

# Michael Scott Balch, PhD

## Address:

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## Contact Information:

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## Summary:

Research-practitioner with 12 years of experience, specializing in aerospace engineering, uncertainty quantification, statistical inference, and model validation.

## Education:

**Ph.D. Aerospace Engineering**      Virginia Polytechnic Institute and State University  
December 2010      (Virginia Tech)

**M.S. Aerospace Engineering**      Virginia Polytechnic Institute and State University  
May 2008      (Virginia Tech)

**B.S. Aerospace Engineering**      Virginia Polytechnic Institute and State University  
May 2006      (Virginia Tech)

## Employment:

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

Identified root cause of "probability dilution" in satellite conjunction analysis. Developed proprietary algorithms for computing collision risk in satellite conjunction analysis and for validating financial models.

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

Project Manager:      Charles Morefield  
Company Owner:      Michael Morefield

Developed linearly scalable algorithm for computing correlations between large numbers of time series. This was applied to stock market data.

**Research Engineer**      August 2012 - April 2013  
*AFRL/RQHF at Wright-Patterson Air Force Base contracting through Universal  
Technology Corporation (UTC)*

Project Manager:      Benjamin P. Smarslok  
UTC Managers:      Roger Rucker and Lanny Jines

Developed statistical approach for assessing plausibility of different explanations for bias in legacy hypersonic wind tunnel data, allowing for free parameters in the proposed models.

**Post-Doctoral Researcher**  
*Applied Biomathematics*

January 2011 - June 2012

Project Manager: Scott Ferson  
Company Owner: Lev Ginzburg

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*

Project Manager: Robert Tolson  
Doctoral Adviser: Robert Walters

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. I spent May 2008 through December 2010 embedded at NASA Langley through the National Institute of Aerospace.

Publications:

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>	7 years	<b>LaTeX</b>	12 years
<b>Linux/Unix</b>	4 years	<b>Microsoft Office</b>	16 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)