Case study analysis of the Real-Time Mesoscale Analysis (RTMA) in the northern Gulf of Mexico

Pat Fitzpatrick and Yee Lau
Mississippi State University
Stennis Space Center, MS

- Description of research consortium CONCORDE and meteorology dataset archive
- RTMA overview
- RTMA validation
- Conclusions
- Future CONCORDE plans

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Environmental Modeling Center
IMSG and NOAA / NWS / NCEP

Consortium CONCORDE
Coastal River-Dominated Ecosystems

2015 CONCORDE is made possible by a grant from BP/The Gulf of Mexico Research Initiative (GoMRI)

Addresses the question:

How do the complex fine-scale biological, chemical, and physical structure and processes in coastal waters - dominated by pulsed-river plumes – control the exposure, impacts, and recovery from offshore spills?

Consortium CONCORDE Coastal River-Dominated Ecosystems

- Field programs:

  Recently completed a Fall 2015 surveying campaign (low river period) with two R/Vs and a small-boat excursion; focus is on chemistry, plankton, ocean dynamics, and meteorology forcing

  Three more surveys planned (February 2016, Spring 2016, Summer 2016)

- Meteorology contribution from MSU is to:

  – *Provide and assess atmospheric forcing fields for hindcast ocean/biophysical models in Mississippi and Chandeleur Sound*
  – *Use RTMA and observations for CONCORDE case studies*

- It is necessary to validate the RTMA fields to assess strengths and weaknesses for these uses
- Few RTMA studies have been performed on the Gulf Coast nearshore regions

* *The Gulf of Mexico Research Initiative (GoMRI) is a ten-year $500 million commitment to study the effects of the Deepwater Horizon incident and the potential associated impact on the environment and public health. GoMRI's organization has overtones of an NSF structure.*

Archive generation for atmospheric forcing

- Model data (RTMA, NAM) is provided by NOAA’s Operational Model Archive and Distribution System (NOMADS).
- Radar data is provided by NOAA's Hierarchical Data Storage System (HDSS). NCDC provides direct online access to these data though the HDSS Access System (HAS). This cannot be automated and has to be run manually, but weeks of data can be downloaded at once.
- High-resolution AVHRR SST data is provided by NOAA's Atlantic Oceanographic & Meteorological Laboratory (AOML). Alternatives under consideration.
- Some variables are converted to specific variables using FSU’s COARE flux algorithm 3.0, for consistency with NRL’s COAMPS.

Archive generation - Summary

The following are generated from different scripts, interpolated to 0.01 deg. RTMA is 2.5 km resolution. NAM is 5.0 km resolution.

1) NOMADS RTMA: pressure, air temperature, relative humidity, winds;
2) NOMADS NAM: Cloud fraction, shortwave radiation flux, longwave radiation flux (radiation not at 00, 06, 12, or 18Z are forecast fields);
3) NEXRAD radar from HAS: accumulated rainfall;
4) AVHRR: 5-day running mean of SST with QC for missing and bad data;
5) COARE Bulk Flux 3.0 algorithm: momentum stress, fluxes.

RTMA overview

2DVAR Grid Statistical Interpolation (GSI) with non-isotropic recursive filter

- A specially configured 2DVAR version of GSI which ingests HRRR 1-h forecast fields and perform a detailed surface analysis
- Key feature non-isotropic recursive filter package which allows more customization of corrections to the background field to better fit special surface features, such as terrain and coast lines.
- Uses surface, synoptic, ship, buoy, pre-approved mesonet, near-sfc satellite winds
- Result is a surface analysis that better matches the observed surface data, while providing a coherent field that best matches the various geographically-related features.

HRRR – High-Resolution Rapid Refresh

The HRRR is a NOAA real-time 3-km resolution, hourly updated, cloud-resolving, convection-allowing atmospheric model.

Radar data is assimilated in the HRRR every 15 min over a 1-h period.

Quality Control in RTMA

- ‘Gross error’ O-B check (relaxed by terrain, buddy check for temp)
- There is a provider and station-based reject/accept lists for mesonets (static, required RFC to change) (StationID based)
- Dynamic reject list (O-B last 6 hours)
- “Variational” nonlinear QC (problems with 2+ obs/hour/station)
- Data could also ‘fall on floor’ if not on “accept list, large time delays, etc.

RTMA references

GSI:

Wu, W.-S., R. J. Purser, and D. F. Parrish, 2002: Three-dimensional variational analysis with spatially inhomogeneous covariances. *Mon. Wea. Rev.*, **130**, 2905–2916.

RTMA:

De Pondeca, M. S. F. V., and Coauthors, 2011: The Real-Time Mesoscale Analysis at NOAA's National Centers for Environmental Prediction: Current status and development. *Wea. Forecasting*, **26**, 593–612.

Anisotropic Recursive Filters:

Purser, R. J., W.-S. Wu, D. F. Parrish, and N. M. Roberts, 2003a: Numerical aspects of the application of recursive filters to variational statistical analysis. Part I: Spatially homogeneous and isotropic Gaussian covariances. *Mon. Wea. Rev.*, **131**, 1524–1535.

Purser, R. J., W.-S. Wu, D. F. Parrish, and N. M. Roberts, 2003b: Numerical aspects of the application of recursive filters to variational statistical analysis. Part II: Spatially inhomogeneous and anisotropic general covariances. *Mon. Wea. Rev.*, **131**, 1536–1548.

Purser, R. J., 2005: A geometrical approach to the synthesis of smooth anisotropic covariance operators for data assimilation. NOAA/NCEP Office Note 447, 60 pp.

Analysis Error Estimation (Lanczos method):

Fisher, M., and P. Courtier, 1995: Estimating the covariance matrices of analysis and forecast error in variational data assimilation. ECMWF Tech. Memo. 220, 29 pp.

Basic Validation

Observations used for validation

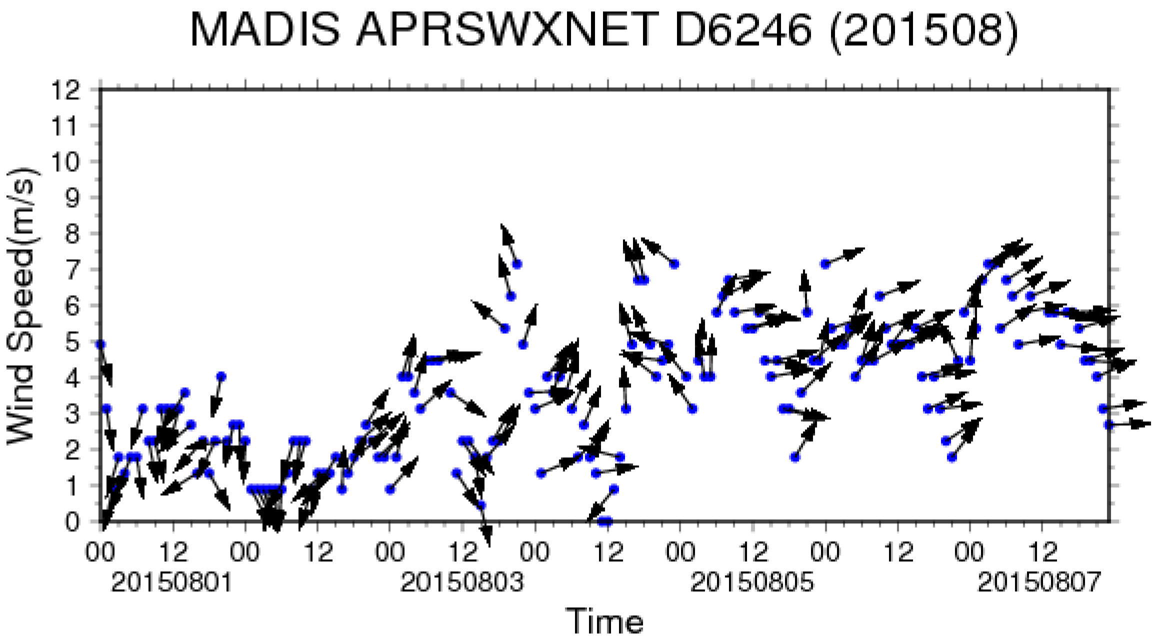
- Used nearest neighbor RTMA with most appropriate land cover
- Wind observations converted to 10-meter height (when possible) and 1-minute average (when possible)
- Future data will include WeatherFlow network (new platform installed at Ship Island, funded by CONCORDE)

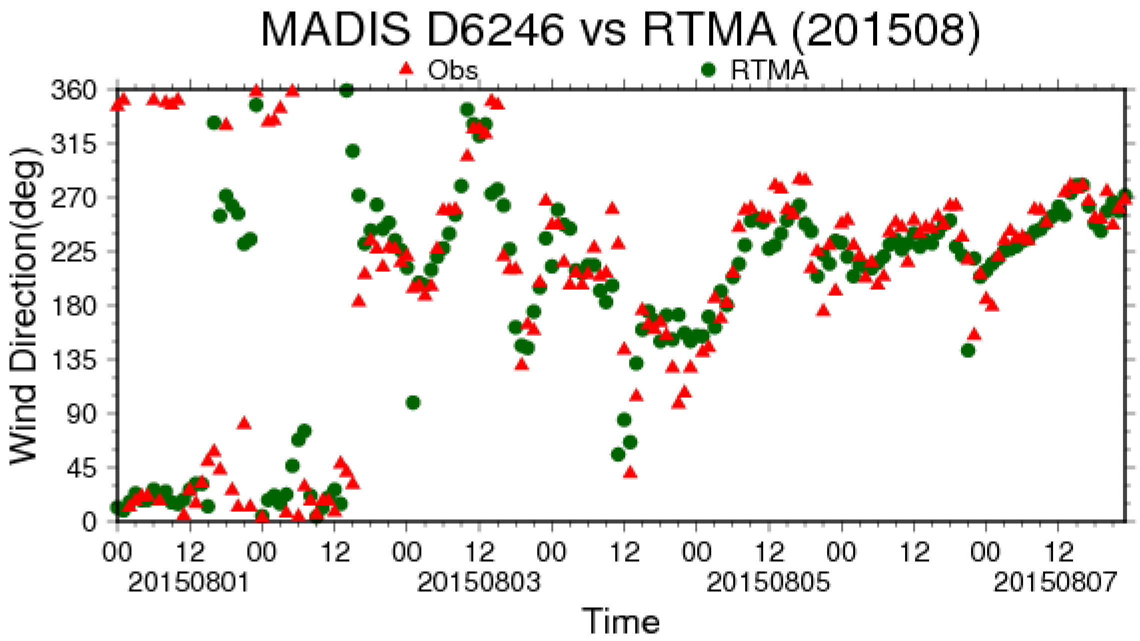
Temperature (C)							***Sample size***		
Station	May 2015		Aug 2015		Oct 2015		May	Aug	Oct
	Bias	*Abs Err*	*Bias*	*Abs Err*	*Bias*	*Abs Err*			
KMSY	-0.8	0.8	-0.4	0.7	-0.6	0.7	191	167	166
BBNL1	0.0	0.5	0.0	1.1	0.1	1.3	190	168	164
D6246	0.1	0.5	0.5	0.8	0.4	1.0	191	167	151
SHBL1	-0.1	0.4	-0.6	0.7	-0.7	0.9	12	8	111
NNHM6	-0.2	0.7	0.3	1.1	-0.1	1.2	187	168	167
KGPT	-0.5	0.6	-0.6	0.8	-0.5	0.8	191	168	167
42067	0.2	0.5	-0.2	0.5	NA	NA	47	53	NA
PTBM6	-1.7	1.9	-0.5	0.8	-0.1	0.8	191	168	167
DPIA1	-0.4	0.5	-0.2	0.4	0.1	0.4	178	168	166

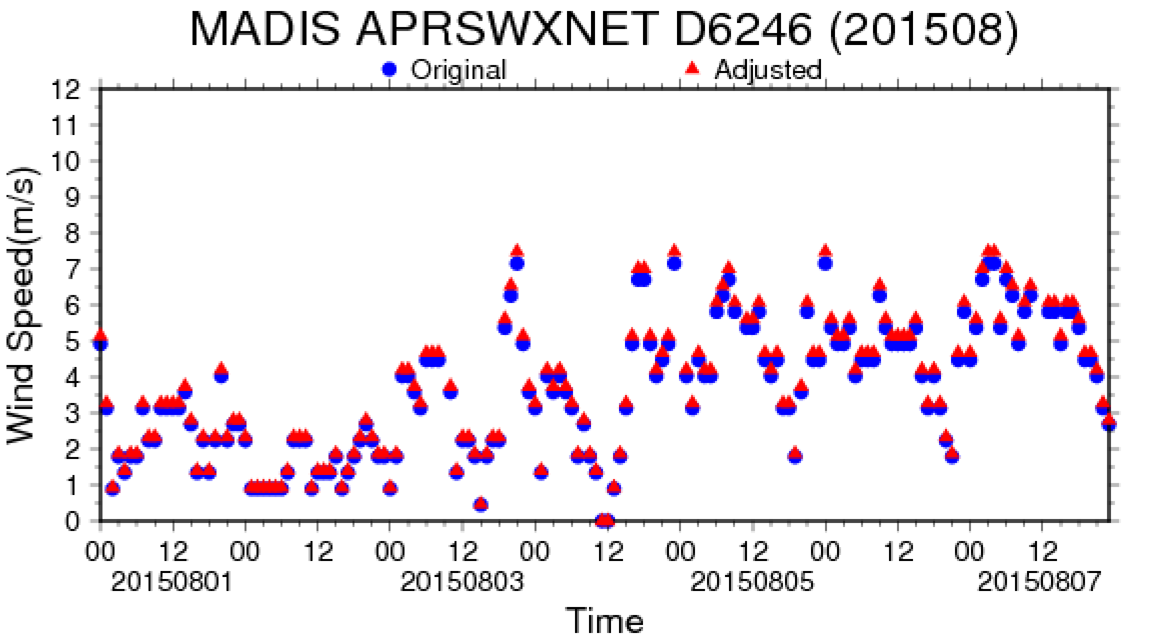
Wind speed (ms^{-1})							***Sample size***		
Station	May 2015		Aug 2015		Oct 2015		May n	Aug n	Oct n
	Bias	*Abs Err*	*Bias*	*Abs Err*	*Bias*	*Abs Err*			
KMSY	-1.9	1.9	-2.1	2.1	-1.7	1.7	187	157	154
BBNL1	0.6	0.8	0.0	0.7	0.0	0.5	188	115	114
D6246	1.6	1.9	0.4	1.2	0.5	1.2	164	161	150
SHBL1	-0.2	0.9	0.1	1.0	-0.7	1.2	164	155	140
NNHM6	1.1	1.2	1.2	1.3	1.1	1.2	170	118	115
KGPT	-2.2	2.2	-0.8	1.0	-2.1	2.1	171	135	130
42067	-0.6	1.3	-0.9	1.5	-0.1	1.1	46	53	13
PTBM6	0.2	1.2	-0.6	1.1	0.1	1.1	189	166	167
DPIA1	-0.1	1.0	0.7	1.5	-0.2	0.9	188	167	165

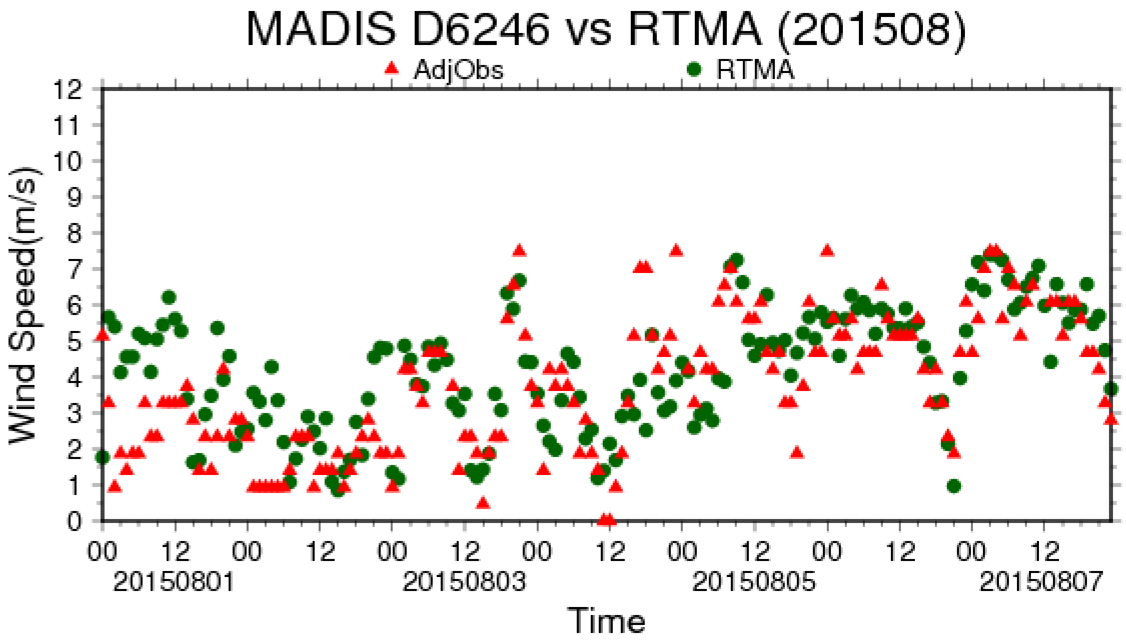
Wind direction (deg)							***Sample size***		
Station	May 2015		Aug 2015		Oct 2015		May n	Aug n	Oct n
	Bias	*Abs Err*	*Bias*	*Abs Err*	*Bias*	*Abs Err*			
KMSY	-3,7	12.0	-2.8	20.7	-3.0	18.2	185	155	151
BBNL1	20.6	24.7	15.3	32.8	23.7	32.5	188	115	114
D6246	12.5	14.0	2.4	25.6	6.2	21.3	164	161	150
SHBL1	7.1	10.7	14.7	29.3	2.6	16.3	164	155	140
NNHM6	14.8	17.9	-1.6	33.1	11.8	24.6	170	118	115
KGPT	4.4	9.1	-4.2	17.3	-0.3	14.4	169	128	127
42067	-2.7	10.4	-6.2	24.1	3.9	15.8	46	53	13
PTBM6	7.5	12.3	-8.7	22.8	6.2	14.7	189	166	167
DPIA1	4.8	12.4	8.2	21.3	9.3	14.4	188	167	165

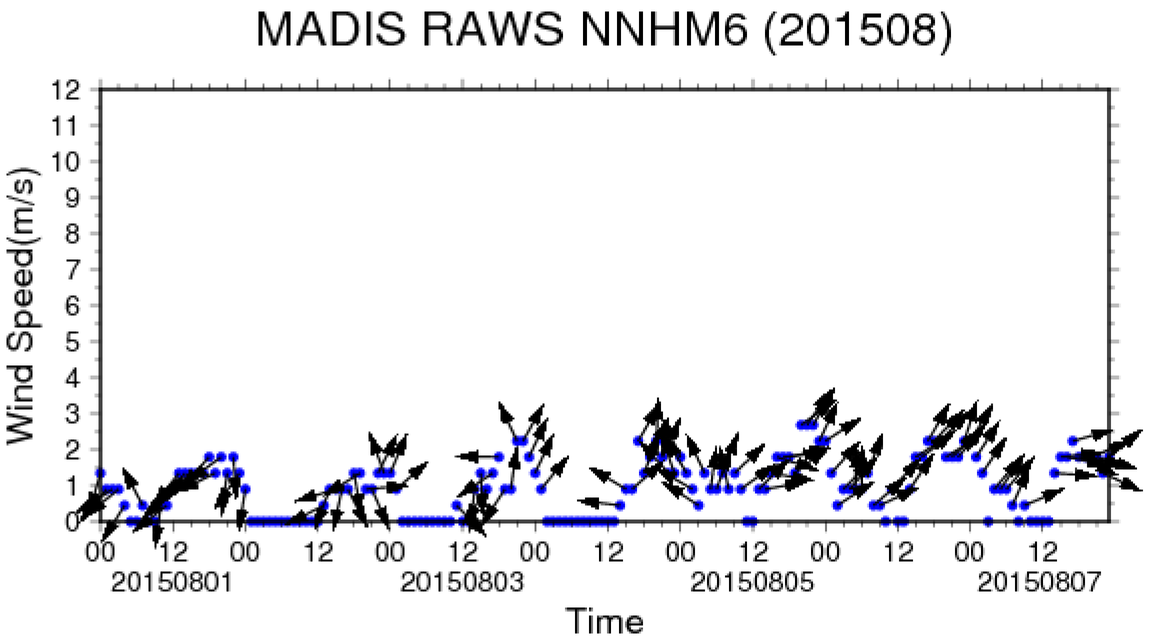
Aug Time series, wind

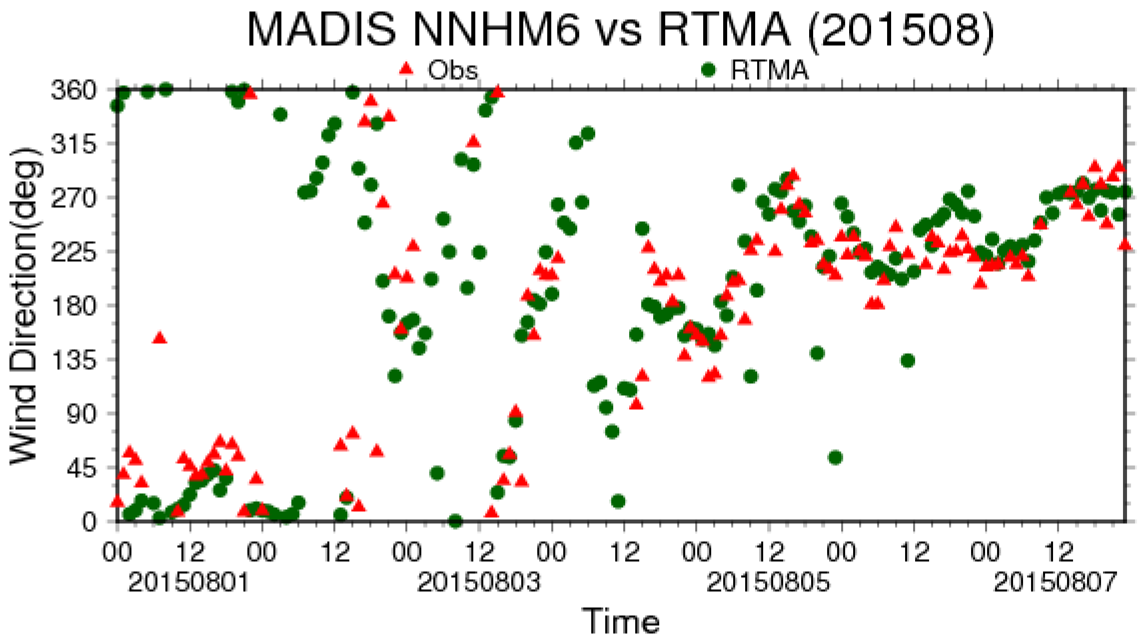

MADIS APRSWXNET D6246 (201508)
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

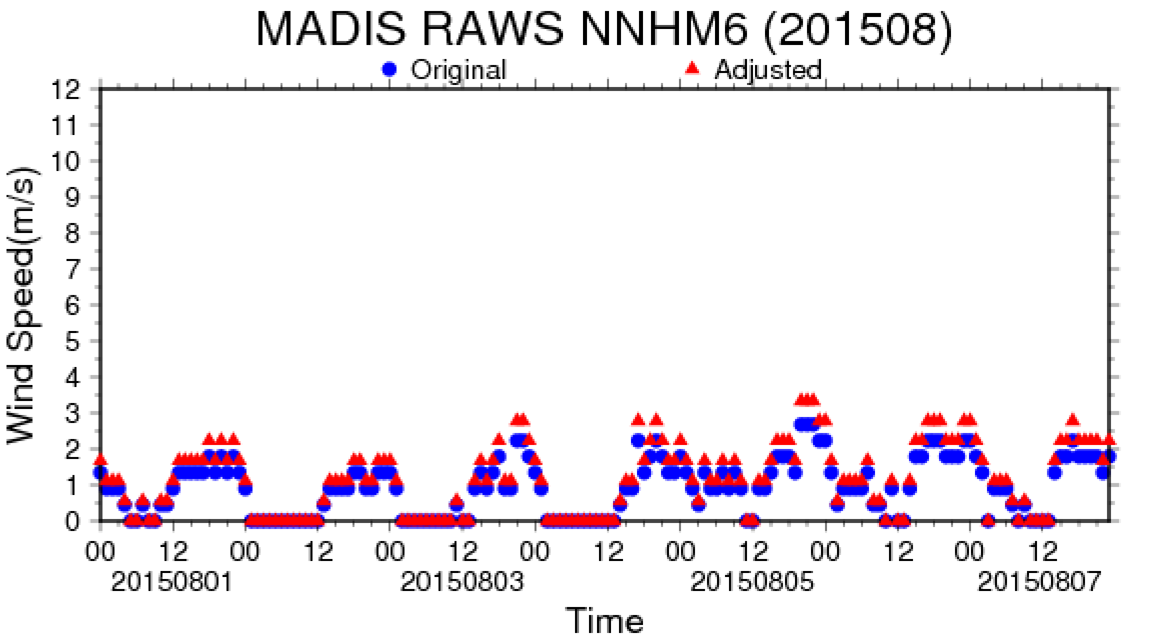

MADIS D6246 vs RTMA (201508)
Obs
RTMA
Wind Direction(deg)
Time
20150801
20150803
20150805
20150807

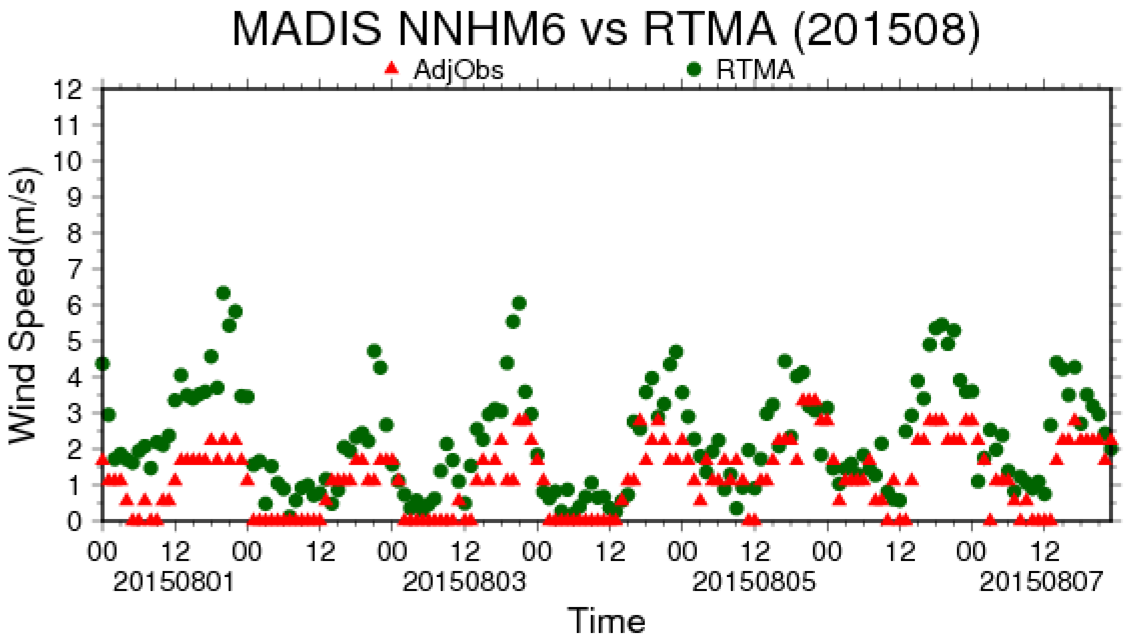

MADIS APRSWXNET D6246 (201508)
Original
Adjusted
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

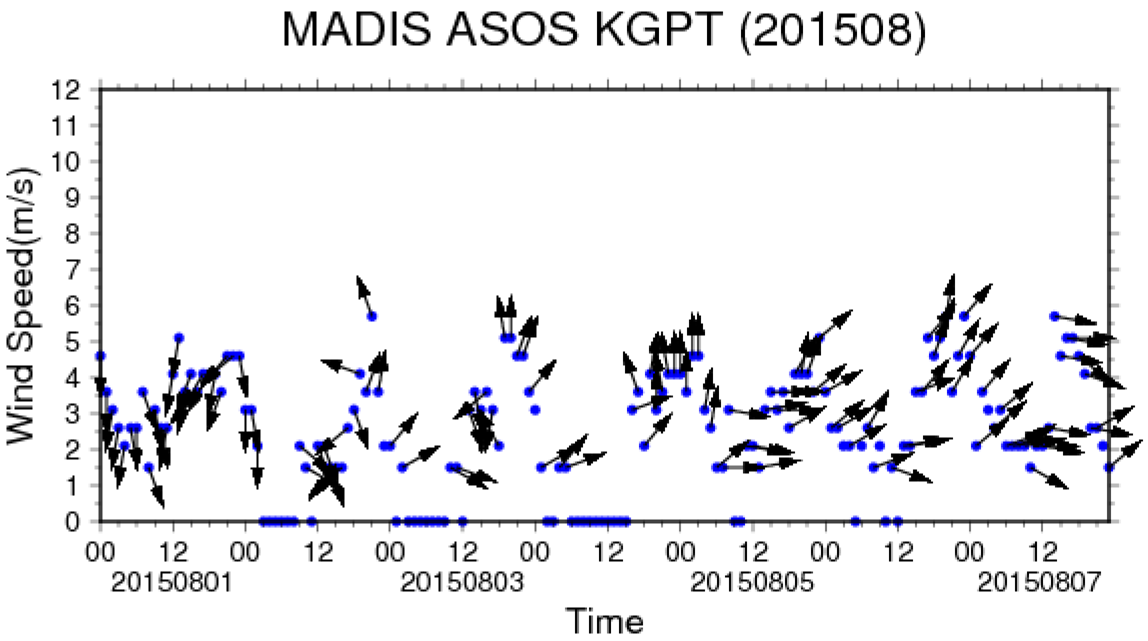

MADIS D6246 vs RTMA (201508)
AdjObs
RTMA
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

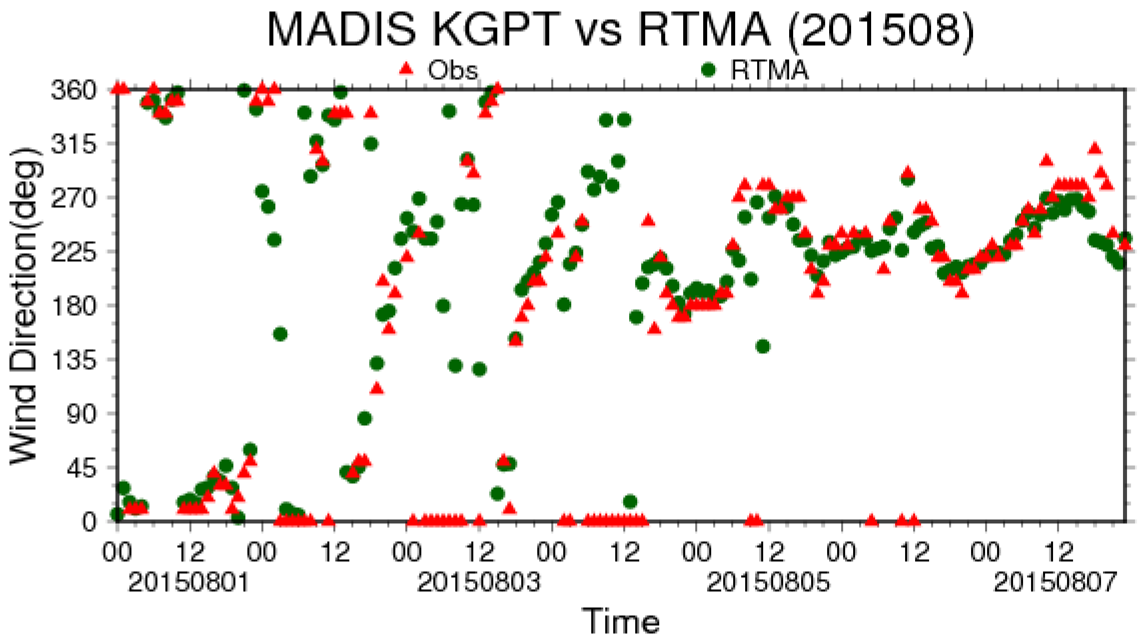

MADIS RAWS NNHM6 (201508)
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

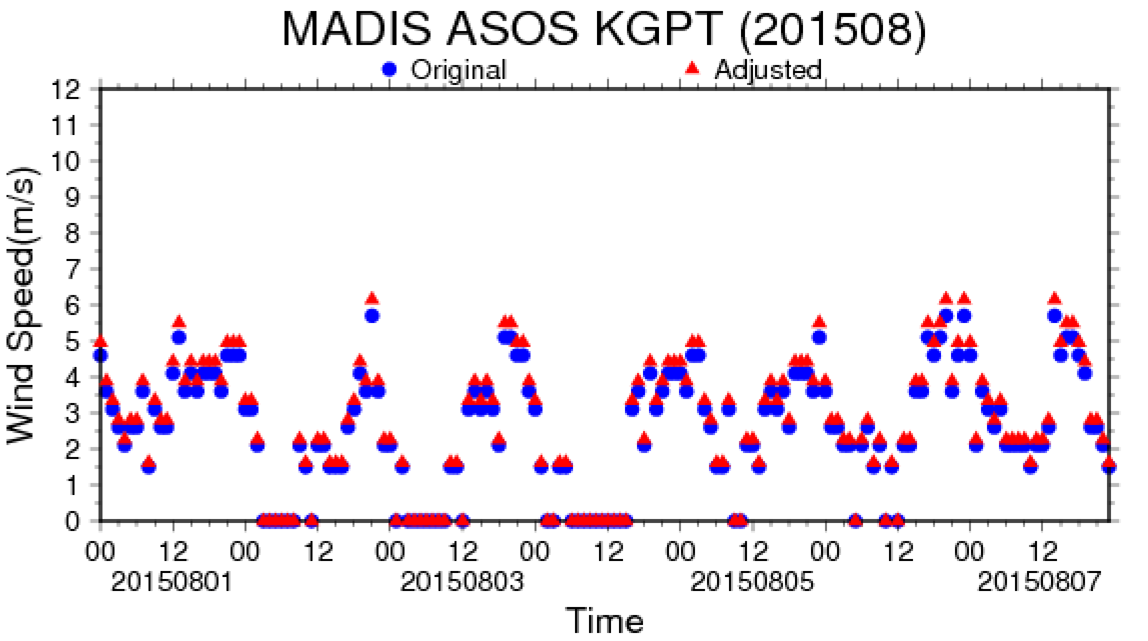

MADIS NNHM6 vs RTMA (201508)
Obs
RTMA
Wind Direction(deg)
Time
20150801
20150803
20150805
20150807

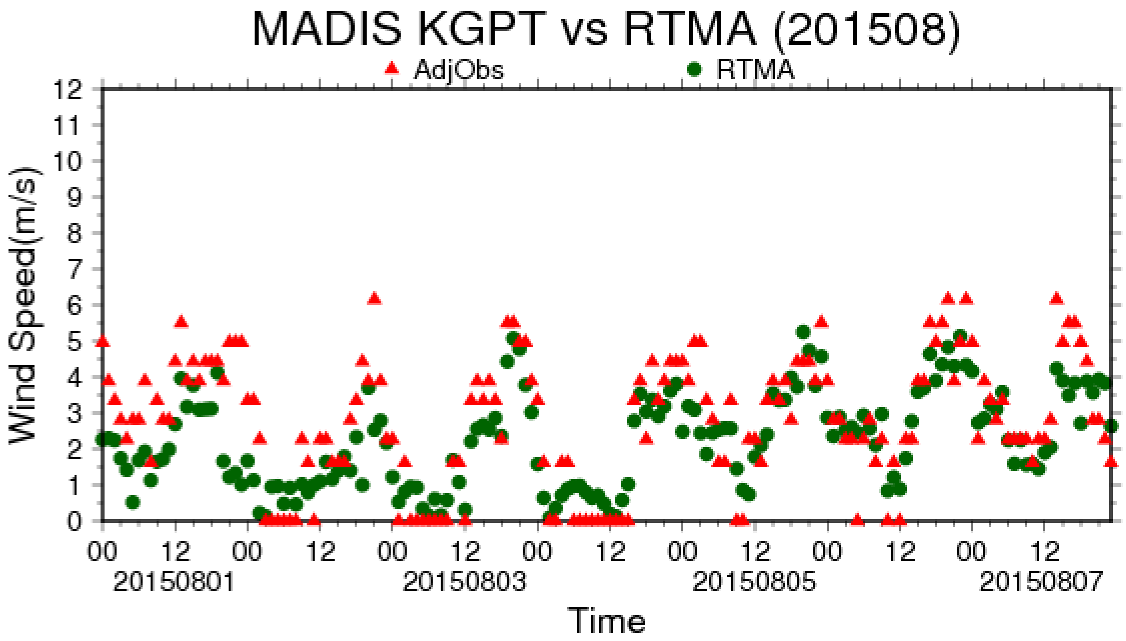

MADIS RAWS NNHM6 (201508)
Original
Adjusted
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

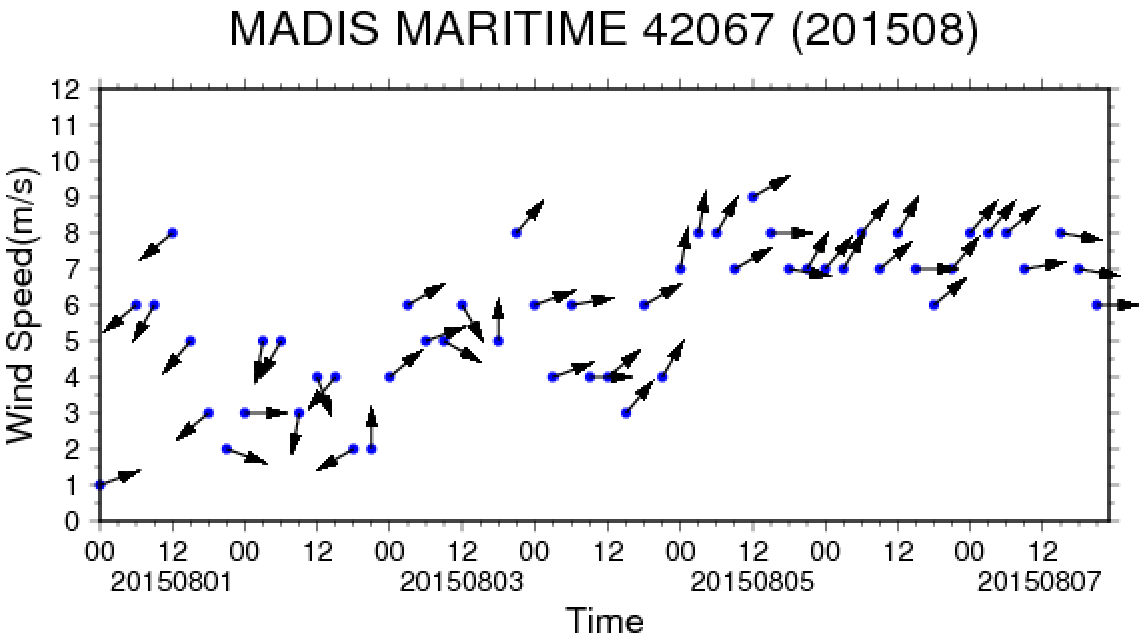

MADIS NNHM6 vs RTMA (201508)
AdjObs
RTMA
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

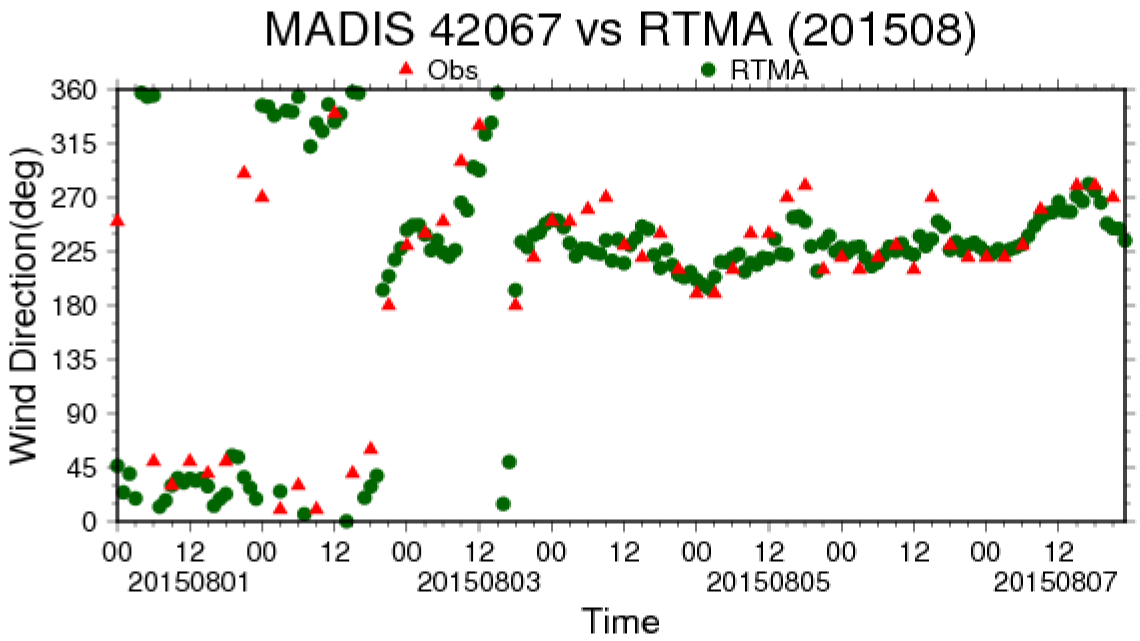

MADIS ASOS KGPT (201508)
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

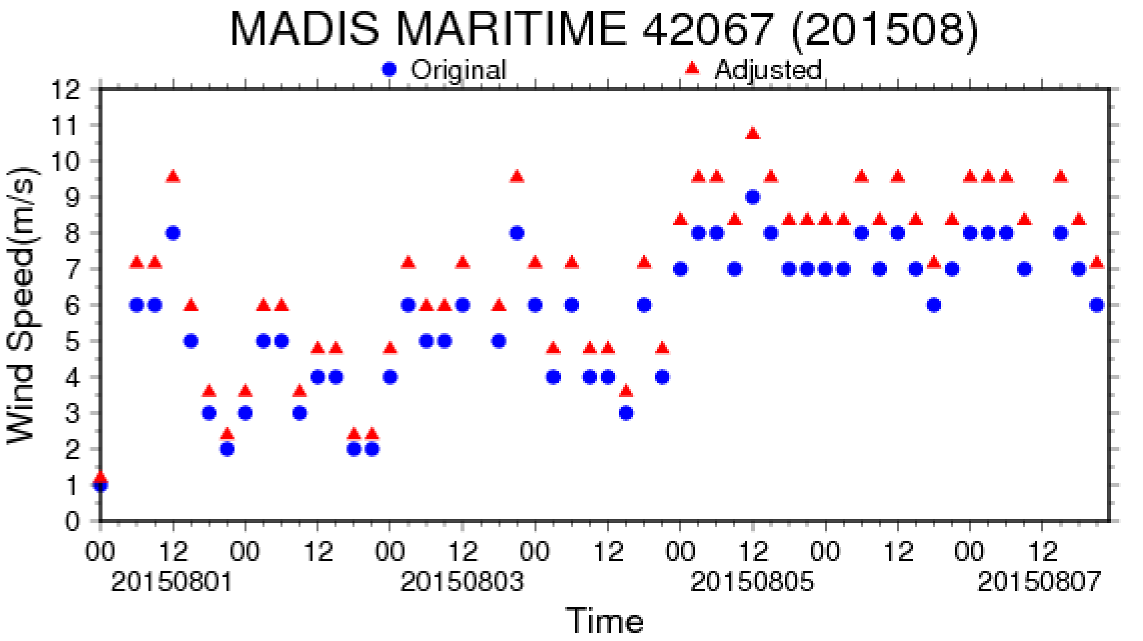

MADIS KGPT vs RTMA (201508)
Obs
RTMA
Wind Direction(deg)
Time
20150801
20150803
20150805
20150807

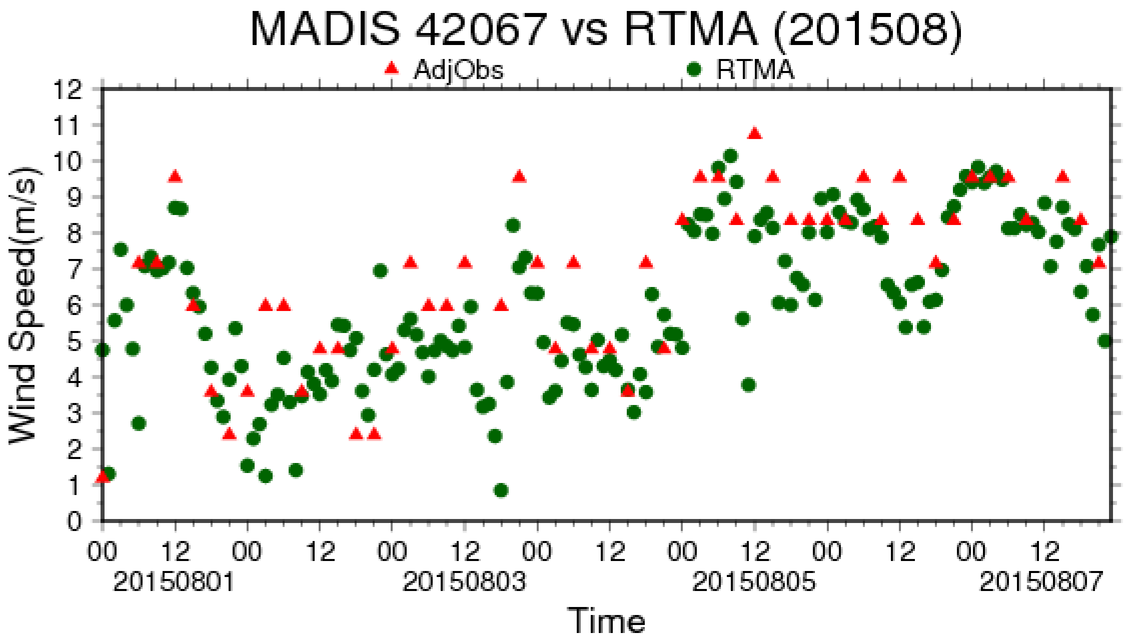

MADIS ASOS KGPT (201508)
Original
Adjusted
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807

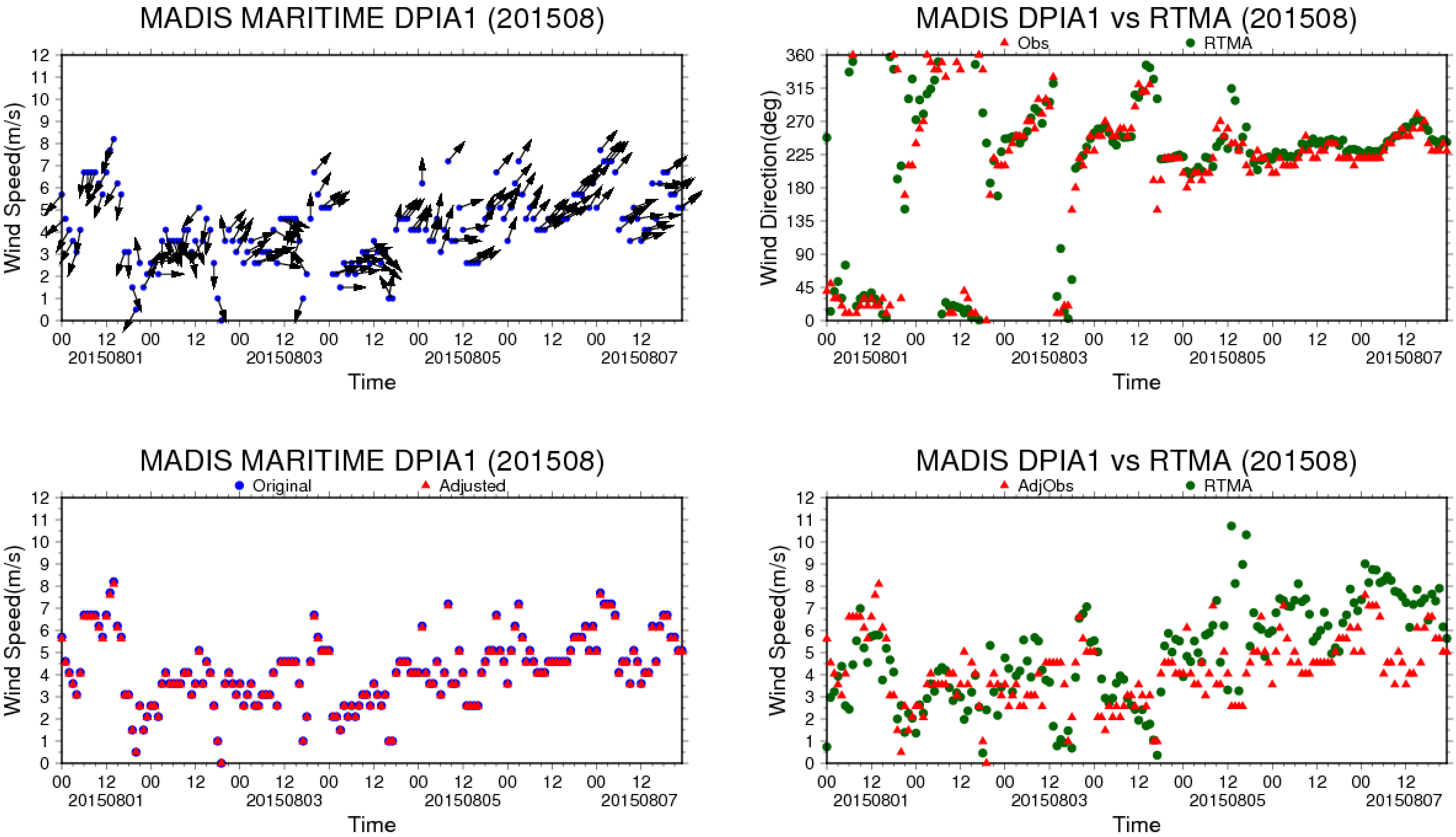

MADIS KGPT vs RTMA (201508)
AdjObs
RTMA
Wind Speed(m/s)
Time
20150801
20150803
20150805
20150807


MADIS MARITIME 42067 (201508)
Wind Speed(m/s)
0
1
2
3
4
5
6
7
8
9
10
11
12
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20150801
20150803
20150805
20150807
Time

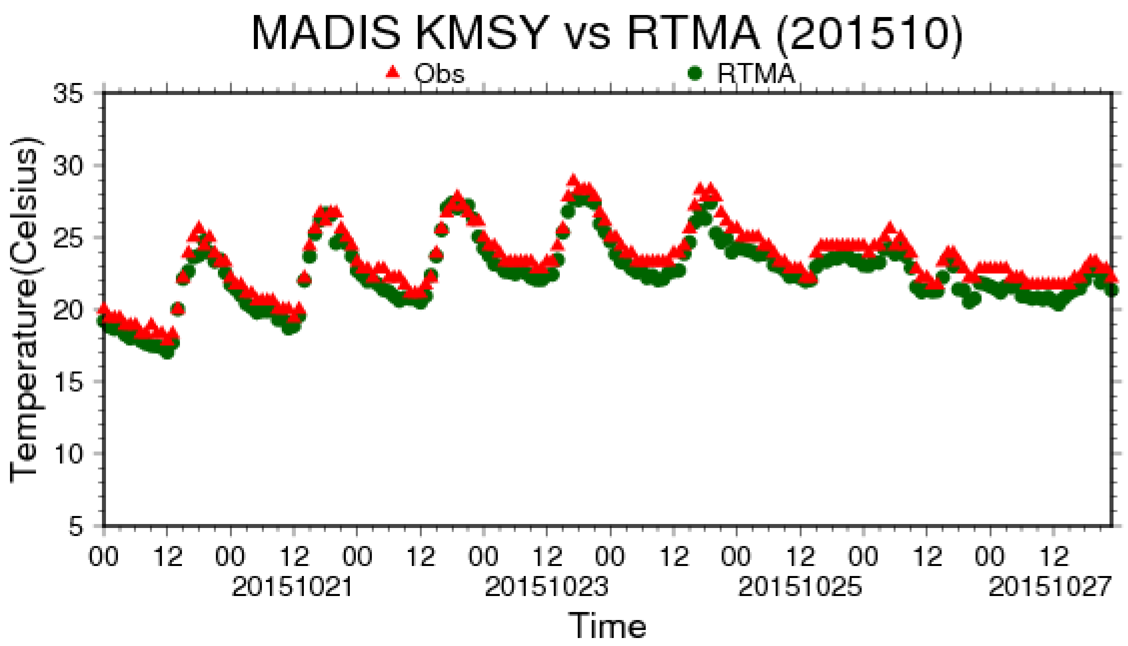

MADIS 42067 vs RTMA (201508)
Obs
RTMA
Wind Direction(deg)
0
45
90
135
180
225
270
315
360
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20150801
20150803
20150805
20150807
Time

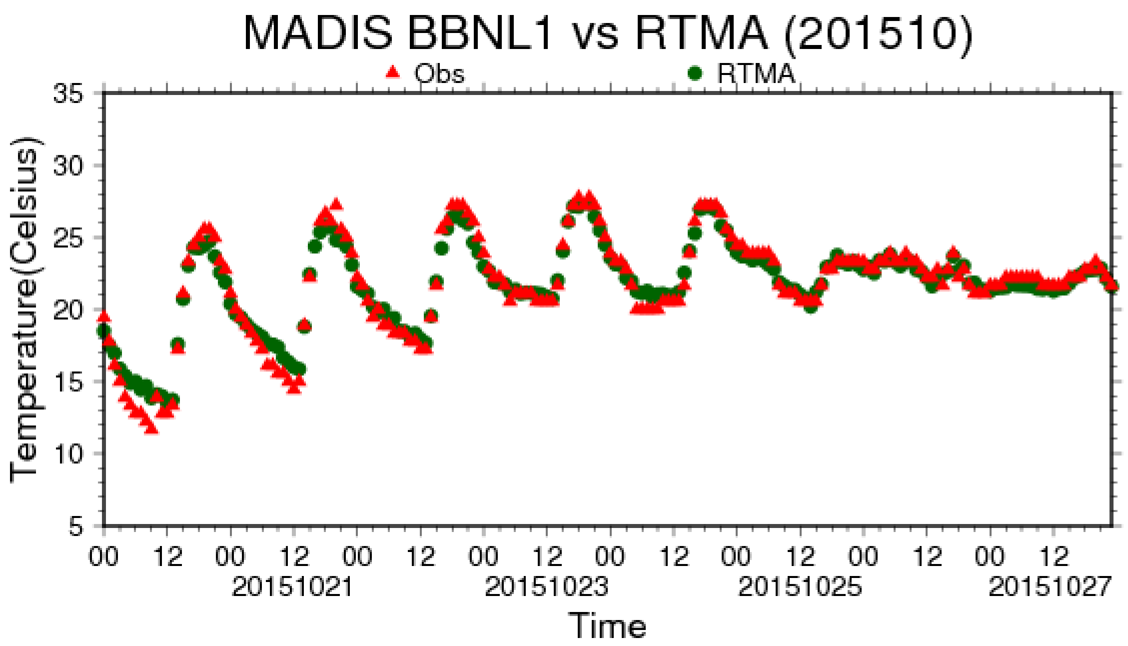

MADIS MARITIME 42067 (201508)
Original
Adjusted
Wind Speed(m/s)
0
1
2
3
4
5
6
7
8
9
10
11
12
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20150801
20150803
20150805
20150807
Time

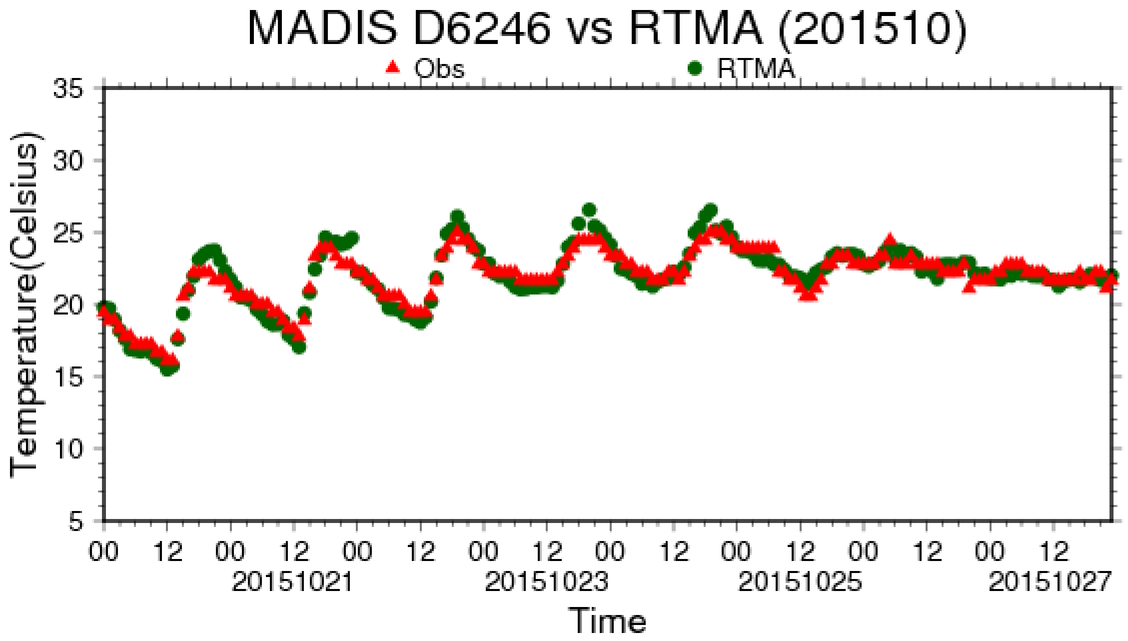

MADIS 42067 vs RTMA (201508)
AdjObs
RTMA
Wind Speed(m/s)
0
1
2
3
4
5
6
7
8
9
10
11
12
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20150801
20150803
20150805
20150807
Time

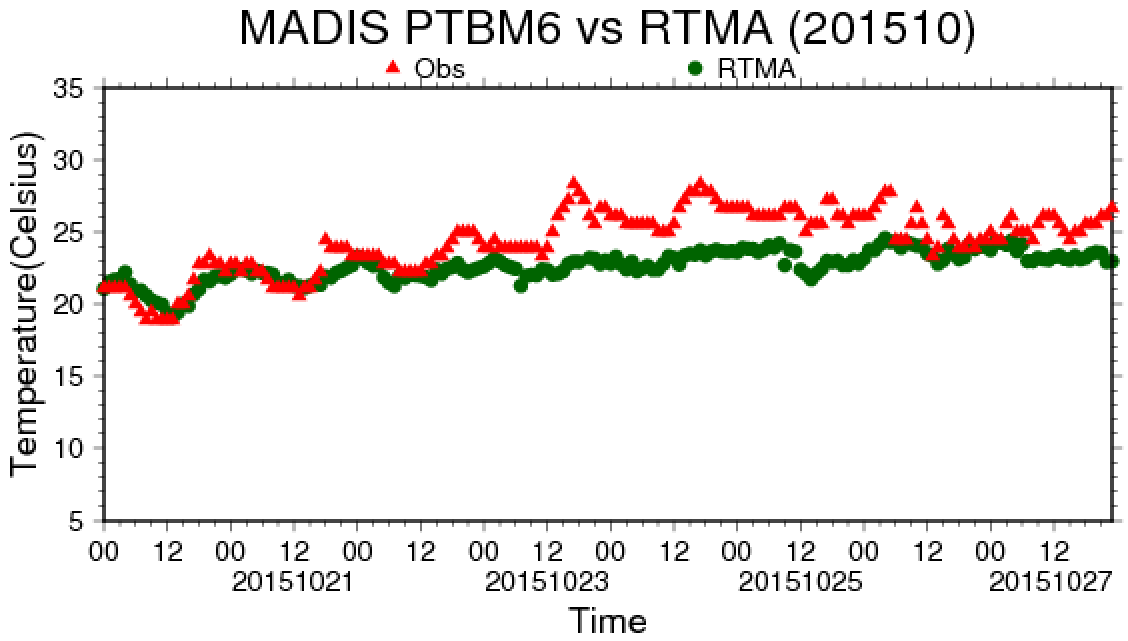

MADIS MARITIME DPIA1 (201508)
Wind Speed(m/s)
Time
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20150801 20150803 20150805 20150807
MADIS DPIA1 vs RTMA (201508)
Obs
RTMA
Wind Direction(deg)
0 45 90 135 180 225 270 315 360
Time
MADIS MARITIME DPIA1 (201508)
Original
Adjusted
Wind Speed(m/s)
Time
MADIS DPIA1 vs RTMA (201508)
AdjObs
RTMA
Wind Speed(m/s)
Time

Aug Time series, temperature


MADIS KMSY vs RTMA (201510)
Obs
RTMA
Temperature(Celsius)
35
30
25
20
15
10
5
00
12
00
12
00
12
00
12
00
12
00
12
00
12
20151021
20151023
20151025
20151027
Time


MADIS BBNL1 vs RTMA (201510)
Obs
RTMA
Temperature(Celsius)
35
30
25
20
15
10
5
00
12
00
12
00
12
00
12
00
12
00
12
00
12
00
12
20151021
20151023
20151025
20151027
Time

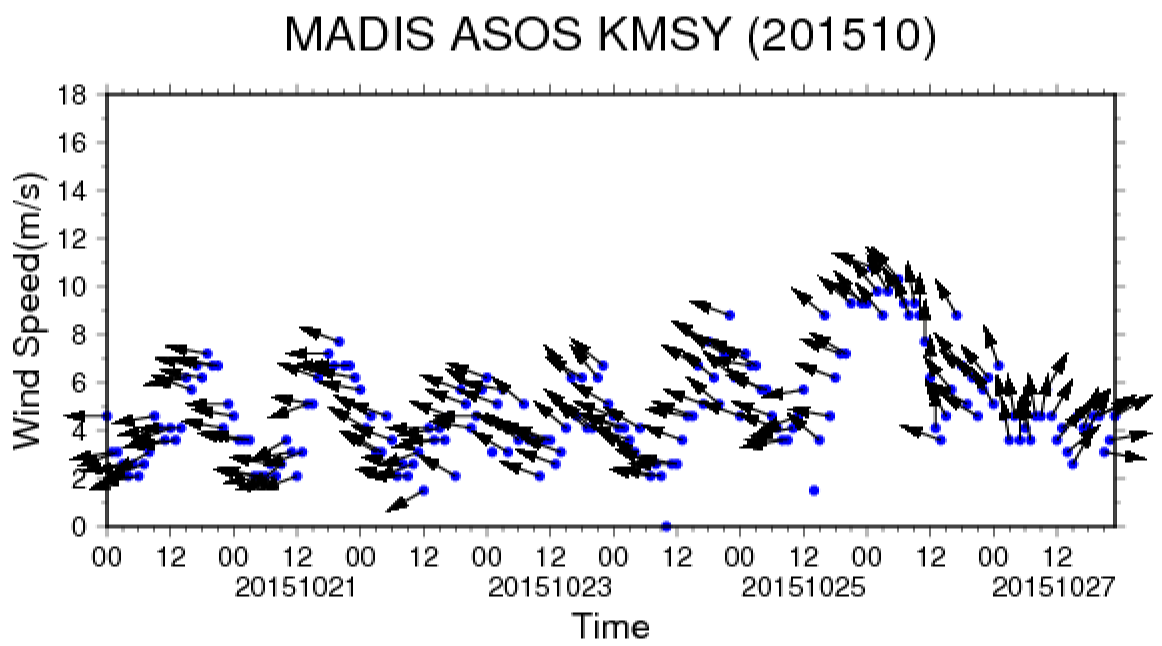

MADIS D6246 vs RTMA (201510)
Obs
RTMA
Temperature(Celsius)
35
30
25
20
15
10
5
00
12
00
12
00
12
00
12
00
12
00
12
00
12
00
12
20151021
20151023
20151025
20151027
Time



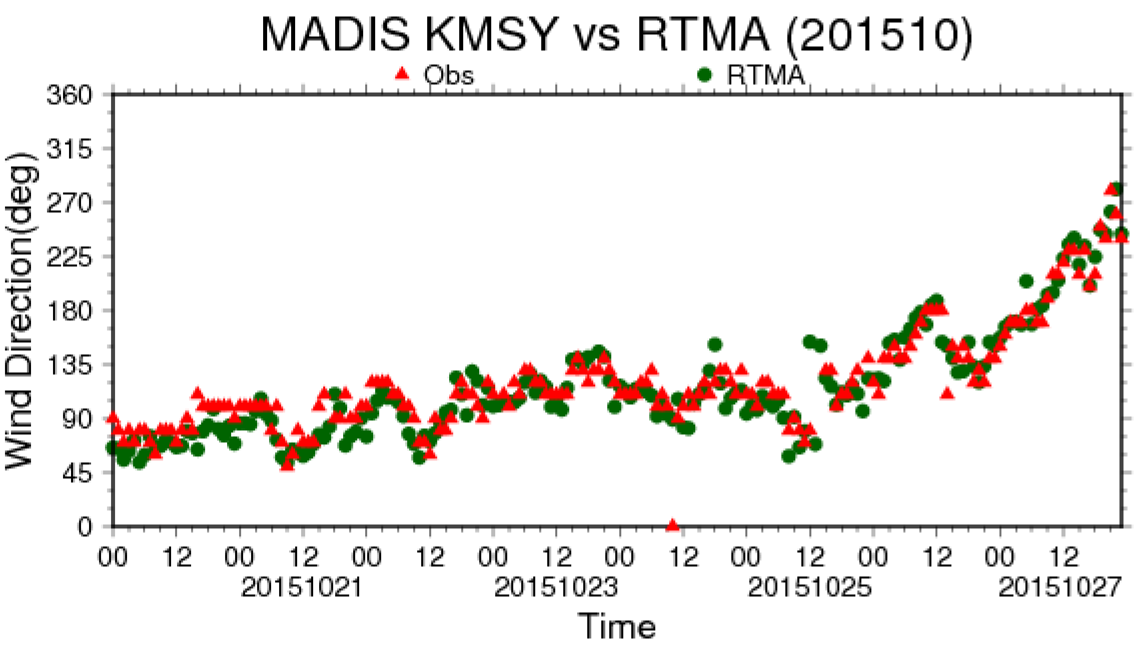
Station probably not on accept list

Oct Time series, wind (Patricia's remnants)

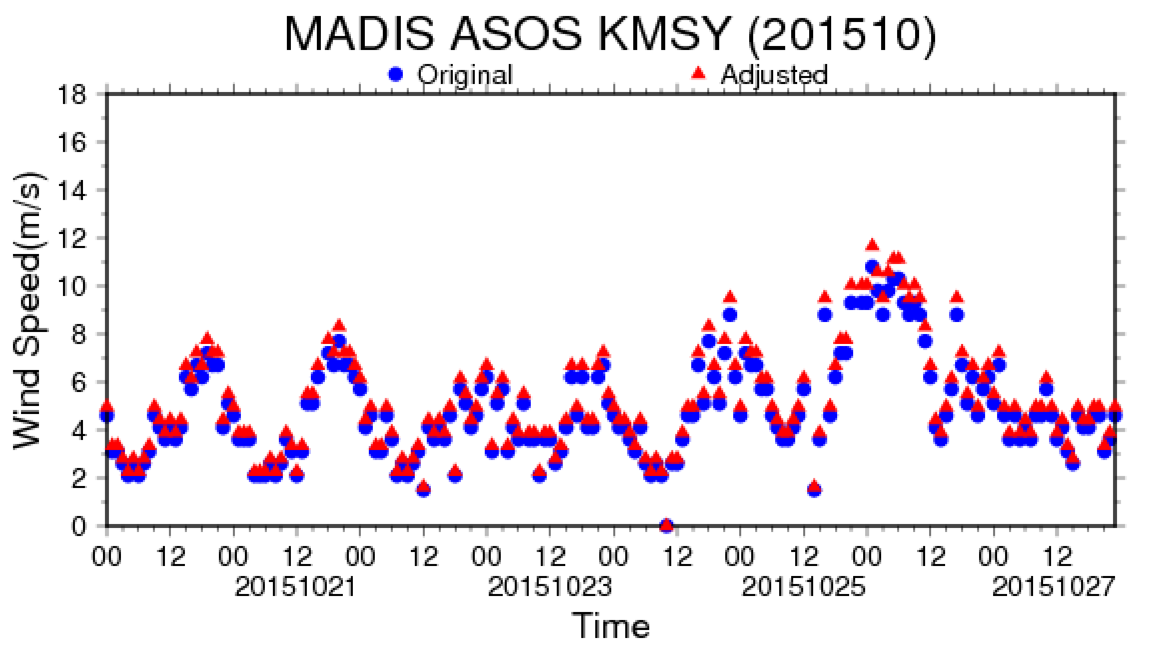
Coincides with first CONCORDE cruises



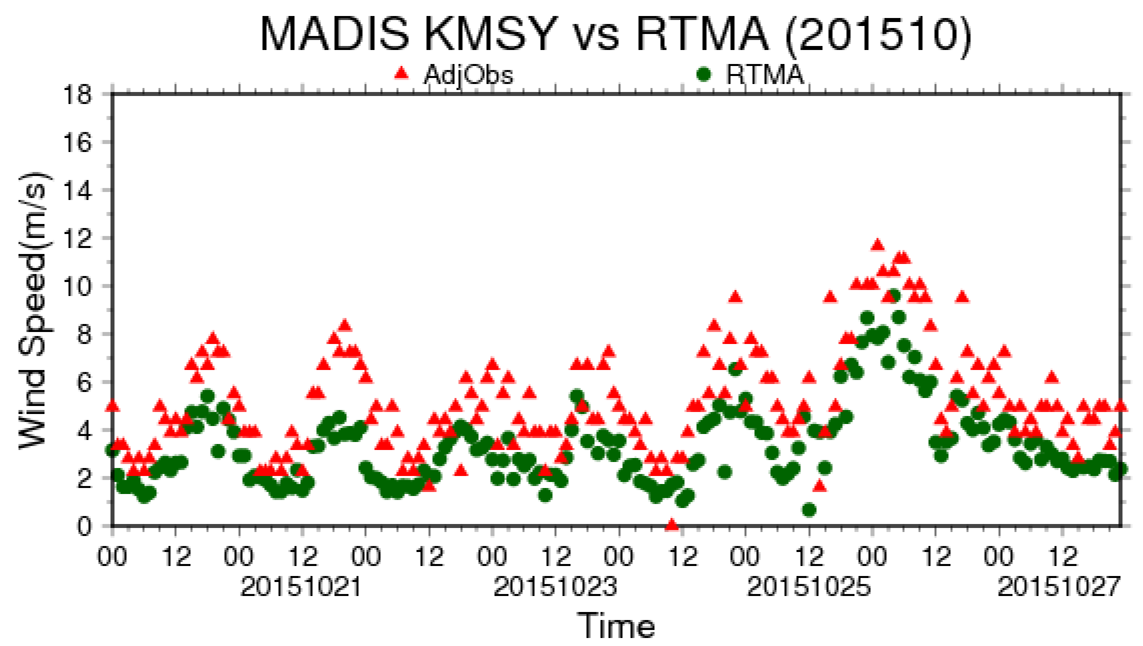
MADIS ASOS KMSY (201510)
Wind Speed(m/s)
Time
20151021
20151023
20151025
20151027



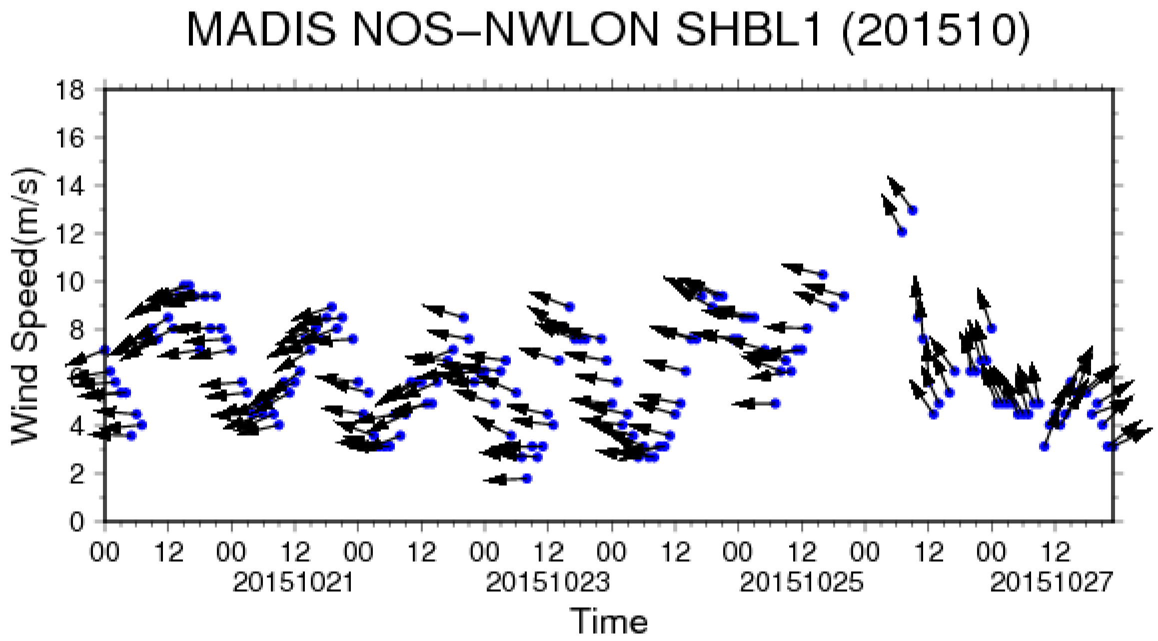
MADIS KMSY vs RTMA (201510)
Obs
RTMA
Wind Direction(deg)
Time
20151021
20151023
20151025
20151027

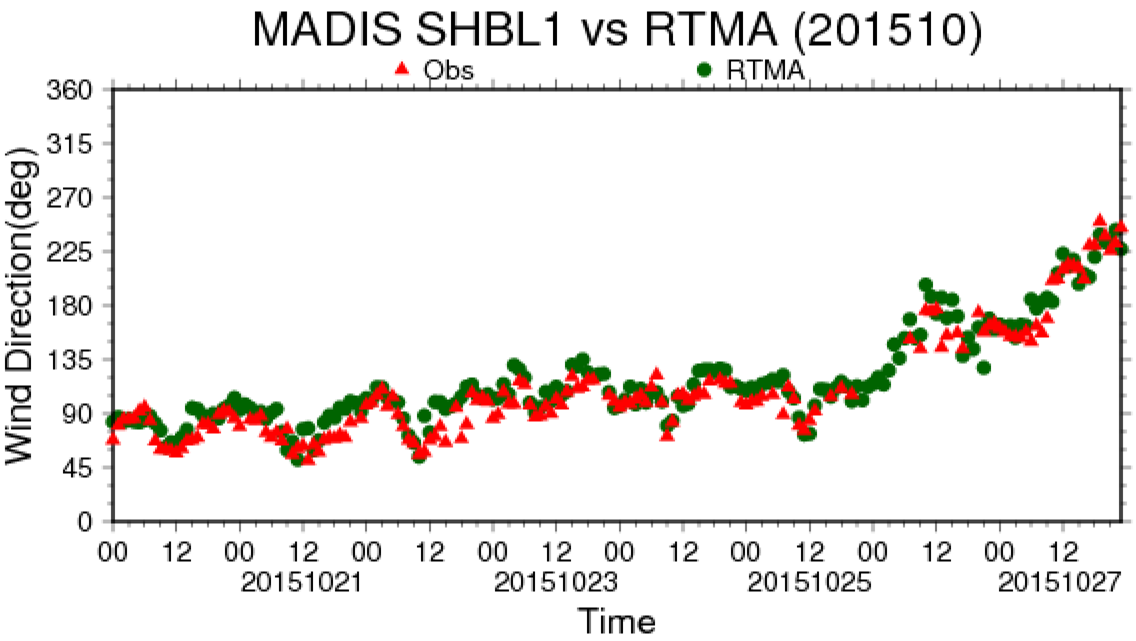


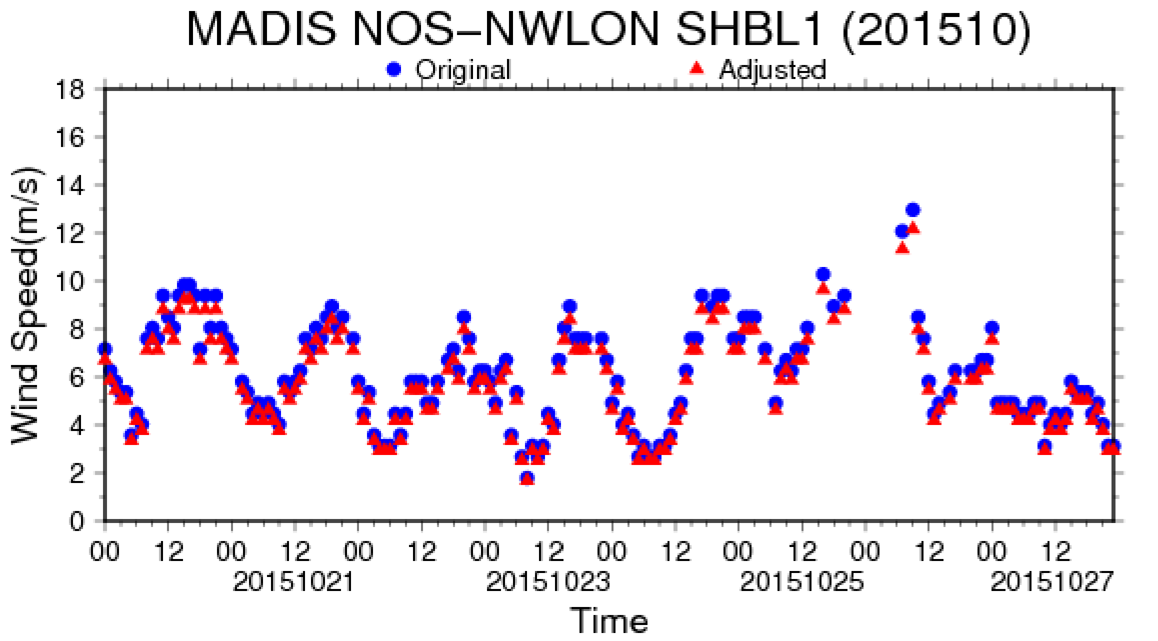
MADIS ASOS KMSY (201510)
Original
Adjusted
Wind Speed(m/s)
Time
20151021
20151023
20151025
20151027

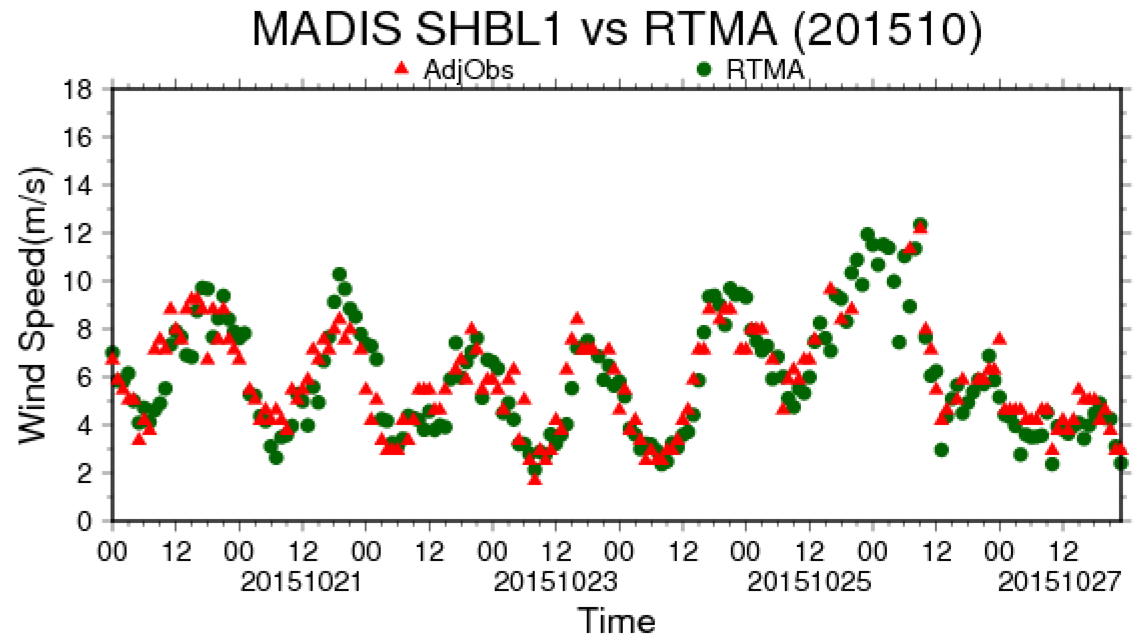


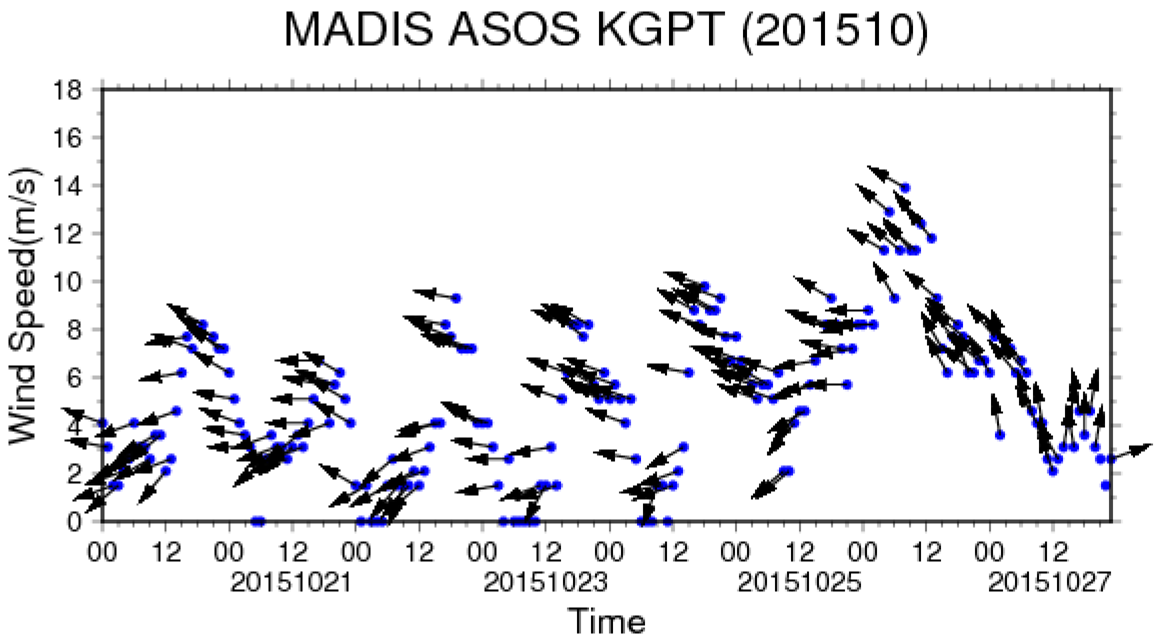
MADIS KMSY vs RTMA (201510)
AdjObs
RTMA
Wind Speed(m/s)
Time
20151021
20151023
20151025
20151027

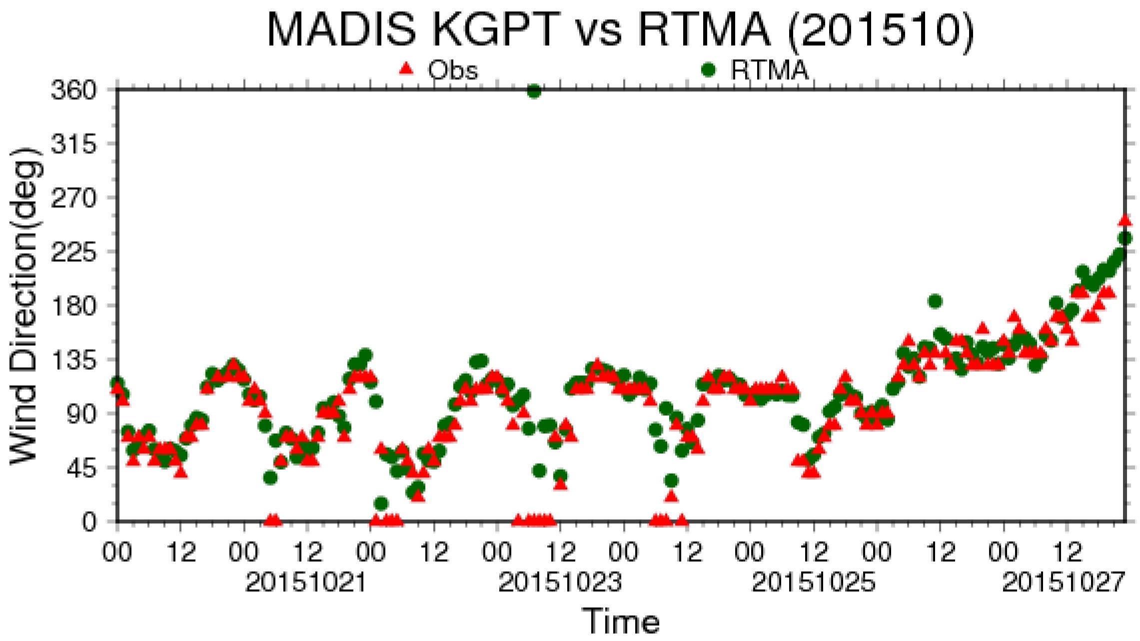

MADIS NOS−NWLON SHBL1 (201510)
Wind Speed(m/s)
Time
20151021
20151023
20151025
20151027

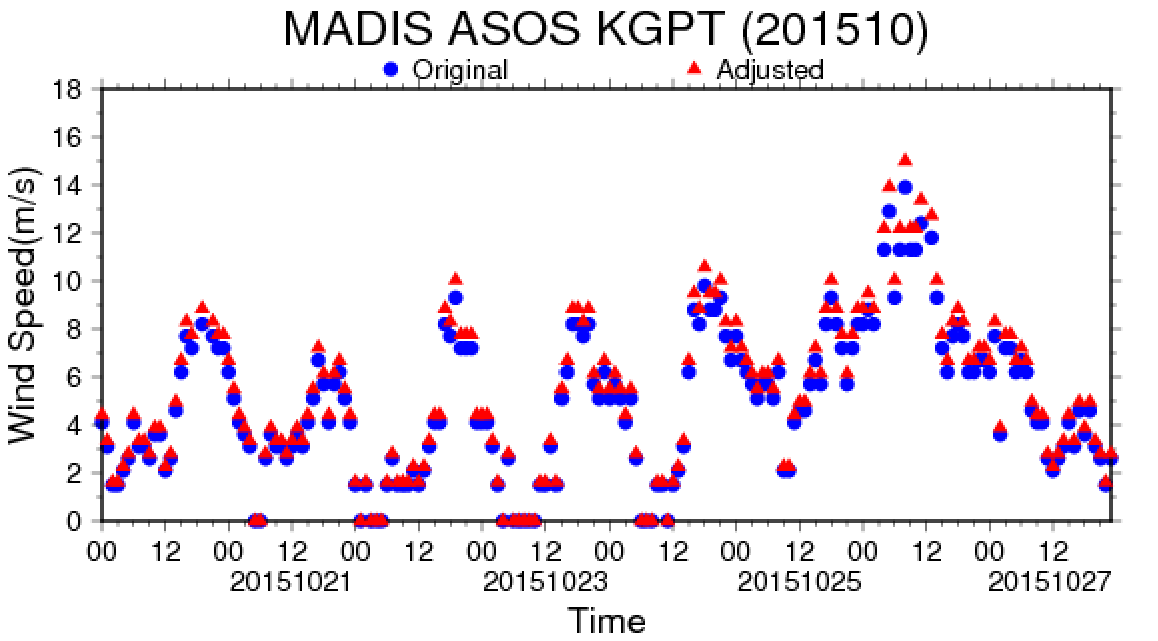

MADIS SHBL1 vs RTMA (201510)
Obs
RTMA
Wind Direction(deg)
Time
20151021
20151023
20151025
20151027

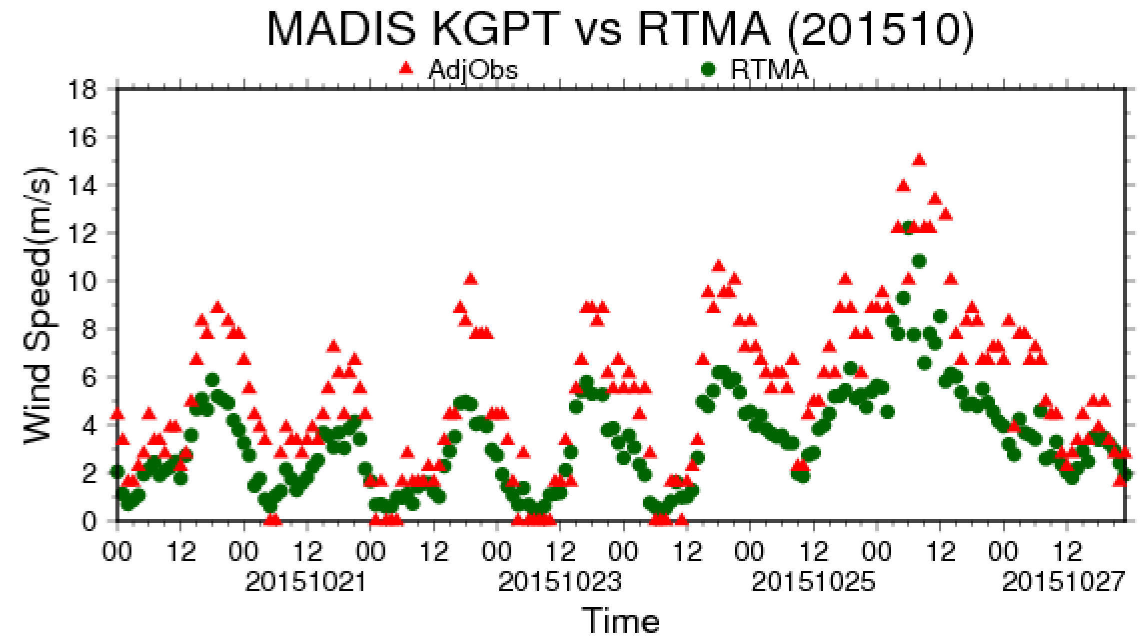

MADIS NOS−NWLON SHBL1 (201510)
Original
Adjusted
Wind Speed(m/s)
Time
20151021
20151023
20151025
20151027

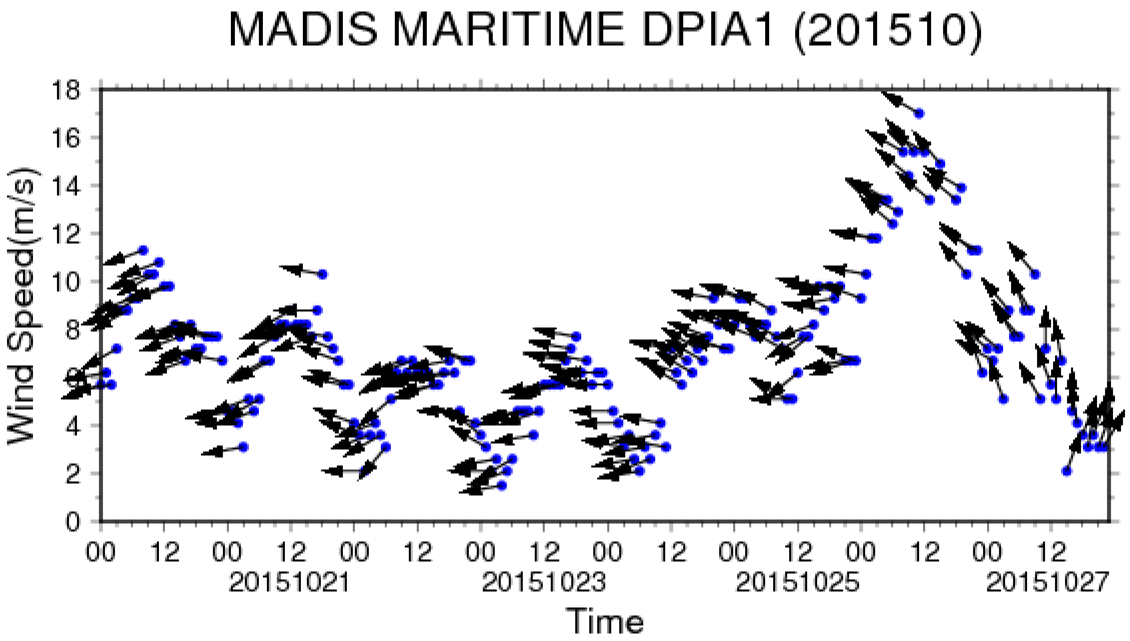

MADIS SHBL1 vs RTMA (201510)
AdjObs
RTMA
Wind Speed(m/s)
Time
20151021
20151023
20151025
20151027

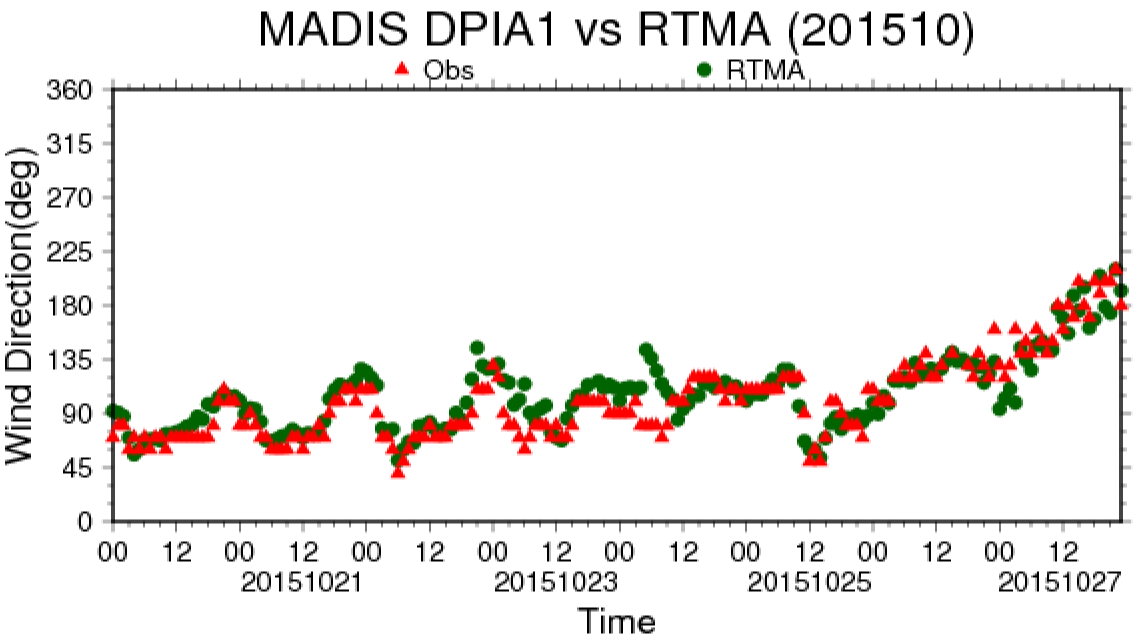

MADIS ASOS KGPT (201510)
Wind Speed(m/s)
18
16
14
12
10
8
6
4
2
0
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20151021
20151023
20151025
20151027
Time

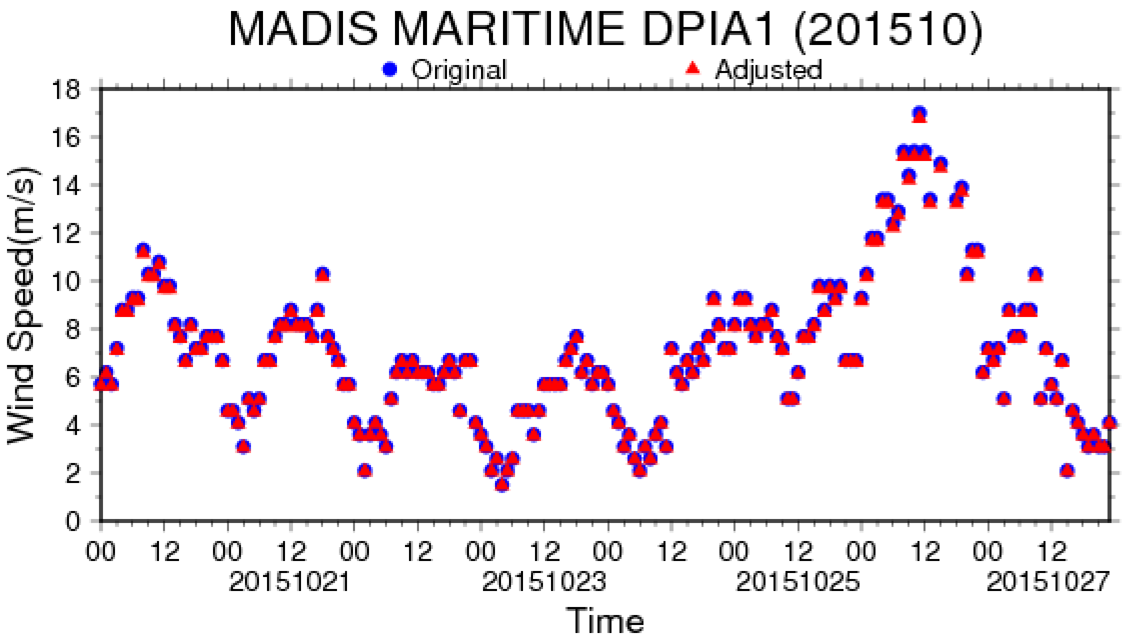

MADIS KGPT vs RTMA (201510)
Obs
RTMA
Wind Direction(deg)
360
315
270
225
180
135
90
45
0
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20151021
20151023
20151025
20151027
Time

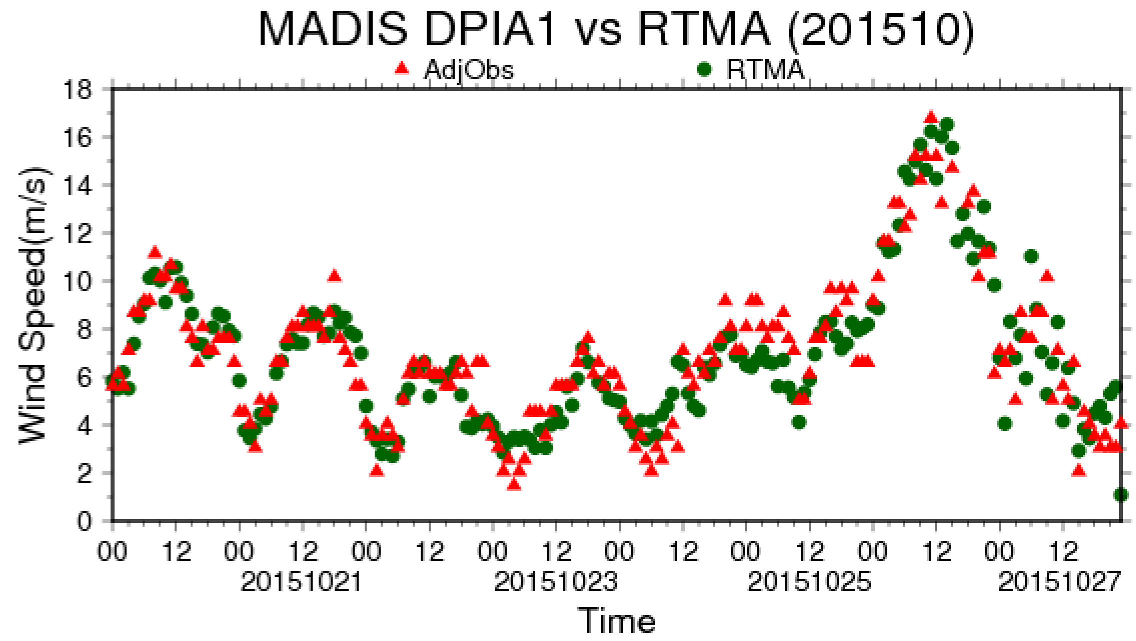

MADIS ASOS KGPT (201510)
Original
Adjusted
Wind Speed(m/s)
18
16
14
12
10
8
6
4
2
0
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20151021
20151023
20151025
20151027
Time


MADIS KGPT vs RTMA (201510)
AdjObs
RTMA
Wind Speed(m/s)
18
16
14
12
10
8
6
4
2
0
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20151021
20151023
20151025
20151027
Time


MADIS MARITIME DPIA1 (201510)
Wind Speed(m/s)
Time
00 12 00 12 00 12 00 12 00 12 00 12 00 12
20151021 20151023 20151025 20151027

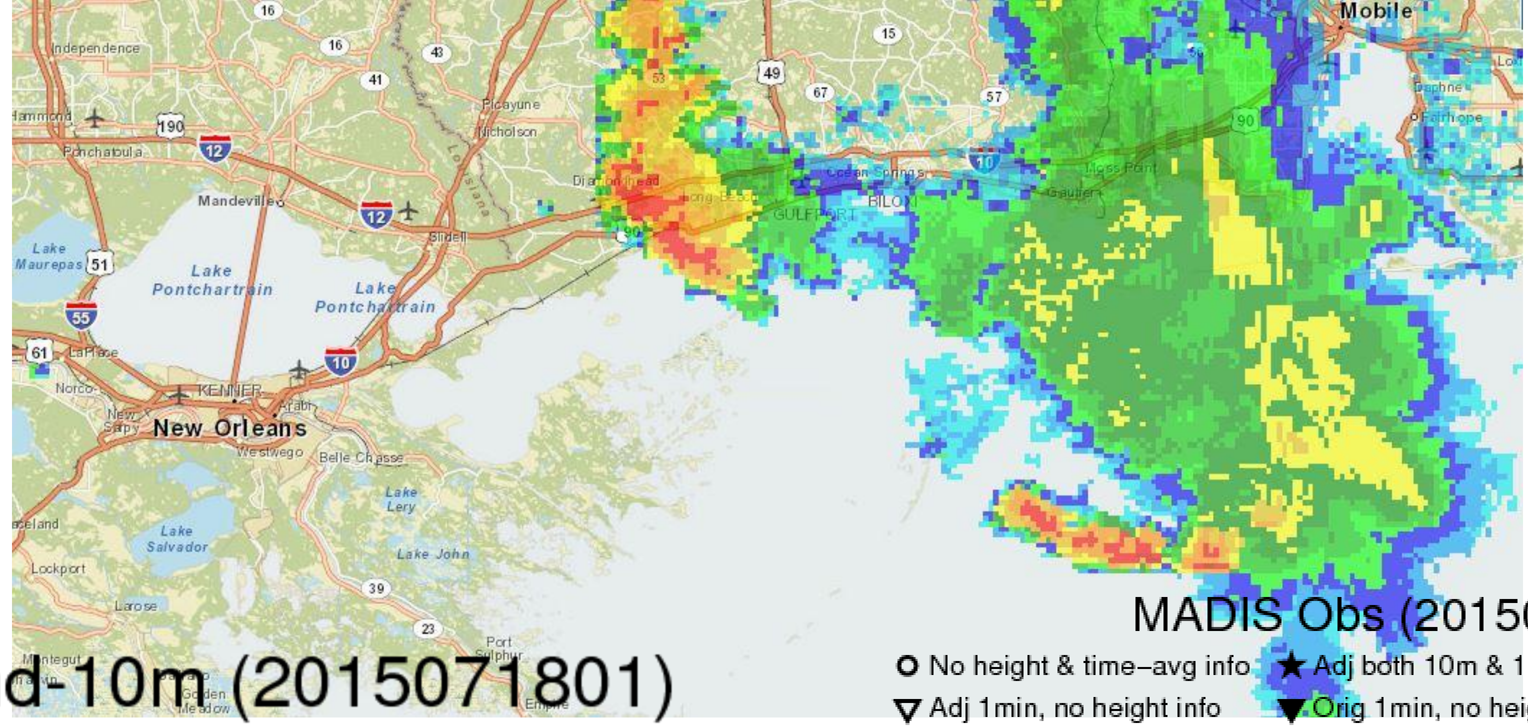

MADIS DPIA1 vs RTMA (201510)
Obs
RTMA
Wind Direction(deg)
Time
20151021 20151023 20151025 20151027


MADIS MARITIME DPIA1 (201510)
Original
Adjusted
Wind Speed(m/s)
Time
20151021 20151023 20151025 20151027

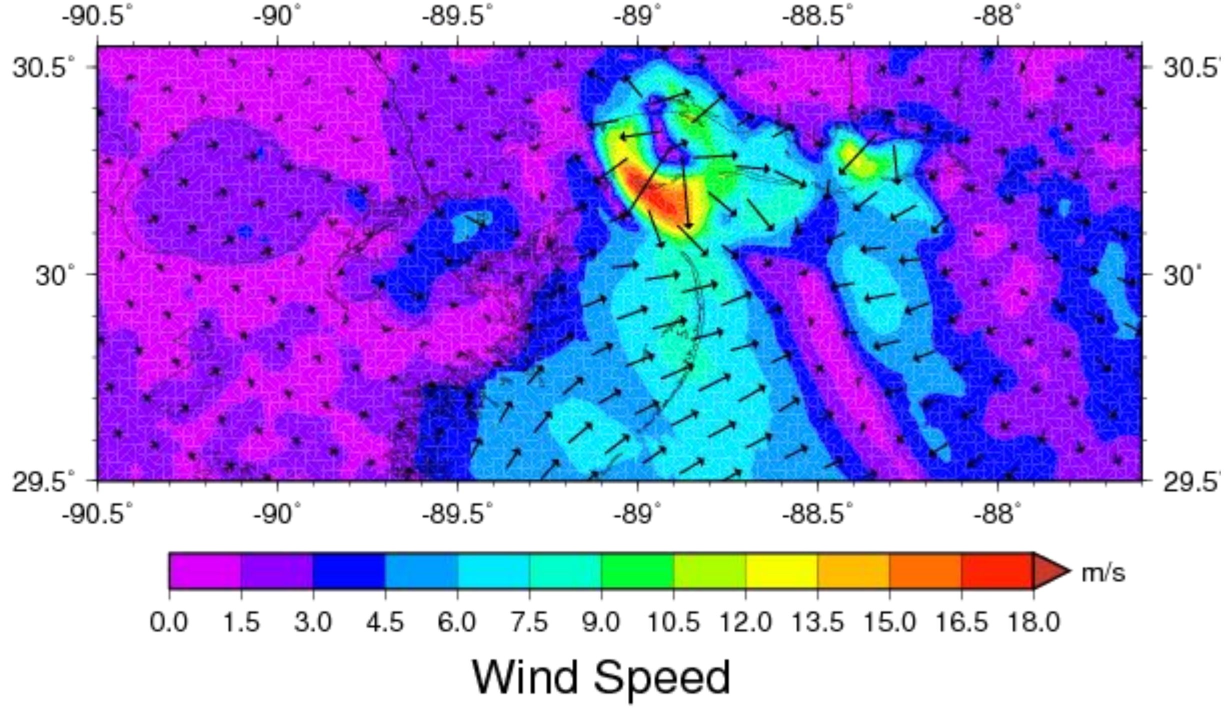

MADIS DPIA1 vs RTMA (201510)
AdjObs
RTMA
Wind Speed(m/s)
Time
20151021 20151023 20151025 20151027

Also reasonably depicts 2D seabreeze structure compared to obs, but analysis still ongoing

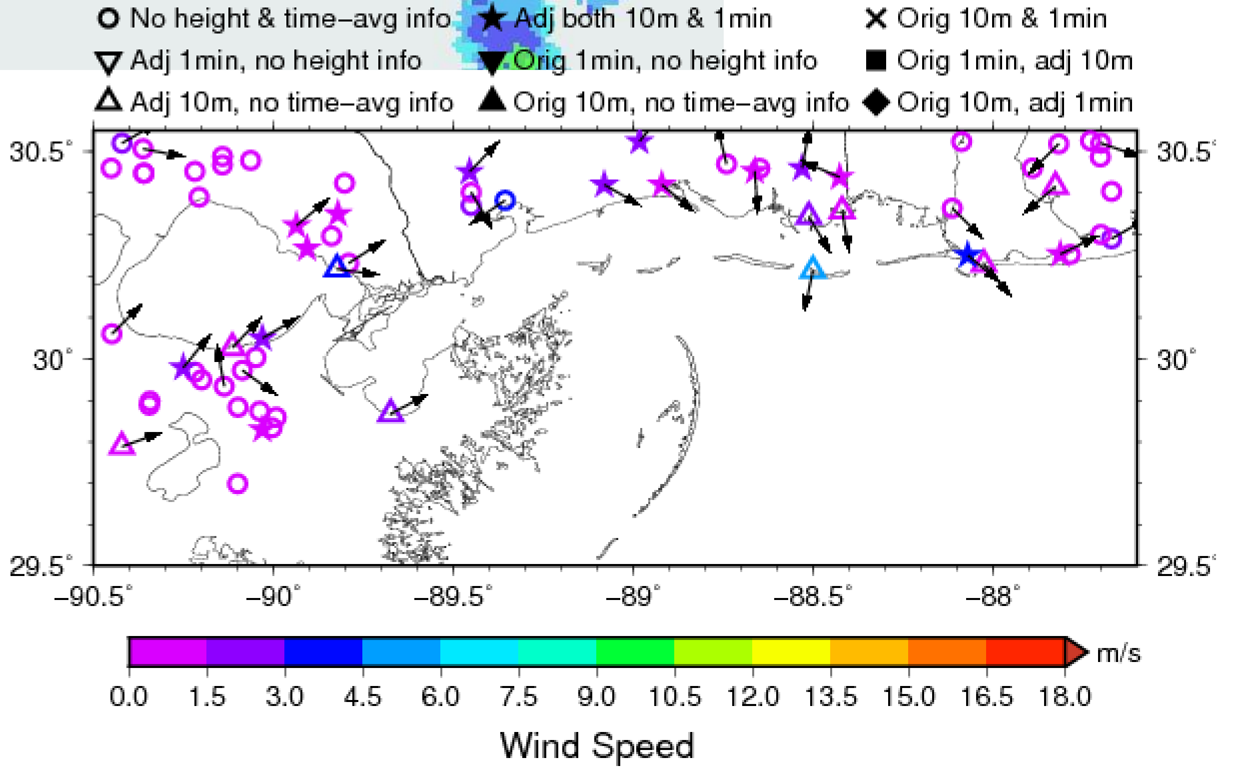
Thunderstorm outflow boundary issues
(from radar data assimilation?)



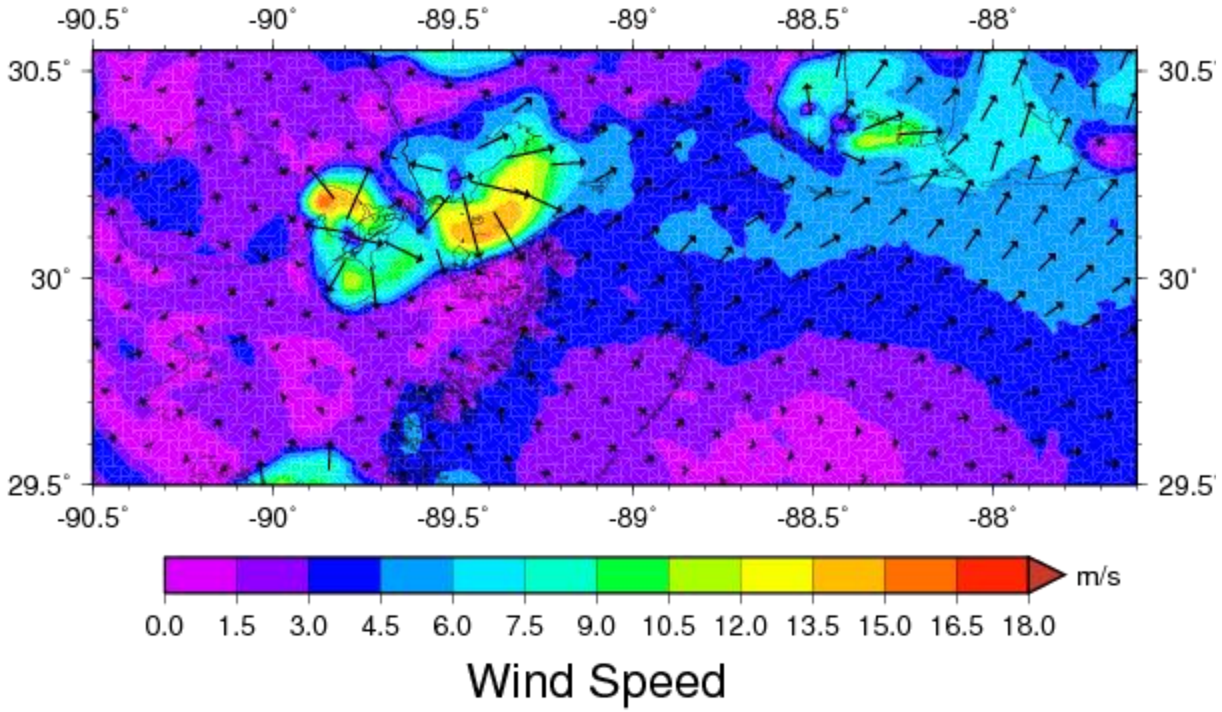
RTMA Wind-10m (2015071801)



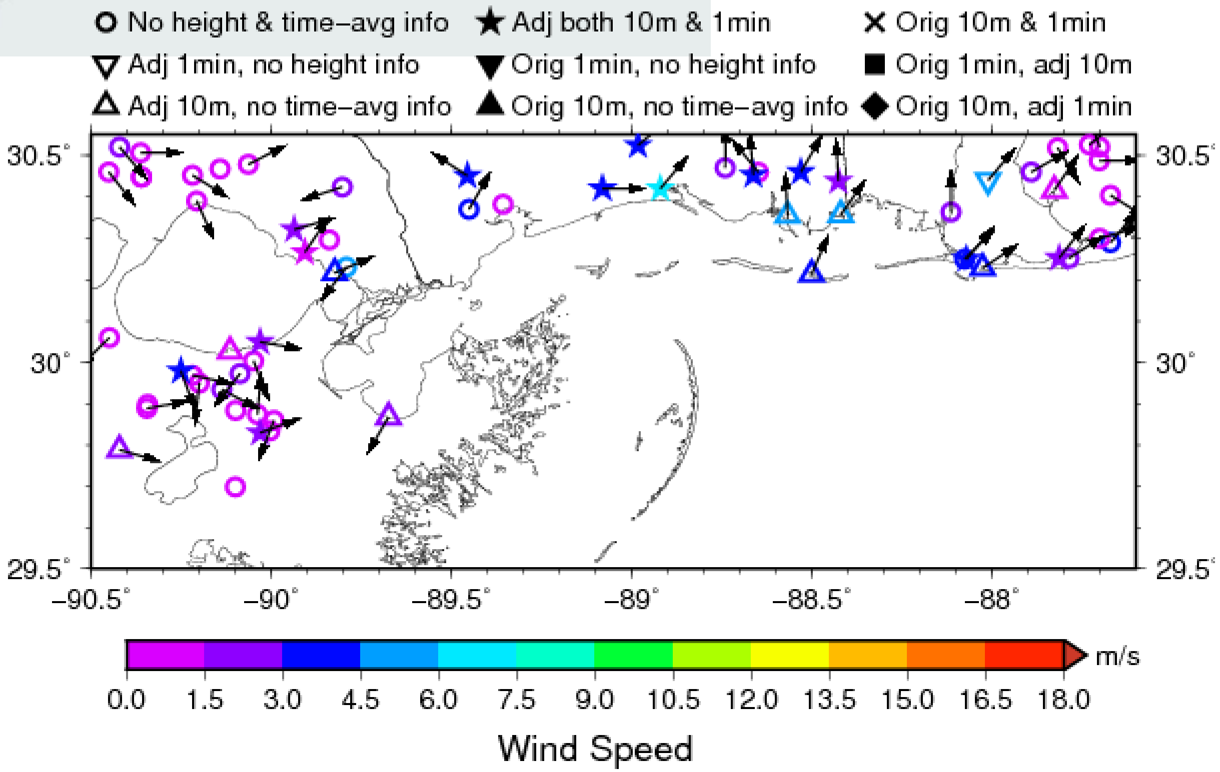
MADIS Obs (2015071801)



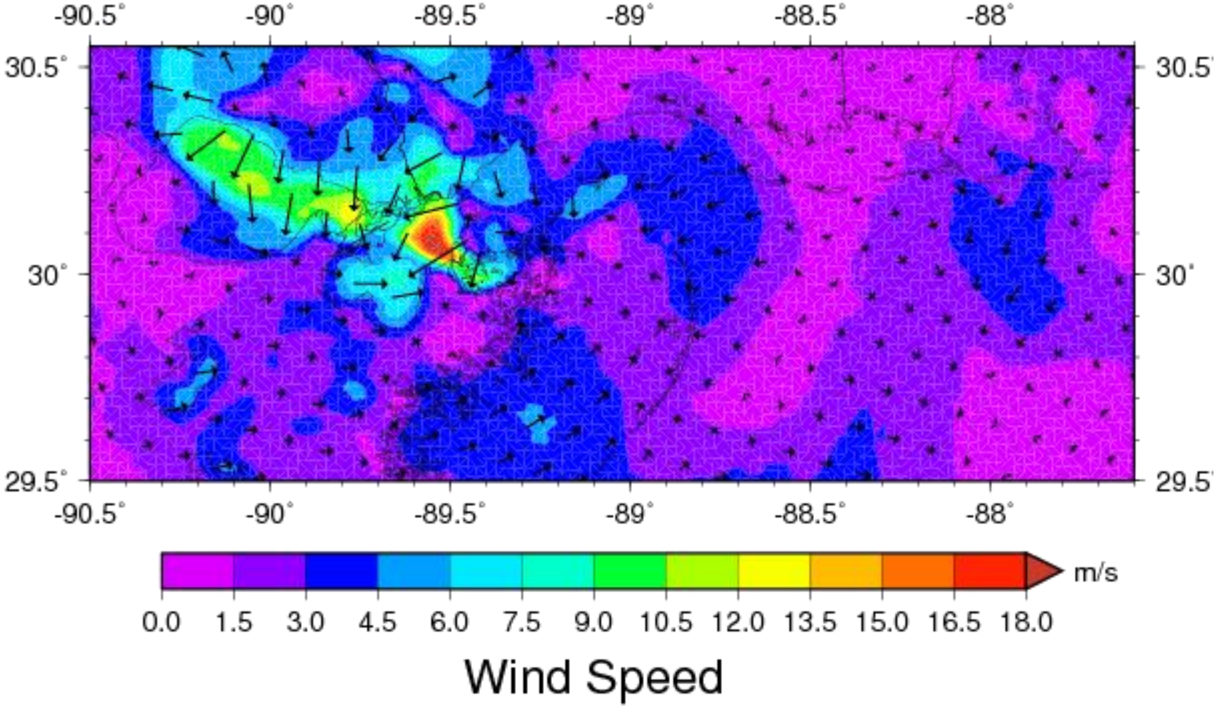
RTMA Wind-10m (2015071822)



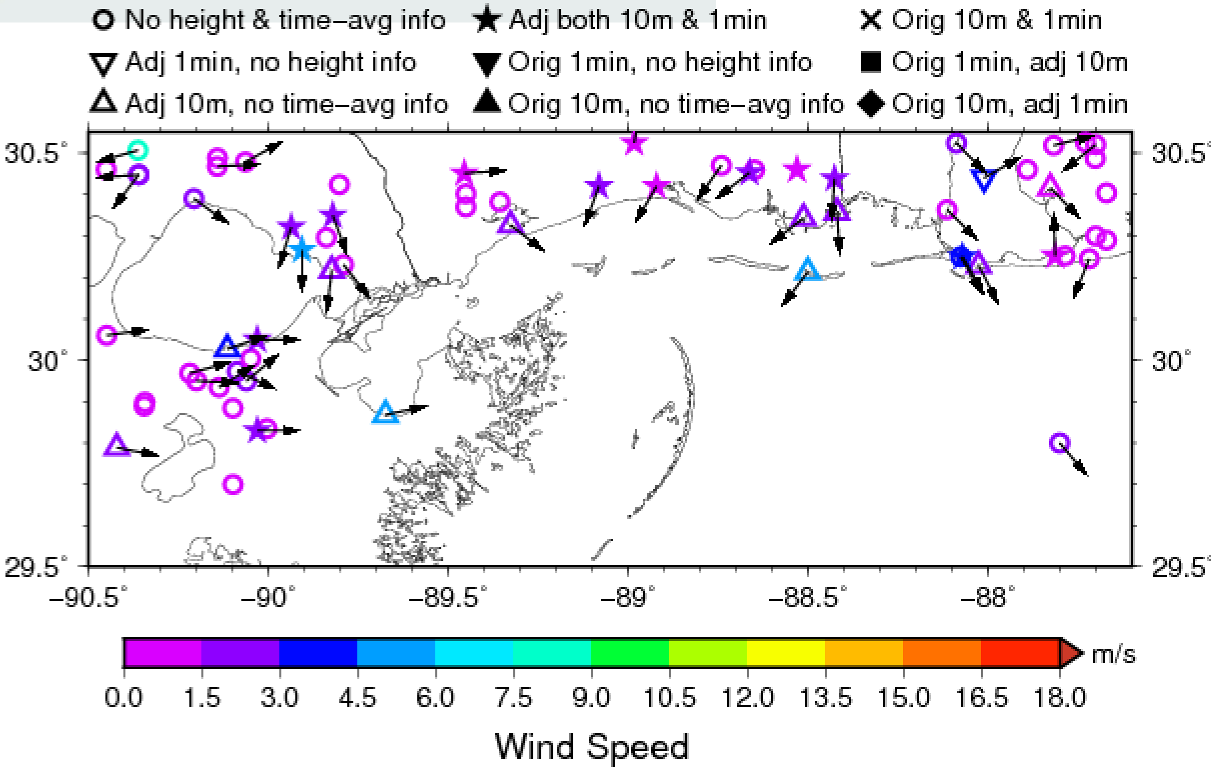
MADIS Obs (2015071822)



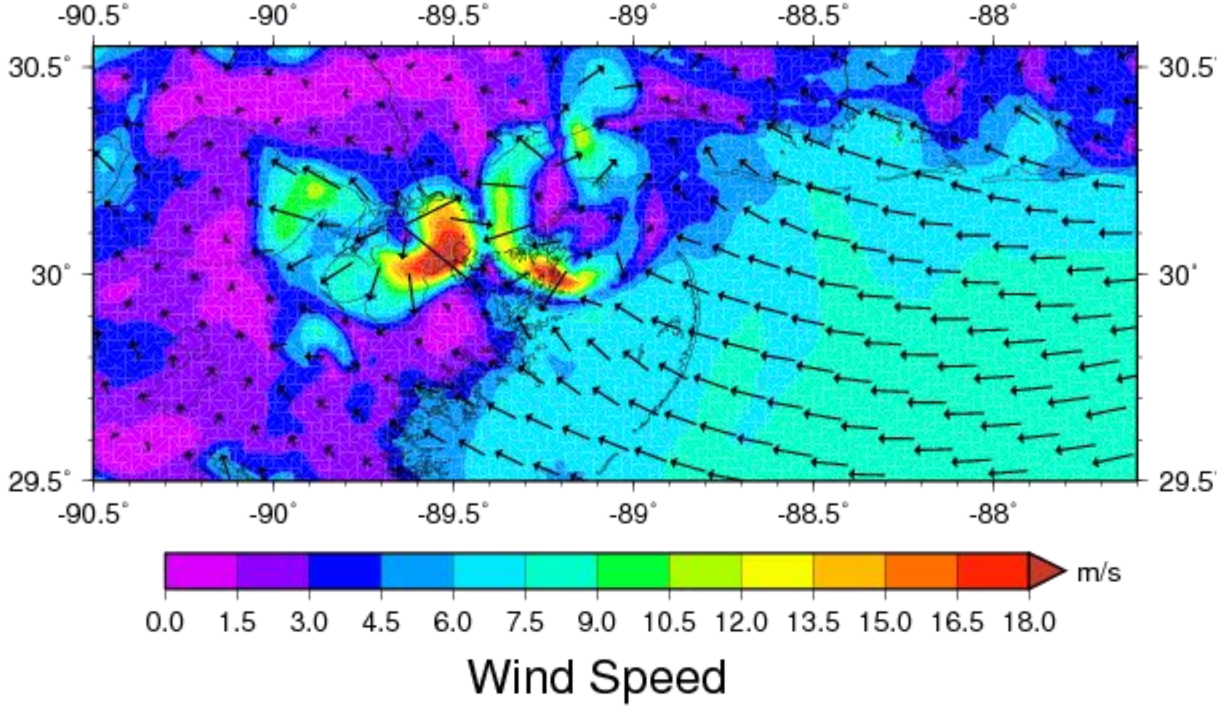
RTMA Wind-10m (2015090601)



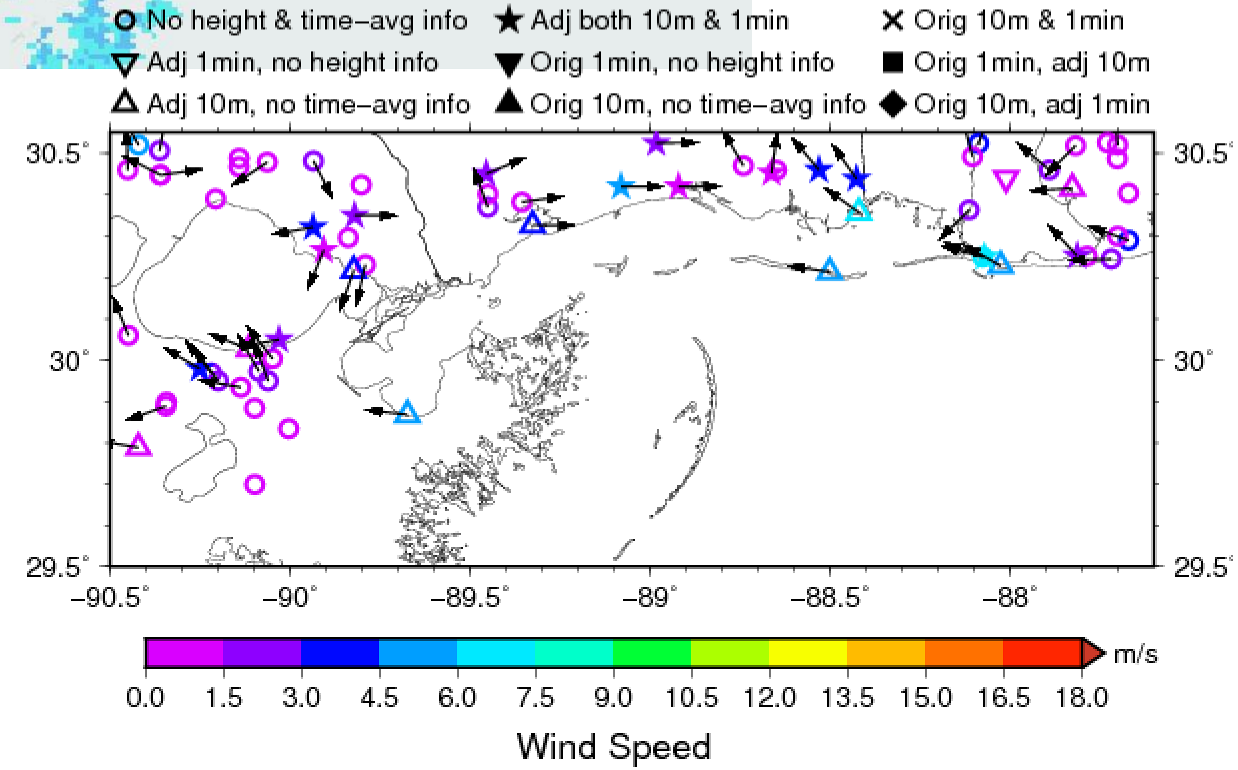
MADIS Obs (2015090601)



RTMA Wind-10m (2015090622)



MADIS Obs (2015090622)



Conclusions

1) RTMA wind and temperature reasonably matches observations in most cases
2) Some mesoscale platforms not in RTMA accept list. If the instruments meet WMO exposure standards and the instruments are reasonably accurate, we will formally request RTMA inclusion.
3) HRRR’s ability to include outflow boundaries qualitatively matches most convective events, but magnitude and spatial patterns are often inaccurate

In particular, HRRR (and hence RTMA) may be overdoing the outflow boundaries

Future plans

A major objective is to generate a synthetic model that incorporates fine-scale 4-D biophysical processes that reveals exposure pathways reflective of DWH, and which will be portable to future spill scenarios impacting similar river-dominated coastal ecosystems.

Components include

- MSU Atmospheric reanalysis product
- NRL Model for boundary conditions
- ROMS-based applications with biogeochemical/lower trophic level model

Will facilitate

- Climatology studies for northern GOM
- Case studies for CONCORDE research cruises

Future interactions with the RTMA team also planned, as well as more validation with WeatherFlow network

Extra slides

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How do complex fine-scale structure and processes in coastal waters dominated by pulsed-river plumes control the exposure, impacts, and ecosystem recovery from offshore spills like the Deepwater Horizon release of 2010?

Physical distribution and ultimate fate of contaminants associated with the Deepwater Horizon incident (Theme 1)

Environmental effects of the contaminants on Gulf of Mexico ecosystems, and the science of ecosystem recovery (Theme 3)

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<u>Objective 1:</u> Characterize the distribution of planktonic organisms at relevant spatial and temporal scales as forced by the complex near shore physical environment and generating the setting for sub-surface ODS exposure.

<u>Objective 2:</u> Characterize the complex 4-D physical, geochemical, and bio-optical fields influenced by pulsed river discharge to characterize potential 3-D pathways of ODS to the coast, and mechanisms for enhanced interactions of ODS with plankton, suspended sediment and oil, which determine fate and toxic exposure, and informs synthetic biophysical-ecotoxicological models.

<u>Objective 3:</u> Generate a synthetic model that incorporates fine-scale 4-D biophysical processes that reveals exposure pathways reflective of DWH, and which will be portable to future spill scenarios impacting similar river-dominated coastal ecosystems.

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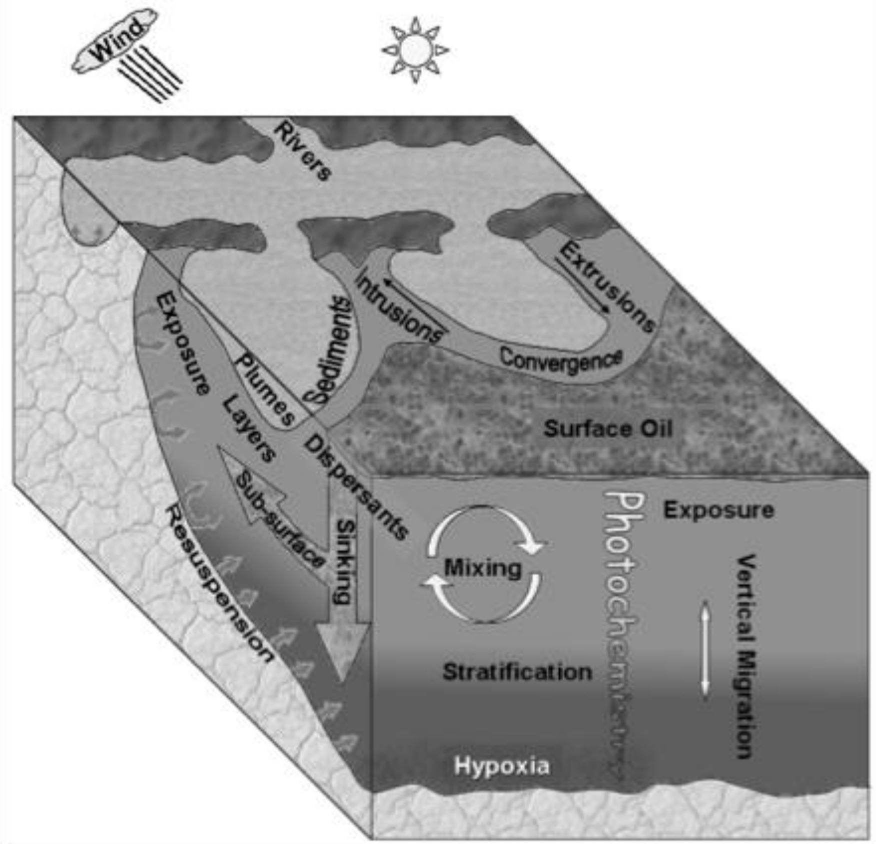
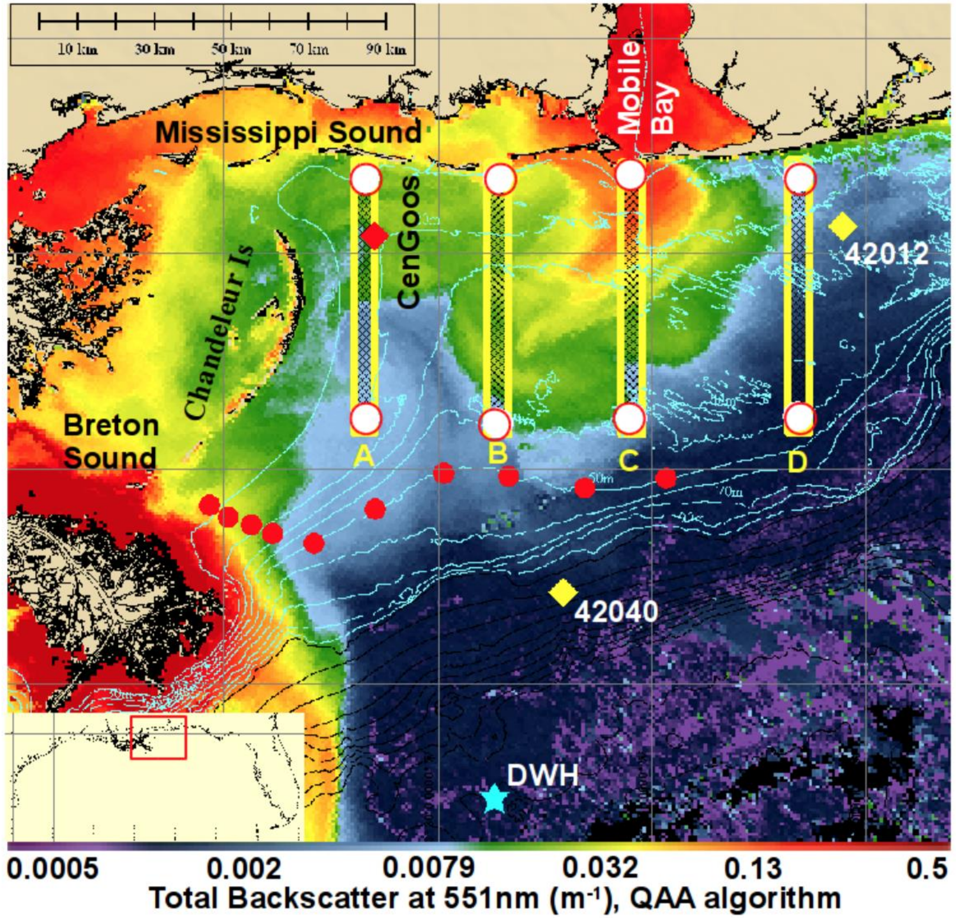
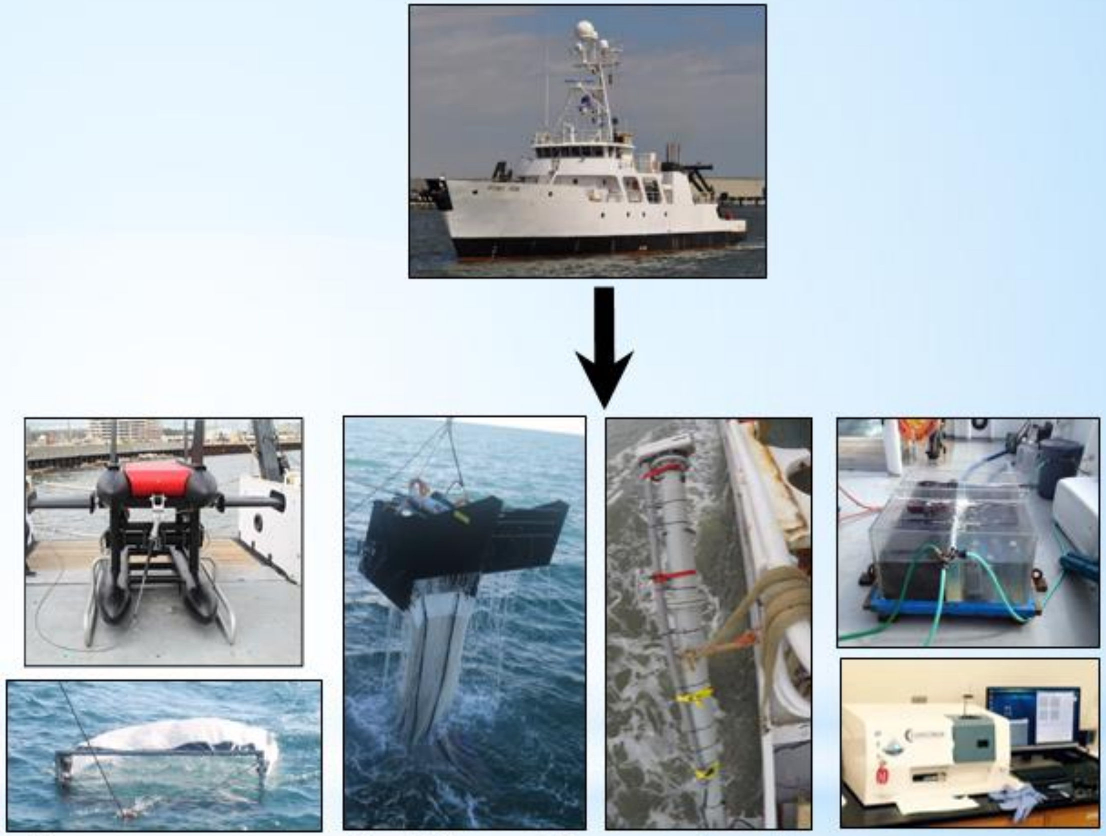




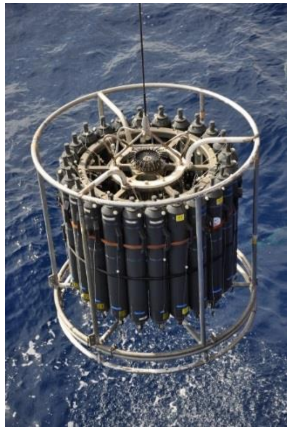
Field program information

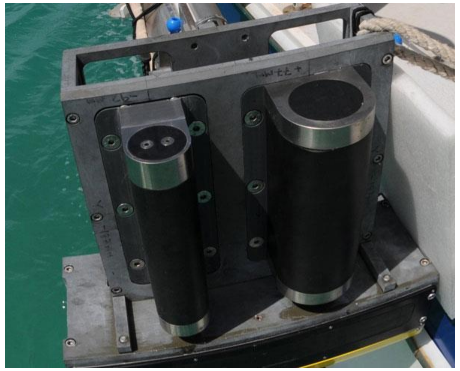
Objectives and Methodology

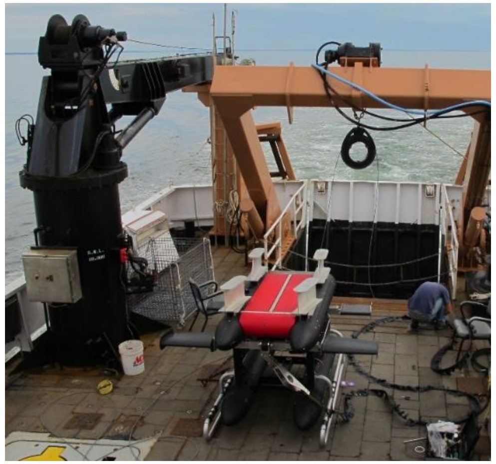
- **Objectives**
  - Relate distribution of plankton in nearshore habitats at relevant spatial and temporal scales to complex and dynamic physical forcers
  - Understand exposure risk of planktonic community during an oiling event

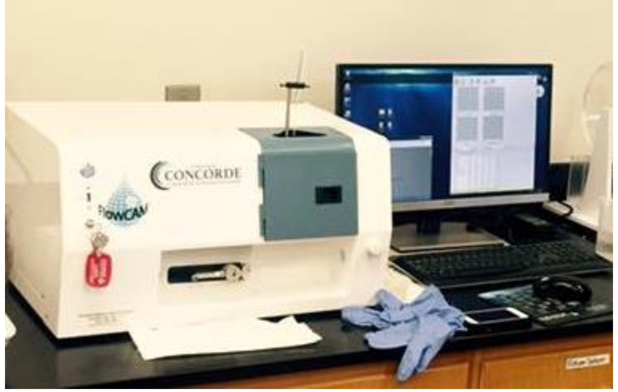


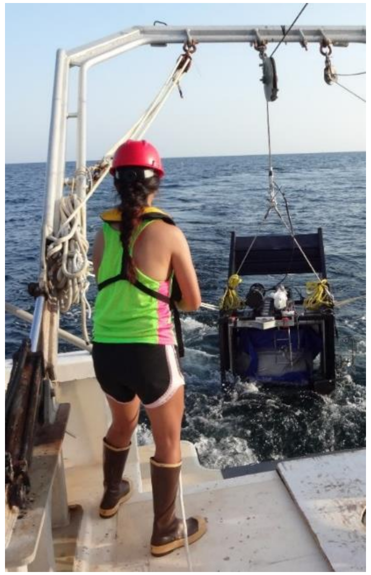
Plankton Sampling Equipment

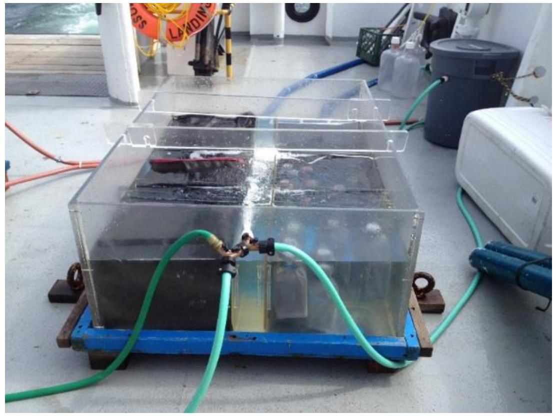












The plankton sub-project will be collecting zooplankton and ichthyoplankton samples using the MININESS and Neuston nets, image data using the DPI, acoustic backscatter data that further complements our plankton samples and DPI images. In addition, we are also using a FlowCam to identify phytoplankton and microzooplankton species.

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Fall Field Campaign

- Ocean Weather Lab
- Deploy the “mixing array”
- Additional met station on Ship Island
- Small vessel surveys of barrier island passes to the Mississippi Sound and Mobile Bay
- Slocum glider deployment
- R/V Pt Sur 24 October-7 November
- R/V Pelican cruise 1-7 November

Objective 2:

Approach: Fall Field Campaign

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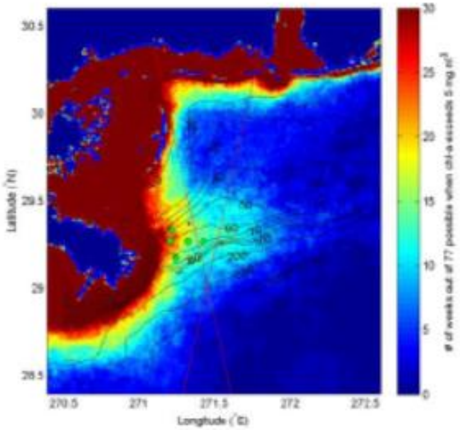
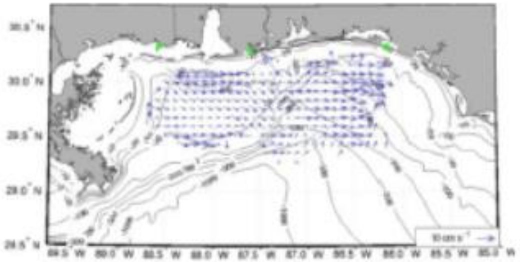
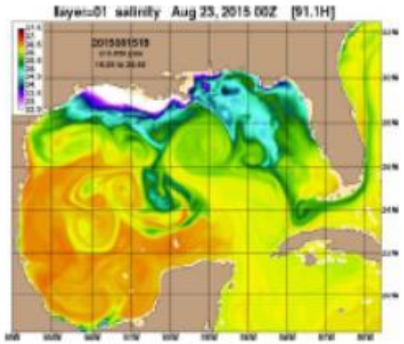
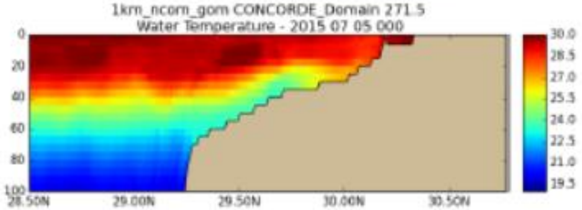
Remote Sensing



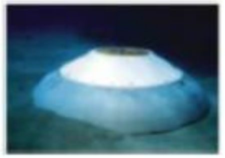


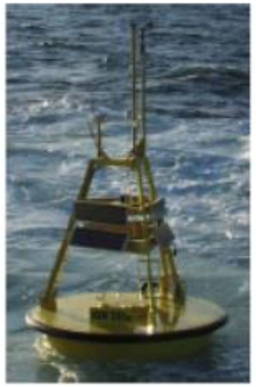
Operational Models





Moorings





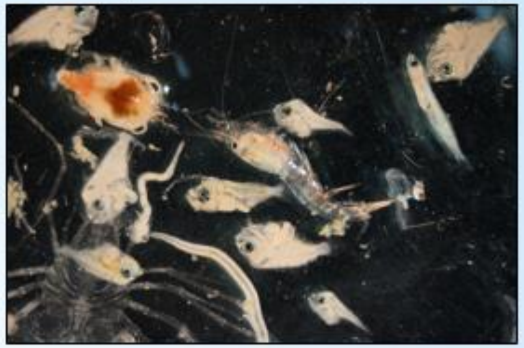
Adaptive Sampling

Gliders

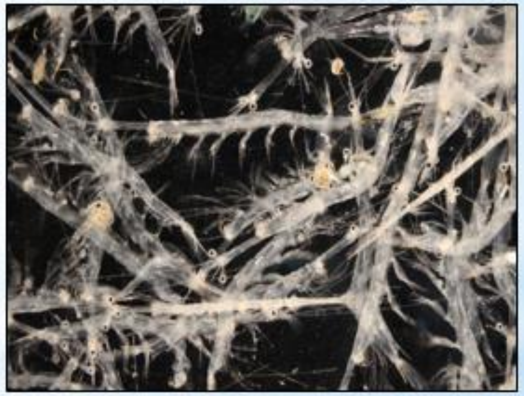
Ship and Boat Surveys

- Water Column well-mixed during Fall Campaign (October 28th-November 2nd, 2015)
  - Preliminary examination of imagery data and plankton samples suggest biological structure present
- Collected
  - 143 depth-discrete plankton net samples
  - 42 hours of ISIIS imagery
  - Analysis of 47 samples of size-fractionated N-15, C-14, biogenic silica, DIC, POC/N, and Silicon-32
  - 147 FlowCam samples

Mobile Bay Corridor- October 30, 2015



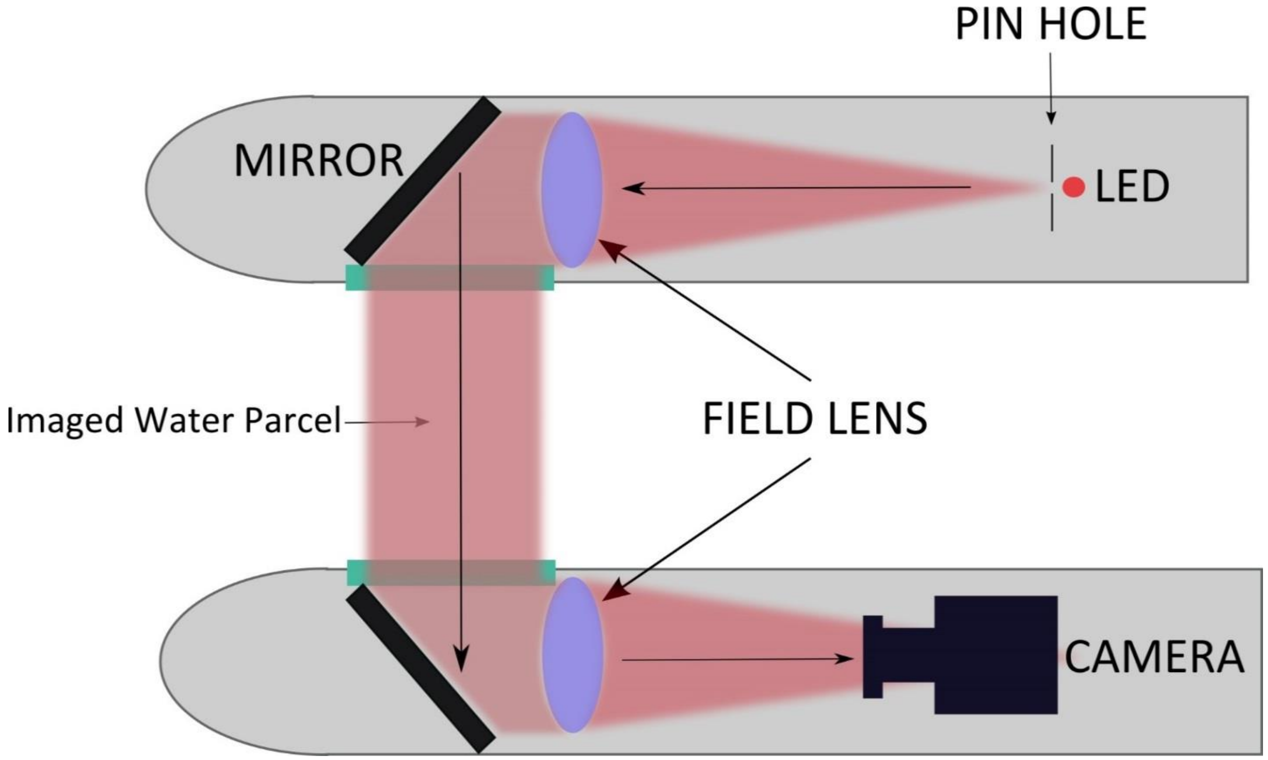
Eastern Corridor- October 31, 2015



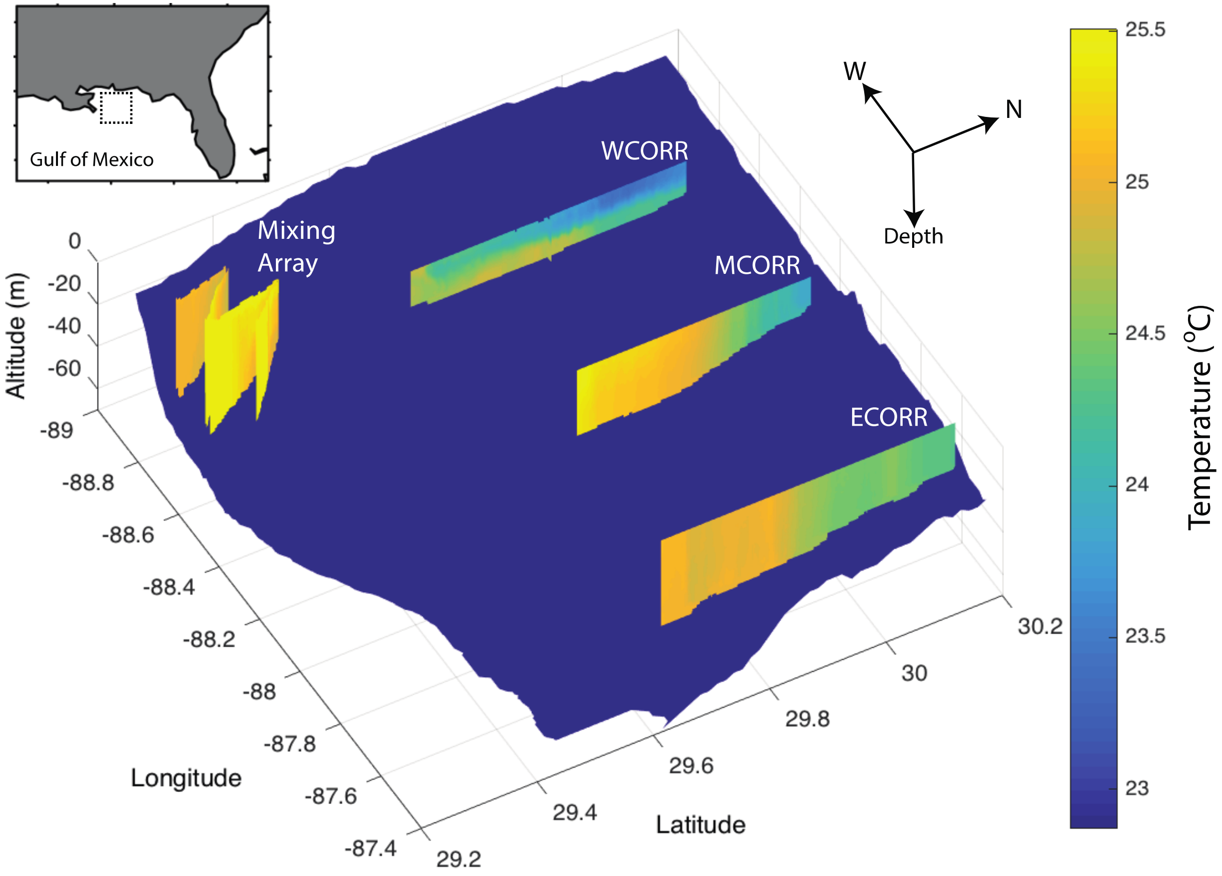
• Fall 2015 Cruise Accomplishments

Mixing was due to remnants of Patricia

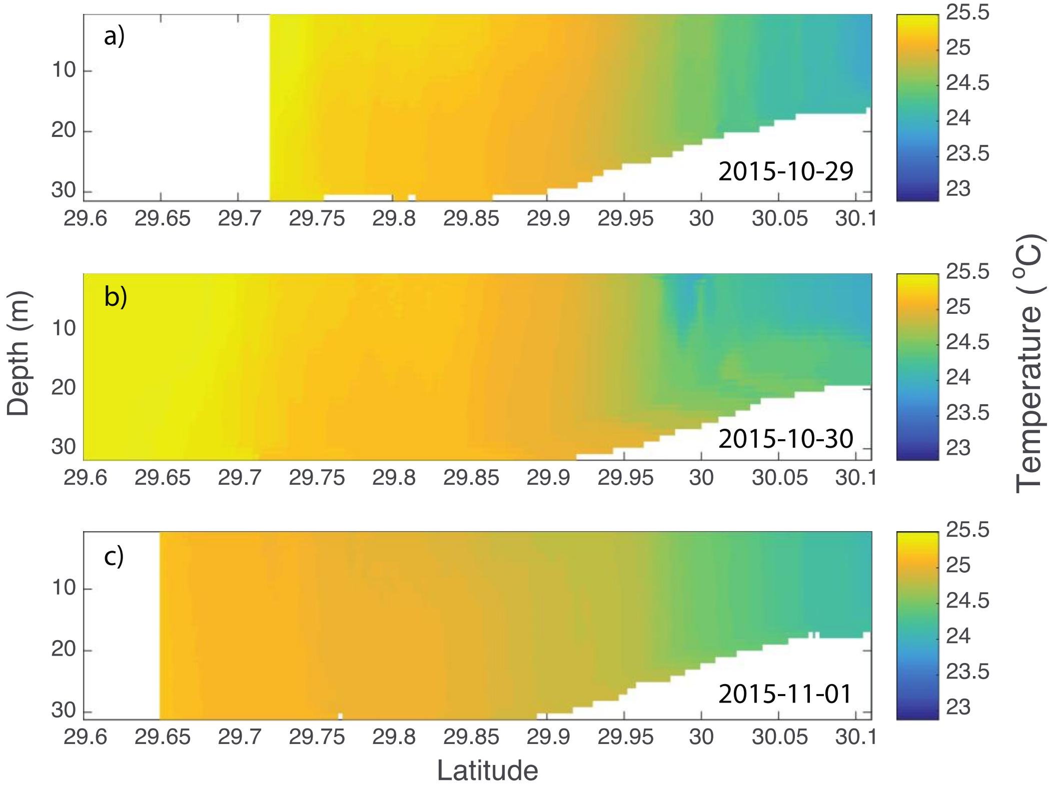
ISIIS – In Situ Ichthyoplankton Imaging System



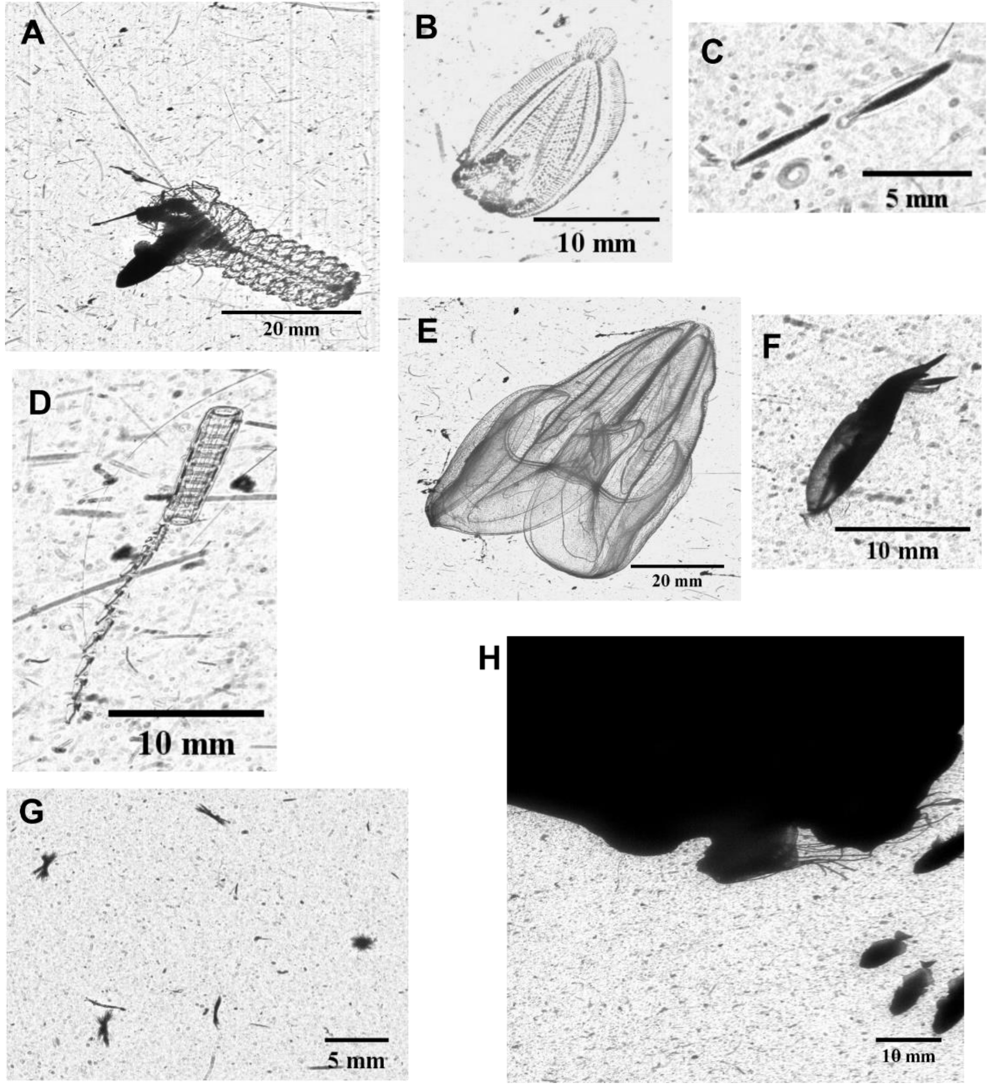
- Motor actuated wings
- Temp, salinity, PAR, chl-a, oxygen collected at 2 Hz
- 16-17 images per second (14 cm * 14 cm * 40 cm)
- 2 TB of image data every 3.5 hours



Temperature measured along 3 corridors with the In Situ Ichthyoplankton Imaging System (ISIIS) (CTD attached to plankton imager)



Temperature along the middle corridor for 3 sampling days



Example images captured with the ISIIS during the Concorde fall campaign a) siphonophore preying on a larval fish b) larval flatfish c) Two round herring larvae found in dense aggregations d) Doliolid e) Lobate ctenophore (Mnemiopsis spp.) f) larval squid g) trichodesmium h) larval jacks near the bell of a large Aurelia spp. jellyfish

Zooplankton captured with the plankton nets to compare to image data

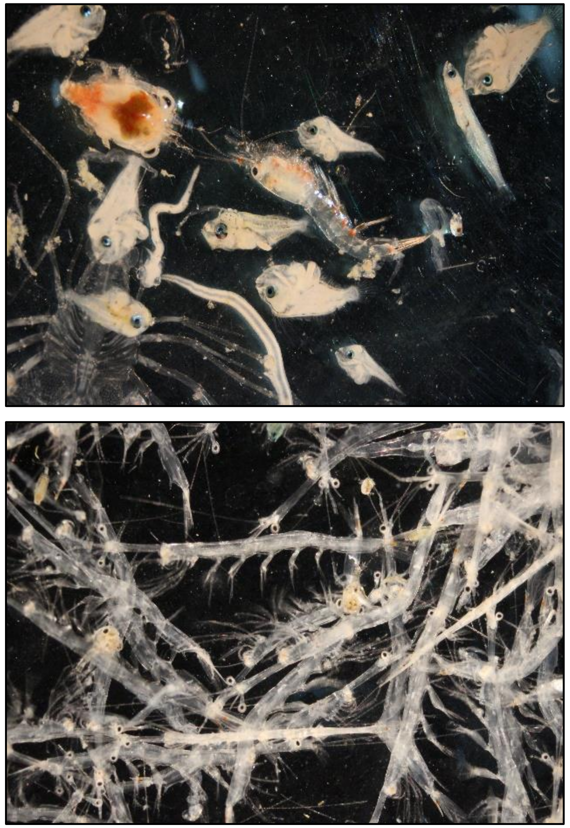
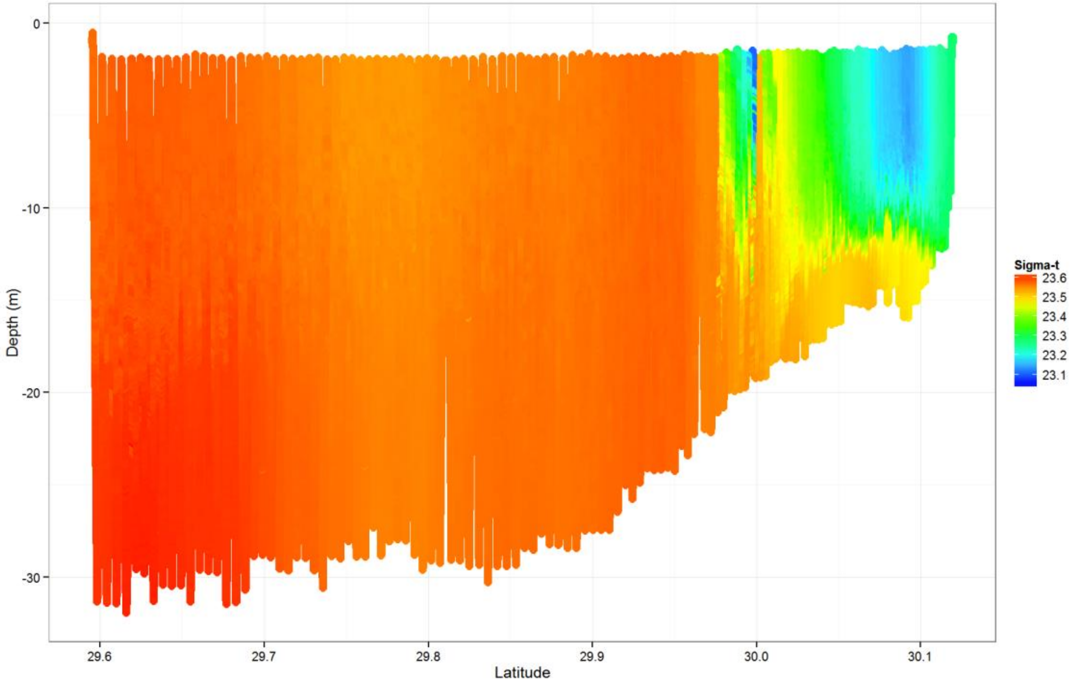
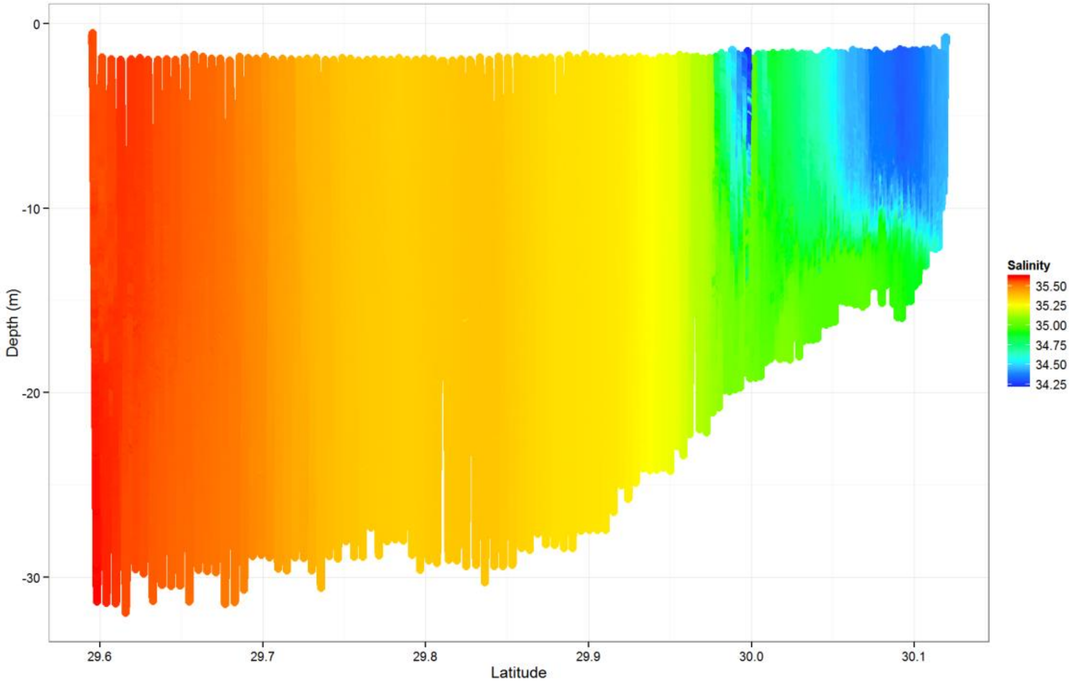


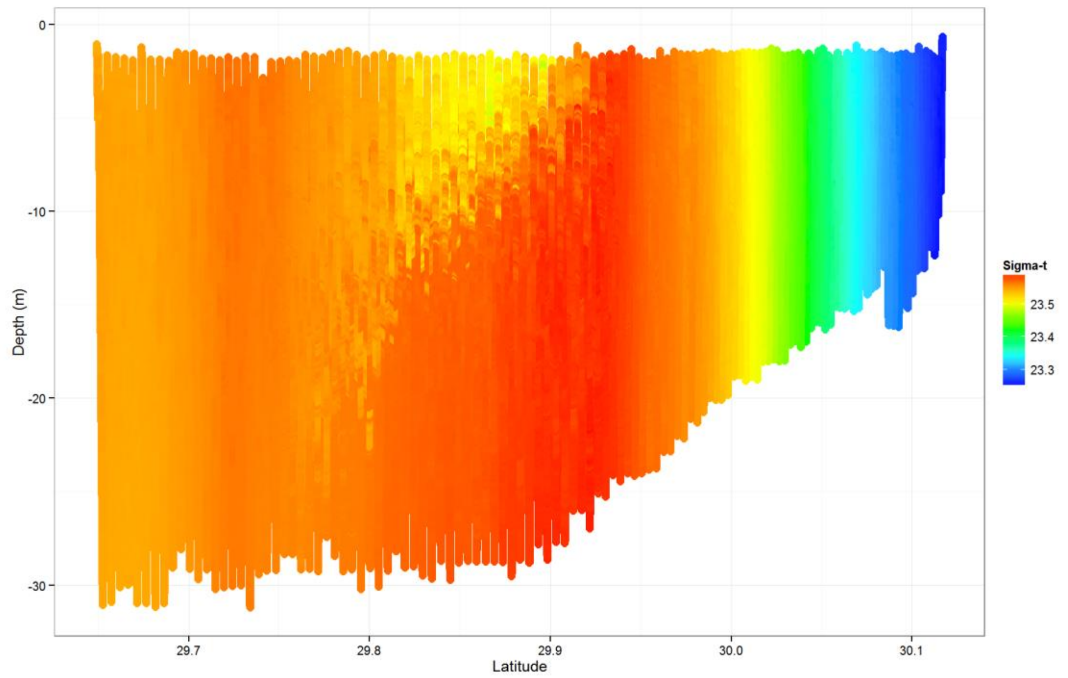
Figure 1. Images of plankton from corridor sampling region from Mobile corridor (top) on October 30th to the Eastern corridor (bottom) on October 31st. Photo credits: Hernandez lab.

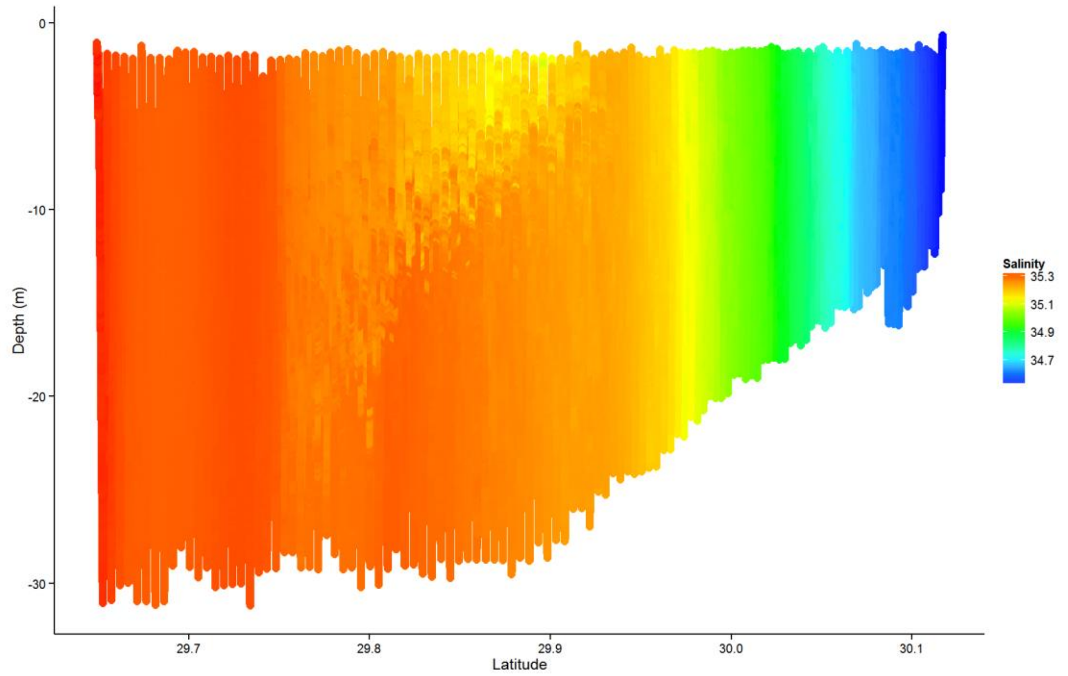
Salinity and Sigma-t from middle corridor on Oct 30 2015





Salinity and
Sigma-t from
middle corridor
on Nov 1 2015





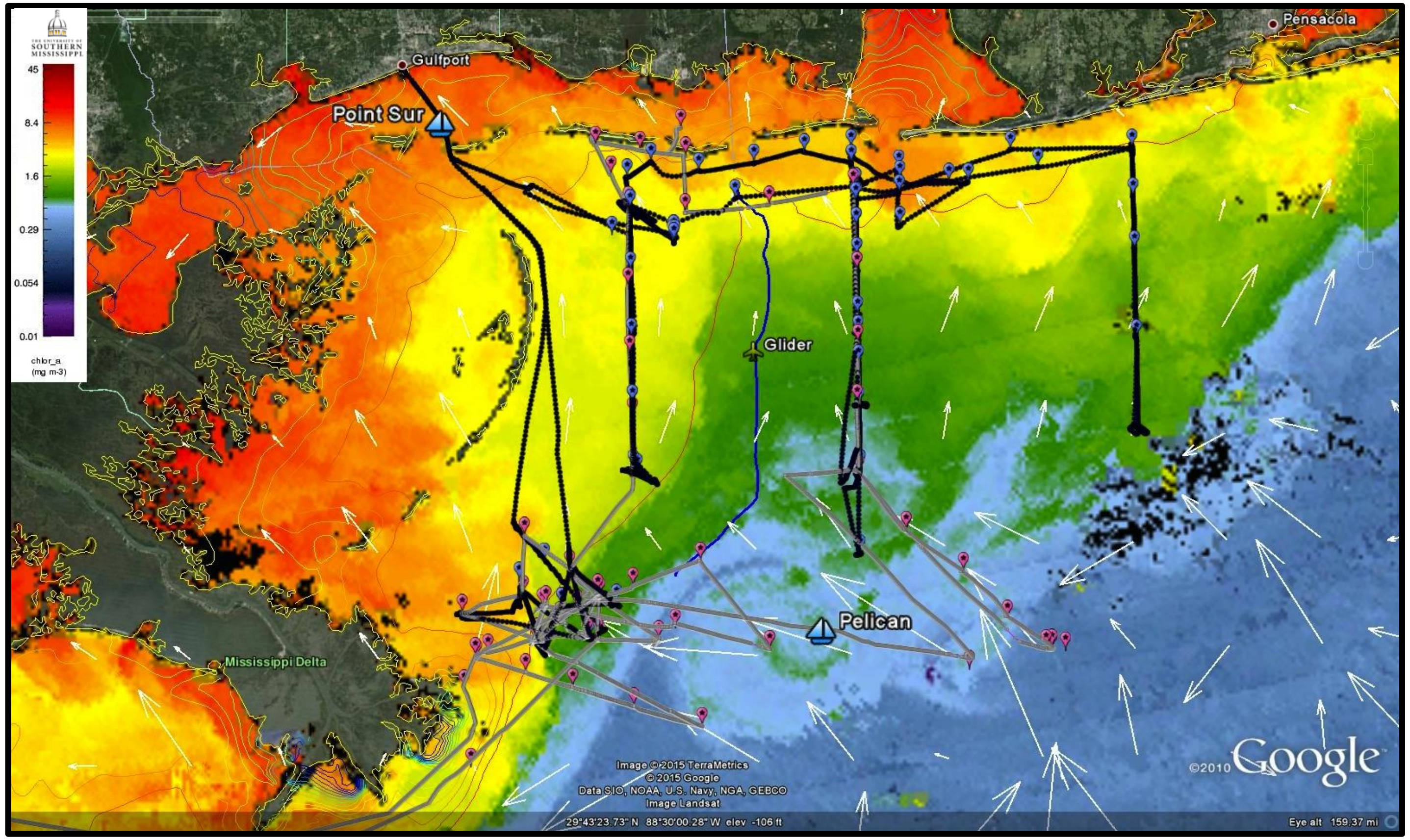
Ocean Weather Laboratory: Daily Now Cast

Circulation Models, Satellite Bio-optics, *In situ* data

Ocean Weather

http://www.usm.edu/marine/research-owx

VIIRS Chlorophyll-a, NCOM Current Vectors and Surface Salinity Contours: November 1st, 2015



Fall Cruise Tracks
Point Sur
Pelican
Glider

The Ocean Weather Lab provided daily satellite and modeled ocean data to assist with strategic cruise planning, glider deployment, and sampling locations.

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Ocean Weather Laboratory: Daily Now Cast

Satellite Products

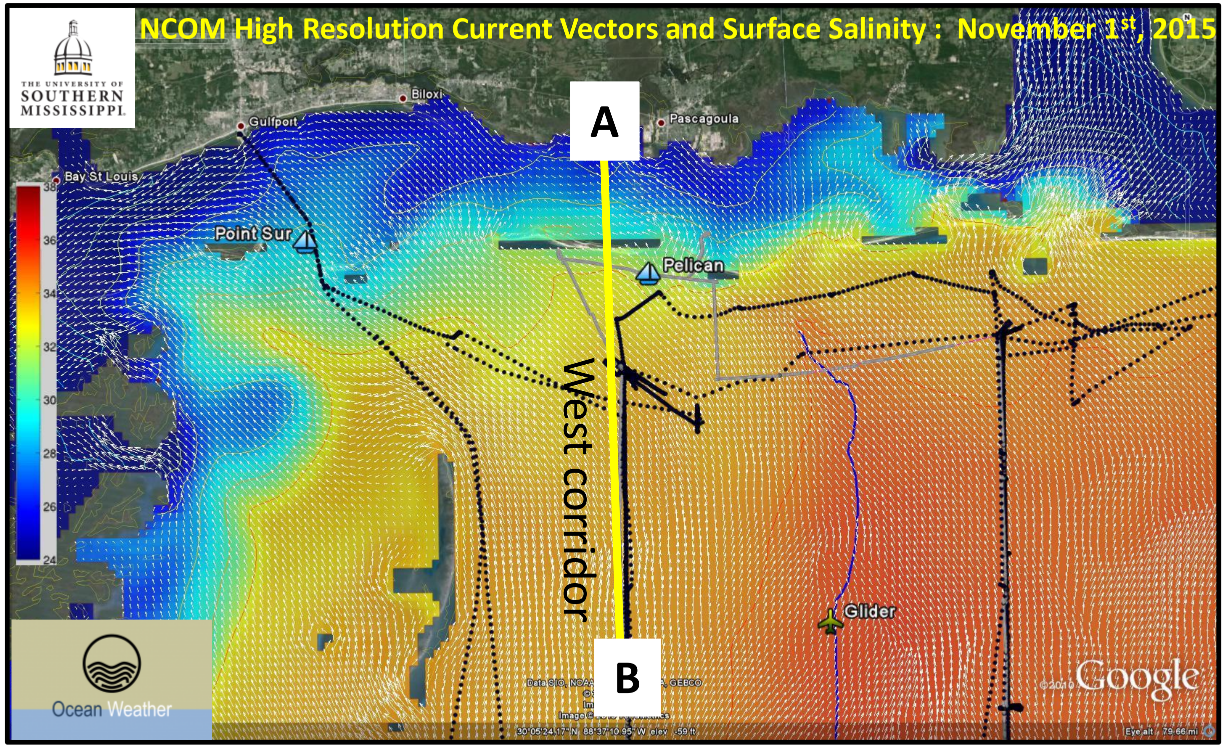
- Chlorophyll-a
- Light Attenuation
- Particles
- Sea Surface Temperature
- Phytoplankton and CDOM Absorption

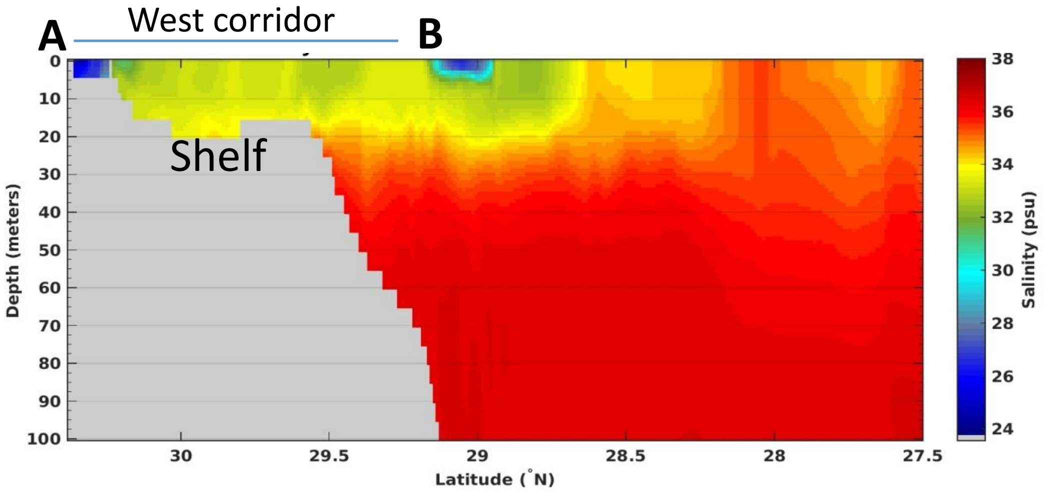
High Resolution Model Products

- Current Vectors and Magnitude
- Sea Surface Salinity
- Sea Surface Temperature
- Mixed Layer Depth
- Sea Surface Height
- Regional cross sections

Insitu Field Work

- Inherent and apparent optical properties





Objective 3 – synthetic modeling effort

Synthetic Model Objectives

- Gain mechanistic understanding of the interlinked physical and biogeochemical processes within the MS Bight
- Targeted Foci of MS Bight Biophysical Complexity
  - Surface and sub-surface advective exchanges across the shelf break of the MS Bight
  - Spatio-temporal patterns of marine planktonic distributions that can be exposed to crude oil toxins when spill events occur
  - Inherent physical or geochemical mechanisms that may protect the nearshore waters of MS Sound from toxicological exposure

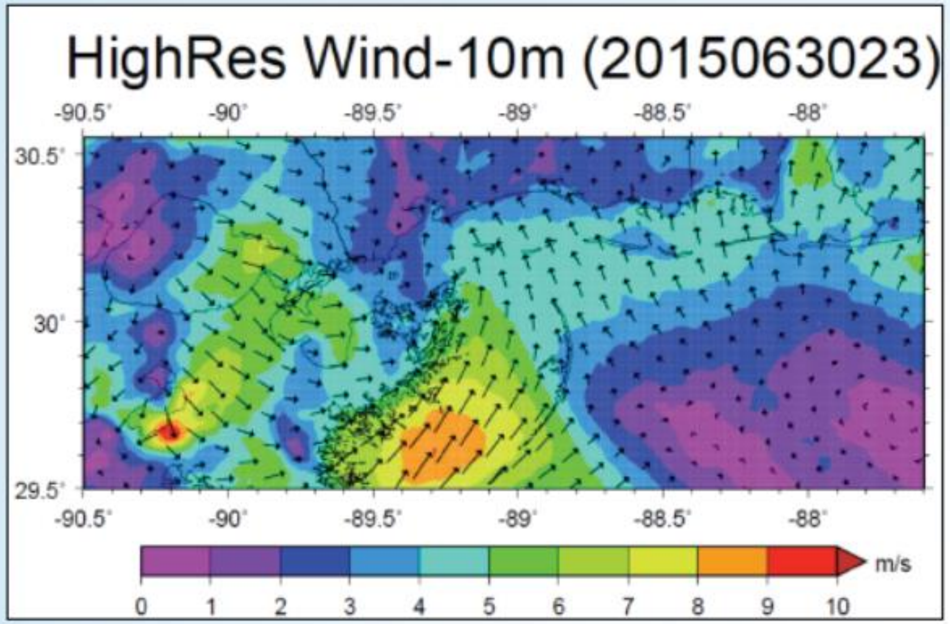
Overarching Motivations:

1) Provide the means to explore and assess these toxicological, hydrodynamic and geochemical influences and their variability
2) Evaluate mitigation strategies that seek to prevent oil spill exposure of sensitive coastal marine ecosystems, fisheries and recreational areas

Components of Synthetic Model Effort

- MSU Atmospheric Reanalysis Product
  - Source of surface boundary conditions (Resolution: 1 km, Hourly)
    - Capture wind events (e.g., storm fronts, cyclones) that raise water levels and create inshore currents in shallow coastal waters
    - Capture the diurnal sea-breeze Synthetic Model
- NRL Operational Model of the Gulf of Mexico
  - Source of outer boundary condition forcing along southern and eastern domain boundaries (Resolution: 1 km, 3 hourly)
    - Critical for informing the synthetic model about cross-shelf advective exchanges, in particular episodic sub-surface intrusions (Sub-group 2)
- ROMS-based application with fully coupled biogeochemical/ lower trophic level model
  - The synthetic model will integrate the forcing and knowledge derived from these two stand-alone modeling components

Atmospheric Reanalysis Development



- 3DVAR, OI, Cressman, Barnes reanalysis code prepared
  - Sensitivity tests underway
- Hourly wind analyses from NOAA's Real-Time Mesoscale Analysis (RTMA) online at MSU
  - These are being transitioned to CONCORDE website
- Scripts to generate 1-km atmospheric forcing for three-year ROMS runs completed
  - Transitioned to USM computers
  - Needs testing with ROMS Application

- Data Sources
  - Model data is provided by NOAA's Operational Model Archive and Distribution System (NOMADS)
  - Radar data is provided by NOAA's Hierarchical Data Storage System (HDSS)
  - High-resolution AVHRR SST data is provided by NOAA's Atlantic Oceanographic & Meteorological Laboratory (AOML)
  - FSU's COARE flux algorithm 3.0 is applied as necessary for consistency with NRL's COAMPS

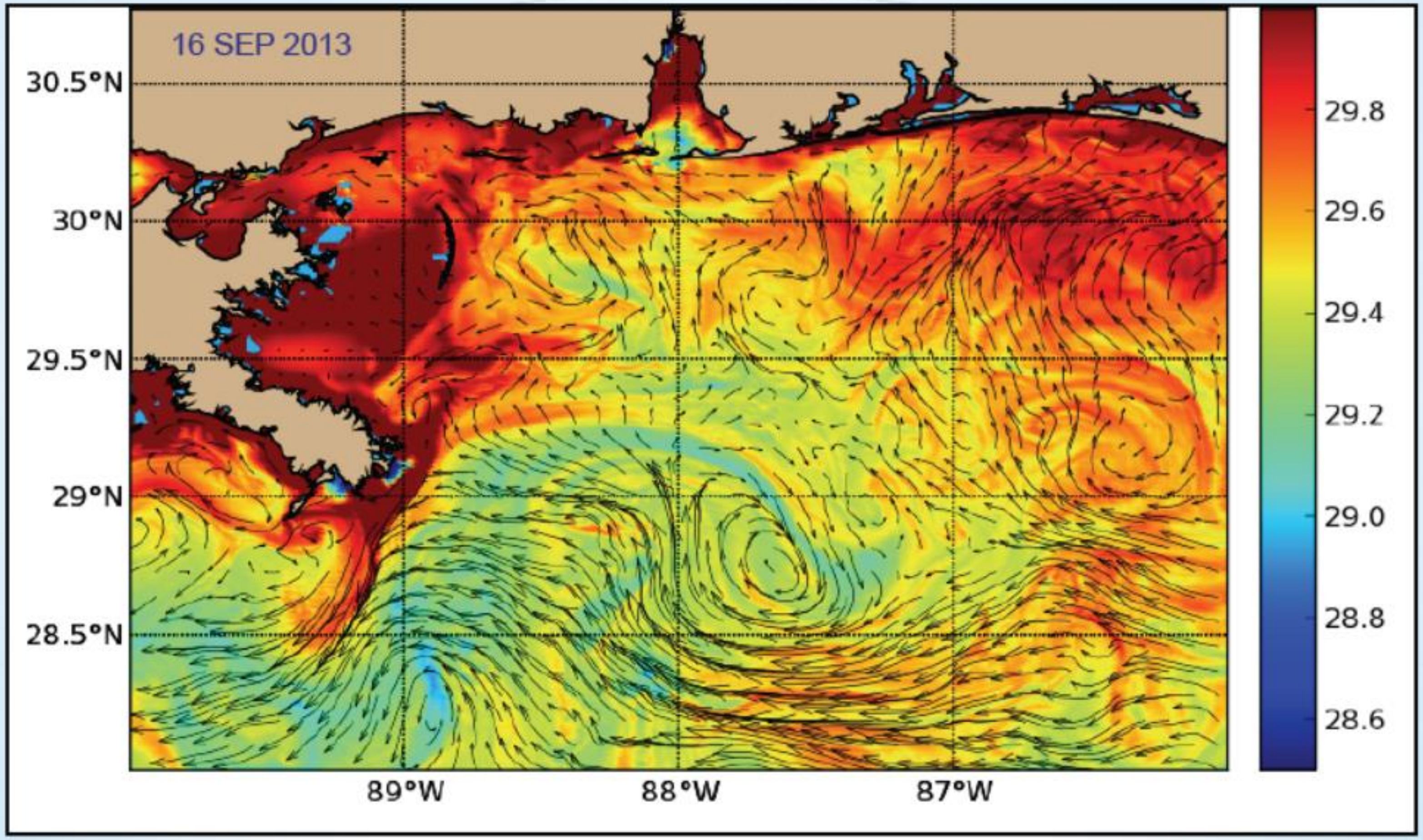
WeatherFlow Platform

(Diurnal Winds Assessment in MS Sound)

Awaiting Coast Guard Approval

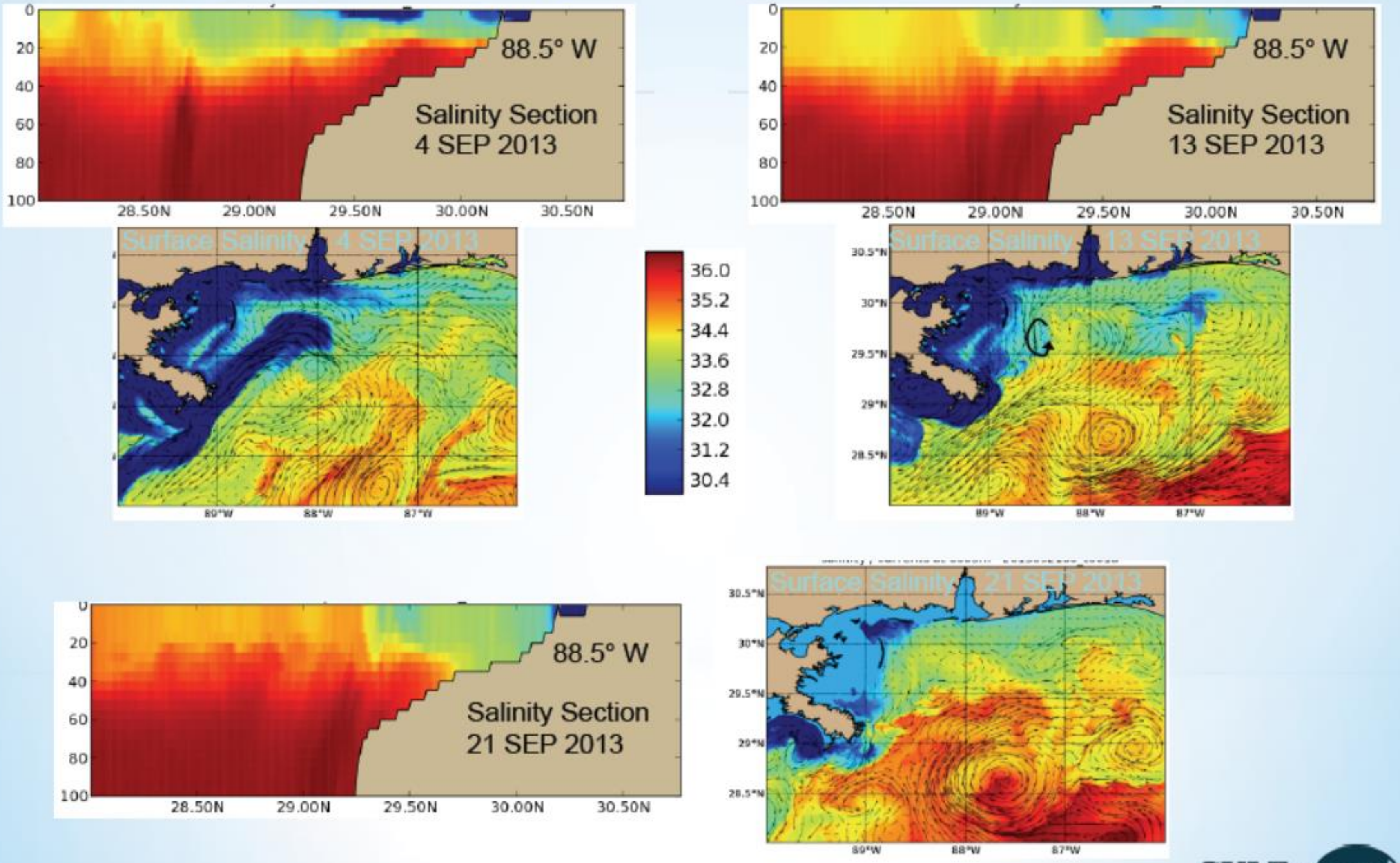
Outer Boundary Conditions

NRL Model: Surface Temperature & Currents

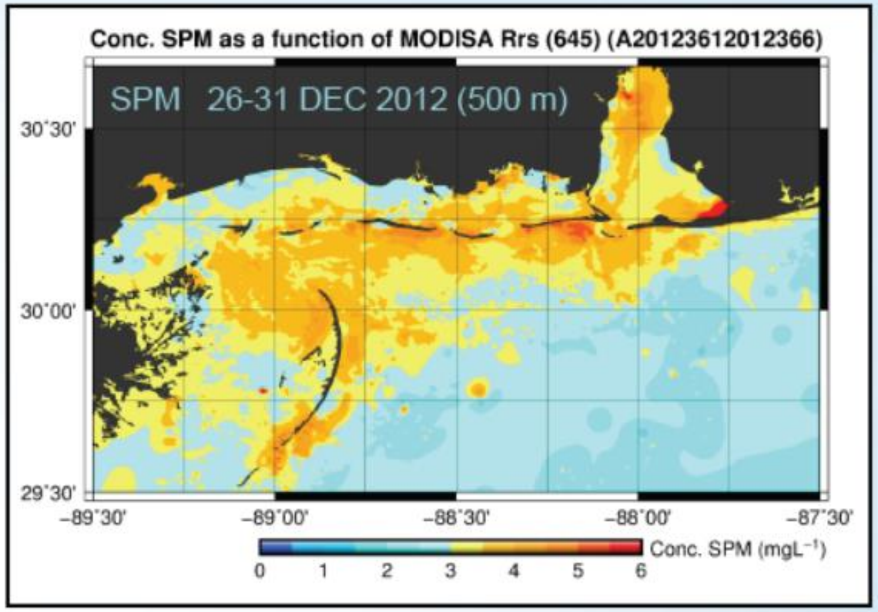


Salinity Evolution on MS Bight: Shelf Connection

(Analysis in progress: Jacobs, Arnone et al.)



Salinity Evolution on MS Bight: MS Sound Connection
(Remote Sensing Bio-optics -> Salinity Proxy)

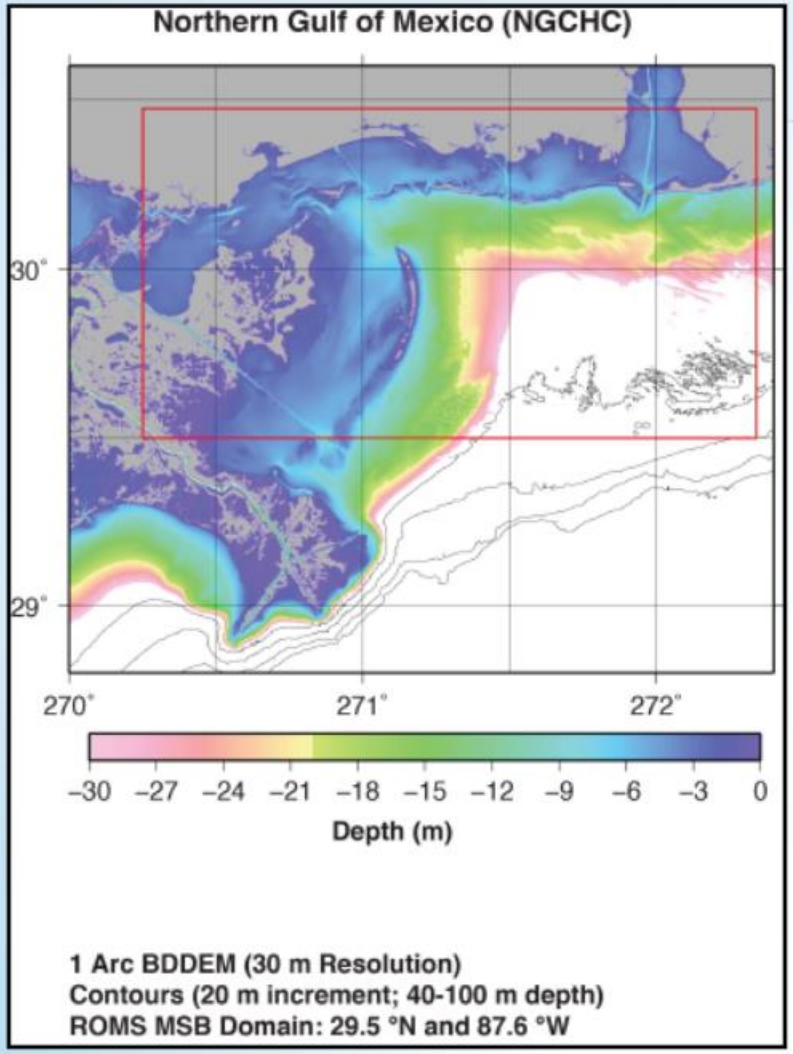


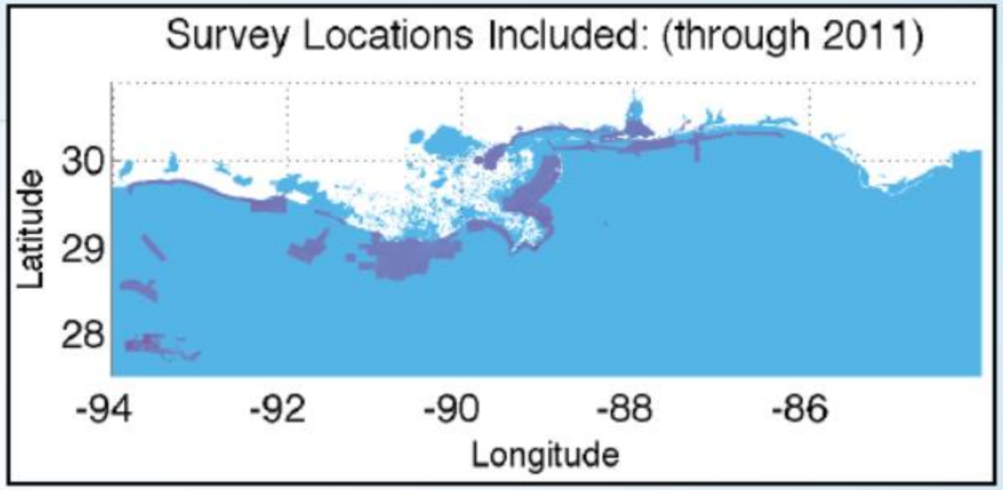
Sediment loadings indicated in these graphics are a critical aspect of the bio-optical variability that is essential to capture for fidelity of the model ecosystem

MODIS and MERIS Level 1 data are being processed to develop insight into spatio-temporal variability of sediment plumes in coastal / shelf waters

Key concern is to accurately simulate the in water light field for model ecosystem

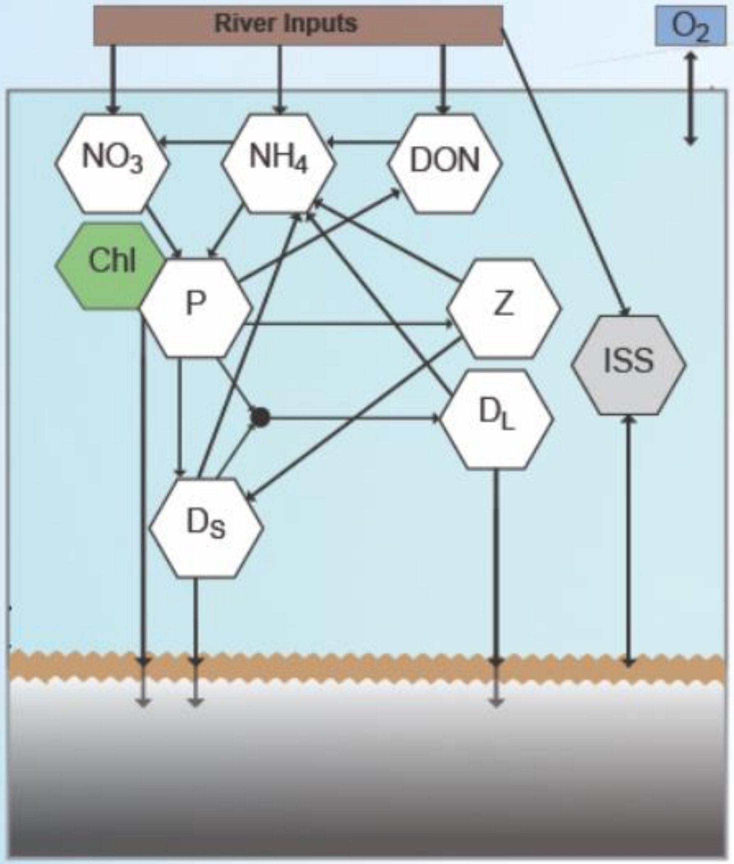
Bathymetry & Domain of Synthetic Model





- Domain bathymetry shows shelf break, MS Bight and MS Sound
- Bathymetry model was updated through 2011 NOS surveys
  - Survey domains are shown in upper graphic
  - 3, 1 and 1/3 Arc bathymetry models were generated and available from USM - DMS THREDDS Server
  - Outcome of an NSF EPSCOR-funded project

Biogeochemical Model



- Considerations & Sub-Group Links
  - P size partition data (J. Krauss)
    - 2 Phytoplankton Size Classes
  - Nutrients (J. Krauss)
  - Bottom Sediment Type (I. Church)
    - Sediment Resuspension
  - LISST and SPM Observations
    - Light Attenuation
  - Spatio-temporal Plankton Distributions from DPI
    - Patterns with environmental context (mixing, bio-optical setting)
  - Nutrient Source (A. Shiller)
    - Nutrient Delivery Path to Inner Shelf