March 20, 2025

Dear Wenbin Xu,

We would like to submit our revised manuscript titled "The InSAR lookbook: an illustrated guide to earthquake deformation interferograms". Our work provides a one-stop reference for interpreting InSAR signals generated by earthquakes. The lookbook has broad implications for quickly assessing rupture kinematics and can also serve as an educational material for the public.

Feedback from the two reviewers has greatly improved the clarity and comprehensiveness of our work, as well as its reproducibility. Apart from point-by-point responses to Reviewer A and B, we summarize the major changes made to the revised manuscript below.

Summary of main changes:

1. We added four gentle-angle oblique-slip faulting configurations into the lookbook for completeness of faulting types.
2. We uploaded scripts used to produce the interferograms as seen in the lookbook in a Github repository (https://github.com/isethanant/insar_lookbook). This information is also provided in the Data and code availability section.
3. We generated synthetic interferograms to demonstrate the effects of dip angle and earthquake burial depth on the InSAR deformation patterns (new Figures 5 and 6).

Please see our Response to Reviews in the following document (our responses are in blue text). The line numbers in our response reflect the revised version of the manuscript.

Thank you for your consideration.

Kind regards,
Israporn Sethanant

Response to Reviews of
Manuscript “The InSAR lookbook: an illustrated guide to earthquake interferograms”

Point-by-point responses:

Reviewer A:

The authors present a thoroughly explained, practically useful, and well illustrated guide to satellite interferograms of earthquake deformation, displaying, describing, and explaining the reasons for varied appearance and varied spatial patterns in measured deformation for different fault-satellite orientations. The submission is well organized and well illustrated with suitable, legible, and intuitive figures. The background description is at an appropriate level, and this contribution fulfills a need demonstrated in the community (e.g., at 2022 SCEC workshops on geodetic data needs for earthquake response). The authors provide clear and accessible explanations for the appearance of various interferograms, in a concise but descriptive manner that is well suited to this product. They make use of previously developed theory and code to generate synthetic examples that reasonably fill the parameter space, providing a comprehensive guide to earthquake interferograms. The final section comparing synthetic interferograms to real observed earthquakes from the past 5 years (plus Bam 2003) illustrate the scientific value of having a reference framework for coseismic interferometric patterns.

This is not strictly a science paper, but it synthesizes important scientific concepts, data, and approaches in a manner that will be highly valuable and an enduring reference. The presentation as submitted is so strong I think the authors have very little to revise, if anything. The manuscript would probably be fine to publish as is, but I have pointed out some places that may warrant the addition of a citation, and I have offered some suggestions of where the phrasing might be made more suitable for a journal article. In general these recommendations follow two main themes: making text more neutral by removing opinion words (like “sadly” “unfortunately” etc.), and making it either more generic or more explicit about its specificity to earthquake deformation. I recommend considering these comments, but none of them represents a problem that would negate publication.

Removed “sadly” and “unfortunately” where present. The sentence now reads:

L252: "There is currently no settled consensus amongst the InSAR community on how to represent the sense of ground displacement in interferograms (whether towards or away from the satellite), and so we first establish our own convention and terminology."

Great work, I hope my comments for your consideration help improve the presentation even further. This is an excellent contribution.
-Austin Elliott

Line by line comments:

Title: this is a concise, direct, and useful contribution; the title captures it neatly, but consider adding the word "deformation" for completeness of the tidy title, i.e., "earthquake deformation interferograms"

We added "deformation". The title now reads as follows:

L4: "The InSAR lookbook: an illustrated guide to earthquake deformation interferograms"

11 - a whole new program of lower-altitude UAVSAR is also being undertaken by, e.g., NASA, so you may wish—throughout—to make it more generic than for satellites alone (though of course satellite orbits are what you've plotted); alternatively, specifically state that this guide is relevant to satellite interferometry and not necessarily other kinds with more varied look angles, though you'll want to mention that those are growing in use now too.

We added the word "Satellite-borne" (L11) since our paper does not cover imagery collected using more varied look angles made possible by emergent aircraft platforms like UAVSAR.

Later, in the Introduction, we add: "Here, we assume the right-side looking SAR antenna geometries prevalent amongst non-commercial, near-polar orbiting satellite platforms, and we do not further discuss emergent airborne platforms that allow for much greater flexibility in look angles (Delbridge et al. 2016)." (L75–77)

12 - I believe you mean to specify "the scientific community" as opposed to, e.g., "the affected community" which is also relevant in large onshore earthquakes

L14: Changed to "scientific community"

12-13 - there might be a more diplomatic, neutral, or non-judgmental way to say this, perhaps something like, “but due to the distinctive method of their derivation and the effects of satellite look direction convolved with ground deformation direction, they remain unintuitive to interpret immediately.”

Thanks for the suggestion of more diplomatic language! We tweaked as follows:

L15-16: “However, interpreting interferograms remains unintuitive, owing to the distinctive way the direction of ground deformation is convolved with effects of satellite viewing geometry.”

We then added a segue sentence; L17: “The aim of this paper is to provide a one-stop guide to this interpretation.”

15 - since “ground motions” has a whole different context in earthquake science, it might be good to refer to these as “ground deformation”, “ground movement” “ground displacement” or “ground shifts” or something like that.

L18, 97: Replaced “ground motion” with “ground displacement” throughout the manuscript

38 - consider mentioning also NASA? https://aria.jpl.nasa.gov/products/index.html

We have added the reference as follow.

L42–45: “With a new generation of satellites collecting increasingly large volumes of data (Elliott et al., 2015) and web portals such as LiC-SAR (Lazecký et al., 2020; Watson et al., 2023), the Alaska Satellite Facility (Kennedy et al., 2021; Meyer et al., 2017), **and the Jet Propulsion Laboratory (The Rapid Imaging and Analysis Project; e.g., Owen et al., 2017)** processing and releasing much of this imagery automatically,…”

47 - want to add “earthquake” before “focal mechanisms”?

We replaced this text with Lines 53–66 describing the applications and advantages of InSAR as suggested by Reviewer B.

49 - “one-stop” and “go-to” are a bit idiomatic to English; consider rephrasing more technically or generically for a global readership. “a singular, quick-reference guide” perhaps?

This is fixed. The sentence now reads as follow.

L66: “However, to our knowledge there is not yet a singular, comprehensive quick-reference guide on how to ``read'' interferograms.”

50-52 - while maybe true, this strikes an accusatory or judgmental tone. Perhaps best to leave only the second half of this sentence, or find another way to state this more neutrally or diplomatically

First half of the sentence is removed.

56 - avoid editorializing with “sadly”

Removed “sadly”.

64 - might say “we intend the lookbook to” rather than “we hope”

We removed this sentence for conciseness and clear aim of the paper.

71 - can you provide a citation for radio frequency band classes? (e.g. https://standards.ieee.org/ieee/521/768/ ?) These labels are definitely not intuitive to non-specialists, nor, I think, to many specialists, and in this overview it may be worth directing people to why they’re called these in addition to your parenthetical about what range they cover. Might even consider breaking down your parenthetical to give the range of each band? Even some example satellites that cover each band? That would be very handy in this reference guide…

This is fixed as follow.

L89: “…usually in the X-band (2.5–3.75 cm), C-band (3.75–7.5 cm), S-band (7.5–15 cm), or L-band (15–30 cm) bands of the radio spectrum (Institute of Electrical and Electronics Engineers, 2020)…”

73 - altitude? not elevation

This is fixed.

79 - “…that illustrate and quantify the spatial distribution of minute changes in distance travelled in reflecting to the satellite”

We further defined ‘interferograms’ as suggested. The sentence now reads as follows.

106–108: “Though a single phase image is effectively random, differencing a pair of images to produce an interferogram creates a meaningful interference pattern which captures the spatial distribution of changes in the distance traveled by the radar pulse.”

87 - might there be citations for these sources of decorrelation?

Citation added.

88 - “half-radar-wavelength” should all be hyphenated? as half refers to wavelength

This is fixed throughout the manuscript.

89 - amidst? instead of amongst? as it’s a continuous field rather than set of things… but this is picky, pardon me.

This is fixed.

89-90 - less picky: before alluding to fault rupture traces, maybe present the more generic case that steep gradients form zones of high strain. A simple insertion there like, “as well as amidst steep deformation gradients, i.e., zones of high strain, which in the case of earthquakes are most commonly found near the causative fault and around surface rupture traces.

This is fixed. The sentence now reads as follow.

L120–122: “This can occur in steep, mountainous topography due to the close spacing of topographic fringes, as well as amidst zones of high strain, which in the case of earthquakes are most commonly found around the causative fault and in particular any surface rupture traces.”

93 - conventionally* displayed

This is fixed.

93 - again, “radar half-wavelength” ? or hyphenate the whole thing

This is fixed.

93 - aside: perhaps I’m mistaken, illustrating your purpose—isn’t it commonly presented as 1 color cycle = 1 full wavelength?

One color cycle is one half-wavelength because of the two-way travel time.

138 & 140 & 147 & 149 - partially* cancelling out, rather than mostly? It would at least make this more generic, and in the diagrams presented I wouldn't say they appear "mostly" cancelled out, and not to the same degree in opposing quadrants

Replaced "mostly" with "partially" throughout the text.

194 - it was already stated that normal and reverse faulting will produce the same patterns but with signs flipped, but it would be worth reiterating here at the end of the section/presentation of normal fault lobe patterns

Added the following sentence at the end of the section.

L234–235: "Interferograms of reverse faulting earthquakes would have the same arrangement but of opposite sense, with three negative lobes and one positive lobe surrounding the dense, central fringes."

207 - wary of editorializing with "unfortunately," though I also feel it's warranted here.

This is fixed. See response above.

214 - add initials as you also present it b-y-r (and r-y-b)

This is fixed.

240 - while the USGS is a global authority on earthquake parameters, it may be better to either name some others or use a more generic phrase about seismological monitoring centers

Replaced USGS with a more generic term. The sentence now reads as follow.

L286: "This type of figure will be most useful when the style of faulting is either known (for example, from an independent seismological focal mechanism, such as those often made available well before the first InSAR imagery **by earthquake monitoring centers)**, or suspected (for example, using knowledge of the tectonic setting)."

284 - citation?

We've added citations to three early InSAR papers that modelled large earthquakes successfully using uniform slip planes: the 1995 Mw 6.3 Dinar, Turkey normal faulting earthquake (Wright et al. 1999), the 1998 Mw 6.6 Fandoqa strike-slip earthquake (Berberian et al. 2001), and the 2005 Mw 6.4 Zarand thrust earthquake (Talebian et al. 2006), i.e. one earthquake of each type. To capture these magnitudes more accurately, we modified the text from “most earthquakes smaller than about Mw 7” to “many earthquakes up to about Mw 6.5” (L331).

363 - mimic? How about simulate

Replaced “mimic” with “simulate”.

557 - “will be invaluable” is a big claim to make yourselves in the original manuscript. This is not to disagree, but it would be more scientifically appropriate to state something more neutral or objective like “will be useful” or “may be used”

Replaced “invaluable” with “useful”.

561 - name T.W. affiliation &/or way to access that software. (Affiliations also for Funning & Han, &/or include citations from their studies on those events)

We confirmed with T.W. to update the source code as being obtained from COMET. Citations of relevant studies are now included.

FIGURES

Fig 1 - great cartoon. rotate “altitude” label so it doesn’t overlap orbit track and lies along the dimension it measures like ground range and slant range do. Move “range direction…” label up so that text doesn’t overlap swath graphical boundary

This is fixed.

Fig 2 - move the “descending” arrow diagram over to the left side of the maps in panels b and d? for tidiness and parallel presentation

This is fixed.

Fig 4 etc. - Excellent, useful figures. Well designed and crafted. Consider adding small symbols of the ascending and descending range&azimuth arrows beside “Asc.” & “Desc.” on each plot.

This is fixed.

Fig. 5 - great summary figure. Consider adding graphically an indication of asc. vs desc. (perhaps the range & azimuth arrows symbol at the top of each column)

This is fixed.

Recommendation: Revisions Required

<u>Reviewer B:</u>

General Comments

The authors present a systematic exploration of the modelled (synthetic) surface displacement patterns expected of shallow continental earthquakes as imaged by space based radar satellites using the technique of InSAR. This paper acts as a visual look up table for interpreting the interferometric fringe patterns observed in interferograms, which can make the 3D displacement field tricky to initially interpret due to the single line of sight viewing geometry of orbiting satellites in the two north-south flying geometries of ascending and descending passes.

The authors explore how the displacement patterns change (in terms of displacement lobes wrapped to InSAR fringes) as you change the strike for a range of different faulting types (i.e. by changing the rake). They then summarise this in a chart of visual systematic pattern matching before finishing the paper on a number of real world comparisons of their lookbook with publically available interferogram products of shallow continental earthquakes of varying slip style to emphasise its utility.

Overall, this is a useful study, which is of value and interest to a significant portion of the potential readers of Seismica. It will be useful to both those generally interested in earthquake deformation (geologists and seismologists) as well as those starting out in training for InSAR analysis.

The study is timely and of particular current interest as there is an expanding amount of examples of earthquakes routinely imaged by InSAR and with data automatically processed and made publically available, and a growing constellation of SAR satellites capable of doing so. Whilst there are a number of modelled real earthquakes available in the literature, and a few training examples online, to my knowledge no one has systematically tried to explore the spread of deformation patterns and present this in one article.

The manuscript is clearly written and well presented, with an easy to follow explanation of the methodology and examples. The figures are also very well presented and illustrated with suitable captioning and are very necessarily and integral to the study. The addition of the unwrapped versions and varying rake figures to the supplemental part of the paper is suitable place for those.

The manuscript's title is suitable and accurate. The abstract is predominately adequate with only a few minor suggestions below (and perhaps a couple of changes to the non-technical summary).

The methods are appropriate and described in sufficient detail to be transparent and reproducible to a specialist. However, in terms of maximising the reproducibility and uptake of the lookbook itself, I would suggest this study would really benefit from an openly available toolbox for generating the forward models. This could be deposited on a github repository where I would envisage the release of an accompanying Jupyter style notebook where the user can input their own strike/dip/rake/length/width/slip/depth to run their own forward models that would greater supplement this study. It would really improve this paper's uptake and citation given its potential for use in training and quick comparison to interferograms as they are released after earthquakes. I would strongly encourage the authors to do this if possible as it will be helpful to both them and the wider community.

Thank you for the suggestion. We agree that this will increase the uptake of the work. We now place in a Github repository the fault parameter input files and scripts to generate all of the interferograms presented in the lookbook. We also updated the Data and code availability section.

L623–625: "Scripts and parameter input files used to generate all lookbook interferograms and figures are provided in https://github.com/isethanant/insar_lookbook."

The conclusions are adequate and supported by the modelling, although here and perhaps in other places, some exploration on the potential implications for our improved understanding of earthquakes could be alluded to from broadening the appeal and usability of such geodetic data.

The paper is of a good length and as a suitable number of synthetic and real world examples. However, I think one major missing component I would like to have seen explored in an additional section and pair of figures is that of the effect of the dip and depth on the models. Whilst I would not want much more added, I think a simple grid of models showing the effect of dip and depth of one strike-slip example and one normal faulting example would suffice to give the idea of the changing wavelength, fringe density and positioning of lobes. This would be a most useful addition to the paper itself.

Thanks for the suggestion. As requested, we have added additional synthetic interferograms to demonstrate the effects of dip angle and fault burial depth on the fringe patterns. These are the new Figures 5 and 6, introduced with new text added to the “Extrapolating and interpolating the lookbook models” section:

L312–317: “We illustrate some of these effects with explicit sensitivity tests for two of the most important source parameters, fault dip angle and burial depth. Figure 5 shows a series of interferograms for N- and E-striking left-lateral and normal faults with varying dip angles. In general, the dip angle is seen to control the balance of fringes on either side of the fault surface trace. Figure 6 shows a similar series of interferograms with varying fault burial depths. Burying the top of the fault acts to smooth out the sharp LOS displacement discontinuity along the projected fault surface trace, without much impacting the far field deformation.”

We also refer back to the new Figure 6 in two places in the Results: at the end of Section 4.1 (L368), and at the end of Section 4.2 (L411).

Overall, whilst this paper does not present novel scientific understanding to the earthquake deformation process itself, it does provide a very useful collection of synthetic examples that will be of wider use to those working with such deformation data. Below I also have provided a set of minor suggestions, largely concentred on the first half of the manuscript.

Specific Comments

Abstract

L10 earthquake land-surface deformation

This is fixed.

L11 onshore and major subduction related earthquake

We added “or nearshore earthquake” (L13). The word major is not needed, since the adjective “large” is already implied from earlier in the sentence.

L21 in the case of shallow earthquakes with near/at surface rupture propagation

We left the sentence unchanged as we described the earthquake depth threshold later in the Lookbook limitations section.

Non-technical summary

L25: avoid starting with a non-technical summary with a specialist acronym “InSAR”

InSAR is spelled out.

L33: end with a concluding sentence of why this might be important (effective communication, scientific understanding, stakeholder engagement, disaster response etc).

We added the following sentence.

L37–38: “This can be useful for earthquake rapid response and can also serve as an effective communication and learning tool for the public and scientific community.”

Motivation

L35: SEASAT L-band in the 1970’s was capable of interferometry – see Gabriel et al, 1989, JGR. I would rephrase “Since its initial widespread application in the early 1990’s,” (also best to avoid relative time 3 decades ago as for a reader in ten years ’time this will not be true).

This is fixed. Citation to Gabriel et al. (1989) is also added.

L36: as well as the largest offshore subduction related events.

We added “as well as near-shore subduction-related events” (L42). The adjective “large" is implied from earlier in the sentence.

L43: In addition to the uptake and dissemination, can you add a section on how are observation of surface deformation in such detail (compared to GNSS say) as well as relative to seismology, has led us to greater scientific understanding and new ideas of crustal deformation, faulting and earthquake behaviour with some examples from notable earthquakes.

We added some applications and advantages of InSAR in studying earthquakes, as follows:

L53–66: “To a trained eye, deformation patterns captured by InSAR are therefore indicative of both the rupture location and mechanism. These data are routinely inverted using elastic dislocation models in order to estimate the causative fault plane geometries and slip distributions (e.g. Wright et al., 2013; Mai & Thingbaijam, 2014), eliminating the multi-kilometer location biases and nodal plane ambiguities inherent in most seismic waveform-based source solutions (Weston et al., 2011, 2012). These refined fault locations can be matched to features expressed in the geomorphology or geology, helping reveal connections between individual earthquakes and large scale topography (e.g. Wright et al., 1999). InSAR fault models provide unparalleled sensitivity to the distribution of slip with depth, vital for understanding shallow slip deficits and off-fault deformation (e.g. Fialko et al., 2005; Dolan and Haravitch, 2014). They can also help characterize multi-segment earthquakes to a degree that is impossible from seismic data alone, helping constrain the processes of rupture propagation and arrest (e.g. Nissen et al., 2016; Hamling et al., 2017). InSAR imagery can also help characterize multi-segment earthquakes to a degree that is impossible from seismic data alone and provides additional sensitivity to the distribution of slip with depth, vital for understanding shallow slip deficits and off-fault deformation . Consequently, InSAR modelling studies have greatly enhanced our understanding of both active tectonics and earthquake physics. Furthermore, interferograms can capture important secondary earthquake effects including surface fracturing or bedding plane slip, landsliding, liquefaction, and even building collapse (e.g. Fielding et al., 2005; Ishitsuka et al., 2012; Nissen et al., 2016; Huang et al., 2017; Xu et al., 2020)."

L43: start as a new paragraph from "Earthquakes…" as introducing new idea.
This is fixed.

L56: as mentioned in the general comments, this is where it would be good to see a set of openly available github deposited release of Juypter style notebooks to run your own forward models that would greater supplement this study.
We now provide our scripts in Github. Please see our response in the major comments above.

L65: I would suggest ending that sentence with a statement as to what aim…
For brevity, we prefer not to lengthen the paragraph further. The aims of the paper are already outlined at the start of this paragraph, as well as in the Abstract.

Introduction to InSAR
I appreciate you have some upfront general review references, but I think some more references throughout this section in specific places would also help – I have specified where I think a few could go if you have good examples of applications of the phenomena.

L72: please be more specific – by scientific, what do you include? i.e. **non-commercial** to avoid recent ICEYE, Capella SAR constellations etc. with agile look directions.

Depending how you categorise RADARSAT though, that has right looking for Radarsat-1 but capable of left or right for RADARSAT-2. Strictly, Sentinel-1 is not a science mission, but an operational one.

Replaced “scientific” with “non-commercial Earth observation” and added the word “most”. The sentence now reads as follows.

L93–98: “To date, most non-commercial Earth observation SAR missions have deployed right side-looking antennae on satellites in low Earth (~800 km altitude), sun-synchronous, near-polar orbits (inclination ~97°–99°). This configuration gives rise to LOS vectors that point just north of eastward on ascending tracks and just north of westward on descending tracks (Figure 1a, b), deviating significantly only where the satellites approach either pole. LOS incidence angles measured from the vertical at the surface range from ~20–45°, depending on the satellite.”

L73: sun synchronous

This is added. See sentence above.

L73-74: it is a long way off north/south at higher latitudes, so worth saying “near north-south at the equator” and give the typical inclination values at the ascending node (i = 97-99 degrees).

This is fixed. See sentence above.

L75-76: add reference to SAR here.

Reference is added.

L77: Repeat-pass Interferometric SAR uses successive phase images collected from approximately the same position (typical baseline separations of 100-1000 m) in orbit, ….

We add typical baseline separations of ~100-1000 m, but prefer to do so in the following paragraph; L109–110: “(1) the difference in antenna position between the two images as measured perpendicular to viewing direction, known as the perpendicular baseline and typically in the range ~100-1000 m”.

L78: worth mentioning about the imaging latency here for frequency of acquisitions as pertinent to how long to capture deformation and the resolvability of changing surface deformation for postseismic. Whilst orbital periods are of the order 100 minutes, the imaging swath is typically

50-250 km, so return visits are of the range 12-35 days for single satellites (commensurately reduced for constellations depending on positioning phasing of satellites relative to each other).

We have added the following.

L100–105: "Minimum revisit times are 4–6 days for newer, multi-satellite missions such as the Canadian Space Agency's RADARSAT Constellation Mission and the European Space Agency's Sentinel-1 pair, and 35–46 days for older, single-satellite missions such as ERS-1, ERS-2, ENVISAT, ALOS-1, and ALOS-2. However, due to power limitations, SAR images are not acquired on every pass. Following an earthquake of interest, the temporal baseline will depend on the timings of the last pre-seismic image acquisition and the next satellite pass. For older satellites, temporal baselines of several months were common."

L81: but also ionosphere, particularly at longer radar wavelengths,

We added the ionospheric delay to the list of phase change factors. The sentence now reads as follows:

L109–112: "These include (1) the difference in antenna position between the two images as measured perpendicular to viewing direction, known as the perpendicular baseline and typically in the range ~100-1000 m; (2) a resulting, perspective effect of Earth's topography; (3) atmospheric path delays from free electrons in the ionosphere and water vapour in the troposphere; and (4) any Earth surface deformation towards or away from the satellite."

L85-97: references to phase decorrelation.

References are added.

L95-96: this sentence reads slightly oddly – please consider rephrasing.

The sentence is rephrased and now reads as follow.

L128–130: "As long as the data are available, deformation associated with the earthquakes of interest will always be mapped from both ascending and descending orbital tracks, providing two independent look angles."

L101: references to unwrapping needed.

References are added.

L108: reference to elastic dislocation modelling.

References are added.

L116: be explicit about vertically dipping and whether surface rupturing or buried in the text in addition to referencing to Table 1.

This is fixed. The sentence now reads as follow:

L155–156: "...we plot the theoretical 3-D displacement field for a surface-rupturing, N-trending and vertically-dipping left-lateral strike-slip earthquake (Table 1)."

L122: it is worth mentioning somewhere (in intro or here) about the sensitivity of InSAR (cm-level depending on noise). E.g. how the small vertical displacements at fault tips mentioned here (or in the far-field additional small amplitude lobes) are very important for constraining some of the parameters e.g. fault length for vertical motion at the tips in this example, or the fault dip and bottom depth from the additional far-field lobes in dip-slip examples.

We think that this belongs in the "2.1. How InSAR works" subsection, where we added/amended a separate, final paragraph, as follows:

L138–145: The detectability of earthquakes in InSAR imagery is conditioned upon fault slip being large and shallow enough that surface deformation exceeds atmospheric noise, which is typically up to a few centimeters in amplitude. A good rule of thumb is that events with moment magnitudes (Mw) greater than ~6 and at depths less than ~10 km are usually detectable unless the imagery is badly compromised by phase decorrelation (Funning and Garcia, 2019). However, important second order features of the surface deformation pattern—for example small fringe lobes at fault tips and drawn out fringe lobes in the far field—may not be resolvable from atmospheric noise until larger magnitudes are realized. Even if a moderate magnitude earthquake is detectable, this limitation can render it difficult to resolve important source parameters such as fault length, dip, and bottom depth.

L130-132: Could you add to the supplement a pair of 3-panel figures (one each for ascending and descending typical geometries) displaying the unit vector contributions for East, North, Up that you applied to convert the ENU to los.

Since the unit vectors do not vary significantly across the scale of the plotted figures, we report the values explicitly instead of adding a supplemental figure.

Figure 2 captions: "Across the ascending scene, LOS unit vectors (pointing from the pixel on the ground to the satellite) have east, north, and up components ranging from -0.67 to -0.54, -0.12

to -0.09, and 0.73 to 0.84, respectively. Across the descending scene, the equivalent ranges are 0.53 to 0.67, -0.13 to -0.10, and 0.73 to 0.84."

Figure 3 captions: "LOS unit vectors are as listed in the Figure 2 caption."

Methodology

L205: "differ by only a few degrees" this is not true. The range in incidence for Sentinel-1 is more like 23-45 degree for near to far range. In addition, the change in azimuth does vary quite a bit at higher latitudes (just there are fewer earthquakes at high latitudes and it matters less for small ones so we do not notice). It is worth adding it makes a difference for longer/larger faults covering more of the footprint, where a varying geometry should be used, but is not necessary for illustrative points raised here for smaller earthquakes where a uniform viewing geometry can be reasonably assumed.

Thanks for catching this! We edited the sentences as follows:

L246–249: Incidence angles along the edges of Sentinel-1's wide swath differ by ±7–8° from those at the center, which for the purposes of our lookbook would give rise to only minimally discernible changes in the model interferograms (though we recognize that for earthquakes rupturing across large InSAR footprints, it is important to account for these variations)."

L217: Section 3.2 I think an important fault configuration missing is the depth dependence on the signal magnitude and wavelength, and the dip dependence on the positioning of the lobes. I would suggest doing a pair of examples - one strike-slip case and one dip slip case (i.e. fix the strike and rake but vary the depth and the dip). You could do this as a grid with depth varying along columns and dip along rows for instance.

The dip could vary in 5 degree increments from 75 south dip through 90 vertical to 75 north dip for an east-west left-lateral strike-slip say, and then from 30 through 45 to 60 for a north-south striking normal faulting earthquake.

We have addressed this. Please see our response in the major comments above.

L245: plane ambiguity if the rupture does not reach the surface.

This is fixed.

Figures

Figure 1:

Mark on typical inclination values for near-polar orbiting SAR satellites of 97-99 degrees (retrograde orbit).

This is fixed.

Mark on the figure the azimuth and range/look directions of the upper arrows as not clear from caption.

This is fixed.

Avoid the text overlapping with the line work if possible (e.g. move Altitude 600-800 km a little).

This is fixed.

Also, note on the figure or in the caption they are sun-synchronous orbits.

Text is added.

Figure 2: Could you provide a little two block cartoon of the fault type beneath a and c of the vertical fault and sinistral motion (similar to the centre panels of all you other figures, but perhaps simplified here)?

We added a block cartoon at the top, and "vertically dipping" in the captions for clarity.

Figure 3: Could you provide a little two block cartoon of the fault type beneath a and c of the dip angle and normal motion (similar to the centre panels of all you other figures, but perhaps simplified here)?

We added a block cartoon at the top, and added "E-dipping" and "S-dipping" in the captions for clarity.

Recommendation: Revisions Required

Other edits apart from Reviewer A and Reviewer B comments:

We made the following changes following the addition of the four gentle oblique-slip faulting configurations.

“The InSAR Lookbook” Section

We removed these lines as we now generated the gentle-dipping configurations.

L383 in previous manuscript: “We acknowledge that other types of oblique-slip earthquake are possible, including ones involving lower angle fault planes (e.g., Nissen et al., 2019; Cheloni et al., 2024), and that these will exhibit different deformation patterns to the models presented here.”

We edited the oblique-slip description as follow.

L434–437: “We model four types of oblique-slip earthquakes, with either left- or right-lateral components, shortening or extensional components, and dipping either steeply at 67.5° (half way between 45° and vertical) or gently at 22.5° (half way between 45° and horizontal). The resulting interferograms (Figures 4g–4n) thus combine aspects of those presented earlier for strike-slip, moderate dip-slip, and low-angle dip-slip earthquakes.”

“Real earthquake comparisons” Section

We referenced the new configurations in the 2023 Mw 6.8 Marrakesh-Safi Morocco earthquake.

L571–576: “Modelling of the InSAR by Cheloni et al. (2024) supported a significant right-lateral component on a buried (~15–30 km), 22°, SSW-dipping fault plane. While there are significant strike and rake discrepancies between our low-angle thrust forward model and Cheloni et al.’s oblique-slip inverse model, both involve NW-directed slip vectors on gently dipping planes, explaining the similarity of deformation. The visual match to our closest oblique-slip lookbook solution—the 120◦ strike model in Figure 4l—is poorer owing to its much shallower depth.”

“Acknowledgements” Section

L632: “We thank Austin Elliott and an anonymous reviewer for feedback that greatly improved the clarity, comprehensiveness, and presentation of the lookbook.”