ADM-Aeolus ground (ocean) calibration

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L1B PM13 : 22-Apr-2008

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Content:

- Problem
- Menzies and Tratt model
- Wave model
- Connecting the 2 models
- Results
- Averaging

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Problem:

- Can we obtain a good zero wind calibration above the ocean surface?
- Questions:
  - What is the average surface motion as seen by the lidar, as a function of wind speed?
  - Does this motion average to zero when taking enough data points?
  - Can reflectivity be used to select calm conditions?

Menzies and Tratt reflectivity model

- Assume a Gaussian distribution of surface facets describes the water surface
- Width of the Gaussian scales with the local wind surface speed: $<s^2> \sim u$
- Assume simple parametrisation for occurrence of white-caps: $W \sim u^{3.52}$
- Combined reflectivity: $R_{wc}\ W + R_s\ (1 - W)$

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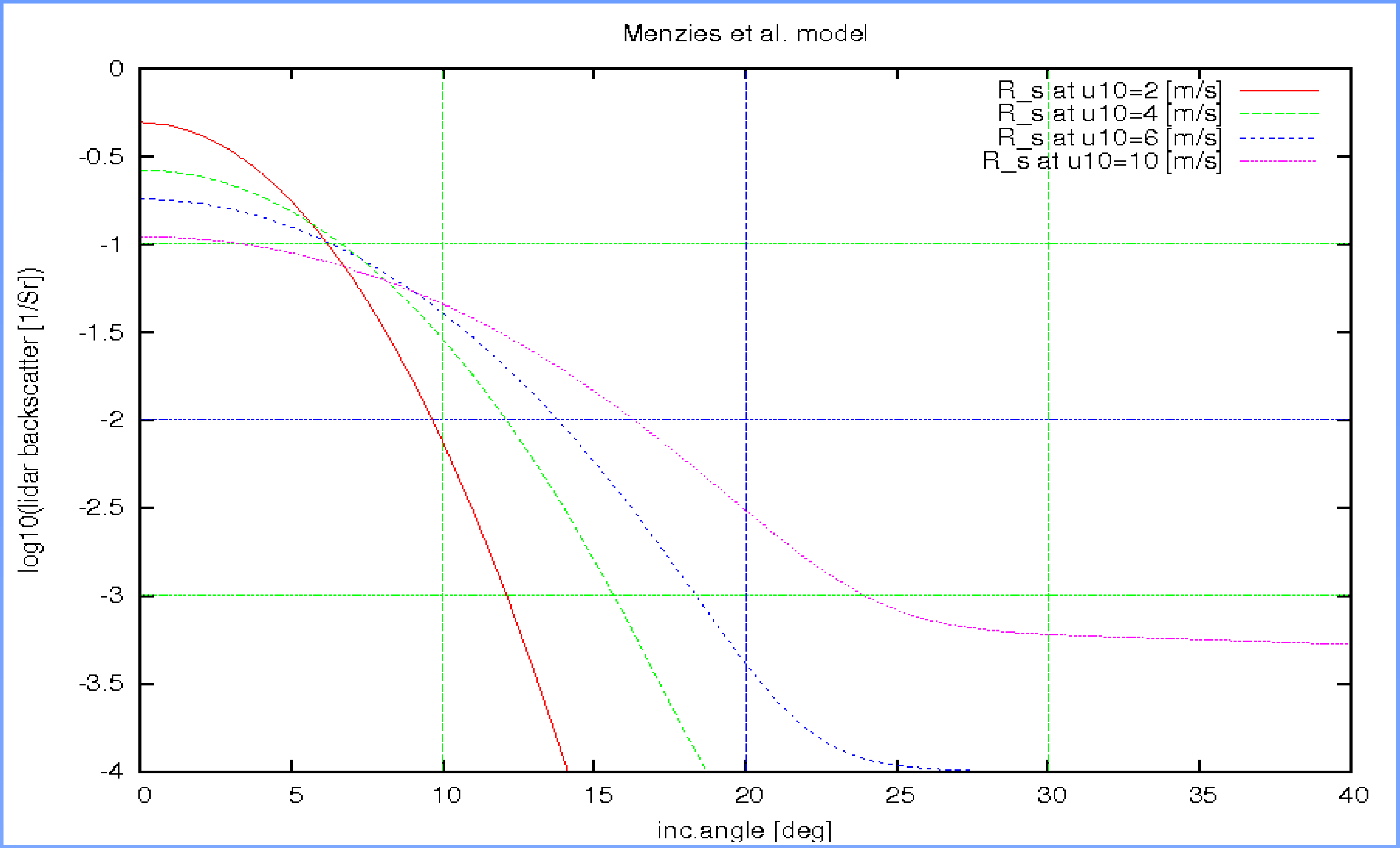
Reflectivity (Menzies & Tratt):



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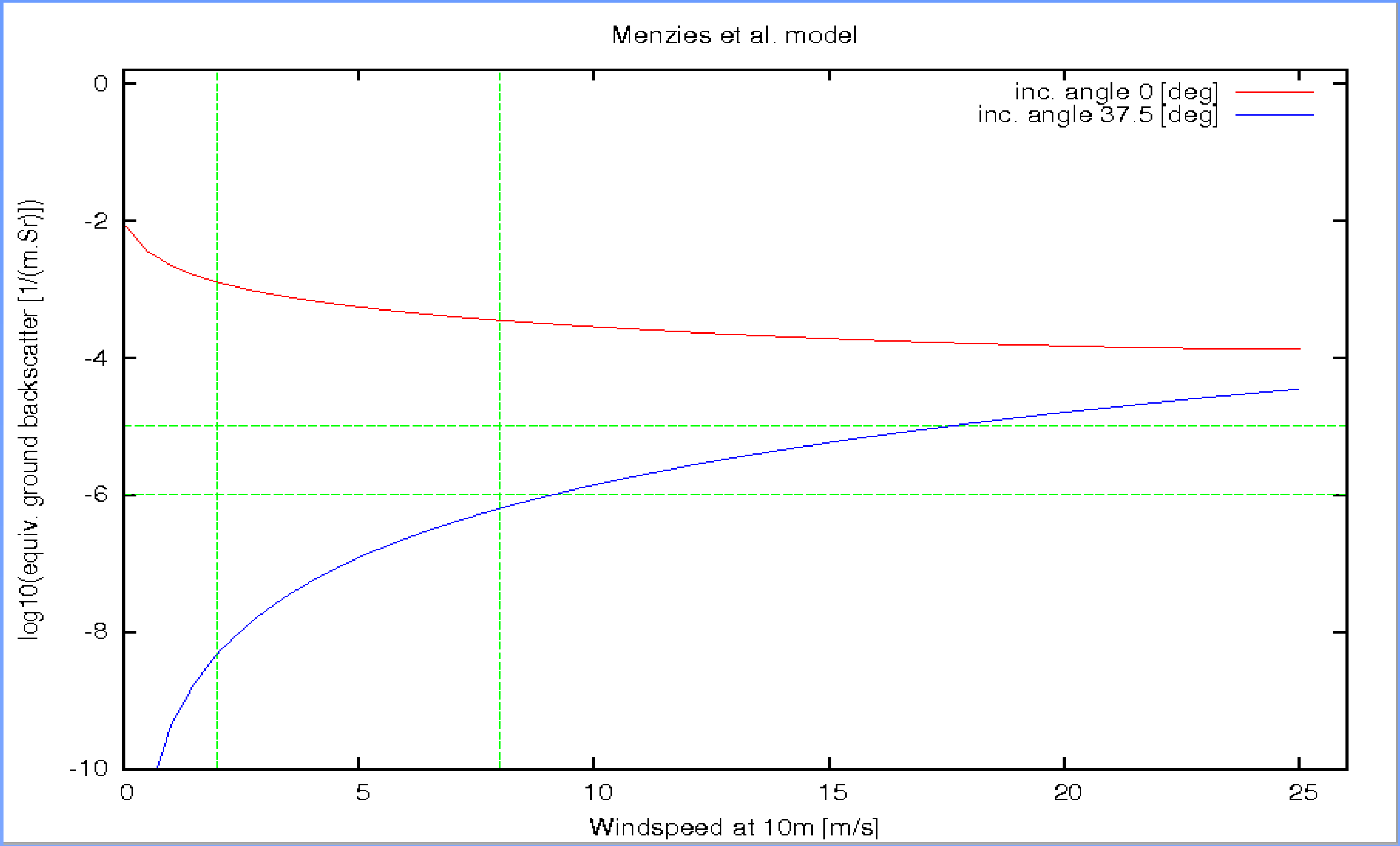
Reflectivity (Menzies & Tratt):



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Wave model

- Assume 1D trochoid motion:

$$x(p) = pL - A\sin(\omega t + 2\pi p) + u_s t$$

$$y(p) = A\cos(\omega t + 2\pi p)$$

one period: $p = [0 \cdots 1]$

- Add Stokes drift to simulate the average net surface motion induced by the wind:

$$u_s = \frac{(2\pi A)^2}{(LT)}$$

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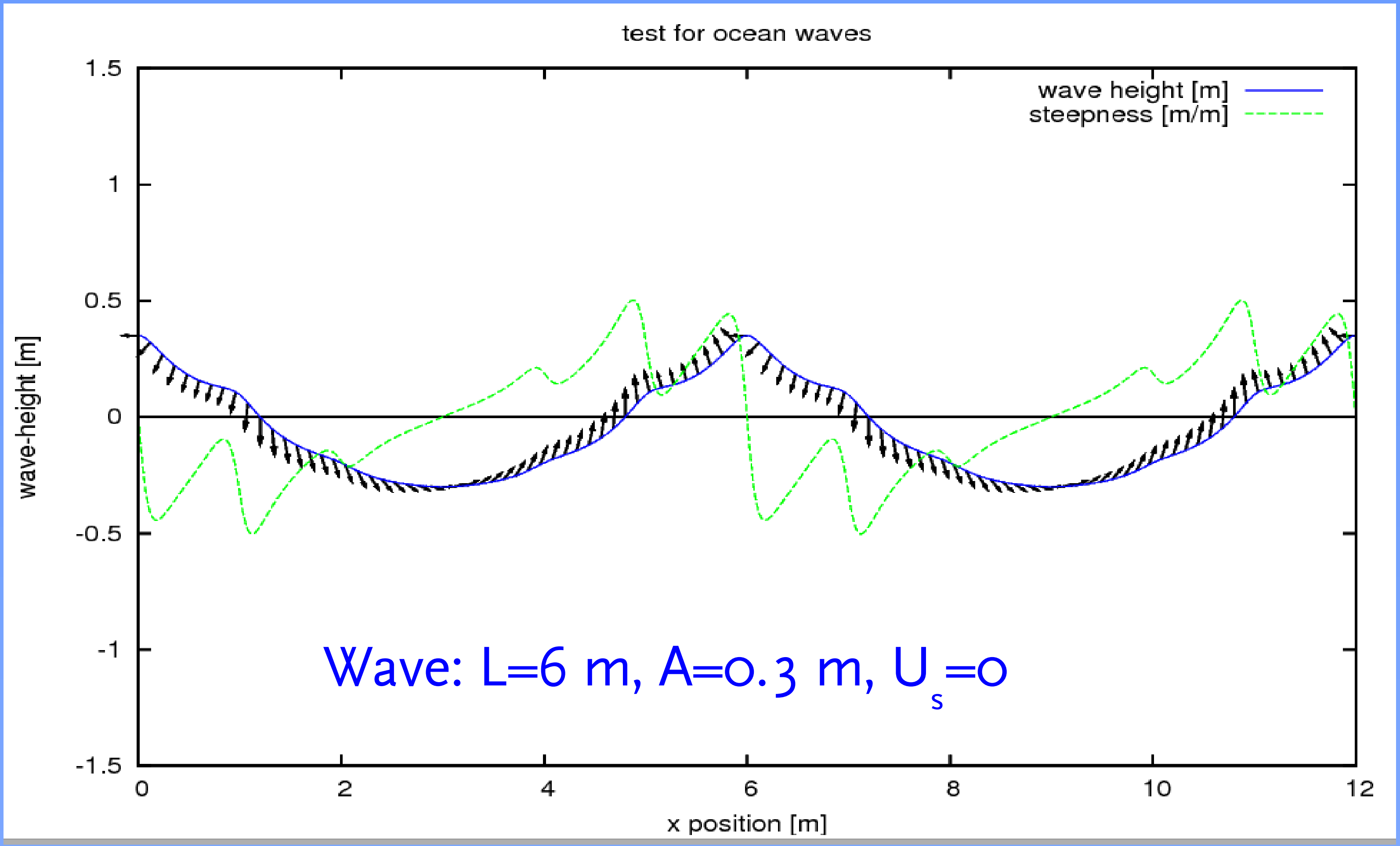
Wave model:



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Connecting both models

- Multiple wavelengths must be included to obtain a slope distribution that is similar to a Gaussian shape
- This gives a set of wave lengths and amplitudes which produce a slope distribution similar to what is assumed in the reflectivity model for each surface wind speed
- However, it is a large simplification. Comparison of the energies of these 3 wavelengths with a proper wave spectrum for a fully developed sea is still t.b.d.

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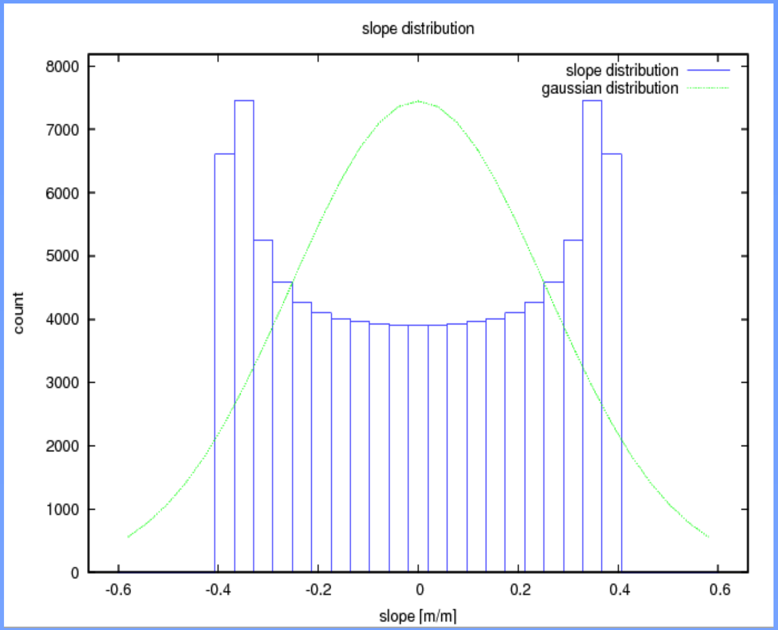
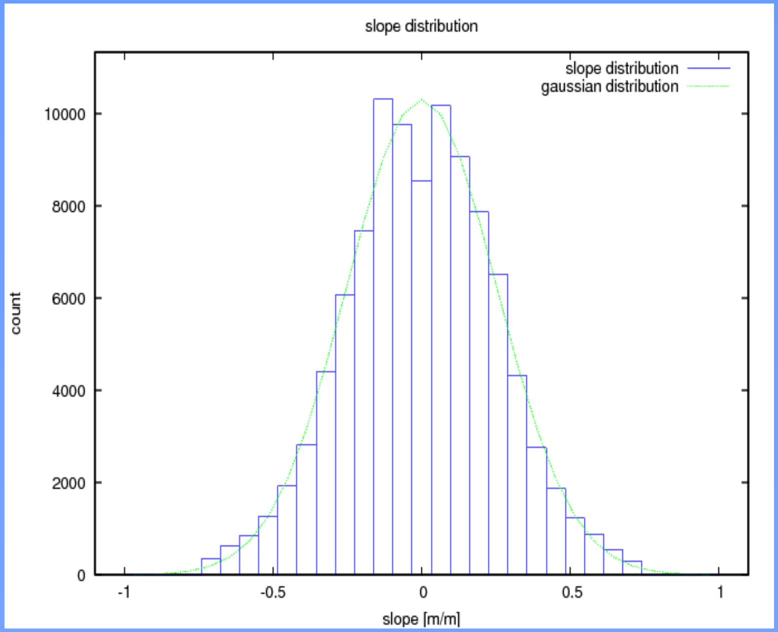
Example slope distributions:

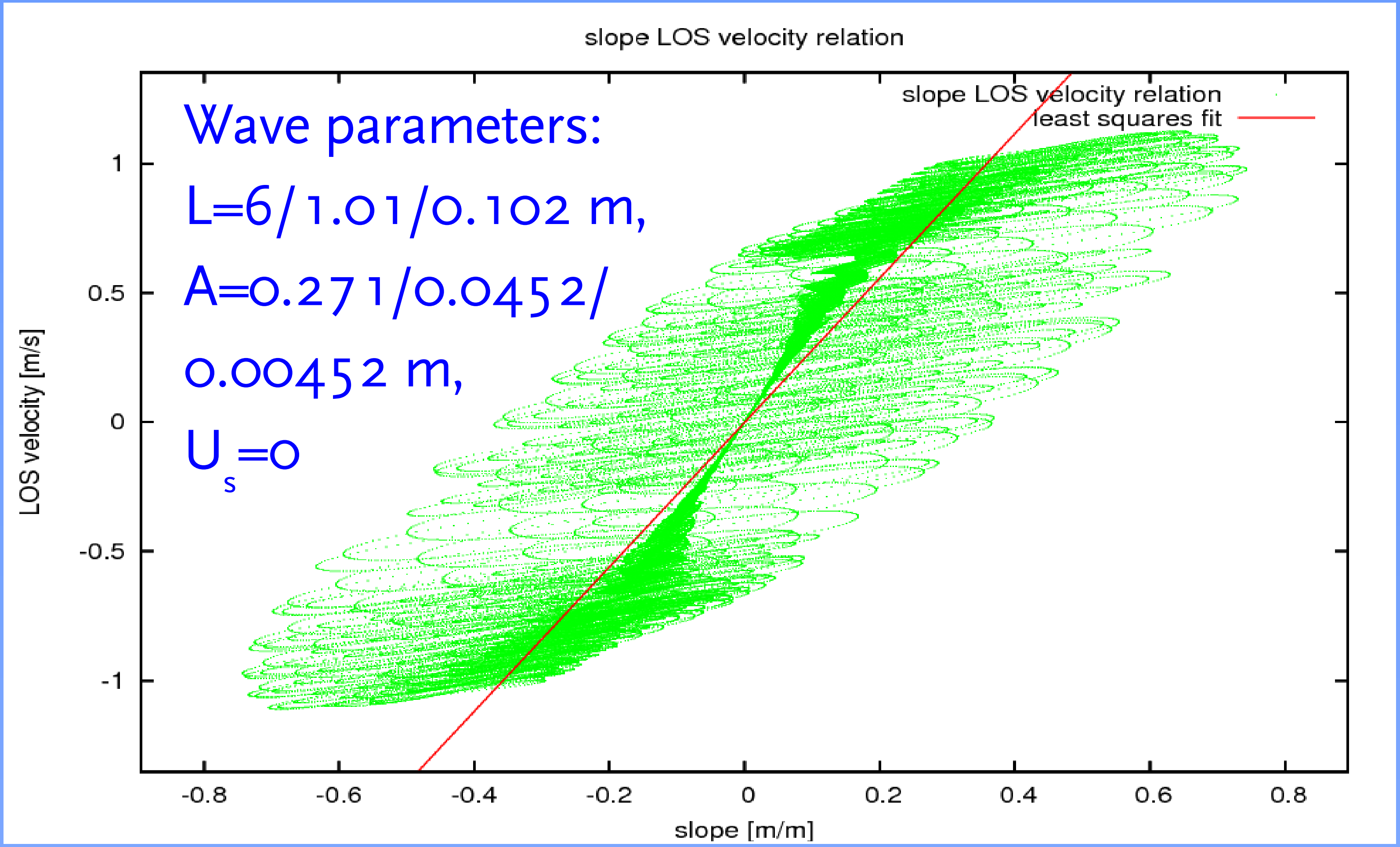




- Left: L=6 m, A=0.339 m, U_s=0
- Right: L=6/1.01/0.102 m, A=0.271/0.0452/0.00452 m, U_s=0

....

Example for nadir geometry:



Wave parameters:

L=6/1.01/0.102 m,

A=0.271/0.0452/0.00452 m,

U_s=0

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Results (specular reflection)

- Nadir observations will always see surface movement very close to 0 m/s
- For the off-nadir case specular reflection typically will see velocities around 2.5 m/s for for upwind, -2.5 m/s for down wind cases.
- Stokes drift causes a small increase to +/-3 m/s for a wind of 25 m/s

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Results (whitecaps added uniformly)

- Nadir observations again will always see surface movement very close to 0 m/s (always below 0.1 m/s).
- For the off-nadir case whitecap reflection dominates. However, most movement will cancel due to averaging and observed velocities will be below 0.1 m/s.
- When stokes drift is taken into account a significant surface velocity in the order of 0.45 m/s will remain for a wind of 25 m/s for the off-nadir case.

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Results (non-uniform whitecaps)

- Nadir observations again will always see surface movement very close to 0 m/s (always below 0.1 m/s).
- For the off-nadir case whitecap reflection dominates and a net movement will result upto 0.4 m/s
- When stokes drift is taken into account a net surface velocity in the order of 0.54 m/s will remain for a wind of 25 m/s for the off-nadir case.
- this result is asymmetric w.r.t. wind direction !
  +25 m/s gives V_LOS=0.54 m/s
  -25 m/s gives V_LOS=-0.07 m/s

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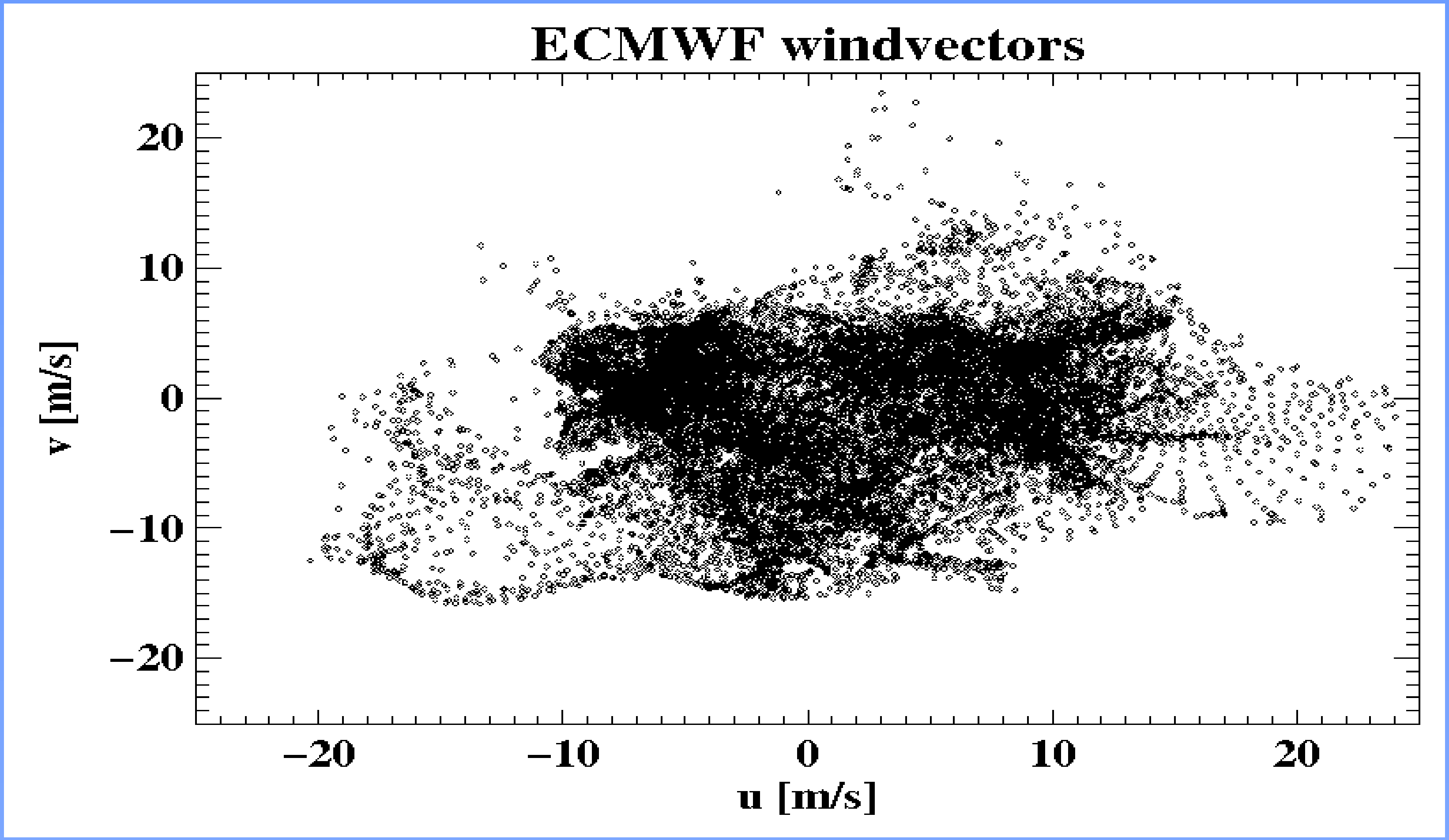
Averaging: wind distribution not uniform!



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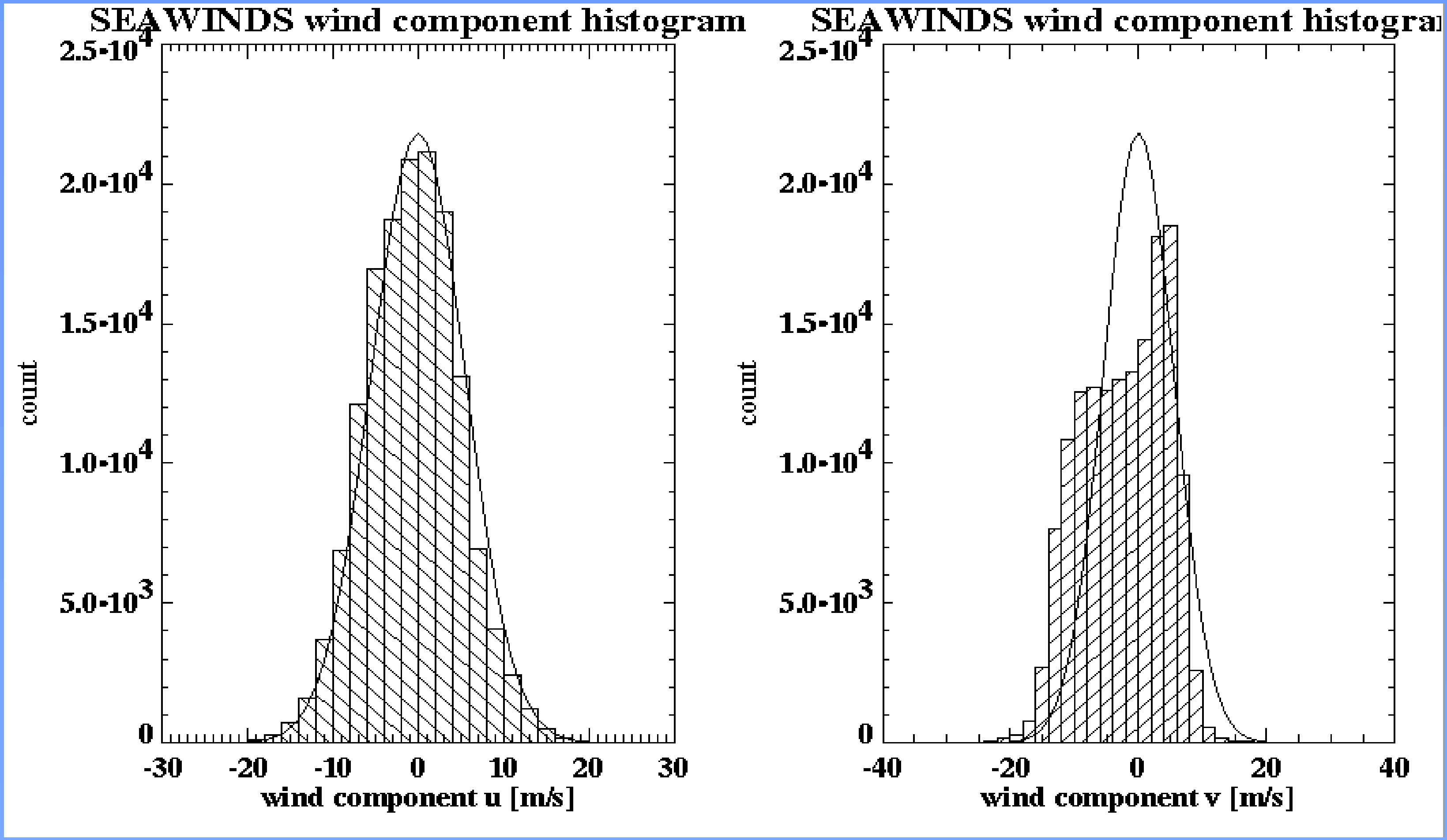
Averaging: wind distribution not uniform!



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Averaging

- From scatterometry we know that this type of averaging is only possible if:
- You take enough data (1 month at least)
- You rescale the statistics to take the asymmetric wind distributions due to the trades into account

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Conclusion:

- What is the average surface motion as seen by the lidar, as a function of wind speed?
  - upto 0.54 m/s depending on wind speed,and asymmetric with wind direction
- Does this motion average to zero when taking enough data points?
  - no, even when rescaling the wind distribution
- Can reflectivity be used to select calm conditions?
  - no

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End of this part

- questions ?

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ADM-Aeolus E2S script

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Why a new E2S script?

- L2B project has a work package "test data generation" with the purpose to have a set of default test scenarios to test the quality of the processing chain.
- For an old version of the software some academic tests have been defined, but this required a lot of manual interaction, and redoing the tests for each new release of the software is not easy (and we have had 3 updates of E2S/L1B this year ...)

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Running the chain of simulators

- available data
  - ASCII database (KNMI)
  - default input files for E2S, L1B, L2B
  - adapted default input/calibration files by ESA and Dorit
- available software:
  - E2S (GUI, java, c++, matlab): hardware simulation
  - L1B (GUI, java, c++): L0, L1A, L1B processing
  - L2B (CL, fortran): L2B processing
  - L2A (CL, GUI, c++): L2A processing

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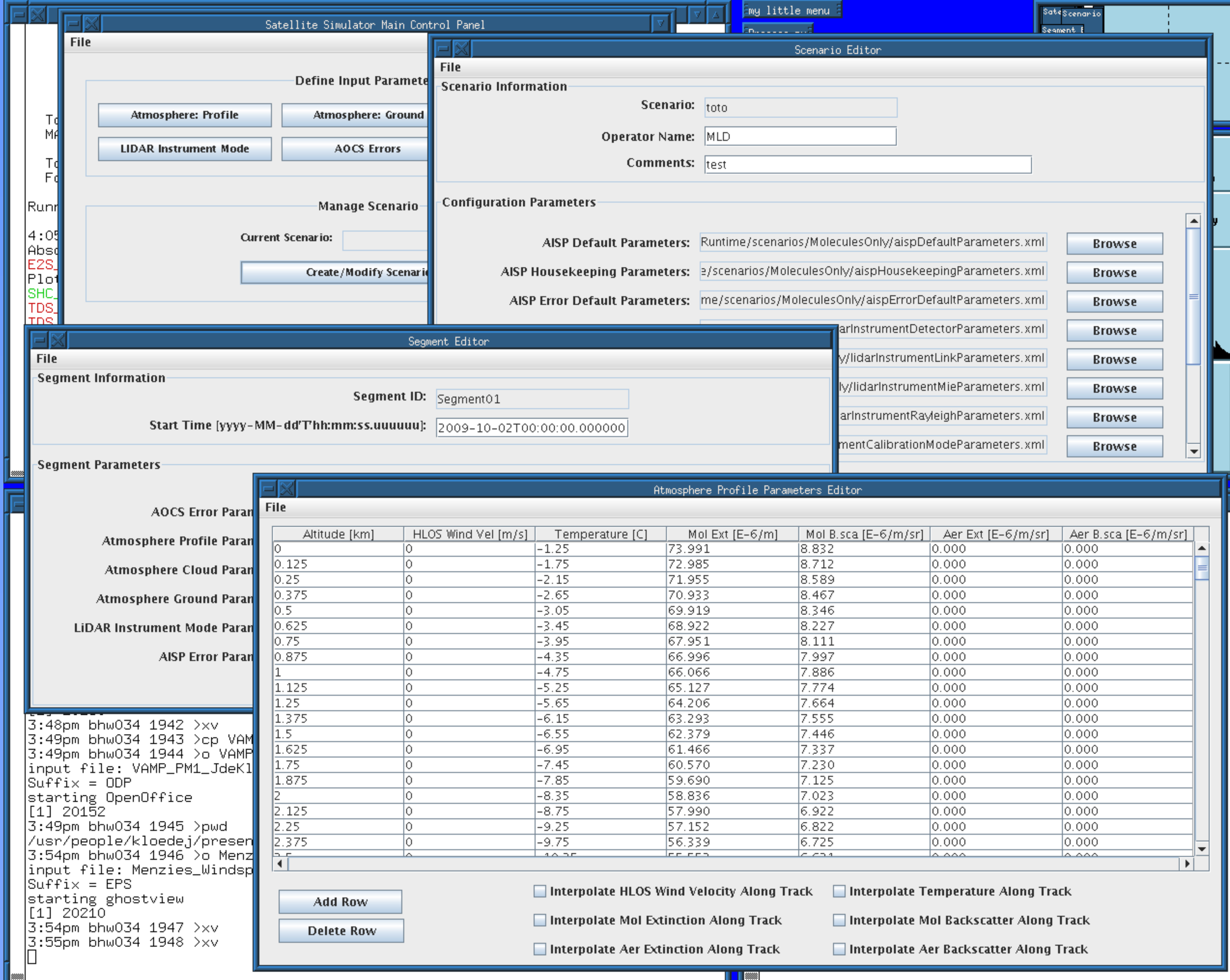
Running the chain of simulators

- available tools:
  - conversion ASCII DB to E2S input (matlab, CL, GUI)
  - conversion ASCII DB to L2B input (fortran, CL)
  - creation of E2S scenario input files (matlab GUI)
  - plotting tool (matlab, CL, GUI)


Satellite Simulator Main Control Panel
File
Define Input Paramete
Atmosphere: Profile
Atmosphere: Ground
LIDAR Instrument Mode
AOCS Errors
Manage Scenario
Current Scenario:
Create/Modify Scenari
Scenario Editor
File
Scenario Information
Scenario: toto
Operator Name: MLD
Comments: test
Configuration Parameters
AISP Default Parameters: Runtime/scenarios/MoleculesOnly/aispDefaultParameters.xml
AISP Housekeeping Parameters: e/scenarios/MoleculesOnly/aispHousekeepingParameters.xml
AISP Error Default Parameters: me/scenarios/MoleculesOnly/aispErrorDefaultParameters.xml
arInstrumentDetectorParameters.xml
y/lidarInstrumentLinkParameters.xml
ly/lidarInstrumentMieParameters.xml
arInstrumentRayleighParameters.xml
mentCalibrationModeParameters.xml
Browse
Segment Editor
File
Segment Information
Segment ID: Segment01
Start Time [yyyy-MM-dd'T'hh:mm:ss.uuuuuu]: 2009-10-02T00:00:00.000000
Segment Parameters
AOCS Error Paran
Atmosphere Profile Paran
Atmosphere Cloud Paran
Atmosphere Ground Paran
LiDAR Instrument Mode Paran
AISP Error Paran
Atmosphere Profile Parameters Editor
File
Altitude [km] | HLOS Wind Vel [m/s] | Temperature [C] | Mol Ext [E-6/m] | Mol B.sca [E-6/m/sr] | Aer Ext [E-6/m/sr] | Aer B.sca [E-6/m/sr]
0 | 0 | -1.25 | 73.991 | 8.832 | 0.000 | 0.000
0.125 | 0 | -1.75 | 72.985 | 8.712 | 0.000 | 0.000
0.25 | 0 | -2.15 | 71.955 | 8.589 | 0.000 | 0.000
0.375 | 0 | -2.65 | 70.933 | 8.467 | 0.000 | 0.000
0.5 | 0 | -3.05 | 69.919 | 8.346 | 0.000 | 0.000
0.625 | 0 | -3.45 | 68.922 | 8.227 | 0.000 | 0.000
0.75 | 0 | -3.95 | 67.951 | 8.111 | 0.000 | 0.000
0.875 | 0 | -4.35 | 66.996 | 7.997 | 0.000 | 0.000
1 | 0 | -4.75 | 66.066 | 7.886 | 0.000 | 0.000
1.125 | 0 | -5.25 | 65.127 | 7.774 | 0.000 | 0.000
1.25 | 0 | -5.65 | 64.206 | 7.664 | 0.000 | 0.000
1.375 | 0 | -6.15 | 63.293 | 7.555 | 0.000 | 0.000
1.5 | 0 | -6.55 | 62.379 | 7.446 | 0.000 | 0.000
1.625 | 0 | -6.95 | 61.466 | 7.337 | 0.000 | 0.000
1.75 | 0 | -7.45 | 60.570 | 7.230 | 0.000 | 0.000
1.875 | 0 | -7.85 | 59.690 | 7.125 | 0.000 | 0.000
2 | 0 | -8.35 | 58.836 | 7.023 | 0.000 | 0.000
2.125 | 0 | -8.75 | 57.990 | 6.922 | 0.000 | 0.000
2.25 | 0 | -9.25 | 57.152 | 6.822 | 0.000 | 0.000
2.375 | 0 | -9.75 | 56.339 | 6.725 | 0.000 | 0.000
Add Row
Delete Row
Interpolate HLOS Wind Velocity Along Track
Interpolate Temperature Along Track
Interpolate Mol Extinction Along Track
Interpolate Mol Backscatter Along Track
Interpolate Aer Extinction Along Track
Interpolate Aer Backscatter Along Track
my little menu
3:48pm bhw034 1942 >xv
3:49pm bhw034 1943 >cp VAM
3:49pm bhw034 1944 >o VAMP
input file: VAMP_PM1_JdeKl
Suffix = ODP
starting OpenOffice
[1] 20152
3:49pm bhw034 1945 >pwd
/usr/people/kloedej/presen
3:54pm bhw034 1946 >o Menz
input file: Menzies_Windsp
Suffix = EPS
starting ghostview
[1] 20210
3:54pm bhw034 1947 >xv
3:55pm bhw034 1948 >xv

Some numbers:

- A realistic scenario using ½ orbit of Calipso data collocated with ECMWF model NWP data
- Takes 39.423 E2S input files (ca. 1 GB) (not counting the DEM files)
- 5606 atmospheric profiles, so 5606 segments, with 7 input files per segment (at 3.5 km resolution, timestep 0.5 s)
- Using a GUI to create this scenario is absolutely impossible

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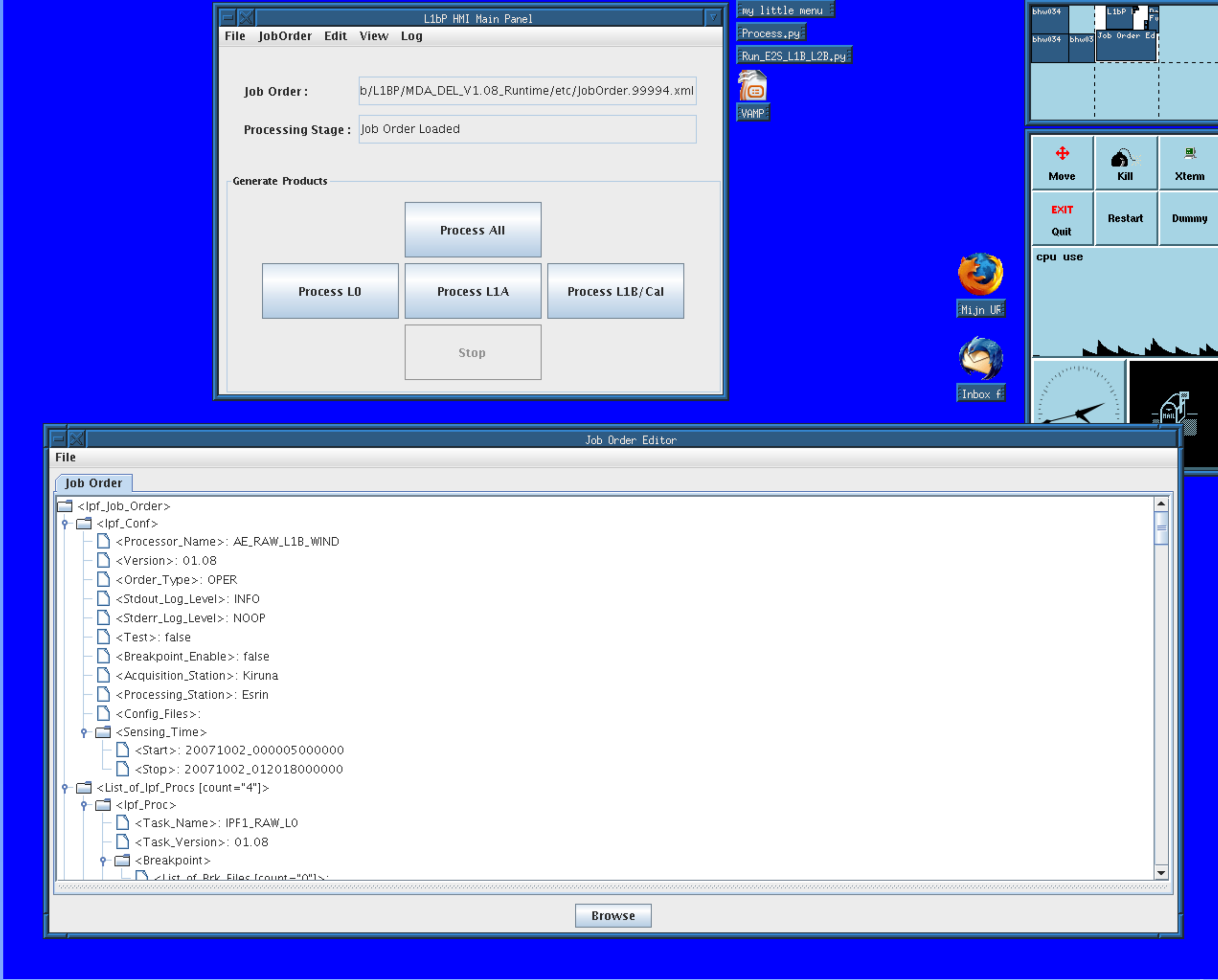
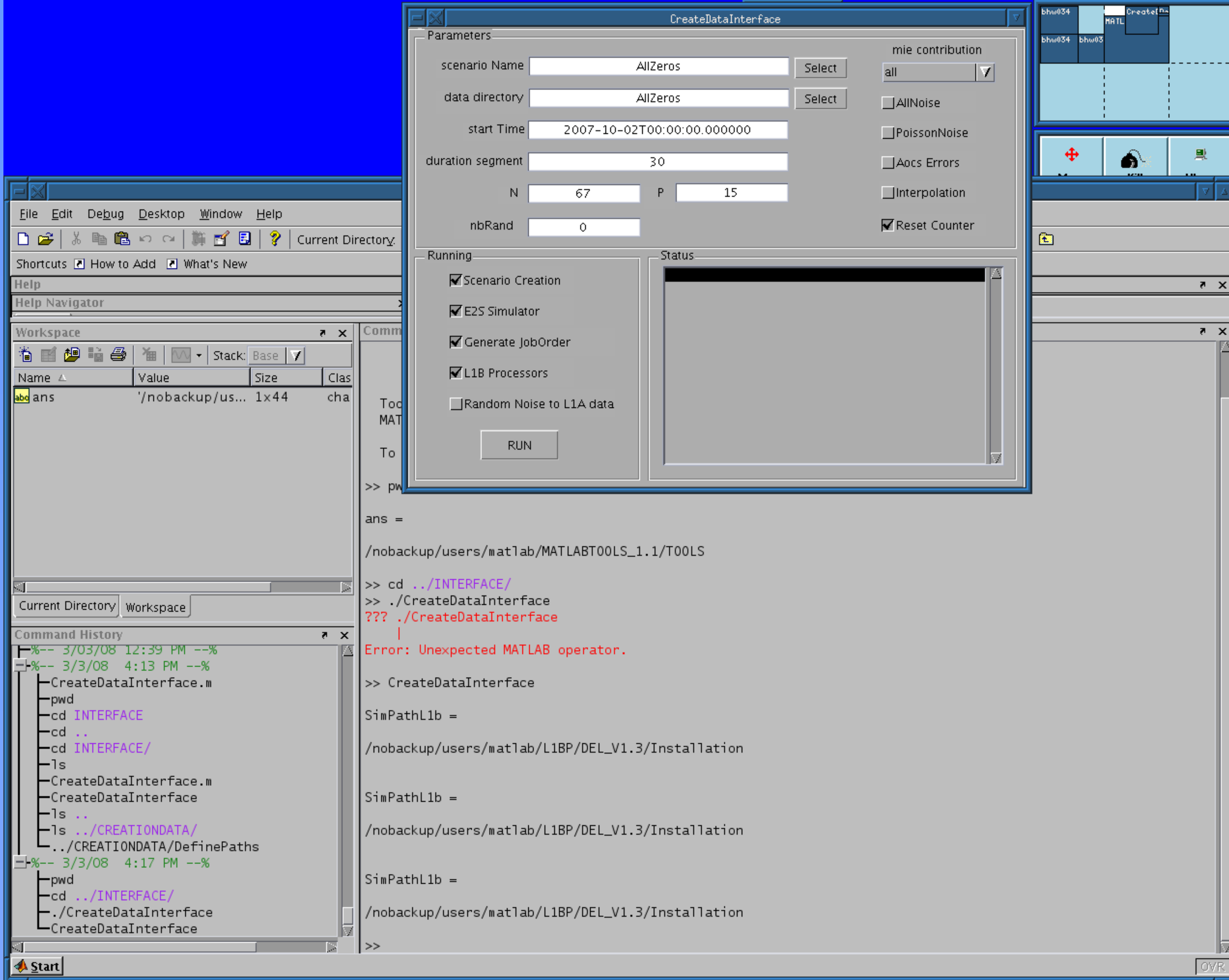


L1bP HMI Main Panel
File JobOrder Edit View Log
Job Order : b/L1BP/MDA_DEL_V1.08_Runtime/etc/JobOrder.99994.xml
Processing Stage : Job Order Loaded
Generate Products
Process All
Process L0
Process L1A
Process L1B/Cal
Stop
my little menu
Process.py
Run_E2S_L1B_L2B.py
VAMP
Mijn UF
Inbox f
Move
Kill
Xterm
EXIT
Quit
Restart
Dummy
cpu use
Job Order Editor
File
Job Order
<Ipf_Job_Order>
<Ipf_Conf>
<Processor_Name>: AE_RAW_L1B_WIND
<Version>: 01.08
<Order_Type>: OPER
<Stdout_Log_Level>: INFO
<Stderr_Log_Level>: NOOP
<Test>: false
<Breakpoint_Enable>: false
<Acquisition_Station>: Kiruna
<Processing_Station>: Esrin
<Config_Files>:
<Sensing_Time>
<Start>: 20071002_000005000000
<Stop>: 20071002_012018000000
<List_of_Ipf_Procs [count="4"]>
<Ipf_Proc>
<Task_Name>: IPF1_RAW_L0
<Task_Version>: 01.08
<Breakpoint>
Browse


CreateDataInterface
Parameters
scenario Name
AllZeros
Select
data directory
AllZeros
Select
start Time
2007-10-02T00:00:00.000000
duration segment
30
N
67
P
15
nbRand
0
mie contribution
all
AllNoise
PoissonNoise
Aocs Errors
Interpolation
Reset Counter
Running
Scenario Creation
E2S Simulator
Generate JobOrder
L1B Processors
Random Noise to L1A data
RUN
Status
File Edit Debug Desktop Window Help
Current Directory
Shortcuts How to Add What's New
Help
Help Navigator
Workspace
Stack: Base
Name Value Size Clas
ans '/nobackup/us... 1x44 cha
Current Directory Workspace
Command History
%-- 3/03/08 12:39 PM --%
%-- 3/3/08 4:13 PM --%
CreateDataInterface.m
pwd
cd INTERFACE
cd ..
cd INTERFACE/
ls
CreateDataInterface.m
CreateDataInterface
ls ..
ls ../CREATIONDATA/
../CREATIONDATA/DefinePaths
%-- 3/3/08 4:17 PM --%
pwd
cd ../INTERFACE/
./CreateDataInterface
CreateDataInterface
ans =
/nobackup/users/matlab/MATLABTOOLS_1.1/TOOLS
>> cd ../INTERFACE/
>> ./CreateDataInterface
??? ./CreateDataInterface
Error: Unexpected MATLAB operator.
>> CreateDataInterface
SimPathL1b =
/nobackup/users/matlab/L1BP/DEL_V1.3/Installation
SimPathL1b =
/nobackup/users/matlab/L1BP/DEL_V1.3/Installation
SimPathL1b =
/nobackup/users/matlab/L1BP/DEL_V1.3/Installation
>>
Start
OVR

Limitations of GUI's:

- large amount of mouse actions, pointing and clicking, needed to fill in many fields
- only those settings can be changed that have been anticipated in the GUI
- making a test reproducible is extremely hard
- creating a new test scenario with only small differences, still requires a lot of work ....
(especially if the different setting is a switch defined at segment level)

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Dedicated test script (1):

- we needed a test script to circumvent all these gui's
- it should enable us to:
  - define a test sequence for given input data and software versions
  - rerun easily when only one switch changes (for example a range bin setting or a noise switch)
  - rerun easily all previously defined tests when one of the software components is updated
  - keep the tests in cvs to ensure reproducability

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Dedicated test script (2):

- script language: python
- first created a toolbox to do basic actions:
  - unpacking zip/tgz files
  - copying files
  - creating symbolic links and directories
  - ensure permissions are correct
  - checks to see if input files are present
  - checks to verify all output files have been generated
  - modifications to xml/ascii files

Dedicated test script (3):

- this toolbox is then used to:
  - install each piece of software
  - insert required new default files
  - set paths to data
  - correct formatting problems and wrong defaults in input files
  - set all required switches in the xml files
  - run each piece of software
  - do some timing
- option: export all actions to csh script

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Dedicated test script (4):

- test sequence will be:
  - Atm.Profile converter
  - Todo: orbit calculator
  - E2S (2 steps: DataGenerator/DownlinkFormatter)
  - L1B (3 steps: L0, L1A, L1B)
  - Atm.DB-to-AuxMet converter
  - L2B
  - Matlab plotting and verification tools
  - Optional: compile all results into a TDS

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Dedicated test script (5):

- Command line input:
  - A small textfile, holding only the changes to the default settings can be provided at the command line when using the test script.
  - In this way a number of different tests can be executed in a loop without having to modify the script itself.

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Dedicated test script (6):

- Example:

```
cat TEST_ZeroWind_NoNoise.py

#!/usr/bin/env python
AtmScenarioName   = "single_RMA_midlat_winter_and_cirrus"
ScenarioName      = "Test_ZeroWind_NoNoise"
PythonLogfileName = "Log_"+ScenarioName+".txt"
RangeBinSetting   = "WVM1"

AllNoiseFlag       = False
PoissonNoiseFlag   = False
AocsErrorFlag      = False
RmsNoiseFlag       = False
ForceLinear        = True
LaserFreqVariation = False

InterpolateHorizontal = True
Use_AtmDataBase  = True # False
UseAtmDBtiming   = False
DateTimeStep     = 28.0
NumSegments      = 2 # minimum is 2 !

#ForceZeroAtmTemperature = True
ForceHlosWind = "0.0" # [m/s]
ForceAlbedo = 0.8

RunAll = True
ForceDeleteOldResults = True
```


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Dedicated test script (7):

- Example of test delta:

```
cat TEST_ZeroWind_NoNoise_0C.py
#!/usr/bin/env python

# copy all settings from the 0 m/s test without temperature forcing
execfile('Tests/TEST_ZeroWind_NoNoise.py')

# and only redefine the scenario name and the temperature forcing
ScenarioName      = "Test_ZeroWind_NoNoise_0C"
PythonLogfileName = "Log_"+ScenarioName+".txt"
ForceZeroAtmTemperature = True
```

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Results for ½ Calipso orbit :

- Rayleigh channel

	std	bias	npoints
L1B	2.14 m/s	-1.61 m/s	1899
L2B Clear	4.03 m/s	0.01 m/s	1858
L2B Cloud	9.72 m/s	-0.63 m/s	439

- Mie Channel

	std	bias	npoints
L1B	1.37 m/s	0.24 m/s	544
L2B Clear	29.8 m/s	0.10 m/s	1053
L2B Cloud	49.3 m/s	2.06 m/s	506

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Optional:

- DEMO

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The end

- questions ?

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