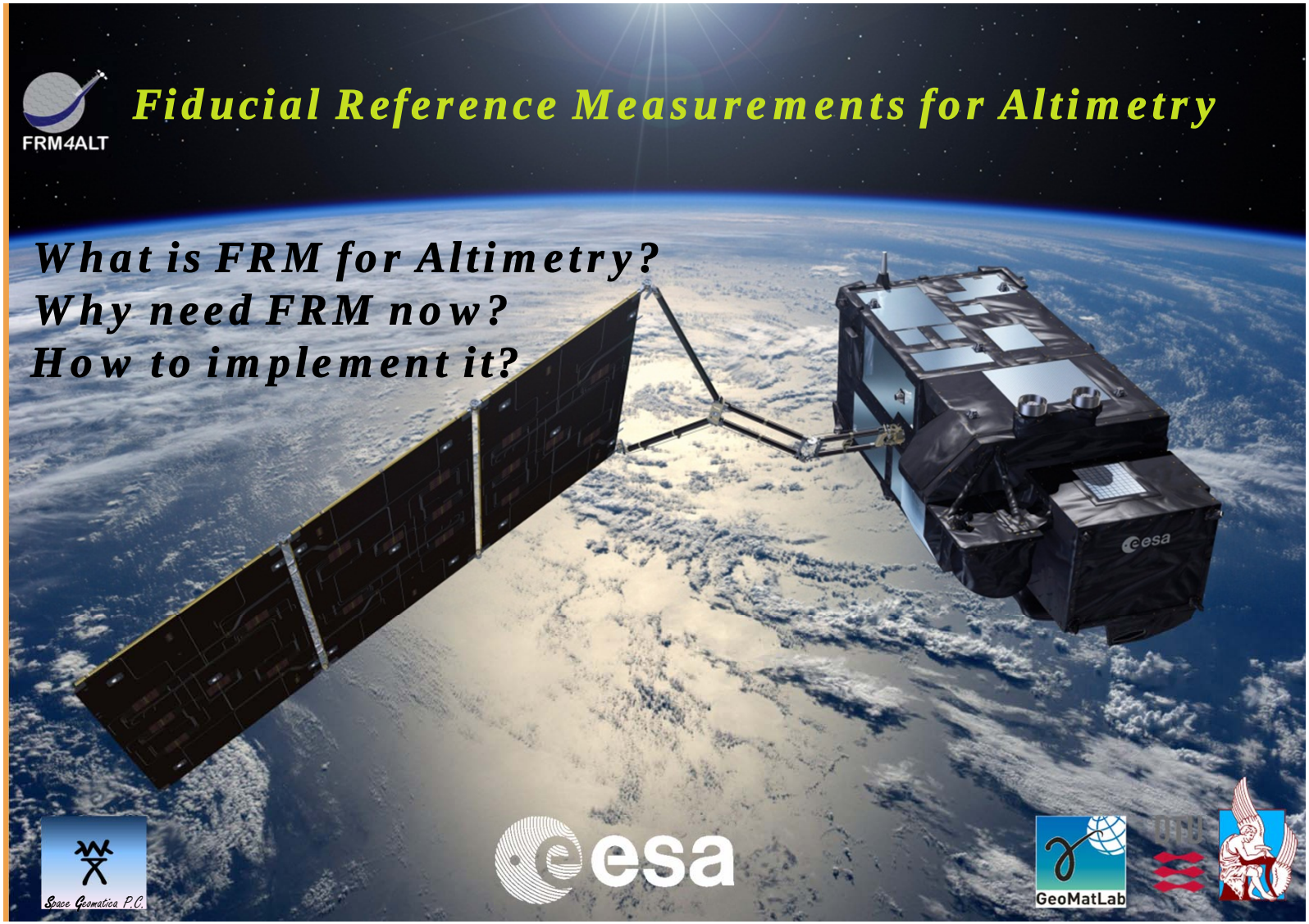
FRM4ALT
Fiducial Reference Measurements for Altimetry
What is FRM for Altimetry?
Why need FRM now?
How to implement it?
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## Laws of Monitoring Sea Level and Climate Change:

| | | |
|---|---|---|
| Accuracy | In scientific and monitoring data we produce and evaluate. | Science |
| Accuracy | Information presented to the Public for understanding effects of sea level rise to their lives. | People |
| Accuracy | In helping make the **right** Decisions, and put into action the **right** Policies. | Future |

## Sea-Level Rise and Concerns to Society

**Even small amounts in sea-level rise can cause devastating effects:**

- Sea-level rises faster at present than in the last 2000 years.
- People living on low-lying lands may abandon or relocate.
- Islands may be lost.
- Cause destructive erosion on coasts.
- Contaminate faster aquifers and water resources with sea water.
- Contaminate agriculture and productive soils.
- Cause hurricane surges to become powerful, higher, with frequent flooding of vast coastal areas.
- Coastal flooding destroys wildlife habitats (birds, fish, animals, vegetation, etc.).
- For every 30 cm of sea level rise coastlines move inland by 30-100 m on average.

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# Why Need Establish FRM? ⇦

**Because we need to monitor Oceans, Inland Waters, Polar Regions and climate change with satellite altimetry in a way that is:**

- Accurate and Reliable,
- Objective,
- Homogenous and continuous,
- Independent of procedures, Cal/Val locations, settings, and
- For many years to come (at least 20 years).

**Because it is appropriate time to:**

- Build upon commonly adopted procedures, protocols and uncertainty for Cal/Val.
- Provide control and checks for monitoring altimeter degradation as fast as possible.
- Connect one altimetry mission with another, seamlessly and smoothly.
- Adopt a stable framework for international and interdisciplinary cooperation.
- Allow data integration between different scientific fields and disciplines,
- Set standards for measurements and results between various Cal/Val facilities.
- Ensure Cal/Val procedures, results are well documented and traceable to SI units.
- Provide transparent protocols and best practices for establishing new Cal/Val sites.
- Dissipate responsibility to end user to decide the extent of fit for his requirements.

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# Uncertainty Constituents in Sea-Surface Cal/Val

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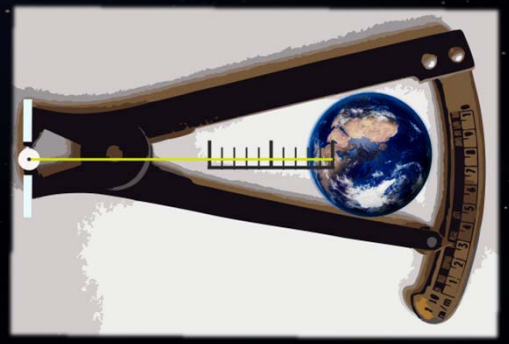
**Absolute coordinates of the reference Cal/Val site**
- Site location,
- Diverse GNSS constellations,
- GNSS Hardware, Observational Strategies, Processing,
- Ground stability of the Cal/Val site,
- Reference frames for site positioning,
- Earth tides,
- Time Reference System.



**Water Level Determination at Cal/Val site**
- Site location,
- Conditions and Settings,
- Tide gauges,
- Local reference surfaces,
- Measuring strategies, estimation, data storage.

**Control ties & ground monitoring at Cal/Val site**
- Geodetic Control ties,
- Ground monitoring.

**Geoid and MDT Models at Cal/Val site**

**Geophysical Parameters**
- Sea State Bias,
- Significant Wave Height,
- Wind Speed.

**Atmospheric Delays in altimetry signals**
- Ionosphere,
- Troposphere.

**Unaccounted effects.**

# Uncertainty Constituents in Transponder Cal/Val

**Control ties & ground monitoring**
- Geodetic Control ties,
- Ground monitoring.

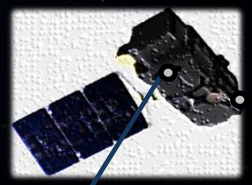
**Time Reference for the Transponder**
- Absolute time reference,
- Hardware Internal delay.

**Data Processing Strategies**
- Satellite Precise orbits,
- Satellite orientation in space,
- Initial time reference of chirp, etc.

**Unaccounted effects**

**Transponder Cal/Val site**
- Conditions and Settings,
- Hardware used,
- Local reference surfaces,
- Atmospheric delays,
- Measuring strategies, estimation.

**Absolute coordinates of the reference Cal/Val site**
- Site location,
- Diverse GNSS constellations,
- GNSS Hardware, Observational Strategies, Processing,
- Ground stability of the Cal/Val site,
- Reference frames for site positioning,
- Earth tides,
- Time Reference System.



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# How to achieve FRM4ALT

**Measurement conformity:**
Before carrying on Cal/Val, inspect for:
- Gross errors,
- Stochastic and Deterministic structures,
- Irregularities, Invalidity of models,
- Symmetry, Serial correlation, ….

**Decision Making Standards:**
- Select true expression of parameter for "uncertainty",
- Identify measurement mechanism based on fundamental reference standards, i.e., speed of light, absolute time, etc.,
- Assess uncertainty on observation models, error distributions, propagation laws, …
- Apply diverse sensors & tools for expressing uncertainty which are:
  - **Complete**: Represent all diversities & nuances in Cal/Val,
  - **Efficient**: Small variance,
  - **Reliable**: No matter what the error distribution, and
  - **Stable**: Same results on the same Cal/Val site.

**Uncertainty Reporting:**
- Determine uncertainty by integration of each weighted contribution, with its sensitivity.


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