

CONICET



Better governance of outdoor SRM experiments: avoiding 'boundary conflation' between research and emergency use

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Disclaimer:
views our own

IM, TD & GM are ARIA creators, TD & IM are also a member of Degrees SPF project

Two aims of this presentation:

1. Defending a robust theory
of emergency risk management

2. Applying the distinction between
'research' and 'non-research' to
outdoor SRM experiments

1. Defending a robust theory of emergency risk management

Objections against emergency framing

- The 2009 Royal Society document that introduced SRM to policy discussions claimed that *'because they act quickly, [SRM techniques] could be useful in an emergency, for example to avoid reaching a climate 'tipping point''* (Royal Society, 2009).
- Since then, the emergency framing has been subject to several criticisms:
 - Implausible emergency 'scenarios' ('Venus', 'tipping points')
 - Political power abuses in a 'state of exception'
 - No single extreme event could justify an international emergency
 - Climate change does not fit emergency framing, not asteroid crash
 - "Urgent" science risks relaxing SRM research standards (appendix)

Horton, J. B. (2015). The emergency framing of solar geoengineering: Time for a different approach. *The Anthropocene Review*, 2(2), 147–151. <https://doi.org/10.1177/2053019615579922>

Sillmann, J., Lenton, T., Levermann, A., et al. (2015). Climate emergencies do not justify engineering the climate. *Nature Climate Change*, 5, 290–292. <https://doi.org/10.1038/nclimate2539>

Hulme, M. (2025). Small Step Funding Models Fit Better for Climate Research. *Nature Climate Change*, 15(4), 339–340. <https://doi.org/10.1038/s41558-025-02281-6>

O'Loughlin, R., & Visioni, D. (2026). When are small-scale field experiments in solar geoengineering worth pursuing? *European Journal for Philosophy of Science*, 16, 54. <https://doi.org/10.1007/s13194-026-00762-9>

Gambill, P. (2026, July 15). Why I Support Stabilization Research. <https://www.inevitableandobvious.com/p/why-i-support-stabilization-research>

GLOSSARY

of Health Emergency and Disaster Risk Management Terminology

[Emergency and disasters risk management (EDRM) intervention user manual]

World Health Organization (WHO). (2020). *Glossary of Health Emergency and Disaster Risk Management Terminology*. World Health Organization. <https://iris.who.int/handle/10665/331716>

Emergency risk management framework

- Based on the **comprehensive emergency management concept** (“continuum of actions”, “all hazards”, “national responsibility”, etc.) (NGA 1979), not traditional emergency response concept (pre-1970s)
 - **Continuum of actions:** prevention, preparedness, response, recovery (PPRR)
 - **All hazards:** sudden- & slow- onset emergencies & disasters, natural & human, etc.
 - **Coordinated (inter)national state responsibility**
- Adopted by human rights agencies
 - WHO, IPCC, UGA, UNDRR, etc. (WHO 2020)
- Adopted by national emergency agencies
 - FEMA (US), AFE, SINAME (Argentina)...

World Health Organization (WHO). (2020). *Glossary of Health Emergency and Disaster Risk Management Terminology*. World Health Organization. <https://iris.who.int/handle/10665/331716>

PPRR continuum



Emergency preparedness, UNDRR definition

(Sendai Framework Terminology on Disaster Risk Reduction)

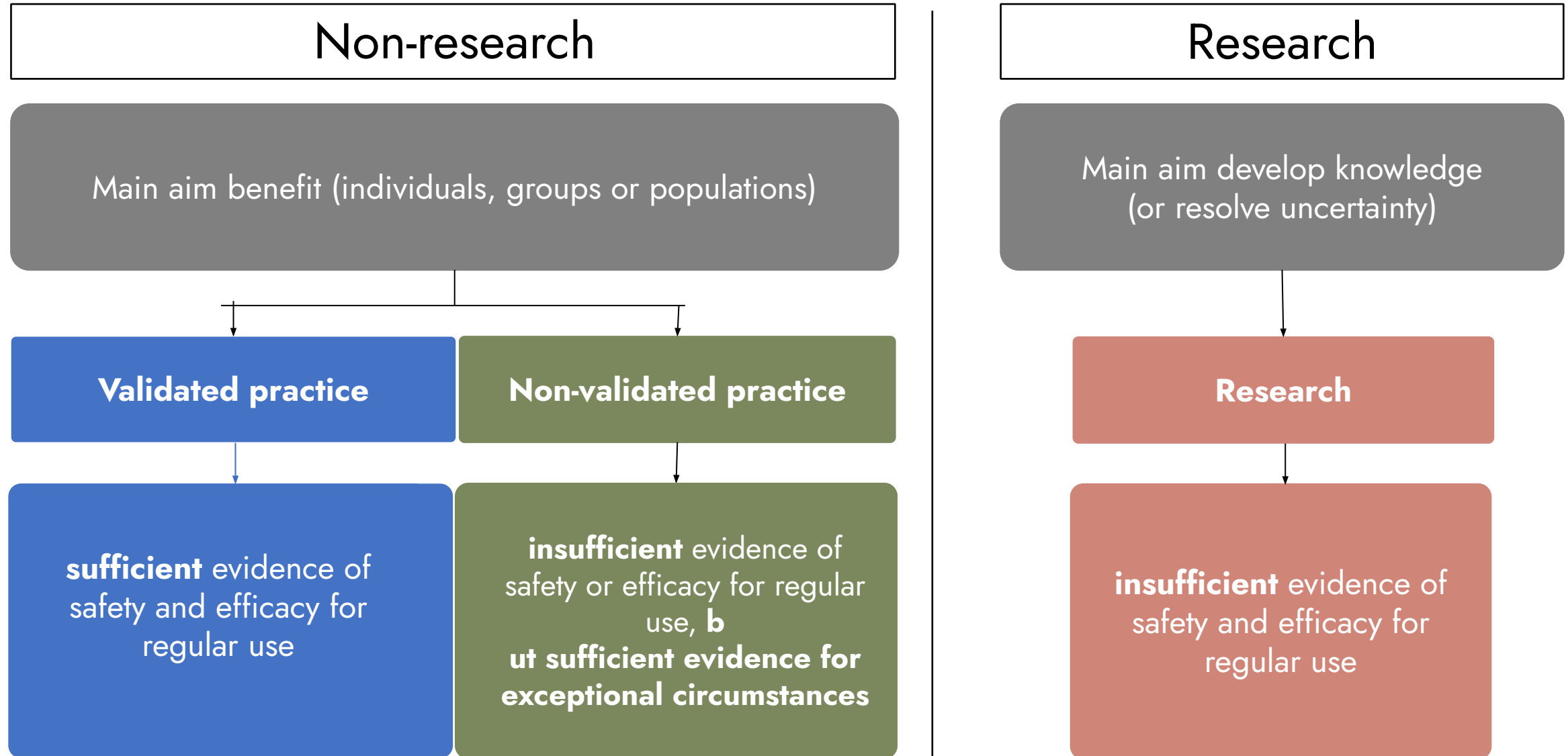
TERM	DEFINITION
Preparedness	The <u>knowledge and capacities developed</u> by [collective & individual agents] governments, response and recovery organizations, communities and individuals to anticipate, respond to and recover from the impacts of likely, imminent or current [sudden- or slow- onset] disasters.

**SRM outdoor research main aim:
SRM knowledge and capacity, not use**

But requires responsible research governance & safeguards
to avoid irresponsible use (e.g. Rayner et al 2013, Visoni & O'Loughling 2026)

2. Applying the distinction between
'research' and 'non-research' to
outdoor SRM experiments

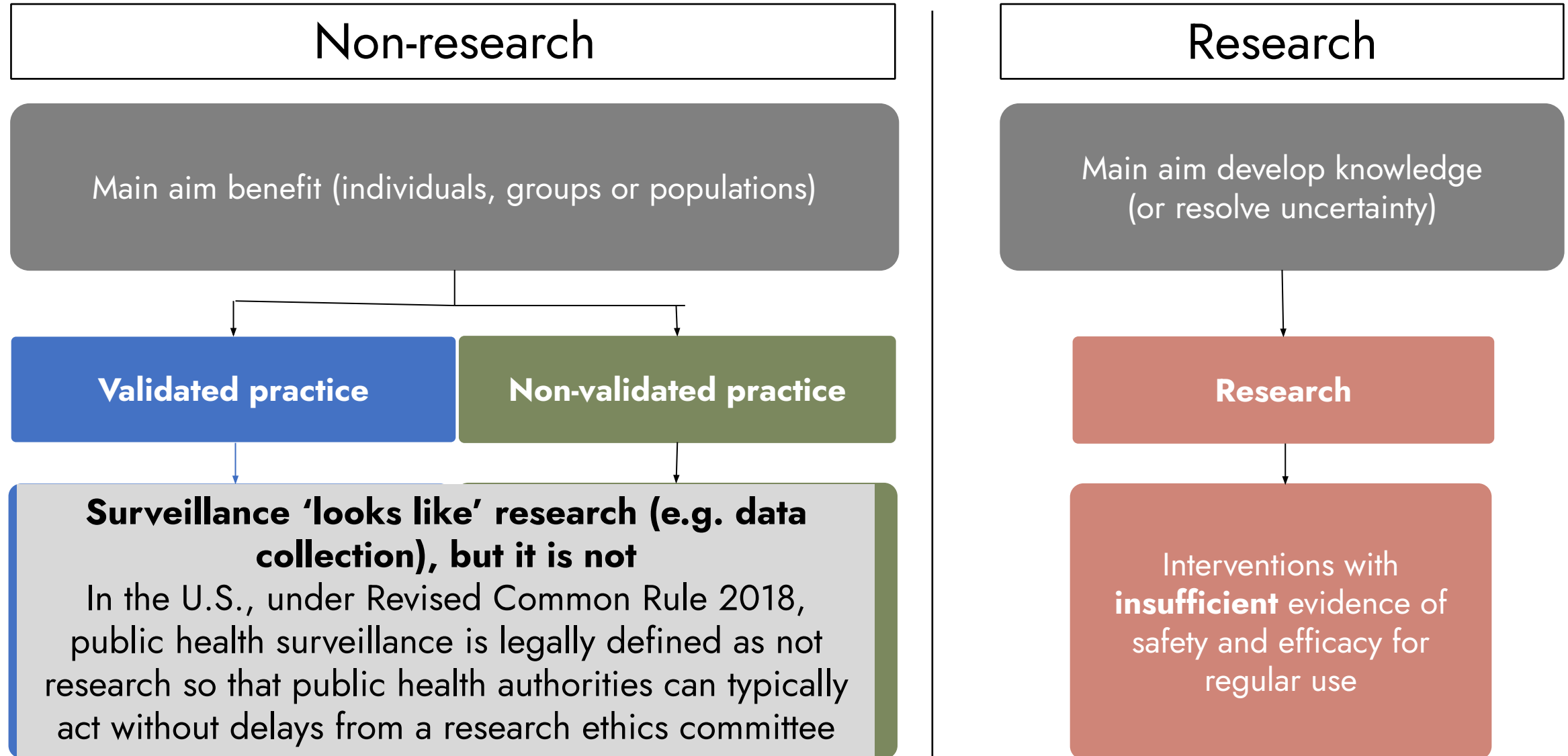
Boundaries between practice and research, Part A. Belmont Report (1979)



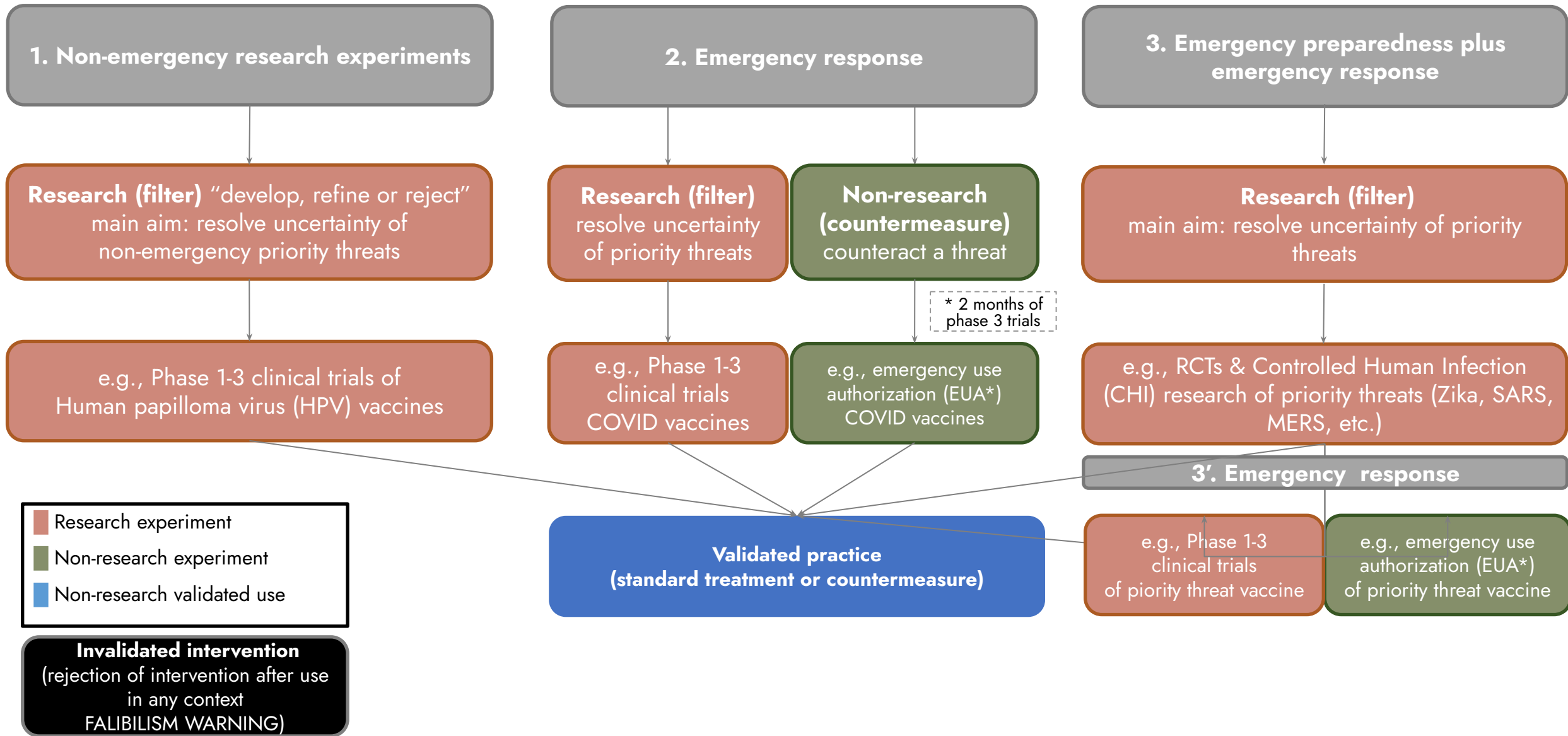
Mastroleo, I. D., & Holzer, F. S. (2020). *New non-validated practice: An enhanced definition of innovative practice for medicine*.

<https://doi.org/10.1080/17579961.2020.1815405>

Boundaries between practice and research, Part A. Belmont Report (1979)

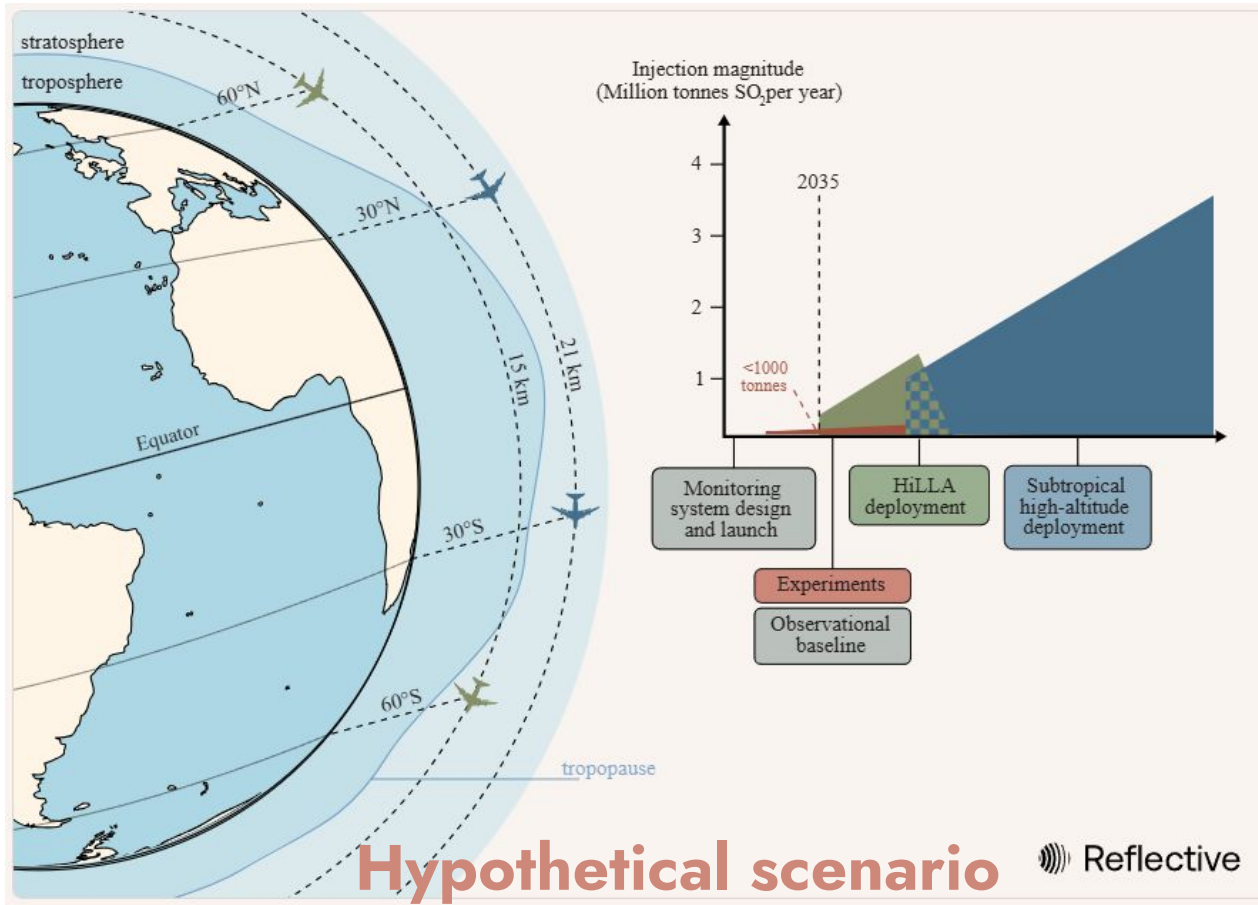


Medicine research & non-research experiments, in context



SAI multi-latitude strategy²: Research + Polar SAI + Subtropical SAI

- Outdoor research experiments (Research 60° N&S?)
- HiLLA deployment (Polar SAI 60° N&S)
- Subtropical deployment (Subtropical SAI 30°N&S)

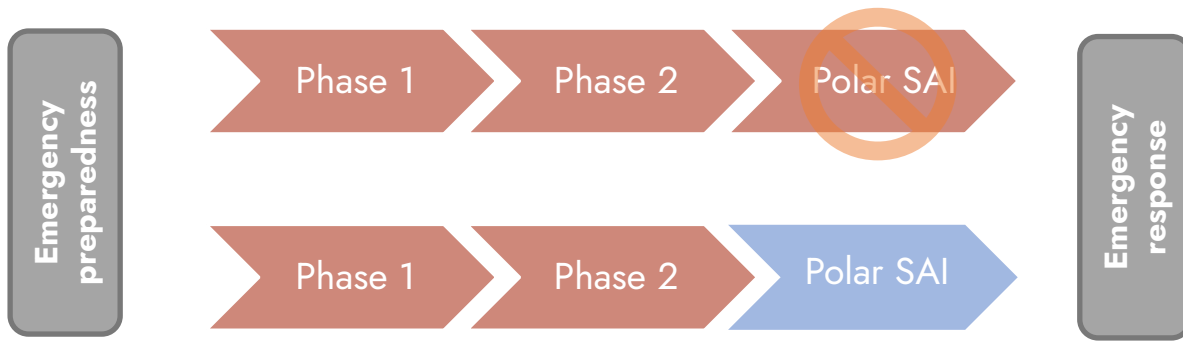


1. Reflective (2026). Scenario dependence (figure). <https://uncertainties.reflective.org/methodology>

2. Duffey, A. (2026). SAI: How Low Can You Go? SRM360. <https://srm360.org/perspective/sai-how-low-can-you-go/>

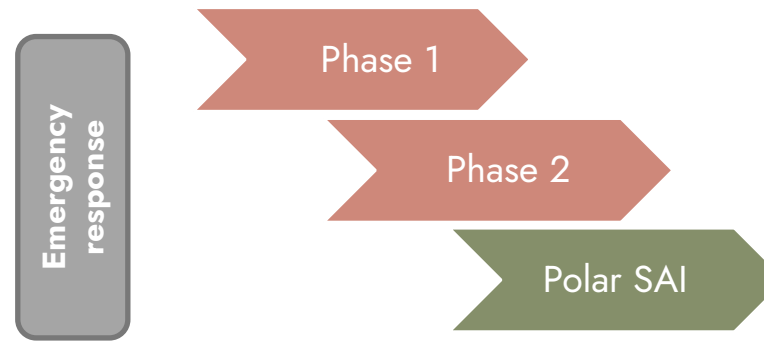
SRM research & non-research outdoor experiments, in context

1. Linear stage-gate process (outdoor experiments)



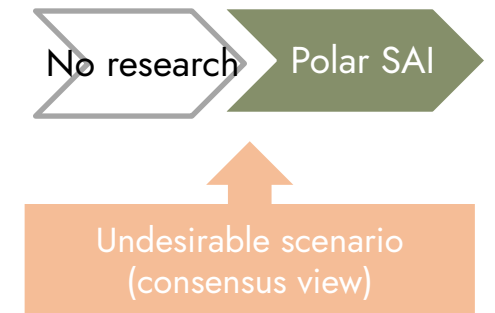
Visioni & Gruener (2025), two potential interpretations

2. Parallel process (outdoor exp.)



Marin Penella, Daly & Mastroleo (2026);
Gruener & Light (2026), see acknowledgments

2'. "Cowboy" solution



Elliot & Martin (2024)

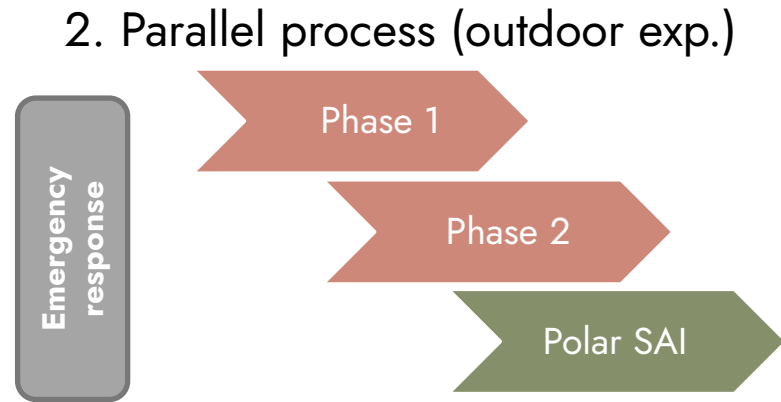
- Research experiment
- Non-research experiment
- Non-research validated use

**Invalidated intervention
(FALIBILISM WARNING)**

- . Marin, Daly & Mastroleo (2026, April). Learning from public health emergencies for SRM governance, preprint, Npj Climate Action (preprint) https://doi.org/10.31235/osf.io/e9d8s_v1
- . Elliott & Martin (2024, March). Advanced Research for Climate Emergencies. <https://t.ly/dl5X5>
- . Reflective (2026). Scenario dependance. <https://uncertainties.reflective.org/methodology>
- . Visioni & Gruener (2025, September). <https://worksinprogress.co/issue/sunscreen-for-the-planet/>
- . Gruener, D., & Light, A. (2026, August 11). A clinical trials framework for sunlight reflection research [Substack newsletter]. *Upon Further Reflection*. <https://reflectiveclimate.substack.com/p/a-clinical-trials-framework-for-sunlight>

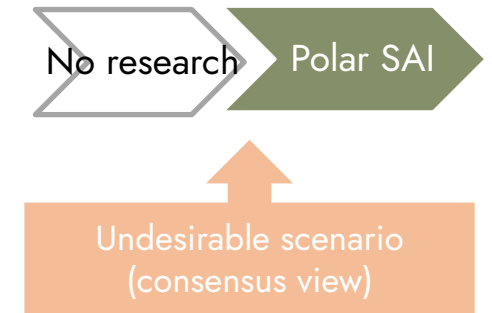
SRM research & non-research outdoor experiments, in context

Explicit reference to EUA in SRM conversations *"A deployment decision for SAI, even a cautious one made in response to a climate emergency ... would need its own justification and possibly its own governance pathway, separate from and not derivable from whatever research program preceded it."*
(Gruener & Light 2026, edited)



Marin Penella, Daly & Mastroleo (2026);
Gruener & Light (2026), see acknowledgments

2'. "Cowboy" solution



Elliot & Martin (2024)

- Research experiment
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On balance (challenges & solutions)

Climate emergency is not just about 'response'

Use the comprehensive emergency concept (PPRR), particularly SRM preparedness research

The research vs. deployment distinction is overly simplistic for SRM ethics & gov.

Use distinction between research & non-research (filters, countermeasures, monitoring/surveillance, etc.)

There could be responsible & irresponsible non-research SRM outdoor experiments.

Develop governance of non-research SRM outdoor experiments (SRM EUA? WIP*...)

*Work in progress... ethics & gov. of SRM research & EUA



The gondola for the SCoPEX project would provide maneuverability, release particles, and take measurements.

Jinnah, S., et al. (2024). Do small outdoor geoengineering experiments require governance? *Science*, 385(6709), 600–603.
<https://doi.org/10.1126/science.adn2853>

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- Elliott, J., & Martin, E. N. (2024). *Advanced Research for Climate Emergencies*. ARC. <https://t.ly/dl5X5>
- Gambill, P. (2026). *Why I Support Stabilization Research*. OE. <https://www.inevitableandobvious.com/p/why-i-support-stabilization-research>
- Gruener, D., & Light, A. (2026). *A clinical trials framework for sunlight reflection research*. Upon Further Reflection. <https://reflectiveclimate.substack.com/p/a-clinical-trials-framework-for-sunlight>
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- Marin, G., Daly, T., & Mastroleo, I. (2026, April). *Learning from public health emergencies for SRM governance* [Preprint]. https://doi.org/10.31235/osf.io/e9d8s_v1
- Mastroleo, I. D., & Holzer, F. S. (2020). New non-validated practice: An enhanced definition of innovative practice for medicine. *Law, Innovation and Technology*, 12(2), 318–346, <https://doi.org/10.1080/17579961.2020.1815405>
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- Rayner, S. [Oxford Martin School]. (2013). *Geoengineering — the problem of competing values in environmental and technological governance* [Video]. YouTube. https://www.youtube.com/watch?v=Jp-b_6-e-4o&t=397s
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- United Nations General Assembly (UNGA). (2016). *Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology relating to Disaster Risk Reduction (A/71/644)*, endorsed by A/RES/71/276 (2017).
- Visioni, D., & Gruener, D. (2025, September). *Sunscreen for the planet*. Works in Progress. <https://worksinprogress.co/issue/sunscreen-for-the-planet/>
- World Health Organization (WHO). (2020). *Glossary of Health Emergency and Disaster Risk Management Terminology*. <https://iris.who.int/handle/10665/331716>

Appendix

Objections against emergency framing

Risk to scientific & ethical standards of SRM research

- “Urgency framework” risks relaxing (incl. bypassing) SRM research scientific and ethical standards (O’Loughlin & Vioni 2026)
 - Usefulness
 - Scientific rigor
 - Transparency
 - Engagement

Comprehensive emergency framework

- Include scientist & non-scientist to articulate SRM research (O’Loughlin & Vioni 2026) with emergency management governance before response
- Do not bypass, but adapt **applications** of research standards to specific contexts
 - e.g. non-emergency, emergency preparedness and emergency response of SRM Research
- Distinguish between **research (filter)** and **non-research** interventions (e.g., **emergency countermeasures, surveillance**)
- Identify SRM research & non-research interventions as part of a larger **emergency management intervention**

Individual expanded access (non-validated practice example)

(aka. non-research experiments, non-trial preapproval access to experimental drugs)

Primary aim, benefit patient not resolving uncertainty. “Single-patient expanded access [non-research] is not a clinical trial [research]. The purpose of single-patient expanded access is to try to treat that individual patient, not to collect data for research. [...]

Compatible with (some) data collection. “This does not mean that data cannot be collected—indeed, safety data must be collected and efficacy data may be collected—but data collection is not the primary purpose of the activity. For more information, see the Code of Federal Regulations (CFR), Title 21, Part 312.310”

Not a good filter (does not replaces research). “data from expanded access programs are not equivalent in quality or usability to data collected in well-done randomized controlled trials (RCTs), [...] because the non-trial data is [generally] more subject to bias and confounding, both of which limit the usefulness of the data”.

Expanded access criteria (simple version)

(non-research experiment, non-validated practice, non-trial preapproval access)

Subpart I—Expanded Access to Investigational Drugs for Treatment Use

Scope. [**right intention or primary aim**] the *primary purpose* is to diagnose, monitor, or treat a patient's disease or condition. [...]

(a) *Criteria*. FDA must determine that:

- (1) [**life threatening context**]. The patient or patients to be treated have a serious or immediately life-threatening disease or condition, and
- [**no reasonable alternative**] there is no comparable or satisfactory alternative therapy to diagnose, monitor, or treat the disease or condition;
- (2) [**proportionality**] The potential patient benefit justifies the potential risks of the treatment use and those potential risks are not unreasonable in the context of the disease or condition to be treated; and
- (3) [**no crowding out of research**] Providing the investigational drug for the requested use will not interfere with the initiation, conduct, or completion of clinical investigations

Code of Federal Regulations (CFR), Title 21, Part 312.310.

https://www.ecfr.gov/current/title-21/chapter-I/subchapter-D/part-312/subpart-I#se21.5.312_1310, emphasis added, edited

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The public health perspective (and why it matters for SRM)

At the level of whole health systems, the research/practice distinction does not exhaust possible actions relevant to ethics and governance regimes.

Public health surveillance is “the continuous and systematic collection, orderly consolidation and evaluation of pertinent data with prompt dissemination of results to those who need to know, particularly those who are in a position to take action.” (WHO EMRO, *Public health surveillance*)

Surveillance ‘looks like’ research (e.g. data collection), but it is not.

In the U.S., under the 2018 Revised Common Rule (OHRP), **public health surveillance is legally defined as not research** so that public health authorities can act without Institutional Review Board (IRB) delays.

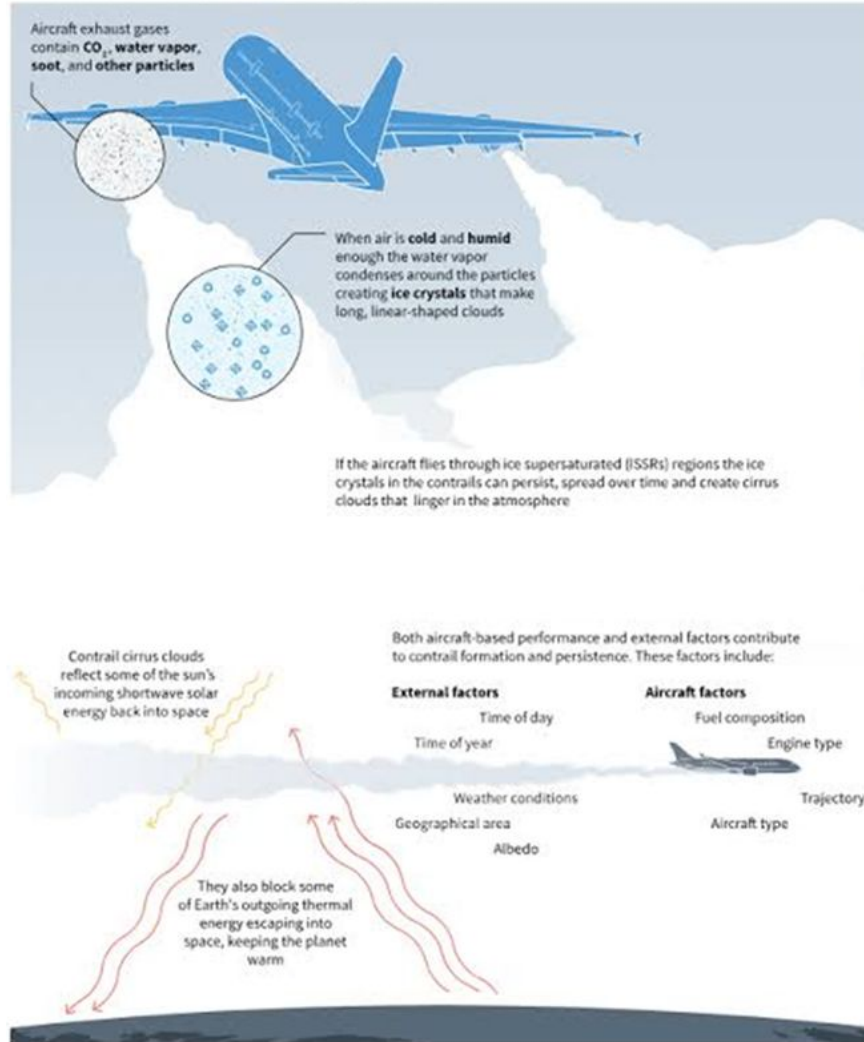
The public health perspective (and why it matters for SRM): avoiding confusion between research and surveillance

The case of irresponsible public health surveillance. “...urgency might be invoked to relax standards of rigor, safety, or engagement. ... in the early COVID-19 pandemic ... *some research initiatives bypassed or minimized ethics review in the name of speed, leaving questions of consent, oversight, and public accountability unsettled.* As one case study documents, a [punitive] door-to-door symptom-survey was launched without submitting a protocol to the national [research] ethics committee, despite the potential for involuntary reporting, loss of privacy, and military presence during data collection (see Voo & Mastroleo, 2024, especially case 4.3). The survey team viewed ethics oversight as an obstacle to timely information gathering, but the absence of review meant that informed consent procedures, participant protections, and the boundaries between research, surveillance, and state enforcement were left unclear. The result was a situation in which urgent public health aims eclipsed safeguards ordinarily seen as non-negotiable.” (O’Loughlin & Visoni 2026, edited)

The **data collection component** of the intervention aimed at contributing to monitor the symptoms and behaviours to inform the next steps of the national public health response during COVID-19 pandemic, while the **controlled component** aimed at lowering the transmission of the virus within the population. Putting those elements together in the same intervention **was bad design and made the survey a “punitive intervention”.** It is irresponsible but not a case of research.

Contrail management: outdoor research & non-research experiments

Contrail Formation and Warming Effects



At present, governments and regulatory bodies appear to be following a sequential path. Research projects stretching years into the future are being funded and these will, undoubtedly, improve understanding and reduce scientific uncertainty. Small-scale trials are being proposed and some are already being run in Europe and North America. [...]

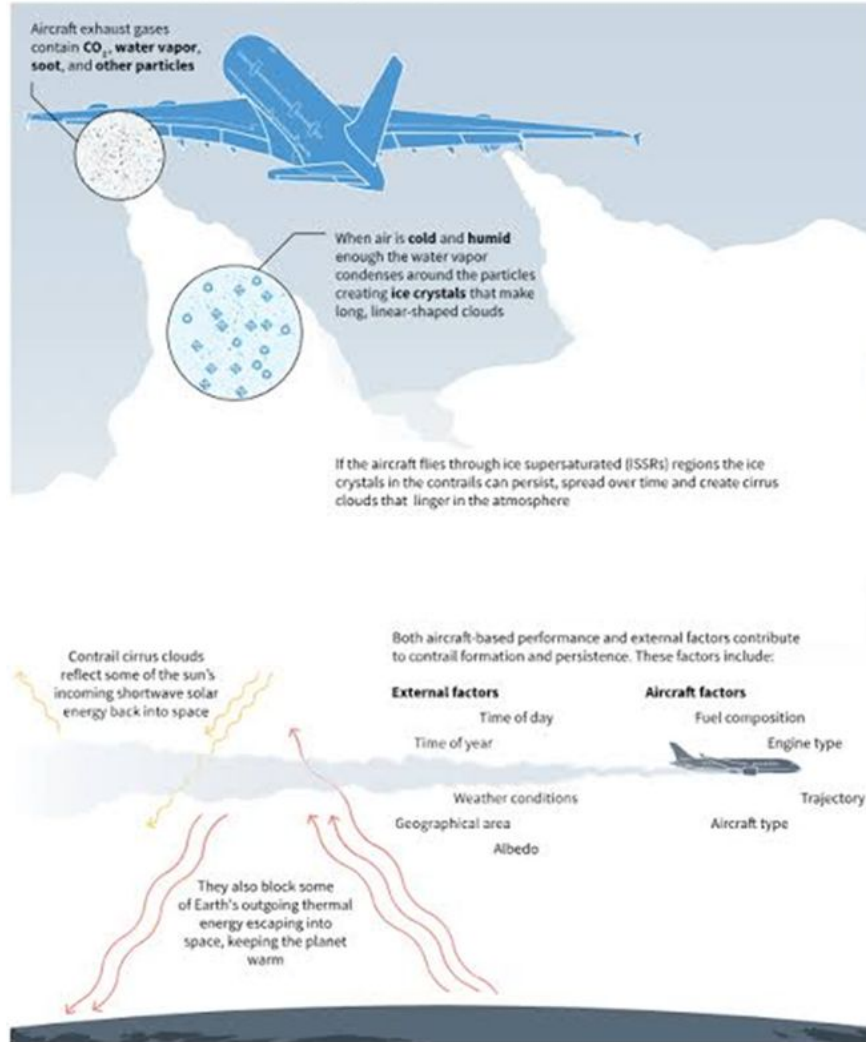
Such a process will take at least a decade and this is 40% of the time left to us between now and the UK's key climate target date of 2050. Why should we continue to repaint the sky white on a daily basis for another ten years, or even another ten months? I would argue that the scientific case is already more than strong enough and the risks more than small enough for immediate action on policy and, given the straightforward nature of creating the capability, we should do it now and move rapidly to implementation at scale.

Poll, I. (2024, December 13). *Contrail control – what are we waiting for?* Royal Aeronautical Society.

<https://www.aerosociety.com/news/contrail-control-what-are-we-waiting-for/>

Contrail management: outdoor research & non-research experiments

Contrail Formation and Warming Effects



With contrail management in operation, the global science community could be invited to participate in unique, global-scale climate science experiments that would be specifically designed to further reduce uncertainty, refine operations, monitor the impact and verify the outcomes.

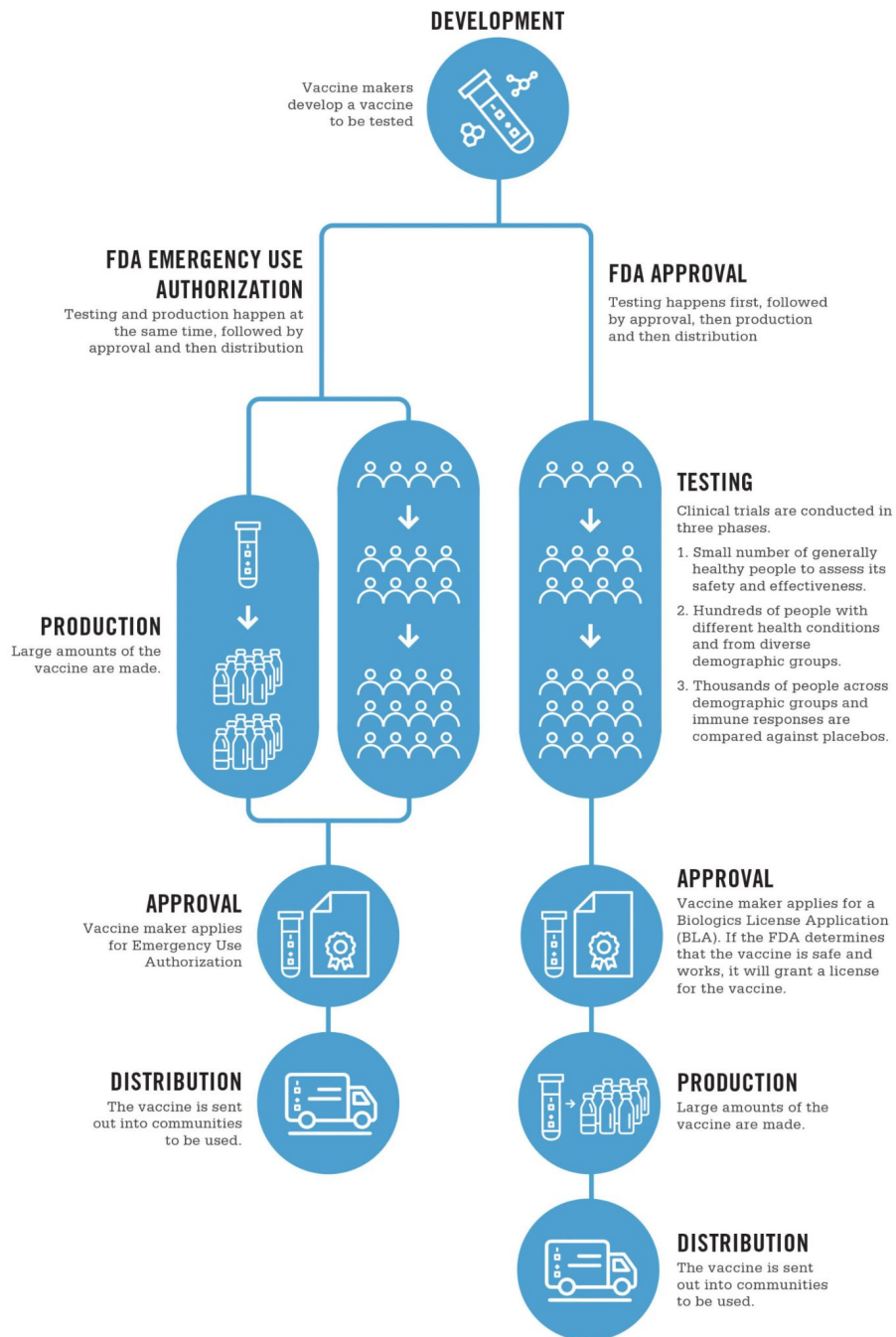
CM Research
experiments

CM Non-research
experiments

Cautionary tale of COVID-19 vaccines Emergency Use Authorization for SRM: How much evidence is sufficient for emergency use?

Argument against EUA without sufficient efficacy data (note that real FDA authorized EUA included 2 months of phase 3 efficacy data)

“Confidence would likely be low in the safety and efficacy of a vaccine candidate that was widely distributed under a EUA after only early phase testing that assessed preliminary safety and immunogenicity, but not efficacy. The public might wrongly believe that they are protected by receiving a widely distributed vaccine when, in fact, it will not be known how protective it is and persons might relax other protective public health methods exposing themselves to greater risk of harm. It would be unclear whether or how to attribute epidemiologic changes to distributed vaccine candidates without any comparator, especially as the pandemic fluctuates in different locations without any vaccine. Wide distribution under a EUA also presents important opportunity costs, increasing the difficulties of testing vaccine candidates which might be safer or more protective. Moreover, a vaccine distributed under a EUA has the potential to become the unproven standard for prevention, creating pressure for other trials to use it as the comparator and making it difficult to interpret subsequent trial results. For these reasons, a EUA strategy for vaccine distribution without prior efficacy evaluation is not ethically acceptable.” (Grady et al 2020)



In the SRM field, proponents of the clinical trials framework for SRM research governance have drawn the analogy explicitly between emergency use authorization (EUA) and deployment decision from SAI, explaining in detail its justification and difference from the governance of medical research, particularly clinical trials (Gruener & Light, 2026, edited, emphasis added):

*A deployment decision for SAI, even a cautious one made in response to a climate emergency ... would need its own justification and possibly **its own governance pathway, separate from and not derivable from whatever research program preceded it.*** (Gruener & Light 2026, edited, emphasis added)

Interventions	Research	Non-Research
Experimental	(1) SRM (filter). Outdoor research experiments (Redmond Roche et al 2026) (1) Medicine (filter). Randomized and non-randomized controlled clinical trials (e.g. epidemiological, observational, interventional without external group control, etc.)	(3) SRM (countermeasure). SAI or contrail management deployment with sufficient evidence of safety and efficacy for limited emergency use, but insufficient for regular use. (Marin, Daly & Mastroleo 2026, Poll 2024). <i>Outdoor climatic experiments (Remond Roche et al 2026)??</i> (3) Medicine (countermeasure). Use of COVID-19 vaccine within a public health vaccination campaign under emergency use authorization (EUA), (Gruener & Light 2026)
Non-experimental	(2). SRM (filter). Implementation research of SRM interventions with sufficient evidence of safety and efficacy for regular use (see (4) (2). Medicine (filter). Implementation research of biomedical interventions with sufficient evidence of safety and efficacy for regular use (see 4)	(4) SRM (countermeasure). SAI deployment with sufficient evidence of safety and efficacy for regular use. (Visioni & Gruener 2025, “Phase 4”) (4) SRM (surveillance). Monitoring of deliberate SAI activity for management with non-experimental instruments. (4) Medicine (countermeasure). Use of COVID-19 vaccine within public health vaccination campaign after finalization of clinical trials and full authorization (Gruener & Light 2026). Quarentine and isolation methods (with or without appropriate safeguards) for outbreaks (e.g. Ebola, COVID-19) (4) Medicine (surveillance). Door-to-door anonymous survey without control measures (quarantine or isolation) to inform COVID-19 emergency management policy.

UNDRR definitions

Sendai Framework Terminology on Disaster Risk Reduction

TERM	DEFINITION
Prevention	Activities and measures to avoid existing and new disaster risks. Prevention expresses the intention to avoid potential adverse impacts entirely; measures may also be taken during or after an event to prevent secondary hazards.
Preparedness	The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to anticipate, respond to and recover from the impacts of likely, imminent or current disasters.
Response	Action taken directly before, during or immediately after a disaster to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of those affected.
Recovery	The restoring or improving of livelihoods and health, and of the economic, physical, social, cultural and environmental assets, systems and activities of a disaster-affected community, in line with sustainable development and "build back better", so as to avoid or reduce future disaster risk.

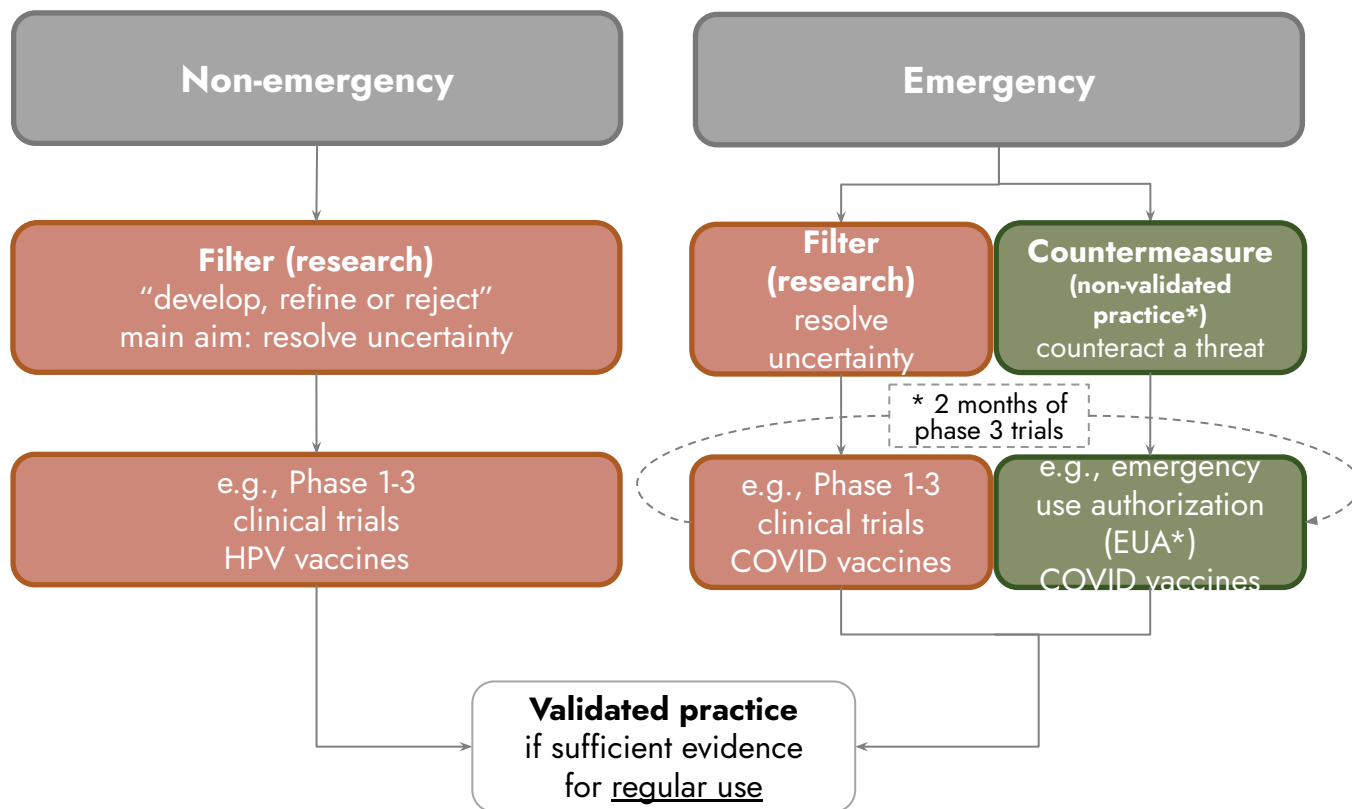
Dimensions of an intervention (SRM or medicine)

Interventions attributes	Negative terms	Positive terms
The attributes of evidence , authorization , novelty and desperate situation are not logically equivalent , i.e. not all unproven interventions are unauthorized, novel or used in desperate situations. The same is true for the other possible combinations of attributes		
Evidence (sufficient)	unproven, experimental, investigational, empirical (knowledge), untested, unvalidated, non-validated	proven, non-experimental, non-investigational, generalizable (knowledge), tested, validated
Authorization (full, partial, modes of use)	unregistered, unlicensed, unauthorized, unapproved, preapproved (partial), off-label, used in unapproved ways (modes of use)	Registered, licensed, authorized, approved, preapproved (partial), repurposed, repositioned (modes of use)
Novelty	innovation, innovative, novel, new, recent (partial), emergent	traditional, long-standing, established
Desperate situation	no reasonable alternative, last chance, last ditch, compassionate use, rescue	comparable, satisfactory, reasonable alternative

Based on Glossary. Other terms for unproven intervention. World Health Organization (WHO). (2022). *Emergency use of unproven clinical interventions outside clinical trials: Ethical considerations*. World Health Organization. <https://apps.who.int/iris/handle/10665/352902>

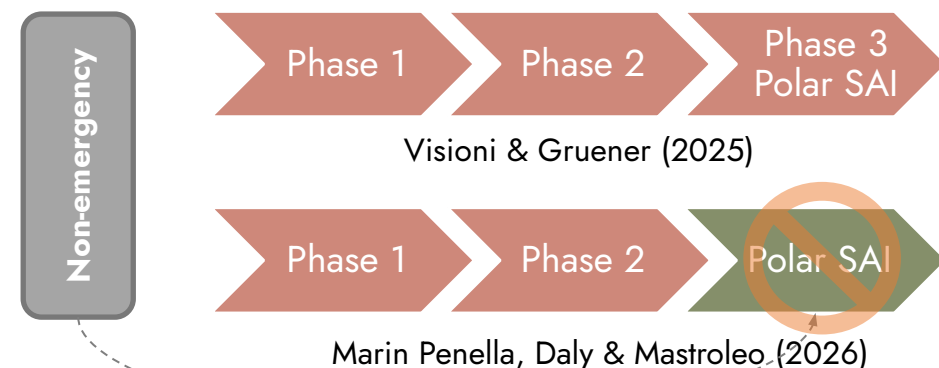
Experiments: do not confuse filters with countermeasures

Medicine experiments

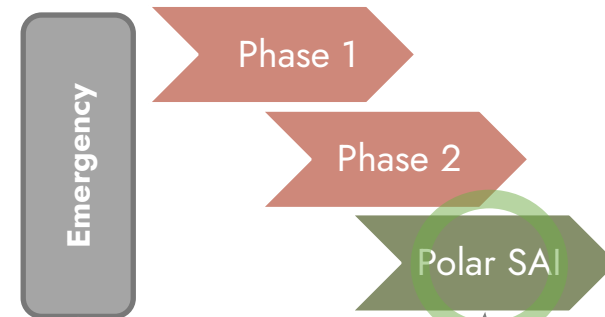


SRM experiments

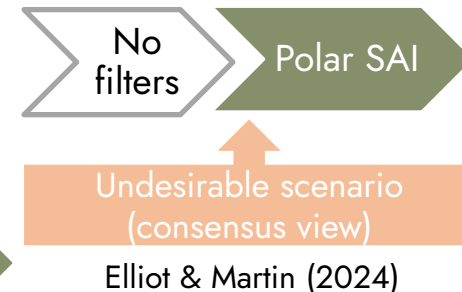
S1. Linear stage-gate process (outdoor experiments)



S2. Parallel process



S3. "Cowboy" solution



Marin Penella, Daly & Mastroleo (2026);
see also Reflective (2026)

