

Idaho Cloud Seeding and SNOWIE

Nov 2, 2021

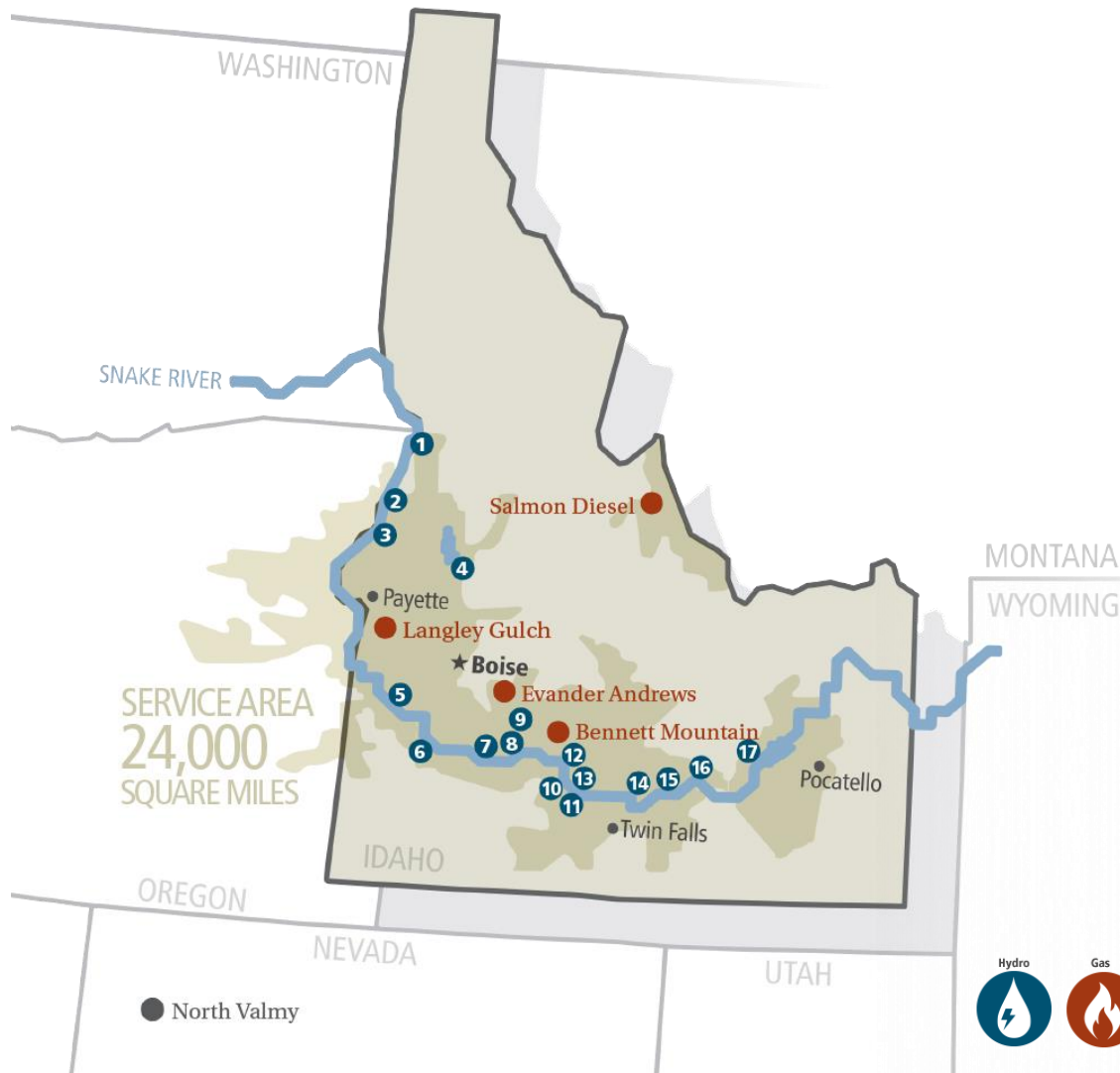




Overview

- Why Idaho Power does Cloud Seeding
- What is Cloud Seeding/Where is it done.
- SNOWIE
- Idaho Power's cloud seeding projects
- Benefits
- Program expansion
- Project Costs

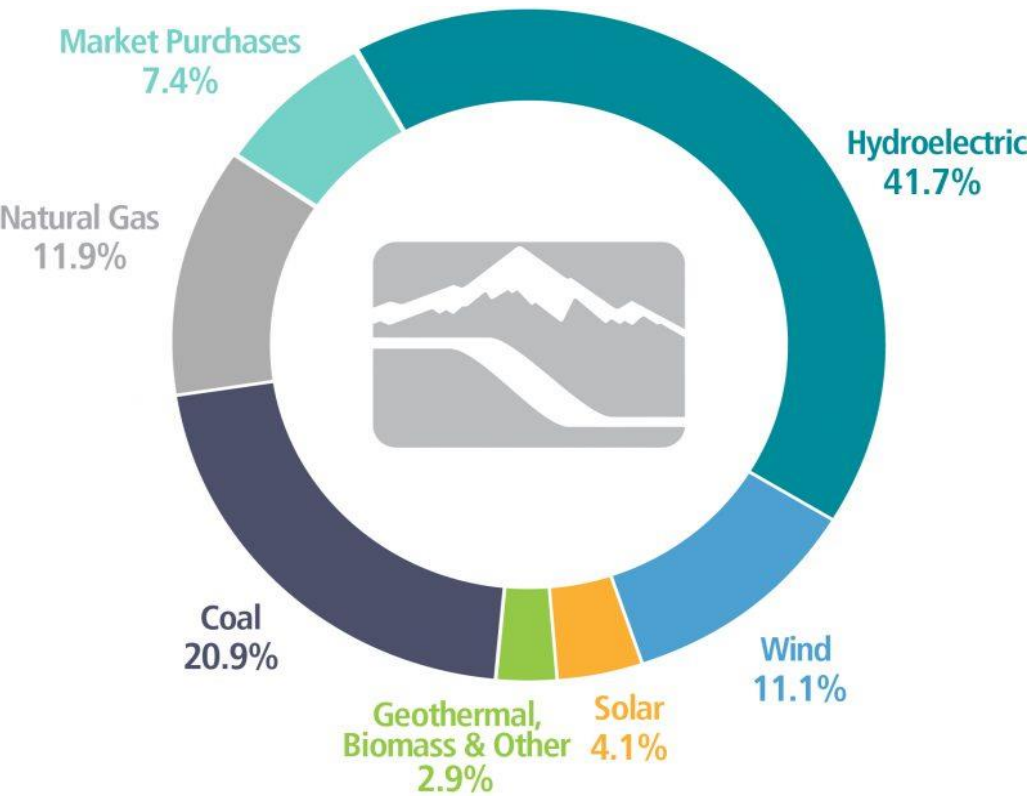
Communities We Serve



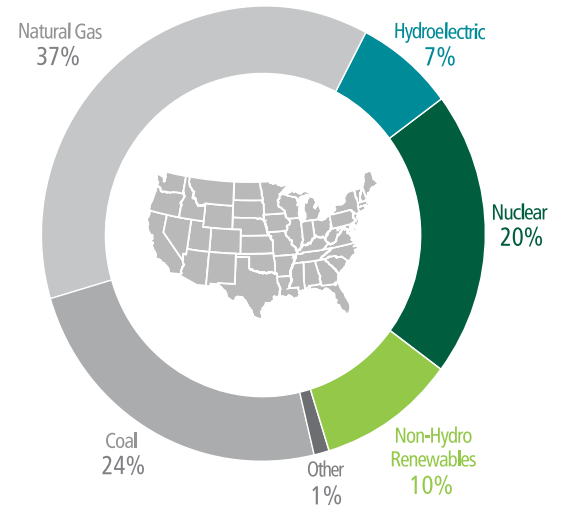
1	Hells Canyon	391,500 kW
2	Oxbow	190,000 kW
3	Brownlee	675,000 kW
4	Cascade	12,420 kW
5	Swan Falls	27,200 kW
6	C.J. Strike	82,800 kW
7	Bliss	75,000 kW
8	Lower Malad	13,500 kW
9	Upper Malad	8,300 kW
10	Lower Salmon	60,000 kW
11	Upper Salmon	34,500 kW
12	Thousand Springs	6,800 kW
13	Clear Lake	2,500 kW
14	Shoshone Falls	13,900 kW
15	Twin Falls	52,900 kW
16	Milner	59,448 kW
17	American Falls	92,340 kW

Clean Energy

2020 Energy Mix



National Average



Almost half of
Idaho Power's
energy comes
from clean
hydropower.

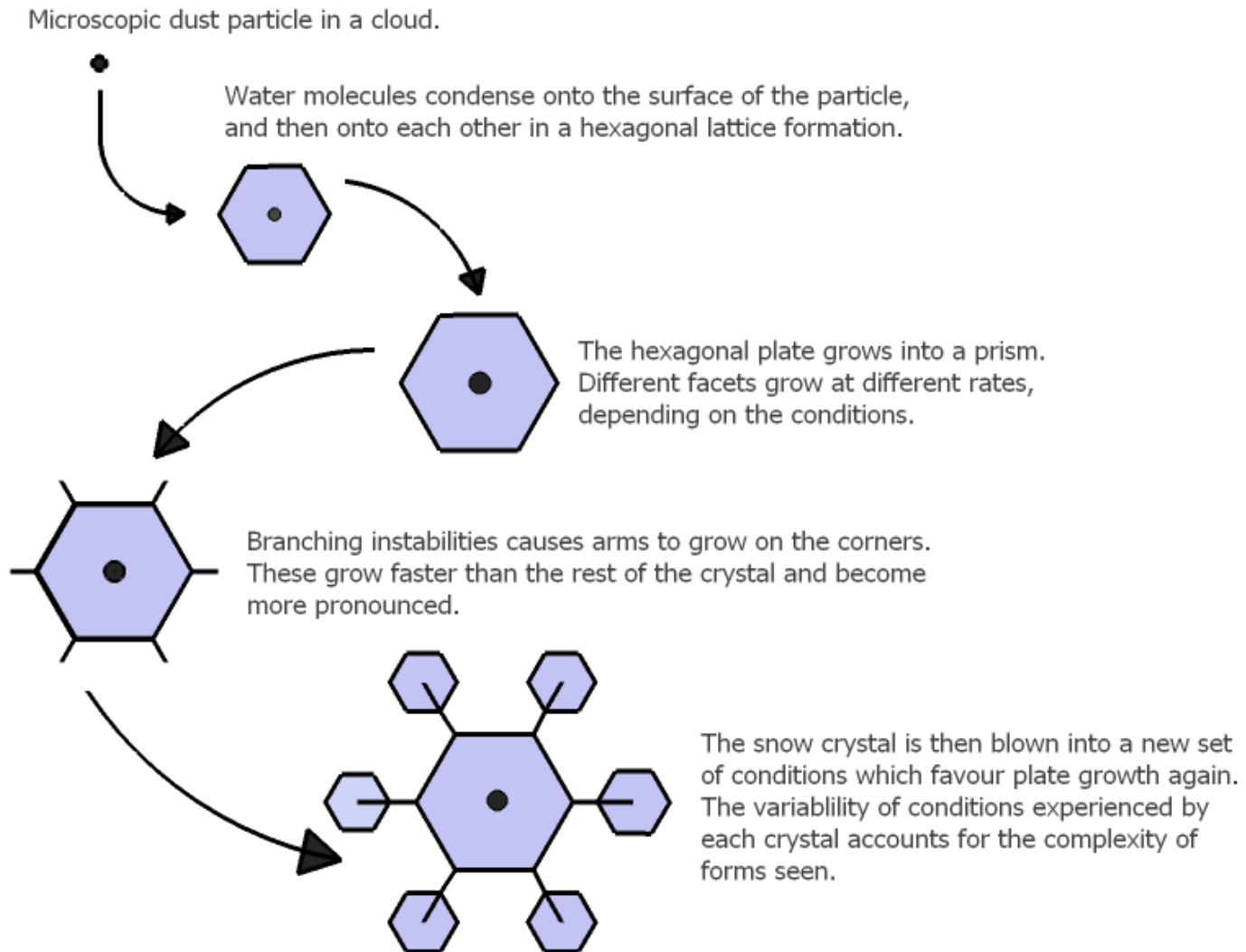
Data Source: U.S. Energy Information Administration

Totals may not equal 100% due to rounding



What is Cloud Seeding??

How does a snowflake/raindrop develop? (Cold Cloud)



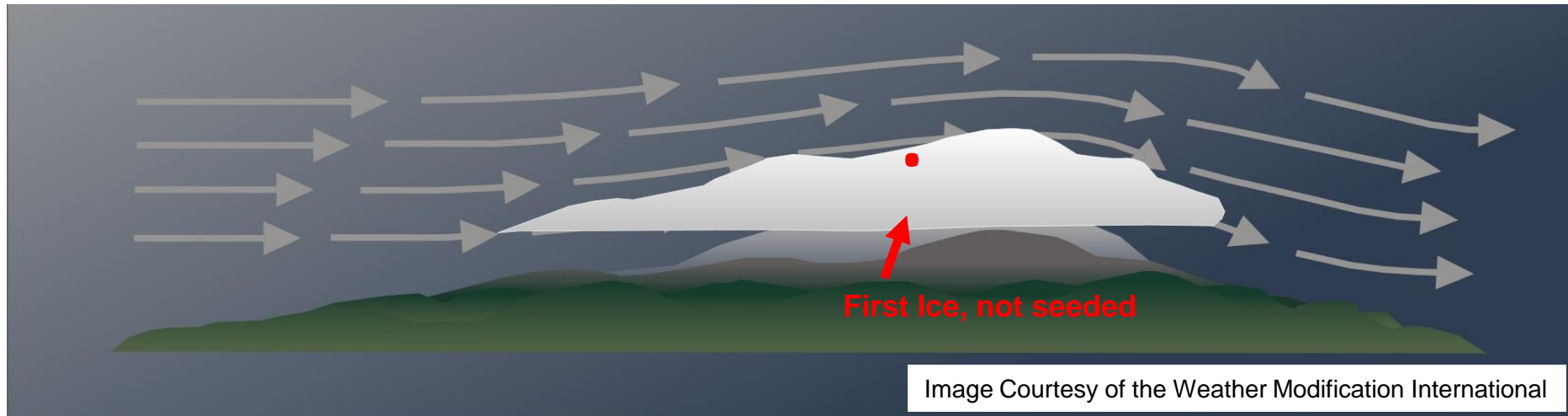


Cold Cloud Seeding Method

- Glaciogenic Seeding
 - Conducted in clouds cold enough to promote growth of ice.
 - Seeding Agents
 - Silver Iodide
 - Dry Ice
 - Liquid Propane (expands into gas form)

Winter Orographic Cloud Seeding

- *Cloud seeding* provides additional efficient ice nuclei that function at warmer temperatures, allowing ice formation to begin sooner
- This occurs at temperatures as warm as 23°F, though more effectively at 17°F or colder
- Natural ice nuclei become effective below 5°F



Winter Orographic Cloud Seeding

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- Natural ice nuclei become effective below 5°F

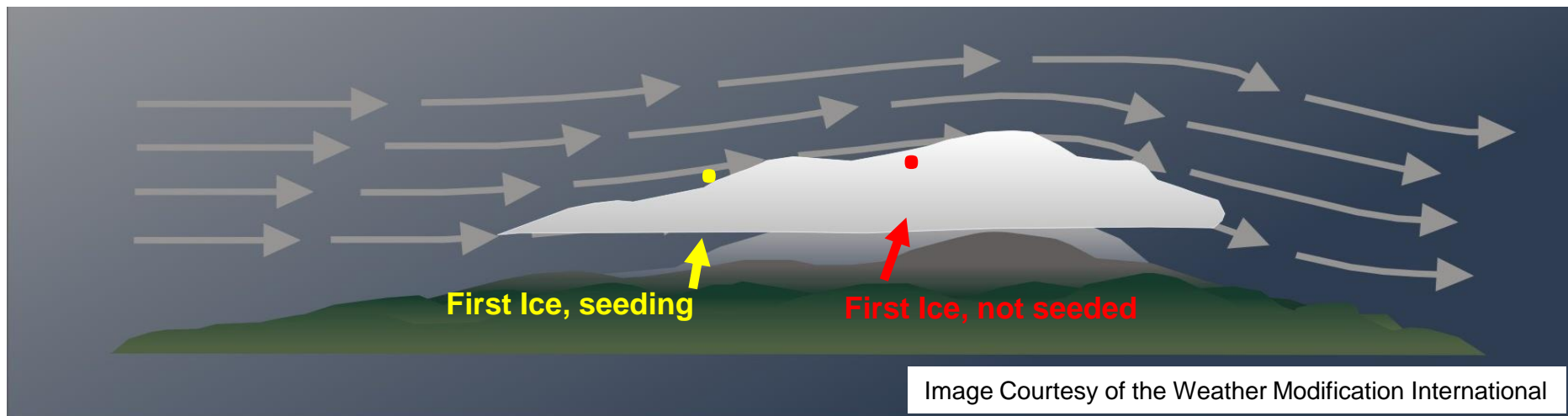
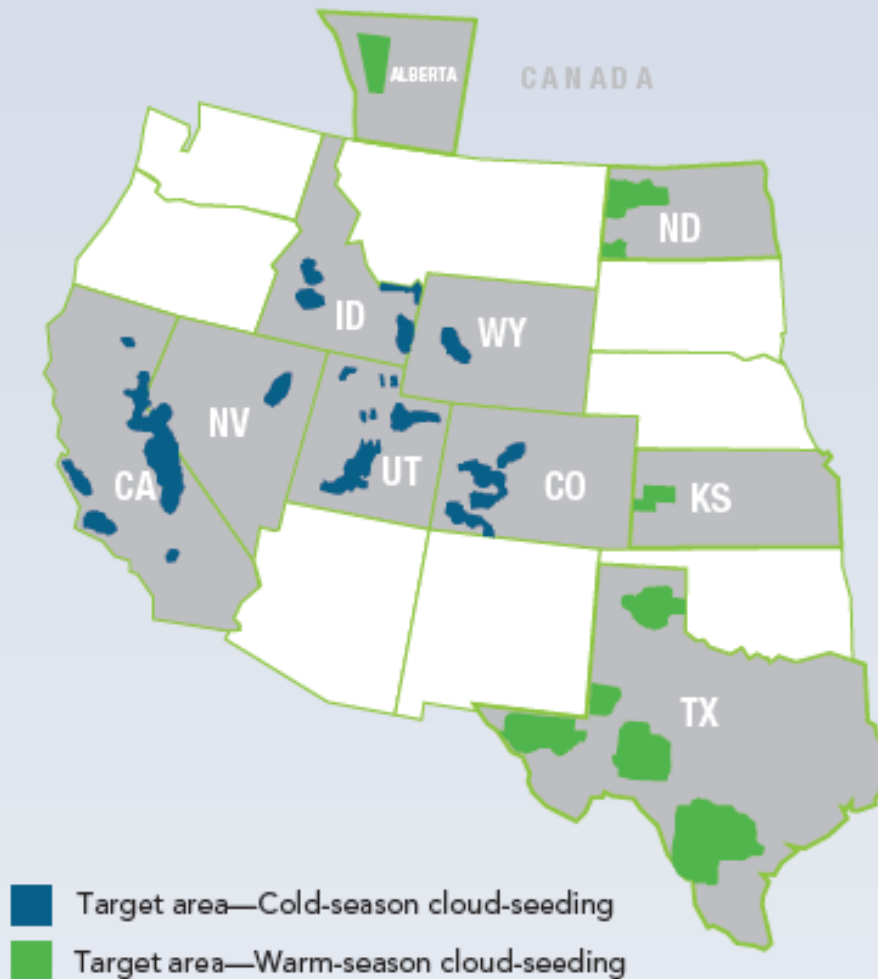


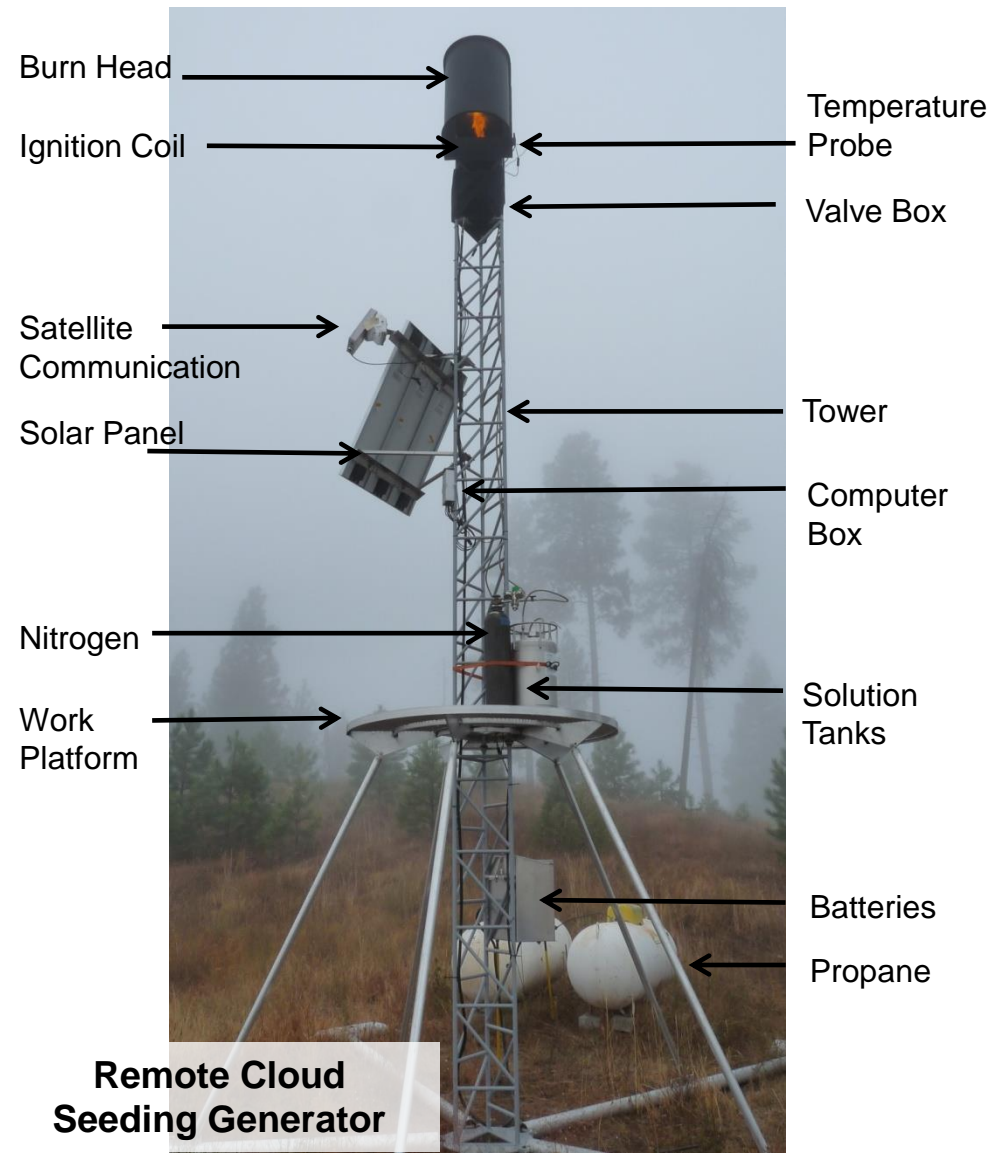
Image Courtesy of the Weather Modification International



Cloud Seeding Programs



Idaho Power Seeding Mechanisms

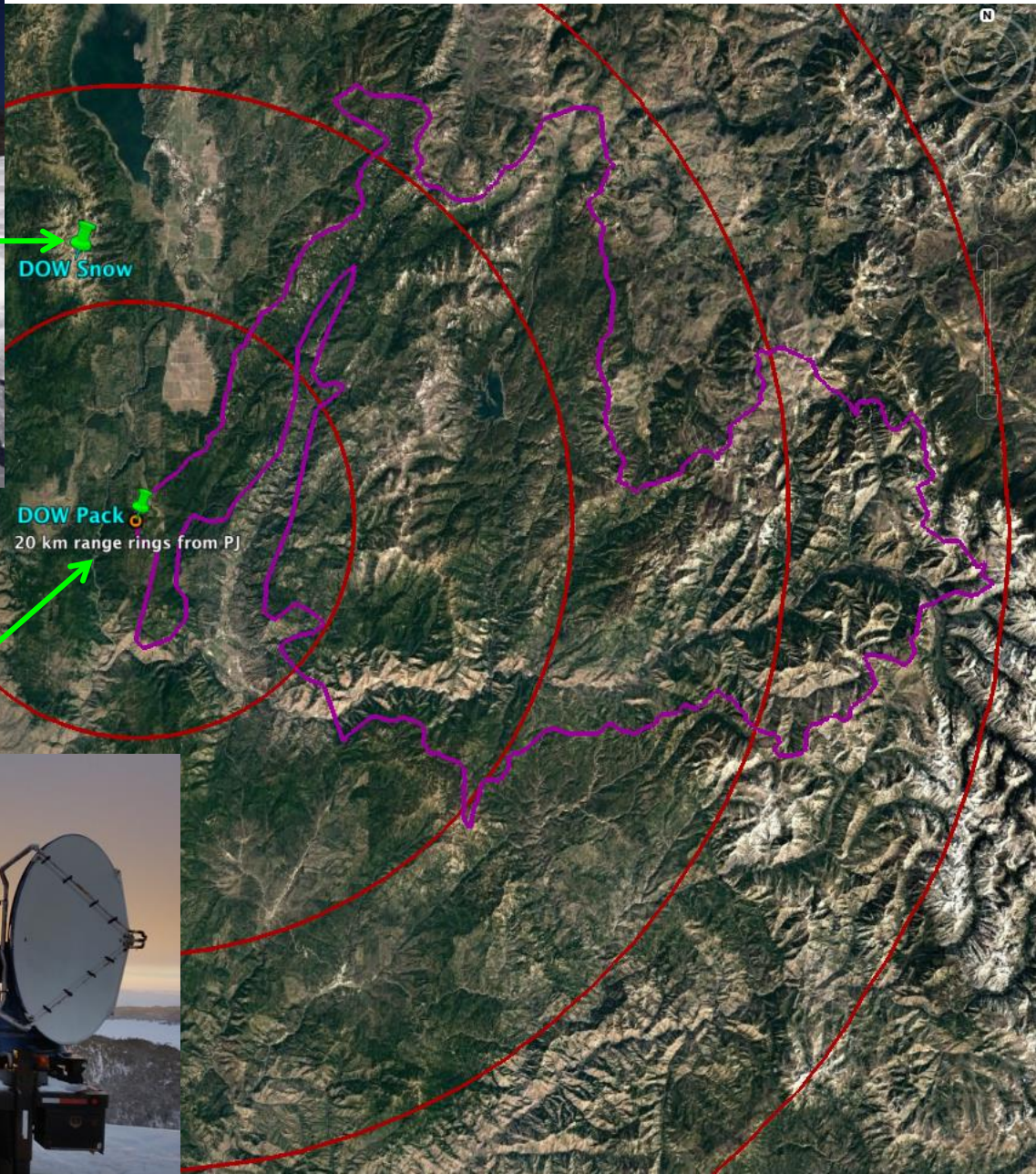


Modified Aircraft

SNOWIE

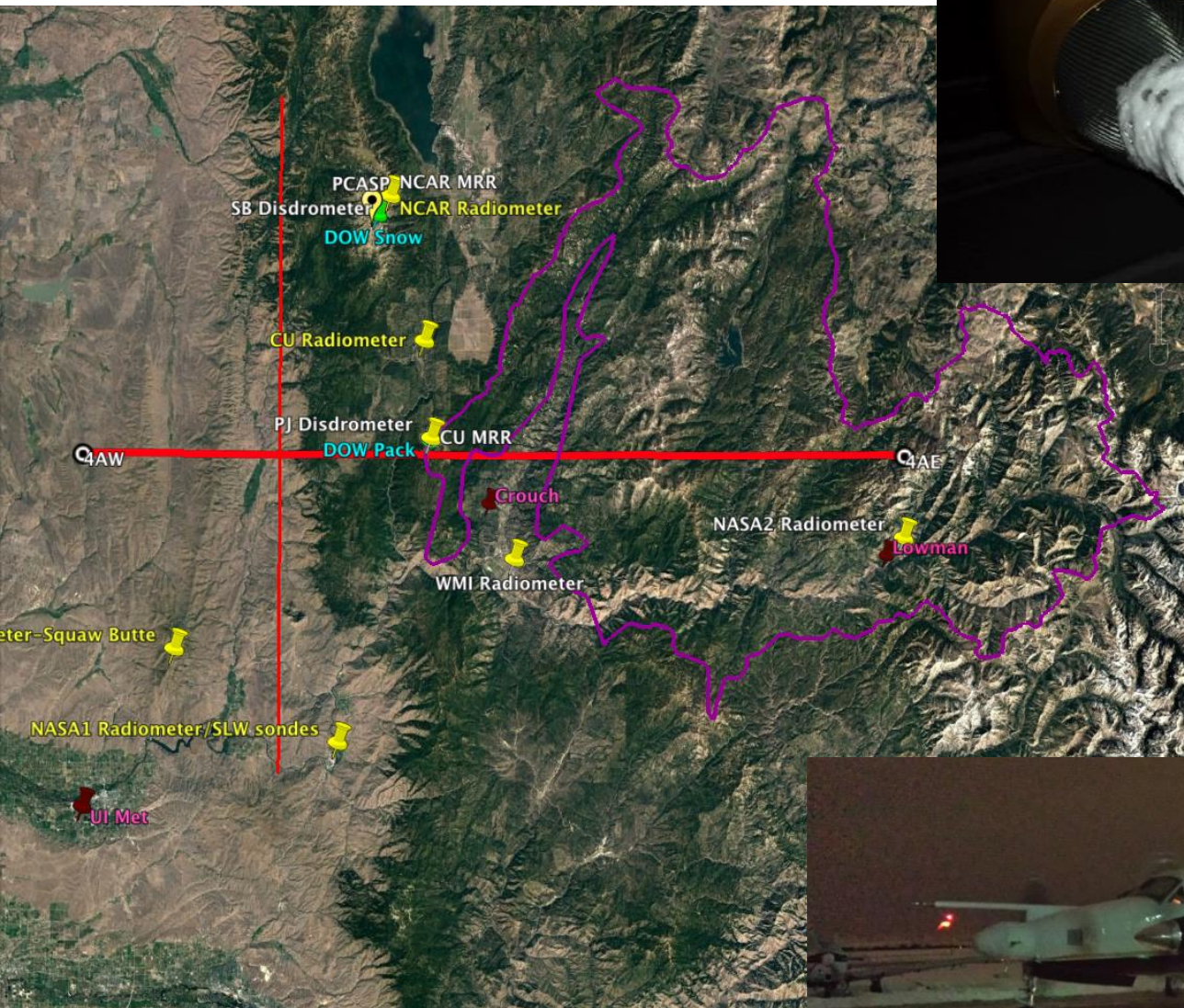
Seeded & Natural Orographic Wintertime clouds: the Idaho Experiment

- NSF funded SNOWIE to study winter precipitation processes (\$2.1M)
- Field campaign early 2017 (Jan – Mar), focused on Payette Basin
- Goal:
 - further understand natural and dynamic winter precipitation processes.
 - determine physical processes by which cloud seeding effects winter precipitation.
- Field Effort:
 - Over 75 additional instruments (research aircraft, ground based instruments)
 - 4 PI's, 11 scientists operating instruments and analyzing data
- Results will directly benefit weather modeling over complex terrain
- Collaborative effort between:
 - National Center for Atmospheric Research (NCAR)
 - University of Wyoming
 - University of Colorado, Boulder
 - University of Illinois
 - Idaho Power Company
- Additional Efforts
 - BSU – silver sampling
 - Research seeding aircraft
 - Ice nuclei counter

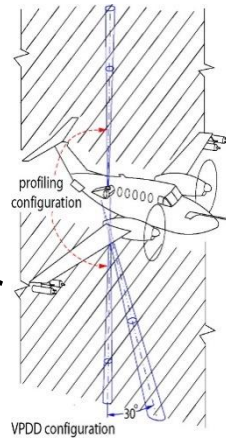




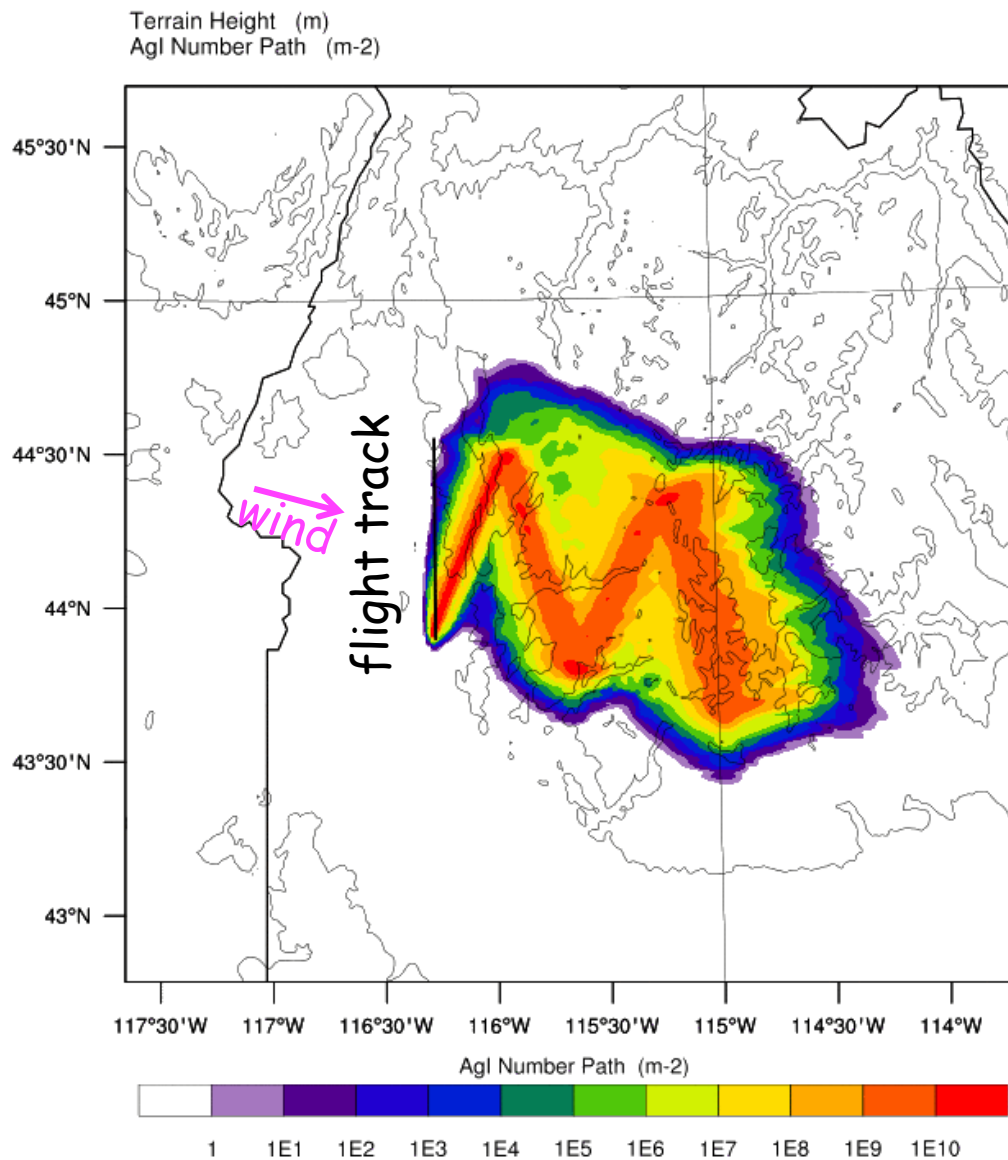




UW King Air
with profiling
radar and lidar



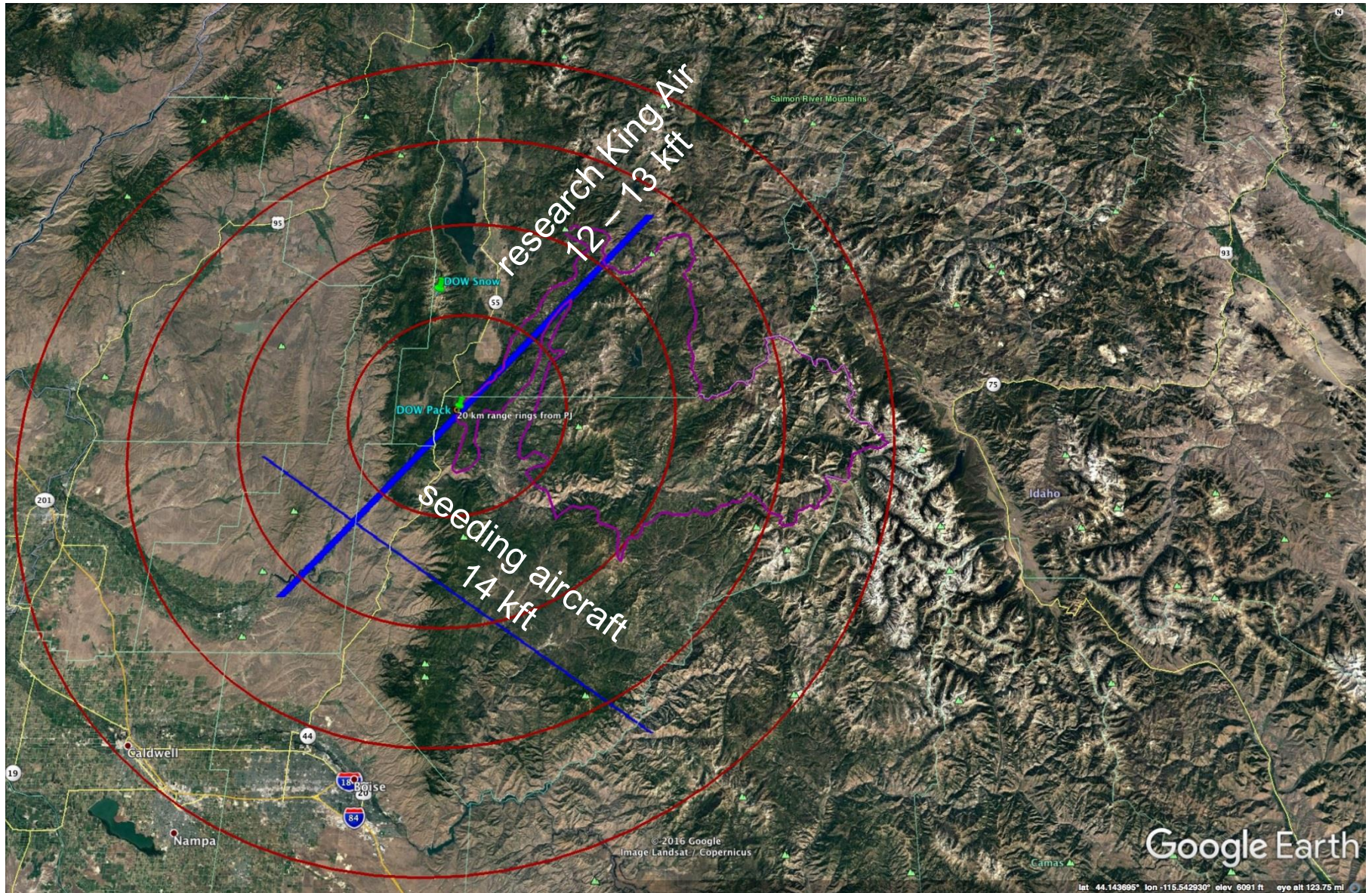




NCAR airborne seeding simulation

IOP

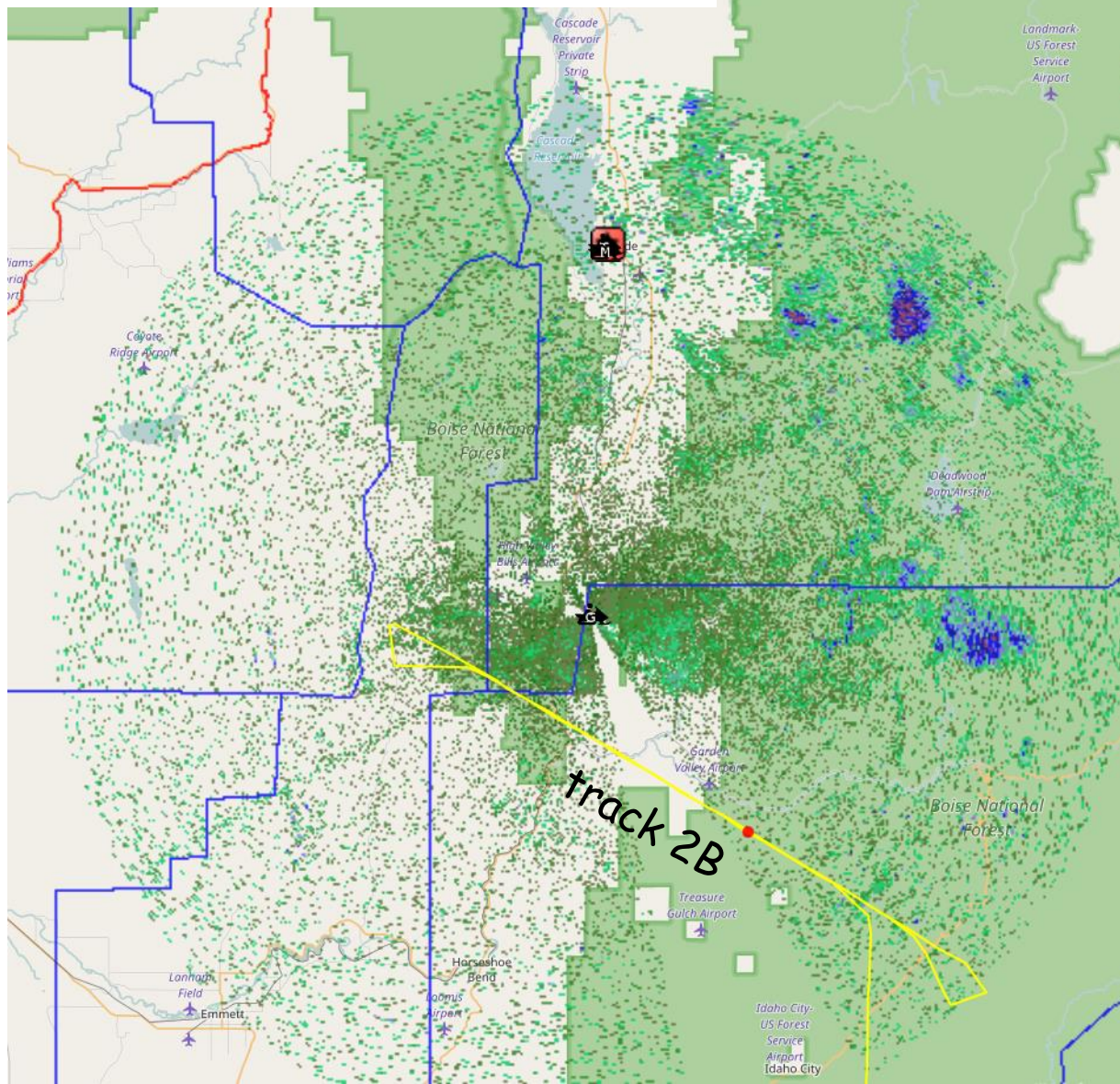
Intensive Observation Period

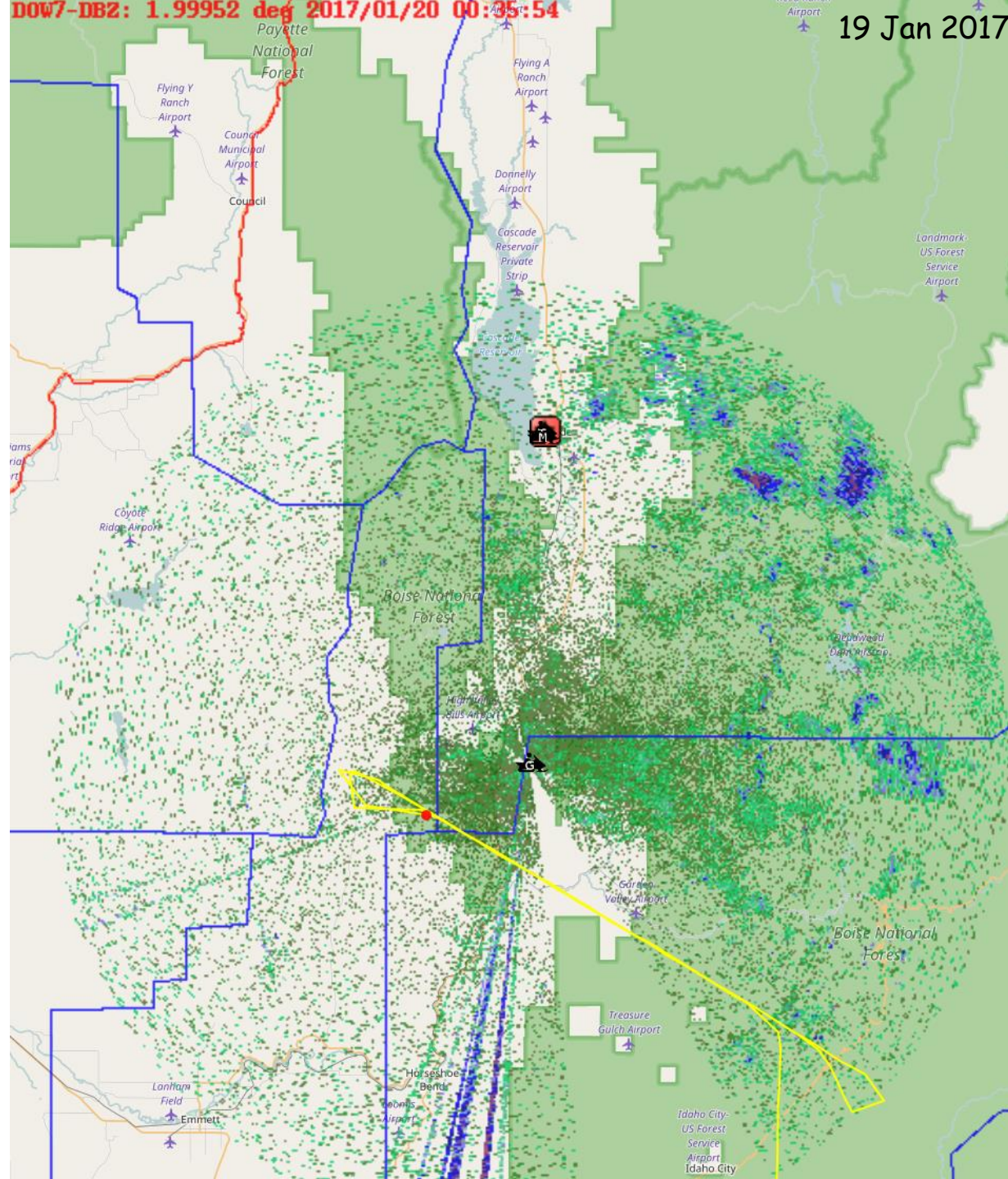


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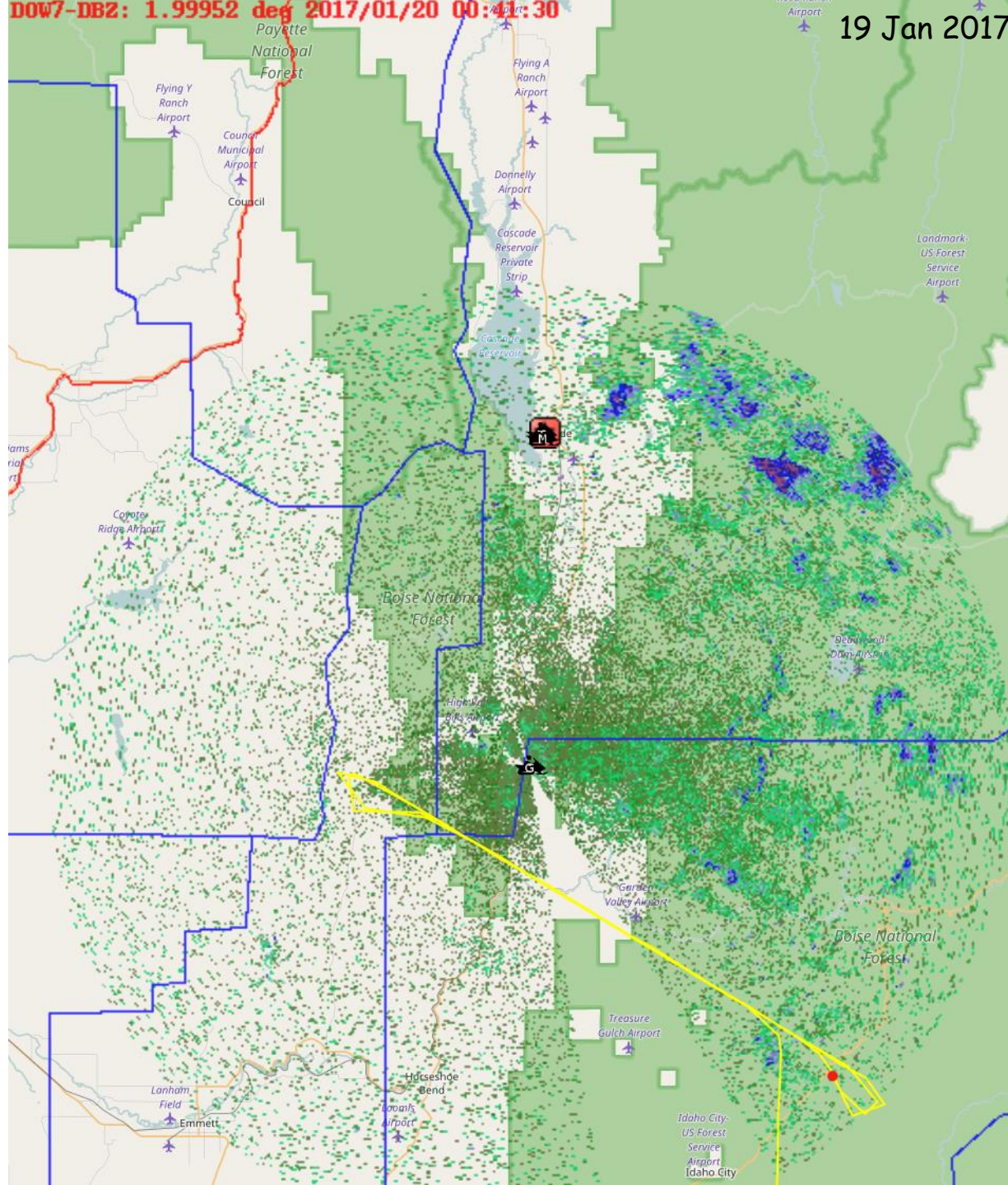
19 Jan 2017

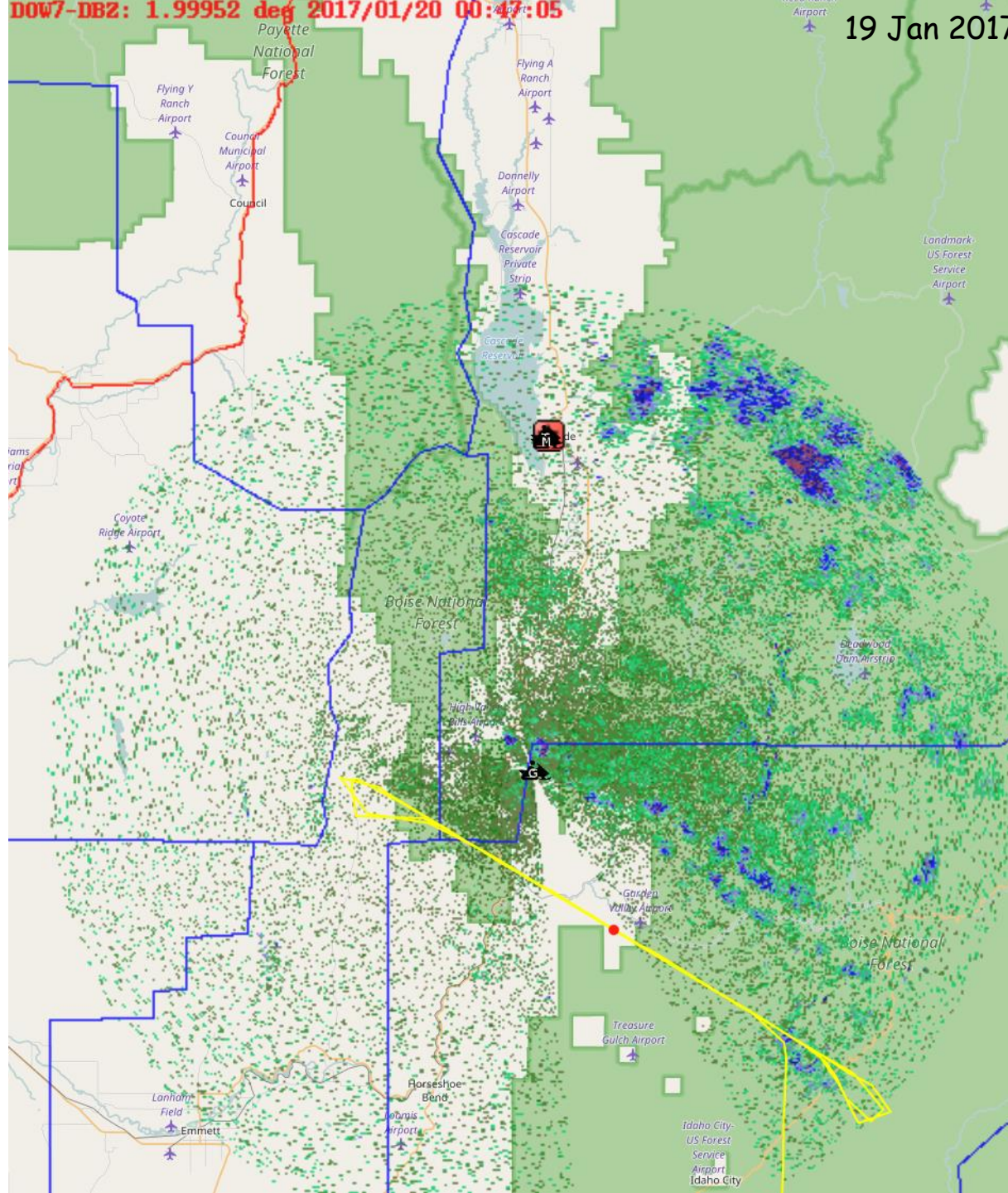
DOW reflectivity + seeding aircraft track

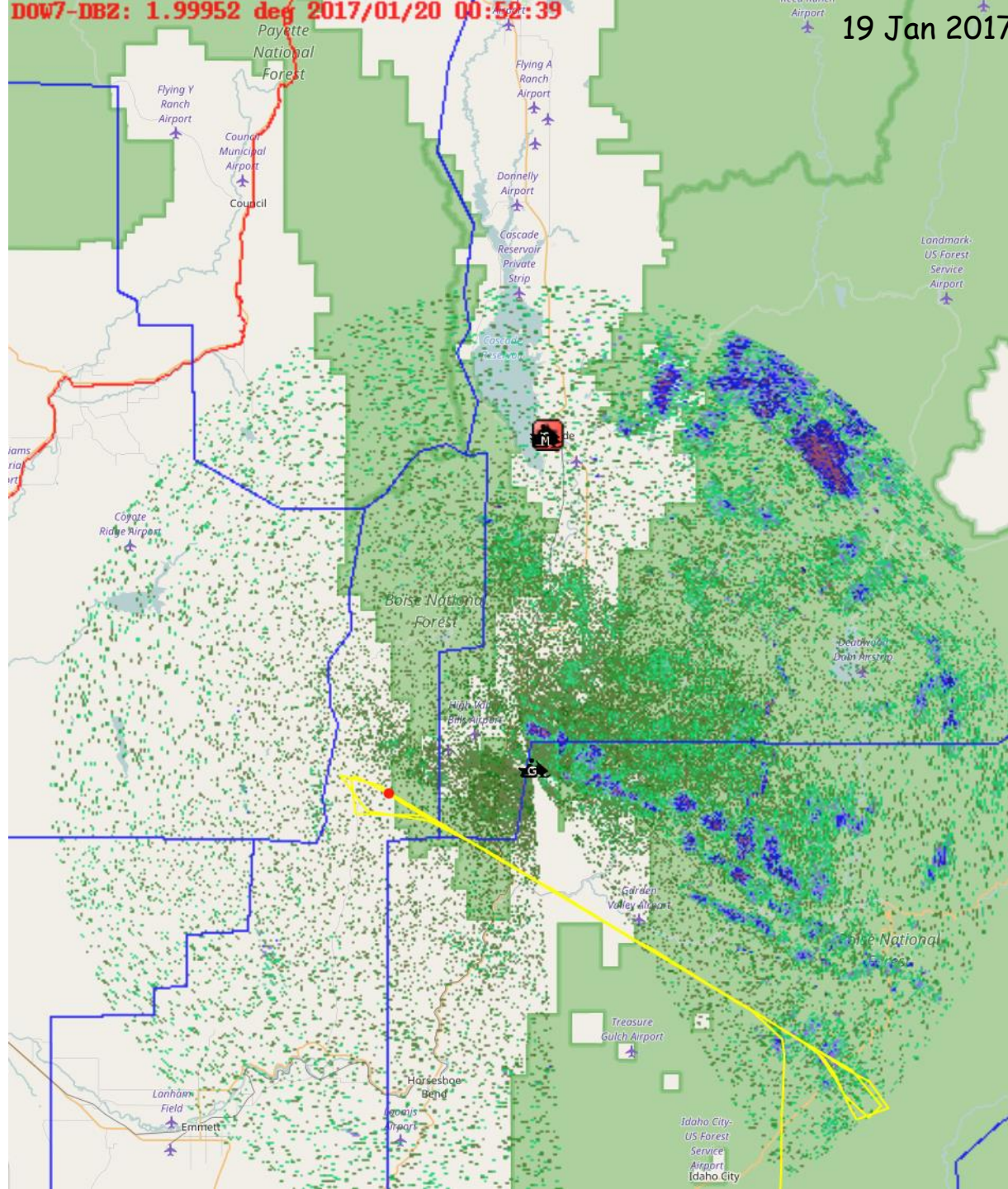


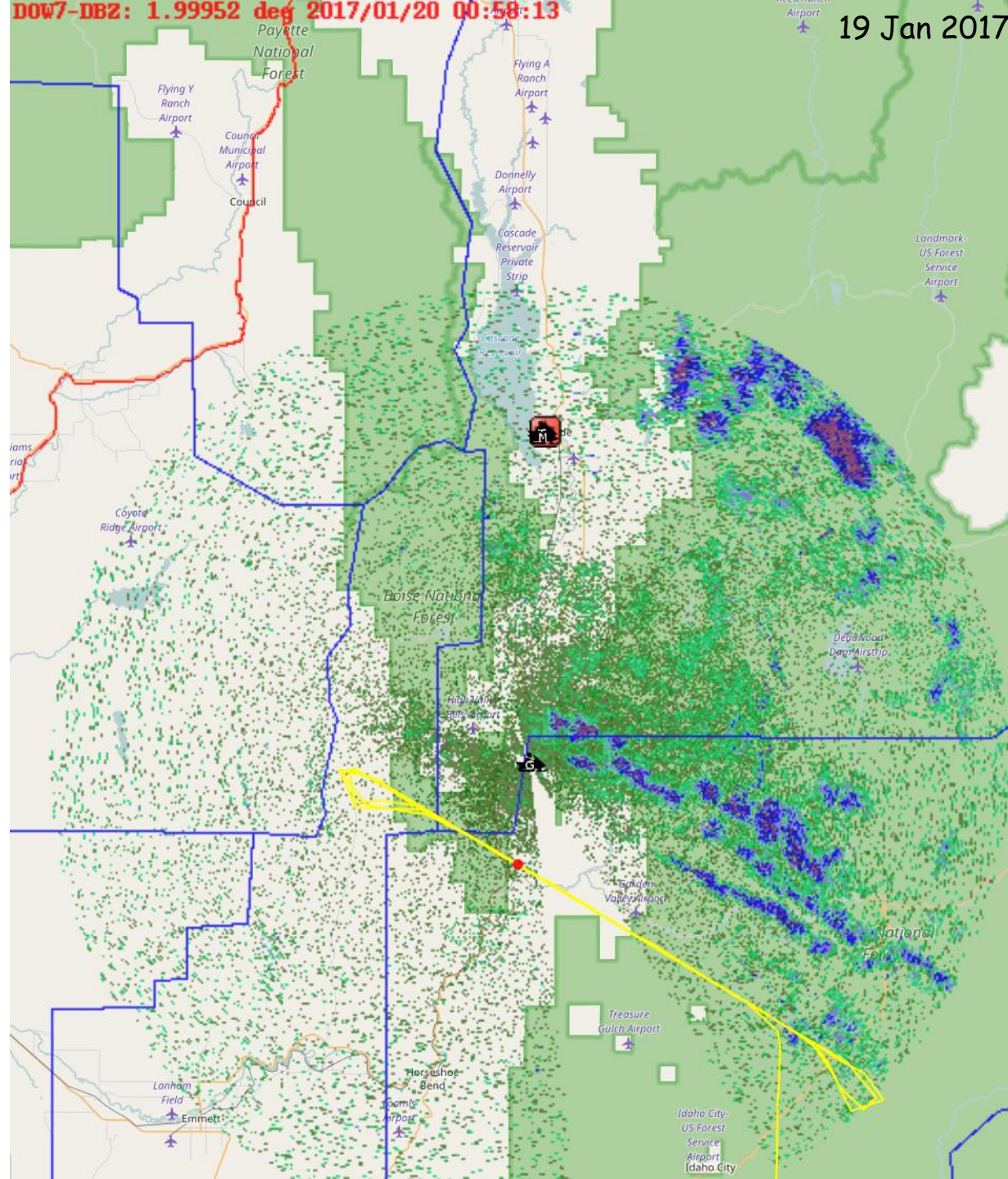


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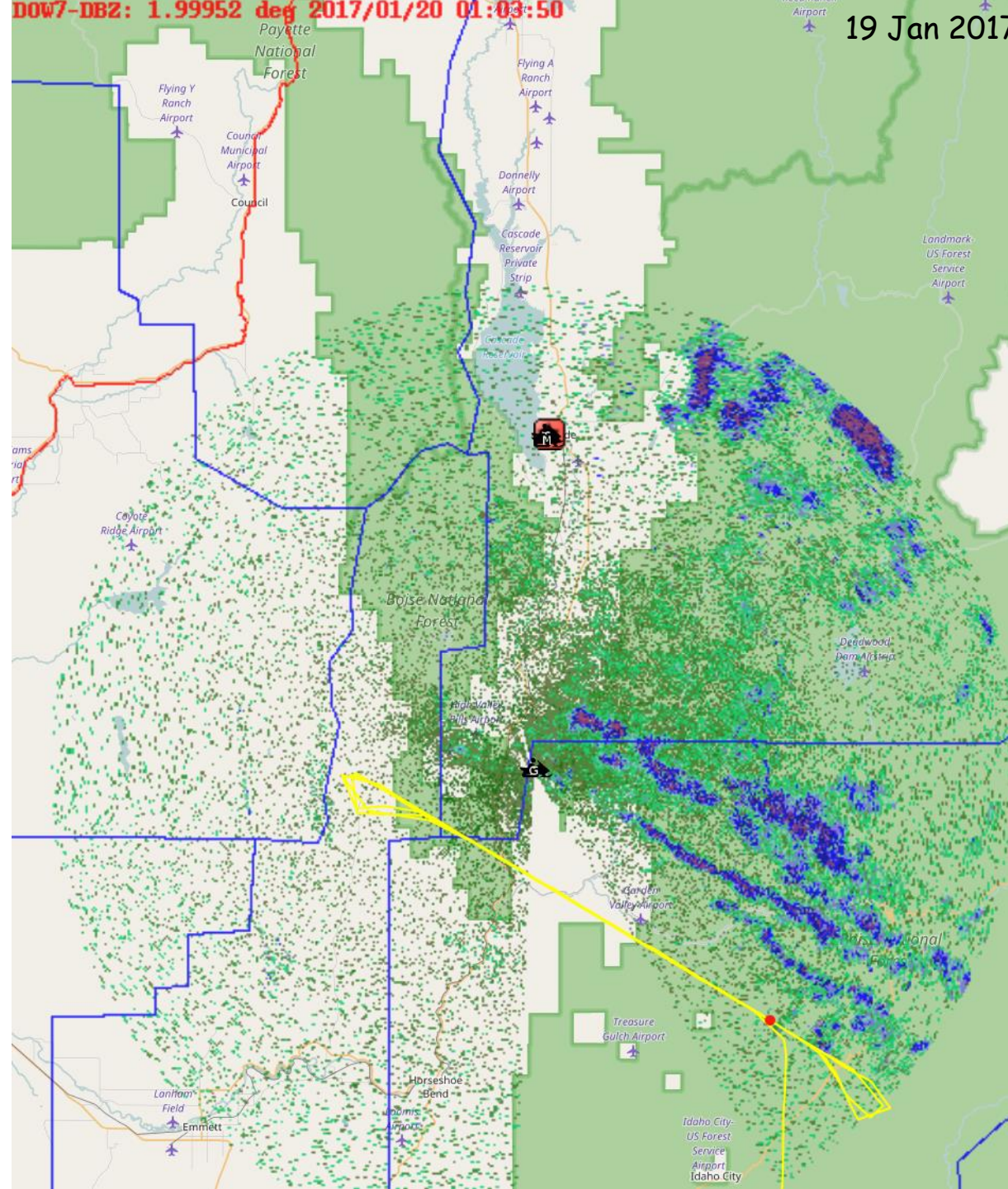


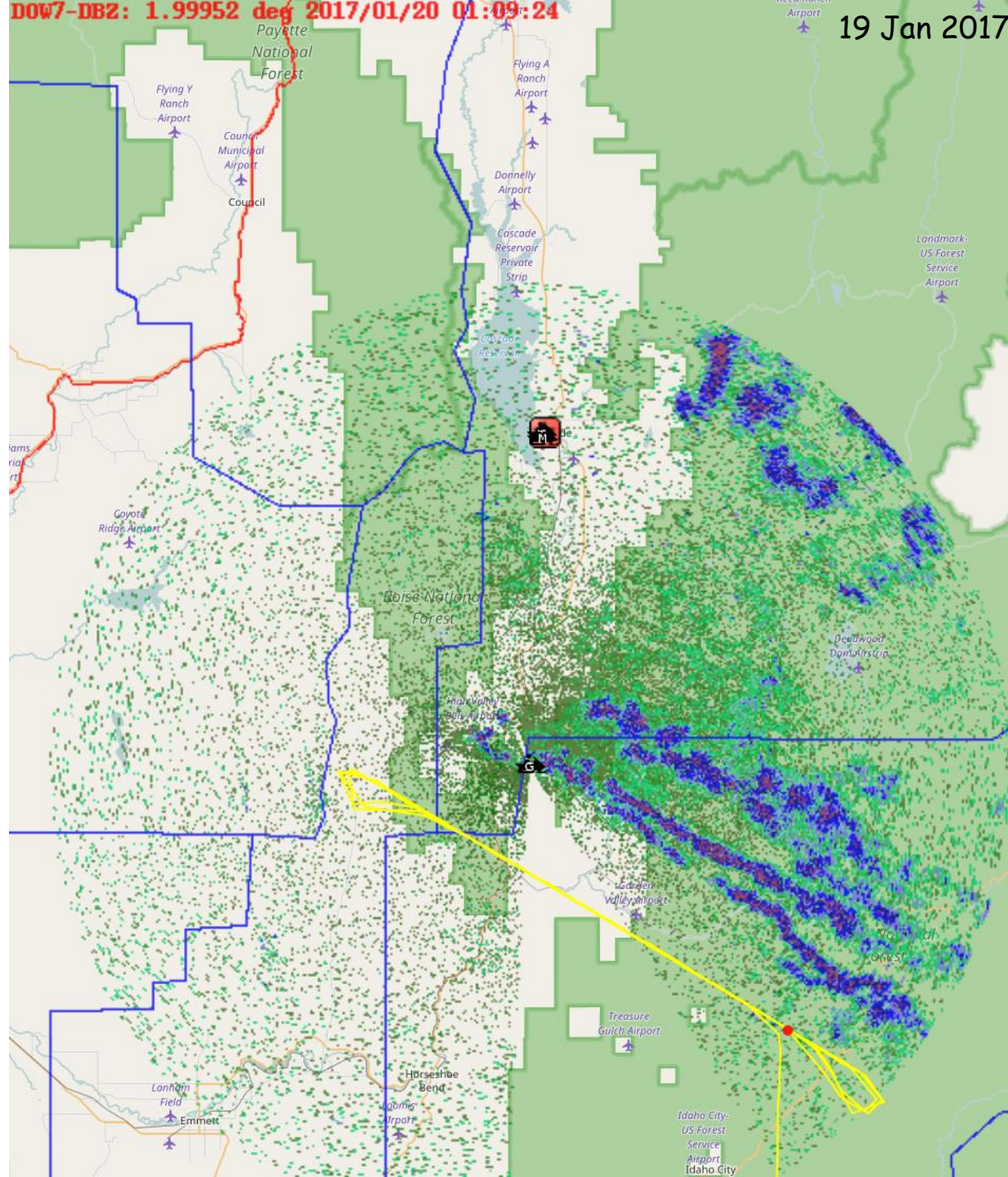




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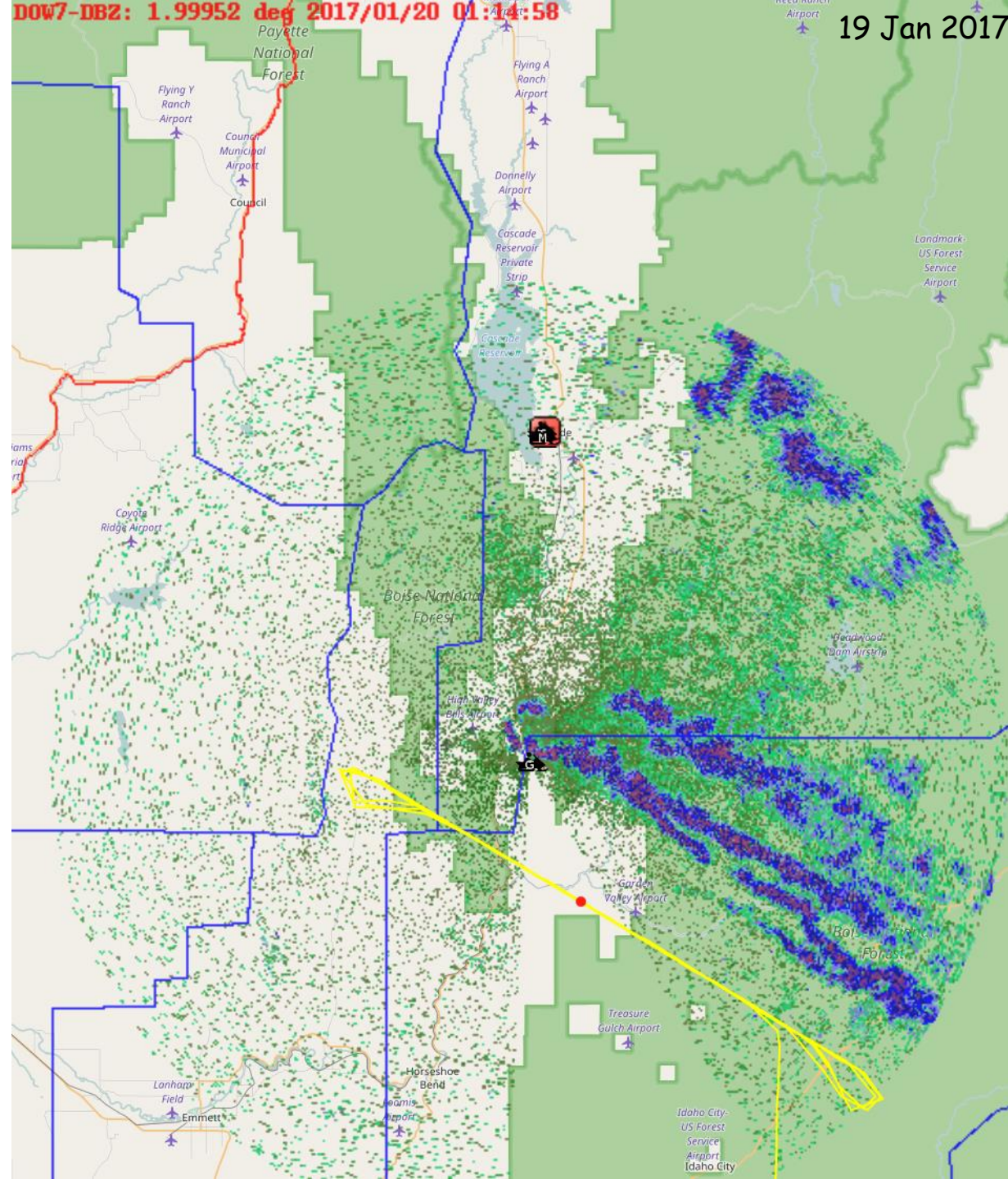
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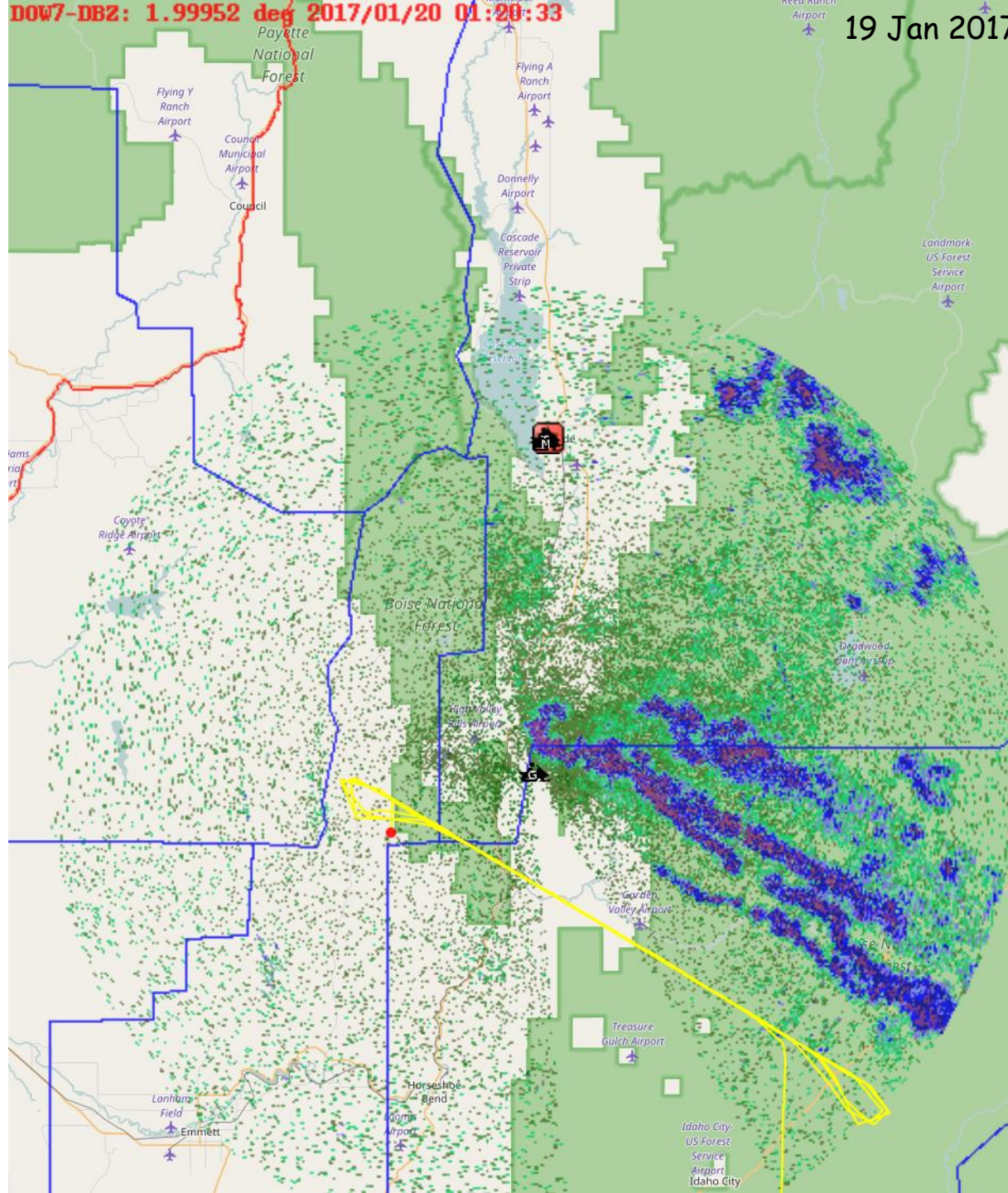
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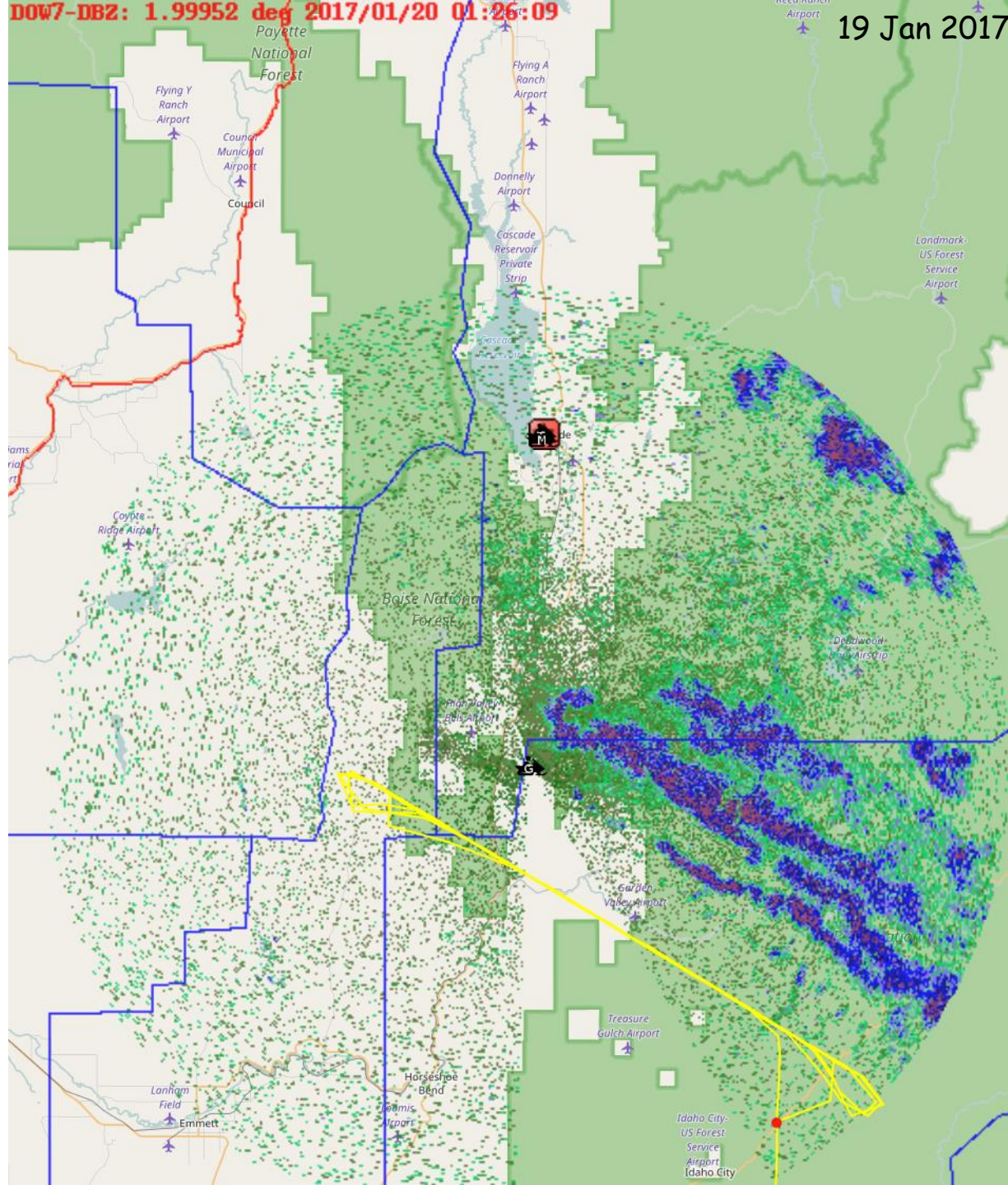
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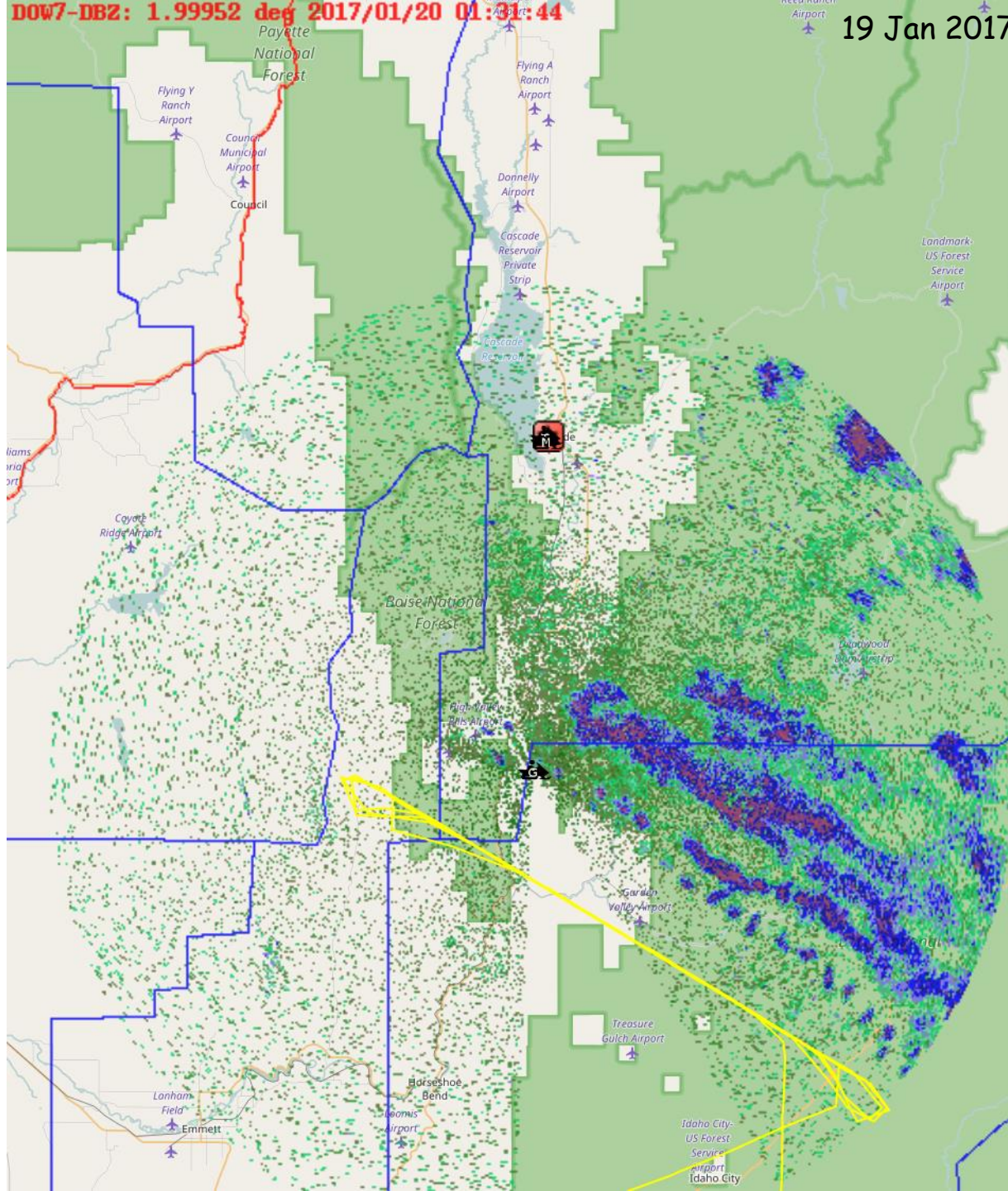
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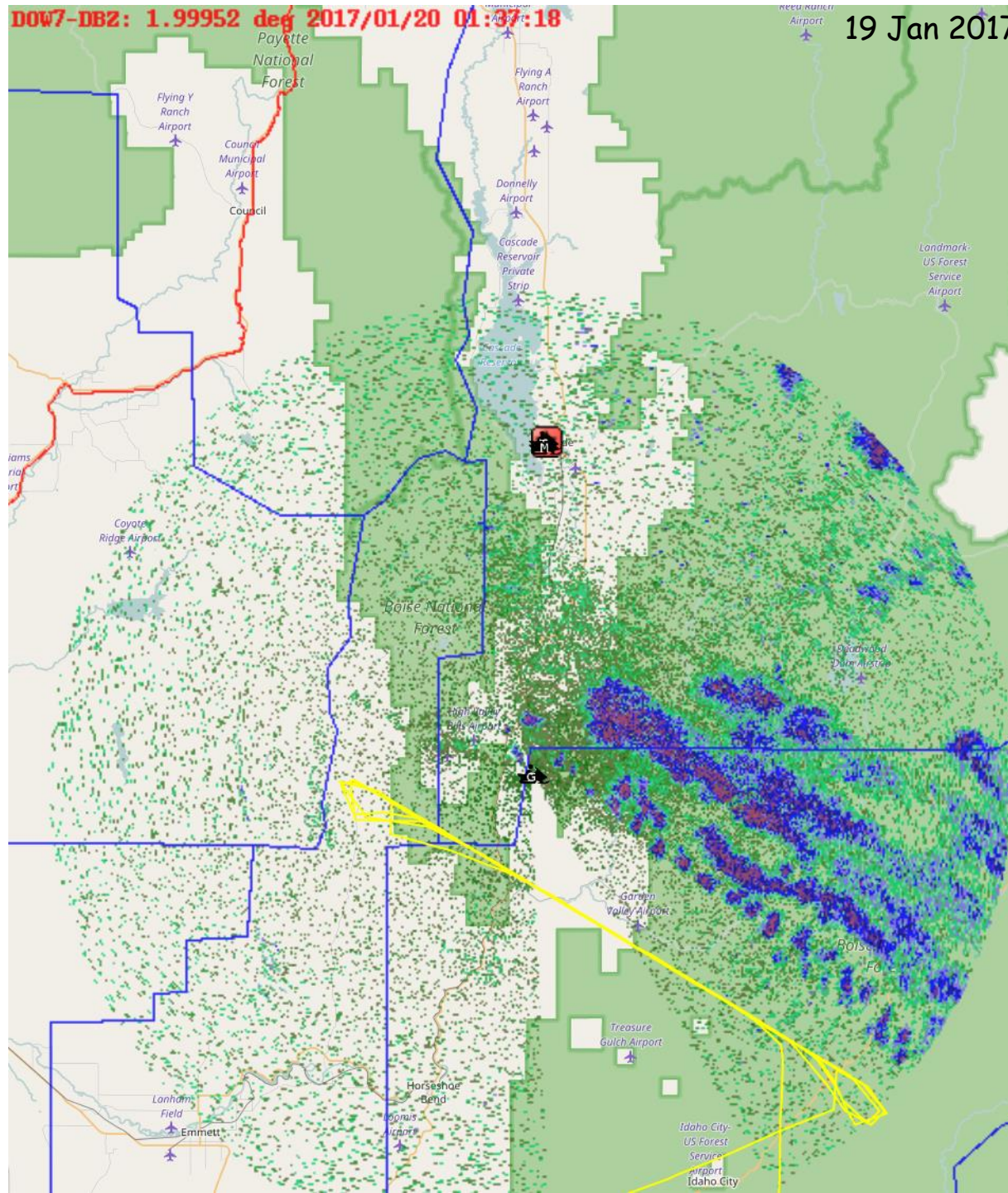


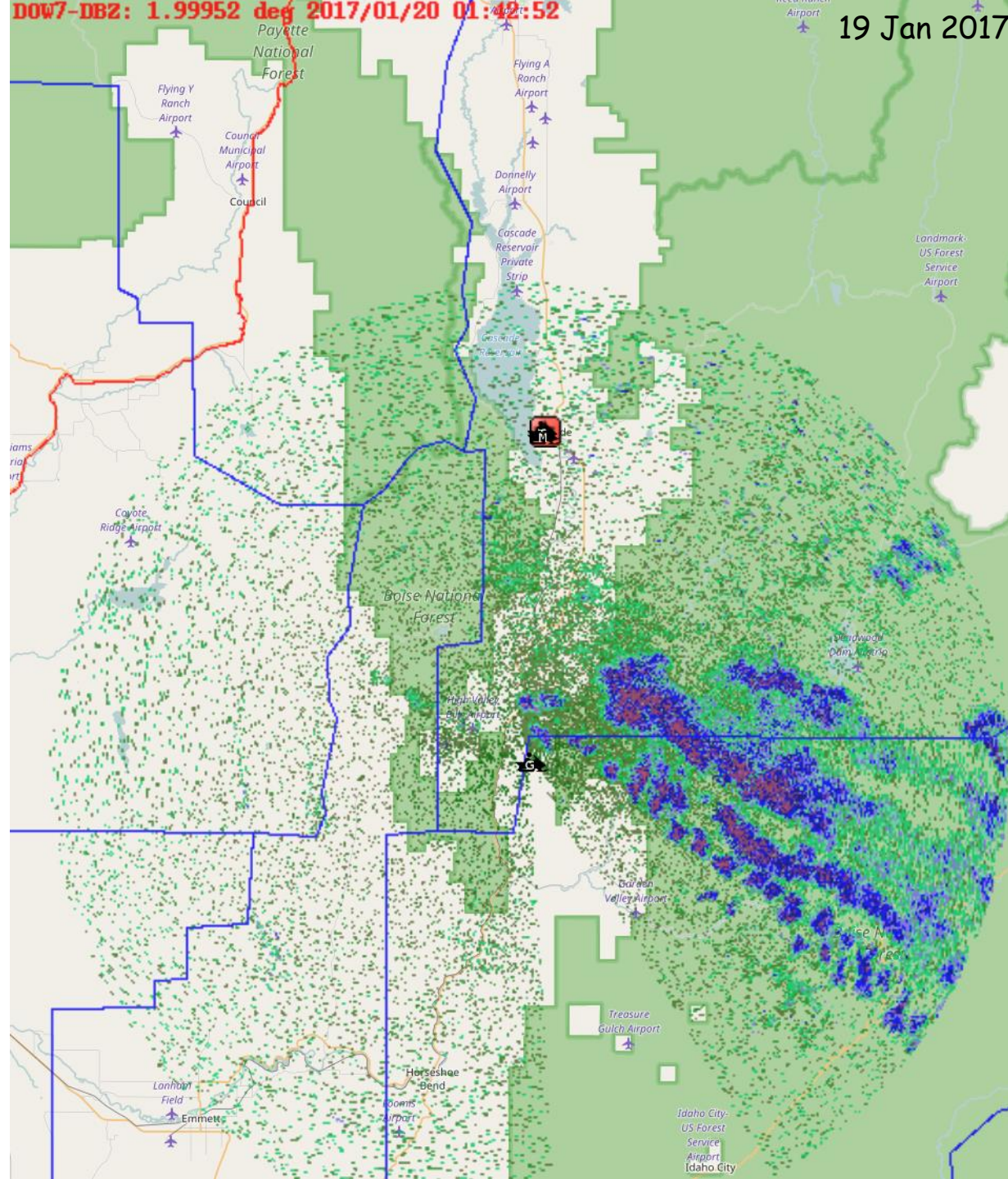
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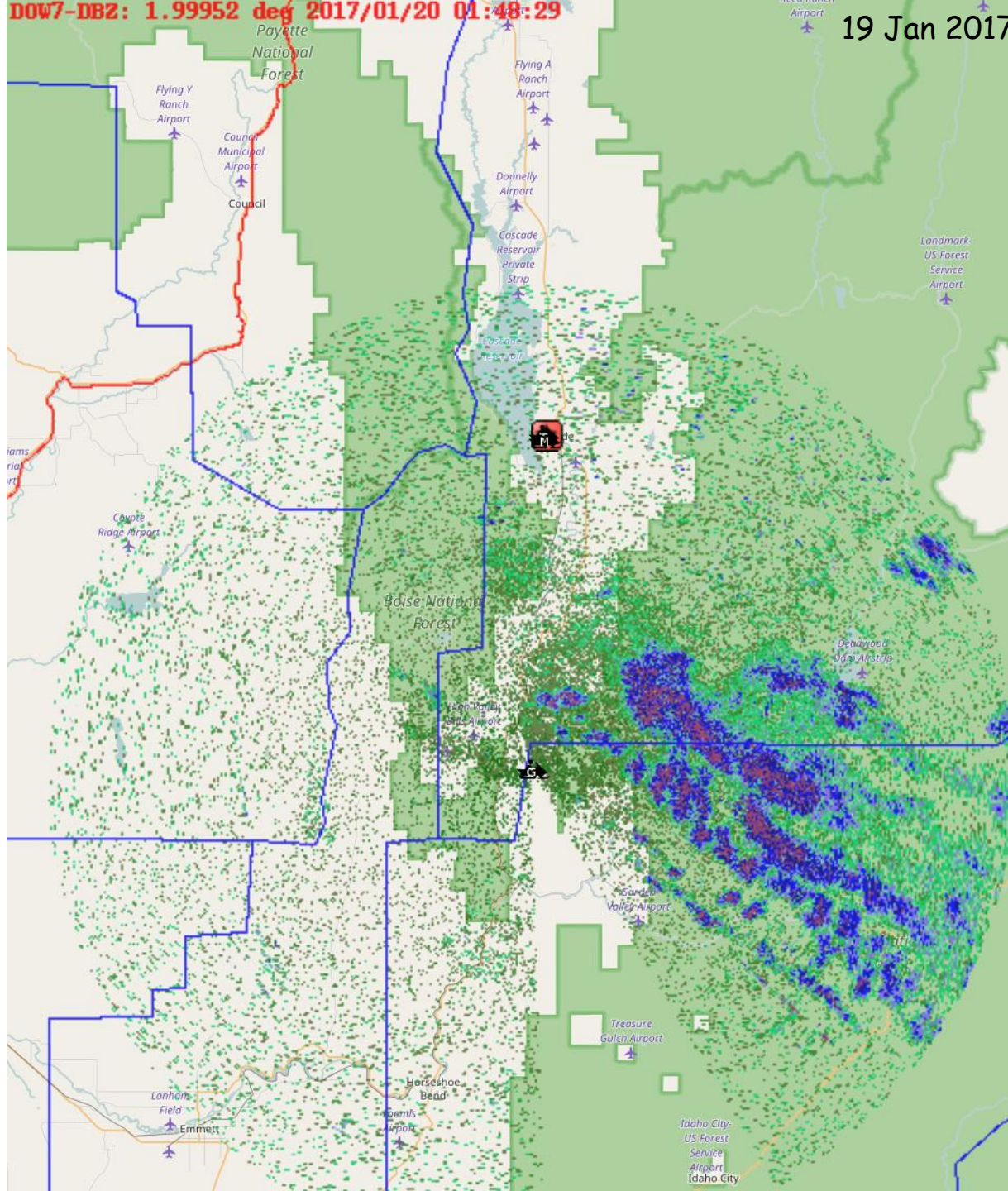
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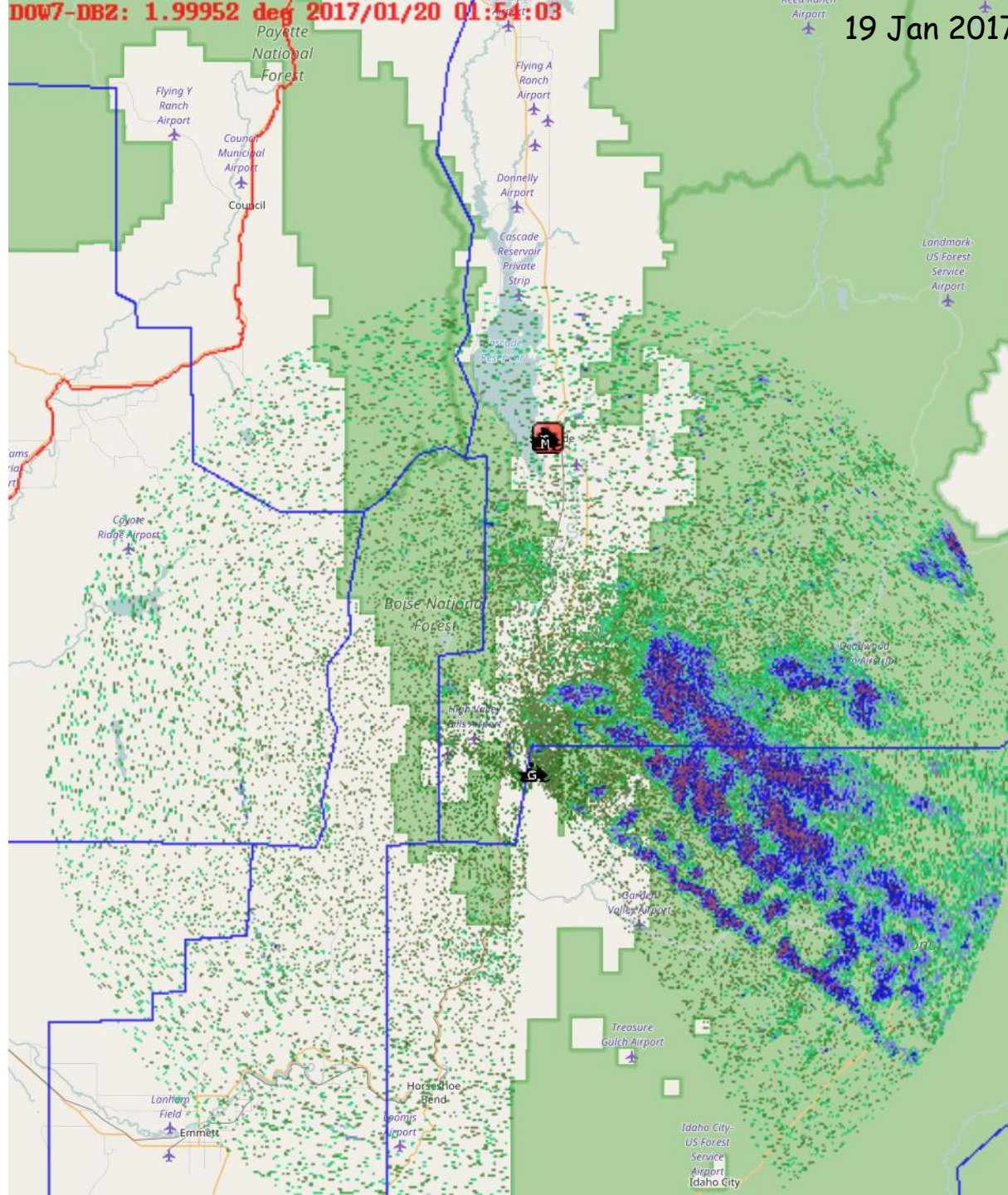


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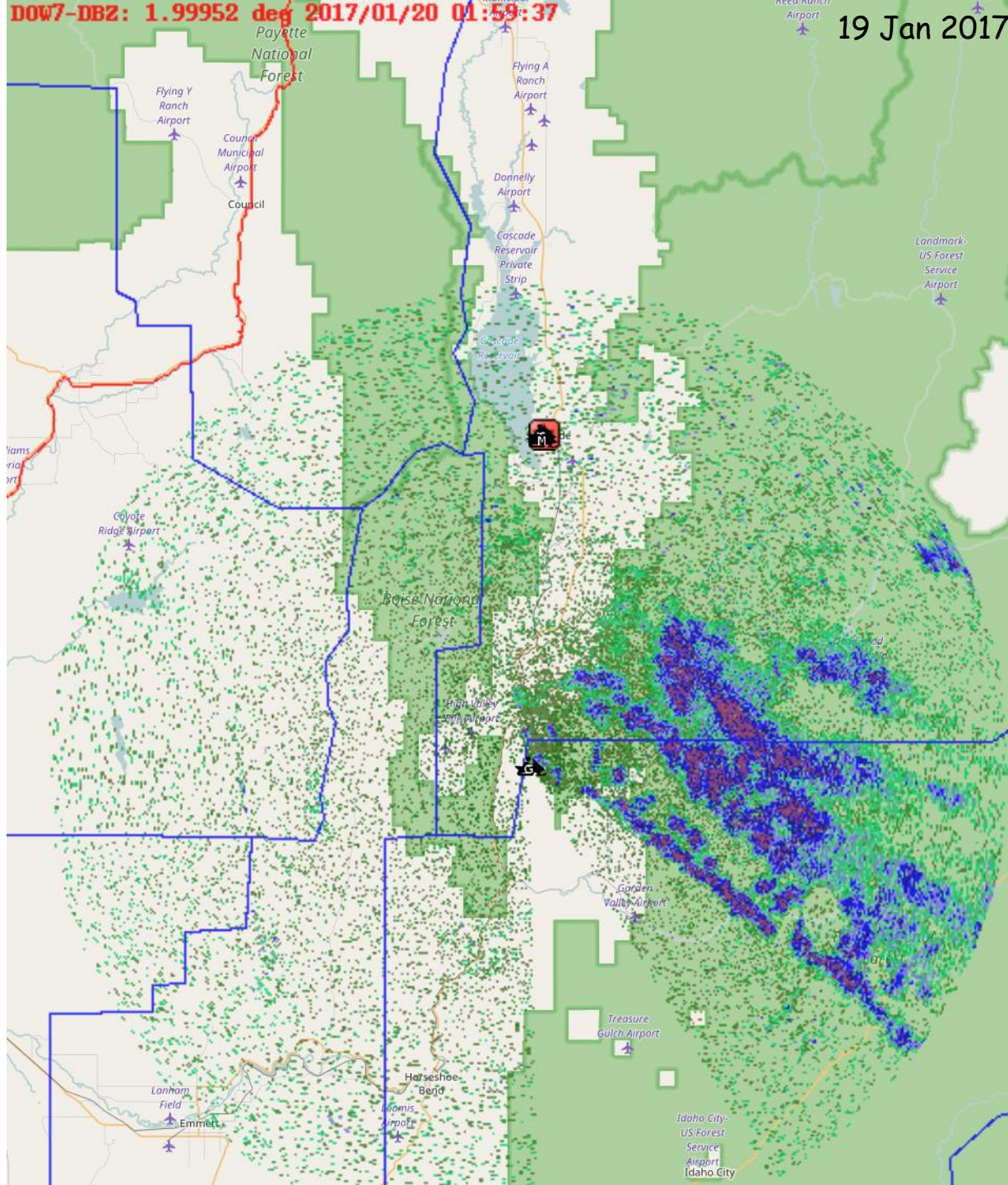






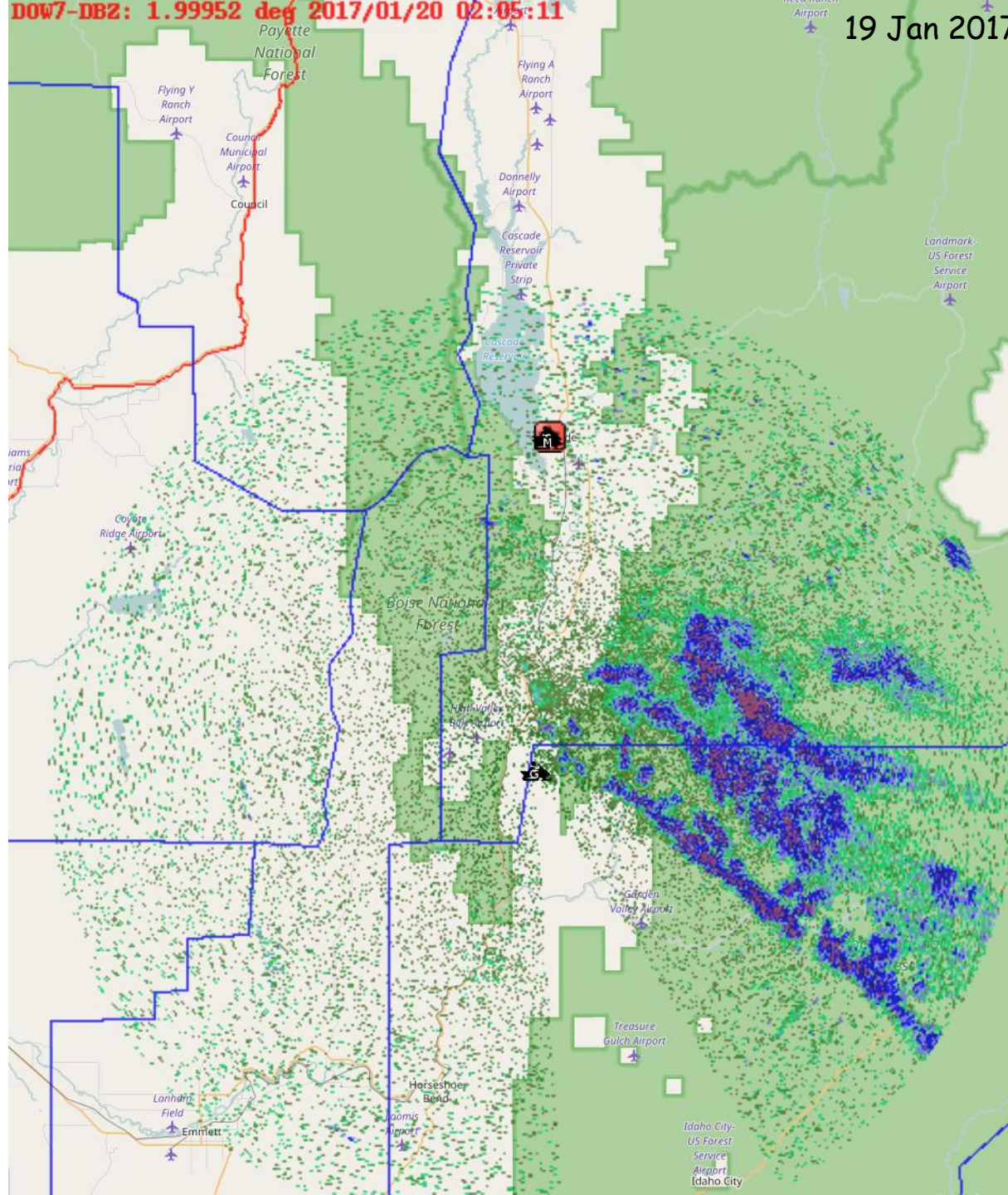
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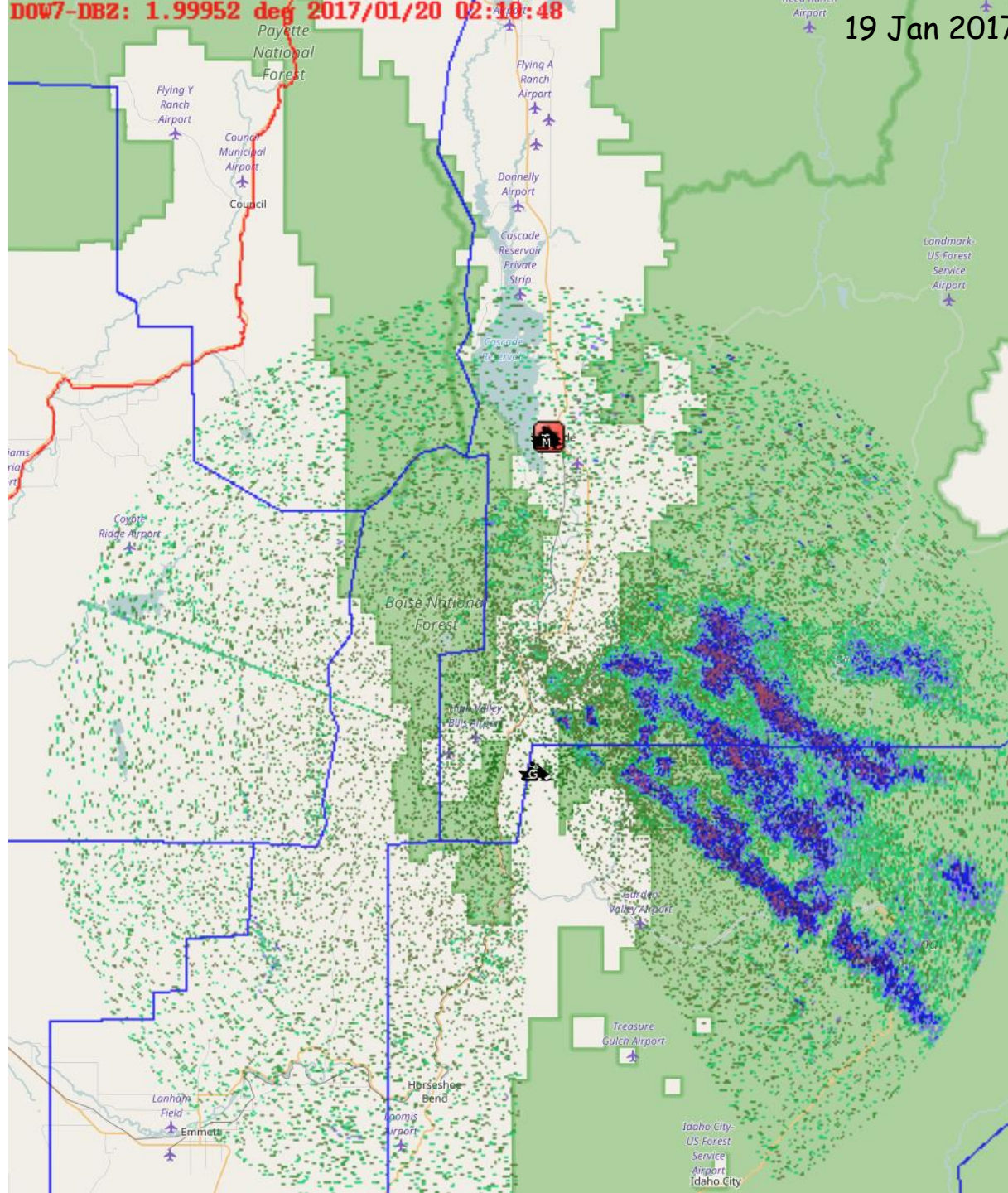
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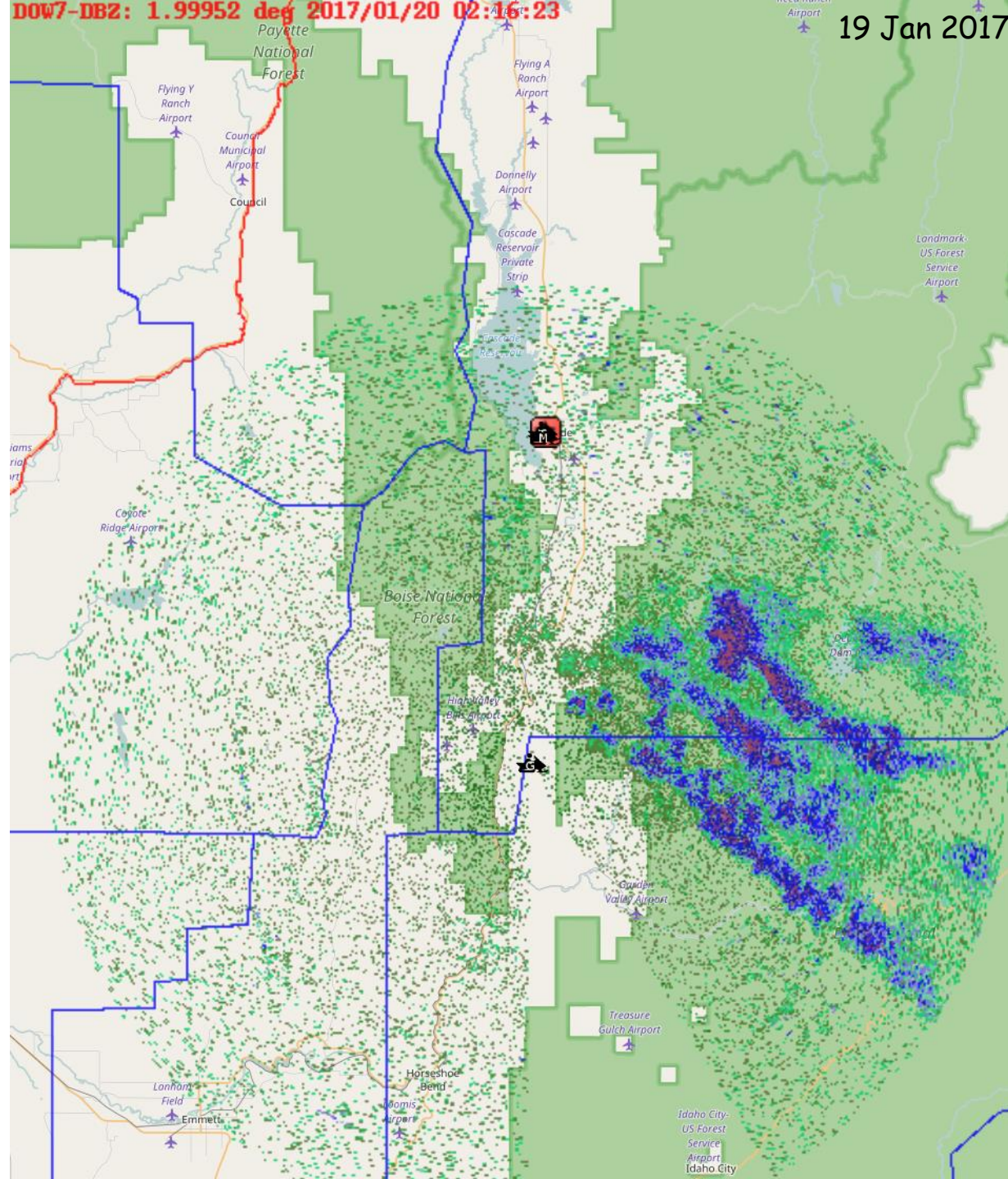
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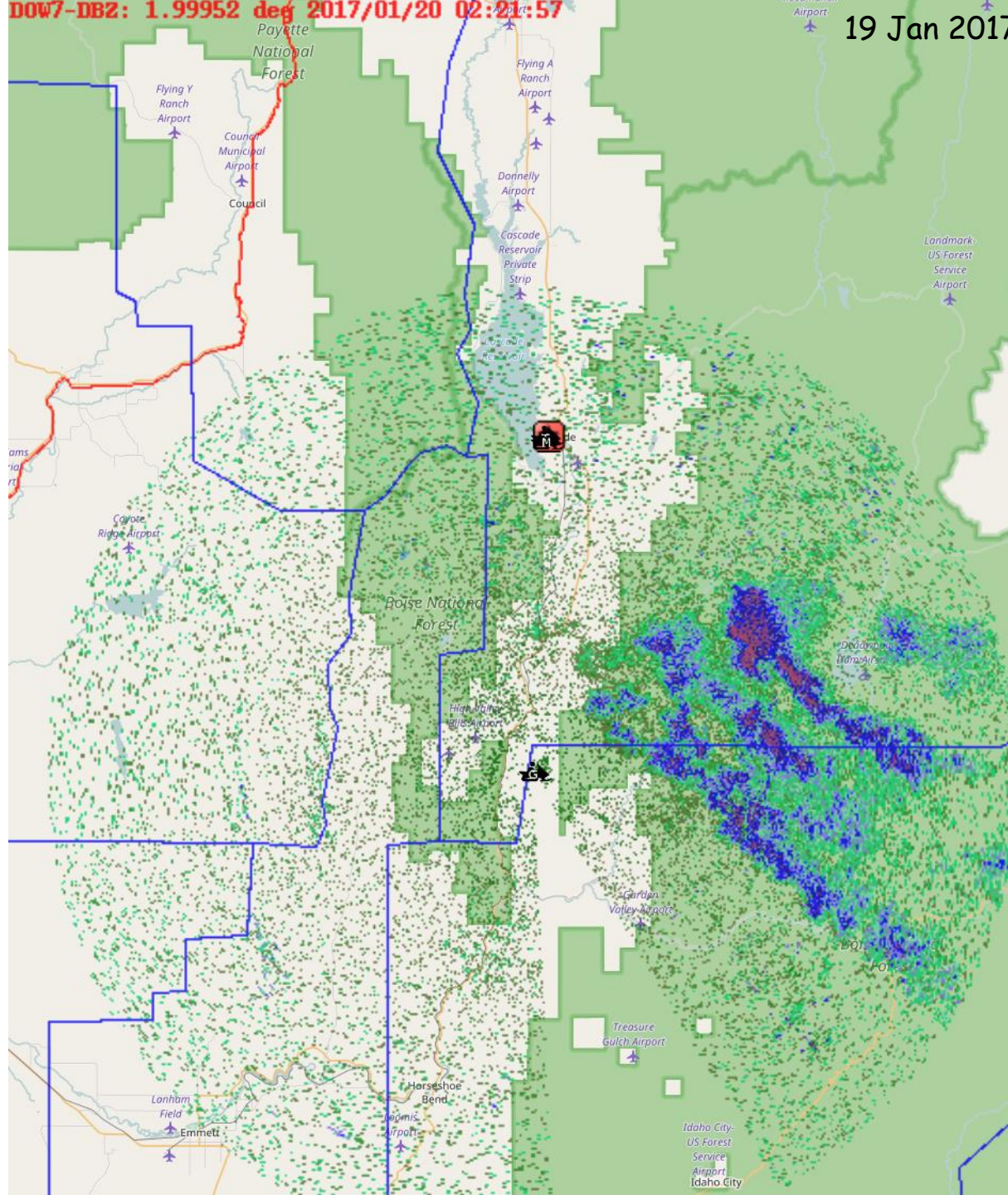




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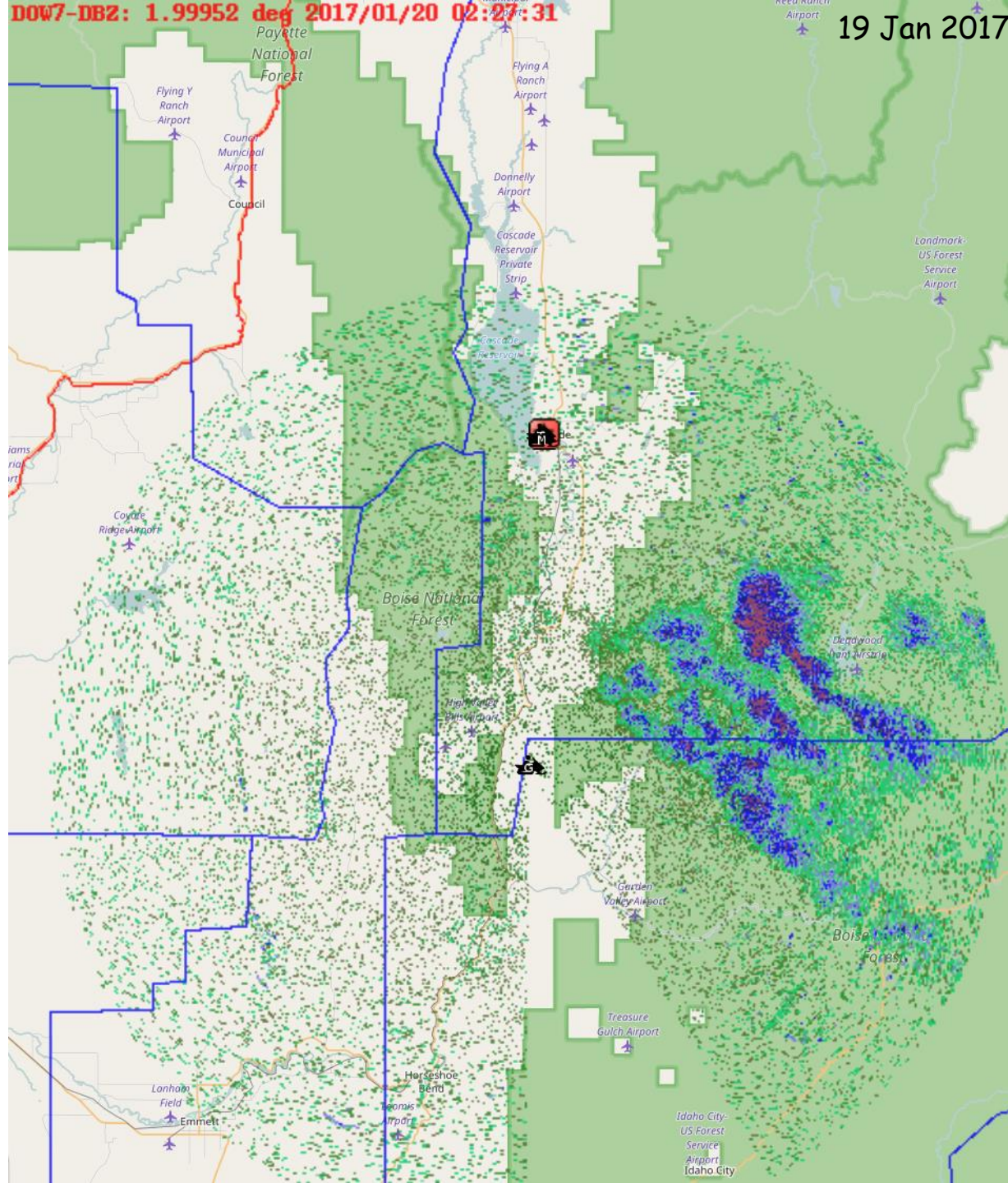
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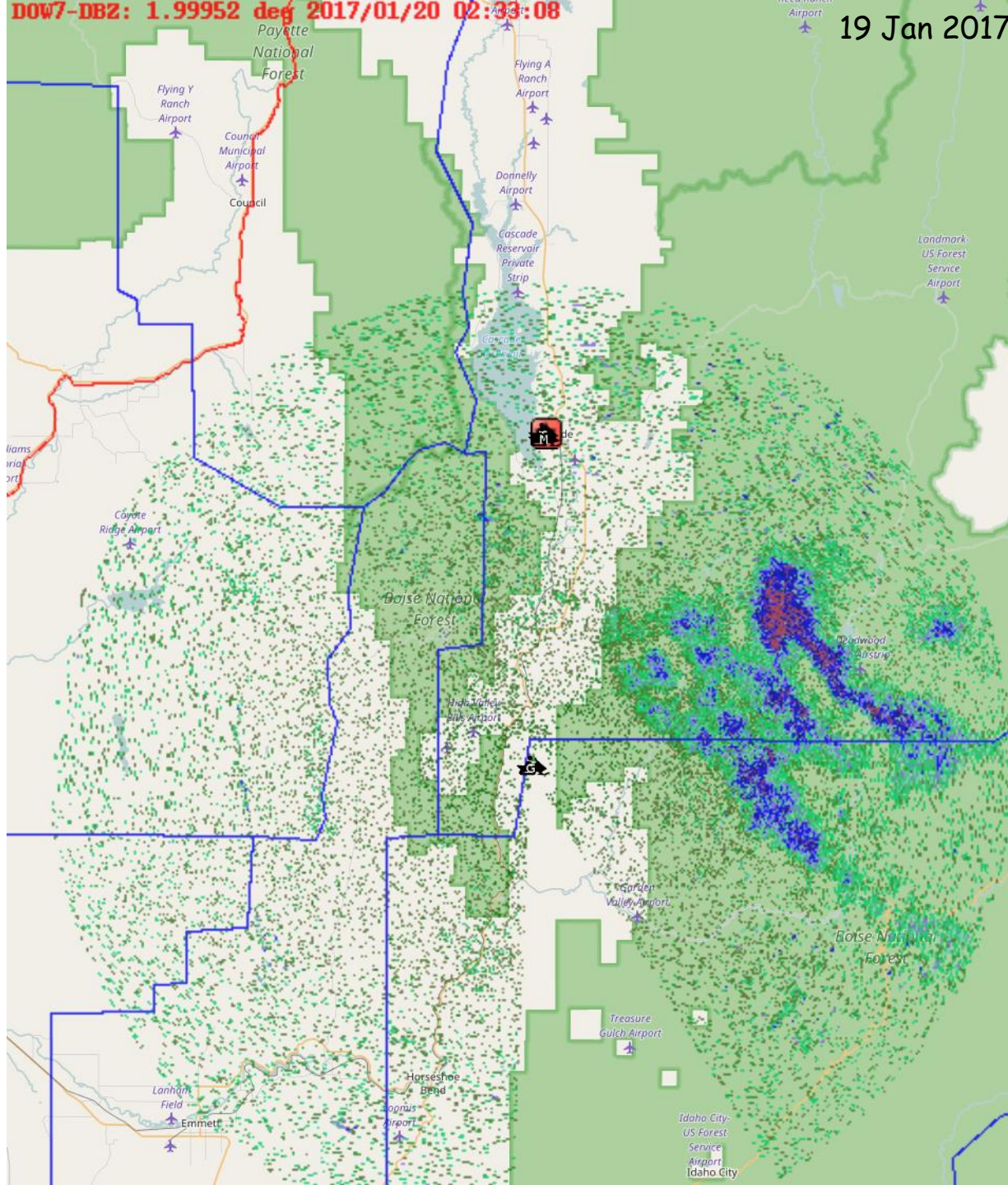
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19 Jan 2017



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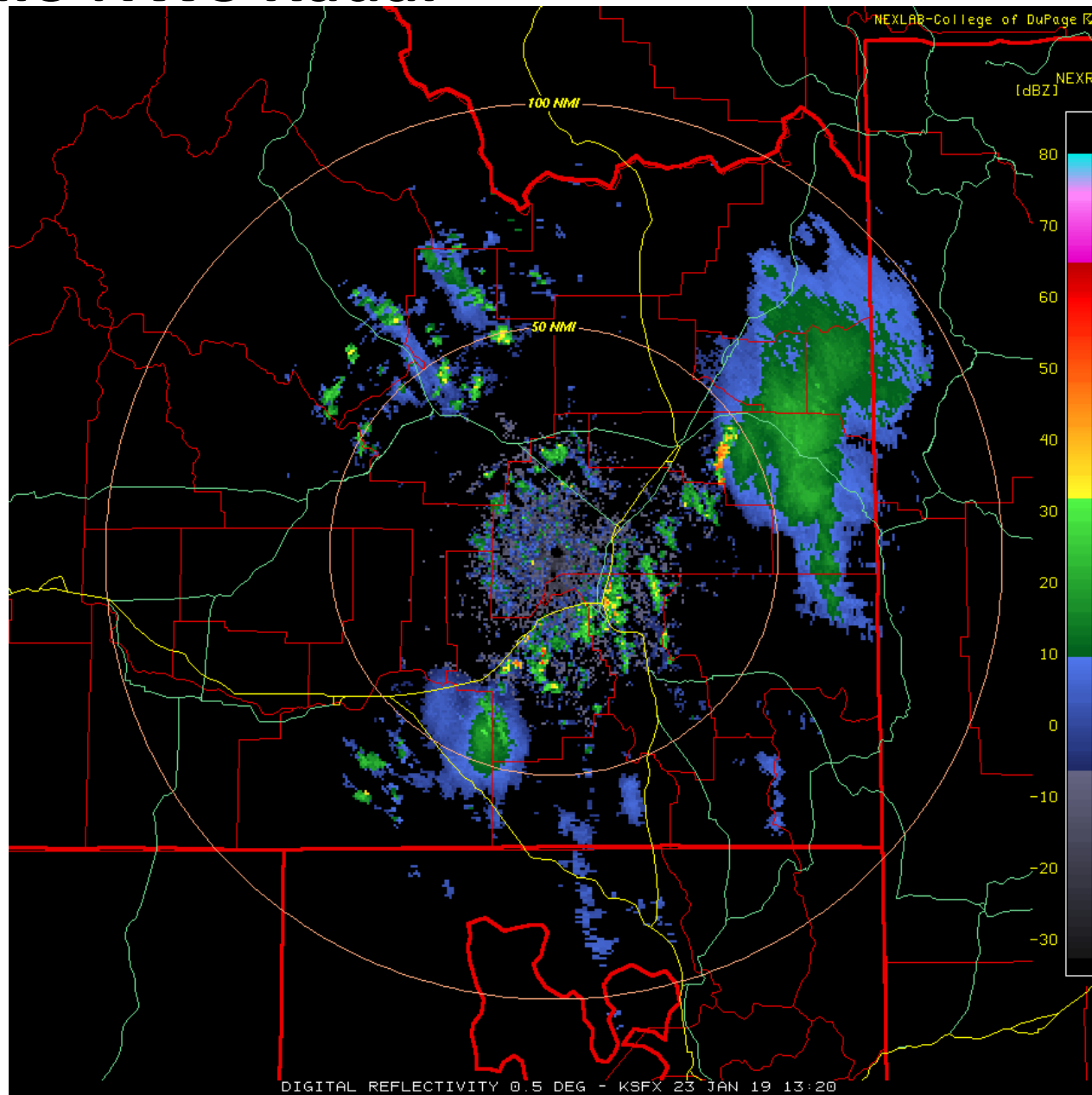
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How does SNOWIE benefit this effort?

- PNAS publication ...
 - SNOWIE provided the ‘... first unambiguous observations of the physical chain of events following introduction of glaciogenic cloud seeding aerosol into supercooled liquid orographic clouds.’
- BAMS publication ...
 - The measurements from SNOWIE aim to address long-standing questions about the efficacy of cloud seeding, starting with documenting the physical chain of events following seeding.
- More than 14 peer-reviewed research publications published, and researchers continue additional analysis
- Researchers received an additional NSF funding to continue analysis due to the large amount of quality data
- Ultimately, the findings are consistent with assumptions applied to estimate benefits

Pocatello NWS Radar

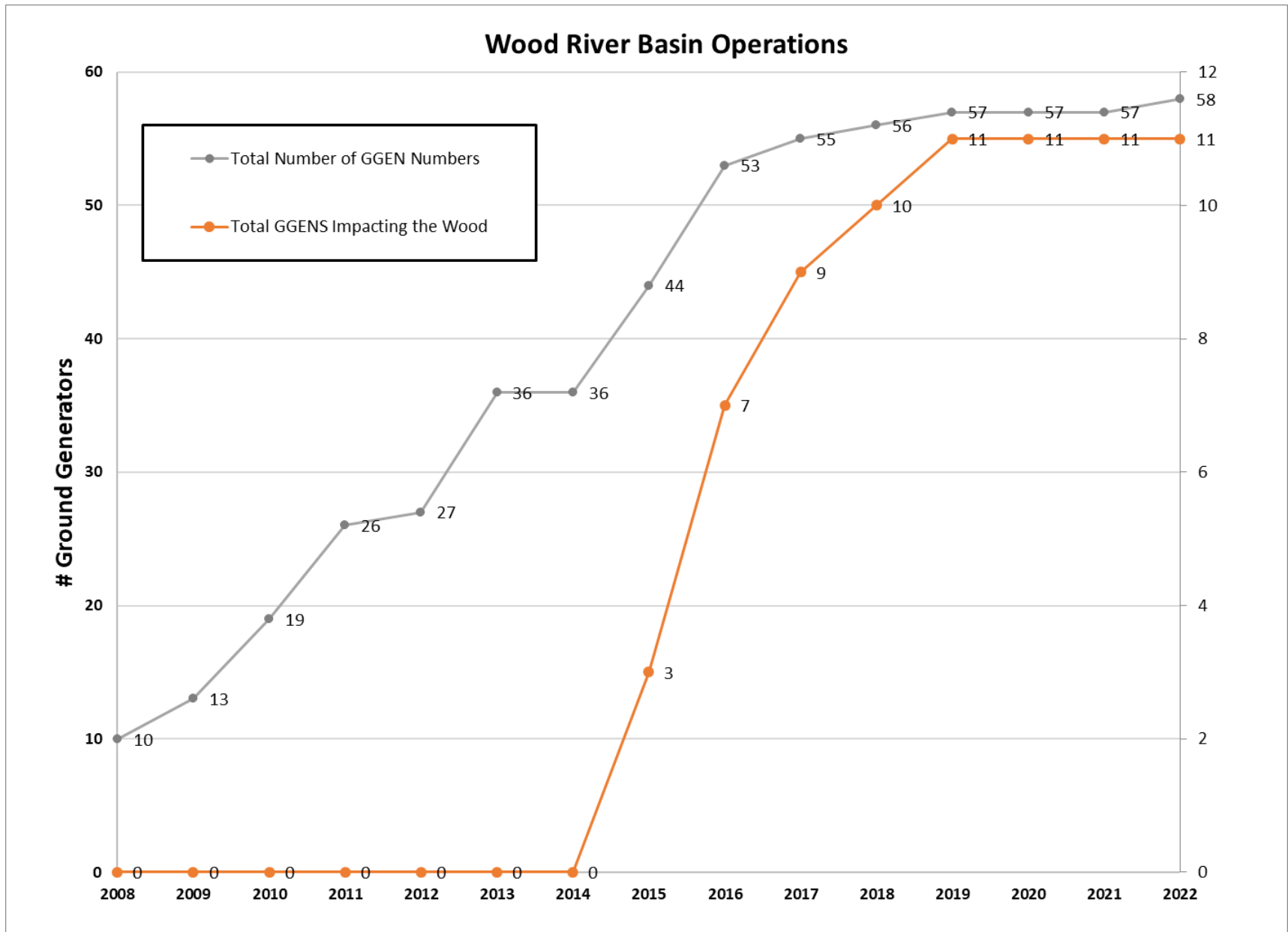




Idaho Power's Cloud Seeding History

- Began investigating cloud seeding in 1993 (shareholder question)
 - Take home: Long-term water management tool
- Operational in fall of 2003 (7 generators, aircraft, assessment)
 - Completed second year of assessment and third year of operations in May 2005
- In 2008 collaborated with HC RC&D and E Idaho Counties to enhance their program 5 year pilot project for CAMP
- In 2010 started working with WW RC&D to evaluate cloud seeding opportunities in western Wyoming
- In 2011 started working with NCAR to develop WRF model to guide and evaluate CS operations and projects
- In 2013 – contracted with Big Wood Canal Company to seed Wood River with aircraft
- WY 2015 Expansion (43 generators, 2 aircraft)
 - Boise and Wood Basin's – remote generators and aircraft seeding
 - Continued expansion in Salt and Wyoming Ranges
 - IWRB funding a grant for equipment associated with expansion
- WY 2016/2017 Expansion
 - Additional remote generators in Central Mountains and Upper Snake (WY16-53/WY17-55)
 - Third aircraft (2016)
- WY 2022 (Current)
 - Total 57 remote generators, 3 aircraft
 - Continued model development

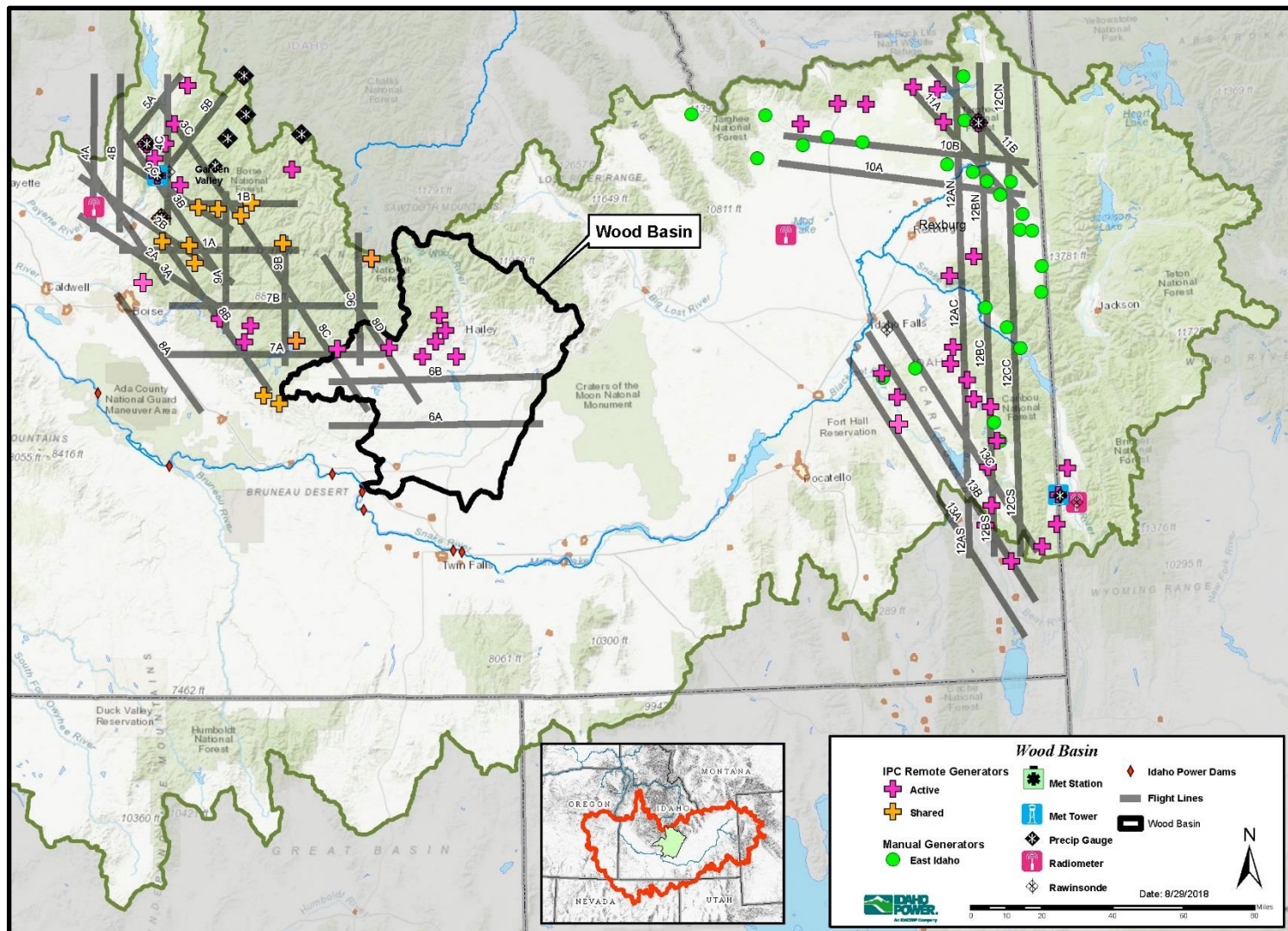
Ground Generators



Current Program

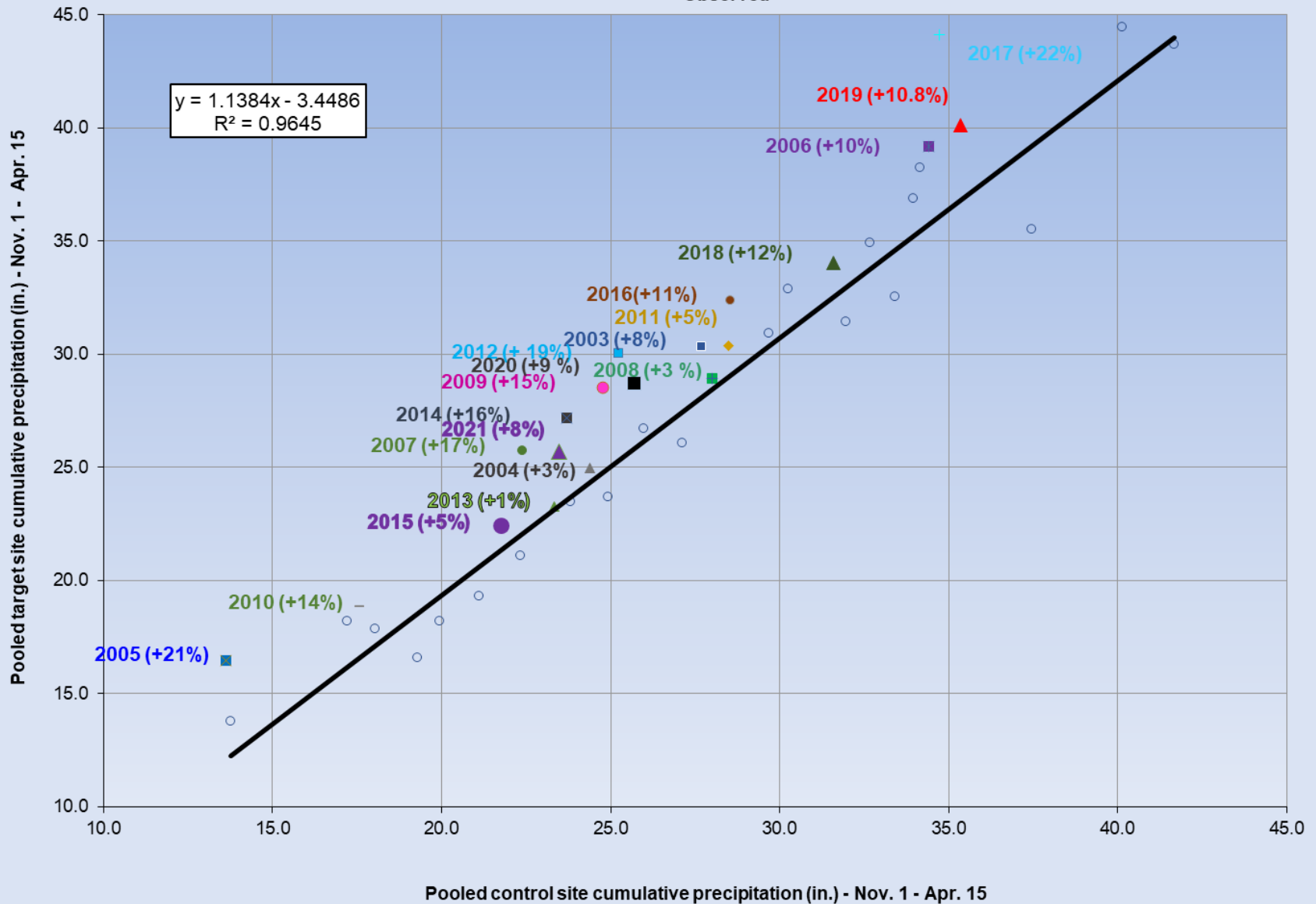
Payette, Boise, Wood & Upper Snake

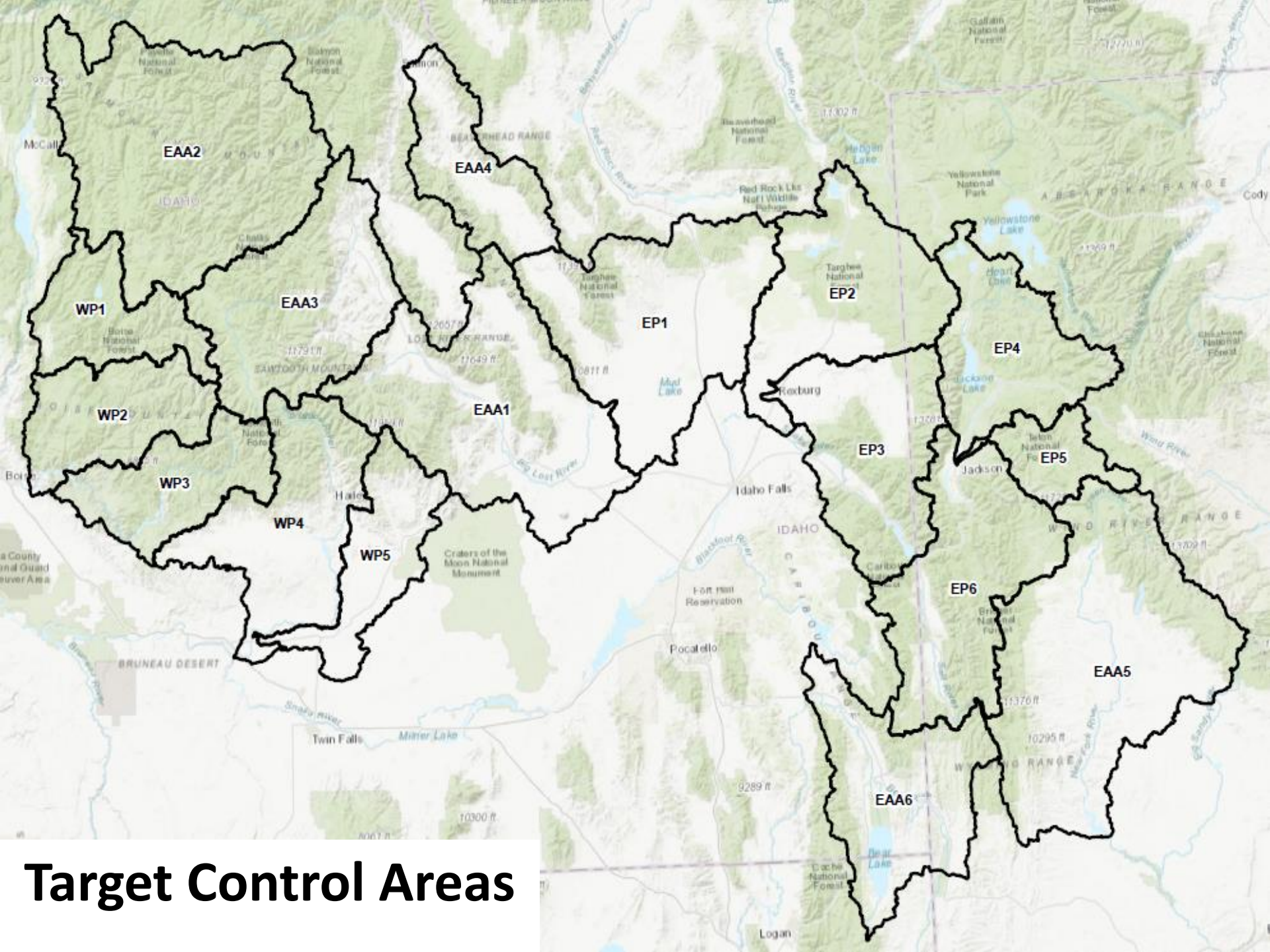
- **Payette and Wood**
 - 17 Remote Gen's
 - Aircraft
 - Radiometer
 - Weather Balloon
 - Weather Tower
 - 9 hi-res precip gauges
- **Boise and Wood**
 - 15 Remote Gen's
 - Aircraft
 - Radiometer
 - 2 hi-res precip gauges
- **Upper Snake**
 - 25 Remote Gen's
 - 25 Manual Gen's
 - Aircraft
 - 2 Radiometers
 - 2 Weather Balloons
 - Weather Tower
 - 2 hi-res precip gauge
- **All**
 - Weather Model



Target Control

Payette Target vs. Control Cumulative Precipitation
1987-2002 Historical Relationship and 2003-2021
Observed





Target Control Areas

Target Control Avg/2021

TC#	Basins	Average	WY2021	Old Basins	Average	WY2021
WP1	Middle/South Forks Payette	11%	8.5%	Payette	11%	7.5%
WP2	North/Middle Forks Boise & Mores Creek	12%	10.1%	Boise	12%	9.6%
WP3	South Fork Boise	11%	9.4%			
WP4	Big Wood & Camas Creek	10%	9.1%	Wood	10%	9.5%
WP5	Little Wood	10%	7.1%			
EP1	Birch & Medicine Lodge & Beaver-Camas	5%	4.0%	Henrys Fork	6%	5.0%
EP2	Upper & Lower Henrys Forks	6%	5.4%			
EP3	Teton River	10%	9.3%	Upper Snake	8%	7.2%
EP4	SNAKE Headwaters	9%	8.3%			
EP5	Gros Ventre	10%	8.8%			
EP6	Palisades/Greys-Hoback/Salt	8%	7.0%			

Estimated Runoff Benefits (Current)

Average Additional Runoff (unregulated)

- Payette – 221 KAF
- Boise – 264 KAF
- Wood – 105 KAF
- Upper Snake – 415 KAF
- Abv Palisades – 276KAF
- Henry's Fork – 139 KAF

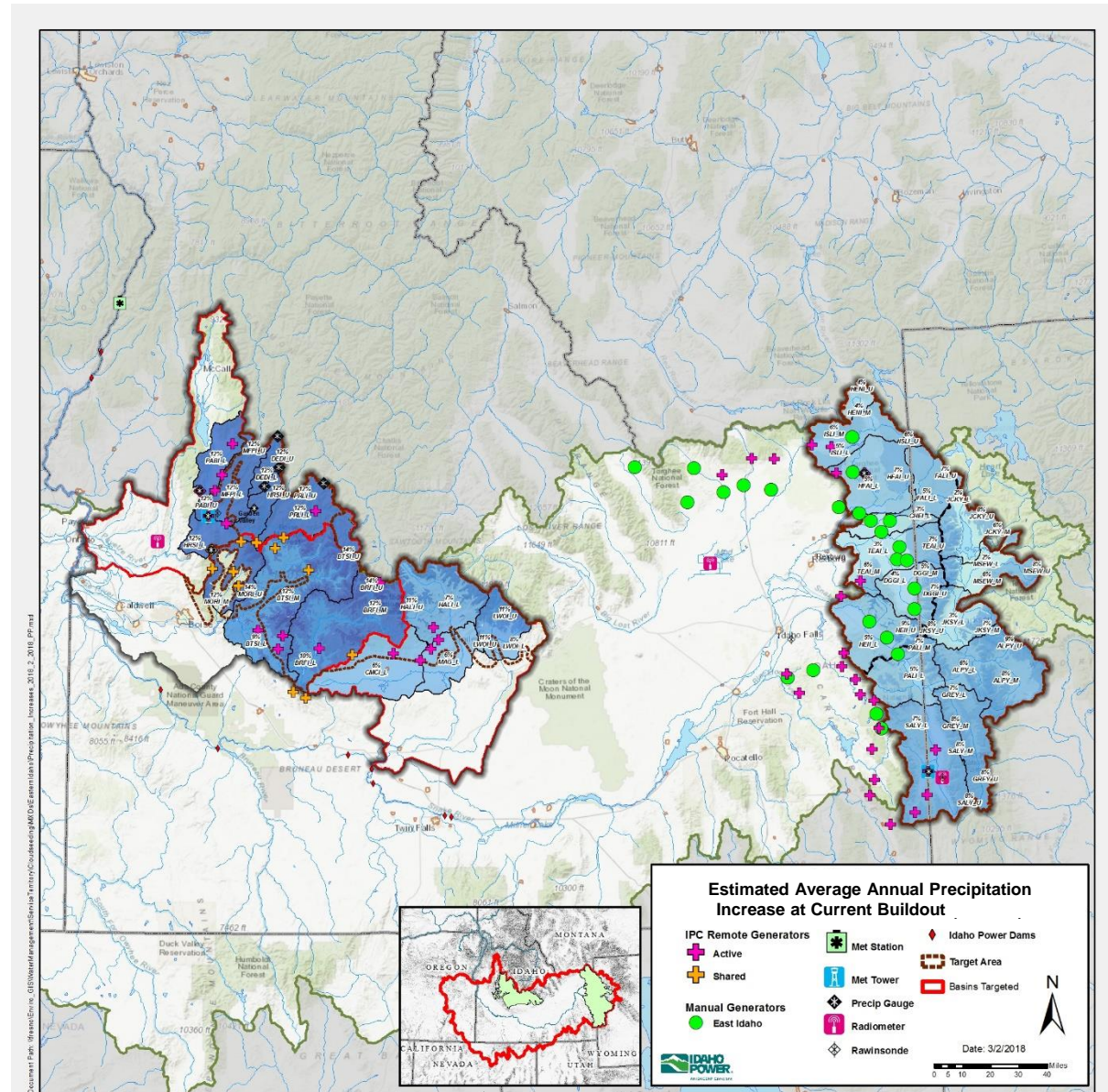
Total – 1,005 KAF

Cost of Additional Water

- Gross ~\$3.4/AF

WY2021 – 42 KAF

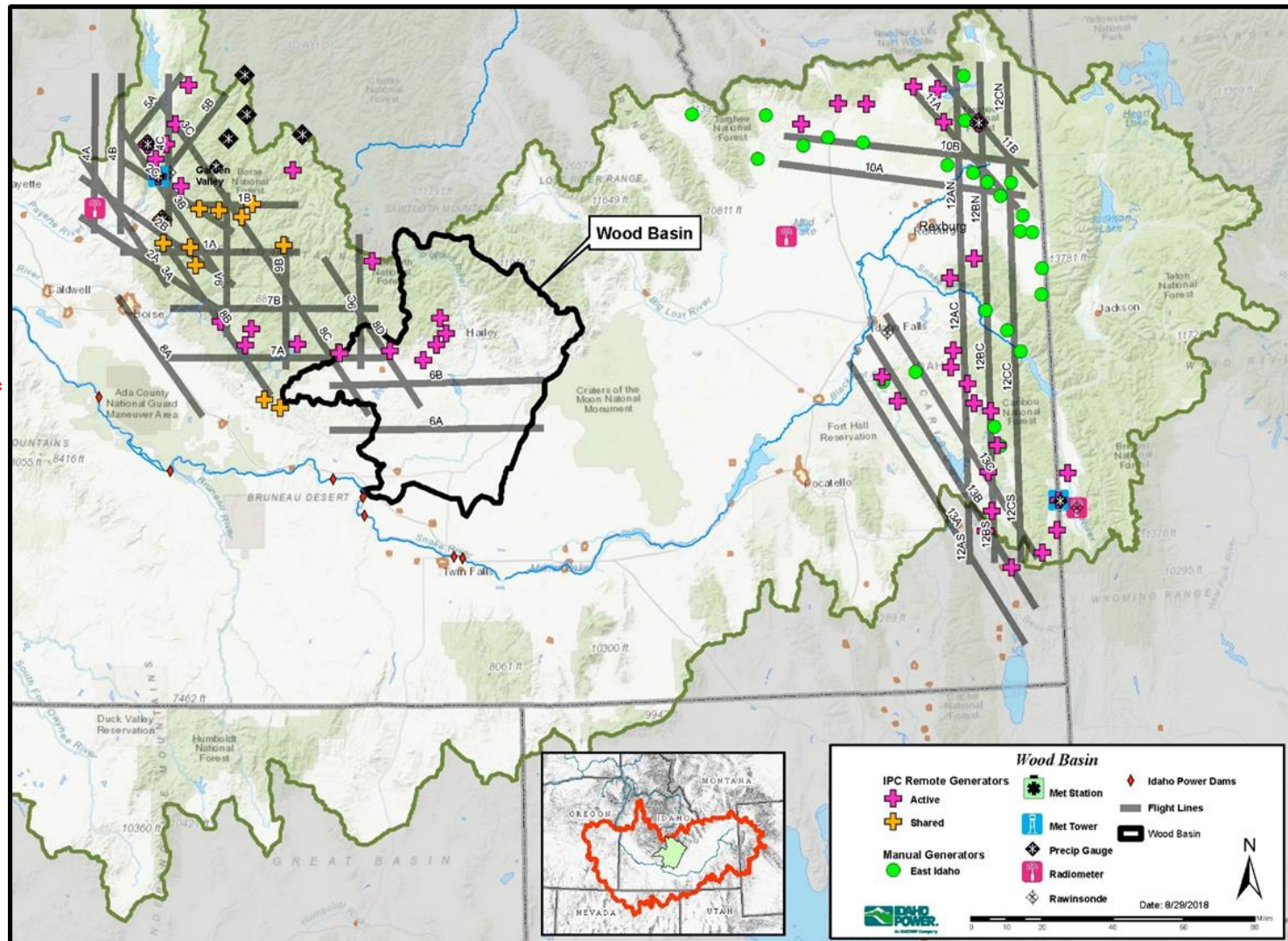
- without cloud seeding, the Wood would have received ~42 KAF less runoff in WY2021.



Potential Future Program

Payette, Boise, Wood & Upper Snake

- **Payette**
 - 17 Remote Gens
 - Aircraft
 - Radiometer
 - Weather Balloon
 - Weather Tower
 - 7 hi-res precip gauges
- **Boise and Wood**
 - 20 - 26 Remote Gen's**
 - Aircraft
 - Radiometer
 - Weather Balloon
 - 4 hi-res precip gauges
- **Upper Snake**
 - ~ 40 Remote Gens
 - 25 Manual Gens
 - **2 Aircraft**
 - 2 Radiometers
 - 2 Weather Balloons
 - Weather Tower
 - 2 to 5 hi-res precip gauges
- **All**
 - Weather Model



Estimated Runoff Benefits (Buildout)

Average Additional Runoff (unregulated)

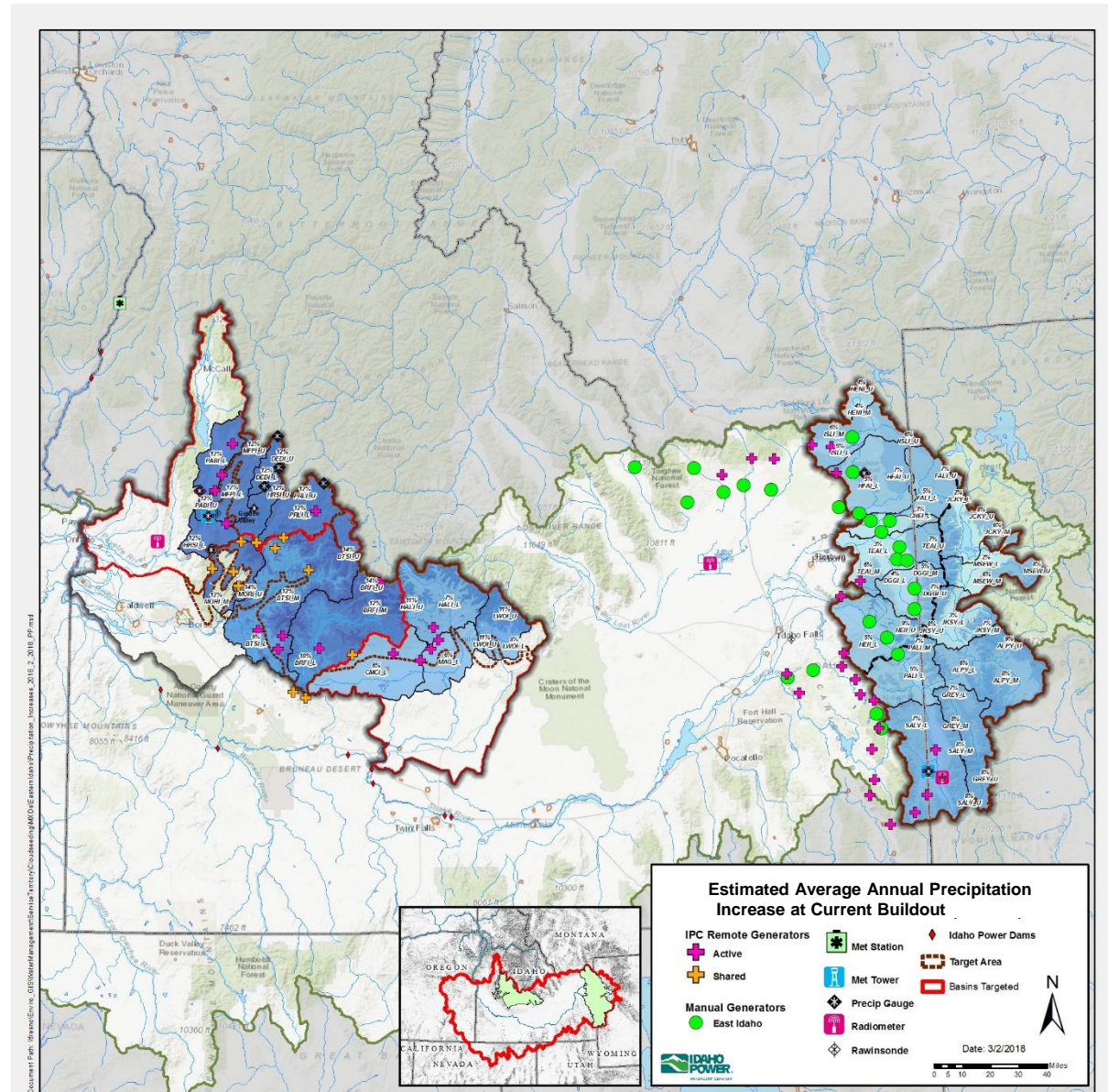
- Payette – 221 KAF
- Boise – 323 KAF
- Wood – 133 KAF

- U Snake – 602 KAF
- Abv Palisades – 419 KAF
- Henry's Fork – 183 KAF

Total – 1,279 KAF

Cost of Additional Water

- Gross ~\$3.6/AF



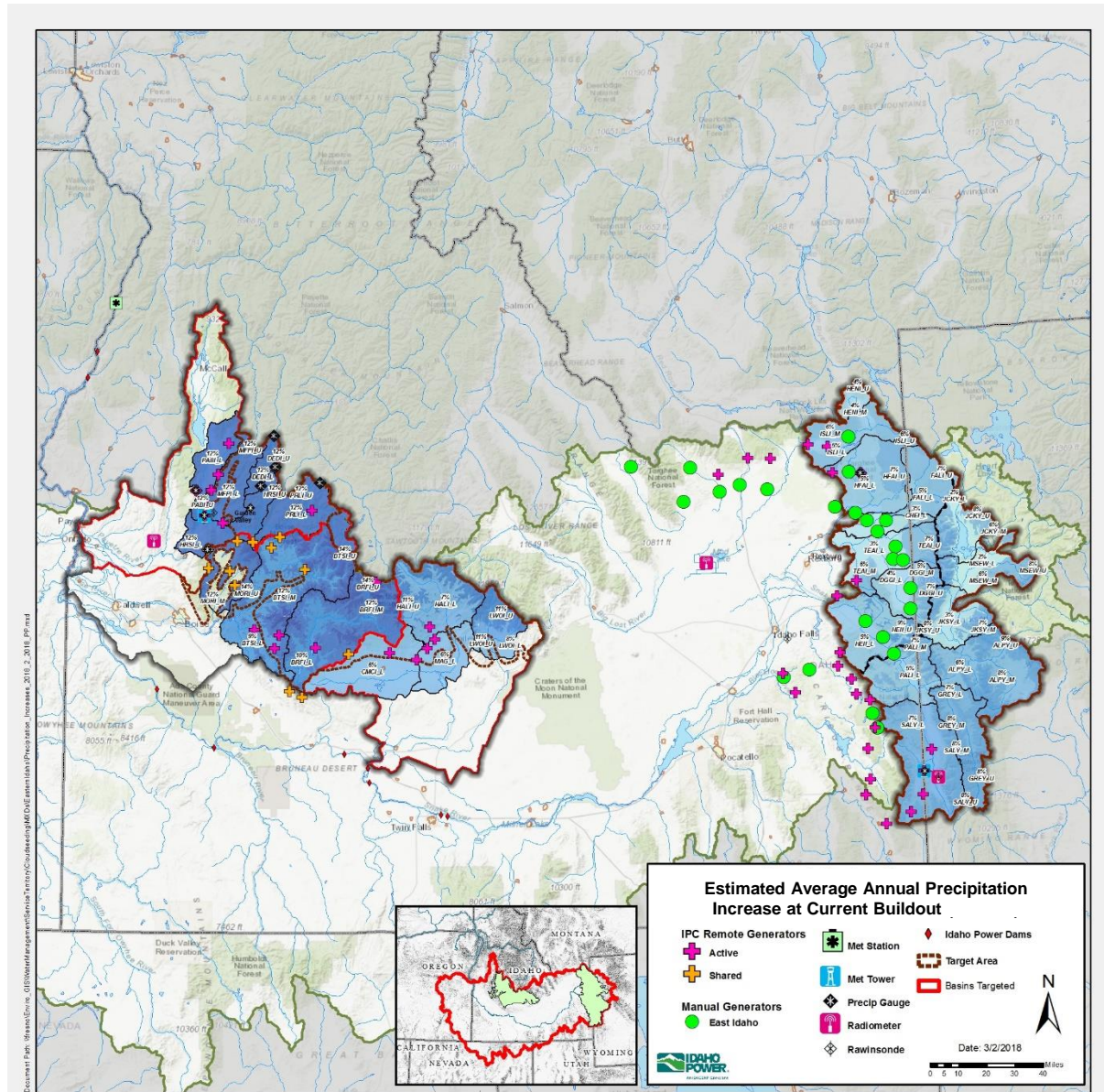
Potential Increases from Expansion

Incremental Additional Runoff (unregulated)

- Payette – 0 KAF
- Boise – 59 KAF
- Wood – 28 KAF

- U Snake – 187 KAF
 - Abv Palisades – 143 KAF
 - Henry's Fork – 44 KAF

Total – 274 KAF





Project Costs

- 2021 level of build-out – Wood Basin
 - Shared aircraft with Boise
 - Remote Ground Generators - 7 dedicated, 4 shared
 - Assuming shared funding 1/3 IPC, 1/3 State, 1/3 water users, average
 - 105,000 AF / year
 - \$191,000 / year (Wood Basin water users funded \$89,000 in WY2021)
 - State made up water user shortages
- 2022 - \$203,000 (Total \$610,000)
- Assuming Buildout – Wood Basin
 - Shared aircraft with Boise
 - Remote Ground Generators – 12 dedicated, 7 shared
 - Total costs \$879,000
 - 133,000 AF / year

Questions?

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