Summary Chart of Incompressible Flow Turbulence Models

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Introduction

- Here is a chart showing some of the major characteristics of turbulence models.
- The order is from least complex to most complex.
- For simplicity, consider incompressible flow without buoyancy, but the flow is three-dimensional.
- Direct numerical simulation is included for completeness, even though it is not a turbulence model.

Model	Number of additional transport equations	Assumptions/Approximations
Algebraic models (zero-equation models)	0	Mixing length
One-equation models	1	Boussinesq eddy viscosity model, $\tau_{ij_{\text{turbulent}}} = -\rho\overline{u_i u_j} \approx -\frac{2}{3}\rho K\delta_{ij} + 2\mu_e E_{ij}$
Two-equation models	2	
Algebraic Reynolds stress models (ASM)	2	Nonlinear extension of Boussinesq eddy viscosity model, $\tau_{ij_{\text{turbulent}}} = -\rho\overline{u_i u_j} \approx -\frac{2}{3}\rho K\delta_{ij} + 2\mu_e E_{ij}$ + additional higher order terms
Reynolds stress models (RSM)	7	Solve for ensemble-averaged quantities only (no details about time-dependent turbulence quantities)
Large Eddy Simulation (LES)	either 0 (algebraic equations) or 1 (transport equation) for the smallest scales	Exact time-dependent solution of large scales; Model small-scale turbulence only
Direct Numerical Simulation (DNS)	0	Exact - model all scales of turbulence (small to large)