Blocking Detection based on Synoptic Filters

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ABSTRACT

To eliminate blocking-like patterns of small size and short duration and to remove cut-off lows, the Tibaldi-Molteni blocking index is supplemented by three filter criteria (intensity, spatial extent and temporal duration):

- **Quantile filter** requires a minimum geopotential height anomaly to reject cut-off lows
- **Extent filter** extracts scales above a minimum zonal width
- **Persistence filter** extracts events of a minimum duration

METHODOLOGY: Blocking detection with a modified Tibaldi-Molteni index

Tibali-Molteni index:

$$GHGS > 0 \qquad GHGN = \frac{Z(\phi_N) - Z(\phi_0)}{\phi_N - \phi_0}$$

$$GHGN < -10\frac{m}{^\circ lat} \qquad GHGS = \frac{Z(\phi_0) - Z(\phi_S)}{\phi_0 - \phi_S}$$

GHG = Geopotential Height (Z = 500hPa) Gradients

Modification:

$$\phi_N = 78.75^\circ + \Delta' \quad \phi_0 = 60^\circ + \Delta \quad \phi_S = 41.25^\circ + \Delta''$$

$$\Delta, \Delta', \Delta'' = [-3.75^\circ, \ldots, 3.75^\circ]$$

- Varying delta-intervals retaining all cases of original method
- All latitudes from each region can be combined with any other from corresponding other region
- Additional possibilities to satisfy modified blocking criteria resulting in ~5% higher frequencies
- No significant changes in spatial distribution

Filters:

Quantile(intensity) $Z(\lambda, \phi_0) - Z_Q(\lambda, \phi_0) > 0$

For Q=0.5 quantile only regions with geopotential height > zonal median are eligible for blocking

Extent(space) Only blocked regions of minimal width are permitted
Smaller regions are eliminated

Persistence(time) Regions have to stay blocked for a certain number of timesteps or days to be considered as a blocking event
Blocked regions can move
At least one blocked longitude in preceding timestep has to remain blocked

Data: ERA-40 (1958-2001, T106, 6-hourly) by ECMWF.

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Tibali, S., D'Andrea, F.,Tosi, E. and Roeckner, E. 1997: Climatology of northern hemisphere blocking in the ECHAM model, *Climate Dynamics*, **13**, 649-666

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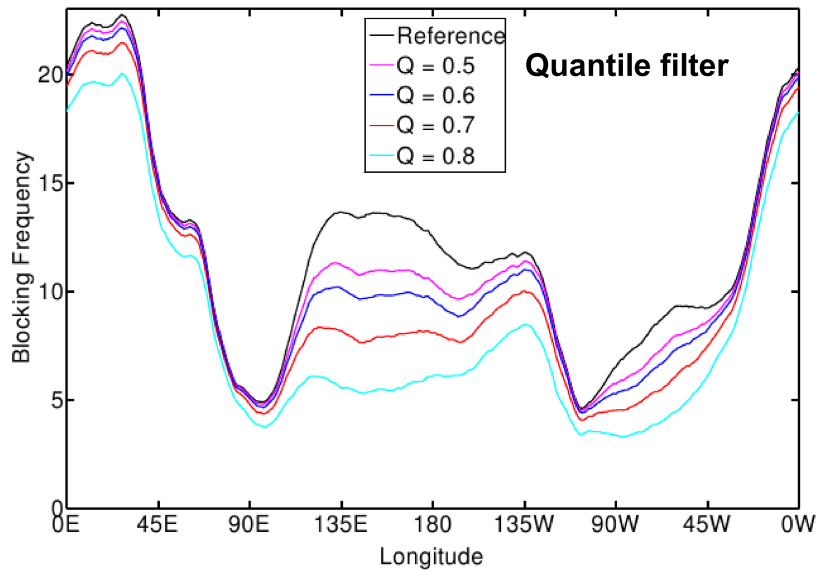
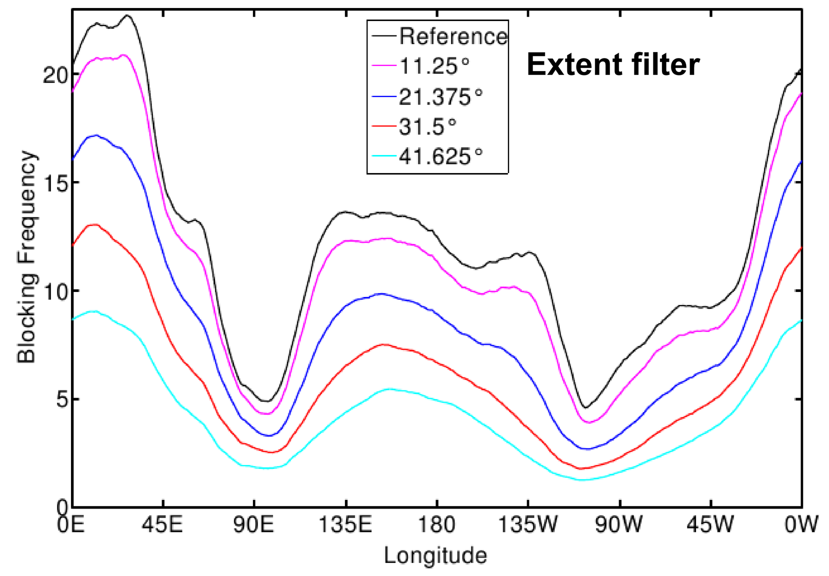
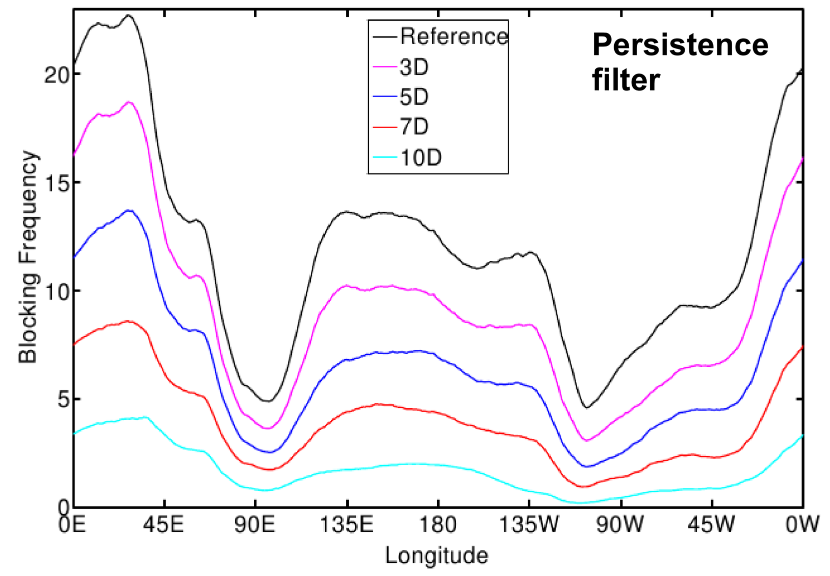
RESULTS

Impact of filters: Blocking frequencies by longitude and their reduction by filters







Quantile filter
- Strong dependence on longitude
- Small reduction except for Pacific 120E to 120W and W-Atlantic 90W to 40W
- Spatial distribution significant

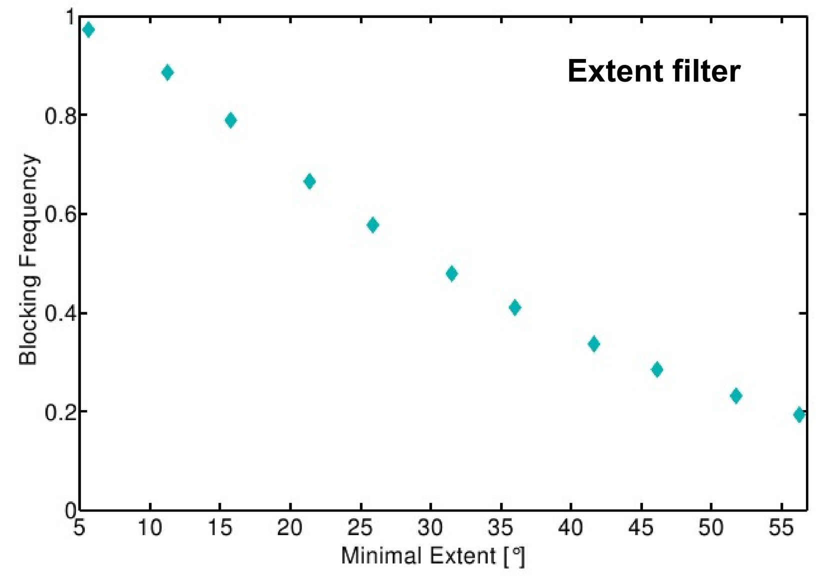
Extent filter
- Weak dependence on longitude
- Largest reduction from 140W to 100W
- Smoothing of distribution

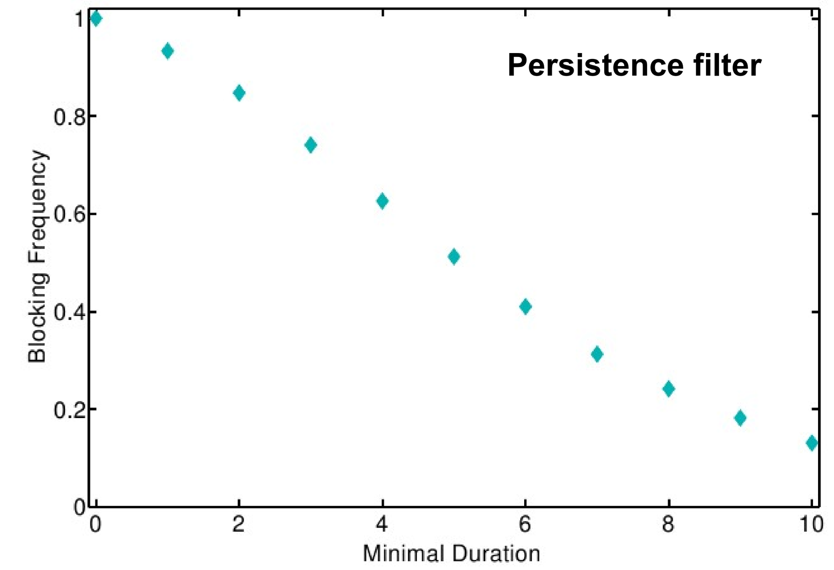
Persistence filter
- Weaker dependence on longitude
- Persistence and extent filters similar
- Smoothing not as strong

Sensitivity analysis

Longitude integrated blocking frequency (normalised by unfiltered frequency):

- Only for extent and persistence filter (weak dependence on longitude)
- Threshold value sensitivities show similar results for both filters





Case study: February 1990

Blocking over E-Europe/W-Russia
Cut-off low in Pacific

Hovmoeller diagrams with
- blocked regions (blue)
- blocked regions without filters (cyan)
- position of highest GHGS (red)

Result for all filters:
Elimination of Pacific cut-off
Presevation of blocking event