Use of DISCOVER Microwave Ocean Products in Climate Studies

www.discover-earth.org

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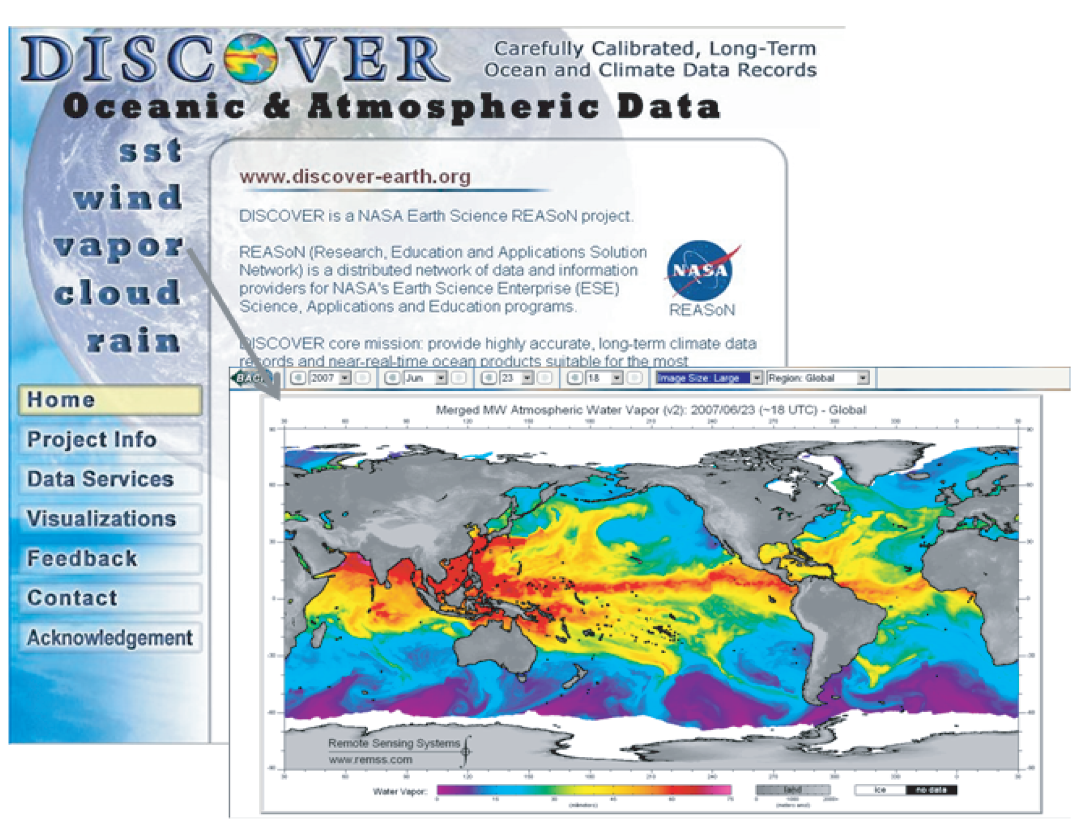
What is DISCOVER?

Distributed Information Services for Climate and Ocean Products and Visualizations for Earth Research

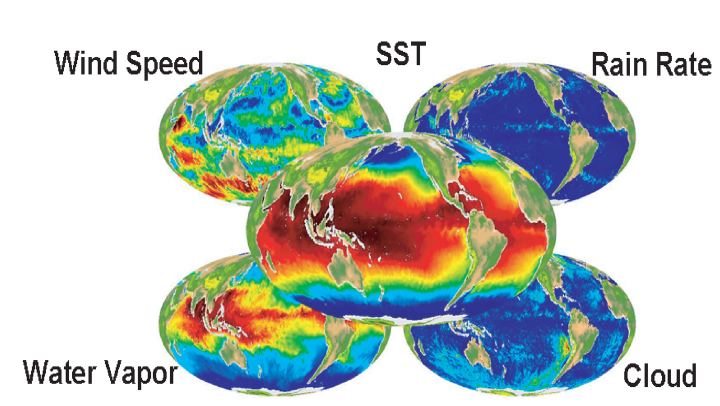
We provide multi-sensor, multi-platform highly accurate, long-term satellite microwave data products suitable for Earth research applications via easy-to-use display and data access tools.

We are funded by the NASA REASoN Project and are a Federation Type-II ESIP member. Our funding will continue under the NASA MEaSUREs Project. We are a collaboration between:

- Remote Sensing Systems — Remote Sensing Systems www.remss.com
- Global Hydrology Resource Center
- ITSC at the University of Alabama in Huntsville
- NASA Marshall Space Flight Center



The above figure shows the DISCOVER web site with access to microwave optimum interpolated SSTs, Merged Water Vapor, and other satellite products, links to the GHRC Data Pool, and more information on the project. An example of a merged water vapor map for June 23, 2007 is shown.



The geophysical products obtained from passive microwave observations of the earth's surface include sea surface temperatures, water vapor, ocean surface wind speeds, cloud liquid water and rain rates. We provide these data for each instrument in operation since 1987 when the first SSM/I was launched on the DMSP F8 satellite. The data are released as ascending and descending swaths gridded on a 0.25 deg grid, 3-day, weekly and monthly averages.

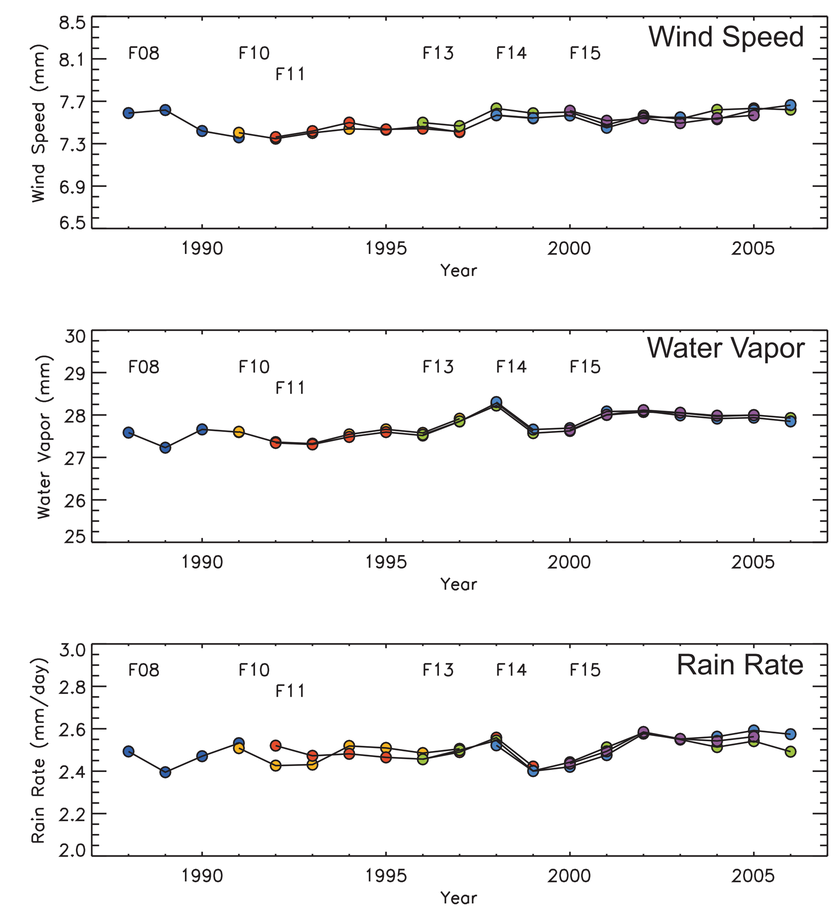
DISCOVER data also include the merging of data from the multiple sensors/platforms into geophysical data sets consistent in both time and space. The DISCOVER merged geophysical ocean products include:

- Daily Optimum Interpolated Sea Surface Temperatures
- 4x-Daily Water Vapor and Wind Speeds
- Daily Rain Rates
- 2x-Daily Cloud Totals

Data Redistributors

These data are used to produce value-added products by other scientists. For example:

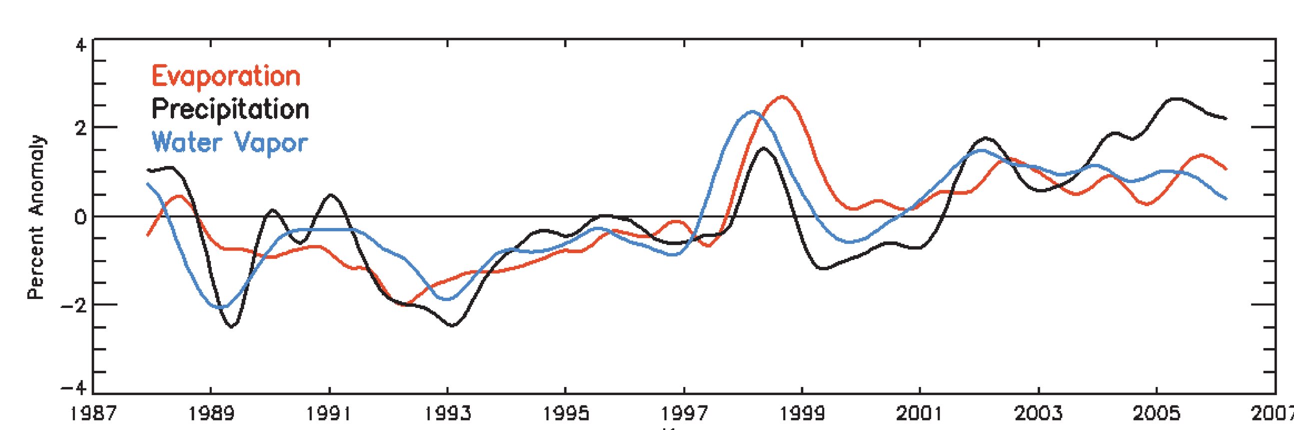
1. Cross-Calibrated, Multi-Platform Ocean Surface Winds produced by Ardizzone/Atlas at NASA Goddard and available from JPL PODAAC. This product uses DISCOVER wind speeds in a 4-D variation analysis model to produce ocean surface wind vectors on a 0.25 degree grid.
2. Blended Sea Winds produced by Zhang at NOAA NCDC (see Zhang et al, 2006) This method uses optimum interpolation to combine DISCOVER winds and produce a 0.25 degree/ 6-hourly product.
3. Cloud Climatology produced by O'Dell at University of Wisconsin (see O'Dell, 2008). This 1-degree diurnally corrected cloud climatology



What is needed to Make a Climate Product?

- Careful intercalibration of brightness temperatures
- Uniform algorithms and consistency in processing
- Full data set reprocessing to incorporate important changes
- Checks of global consistency over time

DISCOVER microwave radiometer data are carefully inter-calibrated by RSS at the brightness temperature level to a precision of 0.1 K. This process removes small intersatellite offsets and instrumental drifts. The agreement over time between the different SSM/I satellites is shown above. Reprocessing in late 2006 resulted in a data set best suited for climate study. The geophysical products from the SSM/I, TMI, and AMSR-E instruments are now consistent among all variables and instrument platforms. To create the time series in the plot above, time-of-day effects for each satellite were removed. To do this, TMI data were used to quantify the diurnal cycle of rain and calculated diurnal offsets for each SSM/I instrument based on individual equatorial crossing times. The diurnal corrections applied are available from support@remss.com. For more information on algorithm improvements, see Wentz,2007 and Hilburn, 2008.

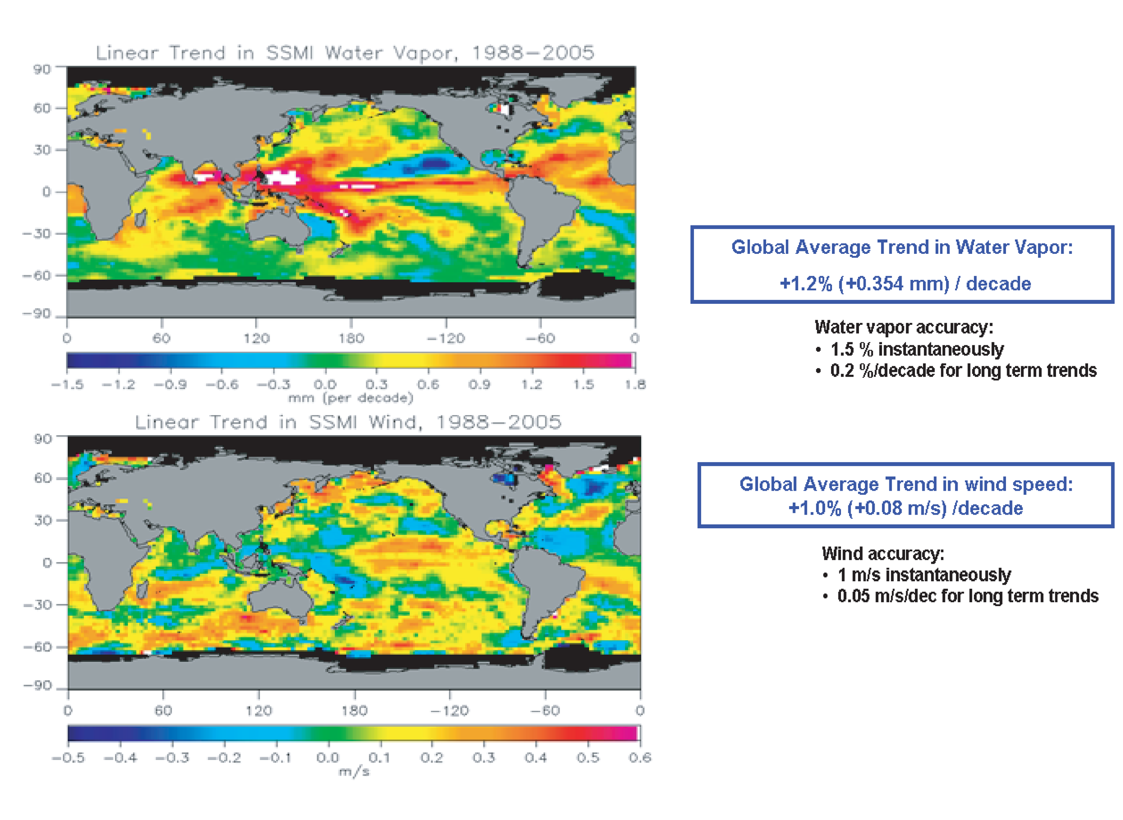


- Global evaporation balances global precipitation (with a static, latitude-dependent adjustment to rain)
- Average evaporation: 962 mm/yr
- Average precipitation: 951 mm/yr
- Imbalance on the order of 1%

- Trends in evaporation and precipitation have the same magnitude as trends in water vapor, in contrast with climate models
- Evaporation Trend: +1.3%/decade
- Precipitation Trend: +1.5%/decade
- Water Vapor Trend: +1.4%/decade

Use of DISCOVER Data in Climate Studies

DISCOVER data products have contributed to instrument validations, field campaigns, synoptic scale studies and global climate analyses. Since 2006 when the data were reprocessed, the data have contributed to a better understanding of climate. For example, the Wentz et al 2007 study showed agreement between SSM/I derived evaporation, precipitation and water vapor trends (see figure above). These results are in contrast to those from climate models.

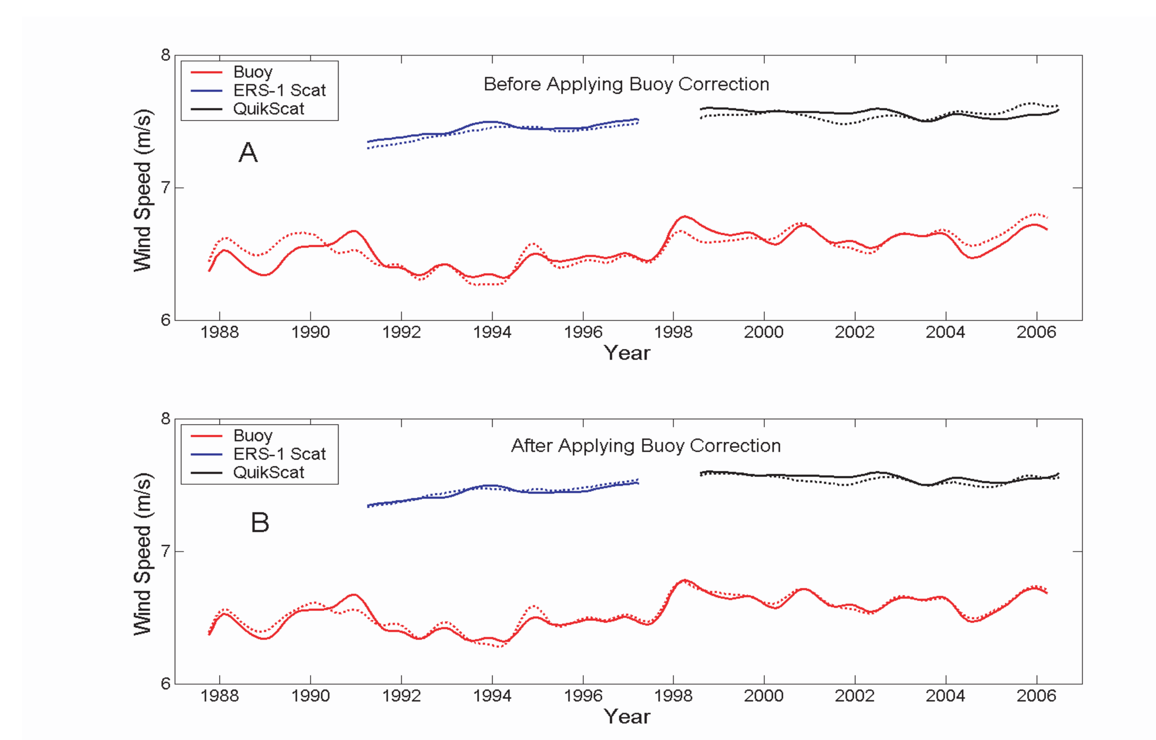


Validation of DISCOVER Data Products

Errors for DISCOVER geophysical products are on the order of:

SST 0.5 deg C
Wind Speed 1.0 m/s
Water Vapor 1.0 mm
Rain Rate 3%

Version-6 SSM/I winds have been validated against buoy, satellite and watehr model winds. Special care has been taken to remove unique buoy biases that result from buoy location with respect to ocean currents, upwelling areas, atmopsheric stability and wind fetch. Essentially no bias was found and standard deviations were 1.21 m/s (NDBC coastal buoys) and 0.85 m/s (TAO and PIRATA tropical buoys). The plot below shows the good agreement between buoys, ERS-1, QuikScat and collocated SSM/I winds. Monthly average anomalies had seasonal variability removed and were low pass filtered using a 4-month window. Small empirical adjustments were applied to the SSM/I winds to bring them in line with the buoy winds. These yearly corrections are 0.1 m/s or less and result in better agreement of SSM/I with scatterometer winds as well.



How Should You Use These Data in Climate Studies?

To perform climate analysis with the radiometer and scatterometer data provided by DISCOVER, follow these guidelines:

- **Begin with daily data** - monthly data currently have some rain and thre is no threshold for the number of counts per cell.
- **Area rain flag the data** - the instrument footprint is larger than the 0.25 deg cell and therefore can be affected by nearby rain.
- **Extend land and ice buffers** - instrument side lobes and reduced sampling along boundaries result in poorer quality data at land and ice edges. For best quality, omit cells next to land and ice.
- **Do not use F15 SSM/I data past August 2006** - A radcal beacon was turned on August 2006 that produces a 10K mean brightness temperature offset for the 22GHz SSM/I observations. We have implemented a correction that works well for wind and vapor, but is too poor for cloud and rain to use in climate work.
- **Apply adjustments to rain** - description provided in Hilburn, 2008
- **Apply adjustments to wind** - see Wentz, 2007 SOM and above validation plot.

References

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