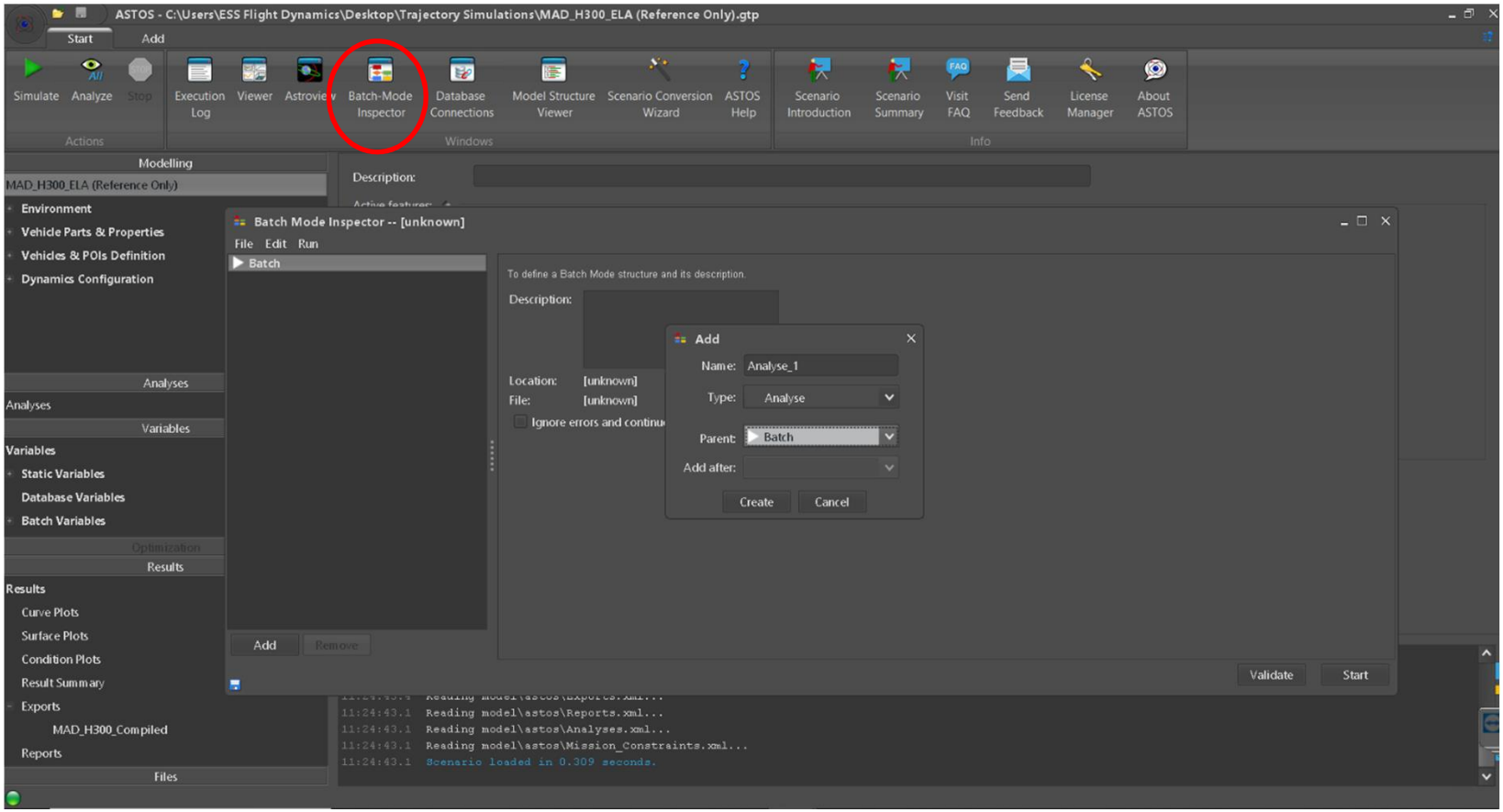
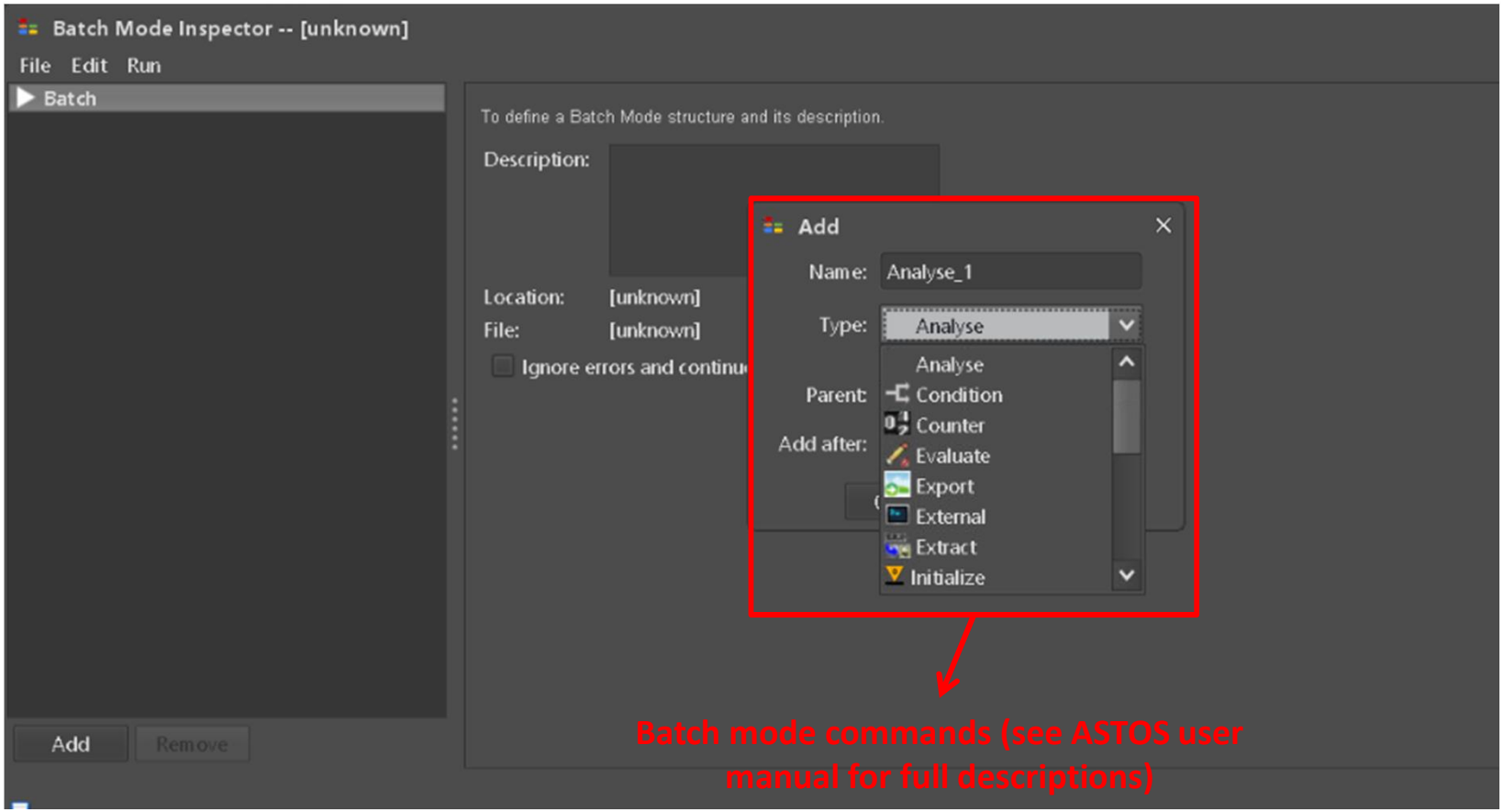
ASTOS Monte-Carlo Simulation Setup

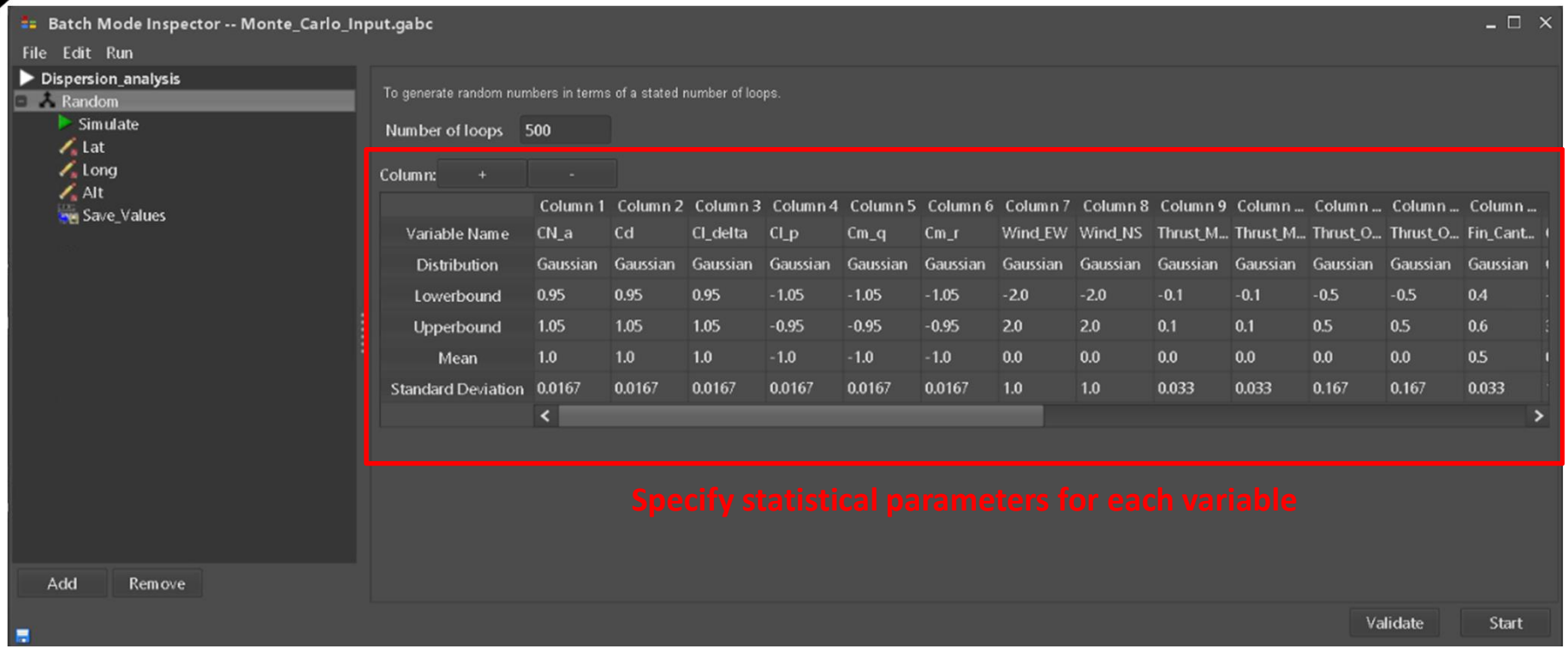
Jason Ong


ASTOS - C:\Users\ESS Flight Dynamics\Desktop\Trajectory Simulations\MAD_H300_ELA (Reference Only).gtp
Start
Add
Simulate
Analyze
Stop
Execution Log
Viewer
Astrovie v
Batch-Mode Inspector
Database Connections
Model Structure Viewer
Scenario Conversion Wizard
ASTOS Help
Scenario Introduction
Scenario Summary
Visit FAQ
Send Feedback
License Manager
About ASTOS
Actions
Windows
Info
Modelling
MAD_H300_ELA (Reference Only)
Environment
Vehicle Parts & Properties
Vehicles & POIs Definition
Dynamics Configuration
Description:
Batch Mode Inspector -- [unknown]
File Edit Run
Batch
To define a Batch Mode structure and its description.
Description:
Location: [unknown]
File: [unknown]
Ignore errors and continu
Add
Name: Analyse_1
Type: Analyse
Parent: Batch
Add after:
Create
Cancel
Add
Remove
Validate
Start
Analyses
Variables
Static Variables
Database Variables
Batch Variables
Optimization
Results
Curve Plots
Surface Plots
Condition Plots
Result Summary
Exports
MAD_H300_Compiled
Reports
Files
11:24:43.1 Reading model\astos\Reports.xml...
11:24:43.1 Reading model\astos\Analyses.xml...
11:24:43.1 Reading model\astos\Mission_Constraints.xml...
11:24:43.1 Scenario loaded in 0.309 seconds.


Batch Mode Inspector -- [unknown]
File Edit Run
Batch
To define a Batch Mode structure and its description.
Description:
Location: [unknown]
File: [unknown]
Ignore errors and continu
Add
Remove
Add
Name: Analyse_1
Type: Analyse
Parent:
Add after:
Analyse
Condition
Counter
Evaluate
Export
External
Extract
Initialize
Batch mode commands (see ASTOS user manual for full descriptions)

EQUATORIAL SPACE

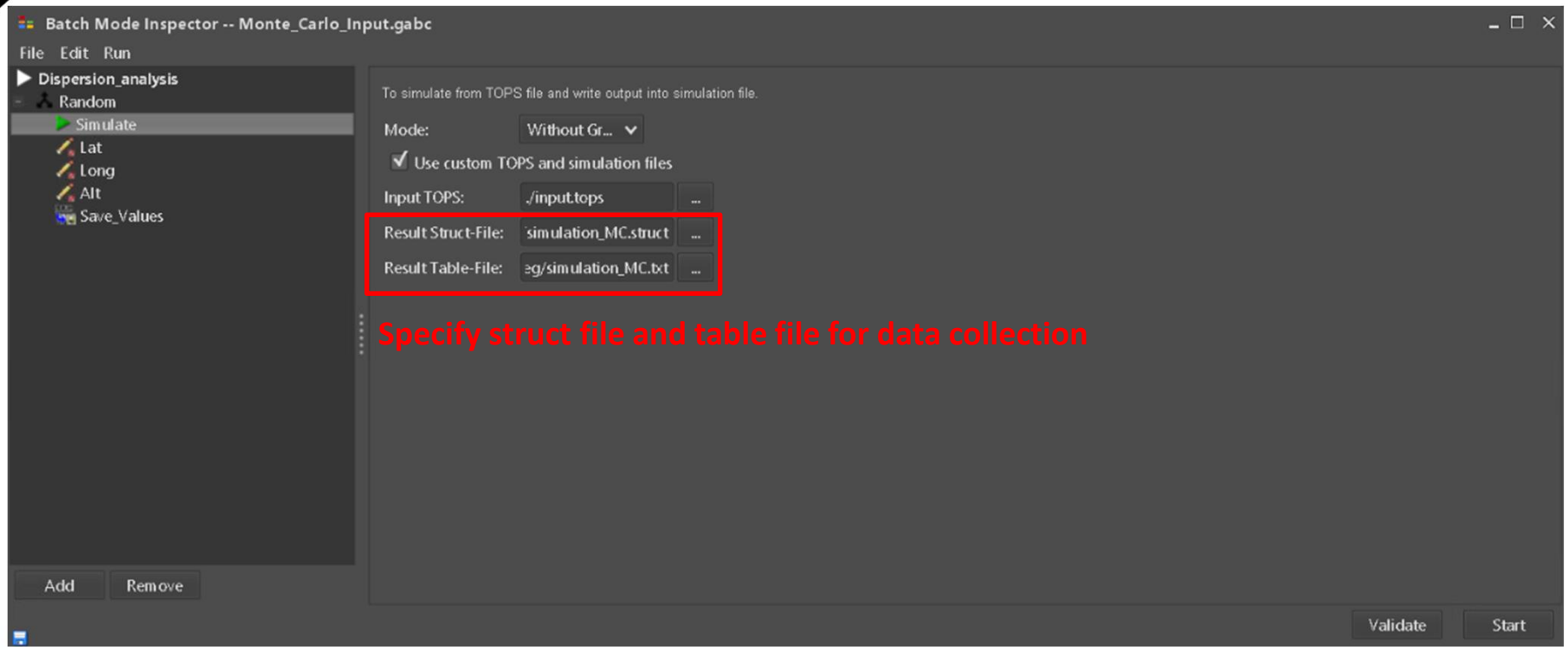
Typical Monte-Carlo Setup



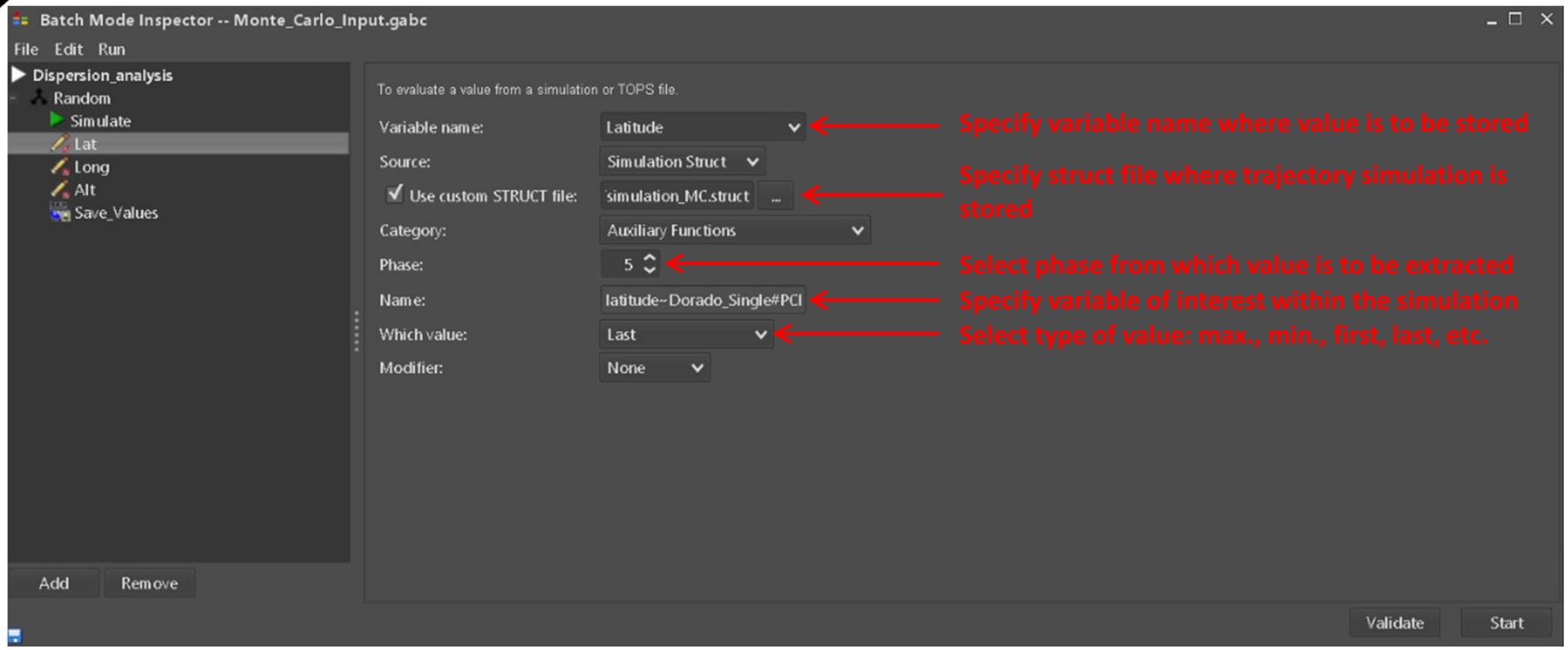
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column ...	Column ...	Column ...	Column ...
Variable Name	CN_a	Cd	Cl_delta	Cl_p	Cm_q	Cm_r	Wind_EW	Wind_NS	Thrust_M...	Thrust_M...	Thrust_O...	Thrust_O...	Fin_Cant...
Distribution	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian
Lowerbound	0.95	0.95	0.95	-1.05	-1.05	-1.05	-2.0	-2.0	-0.1	-0.1	-0.5	-0.5	0.4
Upperbound	1.05	1.05	1.05	-0.95	-0.95	-0.95	2.0	2.0	0.1	0.1	0.5	0.5	0.6
Mean	1.0	1.0	1.0	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Standard Deviation	0.0167	0.0167	0.0167	0.0167	0.0167	0.0167	1.0	1.0	0.033	0.033	0.167	0.167	0.033

Specify statistical parameters for each variable

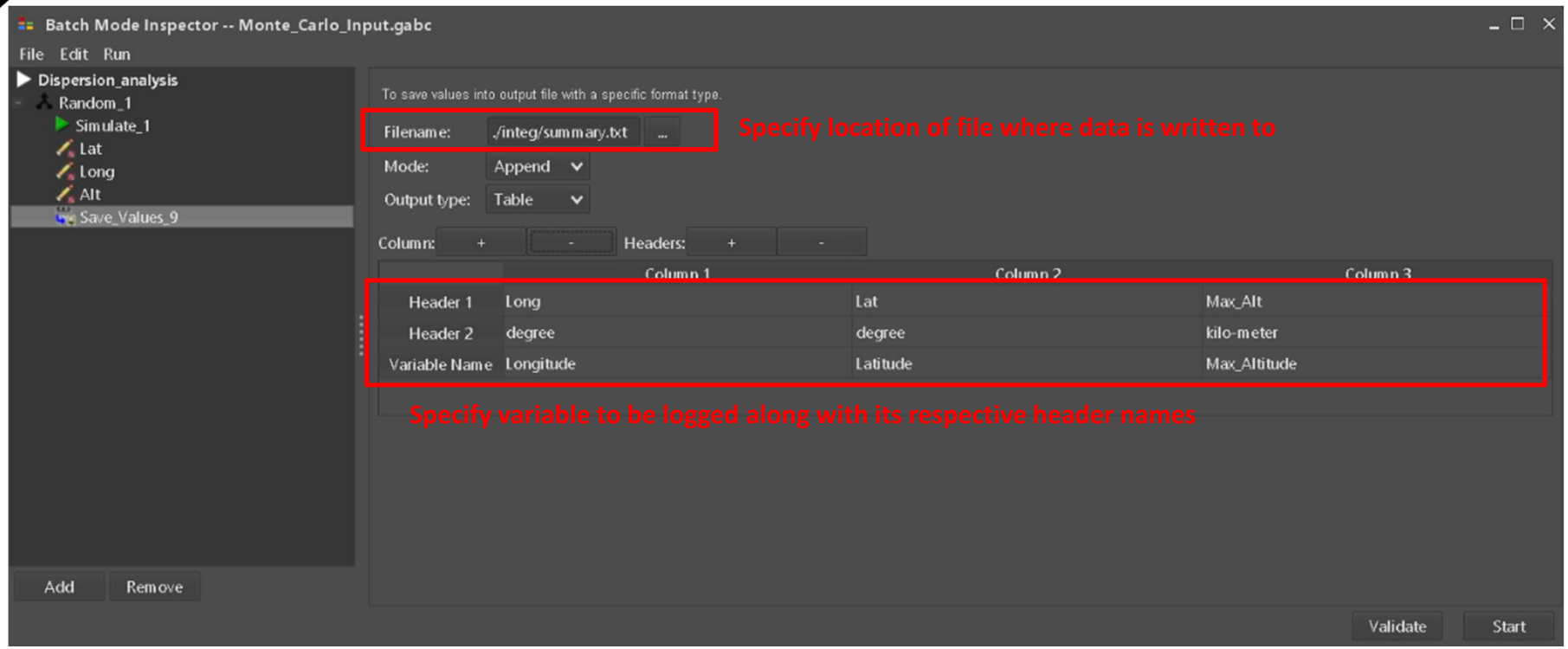
Typical Monte-Carlo Setup



Typical Monte-Carlo Setup



Typical Monte-Carlo Setup



Alternative Methodology

Generation of .xml file using Bash scripting

Manipulate input data (right) as opposed to manual input through GUI

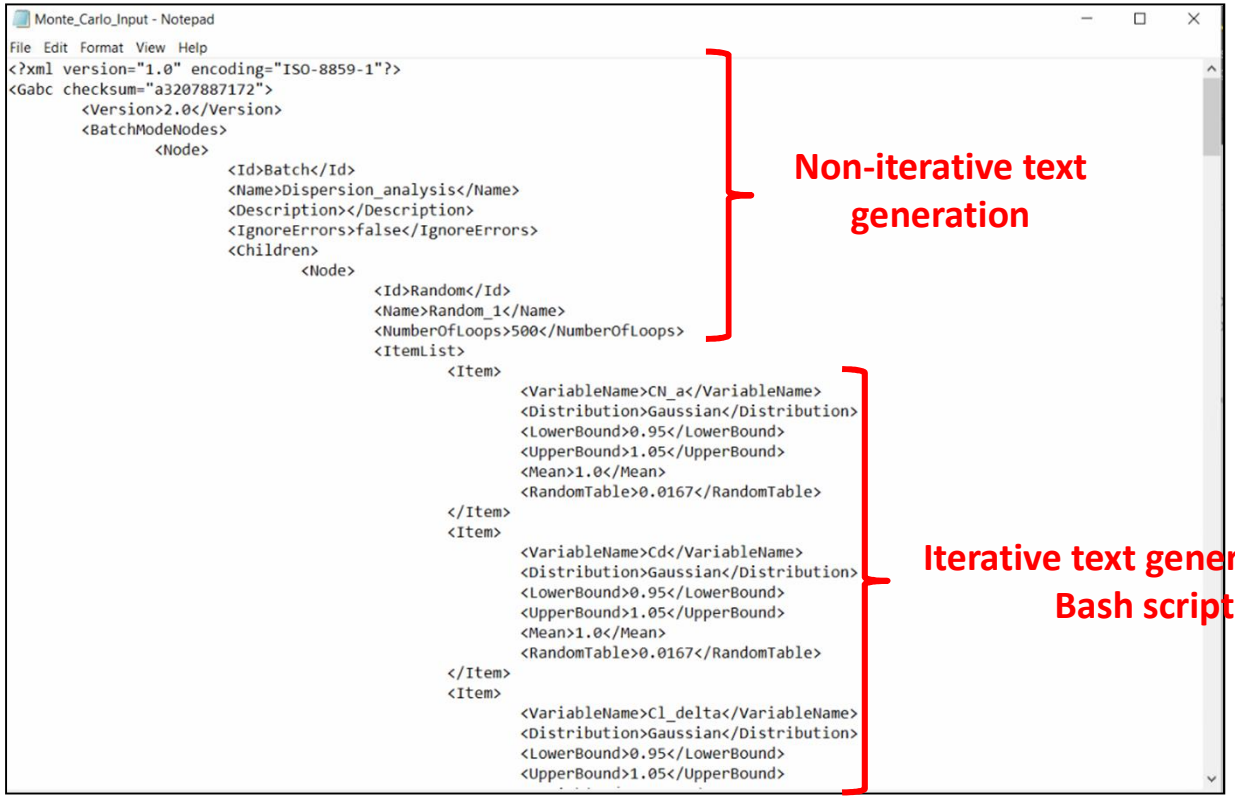
Monte_Carlo_Variables_MTF_Orig - Notepad

File Edit Format View Help

Var	Distribution	LB	UB	Mean	SD	Units
CN_a	Gaussian	0.95	1.05	1.00	0.0167	-
Cd	Gaussian	0.95	1.05	1.00	0.0167	-
Cl_delta	Gaussian	0.95	1.05	1.00	0.0167	-
Cl_p	Gaussian	-1.05	-0.95	-1.00	0.0167	-
Cm_q	Gaussian	-1.05	-0.95	-1.00	0.0167	-
Wind_EW	Gaussian	-2.0	2.0	0.0	1.00	ms-1
Wind_NS	Gaussian	-2.0	2.0	0.0	1.00	ms-1
Thrust_Misalignment_Y	Gaussian	-0.1	0.1	0.0	0.033	deg
Thrust_Misalignment_Z	Gaussian	-0.1	0.1	0.0	0.033	deg
Thrust_Offset_Y	Gaussian	-0.5	0.5	0.0	0.167	mm
Thrust_Offset_Z	Gaussian	-0.5	0.5	0.0	0.167	mm
Fin_Cant_Angle	Gaussian	0.4	0.6	0.5	0.033	deg
CG_Y_Offset	Gaussian	-3.0	3.0	0.0	1.0	mm
CG_Z_Offset	Gaussian	-3.0	3.0	0.0	1.0	mm
Propellant_Mass	Gaussian	158.0	161.0	158.0	1.0	kg
Ixx	Gaussian	0.95	1.05	1.00	0.0167	-
Iyy_zz	Gaussian	0.95	1.05	1.00	0.0167	-
Density_Scaling	Gaussian	95.0	105.0	100.0	1.67	%
CP_X_Offset_Scaling	Gaussian	0.985	1.015	1.00	0.005	-
CG_X_Offset_Scaling	Gaussian	0.985	1.015	1.00	0.005	-
Inclination	Gaussian	84.5	85.5	85.0	0.167	deg
Heading	Gaussian	224.5	225.5	225.0	0.167	deg
Structural_Mass	Gaussian	136.0	142.0	139.0	1.0	kg
Thrust_Scaling	Gaussian	0.97	1.03	1.00	0.01	-

Alternative Methodology

Generation of .xml file using Bash scripting



EQUATORIAL SPACE

Sample Bash Script

```
#!/bin/bash

# 1st argument - input filename, 2nd argument - No. of iterations
# Eg. Run ./Monte_Carlo_Input.sh Monte_Carlo_Variables_MAD.txt 1000

output_file="Monte_Carlo_Input_$2.gabc"
intermediate_input="Monte_Carlo_Input_$2_Intermediate.txt"
vehicle="MAD_H300"
numColumns="1"
lastPhase="5"

# Intermediate file used as text input
sed '1d' $1 >> $intermediate_input

echo -e "\
<?xml version=\"1.0\" encoding=\"ISO-8859-1\"?>
<Gabc checksum=\"a4198783754\">
        <Version>2.0</Version>
        <BatchModeNodes>
                <Node>
                        <Id>Batch</Id>
                        <Name>Dispersion_analysis</Name>
                        <Description></Description>
                        <IgnoreErrors>false</IgnoreErrors>
                        <Children>
                                <Node>
                                        <Id>Random</Id>
                                        <Name>Random_1</Name>
                                        <NumberOfLoops>$2</NumberOfLoops>
                                        <ItemList>" >> $output_file

while read -r f1 f2 f3 f4 f5 f6 f7;
  do
    echo -e "\
                                                <Item>\n\
                                                        <VariableName>$f1</VariableName>\n\
                                                        <Distribution>$f2</Distribution>\n\
                                                        <LowerBound>$f3</LowerBound>\n\
                                                        <UpperBound>$f4</UpperBound>\n\
                                                        <Mean>$f5</Mean>\n\
                                                        <RandomTable>$f6</RandomTable>\n\
                                                </Item>" >> $output_file
done < $intermediate_input

echo -e "\
                                        </ItemList>
                                        <Children>
                                                <Node>
                                                        <Id>Simulate</Id>
                                                        <Name>Simulate_1</Name>
                                                        <Mode>3</Mode>
                                                        <CustomTops>true</CustomTops>
                                                        <InputTops>./input - nominal.tops</InputTops>
                                                        <OutputStruct>./integ/simulation_MC.struct</OutputStruct>
                                                        <OutputTxt>./integ/simulation_MC.txt</OutputTxt>
                                                </Node>
                                                <Node>
```

Variable definitions

Initial part of XML file

Set Monte Carlo parameters using while loop

Set simulation node

EQUATORIAL SPACE

Sample Bash Script (continue from previous)

```
                                        </Item>" >> $output_file
done < $intermediate_input

echo -e "\
                                </ItemList>
                                <Children>
                                        <Node>
                                                <Id>Simulate</Id>
                                                <Name>Simulate_1</Name>
                                                <Mode>3</Mode>
                                                <CustomTops>true</CustomTops>
                                                <InputTops>./input - nominal.tops</InputTops>
                                                <OutputStruct>./integ/simulation_MC.struct</OutputStruct>
                                                <OutputTxt>./integ/simulation_MC.txt</OutputTxt>
                                        </Node>
                                        <Node>
                                                <Id>Evaluate</Id>
                                                <Name>Lat</Name>
                                                <VariableName>Latitude</VariableName>
                                                <Source>Simulation Struct</Source>
                                                <CustomFile>true</CustomFile>
                                                <FileName>./integ/simulation_MC.struct</FileName>
                                                <Category>Auxiliary Functions</Category>
                                                <Phase>$lastPhase</Phase>
                                                <NameOf>latitude~$vehicle#PCPF~Earth@Earth</NameOf>
                                                <WhichValue>Last</WhichValue>
                                                <Modifier>None</Modifier>
                                        </Node>
                                        <Node>
                                                <Id>Save Values</Id>
                                                <Name>Save_Values_9</Name>
                                                <FileName>./integ/summary.txt</FileName>
                                                <Mode>Append</Mode>
                                                <Type>Table</Type>
                                                <Description></Description>
                                                <NumColumns>$numColumns</NumColumns>
                                                <NumHeaders>2</NumHeaders>
                                                <Table>
                                                        <Column>
                                                                <Header>
                                                                        <Name>Lat</Name>
                                                                </Header>
                                                                <Header>
                                                                        <Name>degree</Name>
                                                                </Header>
                                                                <Name>Latitude</Name>
                                                        </Column>
                                                </Table>
                                        </Node>
                                </Children>
                        </Node>
                </Children>
        </Node>
</BatchModeNodes>
</Gabc>" >> $output_file

rm $intermediate_input
```

Set evaluation node

Set save node for data collection

Final part of XML file

EQUATORIAL SPACE

Sample Bash Script (continue from previous)

```
                                        </Item>" >> $output_file
done < $intermediate_input

echo -e "\
                                </ItemList>
                                <Children>
                                        <Node>
                                                <Id>Simulate</Id>
                                                <Name>Simulate_1</Name>
                                                <Mode>3</Mode>
                                                <CustomTops>true</CustomTops>
                                                <InputTops>./input - nominal.tops</InputTops>
                                                <OutputStruct>./integ/simulation_MC.struct</OutputStruct>
                                                <OutputTxt>./integ/simulation_MC.txt</OutputTxt>
                                        </Node>
                                        <Node>
                                                <Id>Evaluate</Id>
                                                <Name>Lat</Name>
                                                <VariableName>Latitude</VariableName>
                                                <Source>Simulation Struct</Source>
                                                <CustomFile>true</CustomFile>
                                                <FileName>./integ/simulation_MC.struct</FileName>
                                                <Category>Auxiliary Functions</Category>
                                                <Phase>$lastPhase</Phase>
                                                <NameOf>latitude~$vehicle#PCPF~Earth@Earth</NameOf>
                                                <WhichValue>Last</WhichValue>
                                                <Modifier>None</Modifier>
                                        </Node>
                                        <Node>
                                                <Id>Save Values</Id>
                                                <Name>Save_Values_9</Name>
                                                <FileName>./integ/summary.txt</FileName>
                                                <Mode>Append</Mode>
                                                <Type>Table</Type>
                                                <Description></Description>
                                                <NumColumns>$numColumns</NumColumns>
                                                <NumHeaders>2</NumHeaders>
                                                <Table>
                                                        <Column>
                                                                <Header>
                                                                        <Name>Lat</Name>
                                                                </Header>
                                                                <Header>
                                                                        <Name>degree</Name>
                                                                </Header>
                                                                <Name>Latitude</Name>
                                                        </Column>
                                                </Table>
                                        </Node>
                                </Children>
                        </Node>
                </Children>
        </Node>
</BatchModeNodes>
</Gabc>" >> $output_file

rm $intermediate_input
```

Set evaluation node

Set save node for data collection

Final part of XML file