US CLIVAR
Program Perspectives

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Director

Program Goals and Phenomenological Foci

Implementation Priorities – through Panels and Activities

Future Opportunities

US CLIVAR Goals

1) Understand the **role of the oceans** in climate variability on different time scales.

2) Understand the **processes** that contribute to climate change and variability in the past, present, and future.

3) Better **quantify uncertainties** in the observations, simulations, predictions and projections of climate variability and change.

4) Improve the **development and evaluation of climate simulations and predictions.**

5) **Collaborate with research and operational communities** that develop and use climate information.

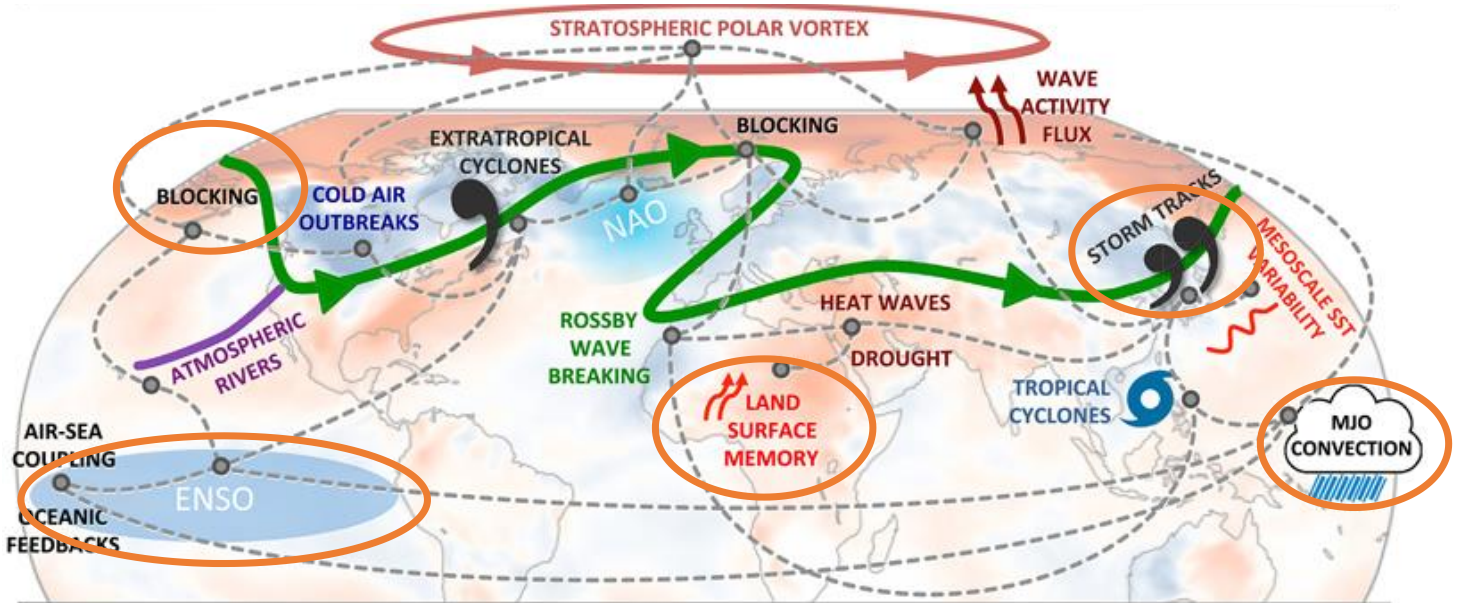
Phenomenological Foci

Climate modes, teleconnections, and interactions

- NAO/AO
- MJO
- ENSO
- Tropical Atlantic Variability
- QBO
- Atlantic Multidecadal Variability
- Pacific Decadal Variability

Precipitation-producing features

- Mesoscale convective systems
- Storm tracks and extratropical cyclones
- Tropical cyclones
- Summer monsoon
- Rossby wave breaking and blocking
- Atmospheric rivers and low-level jets

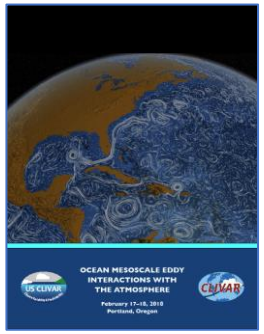


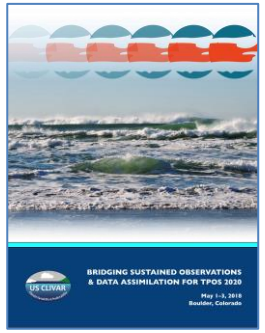
from Lang, Pegion, Barnes, JGR Atmospheres 2020

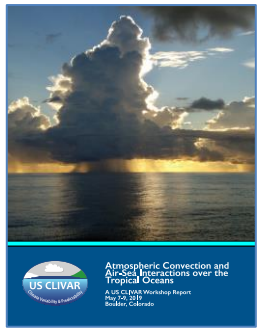
Phenomena, Observations, and Synthesis (POS) Panel

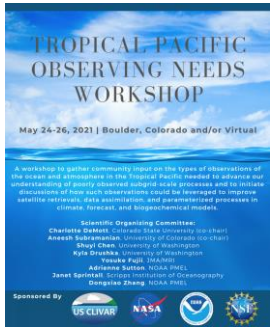
Advocates and leverages long-term climate monitoring and synthesis strategies to better document, understand, model, and predict climate variability

- Evaluate health of the ocean and atmosphere **observing systems for climate**
- Promote **expansion of observations** for climatically important but undersampled variables and regions
  - deep to ocean mixed layer
  - air-sea fluxes
  - marine atmospheric boundary layer
  - water isotopes









Air-Sea Interactions WG (2019-2022)

Co-chairs: Larry O'Neill (OSU) & Hyodae Seo (WHOI)

- Provide guidance on diagnostic metrics, statistical methods, and dynamical frameworks to quantify air-sea coupling over multiple space/time-scales
- Compare air-sea coupling between different model frameworks
- Identify opportunities to advance understanding through future field experiments, modeling studies, and observational strategies

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Water Isotopes WG (2018-2021)

Co-chairs: Kim Cobb (Georgia Tech), Adriana Raudzens Bailey (NCAR), & David Noone (Oregon State U.)

- Develop new strategies for applying isotope ratios to understand and predict the water cycle's role in climate variability and change
- Define improved observational networks for water isotopes in the atmosphere, ocean, and on land
- Establish water isotopes as an essential climate variable
- Identify challenges and advantages of incorporating stable water isotope physics in GCMs

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Phenomena, Observations, and Synthesis (POS) Panel

Linking Observations and Models

Workshop on Future of US's Earth System Reanalysis Effort
Fall 2021 in Boulder, CO

Co-chairs: Sergey Frolov (U. Colorado/NOAA PSL) &
Cécile Rousseau (USRA/NASA GSFC)

- Develop scientific and technological vision for next-gen US atmos and ocean RA
- Review status of modeling and DA infrastructure for RA generation
- Explore collaborations extending to crysosphere, land surface, atmos chemistry, and ocean bgc
- Experimental plans for strongly coupled DA and roadmap to coupled RA

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Process Studies & Model Improvement (PSMI) Panel

Aims to reduce uncertainties in general circulation models used for climate variability prediction and climate change projections through an improved understanding and representation of the physical processes governing climate and its variation

- Provide **feedback on process studies, promoting best practices**
  - Engaged >30 process studies over seven years
  - Provides feedback during planning, post-field synthesis, and sunset phases
  - Promotes best practices in climate model engagement and data sharing
  - Distills and shares lessons

from Sprintall et al. 2020

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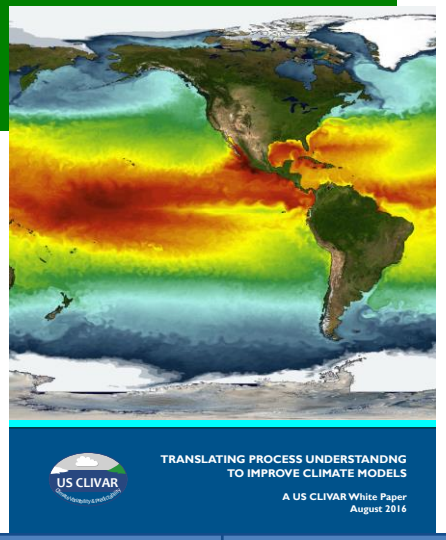
Process Study and Model Improvement (PSMI) Panel
Linking Observations and Models



- Evaluate success and lessons of previous Climate Process Teams and **need for future CPTs**
  - survey modeling center needs
  - capitalize on process studies
  - evaluate biases across models
  - develop and implement improved parameterizations and techniques

Title and Investigator Team	Objective	Sponsors
From Boundary Layer to Deep Convection: The Multi-Plume Eddy-Diffusivity/Mass-Flux (EDMF) Fully Unified Parameterization Joao Teixeira, Julio Bacmeister, Leo Donner, Rong Fu, Georgios Matheou, Mikael Witte, Marcin Kurowski, Kay Sušelj, Y.-H. Chen, Maria Chinita, Rachel Storer	To implement and evaluate a **new unified boundary layer and convective parameterization** in NCAR and GFDL models to improve spatial transition over ocean from stratocumulus to cumulus to deep convection and diurnal cycle over land from dry convection to shallow convection to deep convection.	NOAA, NSF
Improving Modeled Momentum Flux in the Atmospheric Boundary Layer Colin Zarzycki, Vince Larson, Ming Zhao, Leo Donner, Julio Bacmeister, George Bryan, Gunilla Svensson, Kate Thayer-Calder, Christopher Kruse, Xiaowei Zhu, Kyle Nardi, Joakim Pyykkö	To **parameterize momentum transport by prognosing subgrid momentum fluxes directly** and thereby improve representation of tropical cyclones, shallow cumuli, and low-level jets in climate models.	NOAA, NSF
Coupling of Land and Atmospheric Subgrid Parameterizations Nathaniel Chaney, Kirsten Findell, Po-Lun Ma, David Lawrence, Joseph Santanello, Paul Dirmeyer, Elena Shevliakova, Forrest Hoffman, Michael Ek, Gabriel Katul, Ming Zhao, L. Ruby Leung, Randall Koster, Jason Simon, Khaled Ghannam, Patricia Lawston, Abedeh Abdolghafoorian	To **parameterize the effects of sub-grid land heterogeneity on the atmospheric boundary layer and convection** and to characterize its implications for surface climate, variability, and extremes.	NOAA, DOE, NASA

Process Study and Model Improvement (PSMI) Panel

- Expand focus on coupled processes, including **interaction with land, stratosphere, cryosphere, biogeochemical processes**
- Evaluate the use of **new modeling capabilities**
  - eddy resolving ocean models and high-resolution atmospheric models
  - scale-aware parameterizations
  - machine learning and artificial intelligence applications

Emerging Data Science Tools WG (2019-2022) Co-chairs: Mike Pritchard (UC-Irvine) & Elizabeth Barnes (CSU)

- Foster understanding, adoption, and further development of modern data science tools, including machine learning and AI, for analysis of large-to-massive climate data sets
- Gather, prepare, and encourage use of benchmark training data sets
- Identify best practices for interpretability and predictive capacity

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Predictability, Predictions, and Applications Interface (PPAI) Panel

Coordinates plans to understand predictability of the oceans and climate across time scales, advance climate predictions and projections, and quantify/communicate skill and uncertainty

- Help improve subseasonal-to-seasonal (**S2S) predictions** and information products
  - continuation and use of S2S, SubX, NMME data
  - evaluating global-scale modes, teleconnections, and interactions
  - convection-permitting/resolving modeling and downscaling to capture precipitation features and extremes
- Advance **interannual to decadal predictability and predictions**

Workshop on Societally-Relevant Multi-Year Climate Predictions

Co-chairs: Matt Newman (NOAA PSL) and Ben Kirtman (U. Miami)

- Characterize processes spanning oceans, land surface, cryosphere driving multi-year predictability
- Highlight challenges for producing skillful predictions using ESMs
- Identify user/decision risk management needs to inform research
- Foster interagency and international collaborations

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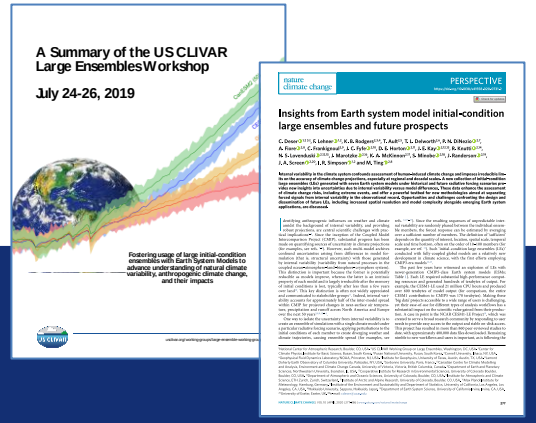
Predictability, Predictions, and Applications Interface (PPAI) Panel

- Understand **climate changes** across space and time scales – CMIP and Large Ensembles
- Coordinate efforts to **evaluate forecast uncertainty**



Large Ensembles WG (2018-2021)

Co-chairs: Clara Deser (NCAR) & Keith Rogers (Princeton U.)

- Establish multi-model archive & data repository (7 models)
- Assess the value of large ensembles for interpreting the observed climate record, evaluating internal variability and forced climate change, and estimating uncertainties in climate projections (Nature Climate Change Perspectives article – Deser et al. 2020)
- Organize observational large ensemble (future hackathon)
- Explore applications to climate impacts and risk assessment, terrestrial and marine ecosystems, and resource management through the use of dynamical and statistical downscaling methods

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Recap of Opportunities

- Grassroots community engagement
  - support of community-organized **workshops and working groups** (spring/fall wksp calls; fall WG calls)
  - enabling interdisciplinary collaborations
  - ensuring diversity in participation across organizational bodies and at workshops/conferences
- Define requirements for the ocean and climate **observing systems**
- Guide and promote best practices for **process studies**
- Promote **Climate Process Teams** to evaluate and improve climate models
- Coordinate **model experiments** to understand climate predictability
- Engage producers and users of **climate information** to inform research directions

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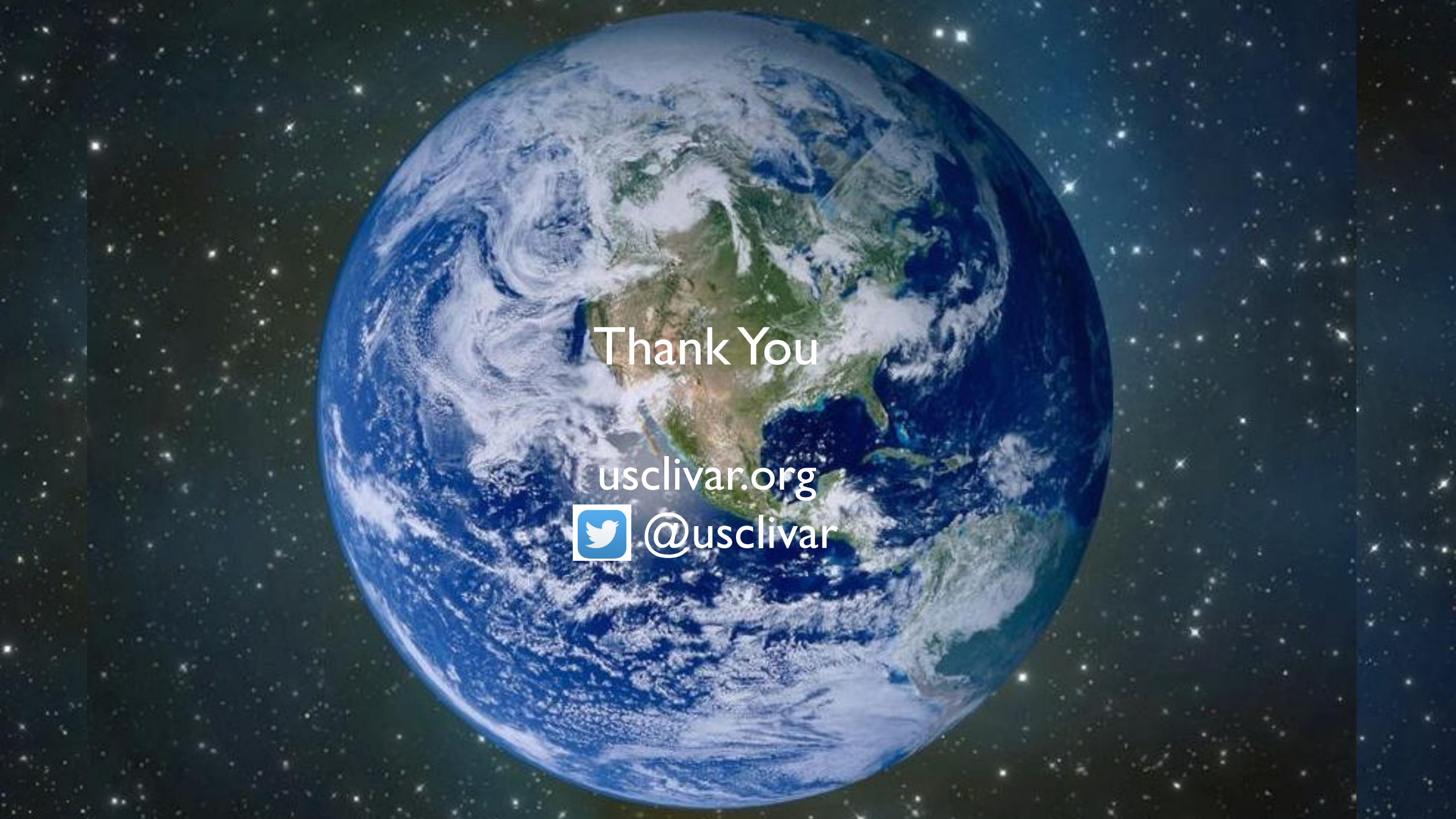
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