

A Comparison of Weather and Research Forecast Model Precipitation Forecasts versus Observed SNOTEL Precipitation

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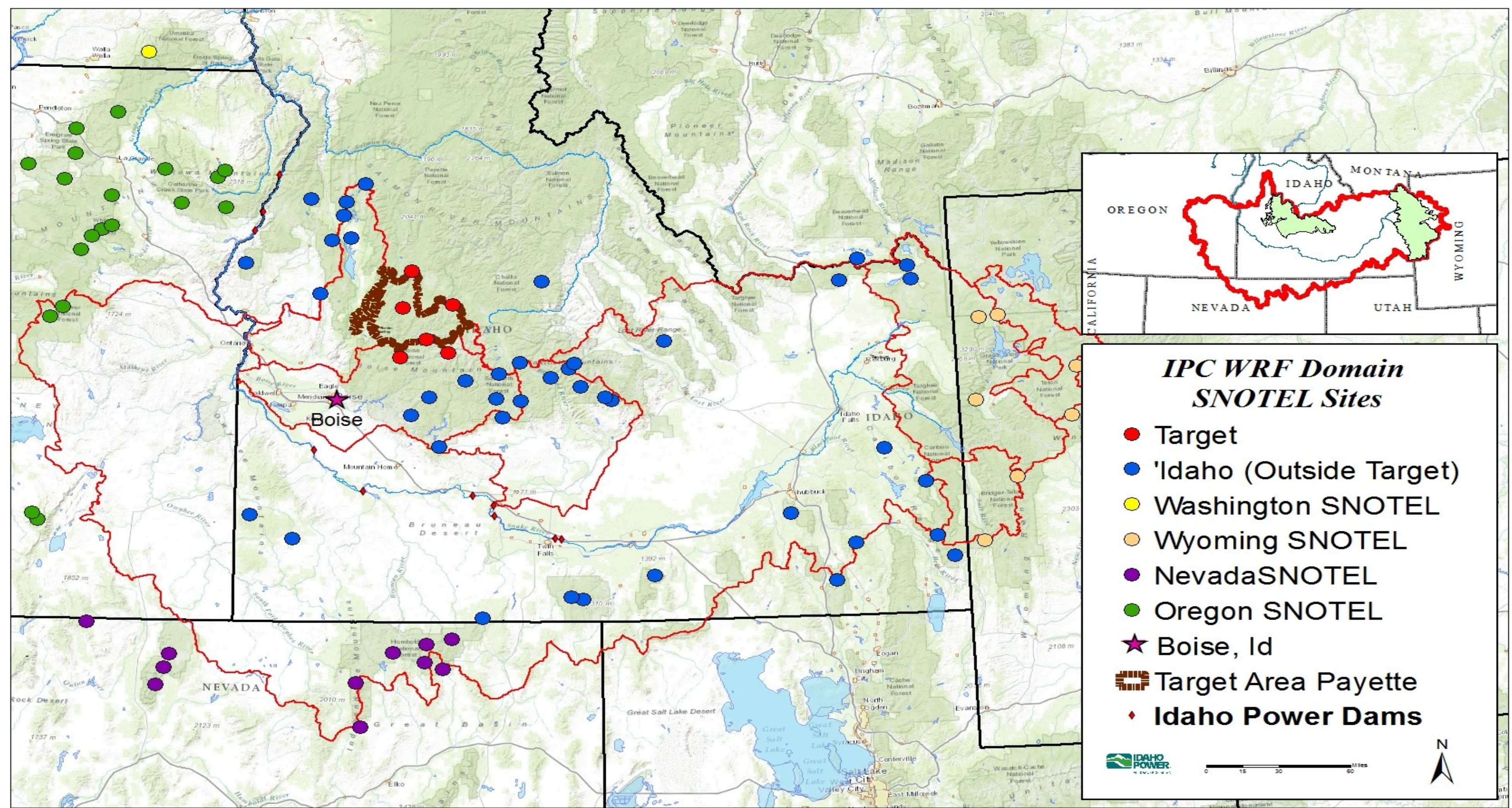
1. Idaho Power Company, 2. Weather Modification Incorporated 3. Boise State University



Introduction

The Idaho Power Company (IPC) Atmospheric Science group is responsible for weather support to IPC Load Service Operations, Operations Hydrology, Stream Gauging, and Reliability groups. The support consists of cloud seeding operations and forecasts, temperature and precipitation forecasts for the River Forecast System (RFS), wind farm power forecasts, load and solar forecasts, and forensic meteorology.

IPC is a hydroelectric based utility serving customers throughout southern Idaho and eastern Oregon. Knowledge of the winter snowpack is critical to IPC operations and the company uses the RFS model to predict flows along the Snake River to optimize hydroelectric operations. A significant portion of the observation network in the mountains is from 89 SNOW TELemetry (SNOTEL) sites (Figure 1) spread across a 6 state region. The RFS also uses 6 hourly forecasts of temperature and precipitation obtained from a 1.8 kilometer resolution Weather and Research Forecast (WRF) model run at the University of Arizona.



Data

The daily (midnight to midnight) WRF-GFS forecast precipitation values were accumulated from Nov 1 through Mar 31. WRF-NAM forecast data was used to augment the data if WRF-GFS model runs were not available. In Water Year 2012, WRF used the WDM6 microphysics scheme but with upgrade to WRF version 3.3.1 the microphysics changed to SBU-YLIN for the subsequent years. Table 1 shows the sum of the error by year for precipitation forecasts for the SNOTEL sites. Both Water Years 2012 and 2014 had similar precipitation but there was a major reduction in error most likely related to the different microphysics package. SNOTEL data was obtained from the NRCS website.

Water Year	WRF (in)	Observed (in)	% Error
2012	22.49	19.33	16.3
2013	17.14	16.87	1.6
2014	20.82	20.02	4.0
2015	16.96	16.98	-0.2

Table 1. WRF and observed SNOTEL average precipitation for all 89 SNOTEL sites in the Snake River basin and percent error for the four water years.

Water Year Precipitation Results

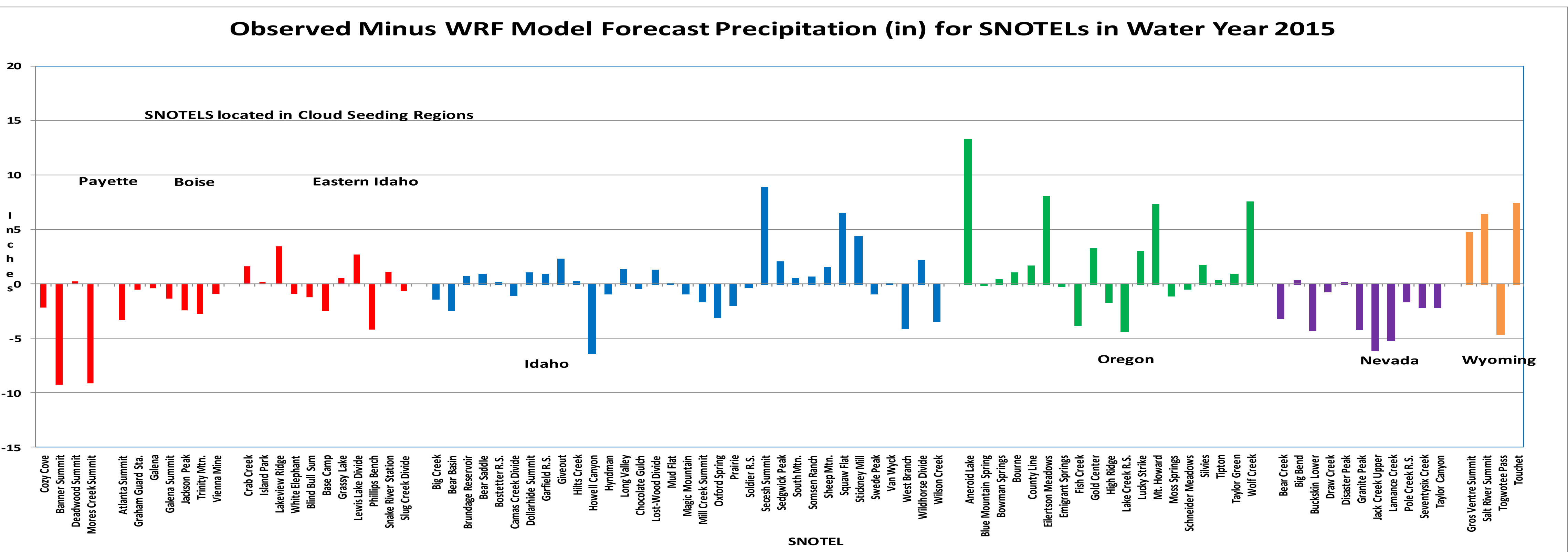
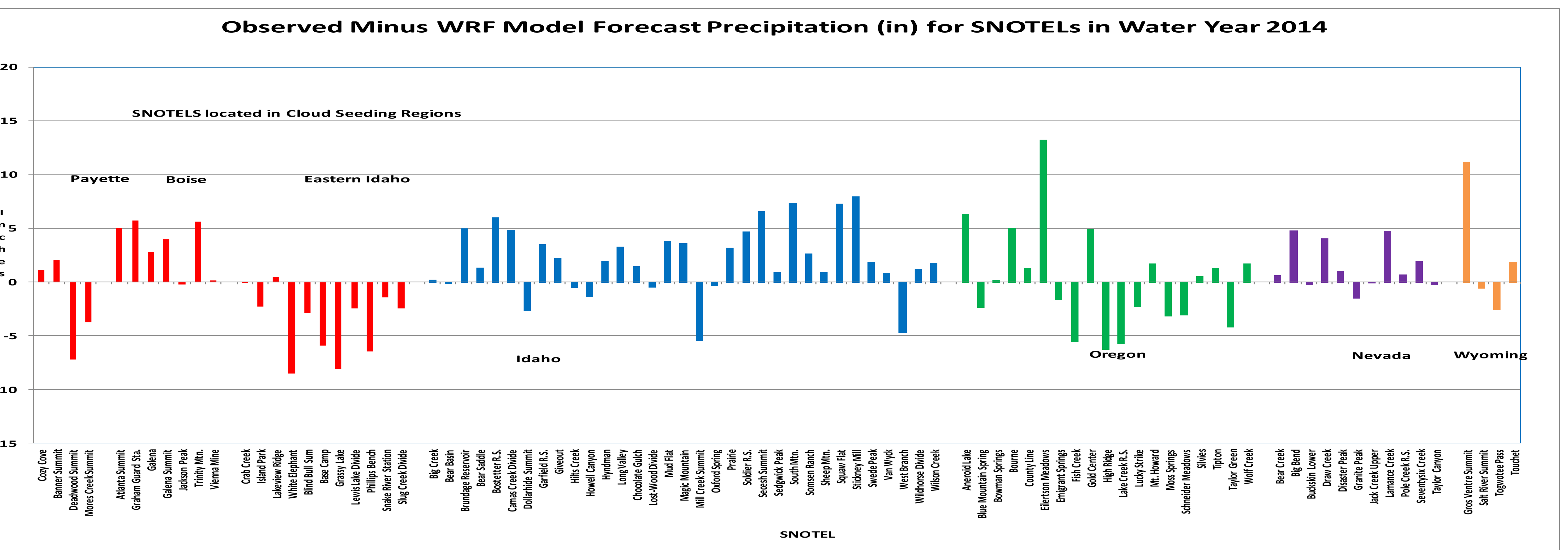
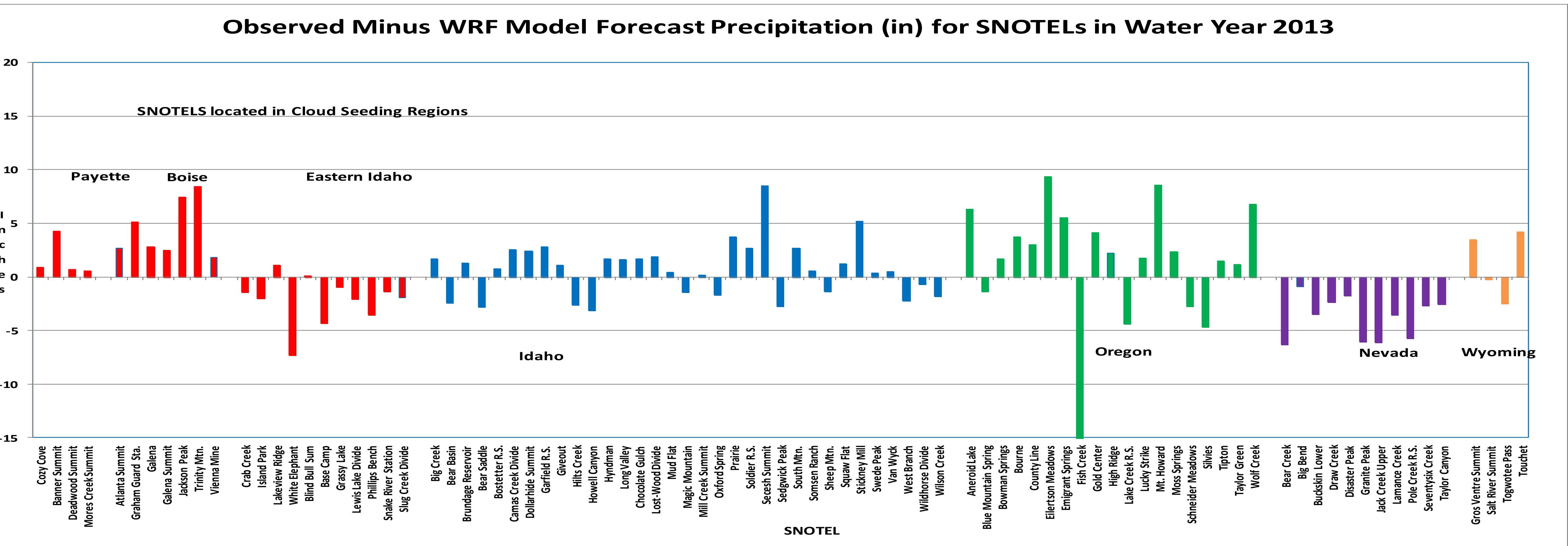
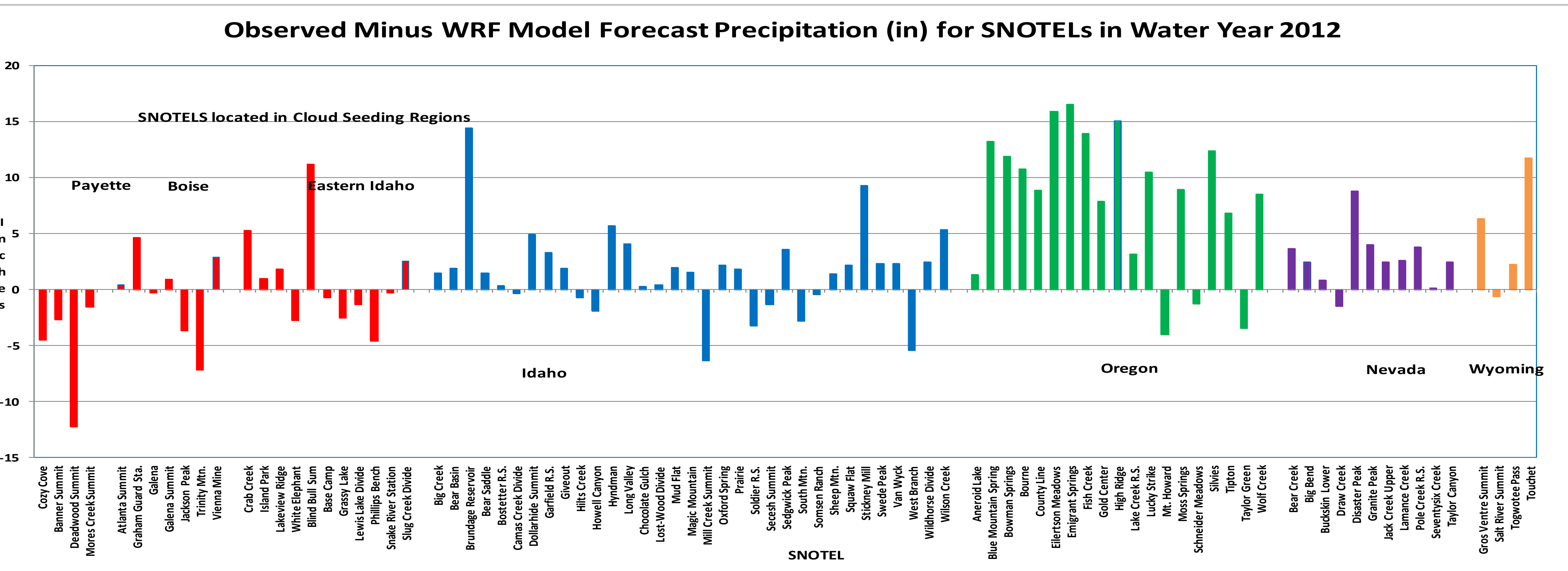


Figure 2. Observed minus WRF-GFS forecast precipitation for SNOTELs in the Snake River Plain for Nov1 through Mar 31 in WYs 2012-2015. Positive values indicate model forecast precipitation greater than

Discussion of Water Year Graphs

Cumulative seasonal WRF 24-hour precipitation forecasts are accurate with the following exceptions:

- Elevation of model forecast point is much lower/higher than SNOTEL or other complex terrain issues.
- Cloud seeding is being conducted.

SNOTEL observation errors:

- SNOTEL precipitation gauges become capped during periods of wet snow.
- Some SNOTEL pillow errors are:
- Melt at beginning and ending of season.
- Blowing and drifting snow.
- Ice covered pillow where new precipitation will not stay on the pillow.

In the river basins affected by cloud seeding (Payette, Boise, and Upper Snake), the model did not account for cloud seeding and underestimated the amount of precipitation. Average error for SNOTELs outside of these basins for WYs 2013-2015 was 5% (overestimation) while the average for the SNOTELs in the Payette was -7% (underestimation). **The delta in precipitation of 12% is similar to the ongoing results of an IPC target/control analysis...most of which is related to the IPC cloud seeding program.**

WRF versus SNOTEL/Geonor Precipitation Observations

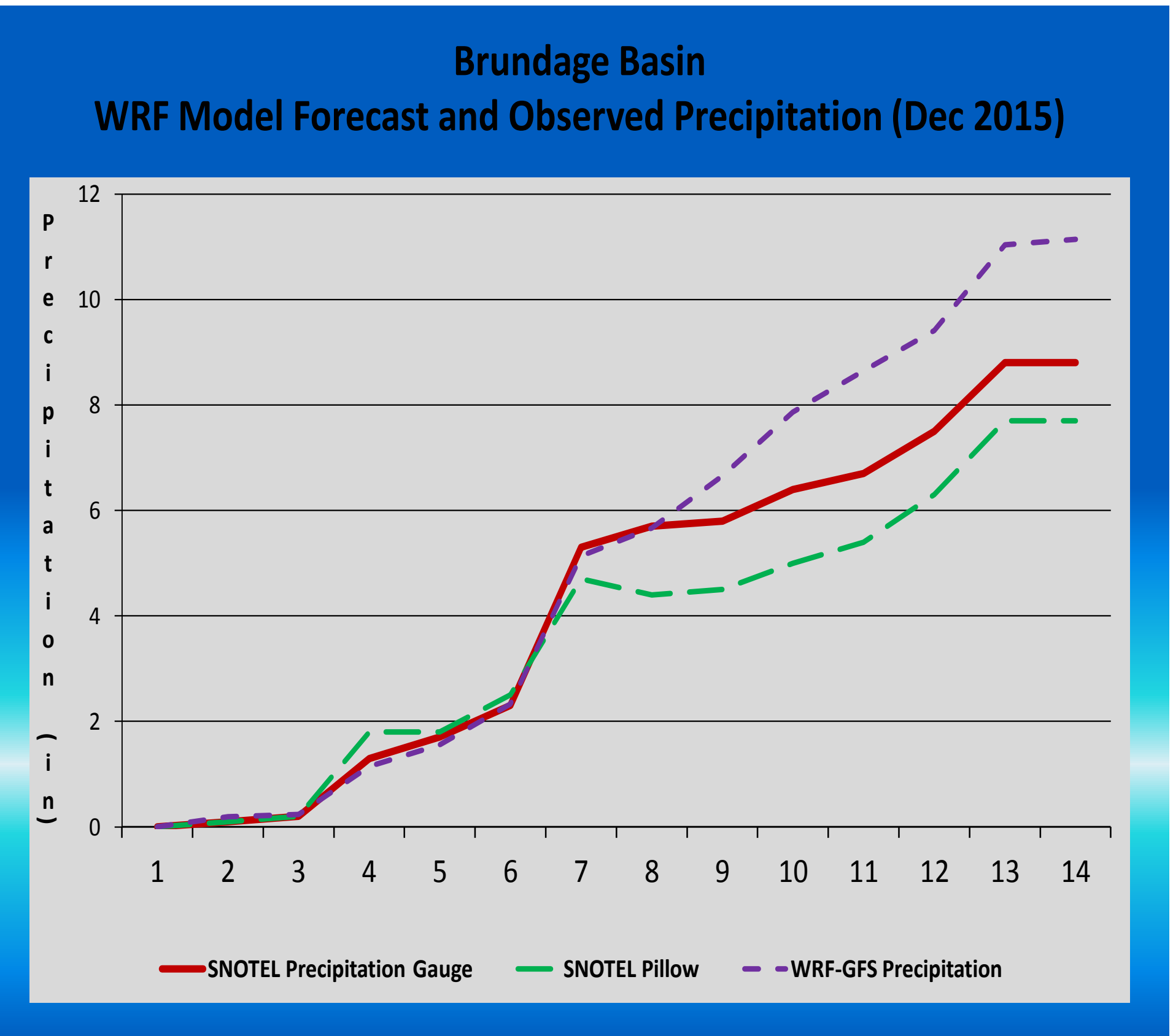
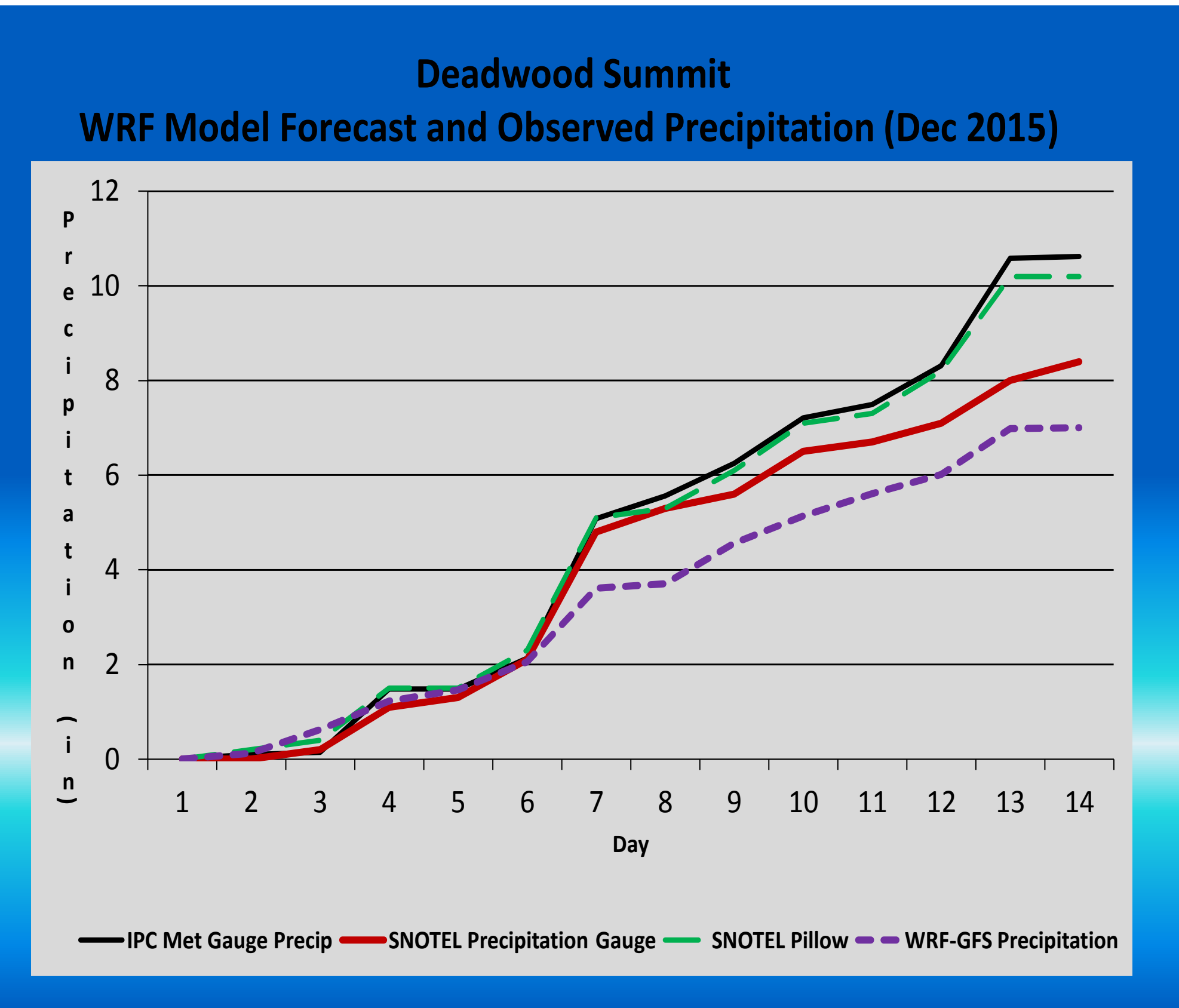
IPC has installed 7 high resolution Geonor precipitation gauges in the Payette River basin...three of which are collocated with SNOTEL gauges. Figure 2 (Deadwood Summit) and 3 (Brundage Basin) are observed and forecast data for the first 15 days of December 2015.

Deadwood Summit:

- No significant difference between SNOTEL pillow and IPC Geonor gauges.
- SNOTEL precipitation gauge capped with first storm.
- WRF-GFS 50%+ underestimation...model not compensating for seeding effect.

Brundage Basin:

- WRF-GFS forecast over 2 inches more than observed at the SNOTEL precipitation gauge.
- SNOTEL pillow data even farther behind due to ice covered pillow with wet snow not staying on pillow on Dec 7th.
- Since model precipitation was close to observed precipitation before Dec 7th,



Figures 3 and 4. Deadwood Summit/Brundage Basin WRF forecast and observed precipitation for first two weeks of December 2015

