Validation and Analysis of Middle and High-Latitude Ocean Precipitation for AMSR-E

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Final Report
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Overview

This report concisely summarizes the work that was undertaken under a three-year grant. We requested and received an automatic one-year no-cost; hence, this final report covers a four-year period.

The grant covered the following research objectives relevant to the objective, quantitative validation of ocean precipitation products in the higher latitudes:

1. Carefully evaluate and document the suitability of a number of existing middle and high latitude island weather stations for use in the quantitative validation of precipitation amounts over the surrounding ocean areas.
2. Demonstrate the utility of surface ship synoptic reports for directly validating the skill of algorithms at delineating instantaneous surface precipitation of various types and intensities over the vast regions not currently covered by radar.
3. AMSR-E precipitation algorithm validation, improvement, and integration into operational data streams.

Objective 1: High Latitude Island Stations

Student Sarah Davis was the primary researcher working on these tasks. She completed her M.S. thesis in February 2010. The main objective of the no-cost extension was to extend her model simulations of orographic precipitation over Jan Mayen Island so as to improve the statistical robustness of the empirical correction of precipitation gauge measurements for validation of satellite-derived precipitation over the surrounding ocean. While these mesoscale model simulations covering a large part of a calendar year in model time have been running for most of the 4th year, they are not quite completed and will continue under our new grant. The final analysis will be undertaken by Senior Research Specialist Dierk Polzin.

Specific subtasks included

1. **Creation of a comprehensive tabulation of candidate island sites.** We identified 16 small islands having WMO stations that routinely report monthly rainfall amounts. An overview of the physical features of these islands and preliminary comparisons with satellite retrievals have been documented on the PI's Wiki (currently being ported to a new software system and reformatted). Many of these islands remain strong candidates for ocean validation of precipitation amounts, but our in-depth analysis for this grant ended up focusing entirely on Jan Mayen Island owing to its especially favorable location in the far North Atlantic.
   Here is a tabulation of the 16 stations that remain candidates for future evaluation.

WMO ID	Name	Latitude Longitude
93987	Chatham Isl.	-43.95 -176.57
85585	Isla San Juan Fernandez	-33.62 -78.82
88889	Mount Pleasant Airport, Falkland Islands	-51.82 -58.45
68906	Gough Isl.	-40.35 -9.88

WMO ID	Name	Latitude Longitude
68994	Marion Isl.	-46.88 37.87
61998	Port-aux-France	-49.35 70.25
94998	Macquarie Isl.	-54.48 158.93
94995	Lord Howe Isl.	-31.53 159.07
70308	St. Paul Isl.	57.17 -170.22
70316	Cold Bay, AK	55.20 -162.72
08506	Horta (Azores)	38.52 -28.63
08515	Santa Maria (Azores)	36.97 -25.17
08513	Ponta Delgada (Azores)	37.75 -25.67
06011	Thorshavn, Faroe Isl.	62.02 -6.77
01001	**Jan Mayen**	**70.93 -8.67**
32618	Nikol'skoe	55.21 65.98

2. **Acquisition of detailed topographic data.** This surprisingly non-trivial task was completed for Jan Mayen Island, our top-priority validation site. It was necessary to track down a high quality topographic map for this seldom-visited island, manually digitize it, and interpolate it to a high-resolution grid for use in numerical simulations.
3. **Interviews with station personnel**. We established email communication with meteorological personnel at Jan Mayen Island for the purpose of documenting rain gauge type and measurement procedures. They were kind enough to supply us with relevant technical documents. The essential information is summarized by Davis (2010).
4. **Comparison of station weather statistics with those from nearby ships.** This task assumed lower priority over the course of the project and was not completed.
5. **Analysis of prevailing wind patterns and other variables in connection with precipitation events**. This task has been completed and is described by Davis (2010).
6. **Numerical model simulations of precipitation over Jan Mayen Island**. We are undertaking extended simulations, at 0.5 km resolution, of precipitation events over Jan Mayen Island using the WRF model. The first stage of this work was completed and written up by Davis (2010). We extended this work to generate more robust statistics that can be used to correct for orographic biases under various conditions. The model runs are nearing completion but will require a month or two more before they can be analyzed and published in final form.

Objective 2: Surface Ship Reports as Validation

While this was initially one of the objectives of our grant, we were unable to allocate researcher time to pursue this objective in light of other research directions that emerged.

Objective 3: Algorithm Integration

During the final year of the project, our ocean precipitation algorithm was successfully ported to the data processing system utilized by Remote Sensing Systems, Inc. (RSS) to produce routine analysis products from passive microwave data, including AMSR-E. RSS scientist Kyle Hilburn has been collaborating with us to evaluate the algorithm on their system. When completed, RSS has indicated their intent to make our retrievals publicly available for long time periods for use in both applications and validation studies.

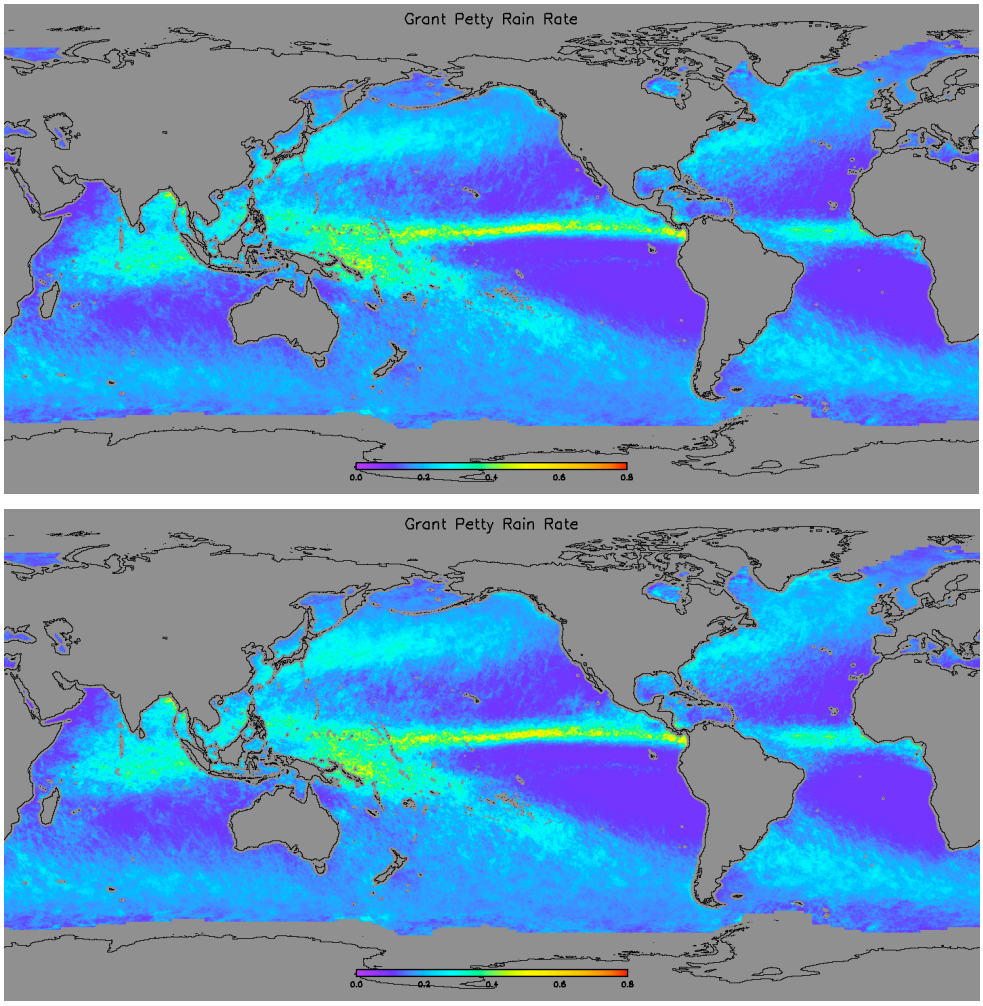

Figure 1. Average rain rate maps from the RSS (top) and UW-Madison (bottom) rain algorithms for the first year of AMSR-E data.

Figure 1 shows initial results comparing the RSS Version-7 rain rates against rain rates from our own algorithm. Overall, the RSS rain rates tend to be higher. We are continuing to collaborate with Dr. Hilburn and RSS in examining the reasons for the differences and in calibrating our own algorithm to yield the best possible product, especially over the high-latitude oceans, where other operational algorithms have historically performed poorly.

Additional Research Activities

Ph.D. student Longtao Wu used AMSR-E retrievals of high-latitude precipitation to validate microphysics schemes utilized in the WRF mesoscale model as applied to polar lows. A paper based on this work (Wu and Petty 2010) has been published in *Monthly Weather Review*. Longtao successfully defended his PhD dissertation in December 2009, and a second paper based on his research (Wu et al. 2010) has been published in *Tellus*.

New work outlined in the 2nd and 3d year progress reports included a novel attack on the problem of optimally estimating precipitation over land and coastal areas. This work is now being supported by a new grant through the Precipitation Measurement Mission (PMM) program.

Publications Relevant to this Grant

Wu, L., and G.W. Petty, 2010: "Intercomparison of Bulk Microphysics Schemes in Model Simulations of Polar Lows." *Monthly Weather Review*, 138, 2211-2228

Wu, L., J.E. Martin, and G.W. Petty, 2010: Piecewise potential vorticity diagnosis of the development of a polar low over the Sea of Japan. *Tellus,* **63A**, 198-211. DOI: 10.1111/j.1600-0870.2011.00511.x

Davis, S., 2010: *Model-based Assessment of Orographic Bias in Surface Precipitation Measurements on Jan Mayen Island.* M.S. Thesis, University of Wisconsin-Madison

Petty, G. and S. Davis, 2012: Assessment of Jan Mayen Island as a validation site for satellite-derived ocean precipitation at high latitudes. Manuscript in preparation for *J. Appl. Meteor.*