# PSE Users Guide

S. Scott Collis
Rice University
Houston, TX 77005-1892

January 27, 2004

## 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 $\omega$ is the fundamental frequency. Similarly, a Fourier representation is also used in $z$ with a fundamental wavenumber of $\beta$. 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<br>1 : nonlinear PSE<br>2 : adjoint PSE<br>3 : discrete adjoint PSE<br>-1 : spatial LST<br>-2 : temporal LST<br>-3 : spatial AST<br>-4 : temporal AST<br>-5 : discrete temporal AST<br>-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<br>1 : curvature terms |

continued on next page

Table 1: Continued from pervious page

| Parameter | Description | Notes |
|---|---|---|
| IMEAN | Meanflow type | 0 : parallel mean flow<br>1 : boundary layer flow<br>2 : Navier–Stokes flow |
| IVBC | $v$-velocity BC on top boundary | 0: $v = 0$<br>1 : $\partial v/\partial y\|_w = 0$ |
| IPWBC | pressure BC on wall boundary | 0 : $\partial p/\partial y\|_w = 0$<br>1 : wall normal momentum equation<br>2 : continuity at wall |
| IPBC | pressure BC on top boundary | 0 : $p = 0$<br>1 : $\partial p/\partial y\|_{y_max} = 0$ |
| 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 $\Delta x$ | 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<br>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<br>1 : phase locked |
| EPS | Mode generation tolerance | $1 \times 10^{-8}$ |
| ALPI | Meanflow modification parameter | $-1 \times 10^{-3}$ |

## 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 $\alpha$ 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`.