

From thermochronometric ages to exhumation rates

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To render a thermochronometric age into a more useful exhumation rate, it is necessary to process that age through a thermal model. We present a set of analytical and numerical thermal modelling methods of increasing complexity; which we feel are as simple as possible, while still retaining the essential physics of the thermal processes. We consider first the simple case of converting a single age into an exhumation rate. We include the dependence of the closure temperature on cooling rate (Dodson, 1973) and the upward advection of heat and derive some simple, analytical expressions relating exhumation rate to age through the kinetic parameters of the thermochronometric system, first, by assuming the geothermal gradient has been constant in time, and, second, using the transient analytical solution for an advecting halfspace. The second problem we consider is the effects of topographic relief on the closure isotherm. We calculate the mean depth to a closure isotherm using the solution described above, and then use spectral methods to calculate topography on this isotherm in response to topography of the surface. Finally, we consider the problem of spatially-varying exhumation rate. For this problem we combine the approaches given above, calculating perturbations to isotherms using spectral methods, combined with 1-D models of heat advection and diffusion. The 1-D models are linked by imposing a spatial correlation structure on the exhumation rate, which is otherwise free to vary in space and time. This approach provides an efficient method to “invert” a large number of thermochronometric ages, distributed in space and elevation, providing maps of time-varying exhumation rate. We illustrate each of these methods with data from the European Alps.

Novel approaches to organic aerosol chemical characterization

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In recent years several new approaches have been introduced to improve the chemical characterization of atmospheric organic aerosol (OA). Here, we highlight two techniques, the thermal desorption aerosol gas chromatograph (TAG) for automated in-situ molecular level OA speciation [1], and the high resolution time-of-flight aerosol mass spectrometer (AMS), which in addition to inorganic speciation, measures total fine OA mass concentrations and determines O/C, H/C, and N/C elemental ratios [2]. While each technique has its strengths, the TAG system is not capable of complete OA analysis without prior chemical derivatization, and the AMS is not capable of separating individual compounds. Here, we will describe recent efforts to create a combined TAG-AMS system to provide measurements of total OA, elemental ratios, and individual compounds. Finally, we discuss our efforts to develop novel data analysis approaches. Positive matrix factorization (PMF) has been used to deconvolve timeseries of AMS mass spectra [3] and timeseries of TAG source-marking compounds [4] into major components contributing to atmospheric OA concentrations. The desire to have combined TAG-AMS input parameters for a single PMF analysis have inspired novel measurement ideas that will be introduced here.

- [1] Williams *et al.* (2006) *Aerosol Sci Technol* **40**, 627-638.
[2] DeCarlo *et al.* (2006) *Anal Chem* **78**, 8281-8289. [3] Ulbrich *et al.* (2009) *Atmos Chem Phys* **9**, 2891-2981. [4] Williams *et al.* (2010) *Atmos Chem Phys* **10**, 11577-11603.