



UA SCIENCE

Hydrology &
Atmospheric Sciences

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

Christopher L. Castro

Professor and Associate Head, Department of Hydrology and
Atmospheric Sciences, University of Arizona

clcastro@email.arizona.edu



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

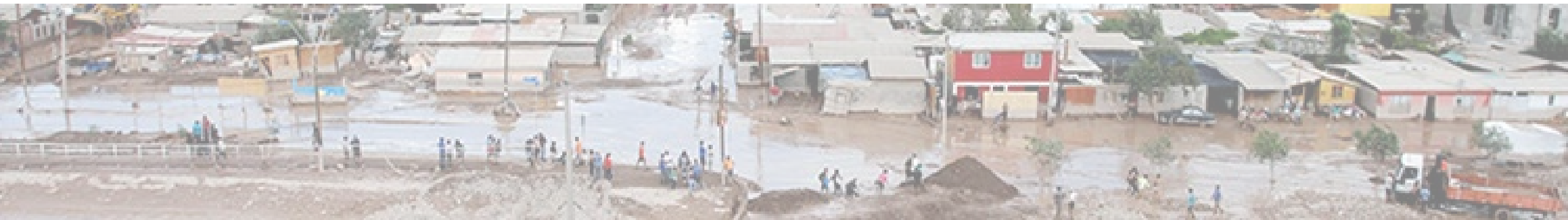


*Tarapacá Region
Northern Chile*



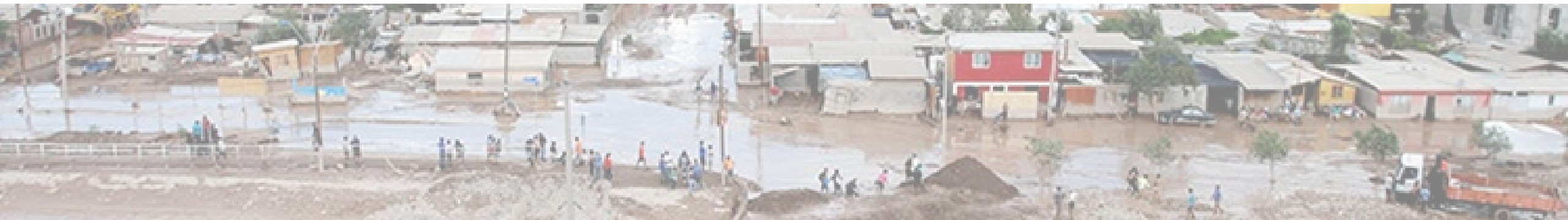
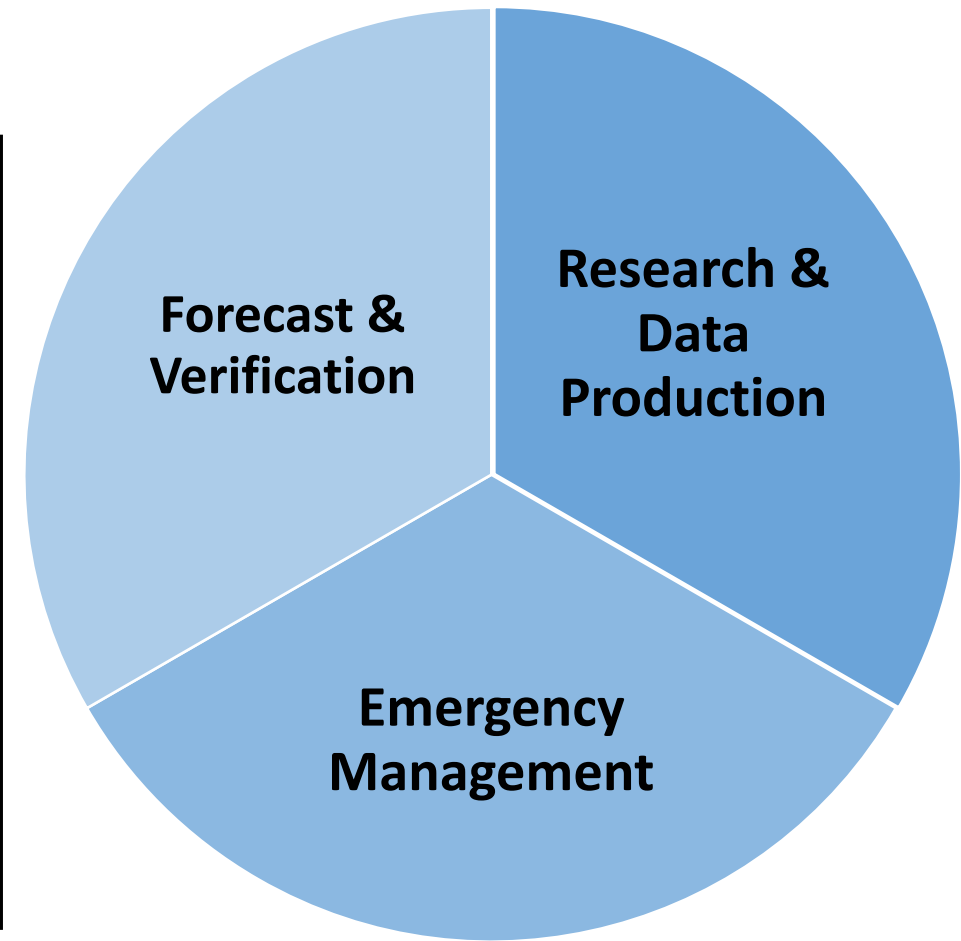
Research problem: Improving weather forecasts at sub-seasonal timescale (3-4 weeks lead time)

- 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.**



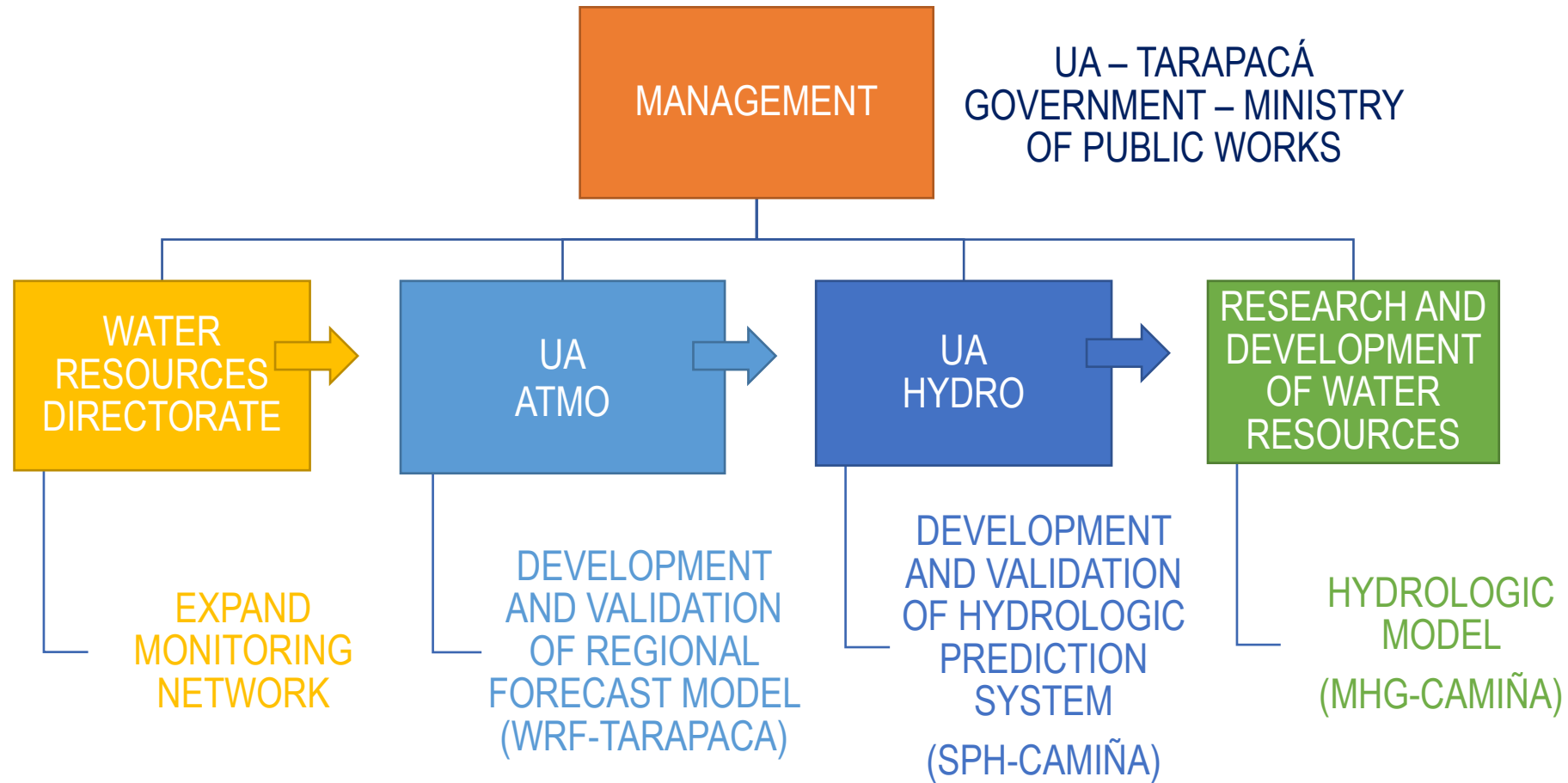
Resilience Framing

- *Prediction*: Provide high resolution real-time forecasts.
- *Research*: Verify the skill of precipitation forecasts, emphasizing extremes
- *Response*: Develop customized products to inform emergency management



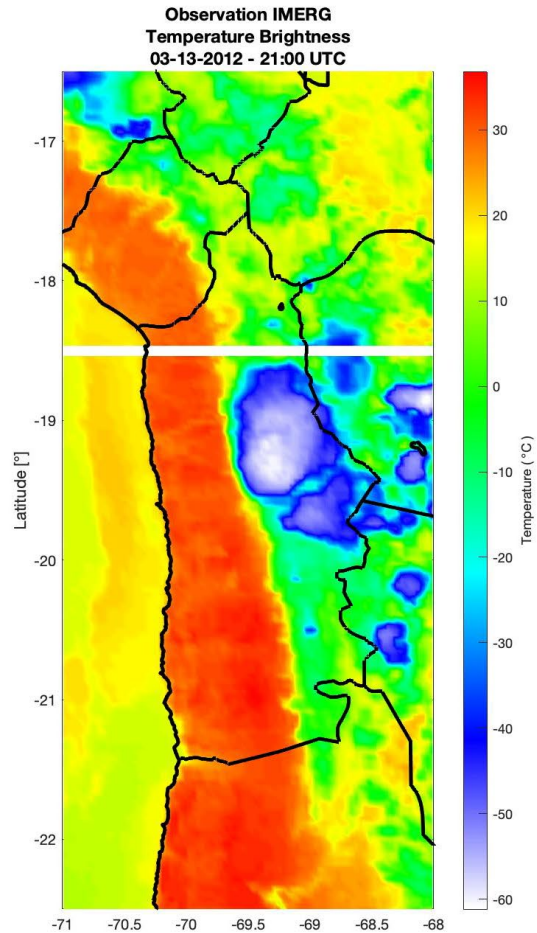
Methods: Tarapacá project example

Developing a pilot hydrometeorological prediction system

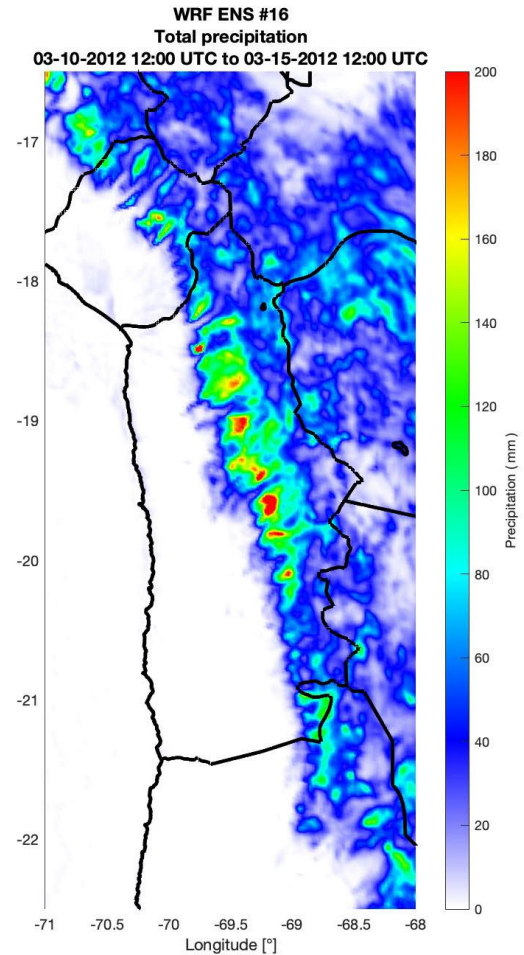
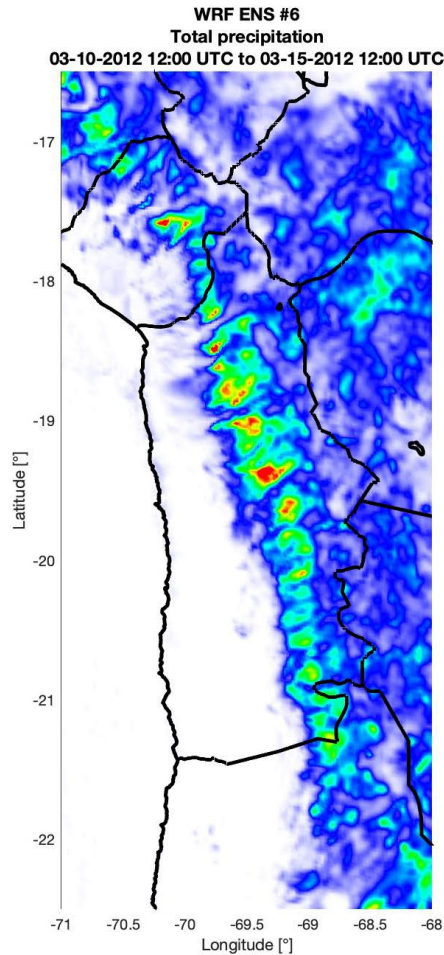


Key finding: improved ability to model extreme convective rainfall in northern Chile

Observed convection

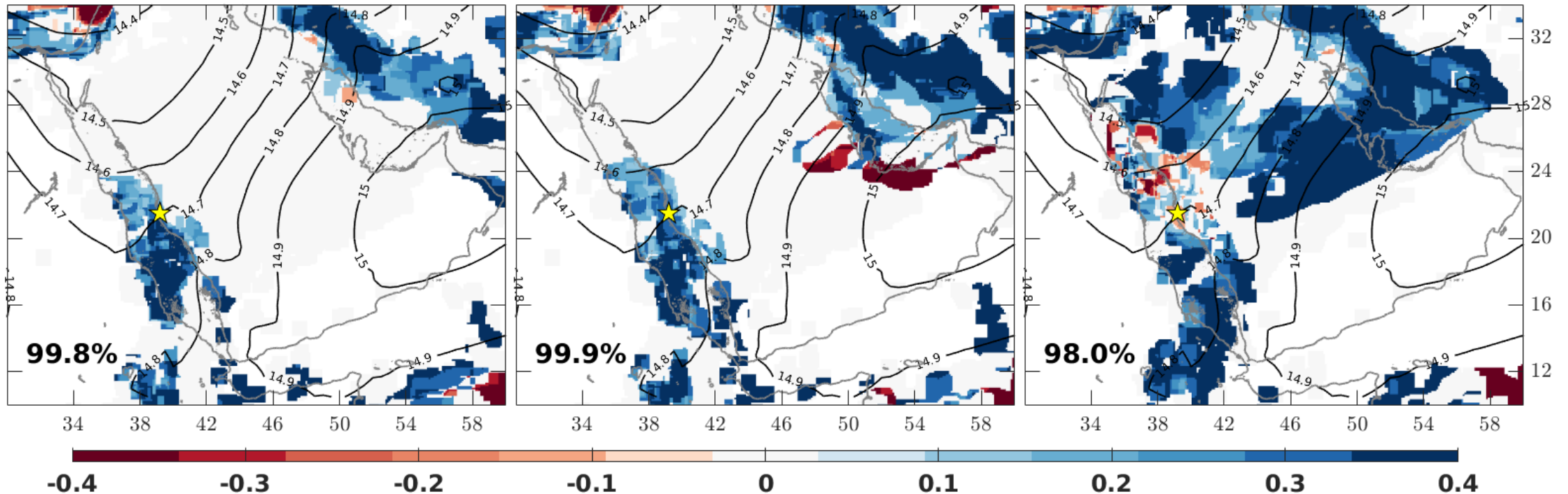


*Model forecast precipitation
From two ensemble members*



Key finding: improvement in extreme precipitation event forecasts in Saudi Arabia (week 1 to 3)

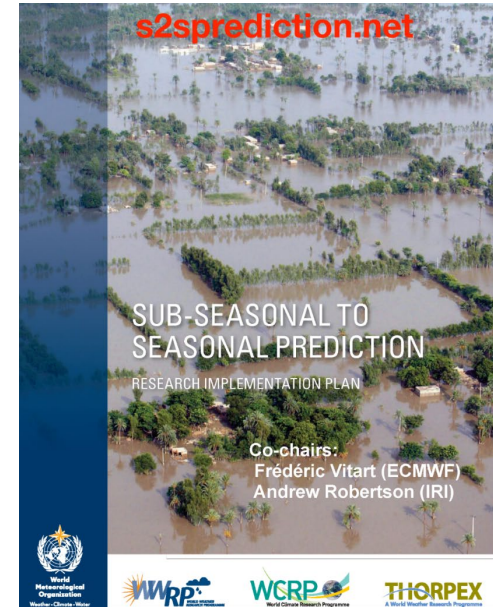
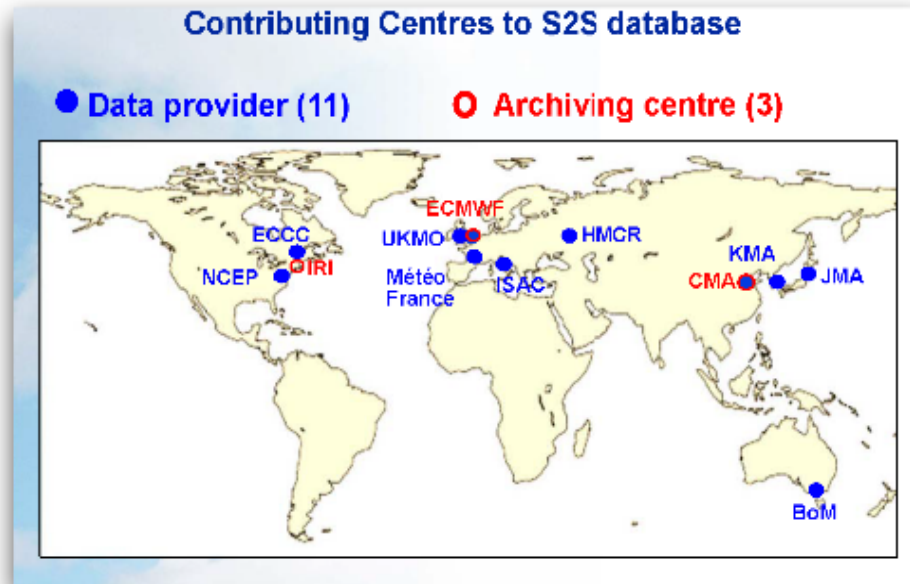
POD DIFF (WRF - ECMWF) 3-day and 7-day precip extratropical CASES thr 20 mm
W3 W2 W1



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



- Improve forecast skill and understanding on the sub-seasonal to seasonal timescale with special emphasis on high-impact weather events
- Promote the initiative's uptake by operational centres and exploitation by the applications community
- Capitalize on the expertise of the weather and climate research communities to address issues of importance to the Global Framework for Climate Services

The S2S Database, hosted by ECMWF and CMA, went online in May 2015. International Coordination Office hosted by KMA.

The project focuses on the forecast range between 2 weeks and a season.



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.