



NATIONAL  
**TORNADO**  
SUMMIT  
& *DISASTER SYMPOSIUM*

**FEBRUARY 26 - 28, 2018**

COX CONVENTION CENTER

OKLAHOMA CITY

# **Wind Speed Estimation Standard - International Working Group**

**Gregory A. Kopp, Ph.D., P.Eng.**

**Boundary Layer Wind Tunnel Laboratory, University of Western Ontario.**

**gakopp@uwo.ca**

**@gregoryalankopp**

# Background

- There is a growing need to have a common, world-wide tornado climatology.
- This requires common tornado intensity and damage assessment methodologies.
- The first stage of the Committee's work is understand what the state-of-practice is for tornado assessments world-wide.
- The long-term goal is to develop international tornado intensity and damage scales that are accepted and used everywhere.

Continent/Country	Approx. Average # of Tornadoes per year	Approx. Average # of Fatalities/Injuries per year
<b>North America</b>	1358	91/1145
USA (2000-2014)	1297	89/1115
Canada (1980-2009)	61	2/30
<b>Europe (2000-2014)</b>	242	n/a
Data by country is presented in Antonescu et al. (2016)		
<b>Asia</b>	>110	>37/ >672
China (1961-2010)	85	35/634
Japan (2006-2015)	26	2/48
India	< 1	
<b>Australia</b>	~60	1/ 30-50
New Zealand	17	n/a
<b>South America</b>	n/a	
Argentina	~10	
<b>Africa</b>		
South Africa	~3	n/a
<b>Global Totals</b>	>1800	>125

# Countries with Official (government-based) Intensity and Damage Assessment Scales

- USA (2007) – EF-Scale with DI/DOD approach
- Canada (2013) – EF-Scale (modified intensity scale and DIs)
- Japan (2016) – JEF-Scale (Japanese-specific EF-Scale and DIs/DODs)
- China – officially records tornadoes, but uses EF- and F-Scale
- Europe – uses DI/DOD approach with modified F-Scale wind speeds
  
- No other countries/regions officially record or assess tornadoes. However, there are often research studies after major events in those regions.

# Official Tornado Intensity Scales (in m/s)

F-Scale	USA (EF-Scale)	Canada (EF-Scale; mod.)	Japan (JEF-Scale)	Europe (F-Scale)
<b>(F0) 19-35</b>	(EF0) 29-38	25-37	25-38	(F0-) 25 +/- 7 to (F0+) 30 +/- 9
<b>(F1) 35-53</b>	(EF1) 38-49	38-49	39-52	(F1-) 37 +/- 11 to (F1+) 45 +/- 14
<b>(F2) 53-72</b>	(EF2) 50-60	50-62	53-66	(F2-) 55 +/- 16 to (F2+) 65 +/- 20
<b>(F3) 72-93</b>	(EF3) 61-74	63-74	67-80	(F3-) 75 +/- 22 to (F3+) 90 +/- 27
<b>(F4) 93-117</b>	(EF4) 74-89	75-87	81-94	(F4) 105 +/- 32
<b>(F5) 117-142</b>	(EF5) >89	>88	>95	(F5) 130 +/- 39)

# Damage Indicators - Buildings

	USA	Canada	Japan	Europe
Buildings	DIs 1 – 23 (see WSEC 2006)	DIs 1 – 23 Same as USA; plus C3, C4 (see Appendix A)  C3: Heritage Churches C4: Solid Masonry Houses	DIs 1 – 9 1: Wooden houses and stores 2: Industrialized steel-framed houses (prefabricated) 3: RC apartment buildings 4: Temporary buildings 5: Large eaves 6: Steel-framed warehouses 7: Small non-residential wooden buildings 8: Greenhouses, gardening facilities 9: wooden livestock sheds	A: weakest outbuilding B: outbuilding (huts and barns, anchored lightweight building) C: strong outbuilding, weak frame house (like typical US-midwest houses , if weakly anchored/connected to the foundation) D: weak brick structure/strong frame house E: strong brick structure F: concrete building

# Damage Indicators – Non-Building Structures

<p><b>Non-Building Structures</b></p>	<p><b>DIs 24 – 26</b>  <b>24: Electrical Transmission Lines</b>  <b>25: Free Standing Towers</b>  <b>26: Free Standing Poles</b></p>	<p><b>DIs 25, 26, C1, C5, C6</b>  <b>25: same as USA</b>  <b>26: same as USA</b>  <b>C1: Electrical Transmission Lines (Canadian)</b>  <b>C5: Farm Silos or Grain Bins</b>  <b>C6: Sheds, Fences or Outdoor Furniture</b></p>	<p><b>10: Small sheds</b>  <b>11: Shipping containers</b>  <b>17: RC utility poles</b>  <b>18: Ground-based billboards</b>  <b>19: Traffic signs</b>  <b>20: Carports</b>  <b>21: Hollow concrete block (HCB) walls</b>  <b>22: Wooden, plastic, aluminium or mesh fences</b>  <b>23: Windbreak or snowbreak fences for roads</b>  <b>24: Net fences</b>  <b>29: Temporary scaffolding (with wall ties)</b>  <b>30: Gantry cranes</b></p>	
---------------------------------------	--	---	---	--

# Damage Indicators – Others

	USA	Canada	Japan	Europe
Vehicles			13: Light vehicles 14: Ordinary vehicles 15: Large vehicles 16: Railway vehicles	
Natural	DIs 27 – 28 27: Trees, Hardwood 28: Trees, Softwood	DIs C2 C2: Trees	25: Broad-leaved trees 26: Coniferous trees	G: branches – leafy H: branches- bare I: tree stands – diseased/unstable J: tree stands – strong K: tree stands – edge trees, hedges, underwood
Other			12: Vending machines 27: Gravestones 28: Road surfaces	



# Recommendations

- There are large differences at the high end of the scales between EF-Scale-based Tornado Intensities (USA, Canada, Japan) and F-Scale-based Intensities (Europe). This could be solved through agreement of common methods to actually assess wind speeds and correlation analyses of various DIs during damage surveys.
- DI/DOD approach is used everywhere. For an international scale, we need more DIs than are used in US version. These can be categorized as (i) Buildings, (ii) Non-building structures, (iii) Vehicles, (iv) Natural, and (v) Other.
- DIs should reflect key features which affect performance in high wind, not building usage.