CERES SSF Simple Surface Flux Parameterizations

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Validation of Ceres Terra & Aqua SSF Surface-only Fluxes

- Down-welling clear-sky and all-sky SW and LW surface fluxes derived from relationships with TOA fluxes and atmospheric data.
- Each component currently computed from two models

  LPSA/LPLA:
  Langley Parameterized SW/LW Algorithm

		Model A	Model B
SW	Clear	Li et al.	LPSA
	All-sky	-	LPSA
LW	Clear	Inamdar and Ramanathan	LPLA
	All-sky	-	LPLA

- Validation criteria:
  ±20 Wm^{-2} for instantaneous CERES FOV
- Validation data sources: SURFRAD, ARM/SGP, BSRN, & CMDL
- CERES date sources: Terra FM1 and FM2; Aqua FM3 and FM4

Algorithms/References

- SW Model A:

  Li *et al.* (1993): *J. Climate*, **6**, 1764-1772.

- SW Model B (LPSA/Staylor Algorithm):

  Darnell *et al.* (1988): *J. Climate*, **1**, 820-835.
  Darnell *et al.* (1992): *J. Geophys. Res.*, **97**, 15741-15760.
  Gupta *et al.* (2001): *NASA/TP-2001-211272*, 31 pp.

- LW Model A:

  Inamdar and Ramanathan (1997): *Tellus*, **49B**, 216-230.

- LW Model B (LPLA):

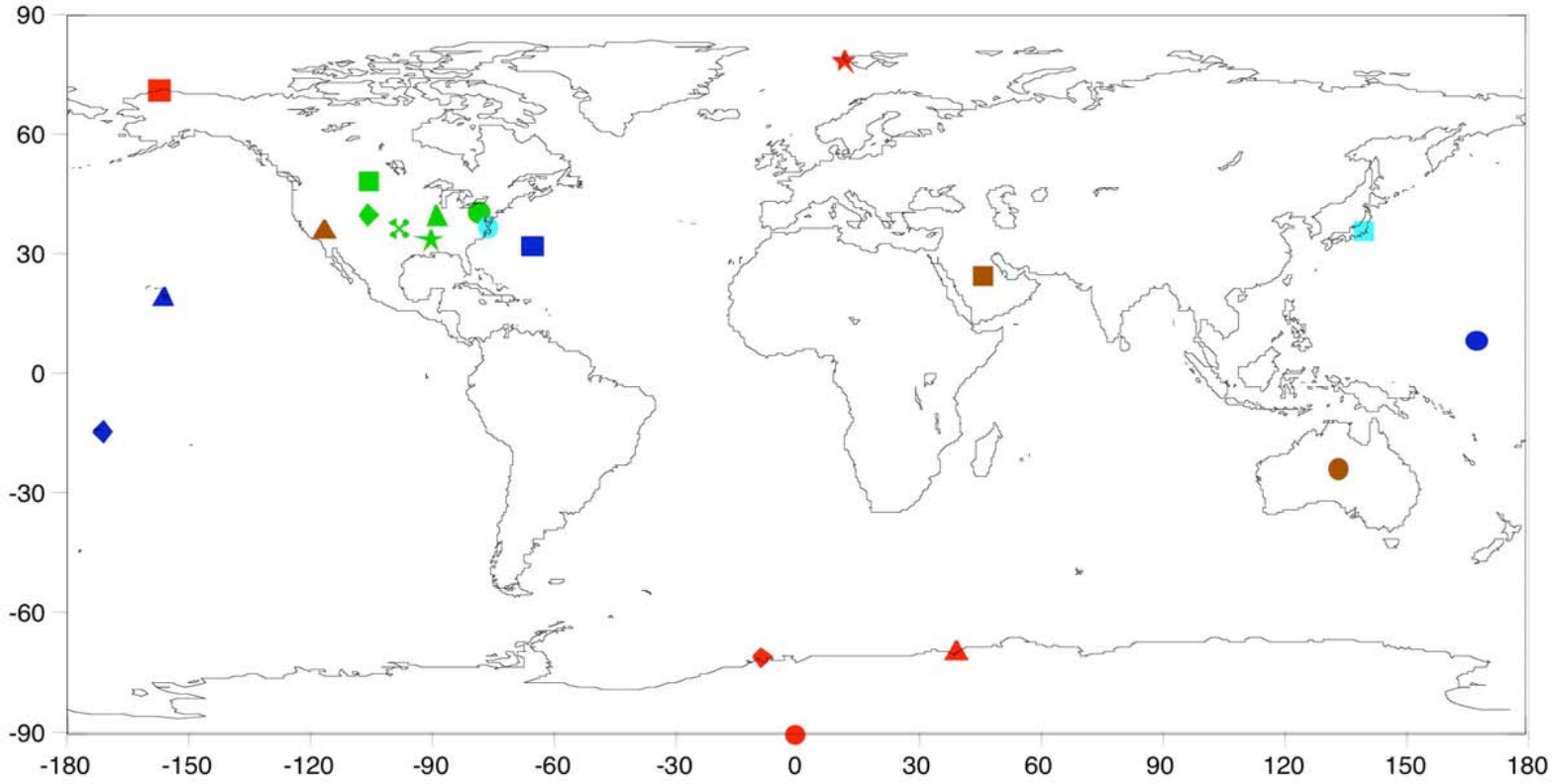
  Gupta (1989): *J. Climate*, **2**, 305-320.
  Gupta *et al.* (1992): *J. Appl. Meteor.*, **31**, 1361-1367.

- SW & LW Model B Validation

  Gupta *et al.* (2004): *J. Atmos. Ocean Tech.*, **21**, 742-752.

CERES Terra & Aqua Data Timeframes

- Data acquisition frozen 18-October-2004 to allow sufficient time for processing and comparison.
- Terra 2A: March 2000 through December 2003.
- Terra 2B: March 2000 through April 2002.
- Aqua 1A: July 2002 through February 2003.

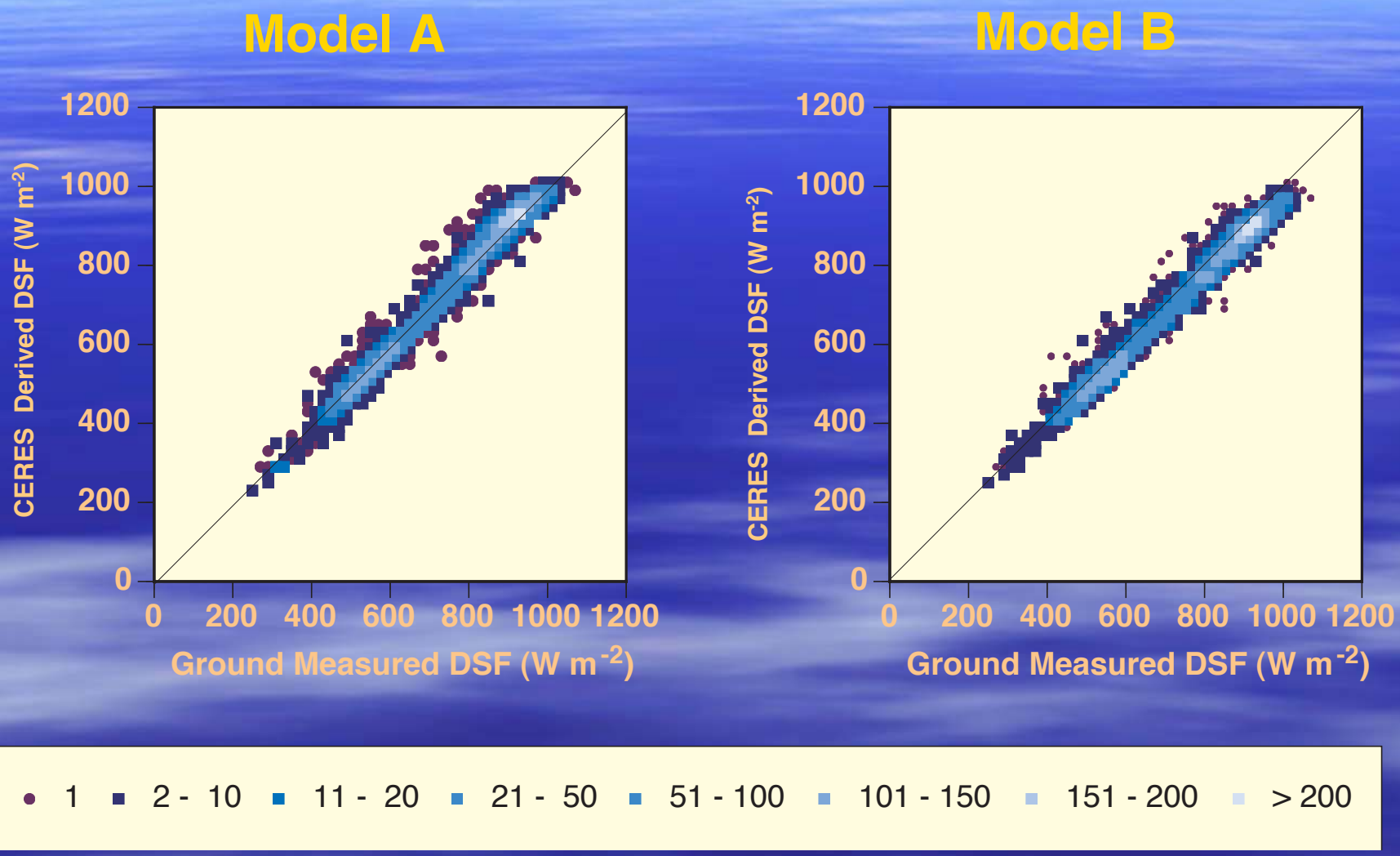


- 48.31N, 105.10W Fort Peck, MT
- 40.72N, 77.93W Penn State, PA
- 40.05N, 88.37W Bondville, IL
- 40.13N, 105.24W Boulder, CO
- 34.25N, 89.87W Goodwin Creek, MS
- 36.60N, 97.48W SGP ARM
- 32.30N, 64.77W Bermuda
- 8.72N, 167.72E Kwajalein
- 19.54N, 155.58W Mauna Loa, HI
- 14.23S, 170.56W American Samoa
- 36.05N, 140.13E Tatano
- 36.9N, 75.71W COVE
- 71.32N, 156.61W Barrow, AK
- 90.00S, 0.00 South Pole
- 69.00S, 39.58E Syowa
- 70.65S, 8.25W Georg von Neumayer
- 78.9N, 11.95E Ny Alesund
- 24.91N, 46.41E Saudi Solar Village
- 23.70S, 133.87E Alice Springs
- 36.63N, 116.02W Desert Rock, NV

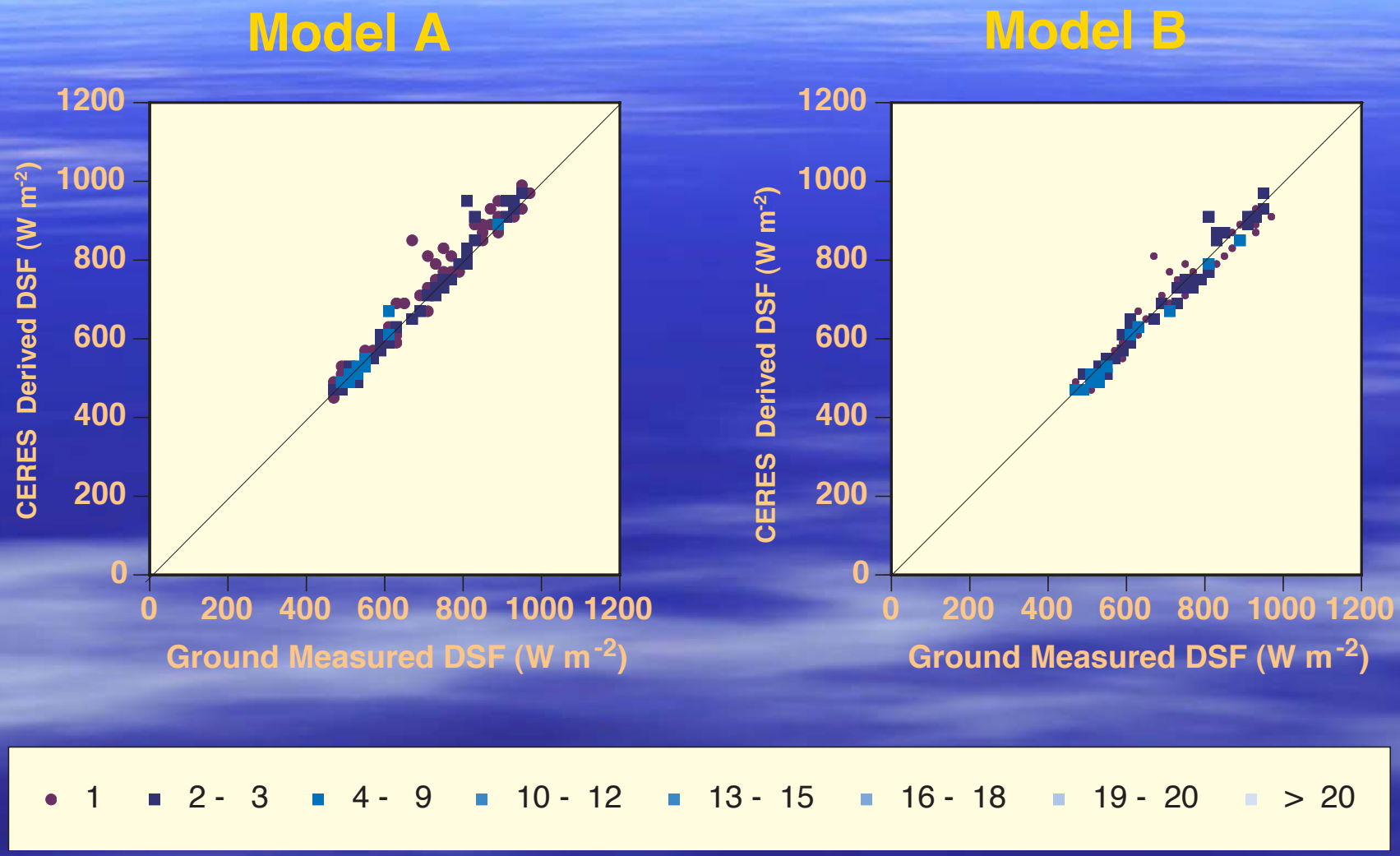
Terra

March 2000 through December 2003

Shortwave Clear-Sky, Continental

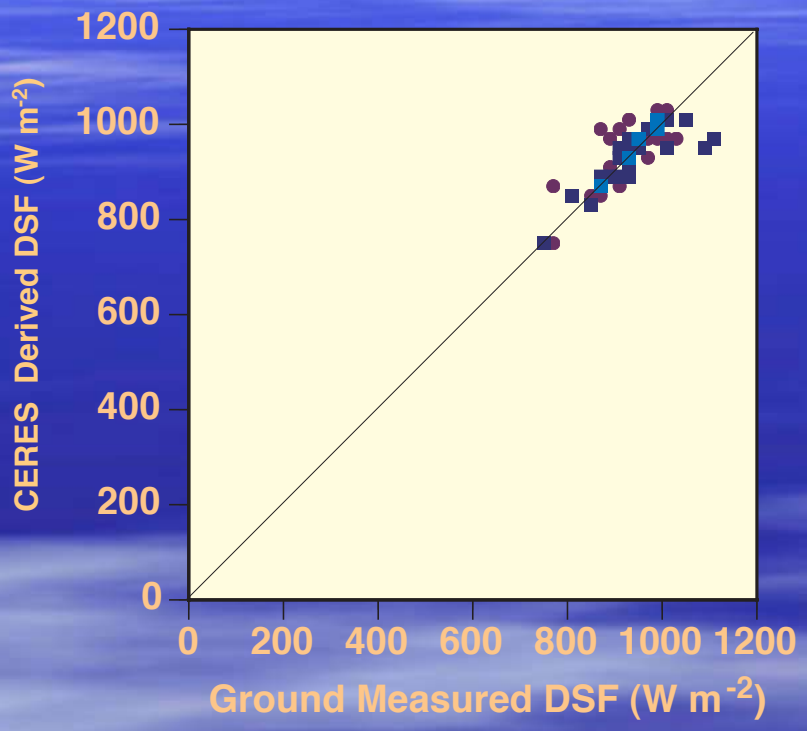


Shortwave Clear-Sky, Coastal

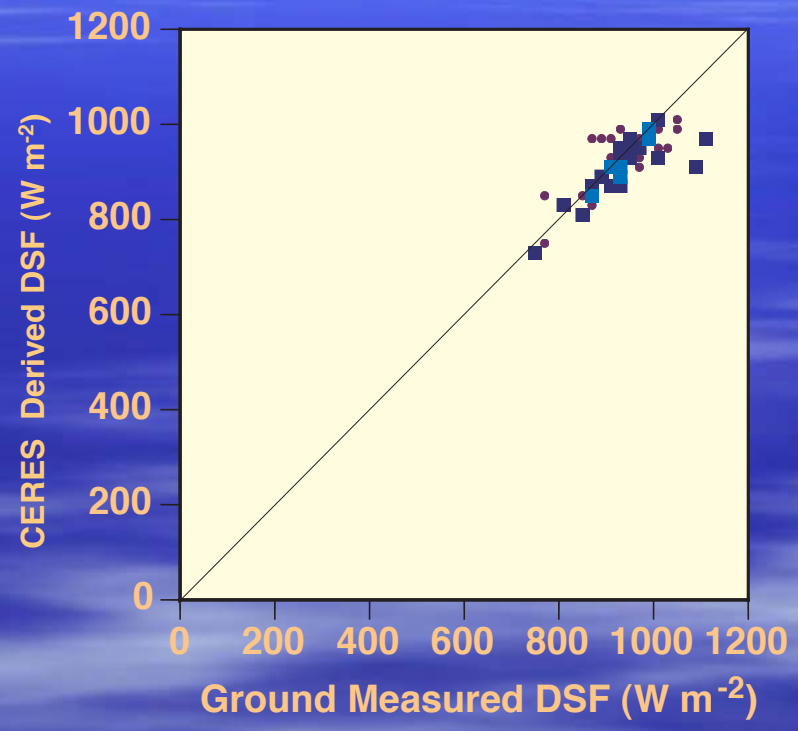


Shortwave Clear-Sky, Island

Model A

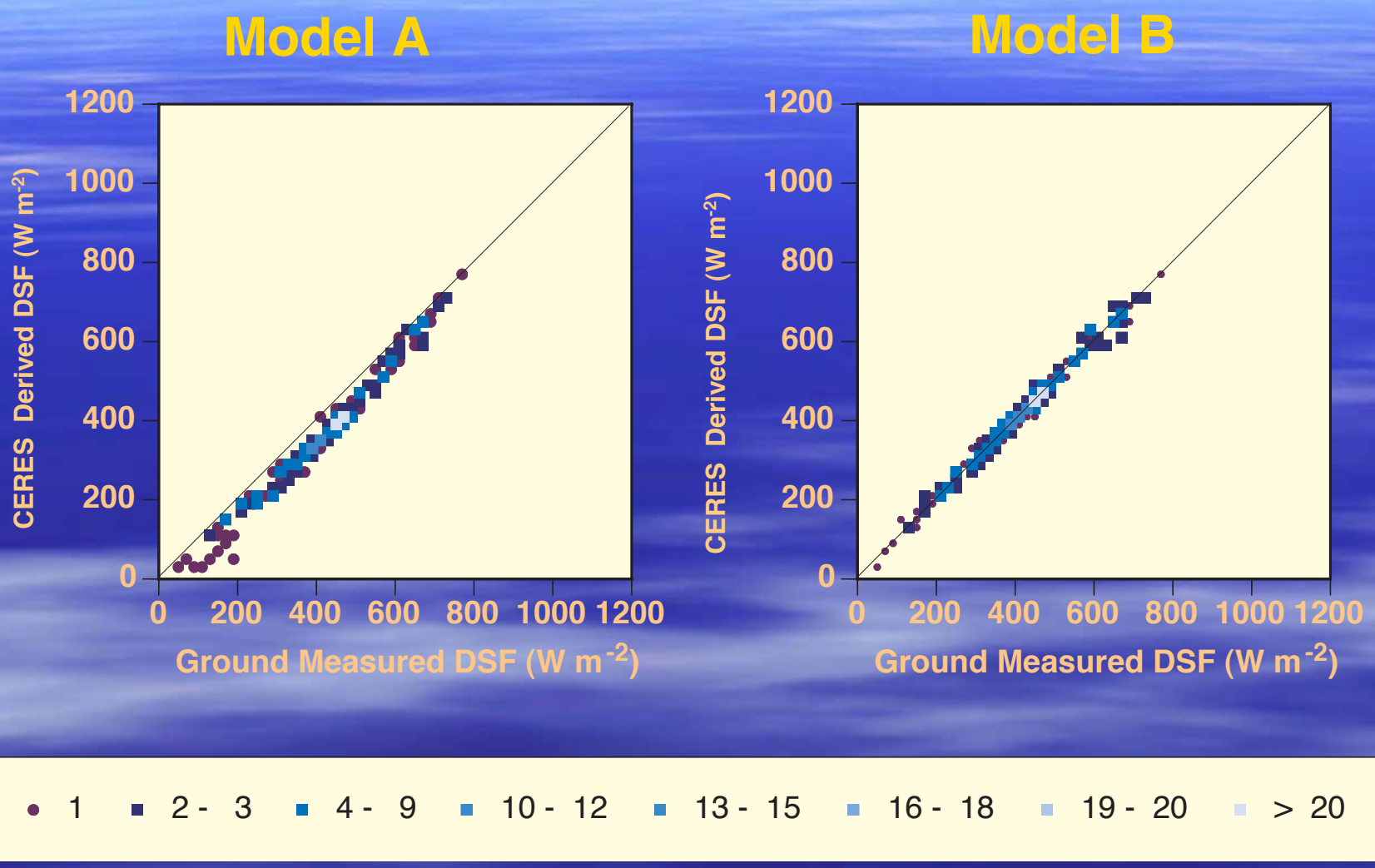


Model B

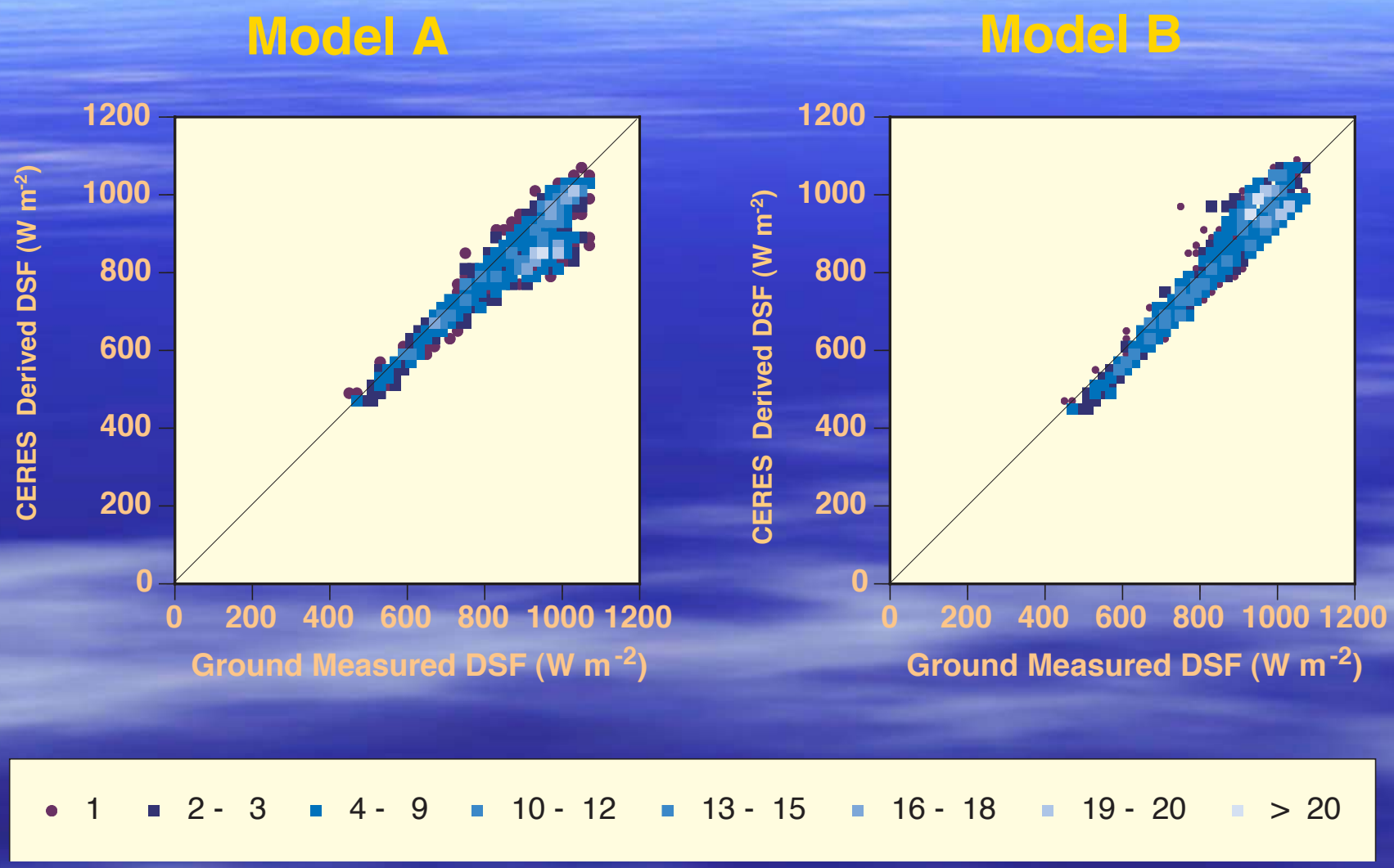


1 | 2 - 3 | 4 - 9 | 10 - 12 | 13 - 15 | 16 - 18 | 19 - 20 | > 20

Shortwave Clear-Sky, (Ant)arctic



Shortwave Clear-Sky, Desert



SW Clear-Sky Comparisons

SW Model A - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	7559	-4.58 (-0.62)	23.1 (3.1)
Coastal	159	5.52 (0.82)	32.4 (4.8)
Island	84	-0.45 (-0.05)	40.2 (4.3)
(Ant)arctic	276	-53.3 (-12.5)	18.9 (4.5)
Desert	1210	-39.3 (-4.6)	44.7 (5.2)

SW Model B - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error . Wm^{-2} (%)
Continental	7559	-22.6 (-3.0)	21.1 (2.8)
Coastal	159	-9.86 (-1.46)	27.6 (4.1)
Island	84	-18.48 (-1.98)	38.4 (4.1)
(Ant)arctic	276	1.87 (0.44)	13.1 (3.1)
Desert	1210	-13.35 (-1.55)	40.9 (4.8)

SW Clear-Sky Comparisons

SW Model A - Terra 2A – 2B

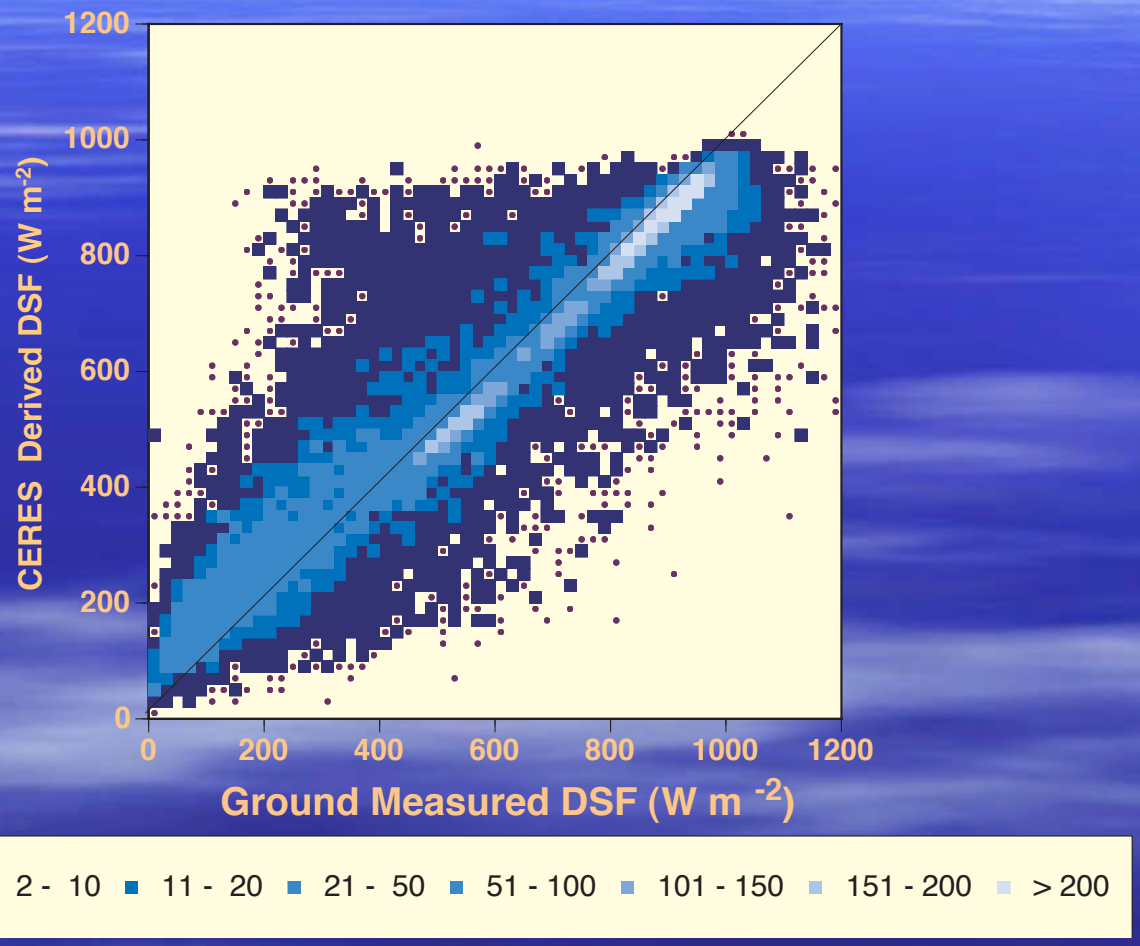
Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	3969	0.01 (0.00)	0.9 (0.1)
Coastal	110	0.18 (0.03)	2.8 (0.4)
Island	45	0.06 (0.01)	0.5 (0.1)
(Ant)arctic	199	-0.61 (-0.18)	5.0 (1.4)
Desert	764	-0.06 (-0.01)	1.0 (0.1)

SW Model B – Terra 2A – 2B

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error . Wm^{-2} (%)
Continental	3969	-0.02 (-0.00)	1.2 (0.2)
Coastal	110	0.41 (0.06)	2.1 (0.3)
Island	45	0.11 (0.01)	2.6 (0.3)
(Ant)arctic	199	0.04 (0.01)	1.2 (0.3)
Desert	764	-0.05 (-0.01)	1.5 (0.2)

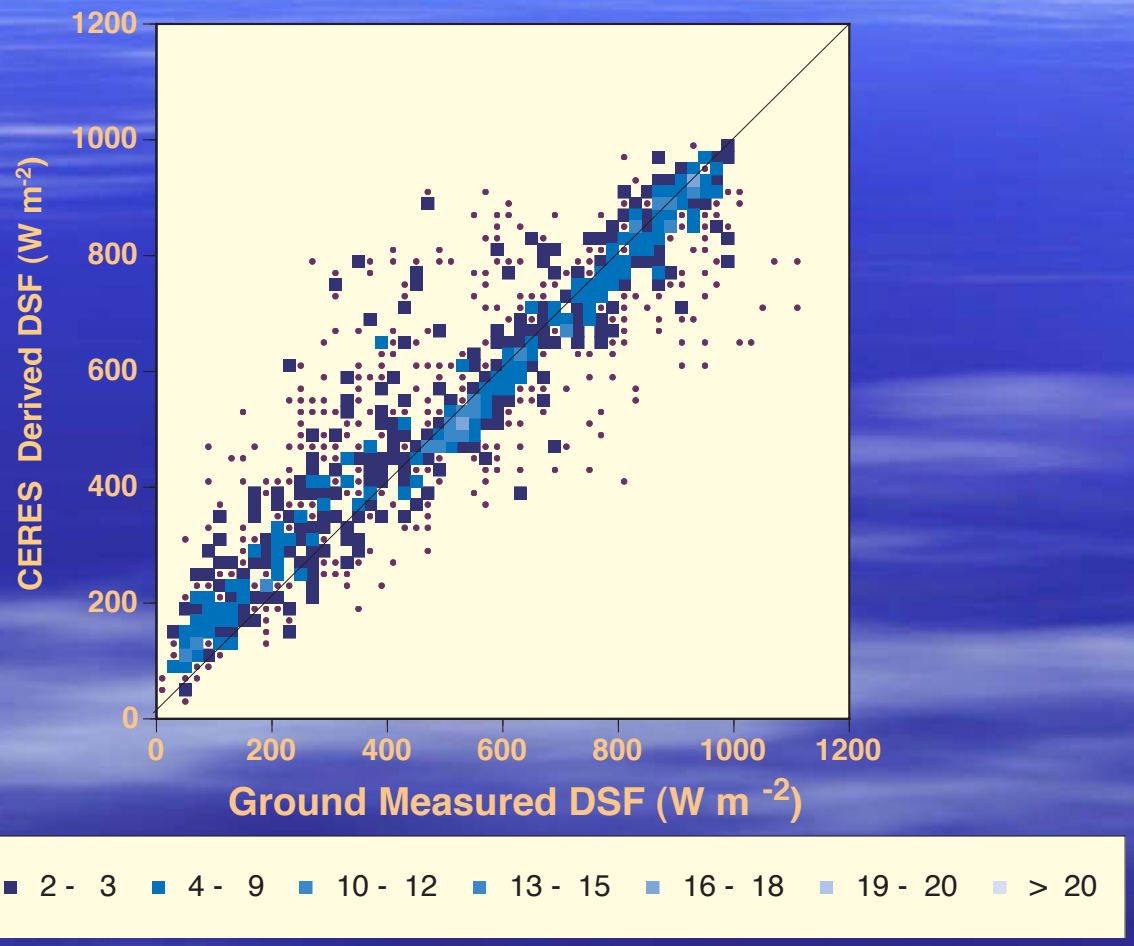
Shortwave All-Sky, Continental

Model B



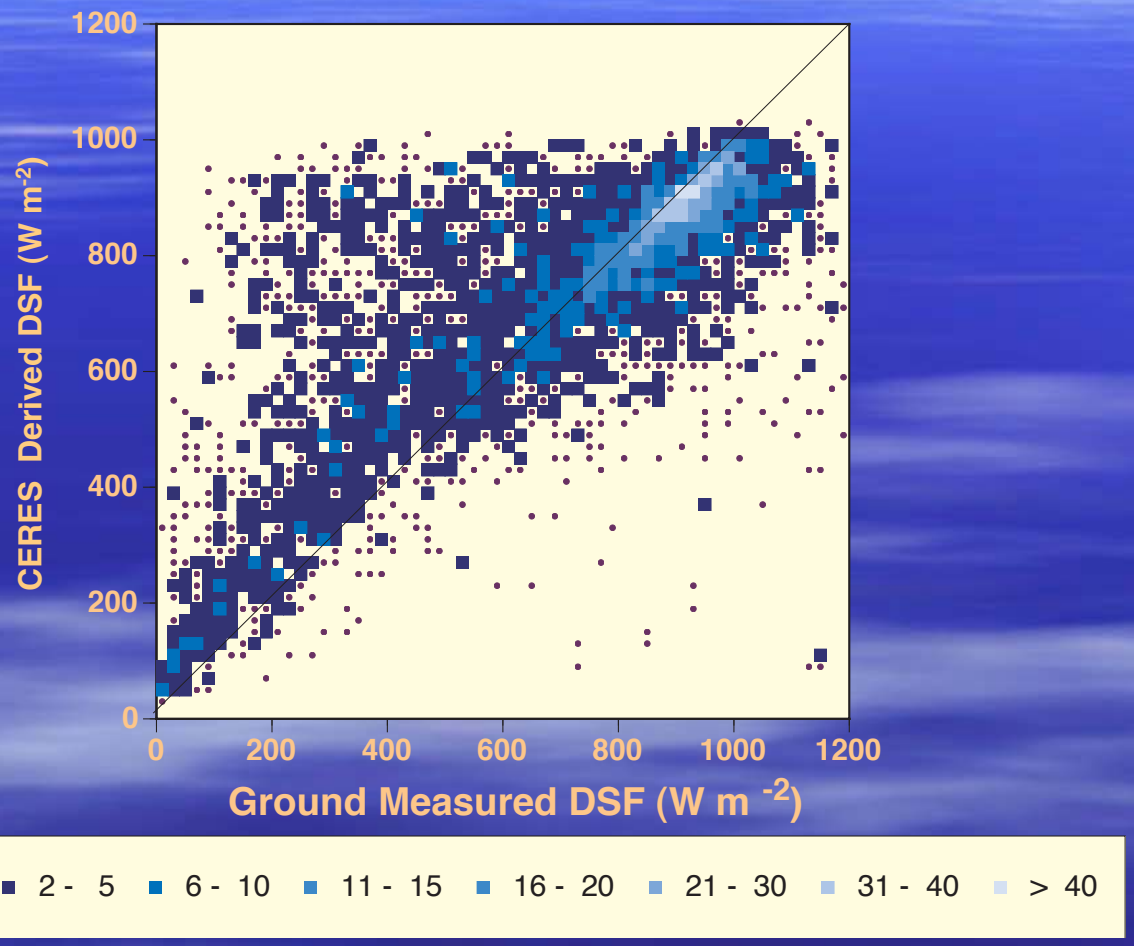
Shortwave All-Sky, Coastal

Model B



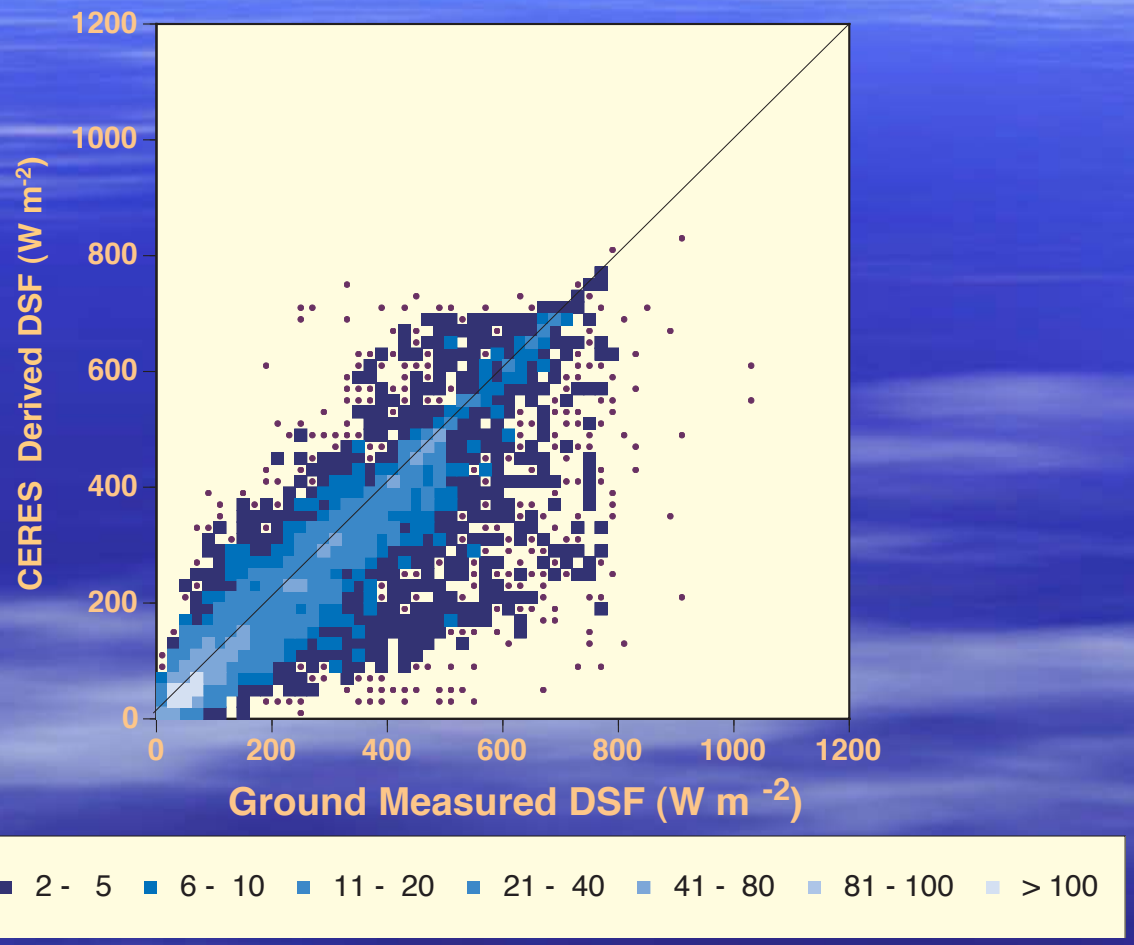
Shortwave All-Sky, Island

Model B



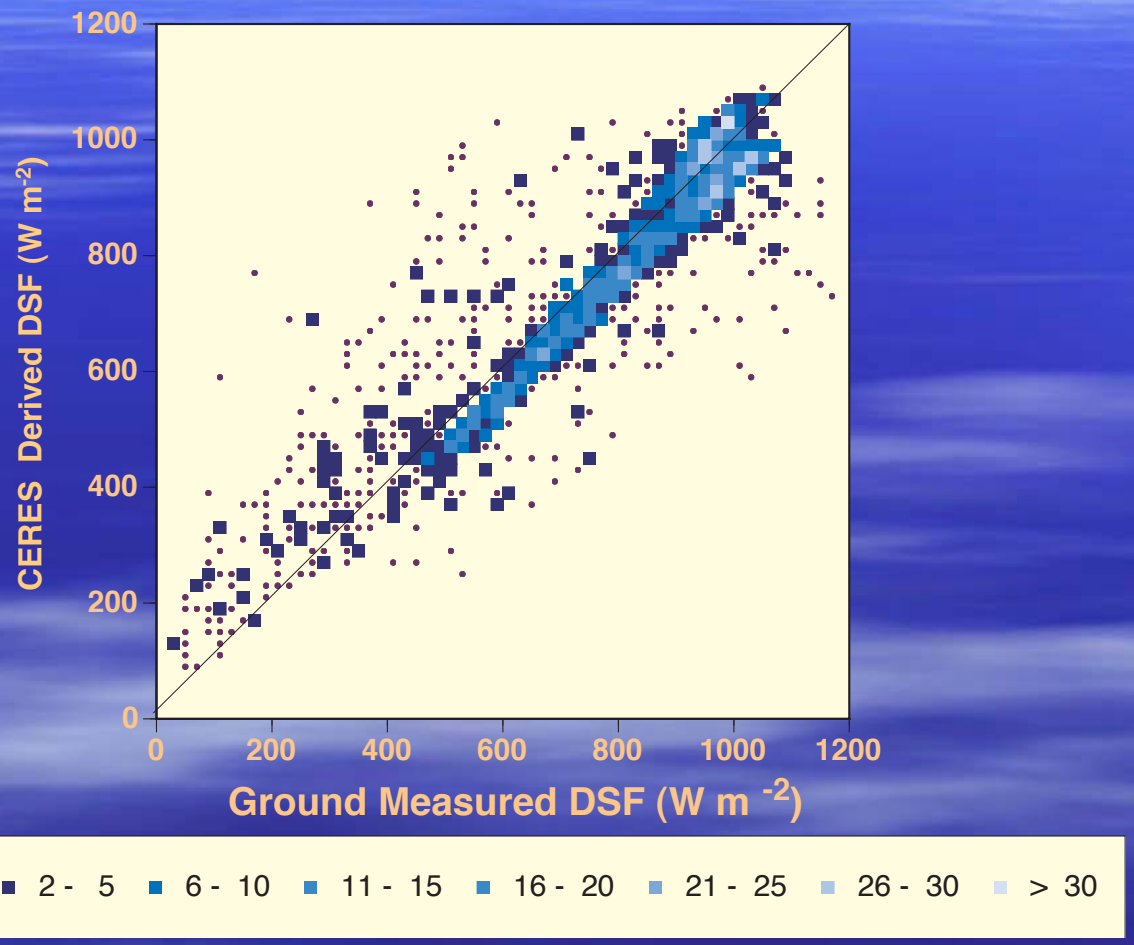
Shortwave All-Sky, (Ant)arctic

Model B



Shortwave All-Sky, Desert

Model B



SW All-Sky Comparisons

SW Model B - Terra Edition 2A (1 min)

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	27000	4.96 (0.85)	106.5 (18.3)
Coastal	1554	29.9 (5.7)	93.3 (17.9)
Island	4842	50.9 (7.6)	151.7 (22.8)
(Ant)arctic	7346	-23.8 (-8.8)	92.2 (34.2)
Desert	2317	-9.40 (-1.22)	83.3 (10.8)

SW Model B - Terra Edition 2A (1 hr)

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error. Wm^{-2} (%)
Continental	27000	8.02 (1.38)	72.7 (12.5)
Coastal	1554	29.7 (5.7)	64.3 (12.3)
Island	4842	52.6 (7.9)	109.4 (16.5)
(Ant)arctic	7346	-23.6 (-8.8)	88.3 (32.8)
Desert	2317	-6.21 (-0.81)	62.5 (8.1)

SW All-Sky Comparisons

SW Model B - Terra 2A – 2B (1 min)

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	14369	-4.89 (-0.84)	17.2 (2.9)
Coastal	1082	-2.47 (-0.46)	14.8 (2.8)
Island	2663	-1.76 (-0.24)	20.2 (2.8)
(Ant)arctic	3961	-1.50 (-0.61)	32.3 (13.1)
Desert	1470	-2.53 (-0.33)	11.8 (1.5)

Conclusions: Shortwave

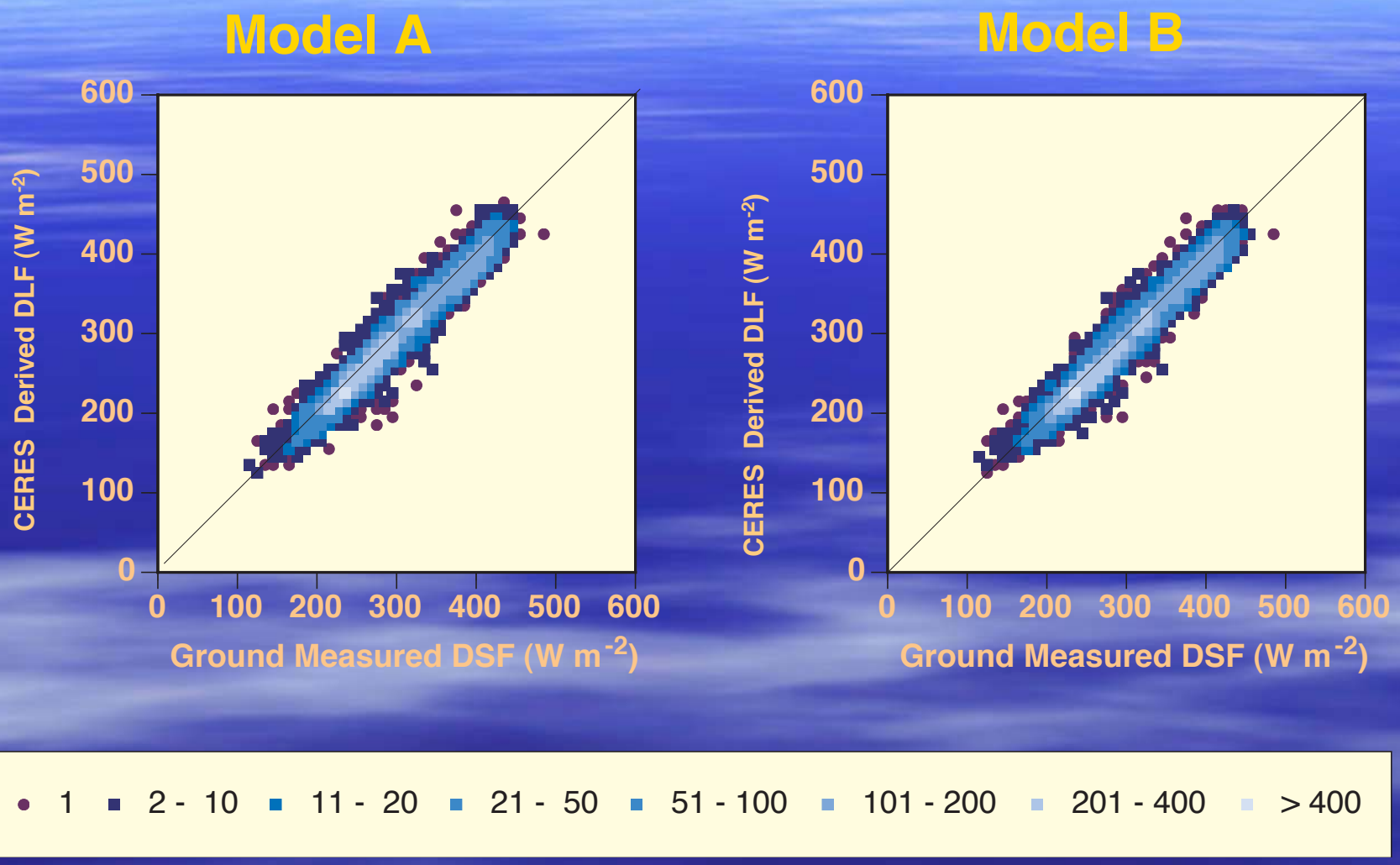
For clear-sky cases, CERES derived SW surface fluxes are within desired accuracies (biases) in all cases for model B, but only for continental, coastal, and island cases for model A, not for the (ant)arctic and desert cases. The source of problem appears to be the current aerosol maps, which will be replaced with a MODIS-derived climatological aerosol map.

All-sky cases are within desired accuracy limits for only the continental and desert cases for model B, not for the coastal, island, and (ant)arctic cases. Some improvement in cloud detection may be warranted.

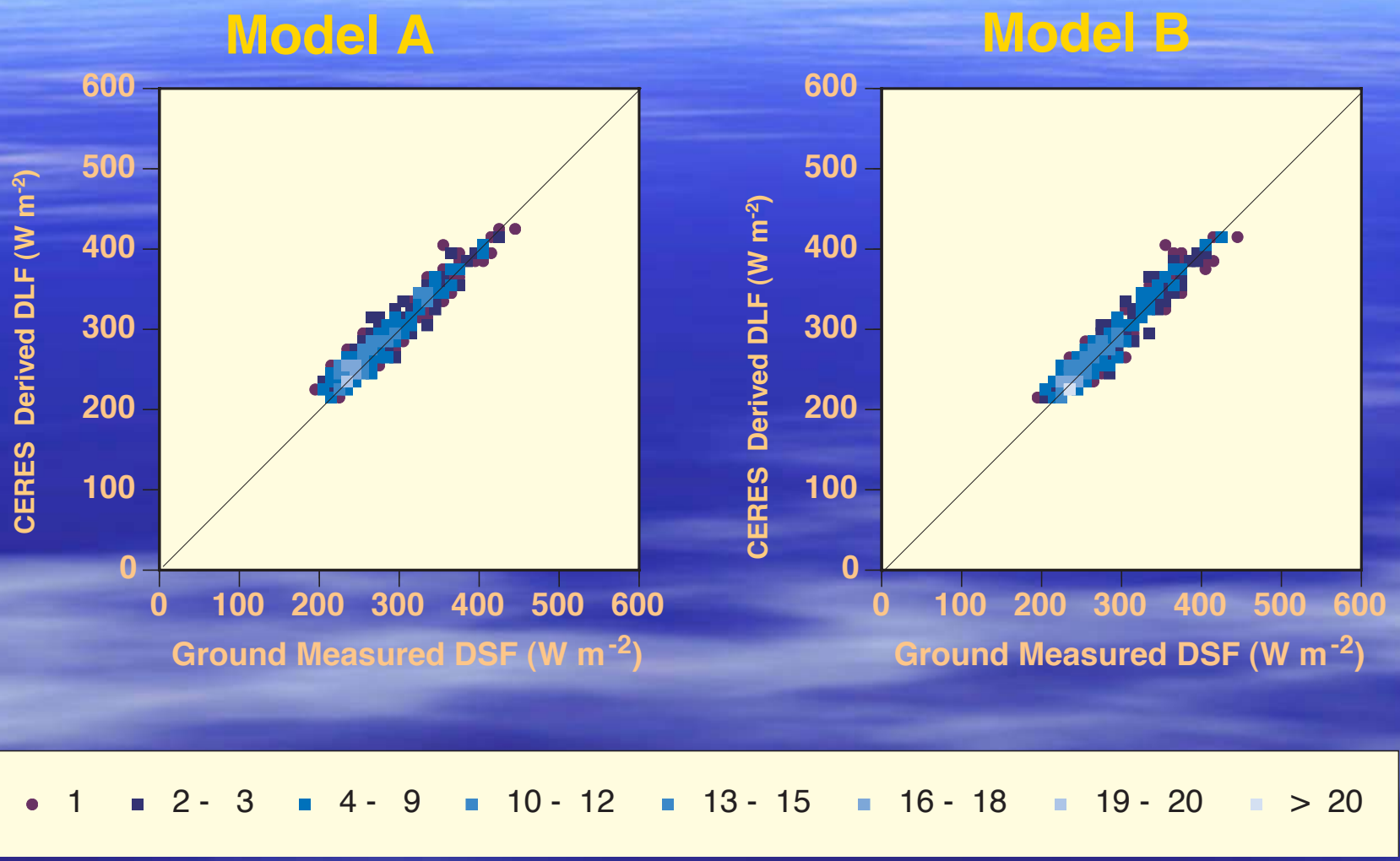
Precision still requires substantial improvement, especially for cases involving clouds.

Terra 2A & Terra 2B results are very similar for clear-sky, with small though non-negligible differences for all-sky conditions.

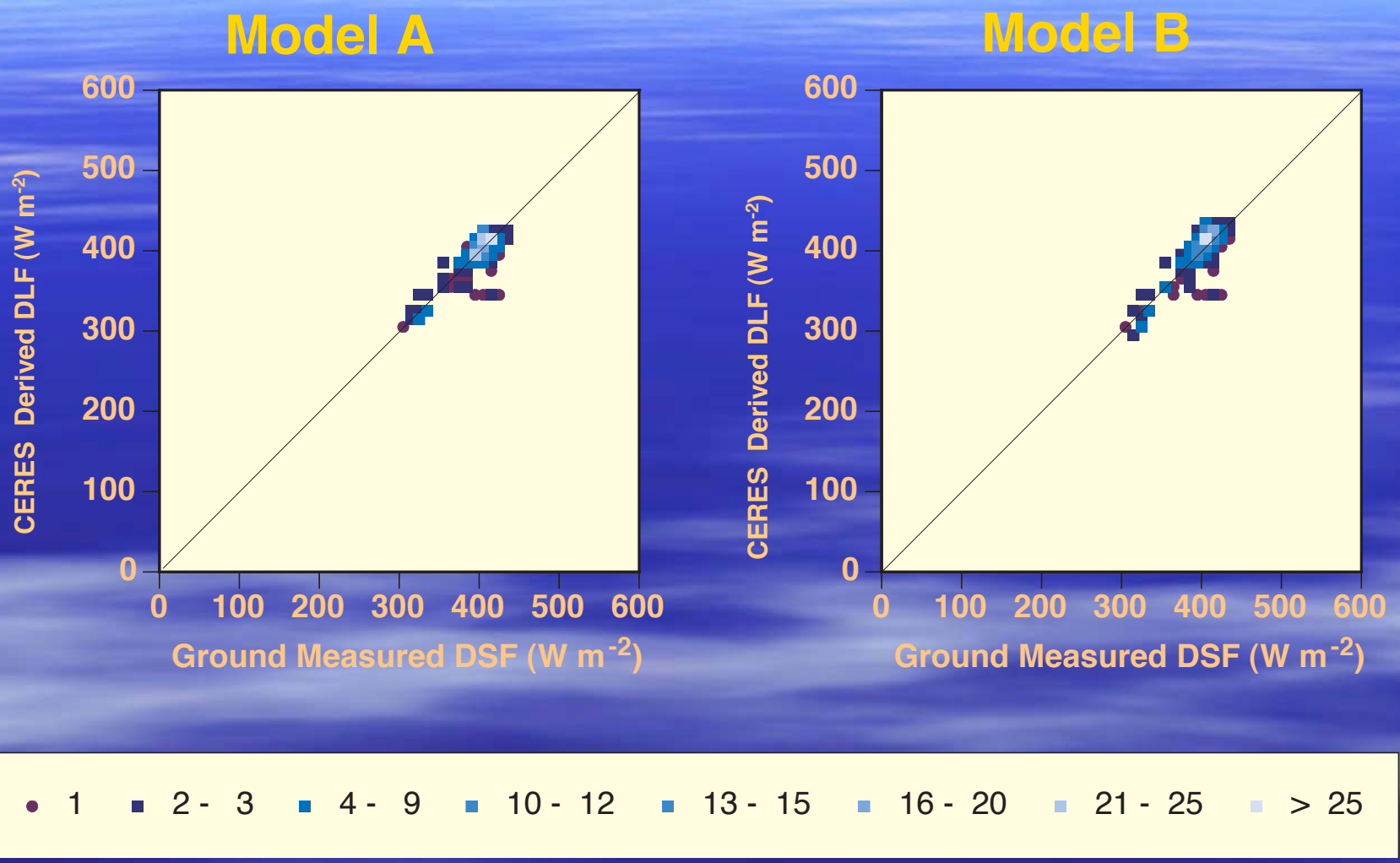
Longwave Clear-Sky, Continental



Longwave Clear-Sky, Coastal

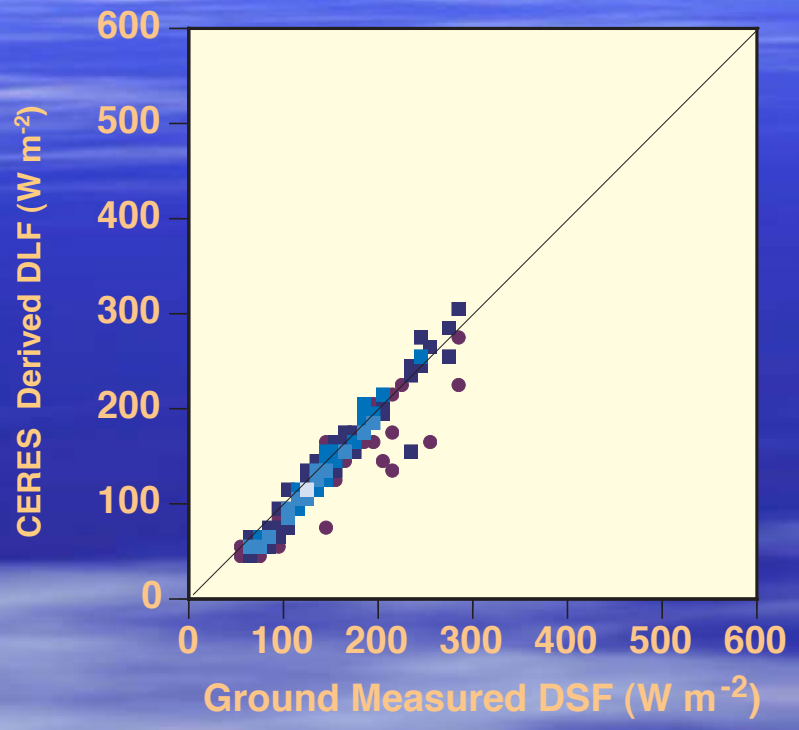


Longwave Clear-Sky, Island

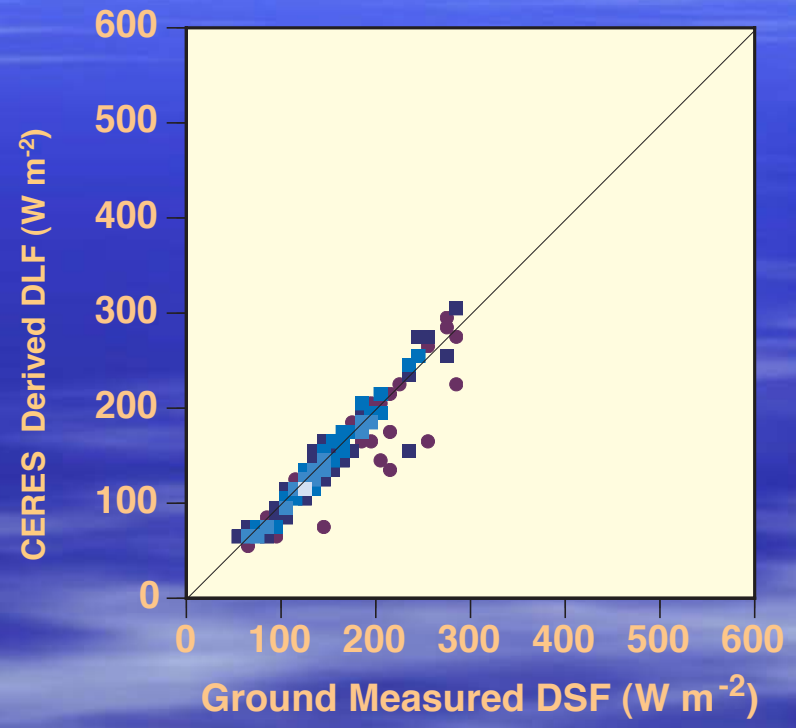


Longwave Clear-Sky, (Ant)arctic

Model A

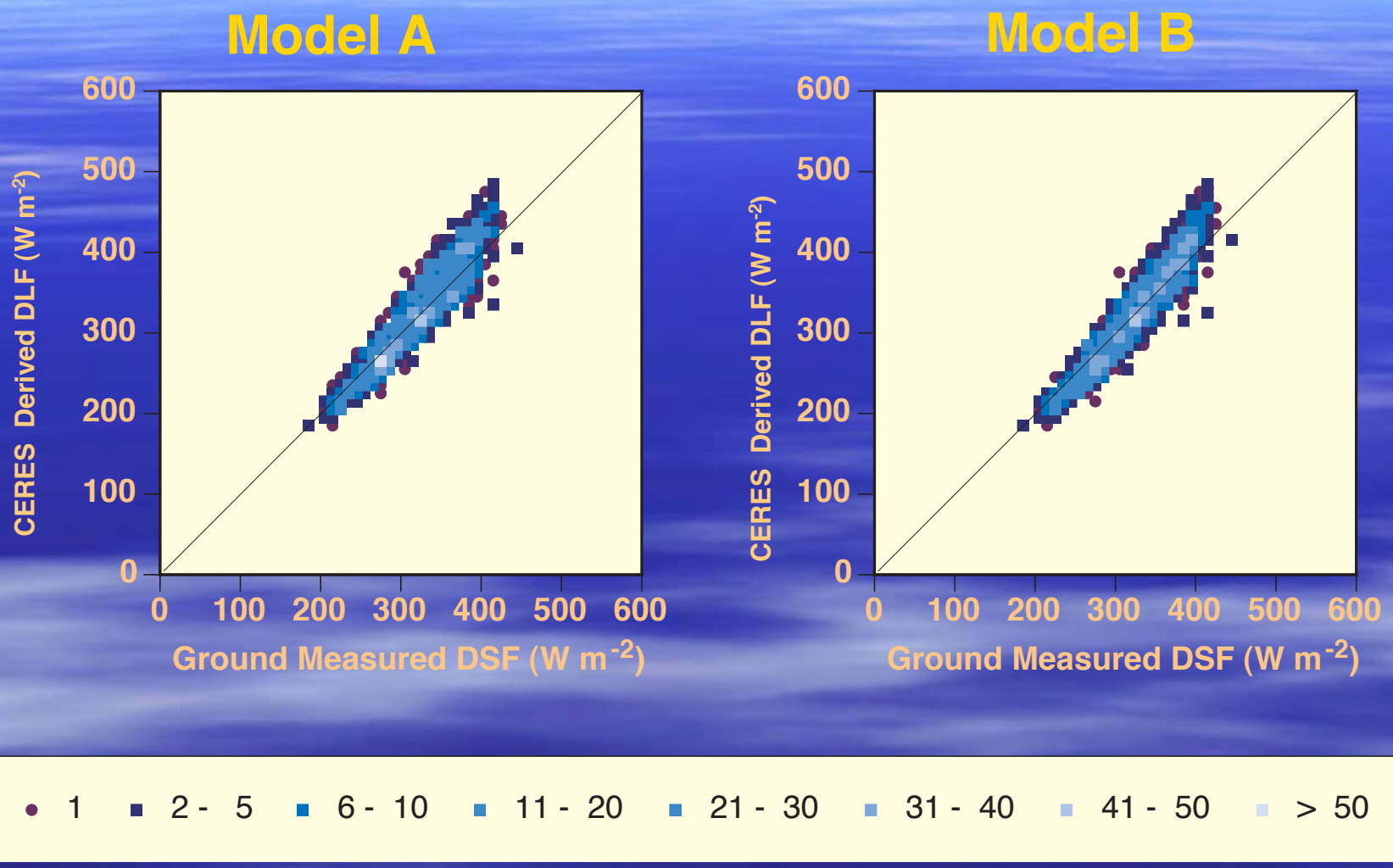


Model B



1 | 2 - 5 | 6 - 10 | 11 - 20 | 21 - 30 | 31 - 40 | 41 - 60 | > 60

Longwave Clear-Sky, Desert



LW Clear-Sky Comparisons

LW Model A - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	16120	-4.63 (-1.53)	14.0 (4.7)
Coastal	564	5.86 (2.08)	14.7 (5.2)
Island	241	-2.33 (-0.59)	15.1 (3.8)
(Ant)arctic	497	-9.98 (-7.09)	16.0 (11.4)
Desert	2331	3.29 (1.01)	22.1 (6.8)

LW Model B - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	16120	-7.43 (-2.46)	15.2 (5.0)
Coastal	564	-0.15 (-0.05)	13.3 (4.7)
Island	241	1.26 (0.32)	16.1 (4.1)
(Ant)arctic	497	-6.06 (-4.30)	13.1 (9.3)
Desert	2331	-0.50 (-0.15)	20.9 (6.4)

LW Clear-Sky Comparisons

LW Model A - Terra 2A – 2B

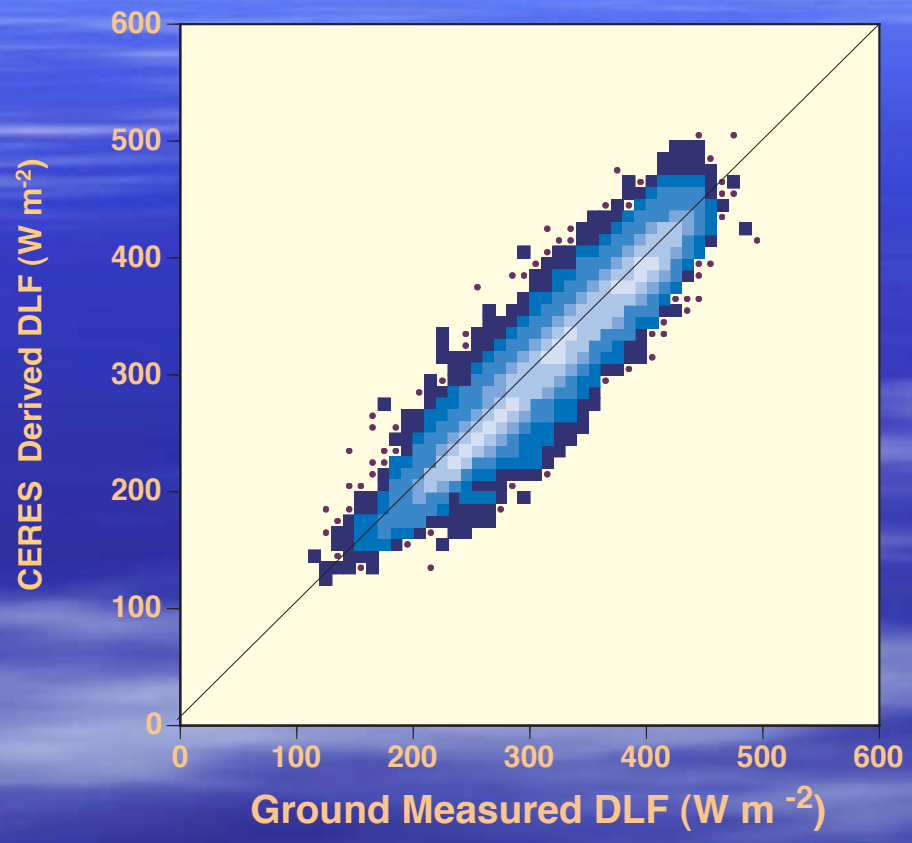
Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	8476	0.00 (0.00)	1.0 (0.3)
Coastal	389	-0.88 (-0.31)	3.5 (1.2)
Island	116	-0.10 (-0.02)	0.5 (0.1)
(Ant)arctic	249	0.05 (0.04)	0.2 (0.2)
Desert	1521	0.16 (0.05)	1.0 (0.3)

LW Model B - Terra 2A – 2B

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error . Wm^{-2} (%)
Continental	8476	0 00 (0.00)	0.9 (0.3)
Coastal	389	-0.87 (-0.32)	3.2 (1.2)
Island	116	-0.08 (-0.02)	0.4 (0.1)
(Ant)arctic	249	0.01 (0.00)	0.1 (0.1)
Desert	1521	0.11 (0.03)	1.0 (0.3)

Longwave All-Sky, Continental

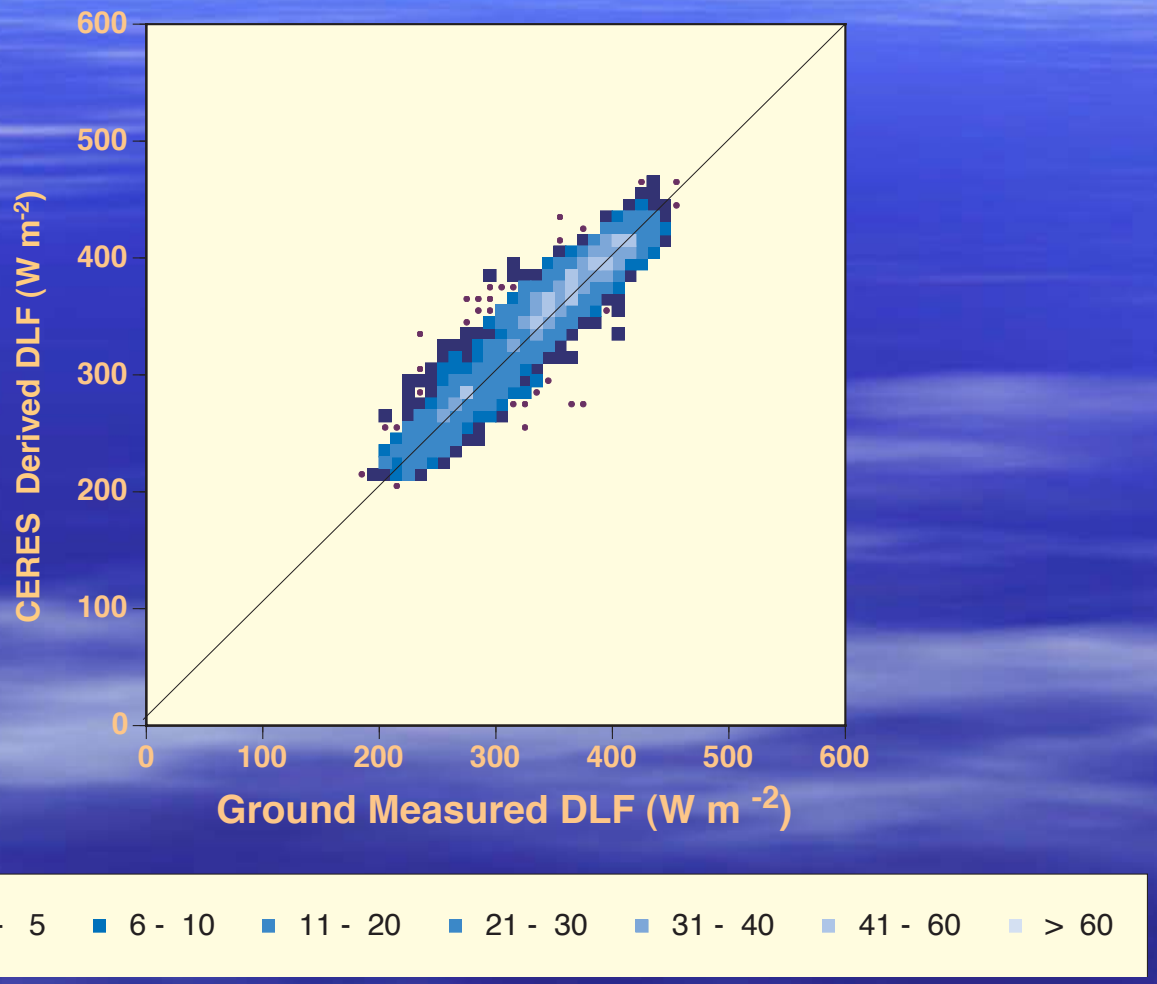
Model B



1 | 1 > 10 | 10 > 30 | 30 > 100 | 100 > 150 | 150 > 300 | 300 > 600 | > 600

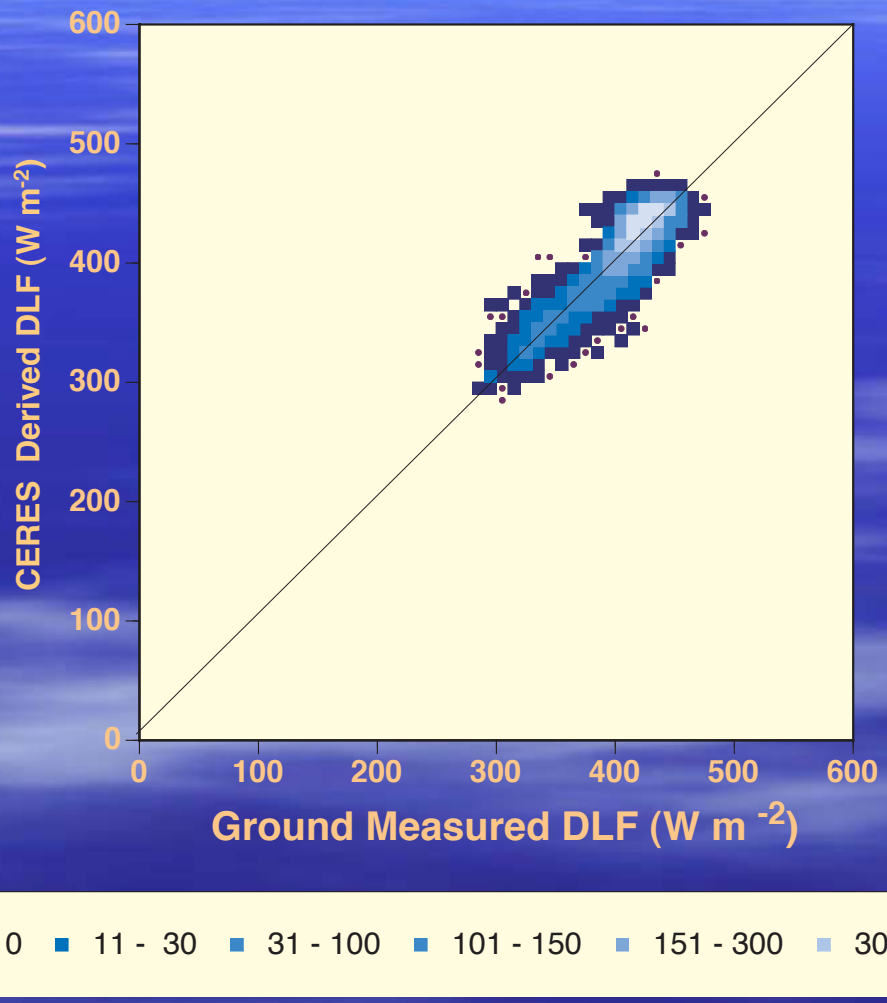
Longwave All-Sky, Coastal

Model B



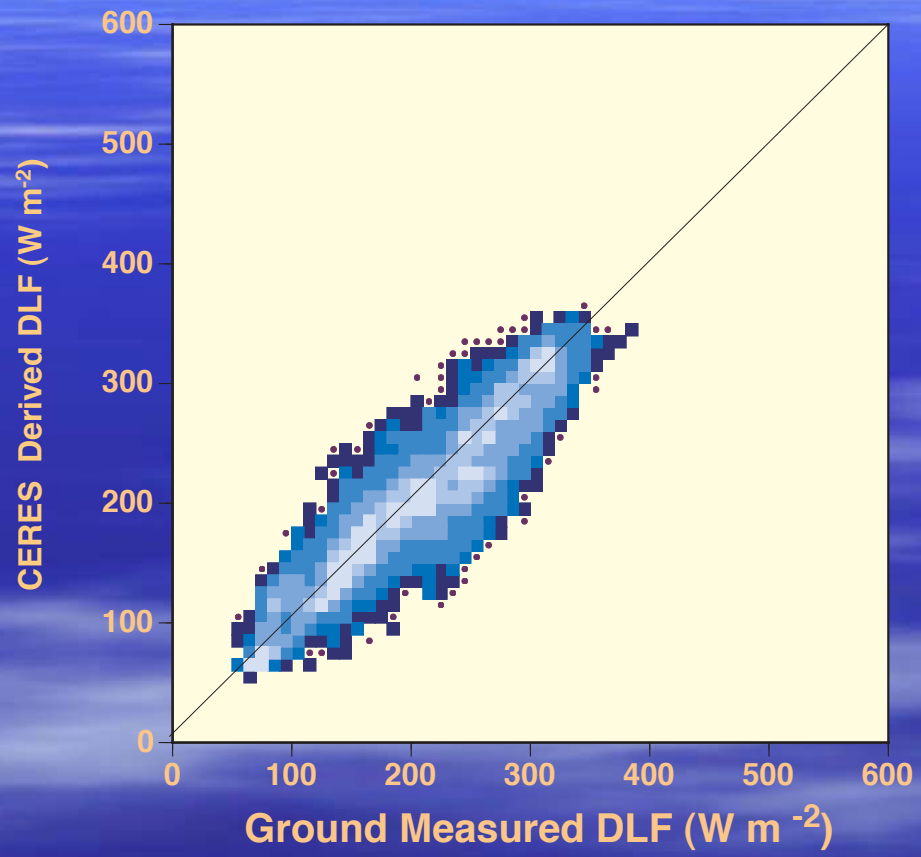
Longwave All-Sky, Island

Model B



Longwave All-Sky, (Ant)arctic

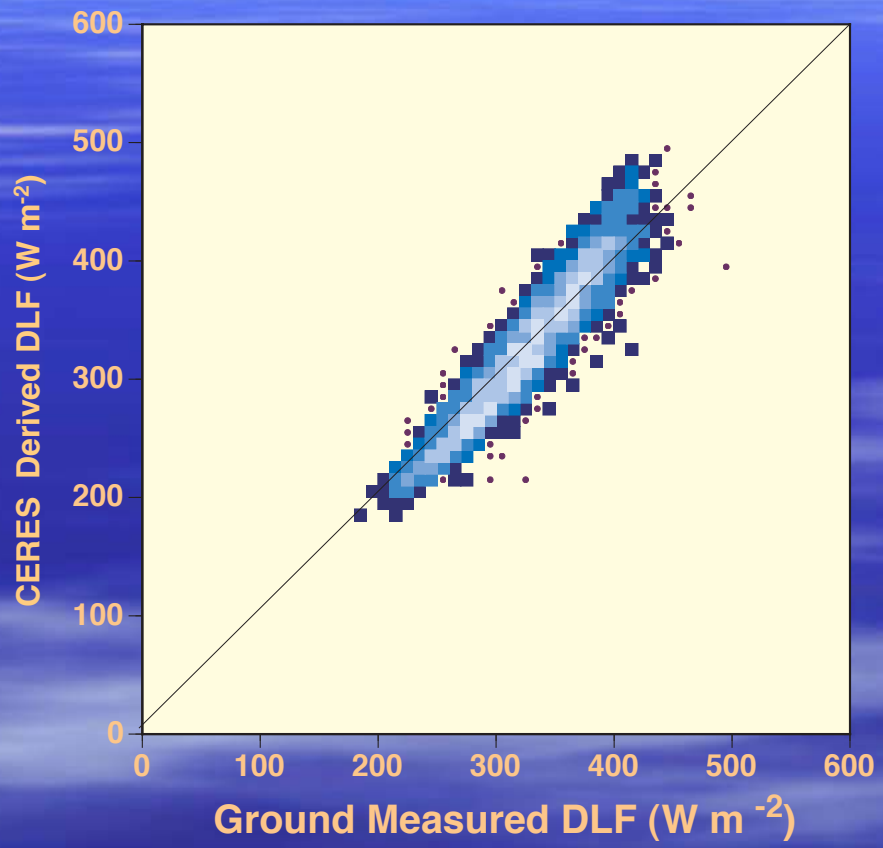
Model B



• 1 ■ 2 - 5 ■ 6 - 10 ■ 11 - 20 ■ 21 - 40 ■ 41 - 80 ■ 81 - 100 ■ > 100

Longwave All-Sky, Desert

Model B



• 1 ■ 2 - 5 ■ 6 - 10 ■ 11 - 20 ■ 21 - 30 ■ 31 - 40 ■ 41 - 60 ■ > 60

LW All-Sky Comparisons

LW Model B - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	56526	-3.50 (-1.08)	19.0 (5.9)
Coastal	3523	7.30 (2.20)	21.0 (6.3)
Island	10317	5.49 (1.33)	15.5 (3.8)
(Ant)arctic	16460	-2.67 (-1.29)	28.4 (13.7)
Desert	5036	0.17 (0.05)	21.0 (6.4)

LW All-Sky Comparisons

LW Model B - Terra 2A – 2B

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	19494	0.01 (0.00)	2.5 (0.8)
Coastal	1626	-0.49 (-0.15)	3.9 (1.2)
Island	3954	-0.05 (-0.01)	1.5 (0.4)
(Ant)arctic	7579	-0.14 (-0.07)	4.4 (2.2)
Desert	2360	0.16 (0.05)	2.0 (0.6)

Conclusions: Longwave

CERES derived LW surface fluxes are within desired accuracies (biases) for both clear-sky (models A & B) & all-sky (model B) cases.

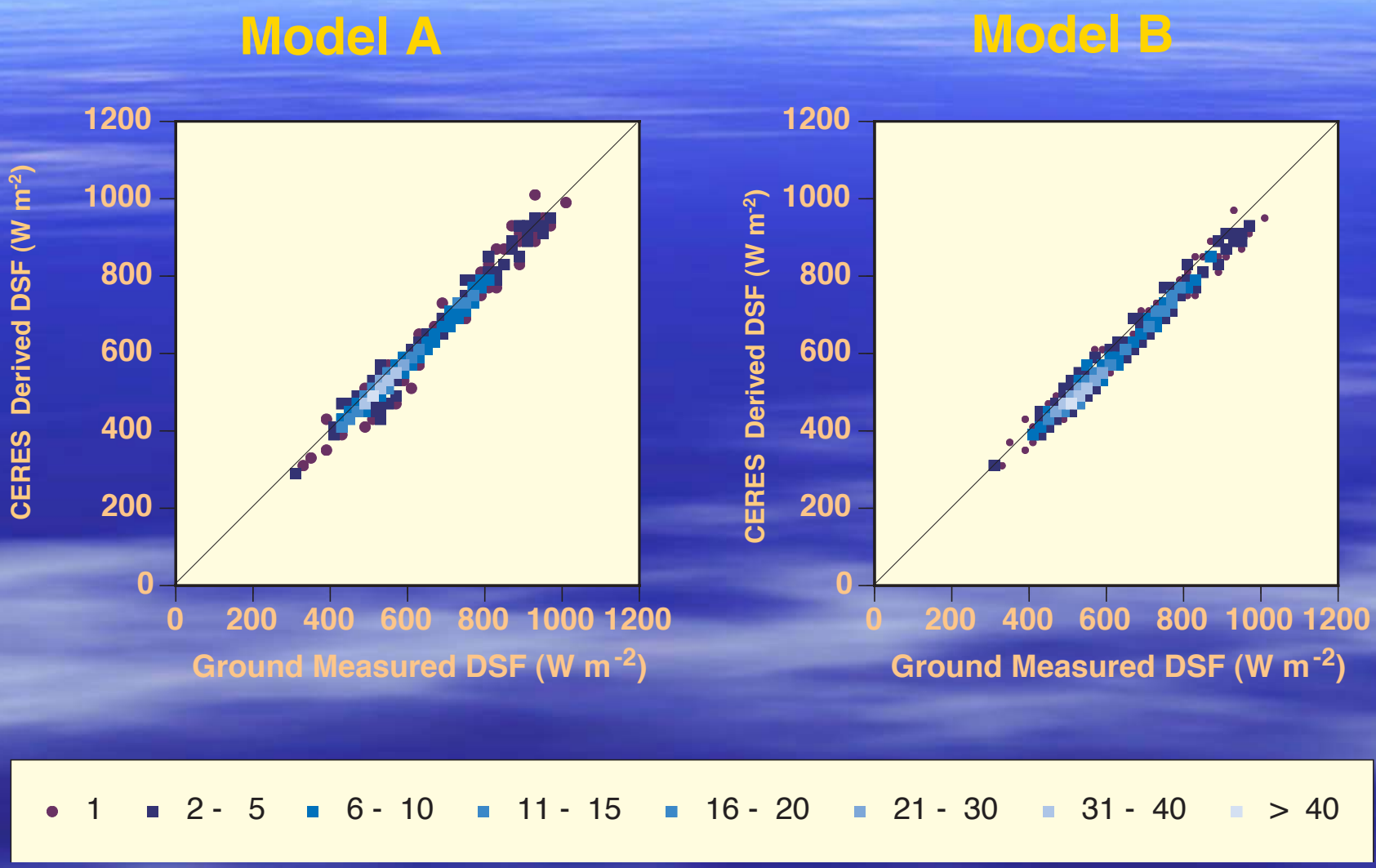
Precision is also within desired limits, with the exception of all-sky (ant)arctic cases where some improvement in cloud detection may be warranted.

Terra 2A & Terra 2B results are very similar.

Aqua

July 2002 through February 2003

Shortwave Clear-Sky, Continental



SW Clear-Sky Comparisons

SW Model A - Aqua Edition 1A

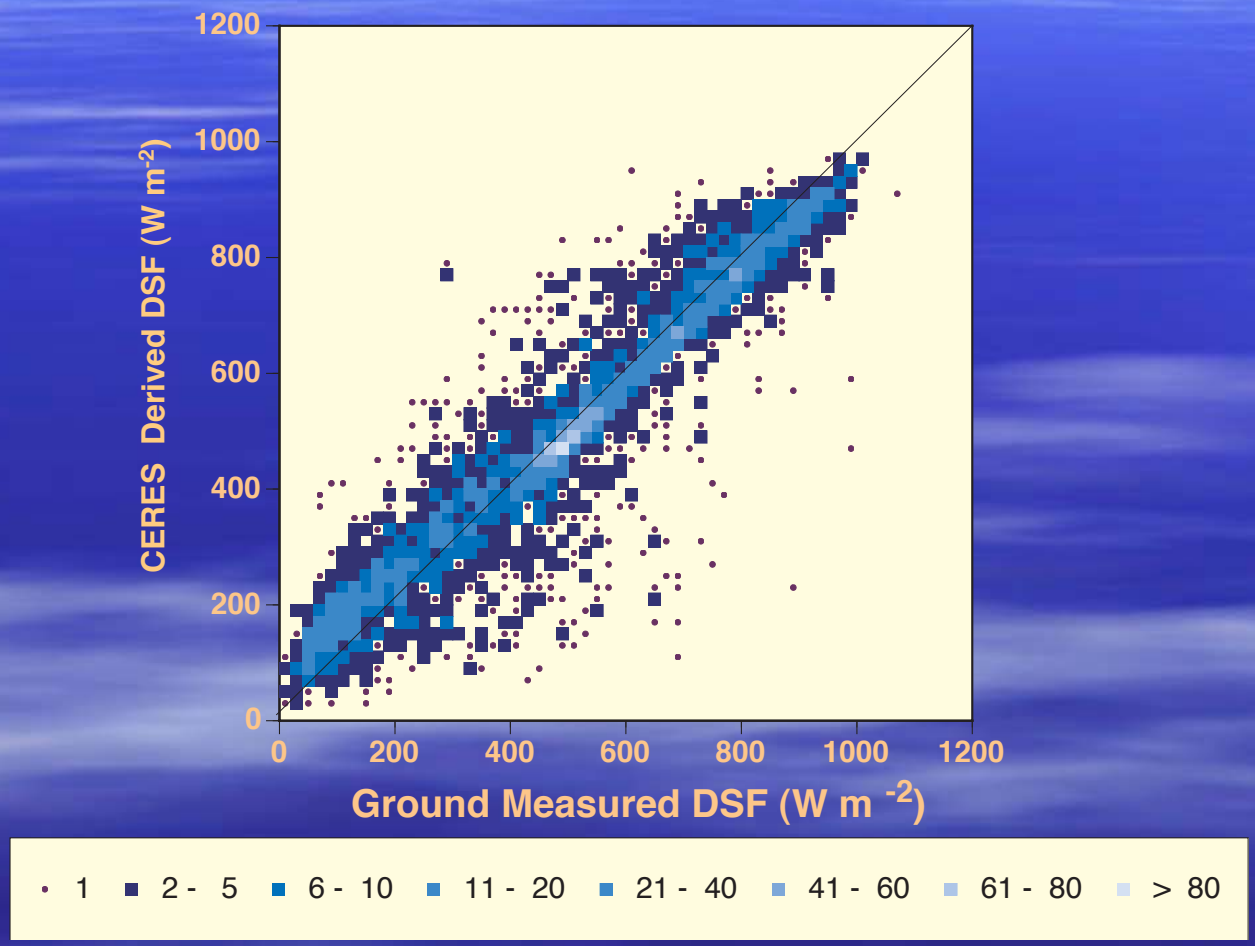
Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	769	-17.76(-2.92)	18.7(3.1)
Coastal	18	-16.04(-2.75)	7.5(1.3)
Island	13	8.03(0.95)	34.2(4.1)
(Ant)arctic	62	-57.59(-13.12)	18.3(4.2)
Desert	64	-55.33(-6.99)	32.0(4.0)

SW Model B - Aqua Edition 1A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error. Wm^{-2} (%)
Continental	769	-29.33(-4.82)	17.3(2.8)
Coastal	18	-0.76(-0.13)	6.1(1.0)
Island	13	3.77(0.45)	26.7(3.2)
(Ant)arctic	62	-0.34(-0.08)	7.4(1.7)
Desert	64	3.19(0.40)	34.2(4.3)

Shortwave All-Sky, Continental

Model B



SW All-Sky Comparisons

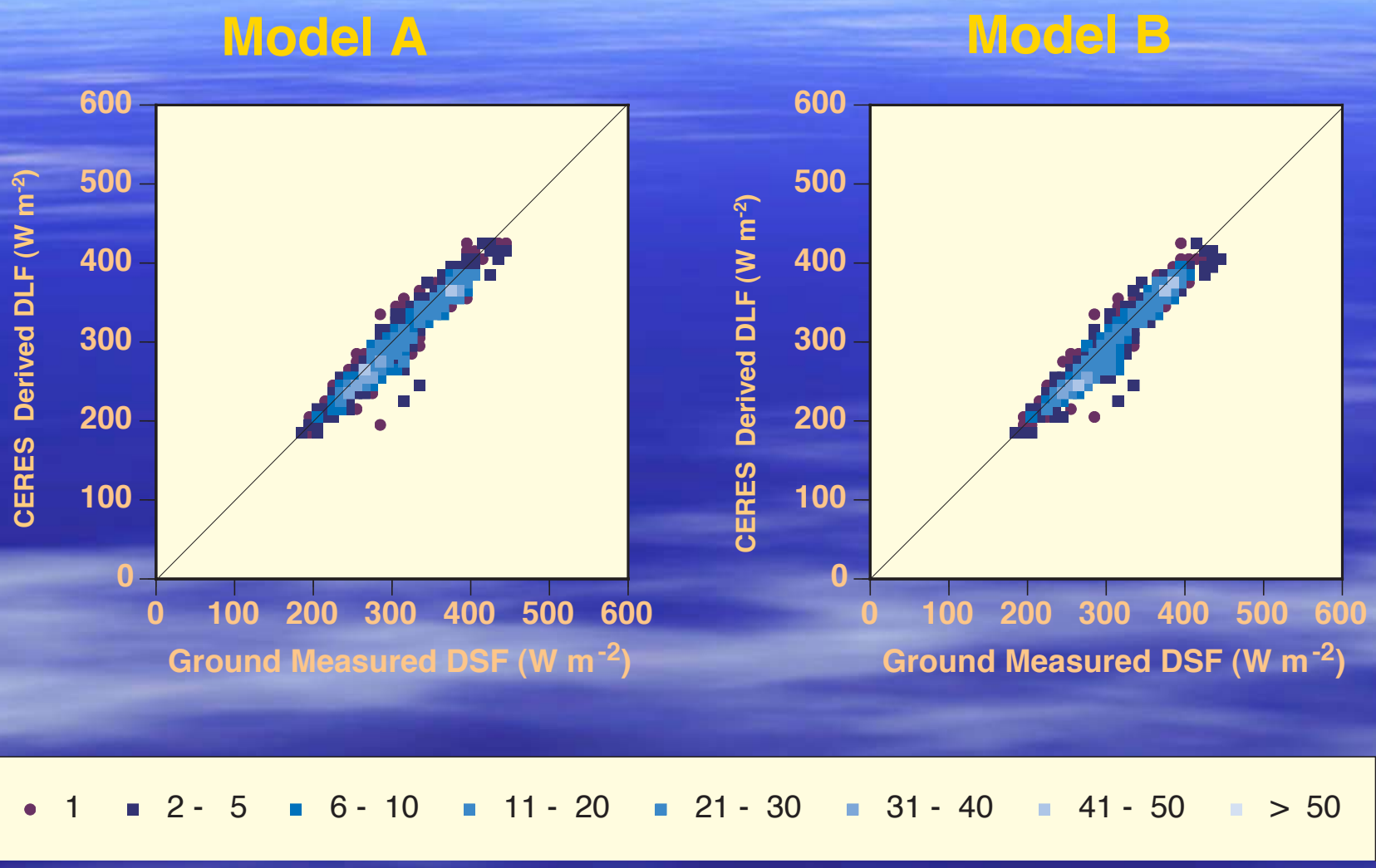
SW Model B - Aqua Edition 1A (1 min)

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	4988	0.78(0.16)	108.9(21.7)
Coastal	222	53.39(10.95)	91.5(18.8)
Island	912	63.55(10.61)	148.2(24.7)
(Ant)arctic	1091	0.67(0.25)	51.9(19.1)
Desert	412	-4.44(-0.64)	111.1(16.0)

SW Model B - Aqua Edition 1A (1 hr)

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error. Wm^{-2} (%)
Continental	5069	5.32(1.07)	77.4(15.6)
Coastal	222	51.65(10.55)	68.0(13.9)
Island	912	64.06(10.70)	110.9(18.5)
(Ant)arctic	1091	-0.64(-0.23)	41.0(15.0)
Desert	412	-6.76(-0.97)	68.7(9.9)

Longwave Clear-Sky, Continental



LW Clear-Sky Comparisons

LW Model A - Aqua Edition 1A

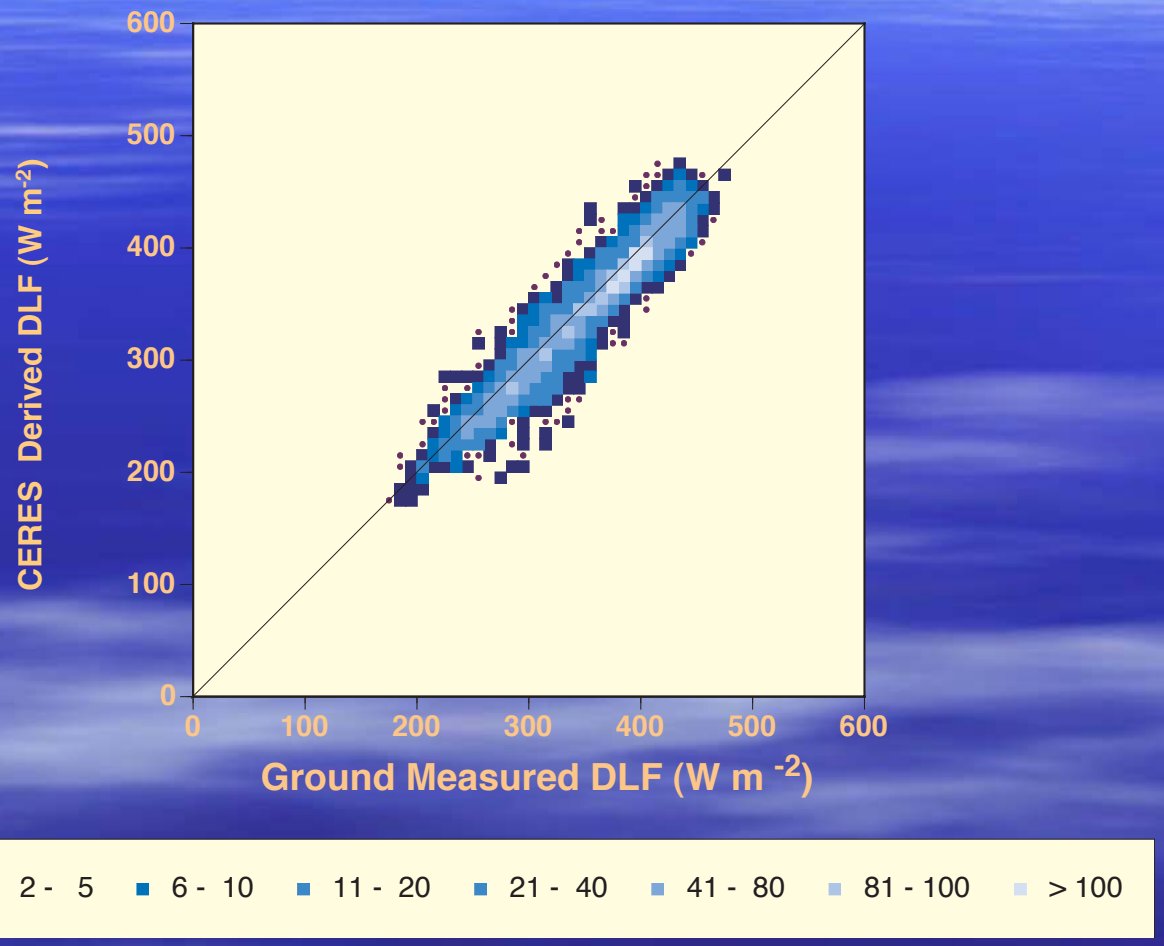
Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	1384	-8.67(-2.76)	15.7(5.0)
Coastal	43	11.88(3.63)	14.5(4.4)
Island	31	-0.37(-0.09)	11.6(2.9)
(Ant)arctic	88	-14.03(-14.47)	16.2(16.7)
Desert	186	-1.85(-0.54)	24.1(7.1)

LW Model B - Aqua Edition 1A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error. Wm^{-2} (%)
Continental	1384	-11.04(-3.52)	17.7(5.6)
Coastal	43	7.48(2.28)	11.7(3.6)
Island	31	1.19(0.30)	14.2(3.6)
(Ant)arctic	88	-5.48(-5.66)	9.2(9.5)
Desert	186	-1.02(-0.30)	23.4(6.9)

Longwave All-Sky, Continental

Model B



LW All-Sky Comparisons

LW Model B - Aqua Edition 1A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	6466	-6.52(-1.89)	18.9(5.5)
Coastal	300	10.73(2.96)	18.8(5.2)
Island	1220	5.91(1.41)	13.9(3.3)
(Ant)arctic	1481	-3.05(-1.47)	23.6(11.4)
Desert	606	6.42(1.84)	27.2(7.8)