A prototype Global Drought Information System based on real-time satellite precipitation estimates

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1. Background

Droughts and floods are pervasive natural hazards. While the absolute magnitude of their associated losses is greatest in the developed world, the relative impact is much higher in the developing world. Nonetheless, **our ability to monitor and predict the development and occurrence of droughts and floods at a global scale in near real-time is limited.** The problem is particularly critical given that many of the most damaging floods and droughts occur in parts of the world that are most deficient in terms of in situ precipitation observations.

2. Global Drought Information System (GDIS)

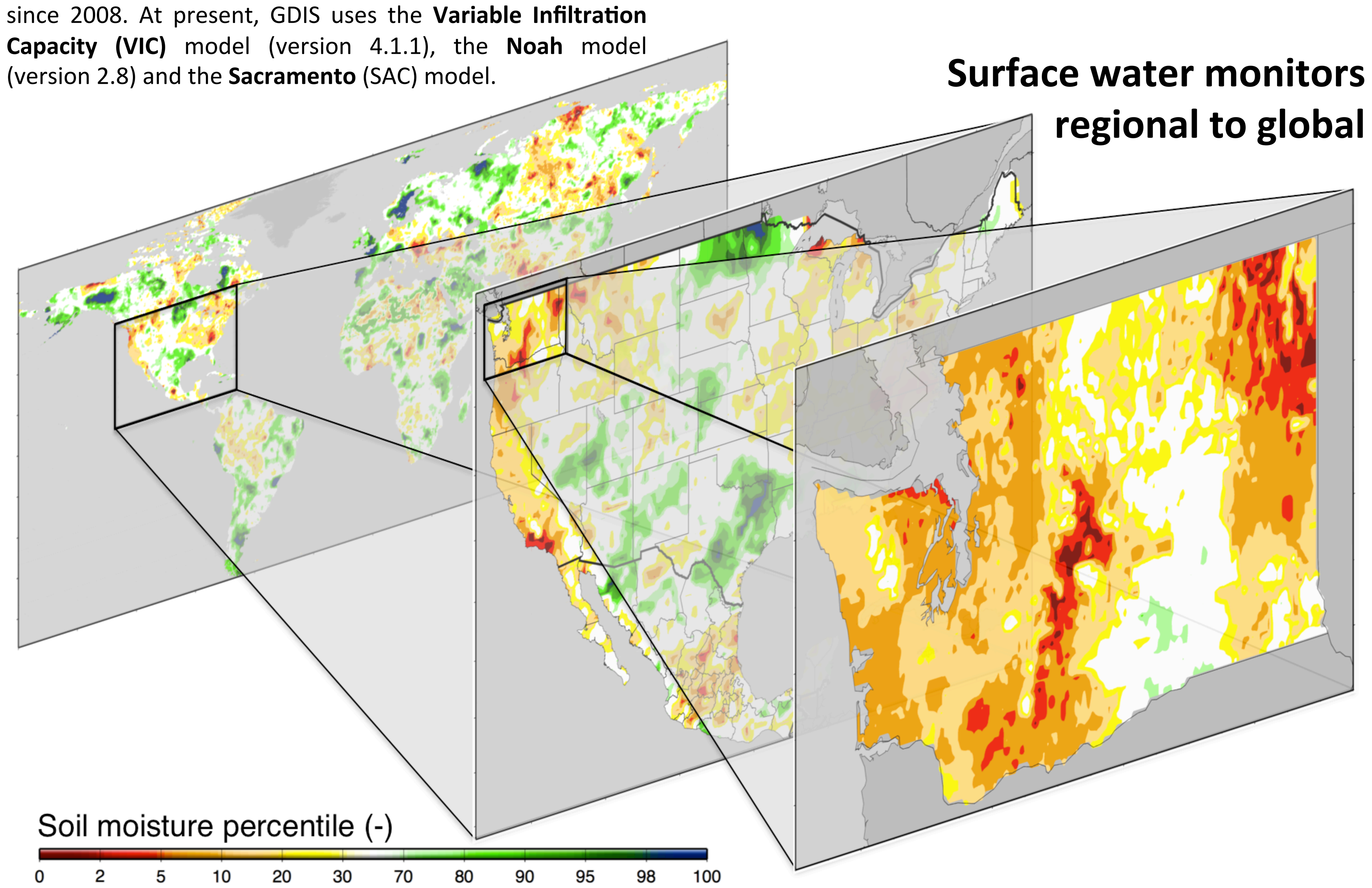
The Global Drought Information System (GDIS) combines soil moisture simulations from multiple land surface models to **provide near real-time estimates of soil moisture conditions for the global land areas between 50ºS and 50ºN.** The system is an extension of similar systems developed by our group for Washington State, the United States, and Africa.

Global application of the protocols used in the U.S. systems poses new challenges, particularly with respect to the generation of meteorological forcings with which to drive the land surface models. For the near real-time component, the system uses analysis fields from the Global Forecast System for temperature as well as TRMM-based precipitation estimates. Once the system is fully operational, drought conditions can be estimated with a time lag of about one day.

3. Models

The land surface models used in the prototype GDIS are a subset of the models that are part of a regional drought monitor, which covers both the United States and Mexico, and which has operated at the University of Washington since 2008. At present, GDIS uses the **Variable Infiltration Capacity (VIC)** model (version 4.1.1), the **Noah** model (version 2.8) and the **Sacramento** (SAC) model.

Surface water monitors regional to global



4. Drought indicator and multimodel estimate

Soil moisture conditions are reported as a **percentile** relative to a simulated soil moisture climatology for the same location and same day of the year. A separate climatology is calculated for each of the land surface models to account for structural differences in the representation of soil moisture.

A single multimodel estimate is calculated by averaging the soil moisture percentiles from the individual models, resulting in a new multimodel time series. This multimodel time series is then treated the same way as the soil moisture estimates from the individual models. A multimodel soil moisture percentile is calculated by comparing the multimodel value for a given date and given location with the multimodel climatology for the same day of year and model grid cell.

5. Challenge

The climatological period, used to determine the soil moisture percentiles for each grid cell for a given date, is based on the period 1960-2008 (Sheffield data set).

Because soil moisture conditions in the real-time simulations are compared with those from the climatological period, systematic differences between the forcing datasets must be avoided.

Correct the precipitation and temperature data sets used for the post-2008 period so that they match the Sheffield dataset (in a statistical sense) for any overlapping period.

6. Precipitation

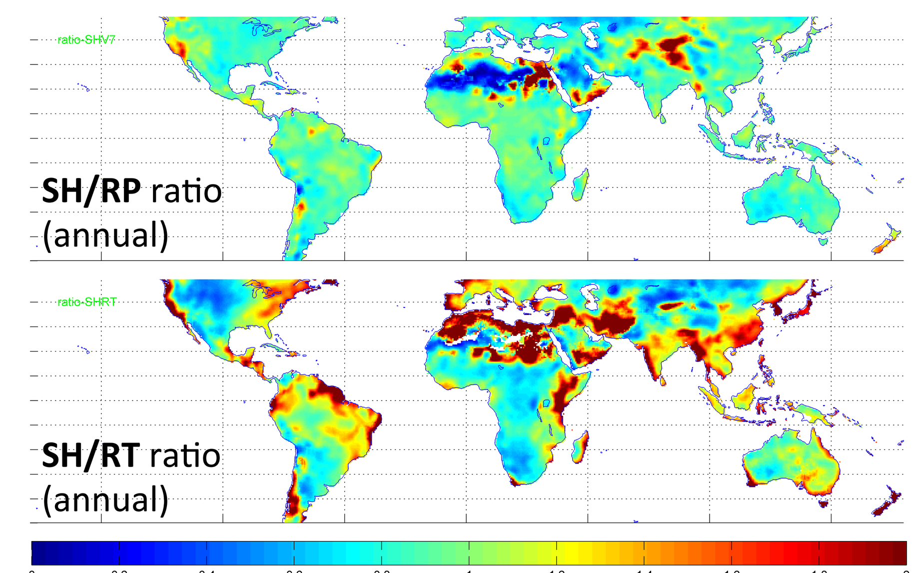
Precipitation data:

- Sheffield et al: 1948-2008 (SH)
- TMPA-V7 3B42 research product (1/1/1998 - 6/30/2012) (RP)
- TMPA-V7 3B42RT (3/1/2000-current) (RT)

Goal: Bias correct RP and RT to SH

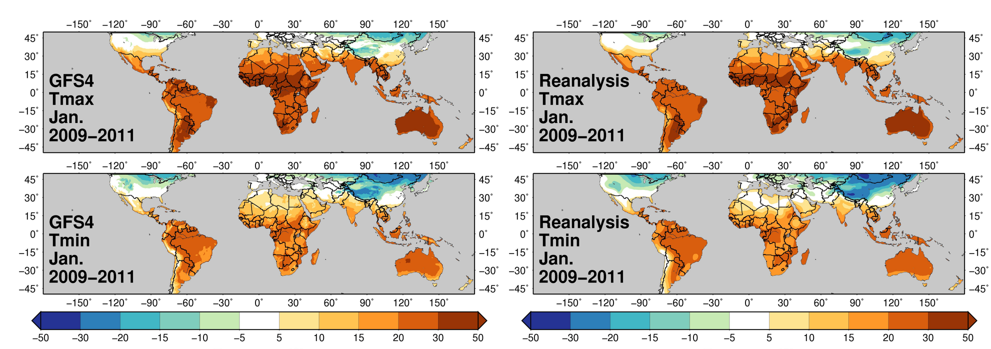
Corrections:

- Match number of rainy days from RT and RP to SH
- Match monthly mean (ratio of long-term mean)



Ratios between RT and SH are much larger (than RP and SH), because the RT data does not include station observations.

7. Temperature



Temperature data:

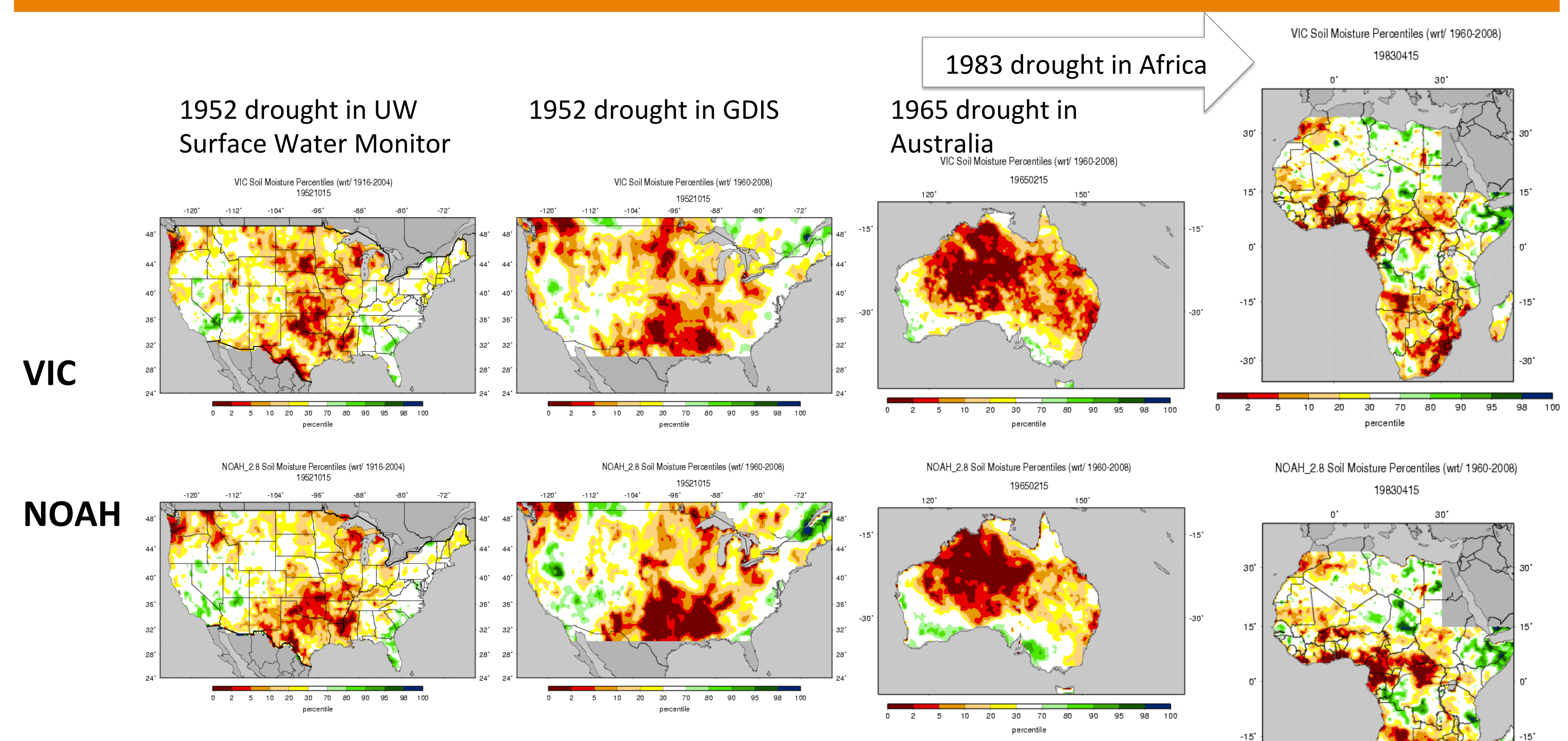
- Sheffield et al: 1948 - 2008
- NCEP/NCAR Reanalysis: 1979 - 2011
- GFS4: 2009 – Current

Goal: Bias correct daily Tmax and Tmin from RA and GFS4 to SH to ensure temperature range is preserved

Corrections:

- Interpolate fields to 0.5 degrees
- Calculate mean monthly Tmax and Tmin offsets
- Impose calculated offsets for each month on interpolated data

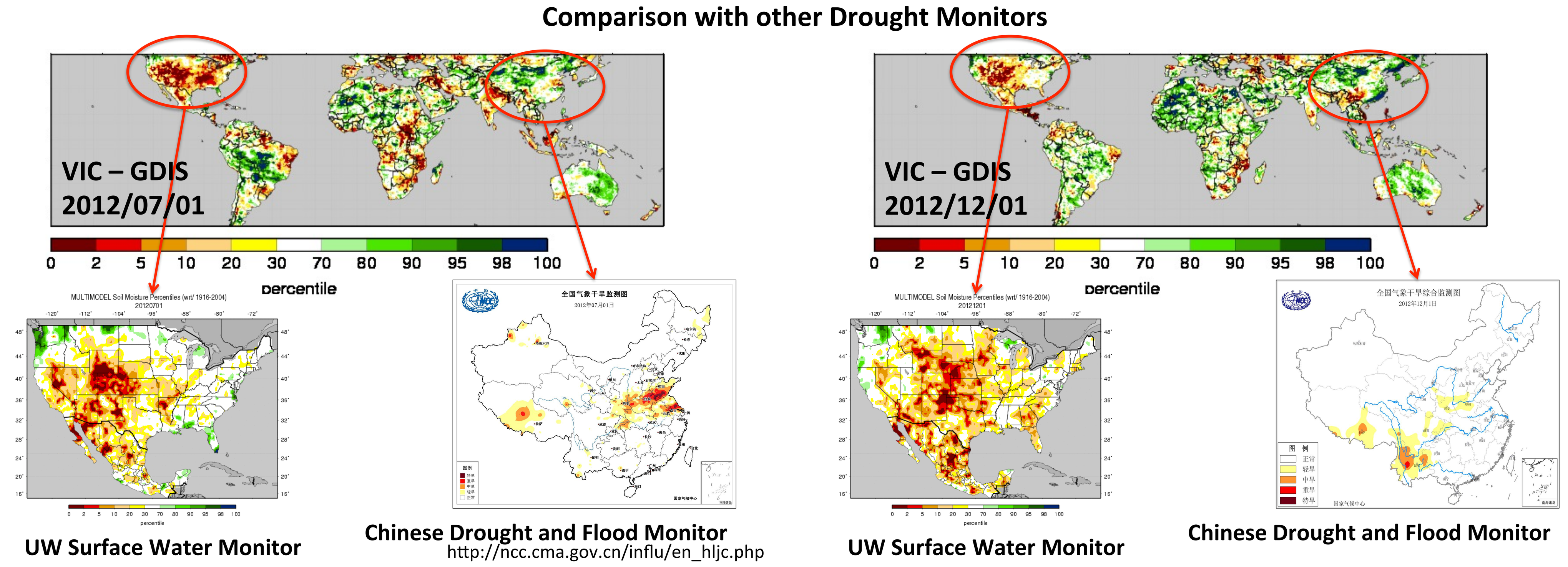
8. Retrospective



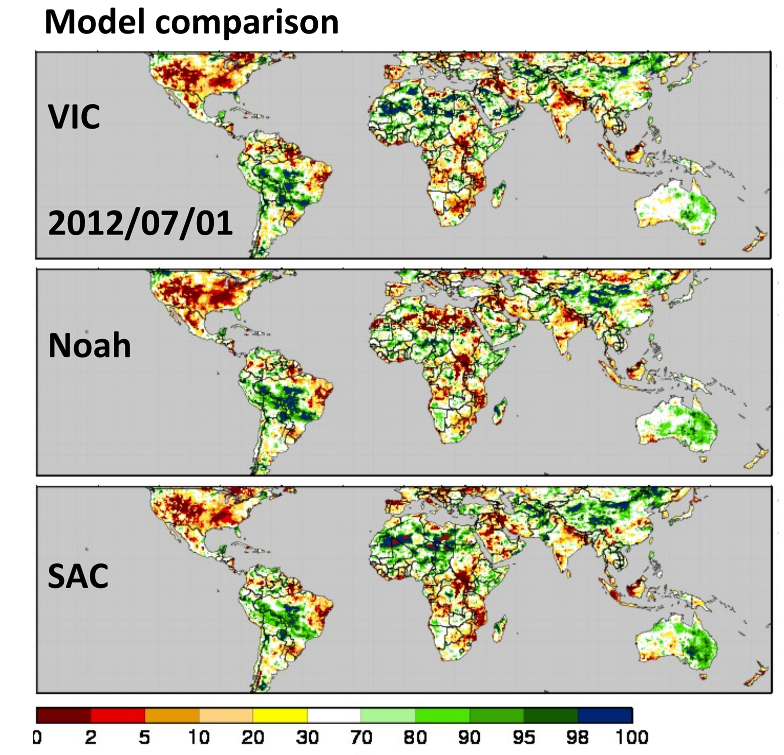
Note that the ability to reproduce historic droughts is simply a test of the GDIS system and does not depend on real-time forcings (GFS and satellite). Instead, its performance depends on the historic forcings as represented by the Sheffield dataset.

9. Near realtime

Comparison with other Drought Monitors



Model comparison



Note that the percentile method is very sensitive to small changes in moisture in dry regions such as the Sahara. The high percentiles ("wetness") in that region is not realistic.

10. Conclusion

- Global multimodel drought nowcasting is entirely feasible now
- Droughts only make sense when expressed relative to a climatology – hence climatically consistent near real-time data are essential.