Comparisons between nadir and oblique flux estimates using along track CERES and POLDER data

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Motivation

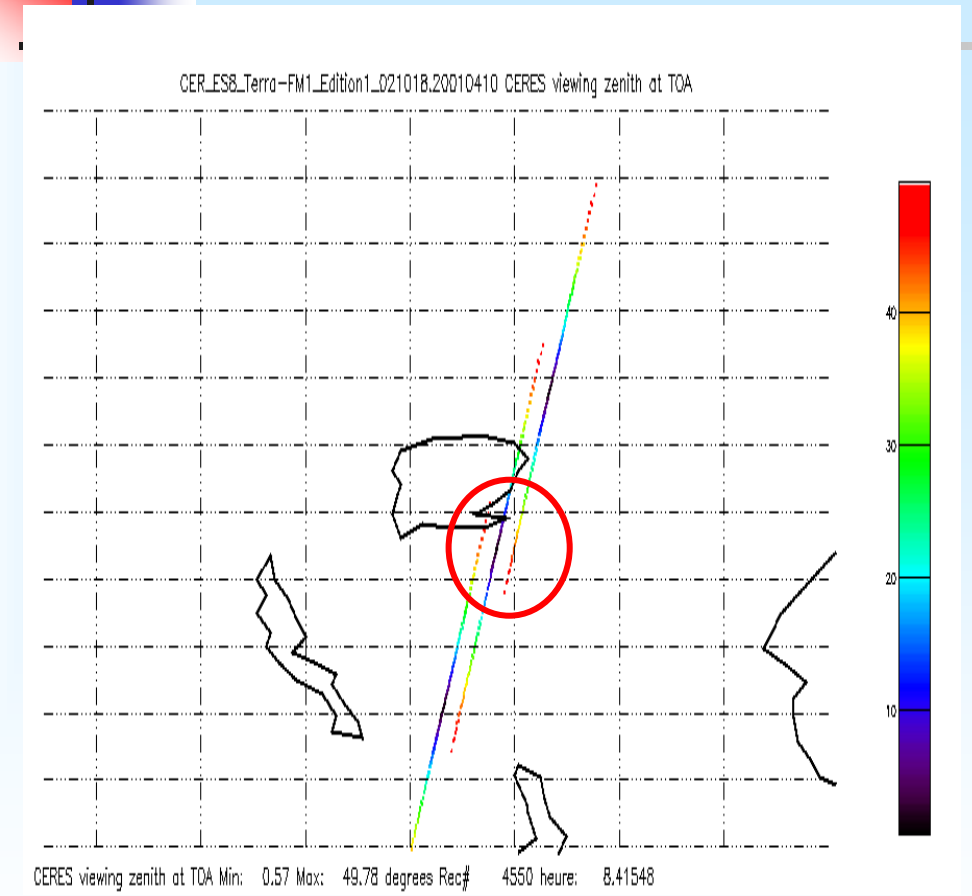
- Create a dataset with 3 along-track observations (nadir and 55° fore and aft)
- Look for improving the instantaneous flux estimate from these 3 directions

(ESA study, prime contractor, E. Lopez Baeza, Valencia U. Spain)

Problem

- The CERES along-track mode does not account for the Earth rotation between the nadir and oblique observations: severe spatial mismatches

CERES Along Track: the instrument is fixed, the scan is aligned with Vsat



The grid-cell is 2° latitude x 2° longitude.

Three along-track CERES/Terra records (centred on Lake Victoria, Africa).

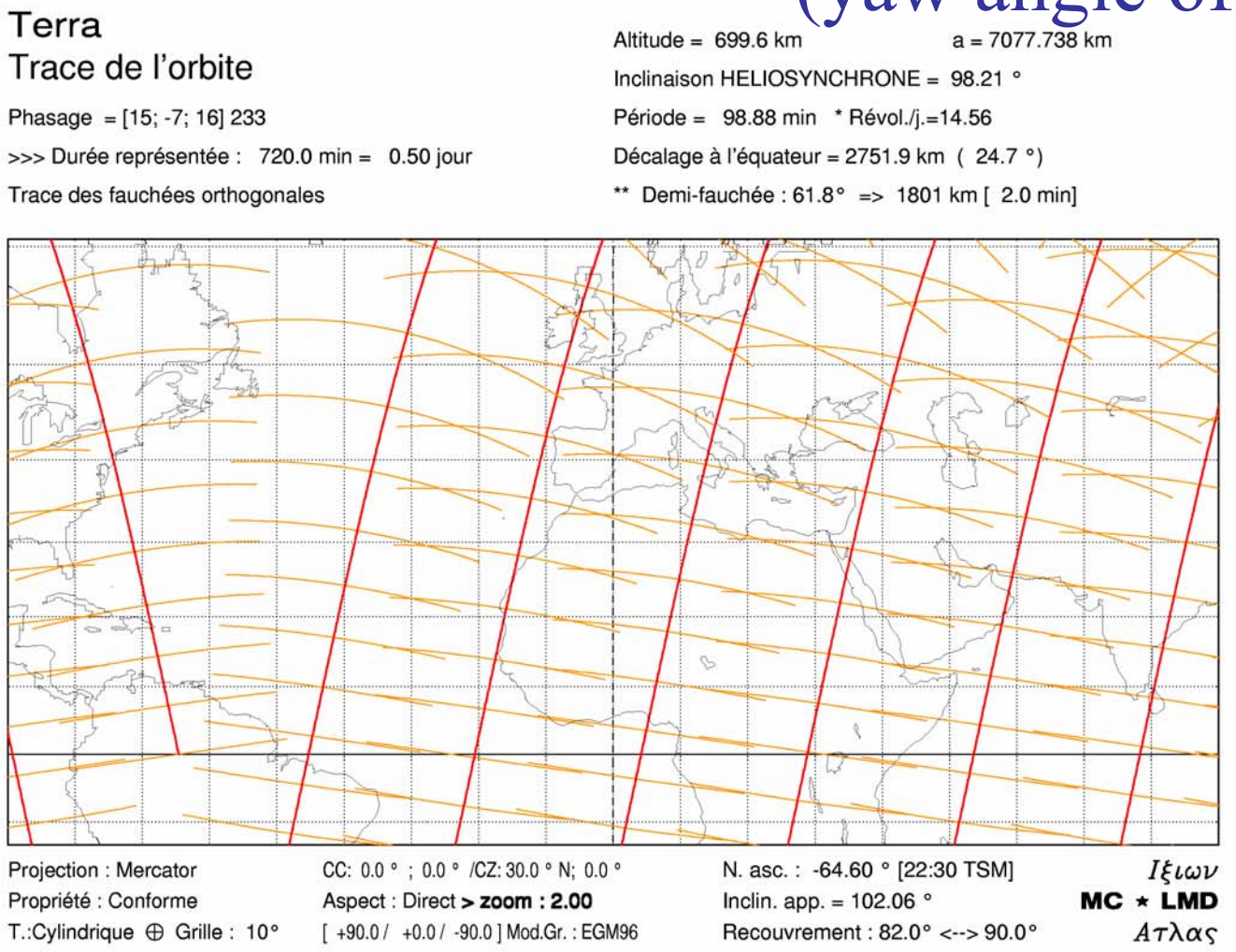
The pixel centres (not the footprints) are plotted with colours illustrating the viewing zenith angle (nadir in dark blue, 50° fore and aft in red).

The shift between the first and the third scans is 0.72° latitude or 80 km, due to the Earth rotation for the 3 measurements.

Theoretical computations for Terra, XT mode

Source:M. Capderou, LMD

(yaw angle of 0°)

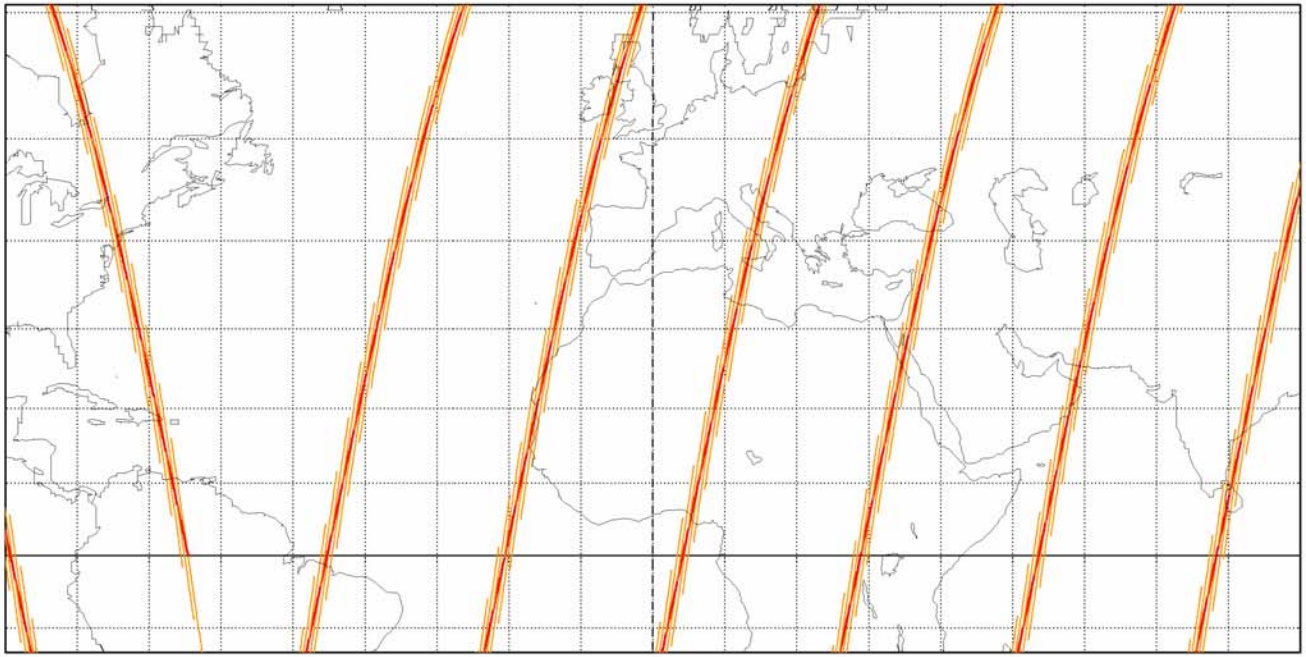


AT mode with a yaw angle of 90°

Terra
Trace de l'orbite

Phasage = [15; -7; 16] 233
>>> Durée représentée : 720.0 min = 0.50 jour
Trace des fauchées le long de la trace

Altitude = 699.6 km a = 7077.738 km
Inclinaison HELIOSYNCHRONE = 98.21 °
Période = 98.88 min * Révol./j.=14.56
Décalage à l'équateur = 2751.9 km (24.7 °)
** Demi-fauchée : 61.8° => 1801 km [2.0 min]



Projection : Mercator
Propriété : Conforme
T.:Cylindrique ⊕ Grille : 10°

CC: 0.0 ° ; 0.0 ° /CZ: 30.0 ° N; 0.0 °
Aspect : Direct **> zoom : 2.00**
[+90.0 / +0.0 / -90.0] Mod.Gr. : EGM96

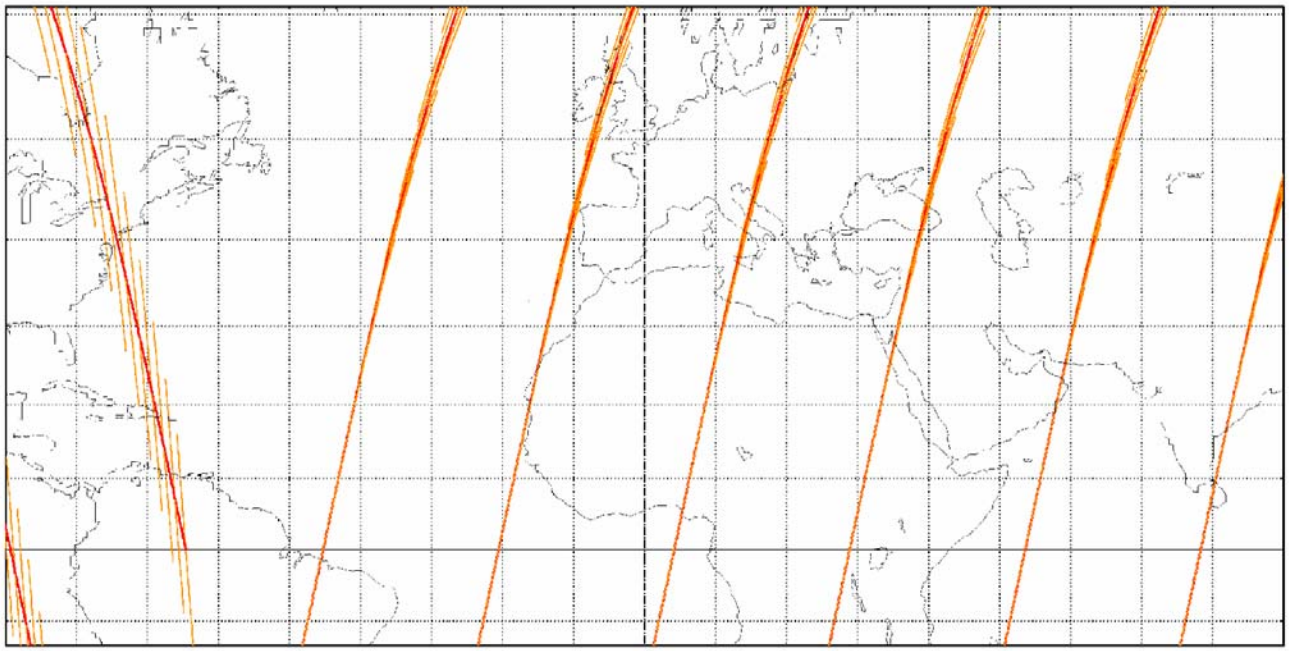
N. asc. : -64.60 ° [22:30 TSM]
Inclin. app. = 102.06 °
Balayage / Lacet = +90.0 °

Ιξιων
MC ⋆ LMD
Ατλας

AT mode with a yaw angle of 86.2°

Terra
Trace de l'orbite

Altitude = 699.6 km a = 7077.738 km
Inclinaison HELIOSYNCHRONE = 98.21 °
Phasage = [15; -7; 16] 233
Période = 98.88 min * Révol./j.=14.56
>>> Durée représentée : 720.0 min = 0.50 jour
Décalage à l'équateur = 2751.9 km (24.7 °)
Trace des fauchées - Lacet = +86.2°
** Demi-fauchée : 61.8° => 1801 km [2.0 min]



Projection : Mercator
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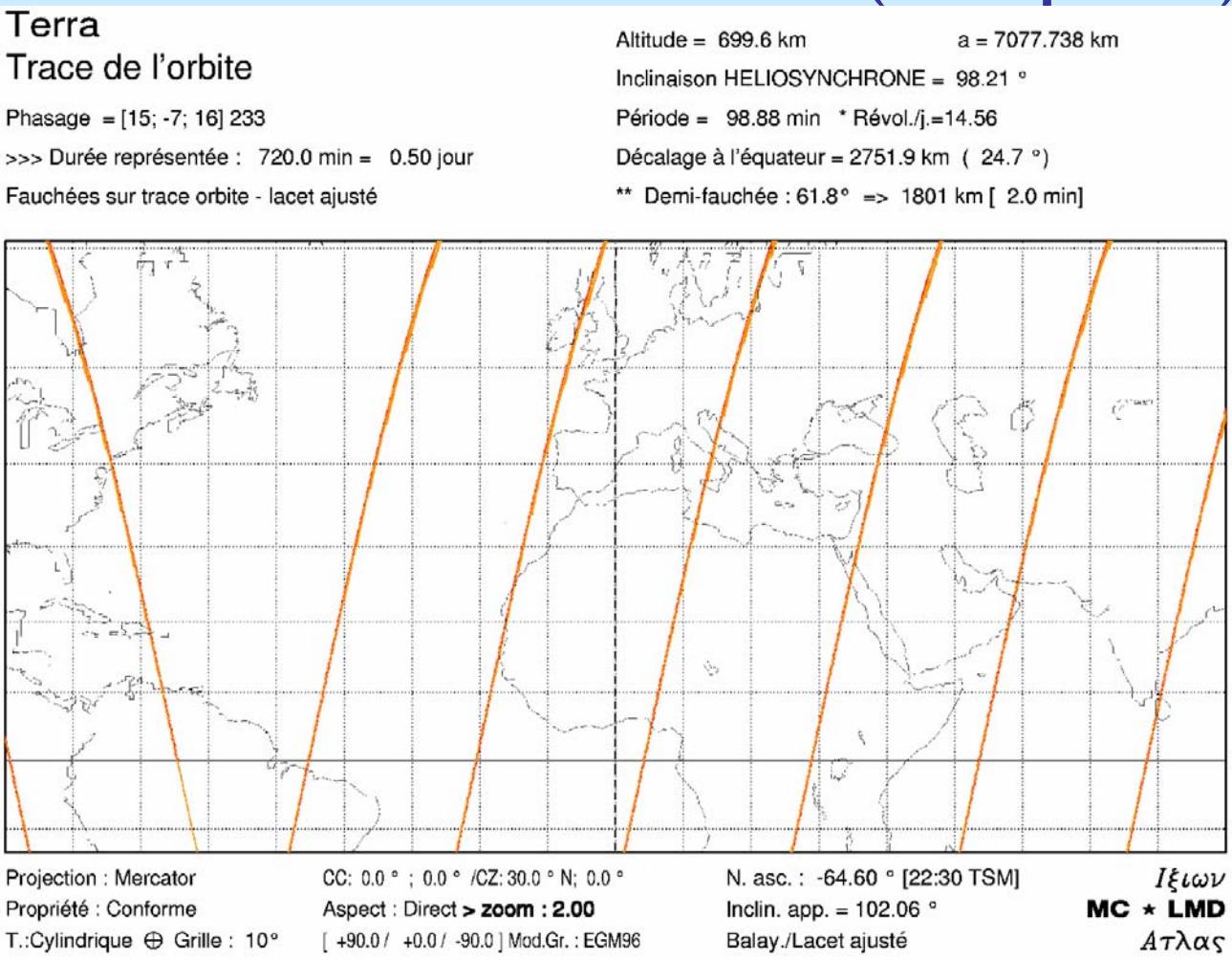
[+90.0 / +0.0 / -90.0] Mod.Gr. : EGM96
N. asc. : -64.60 ° [22:30 TSM]
Inclin. app. = 102.06 °
Balayage / Lacet = +86.2 °
Ιξιων
MC ★ LMD
Ατλας

AT mode with a variable yaw angle between 86.2° and 93.8° (adapted)



Latitude-dependent yaw angle

Latitude	Azimuth
80.00	-89.61
70.00	-88.79
60.00	-88.13
50.00	-87.56
40.00	-87.07
30.00	-86.68
20.00	-86.39
10.00	-86.21
0.00	-86.15

Solution for spatial mismatches

- Focus to high-latitude zones where orbit turns back and the satellite motion accompanies the Earth rotation, and where the CERES triplets are well collocated
- Study homogeneous zones (relative dispersion <5% around the observation) for which the collocation problem is less critical
- Ask NASA for programming a ‘true’ CERES/Terra along-track mode (with a latitude dependent yaw angle between 86.2° and 93.8°) , ….

Aug, 19 2004

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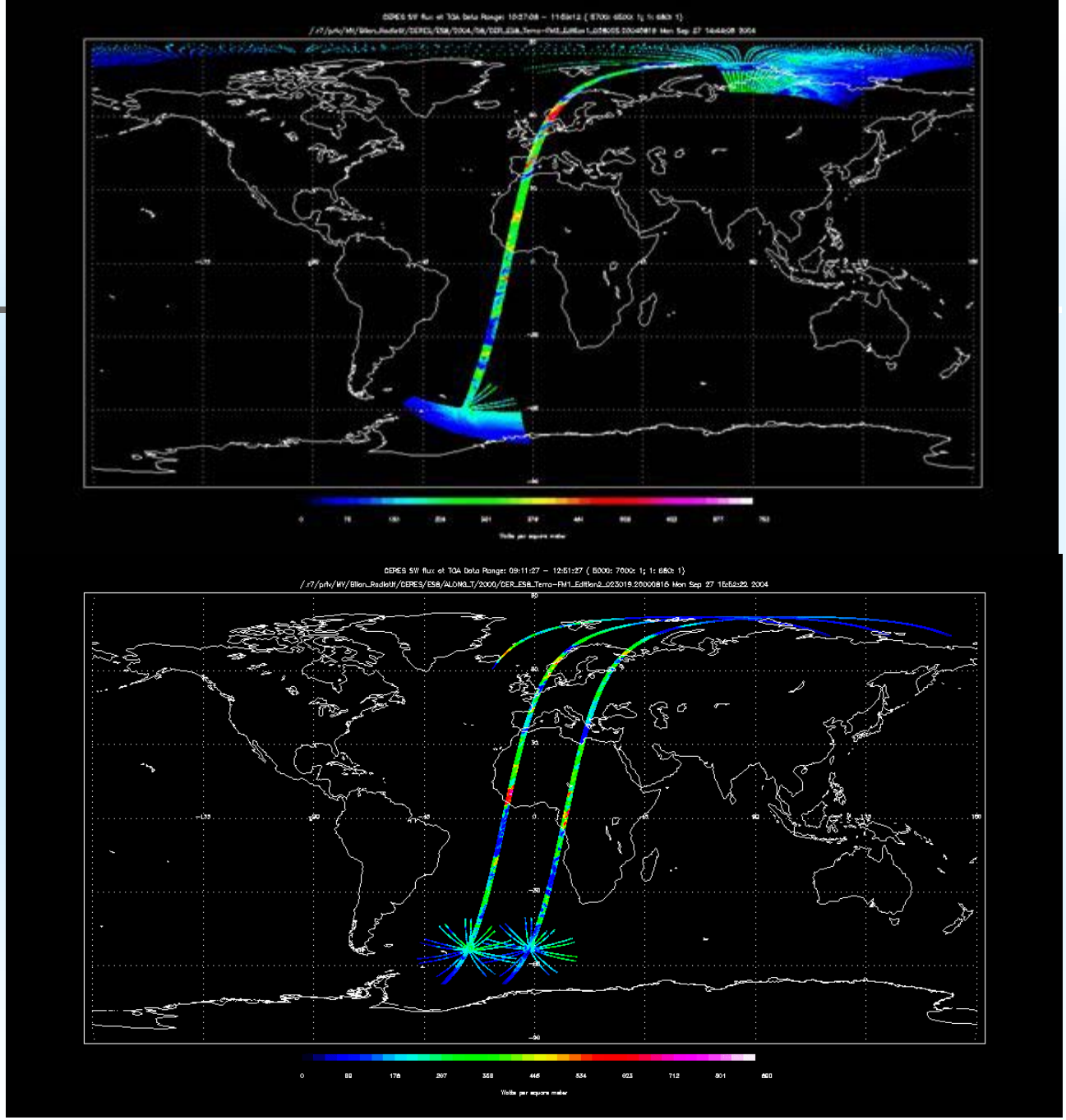
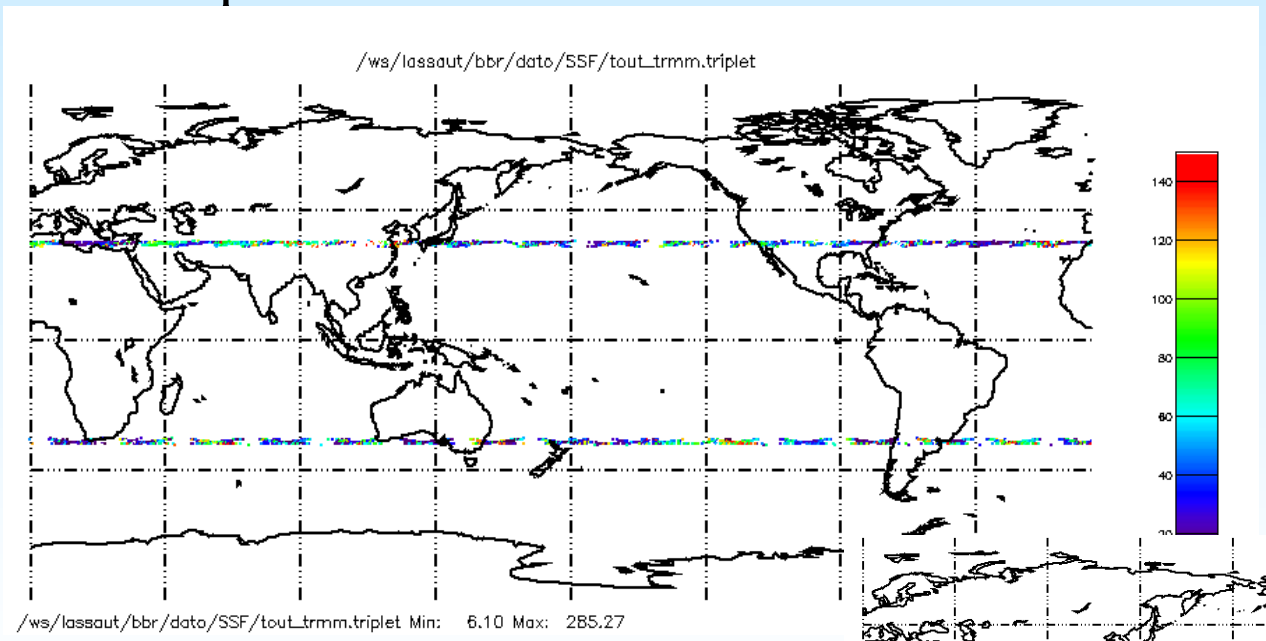
Standard Along-Track

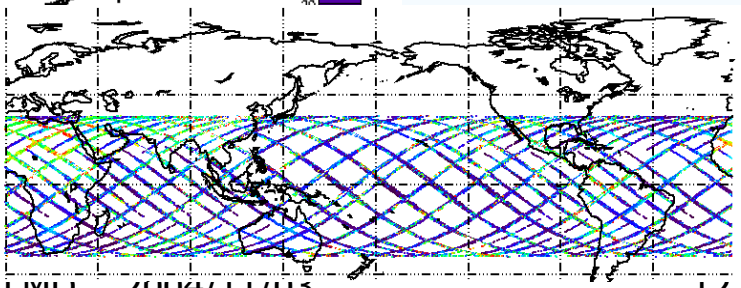
→



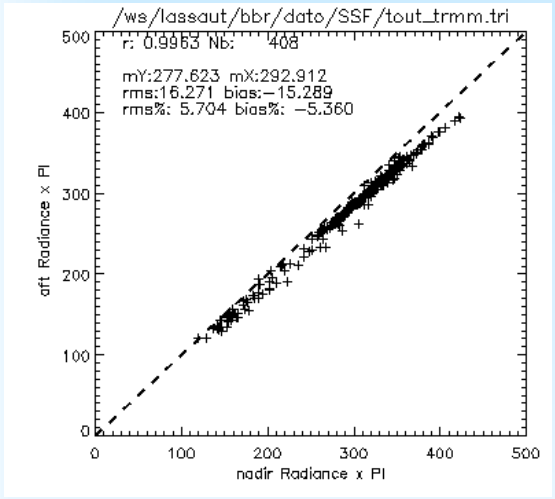
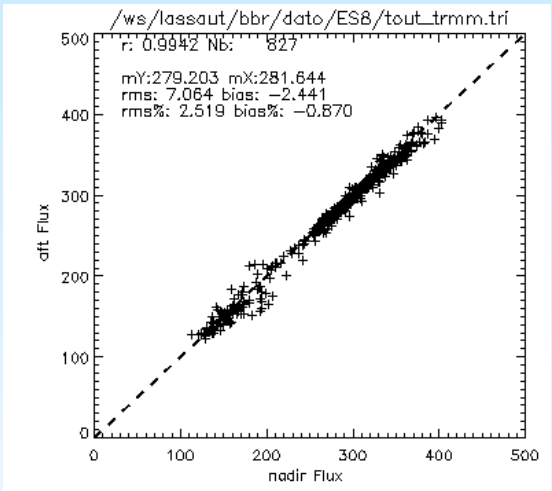
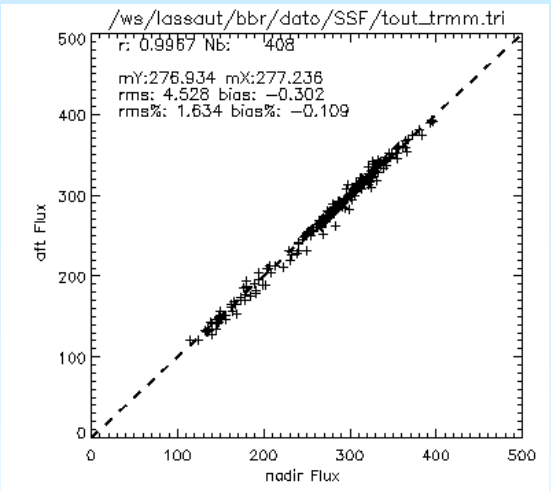
when the closest locations are selected….

when the where orbit turns back and the satellite motion accompanies the Earth rotation

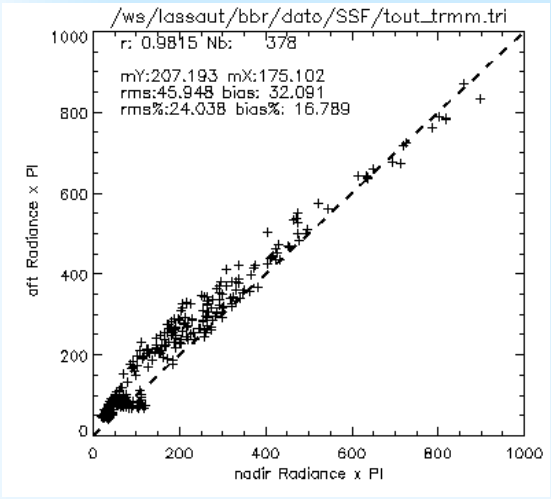


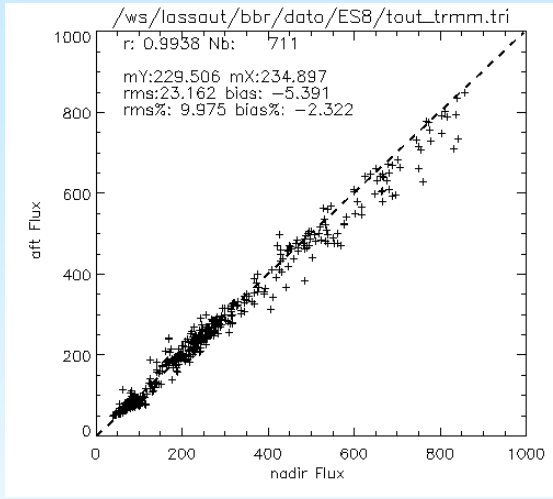


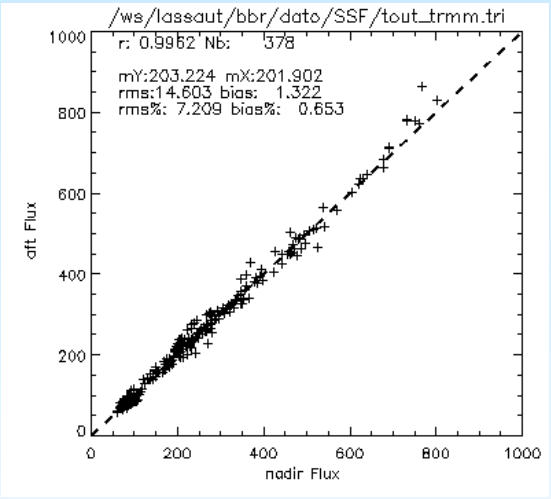
LW flux: oblique / nadir

		
Isotropic Model	S8 Flux	SSF Flux
Difference (%) : -5.4	-0.9	-0.1
Rms 5.7	2.5	1.6

SW flux: oblique / nadir







Isotropic Model	S8 Flux	SSF Flux
Difference (%) : 15.8	-2.3	0.6
Rms 24.0	10.0	7.2

Comparisons with TRMM ADM validation studies

6.5

Loeb, N. G et all, 2003: ..ADM ..for TRMM Part II: Validation. *J. Appl. Meteor.*, **42**, 1748–1769.

1.7

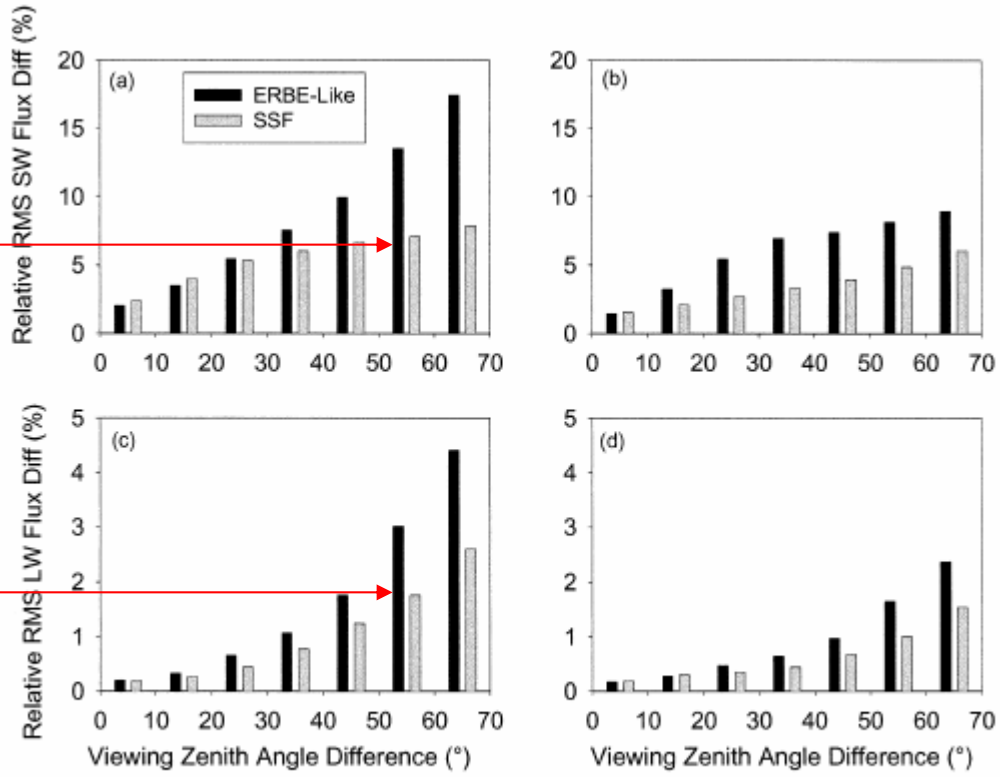


FIG. 7. Relative rms difference between TOA fluxes determined from VIRS nadir radiances and off-nadir CERES measurements as a function of the viewing zenith angle separation for (a) all-sky SW TOA fluxes, (b) clear-sky SW TOA fluxes, (c) all-sky LW TOA fluxes, and (d) clear-sky LW TOA fluxes.

Other cases: LW

case	Selected observations LW			SSF Fluxes aft – nadir (%)			ERBE type fluxes aft-nadir (%)		
	Distance	same id	Dispers.	rms	moy	N	rms	moy	N
1	5 km	yes	<5%	1.5	0.1	289	2.5	-0.9	827
2	5 km	no	< 5%	1.6	-0.1	408			
3	5 km	yes	-	3.2	-0.3	2745	3.9	-0.7	10755
4	5 km	no	-	3.6	-0.1	7589			
5	25 km	yes	<5%	1.8	-0.1	3725			
6	25 km	no	< 5%	2.3	-0.4	7450			
7	25 km	yes	-	3.2	-0.5	25191			
8	25 km	no	-	5.4	-0.5	142723			

Only cases 1,2 and 5 provide relatively low flux differences

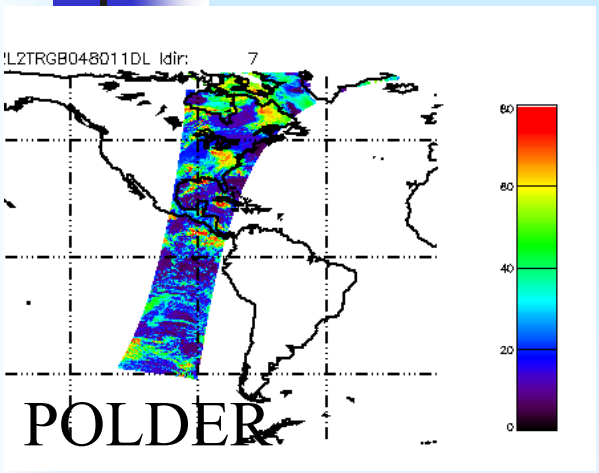
Case 5: same cloud category for the nadir and oblique view (provided by nadir imager data)

Other cases: SW

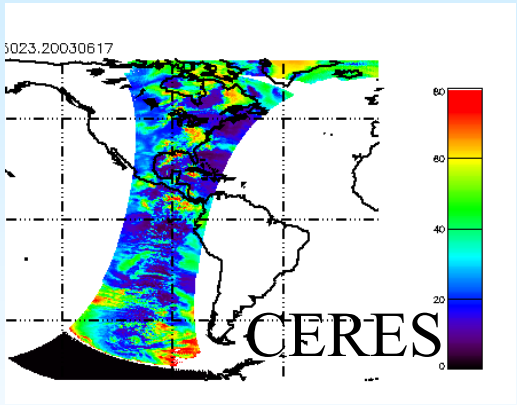
case	Selected observations SW			SSF Fluxes aft – nadir (%)			ERBE type fluxes aft - nadir (%)		
	Distance	same id	Dispers.	rms	moy	N	rms	moy	N
1	5 km	yes	<5%	7.9	+1.7	218			
2	5 km	no	< 5%	7.2	+0.6	378	10.0	-2.3	711
3	5 km	yes	-	12.4	+1.1	981			
4	5 km	no	-	16.2	-0.4	3325	22.5	0.1	3919
5	25 km	yes	<5%	9.1	+0.6	3111			
6	25 km	no	< 5%	11.5	1.7	7014	16,2	-1.4	3381
7	25 km	yes	-	13,4	1.2	9484			
8	25 km	no	-	28.0	1.6	61348	26.0	0.2	19720

Only cases 1,2 and 5 provide relatively low flux differences

POLDER-CERES triplets



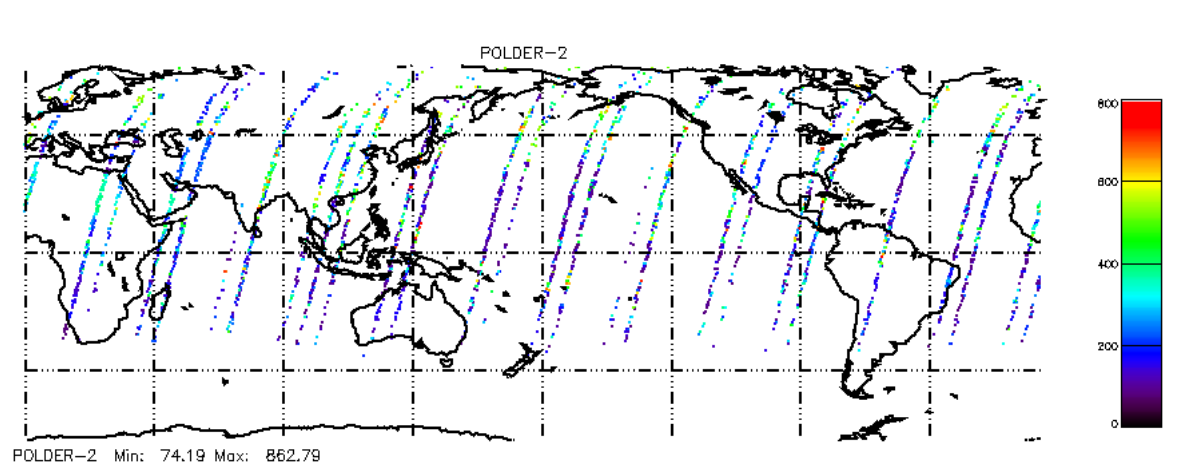
1) from POLDER, select nadir/oblique triplets around the sub-sat track



2) collocate the POLDER triplet with CERES (here with the cross track mode)

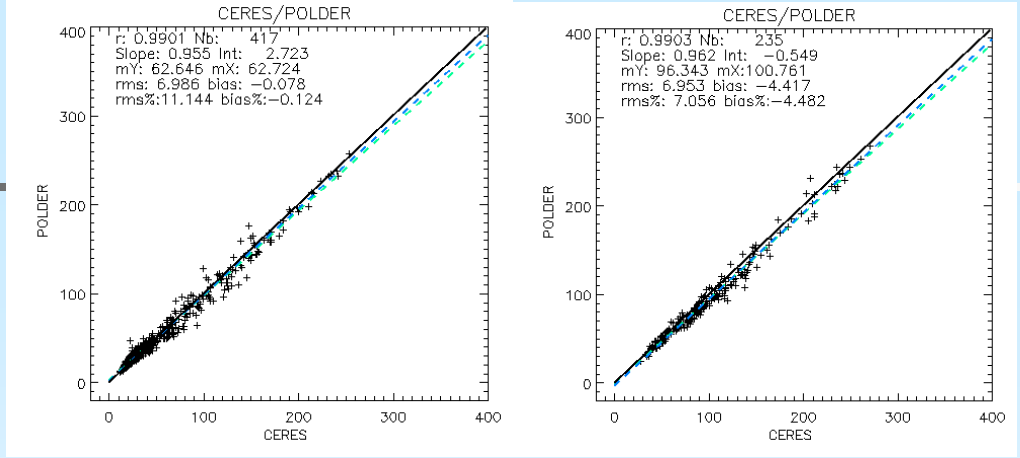
3) keep collocations with $\Delta T < 5$ mn and distance between observation center < 2km

POLDER-CERES triplets



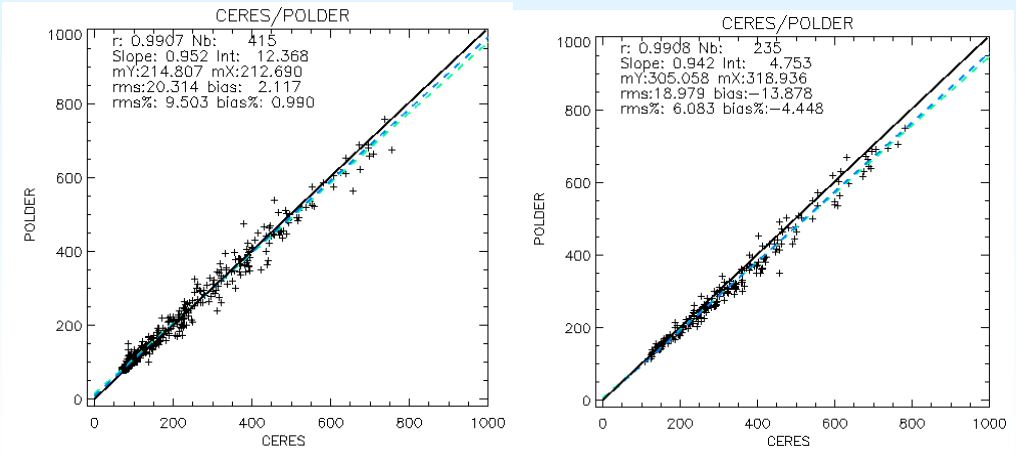
Collocated POLDER triplets and CERES data ($\Delta T < 5$ mn $\Delta D < 2$km) for June 2003 (1, 4, 5, 8, 11, 14, 17, 20, 21, 24, 27, and 30)

POLDER CERES : radiance comparison at nadir



Comparisons between POLDER and CERES radiances

Figure 10b radiance over ocean Figure 10c radiance over continent



Comparisons between POLDER and CERES albedoes

Figure 11d albedo over ocean Figure 11 albedo over continent

Future work

- to study ‘true’ CERES along-track data (Terra)
- to enlarge and improve the 3 directions dataset
- to extend with POLDER, MISR,..