Development of an Operational Real-Time Sub-Seasonal (S2S) Hydrological Forecasting System (HFS) for the Tarapacá Region, Chile

Rodrigo Valdés-Pineda[1], Christopher L. Castro[1], Lourdes Mendoza-Fierro[1], Hsin-I Chang[1], and C. Bayu Risanto[1]

[1] University of Arizona, Department of Hydrology and Atmospheric Sciences, Tucson, Arizona, USA.

Corresponding author e-mail: rvaldes@email.arizona.edu

1. Introduction: The Tarapacá Region

- **Area:** 42,226 Km^2 (similar size as Switzerland)
- **Population:** 324,930
- **Economy:** Natural Resources Extraction, Mining, Fishing and Agriculture.
- **Rainfall climatology:** >2000 m.a.s.l. / 100 - 300 mm yr^{-1} from Bolivian Winter
- **Subject to extreme precipitation:** 12 mm/3 hr. in February 2019, for example

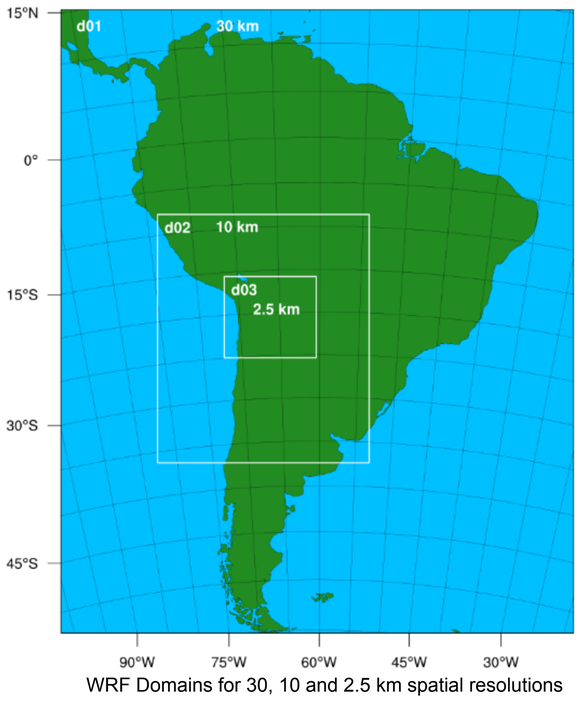
Tarapacá Region (highlighted in light red) and Rio Camarones en Conaxona basin (red outline).

2. Observation and Forecast Limitations near Tarapacá

- Low spatial coverage of instrumental data
- High percentage of missing records from the instrumental data
- Low representativeness of gridded products
- Need high-quality climate forecasts
- Need high-quality hydrologic forecasts
- Restrictions for the implementation of forecasting systems
- Uncertainty about the impact of extreme events

3. Motivation and Objectives

- Increase spatio-temporal availability of instrumental data
- Construct regional hydroclimatic database
- Generate specific climate and hydrologic products
- Develop regional S2S forecasting capabilities
- Improve the understanding of extreme convective precipitation events over Tarapacá Region
- Improve forecast capabilities for convective precipitation quantified by improvements in precipitation forecast skill.



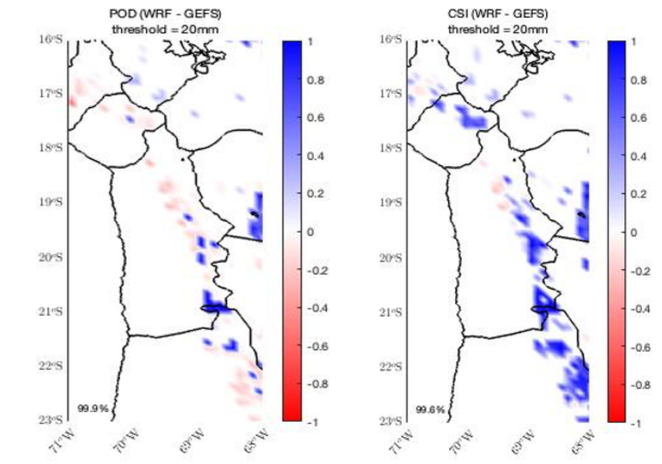
WRF Domains for 30, 10 and 2.5 km spatial resolutions

4. Methods and Framework

- Weather Research and Forecasting model (WRF)
- WRF domains: 30, 10, 2.5km (Tarapacá Region)
- Input: 21 Global Ensemble Forecast System (GEFS) ensembles
- Extreme precipitation case study: 12-13 March 2012.
- Dynamically downscale GEFS reforecast with WRF model to convective-permitting resolution.
- WRF forecast verification as compared to GPM IMERGE, using statistical metrics i.e., POD, FAR, CSI, etc.

Hydrologic modeling framework:

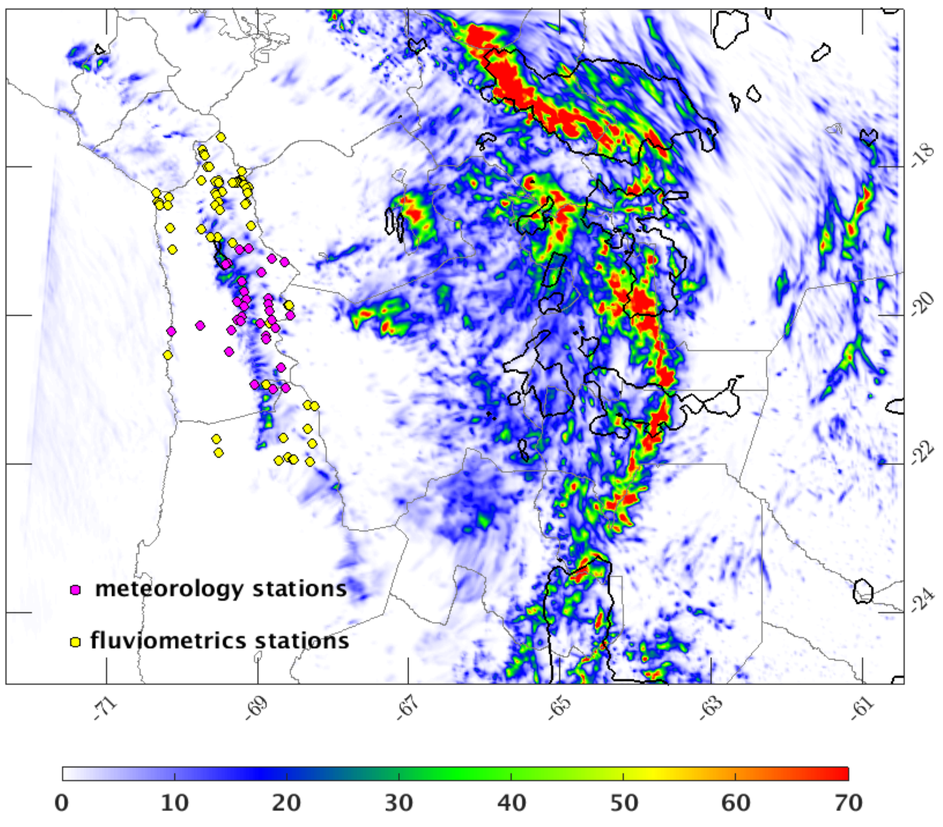
- Pilot catchment within the Region, i.e., Rio Camarones en Conaxona.
- Pre-operational selection and design of lumped and distributed hydrological models i. e., GRJ, Hymod, HBV, etc.
- Short- and long-term Calibration and Validation of Hydrological Models for the basin of interest.
- Input: WRF CPM forecast, i.e., 12-13 March 2012, for 120-hour forecast.
- Evaluation of WRF and hydrological forecast skill for all 21 ensemble members.



Skill score metric differences between WRF precipitation and GEFS data for all ensemble members. Blue color represents higher forecast skill for WRF precipitation

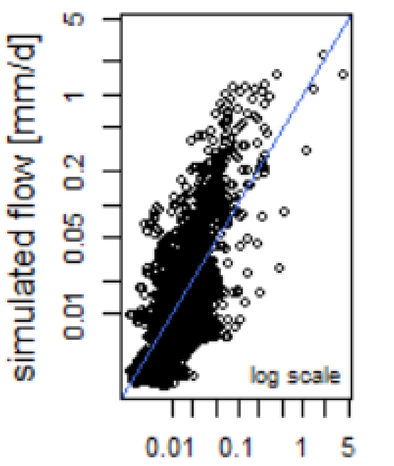
5. Results

- The pre-operational setup of the WRF and GRJ Models has shown satisfactory simulation results for the most extreme hydrological events recorded in the basin.

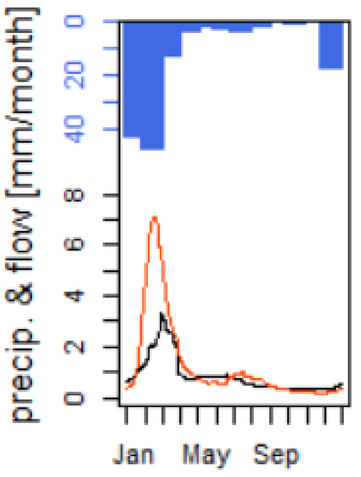


WRF – GEFS Convective Rainfall Simulation for 12-13 March 2012 event for 120-hour forecast

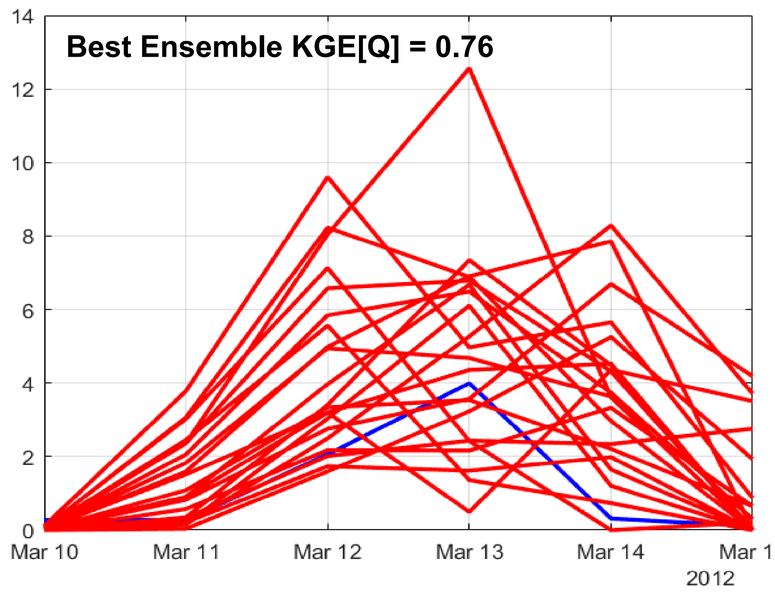
GR5J Model



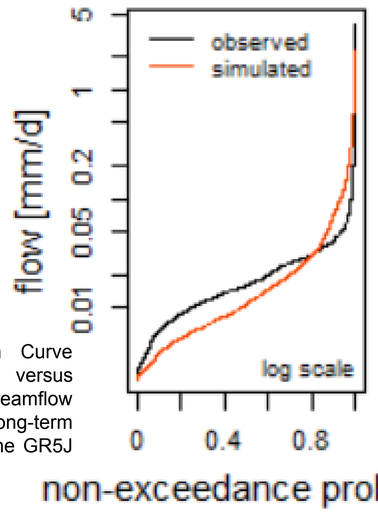
Long-term calibration results for GR5J model showing a scatter plot of observed versus simulated streamflow.



Monthly average instrumental precipitation (blue bars), and monthly observed and simulated streamflow from the long-term calibration of the GR5J model.



Observed and ensemble simulated streamflow between March 10th and 15th



Flow Duration Curve for observed versus simulated streamflow from the long-term calibration of the GR5J model.

6. Conclusions

- CPM improves the precipitation forecast in Tarapacá Region above the 'no skill' raw GEFS.
- The pre-operational configuration of the S2S HFS improves the representation of extreme hydrological events in the Tarapacá Region.

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