Linking Climate and Weather: History, Role, Accomplishments and Future of PSD in ESRL

William D. Neff
Director, Physical Sciences Division
Outline:

- A short history
- The PSD Mission
- The current NOAA Goal structure and where we sit
- Strategic directions moving into the NOAA Climate Service
- How we are organized, staffed, and funded
- Activities and metrics for success
- External linkages
- Setting priorities
- Scientific highlights
- Future challenges and directions
A Short History:

- **1946:** Central Radio Propagation Laboratory (CRPL)
- **1965:** Environmental Science Services Administration (ESSA): CRPL + Weather Bureau + Coast and Geodetic Survey
- **1967:** ESSA Research Laboratories (ERL) formed
  - Three ESSA laboratories emerged from CRPL in Boulder:
    - Ionospheric telecommunications ➔ Space Disturbances Laboratory
    - Upper Atmosphere and Space Physics ➔ Aeronomy Laboratory
    - Tropospheric Telecommunications ➔ Wave Propagation Laboratory
- **1970:** NOAA created with the Director ERL (*Environmental Research Laboratories*) reporting to the Administrator.
History (cont.):

- **1970s – 1990s**
  - Office of Research and Development (ORD) created
  - Program for Regional Observing and Forecasting Services (PROFS) emerges from WPL as a bridging function to promote technology transfer to operations (NWS). (PROFS ➔ FSL)
  - Air Force Cambridge Research Laboratory Boundary Layer Group transfers to WPL and the Boulder Atmospheric Observatory (BAO) is built.
  - Air Resources Lab: Geophysical Monitoring for Climate Change (GMCC ➔ CMDL ➔ CDC)
  - WPL renamed the Environmental Technology Laboratory
History (cont.):

- 2005 Earth System Research Laboratory created

Rationale:

- The “Weather-Climate Connection” research line was developed by ETL and CDC during the period 1999-2001, was proposed through the strategic planning process, and was funded by Congress (this initiated a redirection of ETL from technology development to weather-climate applications).

- Historic linkages between AL and both CDC and ETL existed in areas of tropical meteorology, boundary layer profiler technology, and air quality meteorology.
Lessons Learned Over 40 Years:

- NOAA’s Laboratory structure has evolved to meet changing societal needs (from telecommunications to climate change).
- The capabilities to meet emerging needs were often available through prior research at the “grass roots” and past innovation.
- The evolution has been sustained by:
  - Investing in the best and brightest*,
  - Doing the right thing before knowing it’s the right thing,
  - Taking advantage of the unexpected, and
  - Responding to new challenges and use-inspired needs (requires building bridges to users).

*However, retention requires balancing current mission focus + a reasonable level of intellectual freedom + funding
The PSD Mission:

- With the ESRL consolidation in 2005, PSD carried out an extensive internal science review that resulted in three Branches from the amalgam of three research organizations:
  - Weather and Climate Physics Branch,
  - Water Cycle Branch,
  - Climate Diagnostics Branch,
- and a new mission:
  - **PSD**: “Conducting weather and climate research to observe & understand Earth's physical environment, and to improve weather and climate predictions on global-to-local scales.”
Where we sit in NOAA’s Goal Structure

- **Climate Goal**
  - Climate Research and Modeling Program
    - *Analysis and Attribution* (Dole, Lead)
  - Climate Observations and Monitoring Program

- **Weather and Water Goal**
  - *Science, Technology and Infusion* Program (Ralph, Program Manager)
  - Integrated Water Forecasting Program
  - Air Quality Program
PSD Strategic Directions:

- Conduct research and develop prototypes to improve NOAA environmental information and services.
- Integrate Climate, Weather and Water Research.
- Improve Observations and Understanding of Earth System processes.
- Understand, Attribute and Predict Extremes in a Variable and Changing Climate.
- Advance understanding of regional processes and develop applications related to climate variability and change.

Refocus for the NCS
How We are Organized:

**Director’s Office**
- Directorate (Neff, Dole, Lataitis)
- Budget and Administration Group (Gorton)
- Information Technology Group (Wilde)
- Communication Group (DeLuisi)

**Research Partnership Programs**
- National Integrated Drought Information System (NIDIS)
- Western Water Assessment (WWA)
- Advanced Sensor Applications Program (ASAP)
- University of Colorado – Center for Environmental Technology (CET)
- Special Projects (SP)

**Climate Analysis Branch (Webb)**
- Climate Dynamics Team
- Attribution and Assessments Team
- Ocean-Atmosphere Processes Team
- Data Assimilation and Predictions Team
- Model Evaluation and Development Team
- Tropical Dynamics Team

**Water Cycle Branch (Ralph)**
- Coastal Processes Team
- Hydrometeorological Processes Team
- Observing Systems Team

**Weather and Climate Physics Branch (Fairall)**
- Polar Observations and Processes Team
- Boundary Layer Processes and Applications Team
- Multiscale Interactions Team
PSD Staffing by Fiscal Year

*Guest Workers include: Scientists Emeriti (3), Guest Scientists (25), Post-docs (6), Guest Students (4), Externally Supported Staff (2)
FY09 PSD Staff Profile (Total=161)

- **Male**: 118 / 73%
- **Female**: 43 / 27%

- **White/Caucasian**: 143 / 89%

- **Pacific Islander**: 2 / 1%
- **Hispanic/Latino**: 5 / 3%
- **Asian**: 10 / 6%
- **African American/Black**: 1 / 1%

**Under 40 years of age**
- Cooperative Institute under 40 (13), Post Docs (6), Graduate Students (4), Summer Students (11)
Goal: Recruit the next generation of NOAA scientists

Example: Postdocs Applying Climate Expertise (PACE)

PACE Fellowship Awards

The goal of this program is to train climate researchers to transform their knowledge into solutions and tools for the decision/risk management community.

PACE Alumni and Current Postdoctorates

- **Kelly Mahoney**
  - Research Topic: Western water and Climate
  - PhD Institution: North Carolina State University, Atmospheric Science
  - Host Partners: David Raff (US Bureau of Reclamation) and Michael Alexander (NOAA/ESRL)
  - Appointment: 2009 - 2011

- **Imtiaz Rangwala**
  - Research Topic: Western water and Climate
  - PhD Institution: Rutgers University, Environmental Sciences
  - Host Partners: Jim Prance (Center for Advanced Decision Support for Water & Environmental Systems) and Joe Barsugli (NOAA/ESRL)
  - Appointment: 2009 - 2011

- **Galina Guentchev**
  - PhD Institution: Geography and Climatology, Michigan State University
  - Host Partners: Joe Barsugli (NOAA Western Water Assessment) and Joe Terry Fulp (Bureau of Reclamation, Lower Colorado Region)
  - Appointment: 2006 - 2010
How Our Staff are Supported

Note: In 2000, the combined budgets of ETL and CDC totaled $26.5M (~50% reimbursable)
FY09 PSD Expenditures by Function

(Total ≈ $19.3M)

Infrastructure

$6.5M / 34%

Science

$12.8M / 66%

Water Cycle

($4.6M)

Climate Analysis

($3.8M)

Weather & Climate Physics

($4.4M)

PSD Admin

($1.5M – 8%)

PSD IT

($2.2M)

Boulder Assessments

($1.1M)

ESRL OH

($0.75M)

OAR OH

($0.82M)

NOAA OH

($0.14M)
The Activities that we Support:

- Carrying out applied research targeting Earth system processes using observational, diagnostic, and modeling tools and promoting their transition to applications.

- Conceiving, developing, and prototyping observational, diagnostic and forecasting methods for weather and climate.

- Leading/contributing to high-level assessments and planning activities.

- Communicating/interacting with major interest and user groups in collaboration with the Western Water Assessment and the National Integrated Drought Information System program (both hosted within PSD).
Measuring Our Success:

- Maintaining the preeminence of our science as documented through the peer-review process.
- External recognition of staff (awards, professional recognition).
- New diagnostic and forecasting methods demonstrated/prototyped.
- Contributions to high-level assessments.
- Planning meetings, reports, and activities initiated or advanced with major interest/user groups (including other line offices, federal, state, and NGOs).
PSD Publications by Year

Publication Index = # Publications / # Publishing Staff

Doctorate = 84  
Function = 107
PSD H-Index Distribution

55 staff with H-Index ≥ 10

INDIVIDUAL | H-INDEX
--- | ---
Christopher Fairall | 36
Henry Díaz | 33
Thomas VanZandt | 27
Prashant Sardeshmukh | 27
David Carter | 26
Reginald Hill | 24
Martin Hoerling | 24
Michael Alexander | 22
Ed Westwater | 21
Brant Liebmann | 20
Jeff Whitaker | 20
William Neff | 19
Tom Hamill | 19
Marty Ralph | 19
Sergei Matrosov | 18
Paul Neiman | 18
Lev Ostrovsky | 18
Taneil Uttal | 18
Allen White | 18
Selected Awards:

**International**

Lev A. Ostrovsky, Mandelstam Prize of the Russian Academy of Sciences (2009)

**National/Interagency and White House**

Thomas Hamill, Presidential Early Career Award for Scientists and Engineers (PECASE) (2002)

**Professional Society**


**Professional Society Fellows:**

AMS: Christopher Fairall, Marty Ralph, Henry Diaz, Randy Dole

**NOAA**

R. Dole, R. Webb et al. DOC Bronze Metal, NIDIS Development (2005)
H. Diaz, NOAA Distinguished Career Award (2009)
He. Diaz, NOAA Administrator's Award (2004)
R. Dole, NOAA Administrator's Award (2008)
M. Hoerling, R. Pulwarty, and R. Webb, NOAA Administrator's Award (2008)
M. Ralph, Administrator's Award (2009)
D. Wolfe, D. Welsh, S. Pezoa, M.J. Post, et al., NOAA Administrators Award (2001)
C. Smith, NOAA Research Partner of the Month (2002)
M.J. Post, NOAA Technology Transfer Award (2001)
C. Fairall, NOAA Administrator's Award (2003)
Our Partnership with the Cooperative Institute for Research in the Environmental Sciences

- CIRES is the oldest CI in NOAA’s CI system, established in 1967.
- PSD is heavily involved in CIRES
  - Fellows:
    - Randy Dole: Associate Director for Weather and Climate Dynamics
    - William Neff: Regional Processes Theme Lead
    - Prashant Sardeshmukh: Director CIRES, Climate Diagnostics Center
    - Chris Fairall
  - Academic Interactions:
    - Climate Diagnostic Center
    - ESRL Graduate Student(s)
    - Faculty-Staff exchanges
    - Committee participation (e.g. visiting fellows, MS and PhD students)
Other Partners:

- All other OAR labs, Academia, National Center for Atmospheric Research, Naval Research Laboratory
- National Weather Service (e.g., Climate Prediction Center, Centers for Environmental Prediction,...), National Environmental Satellite Data and Information Service
- World Climate Research Program
How do we set priorities:

- High-level guidance from NOAA
  - Annual guidance memorandum.
  - Goals and Programs develop “alternatives” in the planning process.
  - The “alternatives” are vetted at various levels resulting in a Program Decision Memorandum.
  - These then start moving through the “system” from NOAA to DOC to OMB and, if successful, into the President’s Budget (Recent success: Water Resources Research Initiative in FY11 Budget).
How do we set priorities (cont.):

- Internally (primarily for new higher risk activities):
  - Discussion among the Director, Branch Chiefs, and scientists, often one-on-one, floating ideas for innovative research directions.
  - Examination of budget constraints and assignment of discretionary funds.
  - Potential for leveraging across PSD, ESRL, other labs, agencies, and academia.
  - Identification of common scientific interests.

*Example: Director’s Funding 2009 & 2010 for ENKF work with GSD*
Things we have phased down or out:

- Radiometric Remote Sensing Division (ETL):
  - Transitioned to the Center for Environmental Technology (CET) at the University of Colorado
  - Currently supporting CET’s NSF proposal for “Integrated Sensing in Extreme Environments”

- Radar Division (ETL)
  - Dissolved, small support group redirected to HMT applications in complex-terrain watersheds using dual-polarization X-band radar; other staff moved to our growing polar applications team (including cloud radar).

- Lidar Division (ETL)
  - Moved to Chemical Sciences Division of ESRL
A Few Scientific Highlights:

- Transformed NOAA operations with the transition of the PSD reforecasting capability to produce calibrated, reliable probabilistic subseasonal forecasts at NCEP.
- Demonstrated (with GSD) the ability of ensemble Kalman filtering methods to improve hurricane forecasting.
- Produced a 118 year surface pressure climate reanalysis and online access through PSD's widely-used, web-based visualization and analysis tools.
- Made major contributions leading to the development of a National Integrated Drought Information System (NIDIS).
- NOAA COARE ocean flux parameterization developed for application to climate/weather/trace-gas models.
- Advanced Arctic weather and climate research/monitoring through establishment of the SEARCH/IASOA networks.
- Established Atmospheric Rivers as a key phenomenon linking weather and climate in the water cycle, including flooding and future water supply.
- Created the Hydrometeorology Testbed (HMT), which has brought a NOAA-mission-oriented emphasis on precipitation and hydrologic forcing.
- Transformed PSD's BAO tower to one of GMD's CO₂ Tall Tower sites.
Future Challenges and Directions

- **Climate at Watershed Scales**: Defining and investing in the research and prototyping of services that will help society plan for new weather and climate regimes in the future.

- **Attribution**: Expanding our ability to explain current weather/climate conditions in the context of climate variability and change: Important to the public and decision makers.

- **Anticipatory Research**: Addressing the need to meet current requirements (short-term research) while investing in the long-term research that will result in new requirements 10-20 years from now.

- **Human Capital**: Maintaining the next generation of (diverse) scientists and engineers: How do we find the resources to retain them in the face of declining budgets.

- **Managing in the ‘System’**: How to avoid the stovepipes: cutting across Climate, Weather and Ecosystem goals.
The Review: What you will see:

- PSD-led themes
  
  - **Theme #1: Climate, Weather and Water Science:**
    - The basic science from air-sea fluxes to land-falling storms and climate-weather linkages.
  
  - **Theme #3: Climate, Weather and Water Services:**
    - From research to service prototypes and delivery: PSD’s unique relationship with NIDIS and WWA
  
  - **Theme #5b: Climate System Observations and Analysis:**
    - From historic reanalysis using old observations to documenting the state of the Arctic with new observations.

- Because of the constraints on the review structure, oral sessions will focus on a few core capabilities that have had major investments of resources and time.

- Posters will fill in some details and reflect the diversity of efforts within PSD to expand our understanding the Earth system and support the development of new information products and services in the future.
Supporting NOAA Milestones, 2008-2012

- Initiate the Southern Ocean Gas Exchange Experiment in the Atlantic sector of the Southern Ocean.
- Delivery of CCSP Synthesis and Assessment Products on reanalysis of historical data, climate extremes, and abrupt climate change.
- Implement observation and information component of the National Integrated Drought Information System (NIDIS).
- Improve NOAA’s predictive capability on weekly, monthly, and seasonal time scales by involving and leveraging the external research community.
- Develop and support capacity to provide decadal climate predictions.
- Develop a capability to make ... Arctic forecasts.
- Develop NIDIS pilot projects to better address localized and regional drought issues.
- Improve accuracy in intensity forecasts for tropical storms and hurricanes through accelerated tropical cyclone modeling improvements.
- Using testbeds, transfer up to six research results into operations per year.
- Determine viability of different data assimilation approaches (e.g., 3-D Var, ENKF, 4-D Var).
- Improve the accuracy of global analyses by 25% through better ensemble and statistical postprocessing techniques.
- Conduct field campaign in California to characterize drivers of poor air quality.

Note: Milestones formulated at the beginning of the five-year period, not dynamic in content.
FY09 PSD Staff Degree Distribution and Functions
(Total=161)

Doctorate 84 / 52%
Master’s 38 / 24%
Bachelor’s 32 / 20%
Associate’s 1 / <1%
High School 6 / 4%

Science 95 / 59%
Engineering 19 / 12%
Data 7 / 4%
Technical Support 12 / 7%
Administrative Support 16 / 10%
Lab Management 3 / 2%
Science Management 9 / 6%
FY09 PSD Staff Distribution

(Total=161)

Directors Office
27 / 17%

- Directorate (4)
- Admin (10)
- IT (13)
- SP (1)
- NIDIS (3)
- ASAP (14)
- WWA (9)
- CET (2)

Partnership Programs
29 / 18%

- Core Research (105 / 65%)
- Climate Analysis (37)
- Water Cycle (33)
- Weather & Climate Physics (35)
- Directorate (4)
- Admin (10)
- IT (13)
- SP (1)
- NIDIS (3)
- ASAP (14)
- WWA (9)
- CET (2)
A problem with aging:

- Cooperative Institute Mean = 47
- Federal Mean = 53 (48% retirement eligible)
- Contractor Mean = 51

Bar chart showing age distribution with Federal, CI, and Contractor categories.