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GLOBAL EARTHQUAKE MODEL

working together to assess risk

The ISC-GEM catalogue: examples of application in regional and global contexts

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Presentation outline

- The ISC-GEM catalogue: short introduction
- Current examples of application of the ISC-GEM catalogue
- Some recent developments

GEM hazard global components

The GEM Hazard Global Components:

- Global Historical seismicity catalogue and archive (GHEC and GHEA)
- Global strain rate model (GSRM)
- Global active fault database (GFE)
- Global Ground Motion Prediction Equations (GGMPEs)
- Global Instrumental seismicity catalogue (ISC-GEM)

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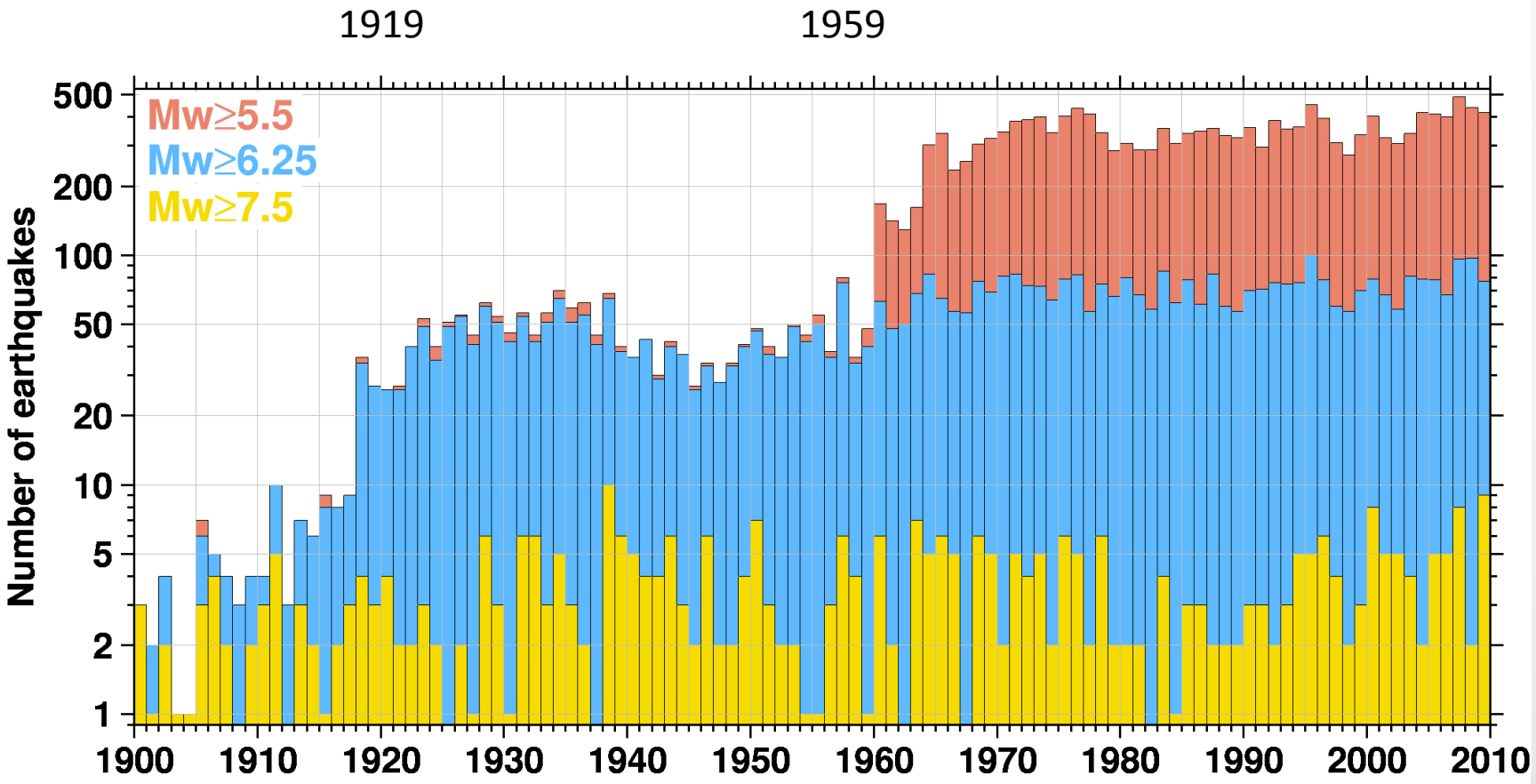
ISC-GEM in a nutshell

Version 1.0 – released in January 2013 (1900-2009)

- 110 years of ~20000 earthquake hypocenters and uncertainties, recomputed using the original arrival-time data and the same technique and velocity model throughout;
- where possible, earthquake magnitudes are expressed in Mw scale based on seismic moment;
- proxy Mw is estimated in all other cases based on the newly developed empirical relationship with MS and mb;
- uncertainty and quality flag for both earthquake hypocenters and magnitudes are estimated using uniform techniques.

ISC-GEM in a nutshell



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ISC-GEM in a nutshell

Version 2.0 – released in January 2015 (1900-2011)

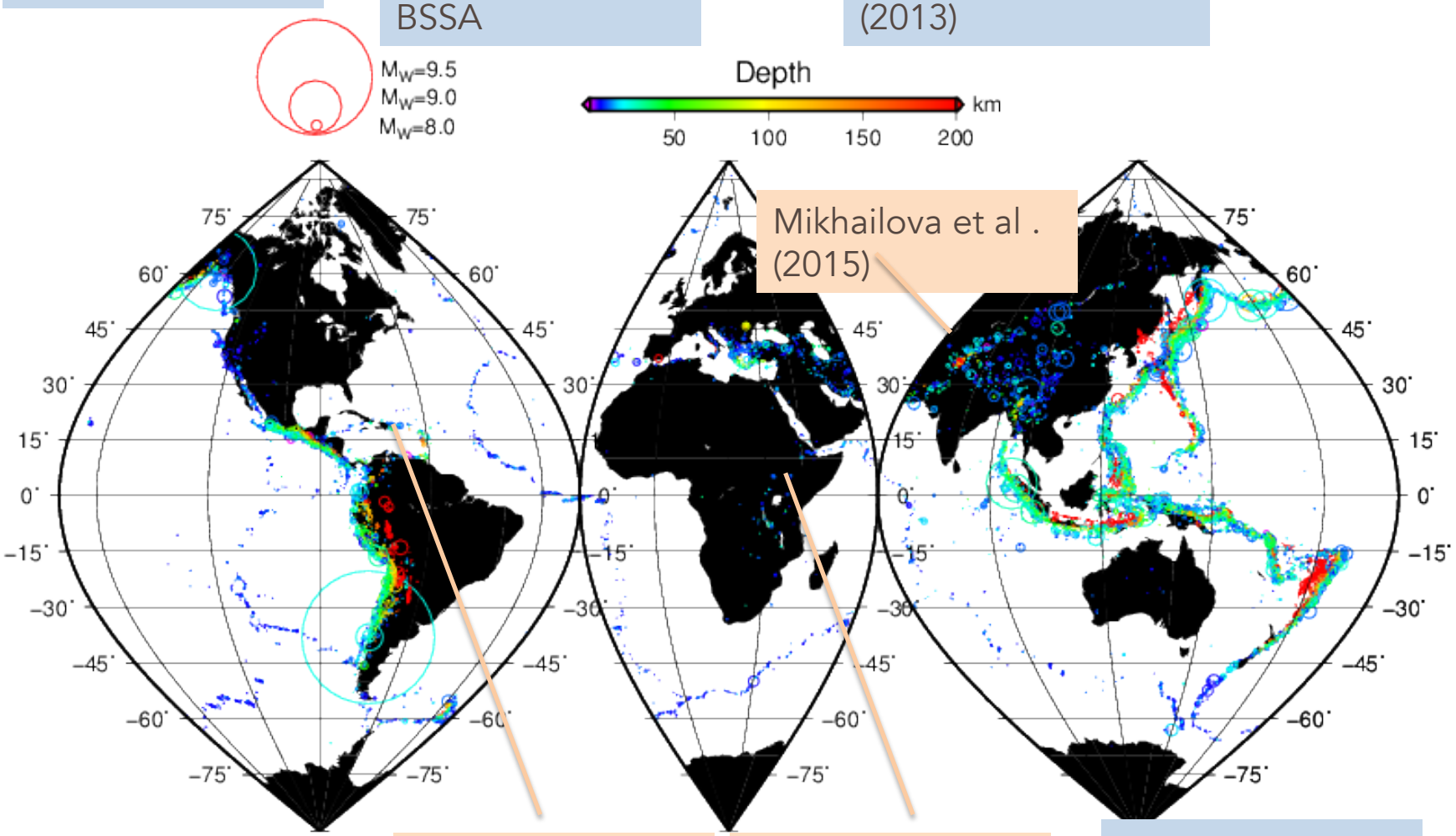
- Added 504 earthquakes from 2010 and 672 from 2011
- For the 1950s, processed and relocated 4156 earthquakes and obtained 2216 new MS and 12 mb values
- 200 new magnitudes of earthquakes previously in the supplementary catalogue and reviewed hypocentre locations of about 500 events.

Examples of ISC-GEM application

Michael (2014) - BSSA

Geist (2014) - BSSA

Christophersen et al. (2013)



Mikhailova et al . (2015)

Bird and Kreemer (2015) - BSSA

Hayes et al . (2013) - GJI

Lubkowski et al . (2014)

Leonard (2014) - BSSA

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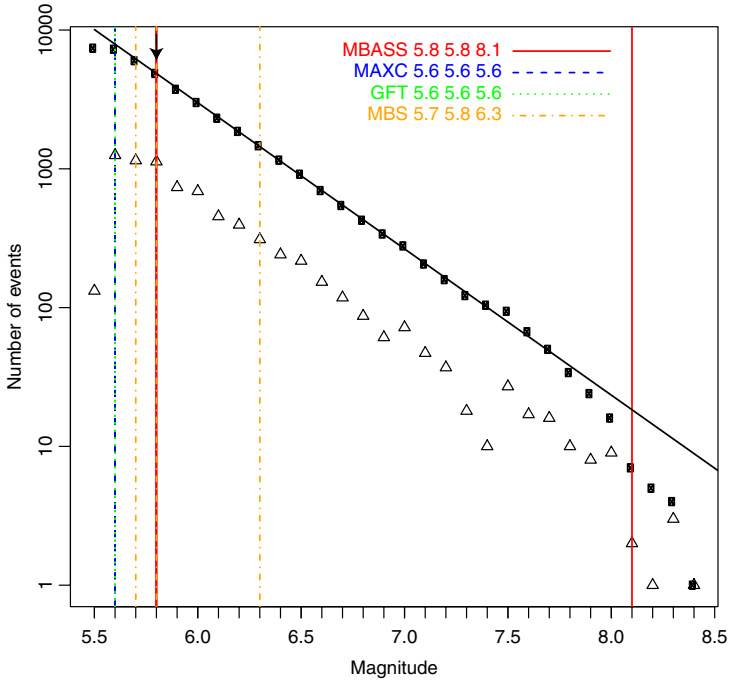
Michael (2014)

Michael analysed the ISC-GEM temporal completeness :

- Earthquakes shallower than 60 km within 7 time periods
- Deep events within 2 periods

Four methodologies for completeness analysis adopted. All rely on the basic concept that for magnitudes larger than the magnitude completeness threshold observations must fit a Gutenberg-Richter relationship.



Michael (2014)

From	To	Mc
1900	1917	7.7
1918	1939	7.0
1940	1954	6.8
1955	1963	6.5
1964	1975	6.0
1976	2003	5.8
2004	2009	5.7

Shallow events

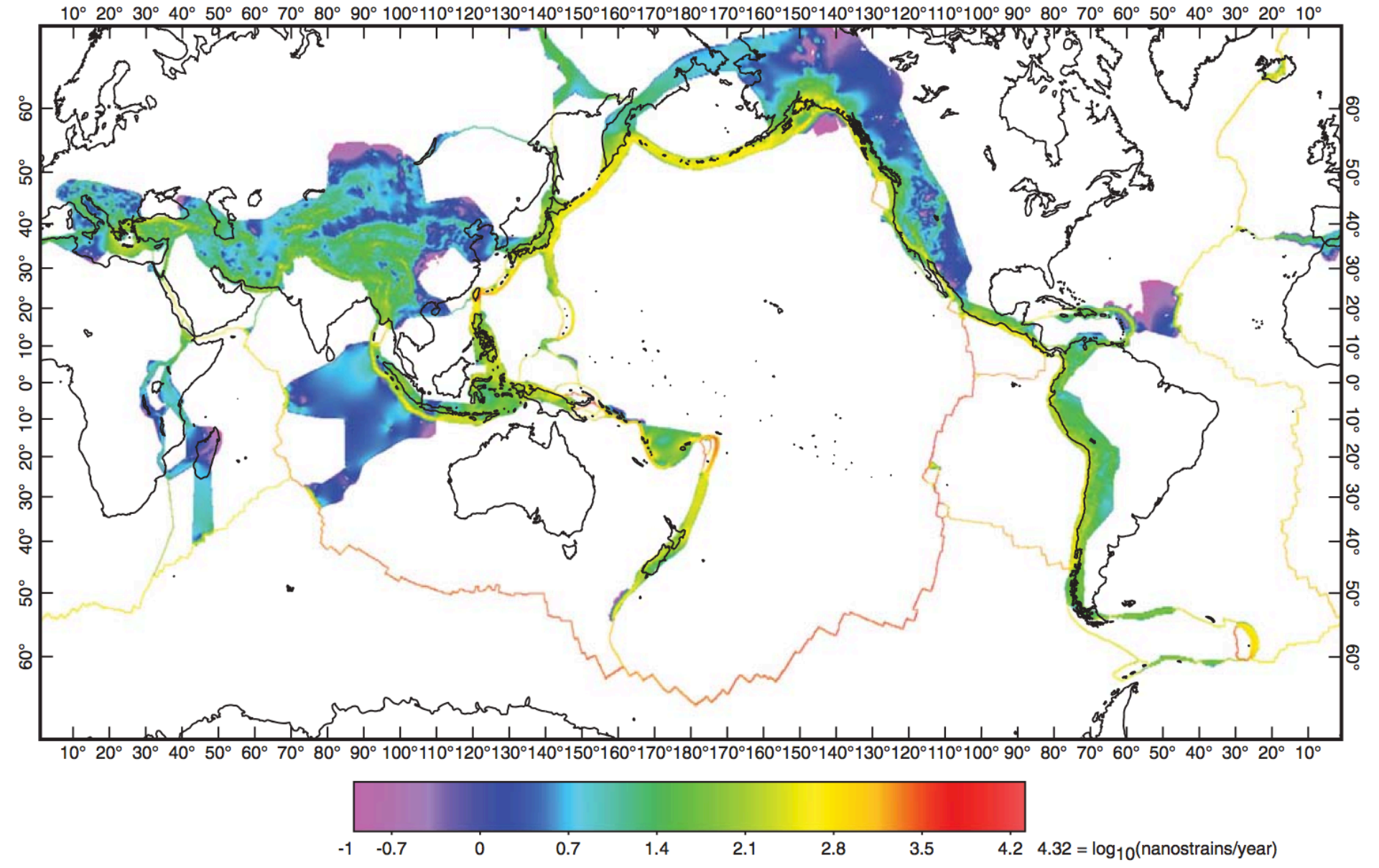
(depth < 60km)

Deep events

(depth < 60km)

From	To	Mc
1900	1963	7.1
1964	2009	5.7

Bird and Kreemer (2015)



Bird and Kreemer (2015)

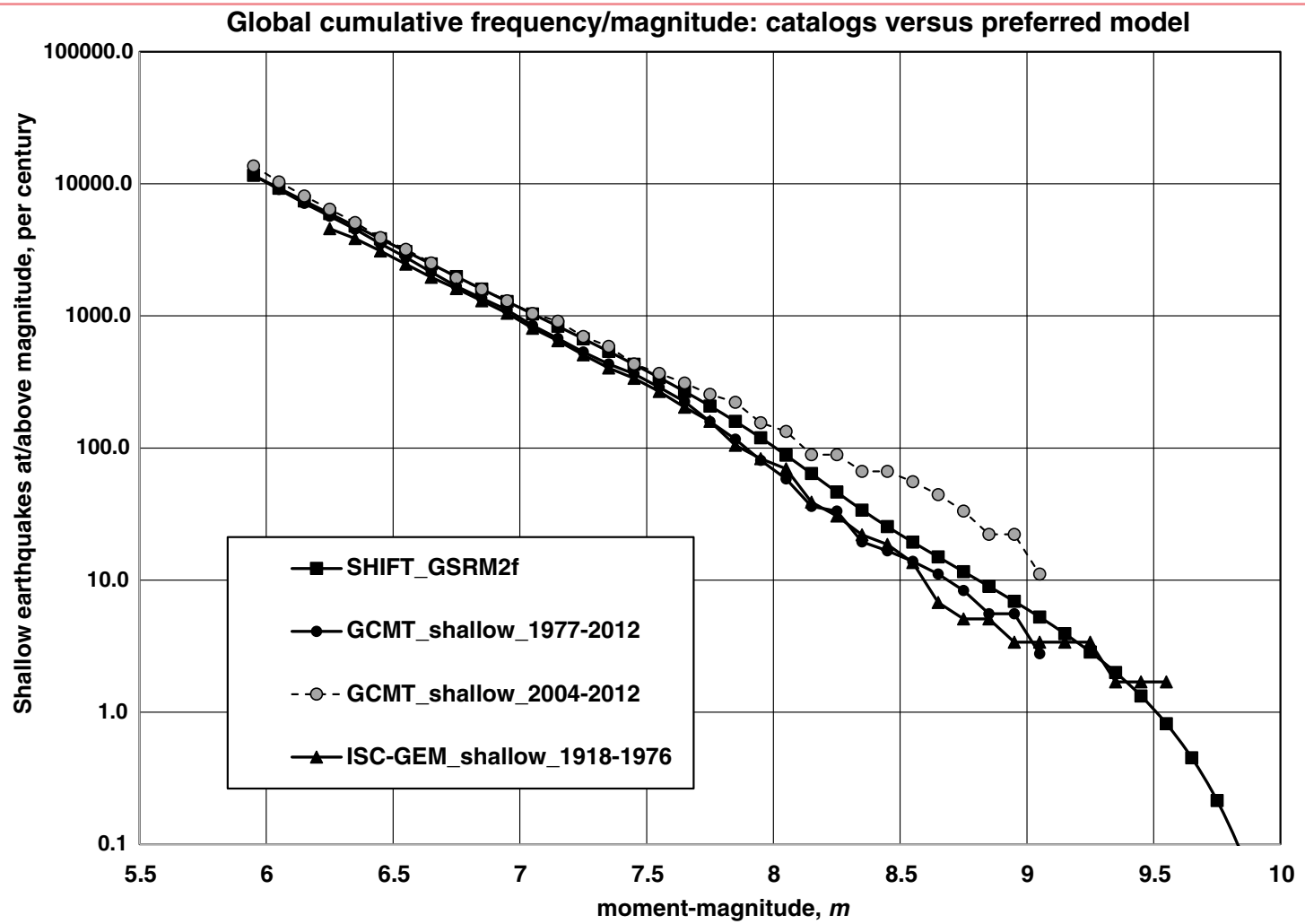


Figure 7. Global cumulative frequency–magnitude distribution of preferred model SHIFT-GSRM2f compared with the distributions of two global seismic catalogs: the International Seismological Centre-Global Earthquake Model (ISC-GEM) catalog of Storchak *et al.* (2012) for years 1918–1976 (including its supplement) and the Global Centroid Moment Tensor (CMT) catalog of Ekström *et al.* (2012) for years 1977–2012. The increased Global CMT rate in 2004–2012 is also shown with a dashed curve. All curves are normalized to 100 years of observation and are restricted to shallow earthquakes, with hypocentroids no deeper than 70 km.

Bird and Kreemer (2015)

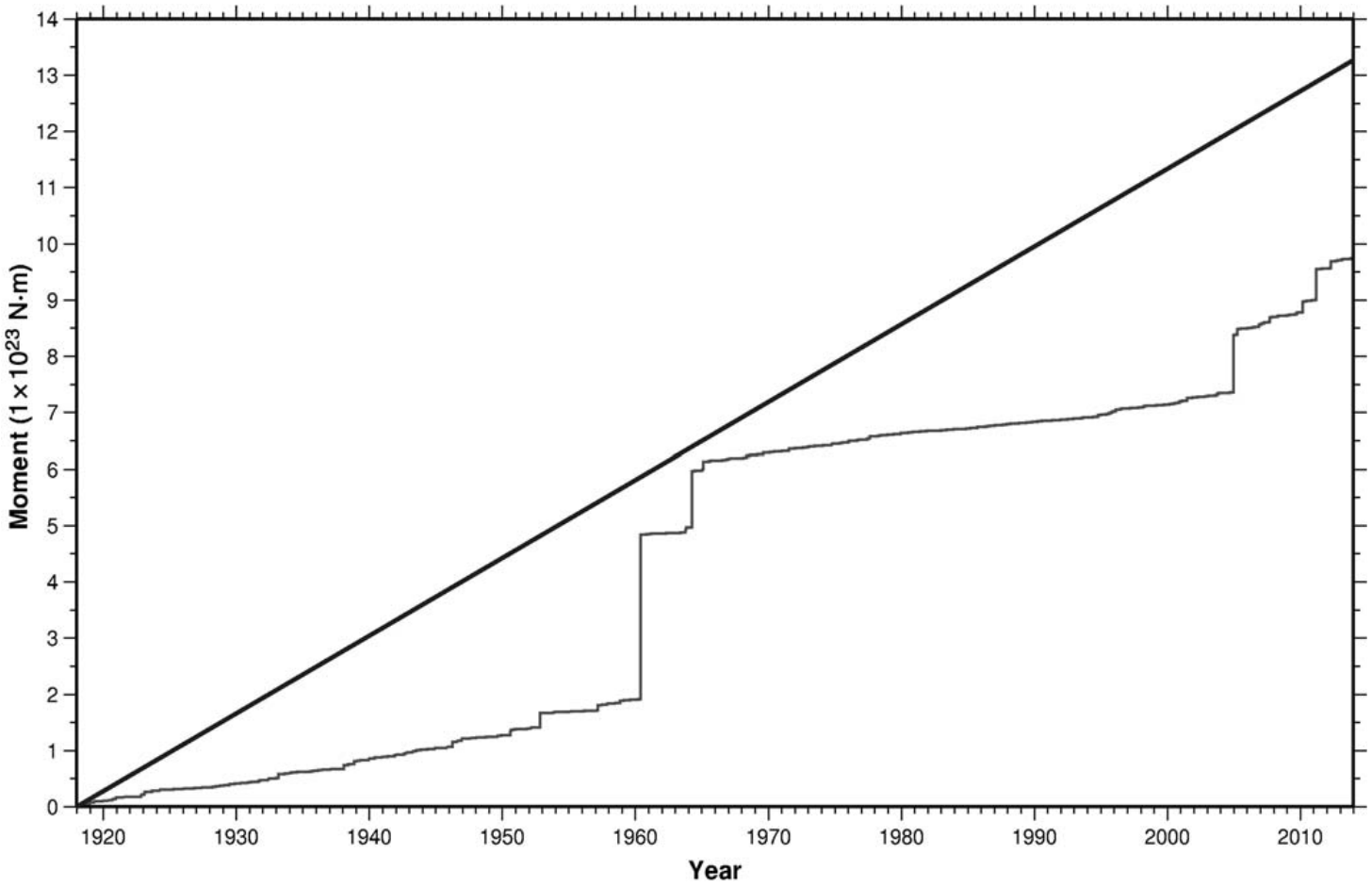


Figure 8. The stair-stepped graph line shows the global cumulative seismic moment release from shallow (≤70 km below sea level) hypocentroids in the ISC-GEM catalog of Storchak *et al.* (2012) from 1 January 1918 until 31 December 1976 and the Global CMT catalog of Ekström *et al.* (2012) from 1 January 1977 until 31 December 2013. The largest step, in 1960, represents the seismic moment of the *m* 9.64 Valdivia subduction earthquake offshore Chile. We increased the moment of the 2004 Sumatra earthquake to 1.0×10^{23} N·m (*m* 9.3) to be consistent with the latest findings (Stein and Okal, 2005, 2007; Tsai *et al.*, 2005). The straight diagonal line is the constant shallow-earthquake seismic moment rate implied by our preferred model SHIFT-GSRM2f.

Mikhailova et al. (2015)

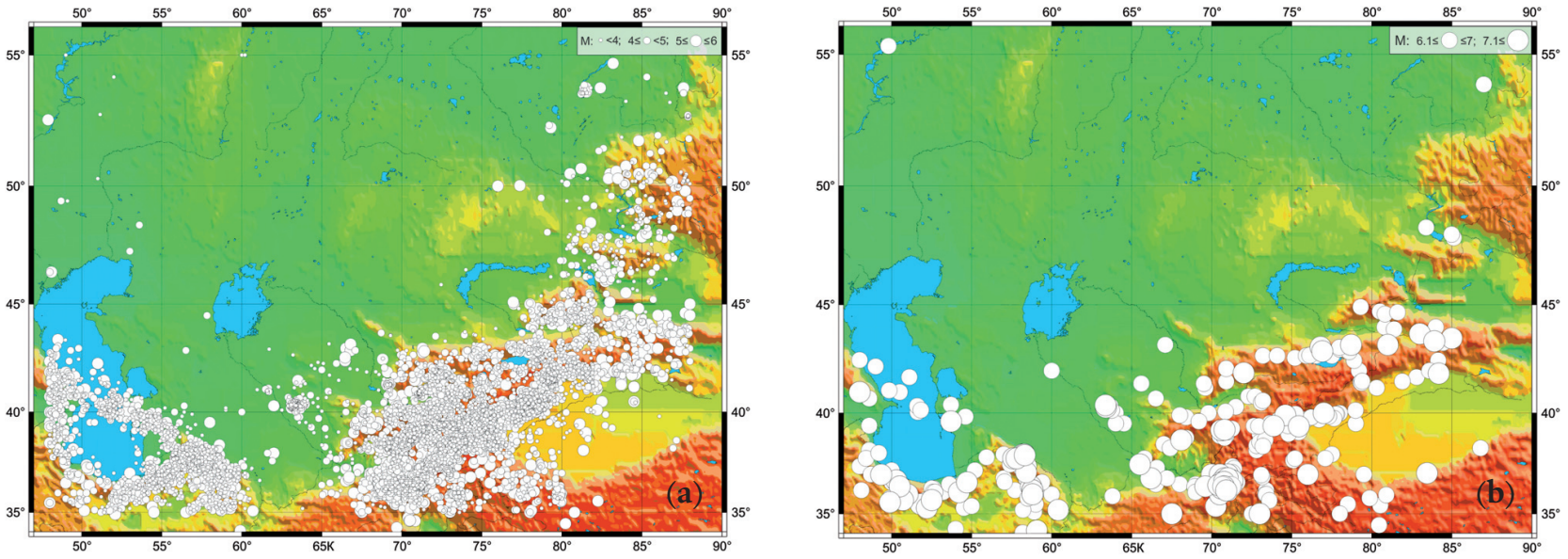
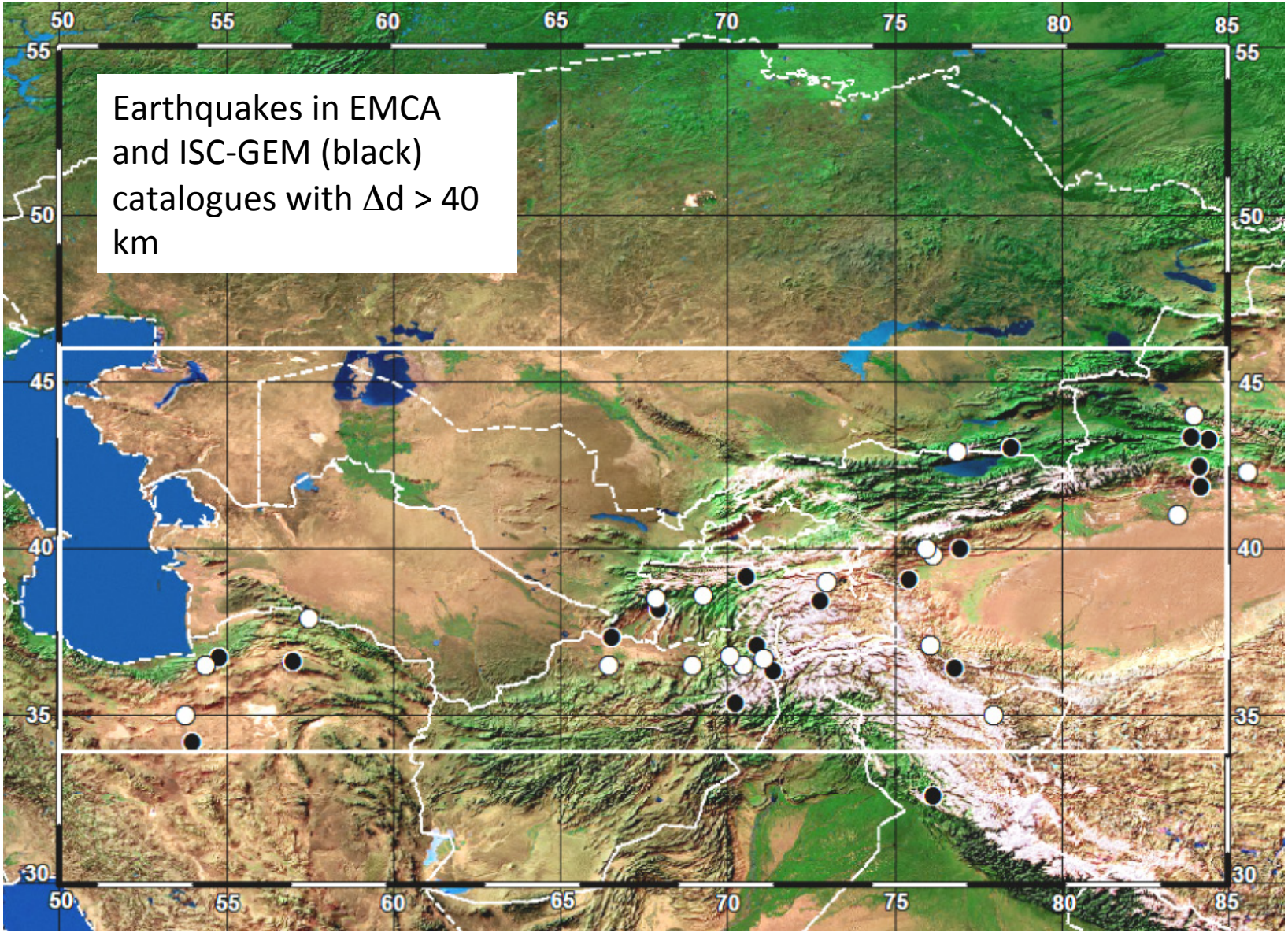


Figure 1. The map of earthquakes epicenters by the Central Asia catalogue EMCA until 1991. (a) with magnitude ≤ 6.0; (b) with magnitude ≥ 6.1.

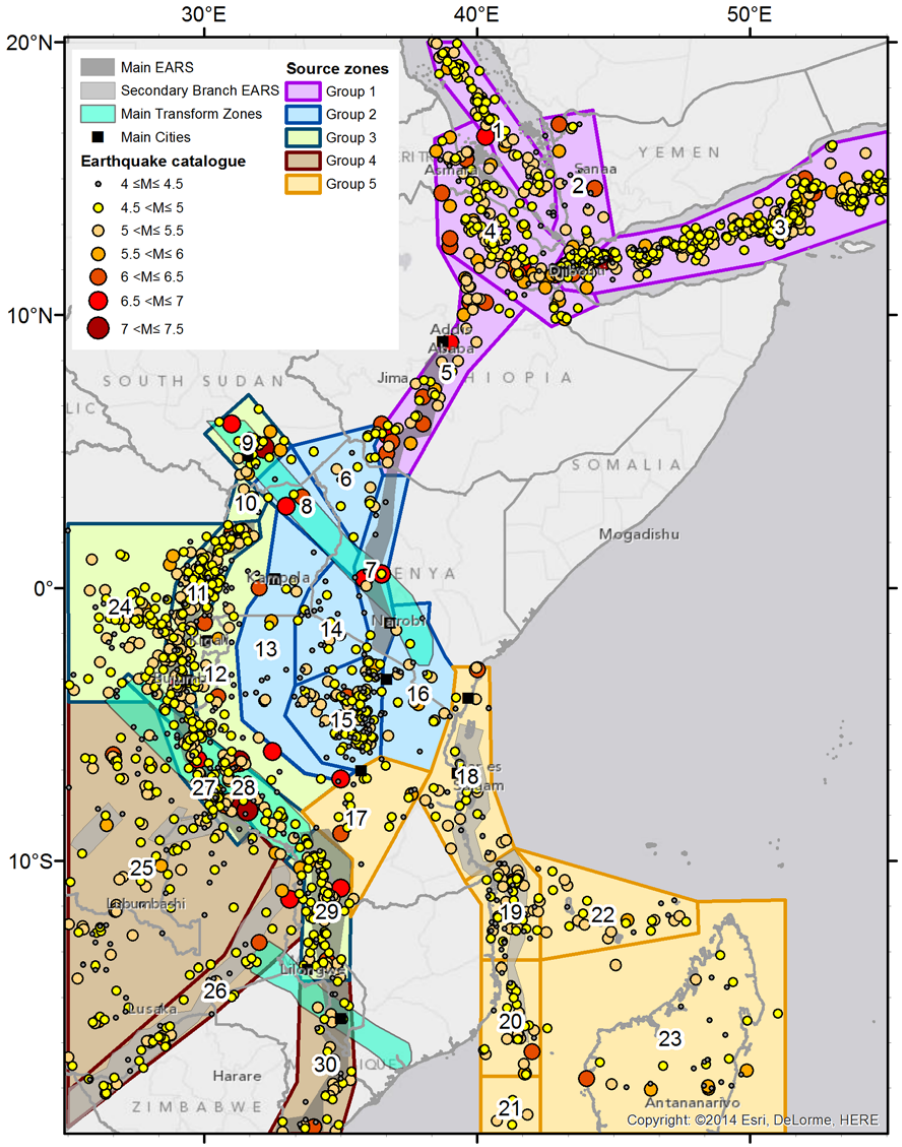
Mikhailova et al. (2014) created a regional catalogue for Central Asia by combining International (e.g. ISC bulletin) and regional catalogues (e.g. Kyrgyzstan and Kazakhstan)

Mikhailova et al. (2015)



Lubkowski et al. (2014)

Lubkoswski et al. (2014) created a regional catalogue for the East African Rift by merging the ISC-GEM with other catalogues



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ISC-GEM and GEM's Regional activities

GEM is developing a suite of tools for:

- Merging different catalogues (e.g. duplicate finding tool)
- Exploring the catalogue database
- Perform regressions between different magnitude types
- Catalogue homogenisation

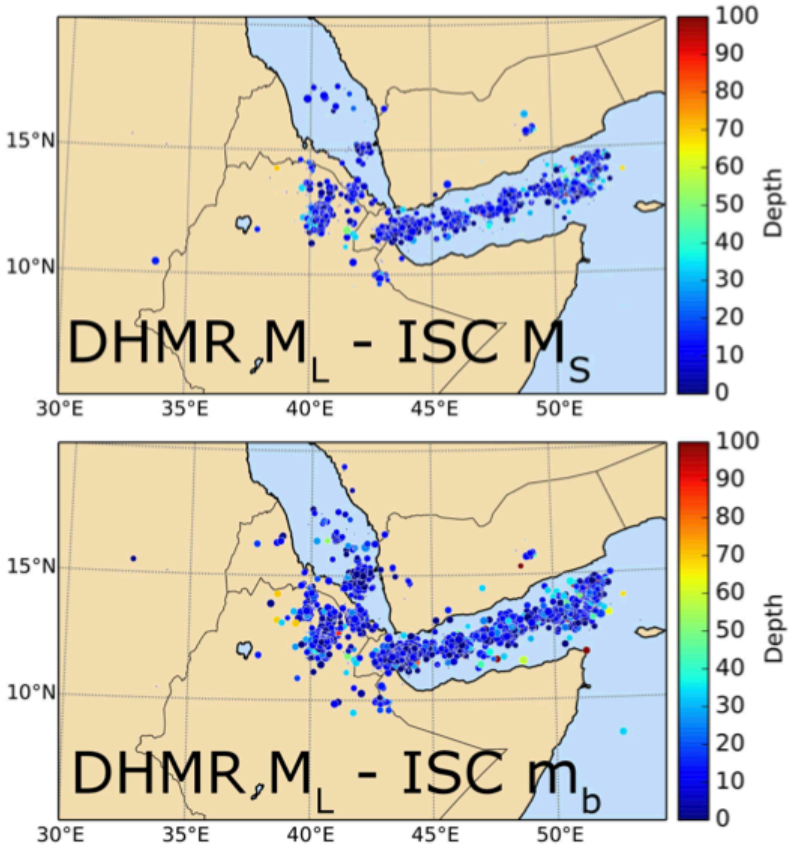
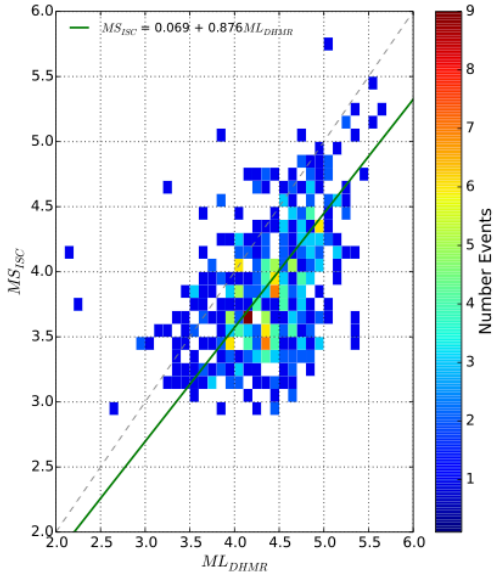


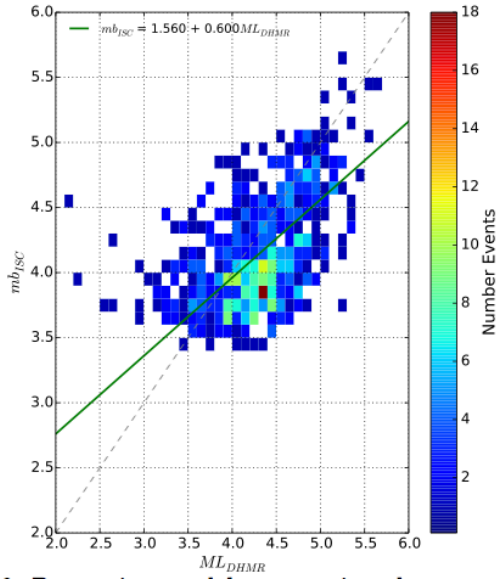
Fig. 8: Common events within the DHMR bulletin and the ISC (M_S) (top), ISC (m_b) (bottom)

ISC-GEM and GEM's Regional activities

Supported magnitude regression models:

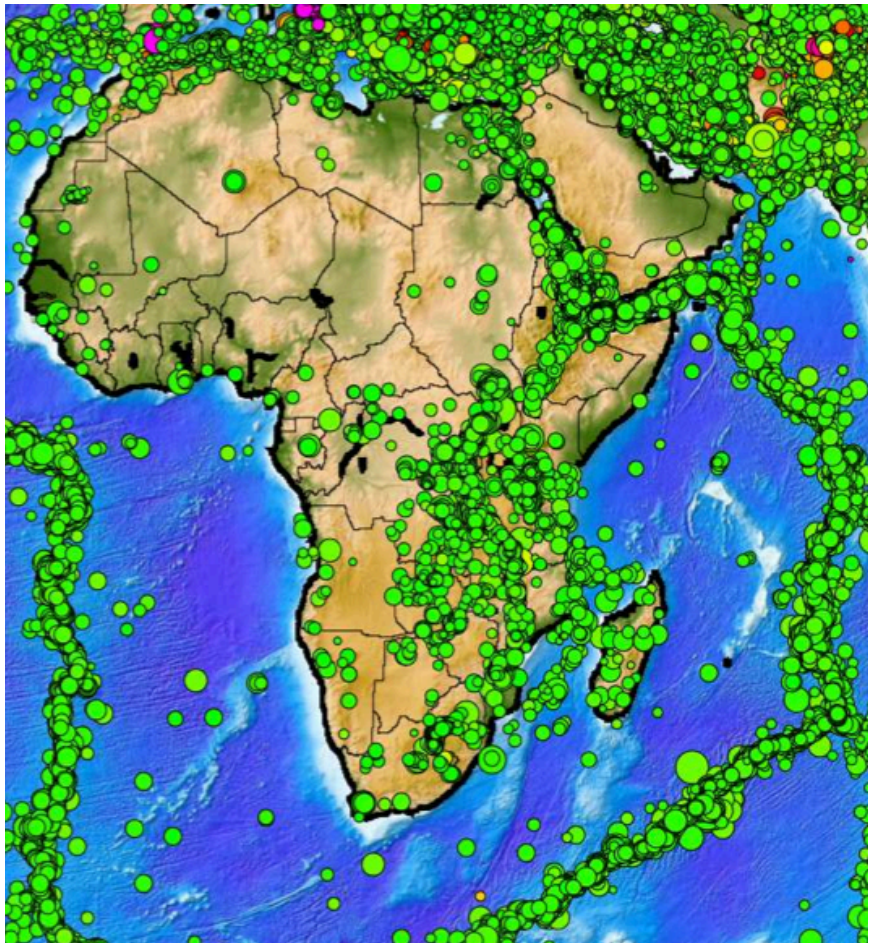
- N-th order polynomial
- Exponential
- N-segment piecewise linear (free cross-over)
- Two-segment piecewise linear (fixed cross-over)





ISC-GEM and GEM's Regional activities

The construction of a homogenised catalogue uses magnitude and location selection criteria (possibly area-dependent)



Conclusions

- Briefly illustrated the ISC-GEM catalogue and described some application examples
- Despite its short life, the ISC-GEM is largely used within the seismological community and finds application in many research areas
- In the regional hazard modelling domain it constitutes a reference resource in the high magnitude range.
- Integration of the information in the catalogue with other DBs will further improve its usability

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Please attribute to the GEM Foundation with a link to -
www.globalearthquakemodel.org

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