Title: Lagrangian Fluid Measurements in Turbulent Mixing

Principal Investigators:
Robert Ecke, MST-10; ecke@lanl.gov, Phone: 667-6733 (4133), Fax: 665-7652
Beth Wingate, CCS-2; wingate@lanl.gov, Phone: 665-7869, Fax: 667-1126

Co-Investigators: Rainer Bleck (EES-2), Mike Brown (D-4), Misha Chertkov (T-13), Matthew Hecht (CCS-2), Tim Germann (X-7), Brad Holian (T-12), Darryl Holm (T-7), Bradley Plohr (T-13), Michael Rivera (MST-10), David Sharp (T-13), Susan Kurien (T-7). External: Shiyi Chen (Johns-Hopkins/T-13), Synte Peacock (Chicago), James Price (WHOI), Alain Pumir (CNRS, Paris), Mark Taylor (Sandia)

Abstract: Turbulent mixing is one of the forefront issues in problems of national importance from nuclear weapons physics to the weather and climate and atmospheric particulate transport. Mixing is driven by material carried along by the fluid velocity and is best represented in a Lagrangian framework, *i.e.*, in a frame moving with a fluid parcel. The recent revolution in experimental technique, in numerical methods, and in theoretical understanding now allow, for the first time, a full-fledged attack on turbulent mixing with the powerful tools of Lagrangian fluid dynamics. We propose a unique combination of precise laboratory experiments, high-resolution direct numerical and atomistic simulations, and careful sub-grid modeling to investigate three aspects of turbulent mixing in exciting areas of turbulence research that have strong connections with Laboratory programs that rely on the science of prediction. The first problem is turbulent mix of Rayleigh-Taylor (RT) unstable fluids, which is of keen fundamental interest and of significant importance in the nuclear weapons program. We propose probing the detailed density and velocity structure of the RT mix layer with a wide range of density ratios and fluid miscibilities and using advanced experimental diagnostics, direct numerical simulations, engineering models, molecular dynamics and theoretical analysis. The second problem is the instability and turbulent mixing that controls formation of cold, dense water in the North Atlantic basin, a process that drives the thermo-haline circulation and that plays a pivotal role in determining global climate variations. Large uncertainties exist in global climate models that result from poor characterization of mixing in a stably-stratified shear flow. The work proposed here will put us at the front of international efforts to resolve this issue. Finally, we propose the detailed investigation of turbulent mix and passive scalar transport in the dispersal of particulates in complex, inhomogeneous conditions, a critical issue in determining how biological, chemical or radiological agents would be spread in an urban setting. Our proposal attacks complex problems in turbulent mix that will be pursued from fundamental science to computational models. The combined experimental, computational and modeling capabilities of our team is outstanding, will help define more clearly how the science of prediction can be applied to problems of national importance and will establish Los Alamos as a premier leader in turbulence research.

Proposal Duration: 3 years
Proposed Funding:

Year	FY2005	FY2006	FY2007
Operating	1550 K	1600 K	1650 K
Capital	100 K	100 K	