PSE Users Guide

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Coordinates and definitions

PSE is written in a body fitted curvilinear coordinate system where x is the streamwise direction, y is the wall normal direction, and z is the spanwise direction. Time is denoted by t and the temporal variation of solutions is represented in the frequency domain where ω is the fundamental frequency. Similarly, a Fourier representation is also used in z with a fundamental wavenumber of β. The velocity components are represented by u, v, and w in the streamwise, wall normal, and spanwise directions, respectively.

PSE input file

The input file for PSE is called `pse.inp` and it is in Fortran90 namelist format. The following table defines each parameter and the values that they can take.

Table 1: PSE Input Parameters

Parameter	Description	Notes
`ITYPE`	Execution mode	0 : linear PSE 1 : nonlinear PSE 2 : adjoint PSE 3 : discrete adjoint PSE -1 : spatial LST -2 : temporal LST -3 : spatial AST -4 : temporal AST -5 : discrete temporal AST -6 : discrete spatial AST
`NX`	Number of nodes in x	only used with `IMEAN`=0
`NY`	Number of nodes in y	overrides mean flow `NY`
`NZ`	Number of modes in z	
`NT`	Number of modes in t	
`BETA`	Fundamental spanwise wavenumber	
`OMEGA`	Fundamental frequency	
`RE`	Reference Reynolds number	
`ICURV`	Curvature flag	0 : no curvature terms 1 : curvature terms
`IMEAN`	Meanflow type	0 : parallel mean flow 1 : boundary layer flow

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Table 1: Continued from pervious page

Parameter	Description	Notes
		2 : Navier–Stokes flow
IVBC	v-velocity BC on top boundary	0: $v = 0$
		1 : $\partial v/\partial y\|_w = 0$
IPWBC	pressure BC on wall boundary	0 : $\partial p/\partial y\|_w = 0$
		1 : wall normal momentum equation
		2 : continuity at wall
IPBC	pressure BC on top boundary	0 : $p = 0$
		1 : $\partial p/\partial y\|_{ymax} = 0$
MKZ	Spanwise modes in initial condition	for nonlinear PSE
MKT	Frequencies in initial condition	for nonlinear PSE
XMAX	Length of domain in x	only for IMEAN = 0
XS1	Stretching parameter 1	only for IMEAN = 0
XS2	Stretching parameter 2	only for IMEAN = 0
DX1	Initial Δx	only for Imean = 0
Ymax	Maximum y	Should be several BL thicknesses
YSTR	Stretching parameter	$0 <$ YSTR < 1
TOL	Tolerance for PSE iterations	$\approx 1 \times 10^{-8}$
IPFIX	Pressure update for PSE	use 1
NITER	Number of PSE iterations	typically 5-50
IS	Starting index for PSE	location for LST
IE	Ending index for PSE	location for AST
NORM	PSE normalization flag	0 : Kinetic energy
		1 : u_{max}
NINT	Interpolation in NY for u_{max} evaluation	
INT	Interpolation factor in NX for field output	< 1 denotes no interpolation
SOR	SOR parameter for PSE iteration	$1 \leq$ SOR < 2
PLOCK	Phase lock flag	0 : unlocked
		1 : phase locked
EPS	Mode generation tolerance	1×10^{-8}
ALPI	Meanflow modification parameter	-1×10^{-3}

Mean flow input files

As indicated in Table 1 there are three options for the meanflow. If running on a parallel baseflow, IMEAN = 0, then the code reads the profile from profile.dat. For boundary layer base flows, IMEAN = 1, the baseflow is read from bl_sta.out. And the last option is for a Navier–Stokes solution, IMEAN = 2 which is read from field.dat.

Disturbance initial profiles

The disturbance profiles are read from inflow.??? where the extension is used to denote the spanwise wavenumber and the temporal frequency. The fundamental is denoted with a 1, the first harmonic by 2, etc. For example, inflow.+12 is the fundmental + mode in the span and the harmonic in time. Likewise inflow.+01 has no variation in the span and the fundamental frequency, and inflow.+00 is the mean flow modification term.

Output

The primary PSE output is in the file `pse.dat` which contains α and other quantities of interest during the PSE calculation. The file `grow.dat` contains various measures of the disturbance amplitude as well as associated growth rates. The file `pro.dat` contains the PSE shapefunctions at the last computed station.

The code also outputs the entire computed fields (possibly interpolated in the x direction depending on the value of `INT`) for each combination of spanwise and temporal modes using the same indexing notation described in but with the basename `field.???`.

To convert a `field.???` file to Plot3D format use the program `mkqr8`.