

# Michael Scott Balch, PhD

## Address:

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## Contact Information:

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## Summary:

Researcher with 14 years of experience, specializing in aerodynamics, orbital mechanics, uncertainty quantification, statistical inference, and model validation.

## Education:

<b>Ph.D. Aerospace Engineering</b> December 2010	Virginia Polytechnic Institute and State University (Virginia Tech)
<b>M.S. Aerospace Engineering</b> May 2008	Virginia Polytechnic Institute and State University (Virginia Tech)
<b>B.S. Aerospace Engineering</b> May 2006	Virginia Polytechnic Institute and State University (Virginia Tech)

## Employment:

**Technical Lead** June 2014 - Present  
*Alexandria Validation Consulting, LLC*

Conduct basic research and develop proprietary software in statistics and uncertainty quantification applications. Identified root cause of "probability dilution" in satellite conjunction analysis.

**Technical Staff** April 2013 - April 2014  
*Arctan, Inc.*

Developed linearly scalable algorithm for computing correlations between large numbers of time series.

**Research Engineer** August 2012 - April 2013  
*Universal Technology Corporation (UTC)*

Embedded in AFRL/RQHF at Wright-Patterson AFB. Developed and applied novel statistical approach for assessing the plausibility of different physical explanations for bias in legacy hypersonic wind tunnel data.

**Post-Doctoral Researcher** January 2011 - June 2012  
*Applied Biomathematics*

Formulated the theory of confidence structures to support applications in medical health risk assessment.

**Graduate Research Assistant** August 2006 - December 2010  
*Virginia Tech, Department of Aerospace and Ocean Engineering*

Embedded at NASA Langley 2008-2010. Developed and applied methods appropriate to the quantification of parameter uncertainty in Mars atmosphere models. This included work in black-box response surface methodology (non-intrusive polynomial chaos) and the adoption of Dempster-Shafer theory to represent a combination of probabilistic and non-probabilistic uncertainty sources.

## Publications:

Oberkampf, W.L. and Balch, M.S. (2020) "Closure on the discussion of 'Models, uncertainty, and the Sandia V&V challenge problem' by G. A. Hazelrigg and G. A. Klutke" *ASME Journal of Verification, Validation and Uncertainty Quantification*. 5(3).

Balch, M.S. (2020). "New two-sided confidence intervals for binomial inference derived using Walley's imprecise posterior likelihood as a test statistic." *International Journal of Approximate Reasoning*. vol. 123. p. 77-98.

Balch, M.S., Ryan, M., and Ferson, S. (2019). "Satellite conjunction analysis and the false confidence theorem." *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*. 475(2227).

Balch, M.S. (2016). "A corrector for probability dilution in satellite conjunction analysis." at *18th AIAA Non-Deterministic Approaches Conference*. San Diego, CA.

Balch, M.S. and Smarslok, B. (2014). "A pre-validation study on supersonic wind tunnel data collected from legacy aerothermal experiments." at *16th AIAA Non-Deterministic Approaches Conference*. National Harbor, MD.

Ferson, S., Balch, M., and O'Rawe, J. (2014). "Computing with confidence: Imprecise posteriors and predictive distributions." in *Vulnerability, Uncertainty, and Risk: Quantification, Mitigation, and Management*.

Ferson, S., Balch, M., Sentz, K., and Siegrist, J. (2013). "Computing with confidence." at *8<sup>th</sup> International Symposium on Imprecise Probability: Theory and Applications*. Compiègne, France.

Balch, M.S. (2012). "Mathematical foundations for a theory of confidence structures." *International Journal of Approximate Reasoning*. 53(7).

Roy, C.J. and Balch, M.S. (2012). "A holistic approach to uncertainty quantification with application to supersonic nozzle thrust." *International Journal for Uncertainty Quantification*. 2(4).

Balch, M.S. (2010). *Methods for rigorous uncertainty quantification with application to a Mars atmosphere model*. Doctoral dissertation, Virginia Tech. Blacksburg, VA.

Hosder, S., Walters, R.W., and Balch, M. (2010). "Point-collocation nonintrusive polynomial chaos method for stochastic computational fluid dynamics." *AIAA Journal*. 48(12).

Balch, M., Hosder, S., and Walters, R. (2008). "Modeling and propagation of physical parameter uncertainty in a Mars atmosphere model." at *46th AIAA Aerospace Sciences Meeting and Exhibit*. Reno, NV.

Hosder, S., Walters, R.W., and Balch, M. (2008). "Efficient uncertainty quantification applied to the aeroelastic analysis of a transonic wing." at *46th AIAA Aerospace Sciences Meeting and Exhibit*. Reno, NV.

Hosder, S., Walters, R.W., and Balch, M. (2007). "Efficient sampling for non-intrusive polynomial chaos applications with multiple uncertain input variables." *at 9th AIAA Non-Deterministic Approaches Conference*. Honolulu, HI.

Computing Languages and Environments:

<b>Matlab</b>	10 years	<b>Fortran 95</b>	2 years
<b>R</b>	9 years	<b>LaTeX</b>	14 years
<b>Linux/Unix</b>	4 years	<b>Microsoft Office</b>	18 years
<b>C++</b>	5 years		

Awards:

Winner of 2006 AIAA Undergraduate Team Space Design Competition  
Peter and Phyllis Pruden Scholarship (2004-2005)

Memberships:

Tau Beta Pi, Engineering Professional Fraternity  
Sigma Gamma Tau, Aerospace Engineering Honor Society  
American Institute of Aeronautics and Astronautics (AIAA), Lifetime Member