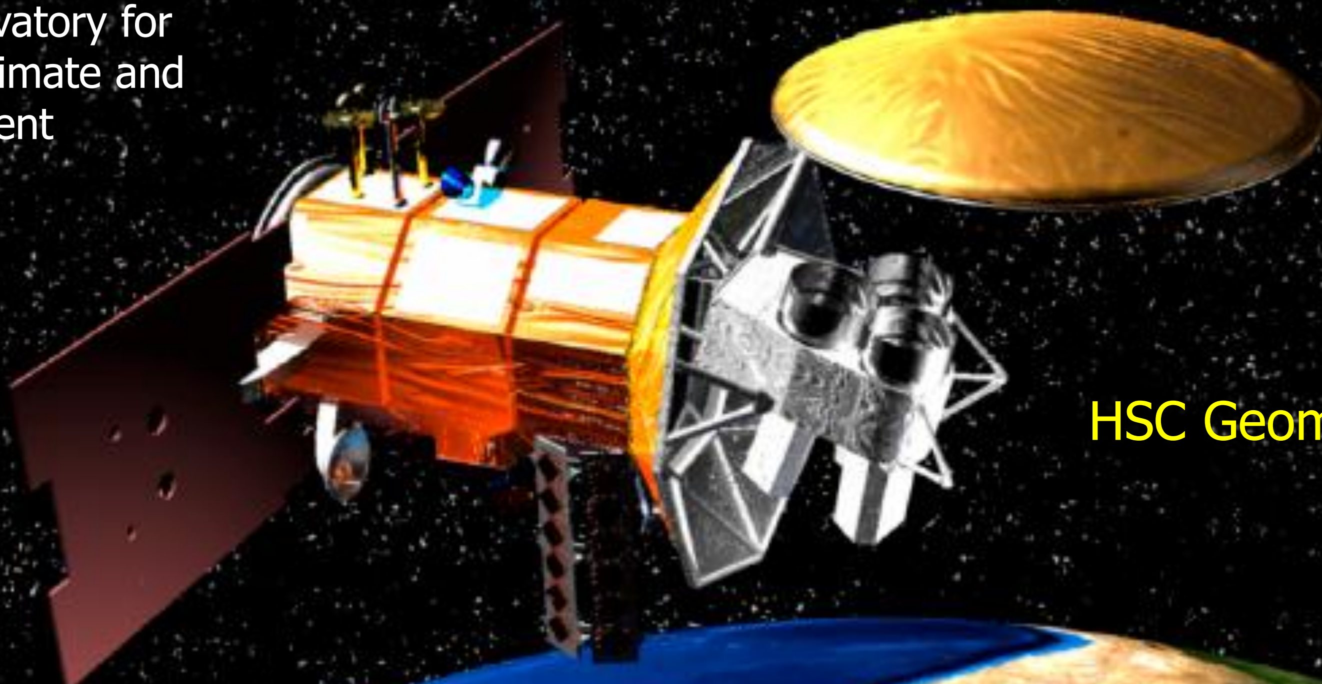
SAC-D/Aquarius

An Observatory for
Ocean, Climate and
Environment



SAC-D/Aquarius

HSC Geometric Correction Algorithms

Felipe Madero

7th Aquarius SAC-D Science Meeting
Buenos Aires – April 11-13, 2012

Geometric Processing Glossary

- Geometric Calibration: Activities done in order to tune the algorithms and models so as to obtain the expected geolocation results

- Geometric corrections: (Systematic) Processes applied to the sensor data, in order to:
  - Obtain knowledge of the geographic location of the measurements.
  - Solve geometric distortions introduced in the acquisition
  - Map the data to useful geographic reference systems

- Geolocation: (Systematic) Process applied to the sensor data in order to obtain knowledge of the geographic coordinates of the measurements

Geolocation Problem

Main reason for having good geolocation accuracy for this sensor

- Provision of data of good quality to the end users

Geolocation outputs

Geographic coordinates (geodetic latitude/longitude) for the center of the 2048 measurements, for the 2 bands.

Auxiliary geographic parameters associated to this positions (range to spacecraft, and zenith/azimuth angle to spacecraft, moon, and sun)

Pre Launch

Pre launch measurements

- Alignment of sensor to platform, at LIT/INPE

- line of sight measurement, for central (integration) line

Pre launch data to processors input data

- Incorporating measured line of sights, and alignment matrix, into a sensor model in order to generate initial set of line of sights for each detector.

Geolocation Algorithms

Geolocation Algorithms development

- ATBD/prototype library developed at the same time

- Geolocation results cross checked with standard geolocation libraries

- Software replacement: library first developed and validated using Python language. Replacement of bottlenecks using c++ code. Last version expected to be mainly c++ code, with python as control code.

Developed Geolocation Libraries

- Time system transformations
- Coordinates systems transformations
- Generic interpolation and smoothing
- Attitude data validation and processing
- State vector data validation and processing
- Intersection of line of sight with earth models
- Generation of auxiliary geolocation parameters

Geolocation Grid

- In order to reduce processing time due to geolocation, a geolocation grid is defined, which is a subsampling of the array of data obtained from acquisition.

- A good trade off between grid geolocation coordinates interpolation error, and time devoted to geolocation, was found by taking one sample per 40 detectors along the 2048 detectors line, and taking all lines.

- Grid interpolation error, by using this parameters, is negligible.

Geolocation Steps: Input data from acquisition

- Validate and filter time data. Fix time measurement errors by fitting the data to a first order polynomial (sample number to time).

- Validate and filter attitude data. No fixing of attitude measurement errors. Quaternions Interpolation.

- Validate and filter state vector data. Fix state vector error measurements by fitting the data to a suitable order polynomial (time to state vector).

Geolocation Steps: Get intersection parameters

- For each sample of the geolocation grid:
  - Get spacecraft position in ECEF, by using time and state vector polynomial (J2000), and J2000 to ECEF transformation.
  - Get SENSOR2ECEF rotation matrix, by using calibrated SENSOR2PLAT rotation matrix, PLAT2J2000 rotation matrix from interpolated quaternions, and J2000 to ECEF transformation
  - Apply SENSOR2ECEF rotation matrix to the line of sight of the center of each measurement included in the sample

Geolocation Steps: Intersect line of sight with earth

- The spacecraft position in ECEF and the line of sight in ECEF defines a vector pointing to the earth, which is intersected to an earth model (WGS84), by solving a quadratic equation

- The resulting intersection point in ECEF is converted to geodetic latitude/longitude (elevation=0 due to using earth model)

- A planned further improvement is to intersect the line of sight with a digital elevation model, by an iteration procedure.

Geolocation Steps: Get auxiliary geolocation parameters

- Obtain moon and sun position in ECEF, by using standard tables, and J2000 to ECEF transformation

- Generate azimuth and elevation angles, between intersection point and spacecraft, sun, and moon, by using acquisition geometry

Product levels in relation to geometric correction

- L1A: geolocation parameters are included.

- L1B2: resampling to map projection by using standard techniques, based in L1A, with recalculated geolocation parameters.

Resampling

Resampling basics

- Transformation of input data to a map projection, by using an inverse mapping

- Output projected pixels are filled one by one, by calculating the associated input data value, by mean of the inverse mapping, and the selected interpolation scheme

- Available interpolation schemes: NN, CC, Bilinear

- Available map projections: Those supported by proj4

Grid cell mapping

- For each cell in the geolocation grid, a forward transformation from Input coordinates to output coordinates is calculated. Transformation is generated by solving a bilinear least squares mapping problem by using SVD.

- Also the inverse transformation for each cell is calculated. Both transformations are used in a iterative process, together with a global rough inverse mapping, in order to arrive
to the global inverse mapping.

Geolocation Errors

Geolocation error from pointing knowledge requirement

- Pointing knowledge error: 0.03 degrees (max 3.1 km)

- Bias plus random

Bias geolocation error

- Error in alignment measurement from ST cube to ref cube: 0.005 degrees (max 530 mts)

- Cyclic (orbital) Thermoelastic deformation errors between ref cube and NIRST reference system: 0.015 degrees (max 1.5 km)

- Goal to reduce it to 0 by post launch geometric calibration. Cyclic Thermoelastic deformation most difficult to correct.

Random geolocation error

- Error in attitude measurement: 0.011 degrees (max 1.1 km)

- Goal is to have it as the final random error, after post launch geometric calibration.

Concluding

Known problems

- Geolocation errors due to star tracker error from moon interference

- Bugs in generation of sun and moon position in ECEF

Todo

- Known problems

- Complete post launch calibration

- Assess geolocation accuracy

- Implementation of intersection with digital elevation models

- Implementation of resampling by using point spread function