



**POLITECNICO**  
MILANO 1863

# **GIS-2025**

## **Global Coordinate System Evolution: Driving Forces and National Case Studies**

**The Arrow of Coordinates, Directing the Future**

**Jiale Guo**

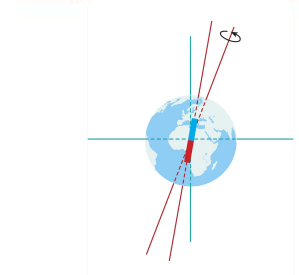
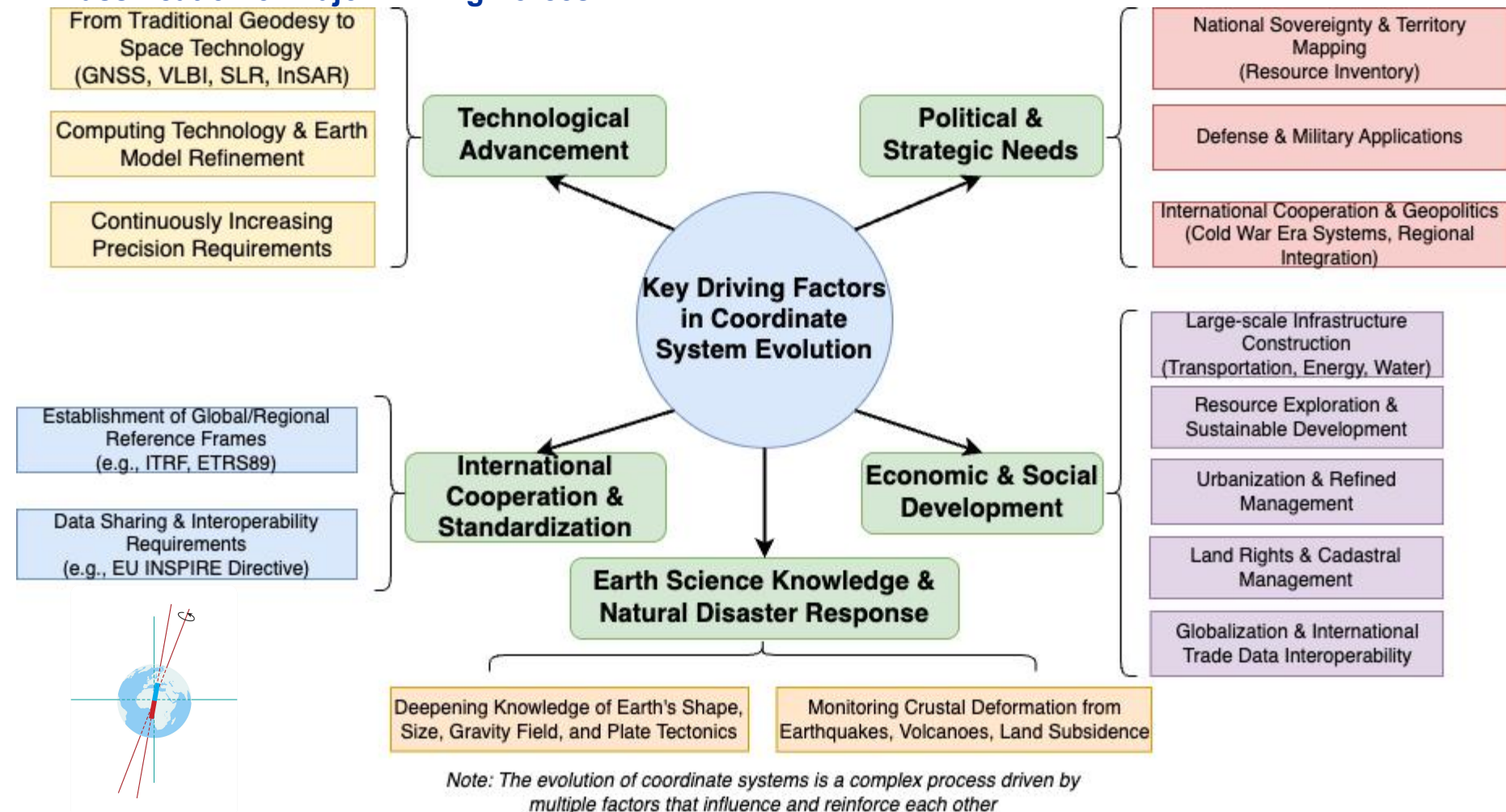
**2024 Fall Geoinformatics**

**May 29 th, 2025**

# The Driving Compass of Coordinate System Evolution)



## ➤ Classification of Major Driving Forces:



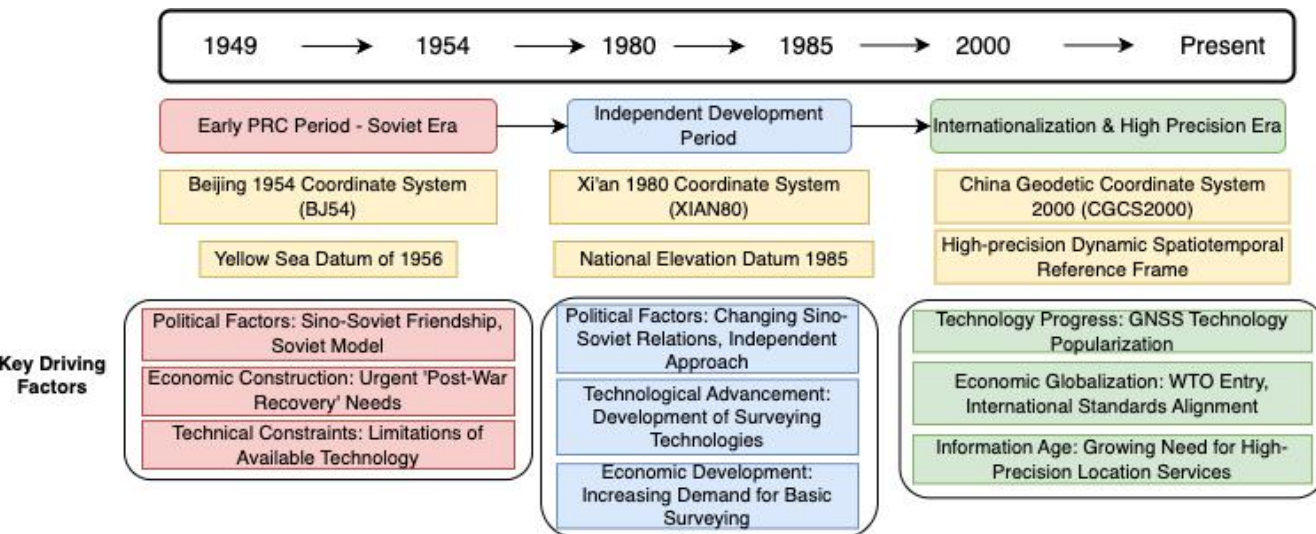
- Complexity and Dynamism of Evolution:**
- 1. Not dominated by a single factor:** In most cases, it is the result of the combined effects of multiple factors.
  - 2. Phased changes in dominant factors:** The dominant driving factors for the evolution of the coordinate system may vary across different countries at different stages of historical development.



# The Soaring Dragon and The Star-Spangled Banner's Mark

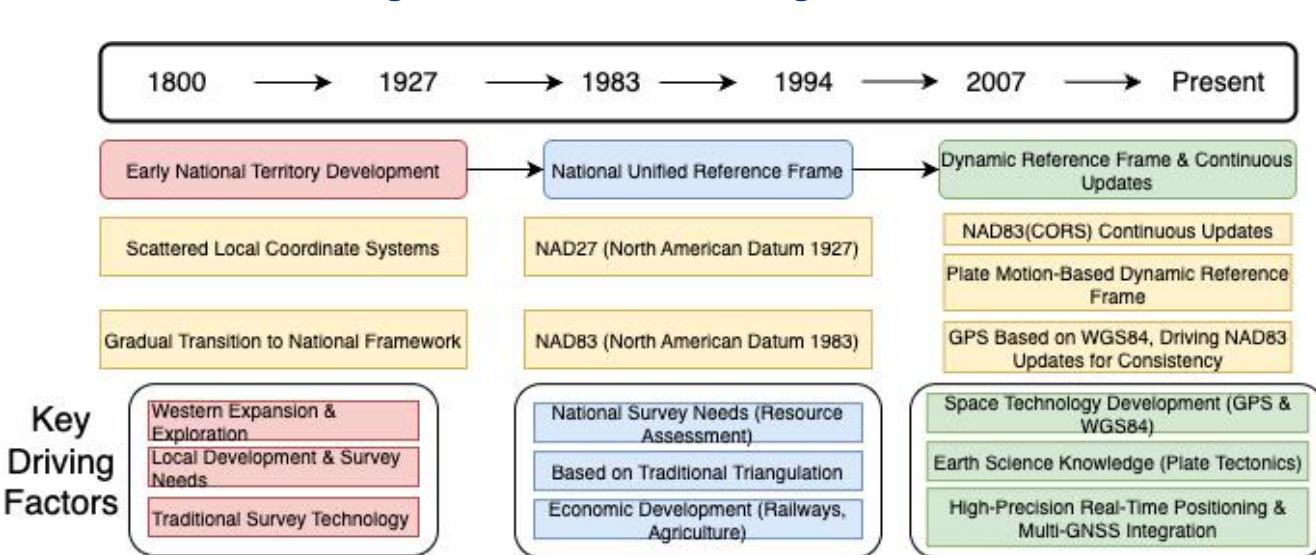


## ➤ China: A Journey from Following to Leading in Coordinate Systems



Professor Deren Li from Wuhan University, former President of the International Society for Photogrammetry and Remote Sensing (ISPRS), Academician of the Chinese Academy of Sciences, Academician of the Chinese Academy of Engineering, Academician of the Eurasian Academy of Sciences, and Academician of the International Academy of Astronautics.

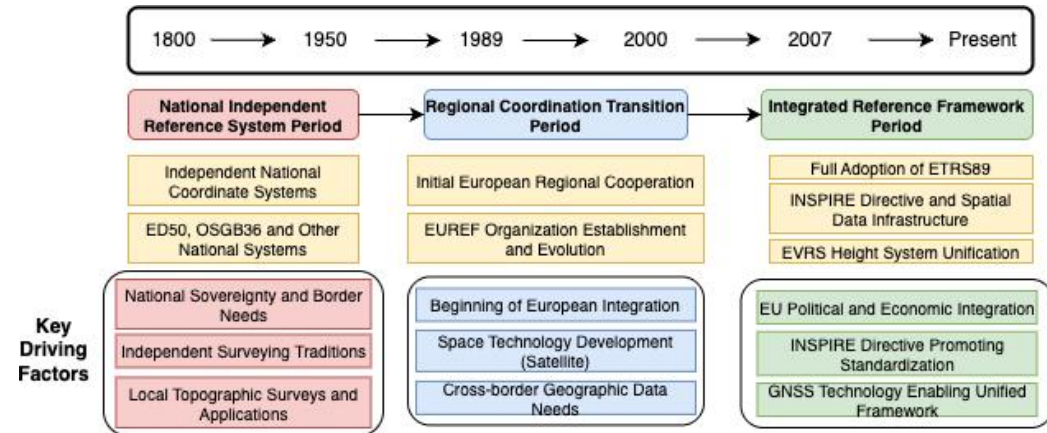
## ➤ United States: Pragmatism and Technological Frontiers in Coordinate Exploration



# European Synergy and an Island Nation's Resilience



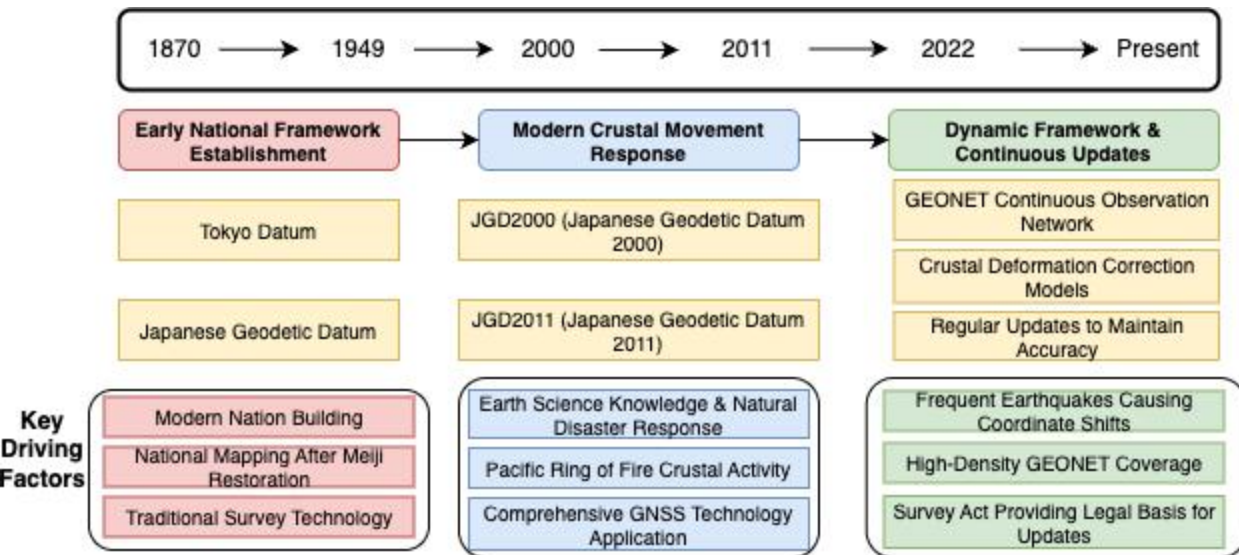
## ➤ (EU): Standardization under the Wave of Integration - ETRS89



The creation of ETRS89 exemplifies the combined effects of political will, economic needs, technological support, and regional cooperation  
 Provides Europe with a unified, high-precision 3D geocentric coordinate reference system, consistent with ITRF, greatly facilitating cross-border geographic information sharing and applications



## ➤ Japan: Coordinate Maintenance and Innovation on the Seismic Belt







## ➤ Conclusion

**Universality and Specificity of Driving Forces:** Technological advancement, political demands, economic development, scientific understanding, and international cooperation are universal factors driving the evolution of geodetic reference systems. However, each country's unique national context, stage of development, and specific challenges (such as Japan's seismic activity) lead to distinct evolutionary trajectories and dominant driving force combinations.

**Interwoven Multidimensional Drivers:** The evolution of coordinate reference systems is a complex process shaped by the interaction of multiple factors, rather than a linear, single-track technological progression.

**From National Orientation to Regional/Global Integration:** The development of reference systems reflects a transition from nation-centric approaches to efforts toward regional and even global unified frameworks.

## ➤ Outlook

**Global Dynamic Reference Frame:** Further considering factors such as plate motion, Earth rotation variations, and tides to achieve higher precision and a "living" coordinate datum.

**Continuous Refinement and Application Deepening of ITRF:** The importance of the International Terrestrial Reference Frame (ITRF) as a global standard is becoming increasingly prominent.

**Ongoing Innovation and Multi-System Integration of GNSS Technologies:** The coexistence and interoperability of multiple systems such as GPS, GLONASS, Galileo, and BeiDou will provide more robust and higher-precision positioning services, placing greater demands on coordinate systems.

**Proliferation of Real-Time Precise Positioning Services:** Emerging fields like autonomous driving, the Internet of Things, and smart cities have strong demand for real-time, high-precision, and seamless coordinate services.

**Deep Integration of Geographic Information Systems and Earth System Science:** As the "language" of spatial data, coordinate systems will play a more critical role in understanding and addressing global climate change and resource-environment challenges.

**Open Thought:** In the face of increasingly complex Earth systems and human activities, what core challenges must future coordinate reference systems still overcome?