**Ecosystem-Based Adaptation and Mitigation in Botswana’s Communal Rangelands**

Annex 2: Feasibility Study

*Section 1: Country Profile and Climate Change Vulnerability Assessment (CCVA)*

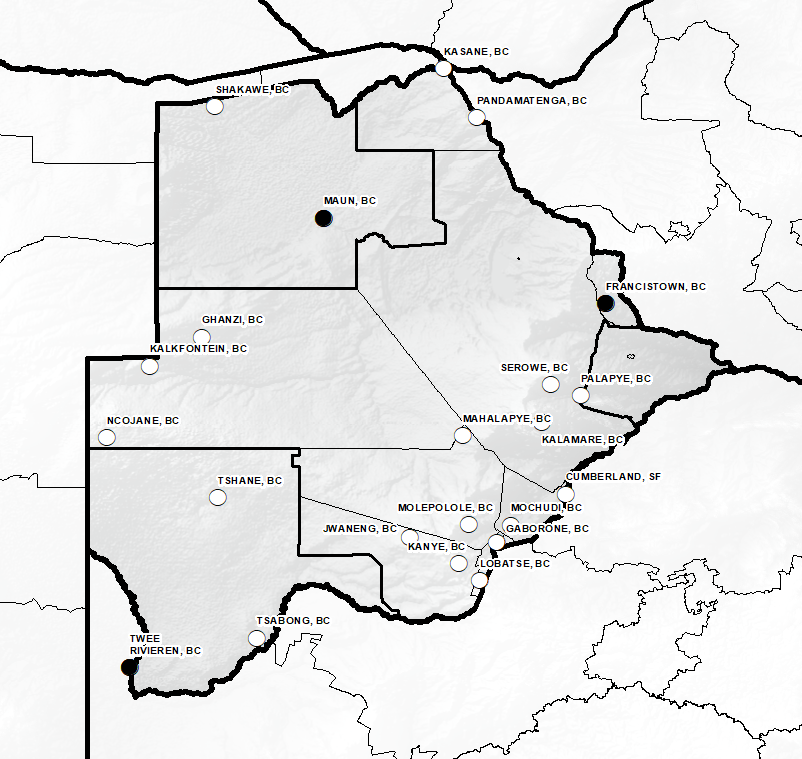
# Appendix 1.5: Climate modelling, and remotely sensed data validation against observational meteorological station data

There are limited long-term observational data available in the more remote areas of Botswana. The decision was therefore taken to use remotely sensed or reanalysis CHIRPS, ARC2, and CORDEX data to provide the required continuous temporal and spatial coverage over the historical period. This was then used as input for the current and future exposure of the Climate Change Vulnerability Assessment (Annex 2: Feasibility Study, Section 1).

Data from three observational stations were used to validate the remotely sensed datasets. These stations have the best temporal coverage (relative to others) and are in close proximity to the three intervention areas (Table 1 and Figure 1).

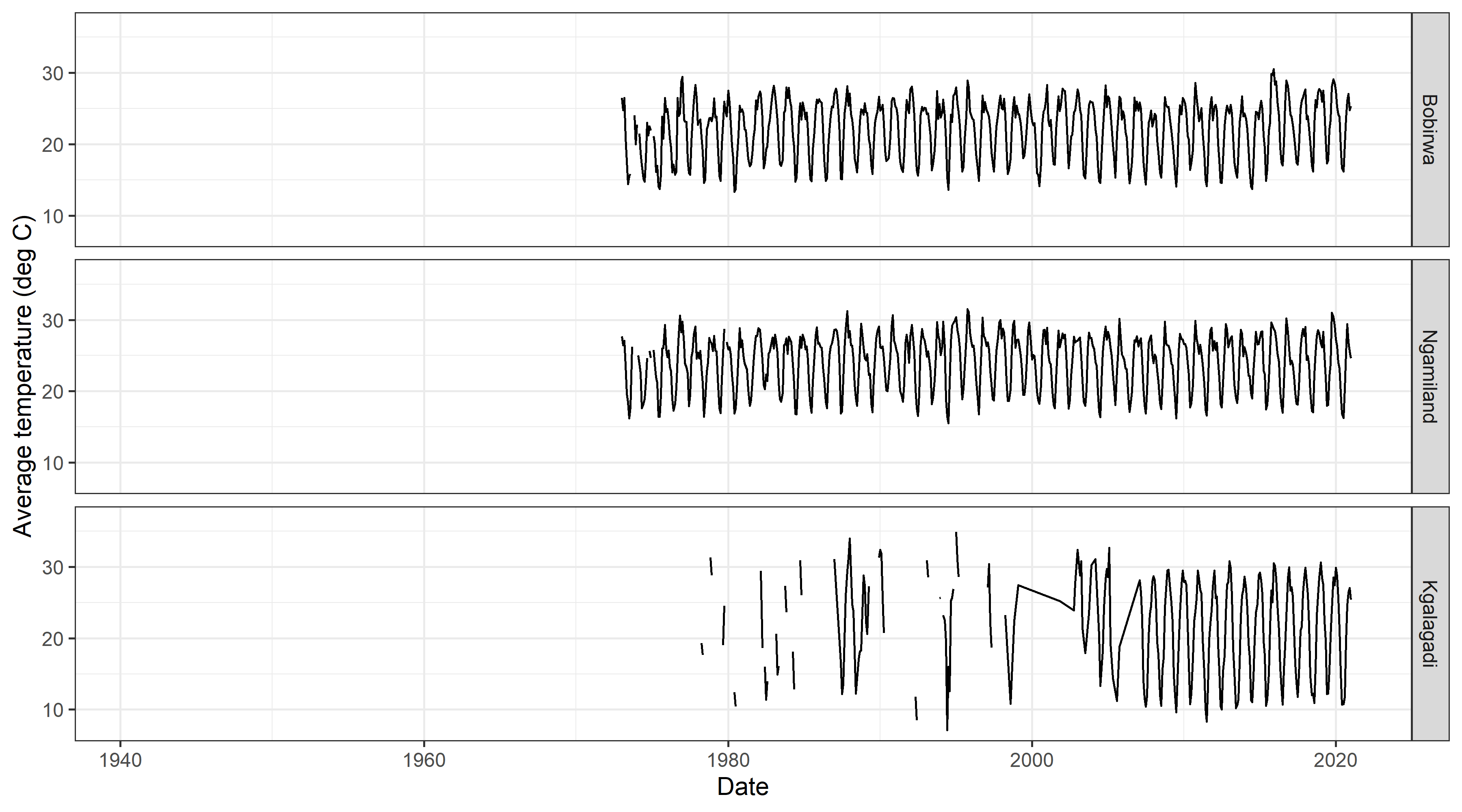
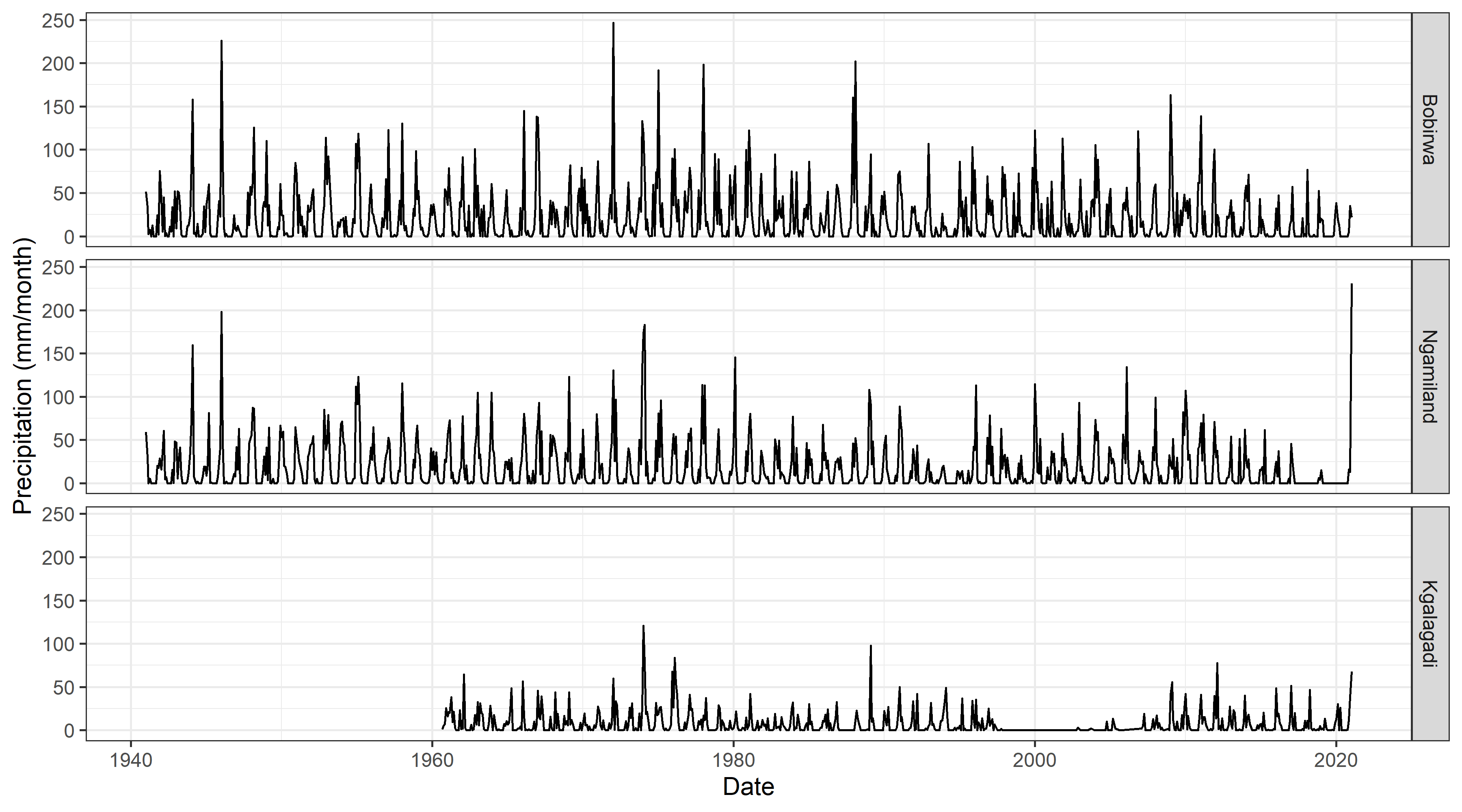
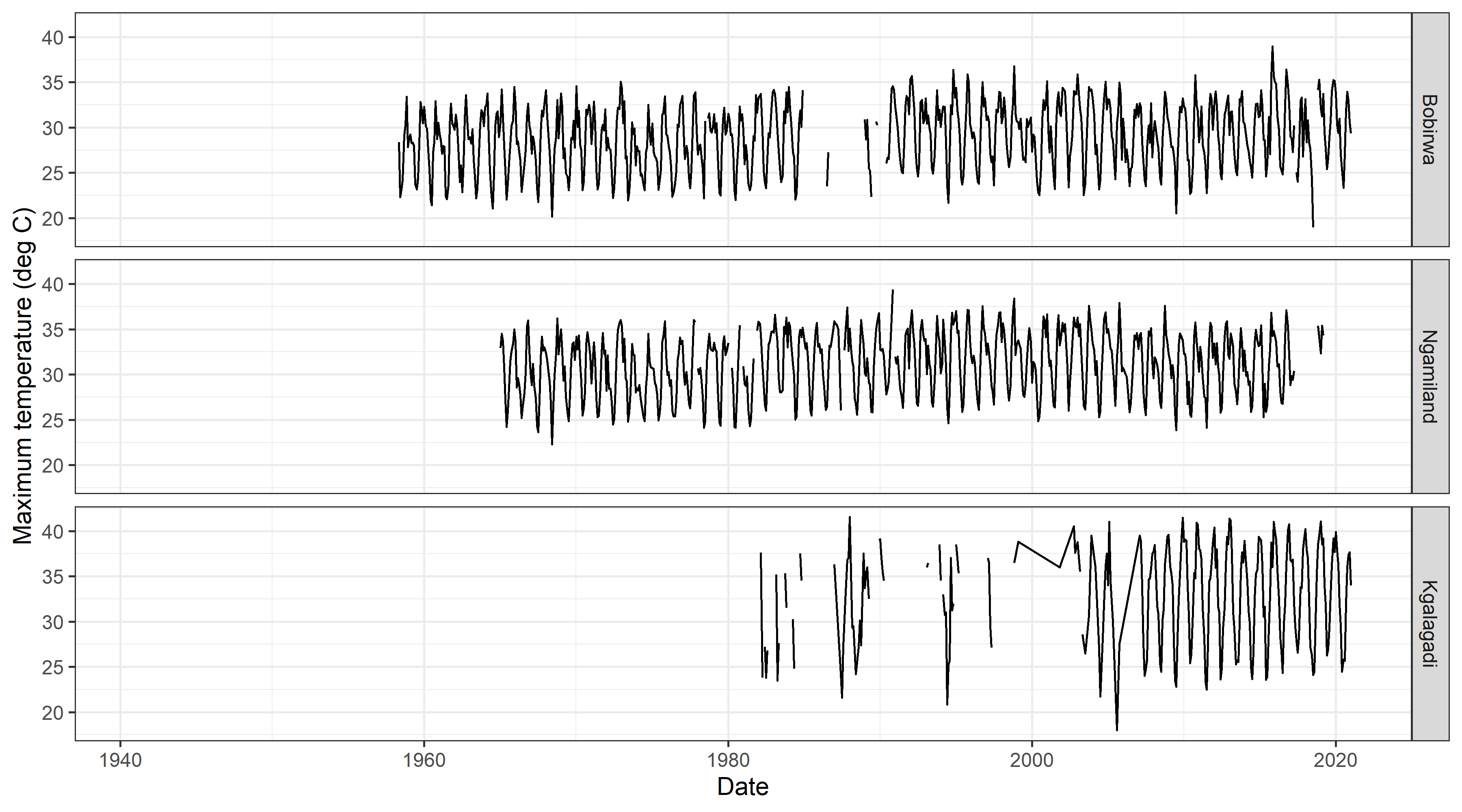
**Table 1.** Intervention areas and representative stations.

|  |  |  |  |
| --- | --- | --- | --- |
| **Intervention area** | **Station Name** | **Station location** | |
| **Latitude** | **Longitude** |
| Kgalagadi | TWEE RIVIEREN, BC | -26.467 | 20.617 |
| Bobirwa | FRANCISTOWN, BC | -21.217 | 27.5 |
| Ngamiland | MAUN, BC | -19.983 | 23.417 |



**Figure 1**. Locations of observational meteorological stations (black dots indicate stations used for validation).

Daily precipitation, temperature average and temperature maximum are recorded at each station with some differences in the historical measurement extent between the stations and between the variables of interest (Figure 2). The earliest records varied between the early 1940s and early 1980s. The quality of the observational data is also variable, with noticeable gaps in the record for Kgalagadi (Twee Rivieren Station). For the purposes of model validation, a 40-year assessment period was applied (1981–2020).

**Figure 2.** Observational monthly station precipitation (top), average temperature (middle) and maximum temperature (bottom) data representing the Bobirwa, Ngamiland and Kgalagadi intervention areas.

### Bobirwa: Francistown

As presented in Figure 3 below, the observational station precipitation data peaks in the summer months from November to March. There is, however, significant inter-annual variability. The CHIRPS and ARC2 data follow the same distribution with similar magnitude, but with a lesser degree of variability. Both data sets show increased peaks in February as is noted in the station data. The CORDEX data follows a similar distribution for the majority of the models though there is a wider overall range between them. Comparatively, there is a close distribution between the station, remote data, and the CORDEX models.

**Figure 3**. Seasonal precipitation data comparison for Bobirwa. Francistown station (top left), CHIRPS (top right), ARC2 (middle left), CORDEX (middle right), and summary (bottom).

Model predictions of average daily temperature demonstrates a high degree of conformity between models and in comparison with the observational station data (Figure 4). The greater performance of temperature models relative to precipitation is consistent with expectations given the inherent variability of precipitation dynamics.

**Figure 4**. Monthly temperature comparison for Bobirwa. CORDEX driving models (top), and a comparison between CORDEX, CHIRTS and observational station data (bottom).

### Ngamiland: Maun

Similar to Bobirwa, station data from Maun shows peak precipitation occurring in the summer months with increased interannual variability in January/February (Figure 5). CHIRPS and ARC2 data mirror this distribution but extend the dry season further into May. This is not reflected in the station data. All the models of the CORDEX data also follow the peak summer rainfall distribution. They do, however, underestimate the late-season rainfall and suggest an earlier cessation of the rain season (Figure 5).

**Figure 5**. Seasonal precipitation data comparison for Ngamiland. Maun station (top left), CHIRPS (top right), ARC2 (middle left), CORDEX (middle right), and summary (bottom).

Model predictions of average daily temperature demonstrates a high degree of conformity between models and in comparison with the observational station data (Figure 6). The greater performance of temperature models relative to precipitation is consistent with expectations given the inherent variability of precipitation dynamics.

**Figure 6**. Monthly temperature comparison for Ngamiland. CORDEX driving models (top), and a comparison between CORDEX, CHIRTS and observational station data (bottom).

### Kgalagadi: Twee Rivieren

The station precipitation data here is the lowest of all the areas assessed. As with the other two sites, the peak is again in January though with a much-reduced magnitude. Again, there is increased variability in February. The CHIRPS and ARC2 data also peak in January/February, though there is a steep drop off in precipitation May that does not seem indicative of the station data. The CORDEX data follows the same shape as the station and remotely sensed data, though it does overestimate the early- and mid-season rainfall. It also shows a longer overall rainfall season (Figure 7).

**Figure 7**. Seasonal precipitation data comparison for Ngamiland. Maun station (top left), CHIRPS (top right), ARC2 (middle left), CORDEX (middle right), and summary (bottom).

Model predictions of average daily temperature demonstrates a high degree of conformity between models and in comparison with the observational station data (Figure 8). The greater performance of temperature models relative to precipitation is consistent with expectations given the inherent variability of precipitation dynamics.

**Figure 8**. Monthly temperature comparison for Kgalagadi. CORDEX driving models (top), and a comparison between CORDEX, CHIRTS and observational station data (bottom).

# Conclusions

The remotely sensed data reasonably matches the station changes over time. The validation here shows that the seasonal signal of the CORDEX data captures the dynamics of the remotely sensed data and the stations. The variability between the models seems to be low but the modelled data does occasionally overestimate the rainfall volumes. As the magnitude discrepancies are propagated from the historical to projected future, the use of anomalies addresses the potential magnitude problem. The application of the climate changes was used in the CCVA (Annex 2: Feasibility Study, Section 1) and was indexed by relative exposure so potential discrepancies propagated in the model are less influential.