Spatial Ensemble Post-Processing with Standardized Anomalies

Markus Dabernig, Georg J. Mayr,
Jakob W. Messner and Achim Zeileis

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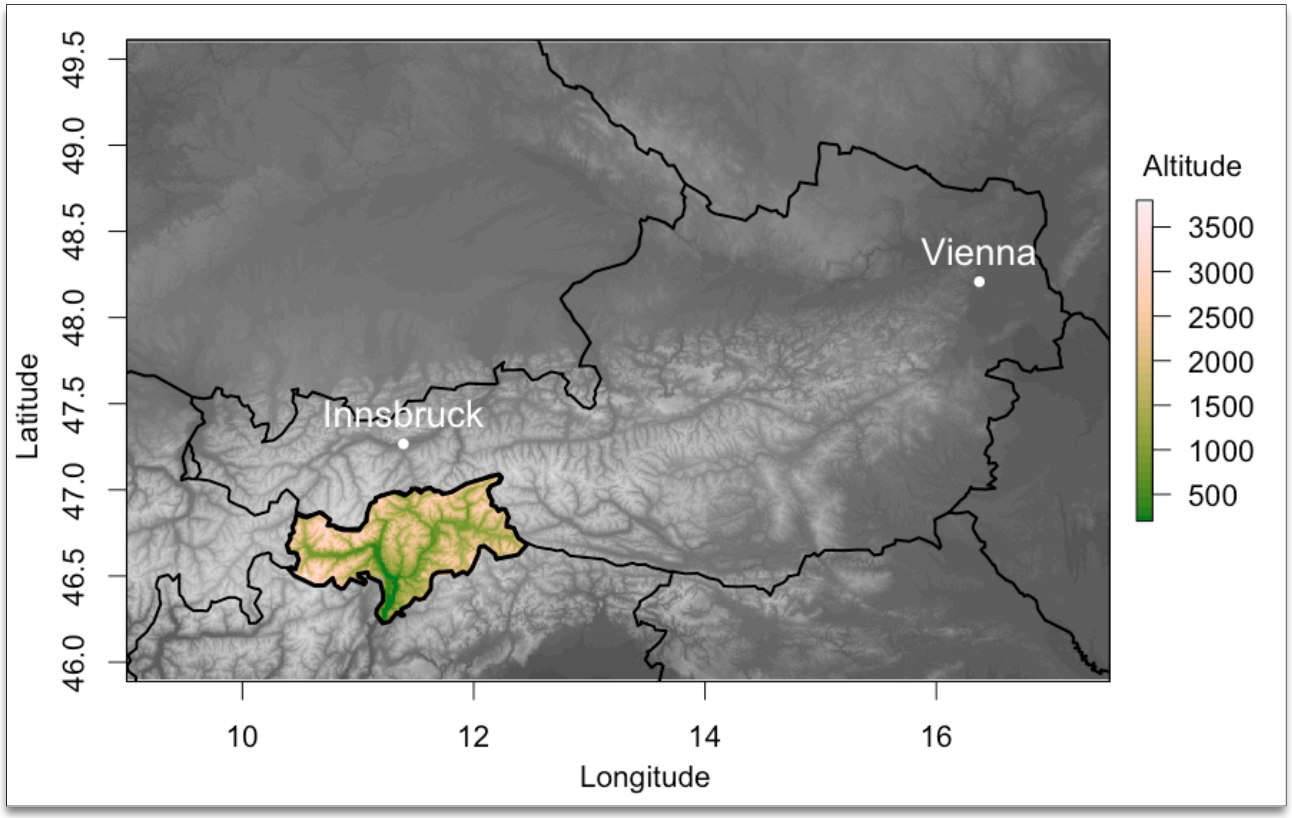
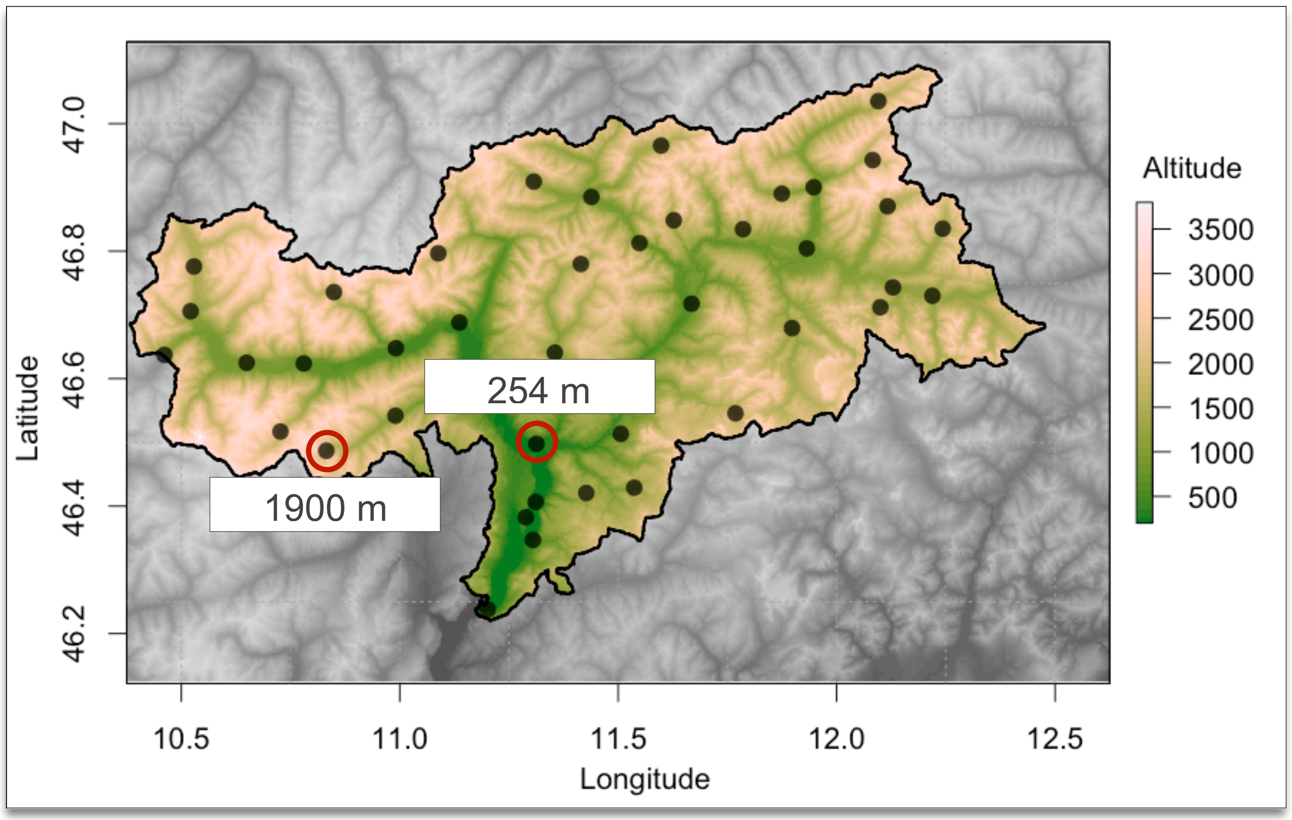
Motivation

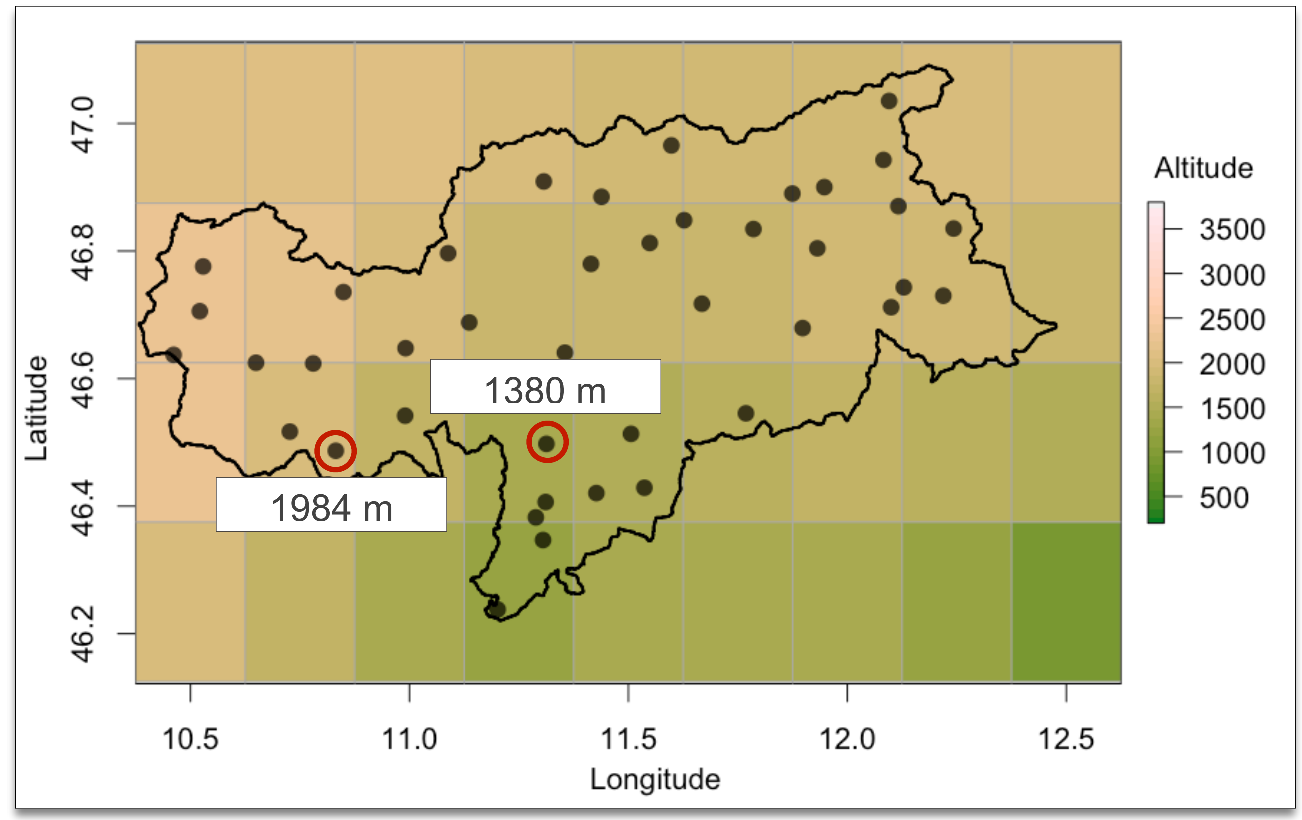


Altitude
3500
3000
2500
2000
1500
1000
500
Vienna
Innsbruck
Latitude
49.5
49.0
48.5
48.0
47.5
47.0
46.5
46.0
10
12
14
16
Longitude

Motivation



Topography



ECMWF ensemble topography (0.25°)

- 18 UTC temperature measurements from automatic weather stations
- + 18 h ECMWF ensemble temperature forecasts, 00 UTC run

Ensemble Model Output Statistics (EMOS)

$$y \sim N(\mu, \sigma)$$

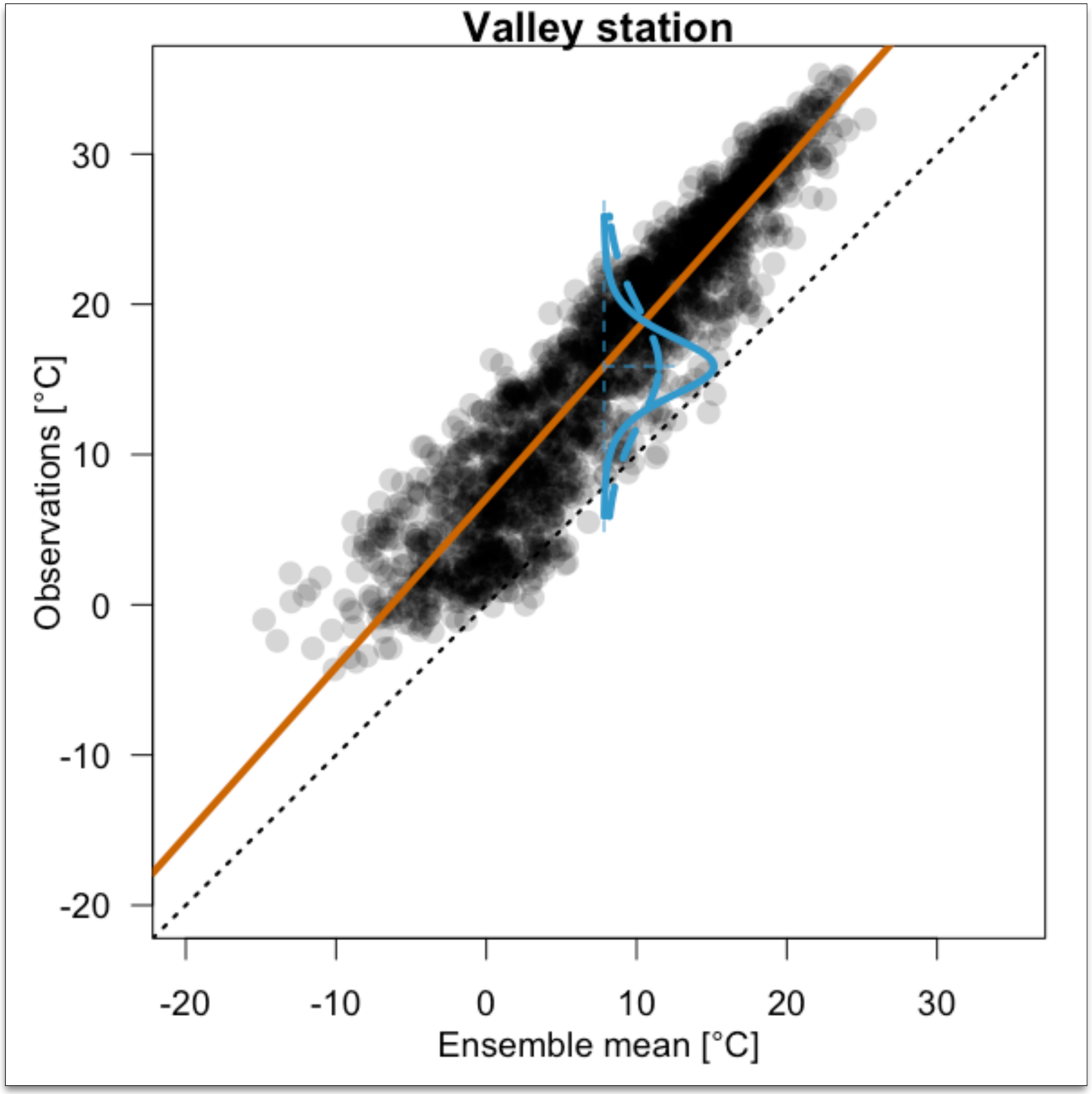
$$\mu = b_0 + b_1 m$$

$$\log(\sigma) = c_0 + c_1 \log(s)$$

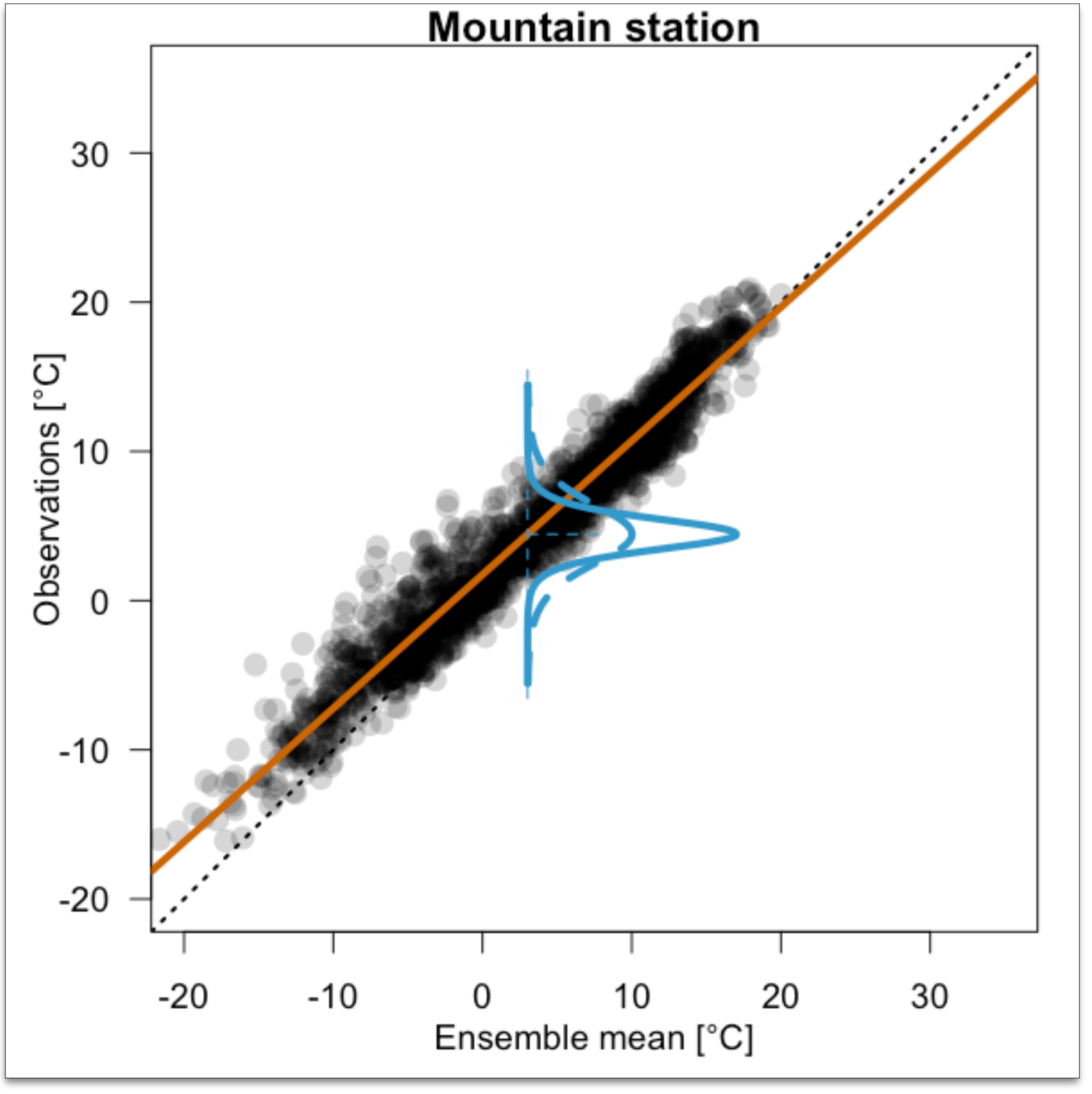
y...Observations

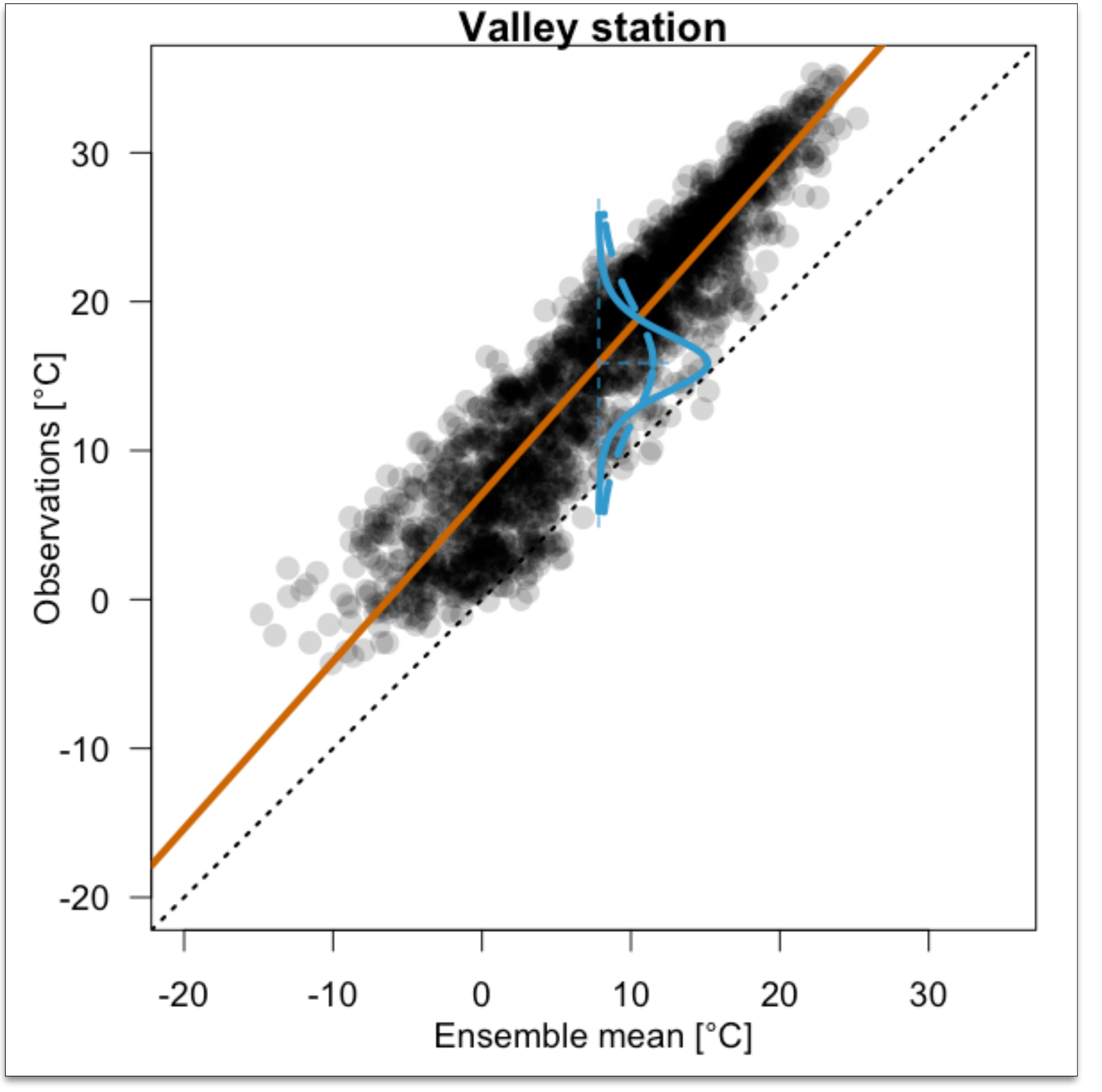
m...Ensemble mean

s...Ensemble spread



Ensemble Model Output Statistics (EMOS)





Standardized Anomaly Model Output Statistics—SAMOS

$$\frac{y - \mu_y}{\sigma_y} \sim N(\mu, \sigma)$$

$$\mu = b_0 + b_1 \frac{m - \mu_m}{\sigma_m}$$

$$\log(\sigma) = c_0 + c_1 \frac{\log(s) - \mu_{\log(s)}}{\sigma_{\log(s)}}$$

$\mu_{y,m,\log(s)}$...Climatological mean

$\sigma_{y,m,\log(s)}$...Climatological standard deviation

Standardized Anomaly Model Output Statistics—SAMOS

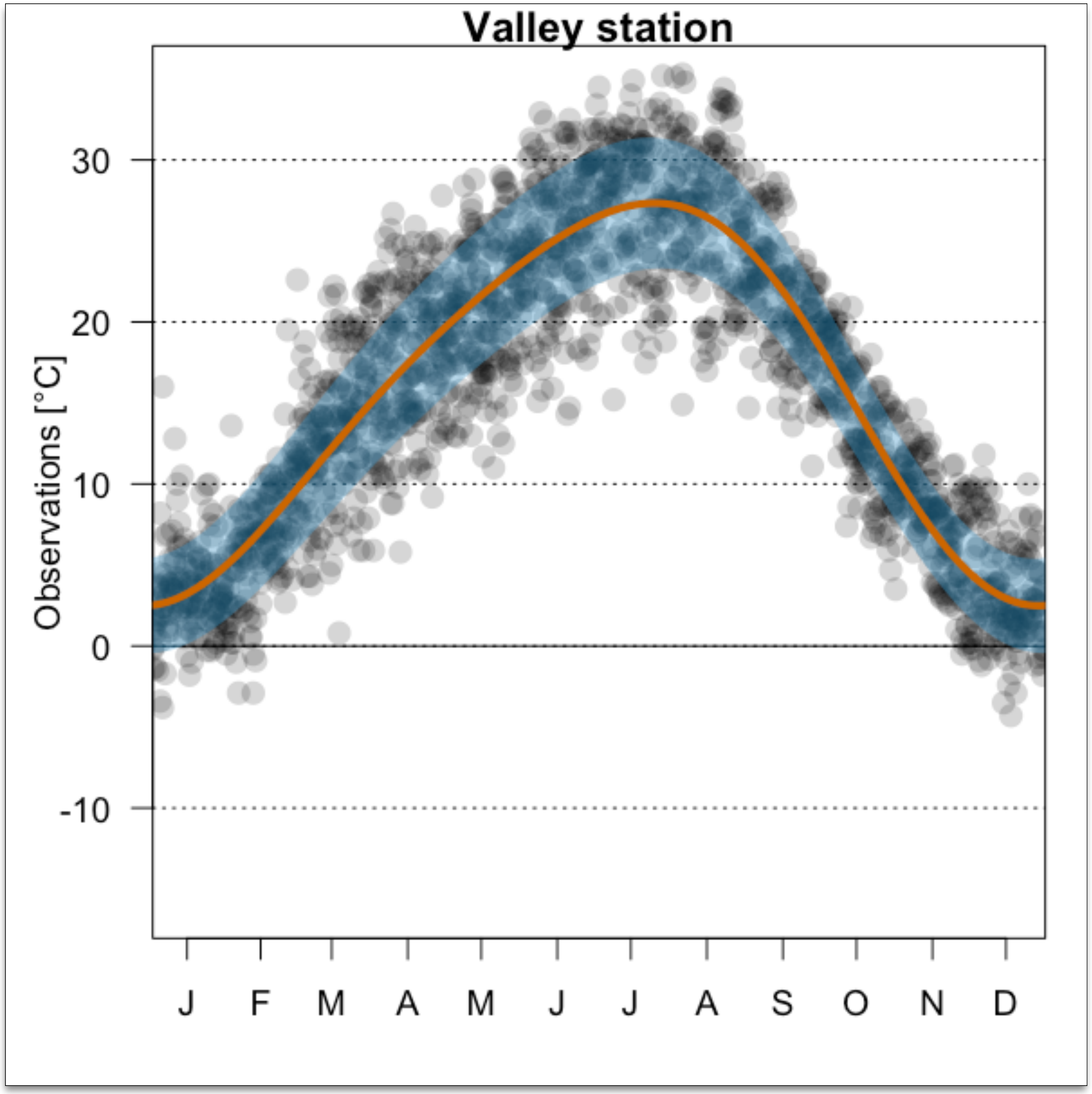
Generalized Additive Model for Location, Scale and Shape:

$$y \sim N(\mu_y, \sigma_y)$$

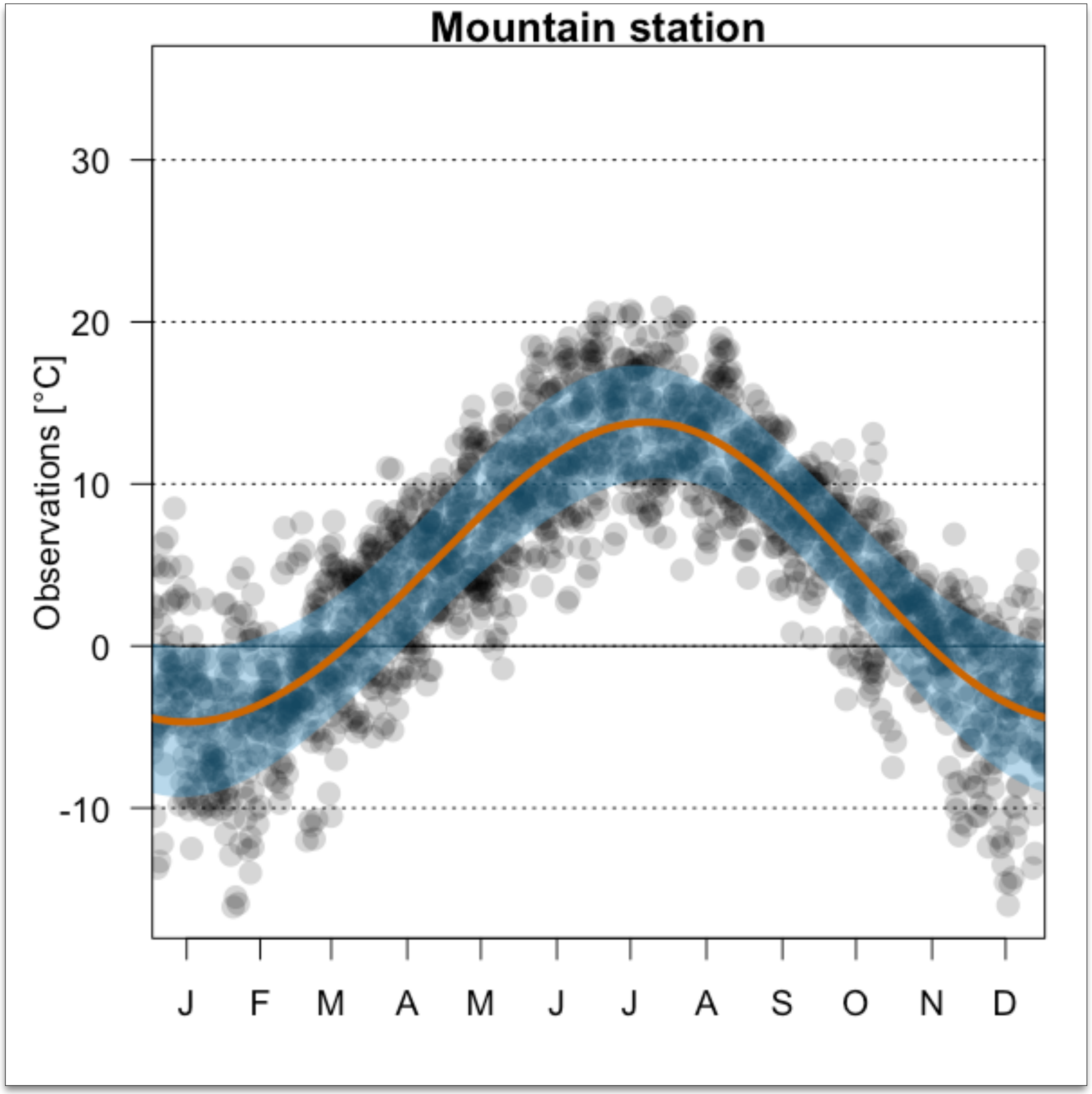
$$\mu_y = \beta_0 + f(\text{Season})$$

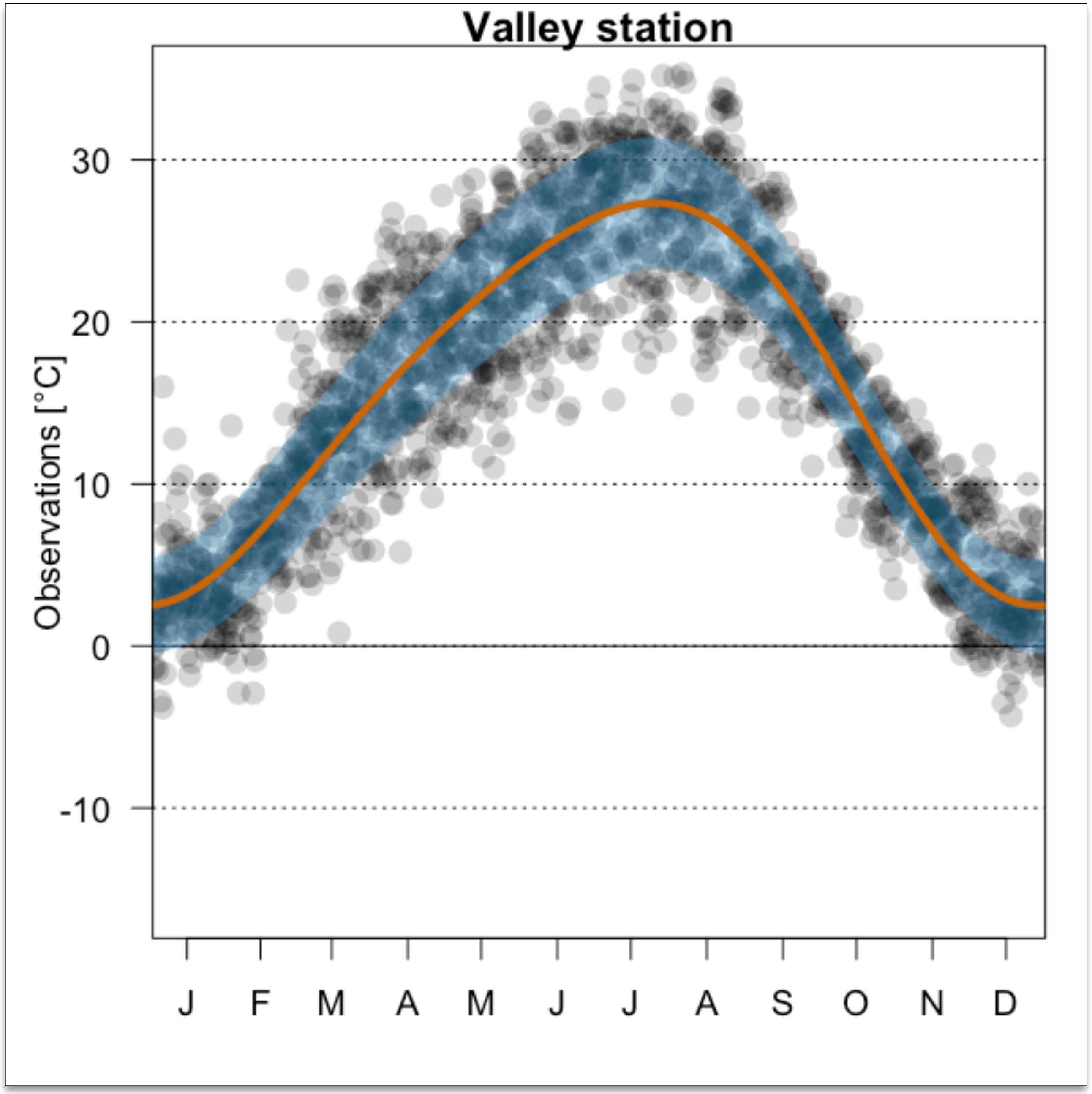
$$\log(\sigma_y) = \gamma_0 + g(\text{Season})$$

f, g...non linear function

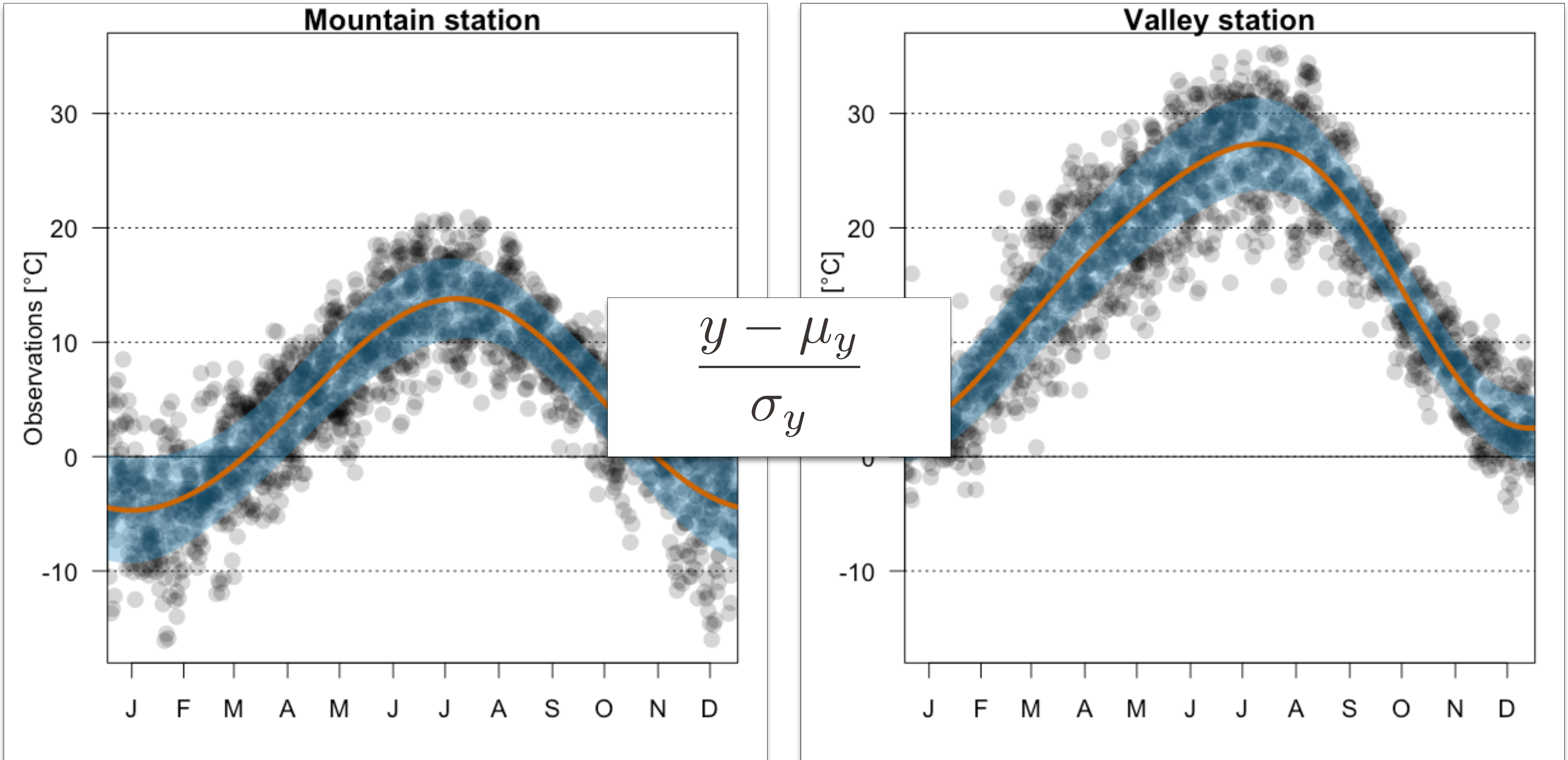


Standardized Anomaly Model Output Statistics—SAMOS



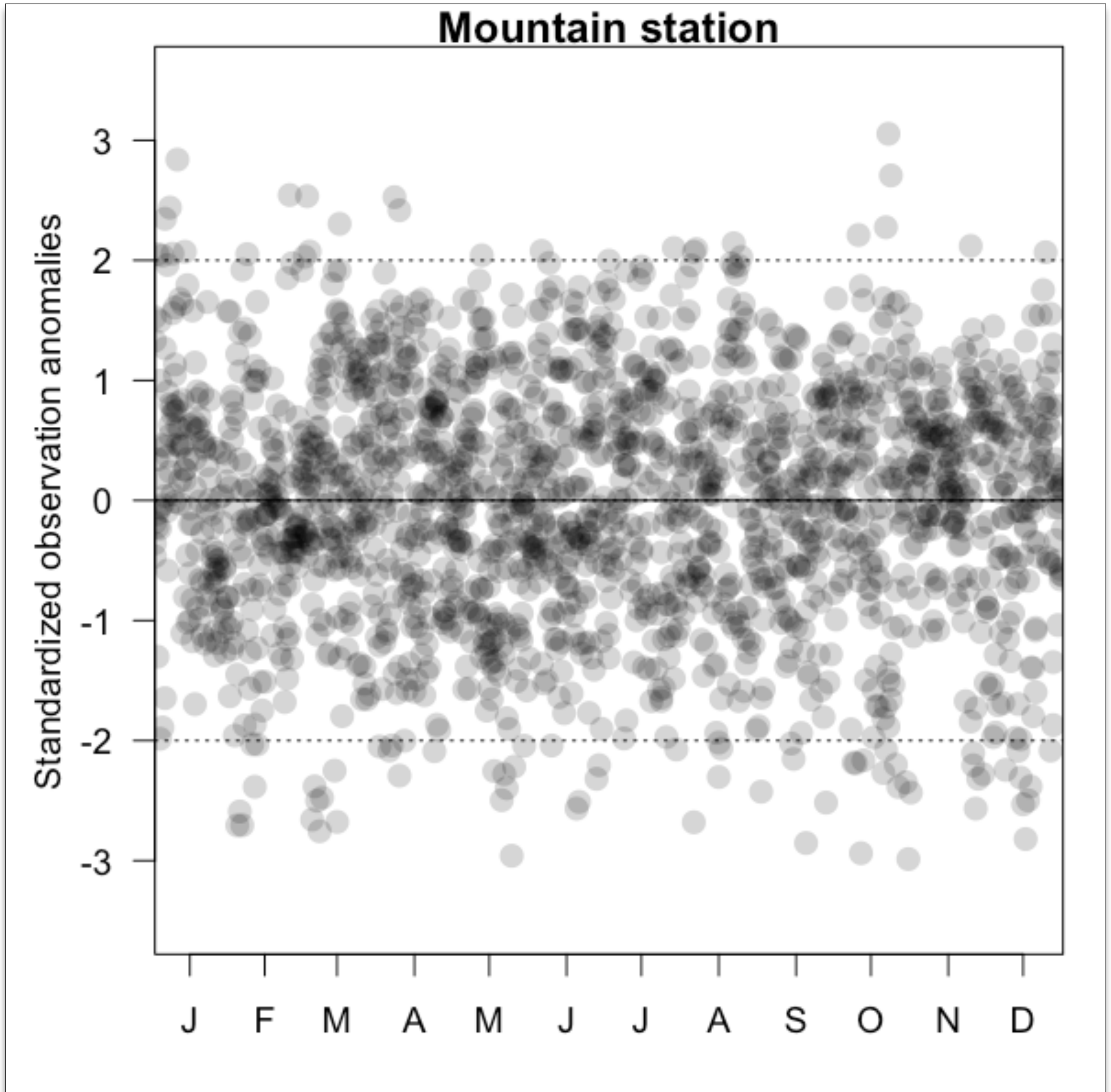


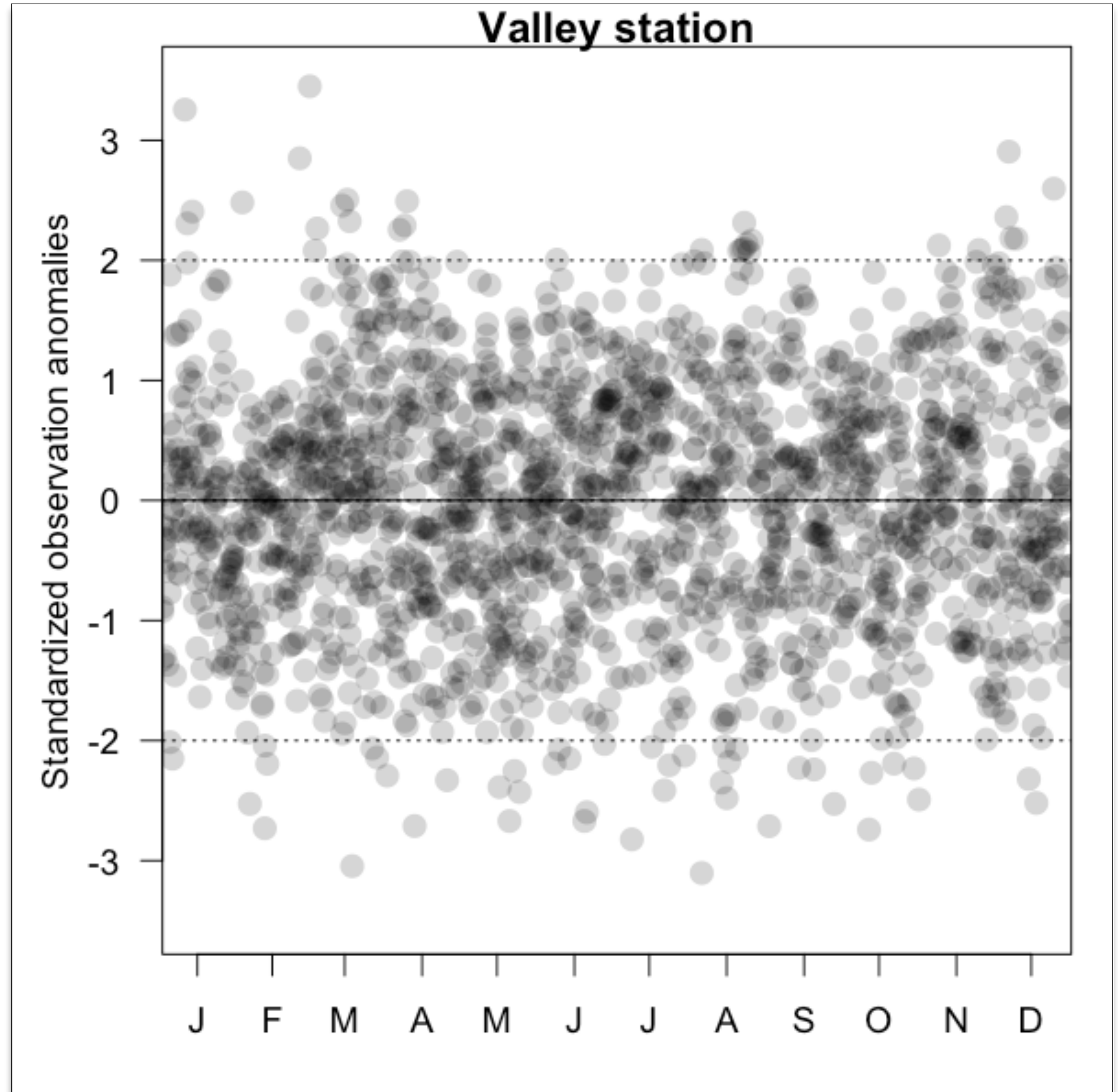
Standardized Anomaly Model Output Statistics—SAMOS



$$\frac{y - \mu_y}{\sigma_y}$$

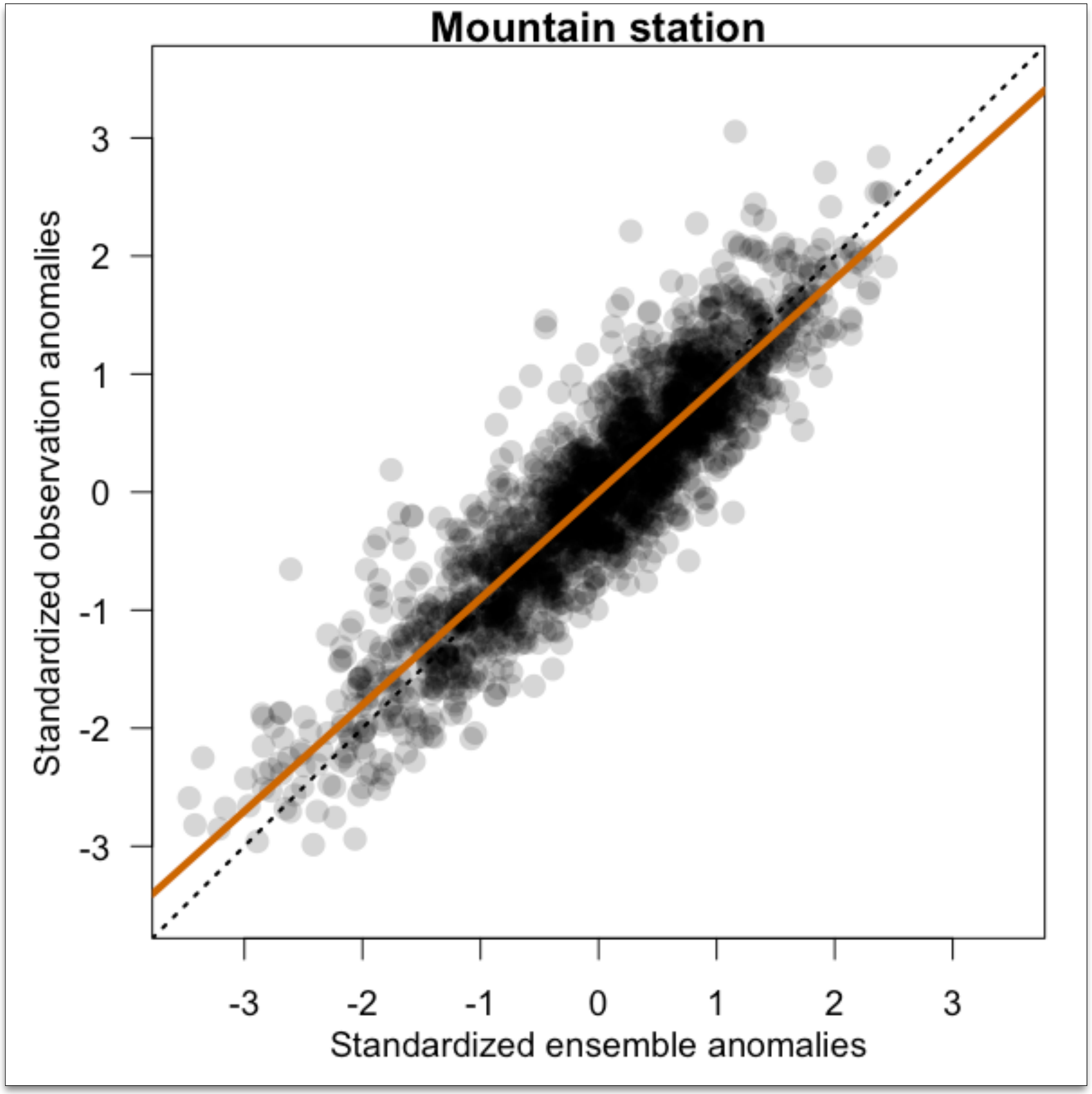
Standardized Anomaly Model Output Statistics—SAMOS

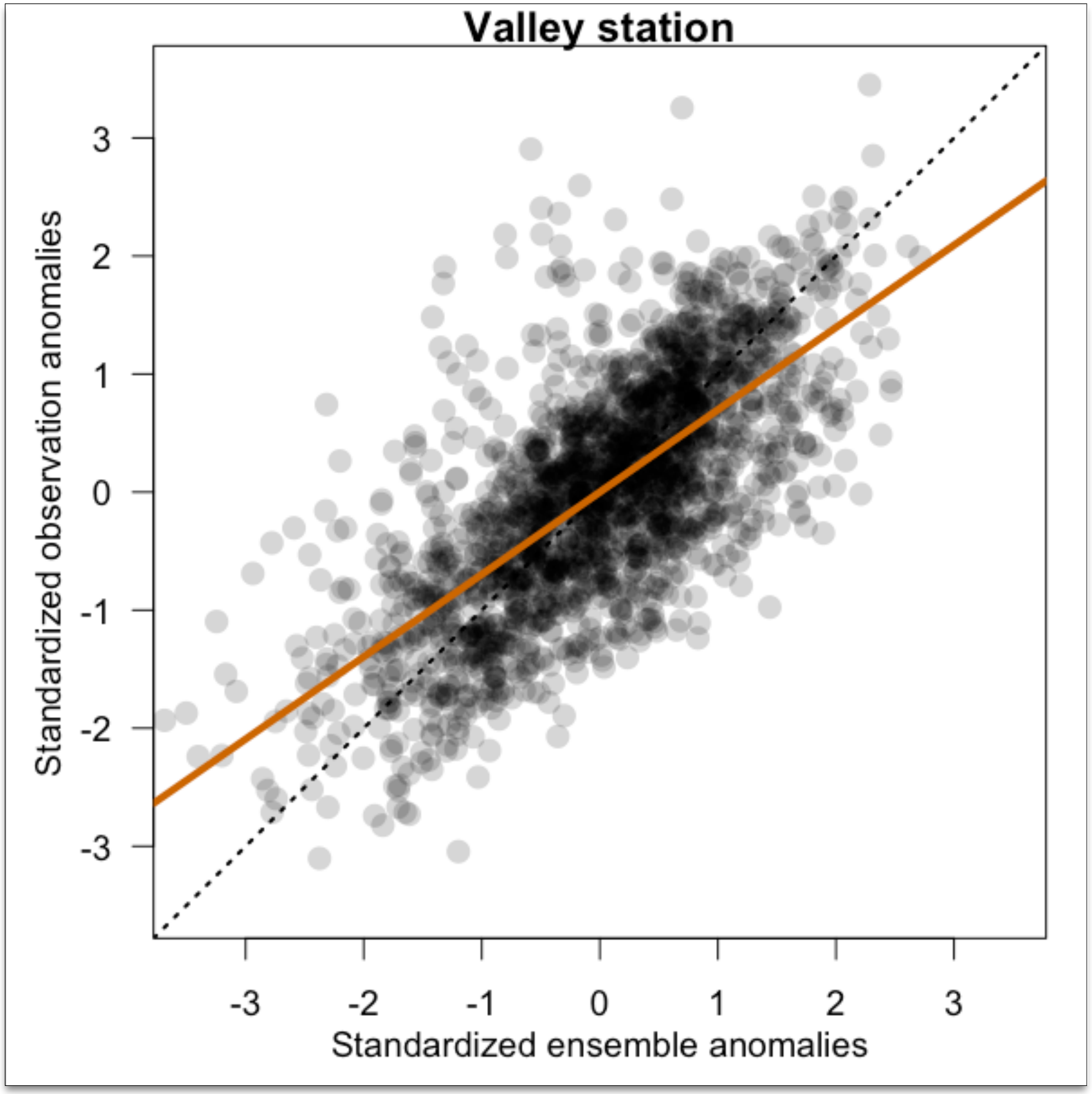




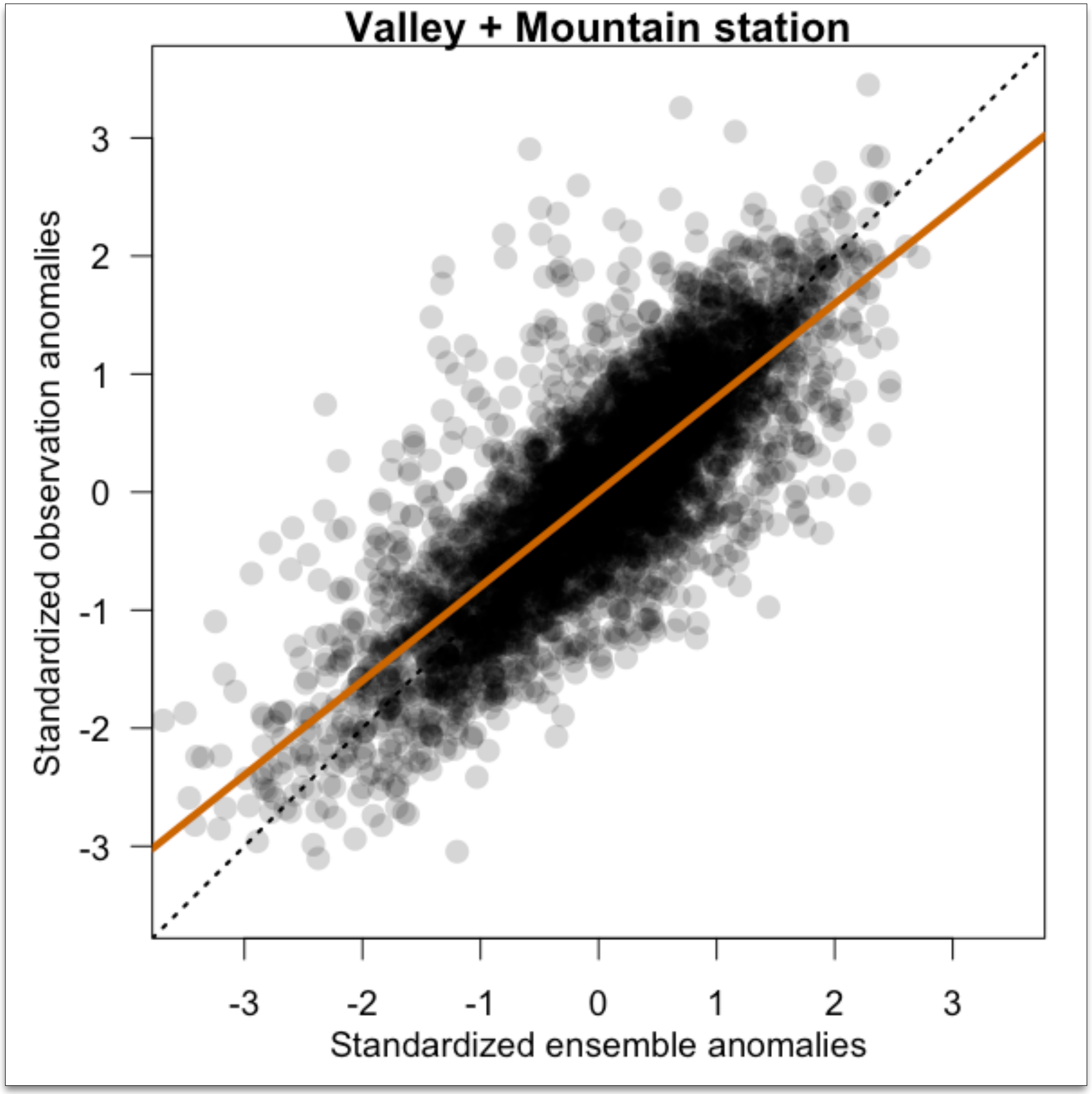
season- and **site-specific** characteristics are removed

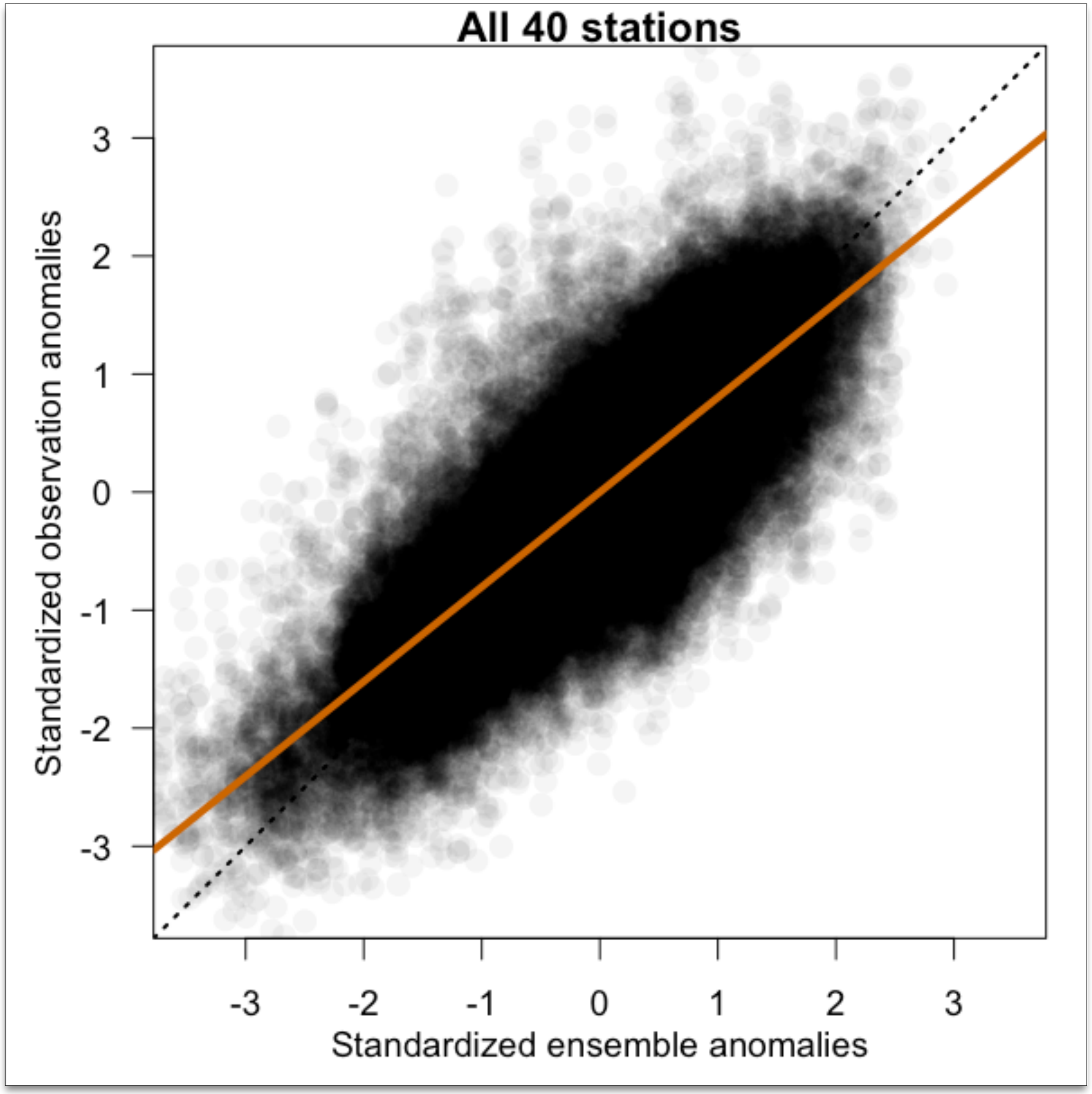
Standardized Anomaly Model Output Statistics—SAMOS





Standardized Anomaly Model Output Statistics—SAMOS





Standardized Anomaly Model Output Statistics—SAMOS

$$\frac{y - \boxed{\mu_y}}{\boxed{\sigma_y}} \sim N(\mu, \sigma)$$

$$\mu = \boxed{b_0 + b_1 \frac{m - \mu_m}{\sigma_m}}$$

$$\log(\sigma) = \boxed{c_0 + c_1 \frac{\log(s) - \mu_{\log(s)}}{\sigma_{\log(s)}}}$$

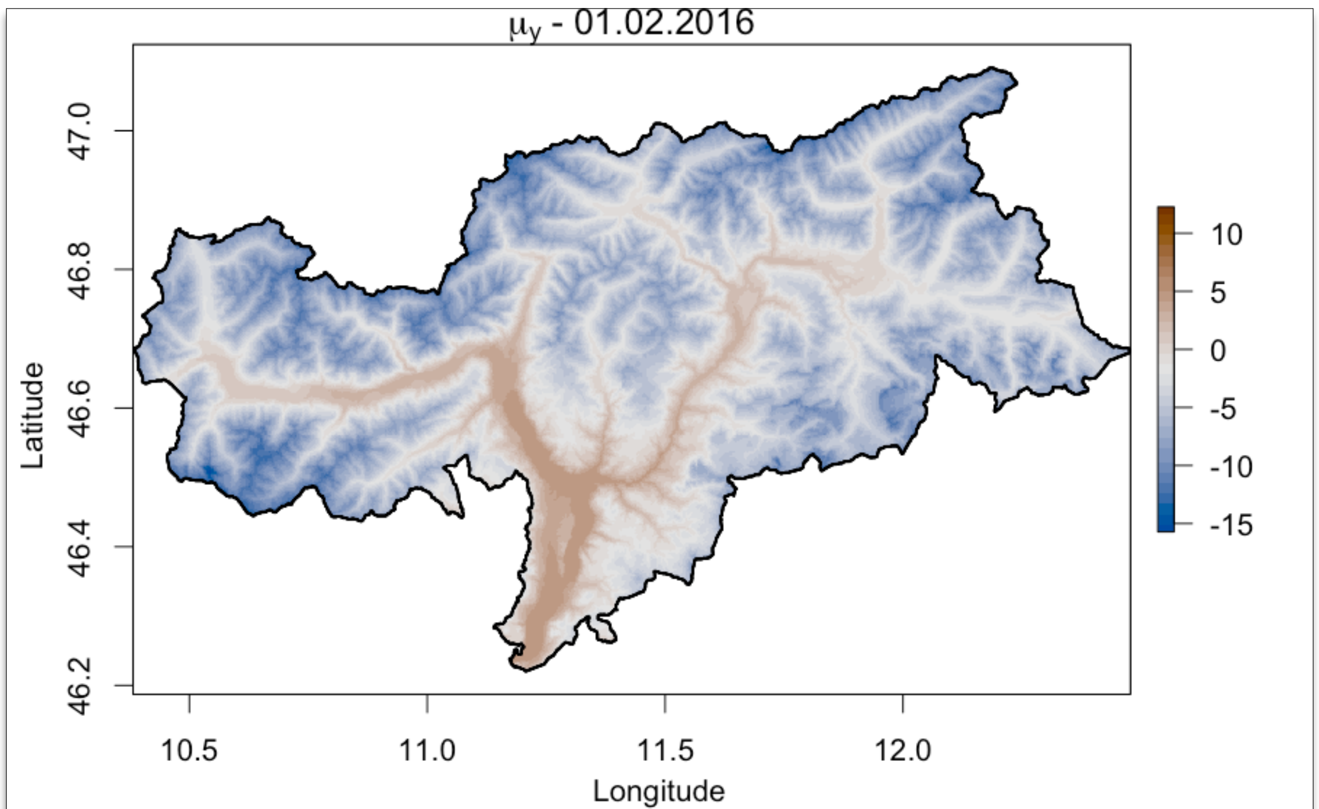
$\mu_{y,m,\log(s)}$...Climatological mean

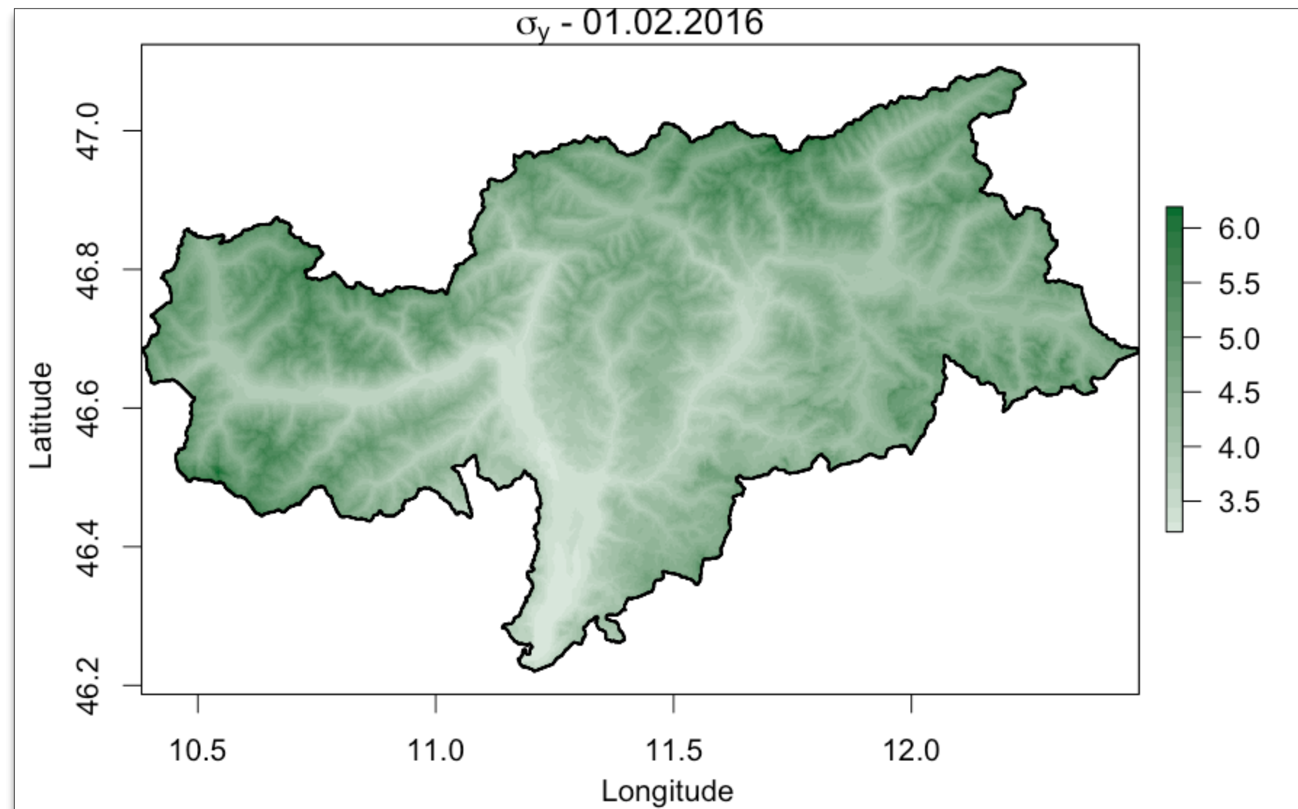
$\sigma_{y,m,\log(s)}$...Climatological standard deviation

Spatial Climatology

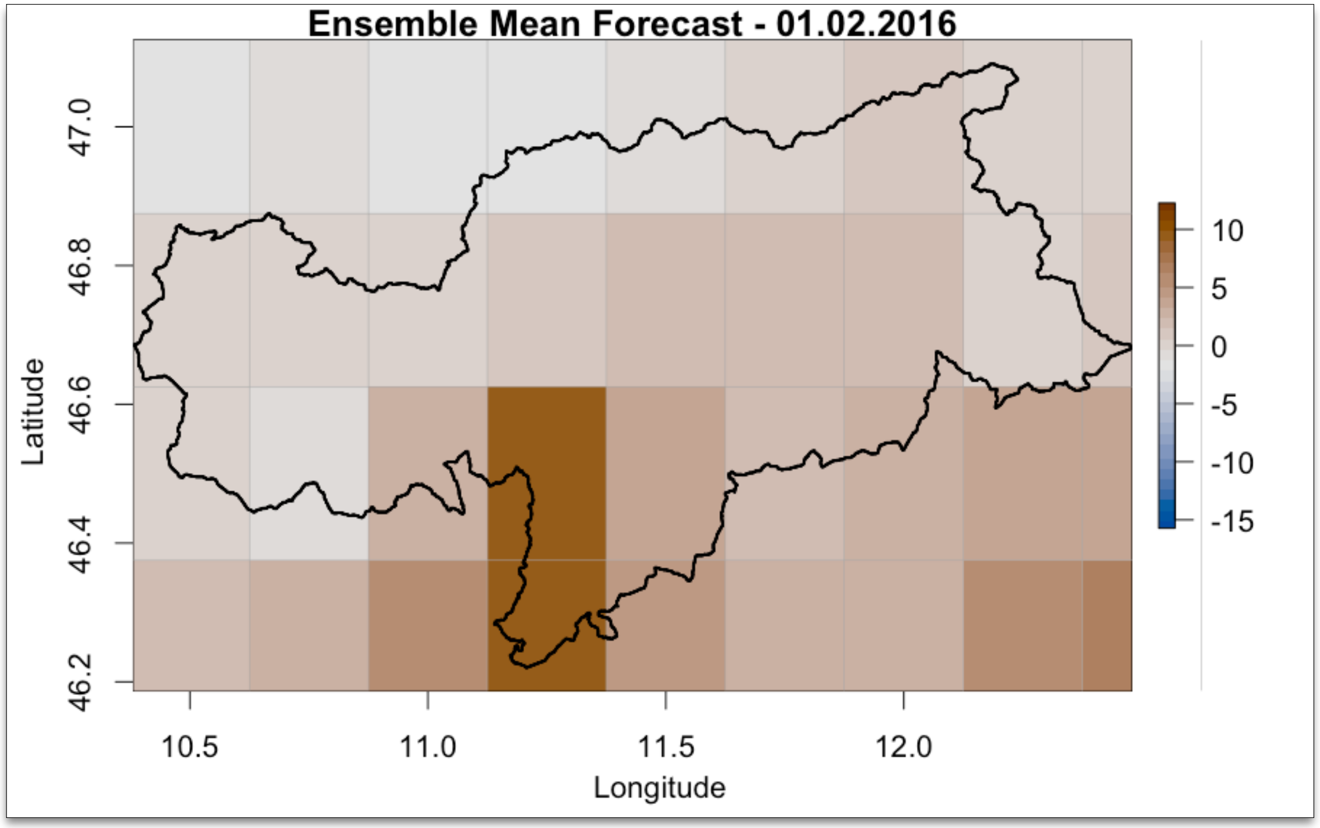
$$\mu_y = \beta_0 + f_1(\text{Season}) + f_2(\text{Altitude}) + f_3(\text{Spatial}) + f_4(\text{Season} \cdot \text{Altitude})$$

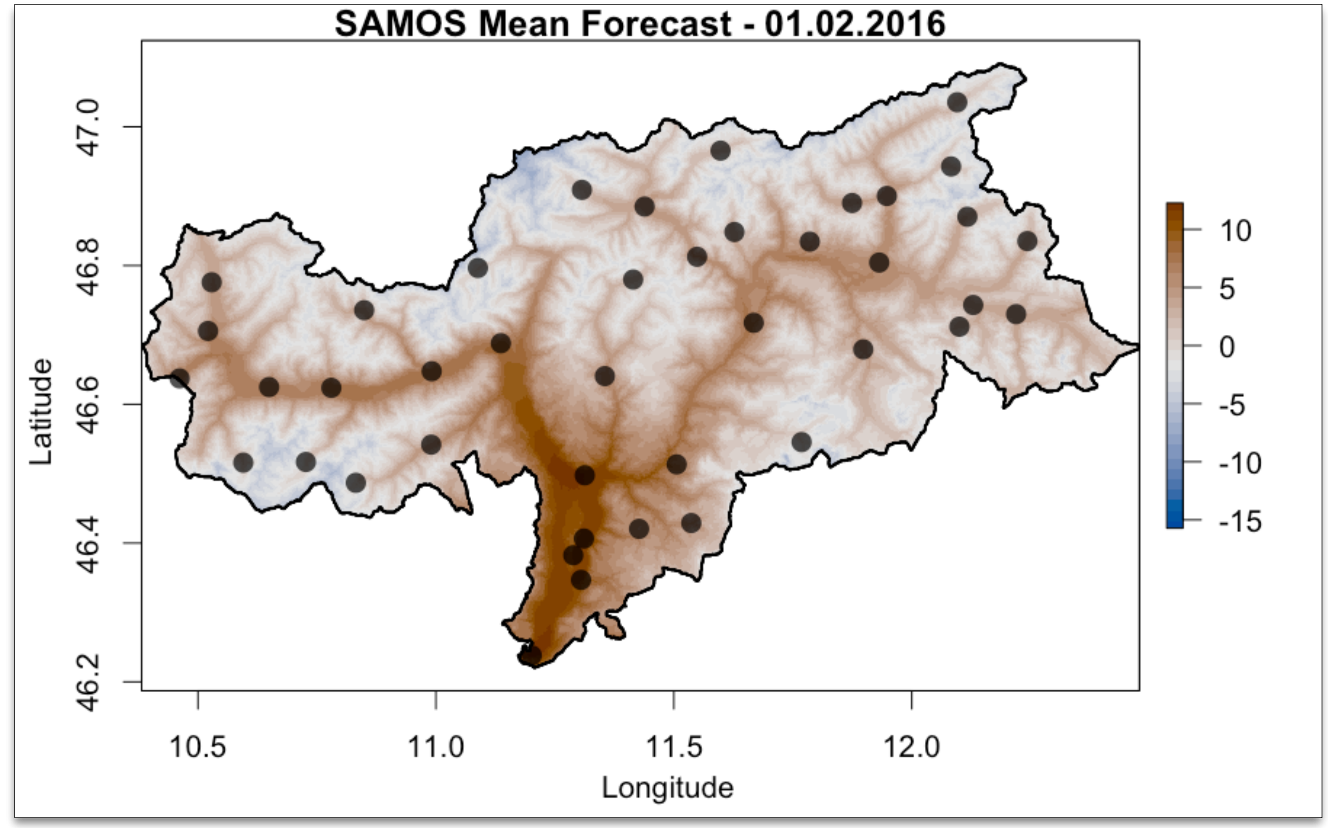
$$\log(\sigma_y) = \gamma_0 + g_1(\text{Season}) + g_2(\text{Altitude}) + g_3(\text{Spatial}) + g_4(\text{Season} \cdot \text{Altitude})$$

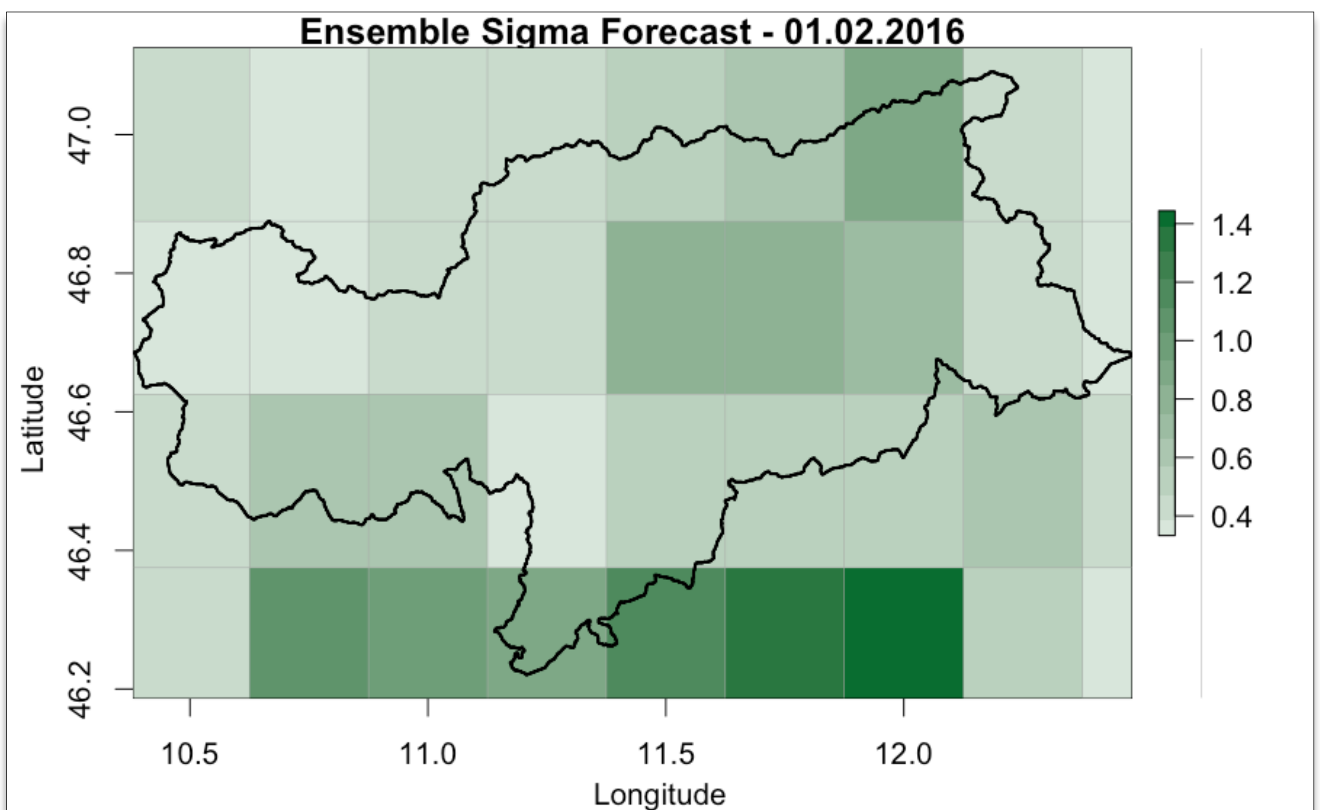


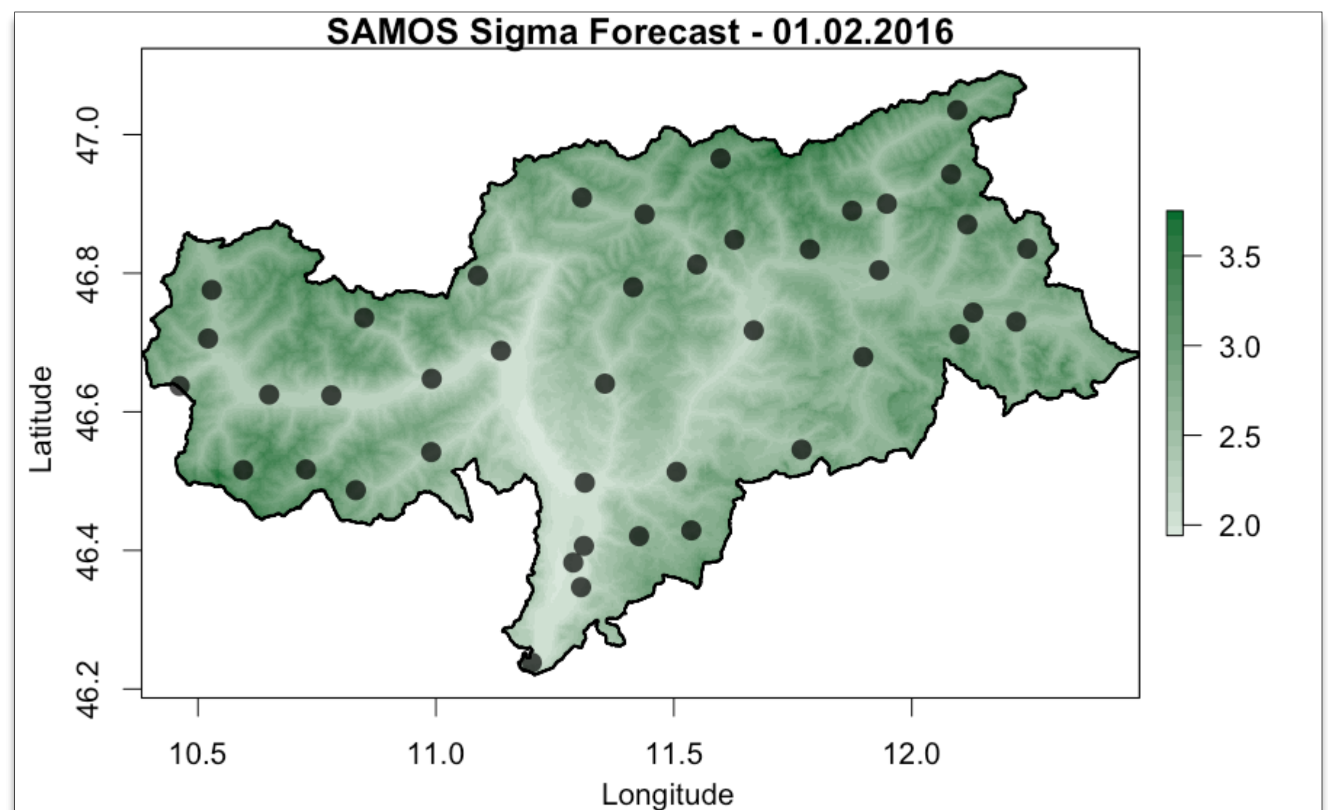


Forecast Example







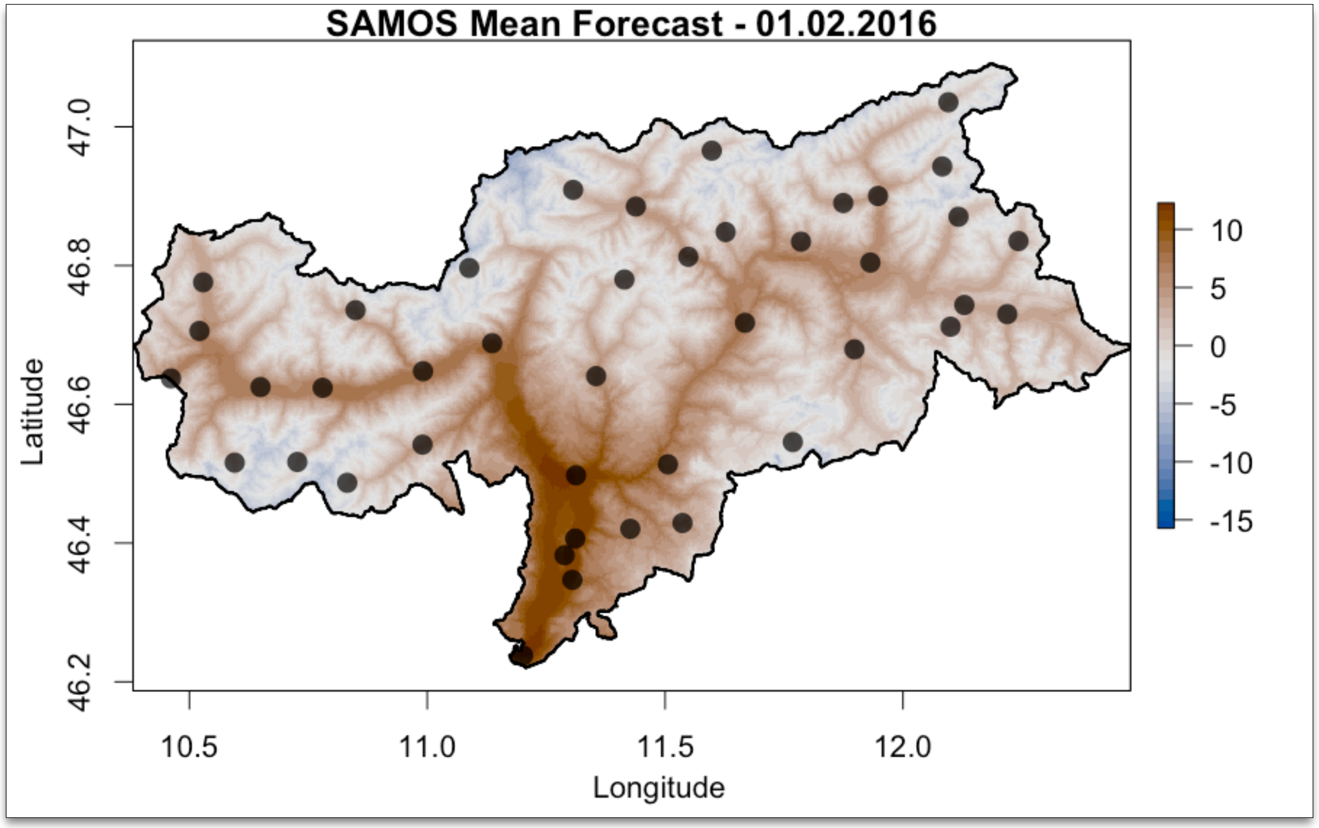


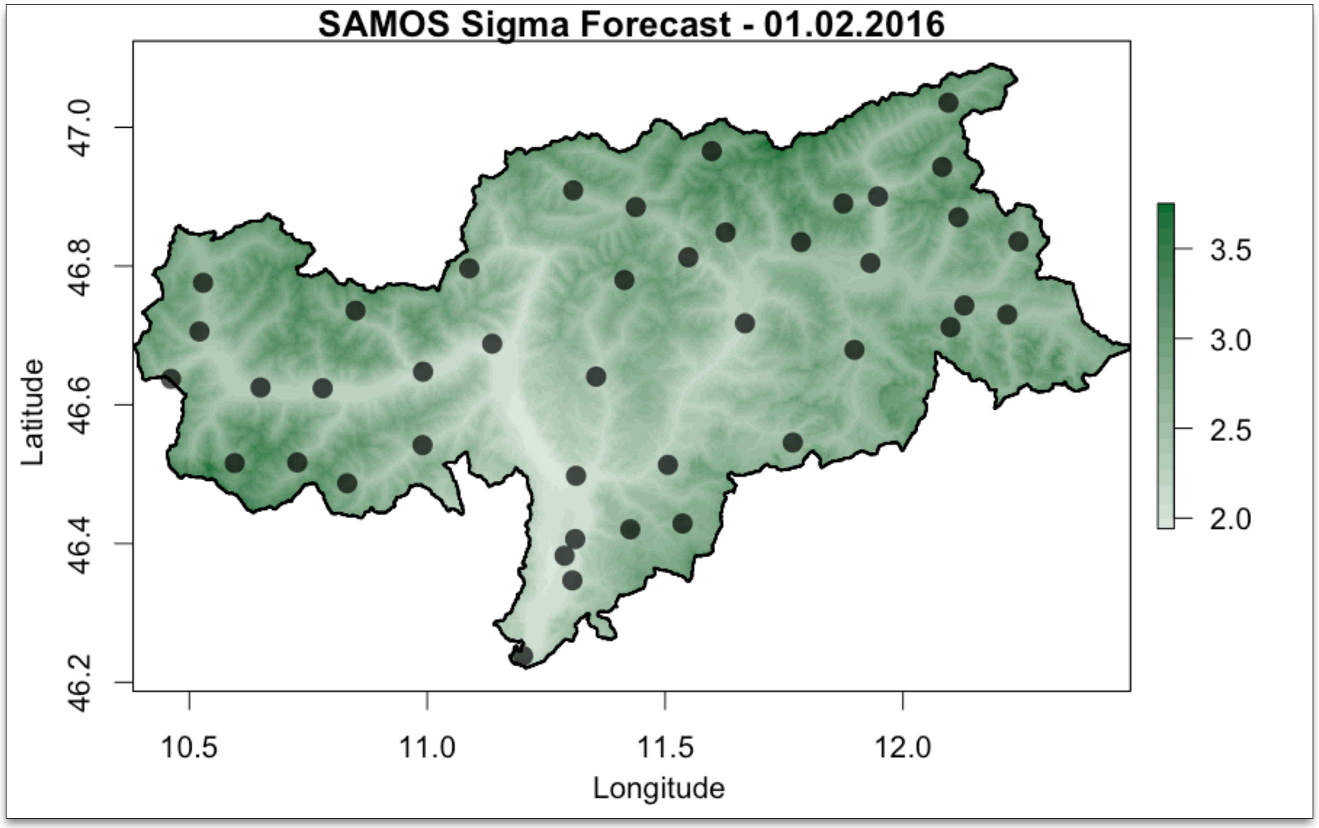
Forecast Example

<u>EMOS:</u>
temporal: trained on last 30 days
spatial: on every station individually

<u>SAMOS same stations:</u>
temporal: full dataset
spatial: tested on the same stations as fitted

<u>SAMOS new stations:</u>
temporal: full dataset
spatial: tested on new stations that are not in the training data (“Leave-One-Out”)



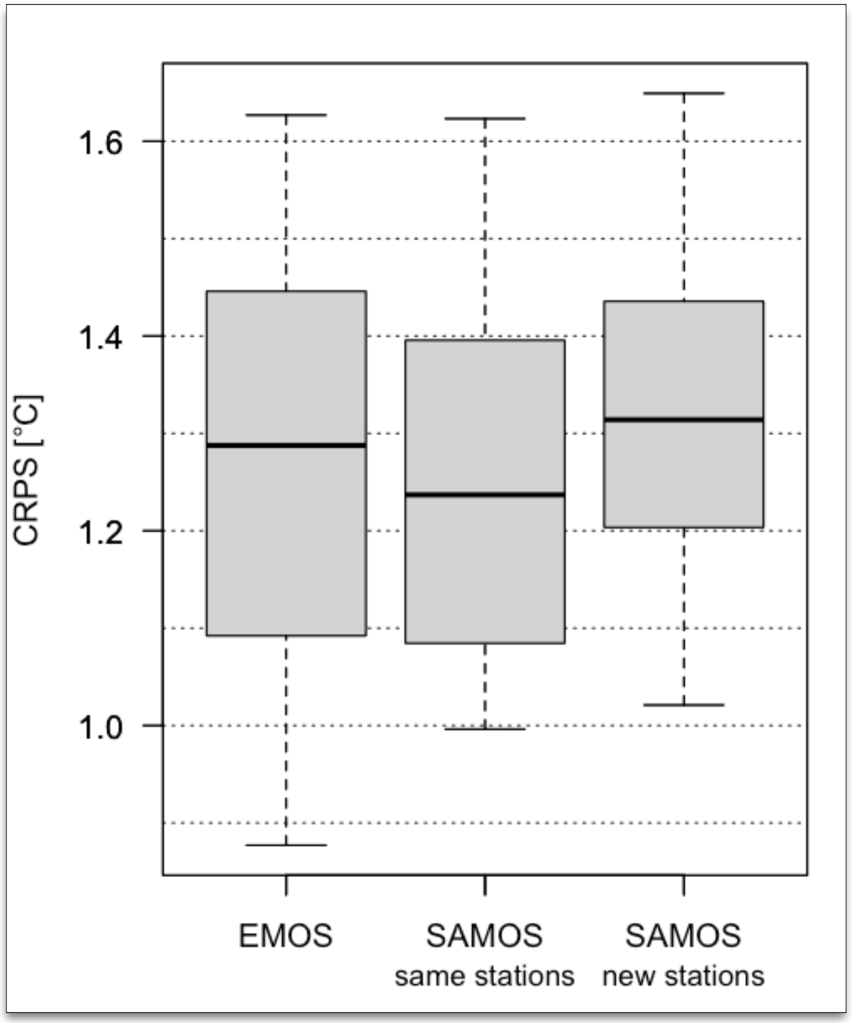


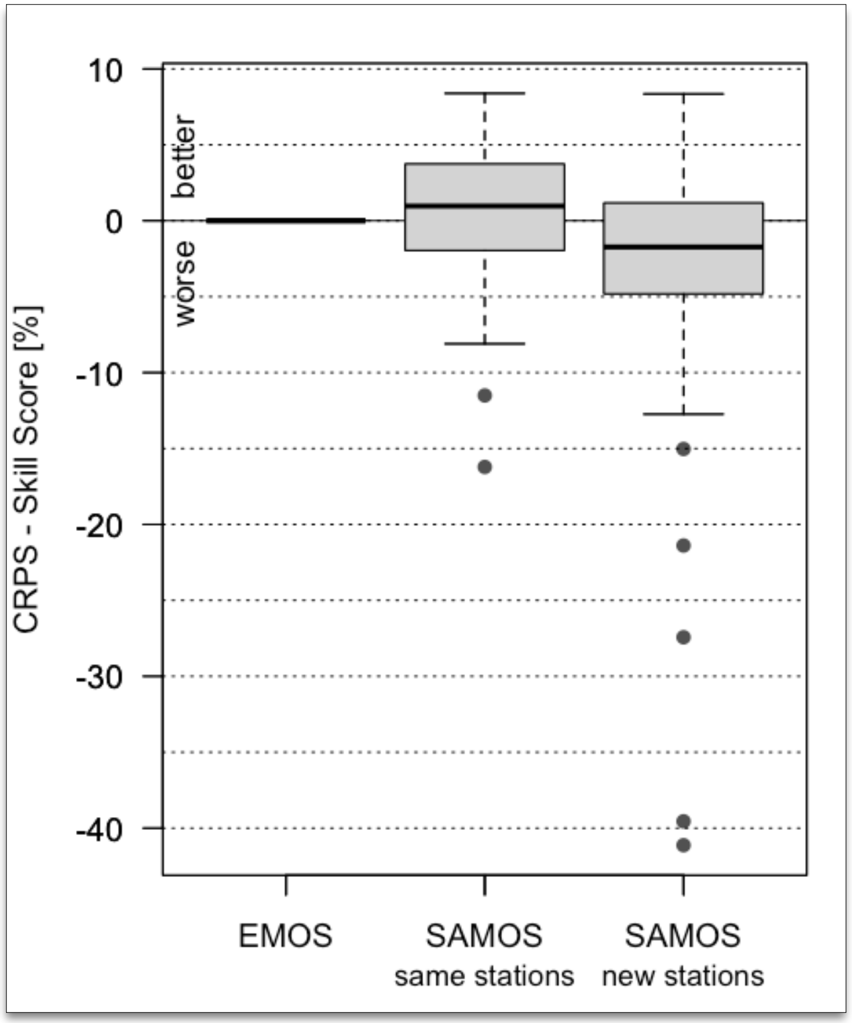
Results

EMOS:
temporal: trained on last 30 days
spatial: on every station individually

SAMOS same stations:
temporal: full dataset
spatial: tested on the same stations as fitted

SAMOS new stations:
temporal: full dataset
spatial: tested on new stations that are not in the training data ("Leave-One-Out")





Conclusion

Standardized Anomalies:

- are without ***season-specific*** characteristic:
  - **all training data** can be used

- are without **site-specific** characteristics:
  - **all stations** can be forecasted simultaneously
  - **every point** in between can be forecasted

- forecasts are **comparable** to stationwise EMOS forecasts

Dabernig M, Mayr GJ, Messner JW, Zeileis A. 2016: Spatial Ensemble Post-Processing with Standardized Anomalies. Working papers, Faculty of Economics and Statistics, University of Innsbruck, URL http://EconPapers.repec.org/RePEc:inn:wpaper:2016-08