

Idaho Wintertime Cloud Seeding

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Presentation Outline

- What is cloud seeding
- How cloud seeding is conducted
- IPC's history of cloud seeding
- Cloud seeding in Idaho
- SNOWIE research project
- Benefit estimates



WINTER CLOUD SEEDING

WITH SILVER IODIDE

1

CLOUD

Air flows over the mountain forming a cloud that may contain supercooled liquid water

Air Flow

0°C (32°F)



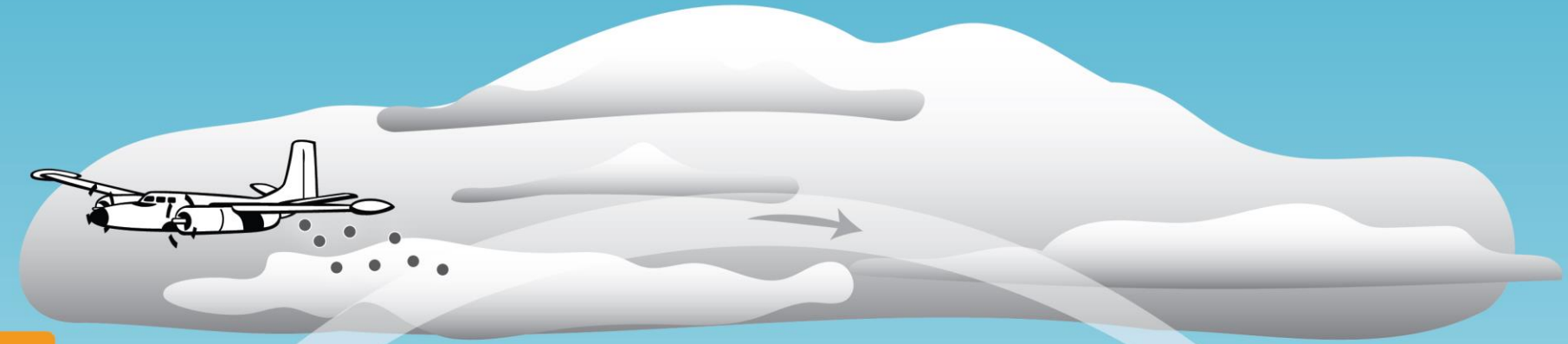
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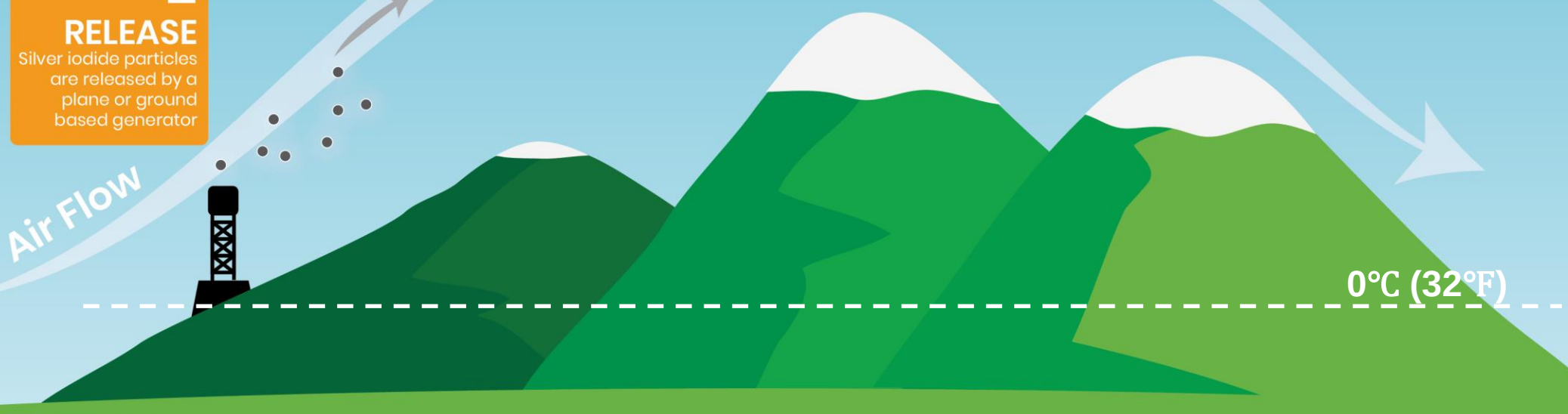


2

RELEASE

Silver iodide particles are released by a plane or ground based generator

Air Flow



0°C (32°F)

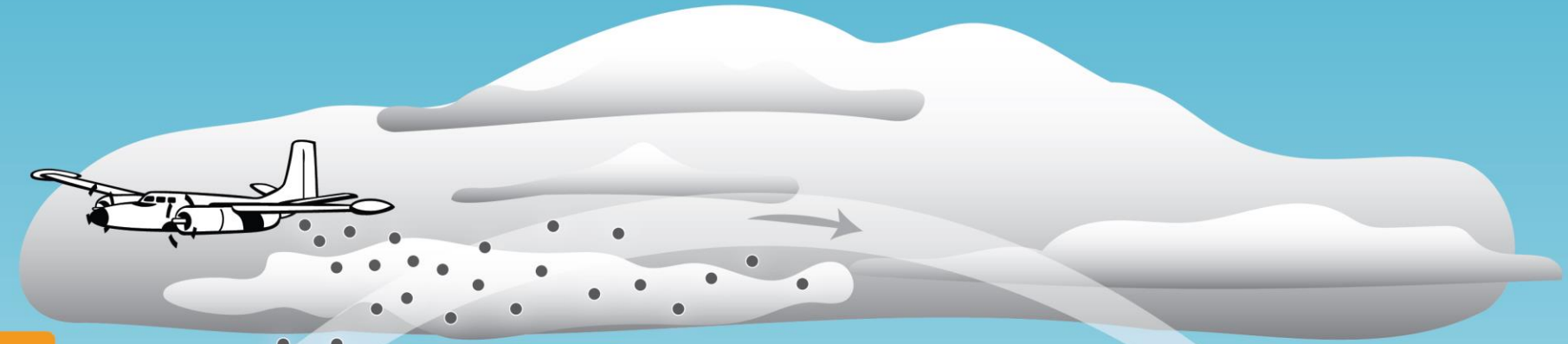
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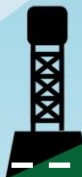


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Silver iodide particles are released by a plane or ground based generator

Air Flow



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MERGE

Silver iodide particles reach the targeted cloud

0°C (32°F)

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The silver iodide forms ice crystals

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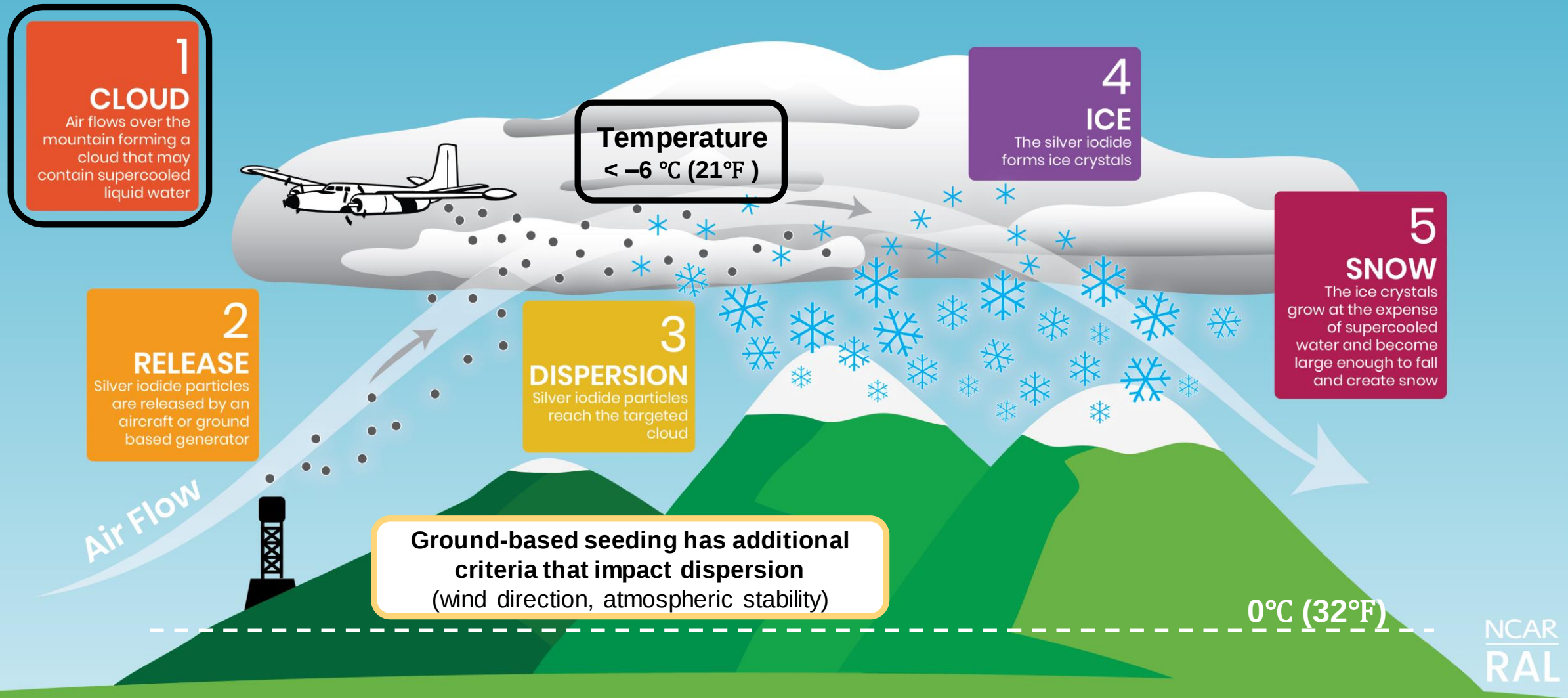
SNOW

The ice crystals grow at the expense of supercooled water and become large enough to fall and create snow

Air Flow

0°C (32°F)

Two key criteria : 1) Supercooled liquid water (SLW) 2) Temperature for silver iodide to nucleate ice



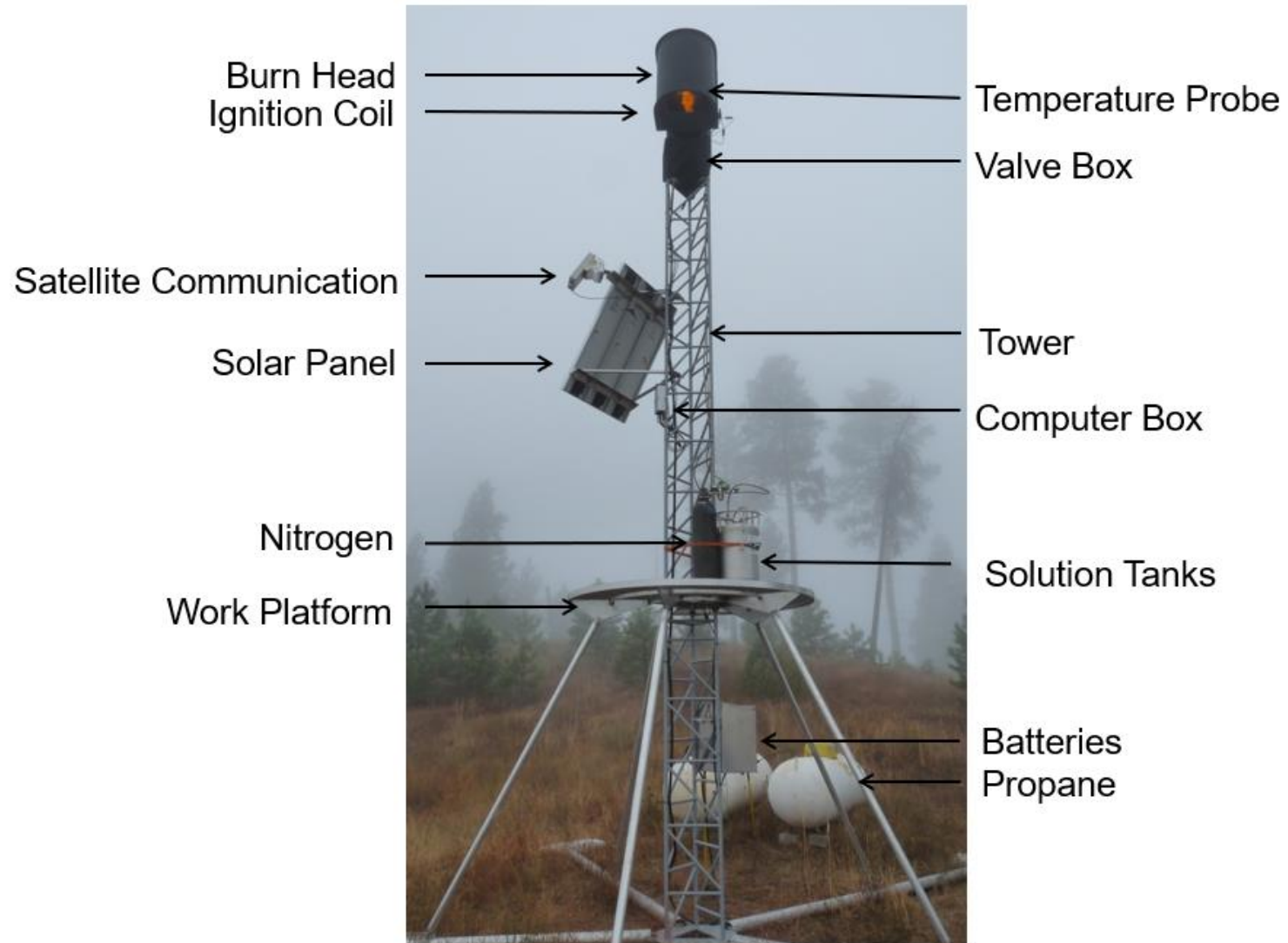


How cloud seeding is conducted

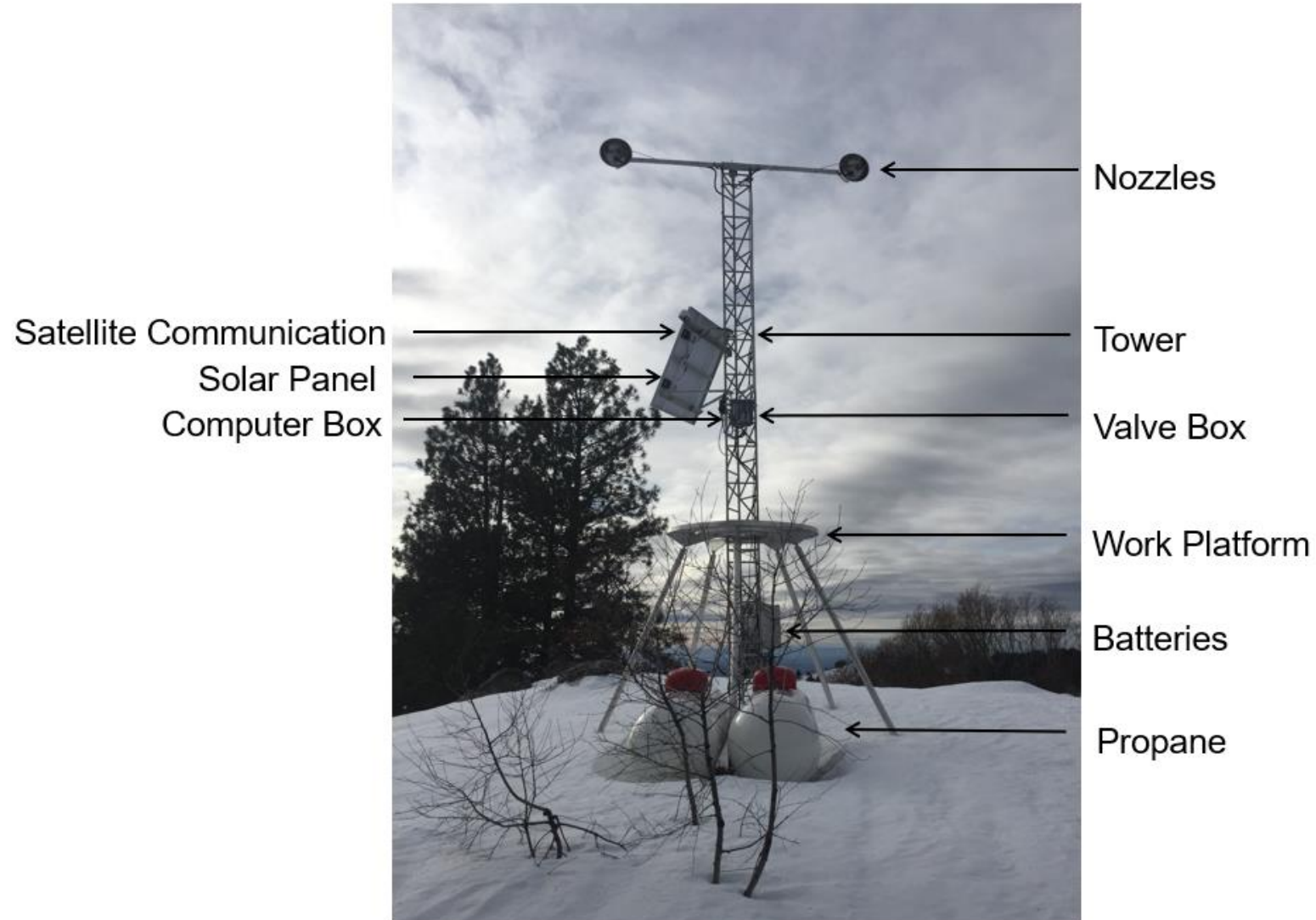


- Generators
 - Remote – Silver Iodide (AgI)
 - Remote - Liquid Propane (LP)
 - Manual – Silver Iodide (AgI)
- Aircraft
 - Flares (AgI)
 - Burn In Place (BIP)
 - Ejectable (EJ)

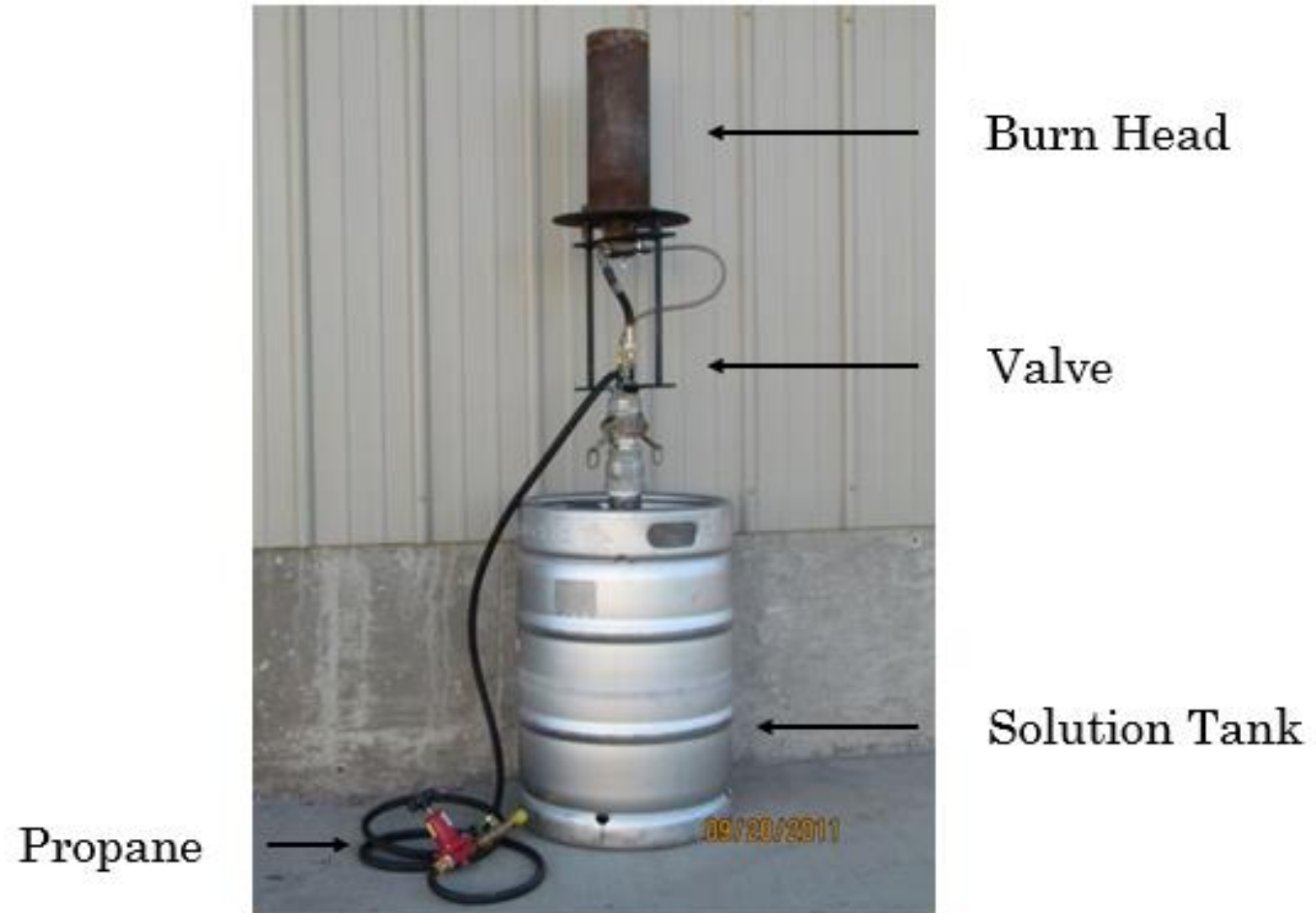
Remote Cloud Seeding Generator - Agl



Remote Cloud Seeding Generator - LP



Manual Cloud Seeding Generator - Agl



Aircraft - Agl

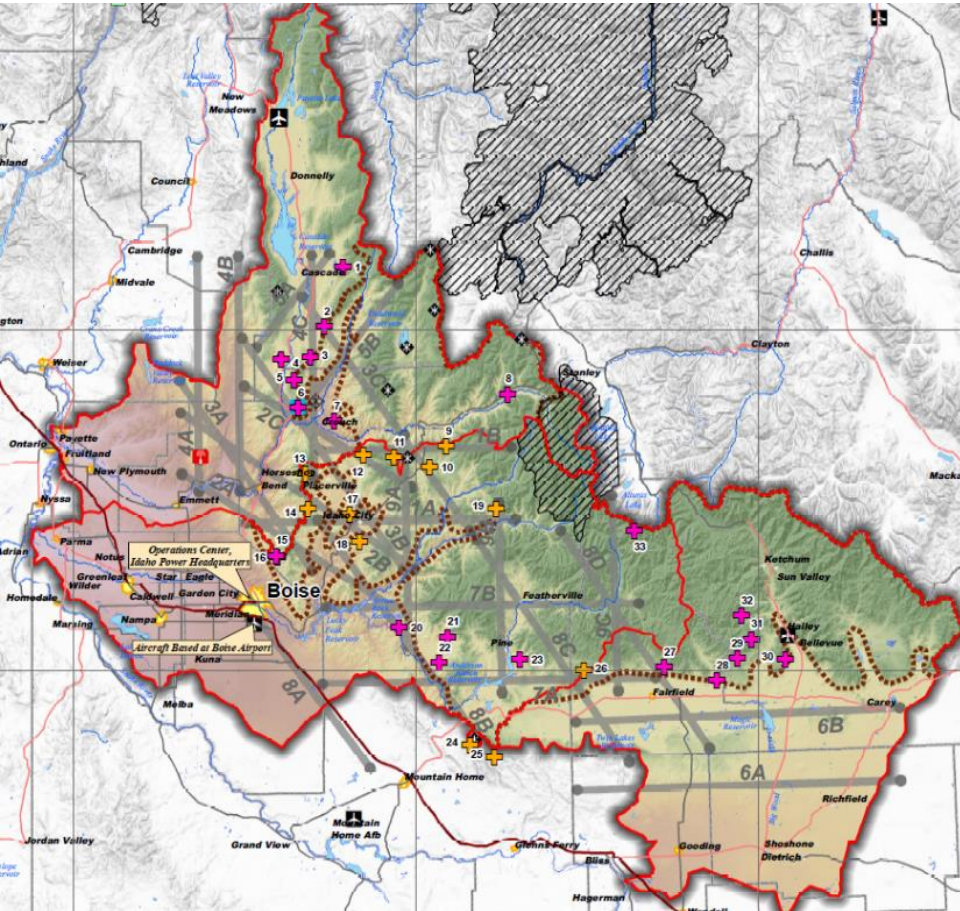


Modified Aircraft



Idaho Power's Cloud Seeding History

- Began investigating cloud seeding in 1993 (shareholder question)
 - Literature review 1993 and 1994
 - Climatology study 1994 and 1995
 - Feasibility and Project Design 1995 -
- Operational in fall of 2003 (Payette - 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 (motivated by 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 (44 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 2024 Current Program
 - 57 Generators AgI, 6 LP
 - 3 aircraft



WY 2024 Idaho Collaborative Cloud Seeding Program

Central Mountains

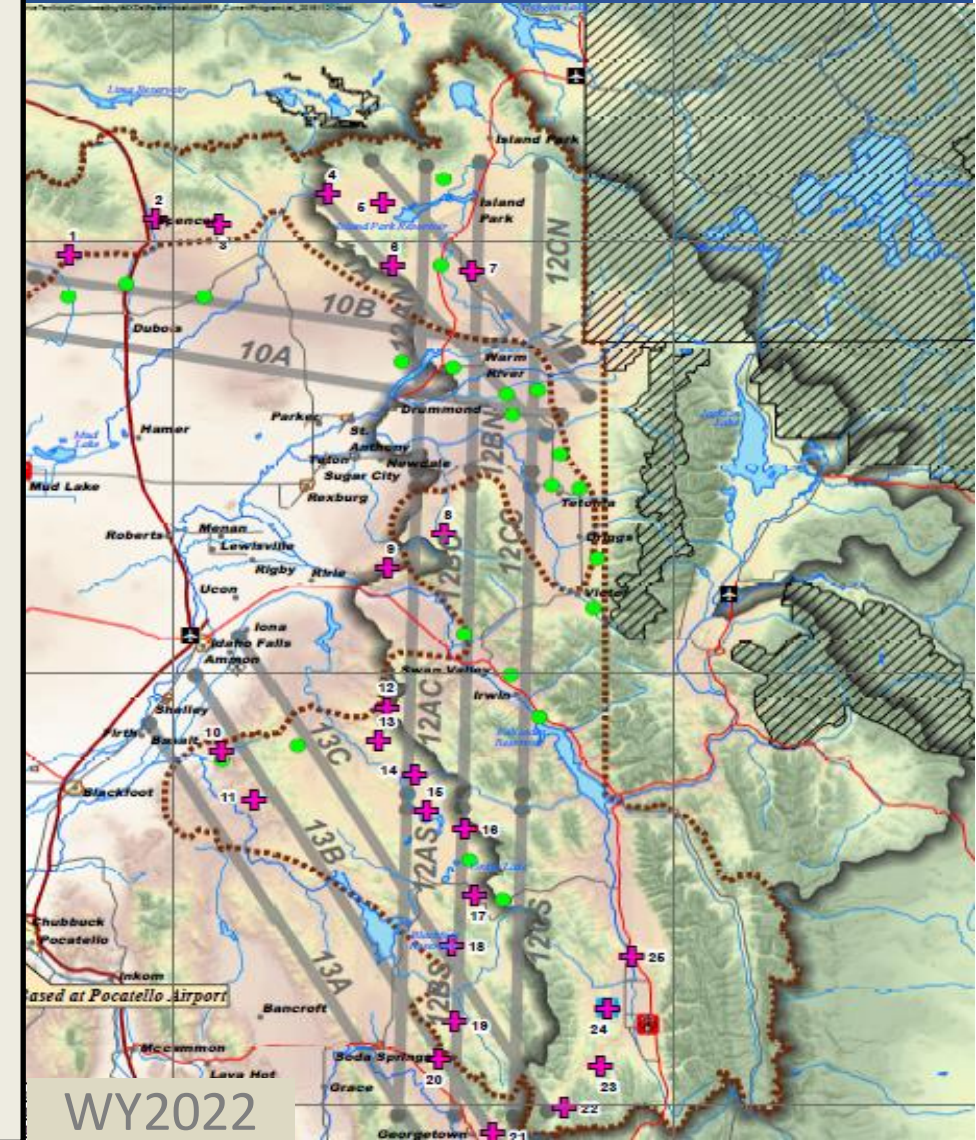
- 32 IPC Remote Agl Ground Generators
 - 17 Payette
 - 15 Boise/Wood
- 6 IPC Remote LP Ground Generators
- 2 Aircraft (Agl)

Upper Snake

- 25 IPC Remote Agl Ground Generators
- 1 Aircraft (Agl)
- 25 Let It Snow Manual Agl Ground Generators

Across the Program

- High Performance Computing System
- High Resolution WRF Weather Model
- WRF-WxMod Module
- High Resolution weather instrumentation

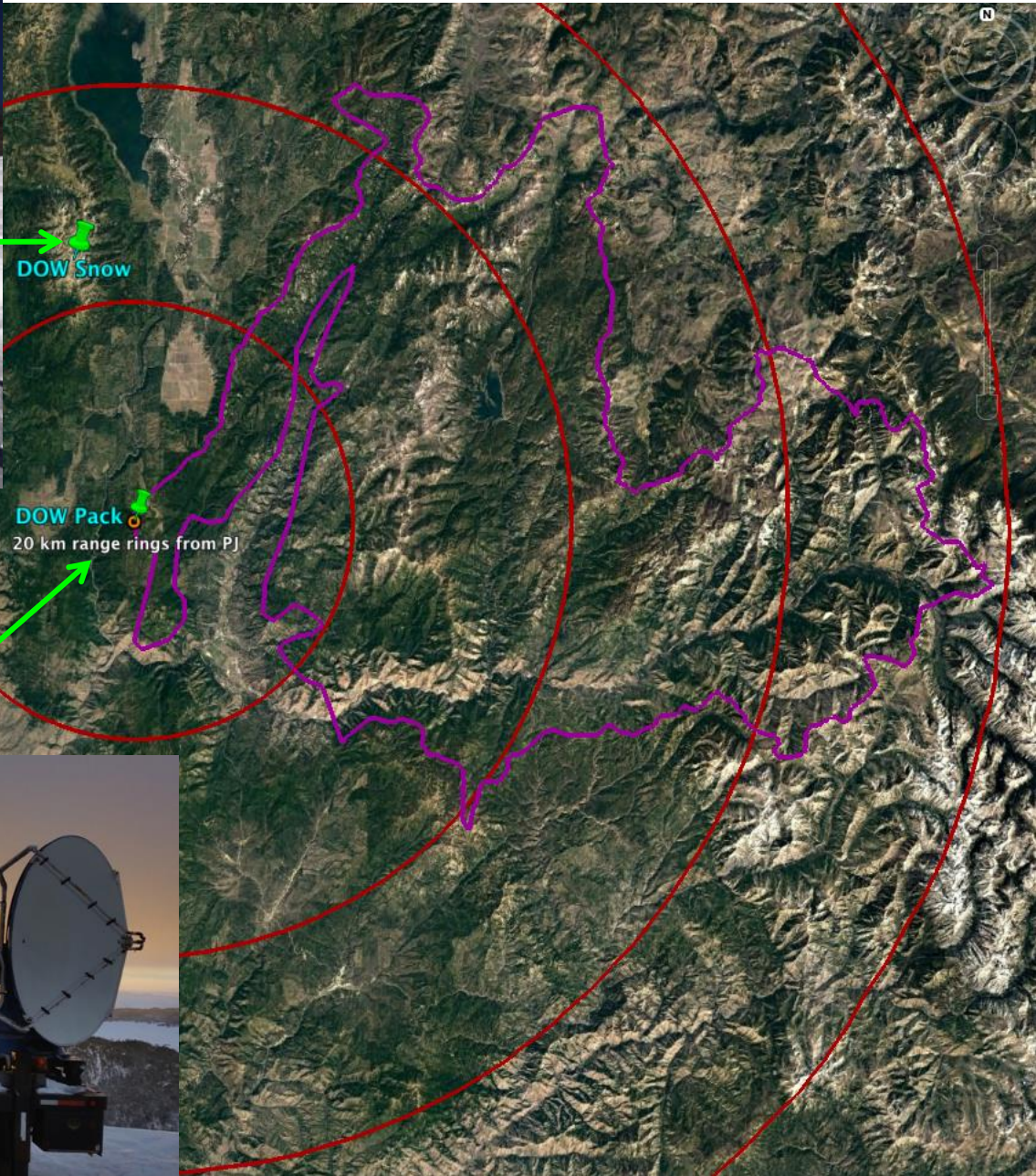


WY2022

SNOWIE

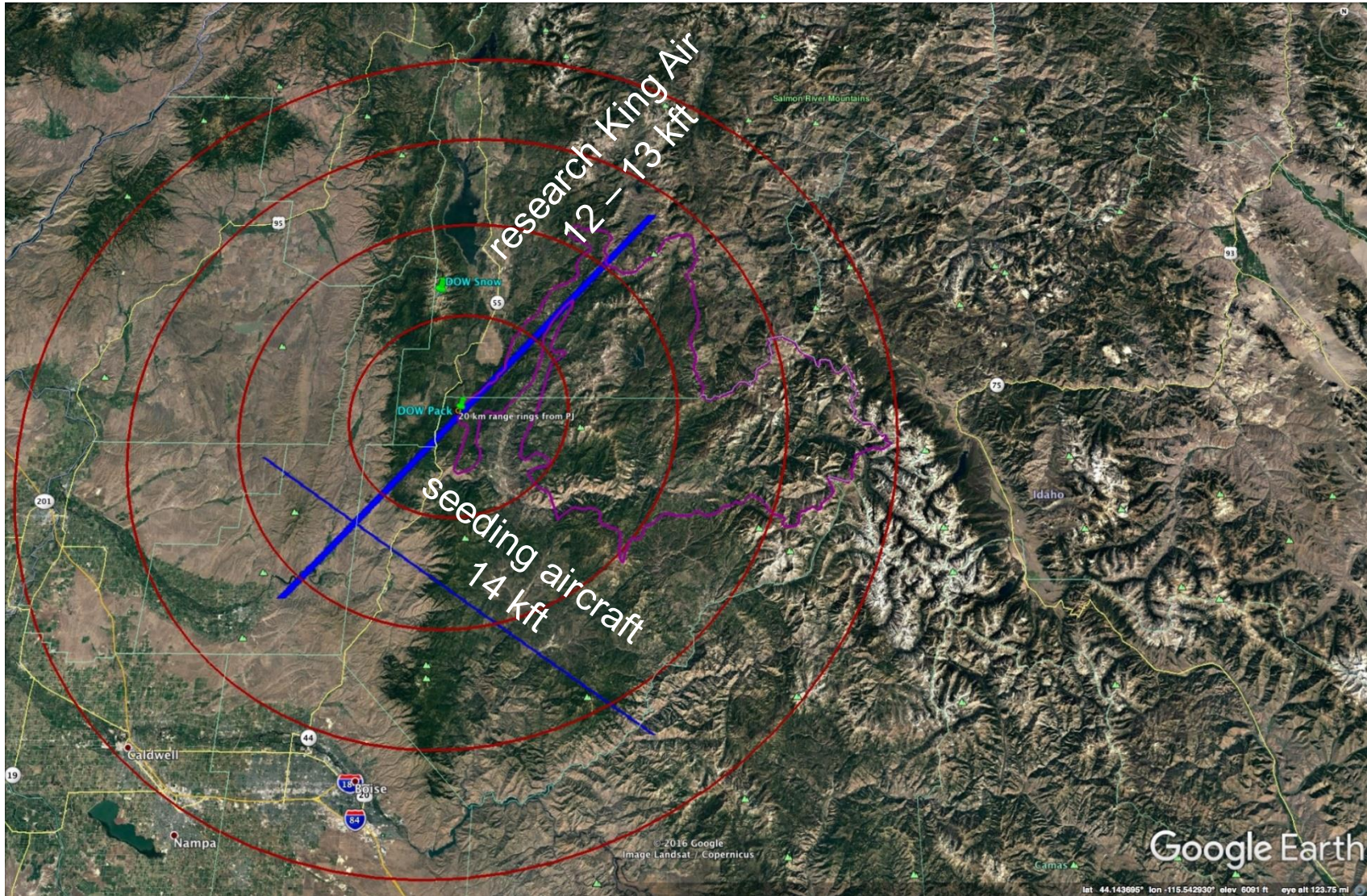
Seeded & Natural Orographic Wintertime clouds: the Idaho Experiment

- National Science Foundation funded SNOWIE to study winter precipitation processes (\$2.1M)
- Goal:
 - further understand natural and dynamic winter precipitation processes
 - determine physical processes by which cloud seeding effects winter precipitation
- 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
 - WMI - Research seeding aircraft
 - WMI - Ice nuclei counter
- A Second NSF grant awarded to continue analyzing data from 2017



SNOWIE IOP

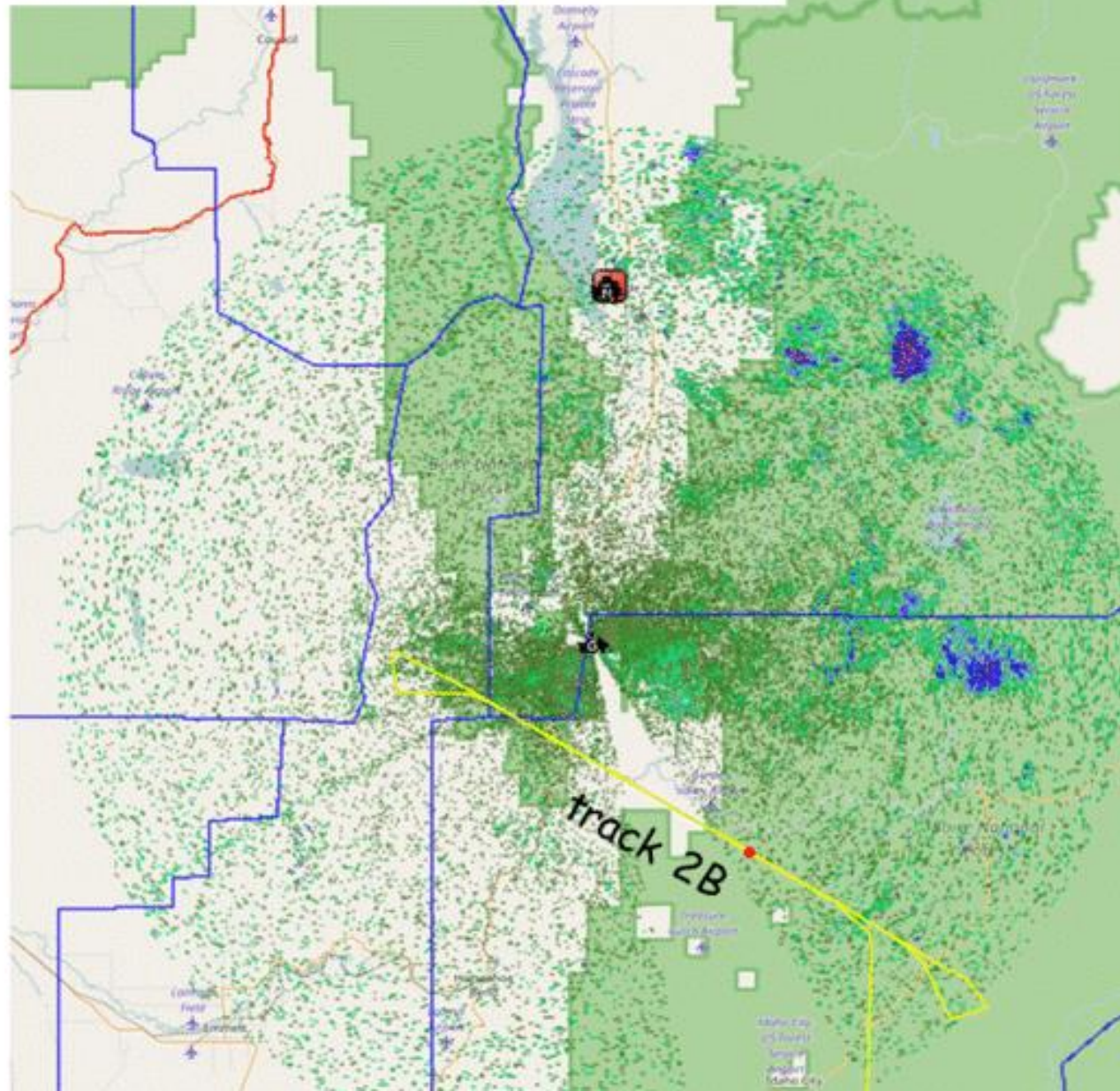
Seeded and Natural Orographic Wintertime clouds - the Idaho Experiment
Intensive Observation Period



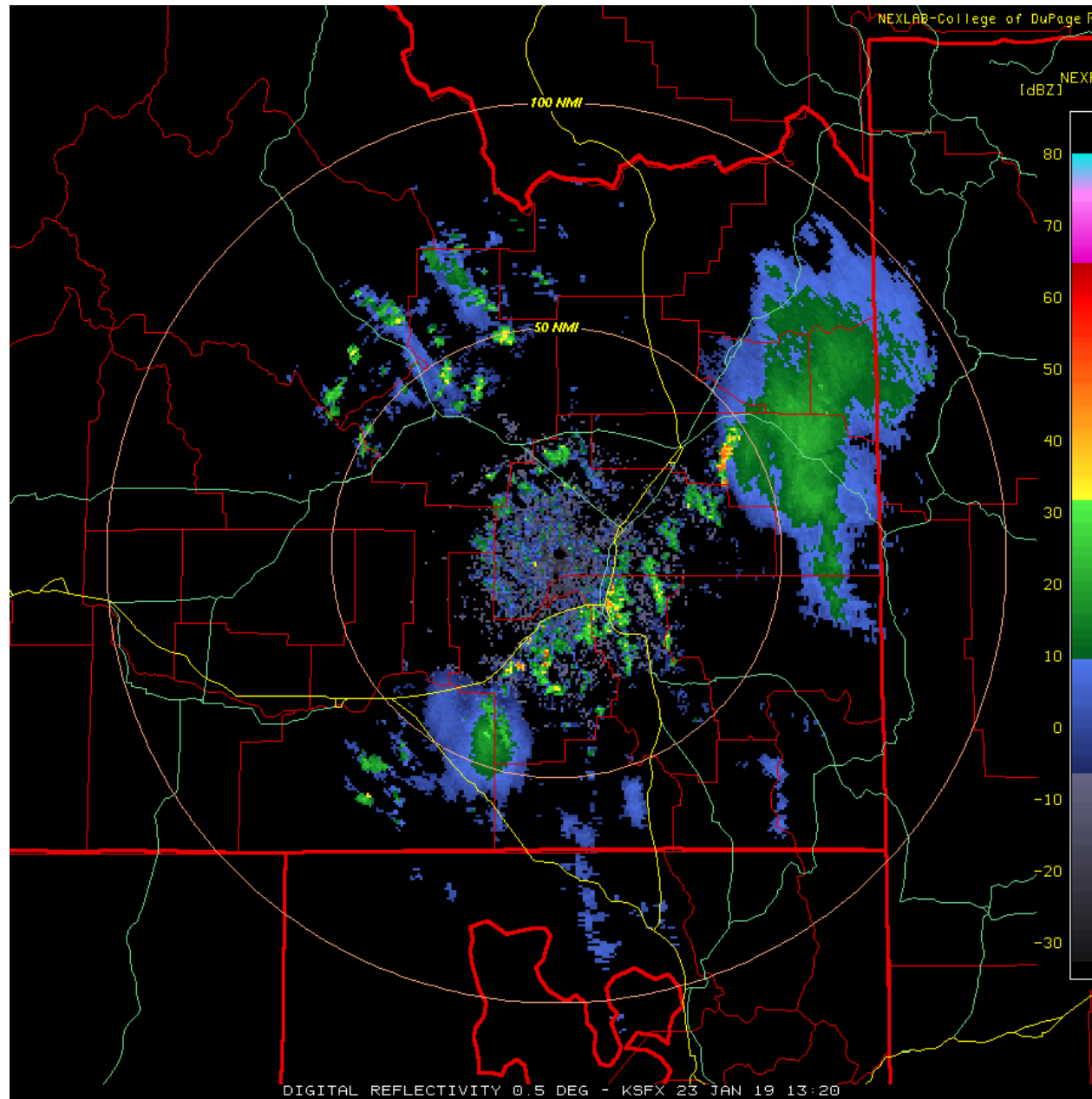
DOW7-DBZ: 1.99952 deg 2017/01/20 00:24:45

19 Jan 2017

DOW reflectivity + seeding aircraft track



Pocatello NWS Radar





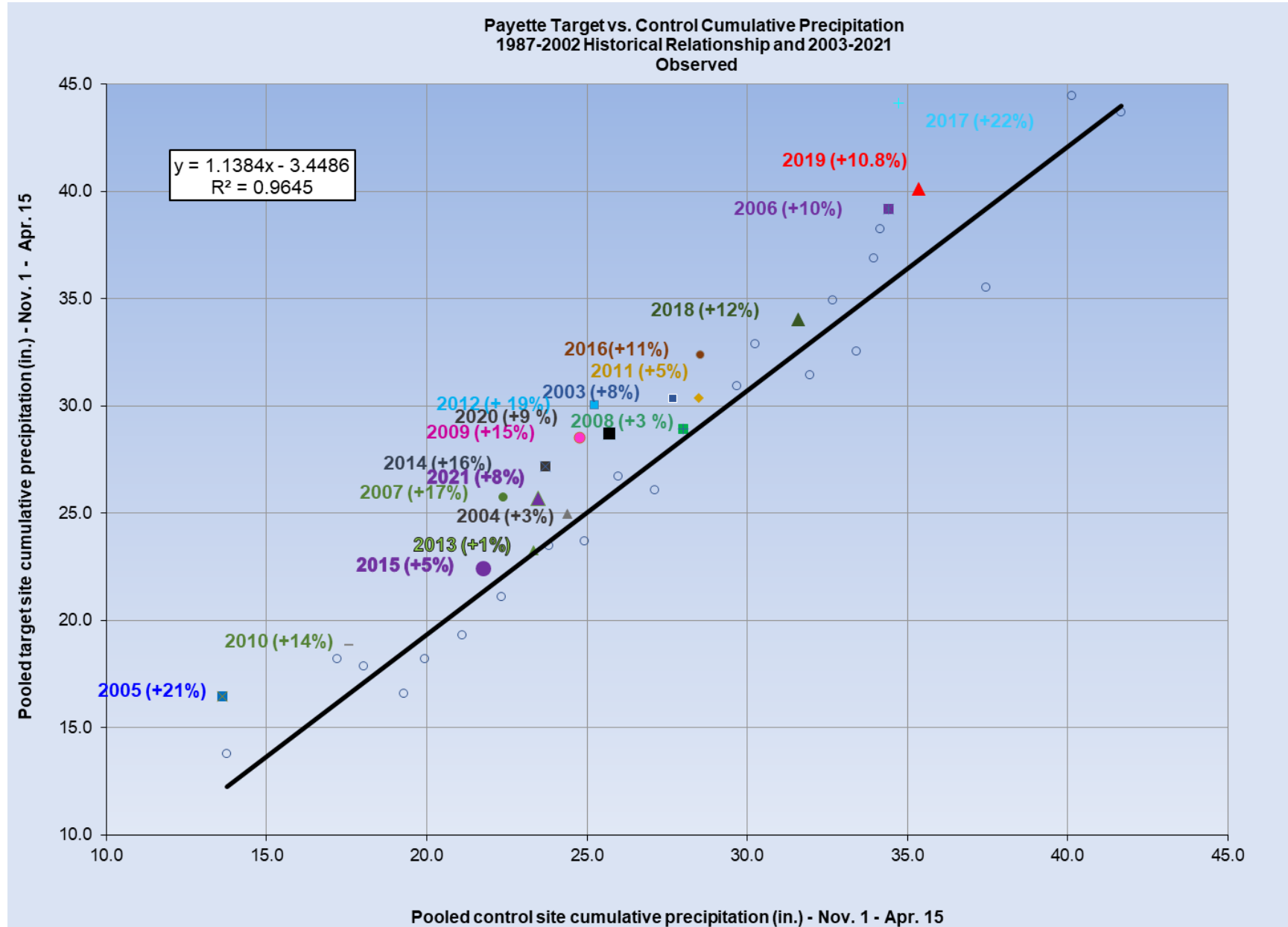
Methods to estimate annual precipitation enhancement from cloud seeding

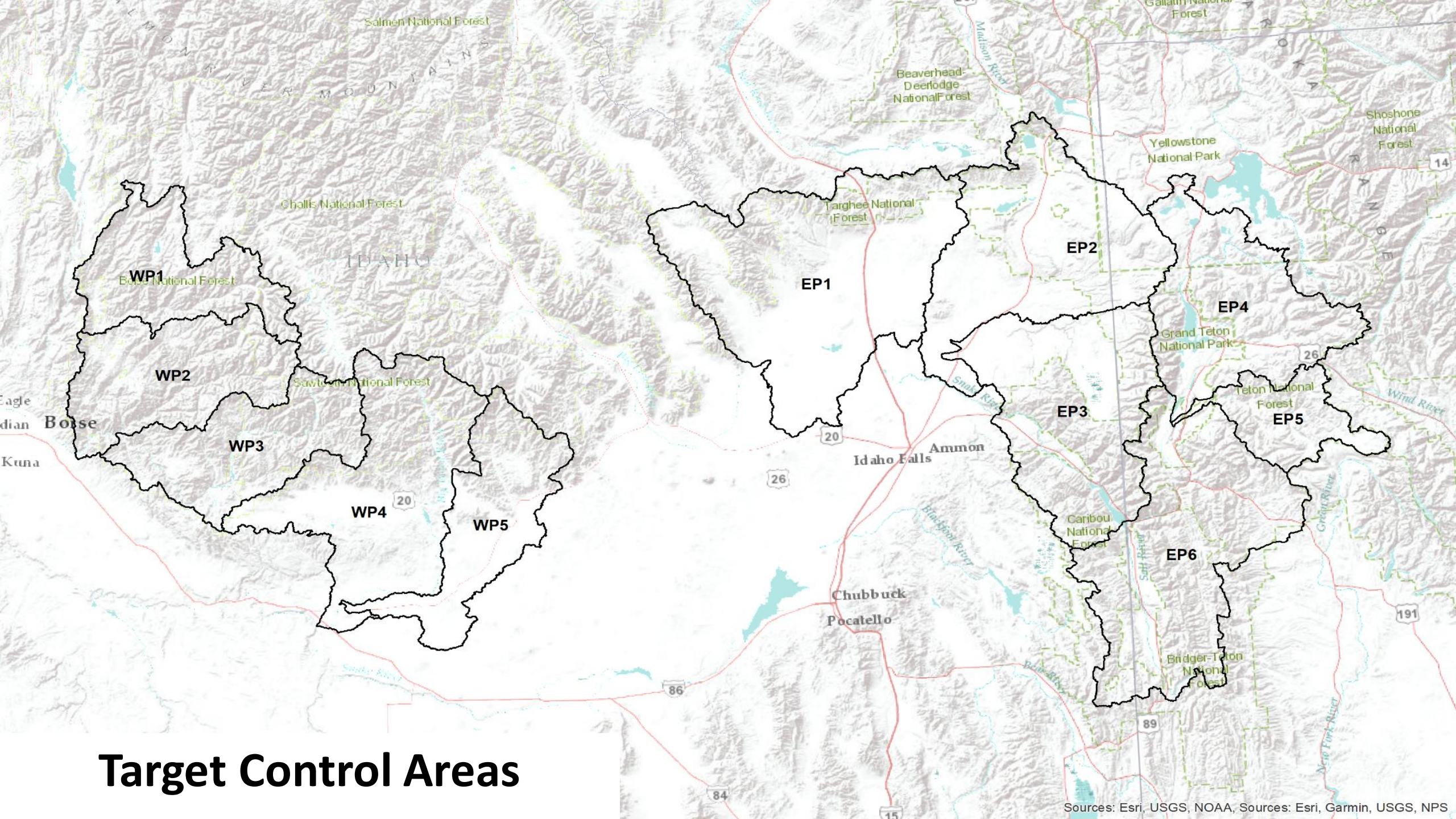


Two Primary Methods

1. Target-Control Analysis
2. NCAR Weather Forecasting and Research (WRF) Weather Modification Module (WxMod).

Target Control





Target Control Areas

Basin Wide Target Control Results

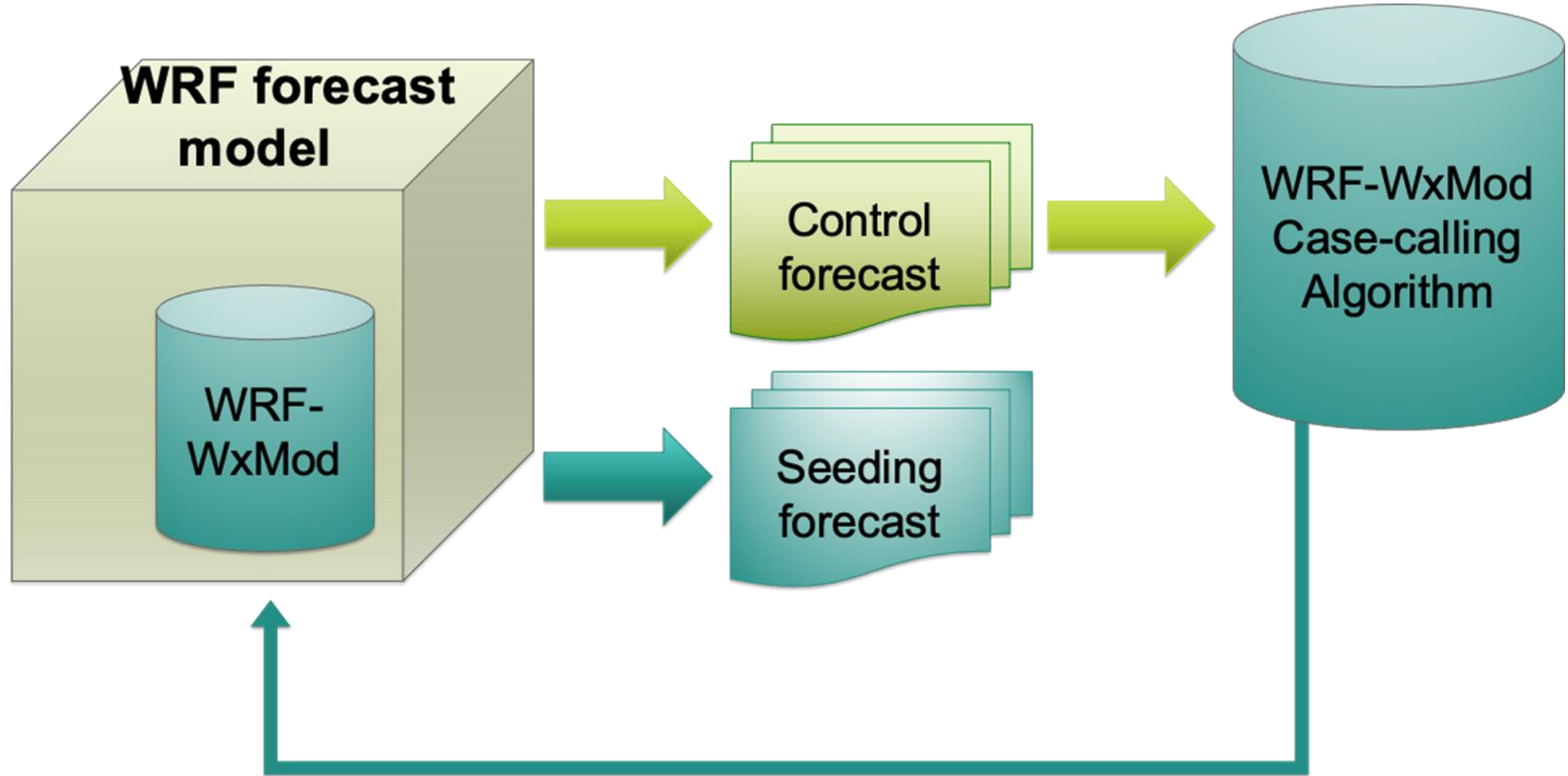
November 1 - April 1

	Payette	Boise		Wood		Henrys Fork		Upper Snake			
Year	WP1	WP2	WP3	WP4	WP5	EP1	EP2	EP3	EP4	EP5	EP6
2003	8%										
2004	3%										
2005	19%										
2006	12%										
2007	14%										
2008	4%					2%	3%	3%	3%	3%	3%
2009	16%					6%	8%	12%	10%	11%	9%
2010	16%					3%	4%	13%	13%	13%	9%
2011	7%					6%	7%	9%	8%	8%	8%
2012	18%					3%	4%	14%	14%	14%	9%
2013	1%	4%	3%	10%	9%	2%	3%	8%	7%	8%	5%
2014	15%	24%	22%	11%	10%	3%	5%	11%	10%	11%	8%
2015	5%	15%	14%	13%	12%	3%	4%	12%	10%	11%	7%
2016	14%	8%	7%	8%	8%	4%	6%	5%	5%	5%	6%
2017	21%	21%	19%	16%	15%	9%	11%	12%	10%	11%	11%
2018	15%	12%	11%	9%	8%	6%	9%	8%	7%	8%	8%
2019	15%	10%	9%	11%	10%	6%	8%	17%	14%	15%	11%
2020	6%	7%	7%	7%	6%	5%	8%	10%	9%	9%	8%
2021	8%	10%	9%	9%	7%	4%	5%	9%	8%	9%	7%
2022	7%	7%	6%	6%	7%	5%	4%	6%	6%	6%	5%
2023	17%	18%	19%	12%	15%	9%	11%	14%	13%	11%	11%
Average	11.5%	12.3%	11.4%	10.2%	9.7%	4.8%	6.2%	10.2%	9.2%	9.6%	7.9%

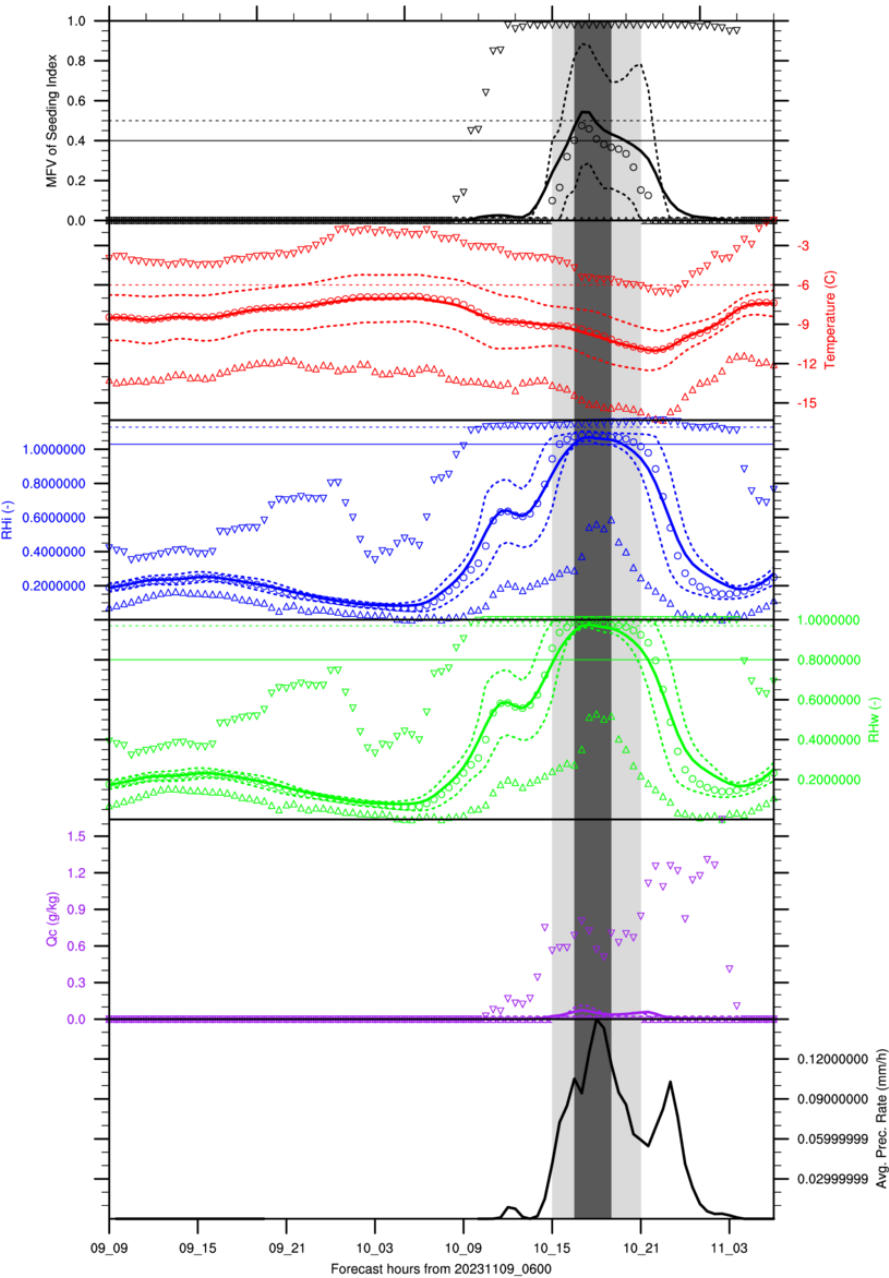
NCAR WRF-WxMod

- Provides a physically based approach to estimating changes in precipitation within a storm for cloud seeding operations.
- Uses High Resolution WRF data (1.8km for IPC) to identify atmospheric conditions and determines if they are suitable for cloud seeding, either by aircraft or ground generator.
- Two different modes operation
 - Case Calling to support operations
 - Benefit estimates

NCAR WRF-WxMod



Ex: WRF-WxMod Output (partial)



No ground seeding for NEID

For NEID, number of suitable airborne seeding period[s]: 1

Period 1 ranges from 2023-11-10_13:00:00 to 2023-11-10_21:30:00

Best case of period 1 seeds from 2023-11-10_15:30:00 to 2023-11-10_18:00:00 at track 12BN

No higher airborne seeding for NEID

**** WRF-WxMod is still a work in progress, it is very useful for operations support in case calling but does not appear to accurately produce cloud seeding benefits in an operational mode.**

Questions?

