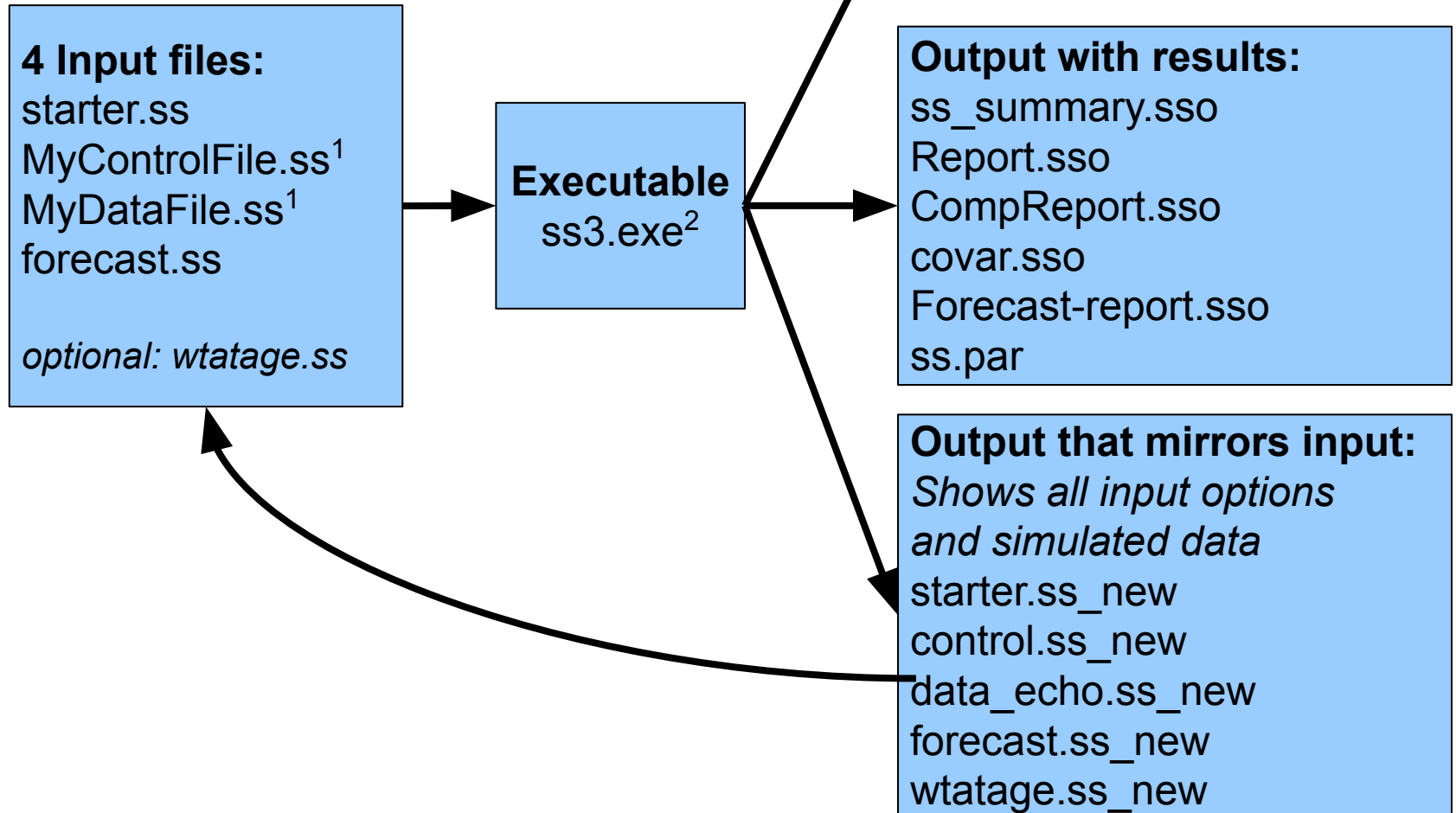# Getting Started with Stock Synthesis (SS3)

How to use these slides

- This powerpoint is aimed at users who are new to SS3 and to running executables via the command line.

- This will cover several workflows for running existing SS3 models.

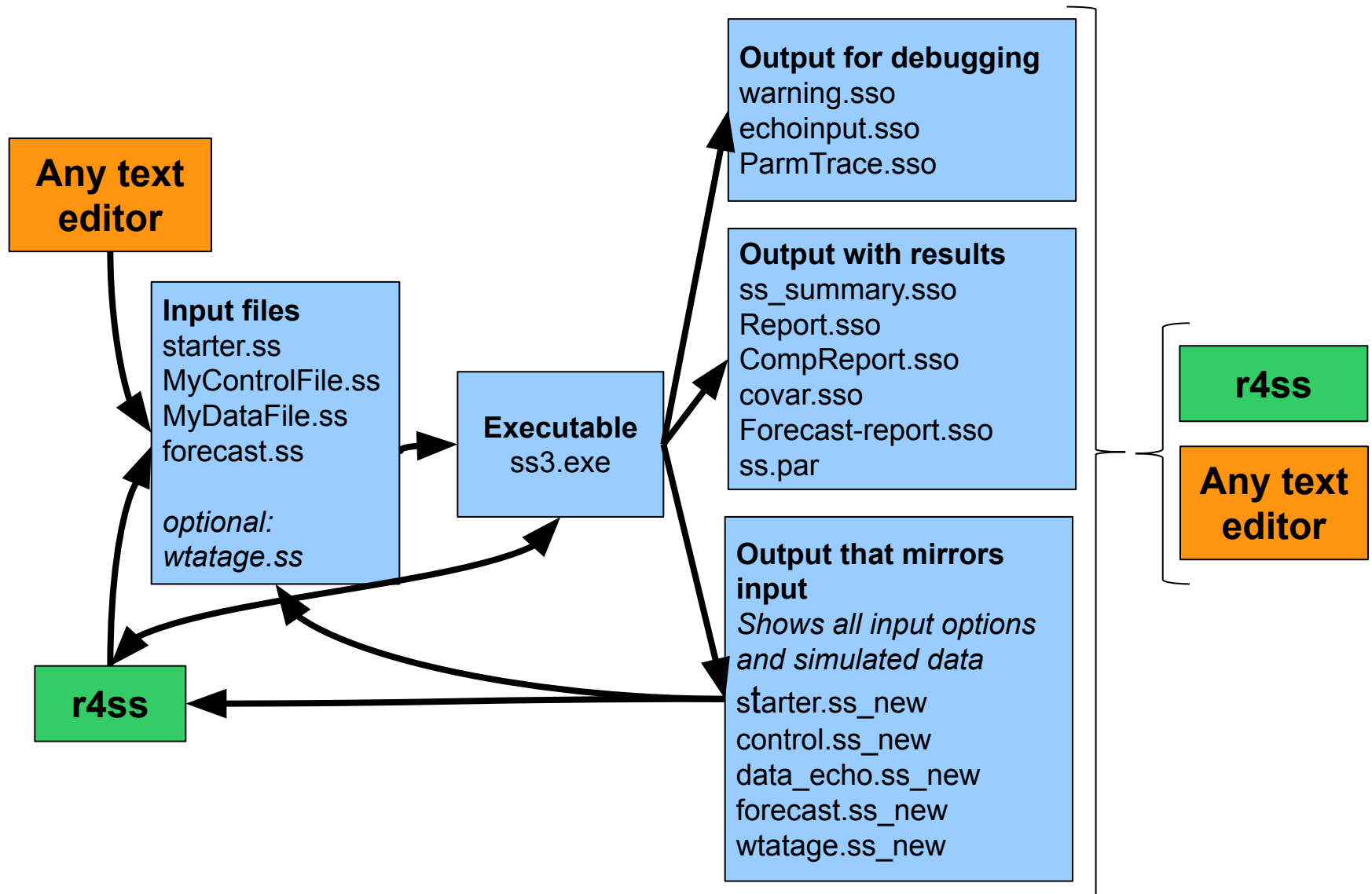- Please see the [SS3 user manual](#) for more details

Background on SS3

Main SS3 files

4 Input files:
starter.ss
MyControlFile.ss[1]
MyDataFile.ss[1]
forecast.ss

optional: wtatage.ss

Executable
ss3.exe[2]

Output for debugging:
warning.sso
echoinput.sso
ParmTrace.sso

Output with results:
ss_summary.sso
Report.sso
CompReport.sso
covar.sso
Forecast-report.sso
ss.par

Output that mirrors input:
Shows all input options and simulated data
starter.ss_new
control.ss_new
data_echo.ss_new
forecast.ss_new
wtatage.ss_new

[1]*Can have any name, as long as specified in the starter file.*
[2]*The SS3 executable can have any name.*

Associated tools

Any text editor

Input files
starter.ss
MyControlFile.ss
MyDataFile.ss
forecast.ss

optional:
wtatage.ss

Executable
ss3.exe

r4ss

Output for debugging
warning.sso
echoinput.sso
ParmTrace.sso

Output with results
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Output that mirrors input
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wtatage.ss_new

r4ss

Any text editor

Please see slide notes for definitions of some of these tools

Recap - Major Concepts

- Dimensions (years, areas, fleets, etc.)

- Numbers of recruits per year

- Natural mortality

- Body weight at age

  - From growth curve or empirical input

  - And maturity-fecundity

- Catch & fishing mortality by fleet

- Age and/or length selectivity by fleet

- Survey catchability (calibration)

- Reference point and forecast specs

- Run controls

The four input files read by ss.exe

1. **starter.ss:** Required file containing file names of the data file and the control file plus other run controls. Must be named starter.ss.

2. **Data file:** File containing model dimensions and the data. Can have any name, but typically ends in .ss or .dat. Must match the name in the starter file.

3. **Control file:** File containing set-up for the parameters. Can have any name, but typically ends in .ss or .ctl. Must match the name in the starter file.

4. **forecast.ss**: File containing specifications for reference points and forecasts. Must be named forecast.ss.

Two optional input files

1. **ss.par:** Text file with one line per parameter where order matters. Could be created from a previous model run. Read in ss.par to overwrite the initial parameter values in the control file (chose whether or not to read ss.par in starter.ss).

2. **wtatage.ss:** File containing empirical input of body weight by fleet and population and empirical fecundity-at-age (choose whether or not to read in a line of the control file)

Running SS3

- SS3 typically runs in a command window
  - One folder approach
  - Two folder approach
  - PATH approach
- It is also possible to download the SS3 exe and run SS3 via the command line from within R using {r4ss}

Interface Comparison

- Command window
  - Input test files, with replicas produced by SS3, contain verbose info regarding model options
  - Hands on, messy text file editing

- R with {r4ss}
  - Most advanced processing and display of model output
  - Scripts to read and write model input files, but no hand-holding or verbose descriptions
  - Ability to download the SS3 executable
  - Vignettes to run SS3 and a family of SS3 dependent models

Running SS3 using the one folder approach

Running SS3: The one folder approach. Model files and exe in same folder

Create a folder and add:
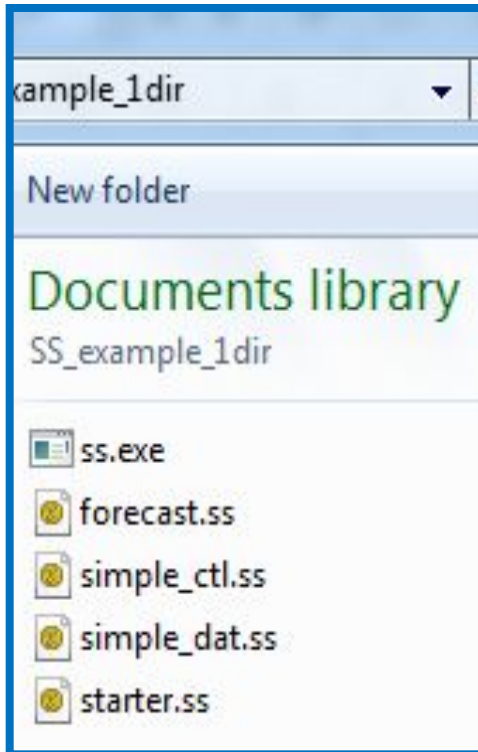
- ss3.exe
- starter.ss
- Control File (Must match name in starter.ss)
- Data File (Must match name in starter.ss)
- forecast.ss
- Optional files: wtatage.ss (if doing empirical wt-at-age approach) or ss.par (to continue from a previous run)

Pros and cons of the one folder approach

- **Pro:** Simple setup to run models

- **Con:** If you update your version of SS3, then you may need to update it in many folders

- **Con:** Requires 1 copy of the executable per folder, which will take up a large amount of space when running many models

Starting SS3 from the command line

Click here to highlight.

Then shift right-click to get to "open command window here" option.

Which opens cmd.exe in that directory.

Then type ss (or other name of the ss3 exe) and hit <enter>
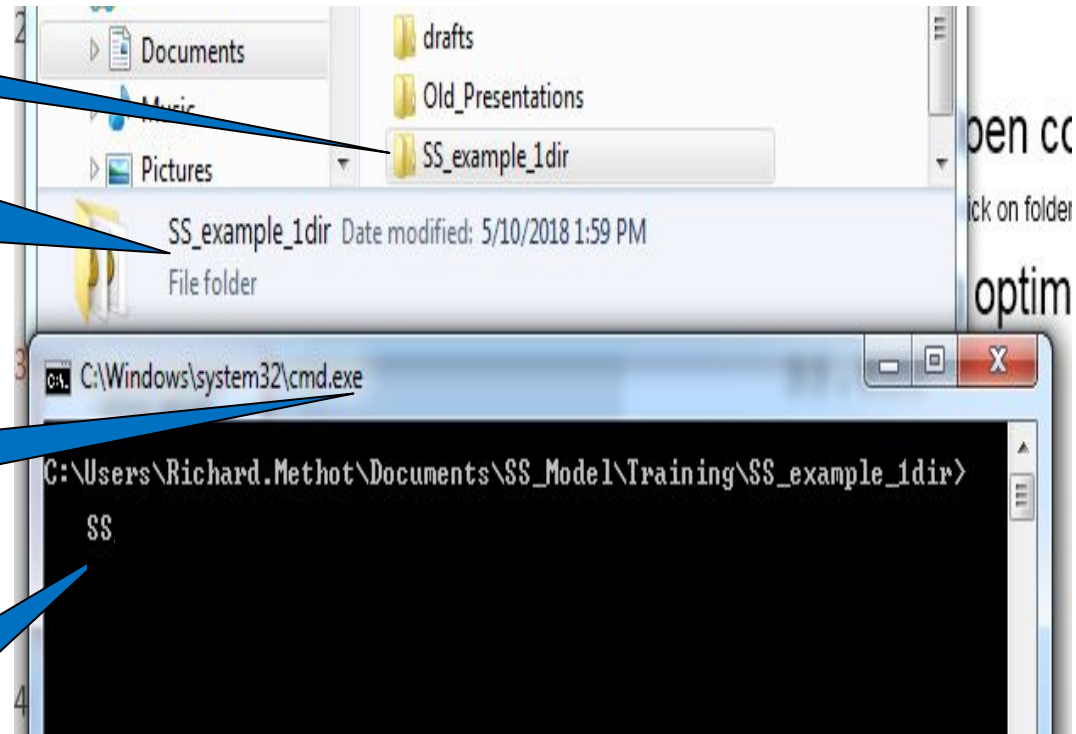
See notes for more tips on running an SS3 model from the command line.

Command line messages after starting an SS3 run

- Volume of information controlled in starter.ss file:
  ```
  1 # run display detail (0,1,2)
  ```
  Middle level (1) is usually best.

SS3 always opens and reads files in the same order, writing to echoinput.sso as it reads

- SS3 inputs are read in order by value, without reference to comments. Depending on the SS3 options selected, SS3 will expect a certain number of values in a certain order, so failing to provide them will result in errors or at least a different model specification than intended.

- Reading order of files: SS3 opens and reads starter.ss, then the data file, then forecast.ss, then the control file, then wtatage if using (optional), and finally ss.par if using (optional).

SS3 run order of operations

1. SS3 proceeds immediately to pre-processing of the data, creation of internal parameter labels, etc. (order as described on the previous slide)

   - Some checks are written to echoinput.sso.
   - Problems written to warnings.sso.

2. Then, SS3 goes to the procedure section where ADMB makes iterative parameter changes to minimize the negative log likelihood

3. When ADMB achieves convergence, control passes to the sd_phase for calculation of parameter variance (unless –nohess option). After the sd_phase, it then goes to the benchmark and forecast code section, and then to the final reporting.

4. Results are written to the same directory

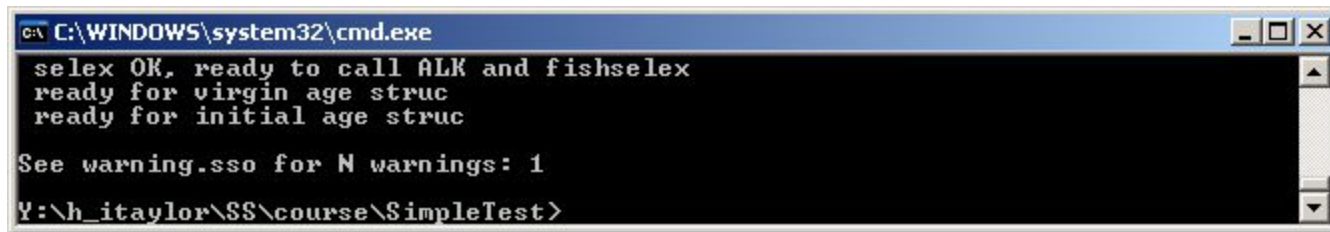# Screen output at the end of a run

- If a run finishes, you will see something like:
  `!! Run has completed !! No warnings`
  (although it can complete with warnings also.)

- If a run does not finish, you will not see this line and likely will see some other error message output.

Examining the output

- Examine warnings.sso for issues and suggestions.

- Many output files are created: Report.sso, Forecast-report.sso, etc.

- Read the output and results into R using the {r4ss} function `SS_output()`

- The results will include the following:

  - Calculated selectivity, biomass, F time series, numbers-at-age, fit to data, etc.

Warning.sso File

- Always look at after running a model, regardless of whether the model run completed or not

- Contains a list of warnings generated during program execution.

- Note in command line if N warnings > 0


```
C:\WINDOWS\system32\cmd.exe
selex OK, ready to call ALK and fishselex
ready for virgin age struc
ready for initial age struc

See warning.sso for N warnings: 1

Y:\h_itaylor\SS\course\SimpleTest>
```

- N warnings include:

  – Notification of errors in input files.

  – Some advice on parameter settings.

Other SS3 run workflows and optional ways to run

Run SS3 – the two folder approach
Exe in different folder and use a batch file

- Folder 1 contains the SS3 executable, ss.exe

- Folder 2 is the model user folder. It contains the SS3 input files for a single model plus a batch file named SS330.bat (or *.bat)

- The first line of the batch file has the full path to SS3.exe

    - `C:\MyDocuments\Assessments\SS3model\SS3.exe %1 %2`

    - Note that %1 … are how to pass command line options to the bat file. If you don't want to pass options (like `-noest` or `-nohess`), then there is no need to include `%1 %2` in your batch file - just put the file path to the executable.

- Open the command window in the model user folder

- Type name of the batch file (e.g., SS330 for SS330.bat) in the command window, which will start the batch file.

- Running the batch file will open SS3.exe and run it with the model files in the directory.

Why the two folder approach?

- With this approach, you can have one (or more) folders with various versions of SS3 and many model user folders each with one (or more) batch files that point to various versions of SS3.

- This eliminates the need to have multiple copies of the same SS3 executable on your computer, which is necessary with the one folder approach.

Run SS3: Using an SS3.exe in your PATH

- The PATH is where your computer will search for files be default. Therefore, if an SS3 executable called ss3.exe is in your path, when you type ss3 into the command window, your computer will be able to find ss3.exe and use it with the model files in the current directory.

- For more information, see the "Putting Stock Synthesis in your PATH" doc in the user manual.

- After initial setup (once per computer), this makes using the same SS3 executable from many folders easy – you can run SS3 as if using the one folder approach, but there is no need to have the exe in the folder.

Running SS3 from within R

- Running SS3 from within R may be desirable for setting up simulations where many runs of SS3 models are required or if {r4ss} is being used to read SS3 model output
- You can use the function `run("ss3")` from the R console to run when executable ss3.exe in the same folder as model input files.
- Another way is to use `system("ss3")` from the R console.
- A variation on the two folder approach is in next slide

Running SS3 from within R

For direct specification of model location, use:

```
run_dir <- "C:/users/Richard.Methot/Documents/SS3_Model/
Training/2021_AFS/simple_long"

setwd(run_dir)

SS3_exe_path <-
"C:/Users/Richard.Methot/Documents/GitHub/StockSynthesis_g
it/stock-synthesis/Compile/ss3.exe" #if you downloaded ss3
exe yourself

r4ss::run(dirvec = run_dir, model = SS3_exe_path,
extras="-nohess -nox -maxI 10", intern=TRUE,
verbose=FALSE, skipfinished = FALSE)

tmp <- SS_output(run_dir, covar=F)

SS_plots(tmp, uncertainty=F)
```

You can also use get_ss3_exe() to get the the ss3 exe.

```
SS3_exe_path<-get_ss3_exe() #downloads exe to working
directory
```

Using ss.par for initial values

- Typically, SS3 uses initial parameter values in the control file. However, initial values can be read from the ss.par file instead.

- To use ss.par instead, in starter.ss below the names of the data and control files, set the value to 1 rather than 0 on the line with comment

```
# 0=use init values in control file; 1=use ss.par
```

- Run model using one of the previously described workflows

- Using the ss.par file comes in handy when you want to use different initial values without modifying the control file. A ss.par file is created during each model run, so using an ss.par file from a previous model run will speed up run time if the initial values are closer to the MLE parameter estimates

Creating and modifying files

- Start from an existing data, control, forecast, and starter *.ss_new files (which will be heavily annotated by SS3) as a template

- Replace the file content with your data/parameter setup and update the descriptors in the text file.

- Save each *.ss_new file as a *.ss and insert the new filenames for control and data files in the starter.ss file.

- Do the same for the parameter file starting from an SS3 annotated control.ss_new, forecast, and starter *.ss_new files.

Command line options

- ADMB options can be added to command line (ADMB).

  - Skip standard errors (for quicker results, or to get Report.sso if Hessian does not invert): `ss -nohess`

  - List all command line options: `SS -?` OR `ss -help`

- SS3 option to Run without estimating anything (as of 3.30.16): `ss -stopph 0`

- More info in ADMB Manual (Chapter 12: Command line options) http://www.admb-project.org/docs/manuals/

Going further: Plotting results and basic troubleshooting

Using {r4ss} to organize and plot SS3 output

- Two main functions: SS_output() and SS_plots()

```
# can also use pak to install

install.packages("remotes")

remotes::install_github("r4ss/r4ss")

library(r4ss) # use r4ss package on github

# create list of quantities for the model in
  mydir

replist <- SS_output(mydir)

SS_plots(replist)# create plots for SS run
```

- See https://r4ss.github.io/r4ss/ for more details.

What to do when SS3 doesn't run?

- Make sure all file names and directories / folders are named correctly (check that the starter file reference the correct names of control and data files). If file names and directories are named incorrectly, SS3 will not be able to find the file.

- If it starts to read files and then crashes:

  - Look at warnings.sso.

  - Look at echoinput.sso and work backwards from the bottom, looking for where it doesn't match your inputs.

  - For further information please refer to SS3 User Manual "Running Stock Synthesis" subsections, especially "Re-Starting a Run" and "Debugging Tips."

If the input is OK and then crashes…

- If model crashes soon after starting the run, or if NAN messages appears on the screen, then:
  - Restart SS3 with the `-stopph 0` option. This will read files, produce report output, and produce *.ss_new files.
- Read Report.sso and Compreport.sso into {r4ss} to examine the details.
  - May show which likelihood component and which data have the NAN calculation.

How to get additional help?

- SS3 GitHub (preferred)
  - [Source code repository](#)
  - [Documentation/user manual](#)
  - [Discussions](#) (like VLAB forums)
  - Post issues (bugs and feature requests) in the [stock-synthesis](#) and [doc](#) repositories
- [VLAB website's](#) resources
  - All can post on the [forums](#)
- [Fisheries Research special issue on Stock Synthesis](#)
- Emailing questions to nmfs.stock.synthesis@noaa.gov
- Other users and models
- http://www.capamresearch.org/