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Supplement of

Strategies for improving the communication of satellite-derived InSAR data for geohazards through the analysis of Twitter and online data portals

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Twitter text cleaning

Remove words:

("utc","km","pm","na","fffef","cm","ms","ki","fe","una","si","fa","b","est","por","les","hai","ka","th","e","le","m","ff","c","ne","dr","cc","ya","ko","es","para","con","di","da","del","se","bfef","fdfef","antiwhale","fb","ada","f","de", "la","eea", "eebeecfccfc","abbasi", "sidna","en", "el","ul", "islam","allah", "de","en", "la","d", "a","muhajir","ur","bread")

Remove users containing:

Autism|autism|Autistic|autistic|Autistics|autistics|sk_insar|hamza_insar|lithifer|myjournals

Scientist classification:

scientist <- c("\\blectur+|\\bprof\\b|\\bprofessor\\b|\\bprofesseur|\\bprofesor|\\bresearch chair\\b|\\bcrccrc\\b|\\bdean\\b|\\bfaculty\\b|\\bdistinguished chair\\b")

science_students1 <- c('\\bbsc?\\b|\\bmsc?\\b|phd|\\bdphil\\b|\\bdoctoral\\b|\\masters\\bgrad+|ologist|ology\\b|oceanography\\b|biome|systems|\\bma\\b|\\bba\\b|science|evolution|istry\\b|ics\\b|\\bmres\\b')

science_students2 <- c('\\bpost?doc|fellow|\\bpost doc\\b|\\bgradschool\\b|\\bstudying\\b|\\bgraduate school\\b')

science_organisations1 <- c('\\bresearch\\b|\\bscien|istry\\b|isheries\\b|olog|\\bstud+|environment|\\bconservation|ogical', '\\bassociation\\b|\\bsynthesis|\\binterdisciplinary\\b|\\bnetwork\\b|\\bdept\\b|\\bdepartment\\b|\\blab|\\ballian ce\\b|\\bcentre|\\bcenter|\\binitiative\\b|\\bacademicians\\b|\\brepository\\b|\\bforum\\b|\\bsection\\b|\\bmeeti ng\\b|\\bsociety\\b|\\bchapter\\b|\\bcouncil\\b|university|\\binstitute\\b|\\bcongress\\b|\\bbirdlife|audobon')

science_organisations2 <- c('\\bresearch\\b|\\bscien|istry\\b|isheries\\b|olog|\\bstud+|environment|\\bconservation|ogical', '\\bobservator|\\bsymposi*|\\bpeer ?review\\b|\\bjournal\\b|\\bresearch group\\b|\\bfield station|\\bmeetings\\b')

other scientists <- c('\\btechnician\\b|\\bacademic\\b|\\bdr\\b|research ass+|\\bresearch scientist\\b|\\blab manager\\b|\\bresearcher\\b|\\boceanographer\\b|chemist\\b|ologist\\b|icist\\b|tician\\b|scientist\\b|\\bbotanist\\b|\\bscholar\\b|\\botanist\\b|physicist\\b|\\bnaturalist\\b')

LiCSAR user feedback questions

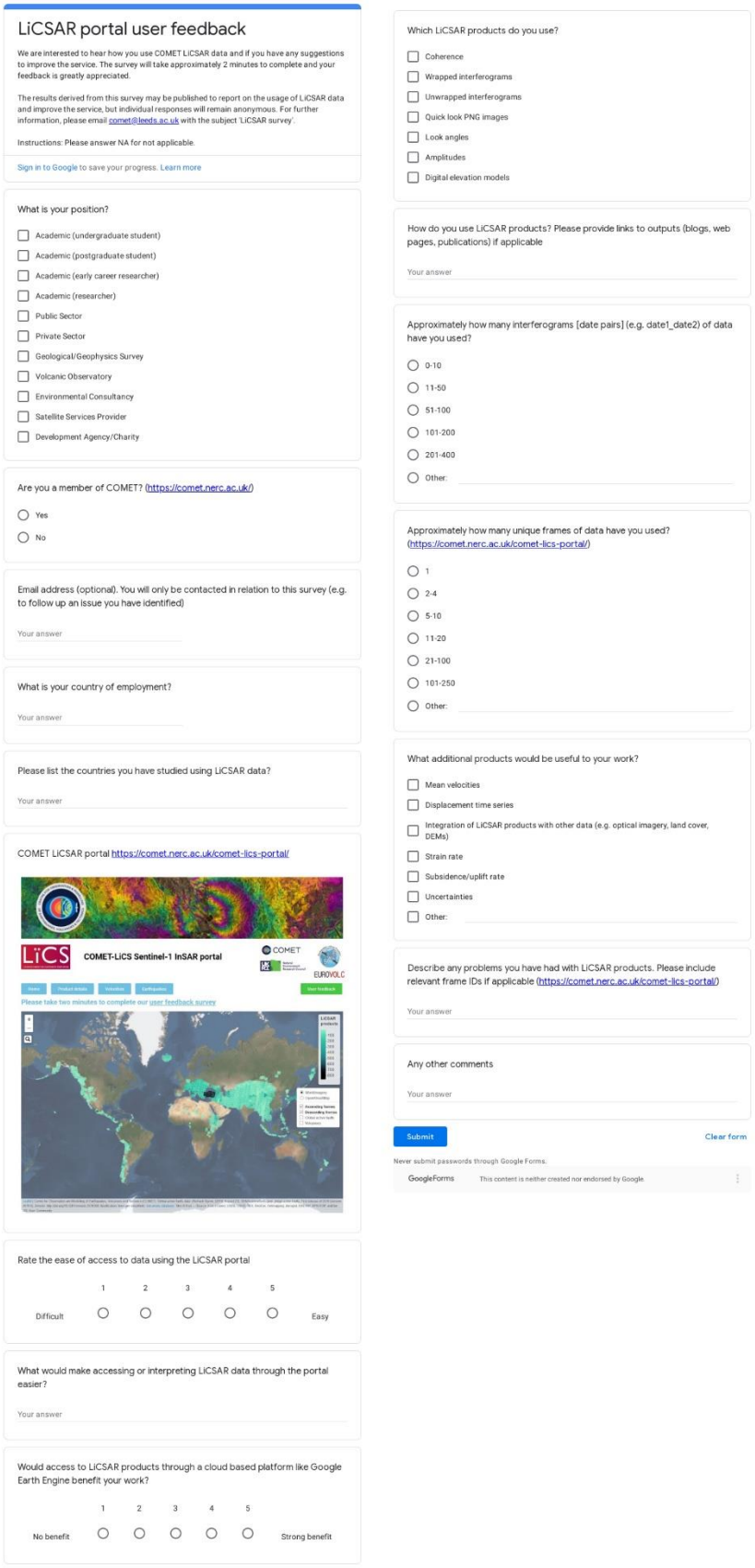

Figure S1. Screenshot of the LiCSAR user feedback survey. LiCSAR Portal map copyright statement: "Leaflet | Centre for Observation and Modelling of Earthquakes, Volcanoes and Tectonics (COMET)., Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community"

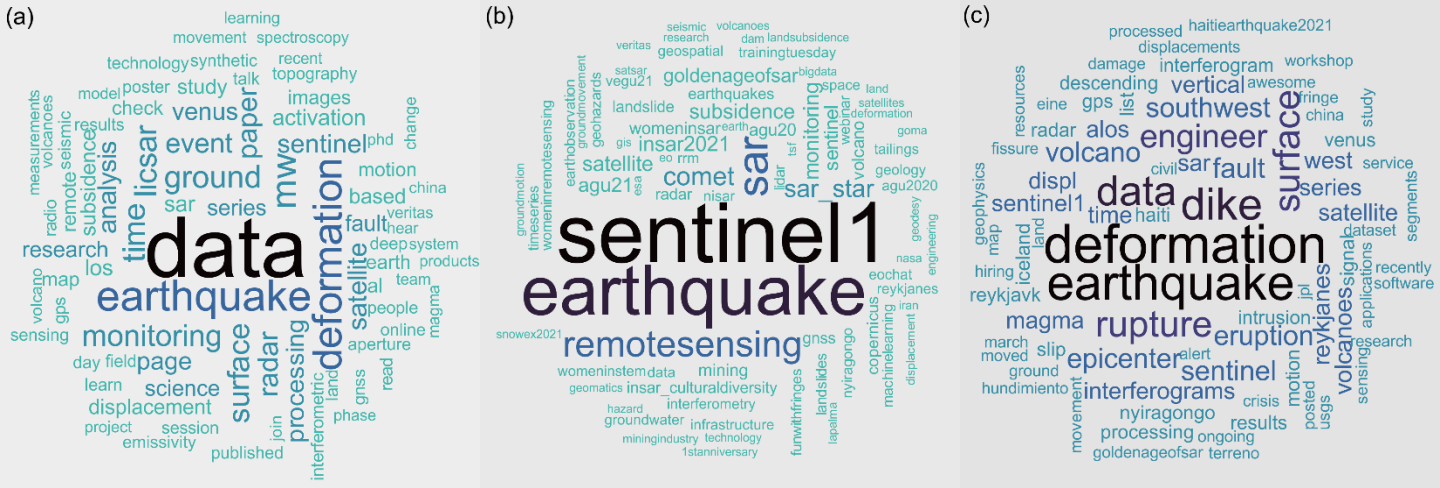

Figure S2. (a) Word cloud showing the top 80 words occurring in the text of InSAR tweets. (b) Word cloud showing the top 80 hashtags occurring in the InSAR tweets. (c) Word cloud showing the combined top 80 words and hashtags occurring in the 50 most retweeted InSAR tweets.

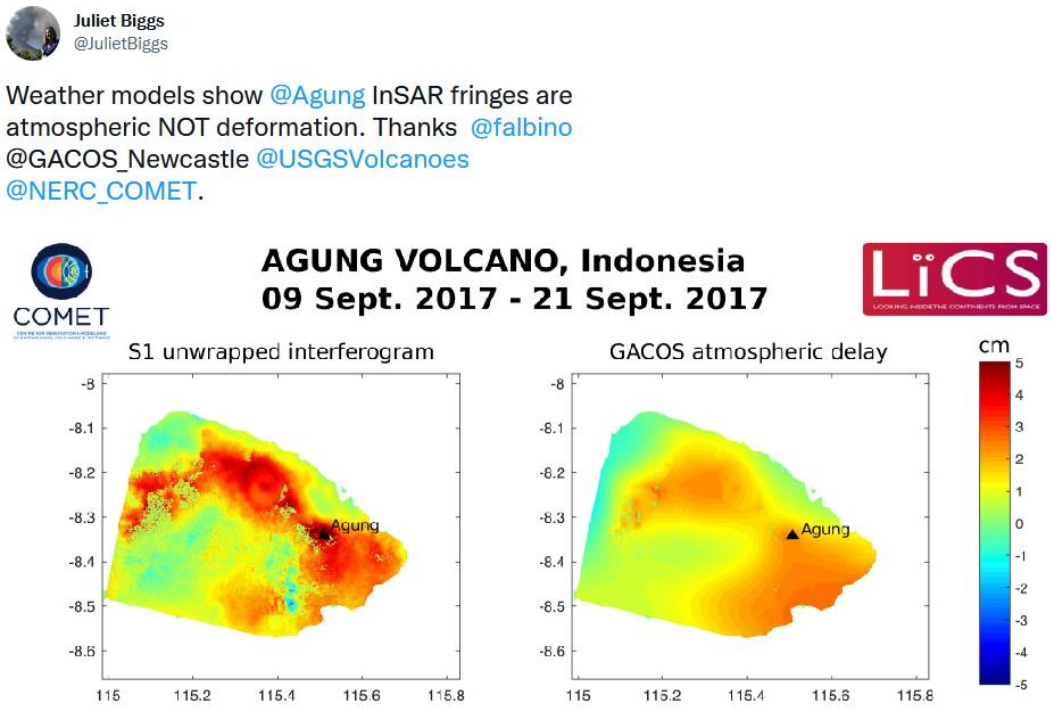

Figure S3. Example Tweet showing the association between apparent InSAR-observed deformation at Agung Volcano and the GACOS atmospheric delay model. The comparison shows that apparent deformation was related to atmospheric signals and not volcanic deformation. Juliet Biggs [Twitter] (2017).

Table S1. InSAR tweet word counts.

Text of all tweets		Hashtags of all tweets		Text and hashtags in the top 50 retweeted tweets	
Word	Count	Word	Count	Word	Count

data	676	sentinel1	323	deformation	11
earthquake	312	earthquake	259	earthquake	10
deformation	269	sar	143	dike	9
mw	222	remotesensing	116	data	8
ground	200	comet	67	rupture	7
time	199	sar_star	63	surface	7
licsar	190	monitoring	48	engineer	6
monitoring	183	subsidence	48	epicenter	5
surface	170	insar2021	46	eruption	5
radar	167	satellite	44	fault	5
paper	165	goldenageofsar	40	sentinel	5
event	163	sentinel	40	southwest	5
sentinel	142	agu21	37	volcano	5
satellite	140	agu20	33	alos	4
analysis	138	volcano	31	displ	4
venus	136	womeninsar	29	interferograms	4
processing	124	mining	27	magma	4
page	121	earthquakes	24	reykjanes	4
research	117	insar_culturaldiversity	23	sar	4
series	115	radar	23	satellite	4
science	114	gnss	22	sentinel1	4
fault	113	copernicus	21	series	4
activation	112	landslide	20	time	4
los	108	landslides	19	vertical	4
sar	105	womeninremotesensing	19	volcanoes	4
subsidence	100	nyiragongo	18	west	4
based	99	womeninstem	18	descending	3
study	98	eochat	17	gps	3
displacement	90	geohazards	17	haiti	3
earth	85	earthobservation	16	iceland	3
check	83	lidar	16	interferogram	3
al	79	machinelearning	16	intrusion	3
map	78	interferometry	15	list	3
motion	78	trainingtuesday	15	motion	3
images	75	agu2020	14	nyiragongo	3
remote	74	funwithfringes	14	processing	3
topography	72	geology	14	radar	3
gps	70	geospatial	14	results	3
deep	69	nisar	14	reykjavk	3
interferometric	69	timeseries	14	signal	3
synthetic	69	vegu21	14	slip	3
talk	69	groundwater	13	venus	3
poster	68	infrastructure	13	academic	2
field	66	reykjanes	13	alert	2
day	65	tailings	13	applications	2

results	65	webinar	13	apply	2
session	65	data	12	ascending	2
technology	64	rrm	12	awesome	2
aperture	63	space	12	based	2
learn	63	engineering	11	china	2
land	62	esa	11	civil	2
people	62	nasa	11	coseismic	2
emissivity	61	satsar	11	crater	2
radio	61	bigdata	10	crisis	2
gnss	60	deformation	10	current	2
online	60	displacement	10	damage	2
seismic	60	geodesy	10	dataset	2
sensing	59	geomatics	10	deep	2
published	58	gis	10	deformacin	2
read	57	goma	10	desc	2
team	55	groundmotion	10	direction	2
volcano	55	hazard	10	displacements	2
hear	54	landsubsidence	10	east	2
magma	54	satellites	10	eastern	2
phd	54	tsf	10	eine	2
recent	54	volcanoes	10	fissure	2
products	53	dam	9	fringe	2
phase	52	earth	9	geodesy	2
model	51	land	9	geophysics	2
spectroscopy	51	lapalma	9	goldenageofsar	2
veritas	50	miningindustry	9	ground	2
volcanoes	50	research	9	haitiearthquake2021	2
china	49	technology	9	hiring	2
join	49	veritas	9	hundimiento	2
measurements	49	1stanniversary	8	info	2
movement	49	eo	8	join	2
project	49	geohazard	8	jpl	2
applications	48	geophysics	8	land	2
change	48	geotechnical	8	lateral	2
learning	48	gps	8	location	2

Table S2. Paired words from Twitter followers profile descriptions classified as scientists (n = 11,902). Followers were included if they followed one of the top 10 InSAR tweeters, or the top 10 retweeted InSAR tweeters.

Paired words		Occurrences
remote	sensing	905
phd	student	598
phd	candidate	273
assistant	professor	202

earth	science	193
earth	observation	192
climate	change	185
earth	sciences	170
data	science	136
associate	professor	121
machine	learning	113
data	scientist	109
research	scientist	99
natural	hazards	80
structural	geology	80
research	fellow	78
student	university	77
postdoctoral	researcher	72
earth	scientist	63
sensing	gis	62
active	tectonics	60
environmental	science	60
ph	student	59
graduate	student	57
research	associate	57
student	studying	57
science	technology	56
phd	researcher	55
gis	remote	54
grad	student	52
opinions	mine	51
sensing	scientist	51
geospatial	data	50
msc	student	48
ph	candidate	48
views	mine	48
research	assistant	45
climate	scientist	44
earth	planetary	44
earthquake	geologist	44
earthquake	geology	44
husband	father	42
structural	geologist	41
water	resources	41
geological	survey	40
planetary	scientist	39
deep	learning	38
earth	space	38
earth	environmental	37
assistant	prof	36
asst	prof	36
department	earth	36

planetary	science	36
satellite	data	36
science	news	34
science	writer	34
sea	level	33
disaster	risk	32
planetary	sciences	32
spatial	data	32
senior	lecturer	31
university	leeds	31
assoc	prof	30
earthquake	engineering	30
master	student	30
research	scholar	30
science	communicator	30
space	science	30
earth	system	29
software	engineer	29
environmental	sciences	28
nature	lover	28
postdoctoral	fellow	28
professor	earth	28
associate	prof	27
born	ppm	27
climate	science	27
geographic	information	27
geophysics	phd	27
natural	resources	27

Table S3. Paired words from Twitter followers profile descriptions classified as non-scientists (n = 19,778). Followers were included if they followed one of the top 10 InSAR tweeters, or the top 10 retweeted InSAR tweeters.

Paired words		Occurrences
remote	sensing	233
earth	observation	107
climate	change	51
gis	remote	50
estudiante	ingeniera	39
machine	learning	38
husband	father	36
los	angeles	33
sensing	gis	32
official	twitter	31
twitter	account	30
software	engineer	27
opinions	mine	26

real	estate	26
views	expressed	26
gis	analyst	25
ingeniera	geofsica	25
lives	matter	23
data	analyst	22
ingeniera	geolgica	22
social	media	22
animal	lover	21
ciencias	tierra	21
civil	engineer	21
geospatial	data	21
oil	gas	21
black	lives	20
love	life	20
gis	specialist	18
human	rights	18
ingeniera	unam	18
puerto	rico	18
social	justice	18
project	manager	17
wife	mom	17
cancer	survivor	16
facultad	ingeniera	16
food	security	16
love	family	16
music	lover	16
ph	candidate	16
satellite	imagery	16
avid	reader	15
deep	learning	15
founder	ceo	15
natural	hazards	15
nature	lover	15
web	developer	15
aperture	radar	14
business	development	14
father	husband	14
geolgica	unam	14
ingeniero	civil	14
land	surveyor	14
personal	account	14
proud	father	14
synthetic	aperture	14
business	owner	13
husband	dad	13
tweets	mine	13
wife	mother	13

amante	los	12
amateur	photographer	12
cuenta	oficial	12
dad	husband	12
disaster	risk	12
dog	lover	12
estudiante	ing	12
geospatial	analyst	12
hugamaur	um	12
ingeniero	gelogo	12
mom	wife	12
mother	grandmother	12
software	developer	12
southern	california	12
views	mine	12
water	resources	12
born	raised	11
content	creator	11
earth	surface	11

Table S4: Barriers to uptake of satellite data identified by volcano observatories. Information is summarised from the responses from a range of official development assistance countries to a 2017 survey described below.

We sent a short questionnaire (in English) to volcano observatories in developing countries and overseas territories, designed to understand their current operational use of remote sensing, the issues they face, and what could be beneficial to them. Ten responses were received to the questionnaires, from Guatemala (x 2), Costa Rica (x 2), Ethiopia (x 2), Democratic Republic of Congo, Trinidad and Tobago (SRC, with responsibility for the English-speaking Caribbean), Montserrat and Indonesia.

Issue	Explanation	Solutions
Awareness	Some observatories are not fully aware of the types of remote sensing available or where to access the data.	Collaboration. Capacity building.
Reliability	The internet and particularly social media means the world is more connected than ever before. Data are frequently posted online, especially during eruption crises, but observatories must ensure they are from a reliable source.	Ready-processed and analysed data. External verification.
Timeliness	In rapidly-developing unrest or eruption situations, timely access to data is crucial. Some data cannot be accessed in real-time or near real-time. The download and processing time of other data renders this inappropriate.	Ready-processed and analysed data.
Background knowledge	To understand the unrest at a volcano some knowledge of background activity is required.	Ready-processed and analysed data.
Ground truth	Ground-truthing can be required to verify what is seen through remote-sensing. This requires on-the-ground expertise, human and economic resources.	Collaboration.
Data cost	Some remotely-sensed data and software for analysis is prohibitively expensive	Collaboration. Data sharing.

Human resources	Training in specialist areas such as satellite data retrieval is costly. There may be no redundancy within a country, with one expert and no back-up.	Capacity building.
Computing resources	Processing data can require significant computing resources, including (often costly) specialist software, fast computers with powerful processors, large amounts of data storage space.	Ready-processed and analysed data.
Power supply and internet	Power can be unreliable in many countries, and particularly at remote observatories. Internet access and speed may be insufficient to download large data files.	Ready-processed and analysed data & small files.

References:

Juliet Biggs [@JulietBiggs]: “Weather models show @Agung InSAR fringes are atmospheric NOT deformation. Thanks @falbino @GACOS_Newcastle @USGSVolcanoes @NERC_COMET.”, Twitter, available at: https://twitter.com/JulietBiggs/status/912740738710016000 (last access: 13 December 2022), posted: 07:08PM, 26 September 2017.