June 1, 2004

Errata for the thesis: Computational Techniques for Turbulence Generated Noise

Comments to Paper IV and the thesis:

A closer investigation of the most recent results from the cold jets has shown that the cold Mach 0.90 jet contains instabilities of the same type as for the hot Mach 0.75 jet. The growth rate was smaller for the cold jet compared to the hot jet. The OASPL of the cold Mach 0.90 jet on page 63 in the thesis and on page 12 in Paper IV is however not affected by the excistence of the instabilities since the instabilities had not grown to be dominant. These instabilities have not been found for the cold Mach 0.75 jet during an extended simulation time of 45 000 time steps, but it can not be dismissed that such instabilities might emerge for longer simulations. The conclusion on page 63 in the thesis and on page 12 in Paper IV that the hot jet contained absolute instabilities but not the cold jets may not fully explain the difference in stability of the jets. The Mach numbers M_j referred to are defined by $M_j = U_j/c_{amb}$. The spectral results from the isotropic jet in figures 5.25a and 5.26a in the thesis (figures 11a and 12a in Paper IV) are based on 20 000 time steps, not 30 000 as stated in the documents. The corresponding spectra based on 30 000 are very similar and the conclusion from the spectra is still that the introduction of anisotropy has little effect on the far-field sound.

In Paper III the first paragraph on page 3 is changed to:

A method to model anisotropic synthetic turbulence has been developed in the present work and this paper is focused on evaluating the properties of the newly developed method. The same method to introduce anisotropy in synthesized turbulence was previously presented by Smirnov *et al* [5]. The procedure to generate anisotropic turbulence in [5] is called RFG (Random Flow Generation) and has several elements in common with the method presented in this paper. A modified version of the one presented in [5] has recently been presented by Batten *et al* [5b]. A full presentation of the method to introduce anisotropy in the framework of the present work will be given.

5b P. Batten and U. Goldberg and S. Chakravarthy. Interfacing Statistical Turbulence Closures with Large-Eddy Simulation, AIAA Journal, Vol 42, No 3 (2004) 485–492

In Paper III the second paragraph on page 12 is changed to:

The reason for the difference in the sound emission directivity levels between the numerical results and the statistical model is unclear. It has been pointed out by Witkowska *et al.* [18b] that unphysical end-effects may dominate the sound generation when source terms with spatial derivatives are used over a truncated source region. The directivity pattern from the stochastic anisotropic turbulence is probably partially masked by this effect which would explain the difference compared to the statistical model. The sound directivity would probably be in better agreement with the statistical model if this effect were removed in the computations. The statistical model for the velocity correlation tensor is however a simple modification of the isotropic expression and might be a too crude model to compare with. The true degree of sound directivity from anisotropic homogeneous turbulence can not be deduced from the present results.

18b A. Witkowska, D. Juvé and J. G. Brasseur. Numerical Study of Noise From Isotropic Turbulence. Journal of Computational Acoustics, Vol 5, No. 3 (1997) 317-336

The first paragraph on page 52 in the thesis should be changed accordingly.

The last sentence in the conclusion of Paper III is changed to:

Numerical errors related to a finite source region in the numerical simulations are believed to be the reason for the difference in directivity level. Further work is though needed for conclusive comparisons.

Equations 20 and 21 in Paper III are changed. It is the sound intensity $I(\mathbf{x})$ which the equations express. The same holds for equation 1 in Paper V. In the statistical model in Paper III $\boldsymbol{\tau}_{ij}$ is changed to $\overline{v_i v_j}$ in equation 22 (and the following text) and to $\overline{u_i u_j}$ in equation 25.

In the thesis references [25] ([6] in Paper IV) and [49] should be

25 M. Billson and L.-E. Eriksson and L. Davidson and P. Jordan. Modeling of Synthetic Anisotropic Turbulence and Its Sound Emission, Manchester, United Kindom 2004. The 10th AIAA/CEAS Aeroacoustics Conference, AIAA 2004-2857.

49 M. Billson, L.-E. Eriksson, P. Jordan and L. Davidson. Anisotropic Formulation of the Velocity Correlation Tensor. Internal report 04/02, Div. of Thermo and Fluid Dynamics, Dept. of Mechanical Engineering, Chalmers University of Technology, 2004.

In Paper IV equation 10 is changed to:

$$\boldsymbol{\tau}_{ij} = 2\mu_T \left(S_{ij} - \frac{1}{3}\frac{\partial \widetilde{u}_k}{\partial x_k}\delta_{ij} \right) - \frac{2}{3}\overline{\rho}\overline{\overline{k}}\delta_{ij}$$

Figure 8 in Paper IV shows the convective autocorrelations for the different velocity components in the shear layer evaluated from LES. The figure should be

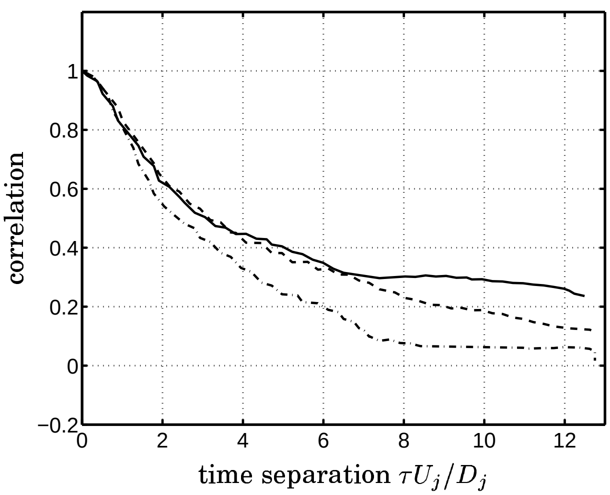

Figure 1: Convected reference field autocorrelations in the xy-plane starting from $(x/D_j, r/D_j) = (10, 0.5)$ of u, v and w in convected reference field in shear-layer (LES data). Solid line: u; dashed line: v; dash-dotted line: w

The following text replaces the second to last sentence in subsection VI.C on page 10 in Paper IV.

The time scale anisotropy is evident in the figure and the w component shows a shorter correlation than the u and v velocity componenets. Labels and x-axis scale in figure 8 in Paper IV should be as in the figure above.

The last sentence on page 28 in the thesis should be

The resolutions for the highest modes in the near-field of the jet simulations are 6 and 3 cells per wavelength respectively for the numerical schemes for the convective operator and the ILEE.