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## Preface to the special issue “The International Union of Geodesy and Geophysics: from different spheres to a common globe”

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Many environmental challenges facing society since the last century require international solutions. Examples include exploration of the Earth and its environment in space; exploration of our rivers, oceans, and atmosphere; climate change; securing clean water and energy; and understanding and mitigating disasters due to natural hazard events. Earth and space sciences lie at the heart of these challenges and occupy a central role in international agendas.

The International Union of Geodesy and Geophysics (IUGG) has been coordinating and promoting international efforts in Earth and space sciences since 1919. Under IUGG’s umbrella, eight international scientific associations and several interdisciplinary bodies cover many disciplines of geo- and space sciences and promote research of the Earth from its core and its space environment up to the Sun. Thousands of scientists from many nations and specific scientific disciplines have developed ways of cooperation through IUGG’s international associations and learned how to work together to promote geosciences. IUGG has been initiating, developing, and implementing international cooperative programs; setting scientific standards; developing research tools; educating and building capacity; and contributing to science for policy and science diplomacy.

The purpose of this special issue (SI) is not to relay a definitive history of the development of international cooperation in the geosciences, but to summarize IUGG’s remarkable role during the 100-year span of its existence. The first part of the SI “The union: bringing together geophysical disciplines” begins with the present overview of the IUGG

mission and structure, and the circumstances of its founding and early development are presented up to the beginning of World War II. The second article starts with recovery after World War II and addresses the years of extraordinary development of geophysical science through the International Geophysical Year (IGY; 1957–1958) and the concurrent evolution of IUGG structure and programs extending up to the General Assembly of 1999. The rapid advances that have occurred thus far into the 21st century are reviewed in the third article, and foresights on IUGG future development conclude this first part of the SI. Outstanding histories of each of the IUGG associations are then told.

The second part of the SI “Around the earth: glaciers, rivers, air, and oceans” presents articles about the histories of the International Association of Cryospheric Sciences (*IACS: past, present, and future of the International Association of Cryospheric Sciences*), the International Association of Hydrological Sciences (*IAHS: a brief history of hydrology*), the International Association of Meteorology and Atmospheric Sciences (*IAMAS: a century of international cooperation in atmospheric sciences*), and the International Association for the Physical Sciences of the Oceans (*IAPSO: tales from the ocean frontier*).

The third part of the SI “Within and on the earth: gravity, magnets, earthquakes, and volcanoes” presents articles about the histories of the International Association of Geodesy (*The International Association of Geodesy: from an ideal sphere to an irregular body subjected to global change*), the International Association of Geomagnetism and Aeronomy

(*IAGA: a major role in understanding our magnetic planet*), the International Association of Seismology and Physics of the Earth's Interior (*IASPEI: its origins and the promotion of global seismology*), and the International Association of Volcanology and Chemistry of the Earth's Interior (*IAVCEI: from small beginnings to a vibrant international association*).

This volume, proposed in 2014 by the IUGG Bureau, is the combined effort of a number of authors and advisors, including past and current IUGG and association officers. We are grateful to Franz Kuglitsch and Katina Rogers Roopchansingh for their technical and editorial assistance, to Hans Volkert for proposing the title of this SI and editorial support, and to reviewers for their constructive comments and suggestions for revision of the initial manuscripts of the papers published in the SI. The IUGG archives, curated by the American Institute of Physics Center for the History of Physics (Gregory Good, director), located in College Park, MD, USA, were heavily consulted in preparation for this SI, and we acknowledge their helpful staff. We are very thankful to Kristian Schlegel, HGSS editor-in-chief, for his enthusiastic efforts and assistance in producing the SI.

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SI Editors

**Appendix A: List of acronyms**

AfSC	African Seismological Commission
AGU	American Geophysical Union
AI	artificial intelligence
AK1345	seismic travel-time model, without special meaning
AMS	Army Map Service
AOGS	Asia Oceania Geosciences Society
ASC	Asian Seismological Commission
BAS	British Antarctic Survey
BCE or BC	Before Common Era
BGI	Bureau Gravimétrique International
BHI	Bureau International de l'Heure
BIPM	Bureau International des Poids et Mesures
BV	Bulletin Volcanologique (Bulletin of Volcanology)
CAST	China Association for Science and Technology
CCEC	Commission on Climatic and Environmental Change (IUGG)
CCTF	Consultative Committee for Time and Frequency
CFC	chlorofluorocarbon
CIESM	Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée
CIG	Comite Internationale de Geophysique
CIG	Commission Internationale des Glaciers
ClIC	Climate and Cryosphere project (WCRP)
CME	coronal mass ejection
CMG	Commission on Mathematical Geophysics (IUGG)
CMIP	Coupled Model Intercomparison Project
CMSLT	Commission on Mean Sea Level and Tides
CNAA	Committee on Nucleation and Atmospheric Aerosols (of ICCP)
CNES	Centre National d'Etudes Spatiales, France
CO <sub>2</sub>	carbon dioxide
CODATA	Committee on Data for Science and Technology
COSPAR	Committee on Space Research
COSTED	Committee on Science and Technology in Developing Countries
CoV	Cities on Volcanoes
COWAR	Committee on Water Research
CRCM	Commission on Recent Crustal Movements
CSAGI	Committee for the International Geophysical Year
CSR	Committee on Space Research (IUGG)
CSTG	Coordination of Space Techniques for Geodesy and Geodynamics
CTBT	Comprehensive Nuclear-Test-Ban Treaty
DACA-13	Davos Atmosphere and Cryosphere Assembly, 2013
DC	District of Columbia
DFG	German Research Foundation
DMI	Danish Meteorological Institute
DOES	Deep Ocean Exchange with the Shelf
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
EC	Executive Committee
ECR	early career researcher
ECS	early career scientist
ECV	essential climate variable
ED50	European Datum 1950
EGIG	Expédition Glaciologique Internationale au Groenland 1957–1960
eGY	electronic Geophysical Year
EMSEV	Inter-Association Working Group on Electromagnetic Studies of Earthquakes and Volcanoes

ENHANS	Extreme Natural Hazards and Societal Implications
ENSO	El Niño–Southern Oscillation
EOS-80	International Equation of State of Seawater – 1980
EOST	Ecole et Observatoire des Sciences de la Terre, Strasbourg
ESA	European Space Agency
ESC	European Seismological Commission
ESM	Earth System Model
FAGS	Federation of Astronomical and Geophysical Data Analysis Services
FAO	The Food and Agriculture Organization of the United Nations
FDSN	International Federation of Digital Seismograph Networks
FIG	Fédération Internationale de Géomètres
FRG	Federal Republic of Germany
G7	Group of Seven countries: Canada, France, Germany, Italy, Japan, UK, and USA
GA	general assembly
GAPHAZ	Glacier and Permafrost Hazards in Mountains standing group (IACS & IPA)
GARP	Global Atmospheric Research Program
GCOS	Global Climate Observing System
GDP	International Geodynamics Project
GDR	German Democratic Republic
GEBCO	General Bathymetric Chart of the Oceans
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GEWEX	Global Energy and Water Exchanges project (WCRP)
GFZ	German Research Centre for Geosciences
GGOS	Global Geodetic Observing System
GGRF	Global Geodetic Reference Frame
GGP	Global Geodynamics Project
GIS	Geographic Information System
GLASS	GEWEX Land Atmosphere System Study
GLIMS	Global Land Ice Measurements from Space initiative
GLOF	glacier lake outburst flood
GLOSS	Global Sea Level Observing System
GNSS	Global Navigation Satellite Systems
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GRC	Commission on Geophysical Risk and Sustainability (IUGG)
GRS 67	Geodetic Reference System 1967
GRS 80	Geodetic Reference System 1980
GRACE	Gravity Recovery And Climate Experiment
GTN-G	Global Terrestrial Network for Glaciers (GCOS)
GVP	Global Volcanism Program (SI)
HMS	His/Her Majesty's Ship
HMSH	His Most Serene Highness
HSJ	Hydrological Sciences Journal (IAHS)
IABO	International Association for Biological Oceanography
IACS	International Association of Cryospheric Sciences (IUGG)
IAG	International Association of Geodesy (IUGG)
IAGA	International Association of Geomagnetism and Aeronomy (IUGG)
IAGC	International Association of Geochemistry and Cosmochemistry
IAGP	International Antarctic Glaciological Project
IAHR	International Association of Hydraulic Research
IAHS	International Association of Hydrological Sciences (IUGG)
IAM	International Association for Meteorology (IUGG); previous name for IAMAS
IAMAP	International Association of Meteorology and Atmospheric Physics (IUGG); previous name for IAMAS
IAMAS	International Association of Meteorology and Atmospheric Sciences (IUGG)

IAPO	International Association of Physical Oceanography (IUGG); previous name for IAPSO
IAPSO	International Association for the Physical Sciences of the Oceans (IUGG)
IAPWS	International Association for the Properties of Water and Steam
IASC	International Arctic Science Committee
IASH	International Association of Scientific Hydrology (IUGG); previous name for IAHS
IASPEI	International Association of Seismology and Physics of the Earth's Interior (IUGG)
IASPEI91	seismic travel-time model, without special meaning
IASY	International Years of the Active Sun
IATME	International Association of Terrestrial Magnetism and Electricity (IUGG); previous name for IAGA
IAU	International Astronomical Union
IAV	International Association of Volcanology (IUGG); previous name for IAVCEI
IAVCEI	International Association of Volcanology and Chemistry of the Earth's Interior (IUGG)
ICACGP	International Commission of Atmospheric Chemistry and Global Pollution (IAMAS)
ICAE	International Commission on Atmospheric Electricity (IAMAS)
ICAO	International Civil Aviation Organization
ICCE	International Commission on Continental Erosion (IAHS)
ICCL	International Commission on Climate (IAMAS)
ICCLAS	International Commission on the Coupled Land-Atmosphere System
ICCP	International Commission of Clouds and Precipitation (IAMAS)
ICCT	Inter-Commission Committee on Theory (IAG)
ICDM	International Commission on Dynamical Meteorology (IAMAS)
ICES	International Council for the Exploration of the Sea
ICET	International Centre for Earth Tides
ICGEM	International Centre for Global Earth Models
ICGW	International Commission on Groundwater (IAHS)
ICMA	International Commission on the Middle Atmosphere (IAMAS)
ICPAE	International Commission on Planetary Atmospheres and their Evolution (IAMAS)
ICPM	International Commission on Polar Meteorology (IAMAS)
ICRCM	International Centre on Recent Crustal Movements
ICRS	International Commission on Remote Sensing (IAHS)
ICSH	International Commission on Statistical Hydrology (IAHS)
ICSI	International Commission on Snow and Ice (IAHS)
ICSIH	International Commission on Snow and Ice Hydrology (IAHS)
ICSU	International Council for Science; formerly, International Council of Scientific Unions
ICSW	International Commission on Surface Water (IAHS)
ICT	International Commission on Tracers
ICTP	Abdus Salam International Centre for Theoretical Physics
ICWQ	International Commission on Water Quality (IAHS)
ICWRS	International Commission on Water Resources Systems (IAHS)
IDEMS	International Digital Elevation Model Service
IDNDR	International Decade for Natural Disaster Reduction
IDS	International DORIS Service
IEEY	International Equatorial Electrojet Year
IERS	International Earth Rotation Service
IGAC	International Global Atmospheric Chemistry Experiment
IGBP	International Geosphere-Biosphere Programme
IGC	International Geological Congress
IGEMS	Integrated Global Earth Monitoring System
IGeS	International Geoid Service
IGETS	International Geodynamics and Earth Tide Service
IGFS	International Gravity Field Service
IGRF	International Geomagnetic Reference Field
IGS	International GNSS Service (previously International GPS Geodynamics Service, International Service for Geodynamics)
IGS	International Glaciological Society

IGSN 71	International Gravity Standardization Net 1971
IGY	International Geophysical Year
IHA	International Hydrology Association
IHD	International Hydrological Decade
IHDP	International Human Dimensions Programme
IHP	International Hydrological Programme
IHY	International Heliophysical Year
IIOE-2	Second International Indian Ocean Expedition
iLEAPS	Integrated Land Ecosystem-Atmosphere Processes Study
ILP	International Lithosphere Program
ILRS	International Laser Ranging Service
ILS	International Latitude Service
IMO	International Meteorological Organization; former name for the WMO
IOC	Intergovernmental Oceanographic Commission
IOC or IO <sub>3</sub> C	International Ozone Commission (IAMAS)
IOS	UK Institute of Oceanographic Sciences
ION	International Ocean Network
IPA	International Permafrost Association
IPCC	International Panel on Climate Change
IPGH	Instituto Panamericano de Geografia Historia (also PAIGH)
IPMS	International Polar Motion Service
IPY	International Polar Year
IPYDIS	IPY Data and Information Service
IQSY	International Years of the Quiet Sun
IRC	International Research Council
IRC	International Radiation Commission (IAMAS)
IRDR	Integrated Research on Disaster Risk
ISA	International Seismological Association
ISC	International Science Council
ISC	International Seismological Centre (UK)
ISG	International Service for the Geoid
ISGI	International Service of Geomagnetic Indices
ISO	International Organization for Standardization
ISS	International Seismological Summary
ISSC	International Social Science Council
ITD	inter- and trans-disciplinary
ITRF	International Terrestrial Reference Frame
ITU	International Telecommunications Union
IUBS	International Union of Biological Sciences
IUCI	Inter-Union Commission on the Ionosphere
IUCRM	Inter-Union Commission on Radio Meteorology
IUCSTP	Inter-Union Commission on Solar-Terrestrial Physics
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
IUPAC	International Union of Pure and Applied Chemistry
IUPAP	International Union of Pure and Applied Physics
IVS	International VLBI Service for Geodesy and Astrometry
IY	International Year
IYD	International Year of Deltas
IYGU	International Year of Global Understanding
IYPE	International Year of the Planet Earth
JCS	The Joint Committee on the Properties of Seawater
JPOTS	Joint Panel on Oceanographic Tables and Standards
KIT	Karlsruhe Institute of Technology, Germany

LACSC	Latin American and Caribbean Seismological Commission
LOICZ	Land-Ocean Interactions in the Coastal Zone
MAP	Middle Atmosphere Programme
MEMS	micro-electro-mechanical systems
MOCA-09	Meteorology, Ocean and Cryosphere Assembly, held in Montreal in 2009
MOCA-21	Meteorology, Ocean and Cryosphere Assembly, to be held in Busan, Republic of Korea, in 2021
m.s.l.	mean sea level
NASA	National Aeronautics and Space Administration (USA)
NMSOP-2	New Manual of the Seismological Observatory Practice (second edition)
NNR NUVEL-1A	No Net Rotation Northwestern University Velocity model 1A
NSIDC	National Snow and Ice Data Center (USA)
OGO	Orbiting Geophysical Observatory
OSIL	Ocean Scientific International Ltd.
PAIGH	Pan-American Institute of Geography and History (also IPGH)
PC	personal computer
PIAHS	Proceedings of IAHS
PIOSA	Pan-Indian Ocean Science Association
POGO	Polar Orbiting Geophysical Observatory
PRC	People's Republic of China
PREM	Preliminary Reference Earth Model (IASPEI)
PSA	Pacific Science Association
PSFG	Permanent Service on the Fluctuations of Glaciers
PSMSL	Permanent Service for Mean Sea Level
PSS-78	Practical Salinity Scale 1978
PUB	Prediction in Ungauged Basins program (IAHS)
RETrig	Réseau Européen de Triangulation
REUN	Réseau Européen Unifié de Nivellement
ROC	Republic of China
ROSTSEA	UNESCO Regional Office for Science and Technology for Southwest Asia
SA	scientific assembly
SCAR	Scientific Committee on Antarctic Research
SCL	Scientific Committee on the Lithosphere
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee on Ocean Research
SCOSTEP	Scientific Committee on Solar-Terrestrial Physics
SCOWAR	Scientific Committee on Water Research
SDG	Sustainable Development Goal
SDO	Solar Dynamics Observatory
SEAN	Scientific Event Alert Network
SEDI	Commission on Study of Earth's Deep Interior (IUGG)
SFE	solar flare effect
SHS	Section d'Hydrologie Scientifique (IUGG)
SI	Smithsonian Institute for Natural Sciences
SLR	satellite laser ranging
SnowMIP	Snow Model Intercomparison Project
SOHO	Solar and Heliospheric Observatory
SOLAS	Surface Ocean-Lower Atmosphere Study
SP6	seismic travel-time model, without special meaning
SPARC	Stratosphere-troposphere Processes And their Role in Climate
$S_R$	Reference Salinity
SSC	storm sudden commencement
SST	Sea surface temperature
SV	Section of Volcanology (IUGG)
TEOS-10	Thermodynamic Equation of Seawater – 2010

TFDC	Task Force for Developing Countries (IAHS)
TGF	transient gamma ray bursts
TLE	transient luminous events
TS/WGI	Technical Secretariat for the World Glacier Inventory
UAV	unmanned aerial vehicles
UCCS	Commission for the Cryospheric Sciences (IUGG)
UCDI	Commission on Data and Information (IUGG)
UCPS	Commission on Planetary Sciences (IUGG)
UGGI	Union Géodésique et Géophysique Internationale (French name of IUGG)
UK	United Kingdom
UMC	Upper Mantle Committee
UMP	Upper Mantle Project
UN	United Nations
UNEP	UN Environmental Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISDR	United Nations Office for Disaster Risk Reduction, established to ensure the implementation of the International Strategy for Disaster Reduction
URSI	Union Radio Scientifique Internationale (International Union of Radio Sciences)
USA	United States of America
USD	USA dollar
USSR	Union of Soviet Socialist Republics
UV radiation	ultraviolet radiation from the Sun
VERSIM	VLf/ELF Remote Sensing of Ionospheres and Magnetospheres
VLBI	very long baseline interferometry
WCRP	World Climate Research Programme
WDMAM	World Digital Magnetic Anomaly Map
WDC	World Data Center
WDS	World Data System
WG	working group
WGH	Union Working Group on History of Earth and Space Sciences (IUGG)
WGMS	World Glacier Monitoring Service
WMO	World Meteorological Organization
WMS	World Magnetic Survey
WWI	First World War
WWII	Second World War