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Corporate Fellows Council Professional Development Series

My Non-traditional Journey and a Little Advice

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Computational Sciences & Engineering Division



U.S. DEPARTMENT
of **ENERGY**

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FOR THE US DEPARTMENT OF ENERGY



Not all journeys look the same

Non-traditional academic paths are just fine

You learn all your life, and it's never too late

**“Imagination is more important than knowledge”
– *Albert Einstein***

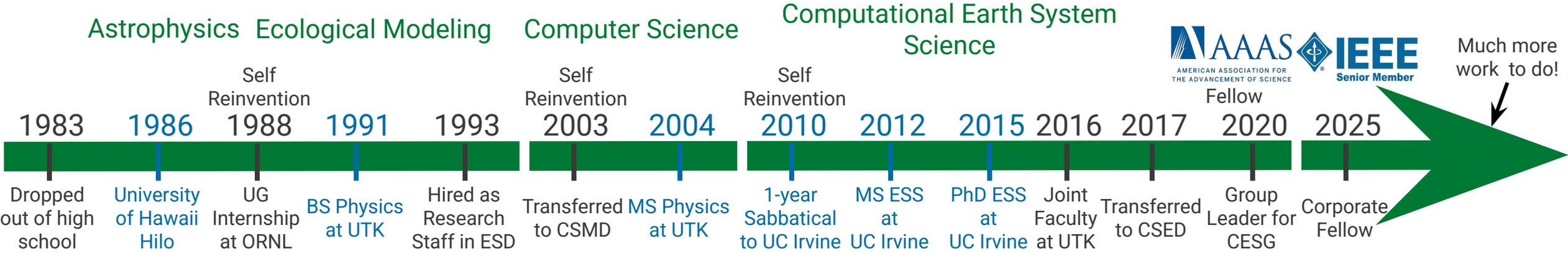
Forrest M. Hoffman, Computational Earth System Scientist

- Group Leader for the ORNL Integrated Computational Earth Sciences Group
- 37 years at ORNL: 15 years in Environmental Sciences Division, 14 years in Computer Science and Mathematics Division, and 8 years in Computational Sciences and Engineering Division
- Develop and apply Earth system models to study global biogeochemical cycles, including terrestrial & marine carbon cycle
- Investigate methods for reconciling uncertainties in carbon-climate feedbacks through comparison with observations
- Apply artificial intelligence methods (machine learning and data mining) to environmental characterization, simulation, & analysis
- Joint Faculty in Civil & Environmental Engineering and Bredesen Center Faculty at University of Tennessee, Knoxville



Professional Journey Punctuated by Educational Achievements

My academic progress overlapped my career development – “You learn all your life” was taken literally!



Unfunded Activities Often Become Your Greatest Achievements



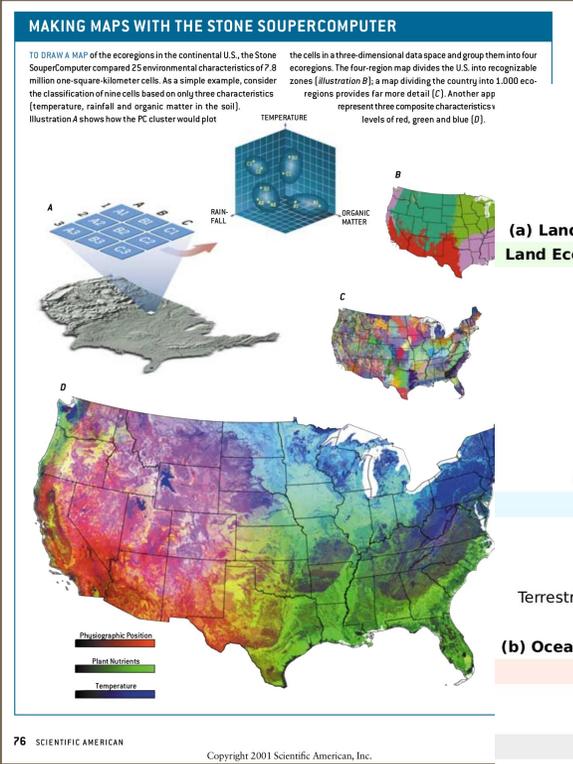
The Do-it-Yourself Supercomputer

By William W. Hargrove, Forrest M. Hoffman and Thomas Sterling
Photographs by Kay Chernush

FOCUS NEXT-GENERATION SUPERCOMPUTERS
This article is the second in a two-part series. The first part, "How to Build a Supercomputer," by Thomas Sterling, appeared in the July 2001 issue.

Scientists have found a cheaper way to solve tremendously difficult computational problems: connect ordinary PCs so that they can work together

Hargrove, W. W., F. M. Hoffman, and T. Sterling (2001), The Do-it-Yourself Supercomputer, *Sci. Am.*, 265(2):72-79, <https://www.scientificamerican.com/article/the-do-it-yourself-superpc/>



(a) Land Benchmarking Results

Land Ecosystem & Carbon Cycle

	bcc-csm1-1	CanESM2	CESM1-BCC	GFDL-ESM2G	IPSL-CM5A-LR	MIROC-ESM	MP-E5M1-LR	MP-E5M1-ME	HadGEM2-ES	BCC-CSM2-MR	CanESM5	GFDL-ESM4	IPSL-CM6A-LR	MIROC-ES2L	MP-E5M1-2-LR	UKESM1-0-L1	Mean CMIP5	Mean CMIP6		
Biomass	0.20	-0.45	-1.52	-0.40	1.26	-0.26	-1.07	1.77	0.92	1.39	0.74	-0.20	-0.54	0.16	0.93	-0.96	-0.01	1.04	1.23	1.64
Burned Area			-0.87				0.10	0.83				1.60								
Leaf Area Index	0.20	-0.64	-1.30	-2.53	-0.01	0.30	0.01	1.85	-0.16	0.27	0.08	0.34	-0.70	1.19	0.82	0.46	0.37	0.69	1.04	1.81
Soil Carbon	0.27	1.26	-1.46	0.07	0.75	0.47	-0.03	1.14	0.07	0.23	1.35	-0.99	2.04	-1.55	0.90	-0.75	-0.17	0.24	1.01	1.48
Gross Primary Productivity	0.59	-1.23	0.01	1.81	-1.40	0.29	-0.53	-0.24	-1.04	0.77	0.04	0.59	-0.38	1.17	-1.02	-0.37	0.73	0.09	1.51	2.22
Net Ecosystem Exchange	-0.42	1.81	-0.21	-0.65	1.10	-0.24	0.80	0.02	-1.03	-1.02	-1.19	0.59	1.69	-0.42	0.63	-0.21	1.08	1.43	1.28	1.43
Ecosystem Respiration	0.90	-0.56	-0.86	-0.24	-1.35	0.99	-0.01	0.94	-1.54	0.81	0.59	0.51	-0.79	0.90	-0.21	1.24	0.43	0.94	1.34	2.21
Carbon Dioxide	-1.54	-0.36	-0.92	-0.74	1.53	-0.00	0.37	0.85		0.42	0.26	0.39	0.59	1.10	-0.87	0.21	0.69	0.09	-0.07	
Global Net Carbon Balance	-1.64	-0.88	-1.13	0.17	-0.31	-0.38	0.50	0.24		-0.23	1.34	-1.70	0.17	-0.74	1.45	1.56	0.26	0.92	1.40	

(b) Ocean Benchmarking Results

Ocean Ecosystems

	bcc-csm1-1	CanESM2	CESM1-BCC	GFDL-ESM2G	IPSL-CM5A-LR	MIROC-ESM	MP-E5M1-LR	MP-E5M1-ME	HadGEM2-ES	BCC-CSM2-MR	CanESM5	GFDL-ESM4	IPSL-CM6A-LR	MIROC-ES2L	MP-E5M1-2-LR	UKESM1-0-L1	Mean CMIP5	Mean CMIP6		
Chlorophyll			2.16	0.20	-0.20		0.04		0.22		-0.37	0.83	-0.37	-0.26	-0.91	-0.67	1.93	0.27	0.30	0.67
Oxygen, surface	-1.50	2.13	0.44	1.02		0.49		0.56		-0.67	0.88	-0.21	0.10	-1.02	-0.41	2.19	1.18	0.13	0.04	

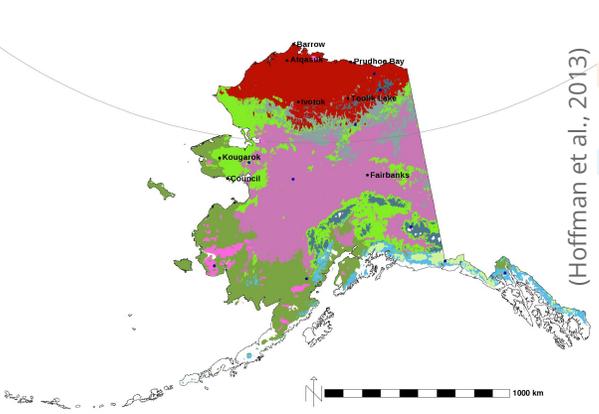
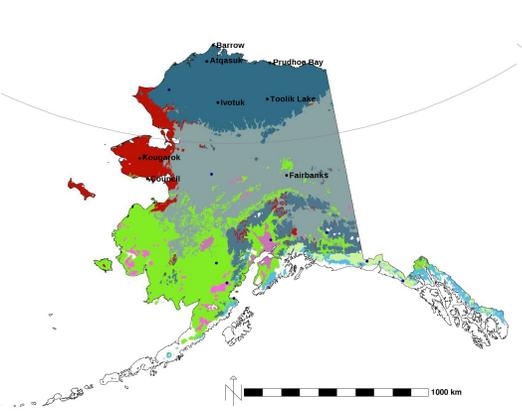
CMIP5 ESMs

CMIP6 ESMs

Relative Scale

Worse Value Better Value

Missing Data or Error



(Hoffman et al., 2013)

Figure 5.22, Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) from Working Group 1 (WG1), Chapter 5 (2021)

Lessons Learned as a Researcher

- You learn more from your mistakes than from your accomplishments
 - If you make enough mistakes, you will learn everything
- The most successful Lab staff are adaptable as research focus shifts and missions change
 - Be prepared to reinvent yourself, multiple times
- Be persistent!
- Earn your reputation outside the Lab; they will eventually notice inside
 - There is a fine line to be walked between humility and self-promotion
- ~~Imagination~~ Creativity is more important than knowledge – what Einstein probably meant
 - Take the time to explore, experiment, (and play!)
- Be persistent!
- Commitments to projects and sponsors are of chief importance
- Build strong, trusted relationships with sponsors; it may take years!
 - For Office of Science, focus your energy in a particular program and sponsor (or two)
- Be persistent!
- Help your sponsors recognize future opportunities and areas for growth
- If they tell you it cannot be done, you are probably onto something big
- Be persistent!

DOE Biological & Environmental Research Participation (1988–present)

- Earth System Grid Federation 2 - US (ESGF2-US) Project (Jay Hnilo)
- Next Generation Ecosystem Experiments (NGEE) Tropics (Dan Stover)
- Biogeochemistry–Climate Feedbacks Science Focus Area (SFA) / Reducing Uncertainties in Biogeochemical Interactions through Synthesis and Computation (RUBISCO SFA) (Renu Joseph)
- Next Generation Ecosystem Experiments (NGEE) Arctic (Dan Stover)
- Enterprise / Accelerated Climate Model for Energy (ACME) / Energy Exascale Earth System Model (E3SM) (Dorothy Koch)
- Scientific Discovery through Advanced Computing (SciDAC) Project (David Bader, Jeff Amthor, Anjuli Bamzai, Renu Joseph)
- Carbon Dioxide Information Analysis Center (CDIAC) (Wanda Ferrell)
- Global Change Data and Information System (GCDIS) (US Global Change Research Program, Data & Information Working Group, Wanda Ferrell)
- Atmospheric Radiation Measurement (ARM) Program (Wanda Ferrell)
- DOE Terrestrial Ecosystem and Carbon Cycle Science (Roger Dahlman)
- Clinch River Environmental Restoration Program (CRERP)
- DOE Groundwater Program (Frank Wobber)

Leadership Philosophy

- ORNL is the vessel in which we build careers and contribute to society
- Be honest and forthright: Eyes wide open!
- Build a culture of trust and engagement, as well as safety: No drama, speak calmly
- Lead by example: Be in the office and get your hands dirty!
- Inspire greatness and be inspired by the greatness of others around us
- Take responsibility and learn from your mistakes
- Create a nurturing environment and foster careers
- Coach instead of managing/directing whenever possible; but manage when necessary
- Spread enthusiasm and cheerlead for others
- Embrace cultural diversity and multidisciplinary
- Motivate high quality research and development by engendering a sense of ownership
- Support students and postdocs to “give back” and develop the next generation of scientists