Doppler velocity validation of EarthCARE cloud profiling radar using ACTRIS ground-based cloud radar network

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UNIVERSITY OF COLOGNE

ACTRIS
Centre for Cloud Remote Sensing

EarthCARE Science and Validation Workshop 2025
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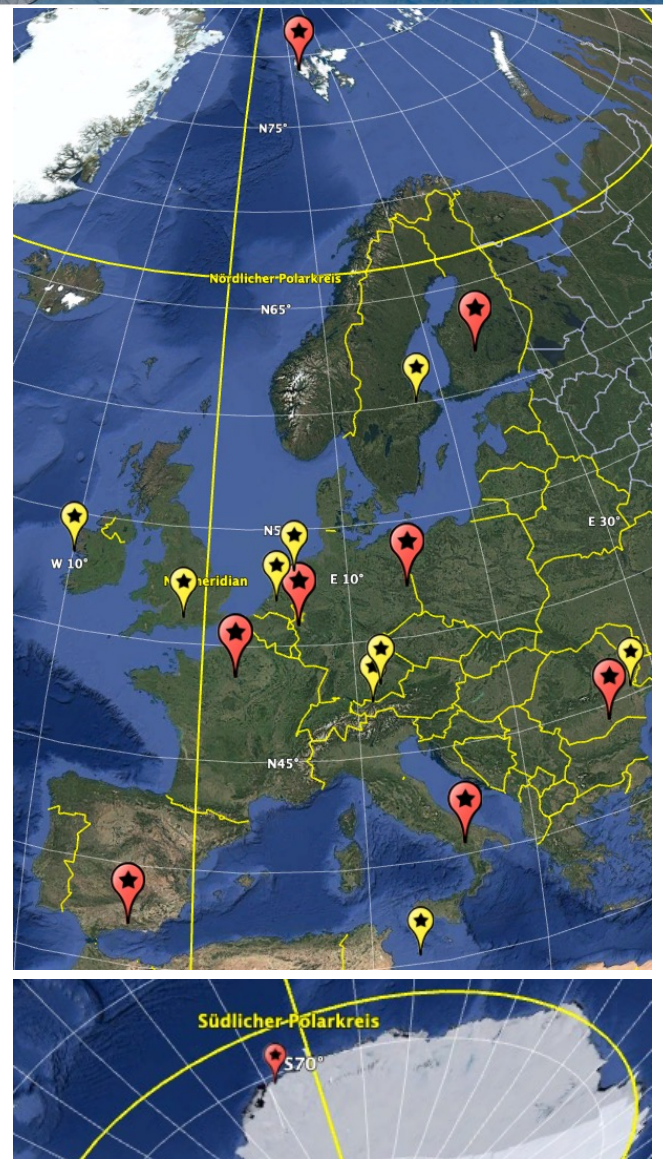
JAXA esa

Doppler velocity Cal/Val – Motivation and idea

ACTRIS Cloud Remote sensing network

- 25+ sites + Mobile facilities → campaign
- Good geographical coverage
- Centralized & homogeneous data processing
  - Comparable data sets (Calibration & quality control)
  - Cloudnet target classification[1], synthetic CPR[2], other products

→ More about ACTRIS in 3 talks by E. O'Conner

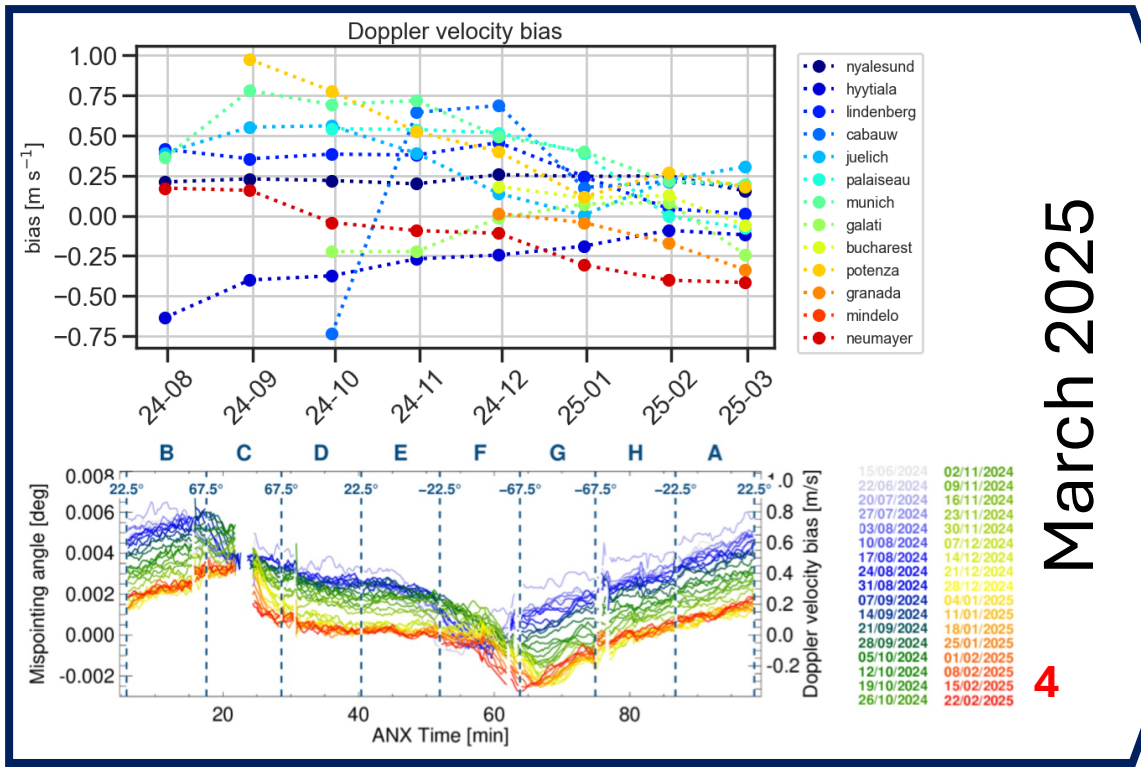


Method based on Protat et al.[3]

- Comparison of CPR and ground within a radius around sites
- time series analysis → track the Doppler velocity bias?
- Statistical analysis → performance of the CPR Doppler?
- trends, similar behaviours, etc?

1) Illingworth et al. BAMS, 2007 & Tukiainen et al., *JOSS* 2020 - 2) Pfitzenmaier et al., GMD, 2025 - 3) Protat et al., JTECH, 2009 – JTECH, 2010 – JTECH, 2011

Doppler velocity Cal/Val – research question



March 2025

4

- Captures antenna miss-pointing trend reported by Puigdomènech Treserras, et al., EGU, 2025
- Difference trends for ASC and DESC orbits.

Can the temporal variability of the Doppler bias be tracked?

Can we observe differences for ASC and DESC orbits?

4) Puigdomènech Treserras, et al., 2025, EGU

Doppler velocity Cal/Val – Adapt method from Protat et al.

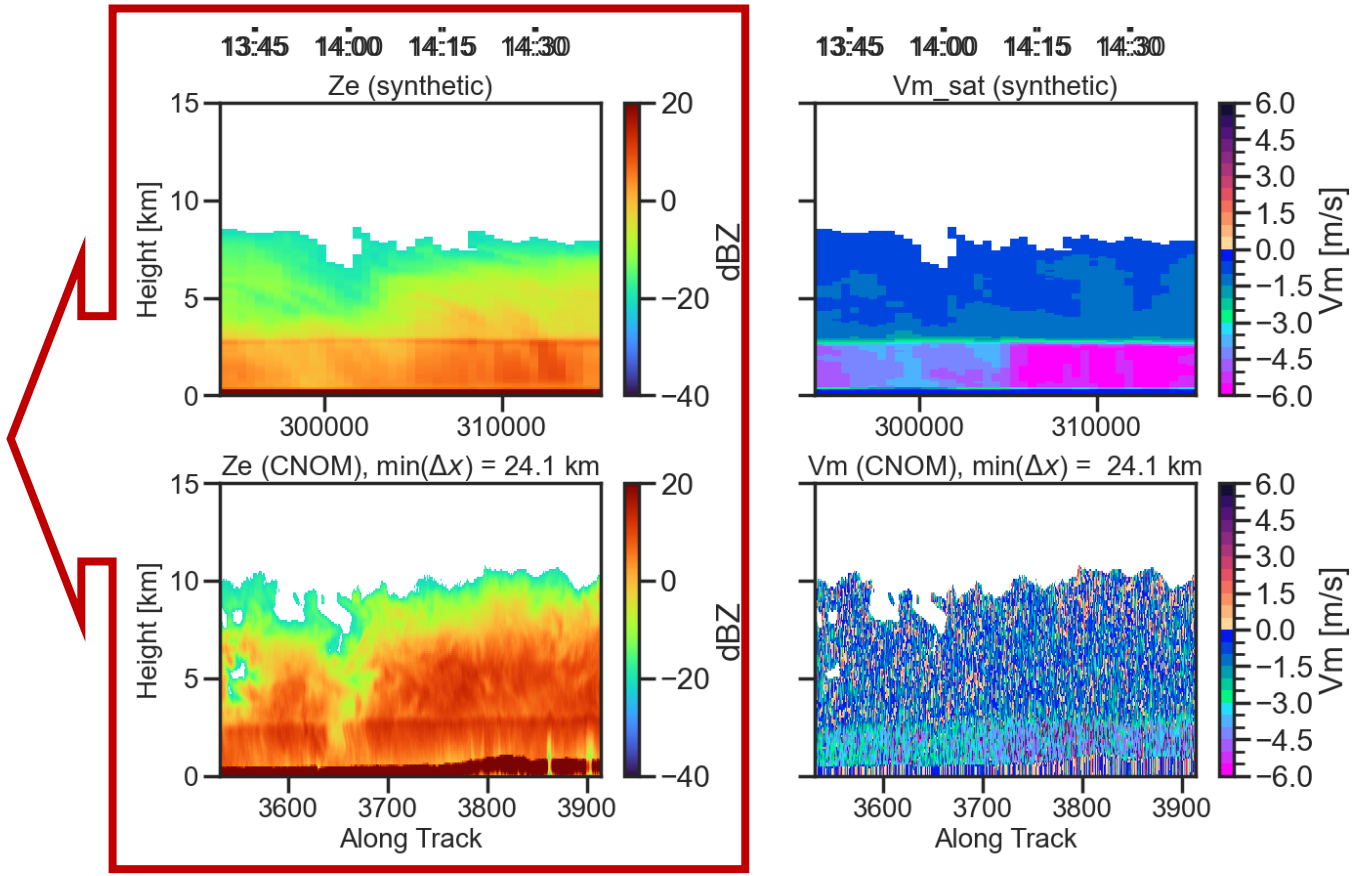
CPR: ± 100km to the site / **GROUND:** synthetic CPR[2] best estimates ± 0.5 h around the overpass

- Filter Doppler velocities Ze_{CPR} & Ze_{GROUND} > -20 dBZ
- Filter out rain and near ground Doppler velocities

Ze-comparison

by Nathan Feuillard

Poster Annex54



2) Pfitzenmaier et al., GMD, 2025

10th September 2024 Jülich, Germany, L1:DA and L2a:BA

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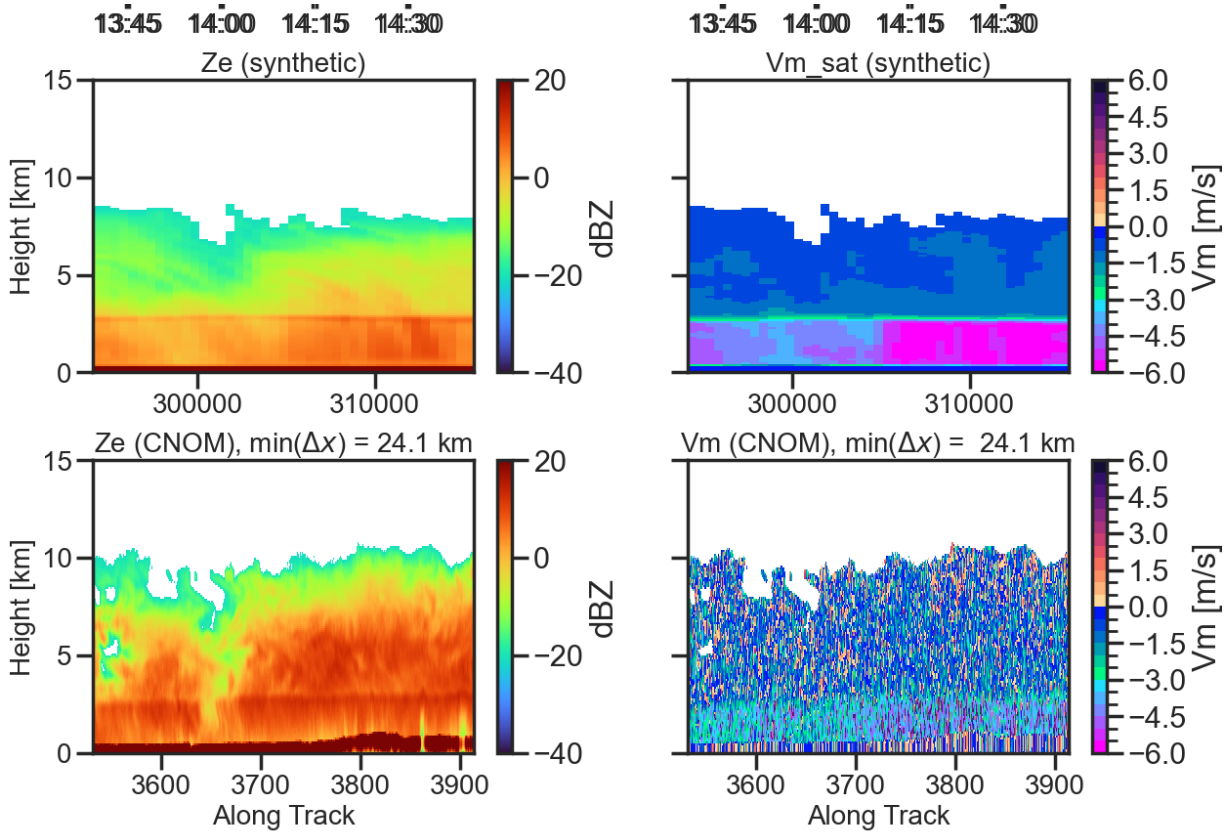
- Filter Doppler velocities Ze_{CPR} & Ze_{GROUND} > -20 dBZ
- Filter out rain and near ground Doppler velocities

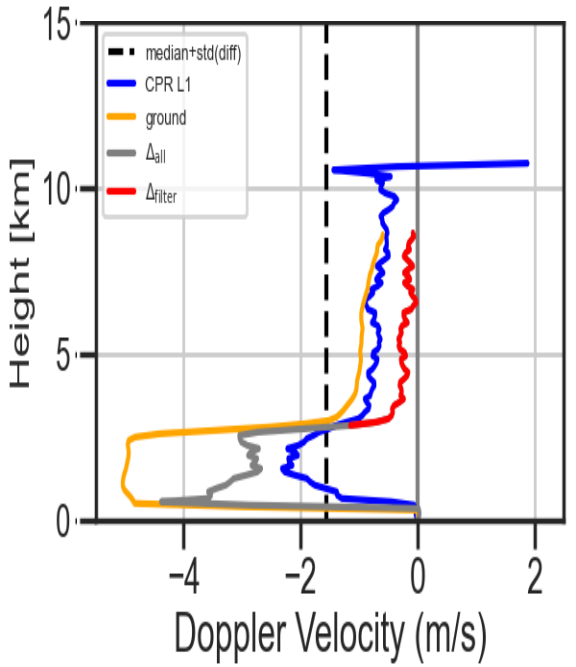
Estimate the median of the filtered profile:

ground-CPR

if profile > 1km



CPR
ground
ground-CPR
Filtered(ground-CPR)



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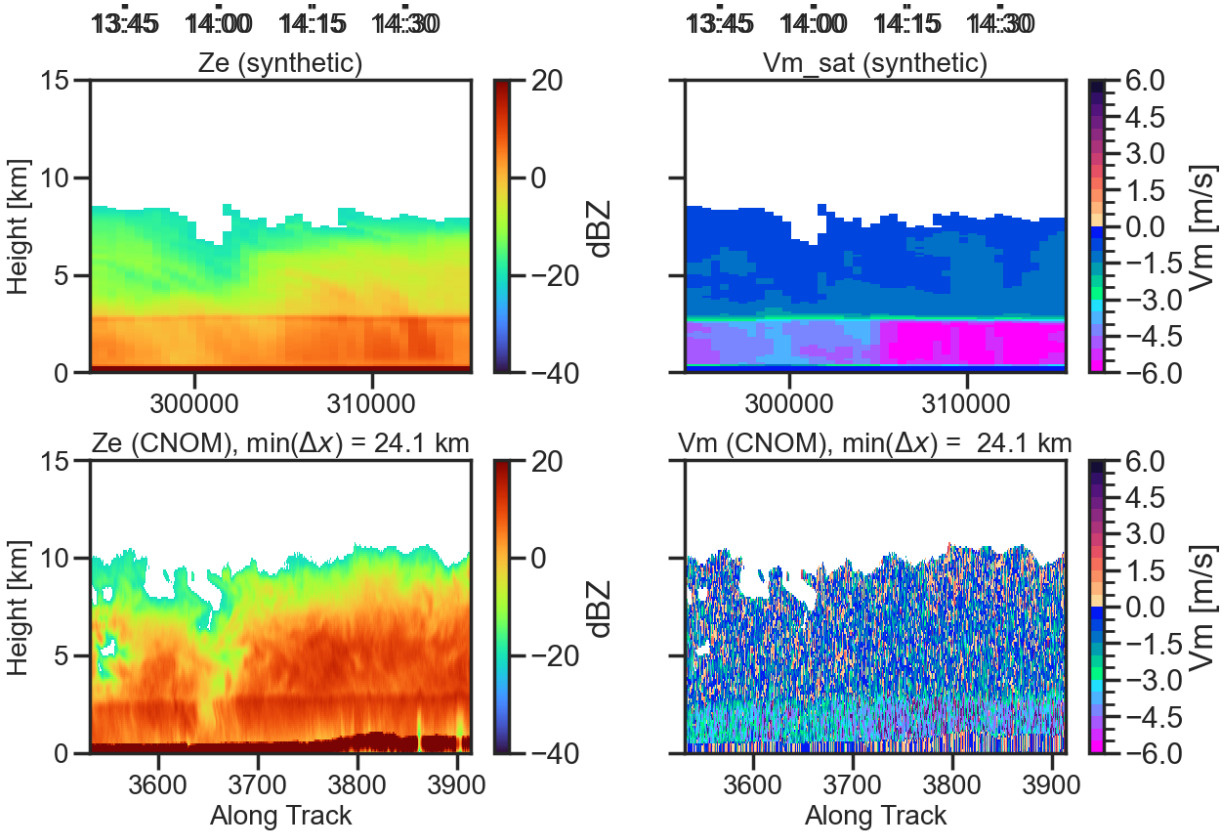
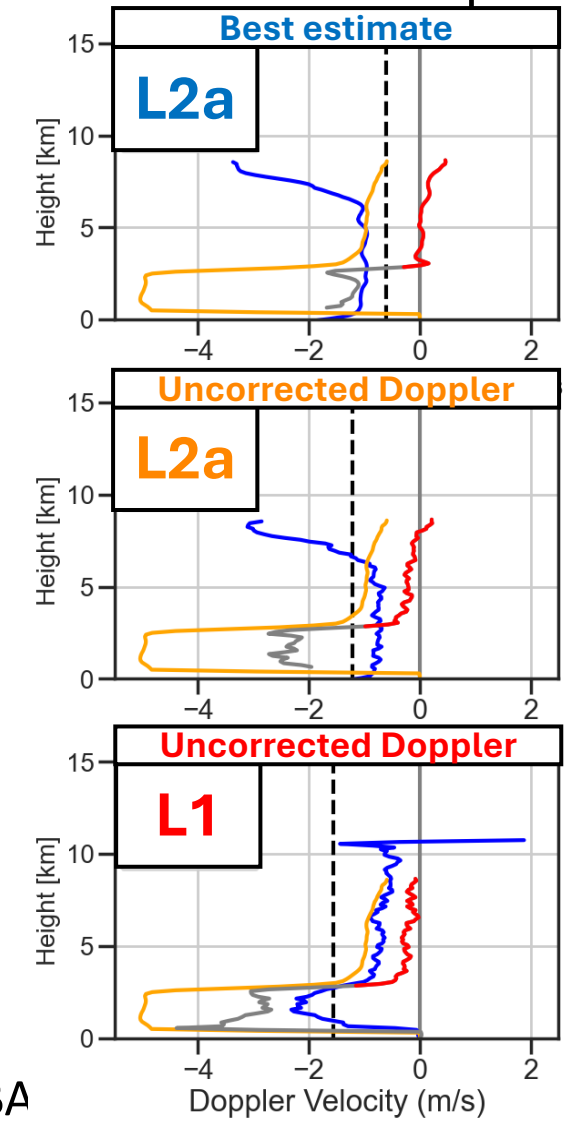
Explore L2a for self consistency checks and miss-pointing correction validation





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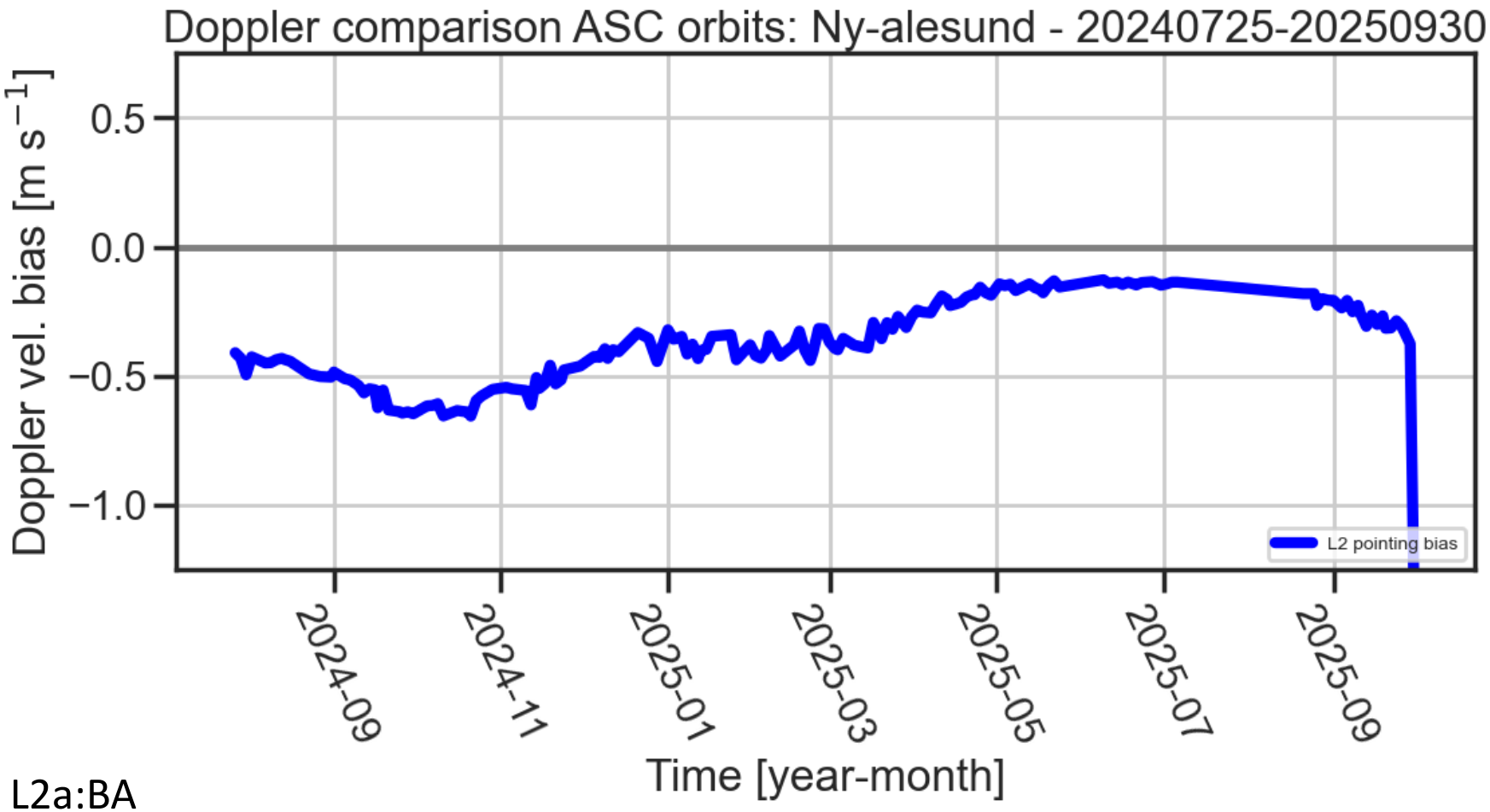
10th September 2024 Jülich, Germany, L1:DA and L2a:BA

Doppler velocity Cal/Val – NyAlesund site & ASC-orbits

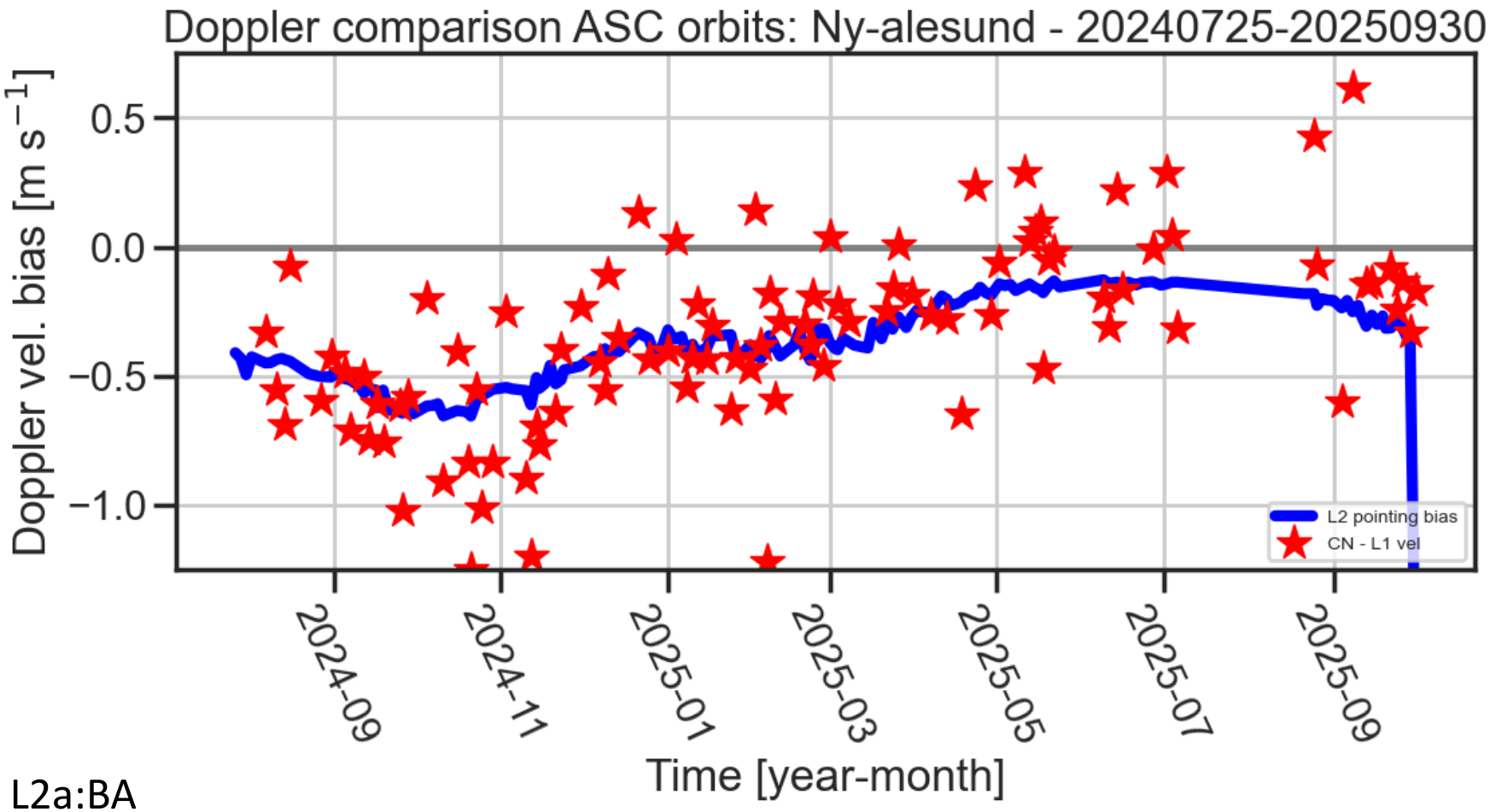


L2a miss-pointing bias
by Puigdomènech Treserras, et al., EGU, 2025

L1:DA & C? & L2a:BA

Doppler velocity Cal/Val – NyAlesund site & ASC-orbits

L1 uncorrected median(ground-CPR) →correlate with L2a miss-pointing bias



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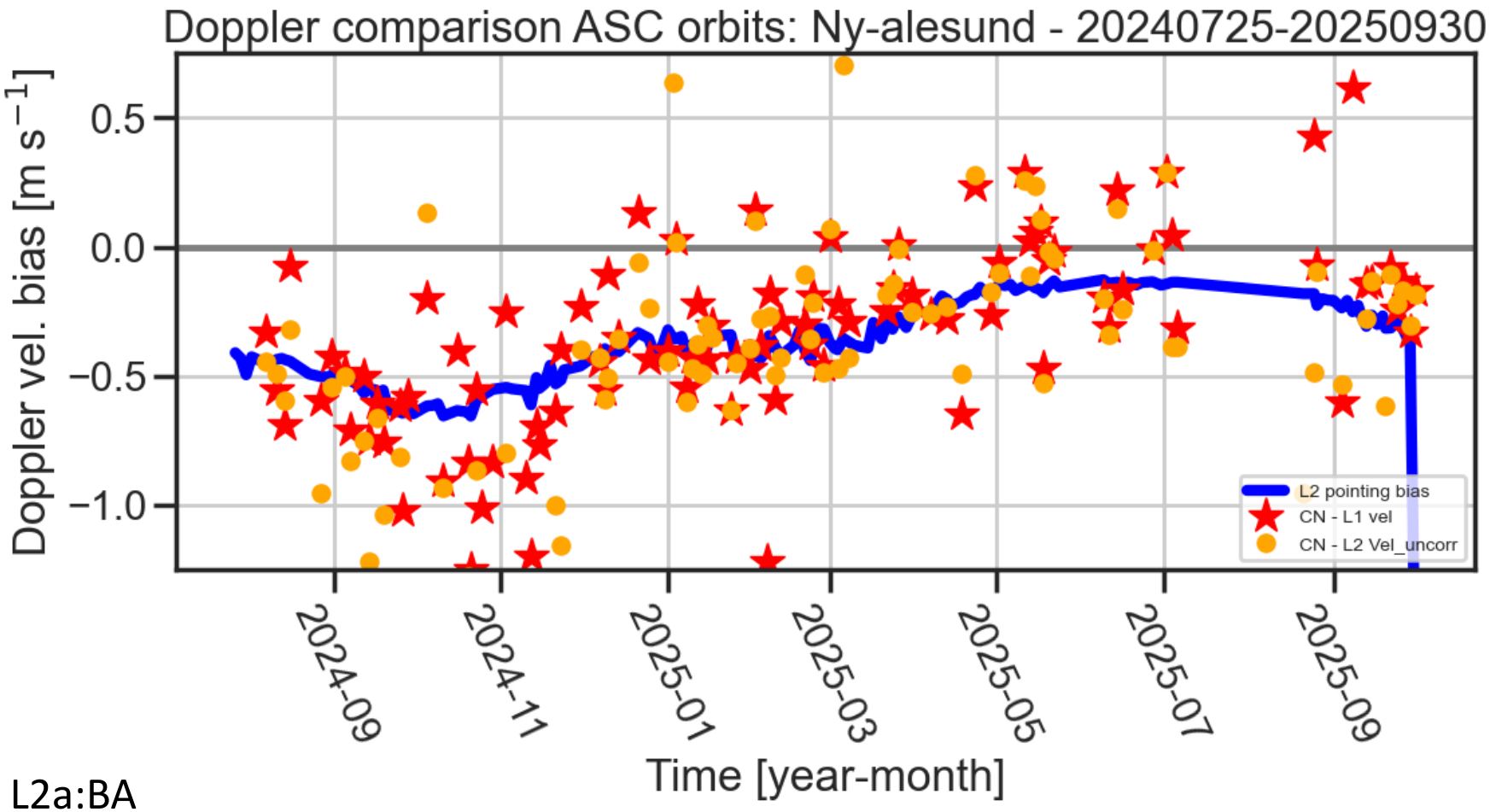
CPR L1: median(ground-CPR)

L1:DA & C? & L2a:BA

Doppler velocity Cal/Val – NyAlesund site & ASC-orbits

L1 uncorrected median(ground-CPR) →correlate with L2a miss-pointing bias

L2a **uncorrected**: median(ground-CPR) →correlate with median(L1) and L2a miss-pointing bias



L2a miss-pointing bias by Puigdomènech Treserras, et al., EGU, 2025

CPR L1: median(ground-CPR)

CPR L2a uncorrected: median(ground-CPR)

L1:DA & C? & L2a:BA

Doppler velocity Cal/Val – NyAlesund site & ASC-orbits

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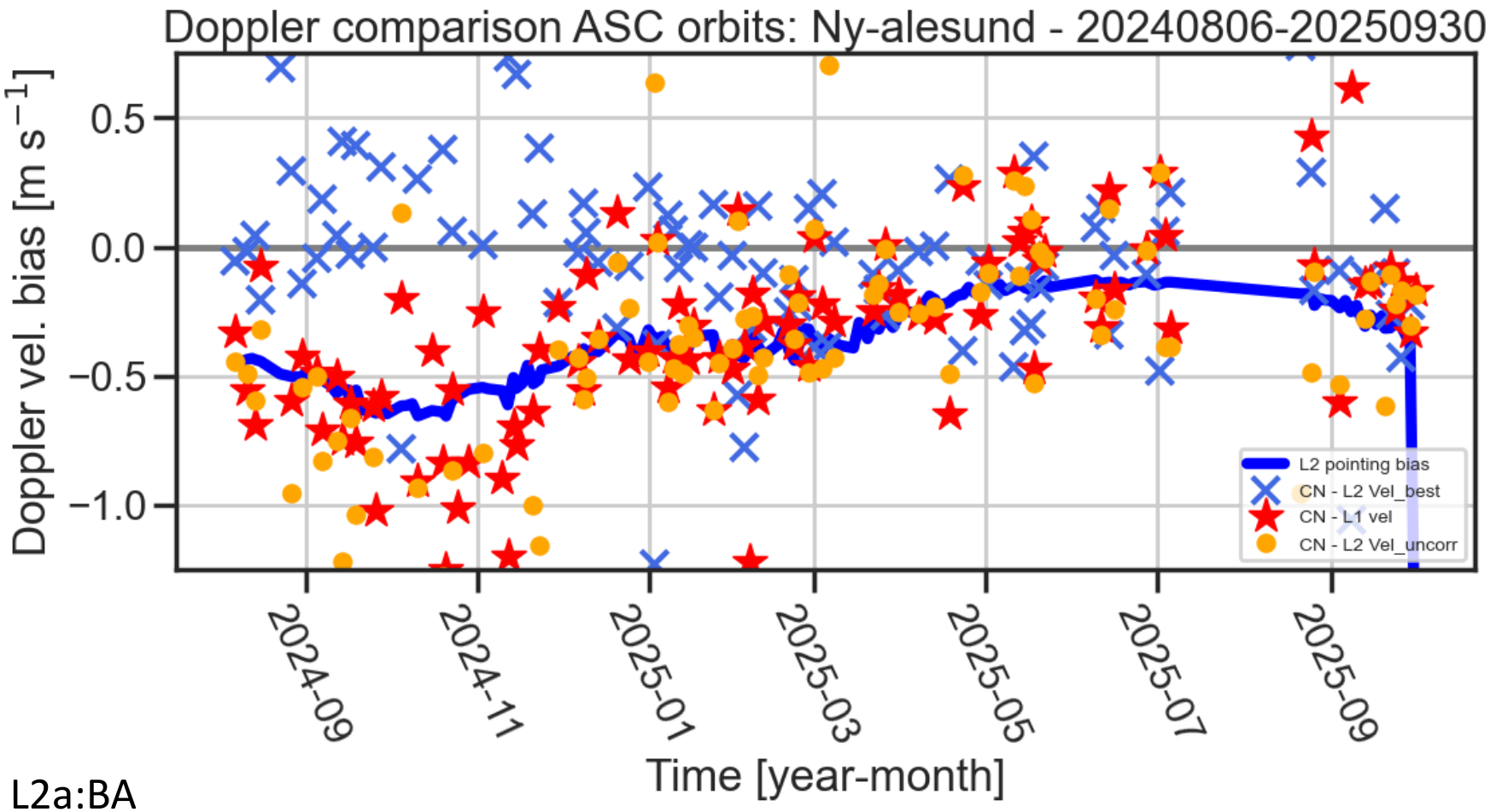
L2a **uncorrected**: median(ground-CPR) →correlate with median(L1) and L2a miss-pointing bias

L2a **best velocity** median(ground-CPR) →if Doppler correction is successful should centre around 0



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CPR L2a best velocity median(ground-CPR)

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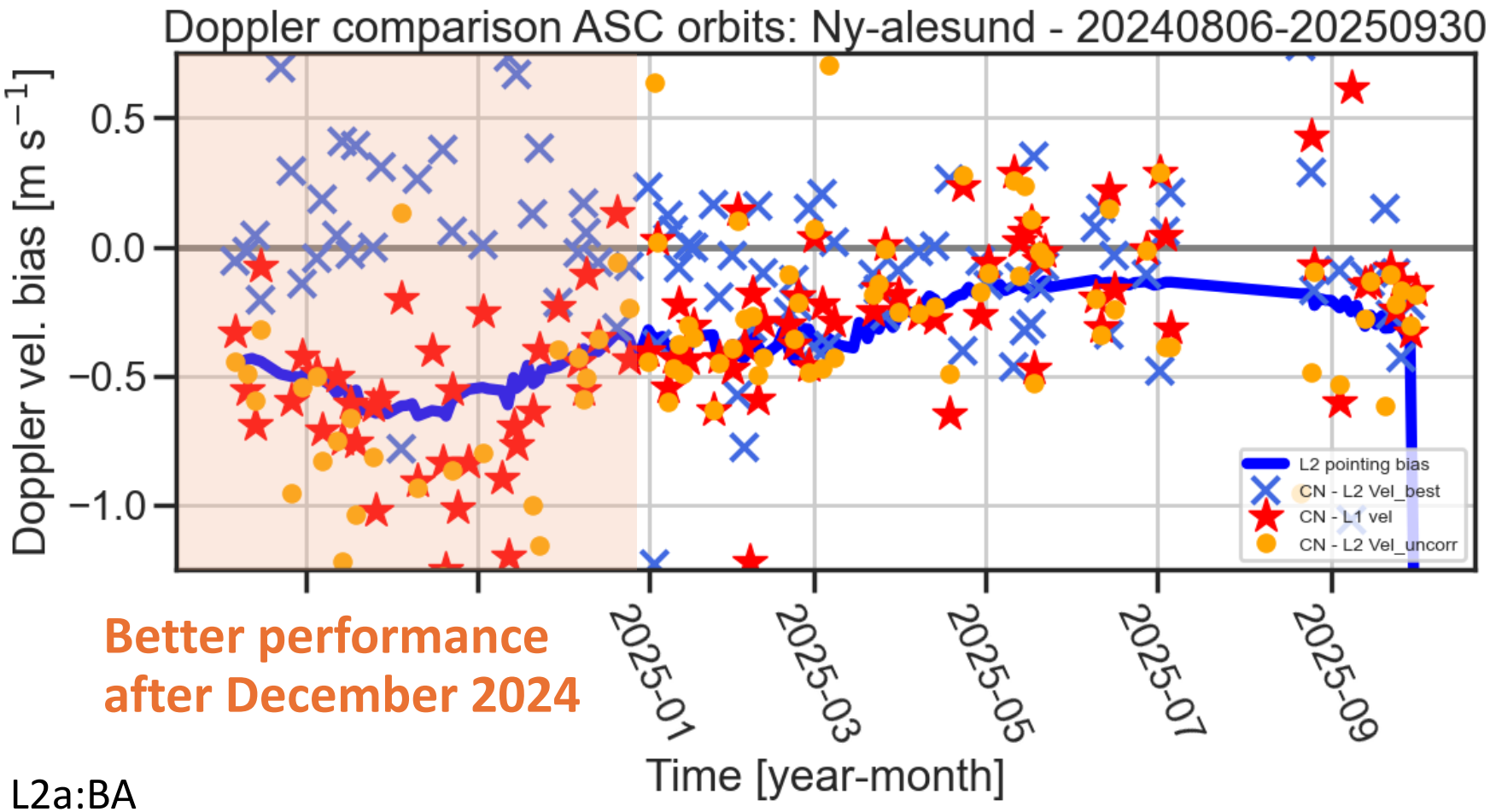


Better performance after December 2024

L2a miss-pointing bias by Puigdomènech Treserras, et al., EGU, 2025

CPR L1: median(ground-CPR)

CPR L2a uncorrected: median(ground-CPR)

CPR L2a best velocity median(ground-CPR)

L1:DA & C? & L2a:BA

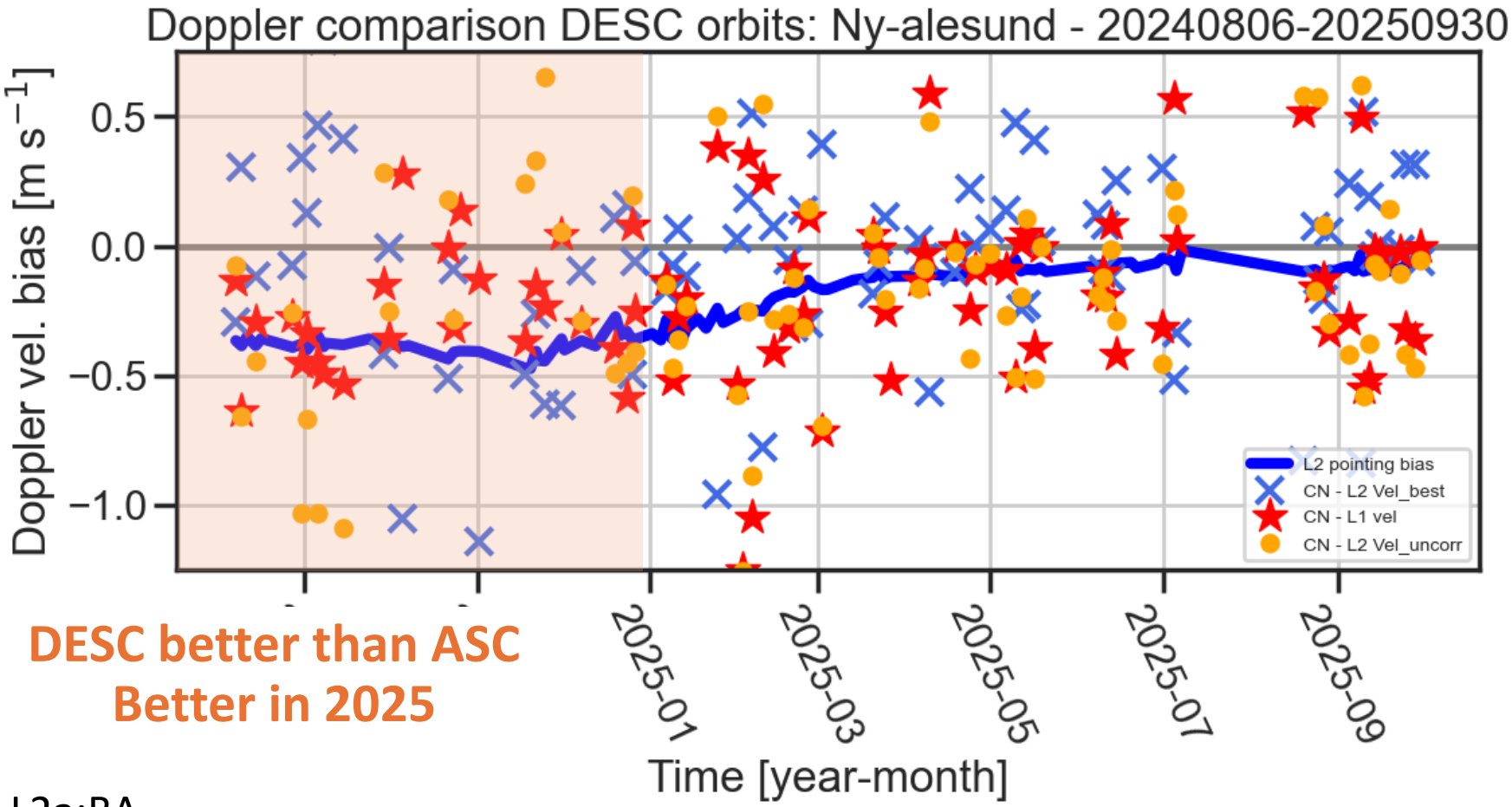
Doppler velocity Cal/Val – NyAlesund site & DESC-orbits

L1 uncorrected median(ground-CPR) →correlate with L2a miss-pointing bias

L2a **uncorrected**: median(ground-CPR) →correlate with median(L1) and L2a miss-pointing bias

L2a **best velocity** median(ground-CPR) →if Doppler correction is successful should centre around 0

DESC orbits



DESC better than ASC
Better in 2025

L2a miss-pointing bias by Puigdomènech Treserras, et al., EGU, 2025

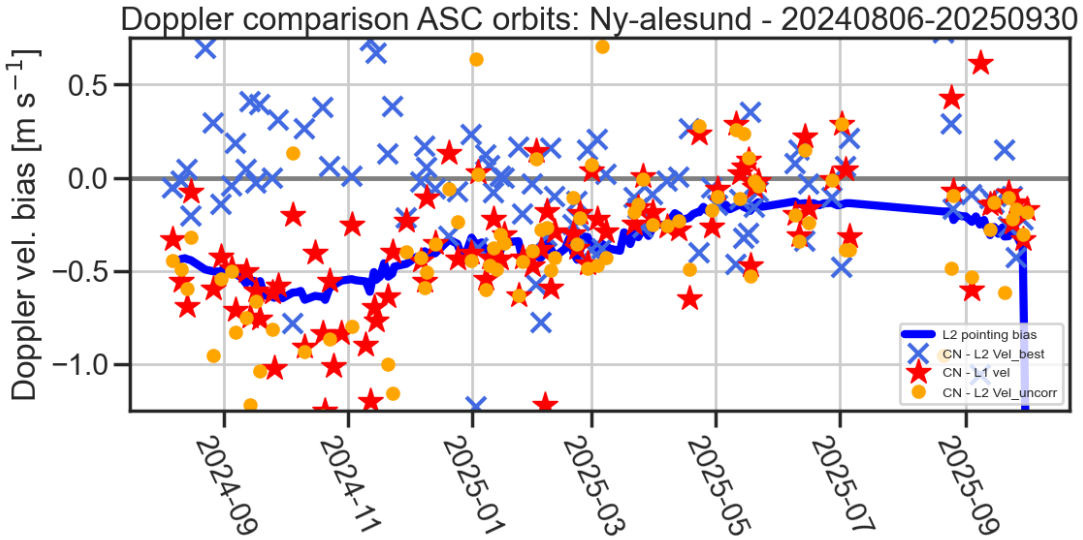
CPR L1: median(ground-CPR)

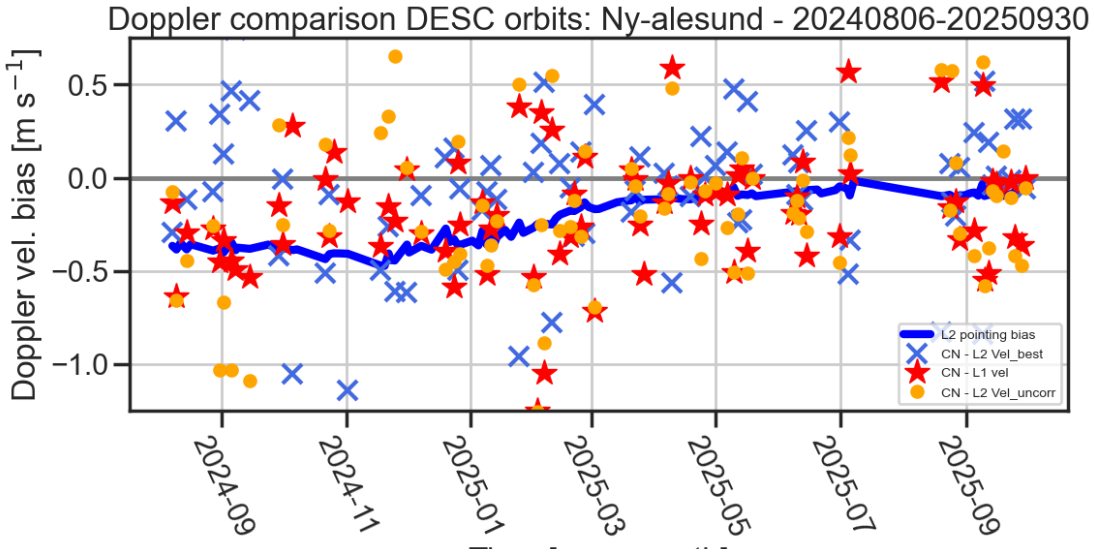
CPR L2a uncorrected: median(ground-CPR)

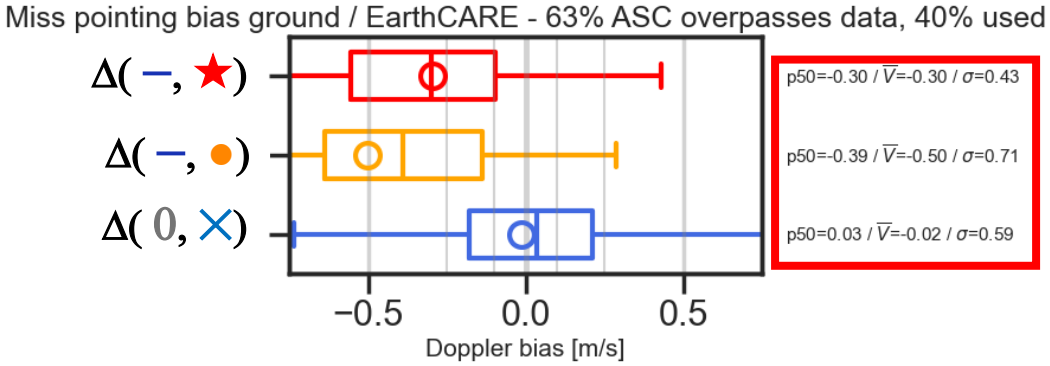
CPR L2a best velocity median(ground-CPR)

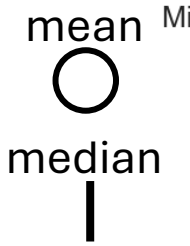
L1:DA & C? & L2a:BA

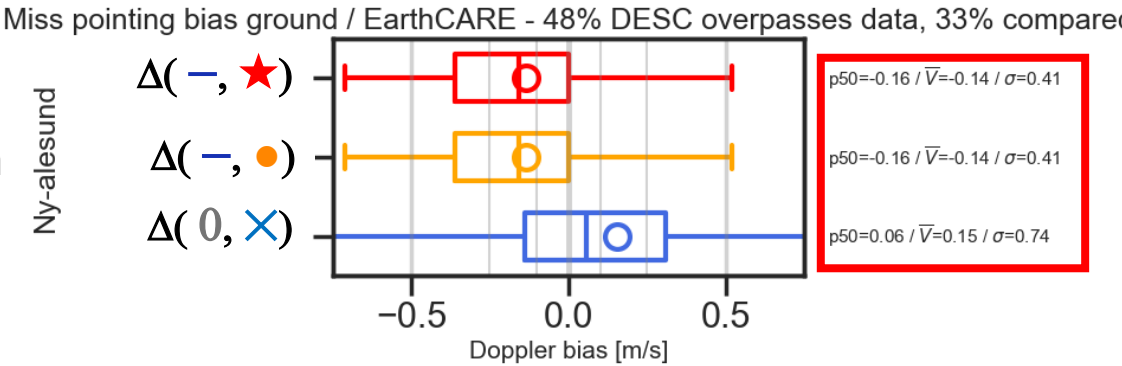
Doppler velocity Cal/Val – NyAlesund site orbits comparison





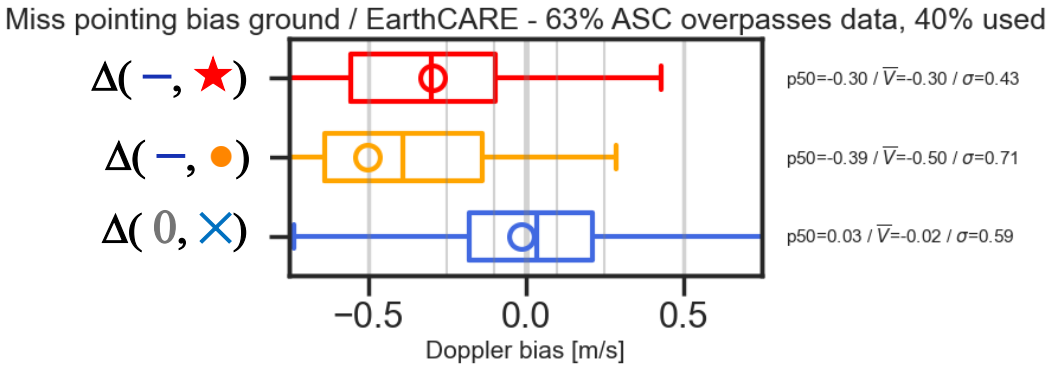


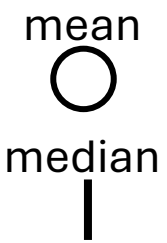


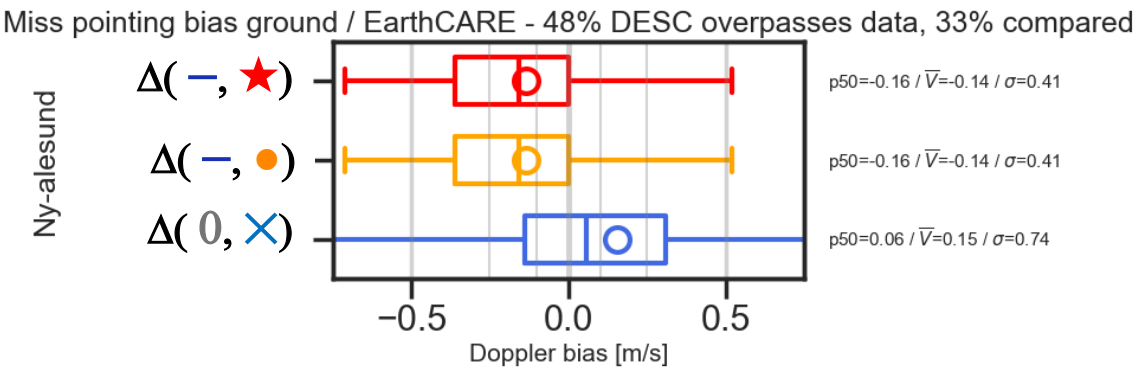


- Difference statistics for ASC and DESC → different data availability, cloud types, etc…
- ASC perform better than DESC orbits → throughout ACTRIS
- No correlation of site distance to the orbit and the bias → related to cloud type

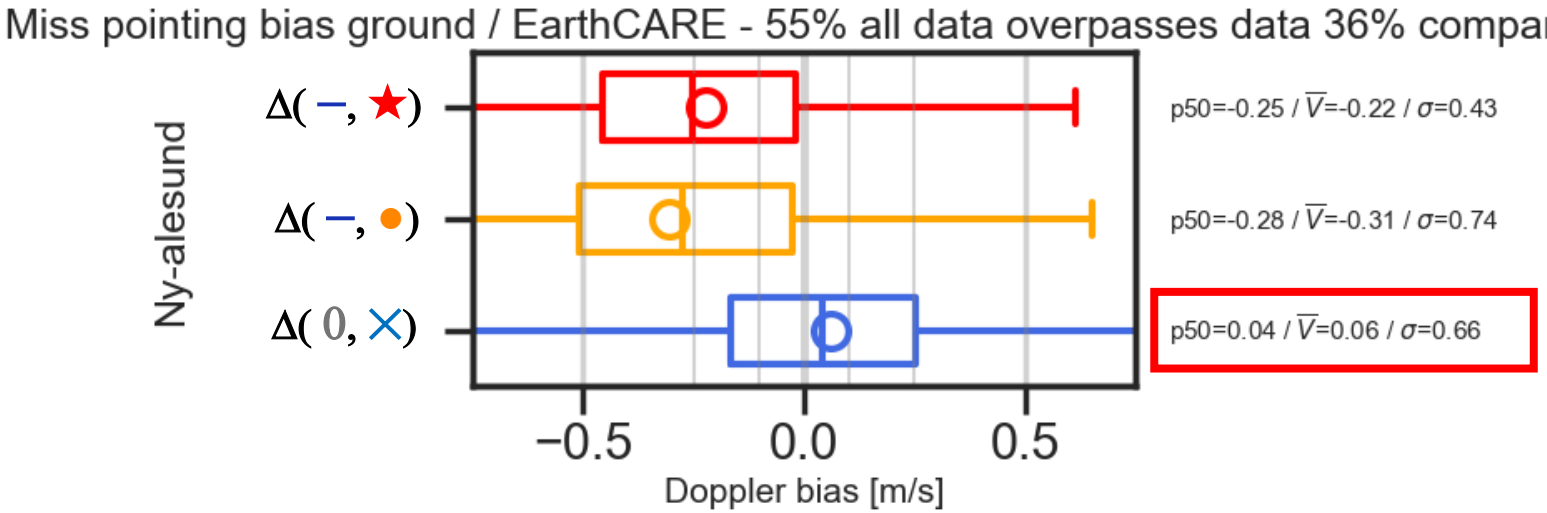
Doppler velocity Cal/Val – NyAlesund ground site vs all orbits



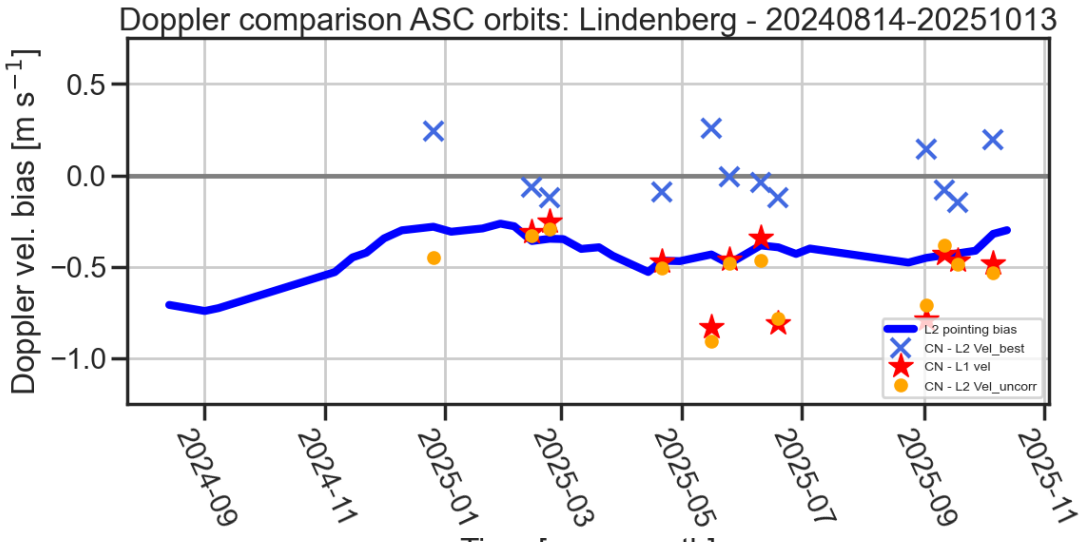


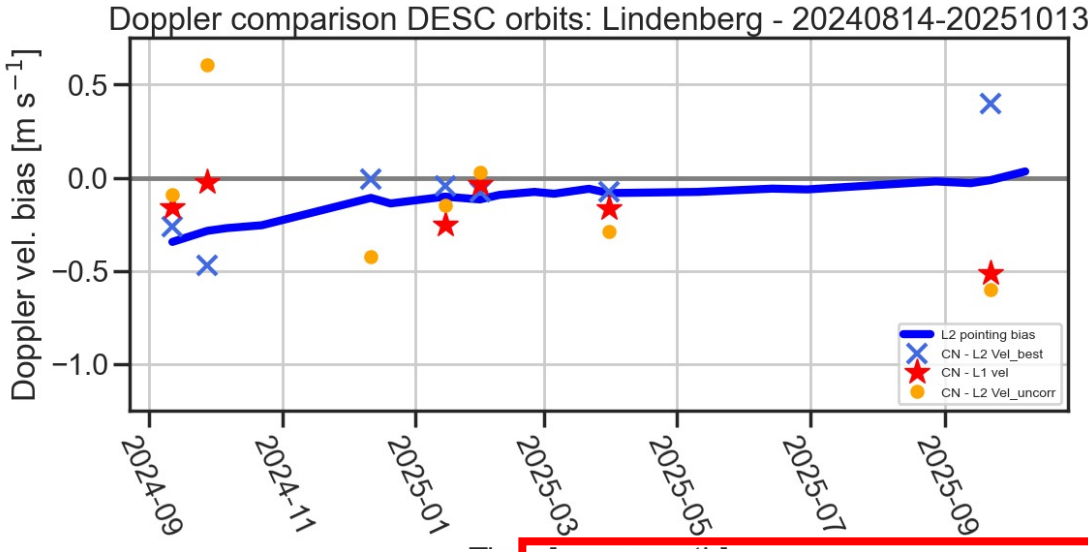


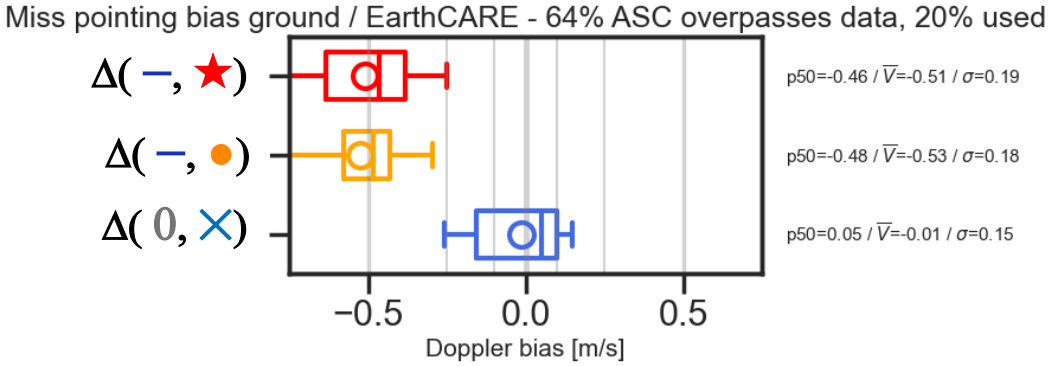
- Difference statistics for ASC and DESC → different data availability, cloud types, etc…
- DESC perform better than ASC orbits → for whole ACTRIS
- No correlation of site distance to the orbit and the bias → related to cloud type



Doppler velocity Cal/Val – Lindenberg site orbits comparison

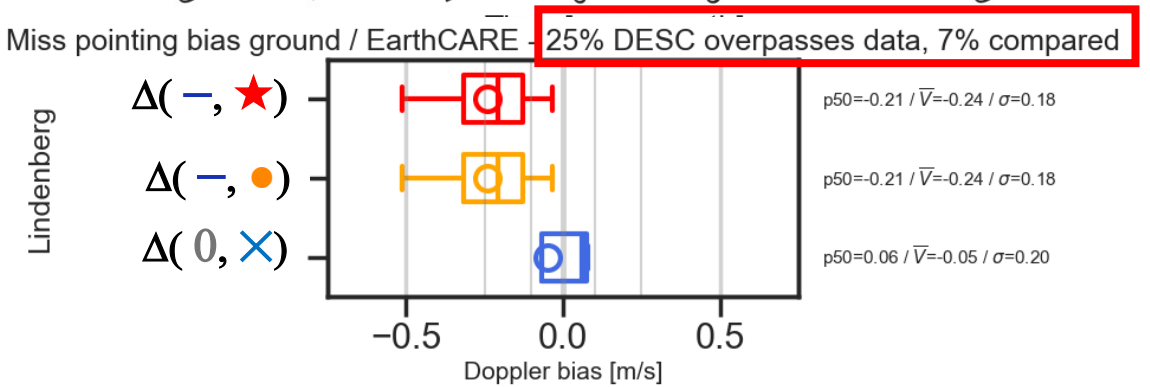






mean ○

median |



- DESC perform better than ASC orbits
- low amount of data to validate → 25% possible orbits downloaded, 7% are analysed extrem examples: Granada and Hyytiälä

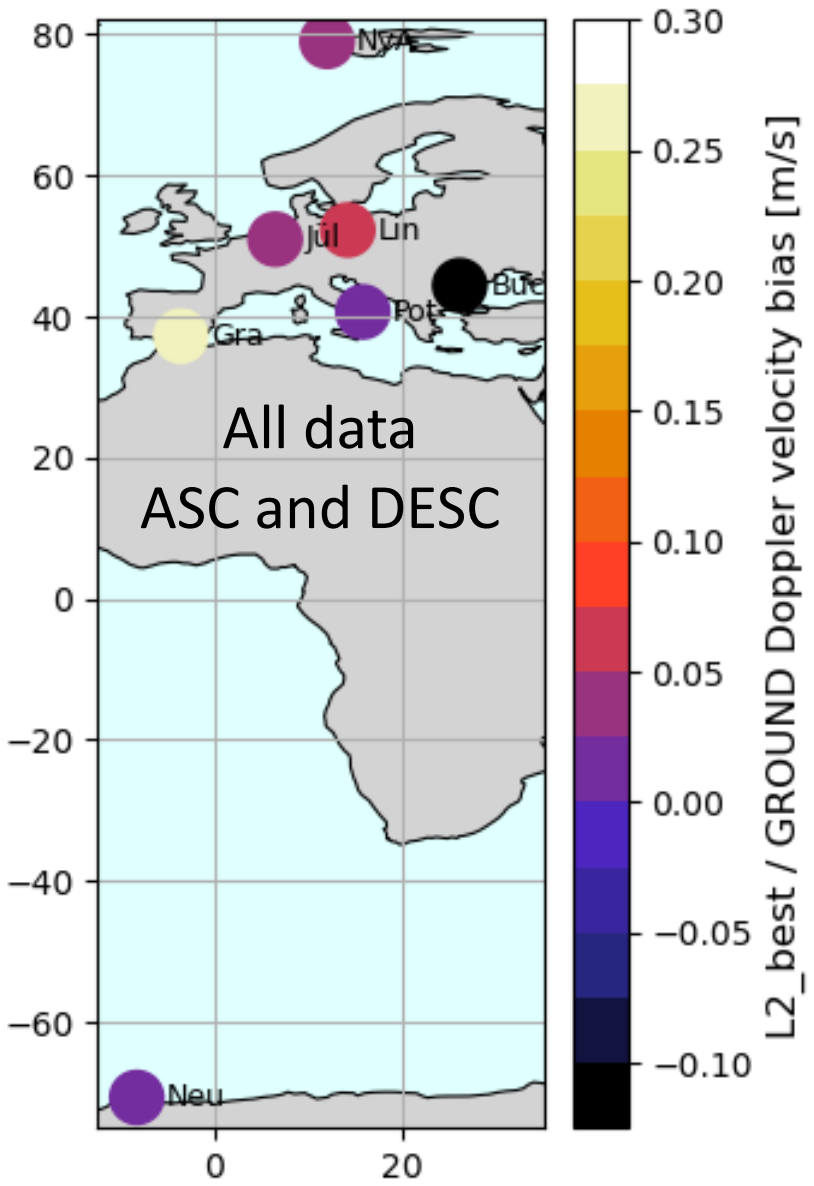
Doppler velocity Cal/Val – Summery ACTRIS Network:

- L2a best estimates +/- 0.1 ms^{-1}
  - Best: Neumeyer +/- 0.01 ms^{-1}
- L1 validation +/- 0.45 ms^{-1}

- Hyytiälä: no data
- Low number of case
  - Granada, Bucharest, Potenza

- ASC and DESC show differences in statistics

- No relation between site and distance to overpass



Improvements for ESA

- Data download for large data sets on MAAP
- issues with the geolocation-information?

→ no location match for Hyytiälä found

→ CPR only problem?

ACTRIS sites to ESA L2a best Doppler product