Assessing the Impact of Potential Climate Changes on Surface Meteorological and Solar Energy Flux Parameters Relevant to Energy Usage and Efficiency

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Project Purpose

Purpose: Contribute to "Assessment Capabilities and Products" for the NCA by using NASA GCM output to assess potential changes

1. of future ***building climate zones*** (defined using temperature and precipitation) relative to present day and

2. in ***solar energy resource*** available for energy production and supplementation.

Project Objectives

Objectives:

- Provide baseline analysis and and uncertainty assessment for the current state of:
  1. the building climate zone estimates from GCM control model runs using MERRA and surface measurements (derived from temperature and precipitation); evaluate downscaled meteorological parameters as needed
  2. the surface solar radiation fluxes GCM control model runs using satellite based estimates of solar resource (e.g., GEWEX SRB and CERES) and surface measurements

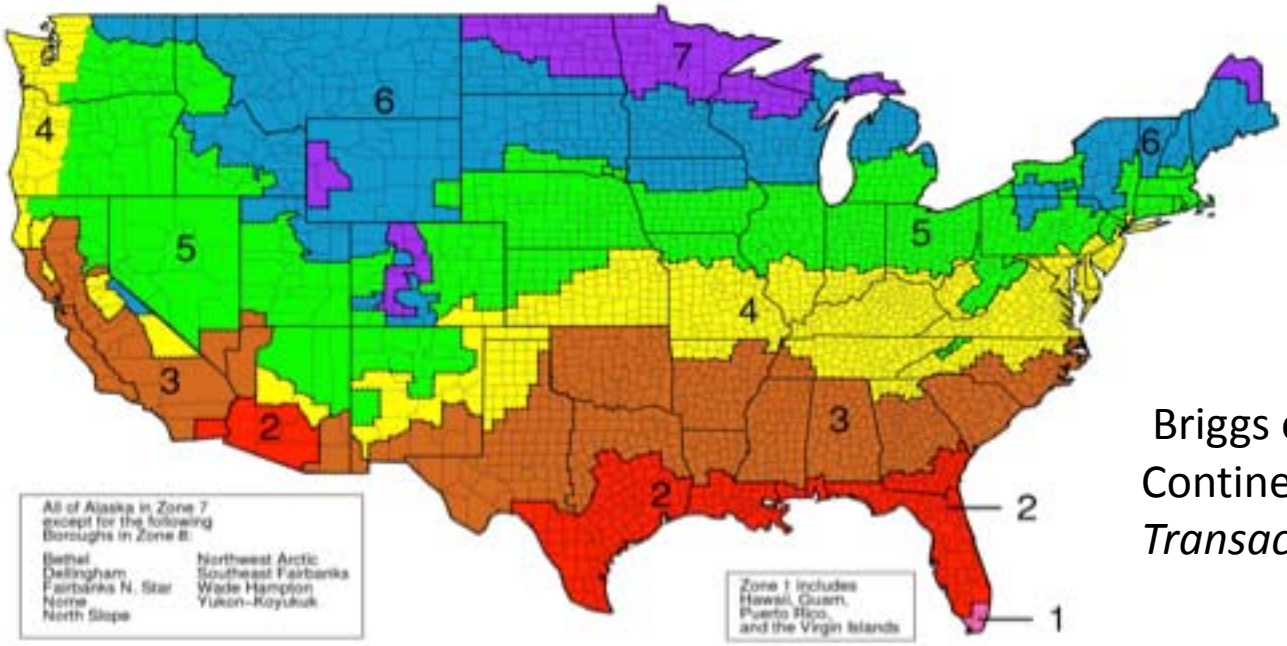
- Provide an assessment and data sets of the building climate zones and solar resource derived using GCM runs from various climate change scenarios to the present day.
  1. Assess observed shifts and changes in terms of the current climate uncertainties and variability for both quantities.
  2. Develop these climate scenario based products in formats commonly used by industry professionals for further use and assessment.
  3. Also, provide these data sets for use by other interested participants.

Work Progress & Tasks

- Assess 30 year baseline of Building Climate Zones
  - Compare MERRA to GCM baseline runs from 1981 – 2010 (match to GCM)
    - Specifically evaluate HDD/CCD and annual precipitation values & produce 30-year climate maps (½ x ½ deg)

- Assess 23 year baseline of solar fluxes
  - Use Long-term GEWEX SRB/CERES & surface measurements to evaluate GCM baseline solar fluxes
    - Evaluate variability and changes use satellite based and surface measurements
    - Leverage GEWEX Radiation Flux Assessment already on going and entering latter stages

Current Climate Zones Maps



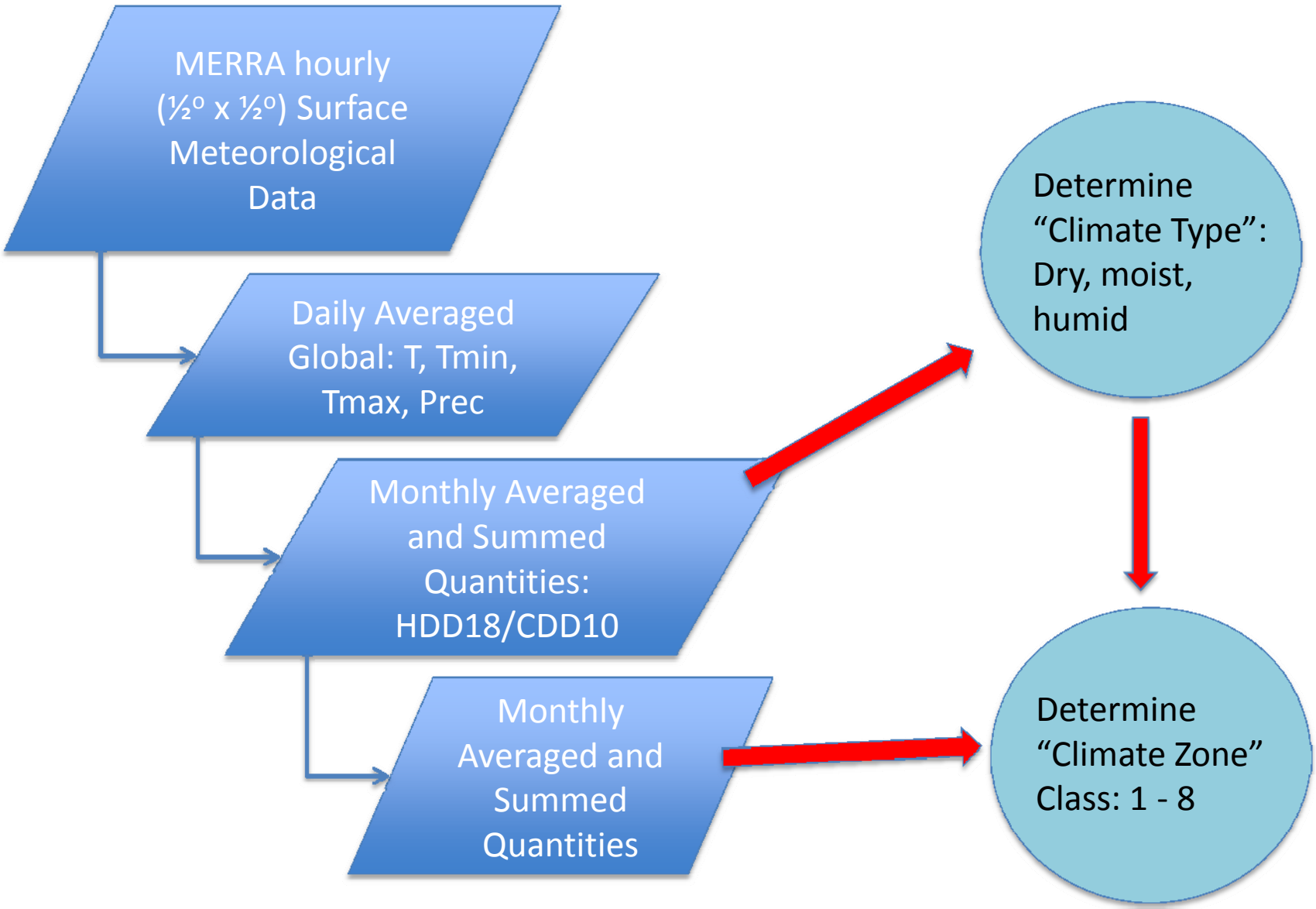
Briggs et al., 2002 of the Continental US (*ASHRAE Transactions*)

Characteristics of Briggs buildings climate zones			
Zone #	**Climate Zone Name and Type**	**Zone #**	**Climate Zone Name and Type**
1A	Very Hot – Humid	4C	Mixed – Marine
1B	Very Hot – Dry	5A	Cool – Humid
2A	Hot – Humid	5B	Cool – Dry
2B	Hot – Dry	5C	Cool – Marine
3A	Warm – Humid	6A	Cold – Humid
3B	Warm – Dry	6B	Cold – Dry
3C	Warm – Marine	7	Very Cold
4A	Mixed – Humid	8	Subarctic
4B	Mixed – Dry		

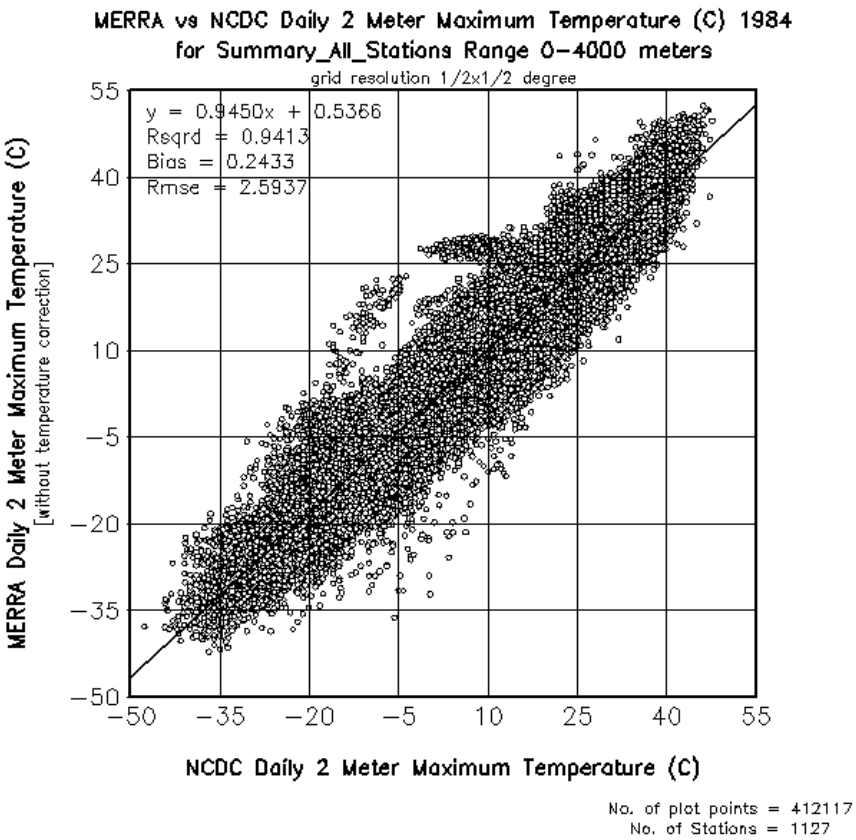
Key Parameters:

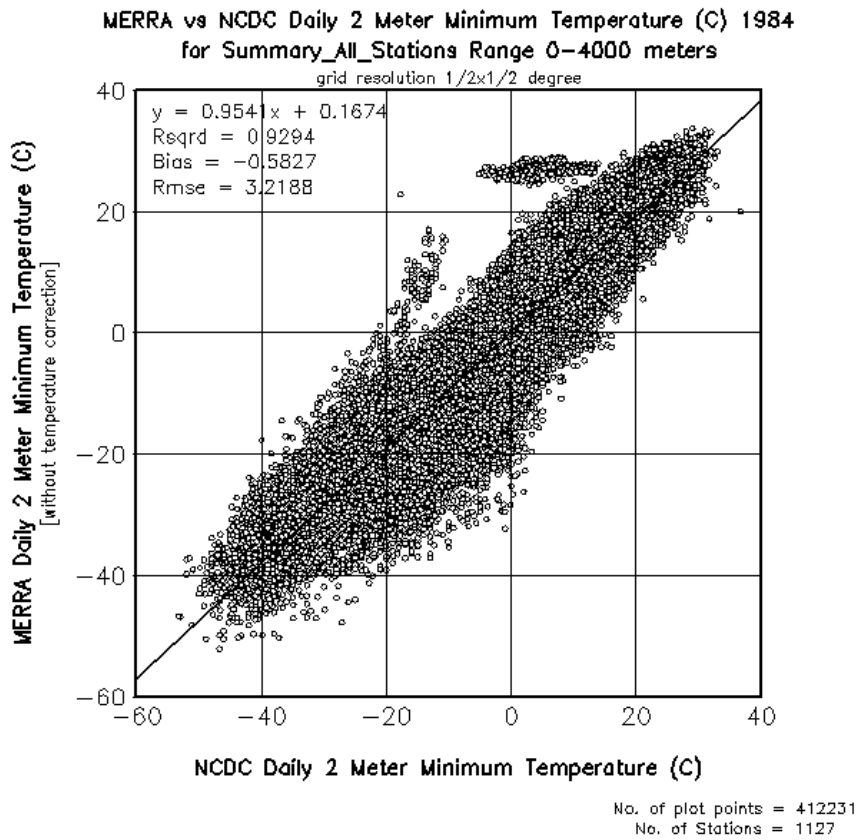
- Heating/Cooling Degree days using Max/Min daily temperatures
- Annual precipitation

Deriving Building Climate Zones from MERA

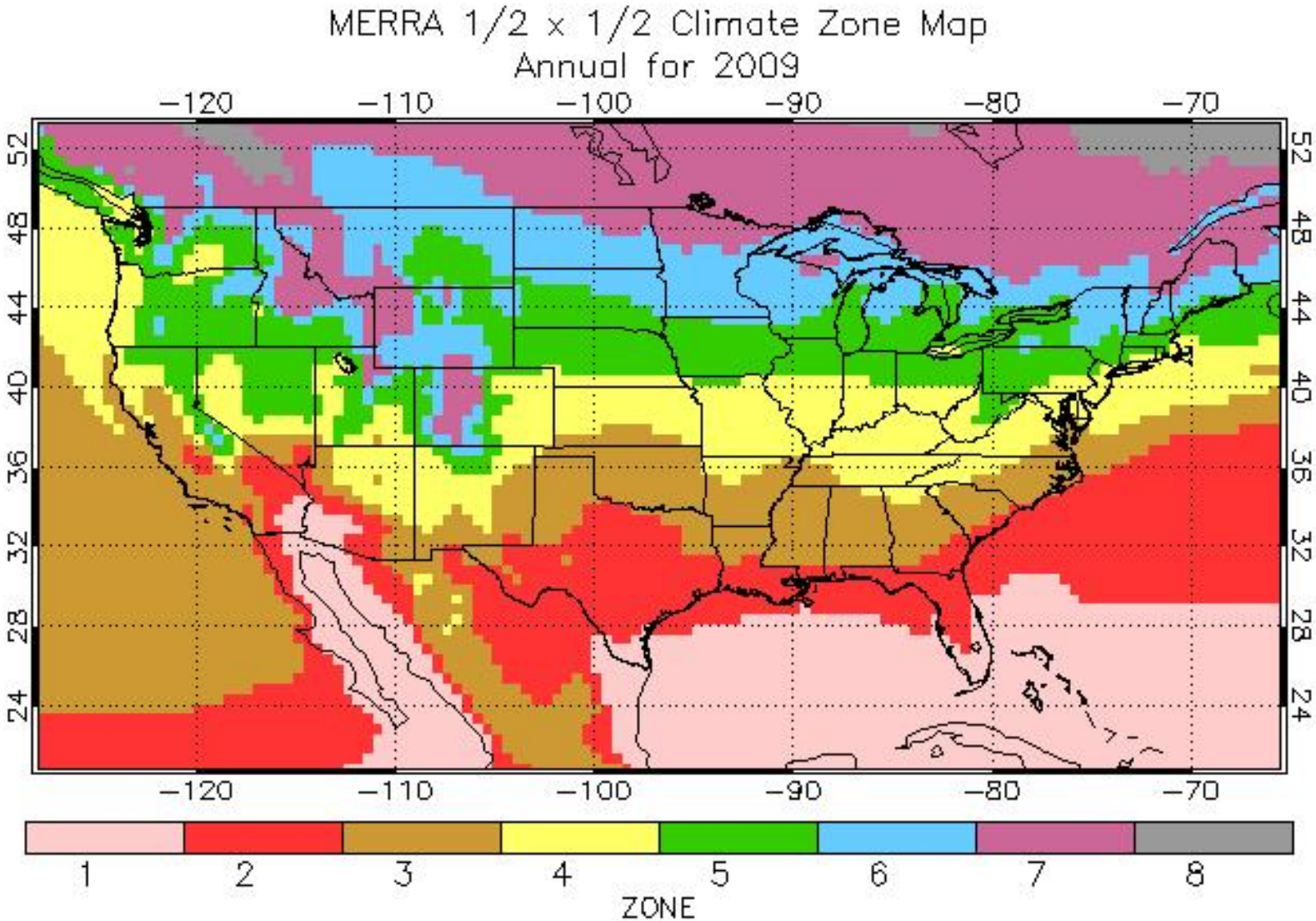


MERRA Validation
(Year by year)

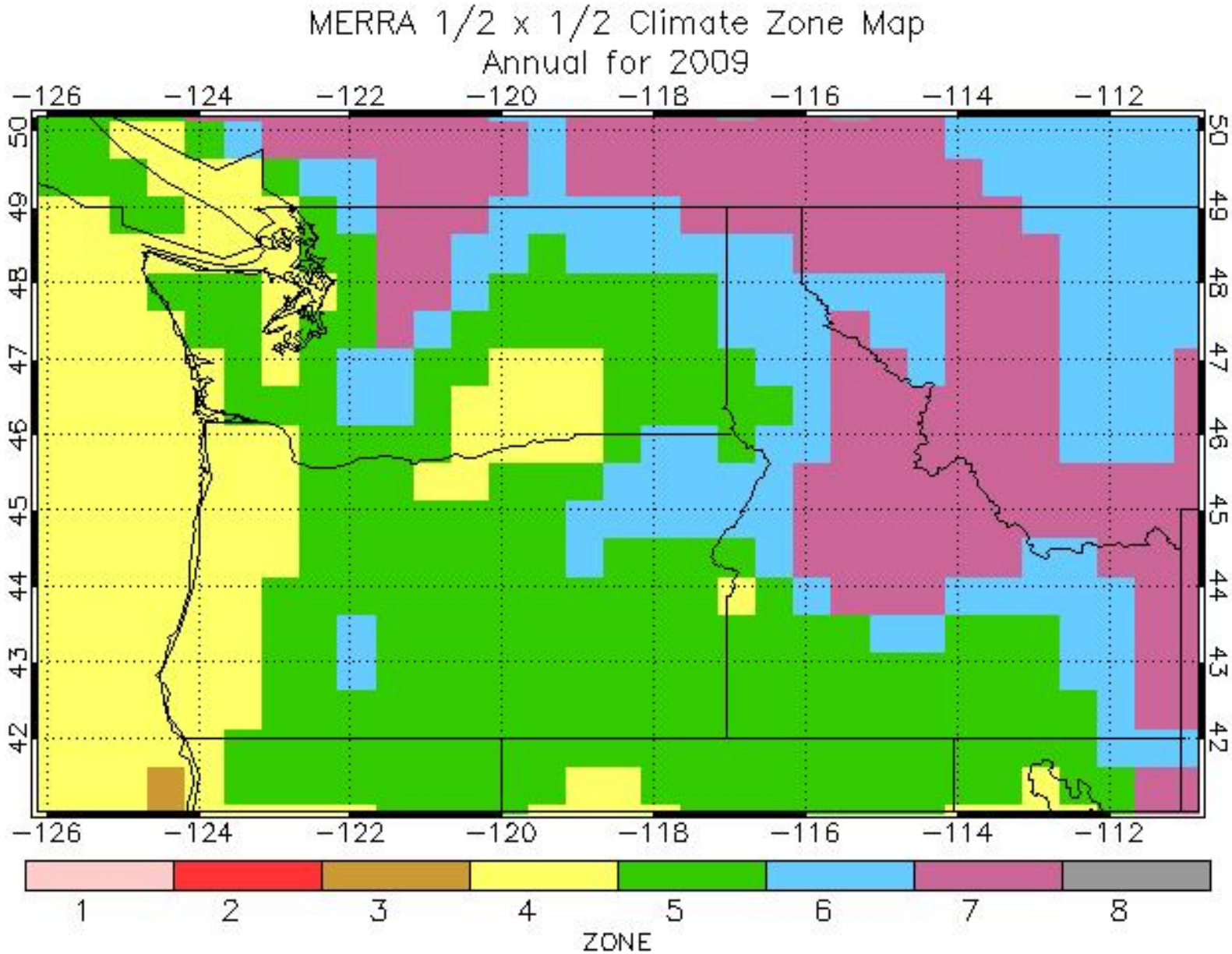




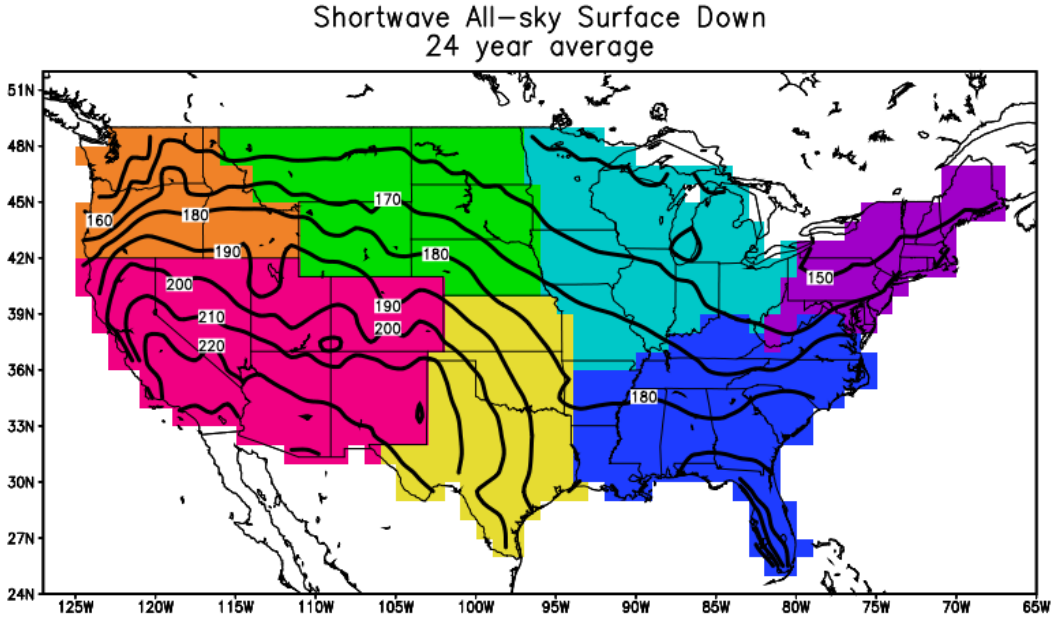
MERRA Annual Climate Zones

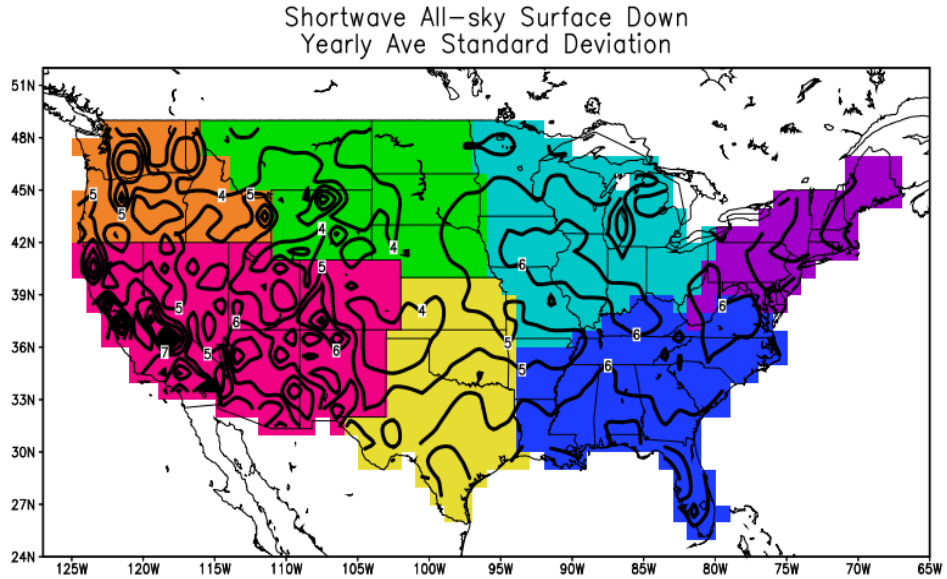


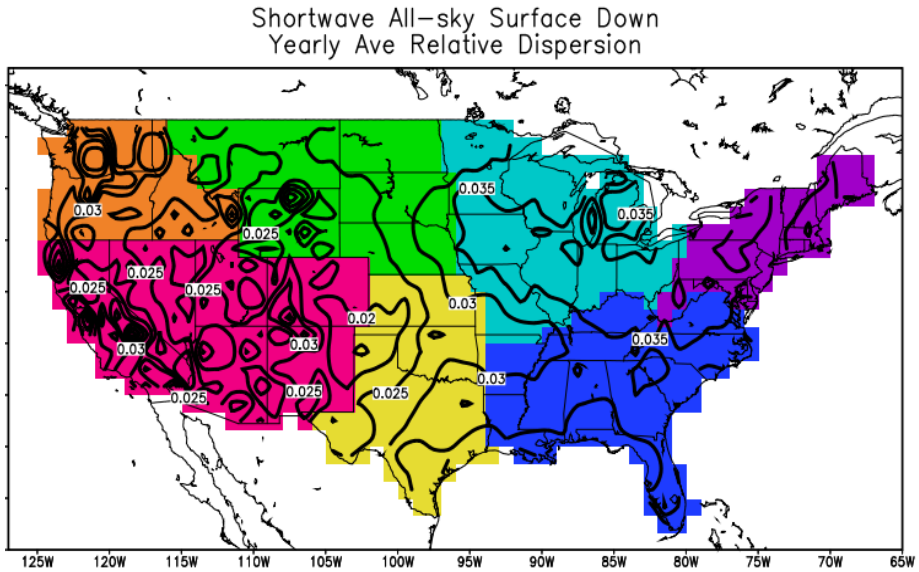
Northwest Pacific Region



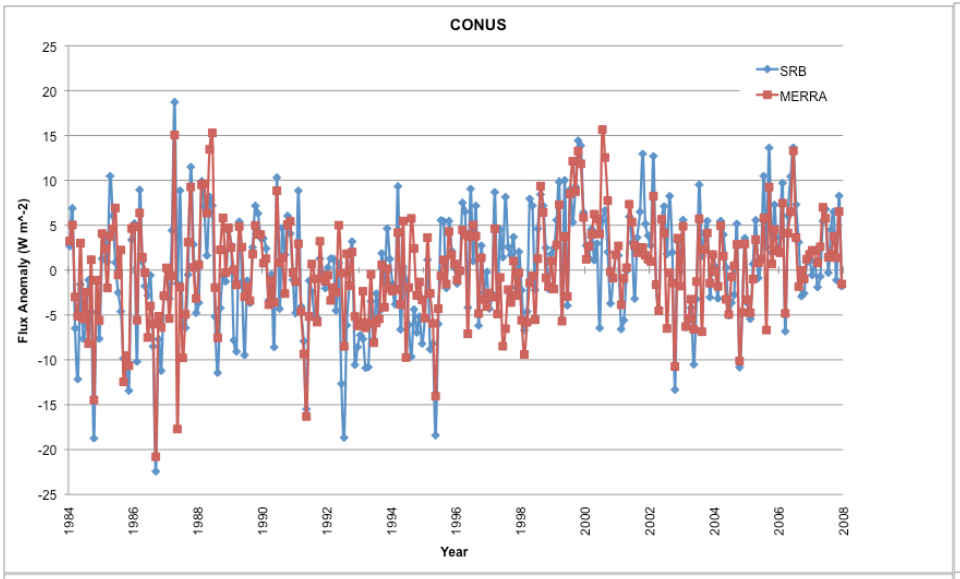
Solar Resource

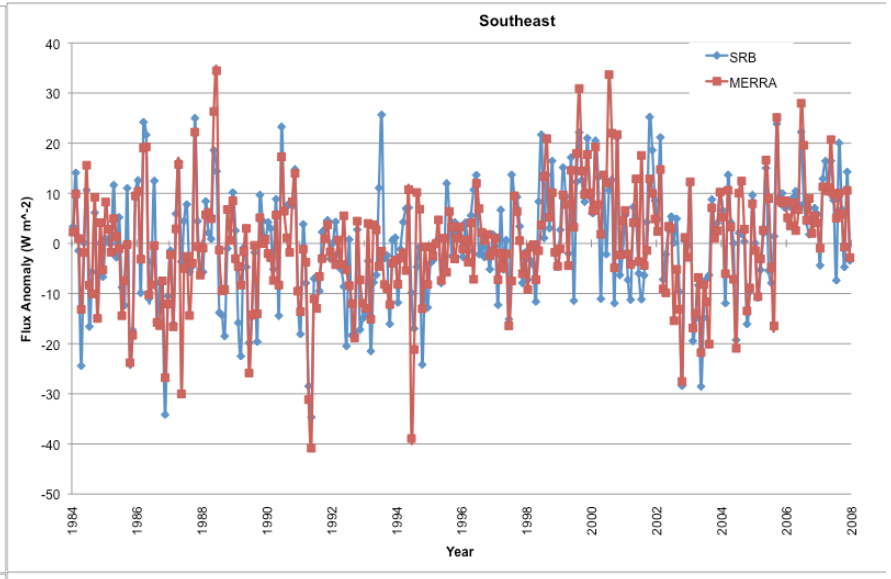


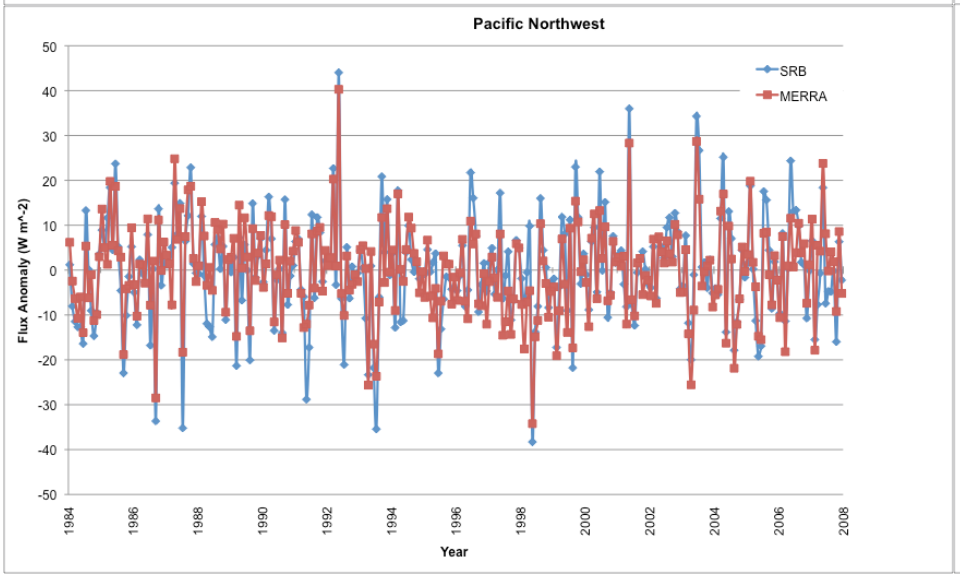


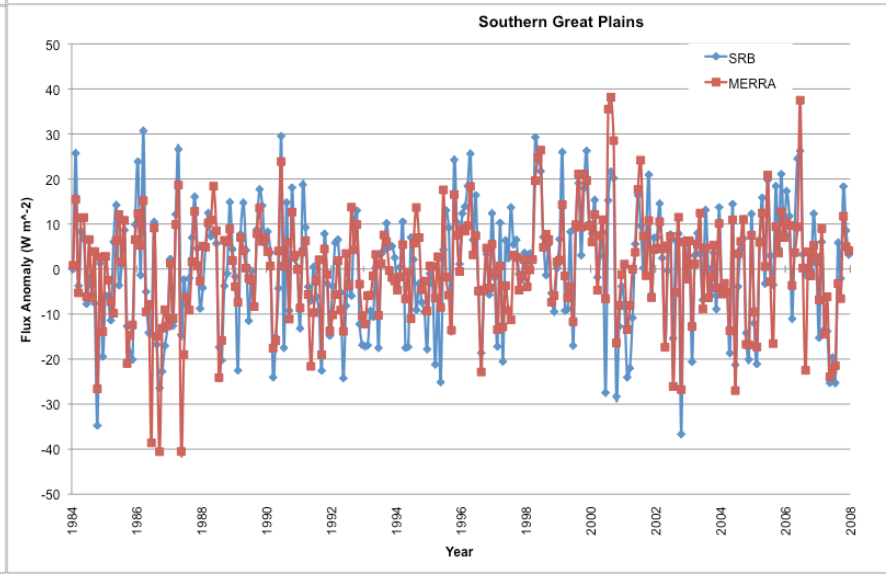


Solar Resource Variability









Complete Baseline Assessments

- **Complete assessment 30 year baseline of Building Climate Zones**
  - Complete production and evaluation of 30 year climate maps
    - Complete evaluation T, Tmin, Tmax, HDD/CCD and annual precipitation values & produce 30-year climate maps (½ x ½ deg)
    - Complete assessment of 30 year climate zones and variability during the past 30 year base period
  - Compare MERRA to GCM baseline runs from 1981 – 2010 (match to GCM)
    - Complete means and variability to GCM base states
- **Complete assessment of 23 year baseline of solar fluxes**
  - Complete solar assessment using NASA and NREL
    - Complete evaluation of variability and changes use satellite based and surface measurements
    - Leverage GEWEX Radiation Flux Assessment already on going and entering latter stages (adding CERES, MERRA)
  - Use Long-term GEWEX SRB/CERES & surface measurements to evaluate GCM baseline solar fluxes

Climate Scenario Assessment

- **Obtain Climate Scenario Runs for:**
  - 3, 30-year periods (2025, 2055, 2085)
  - 3 scenarios RCP2.6, RCP4.5 and RCP8.5
  - Assess relative to baseline with estimates of uncertainty:
    - Future Building climate zone maps
    - Solar Resource

- **Interaction with US Energy Association and ASHRAE**
  - NREL sponsored workshop on solar resources later in summer
  - Participation in ASHRAE Climate Executive Committee