Continuity of Cloud Top Pressure and Cloud Infrared Thermodynamic Phase by Combining CrIS and VIIRS Measurements

FINAL REPORT
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Introduction

This report summarizes results for the final period May 2017 – June 2018 and comprises the final summary for this grant. The premise of this work is to construct a critical 13.3-μm channel at VIIRS 750-m resolution from global merged VIIRS+CrIS data. For continuity of cloud height and cloud phase, we need more information than what is available from VIIRS alone, specifically measurements within the broad 15-μm CO_2 band (e.g., Heidinger et al. 2010). These measurements began in 1978 with HIRS (High resolution Infrared Radiometer Sounder) on the NOAA polar-orbiting platforms, and continued with Terra/Aqua MODIS, Aqua AIRS (Atmospheric IR Sounder), and the HIRS/IASI (Infrared Atmospheric Sounding Interferometer) sensors on the Metop polar-orbiting platforms. We adopted a computer science approach to construct a 13.3- μm channel from VIIRS and CrIS. Moreover, our approach was shown to be able to construct the other MODIS infrared (IR) absorption channels that are not on VIIRS. Our approach will also be applicable to future JPSS platforms that contain both an imager and an IR sounder.

In addition, Dr. Baum serves as the S-NPP Atmosphere Discipline Lead and was active in organizing the team's activities.

Third (and Extended) Year Milestones

The following tasks were completed:

1. The software to fuse (or merge) VIIRS and CrIS data forms the basis for our proposed effort. As noted in earlier reports, we lost our long-time software person but were able to integrate another scientist (Dr. Elisabeth Weisz, SSEC) who completely redeveloped our data fusion software. Furthermore, this software was tested thoroughly on global data and further modified to work with the recently re-formatted 6-minute VIIRS and CrIS Level 1B data. The software is written in a combination of Matlab and Python and the output is in NetCDF4. This process provides an option to restore the VIIRS deleted pixels in the bowtie region by using a nearest-neighbor approach, which is necessary for algorithms that work on pixel arrays (missing pixel values break the array tests).
2. Based on our imager-sounder (VIIRS+CrIS) fusion software, we constructed a high spatial resolution (750m) VIIRS channel at 13.3 μm using the MODIS 13.3-μm response function. We tested this approach on MODIS+AIRS, by constructing a 13.3-μm channel and then comparing to the actual measurements. We found the constructed radiances, within the AIRS swath, to be within 0.5% of the measured radiances.
3. An important research breakthrough of our effort was that we learned that the same fusion approach could also be used to construct the other MODIS IR absorption channels for VIIRS. That is, we can now construct channels for VIIRS at 750 m spatial resolution that are similar to MODIS channels 23, 24, 25 (shortwave CO_2), 27 and 28 (water vapor), 30 (ozone), and 33-36 (longwave CO_2). The software for generating these additional channels has been integrated at the Atmosphere SIPS. In forward stream processing at the SIPS, VIIRS Level 1b granules are now being generated that have the same IR absorption channels as MODIS. This work is summarized in a paper led by Elisabeth Weisz (see references below) that was published in 2017.
4. We worked with Dr. Andrew Heidinger (NOAA/NESDIS/STAR) to integrate the 13.3-μm fusion channel into a cloud processing package called ACHA, which is a 2nd generation acronym for the AWG Cloud Height Algorithm; AWG refers to the Algorithm Working Group established by NOAA for the GOES-R Advanced Baseline Imager (ABI). The ACHA is an existing, well-tested operational package for inferring cloud heights using an optimal estimation (OE) method. ACHA provides a mechanism to process global data efficiently as it is an operational package.
5. We derived global cloud top heights using the ACHA software from VIIRS alone, using the 11 and 12-μm channels, and from VIIRS+CrIS using the 11, 12, and 13.3-μm channels. Our primary focus at this time is to better understand how best to bring the OE-based cloud top heights into better harmony with those from MODIS. The physical retrieval approach used for MODIS Collection 6 is very different from an OE approach, and even with our VIIRS+CrIS data fusion approach, there is much less information content to work with than is available for

MODIS. One approach under serious discussion is to process the MODIS data stream using the same OE approach to derive a "continuity" product that is distinct from the official Collection 6 product.

6. Bryan Baum served as Atmosphere Discipline Lead. In this final report, it should be noted that our team was not the only one that lost a critical software person over the course of the past few years. What this demonstrates is that there is an increasing demand for competent software people, and this leaves the various PIs at risk: for Atmosphere continuity products, a PI team must navigate software through two different data processing systems, MODAPS (MODIS Adaptive Processing System) and the Atmosphere SIPS. Heritage MODIS processing software goes through one system and Suomi-NPP data goes through the other. Each system has different management as they are at different institutions, different coding requirements, and actually quite different ways of doing just about everything. Loss of the person who knows how to navigate one or both of these systems means if and when a suitable replacement can be found, the learning curve is long. ***The suggestion is to consider simplifying this process, by thinking more about how to make the two data systems more uniform in their methodology.***

Relevant References

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