



## The modern climatology of Northern Eurasia tornadoes and waterspouts

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#### **Motivation**





### Climatology of tornadoes from Snitkovsky (1987)



**Fujita Scale** 

#### • 0 • 1 • 2 • 3 🛑 4 • No data available

248 cases. Up to 10-15 tornadoes in particular years.

Snitkovsky, 1987



#### Sources for new climatology

Sources for tornado (and waterspouts) climatology:

- Scientific literature: papers and books (overviews and casestudies);
- Databases of state hydrometeo services (Soviet, Russian, Ukranian etc.), database of All-Russian Institute of hydrometeorological information.
- Station observations (45 years, 508 stations: only 28 cases);
- ESWD (European severe weather database, contains many erroneous cases for fUSSR countries).
- Scanned newspapers (from the mid. 19<sup>th</sup> century).
- Ancient Russian chronicles (word 'vikhor').
- Web overviews, web news, web forums etc.
- Social networks (eyewitnesses photo and video).
- Satellite information
- No radar data yet...



#### New database and ESWD

ESWD for fUSSR countries contains (the end of 2016): 1844 cases 215 were excluded (literature, forecast, combined etc.) 140 were reclassified (e.g. word 'hurricane') Around 90% from rest cases were revised (intensity, place, time, data quality (reliability of events), additional information etc.)

#### New database: 2524 cases

|             |      |          |                    | _ | Fujita scale |     |
|-------------|------|----------|--------------------|---|--------------|-----|
| Reliability |      | Underlyi | Underlying surface |   | undefined    | 933 |
| Very Low    | 208  | Land     | 1914               |   | FO           | 465 |
| Low         | 417  | Water    | 502                |   | F1           | 765 |
| Medium      | 1038 | W->L     | 103                |   | F2           | 300 |
| High        | 860  | L->W     | 5                  |   | F3           | 58  |
|             |      |          |                    |   | F4           | 3   |



#### Fujita rating: USA, Europe, Northern Eurasia





#### ESWD and new database

| Country      | ESWD | New Database |
|--------------|------|--------------|
| Armenia      | 3    | 3            |
| Azerbaijan   | 3    | 3            |
| Belarus      | 118  | 158          |
| Estonia      | 58   | 83           |
| Georgia      | 30   | 37           |
| Kazakhstan   | 12   | 30           |
| Kyrgyzstan   | —    | 5            |
| Latvia       | 54   | 60           |
| Lithuania    | 42   | 41           |
| Moldova      | 12   | 15           |
| Russia       | 1178 | 1730         |
| Turkmenistan | _    | 7            |
| Ukraine      | 331  | 352          |



#### **Case-studies**





Ivanovo, 1984 The most powerful tornadooutbreak in Northern Eurasia (F4)

Khanty-Mansiysk, 2012 One of the most northern tornado (61ºN)

Blagoveshchensk, 2013 One of the most powerful tornado in Far East.



Yanaul, 2014 The most powerful tornado in the 21<sup>st</sup> century (EF3).

Kurgansky et al., 2013; Chernokulsky et al., 2015; Shikhov, 2015.



#### Looking for tornado tracks from space

 Looking for candidates for being tornado track – elongated and narrow forest disturbances (Landsat Global Forest Change base: Year Loss product).

2. Detailed analysis of these tracks with high-resolution images (fallen trees lies in CCW (or CW) direction).

> Features of forest disturbances due to windstorm (a) and tornado (b) on a high-res. satellite images

Example of narrow and elongated track of forest disturbances







Shikhov and

Chernokulsky,

2017, RSE, in press

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#### 'Unknown' tornadoes: climatology



For 2000-2014 we found more than 160 tornadoes (with intensity >F1) in forested regions, that were not reported by eyewitnesses (105 – in the European part of Russia, 55 – in the Asian part).

#### More details: poster P49

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#### Satellite data for well-known tornadoes



Landsat data were used to disentangle 1984 Ivanovo tornado outbreak: 8 tornadoes with precise location and path width and length were discovered. (they are different compare to previously mentioned).



#### Tornado cases from all sources: year to year changes



Further revision is needed for several cases.



#### Location of events (all cases)



Fujita Scale

• 0 • 1 • 2 • 3 • 4 • No data available



#### Density of tornadoes (Medium and High)



# Number of tornado events per 10 000 km<sup>2</sup> with Medium and High reliability (1898 cases).



### Annual and daily cycle





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#### Path length and width





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#### Conclusions

- A new climatology of tornadoes over land and water for Northern Eurasia (fUSSR countries) were compiled from different sources.
- In total: more than 2500 cases of tornadoes were founded. An increase of reported tornadoes is noted for last years (this is not the real increase of tornado cases, rather the result of spreading smartphones and mobile Internet (more eyewitness reports), and use of satellite data for unreported tornadoes in forest).
- July and afternoon time are the most favor for tornadoes over land; August and morning time – for tornadoes over water (waterspouts).
- The characteristic number of tornadoes in Russia is around 100-150 per year. The number of strong tornado (≥F2 intensity) is around first dozens (10-20) per year. The density of tornadoes is up to 3-4 tornadoes per 10 000 km<sup>-2</sup> in some regions. This numbers were underestimated before.



#### **Additional slides**



#### Tornado database

Tornado database includes information on:

- Date and time of event (with time accuracy estimation).
- Coordinates (with place accuracy estimation).
- Data quality estimation.
- Administrative identity (country, region).
- Underlying surface (water/land).
- Tornado intensity (if possible to obtain).
- Tornado path length (if possible to obtain).
- Tornado path width (if possible to obtain).
- Sense of rotation (if possible to obtain).
- Impact of tornado (economic loss, victims), supplementary information about event.
- Information about primary source on tornado

