Visualization & Data Analysis
in support of
NASA's Mission

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Advanced Computing @ NAS



Cloud Computing



Accelerator Technologies



SUPERCOMPUTING

Data Portals



Visualization, Data Analytics & Machine Learning



Disruptive Technologies (Quantum, ...)



NASA's Premier Supercomputer Center:

Hosted by the NAS Division at the Ames Research Center

Charter: to meet the supercomputing needs of all NASA's Mission Directorates

Over 600 science & engineering NASA related projects with more than 1,600 users across the nation & the world



Pleiades: 7.25 PF;
245,000+ cores



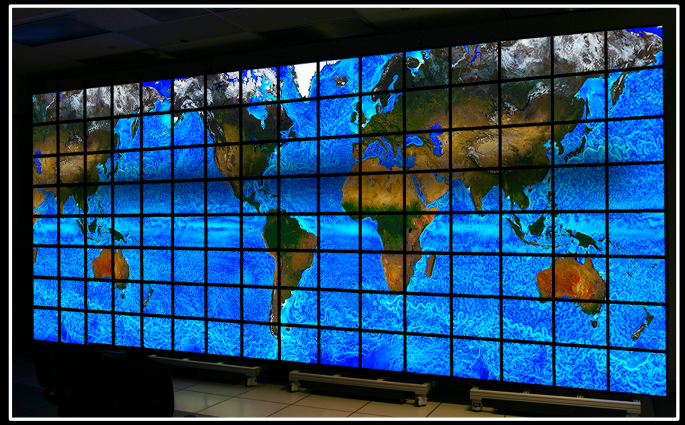
Electra: 8.32 PF;
124,416 cores



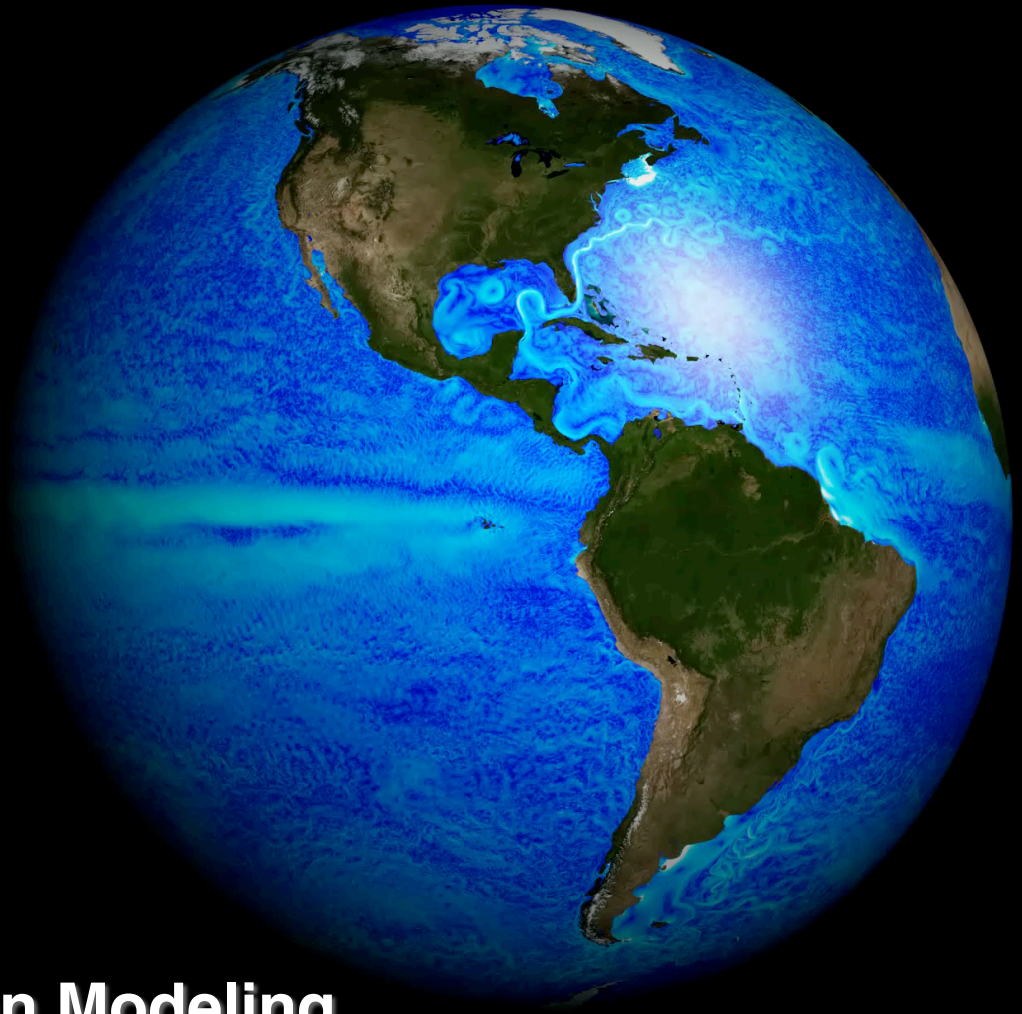
Aitken: 3.69 PF;
46,080 cores

Advanced Visualization

- ***Supercomputing-scale visualization system* to handle massive size of simulation results and increasing complexity of data analysis**
  - 8x16 LCD display (23 feet x 10 feet)
  - 245 million pixels
- ***Two primary modes***
  - Single large high definition image
  - Sets of related images (e.g. parameter study)
- ***High-bandwidth to HPC resources***
  - *Traditional Post-Processing*: Direct read/write access to Pleiades file systems eliminates need for copying large datasets
  - *Concurrent Visualization*: Runtime data streaming allows visualization of every simulation time step - ultimate insight into simulation code without increase in traditional disk I/O

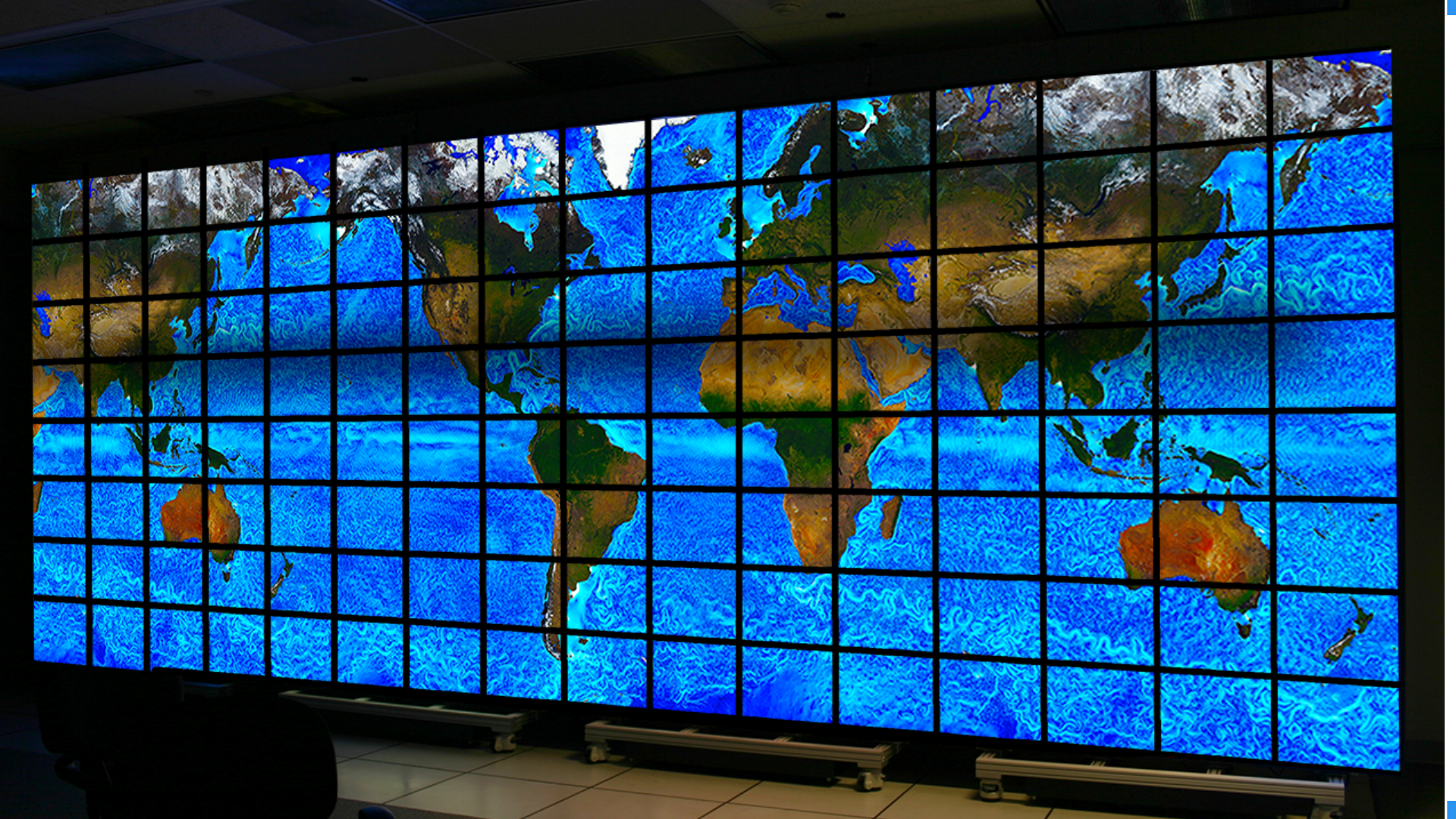






Global Ocean Modeling

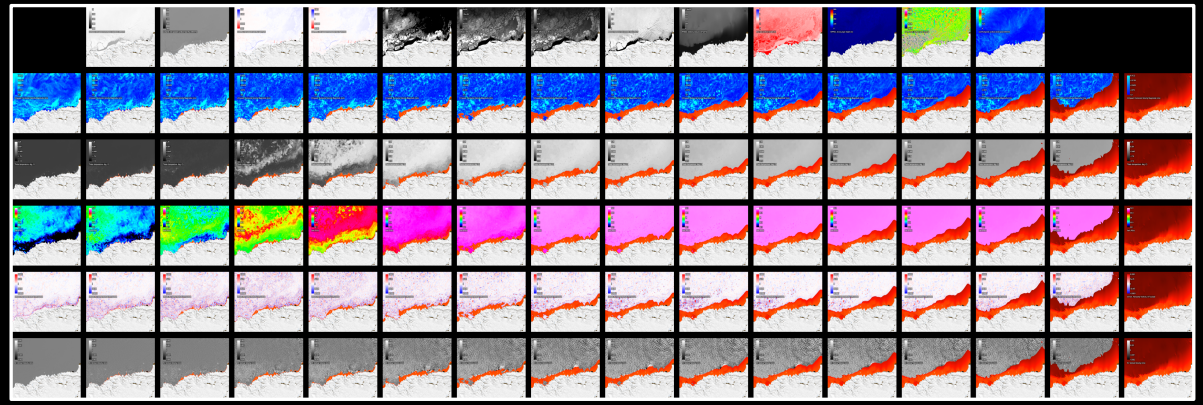
ECCO Consortium: MIT & JPL

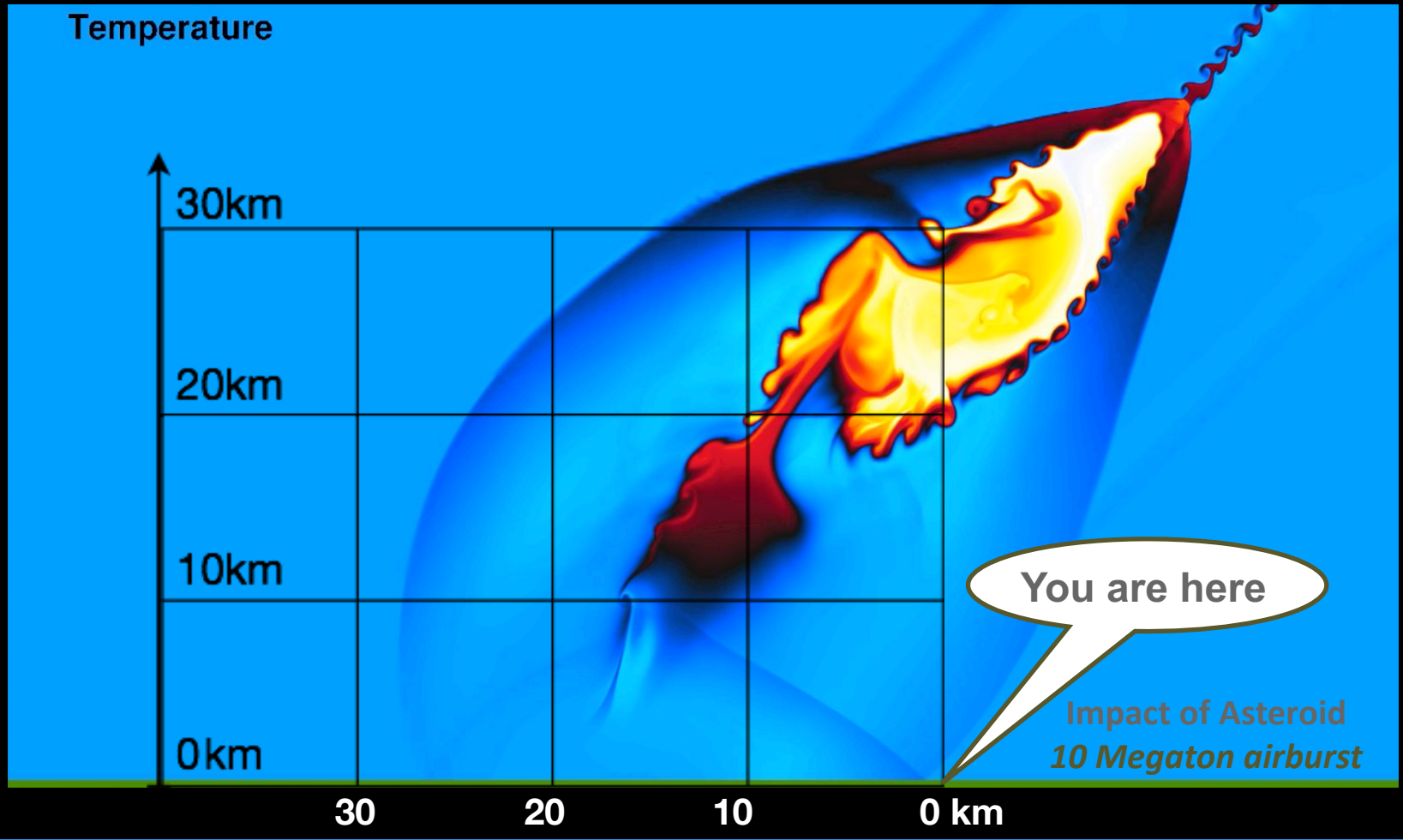




Depth analysis using a view showing multiple depths of a single north-south section of the globe - horizontal velocity magnitude around the Americas, with depth
increasing to the right. The orange is the ocean floor

Finding correlations made easy by showing all data for a given region; depth increases left to right for the 3D fields

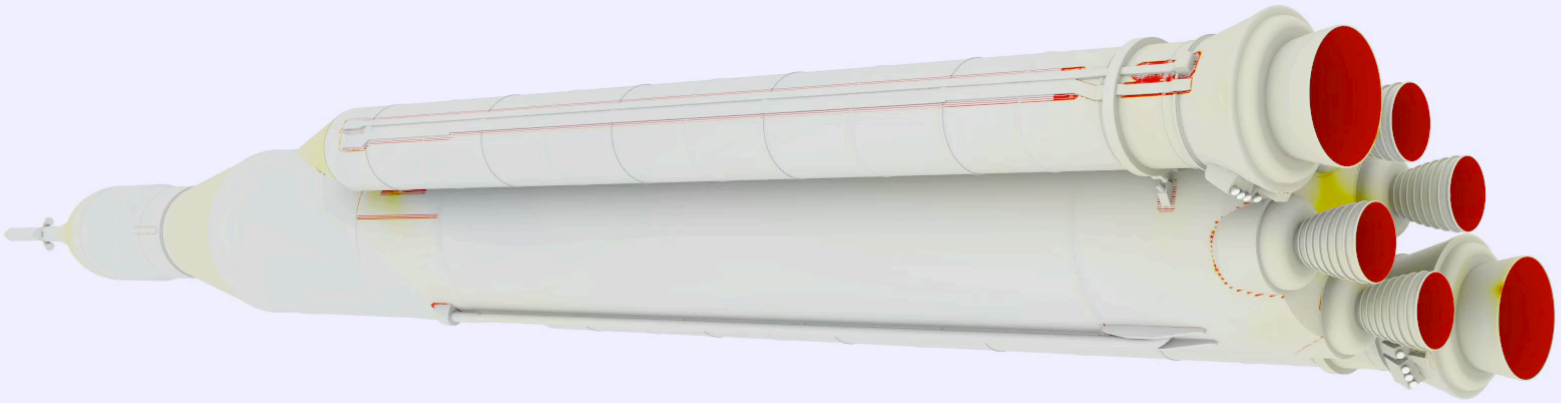



Temperature
30km
20km
10km
0km
30
20
10
0 km
You are here
Impact of Asteroid
10 Megaton airburst

Modeling the Launch Environment

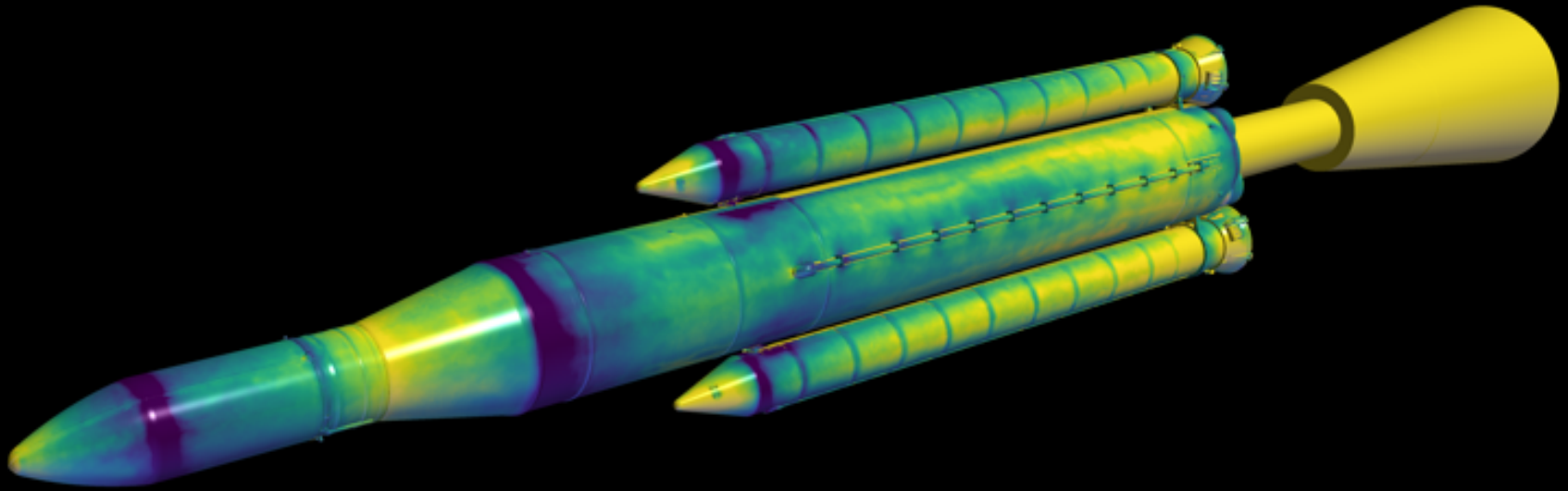


Space Launch System – Stage Separation

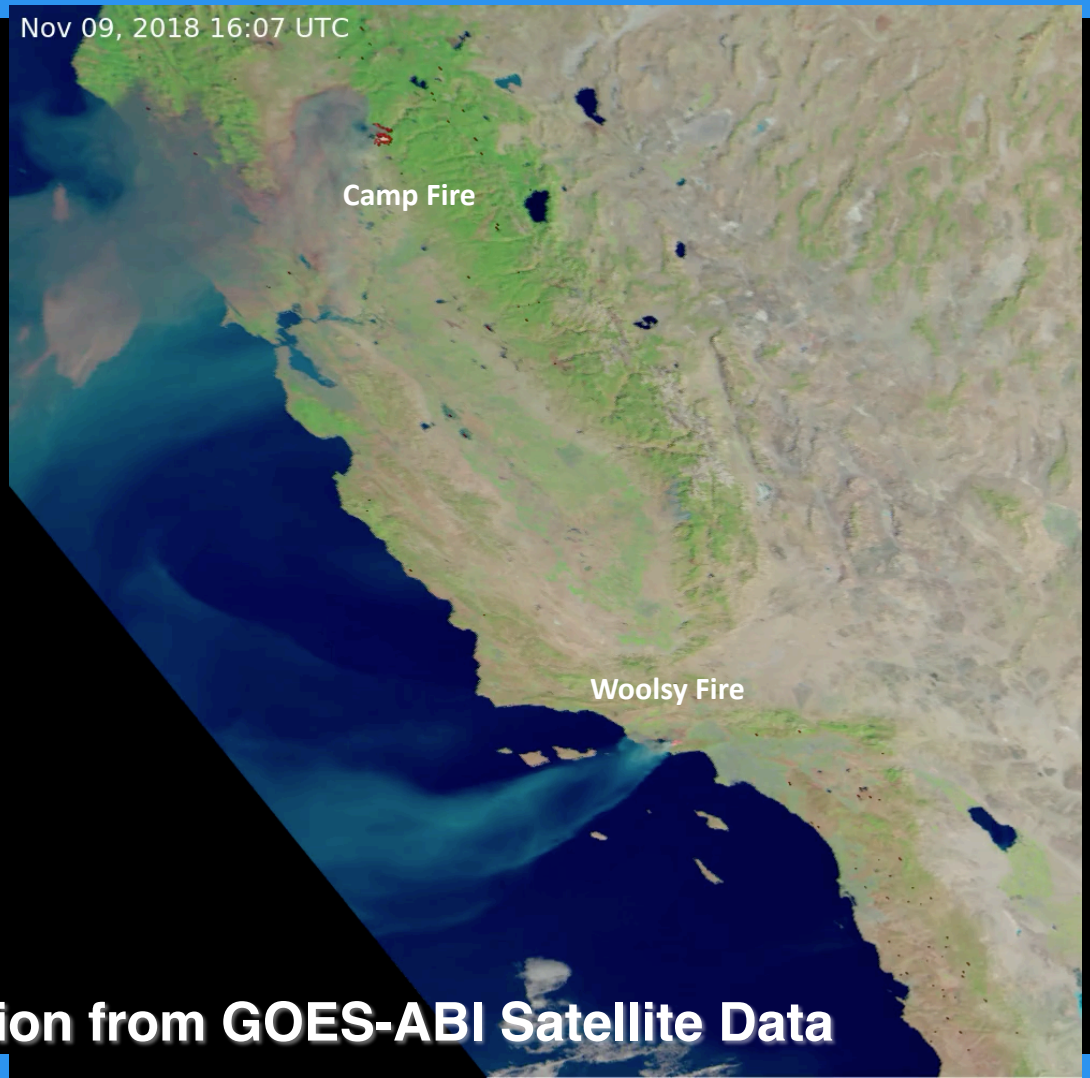


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Wind tunnel runs of SLS model using pressure sensitive paint to estimate pressure/loads



Near real-time analysis of test data using Supercomputer resources
with potential for computer-guided data acquisition



Fire detection from GOES-ABI Satellite Data

GEONEX, NASA Ames

Sample NASA AI/ML Projects

- **Feature detection**
  - Shock waves & vortices from flow data
  - Exoplanet identification from Kepler data
  - Artifact identification, e.g., trees, from satellite data
- **Prediction**
  - Solar flares/space weather from solar surface magnet fields data
  - Asteroid properties from light curves
  - Solar cells current-voltage properties from IV curves
- **Anomaly detection**
  - Aviation safety issues from flight data
  - Systems behavior, e.g., ISS control operations
  - Ammonia and CO2 concentration using carbon nanotube sensors on the ISS
- **Interactive assistants/robots that can learn for ISS crew**
- **Autonomous rovers**

- **Mission Support**
  - Email Classification/Records Management
  - Scientific Document Tagging
  - Network Traffic Anomaly Detection
  - Service Desk Ticket Analysis & Trending
  - Detect CUI* content in documents





NASA's Data Analysis Challenges



NASA data is increasing in volume and complexity from multiple sources: observational, simulation and experimental

- **Discovery**
  - Multi-petabytes of data with little metadata
- **Data Access & Management**
  - Siloed data with non-intuitive access interfaces/APIs
  - Distributed storage not co-located with computational resources
- **Tool/Algorithm development at scale**
  - One-off algorithms/tools/workflows with little support for sharing
- **Analysis infrastructure**
  - Heterogeneous hardware requirements
- **Workforce & Culture issues**

Agency-wide committees:
- Data Stratgey
- Digital Transformation

Questions?



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