HMT-West Transition Project Report

Transitioning Research to Operations
Progress and Future Plans

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Hydrometeorology Testbed
NOAA Earth System Research Laboratory

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Table of Contents

I. Introduction

The Hydrometeorology Testbed (HMT) is a NOAA research program aimed at accelerating the research, development, and infusion of new technologies, models, and scientific results from the research community into daily forecasting operations of the National Weather Service (NWS) Weather Forecast Offices (WFOs), River Forecast Centers (RFCs), and the National Centers for Environmental Prediction's (NCEP) Hydrometeorological Prediction Center (HPC). In addition other agencies such as the US Geological Survey (USGS), US Army Corp of Engineers (USACE), the NWS National Water Center (NWC), and state water management agencies (e.g., the California Department of Water Resources) can and will benefit as these data and information will provide improved decision support to meet their missions. The first phase of HMT was an outgrowth of NOAA's CALJET and PACJET projects from 1997–2003 on the West Coast. HMT-West targeted California's flood-vulnerable American River Basin as the first full-scale deployment of highly sophisticated instrumentation, deployed during the period from 2005 through 2011. Preliminary, small-scale tests of HMT facilities were conducted in California's Coast Range in 2004 (HMT- 04), and the HMT was extended to the western slopes of the Sierra Nevada for the winter of 2004-2005. The year's 2012 through 2014 are expected to be transition years when legacy instrumentation will be permanently installed within California. In addition, decision support tools will be developed and deployed to better utilize these observations by forecasters and decision makers. (See: http://hmt.noaa.gov/resources/pdf/hmt_impl_plan_pullout.pdf for a complete description of the HMT program and science plan.)

HMT has strived to build relationships between the research community and the operational hydrometeorological forecast community. These relationships have fostered an understanding by the HMT research community scientist of the needs and requirements of the operational forecaster. In addition it has allowed the operational forecaster to participate in research therefore providing them with a valuable learning experience that can be shared with their operational colleagues.

Over the past decade, HMT-West has made significant progress in communicating its research results to the operational forecast community along with transitioning key observation systems to operational status and incorporating well designed decision support systems. This document will describe the various methodologies used to transfer key research results into operations. It will also discuss current and future plans for transitioning on-going research into the operational forecast process and describe plans for incorporating new observing platforms into decision support systems that will make for easy access and understanding by operational forecasters.

It should be understood that a successful transition to operations does not necessarily consist of a new software application or observing system operated and run by the NWS. In the context of this report, the following concepts will be used to identify a successful transition project. A successful transition of research results to operations can consist of something as straightforward as improving forecaster situational awareness by improved understanding of the meteorological phenomena that contributes to extreme events. One major example of this is the HMT development of improved understanding and detection of Atmospheric Rivers (ARs). This will be highlighted in the following sections of this document. Additionally, observing systems and decision support tools for improving forecasters' situational awareness can be made available via web displays that do not have to be operated by or be incorporated into forecaster display systems such as AWIPS. There are many situations where forecasters rely on external information systems for making critical decisions to meet mission goals. Utilizing these criteria, transition projects will be highlighted in the following sections of this report.

It should also be noted that the identification of the role of ARs in extreme rainfall events by HMT researchers has led other researchers, such as in the satellite community, to develop tools to better identify these phenomena in Geostationary Operational Environmental Satellites / Polar Orbiter Operational Environmental Satellites (GOES/POES) data. A good example of this is the Blended Total Precipitable Water and Anomalies product developed by the Cooperative Institute for Research in the Atmosphere (CIRA), and transitioned into operations by NOAA's National Environmental Satellite, Data and Information Service (NESDIS). This product combines the Advanced Microwave Sounding Unit (AMSU) / Special Sensor Microwave/Imager (SSM/I) precipitable water retrievals over water with GPS-Met surface based precipitable water observations to obtain a complete mapping of precipitable water, with anomalies derived from the mean observed during the period 1988-1999, for the CONUS and offshore waters. These products are currently viewable in AWIPS for all NWS forecast offices (http://amsu.cira.colostate.edu/gpstpw/). These efforts have led to further focus of the upcoming Soumi NPOESS Preparatory Project to provide an enhanced set of BTPW products for use not only in flood forecasting but in severe local storms.

Ongoing or future transition projects will be identified that expect to have a completion date in the next 2 to 4 years. Some of these projects may be dependent on future funding and others on cooperative efforts among the NWS/NOAA forecast community. The necessary resources needed for these projects will be identified.

II. Improved Forecaster Knowledge Base

Educating forecasters in the understanding of critical meteorological/hydrological forcing's that contribute to hazardous weather has been a major effort of HMT. The most effective means found to facilitate this transfer of knowledge is through a series of GoToMeetings. These have been found to be very effective in allowing an interchange between the researcher and the forecasters thus maximizing the learning experience. A series of GoToMeetings have been conducted via facilitation by Western Region's Scientific Services Division, NOAA-NESDIS/COMET VisitView, and the COMET HydroMet Course.

HMT has been conducting workshops about every-other-year since the pre-cursor years of CalJet and PacJet in the late 1990's (see: http://hmt.noaa.gov/meetings). These are designed around the focus areas of HMT such as ARs, QPF, QPE, special sensor observations such as snow level monitoring, soil moisture, and land based total precipitable integrated water vapor (IWV). By bringing together the researcher with the operational forecasters and decision makers, these workshops facilitate better communication between these key groups thus enhancing information flow. Several of these workshops have led to prioritization of research topics that would be of most benefit to operations. In addition, there is input on how best to provide information to the forecaster and whether it needs to be incorporated into existing display software such as AWIPS. A special workshop held in

Table 1 HMT Training Summary

Date	Presenter	Format	Title	Audience
10/29/2010 **11/2/2010**	Dave Reynolds	GoToMeeting VISIT	Understanding and Forecasting Atmospheric Rivers	12 NWS WFOs NCEP HPC NOAA NESDIS Naval Res Lab CSU CIRA NASA SPORT NCAR COMET
11/18/2010	Marty Ralph	COMET Intense QPF Course	Atmospheric River Scientific Findings	23 NWS WFOs NCEP HPC OCWWS ESRL-PSD Met Svc Canada NWS Warning Decision Training Branch NWS Forecast Development and Training Branch
11/8/2011	Marty Ralph/Allen White	NWS WR Webinar	HMT Field Operations/Legacy HMT network/Recent Developments in AR studies	24 NWS WFOs and 3 RFCs
03/7/2012	Brian Garcia, Wallace Clark, Tara Jensen	NWS WR Webinar	Objective Analysis of ARs	WR SOOs
03/13/2012	Dave Reynolds/ Marty Ralph	GoToMeeting	Expected AR impacts on West Coast and new tools for defining ARs and moisture flux in model guidance	WR SOOs

Table 2 SHEF HMT Data provided hourly to WFO MTR and CNRFC

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SRUS55 KSLC 301710
HMTSLC
.B DEN 120430 DH17/DQZ/PPH/XR/US/TA/UD/TD
: HOURLY SURFACE MET MESSAGE FROM NOAA/ESRL/PSD BOULDER, CO
: FOR SITE METADATA http://www.esrl.noaa.gov/psd/data/obs/sites/

:    Precip / Temp  /Wind Spd/  RH    /Wind Dir/ Dew Pt

ANDCA  0.00 /  63.80 /        / 58.32 /        / 46.11
LSNCA  0.00 /  44.93 /        / 66.47 /        / 44.44
MBGSD  0.00 /  45.68 /        / 61.68 /        / 40.52
RODCA  0.00 /  57.23 /        / 70.87 /        / 54.98
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Sacramento focused specifically on the subject of R2O which led directly to what is now a network of freezing level observatories being installed throughout California to support the California-Nevada River Forecast Center (CNRFC) river forecasts.

Of particular note was a focused session at the annual American Geophysical Union (AGU) Meeting in San Francisco in 2010 which brought together scientist from around the world to discuss the role of ARs in producing extreme rainfall events. This meeting demonstrated that the work being done by HMT scientist has focused attention on these flood producing rivers of moisture and is leading to a much better understanding of how ARs form and when they produce extreme events.

Additional co-sponsored workshops that incorporate HMT observations include the CalWater Workshop. This is a research project sponsored by the California Energy Commission to identify possible outcomes of rainfall in California under a warming climate. This study leverages off of both the extensive knowledge base of HMT but also its expansive network of observations that will help scientist differentiate the role of human impact on precipitation versus natural variability.

An ancillary outgrowth of HMT's identification of the role of ARs in extreme rainfall and flooding was the USGS Hazard Mitigation Program's development of the ARkStorm Scenario. This is a comprehensive look at what a combined series of ARs could do to California, similar to storms that struck in 1861-62. Several HMT researchers participated in the development of this scenario and a two day workshop held In January 2011 engaged hundreds of stakeholders in educating them on the impacts of such an event (possible $500 billion in losses). It again points out the significant contribution HMT has had in its identification of the role of ARs and how this knowledge has rippled through the hydrologic community and accelerated the focus on this phenomena. (Michael D. Dettinger, F. Martin Ralph, Mimi Hughes, Tapash Das and Paul Neiman, et al., 2012: Design and quantification of an extreme winter storm scenario for emergency preparedness and planning exercises in California. *Natural Hazards*, **60** (3), 1085-1111.)

III. Improved/Enhanced Data Flow to Operations

A fundamental part of HMT-West has been to deploy a network of observational systems to improve the understanding of the physical processes that produce extreme precipitation and/or are associated with extreme runoff and thus flooding. Several of these observation systems have proven extremely valuable to the operational decision maker and they have requested these observations be made available in real-time in a form and a frequency that can be used operationally. To meet this requirement the HMT has provided their surface met data in Standard Hydrologic Exchange Format (SHEF) so this information can be ingested directly into the NWS hydro database. An example of a subset of surface met data in SHEF is shown in Table 2.

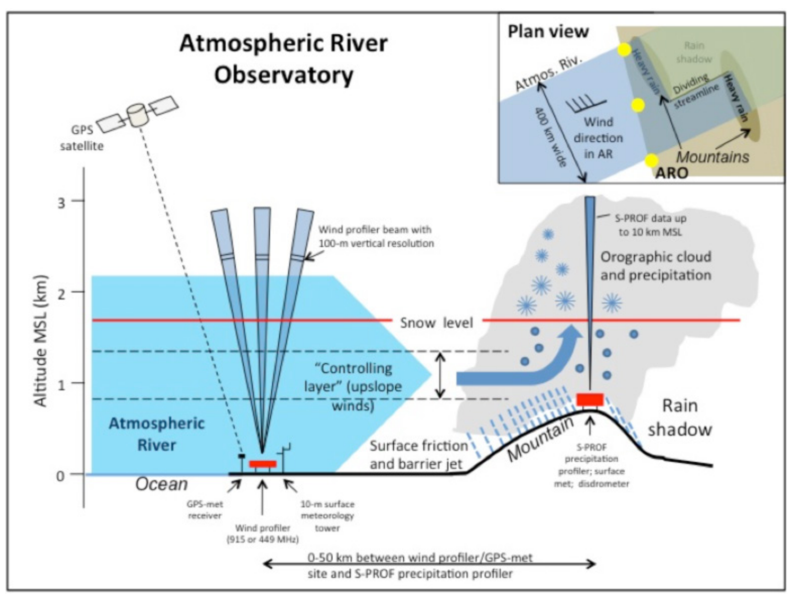


Figure 1. Equipment and observing strategy for an Atmospheric River Observtory

IV. Decision Support Tools

Providing HMT data in a way that can be easily understood and utilized by operational decision makers is a high priority for HMT. Through the workshops conducted as described above, researchers have determined what are the critical decisions faced by forecasters during high impact weather events. This had led to the development of various web-based displays that allow forecasters to monitor the changes taking place in the structure of the storm as it moves ashore as well as changes in physical processes taking place within the cloud that could increase or decrease precipitation over the next few hours. An excellent example of this is the Atmospheric River Observatory (ARO) Water Vapor Flux Tool. This tool/web display combines the output of multiple ground based HMT installed sensors that make up the ARO (Figure 1) to provide the operational decision maker with critical information on low level moisture transport into coastal terrain, its strength compared to established AR thresholds, altitude of the freezing level, and short-term HMT WRF model output provided in the exact same format as the observations to provide continuity into the next 12 hours. In addition, the display overlays the previous 3-hr model forecasts with the current observations to identify any bias in the model in both moisture flux as well as observed precipitation. To make this even more useful to forecasters, the display is auto-updated hourly when the new model output is available (Figure 2).

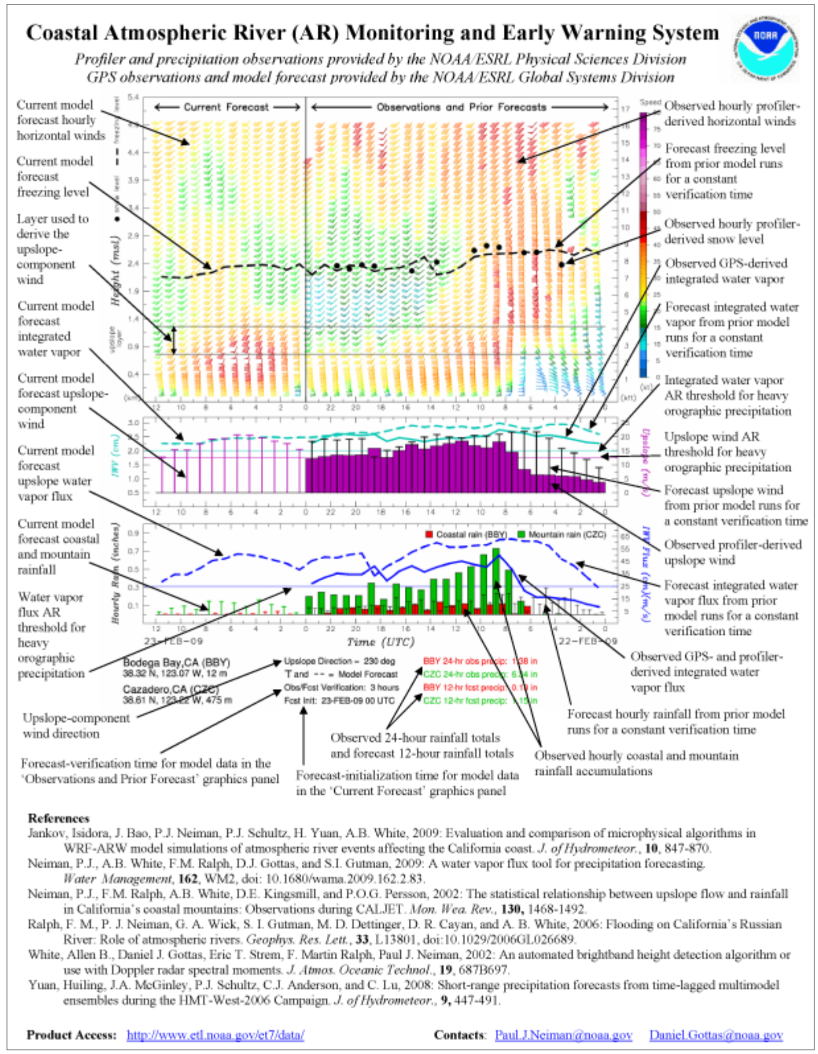


Figure 2. Water Vapor Flux Tool and description of information provided.

V. Web-Based Information

Decision makers in recent years have grown accustomed to viewing operationally-relevant information on the web. This is because it can take years to baseline new tools and observations into the operational display devices used by forecasters such as AWIPS. While AWIPS provides forecasters with a wealth of information on the current and future state of the atmosphere and conditions on the ground, it is a lengthy process to integrate new and improved products into AWIPS. In an effort to accelerate getting new information into the forecaster's arsenal of tools, HMT worked directly with NWS customers, partners, and decision makers to rapidly prototype advanced decision making products for web display. Therefore web-based displays greatly accelerate the use and evaluation of HMT's science and technology advances. This then helps the forecaster identify and communicate the threat from the outlook/forecast period to the defined threat (advisory, warning phase) to the event and recovery phase. The following outlines a few of the key observations that have been found very useful by forecasters:

A. Precipitation Profiler Displays

The S-band profiler is a vertically-pointing radar that collects a time-series of radar reflectivity above the radar site at a very high spatial and temporal resolution. With sufficient numbers of S-bands deployed as part of HMT-West, displays of reflectivity along a north-south and west-east direction can be generated. Figure 3 shows a west-east cross-section from the Sonoma County coast up into the Sierra foothills west of Lake Tahoe. One critical feature of this display is that it allows the forecasters to monitor the progress of important features such as the trailing edge of heavy precipitation. The combined information from these profilers can provide forecasters up to 4 to 8 hours lead time depending on the translation speed of the cold front/upper trough axis. This lead-time information can be critical if rivers are approaching flood stage and just a few more hours of rainfall could create life-threatening conditions. These displays also provide lead time in forecasting changes in the freezing level where rain transitions to snow. Such changes can result in large changes in runoff. The S-band displays can be used to extrapolate these changes from the locations north and west of the Sierra Foothills. These displays are also auto-updated every 15 minutes so decision makers do not have to refresh the display. This makes it very useful to display on situational awareness screens (e.g., flat-screens mounted in operational areas of most NWS offices).

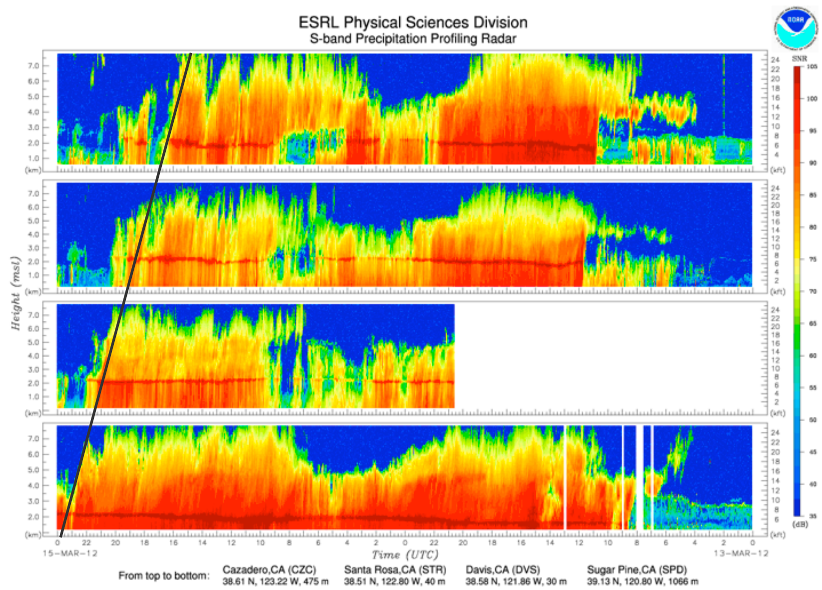


Figure 3. Vertically-pointing S-band radar plots beginning at the Sonoma coastal hills through the central valley and into the foothills of the Sierra Nevada. Darker shading represents increased fall speed. Darkest line is melting level. Time increases right to left. The diagonal line from top to bottom panels shows the translation of the cold front and cessation of heaviest rainfall.

B. Google Maps Meteorological Data Displays

A spatial display of surface met data, land-based GPS IWV, soil moisture, and freezing level height data is made available via Google Map displays where the user can select the parameter of choice and see the spatial gradient/transition of the parameter being viewed. Figure 4 shows the Integrated Water Vapor (IWV) for surface based GPS sensors on the left and snow level on the right for 13 March 2012 as an AR was making landfall.

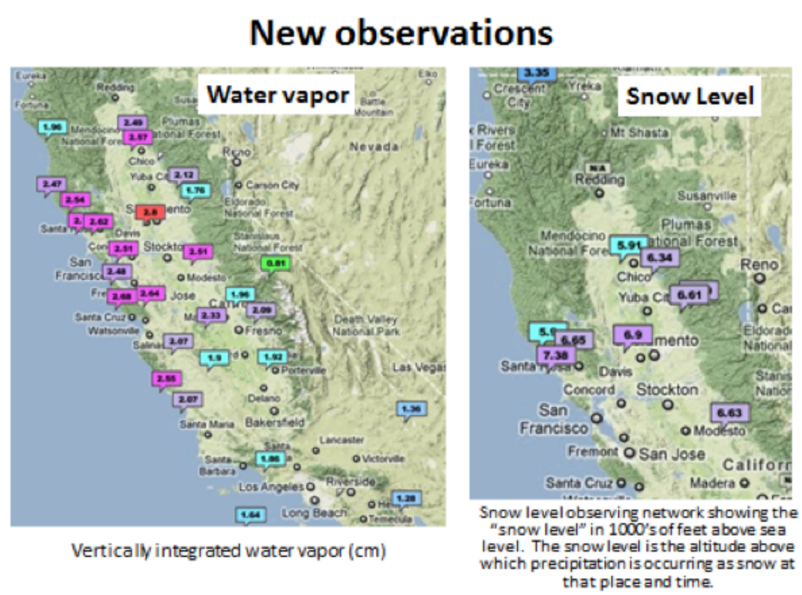


Figure 4. Google maps of IWV on left in cm and snow level on right in 1000s ft.

C. Atmospheric River Detection Tool

An auto-detection tool has been developed by HMT researchers to identify and classify land-falling ARs in SSMI and numerical model guidance utilizing IWV information. This product is called the Atmospheric River Detection Tool or ARDT-IWV, and has shown great promise in automatically identifying ARs with a Probability of Detection (POD) of 98.5% and a False Detection Rate of only 2.5%. When used with numerical guidance data, the technique can be expanded to compute IWV transport (Figure 5). This automated tool has already proven quite valuable in monitoring and forecasting several land-falling ARs this past winter/spring allowing forecasters to first see

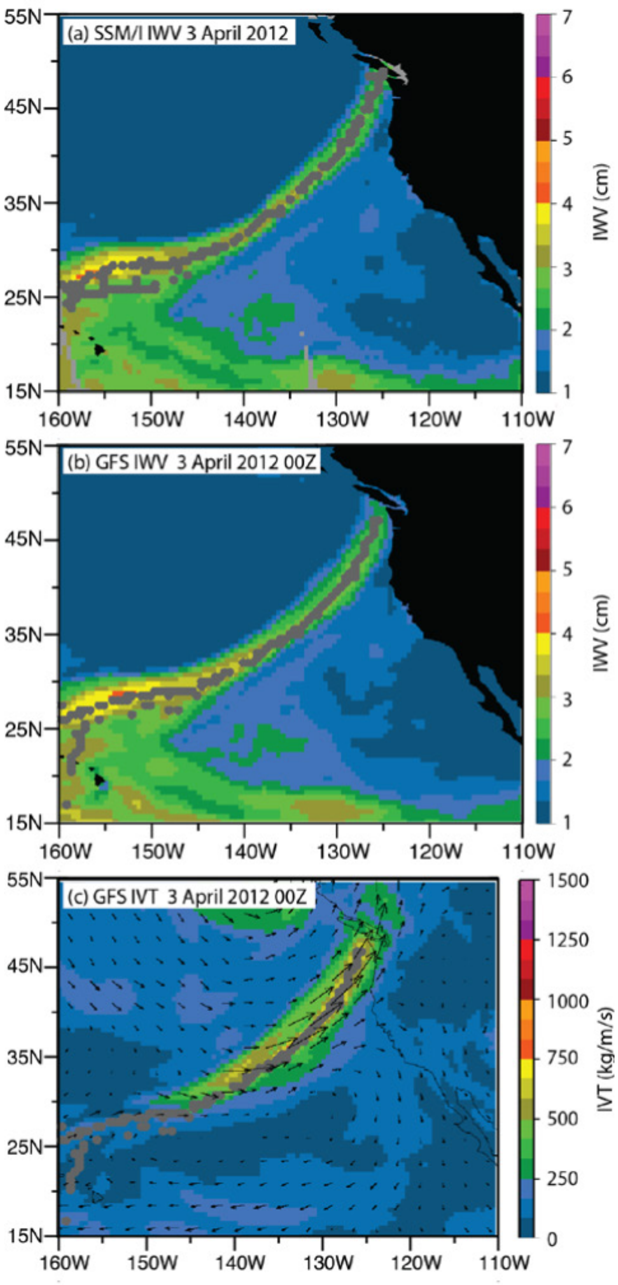


Figure 5. From top to bottom, AR identified in SSMI WV imagery, middle is AR as identified in 00Z GFS IWV grid at initial model time, and bottom is GFS identified AR with low level winds with warmer shading indicating higher moisture flux. Wick, G. A., P. J. Neiman, and F. M. Ralph, 2012: Description and validation of an automated objective technique for identification and characterization of the integrated water vapor signature of Atmospheric Rivers. IEEE Trans. on Geosci. Remote. Sens., accepted for publication.

how well the model has initialized the AR and secondly to monitor run-to-run variations in the timing, strength, and location of AR landfall. This information can help forecasters determine how much confidence to place in the numerical guidance.

D. Global Ensemble Forecast System Vapor Transport Tool

An additional tool has been developed to evaluate AR conditions in the Global Ensemble Forecast System (GEFS). Using various integrated vapor transport (IVT) threshold values at an above defined AR conditions, the tool defines the latitude band and the duration and location of landfall using the ensemble mean displayed in a Hovmoller diagram (Figure 6). A map showing terrain overlaid with the number of hours of AR conditions is also provided. This gives the decision maker a very good diagnostic of where the heaviest rainfall is likely for a given AR event. This tool should provide higher confidence to forecasters in issuing specific statements (Flood Potential Outlooks) as to where extreme rainfall is likely.

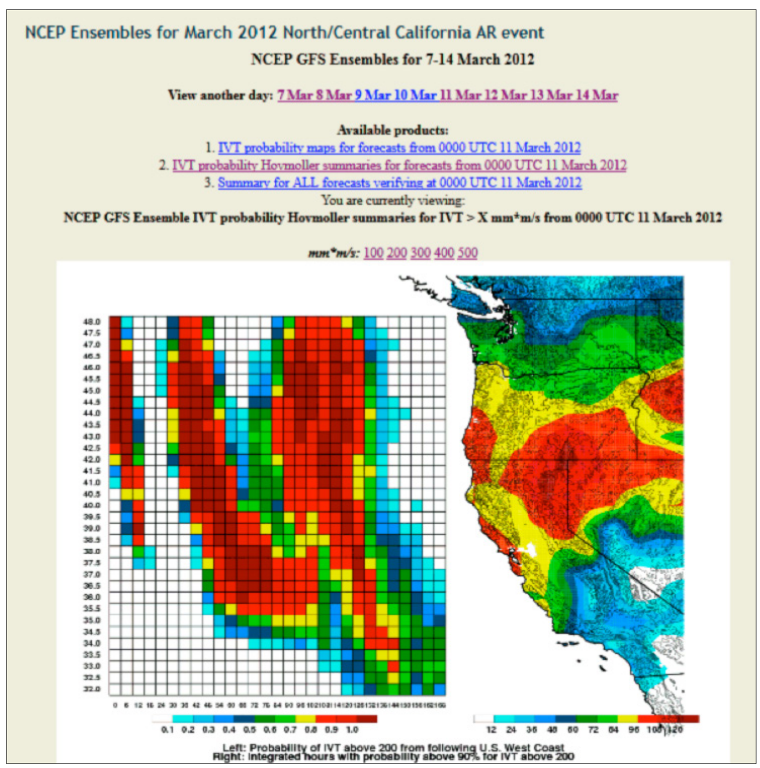


Figure 6. Hovmoller diagram on the left represents the GEFS forecast mean latitude band of identified AR with respect to forecast lead time. Plot on right is the duration in hours of AR conditions using the threshold value selected for the entire forecast period.

VI. Emergency Response Activities

Several times over the past ten years, HMT resources and expertise have been requested to support NWS operations during critical potential high impact weather events. In each of these efforts the HMT has partnered with other government agencies like the USGS to first understand the nature of the threat and what the critical criteria are for triggering serious impacts. These have included potential catastrophic debris flows within massive burn scars in both southern and central California. Another example is the response to the potential Howard Hansen Dam failure near Seattle, Washington, which has been an ongoing effort over the past three winter seasons. Specifically HMT has installed and operated Atmospheric River Observatories (AROs) at critical upwind sites to the high impact area, which provide critical information on incoming ARs that could lead to rainfall rates exceeding debris flow threshold criteria, or inflows to the Howard Hansen reservoir that could threaten dam failure.

AROs have been installed at Goleta, California to support the NWS in forecasting debris flows in the areas around Santa Barbara, and the transverse range of Southern California. Another ARO was installed at Pt. Sur to support the potential for massive debris flows within the Basin Complex fire located in the Santa Lucia Mountains in Monterey County. This was the third largest fire ever to occur in California. Finally, an ARO was installed and continues to operate at Westport, Washington on the coast providing several hours lead-time to potential excessive rainfall allowing emergency response teams time to evacuate downstream residences and businesses. In addition to the ARO, a series of automated rain gages were installed in critical basins along the Cascades to monitor rainfall rates within critical watersheds (Figure 7). A combination of HMT and NWS staff were recently acknowledged for this effort with a Department of Commerce Bronze Medal. Table 3 summarizes these projects and others considered successful R2O transition.

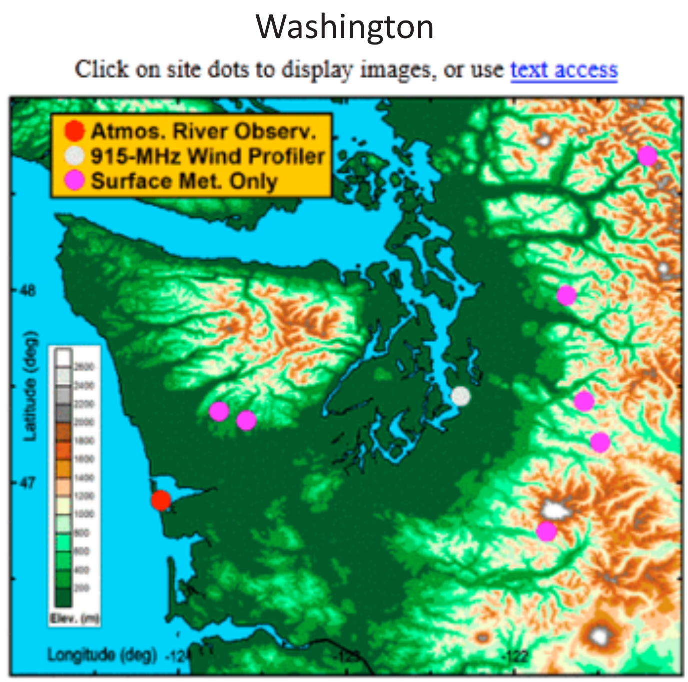


Figure 7. Clickable map of HMT installed sensors to support the emergency Howard Hansen Dam flood forecast project. White, A. B., and Coauthors, 2012: NOAA's rapid response to the Howard A. Hanson Dam flood risk management crisis. Bull. Amer. Meteor. Soc., 93, 189–207.

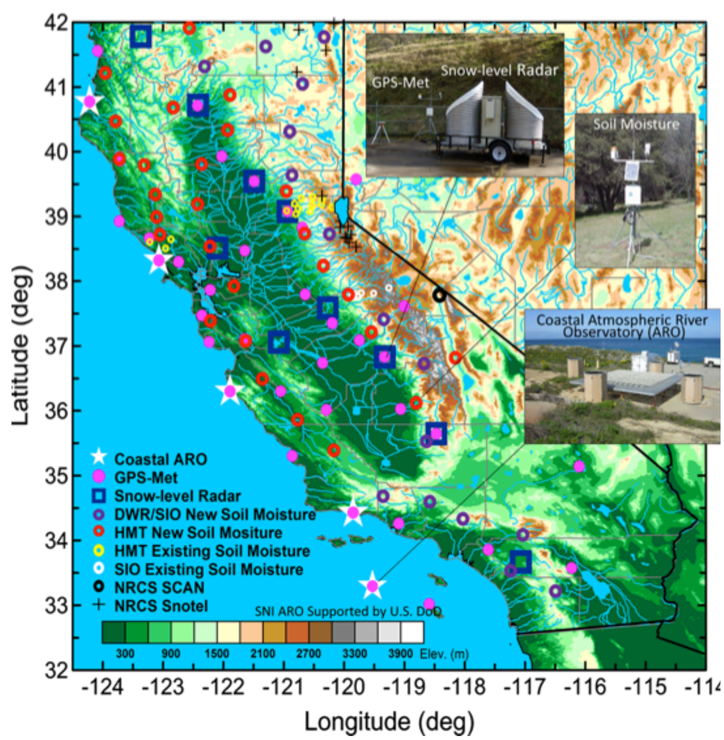


Figure 8. EFREP HMT legacy observing network expected to be completed by winter 2014.

VII. Planned Transition Projects

Over the next few years, several major projects will be undertaken to ensure the HMT and its legacy observations are made available to decision makers in a form and in a manner useful to operations, especially during high impact events.

Table 3 – Summary of HMT Transition Projects

Transition Activity/ Purpose	GoToMeetings	Workshops/ Meetings/Special Secessions/Teams	Real-time Support to Operations	Web Based Information	R2O / O2R
Improved Knowledge Base On AR's - QPF- Orographic effects – Observing systems -Physical processes	VISIT (Virtual Institute for Satellite Integration Training] – WR SSD SOO Calls – COMET HydroMet Workshops	Annual HMT-W HMT-SE workshops AGU Special Session ARs CalWater Debris Flow Workshops HMT HPC Winter Weather Experiments IRWSS Workshop Russian River National Hydrologic Warning Council HMT-W R2O Workshop		Atmospheric River Information Web Page	As of May 2012 – 63 Formal Publications in 14 independent journals.
Decision Support	WR SSD SOO call – Flux Tools HMT Support SCEP/ CSTAR on use of anomaly charts for extreme events	D Reynolds joins NWS WR Uncertainty/Confidence Forecast Team as OAR member ARkStorm Multi-Hazard Demonstration Project CalEma Catastrophic Flood Plan to utilize ARkStorm Scenario	.	ARO Flux Tool S-Prof auto-update pages SSMI –GFS Flux Tool GEFS – AR location-duration at landfall	Tim Schneider –HMT Director to NWS - R2O Dave Reynolds – NWS MIC to NOAA OAR – O2R
Improved /Enhanced Data Flow to operations			HMT Legacy (EFREP) -Surface Met, soil moisture, and Freezing level data encoded and provided hourly to WFOs and CNRFC . AROs installed (to be) coast and Sierra foothills. ALPS workstations deployed – WRF Ensembles	NWS Pacific Region deploy GPS receivers in Pacific Basin CA-DWR HMT Legacy Project Google Maps based soil moisture, GPS TPW, Freezing level,Precip	
Emergency Response Support		Special Seattle WFO training session on ARO system and operational use of Flux Tool	Mobile AROs for Debris flows So Cal, Big Sur Basin Howard Hanson Dam		BAMS article on Howard Hanson Dam support

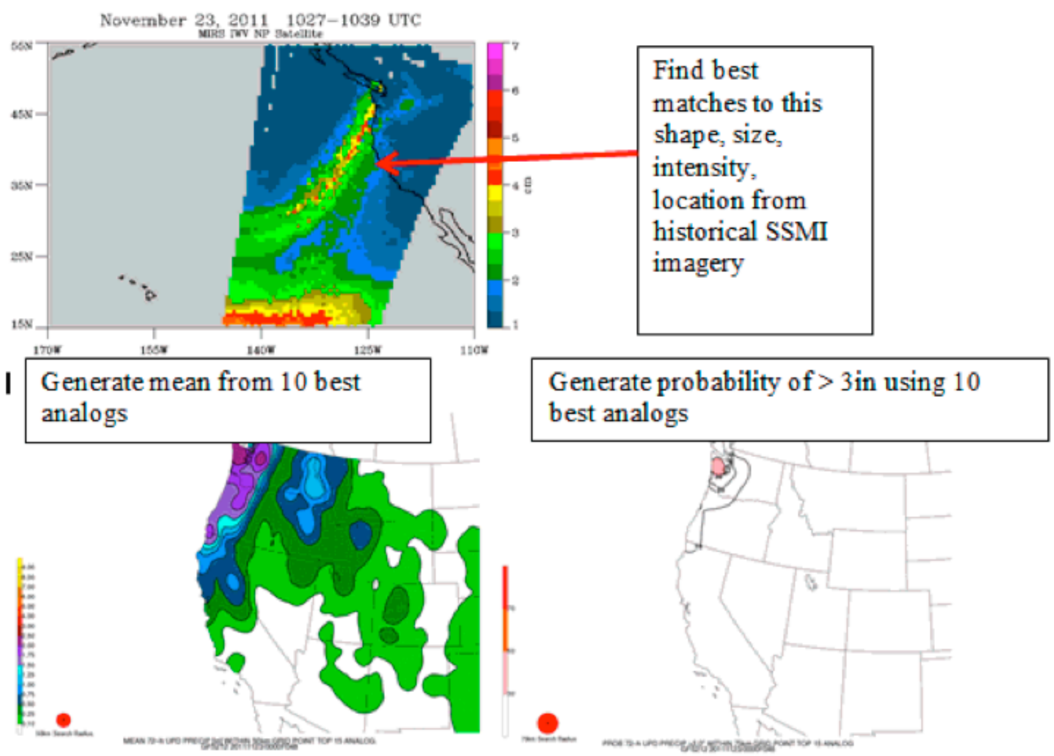


Figure 9. AR Analog Precipitation Tool with top panel showing identified AR which would be matched with the ten best historical ARs from the NARR. The bottom left panel is the mean from the observed 10 best analogs with the right panel showing the probability of greater than three inches of rainfall in 24 hours.

A. Incorporate Legacy HMT Observations into NWS Operations and High Impact Decision Support

EFREP or Enhanced Flood Response and Emergency Preparedness, sponsored by the California Department of Water Resources, will install a 21st century observing network (Figure 8) that will provide critical measurements found to be essential for improved flood forecasting as well as enhanced reservoir management.

B. AR Analog Tool

Utilizing the ARDT-IVT tool with historical climatology from the NCEP reanalysis data one can match a forecast AR to the ten best historical ARs. This would be categorized by location, orientation, dimensions, intensity, and expected land-fall location. From the ten best analogs the 24-hour to 3-day rainfall totals can be derived from the observed rainfall of these ten analogs as well as the probability of exceedance of various rainfall thresholds such as three inches in 24 hrs. An example of this is shown in Figure 9.

C. AR Intensity Classification and Rainfall Threat

Utilizing the ARDT-IWV tool already implemented, this project would identify and categorize the strength of ARs while still in the development stage and offshore. This would be equivalent to something like the Saffir-Simpson scale for tropical storms. It would calculate the flux of moisture in the total column along the length and width of the AR and sum this up into a meaningful parameter, such as the amount of moisture equivalent to the annual flow of the Mississippi River into the Gulf of Mexico. These discharge units would be equivalent to the potential rainfall threat given the AR makes landfall and maintains this strength. Having categorized previous land-falling ARs using this method, the relative threat can be assessed in terms of rainfall magnitudes. These magnitudes can then be referenced to the R-Cat scheme recently published by Ralph and Dettinger (2012), Figure 10.

Flow Chart of AR Flux Intensity/Anomaly and Rainfall Potential

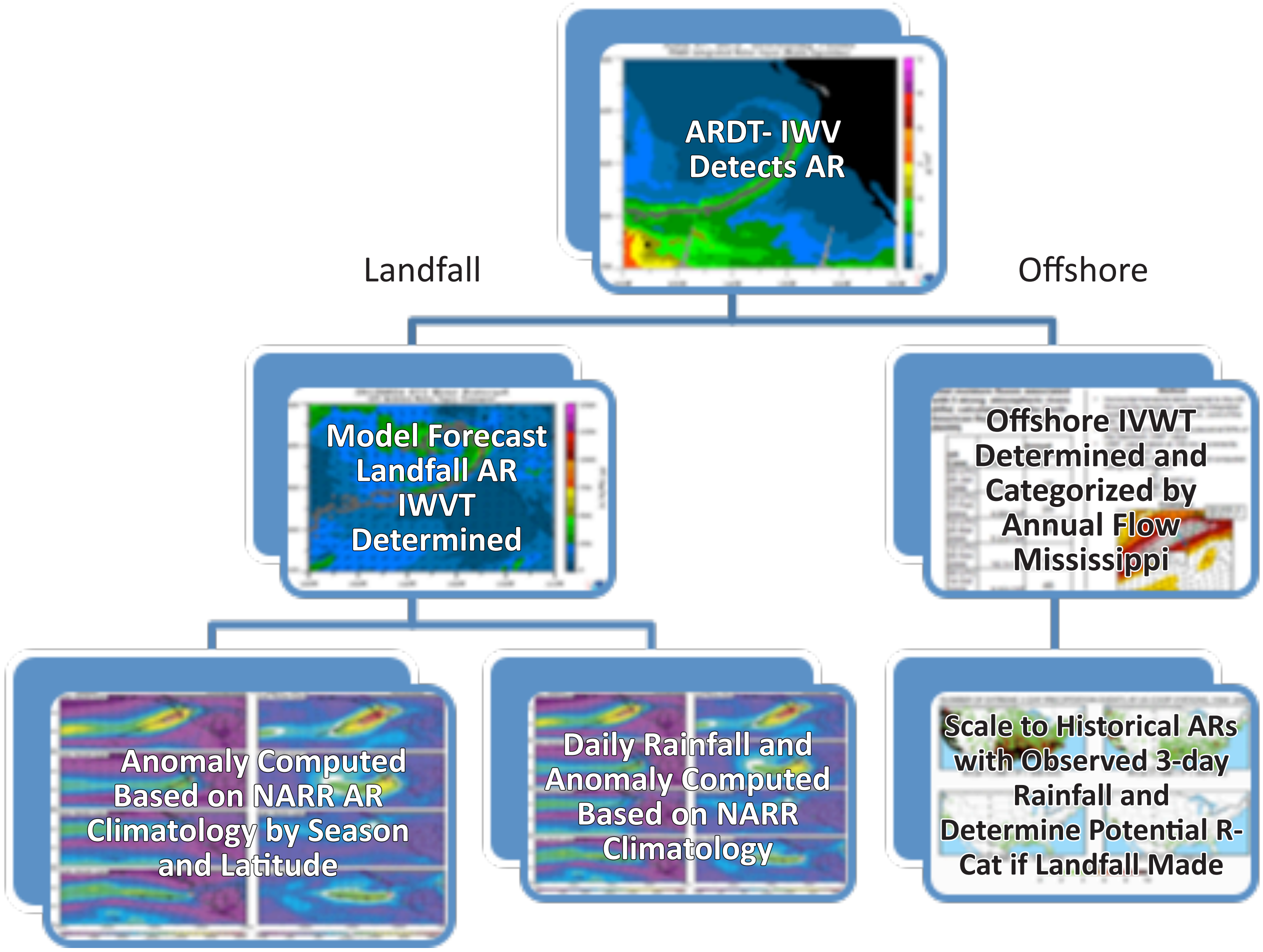


Figure 10. Flow chart of AR flux intensity and potential rainfall for ARs detected in model guidance for offshore ARs (right tree) and model forecast land-falling ARs (left tree).

D. Improved Gap Filling Radar for Best Multi-sensor QPE

HMT has focused on improving QPE in complex terrain, and gap-filling radars have been one way to demonstrate this. Over the past six years, HMT and NSSL researchers have worked closely with the Monterey NWS forecast office to determine the benefits of utilizing a commercial television C-band radar located on the Vacaville hills (KPIX) above Napa and Sonoma Counties. These two counties have very poor radar coverage from the existing NEXRAD radars. It would be of great benefit to the NWS and to the flood protection agencies of these two counties if HMT can quantify the improvements made possible by incorporating KPIX data into the flash flood monitoring and prediction software using the best possible QPE input. Using the existing gage network under the KPIX radar, a bias corrected QPE at high spatial and temporal resolution feeding the existing software is likely the most appropriate approach to QPE in this region. This will be tested using case study data collected during this past 2011-12 winter season. Once the best multi-sensor QPE approach is determined, this methodology will be recommended to the WFO along with appropriate KPIX processing procedures. This test will also be useful for the national Multi-Radar/Multi-Sensor system that will be used by the National Water Center as the main forcing for hydrologic models. The ability to incorporate commercial radars that are capable of scanning at lower elevation angles will certainly help improve the national QPE mosaic in areas lacking good low-level radar coverage.

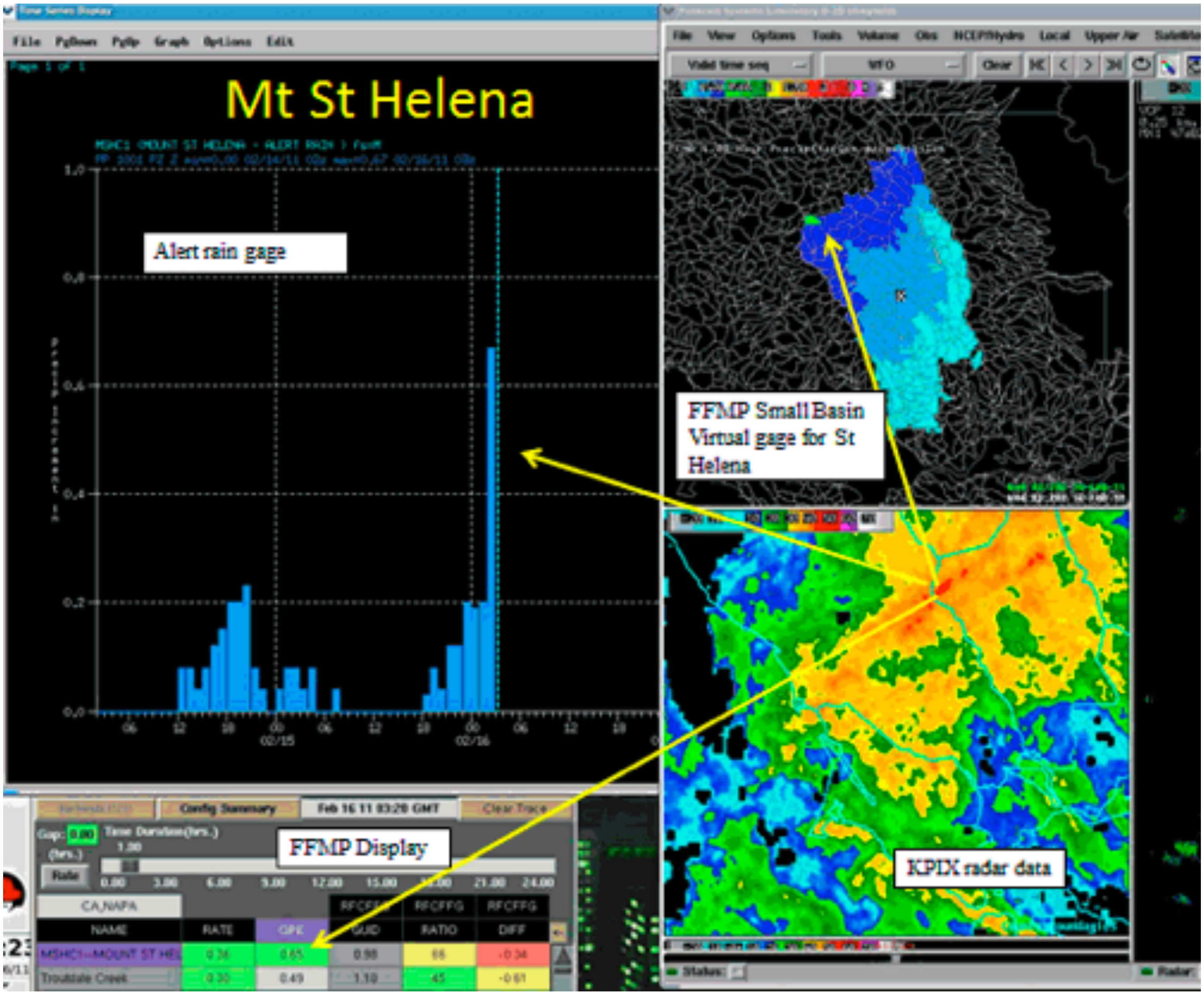


Figure 11. Upper left is the observed hourly rainfall from the Mt. St Helena Alert gage. The upper right panel shows the high resolution basin definition with color shading showing one hour rain rates with warmer colors indicating higher rain rates. The location of the Mt. St. Helena gage is shown. The bottom right is the KPIX .5 degree reflectivity used to obtain the rain rates while the lower left shows the FFMP basin table with the virtual Mt. St. Helena gage showing the estimated QPE for one hour which compares very favorably to the observed.

E. Probabilistic QPF to Enhance Water Vapor Flux Tool

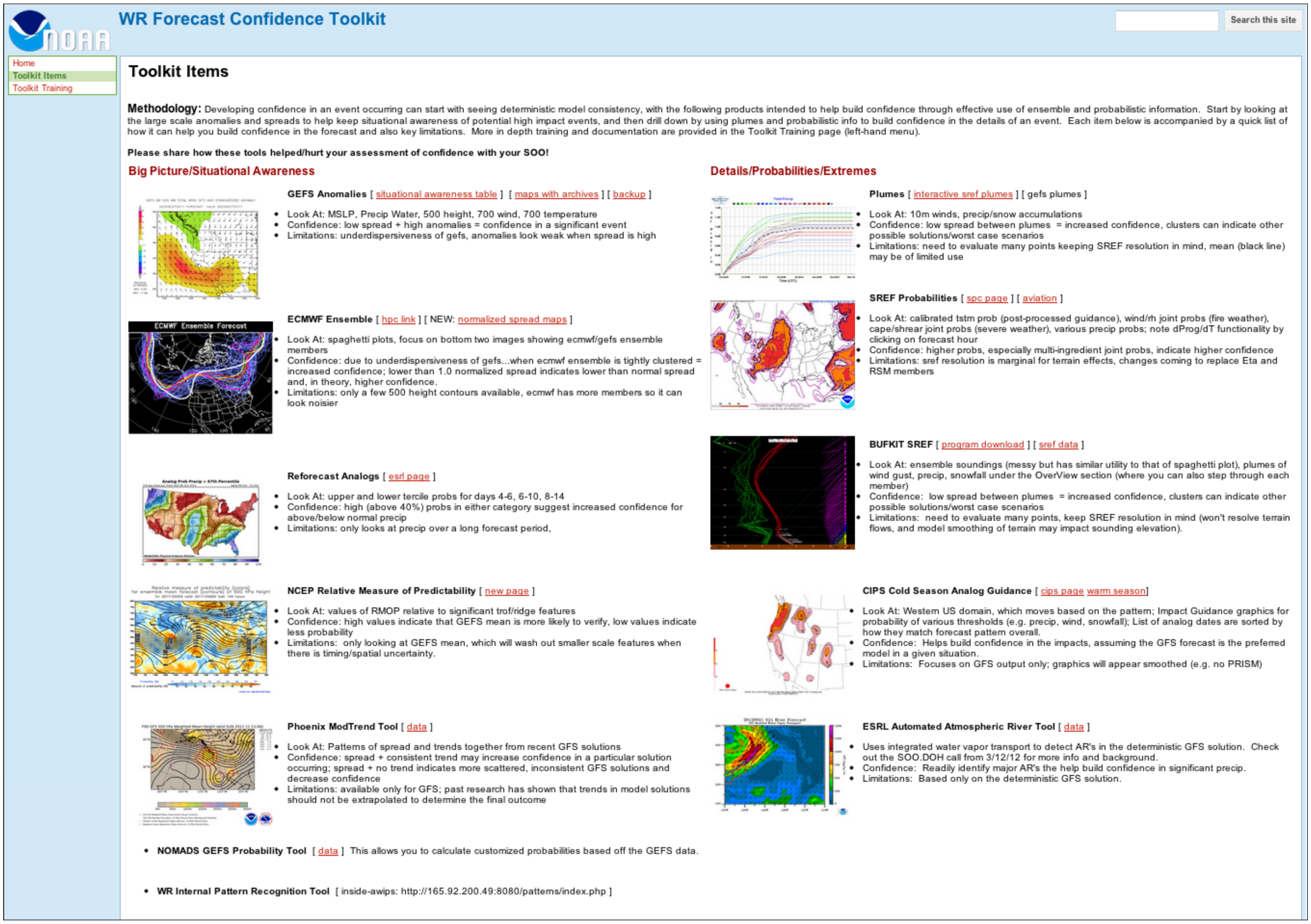
Currently the IWV Flux Tool utilizes a deterministic 9 Km WRF run to forecast the next 12 hours of hourly rainfall for each ARO site. The IWV Flux Tool has proven to be useful in forecasting the kinematic and thermodynamic variables like low-level winds and moisture flux but does a very poor job in predicting hourly rainfall, especially when enhanced by orography. This may be due to model resolution and/or model physics. To provide a more useful tool, it is proposed to utilize the WRF 3 km ensemble mean value along with calibrated ensemble probabilities of exceedance values for various thresholds such as 1 to 3 inch rainfalls over the next 6 and 12 hours. This should provide some measure of confidence to the forecasters in utilizing the flux tool to make better warning decisions.

Table 4 summarizes the proposed projects that will be pursued over the next 2 to 4 years as part of HMT West.

Table 4 – HMT Proposed Transition Projects

Project – Listed in order of priority	Purpose	Resources Required	Personnel and man months	Expected start Expected Completion	User Base	Focal Point For NWS
AR Analog Tool	Pattern match forecast land-falling AR to historical events and corresponding observed rainfall to be used as analog	AR detection tool and historical SSMI AR climatology extracted from tool Stage 4 6-hr QPE	Paul Neiman – 2 Gary Wick – 2 Ellen Sukovich – 2 Dave Reynolds – 1 Tim Coleman – 1 Dan Gottas - 1	October 2012 – September 2013	West Coast WFOs CNRFC NWRFC Army Corps	Jonathan Rutz/Mike Staudenmaier/ WRSSD
Develop offshore AR Intensity Category and Land-falling Rainfall Threat	Provide forecasters and decision makers a method to assess threat of off-shore ARs	Numerical forecast guidance combined with AR tool above to allow automation. Provide in terms of anomalies as well.	Ben Moore – 3 Gary Wick – 1 Dave Reynolds -1	April 2013-December 2013	West Coast WFOs CNRFC NWRFC US Army Corps	Jonathan Rutz/Mike Staudenmaier/ WRSSD
Deliver HMT Ensemble means of various sfc parameters to AWIPS II	Provide forecasters with means to view 3-km WRF ensemble mean sfc fields in AWIPS II and GFE	3-km WRF Ensemble mean field in GRIB2 via LDM through WRH to CA field offices.	SPORT-HMT project GSD- Brian Etherton and Linda Wharton	May 2012-March 2013	West Coast WFOs CNRFC NWRF CNRFC	Trevor Alcott/Chad Kahler/WRSSD Bill Rasch/STO
Enhanced Flux Tool QPF Calibrated Probability of Exceedance	Improve short term-1-12 hr QPF by converting to PQPF	3-km WRF ensembles updated hourly with post-processing to remove bias	GSD – 3 Dan Gottas -1	April 2013- December 2013	West Coast WFOs CNRFC NWRFC US Army Corps SFPUC	Jonathan Rutz/Mike Staudenmaier
EFREP data incorporated into NWS hydro operations	Educate forecasters/hydrologist in operational utility of EFREP data and provide in form directly usable by existing NWS software. Identify NWS champion for this effort	Real-time EFREP data including Freezing level, soil moisture, IWV, and low-level moisture flux coded into format ingested by NWS software	Allen White – 1 Dan Gottas – 2 Tim Coleman – 1 Dave Reynolds -1 NWS - 2	January 2012 September 2015	West Coast WFOs CNRFC NWRFC	Art Henkel, Dan Kozlowski/CNRFC Chad Kahler/ WRSSD Joint NWS/OAR SCEP at STO

Table 4 – Summary of the proposed projects that will be pursued over the next 2 to 4 years as part of HMT West



Western Region Forecaster Confidence Toolkit showing links to decision support tools used by forecasters to build confidence in forecasting significant potential weather events. The goal of this effort is to have forecasters to begin conveying impacts to emergency managers and state and local agencies as early as their conf idence suggests impacts could be significant. Tools such as suggested in this document to be developed, in addition to the Wick AR Flux Tool shown in the lower right of this web page, would provide additi onal information to help forecasters increase confidence in an upcoming significant weather event.

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