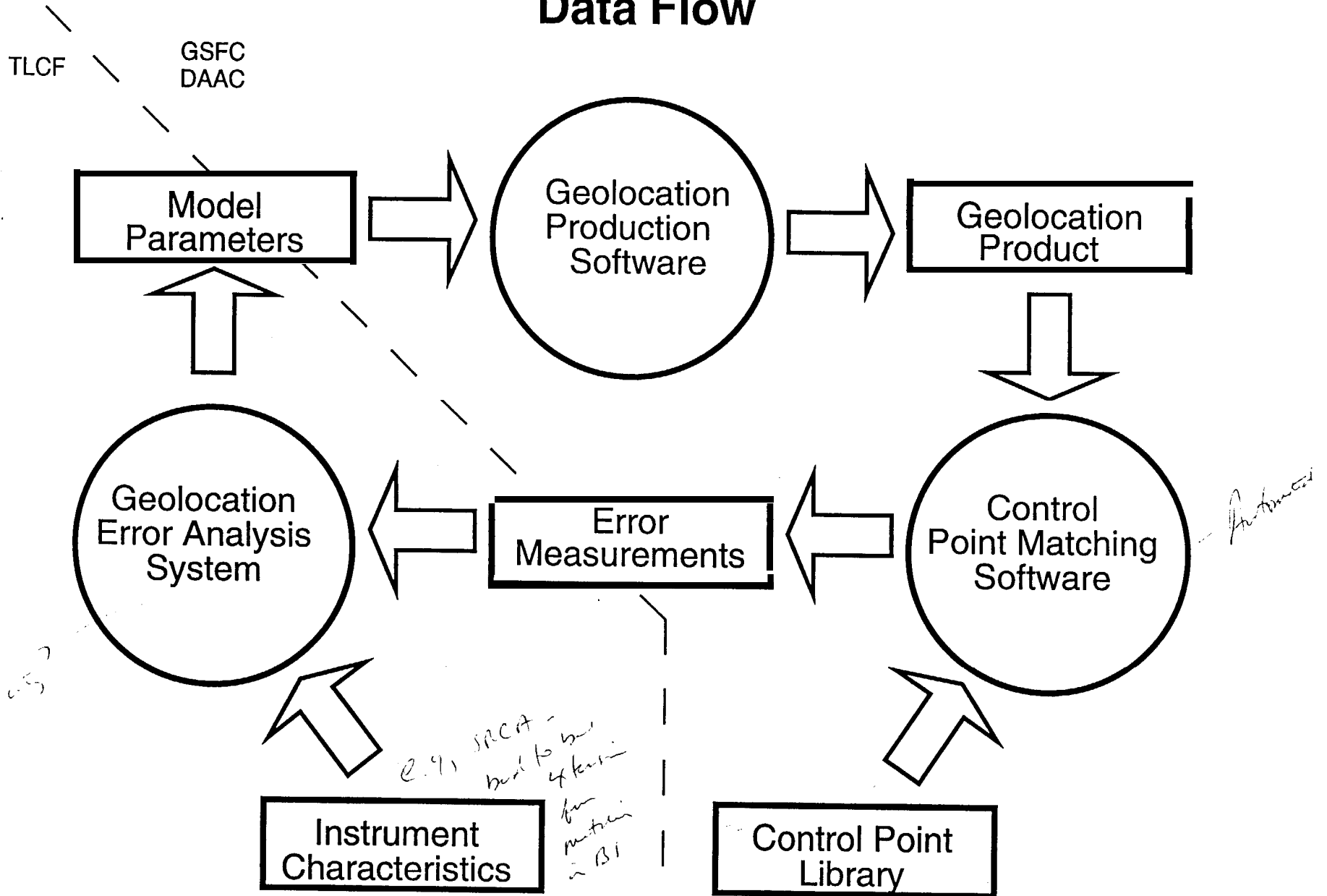


PIXEL GEOLOCATION KNOWLEDGE

		Specification	Dynamic Error (3 σ)	Static Error (3 σ)
Along-Track (m)	Spacecraft ¹	<u>+342</u>	<u>+492 (33)</u> ³	<u>+158</u>
	MODIS	<u>+308</u>	<u>+784</u>	<u>+1204</u>
	RSS	<u>+460</u>	<u>+110 (85)</u>	<u>+240</u>
Cross-Track (m)	Spacecraft ¹	<u>+342</u>	<u>+412 (31)</u> ³	<u>+119</u>
	MODIS	<u>+308</u>	<u>+1504</u>	<u>+1804</u>
	RSS	<u>+460</u>	<u>+156 (153)</u>	<u>+216</u>

1. Three non-optimal 9 minute TDRS contacts per orbit, GJM2 Geopotential (30x30), solar flux of 175, 5% Cd error, TDRS ephemeris error of 75 meters. Resulting position errors of 3.6 m radial, 5.4 m cross-track, and 11.1 m along-track, 3 σ .
2. Single star tracker, rigid body/low frequency pointing knowledge errors included.
3. Two star trackers, rigid body/low frequency pointing knowledge error removed.
4. MODIS static and dynamic pointing knowledge error values from page 2 of MODIS Protoflight Model (PFM) Spatial Testing Preliminary Results, Ed Knight/RDC, October 8, 1996.

Geolocation Control Point Matching Data Flow

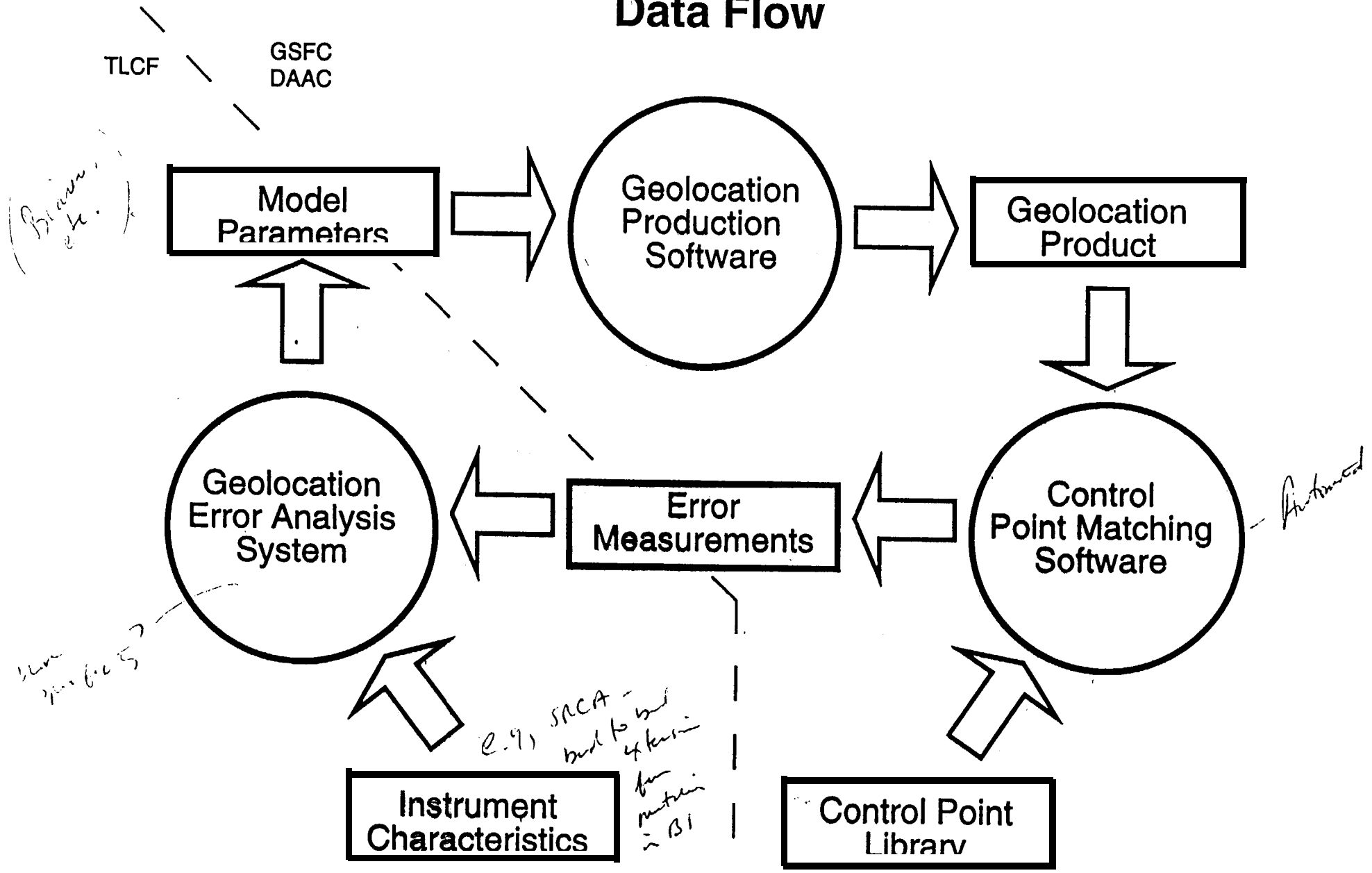


GCP Strategy

Phased Approach (Least Cost Strategy)

- At-launch (Achievable goal: 10 m static error)
 - Use existing precision-rectified TM images, primarily of US (430 images), 598) some foreign images, at EDC
 - Possibly use AVHRR control point library to identify suitable features
 - Provide sufficient number of points to characterize major portion of static error in immediate post-launch period
- Post-launch
 - Add GCPs as needed
 - Stratify by latitude, longitude, day/night, etc.
 - Use ASTER, Landsat data to reduce cost (may require DTMs)
 - reduce dynamic error when periodic on a per-orbit or per-day basis as needed

Ge location Control Point Matching Data Flow



GCPs at EDC (J. Eidenschank)

US :

- 598 georegistered, terrain corrected TM images (USGPO)
- 90-95% coverage of conterminous US, some ^{multiseasonal}
- Control pts could be pulled for about \$50/point

Foreign Holdings @ EDC (TM)

- Humid Tropical Forest Inventory 797
 - Global Change Landsat Data Coll'n ... 490
 - CEES 99
 - NASA Landsat Data Collection 91
- Many are not georegistered -- need to locate good base maps
- Reg'n + GCP selection = ~~\$1000~~ * 600 (scenes)
* 20-50/site

New Foreign Data Acquisition

- Foreign ground stations: * 4000-4500/scene

Bias (Static Error) Removal

Ground Control Pt. Strategy

- Use control points in early post-launch time period to measure & remove bias
- Note: NOT optical navigation
- Best points are from precision-rectified TM land images
- SeaWiFS island data will not be sufficiently accurate (location error; use of BS for land-water contrast; etc.)

How many GCP's?

- Fred Patt estimate:
 - 265 GCPs for daily characterization of bias and measurement of residual (dynamic errors)
- Stratification (Allocation of GCPs)
 - Cloud Cover
 - Latitude
 - Longitude (?)
 - Day/Night
- Chip characteristics - size; bands; metadata; etc.

Geolocation Implementation

Processing Issues

- Due to personnel changes, etc., effort has been variable
- But resources are now committed to provide needed software & GEO library

Problems/Needs

- Need to scope & prepare analysis tools to be ready at launch
- Need improved plan for development:
 - Geolocation production software
 - Control point library & matching software
 - Timeline / Effort chart requested
- Scientists need plot of geolocation uncertainty with time post launch
 - "What will we know and when will we know it?"

PIXEL GEOLOCATION KNOWLEDGE

(Meters @ nadir)

		Specification	Dynamic Error (3 σ)	Static Error (3 σ)
Along-Track (m)	Spacecraft ¹	<u>+342</u>	<u>+402 (33)3</u>	<u>+158</u>
	MODIS	<u>+308</u>	<u>+784</u>	<u>+1204</u>
	RSS	<u>+460</u>	<u>+110 (85)</u>	<u>+240</u>
Cross-Track (m)	Spacecraft ¹	<u>+342</u>	<u>+412 (31)3</u>	<u>+119</u>
	MODIS	<u>+308</u>	<u>+1504</u>	<u>+1804</u>
	RSS	<u>+460</u>	<u>+156 (153)</u>	<u>+216</u>
			$\approx 190 (170) \text{ RSS}$	$\approx 10 (300 \text{ at launch})$

1. Three non-optimal 9 minute TDRS contacts per orbit, GJM2 Geopotential (30x30), solar flux of 175, 5% Cd error, TDRS ephemeris error of 75 meters. Resulting position errors of 3.6 m radial, 5.4 m cross-track, and 11.1 m along-track, 3 σ .
2. Single star tracker, rigid body/low frequency pointing knowledge errors included.
3. Two star trackers, rigid body/low frequency pointing knowledge error removed.
4. MODIS static and dynamic pointing knowledge error values from page 2 of MODIS Protoflight Model (PFM) Spatial Testing Preliminary Results, Ed Knight/RDC, October 8, 1996.

Error Sources

- Position of Center of Mass of Spacecraft (Dynamic)
 - Obtained by TONS using spacecraft's oscillator + Doppler shift
 - Improved use of TONS gives about 8 m (1 σ) positional error
 - Possibility of postprocessing using GEODYNE software

Star Trackers to MODIS (Attitude)

- Dynamic: attitude uncertainty.
 - Solar panels; ASTOR, CORES motions, etc.
- Static: Spacecraft platform warping, uncertainty of location of MODIS on platform, etc.

MODIS to Ground (Pointing)

- Dynamic: Mirror motion; within-orbit thermal; etc.
- Static: post launch changes -- optical alignment, etc.

Geolocation Workshop Report

Pointing Knowledge Errors

- Static Errors: One-time or long period changes. Eliminate by post-launch bias removal using GCPs (Ground Control Points)
- Dynamic Errors: Short period changes. Reduce by better knowledge of predictable portions, either during acquisition or by post-processing.
- Examples:

Dynamic

Attitude errors
Thermal changes
Ephemeris errors
Structure dynamics
Mirror positioning

Static

Instrument platform location
Thermal in-orbit changes
Gravity Field errors
Moisture in bonding compounds
Launch shifts

MODIS Geolocation Workshop Agenda

Tuesday, October 8, 1996

University of Maryland Conference Center (UMCC)

- 8:30 Introduction0..... A. Strahler
- 8:45 Spacecraft Subsystem Status (**TONS, ACS**) .P. Westmeyer
- 9:30 Ground Orbit Determination*..... A. Marshall
Impact on MODIS Processing F. Patt
Discussion * Group
- 10:20 *BREAK*
- 10:30 MODIS Instrument Status E. Knight
- 12:00 *LUNCH*
- 1:00 **MODIS Geolocation Plans**
Technical Approach F. Patt
Development Plans..... J. Blanchette
Schedule and Manpower..... J. Blanchette
- 3:00 *BREAK*
- 3:10 **Collaborative Instrument Plans**
Landsat..... J. Storey
AVHRR Pathfinder 1/2..... N. El Saleous
ASTER..... S. Lambros
- 4:00 **Ground Control Points**
MODIS Requirements..... F. Patt
EDC capability..... D. Carnegie
Discussion: coordinated efforts, SWAMP
preparation Group
- 4:45 Action Item Review and Wrap-up
- 5:00 *ADJOURN MEETING*