

AC cleaning status

Issues, possible improvements, and long term parameter behaviour

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1 Brief reminder

2 AMR-FGM correction

- Observed large disturbances types
- Version 1
- Long term variation

3 IB-OB correction

- Differences from AMR-FGM correction
- Version 1
- Long term variation

4 AC correction Issues

5 Forseeable improvements

- Mean values
- AMR-FGM correction
- IB-OB correction

Assumptions:

- Each disturbance to be corrected has a **well defined direction** of maximum variance
- The disturbance variance is **not much smaller** than the variance of the ambient field

Method (for each order n):

- The **difference $\Delta \mathbf{B}^{n,ij}$** between each (i,j) sensor pair is computed
- The correction is obtained from the **maximum variance component** of the difference
- The correction is applied to both sensors only to their maximum variance components

Restrictions:

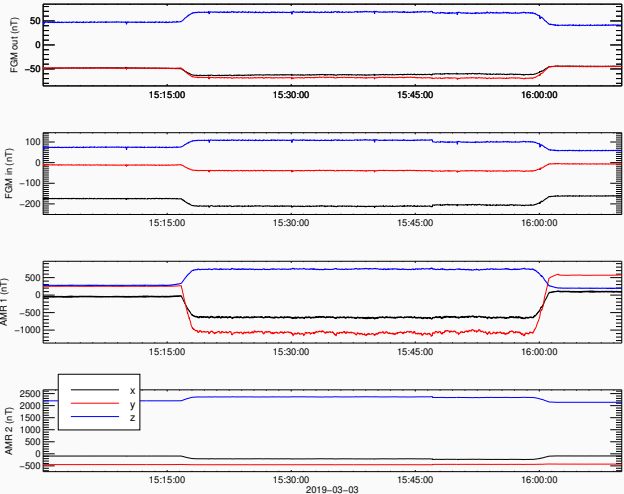
- The sensor **noise might increase** at each step
- The correction can be applied **maximum three times** per sensor pair
- Different sources disturbing the same component are difficult to correct if their positions differ

- AMR1–IB and AMR1–OB
 - corrects the “Midnight Event” (ME) daily single large disturbance
 - corrects only one component (1st order)
 - leaves residual disturbance in the other components
- OB–IB (AMR1 corrected)
 - corrects three disturbance types:
 - high frequency disturbance (seconds) – good
 - spikes (minutes) – good
 - steps (hours) – leaves some residual disturbance
 - corrects two components (up to 2nd order) of the OB sensor (and three of the IB)
 - might transfer sensor temperature effects between sensors

The combined corrections yield the \mathcal{M} -matrices uploaded to GK-2A

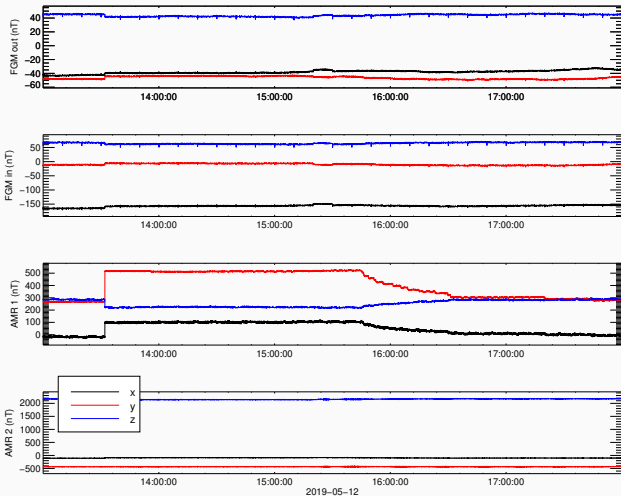
$$\mathbf{B} = \mathcal{M}^{\text{OB}} \mathbf{B}^{\text{OB}} + \mathcal{M}^{\text{IB}} \mathbf{B}^{\text{IB}} + \mathcal{M}^{\text{A1}} \mathbf{B}^{\text{A1}}$$

- the Midnight Event
 - **largest** observed disturbance
 - close to the ecliptic (Magda)
- heater?
- most intense at **AMR1**
 - used to determine V1 AMR1 cor.

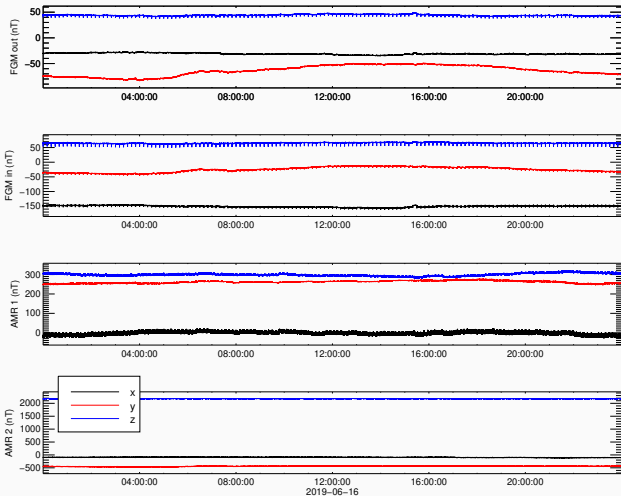


- **smaller** than the ME
- intermittent
- might be part of the ME
- corrected with V1 AMR cor.

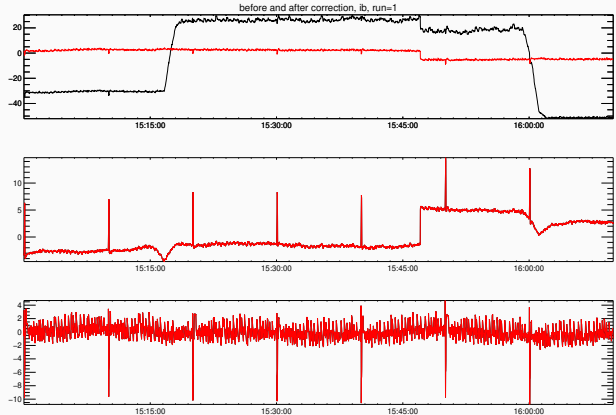
→ same disturbance source



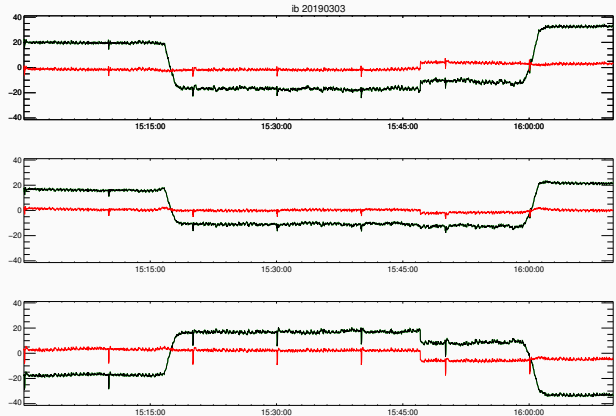
- NO large disturbance
 - AMR correction is still applied
 - very little variation
- negligible AMR contribution



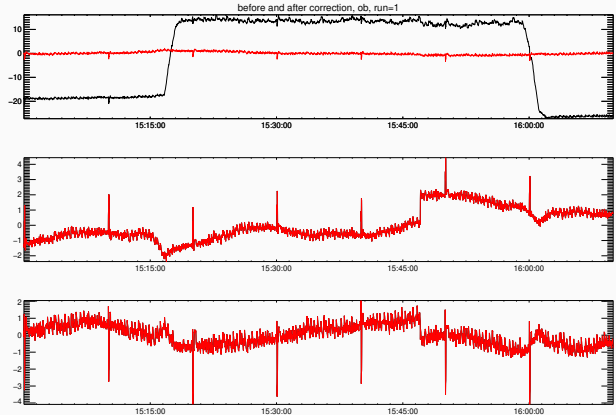
- Max var comp well corrected
- HF disturbance corrected
- middle step (x comp) remains
- **Residuum** left on **y** comp



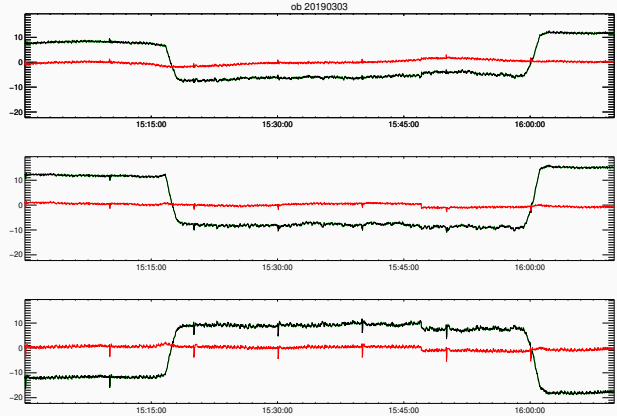
- residuum remains



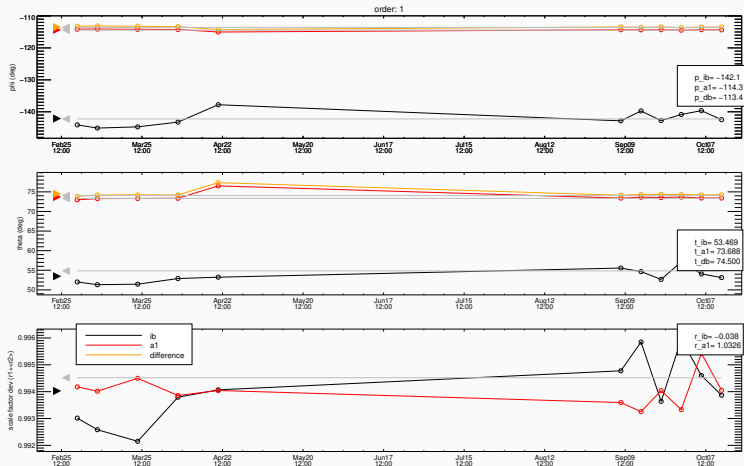
- Max var comp well corrected
- HF disturbance corrected
- no middle step on x comp (\perp)
- Residuum left on y and z comp



- residuum visible

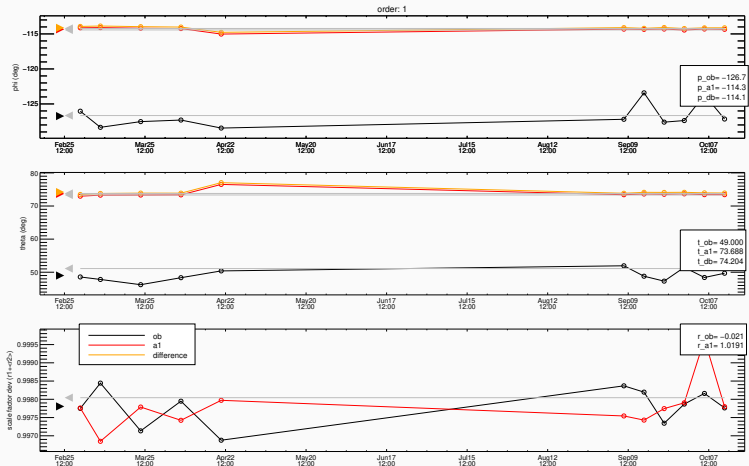


- used Sundays with ME
- 2 outliers excluded
- AMR more stable
- angular variation: 7°
- scale var: 4×10^{-3}



Mean values marked with colored triangles, V1 values marked with grey triangles

- used Sundays with ME
 - 2 outliers excluded
 - AMR more stable
 - angular variation: 6°
 - scale var: 3×10^{-3}
- slightly better than IB

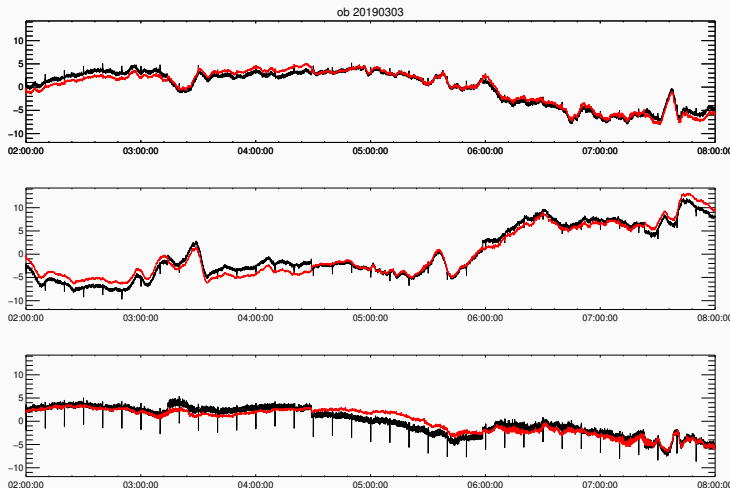


Mean values marked with colored triangles, V1 values marked with grey triangles

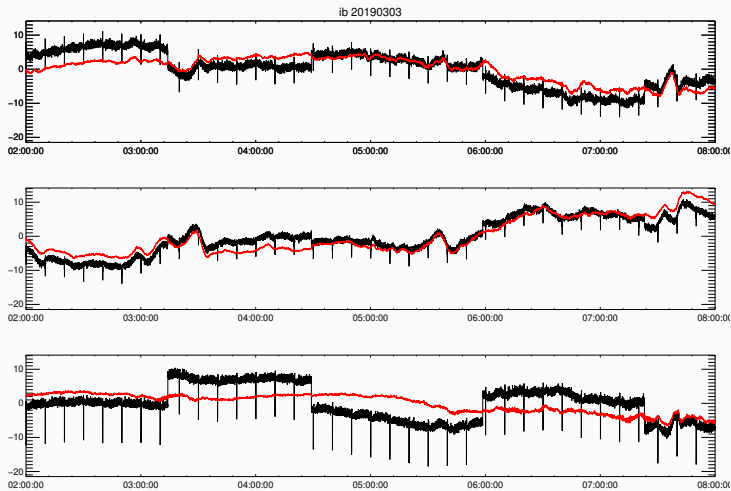
Differences from the AMR correction

- uses **sliding window** to obtain many parameter sets for one day
- the window width selects the desired disturbance to be cleaned
- different window widths/disturbance sources for different orders
- the final parameters are determined through **statistical methods**
- version one IB-OB correction goes up to **order 2 for OB** and **order 3 for IB**

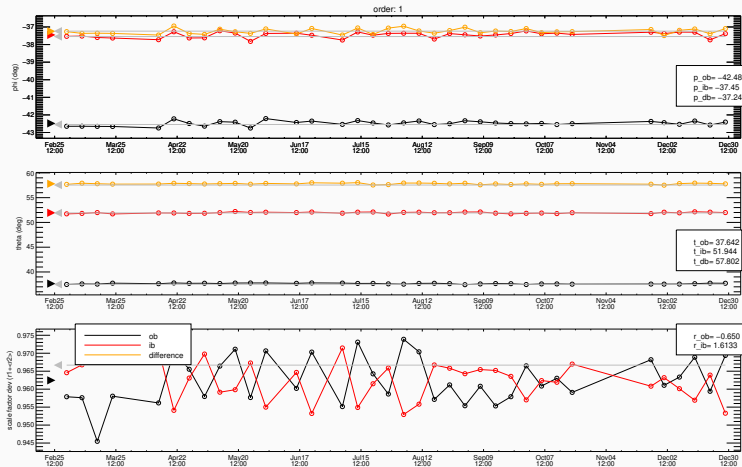
- HF dist. removed
- spikes removed
- steps **only reduced**



- HF dist. removed
- spikes removed
- steps **better reduced**
but still present

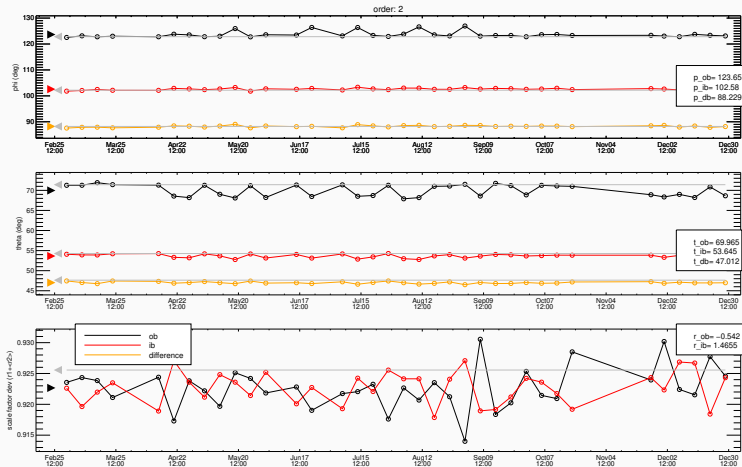


- used Sundays 2019
- 3 outliers excluded
- **very stable**
- angular variation: $< 1^\circ$
- scale var: 3×10^{-2}



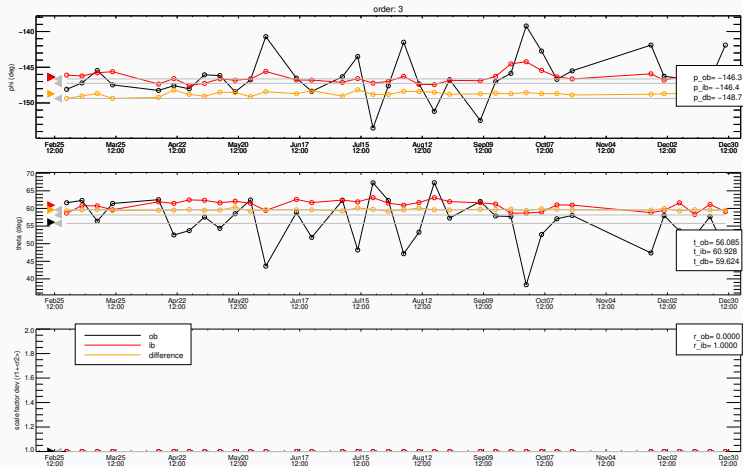
Mean values marked with colored triangles, V1 values marked with grey triangles

- 3 outliers excluded
- reasonably stable
- angular variation: 5°
- scale var: 1.5×10^{-2}



Mean values marked with colored triangles, V1 values marked with grey triangles

- only applied to IB
- 4 outliers excluded
- unstable
- angular variation: 20°
- most variation at OB
- scale var: –



Mean values marked with colored triangles, V1 values marked with grey triangles

Issues:

- AMR-FGM correction
 - residual disturbances around ME
- IB-OB correction
 - residual step-like disturbances
 - temperature driven FGM sensor disturbances

Potential solutions:

- use 2019 mean values – minimal improvement
- use IB instead of OB – improves the step removal
- increase the order for the AMR-FGM correction
 - use the intermediate and minimum variance directions from O1 to compute O2 and O3
- increase the accuracy of the IB-OB maximum variance direction determination
 - use the Kernel Density Estimator (KDE) instead of the histogram
- increase the accuracy of the IB-OB scale factor determination
 - optimize the scale factor by minimizing the correlation between ΔB and $B^{\text{corrected}}$

AMR-IB, AMR-OB changes between version 1 and mean values:

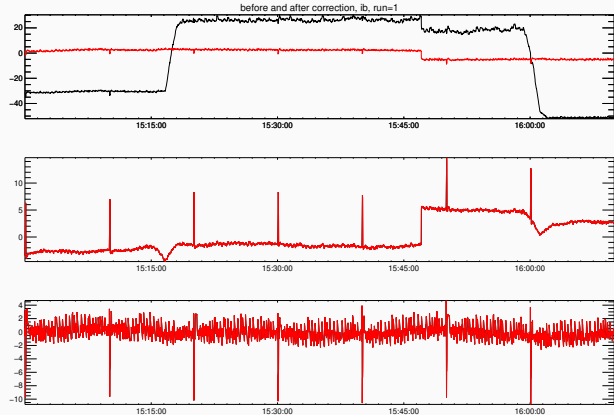
- angular change: $1\text{-}2^\circ$
- scale factor change: 10^{-3}

IB-OB changes between version 1 and mean values:

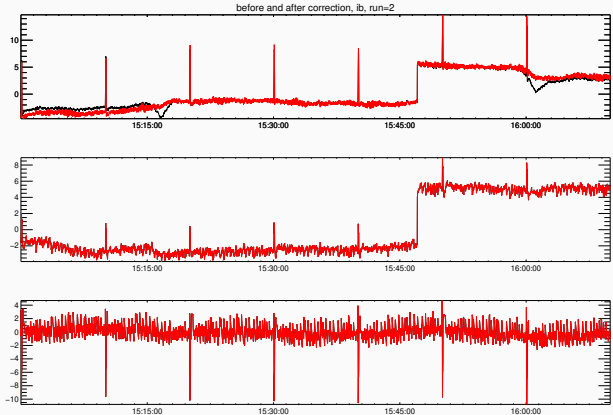
- for order 1 in the same magnitude order as above
- for orders 2, 3 TBD ...

Maximum change in the corrected field: **bellow 1 nT**

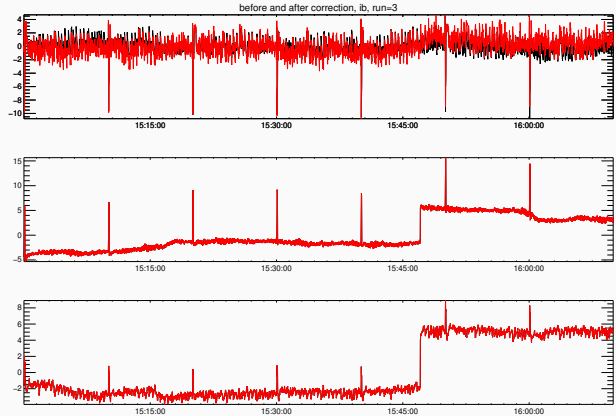
- max var comp well corrected
- residuum left on y component



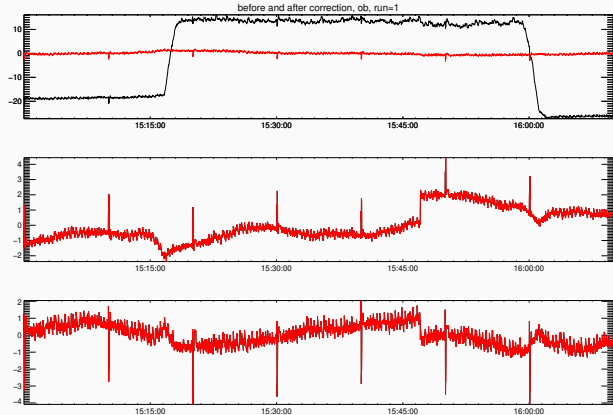
- residual disturbance removed
- level change remains
- disturbance traces on y visible



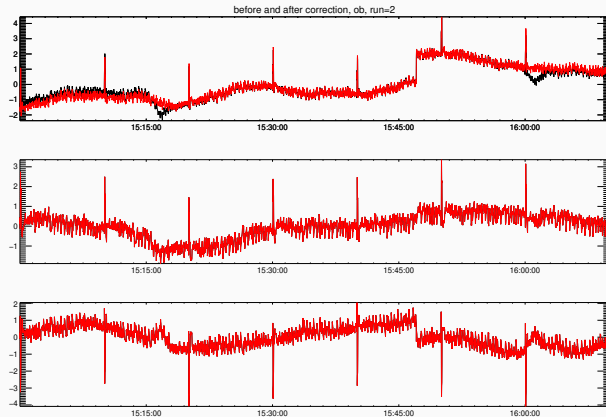
- not clear if usefull



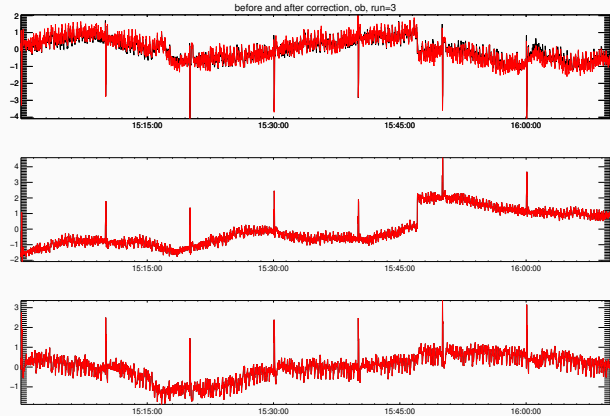
- residual dist on max var comp
- residuum left on y and z comp



- residual disturbance removed
- residuum left on z component



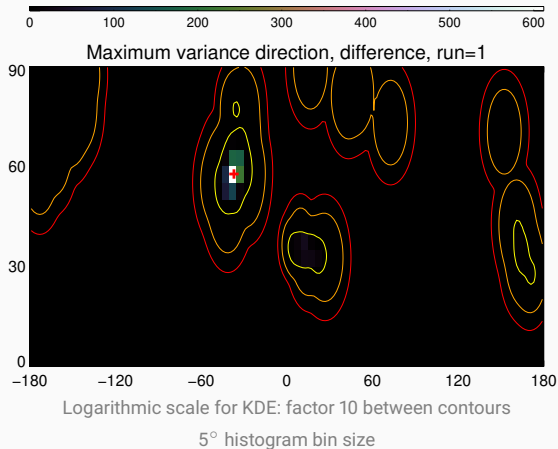
- residuum **not** removed



Steps to follow:

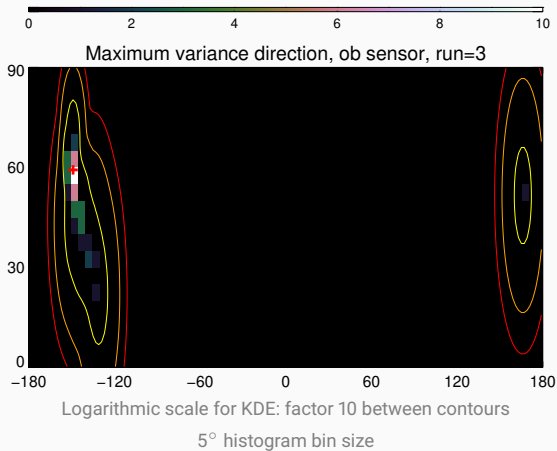
- Use a sliding window to obtain a pool of max var directions and scale factors
- Use 2D Kernel Density Estimator (KDE) to find the most probable max var direction
- Use 1D KDE to find the most probable scale factor
- Use the obtained scale factor as starting value to minimize the correlation $B - \Delta B$

- better direction selection
- better direction accuracy
- more sensitive

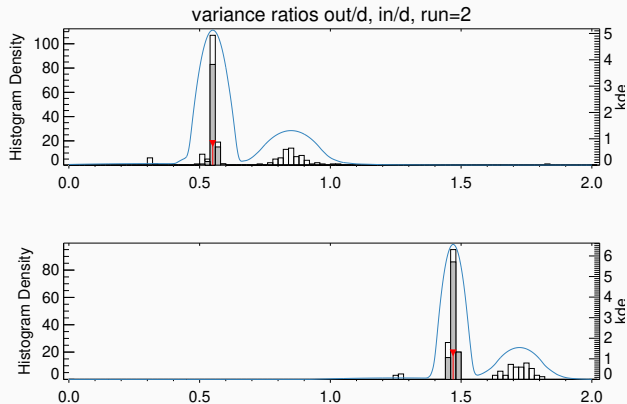


At least three distinct disturbances revealed

- OB order 3: the most difficult
- rough histogram estimation
- more consistent between days



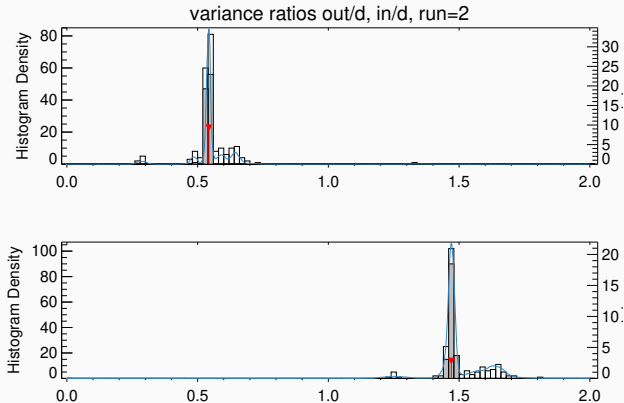
- the KDE is more accurate
- **very** important for scale factors
- more consistent between days



- distribution **significantly** narrowed

→ improved accuracy

- secondary maximum eliminated



- Version 1 parameters are stable in time
- Remaining issues
 - residual disturbance due to ME
 - remaining step-like disturbance
 - temperature driven disturbance
- Possible ways to improve the AC correction
 - mean values
 - IB sensor
 - increase AMR correction order
 - involve AMR2
 - use KDE to pinpoint the maximum variance directions and the scale factors
 - optimize the scale factors by minimizing the correlation between ΔB and B
- Next upload ?