



Weather Statistics ... Plus ... The Raspberry Pi and its Bretheren

Nils Turner

13 March 2024 / CHARA Winter Meeting, Tucson



Weather

Let's talk about ...



Weather

Let's talk about ...

the rain.



Weather

- ▶ 2022-2023 was a record year:



Weather

- ▶ 2022-2023 was a record year: 93.49 inches!



Weather

- ▶ 2022-2023 was a record year: 93.49 inches!
- ▶ ... beating out 1968-1969's 81.23 inches



Weather

- ▶ 2022-2023 was a record year: 93.49 inches!
- ▶ ... beating out 1968-1969's 81.23 inches (80 of it came as snow)



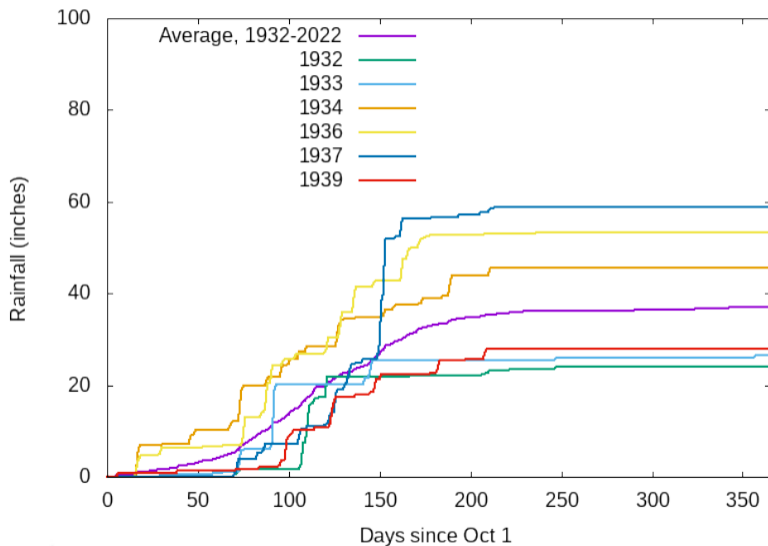
Weather

- ▶ 2022-2023 was a record year: 93.49 inches!
- ▶ ... beating out 1968-1969's 81.23 inches (80 of it came as snow)
- ▶ Rain year is Oct 1, <YEAR> to Sep 30, <YEAR+1>
- ▶ Totals were boosted by a rare tropical storm in August, usually one of the driest months.
- ▶ Mount Wilson Observatory kept rain records from 1904 to 1983. 14 of those years have been transcribed.



Rainfall

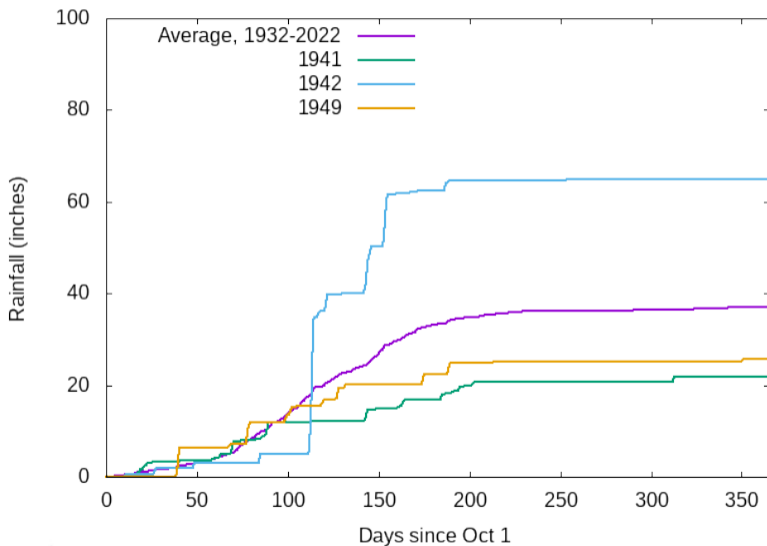
Cumulative Rainfall, Mount Wilson





Rainfall

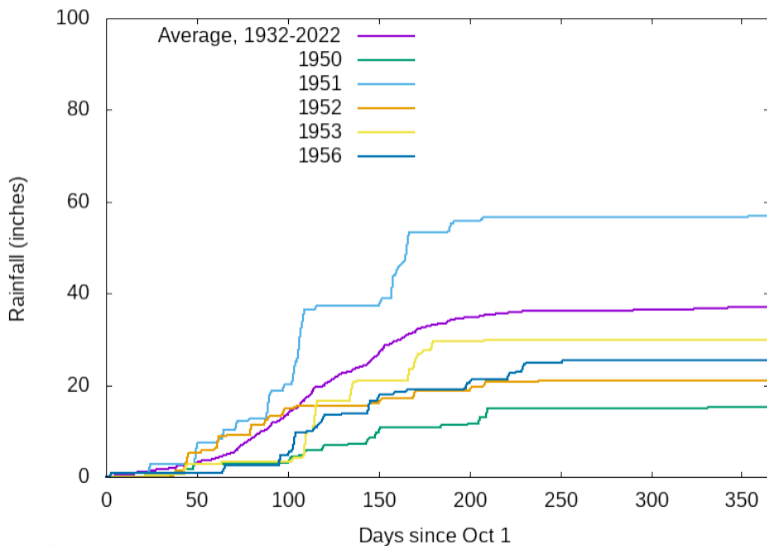
Cumulative Rainfall, Mount Wilson





Rainfall

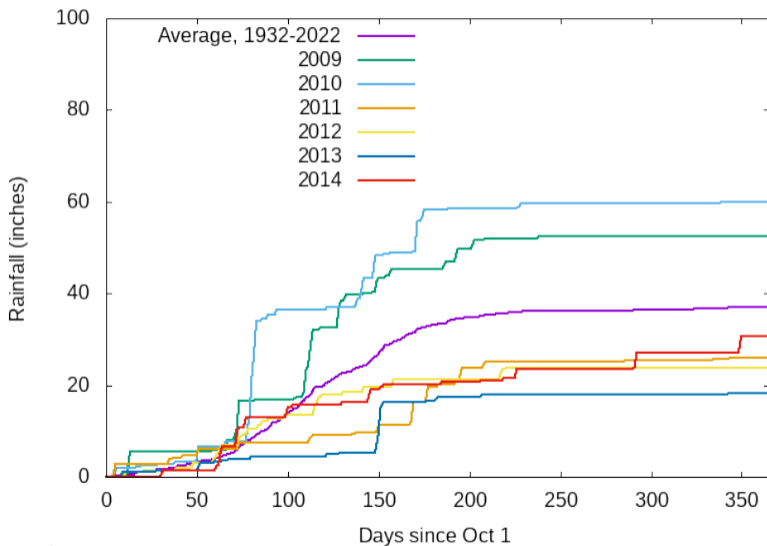
Cumulative Rainfall, Mount Wilson





Rainfall

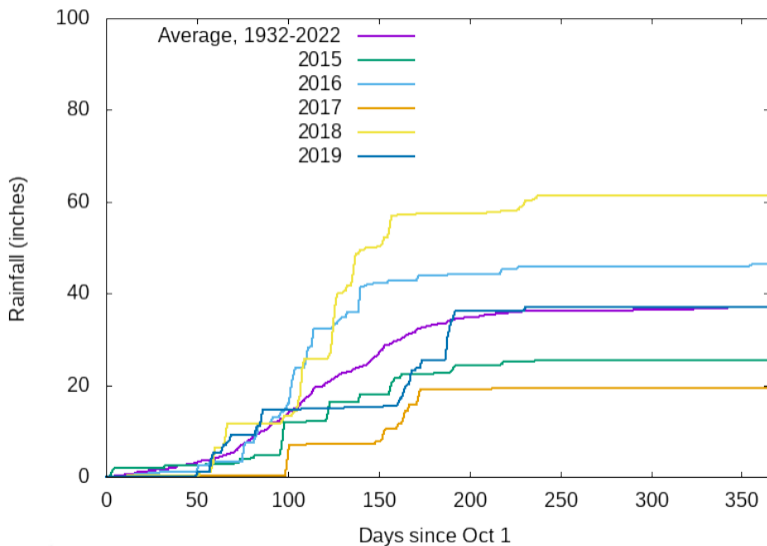
Cumulative Rainfall, Mount Wilson





Rainfall

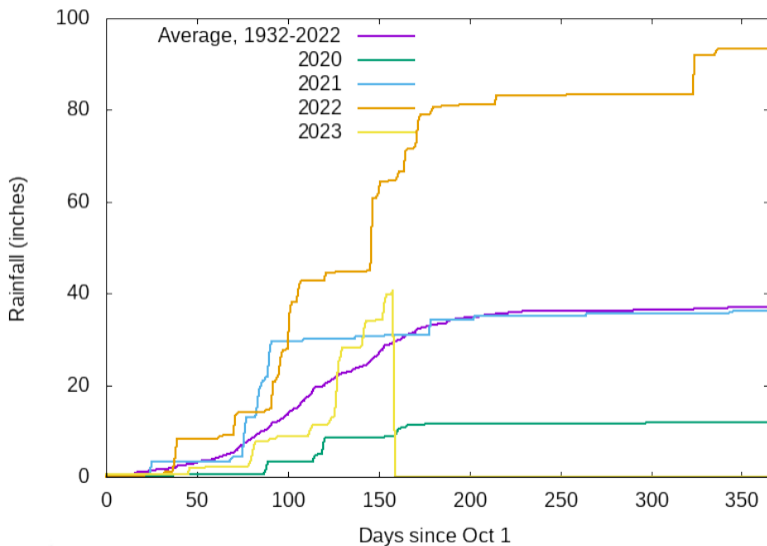
Cumulative Rainfall, Mount Wilson





Rainfall

Cumulative Rainfall, Mount Wilson





Raspberry Pi

- ▶ Based on ARM processors



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine)



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines)



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines – now just ARM)



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines – now just ARM)
- ▶ Uses a system-on-a-chip (SoC) design where the CPU, GPU, memory controller, video output, and network are all on a single chip.



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines – now just ARM)
- ▶ Uses a system-on-a-chip (SoC) design where the CPU, GPU, memory controller, video output, and network are all on a single chip.
- ▶ In addition, the SoC contains hardware video decoding.



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines – now just ARM)
- ▶ Uses a system-on-a-chip (SoC) design where the CPU, GPU, memory controller, video output, and network are all on a single chip.
- ▶ In addition, the SoC contains hardware video decoding.
- ▶ General Purpose I/O header



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines – now just ARM)
- ▶ Uses a system-on-a-chip (SoC) design where the CPU, GPU, memory controller, video output, and network are all on a single chip.
- ▶ In addition, the SoC contains hardware video decoding.
- ▶ General Purpose I/O header
- ▶ Currently at version 5



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines – now just ARM)
- ▶ Uses a system-on-a-chip (SoC) design where the CPU, GPU, memory controller, video output, and network are all on a single chip.
- ▶ In addition, the SoC contains hardware video decoding.
- ▶ General Purpose I/O header
- ▶ Currently at version 5
- ▶ Versions 3 and 4 are still useful



Raspberry Pi

- ▶ Based on ARM processors (initially Acorn RISC Machine – later Advanced RISC Machines – now just ARM)
- ▶ Uses a system-on-a-chip (SoC) design where the CPU, GPU, memory controller, video output, and network are all on a single chip.
- ▶ In addition, the SoC contains hardware video decoding.
- ▶ General Purpose I/O header
- ▶ Currently at version 5
- ▶ Versions 3 and 4 are still useful
- ▶ Pi Zero 2W is also popular
 - ▶ Same SoC as Pi 3
 - ▶ Wifi connectivity
 - ▶ Intended for embedded device projects
 - ▶ Inexpensive – \$15



Raspberry Pi Clones

- ▶ Genuine Pi's use Broadcom SoC's



Raspberry Pi Clones

- ▶ Genuine Pi's use Broadcom SoC's
- ▶ Other popular SoC's are made by Amlogic and Rockchip



Raspberry Pi Clones

- ▶ Genuine Pi's use Broadcom SoC's
- ▶ Other popular SoC's are made by Amlogic and Rockchip
- ▶ Libre Computer makes clones using both of these SoC's
 - ▶ Amlogic: AML-S905X-CC – \$35



Raspberry Pi Clones

- ▶ Genuine Pi's use Broadcom SoC's
- ▶ Other popular SoC's are made by Amlogic and Rockchip
- ▶ Libre Computer makes clones using both of these SoC's
 - ▶ Amlogic: AML-S905X-CC – \$35
 - ▶ Rockchip: ROC-RK3328-CC – \$45



Raspberry Pi Clones

- ▶ Genuine Pi's use Broadcom SoC's
- ▶ Other popular SoC's are made by Amlogic and Rockchip
- ▶ Libre Computer makes clones using both of these SoC's
 - ▶ Amlogic: AML-S905X-CC – \$35
 - ▶ Rockchip: ROC-RK3328-CC – \$45
- ▶ Dozens of other single-board computer manufacturers; they tend to be more expensive.

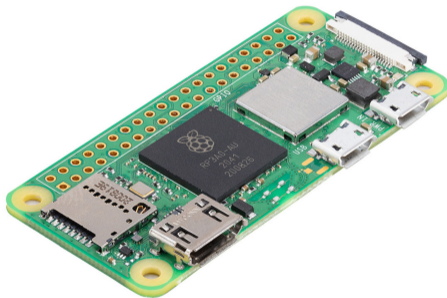


Pi/Clones Pricing

	SoC	Price	Retail
Pi Zero 2W	Broadcom	\$15	www.pishop.us
Pi 3	Broadcom	\$35	www.pishop.us
Pi 4	Broadcom	\$45	www.pishop.us
Pi 5	Broadcom	\$60	www.pishop.us
AML-S905X-CC	Amlogic	\$35	www.amazon.com
ROC-RK3328-CC	Rockchip	\$45	www.amazon.com



Raspberry Pi Zero 2W





Raspberry Pi 3



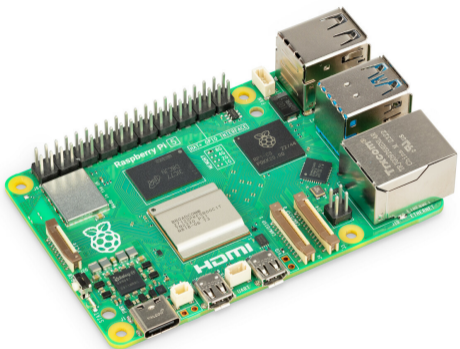


Raspberry Pi 4



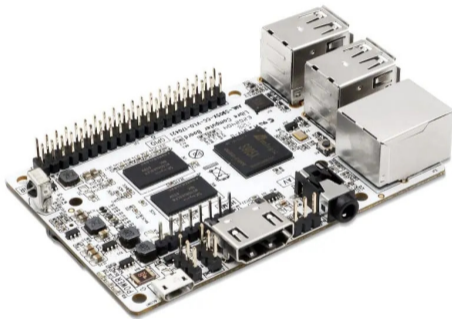


Raspberry Pi 5





Libre Computer AML-S905X-CC





Libre Computer ROC-RK3328-CC





Installing Ubuntu

- ▶ The Pi is fully supported by **Canonical**, the Ubuntu parent organization, since Ubuntu 18
- ▶ Detailed directions can be found in the CHARA git tree module `chara-documentation`,
`howto/Installing_Ubuntu_Raspberry_Pi_4.txt`
- ▶ For a copy of the directions, email me at: `nils@gsu.edu`



Installing Ubuntu

- ▶ In summary (using a Linux machine):
 - ▶ Download the “preinstalled server” image of the desired version
 - ▶ Get a MicroSD card
 - ▶ Use the `dd` command to copy the image to the MicroSD card
 - ▶ Put the MicroSD card into the Pi and start it up
 - ▶ Set an NTP server address
 - ▶ Reboot
 - ▶ Update packages
 - ▶ Set up the network
 - ▶ (Optionally) Install a window manager



Programming the I/O Header

- ▶ The Pi includes a programmable I/O header
- ▶ Basic programming involves a Python3 library
- ▶ The library is installed with the following command:

```
apt install python3-igpio
```
- ▶ The Python3 library uses the `/sys` bus, so one could conceivably write code to address the `/sys` bus directly
- ▶ The header contains:
 - ▶ 3.3V, 5V, and ground pins
 - ▶ 26 general purpose I/O pins (GPIO) which can be configured to be TTL inputs or outputs, pulse-width modulation outputs, or serial peripheral interfaces
 - ▶ 2 of the 26 GPIO pins can be programmed to control an I²C bus
 - ▶ 2 pins are dedicated to an RS-232 serial interface

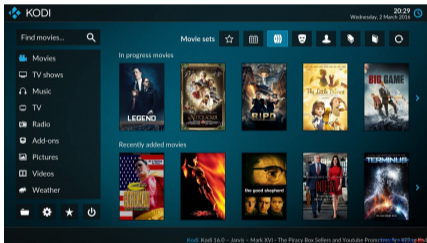


Using the Pi in a Scientific Context

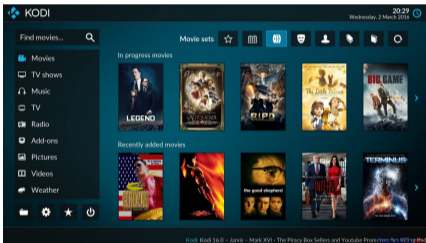
- ▶ Many hardware manufacturers now include linkable libraries for the ARM architecture to control the devices they sell
- ▶ This includes ZW Optical and IDS Imaging, both of whom make CMOS cameras that we use in the CHARA Array
- ▶ Also at the CHARA Array, we use the GPIO header to control our AO beacon



Fun Stuff with the Pi: Kodi Media Player



Fun Stuff with the Pi: Kodi Media Player





Fun Stuff with the Pi: Audiophile-grade Streamer





Fun Stuff with the Pi: Composite Video Player

