Forecast variability of the blocking system over Russia in summer 2010 and its impact on surface conditions

Lisa-Ann Quandt (IMK-TRO, Karlsruhe Institute of Technology)
Summer 2010

**Russian Heat Wave:**
- temperatures over 40°C
- economic losses: $15 billion
- 56,000 fatalities
- Linked with Pakistan Floods in July (1/5 of the country flooded)

**Literature:**
- Barriopedro et al. (2011)
- Dole et al. (2011)
- Grumm (2011)
- Schneidereit et al. (2012)
- …
Euro-Russian blocking in summer 2010

- Forecast variability in TIGGE
- Main scenarios represented in TIGGE
- Impact of the blocking system

Combine predictability and impact
Approach

ECMWF
NCEP
UKMO

Selection of forecasts

EOF analysis & fuzzy clustering

Comparison of main development scenarios

Impact on surface variables
Quantifications

- **Blocking identification:**
  - Overturning in 500 hPa geopotential height (Tibaldi and Molteni, 1990)
  - RWB at dynamical tropopause (Pelly et al., 2003)

- **Definition of impacts:**
  - Heat intensity
    - Maximum and minimum temperatures (thresholds: e.g. tropical night)
    - HI (Steadman, 1979)
    - Humidex (Masterton and Richardson, 1979)
  - Wildfire potential:
    - LASI (Haines, 1988)

Source: [http://i.telegraph.co.uk/multimedia/archive](http://i.telegraph.co.uk/multimedia/archive)
Onset of the blocking system

500 hPa geopotential height + MSLP

+ 216 hours fcst

Potential T @ 2 PVU + 300 hPa zonal wind

With blocking

Without blocking

Analysis mean

Ann Quandt: Forecast variability of the blocking system over Russia in summer 2010 and its impact on surface conditions
Onset of the blocking system

+ 216 hours fcst

2 m temperature

HI

Humidex

With blocking

Without blocking

Analysis mean

2 m temperature

HI

Humidex
Onset of the blocking system

Averaging area:

**LASI** → 37-49°E and 51-57°N (*region of active fires*, Witte et al. 2011)

**Temperature, HI, Humidex** → 35-55°E and 50-60°N (*region of strongest heat wave intensity*, Dole et al. 2011)

With blocking

Without blocking

Analysis mean
Onset of the blocking system

*For Moscow*: 55.75°N and 37.62°E (mean of the four surrounding grid points)
Decay of the blocking system

500 hPa geopotential height + MSLP

+ 192 hours fcst

Potential T @ 2 PVU + 300 hPa zonal wind

Without blocking

With blocking

BL/P1

Analysis mean
Decay of the blocking system

+ 192 hours fcst

2 m temperature

HI

Humidex

Without blocking

With blocking

Analysis mean
Decay of the blocking system

**Averaging area:**

LASI $\rightarrow$ 37-49°E and 51-57°N (region of active fires, Witte et al. 2011)

**Temperature, HI, Humidex** $\rightarrow$ 35-55°E and 50-60°N (region of strongest heat wave intensity, Dole et al. 2011)

---

**With blocking**

**Without blocking**

**Analysis mean**
Decay of the blocking system

For Moscow: 55.75°N and 37.62°E (mean of the four surrounding grid points)
Summary and Outlook

- **Also investigated:** Mature Stage of the blocking system
  - Western flank variability (cf. Matsueda 2011) → influence on precipitation and heat distribution

- Representation of surface variables differs (small-scale) → dependent on forecast variability of the blocking system (large-scale)

- Heat wave identification with heat indices and LASI (temporal differences between forecast and analysis)

- Grid point vs. spatial mean forecast:
  - Spread between scenarios
  - Amplitude of fluctuations
  - Limitations in forecast quality

- **Outlook:**
  - Which processes were responsible for the forecast uncertainty?
HI, Humidex, LASI

- **HI**: Steadman 1979

\[ HI = -c_1 + (c_2 T) + (c_3 RH) - (c_4 T \cdot RH) - (c_5 T^2) - (c_6 RH^2) + (c_7 T^2 RH) + (c_8 T \cdot RH^2) - (c_9 T^2 RH^2) \]

- **Humidex**: Masterton and Richardson 1979

\[ \text{Humidex} = 9 + \frac{5}{9} \cdot (e - 10) \]

- **LASI** (lower atmosphere severity index): Haines 1988

\[ LASI = (\vartheta_{p1} - \vartheta_{p2}) + (\vartheta_{p2} - \tau_{dp2}) \]
Hovmoeller Plots

Onset  Mature Stage  Decay

→ Standard deviation of 500 hPa geopotential height
Onset: EOF

EOF 1

EOF 2

ensemble mean of 500 hPa geopotential height
Onset: Clusters
Mature Stage: EOF

EOF 1

EOF 2

+ ensemble mean of 500 hPa geopotential height
Mature Stage: Clusters
Mature Stage of the blocking system

Left: 500 hPa geopotential height + MSLP

Right: Potential T @ 2 PVU + 300 hPa zonal wind

Scenario 1

Scenario 2

Analysis mean

+ 168 hours fcst
Mature Stage of the blocking system

Left: 2 m temperature

Middle: HI

Right: Humidex

+ 168 hours fcst

Scenario 1

Scenario 3

Analysis mean
Mature Stage of the blocking system

Left and middle: TIGGE (precipitation of the last 24 hours + 500 hPa geopotential height)

Right: GPCC first guess daily analysis

Scenario 1

Scenario 2

First guess analysis
Decay: EOF

EOF 1

EOF 2

ensemble mean of 500 hPa geopotential height

Lisa-Ann Quandt: Forecast variability of the blocking system over Russia in summer 2010 and its impact on surface conditions
Decay: Clusters

Cluster 1
Cluster 2
Cluster 3
No Cluster
Analysis