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ABSTRACTS

Contents

SESSION I: PARTNERSHIP, COORDINATION AND COOPERATION

Per Astra Ad Agro: The NISAR Project

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Abstract

The NISAR Project, a portmanteau of NASA-ISRO and SAT (Synthetic Aperture Radar), its name being symbolic to the joint efforts carried out by the United States of America and India, aims to launch a satellite in the year 2023 to map the various climatic changes observable on the Earth's crust. The Satellite shall be equipped with the largest reflector antenna that neither of the Agencies has launched till date. According to the official website of the NISAR Project, it aims to provide an 'unprecedented' view of the Earth, owing to the latest technological innovations it encapsulates in its structure. The prospective data to be collected by the Satellite shall enable better mapping of the slightest changes on the Earth's outer layer, which shall further help in (*inter alia)* better managing of our limited natural resources and better responsive planning for future hazardous events. It shall also be equipped with issuing of warning signals for volcanic eruptions, melting ice caps, rising sea levels, and depleting groundwater levels. Apart from this, the Satellite shall also keep a track on vegetation and its transition and movement across the globe. This inter-agency Project has a huge significance, particularly from a socialistic perspective.

A Report released in September, 2021, by the Indian Agriculture and Allied Industries Industry, reflected that around 58% of the total population of India is dependent upon the Agricultural Sector as a primary source of income. Though the majority of the Indian population depends upon this sector, certain issues such as mapping of groundwater levels, and the effects of climatic change on vegetation, are still a major cause for concern with our farmers. The data collected by the Satellite shall be beneficial to farmers, specially who are the backbone of majorly agrarian-based economies. It shall also prove to be significant for policy-makers in better planning of agrarian policies, which shall be based on the best factual data available.

The NISAR Project is a symbolic step which reflects increasing international inter-agency cooperation in mapping the pace and effects of climate change. It also enshrines the goal of socialistic approach in using the space data and its assets, including its sustainable use.

Keywords: NISAR Project, Space for Sustainability, Space4Climate Action, space-based applications, socialistic utilization of space data, international cooperation

Bringing the benefits of Space with Integration of Indigenous Knowledge in support of SDG13

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Abstract

With the challenges of accelerated technological inequalities amongst Indigenous Peoples for climate action, there is an urgent need to bridge the gap with the space science and technology communities. The Indigenous knowledge (IK) is valuable and can be further complemented with space-based solutions that focus on ecosystem and environment with great relevance to the civilization. However, there is a need to examine and identify challenges and barriers for Indigenous communities to implement workable and replicable emerging space-based solutions. This presentation highlights examples of series of successful initiatives undertaken during 2020-21 by CANEUS in collaboration and partnership with FILAC (only Indigenous "Inter-Governmental" organization with Permanent Observer representation at the United Nations) and UNOOSA, to help the Indigenous communities bridge the gap using space technologies. CANEUS was the founding partner of UNFCC's Resilience Frontiers Indigenous initiative launched at Songdo, Korea, and invited contributor for space applications to the UN Secretary General's Indigenous Climate Action Summit held at UN-NY on Sept 21-22, 2019. The joint initiatives by CANEUS-FILAC-UNOOSA have been steered using the "Guidance Note for the UN System prepared by the UN Inter- Agency Support Group (IASG) on Indigenous issues" in April 2020, which recommended that the UN system engage with Indigenous Peoples and promotes their participation through traditional knowledge with science experts. Furthermore, these focused activities, covering pilot projects, capacity development training programs, and planned dedicated "Indigenous Knowledge Research Infrastructure (IKRI)", are designed to address challenges covering youth empowerment & entrepreneurship, climate change, food security, ecosystem-based climate risk reduction, amongst others, which are being pursued through FILAC-CANEUS 5-year 2021-2025 cooperation agreement supported by UNOOSA. The results from the completed and ongoing initiatives offer key measurable impacts and recommendations contributing to bridge the space technological and gender inequalities. Based on the lessons learned, this presentation underlines the gaps and barriers and offers potential solutions covering structured framework and mechanisms for integrating IK with space science and technologies for its universal use as one of the key tools.

Keywords: Indigenous Knowledge, Technological Inequalities, Youth Empowerment, Integrated Space Solutions, Global partnership, CANEUS-FILAC-UNOOSA

SESSION III: SPACE-BASED SOLUTIONS FOR CLIMATE ACTION – WHERE ARE THE NEEDS AND WHAT IS THE USER PERSPECTIVE

Monitoring land surface properties with Galileo Reflectometry

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Abstract

Monitoring land surface dynamics is crucial for plant growth and crop yield, as well as for flood/drought, freeze/thaw, and erosion prediction. For instance, soil moisture is a key parameter for planning and managing irrigation strategies, while it simultaneously regulates energy and water exchange between the land and the atmosphere, and other hydrological and climate processes. Land surface dynamics can be estimated locally from a wide variety of direct methods and techniques. However, these traditional methods are expensive and cumbersome over large areas, whereas microwave measurements from unmanned aerial vehicles and satellites have shown numerous advantages, including revisiting time, global coverage, low cost, all-weather measurements, and near real-time data availability. Galileo Reflectometry (Galileo-R) is an innovative Earth observation technology using the signal of opportunity for terrestrial remote sensing, which employs the Earth's surface bouncing of signal transmitted from Galileo satellites to remotely sense geophysical parameters of interface for Earth observation, such as soil moisture, freezing and thawing, forest biomass, inland water and wetlands, etc. A Galileo-R system holds the same geometrical configuration properties of a bi-static radar, providing physical information of a surface, including reflectivity, which allows the assessment of soil dielectric properties and estimation of several land surface parameters. Compared with the traditional monostatic remote sensing, a Galileo-R platform just need to carry a delay/Doppler receiver. These receivers have numerous advantages, including low cost, low mass, and low power consumption. This greatly reduces the costs with respect to traditional techniques, and eases the installation of Galileo-R receivers in any kind of platform (drones, airplanes, satellites, etc.). This project aims to employ Galileo signals for terrestrial remote sensing such as soil moisture and freeze/thaw parameters, and validate and/or combine the resulting output with traditional products. First results for soil moisture and freeze/thaw retrieval using Navstar Global Positioning System (GPS) receivers onboard the Cyclone Global Navigation Satellite System (CYGNSS) satellites have been already published in peer-reviewed academic journals. In our previous work, the reflectivity data from CYGNSS was successfully combined with data from NASA's Soil Moisture Active Passive (SMAP) mission to retrieve soil moisture content (SMC) estimates, and the results were validated with SMAP SMC products [Calabia et al., 2020, doi:10.3390/rs12010122]. The first part of the project will be the installation of a Galileo-R sensor onboard an unmanned aerial vehicle, being an ideal solution for planning and managing irrigation strategies. This low cost application will open the possibility to upgrade to multi-constellation / multi-frequency receivers, and to install a similar receiver in a CubeSat mission. This will be an efficient solution to cover larger regions, ideal for climate change and many other applications. The use of Galileo-R can potentially increase the data coverage and revisiting time that the present techniques offer for terrestrial remote sensing in the microwave domain.

Keywords: GNSS-R, Galileo, Soil Moisture, Microwave Remote Sensing

Prevention of natural disasters, threats and risks, through immediate satellite mapping in South America

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Abstract

Earth observation satellites are a valuable tool for understanding dynamic phenomena in the environment. This work seeks to measure, justify, raise awareness and provide information on the causes and effects associated with climate change, approached from the respective satellite mapping, analyzing natural disasters, threats and risks that occur in various areas of the world, especially in fire situations in Bolivia, and South America. The study has evaluated the current situation with respect to satellites, assessing their detection of atmospheric, hydrological, volcanic disasters, and even some threats, as well as the problems that the general population currently faces to act at this time. Due to the shortage of information in the region and in Bolivia, there is a need for satellite images, with the different bands, frequencies, colors, scale, patterns, texture, complementing projects, and working with specialized satellites, such as NOAA / NASA, NOAA-18, NOAA-19, GOES-16 and GOES-17. In order to provide data for the coherent detection of changes and daily interferometry, synthesize the information, launch an audible application that operates immediately, acquiring the information through remote sensing, collecting data from the earth's surface, it will provide the images in perceptible frequencies. The addition of geometric characteristics such as the wind vector will show the classification of coverage in satellite images automatically, in real time, accurately and economically, in addition to saving the information on the situation. Remote sensing and early warning system, with monitoring and focus on the most recurrent fire places, such as fires in the Amazonas, Chiquitania, places with heat waves, droughts, prone to fires, will provide warning information together with the security system, that will help both the different search, assistance, and rescue groups, as well as the knowledge to the general public about their risk areas, areas of natural disasters, as an effective prevention, to avoid the depredation of the forests, the loss of lives and prevent other possible future disasters, thus achieving effective action in these scenarios, ensuring that in each emergency valuable seconds and resources are optimized with respect to the event.

Keywords: Cooperation Project with SAR Satellites, Fires in the Chiquitania, Amazonas, Tunari and other places in Bolivia, Space4 Climate Action, Climate Change in South America, Natural Disasters and threat

SESSION IV: EXAMPLES AND SUCCESSFUL INITIATIVES

Space in response to Covid pandemic: EPICO19

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Abstract

EPICO19 is a European Space Agency demonstrator project designed by a consortium of SMEs, public health authorities and research institutes that developed a Web based GIS (Geographic Information System) DSS (Decision Support System) aiming to support health organisations and decision-makers in their response to pandemics, in this case COVID19. The web service runs an epidemiology model that uses satellite data to derive population mobility indexes combined with environmental-meteorological conditions in order to improve the forecasting accuracy. EPICO19 system is being tested in the Reggio Emilia province (Emilia-Romagna Region-Italy) in close collaboration with the Reggio Emilia Health Authority (Azienda USL di Reggio Emilia). The goal of the project was to: to assess the effect of public health measures according to a what-if approach both in the past and in the future: e.g. modelling what would have happened in the first and second wave identifying the best interventions to better control a possible third wave; to monitor vulnerability and crowding of population through satellite observation, respectively modelling exposure to air pollution and counting and geo-locating vehicles with an AI engine; to implement a DSS (Decision Support System) integrating all the previous functionalities in a single Web-platform. The space data component comprises a CAMS (Copernicus Atmosphere Monitoring Service) forecast and reanalysis service which merges observations either from satellite sensors (e.g, Sentinel-5P) and ground data, combining and modelling them to estimate PM10, PM2.5, NO2 air concentration. Air pollution is then used to assess the vulnerability of the population coupled with the meteorological conditions that may influence the spread of the infection. The novelty of its approach is the use of VHR satellite and aerial imagery, with a ground resolution respectively of 30-50 cm and 11 cm, used to estimate the population exposure. Images were analysed by a deep learning computer vision algorithm developed by Studiomapp that counts the number of cars, busses or trucks so as to assess the presence of people in sites where crowding is expected to occur, such as hospitals, parking lots, supermarkets, working places, train stations, and logistic hubs.

Keywords: Space4Climate Action, Space-based applications, SDG3 Good Health and Well-being, Artificial Intelligence, Health, COVID19

Towards the establishment of a global e-Biodiversity network for Sustainable Development Goals accomplishment and Ecosystem Services provision

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Abstract

The warnings of 15.000 scientists of the United Nations Paris Climate Change Conference (COP21) and subsequent COPs, jointly with the UN Global Assessment Study, clearly demonstrate that humanity is bringing our life support system, the biosphere, to the point of collapse. Counteracting the current loss of biodiversity and the accelerating rate of species extinction must become our highest priority, not only for ecological and environmental reasons but because it is already a major underlying cause of poverty, increasing social inequalities, growing global economic uncertainty, and conflicts over access to crucial natural resources, including clean water, food, air and energy supplies. The first steps in tackling this crisis must be to improve our current level of knowledge, to move beyond the present fragmentation of science, and to foster greater complementarity and synergy between disciplines by developing new trans-disciplinary paradigms and starting to build synthetic knowledge to boost innovation and involve more young scientists and civil society. LifeWatch ERIC, the e-Science European Infrastructure for Biodiversity and Ecosystem Research & Sustainable Management, is Europe's first line of response to this emergency by applying the ""state-of-art"" of ICT (Remote Sensing, Big Data, HPC-Cloud-Edge Computing, Blockchain, AI-Machine Learning, IoT-Sensor Networks, etc.), interconnecting and providing service to scientific Communities-of-Practice and research centres internationally through its distributed e-Infrastructure. Indeed, LifeWatch ERIC is engaging with Researchers-Technologists, Decision Makers-Environmental Managers, Companies and Entrepreneurs, and last but not least, Citizen Scientists. These stakeholders develop their activities into their Virtual Research Environments (VRE) of the e-Science Infrastructures, by clearly demonstrating the added value which ICT bring to address challenging ""The Big Five"" significant causes of biodiversity loss, alongside habitat destruction, over-exploitation, climate change and pollution (Millennium Ecosystem Assessment, 2005), and measures to control their introduction and establishment which are urgently needed (Aichi Target 9; CBD 2010). These activities are being carried out in synergy with the UNSDGs (in particular, #15 and #14) and Agenda2030, EU-Biodiversity Strategy for 2030 and Green Deal plans, and in addition without neglecting the essential role of the forthcoming Neighborhood, Development and International Cooperation Instrument (NDICI)/Global Europa (e.g. expressed through the current EU-CELAC and EU-African Union cooperation) in relation to the importance of the Indigenous Knowledge reflected, through the recently created Indigenous Knowledge Research Infrastructure (IKRI) where key outcome are expected in cooperation with outstanding stakeholders, including The United National Office for Outer Space Affairs (UNOOSA), The UN International Telecommunications Union (ITU) and LifeWatch ERIC.

Keywords: Climate change, EU Green Deal & Biodiversity 2030, Ecosystem Services, Digitalization for Sustainability, Remote Sensing, International Cooperation –NDICI– for Indigenous Knowledge – IKRI

SESSION V: RECOMMENDATIONS, INNOVATIVE AND NEW APPROACHES

Monitoring emissions from space: rationale and way forward

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Abstract

As the climate change issues come to the fore of the global agenda, with the empirical evidence provided vividly by the IPCC and other stakeholders, the more countries launch long-term emissions reduction programs with some economies making ambitious net zero commitments. At the center of these efforts are both non-market and market-based tools, the latter creating an actual emissions price. According to the ADB, as of now there are at least 64 carbon pricing instruments covering about 21.5% of GHG emissions globally. The analysis conducted by PwC and WEF indicates that if made international, a carbon price could help keep temperatures from rising above 2°C. This is a very lucrative scheme, especially amidst severe challenges of compromising the "fossil fuels" language on a multilateral basis. With divergences relating to the scope of countries' carbon pricing instruments, coverage of emissions and procedural rules, there is a clear similarity in the need to back them up with systems ensuring accurate monitoring (and further verification) of emissions reduction. Whether these be direct bilateral cooperation of the Parties or the UN-wide mechanism with a separate rulebook on designing emissions reduction activities – both require adequate technical solutions. Most preferably – interoperable solutions, since common international standards and principles of climate monitoring are essential for synchronizing domestic efforts, creating transparent and predictable environment for public and private entities, boosting investments into globally recognized sustainable projects. In this vein, several space actors including Russia, USA, ESA, and Canada have already unveiled programs of monitoring specifically GHG emissions from space, to complement their Earth Observation systems and ground-based infrastructure for overseeing changes in natural ecosystems. Remarkably, as the exchange of respective plans at "space" session in Glasgow demonstrated, it is not the case that any of the systems will uniquely cover the demand for monitoring global emissions (at least in the near future). Initiated activities range in geographical scope, gases tracked, frequency of data publication, customers served. The diversity of operational objectives is multiplied with lacking unanimity in regard to methodology of processing and interpreting data received from outer space. Multilateral cooperation, therefore, comes as the most viable solution that could let the global community (1) objectively and comprehensively measure the progress, and consequently (2) build sophisticated mitigation and adaptation policies, including carbon pricing mechanisms, based on these measurements. Platforms like UNOOSA, as well as Group of Twenty, APEC and other formats having incorporated the "climate/space" nexus in their agenda could undoubtedly contribute to the debate.

Keywords: emissions reduction, carbon pricing, monitoring, multilateral cooperation

Sky Indicators x Climate: A Noctilucent Cloud Observation Approach Toward Climate Monitoring

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On August 9, 2021, the Intergovernmental Panel on Climate Change indicated that human influence has warmed the atmosphere, ocean, and land. The report attempts to improve the understanding of this influence on a range of climate characteristics causing change. These characteristics are limited, and any future predictive climate models will have to be based on proven causal pathways. Noctilucent clouds (NLCs) might be one such pathway. These upper atmospheric “ice” or “night-shining” clouds may be our only current visual window into changes in the atmosphere altogether, informing our understanding of how increased carbon dioxide and methane drive NLC growth and how that may demonstrate one cause of global temperature increase. They form when water vapor rises to the mesosphere then crystallizes around specks of meteor smoke, floating at approximately 80 kilometers above the ground. For adequate analysis, we need ground observation, balloon-borne imagining, and polar orbiting satellite data to investigate their correlation to climate shifts. In 2017 our team created a Facebook page to collect ground observation photos and videos of these clouds from around the world. This citizen-science community shares sightings, contributing to a growing body of data that our team organizes, analyzes, and quantifies. This methodology has gradually improved the quality of data collected, increased the frequency of reporting, and enabled us to compare findings with outcomes from the Polar Suborbital Science in the Upper Mesosphere research, Polar Mesospheric Cloud Turbulence imaging campaigns, and the Aeronomy of Ice in the Mesosphere satellite missions. Through a seasonal comparison of ground observations and a trend analysis, we combine various space technologies to discern if the presence of NLCs with measurable concentrations of carbon dioxide and methane in the troposphere are connected to climate shifts in the lower atmosphere. This project puts transformative and accessible power into the hands of citizens cooperating across the planet, working towards achieving several of the Sustainable Development Goals, notably Goal 13 “Climate Action”. Ultimately, NLCs might help us better inform strategies for adaptation and resilience. Our project serves as an affordable and scalable approach relevant for all stakeholders.

Keywords: Citizen-Science, Atmosphere, Climate, Space4Climate Action, International Collaboration, Space-based Applications

The role of space-based data in European Climate Policies

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Abstract

Scientific research building on suitable and reliable datasets is essential to better understand and monitor the extent and consequences of climate change and to support effective public strategies and policies in this domain. In this context, space systems provide unique and essential capabilities and data. In fact, more than half of the Essential Climate Variables (ECVs) necessary to understand the state of climate change are measured from space. While European countries all use space to various extent to inform their climate policies and all have unrestricted access to Copernicus datasets, the essential role played by space-based data is not always fairly reflected in climate policies in Europe. Policy measures regarding the use of space systems are rare. Additionally, there are limited references to space, ESA, and EU Space programmes.

Drawing on extensive research conducted at the European Space Policy Institute (ESPI) with the support of the ESA Climate Change Initiative, this paper will provide a detailed policy landscaping on the use and references to space-based data in the climate policies of ESA Member States. Then, it will assess the potential reasons for the limited number of references to space as well as outstanding issues in the use of space in the policymaking process. It will particularly address the difficulty to measure the policy impact of space-based data as well as the indirect and peripheral nature of references to space in climate policies. Finally, the paper will provide some recommendations to bridge the gap between science and policy and increase the use of space-based data in the climate policymaking process.

The innovative character of this paper is that it provides a comparative analysis of the use of space-based data in ESA Member States from a policy perspective.

Keywords: climate change, ESA, policy, space-based data, Space4 Climate Action