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National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
CENTER FOR SATELLITE APPLICATIONS AND RESEARCH
College Park, MD 20740

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MEMORANDUM FOR: Pamela Sullivan, GEO-XO Lead

FROM: Sid Boukabara Ph.D, SAT chair
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SUBJECT: Initial **Results of the ASPEN-Based Assessment of the 22 GEO-XO Constellations**

Background:

The Advanced Systems Performance Evaluation tool for NESDIS (ASPEN) is a tool that was developed, as part of the Systems performance Assessment team (SAT), to dynamically assess the value brought by various proposed sensors and constellations candidates to individual applications, to categories of applications and to the overall mission of NOAA. ASPEN provides relative comparisons of benefits and benefit-to-cost ratios of sensors and constellations of sensors. The basic principle of ASPEN is to measure the ability of sensors and constellations to satisfy the applications requirements, as defined by direct users, forecasters and application models developers. These are also weighted by the relative importance put on the sensors capabilities. Therefore, ASPEN is designed to support the effort to optimize the future space architecture as well as the process of commercial environmental data buys, and data sharing partnerships. What is important to note is that ASPEN assesses the value's changes due to specific variations in sensors/constellations capabilities, due to specific sensors and constellations characteristics. In other words, using ASPEN can allow the assessment of differences in spatial resolution, temporal refresh, accuracy, vertical resolution, spatial coverage, etc in terms of their degree of satisfaction of the applications requirements.

Purpose of this Memo:

The 22 constellations being considered by GEO-XO have been included in the ASPEN tool. In this memo we summarize the assessment of these constellations based on ASPEN outputs. We also recommend the most beneficial constellations among those 22, based on the assessment made using ASPEN. The 22 constellations are summarized in the appendix of this memo for reference. Finally, the memo lists a number of considerations to keep in mind when accounting for this recommendation.

Methodology Description:

The Applications specific benefits and values are first computed. These depend on applications' specific inputs of requirements ranges and technical priorities. These applications-dependent benefits are then grouped by application type, into Category-dependent sensor/constellation-based benefit (CSCB). We have four categories within ASPEN: meteorology, oceanography (including fisheries), land (including hydrology and ecology), and space weather. Note that space weather was not used in this assessment since the observing systems for this category were de-scoped for GEO-XO. Finally, these categories are grouped and weighted using strategic priorities (given to each category, to represent how much GEO-XO choices should be driven by these categories) in order to compute the overall NOAA mission benefit (MSCB). Note that the strategic priorities in this initial assessment were all set to 1 (equal importance), for both in-category priorities of applications, and for the categories strategic priorities. Finally, the cost estimates (provided by GEO-XO) of these constellations are used to compute the benefit-to-cost ratios corresponding to these constellations. Note that only 13 constellations were costed out by GEO-XO, so an important caveat of these values assessment is that for 9 of these constellations, we initially adopted the average cost (of the 13 constellations that were actually costed out) as a base cost for these 9 non-costed constellations. In this assessment, we obtained cost estimates for constellations 1,3,6,7,8,9,11,14,16,17,20,21 and 22.

Constellations Assessment Results

The Mission sensor/constellation-based benefit gives an overall benefit for the entire suite of applications within ASPEN. Figures 1 and 2 show the MSCB for constellations 1-22. In this analysis, constellations 3-11, 13-17, and 19-21 show the most benefit (Figure 1). Among those 22, Constellation#17 presents the biggest benefit, although by a small margin. When accounting for costs of these constellations, the overall value of these constellations is presented in Figure 2. In this value-based assessment, constellations 1, 3, 8, and 20 show the best value to NOAA. Besides constellation 1, constellation #8 seems to present the best value among these 22 GEO-XO constellations.

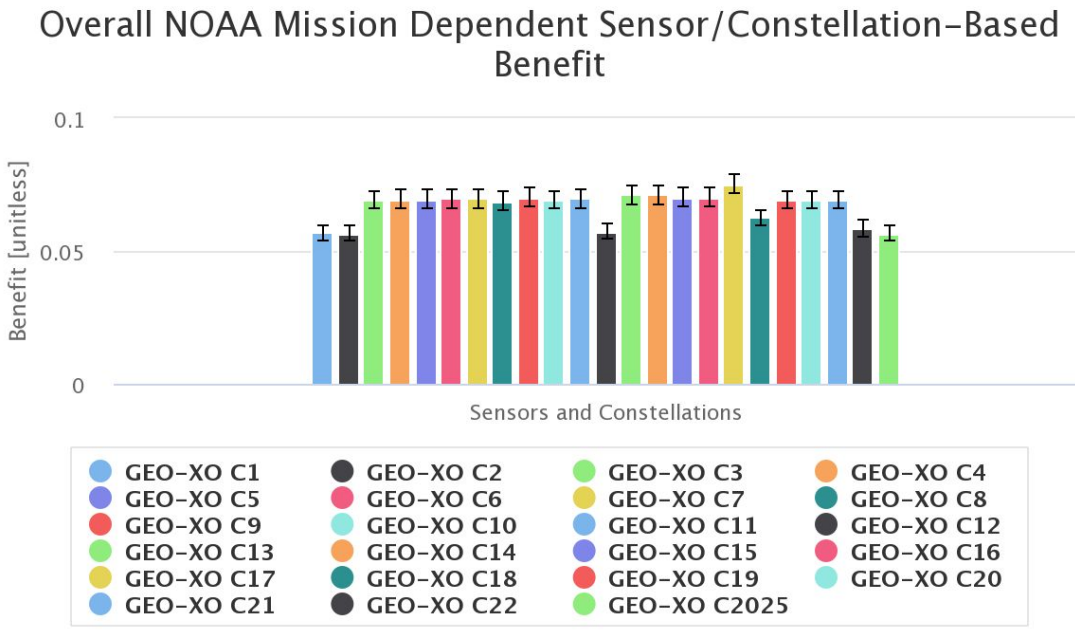

Figure 1. MSCB Benefit for GEO-XO Constellations 1-22.

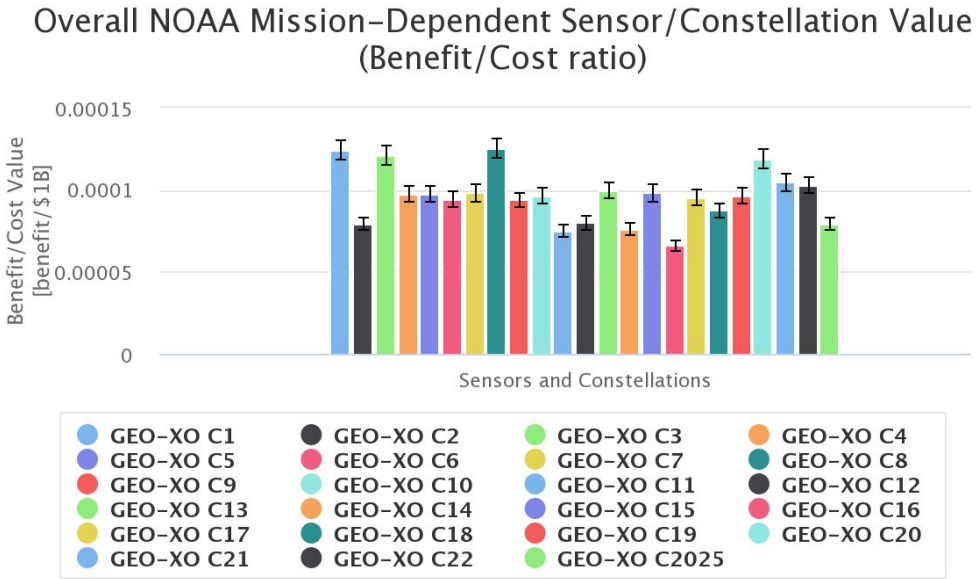

Figure 2. MSCB/Value for GEO-XO Constellations 1-22. Constellations 1, 3, 8 and 20 stand out as the best value constellations. Note that the uncertainty bars are not fully implemented and are artificial in this display.

Quality Control of the Results:

Quality control of ASPEN's results was undertaken collectively by the ASPEN team, with a particular emphasis on assessing how the benefits of the 22 constellations react for the different applications which was undertaken by MIT/LL (Monica Coakley). This has shown that the benefits of the 22 constellations are consistent with expectations. The results are found to be consistent with the results presented at the July 27th 2020 briefing (where a subset of constellations performances were available for ASPEN analysis).

Caveats to Keep in Mind:

A number of items need to be kept in mind when interpreting these results: (1) not all applications were available for ASPEN analysis when this assessment was finalized. TPIO is continuously developing and improving the applications requirements values/ranges. (2) The inputs to ASPEN, both applications requirements and technical priorities (ARR/ATP) and sensor/constellation performance SCP tables, have been generated internally in the ASPEN team. Although the sources of these tables include SMEs and the COURL database, these inputs have not been vetted by users. A more rigorous vetting of both applications and performances inputs should be considered, to increase confidence in ASPEN results. (3) The effort of QC'ing ASPEN was done at a high level. A larger effort to QC and calibrate/validate results will be the focus on upcoming work. Future effort will include adding the supplied uncertainties into the ASPEN display to address significance of the ASPEN results. (4) Finally, having additional applications to assess with (expected soon), might result in a change of the results of this assessment.

Conclusion – Recommendation:

Based on the results above, and with the caveats listed above, we recommend the selection of GEO-XO constellation #8 given its highest value (benefit-to-cost ratio) to the NOAA overall mission, followed closely by constellations 1, 3 and 20.

CC: Ross Hoffman, Stacy Bunin, Monica Coakley, Lou Cantrell, Dave Helms, Roberto Monotoro, Maurice McHugh

Appendix 1: Description of the 22 GEO-XO constellation