

Supplementary material

Atmospheric blocking types: Frequencies and transitions

December 23, 2020

In the following, we show additional results of the identification of atmospheric blocks. We summarize the freva configuration and the output as explained in the article in section 3, Step 1. Further, we give an example of the trapezoid method for the identification of High-over-Lows and Omega blocks as discussed in section 3 Steps 2 and 3.

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1 Configurations of the Freva Blocking tool

Tool configuration of Blocking Plugin Richling et al. (2015)		
climyear_range	1990, 2019	range of years of long-term time period for calculation of CRBL and/or threshold criterion for geopotential height. Use only if "GEOPcrit_calc" and/or "CRBL_calc" are/is set "True"
year_range	1990, 2019	range of years to be processed
CRBL_const	False	Option to set CRBL (Central Reference Blocking Latitude - latitudinal location of mean zonal flow which may be blocked) to a constant latitude location (for all seasons and longitudes).
CRBL_calc	True	Option to calculate seasonal (for every calendar day) and longitudinal varying CRBL. Use only if "CRBL_const" is set "False"!
CRBL_file	None	Option to input a file of seasonal (for every calendar day) and longitudinal varying CRBL. Use only if "CRBL_const" and "CRBL_calc" are set "False"!
GHGN_crit	-10	Criterion of GHGN (geopotential height gradient north (SH: south) of blocking high [in gpm/deg_north])
GHGS_crit	0.0	Criterion of GHGS (geopotential height gradient south (SH: north) of blocking high [in gpm/deg_north])
GEOPcrit_calc	True	Option to calculate threshold criterion for geopotential height (long-term mean) at each grid point for every calendar day.
GEOPcrit_file	None	Option to input file of threshold criterion for geopotential height. Use only if "GEOPcrit_calc" is set "False".
daymean	False	Option to calculate daily mean of geopotential height before calculating IBL.
hemisphere	NH	northern hemisphere
grid	r144x72	Specify a regular lon-lat grid (gridfile or grid description)
delta	10.0	Possible latitudinal northward and southward shifting of CRBL [in deg_lat]
level	50000	level [in Pa]
ntask	6	Number of tasks
Data specifics		(this is specific to the freva server and how it stores the data)
institute	ncep-ncar	
ensemble	r1i1p1	
experiment	ncep2	
product	reanalysis	
project	schieli	
model	cdas	
time_frequency	6hr	
Number of freva run	25002	

2 Freva Output Figures

Freva generates output figures which are displayed in the following subsections. A description is added to the caption of the figures.

2.1 Central Reference Blocking Latitude (CRBL) for NCEP-DOE Reanalysis 2 data (1990-2019)

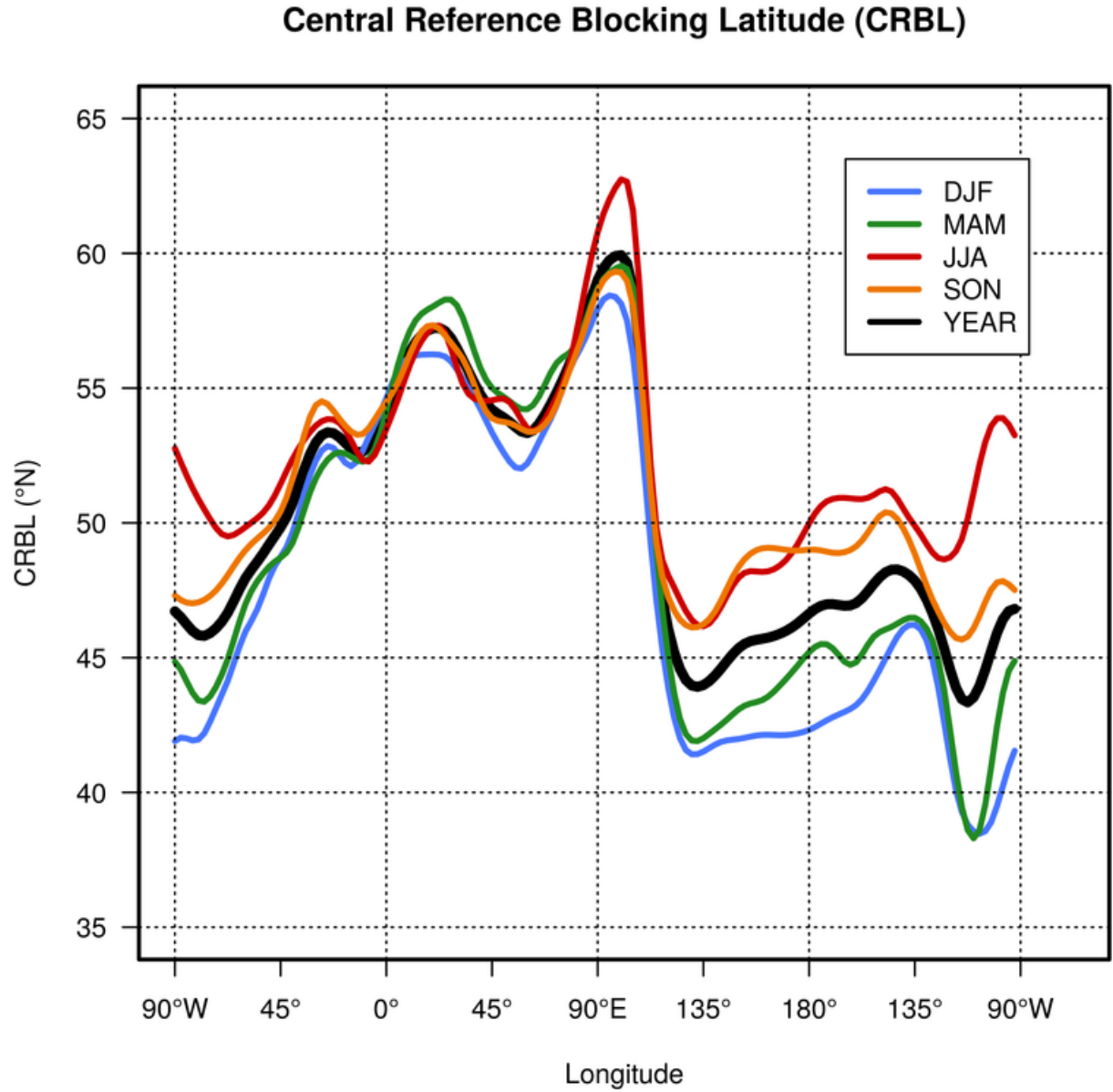


Figure 1: The yearly Central Reference Blocking Latitude (CRBL) frequency for every longitude seasonal averaged is shown.

2.2 Daily Central Reference Blocking Latitude (CRBL) in a Hovmöller diagram

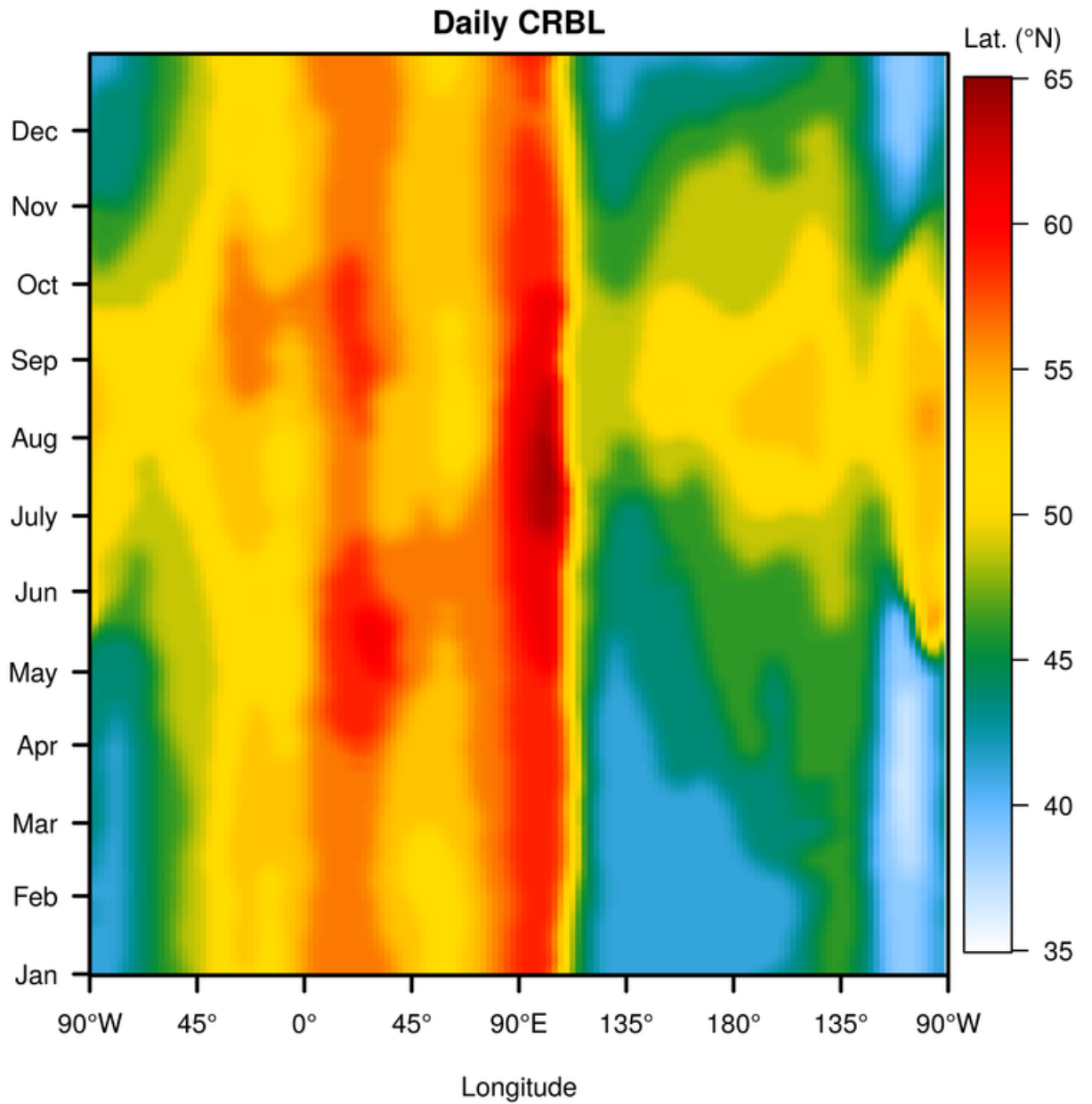


Figure 2: Central Reference Blocking Latitude (CRBL) for every longitude and each calendar day of the year represented in a Hovmöller diagram.

2.3 Instantaneous Blocked Longitude for NCEP-DOE Reanalysis 2 data (1990-2019) split to months

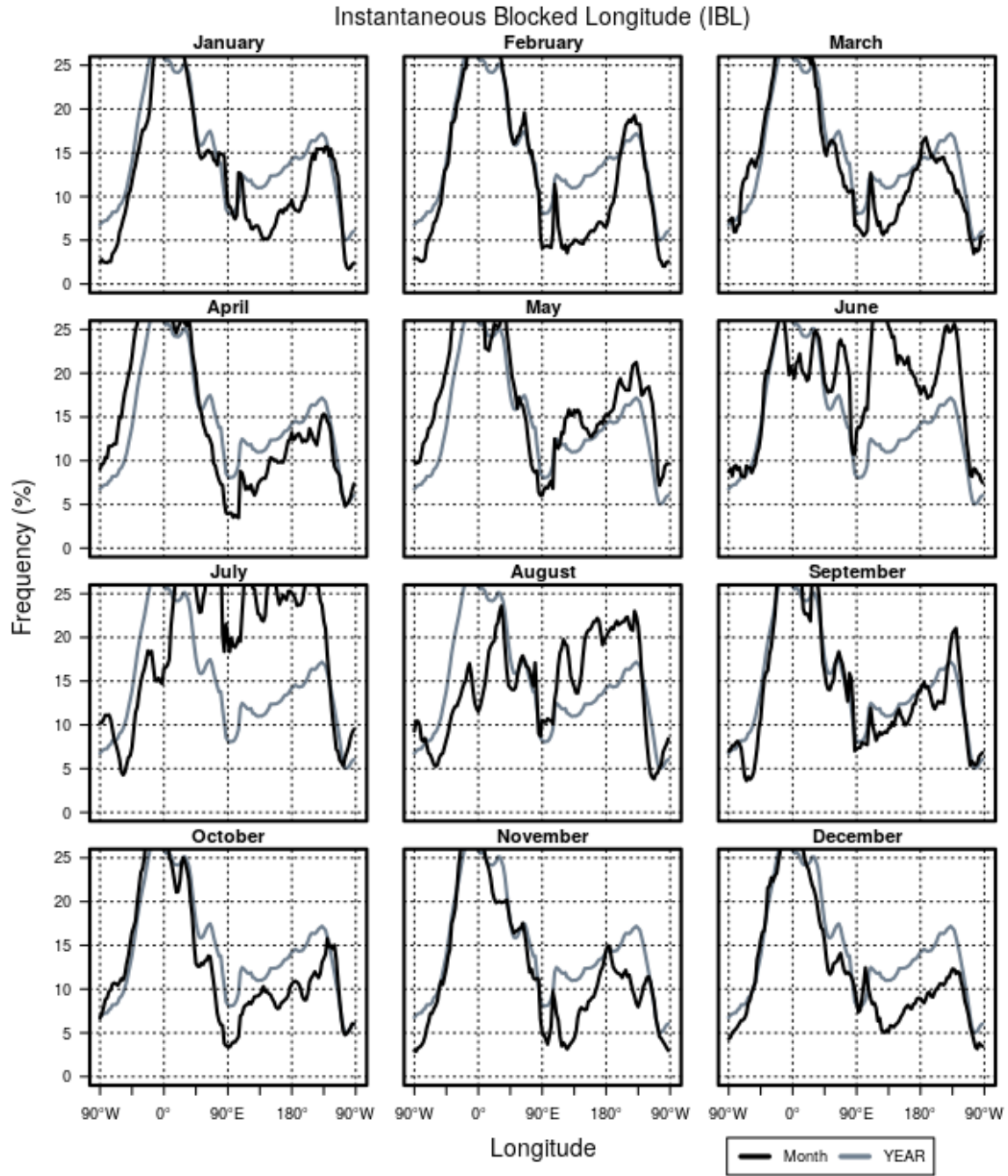


Figure 3: The yearly Instantaneous Blocked Longitude (IBL) frequency for every longitude and monthly averaged is shown.

2.4 Instantaneous Blocked Longitude (IBL) split to seasons

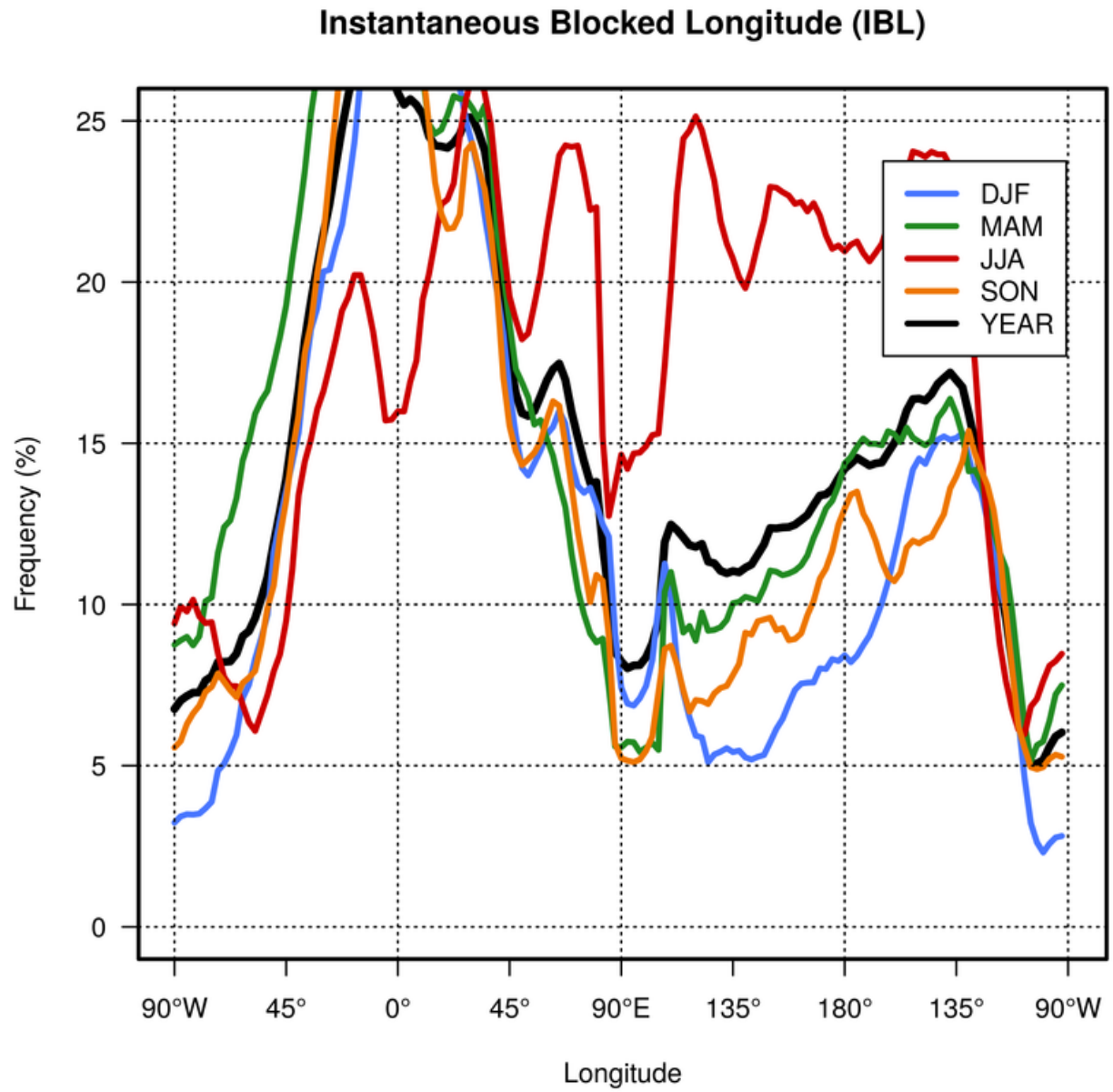


Figure 4: The yearly Instantaneous Blocked Longitude (IBL) frequency for every longitude seasonal averaged is shown.

2.5 Daily Instantaneous Blocked Longitude (IBL) Frequency (Hovmöller diagram)

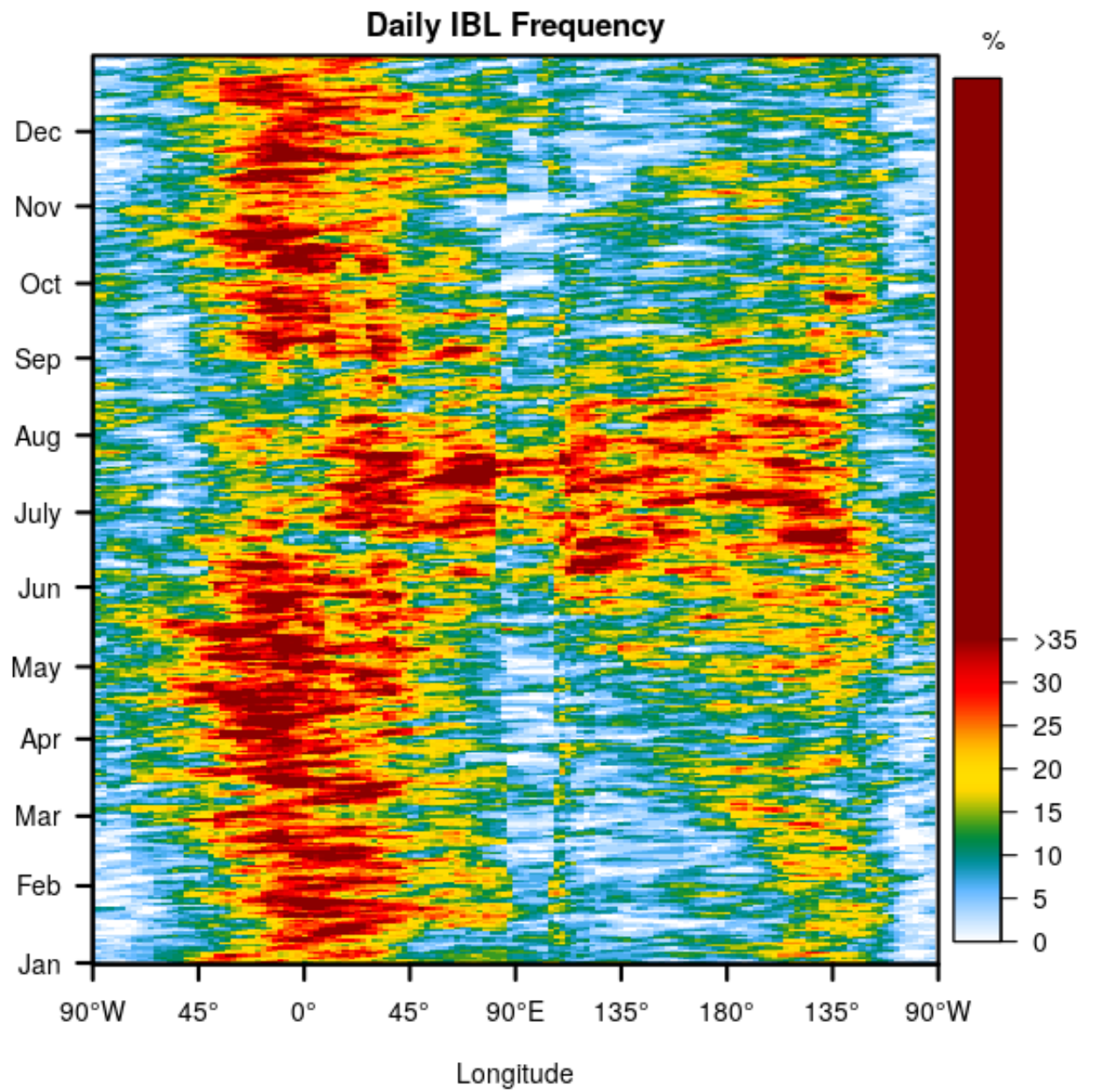


Figure 5: The yearly Instantaneous Blocked Longitude (IBL) frequency for every longitude and each calendar day of the year is represented in a Hovmöller diagram.

3 Movie to a blocking event example broadcasting the methods (Step 2 and 3) described in the paper

The file is called *Blocking_example.mp4* and is an extra file. If you happen to have Adobe Reader, you can directly start the movie in the pdf-Version of this document by clicking on the panels below the figure.

Displayed is an example blocking event, observed between 23 June 2019 6 UTC and 29 June 2019 6 UTC (time interval of 6 hours), that include a transition between *Omega* and *High-over-Low* blocking states. Shaded areas represent the identified vortex field ($W_k > 1$, see also Schielicke et al. 2016) which is colored by vorticity (in $10^{-5}s^{-1}$; blue: anticyclonic; yellow cyclonic). Black contours are isolines of geopotential height in 80 gpm intervals (thick black contour is the 5840 gpm isoline). The outline of the trapezoid/box is given for each time step, solid shape represent the identified shape; circles (crosses) are the circulation centroids of the identified high (red) and low(s) (blue) for the *Omega* (*High-over-Low*) pattern. The red bar(s) at the bottom of the figures shows the identified IBLs from Step 1. The figures for the movie were plotted with help of Matlab (2016) and coastlines were plotted with the built-in Matlab file *coast.mat*.

References

- Matlab (2016), *MATLAB version 9.0.0.341360 (R2016a)*, The MathWorks Inc., Natick, Massachusetts.
- Richling, A., Kadow, C., Illing, S. & Kunst, O. (2015), ‘Freie Universität Berlin evaluation system (Freva) - blocking’, <https://freva.met.fu-berlin.de/about/blocking/>. (Documentation of the Blocking Plugin), Accessed: 2020-09-10.
- Schielicke, L., N  vir, P. & Ulbrich, U. (2016), ‘Kinematic vorticity number – a tool for estimating vortex sizes and circulations’, *Tellus A* **68**.
URL: <http://www.tellusa.net/index.php/tellusa/article/view/29464/44875>