
GRACE
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&
Naoki Ellis
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GFZ
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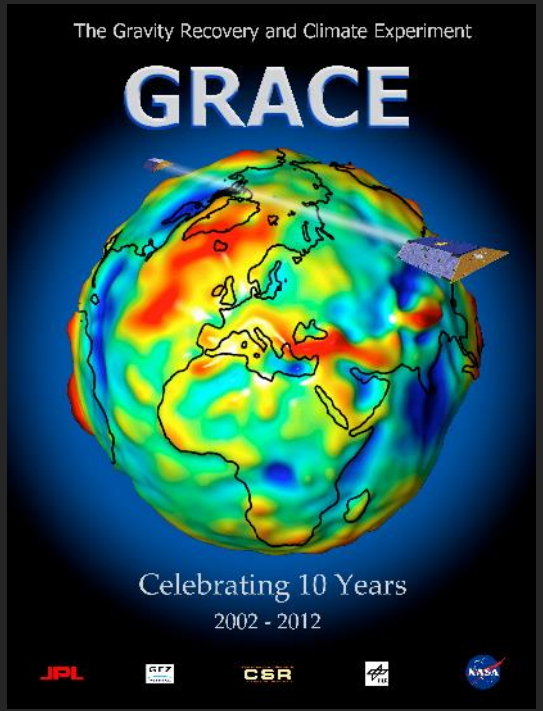
Center for Space Research
CSR
The University of Texas at Austin
DLR

Agenda

- Who We Are
- What is GRACE?
- The Problems
- The Solutions & The Results
- What We Used
- What We've Learned



The Interns

Arthur Pachachura

LASA High School

Class: 2016

Academic Interests

Aerospace Robotics & Computer Science

Naoki Ellis

Cedar Ridge High School

Class: 2015

Academic Interests

Physics, Aerospace, & Mechanics

What's GRACE?

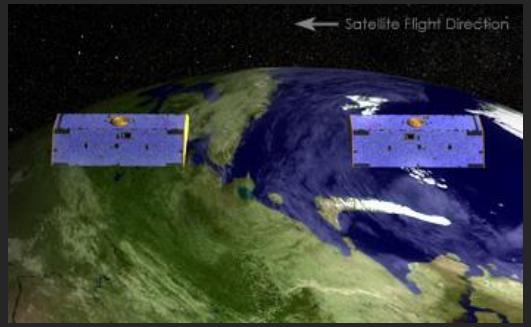
Gravity **R**ecovery **A**nd **C**limate **Experiment**

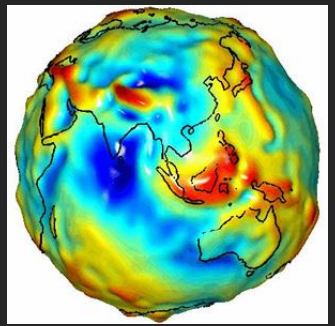
Launched: March 17, 2002

Satellite Distances: ~220 km

Main Instruments: Accelerometers & GPS

GRACE-FO Mission: Planned 2017





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The Problems

GRACE Coverage

"current frequency"

GRACE Data Precision

"missing curves problem"

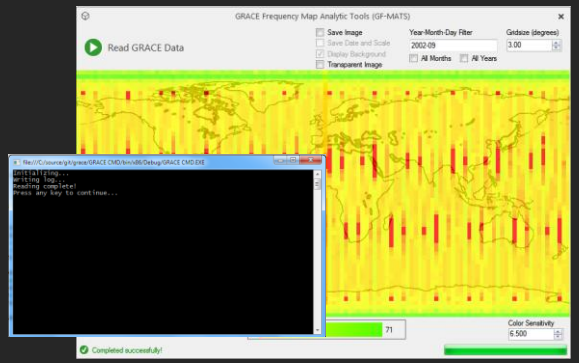
Satellite Pairs Needed

"equalizing coverage"

The Solutions

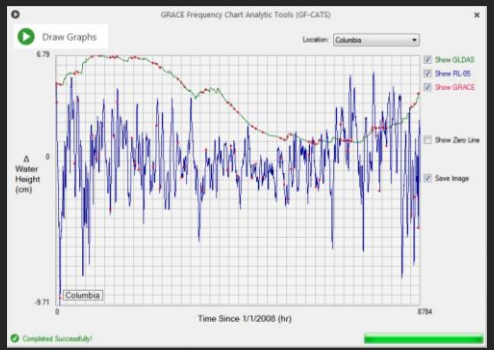
GRACE Coverage

GRACE Frequency Map Analytic Tools (G-CMD & GF-MATS)



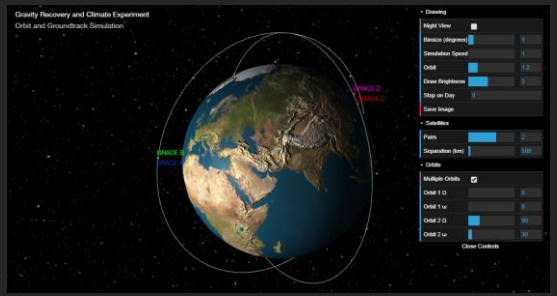
GRACE Data Precision

GRACE Frequency Chart Analytic Tools (GF-CATS)



Satellite Pairs Needed

GRACE Live Orbit and Groundtrack Simulation (G-LOGS)

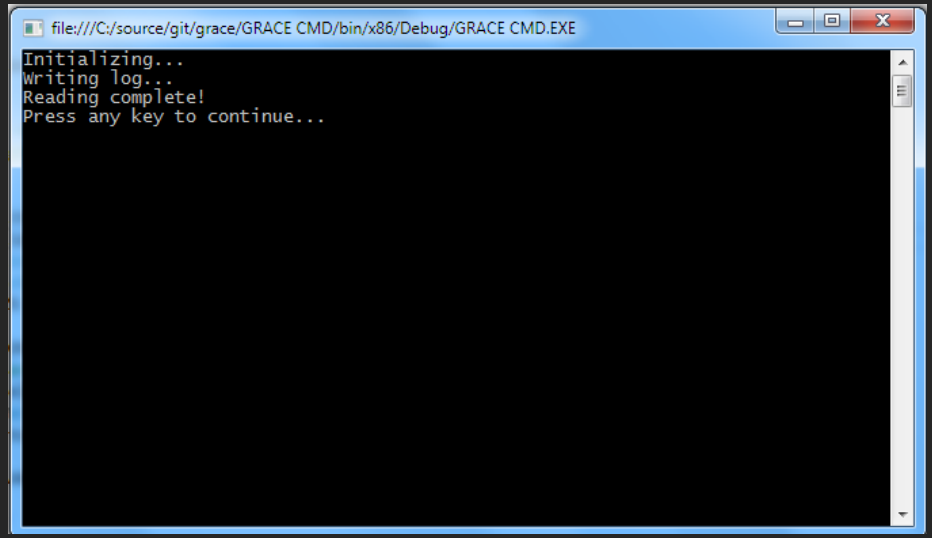


Solution: GRACE Coverage

GRACE Command Line

(GCMD)

- Created coverage arrays
- Problem: Limited functionality, no display

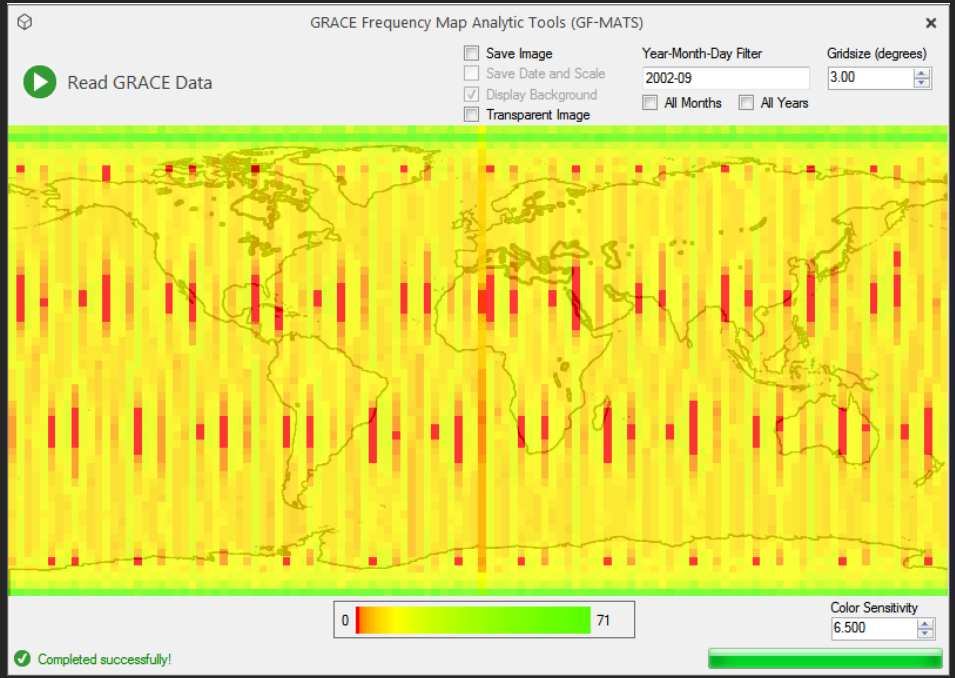


Solution 2.0: GRACE Coverage

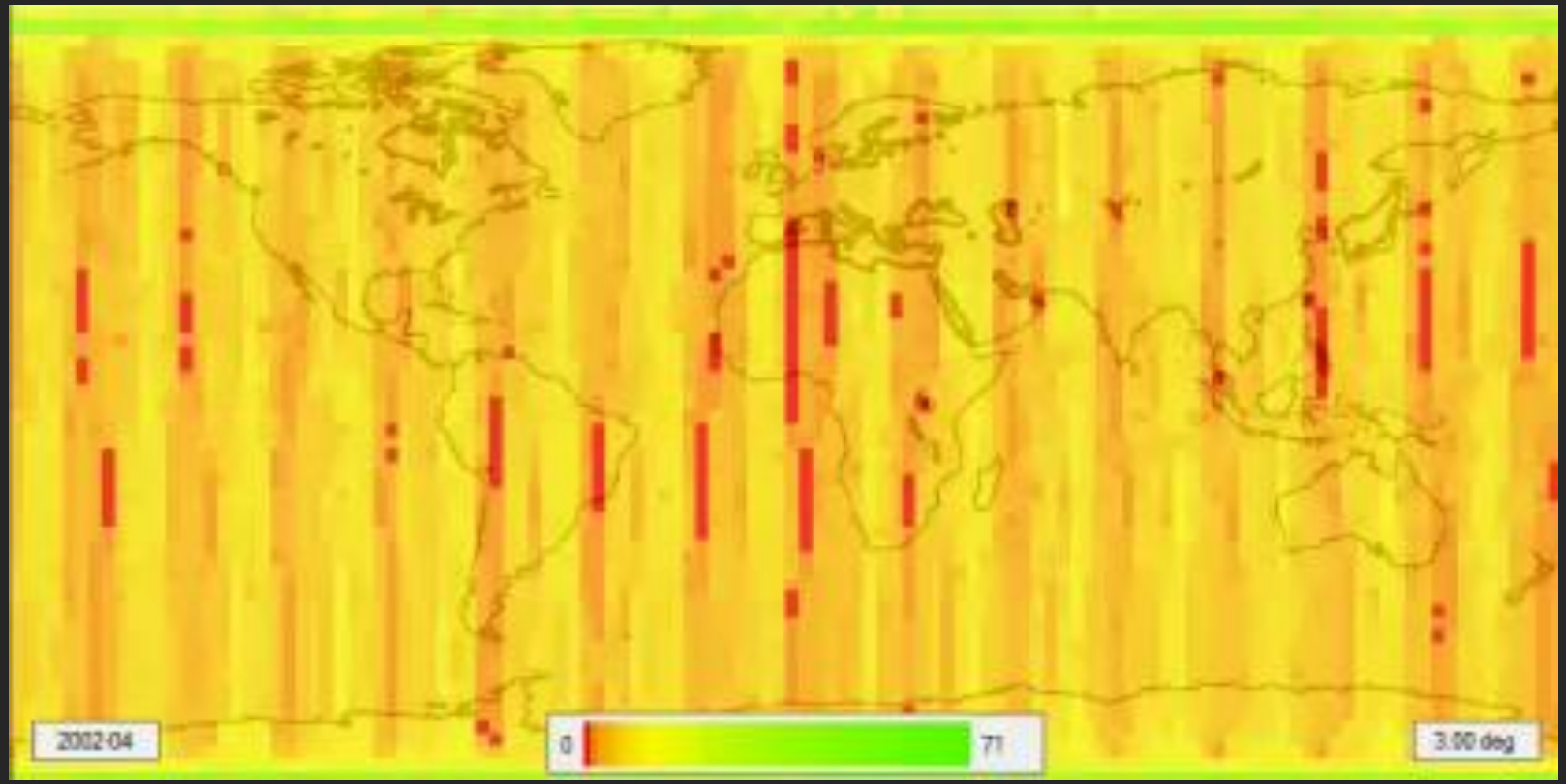
GRACE Frequency Map Analytic Tools (GF-MATS)

- Creates image of relative frequency

Groundtrack (text) → Select Features → Visualization and Image



GRACE Coverage Results



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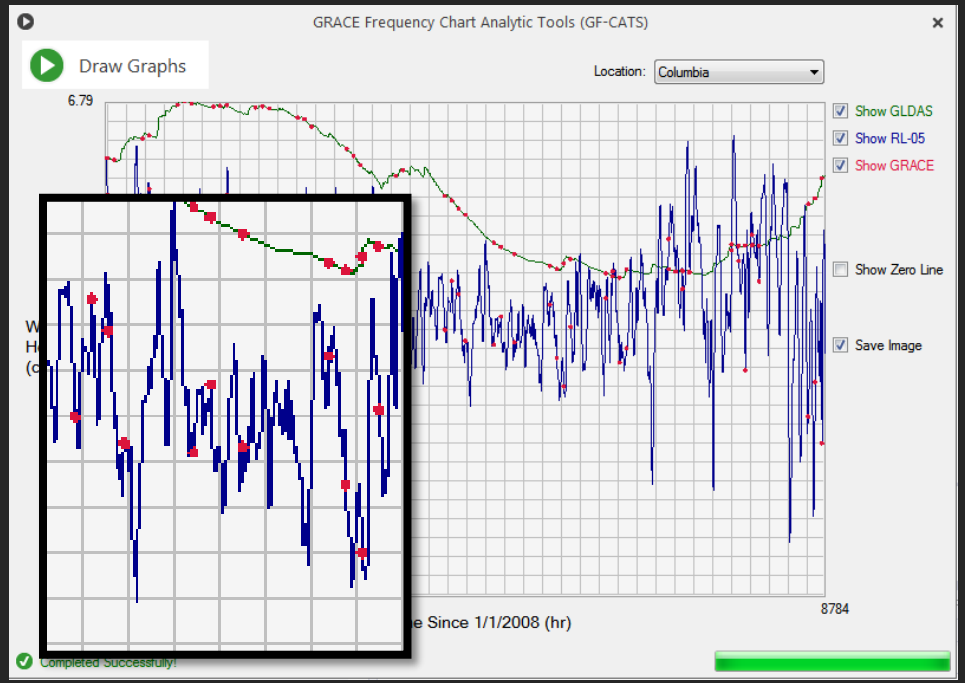
Solution: GRACE Data Precision

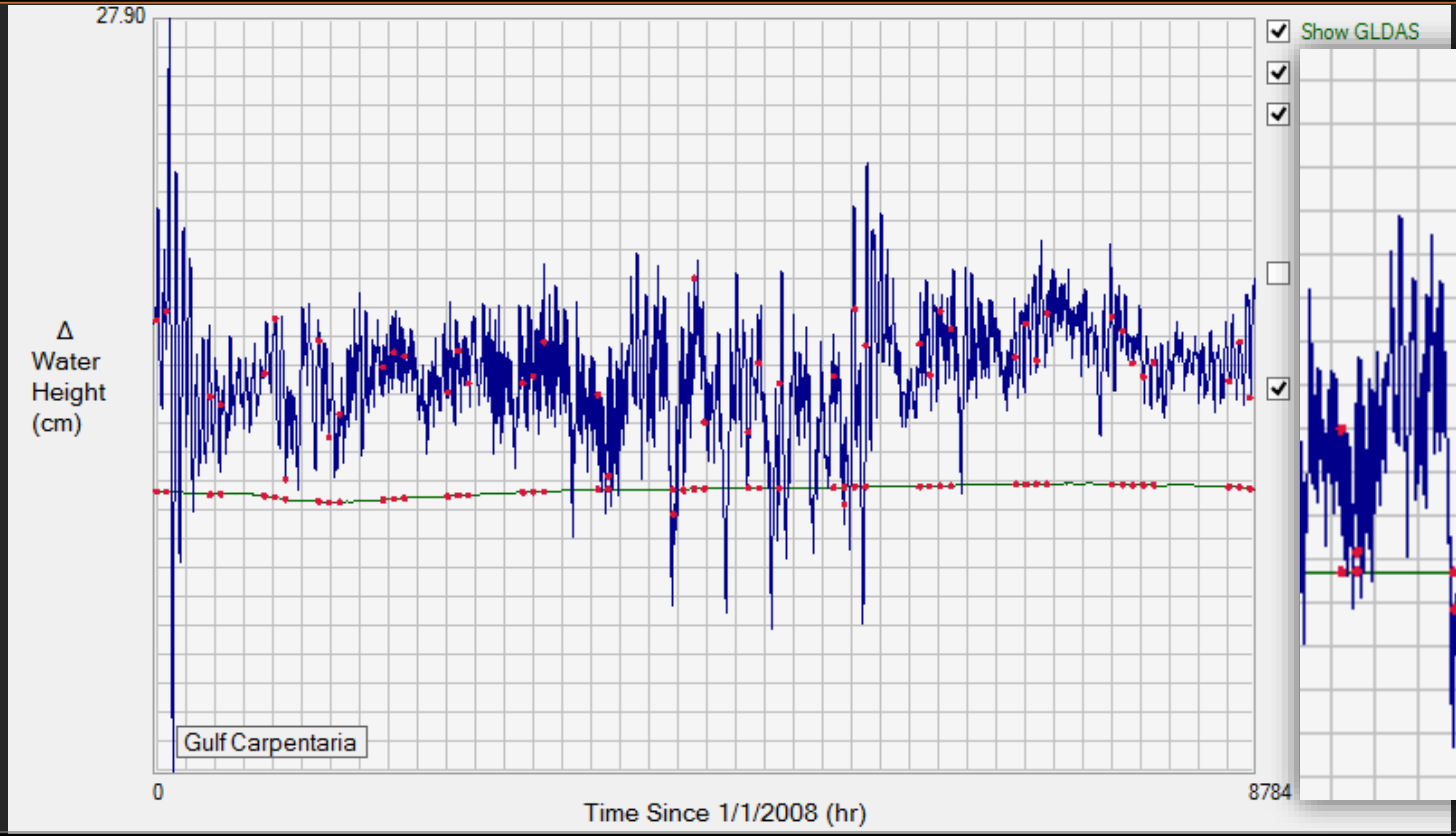
GRACE Frequency Map Analytic Tools (GF-MATS)

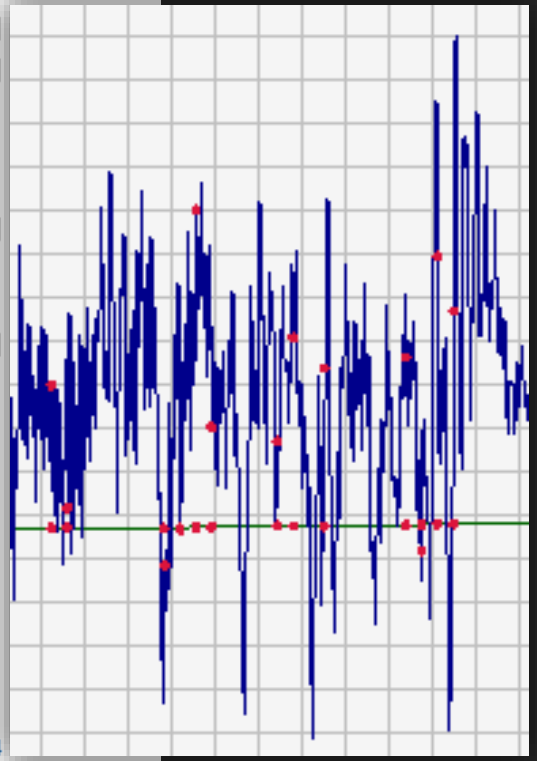
- Missing curves problem
- Locates these curves to measure data precision

Timestamps → Select Location → Visualization and Image

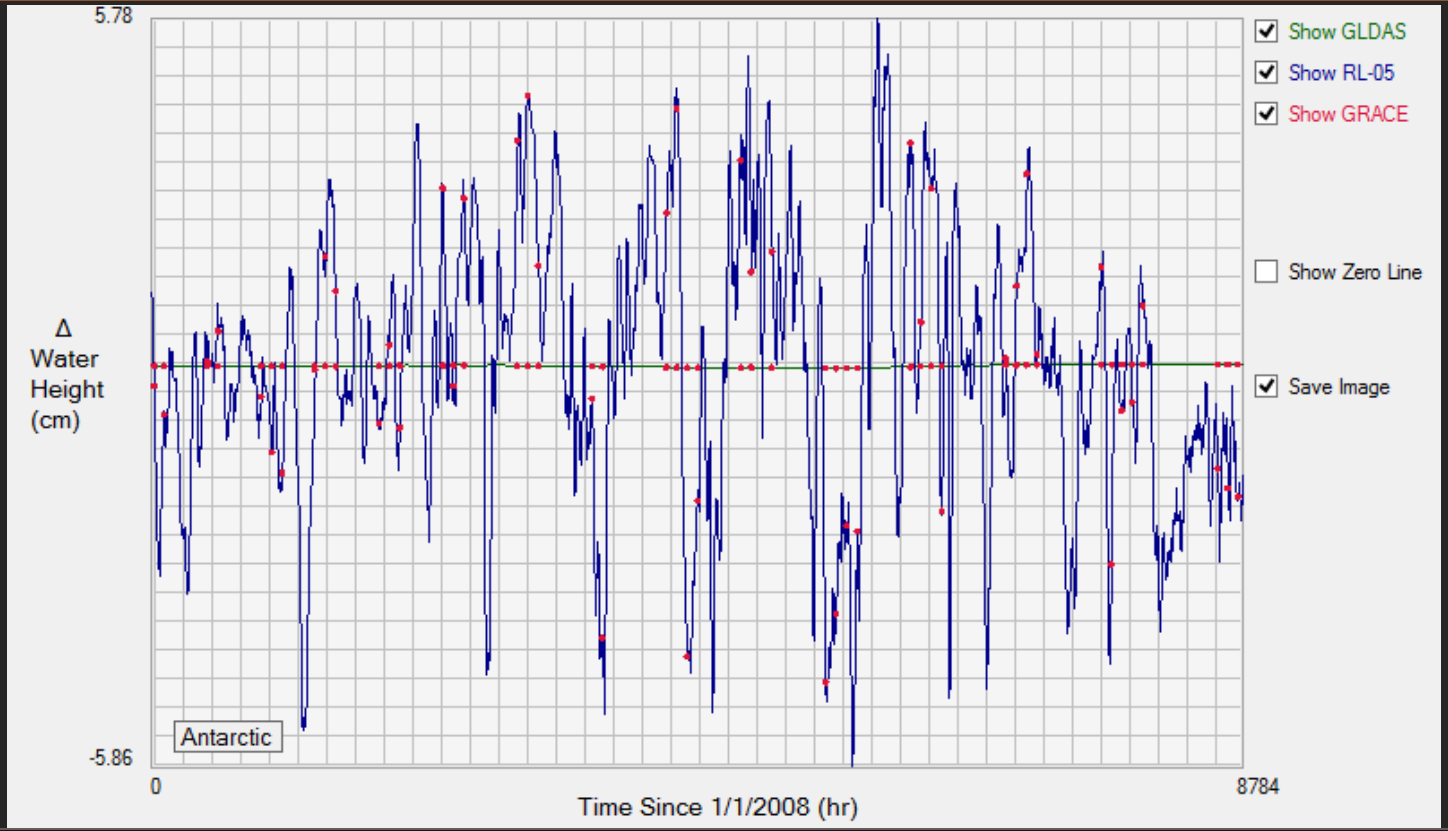


GRACE Data Precision Results

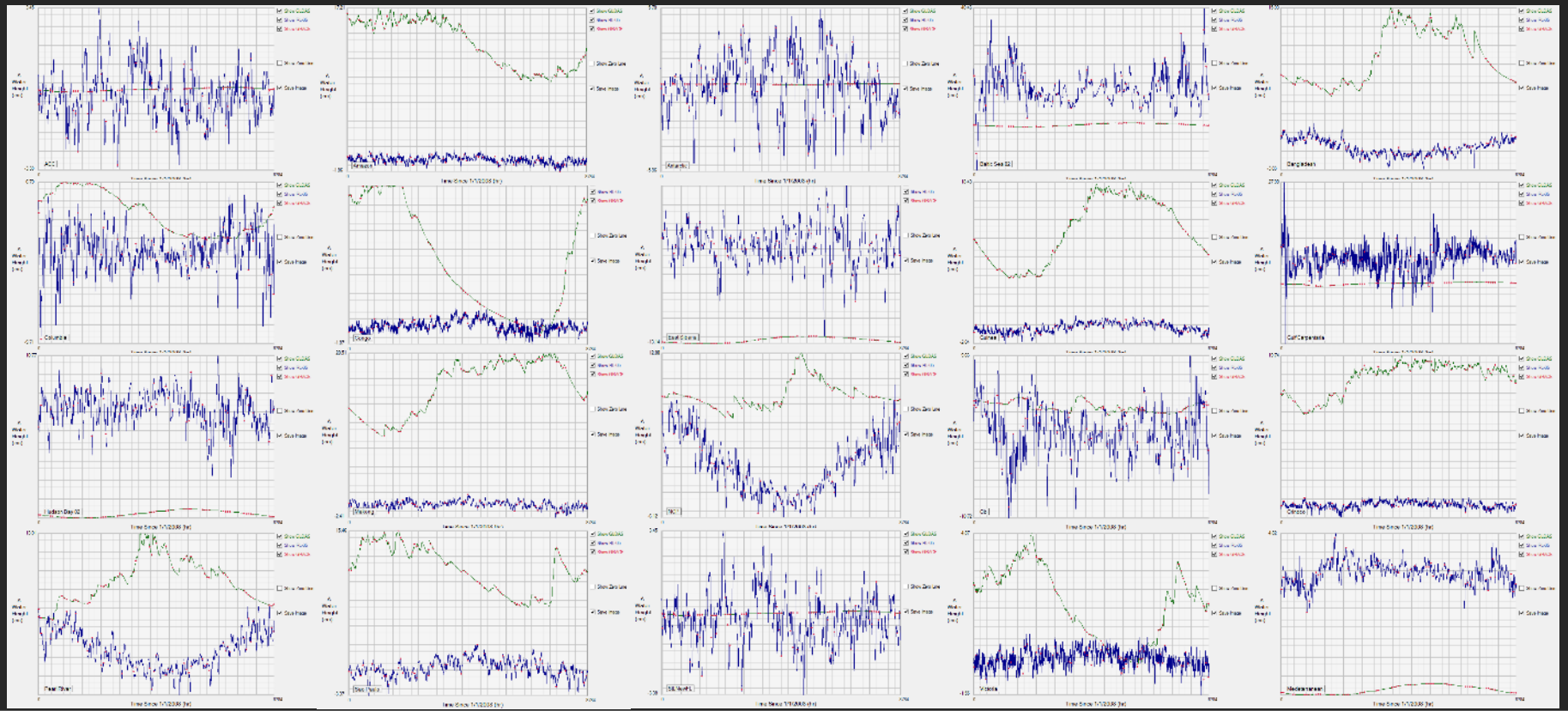




GRACE Data Precision Results



GRACE Data Precision Results

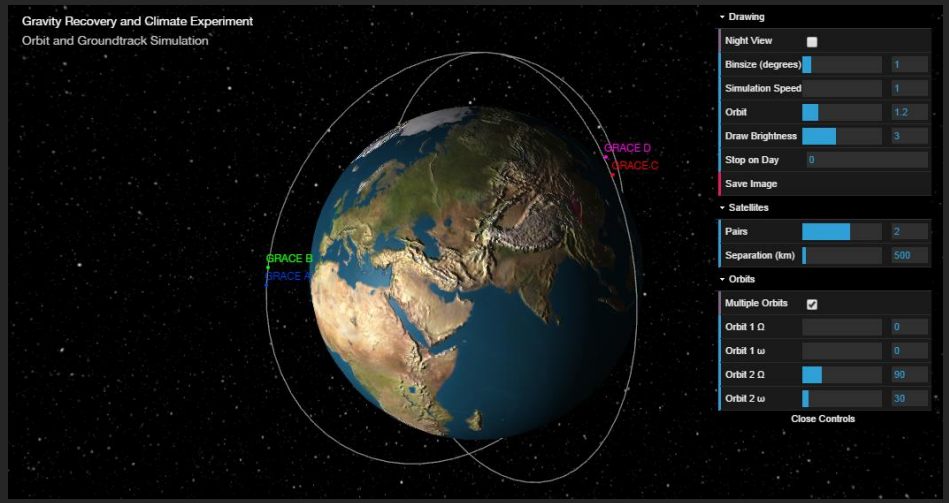


Solution: Satellite Pairs Needed

GRACE Live Orbit & Groundtrack Simulation

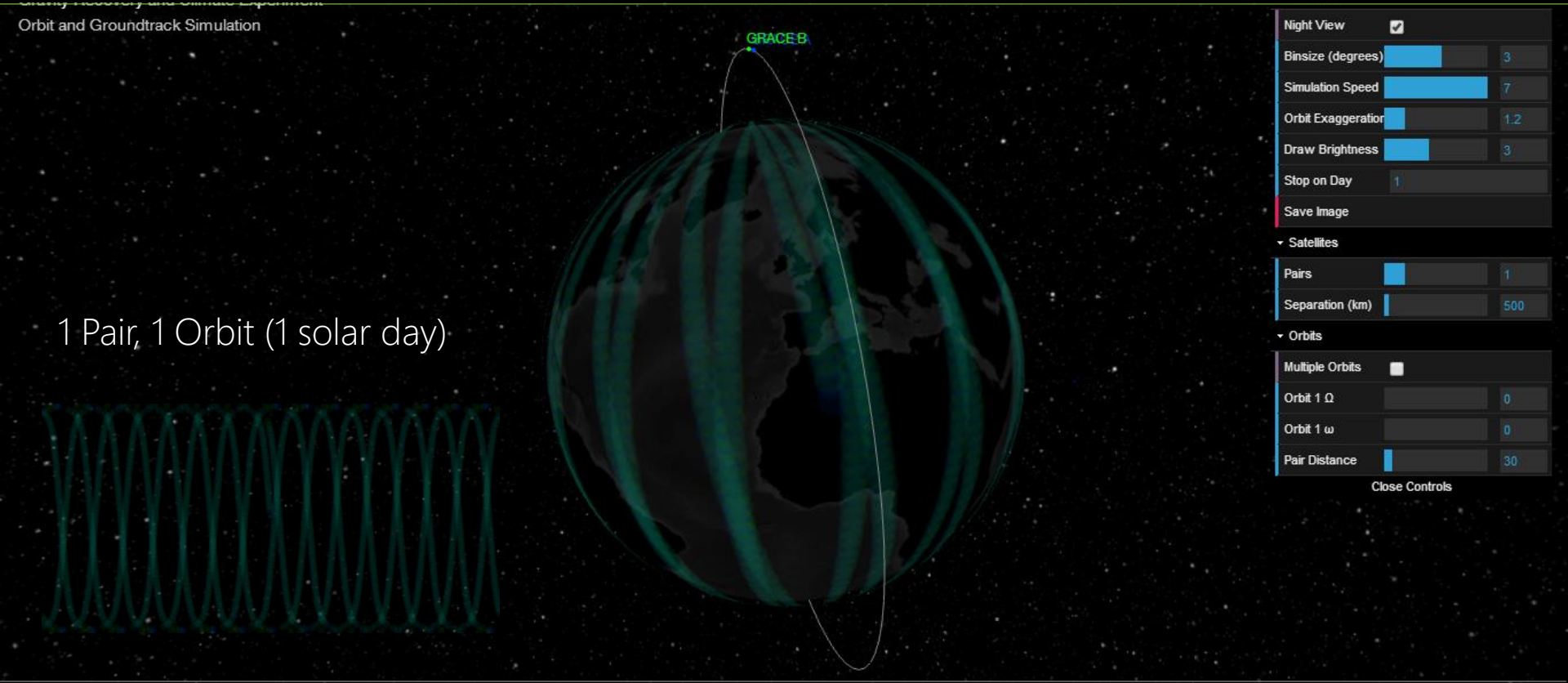
(G-LOGS)

- Most even coverage = most optimal path



http://code.arthurpachachura.com/grace

Satellite Pairs Needed Results

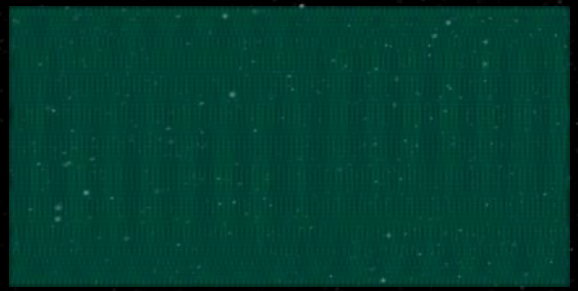


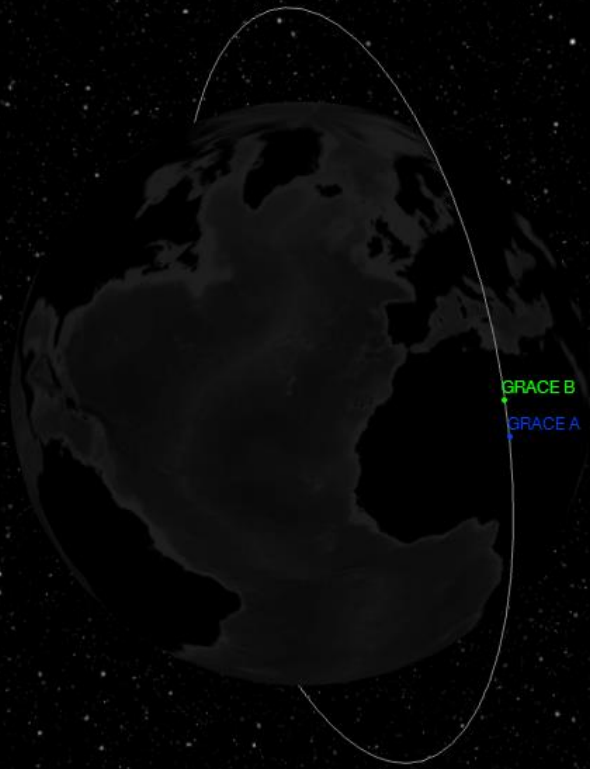
1 Pair, 1 Orbit (1 solar day)

Satellite Pairs Needed Results

Orbit and Groundtrack Simulation

1 Pair, 1 Orbit (30 solar days)

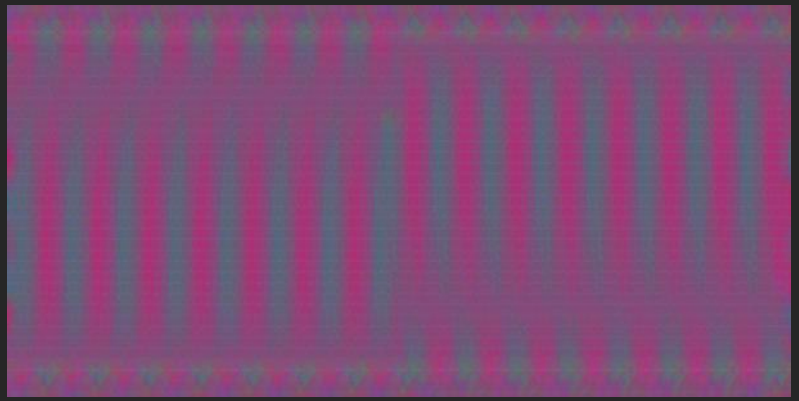


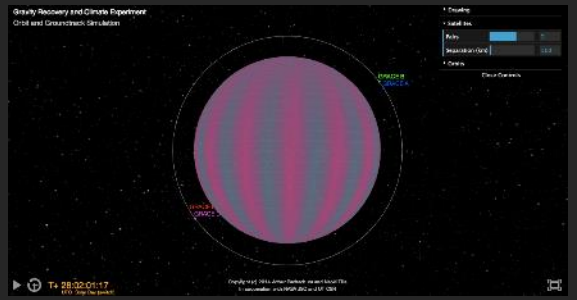


Night View
Binsize (degrees) 1
Simulation Speed 7
Orbit Exaggeration 1.2
Draw Brightness 1
Stop on Day 30
Save Image
Satellites
Pairs 1
Separation (km) 500
Orbits
Multiple Orbits
Orbit 1 Ω 0
Orbit 1 ω 0
Pair Distance 30
Close Controls

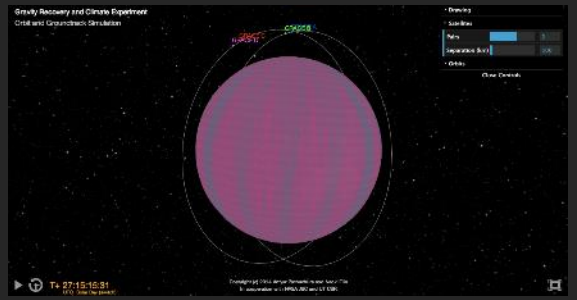
Satellite Pairs Needed Results

2 Pairs, 1 Orbit (30 solar days)



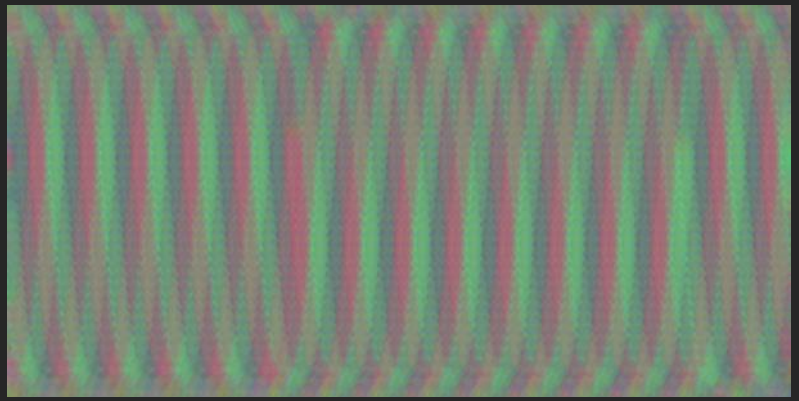


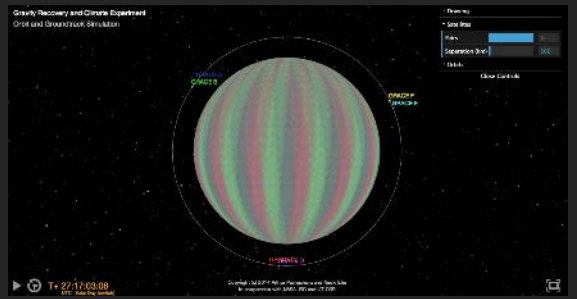
2 Pairs, 2 Orbits (30 solar days)



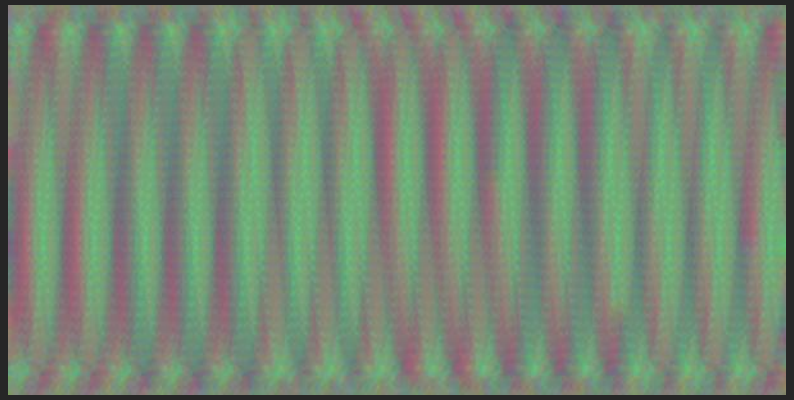
Satellite Pairs Needed Results

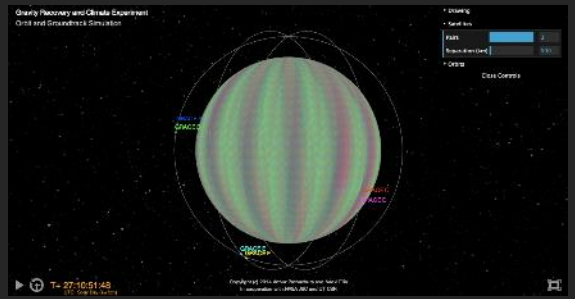
3 Pairs, 1 Orbit (30 solar days)





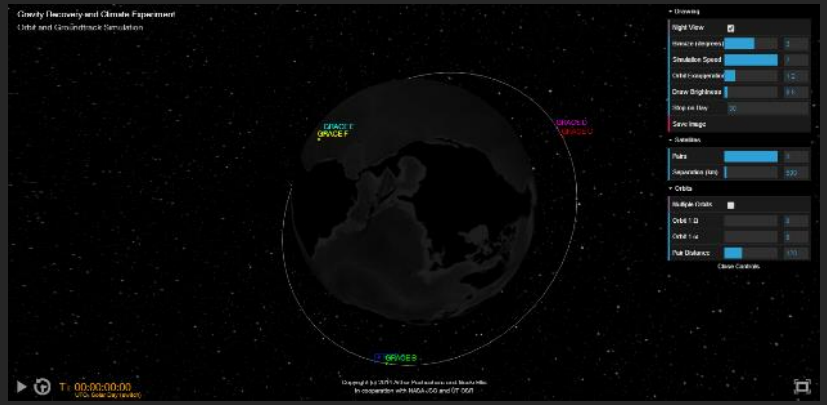
3 Pairs, 3 Orbits (30 solar days)

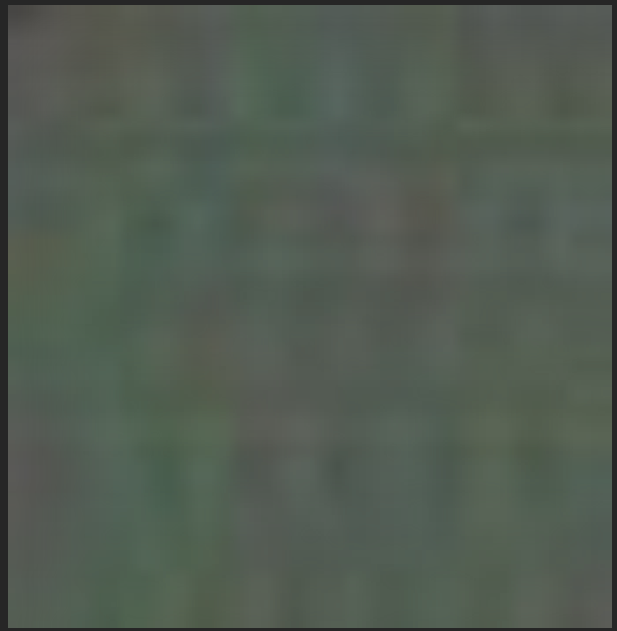




Satellite Pairs Needed Results

3 Pairs, 1 Orbit (30 solar days)





Technology Used

What We've Learned

Arthur Pachachura

- "Fundamental Astromechanics"
- Becoming a more efficient coder
- Teaching someone programming skills
- Presentation skills & time management

Naoki Ellis

- LLR System/Station
- Importance of programming knowledge
- Working with others
- Second guessing

Special Thanks

Program Coordinators

Margaret Baguio
Kerry Johnson
Pan Knab

GRACE Project Scientists

Dr. Himanshu Save
Dr. Christopher McCullough
Dr. Peter Nagel

CSR Director

Dr. Bryon Tapley

CSR Associate Director

Dr. Bob Schutz

NASA Texas Space Grant Consortium Director

Dr. Wallace Fowler

What's next?

- All Code is Open Source
- We're never done…

More Information on GRACE

CSR
http://www.csr.utexas.edu/grace/

NASA
http://www.nasa.gov/mission_pages/Grace/

JPL
http://grace.jpl.nasa.gov/

GFZ
http://op.gfz-potsdam.de/grace/main_GRACE.html

http://www.gfz-potsdam.de/en/grace/

JPL GFZ Potsdam Center for Space Research CSR The University of Texas at Austin DLR