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PREFACE

Special issue "Swarm science results after 2 years in space"

Nils Olsen[1*], Claudia Stolle[2], Rune Floberghagen[3], Gauthier Hulot[4] and Alexey Kuvshinov[5]

Swarm is a three-satellite constellation mission launched by the European Space Agency (ESA) on 22 November 2013. It consists of three identical spacecraft, two of which (*Swarm Alpha* and *Swarm Charlie*) are flying almost side-by-side in polar orbits at lower altitude (about 470 km in September 2016) with an East-West separation of 1.4° in longitude corresponding to 155 km at the equator. The third satellite (*Swarm Bravo*) is in a slightly higher orbit (about 520 km altitude in September 2016). Each of the three satellites carry a magnetometry package (consisting of absolute scalar magnetometer, fluxgate vector magnetometer, and star imager) for measuring the direction and strength of the magnetic field, and instruments to measure plasma and electric field parameters as well as gravitational acceleration. Time and position are provided by on-board GPS. The configuration of the various instruments on each of the three *Swarm* spacecraft is shown in Fig. 1. More information about the mission can be found at http://earth.esa.int/swarm.

The 21 articles collected in this special issue were stimulated by the Joint Inter-Association Symposium "JA4 Results from Swarm, Ground Based Data and Earlier Satellite Missions" at the 26th General Assembly of the International Union of Geodesy and Geophysics (IUGG) held in Prague in July 2015.

Tøffner-Clausen et al. (2016) report on the advanced calibration of the magnetometry package of the *Swarm* satellites. Finlay et al. (2016) and Olsen et al. (2016) present models of Earth's core magnetic field, while Thébault et al. (2016) and Kotsiaros (2016) determine models of the lithospheric field. The importance of high-resolution magnetic field models for studying external magnetic field contributions, in particular during geomagnetic quiet conditions, is discussed by Stolle et al. (2016).

Five contributions discuss the magnetic field produced by ionospheric and magnetospheric currents: Chulliat et al. (2016) present a climatological model of the ionospheric currents responsible for geomagnetic daily variations at non-polar latitudes, while the work of Laundal et al. (2016) concentrates on a consistent description of horizontal ionospheric and field-aligned currents in the polar ionosphere, in particular regarding their dependence on solar irradiation that controls ionospheric conductivity. A scheme for estimating the polar ionospheric currents that form the Polar Electrojets on an orbit-by-orbit basis is presented by Aakjær et al. (2016), while Tozzi et al. (2016) discuss unmodelled magnetic field contributions in satellite-based magnetic field models. Michelis et al. (2016) present a study of high-latitude magnetic field variations during the St. Patrick's Day Storm.

The same event is investigated by Pignalberi et al. (2016) using *Swarm* plasma density measurements, and by Cherniak and Zakharenkova (2016) using GPS data from ground and *Swarm*.

Calibration of the electric field instrument of *Swarm* is presented by Fiori et al. (2016). A combination of electric, magnetic, and TEC observations has been used by Astafyeva et al. (2016) to investigate the magnetic storm of 22–23 June 2015. Aoyama et al. (2016) combine ground magnetic data and *Swarm* TEC observations to study possible ionospheric effects of the 2015 eruption of a volcano in Chile, Zakharenkova et al. (2016) used GPS and *Swarm* plasma observations to study equatorial plasma density irregularities in the topside ionosphere, and Xiong et al. (2016) performed a scale analysis of equatorial plasma irregularities.

van den IJssel et al. (2016) describe improvements of *Swarm* GPS antenna settings to enhance high-precision positioning of the spacecraft, and da Encarnação et al. (2016) discuss various attempts to determine monthly

*Correspondence: nio@space.dtu.dk
[1] Division of Geomagnetism, DTU Space, Technical University of Denmark, Diplomvej 371, 2800 Kongens Lyngby, Denmark
Full list of author information is available at the end of the article

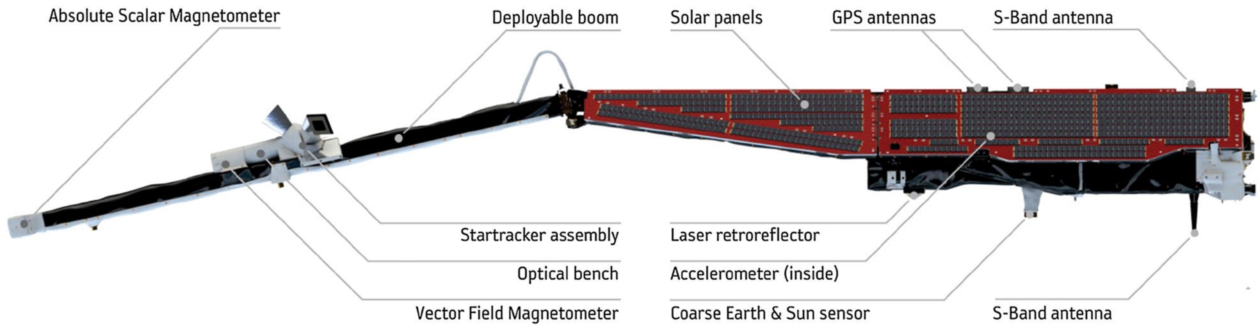

Fig. 1 Various scientific instruments on board each of the three *Swarm* satellites (ESA/AOES Medialab)

snapshot models of the large-scale part of Earth's gravity field from *Swarm* GPS observations.

Finally, the processing of the *Swarm* accelerometer data is described by Siemes et al. (2016).

The work reported in this issue could not have been achieved without the unfailing support of our deeply regretted friend and colleague Gernot Plank (Fig. 2), to which we wish to dedicate this special issue of *Earth Planets Space*. Gernot has been one of the major contributors to the success of the *Swarm* mission. With great enthusiasm he played a considerable role in the establishment of *Swarm SCARF*, the *Swarm* Level-2 data processing facility. *Swarm SCARF* was key to the project and all scientific results presented in the present special issue (as well an in a previous issue, see *Earth Planets Space*, Vol. 65, Issue 11) heavily rely on the success of this facility. Gernot's energy and enthusiastic spirit, from beginning to end of even the most intense meetings, was extremely appreciated. He had a remarkable ability to help solve problems and convince anyone to do the right thing in the interest of the project and science, sometimes even very late in the evening, and always in his unique and particularly cheerful way, whatever the circumstances.

Fig. 2 Gernot Plank (1967–2016)

Gernot passed away in March 2016 after a lengthy, hard, and unfair fight against cancer. He, and his legendary laugh, will be sorrowfully missed by his friends and colleagues.

Authors' contributions

All authors of this article served as guest editors for this special issue. All authors read and approved the final manuscript.

Author details

[1] Division of Geomagnetism, DTU Space, Technical University of Denmark, Diplomvej 371, 2800 Kongens Lyngby, Denmark. [2] Helmholtz-Zentrum Potsdam, Deutsches GeoForschungsZentrum GFZ, 14473 Potsdam, Germany. [3] Directorate of Earth Observation Programmes, ESRIN, Via Galileo Galilei 2, 00044 Frascati, Italy. [4] Equipe de Géomagnétisme, Institut de Physique du Globe de Paris, Sorbonne Paris Cité, Université Paris Diderot, CNRS, 1 rue Jussieu, 75005 Paris, France. [5] Institute of Geophysics, ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland.

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