The Roles of the NSF in Climate Intervention Research

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Four general observations regarding design principles

1. **In a post-normal science program (such as one focused on CI), ethics, governance, and science studies ('Science of Science') need to be core elements (and, in some cases, the lead drivers of projects).**
2. **Actionable science is good, but NSF should not turn itself into DOE – NSF's primary mission is, and should remain, the broad health of the US scientific enterprise.** Even if large centers are more efficient in achieving certain objectives in the short-run, they perhaps should not be the dominant means of funding convergence research. (And big centers should be strongly encouraged to include competed funds in their budget that are available to a broader set of institutions than those running the center.)
3. **Convergence is critical at the programmatic scale; that doesn't mean every funded project has to be convergent.**
4. **Programmatic convergence requires investing in coordination networks to link together funded projects.** Coordination cannot happen on the cheap; it requires personnel for whom this is top-of-mind.

A 4-Program Approach for Climate Intervention at NSF

Global Climate Risk Management

How do we characterize and evaluate, across scales and values, tradeoffs among climate strategies?

Requires a convergence approach at a programmatic level, and in general (but maybe not always) for individual projects. Self-aware scenario development is an important element.

Requires decision science, economics, social sciences, ethics, science studies, climate science (physical + impacts), engineering. Benefits strongly from international engagement.

Should not be climate intervention-specific – we need to think about tradeoffs among different approaches to mitigation and adaptation even if climate intervention weren't in the picture.

Historically this work, to the extent it has been done (and it has not been funded at scale of problem), has been centered in DOE Integrated Assessment/Multisector Dynamics program – NSF needs to foster a broader range of approaches, not just recapitulate the DOE approach of supporting large centers.

Innovative Solutions to Climate Change

What is the scientific, technical, socioeconomic, and ethical feasibility and acceptability of novel climate change solutions (including but not limited to CDR and SRM)?

Needed to have informed tradeoff analyses, and to have technologies available if we want to have option to deploy.

For technologies at an advanced TRL, might start to look like a DOE research program – don't unintentionally duplicate DOE's Carbon Negative Earthshot. (Interagency coordination is good, though!)

Requires a convergence approach at a programmatic level, and sometimes but not always for individual projects. Programmatic international engagement good.

Don't be so narrow as to exclude climate interventions that are not CDR or SRM – these can help us probe our understanding of the Earth system even if unlikely to bear fruit (e.g., interrupting ice-sheet instability.) NSF's ability to spread resources broadly, fostering many ideas, is a strength.

Global Centers for CI Assessment, Ethics and Governance

What are the ethically relevant characteristics of CI (particularly SRM)? How do we ensure CI research is conducted ethically?

SRM research is ethically contested – NSF should not plow across red lines absent a robust ethical and governance framework.

NSF needs to invest substantial resources, in coordination with international partners, to develop frameworks and capacity for evaluating when SRM research that crosses preliminary red lines (e.g., outdoor research) is permissible, and where red lines should be.

Requires assessing the characteristics of CI that make it ethically challenging – thus a ethics/governance-led convergence approach, not a ethics/governance-only approach.

These Centers might develop capacity to run ethical review boards for proposed and ongoing projects, and to facilitate inclusive stakeholder engagement.

Model may also work for marine CDR, which has substantial assessment and governance issues.

Climate Intervention Research Coordination Networks