UV Hygrometer WECAN

2019-01-10

Calculate high-rate UV Hygrometer mixing ratio.
Using fit parameters derived from the low rate data, in WECAN_UVHygrometer_FitParameters.txt

See the low-rate fit file (uvhFit_rf01.nb) for complete description of process and variables.

Initialization

In[195]:=
```
ClearAll[Evaluate[$Context <> "*"]]
SetDirectory[NotebookDirectory[]];
```

In[197]:=
```
kB = QuantityMagnitude[UnitConvert[Quantity["BoltzmannConstant"]]];
```

In[198]:=
```
(* The equation for number density
  (molecules/m^3) with the fit parameters determined by the low-
 rate data. This fit had a factor of 10^22 factored out of the density. *)
densityEqn[v_] = 10^22/(-σl) Log[(v - a)/b];
(* Values calculated from low-rate fit,
after hand adjustment as necessary. *)
{flightNumber, dropAtStart, linearDecayRate, linearDecayStartTime, a, b, σl} =
  {1, 2000, -1.0*^-6, 68809, 0.43, 3.28, 0.0989};
```

In[200]:=
```
(* Data file
 names: high rate (HR) for temp/signal reduced to 25 Hz from 100 Hz,
and sample rate for pressure (recorded only at 10 Hz. *)
(* NOTE: header must be deleted from dataFiles! *)
datafileHR = "/Users/Shared/BigStuff/WecanData/xTempSigRF01h.txt";
datafileSR = "/Users/Shared/BigStuff/WecanData/xpresRF01s.txt";
(* For pressure data only. *)
exportFileHR = "uvh_rf01h.txt";
```

Start and stop times for high rate file.

In[203]:=

```
startTimeHR = 70 000.0;
stopTimeHR = 89 800.0;
```

Read data.

Import data from high-rate file for signal and temperature (25 sps)

In[205]:=
```
dataHR = Import[datafileHR, "CSV"];
(* NOTE: header must be deleted from file!. *)
dataHR[[All, 2]] += 273.15; (* Convert temperature to kelvin *)

(* If seconds rolls over,
find rollover index and add 24x3600=86400 seconds to time. *)
iROLLOVER = Flatten[Position[dataHR[[All, 1]], 0.0]][[1]];
If[IntegerQ[iROLLOVER],
 dataHR[[iROLLOVER ;; -1, 1]] += 86 400;, "No seconds rollover"]

(* Set start and stop times of high-rate data. *)
iSTART = Flatten[Position[dataHR[[All, 1]], startTimeHR]][[1]];
If [IntegerQ[iSTART], "Shortening dataHR at start", {iSTART = 1;
  "No data drop at start"}]

iEND = Flatten[Position[dataHR[[All, 1]], stopTimeHR]][[1]];
If [IntegerQ[iEND], "Shortening dataHR at end", {iEND = -1;
  "No data drop at end"}]

"Using high-rate data from indices:"
{iSTART, iEND}
dataHR = dataHR[[iSTART ;; iEND]];
Dimensions[dataHR]
```

Out[210]= Shortening dataHR at start

Out[212]= Shortening dataHR at end

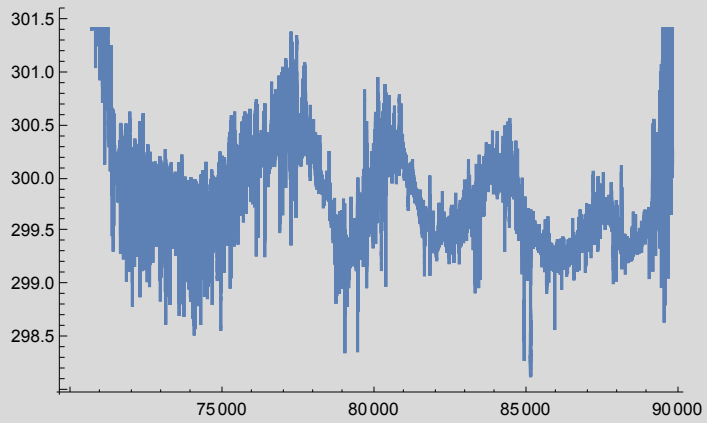
Out[213]= Using high-rate data from indices:

Out[214]= {40 001, 535 001}

Out[216]= {495 001, 3}

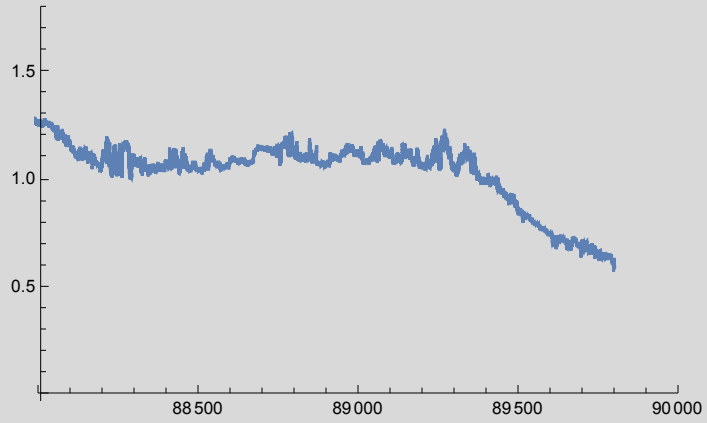
In[217]:=
```
ListPlot[Transpose[{dataHR[[All, 1]], dataHR[[All, 2]]}], Joined → True]
```

Out[217]=



In[218]:=
```
ListPlot[Transpose[{dataHR[[All, 1]], dataHR[[All, 3]]}],
 PlotRange → {{88000, 90000}, Automatic}, Joined → True]
```

Out[218]=



Import data from sample-rate file for pressure (at 10 sps).

In[219]:=
```
xcellpresSR = Import[datafileSR, "CSV"];
(* NOTE: header must be deleted from file!. *)
xcellpresSR[[All, 2]] *= 100; (* Convert hPa to Pa. *)

(*Repeat time checks above.*)
(* If seconds rolls over,
find rollover and add 24x3600=86400 seconds to time. *)
iROLLOVER = Flatten[Position[xcellpresSR[[All, 1]], 0.0]][[1]]
If[IntegerQ[iROLLOVER],
 xcellpresSR[[iROLLOVER ;; -1, 1]] += 86 400;, "No seconds rollover"]

(* Set start and stop times of high-rate data. *)
iSTART = Flatten[Position[xcellpresSR[[All, 1]], startTimeHR]][[1]]
If [IntegerQ[iSTART], "Shortening dataHR at start", {iSTART = 1;
  "No data drop at start"}]

iEND = Flatten[Position[xcellpresSR[[All, 1]], stopTimeHR]][[1]]
If [IntegerQ[iEND], "Shortening dataHR at end", {iEND = -1;
  "No data drop at end"}]

xcellpresSR = xcellpresSR[[iSTART ;; iEND]];
Dimensions[xcellpresSR]
```

Out[221]= 279 191

Out[223]= 115 191

Out[224]= Shortening dataHR at start

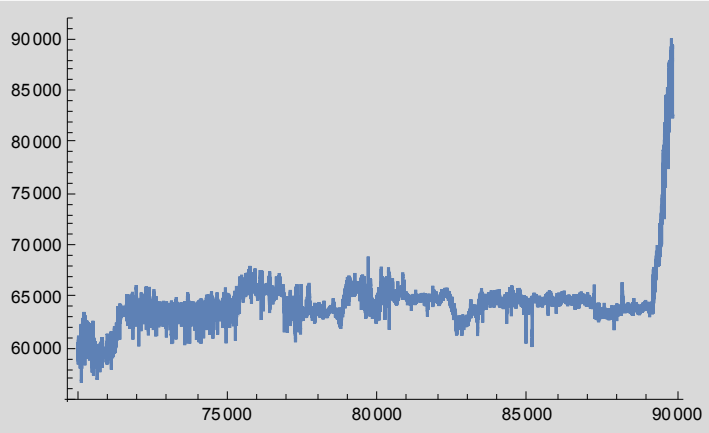
Out[225]= 313 191

Out[226]= Shortening dataHR at end

Out[228]= {198 001, 2}

In[229]:=
```
ListPlot[xcellpresSR, Joined → True, PlotRange → All]
```

Out[229]=



Interpolate pressure data from 10 Hz to 25 Hz.

In[231]:=
```
xcellpresFn = ListInterpolation[xcellpresSR[[All, 2]]];
```

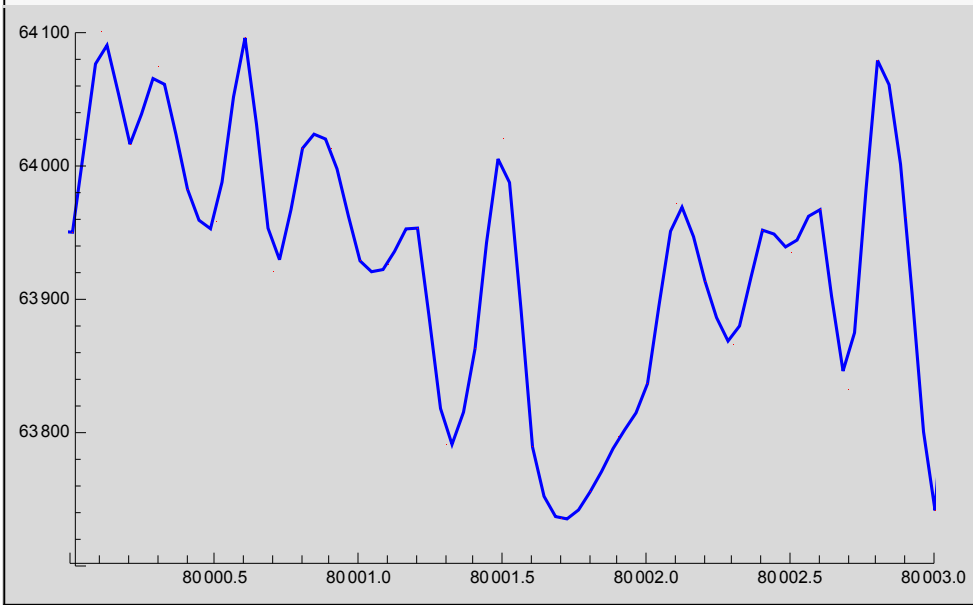
In[232]:=
```
(* Since the pressure data was at 10 Hz,
interpolating at 0.40 will give 0.040 s/sample, = 25 Hz. *)
xcellpresHR = xcellpresFn[Table[i, {i, 1, Length[xcellpresSR], 0.40}]];
Dimensions[xcellpresHR]
```

Out[233]=
```
{495 001}
```

In[234]:=
```
(* Variable to make plotting easier. Consists of {time,value}. *)
xcellpresPlotHR = Transpose[{dataHR[[All, 1]], xcellpresHR}];
```

In[235]:=
```
ListPlot[{xcellpresSR, xcellpresPlotHR},
 PlotRange → {{80 000, 80 003}, {63 700, 64 100}}, Joined → {False, True} ,
 PlotStyle → {Red, Blue}, ImageSize → Scaled[0.8]]
```

Out[235]=



Calculations

Invert for number density from Voltage

Reread the .nc file for time and uvh values to calculate mixing ratio without any gaps.

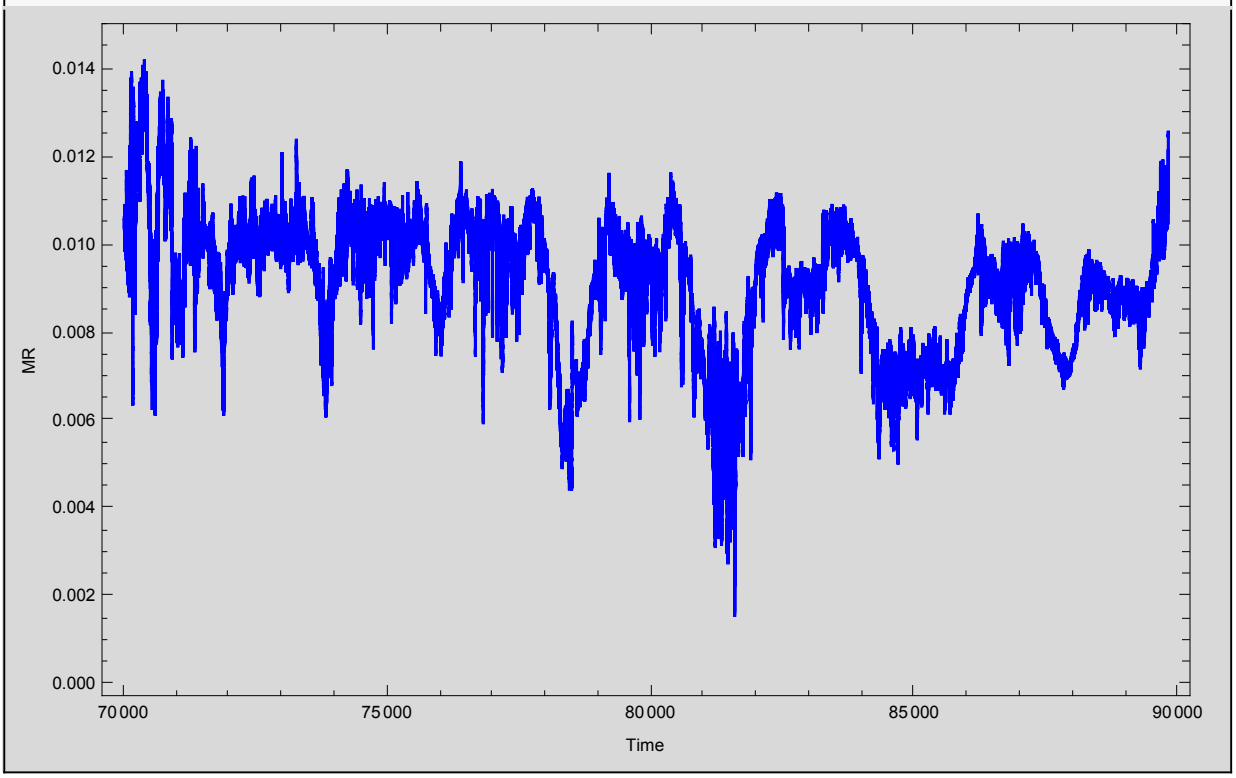
In[236]:=
```
(* Adjust signal voltage for lamp decay, window dirtying. *)
temp =
  Table[dataHR[[i, 3]] + linearDecayRate * (dataHR[[i, 1]] - linearDecayStartTime),
   {i, 1, Length[dataHR]}];

(* Adjust signal voltage for pressure (O2 adsorption). *)
xsigvAdjHR = temp / Exp[-0.25 * xcellpresHR * 10^-5];
Clear[temp];
```

In[239]:=
```
(* Calculate number density in hygrometer
 cell based on adjusted voltage signal. *)
densityCalc = densityEqn[xsigvAdjHR];
cellNumberDensity = xcellpresHR / (dataHR[[All, 2]] * kB);
MR = densityCalc / cellNumberDensity;
MRPlot = Transpose[{dataHR[[All, 1]], MR}];
```

In[243]:=
```
ListPlot[MRPlot, PlotStyle → {Red, Blue}, Frame → True,
 FrameLabel → {"Time", "MR"}, Joined → True, ImageSize → Full]
```

Out[243]=



Export High-rate mixing rate data in ppm.

Multiply calculated mixing ratio by 10^6 to get ppmv.

As post-processing the file needs to have the curly brackets removed and line returns added.

In[244]:=
```
exportData = Transpose[{MRPlot[[All, 1]], MRPlot[[All, 2]] * 1 000 000.0}];
```

In[ ]:=
```
(*NumberForm to get enough digits and in non-
 scientific. Need 2 digits in time to get 0.04 s resolution. *)
Export[exportFileHR, NumberForm[exportData, {8, 2}], "Table"]
```

Out[ ]=
```
uvh_rf01h.txt
```