Analysis of GPS data from an Antarctic Glacier

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Outline

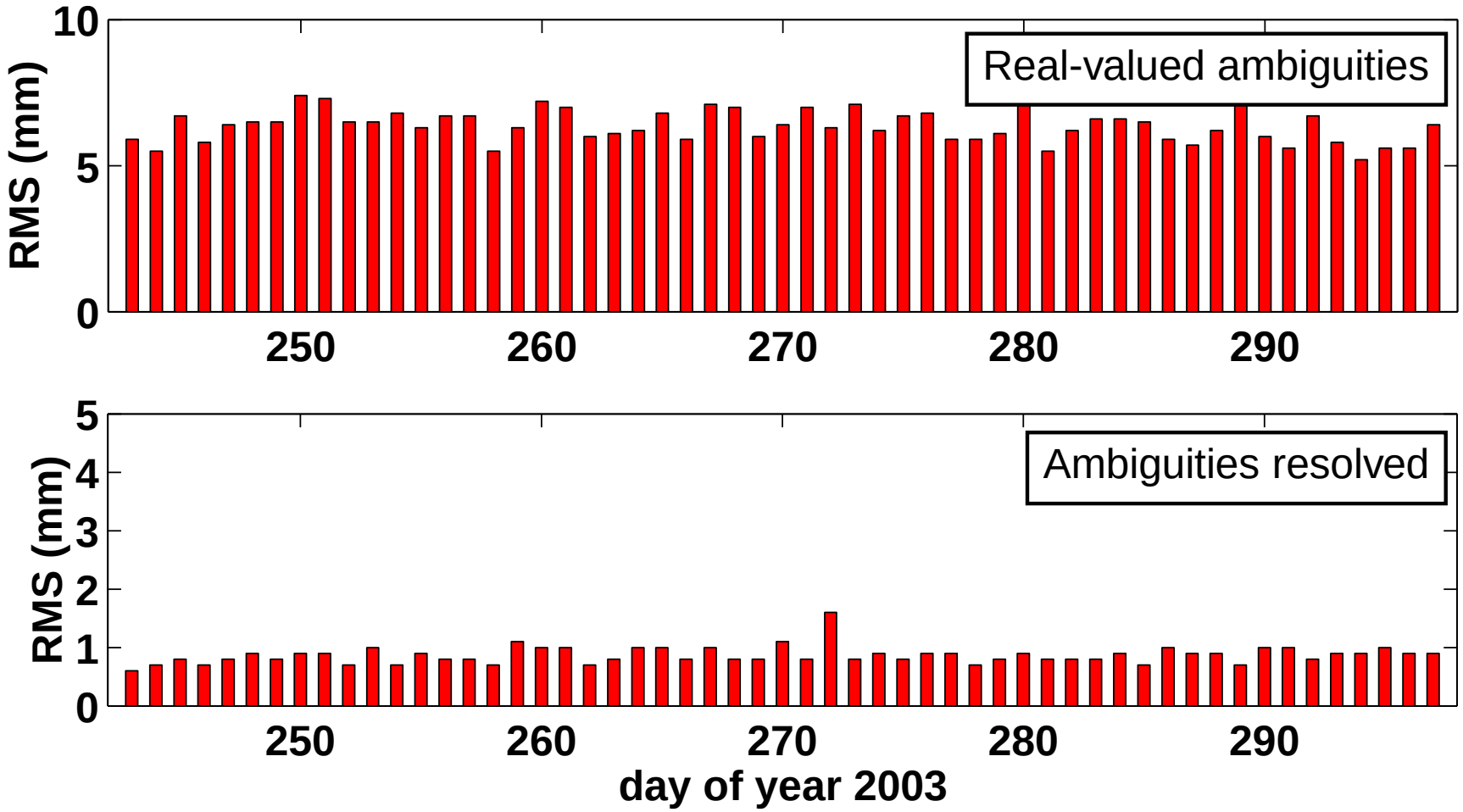
Analysis of GPS data from an Antarctic Glacier:

1. Motivation
2. Description of the data
3. How to characterize the noise of the time series?
4. Comparison of the different analysis methods
5. Summary and Conclusion

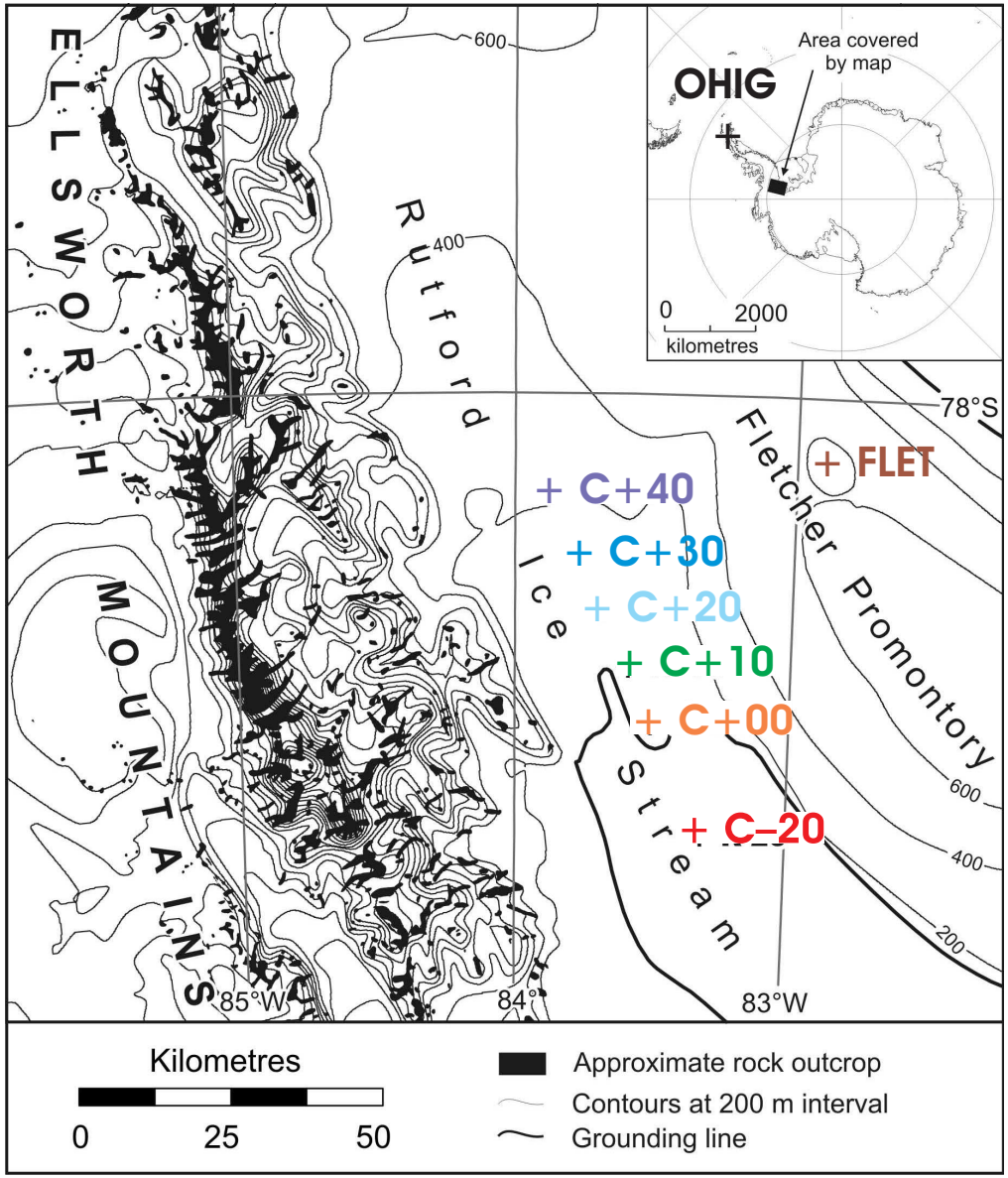
Motivation

Reduced-dynamic orbits differences for GRACE A and B

K-band range RMS errors, Jäggi (2006)



Description of the data



- C−20: Receivers on shelf ice
- C+00: Receiver on the grounding line
- C+10: Receiver 10 km inland
- C+20: Receiver 20 km inland
- C+40: Receiver 40 km inland
- FLET: Receiver on an ice cap
- IGS station O'Higgins is about 2000 km away.

Description of the data

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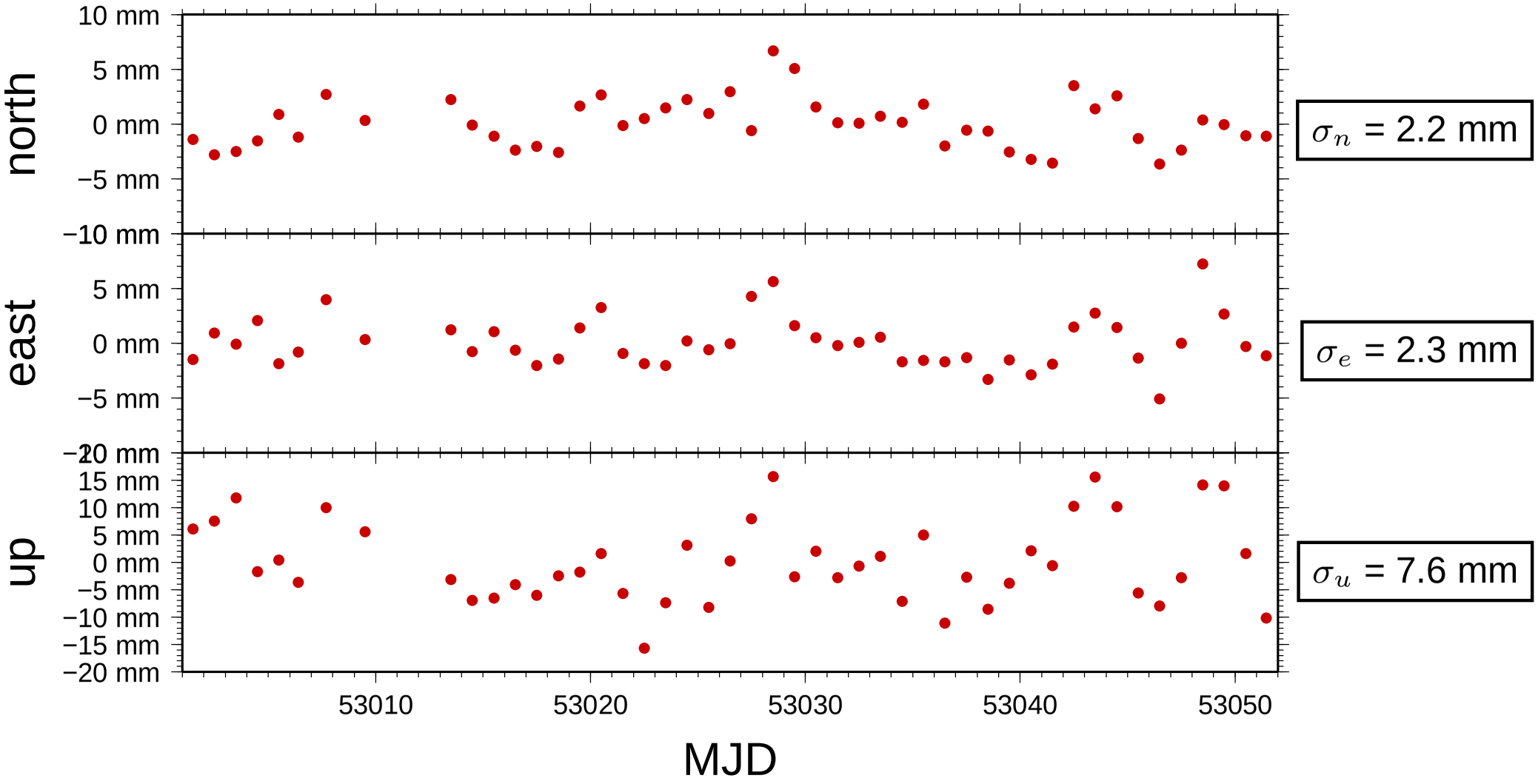
CONTENT OF RINEX OBSERVATION FILES

Number of GPS satellites in phase observations with both frequencies

C-20 |-665567767789888989788789****9988776767565688767787 8*998898889*9989887-
C+00 |66655677--789888989778789****9988776767565588767797 8*998898889*99898777
C+10 |666556776778988898977 8789****9988766767565587677 --8*998898889*99898777
C+20 |676556776778988898977 8889****9988766766565588767797 8*998898889*9989--77
C+30 |666536766778888899878578**9*9988766766555688757777899 8898878**9898788
C+40 |-765567767789888989778889****9988766767565588767797 8*998898889*9989877-
FLET |676556776778888898977 8789***9998877676756558876--7978*998898889*99798777
OHI2 |977667889**8899****98**999****7*99987988668899868******999899***9998998
OHI3 |864445346864666656664444553675554467753244547554555675677643465676554 56
-----+----------------+----------------+----------------+----------------+
     0                                12                                24
                          Hours for day 2004-01-20

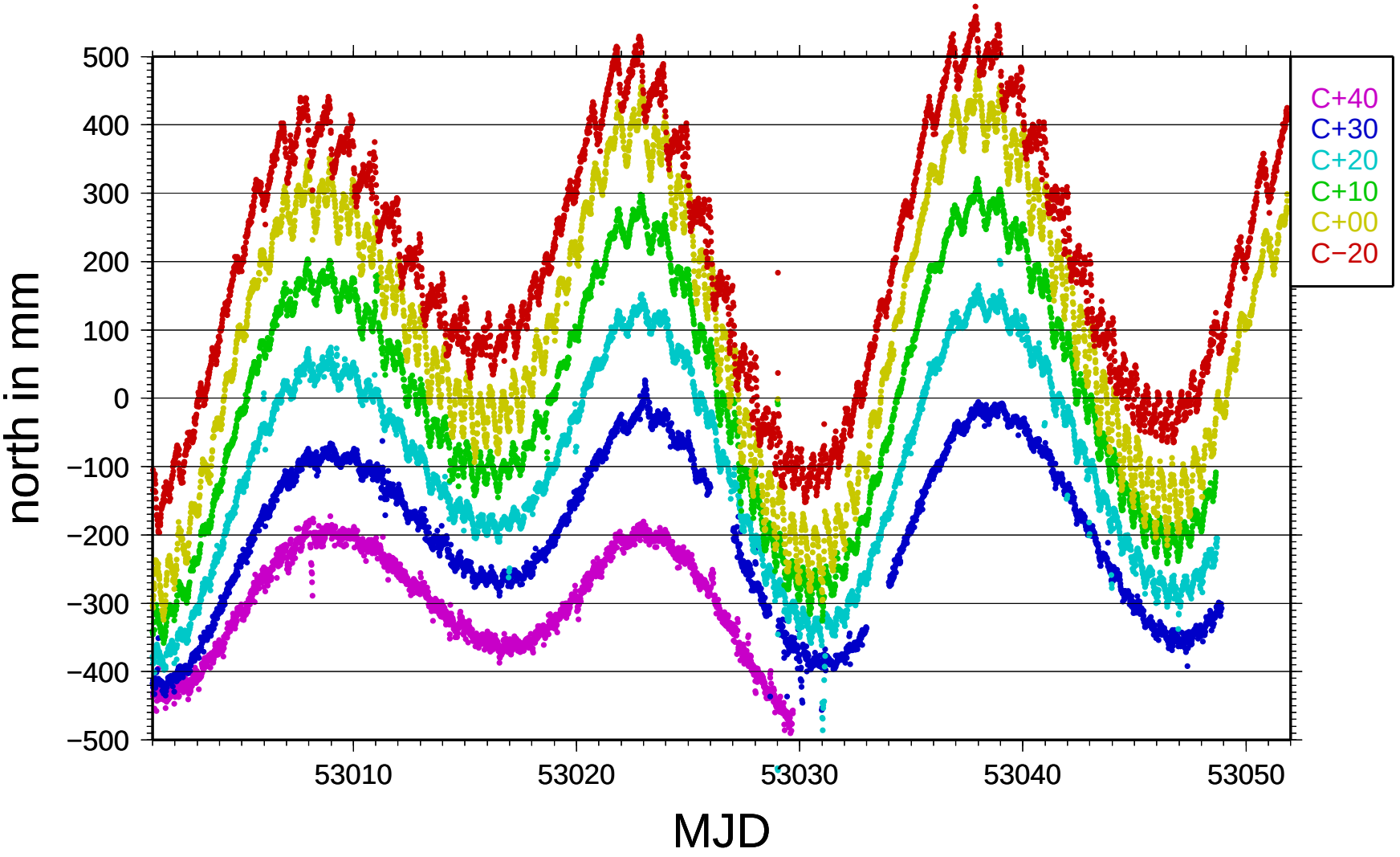
Legend: - missing epochs, incomplete observations
        * more than 9 satellites observed
```

Repeatability of the 2000 km OHI2→FLET



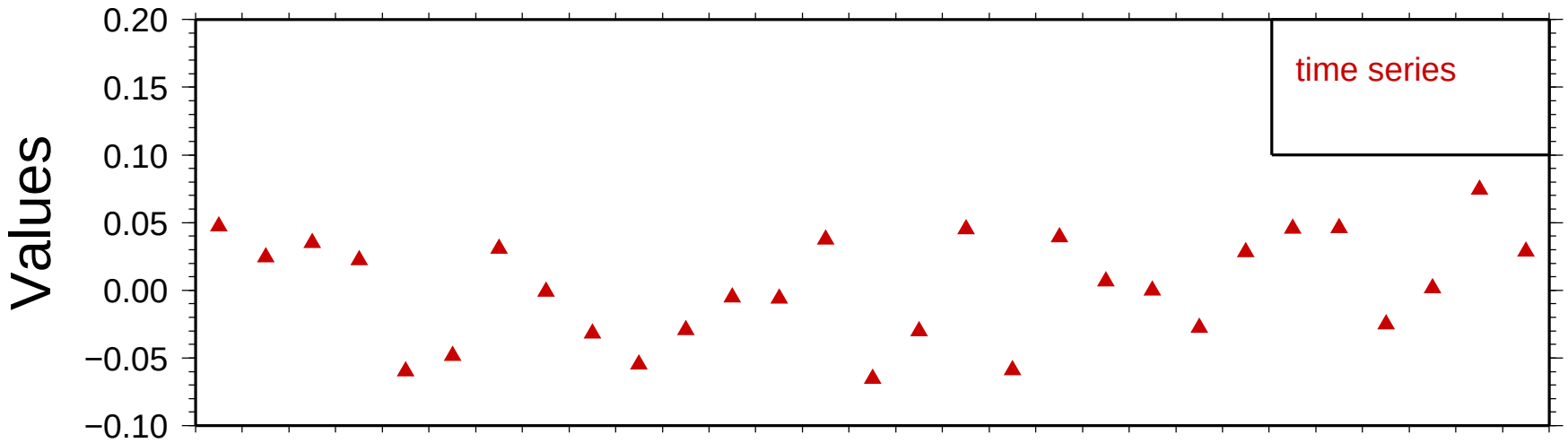
velocity of FLET: ≈1.5 m/year (4 mm/day)

Kinematic Solution for Stations on Ice Stream



Solutions shifted by 100 mm for plotting.

Analysing the Noise Characteristics



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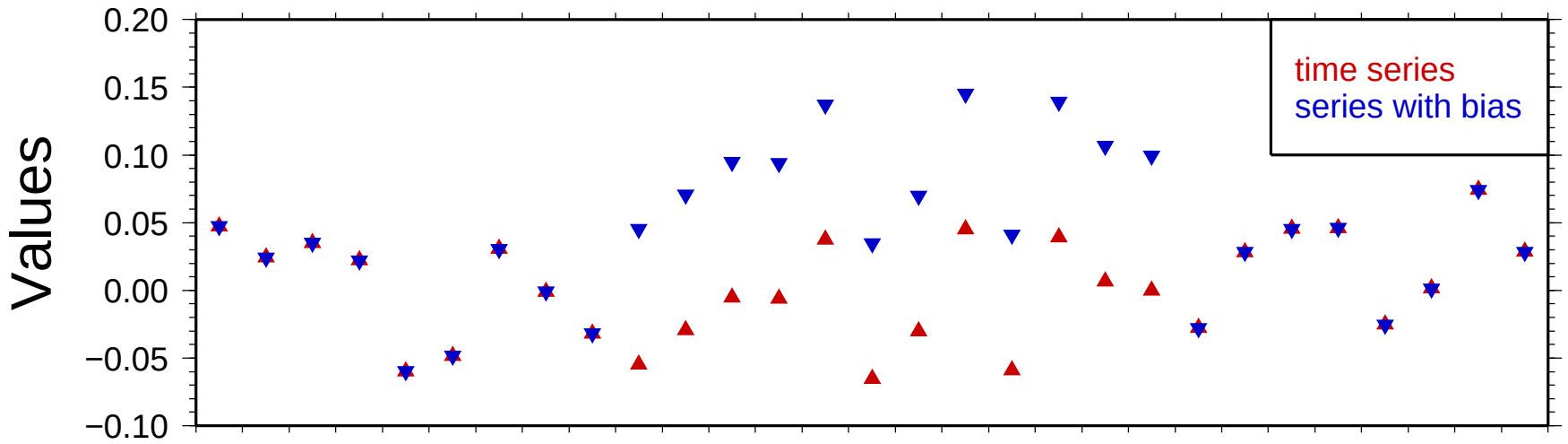
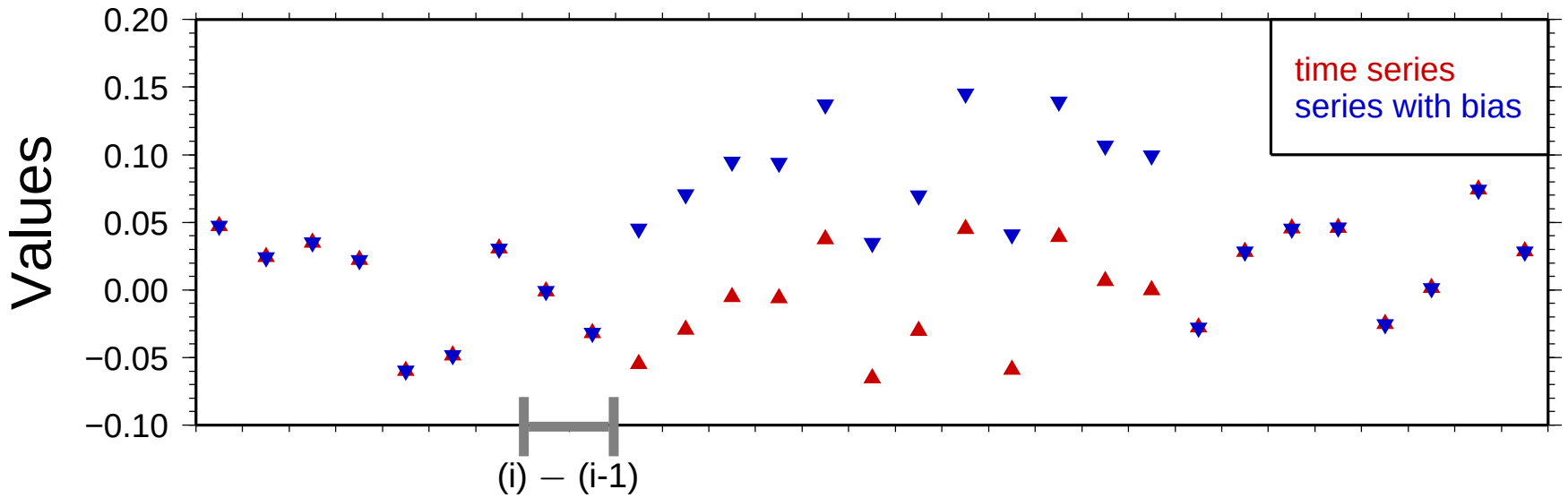


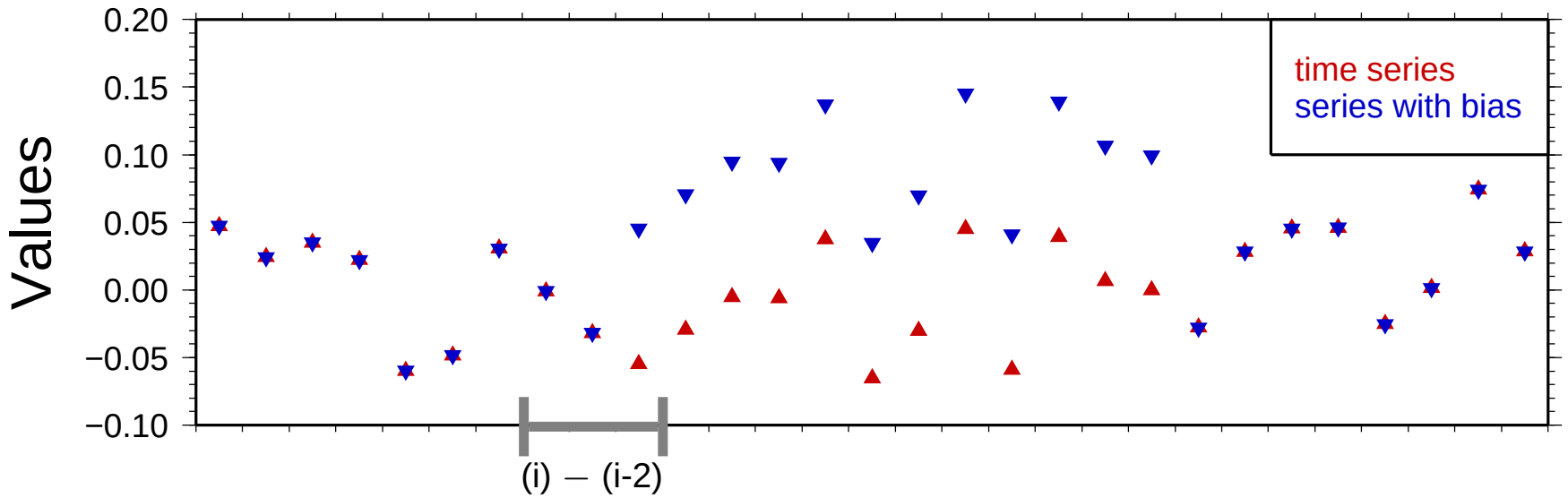
Analysing the Noise Characteristics



Standard deviation:

n	time series	series with bias
1	0.052	0.059

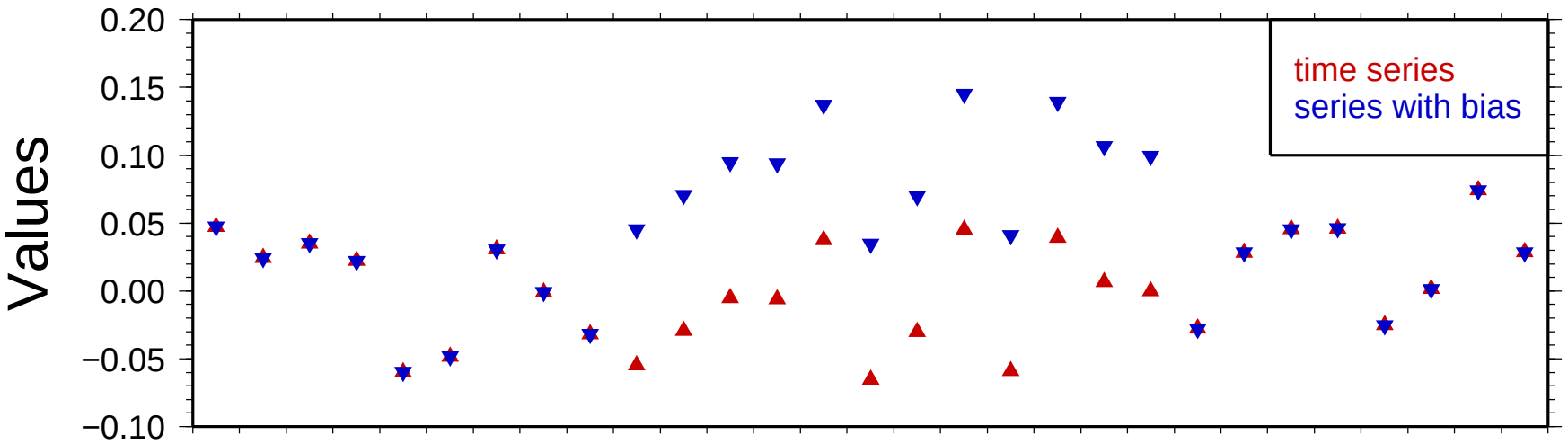
Analysing the Noise Characteristics



Standard deviation:

n	time series	series with bias
1	0.052	0.059
2	0.057	0.066

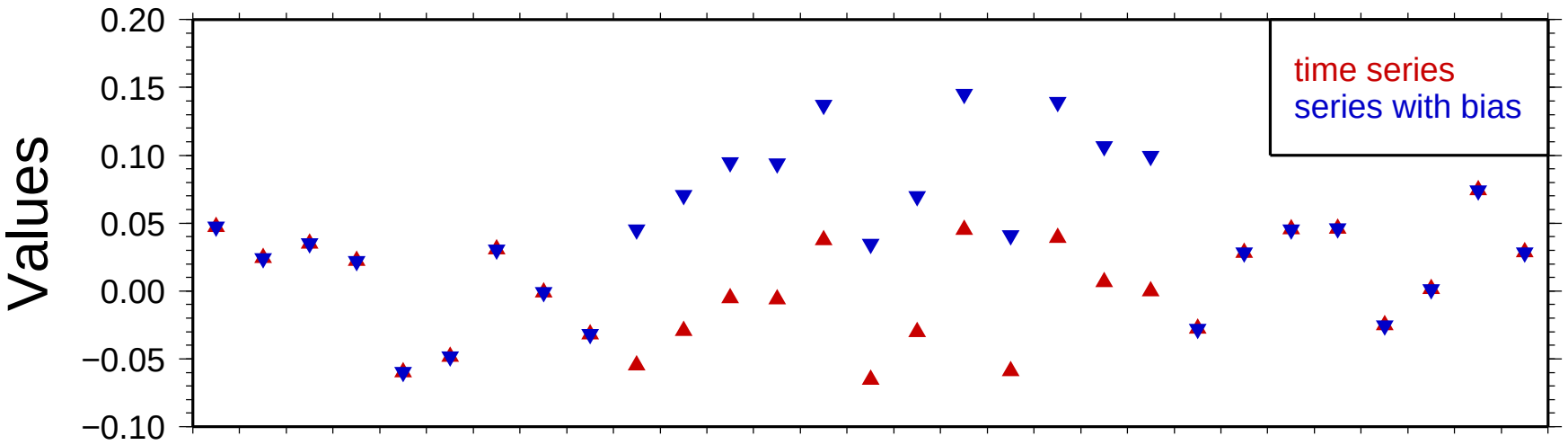
Analysing the Noise Characteristics



Standard deviation:

n	time series	series with bias
1	0.052	0.059
2	0.057	0.066
3	0.052	0.066
4	0.051	0.068
5	0.046	0.080
...	...	...

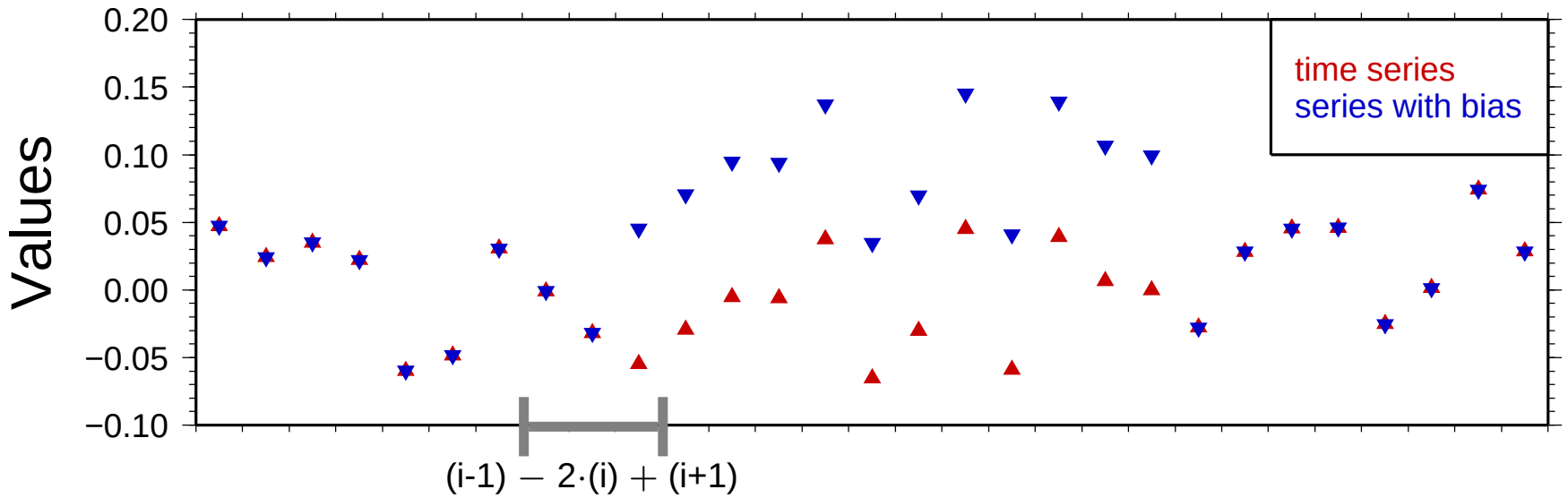
Analysing the Noise Characteristics



Standard deviation (normalized):

n	time series	series with bias
1	0.052	0.059
2	0.029	0.033
3	0.017	0.022
4	0.013	0.017
5	0.009	0.016
...	...	...

Analysing the Noise Characteristics



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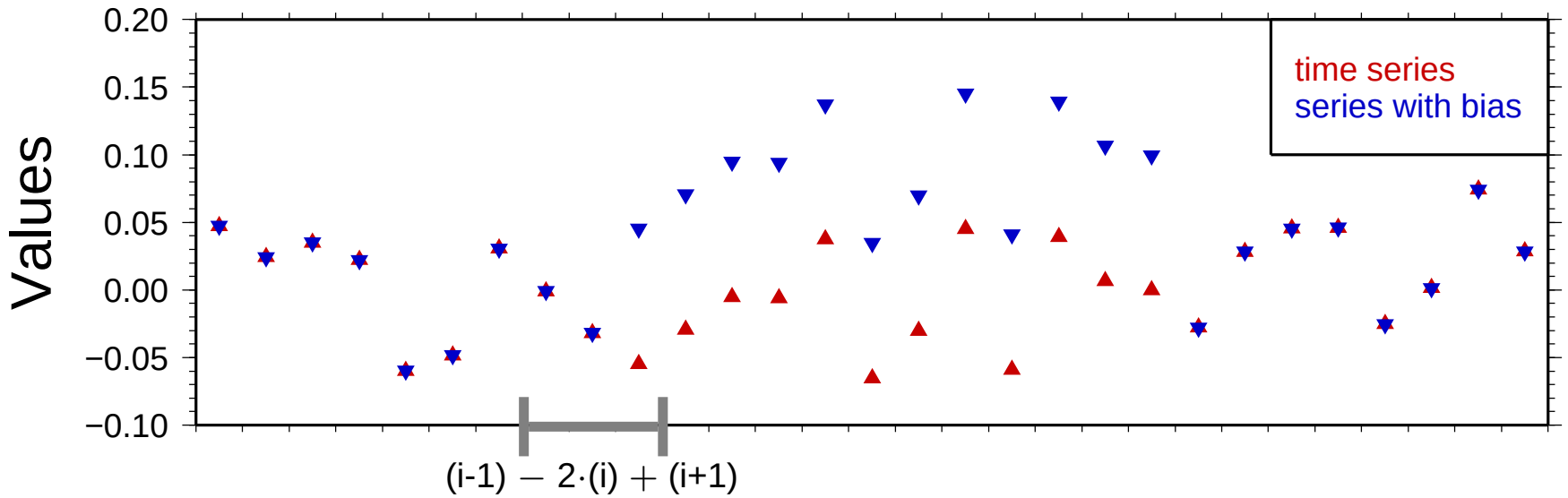

Allan deviation:

n	time series	series with bias
1	0.062	0.070

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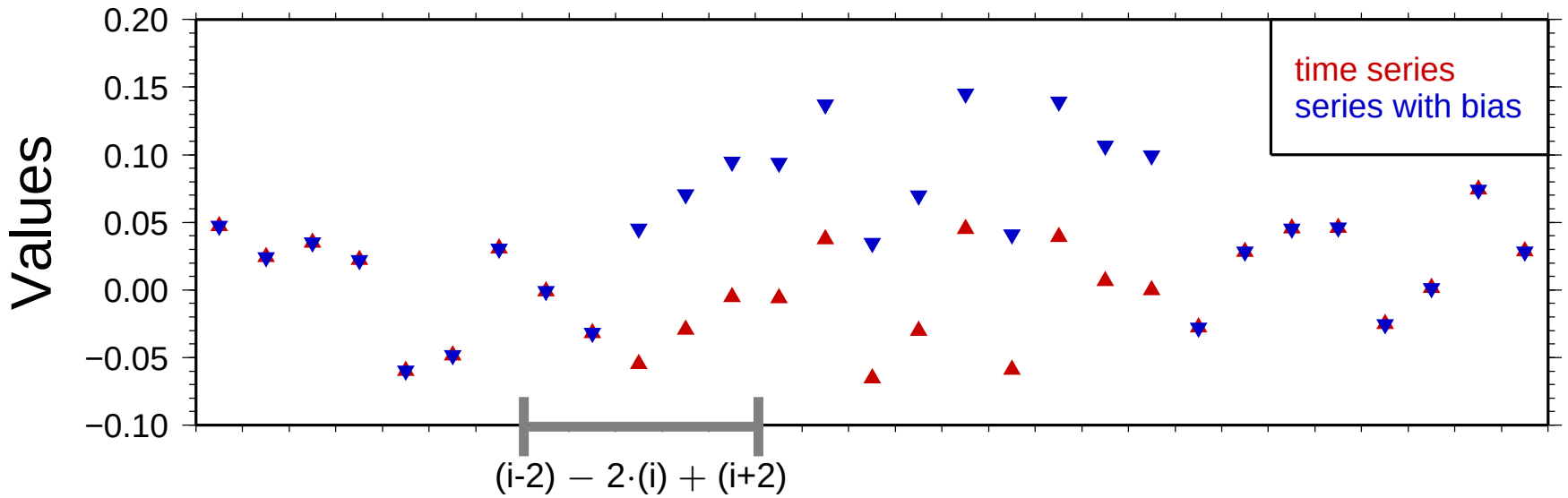

Allan deviation:

n	time series	series with bias
1	0.062	0.070
2	0.036	0.041

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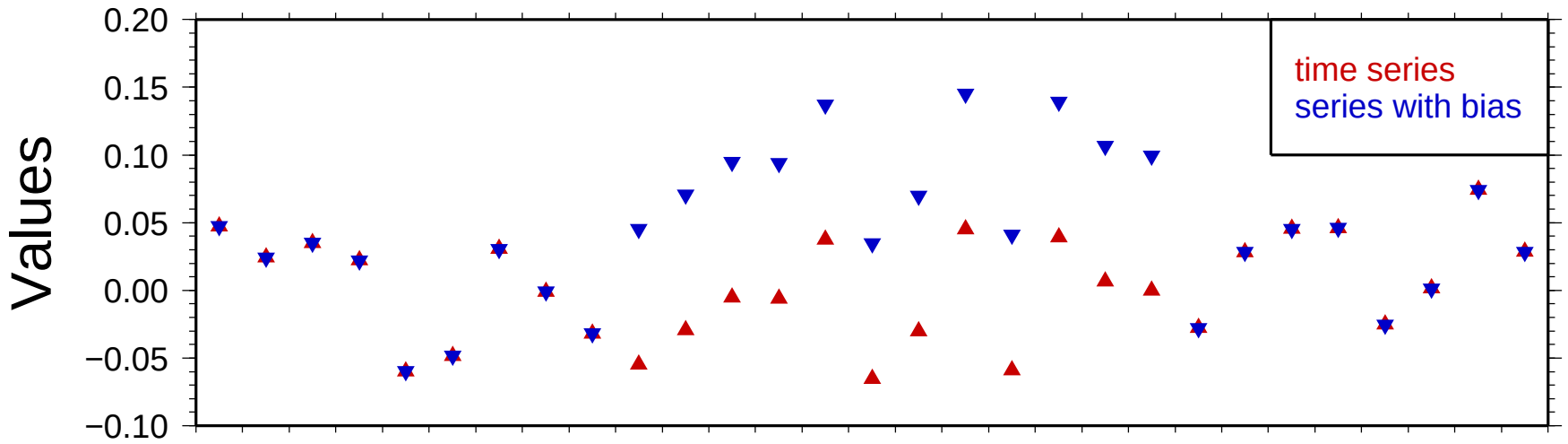
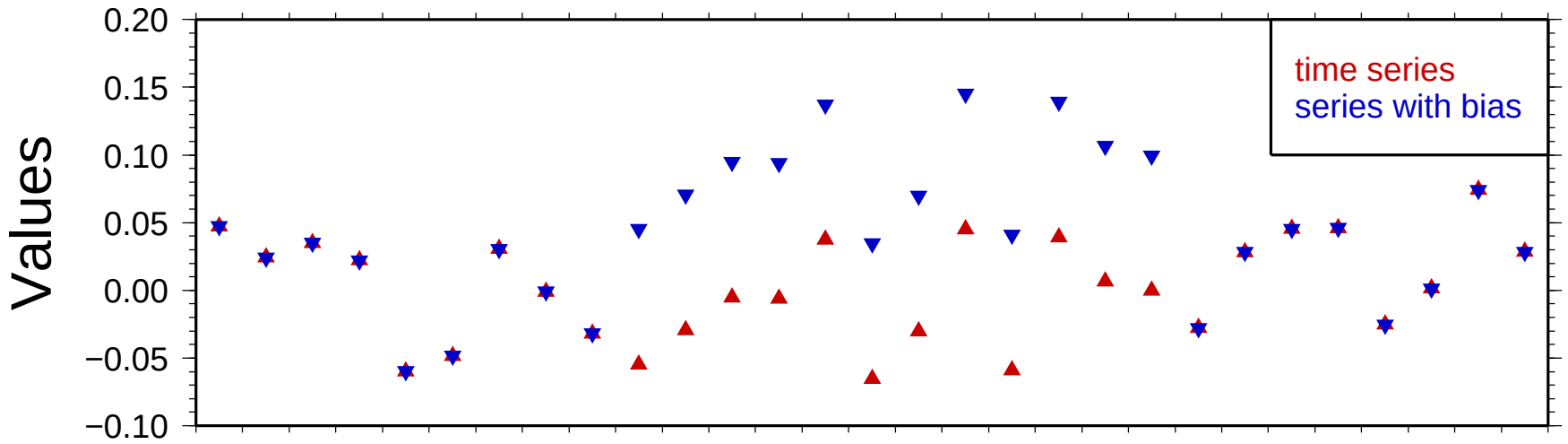


Allan deviation:

n	time series	series with bias
1	0.062	0.070
2	0.036	0.041
3	0.021	0.025
4	0.015	0.019
5	0.011	0.019
...	...	...

Analysing the Noise Characteristics



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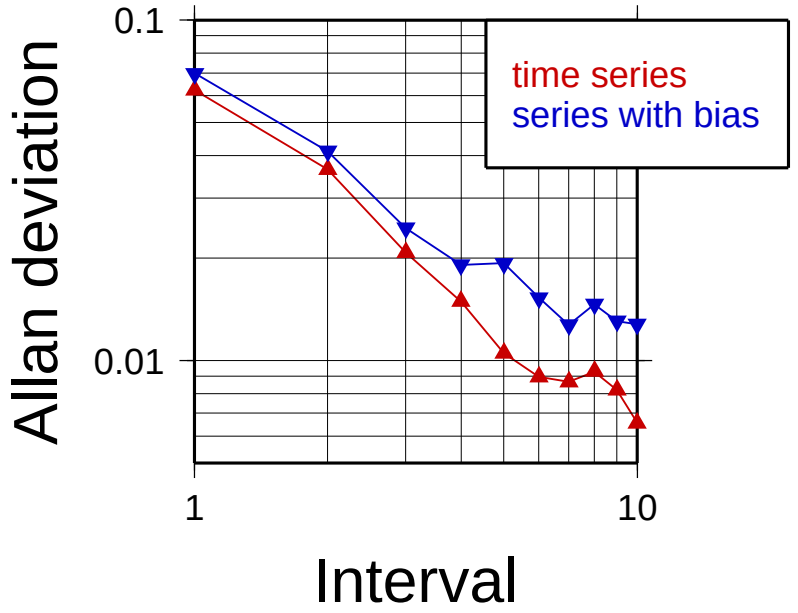
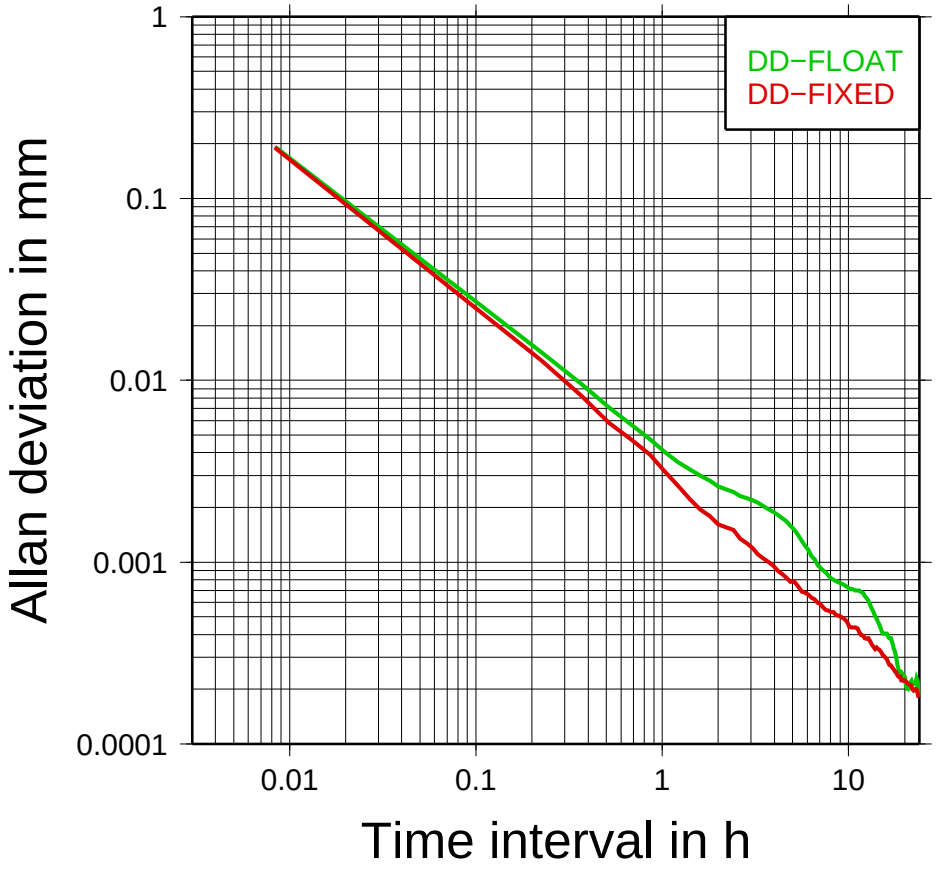


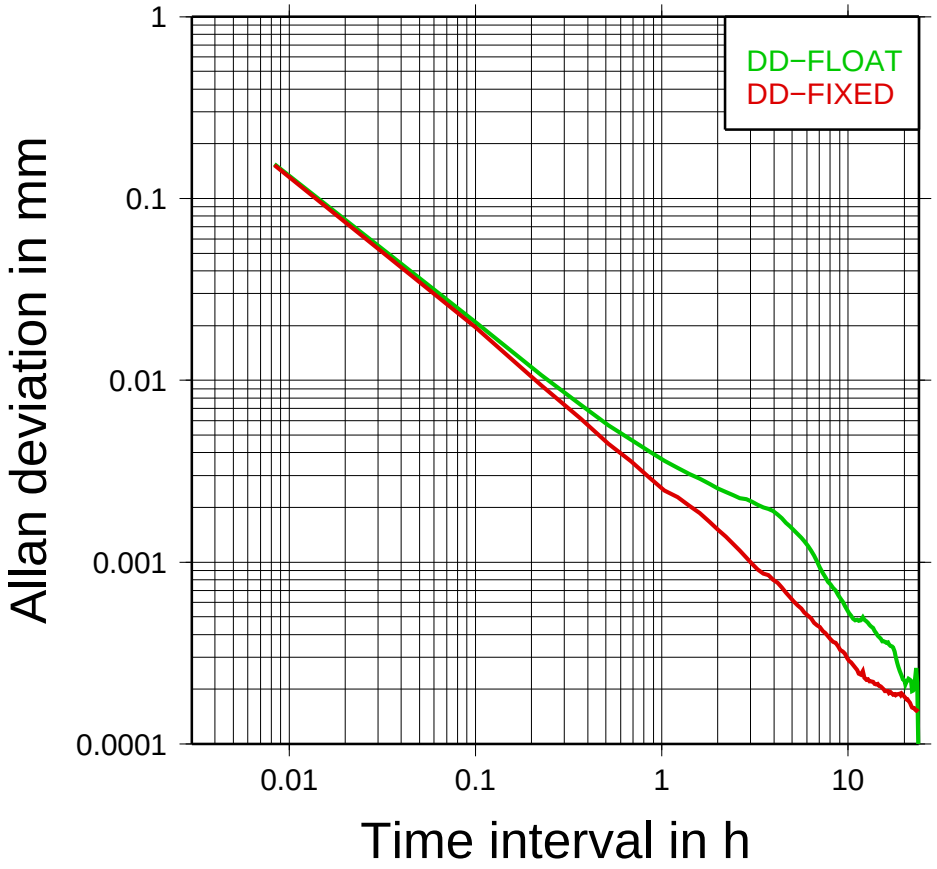
Allan Deviation for stations in the ice stream

Allan Deviation for Station C+40

North component



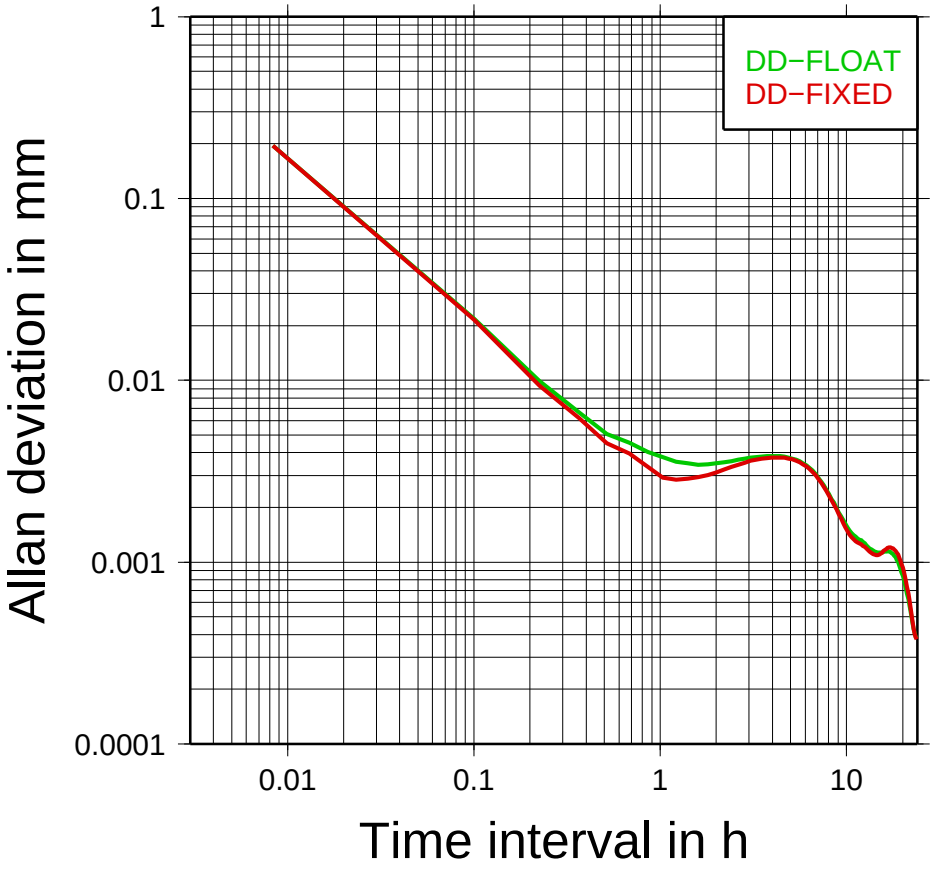
East component



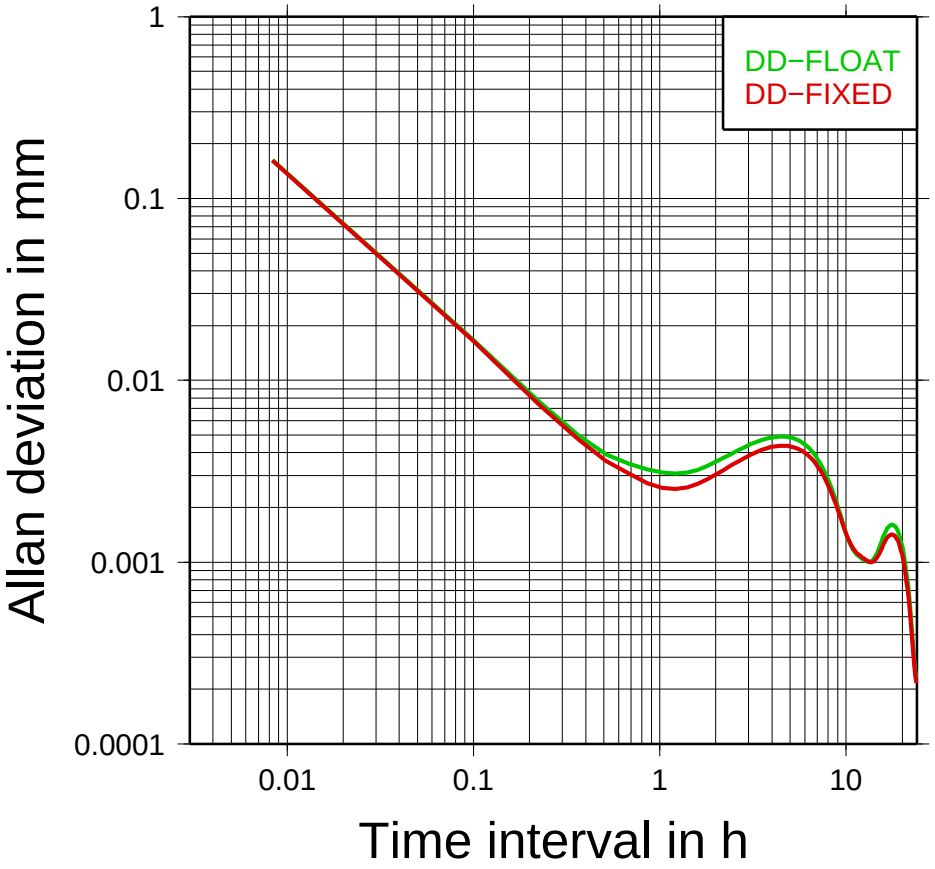
Allan Deviation for stations in the ice stream

Allan Deviation for Station C+00

North component



East component



Analysis Methods

Description of the different analysis methods:

DD–FLOAT: Double–difference network solution with real-valued ambiguities

DD–FIXED: Double–difference network solution with resolved ambiguities

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PPP(IGS): Precise Point Positioning using the satellite clocks from IGS

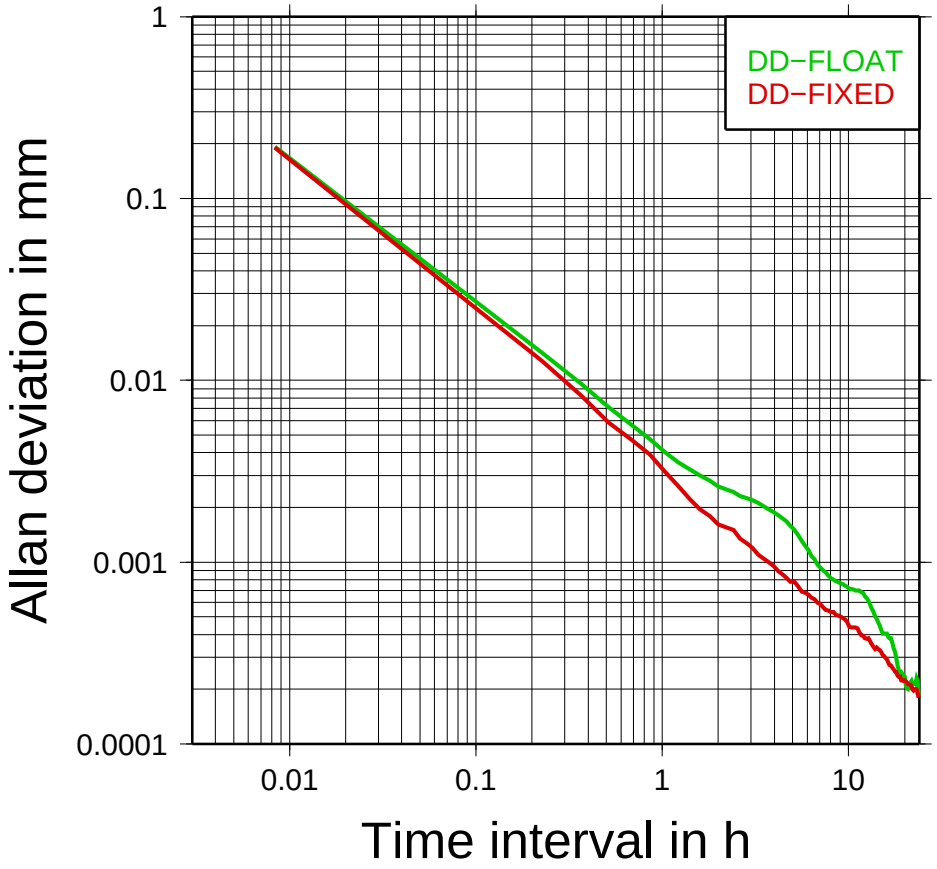
ZD–FLOAT: Zero–difference network solution

PPP(ZD): Precise Point Positioning using the satellite clocks from ZD–FLOAT

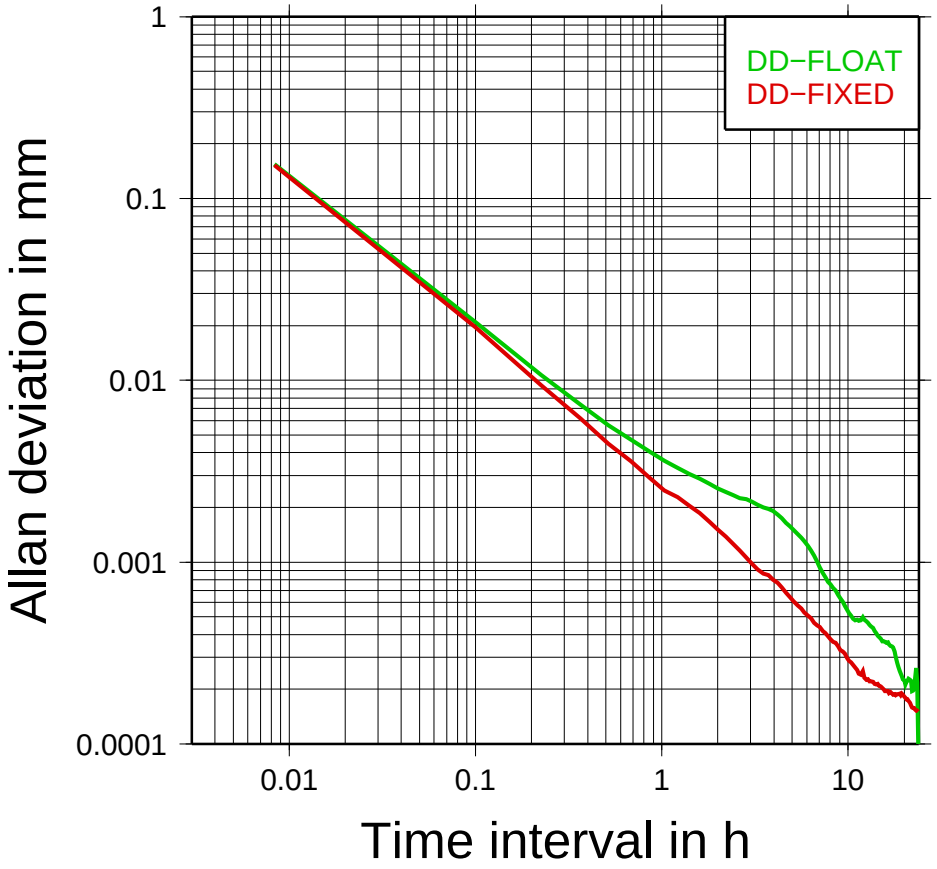
Comparison of the Anaysis Methods

Allan Deviation for Station C+40

North component



East component



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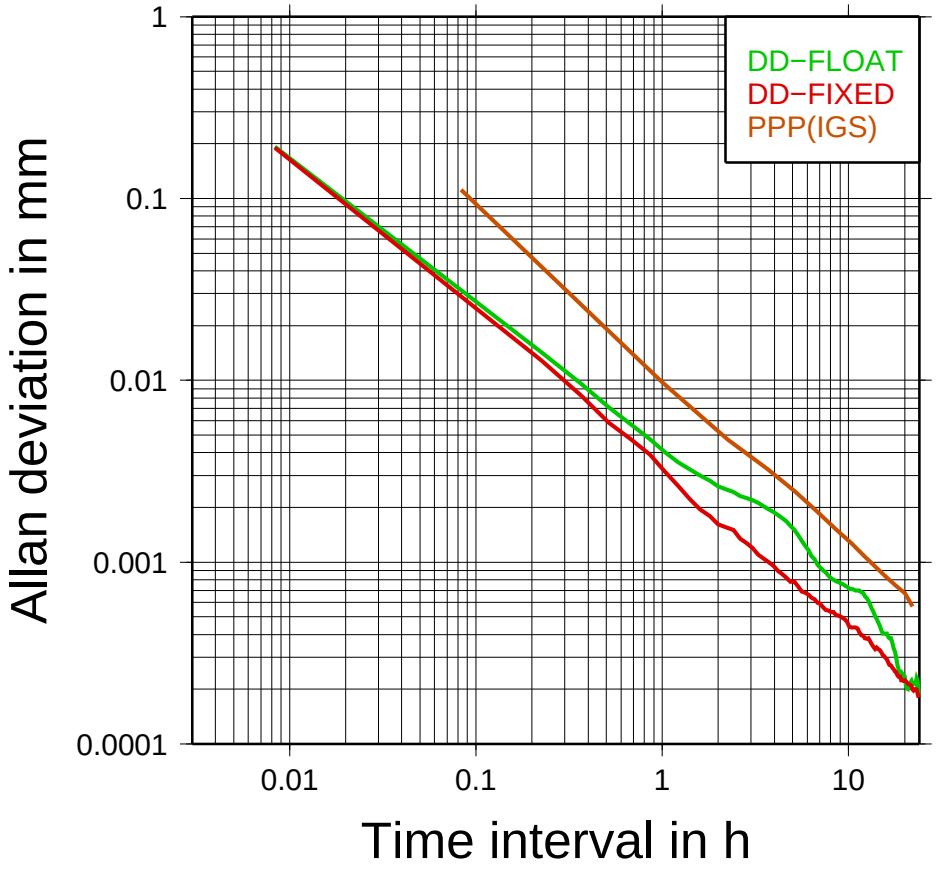
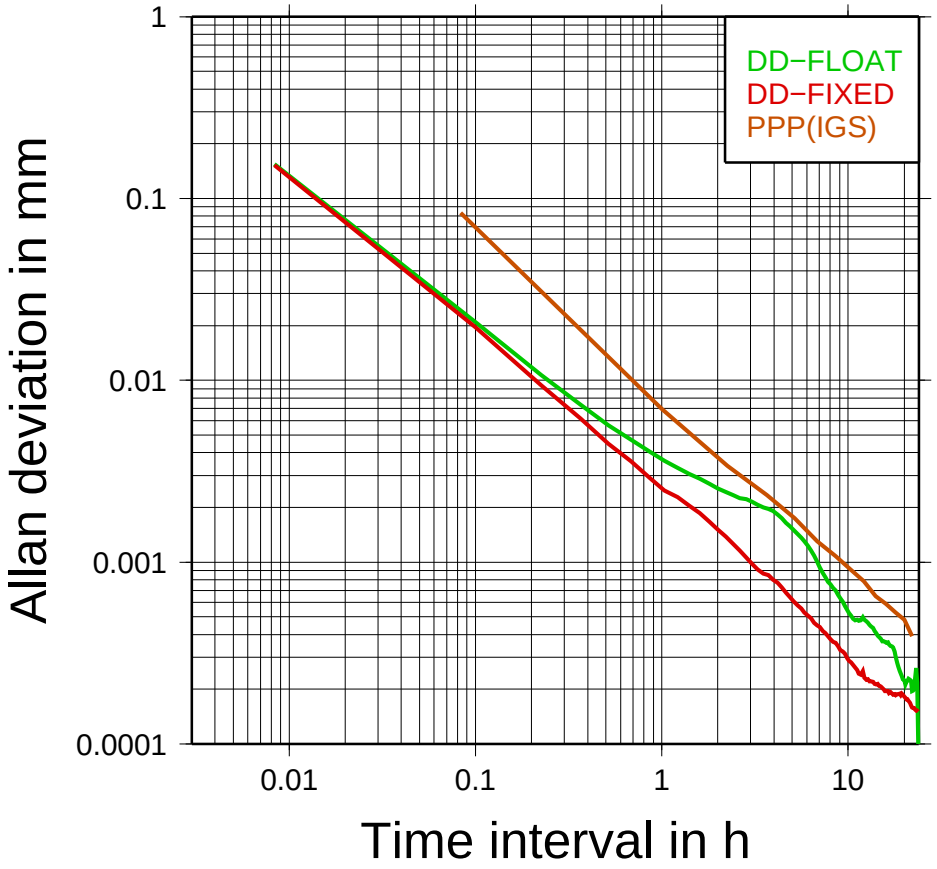


East component



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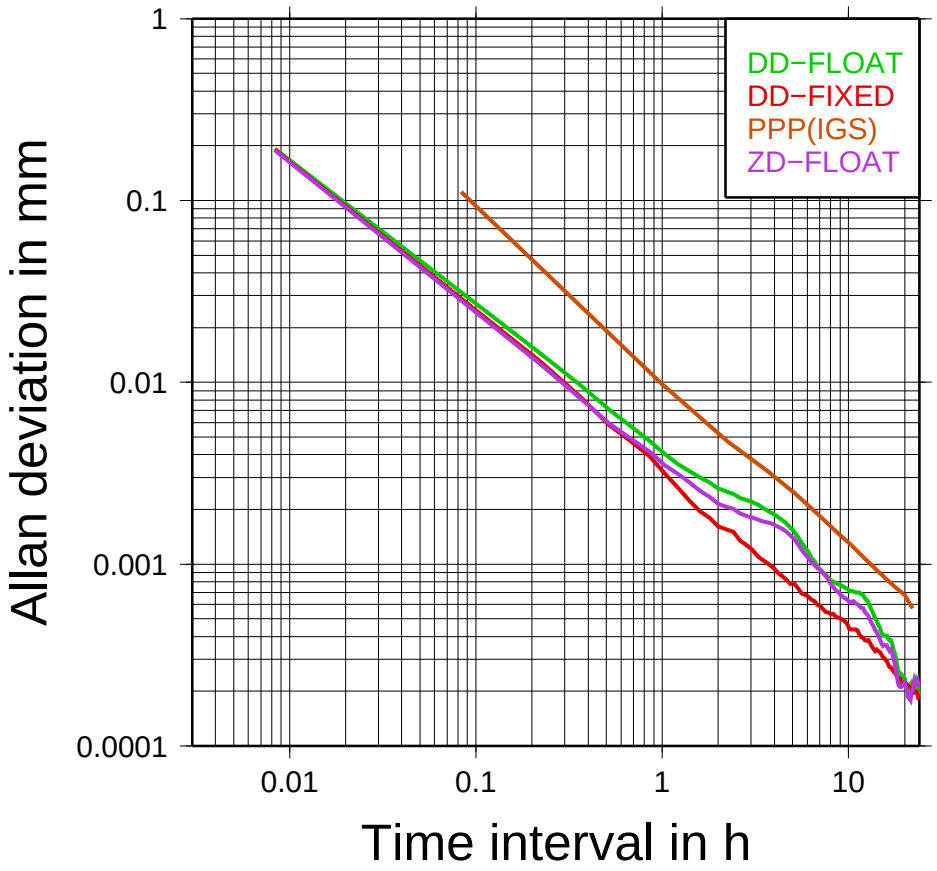

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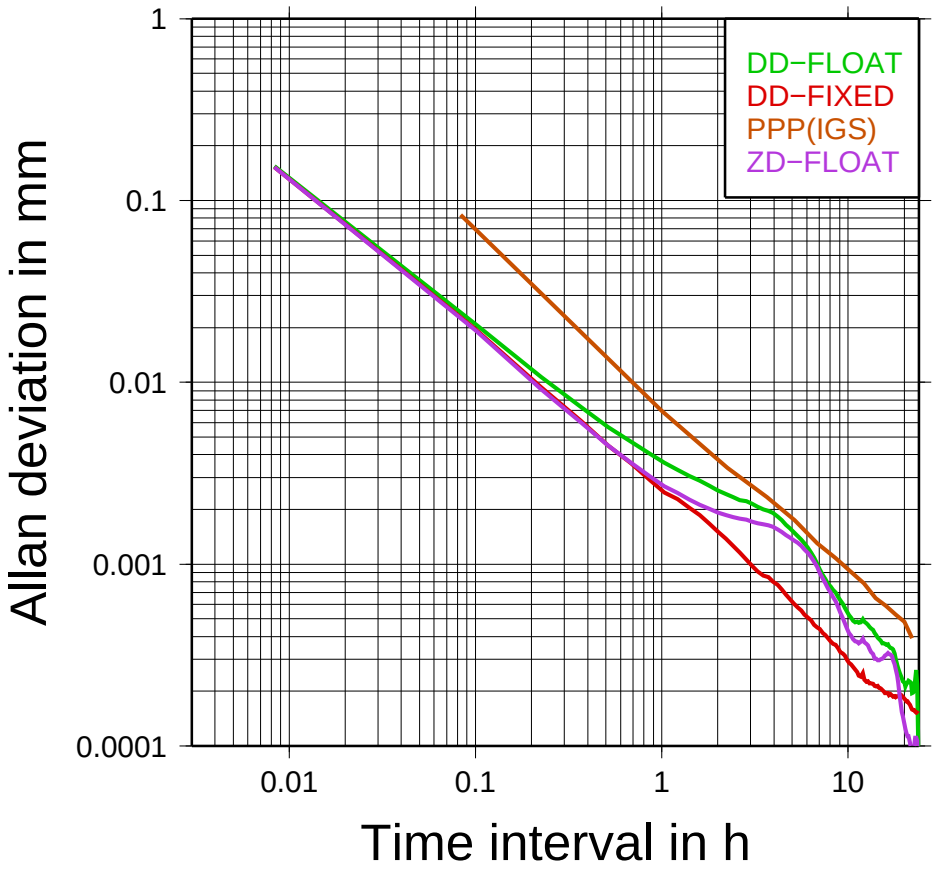

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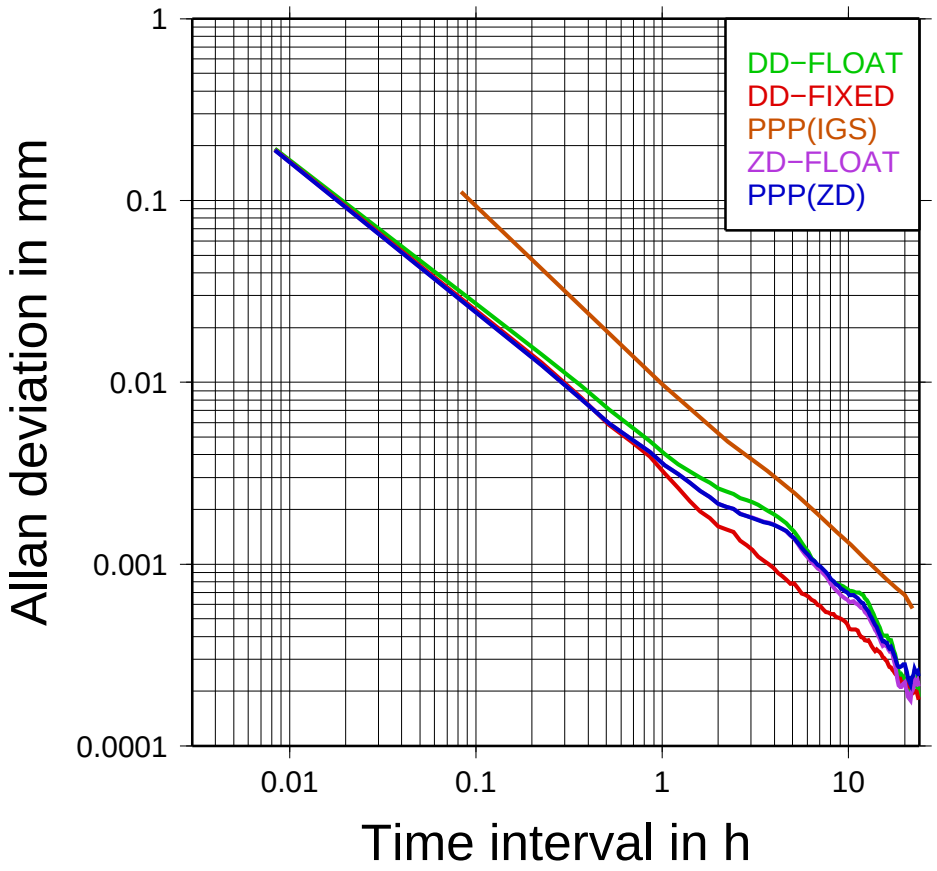

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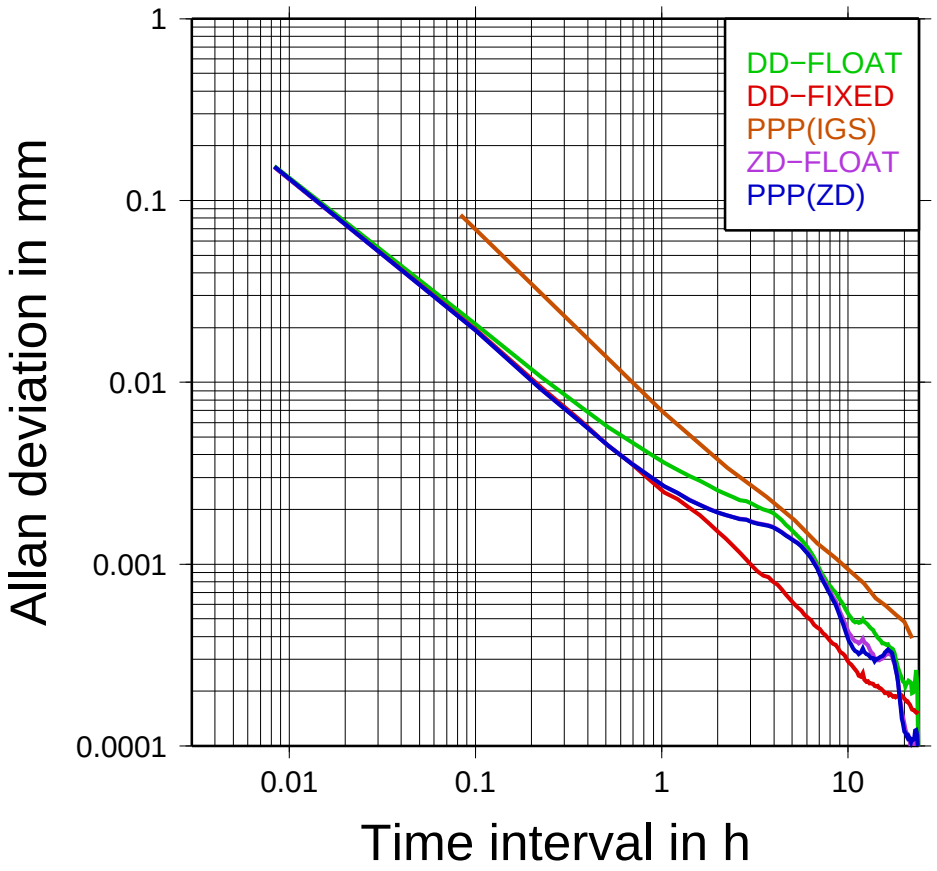

Comparison of the Anaysis Methods

What about the vertical component?

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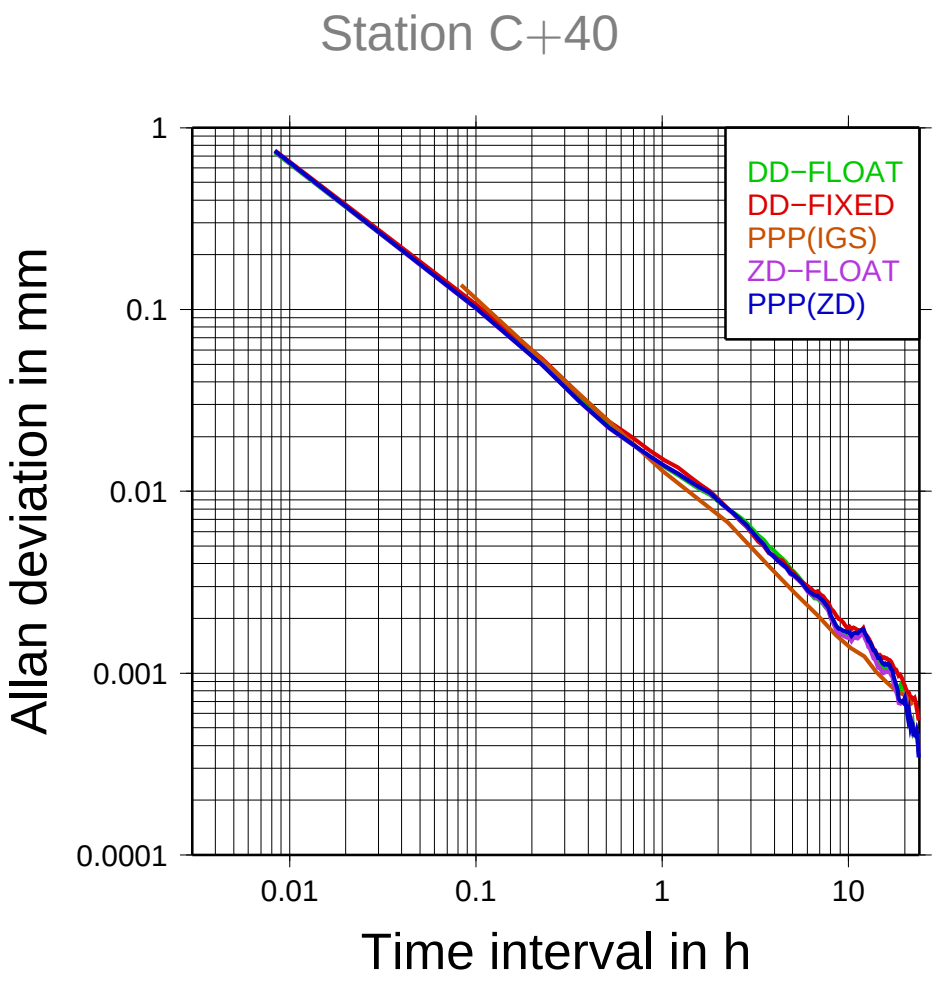
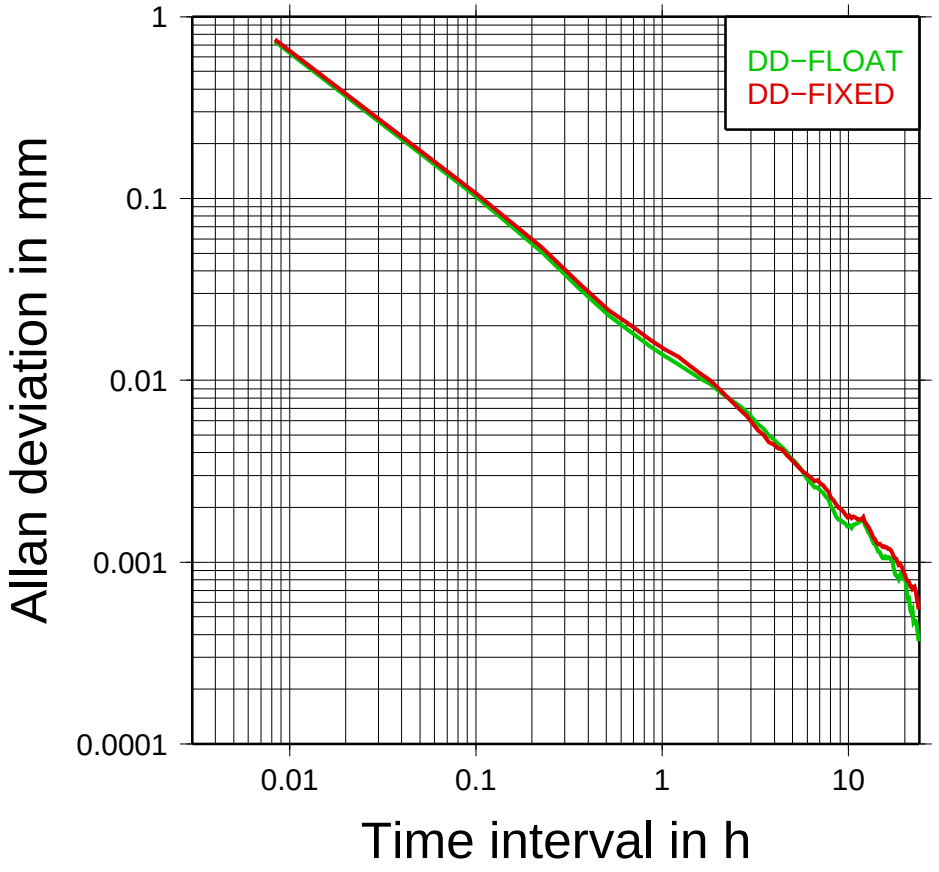


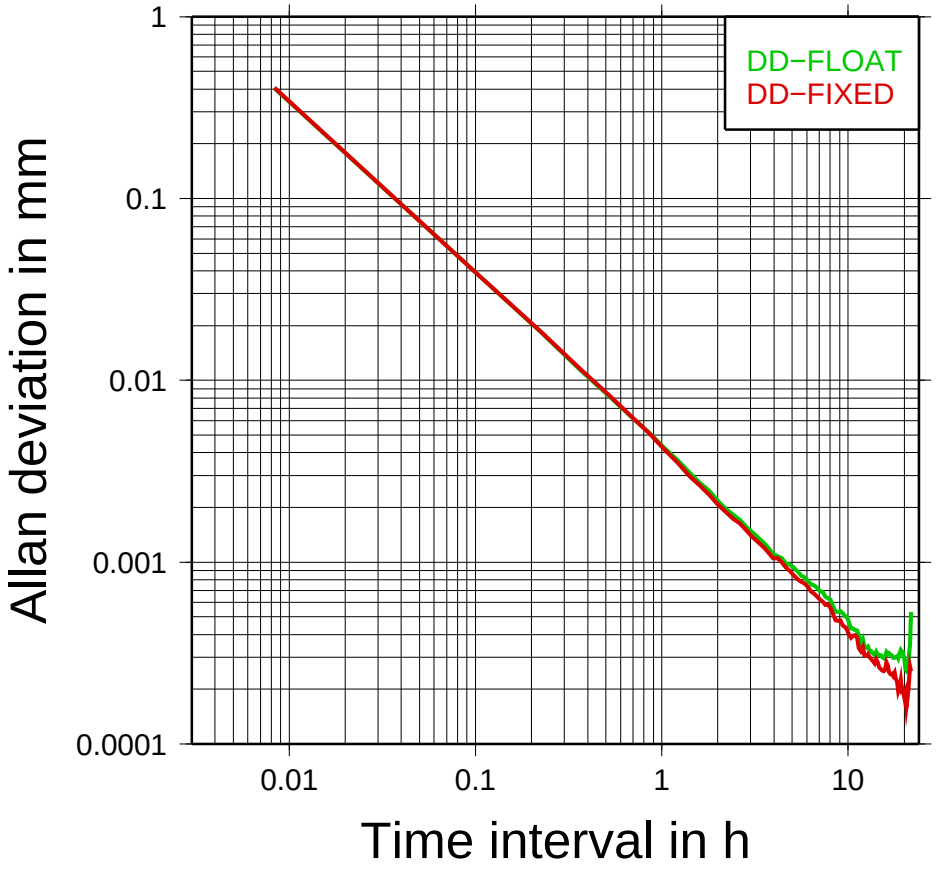
Comparison of the Anaysis Methods

What about the vertical component?

Station C+40



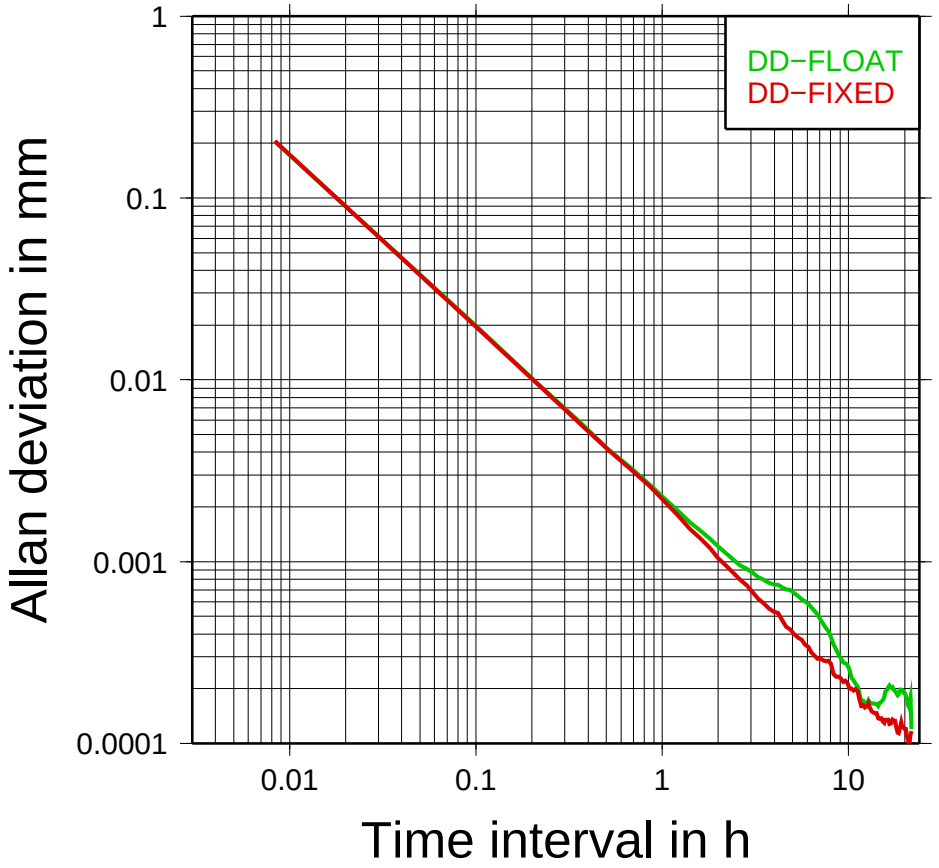
O'Higgins



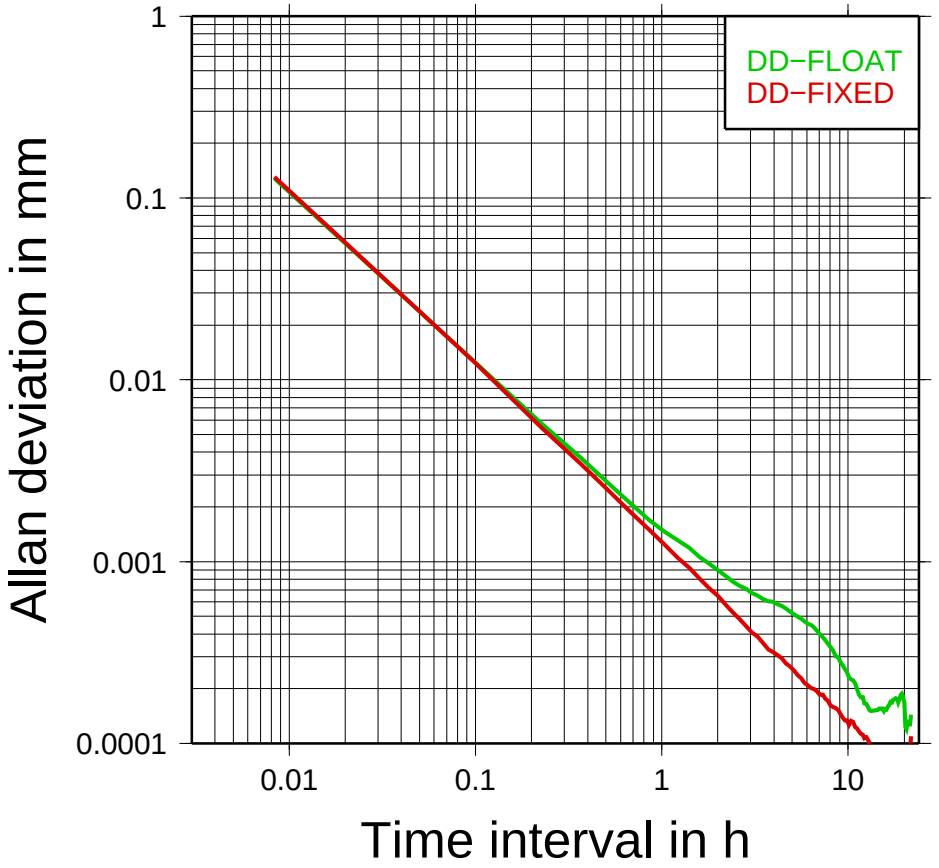
Comparison of the Anaysis Methods

Allan Deviation for Station OHI3

North component



East component



Summary and Conclusion

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- Solutions with resolved ambiguities are in general preferable!
- The Allan deviation is well suited to analyse the noise characteristics from kinematic GNSS solutions.
- In the horizontal components of a kinematic solution with resolved ambiguties the white noise of the phase measurements was found.
- For the vertical component we see the same noise behaviour in the solutions with real–valued and resolved ambiguties.
- Only for very short term characteristics of a kinematic solution (shorter than one hour for terrestrial sites) there is no benefit from the ambiguity resolution. The solution is here dominated by the phase noise.
- On the other hand, these results confirm that very short ambiguities do not contribute to a (static) solution.