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SUMMARY:

- Currently Director of the Joint Numerical Testbed at NCAR/RAL, supporting JNT's mission of transitioning research-to-operations by testing and evaluating numerical weather prediction systems, including data assimilation, and other earth system components.
- Previously Deputy Director of EMC/NCEP, for EMC's mission to "maintain, enhance and transition-to-operations numerical forecast systems for weather, ocean, climate, land surface and hydrology, hurricanes, and air quality for the Nation and the global community and for the protection of life and property and the enhancement of the economy." As Deputy Director, demonstrated leadership and superior problem solving, management, and communication skills to meet the above stated mission of EMC.
- Leading and participating in various national and international activities in numerical model development following a "model development hierarchy", i.e. from assessing process-level components to fully coupled earth system models, with associated validation benchmarks and associated test bed data sets at each hierarchical step.
- Providing leadership and guidance in a number of community research and educational outreach activities, from student competitions at conferences, Ph.D. committees and summer schools on weather and climate, to major research initiatives, program panel reviews and national and international conferences.

AWARDS

- **Federal Laboratory Consortium (FLC) Interagency Partnership Award** received in 2016 for the NASA Soil Moisture Active-Passive (SMAP) Applications Program: *Use of remotely-sensed soil moisture data for numerical weather prediction.*
- **United States Department of Commerce Silver Medal for Meritorious Federal Service** in 2014 for outstanding scientific assessment of the origins of the 2012 Great Plains drought.

EDUCATION

- **Ph.D. (2005) Environmental Sciences/Meteorology, Wageningen University, Netherlands.**
Title: *Interactions of the land-surface with the atmospheric boundary layer.*
Advisor: Professor A. A. M. Holtslag, Department Chair, Meteorology and Air Quality.
- **M.S. (1982) Atmospheric Sciences (Mathematics/Statistics minor), Oregon State Univ.** Title: *The influence of the diurnal variation of atmospheric stability on potential evaporation.* Advisor: Professor Larry Mahrt, College of Earth, Ocean, and Atmospheric Sciences.
- **B.S. (1987) Science and Math Education, Oregon State University.**
- **B.S. (1980) Atmospheric Sciences (Mathematics/Geography minor), Oregon State Univ.**

PROFESSIONAL EXPERIENCE AT NCEP/EMC

EMC Deputy Director (October 2015-present).

Provide scientific and administrative leadership, while assisting the EMC Director, engaging the senior staff at EMC, and communicating with and leading the nearly 200 scientists at EMC on a day-to-day basis. Engage in strategic planning for the development and execution of the EMC Annual Operating Plans (AOP) in support of EMC's model development mission. This includes adapting to changing requirements for NOAA and the NWS and other stakeholders in the U.S. weather-water-climate enterprise and the transnational community, as well as securing and managing internal NWS funds, and external project funds from a number of agencies, i.e. NOAA, NASA, FAA, etc.

As part of this position, help interpret University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for NCEP (UCACN) and UCACN Modeling Advisory Committee (UMAC) recommendations, and those coming from the annual NCEP Production Suite Review, as well as other recommendations to EMC from the community, and fold these into plans for evolving the NCEP Production Suite to better meet user needs.

This position also involves communication with external organizations, projects and programs to ensure that research-to-operations efforts are well connected, i.e. other NCEP centers, NWS offices (e.g. the Next Generation Global Prediction System, NGGPS, program), NOAA labs and programs (e.g. NOAA Test Beds, Climate Program Office, etc.), other agencies and institutes, e.g. programs by the National Center for Atmospheric Research (NCAR), National Aeronautics and Space Administration (NASA), as well as numerous academic partners, both domestic and foreign (e.g. European Center for Medium range Weather Forecasting, UK Met Office), and international programs under the World Meteorological Organization (WMO; see "GEWEX" further below).

Additionally, support the necessary EMC administrative and supervisory tasks to ensure smooth running of EMC, including staff evaluations, recruitment and hiring.

- **EMC Acting Deputy Director** (November 2014-October 2015; official 4-month detail, November 2014-March 2015).

Led the NOAA “Sandy Supplemental” project monitoring at EMC, coordinating monthly input for briefing to NWS Director; led EMC coordination with NWS Headquarters on the Next Generation Global Prediction System (NGGPS) in writing the project plan for comprehensive physics model development for NCEP models.

Working with others, developed plans for the next Climate Forecast System (CFS) and a Unified Global Coupled Modeling and Data Assimilation System for medium-range weather to seasonal prediction.

Assumed the EMC administrative duties of NOAA Corps Officer at EMC (starting in October 2014) when the officer left for a new assignment; these included various aspects of monitoring computer resources, leading the NCEP computer development and implementation meetings, arranging Quarterly Science updates, computer user account access, and EMC Senior Staff meetings; mentored the new NOAA Corps Officer who arrived in February 2015.

- **EMC Land Team Lead** (October 2009-2015; retaining many duties to present).

Manage the land team (8-10 scientists, and sometimes visitors) that is responsible for all aspects of land modeling in NCEP operational numerical models. This includes understanding the role of surface processes and land-atmosphere interaction in weather and climate, remotely-sensed land data sets and land data assimilation, with applications to drought and connections with water resources and hydrometeorology-climatology communities, i.e. through the Global LDAS (GLDAS; operational in the CFS since April 2011), and the stand-alone North American Land Data Assimilation System (NLDAS; operational August 2014).

These efforts involved coordination within NCEP/EMC as well as extensive collaboration with external partners, e.g. other offices in NOAA, as well as NCAR, NASA, many in academia. Conduct individual and group meetings to review progress, via short-term plans and long-range goals for modeling at NCEP generally, and land-hydrology specifically.

Encourage outreach by Land Team members through meeting attendance, working group participation, and journal article publications. Liaise with the NWS Office of Water Prediction to ensure a unified approach to coupled atmosphere-land-hydrology model development (to include streamflow and groundwater) model development (thereby optimizing computer resources) as part of a fully-coupled Earth System modeling approach (includes ocean, waves, sea/land-ice, aerosols, ionosphere), with e.g. connections to ecosystems and air/water quality.

External funding for approximately half of the land team members secured via submission of 30+ proposals since becoming the EMC Land Team Leader in 2009 and later as the EMC Deputy Director, in collaboration with our partners, both within NOAA, e.g. NCEP/EMC, National Environmental Satellite, Data, and Information Service (NESDIS), or externally, e.g. NASA, NCAR, and different universities. Previous projects have been funded by the NWS NGGPS and “Sandy Supplemental”

programs, NOAA Climate Program Office/Modeling, Analysis, Predictions, and Projections (MAPP program), NESDIS (GOES and JPSS) programs, and the U.S. Forest Service.

- **NCEP/EMC Land Team member** (February 1999-January 2009) under the University Corporation for Atmospheric Research (UCAR) Visiting Scientist Program working on land and related model development and implementations in NCEP weather and climate models per the details above, with increasing Land Team responsibilities over this time period.

PROFESSIONAL ACTIVITY (NATIONAL, INTERNATIONAL)

- **Multi-Agency/Multi-Institute Working Groups to Enhance Model Development:** Lead and participate in various working groups to help align land-hydrology, land-atmosphere interaction, and related communities in land data assimilation and model development, with partners from NCAR (e.g. Developmental Testbed Center and Global Model Test Bed, WRF land working group), NASA Goddard, Office of Naval Research/Naval Research Lab, Air Force Weather Agency (AFWA), US Army Corp of Engineers/Cold Regions Research and Engineering Laboratory, NOAA Earth System Research Laboratory (ESRL), NOAA Geophysical Fluid Dynamics Laboratory (GFDL), and various academic partners (e.g. Princeton Univ., Univ. Washington, Univ. Arizona, Univ. Texas-Austin, among others), both national and international (see WMO activities below), e.g. NCEP-NCAR community Noah land model development group, NLDAS working group, Joint Center for Satellite Data Assimilation (JCSDA) land data assimilation working group (JCSDA is co-sponsored by NOAA, NASA, Navy, and Air Force), NCAR Weather Research and Forecasting (WRF) land working group, and land data sets and products created and tested in collaboration with NESDIS and other collaborators. *Many of these collaborative activities here and those described below involve following a “model development hierarchy”, i.e. from assessing process-level components to fully-coupled earth system models, with associated validation benchmarks and associated test bed data sets at each hierarchical step.*
- **Global Energy and Water Cycle Exchanges Project (GEWEX)** (a core project under the WMO’s World Climate Research Programme, WCRP), i.e. the Global Land/Atmosphere System Study (GLASS), and the Global Atmospheric Boundary Layer Study (GABLS). Participation in activities by these groups helps to improve the Noah land model and related NCEP model components.
GLASS science panel (member 2009-present, co-chair January 2015-present). Participating in various activities, i.e. the Local Land-Atmosphere Coupling (LoCo) project, and Diurnal land/atmosphere coupling experiment (DICE; in collaboration with GABLS). Now leading the GLASS panel, providing annual updates to the GEWEX Science Steering Group, organizing the annual GLASS science panel meeting, and ensuring that activities address WCRP Grand Challenges, GEWEX Science Questions, and GEWEX Imperatives. GLASS liaison to the WCRP Modelling Advisory Council (WMAC), with promoting and supporting model development summer schools, an important topic of WMAC.

GLASS liaison to the GEWEX Hydroclimatology Panel (GHP; 2009-2015). Assure coordination with GLASS in the use of GHP data sets for GLASS model development projects.

Organizing Committee for 7th International GEWEX Conference (Netherlands), July 2014.

Scientific Steering Committee for “Including Water Management In Large Scale Models”, a workshop co-sponsored by GLASS and GHP, Centre National de la Recherche Scientifique (CNRS), Gif-Sur-Yvette, France, 28-30 September 2016.

Scientific Committee for “Hydrology Delivers Earth System Sciences To Society 4”, University Of Tokyo, Tokyo, Japan, 16-19 May 2017.

Organizing Committee for the 2018 GEWEX Conference (to be held in Alberta, Canada, summer 2018).

- **WCRP Global Drought Information System (GDIS)**: participated in 2011 and 2012 drought workshops, and working group activities utilizing model output from NCEP/EMC systems, i.e. NLDAS and GLDAS, for drought assessment.
- **Working Group on Numerical Experimentation (WGNE)**; panel member 2014-present). NCEP representative, GLASS ex-officio member, liaison to World Weather Research Project Polar Prediction Project (PPP) / Year of Polar Prediction (YOPP).
Local Organizer for the successful WGNE-30 meeting hosted by NCEP/EMC at NCWCP in March 2015 (polar.ncep.noaa.gov/conferences/WGNE-30).
Local Organizer for the WWRP YOPP Open Session and PPP Steering Group meeting No. 8, hosted by NCEP/EMC at NCWCP, 27 February - 01 March 2017.
Organizing Committee for the WGNE Systematic Errors Workshop (Montreal, Canada, June 2017).
- **Korean Institute for Atmospheric Predictions Systems (KIAPS), Science Advisory Panel (SAC)**, 2015-present, providing feedback on the development of their new global model, specifically as a subject matter expert on model physics. This includes interactions with a number of students and early career scientists in Korea.
- **Speaking Invitations**: many invitations (often supported) to give seminars/lectures/keynote talks and chair sessions on modeling and observation of land-surface/hydrometeorology (including land data assimilations systems, and drought and water resources applications) and boundary-layer processes, and the role of land-atmosphere interaction in the evolution of land-surface fluxes and atmospheric boundary-layer development including clouds at national and international meetings, e.g. AMS and AGU meetings, university seminars, as well as WMO-sponsored meetings (e.g. World Weather Open Science Conference/Montréal 2014) and other conferences and workshops, e.g. 2012 Texas Drought Forum (briefing to scientists and water resources managers on use of NLDAS for drought), speaking on NCEP/EMC model development at the Catalan Meteorology Association meeting (Barcelona, Spain 2009), “Land Surface - Atmosphere Feedbacks in Desert Regions” at the U.A.E. Research Program for Rain Enhancement Science First Research Progress Workshop (January 2017) and follow-on WRF discussions with a professor and his students at the

Masdar Institute in Abu Dhabi. These activities most often included follow-on model development activities and ongoing interaction with interactions with students, often with follow-on communications and mentoring in some cases.

- **Reviewer for Scientific Work**

NWS projects, plans, and proposals, with briefing to upper management in EMC, NCEP, NWS, NOAA and elsewhere as requested.

NOAA, NASA, NSF, DoD, DoE proposals from different land and related programs.

Proposal review panels for NOAA Climate Program Office, NASA land-hydrology-related programs.

Panel member on the NOAA Cooperative Remote Sensing Science and Technology Center (CREST) Science Advisory Board (2014-2015).

Journals of the *American Meteorological Society*, and the *American Geophysical Union*, also *Boundary-Layer Meteorology*, *Journal of Hydrology*, *Meteorology and Atmospheric Physics*, and others.

- **Membership in Professional Societies**

American Meteorological Society, AMS Hydrology Committee (2010-2016, chair 2013-2016). Lead the committee membership in the promotion of events and activities that support hydrometeorology, e.g. the Hydrology Conference at the AMS annual meeting, including evaluating candidates for the Horton Lecture (award), establishing joint sessions with other committees (e.g. Climate Variability and Change, Applied Climate, etc), sponsorship of students and early-career scientists, and AMS activities requiring hydrometeorology expertise, such as other AMS awards.

American Geophysical Union

European Geosciences Union

EDUCATIONAL OUTREACH

- Summer School Lecturer (invited/supported) on land modeling and land-atmosphere interaction in weather and climate models, e.g. NCAR WRF model tutorials, NASA Jet Propulsion Laboratory (JPL) Summer Schools on Climate Models (2011, 2015, 2016, 2017; invited annually), Mesoscale modeling workshops at the Center for Weather Forecasting and Climate Research (CPTEC, Brazil; 2007, 2013, 2016) and at the International Centre for Theoretical Physics (ICTP, Italy; 2008). Lecture on “Overview of Numerical Weather Prediction”, presented at *AMS Project Atmosphere*, a teacher’s training workshop at the NWS Training Center in Kansas City, MO, July 2016. Many of these sessions included hands-on work with students; maintained contact with numerous students over the years as their careers advanced.

- **Conferences:**

Co-managed Student and Early Career Scientist paper/poster competition at the GEWEX Conference in 2014 (The Hague, The Netherlands)

AMS Annual meetings, Hydrology Conferences, led/helped with student competition (2010-2017)

WGNE 2017 Systematic Errors Workshop (Montréal, Canada), will help with Student/Early Career Scientist competition.

- Managing Student Summer Internship program at NCEP/EMC (2017).
- PhD committees (topics on land-hydrology modeling, land-atmosphere interaction, remote sensing of the terrestrial environment):

Princeton:

Craig Ferguson (2010), now a professor at SUNY-Albany, advisor: Prof. Eric Wood.

Nate Chaney (2015), now a post-doc at GFDL, Princeton, advisor: Prof. Eric Wood.

Josh Roundy (2016, PhD reader), now a professor at Univ. Kansas, advisor: Prof. Eric Wood.

Liqing Peng (current student), advisors: Prof. Justin Sheffield (Univ. Southampton, UK) and

Prof. Eric Wood.

Univ. Washington:

Ben Livneh (2012), now at Univ. Colorado, advisor: Prof. Dennis Lettenmaier.

ITC-University Twente, Enschede, The Netherlands:

Muhammad J. Malik (2014), now at the Pakistan National Space Agency, advisor Prof. Z. Su.

Donghai Zheng (2015), now a post-doc at ITC-Univ. Twente, advisor Prof. Z. Su.

Meteorology and Air Quality Department, Wageningen University, The Netherlands:

Obbe Tuinenburg (2008, PhD proposal reader), now at Univ. Utrecht, The Netherlands,

advisor Prof. A.A.M. Holtslag

Univ. Maryland:

David New (current student), advisor: Prof. Xin-Zhong Liang

OTHER PROFESSIONAL EXPERIENCE

- **May-July 2012, Visiting Scientist** (invited/supported via a competitive university fellowship), Wageningen University, Meteorology and Air Quality Department, Wageningen, The Netherlands. Examined the nature of local land-atmosphere interaction and the role of land states in evolving surface fluxes to establish metrics for evaluating (coupled) land and surface-layer model parameterizations, e.g. to be used for NCEP models; this work/collaboration continues.
- **1995-1996, Visiting Scientist** (invited/supported), Royal Netherlands Meteorological Institute (KNMI), Climate Division, DeBilt, Netherlands. Worked on land and boundary-layer models, and observational analysis of land-atmosphere interaction to support development of these models.
- **1988-1999, Research Assistant/Lecturer**, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, OR 97331-2209 USA. Via various project grants from several funded proposals, worked on land and boundary-layer models, and observational analysis of land-atmosphere interaction to support development of these models, i.e. OSU models per above. Wrote proposals to NOAA

and other agencies to secure funds for these projects. Mentored students helping with these projects; taught survey courses in meteorology.

- **1981, 1983-1986, Operational Meteorologist:** Satellite meteorology (National Environmental Satellite Service, now NESDIS; Alaska, Summer 1981), Fire Weather and Mountain Meteorology/Avalanche, including fieldwork (State of Alaska, 1983-1985), NWS Forecast Office in Seattle (1985-1986), Private consulting meteorologist (Seattle, 1985-1986).

PROFESSIONAL REFERENCES

- **Dr. Graeme Stephens**

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PUBLICATIONS

2018:

Dirmeyer, P. A., L. Chen, J. Wu, C.-S. Shin, B. Huang, B. A. Cash, M. G. Bosilovich, S. Mahanama, R. D. Koster, J. A. Santanello, M B. Ek, G. Balsamo, E. Dutra, and D. M. Lawrence, 2018: Verification of Land–Atmosphere Coupling in Forecast Models, Reanalyses, and Land Surface Models Using Flux Site Observations. *J. Hydrometeorol.*, doi:10.1175/JHM-D-17-0152.1.

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- Frasconi, A., and E. Ramirez, D. Castilho, J. G. Z. de Mattos, M. Rixen, A. J. P. Calheiros, D. Cassain, H. F. de Campos Velho, S. R. de Roode, F. Doblas-Reyes, M. Ek, R. Forbes, P. Kubota, P. H. Lauritzen, L. A. T. Machado, G. Martins, K. A. Reed, N. E. Rosário, N. Wedi, 2018: Building the next generation of climate modelers: scale-aware physics parameterization and the ‘Grey Zone’ challenge. Summary report on the 2nd WCRP Summer School on Climate Model Development. *Bull. Amer. Meteorol. Soc.* (submitted).
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- Santanello, J. A. Jr., P. A. Dirmeyer, C. R. Ferguson, K. L. Findell, A. B. Tawfik, A. Berg, M. Ek, P. Gentine, B. P. Guillod, C. van Heerwaarden, J. Roundy, Civil, V. Wulfmeyer, 2018: Land–Atmosphere Interactions: The LoCo Perspective. *Bull. Amer. Meteorol. Soc.*, doi:10.1175/BAMS-D-17-0001.1.
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- Zheng, W., X. Zhan, J. Liu, and M. Ek, 2018: A Preliminary Assessment of the Impact of Assimilating Satellite Soil Moisture Data Products on NCEP Global Forecast System. *Advances in Meteorol.* (in press).
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- 2017:**
- Haughton, N., G. Abramowitz, A. J. Pitman, D. Or, M. J. Best, H. R. Johnson, G. Balsamo, A. Boone, M. Cuntz, B. Decharme, P. A. Dirmeyer, J. Dong, M. Ek, Z. Guo, V. Haverd, B. J. J. van den Hurk, G. S. Nearing, B. Pak, J. A. Santanello Jr., L. E. Stevens, and N. Vuichard, 2017: The Plumbing of Land Surface Models: Is Poor Performance a Result of Methodology or Data Quality? *J. Hydrometeorol.*, doi:10.1175/JHM-D-15-0171.1.
- Xia, Y., D. Mocko, M. Huang, B. Li, M. Rodell, K.E. Mitchell, X. Cai, and M. B. Ek, 2017: Comparison and Assessment of Three Advanced Land Surface Models in Simulating Terrestrial Water Storage Components over the United States. *J. Hydrometeorol.*, **18**, 625-649, doi:10.1175/JHM-D-16-0112.1.
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