A Ten Year Climatology of Rainfall Over Portland, Maine.

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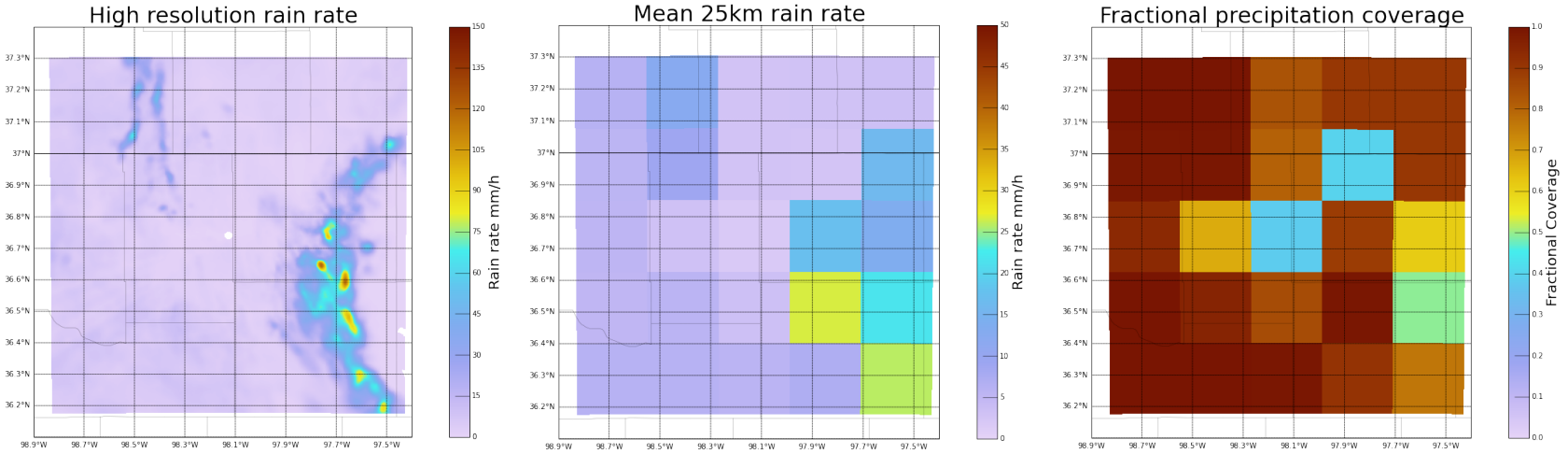
Argonne National Laboratory's work was supported by the U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research (OBER), under Contract DE-AC02-06CH11357.The work is supported by the Department of Homeland Security as part of the Regional Resiliency Assessment Program. We gratefully acknowledge the computing resources provided on Blues, a high-performance computing cluster operated by the Laboratory Computing Resource Center at Argonne National Laboratory.

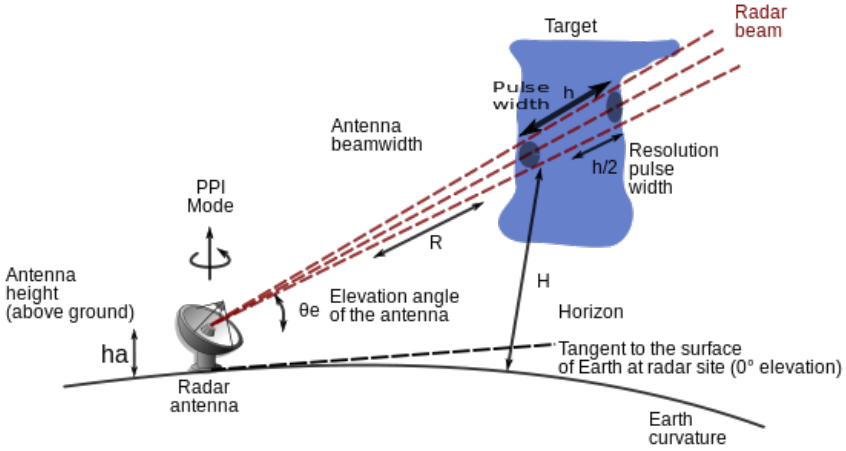
Motivation: Scales of precipitation.

- Decision makers need data on how the return time in high end precipitation events will vary in a changing climate.
- The traditional tool is to ”downscale” course grid climate models using a variety of techniques.
- Typical resolutions are 12-25km.
- The question we ask is: ***Is this fine scale enough to capture high intensity rainfall accumulations.***



Initial charge: Produce high resolution rainfall maps over Portland, Maine.

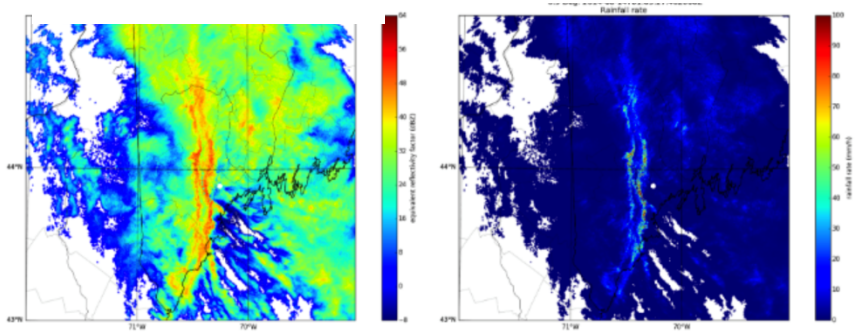
- One month project to produce high resolution maps of rainfall rate over the Portland, Maine, area.
- Mapping data in radial coordinates of azimuth, elevation and range to a user friendly Cartesian grid.
- NetCDF files that are CF-Complaint which will be used by hydrologists to see the impact of reducing the resolution on final streamflow.
- Basic QC and indexing of events.



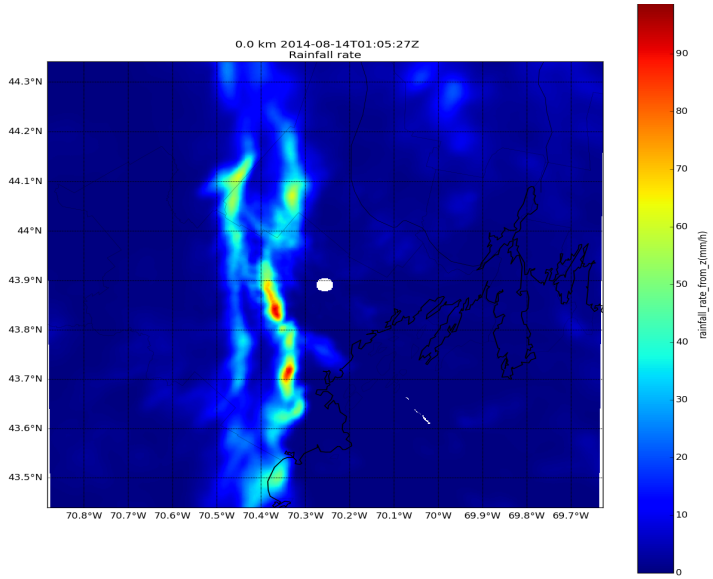
Methodology

- Radars measure a quantity known as reflectivity factor. This is simply how reflective a bunch of “Stuff” is (be it raindrops, ice particles, birds, bats or even TV towers).
- For a given volume of “stuff” the reflectivity factor is the 6th moment of the PDF of drops in that volume.. So a couple of big drops can have a greater impact than many small drops.
- However, for a given distribution of drops common in nature a simple relation between reflectivity and rainfall rate has been determined.
- We apply this, and then use a Barnes filter (inverse distance weighted) to map to a X/Y grid.

$$Z_e = \int N(D) D^6 dD \qquad Z_e = 300R^{1.4}$$

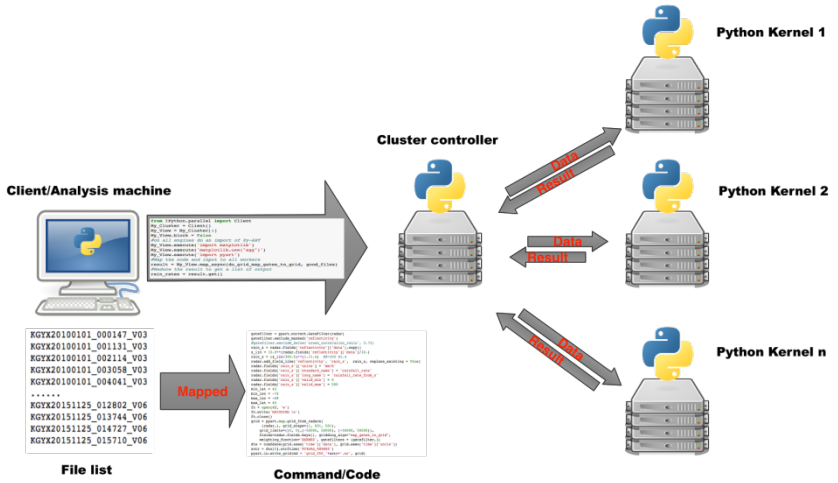


(a) Radar Reflectivity. (b) Rainfall rate.



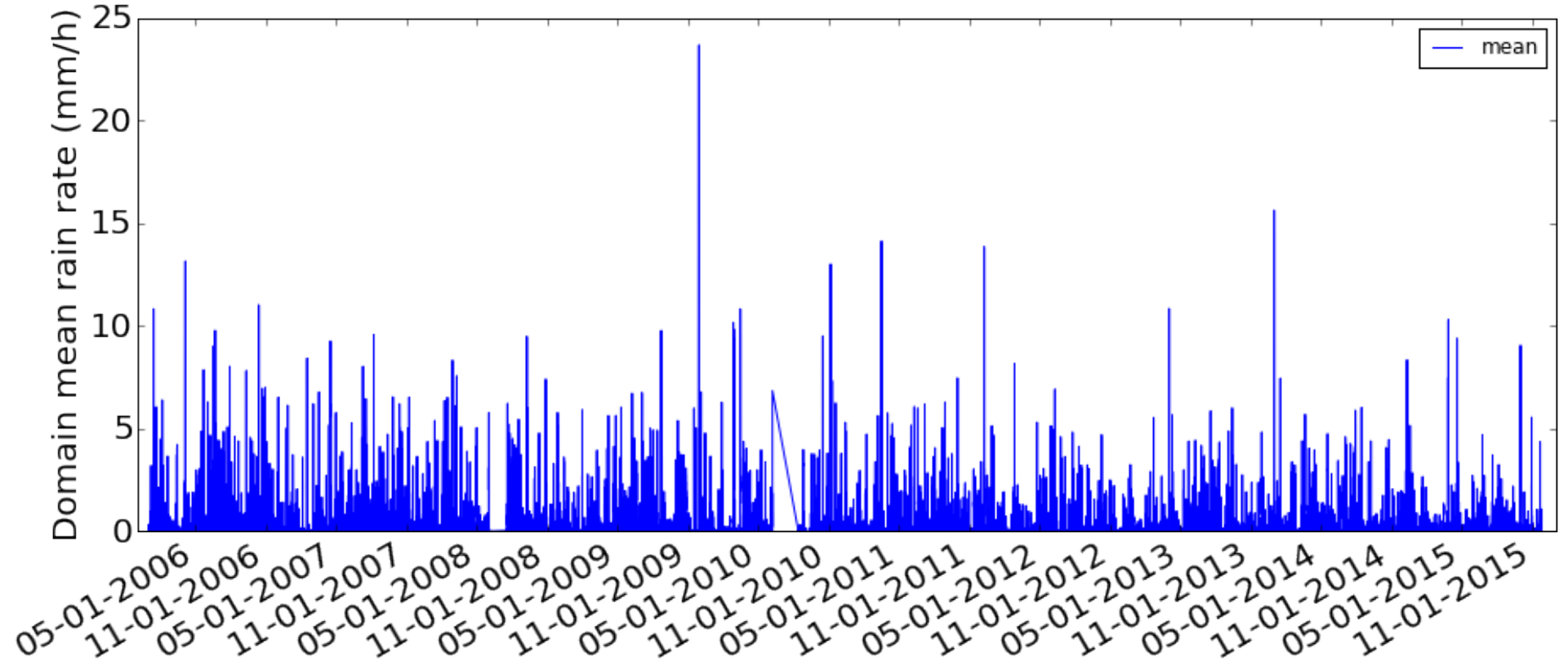
Computational Setup

- Files were downloaded from NCEI's HAS service and staged on Argonne's midrange cluster, Blues.
- 670,353 individual radar files. Each covering 5-10 minutes in time.
- The Python-ARM Radar Toolkit was used to perform IO and calculations.
- We used Ipython Cluster which is part of project Jupyter to map the problem to 100's to 1000's of cores on the cluster.
- We used 8,000 core hours and just over 48 hours of wall time for the analysis.



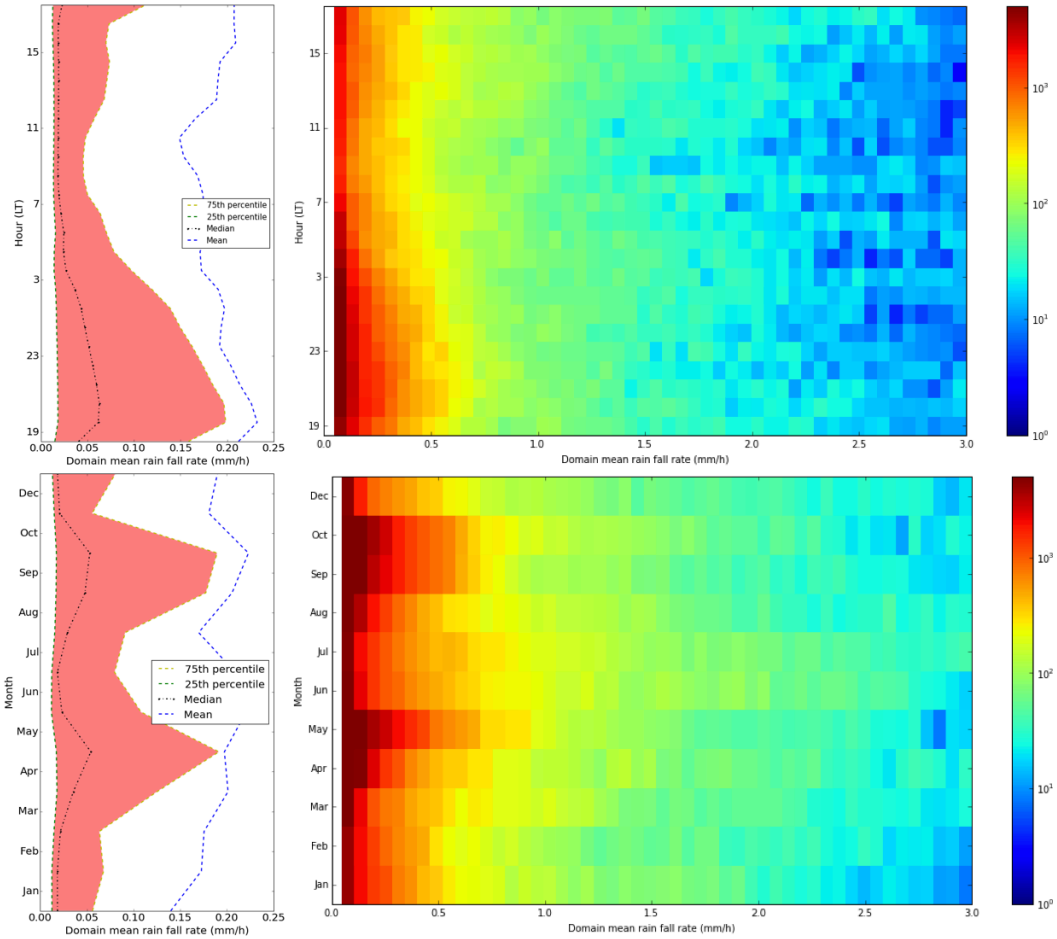
Results

- As we computed the rainfall grid we saved the domain mean and maximum rainfall rate.
- 10TB of radar data -> 1TB of rainfall grids -> 100MB of searchable domain means.
- Phenomenal uptime. Many season. Just a small gap in 2010.



Results (2)

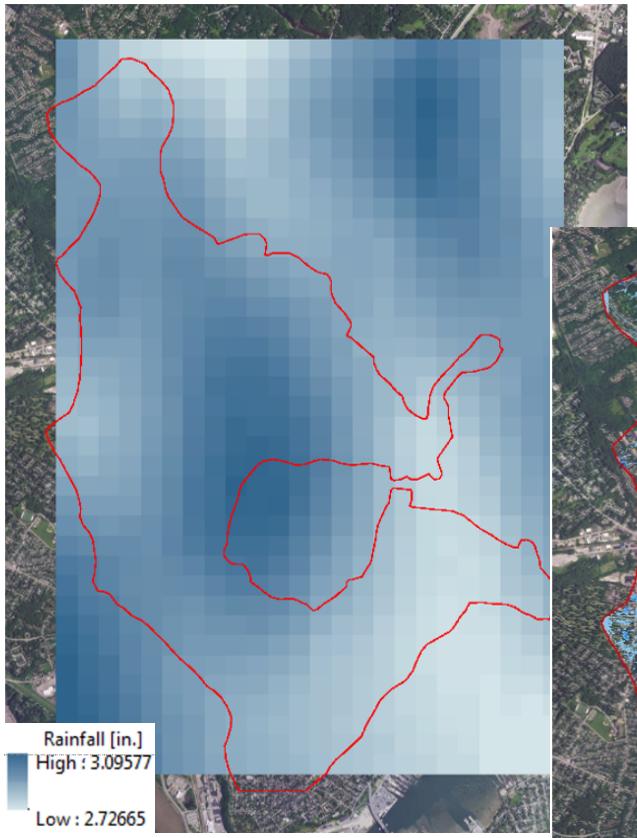
- Since we have all this data we decided to perform some simple stratifying of the data.
- We binned the data by month of the year and hour of the day and looked at the histogram of domain mean rainfall rate.
- Histograms and percentile plots show a peak in rainfall overnight (consistent with many TRMM based studies).
- In addition and spring and fall peak in the frequency of lower rates, however the peak in extremes in rainfall rate occurs over summer.



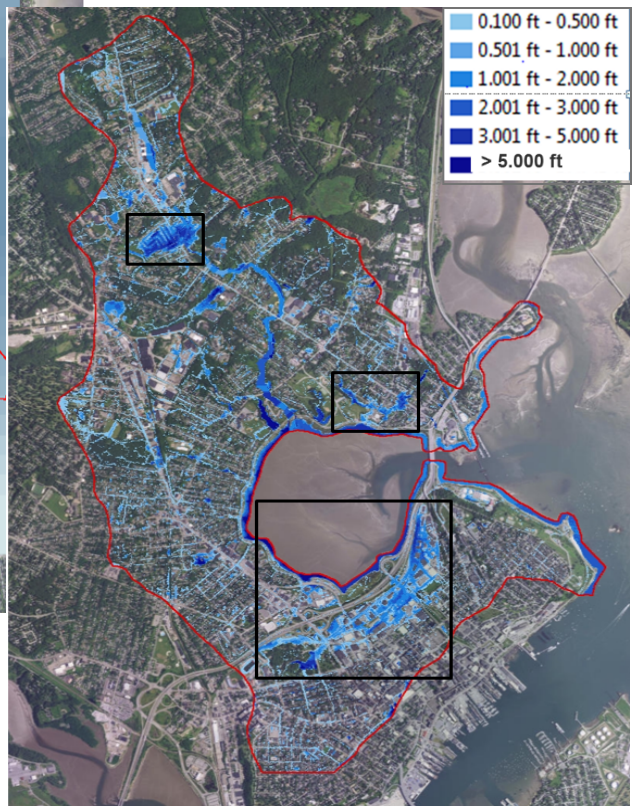
Radar Data For High-Resolution Hydrologic Modeling

- Back Cove in Portland, ME was heavily damaged during the 2007 April storm event
- Radar-derived rainfall data with a 250-m resolution rainfall distribution vs. only on rain gage in the entire area
- 2-D Hydrologic/hydraulic modeling (15 ft x 15 ft) including building, street, and all other structures

Peak Rainfall Distribution

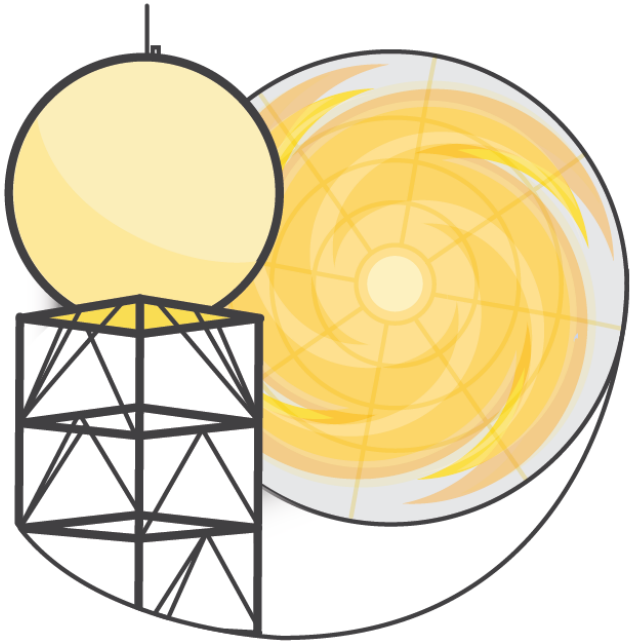


Peak Flooding Depth



The Future

- The task for our group was to deliver grids of rainfall events to the Hydrological modelling team and then work with them to couple to the model.
- The first task is done, the second is ongoing.
- Grids only have basic QC and ignore the latest advances in rainfall retrieval and could contain artifacts (eg we have not filtered for snow events). But act as a starting point. QC is **VITAL** if we want to study trends.
- Using mean rainfall rate is crude. So many other interesting ways we could dissect the data.
- We will make the data available, still working out the best way (AWS S3 bucket).
- Keen to collaborate and continue this work. Need to look into funding.



NEXRAD now in the Amazon Cloud