

What's happening before and around the SSW onset?
The stations in the NH show an enhanced eastward GW forcing. The meridional wind fluctuates with a periodicity of about 10 days.

Is inter-hemispheric coupling real?
The measurements in the SH are consistent with the inter-hemispheric coupling hypothesis. The expected downward shift of GW drag [2] was reproduced by a downward travelling layer of enhanced GW activity.

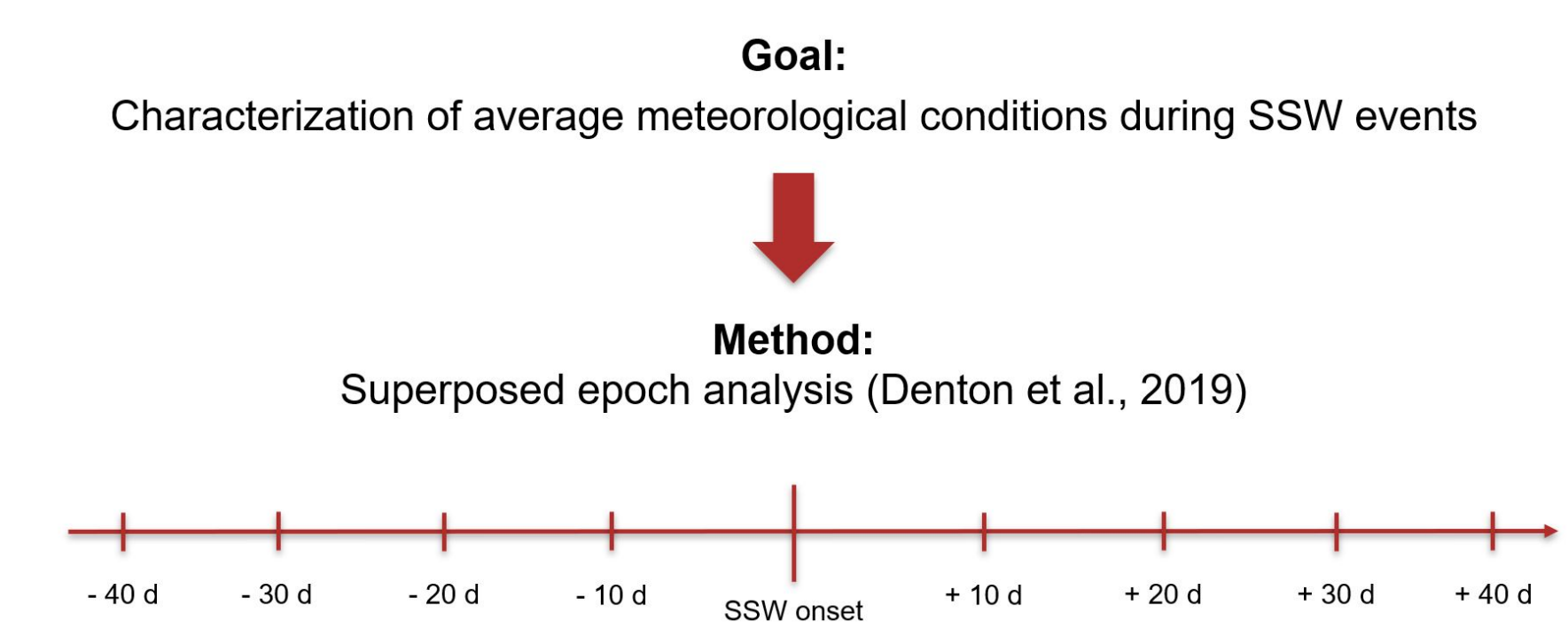
Superposed epoch analysis of coupling mechanisms captured by meteor radars during sudden stratospheric warmings

Benedikt Gast¹, A. Kuchar¹, G. Stober², Ch. Jacobi¹, D. Pokhotelov³, H. Liu⁴ and others*

¹Leipzig Institute for Meteorology, Faculty of Physics and Earth Sciences, University of Leipzig, Germany; ²Institute of Applied Physics & Oeschger Center for Climate Change Research, Microwave Physics, University of Bern, Switzerland ³Institute for Solar-Terrestrial Physics, German Aerospace Center (DLR), Neustrelitz, Germany ⁴Department of Earth and Planetary Science, Kyushu University, Japan

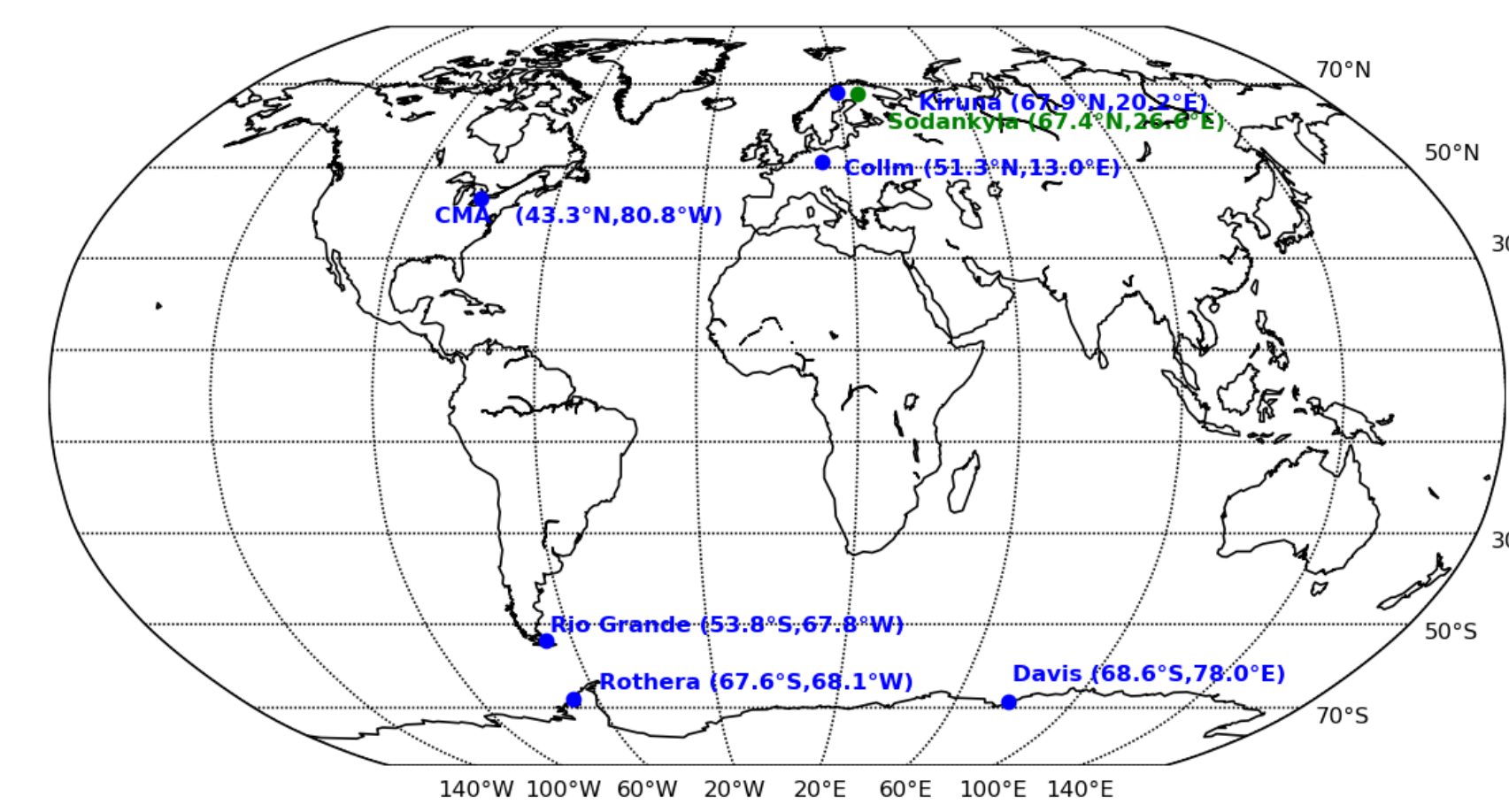
Methods

- Adaptive spectral filtering [3]
- Superposed epoch analysis [1]



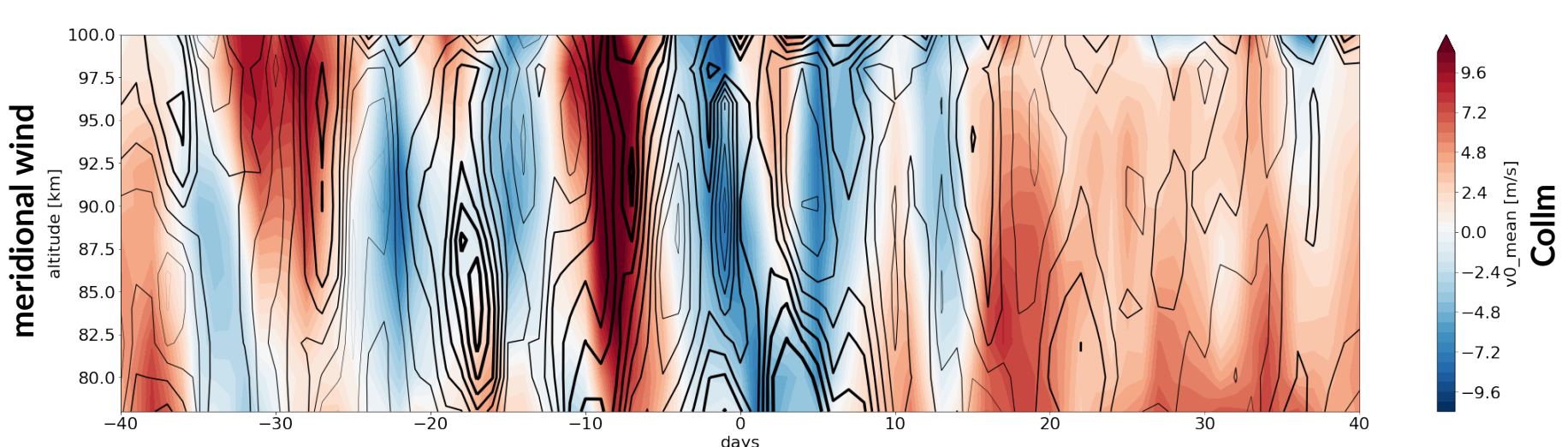
Data

Meteor radar measurements for seven stations are used in this project.



- NH: Kiruna (Esrange), Sodankylä, Collm Observatory and the CMOR meteor radar at London, Ontario (CMA)
- SH: Rio Grande, Davis and Rothera

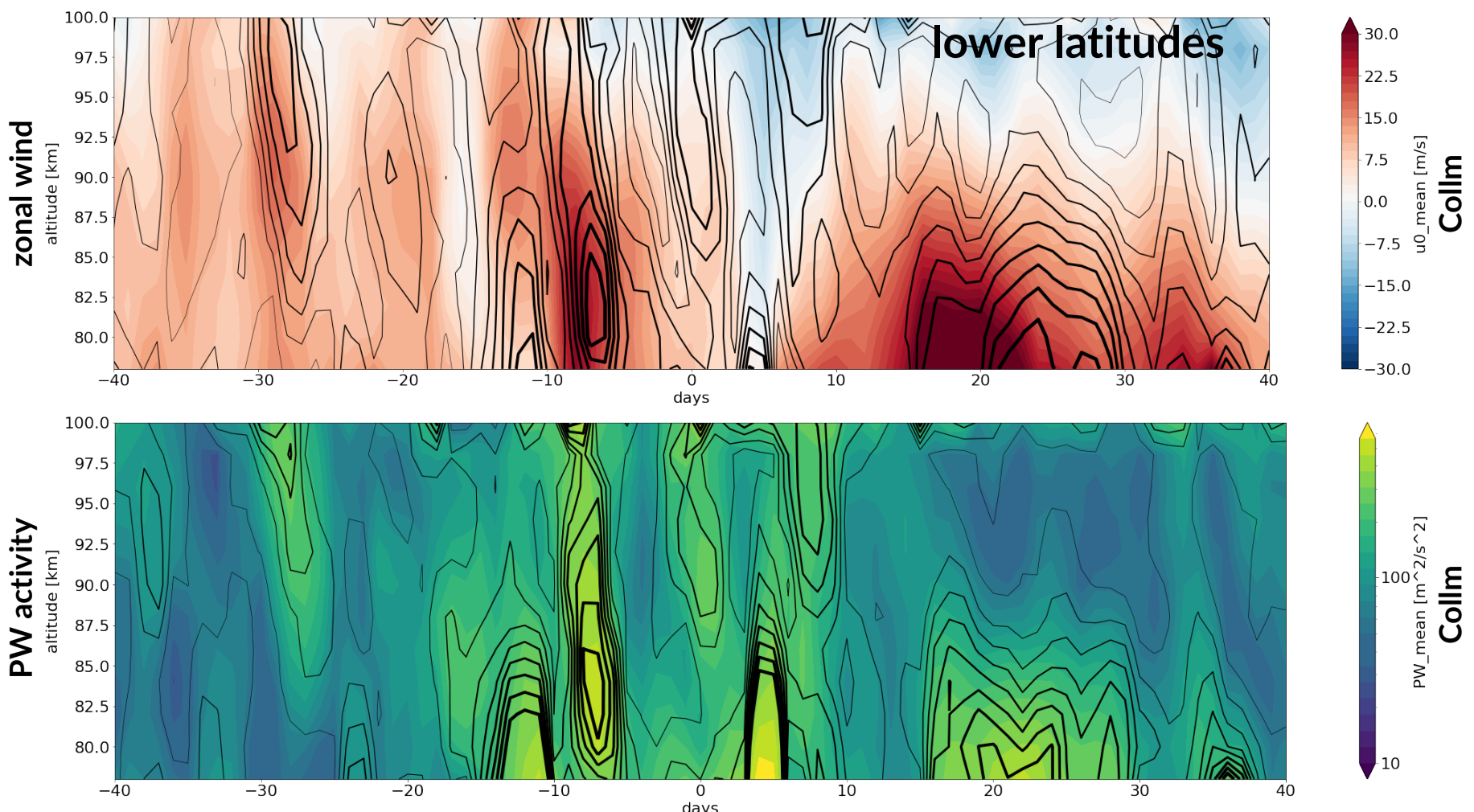
Northern hemisphere (NH) Meridional wind



Fluctuating between positive and negative values, the meridional wind shows a periodicity of around 10 days. The strongest meridional wind speeds are found around 10 days before the SSW onset (northern) and around the SSW onset (southern direction). From about 2 weeks after the onset, the wind becomes mainly northerly.

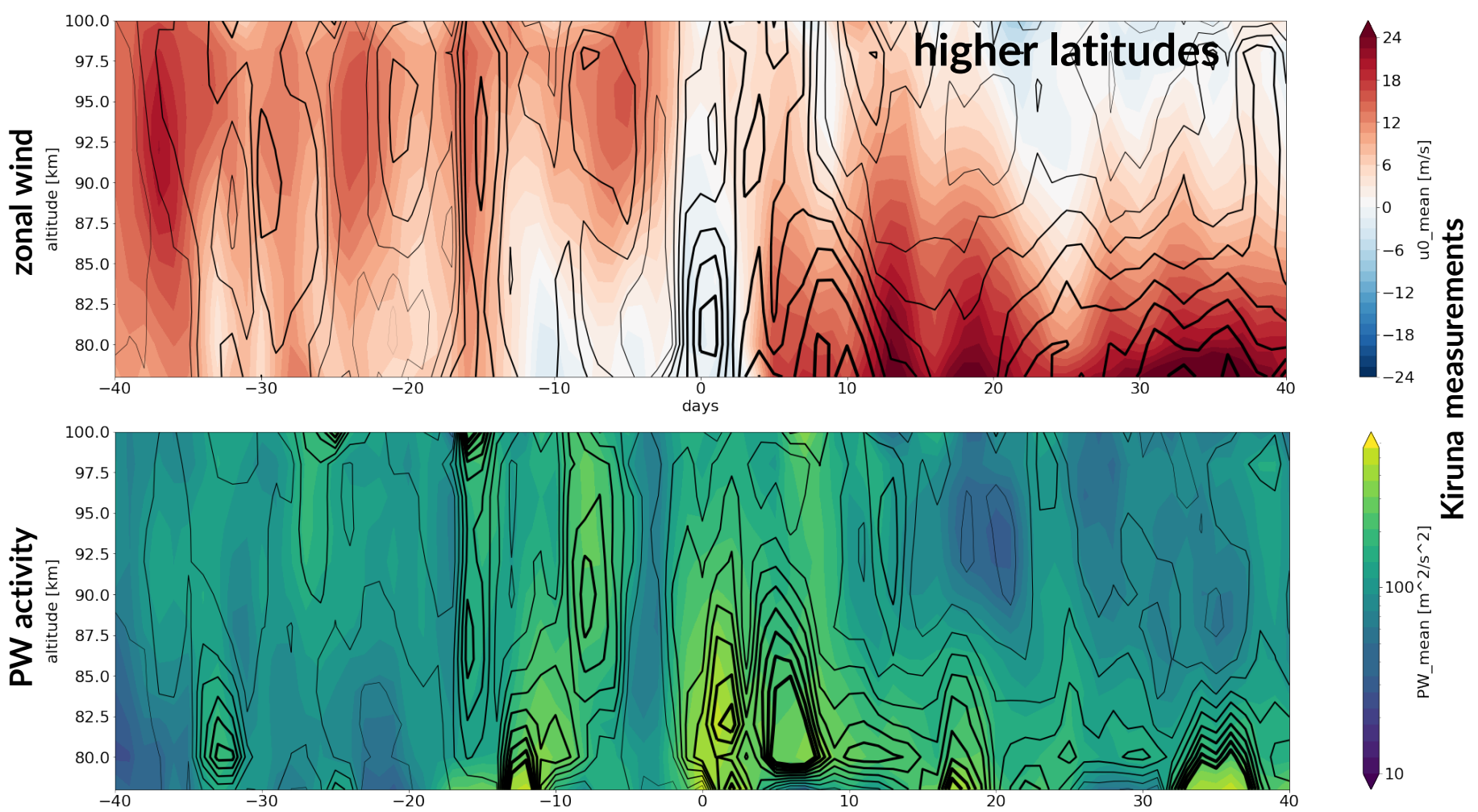
Latitudinal differences in zonal wind

In the NH the zonal wind is decreasing from around two weeks before the SSW onset and onward. This corresponds to an increased planetary wave (PW) activity below and up to 80 km altitude at the same time.



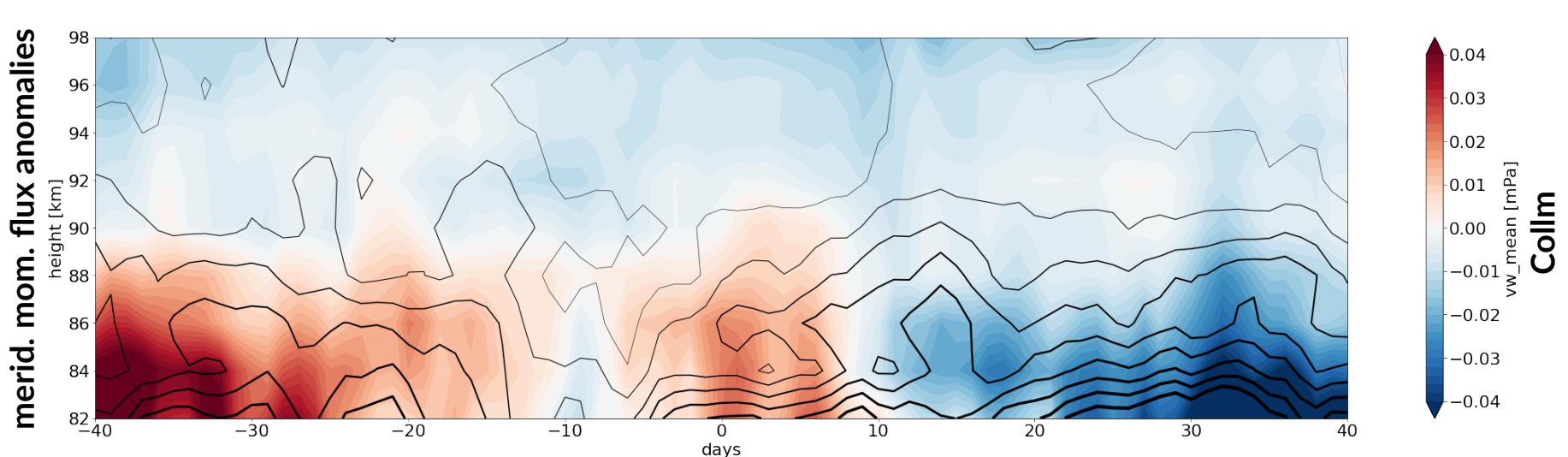
At Collm this decrease is followed by a strong increase in zonal wind and PW activity around one week before the onset of the SSWs.

The stations at lower latitudes show a maximum of the zonal wind reverse around 3-5 days after the SSW onset.



At higher latitudes, the strongest zonal wind reverse is already apparent a few days earlier. Accordingly, the PW activity is enhanced earlier for Kiruna and later for Collm. This leads to the assumption that latitudinal differences are apparent in the PW activity as well.

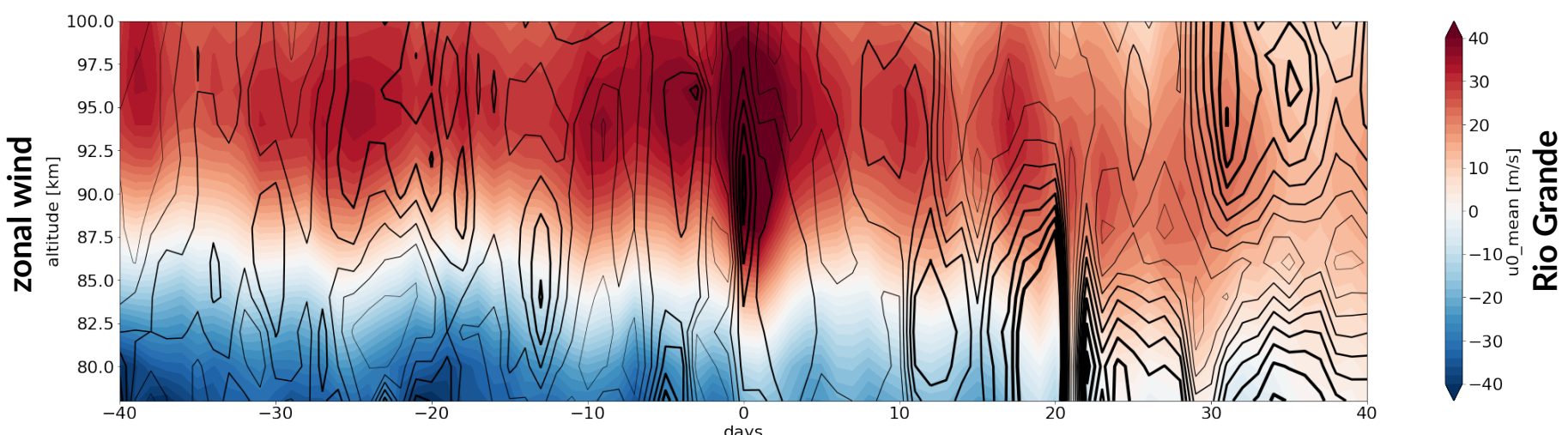
Momentum fluxes



The meridional momentum flux shows positive anomalies before the SSW onset. At Collm, this is broken by negative anomalies around 10 days before the onset.

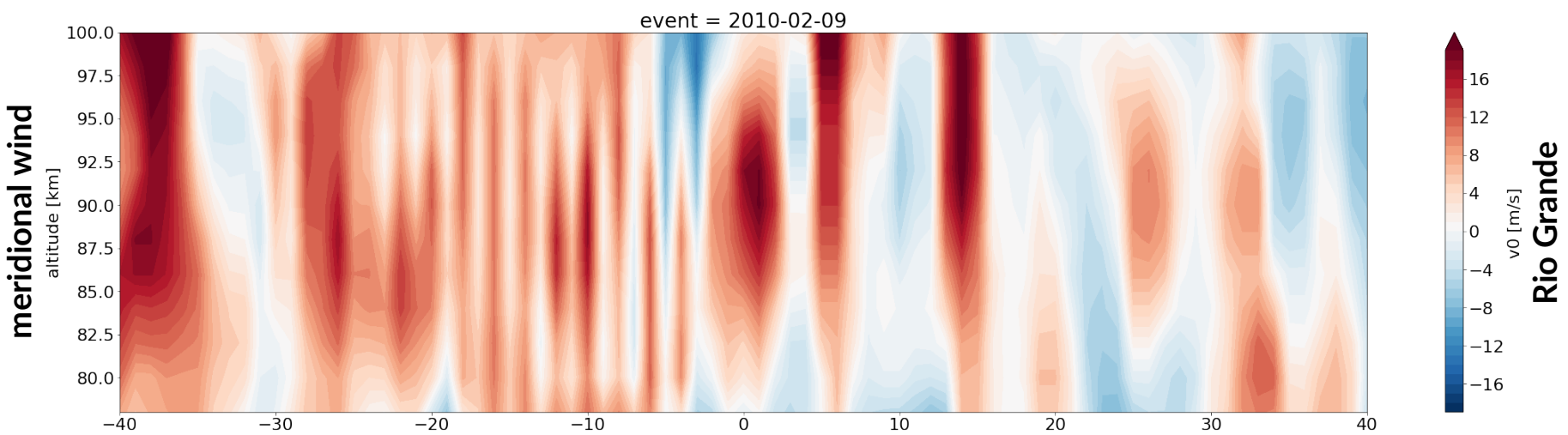
Southern Hemisphere (SH) Zonal wind

In the SH the zonal winds tend to decrease in magnitude after the SSW onset. Thus, the easterlies in around 80 km altitude weaken, which was also expected by the theory of inter-hemispheric coupling.



The meridional wind component shows multi-day fluctuations. These may indicate a quasi-multiday wave propagation.

The climatologies for all events show a reversal of the meridional wind to southward direction around 10 days after the SSW onset. This agrees with the inter-hemispheric coupling theory, which also expected such negative anomalies in the meridional wind component.



Outlook

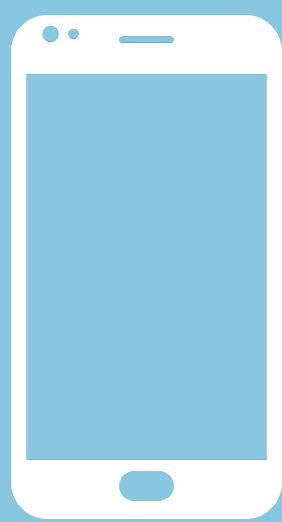
Whether the zonal wind increase at Collm Observatory triggers the planetary wave activity or vice-versa needs further investigation. To identify a possible periodicity of the meridional wind fluctuations in the SH, a wavelet analysis needs to be accomplished.

Acknowledgments

* Thanks to the other co-authors, who supported the study and provided meteor-radar datasets: K. Baumgarten, E. Belova, P. Brown, D. Janches, J. Kero, A. Kozlovsky, M. Lester, H.-L. Liu, N. Mitchell, T. Motffat-Griffin and D. Murphy. This study acknowledges support from Deutsche Forschungsgemeinschaft under grant JA836/43-1.

References

- [1] M.H. Denton, R. Kivi, T. Ulich, C.J. Rodger, M.A. Cillivert, J.S. Denton, and M. Lester. Observed response of stratospheric and mesospheric composition to sudden stratospheric warmings. *Journal of Atmospheric and Solar-Terrestrial Physics*, 191:105054, 2019.
- [2] Heiner Könnich and Erich Becker. A simple model for the interhemispheric coupling of the middle atmosphere circulation. *Advances in Space Research*, 45(5):661 – 668, 2010.
- [3] Gunter Stober, Kathrin Baumgarten, John P McCormack, Peter Brown, and Jerry Czamecki. Comparative study between ground-based observations and naigem-ha reanalysis data in the mid region. *Atmospheric chemistry and physics Discussions*, 2019.



Scan QR code for further information on our project



UNIVERSITÄT
LEIPZIG

