EUROPA HABITABILITY AND EXTANT LIFE EXPLORATION WITH COMBINED FLYBY-LANDER-ORBITER MISSION. M. Blanc[1], G. Jones[2], O. Prieto-Ballesteros[3], D. Mimoun[4], A. Masters[2], S. Kempf[5], L. Iess[6], Z. Martins[7], R. Lorenz[8], J. Lasue[9], N. Andre[1], B. G. Bills[10], G. Choblet[11], G. Collins[12], G. Cremonese[13], P. Garnier[14], K. Hand[10], P. Hartogh[15], K. K. Khurana[16], K. Stephan[17], F. Tosi[18], S. D. Vance[10], T. van Hoolst[19], F. Westall[20], M. Wolwerk[21], J. F. Cooper[22], E. C. Sittler[22], W. Brinckerhoff[22], T. Hurford[22] and *the Europa Initiative*, [1]L'Institut de Recherche en Astrophysique et Planétologie (IRAP), CNRS/Université Paul Sabatier, 9 avenue du colonel Roche, 31028 Toulouse, France (e-mail: michel.blanc@irap.omp.eu), [2]Mullard Space Sciences Laboratory, University College London, United Kingdom, [3]Center for Astrobiology, INTA-CSIC, Spain, [4]Airbus, Toulouse, France, [5]LASP, University of Colorado at Boulder, Boulder, Colorado, [6]Università di Roma Sapienza, Rome, Italy, [7]Imperial College London, London, United Kingdom, [8]Applied Physics Laboratory Johns Hopkins University, Laurel, Maryland, [9]Observatoire Midi-Pyrenees IRAP, Toulouse, France, [10]Jet Propulsion Laboratory, Pasadena, California, [11]Laboratoire de Planétologie et de Géodynamique, Université de Nantes, France, [12]Wheaton College, Norton, Massachusetts, [13]INAF, Osservatorio Astronomico di Padova, Padova, Italy, [14]Université de Toulouse, Toulouse, France, [15]P. Hartogh, Max Planck Institüt für Solar System Research, Katlenburg-Lindau, Germany, [16]Krishan K. Khurana, University of California at Los Angeles, Los Angeles, California, [17]DLR, Institute of Planetary Research, Berlin, Germany, [18]INAF-IAPS, Rome, Italy, [19]Royal Observatory of Belgium, Brussels, Belgium, [20]CNRS-Centre de Biophysique Moléculaire, Orleans, France, [21]Space Research Institute, Austrian Academy of Sciences, Graz, Austria, [22]NASA Goddard Space Flight Center, Greenbelt, Maryland (e-mail: John.F.Cooper@nasa.gov).

1. Introduction. Complementary to the on-going intensive effort by NASA to design an ambitious Europa Lander mission which will focus on the search for life, we describe the important potential benefits of adding scientific investigations performed in Europan orbit as well as by the NASA flyby mission. This can be done by operating scientific instruments either directly on the carrier/relay platform of the lander mission, or on an additional small orbiter platform which will fly to Jupiter and Europa together with the main spacecraft.

2. Measurements. A combination of gravity, magnetic field and plasma instruments, possibly augmented by an altimeter and/or a neutral and ion mass spectrometer, operating in conjunction with magnetic field and gravity/geodesy experiments on the lander platform, will open the way to an in-depth characterization of Europa as a geophysical object made of a set of coupled layers. These layers include the core, mantle, ocean, ice crust, neutral atmosphere, ionosphere, and local magnetospheric environments. Orbital measurements would be optimized to investigate responses to periodic forcing of the Europa multi-layer system at key time scales, 85 hours for the moon's orbital motion around Jupiter and 11 hours for magnetospheric corotation relative to the moon. The deepest probes of the ocean and the lower layers would require several months of continuous observations in low-altitude orbit. This mission duration is possible due to more favorable radiation environment in moon orbit as compared to elsewhere in Europa's orbit around Jupiter.

3. Flyby-Orbiter-Lander Combined Campaign. Best results for exploration of the habitability of this ocean moon, as combined with the lander's search for life, would come from orbital measurements contemporaneous with the 45 flybys of the Europa Multiple Flyby Mission that would likely launch earlier but on a slower trajectory to Jupiter and Europa. Synchronicity of orbiter and flyby measurements can provide a powerful combination, e.g. changes of state in external magnetospheric environment for each flyby can be correlated to orbiter measurements to extract information on intrinsic response of the moon layers as compared to external forcing. Maximum sensivity to ocean depth and thickness, and to magnetic properties of the core, would come from joint flyby, lander, and orbiter measurements. The intrinsic chemical composition of Europa can be better separated from that due solely from the external interactions, i.e. the thin patina of materials passed to the moon surface through the jovian magnetosphere from Io volcanic emissions. Environmental conditions at the landing site would be best characterized by the combined campaign.

The tantalizing prospect of water plume emissions would also be best addressed by the orbiter-flyby combined observational campaign. *There would be no need to wait two weeks for the next flyby to follow up on a plume emission detection.* Smaller plumes would likely be more frequent and easier to detect with the orbiter, while remote imaging during flybys would provide the more global perspective for large plumes.

4. Conclusions. Europa with its putative modern ocean is potentially promising as a habitat for extant and future life, as Mars may have been for past life. Europa's multi-layered responses to external gravitational, magnetic, and plasma forcing can best be investigated with a combined mission campaign, as the lander searches for signs of life in-situ, and with excellent prospects for international collaboration.