High-resolution forecasting of extreme events in semi-arid to arid environments out to the sub-seasonal timescale

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Geographic context for research

Convective precipitation in complex terrain that triggers flash flooding in a semi-arid to arid environment. Similar to monsoon in Arizona

Disciplines involved: atmospheric sciences, hydrology

Kingdom of Saudi Arabia

Tarapacá Region
Northern Chile
Research problem: Improving weather forecasts at sub-seasonal timescale (3-4 weeks lead time)

• Use high-resolution, convective-permitting regional climate modeling, capable of explicitly resolving thunderstorms at the kilometer scale

• Application of convective-permitting modeling at sub-seasonal timescales possible using ensemble model global forecast products, for example from NOAA or the European Center for Medium Range Weather Forecasting.

• The forecast system can be evaluated by considering retrospective forecasts over several decades, that quantify the value added.

• Simulated precipitation can be used to drive hydrologic models, to create an integrated forecast system.

• Saudi Arabia and northern Chile currently lack these types of capabilities, and they are urgently needed in a changing climate with more extreme precipitation.
Resilience Framing

- **Prediction**: Provide high resolution real-time forecasts.
- **Research**: Verify the skill of precipitation forecasts, emphasizing extremes.
- **Response**: Develop customized products to inform emergency management.
Methods: Tarapacá project example
Developing a pilot hydrometeorological prediction system

MANAGEMENT

UA – TARAPACÁ
GOVERNMENT – MINISTRY
OF PUBLIC WORKS

WATER RESOURCES DIRECTORATE

EXPAND MONITORING NETWORK

UA ATMO

DEVELOPMENT AND VALIDATION OF REGIONAL FORECAST MODEL (WRF-TARAPACA)

UA HYDRO

DEVELOPMENT AND VALIDATION OF HYDROLOGIC PREDICTION SYSTEM (SPH-CAMIÑA)

RESEARCH AND DEVELOPMENT OF WATER RESOURCES

HYDROLOGIC MODEL (MHG-CAMIÑA)
Key finding: improved ability to model extreme convective rainfall in northern Chile
Key finding: improvement in extreme precipitation event forecasts in Saudi Arabia (week 1 to 3)

POD DIFF (WRF - ECMWF) 3-day and 7-day precip extratropical CASES thr 20 mm

Risanto et al. (2021, Clim. Dyn., in review)

Blue colors indicate improved forecasts of extreme precipitation with convective-permitting modeling.

Get substantial improvement in forecasts out to week 3 and 4.
Relation to international development: Pivoting to a larger community research effort under the World Meteorological Organization

Evaluating the value added of convective-permitting modeling at S2S timescales is entirely possible right now with existing reforecast products.

There two projects are establishing a transferable methodological framework that can be applied throughout the world, under the auspices of a WMO-supported initiative.