Cyclone and mesocyclone tracking in the Antarctic region and southern polar ocean

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An approach of tracking synoptic-scale and mesocyclone activity in the Antarctic region and southern polar ocean has been undertaken by using the TRACK algorithm of Hodges (1994) and ERA-Interim reanalysis (Simmons et al. 2007).

In a first step, we have determined the seasonal synoptic-scale cyclone activity over 10 years, using the ERA-Interim data (Figure 1). Therefore, we have calculated the relative vorticity field from the 850 hPa wind field on a T159 Gaussian grid. A band pass filter was set to wavenumbers n with 5 < n < 15 which corresponds to a spatial resolution of 1300 to 4000 km for 60°S (the main latitude of synoptic-scale cyclone activity in the southern hemisphere). In addition, with focus on the synoptic scale, we truncated the band pass filtered data to a T42 Gaussian grid. To exclude short lived systems, we have assumed a minimum lifetime of 48 hours for each system. The vorticity anomaly threshold was set to 1.0×10^{-5} s^{-1}. The regional upper bound displacement was set to 6.0 degrees for latitudes higher than 20°S.

As in many studies before (e.g. Simmonds et al. 2003, Uotila et al. 2009), the main synoptic cyclone activity is found in the southern Indian Ocean, between and south of the tip of South Africa and New Zealand. In the summer and autumn month the activity is well pronounced in this region, whereas the winter season show less activity, particularly around the Antarctic Peninsula and Weddell Sea region. Furthermore, in summer a region of higher activity is also apparent in the Bellingshausen Sea.

For the tracking of mesoscale cyclones we use wavenumbers n with 30 < n < 100 which corresponds to a spatial resolution of 200 to 670 km for 60°S. For detecting mesoscale features we work on a T159 Gaussian grid and assume a minimum lifetime of 24 hours. The systems have to be first sighted south of 50°S. The vorticity anomaly is set to 2.0×10^{-5} s^{-1}. The regional upper bound displacement is set to 2.5 degrees. For the mesoscale, we need a post processing filtering which excludes other mesoscale phenomena. We only regard mesocyclones with surface wind speeds higher than 15 m/s once (preliminary results for the year 1991 in Figure 2). We have to exclude stationary confluence zones, forced through orographic structures and we try to identify frontal zones from synoptic scale cyclones, which are often indentified as autonomous mesoscale cyclones. For this reason we now are carrying out sensivity studies using the thermal front parameter with different thresholds.

We also apply these options to higher spatial and temporal resolution analyses. We use global GME analyses from the German Weather Service for a time period of 3 years (June 2007 to May 2010) with a spatial resolution of 0.5 degrees and 3 hourly temporal resolution (instead of 0.75 degrees and 6 hourly of ERA-Interim reanalysis). We want to investigate if there are significant changes on the synoptic and meso-scale.

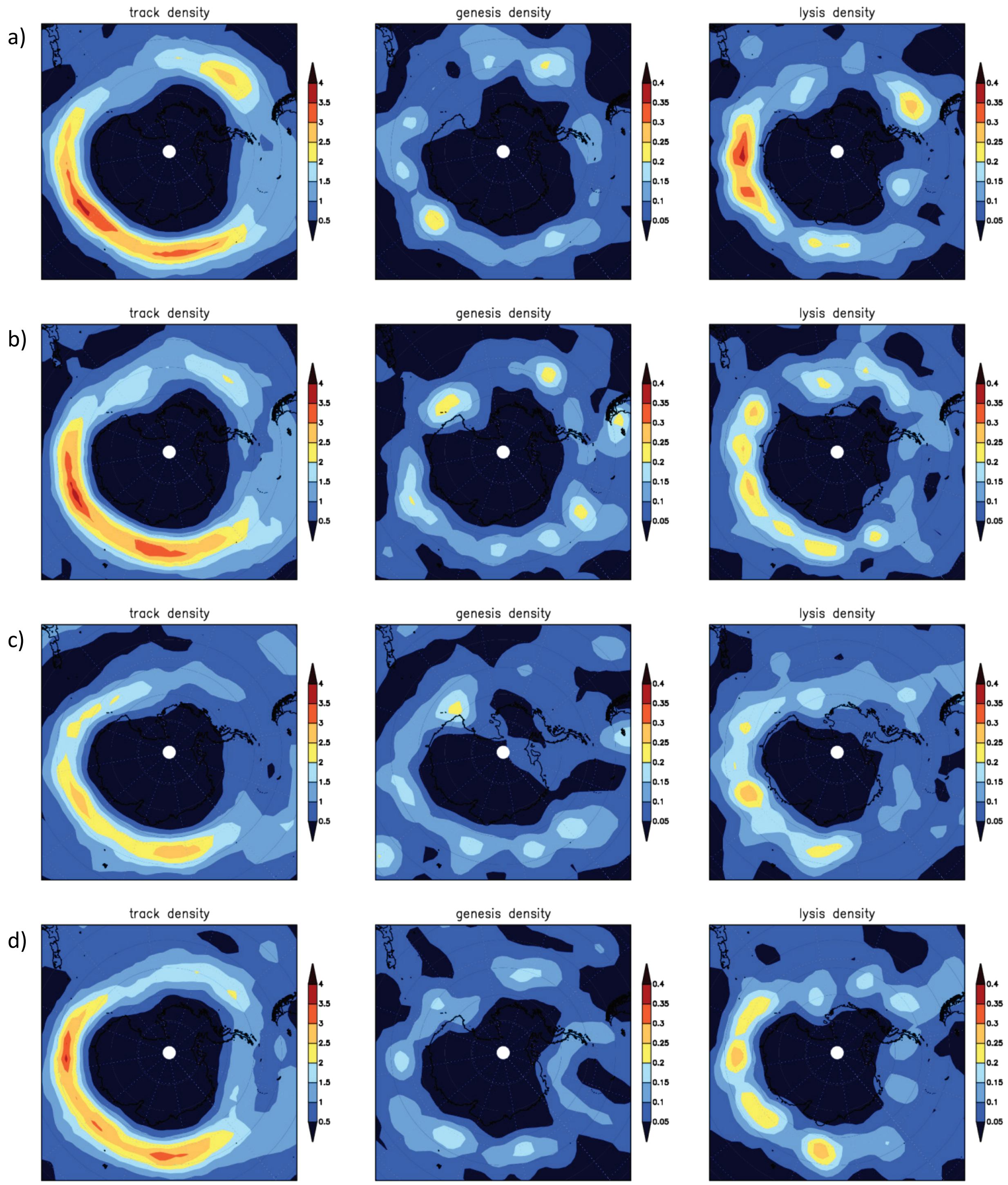

Figure 1: Seasonal a) DJF (summer), b) MAM (autumn), c) JJA (winter), d) SON (spring) synoptic-scale cyclone activity for 10 years (Dec 2001 – Nov 2011) calculated from the 850 hPa vorticity field (ERA-Interim reanalysis data). Numbers are synoptic-scale cyclones per 10000 km² (valid for latitude 60°S).

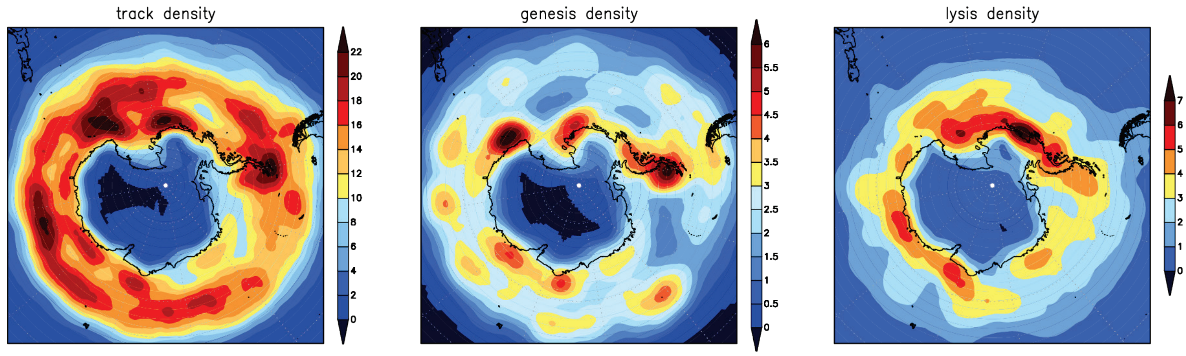

Figure 2: Mesocyclone statistic for the year 1991 after applying different filter options. Numbers are mesoscale cyclones per 10000 km² (valid for latitude 60°S).

References

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