Regional Climate Model Evaluation System

based on satellite and other observations for application to CMIP/AR downscaling

Peter Lean[1], Jinwon Kim[1,3], Duane Waliser[1,3],
Chris Mattmann[1], Cameron Goodale[1], Andrew Hart[1], Paul Zimdars[1],
Alex Hall[2,3], Daniel Crichton[1],

JPL (1), UCLA (2), Joint Institute For Regional Earth System Science & Engineering (3)

Motivation

- IPCC AR5 has a new emphasis on decadal predictions:
  - downscaling provides regional details needed for near-term decision support
- Model evaluation is crucial to understand strengths and weaknesses of individual models.
- JPL/UCLA are collaborating to develop a observation-based regional model evaluation framework for quantifying biases in regional climate model simulations.
- Aim: Create a scalable database and processing system to allow researchers to quickly and efficiently confront model output with observations.

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A new regional climate model evaluation framework

- **Goal**:
  - Make the evaluation process for regional climate models simpler and quicker
    - things that used to take *weeks* should take *days*.
  - Allow researchers to spend more time analysing results and less time coding and worrying about file formats, data transfers.

- **Benefits**:
  - Improved understanding of model strengths/weaknesses allows model developers to improve the models

  - Improved understanding of uncertainties in predictions of specific variables over specific regions for end-users

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System Overview

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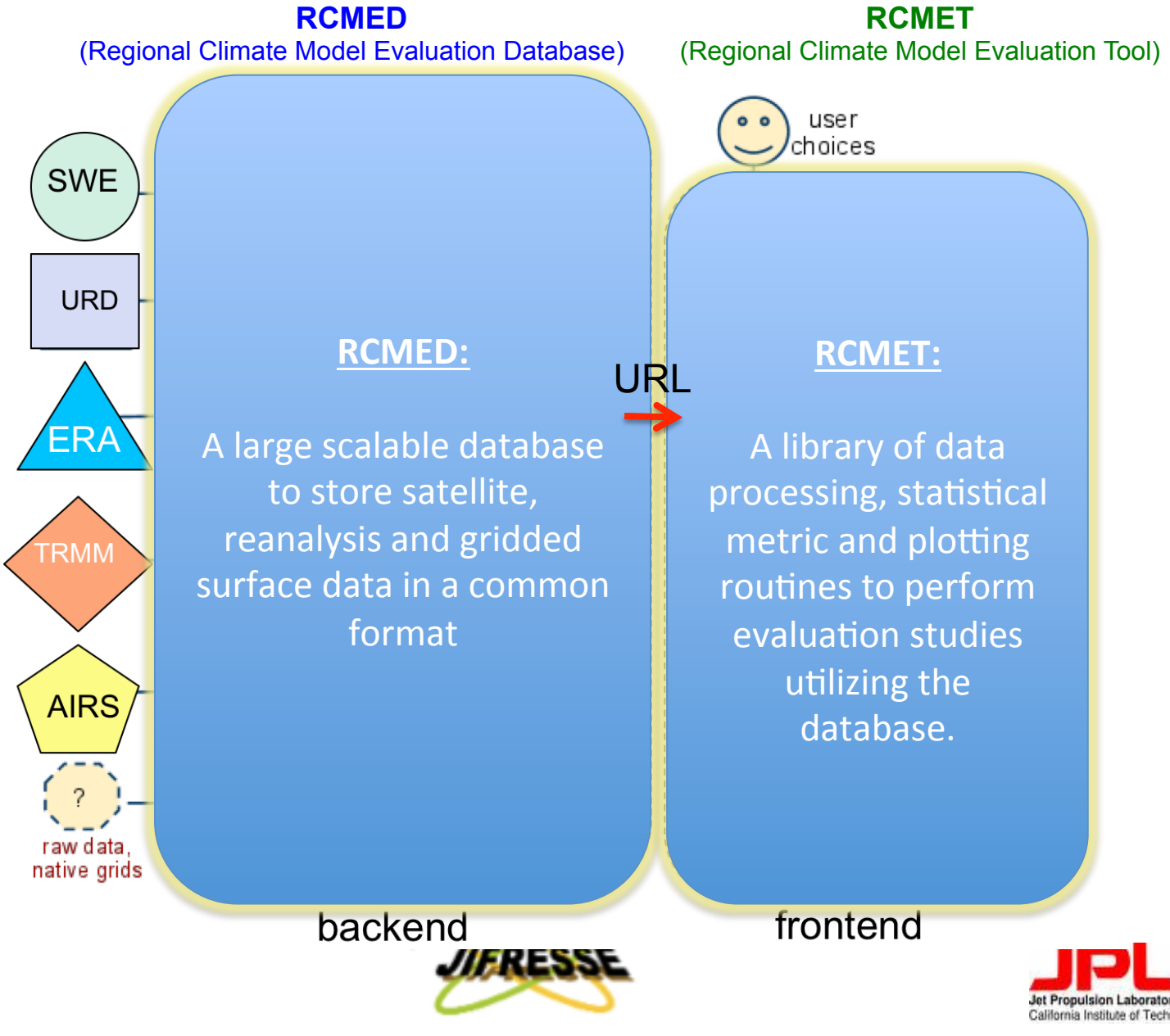
RCMES (Regional Climate Model Evaluation System)
High level technical architecture



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Regional Climate Model Evaluation System overview

- **User friendly**:
  - No need for users to download large datasets
  - No need for users to “re-invent the wheel” coding standard metrics

- **Flexible**:
  - Designed to be relatively easy to add new datasets to the database (extractors written for common formats: netCDF, GRIB, comma-separated ASCII)
  - Front-end written in Python to take advantage of wide range of existing modules and Fortran bindings.

- **Expandable**:
  - Database expands over time as researchers add new datasets for their own evaluation studies
  - Apache Hadoop and MySQL used to provide scalable storage solution.
  - Statistical processing library expands over time as researchers add new metrics

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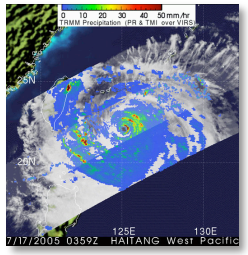
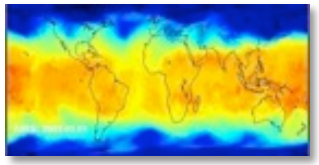
Datasets included so far:





ECMWF

Datasets that have been included so far:

- TRMM (satellite precipitation): [1998 – 2010]
- AIRS (satellite atmospheric surface + profile retrievals) [2002 – 2010]
  T(2m), T(p), z(p)
- ERA-Interim (reanalysis): [1989 – 2010]
  T(2m), Td(2m), T(p), z(p)
- NCEP Unified Rain gauge Database (gridded precipitation):
  [1948 – 2010]
- Snow Water Equivalent (Noah Molotch): [2000-2009]

Statistical Metrics included:

Bias, RMS error, Anomaly Correlation, Pattern Correlation

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User experience:

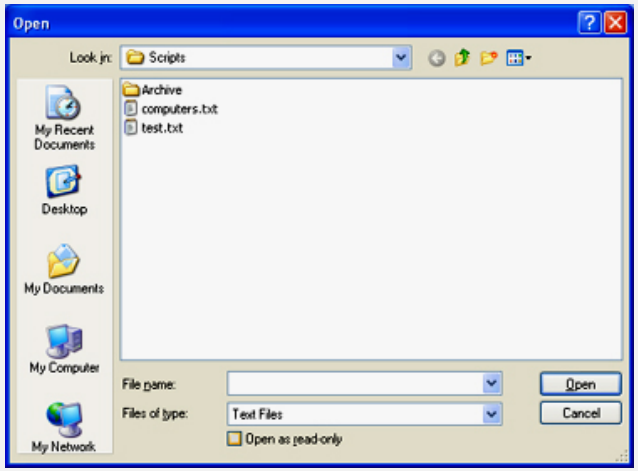
Select Observation Dataset:

- TRMM ○
- AIRS level III gridded ●
- ERA-Interim ○
- URD ○
- SWE ○

Select Variable:

- Surface temperature ●
- Precipitation ○
- Outgoing LW rad (TOA) ○
- Cloud fraction (surface) ○
- 10m wind speed ○

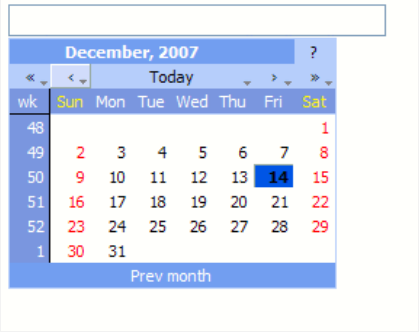
Select model data source:



Next >

User experience:

Select Date Range:



Select granule size:

- Seasonal ●
- Monthly ○
- Pentad ○
- Daily ○
- Annual ○
- Decadal

Select output grid:

- Use observational grid ○
- Use model grid ●
- Other regular grid (specify) ○

Select output plots:

- Map ●
- Time series ●

Select statistical metrics:

- Mean error ●
- RMS error ○
- Mean absolute error ○
- Anomaly correlation ○
- PDF similarity score ○
- Coefficient of efficiency ○
- Pattern Correlation ○

Process

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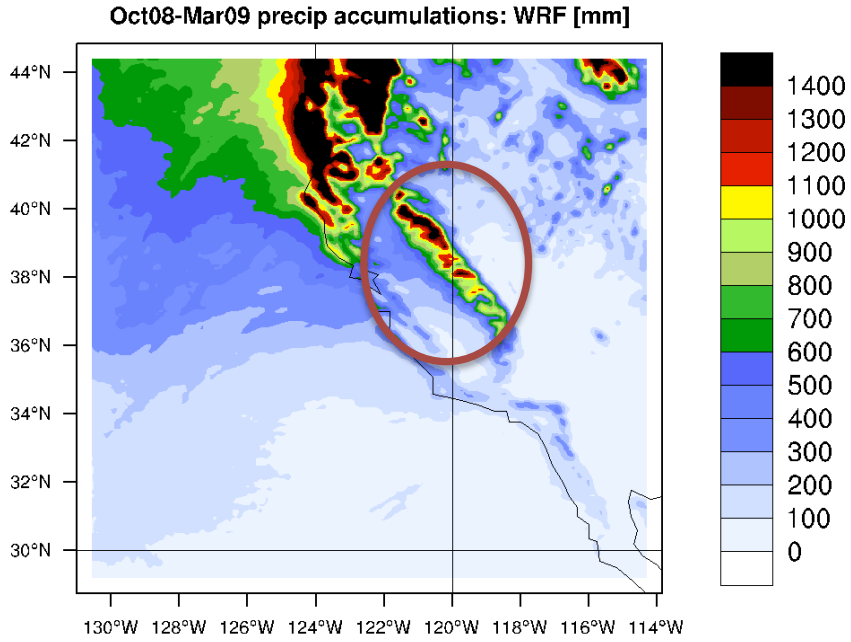
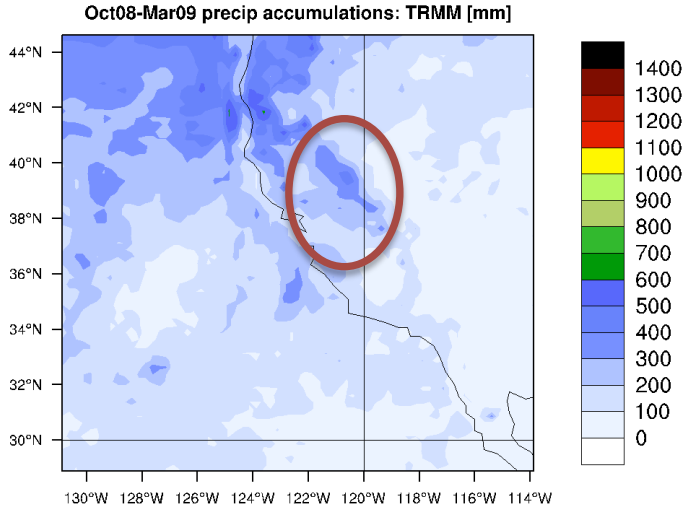
Example output

e.g. Comparison of WRF seasonal precipitation with TRMM & URD

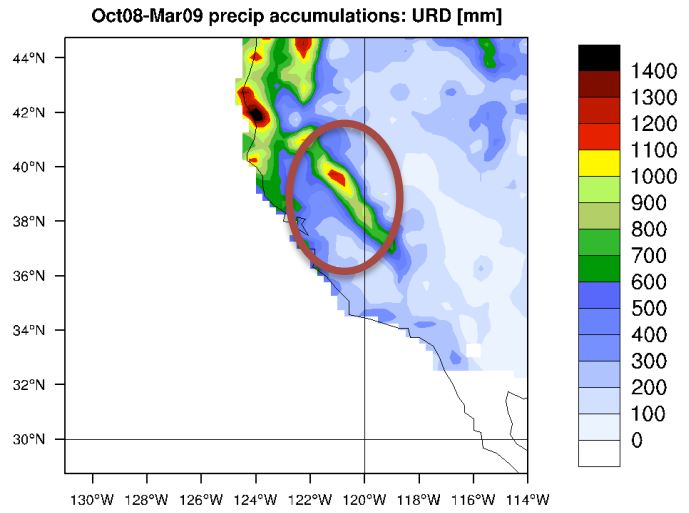
WRF model



TRMM observations

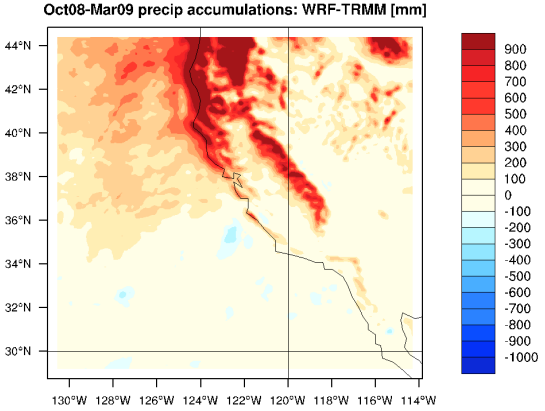


URD gridded rain gauge

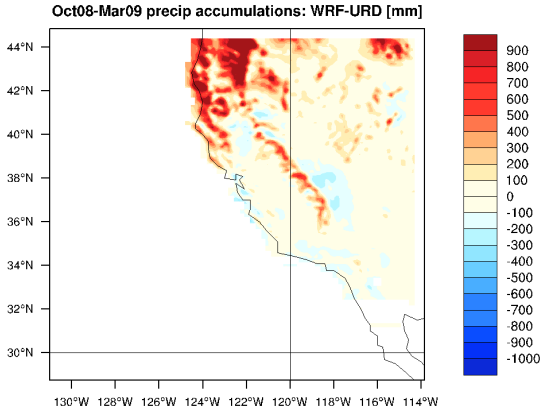


Biases

Against TRMM



Against URD



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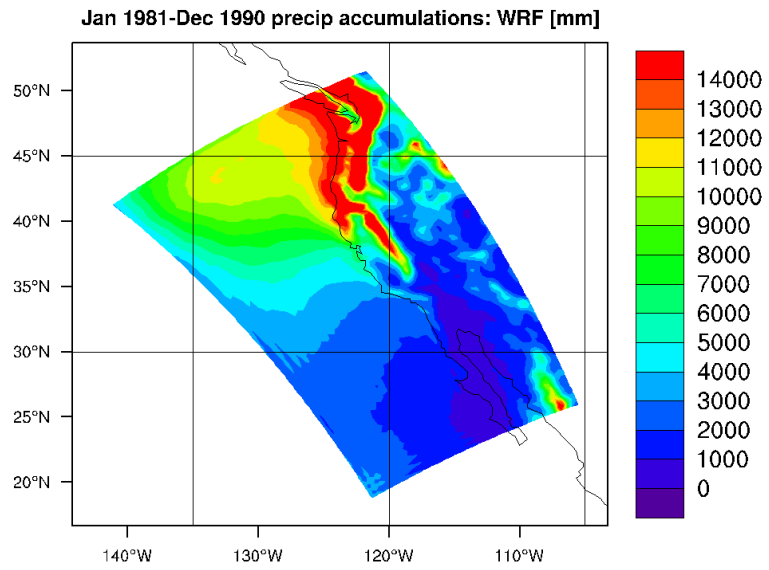
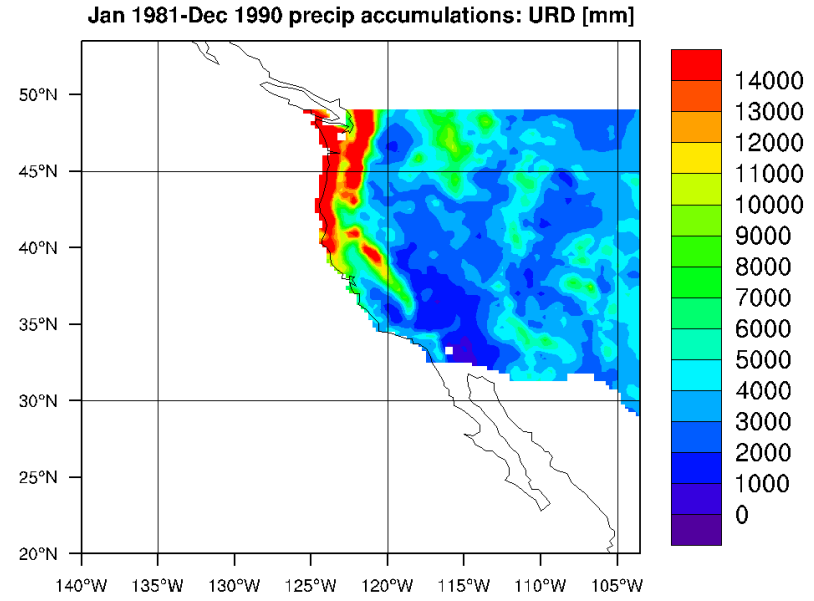
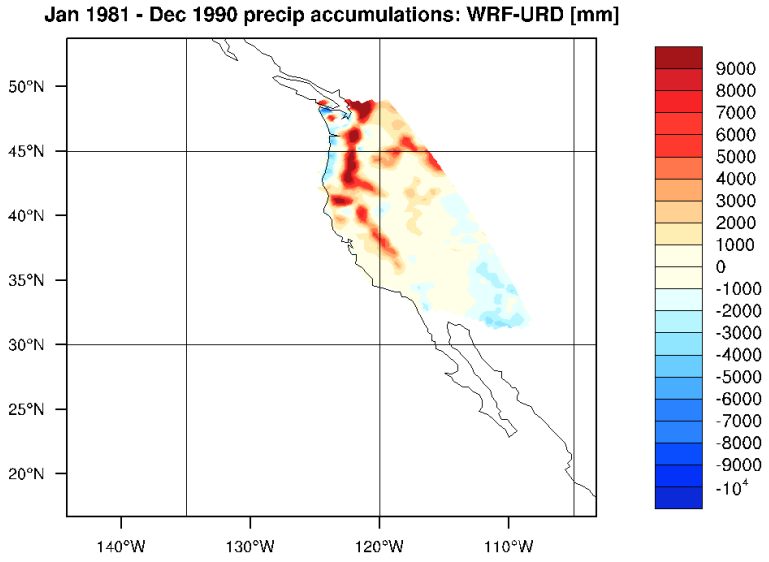
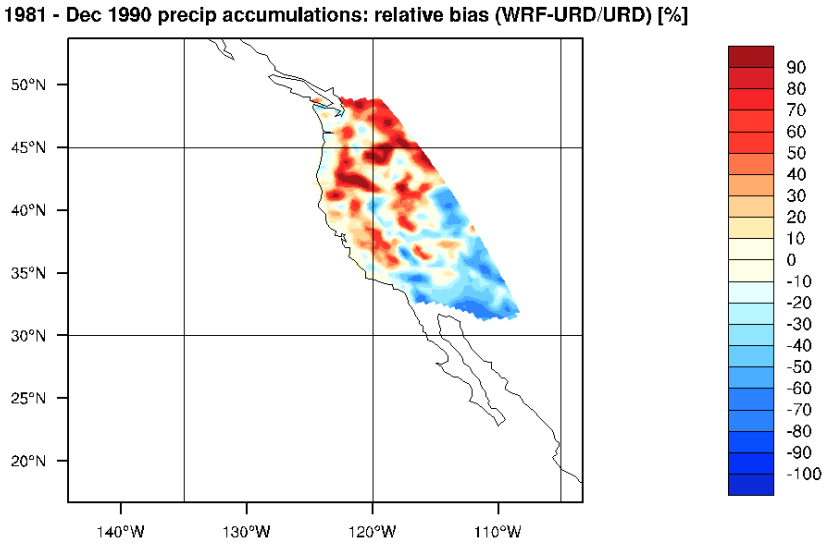
e.g. Using model data on rotated grid and observations with missing data

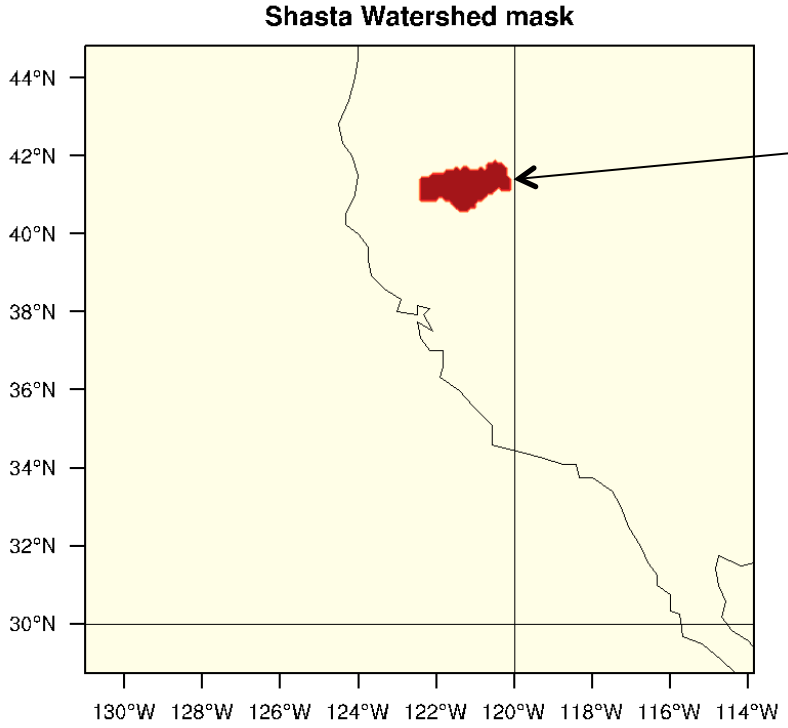




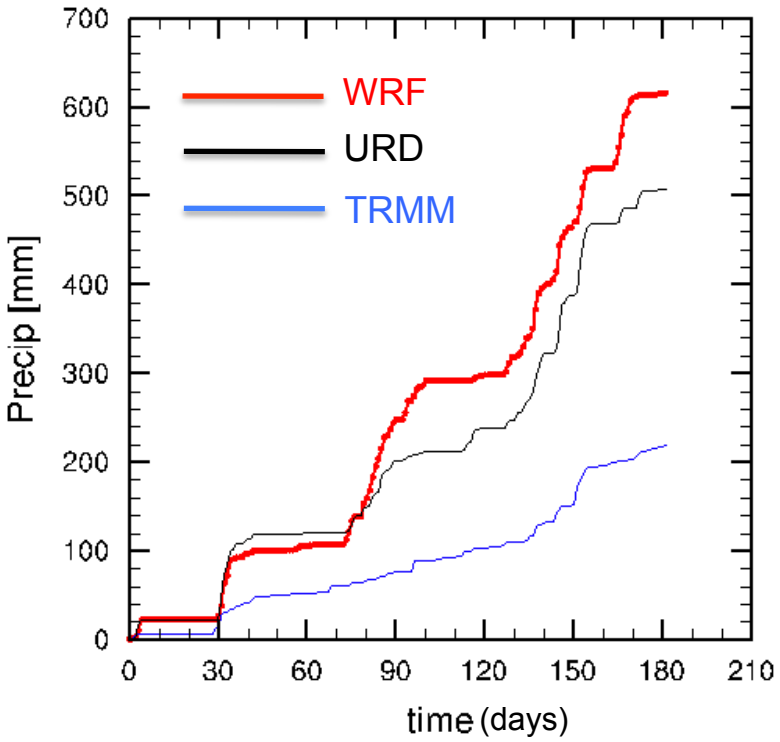




e.g. Metric calculations over masked regions + time series



User specified mask



NB. TRMM resolution = 0.25° x 0.25°
URD resolution = 0.25° x 0.25°
WRF resolution = 0.12° x 0.12°

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Future directions

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CORDEX collaboration

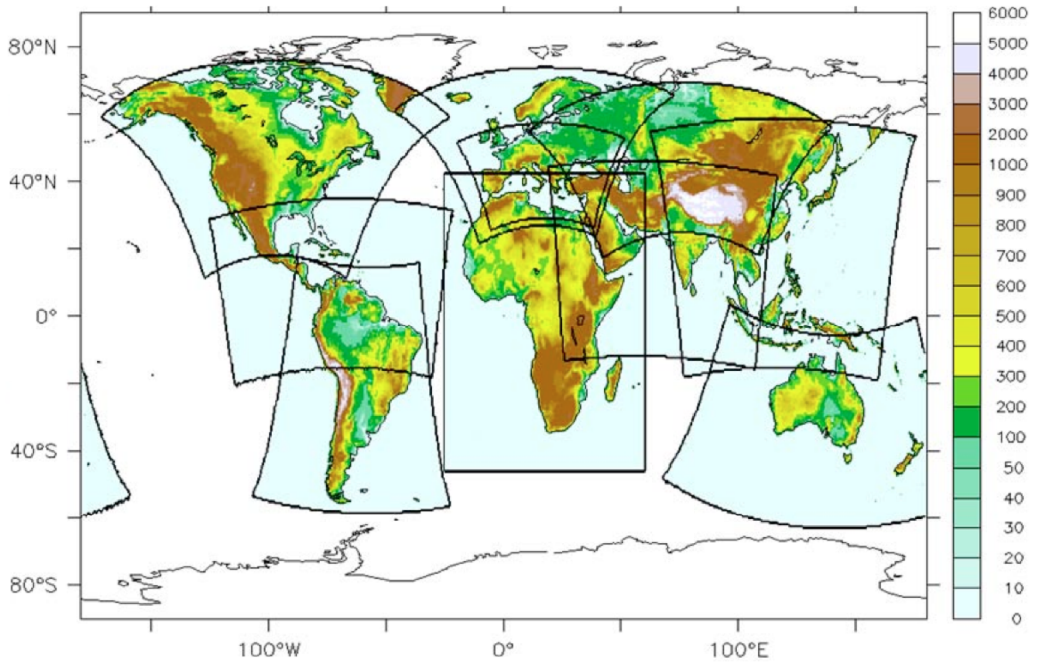
Co-Ordinated Regional climate Downscaling EXperiment (CORDEX)

- Framework to co-ordinate regional modeling activities associated with CMIP5.

- Multiple models on standard pre-defined grids.

- Vast quantity of model data that requires evaluation.

- JPL collaborating with CORDEX project to utilize RCMES in evaluation studies.



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Conclusions

- JPL/UCLA has designed and developed a new model evaluation framework which can be built upon in the future.
- The system has demonstrated the ability to quickly produce comparisons of models against several different observation datasets.
- A collaboration has been setup with the CORDEX project to utilize the system to evaluate downscaled CMIP5 projections from multiple models.

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