Puerto Rico's Agroclimatology

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USDA Hatch

http://pragwater.com

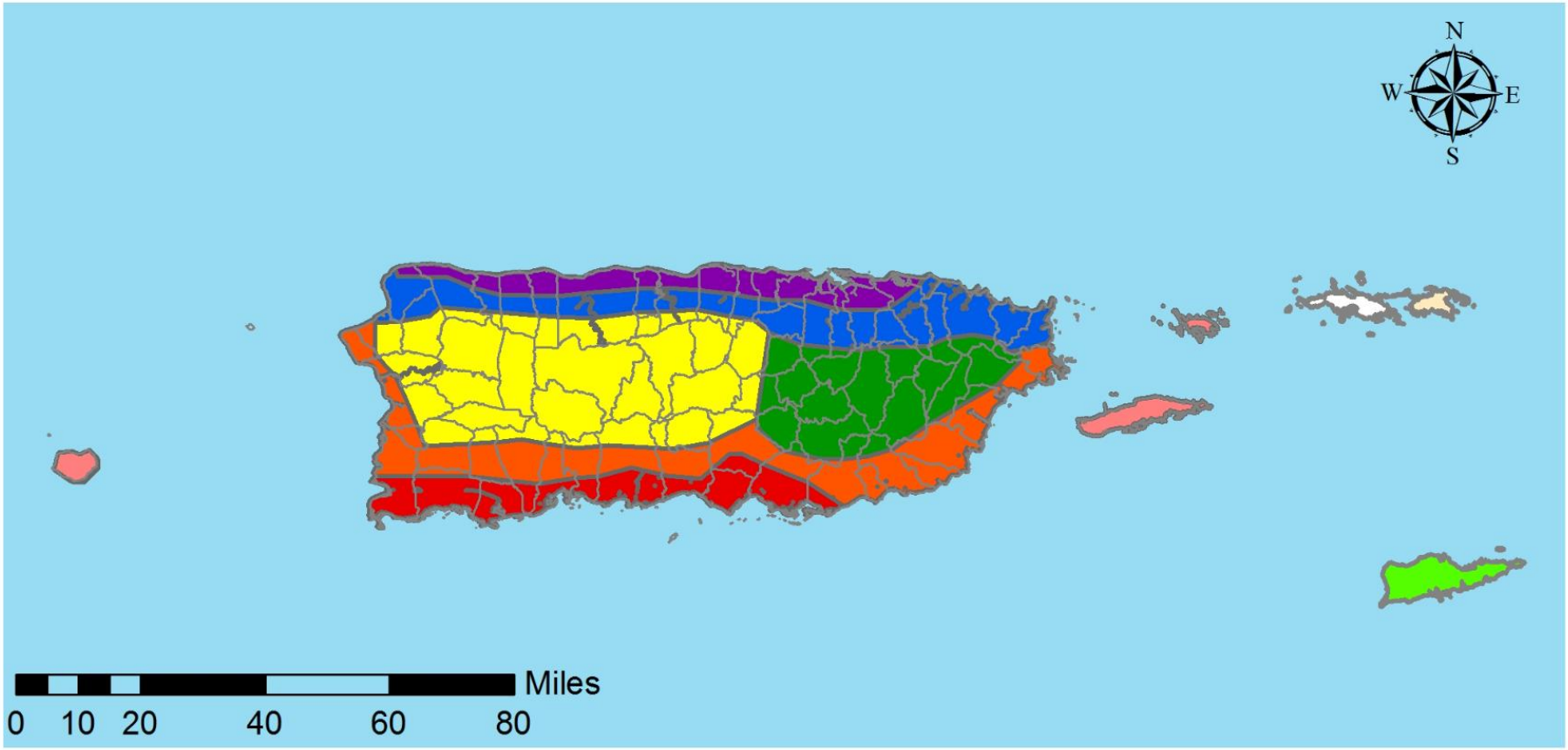
OBJECTIVE

- Provide an overview of climate conditions in Puerto Rico
- Observations from the 2015 drought; and
- Discuss results from a recent climate change study for Puerto Rico and some potential climate change impacts on agriculture.

Climate Overview

- Puerto Rico experiences a wide variation in climatic conditions, ranging from tropical cloud forest in the northeast to semi-arid dry forest in the southwest. The average annual rainfall in these two regions may vary by as much as 4,200 mm (165 inches).
- Several processes including fronts, tropical waves, hurricanes, convection from hot land surfaces, orographic and sea breezes effects produce rainfall in the island.
- Convective storms can produce highly localized, intense rainfalls, resulting in severe surface runoff and soil erosion.
- Relatively cool temperatures occur in the mountains, while the highest temperatures generally occur along southern coasts.
- Wind speed averages around 2 m/s at a height of 2 meters above the land surface.

Puerto Rico and U.S. Virgin Islands Climate Divisions



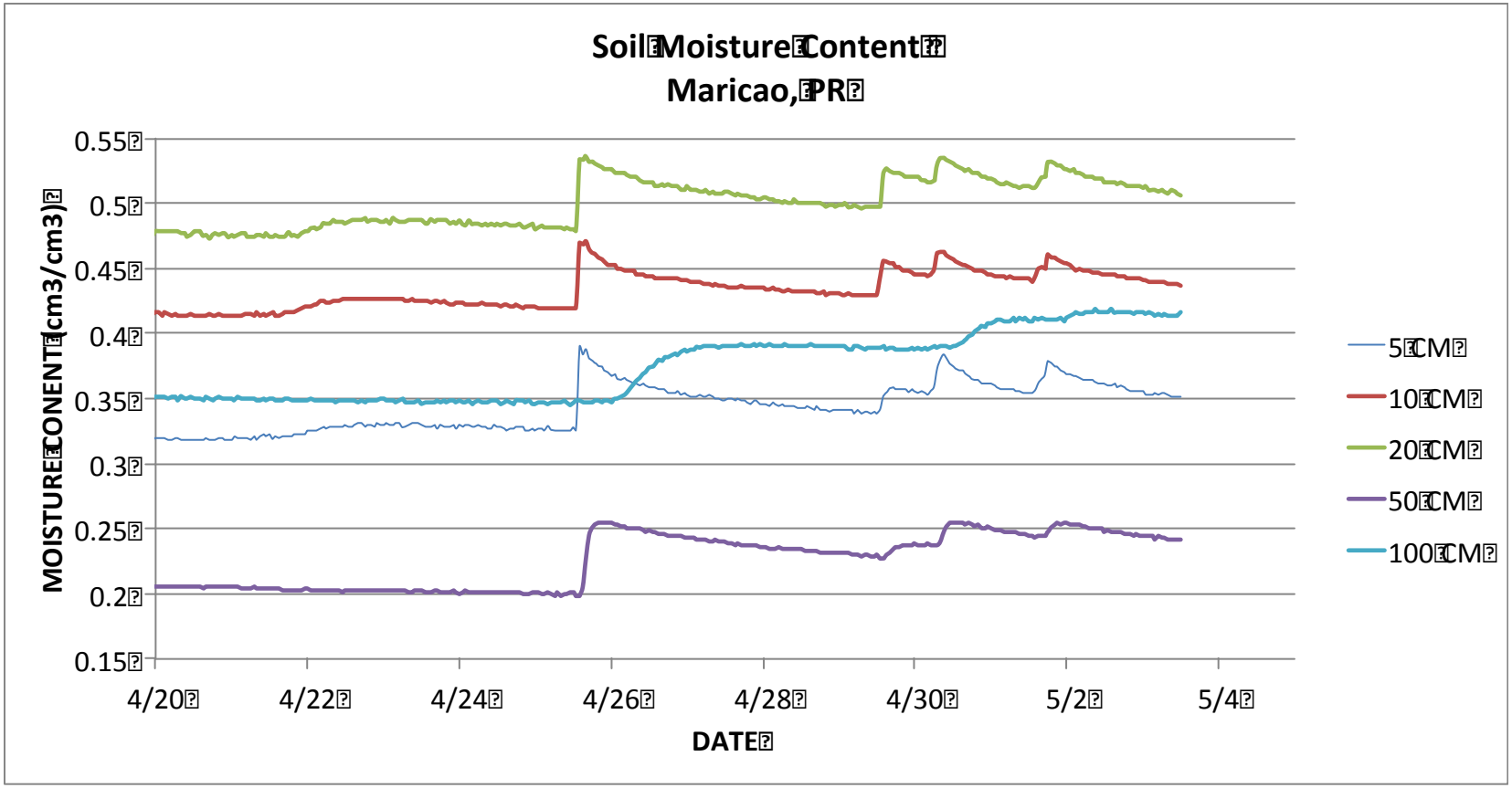
Climate Divisions and Codes

- NORTH COASTAL - 6601
- SOUTH COASTAL - 6602
- NORTHERN SLOPES - 6603
- SOUTHERN SLOPES - 6604
- EASTERN INTERIOR - 6605
- WESTERN INTERIOR - 6606
- OUTLYING ISLANDS - 6607
- SAINT THOMAS - 6701
- SAINT CROIX - 6702
- SAINT JOHN - 6703

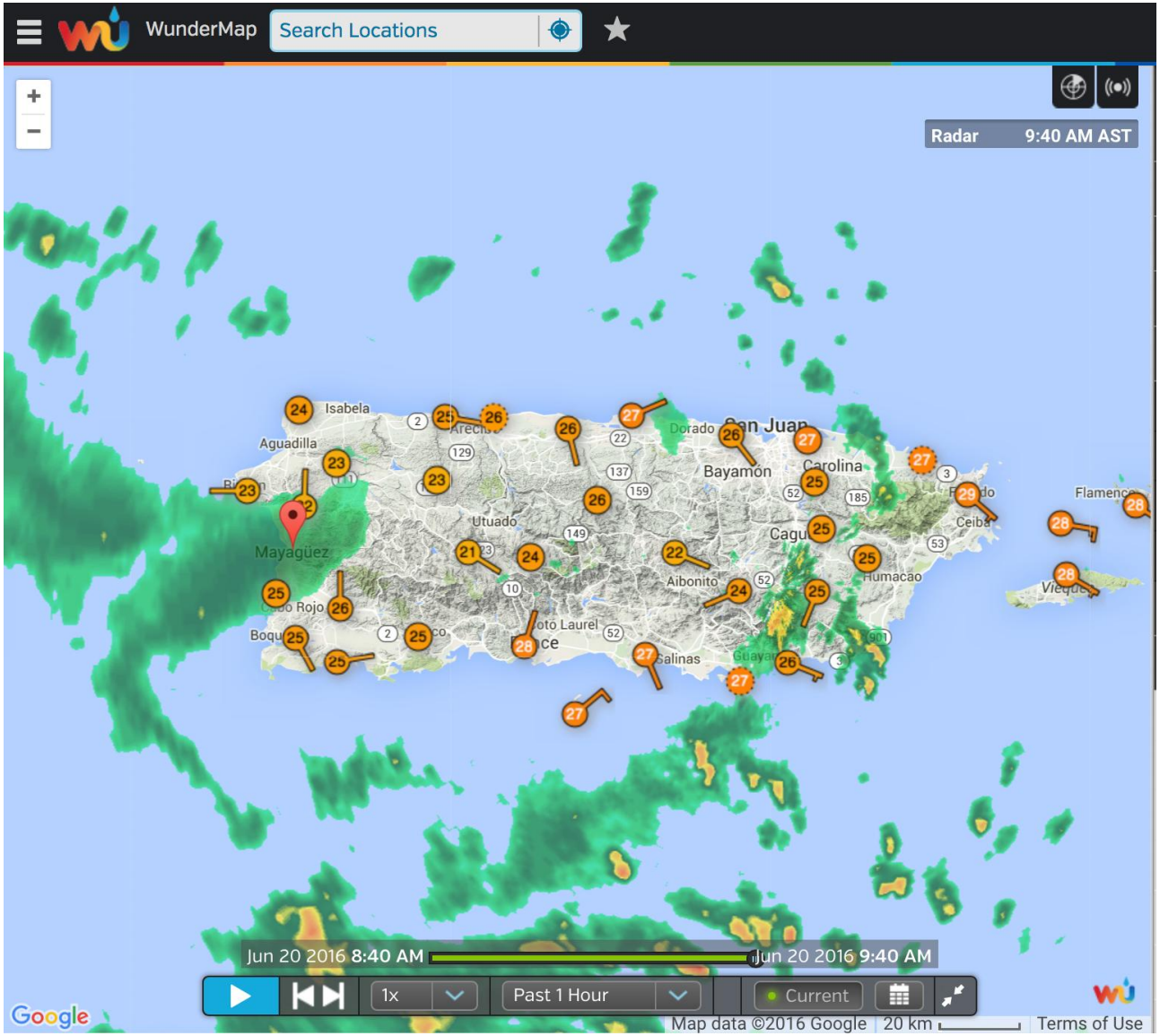
1. Sources of weather station
   a. NRCS sites
   b. Weather underground
   c. USGS
   d. NWS Radar
   e. CASA-UPRM Radar
   f. NOAA and NASA Satellites

NRCS Soil Climate Analysis Network

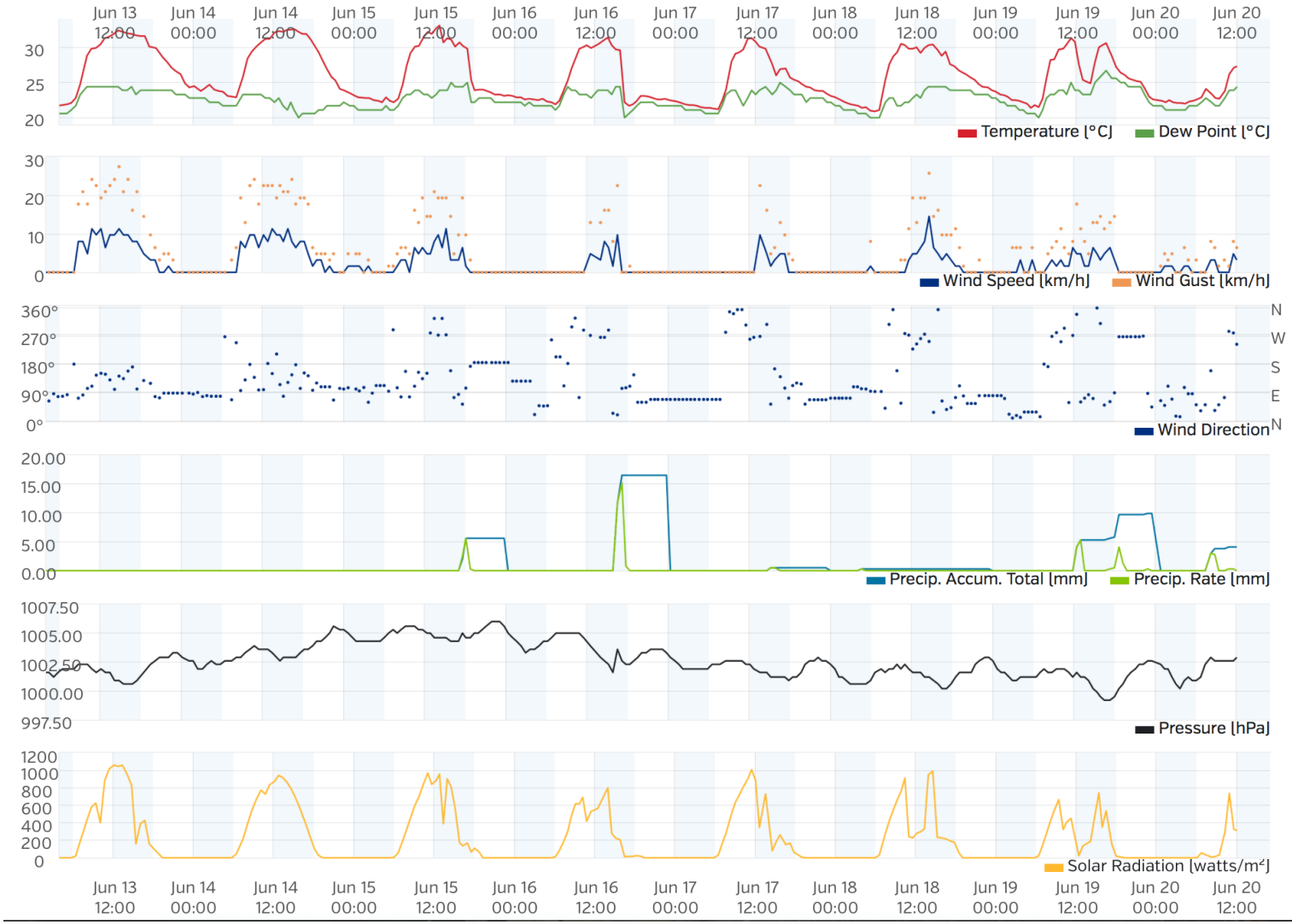
NRCS SCAN Soil Moisture

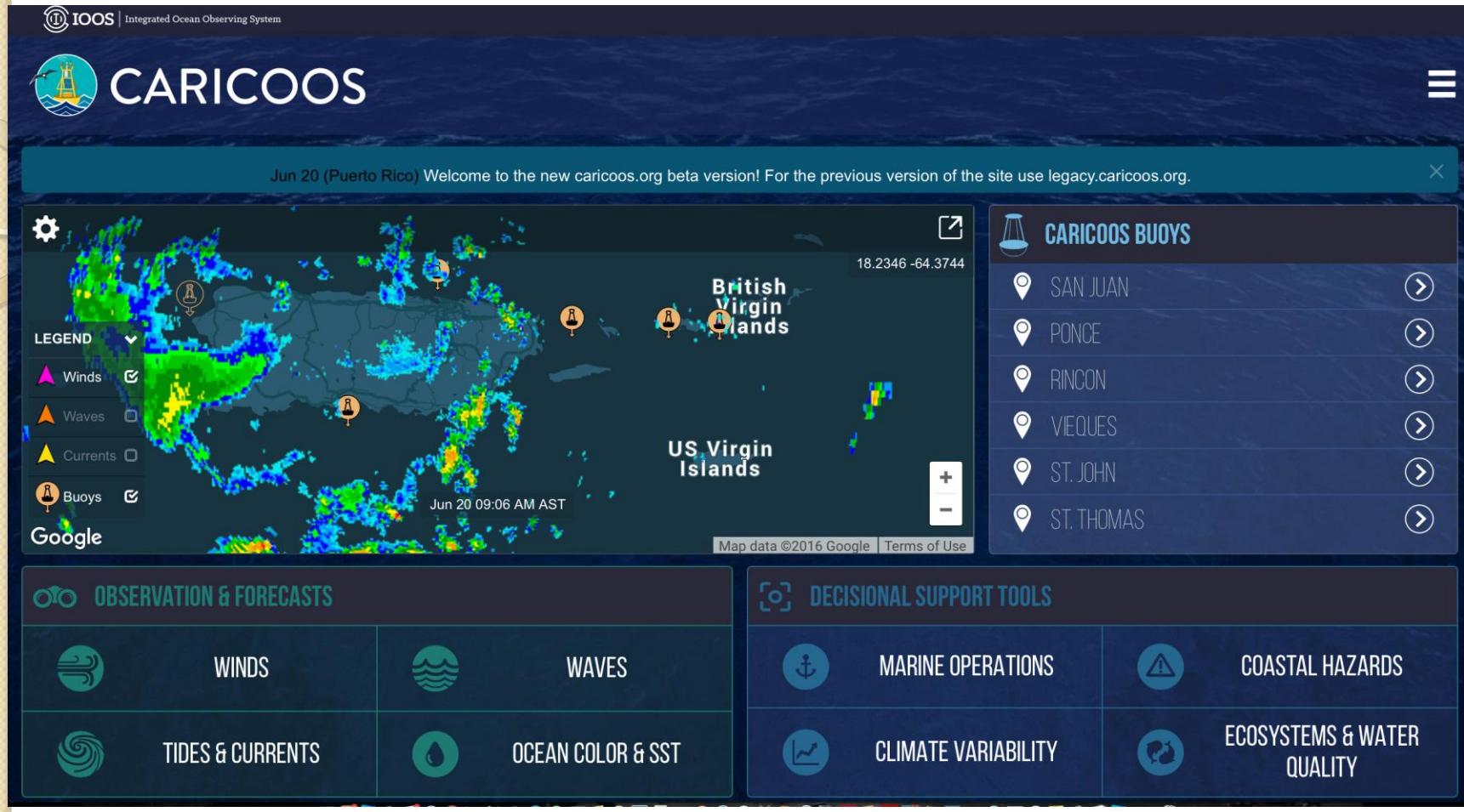


Weather Underground



Finca Alzamora – UPRM Campus





CARICOOS runs an operational WRF model every day.

Jobos Bay Visitor's Center

National Oceanic and Atmospheric Administration's

National Data Buoy Center

Center of Excellence in Marine Technology

Home | News | Organization

Station ID Search
Go
Station List

Observations
- Mobile Access
- Interactive Map
- Classic Maps
  - Recent
  - Historical
  - DART®
  - Oil & Gas
- ADCP
- Obs Search
- Ship Obs Report
- Gliders
- BuoyCAMs
- TAO
- DODS
- OceanSITES
- HF Radar
- OSMC
- Dial-A-Buoy
- RSS Feeds
- Obs Web Widget
- Email Access
- Web Data Guide

Station Status
- NDBC Maintenance
- NDBC Platforms
- Partner Platforms

Program Info

Storm Special! View the latest observations near Atlantic TROPICAL STORM DANIELLE as of ADVISORY NUMBER 4 @ 1000 AM CDT MON JUN 20 2016.

Station JOXP4 - Jobos Bay Reserve, Puerto Rico

Owned and maintained by National Estuarine Research Reserve System
NERRS Weather Station
17.956 N 66.223 W (17°57'23" N 66°13'23" W)

Site elevation: 9 m above mean sea level
Air temp height: 2.7 m above site elevation
Anemometer height: 9.75 m above site elevation
Barometer elevation: 11.7 m above mean sea level

Water Quality data for this Reserve are available at....
JOQP4 -- Station 20
JOBP4 -- Station 9

Search And Rescue (SAR) Data

Meteorological Observations from Nearby Stations and Ships

Oceans

Large icon indicates selected station. Disclaimer
◇ Stations with recent data
◆ Stations with no data in last 8 hours (24 hours for tsunami stations)

Iowa Environmental Mesonet

IEM | Archive | Climate | Current | Info | GIS | Networks | Roads | Svr Wx | Webcams

Enter Product ID Ma...

PIL:
(Example) AFDDMX

Center:
(Optional)

Entries:
1

Start Date:
11/26/2000

End Date:
06/21/2016

Add

Select by WFO & Pr...

Help | AFDSJU-

Refresh | Print Text

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889
FXCA62 TJSJ 200928
AFDSJU

Area Forecast Discussion
National Weather Service San Juan PR
528 AM AST MON JUN 20 2016

.SYNOPSIS...A tropical wave will continue to move across the area
through this afternoon. A drier airmass behind the wave will
encompass the local region late tonight into Tuesday.

&&

.DISCUSSION...Scattered to numerous showers were seen across the
Caribbean coastal waters overnight. This activity was associated
with a Tropical Wave...which is moving across the local area.
Better moisture of the wave will remain south of the local islands
the rest of the day. However...abundant moisture will combine with
daytime heating and local effect to produce showers and
thunderstorms this afternoon mainly over western interior Puerto
Rico.
```

USGS Rain Gauge Data

Current Conditions for Puerto Rico: Precipitation -- 47 site(s) found

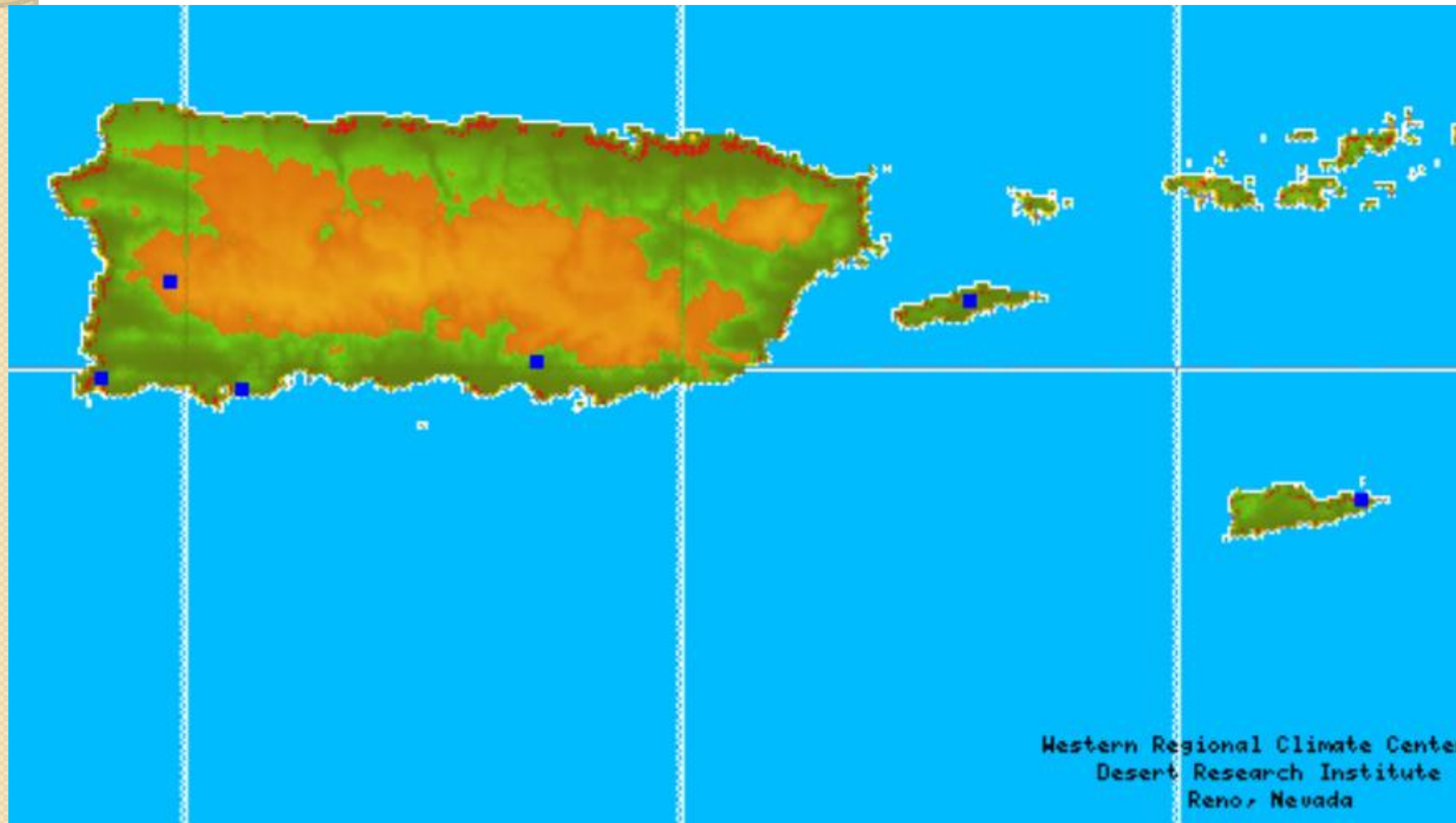
PROVISIONAL DATA SUBJECT TO REVISION

--- Predefined displays --- Puerto Rico Precipitation Table | Group table by Major River Basin | Select sites by number or name | go | show sites on a map

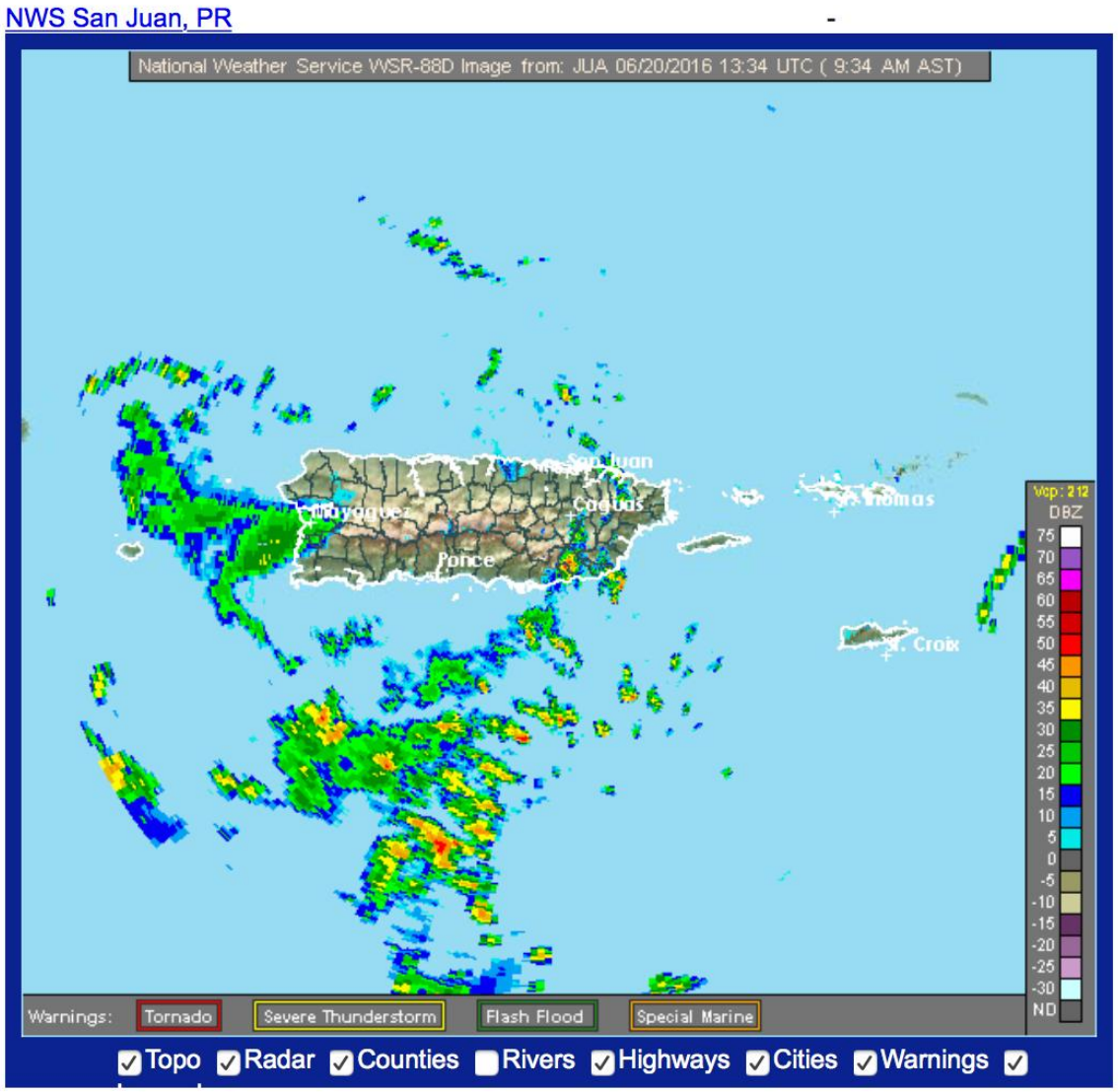
Customize table to display other current-condition parame

Station Number	Station name	Date/Time	1 hour	Preci dur 6 hours
Rio Guajataca Basin, PR				
50010500	RIO GUAJATACA AT LARES, PR	06/20 09:19 AST	0	0
50011088	LAGO REGULADOR DE ISABELA NR HWY 112 ISABELA, PR	06/20 08:45 AST	0.01	0.0
Rio Grande de Arecibo Basin, PR				
50020550	LAGO ADJUNTAS NR ADJUNTAS, PR	06/20 08:45 AST	0	0
50023110	LAGO VIVI NR UTUADO, PR	06/20 08:45 AST	0	0
50028000	RIO TANAMA NR UTUADO, PR	06/20 09:30 AST	0	0.0
50029000	RIO GRANDE DE ARECIBO AT CENTRAL CAMBALACHE, PR	06/20 08:45 AST	0	0
Rio Grande de Manati Basin, PR				
50032290	LAGO EL GUINEO AT DAMSITE NR VILLALBA, PR	06/20 08:45 AST	0.01	0.14
50032590	LAGO DE MATRULLAS AT DAMSITE NR OROCOVIS, PR	06/20 08:45 AST	0	0
Rio de La Plata Basin, PR				
181026066100300	BO. RABANAL RAINGAGE AT CIDRA, PR	06/20 09:30 AST	0	0.0
181708066152400	BO. ANONES RAINGAGE NEAR NARANJITO, PR	06/20 08:45 AST	0	0
50039995	LAGO CARITE AT SPILLWAY, PR	06/20 09:15 AST	0.01	0.0
50043000	RIO DE LA PLATA AT PROYECTO LA PLATA, PR	06/20 09:15 AST	0.02	0.0
50043800	RIO DE LA PLATA AT COMERIO, PR	06/20 09:30 AST	0	0.0
Rio de Bayamon Basin, PR				
50047550	LAGO DE CIDRA AT DAMSITE NR CIDRA, PR	06/20 08:45 AST	0.01	0.0
Rio Puerto Nuevo Basin, PR				
182350066063700	RAINGAGE NEAR ALTAMIRA, GUAYNABO, PR	06/20 09:00 AST	0.01	0.0
50049620	QDA. MARGARITA AT CAPARRA INTER. NR GUAYNABO, PR	06/20 08:45 AST	0.05	0.0
Rio Grande de Loiza Basin, PR				
181529065575200	GURABO RAINGAGE AT GURABO, PR	06/20 08:45 AST	0.04	0.

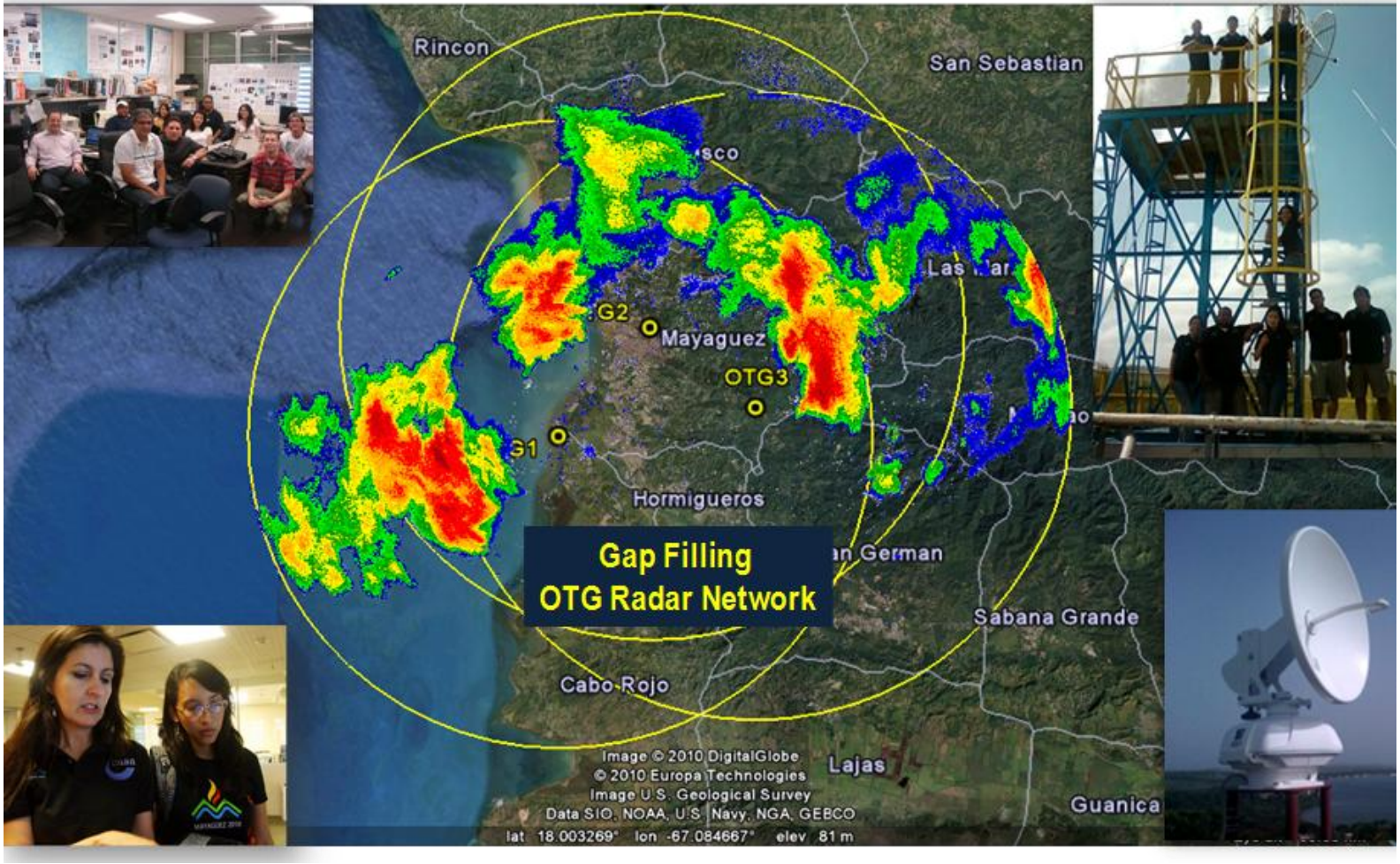
Western Regional Climate Center



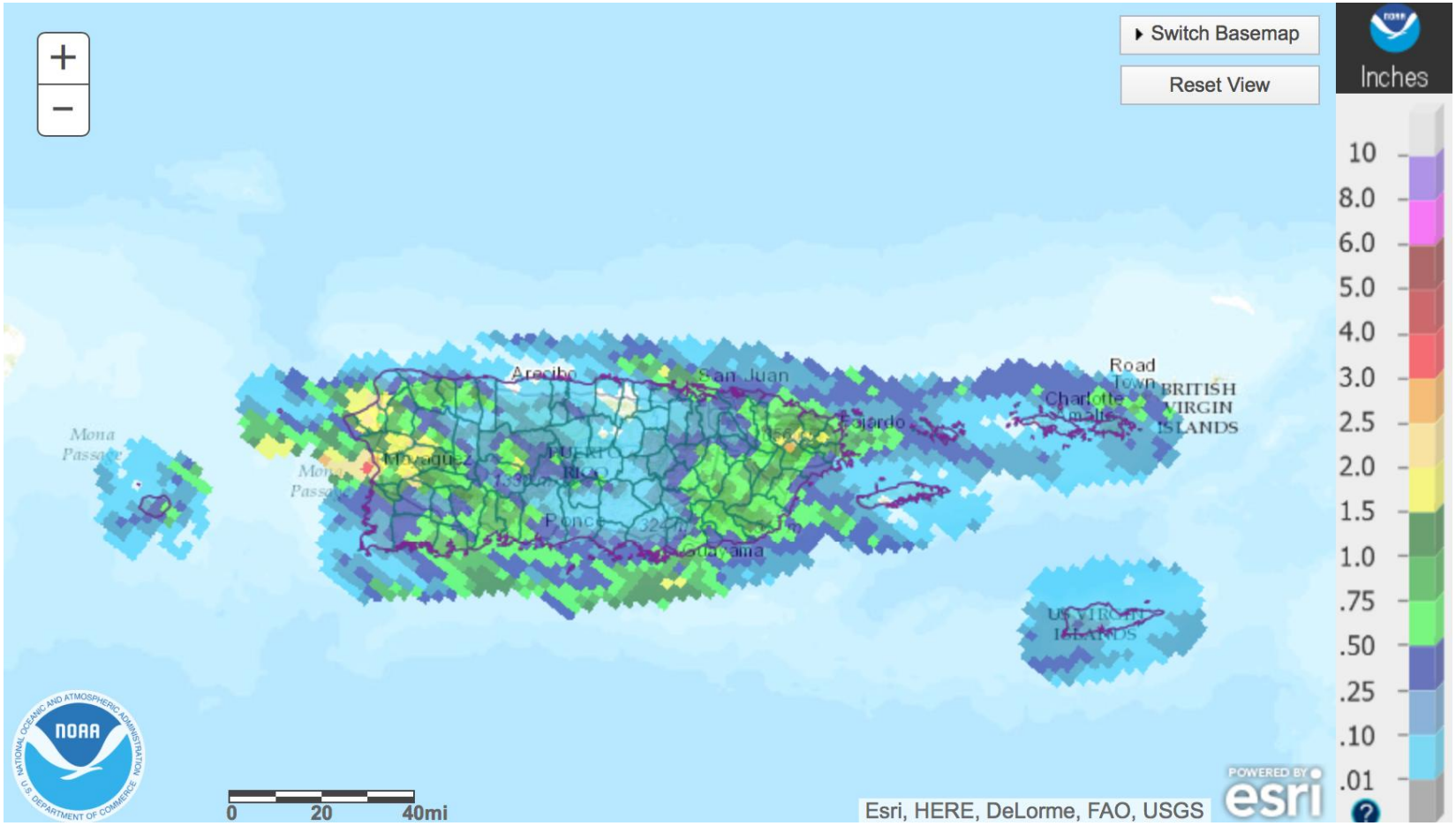
NEXRAD Radar



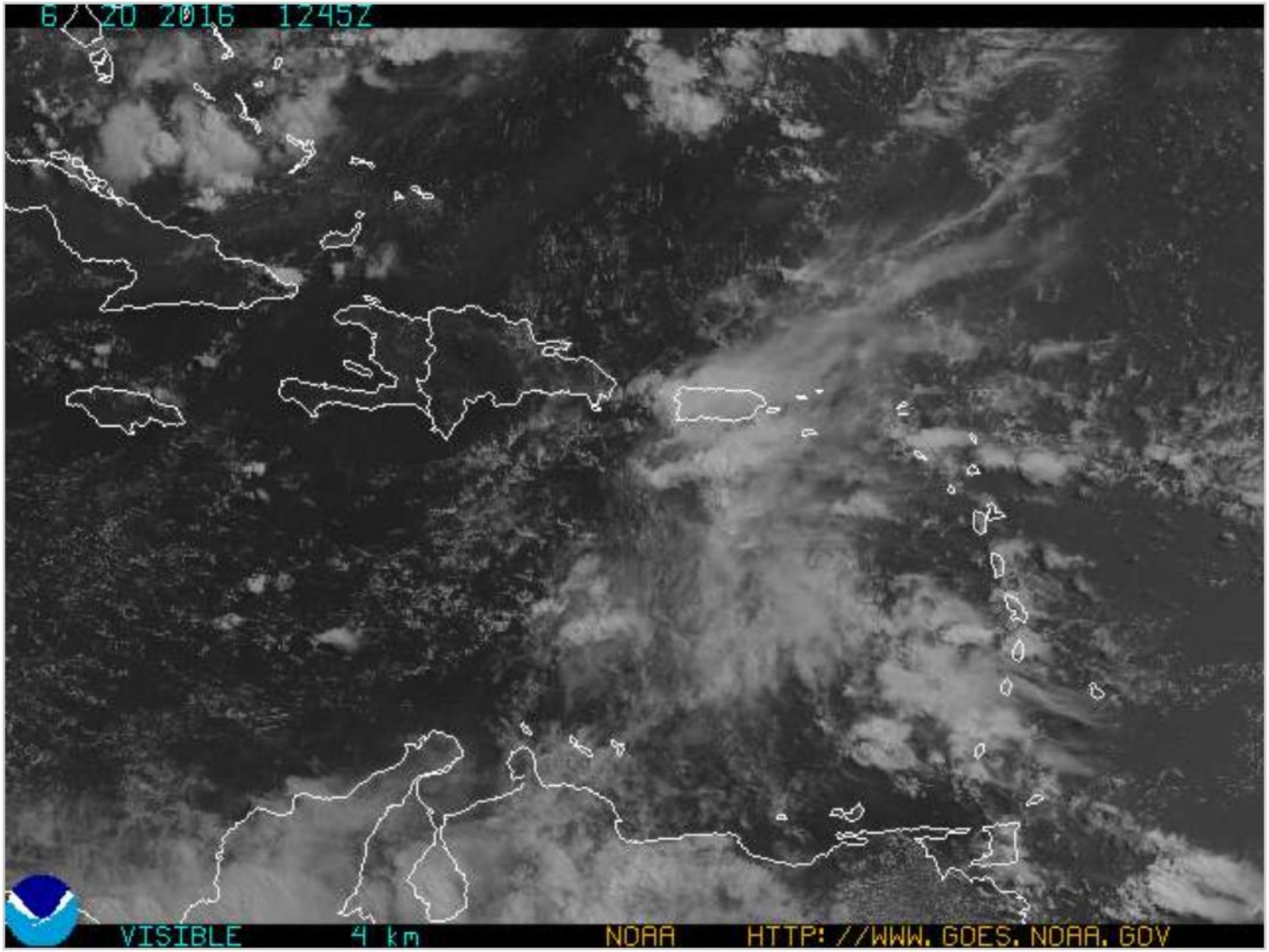
CASA-UPRM high resolution radar



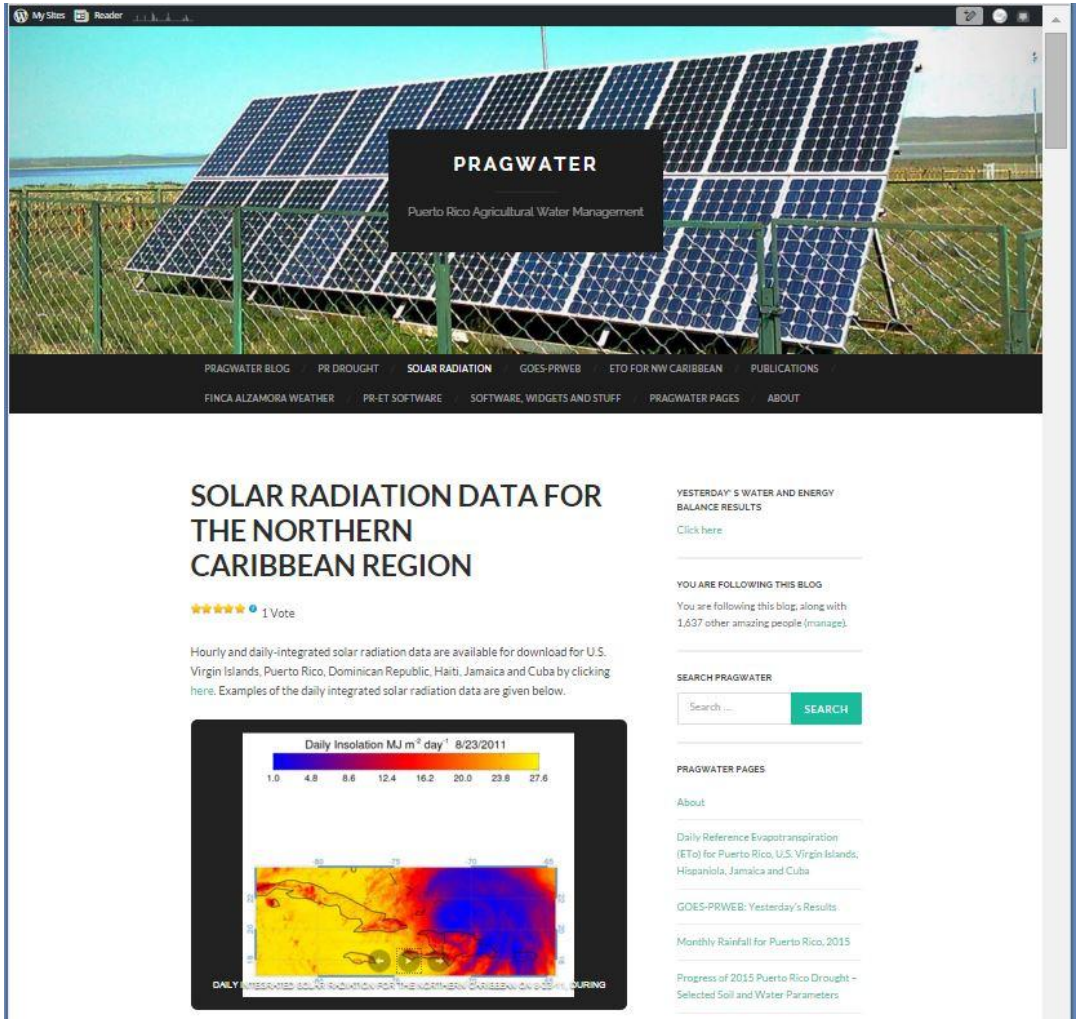
NOAA's Advanced Hydrologic Prediction System
Archived bias-corrected rainfall

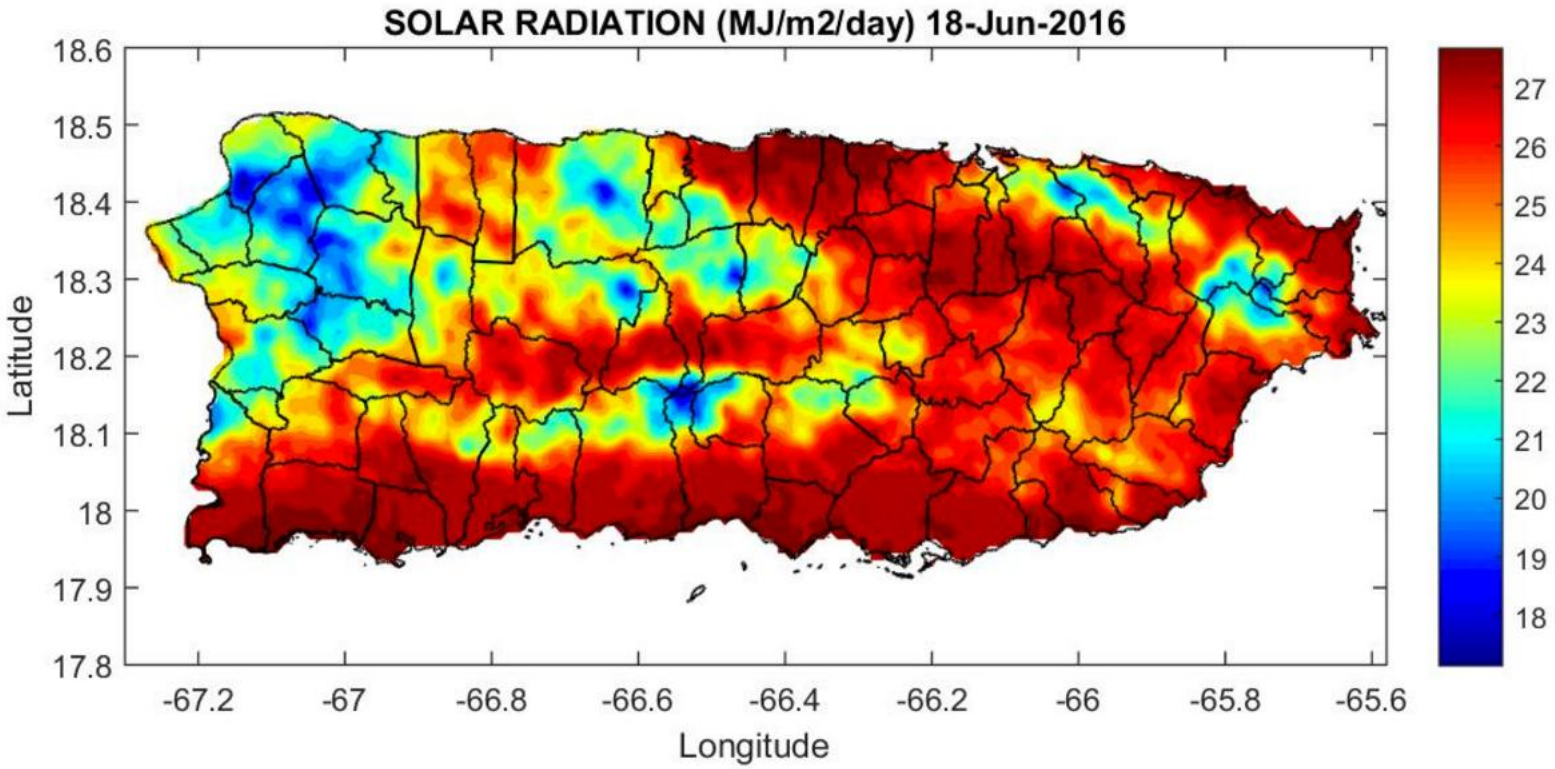


Puerto Rico Visible: GOES East



Hourly and Daily Integrated Solar Radiation Products for the Northern Caribbean Region




SOLAR RADIATION (MJ/m2/day) 18-Jun-2016
Latitude
Longitude
18.6
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18.4
18.3
18.2
18.1
18
17.9
17.8
-67.2
-67
-66.8
-66.6
-66.4
-66.2
-66
-65.8
-65.6
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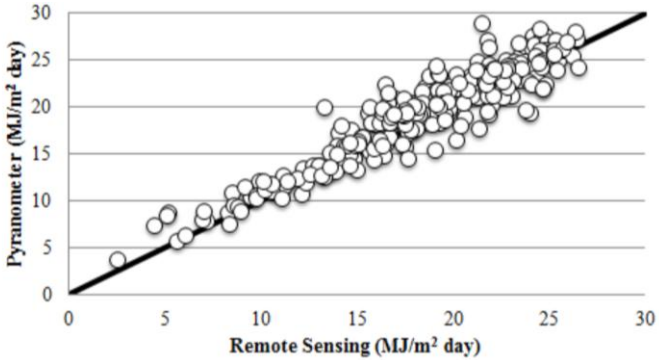
21
20
19
18


Pyranometer (MJ/m² day)
Remote Sensing (MJ/m² day)
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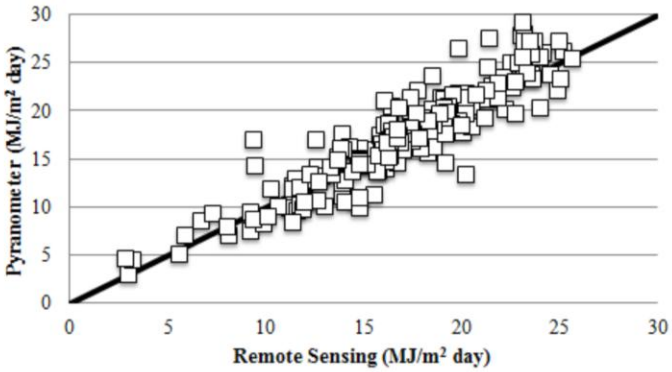
5
10
15
20
25
30


Pyranometer (MJ/m² day)
Remote Sensing (MJ/m² day)
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30

Rainfall Temporal Distribution

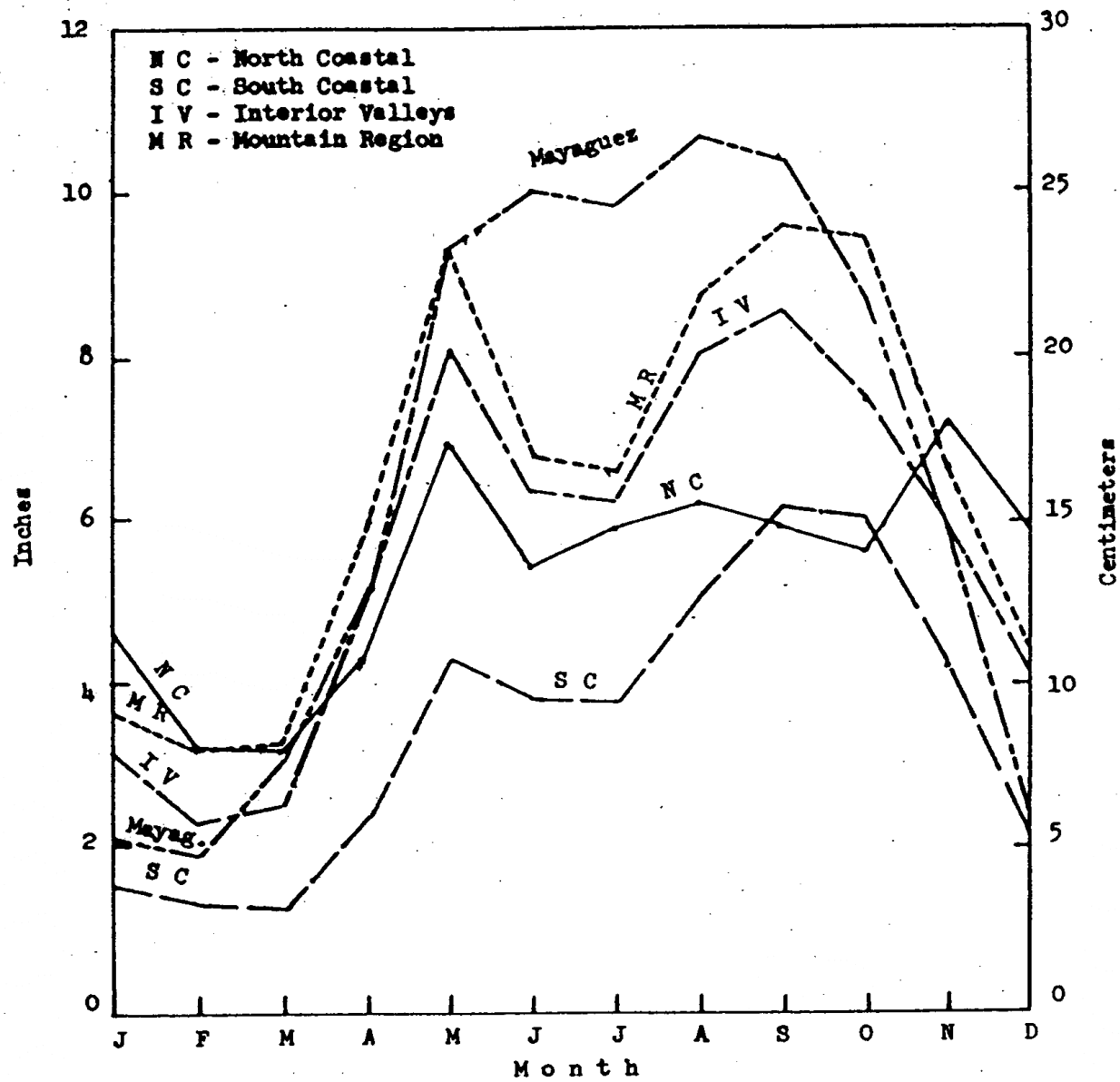


FIG. 4.—Mean monthly rainfall of different geographic regions of Puerto Rico.

Annual Rainfall Spatial Distribution

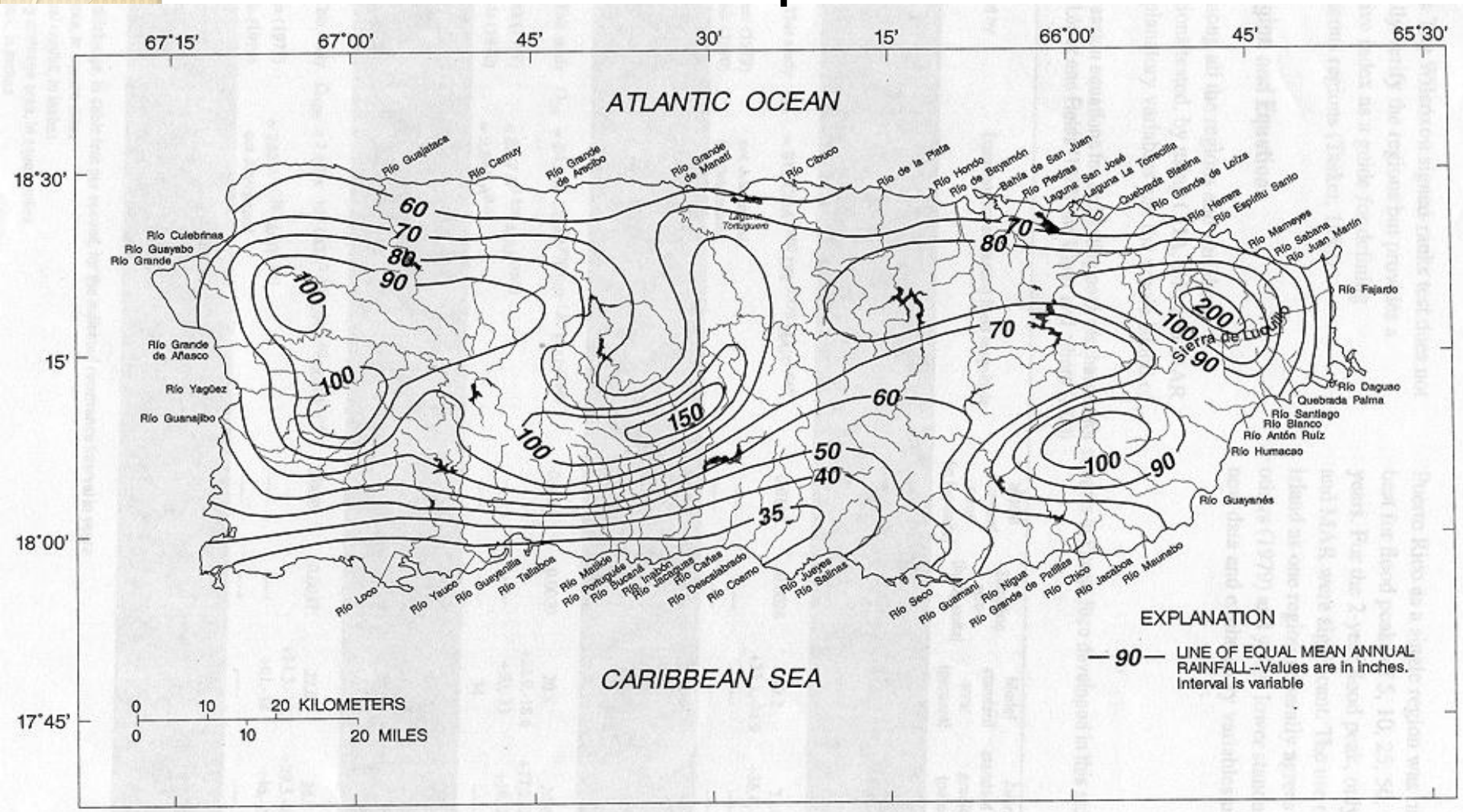
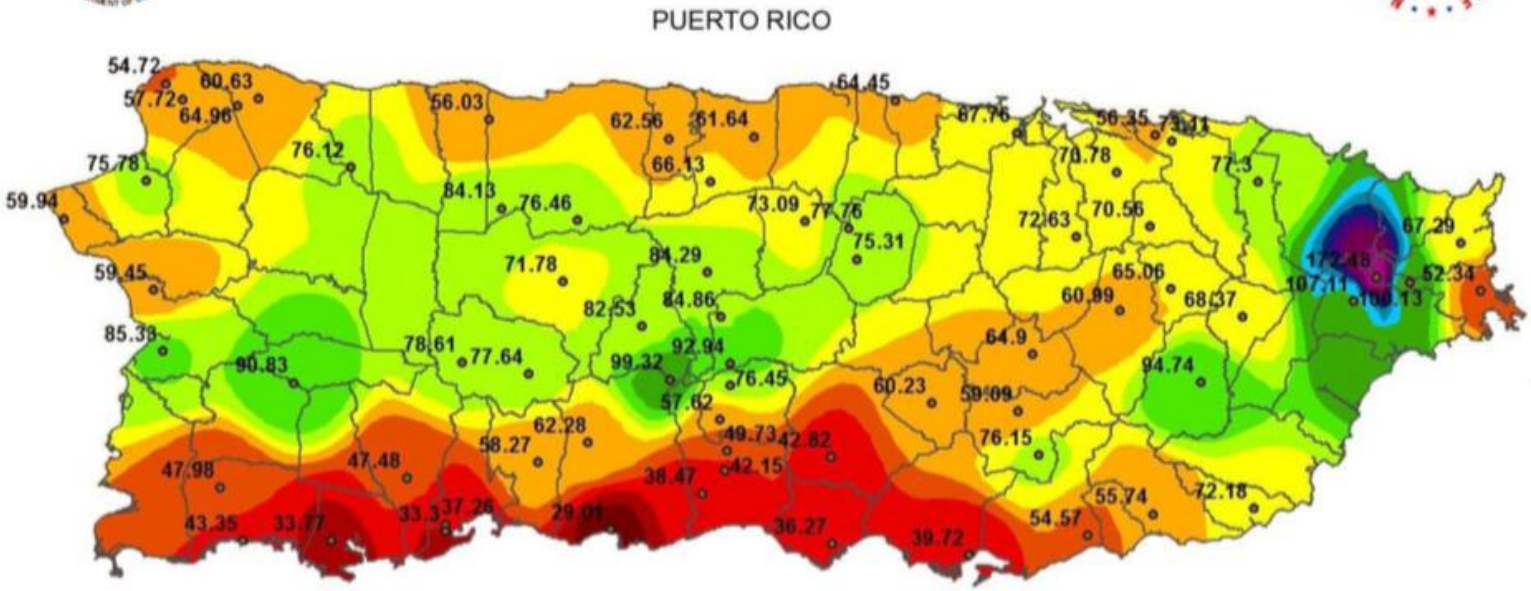
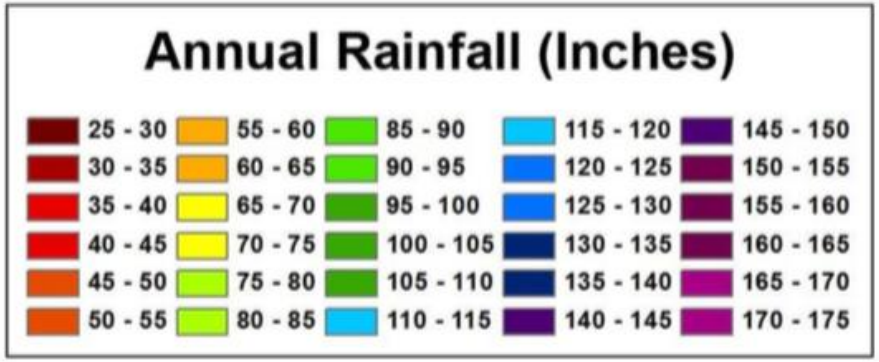
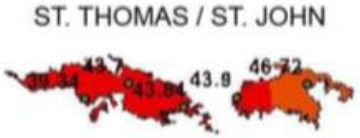


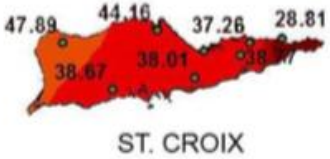
Figure 1. Mean annual rainfall in Puerto Rico, 1931-60 (from Calversbert, 1970).

Mean Annual Rainfall 1981 - 2010

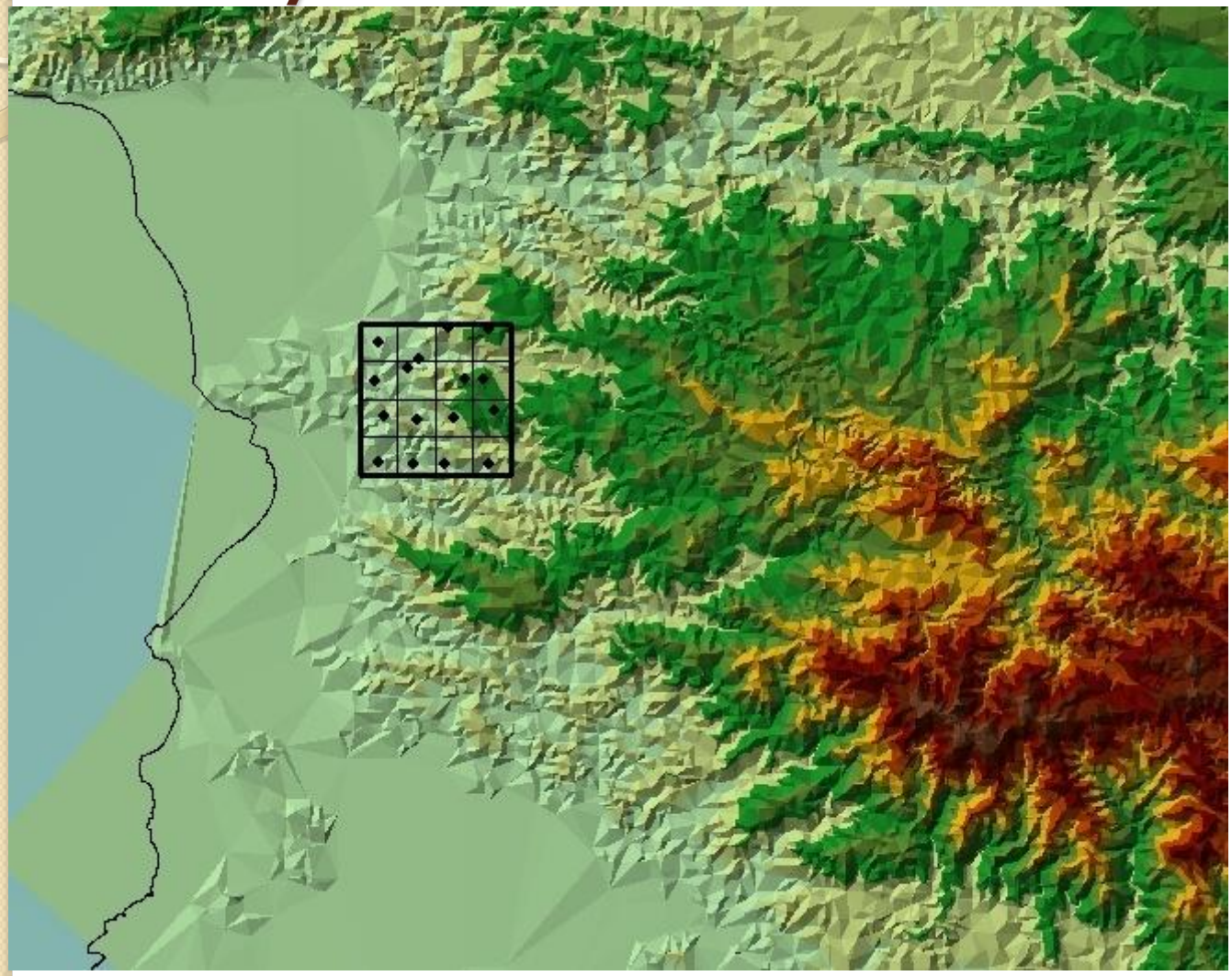




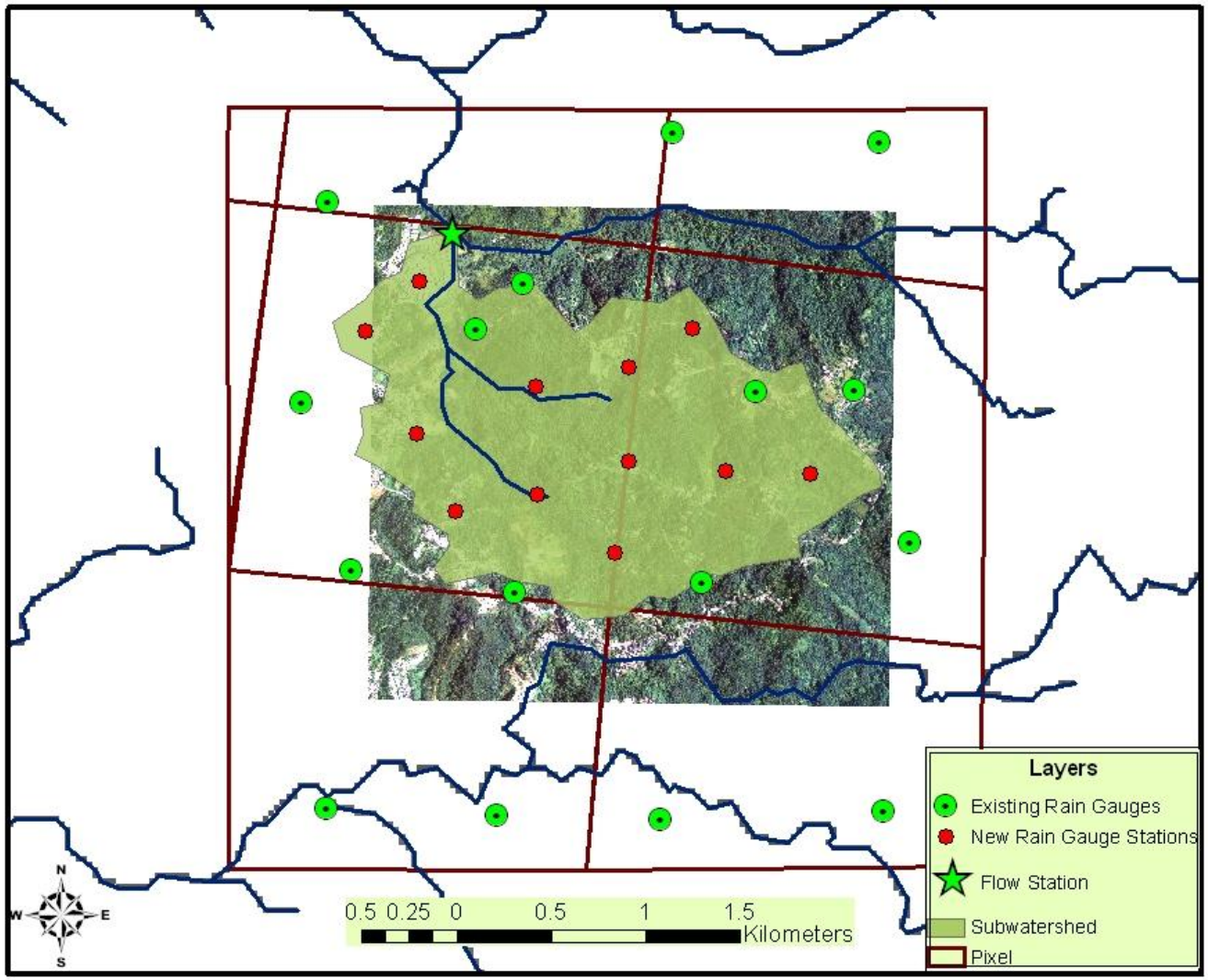




Rainfall Spatial Variability Study area



STUDY AREA –RAIN GAUGE LOCATIONS



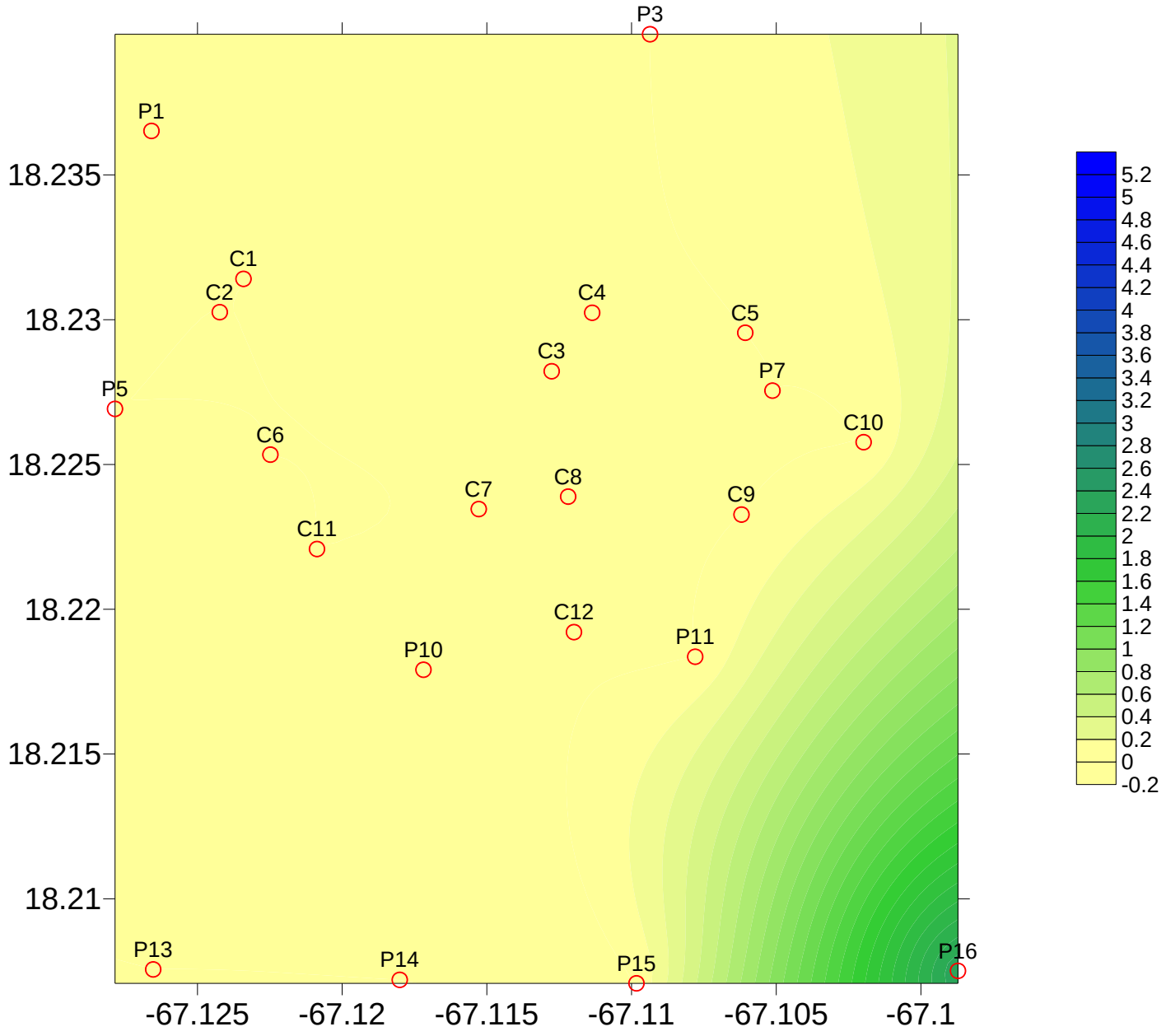
Equipment

Watchdog Rain Gauge

Watchdog Shuttle

RAINFALL ANIMATION FROM RAIN GAUGES NETWORK

JUNE 27, 2007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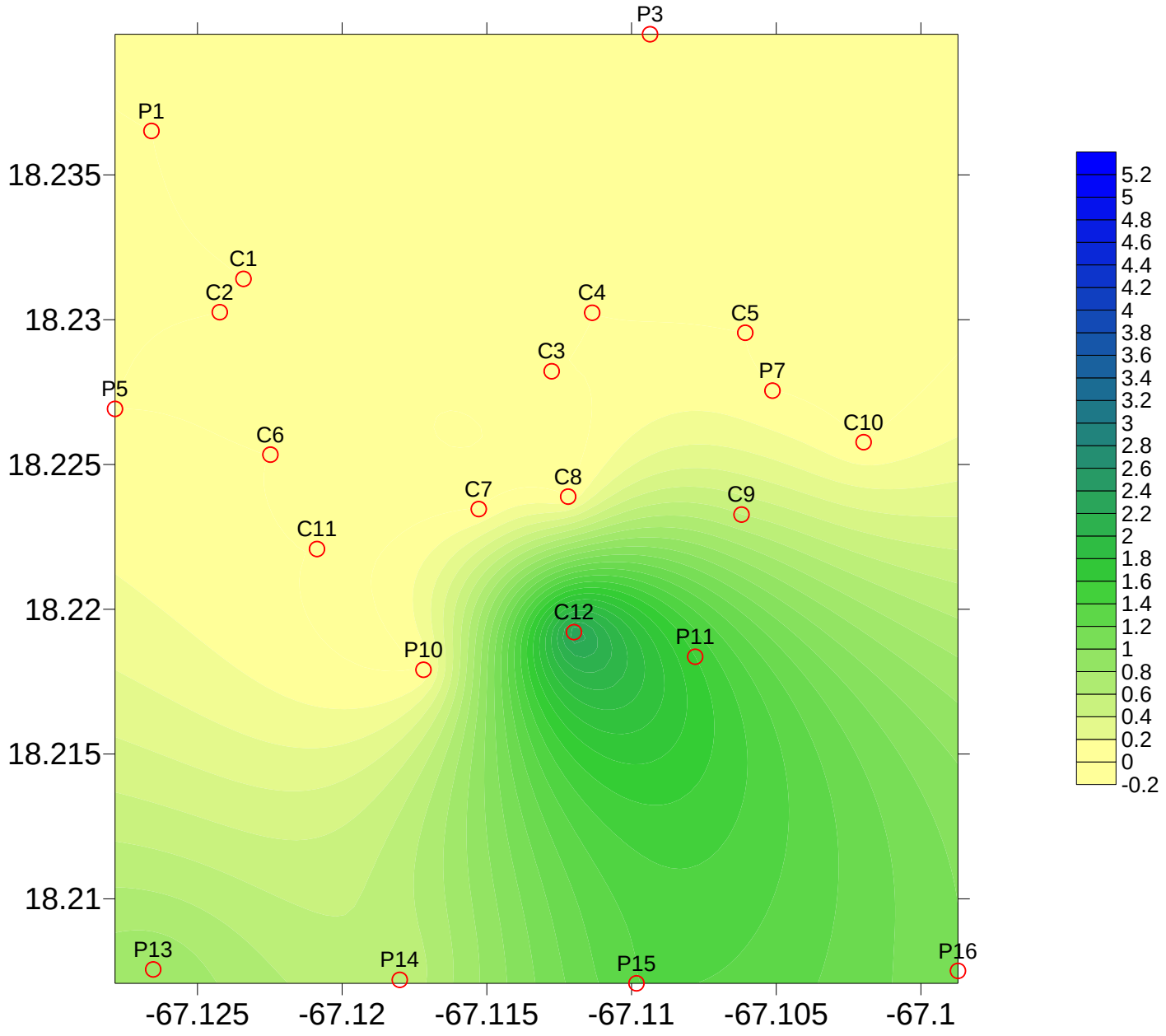
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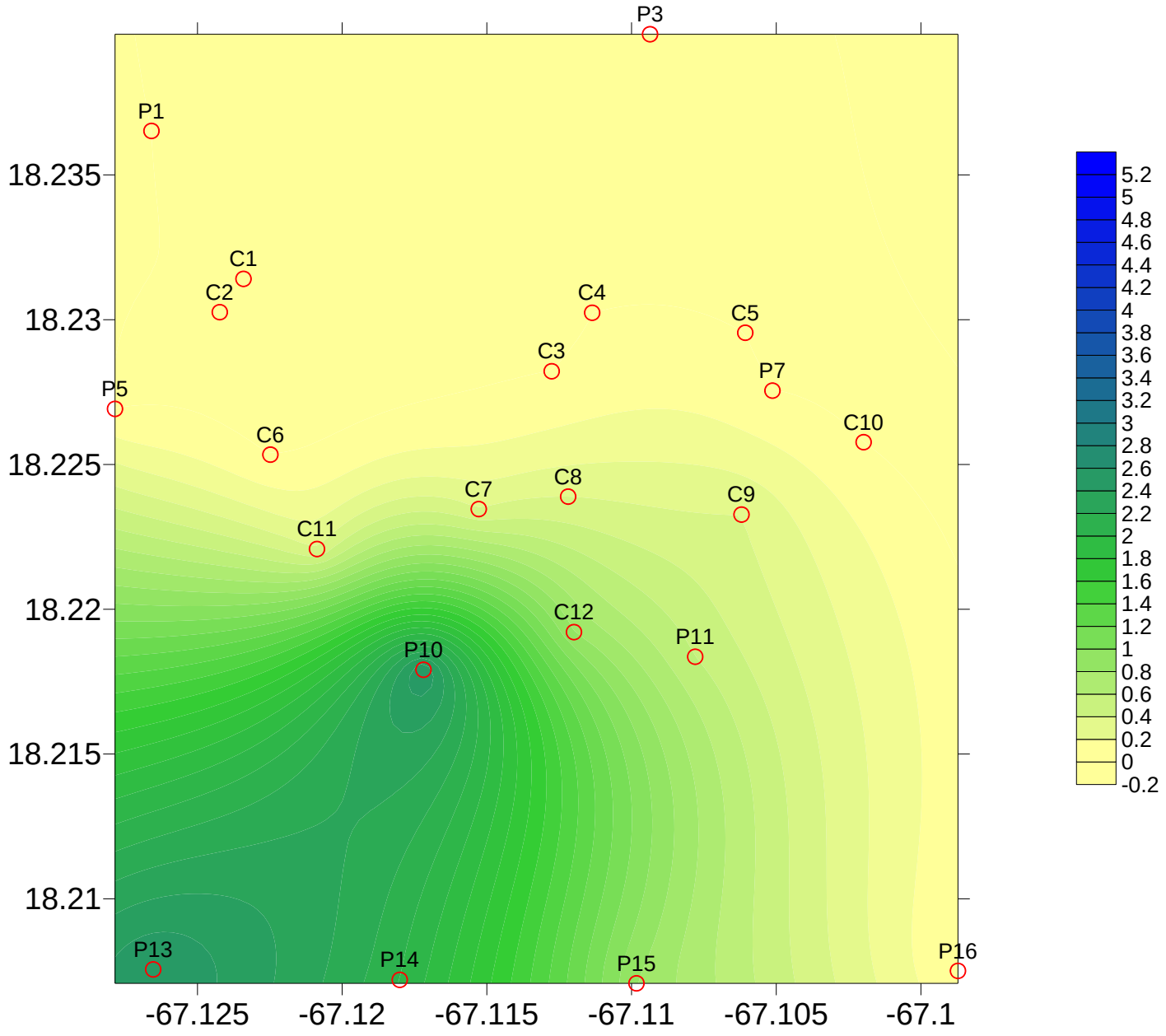
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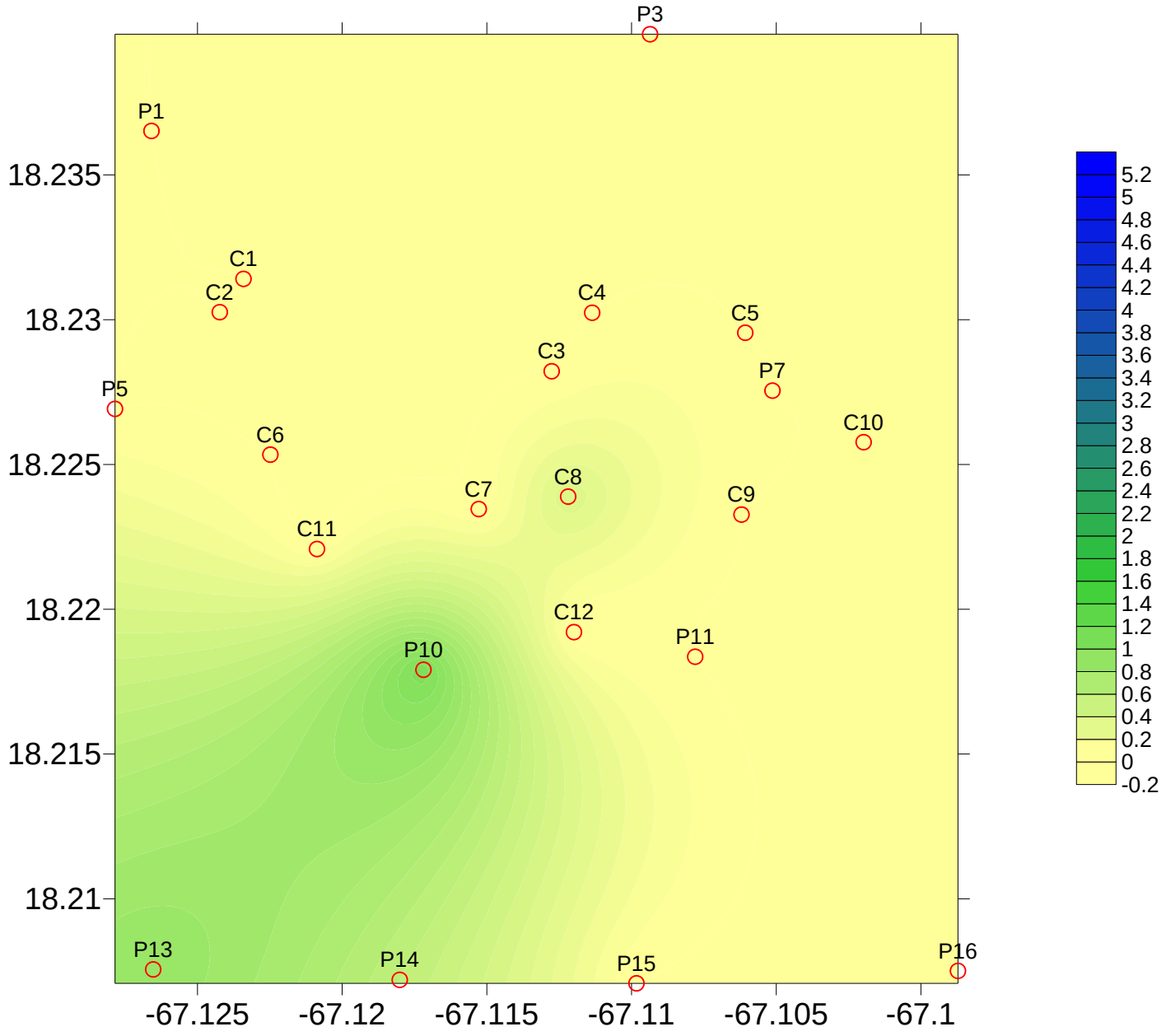
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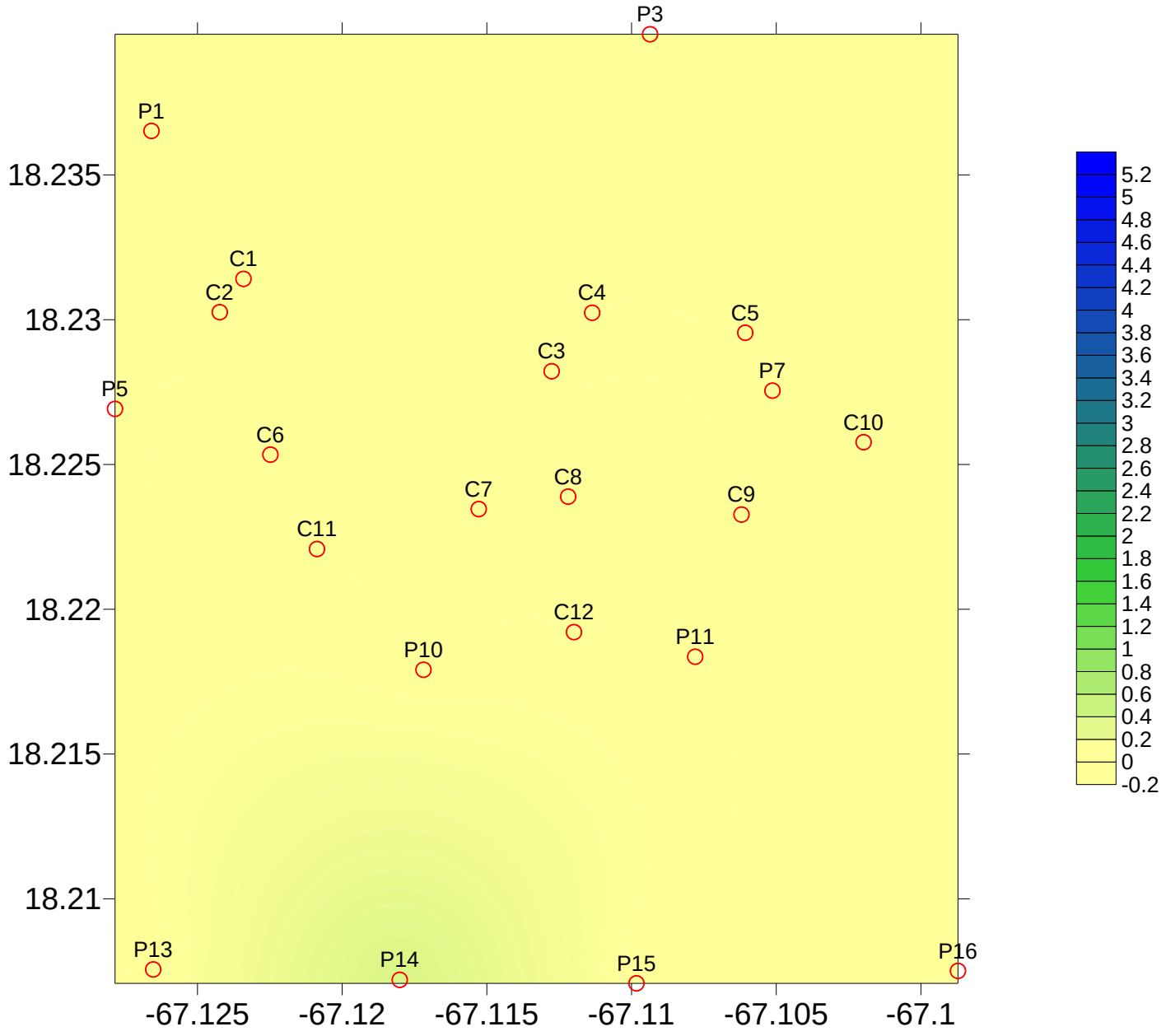
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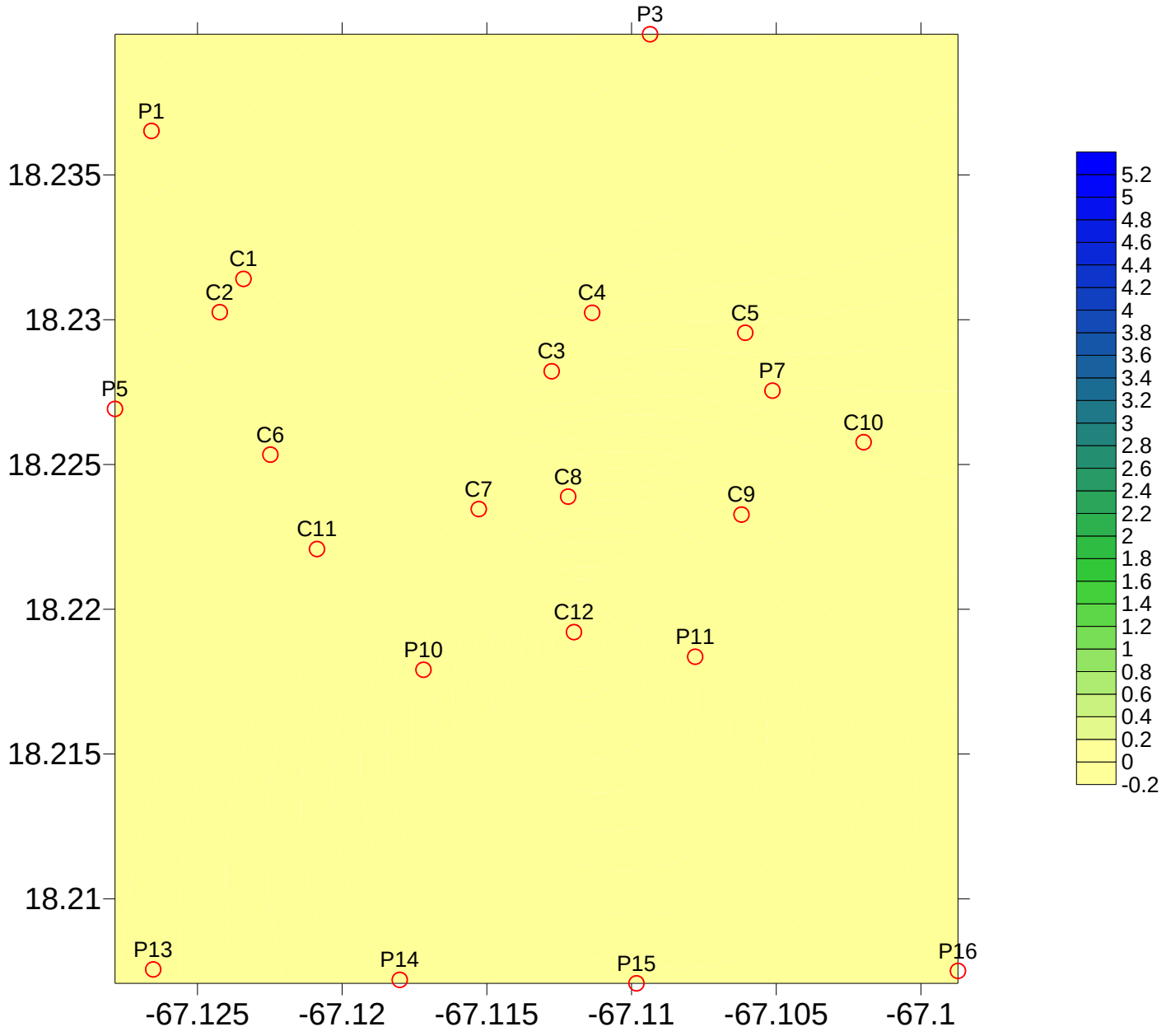
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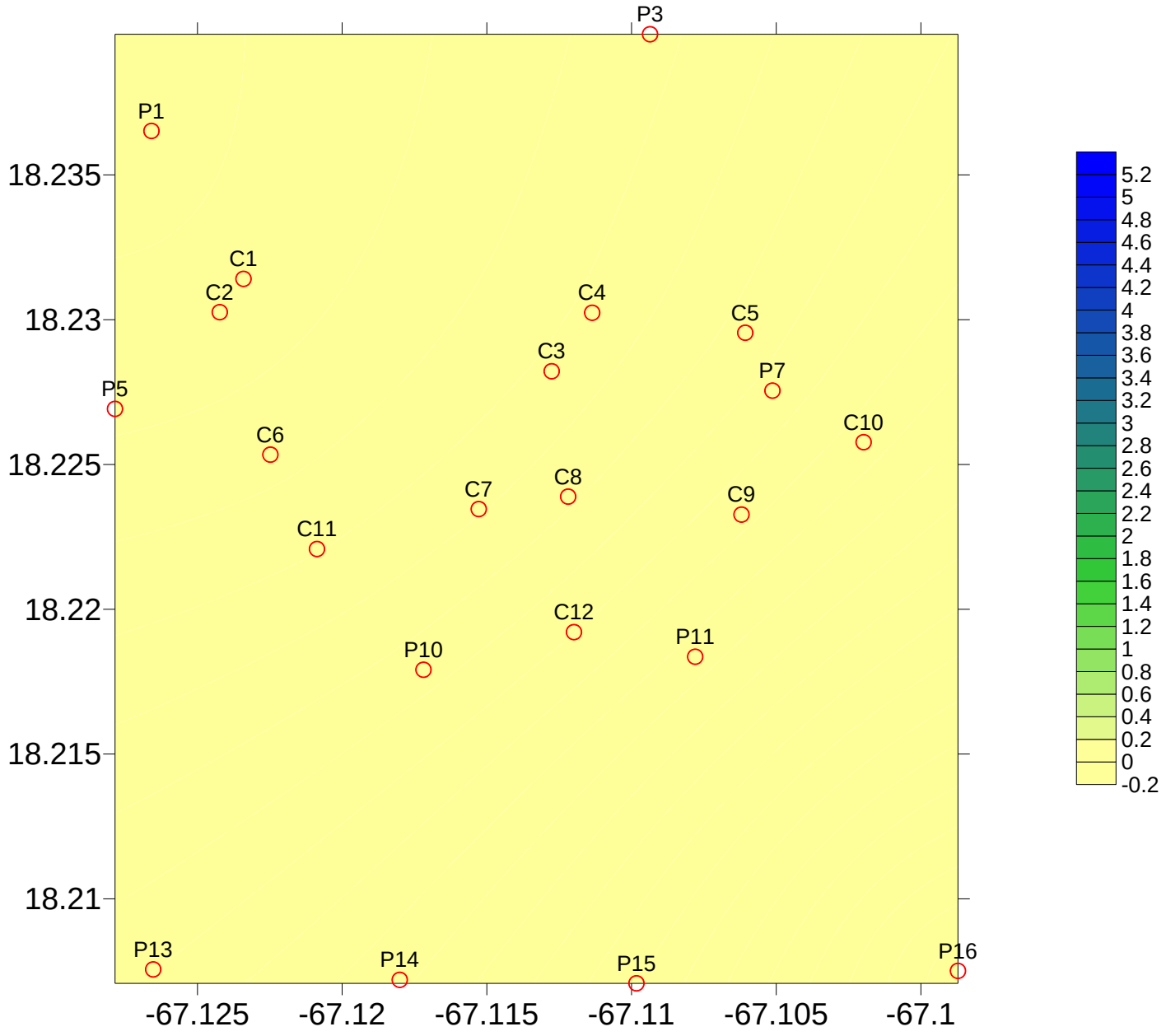
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C4
C5
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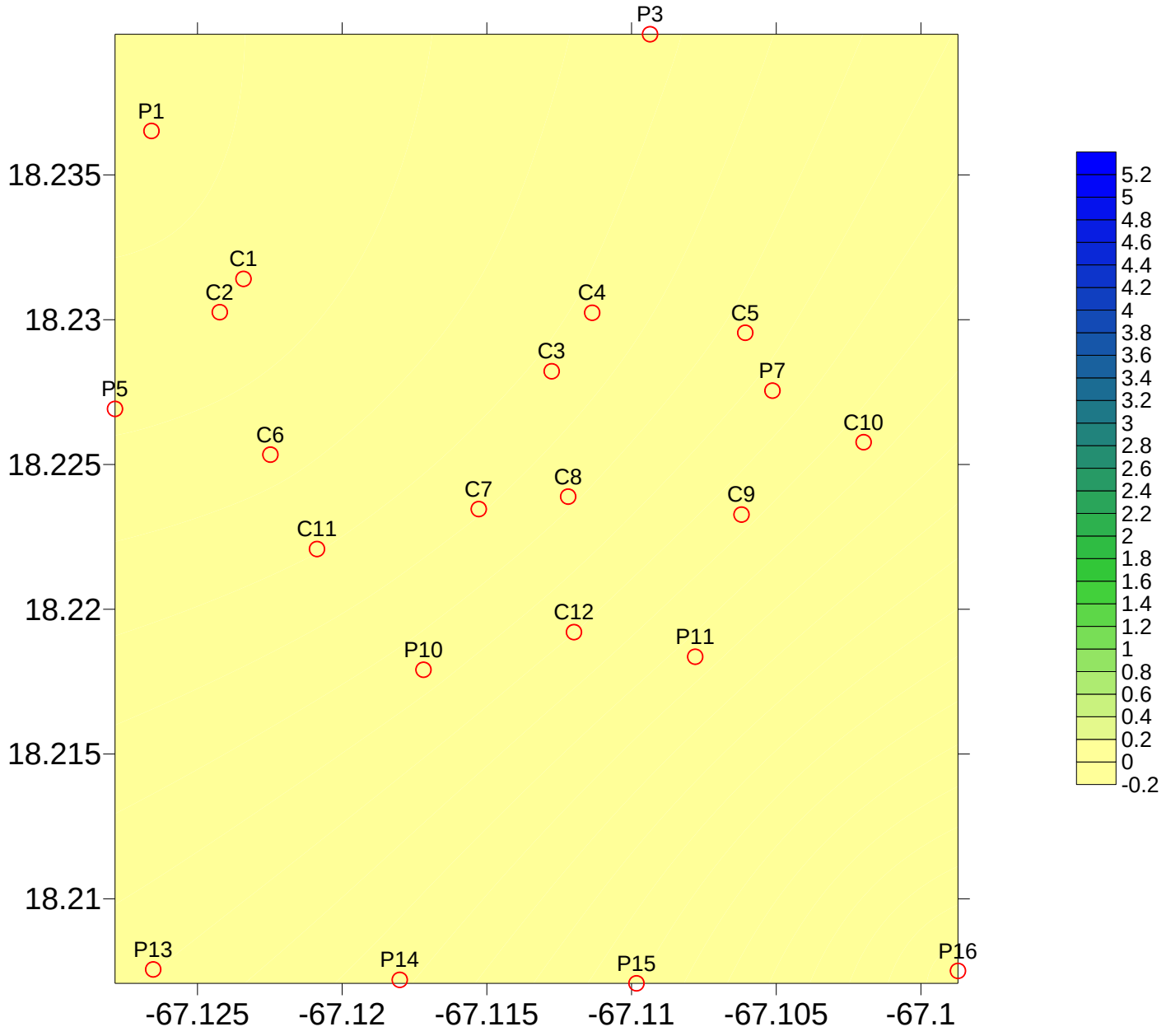
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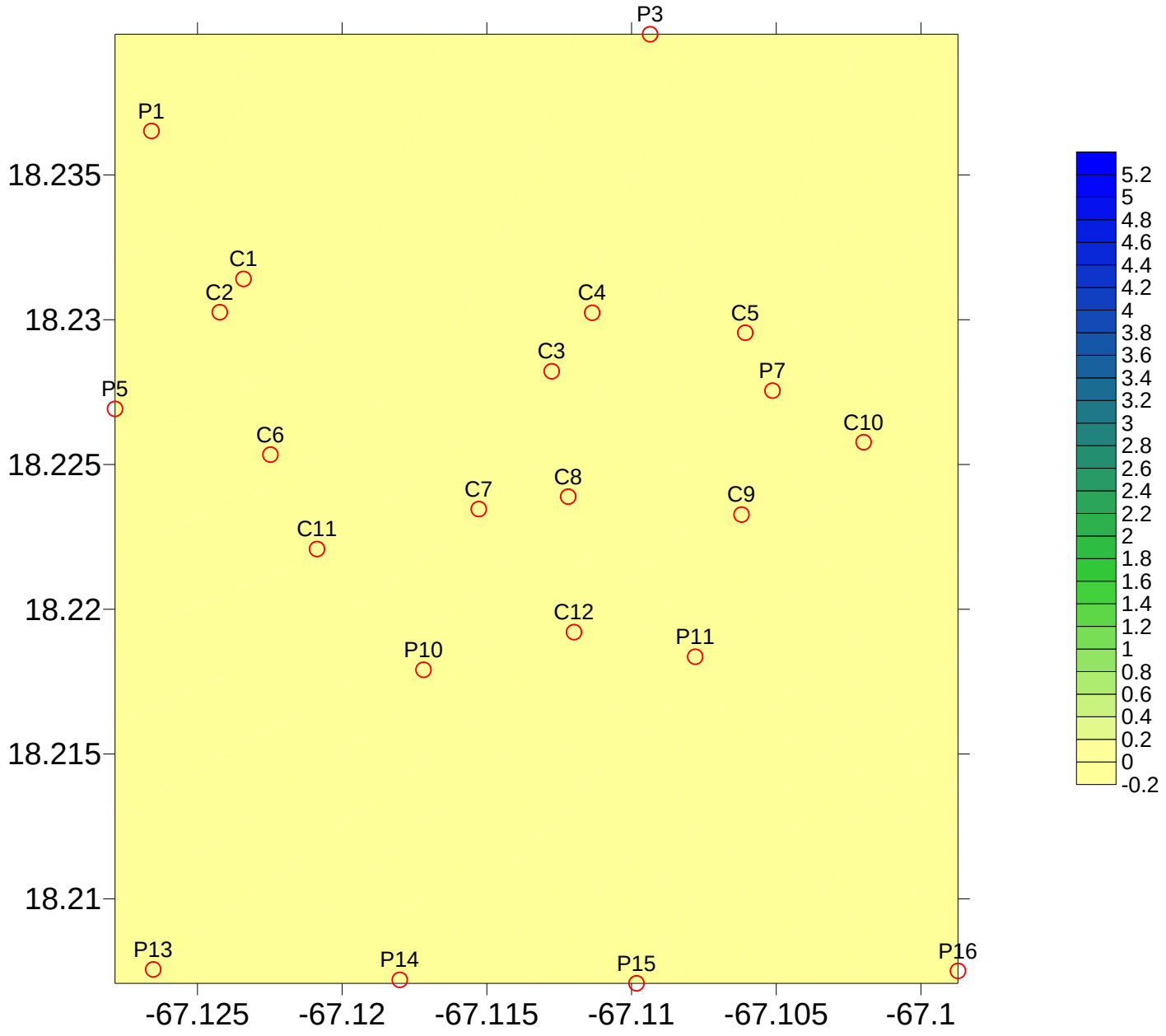
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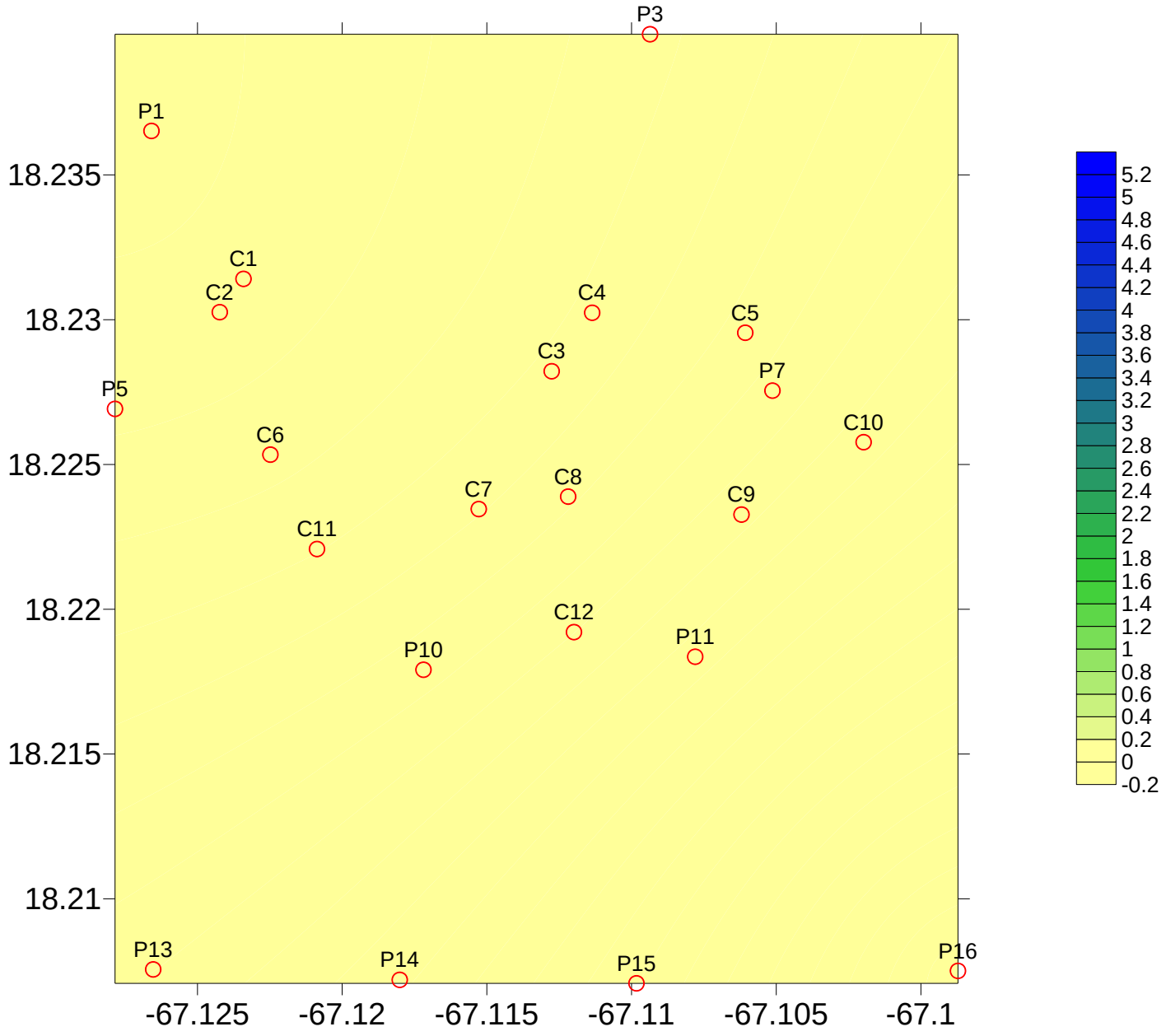
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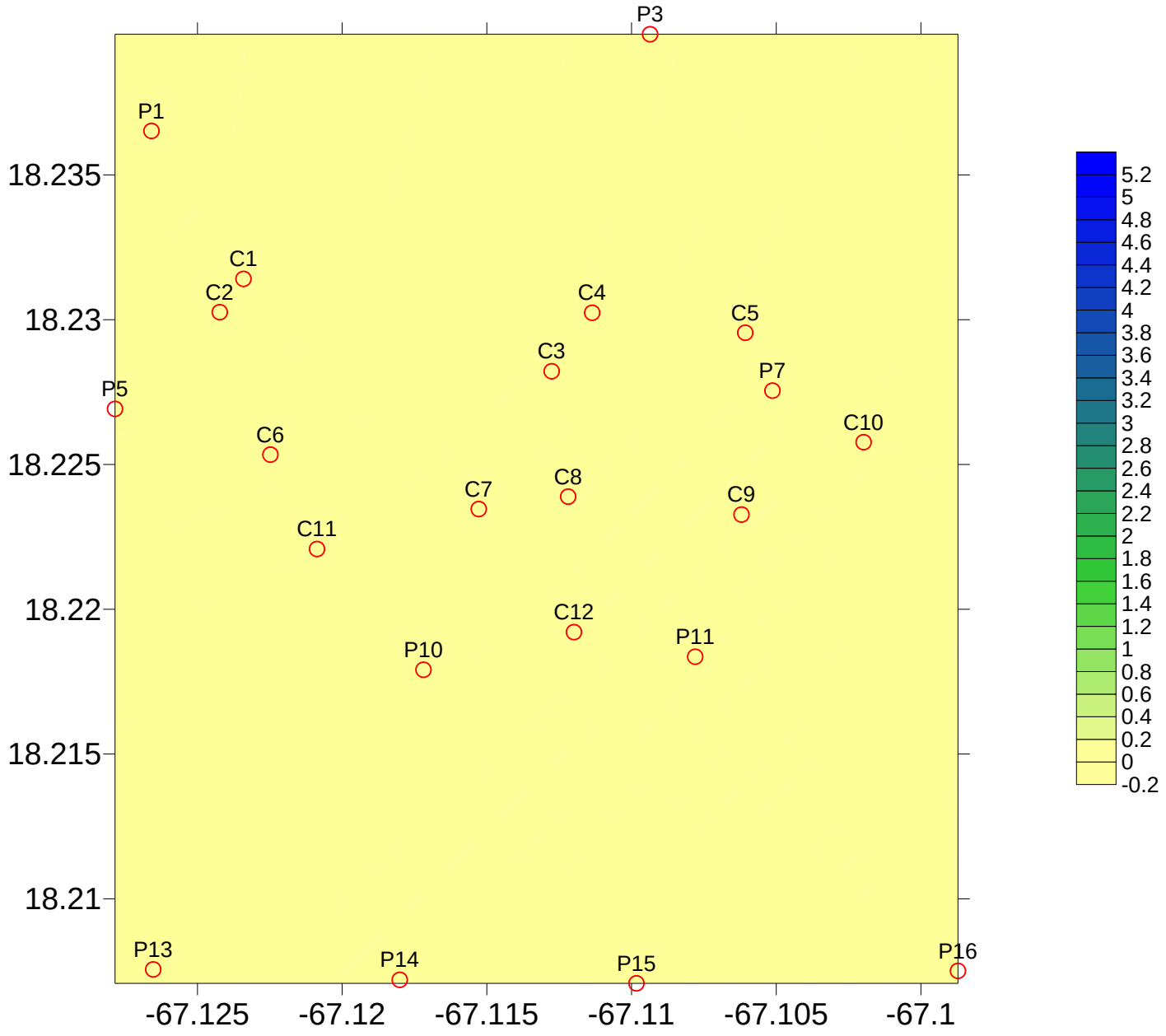
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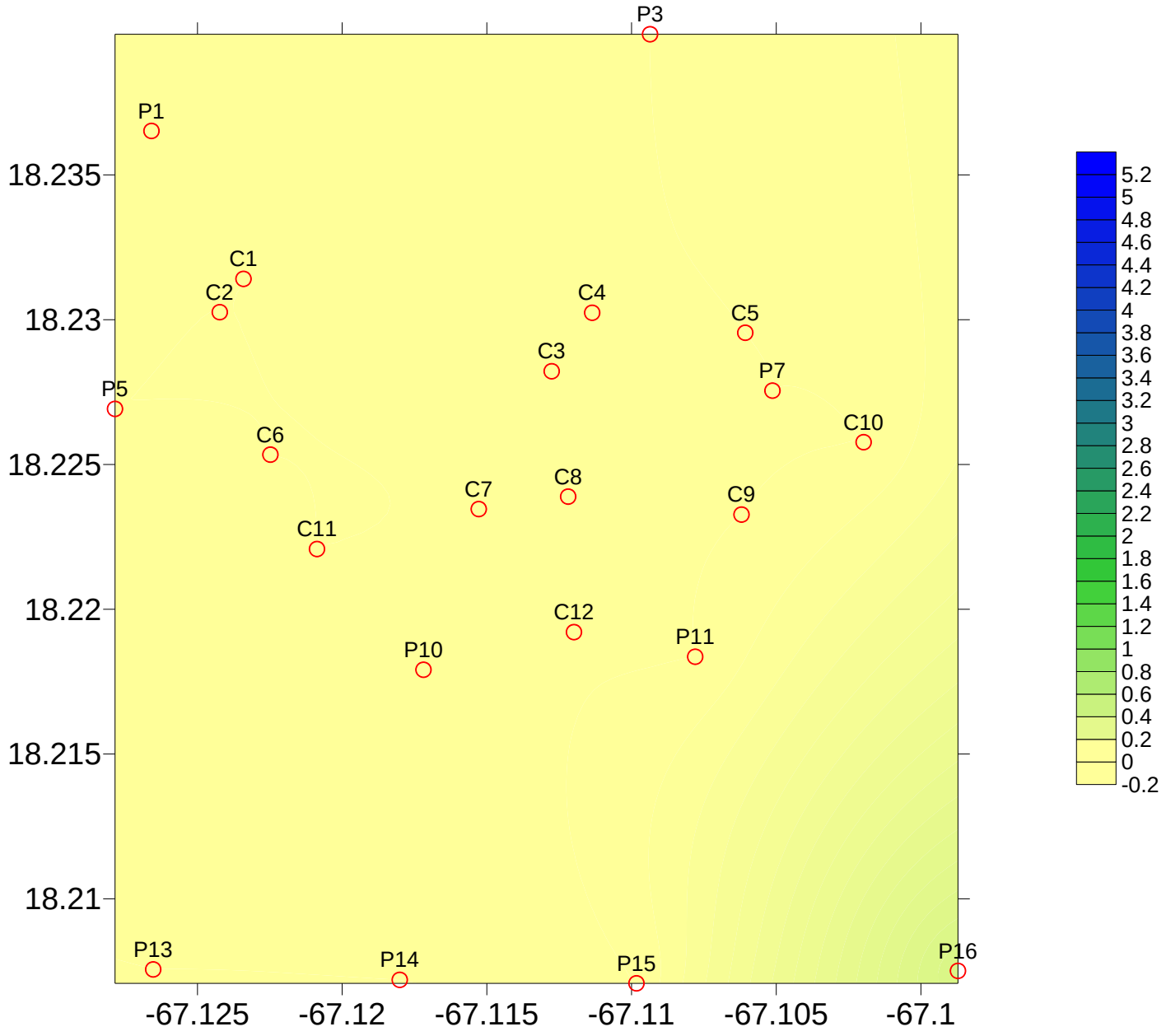
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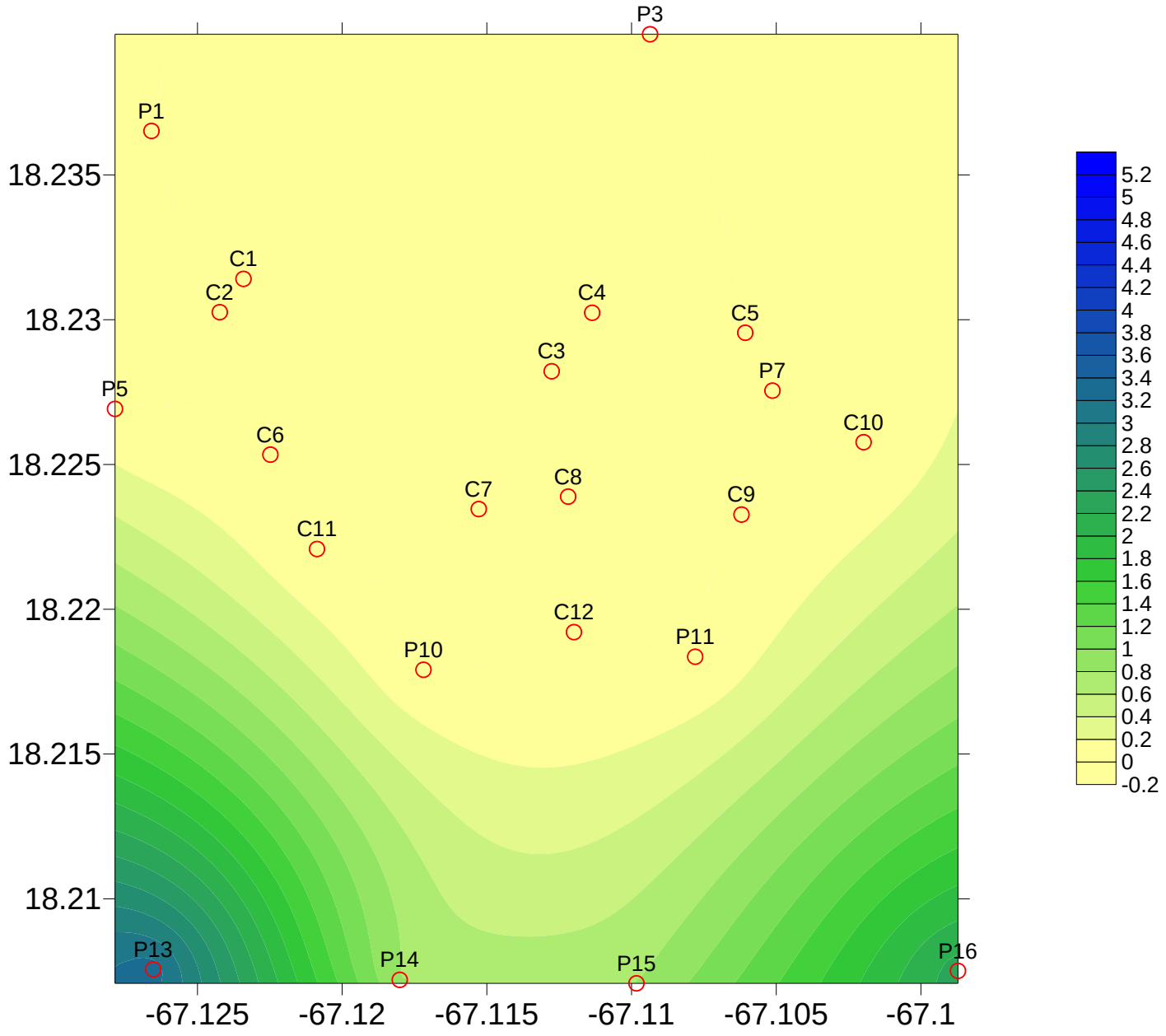
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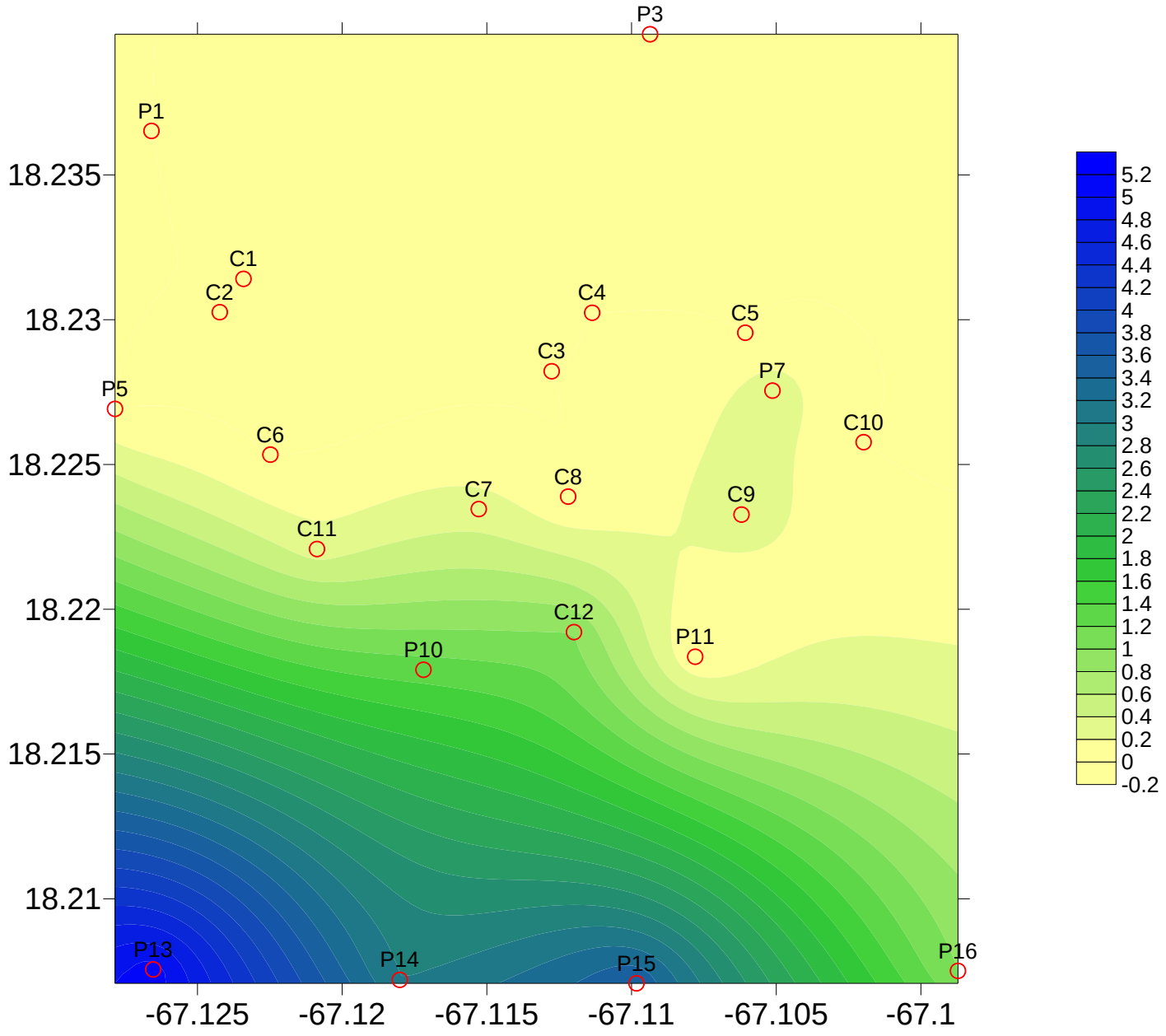
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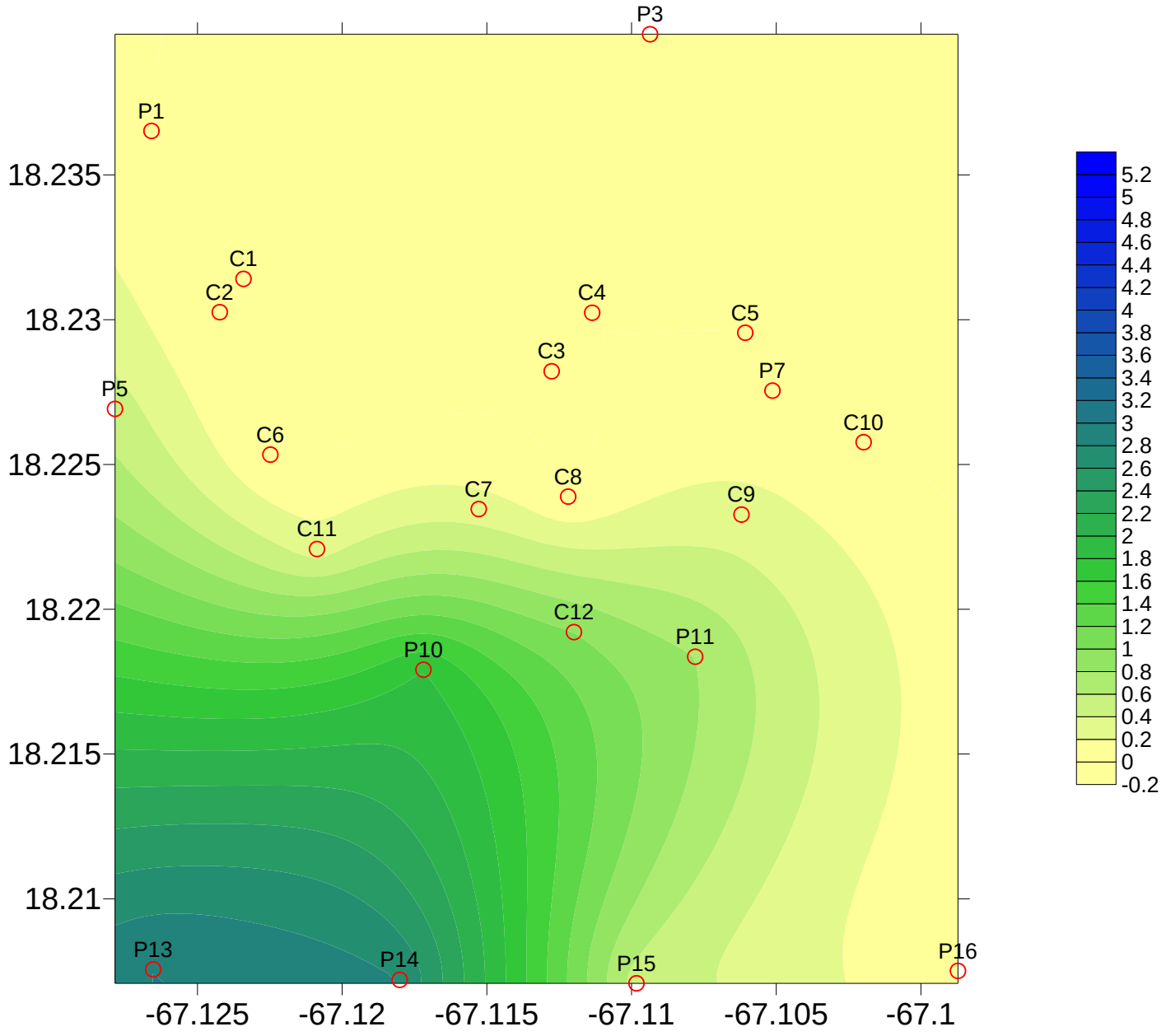
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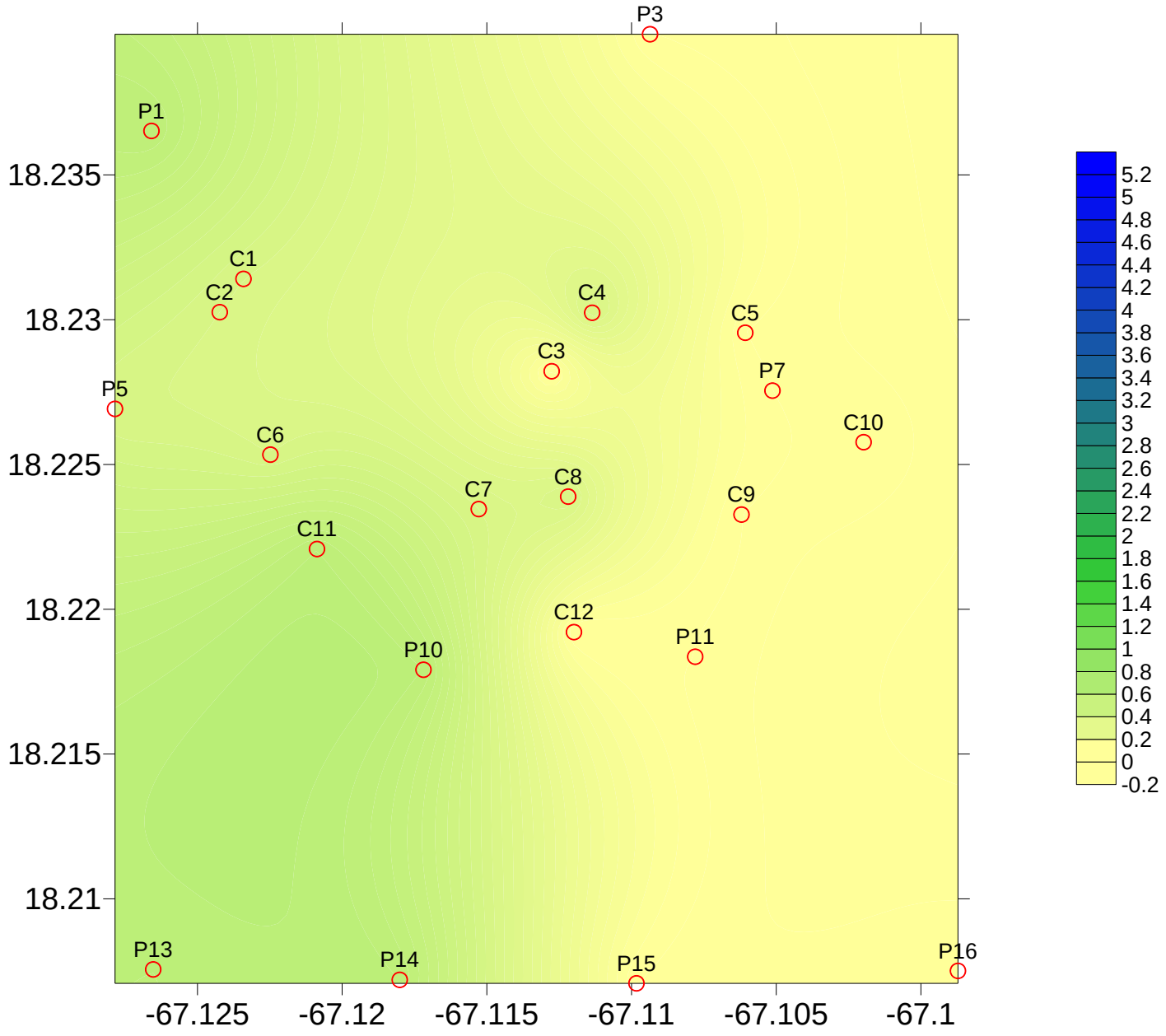
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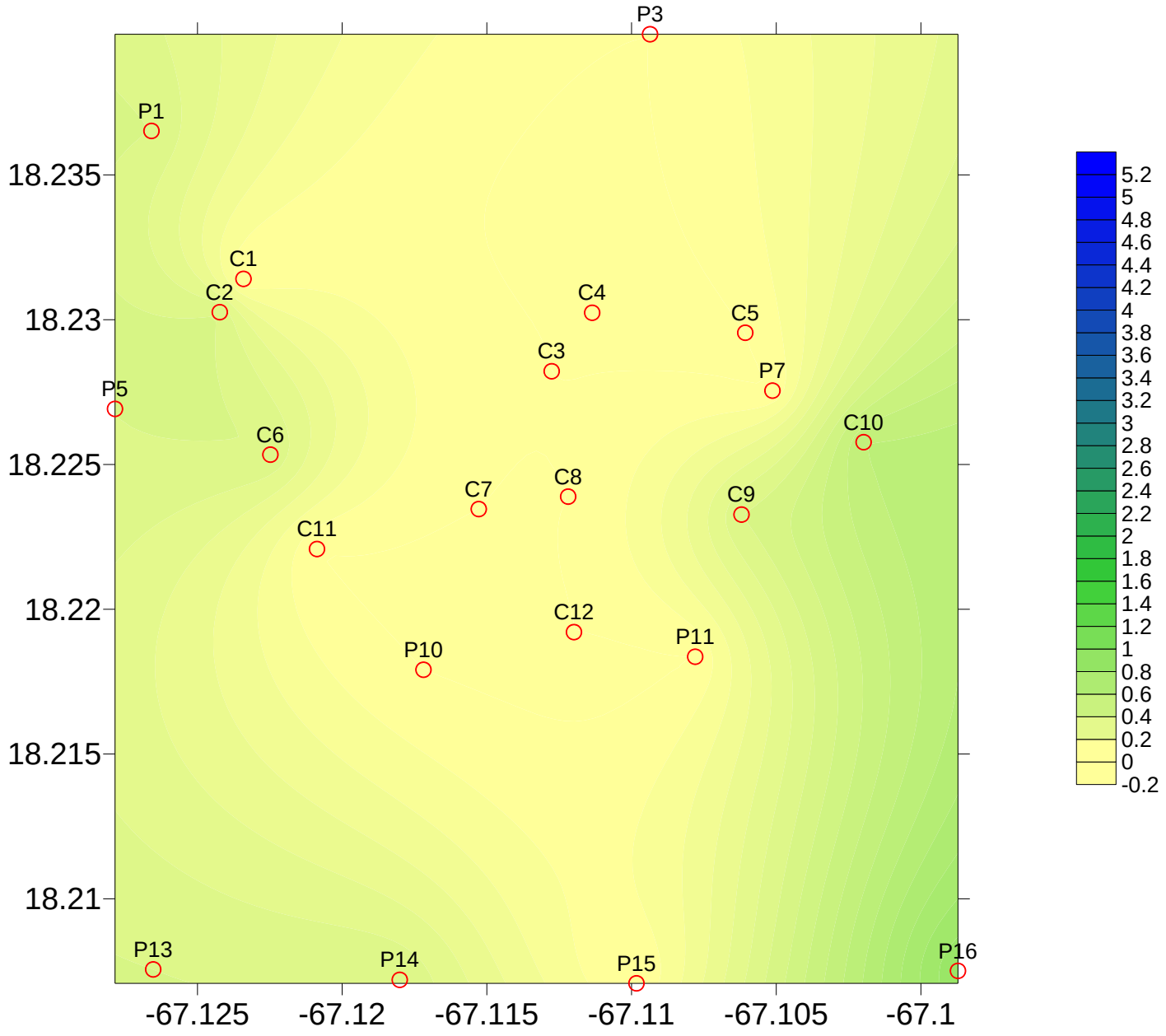
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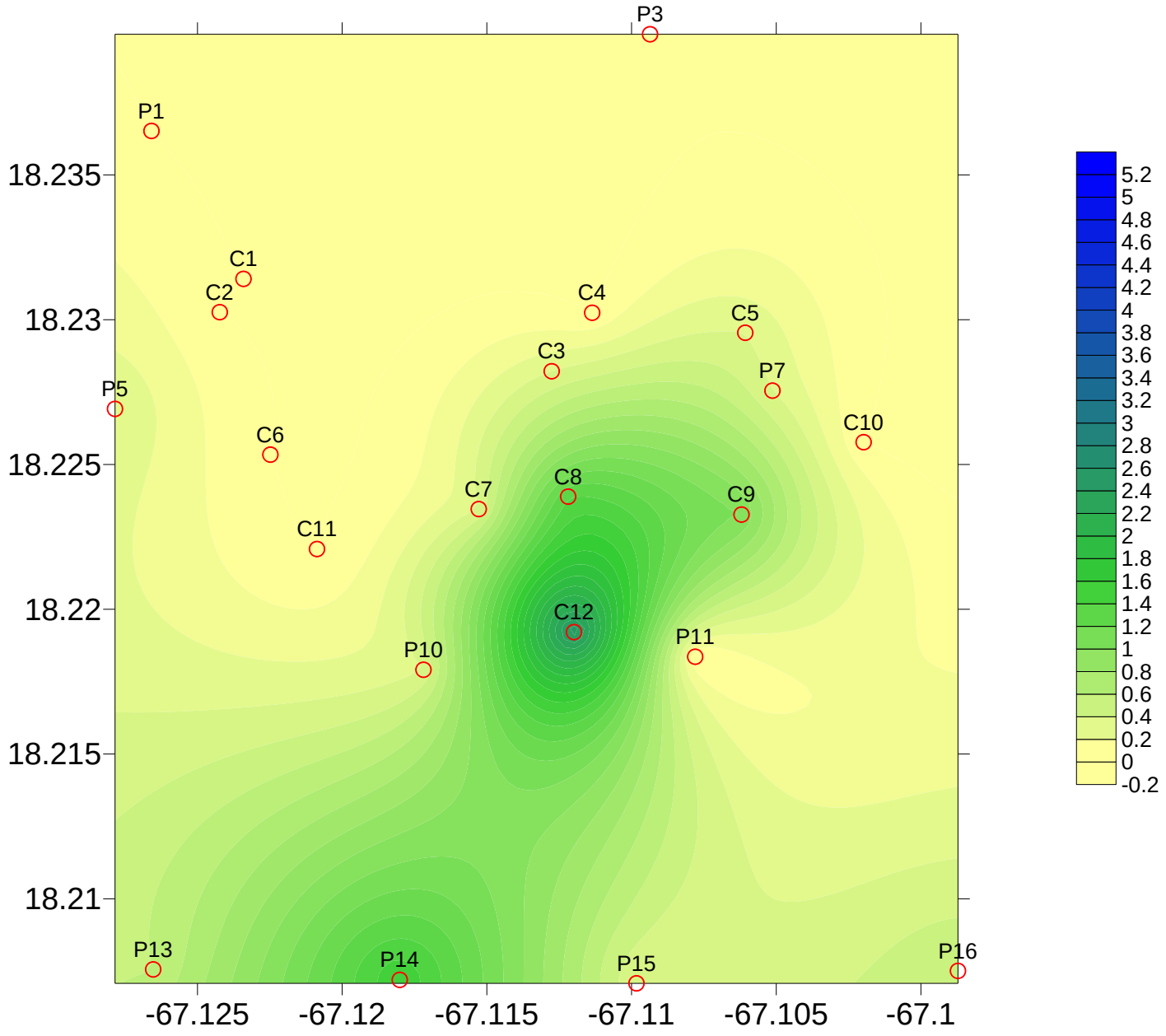
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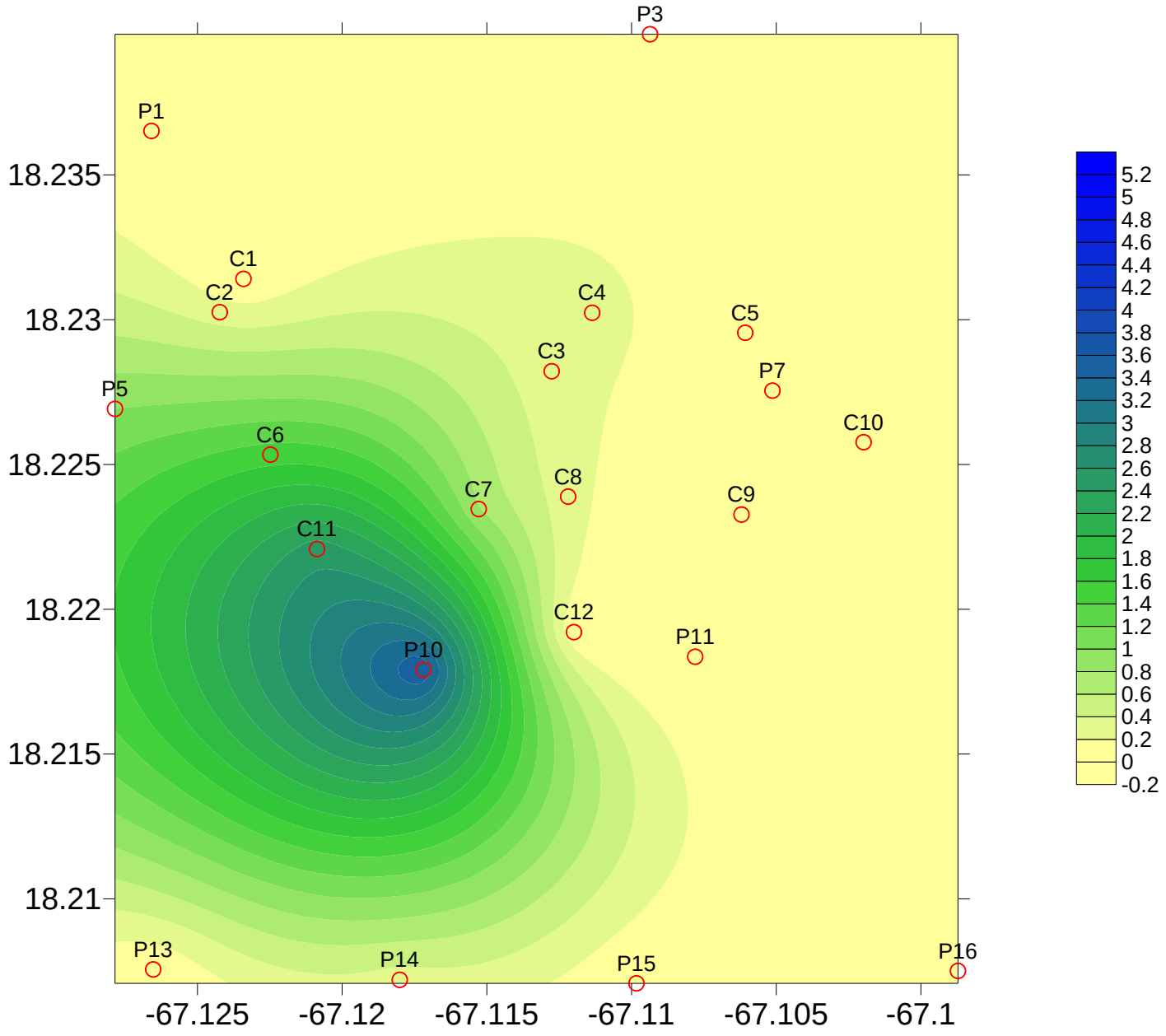
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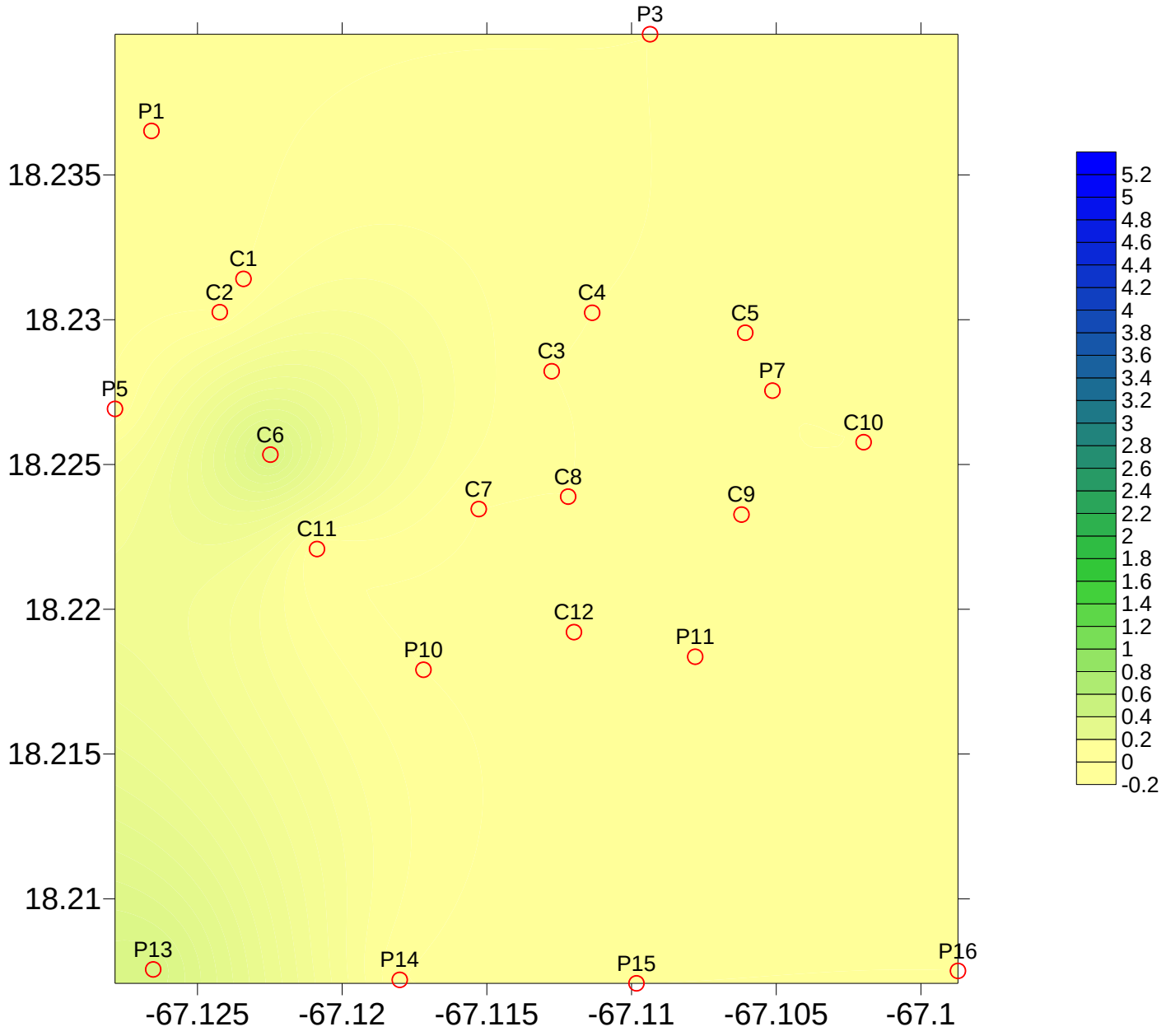
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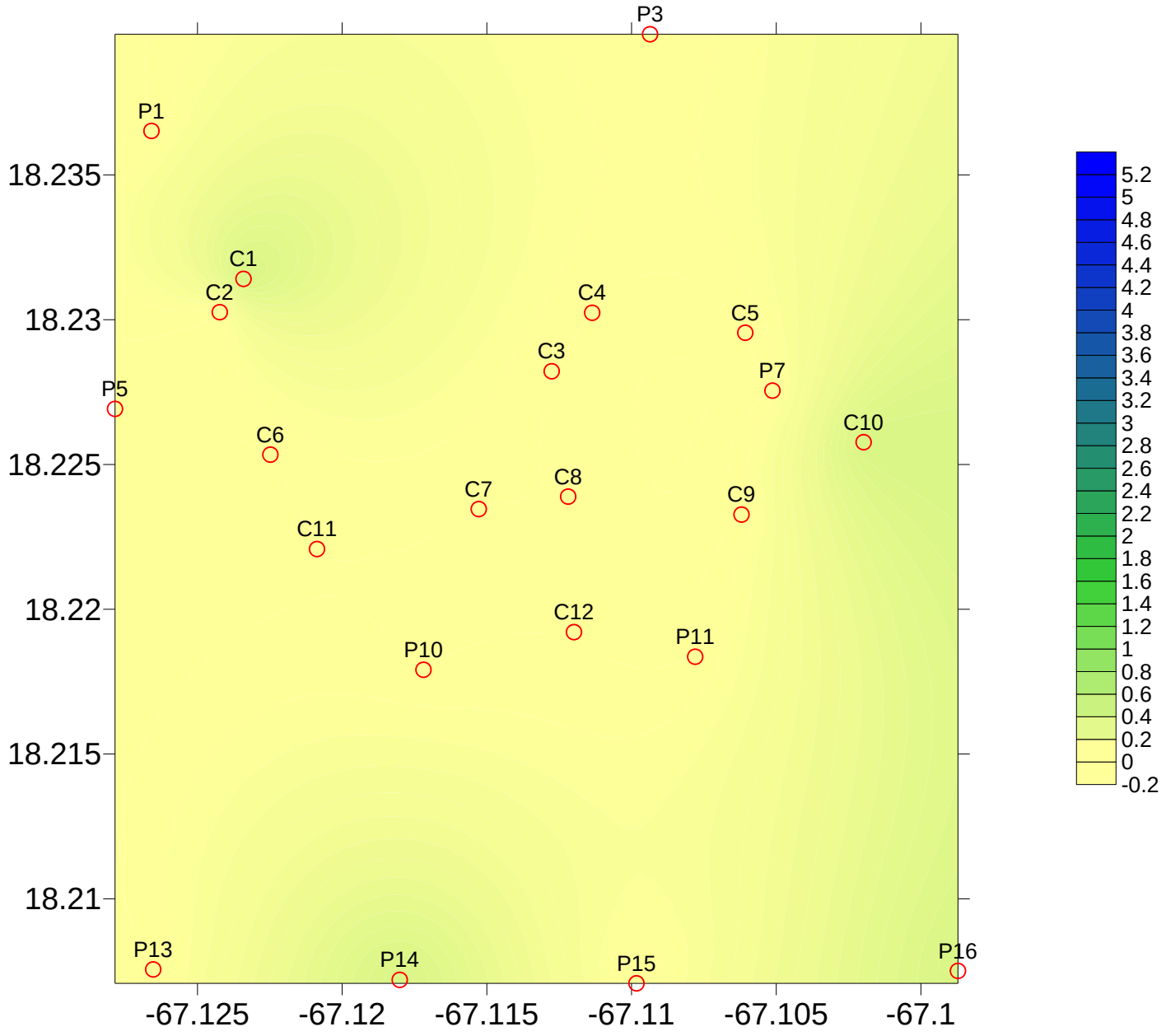
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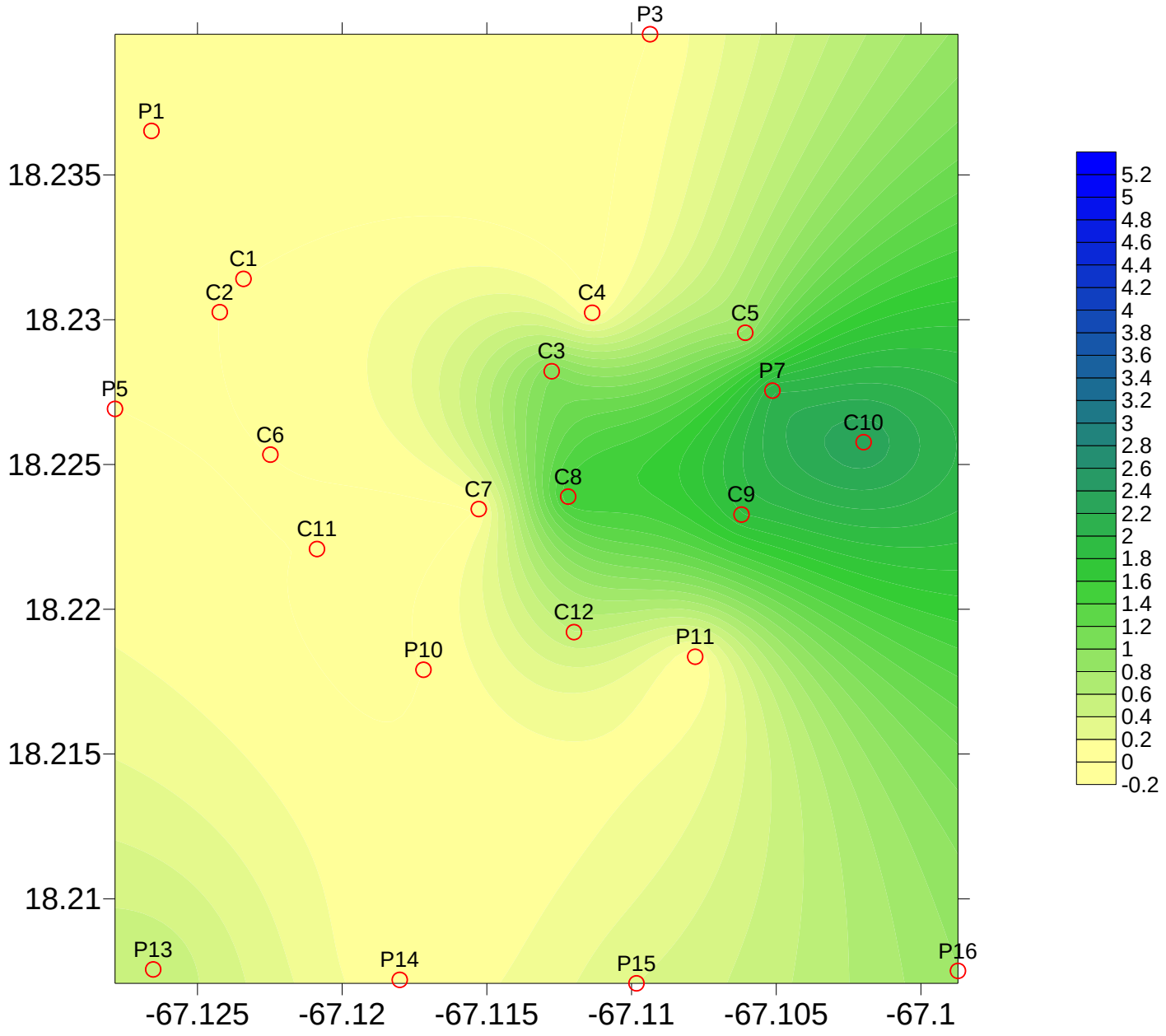
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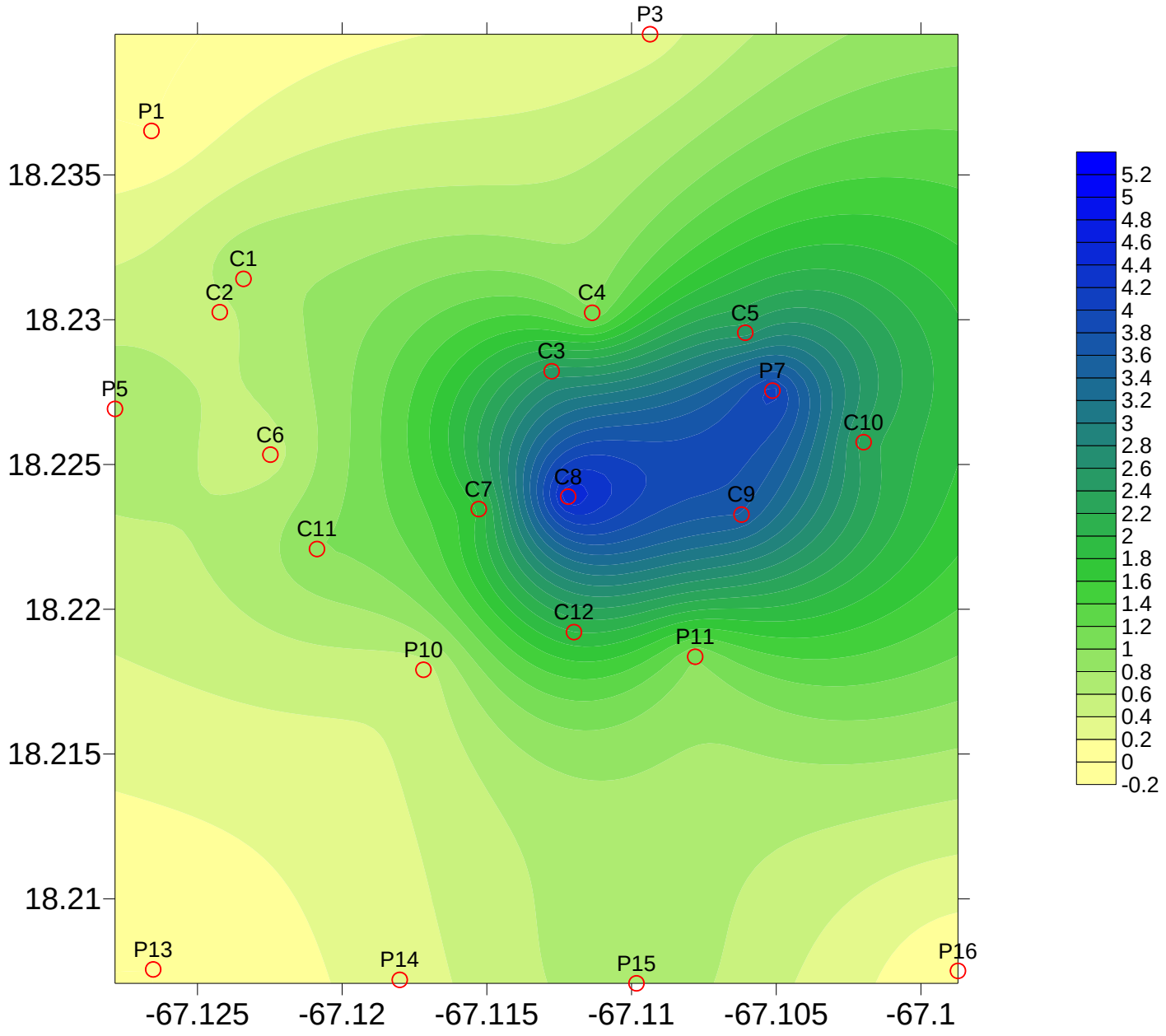
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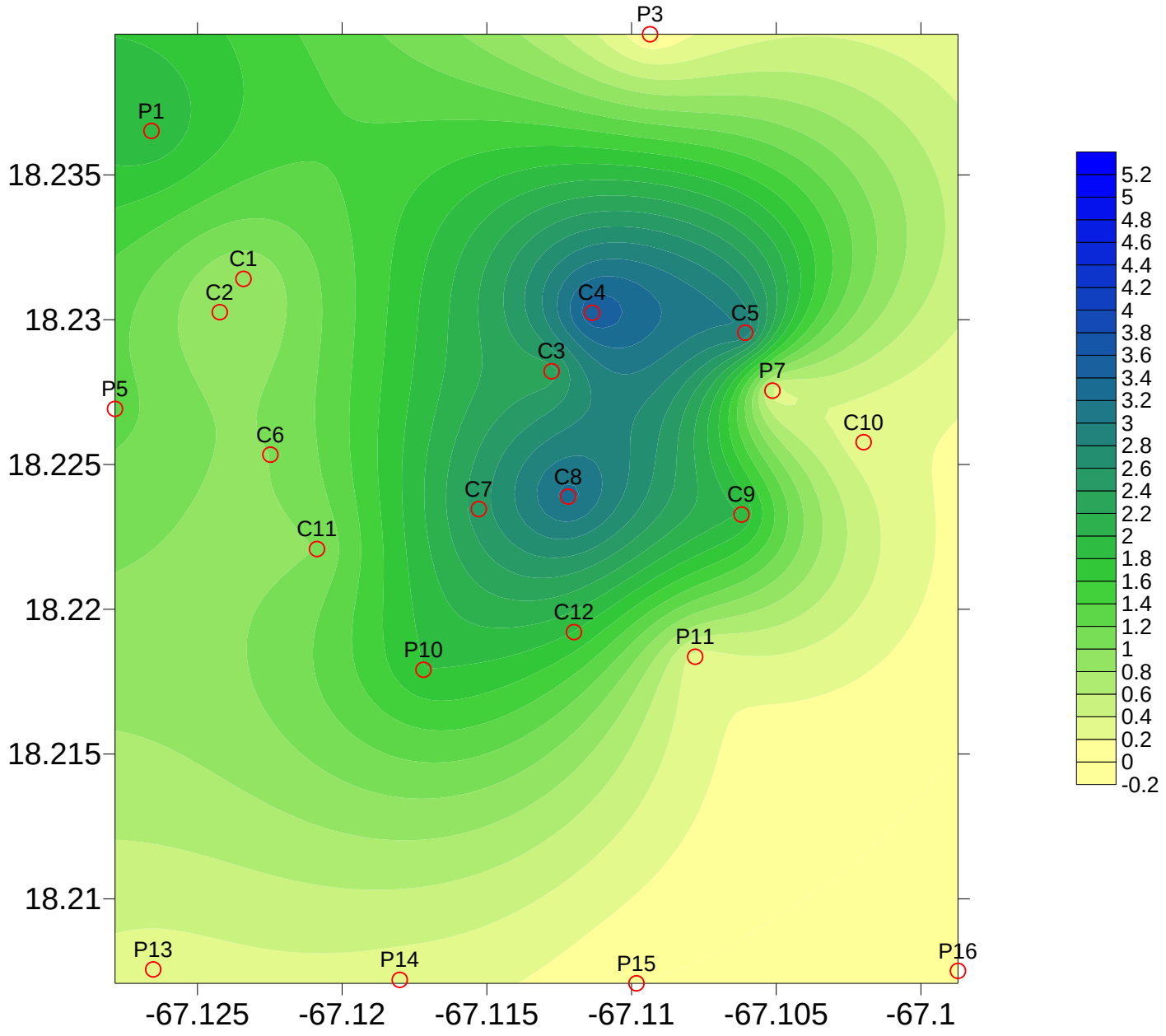
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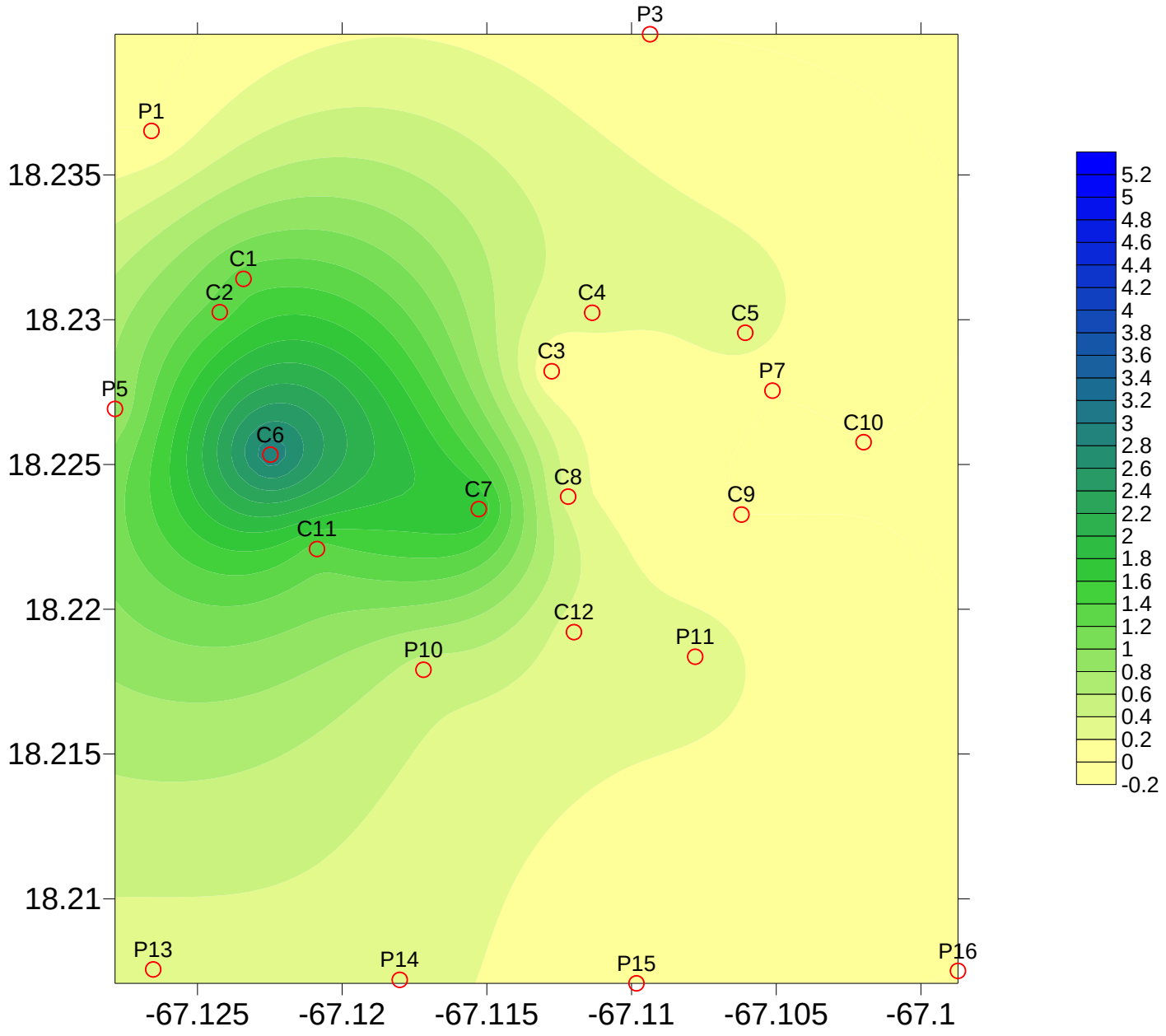
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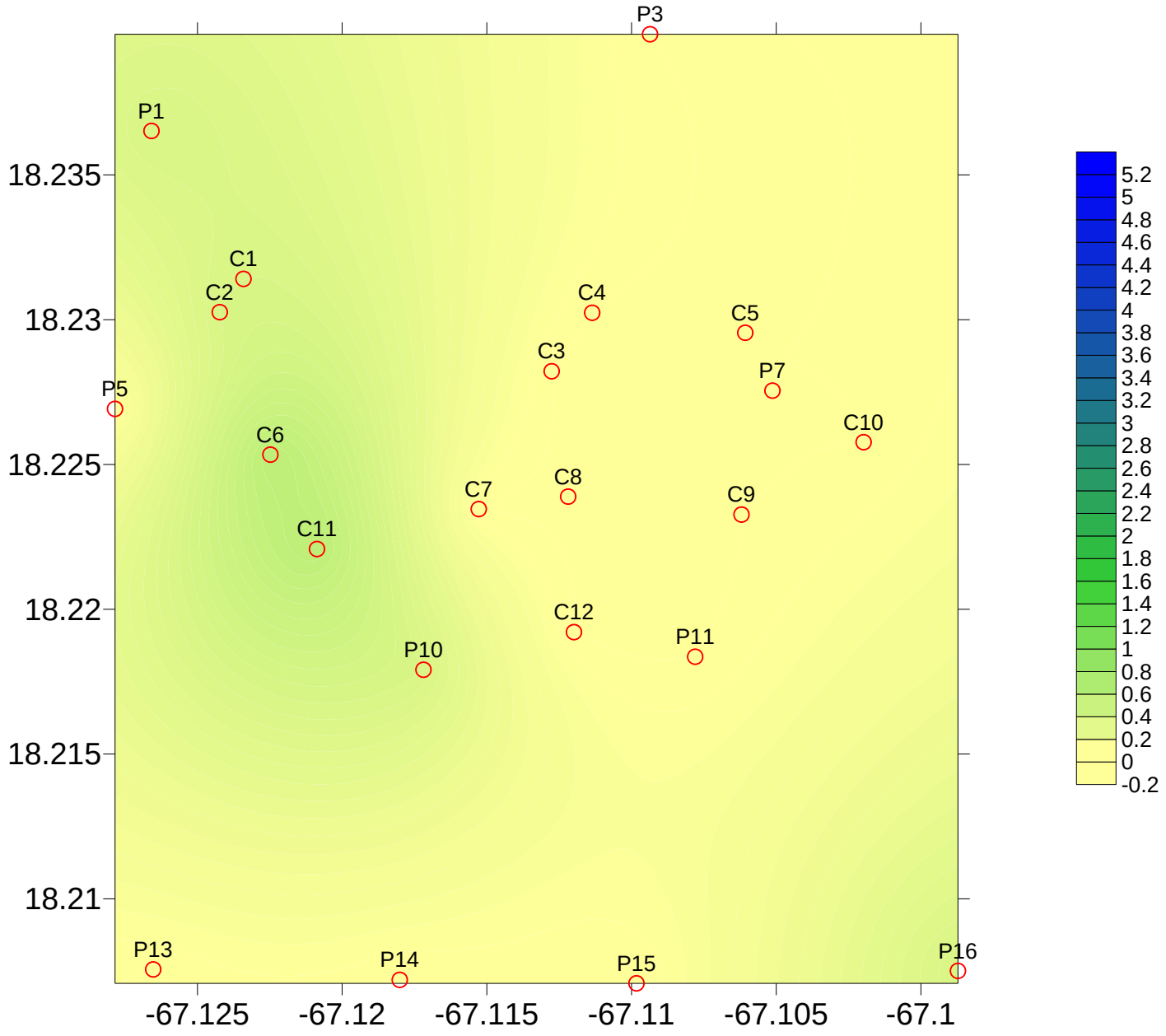
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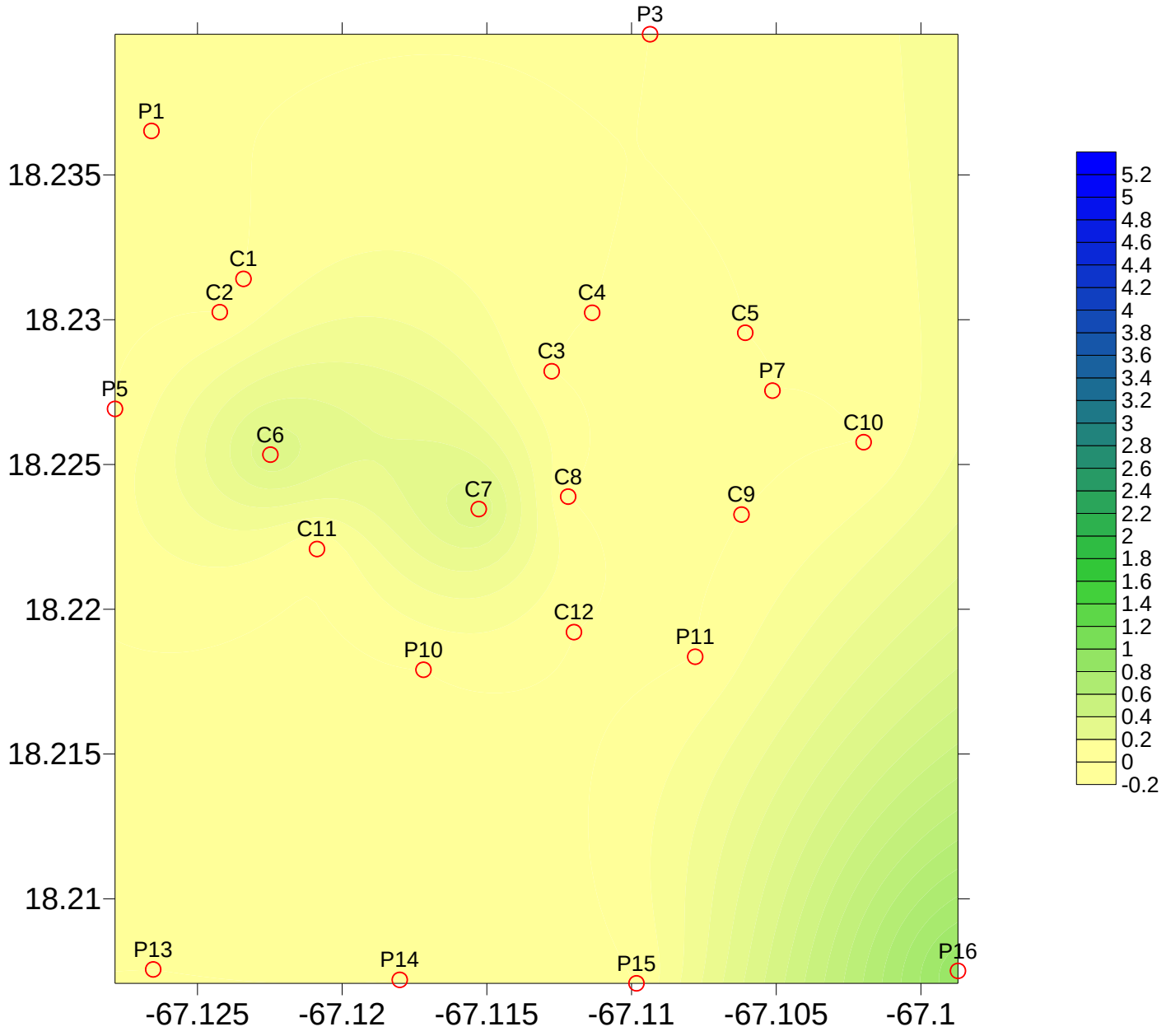
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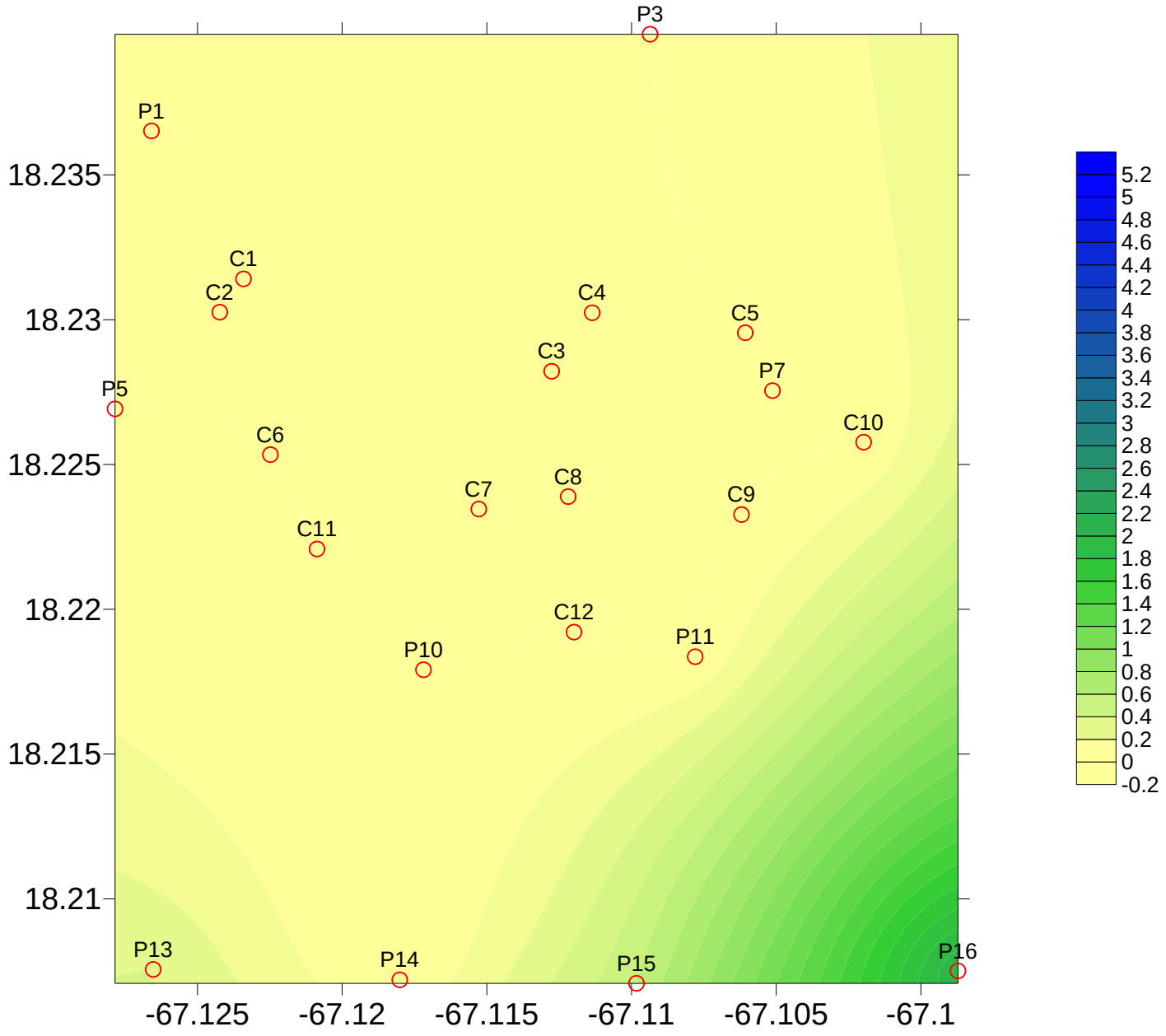
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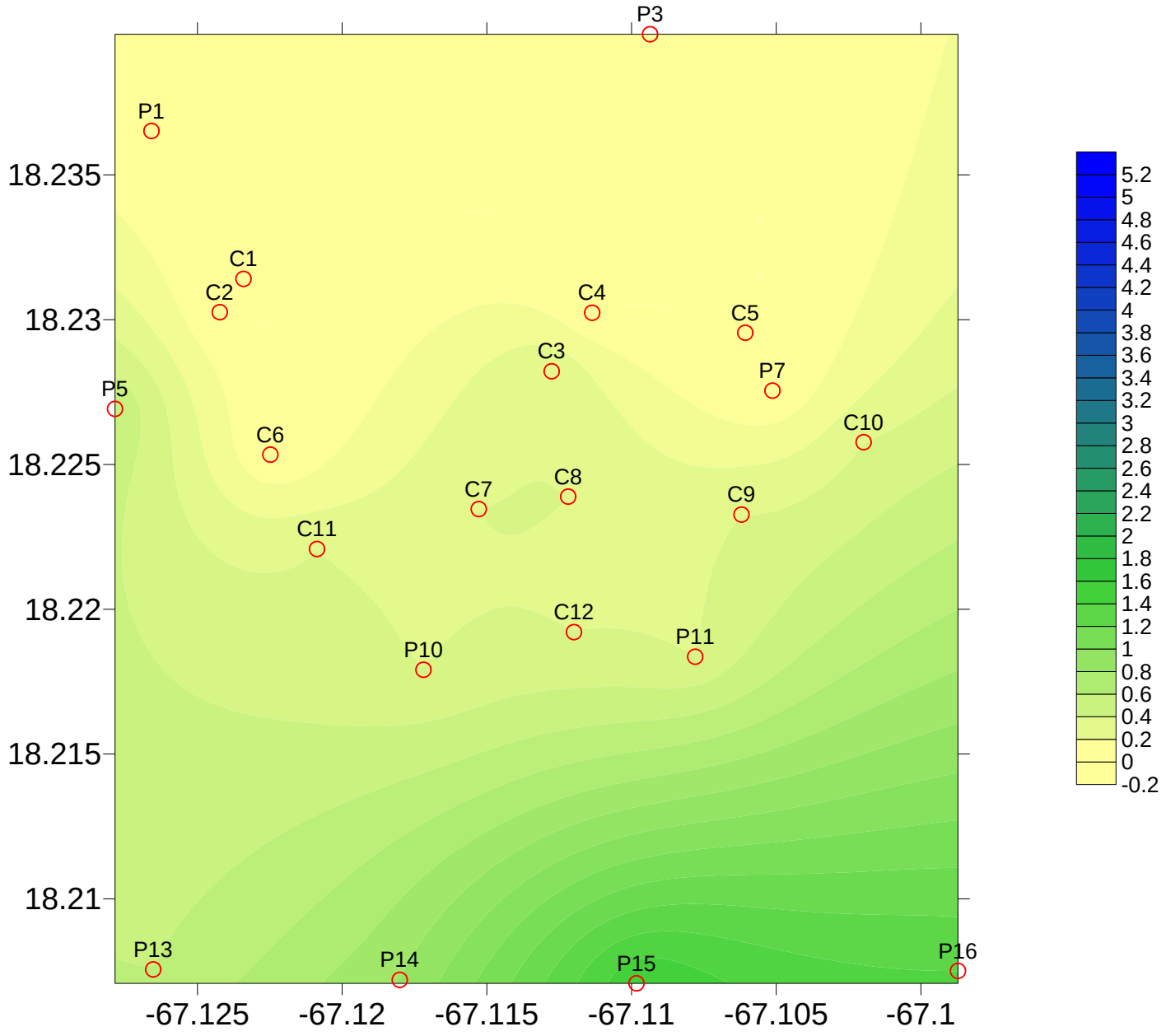
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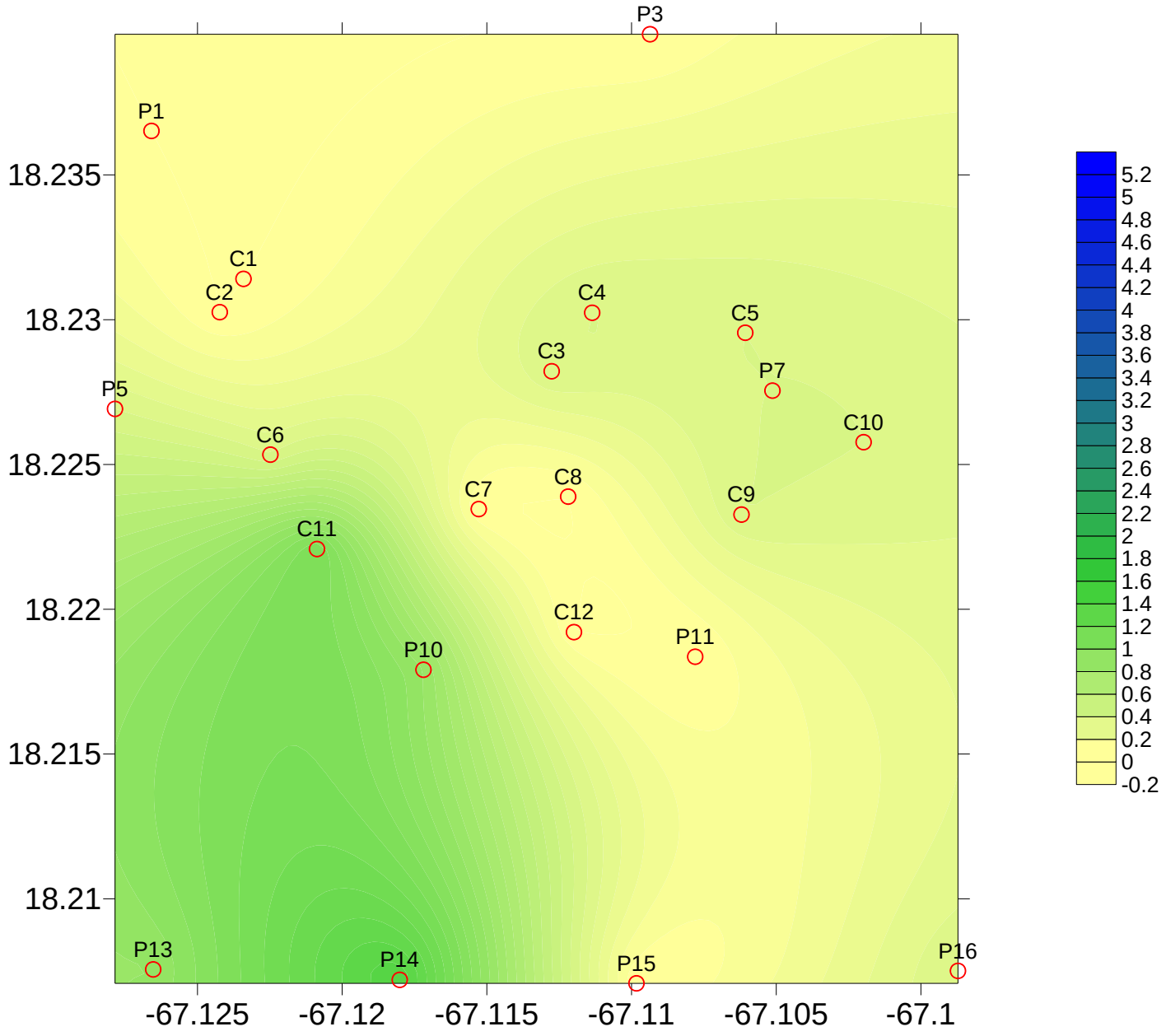
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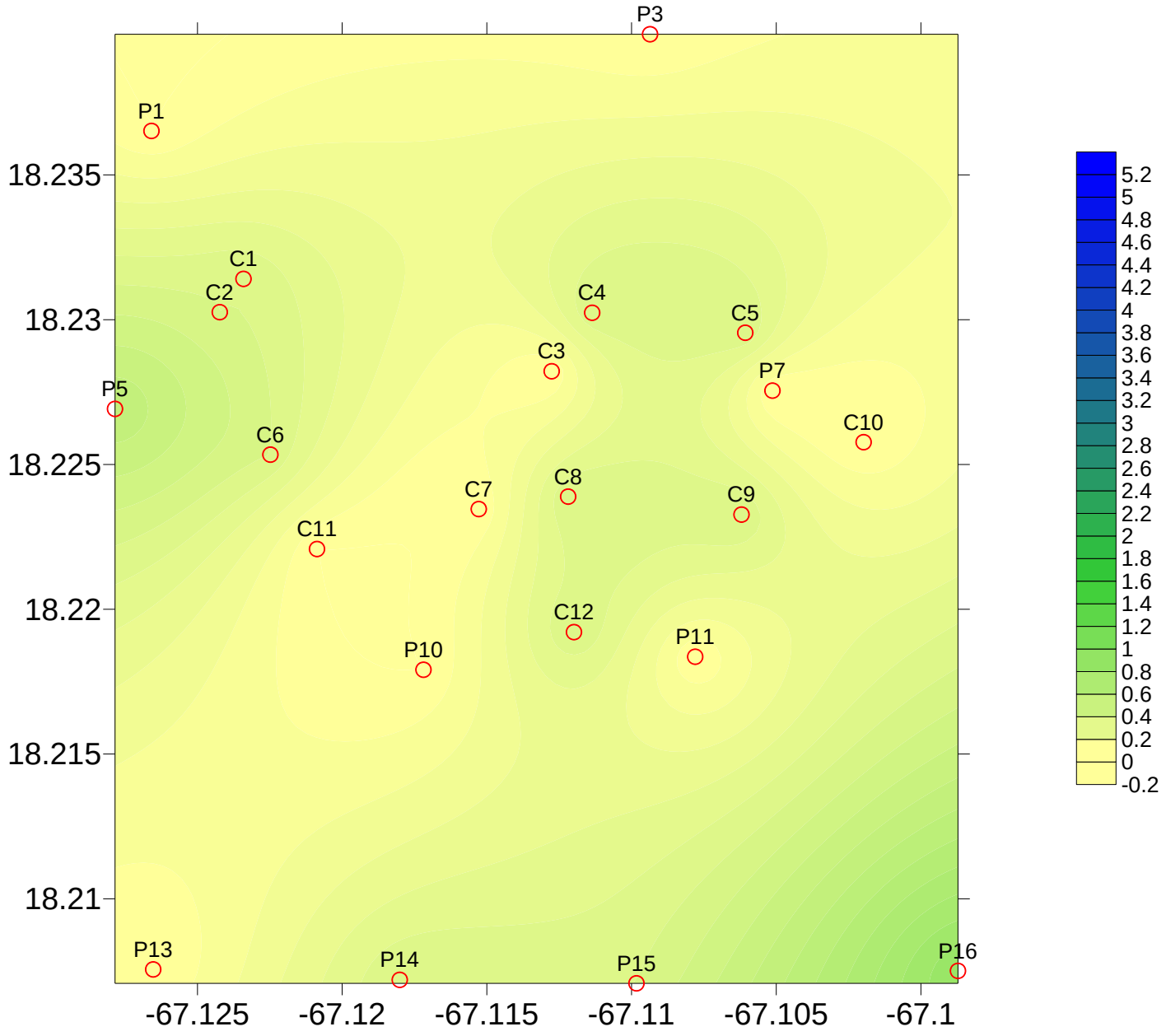
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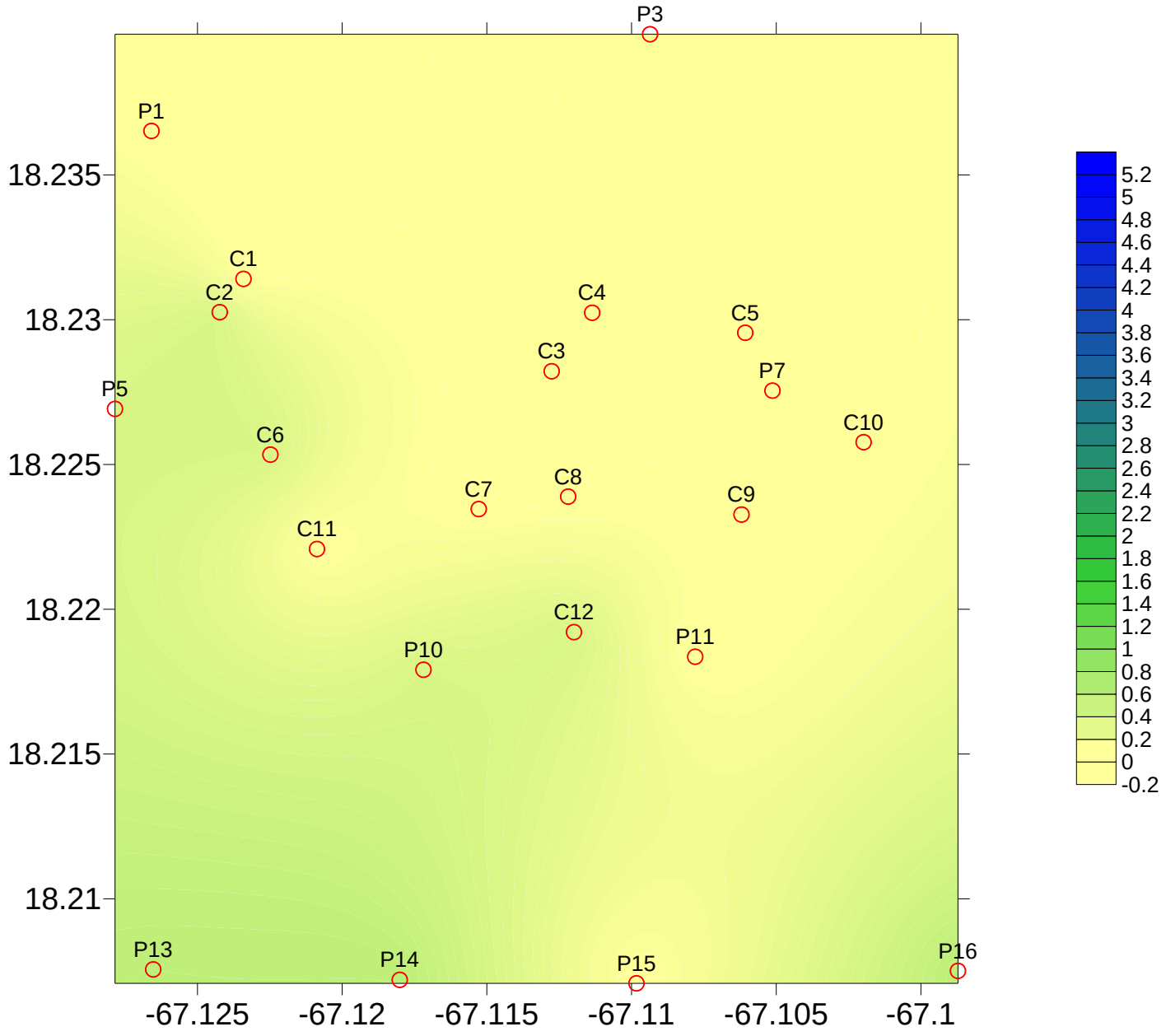
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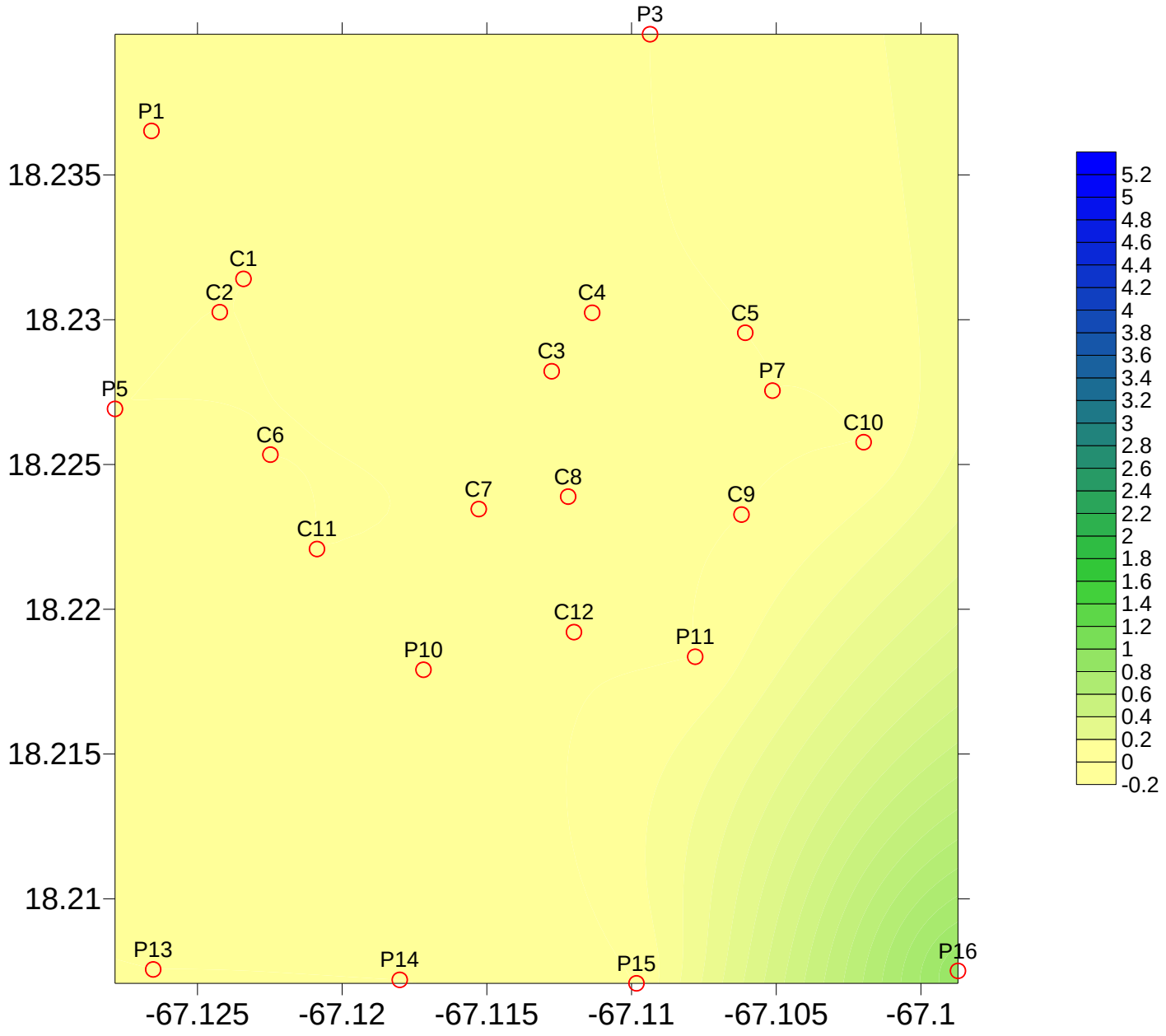
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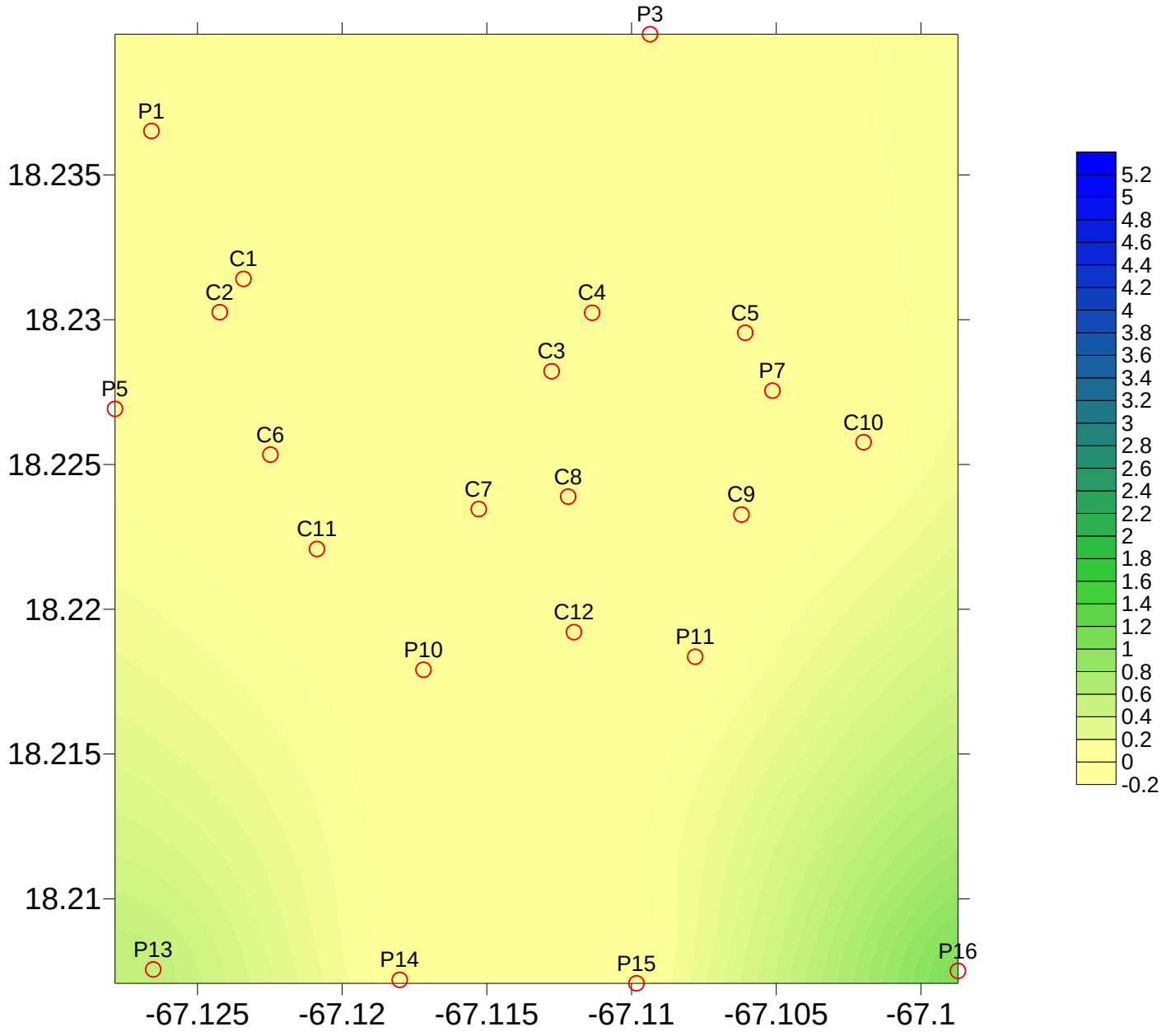
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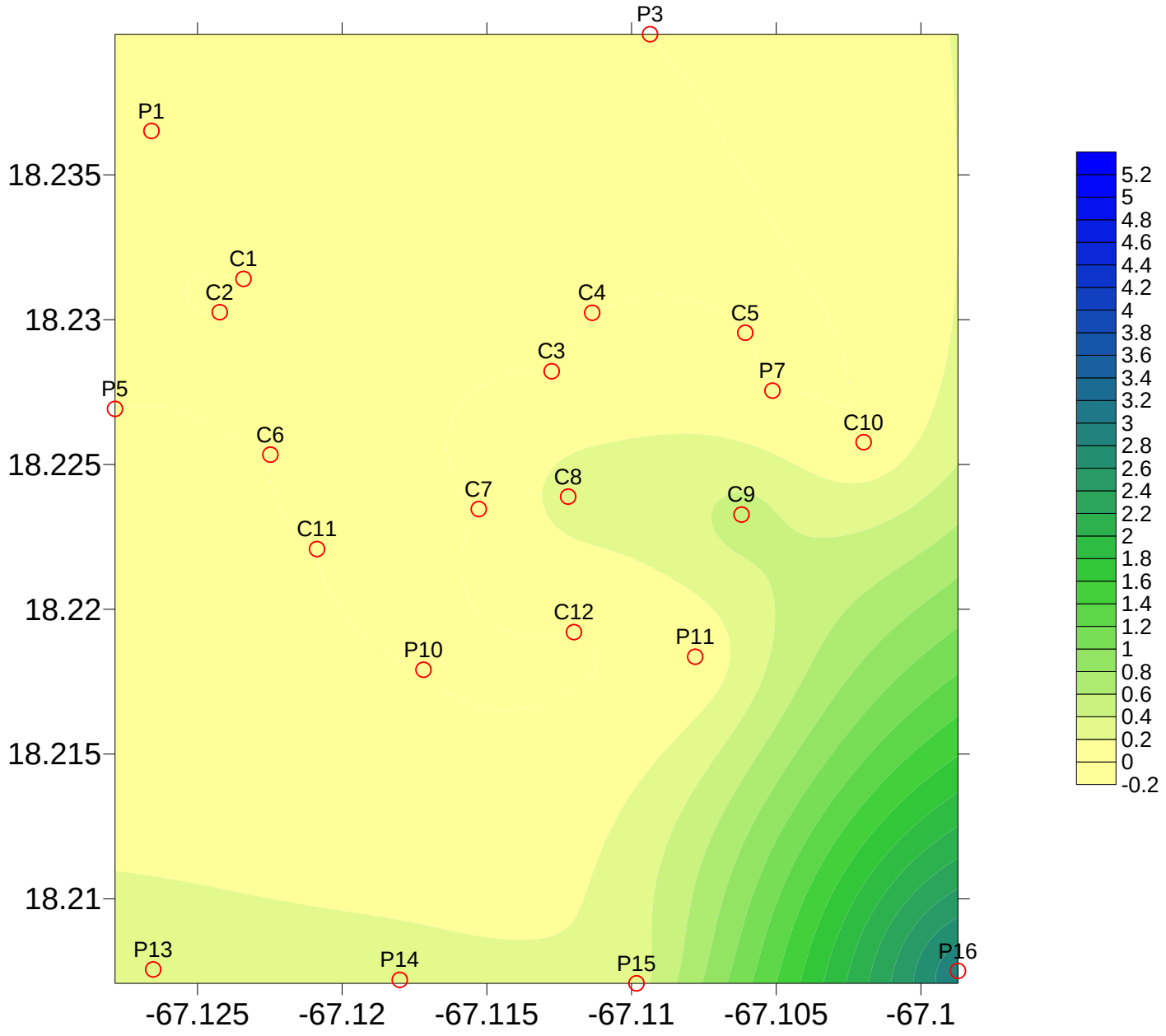
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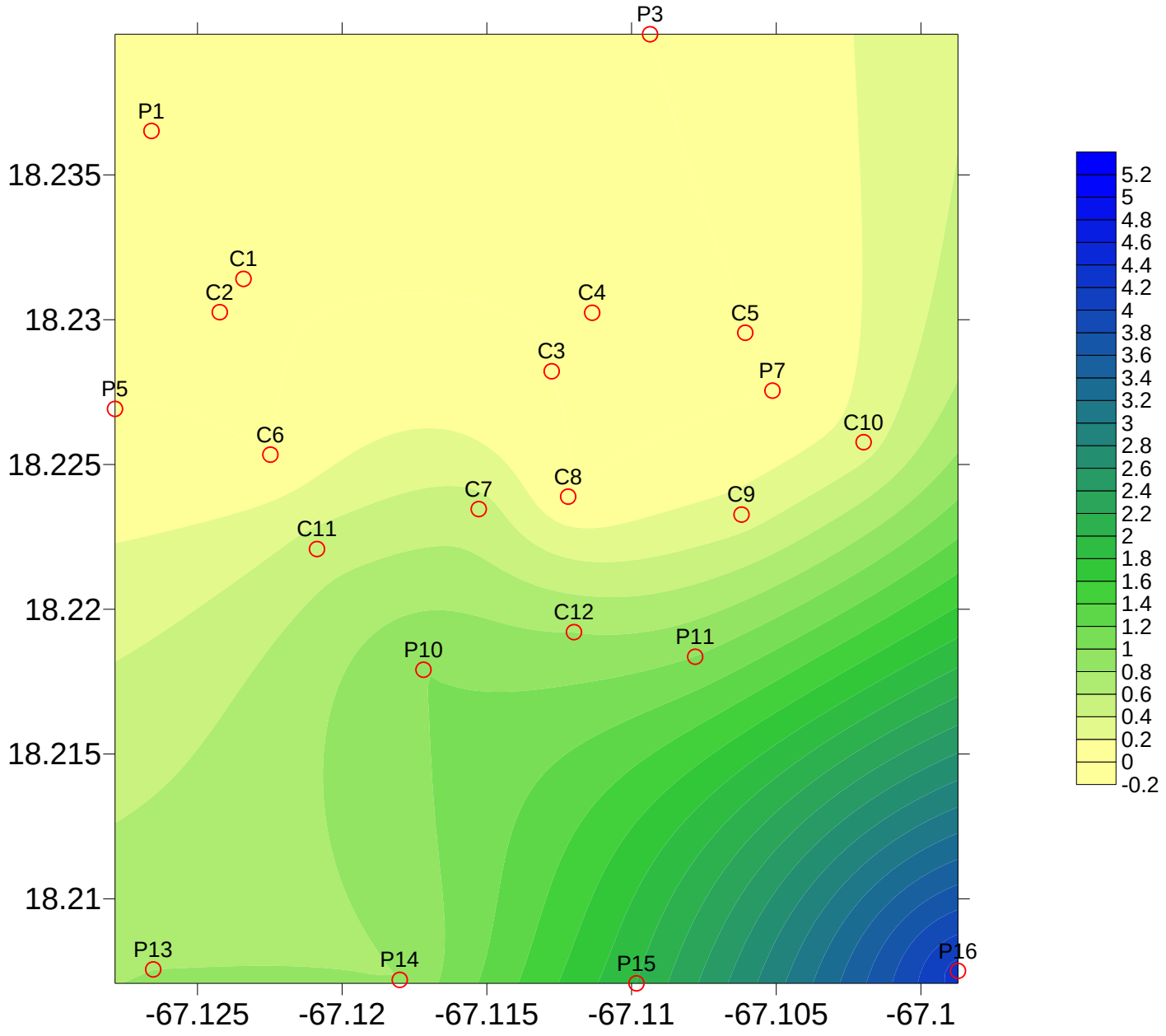
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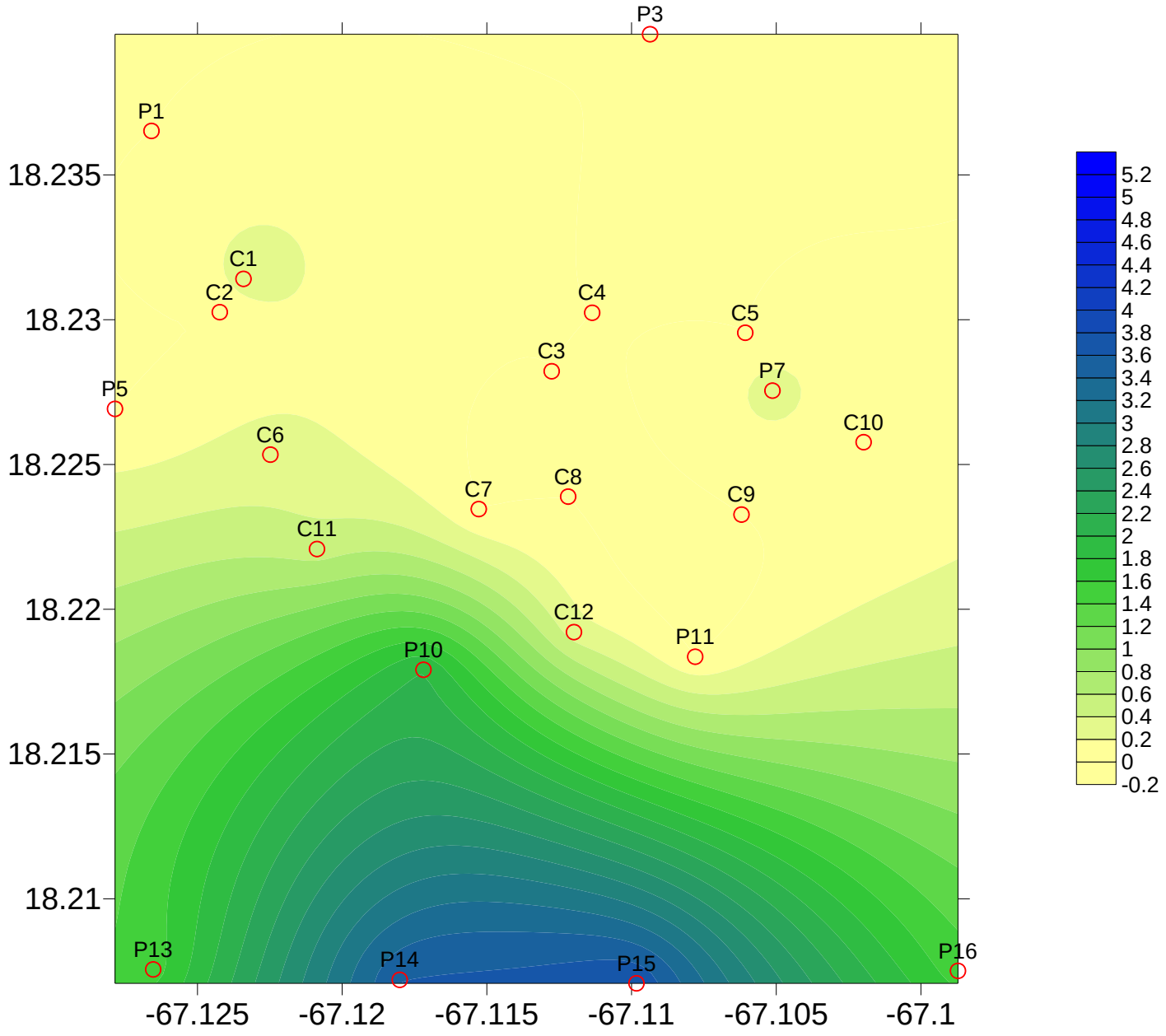
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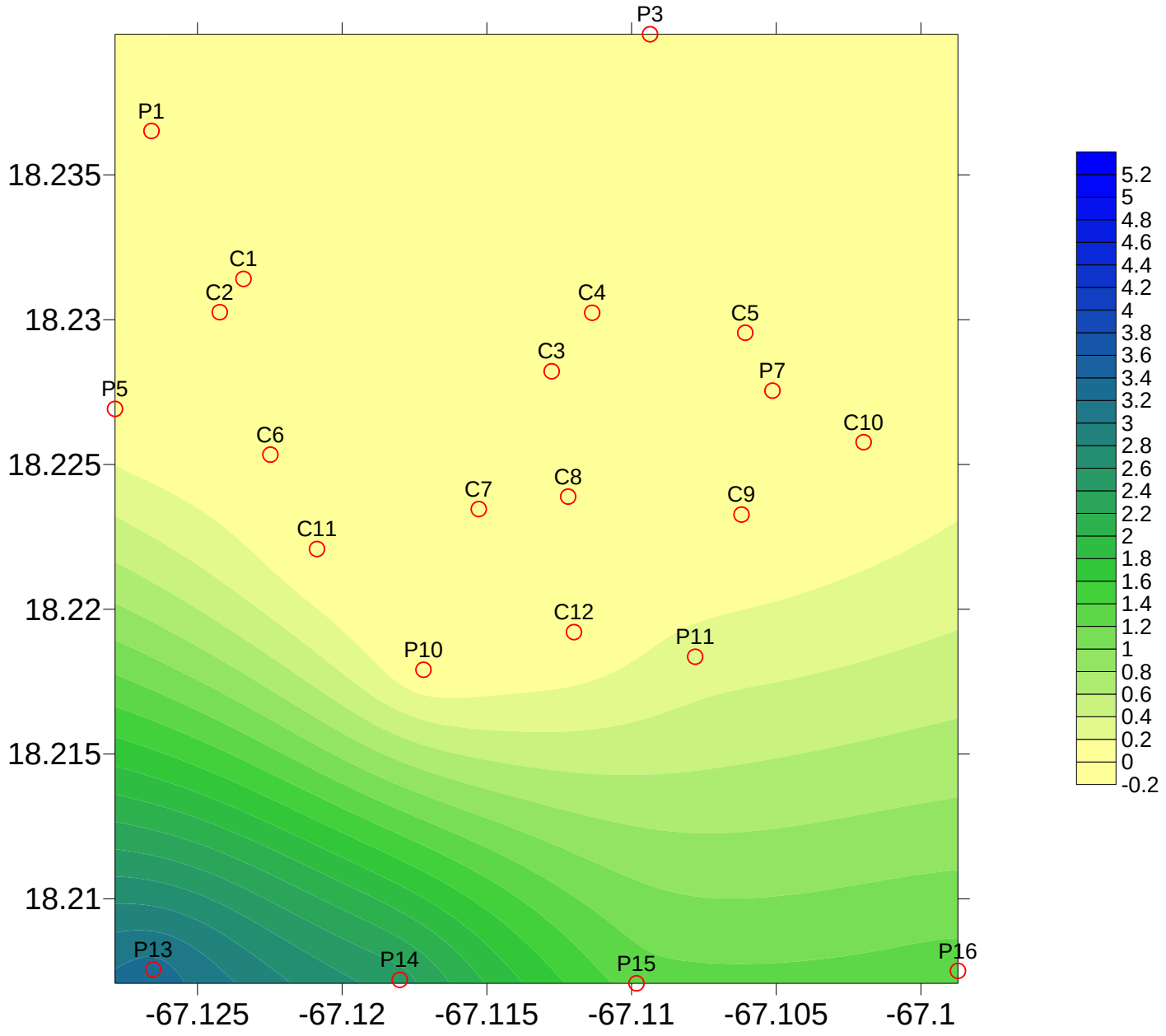
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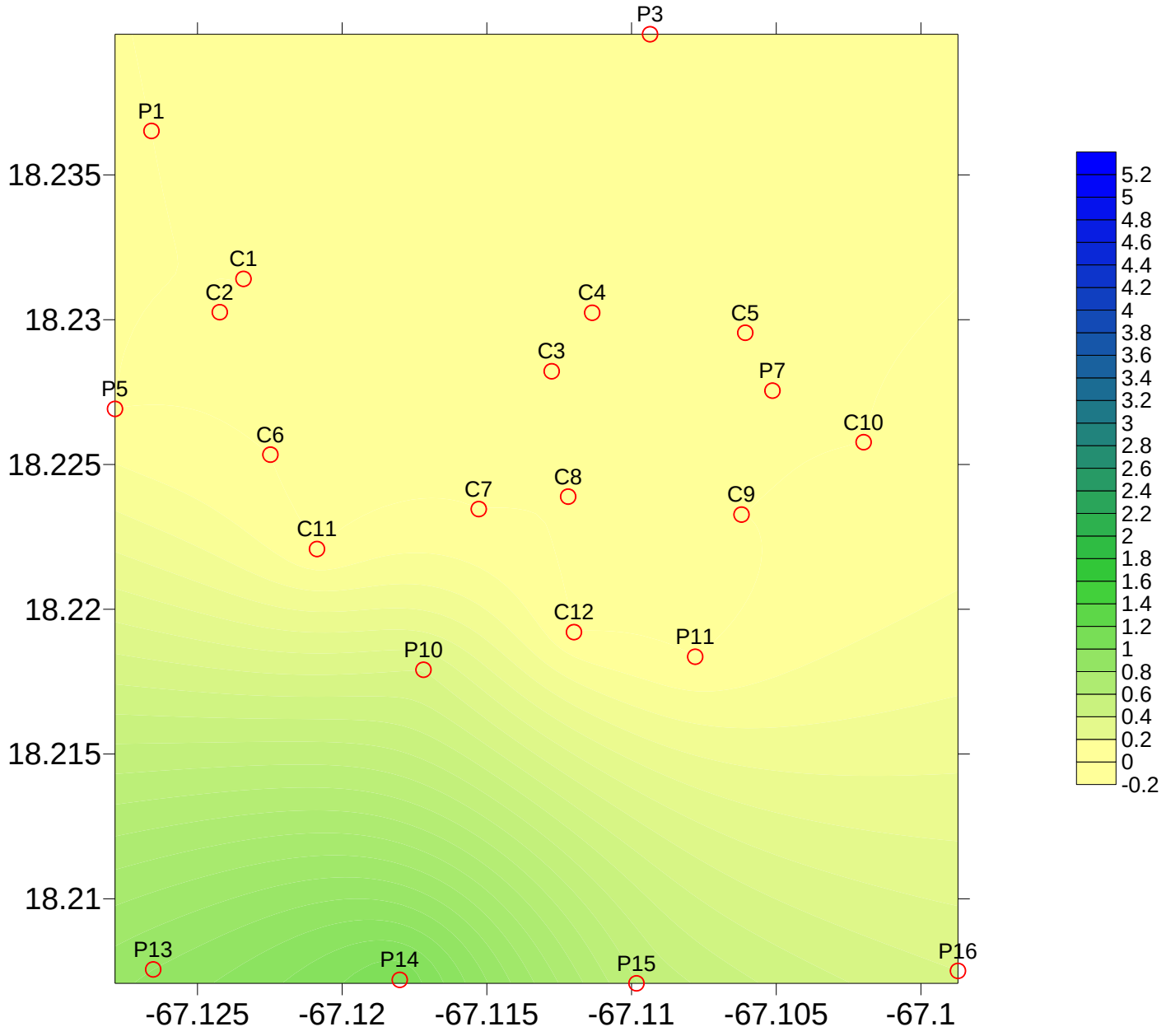
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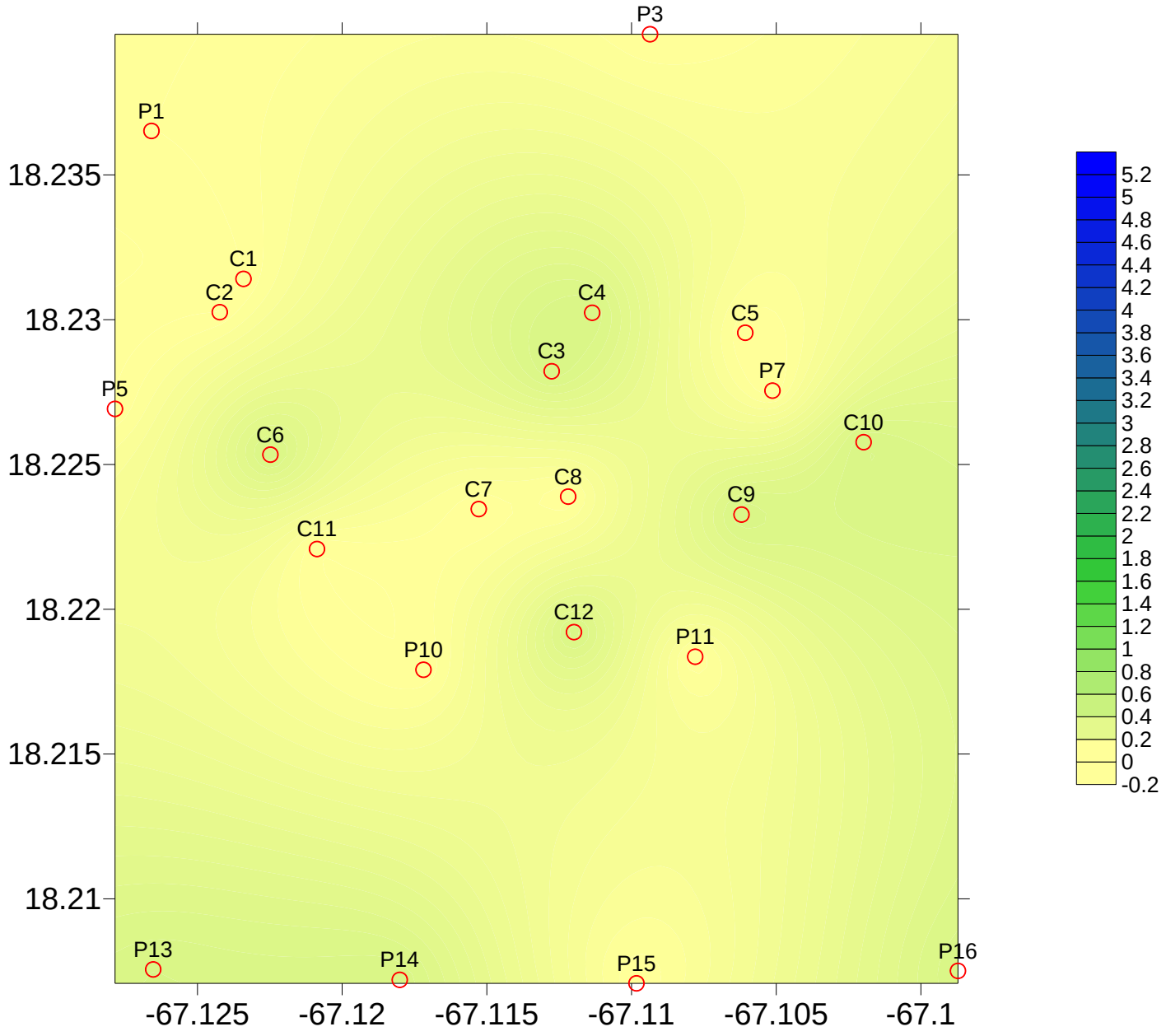
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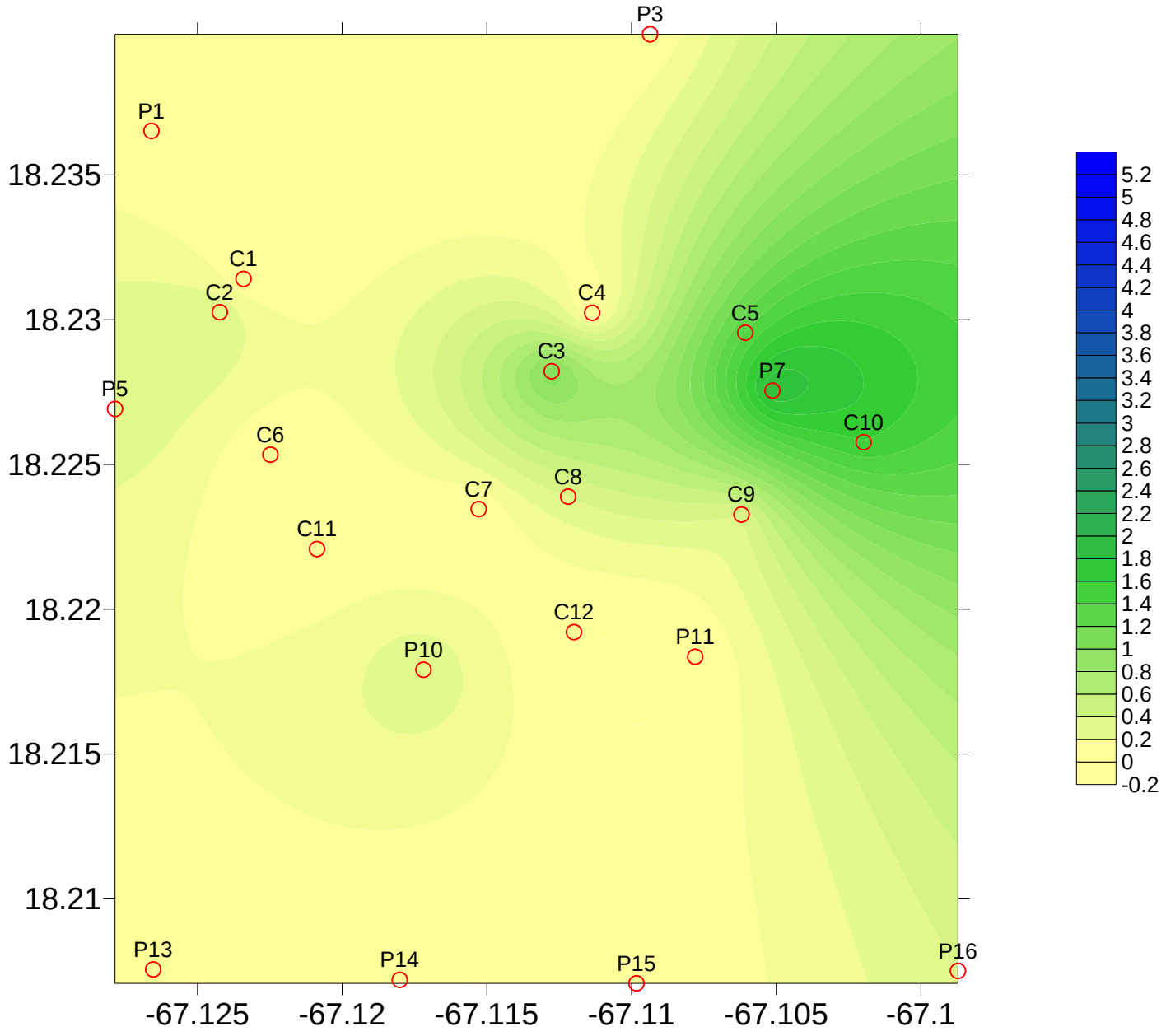
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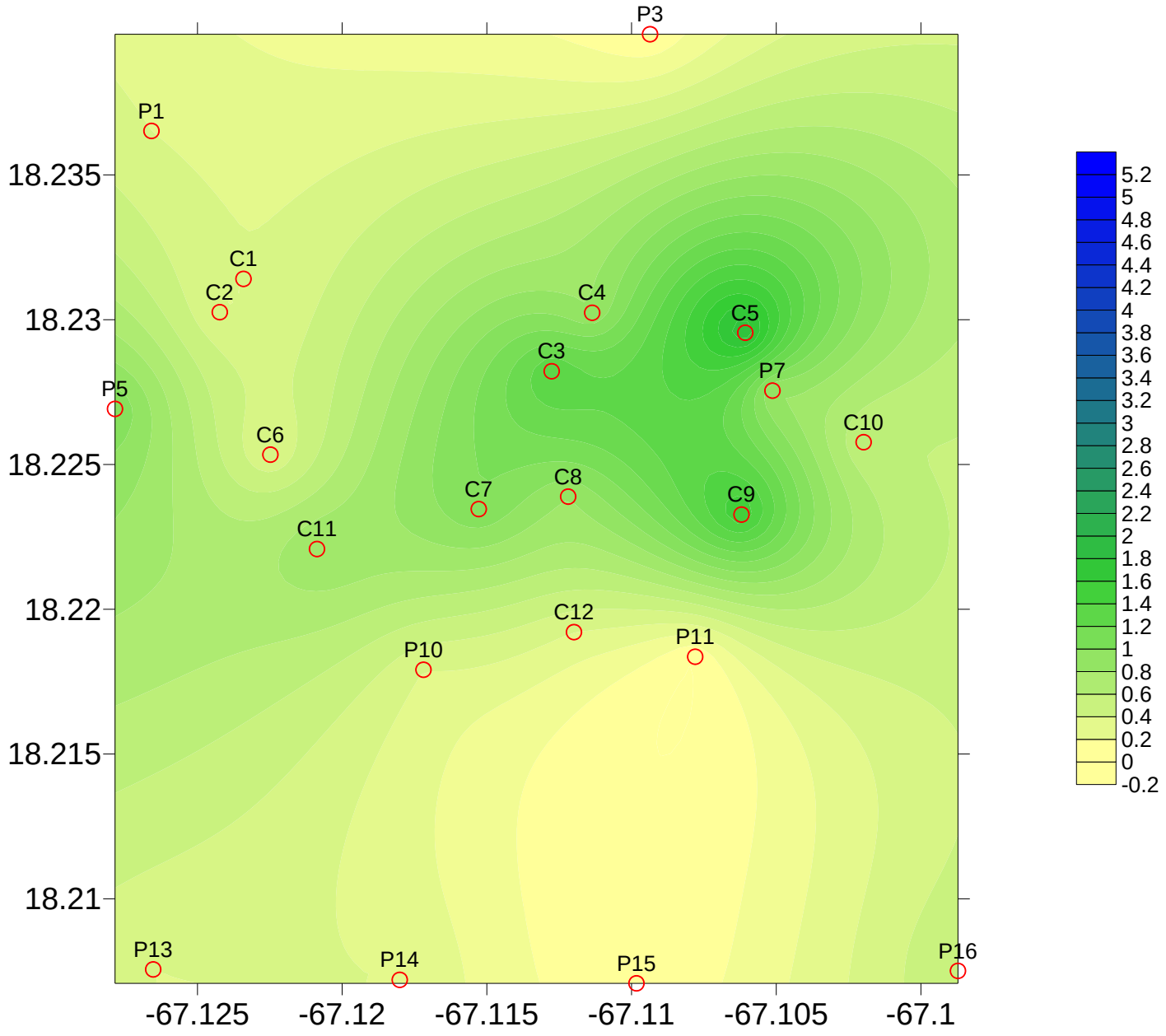
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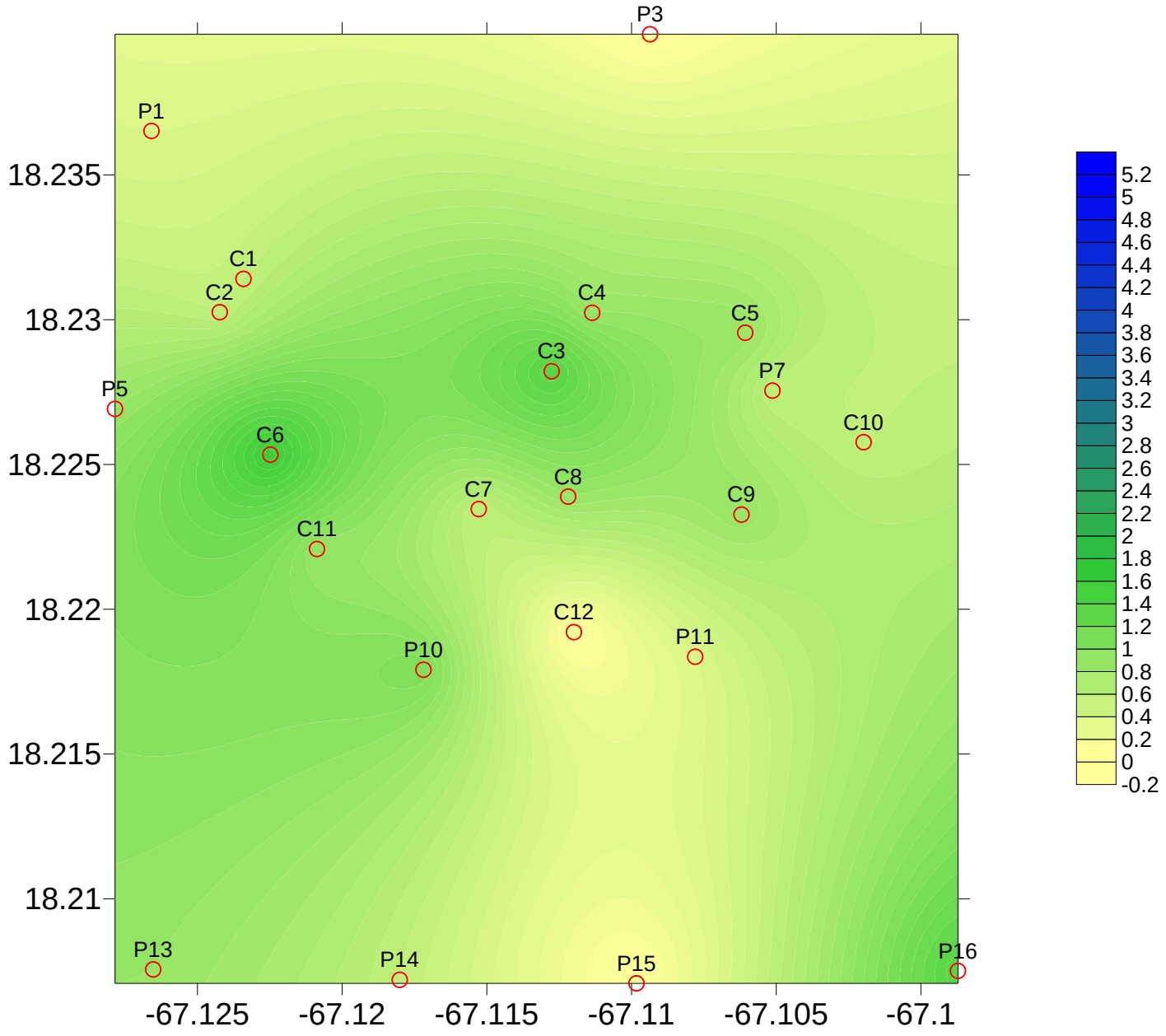
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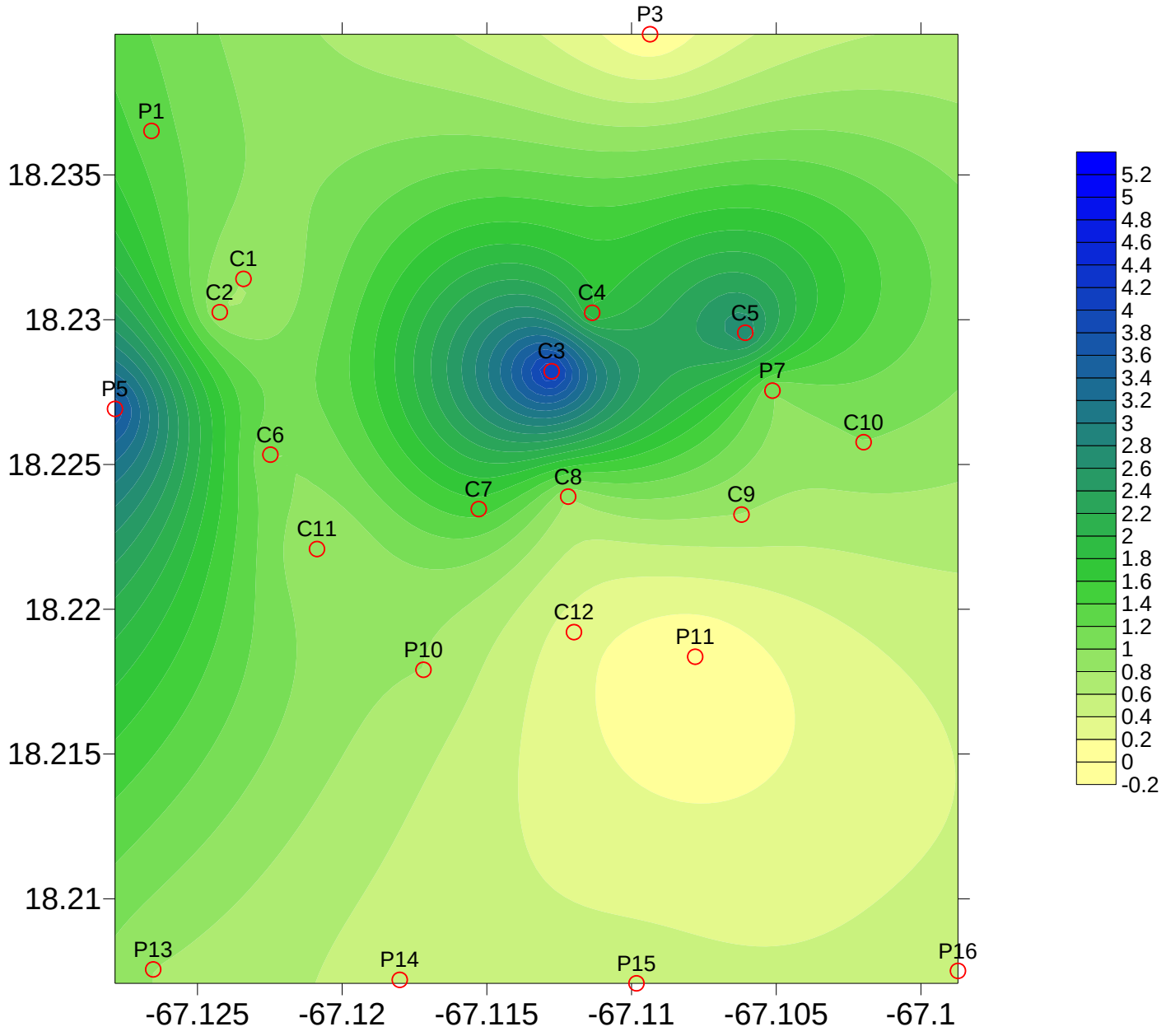
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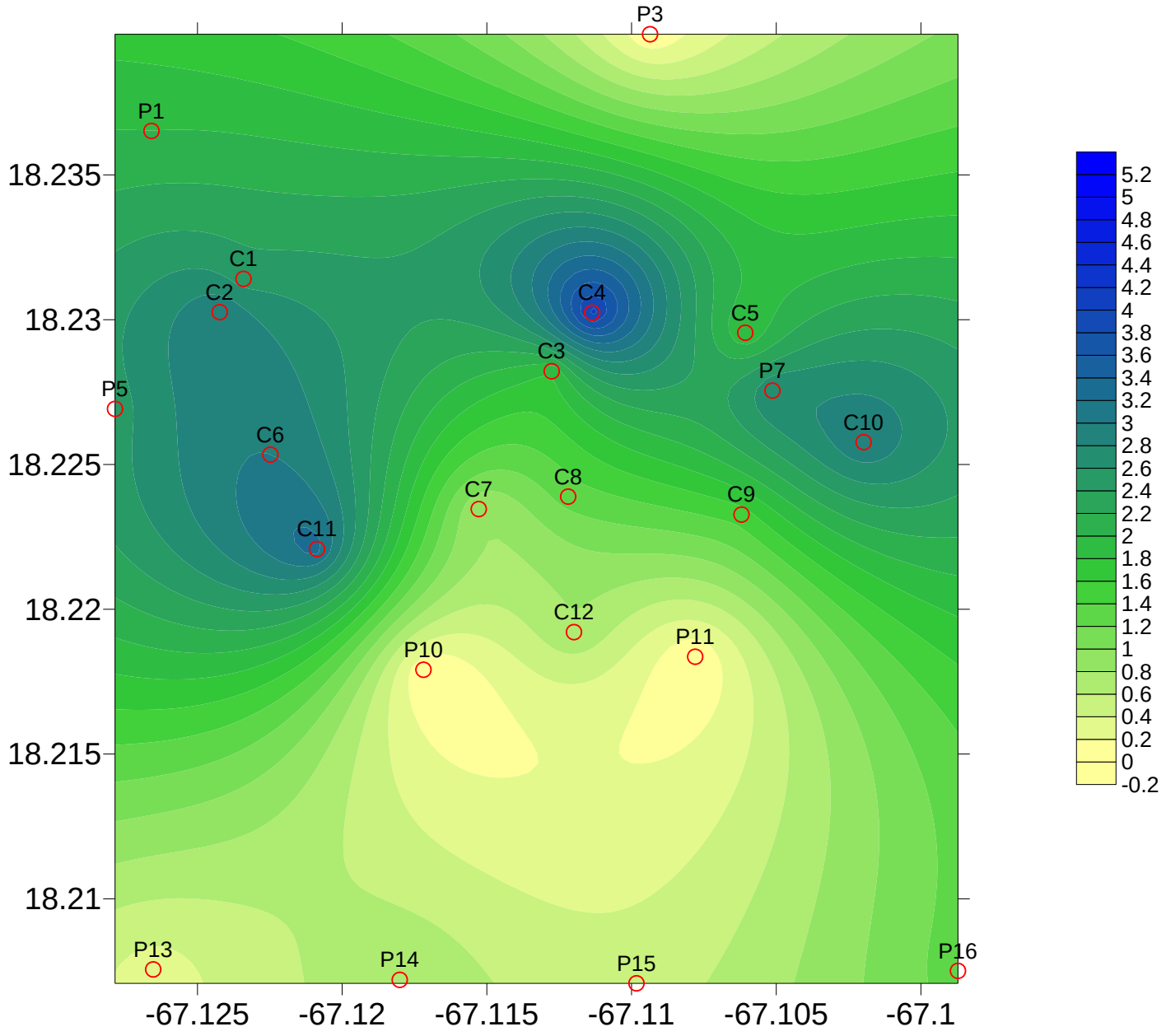
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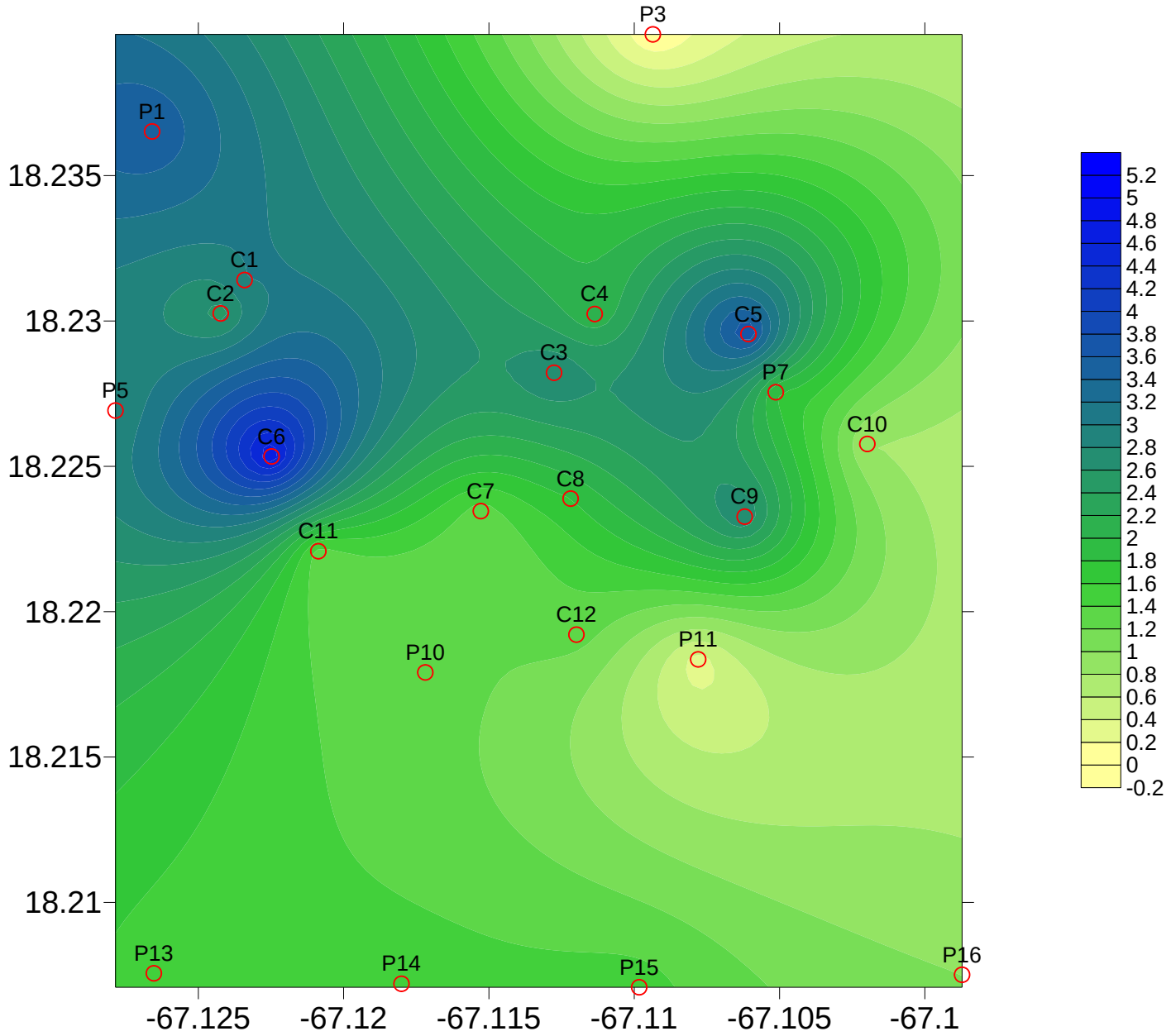
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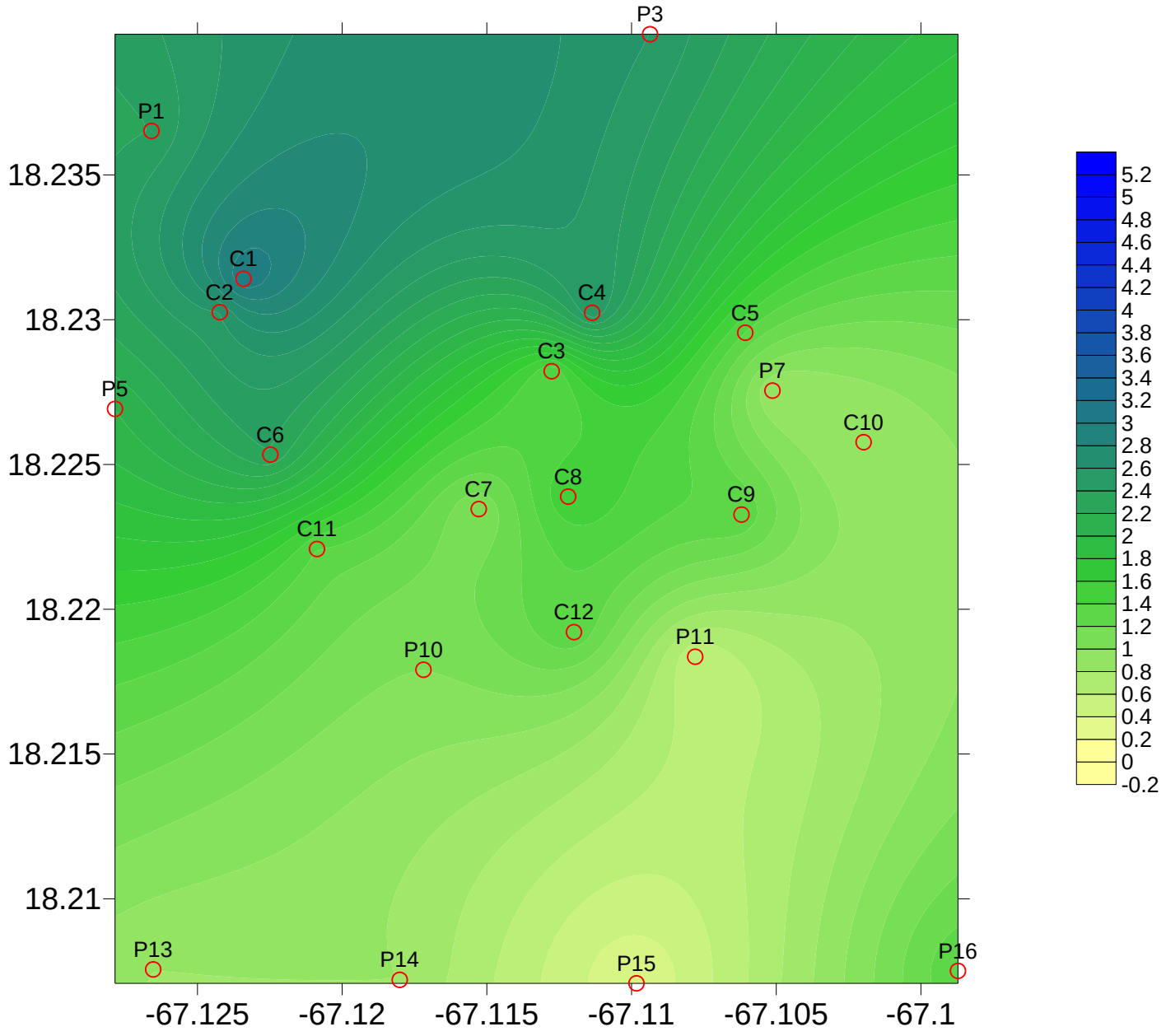
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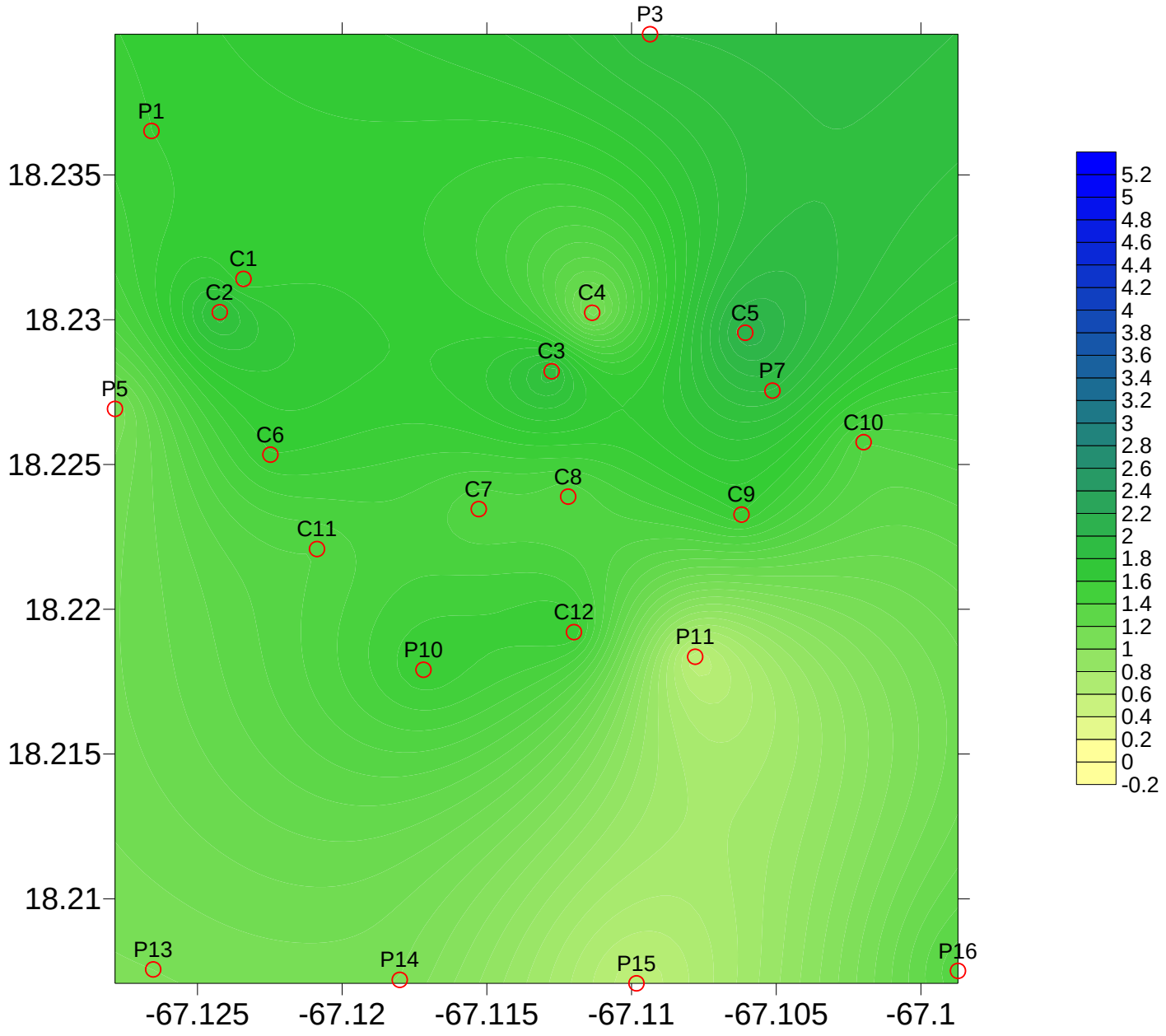
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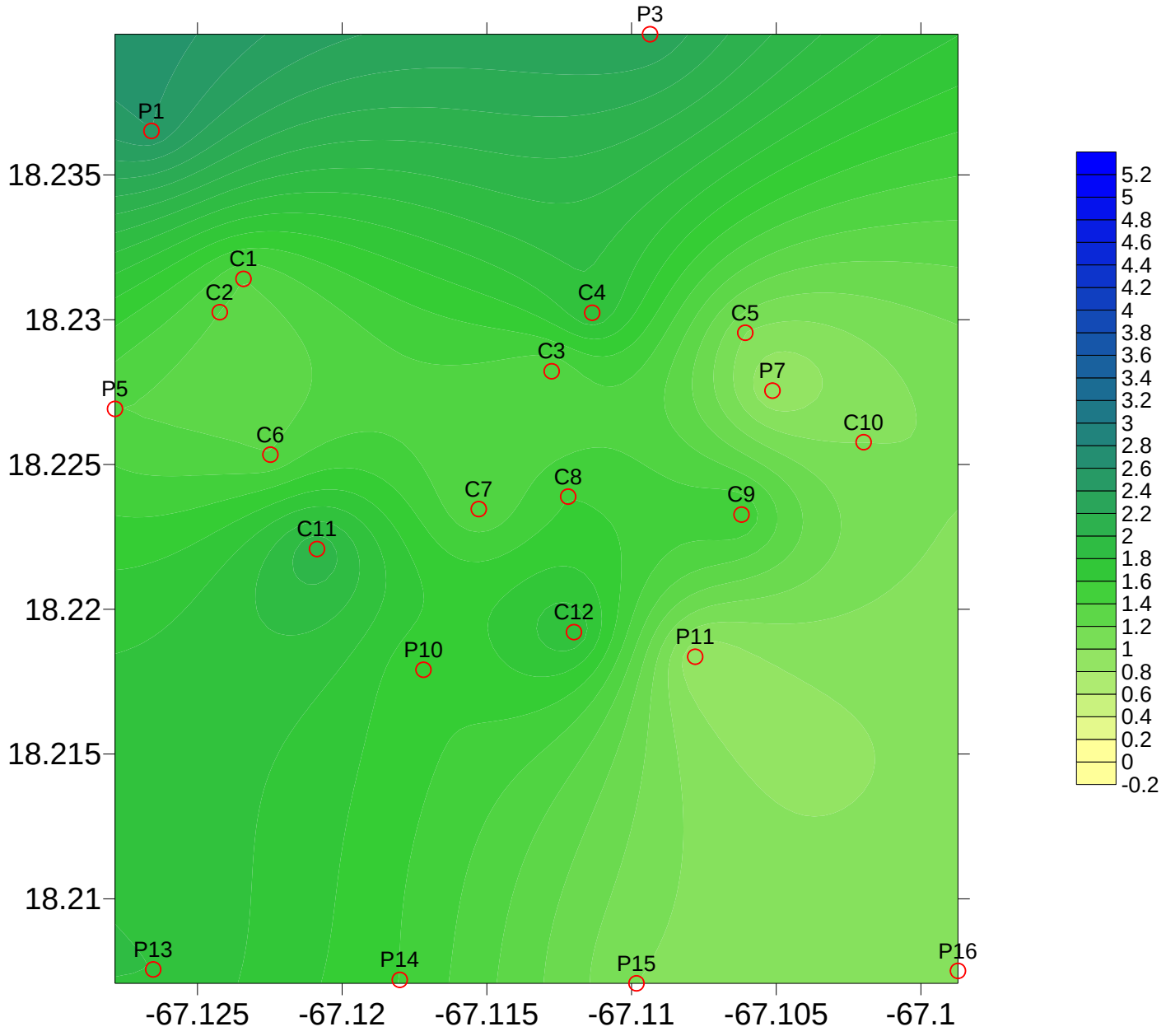
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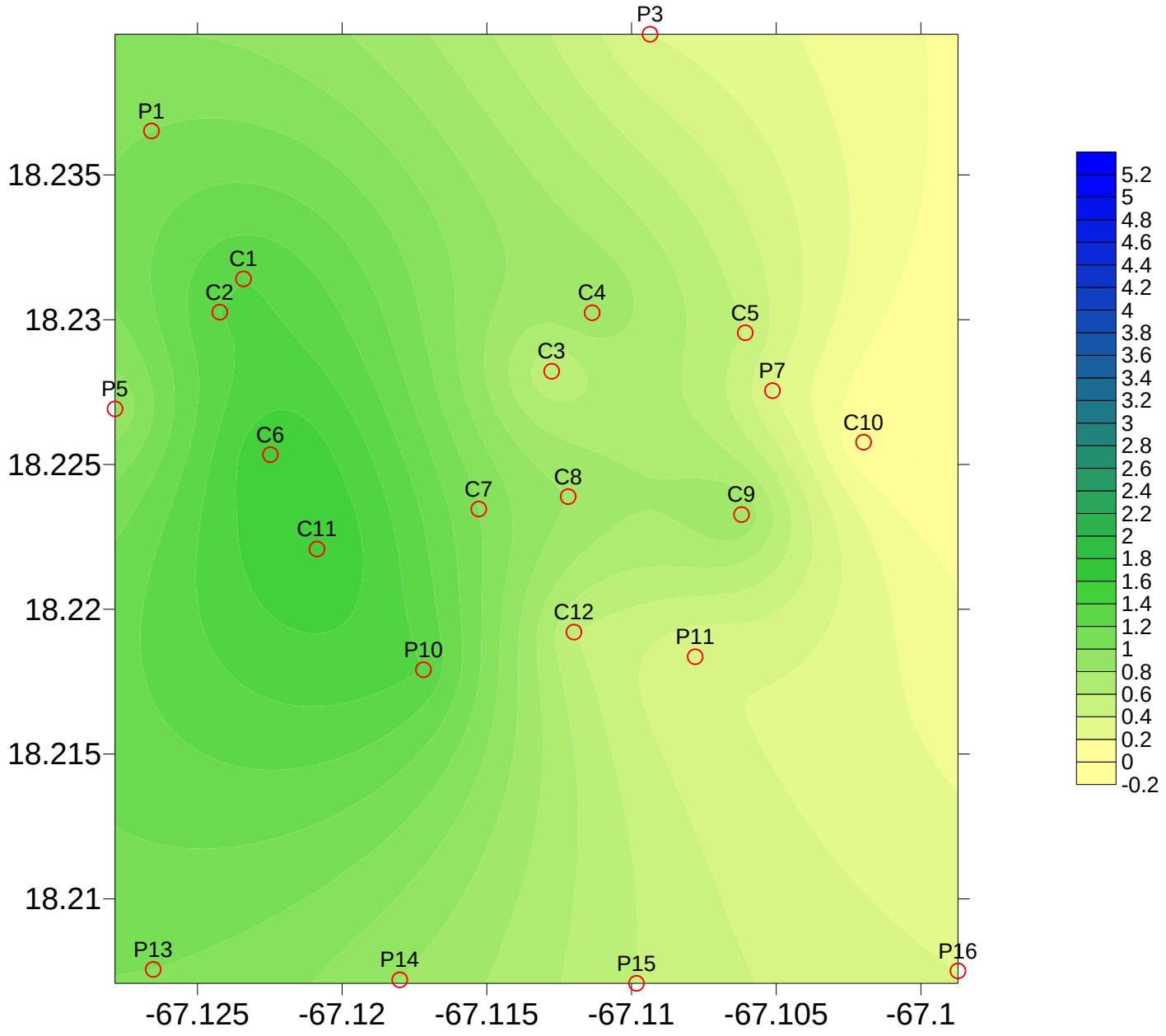
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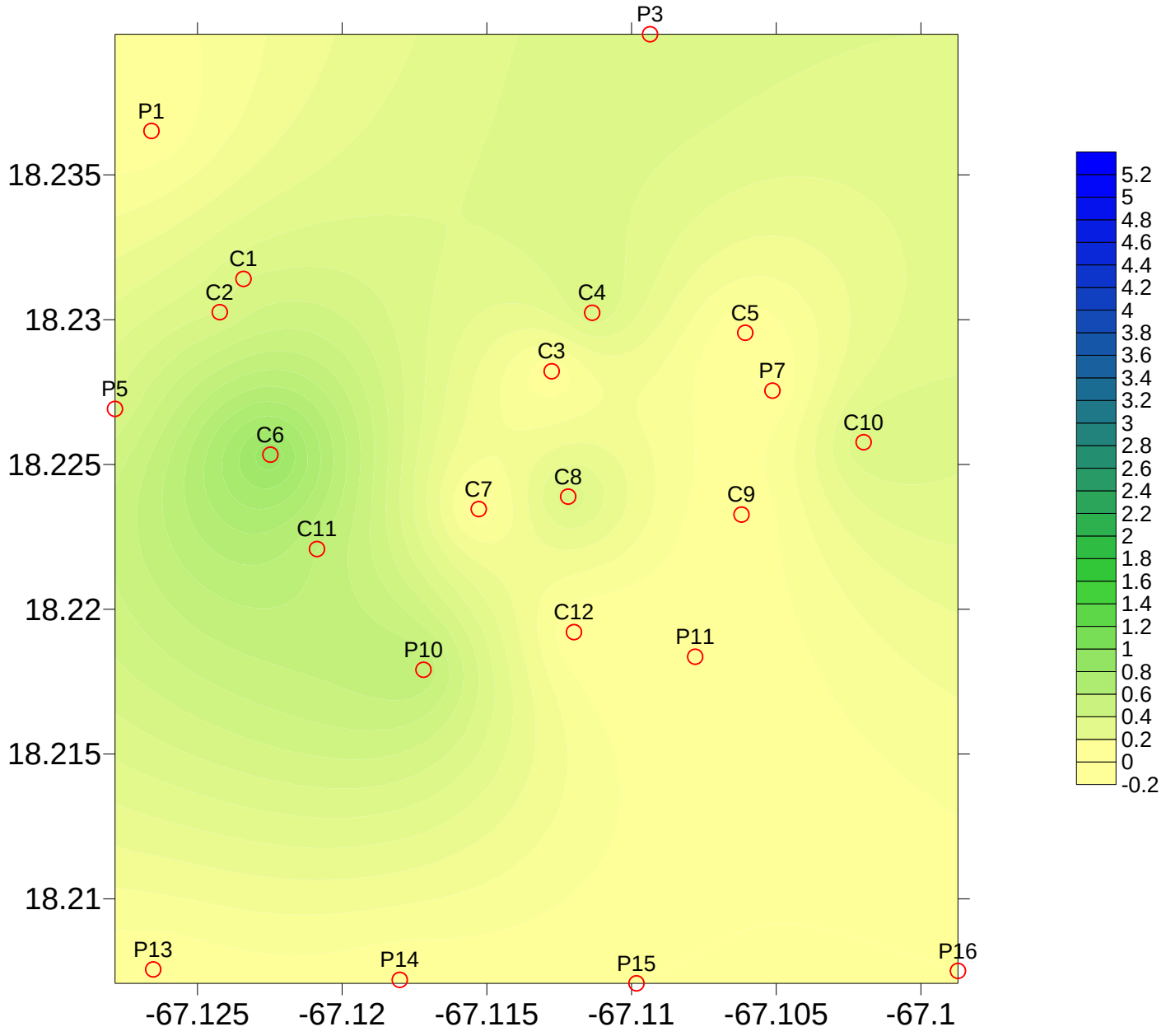
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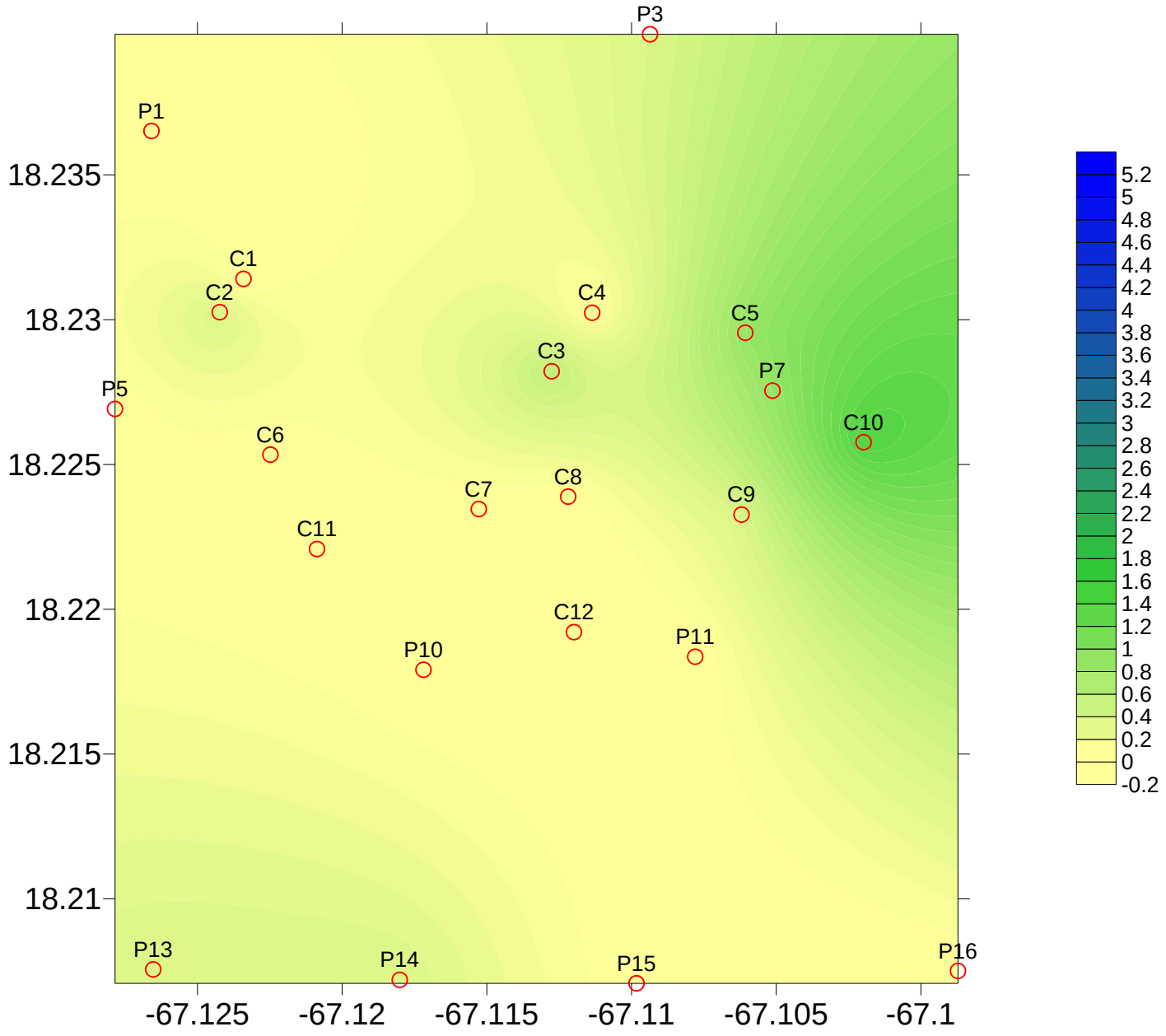
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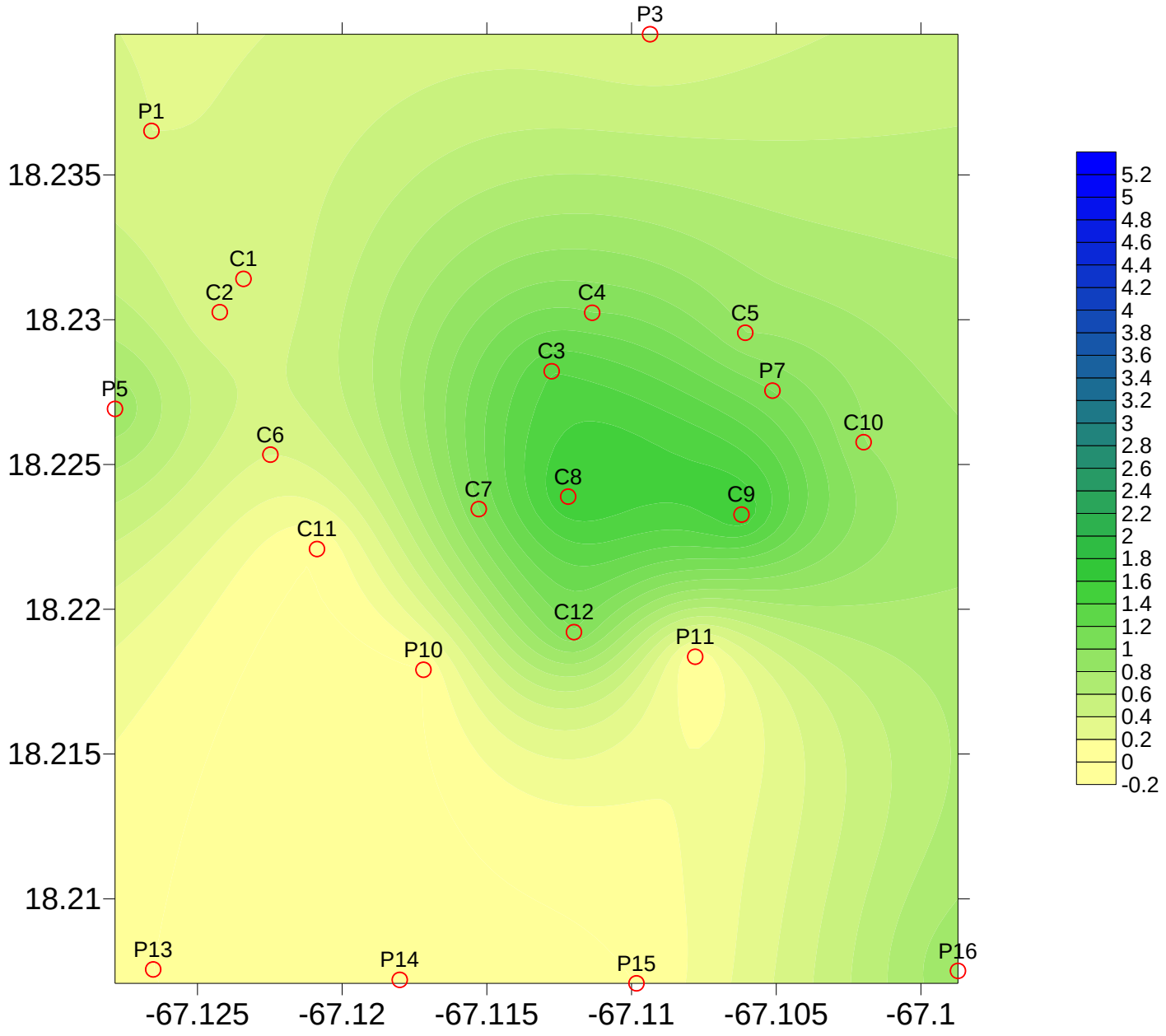
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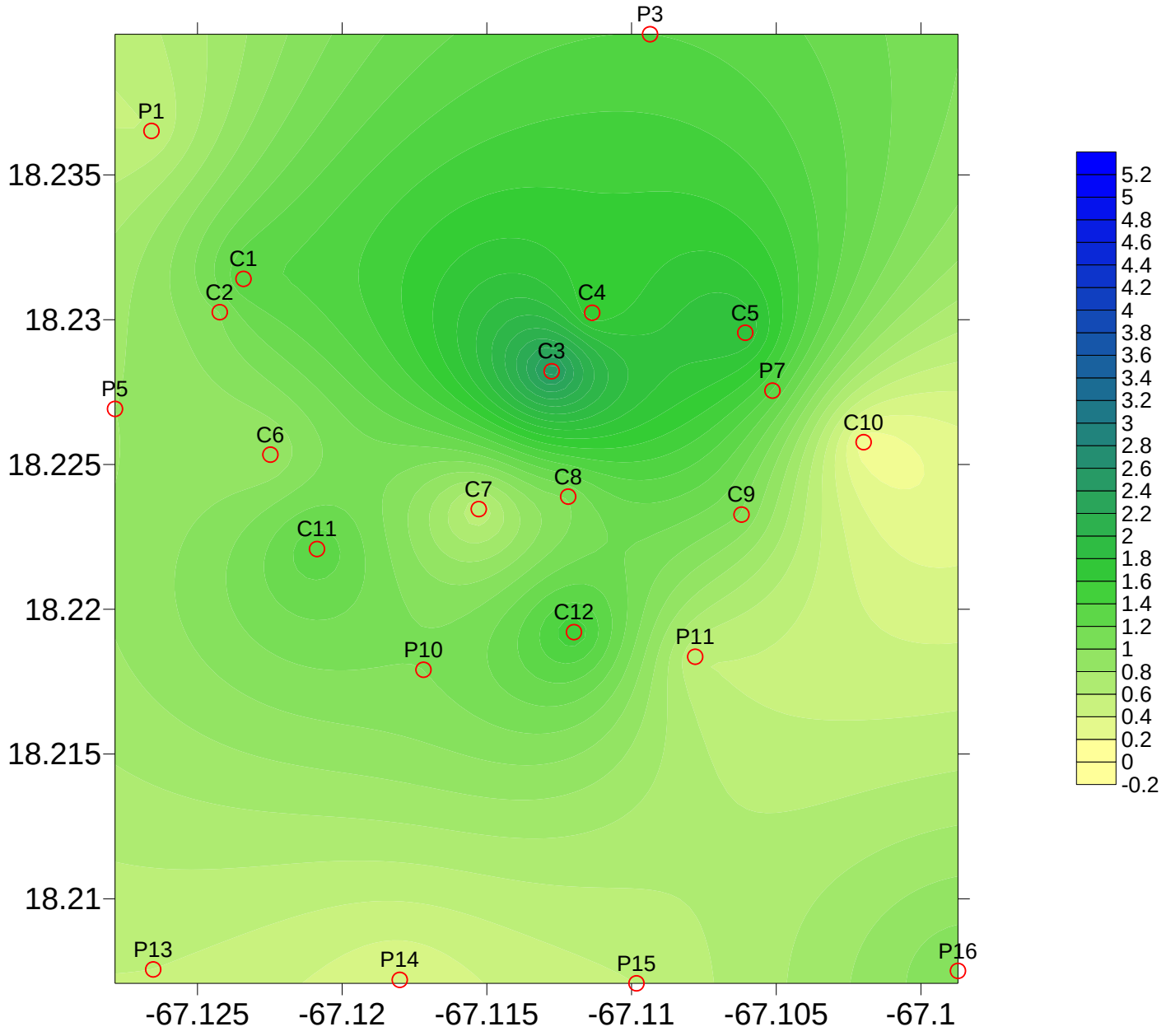
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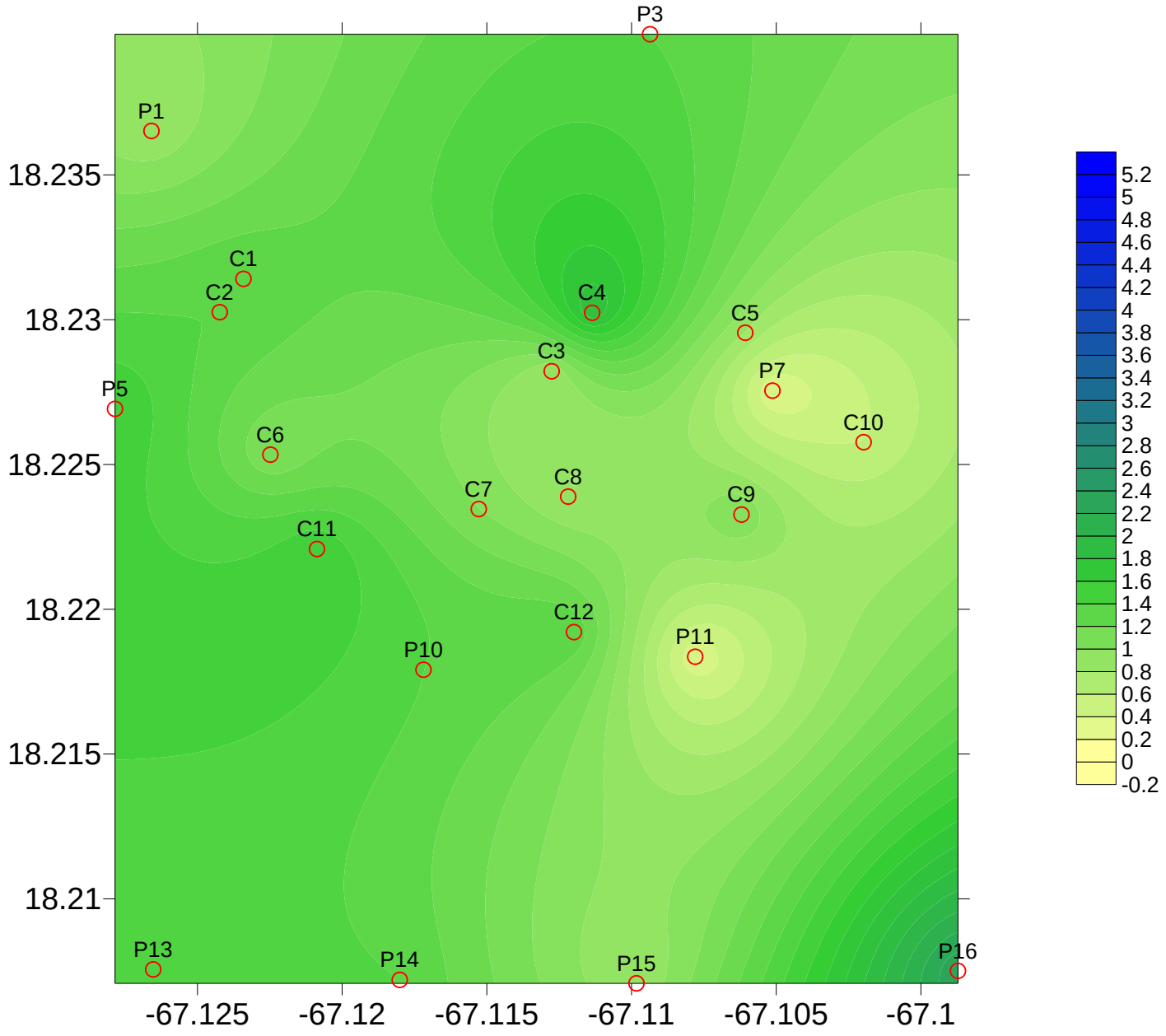
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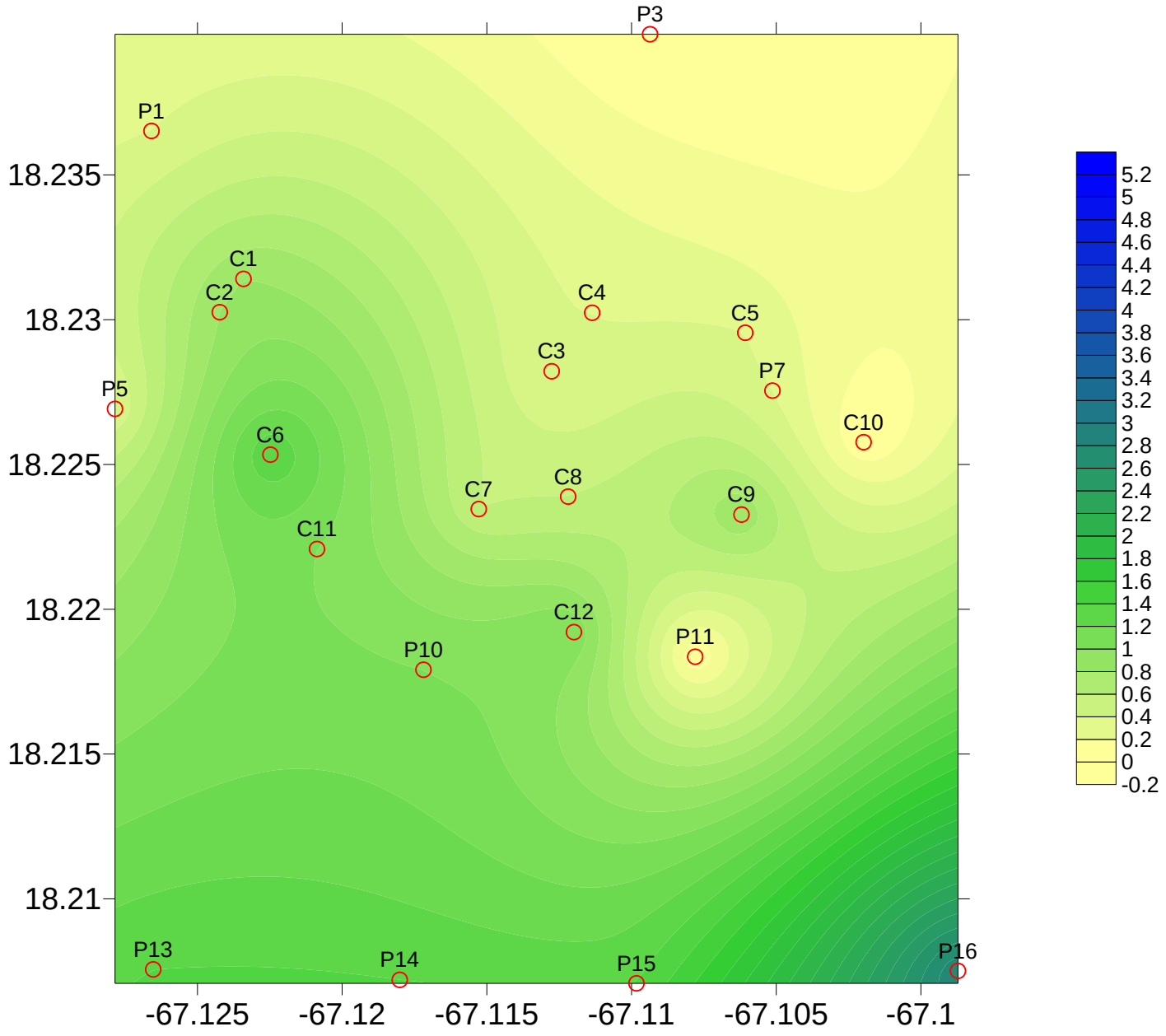
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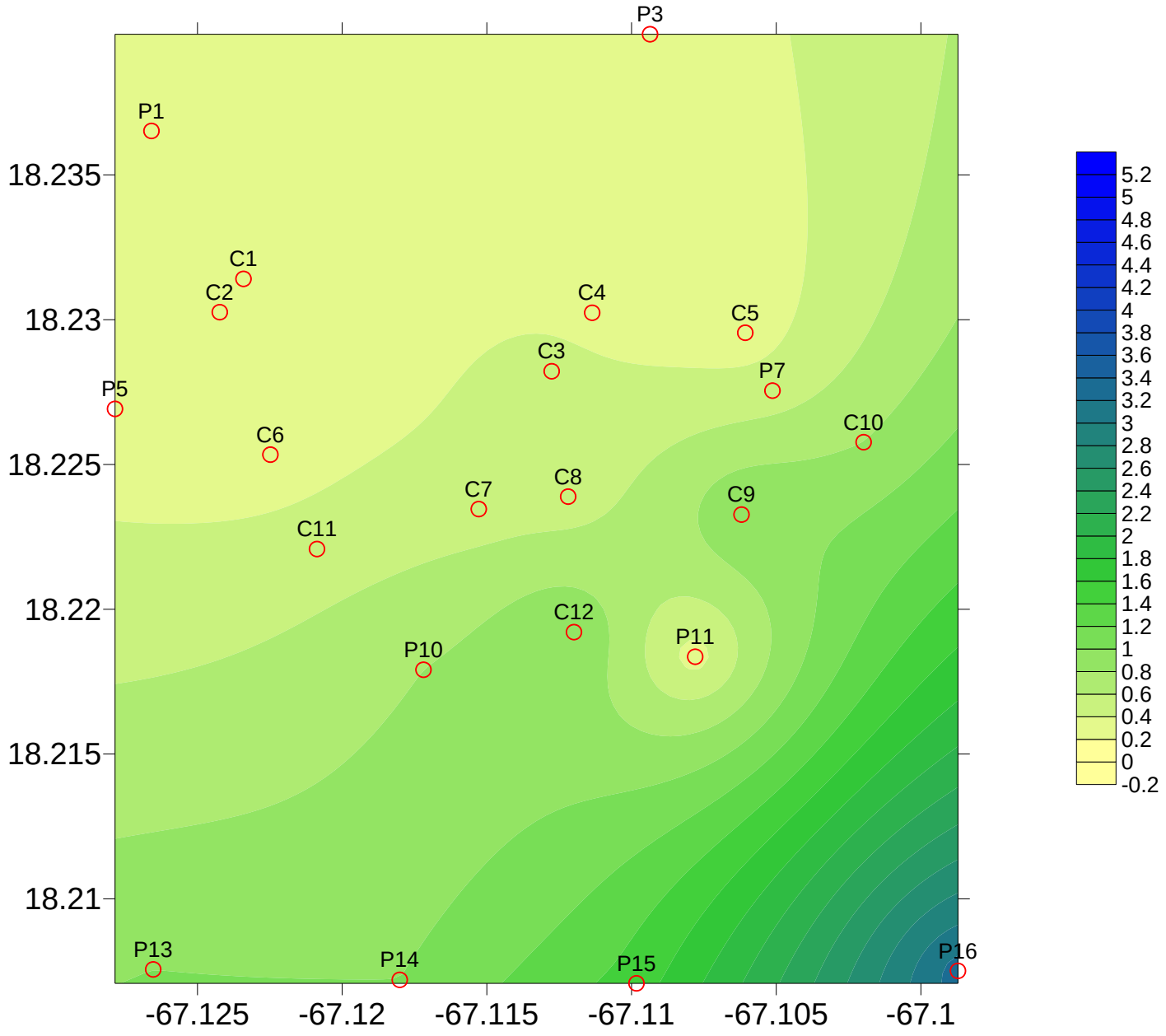
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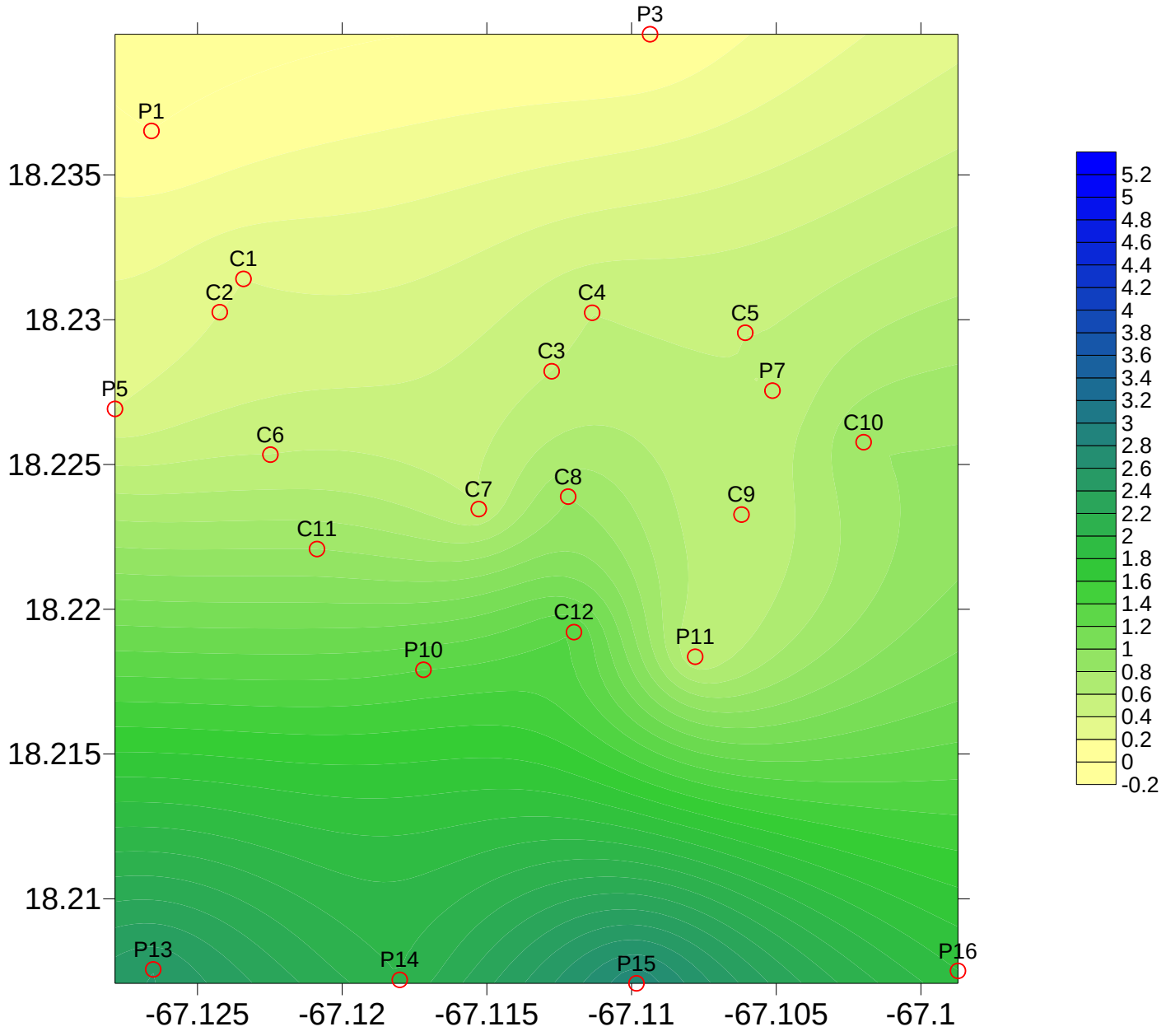
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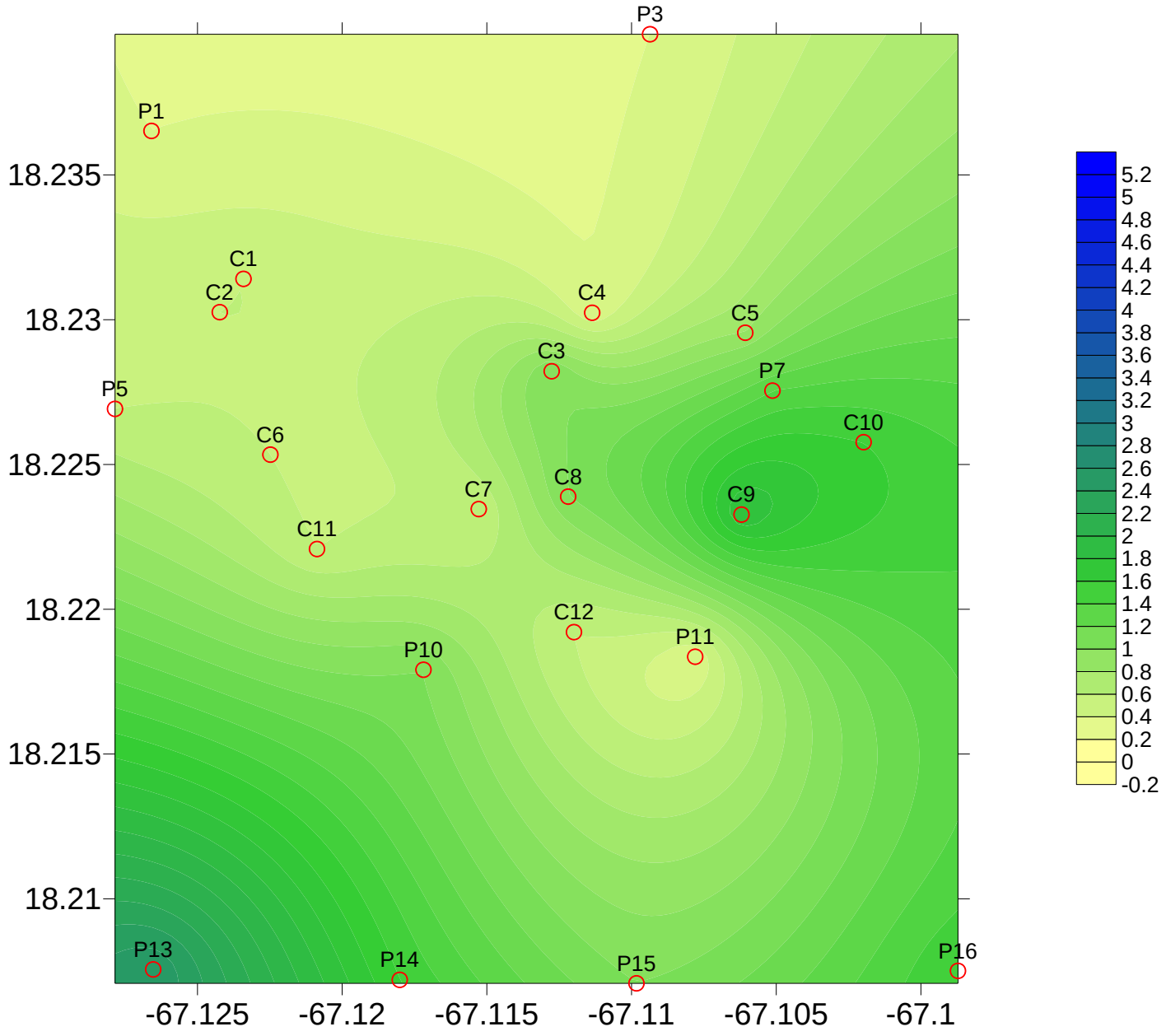
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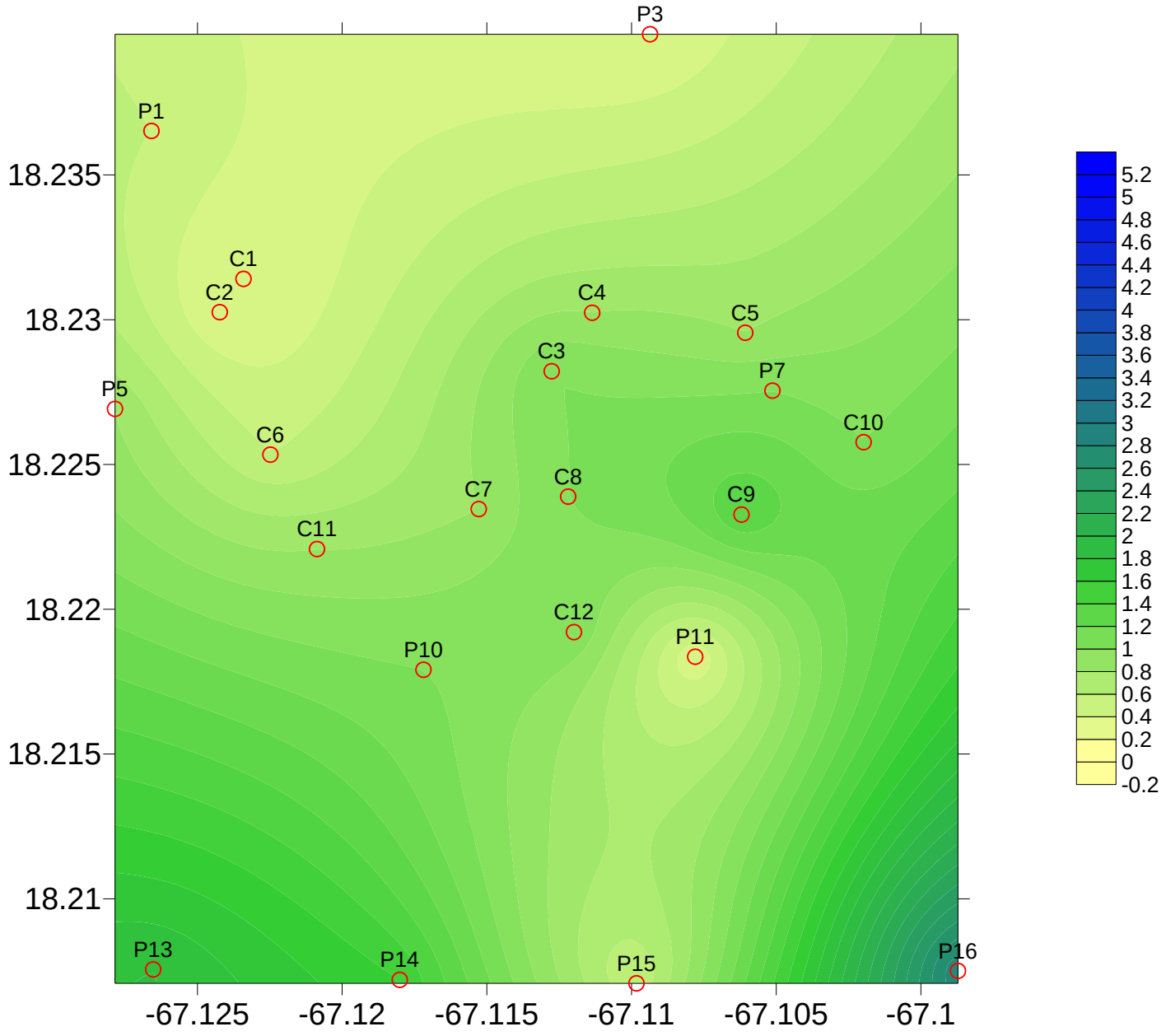
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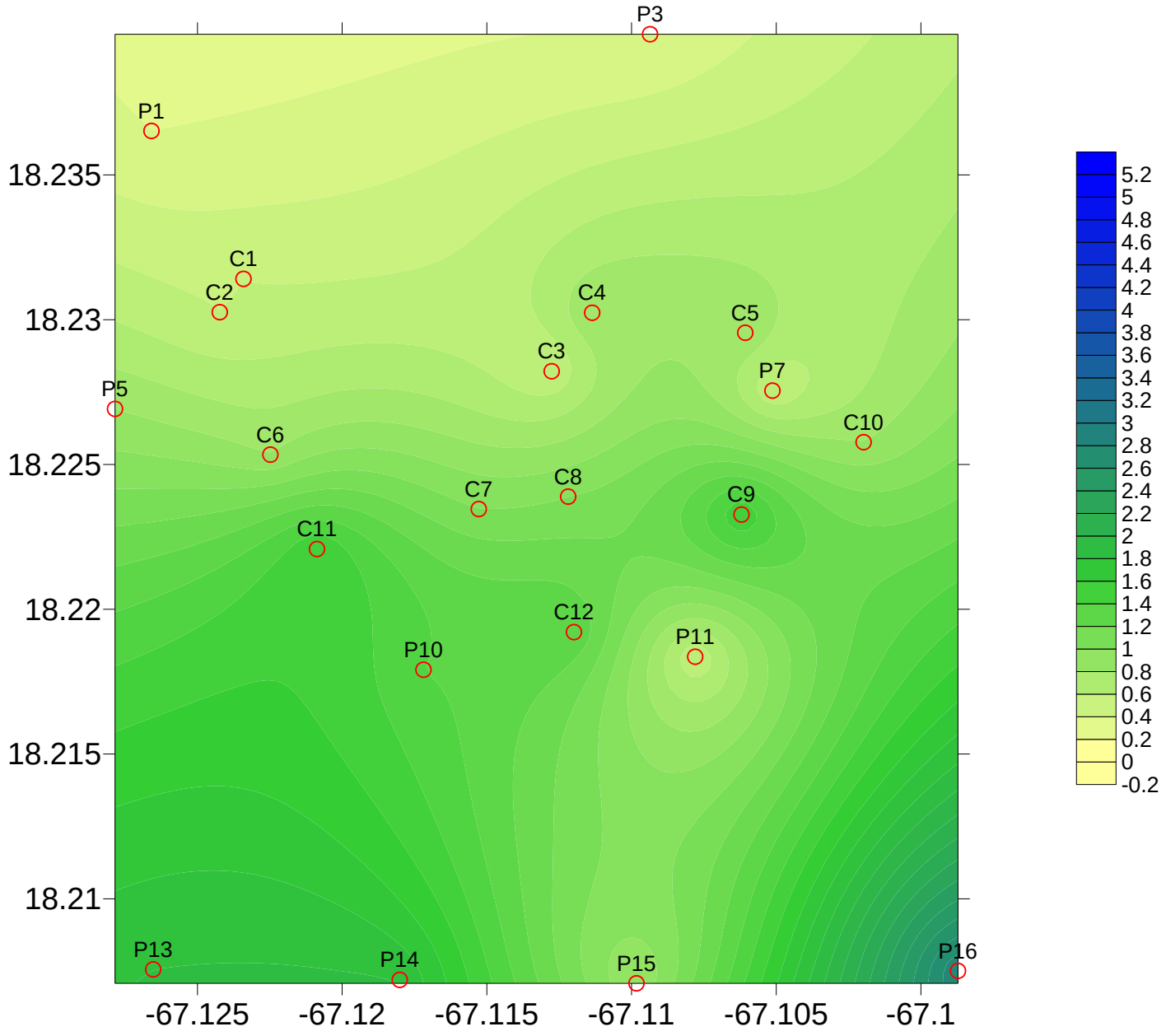
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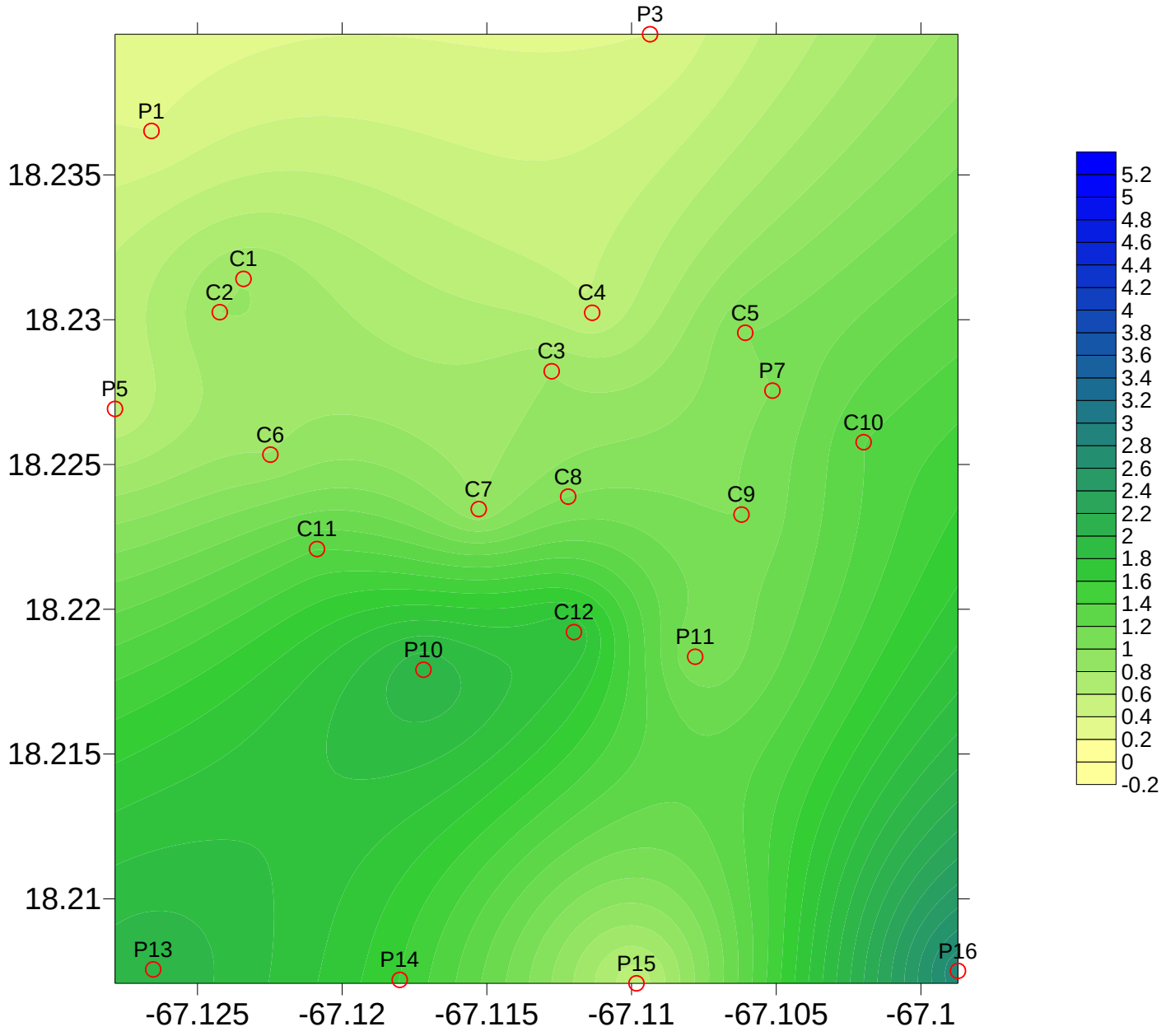
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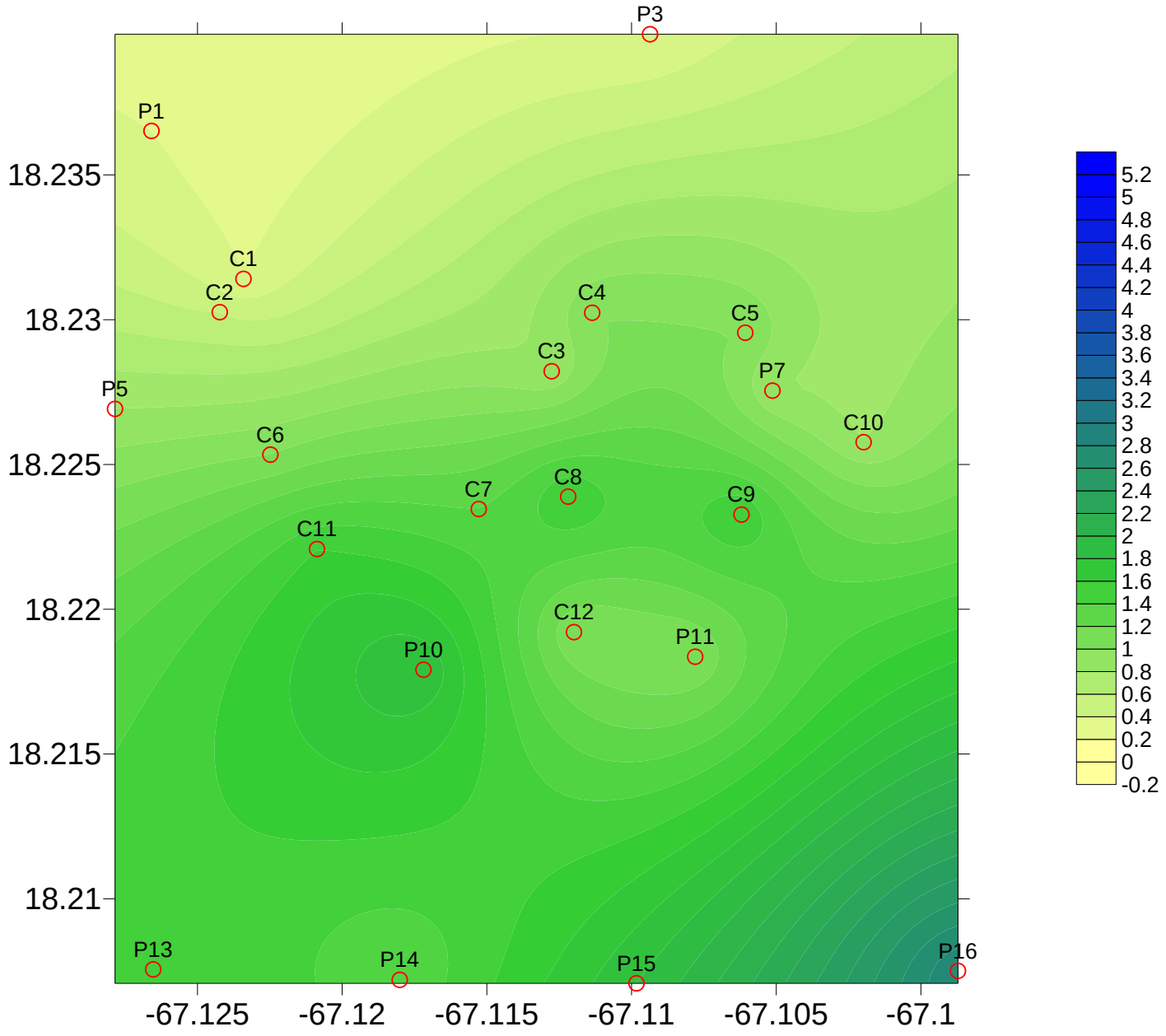
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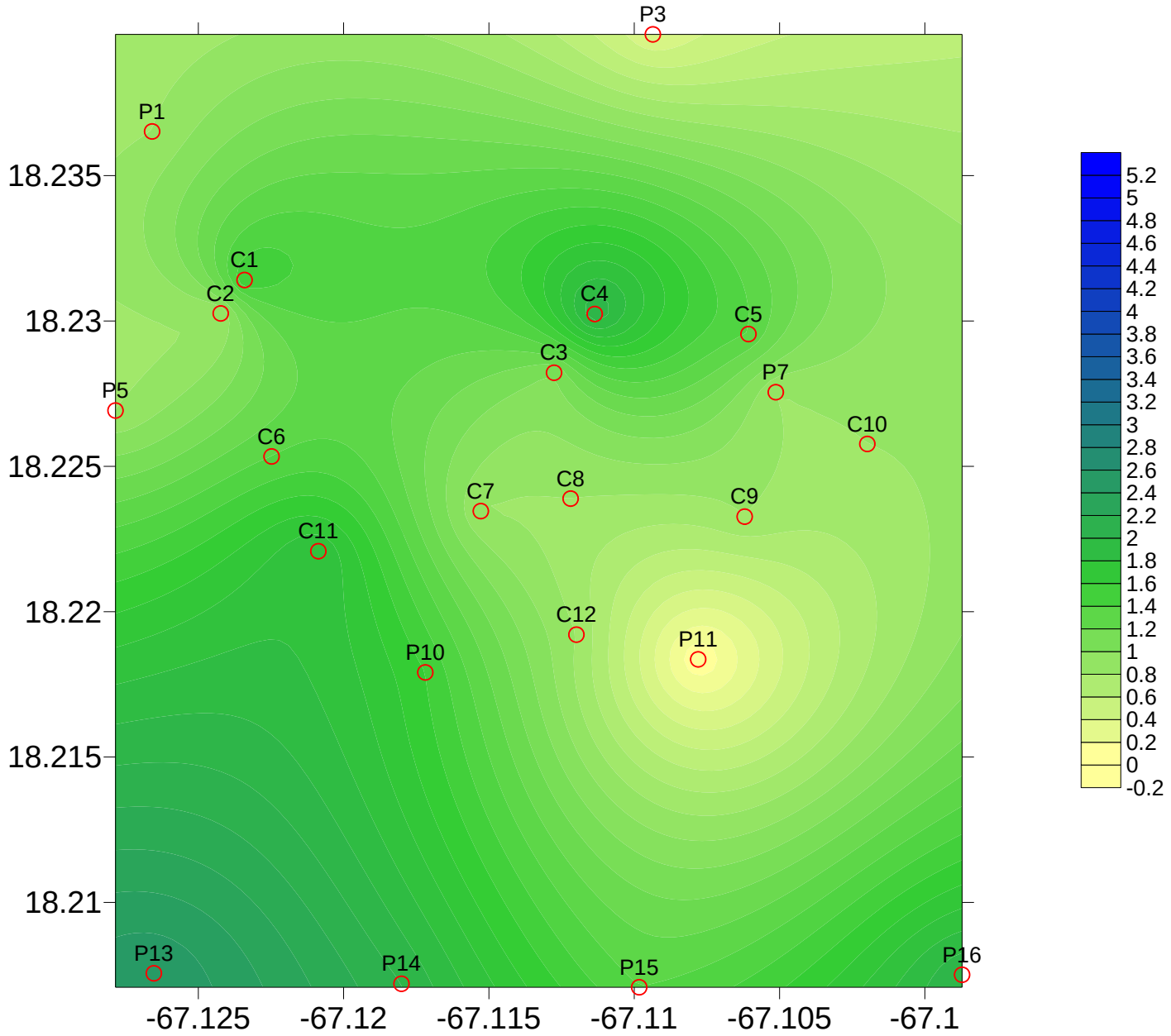
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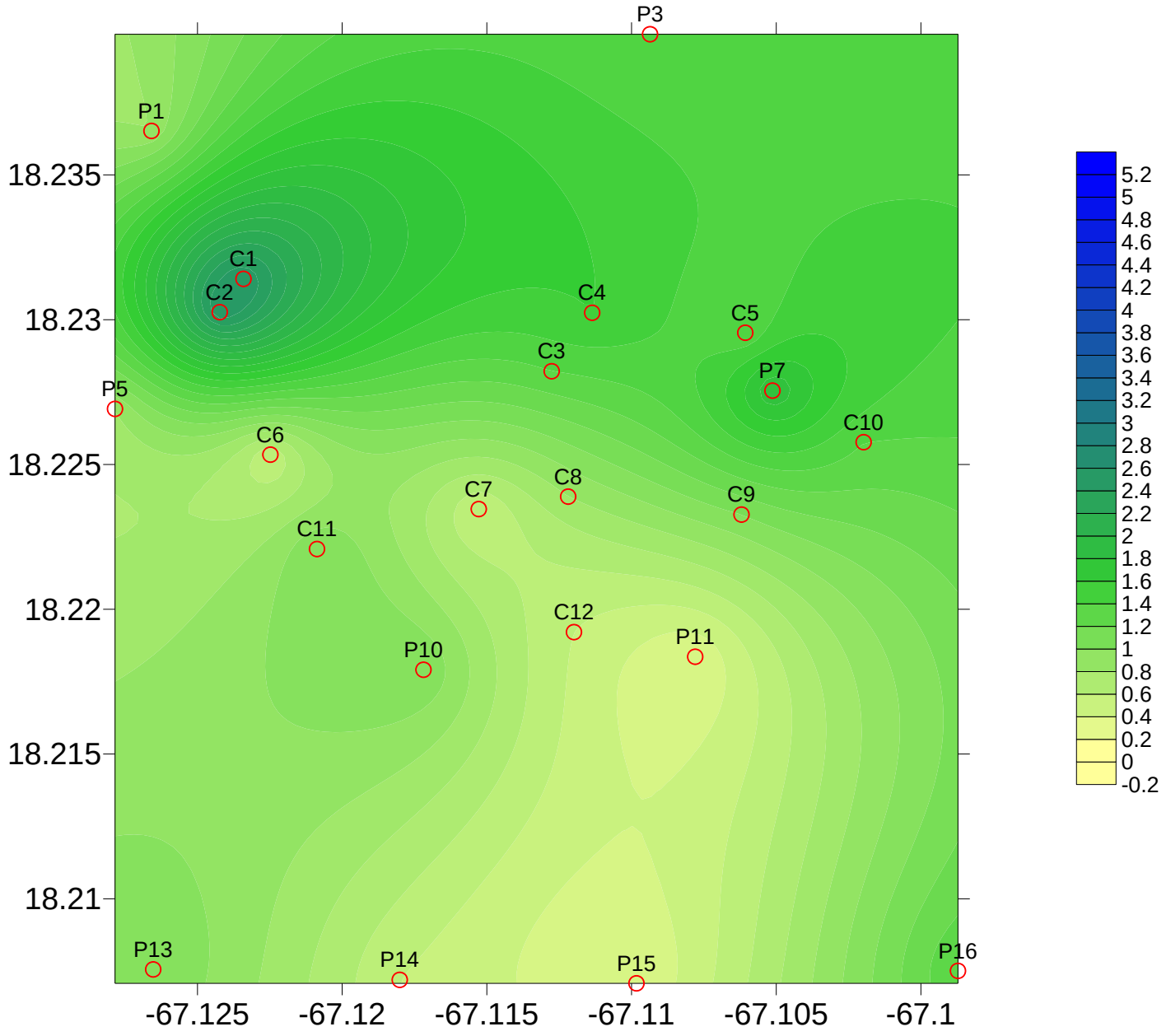
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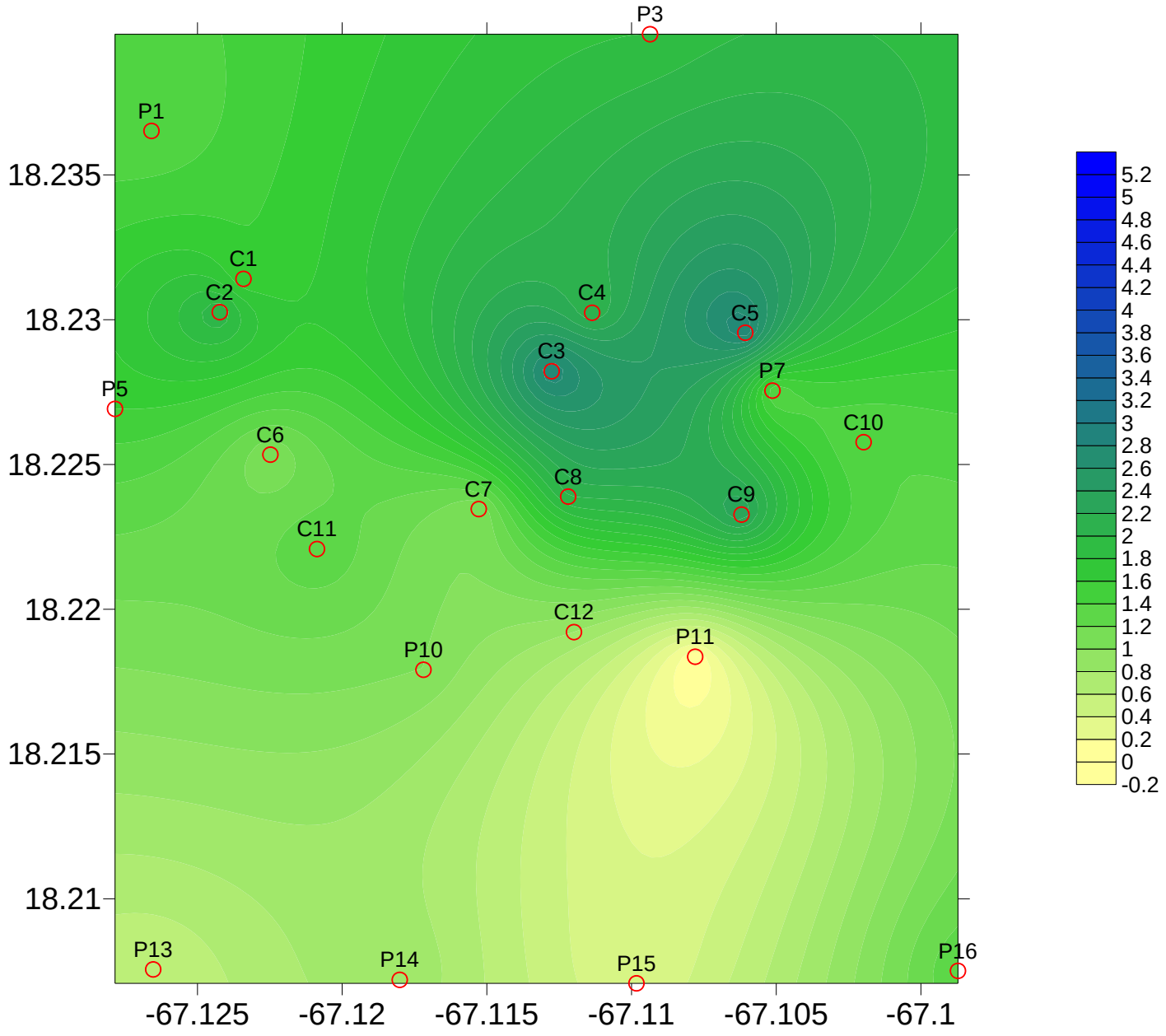
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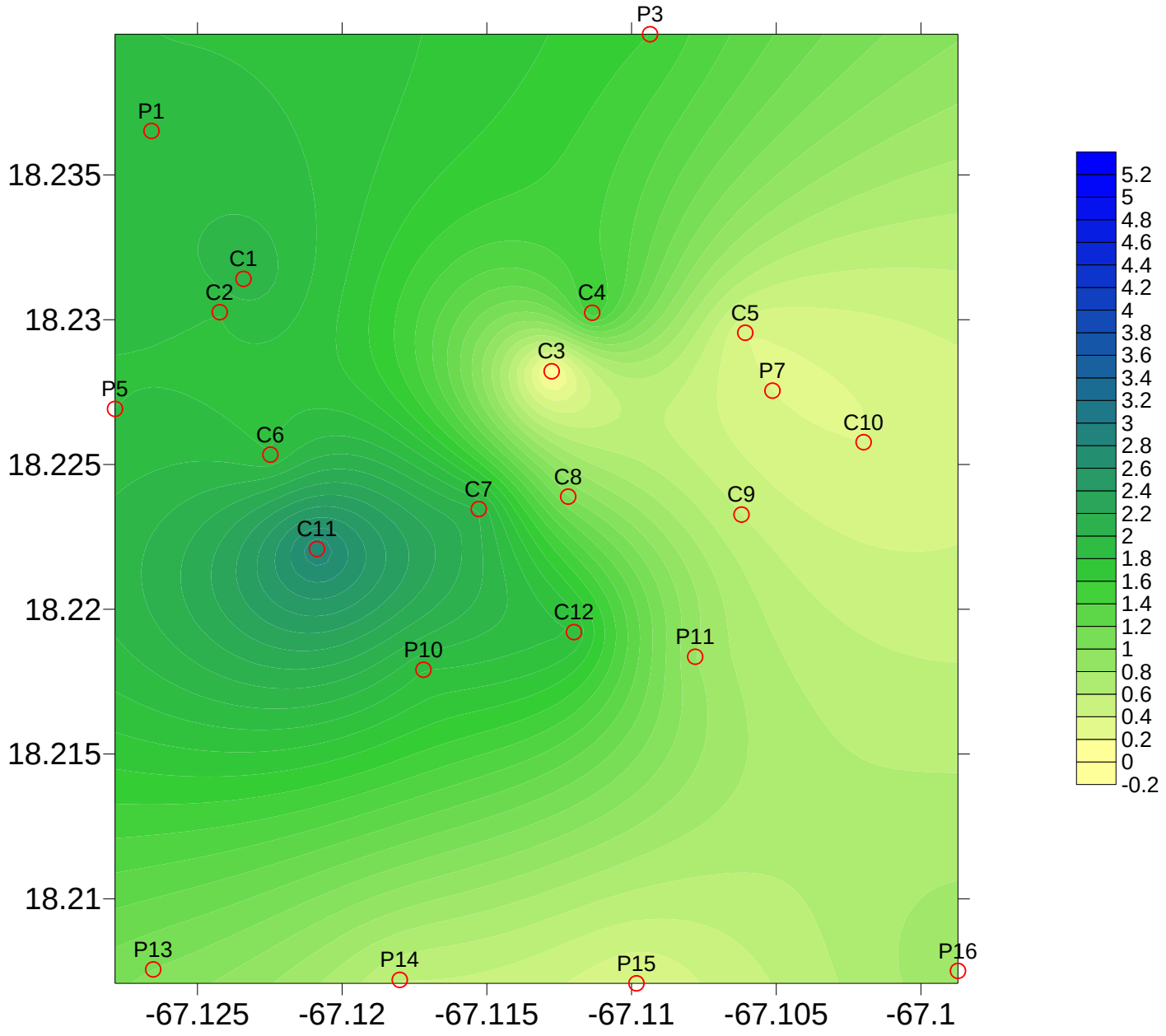
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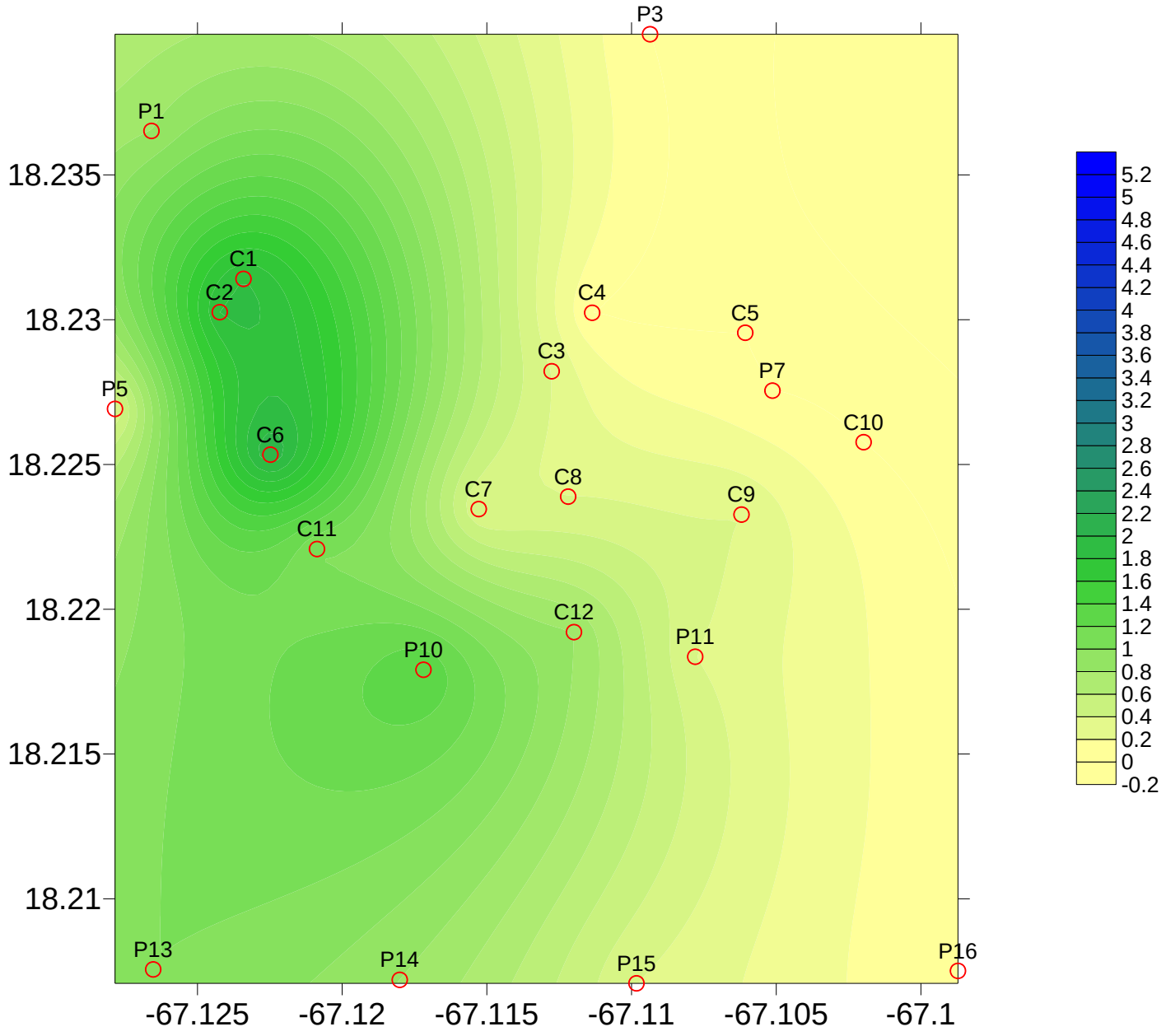
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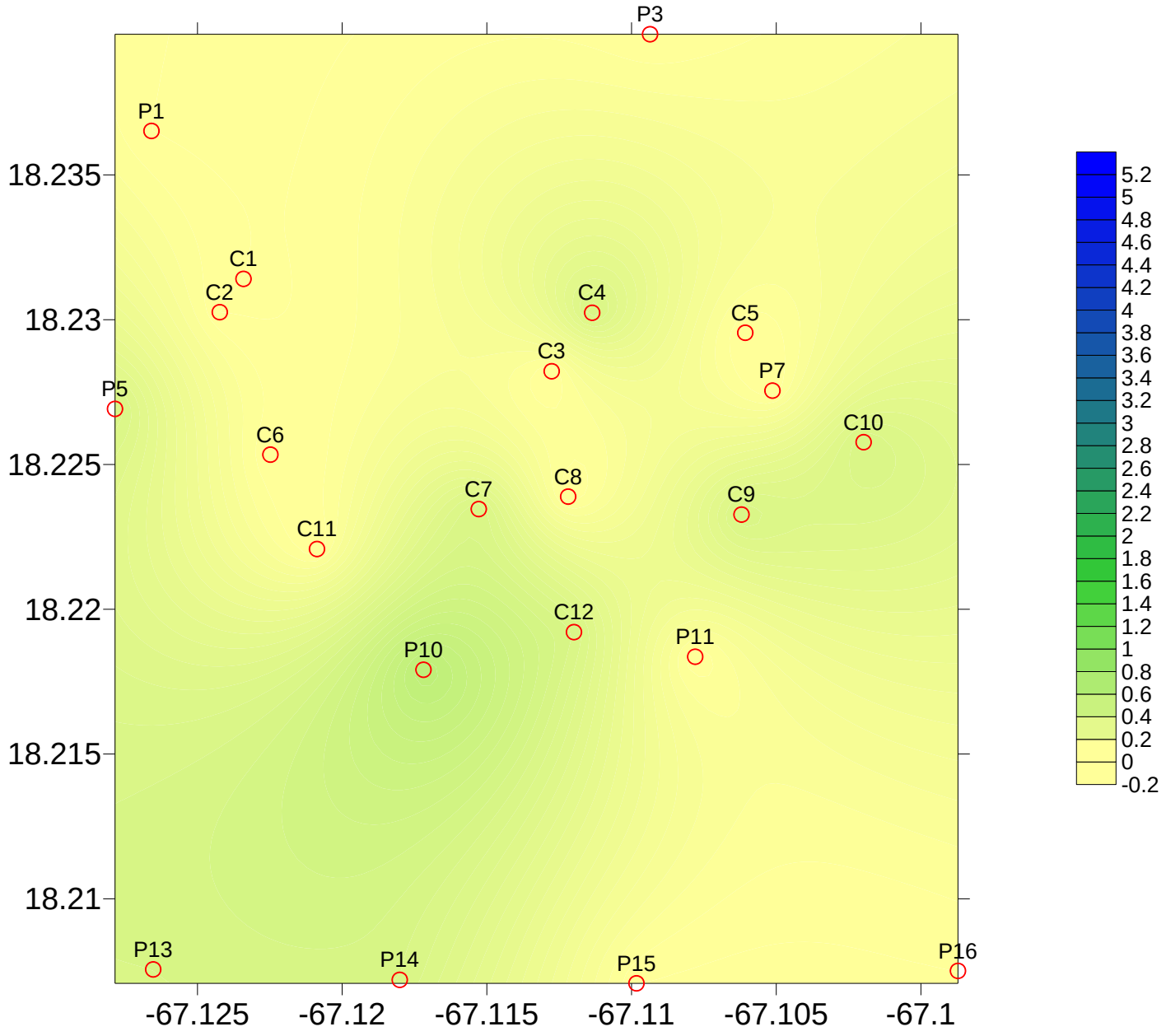
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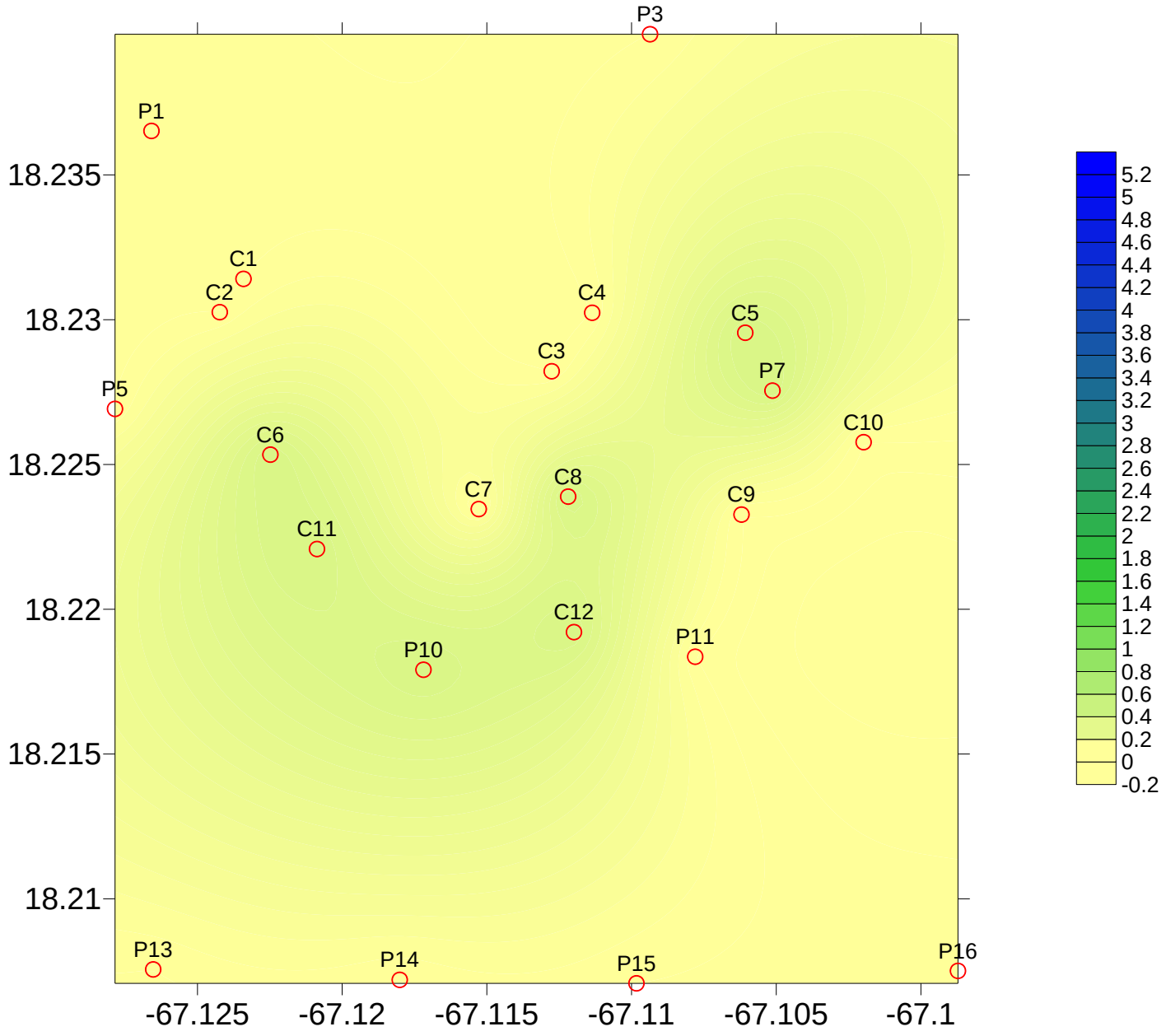
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P16
-67.125
-67.12
-67.115
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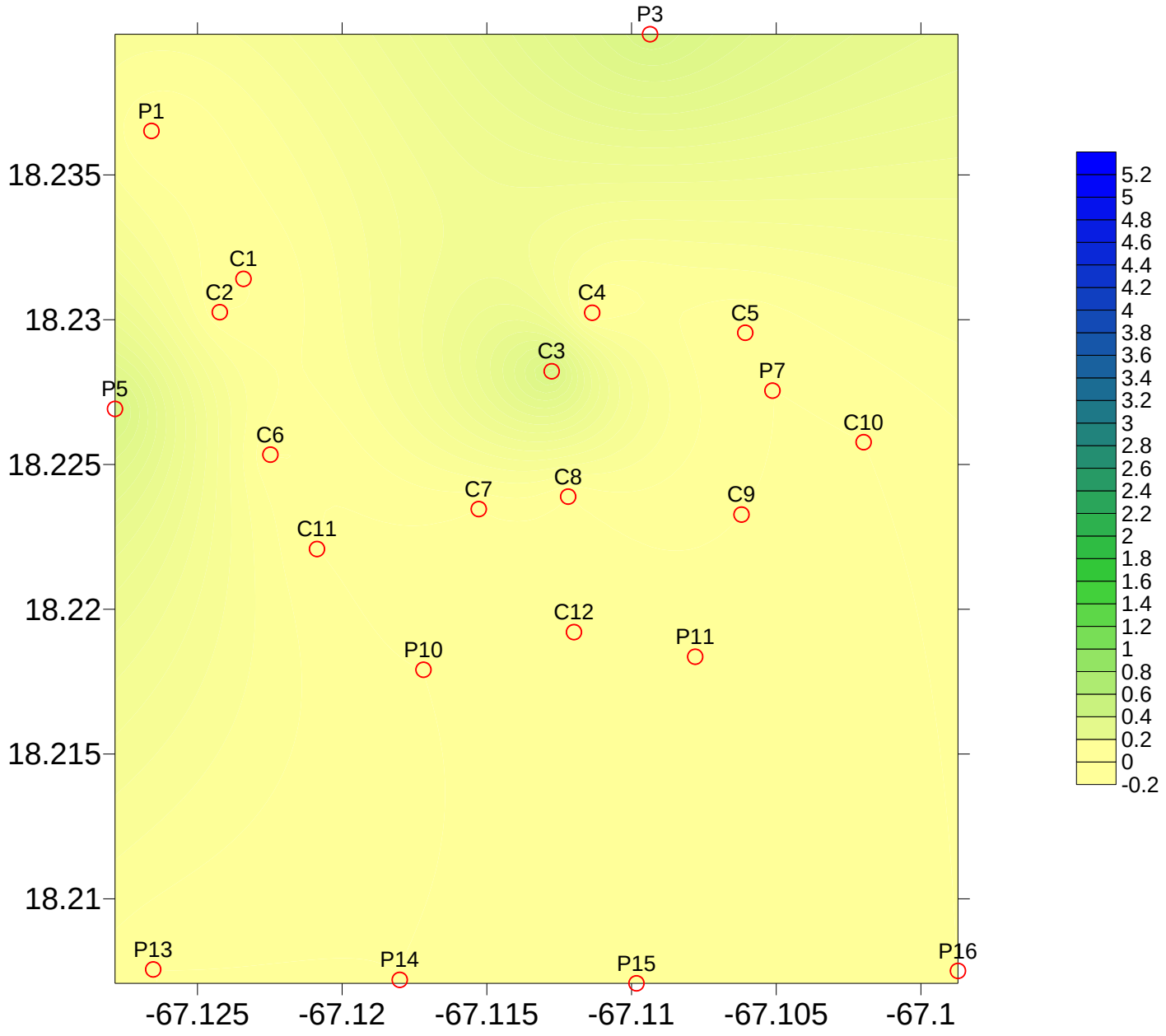
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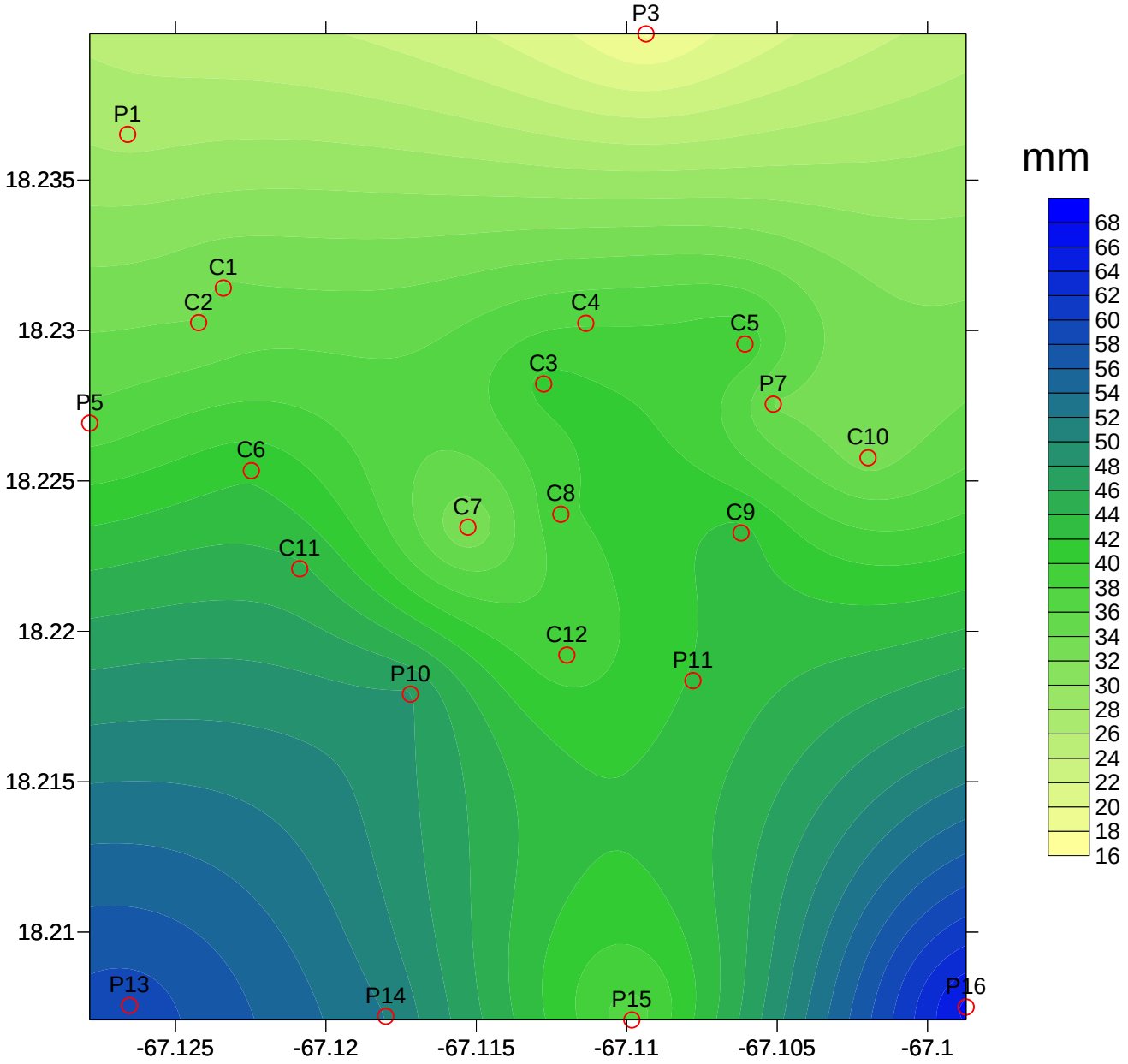
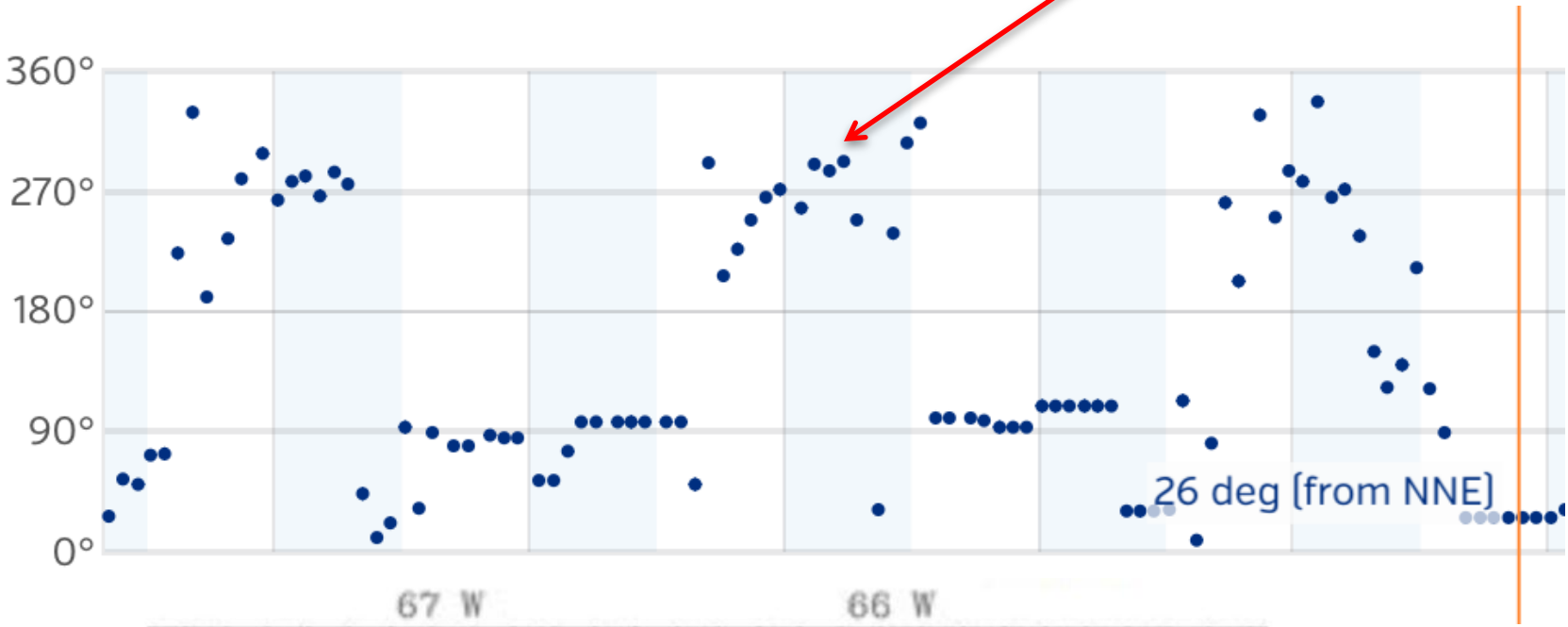
6:27 PM

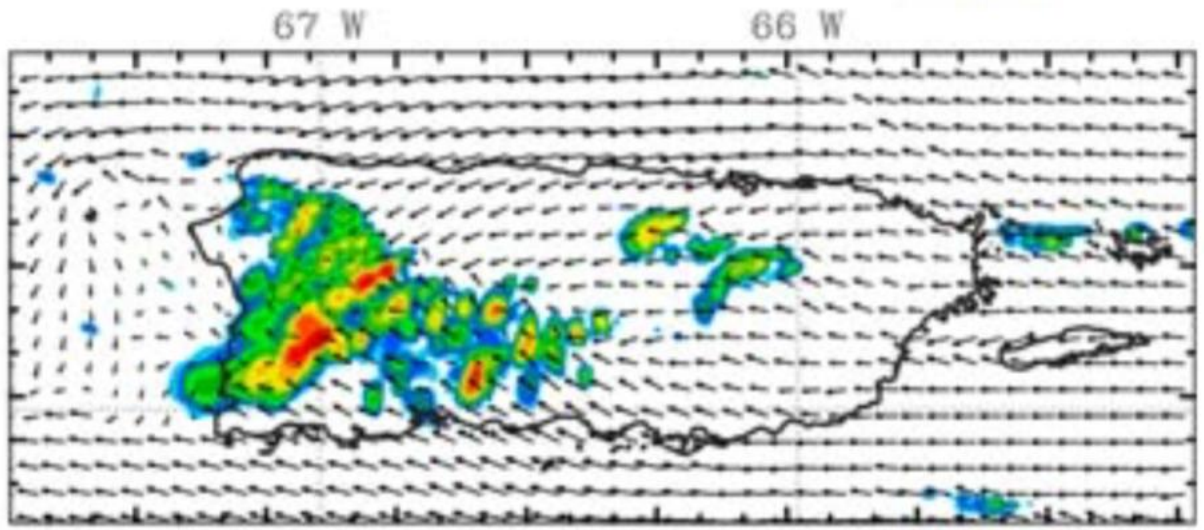
Total Storm Rainfall



Sea Breeze

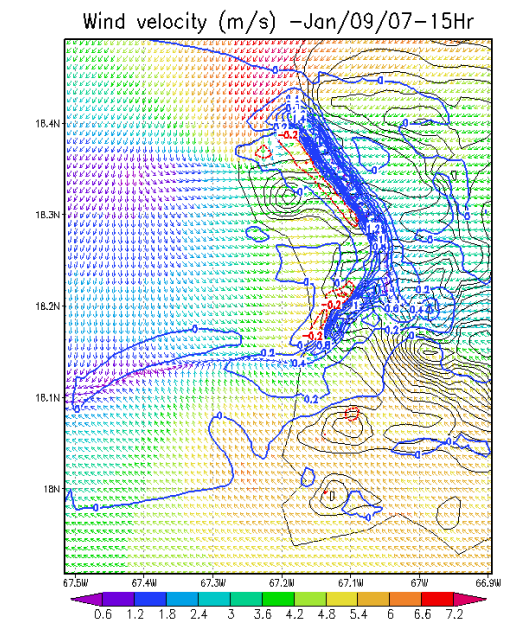
Mayaguez, PR

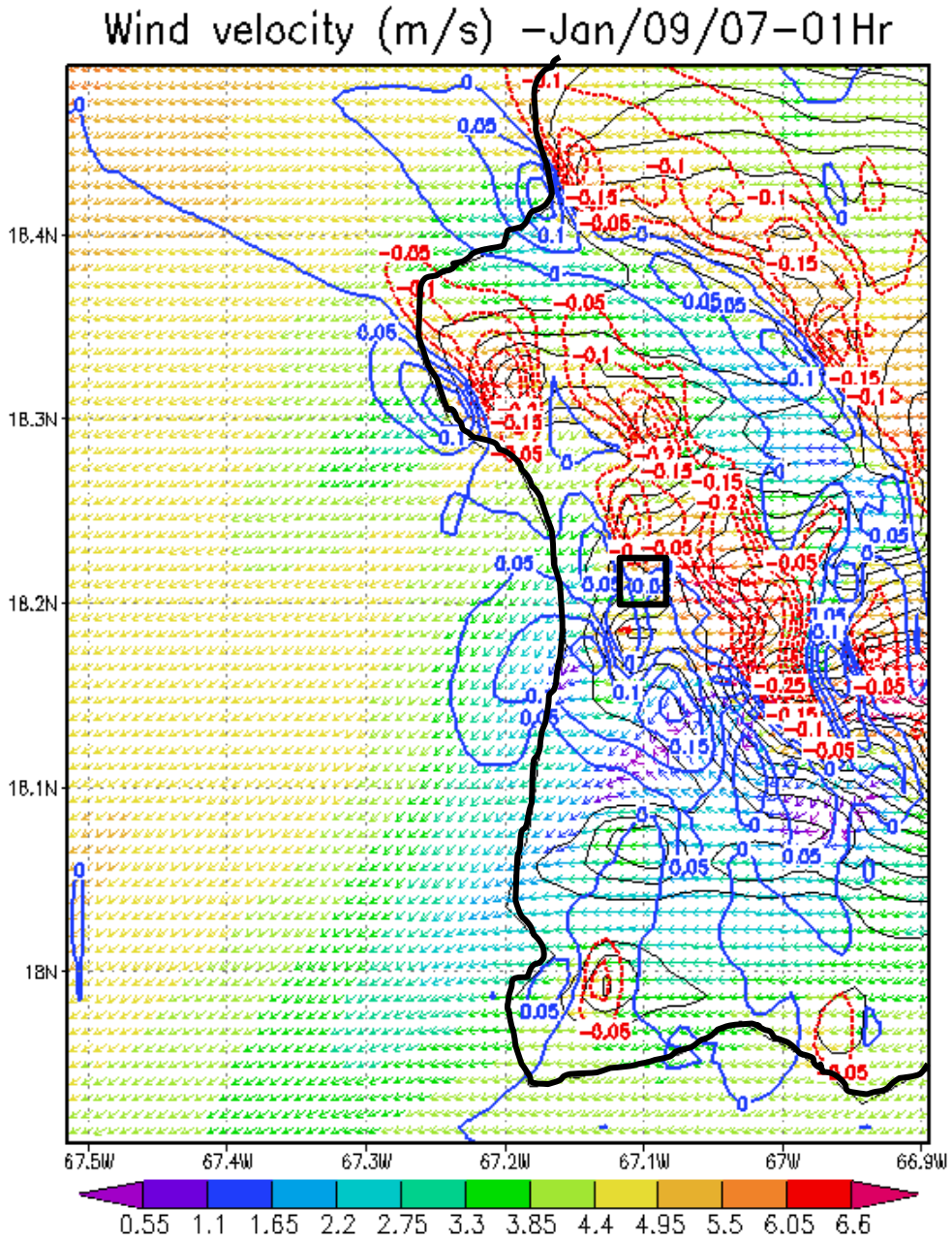




Simulation of Sea Breeze Effect in Western PR using Rams (Regional Atmospheric Modeling system)

- The following plots present the **horizontal velocity vectors** at 48.5 m and the **vertical velocity contours** at 689 m above study area in western Puerto Rico.





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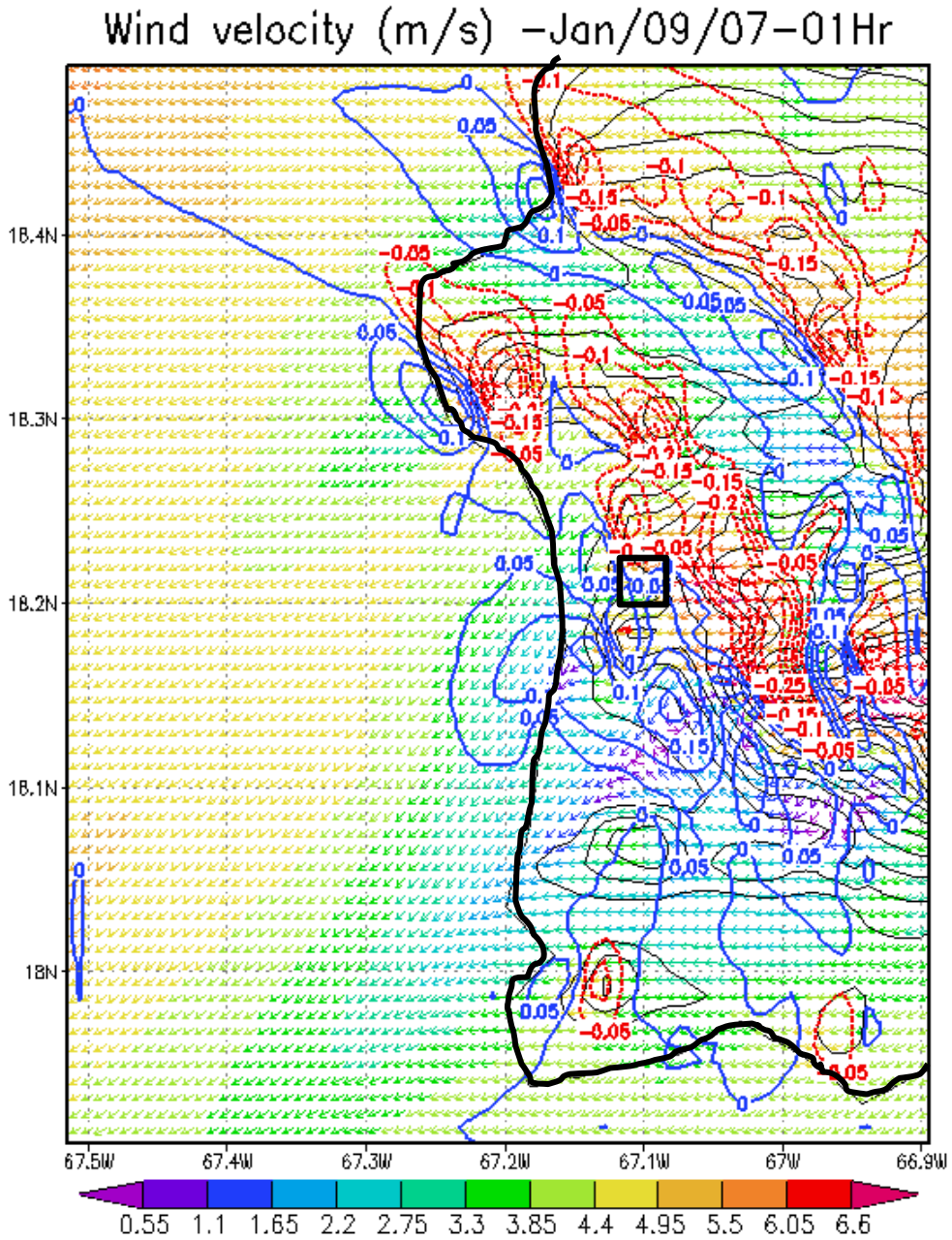
2007-02-26-22:59



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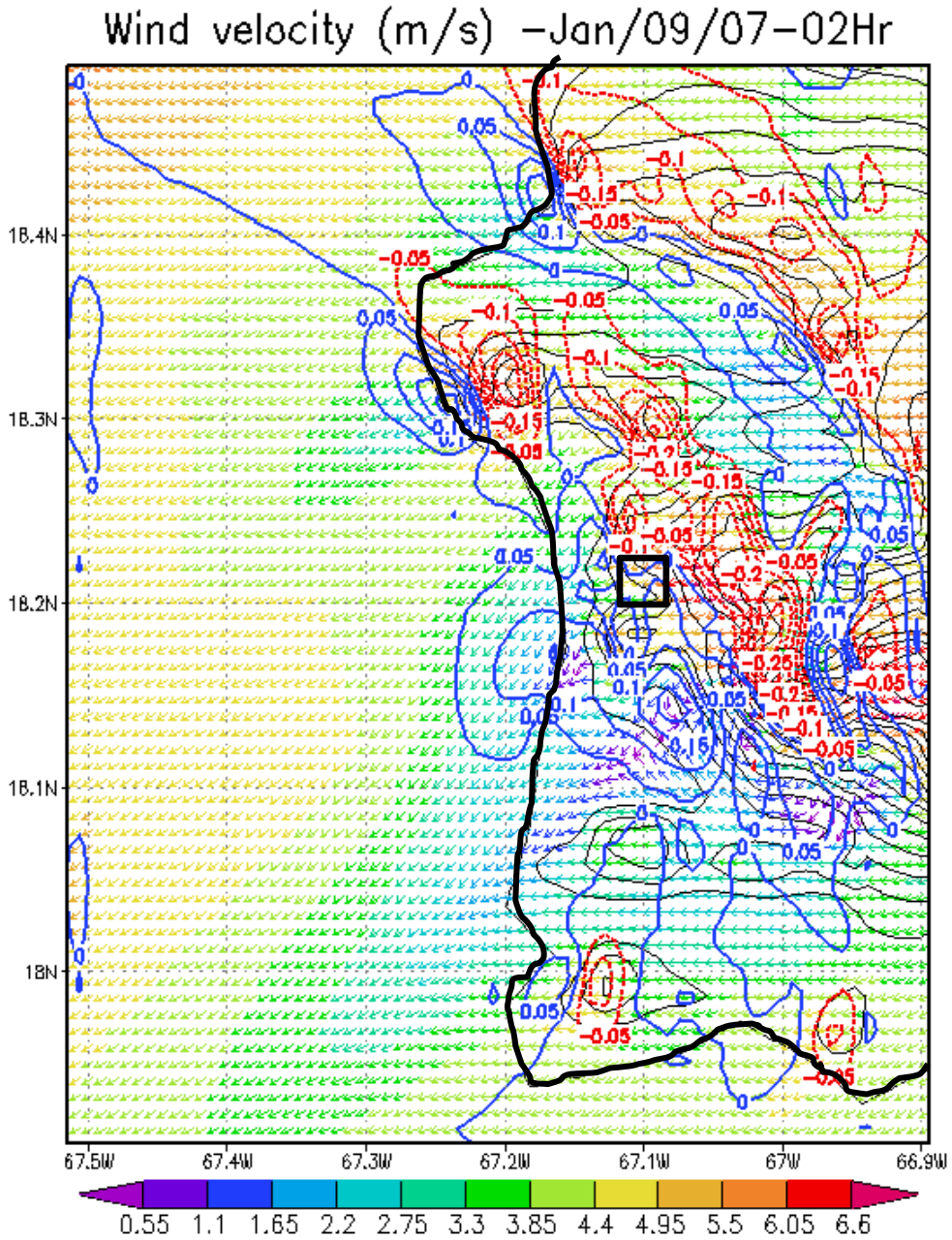
2007-02-26-22:59



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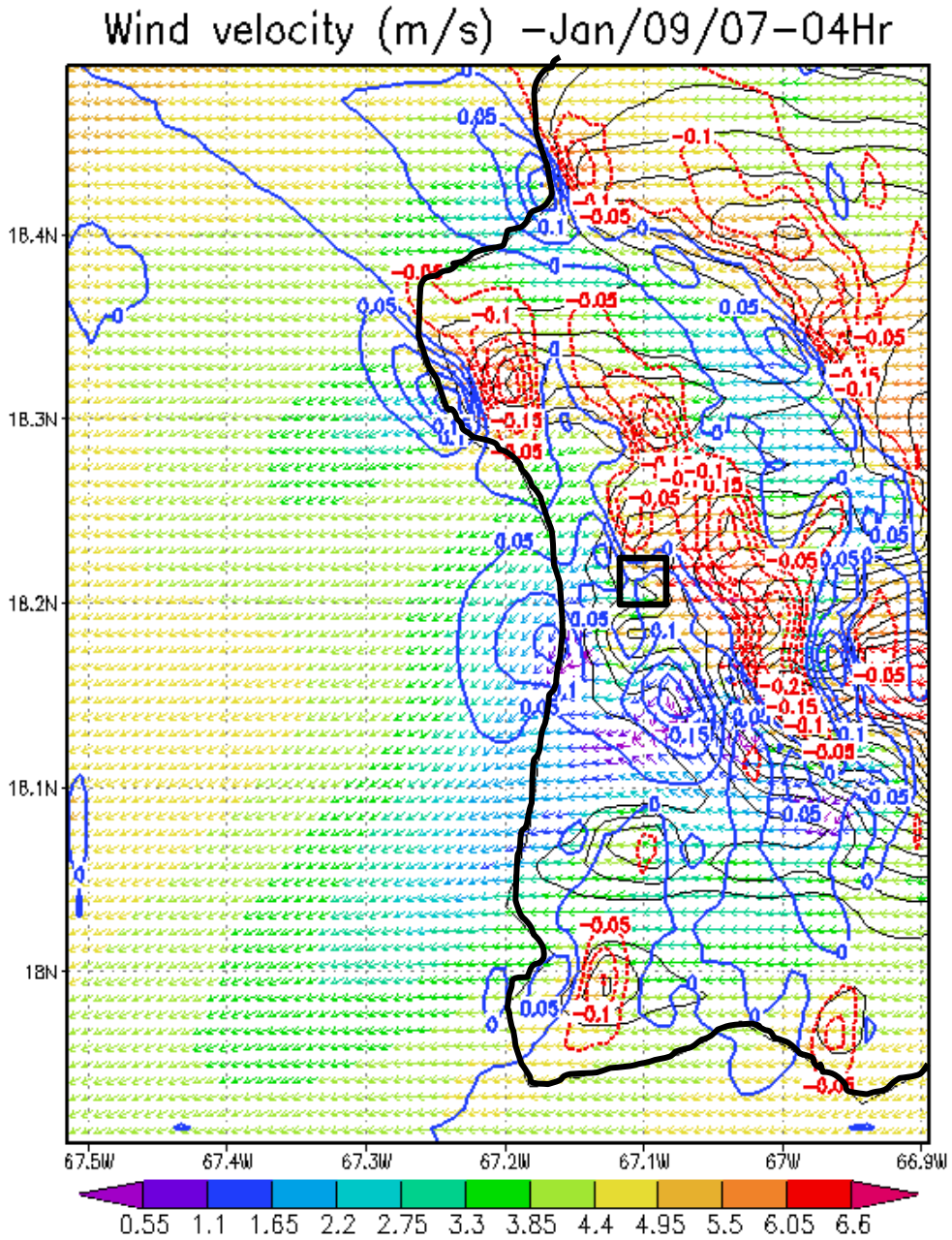
2007–02–26–23:02



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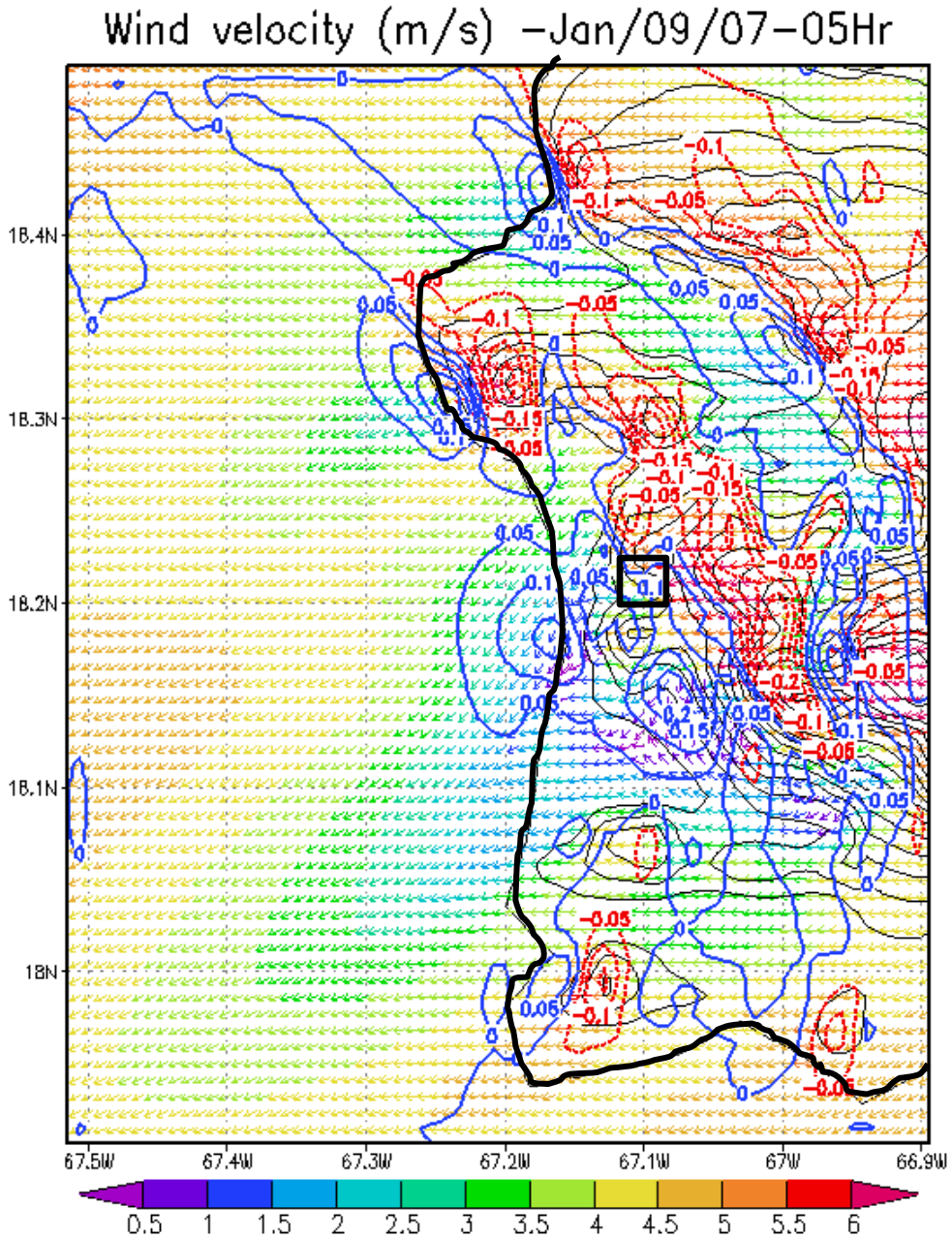

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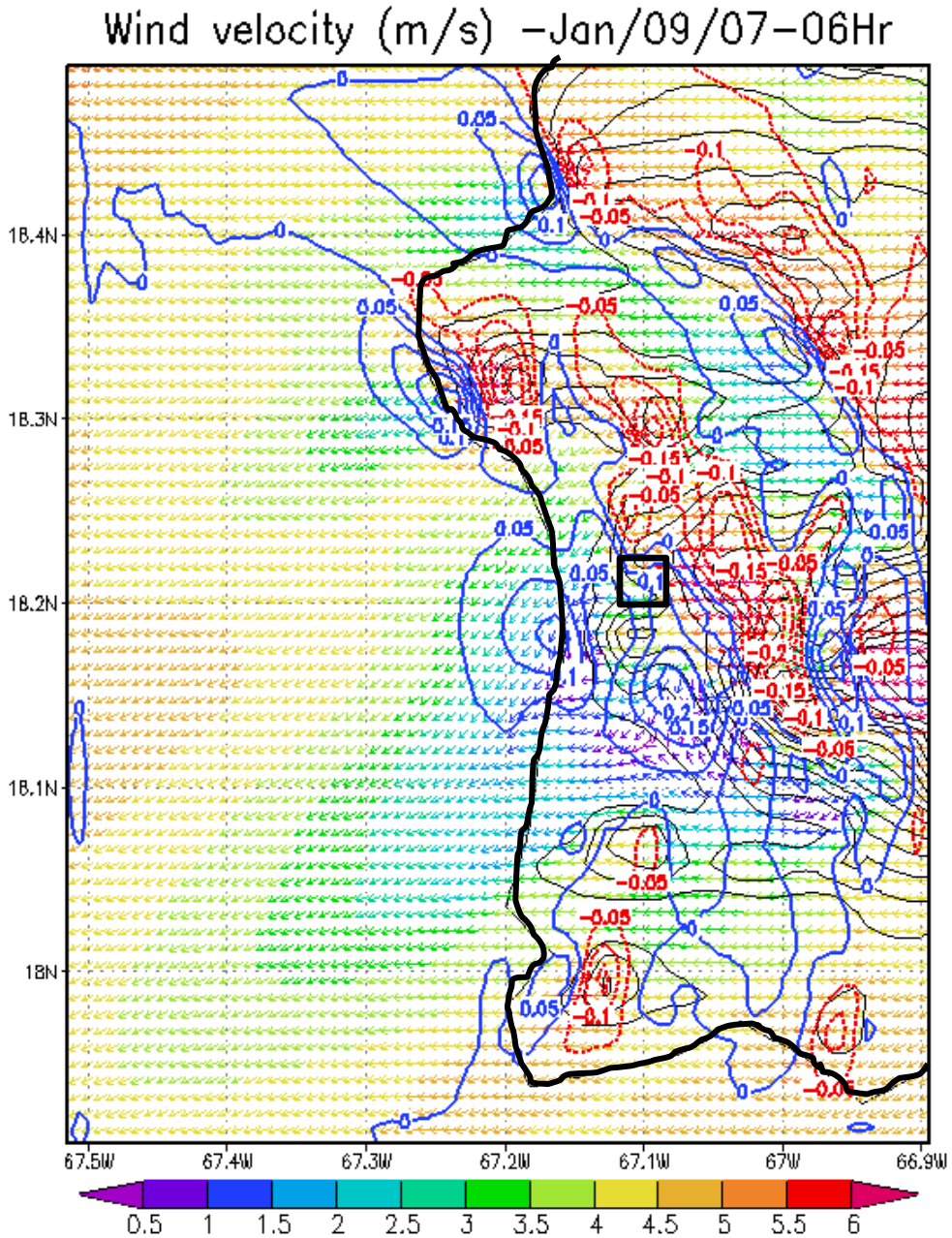

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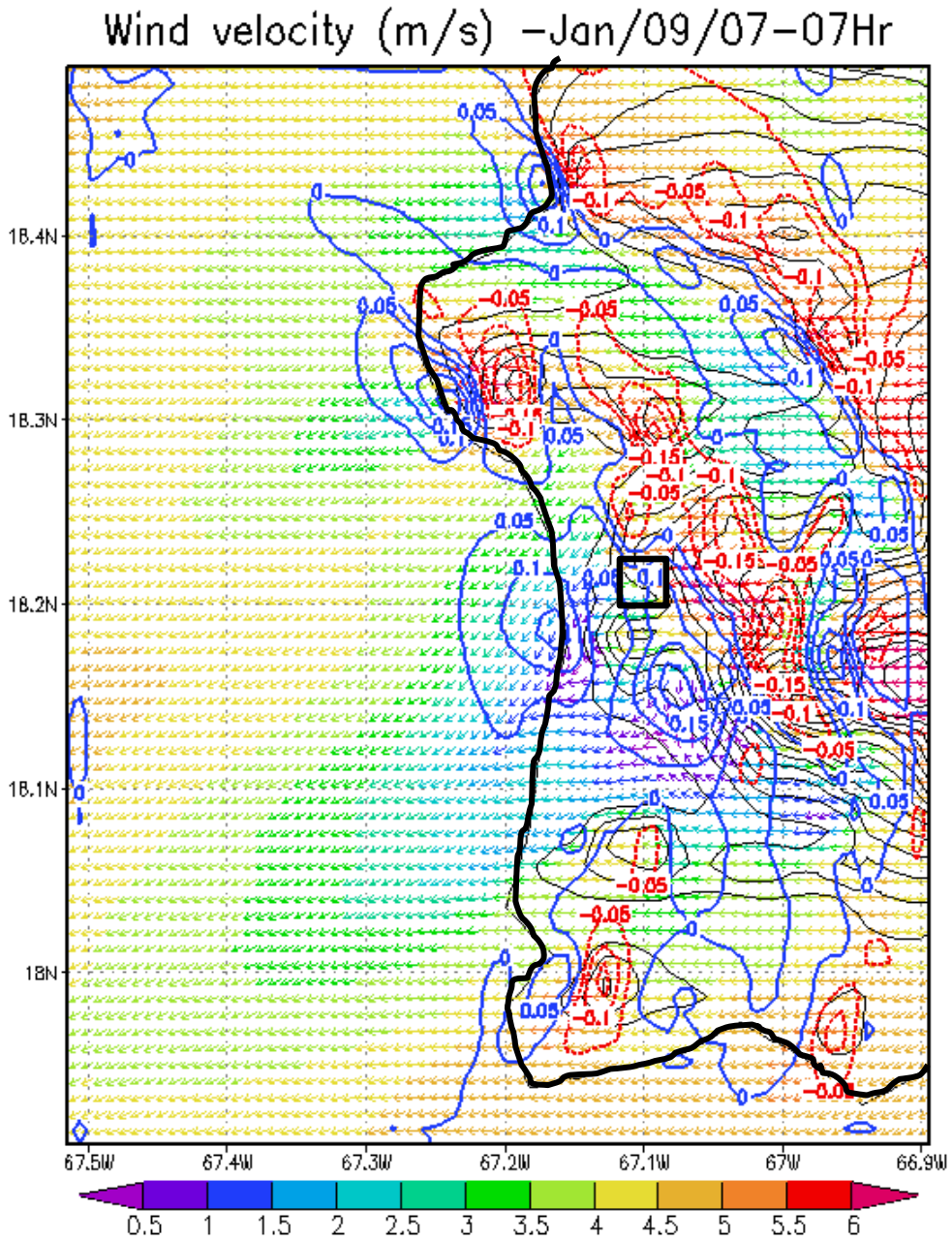

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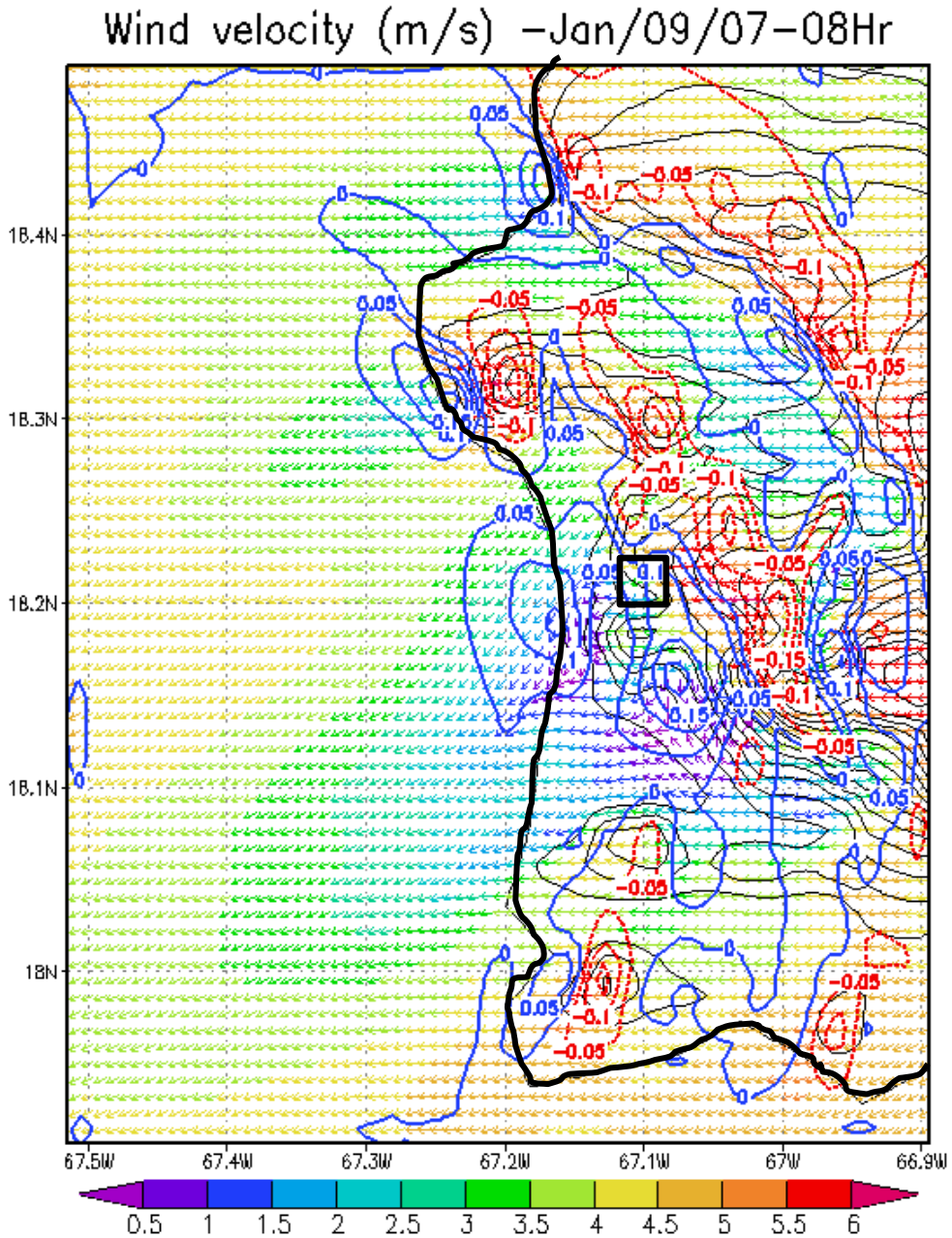

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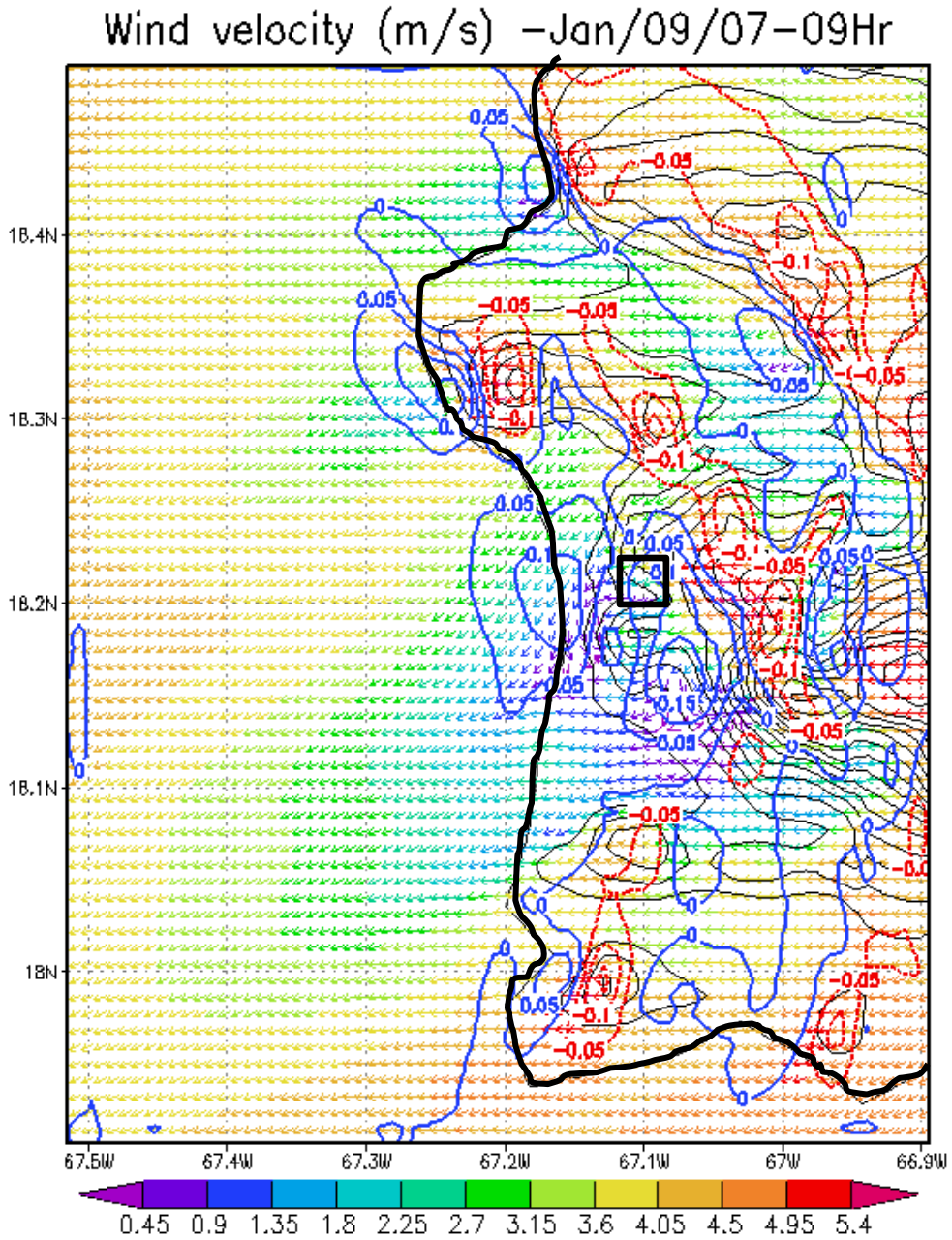

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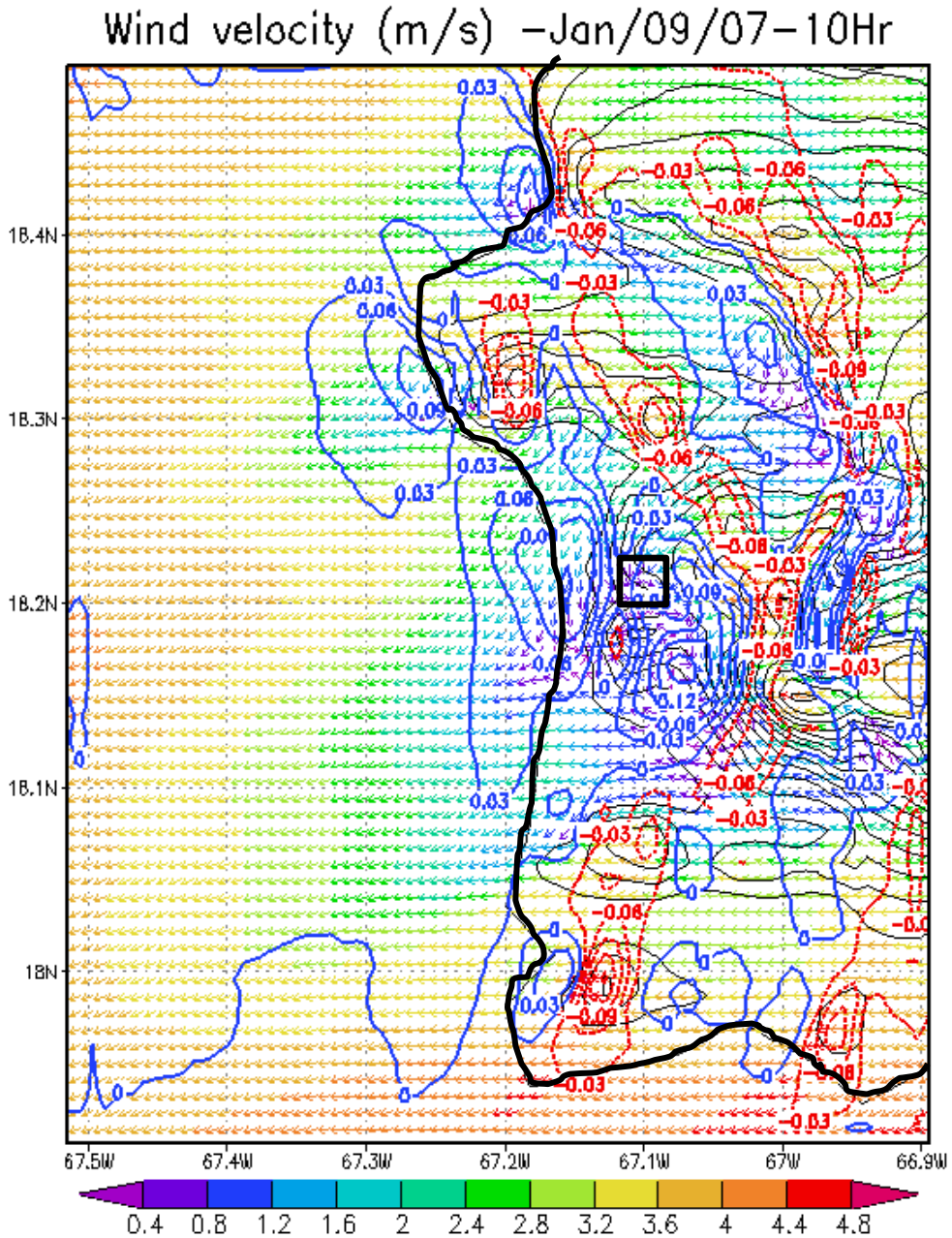

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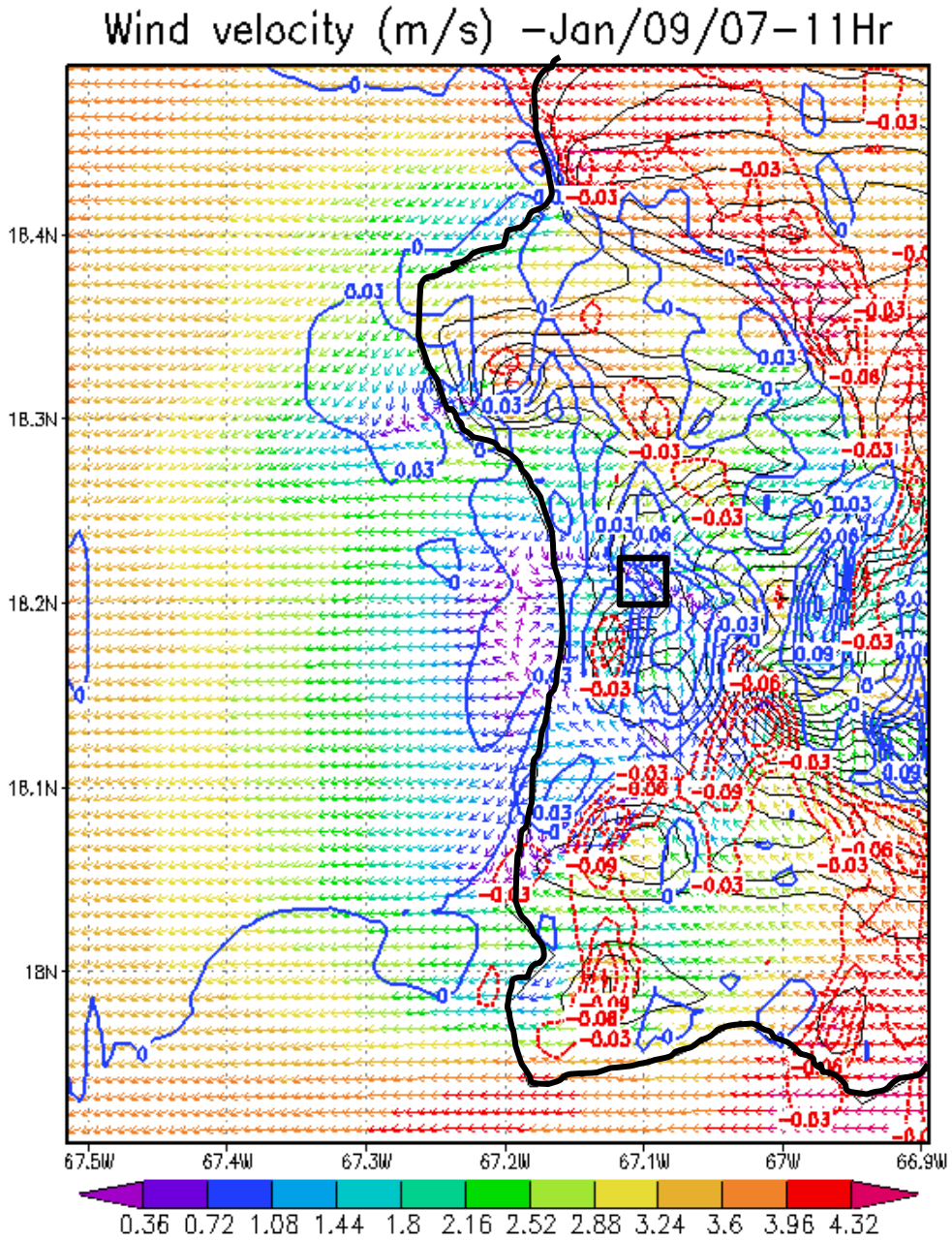
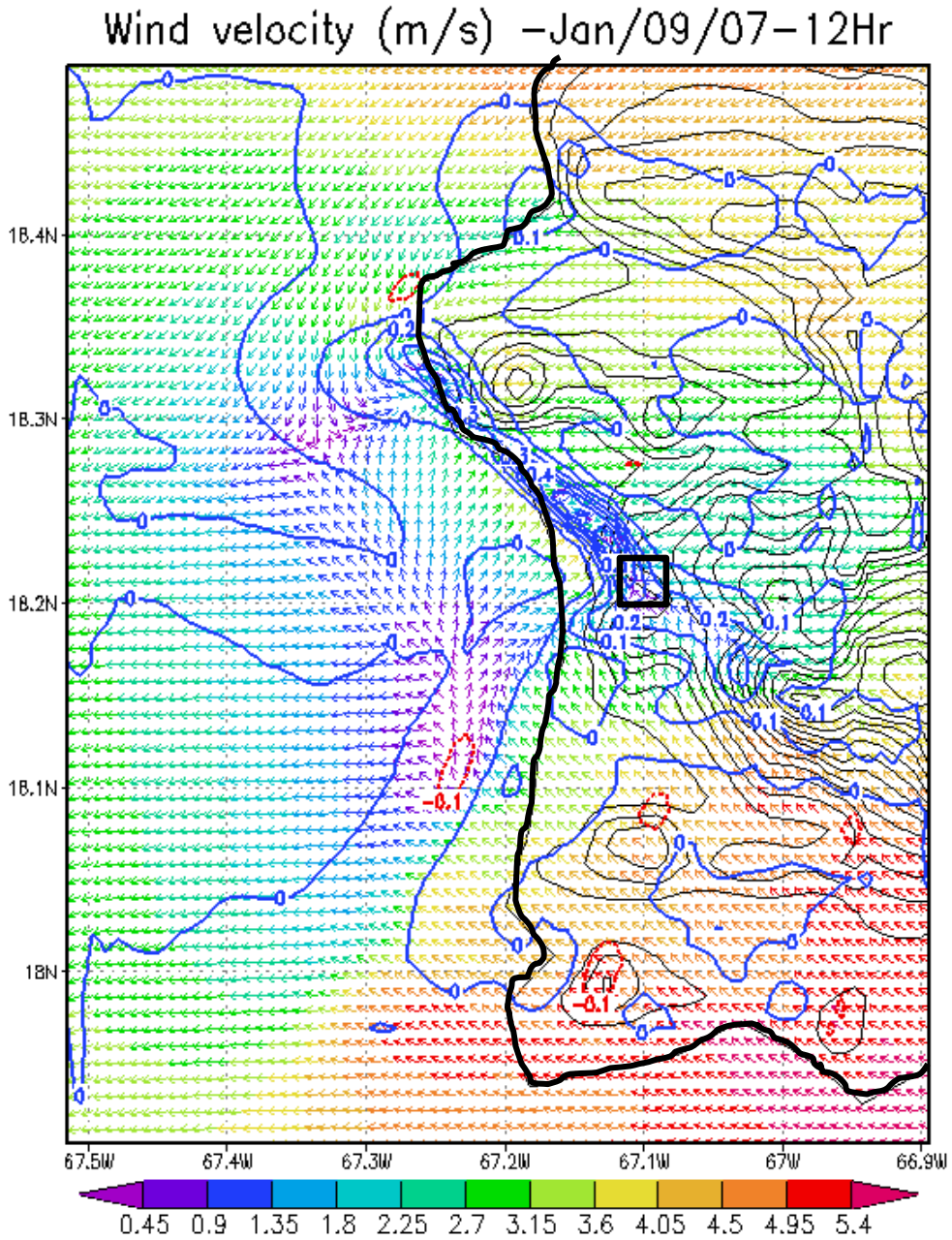

Wind velocity (m/s) –Jan/09/07–11Hr
18.4N
18.3N
18.2N
18.1N
18N
67.5W
67.4W
67.3W
67.2W
67.1W
67W
66.9W
0.36 0.72 1.08 1.44 1.8 2.16 2.52 2.88 3.24 3.6 3.96 4.32
GrADS: COLA/IGES
2007–02–26–23:05



GrADS: COLA/IGES

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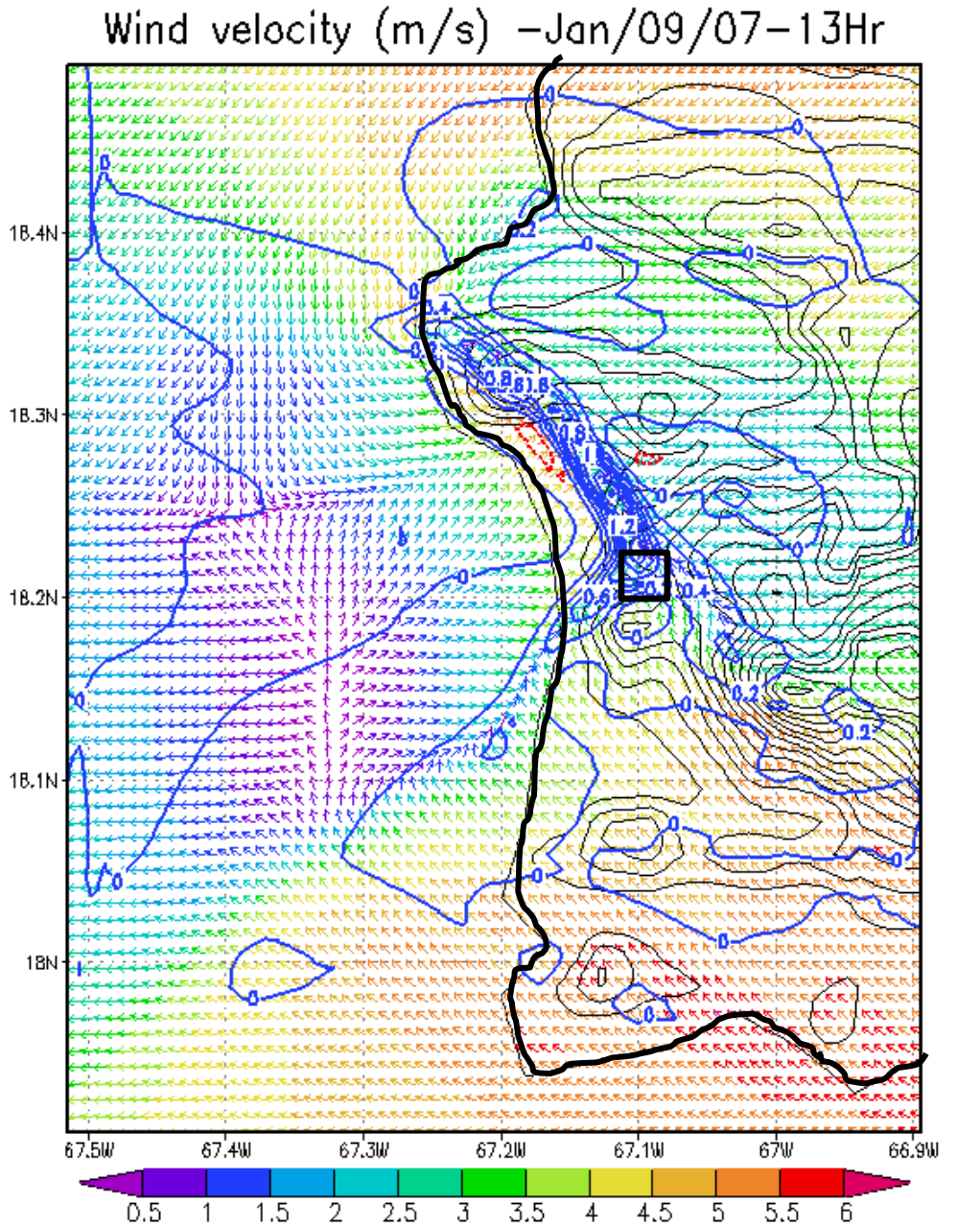
Wind velocity (m/s) -Jan/09/07-13Hr
18.4N
18.3N
18.2N
18.1N
18N
67.5W
67.4W
67.3W
67.2W
67.1W
67W
66.9W
0.5
1
1.5
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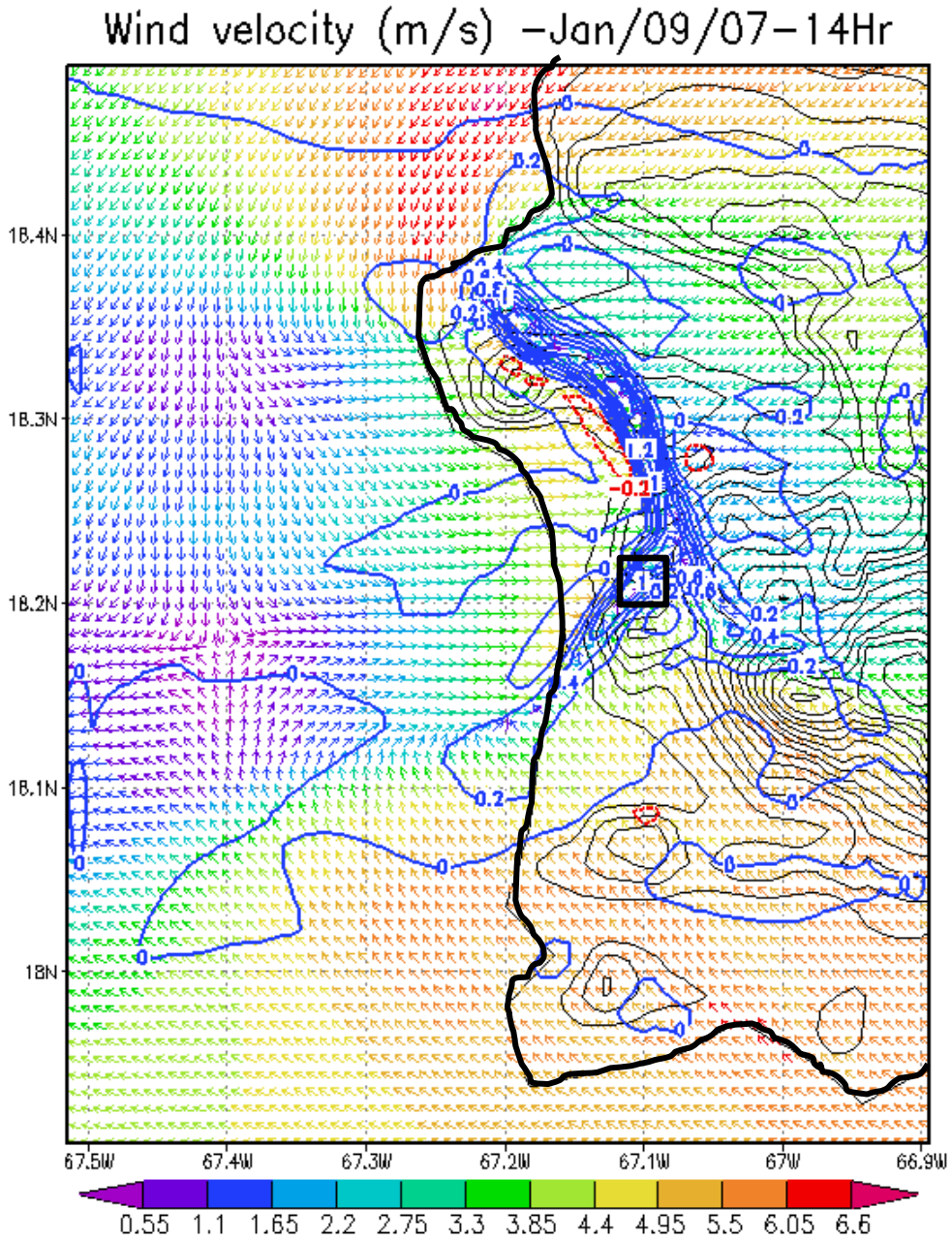
2.5
3
3.5
4
4.5
5
5.5
6
GrADS: COLA/IGES
2007-02-26-23:06



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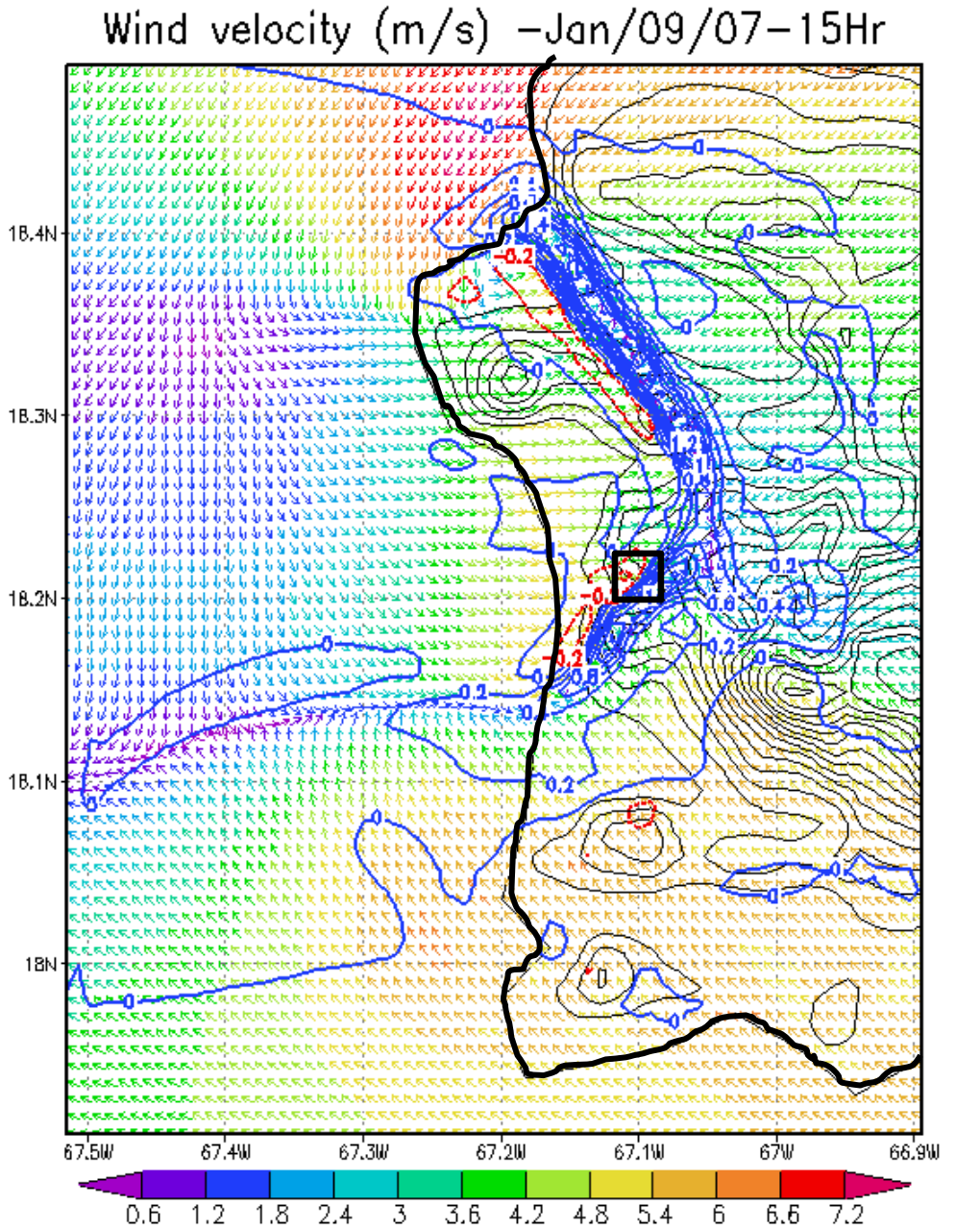
Wind velocity (m/s) –Jan/09/07–15Hr
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18.1N
18N
67.5W
67.4W
67.3W
67.2W
67.1W
67W
66.9W
0.6
1.2
1.8
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6
6.6
7.2
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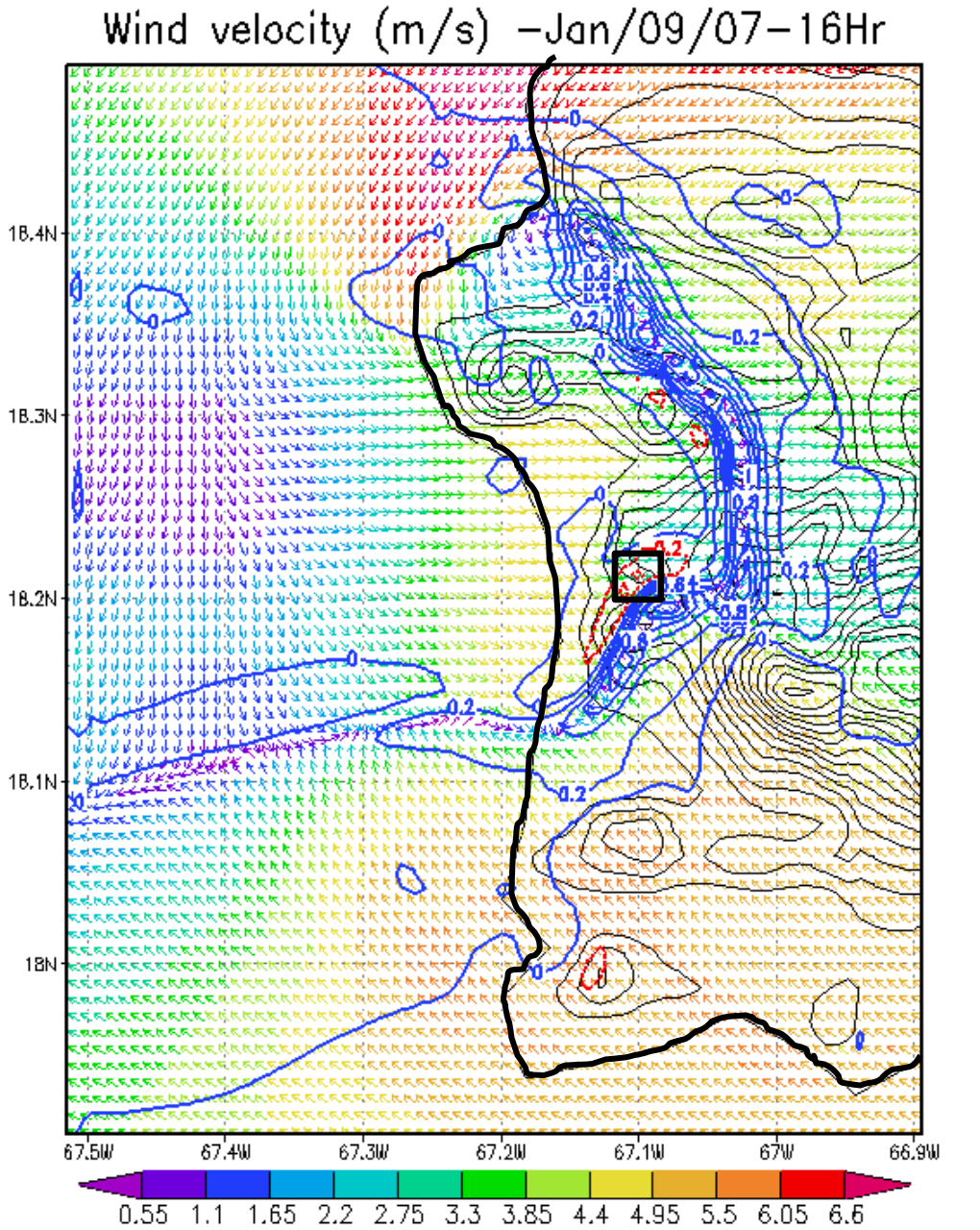
2007-02-26-23:07



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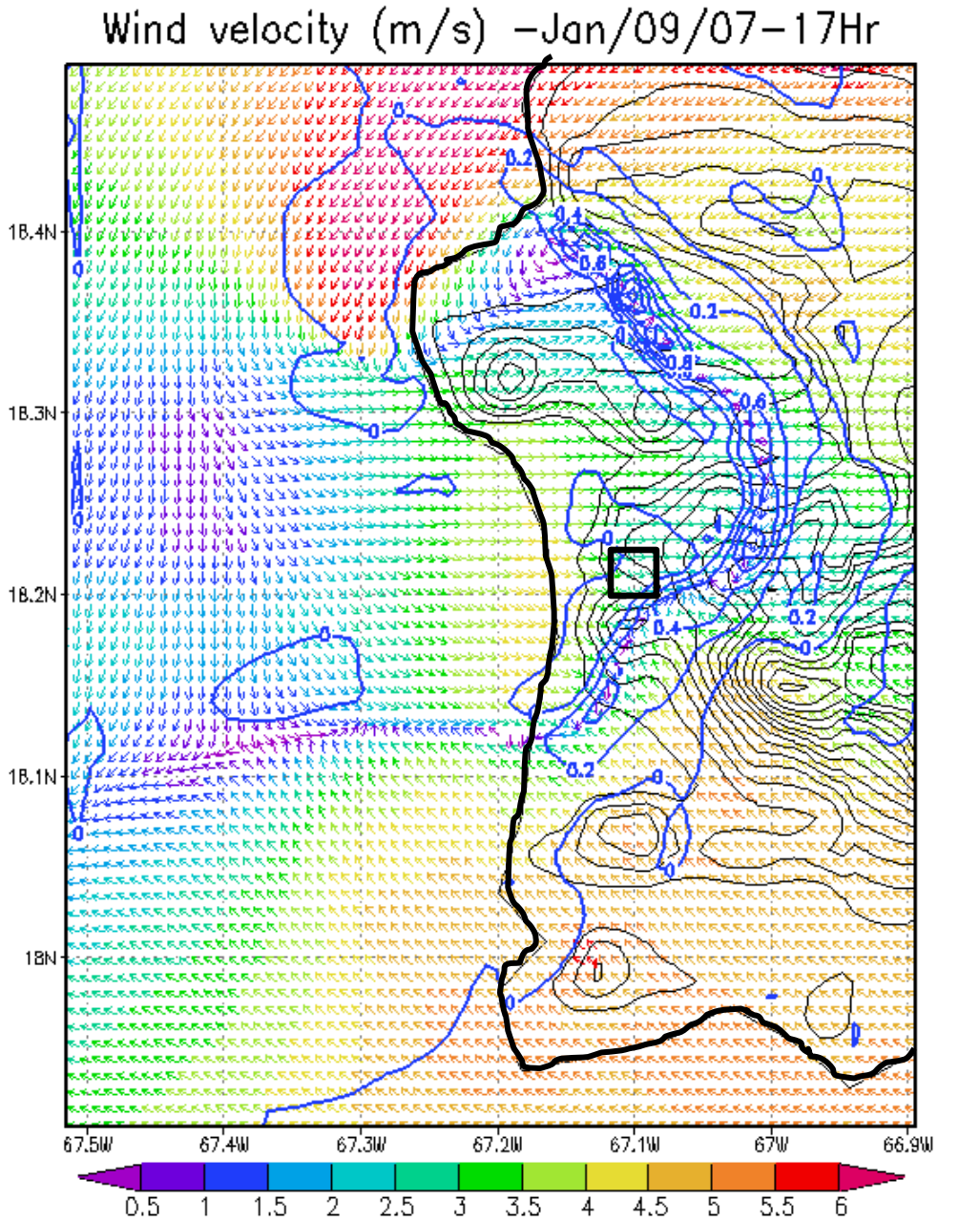
2007-02-26-23:08



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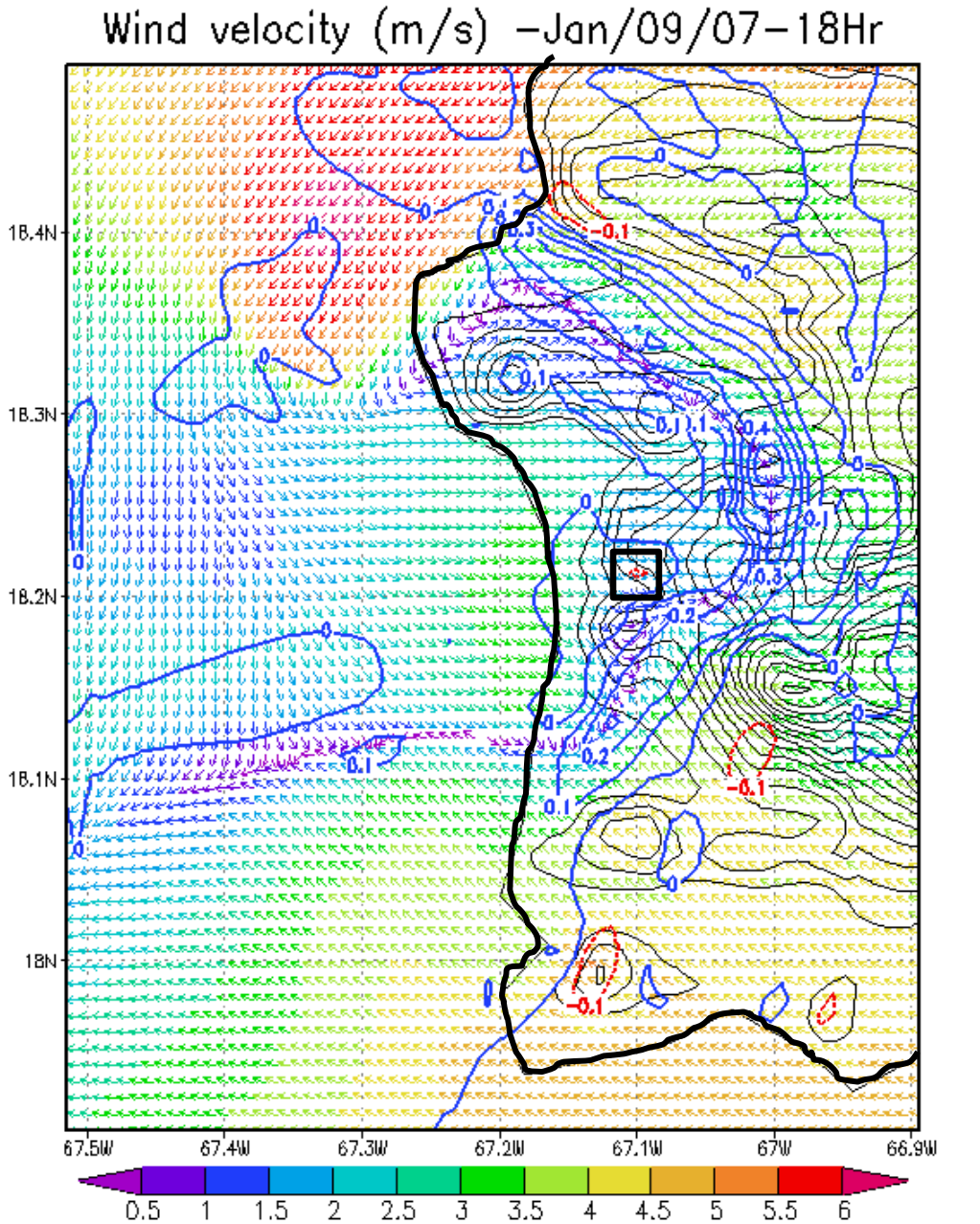

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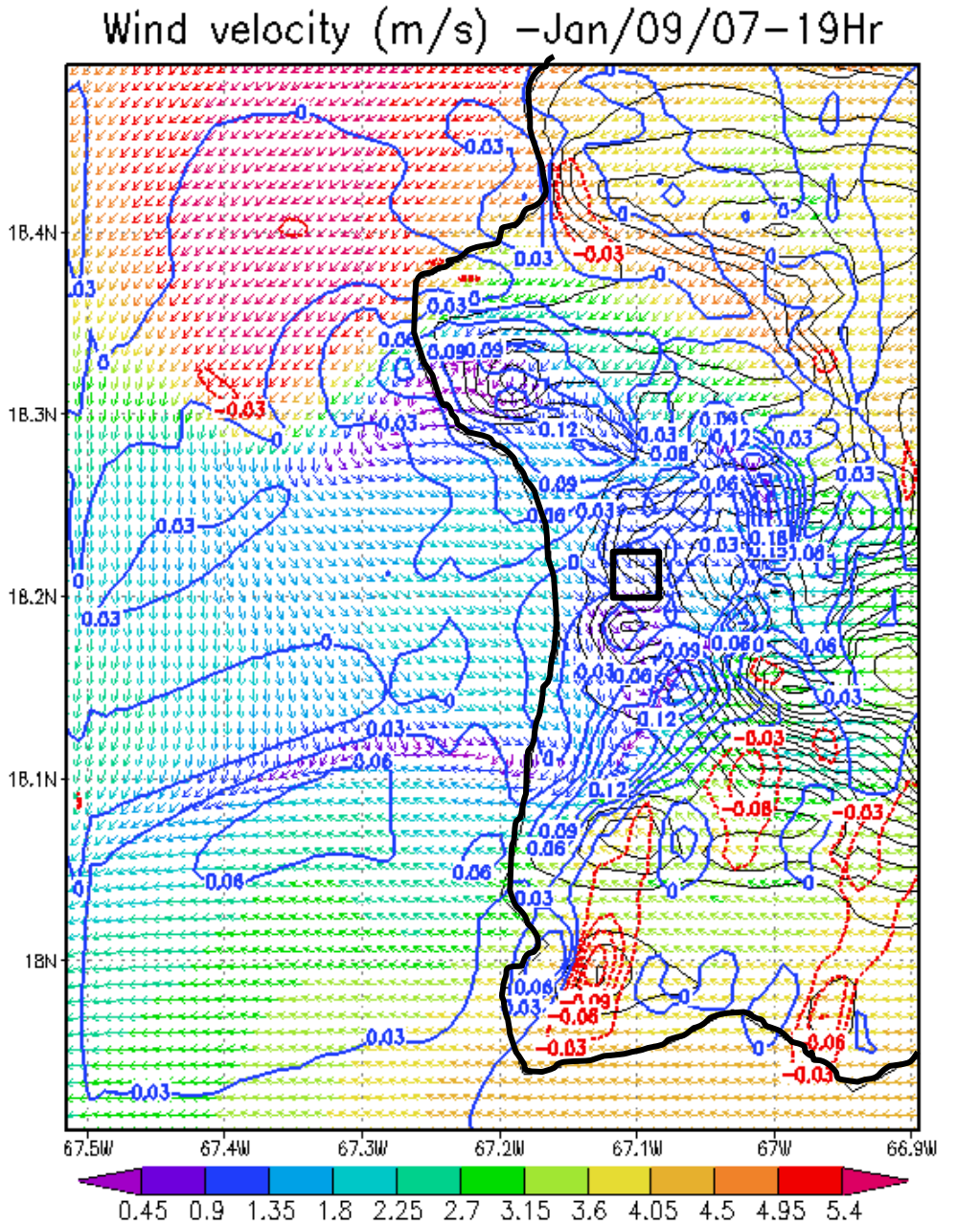
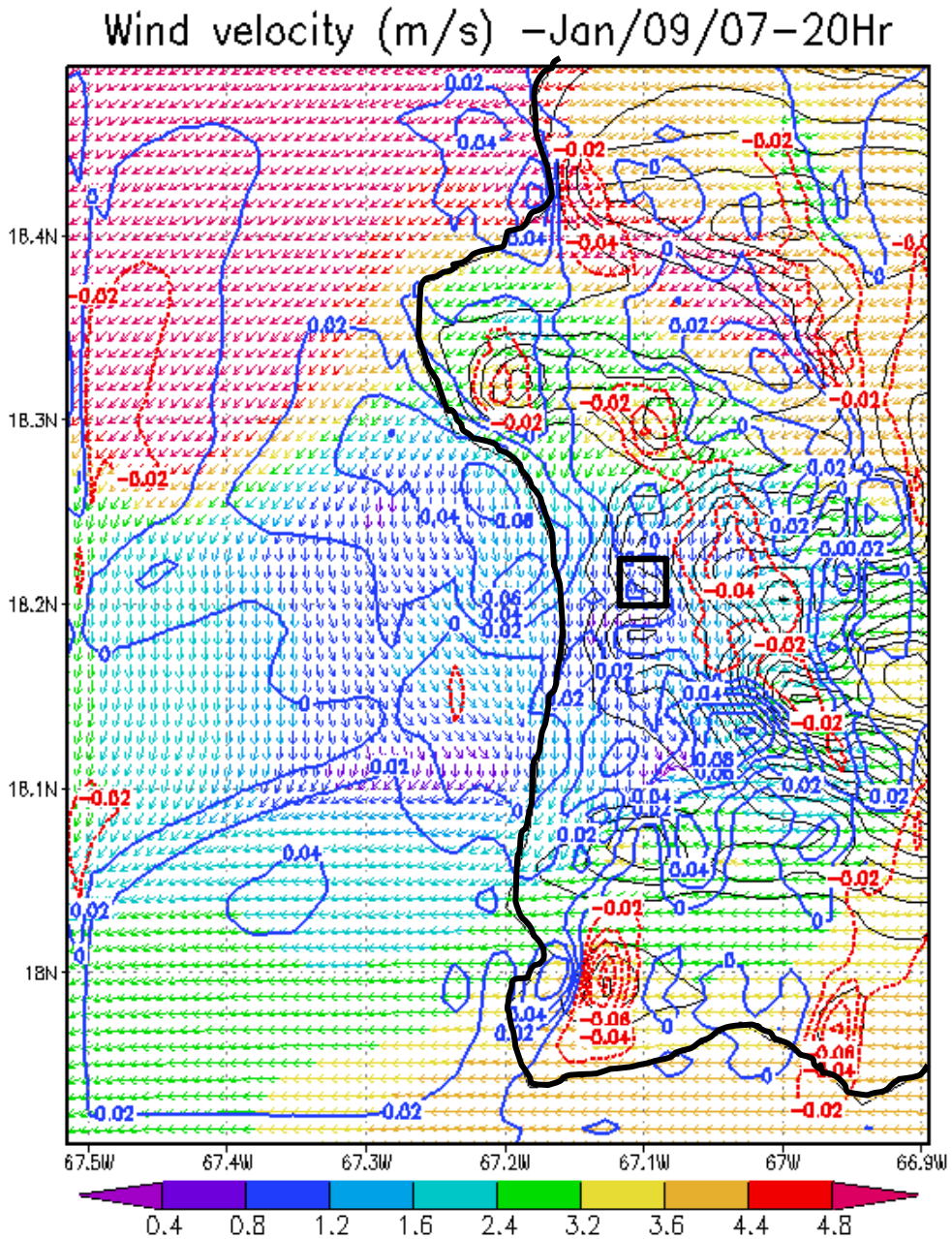

Wind velocity (m/s) –Jan/09/07–19Hr
18.4N
18.3N
18.2N
18.1N
18N
67.5W
67.4W
67.3W
67.2W
67.1W
67W
66.9W
0.45 0.9 1.35 1.8 2.25 2.7 3.15 3.6 4.05 4.5 4.95 5.4
GrADS: COLA/IGES
2007-02-26-23:08



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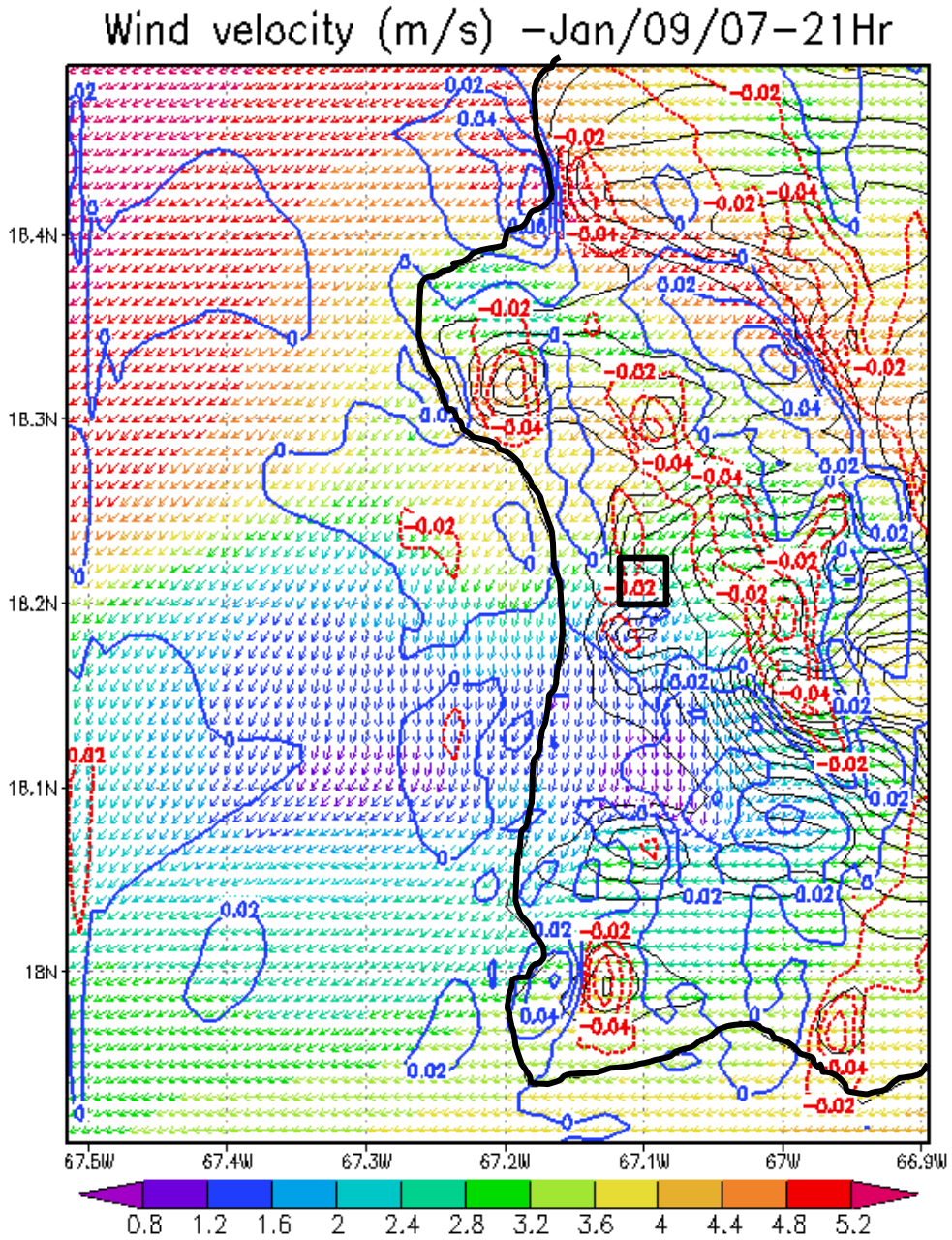

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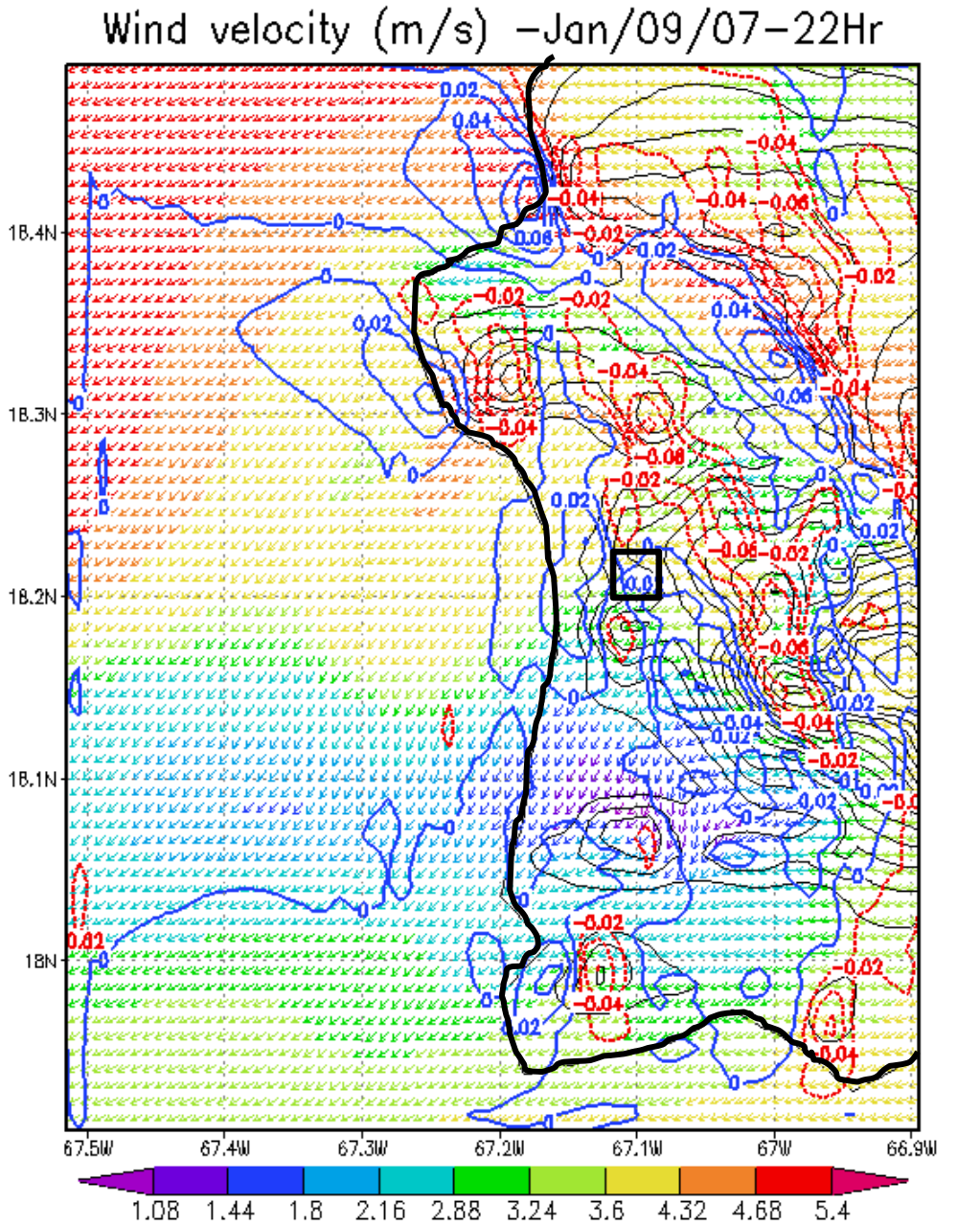

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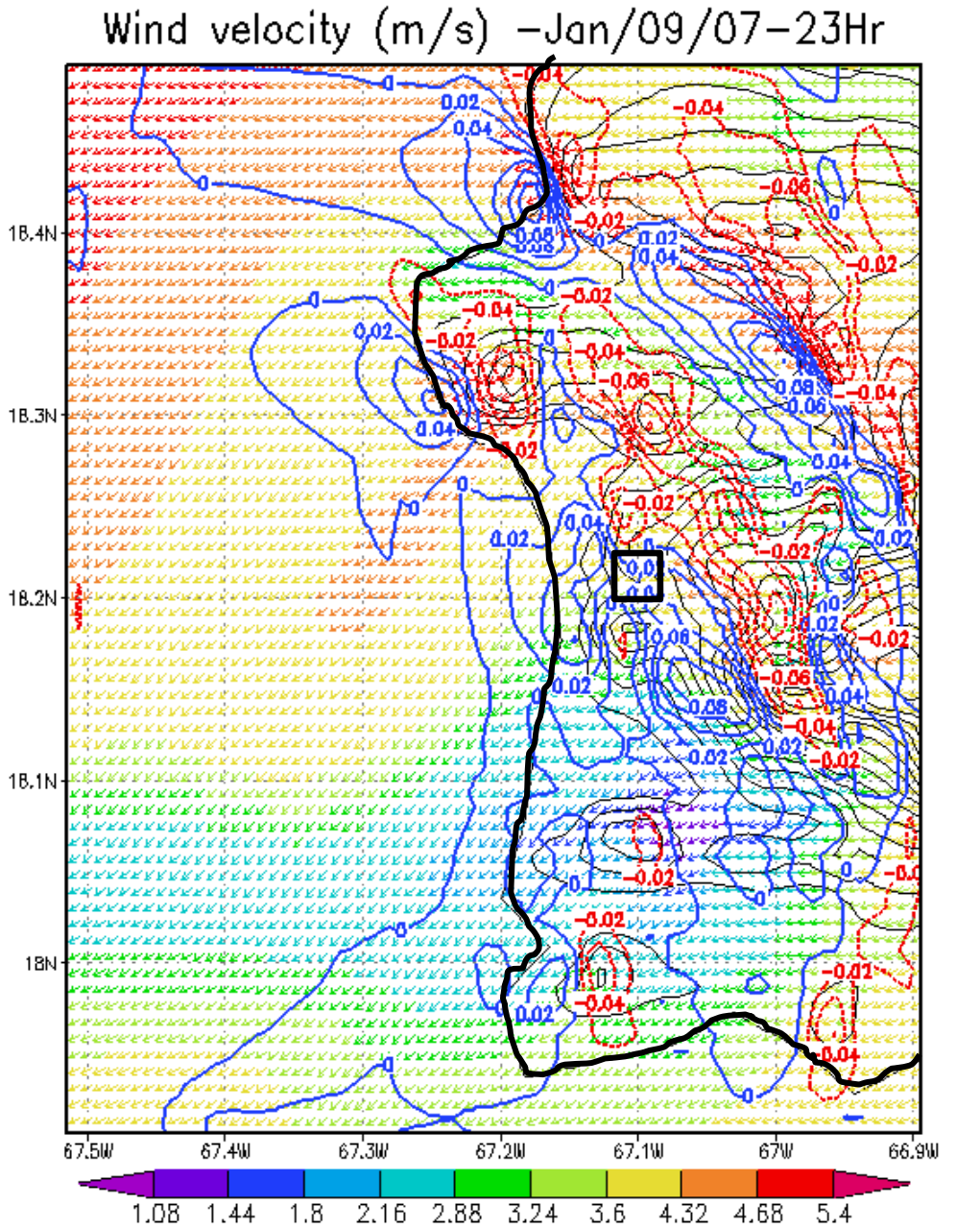
Wind velocity (m/s) -Jan/09/07-23Hr
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18.3N
18.2N
18.1N
18N
67.5W
67.4W
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67.2W
67.1W
67W
66.9W
1.08
1.44
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3.24
3.6
4.32
4.68
5.4
GrADS: COLA/IGES
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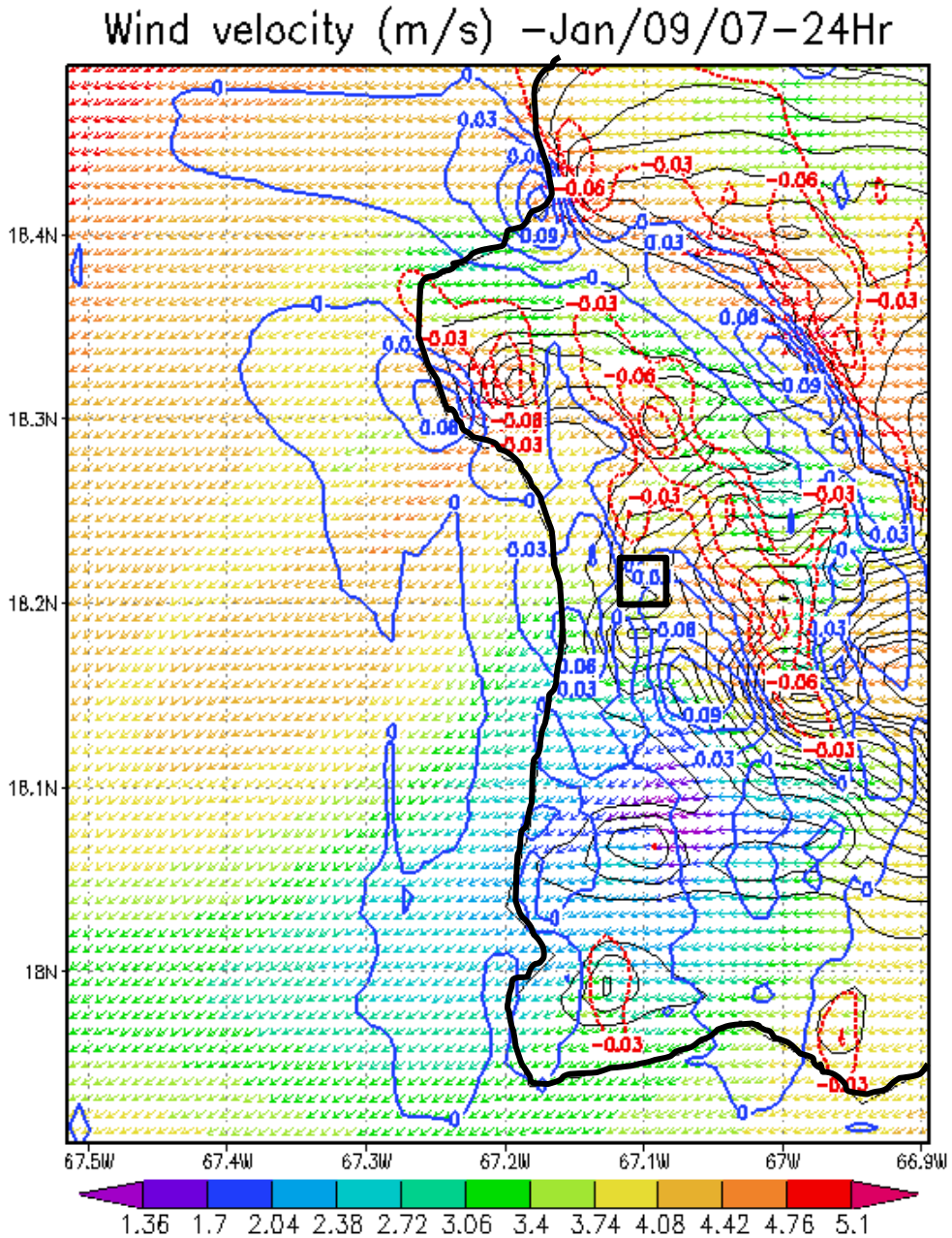

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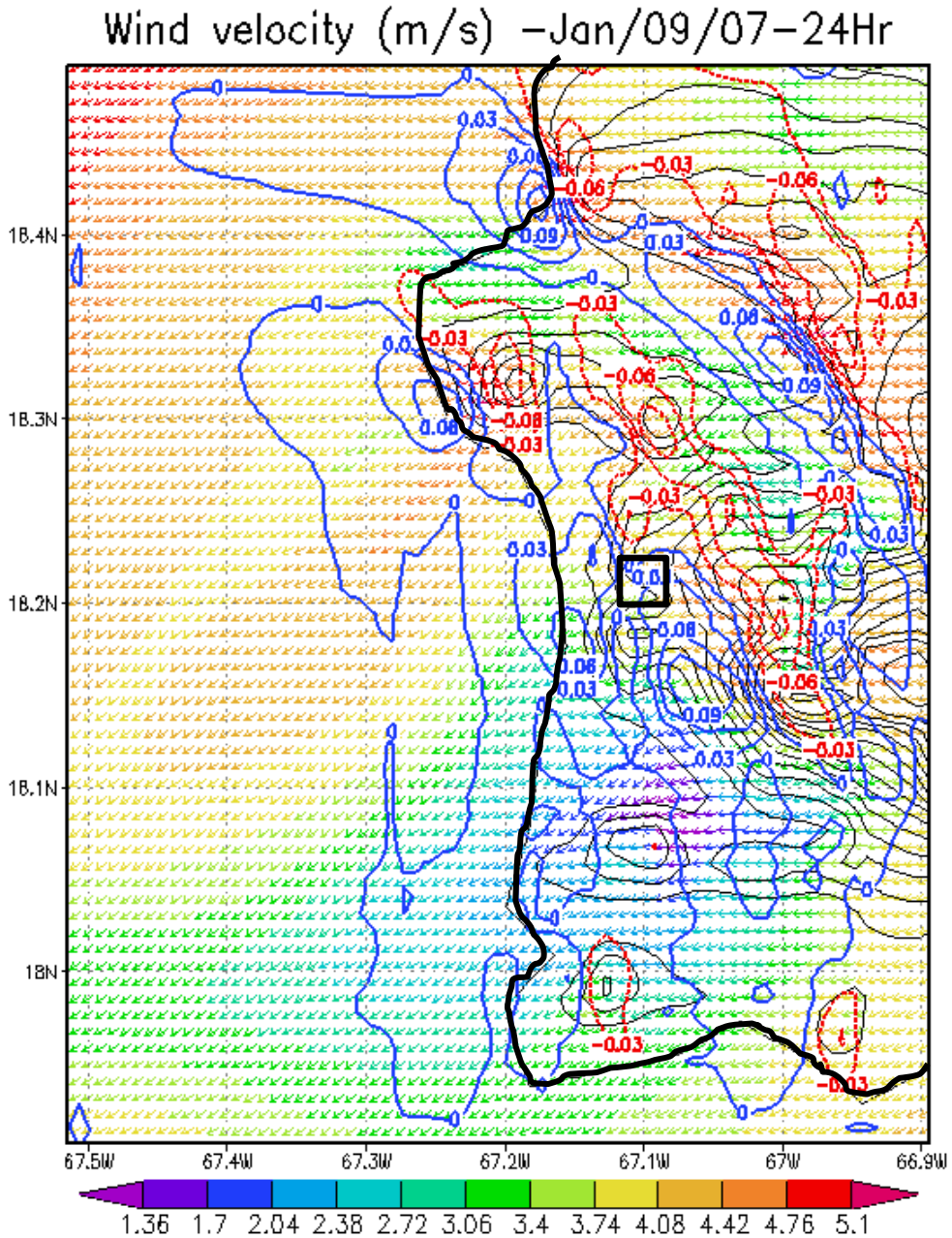
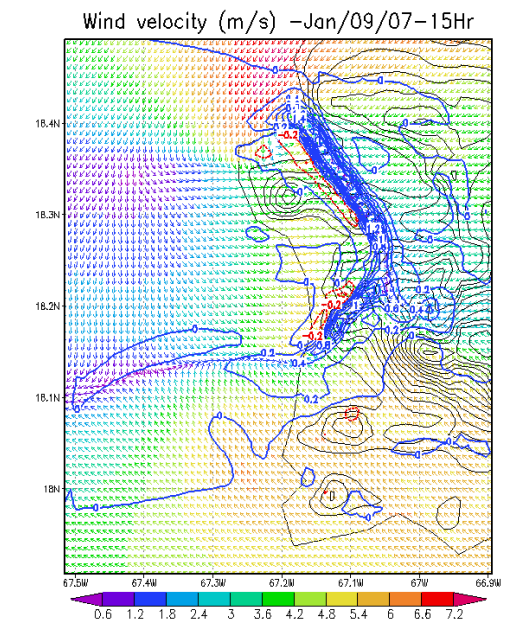


GrADS: COLA/IGES

2007–02–26–23:09

Simulation of Sea Breeze Effect in Western PR using Rams (Regional Atmospheric Modeling system)

- The following plots present the **horizontal velocity vectors** at 48.5 m and the **vertical velocity contours** at 689 m above study area in western Puerto Rico.



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PUBLICATIONS / FINCA ALZAMORA WEATHER / PR-ET SOFTWARE /

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Progress of 2015 Puerto Rico Drought – Selected Soil and Water Parameters

Weekly maps can be viewed by clicking on the following links:

Rainfall
Agricultural rainfall deficit
Agricultural rainfall deficit (negative values only)
Soil Moisture Saturation
Volumetric Soil Moisture Content
Crop Stress Coefficient
Reference (Potential)
EvapotranspirationActual
EvapotranspirationNatural Log of the Bowen Ratio

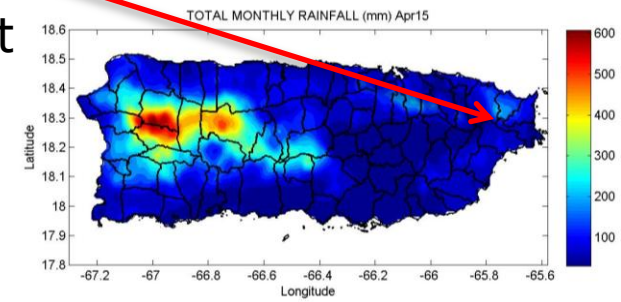
Monthly maps can be viewed by clicking on the following links:

Rainfall
Agricultural Rainfall Deficit
Soil Moisture Saturation
Volumetric Soil Moisture Content
Crop Stress Coefficient
Reference (Potential) Evapotranspiration
Actual Evapotranspiration
Natural Log of the Bowen Ratio

RAINFALL (mm)

NOAA's Advanced Hydrologic Prediction Service

El Yunque Tropical Rain Forest



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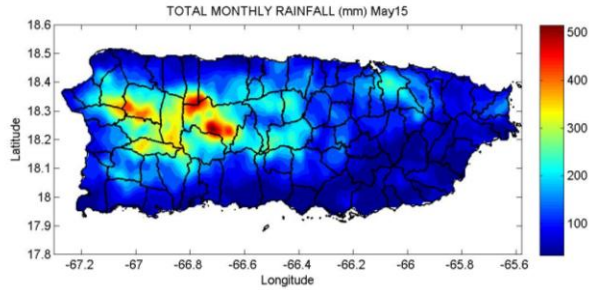

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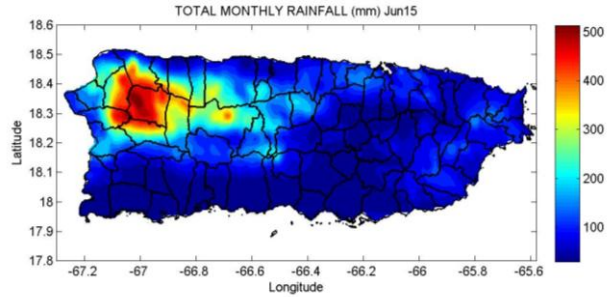

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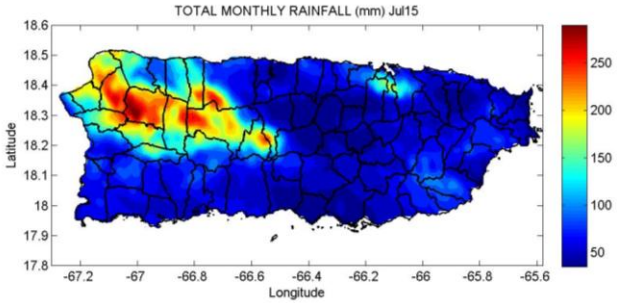

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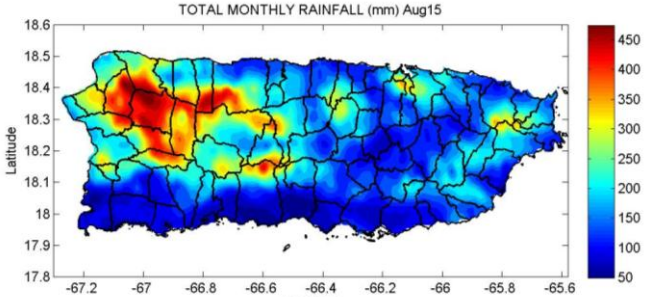

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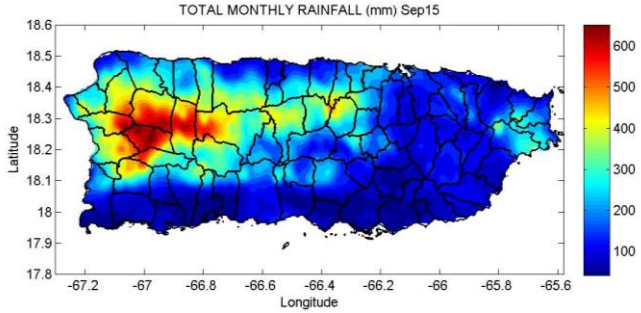

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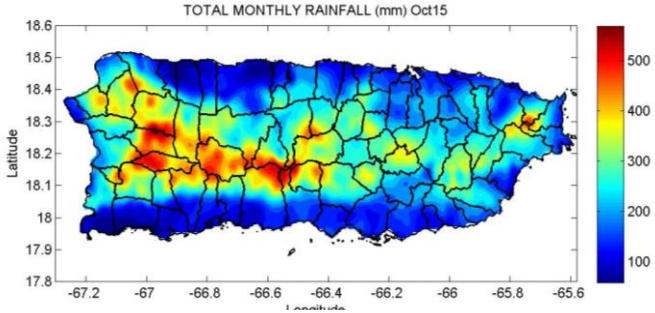

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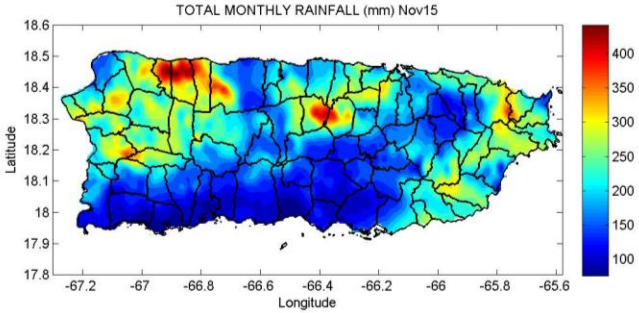

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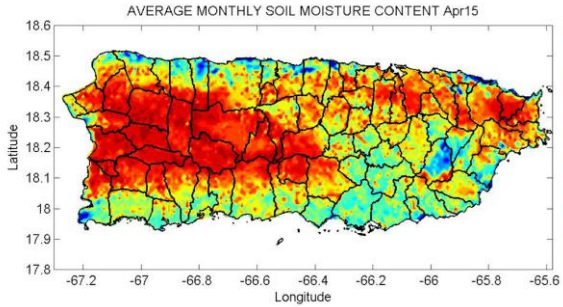
Volumetric Soil Moisture Content (cm^3/cm^3)



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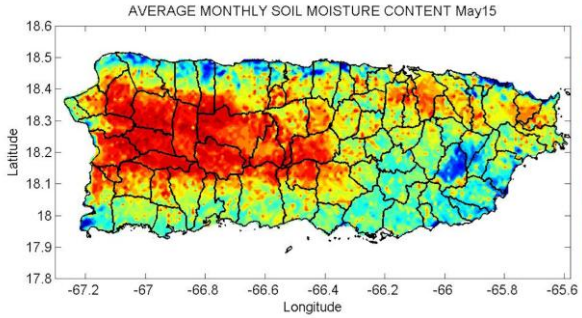

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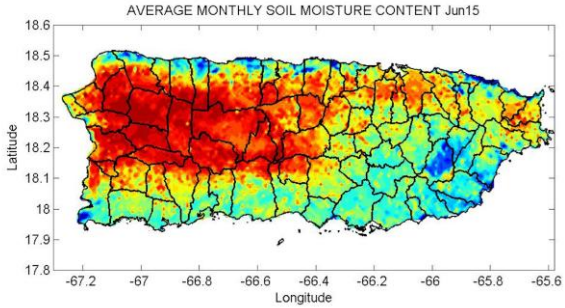

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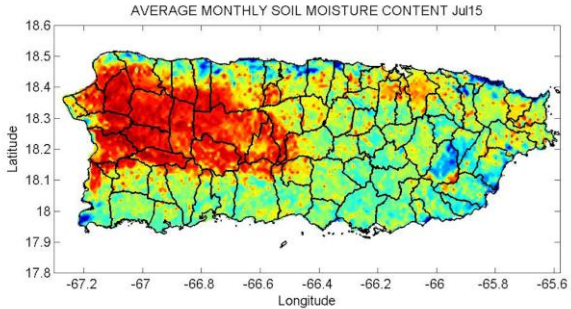

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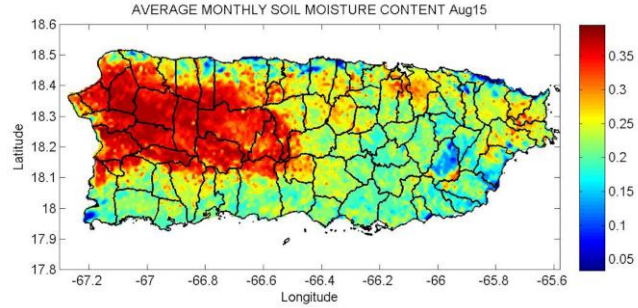

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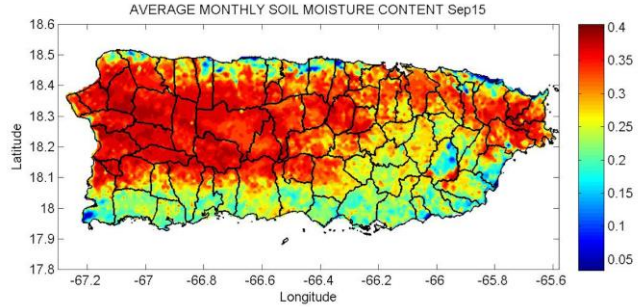

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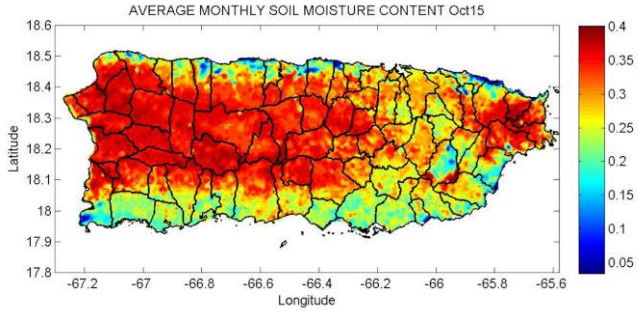

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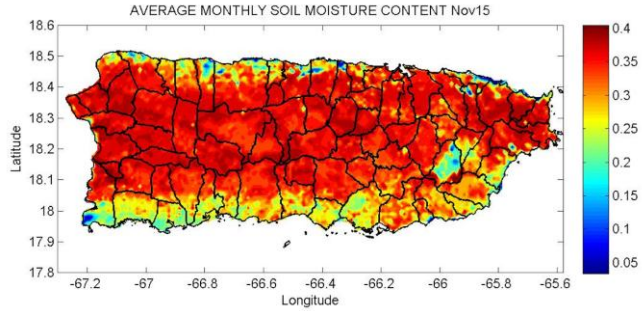

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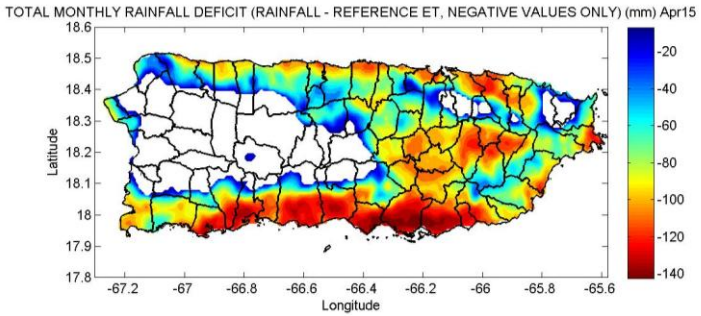
Rainfall Deficit (negative values only) (mm)

Rainfall – Reference Evapotranspiration



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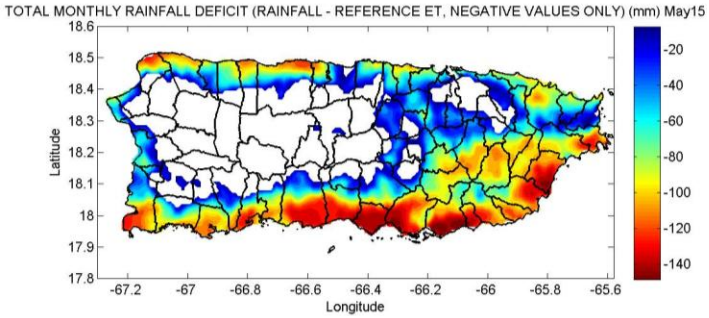

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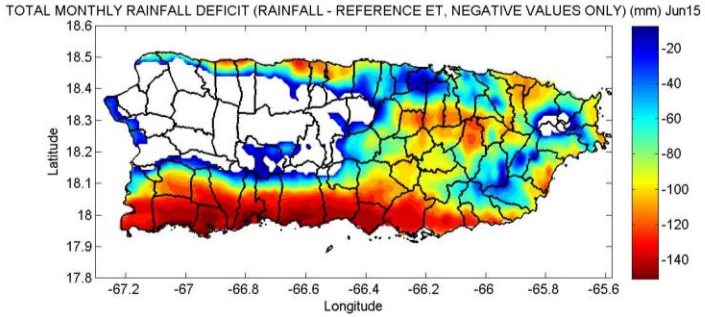

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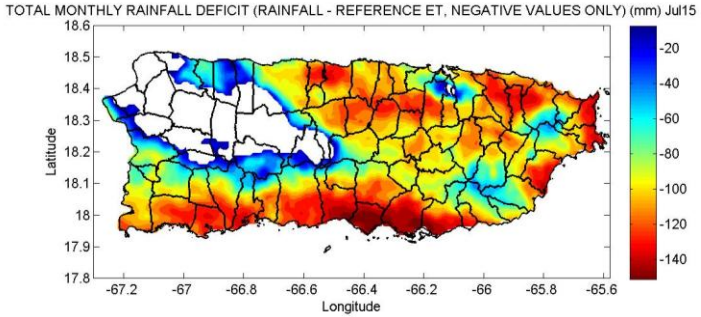

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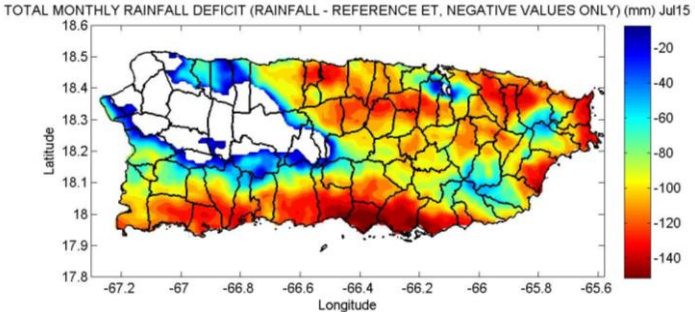

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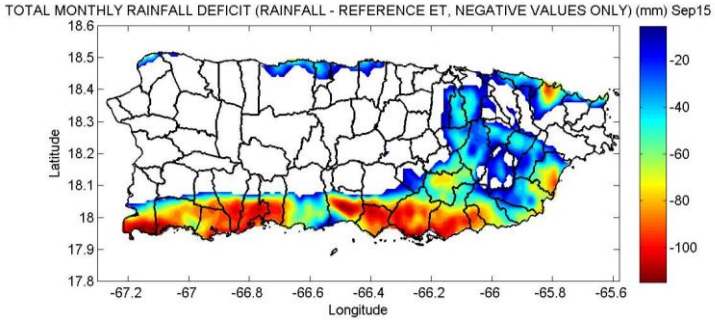

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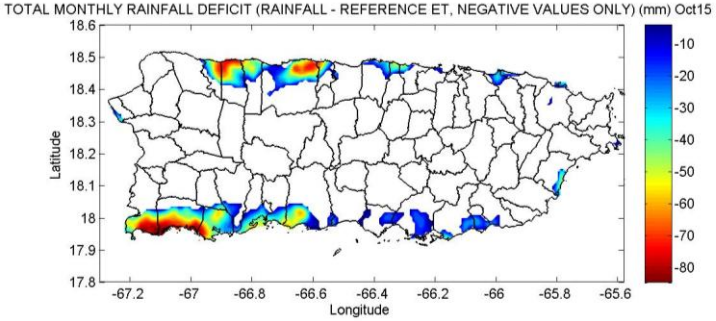

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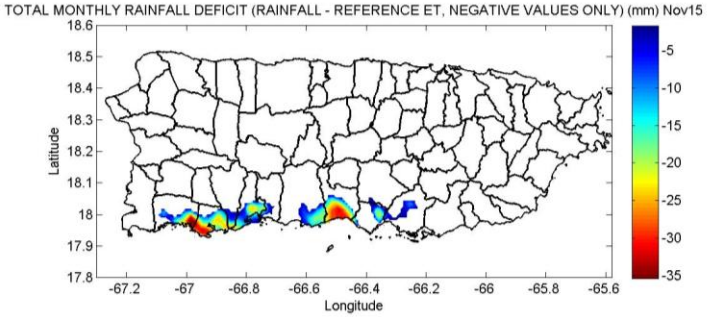

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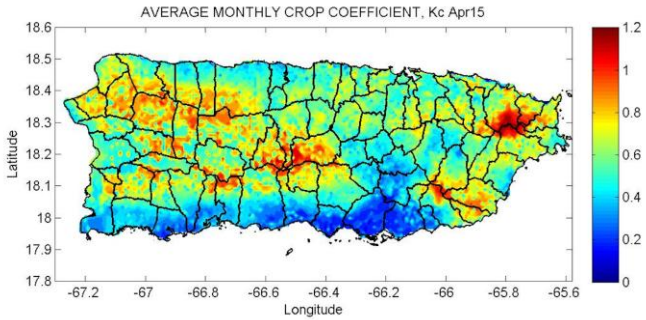
Effective Crop Coefficient



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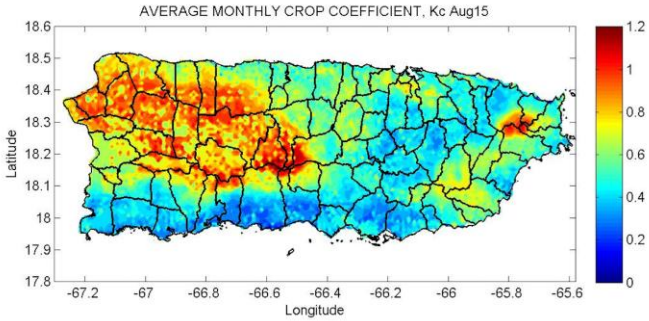

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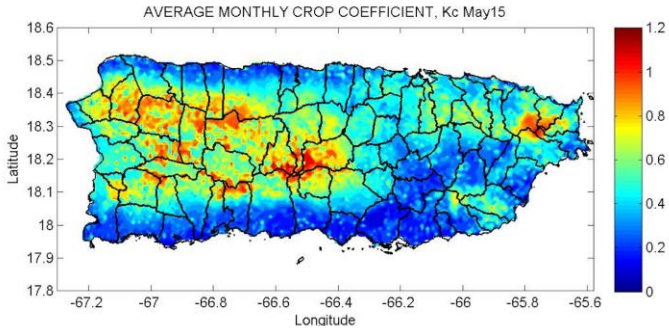

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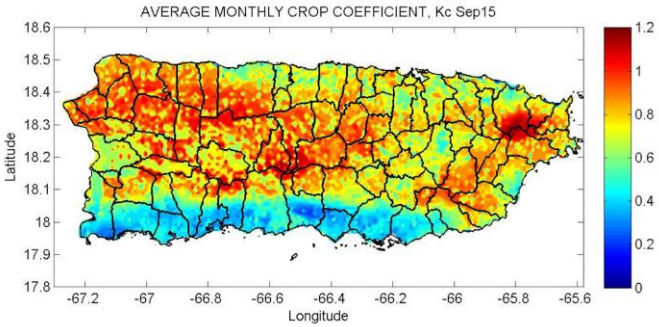

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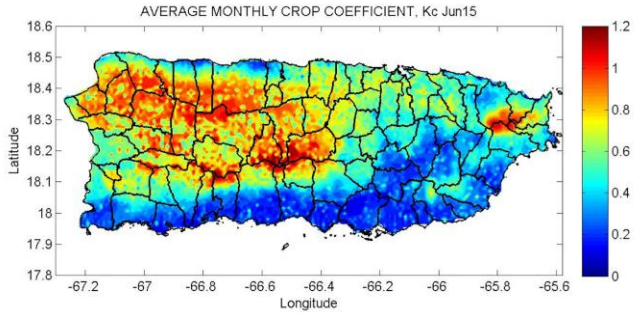

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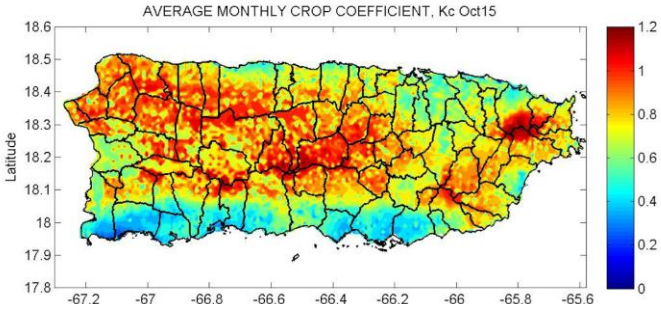

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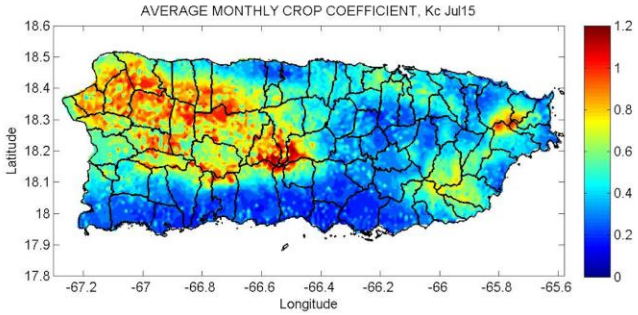

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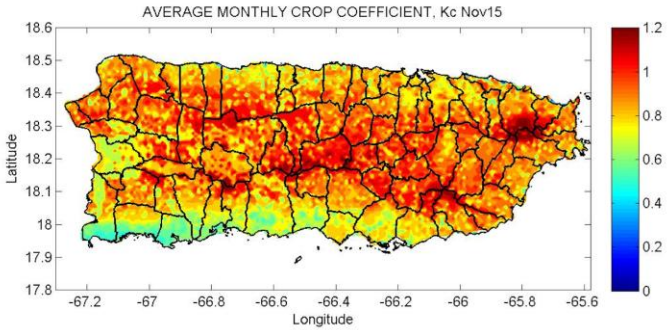

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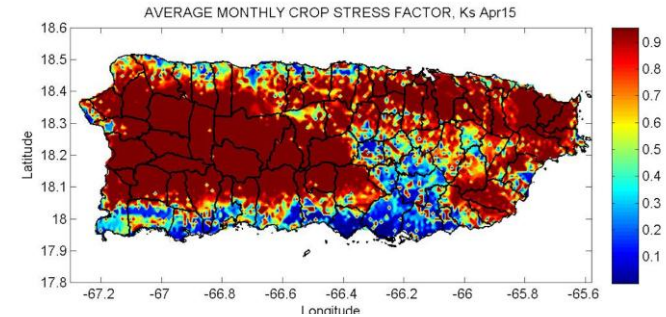
Water Stress Coefficient



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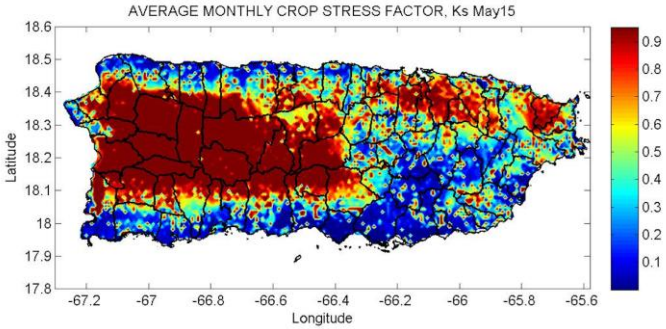

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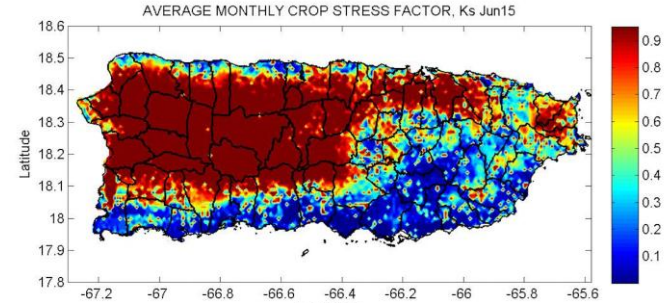

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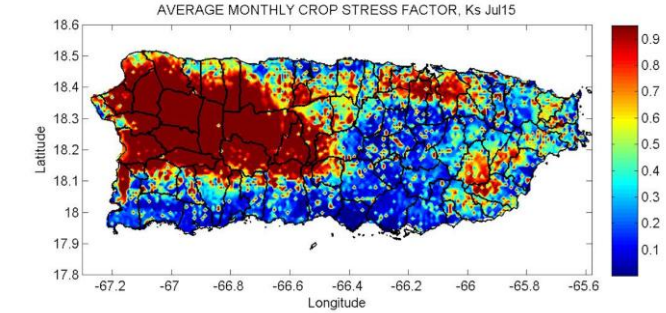

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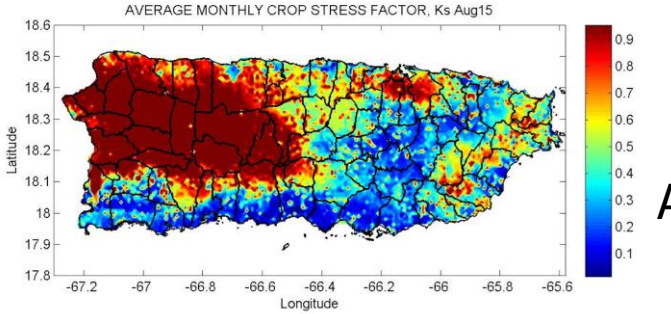

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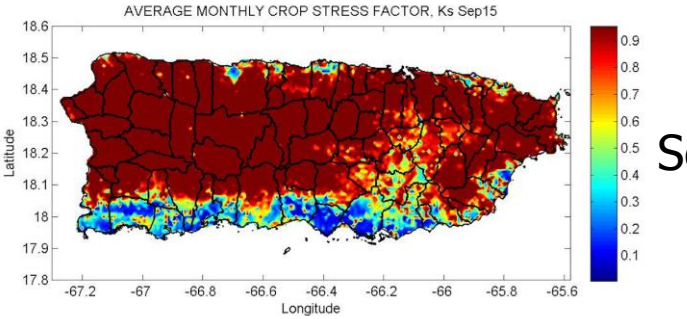

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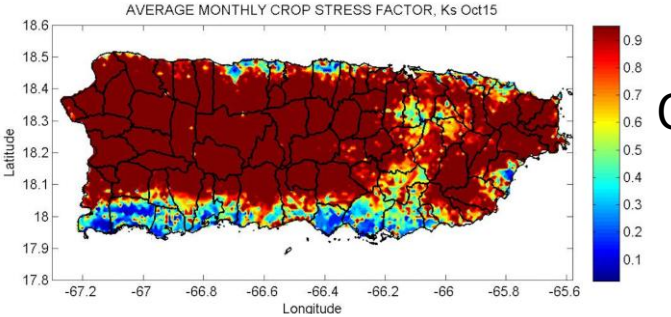

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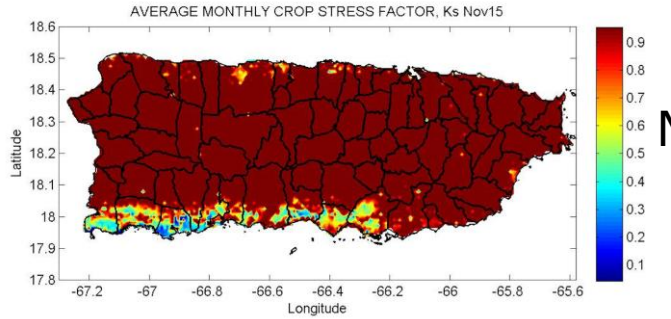

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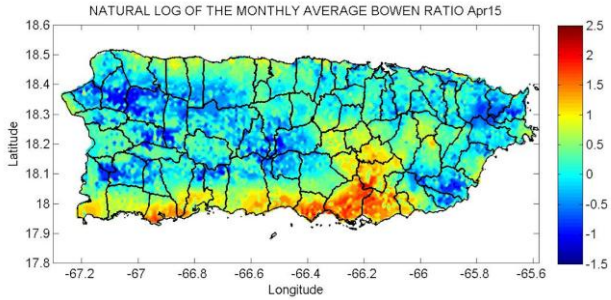
Log of the Bowen Ratio



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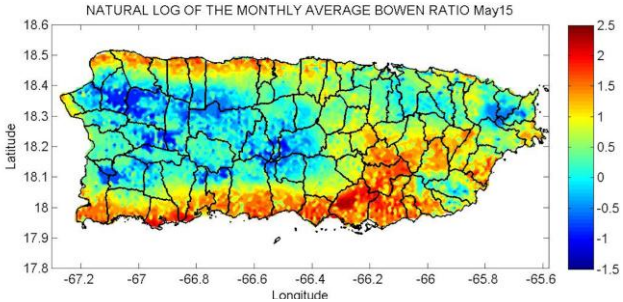

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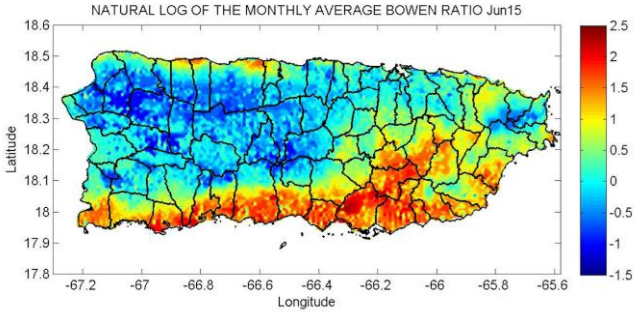

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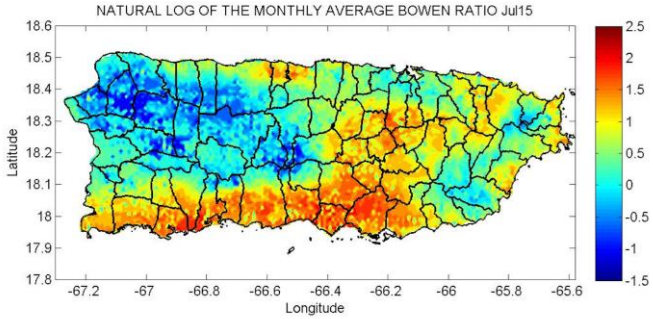

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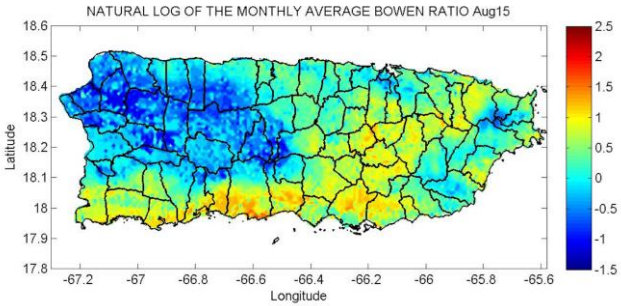

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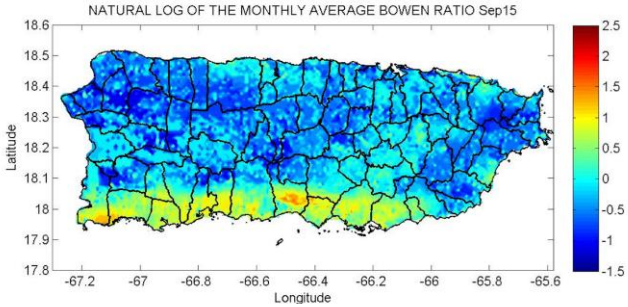

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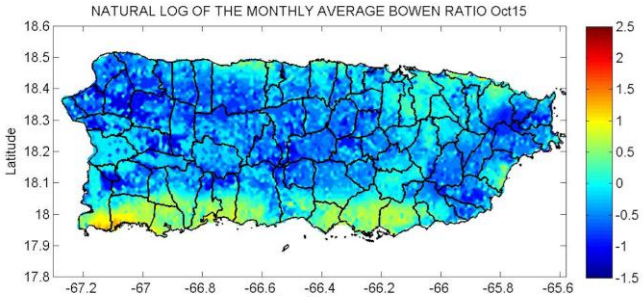

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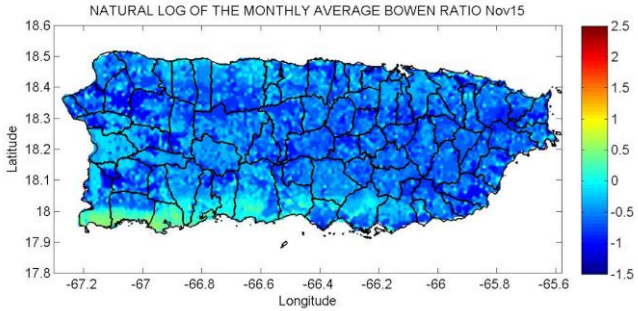


Nov

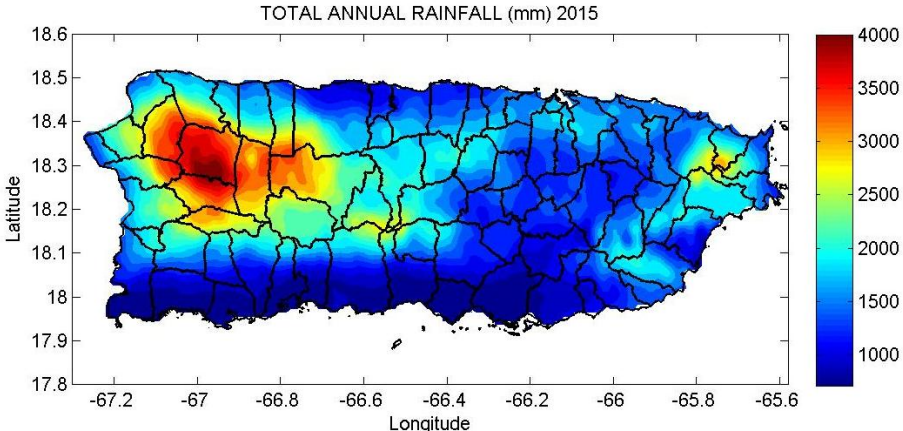
Comparisons of Rainfall in NW PR for drought and non-drought years

Weather Station	Avg. rain drought yrs.	Avg. rain non-drought yrs.
Coloso	72.88	77.48
Hacienda constanza	68.7	69.51
Maricao fish hatchery	81.92	98.62
Mayaguez city	62.31	67.44
Mayaguez airport	62.44	78.24
San sebastian 2 wnw	86.26	91.24

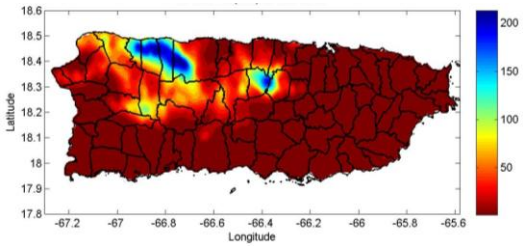
Compared average of:

17 Drought Years

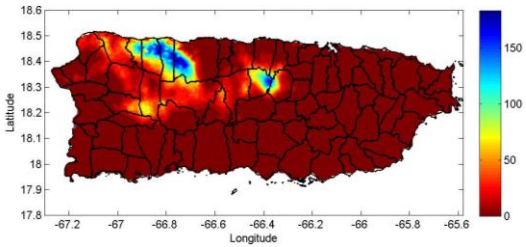
94 Non-Drought Years



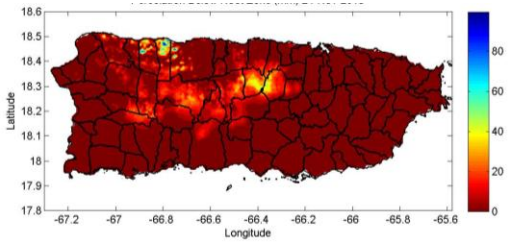
Water and Energy Balance November 24, 2015



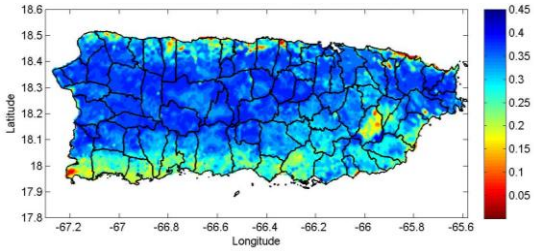
Rainfall



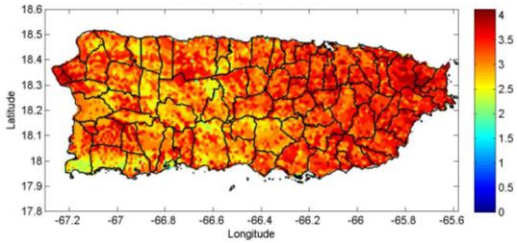
Runoff



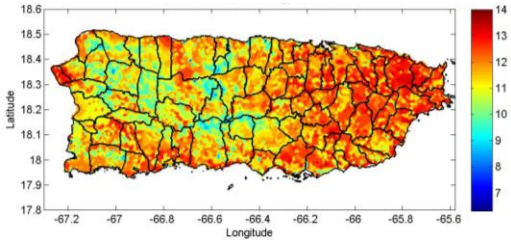
Aquifer Recharge



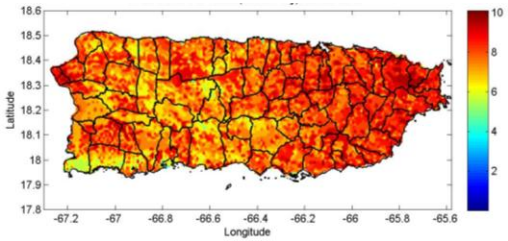
Soil Moisture



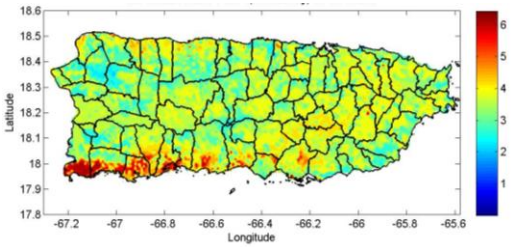
Actual ET



Net Radiation



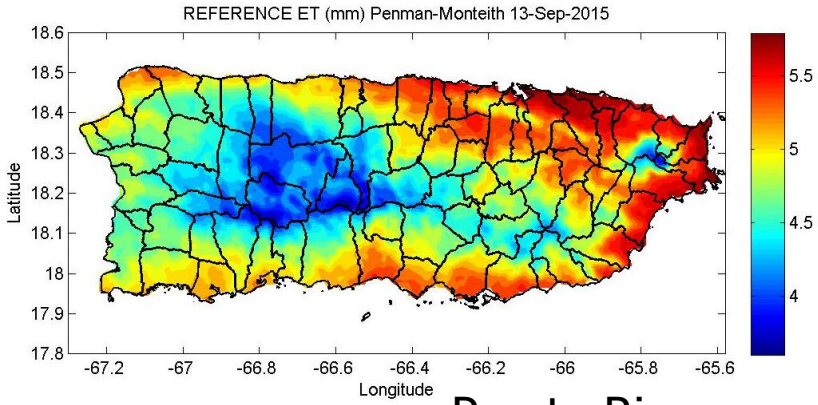
Latent Heat Flux



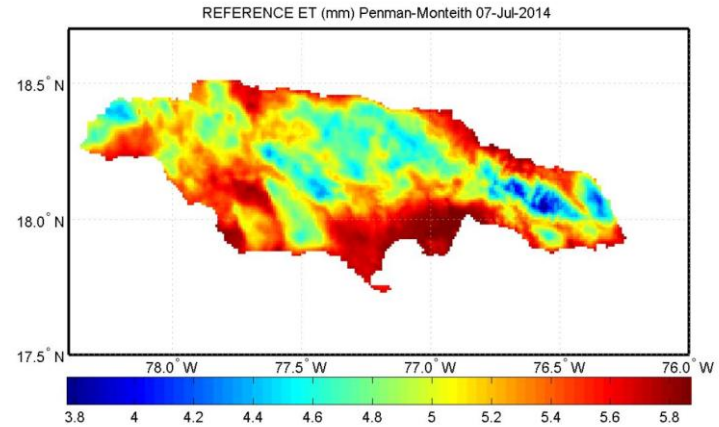
Sensible Heat Flux

Reference ET for PR, USVI, Hispaniola, Jamaica and Cuba

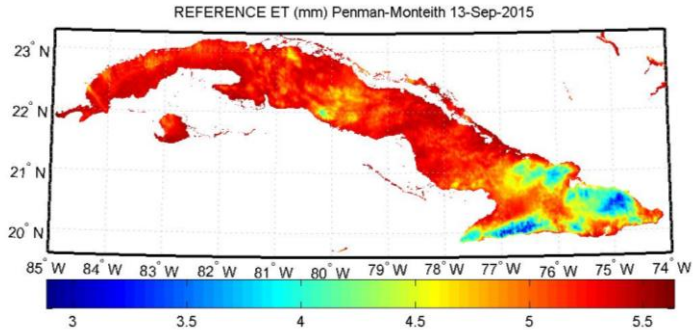
pragwater.com



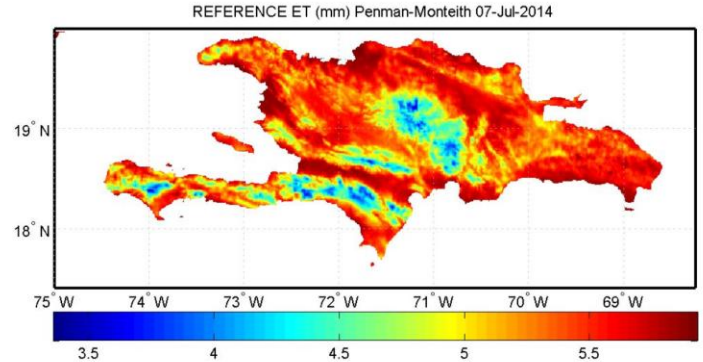
Puerto Rico



Jamaica

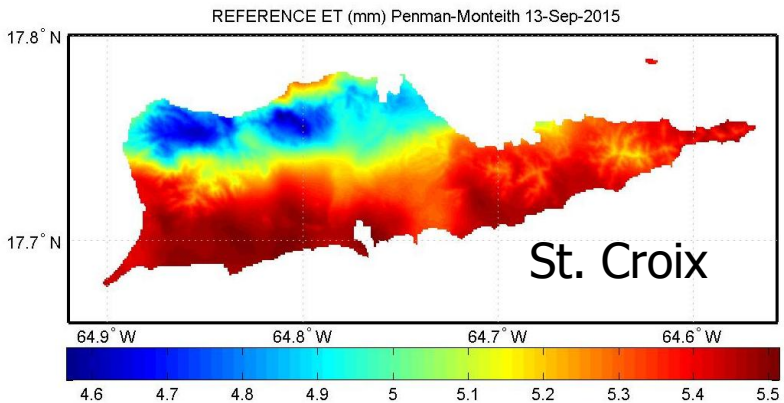


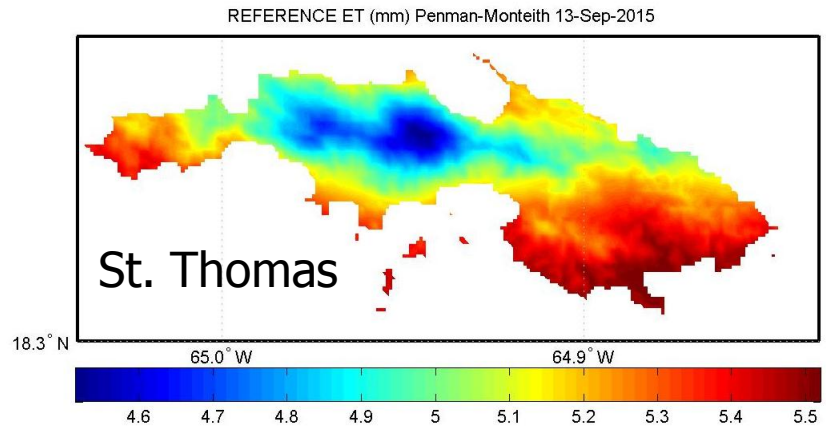
Cuba

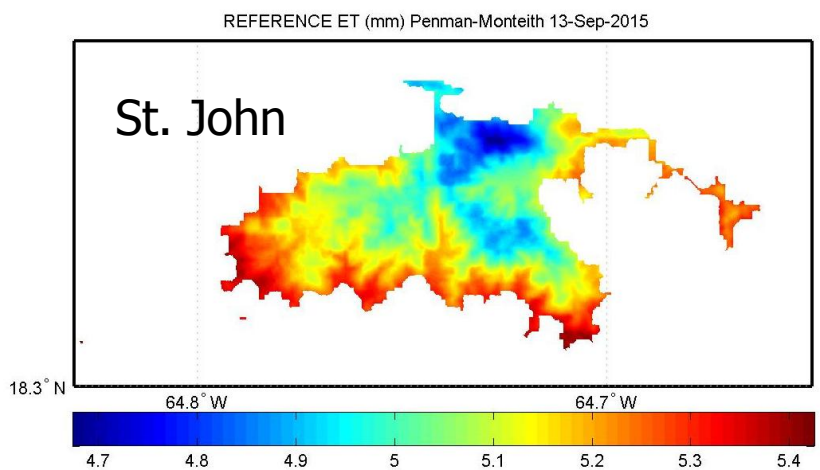


Hispaniola

Reference ET (mm) for the U.S. Virgin Island pragwater.com





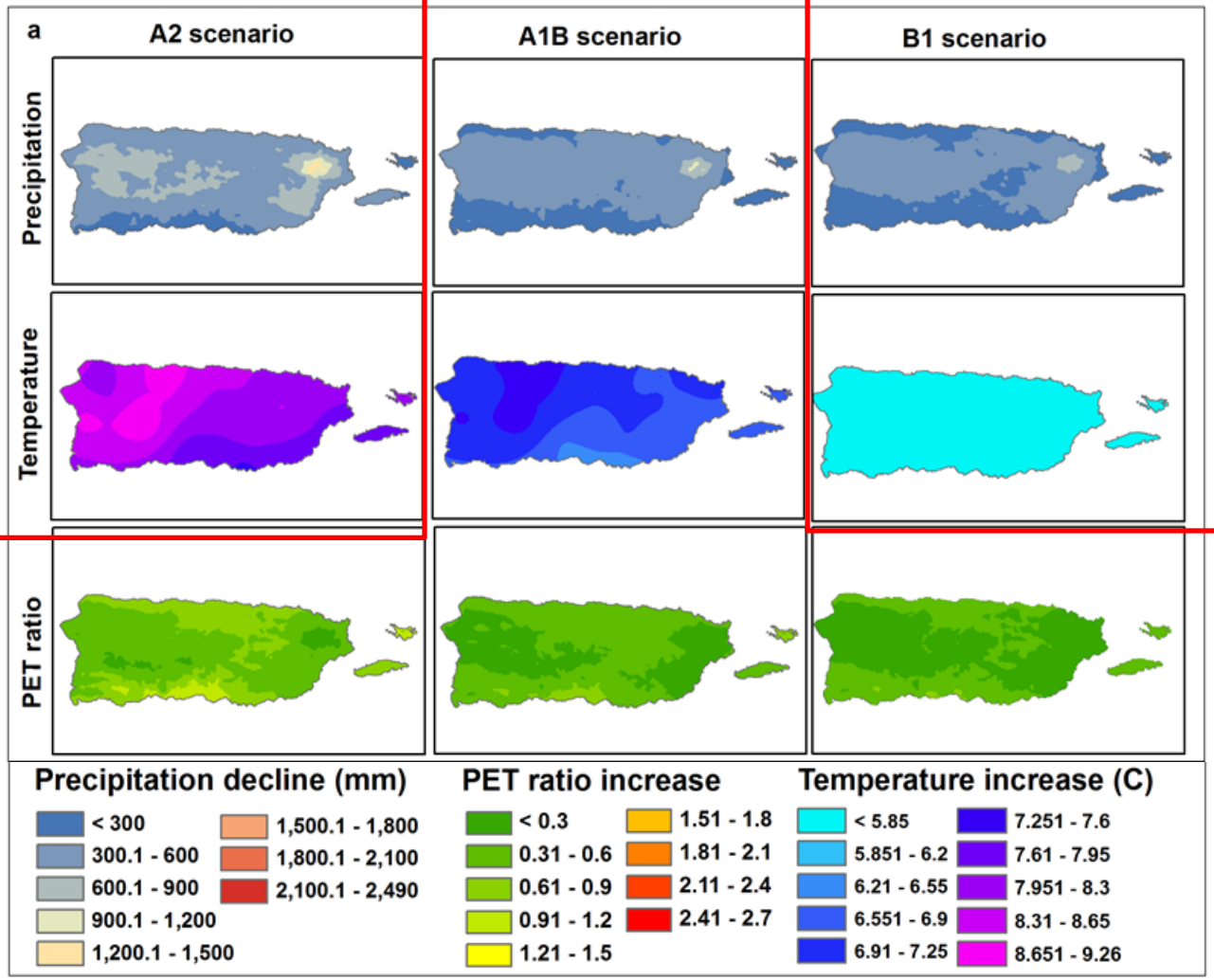


Potential Climate Change Impacts in Puerto Rico

The total changes in precipitation, mean temperature and PET ratio from the first time interval (1960 to 1990) to the last time interval (2071 to 2099) based on the multi-model average of all twelve models

30% Reduction in rainfall

8 °C Increase in Average Temperature

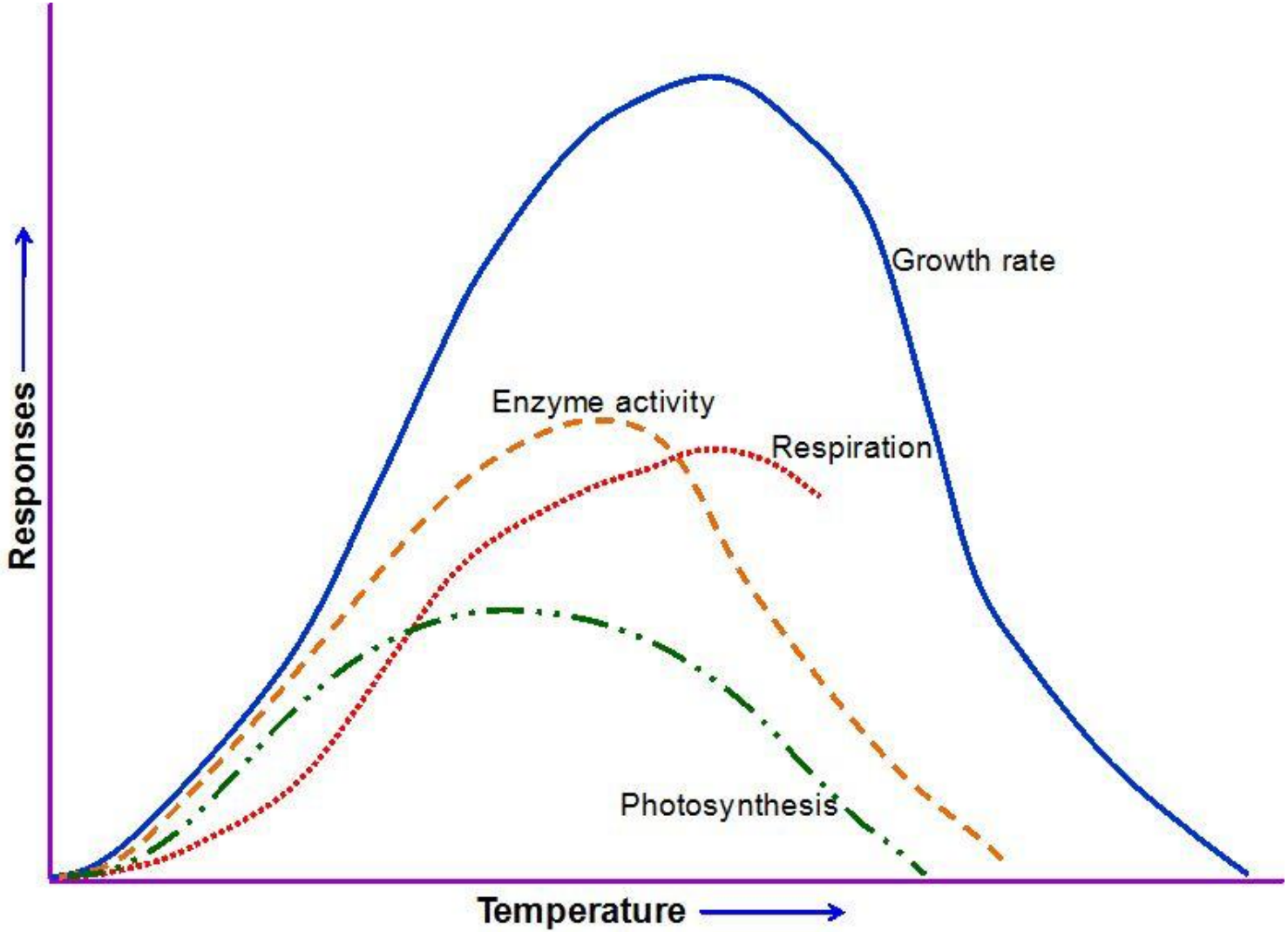


20% Reduction in rainfall

4.5 °C Increase in Average Temperature

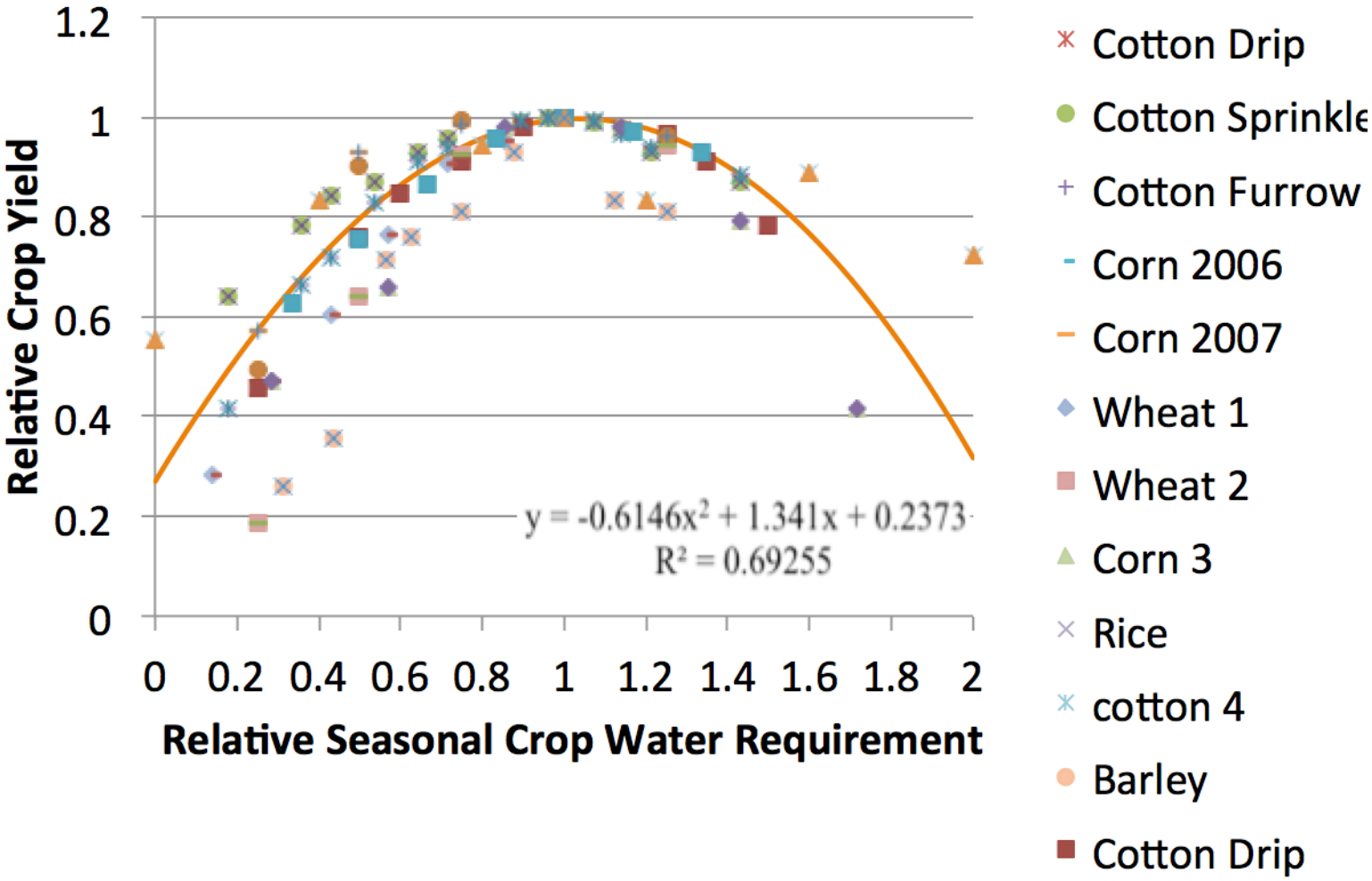
Journal of Applied Meteorology and Climatology

Authors: Azad Henareh Khalyani, Gould, Harmsen, Terando, Quinones and Callazo.



http://www.intechopen.com/source/html/43317/media/image1_w.jpg

Relationship between relative crop yield and relative seasonal crop water requirement applied



Potential climate change impacts on Agriculture

- **Effect of elevated carbon dioxide on crops**
- **Temperature potential effect on growing period**
- **Effect on quality**
- **Erosion and Fertility**
- **Pests, diseases and weeds**
- **Sea level rise**
- **Poverty**

Sea level rise in Puerto Rico

The Caribbean Region

- Significant changes are expected to occur in the air temperature, sea surface temperature, sea level rise, and the magnitude and frequency of extreme weather events.
- Potential impacts on water resources in rain-dominated catchments, such as those found in the Caribbean Region (IPCC, 2007) include: higher precipitation extremes, increase in stream flow seasonal variability, with higher flows during the wet season and lower flows during the dry season; increase in extended dry period probabilities; and a greater risk of droughts and flood.
- Extended dry periods and the potential for greater evaporation will have a negative impact on lake levels used for freshwater supply.

Summary

- Provided an overview of climate conditions in Puerto Rico
- Discussed hydrologic conditions observed during the 2015 drought; and
- Discussed downscaled climate change predictions for Puerto Rico from recently conducted research.

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