Joint Mass Change Mission Expert Group (JMCMEG)

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JMCMEG co-led by

HQ and

Background

- 2013-2016: establishment NASA/ESA Interagency Gravity Science Working Group was established → report indicating a possible future cooperation scenario for a mass change mission (http://www.deos.tudelft.nl/AS/pieter/IGSWG/IGSWG-Report.pdf)

- 2017-2019: discussions between ESA and NASA leading to articulating a strong interest in exploring a joint future mission (ESA letter February 15, 2019, NASA letter February 27, 2019 and NASA letter November 15, 2019).

- 2020: The agencies have agreed to cooperate to establish an Ad-Hoc Joint Science Study Team (AJSST) as an agreed upon first step to support the definition of jointly agreed user and science needs and to prepare a corresponding Mission Requirement Document version 1.0.

- 2021: Subsequently, to support NASA's pre-Phase A and ESA's Phase A studies a Joint Mission Expert Group (JMCMEG) is established, co-led by NASA HQ and ESA as an agreed upon next step to support the consolidation of mission/user requirements.

AJSST (2020)

- The collection and consolidation of relevant user information originating from the ESA NASA International Gravity Science Working Group (IGSWG) Report, the 2017 National Academies of Science Earth Science Decadal Survey, IUGG report, proposals to the Agencies and other relevant recent sources of user needs also in view of potential future contributions to EC Copernicus services,

- The definition and consolidation of the mass change constellation requirements taking account of the objectives of the science and applications user community, in order to define the corresponding mission requirements,

- The compatibility between objectives, targets, requirements and expected performance

JMCMEG (2021 – today)

NASA and ESA agreement:

- cooperate towards preparing a Mission Requirements Document (MRD)
- define support science study activities for a Mass- change And Geosciences International Constellation (MAGIC: essential for understanding global change).

Objectives:

- To support ESA's and NASA's MAGIC Phase A and pre-Phase A activities
- Support the consolidation of the MRD and the end of the study Phases
- Support in promoting and presenting MAGIC

Sub-group	Assignment	Members
Mission performance	Assessment of topics related to mission performance and matching against MRD mission requirements	David Wiese (US), Bryant Loomis (US), Scott Luthcke (US), Srinivas Bettadpur (US), Roland Pail (DE), Pieter Visser (NL), Frank Flechtner (DE)
Hydrology	Review and update science questions and user and mission requirements.	Luca Brocca (IT), Annette Eicker (DE), Susanna Werth (US), Bart Forman (US)
Cryosphere		Jonathan Bamber (UK), Bert Wouters (NL), Scott Luthcke (US), Bryant Loomis (US)
Oceanography		Bert Wouters (NL), Benoit Meyssignac (FR), Carmen Boening (US), Cecilia Peralta-Ferritz (US)
Solid Earth		Isabelle Panet (FR), Jeanne Sauber (US), Susanna Werth (US), Bert Wouters (NL), Jonathan Bamber (UK)
Climate Change		Carmen Boening (US), Cecilia Peralta-Ferritz (US), Annette Eicker (DE), Benoit Meyssignac (FR)
Neutral Atmosphere		Pieter Visser (NL), Srinivas Bettadpur (US)

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Next Generation Gravity Mission as a Mass-change And Geosciences International Constellation (MAGIC)

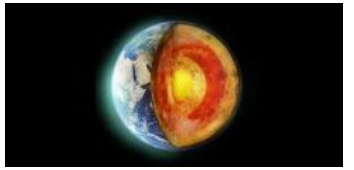
A joint ESA/NASA double-pair mission based on NASA's MCDO and ESA's NGGM studies

Mission Requirements Document

Prepared by	**Earth and Mission Science Division**
Reference	**ESA-EOPSM-FMCC-MRD-3785**
Issue/Revision	**1.0**
Date of Issue	**30 October 2020**
Status	**Issued**
Document Type	**Mission Requirements Document (MRD)**
Distribution	**Public**

Thematic fields and signals

Hydrology	• Ground water storage • Soil moisture • Extreme events warning (e.g. drought, flood) • Water balance closure • Global change impact on water cycle
Cryosphere	• Mass balance of ice sheets and glaciers • Contribution to global and regional sea level • Glacial isostatic adjustment (GIA)
Oceanography	• Ocean bottom pressure • Antarctic Circumpolar Current (ACC) and Atlantic Meridional Overturning Circulation (AMOC) variability • Tidal models • Heat and mass observations • Ocean circulation models
Solid Earth	• Geohazards • Deep interior properties and dynamics • Reshaping of Earth surface under external or internal forcing • Natural resources
Climate Change	• Sea-level change • Separation of contributors to the global water cycle
Neutral atmosphere	• Thermospheric neutral density • Thermospheric wind



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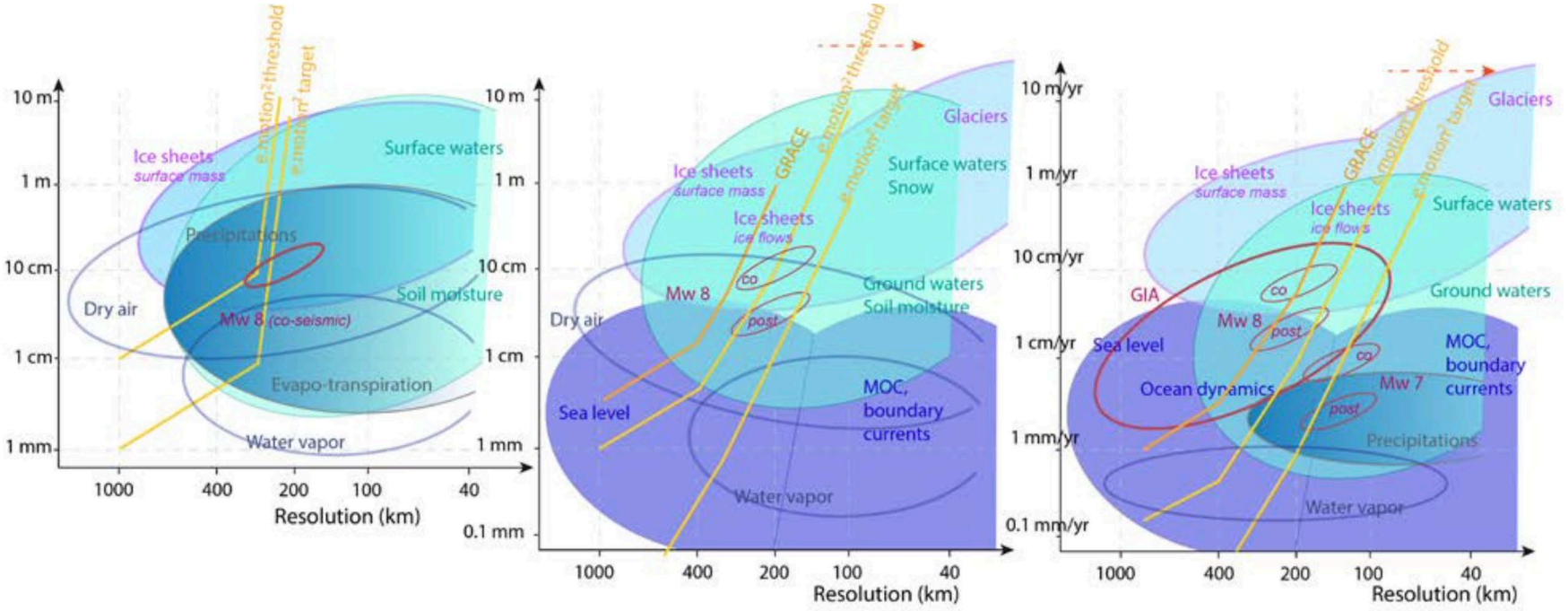
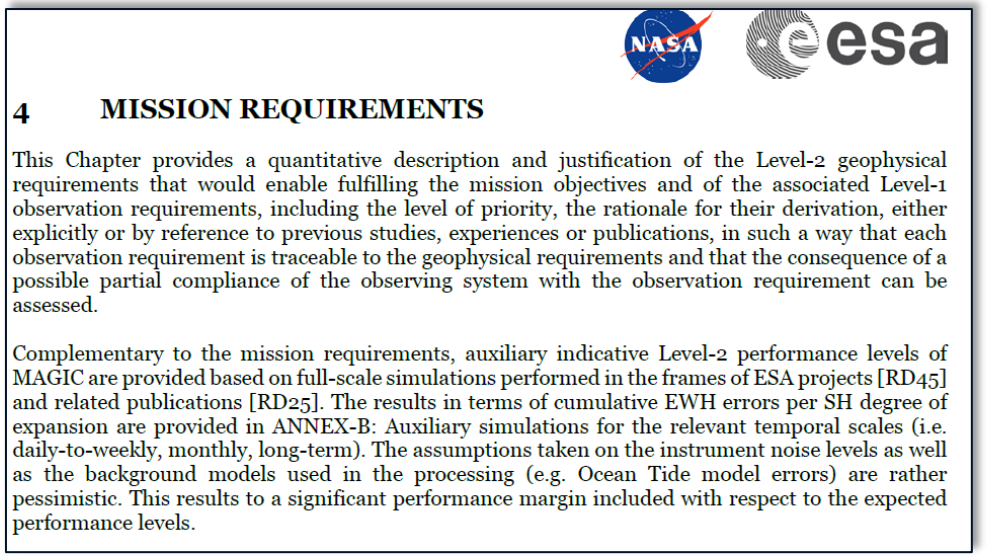


Figure 1. Signal amplitudes of mass variations in EWH as a function of spatial resolution, together with GRACE accuracy and resolution, and e.motion2 expected threshold and target requirements (Figure 1-8 from [RD6]). Three different time scales are shown: on the left the daily to weekly, in the middle the monthly to seasonal and on the right the long-term trend.

Mission Requirements divided into:

- **Constellation Requirements** (Lifetime, Constellation Observation Requirements, Timeliness Requirement & Availability);
- **Satellite-related observation requirements**;
- **Mass Change Products Requirements**;
- **Calibration and Validation Requirements**.

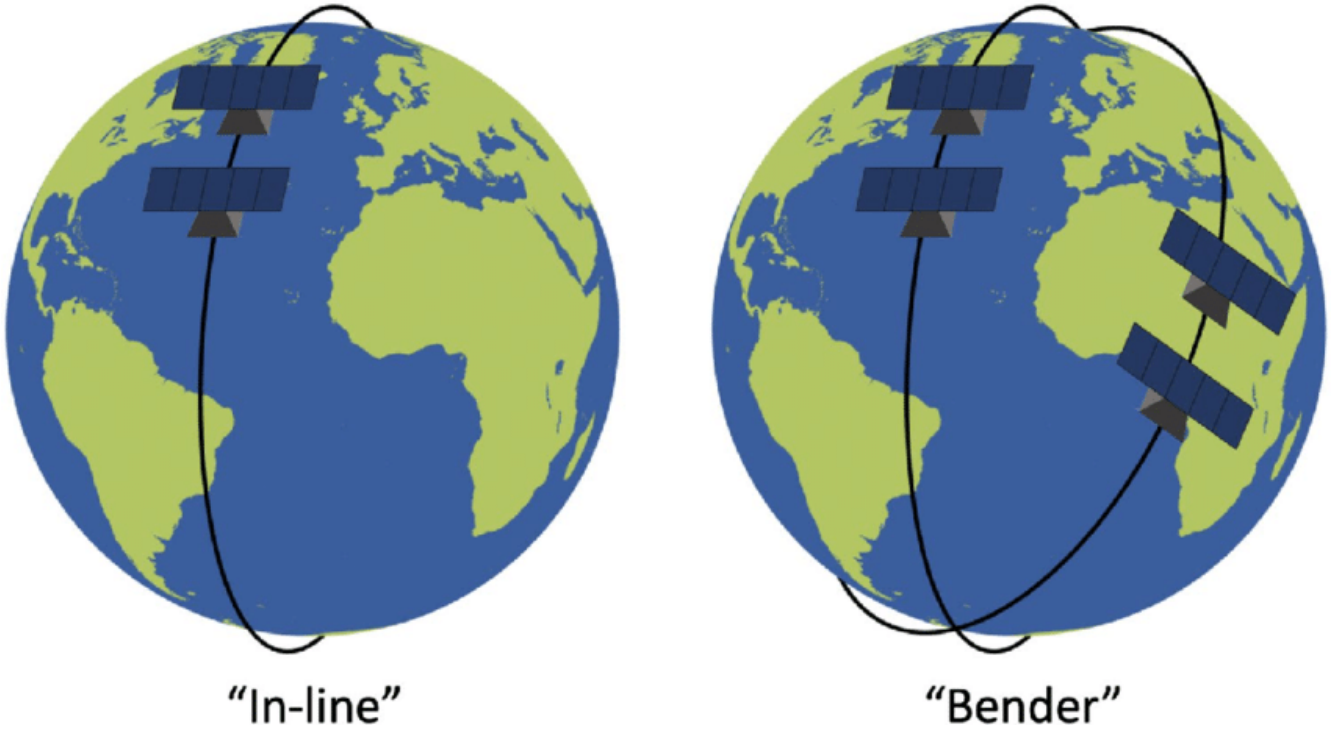


4 MISSION REQUIREMENTS

This Chapter provides a quantitative description and justification of the Level-2 geophysical requirements that would enable fulfilling the mission objectives and of the associated Level-1 observation requirements, including the level of priority, the rationale for their derivation, either explicitly or by reference to previous studies, experiences or publications, in such a way that each observation requirement is traceable to the geophysical requirements and that the consequence of a possible partial compliance of the observing system with the observation requirement can be assessed.

Complementary to the mission requirements, auxiliary indicative Level-2 performance levels of MAGIC are provided based on full-scale simulations performed in the frames of ESA projects [RD45] and related publications [RD25]. The results in terms of cumulative EWH errors per SH degree of expansion are provided in ANNEX-B: Auxiliary simulations for the relevant temporal scales (i.e. daily-to-weekly, monthly, long-term). The assumptions taken on the instrument noise levels as well as the background models used in the processing (e.g. Ocean Tide model errors) are rather pessimistic. This results to a significant performance margin included with respect to the expected performance levels.

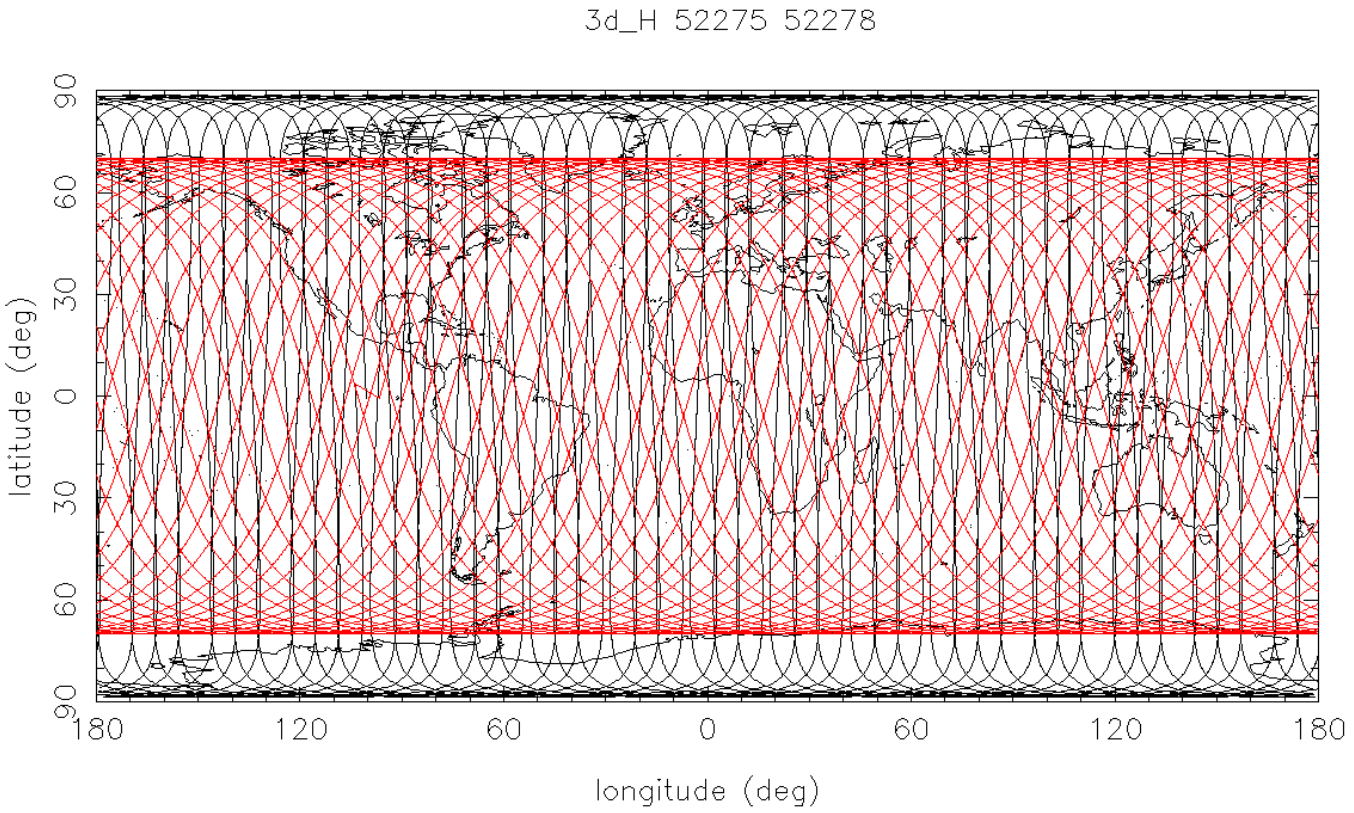
Mission scenarios – realistic E2E simulations



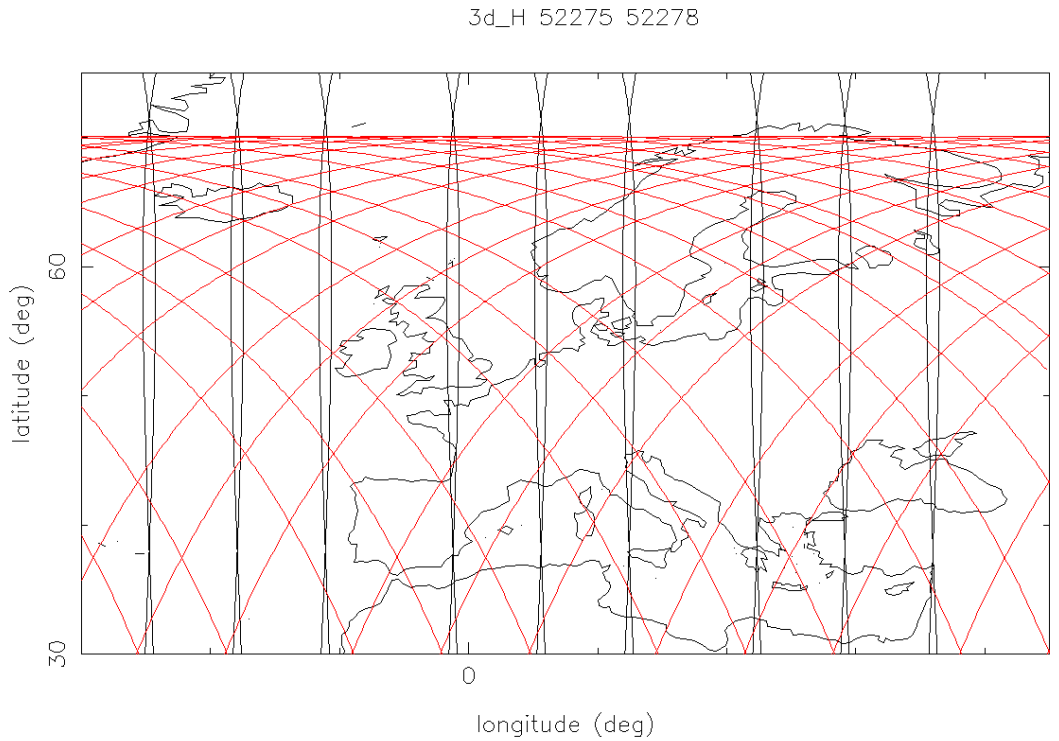
Design parameters:

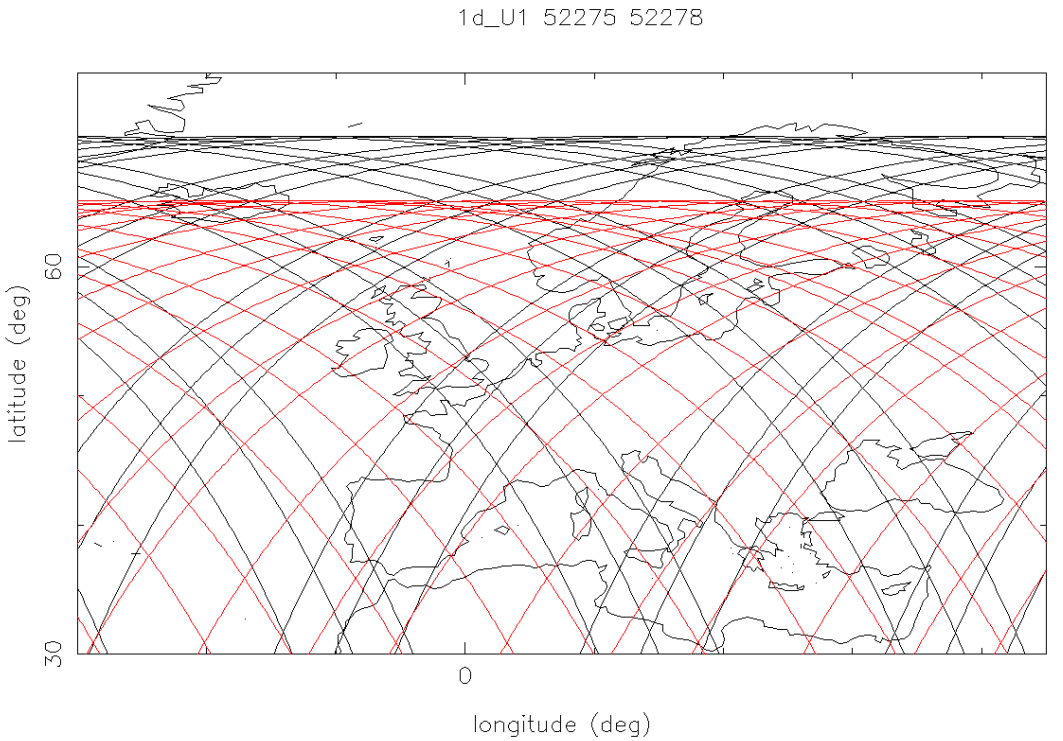
- Single pair: inline, pendulum, dual pair: Bender, other: Marvel …
- (Near-)Repeat and/or coordinated orbits
- Orbital altitudes and inclinations
- Instrument suite and characteristics
- …

Coordinated ground tracks: drifting 3-day near-repeat



Coordinated vs. uncoordinated ground tracks





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Next presentations related to JMCMEG

E2E simulations:

- ESA/NASA science support studies to MAGIC mission

Applications:

- MAGIC mission science and applications related to Cryosphere, Solid Earth and Neutral Atmosphere

- MAGIC mission science and applications related to hydrology, oceanography, and climate change