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A method for Doppler acoustic measurement of black smoker flow fields

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[1] A method is developed for using multibeam sonar to map the flow velocity field of black smoker plumes. The method is used to obtain two-dimensional cross-sectional maps of vertical velocity, but is capable of mapping velocity in three dimensions. This is in contrast to conventional current meters, which measure only at several points and acoustic Doppler current profilers, whose diverging beams cannot readily map the interior of a plume. Geometric corrections are used to estimate the vertical component of velocity, compensating for ambient current. The method is demonstrated using data from the main plume at the Grotto vent complex in the Main Endeavour Field, Juan de Fuca Ridge, and the errors due to noise, signal fluctuations, and fluctuations in plume structure are estimated.

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1. Introduction

[2] Plumes that discharge from high-temperature black smoker-type vents at ocean ridges are being intensively studied as major agents of dispersal of heat, chemicals, and biological material. The buoyant plume entrains and mixes with ambient seawater as it rises tens to hundreds of meters to a level of neutral buoyancy. Standard methods of study involve making asynchronous individual profiles of temperature, salinity and light attenuation or scattering versus depth (CTD-transmissometer-nephelometer profiles [*Lupton*, 1995; *Baker et al.*, 1995]). Acoustic Doppler current profilers (ADCPs) have been used to study flow velocity [*Palmer and Rona*, 1990; *Mitsuzawa*, 2003], but cannot readily map out the velocity field in three-dimensional (3-D) or in 2-D cross sections. First, ADCPs do not provide either 3-D images or 2-D cross sections, so there is a problem in locating the data with respect to the plume boundaries. Second, because their sonar beams diverge in space, ADCPs cannot readily provide meter-scale resolution at the decimeter ranges required for plume observations. We report here on development of a Doppler method to measure the vertical velocity