DE-SC0008507 - Final Report: Geoffrey Bland - NASA/GSFC (610.W/WFF)

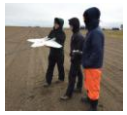
Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems
(ERASMUS/de Boer, et al)

The use of small unmanned aircraft systems (sUAS) with miniature sensor systems for atmospheric research is an important capability to develop. The *Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems (ERASMUS)* project, lead by Dr. Gijs de Boer of the *Cooperative Institute for Research in Environmental Sciences* (*CIRES*- a partnership of NOAA and CU-Boulder), is a significant milestone in realizing this new potential. This project has clearly demonstrated that the concept of sUAS utilization is valid, and miniature instrumentation can be used to further our understanding of the atmospheric boundary layer in the arctic.

The Period of Performance for *ERASMUS* participation by NASA/GSFC (G. Bland/610.W) was August 2014 through February 2016. Activities included attendance in regular team meetings (by teleconference), with a specific focus on review and advising on aircraft systems development (batteries, propellers, etc.), instrument integration (locations, mechanical and electrical systems), and flight preparations (proficiency and test flights). As a result of this participation, a number of observations are noted.

The PI and instrumented platform support team addressed the many technical and operational challenges well. It is clear that Dr. de Bois is focused on maximizing unique science return under significant schedule and environmental constraints. The results clearly indicate a benefit of this approach, yet there likely remains additional work to fully realize a routine measurement capability using sUAS.

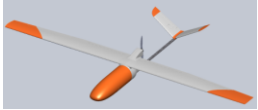
The operations area at Oliktok Point was an important science target that offered accessible airspace. The Restricted Airspace R2204 was an important enabler, while the natural environment for personnel conducting these operations was challenging by contrast. The deployed team was well prepared and it is noted that future operations will benefit from appropriate schedule and personnel resources to accommodate the weather and travel considerations. Overall, Oliktok Point and the associated airspace demonstrated to be a valuable venue for developing boundary layer and cloud measurement capabilities.



The use of two types of instrumented aircraft, namely the larger *Pilatus*, and the smaller *Datahawk*, was an important element. The relatively complex *Pilatus* offered an extensive instrumentation platform, while the *Datahawk* provide a quick-response capability with relatively lower risks. This team is leading the use of new unmanned aircraft technologies, and future activities may benefit from further development.

Continued development of a tailored portfolio of platforms will likely be a valuable investment. Arctic conditions are harsh with challenging temperatures, icing potential, and winds. It is likely that the *ERASMUS* team is well suited for addressing these challenges, as their focus on scientific return combined with instrumentation, aircraft systems, and operational experience represents a productive combination.

Leveraging NASA Small Business Innovation Research investments such as the development of a novel sUAS designed for soil moisture mapping, might be beneficial for future deployments (Black Swift Technologies - http://blackswifttech.com/pages/products/soil_moisture/). Derivations of the *SuperSwift* may be suitable for widespread use for the *Datahawk* mission, and perhaps form the basis of a larger aircraft suitable for straight-forward integration of the suite of instruments flown on the *Pilatus* missions.



The opportunity to work with this team was exciting and very informative. *ERASMUS* clearly has raised the bar for research use of sUAS, and it appears that DOE has the vision and willingness to support pioneering efforts such as this. As result of this work, please see:

de Boer, G., S. Palo, B. Argrow, G. LoDolce, J. Mack, R.-S. Gao, H. Telg, C. Trussel, J. Fromm, C.N. Long, G. Bland, J. Maslanik, B. Schmid, and T. Hock: ***The Pilatus Unmanned Aircraft System for Lower Atmospheric Research***, Atmos. Meas. Tech. Discuss., 8, 11987-12023, doi: 10.5194/amtd-8-11987-2015.

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