Center for Dark Energy Biosphere Investigations
Reverse Site Visit, February 4, 2019

Jan Amend (Director)
Julie Huber (Associate Director)
Rosalynn Sylvan (Managing Director)
Session 1 (Amend)
Research, Accomplishments, Resources

Session 2 (Amend)
Education, Outreach, Diversity

Session 3 (Huber)
Knowledge Transfer, Data Management

Session 4 (Huber)
Synthesis, Phase 3
Research

Director: Jan Amend (USC)
Assoc. Director: Julie Huber (WHOI)
Co-PI: Steven D’Hondt (URI)
Co-PI: Andrew Fisher (UCSC)
Co-PI: Geoffrey Wheat (UAF)

SenSci: Steve Finkel (USC)
SenSci: John Heidelberg (USC)
SenSci: Beth Orcutt (Bigelow)
SenSci: Victoria Orphan (Caltech)
SenSci: Alfred Spormann (Stanford)
Approaches & Disciplines

Exploration

Lab Experiments

Modeling & Synthesis

Hydrology

Geochemistry

Microbiology
Some of our Major Discoveries (2010-2019)
Total Cells in Marine Sediments

3 x $10^{29}$ cells globally in marine sediments

Kallmeyer et al. (2012)
PNAS
C-DEBI # 136
Evidence of cell division, sulfate reduction, and nitrate reduction

Orsi et al. (2013) Nature
C-DEBI # 137
O$_2$ penetration to 10s of meters into seds
Increasing [O$_2$] approaching basement
Sediments in 40% of seafloor may be oxic, with aerobic respiration, to basement

D’Hondt et al. (2015)
*Nature Geoscience*
C-DEBI # 254
1\textsuperscript{st} Novel Species from Ocean Crust

Bacillus rigiliprofundi

Sylvan et al. (2015)

*IJSEM*

C-DEBI \# 257
1st Tracer Test in Ocean Crust

- Tracer transport rate >2 m/day
- Effective crustal porosity <1%

Neira et al. (2016)
*Earth & Planet. Sci. Letters*
C-DEBI # 331
Total Sediment and Porewater Volume

- Global average sediment depth: 720 m
- 5-6% of ocean trapped in sediment pores

LaRowe et al. (2017)
Geology
C-DEBI # 350
Ocean basement has distinct assemblage of novel viruses, with many that infect archaea

Nigro et al. (2017) 
mBio
C-DEBI # 354
Metabolism in 2 km-deep Coal Bed

- Active metabolism of methylated substrates
- Slow rates of environmental biosynthesis

Trembath-Reichert et al. (2017) *PNAS*
C-DEBI # 389
Extracellular DNA in Marine Sediments

- Low abundance of eDNA in marine sediments
- Minimal influence on molecular surveys

Ramirez et al. (2018)  
*Frontiers in Microbiology*  
C-DEBI # 446
Temporal Stability of Microbial Taxa

Metagenomic, metatranscriptomic, and geochemical analyses of hydrothermal vent fluids show stable microbial communities over years

Fortunato et al. (2018) Environmental Microbiology C-DEBI # 399
Overlooked Carbon Reservoir

Up to $1.6 \times 10^{22}$ g of OC are sequestered on million-year timescales in oxic pelagic sediment.

Estes et al. (2019)
Nature Geoscience
C-DEBI # 450
Research Themes

1. Fluxes, Connectivity, and Energy
   - Environmental Conditions

2. Activities, Communities, and Ecosystems
   - Microbial Communities

3. Metabolism, Survival, and Adaptation
   - Individual Species
Dead organic matter cannot support the energy/power demands of sediment microorganisms.

Bradley et al. (2018)  
*JGR Biogeosciences*  
C-DEBI # 416
Major ions at DO are very similar to SW.
Trace elements, metals, and oxygen at DO are very different than SW.
Compare to chemistry of rivers.
• Complex fluid flow patterns in basement
• Fluid flow rates are consistent with regional heat budget
• Massive fluid flows require high basement permeability ($10^{-9}$ m$^2$)
• Some of highest ocean crust permeability
• Discharge of 1,000-8,000 L/sec

Lauer et al. (2018)  
*EPSL*  
C-DEBI # 439
• Started modeling in 2-D (shown here)
• Heat is applied from below and convection occurs in volcanic crust
• Convection is unstable and mixes with water from different depths
What’s next for Theme 1?

- Embrace heterogeneity! It leads to flow channeling and isolation of much of the aquifer
- Incorporate rules for abiotic/biotic reactions and microbial growth into global sediment ecosystem models
Research Themes

1. Fluxes, Connectivity, and Energy

2. Activities, Communities, and Ecosystems

3. Metabolism, Survival, and Adaptation

Environmental Conditions

Microbial Communities

Individual Species
Relict and active bacterial taxa show major differences attributable to rapid sedimentation.
DOC consumption tracks $O_2$ removal and fluid residence time
- Microbes in cool crustal rocks oxidize and thereby remove $\sim$5% of global deep-sea DOC

Shah Walter et al. (2018)
*Nature Geosciences*
C-DEBI # 413
Phylogenetically novel uncultured microbial cells dominate Earth microbiomes, including in marine subsurface (purple).

- ¼ of microbial cells from phyla with no cultured relatives
- Their undiscovered physiologies may be important for ecosystem functions

Lloyd et al. (2018)
*mSystems*
C-DEBI # 437
What’s next for Theme 2?

Dead? Active? Dormant? Persisting? Growing?

Community activity via stable isotope probing

Single cell ecophysiology via Single Cell Genomics and nanoSIMS

- Experiments underway with subsurface crustal samples from North Pond (2017 cruise)
- Fresh experiments to start with crustal samples from Juan de Fuca (May 2019 cruise)
Research Themes

1. Fluxes, Connectivity, and Energy

2. Activities, Communities, and Ecosystems

3. Metabolism, Survival, and Adaptation

Amend: Research, Accomplishments, Resources

C-DEBI Reverse Site Visit
MCR operons in near-complete Archaeoglobi MAG from JdF Ridge basement fluid were horizontally transferred, changing evolutionary understanding.

Boyd et al. (2018)
*ISME Journal*
C-DEBI # 457
GASP Mutants of Increased Fitness

- Metabolic heat measured by nano-calorimetry
- ‘Bursts’ of heat associated with potential adaptive evolution events under low nutrient conditions

Robador et al. (2019)
*AEM (in revision)*
C-DEBI # ?
‘Bursts’ of metabolic heat correspond with detectable changes in relative fitness of mutant populations after 10, 15, or 20 days of incubation.

Robador et al. (2019)
*AEM (in revision)*
C-DEBI # ?
Adaptation of Crustal *Halomonas*

- 46 strains of *Halomonas* from oligotrophic crustal fluids adapt very rapidly to high nutrient environments.
- Evolving strains are modifying their metabolisms to the new medium, but reach the same carrying capacity.

Sebastian et al. (in prep)
What’s next for Theme 3?

Dead, active, dormant, persisting, or growing?

Are subseafloor microbes undergoing adaptive evolution where new genotypes are under positive natural selection or is most selection a form of ecological selection where existing genotypes are under positive selection for those phenotypes that allow maximum fitness in a system?
Major Accomplishments to Date
(a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
Major Accomplishments to Date
(a few highlights)

• 5 Major Field Programs (JdF, SPG, NP, DO, AM)
• ~20 other Subseafloor Sampling Expeditions
# Upcoming Field Expeditions

<table>
<thead>
<tr>
<th>Cruise</th>
<th>Dates</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF-OCE</td>
<td>May 2019</td>
<td>Microbial Activity in Crustal Deep Biosphere (B. Orcutt)</td>
</tr>
<tr>
<td>NASA-PSTAR</td>
<td>June 2019</td>
<td>Gorda Ridge, E/V Nautilus (J. Huber)</td>
</tr>
<tr>
<td>IODP 385T</td>
<td>Aug – Sep 2019</td>
<td>Holes 504B and 896A (B. Orcutt, G. Wheat)</td>
</tr>
<tr>
<td>IODP 385</td>
<td>Sep – Nov 2019</td>
<td>Guaymas Basin Tectonics and Biosphere (A. Teske)</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>Nov – Dec 2019</td>
<td>Mid-Cayman Rise (S. Lang)</td>
</tr>
</tbody>
</table>
Major Accomplishments to Date
(a few highlights)

• 5 Major Field Programs (JdF, SPG, NP, DO, AM)
• ~20 other Subseafloor Sampling Expeditions
• ~350 Peer-reviewed Publications
Major Accomplishments to Date
(a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
## Resource Leveraging

<table>
<thead>
<tr>
<th>Agency</th>
<th>C-DEBI lead</th>
<th>$</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moore</td>
<td>K Edwards</td>
<td>3.9 M</td>
<td>The Deep Subsurface Biosphere at North Pond</td>
</tr>
<tr>
<td>NSF-RCN</td>
<td>K Edwards,</td>
<td>0.5 M</td>
<td>A Deep-Biosphere Research Coordination Network</td>
</tr>
<tr>
<td></td>
<td>J Amend</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IODP</td>
<td>J Cowen, S</td>
<td>~30-35 M</td>
<td>(Juan de Fuca Ridge Flank-Exp. 327, South Pacific Gyre-Exp. 329, North Pond-Exp. 336: ship time, equipment, salaries, and research support)</td>
</tr>
<tr>
<td></td>
<td>D’Hondt, K</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edwards, A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fisher, G</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agency</td>
<td>C-DEBI lead</td>
<td>$</td>
<td>Title</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------</td>
<td>-------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>J Huber</td>
<td>1.2 M</td>
<td>Characterization of Microbial Transformations in Basement Fluids, from Genes to Geochemical Cycling</td>
</tr>
<tr>
<td>DFG Germany</td>
<td>G Wheat, K Edwards</td>
<td>(~4.4 M)</td>
<td>(North Pond: 100 days at sea – 1 site survey and 2 ROV cruises)</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>A Fisher, G Wheat</td>
<td>2.2 M</td>
<td>Single- and Cross-hole experiments on the eastern flank of the Juan de Fuca Ridge (five co-PI grants, ship and ROV time: two expeditions)</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>G Wheat, A Fisher</td>
<td>1.5 M</td>
<td>Completing single- and cross-hole hydrogeologic and microbial experiments: Juan de Fuca Flank (six co-PI grants, ship and sub time)</td>
</tr>
<tr>
<td>NASA (NAI)</td>
<td>J Amend, V Orphan</td>
<td>6.8 M</td>
<td>Life Underground</td>
</tr>
<tr>
<td>Moore/SOI</td>
<td>J Huber</td>
<td>3.4 M</td>
<td>Chemolithoautotrophic Subseafloor Microbial Ecosystems at Axial Seamount, a Mid-Ocean Ridge Cabled Observatory</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>G Wheat, A Fisher</td>
<td>1.4 M</td>
<td>Discovery, sampling, and quantification of flows from cool yet massive ridge-flank hydrothermal springs (three co-PI grants, ship and ROV/sub time: two expeditions)</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>S D’Hondt</td>
<td>3.0 M</td>
<td>North-Atlantic long-coring expedition with R/V Knorr</td>
</tr>
<tr>
<td>MacArthur</td>
<td>V Orphan</td>
<td>625 K</td>
<td>Just for being a ‘genius’</td>
</tr>
</tbody>
</table>
## More Resource Leveraging

<table>
<thead>
<tr>
<th>Agency</th>
<th>C-DEBI lead</th>
<th>$</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF-OCE</td>
<td>G Wheat, B Orcutt</td>
<td>(1.5 M)/700 M</td>
<td>Completing North Pond Borehole Experiments (three co-PI grants, ship</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and ROV time) [$700K science money]</td>
</tr>
<tr>
<td>IODP/USSSP</td>
<td>B Orcutt</td>
<td>(3.5 M)/170 K</td>
<td>IODP Expedition Atlantis Massif (expedition costs and research support)</td>
</tr>
<tr>
<td>Moore</td>
<td>V Orphan</td>
<td>1.5 M</td>
<td>Investigator grant: Molecular microbial ecology and stable isotope geochemistry of anoxic ecosystems</td>
</tr>
<tr>
<td>IODP/USSSP</td>
<td>G Wheat</td>
<td>(10 M)/190 K</td>
<td>IODP Expedition Mariana forearc serpentinite mud volcanoes (ship time and USSSP support)</td>
</tr>
<tr>
<td>NOMIS</td>
<td>V Orphan</td>
<td>2.1 M</td>
<td>Distinguished Scientist Award: Understanding virus-host dynamics in ocean ecosystems, using new approaches in nanometer scale stable isotope imaging</td>
</tr>
<tr>
<td>NSF-OTIC</td>
<td>G Wheat</td>
<td>411 K</td>
<td>Development and fabrication of high-temperature borehole fluid sampler</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>B Orcutt</td>
<td>(739 K)/455 K</td>
<td>May 2019 “Slow Life in the Fast Lane” Juan de Fuca cruise</td>
</tr>
<tr>
<td>NSF-OIA</td>
<td>R Stepanauskas, B Orcutt</td>
<td>6 M</td>
<td>EPSCOR Track 2 Single cell genome-to-phenome (leverages May 2019 JdF Orcutt cruise)</td>
</tr>
<tr>
<td>NASA-PSTAR</td>
<td>P Sobron, J Amend</td>
<td>4.3 M</td>
<td>In-situ Vent Analysis Divebot for Exobiology Research (InVADER)</td>
</tr>
</tbody>
</table>
## Resource Leveraging (Education)

<table>
<thead>
<tr>
<th>Agency</th>
<th>C-DEBI lead</th>
<th>$</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF-STC</td>
<td>J Amend, S Schroeder</td>
<td>100 K</td>
<td>C-DEBI education supplement</td>
</tr>
<tr>
<td>NSF-OCE</td>
<td>J Amend, S Schroeder</td>
<td>261 K</td>
<td>REU Site: Community College Cultivation Cohort (C4) and REU supplement</td>
</tr>
<tr>
<td>NAI</td>
<td>J Amend</td>
<td>340 K</td>
<td>Life Underground education</td>
</tr>
<tr>
<td>GOMRI</td>
<td>G Wheat</td>
<td>25 K</td>
<td>Ecosystem Impacts of Oil &amp; Gas Inputs to the Gulf (ECOGIG)</td>
</tr>
</tbody>
</table>

 Amend: Research, Accomplishments, Resources

C-DEBI Reverse Site Visit
Major Accomplishments to Date (a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
- >1000 Participants in ~40 Countries
Major Accomplishments to Date
(a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
- >1000 Participants in ~40 Countries
- 57 Seed Grants, 75 Individuals, 38 Institutions, $3.5 M
Major Accomplishments to Date (a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
- >1000 Participants in ~40 Countries
- 57 Seed Grants, 75 Individuals, 38 Institutions, $3.5 M
- 55 GS/PD Fellowships, totaling $5.4 M
Major Accomplishments to Date
(a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
- >1000 Participants in ~40 Countries
- 57 Seed Grants, 75 Individuals, 38 Institutions, $3.5 M
- 55 GS/PD Fellowships, totaling $5.4 M
- 22 Workshops, 8 Annual Mtgs, 21 Networked Speakers

Amend: Research, Accomplishments, Resources
Major Accomplishments to Date
(a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
- >1000 Participants in ~40 Countries
- 57 Seed Grants, 75 Individuals, 38 Institutions, $3.5 M
- 55 GS/PD Fellowships, totaling $5.4 M
- 22 Workshops, 8 Annual Mtgs, 21 Networked Speakers
- 15 EOD Grants, 17 Individuals, 10 Institutions, $654 K
Major Accomplishments to Date  
(a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
- >1000 Participants in ~40 Countries
- 57 Seed Grants, 75 Individuals, 38 Institutions, $3.5 M
- 55 GS/PD Fellowships, totaling $5.4 M
- 22 Workshops, 8 Annual Mtgs, 21 Networked Speakers
- 15 EOD Grants, 17 Individuals, 10 Institutions, $654 K
- Shipboard Education, Outreach, Communications
Major Accomplishments to Date
(a few highlights)

- 5 Major Field Programs (JdF, SPG, NP, DO, AM)
- ~20 other Subseafloor Sampling Expeditions
- ~350 Peer-reviewed Publications
- ~$95 M in Leveraged Funds
- >1000 Participants in ~40 Countries
- 57 Seed Grants, 75 Individuals, 38 Institutions, $3.5 M
- 55 GS/PD Fellowships, totaling $5.4 M
- 22 Workshops, 8 Annual Mtgs, 21 Networked Speakers
- 15 EOD Grants, 17 Individuals, 10 Institutions, $654 K
- Shipboard Education, Outreach, Communications
- Graduate Students and Post-Docs ‘moving on’
People getting jobs

James Bradley  Queen Mary U, Asst. Professor
Tess Weathers  Chabot College, Instructor
Elizabeth Trembath-Reichert  ASU, Assistant Professor
Karen Lloyd  UTK, Associate Professor
Alberto Robador  USC, Res. Asst. Professor
Nagissa Mahmoudi  McGill, Assistant Professor
Annie Rowe  U Cincinnati, Assistant Professor
Olivia Nigro  Hawaii Pacific, Assistant Professor
Heather Fullerton  College of Charleston, Assistant Professor
Rosa Leon Zayas  Willamette, Assistant Professor
Stephanie Carr  Hartwick College, Asst. Professor
Kat Dawson  Rutgers, Assistant Professor
Caroline Fortunato  Wilkes, Assistant Professor
Michael Graw  DE SeaGrant, Digital Outreach Specialist
Mark Torres  Rice U, Assistant Professor
More people getting jobs

Ileana Perez-Rodriguez  U Penn, Asst. Professor
Doug LaRowe  USC, Research Associate Professor
Rika Anderson  Carleton College, Assistant Professor
Leila Hamdan  U Southern Mississippi, Assoc. Prof.
Jessica Labonté  TAMU, Assistant Professor
Delphine Defforey  Nature Comm, Associate Editor
Cara Magnabosco  Simons Foundation, Systems Biologist
Roland Hatzenpichler  MT State, Assistant Professor
Jason Sylvan  TAMU, Assistant Professor
Carolyn Buchwald  Dalhousie, Assistant Professor
Rachel Lauer  Univ Calgary, Assistant Professor
Brandi Reese  TAMU, Assistant Professor
Dustin Winslow  GrowthIntel, Data Scientist
Erin Field  ECU, Assistant Professor
Anne Dekas  Stanford Univ, Assistant Professor
Brandon Briggs  Univ. Alaska, Assistant Professor
Bill Orsi  LMU-Munich, ‘Assistant’ Professor
And more people getting jobs

Julie Meyer  U Florida, Research Asst. Professor
Karyn Rogers  RPI, Assistant Professor
Roy Price  Stony Brook U, Research Professor
Esther Schwarzenbach  Res. Scientist, Freie Universität Berlin
Everett Salas  Chevron, Decision Analysis Advisor
Charles Vidoudez  Harvard Core Facility, Mass Spectrometrist
Cecilia Batmalle Kretz  CDC, Molecular Microbiologist and Bioinformatician
Brian Marquardt  MarqMetrix Inc, Chief Science Officer
Giora Proskurowski  MarqMetrix Inc, Manager, Raman Division
Amanda Martino  Saint Francis U, Assistant Professor
Andrew Steen  UTK, Assistant Professor
Joshua Steele  SCCWRP, Microbiologist
Anna Kaster  Karlsruhe Inst. Technology, Professor
Ulrike Jaekel  Research Council of Norway, Senior Advisor
Kiana Frank  Univ Hawaii, Research Assistant Professor
Melissa Adams  Lando & Anastasi, Patent Agent
Tina Lin  National Taiwan U, Assistant Professor
People getting postdocs

Amy Smith  WHOI, Post-Doc
Jacqueline Goordial  Bigelow, Post-Doc
Emily Estes  U Delaware, Post-Doc
Maria Pachiadaki  Bigelow, Post-Doc
Sean Jungbluth  DOE JGI, Post-Doc
Gus Ramirez  URI, Post-Doc
Lily Momper  MIT, W.O. Crosby Post-Doc
Alexander Michaud  Aarhus U, Post-Doc
Beate Kraft  U Southern Denmark, Post-Doc
Katrina Twing  Univ Utah, Post-Doc
Kristin Woycheese  MIT, NAI Post-Doc
Luke McKay  Montana State, NAI Post-Doc
Roman Barco  USC, Post-Doc
Esther Singer  DOE JGI, Post-Doc
Laura Zinke  UC Davis, Post-Doc
Major Accomplishments to Date
(a few highlights)

• 5 Major Field Programs (JdF, SPG, NP, DO, AM)
• ~20 other Subseafloor Sampling Expeditions
• ~350 Peer-reviewed Publications
• ~$95 M in Leveraged Funds
• >1000 Participants in ~40 Countries
• 57 Seed Grants, 75 Individuals, 38 Institutions, $3.5 M
• 55 GS/PD Fellowships, totaling $5.4 M
• 22 Workshops, 8 Annual Mtgs, 21 Networked Speakers
• 15 EOD Grants, 17 Individuals, 10 Institutions, $654 K
• Shipboard Education, Outreach, Communications
• Graduate Students and Post-Docs ‘moving on’
• Awards, Television, Movies in 2018
Major Recognitions

Victoria Orphan  NOMIS
Distinguished Scientist and Scholar Award

Beth Orcutt  GSA Geobiology & Geomicrobiology Division Post-Tenure Award

Andy Fisher  AGU Fellow
More Major Recognitions

Elizabeth Trembath-Reichert (WHOI) L’Oreal For Women in Science Fellowship

Pete Girguis (Harvard) Lowell Thomas Award for ‘engineering exploration’ in deepsea biology

Adina Paytan (UCSC) AGU Fellow
“The Most Unknown is an epic documentary film that sends nine scientists to extraordinary parts of the world to uncover unexpected answers to some of humanity’s biggest questions. How did life begin? What is time? What is consciousness? How much do we really know?”
Specific Charge for First Meeting:

- Get to know the C-DEBI community and the current research and education projects.
- Learn from C-DEBI graduate students and post-docs about their experiences as part of the STC, especially professional training.
- Obtain a clear picture of the types of datasets C-DEBI generates and the datasets the community needs, and provide suggestions regarding data management and integration.
- Provide advice on paths forward beyond the end of the STC Phase 2, with a focus on both integrated research/education priorities and a funding model that can sustain C-DEBI for the long term.

C-DEBI suite of five offices, conference room, storage room, and reception area

- Dedicated conferencing AV facilities with 72” wall-mounted monitor, video camera, Mac Mini, and telecom capability

- Dean’s matching funds for student support (~$930k over 5 yrs)

- Dean’s matching funds for operating expenses (~$450k over 5 yrs)

- Support for Center Director, including academic year salary, administrative stipend, course release (~$600k)
2018-2019 Research Funds in Support of C-DEBI Themes (direct dollars)

- **Theme 1**
  - Fluxes, Connectivity, and Energy
  - 24% Leadership, 24% Grants

- **Theme 2**
  - Activities, Communities, and Ecosystems
  - 34% Leadership, 42% Grants

- **Theme 3**
  - Metabolism, Survival, and Adaptation
  - 34% Leadership, 34% Grants

Amend: Research, Accomplishments, Resources

C-DEBI Reverse Site Visit
NSF STC Phase Down

2018-2019

$5 M

2019-2020

$3.7 M

2020 (6 mo)

$1.3 M

- USC Indirects
- Leadership Research
- Data Management
- Meetings & Activities
- Admin
- Education & Diversity
- Grants & Fellowships

Amend: Research, Accomplishments, Resources

C-DEBI Reverse Site Visit