Annexure A
Solar Maps

A.1: SRRA MAP DNI (LONG TERM AVERAGE) [Source: C-WET, 2017]

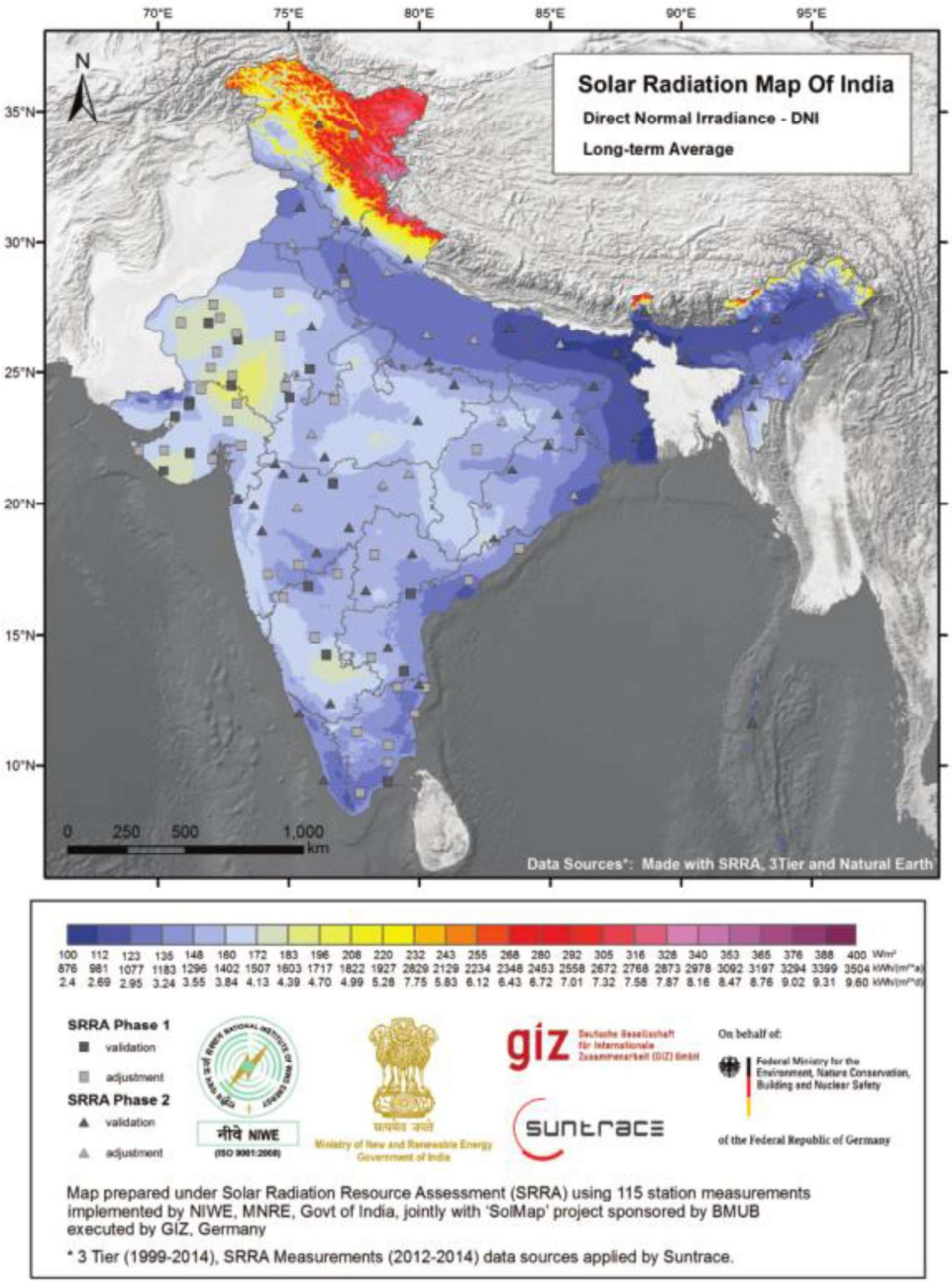

Fig A.1: SRRA Map DNI (Long Term Average)

A.1.2: SRRA MAP GHI (LONG TERM AVERAGE) [Source: C-WET, 2017]

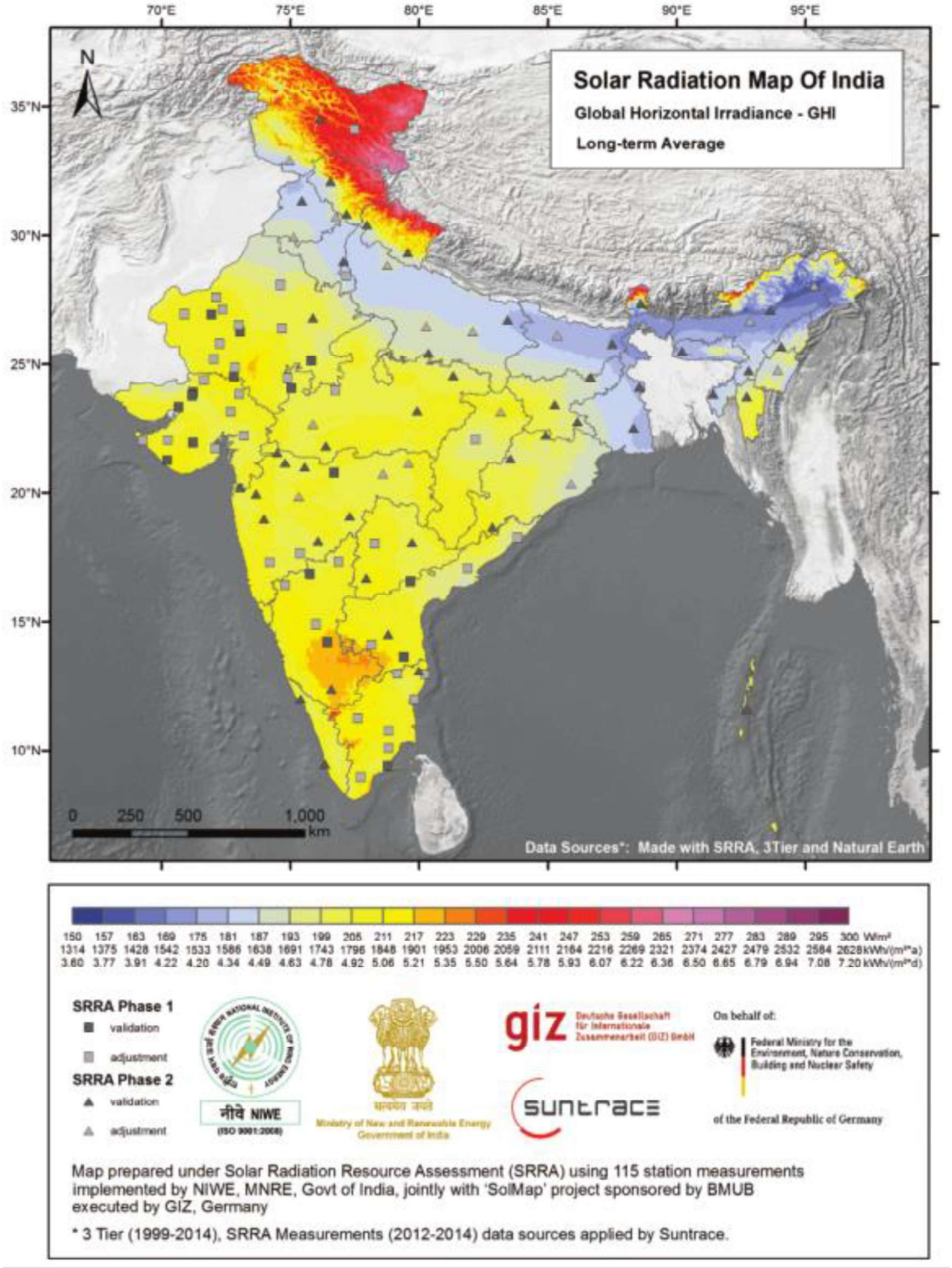

Fig A.2: SRRA Map GHI (Long Term Average)

A.1.3: SRRA MAP GHI (RELATIVE STANDARD DEVIATION) [Source: C-WET, 2017]

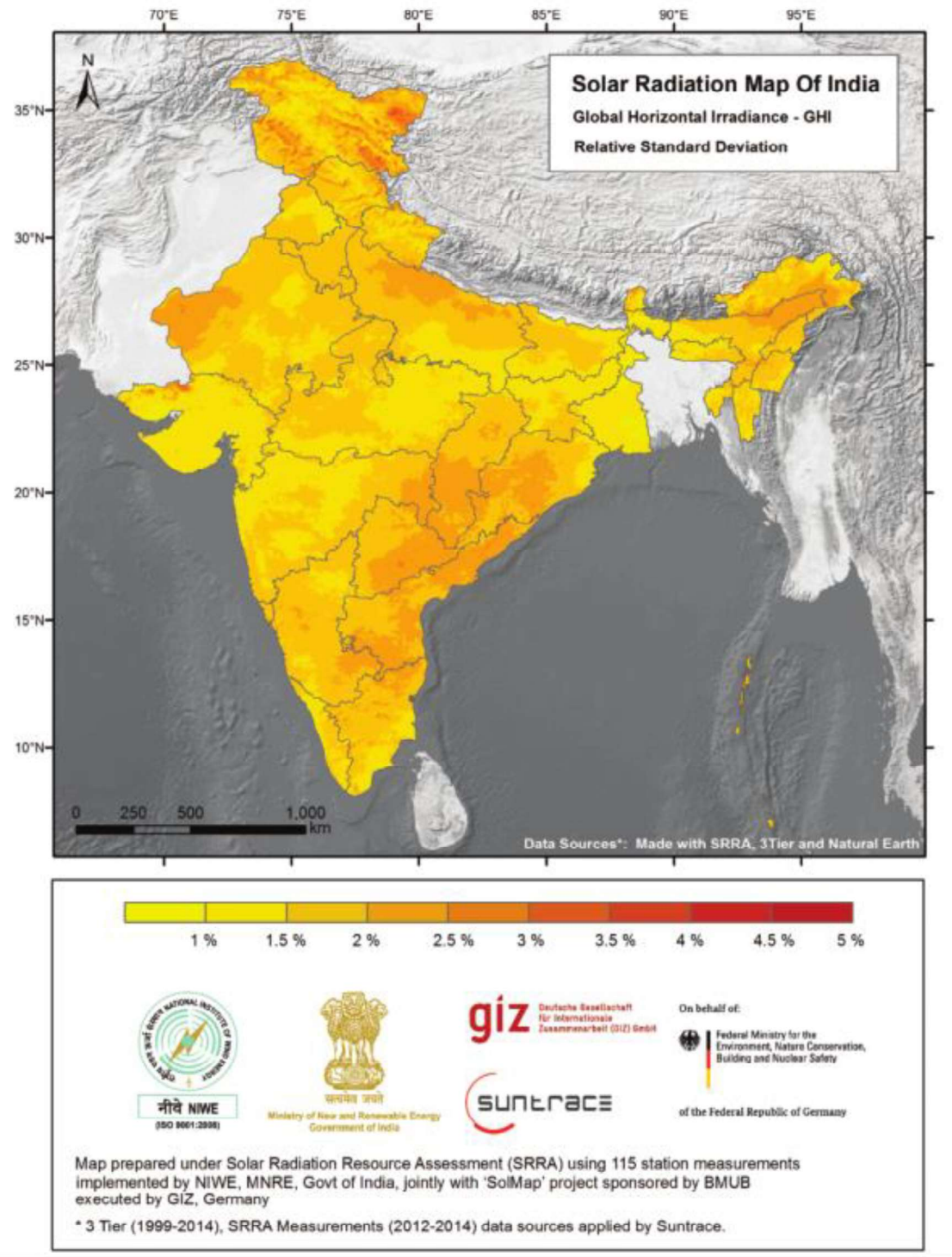

Fig A.3: SRRA Map GHI (Relative Standard Deviation)

Annexure B
ISO Standard Sheets

B.1: ISO-9060 SPECIFICATION SUMMARY FOR PYRHELIOMETER [Source: WMO (2), 2008]

Table B.1: ISO-9060 Specification Summary for Pyrheliometer

Pyrheliometer Specification List			
Specification	Class of Pyrheliometer		
	Secondary Standard Class	First Class	Second
Response time—95% response	< 15 s	< 20 s	< 30 s
Zero offset Response to 5-K h-1 change in ambient temperature	± 1 Wm^{-2}	± 3 Wm^{-2}	± 6 Wm^{-2}
Resolution—smallest detectable change in Wm^{-2}	± 0.5 Wm^{-2}	± 1 Wm^{-2}	± 5 Wm^{-2}
Stability—percentage of full scale, change/year	± 0.5%	± 1%	± 2%
Nonlinearity—percentage deviation from the responsivity at 500 W/m^2 because of change in irradiance between 100 Wm-2 and 1,000 Wm^{-2}	± 0.2%	± 0.5%	± 2%
Spectral selectivity—percentage deviation of the product of the spectral absorptance and the spectral transmittance from the corresponding mean between 0.35 µm and 1.5 µm	± 0.5%	± 1%	± 5%
Temperature response—total percentage deviation because of change in ambient temperature within an interval of 50 K	± 1%	± 2%	± 10%
Tilt response—percentage deviation from the responsitivity at 0 degrees tilt (horizontal) because of change in tilt from 0 degrees to 90 degrees at 1,000 W/m^{-2} irradiance	± 2%	± 0.5%	± 2%
Traceability—maintained by periodic comparison	With a primary standard pyrheliometer	With a secondary standard pyrheliometer	With a first-class pyrheliometer or better

B.2: ISO-9060 SPECIFICATION SUMMARY FOR PYRANOMETER [Source: WMO (2), 2008]

Table B.1: ISO-9060 Specification Summary for Pyranometer

Pyrheliometer Specification List			
Specification	Class of Pyrheliometer[a]		
	Secondary Standard Class	First Class	Second
Response time—95% response	< 15 s	< 30 s	< 60 s
Zero offset Response to 200 Wm^{-2} net thermal radiation (ventilated) Response to 5-Kh^{-1} change in ambient temperature	± 7 Wm^{-2} ± 2 Wm^{-2}	± 15 Wm^{-2} ± 4 Wm^{-2}	± 30 Wm^{-2} ± 8 Wm^{-2}
Resolution—smallest detectable change	± 0.5%	± 1%	± 3%
Stability—percentage change in responsivity per year			
Nonlinearity—percentage deviation from the responsivity at 500 W/m^2 because of change in irradiance between 100 Wm-2 and 1,000 Wm^{-2}	± 10 Wm^{-2}	± 20 Wm^{-2}	± 30 Wm^{-2}
Directional response for beam radiation (the range of errors caused by assuming that the normal incidence responsivity is valid for all directions when measuring, from any direction, a beam radiation that has a normal incidence irradiance of 1,000 Wm^{-2}	± 3%	± 5%	± 10%
Spectral selectivity—percentage deviation of the product of the spectral absorptance and the spectral transmittance from the corresponding mean between 0.35 µm and 1.5 µm	2%	4%	8%
Temperature response—total percentage deviation because of change in ambient temperature within an interval of 50 K	± 0.5%	± 2%	± 5%
Tilt response—percentage deviation from the responsitivity at 0 degrees tilt (horizontal) because of change in tilt from 0 degrees to 90 degrees at 1,000 W/m^{-2} irradiance			

Annexure C
Climate Classification

C.1: MNRE, CLIMATE CLASSIFICATION [SP 7, 2005]

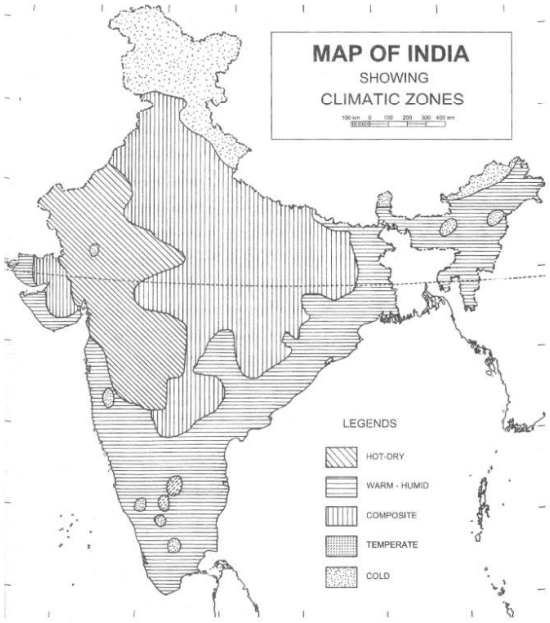

Fig C.1: India Climate Classification Map (MNRE)

Table C.1: Classification India Climate Classification Map (MNRE)

Criteria of [Bansal and Minke, 1988]			*Criteria of [SP 7:2005]*		
Climate	*Mean monthly temperature (°C)*	*Relative Humidity (%)*	*Climate*	*Mean monthly maximum temperature (°C)*	*Relative Humidity (%)*
Hot and dry	>30	<55	*Hot and dry*	>30	<55
Warm and humid	>30	>55	*Warm and humid*	>30 >25	>55 >75
Moderate	25-30	<75	*Temperate*	25-30	<75
Cold and cloudy	<25	>55	*Cold*	<25	All values
Cold and sunny	<25	<55			
Composite	Climate condition not identified for more than 6 months		*Composite*	Climate condition not identified for more than 6 months	

C.2: KŐOPEN CLIMATE CLASSIFICATION [Source: Peel, *et al*, 2007]

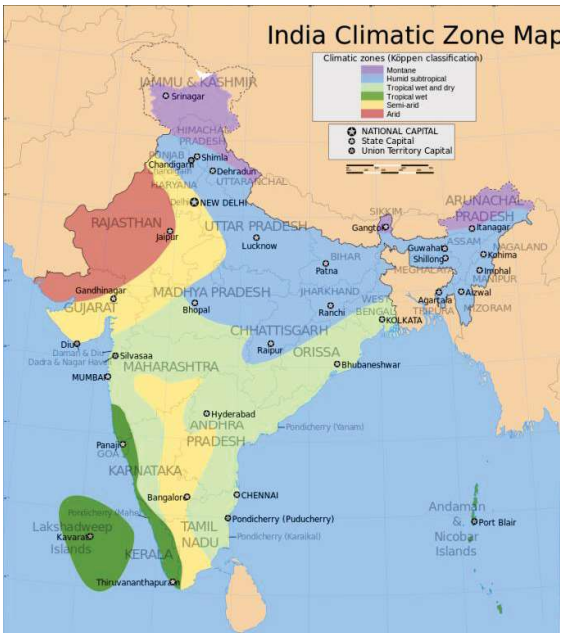

Fig C.2: Köopen Climate Classification

It is the most widely used climate classification system given by Wladimir köopen in 1884, after that many peoples have updates these results. In this plot we are following the updates given in 1960s by Trewartha climate classification. The classification criteria followed here is done using type of vegetation available. Classification is done by combining annual and monthly average temperature and precipitation values, comparing with the seasonality of precipitation. India climate can be classified into four major climatic groups which are further subdivided into seven climate types. Here all prevailing climate class for India is given below:

i) Tropical wet (dry and humid): High temperature location, where minimum value don't go below 18° C. Also heavy rainfall (~78mm) is expected with good green forest and coastal areas.

ii) Tropical wet and dry: Maximum India enjoys this climate and location have high temperature with less rainfall.

iii) Tropical Semi-Arid: Southern locations, with normal rainfall (40-75mm) and year-round uniform temperature.

iv) Sub-tropical Semi-Arid: Western side desert area, with less rainfall and wide temperature variation.

v) Sub-Tropic Arid: Westernmost side, deep dry desert with less rainfall, low and high temperature due to less vegetation and cold wave

vi) Sub-Tropical humid with dry winters: Northern Himalaya regions, with high rainfall(65-250mm) and high temperature.

vii) Montane or highland climate: Low temperature with high snowfall.

Annexure D
Clear Sky Equations

D.1 : ASHRAE CLEAR SKY MODEL [Source: Sukhatme and Nayak, 2008]

$I_G = I_B + I_D$

$I_B = I_{BN} * (\cos z)$

$I_{BN} = A * \exp [-B/\cos z]$

$I_D = C * I_{BN}$

Here A, B and C are constants, derived for each month. [Proposed by Iqbal, 1983]

Table D.1 : Values of the Constants A, B and C used for Predicting Hourly Solar Radiation on Clear Sky Days

	A (W/m²)	*B*	*C*
January 21	1202	0.141	0.103
February 21	1187	0.142	0.104
March 21	1164	0.149	0.109
April 21	1130	0.164	0.120
May 21	1106	0.177	0.130
June 21	1092	0.185	0.137
July 21	1093	0.186	0.138
August 21	1107	0.182	0.134
September 21	1136	0.165	0.121
October 21	1136	0.152	0.111
November 21	1190	0.144	0.106
December 21	1204	0.141	1.103

Note: This model is proposed for calculating hourly average values, but for sub-hourly intervals also the model performs well (only accurate solar zenith is required) for clear sky day radiation estimation.

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