CBERS-2

Attitude Control and its Effects on Image Geometric Correction

* Follow up to TCM-06 *

Topics for discussion

- Known issues about CBERS-2 attitude data
  - Transmitted attitude angles are usually too small
  - However … IRES output data are significant
- During TCM-06 INPE demonstrated that IRES output data was changing according to the satellite controlling side
- During TCM-06 both sides detected a time reference problem in the procedure used by XSCC to upload ephemeris data
- What is the current situation after changes made by XSCC in the process of uploading ephemeris data?

Background

- Systematic evaluation of CBERS-2 images
  - Presentation to CRESDA in Beijing (October, 2004)
  - Presentation in the Brazilian Remote Sensing Symposium (April, 2005)
  - Presentation to CRESDA in São José dos Campos (June, 2005)
  - Presentation to CRESDA and CAST during TCM-06 (October, 2005)
  - Continuous interaction with CBERS users in Brazil
- Cooperative investigation among CBERS segments at INPE
  - Application
  - Control
  - Space

Background

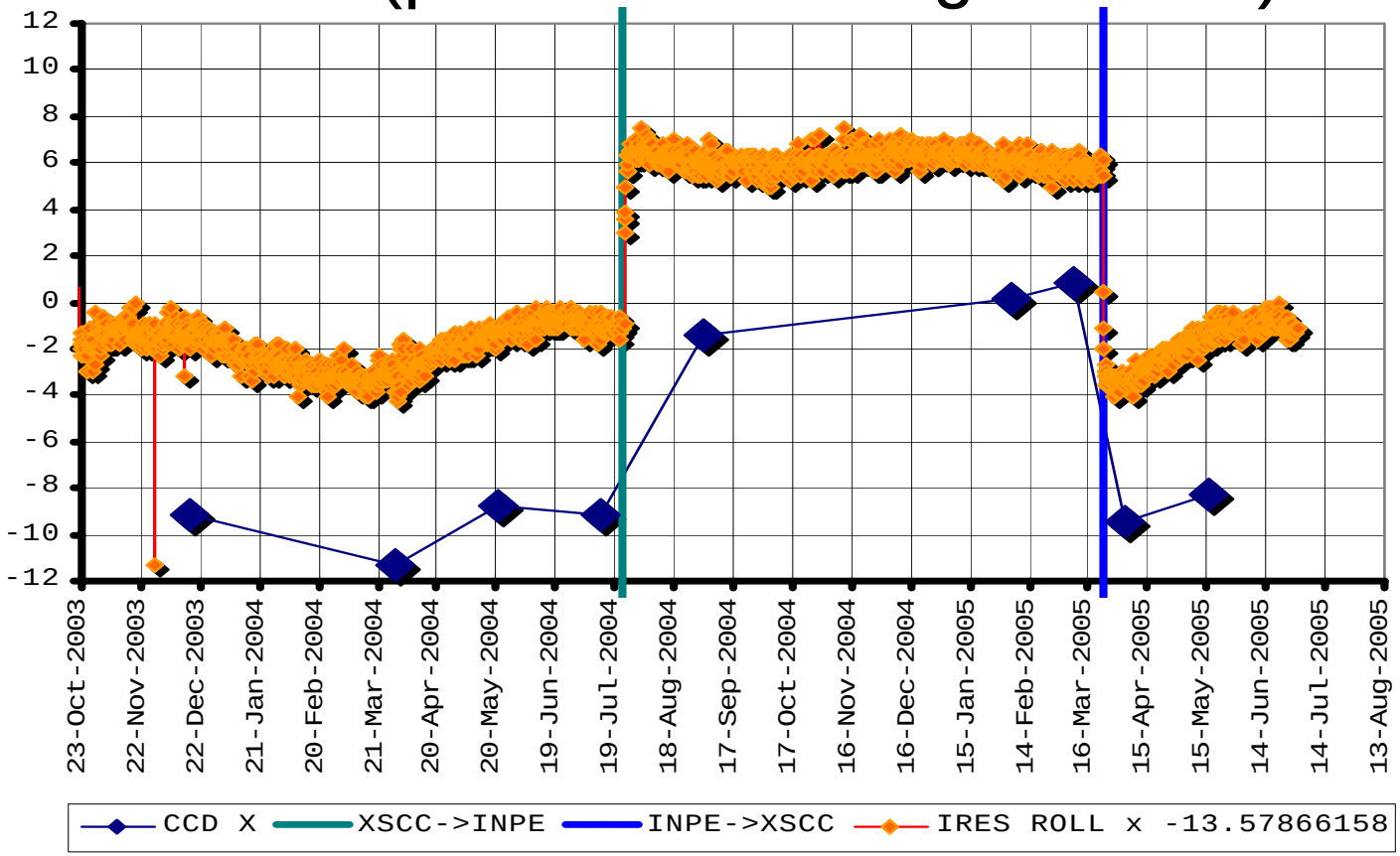
- Previous geometric evaluations of CBERS-2 positioning error

DATE	ΔX (km)	ΔY (km)	RESULTANT (km)
17-Dec-2003	-7.4	+7.7	10.7
30-Mar-2004	-11.8	+5.0	12.8
21-May-2004	-9.7	+4.3	10.6
12-Jul-2004	-10.0	+3.7	10.7
02-Sep-2004	-2.5	+4.1	4.8
05-Feb-2005	+0.7	+4.2	4.3
29-Mar-2005	-8.4	+8.2	11.7
20-May-2005	-7.6	+3.2	8.2

Background

Final comments →

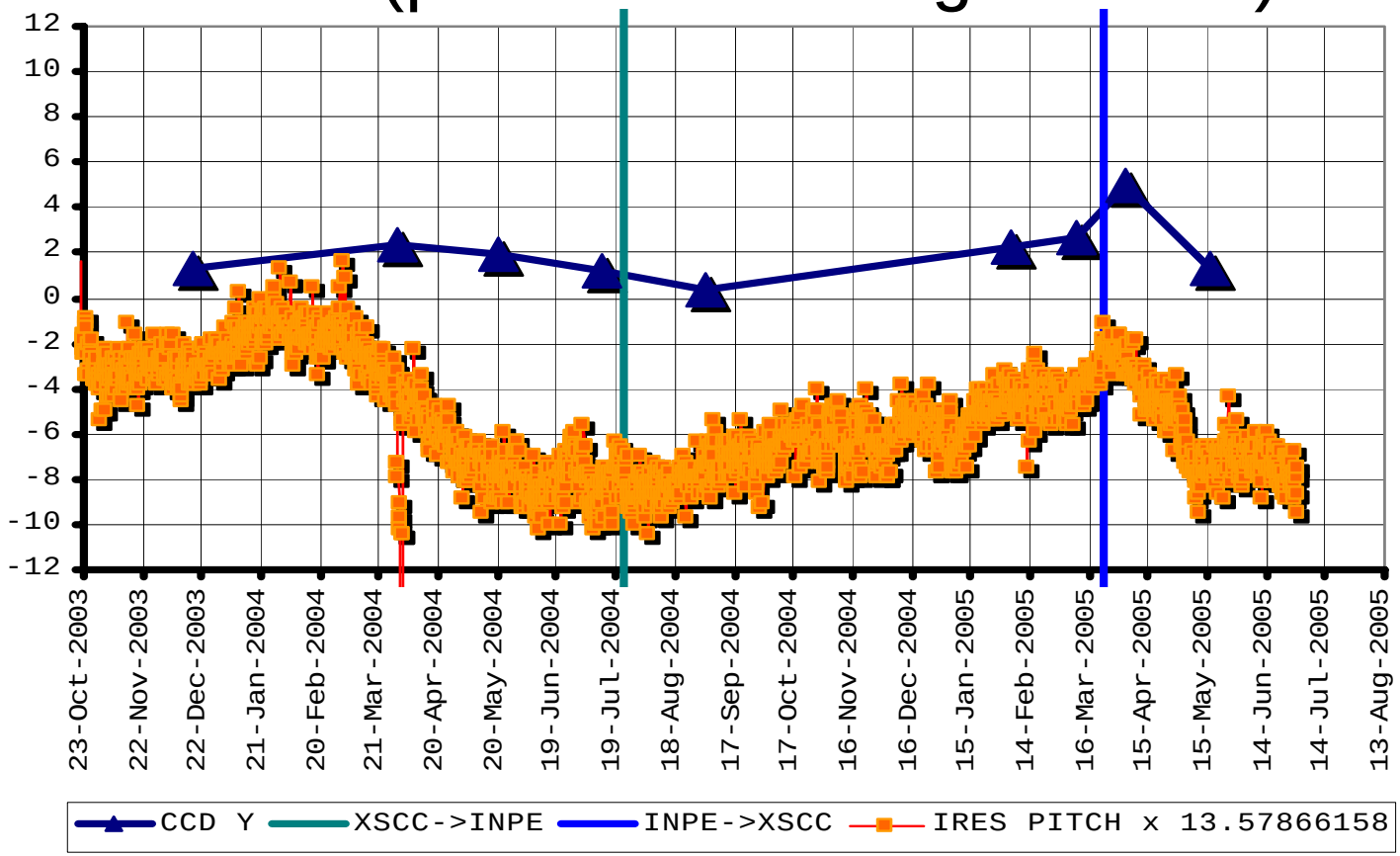
- Correlation between Δx error and roll angle from IRES (presented during TCM-06)



Background

Final comments →

- Correlation between Δy error and pitch angle from IRES (presented during TCM-06)

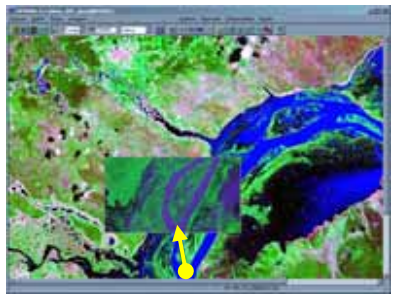


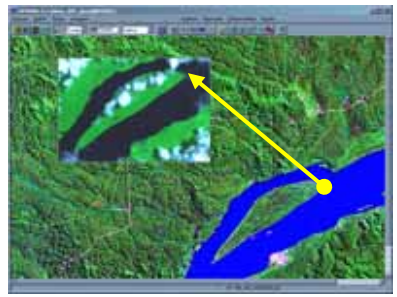
Background

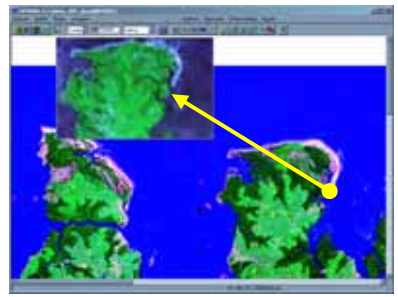
Synthesis of attitude tests →

- Test 1 – transmitted attitude


March 20, 2005

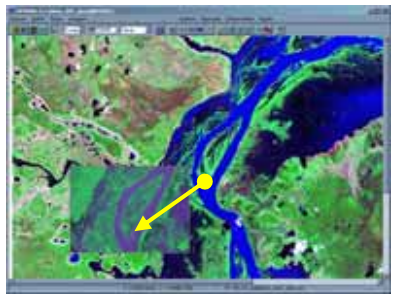

March 21, 2005

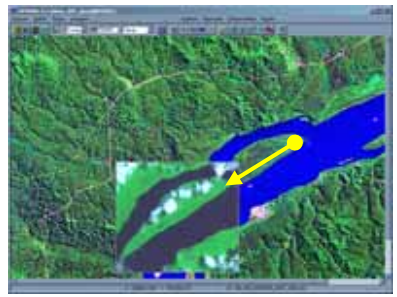

March 25, 2005


March 26, 2005

- Test 2 – post-processed attitude


March 20, 2005


March 21, 2005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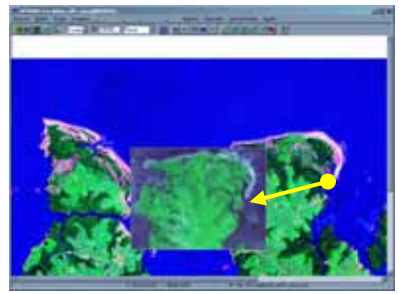

March 26, 2005

Attitude investigation

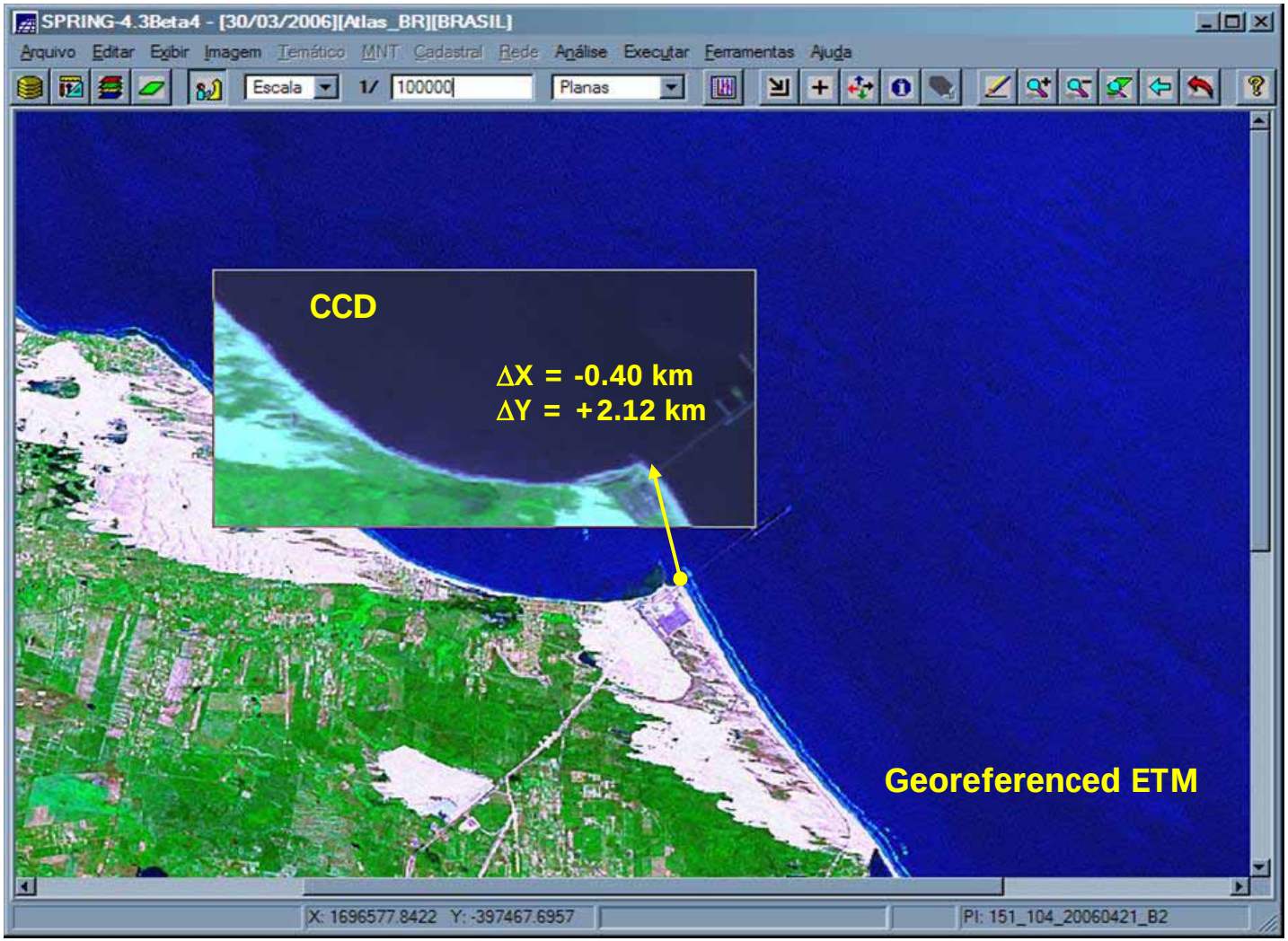
- Attitude was tested again around the last control transition from Brazil to China
  - April 21, 22, 23, 24, and 25, 2006
  - CCD
  - Bore-sight(x) = bore-sight(z) = 0; bore-sight(y) = -1.923e-2 radians
- Test 1
  - Transmitted attitude and ephemeris data computed from TLEs
- Test 2
  - Post-processed attitude (computed from IRES and DSS data) and ephemeris data computed from TLEs

Test 1

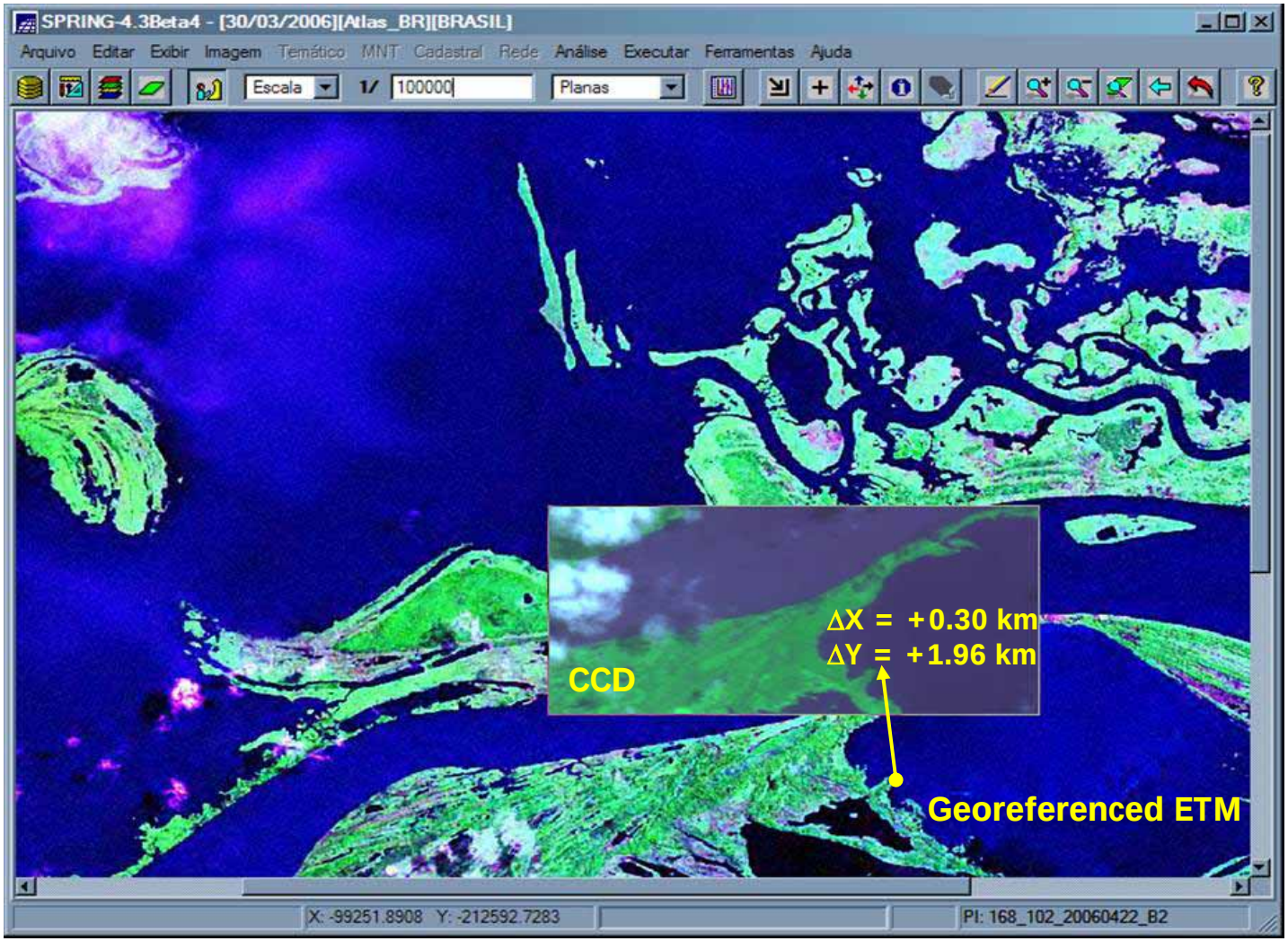
- Positioning error with transmitted attitude and ephemeris data computed from TLEs

DATE	ΔX (km)	ΔY (km)	RESULTANT (km)
21-Apr-2006	-0.40	+2.12	2.16
22-Apr-2006	-0.30	+1.96	1.98
23-Apr-2006	+0.30	+1.82	1.85
24-Apr-2006	+0.16	+2.87	2.87
25-Apr-2006	-0.16	+2.68	2.68

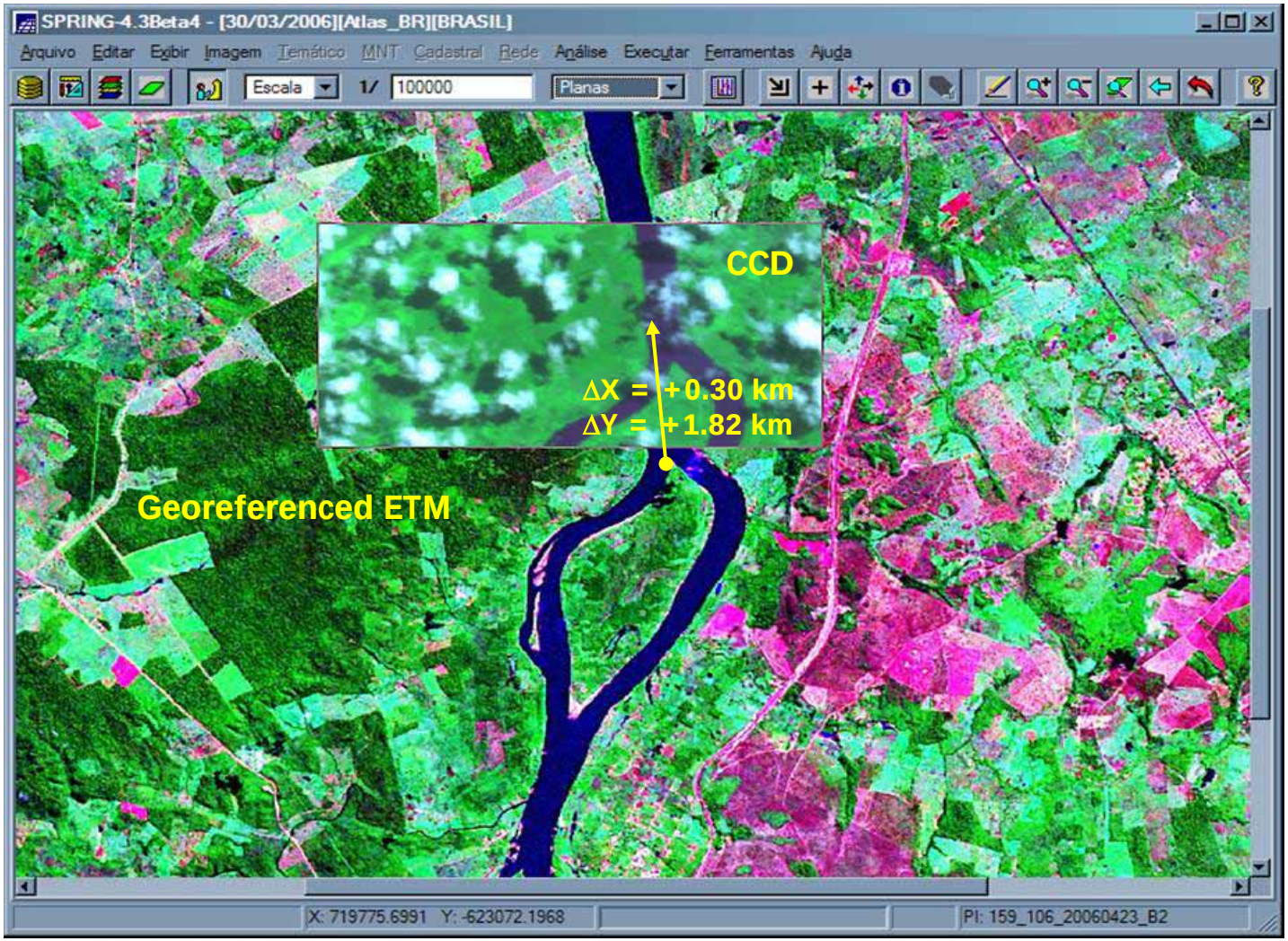
Test 1 on April 21, 2006



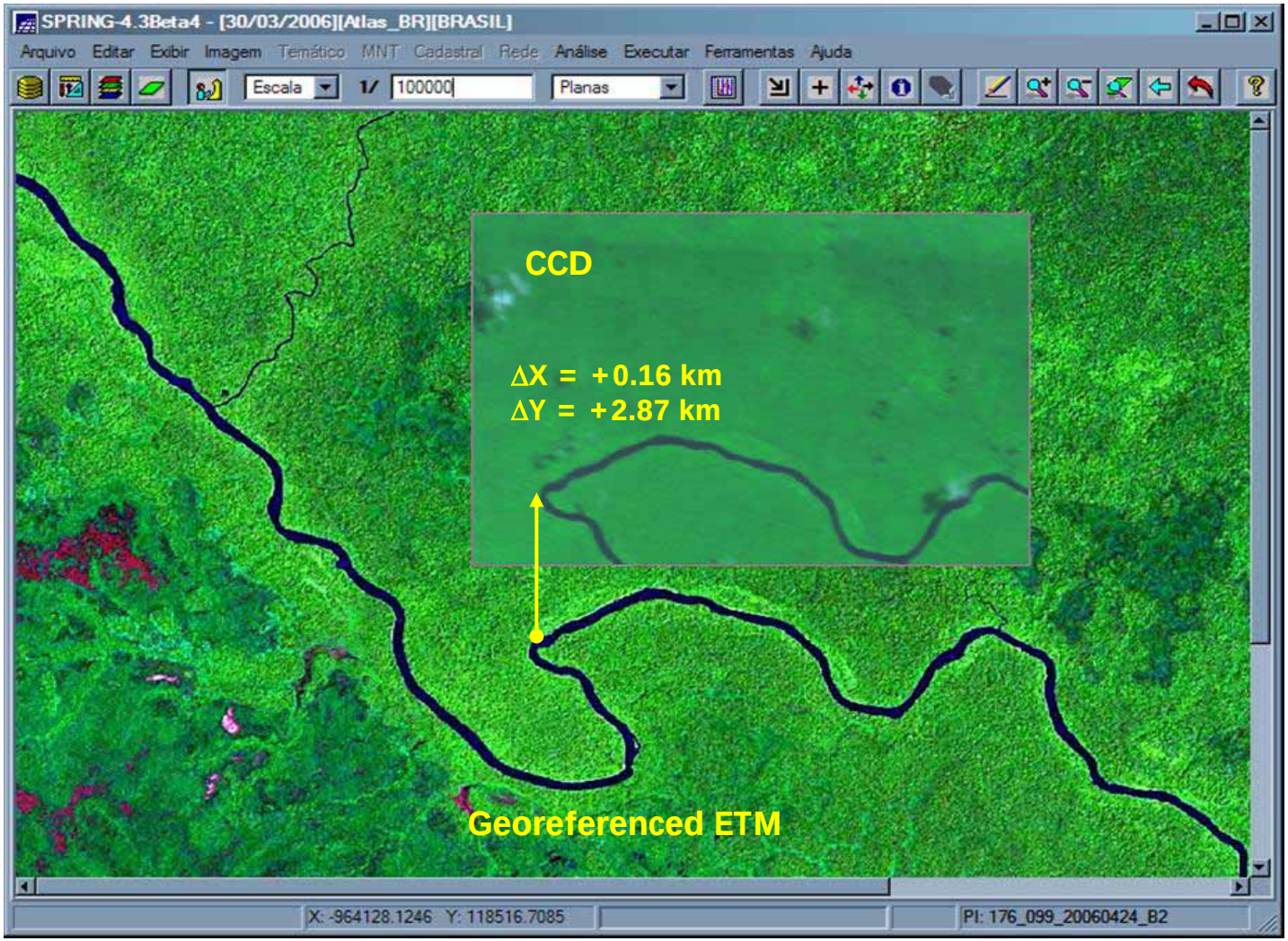
Test 1 on April 22, 2006



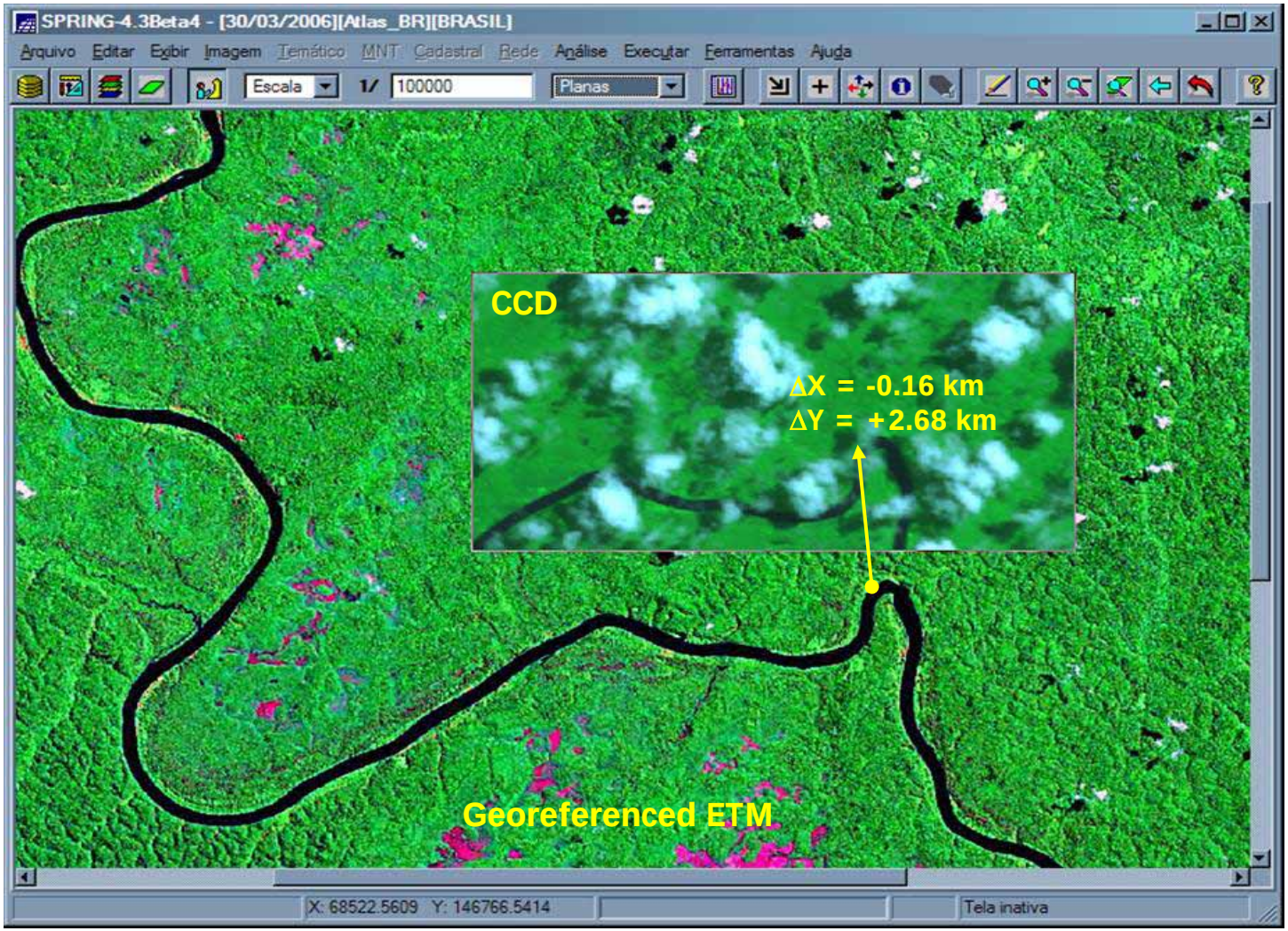
Test 1 on April 23, 2006



Test 1 on April 24, 2006



Test 1 on April 25, 2006

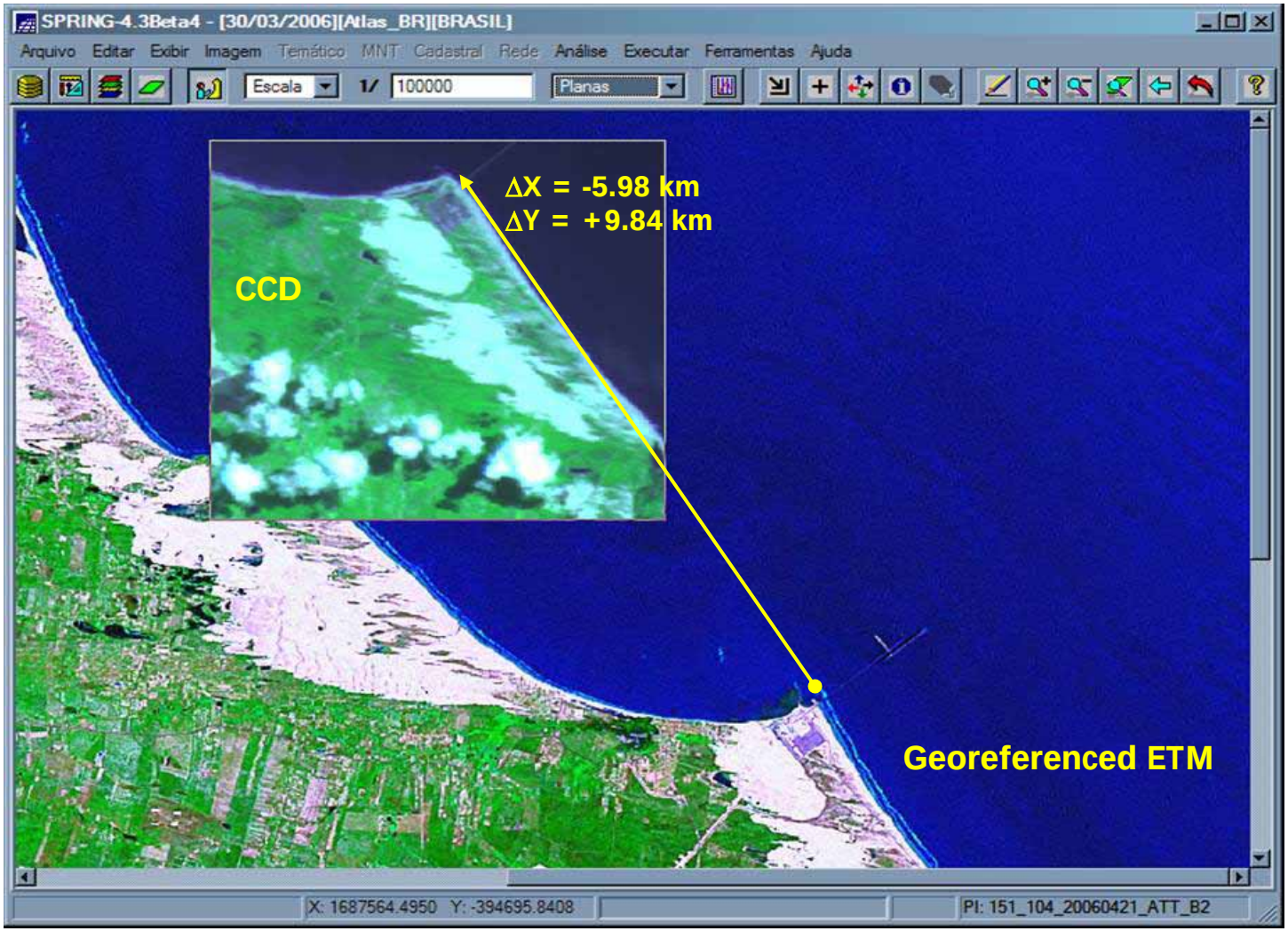


Test 2

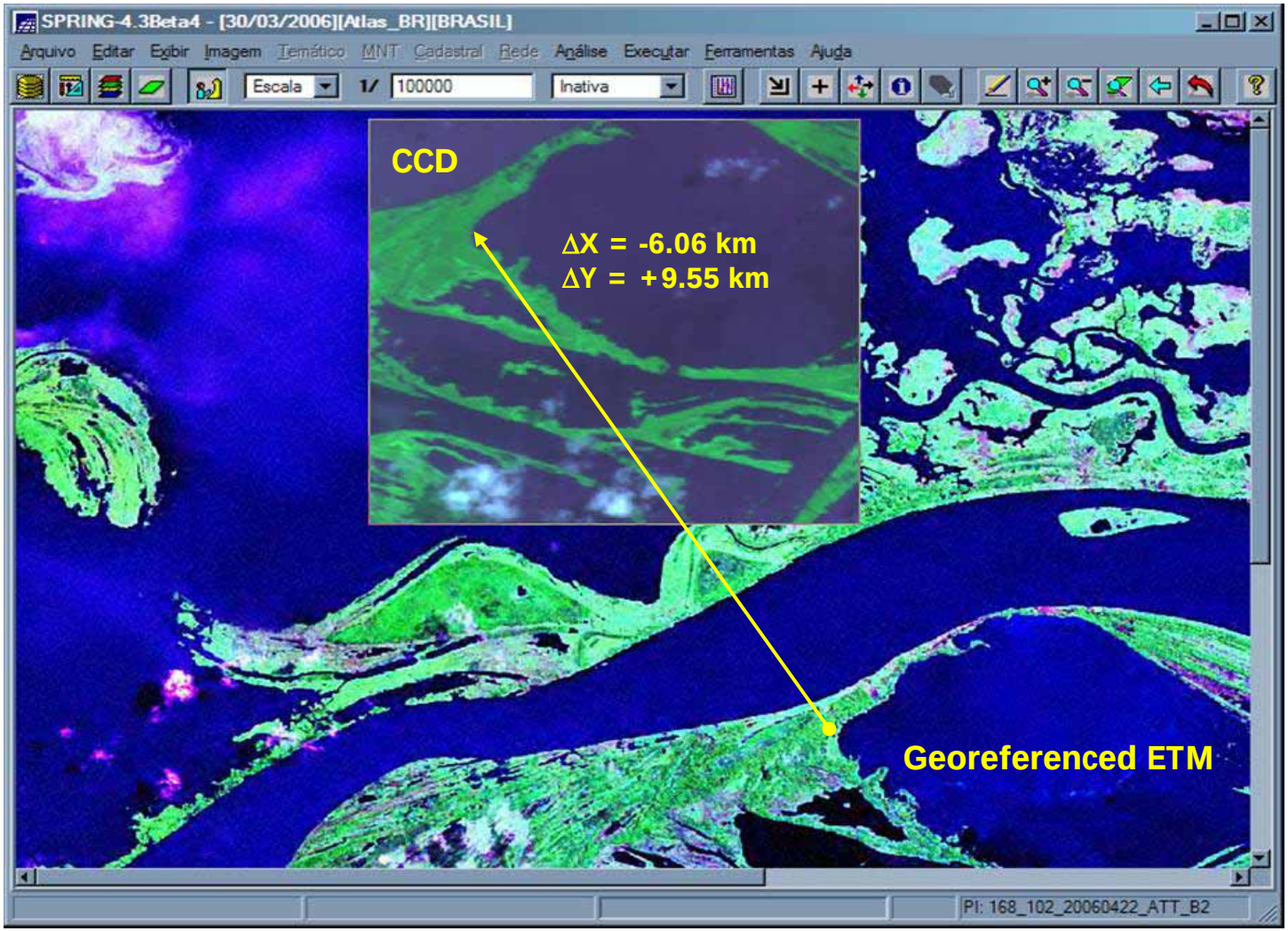
- Positioning error with post-processed attitude and ephemeris data computed from TLEs

DATE	ΔX (km)	ΔY (km)	RESULTANT (km)
21-Apr-2006	-5.98	+9.84	11.51
22-Apr-2006	-6.06	+9.55	11.31
23-Apr-2006	-5.80	+8.23	10.07
24-Apr-2006	-6.19	+7.68	9.86
25-Apr-2006	-6.17	+8.28	10.32

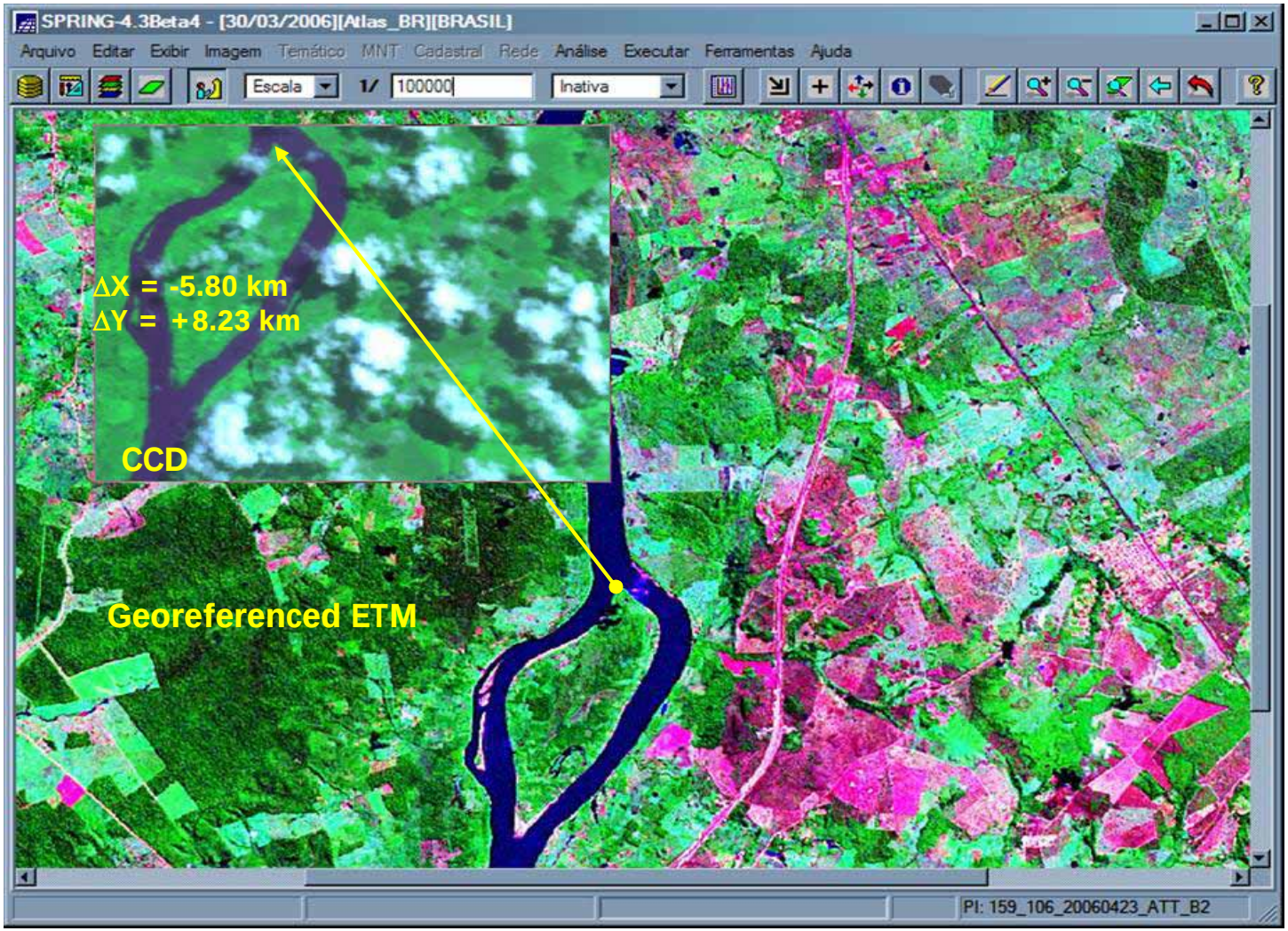
Test 2 on April 21, 2006



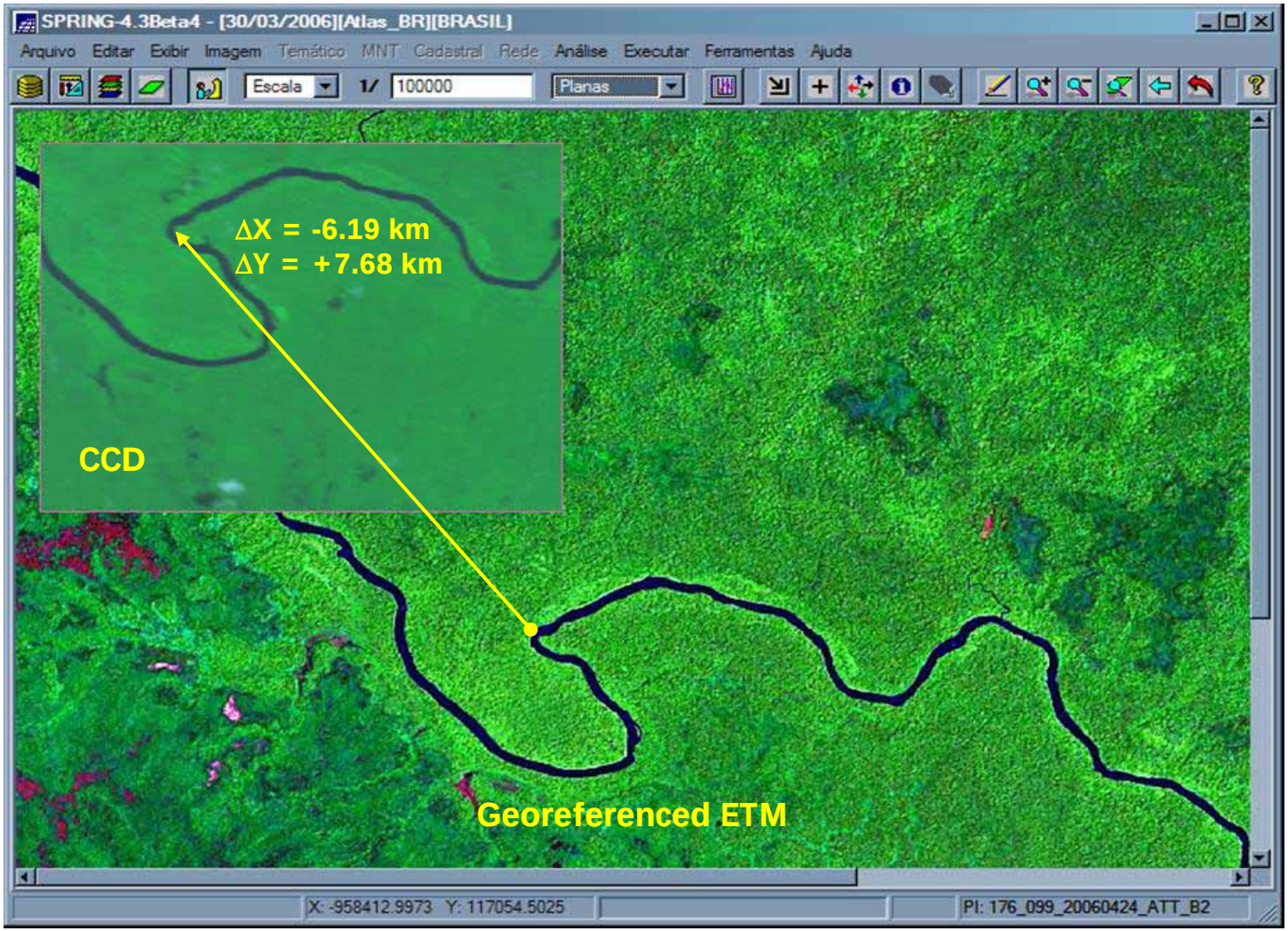
Test 2 on April 22, 2006



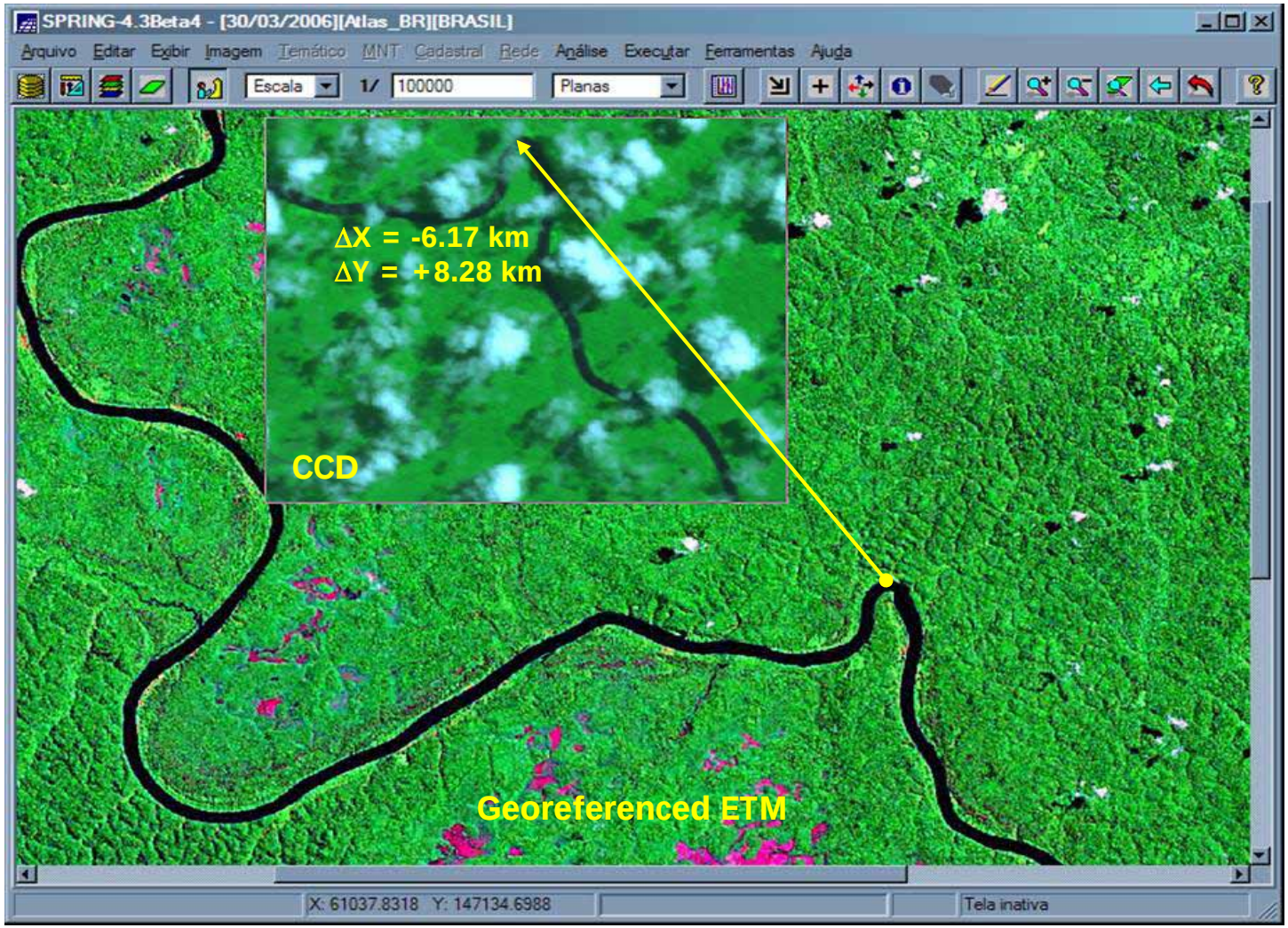
Test 2 on April 23, 2006



Test 2 on April 24, 2006



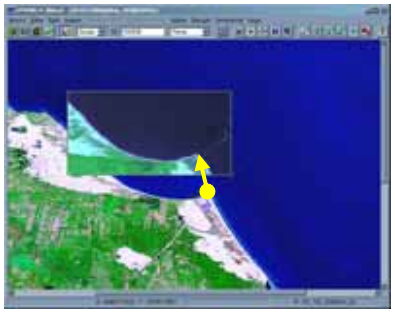
Test 2 on April 25, 2006

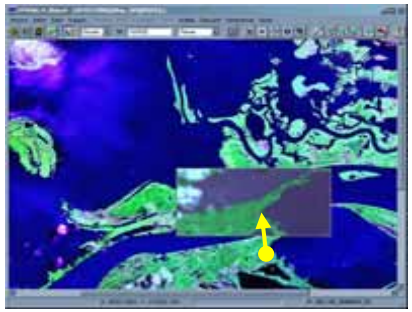


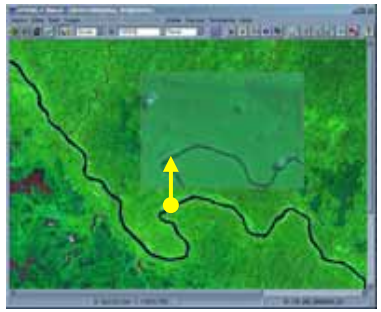
← Background

Synthesis of attitude tests

- Test 1 – transmitted attitude

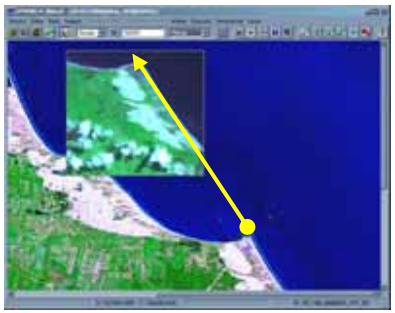

April 21, 2006


April 22, 2006


April 24, 2006


April 25, 2006

- Test 2 – post-processed attitude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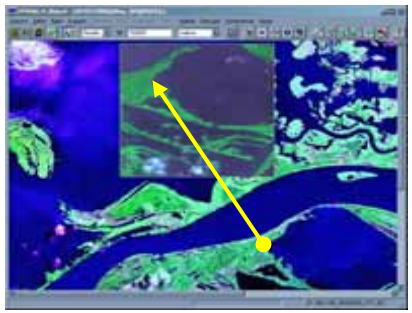
April 22, 2006


April 24, 2006


April 25, 2006

Final comments

- The analysis is based on
  - Image positioning errors
  - On ground attitude determination
- Image positioning errors using attitude telemetry
  - Longitude errors from -0.40km to +0.16km (Δ = 0.56km)
  - Latitude errors from +1.82km to +2.87km (Δ = 1.05km)
- Image positioning errors using attitude estimated on ground
  - Longitude errors from -5.80km to -6.19km (Δ = 0.39km)
  - Latitude errors from +7.68km to +9.84km (Δ = 2.16km)

Final comments

- Image analysis conforms to IRES angles behavior after changes made by XSCC
- Procedures used in both control centers must be consistent for CBERS 2B, 3, and 4 missions
- Inaccurate attitude control is critical for CBERS-2B HRC
- Accuracy of attitude telemetry data should be improved by using a more reliable onboard computer for CBERS 3 and 4

Thank you!

IRES angles current behavior