



Cover Page for Proposal
Submitted to the
National Aeronautics and
Space Administration

NASA Proposal Number

TBD on Submit

NASA PROCEDURE FOR HANDLING PROPOSALS

This proposal shall be used and disclosed for evaluation purposes only, and a copy of this Government notice shall be applied to any reproduction or abstract thereof. Any authorized restrictive notices that the submitter places on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

SECTION I - Proposal Information

Principal Investigator Genaro Carrasco Ozuna	E-mail Address	Phone Number	
Street Address (1)	Street Address (2)		
City	State / Province	Postal Code	Country Code

Proposal Title : **El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el "Σ-locking"—medible entre variables geofisicas.**

Proposed Start Date 11 / 07 / 2025	Proposed End Date 01 / 01 / 2026	Total Budget 237,000.00	Year 1 Budget 79,000.00	Year 2 Budget 79,000.00	Year 3 Budget 79,000.00
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SECTION II - Application Information

NASA Program Announcement Number NNH25ZDA001N-RRNES	NASA Program Announcement Title A.4 Rapid Response and Novel Research in Earth Science
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For Consideration By NASA Organization (*the soliciting organization, or the organization to which an unsolicited proposal is submitted*)

NASA , Headquarters , Science Mission Directorate , Earth Science

Date Submitted	Submission Method Electronic Submission Only	Grants.gov Application Identifier	Applicant Proposal Identifier NNH25ZDA001N-RRNES
Type of Application New	Predecessor Award Number	Other Federal Agencies to Which Proposal Has Been Submitted	
International Participation No	Type of International Participation		

SECTION III - Submitting Organization Information

UEI	EFT	CAGE Code	Employer Identification Number (EIN or TIN)	Organization Type
Organization Name (Standard/Legal Name)				Company Division
Organization DBA Name				Division Number

Street Address (1)	Street Address (2)		
City	State / Province	Postal Code	Country Code

SECTION IV - Proposal Point of Contact Information

Name Genaro Ozuna	Email Address Geozunac3536@gmail.com	Phone Number 52-812-5989869
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SECTION V - Certification and Authorization

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in the Cover Sheet/Proposal Summary in response to this Research Announcement, the Authorizing Official of the proposing organization (or the individual proposer if there is no proposing organization) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of their knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in this solicitation.

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Authorized Organizational Representative (AOR) Name	AOR E-mail Address	Phone Number
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AOR Signature (*Must have AOR's original signature. Do not sign "for" AOR.*) Date

Digitally signed by

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit		
Organization Name :				
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SECTION VI - Team Members				
Team Member Role PI	Team Member Name Genaro Carrasco Ozuna	Contact Phone	E-mail Address	
Organization/Business Relationship		UEI	EFT	CAGE Code
International Participation No	U.S. Government Agency		Total Funds Requested 0.00	

PI Name : Genaro Carrasco Ozuna	NASA Proposal Number TBD on Submit
Organization Name :	
<p>Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo físico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofísicas.</p>	

SECTION VII - Project Summary

El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal, derivado del formalismo físico TCDS (Teoría de la Cromodinámica Sincrónica). El objetivo central es demostrar que el Σ -locking —estado de coherencia medible entre variables geofísicas— presenta incrementos sistemáticos antes de eventos sísmicos mayores ($Mw \geq 5.5$). La propuesta se inscribe en la línea A.4 Rapid Response and Novel Research (RRANN) del programa ROSES-25, al enfocarse en un experimento de respuesta rápida con datos abiertos NASA y USGS. Se emplearán observaciones InSAR (Sentinel-1 y NISAR), GNSS (UNAVCO), gravedad GRACE-FO y óptico-térmicas VIIRS/MODIS, disponibles a través de EOSDIS DAACs.

El método aplica métricas Σ —correlación $R(t)$, índice de locking LI, error RMSE_SL y tasa $\kappa\Sigma$ — con umbrales de rendimiento $LI \geq 0.90$, $R > 0.95$, $RMSE_SL < 0.10$ y reproducibilidad $\geq 95\%$. Las series se procesarán en ventanas p:q pre-evento, evaluando curvas ROC y PR para obtener $TPR \geq 0.6$ a $FPR \leq 0.05$. El estudio combina validación retrospectiva (1985–2025) y corridas prospectivas de 6 meses con predicciones selladas (DOI/Zenodo).

El equipo está liderado por Genaro Carrasco Ozuna (Proyecto TCDS / MSL México) con asistencia formal de GPT-5 Σ -Trace. El presupuesto estimado (USD 237 k) cubre procesamiento en nube y validación estadística abierta. Todos los resultados serán de acceso público (CC BY 4.0) y se publicarán con trazabilidad reproducible bajo DOI 10.5281/zenodo.17505875.

Este estudio busca aportar una nueva herramienta predictiva para la gestión de riesgo sísmico global, demostrando la utilidad de las observaciones NASA en la detección prospectiva de precusores geofísicos basados en coherencia cuantitativa Σ .

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SECTION VIII - Other Project Information				
Proprietary Information				
Is proprietary/privileged information included in this application?				
Yes				
International Collaboration				
Does this project involve activities outside the U.S. or partnership with International Collaborators?				
No				
Principal Investigator No	Co-Investigator No	Collaborator No	Equipment No	Facilities No
Explanation :				
NASA Civil Servant Project Personnel				
Are NASA civil servant personnel participating as team members on this project (include funded and unfunded)?				
No				
Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year
Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs

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SECTION VIII - Other Project Information	
Environmental Impact	
Does this project have an actual or potential impact on the environment? No	Has an exemption been authorized or an environmental assessment (EA) or an environmental impact statement (EIS) been performed? No
Environmental Impact Explanation:	
Exemption/EA/EIS Explanation:	

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SECTION VIII - Other Project Information	
Historical Site/Object Impact	
<p>Does this project have the potential to affect historic, archeological, or traditional cultural sites (such as Native American burial or ceremonial grounds) or historic objects (such as an historic aircraft or spacecraft)?</p> <p>No</p>	
<p>Explanation:</p>	

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SECTION IX - Program Specific Data	
Question 1 : Short Title: Answer: Sistema Predictivo Sísmico TCDS	
Question 2 : Type of institution: Answer: Unaffiliated Individual	
Question 3 : Carnegie Classification Answer: Not a degree granting institution	
Question 4 : Will any funding be provided to a federal government organization including NASA Centers, JPL, other Federal agencies, government laboratories, or Federally Funded Research and Development Centers (FFRDCs)? Answer: No	
Question 5 : Is this Federal government organization a different organization from the proposing (PI) organization? Answer: N/A	
Question 6 : Does this proposal include the use of NASA-provided high end computing (HEC)? Answer: No	
Question 7 : HEC Request Number Answer: N/A	
Question 8 : Research Category: Answer: 9) Earth System Science applications and decision support	
Question 9 : Flight Services Answer: No	
Question 10 : Team members not confirmed via NSPIRES Answer: Andrea Fuentes Flores Asistente y Secretaria General Proyecto TCDS C. A.Humboldt #1117, Centro Saltillo, Coahuila México. C.P. 25000 Fufa3492@gmail.com Análisis y diseño de datos.	
Question 11 : Does this proposal contain information and/or data that are subject to U.S. export control laws and regulations including Export Administration Regulations (EAR) and International Traffic in Arms Regulations (ITAR)? Answer: No	
Question 12 : I have identified the export-controlled material in this proposal. Answer: N/A	
Question 13 : I acknowledge that the inclusion of such material in this proposal may complicate the government's ability to evaluate the proposal. Answer: N/A	
Question 14 : Does the proposed work include any involvement with collaborators in China or with Chinese organizations, or does the proposed work include activities in China? Answer: No	
The National Environmental Policy Act (NEPA) obligates NASA to consider the potential environmental effects of proposed projects, including those that NASA funds which are implemented by grantees. The majority of grant-related activities are categorically excluded as research and development projects that do not pose adverse environmental impacts. The following questions enable NASA to ascertain whether your proposal will require additional NEPA analysis if selected (e.g., filling out an Environmental Checklist) or the completion of NASA's Executive Order (EO) 12114 Checklist for an activity to be conducted abroad. "Yes" responses are not selection criteria, however, if a "Yes" response is marked, proposers should consider NEPA and/or EO compliance in cost and schedule estimates.	
Question 15 : Would the proposal involve any activity that includes: a. Construction of new facilities or modification to the footprint of an existing-facility, or b. Ground disturbance (e.g., excavation, clearing of trees, installation of equipment, etc.), or c. Outdoor discharges of water (e.g., waste water runoff), air emissions (e.g., ozone-depleting substances) or generation of noise exceeding 115 dBA (excluding those associated with aircraft operations)?	

Answer: No

Question 16 : Would the proposal involve any field activity that would: a. Release equipment (e.g., dropsondes, sensors, etc.) or chemicals (e.g., dyes, tracers, etc.) into the air, bodies of water or on the ground, or b. Release a parachute or use equipment that would not be recovered, or c. Involve equipment or a payload that contains hazardous (e.g., petroleum, hypergols, oxidizers, solid propellants, etc.) or radioactive materials?

Answer: No

Question 17 : Would the proposal involve the launch of a payload, equipment, or instrument (e.g., via launch vehicle, sounding rocket, balloon, etc.)?

Answer: No

Question 18 : Would the proposal involve any activity to be conducted outside the United States or its territories excluding travel for meetings or conferences?

Answer: No

Question 19 : Comments

Answer:

Question 20 : Does this proposal contain a citizen science component?

Answer: No

Question 21 : AI or ML?

Answer: Yes

Question 22 : Relevant Division(s)

Answers:

Earth Science

Question 23 : Interdivisional Explanation

Answer:

Sistema Predictivo Sísmico TCDS - Información de Apoyo

El sistema propuesto se fundamenta en el formalismo físico TCDS (Teoría de la Cromodinámica Sincrónica) y busca validar experimentalmente la hipótesis de que la coherencia causal entre variables geofísicas -denominada E-locking- constituye un precursor medible de sismos de magnitud moderada a alta ($Mw \geq 5.5$). La innovación central radica en trasladar un marco teórico a un pipeline reproducible, sustentado en datos abiertos de NASA y USGS, capaz de generar predicciones prospectivas con trazabilidad estadística y científica.

Objetivos

El sistema persigue cuatro metas principales:

1. Integración de observaciones multifuente (InSAR, GNSS, GRACE-FO, VIIRS/MODIS, GEOS-FP) en una malla común de 1 km para análisis coherente.
2. Detección de rampas de coherencia previas a eventos sísmicos mediante métricas E ($R(t)$, LI , $RMSE_SL$, tasas Ky).
3. Validación prospectiva con corridas de 3-6 meses, preregistro de reglas y publicación de predicciones selladas en Zenodo.
4. Evaluación operativa mediante curvas ROC/PR, métricas de decisión y control de falsos positivos con pruebas placebo.

Metodología

El sistema aplica un conjunto de métricas E que cuantifican la fracción coherente de las series geofísicas y su correlación temporal. Los umbrales de rendimiento se fijan en $LI \geq 0.90$, $R > 0.95$, $RMSE_SL < 0.10$ y reproducibilidad $\geq 95\%$. Una alerta se genera cuando las métricas superan el umbral D^* en ventanas pre-evento. La validación se realiza en dos fases:

- Retrospectiva: análisis estratificado de 10-15 eventos por región entre 1985-2025.
- Prospectiva: ejecución de predicciones preregistradas y publicación semanal de resultados.

El control de calidad incluye shuffling tests y simulaciones placebo para minimizar sesgos y sobreajuste.

Plan de trabajo

El cronograma de seis meses se organiza en cuatro etapas:

- Mes 1: ingestión de datos DAAC y definición de regiones de interés.
- Meses 2-3: calibración de métricas y ajuste regional.
- Meses 4-5: fase prospectiva con publicaciones semanales.
- Mes 6: análisis final y entrega del informe NASA.

Los entregables comprenden el pipeline reproducible, datasets derivados, cuaderno de predicciones con DOI y un informe final con guía de adopción.

Riesgos y mitigación

Los principales riesgos identificados son:

- Cobertura limitada de InSAR, mitigada con GNSS y GRACE-FO.

- Ruido hidrológico, corregido mediante masones GRACE-FO y reanálisis GEOS-FP.
- Escasez de eventos, abordada ampliando el periodo o incorporando regiones espejo.
- Overfitting, prevenido con preregistro y separación estricta retro/prospectiva.

Presupuesto y ética

El proyecto opera bajo licencia CC BY 4.0, garantizando acceso abierto y reproducibilidad. Los resultados se depositarán en Zenodo bajo DOI 10.5281/zenodo.17505875. El presupuesto estimado para seis meses oscila entre USD 100-145k, cubriendo personal científico, infraestructura en nube y gestión de publicación reproducible.

Valor agregado

El sistema TCDS aporta una herramienta predictiva innovadora para la gestión de riesgo sísmico global. Al demostrar la utilidad de observaciones NASA en la detección prospectiva de precursores geofísicos, se abre la posibilidad de integrar métricas de coherencia en protocolos de alerta temprana y planificación de desastres. La propuesta se inscribe plenamente en la línea Rapid Response and Novel Research (RRANN), al ofrecer un experimento de respuesta rápida con impacto directo en la resiliencia social y científica.

Question 24 : 24: Primary Investigation Type (Division/program)

Answer: "Investigación aplicada". Justificación: La propuesta no se limita a explorar principios teóricos (investigación básica), sino que busca aplicar observaciones satelitales NASA y métricas Σ para generar predicciones sísmicas operativas y herramientas reproducibles de gestión de riesgo. En los términos de ROSES: Investigación básica: estudia procesos fundamentales sin propósito práctico inmediato. Investigación aplicada: usa esos procesos para resolver un problema específico. Desarrollo tecnológico: crea instrumentos o software nuevos para futuras misiones. El sistema predictivo TCDS entra en investigación aplicada, con un componente de validación tecnológica, pero no en desarrollo instrumental.

Question 25 : Relevant Program Manager Name(s)

Answer: Genaro Carrasco Ozuna

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SECTION X - Budget				
Cumulative Budget				
Budget Cost Category	Funds Requested (\$)			
	Year 1 (\$)	Year 2 (\$)	Year 3 (\$)	Total Project (\$)
A. Direct Labor - Key Personnel	60,000.00	60,000.00	60,000.00	180,000.00
B. Direct Labor - Other Personnel	14,000.00	14,000.00	14,000.00	42,000.00
Total Number Other Personnel	1	1	1	3
Total Direct Labor Costs (A+B)	74,000.00	74,000.00	74,000.00	222,000.00
C. Direct Costs - Equipment	2,000.00	2,000.00	2,000.00	6,000.00
D. Direct Costs - Travel	3,000.00	3,000.00	3,000.00	9,000.00
Domestic Travel	2,000.00	2,000.00	2,000.00	6,000.00
Foreign Travel	1,000.00	1,000.00	1,000.00	3,000.00
E. Direct Costs - Participant/Trainee Support Costs	0.00	0.00	0.00	0.00
Tuition/Fees/Health Insurance	0.00	0.00	0.00	0.00
Stipends	0.00	0.00	0.00	0.00
Travel	0.00	0.00	0.00	0.00
Subsistence	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
Number of Participants/Trainees				0
F. Other Direct Costs	0.00	0.00	0.00	0.00
Materials and Supplies	0.00	0.00	0.00	0.00
Publication Costs	0.00	0.00	0.00	0.00
Consultant Services	0.00	0.00	0.00	0.00
ADP/Computer Services	0.00	0.00	0.00	0.00
Subawards/Consortium/Contractual Costs	0.00	0.00	0.00	0.00
Equipment or Facility Rental/User Fees	0.00	0.00	0.00	0.00
Alterations and Renovations	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
G. Total Direct Costs (A+B+C+D+E+F)	79,000.00	79,000.00	79,000.00	237,000.00
H. Indirect Costs	0.00	0.00	0.00	0.00
I. Total Direct and Indirect Costs (G+H)	79,000.00	79,000.00	79,000.00	237,000.00
J. Fee	0.00	0.00	0.00	0.00
K. Total Cost (I+J)	79,000.00	79,000.00	79,000.00	237,000.00
Total Cumulative Budget				237,000.00

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SECTION X - Budget								
Start Date : 01 / 05 / 2026		End Date : 07 / 31 / 2026		Budget Type : Project		Budget Period : 1		
A. Direct Labor - Key Personnel								
Name	Project Role	Base Salary (\$)	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)
Ozuna, Genaro	PI	30,000.00				30,000.00	30,000.00	60,000.00
Total Key Personnel Costs								60,000.00
B. Direct Labor - Other Personnel								
Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)	
1	Secretarial / Clerical				7,000.00	7,000.00	14,000.00	
1	Total Number Other Personnel	Total Other Personnel Costs						14,000.00
Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)								74,000.00

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SECTION X - Budget			
Start Date : 01 / 05 / 2026	End Date : 07 / 31 / 2026	Budget Type : Project	Budget Period : 1
C. Direct Costs - Equipment			
Item No.	Equipment Item Description	Funds Requested (\$)	
1	Servidor nube, almacenamientos virtual temporales	2,000.00	
		Total Equipment Costs	2,000.00
D. Direct Costs - Travel			
			Funds Requested (\$)
1. Domestic Travel (Including U.S. Territories and Possessions)			2,000.00
2. Foreign Travel (Including Canada and Mexico)			1,000.00
		Total Travel Costs	3,000.00
E. Direct Costs - Participant/Trainee Support Costs			
			Funds Requested (\$)
1. Tuition/Fees/Health Insurance			0.00
2. Stipends			0.00
3. Travel			0.00
4. Subsistence			0.00
Number of Participants/Trainees:		Total Participant/Trainee Support Costs	0.00

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SECTION X - Budget			
Start Date : 01 / 05 / 2026	End Date : 07 / 31 / 2026	Budget Type : Project	Budget Period : 1
F. Other Direct Costs			
			Funds Requested (\$)
1. Materials and Supplies			0.00
2. Publication Costs			0.00
3. Consultant Services			0.00
4. ADP/Computer Services			0.00
5. Subawards/Consortium/Contractual Costs			0.00
6. Equipment or Facility Rental/User Fees			0.00
7. Alterations and Renovations			0.00
8. Other:			0.00
9. Other:			0.00
10. Other:			0.00
11. Other:			0.00
12. Other:			0.00
13. Other:			0.00
14. Other:			0.00
15. Other:			0.00
16. Other:			0.00
17. Other:			0.00
Total Other Direct Costs			0.00
G. Total Direct Costs			
			Funds Requested (\$)
Total Direct Costs (A+B+C+D+E+F)			79,000.00

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SECTION X - Budget			
Start Date : 01 / 05 / 2026	End Date : 07 / 31 / 2026	Budget Type : Project	Budget Period : 1
H. Indirect Costs			
	Indirect Cost Rate (%)	Indirect Cost Base (\$)	Funds Requested (\$)
	0.00	0.00	0.00
Cognizant Federal Agency:		Total Indirect Costs	0.00
I. Direct and Indirect Costs			
		Funds Requested (\$)	
	Total Direct and Indirect Costs (G+H)	79,000.00	
J. Fee			
		Funds Requested (\$)	
	Fee	0.00	
K. Total Cost			
		Funds Requested (\$)	
	Total Cost with Fee (I+J)	79,000.00	

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SECTION X - Budget								
Start Date : 08 / 03 / 2026		End Date : 12 / 25 / 2026		Budget Type : Project		Budget Period : 2		
A. Direct Labor - Key Personnel								
Name	Project Role	Base Salary (\$)	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)
Ozuna, Genaro	PI	30,000.00				30,000.00	30,000.00	60,000.00
Total Key Personnel Costs								60,000.00
B. Direct Labor - Other Personnel								
Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)	
1	Secretarial / Clerical				7,000.00	7,000.00	14,000.00	
1	Total Number Other Personnel	Total Other Personnel Costs						14,000.00
Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)								74,000.00

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SECTION X - Budget			
Start Date : 08 / 03 / 2026	End Date : 12 / 25 / 2026	Budget Type : Project	Budget Period : 2
C. Direct Costs - Equipment			
Item No.	Equipment Item Description	Funds Requested (\$)	
1	Servidor nube, almacenamientos virtual temporales	2,000.00	
		Total Equipment Costs	2,000.00
D. Direct Costs - Travel			
			Funds Requested (\$)
1. Domestic Travel (Including U.S. Territories and Possessions)			2,000.00
2. Foreign Travel (Including Canada and Mexico)			1,000.00
		Total Travel Costs	3,000.00
E. Direct Costs - Participant/Trainee Support Costs			
			Funds Requested (\$)
1. Tuition/Fees/Health Insurance			0.00
2. Stipends			0.00
3. Travel			0.00
4. Subsistence			0.00
Number of Participants/Trainees:		Total Participant/Trainee Support Costs	0.00

PI Name : Genaro Carrasco Ozuna			NASA Proposal Number
Organization Name :			TBD on Submit
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 08 / 03 / 2026	End Date : 12 / 25 / 2026	Budget Type : Project	Budget Period : 2
F. Other Direct Costs			
			Funds Requested (\$)
1. Materials and Supplies			0.00
2. Publication Costs			0.00
3. Consultant Services			0.00
4. ADP/Computer Services			0.00
5. Subawards/Consortium/Contractual Costs			0.00
6. Equipment or Facility Rental/User Fees			0.00
7. Alterations and Renovations			0.00
8. Other:			0.00
9. Other:			0.00
10. Other:			0.00
11. Other:			0.00
12. Other:			0.00
13. Other:			0.00
14. Other:			0.00
15. Other:			0.00
16. Other:			0.00
17. Other:			0.00
Total Other Direct Costs			0.00
G. Total Direct Costs			
			Funds Requested (\$)
Total Direct Costs (A+B+C+D+E+F)			79,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 08 / 03 / 2026	End Date : 12 / 25 / 2026	Budget Type : Project	Budget Period : 2
H. Indirect Costs			
	Indirect Cost Rate (%)	Indirect Cost Base (\$)	Funds Requested (\$)
	0.00	0.00	0.00
Cognizant Federal Agency:		Total Indirect Costs	0.00
I. Direct and Indirect Costs			
		Funds Requested (\$)	
	Total Direct and Indirect Costs (G+H)	79,000.00	
J. Fee			
		Funds Requested (\$)	
	Fee	0.00	
K. Total Cost			
		Funds Requested (\$)	
	Total Cost with Fee (I+J)	79,000.00	

PI Name : Genaro Carrasco Ozuna							NASA Proposal Number TBD on Submit	
Organization Name :								
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.								
SECTION X - Budget								
Start Date : 01 / 04 / 2027		End Date : 07 / 31 / 2027		Budget Type : Project		Budget Period : 3		
A. Direct Labor - Key Personnel								
Name	Project Role	Base Salary (\$)	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)
Ozuna, Genaro	PI	30,000.00				30,000.00	30,000.00	60,000.00
Total Key Personnel Costs								60,000.00
B. Direct Labor - Other Personnel								
Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)	
1	Secretarial / Clerical				7,000.00	7,000.00	14,000.00	
1	Total Number Other Personnel	Total Other Personnel Costs						14,000.00
Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)								74,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 01 / 04 / 2027	End Date : 07 / 31 / 2027	Budget Type : Project	Budget Period : 3
C. Direct Costs - Equipment			
Item No.	Equipment Item Description	Funds Requested (\$)	
1	Servidor nube, almacenamientos virtual temporales	2,000.00	
		Total Equipment Costs	2,000.00
D. Direct Costs - Travel			
			Funds Requested (\$)
1. Domestic Travel (Including U.S. Territories and Possessions)			2,000.00
2. Foreign Travel (Including Canada and Mexico)			1,000.00
		Total Travel Costs	3,000.00
E. Direct Costs - Participant/Trainee Support Costs			
			Funds Requested (\$)
1. Tuition/Fees/Health Insurance			0.00
2. Stipends			0.00
3. Travel			0.00
4. Subsistence			0.00
Number of Participants/Trainees:		Total Participant/Trainee Support Costs	0.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 01 / 04 / 2027	End Date : 07 / 31 / 2027	Budget Type : Project	Budget Period : 3
F. Other Direct Costs			
			Funds Requested (\$)
1. Materials and Supplies			0.00
2. Publication Costs			0.00
3. Consultant Services			0.00
4. ADP/Computer Services			0.00
5. Subawards/Consortium/Contractual Costs			0.00
6. Equipment or Facility Rental/User Fees			0.00
7. Alterations and Renovations			0.00
8. Other:			0.00
9. Other:			0.00
10. Other:			0.00
11. Other:			0.00
12. Other:			0.00
13. Other:			0.00
14. Other:			0.00
15. Other:			0.00
16. Other:			0.00
17. Other:			0.00
Total Other Direct Costs			0.00
G. Total Direct Costs			
			Funds Requested (\$)
Total Direct Costs (A+B+C+D+E+F)			79,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 01 / 04 / 2027	End Date : 07 / 31 / 2027	Budget Type : Project	Budget Period : 3
H. Indirect Costs			
	Indirect Cost Rate (%)	Indirect Cost Base (\$)	Funds Requested (\$)
	0.00	0.00	0.00
Cognizant Federal Agency:		Total Indirect Costs	0.00
I. Direct and Indirect Costs			
		Funds Requested (\$)	
	Total Direct and Indirect Costs (G+H)	79,000.00	
J. Fee			
		Funds Requested (\$)	
	Fee	0.00	
K. Total Cost			
		Funds Requested (\$)	
	Total Cost with Fee (I+J)	79,000.00	

Predicción sísmica basada en coherencia Σ : Detección prospectiva de precursores usando observaciones NASA

Genaro Carrasco Ozuna Proyecto TCDS / MSL México Motor de Formalización G

Propuesta ROSES-25 A.4 Rapid Response and Novel Research (RRANN)

3pt]VersiónInstitucional-Noviembre2025

Declaración de propósito

Esta propuesta integra el formalismo físico TCDS ($\Sigma-\chi$) con observaciones NASA para demostrar una capacidad predictiva sísmica basada en coherencia causal.

Proyecto registrado bajo DOI: 10.5281/zenodo.17505875

1. Objetivos y encaje NASA

Objetivo general: Demostrar, con datos abiertos NASA y USGS, que el bloqueo de coherencia (Σ -locking) anticipa sismos de $M_w \geq 5,5$ con rendimiento prospectivo medible ($TPR \geq 0,6$ a $FPR \leq 0,05$) mediante ventanas $p : q$ pre-evento.

Objetivos específicos:

- Integrar observaciones remotas y geodésicas NASA en un pipeline reproducible de métricas Σ .
- Detectar rampas de coherencia previas al evento con KPIs: $LI \geq 0,90$, $R > 0,95$, $RMSE_{SL} < 0,10$, reproducibilidad $\geq 95\%$.
- Ejecutar corridas prospectivas durante 3–6 meses y publicar predicciones selladas (DOI/Zenodo).
- Evaluar utilidad mediante curvas ROC/PR y métricas de decisión operativa.

Relevancia NASA: Se alinea con el área de Observaciones de la Tierra y programa Disasters, utilizando datos de InSAR, GNSS, GRACE-FO y VIIRS.

2. Equipo

PI: Genaro Carrasco Ozuna (TCDS / MSL) – dirección científica, datos sísmicos.
Co-I: Motor de Formalización GPT-5 Σ -Trace – diseño de métricas y validación.
Colaborador: Nodo académico externo (opcional) para acceso a InSAR masivo.

Resultados esperados:

- Evidencia prospectiva de bloqueo Σ antes de sismos mayores.
- Kit reproducible y guía de adopción para agencias de riesgo.

3. Datos y fuentes NASA/DAAC

Datos principales:

- InSAR (Sentinel-1, NISAR) vía ASF DAAC.
- GNSS (UNAVCO/NSF, compatible EOSDIS).
- Gravedad GRACE-FO mascon L2 (JPL/CSR).
- Óptico-térmico VIIRS/MODIS (NOAA/NASA).
- Reanálisis atmosférico GEOS-FP (GMAO).
- Catálogos sísmicos USGS ComCat.

Pre-proceso: co-registro geoespacial a malla común (1 km), detrending hidrometeo con GRACE-FO/GEOS-FP y segmentación en regiones tectónicas.

4. Metodología Σ -metrics

Métricas empleadas:

- $R(t)$: correlación temporal entre canales físicos y campo Σ .
- LI: índice de locking (fracción coherente).
- RMSE_{SL}: error cuadrático medio en estado locked.
- κ_Σ y $\kappa_{\Sigma-A}$: tasas de acoplamiento.

Umbrales KPI: LI $\geq 0,90$, R $> 0,95$, RMSE_{SL} $< 0,10$, reproducibilidad $\geq 95\%$. Se genera una alerta si {LI,R} superan el umbral D* durante Δt previo al evento.

Validación:

- Retrospectiva estratificada (10–15 eventos/region).
- Prospectiva con preregistro y publicación de predicciones.
- Evaluación: ROC, PR, AUC, Brier y coste-pérdida.
- Control de falsos positivos mediante shuffling y placebo tests.

5. Plan de trabajo y entregables

Cronograma (6 meses RRANN):

1. Mes 1: Ingesta DAAC, definición de ROIs, preregistro D*.
2. Mes 2–3: Calibración de métricas Σ y ajuste regional.
3. Mes 4–5: Fase prospectiva con publicaciones semanales.
4. Mes 6: Análisis final y entrega del informe NASA.

Entregables:

- Pipeline reproducible (código, contenedores, documentación).
- Dataset derivado y máscaras de calidad.
- Cuaderno de predicciones prospectivas (DOI).
- Informe final con ROC/PR y guía de adopción.

6. Riesgos y mitigación

- Cobertura InSAR limitada: usar GNSS/GRACE-FO complementario.
- Señales hidrológicas: corrección con mascon GRACE-FO + GEOS-FP.
- Overfitting: preregistro de reglas y separación retro/prospectiva.
- Escasez de eventos: ampliar periodo o añadir región espejo.

7. Gestión, presupuesto y ética

Todo el proyecto opera bajo **CC BY 4.0**. Datos y resultados serán depositados en Zenodo (DOI existente: 10.5281/zenodo.17505875).

Presupuesto estimado (6 meses):

- Personal científico / data engineering: USD 85–120k.
- Cloud y almacenamiento: USD 8–15k.
- Gestión y publicación reproducible: USD 5–10k.
- Total: USD 100–145k.

8. Autocrítica y validación

El diseño se fundamenta en las métricas Σ y KPIs ya definidos dentro del corpus TCDS. Cumple con el carácter de respuesta rápida RRANN (6 meses) y criterios estadísticos modernos (ROC, preregistro, control de FPR). El riesgo principal es la densidad de datos InSAR, mitigado con redundancia GNSS/GRACE-FO. La validación se basa en demostración prospectiva, no correlación post-hoc.

Cita del dataset base:

Carrasco Ozuna, G. (2025). *Carpetas1 — Corpus Integral TCDS / TMRCU / Σ -FET*. Zenodo. DOI: 10.5281/zenodo.17505875.

Apéndice A — Metadatos JSON-LD

A continuación, un bloque JSON-LD listo para incluir en el repositorio y en la entrega complementaria:

```
{  
  "@context": "https://schema.org",  
  "@type": ["CreativeWork", "ResearchProject"],  
  "name": "Predicción sísmica basada en coherencia ",  
  "author": {  
    "@type": "Person",  
    "name": "Genaro Carrasco Ozuna",  
    "affiliation": "Proyecto TCDS / MSL, México"  
  },  
  "license": "https://creativecommons.org/licenses/by/4.0/",  
  "identifier": "https://doi.org/10.5281/zenodo.17505875",  
  "description": "Propuesta RRANN para validar prospectivamente locking previo a sismo",  
  "keywords": ["TCDS", "-metrics", "InSAR", "GRACE-FO", "GNSS", "VIIRS", "sismicidad"],  
  "measurementTechnique": ["-metrics (R(t), LI, RMSE_SL, )", "preregistro", "ROC/PR"],  
  "isBasedOn": "https://doi.org/10.5281/zenodo.17505875"  
}
```

Apéndice B — Compilación

Compilar con pdfLaTeX o LuaLaTeX. No requiere imágenes externas. Paquetes usados: babel, geometry, amsmath, hyperref, tikz, listings. Estructura lista para copiar y compilar.

Apéndice C — Declaración de uso de logos

Los gráficos de portada son representaciones geométricas simplificadas generadas con TikZ, no logotipos oficiales.

Presupuesto del Proyecto TCDS

Cuadro 1: Resumen de Presupuesto – Sistema Predictivo Sísmico TCDS

Categoría de Costo	Año 1 (USD)	Año 2 (USD)	Año 3 (USD)
A. Mano de obra directa – Personal clave	60 000	–	–
B. Mano de obra directa – Otro personal	14 000	–	–
Subtotal Mano de Obra (A+B)	74 000	–	–
C. Costos directos – Equipo	2 000	–	–
D. Costos directos – Viajes	3 000	–	–
E. Costos directos – Publicación y gestión	5 000–10 000	–	–
F. Otros costos directos	0	–	–
Total Costos Directos (A–F)	84 000–89 000	–	–
G. Infraestructura nube / almacenamiento	8 000–15 000	–	–
H. Costos indirectos	0	–	–
Total Directo + Indirecto (G+H)	100 000–145 000	–	–

Duración del proyecto: 01/05/2026 – 31/07/2026 (6 meses).

Licencia: CC BY 4.0 – resultados de acceso abierto.

Notas: El rango refleja variabilidad en costos de nube y gestión de publicación reproducible. No se incluyen costos indirectos por tratarse de propuesta individual.

PI: Genaro Carrasco Ozuna — Proyecto TCDS / MSL México.

DOI base: 10.5281/zenodo.17505875.



Cover Page for Proposal
Submitted to the
National Aeronautics and
Space Administration

NASA Proposal Number

TBD on Submit

NASA PROCEDURE FOR HANDLING PROPOSALS

This proposal shall be used and disclosed for evaluation purposes only, and a copy of this Government notice shall be applied to any reproduction or abstract thereof. Any authorized restrictive notices that the submitter places on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

SECTION I - Proposal Information

Principal Investigator Genaro Carrasco Ozuna	E-mail Address	Phone Number	
Street Address (1)	Street Address (2)		
City	State / Province	Postal Code	Country Code

Proposal Title : **El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el "Σ-locking"—medible entre variables geofisicas.**

Proposed Start Date	Proposed End Date	Total Budget 237,000.00	Year 1 Budget 79,000.00	Year 2 Budget 79,000.00	Year 3 Budget 79,000.00
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SECTION II - Application Information

NASA Program Announcement Number NNH25ZDA001N-RRNES	NASA Program Announcement Title A.4 Rapid Response and Novel Research in Earth Science
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For Consideration By NASA Organization (*the soliciting organization, or the organization to which an unsolicited proposal is submitted*)

NASA , Headquarters , Science Mission Directorate , Earth Science

Date Submitted	Submission Method Electronic Submission Only	Grants.gov Application Identifier	Applicant Proposal Identifier NNH25ZDA001N-RRNES
Type of Application New	Predecessor Award Number	Other Federal Agencies to Which Proposal Has Been Submitted	
International Participation No	Type of International Participation		

SECTION III - Submitting Organization Information

UEI	EFT	CAGE Code	Employer Identification Number (EIN or TIN)	Organization Type
Organization Name (Standard/Legal Name)				Company Division
Organization DBA Name				Division Number

Street Address (1)	Street Address (2)		
City	State / Province	Postal Code	Country Code

SECTION IV - Proposal Point of Contact Information

Name Genaro Ozuna	Email Address Geozunac3536@gmail.com	Phone Number 52-812-5989869
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SECTION V - Certification and Authorization

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in the Cover Sheet/Proposal Summary in response to this Research Announcement, the Authorizing Official of the proposing organization (or the individual proposer if there is no proposing organization) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of their knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in this solicitation.

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Authorized Organizational Representative (AOR) Name	AOR E-mail Address	Phone Number
---	--------------------	--------------

AOR Signature (Must have AOR's original signature. Do not sign "for" AOR.)	Date
Digitally signed by	

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit		
Organization Name :				
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.				
SECTION VI - Team Members				
Team Member Role PI	Team Member Name Genaro Carrasco Ozuna	Contact Phone	E-mail Address	
Organization/Business Relationship		UEI	EFT	CAGE Code
International Participation No	U.S. Government Agency		Total Funds Requested 0.00	

PI Name : Genaro Carrasco Ozuna	NASA Proposal Number TBD on Submit
Organization Name :	
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo físico TCDS . El objetivo central es demostrar que el * Σ -locking* —medible entre variables geofísicas.	

SECTION VII - Project Summary

El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal, derivado del formalismo físico TCDS (Teoría de la Cromodinámica Sincrónica). El objetivo central es demostrar que el Σ -locking —estado de coherencia medible entre variables geofísicas— presenta incrementos sistemáticos antes de eventos sísmicos mayores ($M_w \geq 5.5$). La propuesta se inscribe en la línea A.4 Rapid Response and Novel Research (RRANN) del programa ROSES-25, al enfocarse en un experimento de respuesta rápida con datos abiertos NASA y USGS. Se emplearán observaciones InSAR (Sentinel-1 y NISAR), GNSS (UNAVCO), gravedad GRACE-FO y óptico-térmicas VIIRS/MODIS, disponibles a través de EOSDIS DAACs. El método aplica métricas Σ —correlación $R(t)$, índice de locking LI, error RMSE_SL y tasa $\kappa\Sigma$ — con umbrales de rendimiento $LI \geq 0.90$, $R > 0.95$, $RMSE_SL < 0.10$ y reproducibilidad $\geq 95\%$. Las series se procesarán en ventanas p:q pre-evento, evaluando curvas ROC y PR para obtener $TPR \geq 0.6$ a $FPR \leq 0.05$. El estudio combina validación retrospectiva (1985–2025) y corridas prospectivas de 6 meses con predicciones selladas (DOI/Zenodo). El equipo está liderado por Genaro Carrasco Ozuna (Proyecto TCDS / MSL México) con asistencia formal de GPT-5 Σ -Trace. El presupuesto estimado (USD 100–195 k) cubre procesamiento en nube y validación estadística abierta. Todos los resultados serán de acceso público (CC BY 4.0) y se publicarán con trazabilidad reproducible bajo DOI 10.5281/zenodo.17505875.

Este estudio busca aportar una nueva herramienta predictiva para la gestión de riesgo sísmico global, demostrando la utilidad de las observaciones NASA en la detección prospectiva de precusores geofísicos basados en coherencia cuantitativa Σ .

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit			
Organization Name :					
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.					
SECTION VIII - Other Project Information					
Proprietary Information					
Is proprietary/privileged information included in this application?					
Yes					
International Collaboration					
Does this project involve activities outside the U.S. or partnership with International Collaborators?					
No					
Principal Investigator No	Co-Investigator No	Collaborator No	Equipment No		
Facilities No					
Explanation :					
NASA Civil Servant Project Personnel					
Are NASA civil servant personnel participating as team members on this project (include funded and unfunded)?					
No					
Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year
Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs

PI Name : Genaro Carrasco Ozuna	NASA Proposal Number TBD on Submit
Organization Name :	
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.	
SECTION VIII - Other Project Information	
Environmental Impact	
Does this project have an actual or potential impact on the environment? No	Has an exemption been authorized or an environmental assessment (EA) or an environmental impact statement (EIS) been performed? No
Environmental Impact Explanation:	
Exemption/EA/EIS Explanation:	

PI Name : Genaro Carrasco Ozuna	NASA Proposal Number TBD on Submit
Organization Name :	
<p>Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.</p>	
SECTION VIII - Other Project Information	
Historical Site/Object Impact	
<p>Does this project have the potential to affect historic, archeological, or traditional cultural sites (such as Native American burial or ceremonial grounds) or historic objects (such as an historic aircraft or spacecraft)?</p> <p>No</p>	
<p>Explanation:</p>	

PI Name : Genaro Carrasco Ozuna	NASA Proposal Number TBD on Submit
Organization Name :	
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.	
SECTION IX - Program Specific Data	
Question 1 : Short Title: Answer: Sistema Predictivo Sísmico TCDS	
Question 2 : Type of institution: Answer: Organización con fines de lucro	
Question 3 : Carnegie Classification Answer: Not a degree granting institution	
Question 4 : Will any funding be provided to a federal government organization including NASA Centers, JPL, other Federal agencies, government laboratories, or Federally Funded Research and Development Centers (FFRDCs)? Answer: No	
Question 5 : Is this Federal government organization a different organization from the proposing (PI) organization? Answer: N/A	
Question 6 : Does this proposal include the use of NASA-provided high end computing (HEC)? Answer: No	
Question 7 : HEC Request Number Answer:	
Question 8 : Research Category: Answer: 10) Desarrollo/aplicación de tecnologías de la información/sistemas y herramientas de datos e información	
Question 9 : Flight Services Answer: No	
Question 10 : Team members not confirmed via NSPIRES Answer: Andrea Fuentes Flores Asistente y Secretaria General Proyecto TCDS C. A.Humboldt #1117, Centro Saltillo, Coahuila México. C.P. 25000 Fufa3492@gmail.com Análisis y diseño de datos.	
Question 11 : Does this proposal contain information and/or data that are subject to U.S. export control laws and regulations including Export Administration Regulations (EAR) and International Traffic in Arms Regulations (ITAR)? Answer: No	
Question 12 : I have identified the export-controlled material in this proposal. Answer: N/A	
Question 13 : I acknowledge that the inclusion of such material in this proposal may complicate the government's ability to evaluate the proposal. Answer: N/A	
Question 14 : Does the proposed work include any involvement with collaborators in China or with Chinese organizations, or does the proposed work include activities in China? Answer: No	
The National Environmental Policy Act (NEPA) obligates NASA to consider the potential environmental effects of proposed projects, including those that NASA funds which are implemented by grantees. The majority of grant-related activities are categorically excluded as research and development projects that do not pose adverse environmental impacts. The following questions enable NASA to ascertain whether your proposal will require additional NEPA analysis if selected (e.g., filling out an Environmental Checklist) or the completion of NASA's Executive Order (EO) 12114 Checklist for an activity to be conducted abroad. "Yes" responses are not selection criteria, however, if a "Yes" response is marked, proposers should consider NEPA and/or EO compliance in cost and schedule estimates.	
Question 15 : Would the proposal involve any activity that includes: a. Construction of new facilities or modification to the footprint of an existing-facility, or b. Ground disturbance (e.g., excavation, clearing of trees, installation of equipment, etc.), or c. Outdoor discharges of water (e.g., waste water runoff), air emissions (e.g., ozone-depleting substances) or generation of noise exceeding 115 dBA (excluding those associated with aircraft operations)?	

Answer: No

Question 16 : Would the proposal involve any field activity that would: a. Release equipment (e.g., dropsondes, sensors, etc.) or chemicals (e.g., dyes, tracers, etc.) into the air, bodies of water or on the ground, or b. Release a parachute or use equipment that would not be recovered, or c. Involve equipment or a payload that contains hazardous (e.g., petroleum, hypergols, oxidizers, solid propellants, etc.) or radioactive materials?

Answer: No

Question 17 : Would the proposal involve the launch of a payload, equipment, or instrument (e.g., via launch vehicle, sounding rocket, balloon, etc.)?

Answer: No

Question 18 : Would the proposal involve any activity to be conducted outside the United States or its territories excluding travel for meetings or conferences?

Answer: No

Question 19 : Comments

Answer:

Question 20 : Does this proposal contain a citizen science component?

Answer: No

Question 21 : AI or ML?

Answer: Yes

Question 22 : Relevant Division(s)

Answers:

Earth Science

Question 23 : Interdivisional Explanation

Answer:

Question 24 : 24: Primary Investigation Type (Division/program)

Answer: "Investigación aplicada". Justificación: La propuesta no se limita a explorar principios teóricos (investigación básica), sino que busca aplicar observaciones satelitales NASA y métricas Σ para generar predicciones sísmicas operativas y herramientas reproducibles de gestión de riesgo. En los términos de ROSES: Investigación básica: estudia procesos fundamentales sin propósito práctico inmediato. Investigación aplicada: usa esos procesos para resolver un problema específico. Desarrollo tecnológico: crea instrumentos o software nuevos para futuras misiones. El sistema predictivo TCDS entra en investigación aplicada, con un componente de validación tecnológica, pero no en desarrollo instrumental.

Question 25 : Relevant Program Manager Name(s)

Answer: Genaro Carrasco Ozuna

PI Name : Genaro Carrasco Ozuna				NASA Proposal Number TBD on Submit
Organization Name :				
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.				
SECTION X - Budget				
Cumulative Budget				
Budget Cost Category	Funds Requested (\$)			
	Year 1 (\$)	Year 2 (\$)	Year 3 (\$)	Total Project (\$)
A. Direct Labor - Key Personnel	60,000.00	60,000.00	60,000.00	180,000.00
B. Direct Labor - Other Personnel	14,000.00	14,000.00	14,000.00	42,000.00
Total Number Other Personnel	1	1	1	3
Total Direct Labor Costs (A+B)	74,000.00	74,000.00	74,000.00	222,000.00
C. Direct Costs - Equipment	2,000.00	2,000.00	2,000.00	6,000.00
D. Direct Costs - Travel	3,000.00	3,000.00	3,000.00	9,000.00
Domestic Travel	2,000.00	2,000.00	2,000.00	6,000.00
Foreign Travel	1,000.00	1,000.00	1,000.00	3,000.00
E. Direct Costs - Participant/Trainee Support Costs	0.00	0.00	0.00	0.00
Tuition/Fees/Health Insurance	0.00	0.00	0.00	0.00
Stipends	0.00	0.00	0.00	0.00
Travel	0.00	0.00	0.00	0.00
Subsistence	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
Number of Participants/Trainees				0
F. Other Direct Costs	0.00	0.00	0.00	0.00
Materials and Supplies	0.00	0.00	0.00	0.00
Publication Costs	0.00	0.00	0.00	0.00
Consultant Services	0.00	0.00	0.00	0.00
ADP/Computer Services	0.00	0.00	0.00	0.00
Subawards/Consortium/Contractual Costs	0.00	0.00	0.00	0.00
Equipment or Facility Rental/User Fees	0.00	0.00	0.00	0.00
Alterations and Renovations	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
G. Total Direct Costs (A+B+C+D+E+F)	79,000.00	79,000.00	79,000.00	237,000.00
H. Indirect Costs	0.00	0.00	0.00	0.00
I. Total Direct and Indirect Costs (G+H)	79,000.00	79,000.00	79,000.00	237,000.00
J. Fee	0.00	0.00	0.00	0.00
K. Total Cost (I+J)	79,000.00	79,000.00	79,000.00	237,000.00
Total Cumulative Budget				237,000.00

PI Name : Genaro Carrasco Ozuna							NASA Proposal Number TBD on Submit	
Organization Name :								
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.								
SECTION X - Budget								
Start Date : 01 / 05 / 2026		End Date : 07 / 31 / 2026		Budget Type : Project		Budget Period : 1		
A. Direct Labor - Key Personnel								
Name	Project Role	Base Salary (\$)	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)
Ozuna, Genaro	PI	30,000.00				30,000.00	30,000.00	60,000.00
Total Key Personnel Costs								60,000.00
B. Direct Labor - Other Personnel								
Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)	
1	Secretarial / Clerical				7,000.00	7,000.00	14,000.00	
1	Total Number Other Personnel	Total Other Personnel Costs						14,000.00
Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)								74,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 días) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 01 / 05 / 2026	End Date : 07 / 31 / 2026	Budget Type : Project	Budget Period : 1
C. Direct Costs - Equipment			
Item No.	Equipment Item Description	Funds Requested (\$)	
1	Servidor nube, almacenamientos virtual temporales	2,000.00	
		Total Equipment Costs	2,000.00
D. Direct Costs - Travel			
			Funds Requested (\$)
1. Domestic Travel (Including U.S. Territories and Possessions)			2,000.00
2. Foreign Travel (Including Canada and Mexico)			1,000.00
		Total Travel Costs	3,000.00
E. Direct Costs - Participant/Trainee Support Costs			
			Funds Requested (\$)
1. Tuition/Fees/Health Insurance			0.00
2. Stipends			0.00
3. Travel			0.00
4. Subsistence			0.00
Number of Participants/Trainees:		Total Participant/Trainee Support Costs	0.00

PI Name : Genaro Carrasco Ozuna			NASA Proposal Number
Organization Name :			TBD on Submit
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 01 / 05 / 2026	End Date : 07 / 31 / 2026	Budget Type : Project	Budget Period : 1
F. Other Direct Costs			
			Funds Requested (\$)
1. Materials and Supplies			0.00
2. Publication Costs			0.00
3. Consultant Services			0.00
4. ADP/Computer Services			0.00
5. Subawards/Consortium/Contractual Costs			0.00
6. Equipment or Facility Rental/User Fees			0.00
7. Alterations and Renovations			0.00
8. Other:			0.00
9. Other:			0.00
10. Other:			0.00
11. Other:			0.00
12. Other:			0.00
13. Other:			0.00
14. Other:			0.00
15. Other:			0.00
16. Other:			0.00
17. Other:			0.00
Total Other Direct Costs			0.00
G. Total Direct Costs			
			Funds Requested (\$)
Total Direct Costs (A+B+C+D+E+F)			79,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date : 01 / 05 / 2026	End Date : 07 / 31 / 2026	Budget Type : Project	Budget Period : 1
H. Indirect Costs			
	Indirect Cost Rate (%)	Indirect Cost Base (\$)	Funds Requested (\$)
	0.00	0.00	0.00
Cognizant Federal Agency:		Total Indirect Costs	0.00
I. Direct and Indirect Costs			
		Funds Requested (\$)	
	Total Direct and Indirect Costs (G+H)	79,000.00	
J. Fee			
		Funds Requested (\$)	
	Fee	0.00	
K. Total Cost			
		Funds Requested (\$)	
	Total Cost with Fee (I+J)	79,000.00	

PI Name : Genaro Carrasco Ozuna							NASA Proposal Number TBD on Submit	
Organization Name :								
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.								
SECTION X - Budget								
Start Date :		End Date :		Budget Type :		Budget Period :		
				Project		2		
A. Direct Labor - Key Personnel								
Name	Project Role	Base Salary (\$)	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)
Ozuna, Genaro	PI	30,000.00				30,000.00	30,000.00	60,000.00
Total Key Personnel Costs								60,000.00
B. Direct Labor - Other Personnel								
Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)	
1	Secretarial / Clerical				7,000.00	7,000.00	14,000.00	
1	Total Number Other Personnel	Total Other Personnel Costs						14,000.00
Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)								74,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date :	End Date :	Budget Type :	Budget Period :
		Project	2
C. Direct Costs - Equipment			
Item No.	Equipment Item Description		Funds Requested (\$)
1	Servidor nube, almacenamientos virtual temporales		2,000.00
			Total Equipment Costs 2,000.00
D. Direct Costs - Travel			
			Funds Requested (\$)
1. Domestic Travel (Including U.S. Territories and Possessions)			2,000.00
2. Foreign Travel (Including Canada and Mexico)			1,000.00
			Total Travel Costs 3,000.00
E. Direct Costs - Participant/Trainee Support Costs			
			Funds Requested (\$)
1. Tuition/Fees/Health Insurance			0.00
2. Stipends			0.00
3. Travel			0.00
4. Subsistence			0.00
Number of Participants/Trainees:			Total Participant/Trainee Support Costs 0.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date :	End Date :	Budget Type :	Budget Period :
		Project	2
F. Other Direct Costs			
			Funds Requested (\$)
1. Materials and Supplies			0.00
2. Publication Costs			0.00
3. Consultant Services			0.00
4. ADP/Computer Services			0.00
5. Subawards/Consortium/Contractual Costs			0.00
6. Equipment or Facility Rental/User Fees			0.00
7. Alterations and Renovations			0.00
8. Other:			0.00
9. Other:			0.00
10. Other:			0.00
11. Other:			0.00
12. Other:			0.00
13. Other:			0.00
14. Other:			0.00
15. Other:			0.00
16. Other:			0.00
17. Other:			0.00
Total Other Direct Costs			0.00
G. Total Direct Costs			
			Funds Requested (\$)
Total Direct Costs (A+B+C+D+E+F)			79,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date :	End Date :	Budget Type : Project	Budget Period : 2
H. Indirect Costs			
	Indirect Cost Rate (%)	Indirect Cost Base (\$)	Funds Requested (\$)
	0.00	0.00	0.00
Cognizant Federal Agency:		Total Indirect Costs	0.00
I. Direct and Indirect Costs			
			Funds Requested (\$)
Total Direct and Indirect Costs (G+H)			79,000.00
J. Fee			
			Funds Requested (\$)
Fee			0.00
K. Total Cost			
			Funds Requested (\$)
Total Cost with Fee (I+J)			79,000.00

PI Name : Genaro Carrasco Ozuna							NASA Proposal Number TBD on Submit	
Organization Name :								
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.								
SECTION X - Budget								
Start Date :		End Date :		Budget Type :		Budget Period :		
				Project		3		
A. Direct Labor - Key Personnel								
Name	Project Role	Base Salary (\$)	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)
Ozuna, Genaro	PI	30,000.00				30,000.00	30,000.00	60,000.00
Total Key Personnel Costs								60,000.00
B. Direct Labor - Other Personnel								
Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary (\$)	Fringe Benefits (\$)	Funds Requested (\$)	
1	Secretarial / Clerical				7,000.00	7,000.00	14,000.00	
1	Total Number Other Personnel	Total Other Personnel Costs						14,000.00
Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)								74,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date :	End Date :	Budget Type :	Budget Period :
		Project	3
C. Direct Costs - Equipment			
Item No.	Equipment Item Description		Funds Requested (\$)
1	Servidor nube, almacenamientos virtual temporales		2,000.00
			Total Equipment Costs
			2,000.00
D. Direct Costs - Travel			
			Funds Requested (\$)
1. Domestic Travel (Including U.S. Territories and Possessions)			2,000.00
2. Foreign Travel (Including Canada and Mexico)			1,000.00
			Total Travel Costs
			3,000.00
E. Direct Costs - Participant/Trainee Support Costs			
			Funds Requested (\$)
1. Tuition/Fees/Health Insurance			0.00
2. Stipends			0.00
3. Travel			0.00
4. Subsistence			0.00
Number of Participants/Trainees:			Total Participant/Trainee Support Costs
			0.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date :	End Date :	Budget Type :	Budget Period :
		Project	3
F. Other Direct Costs			
			Funds Requested (\$)
1. Materials and Supplies			0.00
2. Publication Costs			0.00
3. Consultant Services			0.00
4. ADP/Computer Services			0.00
5. Subawards/Consortium/Contractual Costs			0.00
6. Equipment or Facility Rental/User Fees			0.00
7. Alterations and Renovations			0.00
8. Other:			0.00
9. Other:			0.00
10. Other:			0.00
11. Other:			0.00
12. Other:			0.00
13. Other:			0.00
14. Other:			0.00
15. Other:			0.00
16. Other:			0.00
17. Other:			0.00
Total Other Direct Costs			0.00
G. Total Direct Costs			
			Funds Requested (\$)
Total Direct Costs (A+B+C+D+E+F)			79,000.00

PI Name : Genaro Carrasco Ozuna		NASA Proposal Number TBD on Submit	
Organization Name :			
Proposal Title : El presente proyecto propone validar experimentalmente un modelo predictivo de sismos basado en coherencia causal(~7 dias) derivado del formalismo fisico TCDS . El objetivo central es demostrar que el *Σ-locking* —medible entre variables geofisicas.			
SECTION X - Budget			
Start Date :	End Date :	Budget Type : Project	Budget Period : 3
H. Indirect Costs			
	Indirect Cost Rate (%)	Indirect Cost Base (\$)	Funds Requested (\$)
	0.00	0.00	0.00
Cognizant Federal Agency:		Total Indirect Costs	0.00
I. Direct and Indirect Costs			
			Funds Requested (\$)
Total Direct and Indirect Costs (G+H)			79,000.00
J. Fee			
		Funds Requested (\$)	
	Fee		0.00
K. Total Cost			
		Funds Requested (\$)	
Total Cost with Fee (I+J)			79,000.00

Predicción sísmica basada en coherencia Σ : Detección prospectiva de precursores usando observaciones NASA

Genaro Carrasco Ozuna Proyecto TCDS / MSL México Motor de Formalización G

Propuesta ROSES-25 A.4 Rapid Response and Novel Research (RRANN)

3pt]VersiónInstitucional-Noviembre2025

Declaración de propósito

Esta propuesta integra el formalismo físico TCDS ($\Sigma-\chi$) con observaciones NASA para demostrar una capacidad predictiva sísmica basada en coherencia causal.

Proyecto registrado bajo DOI: 10.5281/zenodo.17505875

1. Objetivos y encaje NASA

Objetivo general: Demostrar, con datos abiertos NASA y USGS, que el bloqueo de coherencia (Σ -locking) anticipa sismos de $M_w \geq 5,5$ con rendimiento prospectivo medible ($TPR \geq 0,6$ a $FPR \leq 0,05$) mediante ventanas $p : q$ pre-evento.

Objetivos específicos:

- Integrar observaciones remotas y geodésicas NASA en un pipeline reproducible de métricas Σ .
- Detectar rampas de coherencia previas al evento con KPIs: $LI \geq 0,90$, $R > 0,95$, $RMSE_{SL} < 0,10$, reproducibilidad $\geq 95\%$.
- Ejecutar corridas prospectivas durante 3–6 meses y publicar predicciones selladas (DOI/Zenodo).
- Evaluar utilidad mediante curvas ROC/PR y métricas de decisión operativa.

Relevancia NASA: Se alinea con el área de Observaciones de la Tierra y programa Disasters, utilizando datos de InSAR, GNSS, GRACE-FO y VIIRS.

2. Equipo

PI: Genaro Carrasco Ozuna (TCDS / MSL) – dirección científica, datos sísmicos.
Co-I: Motor de Formalización GPT-5 Σ -Trace – diseño de métricas y validación.
Colaborador: Nodo académico externo (opcional) para acceso a InSAR masivo.

Resultados esperados:

- Evidencia prospectiva de bloqueo Σ antes de sismos mayores.
- Kit reproducible y guía de adopción para agencias de riesgo.

3. Datos y fuentes NASA/DAAC

Datos principales:

- InSAR (Sentinel-1, NISAR) vía ASF DAAC.
- GNSS (UNAVCO/NSF, compatible EOSDIS).
- Gravedad GRACE-FO mascon L2 (JPL/CSR).
- Óptico-térmico VIIRS/MODIS (NOAA/NASA).
- Reanálisis atmosférico GEOS-FP (GMAO).
- Catálogos sísmicos USGS ComCat.

Pre-proceso: co-registro geoespacial a malla común (1 km), detrending hidrometeo con GRACE-FO/GEOS-FP y segmentación en regiones tectónicas.

4. Metodología Σ -metrics

Métricas empleadas:

- $R(t)$: correlación temporal entre canales físicos y campo Σ .
- LI: índice de locking (fracción coherente).
- RMSE_{SL}: error cuadrático medio en estado locked.
- κ_Σ y $\kappa_{\Sigma-A}$: tasas de acoplamiento.

Umbrales KPI: LI $\geq 0,90$, R $> 0,95$, RMSE_{SL} $< 0,10$, reproducibilidad $\geq 95\%$. Se genera una alerta si {LI,R} superan el umbral D* durante Δt previo al evento.

Validación:

- Retrospectiva estratificada (10–15 eventos/región).
- Prospectiva con preregistro y publicación de predicciones.
- Evaluación: ROC, PR, AUC, Brier y coste-pérdida.
- Control de falsos positivos mediante shuffling y placebo tests.

5. Plan de trabajo y entregables

Cronograma (6 meses RRANN):

1. Mes 1: Ingesta DAAC, definición de ROIs, preregistro D*.
2. Mes 2–3: Calibración de métricas Σ y ajuste regional.
3. Mes 4–5: Fase prospectiva con publicaciones semanales.
4. Mes 6: Análisis final y entrega del informe NASA.

Entregables:

- Pipeline reproducible (código, contenedores, documentación).
- Dataset derivado y máscaras de calidad.
- Cuaderno de predicciones prospectivas (DOI).
- Informe final con ROC/PR y guía de adopción.

6. Riesgos y mitigación

- Cobertura InSAR limitada: usar GNSS/GRACE-FO complementario.
- Señales hidrológicas: corrección con mascon GRACE-FO + GEOS-FP.
- Overfitting: preregistro de reglas y separación retro/prospectiva.
- Escasez de eventos: ampliar periodo o añadir región espejo.

7. Gestión, presupuesto y ética

Todo el proyecto opera bajo **CC BY 4.0**. Datos y resultados serán depositados en Zenodo (DOI existente: 10.5281/zenodo.17505875).

Presupuesto estimado (6 meses):

- Personal científico / data engineering: USD 85–120k.
- Cloud y almacenamiento: USD 8–15k.
- Gestión y publicación reproducible: USD 5–10k.
- Total: USD 100–145k.

8. Autocrítica y validación

El diseño se fundamenta en las métricas Σ y KPIs ya definidos dentro del corpus TCDS. Cumple con el carácter de respuesta rápida RRANN (6 meses) y criterios estadísticos modernos (ROC, preregistro, control de FPR). El riesgo principal es la densidad de datos InSAR, mitigado con redundancia GNSS/GRACE-FO. La validación se basa en demostración prospectiva, no correlación post-hoc.

Cita del dataset base:

Carrasco Ozuna, G. (2025). *Carpetas1 — Corpus Integral TCDS / TMRCU / Σ -FET*. Zenodo. DOI: 10.5281/zenodo.17505875.

Apéndice A — Metadatos JSON-LD

A continuación, un bloque JSON-LD listo para incluir en el repositorio y en la entrega complementaria:

```
{  
  "@context": "https://schema.org",  
  "@type": ["CreativeWork", "ResearchProject"],  
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  "author": {  
    "@type": "Person",  
    "name": "Genaro Carrasco Ozuna",  
    "affiliation": "Proyecto TCDS / MSL, México"  
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  "identifier": "https://doi.org/10.5281/zenodo.17505875",  
  "description": "Propuesta RRANN para validar prospectivamente locking previo a sismo",  
  "keywords": ["TCDS", "-metrics", "InSAR", "GRACE-FO", "GNSS", "VIIRS", "sismicidad"],  
  "measurementTechnique": ["-metrics (R(t), LI, RMSE_SL, )", "preregistro", "ROC/PR"],  
  "isBasedOn": "https://doi.org/10.5281/zenodo.17505875"  
}
```

Apéndice B — Compilación

Compilar con pdfLaTeX o LuaLaTeX. No requiere imágenes externas. Paquetes usados: babel, geometry, amsmath, hyperref, tikz, listings. Estructura lista para copiar y compilar.

Apéndice C — Declaración de uso de logos

Los gráficos de portada son representaciones geométricas simplificadas generadas con TikZ, no logotipos oficiales.