ANALYSIS OF WEEKEND-WEEKDAY DIFFERENCES OF O_3 USING THE ANALYSIS TOOL: PAW

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PAW: Physics Analysis Workstation

Version 1 ~1988 at CERN (European Center for Nuclear Research) and extensively used worldwide by the nuclear and high-energy physics fields for data analysis.

Open source and free. Precompiled versions exist for many platforms: Unix,Linux, Windows. **(I have brought a Linux version of PAW and a sample data file on a CD.)**

Operates through simple, intuitive commands at a terminal window, and graphics are plotted on a separate window.

Ease of use: New user can do "something useful" at the end of a day

PAW: Data

Commonly used PAW data form is the **Ntuple**
Simply a collection of data lines, each consisting of N data fields. A simplified Ntuple would contain lines like:

Date Time IX IY IZ [O3] [NO2] [VDIF_O3] [TEMP] [EMIS_NO]

Entries on the same ntuple line can be plotted against one another as 1D,2D and 3D plots

Mathematical operations (including trignometric, exponential, and log) allowed

Conditional Boolean cuts on variables are allowed.

PAW: Other Features

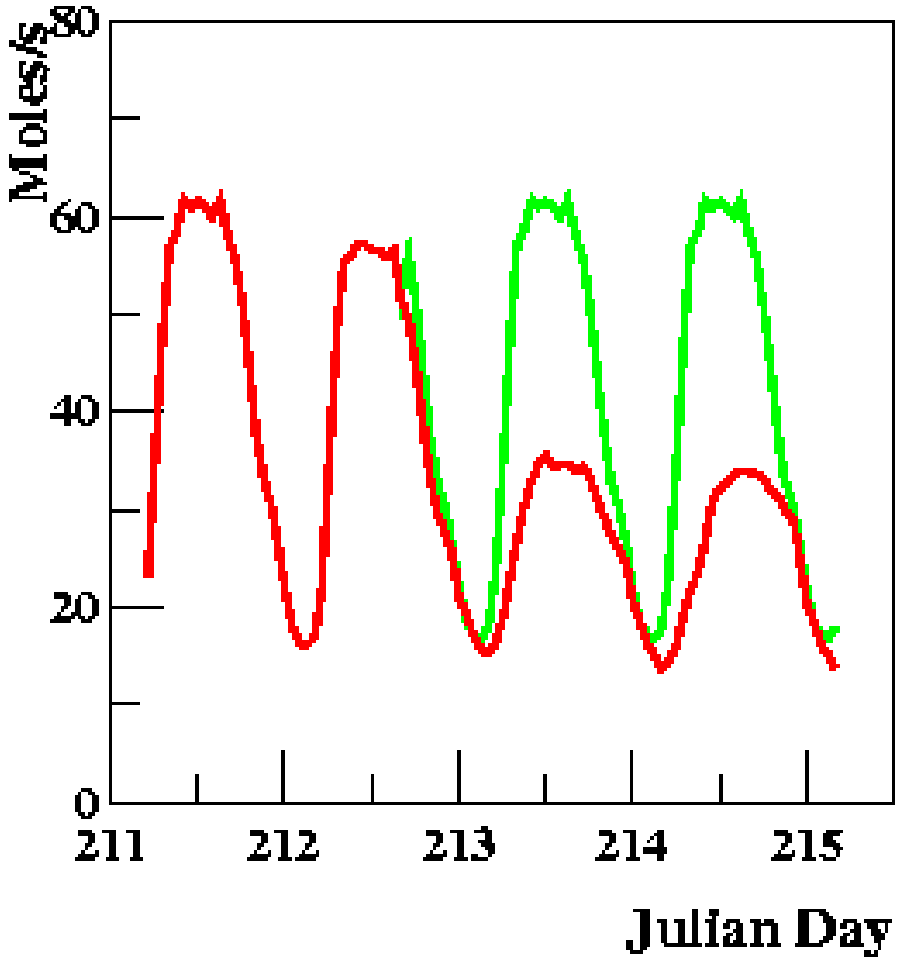
- Multiple commands can be executed in macros, which also allow IF and DO constructs and take arguments ($1,$2…)
- Built-in Fortran 77 interpreter for more complicated operations. Any ntuple variable can be passed to Fortran.
- Graphical cuts can be drawn on the graphics window and saved; useful for interrogating areas on a scatterplot
- A fitting package (MINUIT) is part of PAW
- Help on any command available by typing HELP or USAGE

IOAPI2AHB: Getting your data from CMAQ → PAW

- We wrote this in Fortran 90, linked only to IOAPI,Netcdf
- Control Ioapi2ahb with a simple ascii input file to select variables from multiple IOAPI files (typically ACONC, Process Analysis, Emissions, Met file) and consolidate variables with the same cell XYZ indices and timestep onto same ntuple line
- Allows limits on X,Y,Z indices, and timestep range
- In addition to writing output for every X,Y,Z cell, also performs weighted averaging/summing of the variables over the column of Z layers over each X,Y cell (Z index set to minus 1) and for the domain as a whole (X,Y,Z indices set to minus 1)
- Option: PAVE-style alphabetical suffixing of variables
- Option: Variable name translation (O3 →O3wkend)

No_x emissions: Thu,Fri,Sat,Sun

"Weekend effect" in which urban regions tend to have higher concentration of ozone on weekends than weekdays even though anthropogenic emissions of NO_x are typically lower



The domain at 3pm PDT.

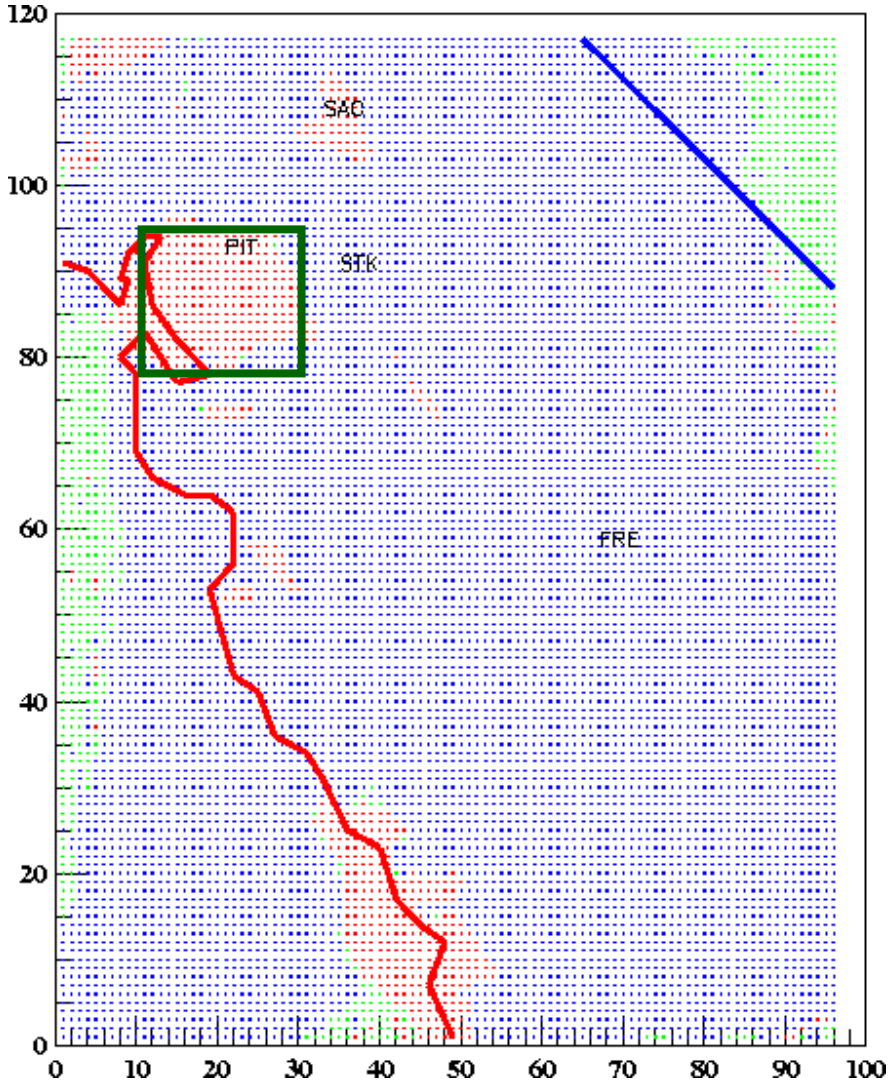
Grid cell colors:

Weekend O3 > Weekday O3

Weekend O3 = Weekday O3

Weekend O3 < Weekday O3

Cities of Pittsburgh, Sacramento, Stockton and Fresno are shown



Paw commands:

NULL 0 100 0 120 (draws empty box)

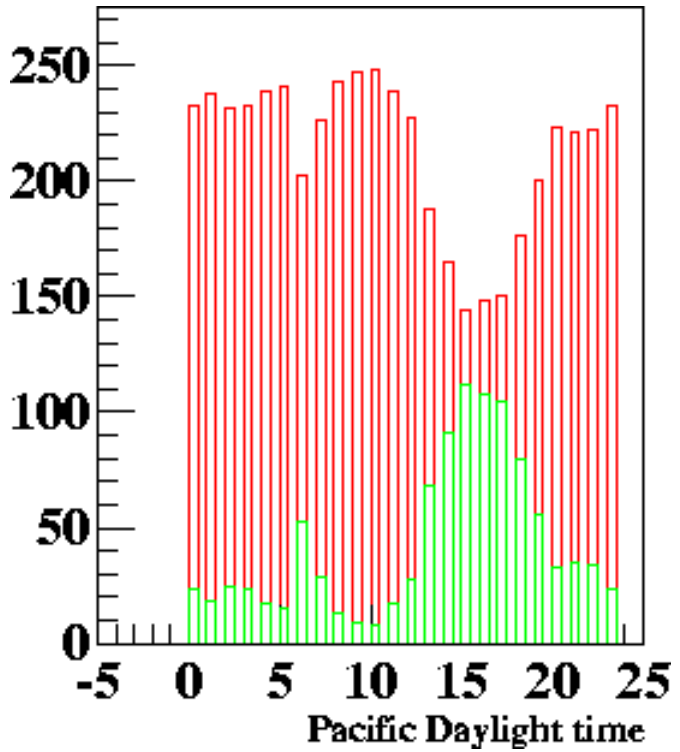
exec map (draws coast, border,cities)

NTUPLE/CUT 50 pdt.for(time) =15 &&DATE=214 (Cut 50 defines date/time cut)

NTUPLE/PLOT 1.Y%X $50 && O3E>O3D option=s

Time dependence of frequency of Weekend $[O_3]$ excess

Histogram number of cells for which weekend $[O_3]$ is greater than or less than weekday $[O_3]$



SET HCOL 2; NT/PL 1.pdt.for(time) (O3E-O3D)>0

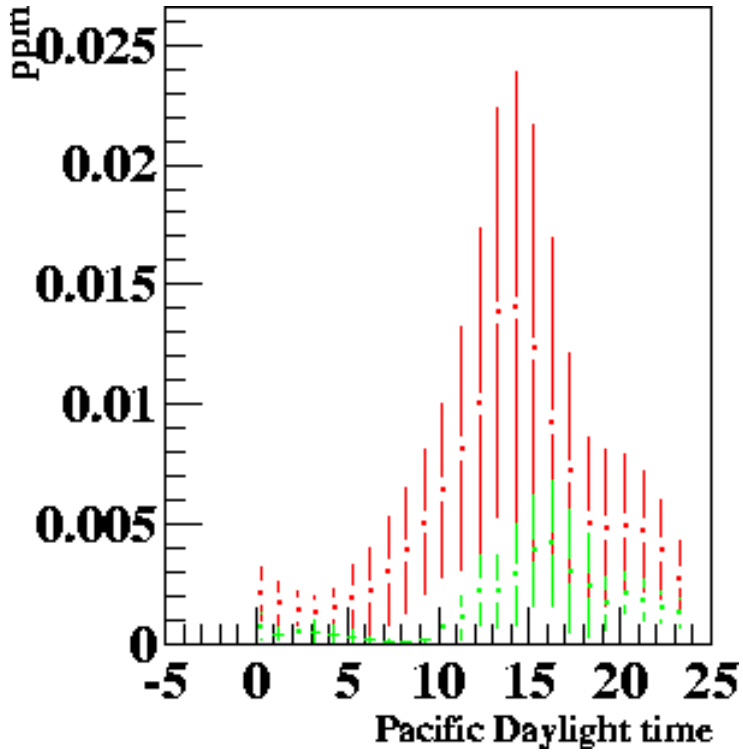
SET HCOL 3; NT/PL 1.pdt.for(time) (O3E-O3D)<=0 option=s

Time dependence of degree of Weekend [O_3] excess

Profile plot of the mean difference of the excess O3 as a function of time for all column averaged cells:

weekend greater than weekday

weekend less than weekday



ΔO3 vs. time

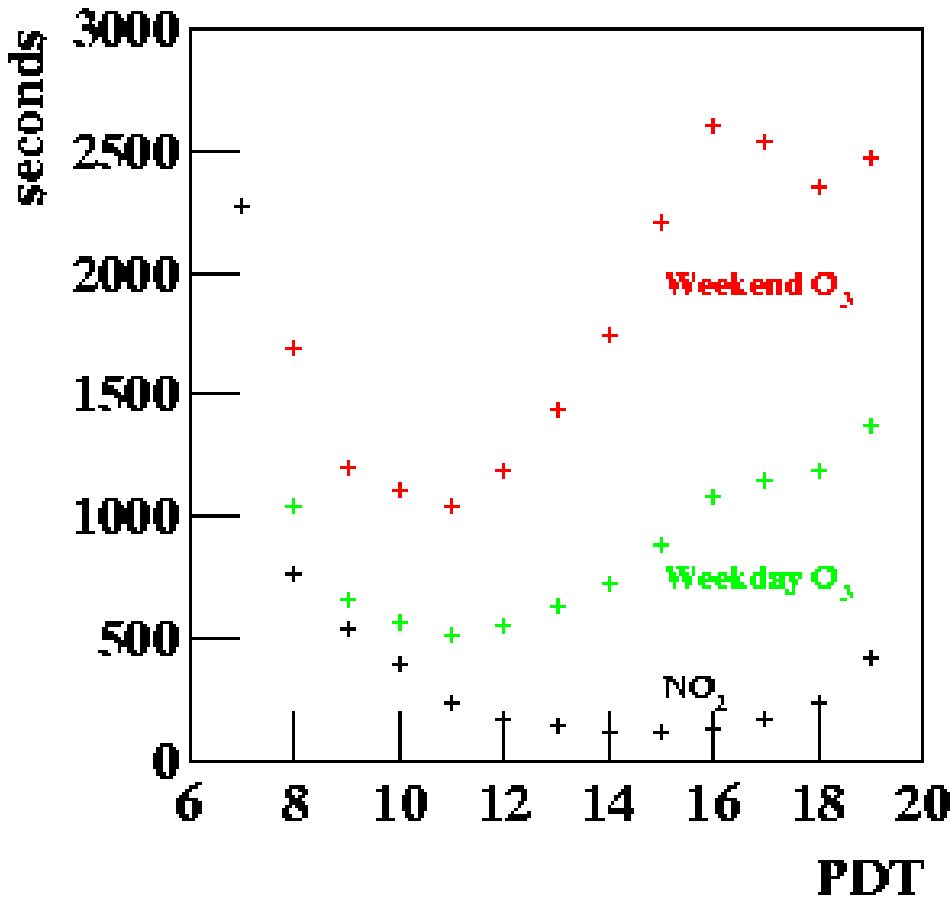
NTUPLE/PLOT 1.(o3e-o3d)%pdt.for(time) (o3e>o3d) option=profs

Lifetimes of O_3 and NO_2

weekend O3 longer lived

than weekday O3

NO_2 lifetime same (depends only on sunlight)



Lifetime in seconds = Concentration / loss rate:

NTUPLE/PLOT 1.3600. * o3e/pno2fo3e%pdt.for(time)

Titration through $O_3+NO \rightarrow NO_2$ or more..?

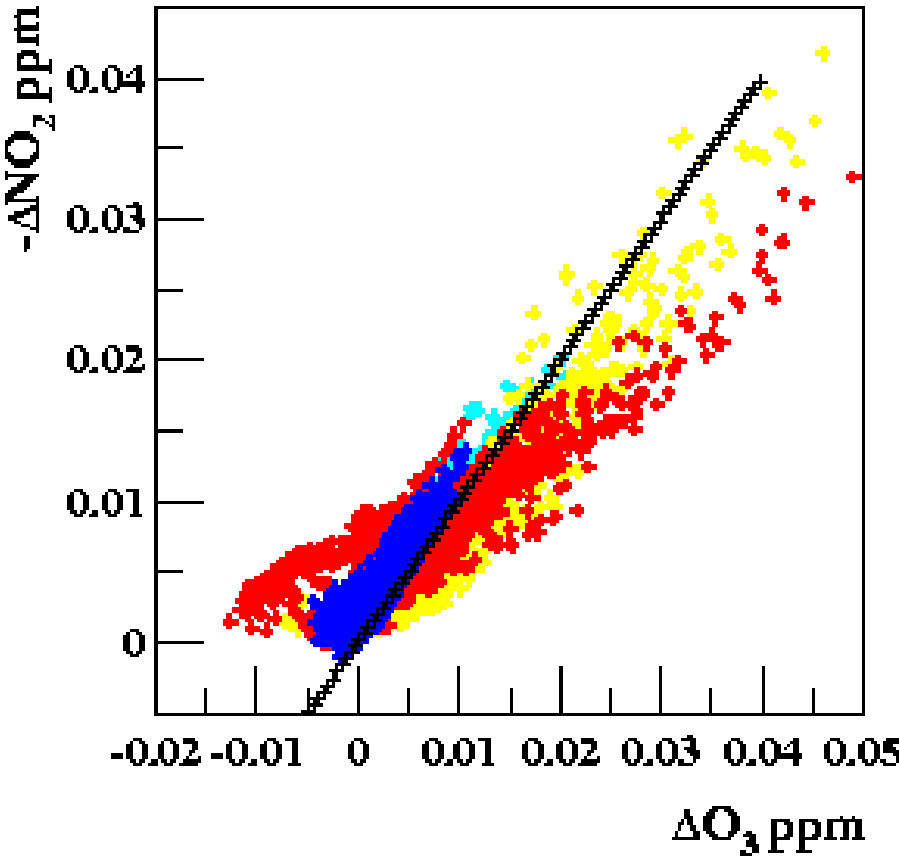
If only titration then points would lie near black line, i.e excess O_3 compensated by deficit NO_2

Cyan 6am-9am

Yellow: 9am-Noon

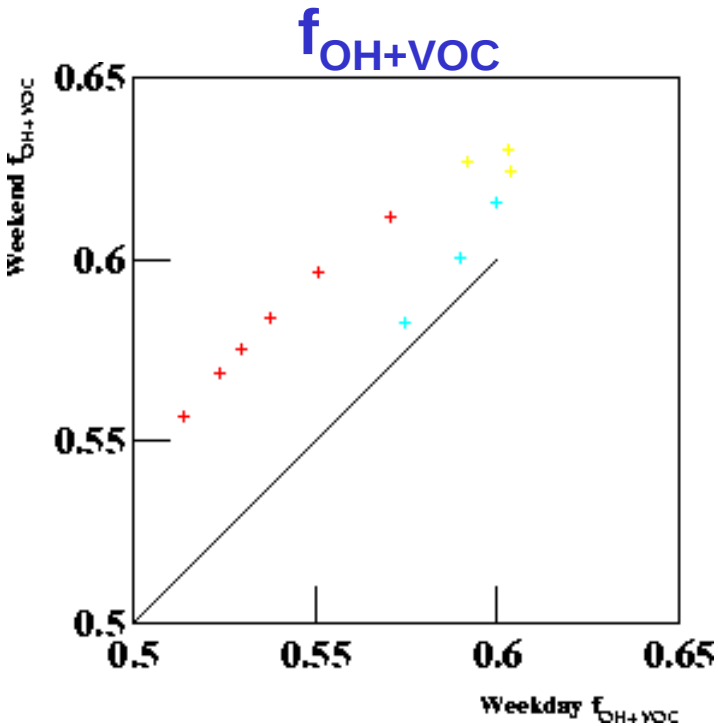
Red: Noon-6pm

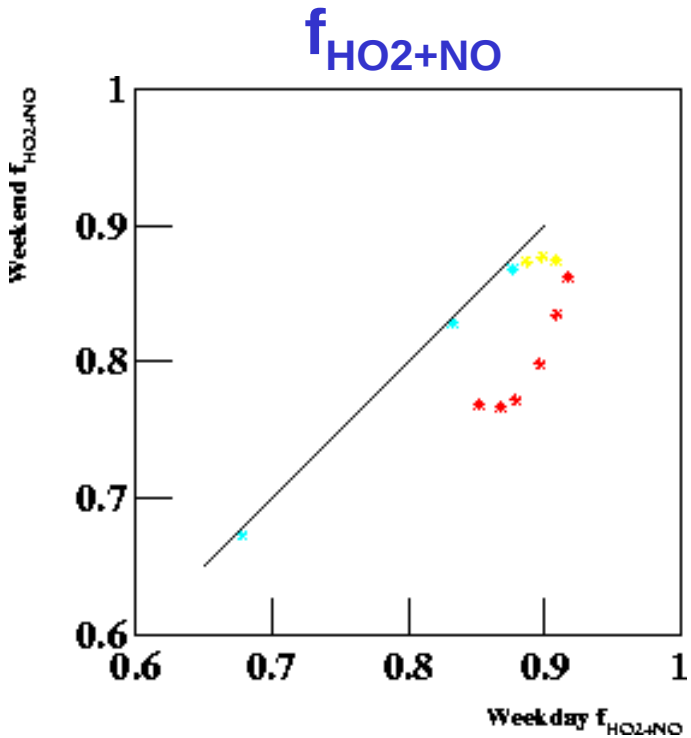
Blue: 6pm onward



General-purpose macro to color code by time of day:
exec utils#orbit2 (no2d-no2e)%(O3E-O3D)

OH Chain Length





Convolute f_{OH+VOC} with f_{HO2+NO} to get OH chain length

PAW: Pros & Cons

Pros:

- Interrogate data very quickly, change cuts, variables quickly
- Easy to learn, non-cryptic commands
- Recommend for Linux and Unix users. Windows version exists, but do not have personal experience
- Can use complicated and long expressions in commands

Cons:

- Data interrogation good for elements on same Ntuple line, (in our case same timestep) not good between different timesteps
- 3D graphics exist but no graphical cuts, not very fancy

Links:

- http://wwwasd.web.cern.ch/wwwasd/paw/
- or just Google my name and look for my employee web page

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