OSCER
State of the Center

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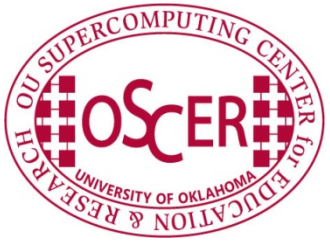


Wednesday September 29 2021
University of Oklahoma

Happy Anniversary!

- Aug 31 2021 was our 20th anniversary as a supercomputing center.
- Thank you for 20 amazing years – the best is yet to come!
- If we've done good by you, let us and the higher-ups know!

Use Our Ugly Symposium Website!

Our ugly Symposium website

http://symposium2021.oscer.ou.edu/

has a complete agenda and speaker information.

It's so ugly that it's optimized for phones and tablets.

We encourage you to use it!

Preregistration Profile 2021

- **Organizations**: 552 preregistered (and/or speaking) from 47 US states and 3 US territories, plus 4 other countries
  - **Academic**: preregistered 180 institutions
    - Includes 61 academic institutions in 22 of 28 EPSCoR jurisdictions
  - **Industry**: preregistered 28 private companies
  - **Government**: preregistered 18 agencies (federal, state, tribal, non-US)
  - **Non-governmental/not-for-profit**: preregistered 20 organizations
- **Demographics**: 552 preregistered (and/or speaking)
  - 15% OU, 85% non-OU (or unknown)
  - 33% Oklahoma, 67% non-Oklahoma (or unknown)
  - 51% from EPSCoR states, 49% non-EPSCoR (or unknown)
  - 82% academic, 18% non-academic (or unknown)

Attendee Profile 2002-2020

- Over 5000 attendees at the previous 19 Symposia
  - 69 in 2002, 175-350 per year thereafter, typically 275±25, except 2020 was 500+
- Organizations: 362 2002-2019
  - **Academic**: from 295 institutions in 50 US states & territories plus 10 other countries
    - 66 institutions in 12 EPSCoR jurisdictions
    - 35 institutions in Oklahoma
      - PhD-granting, masters-granting, bachelors-granting, community colleges, career techs, high school
      - Historically Black University, Tribal College, Native American Serving Non-tribal Institutions
      - public, private, for-profit
  - **Industry**: from 202 firms
  - **Government**: from 48 agencies (fed, state, municipal, tribal, non-US)
  - **Non-governmental/not-for-profit**: from 30 organizations

Symposium 2004-19 Sponsors: Thank You!

- Sponsors: 98 commercial, 7 non-commercial

Thank you all! Without you, past Symposia couldn't happen.

Of our 98 commercial sponsors, half have repeated (and/or were acquired by or merged with other sponsors).

Thanks!

- OU IT
  - OU CIO David Horton
  - OSCER Operations Team: Dave Akin, Patrick Calhoun, Kali McLennan, Jason Speckman
  - OSCER Research Computing Facilitator: Horst Severini
  - Jeremy Hessman, OU IT, for Zoom license help
  - All of the OU IT folks who helped put this together

Thanks: Plenary Speakers

- Margaret Martonosi, National Science Foundation
- Lynne Parker, National AI Initiative Office and
  Office of Science & Technology Policy, The White House
- Katherine Riley, Argonne National Laboratory
- Dan Stanzione, Texas Advanced Computing Center,
  University of Texas at Austin
- Thirumalai (Venky) Venkatesan, University of Oklahoma

Thanks: Panel/Roundtable

- Kim Owen,
  North Dakota State U
- Natasha Pavlovikj,
  U Nebraska Lincoln
- Christina Roberts,
  U Missouri Columbia
- Kendra Dresback,
  U Oklahoma
- David Jahn,
  NOAA Storm Prediction Center
- Dimitrios Papavassiliou,
  U Oklahoma
- Patrick Skubic, U Oklahoma
- Louis J. Wicker,
  NOAA/OAR National Severe Storms Laboratory

Thanks!

To all of your for participating, and to those many of you who've shown us so much loyalty over the past 19 years.

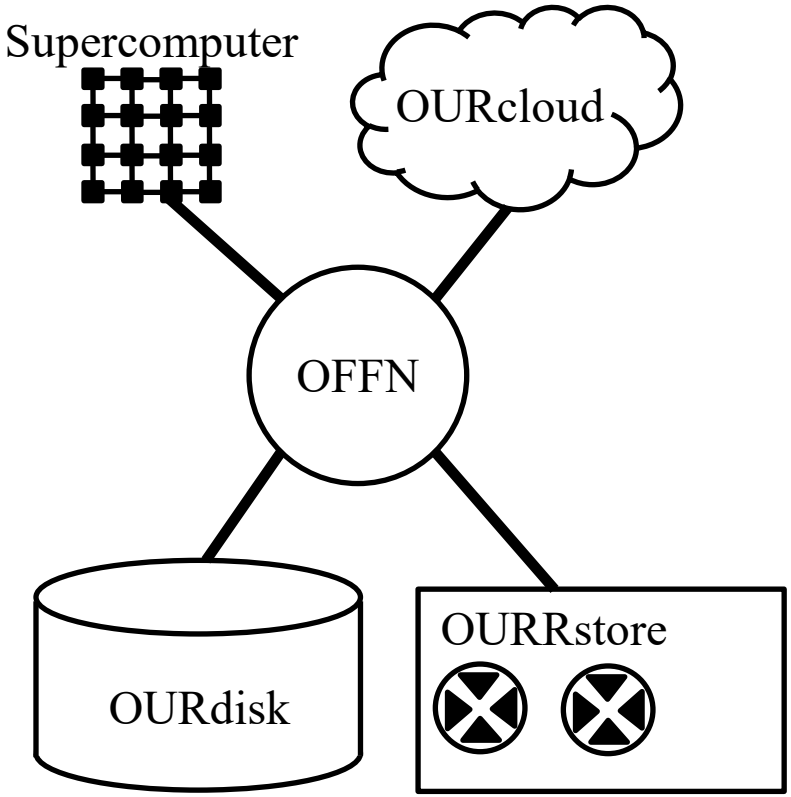
Outline

- OU
  - Resources
  - Upcoming Resources
  - Accomplishments
- OCII/OneOCII

Resources

OSCER Resources

Deploying/Upgrading 5 Major Systems This Year!



OSCER Resource Summary

- **Supercomputer Refresh**
  - We've purchased network, storage and support servers – being deployed now.
  - We'll purchase a bunch of compute servers this fall.
  - Initially includes 4 OSCER-owned A100 GPUs and (11 user-owned A100 GPUs); more coming.
  - "Friendly user" mode expected in spring 2022.
- **OU Research Cloud (OURcloud)**: New supercomputer includes OURcloud hardware/software refresh.
- **OU Research Disk (OURdisk)**
  - Friendly user mode **NOW** (more features coming).
  - Available **NOW** locally at OU Norman, soon at OUHSC.
- **OURRstore Tape Archive**
  - Friendly user mode **NOW** (but valuable features still to come).
  - Developing control scripts etc now.
- **OneOklahoma Friction Free Network (OFFN)**: deploying new OU instance now.
- **HIPAA Enclaves for all of these in c. 2022**: Planning underway with OU IT Governance, Risk & Compliance team and OU IT Security Operations team.
- **OSCER Team**: Hiring a new Research Computing Facilitator now.

Supercomputer

Old Supercomputer (Starting Point)

Peak speed: 537 TFLOPs* (base), 730 TFLOPs (max turbo)

*TFLOPs: trillion calculations per second

705 compute nodes

1408 CPU chips: Intel Xeon
"Ice Lake," "Skylake," "Cascade Lake,"
"Rome," "Haswell," "Broadwell,
"Knights Landing," "Sandy Bridge"

16,608 CPU cores

45 TB RAM

500+ TB global public disk

3 PB global condominium disk

Mellanox FDR10 Infiniband
(3:1 oversubscribed, 13.33 Gbps,
~1 microsec latency)

Dell N-series Gigabit/10G Ethernet

CentOS 7.8

52% of the nodes are "condominium"
(owned by individual research teams).

schooner.oscer.ou.edu

Photo: Jawanza Bassue

New Supercomputer Status

- **ETA**: Friendly user mode spring 2022, full production summer 2022.
  - Gradually shift compute components from the old one to the new one.
- **Schooner Compute Hardware**: Most of the old supercomputer (Schooner) compute nodes will move to the new supercomputer, and new compute nodes will be bought starting this summer.
- **Support Hardware**: Network switches, storage and support servers have been purchased, are physically deployed, and are being installed.
  - Infiniband: New Lake/EPYC nodes have HDR100, old have FDR10, EDR super-core links them.
  - Storage: /home and /scratch will be Ceph parallel filesystem, like OURdisk; OURdisk will be mounted; all-SSD for "burst buffer."

New Supercomputer Purchasing

Change in Purchasing Approach

- No leasing => rolling year-by-year additions.
  - We used to do a "forklift upgrade" that took the old supercomputer out shortly after the new one came in, but we can't do that any more.
- Retain old (2015) supercomputer hardware (Haswell/Broadwell) in production through ~2024 (no capacity loss in the meantime, more bang per buck per node).
- This year, we've bought very little compute, but some A100 GPUs (for AI/ML), networks, storage, support components.
  - Includes Infiniband network bridge between old FDR10 40 Gbps and new HDR 100/200 Gbps.
  - Includes Infiniband-to-Ethernet network gateways for storage, especially OURdisk (which isn't part of the supercomputer, strictly speaking).
- Still increased general-use core count by 20% this year.
  - Except for a couple weeks at the start of the semester, few jobs pending for more than 48 hours.

Condominium

- **Buy**: OU users can buy "condominium" nodes any time!
  - You buy the node and a few cables, OU's COI sponsors space, power, cooling, network (including internal networks) and labor.
  - Good for the current supercomputer and its immediate successor.
- **Pricing** is available on request:
  - **NOW**: Compute nodes with Intel Ice Lake, AMD Rome/Milan.
  - **NOW**: NVIDIA GPUs (A100 strongly recommended).
- **Upcoming** Options
  - **COMING**: Compute nodes w/ Intel Sapphire Rapids, AMD Genoa.
  - **COMING**: "Ampere Next" GPUs.
- **Storage**: See OURdisk.
  - No new standalone diskfull nodes.

OU Research Cloud (OURcloud)

OU Research Cloud (OURcloud)

- OURcloud: Virtual servers as physical server replacement.
- Available in portions of 16 GB + 2 virtual CPUs.
  - RAM is slightly undersubscribed ($^{7}/_{8}$).
  - Physical CPU cores are oversubscribed (3:1).
  - Good for at least 5 years.
- You get a virtual server, paying only the hardware cost.
  - OU's CIO sponsors space, power, cooling, network, extremely basic labor (basic setup, basic monthly maintenance).
- **Pricing**: Coming soon!

OU Research Disk (OURdisk)

OU Research Disk (OURdisk) #1

- **Researcher's Price**: Under $1000 per ~9.3 TB portion (minimum buy-in) = < $100 per usable TB, good for 5 years
  - Least expensive research disk offering in OU IT history!
- **Speed**: 14+ GB/sec: fastest research spinning disk offering in OU IT history!
- **Size**: Initially 3.8 PB @ OU Norman, 3.8 PB @ OUHSC; each grows as needed.
  - **Already committed**: ~2.8 PB (~74%)
- **Status**: Currently in friendly user mode, on supercomputer only.
- **ETA**: Full production fall 2021.
- **Where Available**
  - Already mounted on the supercomputer.
  - Tested on Meteorology server computers in the National Weather Center.
  - Will be mounted on other OU IT/non-IT systems on OU campuses.
    - Inside Norman 4PP and OUHSC data centers: very fast (14+ GB/sec).
    - Outside Norman 4PP and OUHSC data centers: much slower.

OU Research Disk (OURdisk) #2

- Each of OU Norman and OUHSC will have a purely local partition.
- There'll be a mirrored partition on both campuses for dual copies.
  - We expect non-mirrored to be popular because mirrored will cost double.
- Identical initial hardware at each of OU Norman and OUHSC:
  - Capacity: ~3.8 PB usable per campus:
    17 × diskfull server @ 24 × 16 TB spinning drives + 2 × SSD for metadata;
    5 × metadata servers
    - Each campus's storage capacity will grow with demand on that campus.
  - Resiliency: 8 + 3 "erasure coding" (better than RAID6) at the server level,
    so up to 3 simultaneous failed servers or drives would be invisible to users.
    - We wrote a disk drive failure simulator that showed many double failures,
      very few triple failures (0.1% chance per 5 years), no quadruple failures.
  - High speed network: 4 × 25GE switches per campus (2 world-facing, 2 back-facing)
    (plus 2 × GigE switches per campus for management)
  - Science DMZ Research-only Network: OU Norman 25GE switches
    uplinked to 100GE OneOklahoma Friction Free Network (OFFN) switches;
    similar at OUHSC soon.

OU & Regional Research Store (OURRstore)

New OURRstore Tape Archive #1

- **OU Regional & Research Store: Giant robotic tape archive**
- Business Model: NSF MRI buys HW/SW, researchers buy tapes, CIO covers space/power/cooling/network/labor/maintenance (same business model as PetaStore).
  - Currently ~$45 per LTO-7 "Type M" tape cartridge (~7.65 TB usable) => ~$12 per usable TB dual copies, good for OURRstore's lifetime (8+ years)
- Tape Cartridge Slots: Initially ~11,000, will double this coming year.
- Tape Drives: Initially, ~1.8 GB/sec in aggregate (6 × LTO-8 @ 300 MB/sec/drive) – almost double PetaStore's!
  - LTO-8 drives can read and write LTO-7 "Type M" and LTO-8.
  - Later, we'll add 4 × LTO-10 (or LTO-9) tape drives (can read and write LTO-9/10): 3+ GB/sec total.
- Disk: ~450 TB usable disk front end "landing pad."
- Resiliency: Secondary copies are exported from OURRstore to OUHSC.

https://www.pmddatasolutions.com/admin/resources/products/ts4500expanded650x433px-w534h356.gif

New OURRstore Tape Archive #2

- **Status**: All hardware and software has been physically deployed.
  - Our tape archive technical lead is now developing control scripts, reporting scripts, etc.
- **ETA**: Friendly user mode **NOW**, full production fall 2021.

https://www.pmddatasolutions.com/admin/resources/products/ts4500expanded650x433px-w534h356.gif

New OURRstore Tape Archive #3

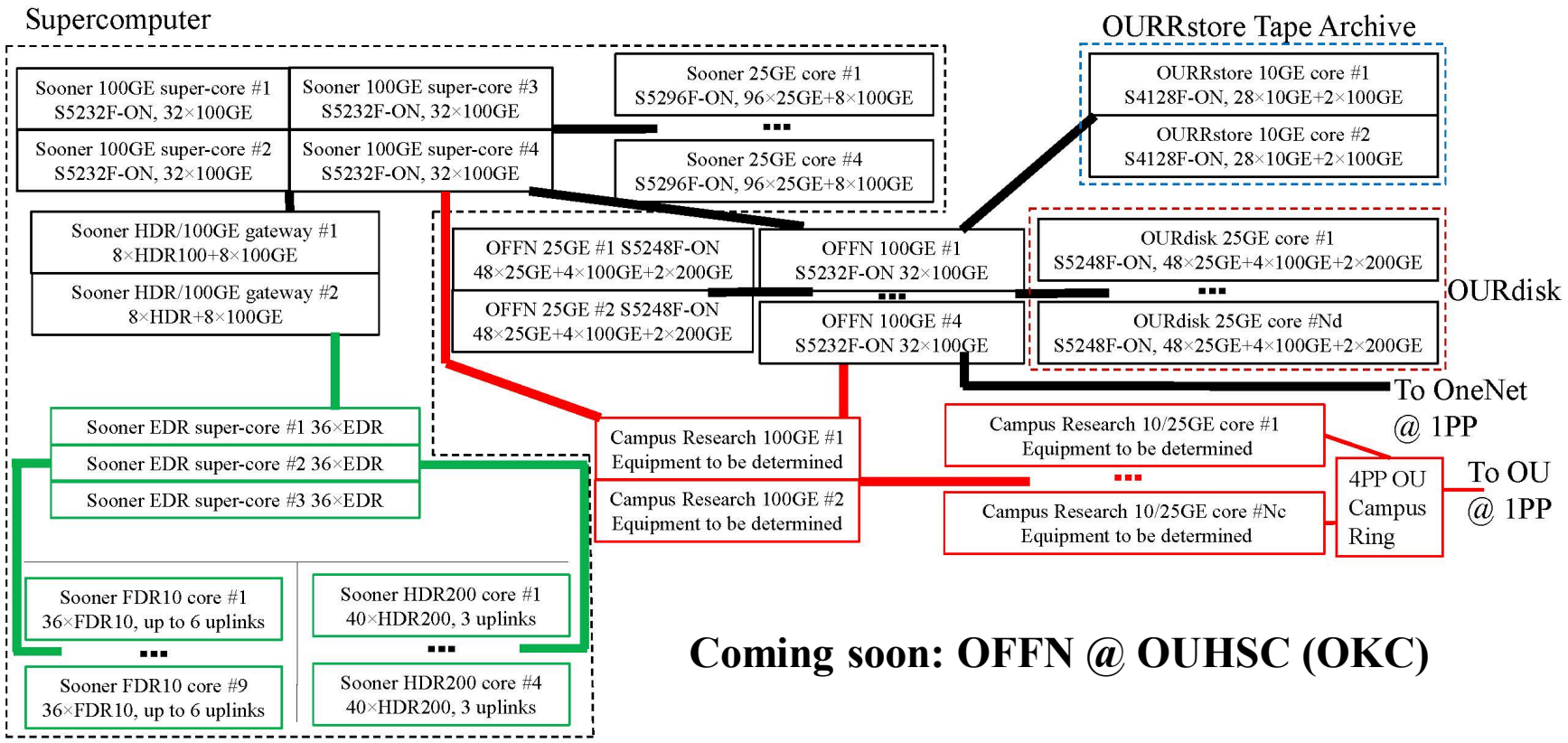
NEW FEATURES (compared to the soon-to-be-decommissioned PetaStore)

https://www.pmddatasolutions.com/admin/resources/products/ts4500expanded650x433px-w534h356.gif

- **Auto-Archiving**: User places files in a specific directory, a "daemon" process archives those files automatically.
- **File Sharing** (via Globus license): With a few clicks, a file owner can designate a file to be downloadable by (a) a specific user, (b) a specific group or (c) the whole world. (Files are private by default.)
- **Caching**: Files reside on the disk front end until they're the least recently used and need to be cleared out to make room for incoming files – popular files are on both disk and tape, unpopular files are on tape only.
- **Disk Purchase**: Buy disk that files can live on permanently, for fast downloading.
- **Researcher's Price**: LTO-7 "Type M" is 3.6 times bigger, half the cost per TB of LTO-6 on the PetaStore (and we'll add LTO-8, LTO-9 etc as they become viable in $/TB).
  - ~$45 per LTO-7 tape cartridge (~7.65 TB usable) => ~$12 per usable TB for dual copies, plus IDC

OneOklahoma Friction Free Network (OFFN)

OFFN @ OU Norman



Coming soon: OFFN @ OUHSC (OKC)

OFFN Across Oklahoma

6 NSF CC* grants, 18 institutions

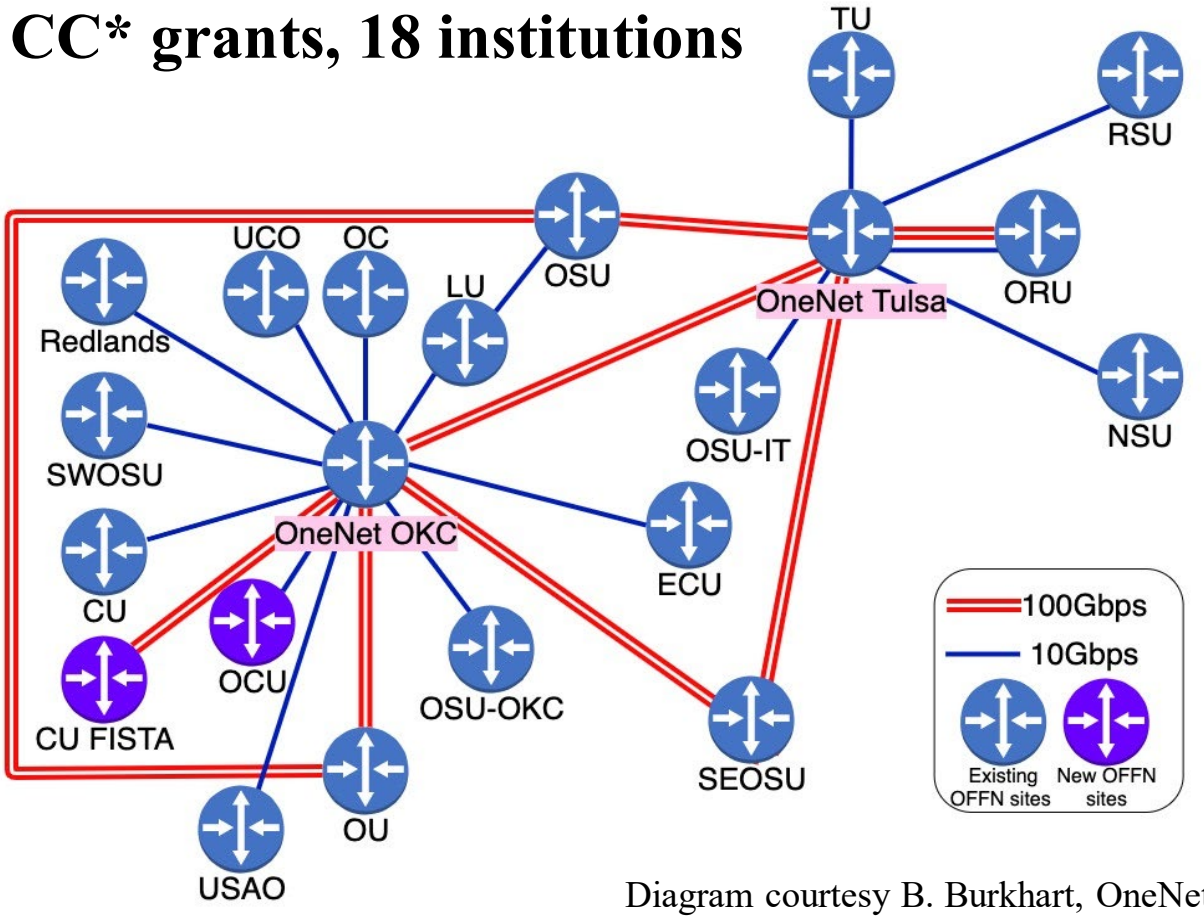


Diagram courtesy B. Burkhart, OneNet

OSCER Team

OSCER Personnel

- Director: Henry Neeman
- Senior System Administrator: Dave Akin
- Petascale Storage Administrator: Patrick Calhoun
- System Administrators: Kali McLennan, Jason Speckman
- Research Computing Facilitator, Associate Director for Remote & Heterogeneous Computing: Horst Severini
- Research Computing Facilitator: **COMING SOON**

OU IT Collaborators

- CIO David Horton
- Governance, Risk & Compliance Team: April Dickson, Scott Luney – meeting twice a month for more than a year
- Security Operations: Chad Miller – now joining us regularly
- Network Operations: Michael Heard – attending our weekly meetings for ~2 years
- Design: Scott DeWitt, Zane Gray (longtime collaborator)
- ... and more!

Accomplishments

OSCER Outcomes: Research

- External research funding to OK institutions facilitated by OneOCII lead institutions (Fall 2001- Summer 2013): **$396M+**
- Funded projects facilitated: **600+**
- OK faculty and staff: **275** in **30+** academic disciplines
- Specifically needed OneOCII just to be funded: **~$46M** (necessary but far from sufficient)
  - NSF EPSCoR RII Track-1 (2008-13, OU+OSU): $15M
  - NSF EPSCoR RII Track-1 (2013-18, OU+OSU+Noble)): $20M
  - NSF EPSCoR RII Track-2 (OU+OSU+KU+KSU): $6M ($3M to OU+OSU)
  - NSF EPSCoR RII C2 (OU+OSU+TU+LU+Noble+OneNet): $1.17M
  - NSF CC-NIE (OU+OSU+LU+OII+UCO+OneNet): $500K
  - NSF CC*IIE (OU): $400K
  - NSF CC*IIE (OneNet+GPN): $350K
- Publications facilitated: **3300+**

- **NSF CC* (OCU/CU): $415K**
- NSF CC* (USAO/OC/RCC/OSUIT/OSUOKC): $232K
- NSF CC* (ORU/CU/ECU): $500K
- NSF MRI (OU): $968K
- NSF MRI (OU): $793K
- NSF MRI (OSU): $908K
- NSF MRI (OSU): $950K
- NSF MRI (Langston U): $250K
- NSF MRI (UCO): $304K
- NSF MRI (TU): $180K
- DOD DURIP (TU): $200K
- NSF CC* (NSU/SWOSU/SE/RSU): $334K

OSCER Outcomes: Education #1

- Courses at OU
  - Ricardo Betancur, Biology
  - Sudarshan Dhall, Computer Science – multiple times
  - Andy Fagg, Computer Science – multiple times
  - Paul Huang, Chemical, Biological & Materials Engineering
  - Amy McGovern, Computer Science
  - Richard Veras, Computer Science
  - Chongle Pan, Computer Science – multiple times
  - Tyler Ransom, Economics
  - Ming Xue, Meteorology – multiple times

OSCER Outcomes: Education #2

Teaching: 10 institutions including 3 MSIs

- Taught parallel computing using OSCER resources:
  - Cameron U – multiple times
  - East Central U (NASNI) – multiple times
  - Oklahoma City U – multiple times
  - Southeastern Oklahoma State U (NASNI) – 3 semester sequence, multiple times
- Taught computational chemistry using OSCER resources:
  - Northeastern State U (NASNI) – multiple times
  - Southern Nazarene U
  - Rogers State U – multiple times
- Taught Bioinformatics using OSCER resources:
  - U Tulsa – 2 semester sequence

OneOCII CI Grants

COMPLETED

1. Grant No. EPS-0919466, "A cyberCommons for Ecological Forecasting," OU+OSU+KU+KSU, $6M ($3M to Oklahoma)
2. Grant No. EPS-1006919, "Oklahoma Optical Initiative," OU+OSU+Noble+TU+LU+OneNet, $1.17M
3. Grant No. OCI-10310029, "MRI: Acquisition of Extensible Petascale Storage for Data Intensive Research," OU, $793K
4. Grant No. OCI-1126330, "Acquisition of a High Performance Compute Cluster for Multidisciplinary Research," OSU, $908K
5. Grant No. ACI- 1229107, "Acquisition of a High Performance Computing Cluster for Research and Education," LU, $250
6. Grant No. ACI-1440774, "ENCITE: ENabling CyberInfrastructure via Training and Engagement," OneNet+GPN, $130K
7. Grant No. ACI-1341028, "OneOklahoma Friction Free Network," OU+OSU+LU+OII+UCO+OneNet, $500K
8. Grant No. ACI-1440783, "A Model for Advanced Cyberinfrastructure Research and Education Facilitators," OU, $400K
9. Grant No. ACI-1429702, "MRI: Acquisition of a High Performance Computing Cluster for Research at a Predominantly Undergraduate Institution," UCO, $304K
10. Grant No. ACI-1531128, "MRI: Acquisition of Shared High Performance Compute Cluster for Multidisciplinary Computational and Data-Intensive Research," OSU, $950K
11. Grant No. ?, "DURIP-ARO: Heterogeneous Cluster for Cyber-Physical System Security Analytics," TU, $200K
12. Grant No. CNS-1531270, "MRI: Development of Heterogeneous Cluster for Cyber-Physical System Hybrid Analytics," TU, $180K
13. Grant No. OAC-1659235, "CC* Network Design: Multiple Organization Regional One Oklahoma Friction Free Network (MORe OFFN)", NSU+SWOSU+SE+RSU, $334K

ONGOING

1. Grant No. OAC-1828567, "MRI: Acquisition of a Regional Resource for Long-term Archiving of Large Scale Research Data Collections," OU, $968K
2. Grant No. OAC-1925744, "CC* Regional: Extended Vital Education Reach Multiple Organization Regional OneOklahoma Friction Free Network," ORU+CU+ECU, $500K
3. Grant No. OAC-1925681, "CC* Team: Great Plains Regional CyberTeam," $950K (OU subaward $127K) – all of GPN
4. Grant No. OAC-2018453, "Small Institution Multiple Organization Regional OneOklahoma Friction Free Networl," USAO+OC+OSUIT+OSUOKC+RCC, $232K
5. Grant No. OAC-2126285, "Extended Small Institution - Multiple Organization Regional - OneOklahoma Friction Free Network," OCU+CU, $415K

TOTAL to OK under OCII/OneOCII: Sep 2008-Sep 2021:

$11.4M in 18 CI grants to 21 OK institutions

Average of $874K per year in new CI grants to OK institutions

Comparison: 2001-2008: $722K (3 grants) TOTAL (1/8 as much per year)

Grants That Needed OCII/OneOCII

COMPLETED

- Grant No. EPS-0814361, "Building Oklahoma's Leadership Role in Cellulosic Bioenergy," OU+OSU, $15M
- Grant No. EPS-1301789, "Adapting Socio-ecological Systems to Increased Climate Variability," OU+OSU+TU+Noble, $20M

<u>TOTAL under OCII/OneOCII</u>: $35M in 2 grants that needed OCII/OneOCII to be fundable, to 4 OK institutions since Sep 2008

Papers About Pieces of/by OneOCII #1

1. H. Neeman, L. Rivera, L. DeStefano, H. Al-Azzawi, D. Brunson, P. J. Clemins, D. Colbry, C. Frye, S. Gesing, J. V. Gyllinsky, A. Klimaszewski-Patterson, A. Phataralaoha, T. Price, M. Tanash and D. Voss, 2021: "An Evaluation of Cyberinfrastructure Facilitators Skills Training in the Virtual Residency Program." Proc. PEARC'21, article 53. DOI: 10.1145/3437359.3465560
2. H. Neeman, D. Akin, H. Al-Azzawi, K. L. Brandt, J. Brooks Kieffer, D. Brunson, D. Colbry, S. Gesing, A. Klimaszewski-Patterson, C. Mizumoto, J. A. Pine-Thomas, A. Z. Schwartz, H. Severini, D. Voss and M. Tanash, 2020: "Cyberinfrastructure Facilitation Skills Training via the Virtual Residency Program." *Proc. PEARC'20*, 421-428. DOI: 10.1145/3311790.3396629.
3. S. P. Calhoun, D. Akin, B. Zimmerman and H. Neeman, 2019: "Large Scale Research Data Archiving: Training for an Inconvenient Technology." *Journal of Computational Science*, 36, article 100523 (available online 2016). DOI: 10.1016/j.jocs.2021.07.005.
4. H. Neeman, H. M. Al-Azzawi, D. Brunson, W. Burke, D. Colbry, J. T. Falgout, J. W. Ferguson, S. Gesing, J. Gyllinsky, C. S. Simmons, J. L. Simms, M. Tanash, D. Voss, J. Wells and S. Yockel, 2021: "Cultivating the Cyberinfrastructure Workforce via an Intermediate/Advanced Virtual Residency Workshop." *Proc. PEARC'19*, article 79. DOI: 10.1145/3332186.3332204.
5. N. Berente, S. Ahalt, J. Bottum, D. Brunson, J. Cutcher-Gershenfeld, J. Howison, J. L. King, H. Neeman, J. Towns, N. Wilkins-Diehr and S. Winter, 2021: "The Professionalization of Cyberinfrastructure Personnel?" *Proc. PEARC'19*, article 87. DOI: 10.1145/3332186.3332225. **Best Paper, Workforce Development and Diversity Track.**
6. M. Brazil, D. Brunson, A. Culich, L. DeStefano, D. Jennewein, T. Jolley, T. Middelkoop, H. Neeman, L. Rivera, J. Smith and J. Wernert, 2021: "Campus Champions: Building and Sustaining a Thriving Community of Practice Around Research Computing and Data." *Proc. PEARC'19*, article 78. 10.1145/3332186.3332200.

Papers About Pieces of/by OneOCII #2

7. H. Neeman, H. M. Al-Azzawi, A. Bergstrom, Z. K. Braiterman, D. Brunson, D. Colbry, E. Colmenares, A. N. Fuller, S. Gesing, M. Kalyvaki, C. Mizumoto, J. Park, A. Z. Schwartz, J. L. Simms and R. Vania, 2018: "Progress Update on the Development and Implementation of the Advanced Cyberinfrastructure Research & Education Facilitators Virtual Residency Program." *Proc. PEARC'18*, paper 71. DOI: 10.1145/3219104.3219117.
8. D. Akin, M. Belgin, T. A. Bouvet, N. C. Bright, S. Harrell, B. Haymore, M. Jennings, R. Knepper, D. LaPine, F. C. Liu, A. Maji, H. Neeman, R. Reynolds, A. H. Sherman, M. Showerman, J. Tillotson, J. Towns, G. Turner and B. Zimmerman, 2017: "Linux Clusters Institute Workshops: Building the HPC and Research Computing Systems Professionals Workforce." *HPCSYSPROS'17: Proc. HPC Systems Professionals Workshop 2017*, article 4. DOI: 10.1145/3155105.3155108.
9. H. Neeman, A. Bergstrom, D. Brunson, C. Ganote, Z. Gray, B. Guilfoos, R. Kalescky, E. Lemley, B. G. Moore, S. K. Ramadugu, A. Romanella, J. Rush, A. H. Sherman, B. Stengel and D. Voss, 2016: "The Advanced Cyberinfrastructure Research and Education Facilitators Virtual Residency: Toward a National Cyberinfrastructure Workforce." *Proc. XSEDE'16*, article 57. DOI: 10.1145/2949550.2949584.
10. H. Neeman, K. Adams, J. Alexander, D. Brunson, S. P. Calhoun, J. Deaton, F. Fondjo Fotou, K. Frinkle, Z. Gray, E. Lemley, G. Louthan, G. Monaco, M. Morris, J. Snow and B. Zimmerman, 2015: "On Fostering a Culture of Research Cyberinfrastructure Grant Proposals within a Community of Service Providers in an EPSCoR State." *Proc. XSEDE'15*, article 19. DOI: 10.1145/2792745.2792764.
11. H. Neeman, D. Akin, J. Alexander, D. Brunson, S. P. Calhoun, J. Deaton, F. Fondjo Fotou, B. George, D. Gentis, Z. Gray, E. Huebsch, G. Louthan, M. Runion, J. Snow and B. Zimmerman, 2014: "The OneOklahoma Friction Free Network: Towards a Multi-Institutional Science DMZ in an EPSCoR State." *Proc. XSEDE'14*, article 49. DOI: 10.1145/2616498.2616542.

Papers About Pieces of/by OneOCII #3

12. S. P. Calhoun, D. Akin, J. Alexander, B. Zimmerman, F. Keller, B. George and H. Neeman, 2014: "The Oklahoma PetaStore: A Business Model for Big Data on a Small Budget." *Proc. XSEDE'14*, article 48. DOI: 10.1145/2616498.2616548.
13. C. Carley, B. McKinney, L. Sells, C. Zhao and H. Neeman, 2013: "Using a Shared, Remote Cluster for Teaching HPC." *Proc. IEEE CLUSTER 2013*. DOI: 10.1109/CLUSTER.2013.6702630.
14. H. Neeman, D. Brunson, J. Deaton, Z. Gray, E. Huebsch, D. Gentis and D. Horton, 2013: "The Oklahoma Cyberinfrastructure Initiative." *Proc. XSEDE'13*, article 70. DOI: 10.1145/2484762.2484793.
15. A. Fitz Gibbon, P. Gray, D. A. Joiner, T. Murphy, H. Neeman, R. M. Panoff, C. Peck and S. Thompson, 2010: "Teaching High Performance Computing to Undergraduate Faculty and Undergraduate Students." *Proc. TeraGrid'10*, article 7. DOI: 10.1145/1838574.1838581. **Best Paper: Education, Outreach & Training Track.**
16. H. Neeman, H. Severini, D. Wu and K. Kantardjieff, 2010: "Teaching High Performance Computing via Videoconferencing." *ACM Inroads*, 1 (1), 67-71. DOI: 10.1145/1721933.1721954.
17. H. Neeman, H. Severini, D. Wu and K. Kantardjieff, 2008: "Teaching Supercomputing via Videoconferencing." *Proc. TeraGrid 2008*. **Best Paper: Education, Outreach & Training Track.**
18. H. Neeman, H. Severini and D. Wu, 2008: "Supercomputing in Plain English: Teaching Cyberinfrastructure to Computing Novices." *inroads: SIGCSE Bulletin*, 40 (2), 27-30. DOI: 10.1145/1383602.1383628.

HPC Capacity

- 2002: 1.2 TFLOPs statewide, 1 Service Provider
- 2005: 6.5 TFLOPs statewide, 1 Service Provider
- 2008: 40 TFLOPs statewide, 2 Service Providers
- 2012: 200+ TFLOPs statewide, 4 Service Providers
- 2015: 400+ TFLOPs statewide, 5 Service Providers
- 2016: 400+ TFLOPs statewide, 6 Service Providers
- 2018: 500+ TFLOPs statewide, 5 Service Providers
- **2021: 800+ TFLOPs statewide, 6 Service Providers**
  - OU, OSU, TU, Langston U, UCO, ORU

External Funding Summary

- External research funding facilitated by OSCER (Fall 2001- Fall 2021): **$861M total, $396M to OU** (46%)
- Funded projects: **735**
- **275** OU faculty and staff in **36** academic departments and **13** non-academic units
- Comparison: Fiscal Year 2002-21 (July 2001 – June 2021): OU Norman externally funded research expenditure: $1.9B

Since being founded in fall of 2001,
OSCER has enabled research projects comprising **over 1 / 5 of OU Norman's total externally funded research expenditure**, with more than a **10-to-1 return on investment**.

External Research Grants

1. C. Ceccarelli, "Astro-Chemical Origins," EU Horizon 2020, $4.8M
2. P. Fritsch, A. Moore, "American Crossroads: Digitizing the Vascular Flora of the South-Central United States," NSF, $4.7M
3. R. Palmer, C. Fulton, J. Salazar Cerrano, H. Sigmarsson, M. Yeary, T.-Y. Yu, B. Cheong, D. Bodine, G. Zhang, "Exploitation of the Horus All-digital Polarimetric Phased Array Radar," NOAA, $2M
4. M. Xue, Y. Hong, X. Hu, E. Martin, R. McPherson, "Very-High-Resolution Regional Climate Dynamic Downscaling and Hydrological Simulations for Peru and Arequipa Regions," USNA, $2M
5. T. Neeson et al, "Conservation incentives and the socio-spatial dynamics of water sustainability," NSF, $1.6M
6. A. Striolo, P. Angeli Co-I), "Sustainable Formulation of Agri-Chemicals via Dynamic Molecular Interfaces," EPSRC+NSF+industry, $1.4M
7. D. Mykles, D. Durica et al, "Signaling mechanisms in the crustacean molting gland," $1.2M
8. J. Zhou, "Quantifying the Impact of Eutrophication on the World's Grassland Soil Microbial Biodiversity and Functioning," NSF, $1M
9. D. Resasco, S. Crossley, L. Lobban L. B. Wang, "Structure and Properties of Zeolite Catalysts," industry, $941K
10. A. Striolo, "Improving CSMHyK via Molecular Modelling and Stochastic Simulations," EPSRC/NSF, $745K
11. D. Parsons, S. Cavallo, "Understanding and Reducing Barriers to Predictive Skill in the Arctic with a Focus on Arctic Cyclones and Sea Ice," ONR, $688K
12. B. Moore, N. Snook, K. Brewster, "National Mesonet Program XXX Year 1," industry, $647K
13. B. Moore, N. Snook, K. Brewster, "National Mesonet Program XXX Year 2," industry, $647K
14. T. Y. Yu, R. Palmer, H. Bluestein, D. Bodine, P.-E. Kirstetter, "Mobile Rapid Scanning Radar for Enhancing Weather Radar Research and Education," NSF, $601K
15. H. Yazdani, "DURIP: A Materials Characterization and Testing System for Enhancing Transdisciplinary Research and Education at Howard University," AFOSR, $570K
16. B. McKinney, "The Center for Neuroscience-based Mental Health Assessment and Prediction," NIH, $475K
17. G. McFarquhar, X. Hu, W. Wu, "Use of MARCUS, MICRE and COMBLE data to enhance understanding of cloud and aerosol processes in their interactions in high-latitude regions," DOE, $458K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

18. S. Cavallo, W. Skamarock, "Multi-scale Predictability with a New Coupled Non-hydrostatic Global Model over the Arctic," ONR, $454K
19. Y. Shao, Z. Yang, "The Development of Spin-Adiabatic Approaches for Studying Spin-Crossing Reactions," NSF, $445K
20. M. Wenger, "Iron deficiency at perimenopause: Effects on brain and behavior," NIH, $428K
21. C. Liu, M. Xue, "Implementation, Testing and Evaluation of Radar Data Assimilation Capabilities within JEDI Hybrid EnVar System for the Rapid Refresh Forecast System," NOAA, $405K
22. D. Bodine, "Detection and estimation ofmulti-scale complex spatiotemporal processes in tornadic supercells from high resolution simulations and multiparameter radar," NSF, $403K
23. C. Pan, "Proteomic Stable Isotope Probing as a Novel Approach for Linking Prebiotics with Active Gut Microbiota," NIH, $381K
24. M. Xue, A. Fierro, R. Kong, E. Mansell, "Direct Assimilation of GOES-R Geostationary Lightning Mapper (GLM) Data within JEDI Hybrid System for Operational UFS Convection-Allowing Predictions," NOAA, $339K
25. H. Baer, K. Sinha, "TASK B: From Colliders to Cosmology in the LHC Era," DOE, $333K
26. D. Rosendahl, "Building tools for identifying drought vulnerabilities and assessing climate change impacts on the water resources of the Canadian River Basin," USGS, $325K
27. D. Blume, "Dynamics of matter and light-matter systems," NSF, $300K
28. D. Arcila, "Exploring the genomics of convergent snout elongations in deep-sea fishes," NSF, $300K
29. S. Cavallo, D. Turner, "Sensitivity of the mid-latitude waveguide to the dynamics and observations of Arctic tropopause-based vortices," NSF, $298K
30. J. Tobin, N. Kaib, "The Formation, Evolution, and Fate of Multiple Star Systems," NSF, $288K
31. J. Redemann, "Leadership of Aerosol Investigations in Support of SIT for the A-CCP Designated Observables (DO) Study," NASA, $286K
32. Q. Xu, "Advance the Cutting-Edge Science and Technology in Radar and Satellite Data Assimilation for Analyses and Predictions of Severe Storms and Tropical Cyclones," ONR, $286K
33. W. Wu, G. McFarquhar, "From Clouds to Precipitation: Multiscale Dynamics-Microphysics Interactions in Cumulus Clouds," NCAR, $278K
34. B. Wang, "Promoting Lithium Sulfides Redox Cycle via Atomically Dispersed Active Sites for Batteries," NSF, $256K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

35. S. Cavallo, D. Parsons, "Improved characterization and prediction of Antartic weather and climate through utilization of the CONCORDIASI data set," NSF, $273K
36. S. Cavallo, D. Turner, "Integrated Characterization of Energy, Clouds, Atmospheric State, and Precipitation at Summit (ICECAPS)," NSF, $251K
37. K. Hambright, "Harmful algal blooms and public safety: a monitoring an research program aimed at understanding cyanobacterial blooms and toxin production," OSU, $250K
38. X. Chen, "RII Track-4: Illuminating the Dark Subsurface using Fiber Optic Distributed Acoustic Sensing (DAS) Array," NFS, $228K
39. C. Homeyer, A. McGovern, "Automated Detection and Analysis of Severe, Tropopause-Penetrating Convective Storm Patterns Using Remote Sensing Data Fusion and Deep Learning," NASA, $216K
40. L. Stein, D. Allen, D. Arcila, R. Betancur, R. Broughton, L. Fornelli, M. Kaspari, J. Kelly, H. Lanier, M. Markham, K. Marske, A. Rowe, M. Rowe, C. Siler "BII-Design: Institute for the Biogeography of Behavior," NSF, $199K
41. M. Xue, C. Liu, N. Snook, "Advanced Data Assimilation and Prediction Research for Convective-Scale," NOAA, $195K
42. D. MacGorman, "Lightning Studies in a Polluted Atmosphere," NSF, $160K
43. S. Cavallo, D. Turner, "Characterizing the Roles of Atmospheric Structure and Clouds on the Radiation and Precipitation Budgets at Summit, Greenland," NSF, $140K
44. M. Wenger, J. Haas, L. Murray-Kolb, "Cognitive performance testing: validation and norming of cognitive tests used in the HarvestPlus Biofortified pearl millet efficacy study in Maharashtra, India," Gates Foundation, $134K
45. D. Devegowda, "Factors Governing Diffusiophoresis and its Impact on Fluid Flow in Porous Media,"ACS, $110K
46. J. Garg, "Investigation of phonon scattering in superlattices for design of efficient multiple quantum-well hot carrier solar cells," NSF, $107K
47. C. Pan, "Role of Maternal Fiber in Development of Diabetes-Promoting Invariant T Cells," OUHSC, $40K
48. D. Rosendahl, "Future Drought Across Oklahoma," OSU, $30K
49. S. Cavallo, "Predictability of midlatitude cyclones in relation to tropopause-based vortices over the Arctic, and sensitivity to reductions in sea ice," NASA, $30K
50. S. Cavallo, D. Parsons, "Scientific Program Overview: THINICE," NSF, $23K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

51. A. McGovern et al, "AI Institute: Artificial Intelligence Institute for Environmental Sciences (AI2ES)," NSF, $20M
52. J. Zhou, "Searching for General Rules Governing Microbiome Dynamics Using Anaerobic Digesters as Model Systems," NSF, $3M
53. A. Pereira, "Systems Genetics Studies on Rice Genomes for Analysis of Grain Yield and Quality Under Heat Stress," NSF, $2.5M
54. D. Devegowda, C. Sondergeld, C. Rai, "Reservoir Characterization in Unconventional Oil & Gas Reservoirs," Marathon Oil, $2M
55. S. Crossley, L. Lobban, B. Wang, A. Feltz, "EFRI E3P: Tuning Catalyst Design to Recycle Mixed Polymer Streams," NSF, $2M
56. S. Welch, "Building Field-Based Ecophysiological Genome-to-Phenome Prediction," NSF, $2M
57. L. Bartley, Stacey, Thelen, Du, "Genome-enabled characterization of orphan receptor-like kinases in plants," NSF, $2M
58. D. Devegowda, F. Civan, R. Sigal, "Simulation of Shale Gas Reservoirs Incorporating Appropriate Pore Geometry and the Correct Physics of Capillarity and Fluid Transport," RPSEA, $1.4M
59. Y. Shao, "Multiscale Modeling of Enzymatic Reactions and Firefly Bioluminescence," NIH, $1M
60. R. Palmer, B. Cheong, C. Fulton, J. Salarzar, H. Sigmarsson, M. Yeary, T.-Y. Yu, G. Zhang, "ARRC R&D Activities in Phased Array Weather Radar," NOAA, $1.1M
61. E. Martin, "CAREER: Precipitation Variability Across Timescales," NSF, $940K
62. P. Fritsch, "American Crossroads: Digitizing the Vascular Flora of the South-Central United States," NSF, $934K
63. R. McPherson, E. Kuster, E. Martin, B. Moore, M. Shafer, "Hosting the Department of the Interior's South Central Climate Adaptation Science Center," USGS, $896K
64. M. Elshahed, "PurSUit: Discovery, characterization, and elucidation of the global patterns and determinants of anaerobic fungal (Neocallimastigomycota) diversity in the herbivorous gut," NSF, $762K
65. G. McFarquhar, W. Wu, X. Hu, "Use of MARCUS, MICRE and COMBLE data to enhance understanding of cloud and aerosol processes in their interactions in high-latitude regions," DOE, $690K
66. D. Resasco, B. Wang, "Hydrophobic enclosures in bio-inspired nanoreactors for enhanced phase selectivity. A combined experimental/theoretical approach," DOE, $675K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

67. G. McFarquhar, "Experiment of Sea Breeze Convection, Aerosols, Precipitation and Environment (ESCAPE)," NSF, $605K
68. A. Holgado, "RUI: Examining Molecular Players Integrating Autophagy and Neuronal Development and Maintenance," NSF, $600K
69. D. Devegowda, C. Sondergeld, C. Rai, "Unconventional Shale Consortium," Industry Consortium, $600K
70. N. Youssef, "BEE: Discovery and characterization of novel microbial lineages in an early Earth analog sulfur-based ecosystem," NSF, $578K
71. H. Bluestein, B. L. Cheong, D. Bodine, "Enhanced Radar Studies of Severe Convective Storms and Tornadoes," NSF, $576K
72. D. Devegowda, C. Sondergeld, C. Rai, "Enhanced Oil Recovery in Shales," Ovintiv Corp, $500K
73. E. Baron, "Modeling the Atmosphere of Solar and Other Stars: Radiative Transfer with phxT," NASA, $478K
74. X. Wang, "Advancing the Direct Assimilation of Radar Observations to Improve Convective Scale Numerical Weather Prediction through Optimizing Combined Use of Static and Ensemble Covariances, the Additive Perturbations, and the Assimilation Frequency in the Hybrid E," NOAA, $523K
75. B. Schenkel, N. Yussouf, "Investigating the impact of ambient deep-tropospheric vertical wind shear on tornadoes and their attendant supercells within tropical cyclones," NSF, $499K
76. A. Johnson, X. Wang, "Flow-dependent machine learning based post-processing of convection allowing ensembles to provide convective outlooks of severe weather hazards," NOAA, $489K
77. K. Leighly, D. Terndrup, "Spectral Synthesis for Broad Absorption Line Quasars – Feedback and Physics for Everyone," NSF, $474K
78. A. Ford Versypt, "CAREER: Multiscale Modeling of a Virtual Kidney during the Onset and Progression of Diabetic Kidney Disease," NSF, $459K
79. P. Zhu, "CAREER: Lead-Free Pseudohalide/Halide Perovskite Nanocrystals for White Light-Emitting Diodes," NSF, $440K
80. D. Devegowda, F. Civan, R. Sigal, "Simulation of Shale Gas Reservoirs Incorporating Appropriate Pore Geometry and the Correct Physics of Capillarity and Fluid Transport," Industry Consortium, $405K
81. D. Arcila, "Exploring the genomics of convergent snout elongations in deep-sea fishes," NSF, $300K
82. K. Nicholas, "SusChEM: Deoxygenation and Reductive Coupling of Alcohols Catalyzed by Oxo-Metal Complexes," NSF, $405K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

83. Y. Jung, C. Liu, M. Xue, "Development and Testing of a GSI-based Multi-Scale EnKF System for Convection-Allowing Stand-Alone Regional FV3," NOAA, $402K
84. Y. Kuang, "RoL: The rules of life were made to be broken - Connecting physiology, evolutionary ecology, and mathematics to identify a Growth Rate Rule," NSF, $396K
85. N. Youssef, "Phylogenomics and evolutionary history of the anaerobic fungal group, Neocallimastigomycota," NSF, $393K
86. K. Hambright, "Challenging the broadcast allelopathy paradigm in toxigenic microbial eukaryotic ecology," NSF, $385K
87. N. Snook, C. Homeyer, A. McGovern, "0-3 Hour Tornado Prediction using the Warn on Forecast System and Machine Learning," NOAA, $363K
88. D. Andresen et al, "GP-ARGO: The Great Plains Augmented Regional Gateway to the Open Science Grid,", NSF, $357K
89. W. Wu, G. McFarquhar, "From Clouds to Precipitation: Multiscale Dynamics-Microphysics Interactions in Cumulus Clouds," DOE, $344K
90. A. McGovern, "Deep learning for operational identification and prediction of synoptic-scale fronts," NOAA, $334K
91. M. Fishbein, "Can Hundreds of Unlinked Loci Really Resolve Recent, Rapid Radiations of Plant Species?," NSF, $304K
92. C. Homeyer, A. McGovern, "Automated Detection and Analysis of Severe, Tropopause-Penetrating Convective Storm Patterns Using Remote Sensing Data Fusion and Deep Learning," NASA, $325K
93. P. D. Sheehan, "Demographics of the Youngest Protostars and their Disks," NSF, $300K
94. M. Xue, X. Hu, N. Snook, T. Supinie, "Unified Forecast System Research-to-Operations Project (UFS-R20) Task: RRFS and Retirement of Legacy Models," NOAA, $292K
95. M. Biggerstaff, K. Elmore, "Understanding the Propagation and Evolution of Rotation in Linear Storms," NOAA, $259K
96. X. Wang, "Accelerate the development of the Hurricane Analysis and Forecasting System (HAFS)," NOAA, $250K
97. D. Bodine, B. L. Cheong, T. Y. Yu, R. Palmer, A. Reinhart, P. E. Kirstetter, "Using Observations, Simulations, and Artificial Intelligence to Develop a Lake-Effect Snow Prediction System," Weathernews Americas, $249K
98. X. Wang, A. Johnson, "UFS-R20 CAM Sub-Project: Rapid Refresh Forecast System (RRFS) development and implementation," NOAA, $244K

OSCER-FACILITATED FUNDING TO DATE:
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External Research Grants (cont'd)

99. J. Walter, B. Carpenter, "Refining principal stress measurements in reservoir underburden in regions of induced seismicity through seismological tools, laboratory experiments, and theory," Electric Power Research Institute Inc, $233K
100. M. Xue, C. Liu, N. Snook, "Advanced Data Assimilation and Prediction Research for Convective-Scale 'Warn-on-Forecast'," NOAA, $200K
101. P. Zhu, "CAREER: Lead-Free Pseudohalide/Halide Perovskites for Next-Generation White Light-Emitting Diodes," NSF, $225K
102. F. Kong, M. Xue, "Development of a Storm-Scale Ensemble Numerical Weather Prediction System for Chongqing Meteorological Service," Chinese Acad Sci, $199K
103. R. Nygaard, "Real-Time Drilling Optimization System for Improved Overall Rate of Penetration and Reduced Cost/Ft in Geothermal Drilling," Oklahoma State U, $187K
104. E. Baron, "Unlocking Type Ia Supernovae with an Ultraviolet Key," NASA, $181K
105. P. Gignac, "Ecomorphological diversification and the origin of phenotypic disparity in crocodile-line archosaurs," NSF, $161K
106. T. Misiewicz, A. Moore, "NSF Postdoctoral Fellowship in Biology FY 2018," NSF, $138K
107. J. Basara, "19-EARTH19-321, Evaluating the Contributions of Local and Non-Local Land Atmosphere Coupling to Flash Drought Evolution and Prediction," NASA, $135K
108. B. Mooers, "Role of a Lysine Hydroxylase in Breast Cancer," OCAST, $135K
109. Q. Xu, "Advance the Cutting-Edge Science and Technology in Radar and Satellite Data Assimilation for Analyses and Predictions of Severe Storms and Tropical Cyclones," DOD ONR, $124K
110. E. Maher, D. Horm, "OKFutures Systems-Level Evaluation Planning Oklahoma Partnership for School Readiness," OKFutures, $112K
111. D. Devegowda, "Factors Governing Diffusiophoresis and its Impact on Fluid Flow in Porous Media," American Chemical Society, $110K
112. X. Wang, Y. Wang, "Development and Research of Hybrid EnVar Data Assimilation for Convective-Scale," NOAA, $100K
113. R. Nygaard, "Advanced cement characterization and modeling to evaluate novel additives to improve wellbore integrity," Oklahoma State U, $100K
114. P. Kotlik, S. Markova, H. Lanier, "Genomics of adaptation along a latitudinal cline: Bank vole genome sequencing collaboration," Czech Academy of Science $90K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

115. K. Brewster, F. Carr, N. Snook, "CASA DFW Testbed Operations and Data Impacts," Synoptics, $89K
116. F. Kong, X. Hu, "Development of a Storm-Scale Ensemble Numerical Weather Prediction System for Chongqing Meteorological Service," Chinese Acad Sci, $87K
117. X. Dai, "Microlensing Size of AGN Reflection Hump," NASA, $73K
118. J. Pei, "Improving the Modeling Fidelity of Complex Aerospace Systems with Mem-Models," Oklahoma State U, $27K
119. ?, S. Schroeder, "Modulation of the human lung transcriptomic immune response by SARS-CoV-2 M protein," Presbyterian Health Fndtn, $25K
120. S. Schroeder, "Viral RNA Structures, Function, and Energetics," NIH, $25K
121. P. D. Sheehan, "Surrogate Modeling of Protostellar Disk Radiative Transfer Models," NRAO, $10K
122. P. Brown, C. Ashall, E. Baron, A. Cikota, L. Galbany, P. Hoeflich, D. Howell, P. Milne, N. Suntzeff, L. Wang, X. Wang, Y. Yang, J. Zhang, "Ultraviolet Spectroscopy of Extreme Standard Candles, 2021-2022, 62 Orbits," NASA, $?

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

123. A.T. Peterson (KU), X. Xiao, J. Basara, R. Jabrzemski, H. Neeman, S. Little (OSU), R. Brennan (UCO), F. Agusto (KU), R. Raghavan (KSU), A. Ghosh (PSU), A. Khalighifar (KU), "RII Track-2 FEC: Marshalling Diverse Big Data Streams to Understand Complexity of Tick-borne Diseases in the Southern Great Plains," NSF, $3.9M (total), $883K (OU)
124. L. Xiang, "Academic-Industry Partnership for the Translation of a 4D in vivo Dosimetry Approach for Radiation Therapy," NIH, $3.8M
125. X. Xiao, D. Prosser (USGS), R.Webby (St. Jude Children's), Yuanwei Qin, "US-China Collab: Harnessing big data to understand and predict diversity and transmission of human- and animal-infected avian influenza viruses in China," NSF, $2.5M (total), $2M (OU)
126. P. Gaffney (OMRF), B. McKinney (TU), "Molecular Mechanisms and Genetics of Autoimmunity," NIH, $2.4M
127. K. D. Hambright, L. Krumholz, A. Wilson (Auburn U), H. Paerl (UNC Chapel Hill), M. Steffen (James Madison U), "Dimensions: Collaborative research: The cyanobacterial bloom microbial interactome as a model for understanding biogeographical and seasonal patterns in functional biodiversity," NSF, $2M
128. M. Paulus (LIBR), B. McKinney (TU), "The Center for Neuroscience-based Mental Health Assessment and Prediction (NEUROMAP)," NIH, $1.49M
129. R. McPherson, E. Kuster, E. Martin, B. Moore, M. Shafer, "Hosting the Department of the Interior's South Central Climate Adaptation Science Center," USDOI/USGS, $870K
130. G. McFarquhar, R. Rauber (UIUC), "SOCRATES: Microphysical processes in Southern Ocean Clouds," NSF, $821K (total), $367K (OU)
131. D. K. Walters, "Implementation and Validation of Advanced Turbulence Modeling Methods for Liquid Metal Flow in Nek5000," DOE, $756K
132. K. Brewster, F. Kong, N. Snook, M. Xue, C.Zhang, "Enhancing CAM Ensemble Forecast System and Improving Ensemble Forecast Products in Support of HMT Winter Weather and Heavy Precipitation Forecasting," NOAA, $748K
133. B. Wang, "Catalysis Driven by Confined Hot Carriers at the Liquid/Metal/Zeolite Interface," DOE, $750K
134. M. Biggerstaff, "Spatiotemporal maps of damaging winds from integrated remote and in situ observations," NIST, $737K
135. C. Pan, "Integrating single-cell wetland microbiome structure, function, and activity to ecosystem-scale biogeochemical fluxes," DOE, $637K

OSCER-FACILITATED FUNDING TO DATE:
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External Research Grants (cont'd)

136. G. McFarquhar, W. Wu, R. Rauber (UIUC), "Collaborative Research: Impacts of microphysical, thermodynamic, and dynamical processes on nocturnal and oceanic convective systems via analyses from PECAN and HAIC/HIWC," NSF, $549K
137. N. Yussouf, P. Heinselman, L. J. Wicker, Y. Jung, M. Xue, "Impact of Assimilating Phased Array Radar Observations on Convective-scale Numerical Weather Prediction Model for Severe Weather Forecasts, Spectrum Efficient National Surveillance Radar (SENSR) research as part of 2015 Spectrum Pipeline Act," ?, $544K
138. G. Richter-Addo, "Chemical Reactivity and Redox Behavior of Heme-HNOx Derivatives," NSF, $540K
139. M. Xue, C. Ziegler, X. Hu, "Collaborative Research: Observing and Understanding PBL Heterogeneities and Their Impacts on Tornadic Storms During VORTEX-SE 2018 Field Experiment," NSF, $524K
140. N. Kaib, "CAREER: Next Generation Models of Planet Formation and Evolution," NSF, $521K
141. J. Garg, "Investigation of strain and superior functionalization schemes for large enhancement of thermal conductivity in polymer-graphene nanocomposites and binary semiconductors," NSF, $500K
142. S. Razavi, D. Papavassiliou, "Effect of heterogeneous particles and surfactants on the stability and rheology of fluid interfaces," NSF, $500K
143. S. Razavi, D. Papavasssiliou, "Effect of heterogeneous particles and surfactants on the stability and rheology of fluid interfaces," NSF, $500K
144. R. Voronov (NJIT), "Developing New Tissue Engineering Technology for Bone Implants," Gustavus and Louise Pfeiffer Research Foundation, $400K
145. Y. Jung, M. Xue, C. Liu, F. Kong, "Accelerated Implementation, Testing and Evaluation of Optimized Radar Data Assimilation Capabilities within Ensemble-Variational Hybrid GSI for the NOAA Convection-allowing rapidly updated Forecasting System," NOAA, $394K
146. M. Galizia, B. Wang, "Collaborative Research: Molecular-level understanding of small molecule transport in glassy polymers exhibiting configurational free volume," NSF, $391K
147. G. McFarquhar, R. Marchand (UW), "Quality control and analysis enabling use of MARCUS and MICRE data for scientific purposes," DOE, $390K
148. X. Wang, "Accelerate FV3-based ensemble prediction system: Hourly Updating CAM Ensemble Development," NOAA, $383K
149. X. Wang, "MPAR targeting observation research for WoF," NOAA, $362K
150. N. Kaib, "Planetary Systems as the Bottom Levels of Hierarchies," NASA, $345K

OSCER-FACILITATED FUNDING TO DATE:
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External Research Grants (cont'd)

151. D. Papavassiliou, "Turbulent transport in wall turbulence: The role of VLSMs and the interplay of molecular/convective effects," NSF, $325K
152. Wu, "Collaborative Proposal: Observational and Numerical Modeling Studies of Rain Microphysics," NSF, $318K
153. K. D. Hambright, J. Beyer, "Challenging the broadcast allelopathy paradigm in toxigenic microbial eukaryotic ecology," NSF, $300K
154. M. Xue, X. Hu, Y. Jung, K. Brewster, "Evaluation and Optimization of Two New Scale-Aware PBL Schemes within WRF for the Prediction of Day- and Night-Time Storm Environment and Tornadic Storms during VORTEX-SE," NOAA, $287K
155. R. Betancur, "Collaborative Research: FishLife: genealogy and traits of living and fossil vertebrates that never left the water," NSF, $273K
156. B. Moore, K. Brewster, F. Carr, "CASA DFW Testbed Operations and Data Impacts," SGT & EarthNetworks, $260K
157. G. McFarquhar, "Observations of aerosols above clouds and their interactions (ORACLES)," NASA, $249K
158. D. K. Walters, "Robust Adaptive Controls for Shipboard Landing of Multi-Rotor Unmanned Aerial Vehicles," DoD ONR, $243K
159. X. Wang, "Improving National Weather Service Convection Allowing Hazardous Weather Prediction by Using a Cost-Effective Large Background Ensemble in a Regional FV3 EnVar Data Assimilation System," NOAA, $462K
160. F. Kong, X. Hu, M. Xue, K. Brewster, "Development of a Storm-Scale Ensemble Numerical Weather Prediction System for Chongqing," Chongqing Inst of Green and Intelligent Tech, Chinese Academey of Sciences, $225K
161. X. Chen, "Collaborative Research: Multi-scale validation of earthquake source parameters to resolve any spatial, temporal or magnitude-dependent variability at Parkfield, CA," NSF, $224K
162. F. Kong, M. Xue, Y. Jung, X. Hu, "Upgrade the Storm-Scale Assimilation and Ensemble Forecast Capability for Shenzhen Meteorological Bureau," Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, $214K
163. L. Xiang, "Real-Time Dosimetry in External Beam Radiation Therapy with X-Ray Acoustic Computed Tomography," OK-CAST, $209K
164. R. Janknecht, B. Mooers, "Role of JMJD4 in Breast Cancer," Presbyterian Health Foundation, $200K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

165. N. Yussouf, "Development of a Regional Storm-scale Ensemble Forecasting System Embedded in HWRF for Extreme Rainfall Producing Landfalling Tropical Cyclones," NOAA/OAR/NSSL $200K
166. X. Wang, "Development of the ground-based radar observation assimilation capability within the HWRF hybrid ensemble-variational data assimilation system to improve the land-falling hurricane prediction," NOAA, $193K
167. L. Huang, Y. Wu, L. McNeil (UNC Chapel Hill), C. Karwacki (Edgewood Chemical Biological Ctr), "Influences of Structural Design on Molecular Accessibility, Kinetics, Adsorption, and Reactivity: Degradation of CWAs by MOFs," DTRA, $180K
168. T. Jones, P. Skinner, A. Fierro, A. Reinhart, K. Knopfmeier, "Short-term Ensemble Prediction of Tornadoes in Landfalling Tropical Cyclones," NOAA, $163K
169. Y. Shao, "Structure Based Design of Potent and Selective Inhibitors to Pro-apoptotic Bax/Bak (Pilot project)," NIH, $150K
170. C. Pan, "High Performance Bioinformatics Workflow for Integrative …," U Tennessee Knoxville, $146K
171. M. Biggerstaff, "2018 Hurricane Season RAPID Study of Hurricane Florence at Landfall," NSF, $143K
172. X. Wang, A. Johnson, Clark, "Improving NWS Convection Allowing Hazardous Weather Ensemble Forecasts through Optimizing Multi-Scale Initial Condition (IC) Perturbations," NOAA, $138K
173. Y. Shao, "Rational Development of Selective and Potent Inhibitors to Pro-apoptotic Bax Protein," OCAST, $135K
174. E. Epifanosky(Q-CHEM Inc), Y Shao, "Multiscale ab initio QM/MM and machine learning methods for accelerated free energy simulations," NIH, $132K (total), $24K (OU)
175. N. Kaib, "(XRP18 Step-2) Planetary Systems as the Bottom Levels of Hierarchies," NASA, $126K
176. D. Bodine, Yu, B. Cheong, A. Reinhart, R. Palmer, "Observation-based Microphysics Classification and Cloud Activity for Lake-effect Snow," Weathernews Americas, $124K
177. D. Bodine, A. Reinhart, "Evaluation of Structural Vulnerability in the Southeast United States Using High-Resolution Tornado Simulations with Buildings and Terrain," NOAA, $124K
178. U. Hansmann, "Role of Lipid-derived Oligomer Strains in Alzheimer Disease Phenotypes," U Southern Mississippi, $122K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

179. C. Pan, "Identification of orthologous gene families across diverse eukaryotic genomes," UT Battelle, $182K
180. F. Kong, M. Xue, C. Liu, "Application of Advanced Data Assimilation for Chongqing Meteorological Service," Chongqing Inst of Green and Intelligent Tech, Chinese Academey of Sciences, $112K
181. K. Dresback, R. Kolar, "Automating River Connections Between NWM and ADCIRC – Precipitation, Lateral Inflows and Operational Strategies," NSF, $100K
182. K. Dresback, R. Kolar, "Automating River Connections Between NWM and ADCIRC - Precipitation, Lateral Inflows and Grid Development," NOAA NSSL, $97K
183. R. Betancur, "Collaborative Research: The role of habitat transitions in parallel marine fish radiations," NSF, $82K
184. S. Cavallo, "Tropopause polar vortices and multi-scale Arctic predictability," DOD, $60K
185. P. Skubic, P. Gutierrez, M. Strauss, B. Abbott, J. Stupak, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center," U Texas Arlington, $53K
186. X. Chen, J. Walter, "Roles of stress heterogeneity and stress interaction in induced seismicity: example from the Fairview/Woodward area in Oklahoma," USGS, $52K
187. N. Kaib, "Exploring the Evolution and Characterizing the Chaos of the Terrestrial Planets," UIUC, $50K
188. G. McFarquhar, "Investigation of Microphysics and Precipitation for Atlantic Coastal Threatening Snowstorms (IMPACTS)," NASA, $41K
189. L. Huang, X. Wu, "Dew Point Pressure Prediction of Natural Gas and Gas Condensation," Industry, $36K
190. X. Chen, "Understanding the triggering process of the foreshock sequence of the 2010 M7.2 El-Mayor-Cucapah earthquake," U California Southern California Earthquake Center, $25K
191. X. Chen, "Probing the characteristics of earthquake source complexity in areas of structural complexity," U California Southern California Earthquake Center, $15K
192. K. Brewster, "Observing System Simulation Experiments (OSSEs) for Humidity using Cellular Network Signals," NOAA, $9K
193. G. McFarquhar, R. Peppler, "CIMMS CA - Task II/ROC/Task I/Admin," NOAA, $4K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

194. H. Neeman, L. Bartley, K. Dresback, A. McGovern, H. Severini, M. Laufersweiler, "MRI: Acquisition of a Regional Resource for Long-term Archiving of Large Scale Research Data Collections," NSF, $968K
195. S. Crowell, "The OCO-2 Model Intercomparison Project," NASA Science Team for the OCO-2 Missions, $123K
196. A. Duerfeldt, 'Hit to Lead Optimization of a Systemically Available Treatment for Diabetic Retinopathy," NIH, $275K
197. A. West, A. Duerfeldt et al, "Structure, Function, and Therapeutic Potential of Clostridium difficile Caseinolytic Protease P," NIH, $10.5M
198. G. Richter-Addo, "MRI: Acquisition of an X-ray Diffractometer for Research and Training in Chemical Structure-Function Studies," NSF, $217K
199. B. Uchoa Barboza, "Interactions and quantum effects in nodal materials," NSF, $402K
200. S. A. Shirazi, "Erosion/Corrosion Research Center (E/CRC)," Industrial, $540K
201. S. A. Shirazi, "Tulsa University Sand Management Projects (TUSMP)," Various Oil and Gas Producers, $150K
202. S. Schroeder, "Metal Ion Interactions in RNA Shapeshifters," Burroughs Wellcome Fund, $9K
203. A. Duerfeldt, "Hit to Lead Optimization of a Systemically Available Treatment for Diabetic Retinopathy Major Aim: To determine structure-activity relationships of NCI8, a novel PPARα agonist," NIH, $422K
204. N. Snook, M. Xue, Y. Jung, A. McGovern, M. Xue, "Improving Operational Hail Prediction through Machine Learning from HREF and CAPS Storm-Scale Ensemble FV3 and WRF ARW Forecasts including Advanced Microphysics," NOAA, $342K
205. W. Freeman, "Neuroepigenomics of Neural Stem Cell Aging.," OCASCR, $232K
206. W. Freeman, "Sex divergence and cell specificity of age-related hippocampal DNA modifications," NIH, $75K
207. W. Freeman, "Dynamics of the brain epigenome with aging," NIH, $960K
208. P. Skubic, J. Stupak, B. Abbott, M. Strauss, P. Gutierrez, "Experimental Physics Investigations using the ATLAS Detector at the LHC," DOE, $420K
209. P. Skubic, B. Abbott, J. Stupak, M. strauss, P. Gutierrez, "University of Oklahoma High Energy Physics: Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the Large Hadron Collider (LHC) (TASK A) 2013-2016," DOE, $500K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

210. P. Skubic, B. Abott, P. Gutierrez, M. Strauss, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center," DOE, $115K
211. T. Smith, A. Reinhart, K. Ortega, K. Calhoun, "Implementing convective storm statistics from a large reanalysis of WSR-88D data for model verification and forecasting probabilistic uncertainty," NOAA, $592K
212. J Gallant (Michigan State U), M. Markham (OU), Sawtell (Columbia U), Warren (Washington U St. Louis), Zakon (U Texas), "IOS EDGE: Enabling genotype-phenotype studies in weakly electric fish.," NSF, $1.5M (total), $279K (OU)
213. M. Markham, "CAREER: The energetic costs of active sensory and communication signals: Integrating research and education through organismal, cellular, and molecular approaches," NSF, $719K
214. D. Allen, T. Neeson, Y. Hong, "Collaborative Research: MSB-FRA: Scaling Climate, Connectivity, and Communities in Streams," NSF, $1.4M
215. S. Hussaini, (U Tulsa), F. Acquah, (OUHSC), B. Mooers (OUHSC), "HR18-049 Discovery of Indolizidine (–)-237D Analogs as Selective α6* Receptor Antagonists," OCAST, $135K (total), $13K (OU)
216. J. Salazar, N. Aboserwal, R. Palmer, "Shared Aperture Array Antenna for Multiband Radar Applications," Nanowave Technologies Inc, $130K
217. M. Yeary, R. Palmer, P. Chilson, "Development and Commercialization of a Ground-Based Radar to Enable the Next-Generation of Atmospheric Measurements via Unmanned Aircraft Systems (UAS)," OCAST, $300K
218. T.Yu, B.Cheong, R. Palmer, "Technical Support for the Procurement of an S-band Polarimetric Weather Radar," National Central University, Taiwan, $88K
219. R. Palmer, B. Cheong, C. Fulton, J. Salazar, H. Sigmarsson, M. Yeary, T. Yu, Y. Zhang, "Spectrum Efficient National Surveillance Radar (SENSR) - ARRC Risk Reduction Activates," NOAA, $2.22M
220. R. Palmer, C. Fulton, J. Salazar, H. Sigmarsson, "Spectrum Ef- ficient National Surveillance Radar (SENSR) - Development of the All-Digital Horus Demonstrator," NOAA, $2.9M
221. N. Goodman, J. Ruyle, H. Sigmarsson, C. Fulton, M. Yeary, R. Palmer, J. Salazar, "Technologies for Next-Generation Conformal and Reconfigurable Radar Systems," ONR, $3.5M
222. T. Yu, R. Palmer, B. Cheong, "Developing strategies for deploying a network of reflected-array radars," Weathernews Inc., $97K
223. B. Cheong, R. Palmer, T. Yu, "Technical Support for the Design and Test of an X-Band SSPA-Based Polarimetric Weather Radar," Novimet, $36K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

224. R. Palmer, C. Fulton, J. Salazar, H. Sigmarsson, M. Yeary, "Development of the All-Digital Horus Radar for SENSR," NOAA, $3.3M
225. T. Yu and B. Cheong, "Phase II: SBIR A16-028:Miniature, Software-defined Man-Portable Doppler
226. Radar (MPDR) for Atmospheric Measurement," Helios Remote Sensing Systems Inc., $164K
227. M. Xue, K. Brewster, C. Zhang, F. Kong, Y. Jung, "Continued Enhancements to FV3 Model with Advanced Physics through CCPP and Convective-Scale Data Assimilation into GSI and JEDI for Convection-Allowing Forecasting and Evaluations through Hazardous Weather Testbed towards Accelerated Operational," NOAA, $200K
228. N. Kaib, "The Formation and Evolution of Multiple Protostar Systems," NSF, $288K
229. X. Wang, "Scale-dependent Covariance Localization for
230. FV3GDAS 4DEnVar Data Assimilation System to
231. Improve Global, Hurricane and Cloud Predictions," NOAA, $194K
232. L. Krumholz, K. D. Hambright, "Dimensions: Collaborative Research: Leveraging Biogeography and Seasonality to Explore Underlying Mechanisms in the Biodiversity of the Cyanobacterial Bloom Microbial Interactome," NSF, $2M (total), $810K (OU)
233. D. Blume, "Spin and Spatial Correlations of Few-body Systems," NSF, $294K
234. X. Wang, Y. Wang, "Development and Research of GSI based Dual Resolution EnVar Data Assimilation for Convective-Scale," NOAA, $106K
235. Y. Shao, "Rational Design of Pro-apoptotic Bax/Bak Inhibitors," OK-CAST, $45K
236. Y. Shao, "Accelerated Free Energy Calculations on the Catalytic Activity of Mercuric Reductase," ORAU, $5K
237. D. K. Walters, "Collaborative Research: Development of Low Order Modeling Methods for Oscillating Foil Energy Harvesting based on Experimental and Computational Fluid Dynamics," NSF, $160K
238. M. Xue, G. Zhang, X. Xue, "Development and Evaluation of an Ensemble Kalman Filter
239. (EnKF)-Based," Beijing Meteorological Service, $50K
240. S. Cavallo, "Tropopause polar vortices and multi-scale Arctic predictability," ONR, $60K
241. A. Johnson, X. Wang, "Understanding and Improving the Predictability of Arctic Meso- and Synoptic-scale Cyclones through Multi-scale Ensemble based Data Assimilation and Ensemble Forecast," ONR, $162K
242. J. Tobin, "NRAO Student Observing Support Award to Nickalas Reynolds: Are Close Binaries Formed Through Disk Fragmentation?" NRAO, $29K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

243. H. Moreno, "Human-scale surface energy budget and ground thermal responses to soil moisture and vegetation change in flat and complex terrain," ARO, $92K
244. G. Kosmopoulou, "(EAGER) Collaborative Research DCL: HBCU Network effects, competition and survival of small and minority owned firms in public procurement," NSF, $76K
245. E. Martin, C. Homeyer, M. Richman, R. McPherson, J. Furtado, "PREEVENTS Track 2: Collaborative Research: Developing a Framework for Seamless Prediction of Sub-Seasonal to Seasonal Extreme Precipitation Events in the United States," NSF, $1.8M
246. B. Moore, J. Basara, K. Brewster, K. Kloesel, B. Illston, F. Carr, K. Brewster, P. Klein, "National Mesonet Program," Earth Networks Inc/Stinger Ghaffarian Technologies, $744K
247. P. Skubic, P. Gutierrez, M. Strauss, B. Abbott, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center," DOE, $148
248. D. Papavassiliou, "Investigation of the effects of turbulent flow on energy and mass transfer close to solid surfaces," NSF, $326K
249. D. Papavassiliou, "Stability of Surfactant Systems for Oil Mobilization," ACS PRF, $110K
250. K. Brewster, F. Carr, "Prototyping and Evaluating Key Network-of-Networks Technologies: Project Extension," NOAA, $194K
251. K. Dresback, R. Kolar, "Steps Towards Automating River Connections and Addressing Precipitation in ADCIRC," NOAA, $101K
252. K. Calhoun, D. Kingfield, K. de Beurs, "Storms, Forms, and Complexity of Urban Canopy," NASA, $21K
253. K. Calhoun, D. MacGorman,"Storm Tracking and Lightning Cell Clustering Using Geostationary Lightning Mapping Data for Data Assimilation and Forecast Applications," NOAA, $110K
254. N. Kaib, "EW Step 2: Understanding the Evolution of the Primordial Kuiper Belt During the Solar System's Early Years," NASA, $315K
255. B. Wawrik, "Primer Validation and Design Project," Total S.A., $112K
256. B. L. Cheong, "The Weather Butler Project," Weathernews Americas Inc, $145K
257. D. Bodine, R. Palmer, S. Torres, B. L. Cheong, C. Fulton, "Understanding the Relationship Between Tornadoes and Debris Through Observed and Simulated Radar Data," NSF, $787K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

258. J. White (OSU), S. Crossley, B. Wang, "Understanding an Active and Beneficial Role for Water in Solid-Acid Catalyzed Hydrocarbon Chemistry," $598K (OU)
259. M. Elwood Madden, "Raman Spectral Database of Aqueous Solutions for Planetary Science," NASA, $381K
260. M. Nanny, I. Sellers, J. Vogel, J. Kelly, R. Ramesh, "MRI: Acquisition of an Inductively Coupled Plasma Mass Spectrometer (ICP-MS) System to Enable Elemental Analysis in Research, Training and Education," NSF, $397K
261. A. McGovern, C. Homeyer, C. Potvin, T. Smith, "EAGER: Improving our Understanding of Supercell Storms through Data Science," NSF, $169K
262. F. Wang, U. Hansmann, "Efficient and Accurate Force Fields for Computer-Aided Drug Design," NIH, $448K
263. U. Hansmann, "Structural Transitions in Proteins and Protein Assemblies," NIH, $1.18M
264. E. Bridge, J. Kelly, X. Xiao, "Enhancing and disseminating miniaturized tracking technology for widespread use on small migratory songbirds," NSF, $303K
265. M. A. Terr (U New Orleans), R. Schmehl (Tulane U), A. V. Callaghan (OU), J. M. Suflita (OU), "Effect of Photochemistry on Biotransformation of Crude Oil," BP, $1.47M
266. M. Xue, A. Fierro, E. Mansell, D. MacGorman, G. Zhao, "Assimilation of High-Frequency GOES-R Geostationary Lightning Mapper (GLM) Flash Ex-tent Density Data in GSI-Based EnKF and Hybrid for Improving Convective Scale Weather Predictions," NASA, $599K
267. A. Fierro, J. Gao, A. Clark, E. Mansell, C. Ziegler, D. MacGorman, Y. Wang, A. Lai, "Real time assimilation of GOES-16 total lightning into the NSSL 3DVAR code to improve 0-12h forecasts of high impact weather events at cloud resolving scales," NOAA, $250K
268. N. Yussouf, M. Erickson (NWS), P. Skinner, A. Fierro, K. Wilson, ""Development and NWS Forecaster Evaluation of a Convective-scale Ensemble System for Probabilistic Heavy Rainfall and Severe Weather Forecasts, NOAA, $417K
269. A. Moore, "Preliminary study of genetic diversity in Grindelia ciliata, a promising biofuel crop native to Oklahoma," OCAST, $100K
270. D. Resasco, B. Wang, "Hydrophobic enclosures in bio-inspired nanoreactors for enhanced phase selectivity. A combined experimental/theoretical approach," DOE, $650K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

271. M. Xue, G, Zhang, "Assimilation of High Frequency GOES-R Geostationary Lightning Mapper (GLM) Flash Ex-tent Density Data in GSI-Based EnKF and Hybrid for Improving Convection Scale Weather Predictions," NOAA, $581K
272. Y. Jung and M. Xue, "Impact of Assimilating Polarimetric Phased Array Radar Observations on Convective-scale Numerical Weather Prediction Model for Severe Weather Forecasts", NOAA, $346K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

273. R. Palmer, B. Cheong, C. Fulton, J. Salazar, H. Sigmarsson, M. Yeary, T. Yu, Y. Zhang, "," NOAA NSSL, $2.51M
274. T. Yu, J. Salazar, C. Fulton, H. Bluestein, R. Palmer, B. Cheong, M. Biggerstaff, B. Isom, J. Kurdzo, R. Doviak, X. Wang, M. Yeary, "MRI: Development of C-band Mobile Polarimetric Imaging Radar," NSF, $3.1M
275. R. Palmer, B. Cheong, C. Fulton, J. Salazar, H. Sigmarsson, M. Yeary, T. Yu, G. Zhang, Y. Zhang, "ARRC Demonstrator Development Activities for the MPAR Program: CPPAR and Horus," NOAA NSSL $2.42M
276. R. Palmer, B. Cheong, "Electromagnetic Sensor Research & Development," Nanowave Technologies, $1.5M
277. S. Wolff, J. Bottum, D Atkins, H. Neeman, "EAGER: Fact-Gathering and Planning for a National-Scale Cyberpractitioner Program," NSF, $41K
278. G. Monaco et al, "The Role of Regional Organizations in Improving Access to the National Computational Infrastructure," NSF, $50K
279. J. Towns et al, "XSEDE: eXtreme Science and Engineering Discovery Environment (supplement)," NSF $3.7M
280. J. Bottum, M. Livny, H. Neeman, N. Tsinoremas, "RCN: Advancing Research and Education Through National Network of Campus Research Computing Infrastructures – The CaRC Consortium," NSF, $748K
281. J. Towns et al, "XSEDE 2.0: Integrating, Enabling and Enhancing National Cyberinfrastructure with Expanding Community Involvement," NSF, $131.8M
282. J. Neeman, J. Bottum, D. Atkins, D. Brunson, S. Wolff, "Cyberinfrastructure Leadership Academy," NSF, $49K
283. F. Kong, M. Xue, "Technical Support to the Storm-Scale Numerical Weather Prediction Capability for Shenzhen Meteorological Bureau," Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, $173K
284. B. Wawrik, Z. Yang, L. Atkinson, "Collaborative Research: Creatine Cycling in Marine Bacterial and Phytoplankton Assemblages," NSF, $362K
285. E. Bridge, "Life history, kinship, and the evolution of alternative female reproductive strategies," $3K
286. M. Biggerstaff;, "Optimizing radar guidance for triggered lightning," DARPA, $200K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

287. C. Ziegler, M. Biggerstaff, M. Coniglio., "Measurement and analysis of nocturnal mesoscale convective systems and their stable boundary layer environment during PECAN," NSF,. $583K
288. M. Biggerstaff;,"Impact of cloud dynamics on chemical and electrical properties of storms observed during DC3," NSF, $661K
289. K. Nicholas, "Deoxygenation and Reductive Coupling of Alcohols Catalyzed by Oxo-Metal Complexes," NSF. $405K
290. S. Schroeder, N. Sloat, "Blue Water Student Internship Program," $5K
291. S. Schroeder, "Protein and Metal Ion Binding in Viral RNA, HIV Accessory and Regulatory Complexes (HARC)," NIH, $25K
292. L. Ding, "RII Track-2 FEC: Innovative, Broadly Accessible Tools for Brain Imaging, Decoding, and Modulation," NSF, $6M
293. L. Ding, "Development of Imaging and EEG Biomarkers to Refine Neuromodulation Treatment Targets in MdDS," LIBR via NdDS, subaward PI, $55K
294. L. Ding, "Development of the EEG Neuroergonomics Toolbox or EEGNT," FAA, $243K
295. J. P. Shaffer, "Atom Surface Interactions and Hybrid Quantum Systems for Quantum Engineering Applications," AFOSR, $750K
296. J. P. Shaffer, "High Sensitivity Absolute Electric Field Sensing with Atoms," National Reconnaissance Office, $309K
297. J. P. Shaffer, "Control of Rydberg Interactions and Exotic States of Matter," NSF, $472K
298. M. J. Wenger, "Building a unified theory methodology for identification of elementary cognitive systems," NSF, $364K
299. B. Wang et al, "High Efficiency Flexible Dilute Nitrides Solar Cells for Space Applications," NASA EPSCoR, $750K
300. D. LaDue, "REU Site: Real-World Research Experiences at the National Weather Center," NSF, $885K
301. K. Marfurt, "3D Seismic Attribute Analysis using AASPI Prestack Technology," Korea Institute of Geoscience Mineral Resources, $35K
302. B. Moore, "National Mesonet Program 2015-2021," Global Science Technology Inc, $473K
303. S. Cavallo, "Multi-scale Predictability with a New Coupled Non-hydrostatic global model over the Arctic," DOD-ONR, $273K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

304. X. Chen, "Multi-scale validation of earthquake source parameters to resolve any spatial, temporal or magnitude-dependent variability at Parkfield, CA, "NSF, $224K
305. J. Ruyle, "Electrically Small Antenna Design Tool," U.S. Federal Govt, $110K
306. J. Ruyle, "Two-Dimensionality for Conformal Multi-Platform Use," DARPA, $499K
307. X. Wang, "Ensemble Kalman Filter and Hybrid Data Assimilation for Convective-Scale," $73K
308. X. Wang, "Developing and Evaluating GSI-based EnKF-Variational Hybrid Data Assimilation for NCEP NAMRR to Improve Convection-Allowing Hazardous Weather Forecast," NOAA, $123K
309. X. Wang, "Hybrid Data Assimilation for Convective-Scale," NOAA, $99K
310. X. Wang, "Improving Global and Hurricane Prediction b Using Minimum-Cost Large Ensemble in GFS 4DEnVar Hybrid Data Assimilation System," NOAA, $389K
311. X. Wang, "Tzero Revolution," Weathernews Americas, Inc., $59K
312. X. Wang, "Improving the Understanding and Prediction of Nocturnal Convection through Advance Data Assimilation and Ensemble Simulation in PECAN," NSF, $602K
313. J. Dyer, "Heart Rate Variability Assessment as an Indicator of Health," OUHSC, $121K
314. M. Zaman, "Southern Plains Transportation Center (SPTC)," USDOT, $7.7M
315. M. Zaman, "Matching Support for The Southern Plains Transportation Center," State of Oklahoma, Dept of Transportation, $3M
316. K. De Beurs, "Storms, Forms, and Complexity of the Urban Canopy: How Land Use, Settlement Patterns, and the Shapes of Cities Influence Severe Weather," NASA, $437K
317. E. Baron, "Models of Interacting Supernovae: Probing the Circumstellar Environment," NASA, $381K
318. A. Fierro, K. Calhoun, E. Mansell, C. Ziegler, D. MacGorman, J. Gao, "Assimilation of GOES-R total lightning into GSI to improve short-term forecasts of high impact weather events at cloud resolving scales," NOAA, $230K
319. M. Xue, K. Brewster, Y. Jung, , "Advanced Data Assimilation and Prediction Research for Convective-Scale 'Warn-on-Forecast'," NOAA, $450K
320. M. Xue, F. Kong, Y. Jung, N. Snook, "mproving Initial Conditions and their Perturbations through Ensemble-Based Data Assimilation for Optimized Storm-Scale Ensemble Prediction in Support of HWT Severe Weather Forecasting," NOAA, $249K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

321. M. Xue, K. Brewster, F. Kong, "Storm-Scale Ensemble Prediction Optimized for Heavy Precipitation Forecasting in Support of the Hydrometeorological Testbed (HMT)," NOAA, $236K
322. J. Kelly, E. Bridge, P. Chilson, A. McGovern, K. deBeurs, J. Reedy, L. Jervis, "NRT: Aeroecology as a testbed of interdisciplinary STEM training," $2.95M
323. F. Carr, J. Brotzge, "National Mesonet Program", GST and Earth Networks, $50K
324. F. Carr, K. Brewster, "National Mesonet Program," $100K
325. F. Carr, J. Brotzge, K. Brewster, "Network of Networks: Preliminary Study," NOAA/NWS Office of Science and Technology, $210K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

326. J. van de Lindt, B. Ellingwood, A. Cerato, N. Wang, C. Nicholson et al, "NIST Center for Risk-Based Community Resilience Planning," $1.37M
327. J. van de Lindt, A. Cerato, N. Wang, "A Risk-Informed Decision Framework to Achieve Resilient and Sustainable Buildings that Meet Community Objectives," NSF, $380K
328. J. Straka, K. Kanak, "Challenges in understanding tornadogenesis and associated phenomena," NSF, $750K
329. J. Straka, "Challenges in understanding tornadogenesis and associated phenomena (supplement)," NSF, $29K
330. P. Kirstetter, B. L. Cheong, T.-Y. Yu, "Deployment of a Novel Solid-state Polarimetric Weather Radar for Hydrology," NSF, $87K
331. B. L. Cheong, R. D. Palmer, "Development of a Novel Solid-State Polarimetric Weather Radar PX-10,000," Nanowave Technologies, Inc., $550,000,
332. K. Nicholas, "Catalytic Deoxydehydration," DOE, $438K
333. M. Libault, "CAREER: Exploring the Transcriptional Regulatory Networks Controlling the Early Stages of Legume Nodulation," NSF, $1.1M
334. B. Shiau, D. Papavassiliou, J. Harwell, "Interfacially active SWNT/silica nanohybrids," Advanced Energy Consortium, $419K
335. S. Crowell, B. Moore, Y. Luo, "Improved Parameterization of Carbon Cycle Models Across Scales Using OCO-2 Measurements of XCO2 and SIF," NASA, $477K
336. B. Wawrik, "MGMIC: Metagenome Analysis for Corrosion Tracking," OU Biocorrosion Center, $131K
337. B. Wawrik, A. Callaghan, "Development of Techniques for the Quantification of Functional Gene Expression Associated with Biocorrosion," OU Biocorrosion Center, $37K
338. B. Wawrik, D. Bronk, "Collaborative Research: Determining Rates of Group-specific Phytoplankton and Bacterial Uptake of Inorganic and Organic Nitrogen by means of Stable Isotope Techniques," NSF, $770K
339. A. Callaghan, B. Wawrik, J. Suflita, "Biochemistry and Genetics of Anaerobic Alkane Metabolism: Interrogation of Sulfate-Reducing Isolates and Enrichments Using Genome-Enabled and Proteomic Approaches," NSF, $725K
340. B. Wawrik, "Determining Rates of Group-specific Phytoplankton and Bacterial Uptake of Inorganic and Organic Nitrogen by Means of Stable Isotope Techniques," NSF, $10K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

341. B. Wawrik, G. Sinclair, "Transcriptomic Response to Nutrient Depletion of Marine Dinoflagellates," Gordon and Betty Moore Foundation, $70K in-kind
342. Joseph M. Suflita. Co-PIs: A. Callaghan, L. Gieg, Z. He, B. Wawrik, J. Zhou, "Extending Knowledge of Anaerobic Hydrocarbon Metabolism: Linking Metabolism, Functional Gene Molecular Markers and the GeoChip," ConocoPhillips, $999K
343. A. Striolo, "Anti-Agglomerants Performance in Hydrates Management: Fundamental Insights," EPSRC, £330K
344. A. Striolo et al, "ShaleXenvironmenT," European Commission, €3M
345. A. Striolo, "Flow Transport in Shale Rocks," Halliburton, £69K
346. A. Striolo, D. Cole, "Nanopore Confinement of C-H-(O) Mixed-Volatile Fluids Relevant to Subsurface Energy Systems," DOE, £60K
347. A. Striolo, "Hydrates Inhibitor Research," Halliburton, £69K
348. A. Striolo, "Fraccing Fundamentals," Marie Curie Career Integration Grant, €100K
349. J. Li, "Targeting Mosquito FREP1 Protein for Malaria Control," NIH, $424K
350. J. Li, "CAREER: Genetic and Molecular Mechanisms of Parasite Infection in Insects," NSF, $783K
351. D. Atkins, J. Li, "Memory T cell-mediated protecting against malaria," NIH, $76K
352. J. Li, "Genomics analysis of Anopheles gambiae mosquitoes to Plasmodium falciparum parasite Infection," OCAST, $135K
353. P. Klein, P. B. Chilson, E. Fedorovich, A. Shapiro, D. Turner, "Low-level jets in the nocturnal stable boundary layer: structure, evolution, and interactions with mesoscale atmospheric disturbances," NSF, $984K
354. E. Bridge, "The Electronic Transponder Analysis Gateway (ETAG): An Animal Behavior Observatory," NSF, $315K
355. B. Capogrosso-Sansone, "Multi-Worm Algorithm for Path Integral Quantum Monte Carlo in Ultracold Dipolar Gases, NSF, $293K
356. K. Dresback, R. Kolar, "Performance Optimization of the Advanced Circulation (ADCIRC) Model," Intel Parallel Computing Center, $300K
357. U. Hansmann, "Modeling the molecular mechanism of amyloid oligomer and fibril self assembly," OCAST, $90K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

358. J. Wicksted, A. Knoedler et al, "Adapting Socio-ecological Systems to Increased Climate Variability," NSF, $20M + $4M Regents (total), $7.0M + $1.9M Regents (OU)
359. M. Engle et al, "Resilience and vulnerability of beef cattle production in the Southern Great Plains under changing climate, land use and markets," $9.5M (total), $1.9M (OU)
360. R. Palmer, G. Zhang, Y. Zhang, T. Yu, M. Yeary, S. Karimkashi, C. Fulton, B. Cheong, "Multi-Mission Phased Array Radar Risk Reduction: A Collaborative Effort with the ARRC at the University of Oklahoma," NOAA, $1.5M
361. R. Palmer, G. Zhang, Y. Zhang, T. Yu, M. Yeary, Y. Hong, J. Crain, P. Chilson, "Next Generation Weather Radar Technology," NOAA, $900K
362. R. Palmer, D. Bodine, S. Torres, B. Cheong, C. Fulton, "Understanding Polarimetric Radar Tornadic Debris Signatures Using Modeling, Simulations, and Field Measurements,," NSF, $860K
363. A. Callaghan, "Elucidation of Alkene Metabolism in Two Sulfate-reducing Isolates via Metabolite Profiling and Transcriptomics," NSF, $848K
364. D. LaDue, K. Kloesel, "REU Site: Research Experiences for Undergraduates at the National Weather Center," NSF, $822K
365. J. Brotzge, M. Xue, N. Snook, Y. Jung, A. McGovern, "The Severe Hail Analysis, Representation, and Prediction (SHARP) Project," NSF, $819K
366. L. Krumholz, J. Zhou, M. McInerney, J. Wall, "Characteristics of H2 Producing Biological Systems Operating at 1 nM H2 Concentration," DOE, $819K (total), $693K (OU)
367. P. Chilson, E. Fedorovich, R. Palmer, "Studies of the Atmospheric Boundary Layer Using Numerical Simulations Coupled With Radar/Sodar-Based Field Experiments," NSF, $757K
368. M. Xue, K. Brewster, F. Kong, "Establishment of Precision Weather Analysis and Forecasting Systems (PWAFS) for the Jiangsu Province Meteorological Bureau (JSMB)," NRIET, $505K
369. H. Neeman, D. /Brunson, J. Deaton, S. Radhakrishnan et al, "CC-NIE: OneOklahoma Friction Free Network," NSF, $500K
370. F. Kong, M. Xue, "Further Development of the Storm-Scale Numerical Weather Prediction Capability for Shenzhen Meteorological Bureau," Shenzhen, $479K
371. E. Bridge, J. Kelly, "Optimizing Grassland Bird Conservation in an Era of Biofuel Production," USDA, $466K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

372. R. Kolar, "Dynamic Integration of Natural, Human, and Instructure Systems for Hurricane Evacuation and Sheltering," NSF, $456K
373. L. Ding, "Neuroimaging Study of Mental Fatigue," FAA, $430K
374. U. Hansmann, "Development of Generalized-Ensemble Algorithms and their Application in Protein Studies," NSF, $410K
375. L. Ding, "Large-Scale Computational Neuroimaging of Brain Electrical Activity," NSF CAREER, $400K
376. P. Attar, "Optimal Spatiotemporal Reduced Order Modeling for Nonlinear Structural Dynamics," NSF, $360K
377. B. L. Cheong, Y. Jung, G. Zhang,, "Support for X-band Solid-state Weather Radar Development," WeatherLink, $334K
378. P. Vedula, P. J. Attar, "Fast simulations of turbulent flows based on spatiotemporal statistical information," NSF, $330K
379. M. Xue, K. Brewster, F. Kong, "Development of a Short-Range Realtime Analysis and Forecasting System based on the ARPS for Taiwan Region Year 3 (IA#24) and Year 4 (IA #25)," NOAA, $310K
380. E. Bridge, J. Kelly, X. Xiao, "Enhancing and disseminating miniaturized tracking technology for widespread use on small migratory songbirds," NSF, $302K
381. J. Kelly, L. Gruenwald, P. Chilson, V. Lakshmanan, E. Bridge, "Advancing Biological Interpretations of Radar Data," NSF EAGER, $299K
382. L. Ding, "High-Resolution Noninvasive Computational Neuroimaging," OCAST, $283K
383. F. Kong, "Further Development to the Storm-Scale Numerical Weather Prediction Capability for Shenzhen Meteorological Bureau," SIATCAS, $251K
384. R. Slatt, Consortium from 14 oil and gas company, $245K
385. J. Brotzge, F. Carr, "Protyping and Evaluating Key Network-of-Networks Technologies: Project Extension," NOAA, $210K
386. Y. Jung, M. Xue, G. Zhang, "Development of a Polarimetric Radar Data Simulator for KLAPS," KMA, $176K
387. J. Ruyle, "BRIGE: Investigation of Slot Antenna Recon figuration Mechanisms," NSF, $175K
388. J. Brotzge, F. Carr, "CASA Warning System Innovation Institute," U Mass, $160K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

389. J. Kelly, "Developing Innovative Tools to Use Weather Radar Data to Assess and Monitor Impacts of Existing and Future Energy Facilities on Aerial Faunas in California," CIEE, $150K (total), $49K (OU)
390. J. Brotzge, F. Carr, "Prototyping and Evaluating Key Network-of-Networks Technologies," NOAA, $145K
391. T. Yu, Y. Wang, R. Palmer, B. Cheong, „Algorithm development for solid-state polarimetric weather radars," Toshiba, $130K
392. M. Xue, K. Brewster, F. Kong, "Establishment of an Urban-Scale Weather Forecasting System (USWFS) for the Su Zhou Meteorological Bureau (SZMB)," $127K
393. L. Ding, "Neurophysiological Assessment of Mental Fatigue and Cognitive Performance," FAA, $115K
394. K. Dresback, R. Kolar, "Next Generation ADCIRC Tidal Database: Phase 2 - West Coast," DOD, $75K
395. K. Dresback, R. Kolar, "Next Generation ADCIRC Tidal Database," NOAA, $75K
396. P. Risser, J. Duckles, J. Bratton, NSF I-Corps, $50K
397. R. Palmer, M. Yeary, "System and Software Engineering Support Services for CGI," CGI, $46K
398. M. Yeary, M. Xue, "GRDS: Request to support a Native American Indian graduate student beginning his PhD within the CASA Engineering Research Center," NSF, $32K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

399. I. Y. Akkutlu, J. Callard, C. Rai, C. Sondergeld, "OU Shale Gas and Unconventional Reservoir Research Cooperative," $2.8M per year
400. J. P. Shaffer, T. Pfau, "A Rydberg Atom Electric Field Sensor," DARPA-ARO, $1.18M (total),$1.06M (OU)
401. Y. Luo, "Data Synthesis and Data Assimilation at Global Change Experiments and Fluxnet toward Improving Land Process Models," DOE, $1.05M
402. F. Kong, M. Xue, K. Brewster, "Establishment of an Improved Numerical Weather Forecasting System for Chongqing Meteorological Service," Chongqing Institute of Green and Intelligent Technology, China, $852K
403. G. Zhang, M. Xue, B. L. Cheong, T. J. Schurr, "Advanced Study of Precipitation Microphysics with Multi-Frequency Polarimetric Radar Observations and Data Assimilation," NSF, $637K
404. J. P. Shaffer, "A Quantum Hybrid System for Linking Rydberg Atom Quantum Gates. NSF, $465K
405. J. P. Shaffer, "Rydberg Atom Interactions and Collective Behavior," NSF, $436K
406. J. P. Shaffer, "Interactions in Cold Rydberg Gases," NSF, $422K
407. J. Cruz, "CIF: Small: Two-Dimensional Channel Modeling, Detection and Coding for Shingled Magnetic Recording," NSF, $418K
408. M. Yuan, "Supplement to Developing and Evaluating the Effectiveness of the Location-based Offender Monitoring System for Offender Supervision," National Institute of Justice, $396K
409. X. Wang, M. Xue, F. Kong, "Optimal Design of Multi-scale Ensemble Systems for Convective-Scale Probabalistic Forecasting," NSF, $359K
410. F. Kong, M. Xue, "Further Development of the Storm-Scale Numerical Weather Prediction Capability for Shenzhen Meteorological Bureau," Shenzhen Institute of Advanced Technology, China, $251K
411. J. Snow & F. Fondjo Fotou (Langston U), "MRI: Acquisition of a High Performance Computing Cluster for Research and Education," NSF, $250K
412. M. Xue, K. Brewster, Y. Jung, "Advanced Data Assimilation and Prediction Research for Convective-Scale Warn-on-Forecast," NOAA, $243K
413. I.Y. Akkutlu, "Multi-scale Characterization of Transport Phenomena in Shales for Improved Gas Recovery," Devon Energy, $200K
414. M. Xue, R. McPherson, J. Brotzge, B. Moore, "Very High-Resolution Dynamic Downscaling of Regional Climate and Hydrology," USG, $24K
415. J. Brotzge, F. Carr, "CASA DFW Testbed Enchancement: Task B of National Mesonet Program (NWP)," Earth Networks Inc., $25K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

416. R. Voronov, "Intra-Thrombus Chemo-Transport and Local Stress Mechanics under Flow," American Heart Association Postdoctoral Fellowship, $150K
417. X. Wang, M. Xue, "Improving High Resolution Tropical Cyclone Prediction using GSI-based Hybrid Ensemble-Variational Data Assimilation System for HWRF," NOAA, $150K
418. I. Y. Akkutlu, "Molecular Theory of Capillarity in Kerogen - A Multi-component Approach to Predict Shale Gas/Liquid In-place and Transport in Nanopores," Devon Energy, $150K
419. S. Dhall, L. Gruenwald, "Autonomous Database Partitioning using Data Mining for High End Computing," NSF, $150K
420. M. Xue, K. Brewster, F. Kong, "Ensemble Simulation of GOES-R Proxy Radiance Data from CONUS Storm-Scale Ensemble Forecasts, Product Demonstration and Assessment at the Hazardous Weather Testbed GOES-R Proving Ground," NOAA, $126K
421. M. Xue, K. Brewster, F. Kong, "Ensemble Simulation of GOES-R Proxy Radiance Data from CONUS Storm-Scale Ensemble Forecasts, Product Demonstration and Assessment at the Hazardous Weather Testbed GOES-R Proving Ground," NOAA, $94K
422. K. Brewster, M. Xue, "High Resolution Data Assimilation for Trajectory Improvement," DOD-Air Force, $79K
423. F. Kong, "CAPS support to the WRF Lightning Forecast Algorithm for the NOAA R3 effort," NOAA GOES-R/Universities Space Research Assn, $48K
424. R. McPherson, M. Shafer, Y. Hong, "Utilization of Regional Climate Science Programs in Reservoir and Watershed Impact Assessments," OSU Water Resources Responses to Climate Change: Pilot Study, $43K
425. P. Attar, "Numerical Simulation of a Membrane Micro Air Vehicle in a Gust Field, Ohio Aerospace Institute, $35K
426. J.R. Cruz, "Signal Processing for Magnetic Recording Channels," Hitachi Global Storage Technologies, Inc., Director, $30K
427. J.R. Cruz, "Equalization, Detection, and Coding Algorithms for Bit Patterned Media Recording," Advanced Storage Technology Consortium, $17K
428. L. Sells, J. Goulden, H. Aboudja, "LittleFe grant," LittleFe project, $2.5K
429. L. Sells, J. Goulden, "Early Adopter Grant," NSF/TCPP, $2.5K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

430. B. Moore III et al, "Department of the Interior South-Central Regional Climate Science Center," US Dept of the Interior, $3.5M (total), $1.4M (OU)
431. A. Striolo, D. Resasco et al, "Center for Application of Single-Walled Carbon Nanotubes," DOE, $1M
432. J. K. Shen, "CAREER: Electrostatic Mechanisms in Protein Stability and Folding, NSF, $773K
433. Y. Kogan, "Parameterization of cumulus convective cloud systems in mesoscale forecast models," ONR, $594K
434. X. Wang, M. Xue, F. Kong, "Optimal Design of Multi-scale Ensemble Systems for Convective-Scale Probabilistic Forecasting," NSF, $395K
435. R. D. Palmer, T.-Y. Yu, "NMQ and WDSS-II for the KMA radar network: Real-time, effective, and integrated weather products," Space Environment Laboratory, Inc., $361K
436. B. Grady, A. Striolo, "Novel Supramolecular Structures of Laterally Confined Amphiphilic Molecules," NSF, $335K
437. D. Resasco, D. Papavassiliou et al, "Interfacially active SWNT/silica nanohybrids," Advanced Energy Consortium, $331K
438. C. Y. Tang , R. Ramakumar, N. Jiang , "Control and Operation of Large-Scale Wind Farms in the Power System", NSF, $231K
439. J. Shen, "Electrostatic Modulationof Protein Stability and Folding," NIH, $1.4M
440. Y. Wang, "Theoretical Tools for Measuring Dark Energy from Galaxy Clustering," DOE, $230K
441. F. Kong, M. Xue, "Further Enhancement to the Hourly Assimilation and Prediction System (HAPS) for Shenzhen Meteorological Bureau." Shenzhen Institute of Advanced Technology, Chinese Academy of Science, $228K
442. P. Attar, P. Vedula, "Multi-fidelity Modeling and Simulation (M&S) Tool for Nonlinear Aeroelasticity," Advanced Dynamics, $160K
443. B. Eskridge, "CDI-TYPE I: RUI: Emergent Hierarchies of Leaders in Multi-Robot Systems," NSF, $159K
444. A. Striolo, "Mixed-Volatile Fluids Relevant to Subsurface Energy Systems," DOE, $120K
445. P. Skubic, M. Strauss, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center (Supplement)," NSF, $110K
446. P. Attar, "High-Fidelity Computational Aeroelastic Solver Research," Ohio Aerospace Institute, $53K
447. P. Skubic, M. Strauss, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center (Supplement)," NSF, $50K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

448. P. Skubic, M. Strauss, "University of Oklahoma Contribution to OSG Software Development," Brookhaven National Laboratory, $50K.
449. P. Attar, "Computational Model Development and Experimental Validation Measurements for Membrane-Batten Wing," Ohio Aerospace Institute, $43K
450. A. Striolo, "Reduced Carbon in Earth's Crust and Mantle I," Alfred P. Sloan Foundation, $39K.
451. J. Gao, "Advancing Research on Realtime Weather-Adaptive 3DVAR Analyses with Automatic Storm Positioning and On-demand Capability," NOAA, $36K
452. M. Xue, "Probabilistic Forecasting for Aviation Decision Aid Applications," Impact Technologies,$20K
453. P. Attar, P. Vedula, "Towards Better Modeling and Simulation of Nonlinear Aeroelasticity On and Beyond Transonic Regimes," Advanced Dynamics, $20K
454. P. Attar, P. Vedula, "High-Fidelity Computational Aeroelastic Models in Support of Certification Airworthiness of Control Surfaces with Freeplay and Other Nonlinear Features," Advanced Dynamics, $9K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

455. H. Neeman, D. Brunson (OSU), J. Deaton (OneNet), J. He (Noble Foundation), D. Schoenefeld (TU), J. Snow (Langston U), M. Strauss (OU), X. Xiao (OU), M. Xue (OU), "Oklahoma Optical Initiative," NSF, $1.17M
456. H. Neeman, M. Jensen, M. Strauss, X. Xiao, M. Xue, E. Baron, K. Dresback, R. Kolar, A. McGovern, R. Palmer, D. Papavassiliou, H. Severini, P. Skubic, T. Trafalis, M. Wenger, R. Wheeler (Duquesne U), "MRI: Acquisition of Extensible Petascale Storage for Data Intensive Research," NSF, $793K
457. D. Resasco, J. Harwell, F. Jentoft, K. Gasem, S. Wang, "Center for Interfacial Reaction Engineering (CIRE)," DOE EPSCoR, $2.4M ($1.97M OU)
458. P. Skubic, M. Strauss, B. Abbott, P. Gutierrez, "Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the Large Hadron Collider (LHC) (TASK A) 2010-2013 Renewal," DOE, $2.8M
459. R. Palmer, Y. Zhang, G. Zhang, T. Yu, M. Yeary, Y. Hong, J. Crain, P. Chilson, "Next Generation Phased Array," NSSL, $2M
460. P. Skubic, M. Strauss, B. Abbott, P. Gutierrez, "Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the Large Hadron Collider (LHC) (TASK A) 2010-2013 Renewal-Revision," DOE, $1.52M
461. D. Cole, Alberto Striolo, "Structure and Dynamics of Earth Materials, Interfaces and Reactions," DOE, $1.5M ($90K OU)
462. R. Sigal, F. Civan, D. Devegowda, "Simulation of Shale Gas Reservoirs Incorporating the Correct Physics of Capillarity and Fluid Transport," Research Partnership to Secure Energy for America (RPSEA), $1.05M
463. M. Biggerstaff , J. Straka, L. Wicker, Zrnic, Zahari, "MRI Development of C-Band Mobile Polarimetric Weather Radars," NSF, $989K ($439K OU)
464. D. Resasco, D. Papavassiliou et al, "Carbon Nanotube Technology Center," DOE, $925K
465. M. Saha, D. Papavassiliou, A. Striolo, K. Mullen, B. Grady, C. Altan, D. Resasco, "Experimental and theoretical studies of carbon nanotube hierarchical structures in multifunctional polymer composites," DoD-EPSCoR, $897K
466. E. Mansell , J. Straka, C. Ziegler, D. MacGorman, "Numerical modeling studies of storm electrification and lightning," NSF, $817K
467. E. Rasmussen, J. Straka, K. Kanak, "Collaborative Research: Challenges in understanding tornadogenesis and associated phenomena, $755K ($489K OU)
468. J. Straka, K. Kanak, "Challenges in tornadogenesis and associated phenomena," NSF, $584K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

469. M. Xue, F. Kong, "Advanced Multi-Moment Microphysics for Precipitation and Tropical Cyclone Forecast Improvement with COAMPS," ONR, $592K
470. J. Straka, K. Kanak, "Collaborative Research: Challenges in Understanding Tornadogenesis and Associated Phenomena," NSF, $515K
471. D. MacGorman, E. Mansell, C. Ziegler, A. Fierro, M. Xue, "Techniques for Assimilating Geostationary Lightening Mapper Data and Assessment of the Resulting Impact on Forecasts," NOAA, $415K
472. M. Xue, F. Kong, K. Brewster, X. Wang, "A Partnership to Develop, Conduct, and Evaluate Realtime High-Resolution Ensemble and Deterministic Forecasts for Convective-scale Hazardous Weather: Moving to the Next Level," NOAA CSTAR, $375K
473. M. Xue, K. Brewster, J. Gao, X. Wang, "Advanced Data Assimilation and Prediction Research for Convective-Scale 'Warn-on-Forecast,'" $500K, NOAA
474. X. Wang, "Improving satellite radiance data assimilation using a hybrid ensemble-Gridpoint Statistical Interpolation (GSI) method for global numerical weather prediction," NASA, $276K
475. X. Wang, M. Xue, "Improving NOAA operational global numerical weather prediction using a hybrid-ensemble Kalman filter data assimilation and ensemble forecast system," NOAA, $207K
476. D. Resasco, D. Papavassiliou et al, "Interfacially active SWNT/silica nanohybrids," Advanced Energy Consortium (AEC), $333K
477. D. Oliver, "Data analysis and inversion for mobile nanosensors," AEC, $320K
478. R. Palmer, T. Yu, G. Zhang, M. Yeary, P. Chilson, Y. Zhang, J. Crain, "Advancements in Phased Array Weather Radar Research at OU," NOAA National Severe Storms Laboratory (NSSL), $270K
479. A. Striolo, "The Emergent Behavior of Solid Nanoparticles at Oil-Water Interfaces: A Multi-Scale Thermodynamic Approach to Enable Bio-Oil Upgrade," NSF, $238K
480. M. Xue, K. Brewster, F. Kong, "Development of a Short-Range Realtime Analysis and Forecasting System based on the ARPS for Taiwan Region," NOAA, $200K
481. J. Straka, K. Kanak, "Formative dynamics of the mammatus clouds in thunderstorm cirrus," NSF, $318K
482. M. Yeary, C. Tang, "Computationally Efficient Linear Transforms for Remote Sensing Systems," NSF, $299K
483. A. Striolo, "Probing regular solution theory for mixed amphoteric/ionic surfactant systems by molecular dynamics simulations," ACS, $100K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

484. K. Brewster, M. Xue, F. Kong, meteorology project, $211K
485. M. Xue, meteorology project, $120K
486. A. McGovern, "Learning to guide search in large state spaces," IBM DARPA, $95K
487. J. Straka, K. Kanak, "Supplement: Challenges in tornadogenesis and associated phenomena (VORTEX2)," NSF, $87K
488. F. Kong, M. Xue, "Establishment of an Experimental Real-Time Short-Term Storm Prediction System for Shenzhen Meteorological Bureau," $58K
489. J. Straka, "Improved Understanding/Prediction of Severe Convective Storms and Attendant Phenomena through Advanced Numerical Simulation," NSF, $58K
490. M. Xue, "Assimilation of NEXRAD Radial Winds in a Regional Mesoscale Model," Miss State U, $79K
491. J. Cruz, R. Todd, "Medium-Density Parity-Check Codes for Tape Systems," INSIC, $36K
492. M. Xue, D. Stensrud, J. Gao, "Advancing Warn on Forecast – Storm-scale Analysis of Vortex 2 Thunderstorms," NSSL, $70K
493. P. Attar, "High-Fidelity Computational Aeroelastic Solver Research," Ohio Aerospace Institute, $60K
494. J. Straka, K. Kanak, "Development of Unmanned Aircraft System for Research in a Severe Storm Environment and Deployment within the VORTEX 2," NSF, $44K
495. J. Cruz, "Equalization, Detection, and Coding Algorithms for Bit Patterned Media Recording Channels," International Storage Industry Consortium (INSIC), $35K
496. J. Cruz, R. Todd, "Signal Processing for Magnetic Recording Channels," private company, $30K
497. P. Attar, P. Vedula, "Deterministic and Statistical Characterization of the Impact of Control Surface Freeplay on Flutter and Limit-Cycle Oscillation (LCO) using Efficient Computational Modeling," Advanced Dynamics, $30K
498. P. Attar, P. Vedula, "Novel Reduced Order in time Models for Problems in Nonlinear Aeroelasticity," Advanced Dynamics, $29K
499. F. Carr, J. Straka, "Severe storm research," Jonathon Merage Foundation, $21K
500. F. Carr, J. Straka, "Severe storm research," Jonathon Merage Foundation, $20K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

501. A. Striolo, "Electrolytes at Solid-Water Interfaces: Theoretical Studies for Practical Applications," DOE EPSCoR, $450K
502. A. Striolo, Saha, "Experimental and Theoretical Studies of Carbon Nanotube Hierarchical Structures in Multifunctional Polymer Composites," DOD EPSCoR, $450K
503. D. Cole (ORNL), A. Striolo, "Structure and Dynamics of Earth Materials, Interfaces and Reactions," DOE, $1.5M ($75K OU)
504. D. Papavassiliou, A. Striolo, "Effects of Hydrophobicity-Induced Wall Slip on Turbulence Drag and Turbulence Structure," NSF, $230K
505. A. Striolo, D. Resasco, U. Nollert, "Understanding the Interactions between Carbon Nanotubes and Cellular Membranes," NSF, $380K
506. M. Xue, Y. Hong, X. Hu (GSU), "Integrated Weather and Wildfire Simulation and Optimization for Wildfire Management," NSF, $997K ($483K OU)
507. Y. Hong, "Next Generation QPE: Toward a Multi-Sensor Approach for Integration of Radar, Satellite, and Surface Observations to Produce Very High-resolution Precipitation Data," NOAA/OAR/NSSL via CIMMS, $83K
508. R. Palmer, Y. Hong, "Phased Array Technology for Weather Radar Applications," NOAA/OAR/NSSL via CIMMS, $426K
509. Y. Hong, Baski (OSU), "Proactive approach to transportation resource allocation under severe winter weather emergencies," OK-DOT/OTC, $261K ($101K OU)
510. R. Palmer, Y. Hong, "Atmospheric Observations using PhasedArray Technology," $340K
511. Y. Hong, "Toward Improved Flood Prediction and Risk Mitigation: Capacity Building for Africa," NASA, $87K
512. Y. Hong, "Improving NASA Global Hazard System and Implementing SERVIR-Africa," NASA, $272K
513. Y. Hong, "Link SERVIR-Africa Work to NASA Land Information System: Workshop Training and Data Assimilation of GRACE to NASA-OU Hydrologic Model," NASA, $10K
514. R. Adler (NASA), Y. Hong, "Global Hazard (Flood-Landslide) Decision-Support System," NASA, $900K
515. S. Schroeder, "CAREER: Advancing Viral RNA Structure Prediction," NSF, $750K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

516. P. Attar, "High Fidelity Computational Aeroelastic Analysis of a Flexible Membrane Airfoil Undergoing Dynamic Motion," Ohio Aerospace Institute, $35K
517. P. Attar, "Computational Model Development and Experimental Validation Measurements for Membrane-Batten Wing" Flexible Membrane Airfoil Undergoing Dynamic Motion," Ohio Aerospace Institute, $43K
518. K. Droegemeier, F. Kong, P. Attar, "A Partnership to Develop, Conduct, and Evaluate Realtime High-Resolution Ensemble and Deterministic Forecasts for Convective-scale Hazardous Weather," NOAA, $375K
519. M. Xue, G. Zhang, K. Brewster, F. Kong, "Prediction and Predictability of Tropical Cyclones over Oceanic and Coastal Regions and Advanced Assimilation of Radar and Satellite Data for the Navy Coupled Ocean-Atmosphere Mesoscale Prediction System," ONR/DOD EPSCoR, $476K; OK Board of Regents $100K
520. S. Ahalt, A. Apon, D. Lifka, H. Neeman, "NSF Workshop High Performance Computing Center Sustainability," NSF, $49K ($0 OU)
521. Y. Luo, S. Lakshmivarahan, "Development of a Data Assimilation Capability towards Ecological Forecasting in a Data-Rich Era," NSF, $1.08M
522. Y. Luo, D. Schimmel (NEON), J. Clark (Duke U.), Kiona Ogle (U. Wyoming), S. LaDeau (Cary Institute of Ecosystem Study), "RCN: Forecasts Of Resource and Environmental Changes: Data Assimilation Science and Technology (FORECAST)," NSF, $500K
523. J. Straka, K. Kanak, Davies-Jones, H. Neeman, "Challenges in understanding tornadogenesis and associated phenomena," NSF, $854K
524. P. Risser et al, "A cyberCommons for Ecological Forecasting," NSF, $6M ($2.78M OU)
525. M. Xue, X. Wang, X. Li (OSU), R. Barnes, S. Sanielevici (PSC), H. Neeman, "Enabling Petascale Ensemble-Based Data Assimilation for the Numerical Analysis and Prediction of High-Impact Weather," NSF, $1.2M ($902K OU)
526. P. Skubic, B. Abbott, P. Gutierrez, M. Strauss, "ATLAS Southwest Tier 2 Computing Center," NSF, $600K/year ($60K/year OU)
527. Y. Hong, "Evaluation of NASA Global Hazard System," NASA, $45K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

528. J Wicksted, F. Waxman et al, "Building Oklahoma's Leadership Role in Cellulosic Bioenergy," NSF EPSCoR, $15M ($5.7M OU)
529. D.S. Oliver, software, $16.7M
530. K.K. Muraleetharan, G. Miller, and A. Cerato, "Understanding and Improving the Seismic Behavior of Pile Foundations in Soft Clays," NSF, $1.15M ($500K OU)
531. K. Droegemeier, F. Kong, "Multisensor Studies of Precipitation for Model Verification and Data Assimilation," U Minn, ($7K OU)
532. K. Droegemeier, M. Xue, F. Kong, "Observing System Simulation Experiments for Airborne Weather Sensors," HRL, ($33K OU)
533. M. Nollert, Scholarship, FD-OMRF, $12K
534. R. Sigal, R. Philp, C. Rai,, S. Shah, R. Slatt, C. Sondergeld, D. Zhang, energy company, $1.9M
535. B. Grady, D. Schmidtke, A. Striolo, A. Cheville, D. Teeters, "Polymer Nanostructures on Solid Surfaces,"$208K ($125K OU)
536. T. Conway, "E. coli Model Organism Resource," UN-Purdue, ($685K OU)
537. R. Kolar, "Storm Surge Modeling in SE Liousiana - 2006," ARCADIS, ($37K OU)
538. D. Cole (ORNL), A. Striolo, "Rates and Mechanisms of Mineral-Fluid Interactions at the Nanoscale," DOE, $1.65M (total), ($55K OU)
539. R. Kolar, "A Prototype Operational Modeling System for Waves, Coastal Currents, Inundation and Hydrologic Flooding for Eastern North Carolina," UN-UNC-CH, ($209K OU)
540. R. Kolar, "A Coupled Regional-Coastal Ocean Model: HYCOM/CG-ADCIRC," DOD-NRL, ($333K OU)
541. M. Xue, "Contribution to WRF Model Development by the Center for Analysis and Prediction of Storms," DOC-NOAA, $821K
542. K. Marfurt, "Improving Geologic and Engineering Models of Midcontinent Fracture and Karst Modified Reservoirs Using 3-D Seismic Attributes," UKCRINC, ($61K OU)
543. P. Attar, P. Vedula, "Novel, Optimal, Physics-based Reduced Order Models for Nonlinear Aeroelasticity," Advanced Dynamics, $49K
544. S. Dhall, "Autonomous Data Partitioning using Data Mining for High Performance Computing," NSF, ($125K OU)

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

545. M. Xue, K. Brewster, J. Gao, "Ensemble-based Data Assimilation for Tropical Storms, and Realtime 3DVAR Analysis for Initial Proof of 'Warn-on-Forecast' Concept: Collaborative Research between CAPS and NSSL," DOC-NOAA, $100,000
546. M. Xue, "Contribution to Model Development and Enhancement Research Team by the Center for Analysis and Prediction of Storms," DOC-NOAA, $620K
547. M. Xue, K. Brewster, "Ensemble-based Data Assimilation for Convective Storms and Hurricanes," DOC-NOAA, $100,000
548. S. Schroeder, "Discovering Satellite Tobacco Mosaic Virus Structure," OCAST, $85K
549. S. Schroeder, "Computational Advacnes Toward Predicting Encapsidated Viral RNA Structure," Pharmaceutical Research and Manufactuerer's Association of America, $60K
550. R. Kolar, "Outer Boundary Forcing for Texas Coastal Models," Texas Water Development Board, $20K
551. K. Milton, "Collaborative Research: Quantum Vacuum Energy", NSF, $250K
552. A. McGovern, "Developing Spatiotemporal Relational Models to Anticipate Tornado Formation," NSF, $500K
553. Y. Kogan, "Midlatitude Aerosol-Cloud-Radiation Feedbacks in Marine Boundary Layer Clouds", ONR, $638K
554. J. Straka, K. Kanak, Davies-Jones, "Challenges in understanding tornadogenesis and associated phenomena," NSF, $854K (total), $584K (OU)
555. Y. Hong, "Improvement of the NASA Global Hazard System and Implement Server-Africa," NASA, $272K
556. J. Antonio, S. Lakshmivarahan, H. Neeman, "Predictions of Atmospheric Dispersion of Chemical and Biological Contaminants in the Urban Canopy." Subcontract No. 1334/0974-01, Prime Agency DOD-ARO, Subcontract through Texas Tech University, Lubbock, TX, Sep. 29, 2000 to Nov. 3, 2001, $75K
557. A. Striolo, "Electrolytes at Solid-Water Interfaces: Theoretical Studies for Practical Applications," OSRHE Nanotechnology, $15K
558. D. Papavassiliou, "Turbulent transport in non-homogeneous turbulence, " NSF, $320K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

559. K. Droegemeier et al., "Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere," NSF, $17M (total), $5.6M (OU)
560. K. Droegemeier et al., "Linked Environments for Atmospheric Discovery (LEAD)," NSF, $11.25M (total), $2.5M (OU)
561. M. Strauss, P. Skubic et al., "Oklahoma Center for High Energy Physics", DOE EPSCoR, $3.4M (total), $1.6M (OU)
562. M. Richman, A. White, V. Lakshmanan, V. DeBrunner, P. Skubic, "Real Time Mining of Integrated Weather Data," NSF, $950K
563. D. Weber, K. Droegemeier, H. Neeman, "Modeling Environment for Atmospheric Discovery," NCSA, $435K
564. H. Neeman, K. Droegemeier, K. Mish, D. Papavassiliou, P. Skubic, "Acquisition of an Itanium Cluster for Grid Computing," NSF, $340K
565. J. Levit, D. Ebert (Purdue), C. Hansen (U Utah), "Advanced Weather Data Visualization," NSF, $300K
566. D. Papavassiliou, "Turbulent Transport in Wall Turbulence," NSF, $165K
567. L. Lee, J. Mullen (Worcester Polytechnic), H. Neeman, G.K. Newman, "Integration of High Performance Computing in Nanotechnology," NSF, $400K
568. R. Wheeler, "Principal mode analysis and its application to polypeptide vibrations," NSF, $385K
569. R. Kolar, J. Antonio, S. Dhall, S. Lakshmivarahan, "A Parallel, Baroclinic 3D Shallow Water Model," DoD - DEPSCoR (via ONR), $312K
570. R. Luettich (UNC), R. Kolar, B. Vieux, J. Gourley, "The Center for Natural Disasters, Coastal Infrastructure, and Emergency Management," DHS, $699K
571. D. Papavassiliou, M. Zaman, H. Neeman, "Integrated, Scalable MBS for Flow Through Porous Media," NSF, $150K
572. Y. Wang, P. Mukherjee, "Wavelet based analysis of WMAP data," NASA, $150K
573. E. Mansell, C. L. Ziegler, J. M. Straka, D. R. MacGorman, "Numerical modeling studies of storm electrification and lightning," $605K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

574. K. Brewster, J. Gao, F. Carr, W. Lapenta, G. Jedlovec, "Impact of the Assimilation of AIRS Soundings and AMSR-E Rainfall on Short Term Forecasts of Mesoscale Weather," NASA, $458K
575. R. Wheeler, T. Click, "National Institutes of Health/Predoctoral Fellowships for Students with Disabilties," NIH/NIGMS, $80K
576. K. Pathasarathy, D. Papavassiliou, L. Lee, G. Newman, "Drag reduction using surface-attached polymer chains and nanotubes," ONR, $730K
577. D. Papavassiliou, "Turbulent transport in non-homogeneous turbulence, " NSF, $320K
578. C. Doswell, D. Weber, H. Neeman, "A Study of Moist Deep Convection: Generation of Multiple Updrafts in Association with Mesoscale Forcing," NSF, $430K
579. D. Papavassiliou, "Melt-Blowing: Advance modeling and experimental verification," NSF, $321K
580. R. Kol,ar et al., "A Coupled Hydrodynamic/Hydrologic Model with Adaptive Gridding," ONR, $595K
581. D. Papavassiliou, "Scalar Transport in Porous Media," ACS-PRF, $80K
582. M. Xue, F. Carr, A. Shapiro, K. Brewster, J. Gao, "Research on Optimal Utilization and Impact of Water Vapor and Other High Resolution Observations in Storm-Scale QPF," NSF, $880K.
583. J. Gao, K. Droegemeier, M. Xue, "On the Optimal Use of WSR-88D Doppler Radar Data for Variational Storm-Scale Data Assimilation," NSF, $600K.
584. K. Mish, K. Muraleetharan, "Computational Modeling of Blast Loading on Bridges," OTC, $125K
585. V. DeBrunner, L. DeBrunner, D. Baldwin, K. Mish, "Intelligent Bridge System," FHWA, $3M
586. D. Papavassiliou, "Scalar Transport in Porous Media," ACS-PRF, $80K
587. Y. Wang, P. Mukherjee, "Wavelet based analysis of WMAP data," NASA, $150K
588. R. Wheeler et al., "Testing new methods for structure prediction and free energy calculations (Predoctoral Fellowship for Students with Disabilities)," NIH/NIGMS, $24K
589. L. White et al., "Modeling Studies in the Duke Forest Free-Air CO2 Enrichment (FACE) Program," DOE, $730K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

590. Neeman, Severini, "Cyberinfrastructure for Distributed Rapid Response to National Emergencies", NSF, $132K
591. Neeman, Roe, Severini, Wu et al., "Cyberinfrastructure Education for Bioinformatics and Beyond," NSF, $250K
592. K. Milton, C. Kao, "Non-perturbative Quantum Field Theory and Particle Theory Beyond the Standard Model," DOE, $150K
593. J. Snow, "Oklahoma Center for High Energy Physics", DOE EPSCoR, $3.4M (total), $169K (LU)
594. M. Xue, F. Kong, "OSSE Experiments for airborne weather sensors," Boeing, $90K
595. M. Xue, K. Brewster, J. Gao, A. Shapiro, "Storm-Scale Quantitative Precipitation Forecasting Using Advanced Data Assimilation Techniques: Methods, Impacts and Sensitivities," NSF, $835K
596. Y. Kogan, D. Mechem, "Improvement in the cloud physics formulation in the U.S. Navy Coupled Ocean-Atmosphere Mesoscale Prediction System," ONR, $889K
597. G. Zhang, M. Xue, P. Chilson, T. Schuur, "Improving Microphysics Parameterizations and Quantitative Precipitation Forecast through Optimal Use of Video Disdrometer, Profiler and Polarimetric Radar Observations," NSF, $464K
598. T. Yu, M. Xue, M. Yeay, R. Palmer, S. Torres, M. Biggerstaff, "Meteorological Studies with the Phased Array Weather Radar and Data Assimilation using the Ensemble Kalman Filter," ONR/Defense EPSCOR/OK State Regents, $560K
599. B. Wanner, T. Conway, et al., "Development of the www.EcoliCommunity.org Information Resource," NIH, $1.5M (total), $150K (OU)
600. T. Ibrahim et al., "A Demonstration of Low-Cost Reliable Wireless Sensor for Health Monitoring of a Precast Prestressed Concrete Bridge Girder," OK Transportation Center, $80K
601. T. Ibrahim et al., "Micro-Neural Interface," OCAST, $135K
602. J. Snow, "Langston University High Energy Physics," $155K (LU)

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

603. L.M. Leslie, M.B. Richman, C. Doswell, "Detecting Synoptic-Scale Precursors Tornado Outbreaks," NSF, $548K
604. L.M. Leslie, M.B. Richman, "Use of Kernel Methods in Data Selection and Thinning for Satellite Data Assimilation in NWP Models," NOAA, $342K
605. J. Gao, K. Brewster, M. Xue, K. Droegemeier, "Assimilating Doppler Radar Data for Storm-Scale Numerical Prediction Using an Ensemble-based Variational Method," NSF, $200K
606. E. Chesnokov, "Fracture Prediction Methodology Based On Surface Seismic Data," Devon Energy, $1M
607. E. Chesnokov, "Scenario of Fracture Event Development in the Barnett Shale (Laboratory Measurements and Theoretical Investigation)," Devon Energy, $1.3M
608. M. Xue, K. Brewster, J. Gao, "Study of Tornado and Tornadic Thunderstorm Dynamics and Predictability through High-Resolution Simulation, Prediction and Advanced Data Assimilation," NSF, $780K
609. A. Striolo, "Heat Transfer in Graphene-Oil Nanocomposites: A Molecular Understanding to Overcome Practical Barriers." ACS Petroleum Research Fund, $40K
610. D.V. Papavassiliou, "Turbulent Transport in Anisotropic Velocity Fields," NSF, $292.5K
611. D. Oliver, software license grant, $1.5M
612. R. Broughton et al, "Assembling the Eutelost Tree of Life – Addressing the Major Unresolved Problem in Vertebrate Phylogeny," NSF, $3M ($654K to OU)
613. A. Fagg, "Development of a Bidirectional CNS Interface or Robotic Control," NIH, $600K
614. M. Xue, J. Gao, "An Investigation on the Importance of Environmental Variability to Storm-scale Radar Data Assimilation," NSSL, $72K
615. JV. Sikavistsas and D.V. Papavassiliou , "Flow Effects on Porous Scaffolds for Tissue Regeneration," NSF, $400K
616. P. Skubic, M. Strauss, et al., "Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the LHC," DOE, $503K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

617. Y. Wang, "Science for the Euclid Mission", NASA/JPL, $52K (2021)
618. D. LaDue, K. Kloesel, "EPSCoR Funded Participant in the National Weather Center Research Experiences for Undergraduates Program," Oklahoma EPSCoR, $9K
619. V. Sikavitsas, D. Papavassiliou, "The influence of fluid shear forces, oxygen and nutrient mass transport in the development of bone grafts in perfusion bioreactors," OCAST,, $45K
620. D. Schmidtke, D. Papavassiliou, "Development of a Miniature Right Heart Support Device," NIH, $347K
621. D. Resasco, D. Papavassiliou, "Interfacially active SWNT/silica nanohybrids," Advanced Energy Consortium, $688K
622. B. L. Cheong, T.-Y. Yu, R. .D. Palmer, "Instrumental Support for the Winter Experiment Campaign," SELab Inc, $215K
623. E. Bridge, "CAREER: Unwrapping the Migratory Gene Package," NSF, $760K
624. E. Bridge, "The Electronic Transponder Analysis Gateway (ETAG): An Animal Behavior Observatory," NSF, $315K
625. E. Bridge, "An Open-Source Radio Frequency Identification System for Animal Monitoring," NSF, $331K
626. R. McPherson, E. White, M. Shafer, D. Rosendahl, M. Richman, "Trends in cold temperature extremes and winter weather for the SPTC region," USDOT, $132K
627. R. Palmer, B. Cheong, C. Fulton, J. Salarzar, M. Yeary, T.-Y. Yu, Y. Zhang,. "Meeting the Technical Challenges of the Multi-Mission Phased Array Radar," NOAA, $1.65M
628. M. J. McInerney, L. Krumholz, Bioremediation of Chromium and Arsenic from Industrial Wastewater," Nat'l Academies of Science, $162K
629. M. Coniglio (PI), C. Doswell III, R. J. Trapp
630. "Improved understanding of convective-storm predictability and environment feedbacks from observations during the Mesoscale Predictability Experiment (MPEX)," NSF, $272K
631. Y. Kogan, "Parameterization of Cumulus Convective Cloud Systems in Mesoscale Forecast Models," ONR, $267K
632. S. Schroeder, "Predicting Viral RNA Structures, Function, and Drug Targets from Sequence," OCAST, $145K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

633. L. Ding, "NRI-Small: Robot Assistants for Promoting Crawling and Walking in Children at Risk of Cerebral Palsy," NSF, $1.135M
634. E. Baron, "Collaborative Research: Three-Dimensional Simulations of Type Ia Supernovae Constraining Models with Observations," NSF, $26K
635. H. Neeman, K. Brewster, A. McGovern, H. Severini, T. Yu, M. Atiquzzaman, G. Creager, B. George, Z. Gray, S. Radhakrishnan, P. Skubic, M. Strauss, X. Xiao, M. Xue, "A Model for Advanced Cyberinfrastructure Research and Education Facilitators," NSF, $400K
636. E. Lemley, G. Qian, "MRI: Acquisition of a High Performance Computing Cluster for Research at a Predominantly Undergraduate Institution," NSF, $305K
637. R. Floyd, J. Pei, "Understanding the Behavior of Prestressed Concrete Girders after Years of Service," OK DOT, $327K
638. G. Zhang, S. Arani, "Polarimetric Phased Array Radar Research in Support for MPAR Strategy," NOAA, $438K
639. A. Fierro, M. DeMaria, E. Mansell, C./ Ziegler, D. MacGorman, A.Schumacher, R. Brummer. "Using total lightning data from GLM/GOES-R to improve real-time tropical cyclone genesis and intensity forecasts," NOAA, $268K ($123K to OU)
640. U. Hansmann, "Folding, Mis-folding and Aggregation of Proteins," NIH, $887K
641. G. R. Keller, S. Holloway, D. Devegowda, K. Crain, A. Holland, A. Ghassemi, "4D Integrated Study Using Geology, Geophysics, Reservoir Modeling and Rock Mechanics to Development Assessment Models for Potential Induced Seismicity Risk,." $1.478M
642. J. Gao, D. Stensrud, X. Wang, "Assimilation of Doppler Radar Data with an Ensemble-based Variational Method for Storm-scale NWP," NSF, $481K
643. M. Soe (RSU), "Unitary Qubit Lattice Algorithms for Quantum Turbulence with Non-Abeliam Vortices," NSF, $75K
644. J. Cruz, "Two-Dimensional Channel Modeling, Detection and Coding for Shingled Magnetic Recording," NSF, $419K
645. J. Shaffer, "Laser Stabilization System for Rydberg Atom Physics," Army Research Office, $75K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

646. R. Sani (SDSMT), L. Krumholz, "Building Genome-to-Phenome Infrastructure for Regulating Methane in Deep Environments (BuG ReMaDE)," NSF, $6M (total), $1.4M (OU)
647. A. Striolo (U College London), "Science 4 Clean Energy," European Commission, €12M (not to OU)
648. A. Striolo, D. Blankschtein, "Hydrates Growth and Coalescence: From Molecular Understanding to Useful Models," Royal Society, £12K (not to OU)
649. A. P. Khain (Hebrew U), A. V. Ryzhkov, "Coupling of polarimetric radar and cloud model," BSF, $102K
650. A. V. Ryzhkov, A. P. Khain (Hebrew U), "Investigation of hazardous weather events using polarimetric radar and cloud model," BSF, $111K
651. I. Jirak, H. Brooks, M. Pyle, "Information Extraction and Verification of Numerical Weather Prediction for Severe Weather Forecasting," NOAA, $430K
652. I. Jirak, "Information Extraction and Verification of Convection-Allowing Models for Severe Hail Forecasting," NOAA, $209K
653. I. Jirak, H. Brooks, M. Pyle, "Information Extraction and Verification of Convection-Allowing Models for Tornado Forecasting," NOAA, $297K
654. X. Wang, "OU/WNI Collaborative Work on Assimilation of MURON and Himawari-8 Clear Sky Radiances to Improve Tropical Cyclone Forecast Over the West Pacific," WeatherNews Inc, $136K
655. X. Wang, "GSI based Dual Resolution EnVar Data Assimilation for Convective-Scale 'Warn-on-Forecast'," NOAA, $100K
656. X. Wang, ""MPAR targeting observation research for WoF," NOAA, $362K
657. X. Wang, A. Johnson, A. Clark, "Improving NWS Convection Allowing Hazardous Weather Ensemble Forecasts through Optimizing Multi-Scale Initial Condition (IC) Perturbations," NOAA, $277K
658. X. Wang, A. Johnson, T. Jones, "Assimilation of high resolution GOES-R ABI infrared water vapor and cloud sensitive radiances using the GSI-based hybrid ensemble-variational data assimilation system to improve convection initiation forecast," NOAA, $368K
659. X. Wang, "Further Advancement of HWRF Self-Consistent Ensemble-Variational Hybrid Data Assimilation System to Improve High Resolution Hurricane Vortex Initialization," NOAA, $377K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

660. X. Wang, "Advancing the Assimilation of Airborne Hurricane Observations using the GSI-based Hybrid Ensemble-Variational Data Assimilation System for HWRF," NOAA, $294K
661. X. Wang, L. Leslie, "Understanding the Impact of Outflow on Hurricane Intensification through Ensemble-based Data Assimilation and Ensemble Simulation with Multiple Models," ONR, $376K
662. J. P. Shaffer, "Atom Surface Interactions and Hybrid Quantum Systems for Quantum Engineering Applications," AFOSR, $750K
663. J. P. Shaffer, "SBIR," DARPA-SBIR, $15K
664. J. P. Shaffer, "High Sensitivity Absolute Electric Field Sensing with Atoms," NRO, $309K
665. J. P. Shaffer, "US -Brazil Professorship and Lectureship," American Physical Society, $4K
666. J. P. Shaffer, "Control of Rydberg Interactions and Exotic States of Matter," NSF, $473K
667. L. Ding, "Neurophysiological Assessment of Thresholds of Audibility and Loudness in Healthy Persons and Cochlear Implants Users," Hearts for Hearing, $100K
668. D. Myers (ECU), C. Crittell (ECU), "STEM-Double Bridge," NSF via UCO, $335K
669. B. Moore, S. Crowell, "(EVM-2) The geoCARB Mission, NASA, $161M (total), $39M (OU)
670. M. Kaspari, C. Siler, M. Weiser, K. Marshall, M. Miller, "Testing abiotic drivers of activity, abundance, and diversity of ground-dwelling arthropod communities at a continental scale," NSF, $1.5M
671. T. Gamble (Marquette U), C. Siler (OU), J. Daza (Sam Houston State U), M. Heinicke (U Michiga - Dearborn), "From Exaptation to Key Innovation - Evolutionary Insights from Gliding Geckos," NSF, $1.1M (total), $323K (OU)
672. F. Kong, M. Xue, K. Brewster, X. Hu, "Development of a Storm-Scale Ensemble Numerical Weather Prediction System for Chongqing Meteorological Service," Chongqing Inst of Green &Intelligent Tech, Chinese Academey of Sciences, $643K
673. K. Brewster, X. Wang, F. Carr, "Prototyping and Evaluating Key Network-of-Networks Technologies," NOAA, $192K
674. B. Moore, K. Brewster, F. Carr, "CASA DFW Testbed Operations and Data Impacts," Global Science Technology, $97K

OSCER-FACILITATED FUNDING TO DATE: $861M total, $396M to OU

External Research Grants (cont'd)

675. M. Xue, X. Hu, Y. Jung, K. Brewster, "Assessment and Optimization of YSU-Type Non-Local PBL Scheme for the Prediction of Day- and Night-Time Storm Environment and Tornadic Storms during VORTEX-SE," NOAA, $3M
676. M. Xue, N. Snook, K. Brewster, Y. Jung, F. Kong, "A Partnership to Develop and Evaluate Optimized Realtime Convective-Scale Ensemble Data Assimilation and Prediction Systems for Hazardous Weather: Toward the Goals of a Weather-Ready Nation," NOAA. $450K
677. M. Xue, K. Brewster, Y. Jung, F. Kong, "A Partnership to Develop, Conduct, and Evaluate Realtime Advanced Data Assimilation and High-Resolution Ensemble and Deterministic Forecasts for Convective-scale Hazardous Weather: Towards the Goals of Weather Ready Nation," NOAA, $375K
678. y. Jung, M. Xue, G. Zhang, "Development of a Polarimetric Radar Data Simulator for KLAPS," IN-KMA, $188K
679. K. Brewster, F. Carr, X, Wang, "Protyping and Evaluating Key Network-of-Networks Technologies: Project Extension," ?, $192K
680. B. Moore, M. Xue, A. Bamzai, R. McPherson, "Very-high resolution dynamic downscaling of regional climate for use in long-term hydrologic planning along the red river valley system," DOI-USG, $127K
681. X. Hu, "Collaborative Research: Studies of Chlorine, Bromine and Iodine Chemistry in the Artic, and its Impacts," NSF/U Michigan, $47K
682. N. Snook, M. Xue, Y. Jung, A. McGovern, "Development and Implementation of Ensemble Hail Forecast Products using Multi-moment Microphysics and Machine Learning Algorithms," NOAA, $335K
683. B. Moore, X. Hu, M. Xue, "Atmospheric Carbon and Transport – America," NASA, $168K
684. M. Xue, G. Zhang, "Assessment of the Performance of Beijing Meteorological Service (BMS) X-band Polarimetric Radars and Data Quality Control and Assimilation for the BMS X-band Radar Network," IN-BMS, $120K
685. M. Xue, F. Kong, Y. Jung, C. Liu, "Development and Optimization of Radar-Assimilating Ensemble-Based Data Assimilation for Storm-Scale Ensemble Prediction in Support of HWT Spring Experiments," NOAA, $291K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

636. M. Xue, F. Kong, K. Brewster, N. Snook, "Convection-Allowing Ensemble Prediction for Heavy Precipitation in Support of the Hydrometeorology Testbed (HMT): New QPF Products, Data Assimilation Techniques and Prediction Model," NOAA, $290K
637. M. Xue, Y. Jung, F. Kong, K. Brewster, "Enhancement and Evaluation of NGGPS Model FV3 at Convection-Allowing Resolutions through Hazardous Weather Testbed Spring Experiment towards Accelerated Operational Implementation of FV3 for Mesoscale Applications," NOAA, 194K
638. M. Xue, Y. Jung, "Advanced Data Assimilation and Prediction Research for Convective-Scale 'Warn-on-Forecast," NOAA, $208K
639. L. Gruenwald, "Cost- and Energy-Aware Spatio-Temporal Query Processing in Mobile Clouds," NSF, $200K
640. T. Neeson, H. Moreno, "A Return on Investment Approach to Restoring Natural Flow Regimes in the Red River," Great Plains Landscape Conservation Cooperative, $195K
691. T. Neeson, H. Moreno, "Balancing water usage and ecosystem outcomes under drought and climate change: enhancing an optimization model for the Red River, USGS-SCCSC, $213K
692. D. K. Walters, "Implementation and Validation of Advanced Turbulence Modeling Methods for Liquid Metal Flow in Nek5000," DOE, $756K
693. D. K. Walters, "Multiphysics Simulations of Multi-Component, Off-Design Aircraft Engine Operation Using Dynamic Hybrid RANS/LES," DoD HPC Modernization Program, $164K
694. X. Chen, "Rapid Response for the M5.1 Fairview Earthquake - Detailed Understanding of the Fault Systems in Western Oklahoma," NSF, $14K
695. J. Zhao, L. Xiang, "Photoacoustic Imaging of Myeloproliferative Neoplasms and Associated Vascular Complications," PHF Team Science, $100K
696. L. Xiang, K. Stratton, "Photoacoustic Imaging for Prostate Cancer Detection," OU COE, $10K
697. J. Suflita, K. Duncan, J. Sunner, I. Davidova, "Managing Microbial Corrosion in Canadian Offshore & Onshore Oil Production Operations," U Calgary, $363K

691. x

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

698. A. Ryzhkov (OU), A. Khain (Hebrew U), M. Kumjian (Penn State U), "Investigations of Microphysical Processes in Clouds Using Spectral Cloud Models Coupled with Polarimetric Radar Measurements at Multiple Frequencies," DOE, $431K (total), $231K (OU)
699. A. Ryzhkov (OU), A. Khain (Hebrew U), "Microphysical and Thermodynamic Retrievals in Deep Convective Clouds Using Polarimetric Radar Measurements and Spectral Cloud Models with Explicit Treatment of Aerosol Impact on Convective Processes," DOE, $433K (total), $230K (OU)
700. K. Duncan, J. Suflita, R. Tanner, "BHP/Nalco/OU MIC Project," bhpBilliton, $310K
701. K. Duncan, B. Wawrik, J. Suflita, "Amendment 2 to the Research Agreement FR00008538, Primer Validation and Design Project and RPA Project," TOTAL S.A, $95K
702. W. Freeman, A. Richardson, "High throughput single cell analysis of hippocampus with Alzheimer's Disease," National Institute on Aging. $148K
703. X. Wang, D. Parsons, D. Stensrud, "Improving the Understanding and Prediction of Nocturnal Convection through Advance Data Assimilation and Ensemble Simulation in PECAN," NSF, $708K
704. D. Parsons, H. Bluestein, "Investigation into the mechanisms for the maintenance of nocturnal convective systems," NSF, $599K
705. L. Bumm, L. Huang, "Advanced Real-Space Measurements with STM: Application to Molecular Monolayers, Monolayer Defects, and Surface Chemistry," NSF, $442K
706. F. Kong, K. Brewster, X. Hu, M. Xue, "Development of a Storm-Scale Ensemble Numerical Weather Prediction System for Chongqing Meteorological Service," Chongqing Inst of Green and Intelligent Tech, Chinese Academey of Sciences, $212K
707. N. Nakata, "Ambient Field Analysis of Earthquake Ground Motion at Groningen Gas Field, Stanford University & Shell Oil Company, $47K
708. B. Moore III, K. Brewster, F. Carr, B. Illston, K. Kloesel, "National Mesonet Program," Earth Networks Inc. & Stinger Ghaffarian Technologies, $446K
709. D. K. Walters, "Aerodynamic Flow Deflector for Current and Future Wind Turbines to Increase the Annual Energy Production by 10% and Reduce the Levelized Cost of Energy by 8%," XPEED Turbine Technology & NSF, $131K

OSCER-FACILITATED FUNDING TO DATE:
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External Research Grants (cont'd)

710. P. Skubic, B. Abbott, P. Gutierrez, M. Strauss, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center," U Texas Arlington, $30K
711. S. Schroeder, "Metal Ion Interactions in RNA Shapeshifters," Burroughs Wellcome Fund Collaborative Research Travel Grant, $9K
712. E. Baron, "Modeling the Atmosphere of Solar and Other Stars Radiative Transfer with PHOENIX/3D," NASA, $478K
713. U. Hansmann, "Efficient and Accurate Force Fields for Computer-Aided-Drug Design," U Arkansas/NIH, $73K
714. C.-H. Lee, "Computer-Assisted Management and Treatment of Functional Tricuspid Regurgitation," American Heart Association, $30K
715. C. Lewis, P. Lawson, C. Warinner, "Microbial Ecologies of Indigenous Communities," NIH, $743K
716. J. Ruyle, E. Bridge, M. Stacy, "Collaborative Research: IDBR: Type B: An Open-Source Radio Frequency Identification System for Animal Monitoring (NonDeclination; routing ATF)," NSF, $344K
717. X. Wang, "Further Advancement of HWRF Self-Consistent Ensemble-Variational Hybrid Data Assimilation System to Improve High Resolution Hurricane Vortex Initialization,' NOAA, $292K
718. X. Wang, "Development of NWS convective scale ensemble forecasting capability through improving GSI-based hybrid ensemble-variational data assimilation and evaluating multi-dynamic core approach," NOAA, $449K
719. B. Holt, "NF-Y Transcription Factor Roles in Far Red Light Signaling - A First Look," OCAST, $100K
720. M. Xue, Y. Jung, "Advanced Data Assimilation and Prediction Research for Convective-Scale ...," NOAA, $200K
721. S. Cavallo, "Polar predictability and dynamics through multi-scale atmospheric vortices," DOD-ONR, $105K
722. G. Richter-Addo, "Redox Behavior and Chemical Reactivity of Heme-HNOx Complexes," NSF, $516K
723. J. Suflita, K. Duncan, J. Sunner, B. Wawrik, "Continued Studies of the OUBC with Total," Total S.A., $222K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Research Grants (cont'd)

724. M. Xue, K. Brewster, N. Snook, Y. Jung, F. Kong, "A Partnership to Develop and Evaluate Optimized Realtime, Convective-Scale Ensemble Data Assimilation and Prediction, Systems for Hazardous Weather: Toward the Goals of a Weather-Ready Nation," NOAA, $450K
725. J. Abbas, S. Huskey, C. Weaver, "Digital Latin Library Implementation," Andrew Mellon Foundation, $1M
726. C. Warinner, C. Lewis, K. Sankaranarayanan, "Evolution and Ecology of the Human Oral Microbiome," NSF, $101K
727. T. Fritz, C. Miller, R. Munoz, C. Hellman, "Oklahoma SBIRT Training Collaborative," Health and Human Services, Substance Abuse Mental Health Services Admin, $622K
728. D. Bodine,A. Reinhart, "Exploration of Terrain Effects, on Tornado and Supercell Dynamics in the Southeast United States," NOAA, $192K
729. N. Kaib, "Numerical Studies of the Dynamical Interplay Between the Inner and Outer Planets," NSF, $227K
730. N. Kaib, "The Influence of Stellar Companions on Fomalhaut's Planetary System, NASA, $59K
731. N. Kaib, "Exploring the Evolution and Characterizing the Chaos of the Terrestrial Planets," U Illinois at Urbana-Champaign Blue Waters Grad Fellowship, $50K
732. A. Shapiro, C. Potvin, "Improving vertical velocity retrievals from Doppler radar observations of convection," NSF, $599K
733. M. Richman, L. Leslie, C. Doswell, "Objective Probabilistic Guidance for Severe Weather Outbreaks," NOAA, $51K
734. M. Nanny, C. Mao, P. Hardre, S. Wu, A. Burgett, U. Hansmann,
735. L. Krumholz, S. Liu, L. Bartley, "RET Site: Rural Educators Engaged in Bioanalytical Engineering Research and Teaching," NSF, $600K

OSCER-FACILITATED FUNDING TO DATE:
$861M total, $396M to OU

External Funding Summary

- External research funding facilitated by OSCER (Fall 2001- Fall 2021): **$861M total, $396M to OU** (46%)
- Funded projects: **735**
- **275** OU faculty and staff in **36** academic departments and **13** non-academic units
- Comparison: Fiscal Year 2002-20 (July 2001 – June 2021): OU Norman externally funded research expenditure: $1.9B

Since being founded in fall of 2001,
OSCER has enabled research projects comprising **over 1 / 5 of OU Norman's total externally funded research expenditure**, with more than a **10-to-1 return on investment**.

OSCER Users vs Non-Users @ OU Norman #1

During FY2016-20, among OU Norman PIs credited with external research expenditure, OSCER users (and advisors of OSCER users) were credited with 2.7 times as much median annual expenditure as non-users of OSCER:

- OSCER users @ OU Norman: median $89,318.20/year
- OSCER non-users @ OU Norman: median $33,160.30/year (Based on analysis of VPRP's PI annual research expenditure spreadsheets FY2016-20.)

OSCER Users vs Non-Users @ OU Norman #2

NOTES

- The real disparity is probably far more than 2.7x, because:
  - **185** of 209 (**89%**) of OSCER-user PIs at OU Norman had external research expenditure in FY2016-20;
  - **688** OU Norman non-OSCER-users had external research expenditure, out of an estimated 2-4000, based on fall 2019's potential research PIs (2002 full- and part-time faculty, and 1980 full- and part-time support/service professional staff).
  - So, 17-34% of non-OSCER users vs 89% of OSCER users.
- We make no claims about causality (existence or direction) – we only note the disparity between these two populations.

Publications Facilitated by Research IT

- Publications facilitated by Research IT resources
  - **2021: 151 (so far)**
  - 2020: 293
  - 2019: 308
  - 2018: 320
  - 2017: 230
  - 2016: 277
  - 2015: 225
  - 2014: 212
  - 2013: 250
  - 2012: 281
  - 2011: 184
  - 2010: 140
  - 2009: 109
  - 2008: 112
  - 2007: 77
  - 2006: 96
  - 2005: 71
  - 2004: 32
  - 2003: 12
  - 2002: 10
  - 2001: 3

TOTAL SO FAR: 3393 publications

http://www.oscer.ou.edu/publications/

Includes 91 PhD dissertations, 97 MS theses.

Top 10 OU Research Teams FY2020

1. High Energy Physics: 18.7M core-hours
2. Meteorology: PI X. Wang: 5.4M core-hours
3. Center for Analysis & Prediction of Storms: 4.2M core-hours
4. Petroleum & Geological Engr: PI A. Ghassemi: 3.7M core-hours
5. Chemistry & Biochemistry: PI Y. Shao: 3.6M core-hours*
6. Chemistry & Biochemistry: PI U. Hansmann: 3.4M core-hours
7. Aerospace & Mechanical Engr: PI D. K. Walters: 2.9M core-hours
8. Chemical, Biological & Materials Engr: PI L. Huang: 2.6M core-hours
9. Aerospace & Mechanical Engr: PI J. Garg: 2.2M core-hours*
10. Computer Science: PI A. McGovern: 1.7M core-hours

* Asst Prof

How Did We Get This Data?

- We e-mailed hundreds of faculty, staff, postdocs and students, and asked them to send us whatever grants and publications they had new.
  - For each one, we gave them the list of grants and publications of theirs that we already had.
  - The labor cost was on the order of 40 hours.
- We also asked OU Research Services for all 2020-21 new grants that had pressed the OSCER button on the web form for starting the internal paperwork for a new proposal.

NSF AI Research Institute

- A team led by Prof. Amy McGovern of OU CS has been awarded a 5-year, $20M NSF AI Research Institute grant to study the use of AI/Machine Learning for environmental sciences.
- OSCER is running the computing component.

OU Meteorology NASA Projects

- The Director of OU Meteorology and his team have done multiple large scale projects for NASA, suddenly needing lots of CPU cores for weeks at a time.
- They bought some condominium nodes, and we lent them the rest.
- These projects are typically mid 5 figures to low 6 figures of single-core jobs, several hours each.

Ongoing, Current and New Initiatives

Virtual Residency

- "Everyone complains about the weather,
  but no one ever does anything about it."
- We created a program to teach people how to be research computing facilitators, and ultimately to be institutional CI leaders.
- No one had ever been dumb enough to try to teach this until we decided to.
- Workshops: Introductory 2015, 2016, 2017; Intermediate/Advanced 2018; Introductory/Intermediate 2019; Intermediate/Advanced 2020; **Intro/Intmd/Adv 2021**
- Regular conference calls
- Grant Proposal Writing Apprenticeship (2017-18 thru 20-21)
- Paper Writing Apprenticeship (2018-21: PEARC'19-21 papers)

Virtual Residency Program

2015-present: 1116 people from 417 institutions
in 50 US states & 4 US territories, plus 13 other countries:

- 64 institutions are Minority Serving Institutions (15% of VRP institutions, **17% of 4+ year MSIs**, 10% of all MSIs);
- 113 institutions are non-PhD-granting institutions (27% of VRP);
- 112 institutions in all 28 EPSCoR jurisdictions (27% of VRP);
- 272 institutions are Campus Champion institutions (80% of 344 Campus Champion institutions, 65% of VRP institutions).

NEW! CCIFTD

- Certified Cyberinfrastructure Facilitator Training and Development (CCIFTD)
- NSF CyberTraining Pilot grant ($300K, 2 years) started Sep 1
- Professional development certification for researcher-facing Cyberinfrastructure professionals
- Many badges (starting with ~15)
- Specific collections of badges become a certification
  - Starting with introductory level, but will add other levels if we can get a CyberTraining Implementation grant.
- External evaluation (same evaluator as NSF XSEDE project)
- First meeting: **TOMORROW** (Thu Sep 30)
- Board of Expert Advisors inaugural meeting Thu Oct 14

CCIFTD Board of Expert Advisors

Board of Expert Advisors inaugural meeting Thu Oct 14

- Linda Akli, Southeastern Universities Research Association: XSEDE Mgr Broadening Participation & Workforce Development; SURA Director of IT Initiatives.
- Tony Baylis, Lawrence Livermore National Laboratory: Director, Strategic Diversity & Inclusion Programs.
- Jim Bottum, Clemson U (retired): PI, ACI-REF; inaugural PI, CaRCC.
  Marla Meehl, University Corporation for Atmospheric Research: PI, Women in IT Networking at SC.
- John Towns, U Illinois Urbana-Champaign: PI, XSEDE.
- Michael Zentner, San Diego Supercomputer Center: Director, of Sustainable Scientific Software.
- Tom Cheatham, U Utah: CaRCC Chair.

Lead, Follow or Get Out of the Way

Taking Leadership

- Statewide
- Regional
- National

Statewide Leadership Examples

The OneOklahoma Cyberinfrastructure Initiative (OneOCII) is a volunteer, ad hoc collaboration among CI providers and users across our state.

- We've grown to 6 CI providers.
- We're on a weekly phone call every Tuesday at 4:00pm CT, working together on a wide variety of projects.
- It's helped us get CI grants, start a statewide HPC contest, help each other help our researchers, and so much more.

Regional Leadership Examples

- Within the Great Plains region, we've been building our leadership across the 6 member states of the Great Plains Network (Arkansas, Kansas, Missouri, Nebraska, Oklahoma and South Dakota).
- Our former OneNet CTO is now the GPN Executive Director.
- The GPN institutions have been awarded two NSF CC* grants: a CC* Cyber Team grant and a CC* Compute grant.

National Leadership Examples

- OneOCII institutional CI leads have, or have had, the following leadership roles:
  - XSEDE Campus Engagement joint co-managers (the umbrella over Campus Champions)
  - Founded the Virtual Residency Program
  - Founded CCIFTD
  - Linux Clusters Institute steering committee
  - SC10-11 Education Program leadership
  - NSF Advisory Committee for Cyberinfrastructure

Acknowledgements

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- Grant No. EPS-0814361, “Building Oklahoma's Leadership Role in Cellulosic Bioenergy”
- Grant No. EPS-1006919, “Oklahoma Optical Initiative”
- Grant No. OCI-1039829, “MRI: Acquisition of Extensible Petascale Storage for Data Intensive Research”
- Grant No. OCI-1126330, “Acquisition of a High Performance Compute Cluster for Multidisciplinary Research”
- Grant No. ACI- 1229107, “Acquisition of a High Performance Computing Cluster for Research and Education”
- Grant No. EPS-1301789, “Adapting Socio-ecological Systems to Increased Climate Variability”
- Grant No. ACI-1341028, “OneOklahoma Friction Free Network”
- Grant No. ACI-1429702, “Acquisition of a High Performance Computing Cluster for Research at a Predominantly Undergraduate Institution”
- Grant No. ACI-1440774, “Leveraging Partnerships Across the Great Plains to Build Advanced Networking and CI Expertise”
- Grant No. ACI-1440783, “A Model for Advanced Cyberinfrastructure Research and Education Facilitators”
- Grant No. ACI-1649475, “Cyberinfrastructure Leadership Academy,” OU, $49K
- Grant No. OAC-1828567, “MRI: Acquisition of a Regional Resource for Long-term Archiving of Large Scale Research Data Collections,” OU, $968K
- Grant No. OAC- 2118193, ““CyberTraining: Pilot: A Professional Development and Certification Program for Cyberinfrastructure Facilitators,” OU, $300K

Symposium 2004-19 Sponsors: Thank You!

- Sponsors: 98 commercial, 7 non-commercial

Thank you all! Without you, past Symposia couldn't happen.

Of our 98 commercial sponsors, half have repeated (and/or were acquired by or merged with other sponsors).

Thanks!

- OU IT
  - OU CIO David Horton
  - OSCER Operations Team: Dave Akin, Patrick Calhoun, Kali McLennan, Jason Speckman
  - OSCER Research Computing Facilitator: Horst Severini
  - Jeremy Hessman, OU IT, for Zoom license help
  - All of the OU IT folks who helped put this together

Thanks: Plenary Speakers

- Margaret Martonosi, National Science Foundation
- Lynne Parker, National AI Initiative Office and Office of Science & Technology Policy, The White House
- Katherine Riley, Argonne National Laboratory
- Dan Stanzione, Texas Advanced Computing Center, University of Texas at Austin
- Thirumalai (Venky) Venkatesan, University of Oklahoma

Thanks: Panel/Roundtable

- Kim Owen, North Dakota State U
- Natasha Pavlovikj, U Nebraska Lincoln
- Christina Roberts, U Missouri Columbia
- Kendra Dresback, U Oklahoma
- David Jahn, NOAA Storm Prediction Center
- Dimitrios Papavassiliou, U Oklahoma
- Patrick Skubic, U Oklahoma
- Louis J. Wicker, NOAA/OAR National Severe Storms Laboratory

Thanks!

To all of your for participating, and to those many of you who've shown us so much loyalty over the past 19 years.

To Learn More

http://www.oscer.ou.edu/

http://oneocii.okepscor.org/

Thanks for your attention!

Questions?

Henry Neeman, PI

Cyberinfrastructure Leadership Academy

University of Oklahoma
Norman, Oklahoma
http://www.oscer.ou.edu/
hneeman@ou.edu

- **Senior Cyberinfrastructure leaders** are retiring and taking their knowledge, experience and wisdom with them. We need to capture this quickly.
- **Emerging midcareer CI leaders** are excellent at responding to national needs and serving their institutions' researchers, but need to learn how to **shape the national CI agenda**.
- **Goals** of this workshop in **bringing these two groups together**:
  - **Transfer knowledge, experience and especially wisdom** from senior CI leaders to emerging CI leaders, in order to enable emerging CI leaders to shape the national research CI landscape.
  - **Initiate mentoring relationships** between senior CI leaders and emerging CI leaders, in order to foster longer term professional development.
  - **Establish peer mentoring** among emerging CI leaders, in order to prepare and position them for national leadership, as senior CI leaders reduce their day to day engagement.
- **National Strategic Computing Initiative**: This workshop focus is a key aspect of the NSF's **workforce development** mission within NSCI.

A Business Model for Physical Management of Big Data

Business Model

OURRstore

- **Grant**: hardware, software, multi-year extended warranties on everything
- **Institution (CIO)**: space, power, cooling, labor, maintenance after the initial extended warranty period
- **Researchers**: media (tape cartridges)
- Compared to roll-your-own disk, for researchers OURRstore tape is:
  - cheaper
  - more reliable
  - less labor
  - requires less training (~1 hour)
  - slower (moderate bandwidth, very high latency)

OURRstore Technology Strategy

- Distribute the costs among a research funding agency, the institution, and the research teams.
- Archive, not live storage: “Write once, read seldom if ever.”
- Independent, standalone system; not part of a cluster.
- Spend grant funds on many slots but few tape cartridges.
- Media slots are available on a first come first serve basis.*
- Software cost should be a modest fraction of total cost.
- Maximize media longevity.
- Globus for file transfers, file sharing, file publishing, discoverability etc.
- LTFS (tiny file catalog on each tape cartridge): Ship secondary copies to the data owner -- if anything goes wrong, it’s under $3K to buy an LTO tape drive, and the software is free.

NSF MRI Grant

"MRI: Acquisition of a Regional Resource for Long-term Archiving of Large Scale Research Data Collections"

National Science Foundation grant no. OAC-1828567

9/1/2021 - 8/31/2021

Grant is 3 years -- archive is 8+ years.

Who's Eligible? Who's In?

- Institutions in Great Plains Network states (AR,KS,MO,NE,OK,SD)
- Institutions in EPSCoR jurisdictions
- Institutions (and consortia) in non-EPSCoR jurisdictions, if they buy an expansion cabinet
- So far, 85 research teams at 27 institutions in 17 states, including 27 research teams at OU.
  - Just voted to start actively recruiting more!
- 16 teams will each need at least 1 PB: 8 at OU, 1 in another GPN state, and 7 in non-GPN EPSCoR states. By contrast, the original PetaStore proposal included only 12 teams *total*, regardless of capacity need.

How Much Need?

Per the proposal:

- Capacity needed: 134 PB
  - $25M+ in on-premise RAID, OR
  - $15M+ in cloud, OR,
  - $8M in USB disk drives (Good luck managing that!), OR
  - $2.4M in tape cartridges
    - If we bought the full 134 PB today.
- Current funding of these projects: $162M
- Pending/planned funding: $140M
- Faculty: 250+
- Staff: 150+
- Postdocs: 100+
- Graduate students: 500+
- Undergraduate students: 500+

Yeah, But Tape Sucks!

- Well, yes, tape does suck:
  - Retrieval has very high latency (typically 1 minute per file).
  - Tape medium inside a tape cartridge can break!
- How to resolve?
  - Only store large files (OURRstore minimum is 1 GB).
    - So, you have to create Zip files or compressed tar files.
  - Offline storage: download file to disk before using.
  - Think hierarchically:
    - Small amount of very fast disk
    - Medium amount of "slow" disk
    - Large amount of tape

Investment Protection

- PetaStore (current archive) will reach end-of-life when OURRStore gets to full production.
- Faculty may not have funds for purchasing new media in the next archive for their old data (that's not relevant to their current grants).
- Need to provide for buying up front instead of recurring charges.
- How to handle the tape?

Longevity Strategy

- OURRstore has to be backward-compatible with the PetaStore, in the sense of allowing LTO, including LTO-5 and LTO-6.
  - Tape cartridges are good for the earliest of:
    - 15 years
    - 5000 load/unload cycles
    - 200 complete tape read/writes
  - So far, only 6 PetaStore tape cartridges (<< 1%) are in danger of wearing out in less than 15 years.
- OURRstore must include some LTO-6 drives, which can read and write both LTO-6 and LTO-5, but new tapes will be LTO-7 Type M (9 TB).
- Unlike disk drives, tape cartridges can migrate from system to system.

Longevity Mechanism

Once OURRstore is in full production:

- Set PetaStore to read-only.
- On the PetaStore, for a small number of tape cartridges, identify all the files on them.
- Copy all those tape cartridges to OURRstore.
- Export those tape cartridges from the PetaStore.
- Import them into OURRstore and reformat.
- Repeat, copying the new files onto the newly imported cartridges.
- When all files are copied (months, maybe a year), decommission the PetaStore.

We'll use this same procedure at OURRstore's end of life.

Schooner: non-condominium nodes

- Compute nodes, non-condominium, Haswell
  - 266 x R430, dual E5-2650v3 10-core 2.3/2.0/2.6 GHz, 32 GB RAM
  - 72 x R430, dual E5-2660v3 10-core 2.6/2.2/2.9 GHz, 32 GB RAM
  - 48 x R430, dual E5-2670v3 12-core 2.3/2.0/2.6 GHz, 64 GB RAM
- Accelerator-capable nodes, non-condominium, Haswell
  - 28 x R730, dual E5-2650v3 10-core 2.3/2.0/2.6 GHz, 32 GB RAM
  - 5 x R730, dual E5-2670v3 12-core 2.3/2.0/2.6 GHz, 64 GB RAM
- Large RAM node, non-condominium, Haswell
  - 1 x R930, quad E7-4809v3 8-core 2.0/1.8/1.8 GHz, 1024 GB RAM
- Accelerators, non-condominium
  - 6 x NVIDIA K20M
  - 24 x Intel Xeon Phi 31S1P
- Subtotal peak CPU speed, non-condominium: 280.47 TFLOPs (base), 365.26 TFLOPs (max turbo)

Schooner: Condominium, Haswell/Broadwell

- Compute nodes, condominium, Haswell/Broadwell
  - 7 x R630, dual E5-2640v3 8-core 2.6/2.2/2.8 GHz, 32 GB RAM
  - 6 x R430, dual E5-2650Lv3 12-core 1.8/1.5/2.1 GHz, 64 GB RAM
  - 84 x R430, dual E5-2670v3 12-core 2.3/2.0/2.6 GHz, 64 GB RAM
  - 5 x R430, dual E5-2670v3, 12-core 2.3/2.0/2.6 GHz, 128 GB RAM
  - 14 x R430, dual E5-2650v4 12-core 2.2/1.8/2.8 GHz, 64 GB RAM
  - 6 x R730, dual E5-2630v3, 8-core 2.4/2.1/2.6 GHz, 128 GB RAM
- Accelerator-capable nodes, condominium, Haswell
  - 1 x R730, dual E5-2650v3 10-core 2.3/2.0/2.6 GHz, 32 GB RAM
  - 3 x R730, dual E5-2670v3 12-core 2.3/2.0/2.6 GHz, 64 GB RAM
- Large RAM node, condominium, Haswell/Broadwell
  - 1 x R930, quad E7-4809v3 8-core 2.0/1.8/1.8 GHz, 3072 GB RAM
  - 1 x R930, quad E7-4830v4 14-core 2.0/1.6/2.2 GHz, 2048 GB RAM
- Accelerators
  - 8 x NVIDIA K20M
- Subtotal peak CPU speed, new condominium:
  93.95 TFLOPs (base), 124.29 TFLOPs (max turbo)

Schooner: Condominium, Skylake/Cascade Lake/KNL

- Compute nodes, condominium, Skylake/Cascade Lake
  - 12 x R640, dual Gold 6140 18-core 2.3/1.5/2.1 GHz, 96 GB RAM
  - 1 x R640, dual Gold 6152 22-core 1.8/1.5/2.1 GHz, 384 GB RAM
  - 4 x R640, dual Gold 6230 12-core 2.1/1.1/2.0 GHz, 96 GB RAM
  - 5 x R440, dual Gold 6230 12-core 2.1/1.1/2.0 GHz, 192 GB RAM
  - 4 x R440, dual Gold 6230 12-core 2.1/1.1/2.0 GHz, 96 GB RAM
- Compute nodes, condominium, Intel Xeon Phi Knights Landing
  - 5 x C6320p, sgl 7210, 64-core 1.3/1.5 GHz, 48 GB RAM
  - 3 x C6230p, sgl 7230, 64-core 1.3/1.5 GHz, 48 GB RAM
- Subtotal peak CPU speed, condominium Skylake/Cascade Lake/KNL:
  62.31 TFLOPs (base), 76.53 TFLOPs (max turbo)

Schooner: Condominium, Sandy Bridge

As an experiment, we transferred condominium nodes from Boomer over to Schooner. This worked great!

- Compute nodes, condominium, old
  - 59 x R620, dual E5-2650 [v1], 8-core, 2.0 GHz, 32 GB
- Accelerator-capable nodes, condominium, old
  - 6 x R720, dual E5-2650 [v1], 8-core, 2.0 GHz, 32 GB
- Accelerators, condominium, old
  - 12 x NVIDIA M2075
  - 6 x NVIDIA K20M
- Storage, diskfull nodes, condominium, old
  - 4 x R720xd, 12 x 3 TB = ~19 TB usable each
- Subtotal peak CPU speed, old condominium: 16.64 TFLOPs

Schooner: non-condominium other

- Interconnects
  - Infiniband: Mellanox FDR/FDR10 3:1 oversubscribed (40 Gbps native, 13.33 Gbps oversubscribed)
  - Ethernet: GigE downlinks to nodes, 10GE uplinks to core
- Storage (user-accessible)
  - DataDirect Networks SFA7700X Lustre w/70 x 6 TB = ~309 TB usable
  - 7 x home/scratch/work/data 12 x 6 TB = ~176 TB usable

New Supercomputer Features

- **NEW! Long job queue (7 days)**
- **NEW! Daily report on queue wait times**
- COMING! Unlimited job durations
  (If we can get batch job preemption/suspension to work ….)
- COMING! Core and RAM request enforcement via cgroups

New Initiatives

- **GPU Needs Analysis**: We want to know who is likely to need GPUs for their number crunching, including but not limited to AI/Machine Learning/Deep Learning.
- **Single-node/Multi-thread Benchmarking**: For researchers who run single-node/multi-threaded parallel applications, we want to work with them, to benchmark their software to see what the best number of threads to run on is. This is very important because the next generation of CPUs have up to 128 cores per CPU chip! So if your code runs best on, say, 12 cores, we'd rather let other users run on the rest of the cores.

Research Computing and Enterprise IT

Enterprise IT vs Research Computing

Enterprise IT: HARDENED

- Secure
- Established technology
- Best practices
- 5 nines: 99.999% uptime = 5.25 **minutes** of downtime per year

Research Computing: SQUISHY

- Fast and flexible (turn on a dime)
- Cutting edge technology (= broken)
- In some cases, **no such thing** as best practices!
- 1.5 nines: 95% uptime = 18.25 **days** of downtime per year
  - This is the NSF's standard, from NSF solicitation 17-558:

"… [$60M NSF-funded] production resources should be unavailable as a result of scheduled and unscheduled maintenance no more than 5% of the time." [OSCER: < 1%]

Enterprise IT: Why 5 9s?

- On Aug 8 2016, Delta Air Lines experienced a power outage in their Atlanta data center that lasted 5 hours.
  - Cost: $150M ($1M every 2 minutes of downtime)

https://money.cnn.com/2016/09/07/technology/delta-computer-outage-cost/

Enterprise vs Research: Incentives

- Suppose payroll is going out tomorrow, and the payroll system goes down tonight.
  - On payroll day, what happens on the Enterprise IT people who are accountable for the outage?
  - Therefore, what must Enterprise IT people do to stay in business?
- Suppose Research Computing isn't on the cutting edge, and so proposals from the institution are less competitive.
  - Eventually, what will happen to the Research Computing team?
  - Therefore, what must Research Computing people do to stay in business?

Research: Why 1 ½ 9s?

- **Research Computing can afford to make mistakes**:
  A system that's mostly up but crashes occasionally is fine.
  - 1 day of HPC downtime = 10-100 lost grad student days
    - 1 grad student = ~$59K/yr fully loaded with fringe+tuition+Indirect
      => 100 grad student days = ~$16K productivity loss **WORST CASE**
      => ~$300-$1600 productivity loss per research group
- **Cost of 5 Nines vs 1.5 Nines**: 5-10x, but budgets are fixed – so the actual cost is cutting computing-intensive and data-intensive research productivity by 80-90%.
- **Therefore**: Let the machine go down from time to time,
  as a tradeoff for having more (but less resilient) resources,
  to maximize research productivity per year,
  at the cost of occasional lost days.

Research is the Enterprise Testbed

- Research Computing has only limited best practices.
- But, technologies currently being adopted by Research Computing are likely to become enterprise requirements in a few to several years.
- So, let Enterprise IT watch Research Computing make mistakes (which in Research Computing is a good thing), and use those observations to develop best practices for Enterprise IT.