Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Solute Dynamics and Imaging in the Tear Film on an Eye-shaped Domain[1] R.J. BRAUN, University of Delaware, LONGFEI LI, WILLIAM HENSHAW, Rensselaer Polytechnic Institute, TOBIN DRISCOLL, University of Delaware, P.E. KING-SMITH, The Ohio State University — The concentration of ions in the tear film (osmolarity) is a key variable in understanding dry eye symptoms and disease, yet its global distribution is not available; direct measurements are restricted to a region near the temporal canthus. It has been suggested that imaging methods that use solutes such as fluorescein can be used as a proxy for estimating the osmolarity. The concentration of fluorescein is not measured directly either but the intensity as a function of concentration and thickness of the film is well established. We derived a mathematical model that couples multiple solutes and fluid dynamics within the tear film on a 2D eye-shaped domain. The model includes the physical effects of evaporation, surface tension, viscosity, ocular surface wettability, osmolarity, osmosis, fluorescence and tear fluid supply and drainage. We solved the governing system of coupled nonlinear PDEs using the Overture computational framework developed at LLNL, together with a hybrid time stepping scheme (using variable step BDF and RKC). Results of our numerical simulations provide new insight about the osmolarity distribution and its connection with images obtained in vivo over the whole ocular surface and in local regions of tear thinning due to evaporation and other effects.

[1]This work was supported in part by NSF grants 1022706 and 1412085, and NIH grant 1R01EY021794.

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Date submitted: 01 Aug 2015 Electronic form version 1.4