Baseline Development:
A Quick Look at Comparing CMIP3 to CMIP5 GCM Outcomes for Santa Cruz

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As part of developing the "baseline," we are working to integrate climate change information into the analysis of surface water stream flows (developed by Shawn Chartrand, at Balance Hydrologics). These results will then be used as inputs in the *Confluence* model (developed and run by Gary Fiske), so we can examine impacts on surface water yields and system performance.

As part of this on-going work item, we have been examining what climate change information to place into this assessment. The initial effort is looking at a relatively benign (relatively "wet") climate change projection to integrate into the baseline (for what we are calling an "Enhanced Traditional" scenario, which is a "best case" scenario against which to evaluate the status quo water system as baseline). We also plan, later, to use results from relatively "dry" climate change projections to better assess outcomes under the Climate Change scenario.

The on-going work examining climate change impacts on surface water flows and system performance for Santa Cruz draws on downscaled projections from *CalAdapt*, derived from two Global Climate Models (GCMs) selected from the suite of CMIP3 GCMs used in IPCC's *4th Assessment Report*. This enables an expeditious look at potential climate change impacts, as the downscaled results are already available, and Shawn Chartrand has already accessed and reviewed them. He currently is working on developing the best approach for integrating these climate change impacts through his flow model, and these results will then be fed by Gary Fiske through the *Confluence* model.

There is a new suite of GCMs from the more recent IPCC's *5th Assessment Report*, and these are known as the CMIP5 suite of GCMs. Downscaled results for the CA-endorsed subset of CMIP5 GCMs are not yet available from *CalAdapt.* However, we have our own set of CMIP5 results, derived from a similar approach, as reported in materials we circulated to the Committee in late July.[1] Hence, we are able to examine how the CMIP3 findings may differ from the more recent CMIP5 results.

We undertook a preliminary investigation of how the CMIP3 results may differ from the newer suite of CMIP5 GCMs, to gain some perspective as to whether the newer models might yield significantly different results than those derived from CMIP3. We had run projections for 3 of the CA-endorsed

[1] The results generated and reported here by Stratus, for both CMIP3 and CMIP5 GCMs, are derived using SimCLIM 2013 software (Yin et al., 2013; Warrick, 2009). The results developed and available through *CalAdapt* may entail a somewhat different methodology and/or report results in different spatial grids or timesteps. Both approaches entail "Bias-Correction Spatial Disaggregation" (BCSD) which is a commonly used method to increase the resolution of the GCM data and "correct" for biases in the GCM. "Biases" are identified by examining differences between climatological mean values for the observed data and GCM-generated values for a historical reference period. This correction is done at a higher spatial resolution than provided by the GCM (with GCM grid sizes typically over 100 miles by 100 miles). The "correction" is then applied to future GCM-generated projections.

CMIP5 GCMs in July, so we had those results available -- these are "bias corrected spatial disaggregation" (BCSD) results from the GCMs, to get to smaller grid scale results. The charts that follow provide some insights as to how the CMIP3 model results we derive compare to the CMIP5 results, and suggest that the results are likely to be similar (i.e., that using the CMIP3 results may be sufficient).

More specifically, for the least impactful (wetter) of the projections, the model being used from the CMIP3 suite has monthly results that are very similar to the CMIP5 projections for maximum monthly temperature (Figure 1), albeit a tad cooler in some months. For monthly precipitation, projections from the relatively wet CMIP5-based GCM are higher for the winter period, and roughly similar for other months (Figure 2). The annual average precipitation results (Figure 3) indicate that for an average year, total precipitation using the selected CMIP5 wet model is somewhat higher than the CMIP3 result. It is not clear if this divergence would have a significant impact on the results being generated by Shawn Chartrand using the CMIP3 results (Shawn may have some additional insight on this matter, based on what he uses as inputs and how sensitive his model is to such changes).

For the driest of the models examined (Figures 4 through 6), there does not appear to be much divergence across the CMIP3- and CMIP5-based results for the GCMs selected. There is however a variation in the seasonal pattern of monthly precipitation, and the CMIP3 model is drier in terms of average annual precipitation than the dry CMIP5 model used. So, using the CMIP 3 findings for the dry scenario should be suitably conservative.

It is not clear at this level of evaluation whether the use of the CMIP3 models will skew the streamflow and *Confluence* results to any significant degree, compared to the CMIP5 results. The results appear reasonably consistent across model generations. However, the seasonal results could have important implications for stream flows and water system performance (and Shawn Chartrand can probably offer some insight based on his experience and knowledge of the stream flow models).

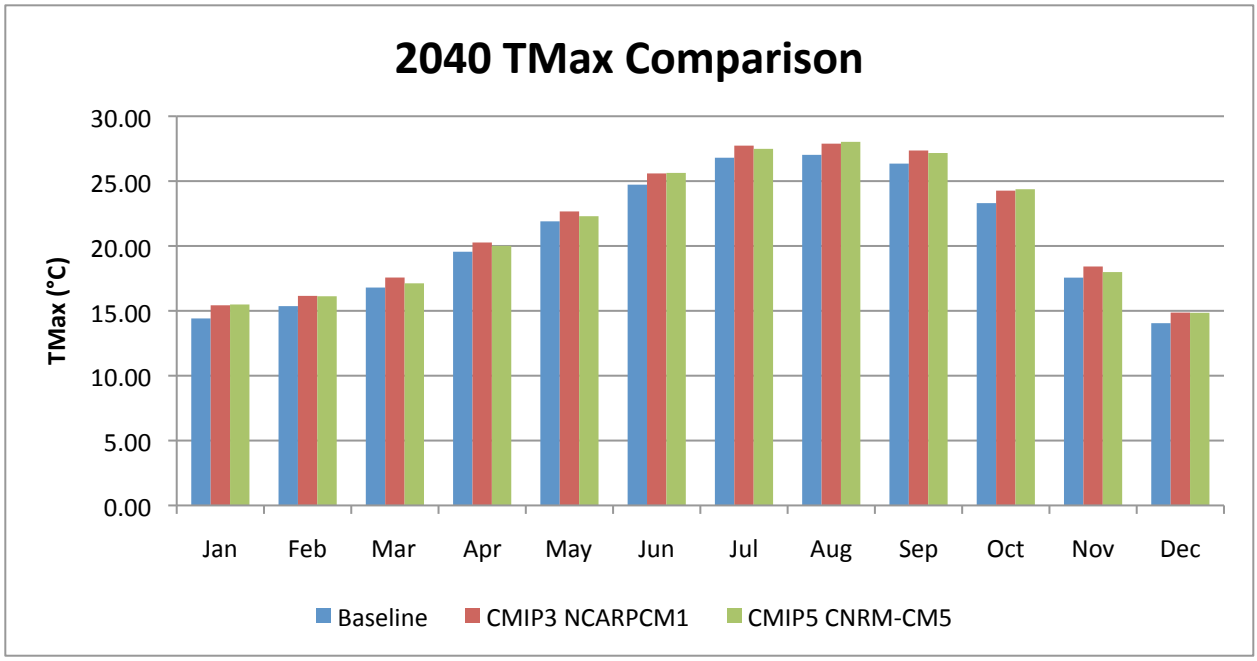

Figure 1: Wet case CC scenario – Max Monthly Temperature

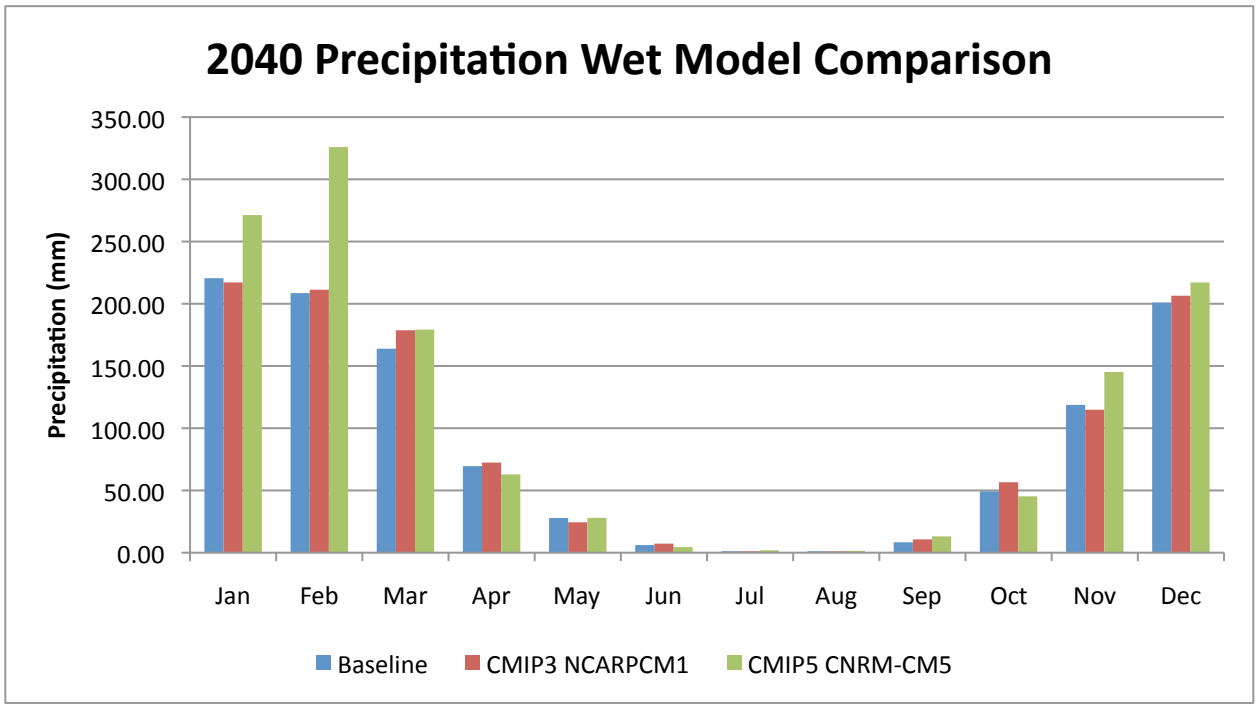

Figure 2: Wet Case CC Scenario – Monthly Precipitation

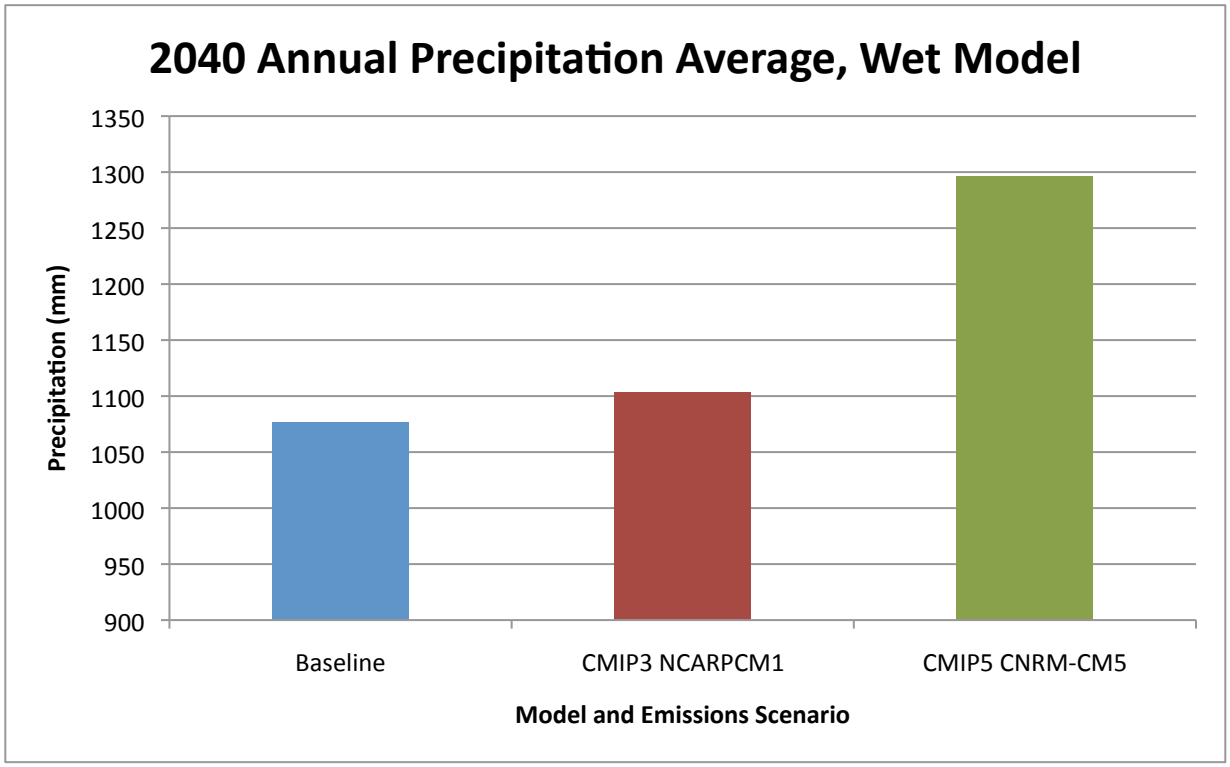

Figure 3: Annual average precipitation for wet models (CMIP3 compared to CMIP5 and baseline)

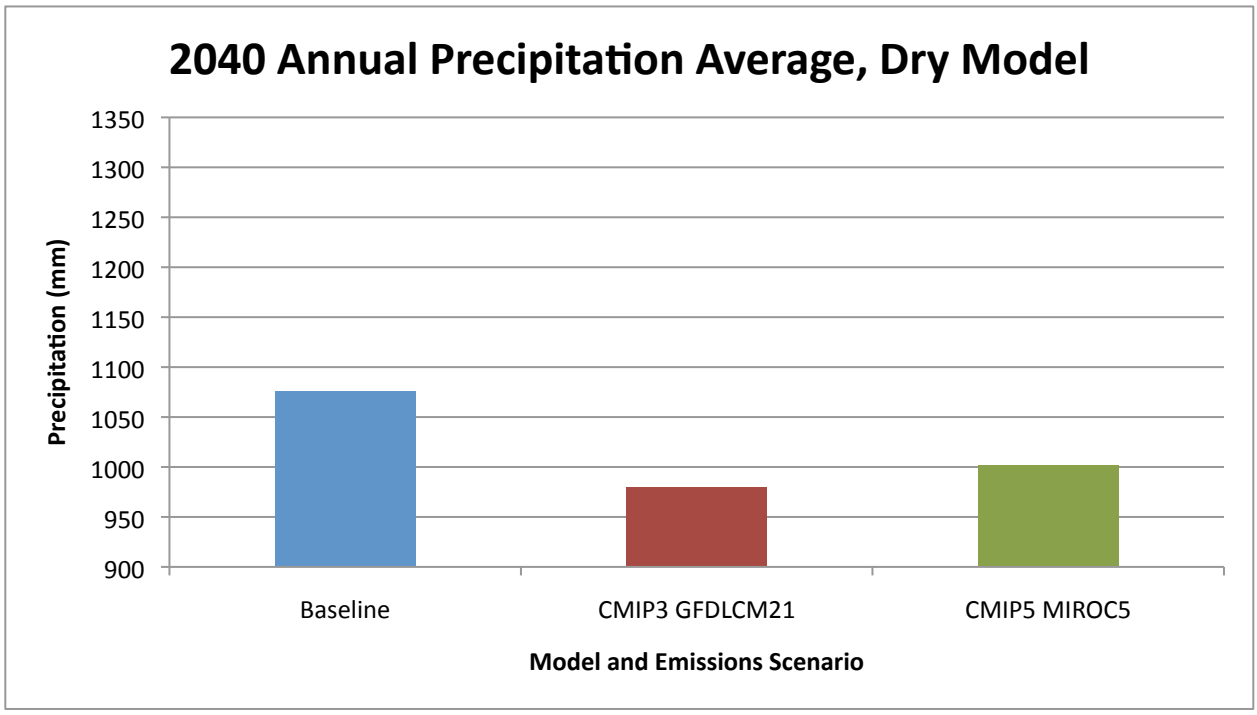

Figure 4: Annual average precipitation, dry models (CMIP3 compared to CMIP5 and baseline)

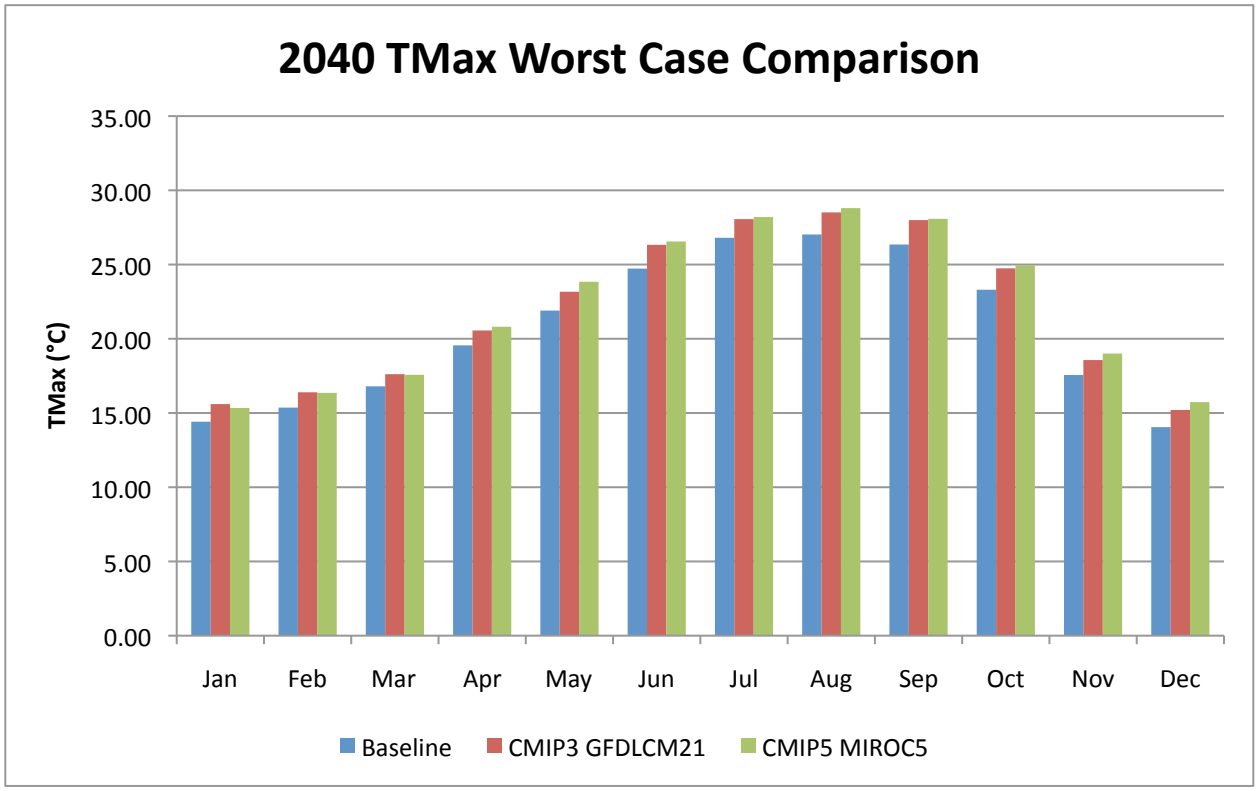

Figure 5: Dry Model projections: Max daily temp. (CMIP3 compared to CMIP5 and baseline)

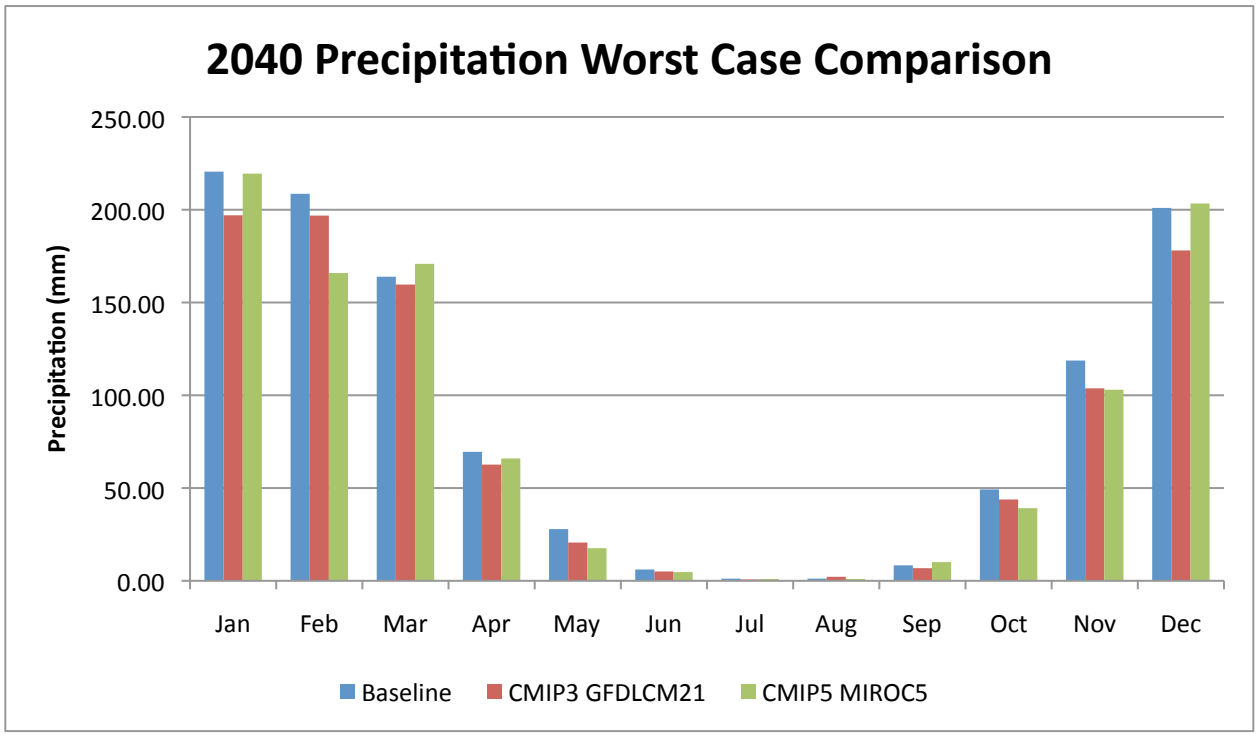

Figure 6: Dry model results: Monthly Precipitation (CMIP3 compared to CMIP5 and baseline)