The Character and Variability of Solar Irradiance across the U.S. Pacific Northwest

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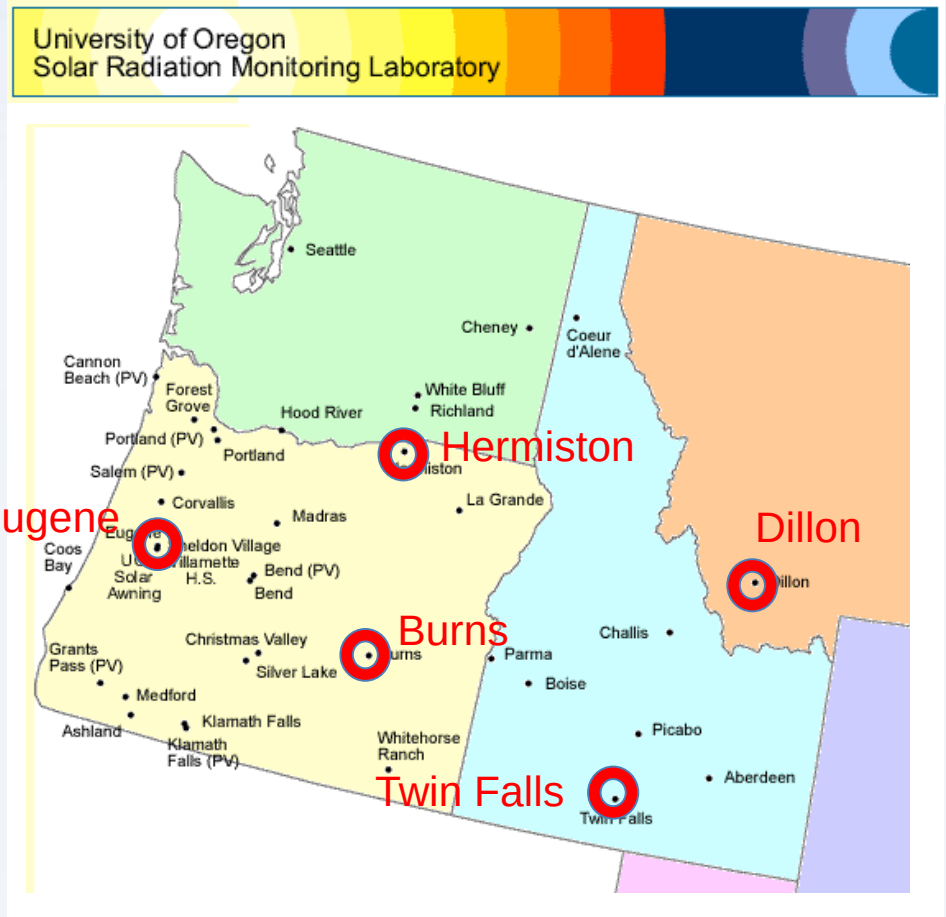
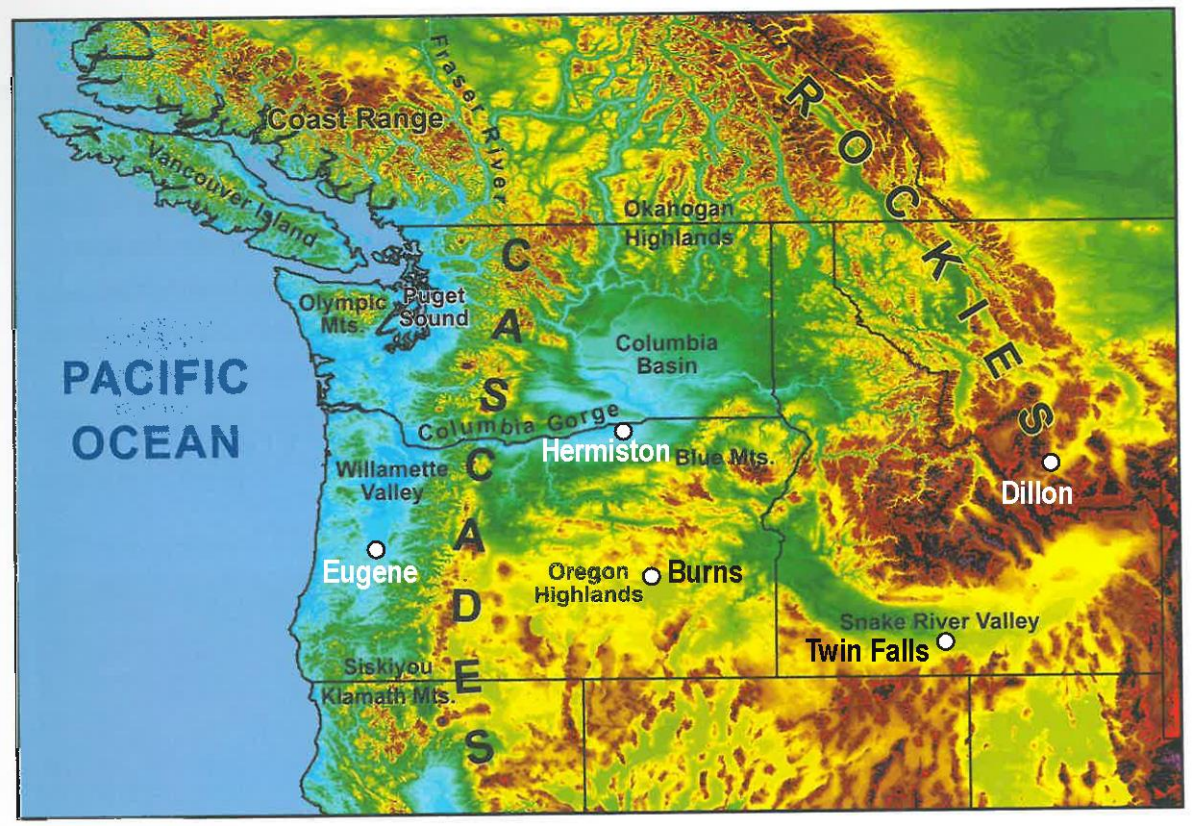
Study Sites



http://solardat.uoregon.edu

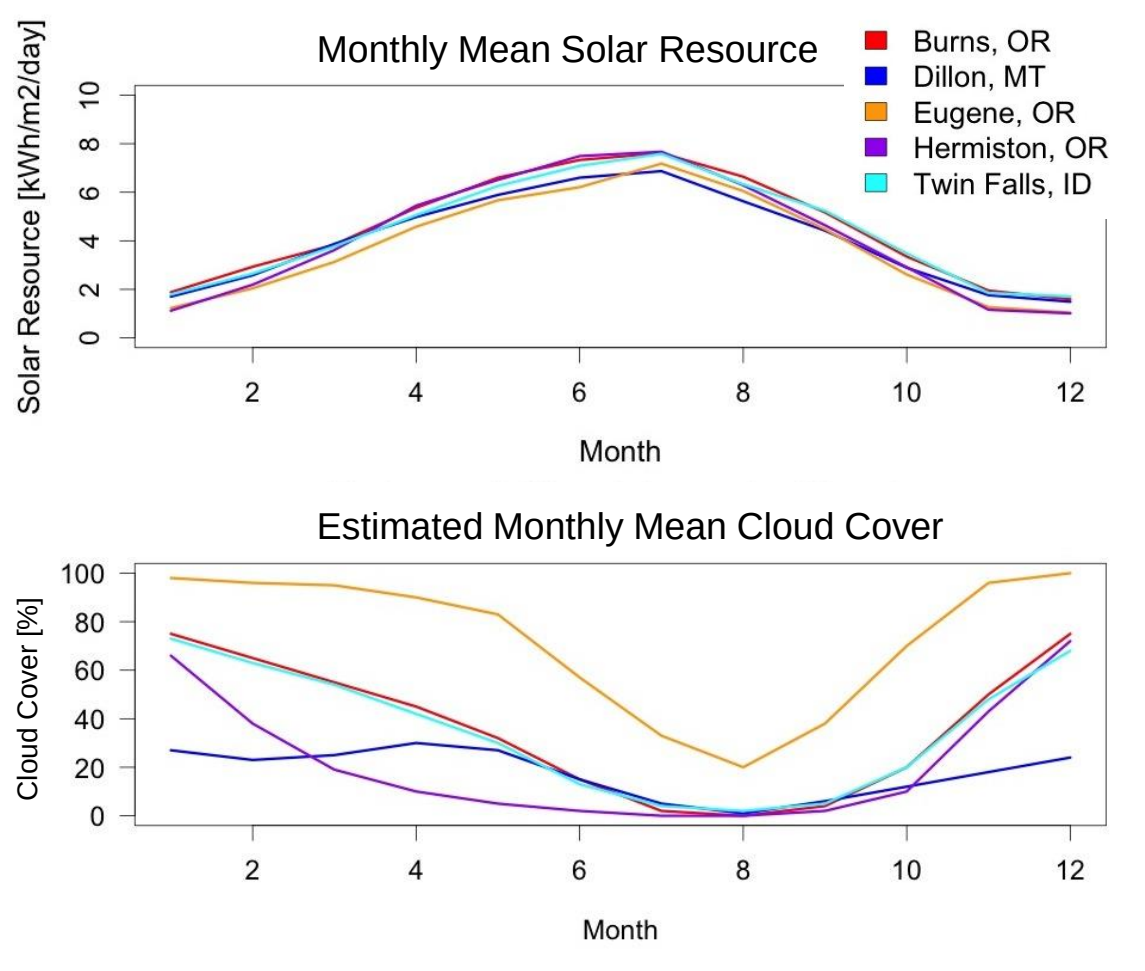
Geography of the Northwestern U.S.



Source: The Weather of the Pacific Northwest, Cliff Mass, 2008

Factors Affecting NW Solar Resource

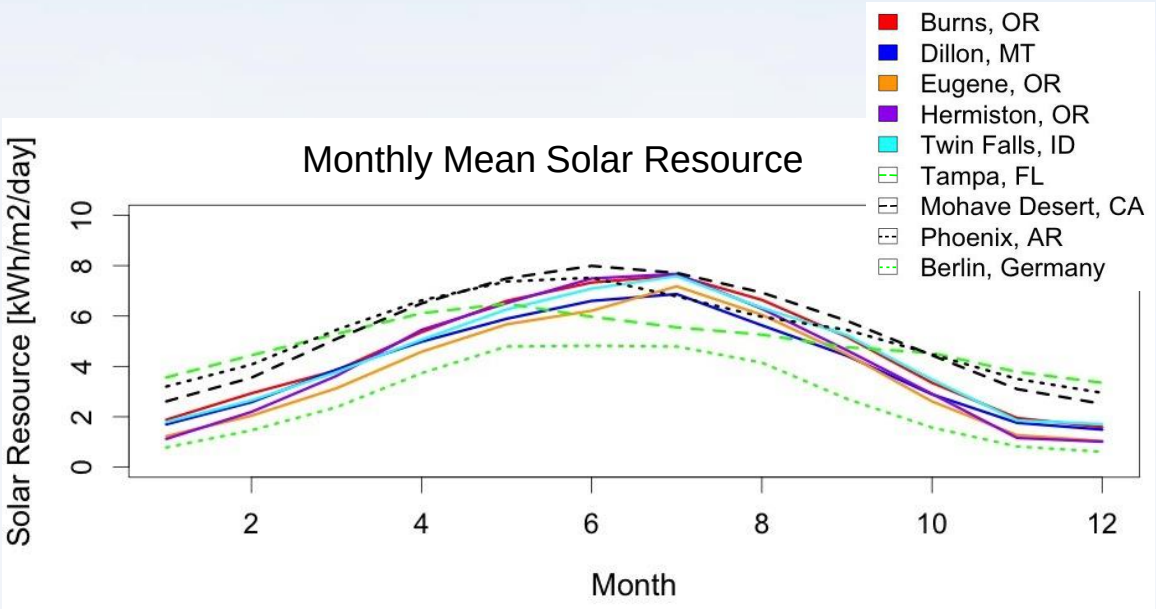
Location	Annual Mean Resource (kWh/m²/d)	Annual Mean TOA (W/m²)
Hermiston	4.21	300
Dillon	4.08	304
Eugene	3.81	308
Burns	4.53	313
Twin Falls	4.44	317
Average	4.32	308



Source: http://weatherspark.com

Regional Solar Resource

Location	Annual Mean Solar Resource (kWh/m²/day)
Hermiston, OR	4.21
Dillon, MT	4.08
Eugene, OR	3.81
Burns, OR	4.53
Twin Falls, ID	4.44
Average of NW sites	4.32
Berlin, Germany	2.71
Mohave Desert, CA	5.31
Phoenix, AZ	5.28
Tampa, FL	4.92



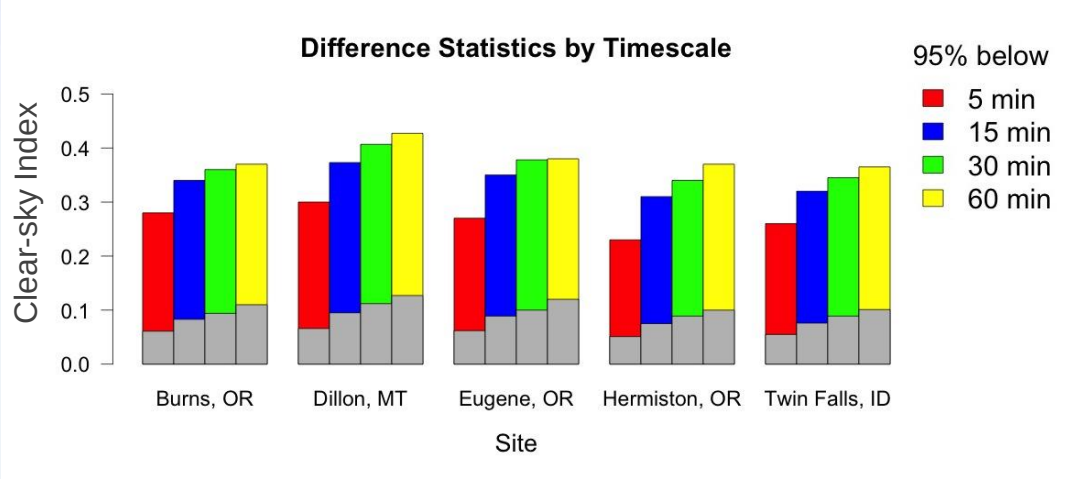
- NW has moderate solar resource, but quite seasona
- In summer, all NW sites exceed Tampa, FL
- AZ has monsoon season in mid to late summer

Source for non-NW data:
http://solarelectricityhandbook.com/solar-irradiance.html

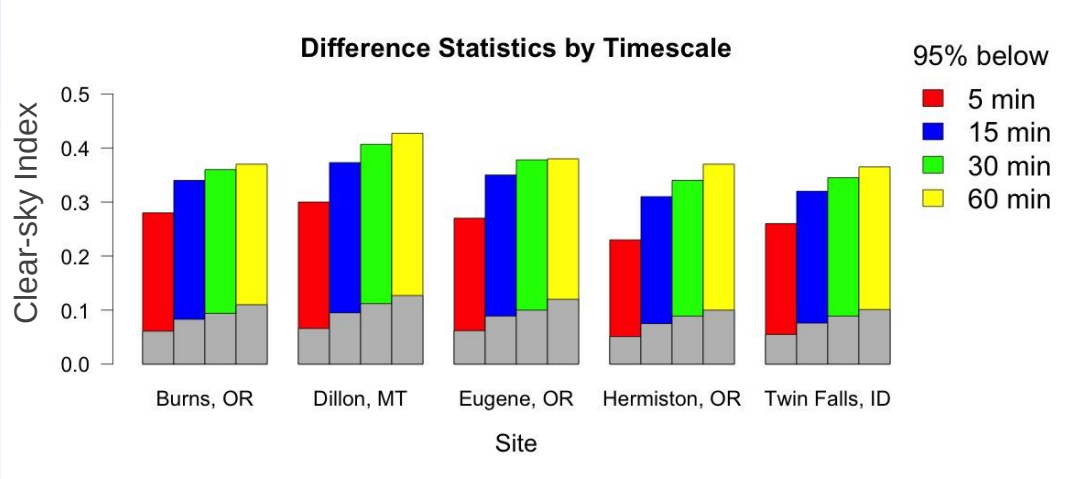
Analysis Method

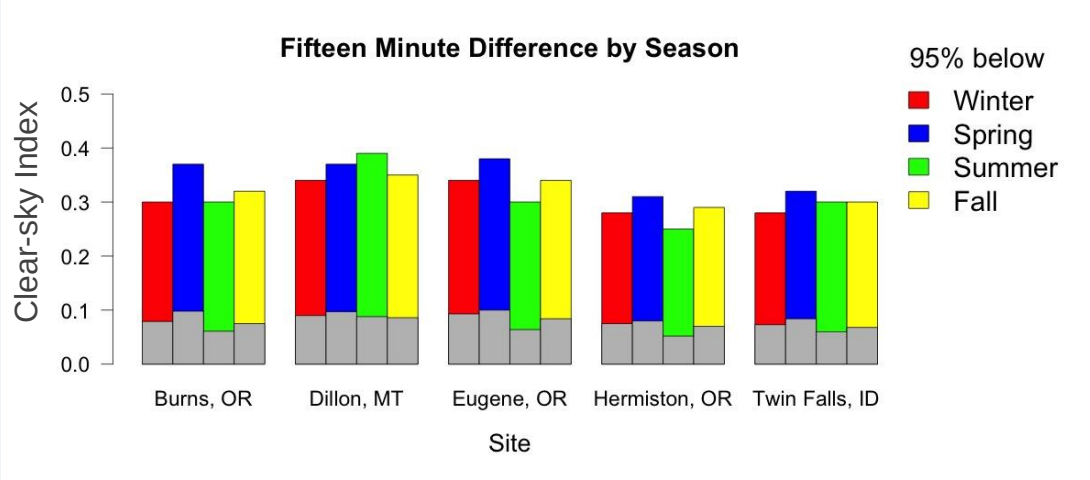
- Obtain total horizontal irradiance (GHI) data for 2004-2013.
  - LI-COR pyranometer (Twin Falls)
  - Eppley PSP (others)
- Estimate clear-sky irradiance using Long and Ackerman (2000) algorithm and compute clear-sky index.
- Average 5-min samples to 15, 30, and 60 min.
- Calculate variations as differences between consecutive samples.
- Compute statistics and power spectra for raw values and differences.

Clear-sky Index Variability

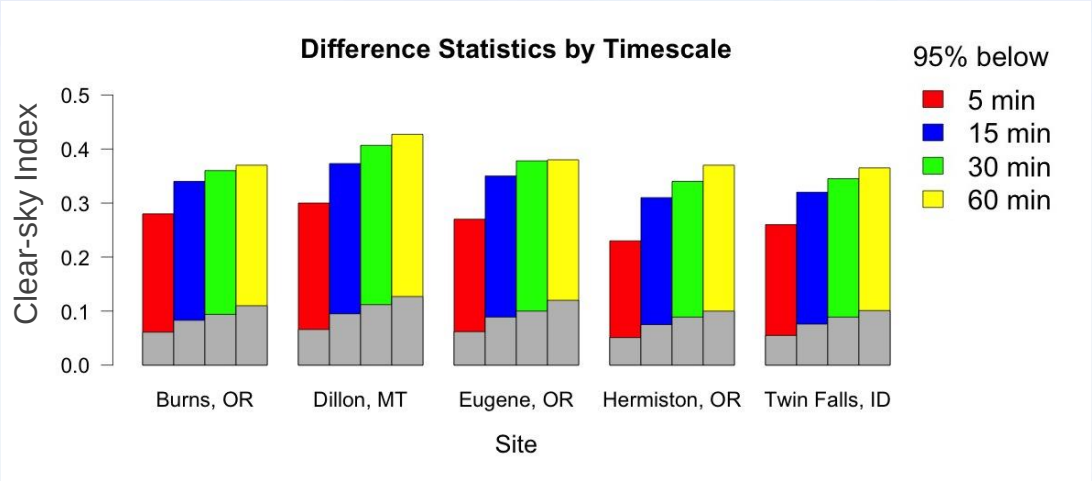


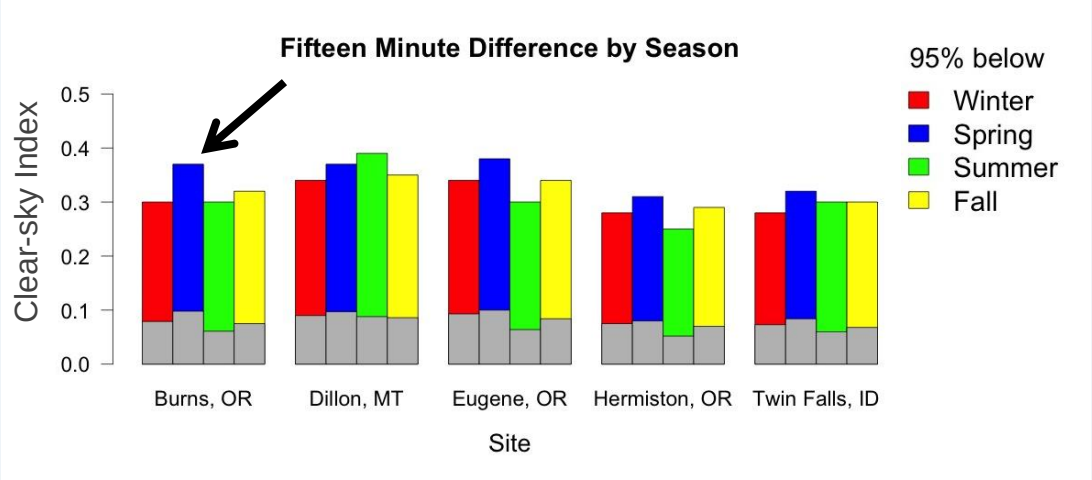
Clear-sky Index Variability





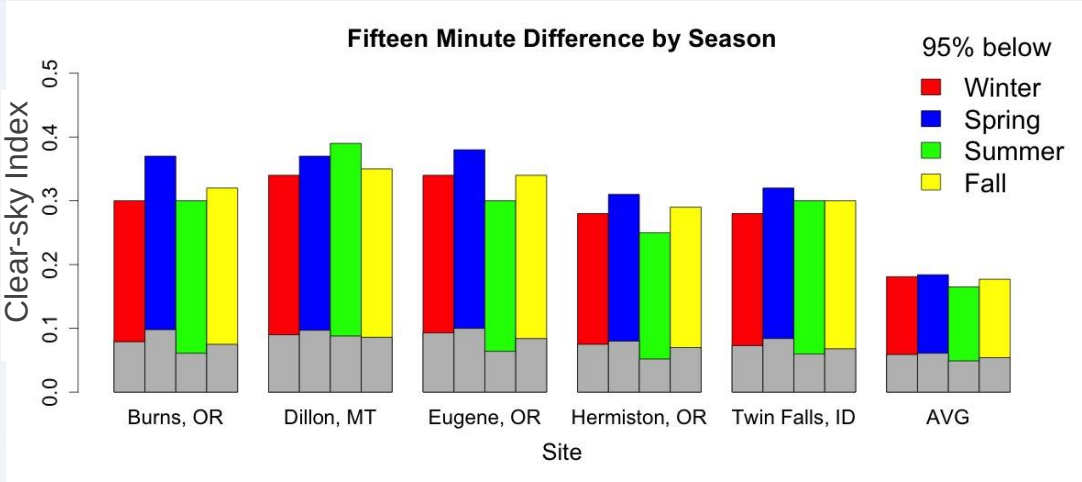
Clear-sky Index Variability





- Magnitude of variations increases with averaging period.
- Greatest variability in spring.

Effect of Averaging on Variability



- Means and extremes reduced.
- Extremes decreased more than means (45% vs. 30%).
- Seasonality is decreased.

Clear-Sky Index Correlation between Sites

Separation (mi) Correlation	Burns, OR	Dillon, MT	Eugene, OR	Hermiston, OR	Twin Falls, ID
Burns, OR	-	336	204	156	243
Dillon, MT	0.21	-	520	325	205
Eugene, OR	0.35	0.15	-	223	446
Hermiston, OR	0.41	0.14	0.41	-	330
Twin Falls, ID	0.30	0.33	0.22	0.23	-

Conclusions

- Solar resource in Northwest not insignificant.
- Resource at specific locations depends on latitude and cloud cover.
- Hermiston least variable, Dillon most variable on short time scales
- Greatest variability in spring, except summer at Dillon
- Averaging reduces variability, decreasing interseasonal differences.
- Clear-sky indices at studied sites relatively uncorrelated.