



NASA Earth Exchange (NEX) in support of the NCA

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NASA Ames

June 22, 2015



NEX Goal

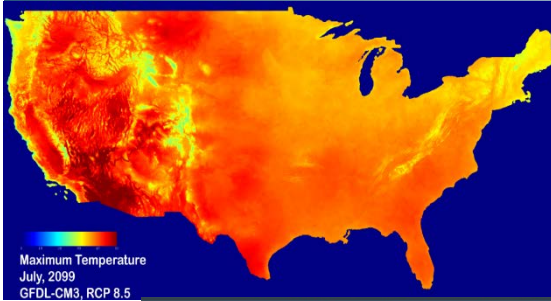


- **To engage and enable the Earth science community to address global environmental challenges**
- **To improve efficiency and expand the scope of NASA Earth science technology, research and applications programs**
- **How? Provide access to data, models, analysis tools, and scientific results through a supercomputing/cloud platform that fosters knowledge sharing, collaboration, and innovation.**

A satellite image of Earth showing the Western Hemisphere, including North and South America, the Atlantic Ocean, and parts of Europe and Africa. The image is a circular view of the planet from space, with the blue of the oceans and the green and brown of the continents clearly visible. The curvature of the Earth is evident at the edges.

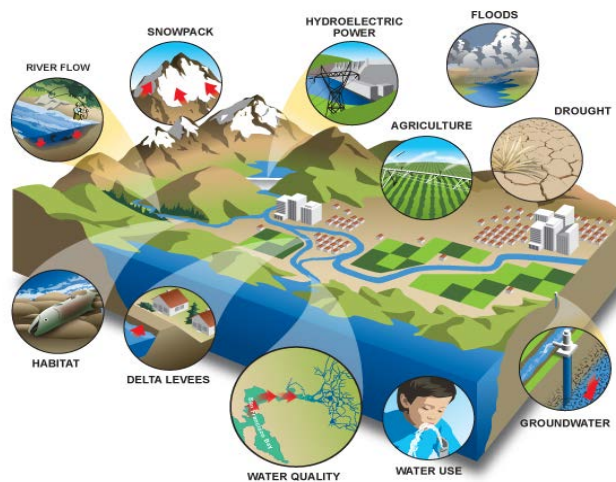
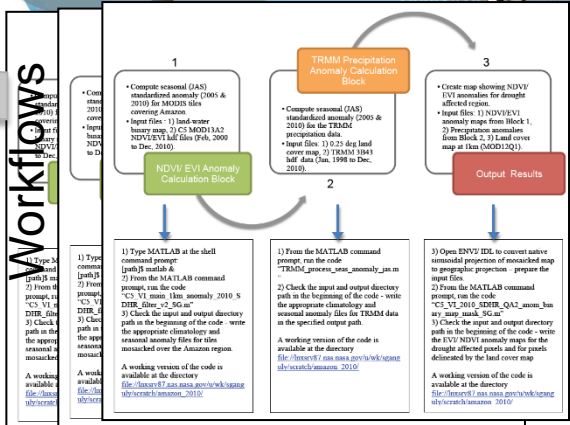
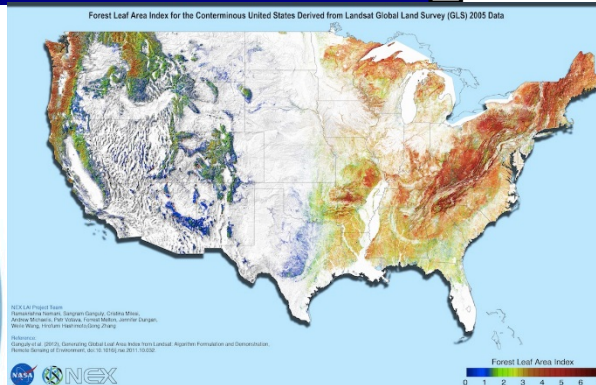


Climate modeling



Downscaling

Promoting consistency, repeatability, and transparency in global change science



Modeling impacts



NEX Resources available to the community



Data sets:

- 35 CMIP5 model outputs
- 30 yr AVHRR (1981-2011)
- 1972-2012 Landsat (over 1.8 million scenes)
- CMIP5 data (NEX-DCP30 and NEX-GDDP)

Models (used by the NEX community):

Biome-BGC	CAM/CCSM	TM5
LPJ	WRF	STILT
TOPS-BGC	ROMS	WRF/CHEM
VIC		
RegCM		

Tools

- UV-CDAT visualization
- VisTrails workflow management
- R, Python, Matlab, IDL, ...



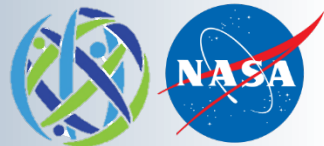
Outline



- 1) Support for derivation and distribution of high spatial resolution climate projections**
- 2) Climate impact modeling**
- 3) NCA community engagement and support in use of NEX and NEX datasets**
- 4) Plans**
- 5) Summary**



1) Support for derivation and distribution of climate projections



- NEX-DCP30 update (conterminous US, monthly)
- NEX-GDDP (global, daily)
- Related downscaling activities



NEX-DCP30



USGCRP proposed the following criteria for developing Climate Scenarios for the Sustained Assessment Process (including NCA4):

1. *State-of-the-art science basis (essential)*
2. *Vetted in the scientific literature (essential)*
3. *Daily or higher time resolution (highly desirable)*
4. *Temporal coverage continuous through 21st Century (highly desirable)*
5. *Spatial coverage includes at a minimum the continental United States (CONUS) (highly desirable)*

The NEX-DCP30 dataset meets most of the above criteria (except for #3) and is proposed as one of the three “prime candidates for use as NCA4 scenario information”. (In addition, the newly released NEX-GDDP dataset is of daily time resolution and thus supplements NEX-DCP in meeting the corresponding requirement.



NEX-DCP30 Update



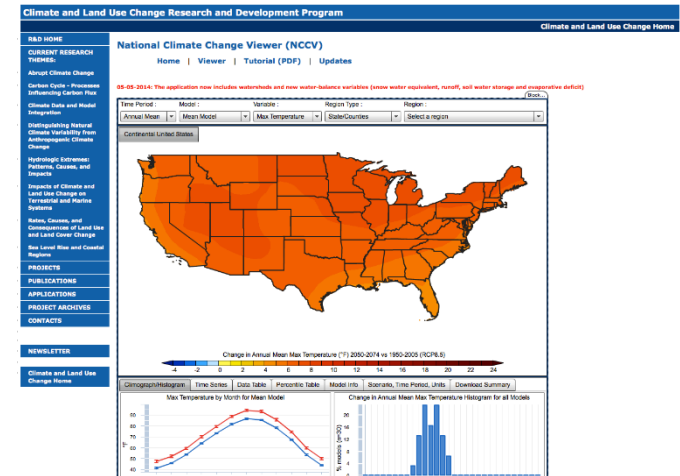
- Created a revised version of the dataset (V2) to correct minor issues in workflow used to prepare V1 (associated errors of $< 0.1\%$ affecting a total of 1.7% of pixels)
- Updates to V1 to be replaced at NCCS with V2
- Updates to NEX-DCP30 page on the NEX Portal
- Update to TechNote
- Notification of update to NEX-DCP30 users at Google, USFS, EPA, NPS, and USGS.

NEX-DCP30 Derivative Products and Uses



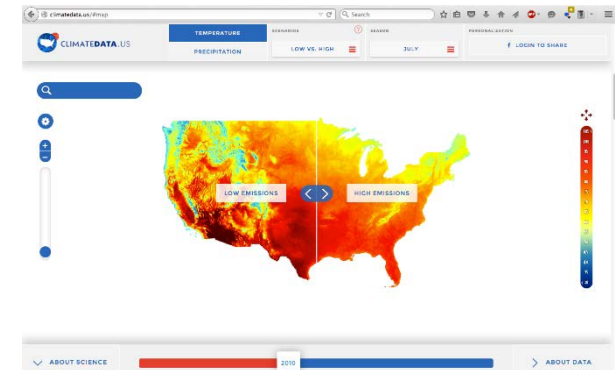
Examples of uses of NEX-DCP30 data to date by NCA community include:

- Calculation of county-level summaries and water balance variables by USGS for National Climate Change Viewer
- USFS vapor pressure deficit scenarios for forest management planning
- EPA reference evapotranspiration scenarios
- NPS analysis of climate trends for US national parks
- Web visualization portal developed by Habitat Seven with support from Packard Foundation
- Retrieval of NEX-DCP30 by Google Earth Engine → analyses ongoing



USGS National Climate Change Viewer

http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp



ClimateData.us



NEX-GDDP



CMIP5 archive downscaled using the Bias Correction and Spatial Disaggregation (BCSD) approach (Wood et al., 2002; Thrasher et al. 2012)

Global daily temperature and precipitation scenarios from 1950-2100 at 0.25 degree spatial resolution (~25km x 25km)

21 coupled General Circulation Models (global climate models)

2 Representative Concentration Pathways (RCPs) - RCP 4.5 and RCP 8.5

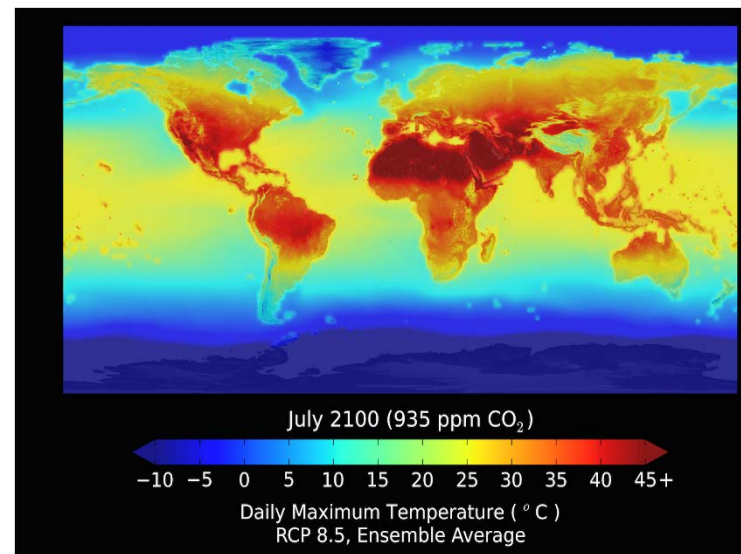
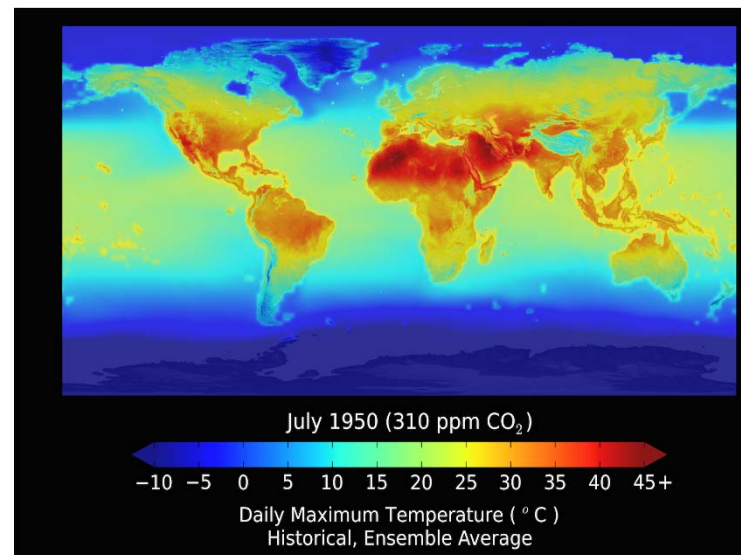
12 terabyte dataset available via THREDDS at NCCS; visualizations developed by OpenNEX community and available at www.climateinternational.org

Used ~50,000 SBUs on Pleiades

More information available at:

<https://cds.nccs.nasa.gov/nex-gddp/>

<https://nex.nasa.gov/nex/projects/1356/>





Dataset Release June 9



- **White House press release:**

<https://www.whitehouse.gov/the-press-office/2015/06/09/fact-sheet-launching-public-private-partnership-empower-climate-resilien>

- **Press release at NASA HQ**

<https://www.nasa.gov/press-release/nasa-releases-detailed-global-climate-change-projections>

- *63 news articles according to Google News Search*

- **NEX portal posted largest-ever back-to-back daily incoming traffic for every day between 6/9 and 6/19:**

- *Almost 3,500 average visitors per day with peak at 6,500*
- *Visitors from 125 countries*
- *522 links from external web pages to the portal*

- **OpenNEX site with additional information and training materials:**

- *5,724 sessions started by 5,388 users*



Perfect Model Experiment



We have been working with Dr. Keith Dixon (GFDL) to set up a "Perfect Model" experiment on NEX to characterize uncertainty stemming from assumption inherent in most methods of statistical downscaling of climate projections.

Three downscaling algorithms are being tested in this experiment

BCSD

BCCA

LOCA, developed by David Pierce of SIO

In particular, we have developed a set of metrics to quantify theoretical downscaling uncertainties introduced by different sub-processes:

Bias Correction

Spatial Disaggregation

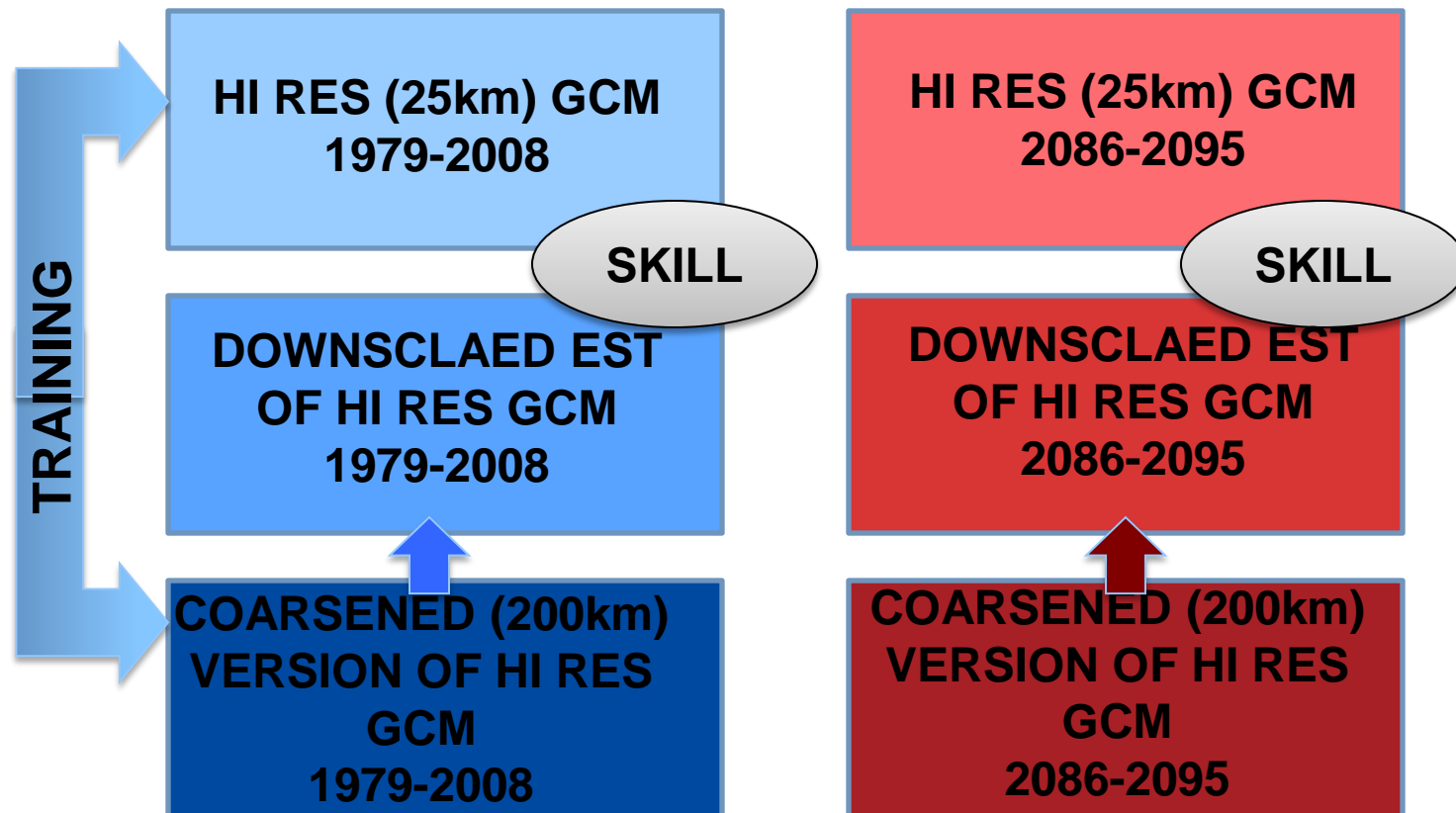
Stationarity Assumption



Perfect Model Experiment



The idea of the PM experiment is to use high-resolution model simulations as proxies of (past and future) observations and use low-resolution model simulations as normal GCM outputs. It then uses downscaling algorithms to "downscale" the low-res model data to high resolution. The (temporal and spatial) uncertainties of the downscaled data can then be quantified through comparisons with the pseudo observations.





Dynamic Downscaling



- **Objectives:** To explore the skills and the potentials of climate downscaling with regional climate models over the US, with a focus on climatic phenomena of Atmospheric Rivers, Mesoscale Convective Systems, and North-East Winter Storms.
- **Models:** NASA Unified – WRF (NU-WRF) regional climate model constrained with NASA MERRA2 reanalysis dataset;
- **Spatial Domain:** A domain of $\sim 8000\text{km} \times \sim 4000\text{km}$ that includes continental US and adjacent oceans. Simulations are conducted at 24km, 12km, and 4km resolutions;
- **Time Period:** 10 years from 11/01/1999 to 01/01/2010, with full 3D atmospheric fields saved at 3-hourly steps and selected variables saved at hourly steps;
- **Nudging and Microphysics:** Simulations at each spatial resolution are conducted with and without spectral nudging. Convective precipitation is directly simulated at 4km resolution with the cumulus cloud scheme turned off.



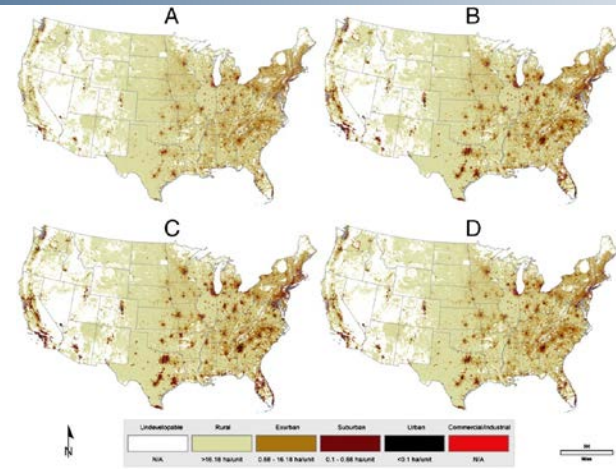
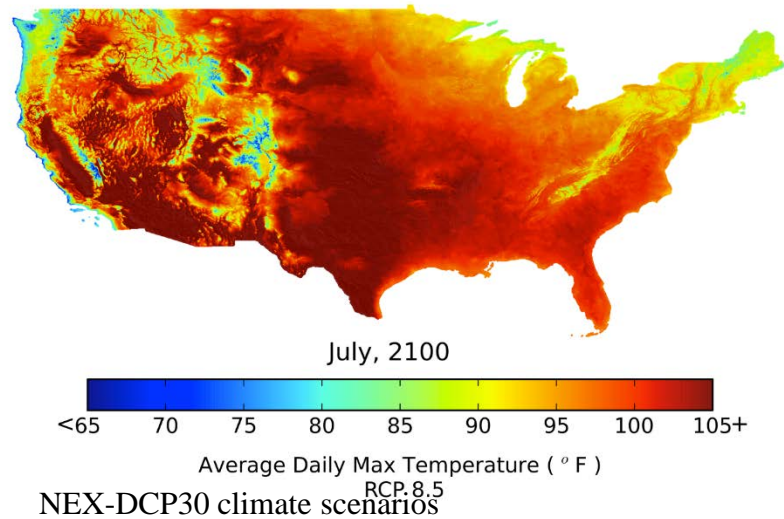
2) Climate Impact Modeling



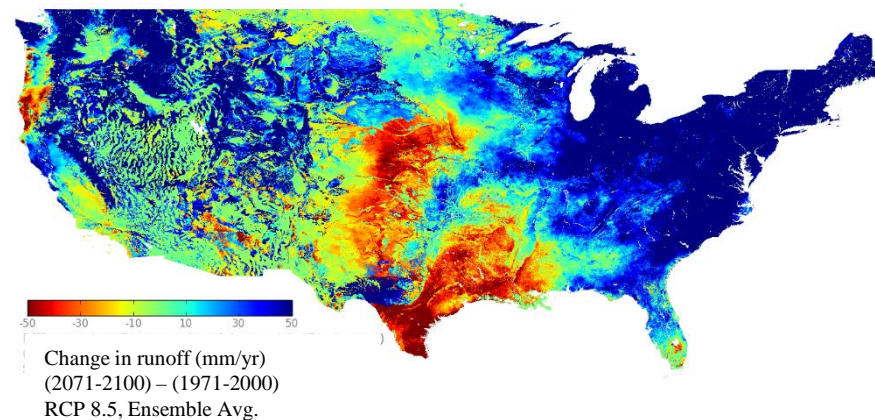
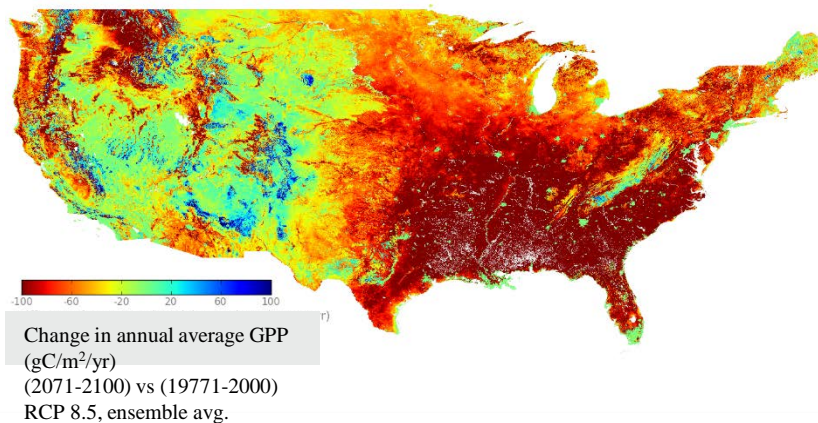
- Through engagement with
 - *NPS*
 - *Montana State*



Modeling Impacts of Climate and Land Use Change on Ecosystem Processes on NEX with TOPS



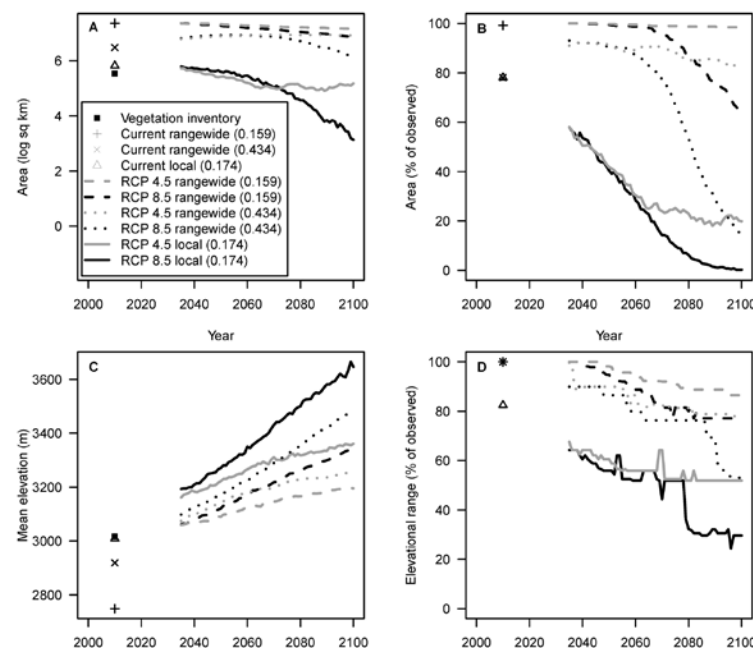
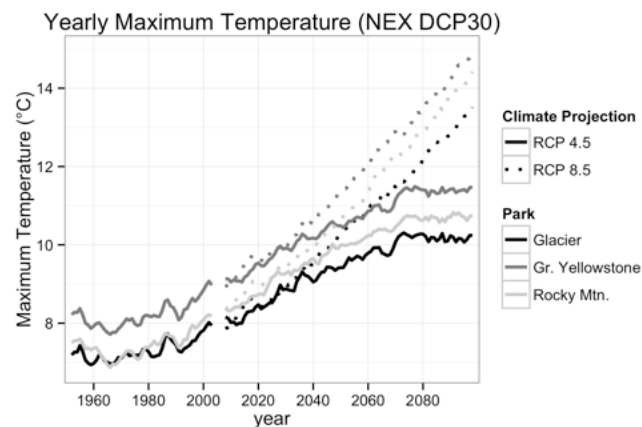
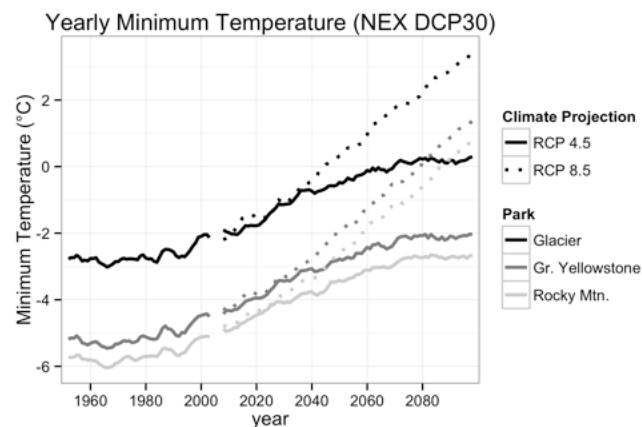
SERGoM land cover change scenarios for ISA



Integration of climate and land use scenarios to assess trends in key ecosystem variables



NPS Analysis of Climate Patterns and Shifts in Range of High Priority Species for Park Managers



Predicted shifts in Limber pine distribution; Monahan et al., 2013, PLOSONe

Example of climate summaries being computed for US National Parks (Gross et al., in review)



3) NCA Community Engagement



- List of collaborators
- NEX on the Amazon cloud
- INCA Project Support



Community Engagement



Academic Institutions

1. Walter Jetz, Yale University
2. Andy Hansen, Montana State U
3. Y.Q. Yang, U of RI
4. R. Waring, Oregon State
5. Steve Running, U of Montana
6. Scott Geotz, WHRC
7. Debbie Huntzinger, U of Northern Arizona
8. John Kimball, U of Montana
9. Ranga Myneni, Boston U
10. Chengquan Huang, UMD
11. Ed Maurer, Santa Clara U
12. Randy Wynne, Virginia Tech
13. Balaji Rajagopalan, U of Colorado
14. Jonathan Overpeck, U of Arizona
15. Dan Cayan, Scripps Inst. Of Oceanography
16. David Roy, South Dakota State U.
17. Ralph Keeling, Scripps Inst. Of Oceanography
18. Rong Fu, U of Texas

Federal Agencies/labs

19. USGS, Jeff Morisette, Prasad T.
20. NOAA, Eric Danner, Keith Dixon
21. NOAA/ESRL, Andy Jacobson
22. USBR, Levi Brekke
23. USFS, Warren Cohen, Jessica Haas
24. EPA, Don Hodge
25. USFWS, Tom Oliff
26. CASI team, Cristina Milesi
27. NPS, John Gross

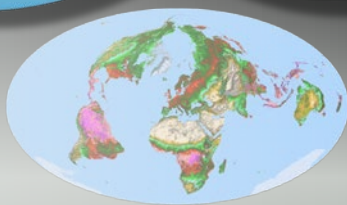
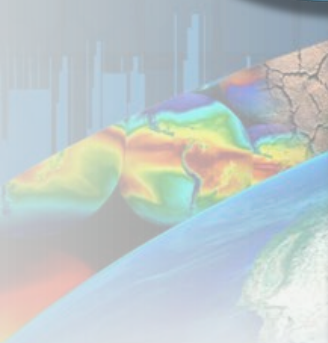
Non-Profit

28. Climate Central, Bridget Thrasher
29. John Musinsky, Conservation International
30. Habitat 7, Jamie Herring

NEX on the Amazon Cloud

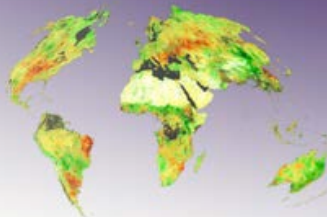


Open Access to Data, Virtual Labs,
Lectures, Computing and More ...



AVHRR
R

MODIS



LANDSAT

Data for
Climate
Assessment



OPENNEX

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NEX on the Amazon Cloud



- Renegotiating the Space Act Agreement with Amazon Web Services
- NEX-DCP30 and NEX-GDDP data available in the public cloud
- Adding video tutorials
- Adding machine images for
 - *Accessing the data*
 - *Calculating summaries*



INCA Project support



- 9 proposals requested use of NEX
- Supported INCA teams in scoping use of NEX resources for proposals
- Currently planning training activities for INCA teams and other new NEX users
- Working on allocation management strategies to minimize resource use conflicts on NEX



4) Plans for 2015



- **Expanding and improving NEX collections of high-resolution climate datasets**
- **Customizing and dedicating NEX capabilities for the Climate Change Indicators program**
- **Promoting broad NCA community engagement and collaborations through Amazon Web Services**
- **Climate change assessment with Landsat data**



5) Summary



- **Created/compiled 12 TB of scientific data and continued assisting with development of scientific models and analysis tools on NEX**
- **Engaged and provided technical support to ~30 research teams**
- **Continuing to develop the OpenNEX platform through collaborations with Amazon Web Services to bring the NEX capability to a broader audience**
- **Continuing collaborations on impact modeling including at the Landsat scale to assess ecological impacts of climate changes in specific regions**



Questions?





Thank you

<https://nex.nasa.gov>

<https://nex.nasa.gov/OpenNEX>