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Interdisciplinary Science: Opportunities & Obstacles

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Presentation Outline

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- **My Role**
- **The Plan**
- **What is Interdisciplinarity?**
  - What is *disciplinarity*?
  - *Inter*-disciplinarity
  - Analyzing interdisciplinary research
- **Interdisciplinary Science**
  - Example: Coastal fog as a system
  - Opportunities
  - Obstacles
  - Interdisciplinary Workshop Goals
- **Workshop #1**
- **Workshop #2**

My Role

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Guide Reflection on Interdisciplinary Science

- A philosopher by training who has focused on the nature of knowledge and communication
- Worked during the past 10 years on explicitly interdisciplinary projects, including AUVs
- Current research: *science of team science*, e.g., understanding and facilitating interdisciplinarity
- Here, I have been asked to help break down disciplinary barriers and foster collaboration

The Plan

Structuring Interdisciplinary Reflection

- Presentation on interdisciplinary science (10:45-11:40)
- Complete MMI Toolbox instrument (11:40-12:00)
- Workshop #1: Toolbox workshop - *today*
  - Group dialogue (1:30-2:30)
  - General debrief discussion (2:30-3:00)
- Workshop #2: Impacts workshop – *tomorrow*
  - Group discussion and informal concept mapping exercise (2:30-3:30)
  - General debrief discussion (3:30-4:00)

What is Interdisciplinarity?

What is *disciplinarity*?

- An important unit for thinking about knowledge creation is the *discipline*, but what are disciplines?
- Examples: chemistry, geochemistry, biogeochemistry
- They can be conceived of *from the inside*:
  - Focused practices (Bammer 2013)
  - Knowledge cultures
  - Forms of life
- The can be conceived of *from the outside*:
  - Institutions (e.g., departments, societies)
  - Markets (Turner 2000)

What is Interdisciplinarity?

What is *disciplinarity*?

- Think about disciplines as *knowledge cultures* (Knorr Cetina 1999)
  - These generate understanding by isolating topics of interest and then examining them using various methods
  - Members of knowledge cultures share assumptions about how one should investigate the topics of interest
  - One is acculturated during training and early in one's career
- These cultures produce different languages, thoughts, actions – i.e., *research worldviews*

What is Interdisciplinarity?

Inter-disciplinarity

- If *disciplines* are knowledge cultures,
  - then *inter*-disciplinarity involves bringing different cultures together
  - As such, it is a form of *intellectual multiculturalism*
- Further, interdisciplinarity differs from other combinations (e.g., *multi*disciplinarity) in being more integrated (Klein 2010)
  - Integration can involve common questions, sharing data, combining methods, use of a common model, etc.
  - The result is a research result that is a sum of different disciplinary vectors (Brigandt 2010)

What is Interdisciplinarity?

Analyzing Interdisciplinary Research

- Interdisciplinary research (IDR) need not be collaborative, but it generally is in science – we will focus on *collaborative* IDR (Voosen 2013)
- IDR often concerns complex, "real world" problems (e.g., climate change), but can also be motivated by complex questions (e.g., bacterial roles in ocean biogeochemistry) (NAS 2004)
- Two Modes of IDR:
  - *Intrinsic mode*
  - *Extrinsic mode*

What is Interdisciplinarity?

Analyzing Interdisciplinary Research

- Intrinsic Mode:
  - This concerns the structure and functionality of an interdisciplinary collaboration *on the inside*
  - There are typically several disciplinary perspectives on the common research question that
    - Emphasize different methods
    - Issue in different hypotheses
    - Generate different interpretations (Eigenbrode et al. 2007)
  - Success will depend on these different perspectives "coming together" in some fashion (Klein 2011)

What is Interdisciplinarity?

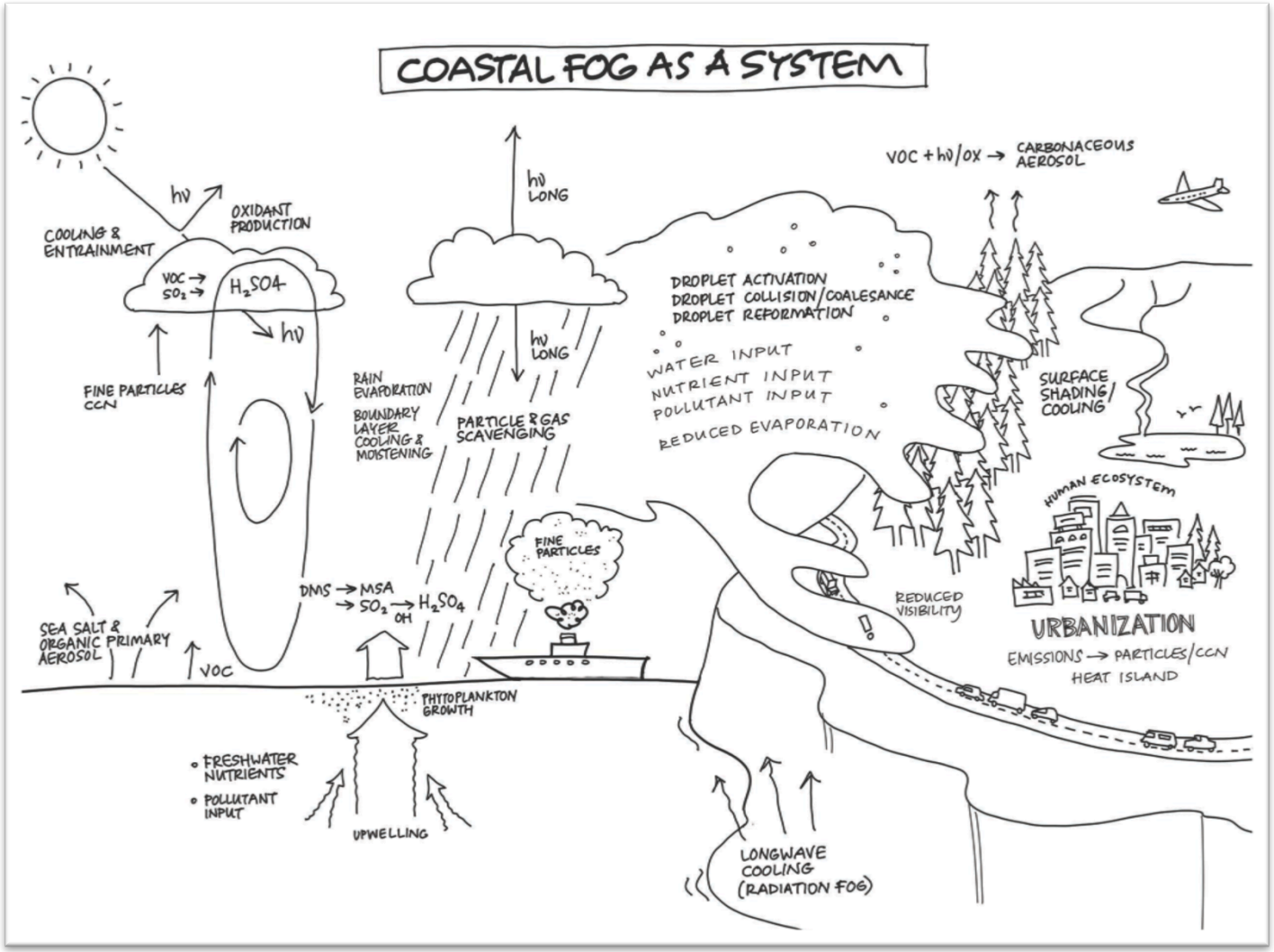
Analyzing Interdisciplinary Research

- Extrinsic Mode:
  - This concerns the influence and impact that IDR can have on those outside of the collaboration proper
  - Those affected can include:
    - Other scientists outside of the collaboration
    - Funders
    - Policymakers
    - Stakeholders
  - We tend to limit our extrinsic view to our own disciplines
  - The spheres of influence extend much farther out (consider: the NSF “broader impacts” criterion) (Frodeman et al. 2013)

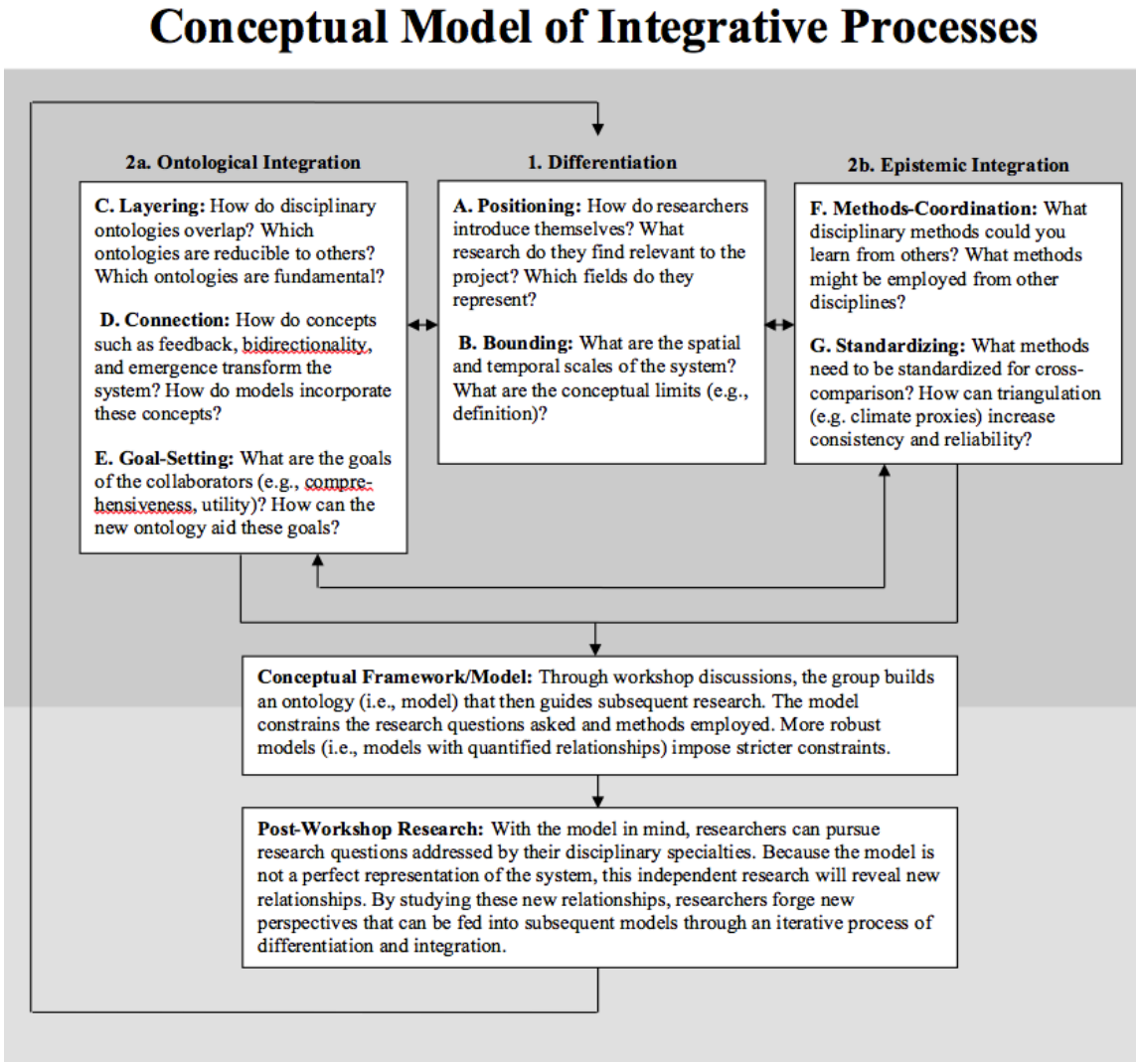
Example: Coastal Fog as a System

- IDR takes place all over the map of knowledge, but our interest here is on scientific IDR
- To fix ideas, consider a recent GBMF-funded effort to investigate coastal fog as a system
  - An intentional effort to catalyze interdisciplinary capacity around coastal fog understood as more than just a chemical or physical phenomenon
  - Involves atmospheric physicists and chemists, oceanographers, aquatic and terrestrial ecologists, climatologists, modelers, and eventually social scientists

Example: Coastal Fog as a System



Example: Coastal Fog as a System



Opportunities

- You are young scientists with a stake in a discipline, so why care about IDR?
- There are valuable opportunities that await if you are willing to expand your sense of what's relevant
- *Intrinsic:*
  - Meet complex problems with complex responses
  - Achieve explanatory coherence across a range of knowledge cultures (Thagard 1997)
  - Make connections that could result in access to data, models, etc.

Interdisciplinary Science

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Opportunities

- *Extrinsic:*
  - Funder interest in this kind of work:
    - GBMF: MMI, Data-driven Discovery
    - NSF: National Ecological Observatory Network (NEON), Long-Term Ecological Research (LTER), INSPIRE
    - NOAA: Climate and Societal Interactions (CSI)
  - Enhance the scientific reach of your research
  - Influence policy and help a broader swath of stakeholders (Sarewitz 2013)

Obstacles

- But working across disciplines is challenging, with no shortage of obstacles (Morse et al. 2007)
- *Intrinsic:*
  - Different knowledge cultures operate differently, and there is much that can be lost in translation (Holbrook 2013)
  - Collaborators in IDR projects use different technical terms and methods, have different values and priorities, and can take different things to qualify as results
  - Further, you are not always an expert in IDR – you must be willing to *be the student*

Obstacles

– *Extrinsic:*

- Getting credit for IDR within your unit (NAS 2004)
- Finding publication venues for IDR results
- Getting the word out to the various parties (e.g., policymakers) who might have an interest in this work
- Once those parties are identified, communicating with them effectively

Interdisciplinary Workshop Goals

- In two 90-minute workshops, we'll focus on the obstacles and build on the opportunities
- Workshop #1: The Value of Conceptual Dialogue
  - Focus on the intrinsic obstacles associated with communicating with collaborators
  - *Goal*: enhance mutual understanding about research perspectives across several disciplines
- Workshop #2: Mapping the Space of Collaboration
  - Focus on the extrinsic obstacles associated with identifying communities with interest in the work
  - *Goal*: think collectively about the impact of an interdisciplinary project

Workshop #1

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The Toolbox Project

- The Toolbox Project focuses on communication about research content within collaborative IDR
- The Leading Idea:
  - You can enhance communication by enhancing mutual understanding
  - You can enhance mutual understanding by structured dialogue about your research worldview
- The Goal: Enhance communication and increase collaborative capacity by reducing the amount "lost in translation" (O'Rourke & Crowley 2013)

Workshop #1

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The Toolbox Approach

- The Toolbox Project runs dialogue-based workshops in which collaborators:
  - Teach their worldview to others
  - Learn from others about their worldviews
- Two Moving Parts:
  - *The Instrument*: the "Toolbox" is a survey instrument that structures the dialogue by highlighting core aspects of a research worldview
  - *The Workshop*: using the instrument, collaborators compare their different perspectives on scientific research

Workshop #1

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The Instrument

Methodology

Core Question: What methods do you employ in your disciplinary research (e.g. experimental, observational, modeling)?

1. Scientific research must be hypothesis driven.
   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

2. Qualitative science is as credible as quantitative science.
   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

3. Scientific observations of the ocean should be valued more highly than computational modeling results.
   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

4. Scientific results are more credible if they derive from controlled experiments.
   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

5. Experimental work in marine microbial ecology is too dependent on context to yield general principles.
   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

6. _____
   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

Workshop #1

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The Workshop

- This focuses on dialogue about the prompts within eight groups (see the handout)
  - Begin anywhere you wish
  - Follow your interests and insights around the instrument—the dialogue is usually facilitated, but not today
  - We don't define or delimit terms—extremity, vagueness, and ambiguity are there for you to negotiate in dialogue
  - We recognize that you may have a complex research perspective—do your best to represent that in your responses
- It ends with a general debrief conversation

Workshop #1

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A History

- Motivated by graduate students in a team-based IGERT (IGERT) project at U. Idaho
- Led to Eigenbrode et al. (2007) and funding by the NSF (SES-0823058, 2008; SBE-1338614, 2013)
- Over 120 workshops on 3 continents, multiple publications and presentations, and an international conference that issued in this recently published volume:

Workshop #1

IRB Approval

- A research project with human subjects: IRB approval from Michigan State University
- Today we are only collecting the instruments—we ask that you submit them to us after the session
- The project is anonymous—we ask that you not put your name on the instrument
- You are not required to participate in this project, and can opt out and keep the instrument
- Submitting them indicates your willingness to use the data in presentations and publications

Workshop #2

Mapping the Space of Collaboration

- This workshop concerns the *extrinsic* mode of IDR
- In the same groups, you will devote the first hour of the workshop to:
  - Introductions by research focus
  - A conversation identifying a research project that you could engage in as a group
  - Development of the project with a *concept map* of the problem that combines your different perspectives
  - Discussion of the problem as you have mapped it, focusing on its broader impacts

Workshop #2

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Mapping the Space of Collaboration

- The Concept Map
  - Map the spatiotemporal extent of the problem, using a box-and-line system
  - Indicate how your various disciplines will help address the problem:
    - Will they structure the response?
    - Will they generate necessary data?
    - Will they assist in the analysis of the data?

Workshop #2

Mapping the Space of Collaboration

- Beyond the Concept Map
  - What other disciplines are needed to address the problem?
  - Beyond scientists, who will be interested in the work? How can it be conveyed to them?
    - Could it have policy implications?
    - Are there stakeholder groups who could be affected?
    - What sort of communication plan might aid you in getting the word out to them?

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- Project advisors: Julie Thompson-Klein (Wayne State University), Frank Davis (UC Santa Barbara), Paul Griffiths (University of Sydney)

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