

Patents and Cooperative Research and Development Agreements (CRADAs) with industry (1i)

NSSL's Involvement with Industry

Patents in Place

Simultaneous differential polarimetric measurements and co-polar correlation coefficient measurement, *U.S. Patent #5,500,646, 1995, (Zrnice, D.)*. Licensing agreements in place include:

- Enterprise Electronics Corporation (EEC)
- SIGMET
- RADTEC

Signal processing and systematic phase coding for mitigating of range and velocity ambiguities in Doppler weather radars, *U.S. Patent No. 6,081,221, 2000, (Zrnice, D. and Sachidananda, M.)*.

Recoverable airborne instrument platform, *U.S. Patent No. 6,144,899, 2000, (Babb, M., Douglas, M., Egle, D., and Howard, K.) UCAR*.

Efficient estimation of spectral moments and the polarimetric variables on weather radars, sonars, lidars, sodars, and similar active remote sensing instruments, *U.S. Patent No. 6,448,923, 2002, (Zrnice, D. and Torres, S.)*.

Patents under Review

A real time, multi-sensor local-area lightning detection system based upon a method and system for determining information about cloud-to-ground lightning strikes, filed by U.S. Navy (*Case No. 98,570*), *U.S. patent #, International patent #, 2008, (Mazur, V., Ruhnke, L., and Karabin)*.

Software Disclosures in Partnership with the University of Oklahoma

Several software copyrights have been disclosed through the University of Oklahoma Office of Technology Development (OU/OTD). Intellectual property jointly developed by NSSL staff and Joint Institute partners are managed by the OU/OTD and royalties generated by license fees are distributed to CIMMS for project development needs.

1. The Warning Decision Support System – Integrated Information (WDSS-II) is the second generation of a suite of weather applications and tools for weather analysis and prediction. WDSS-II includes the a) infrastructure to develop, test, and deploy

collaborating weather applications on networked, distributed systems; b) tools to ingest data from a variety of weather sensors such as weather radars, satellites, surface observations, lightning mapping arrays, numerical models (such as RUC2), algorithms and systems of weather analysis algorithms such as the ORPG; c) a suite of weather detection, diagnosis and prediction algorithms for many weather phenomena including hail, mesocyclones, tornadoes, precipitation; d) a suite of tools used by such algorithms including tools for accumulation, tracking, clustering, fusing, filtering, quality-control; and e) the 4D display of ingested data and the intermediate and final products of the weather algorithms organized to help both the researcher and the forecaster. The WDSS-II software was disclosed in several parts as shown below:

OU Disclosure No. 04NOR047C entitled "The Warning Decision Support System – Integrated Information (WDSS-II) Display" authored by Thomas Vaughan, Robert Toomey, V. Lakshmanan, Kurt Hondl, Jeff Brogden, Charles Kerr, Lulin Song, Travis Smith, Gregory Stumpf, and Kevin Scharfenberg; and

OU Disclosure No. 04NOR048C entitled "The Warning Decision Support System – Integrated Information (WDSS-II) Infrastructure", which provides the tools to ingest data from a variety of weather sensors, authored by Kurt Hondl, V. Lakshmanan, Travis Smith, and Gregory Stumpf; and

OU Disclosure No. 05NOR007C entitled "The Warning Decision Support System – Integrated Information (WDSS-II) Multi-Radar Algorithms" authored by Kurt Hondl, V. Lakshmanan, Travis Smith, Gregory Stumpf, Jian Zhang, and Robert Rabin; and

OU Disclosure No. 05NOR008C entitled "The Warning Decision Support System – Integrated Information (WDSS-II) Single-Radar Algorithms" authored by Kurt Hondl, V. Lakshmanan, Travis Smith, Gregory Stumpf, and Kim Elmore; and

OU Disclosure No. 05NOR009C entitled "The Warning Decision Support System – Integrated Information (WDSS-II) Multi-Sensor Inputs to Algorithms" authored by Kurt Hondl, V. Lakshmanan, Travis Smith, and Gregory Stumpf.

2. The National Radar Mosaic and Quantitative Precipitation Estimation Using Multiple Sensors (QPESUMS) software is a suite of algorithms/processes to obtain a CONUS product of reliable precipitation estimates. The technique integrates the radar data with other observational datasets (satellite, rain gage)

OU Disclosure No. ##### entitled "QPESUMS"

OU Disclosure No. ##### entitled "National Mosaic"

License Agreements in Partnership with the University of Oklahoma

The OU/OTD has negotiated several licenses for the commercial use of intellectual property jointly developed at NSSL.

Weather Decision Technologies Incorporated (WDT):

National Mosaic and QPESUMS software

Weather Services International (WSI), Incorporated:

Licensed "Warning Decision Support System – Integrated Information" software (Oct 2005). The licensed system included single radar algorithms and display software for internal use at WSI for ten years.

Weather Decision Technologies (WDT), Incorporated:

Licensed "Warning Decision Support System – Integrated Information" software (Oct 2005). The license agreement provides for the internal use, product generation and distribution, and sublicensing of WDSS-II software. The initial agreement was for 18 months, but was later extended for three additional years.

Weather Central, Incorporated:

Licensed "Warning Decision Support System – Integrated Information" software (Dec 2008). The license agreement provides for the internal use, product generation and distribution, and sublicensing of the WDSS-II software and is in effect for three years.

CRADAs Completed

WeatherData, Incorporated CRADA:

NSSL's first CRADA was with WeatherData and Mike Smith for \$68K from March 1998 through Feb 1999 to develop a lightning threat algorithm.

MITRETEK CRADA:

The next CRADA was with MITRETEK Systems executed on Feb 15 2000 for \$25K to help them enhance their Weather Information for Surface Transportation Decision Support System (WIST-DSS).

Weather Decision Technologies, Incorporated CRADA:

- a) Original WDT CRADA for early version of WDSS and some algorithms was established in Sept 2001 - that ran for 2 years. A linux version of the NSSL-developed Severe Storm Analysis Program (SSAP) as implemented in the early WDSS-II infrastructure was delivered.
- b) Next was a modification of original CRADA in Sept 2003 that ran for 3 more years. This concentrated on Dual Pol activity, QC algorithms, and new algorithm development.
- c) In Dec 2005, a new 5-year CRADA was put in place that was very much like the 2003 CRADA in scope. (WDT has not funded anything under this agreement.)

Salt River Project CRADA:

An agreement was created Oct 10, 2001 and expired April 15, 2003. The collaboration with the Salt River Project (SRP) (electric utility serving Phoenix, AZ) concerned the research and development of rainfall-from-radar estimations and severe weather products for the southwest desert region. Field experiments for studying the North American Monsoon using C-band dual-polarization mobile radar have been carried out. Specific severe storm algorithms (e.g., "haboob" and lightning warning algorithms) have been developed and used at the SRP.

Weather Services International, Incorporated CRADA:

The WSI/Landmark CRADA was signed in June 2003 and was in place for 2 years. A version of SSAP was delivered in the first year and no additional work was done in the second year.

CRADAs under Review

No new CRADAs are in review.

Other Interaction with Industry

"Special Studies" arrangement with WDT:

In April 2001 an agreement for the preparation and distribution to WDT of the statistical database Harold Brooks created on severe weather climatology.

National Weather Radar Testbed (NWRT):

The Spy-1 based NWRT Phased Array Radar was developed by 10 partner organizations including two private companies, Basic Commerce and Industries (BCI) and Lockheed Martin. Lockheed Martin estimates its in-kind contribution to be over \$1 M.

Short Courses:

Over the years Dusan Zrnić and Dick Doviak have taught many short courses and tutorials on Doppler and polarimetric weather radar for the American Meteorological Society (AMS), the Institute for Electrical and Electronic Engineers (IEEE), and several private companies.