Sensitivity of resolved gravity wave momentum fluxes on different background separation methods in a high resolution simulation

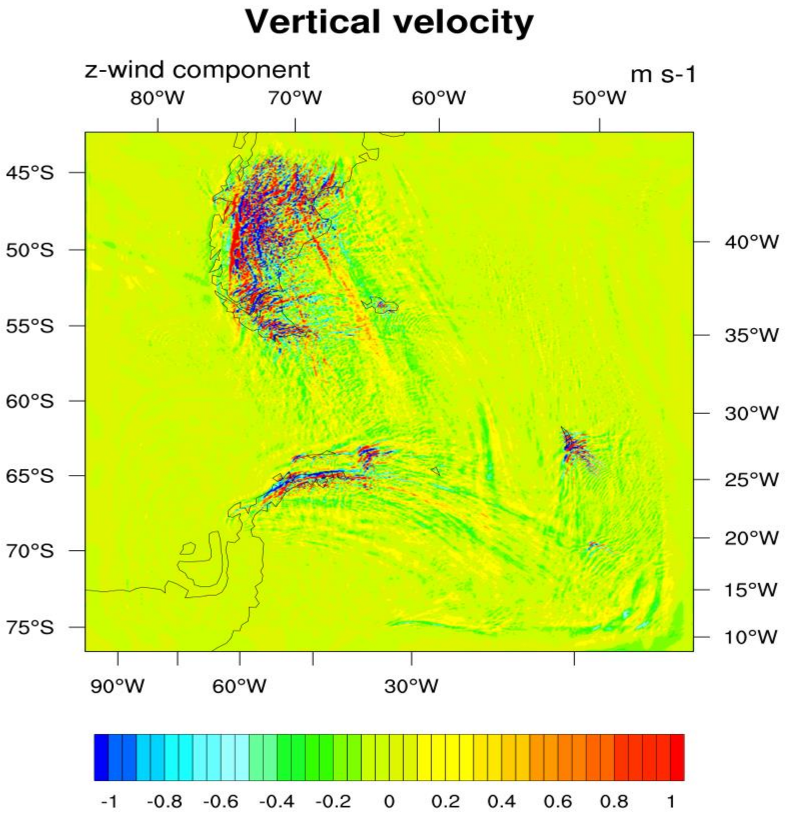
Z. Procházková, P. Šácha, A. Kuchař, P. Pišoft, and C. Kruse

Internal gravity waves (GWs) and their interaction with the atmospheric circulation present a complex problem for global climate models (GCMs) due to a variety of spatial and temporal scales involved. GWs and their effects in GCMs are parameterized by employing various simplifications and restrictions (propagation, spectrum). Also, our incomplete knowledge of the GW properties in the real atmosphere complicates the situation. Global (satellite) observations of the GW activity are spatiotemporally sparse, making the quantification of the GW interaction with the circulation hardly possible. Recently, atmospheric models capable of resolving most of the GW spectrum have been emerging due to the increasing performance of computing systems. It is increasingly acknowledged that a combination of various types of observations with dedicated high-resolution, GW resolving, simulations has a potential to provide the most precise information about GWs. This combination will allow us to better understand the uncertainty of satellite observations of GW activity, which in turn will be used to develop new GW parameterizations or in development of GW resolving models. In this study, we will analyze sensitivity of GW momentum flux and its divergence on background separation (and other GW detection) methods and approximations (Boussinesq, anelastic) used in the formulas. We analyze data from high-resolution model simulations produced for an observing system simulation experiment of the ISSI team "New Quantitative Constraints on Orographic GW Stress and Drag" (to be introduced in an invited presentation by C. Kruse).

First results – supplementing Chris Kruse‘s presentation

So far a single time-step of the WRF simulation analyzed

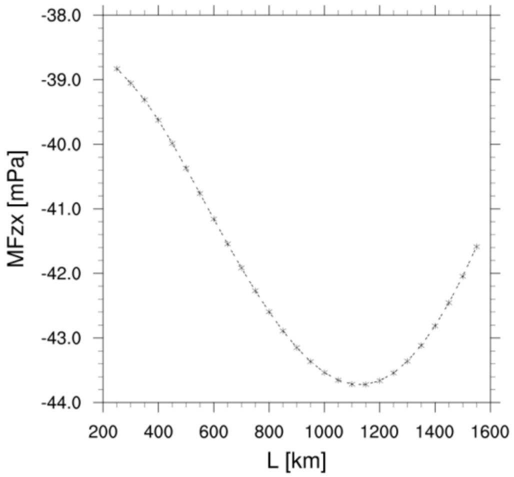
(10. 10. 2010, 12:00)



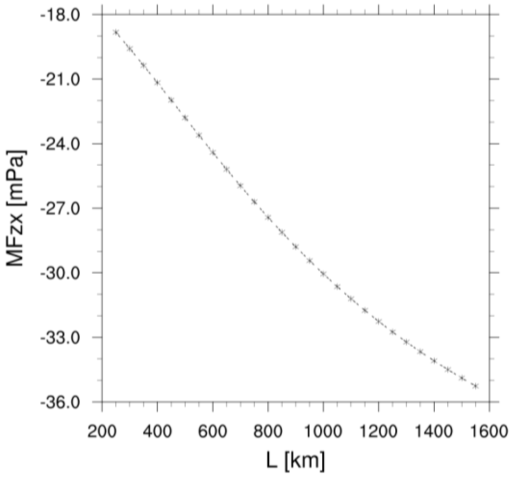
First results– sensitivity of MFs to the cutoff value of the high pass filter

- Background - GW separation using the high-pass filter with cutoff L=500 km
- Sensitivity of the area averaged MFzx near the source (at 3km):

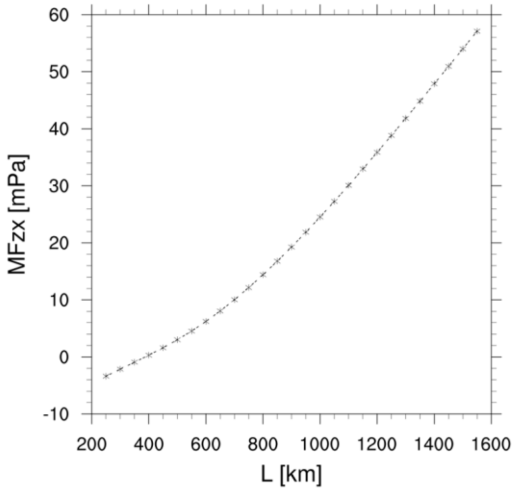
South Andes



Antarctic Peninsula



South Georgia



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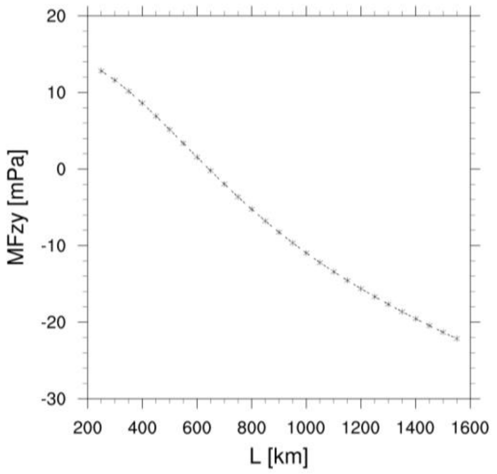

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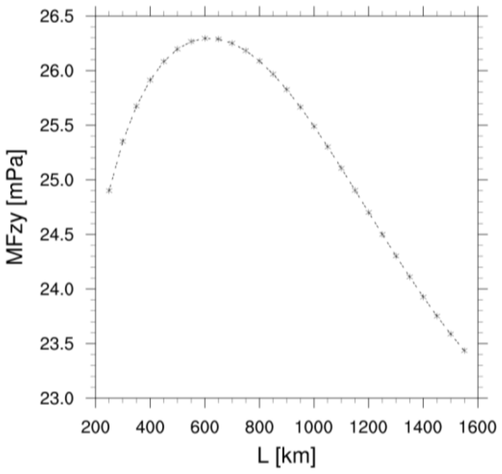

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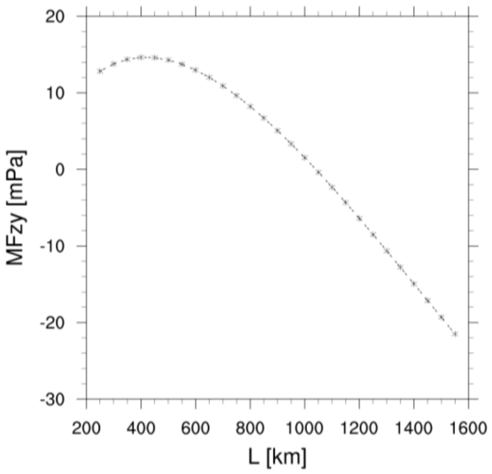
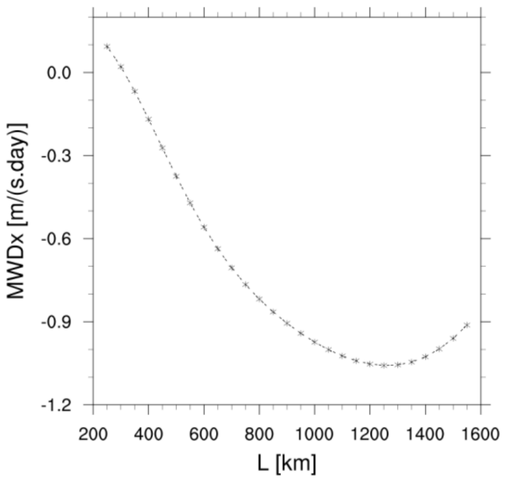


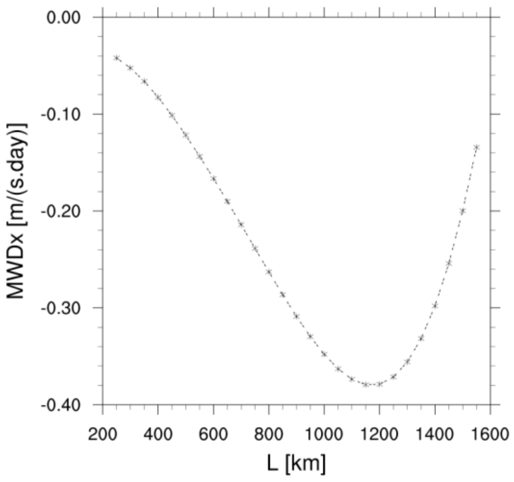
First results– sensitivity of MWD to the cutoff value of the high pass filter

- Background - GW separation using the high-pass filter with cutoff L=500 km
- Sensitivity of the area averaged MWDx at 20km:

South Andes



Antarctic Peninsula



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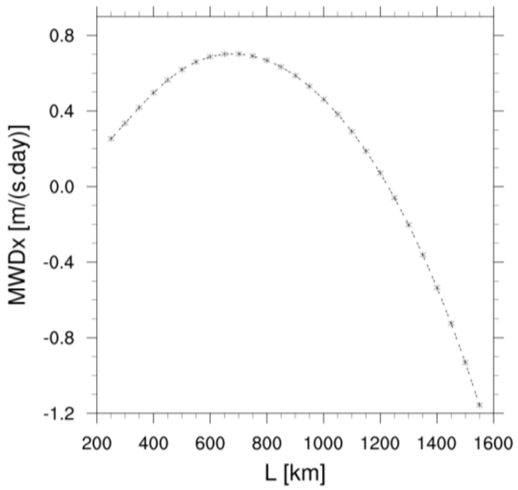
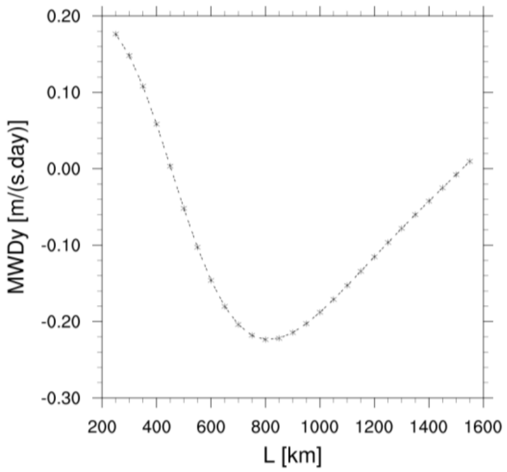


First results– sensitivity of MWD to the cutoff value of the high pass filter

- Background - GW separation using the high-pass filter with cutoff L=500 km
- Sensitivity of the area averaged MWDy at 20km:

South Andes



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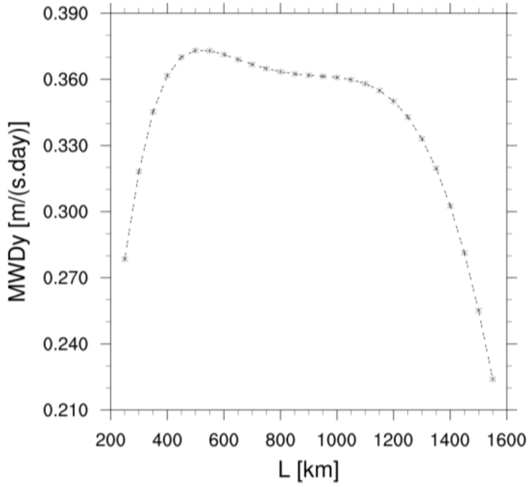

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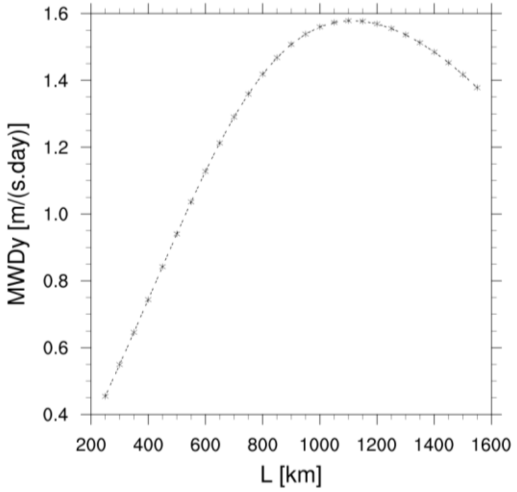


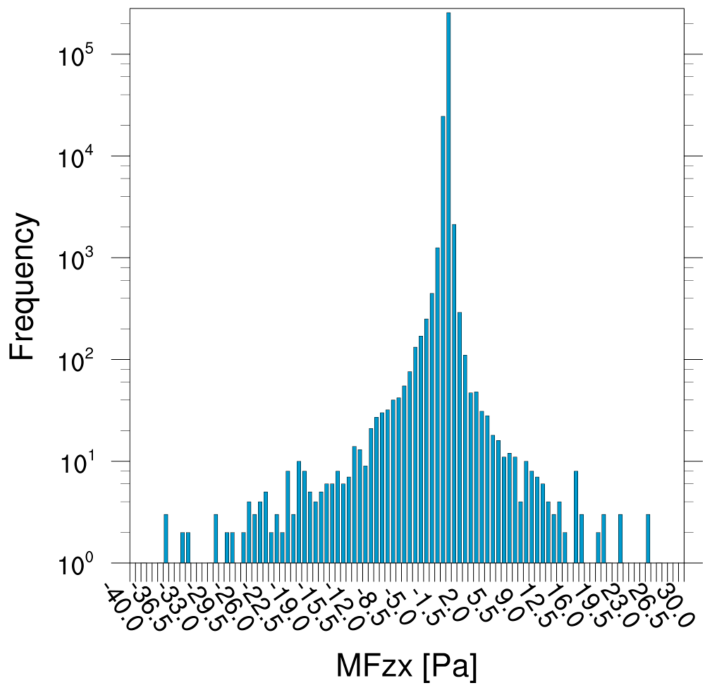
First results – what is hidden behind the spatial averages over the hotspot domain?

- Slightly different MF distribution for each domain (but approximately Gaussian near the surface).
- Positive MF values are less frequent higher above (i.e. dissipate during propagation)
    - Reason for the positive drags in Chris Kruse‘s results?

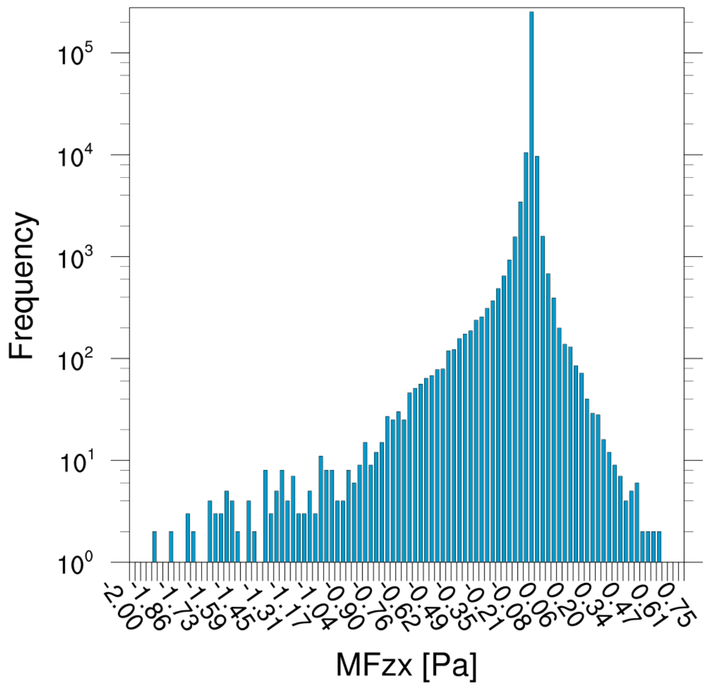
First results – what is hidden behind the spatial averages over the hotspot domain?

Southern Andes, MFzx

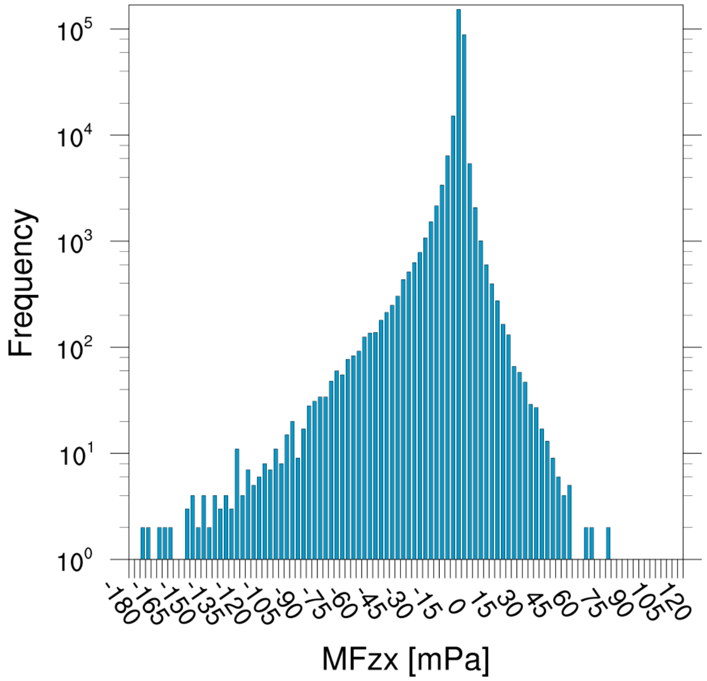
3 km



20 km



40 km



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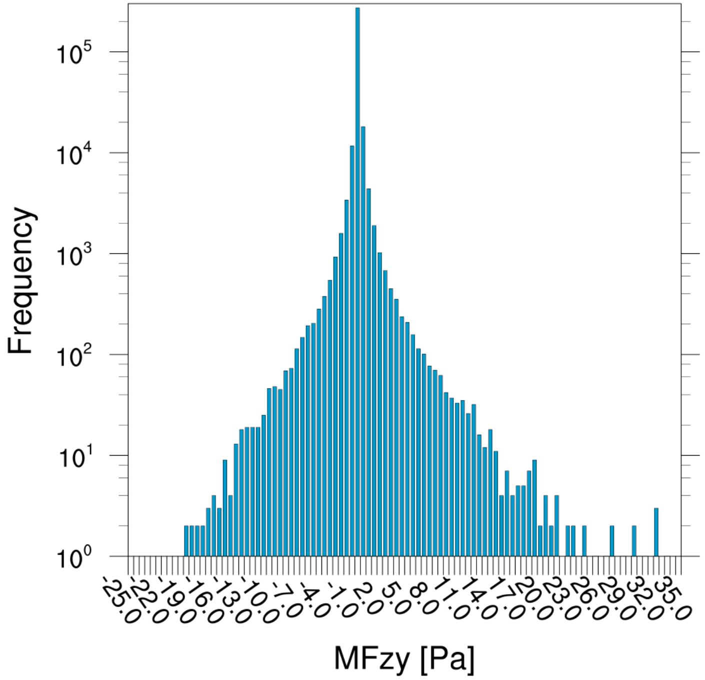
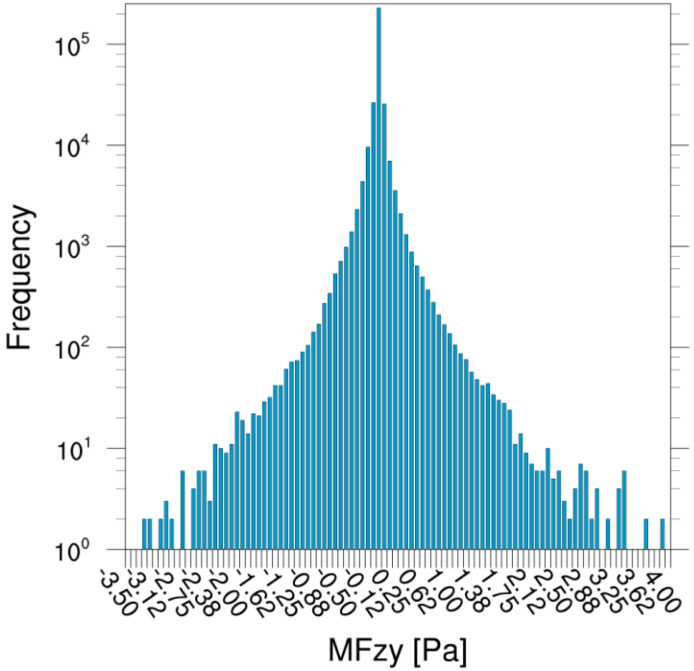
Southern Andes, MFzy

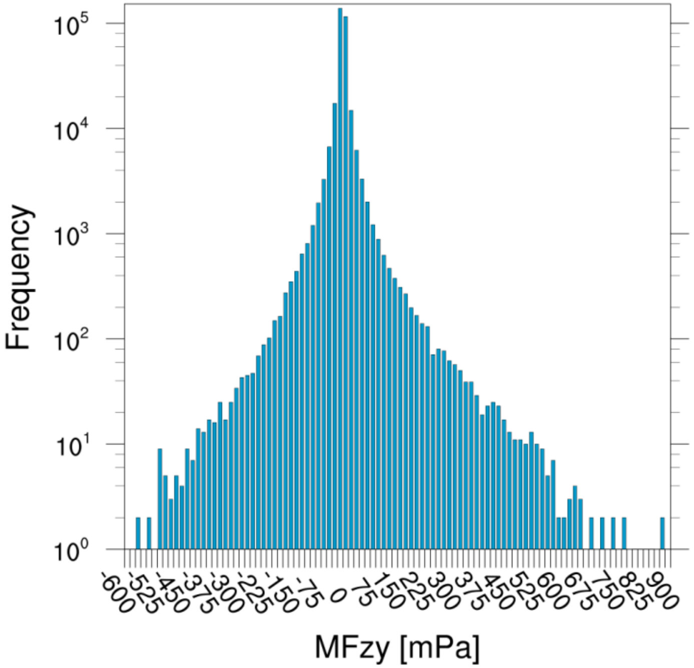
3 km



20 km



40 km



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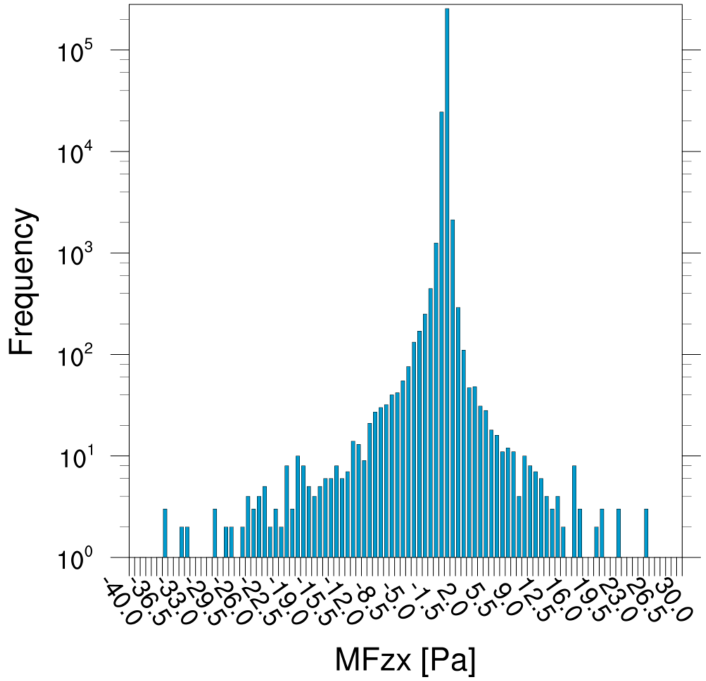
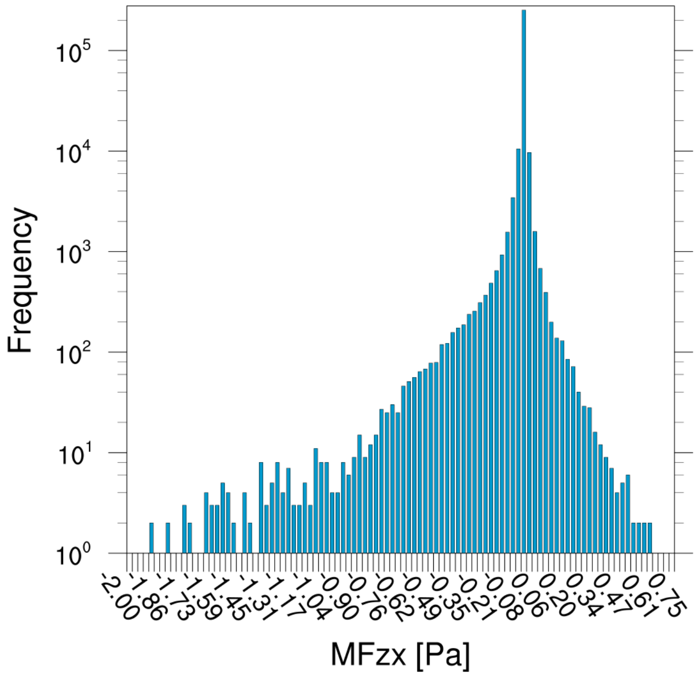
Antarctic Peninsula, MFzx

3 km



20 km



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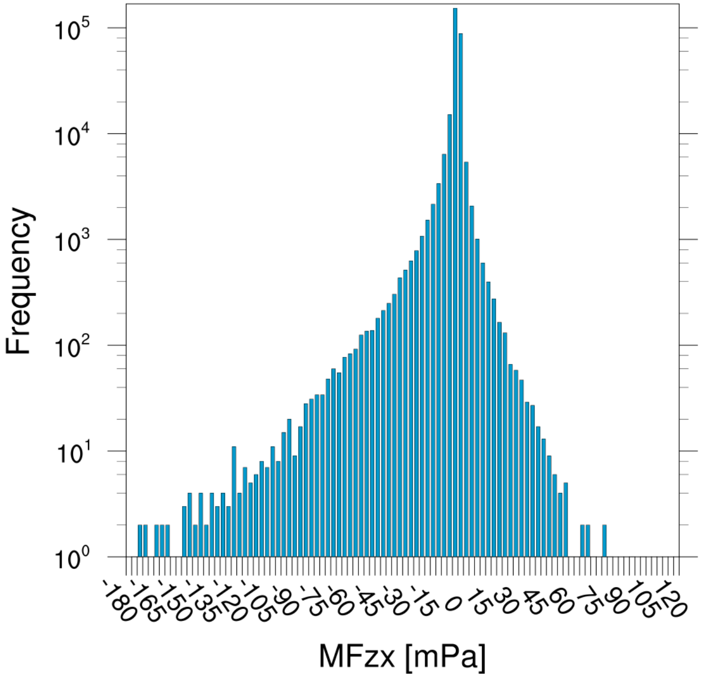

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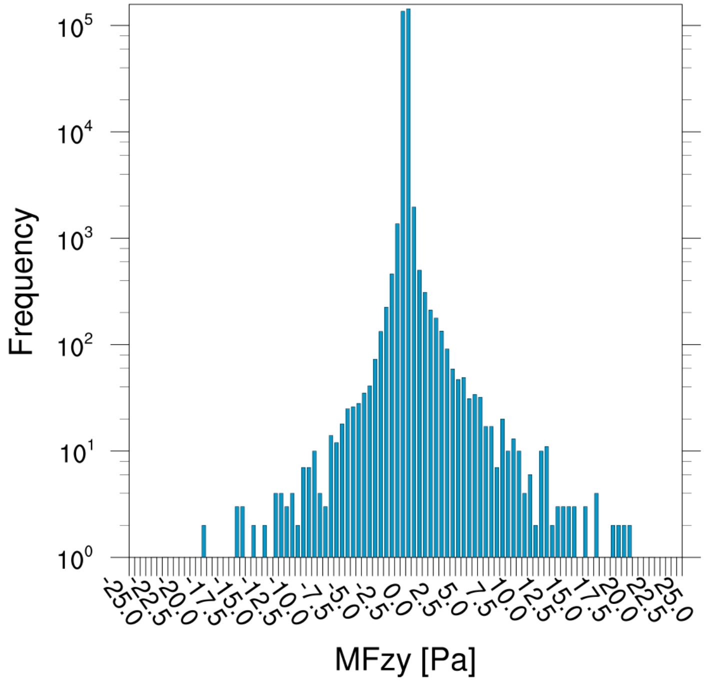
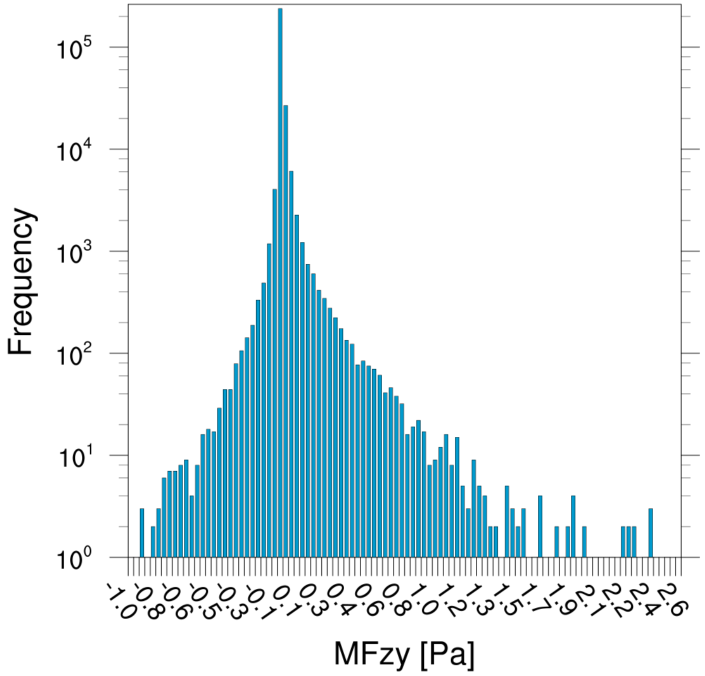
Antarctic Peninsula, MFzy

3 km



20 km



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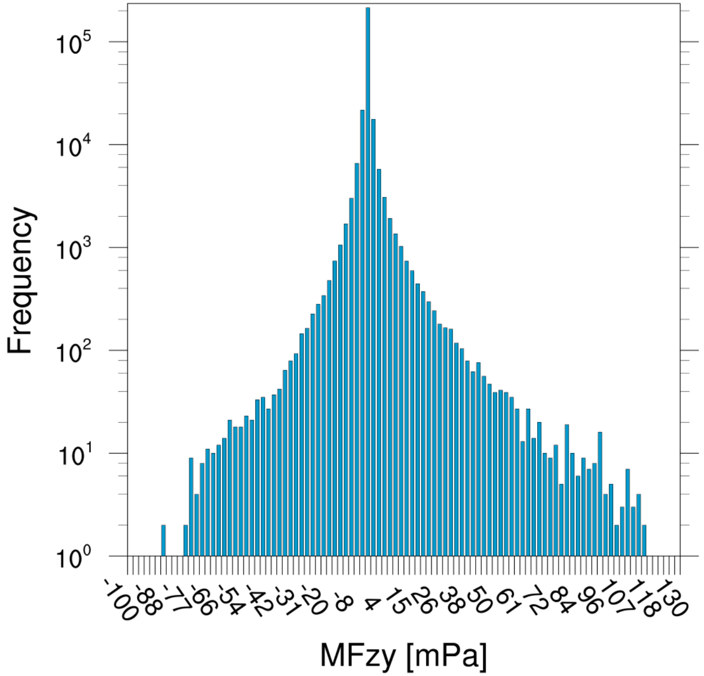

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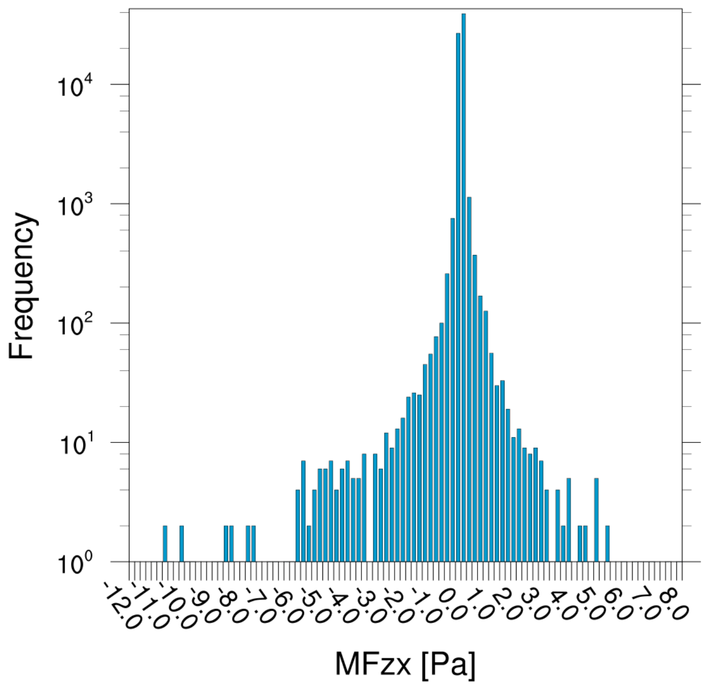
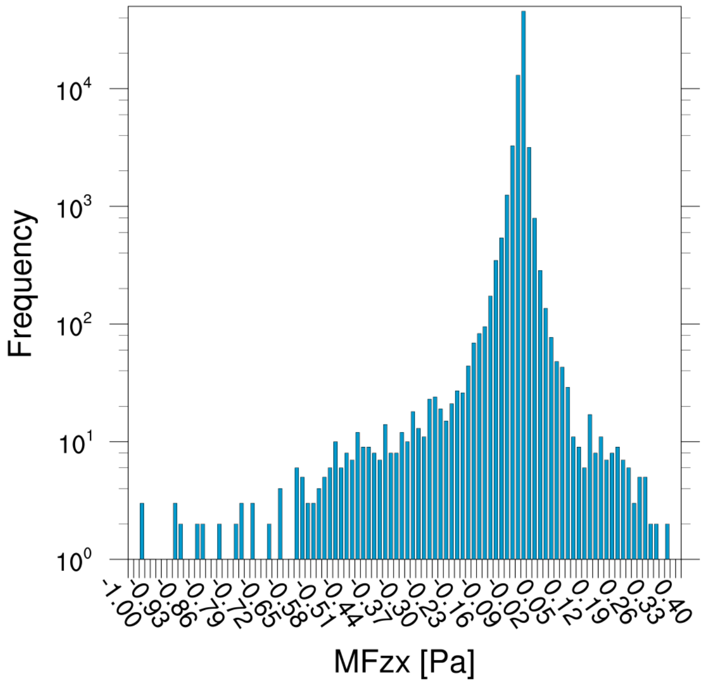
South Georgia, MFzx

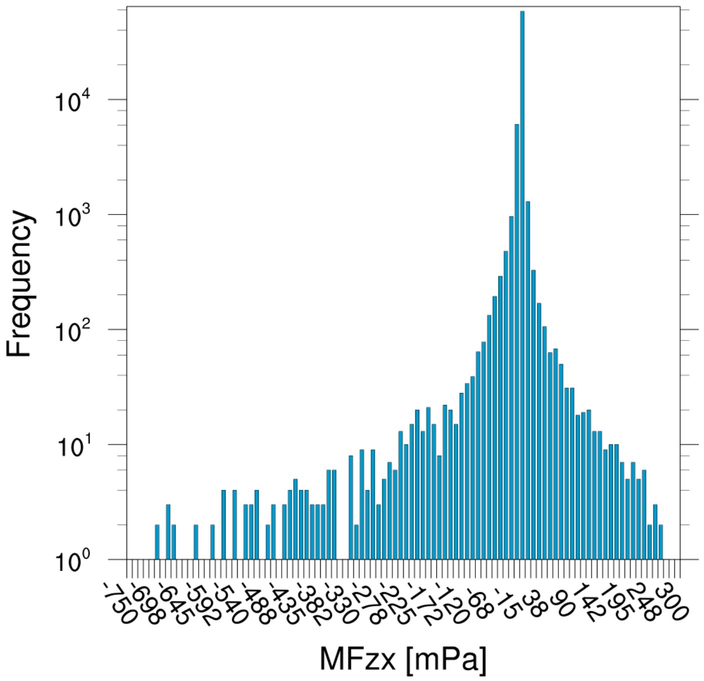
3 km



20 km



40 km



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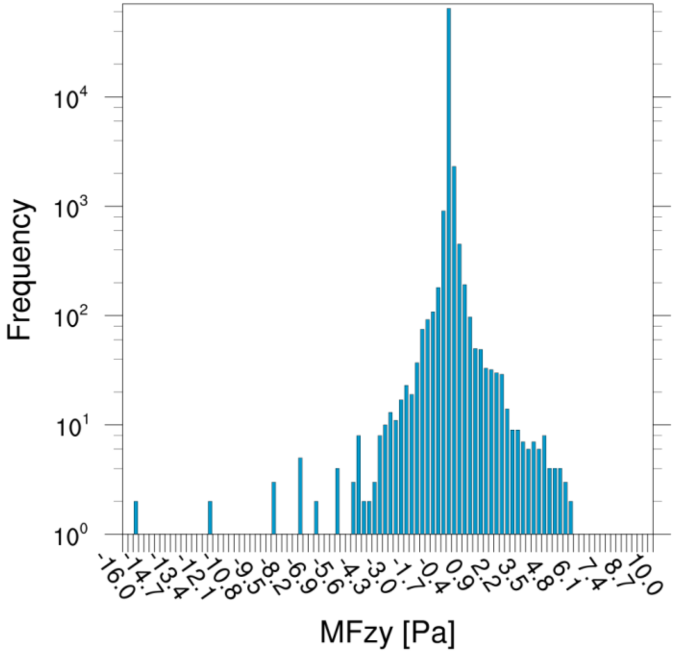
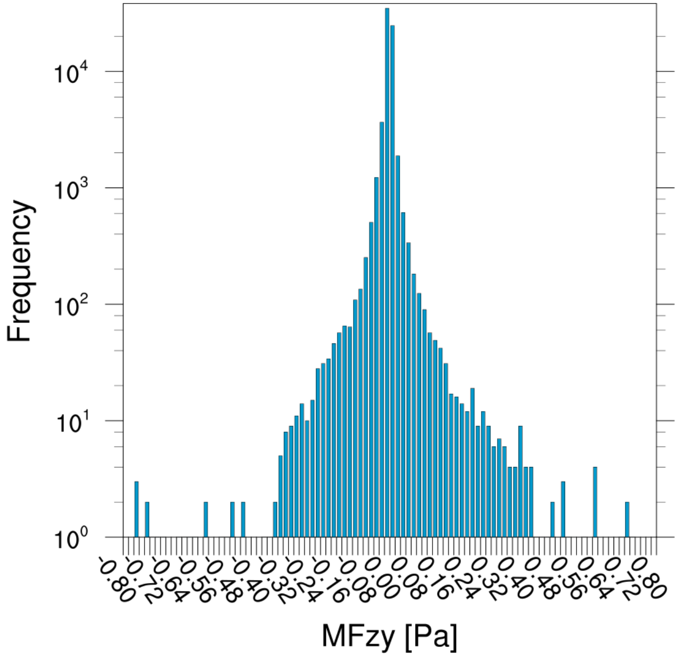
South Georgia, MFzy

3 km



20 km



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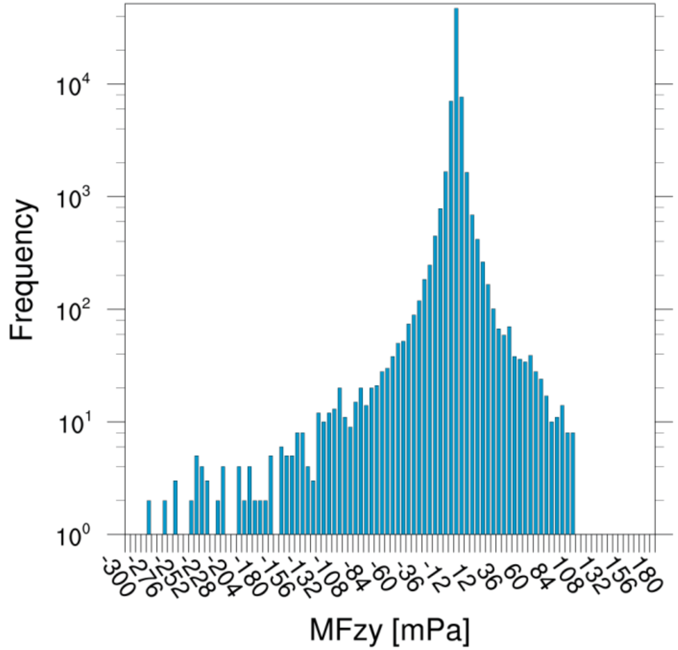

Future plans and conclusions

- We plan to study the sensitivity also to other GW-background separation methods (statistical and analytical) and to approximations used for MWD calculations (e.g. uniform density for all grids inside a hotspot).
- Study the wave-mean flow interaction with respect to the intermittency of the GWs.
- There is a lot of information behind spatial averages in the hotspot regions. Deviations from the Gaussian distribution suggest that arithmetic average may be biased.

Acknowledgements

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