THE INTERNATIONAL CONFERENCE ON THE 120TH ANNIVERSARY OF THE BULNAY EARTHQUAKE: ADVANCES IN ASTRONOMY AND GEOPHYSICS

"CURRENT GNSS GEODETIC NETWORK AND GEODYNAMIC STUDY IN MONGOLIA BASED ON GNSS OBSERVATIONS"

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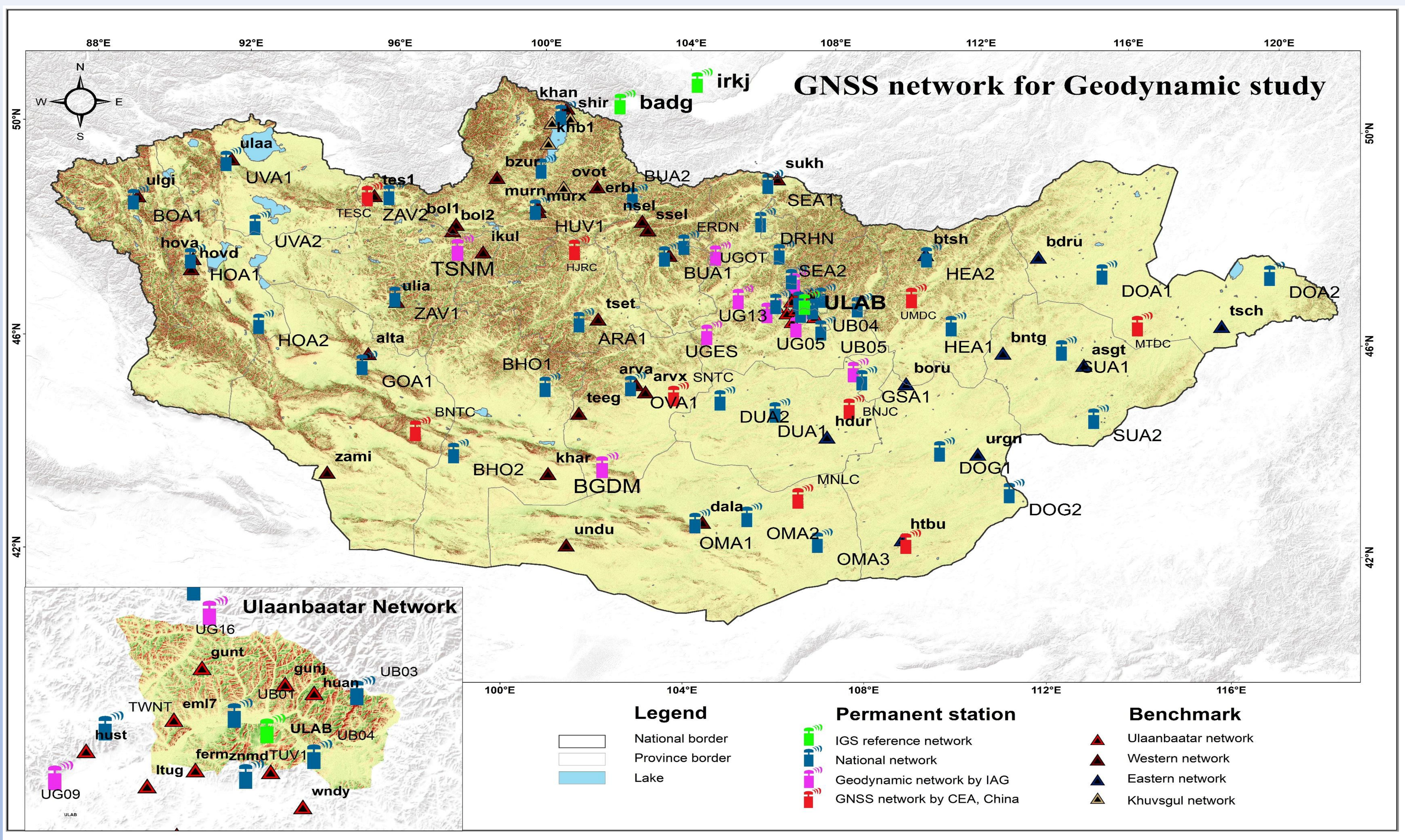
In Mongolia, a number of Continuous GNSS stations are operated and maintained by various national scientific institutions, government agencies, and private companies. These stations serve multiple purposes, including topographic and cadastral surveying, cartography, mining, geodynamic research, and crustal movement monitoring.

The recent expansion and establishment of GNSS networks across Mongolia have significantly enhanced the spatial and temporal resolution of crustal deformation monitoring. This enables a more detailed analysis of tectonic activity and a better understanding of the complex interactions among different orogenic systems, such as those in the Baikal–Mongolia collision zone.

All available GNSS raw data collected from 1994 to 2024 have been processed using the GAMIT/GLOBK software. This analysis produced time series of station positions within a consistent reference frame, yielding crucial data for both regional and local geodynamic studies. As a result, a comprehensive tectonic velocity field was developed, providing an updated view of crustal kinematics (velocity map) and deformation patterns (strain rate map) across Mongolia.

This work outlines the procedures for data acquisition, archiving, and processing, and presents a unified crustal velocity field derived from diverse sources. The results offer valuable input for geo-kinematic modeling and contribute to a deeper understanding of active tectonic processes shaping the Mongolian region and its surroundings.

GEOGRAPHICAL LOCATION OF THE GEODETIC GNSS NETWORK IN MONGOLIA



Permanent stations were established in 2013:

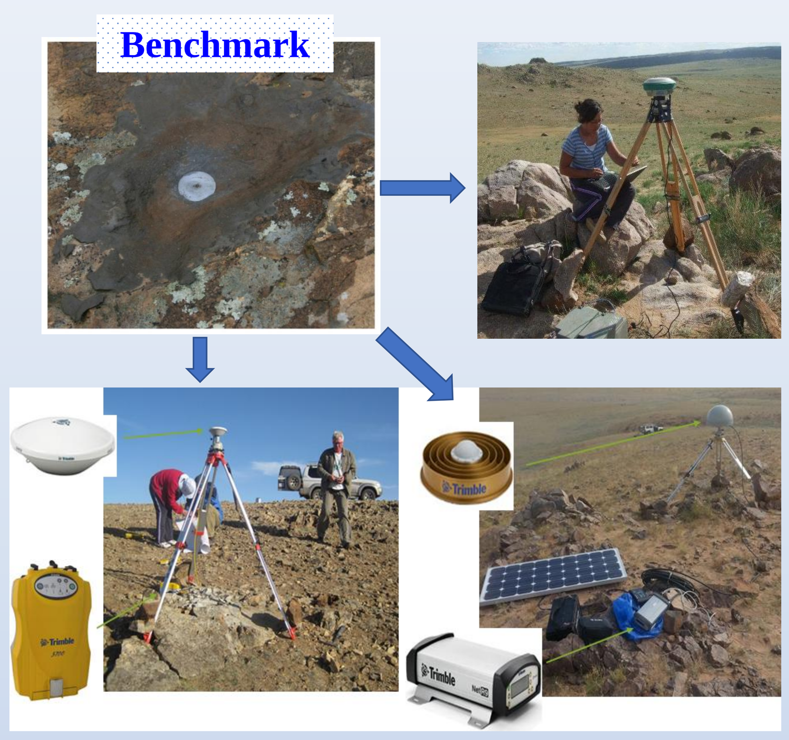
- *Institute of Astronomy & Geophysics - 7 stations*
- *Agency for Land Administration and Management, Geodesy and Cartography - 43 stations*

Benchmarks:

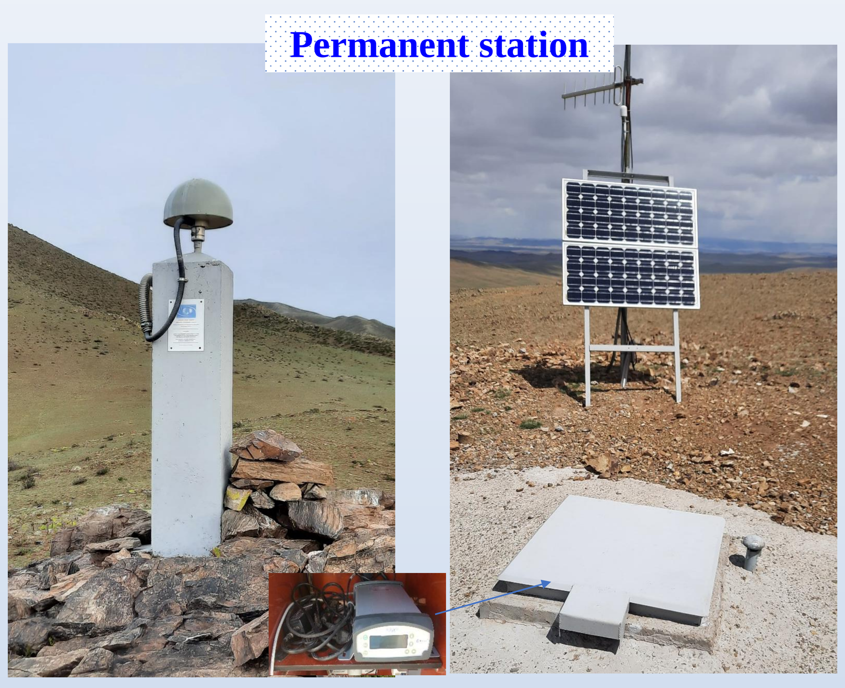
- *Since 1997:– Western region -18 points*
- *Since 2010:– Central and Eastern regions –27 points*

INSTRUMENTS

High-precision geodetic GNSS measurements were initially conducted using dual-frequency receivers, including the Trimble 5700 and R7 models (USA) with Zephyr TRM39105 antennas, as well as the Sokkia GSR2700 ISX receiver with an internal Pinwheel™ GNSS antenna. Since 2012, all measurements have been consistently performed using the Trimble NetR9 multi-channel receiver paired with a Choke Ring antenna.



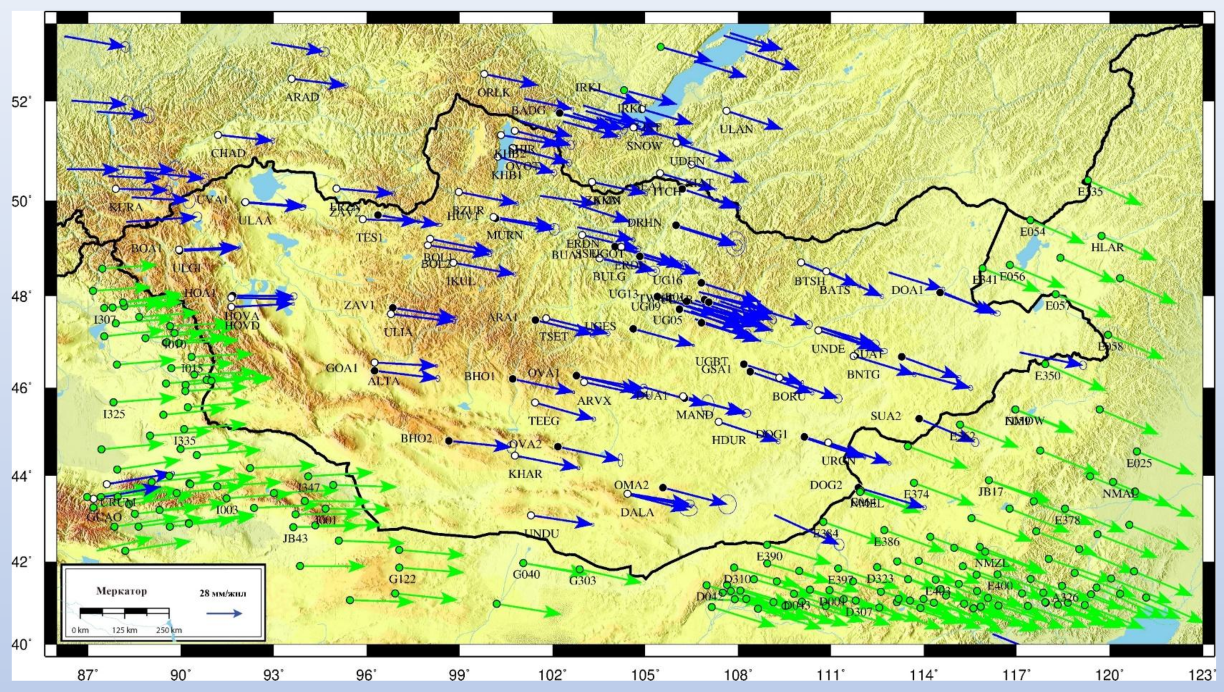
Campaign GNSS field measurements

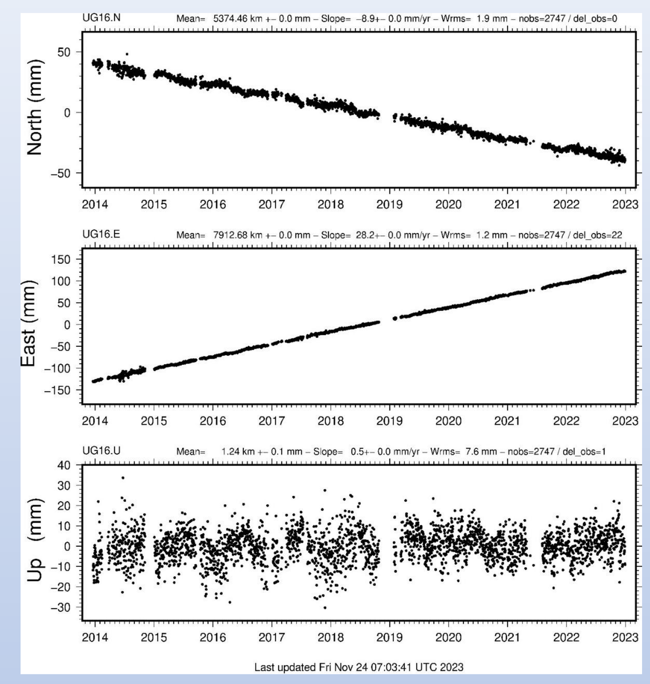


For geodynamic research, permanent GNSS stations collect data at 1-second sampling intervals and transmit it every 15 minutes to the server (IAG-MAS).

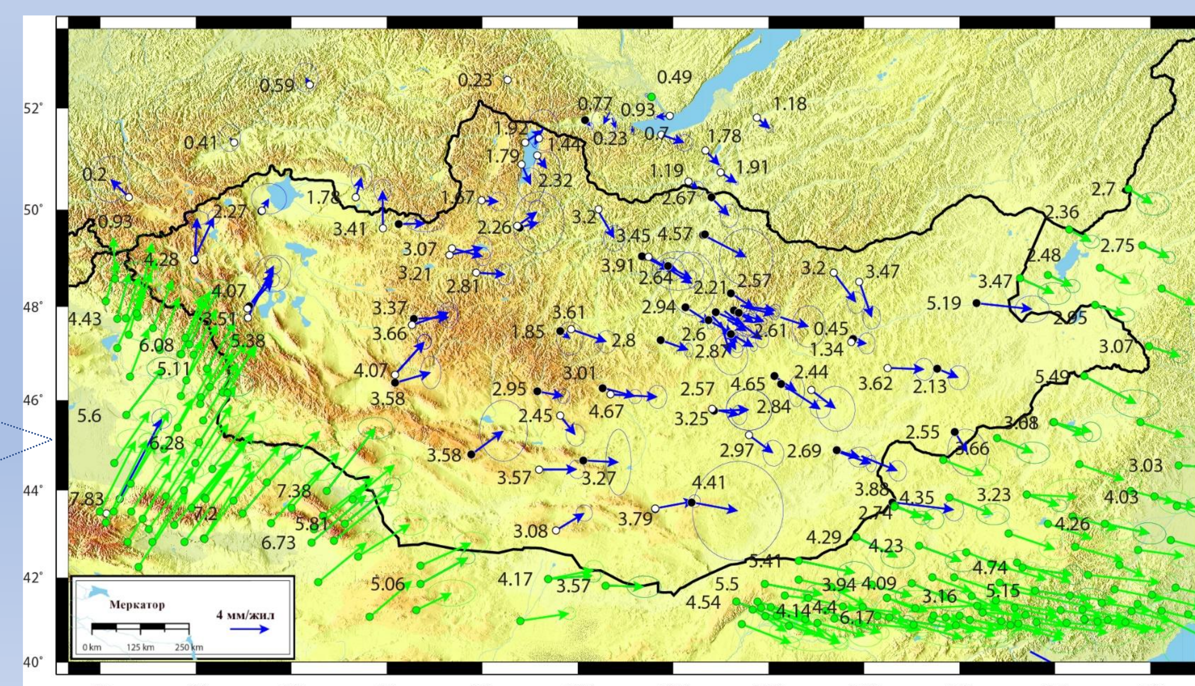
HORIZONTAL VELOCITY FIELD OF THE EARTH's CRUST IN THE STUDY REGION

GNSS permanent station data, including repeated field measurements (≥72 hours) were processed using the GAMIT/GLOBK software to estimate crustal movement velocities.

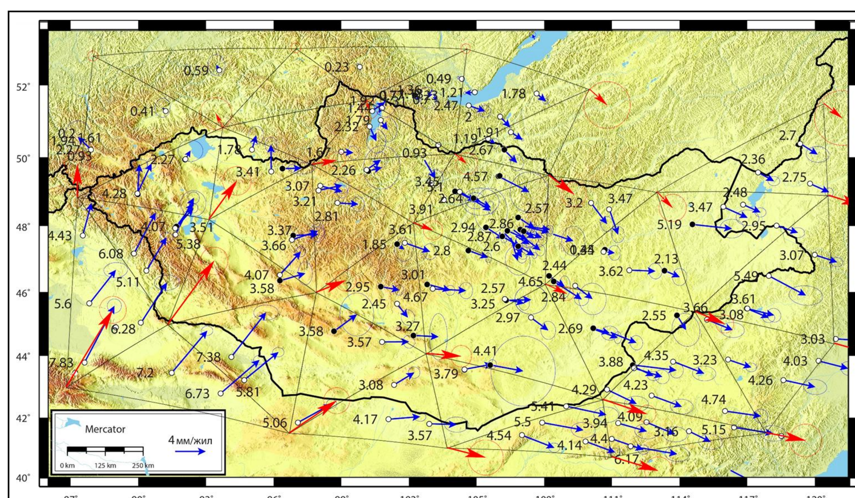


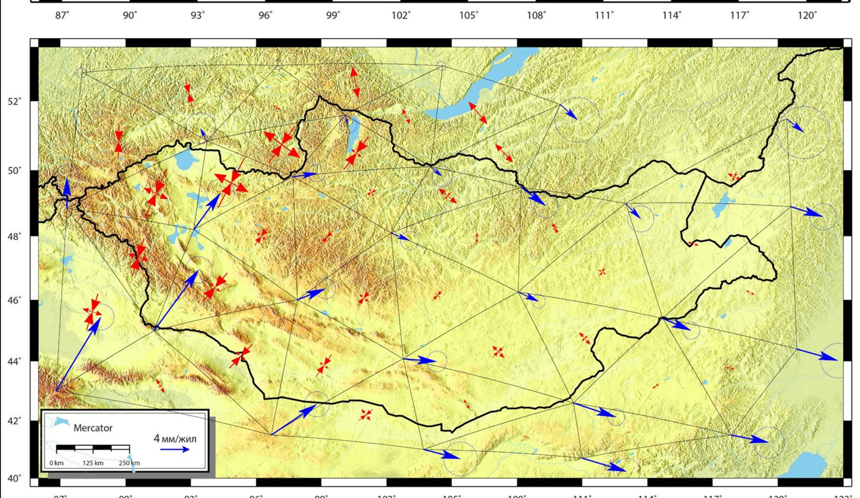


Estimated crustal motion in the ITRF2014 reference frame



During data processing, measurement points with uncertainties exceeding 1.5 mm/year were excluded, along with the calculation of relative motion with respect to stable Eurasia and velocity values of the Mongolian crust.



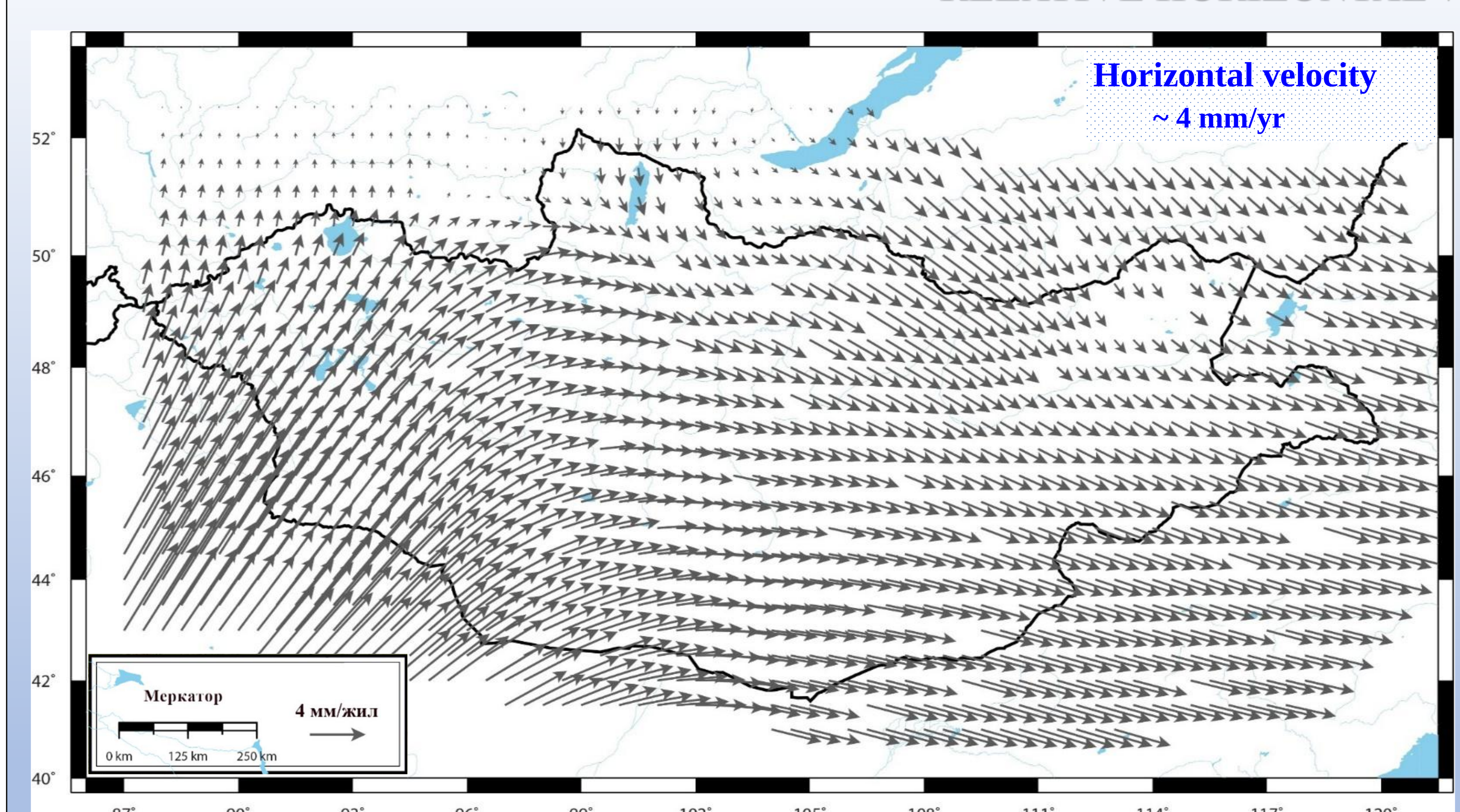


Geodetic GNSS measurements, conducted at regular intervals, enable the estimation of both absolute and relative velocity fields at specific points on the Earth's surface. Crustal deformation arises from the spatial variations within these velocity fields.

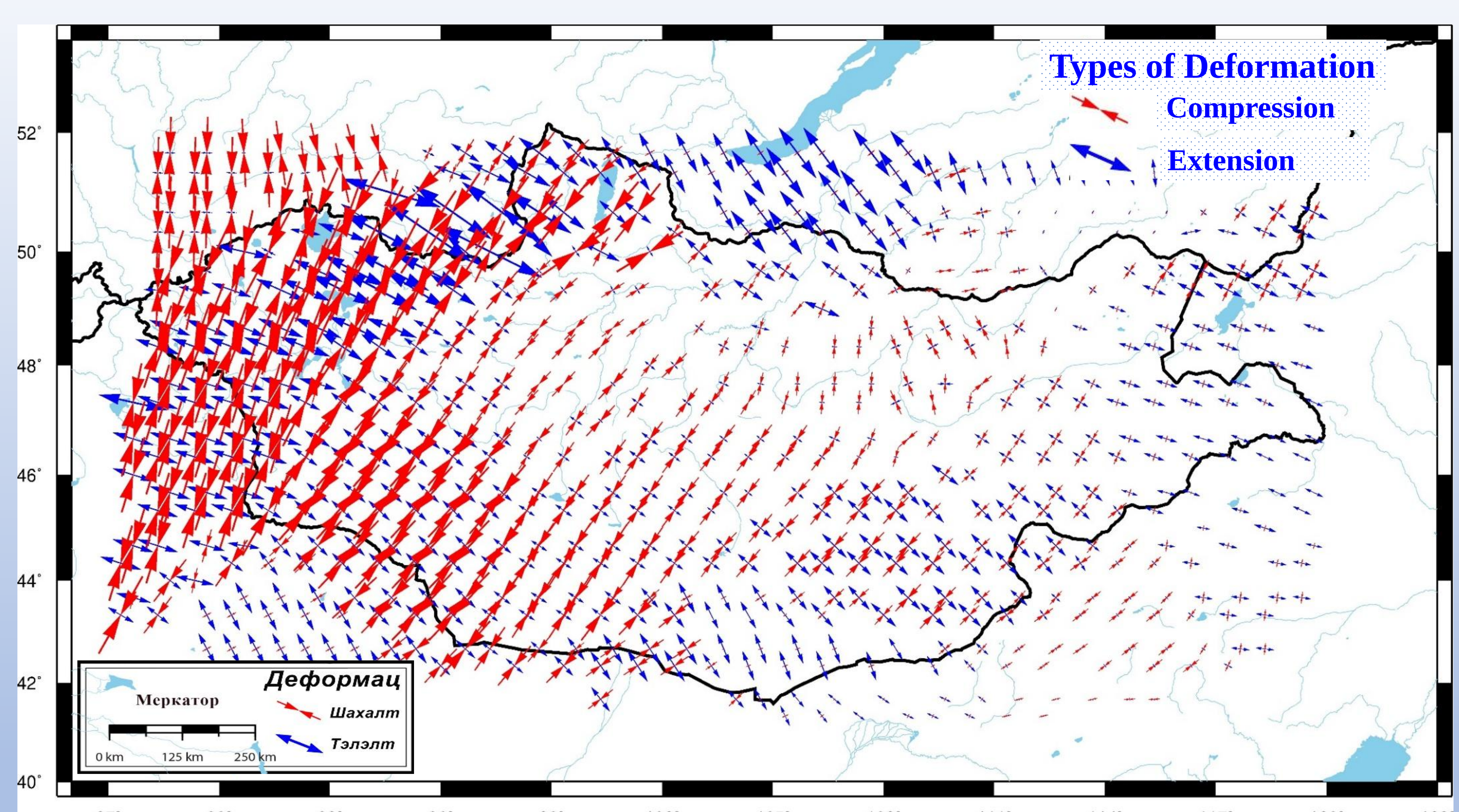
Study has shown that the territory of Mongolia is undergoing relative motion to the northwest and east-southeast. This movement is driven by the compression between the Indian and Eurasian plates, the extensional tectonics associated with the Baikal and Khuvsgul basins, and the influence of magmatic activity in the East Asian subduction zone (Vergnolle et al., 2007). These dynamics indicate that the Earth's crust in this region is in a continual motion and deformation.

Deformation was calculated by dividing the surface of the study area into triangular elements, enabling the identification of regions undergoing slow deformation that may however be motivated to strong earthquakes.

RELATIVE HORIZONTAL VELOCITY AND STRAIN MODEL



Kinematic model of the crustal deformation in Mongolia based on GNSS velocity vectors. The arrows indicate the direction and magnitude of the horizontal crustal motion relative to a stable Eurasian reference frame. */Kinematic modelling /*



To better understand the driving mechanisms behind the observed crustal deformation in Mongolia, a conceptual dynamic model has been developed. This model incorporates regional tectonic, lithospheric rheology to explain the spatial distribution of strain and seismicity. */Dynamic modelling /*