AUTOMATED COVERAGE PLANNING FOR MISSION ANALYSIS AND OPERATIONS: ECOSTRESS, OCO-3, EMIT, AND NISAR. A. Yelamanchili[1] and C. Wells[1] and J. Doubleday[1] and S. Chien[1], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive Pasadena, CA 91109, firstname.lastname@jpl.nasa.gov © California Institute of Technology 2020. All Rights Reserved.

Introduction: Automated coverage planning software has been instrumental in mission analysis (and in some cases operations) for a set of recent and upcoming NASA Earth-observing instruments. These include ECOSTRESS (ECOSystem Thermal Radiometer Experiment on Space Station), OCO-3 (Orbiting Carbon Observatory-3), EMIT (Earth Surface Mineral Dust Source Investigation), and NISAR (NASA-ISRO Synthetic Aperture Radar) missions. In the full paper we discuss in greater detail the use of automated coverage scheduling for these emissions in both mission analysis and operations.

Automated Coverage Planning: Each of the aforementioned missions uses the CLASP (Compressed Large-scale Activity Scheduling and Planning) tool [1]. CLASP is given:

- Science Targets (points and areas), with priorities and viewing constraints
- Spacecraft Orbit
- Spacecraft instrument definitions, such as field of view, slew/pointing model and data rate
- Spacecraft constraints, such as onboard memory and downlink capability
- Ground station locations and downlink models

CLASP seeks to maximize prioritized coverage of the science targets while respecting all given spacecraft constraints.

ECOSTRESS: The ECOSTRESS instrument has been operating from the ISS (International Space Station) since July 2018 [2]. Prior to launch, CLASP was used to understand how to achieve global land coverage beyond the original science targets given visibility and data volume constraints. In operations, CLASP has been used to schedule observations for the instrument. The operations constraints for the instrument have changed significantly in the past two years, such as memory management changes with the loss of the main onboard storage devices, and orbital areas requiring instrument safing due to radiation [3].

OCO-3: The OCO-3 instrument has been operating from the ISS since May 2019 [4]. Since operations began, CLASP has been used for scheduling science observations in four different modes: Nadir over land, Glint over the ocean, Snapshot Area Map for rectangular regions of interest, and Target for points of interest, incorporating science derived observation priorities. A separate automated scheduling tool was developed for scheduling calibration observations for its agile Pointing Mirror Assembly. The field of view of the OCO-3 instrument contains a keepout zone, where the instrument should not point, due to the presence of the ISS solar panels. CLASP models this zone, preventing scheduling of observations that would point the instrument in this region [5].

EMIT: The EMIT mission is slated for launch to the ISS in late 2021. CLASP automated scheduling has been used for mission analysis to study coverage achieved and impact of factors on coverage including: pointing capability, downlink capacity, clouds, and cloud detection/compression [6]. CLASP is baselined for operational scheduling of EMIT.

NISAR: The NISAR mission is scheduled for launch in December 2021 [7]. CLASP has been used to model the baseline mission plan for many years including when it was the Desdyni mission concept [8]. NISAR has numerous science campaigns, involving varying observation modes. These various campaigns compete for the available data volume.

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References: [1] Knight, R. and Chien, S. (2006) *Producing Large Observation Campaigns Using Compressed Problem Representations* in *1WPSS.* [2] ecostress.jpl.nasa.gov. [3] Yelamanchili. A. et al. (2019) *Automated Science Scheduling for the ECOSTRESS Mission* in *IWPSS,* 204-211. [4] oco3.jpl.nasa.gov. [5] Moy. A et. al (2019), *Automated Scheduling for the OCO-3 Mission* in *IWPSS,* 195-203 [6] Thompson, D. O. et al. (2014) *Rapid Spectral Cloud Screening Onboard Aircraft and Spacecraft* in *IEEE Transaction on Geoscience and Remote Sensing*, *52*, 6779-6792. [7] nisar.jpl.nasa.gov. [8] Doubleday, J. R. (2016) *Three Petabytes or Bust: Planning Science Observations for NISAR* In *SPIE, 9881*.