HYPERFACETS: IMPROVING ANALYSIS AND MODELING OF EARTH SYSTEM AND INTERSECTORAL DYNAMICS AT REGIONAL SCALES

The production of actionable climate science relies on effective communication of regional climate information and its associated uncertainties across sectors. To be of value beyond academic circles, climate data must be sufficiently credible (i.e., physically grounded), understandable (communicated in the vocabulary of the decision-makers), and useful for the particular decisions that need to be made.

Comprehensive assessment of both dynamical and statistical climate models adds substantial value to their outputs, particularly when the evaluation criteria are the product of a two-way dialogue between scientists and end-users.

Substantial progress has now been made on developing comprehensive frameworks for climate data assessment that incorporate process-oriented, feature-specific, and use-inspired metrics. These efforts have been particularly advanced over the contiguous United States (CONUS) under both the U.S. Department of Energy (DOE) Hyperion and FACETS projects. HyperFACETS represents the continuation of these endeavors.

Funding and Participating Institutions

The DOE's Office of Science sponsors HyperFACETS through the Regional and Global Model Analysis and MultiSector Dynamics program areas. Researchers comprise a diverse team from seven universities and three national laboratories.

- University of California, Davis
- Iowa State University
- Stony Brook University
- Cornell University
- University of California, Los Angeles
- Pennsylvania State University
- Utah State University
- Lawrence Berkeley National Laboratory
- Pacific Northwest National Laboratory
- National Center for Atmospheric Research

RESEARCH

HyperFACETS is advancing our understanding of regional processes at the atmosphere-water-energy-land interface, and consequently quantifying and improving our ability to perform credible climate modeling at regional scales across the contiguous United States.

Researchers are building an analysis framework on stakeholder engagement and the concept of storylines, allowing them to focus efforts on regions and periods where severe or unusual climatic conditions have framed historical decisions. An integrated and multi-pronged approach has been developed to achieve these goals:

1. **Engaging climate scientists and stakeholders** within working groups to build common understanding and strategy for achieving these goals. Guided by past stakeholder engagement through the Hyperion project, researchers are refining the engagement process from earlier work to understand how climate datasets are being used for specific decision applications.

2. **Developing a storyline** context to frame the assessment activities and provide a means to interface scientific pursuits with stakeholder interests effectively. A storyline is a physically self-consistent unfolding of a past event, a plausible future event, or pathway. Storylines are chosen to represent major climatic events that have impacted or would impact, the policy or decision context.

3. **Developing new metrics** and leveraging existing metrics to evaluate and understand modeled processes, and subsequently, inform credibility and uncertainty in light of a non-stationary climate system. Researchers are performing deep dives into weather extremes, snowpack, low-flows, and flooding regimes in rivers, water quality, and wind extremes. A key outcome will be the identification of process biases and errors that are most responsible for uncertainties in available products.

4. **Using differential credibility analysis (DCA)** to understand what aspects of predictions and projections of climate change are credible given the understanding of the processes and errors in these models. This process involves a broad assessment of model performance and will target the validity of climate datasets for decision making.

5. **Developing a deeper understanding** of multi-sector interactions (those at the climate-water-energy-land-decision interface), the interplay between global and regional climate forcings and implications for key aspects of energy supply using climate simulations conducted at a range of spatial scales for scenarios of changing land use, irrigation and energy mix.
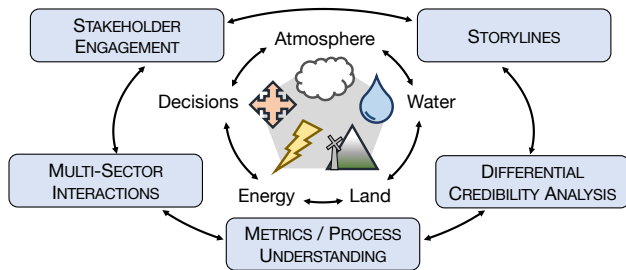
The HyperFACETS cooperative agreement works to improve and understand the credibility and usability of climate models and climate data sets in the context of the contiguous United States. By focusing on particular events of historical importance and understanding the sensitivity of those events to future change, we connect scientists and stakeholders and enable use-inspired science.
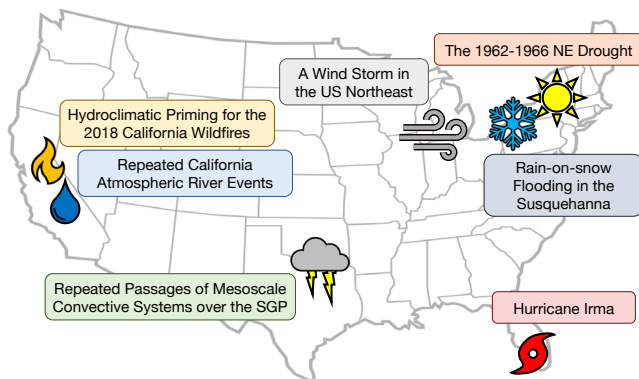
Key storylines being investigated under the HyperFACETS cooperative agreement, representing a broad sampling of hydroclimatic processes and geographic regions across the contiguous United States.
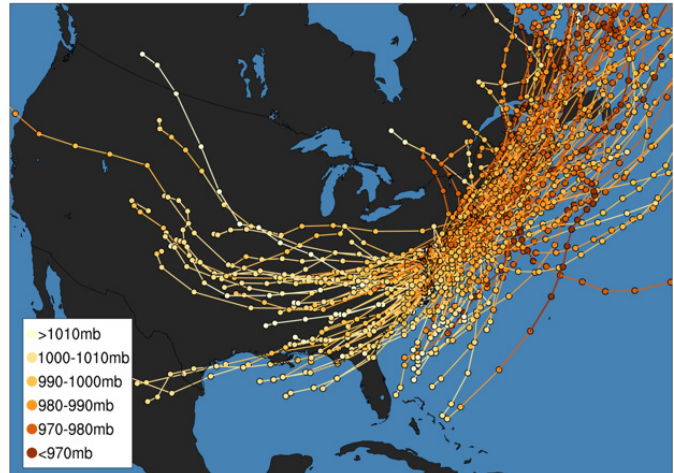
Tracks of all major snowstorms extracted from the CESM large ensemble (LENS) using tracking capabilities developed and refined under HyperFACETS.

ACCOMPLISHMENTS

Over the past three years, HyperFACETS and its predecessor projects have pioneered the development of a multitude of new metrics and model assessment capabilities and have identified key atmospheric processes and features with direct societal impacts. The innovative scientific efforts pursued by this project have resulted in more than 57 peer-reviewed publications and publicly available analysis toolsets.

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