Water level analysis in Tibet using CryoSat-2

Lun Yan, Hassan Hashemi Farahani, Dennis Mattes, Omid Elmi, Nico Sneeuw

Geodätisches Institut der Universität Stuttgart - GIS

Image reference: https://www.tibetdiscovery.com/assets/images/about-tibet/tibet-namtso-lake-320.jpg

Outline

- Introduction
- Methodology
  - Calculation of water level
  - Choice of Geoid
  - Stepwise data snooping
  - Trend analysis
- Results
  - Water level and trend of selected lakes
  - Comparison with other work
- Conclusion

Introduction

- ➢ **Research Area**
  - ➢ Tibetan plateau
  - ➢ Approx. 400 lakes
- ➢ **Data gap**
  - ➢ Lack of in situ stations
  - ➢ Solution: Satellite Altimetry
- ➢ **CryoSat-2**
  - ➢ SARin: discrimination of coastal echoes
    between land and water
  - ➢ L2 data: 2010 - 2018

Tibet

Methodology

➢ Calcuation of water level H

$$h = A - R$$
$$H = h - N$$

H: Orthometric height ($\rightarrow$ Water level)
h: Ellipsoidal height
N: Geoid undulation
A: Altitude
R: Range (with retracking correction)

Satellite

R

A

Water surface

h H

N

Ellipsoid
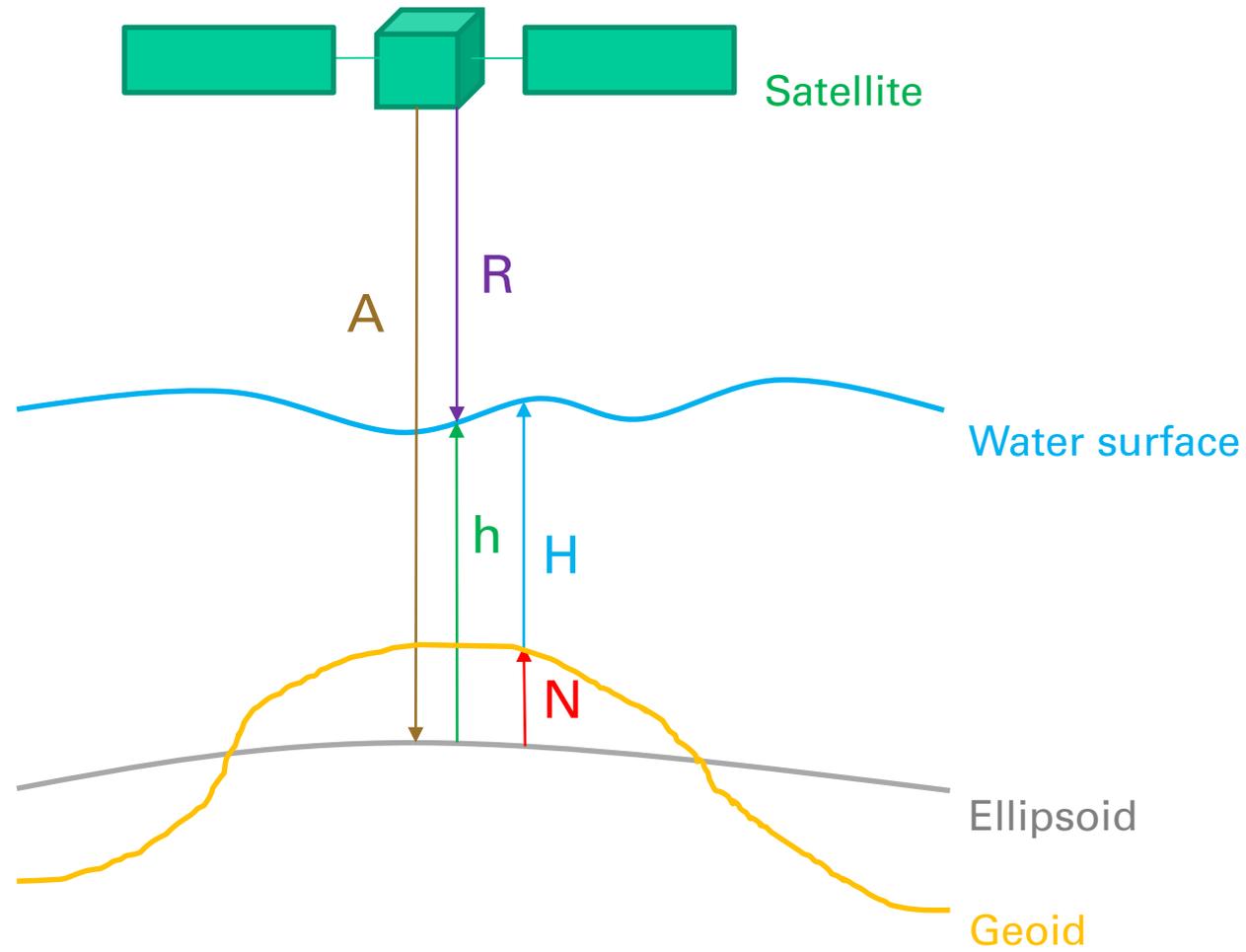
Geoid

Methodology

➢ **Choice of Geoid**

    ➢ EGM2008:

      Geoid matrix provided by earlier work

   Accuracy low **-> not good anymore**

    ➢ Eigen6C4

      Geoid matrix calculated with ICGEM

      http://icgem.gfz-potsdam.de/home

      Accuracy high **-> good**

Image reference: http://deepearthscience.blogspot.com/2013/10/measuring-geoid-what-is-geoid.html
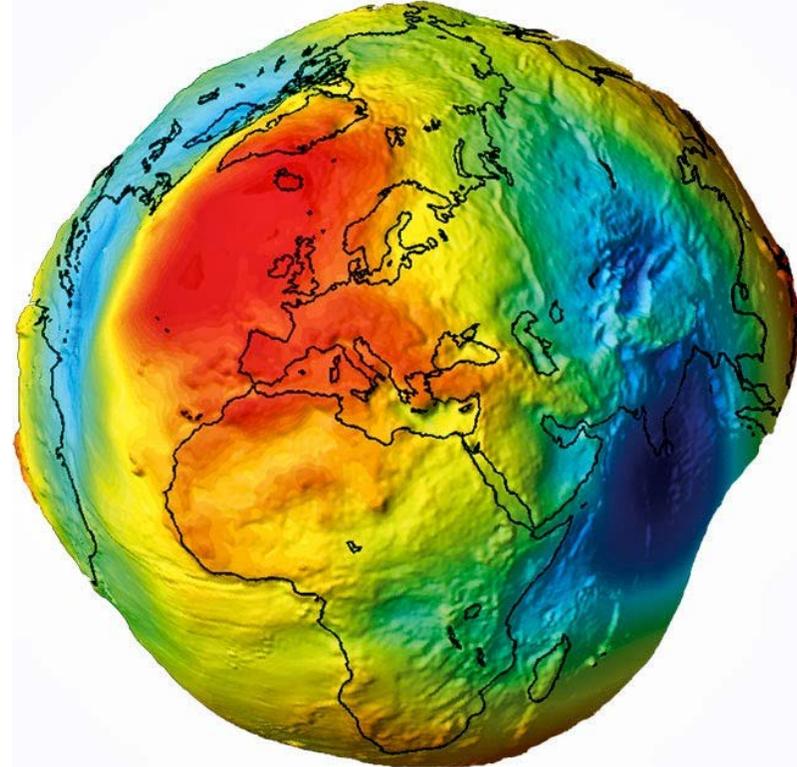
Geoid difference (Eigen6C4 - EGM2008)
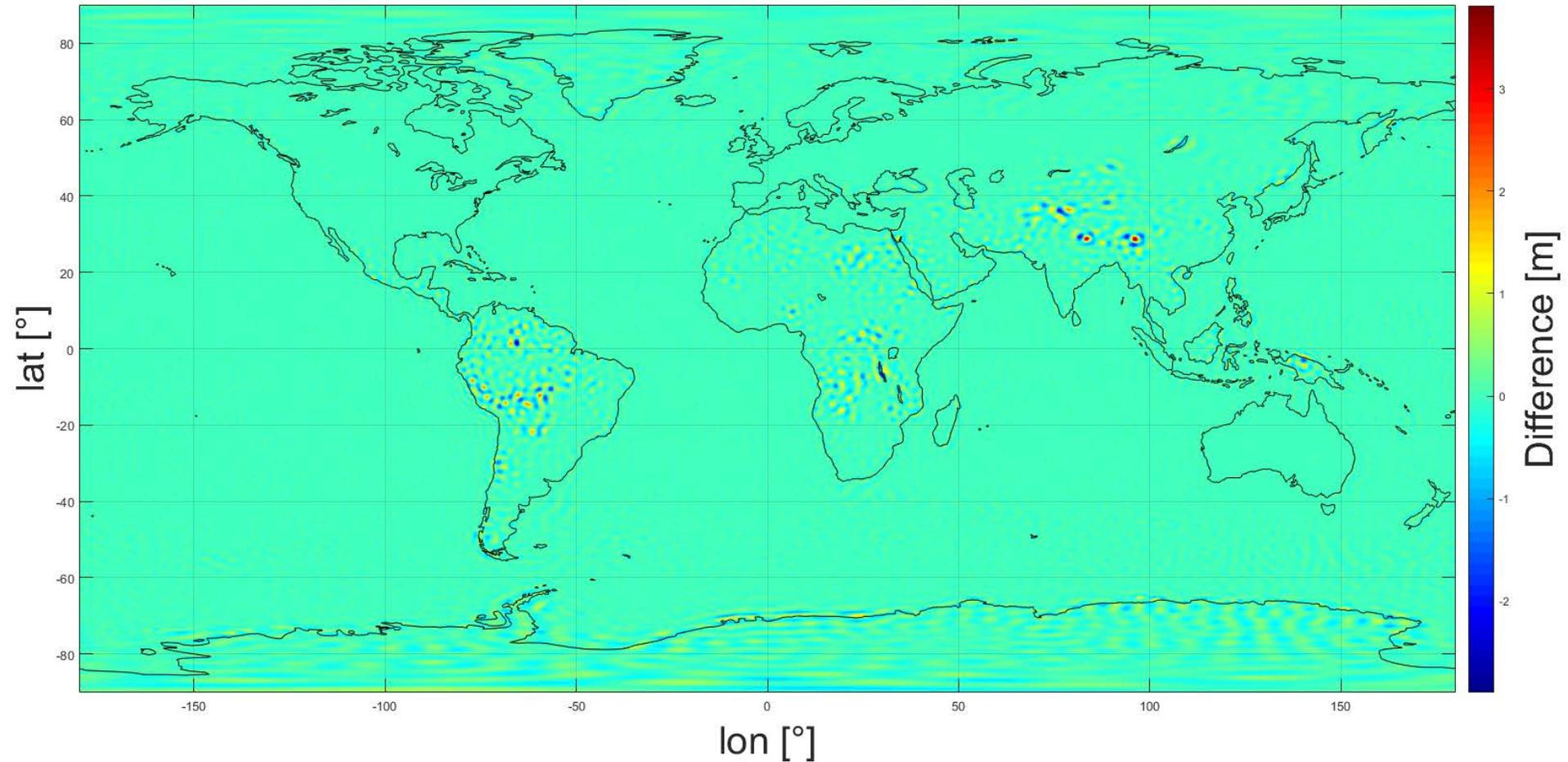
Geoid difference in Tibet

Taro Co all measurements before outlier detection
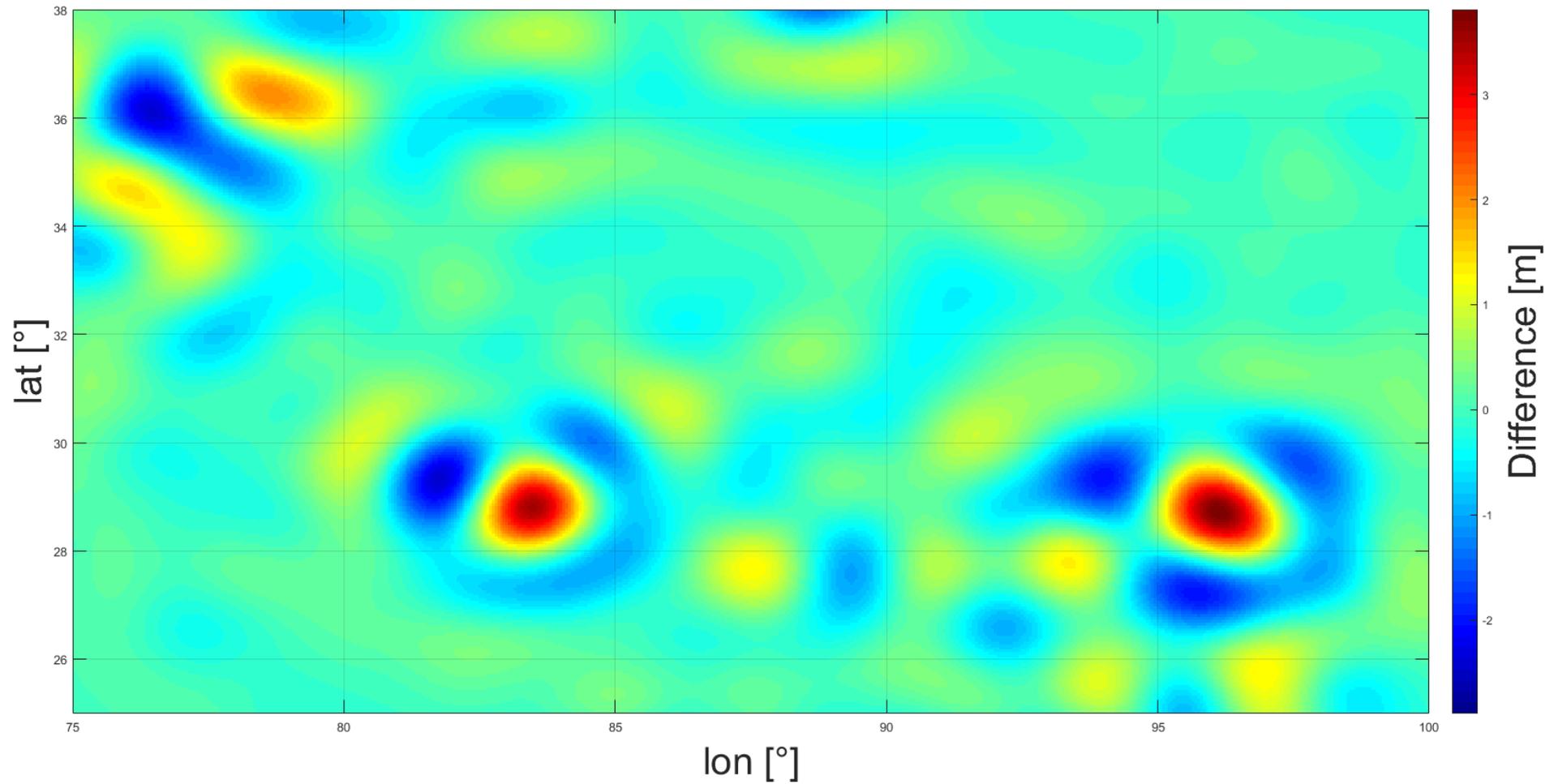
Methodology

➢ Data snooping step 1

    ➢ For measurements in the whole area (4 sigma)

➢ Data snooping step 2

   ➢ For measurements along 1 track (3 sigma)

➢ Example: Taro Co
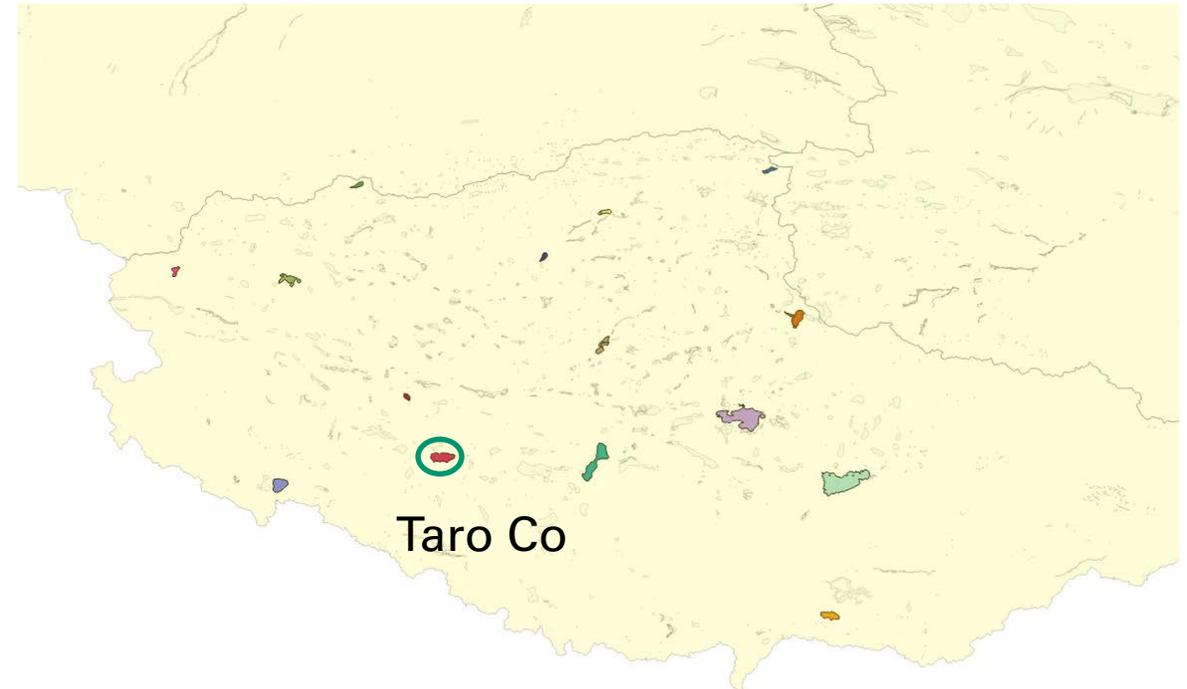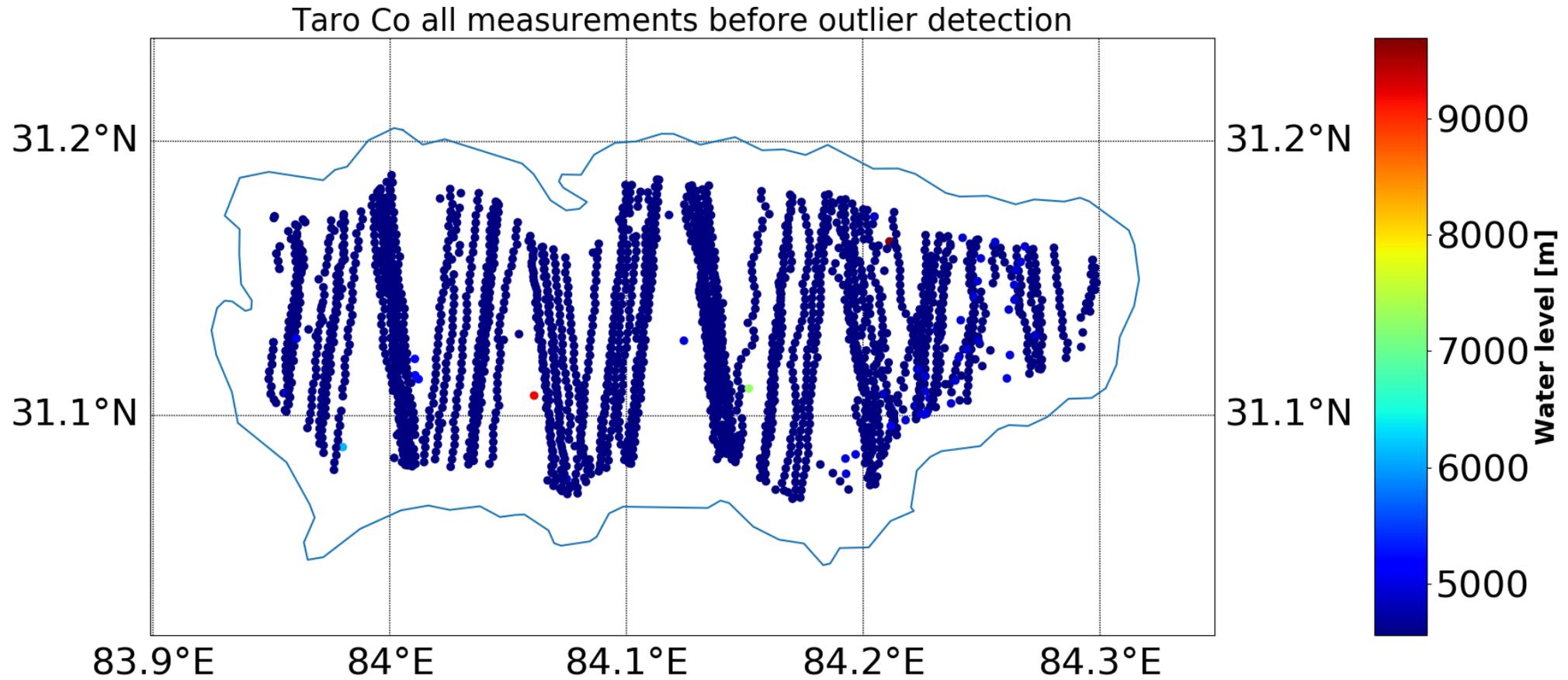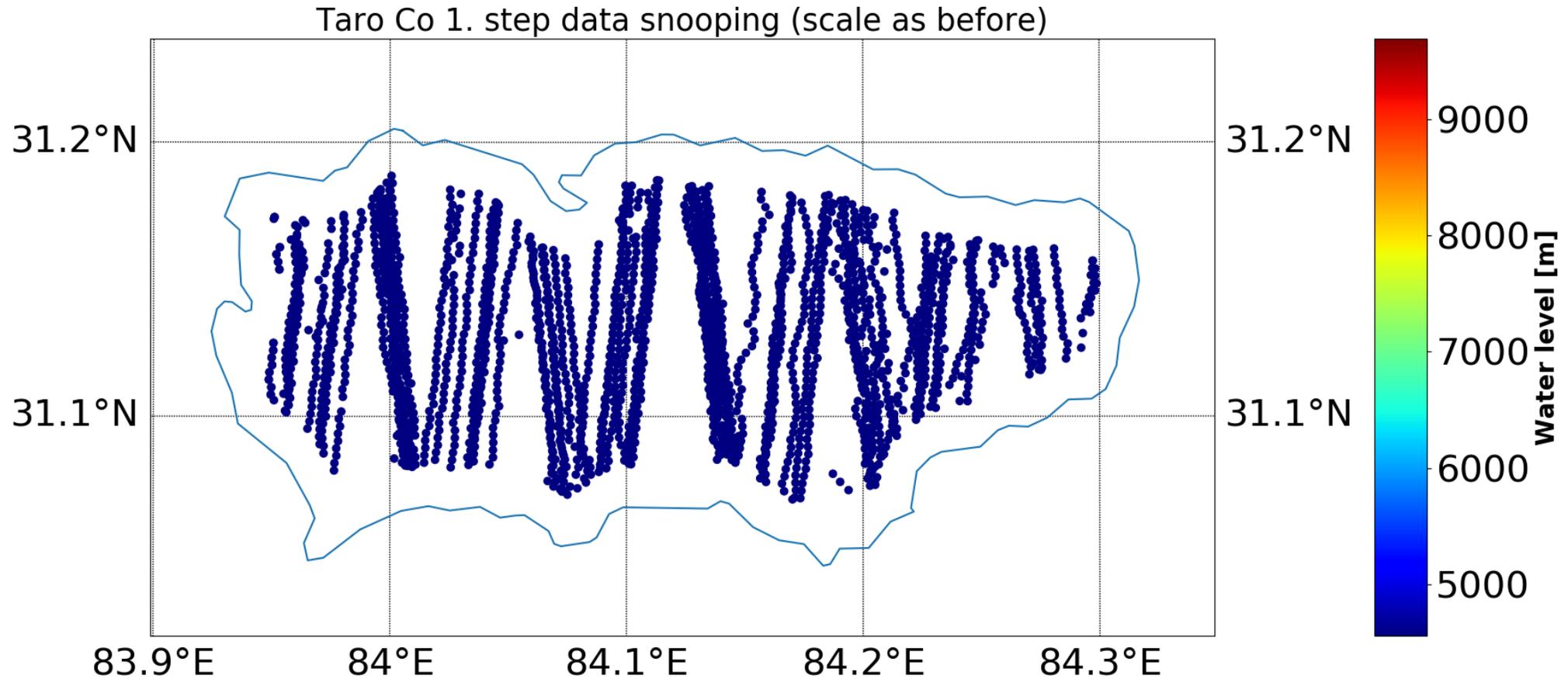
Taro Co

Taro Co all measurements before outlier detection

Total: 2453

Taro Co 1. step data snooping (scale as before)

Total: 2453   Eliminated: 78

Taro Co 1. step data snooping (true scale)

Total: 2453   Eliminated: 78

Taro Co 2. step data snooping (true scale)
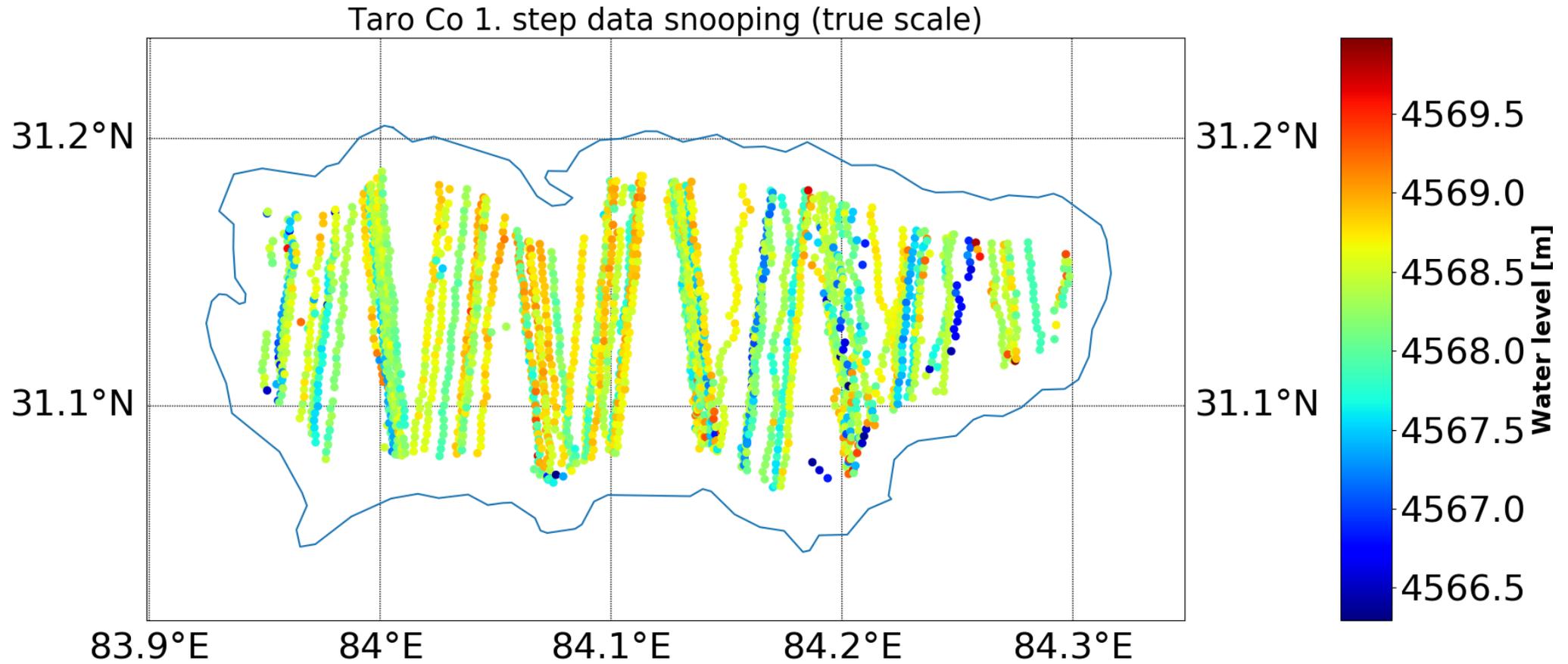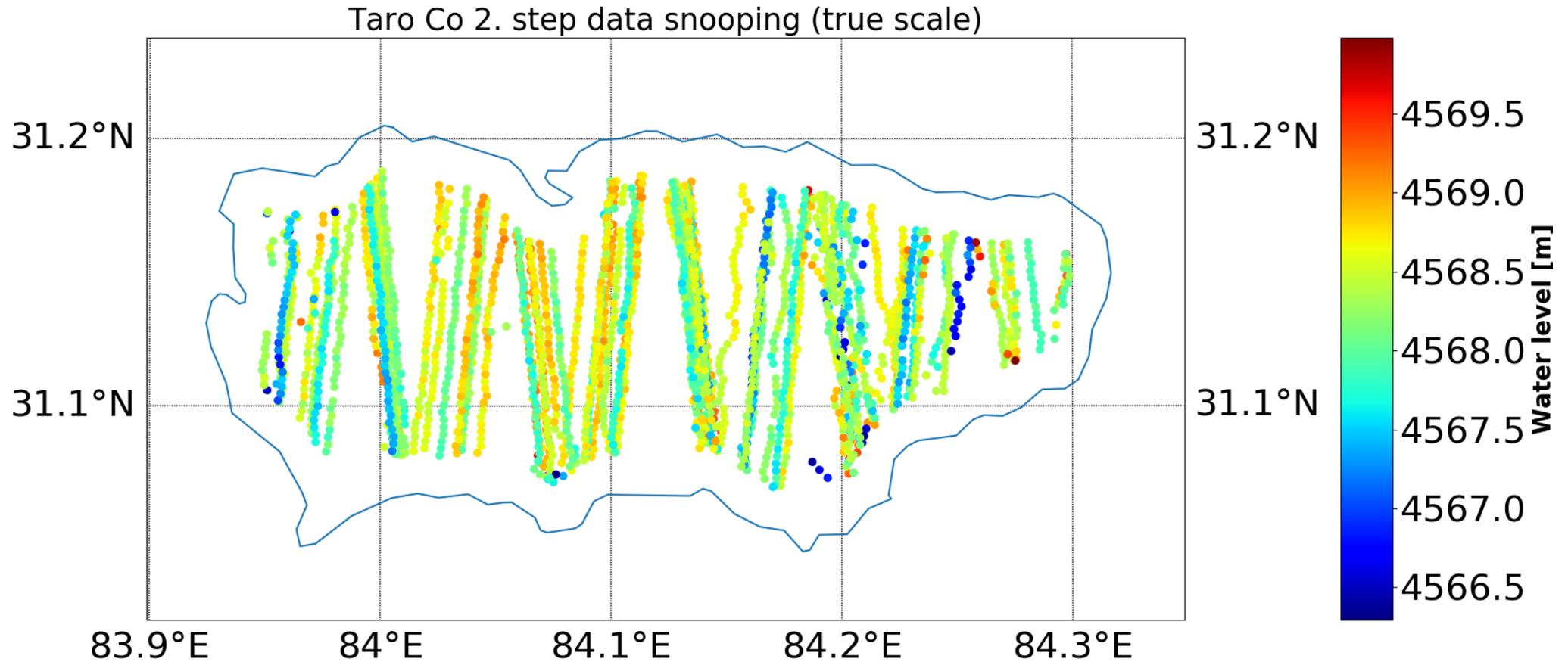
Total: 2453   Eliminated: 29
Quote: (78+29)/2453 ≅ 4.36 %

Methodology

- ➢ Trend analysis
 - ➢ Rising or sinking?
  - ➢ How Fast?
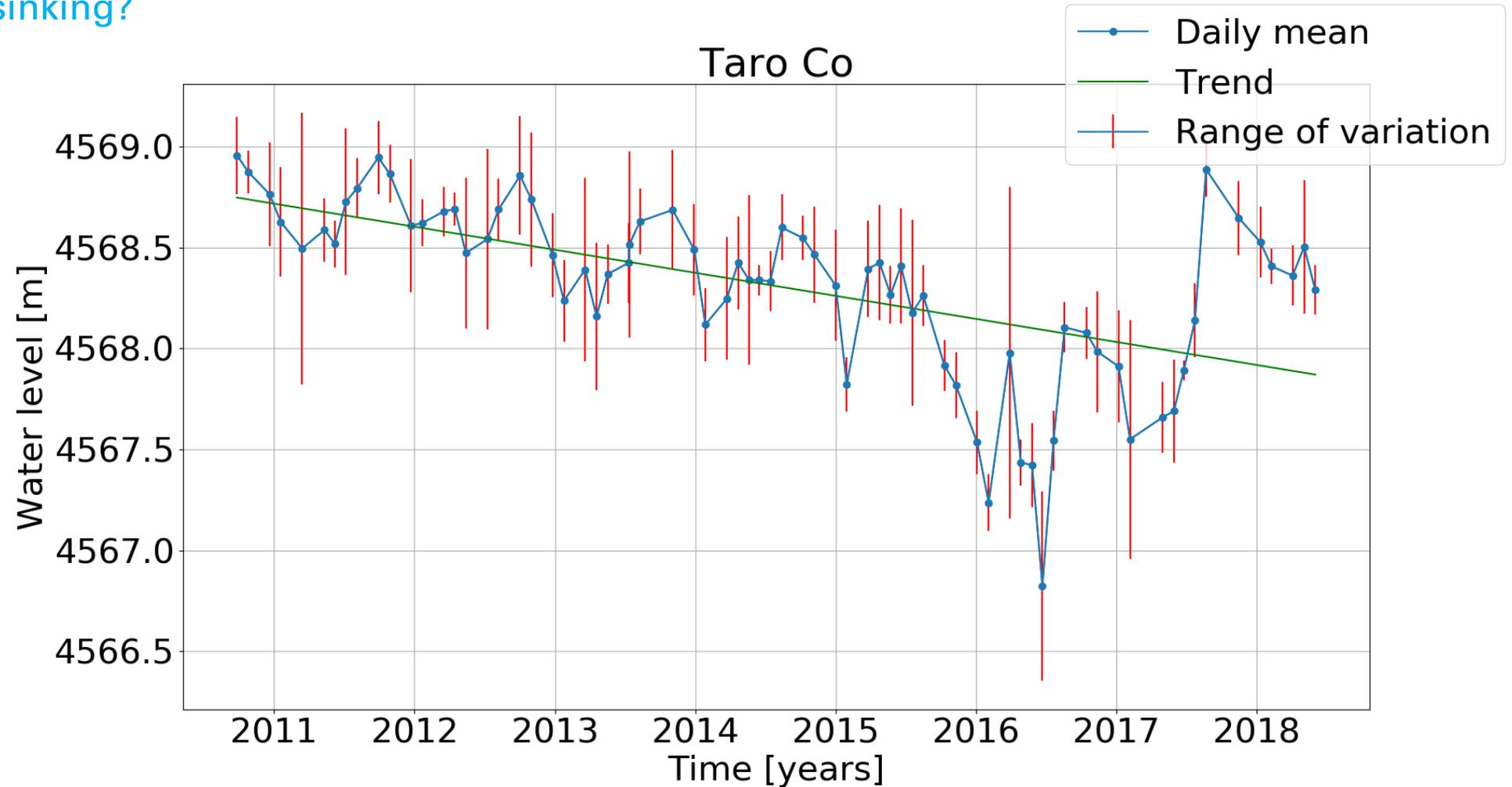
Trend: -0.121 m /yr

Results

➢ Water level and trend of selected lakes
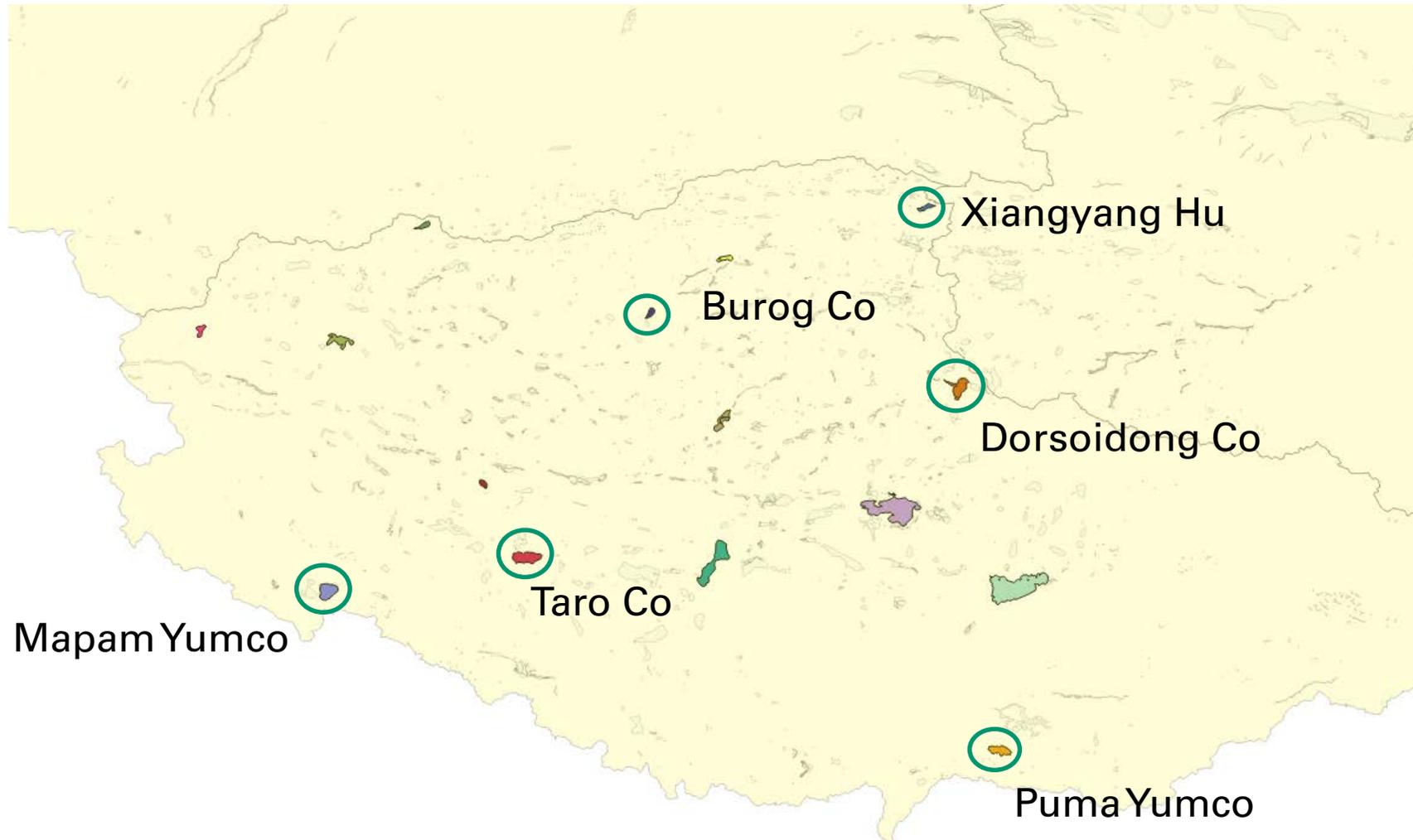
➤ Water level and trend of selected lakes
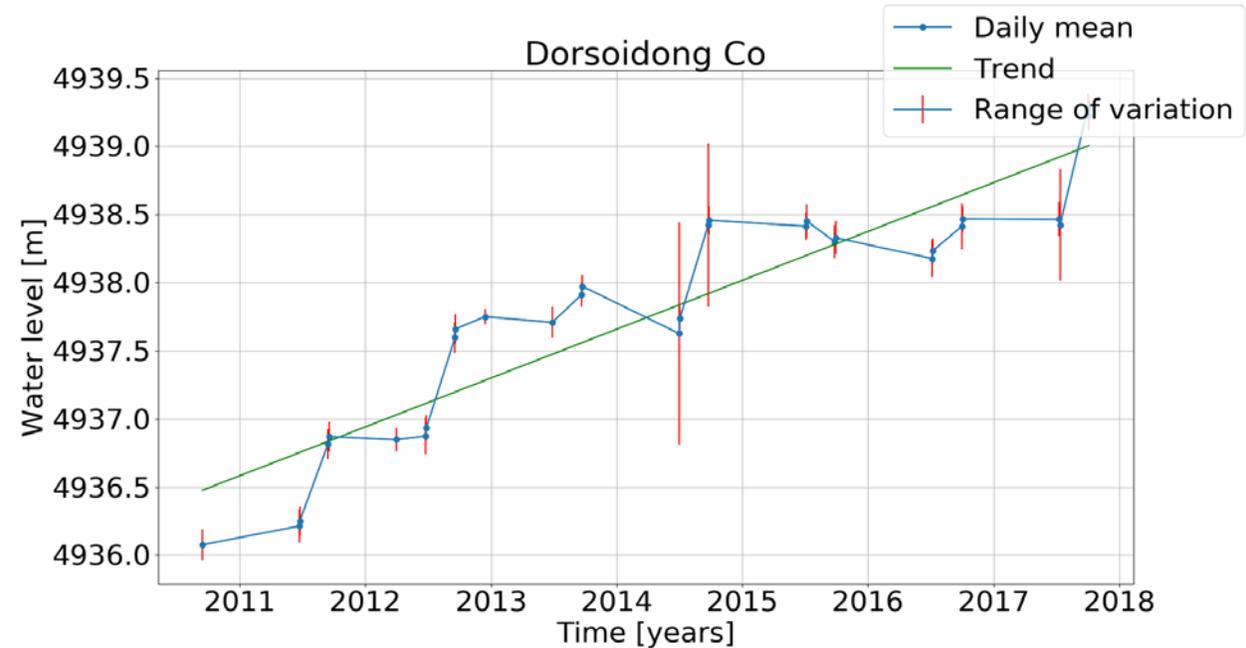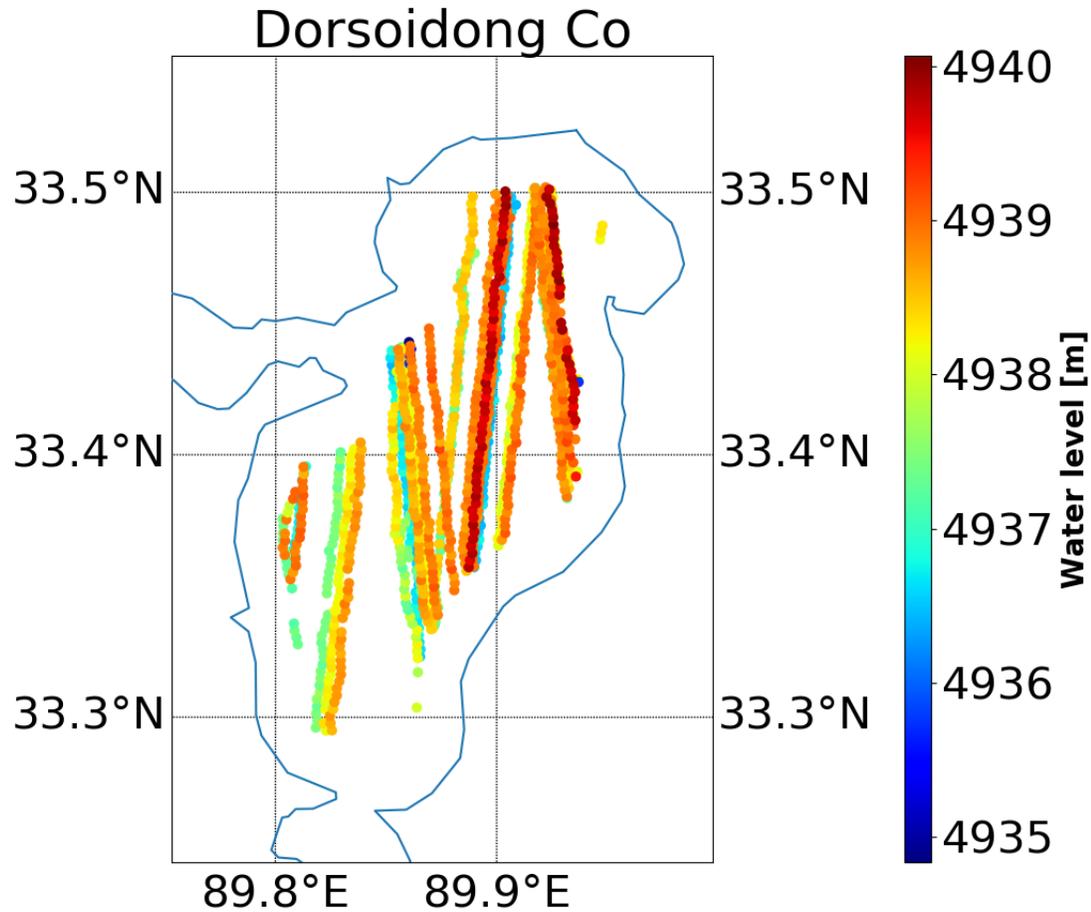
Eliminated Quote: 1.88 %   Trend: +0.318 m /yr

Results

➢ Water level and trend of selected lakes
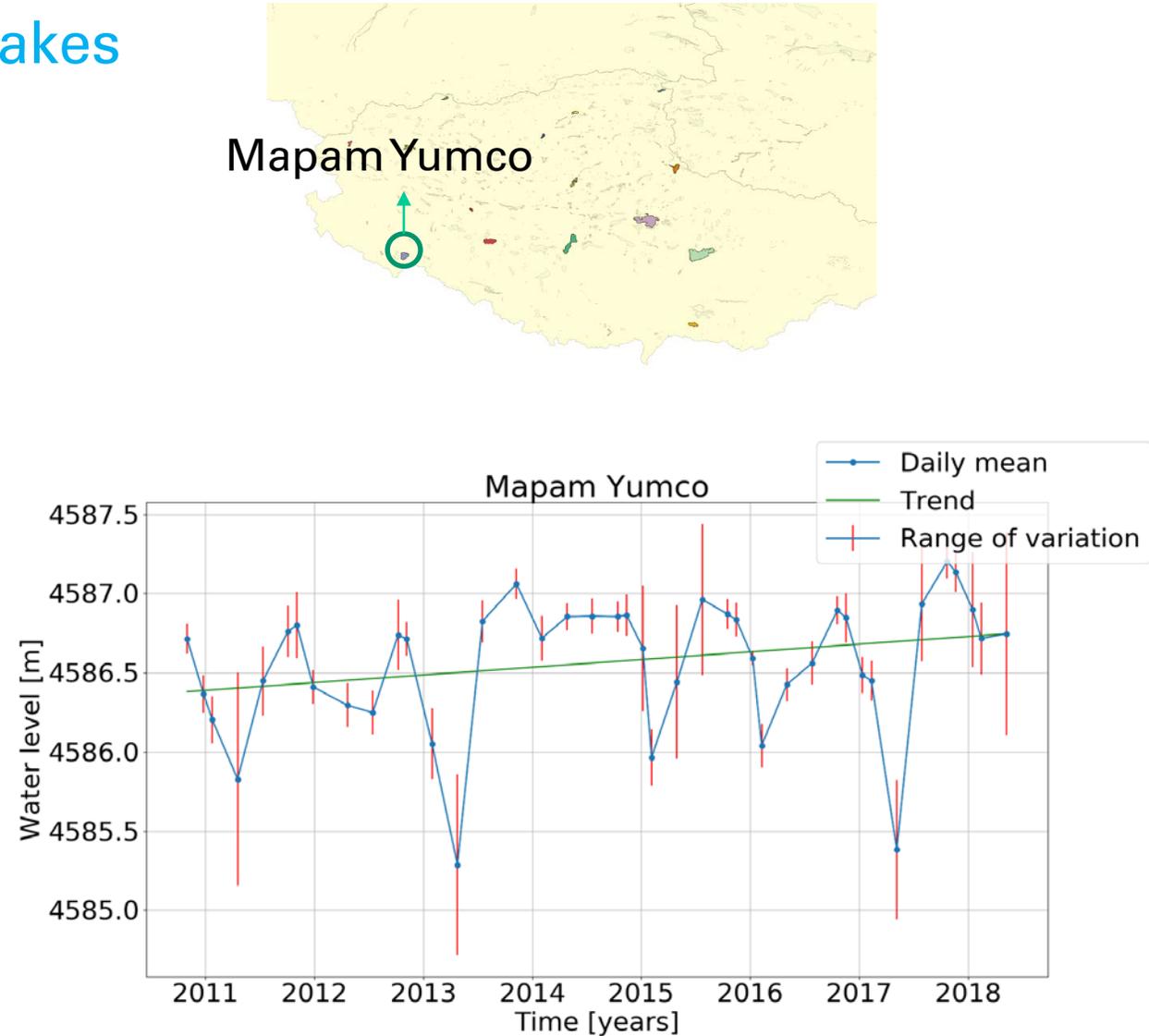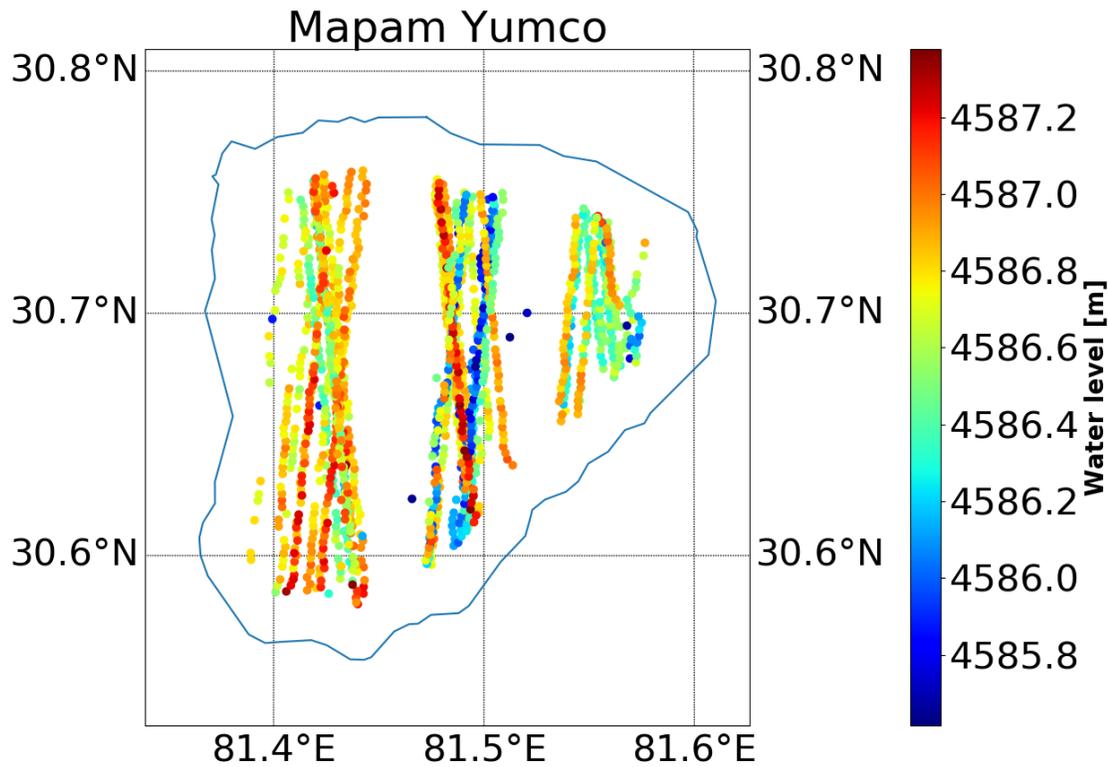
Eliminated Quote: 22.33 %   Trend: +0.043 m /yr

Results

➢ Comparison
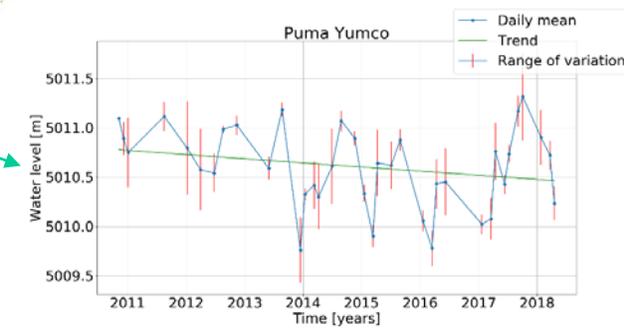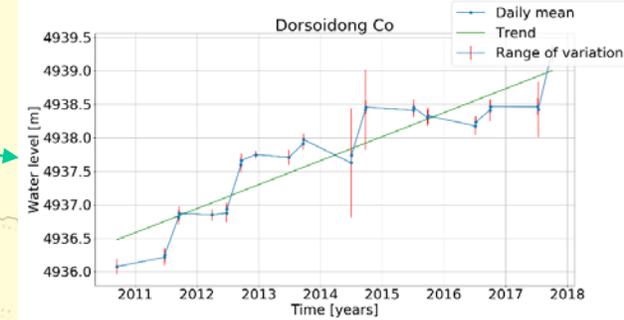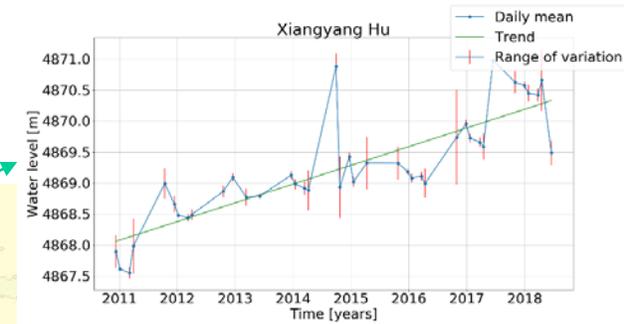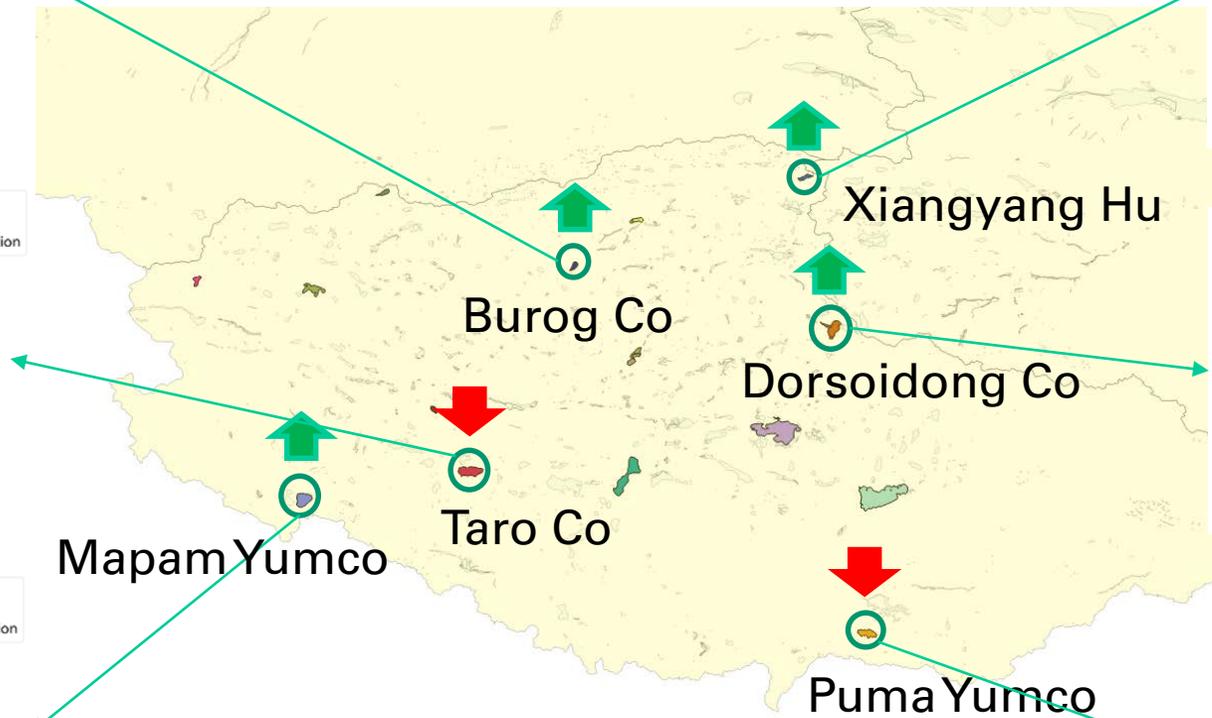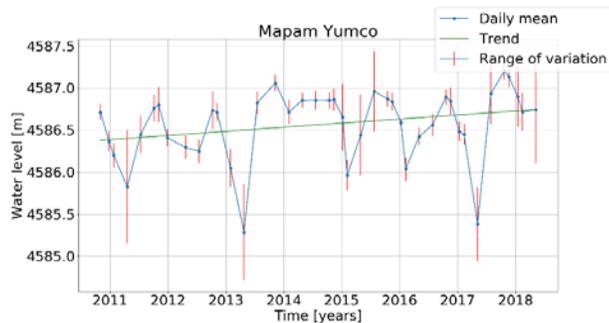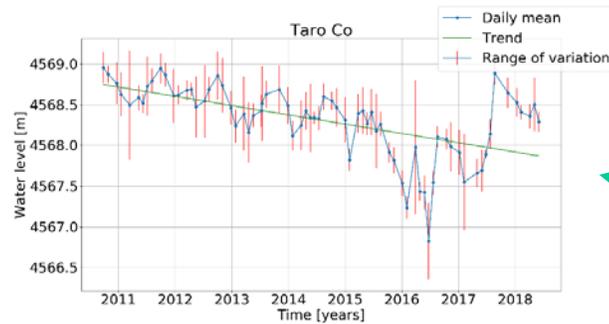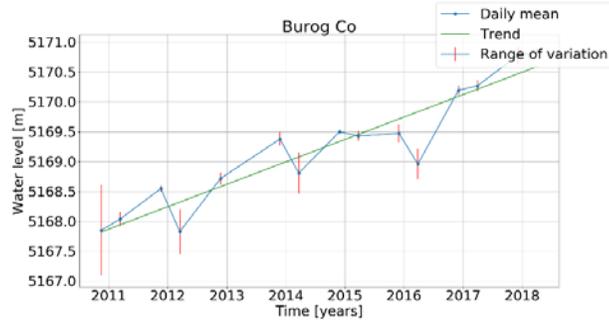
Conclusion

- ➢ Tendency
 - ➢ South ↘
  - ➢ North ↗
- ➢ Cause
  - ➢ Global warming
  - ➢ Usage & Pollution
- ➢ Future work
  - ➢ Small lakes in Tibet
  - ➢ Comparison with Jason-2

Tibet
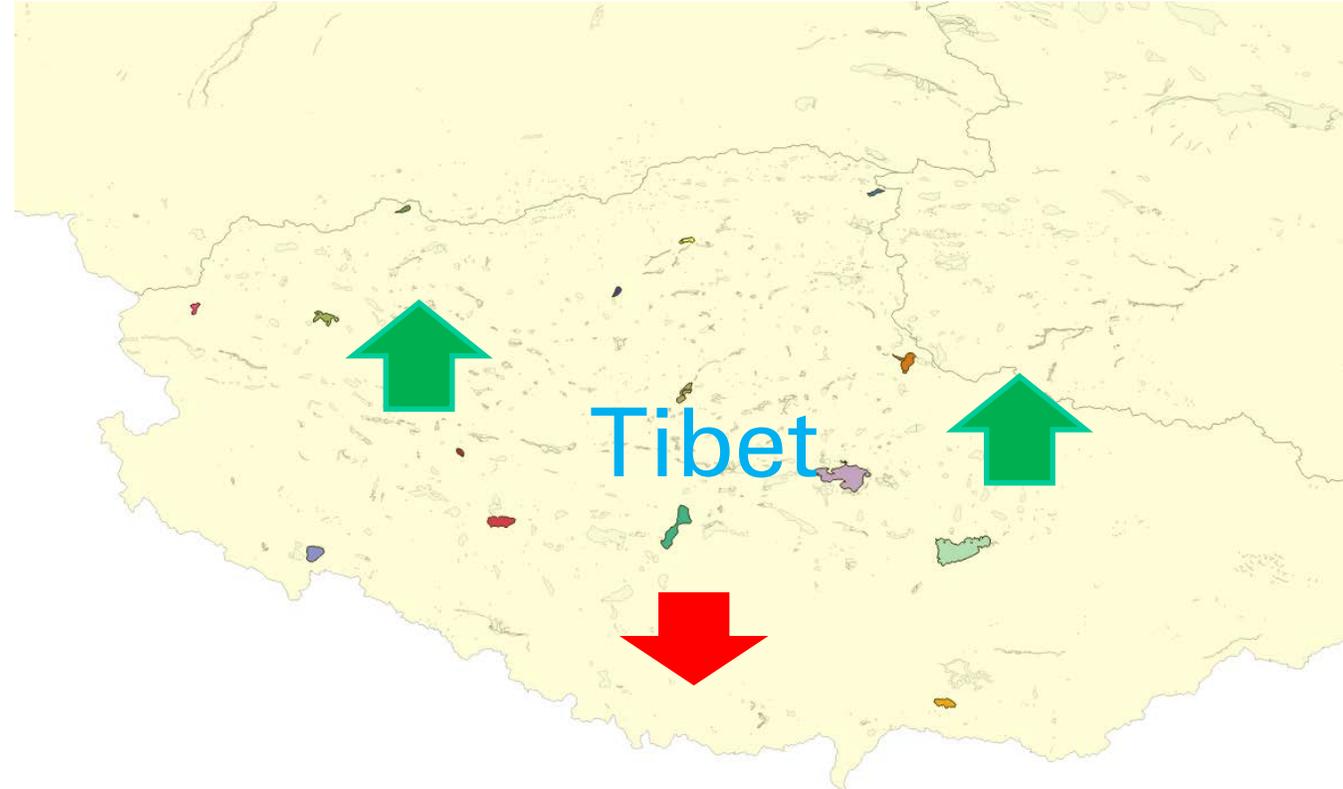
Thank you very much!

Lun Yan, Hassan Hashemi Farahani, Dennis Mattes, Omid Elmi, Nico Sneeuw

Geodätisches Institut der Universität Stuttgart - GIS

Image reference: https://www.tibetdiscovery.com/assets/images/about-tibet/tibet-namtso-lake-320.jpg