Gravity field models and precise satellite orbits

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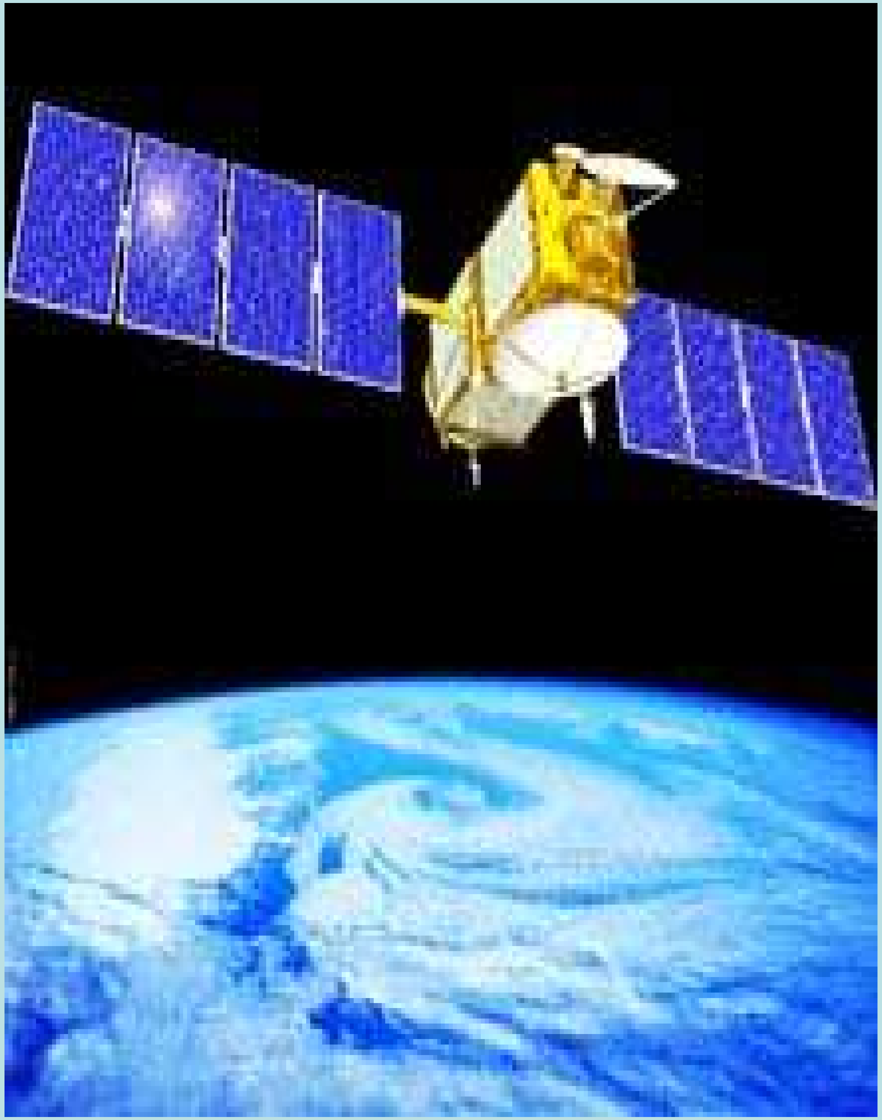
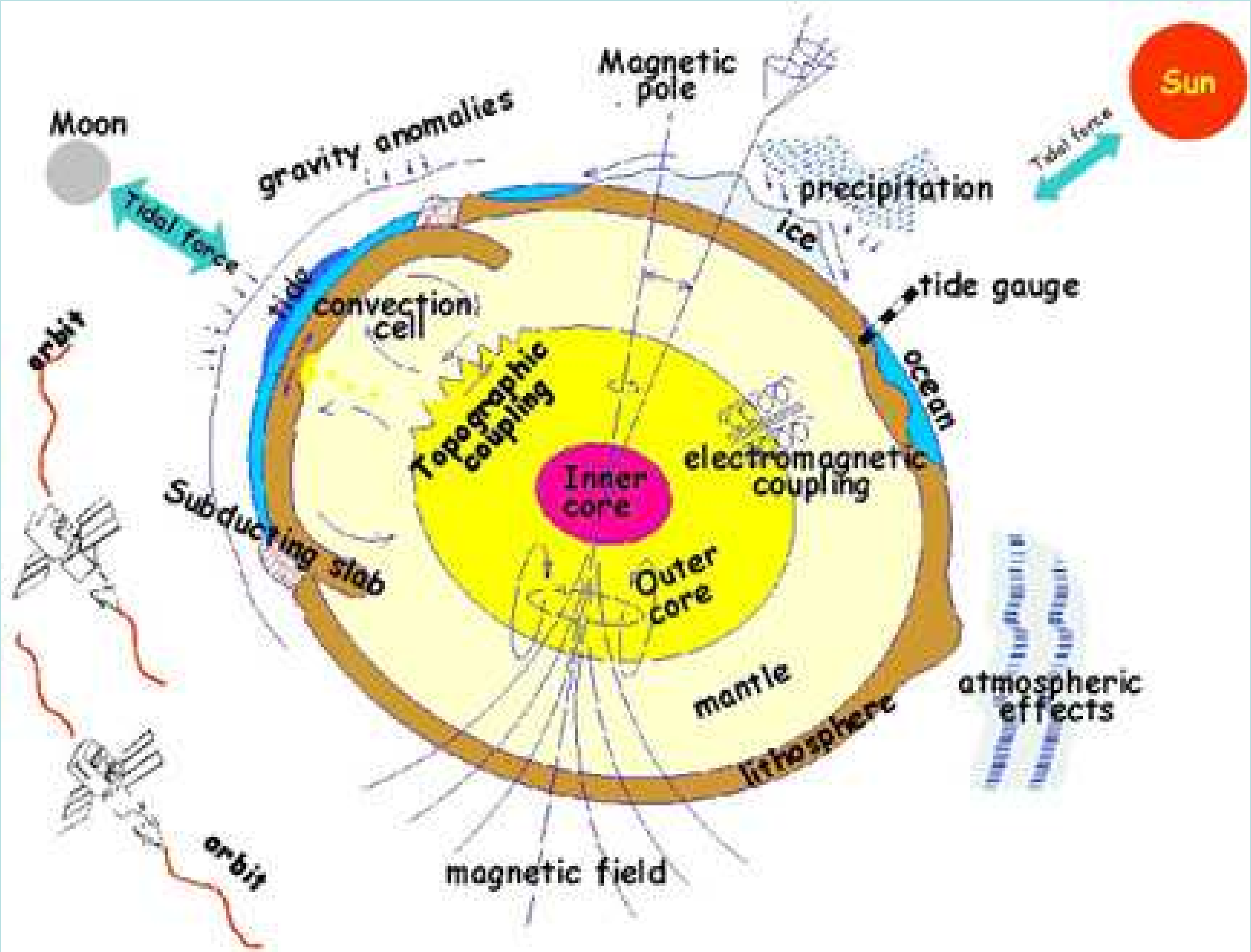
Outline

- Introduction:
  - Gravity fields
  - Gravity field models
- Motivation
- Data and method



http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/jas1_general.html

Earth’s gravity fields



http://www.geod.nrcan.gc.ca/edu/geod/gravity/gravity04_e.php

Global geopotential models

Derived from the equation

$$V(r,\theta,\lambda) = \frac{GM}{r}\left\{1 + \sum_{n=2}^{\infty}\left(\frac{R_e}{r}\right)^n \sum_{m=0}^{n}\left(C_{nm}\cos m\lambda + S_{nm}\sin m\lambda\right)P_{n,m}\left(\cos\theta\right)\right\}$$

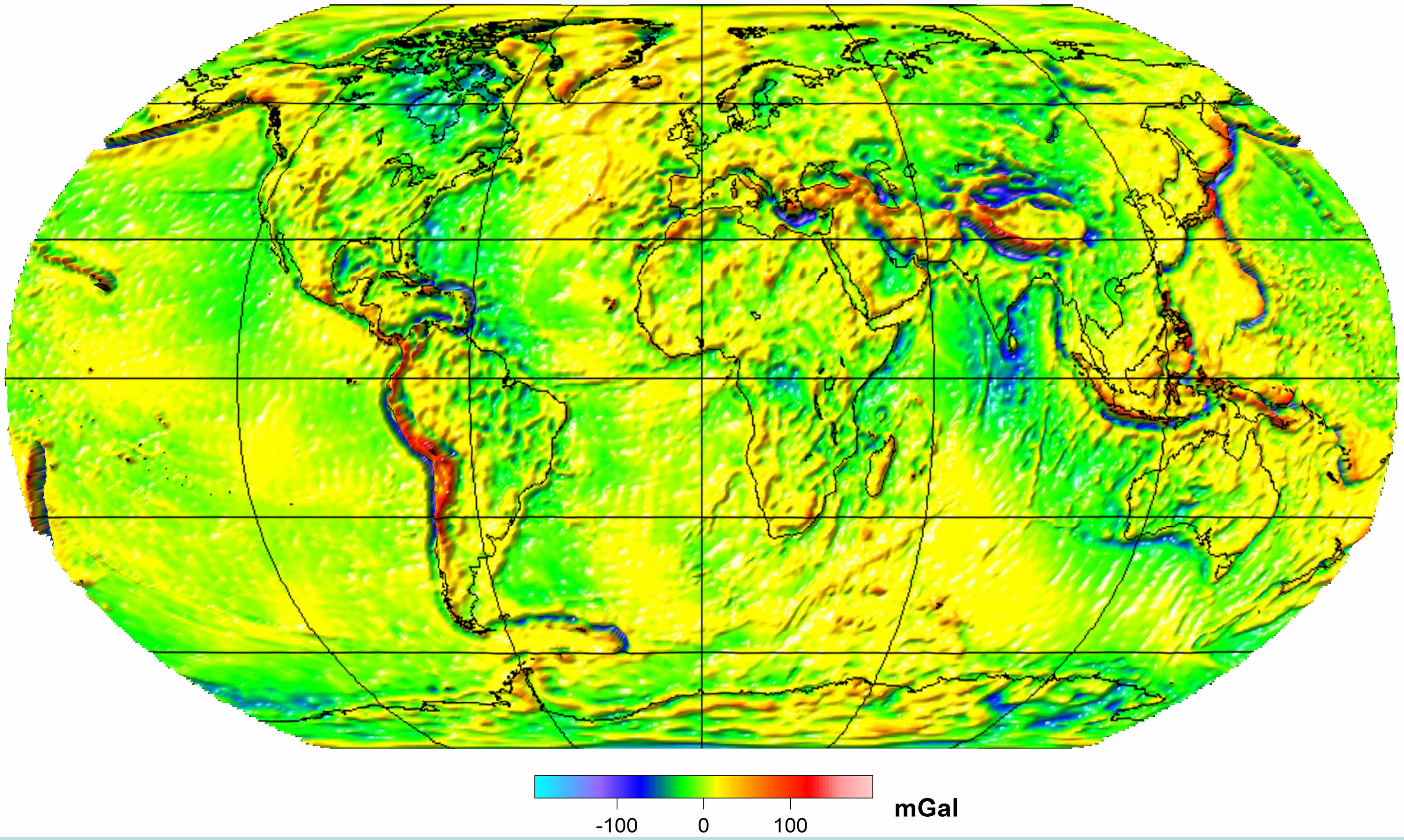
GM	Earth's gravity constant
r	magnitude of radius vector
n, m	degree and order of spherical harmonics
P_{nm}	Legendre functions
C_{nm}, S_{nm}	coefficients of spherical harmonics
θ	latitude
λ	longitude

Global geopotential models (cont.)

3 types GGMs: - satellite only (from orbits of satellites), combined (satellite data, surface gravity data and satellite altimeter data), tailored (1/2 but extended to higher degrees)

Model	Degree (n)	Type	Citation
JGM-3	70	Combined	Tapley et al. (1996)
EGM96	360	Combined	Lemoine et al. (1998)
EIGEN-2	120	Satellite only	Reigber et al. (2003)
GGM01S	120	Satellite only	Tapley et al. (2004)
EGM96S	70	Satellite only	Lemoine et al. (1998)
GPM98C	1800	Tailored	Wenzel (1998b)

Global distribution of gravity anomalies

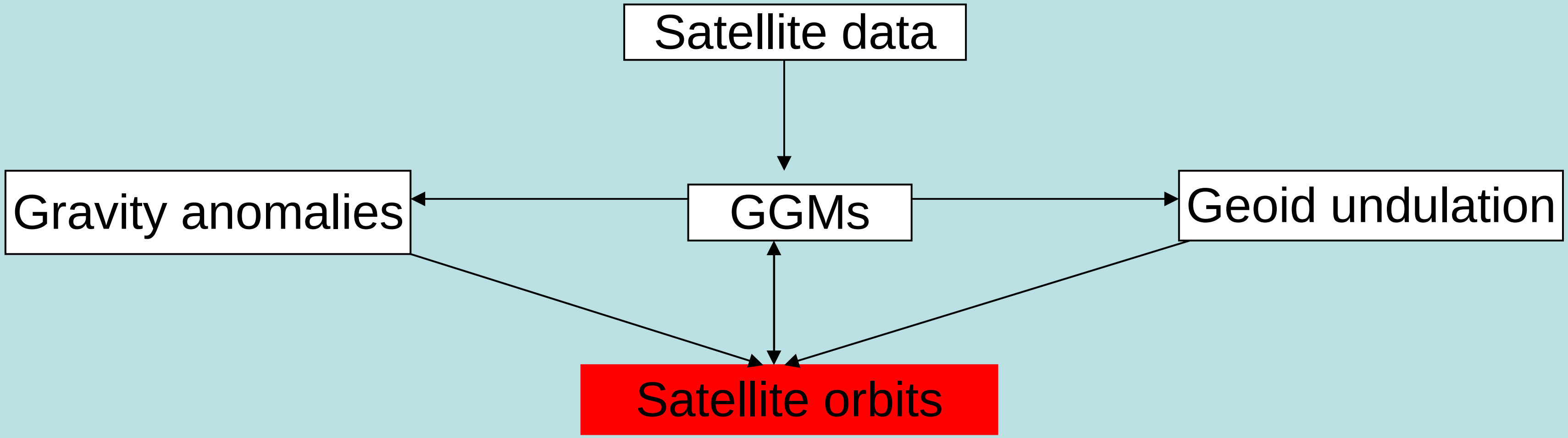


http://op.gfz-potsdam.de/grace/results/grav/g003_eigen-cg01c.html

Motivation

Gravity field → structure of the earth, ocean circulation, sea level changes and geoid height calculations.

- Gravity field fluctuations (due to tides, mass distribution and tectonic plate motion) induces satellite orbit anomalies.



How good are the models?

``... the various models are not as good as they are said to be. If they were, the differences between them should not be so great as they are" Lambeck, K. and Coleman, R., 1983 …"

Aim and objectives

Aim: Investigate the effects of the different gravity models on the determination of high-precision satellite orbits.

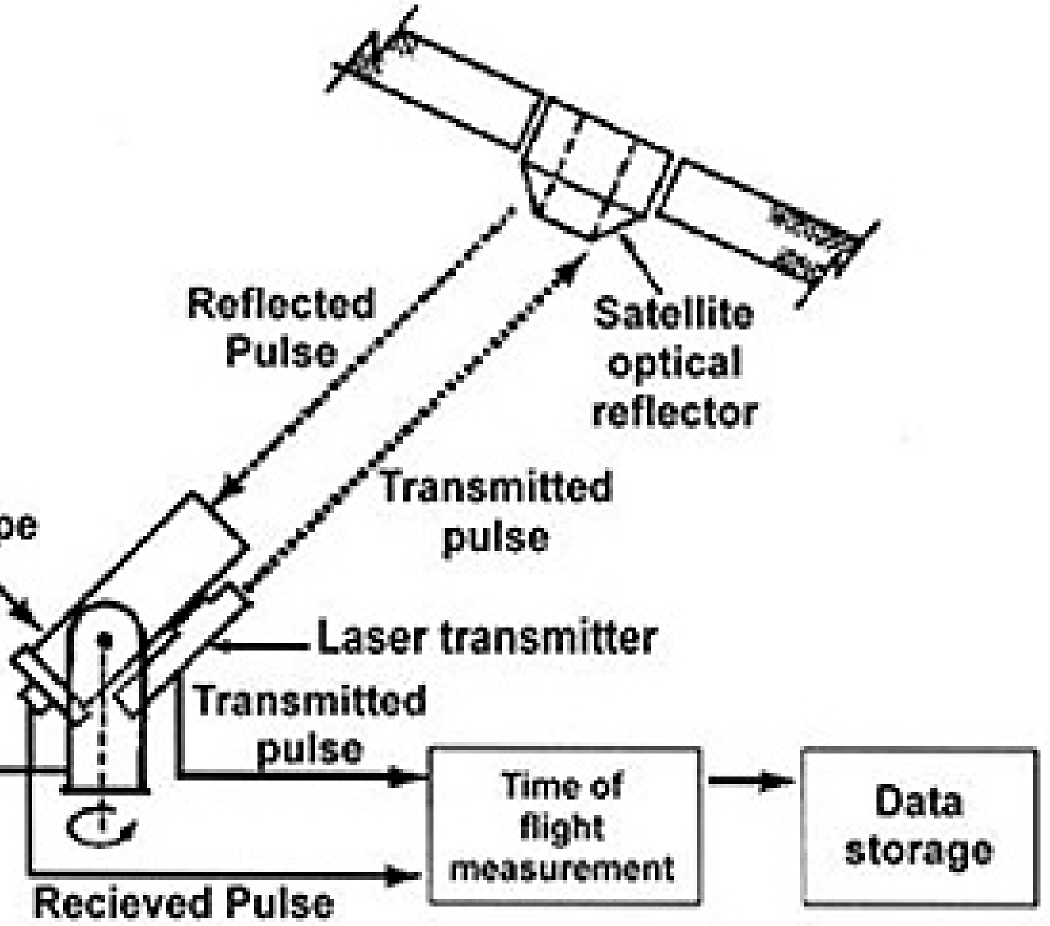
- Determine satellite orbital parameters based on different gravity field models
- Inter-model validation of the gravity field models and determine the most suitable gravity model that can be used for precise satellite orbit determination by minimising the observed - computed residuals
- Identify solve-for parameters which are affected adversely by less-accurate gravity models
- Develop a method to improve observed-computed residuals by choice of gravity model

Data

Satellite Laser Ranging (SLR)

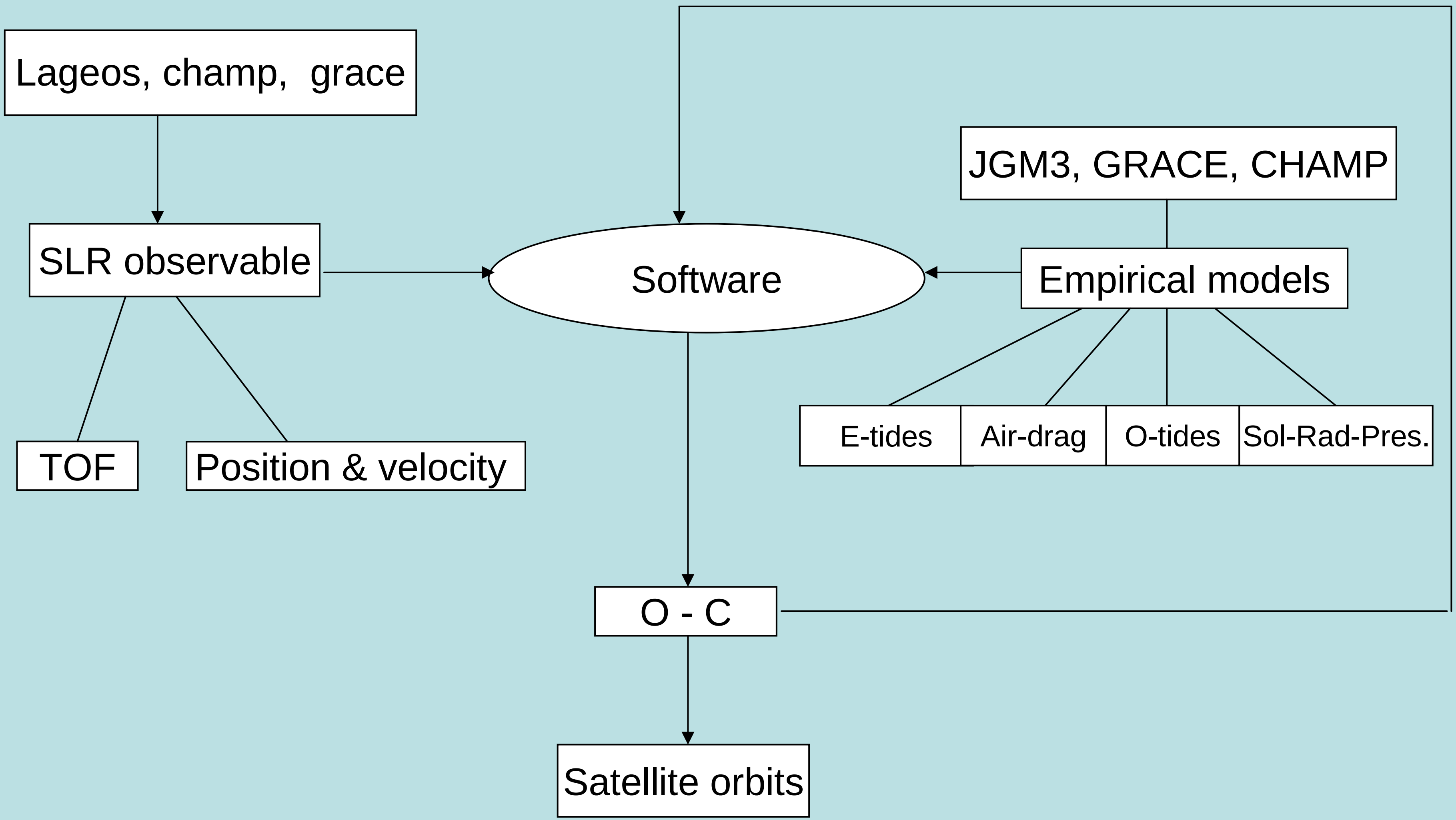
Degnan J. J. 1985

Method of tracking satellites:
Laser pulse reflected by the orbiting satellite is detected by the telescope receiver and time of flight is measured.



International Laser Ranging Service station network

Methodology



In what follows…

- Background literature
- Data and software:
  - format data and run sample tests
- Gravity models

Thank you!