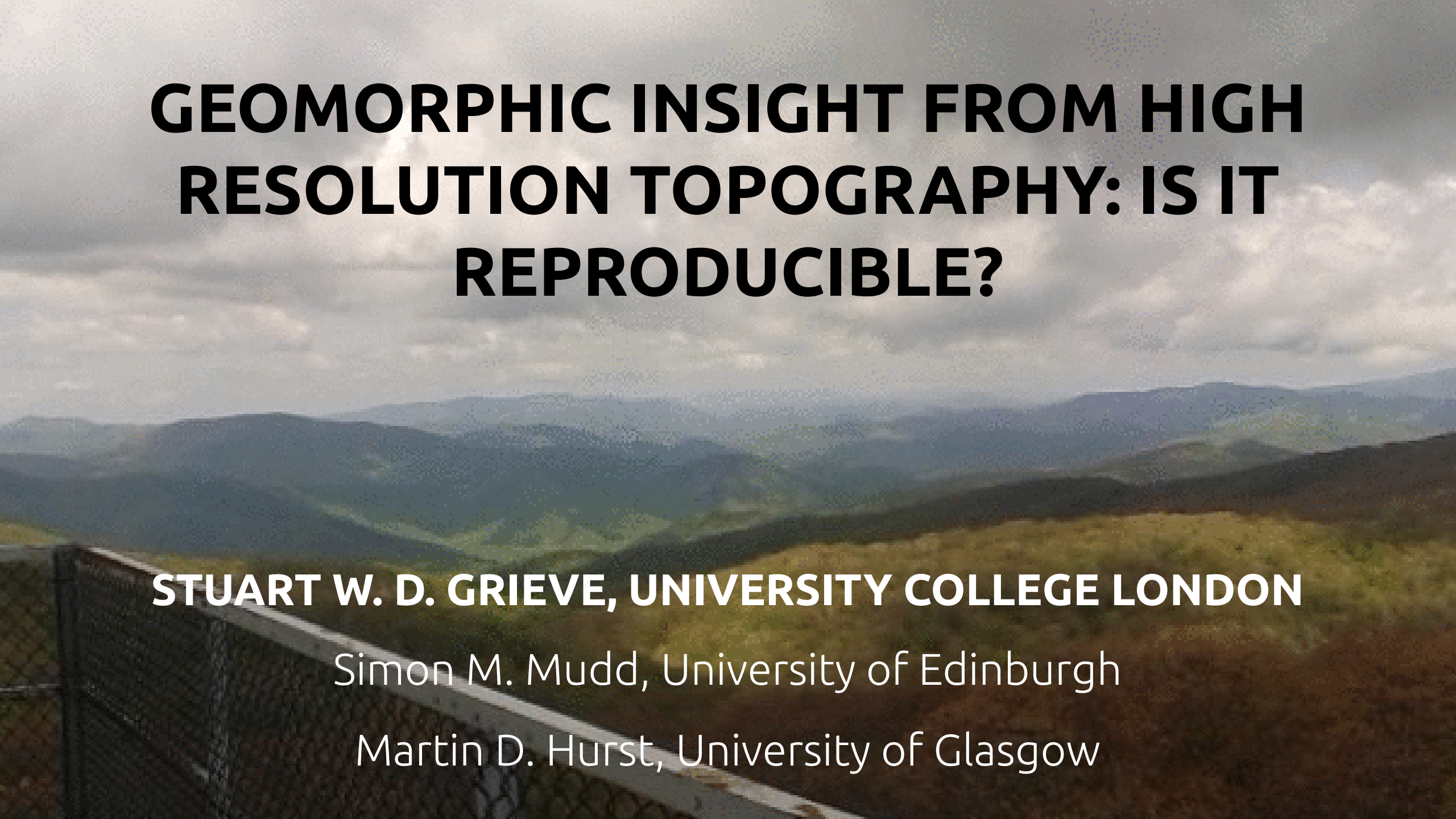

GEOMORPHIC INSIGHT FROM HIGH RESOLUTION TOPOGRAPHY: IS IT REPRODUCIBLE?

STUART W. D. GRIEVE, UNIVERSITY COLLEGE LONDON

Simon M. Mudd, University of Edinburgh

Martin D. Hurst, University of Glasgow

OVERVIEW

OVERVIEW

1. HOW LONG IS A HILLSLOPE?

OVERVIEW

1. HOW LONG IS A HILLSLOPE?
2. REPRODUCIBLE TOPOGRAPHIC ANALYSIS

WHAT CAN TOPOGRAPHY TELL US QUANTITATIVELY ABOUT PROCESS?

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SEDIMENT FLUX

Volume of sediment transported on a hillslope per unit area in a period of time

Sediment flux controls:

SEDIMENT FLUX

Volume of sediment transported on a hillslope per unit area in a period of time

Sediment flux controls:

- Geometry of hillslopes

SEDIMENT FLUX

Volume of sediment transported on a hillslope per unit area in a period of time

Sediment flux controls:

- Geometry of hillslopes
- Landscape response to climate and tectonic forcing

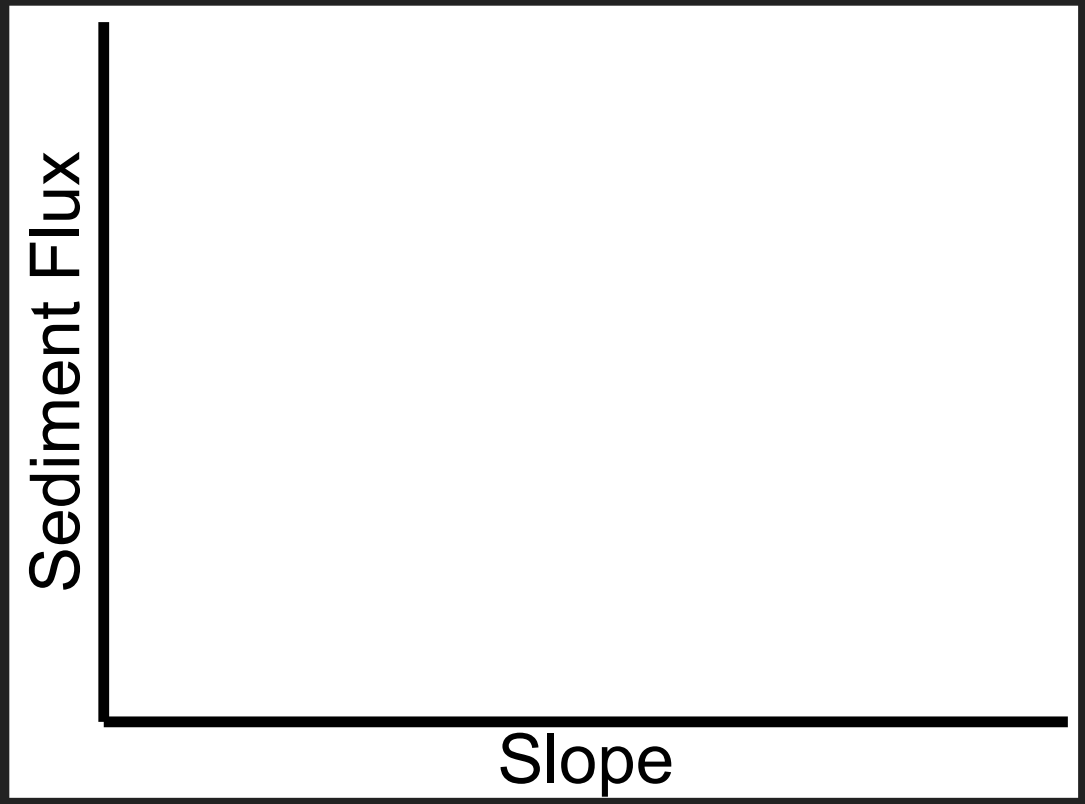
SEDIMENT FLUX

Volume of sediment transported on a hillslope per unit area in a period of time

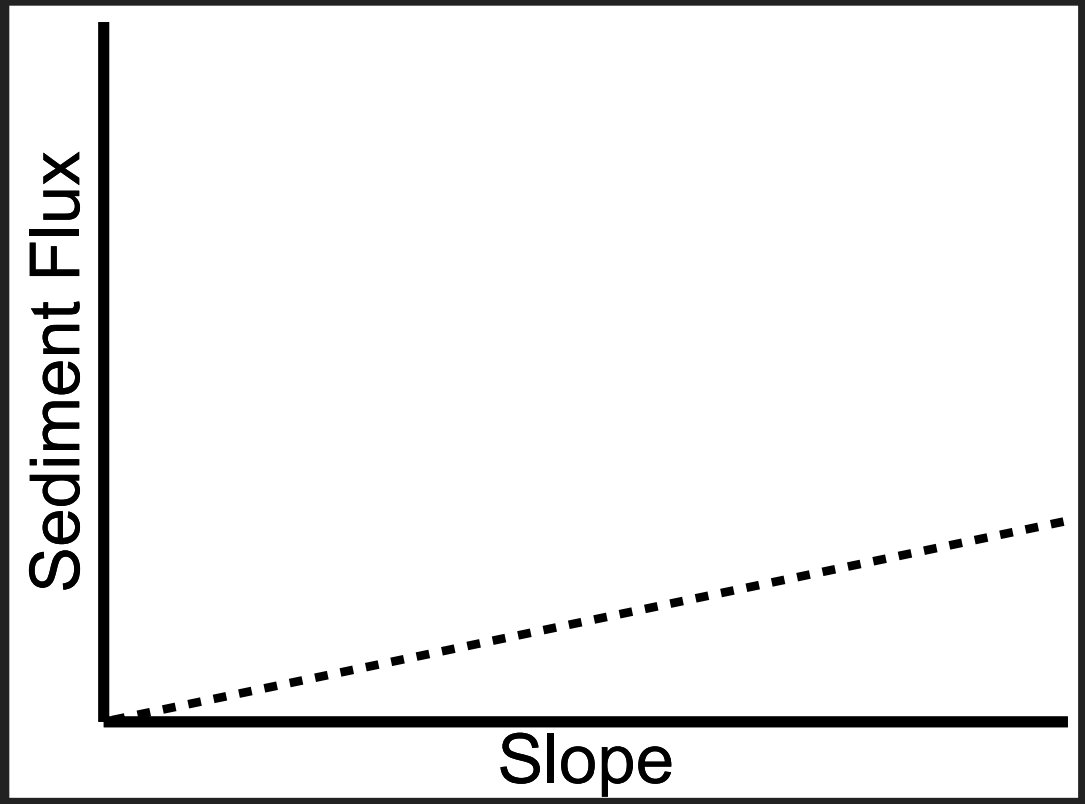
Sediment flux controls:

- Geometry of hillslopes
- Landscape response to climate and tectonic forcing
- Landscape evolution modelling

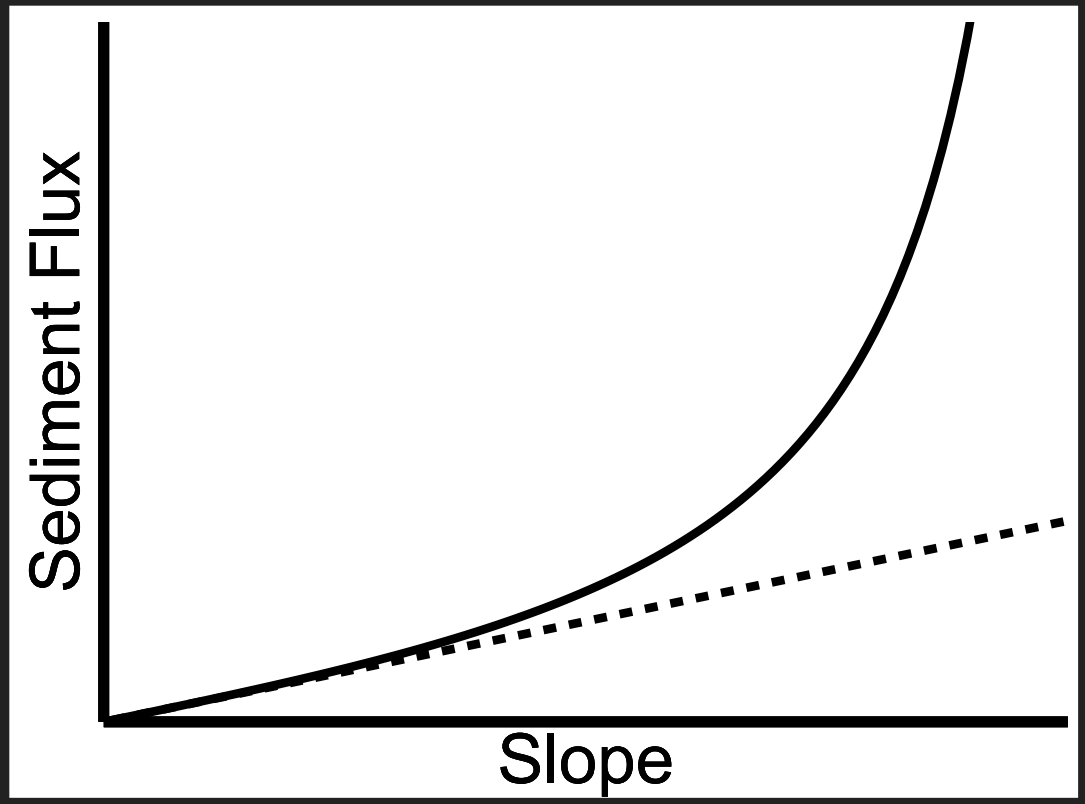
SEDIMENT FLUX LAWS



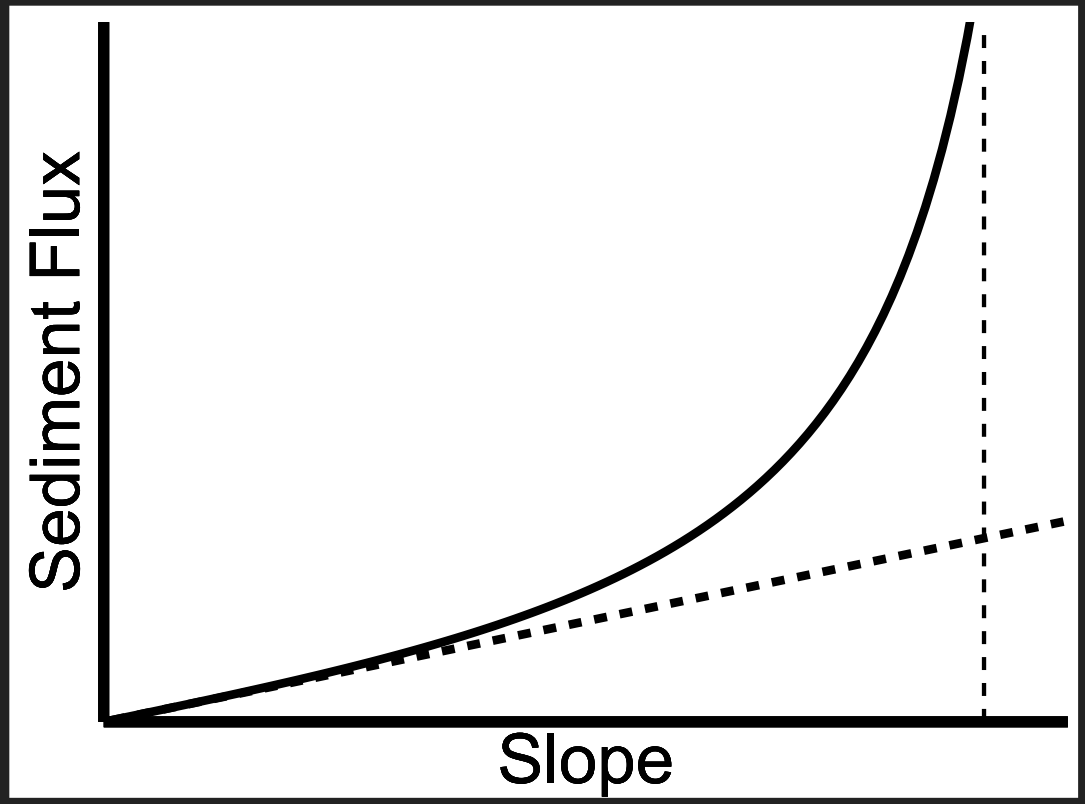
SEDIMENT FLUX LAWS



SEDIMENT FLUX LAWS

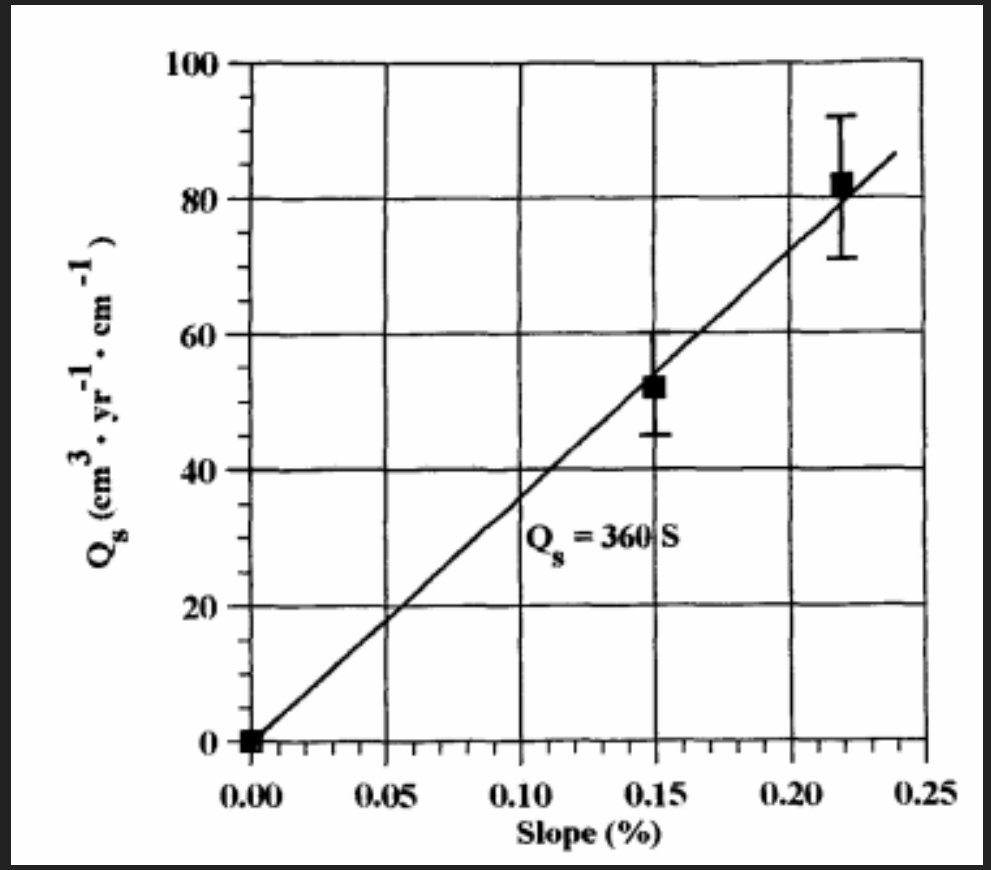


SEDIMENT FLUX LAWS

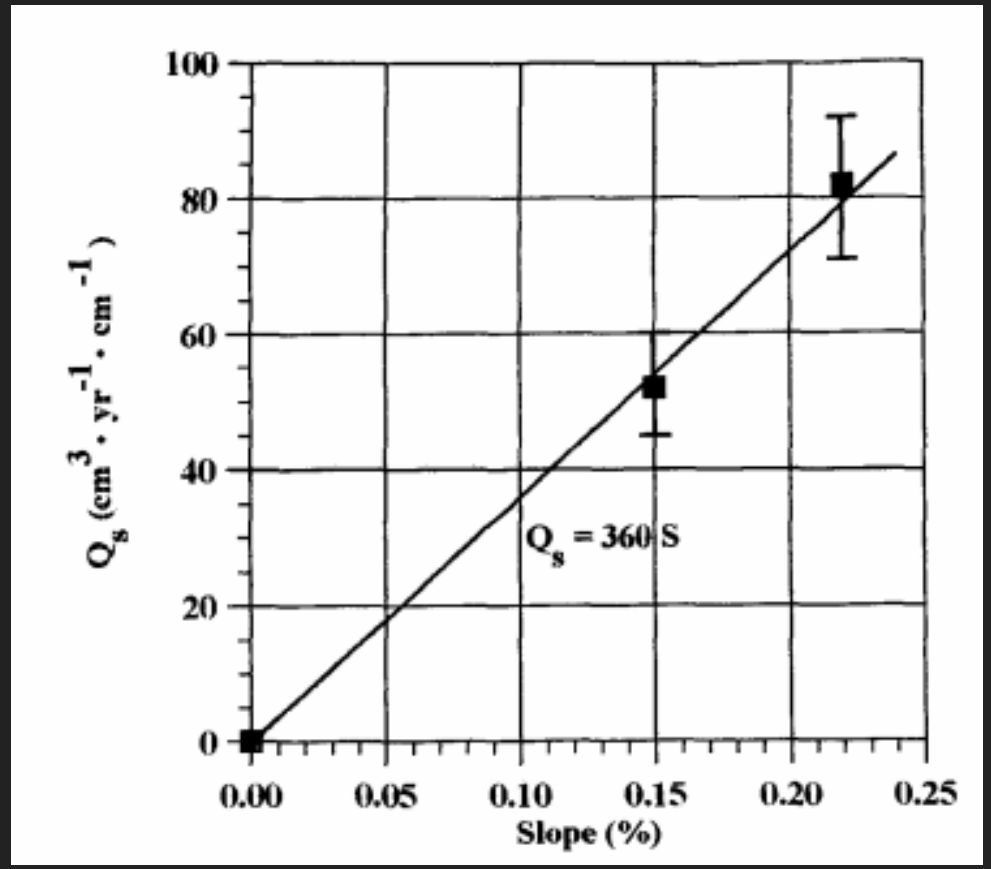


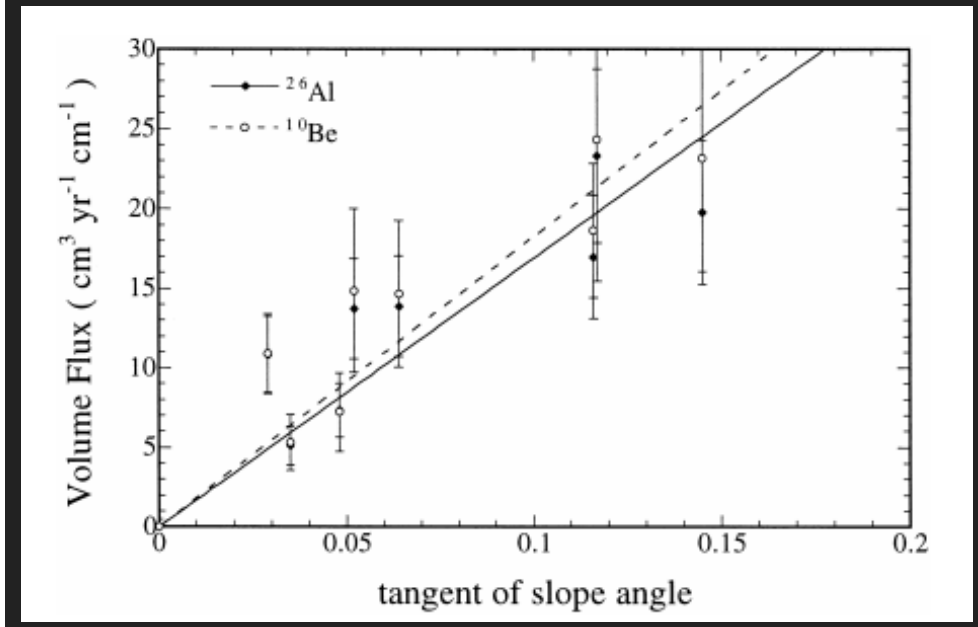
CONSTRAINING LINEAR FLUX

CONSTRAINING LINEAR FLUX



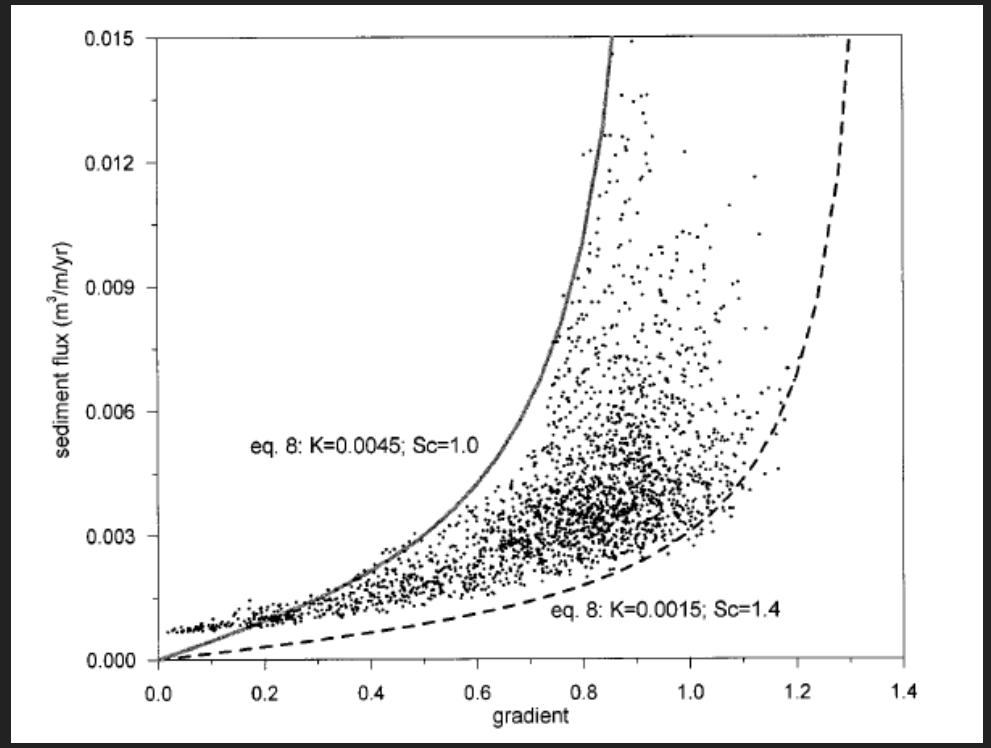
CONSTRAINING LINEAR FLUX



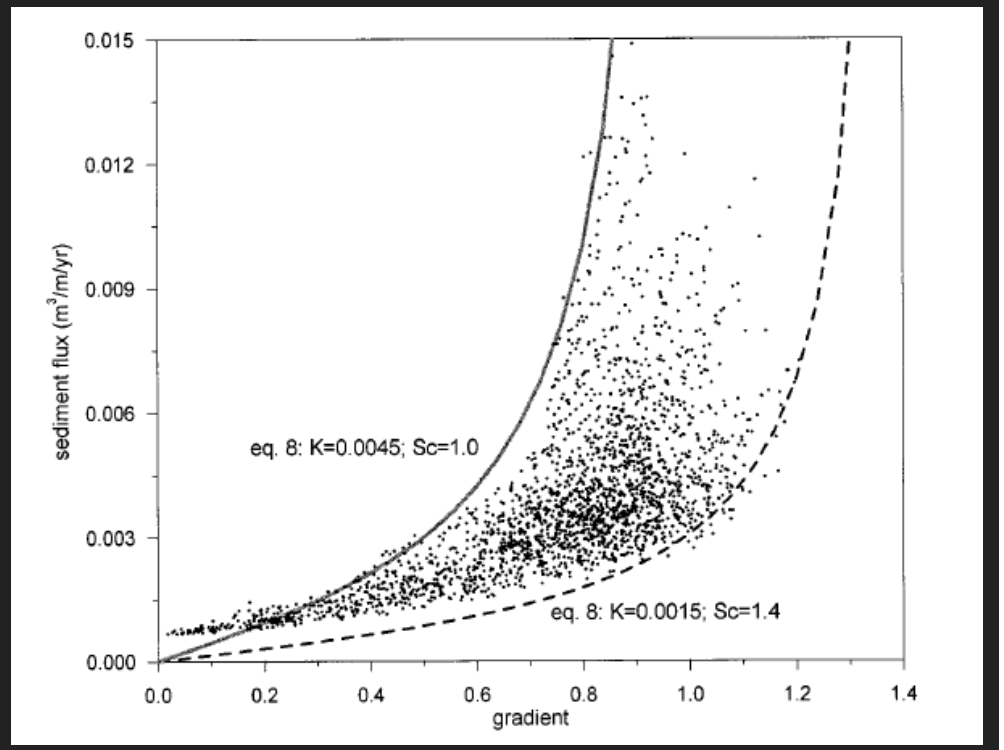


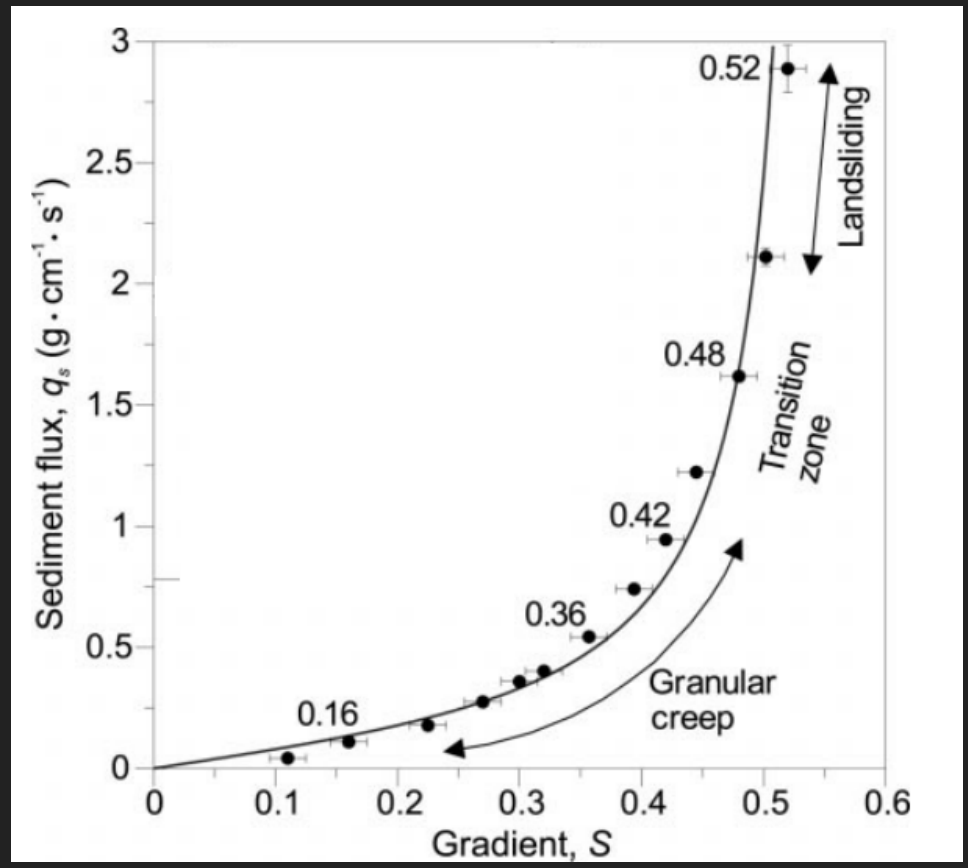
CONSTRAINING NONLINEAR FLUX

CONSTRAINING NONLINEAR FLUX

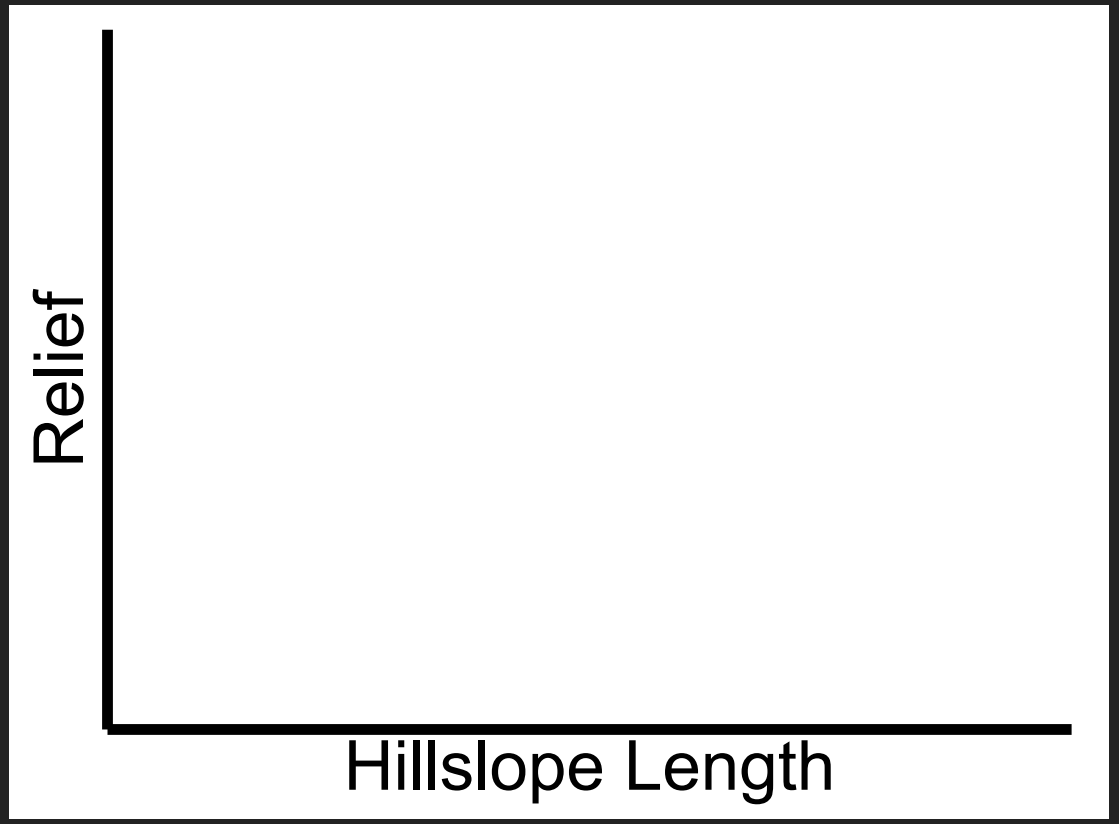


CONSTRAINING NONLINEAR FLUX

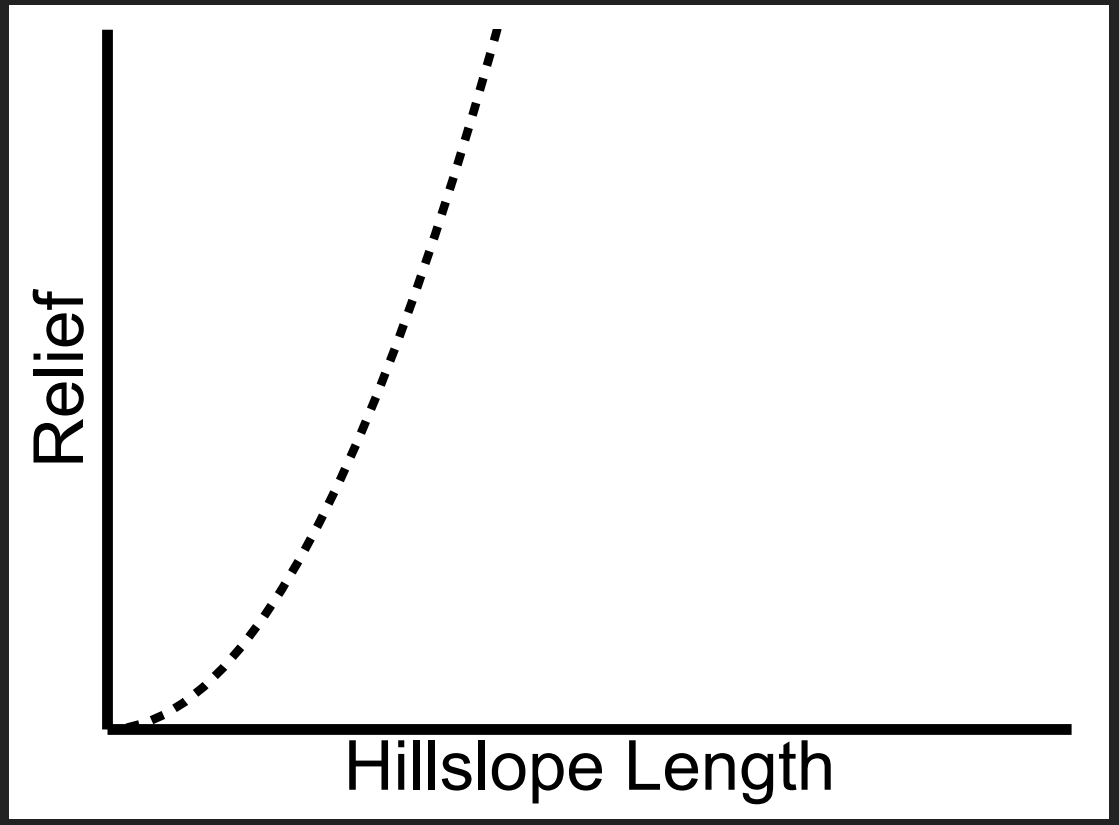




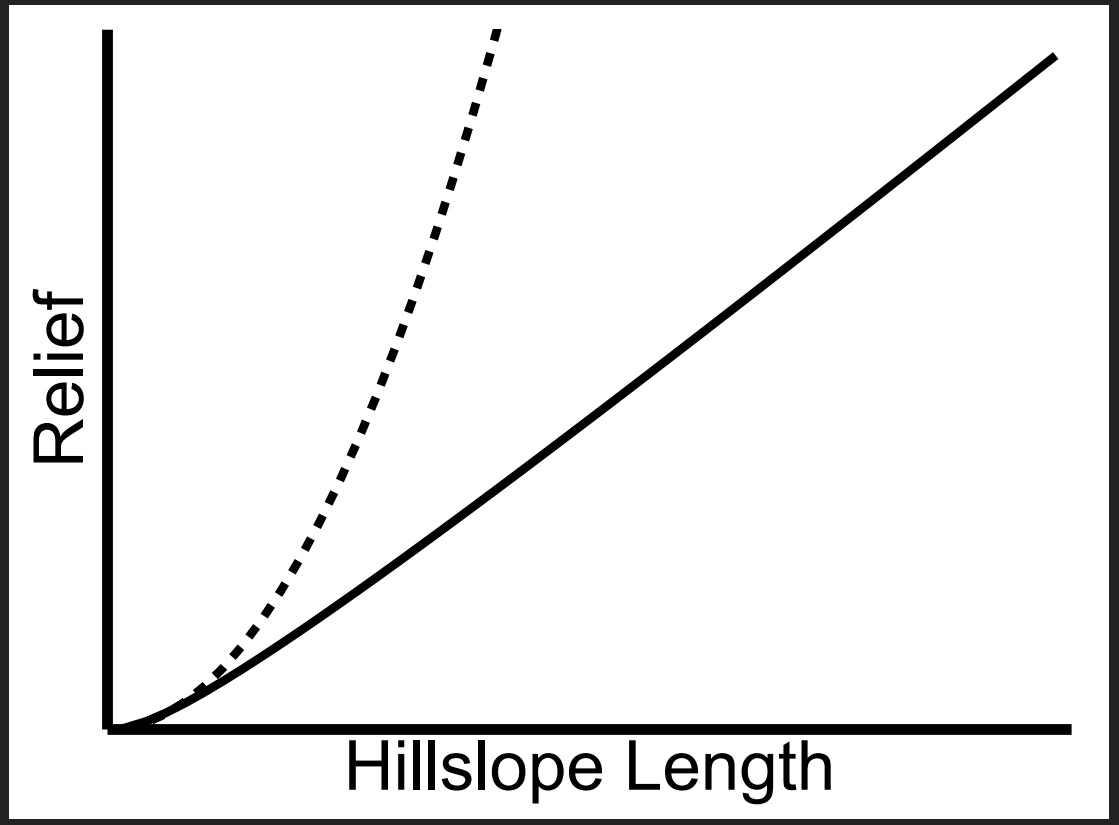
PREDICTIONS OF THE RELIEF STRUCTURE OF LANDSCAPES



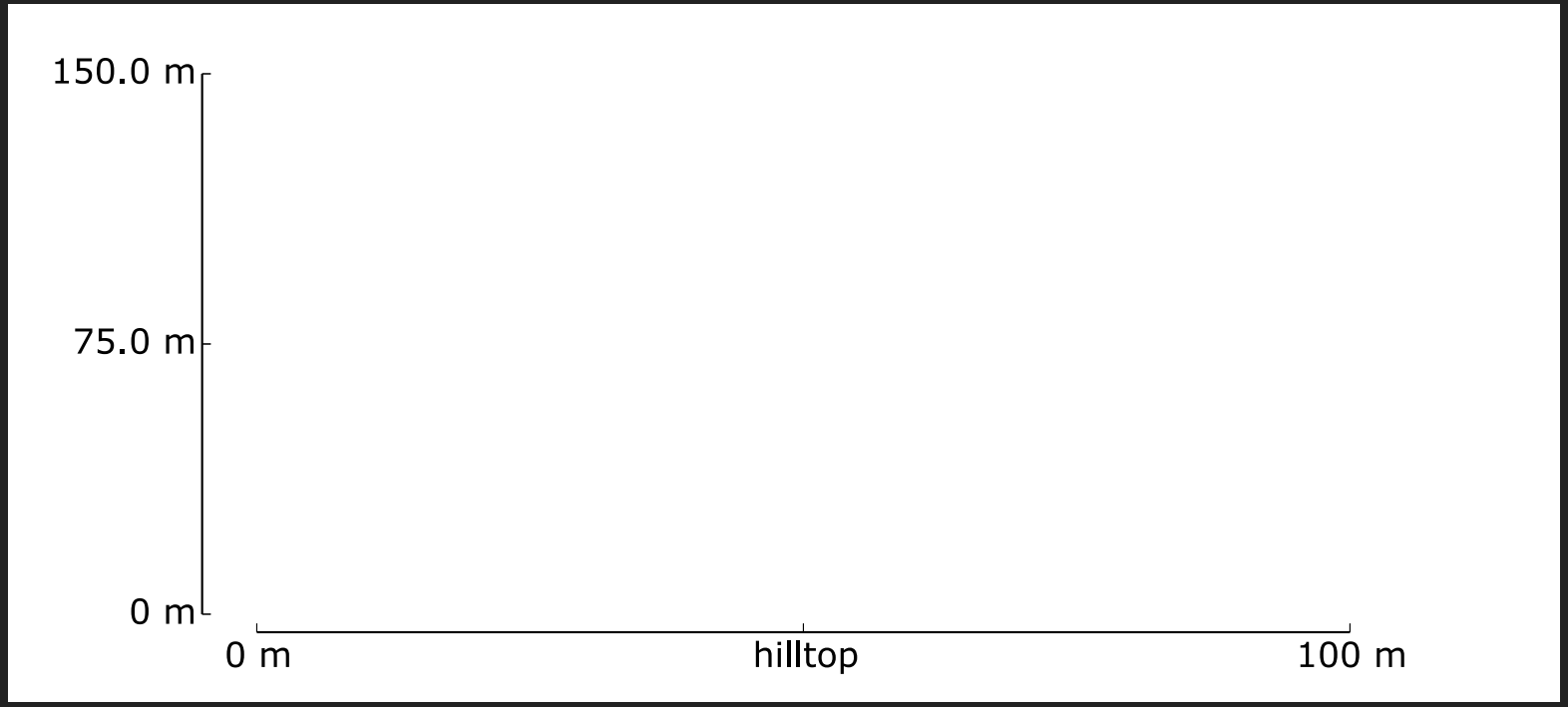
PREDICTIONS OF THE RELIEF STRUCTURE OF LANDSCAPES



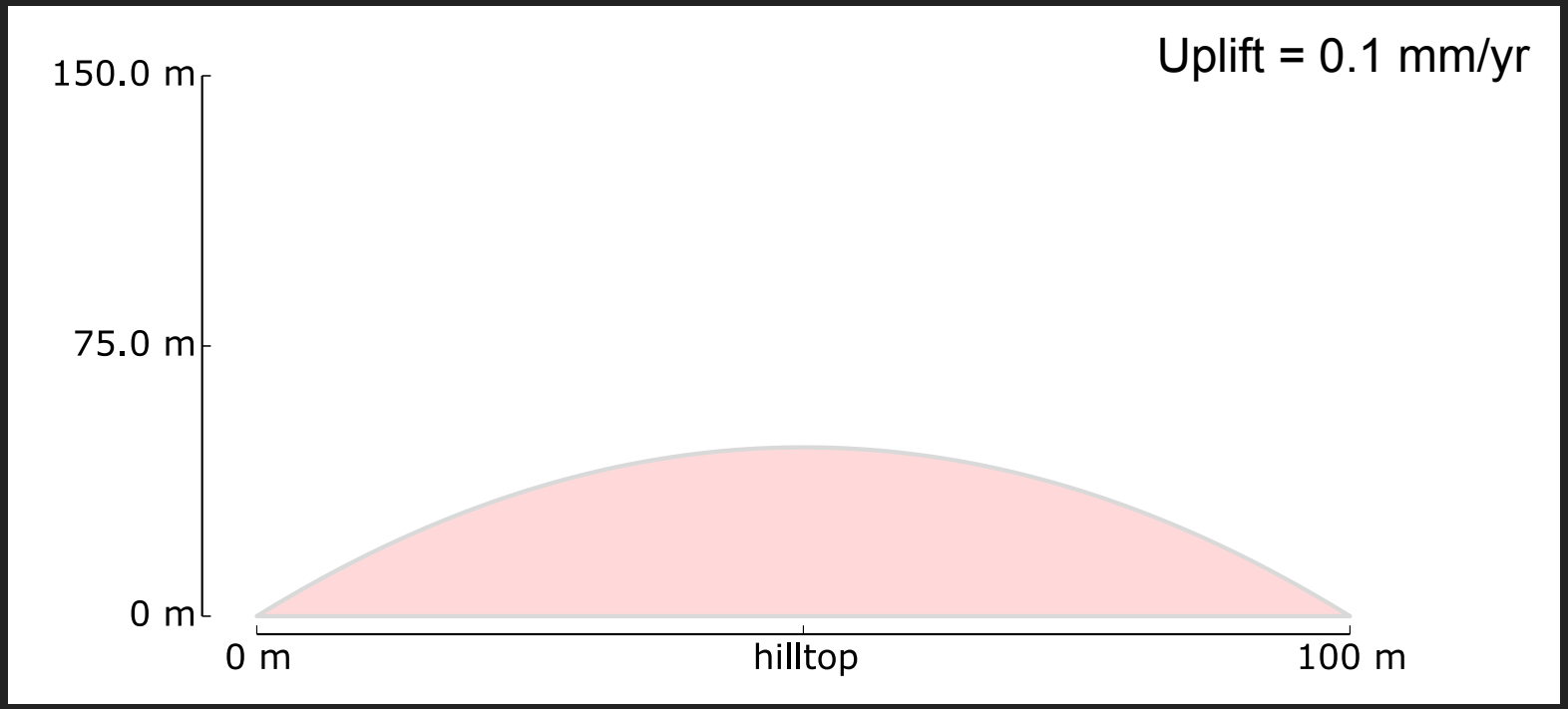
PREDICTIONS OF THE RELIEF STRUCTURE OF LANDSCAPES



TOPOGRAPHIC PREDICTIONS OF LINEAR SEDIMENT FLUX



TOPOGRAPHIC PREDICTIONS OF LINEAR SEDIMENT FLUX



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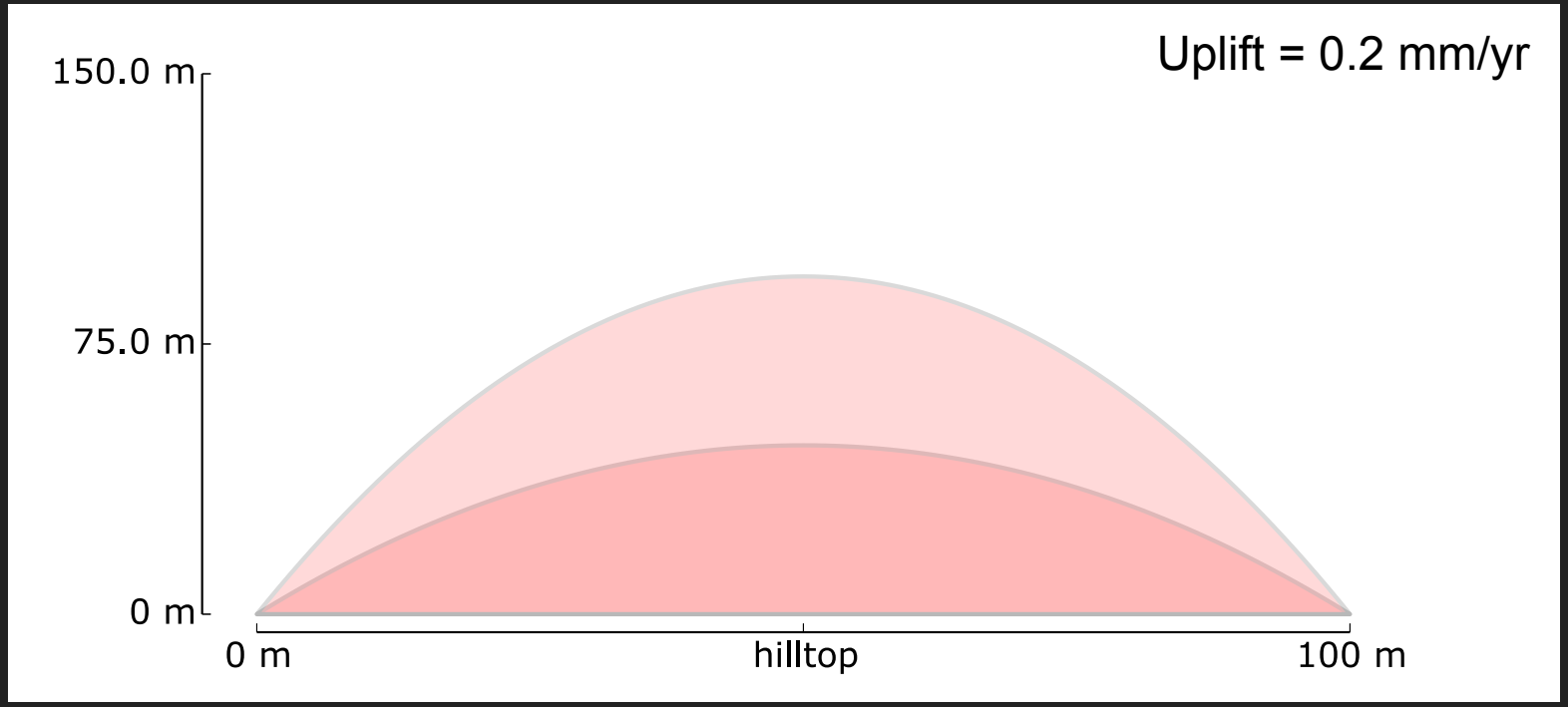
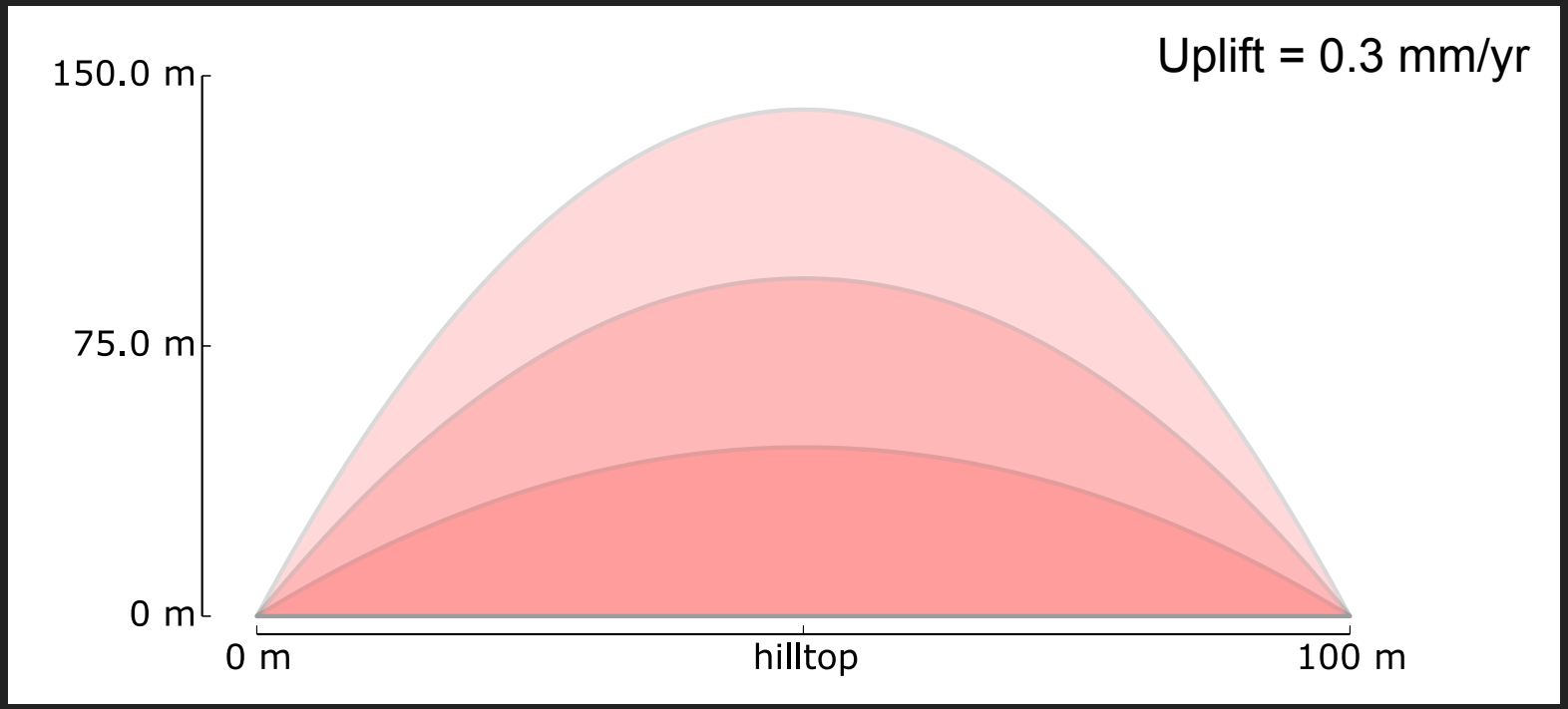
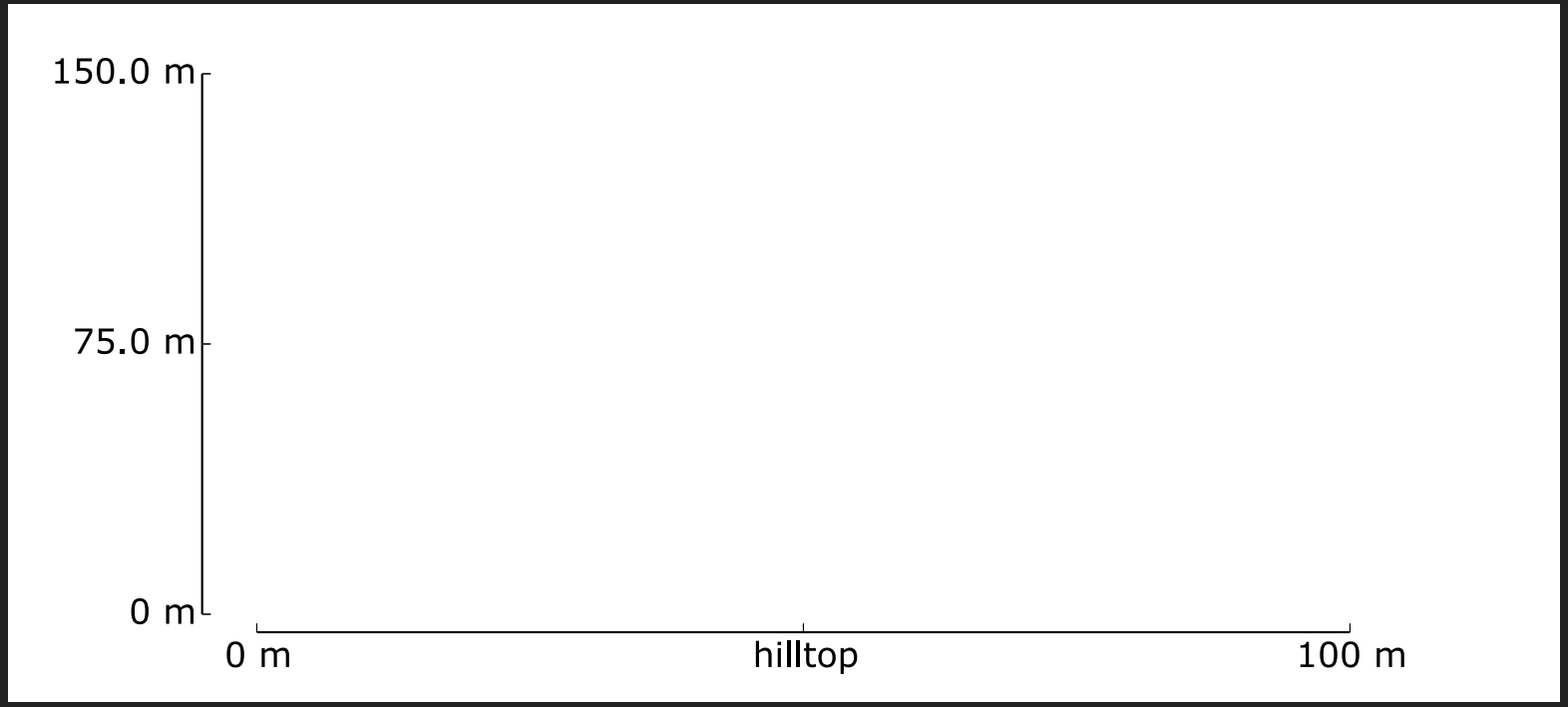


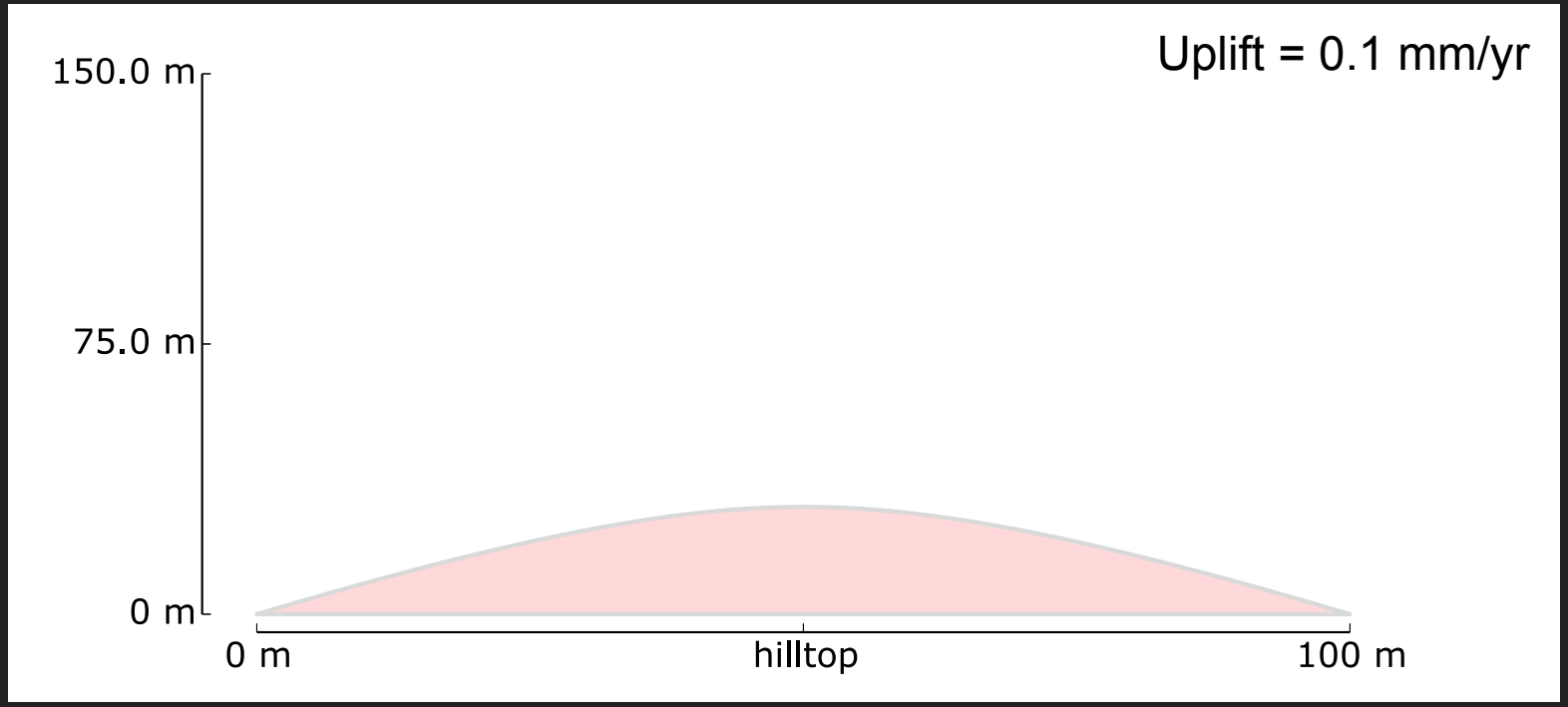
TOPOGRAPHIC PREDICTIONS OF LINEAR SEDIMENT FLUX



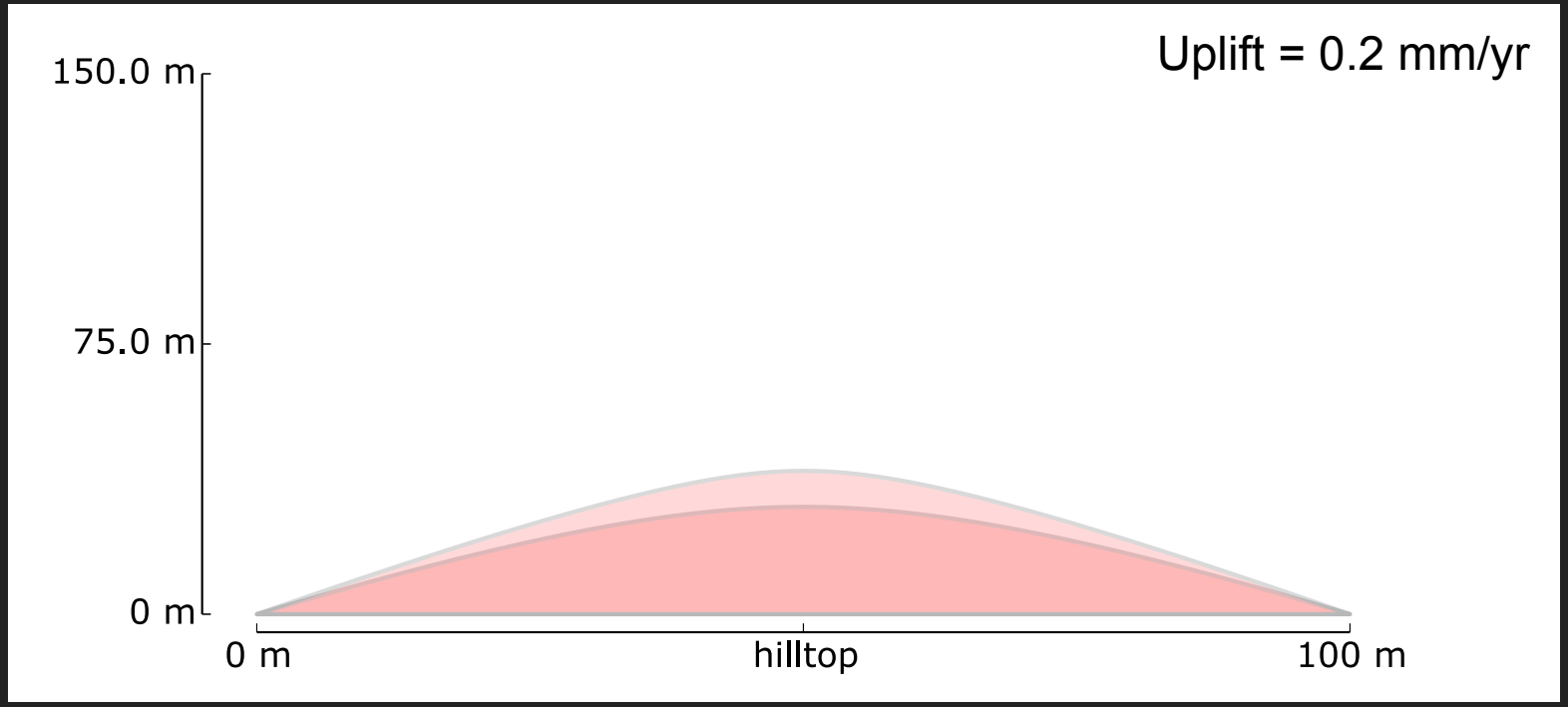
TOPOGRAPHIC PREDICTIONS OF NONLINEAR SEDIMENT FLUX



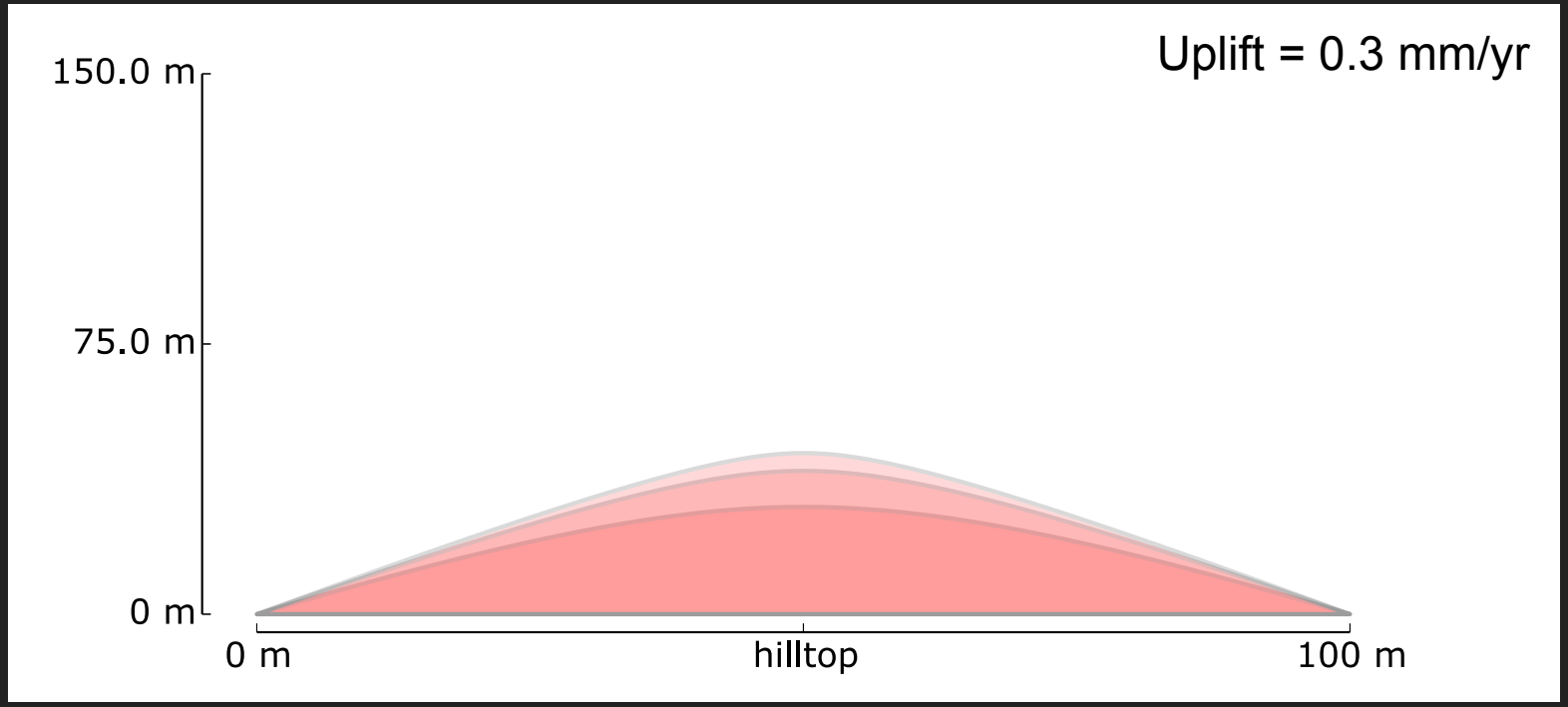
TOPOGRAPHIC PREDICTIONS OF NONLINEAR SEDIMENT FLUX



TOPOGRAPHIC PREDICTIONS OF NONLINEAR SEDIMENT FLUX



TOPOGRAPHIC PREDICTIONS OF NONLINEAR SEDIMENT FLUX



IF WE CAN MEASURE HILLSLOPE LENGTH AND RELIEF WE CAN LOOK FOR THIS RELATIONSHIP ACROSS A LANDSCAPE

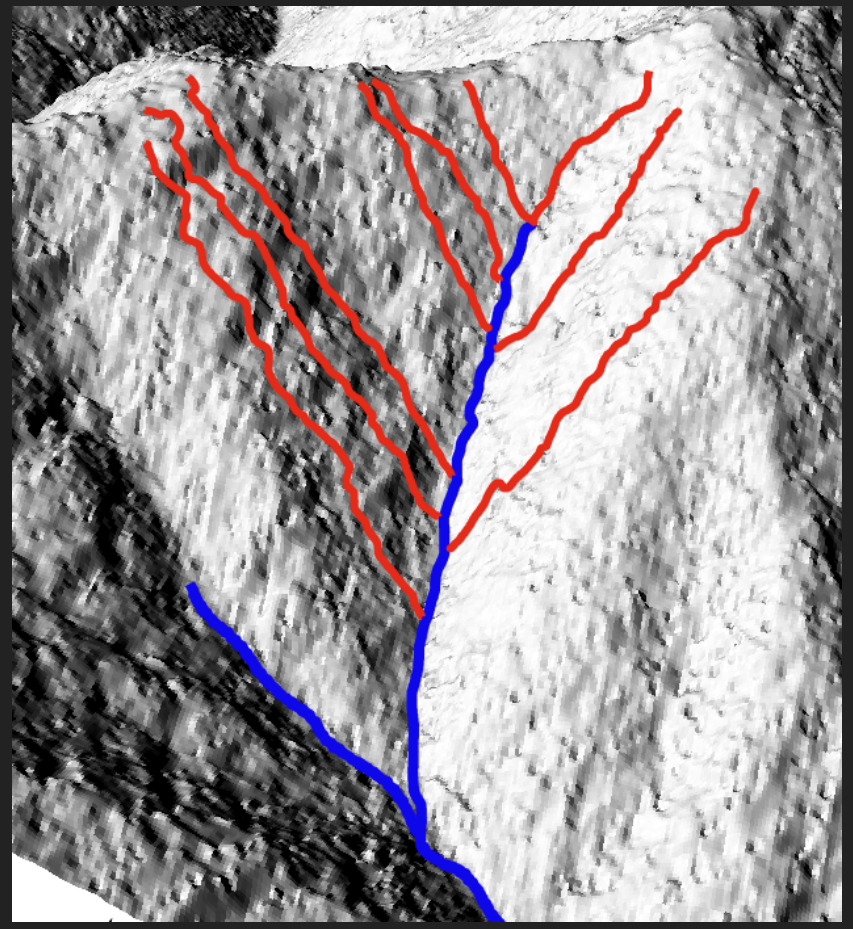
MEASURING HILLSLOPE LENGTH AND RELIEF

Measure hillslope length as a flow path

Connect ridges to channels

Get hilltop to channel relief

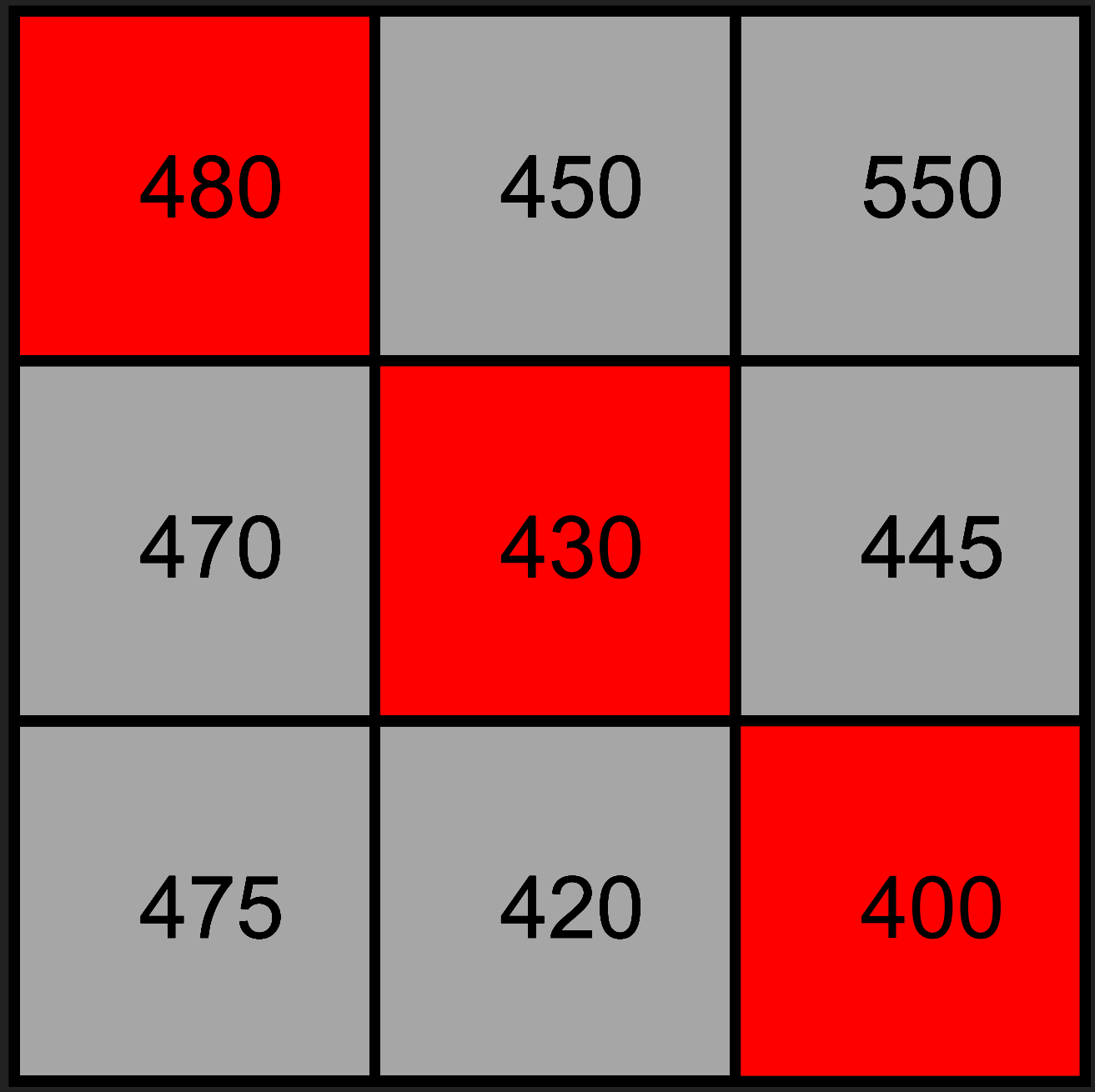
Allows us to test the relationship between relief and hillslope length



480	450	550
470	430	445
475	420	400

480	450	550
470	430	445
475	420	400

480	450	550
470	430	445
475	420	400


480
450
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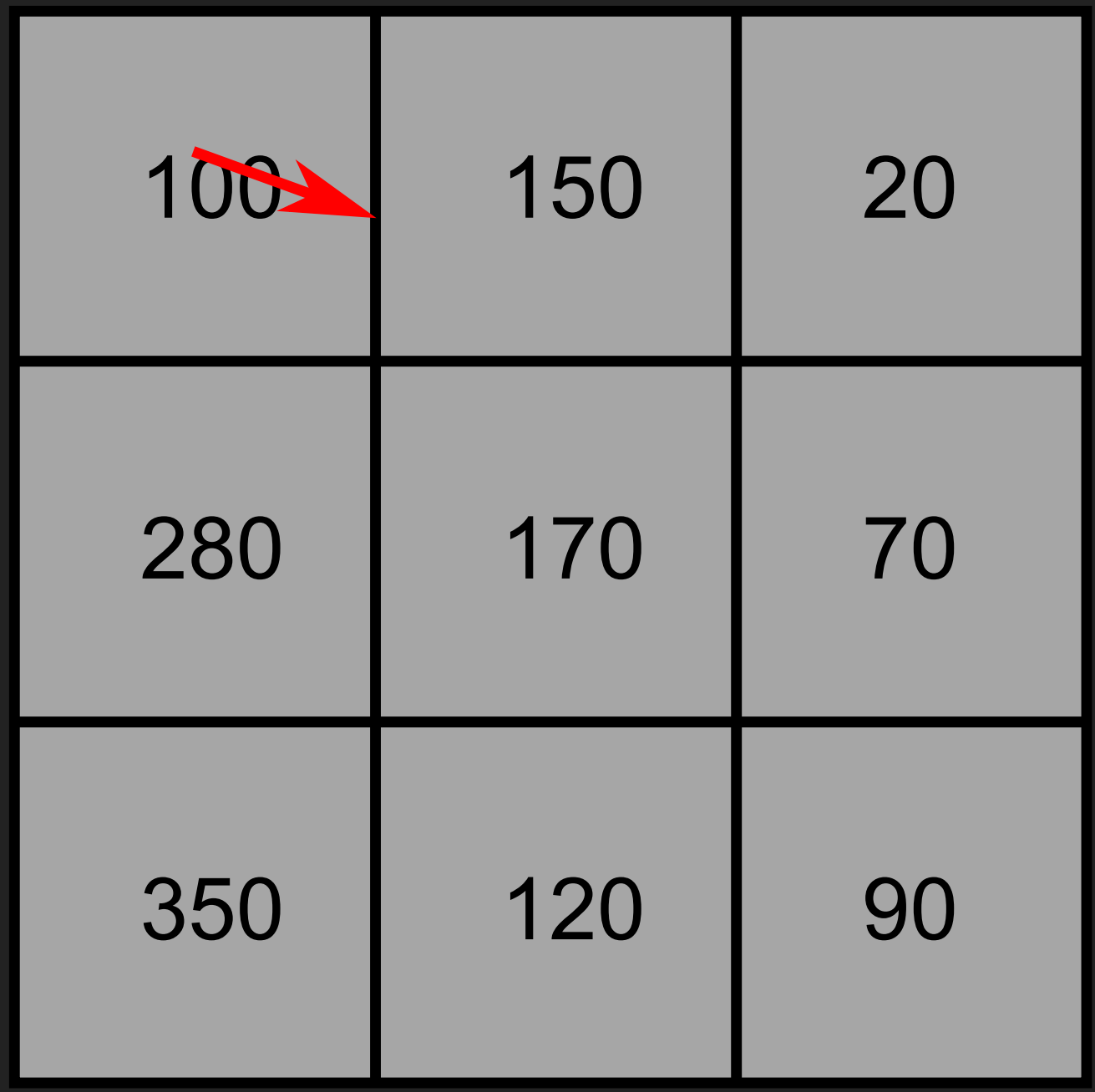
470
430
445
475
420
400

100	150	20
280	170	70
350	120	90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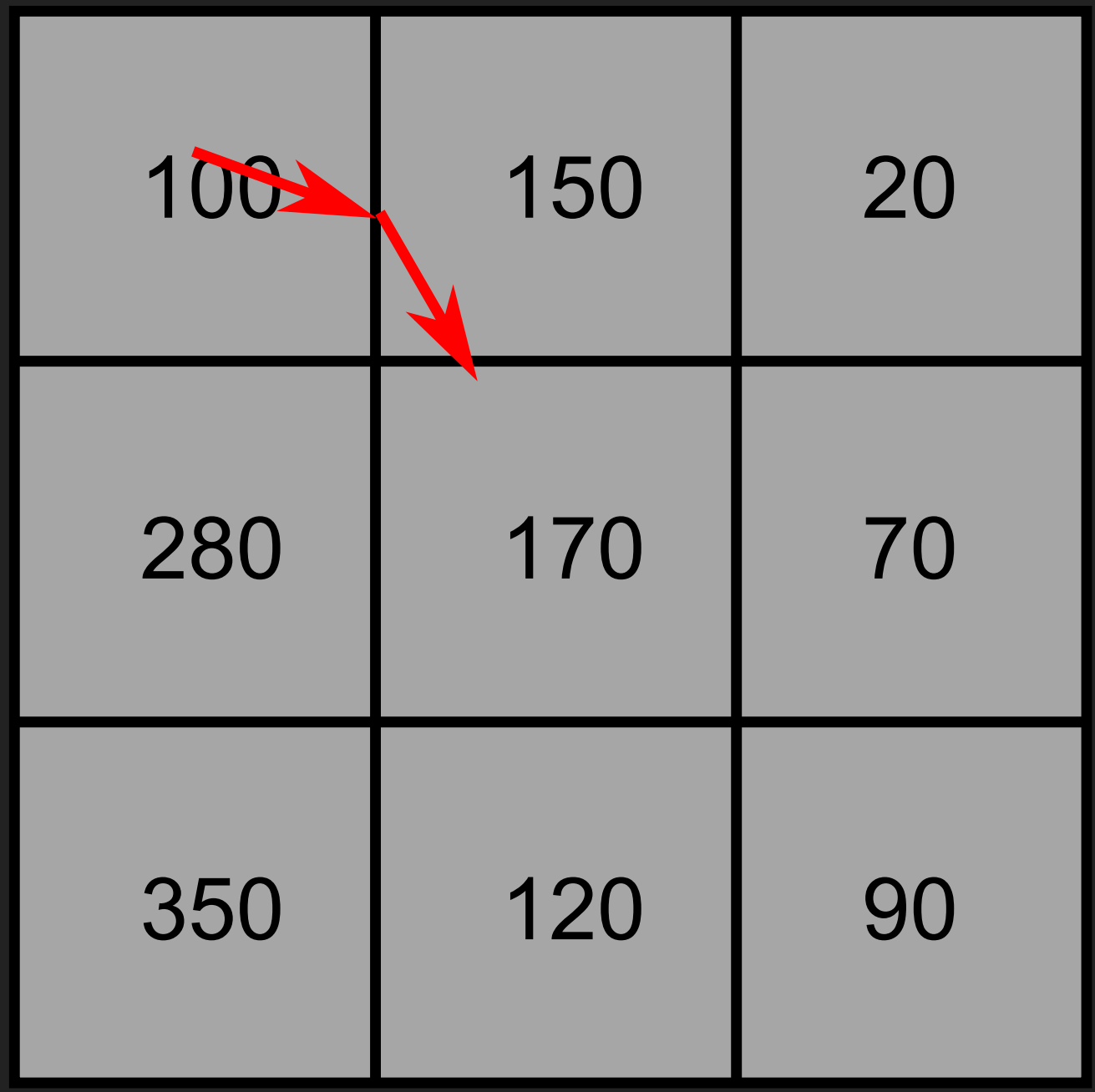
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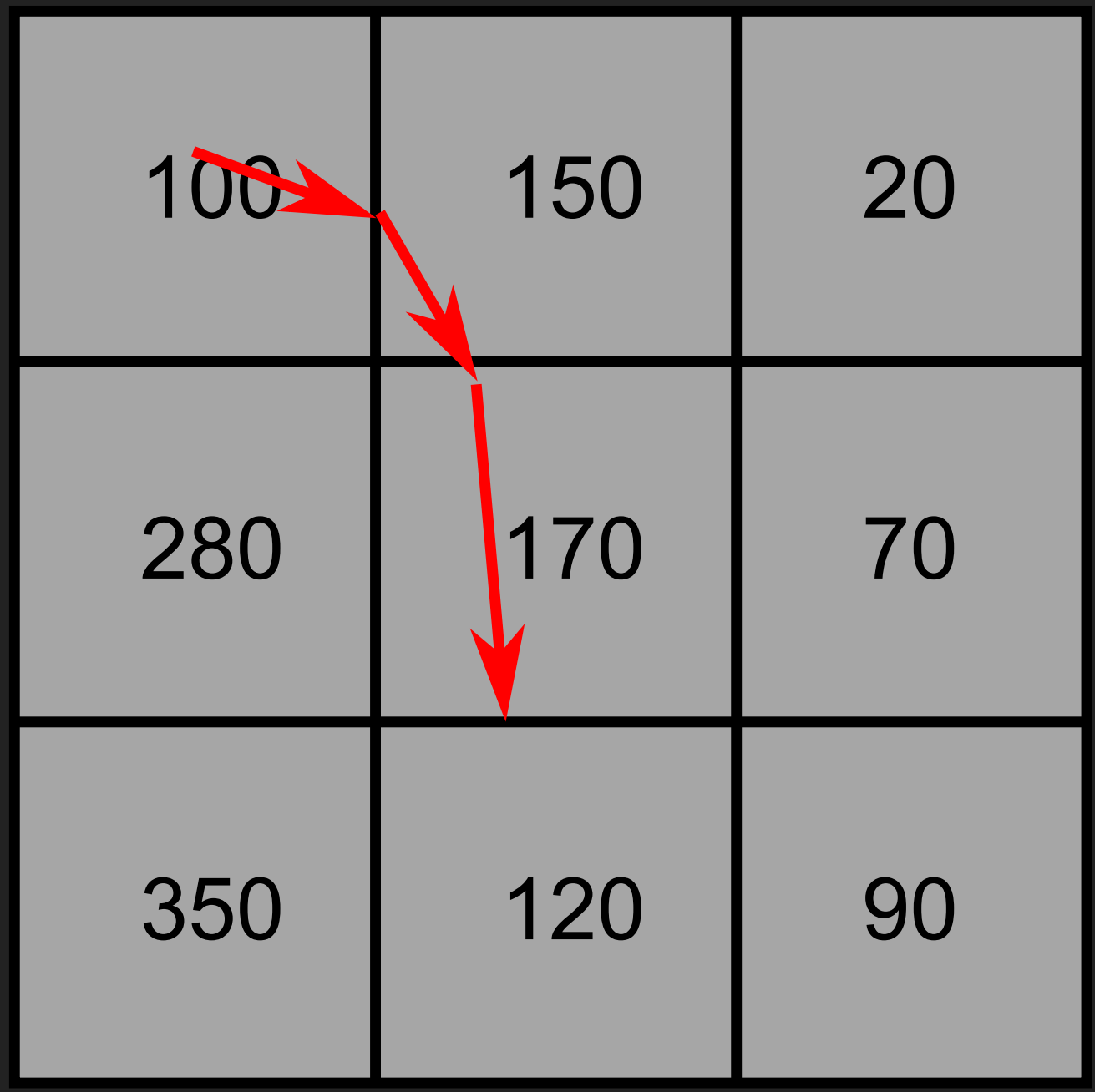
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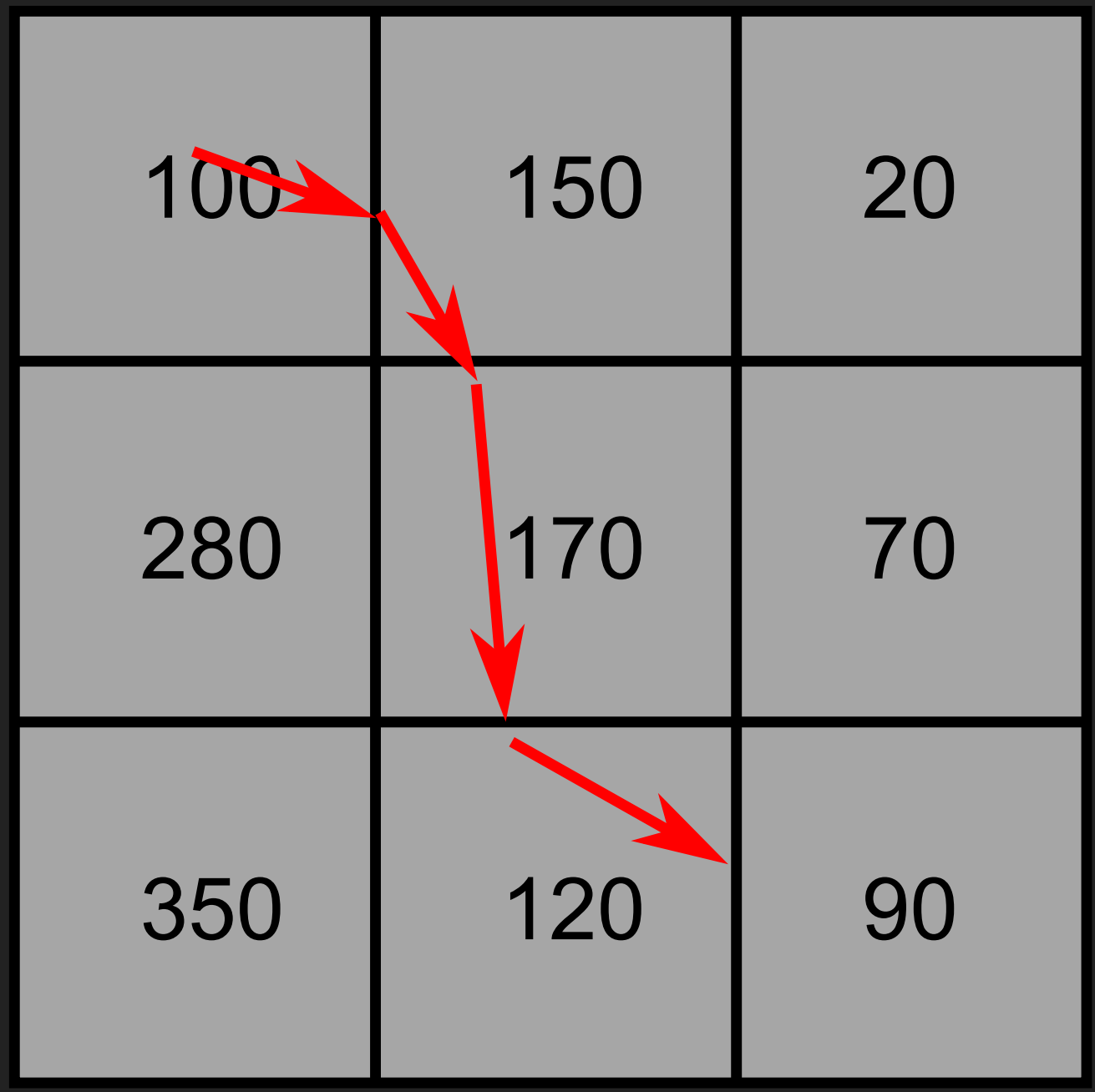
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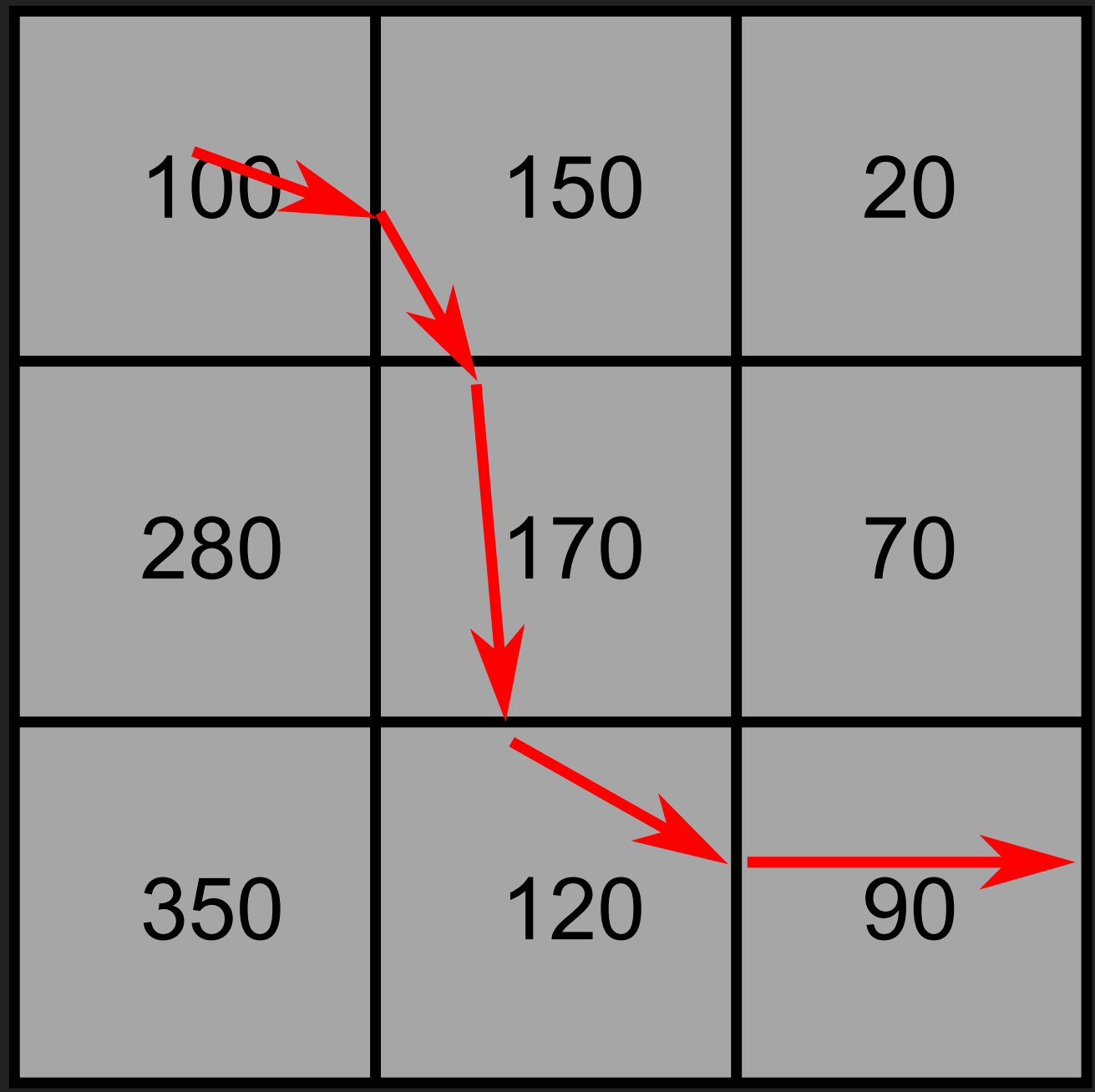
350
120
90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170
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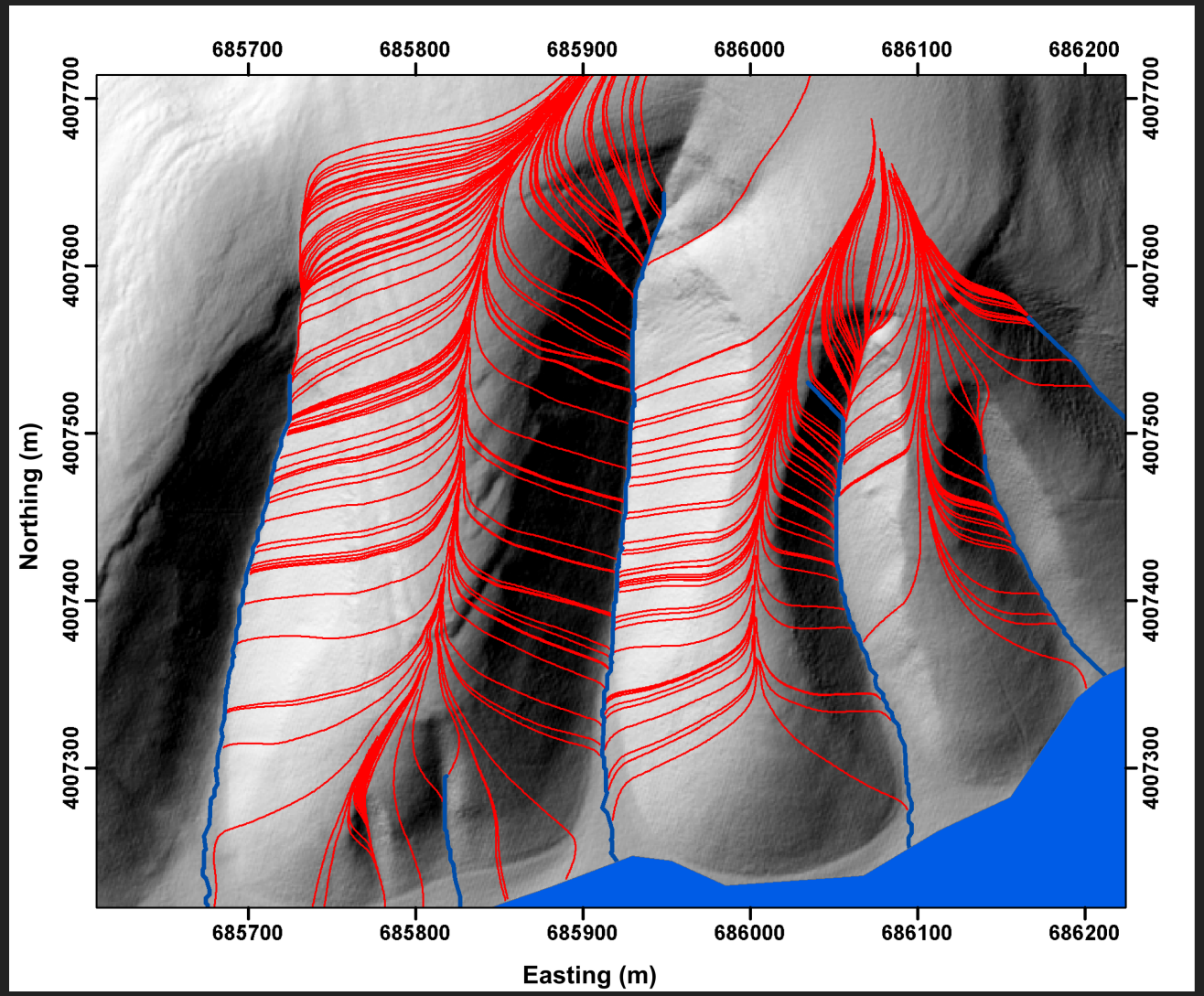
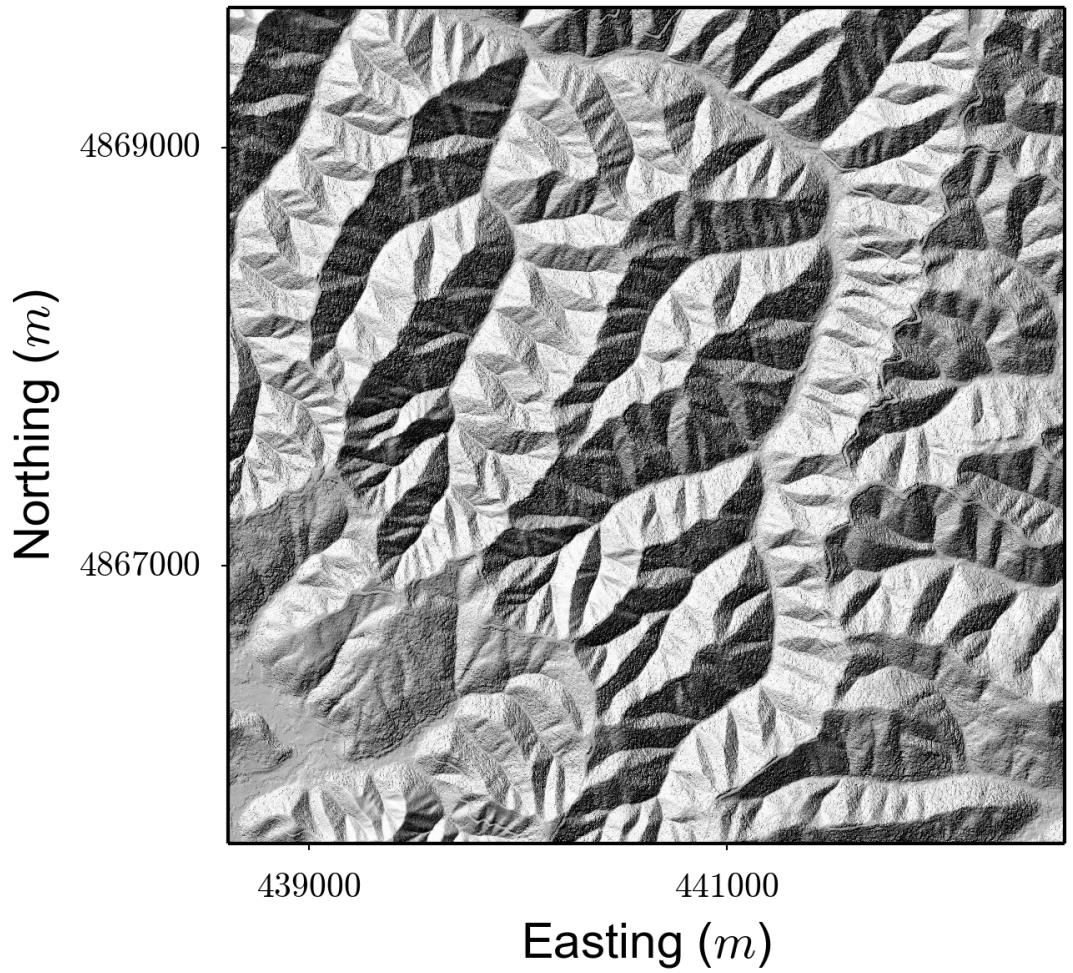
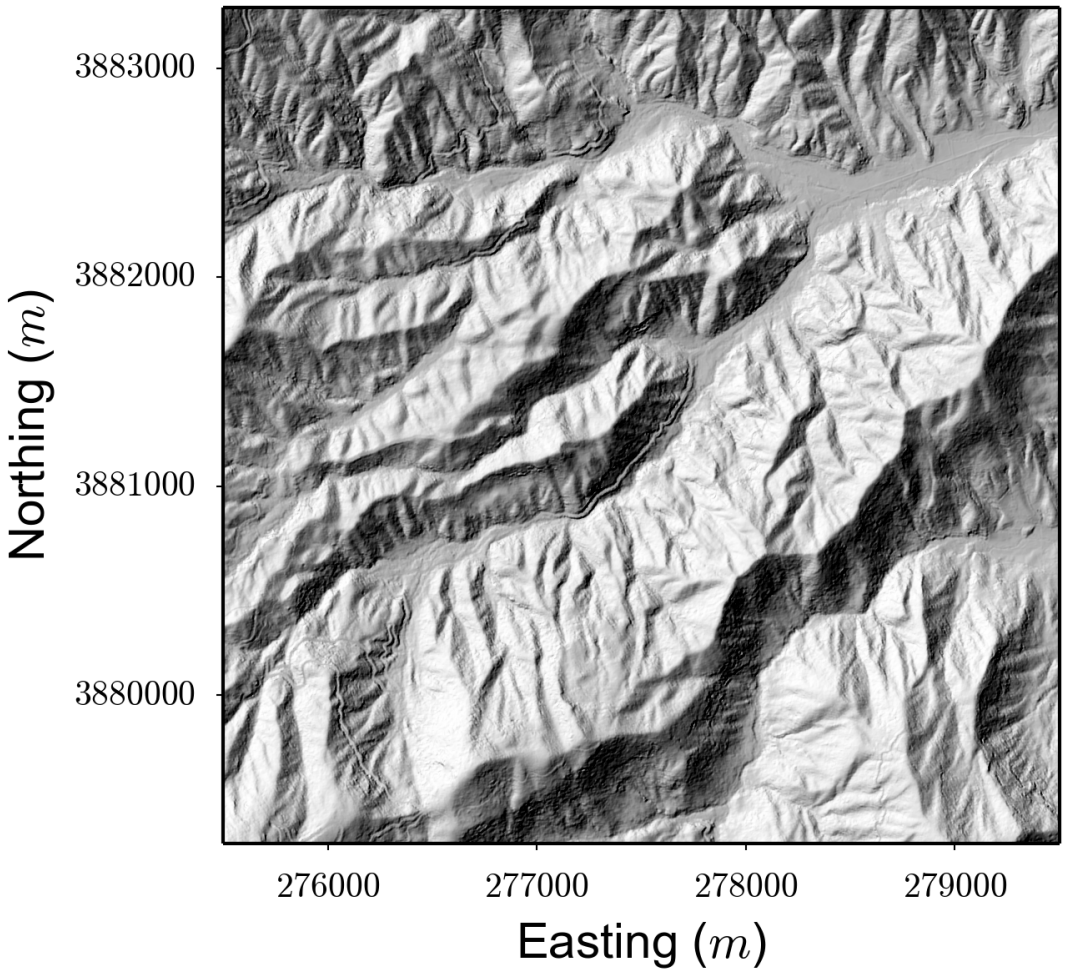
350
120
90

MEASURING HILLSLOPE LENGTH AND RELIEF

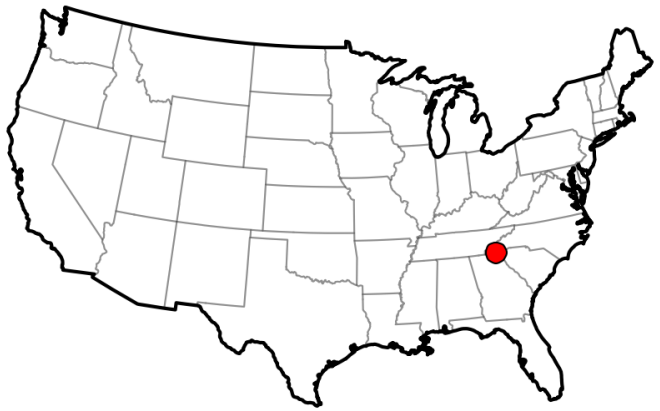


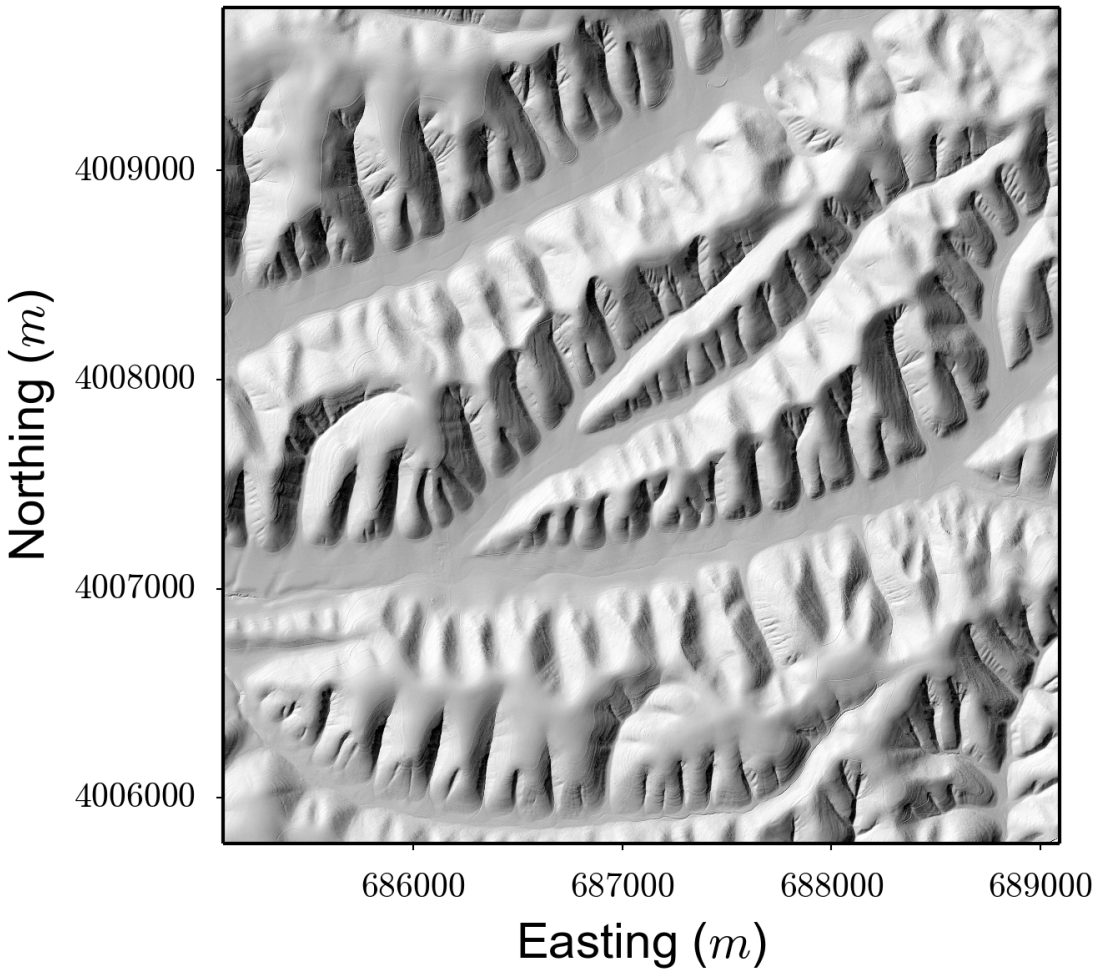


Oregon Coast Range, Oregon

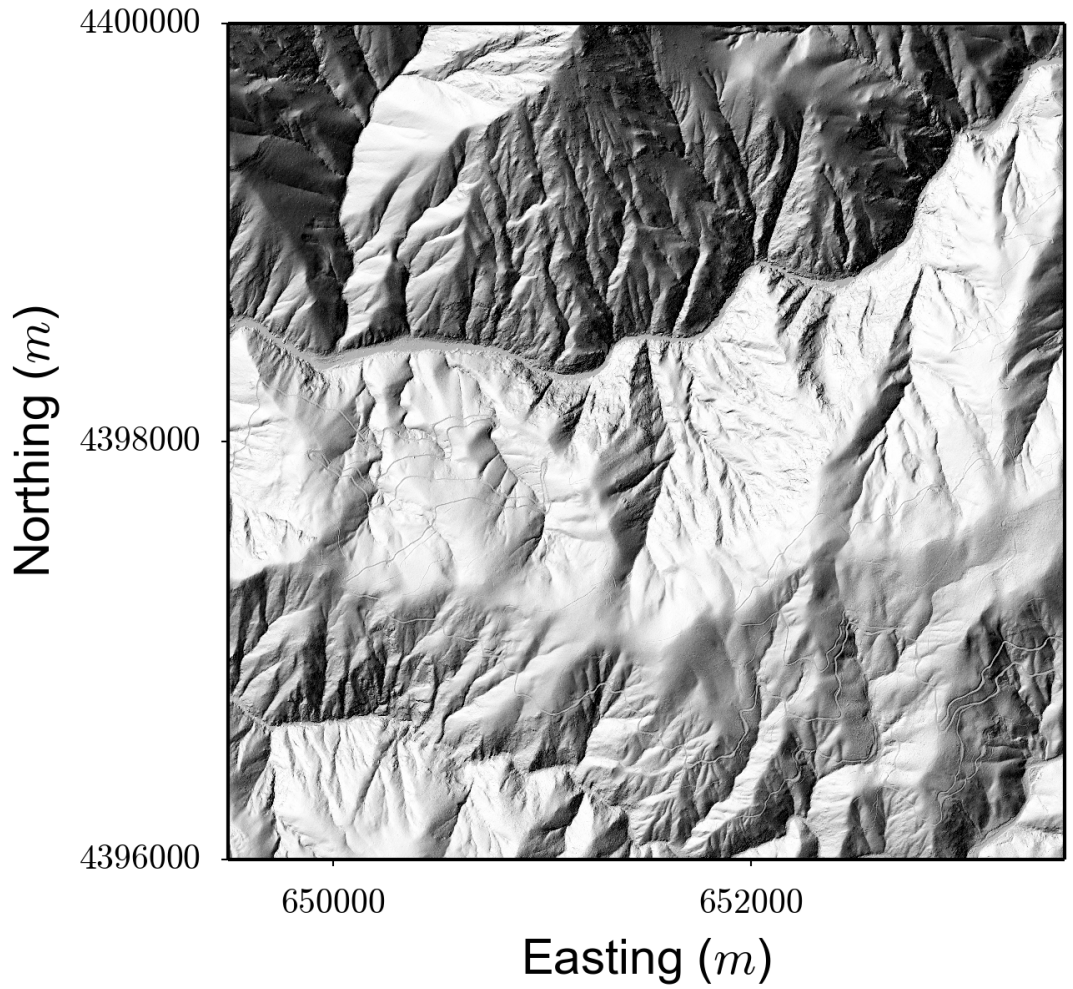


Coweeta,
North Carolina

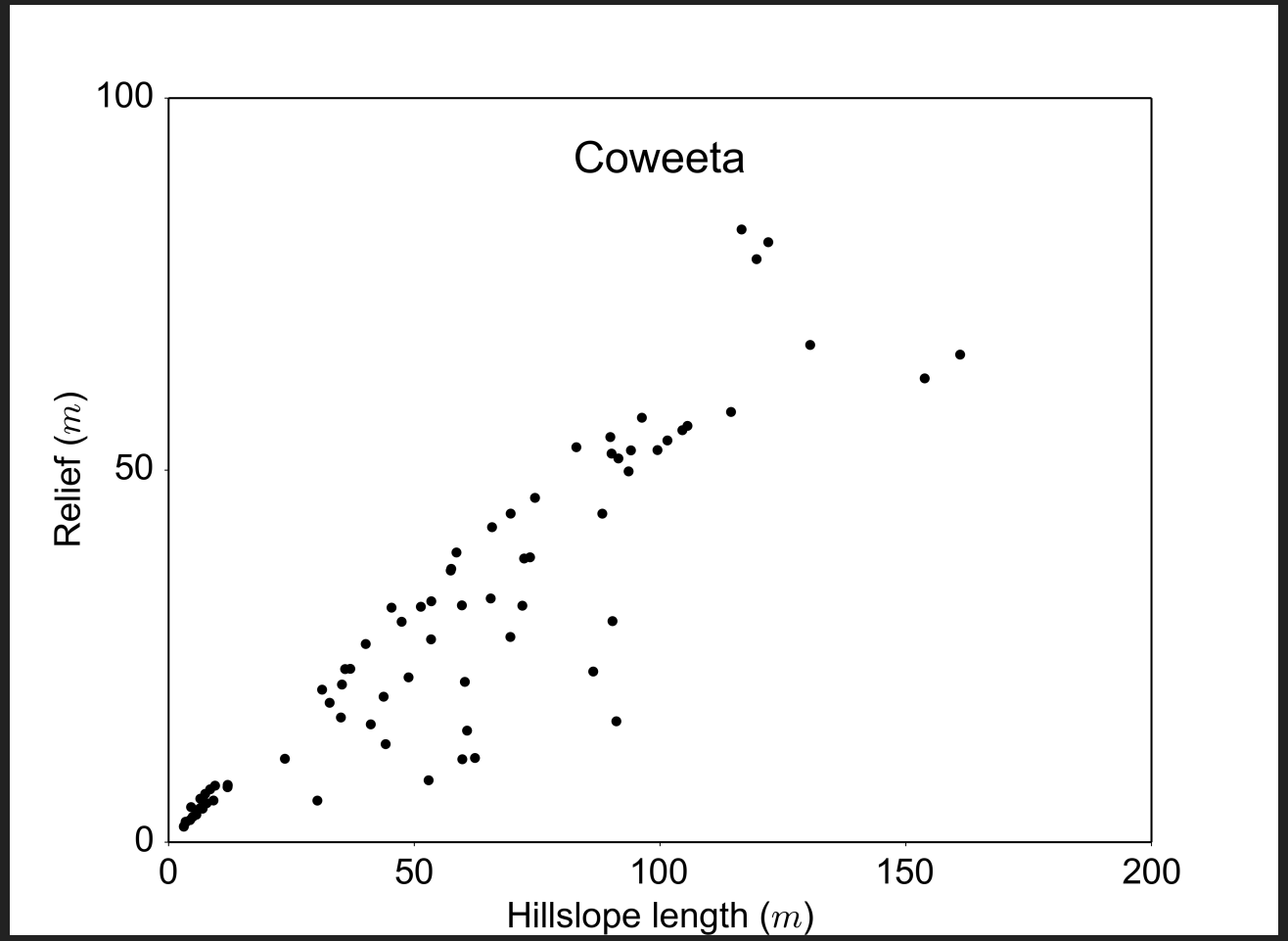


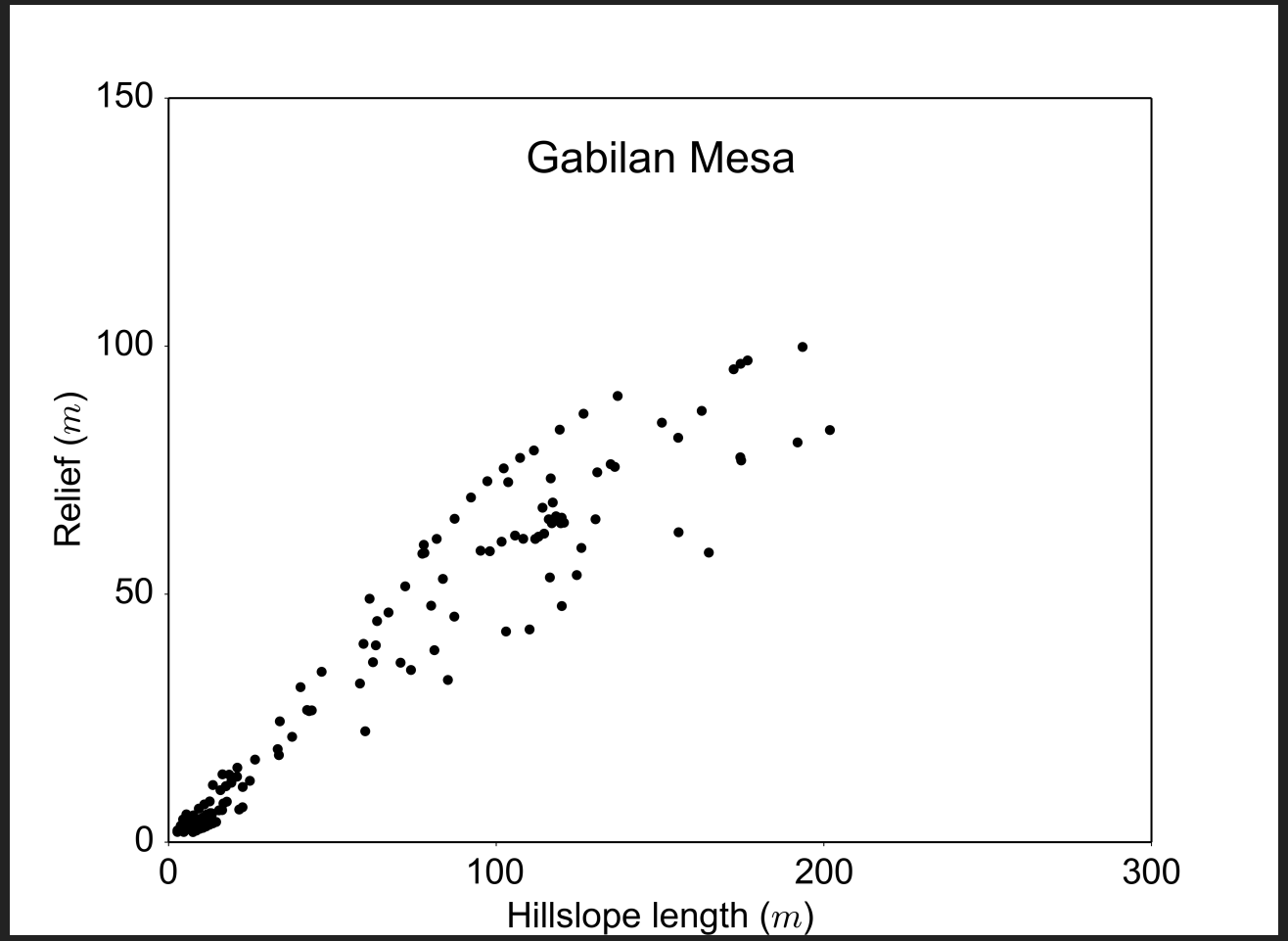


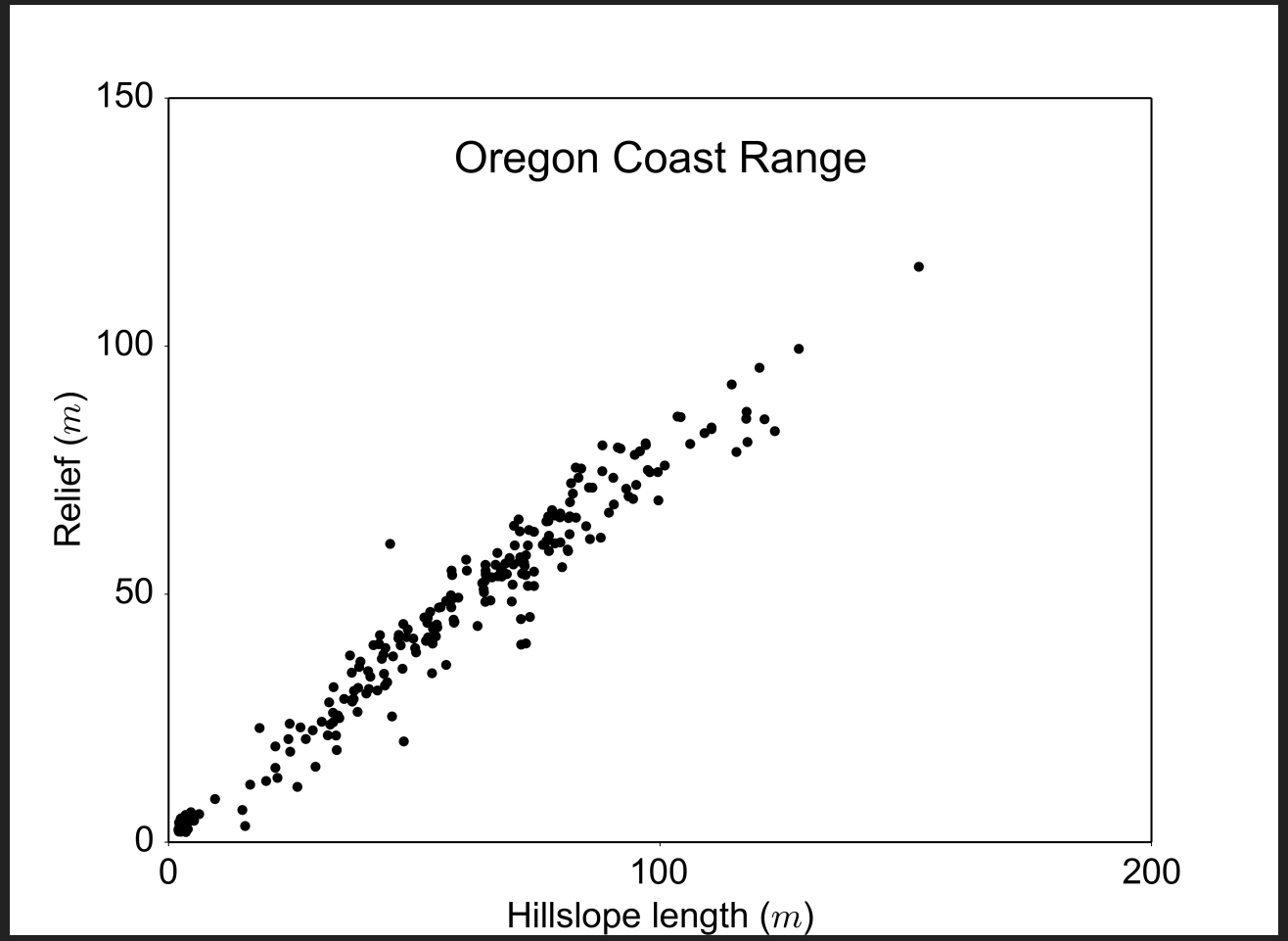
Gabilan Mesa,
California

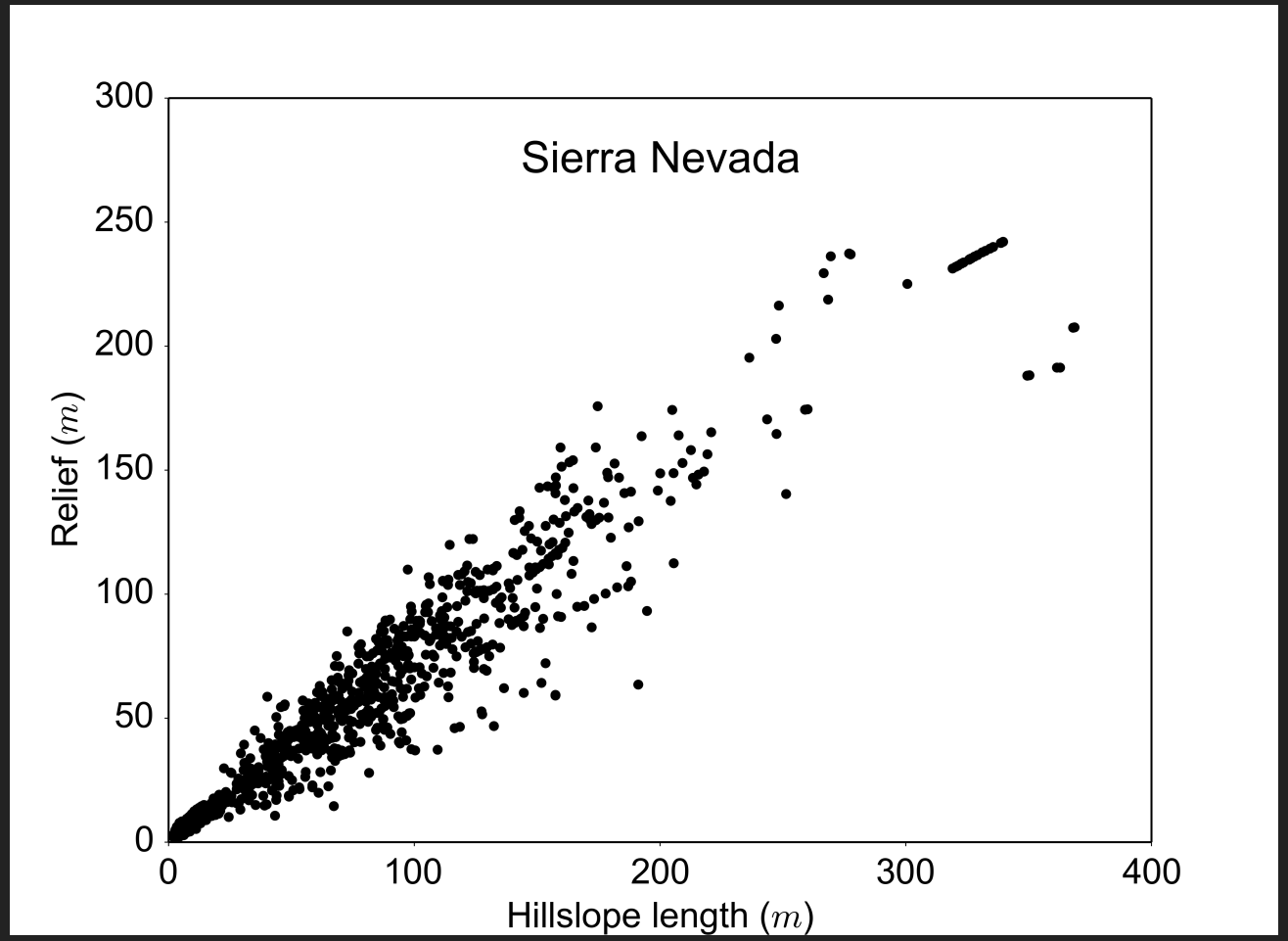


Northern Sierra Nevada, California


Coweeta
100
50
0
Relief (m)
0
50
100
150
200
Hillslope length (m)


Gabilan Mesa
150
100
50
0
Relief (m)
0
100
200
300
Hillslope length (m)


Oregon Coast Range
150
100
50
0
Relief (m)
0
100
200
Hillslope length (m)


Sierra Nevada
300
250
200
150
100
50
0
Relief (m)
0
100
200
300
400
Hillslope length (m)

TOPOGRAPHY IS CONSISTENT WITH NONLINEAR SEDIMENT FLUX

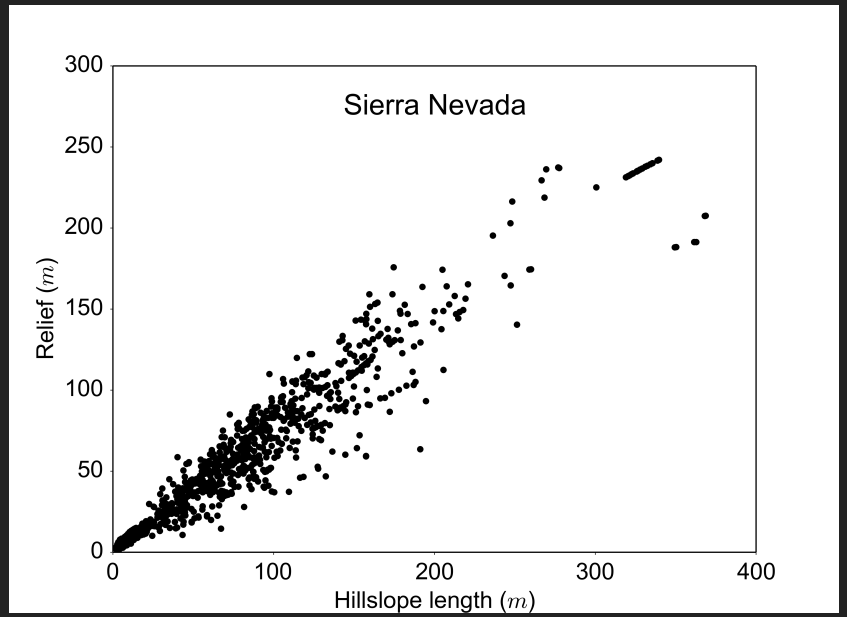
TOPOGRAPHY IS CONSISTENT WITH NONLINEAR SEDIMENT FLUX

TOPOGRAPHY IS CONSISTENT WITH NONLINEAR SEDIMENT FLUX

Demonstrated at a landscape scale

Can be applied anywhere

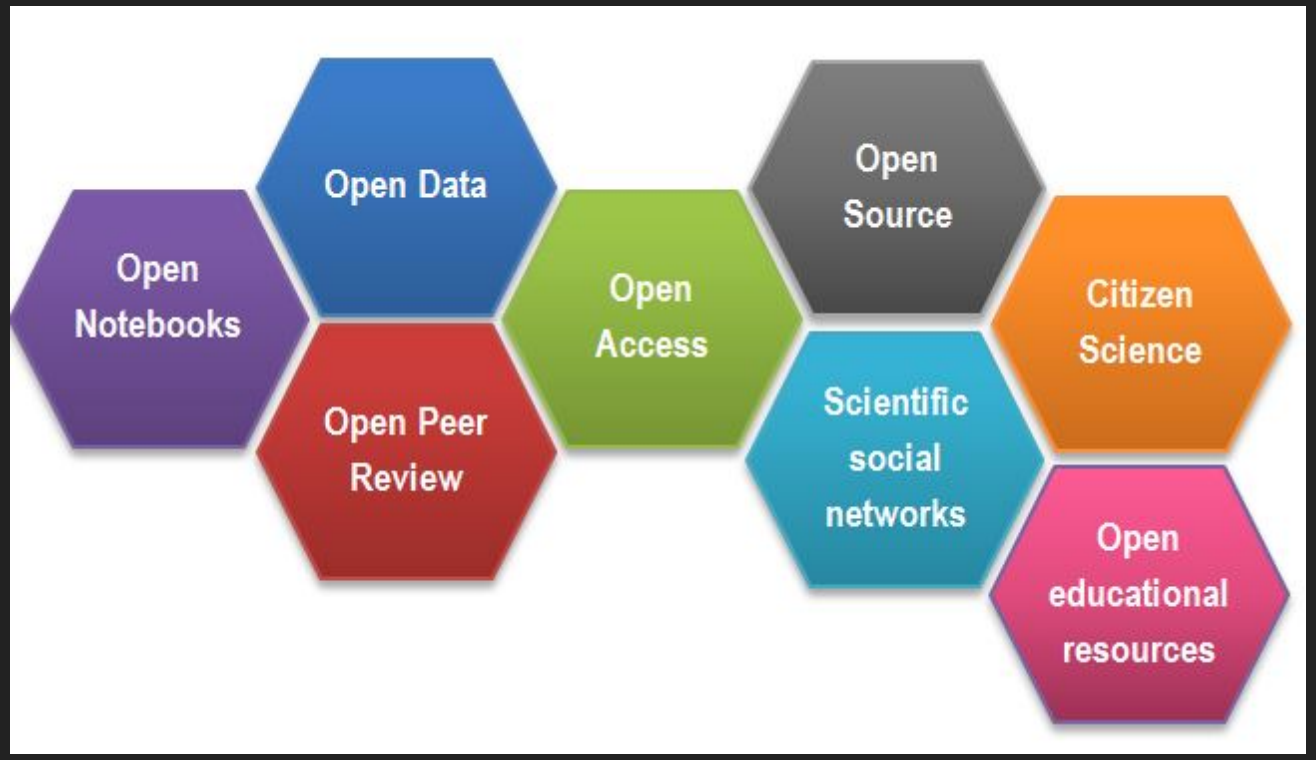
First test that relies only on topographic data



REPRODUCIBLE TOPOGRAPHIC ANALYSIS

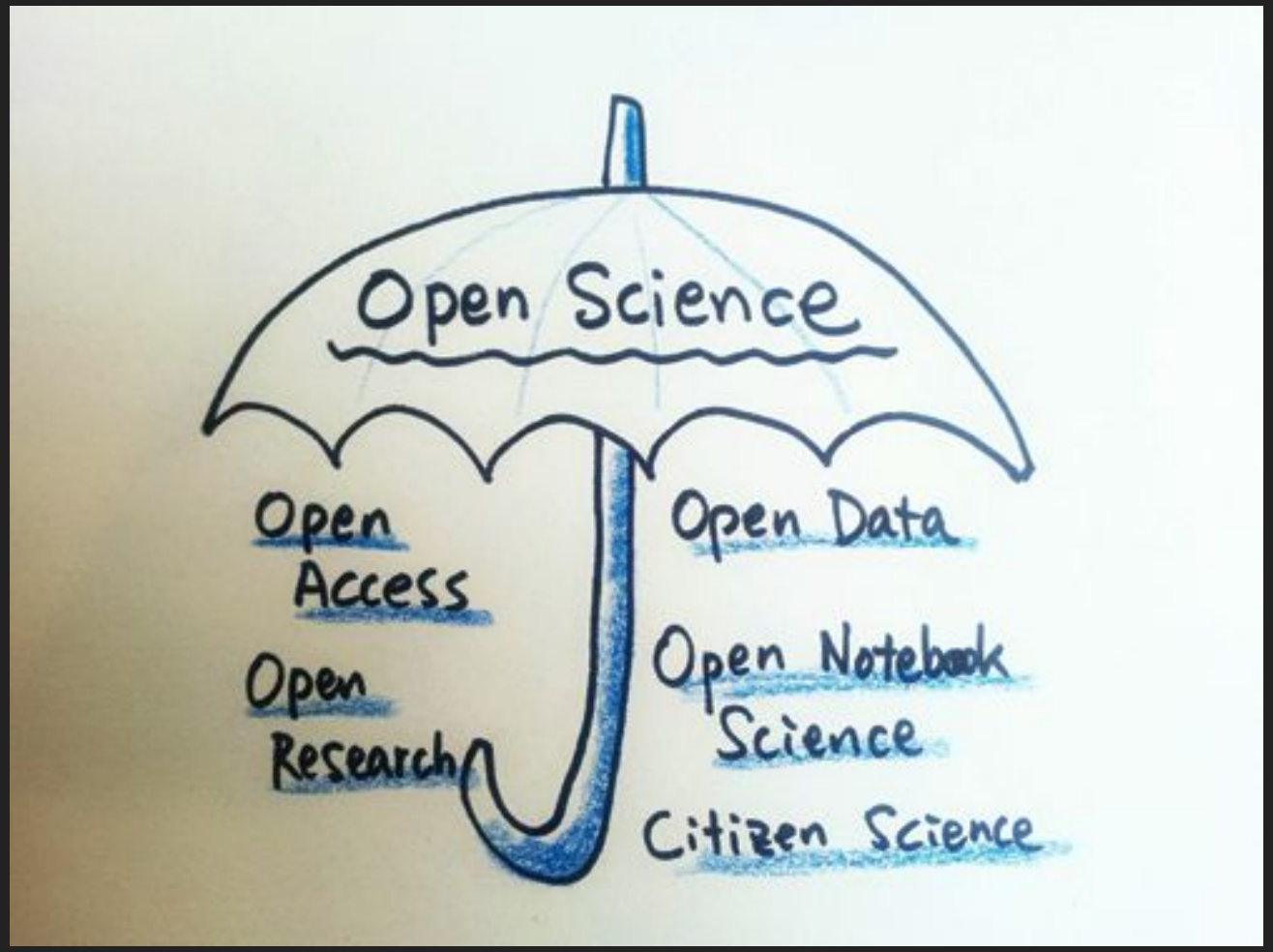
OPEN SCIENCE

OPEN SCIENCE

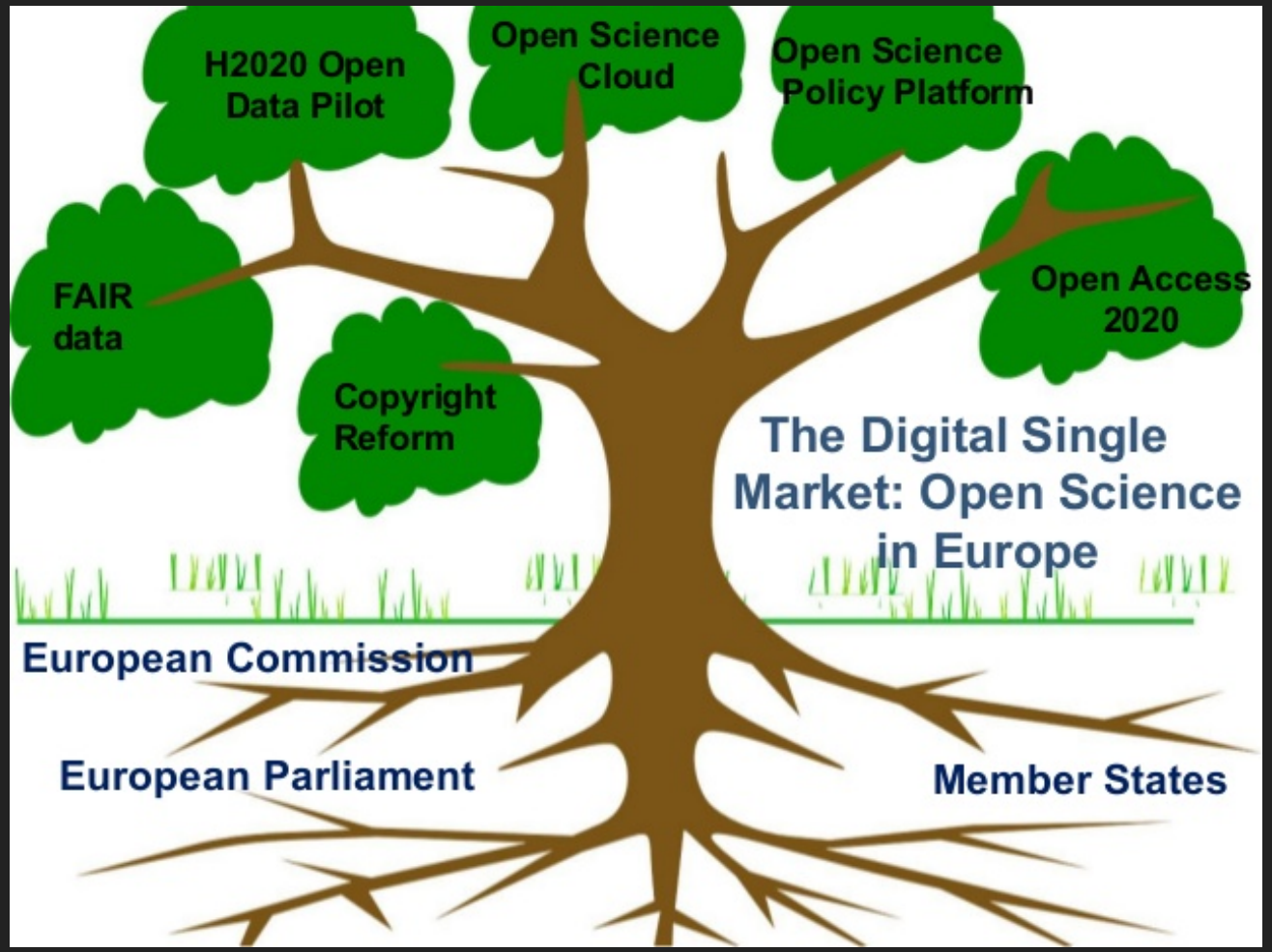


OPEN SCIENCE

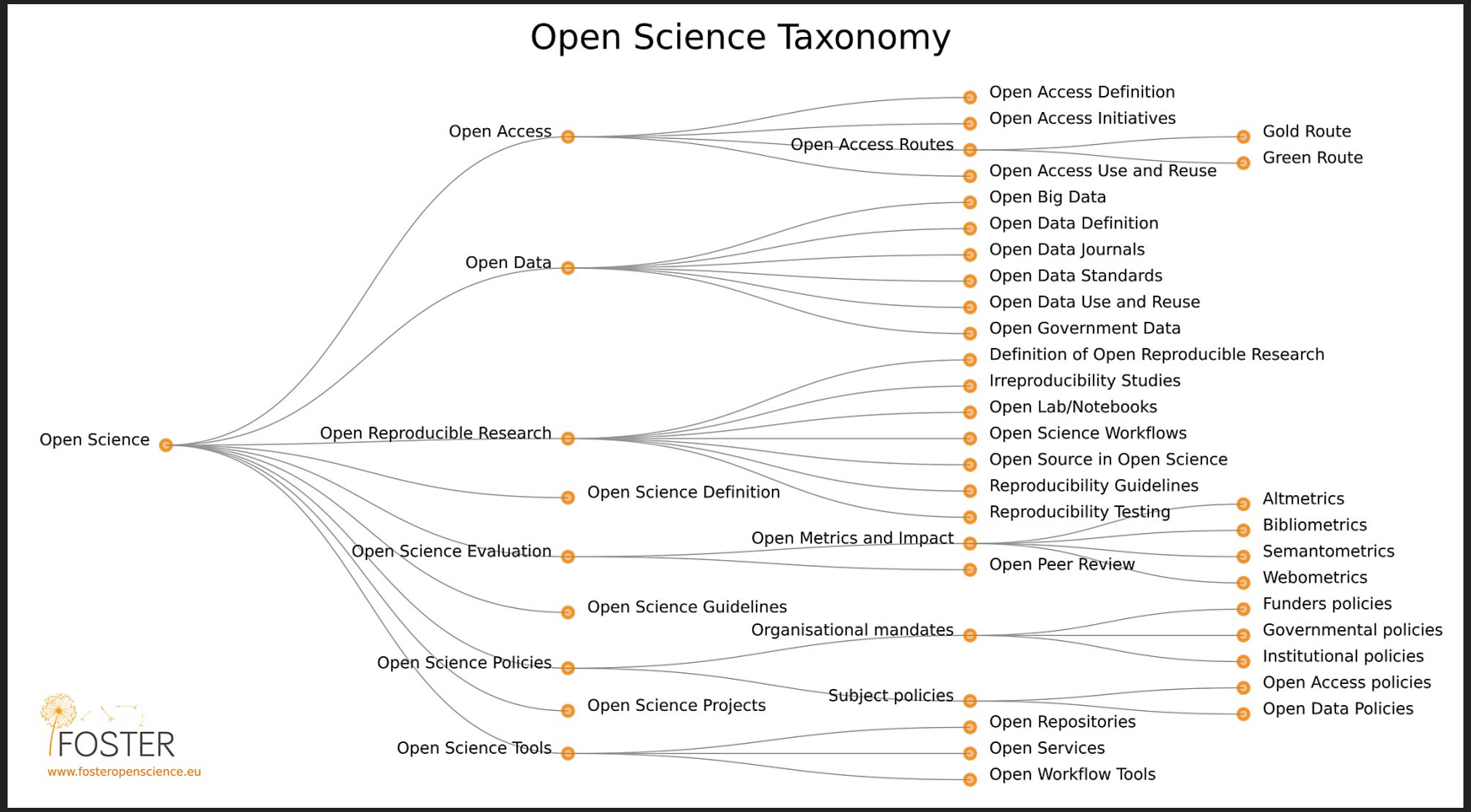
OPEN SCIENCE



OPEN SCIENCE



OPEN SCIENCE



OPEN SCIENCE

1. Open data
2. Open methods
3. Open data visualisation
4. Open access publication

OPEN SCIENCE

1. Open data
2. Open methods
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TRANSPARENT METHODS AND OPEN DATA

“We calculated slope for our study area.”

We all know what this means qualitatively, but how would you do it?

TRANSPARENT METHODS AND OPEN DATA

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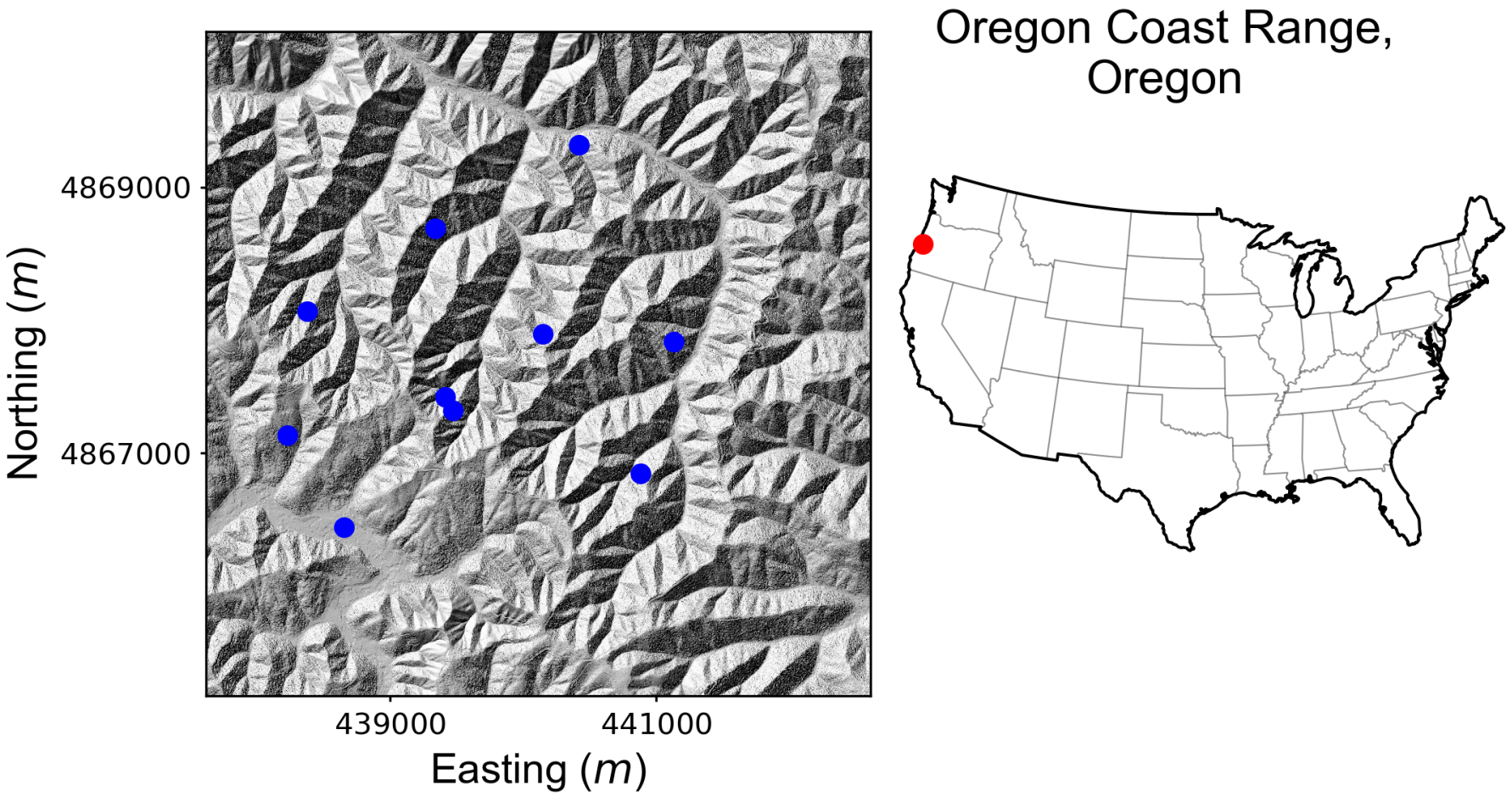
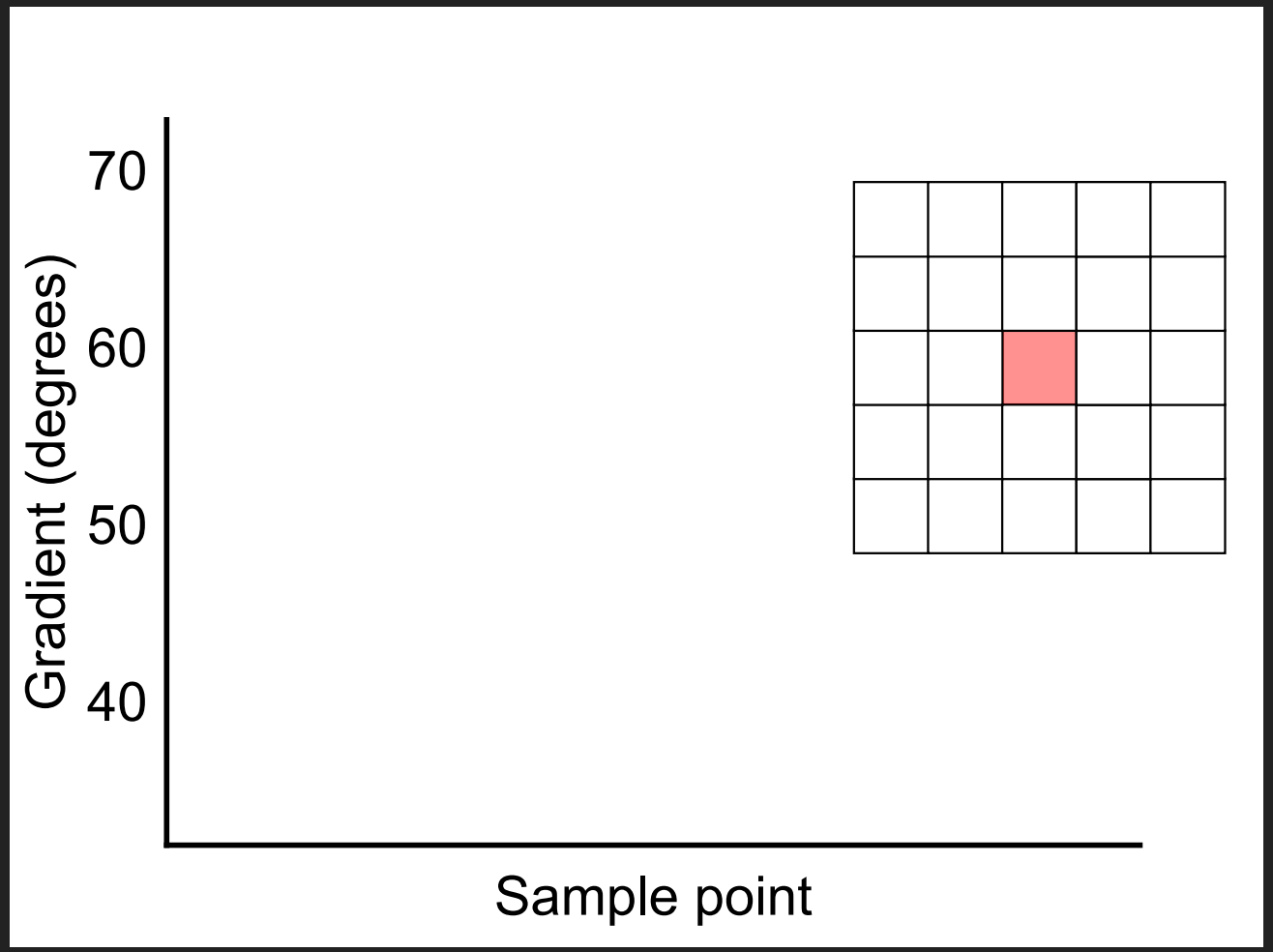
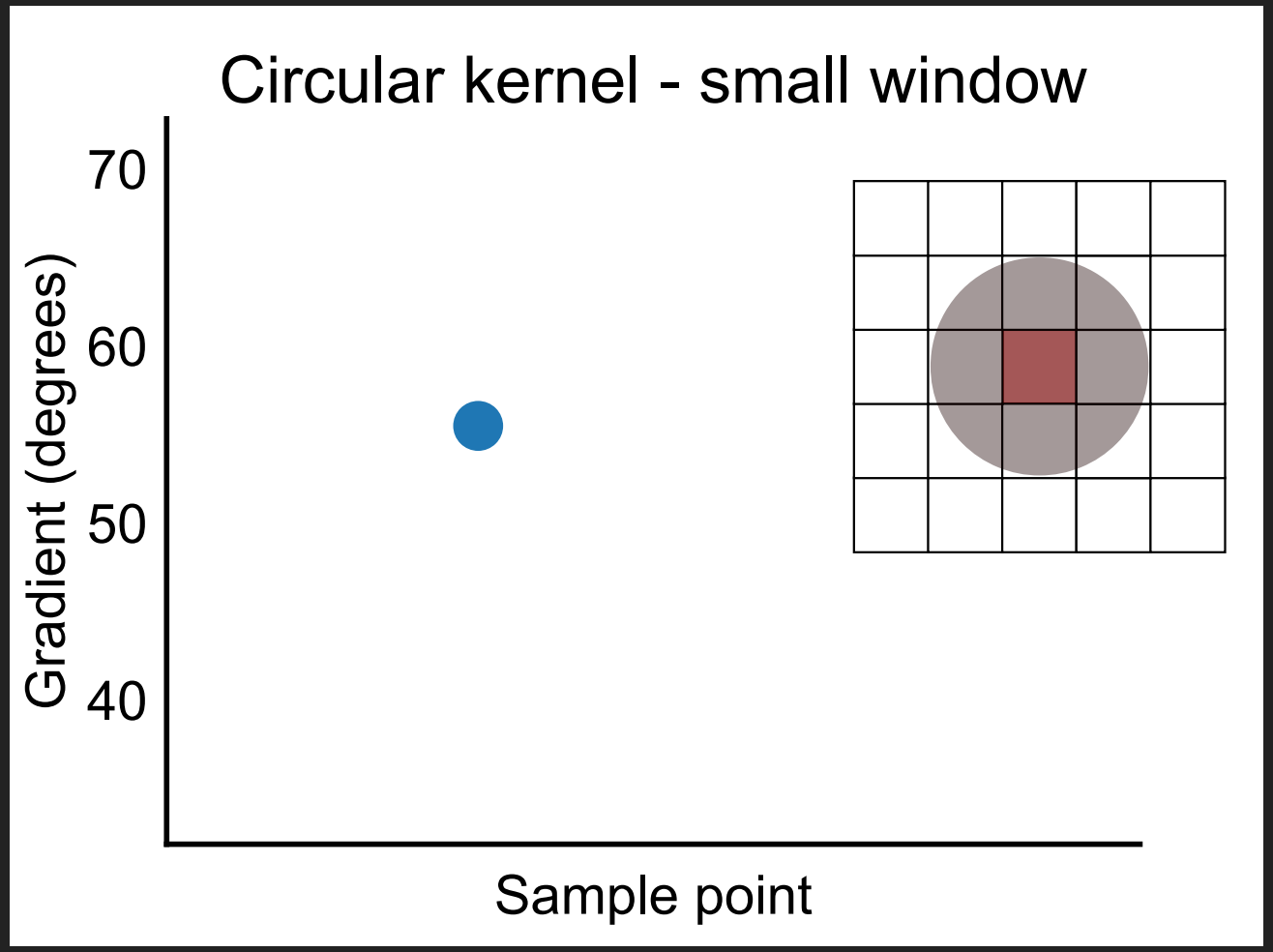
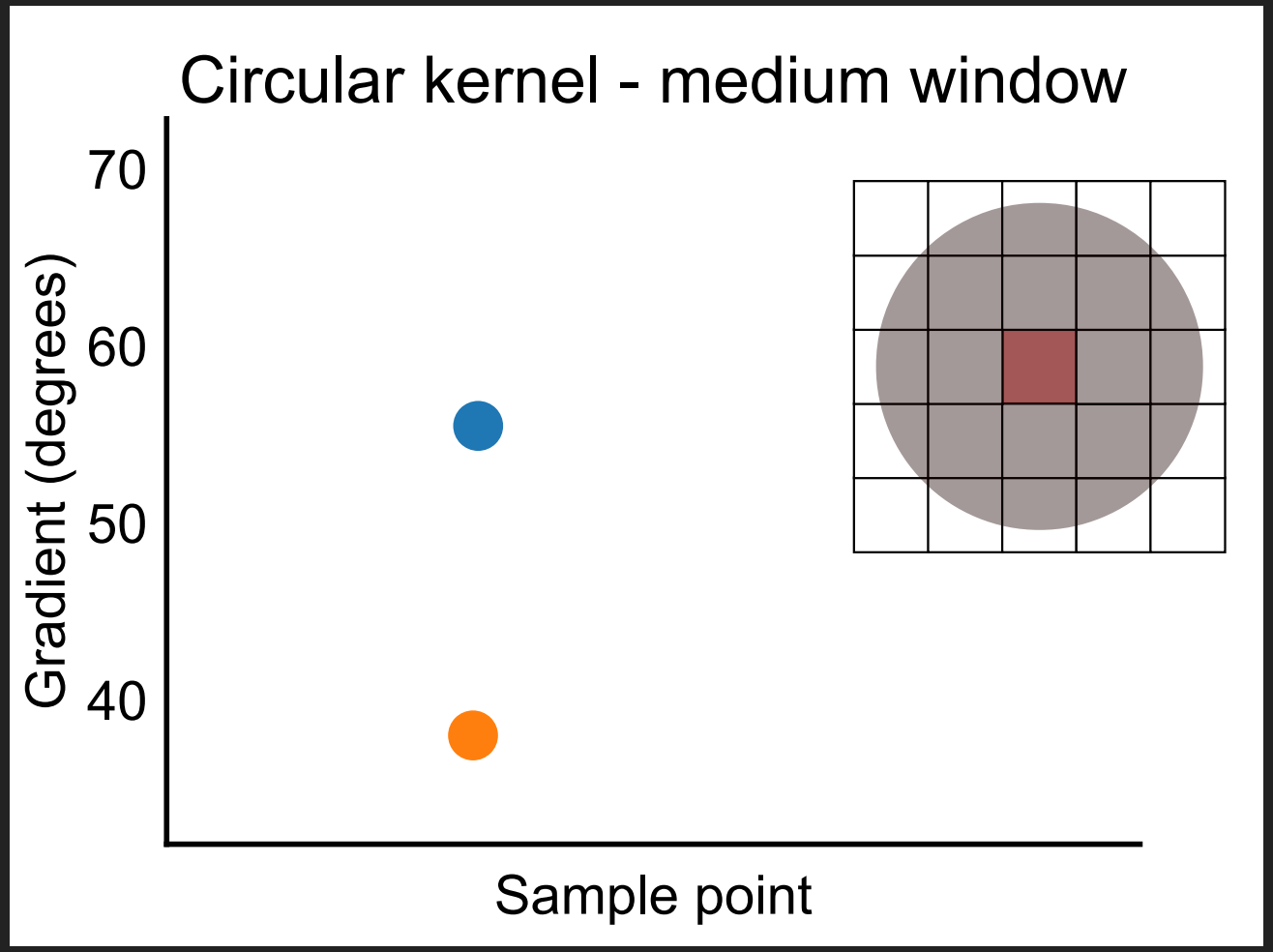
We all know what this means qualitatively, but how would you do it?

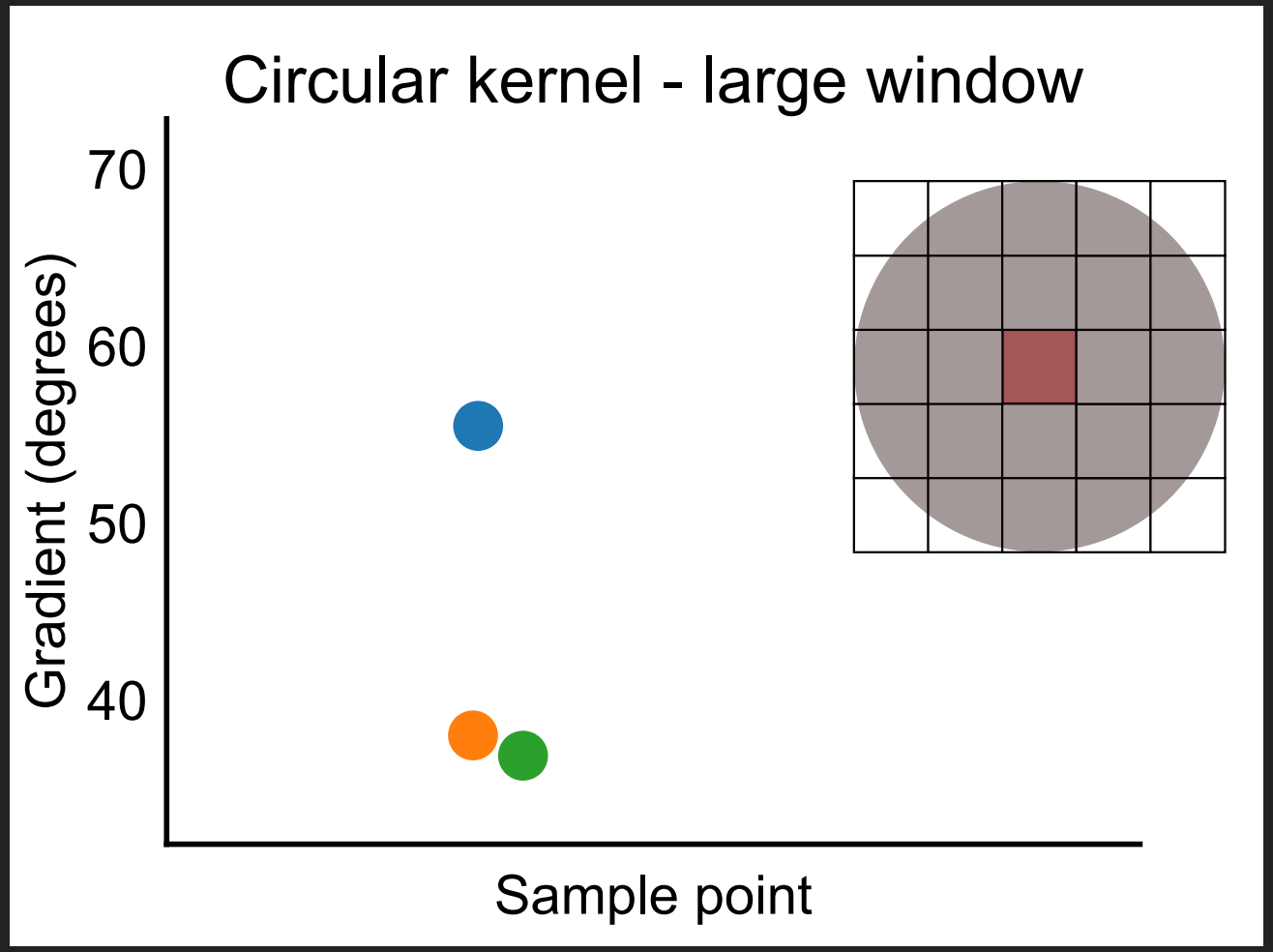


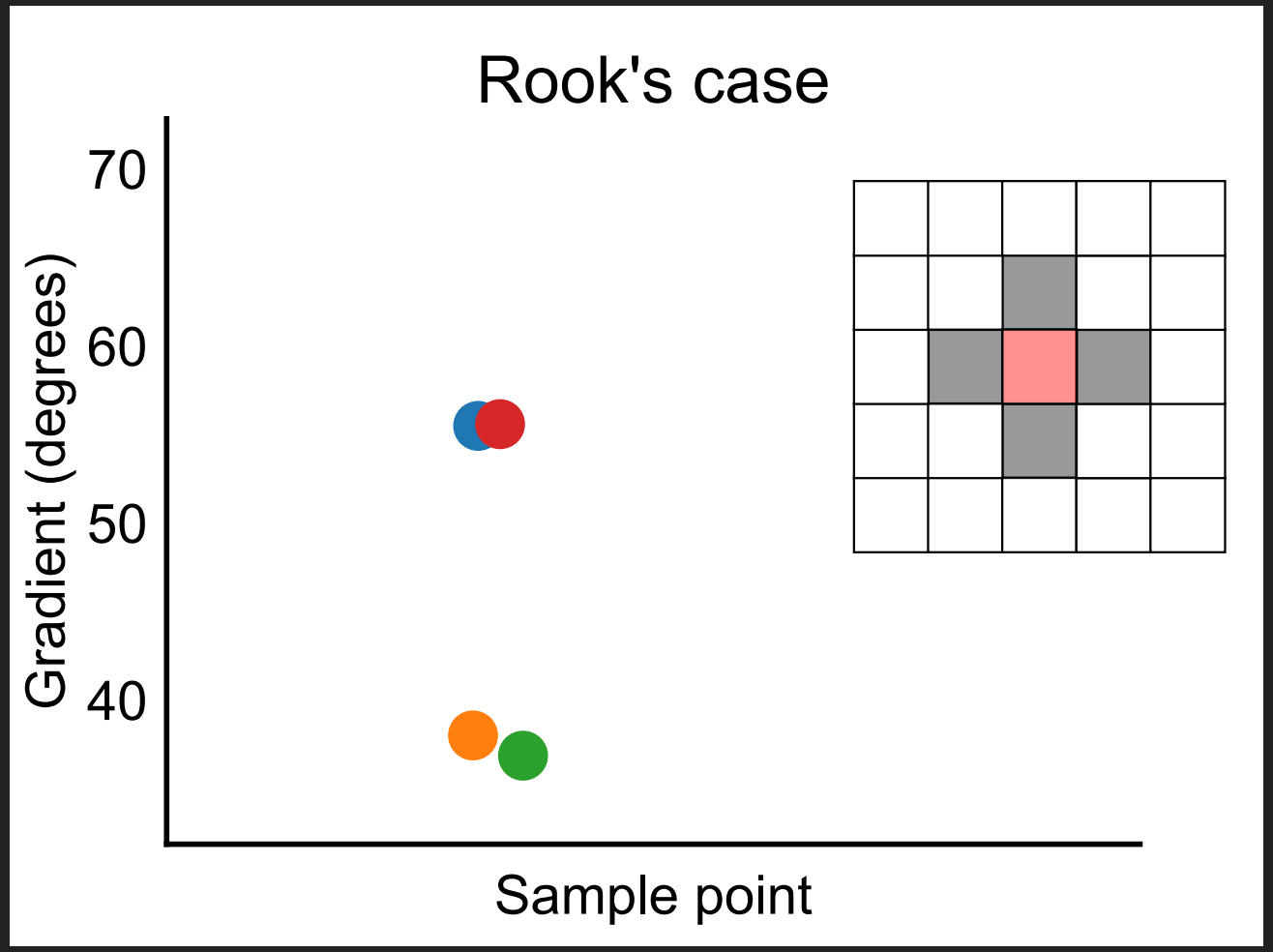
Oregon Coast Range, Oregon

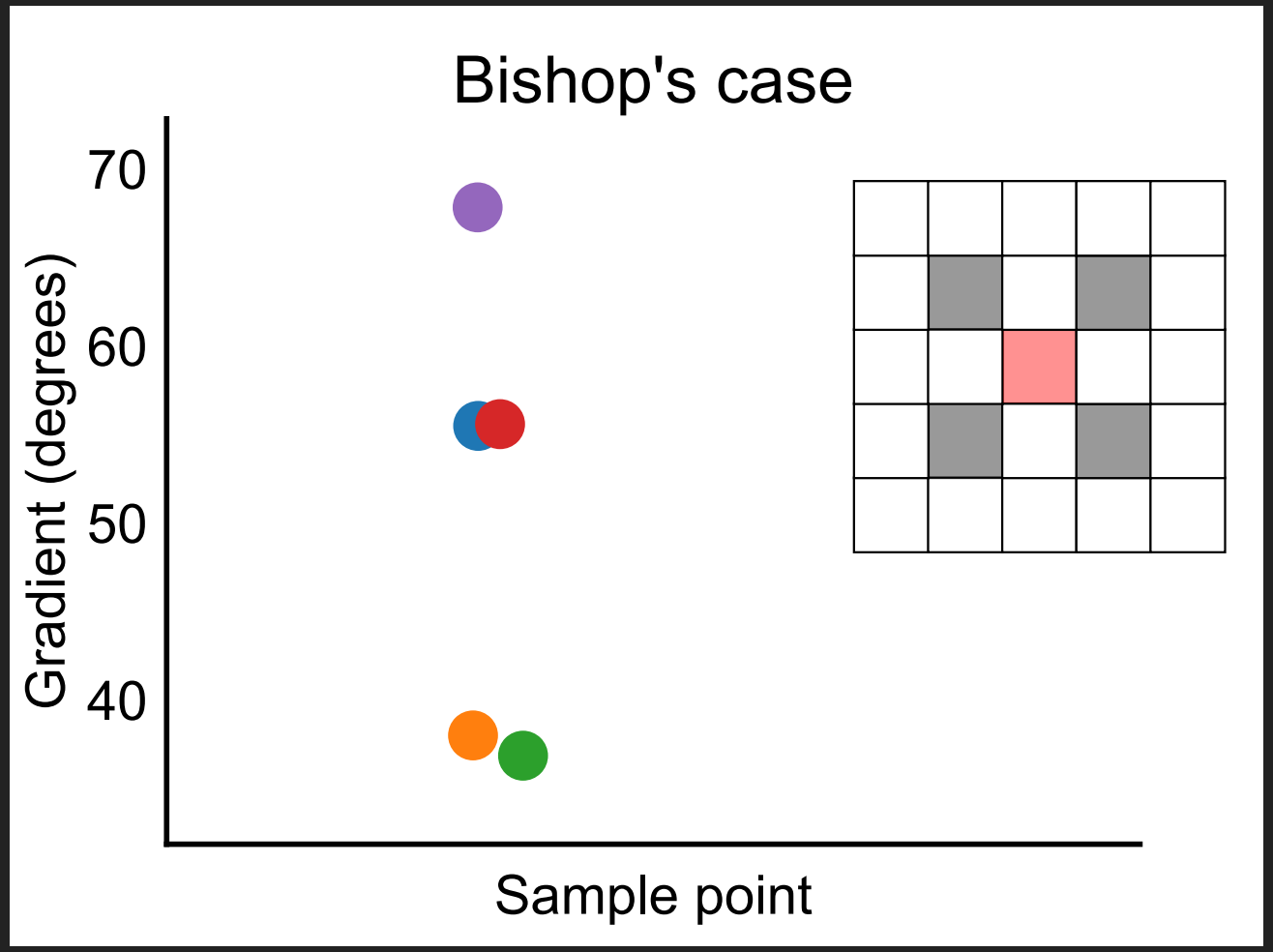

70
60
50
40
Gradient (degrees)
Sample point

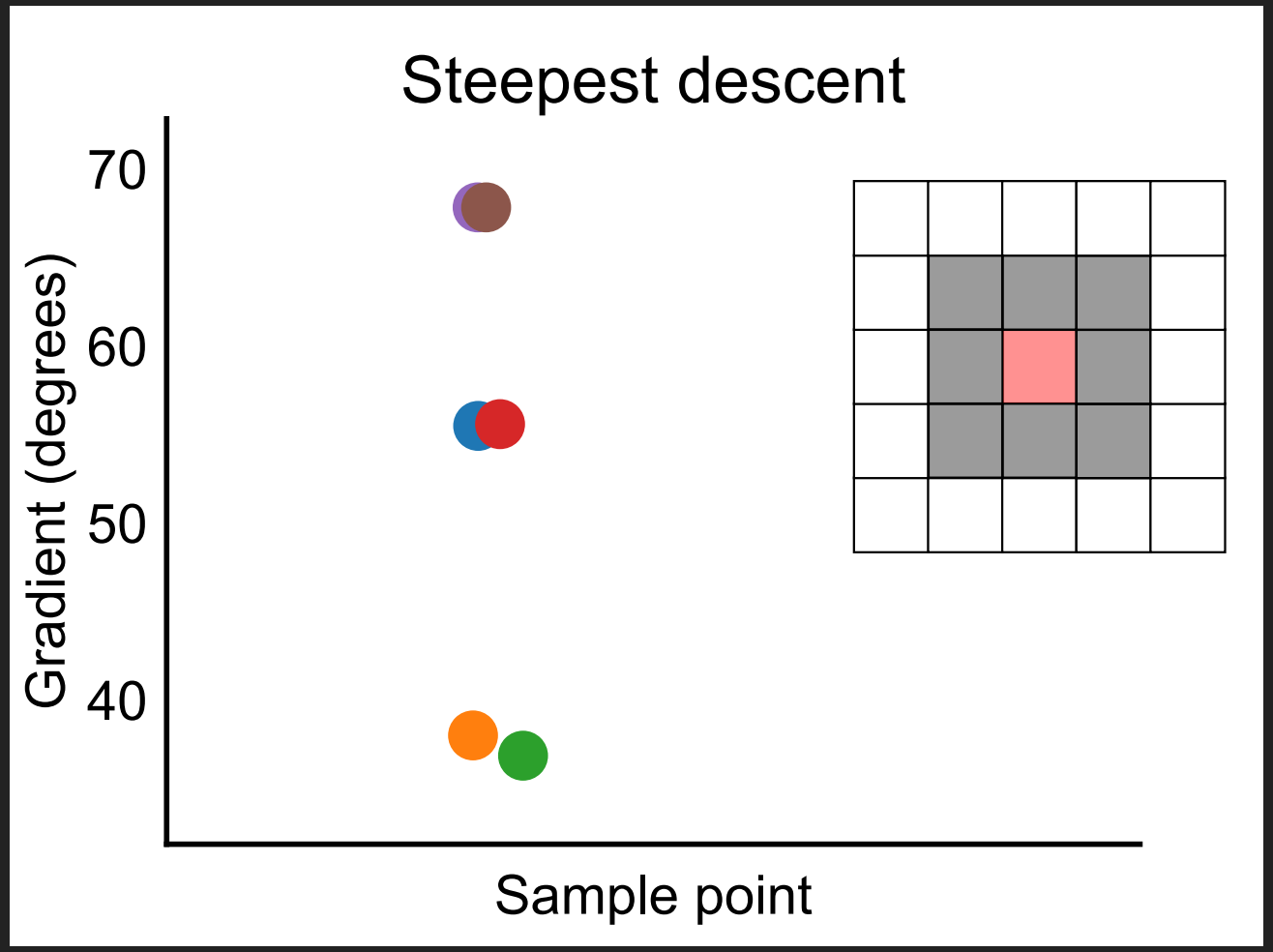

Circular kernel - small window
70
60
50
40
Gradient (degrees)
Sample point

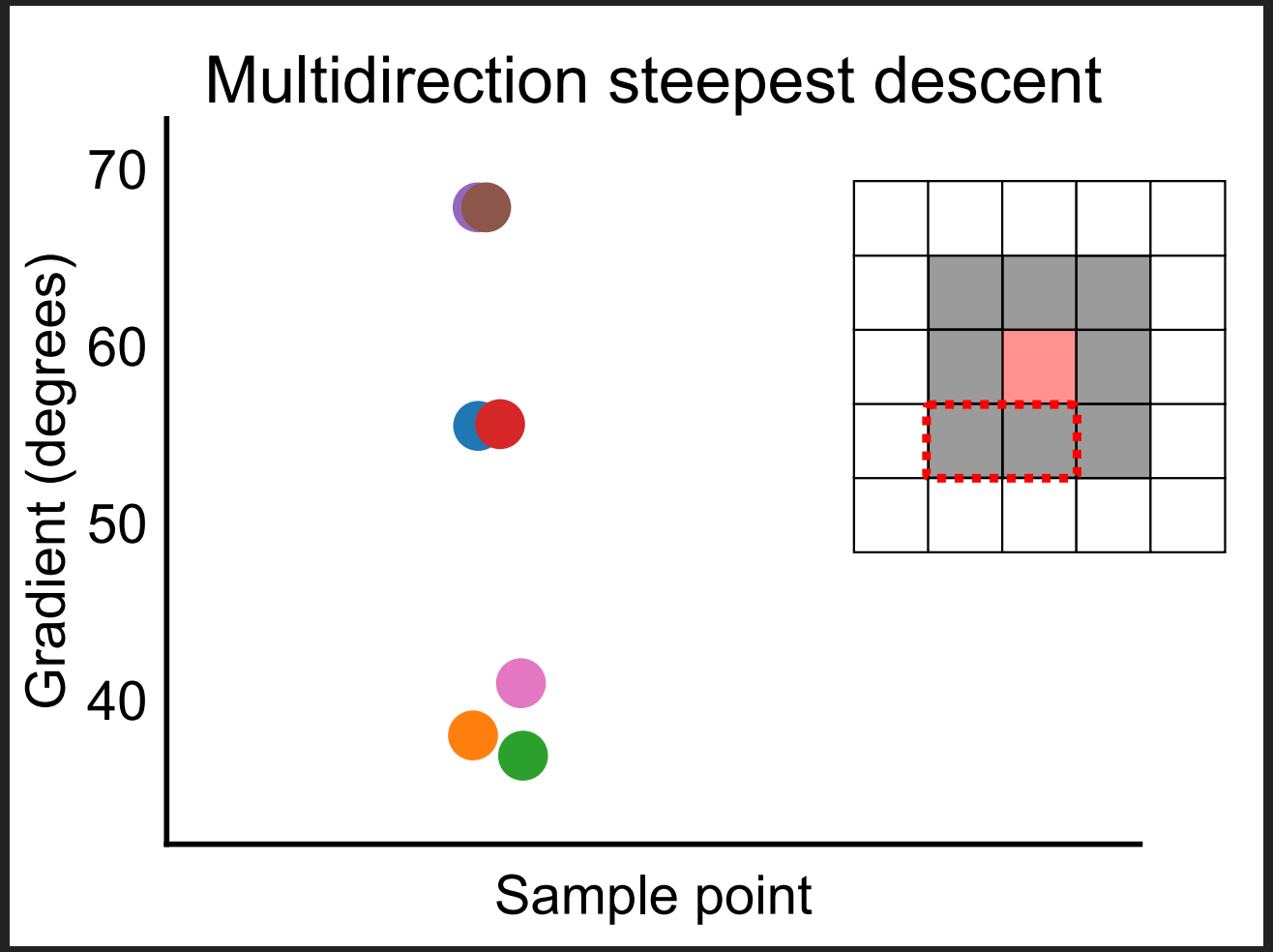

Circular kernel - medium window
70
60
50
40
Gradient (degrees)
Sample point

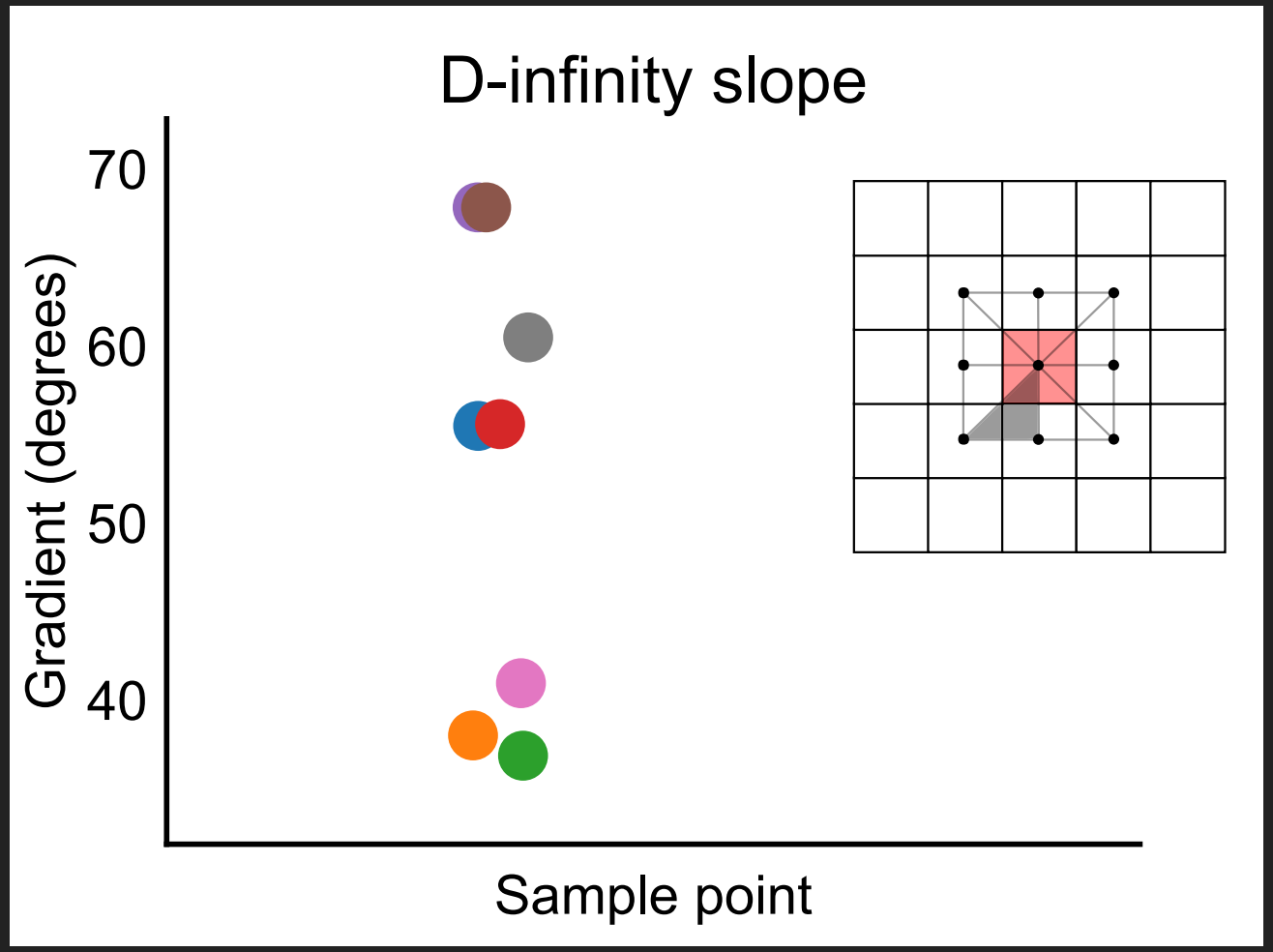

Circular kernel - large window
70
60
50
40
Gradient (degrees)
Sample point

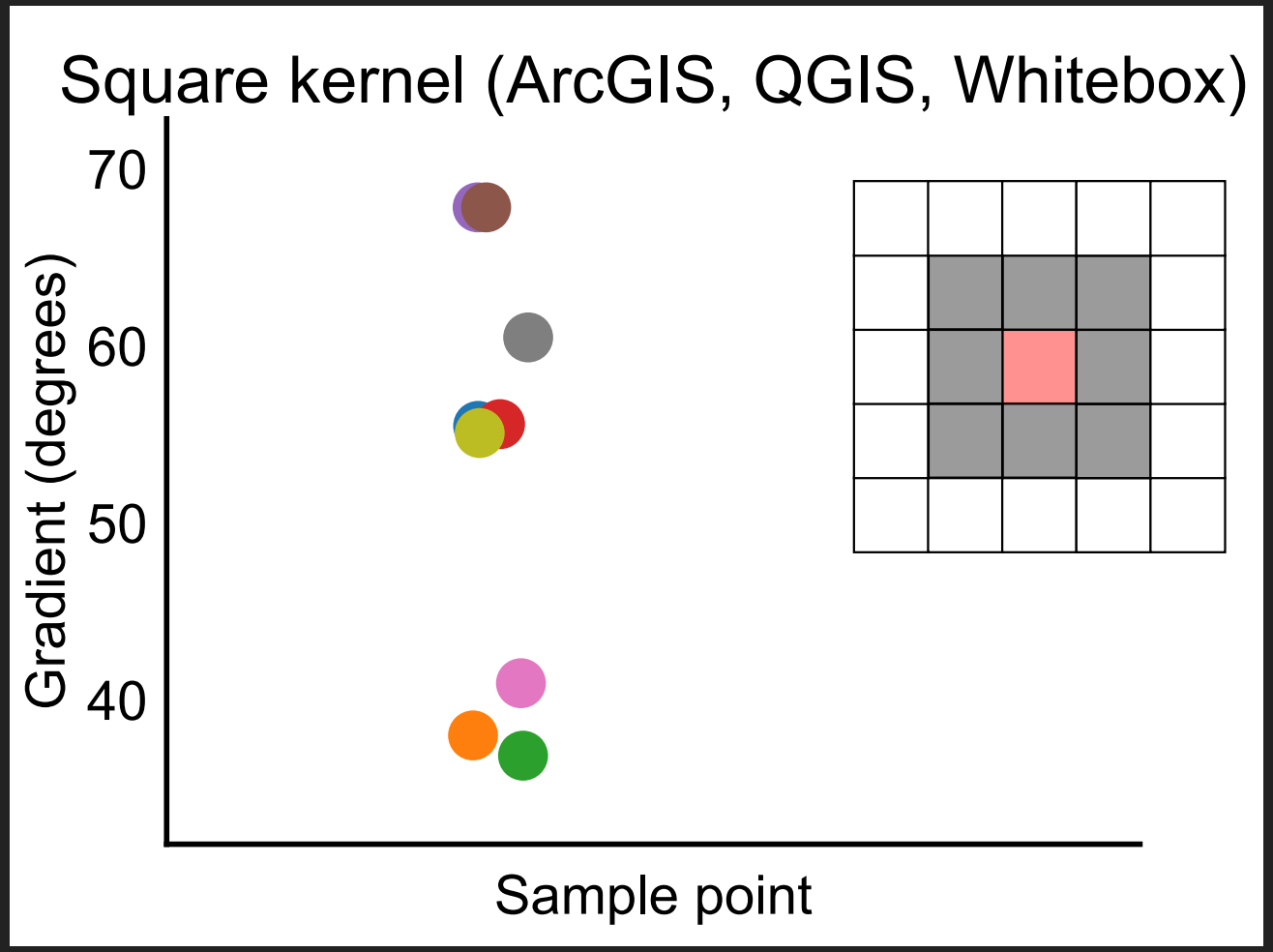

Rook's case
70
60
50
40
Gradient (degrees)
Sample point

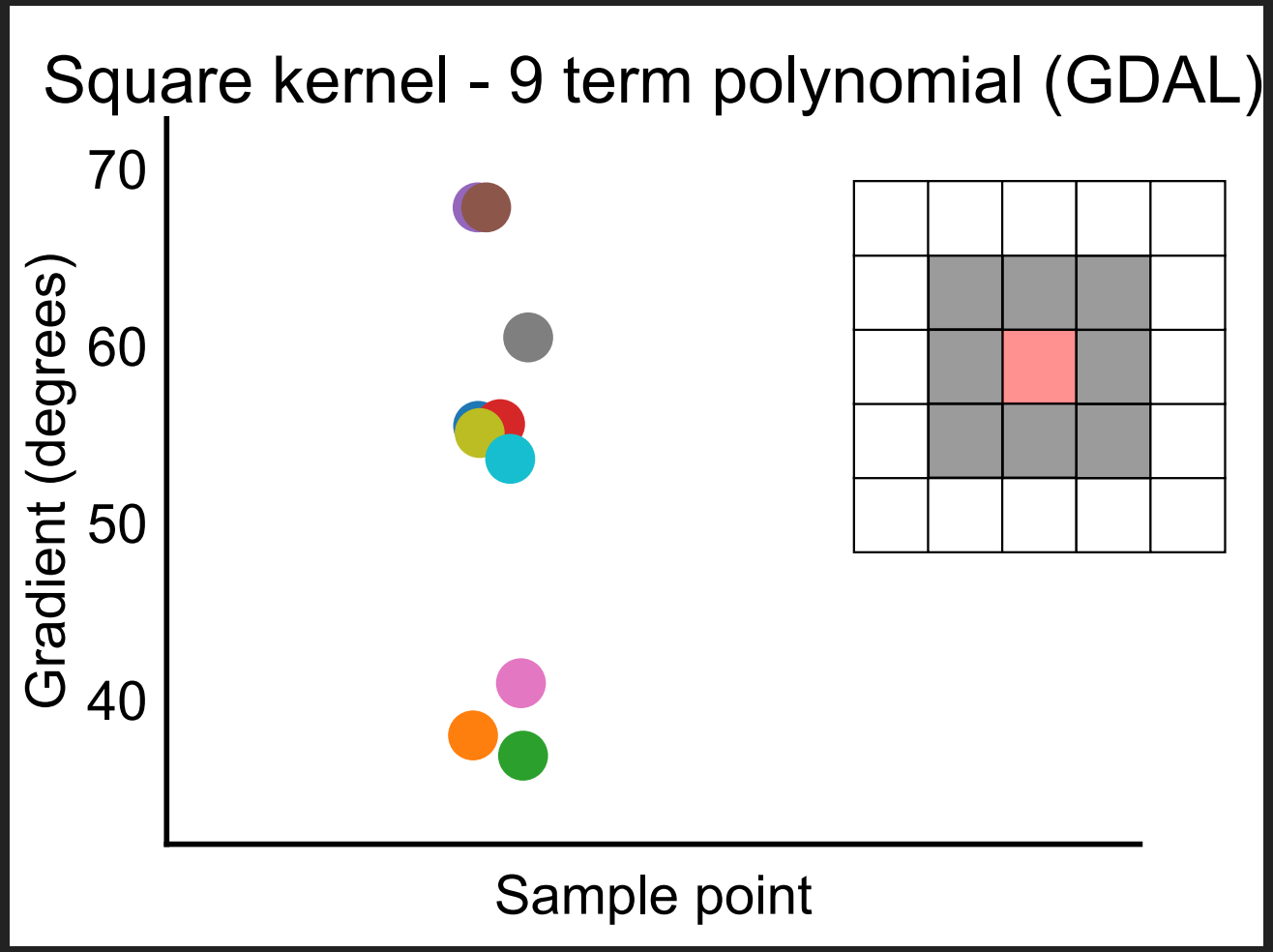

Bishop's case
70
60
50
40
Gradient (degrees)
Sample point

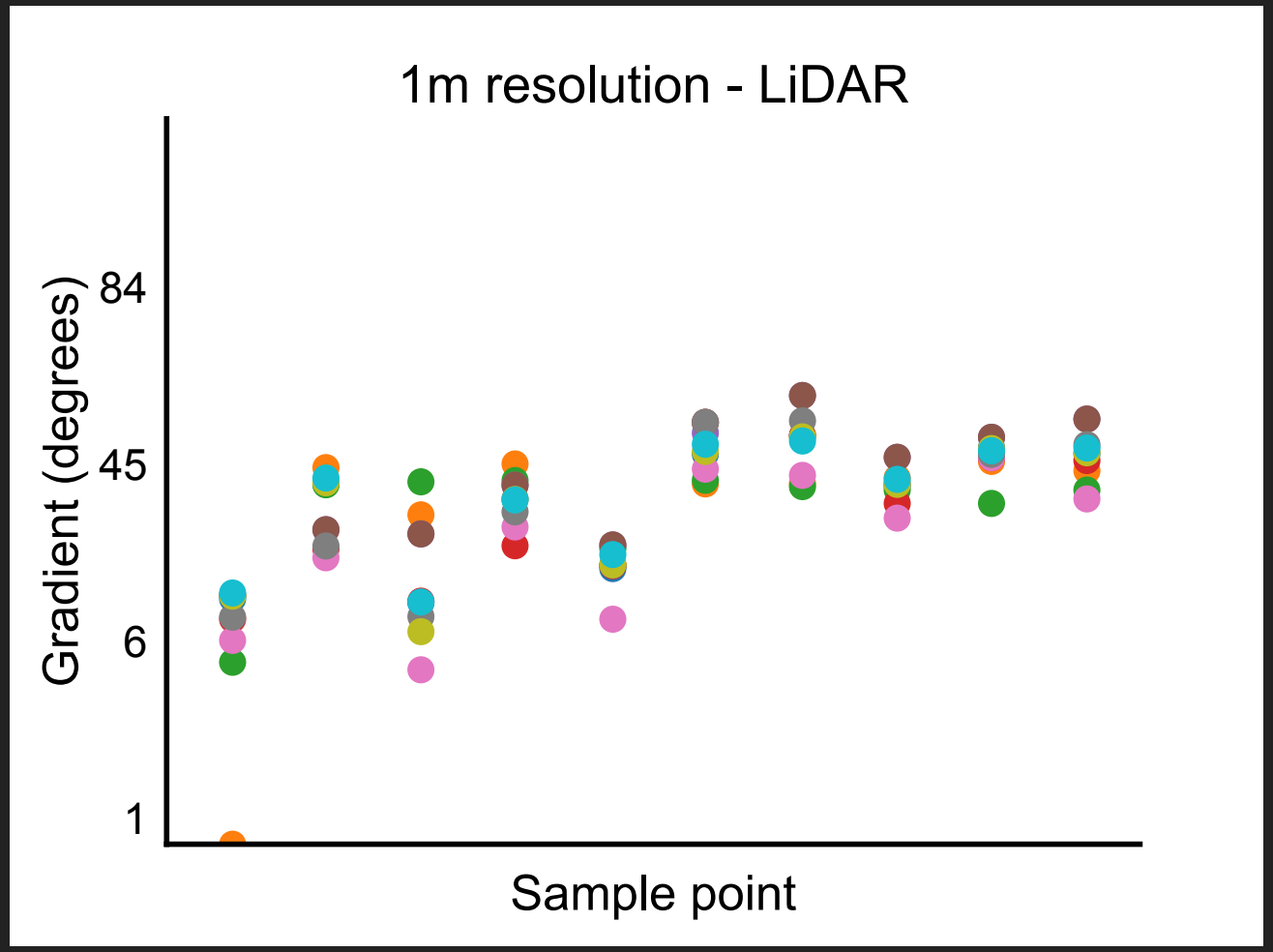

Steepest descent
70
60
50
40
Gradient (degrees)
Sample point

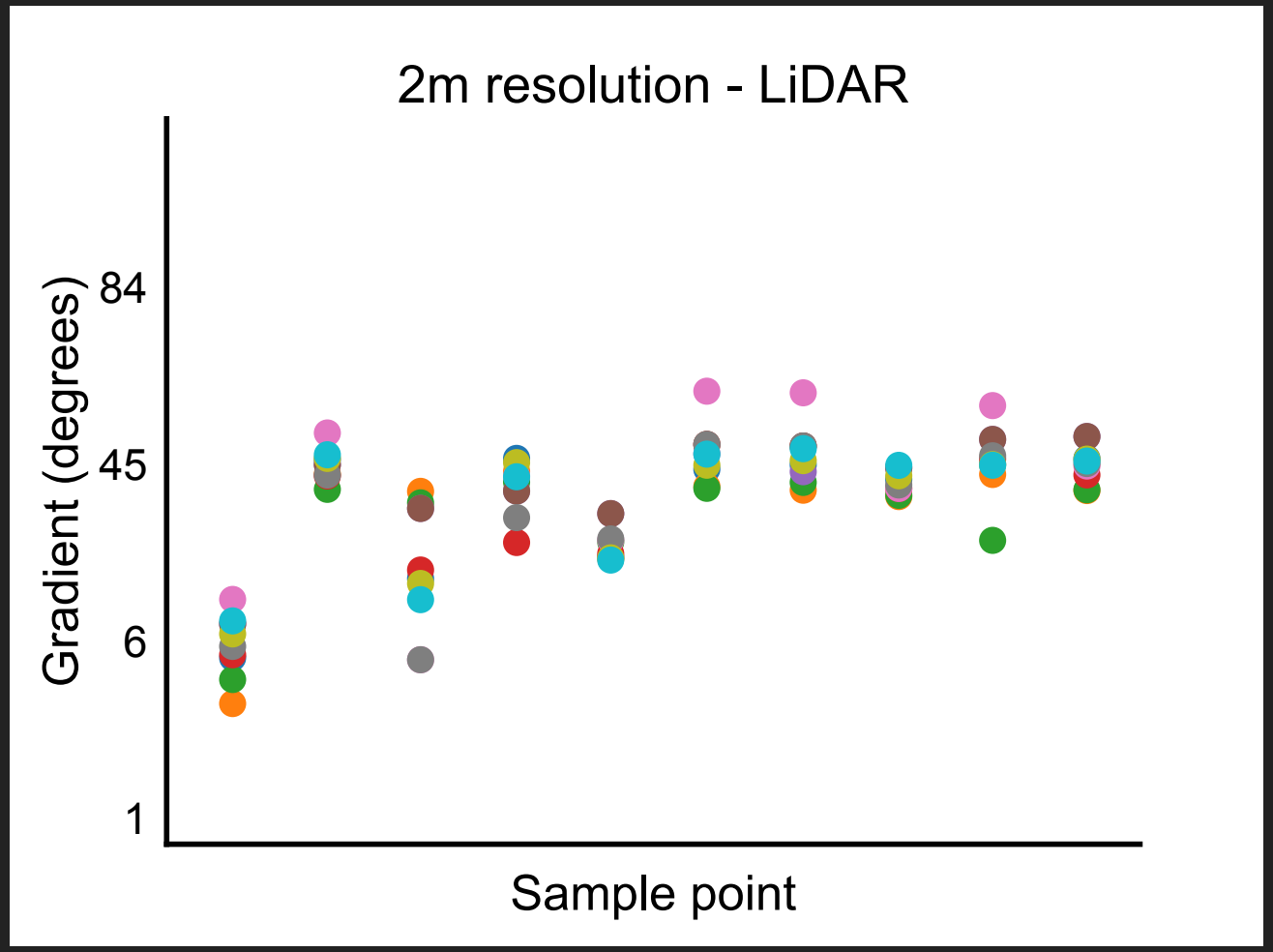

Multidirection steepest descent
70
60
50
40
Gradient (degrees)
Sample point

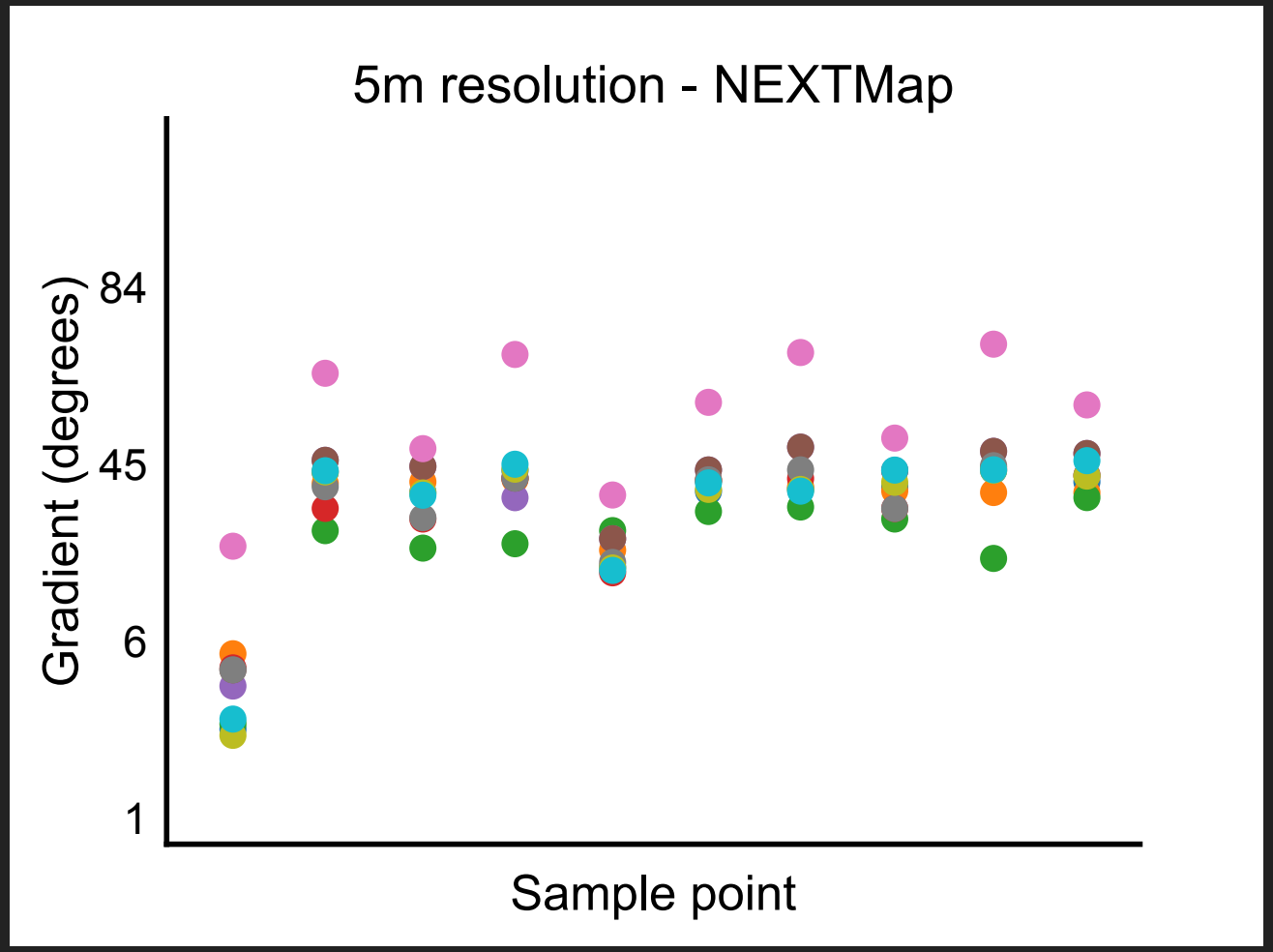

D-infinity slope
70
60
50
40
Gradient (degrees)
Sample point

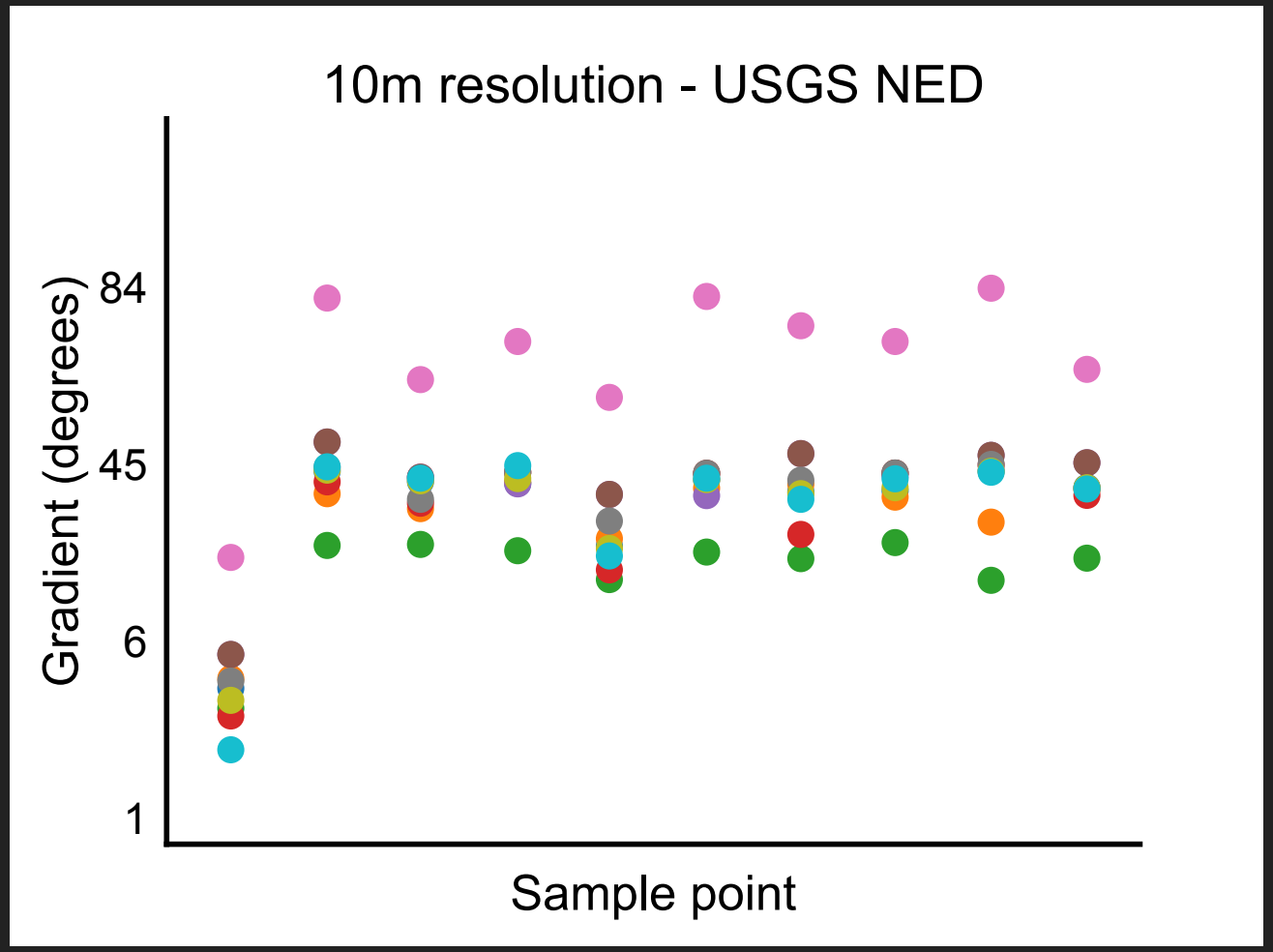

Square kernel (ArcGIS, QGIS, Whitebox)
70
60
50
40
Gradient (degrees)
Sample point

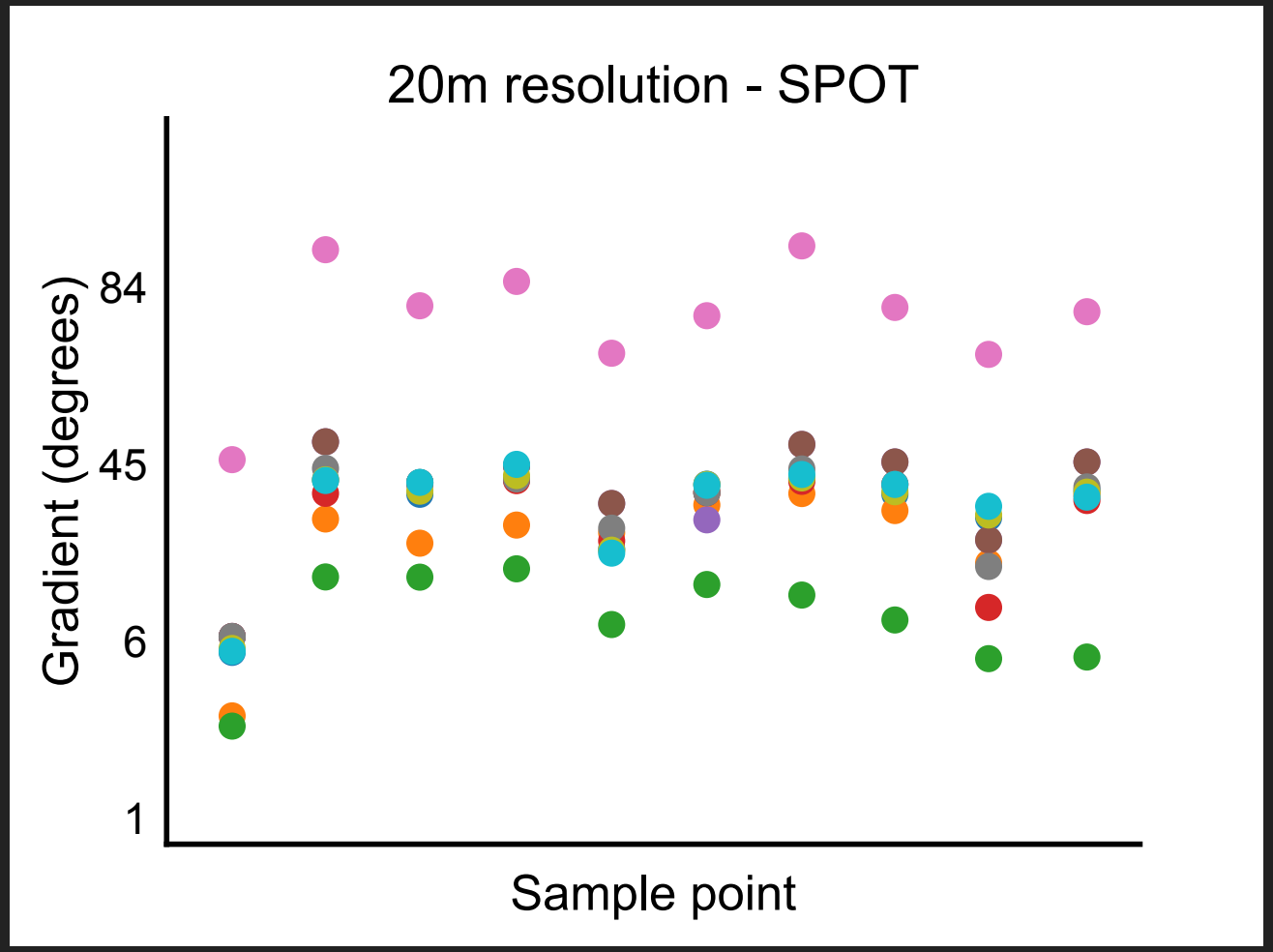

Square kernel - 9 term polynomial (GDAL)
70
60
50
40
Gradient (degrees)
Sample point

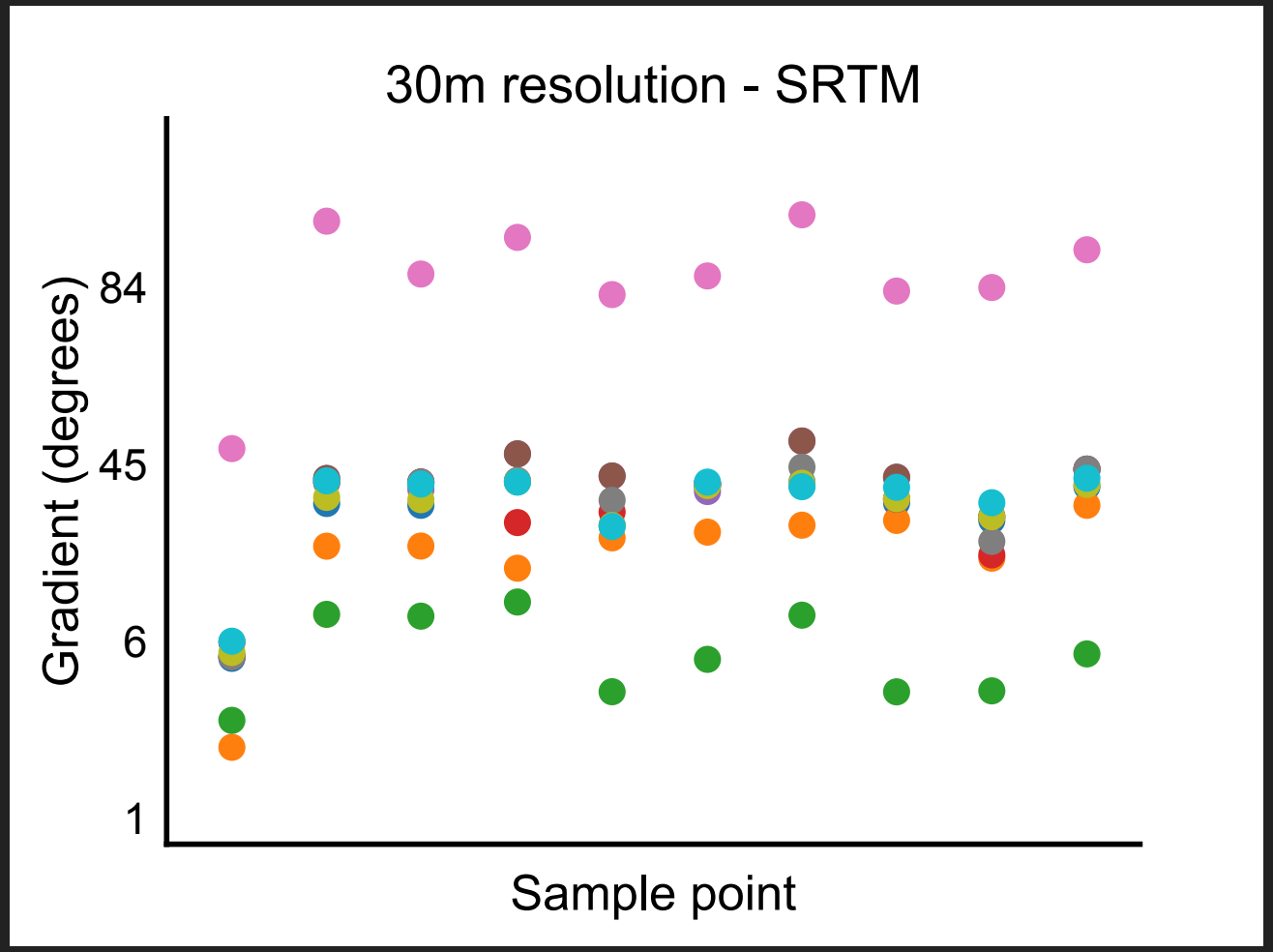

1m resolution - LiDAR
Gradient (degrees)
84
45
6
1
Sample point

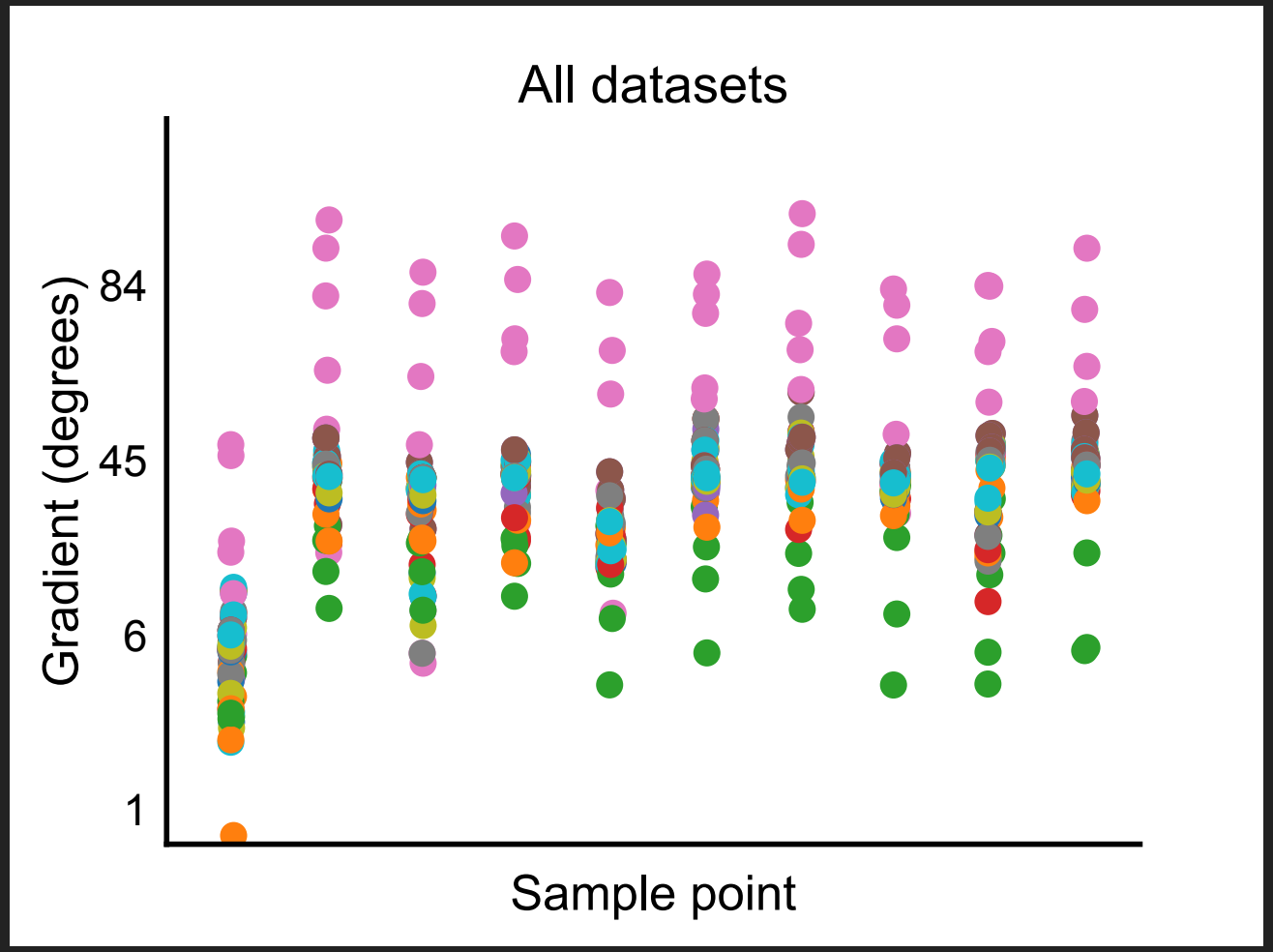

2m resolution - LiDAR
Gradient (degrees)
84
45
6
1
Sample point


5m resolution - NEXTMap
Gradient (degrees)
84
45
6
1
Sample point


10m resolution - USGS NED
Gradient (degrees)
84
45
6
1
Sample point


20m resolution - SPOT
Gradient (degrees)
84
45
6
1
Sample point


30m resolution - SRTM
Gradient (degrees)
84
45
6
1
Sample point


All datasets
Gradient (degrees)
84
45
6
1
Sample point

WITHOUT TRANSPARENT METHODS AND DATA SOURCES OPEN SCIENCE IS NOT POSSIBLE

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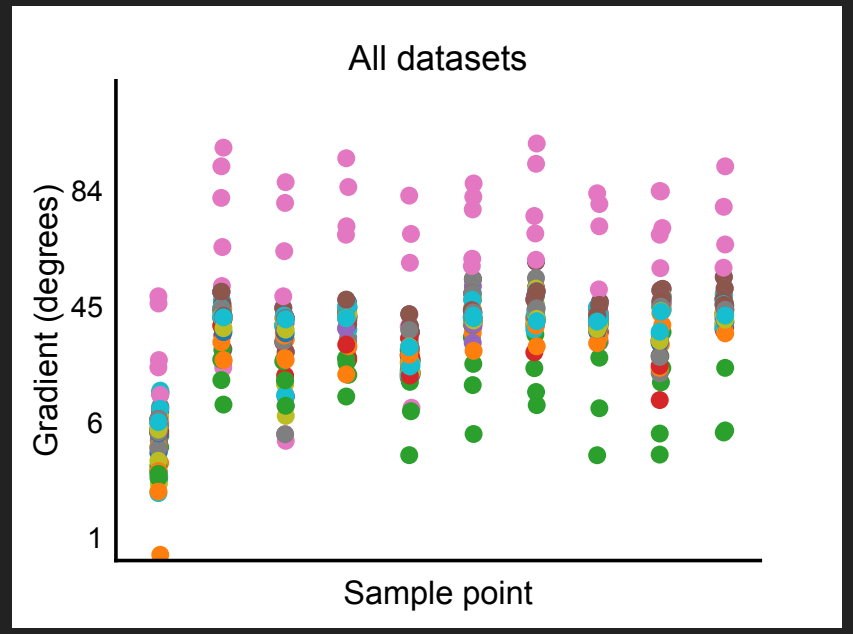
Impacts reproducibility

Changes interpretation of results

Wastes time



OUR ORIGINAL METHODS STATEMENT:

“We calculated slope for our study area.”

A BETTER METHODS STATEMENT?

“We calculated slope as the steepest descent value within an 8 cell kernel, on 1 meter resolution LiDAR data .”

A BETTER METHODS STATEMENT?

“We calculated slope as the steepest descent value within an 8 cell kernel, on 1 meter resolution LiDAR data .”

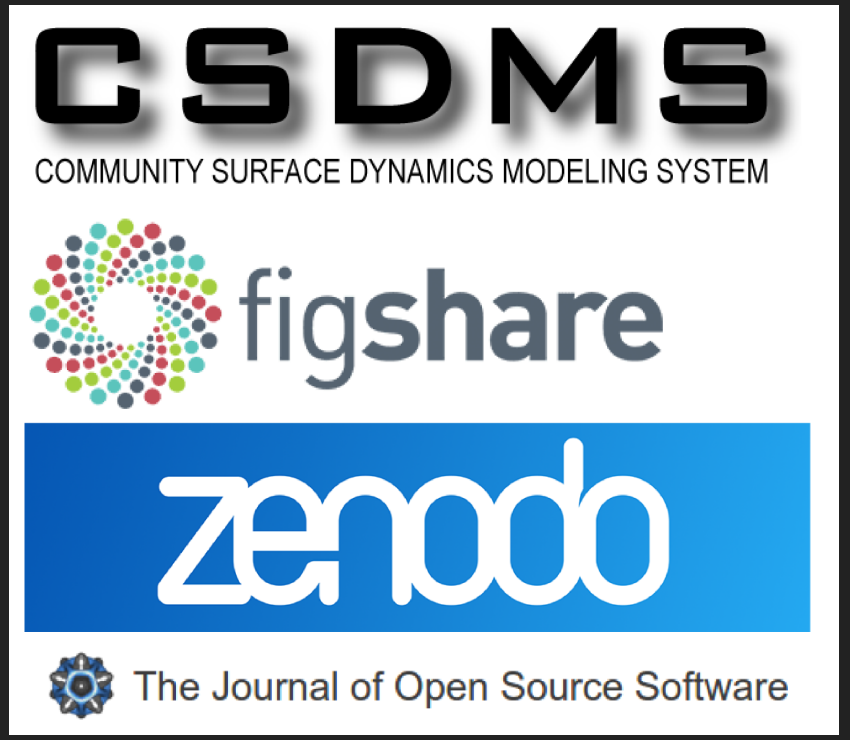
PATHWAYS TO OPEN METHODS

Write clearer methods sections

Make better use of supplemental information

BSG Geomorphological Techniques

Publish code



PATHWAYS TO OPEN DATA

Cite data properly, with a DOI

Put it in a stable repository

Document your data

NEW PREPRINT ARCHIVE

CONTACT CHRIS JACKSON FOR DETAILS:

@EarthArXiv

@seis_matters

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THANK YOU

Interested in learning more?

Need help with software as part of your research?

Want to collaborate?

s.grieve@ucl.ac.uk

swdg.io