

Joint CSA-DLR-INTA

Scientific Announcement of Opportunity

Canadian Space Agency (CSA)



German Aerospace Center (DLR)



Spanish National Institute of Aerospace
Technology (INTA)



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1 ACRONYMS

AO	Announcement of Opportunity
CSA	Canadian Space Agency
EULA	End user license agreement
DLR	German Aerospace Center
INTA	Spanish National Institute of Aerospace Technology
PAZ	Spanish Synthetic Aperture Radar in X-band
PI	Principal Investigator
PAZ	PAZ is the Spanish Earth Observation Satellite using Synthetic Aperture Radar in X-band
RCM	RADARSAT Constellation Mission
SAR	Synthetic Aperture Radar
SC	ScanSAR
SL	Spotlight
SM	Stripmap
ST	Staring Spotlight
TSX	TerraSAR-X: is the German Earth Observation Satellite using Synthetic Aperture Radar in X-band (mono-static)
TDX	TanDEM-X: stands for TerraSAR-X add-on for Digital Elevation Measurement (bi-static)

2 PURPOSE AND SCOPE OF THE CALL

This call is intended to foster the joint scientific use of SAR products provided by RCM (CSA), TSX and TDX (DLR) and PAZ (INTA) missions, focusing on the evaluation of these sensors and missions for research on algorithms, methods and applications.

3 ONLINE PROPOSAL SUBMISSION WEBSITES

Researchers interested in the submission of a proposal shall read carefully this document that states the limitations and highlights for an acceptable proposal.

It has to be considered that although this is a Joint Announcement of Opportunity, interested researchers shall send their scientific proposals to the Institutions, DLR and INTA. Each institution will independently evaluate the proposals and provide their approvals. CSA will be involved in the proposal evaluation processes of both INTA and DLR regarding the provision of RCM data.

- No RCM proposal is required.
- The TerraSAR-X proposal must be sent in a pre-defined format by Email to tsx.science@dlr.de . Templates are available at <http://sss.terrasar-x.dlr.de/> .
- To access TanDEM-X data, the secure online submission website is: <https://tandemx-science.dlr.de/>
- To access PAZ-science data, the secure online submission website is: <https://www.inta.es/paz-ciencia/en/AO/ao-006/>

4 APPLICABLE DOCUMENTS

Reference	Title
AD-1	All Documents available on the TerraSAR-X science server (http://sss.terrasar-x.dlr.de)
AD-2	All Documents available on the TanDEM-X science server (https://tandemx-science.dlr.de/)
AD-3	All Documents available on the INTA science server (https://www.inta.es/paz-ciencia/en/paz-science-activities/)
AD-4	Alberto Alonso-González, Member, IEEE, Nuria Gimeno Martínez, Irena Hajnsek, Fellow, IEEE, Patricia Cifuentes Revenga, María José González Bonilla, Christo Grigorov, Achim Roth, Ursula Marschalk, Nuria Casal Vázquez, Juan Manuel Cuerda, Marcos Gracia Rodríguez and Alberto Moreira, Fellow, IEEE, Joint PAZ & TanDEM-X Mission Interferometric Experiments: Performance and Products in IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, accepted

5 DESCRIPTION OF THE JOINT ANNOUNCEMENT OF OPPORTUNITY

5.1 Objectives of the Joint CSA, DLR and INTA Opportunity

This call is intended to explore the scientific possibilities of SAR products provided by the RCM (CSA), TSX and TDX (DLR) and PAZ (INTA) missions.

- Explore the influence of sensor wavelength
 - o The three RCM satellites operate in C-Band whereas TSX, TDX and PAZ operate in X-Band
- Explore the influence of different polarization
- Explore imaging modes and resolutions
- Take advantage of improved revisit time and temporal coverage

The three RCM satellites are identical and evenly spaced on the same orbital plane at an altitude of 600 km. This three-satellite configuration provides daily revisits (on average) of Canada's vast territory and maritime approaches, including the Arctic up to 4 times a day, as well as daily access to any point on 90% of the world's surface.

The two German satellites of the TerraSAR-X/TanDEM-X mission and the Spanish PAZ mission are almost identical and they were launched in the same orbital plane (offset 98.18° in true anomaly) at an altitude of 517 km. Comparable images of the same area under the same geometry may be regularly acquired by them. This allows the simultaneous use of TSX, TDX and PAZ missions for building larger time series and improving the revisit time of 11 days for each mission up to 4 or 7 days while combining both.

5.2 General Guidelines

The present document describes the Call to conduct research and development projects lead by **German, Spanish and Canadian** investigators that will utilize RCM, PAZ AND TerraSAR-X/TanDEM-X data. The Joint RCM, TerraSAR-X, TanDEM-X and PAZ call is based on the reception and approval of Scientific Proposals.

Although it is a common AO, interested research teams shall submit their proposal to both, DLR and INTA, for the independent revision of each institution as well as the signature of PAZ EULA (for the use of PAZ scientific products).

Despite of the project approval, project acquisitions are dependent on specific mission restrictions, such as specific scientific quota or commercial priority. Area of interest can be selected from the reference test sites specified in section 7 of this document.

5.3 Schedule

The joint RCM, TerraSAR-X, TanDEM-X, PAZ announcement of opportunity is expected to be open in 2024, starting in **March the 1st**.

The AO proposal submission will end with **September 30th**, 2024.

The evaluation of each proposal will start as soon as they are received by each entity.

5.4 Promotion of the results

In accordance with the objectives of this RCM, TerraSAR-X, TanDEM-X and PAZ initiative, all, CSA, DLR and INTA intend to promote scientific results.

In this way, proposers must agree and commit to report the results of their project in scientific or technical publications, and a final report to CSA, DLR and INTA, and acknowledge the scientific CSA, DLR and INTA programs appropriately. Results are expected to be presented on the corresponding Science Team Workshops.

5.5 Data

The joint CSA-DLR-INTA AO will be based in the use by scientific users of products acquired by the three missions specified in section 7 and limited for other sites and requires justifications.

For those test sites that have a scientific catalogue prior to the start of the project, the user can select to obtain products from the archive or only the new products that will be acquired in the period of interest.

5.6 Project Duration

The expected project lifetime is two years.

6 ISSUES APPLICABLE TO THE INDIVIDUAL MISSIONS

6.1 CSA

Launched in June 2019, the RADARSAT Constellation Mission (RCM) aims to ensure continuity of operational SAR imagery for RADARSAT-2 users, as well drawing from the constellation approach to enable new applications. Now more than seven months after commissioning, the RCM is becoming the Canadian Government's premier mission to provide all-weather day and night data in support of Canadian sovereignty and security, environmental monitoring, natural resources management and other government priorities such as Northern development. As a three-satellite constellation coverage of most of Canada and its surrounding waters are covered daily. Compared to previous RADARSAT missions, coverage increases significantly in Canada's North, for example providing coverage of the Northwest Passage three to four times daily. With the increased frequency of revisit, emerging applications such as land de-formation and operational disaster management can be further exploited. <http://asc-csa.gc.ca/eng/satellites/radarsat/default.asp>

The RCM can provide on average 15 minutes of imaging time per orbit per satellite, with peak imaging of 25 minutes per orbit per satellite outside the eclipse season, with each satellite having a ground swath of about 350 km, to allow monitoring the Canadian maritime approaches on a daily basis and a capacity to image any location in Canada every day

Together, the three RCM satellites provide a four-day exact revisit, allowing coherent change. Most of the requests by Canadian Government Users require re-look at least daily and an exact revisit once to twice weekly for interferometric change detection applications. Very frequent re-look capability is critical to certain disaster management applications.

RCM was designed as a constellation of three small satellites in order to significantly reduce the time between successive imaging of the same part of the Earth (revisit time). The creation of a three-satellite constellation increases the frequency of available information, as well as the reliability of the system, making it better suited to operational requirements of Government Departments. In the event of a satellite failure, the other satellites can continue to provide a certain level of service. The lower cost of individual satellites facilitates the replacement and makes the system scalable.

The constellation configuration consists in flying three C-band SAR evenly spaced at 120° on the same orbit. The satellites will operate in a sun-synchronous low-earth polar orbit, at an altitude of approximately 600 kilometers, translating into satellites following each other after 30 minutes.

Each satellite is capable of providing SAR imagery through an extensive set of imaging modes and polarization options. In Wide-area mode, the RCM SARs acquire data over large areas of interest at medium resolution (from 16 to 100 meters). In High-resolution and Very High

resolution modes, the RCM acquires specific on-demand images at a spatial resolution of 5 meters or 3 meters, respectively. RCM also has a 1 meter by 3 meters resolution in Spotlight mode. In addition, the RCM has a dual-polarization capability, a fully quad-polarimetric mode, as well as a compact polarization option available with most RCM imaging modes. Polarization options maximize the information content in the collected data.

The RCM also includes a stepped receive capability which is an ability to steer the receive beam in elevation in discrete steps during the receive window. This capability improves SAR imaging performance by reducing the noise-equivalent sigma-zero as well as the range ambiguity levels compared to conventional operation with a fixed beam position during the receive window. This capability provides the most improvement in wide swath cases, and thus, it is used operationally in all the ScanSAR modes of operation.

With RCM, emphasis is put on standard observation scenarios known as ‘Standard Coverages’. The objective is to provide consistent and predictable SAR coverage for key applications over sustained periods and large geographic areas. Through the inter-departmental RCM Standard Coverage Working Group, the operational and research and development user communities of the Government of Canada work together to manage the ‘Standard Coverages’ in order to maximize the use of the RCM imaging capacity. ‘Standard Coverage’ acquisition plans, unless they are restricted for security considerations, are to be published and made available to a wider user base outside of the Government of Canada, providing information ahead of time on the location, time period, and type of beam modes and products to be acquired by the RCM. RCM image products from Standard Coverages are archived and made available on the Earth Observation Data Management System (EODMS) web portal to the broadest extent possible under Canadian regulations, with the intent of fostering wide utilization of the data to the benefit of sectors such as industry or academia.

6.1.1 RCM Data Access

CSA is coordinating with DLR and INTA to acquire RCM data stacks over joint test sites. All RCM image products are archived and made available on the Earth Observation Data Management System (EODMS) web portal to the broadest extent possible under Canadian regulations, with the intent of fostering wide utilization of the data to the benefit of sectors such as industry or academia. RCM archived data 16m and coarser over land is open to public. However, high resolution data (5m, 3m, and Spotlight) requires to be a vetted user:

[About access to RCM data | Canadian Space Agency \(asc-csa.gc.ca\)](#). Being a vetted user gives access to the entire RCM archive.

6.2 DLR

The TerraSAR-X and TanDEM-X satellites are owned and operated by DLR. The commercial exploitation rights are exclusively granted to Airbus. DLR is also responsible for the scientific utilization of the data. Both satellites carry a high frequency X-band Synthetic Aperture Radar

(SAR) sensor that can be operated in different modes and polarizations. The Spotlight-, Stripmap- and ScanSAR- TerraSAR-X modes provide high resolution SAR images for detailed analysis as well as wide swath data whenever a larger coverage is required. Operationally imaging is possible in single and dual polarization. A more detailed description of the TerraSAR-X operating modes can be found in the Basic Product Description (see <http://sss.terasarsar-x.dlr.de/>).

TanDEM-X with its single pass interferometric mode provides high resolution stripmap and spotlight co-registered SAR data for digital elevation model derivation and other application related to the interferometric coherence.

The main objective of this call is the joint evaluation of TerraSAR-X / TanDEM-X data with PAZ data. Scientific requests addressing monostatic acquisitions of just one of the two TSX and TDX satellites need to submit a TerraSAR-X proposal while bi-static acquisitions of both satellites will be provided via a TanDEM-X proposal. The status “Scientific Use” needs to be gained via the proposal submission and evaluation process. The corresponding criteria are described in chapter 6.2.3.

6.2.1 TerraSAR-X AO

The TerraSAR-X proposal must be sent in a pre-defined format by Email to tsx.science@dlr.de. Templates are available at <http://sss.terasarsar-x.dlr.de/>.

The proposal should clearly describe the intended research, the scientific benefit, the contribution to the mission objectives, the required data and the acquisition plan. In particular the following information should be provided:

- **Template for personal data:**
 - General information about the PI and the person authorised to sign the license agreement and to confirm the funding;
 - the list of all Co-Is and the team organization;
- **Template for proposed research project:**
 - the innovation of the proposed activity and the contribution to the mission objectives;
 - a detailed description of the intended work;
 - the work plan and schedule;
 - the data requirements;
 - information demonstrating the coverage of the “scientific use” criteria (see 6.2.3); and
 - the proposal type (related AO) shall be set to **Joint RCM/TSX/PAZ AO**

Each proposal will go through a scientific and technical evaluation. The scientific benefit and the synergistic utilization with PAZ will be judged. Additionally, the data requirements and the fulfillment of the scientific use criteria are checked. As a result of the evaluation process a user account will be created for each accepted proposal and the announced quota will be assigned. This user account allows for ordering archived data from the catalogue as well as

new TerraSAR-X/TanDEM-X monostatic acquisitions. The PI is responsible for ordering the new TSX acquisitions. The investigator shall be informed about the evaluation within 2 months after submission.

Electronically delivered data will be provided **free of charge**. No other delivery media are supported.

6.2.2 TanDEM-X AO

The data request for TanDEM-X need to be send through an online system. Please go to the <https://tandemx-science.dlr.de/> and register first, then please open the general proposal and select the type of proposal indicated with '**Joint RCM-PAZ-TanDEM-X Experiment**' and fill your data request. The online form will guide you through several sections, that you will need to fill.

The registration on the TanDEM-X website is displayed in the sidebar and is named Register User Access as an Investigator. After registration you will receive the login information and you will have access to the online data request page. Please select from the side bar CoSSC Proposal and select the bottom Create CoSSC Proposal.

You will immediately be directed to the online proposal submission form with the following items:

- Cover Page: Please enter here the title of the proposal, the application domain, the type of proposal '**Joint RCM-PAZ-TanDEM-X Experiment**' and a short geographical description.
- General Proposal Description: In this section please describe in short, the motivation and the main purpose of using the data. This abstract can be published and be visible to each Principle Investigator.
- Detailed Proposal Description: A detailed description of the motivation and purpose of the data usage is requested.
- Data Requirements: On a geographical map the coordinated (either as a point or frame) of the requested testsite can be added and the possible TanDEM-X frames at different incidence angles are displayed. The frames can be then selected from the proposal submitter.
- Overview: Provides you an overview of the filled text and the requested data.
- Final Submission: At the end everything can be submitted.

The same as for TerraSAR-X each proposal will go through a scientific and technical evaluation. The scientific benefit and the synergistic utilization with RCM, as well as PAZ will be judged. Additionally, the data requirements and the fulfillment of the scientific use criteria are checked. As a result of the evaluation process a user account will be created for each accepted proposal and the announced quota will be assigned. The investigator shall be informed about the

evaluation within 2 months after submission. All electronically delivered data will be provided **free of charge**. No other delivery media are supported.

6.2.3 Scientific Use Criteria

Every use of TerraSAR-X and TanDEM-X data and products for basic and application-oriented research by national or international research establishments or through government sponsored projects is considered scientific, non-commercial use, including the development of future applications for scientific and/or operational use.

Every utilization of TerraSAR-X/TanDEM-X data/products that is not targeting the commercial use with profit orientation is a scientific use. This includes the use of TerraSAR-X/TanDEM-X data/products:

- by educational (schools, universities, etc.) and research institutions (DLR, ESA, NASA, etc.),
- for preparation and execution of government financed education-, research- and development-programs,
- for preparation and execution of data exchange with international partners of the FRG to support research- and educational programs,
- for demonstration of new applications for potential users,
- for use within the TerraSAR-X/TanDEM-X project (calibration, validation, quality assurance, public outreach, experimental instrument operations, etc.).

Scientific Users:

- will be generally provided with data/products via a selection process (e.g. an Announcement of Opportunity (AO) for the Scientific Exploitation of TanDEM-X / TerraSAR-X data).
- are required to follow the license agreement for use of TanDEM-X / TerraSAR-X data.
- must not hand over the TanDEM-X / TerraSAR-X data/products or derived products (to the extent that the contribution of TanDEM-X / TerraSAR-X is substantial and recognisable) to third parties without authorization by DLR.

6.2.4 Security regulations

The provision of TerraSAR-X and TanDEM-X data are governed by national security regulations. These regulations might affect the location of the test site, the acquisition time and the persons involved. DLR will be obliged to verify the sensitivity of data requests. The sensitivity check will be performed in two steps:

- The proposal evaluation includes the verification of the investigators and the team members.
- The main sensitivity check will be applied to each order and will comprise location, time and the persons involved.

In case of sensitivity of an order DLR needs to apply for authorization of distribution by a state authority to be determined. This means that orders still can be rejected even for accepted proposals.

6.3 INTA

PAZ mission is the radar element of the National Program for Earth Observation by Satellite (PNOTS) for the development, operation and exploitation of space sensors for Earth observation.

The PAZ satellite was launched on February 22nd, 2018 from the Vandenberg air base (California) aboard a Falcon 9 rocket. After the initial LEOP phase, the commissioning phase began on April 3rd, extending 5 months until September 6th, at which time the system was officially declared operational.

The Space Segment of PAZ mission is owned by Hisdesat Servicios Estratégicos S.A., the mission operator. PAZ platform is an heritage of TANDEM-X having a new front end developed by AIRBUS Spain. Main payload is a synthetic aperture radar (SAR) operating in X-band at 9.65GHz with up to 300Mhz of bandwidth and versatile modes of operation configurable from the ground.

PAZ Ground Segment is property of INTA, responsible for its development and maintenance. INTA is also in charge of the science activities of PAZ mission, including scientific exploitation.

Current nominal modes are Stripmap, ScanSAR (4 and 6 beams), Spotlight, High Resolution Spotlight and Staring Spotlight.

6.3.1 PAZ Scientific Exploitation

The objective of INTA with the PAZ Scientific Exploitation is the implementation of a system for the use of PAZ image products with a scientific objective, to promote the promotion of SAR technology and its applications to national and international entities dedicated to research.

The primary objectives of the scientific exploitation of PAZ are:

- Development of new methods, techniques and algorithms for the processing of L1B products and SAR calibration.
- Fusion of data, considering image products from different spaceborne or airborne SAR sensors, and fusion of PAZ images with other images from optical sensors.
- Exploitation of products, via means of, among others:
 - Development of applications to expand the use of PAZ products, with special emphasis on those oriented to crisis management.
 - Use of the polarimetric and interferometric capabilities of PAZ.
 - Application of PAZ products to monitoring, including urban areas, land cover and vegetation and hydrological resources, among others.
 - Obtention of derived parameters from PAZ L1B products.

The BOE of November 28, 2023 includes the Agreement between the National Institute of Aerospace Technology "Esteban Terradas" and Hisdesat Servicios Estratégicos, SA, for the realization of science activities during the mission of the satellite PAZ, starting on January 1st of 2019.

This Agreement includes the establishment of a quota for the use of the PAZ satellite of 5 daily acquisitions by INTA for its scientific use. All the acquisitions will be property of HISDESAT and the distribution of images to third parties will include the License Agreement with the End User (EULA) that HISDESAT provides (<https://www.inta.es/paz-ciencia/en/AO/ao-documents/>).

6.3.2 PAZ AO

Proposals responding to DLR-INTA Joint Announcement of Opportunity will be sent to INTA via PAZ-Science Activities website (<https://www.inta.es/paz-ciencia/en/AO/ao-006/>).

Proposals may be prepared in English, in Word or PDF format and they proposals must contain the sections required in Table 1. The omission of the required information may imply the non-approval of the proposal. INTA scientific team may request the correction of errors after the reception of the proposal.

AO-006 Joint RCM, TSX, TDX, PAZ Call
1. Identification of the project
<ul style="list-style-type: none"> • Title of the project. • Scientific objective (150 words). Summary formulation of the project objective. • Duration of the project (Maximum 36 months. This duration can be extended)
2. Project description
<ul style="list-style-type: none"> • Executive summary (500 words), including the objectives of the research work, main points and milestones. This abstract can be published. • Description of the research team, identifying: <ul style="list-style-type: none"> • Principal Investigator (including contact e-mail) and other members, including CV and structure of the organization. • Financing source, which ensures the viability and execution of the project. • Definition of the contribution of the project to the objectives of the Joint csm, TSX/TDX-PAZ Experiment. • Definition of expected results and publications. <ul style="list-style-type: none"> • Definition of the project duration. Identification of the expected delivery dates of progress (bi-annual) and final reports.

3. PAZ Data Requirements
<p>For each requested product:</p> <ul style="list-style-type: none"> • Identification of the data take acquisition characteristics: <ul style="list-style-type: none"> • Test Site(s). <ul style="list-style-type: none"> ○ Select from Section 7. • Range of dates of interest. As far as possible, the demand for specific dates will be avoided, with the indication of months or range of months of interest being preferable. • Processing options: <ul style="list-style-type: none"> ○ Geometric correction (SSC / MGD / GEC / ECC) ○ Resolution type for detected products (SE / RE) ○ Orbit Type (Rapid o Scientific)

TABLE 1. PAZ PROPOSAL TEMPLATE

Each proposal will go through a scientific and technical evaluation. The scientific benefit and the synergistic utilization with TSX and TDX will be judged. Additionally, the data requirements and the fulfilment of the scientific use criteria are checked:

- Proposals meet the objectives of the PAZ Scientific Exploitation.
- Investigators do not have a commercial purpose.
- Project establishes a work plan, working team and funding clear and convenient to achieve the project objectives.
- Proposals defines viable data take acquisitions, not having conflicts with commercial or national security interests.

The investigator shall be informed about the evaluation within 2 months after submission.

All proposals received within the period identified in the announcement will be evaluated by the scientific committee of PAZ. The result of the evaluation may be:

- **Approved.** It means the start of the project, with the signing of PAZ end user license agreement with the end user (EULA), which confirms:
 - The intention to execute the project.
 - The availability of financing to carry out the project.
 - The work team that will work on the project, including their CVs.
 - Acceptance of the quantity of products to be provided and the method of delivery.

- Acceptance of reporting and publishing results.
- Acceptance of the use of the data according to the terms and conditions stipulated in the use agreement.
- **Denied.** In case the proposal does not meet the evaluation criteria.
- **Need to be rectified.** In this case INTA will communicate to the Principal Investigator the information needed and a re-evaluation will be performed.

6.3.3 Scientific User Criteria

PAZ scientific exploitation is devoted to provide basic products, with the goal of the promotion of SAR technology and its applications to national and international research entities. In this way Scientific Users shall submit a scientific project covering the definition of the objectives and identifying that the utilization of PAZ products that is not intended to the commercial use with profit orientation but is a scientific use. This includes the use of PAZ products:

- by educational and research institutions,
- for preparation and execution of government financed education-, research- and development-programs,
- for demonstration of new applications for potential users,
- for use within the PAZ project (calibration, validation, quality assurance, public outreach, experimental instrument operations, etc.).

Interested investigators will have to respond to this Announcement of Opportunity by means of a Project Proposal submission which defines the scientific work to be carried out and. Proposals will be reviewed by INTA PAZ Science Team. The proposals that obtain the status of approved will receive the EULA that the principal investigator must sign as a starting point for the project. This signature will stablish the launch of the project, starting the acquisition and dissemination of the corresponding PAZ products according to the definition contained in the proposal.

6.3.4 Security Regulations

All the acquisitions will be property of HISDESAT and a final use license will be provided to INTA. The distribution of images to third parties will include the License Agreement with the End User (EULA) that HISDESAT provides.

The requested acquisitions will be checked against the sensitivity filter defined by the Ministry of Defense.

7 TEST SITES Opportunities

In this section specific data acquisition sites are listed where data of the corresponding mission have data already acquired over a longer time frame.

Investigators are encouraged to prepare their proposals, taking into account these specific sites.

The test sites are defined by means of the following items:

- Test site identifier
- Reference coordinates
- Main application field
- Mission.

Note that **Mission field** refers to the existence of catalogue data already acquired by the specified mission (RCM, TerraSAR-X, TanDEM-X and/or PAZ). All the specified test sites can be requested for future acquisitions to be performed by RCM, TerraSAR-X, TanDEM-X or PAZ.

Id	Test site	Coordinates (Lat, Lon)	Application Area	Mission
01	Aswan	(23.976951, 32.873724)	Engineering	PAZ, RCM
02	Atacama	(-23.50000, -68.25)	Ecosystem	PAZ, RCM
03	Baltoro Glacier, Pakistan	(35.7370902, 76.3758699)	Glacier	TSX, RCM
04	Bardarbunga, Iceland	(64.4227820, -17.047938)	Volcano, Glacier	TSX, RCM
05	BareSalar Uyuni	(-20.199024, -67.693419)	Agriculture, Salar Lake	TSX, PAZ, RCM
06	Barry Arm Fjord	(61.0505383, -148.1386306)	Landslides hazards	PAZ, RCM, TSX
07	Bayerischer Wald, Germany	(49.0220599, 13.3368279)	Forest	TSX, RCM
08	Beaufort Coast	(69.568436, -139.014233) (69.630258, -140.849342) (69.689467, -134.937956)	Coastal erosion	PAZ, RCM, TSX
09	Beaufort Sea	(72.258648, -138.040045)	Sea Ice	PAZ, RCM
10	Berlin, Germany	(52.4965462, 13.4299324)	Urban	TSX, RCM
11	Breidamerkurjokull	(64.147125, -16.369136)	Volcano	TSX, TDX, RCM
12	Burwa_Indian Himalaya	(32.355194, 77.126417)	Snow	PAZ, RCM
13	Canadian Roads	(62.448358, -114.334838) (63.076659, -113.184975) (53.875331, -94.803430)	InSAR	PAZ, RCM
14	Chaco, Argentina	(-28.6159373, -59.1943666)	Wetlands	TSX, PAZ, RCM
15	ChamonixMountBlanc	(45.900444, 6.943027)	Ice	PAZ, RCM
16	Columbia Glacier	(61.378305, -147.062988)	Glacier	TDM, RCM

17	Columbia Icefields. Glacier surface velocities	(52.132156, -117.294394)	Glacier	PAZ, RCM, TSX
18	Deception Island Antartic	(-62.977010, -60.675404)	Snow, Volcano	TSX, PAZ, RCM
19	Demmin Agriculture	(53.989766, 13.258538)	Agriculture	TSX, TDX, PAZ, RCM
20	Etna	(37.740313, 14.983292)	Volcano	TSX, TDX, RCM
21	Eyjafjalla and Hekla, Iclean	(63.6743152, -19.2613556)	Volcano, Glacier	TSX, RCM
22	Fleming Glacier, Antarctica	(-69.3617562, -67.1425765)	Glacier	TSX, RCM
23	German Bight Sea	(54.9992457, 7.4663598)	Coastal applications	TSX, RCM
24	German Bight Ship	(54.0255351, 7.8535851)	Coastal applications	TSX, RCM
25	German Bight Wadden	(53.9017898, 8.6240006)	Coastal applications	TSX, RCM
26	Grey-Tyndall	(-50.9955959, -73.3816755)	Glacier	TSX, RCM
27	Grimsvotn and Skafta Cauldrons	(64.433236, -17.510343)	Volcano	TSX, TDX, RCM
28	Gulmarg_Indian Himalaya	(34.055444, 74.390944)	Snow	PAZ, RCM
29	Herschel Island, Canada	(69.573669, -139.095840)	Permafrost, Snow	TSX, TDX, RCM
30	Kaufering, Germany	(48.0935723, 10.8534136)	Agriculture, Wetlands	TSX, TDX, RCM
31	Kilauea summit	(19.414307, -155.273209)	Volcano	TSX, TDX, PAZ, RCM
32	Kongsvegen	(78.8002925, 12.9708738)	Glacier	PAZ, RCM
33	La grande Soufriere_Guadeloupe	(16.044600, -61.664200)	Volcano	TSX, PAZ, RCM
34	La Selva	(10.420900, -84.022400)	Forest	TDX, RCM
35	Larsen C ice shelf. Rift propagation	(-68.2, -62.2)	Ice	PAZ, RCM
36	LaurentianHills	(45.973026, -77.498983)	Forest	PAZ, RCM, TSX
37	Merapi Vulcano	(-7.544685, 110.444647)	Volcano	TSX, TDX, PAZ, RCM
38	Mittie. Glacier surface velocities	(76.802633, -79.208133)	Ice	PAZ, RCM
39	Moreno	(-50.5462568, -73.2063474)	Glacier	PAZ, RCM
40	MountSt. Helens	(46.200000, -122.188000)	Volcano	TSX, PAZ, RCM
41	Munich, Germany	(48.1433072, 11.5417820)	Urban	TSX, RCM
42	Neva Bay	(59.994035, 29.966484)	Sea Ice	PAZ, RCM
43	Norris Yellowstone	(44.729000, -110.706000)	Volcano	TSX, PAZ, RCM

44	North-western Himalaya	(33.918,75.893)	Glacier	PAZ, RCM
45	Oder valley, Ger/Poland	(53.288322, 14.487628)	Wetlands	TSX, RCM
46	Oetztal, Austria	(46.902008, 10.858955)	Glacier	TSX, RCM
47	Ontario	(43.183918, -81.289773)	Crop	PAZ, RCM
48	Oraefajokull, Iceland	(64.4227820, -17.047938)	Volcano, Glacier	TSX, RCM
49	Petermann Glacier	(80.722458, -60.281640)	Glacier	TSX, TDX, PAZ, RCM
50	Pine Island Glacier Mid	(-75.198609, -99.536260)	Glacier	TSX, RCM
51	Pine Island Glacier North	(-75.196072, -98.088726)	Glacier	TSX, RCM
52	Pine Island Glacier South	(-75.243818, -100.563795)	Glacier	TSX, RCM
53	Pio XI	(-49.2935321, -73.7604114)	Glacier	TSX, RCM
54	Piton de la Fournaise	(-21.249702, 55.730896)	Volcano	TSX, TDX, PAZ, RCM
55	Prince William Sound	(61.238031, -147.694936)	Glacier	PAZ, RCM
56	Remningstorp	(58.462020, 13.628747)	Forest	TSX, TDX, RCM
57	RioGrande colorado	(37.9877536, -107.2528373)	Landslide	PAZ, RCM
58	Samoylov, Lena River	(72.379989, 126.469459)	Permafrost	TSX, TDX, RCM
59	San Raphael	(-46.7291507, -73.6726346)	Glacier	TSX, RCM
60	Smith-Pope, Antarctica	(-75.0788362, -111.8737526)	Glacier	TSX, RCM
61	Sydkap.	(76.7194628, -85.423378)	Glacier surface velocities	PAZ, RCM
62	Tapajos	(-3.114800, -54.955000)	Forest	TDX, PAZ, RCM
63	Thwaites Glacier North	(-75.305306, -106.861204)	Glacier	TSX, TDX, RCM
64	Tibetan Plateau	(29.698274,94.924241)	Subsidence	PAZ, RCM
65	Trinity. Glacier surface velocities	(78.032908, -78.723683)	Ice	PAZ, RCM
66	Upsala-Viedma	(-49.6123754, -73.2336078)	Glacier	TSX, RCM
67	Vesuvius	(40.820982,14.426305)	Volcano	TSX, PAZ, RCM
68	Whittier Landslide hazards	(60.792659, -148.725331)	Landslide	PAZ, RCM
69	Yellowstone caldera	(44.412896, -110.730248)	Volcano	TSX, PAZ, RCM
70	Zacchariae Isstrom	(78.8567431, -22.1901868)	Glacier	TSX, RCM