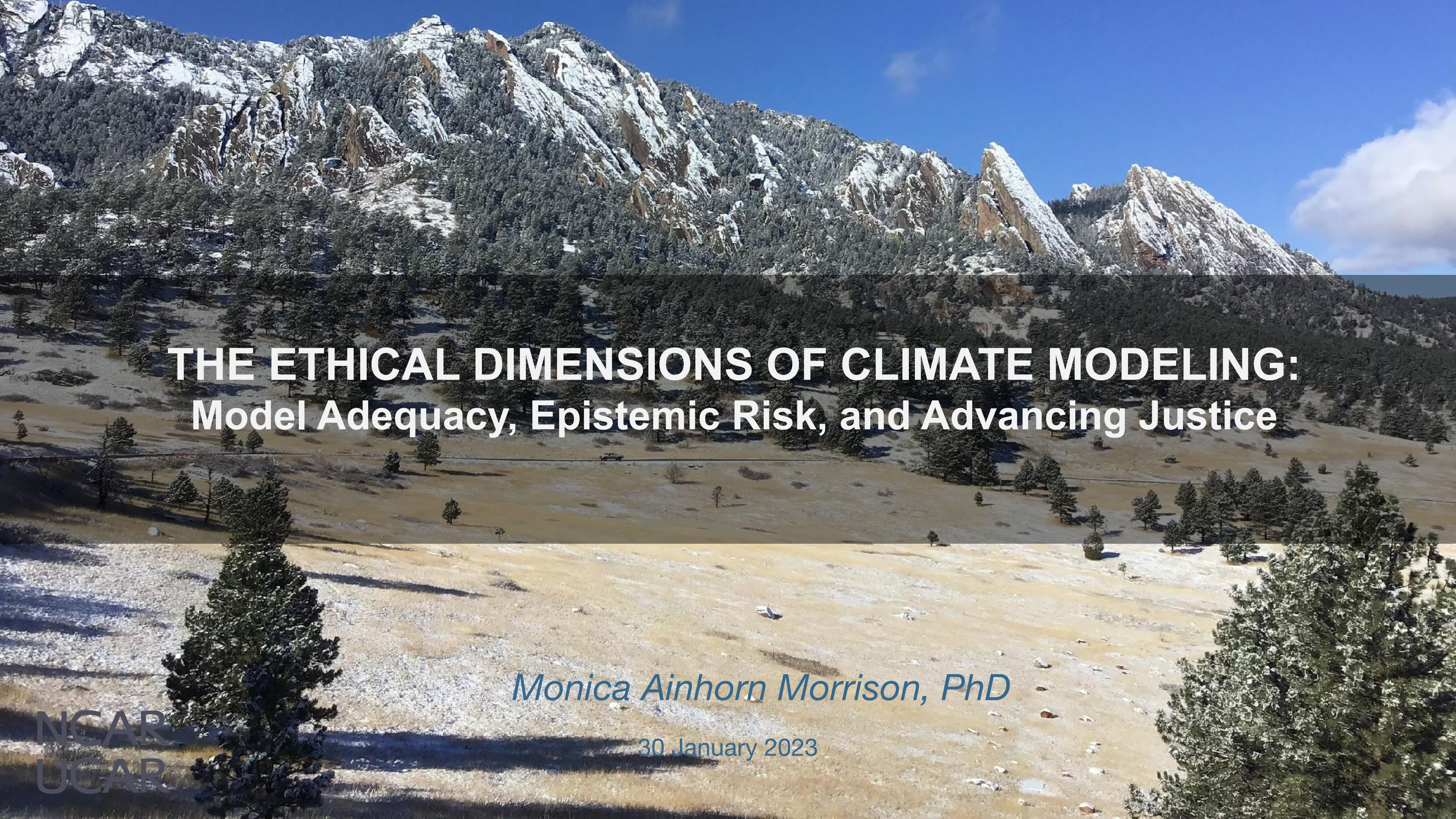

THE ETHICAL DIMENSIONS OF CLIMATE MODELING:
Model Adequacy, Epistemic Risk, and Advancing Justice

Monica Ainhorn Morrison, PhD

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NCAR
UCAR

Epistemic risk and hazard management—in terms of greater transparency and explicit and systematic communication about adequacy-for-purpose—is how the modeling community can contribute to actionable science and climate justice.

Epistemic Risk

Scientific inquiry involves making decisions.

With each decision there is a possibility of mistake.

Decisions about what assumptions to involve, what approaches to use, how to evaluate results, carry this risk.

This “risk of getting it wrong” is epistemic risk—as is the risk of the decision being “inadequate” for a purpose.

Philosophy of Scientific Representation

Models are adequate-for-purpose, and built to be such.

A model will represent certain features of the complex causal system at the expense of oversimplifying, obscuring, or omitting other features of the causal space.

This representational perspective a model occupies is a function of the interests, aims, and priorities of the research and development communities.

Parker, 2020 (see also Giere and van Fraassen)

Risk in Model Development Choices

Representational risk is a specific kind of epistemic risk in model-based science.

It results when a representational decision is inadequate for a purpose, as a hazard can be introduced and result in a downstream harm depending on the information use context.

The presence of risk, and the introduction of hazards, is amplified, and becomes especially salient when models are repurposed, or applied to answer questions for which they were not originally constructed—inconsistent with development purposes.

Morrison, forthcoming, 2022

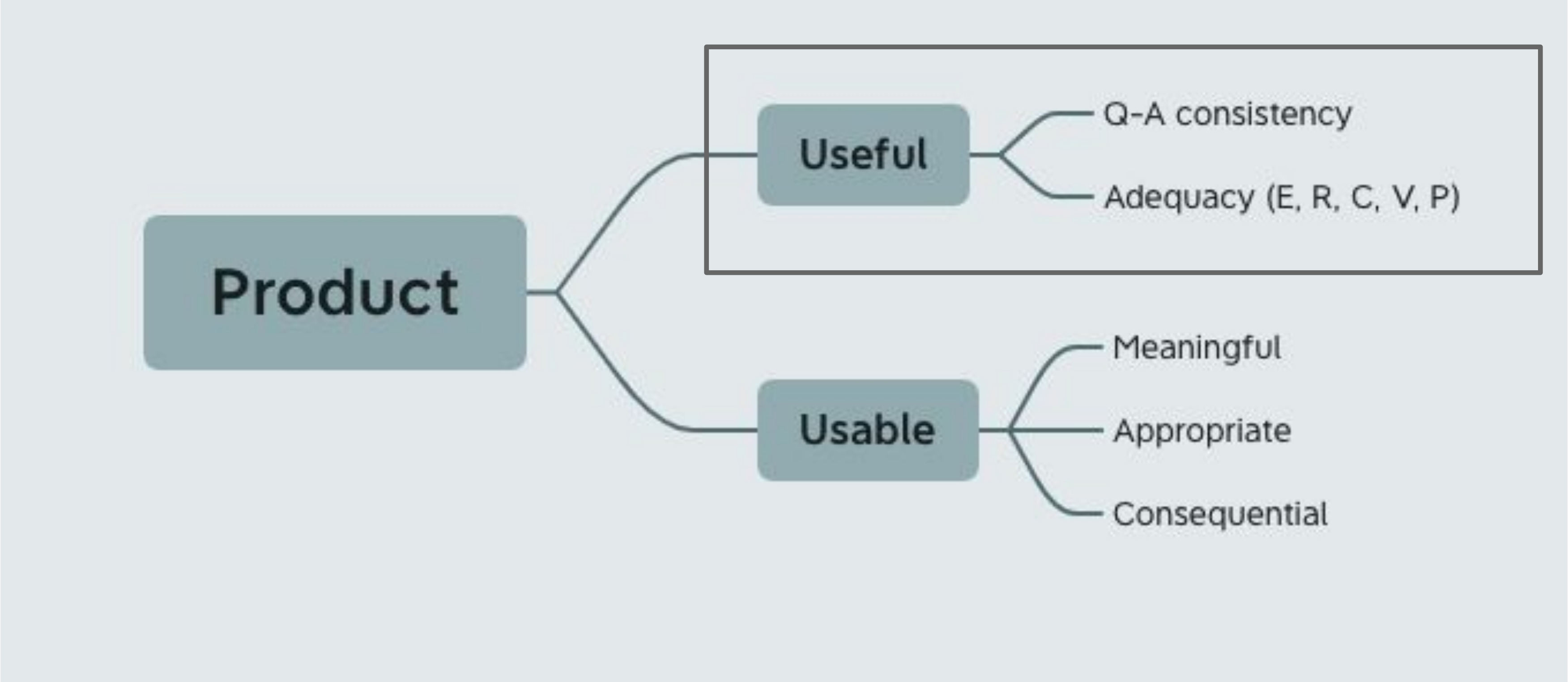
Duties in Scientific Modeling

We have a moral-epistemic duty to identify, manage, and assess epistemic risk in modeling and the associated hazards.

Not doing so could leave to downstream consequences with implications for social, ethical, economic, ecological, etc. harms.

Adapted from Harvard and Winsberg 2022

Actionable Information Products



Morrison, forthcoming

Criterion for Representational Adequacy of Models

Representational adequacy—representational content (what is represented, and how)

Configuration adequacy—experimental set up

Process and dynamical adequacy—simulated behavior of key causal determinants/drivers

Data adequacy-for-purpose

The Ethical Dimensions of Scientific Modeling

If our model is inadequate in terms of its representational features for answering certain questions…

There are associated hazards with using the model to answer those questions…

And in actionable contexts this can lead to harms such as maladaptation, mal-intervention…high degrees of inaccuracy, irrelevance, misleading or largely incomplete results.

At the Very Least…

…explicit guidance must be provided about the representational limitations of the models—their simulations and data—for certain purposes, and more communication about what models, their simulations and related output, have been purposed for, and not purposed for…

Epistemic Injustice

Epistemic injustice occurs when there is harm or a wrong to an individual in terms of their capacity as a knower.

An individual or group experiencing one or another form of injustice can be disadvantaged epistemically and practically when information they might use or apply is obscured or omitted.

Fricker 2007

Intersections of Climate and Epistemic Injustice

Epistemic disadvantage as not having their epistemic standpoints, perspectives, values, and priorities represented in development or application practices.

Inadequacy of development and application decisions—hazards—compounded harms.

No insight or transparency surrounding these decisions and the adequacy for ***their*** purposes reproduces and amplified disadvantages.

Fricker 2007

At the Very Least…

…explicit guidance must be provided about the representational limitations of the models—their simulations and data—for certain purposes, and more communication about what models, their simulations and related output, have been purposed for, and not purposed for…

What Does this Mean for our Practices?

Less

Boundary Management

- Guidance documents—standardization
- Decision and purpose transparency
- Translations/translators

Collaboration

- Minimal-adequacy studies—model culling
- Co-design—tailored-assessments
- Co-development/production—configurations, experiments, etc.

More

Minimal representational adequacy:

Are the key features of the system of interest adequately represented in the model—are the physical characteristics that are causal determinants of the phenomenon of interest included in the model, and are these parameterizations designed to simulate the processes associated with the phenomenon of interest in the actionable science question?

Think—are there 3-D lakes or not for adequate representation of lake-atmosphere interactions in model?

Yes—minimally adequate; no-inadequate

Example: GLISA evaluation of G.L. treatment

Physical/parameter adequacy-for-purpose: Assessment of the representational choices (description and assumptions) surrounding key processes (parameterized) that function as causal determinants of the phenomena central to the model application purpose

Set-up adequacy-for-purpose: Assessment of the configuration choices fitness to model application purpose

Example: process, pattern, and dynamic adequacy tests

System simulated behavior adequacy-for-purpose: Assessment of characteristic and identifiable structures, and representations of key climate features and behavior under change, which function as determinants of the phenomena central to the model application purpose (ability to simulate the causal and dynamical dependencies for key processes that govern the variable/phenomena of interest)…

Example: process, pattern, and dynamic adequacy tests

1. What information do we want to take from the model—what is the phenomenon of interest?
    1. Precipitation regimes in Great Plains.
2. What are the climatic drivers (systematic or regional) that are the causal determinants of the phenomenon of interest?
    1. Upper-level jet; Great Plains lower-level jet; land surface feedbacks; monsoon anticyclone
3. What can we say about how those driver will change under future climate conditions?
    1. (Upper-level jet): northward shift—increase in speed of winds in north, and decrease speed of winds in south
4. What are the underlying processes that interact to determine the emergent behavior of the drivers?
    1. Specific humidity; perpendicular air flow; parallel air flow.
5. Are ways in which the processes simulated going to produce the behaviors for the driver hypothesized in (3)?

Bukovsky et al. 2017, see Kawamleh 2022 (analysis)

Questions?