The NOPP Operational Wave Model Improvement Project

Toward a next generation of wind wave model physics

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NOPP project:
Improving Wind Wave Predictions;
Global and Regional Scales

- Considering progress in understanding of wave model physics, particularly dissipation and economical interaction approximations, Linwood, Don and Hendrik started pushing for this project after the 2008 Ocean Sciences meeting.
- Buy-in from:
  - ONR, BOEM (was MMS) with funding.
  - NOAA, USACE, NRL with in-kind contributions.
- Focus on operational modeling, basin and shelf scale.
  - Several “surf-zone” proposals also funded.

Outline of paper:

- NOPP teams
- Validation data.
- Validation techniques.
- 30 year hindcast.
- Code management.
- Outlook.

Conclusion:

- Making great progress toward improved operational models.
- Laying ground work for community model development and modeling environment.

NOPP teams

PI-s	Topics	Focus areas
Ardhuin	in+ds	Dissipation (breaking, swell, bottom) Unstructured grids in WW III.
Babanin	in+ds	Observations based + swell diss.
Banner	in+ds	Extreme conditions, explicit breaking prediction, fluxes including sea spray
Perrie	nl	Two-Scale Approximation.
Tim Janssen	nl (shal)	Combine quads & triads, field data sets.
Zakharov / Pushkarev	nl+in+ds	Advanced statistical and dynamical nonlinear models + input and dissipation
Kaihatu / Sheremet	shal	Traditional mud and vegitation models Two-layer Boussinesq mod. Field data.
Van Vledder	shal	Shallow water models and obs., including surf beats.
Hanson	shal	Duck data sets, spatial partitioning.

NOPP teams

Organization	PIs	In-kind contributions
USACE	Resio Smith	FRF + Currituck Sound data. New source terms / studies (in+nl+ds) IMEDS + Additional model metrics WAM/STWAVE + ADCIRC coupling Partitioning + tracking (with NCEP)
NOAA/NCEP	Tolman Alves Chawla V/d W.	Source terms + QS model for WW III. Code management for WW III. NOPP data server. Pre-operational testing of new ST. 30 year wave hindcasts.
NRL/Stennis	Rogers Campbell	Curvilinear grids in mosaic (WW III). ESMF wrapper (SWAN, WW III). Automated regression testing (WW III). Code management best practices.

Two type of validation / data important for operational wave models.

- Model needs to work all the time:
  - Bulk long term validation / development against routine observations.
    - In-situ, altimeter, SAR (?).
- Model needs to make physical sense.
  - Directed measurement campaigns focused on specific physics of waves.
    - Individual campaigns.
    - Data mining of routine observations.

- Select data set types and conditions, rather than campaigns.

Validation data

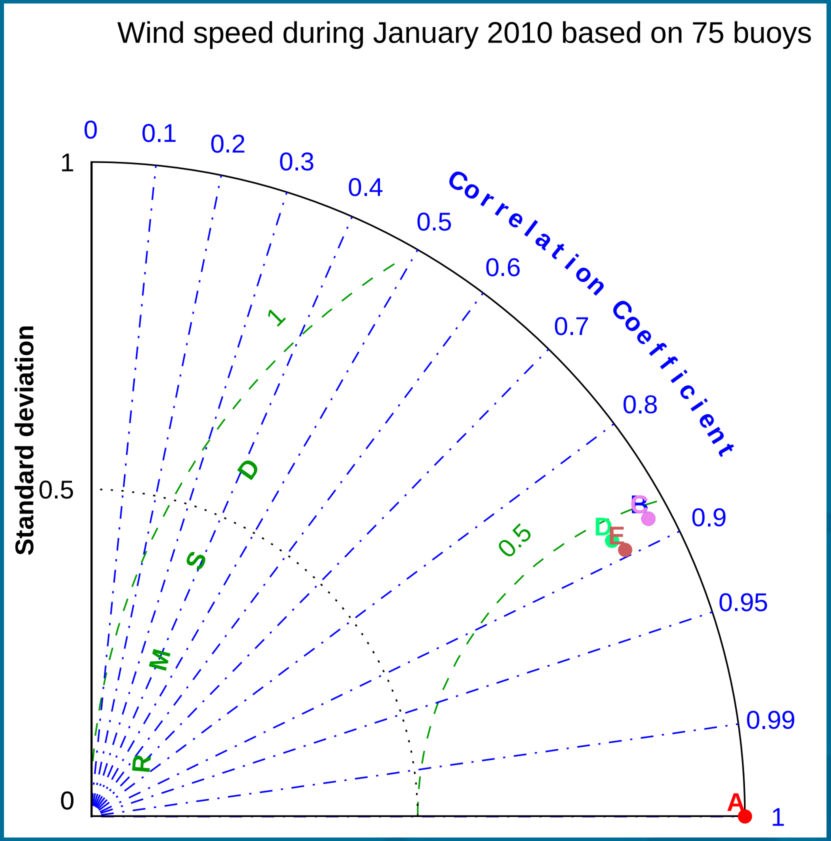
Conditions	Data sources
Long term validation	In-situ, altimeters, SAR.
Wind Sea and Swell	“JONSWAP”, Great Lakes, Lake George, SAR, Tehuantepec, Duck. Spectral partitioning of buoy data.
Non-Aligned winds	Slanting fetch, Tropical cyclones (Duck, SRA, WSRA).
Extreme conditions	TCs, data mining.
Diminishing winds	FAIRs, data mining, tradewind and monsoon data (INCOIS, …)
Shallow water	Data sets provided by teams, older bottom friction data sets.

Going beyond the traditional validation techniques used for wave models.

- Traditional: bulk error measures:
  - Mean, std, SI, r^2, scatter/pdf, sometimes qq …
- Event-based statistics:
  - Peak values, timing, shape of signal.
- Spectral wave model validation:
  - Ridge plots identifying individual swell events.
  - IMEDS analysis using spectral partitioning.
- For forecasting, hit-miss statistics are very important, but rarely used in scientific papers.
- Use additional relevant physical parameters, mss, peakedness, etc ….

Using more concise presentations.

- Taylor diagram.
  - Variance
  - Correlation
  - Error
- Target plot
  - Bias
  - Error



The Climate Forecast System (CFS) reanalysis and re-forecasting project (CFSRR) provides a 30+ year high resolution wind field

- 0.5° hourly wind and temperature fields.
- Associated 0.5° daily ice analyses.

This data set appears ideal to be the basis of a wave reanalysis over the same 30+ year period.

- There is insufficient data in any period to obtain a data-dominated analysis, therefore
- It makes more sense to do a hindcast without assimilation, and use data possibly later for bias corrections of the hindcast only.
- Ideal as basis for long-term validation in NOPP project.

http://cfs.ncep.noaa.gov/cfsr

WAVEWATCH III community modeling code management environment

- Traditionally code distributed as “tarball”, code delivered back to NCEP the same way.
- Does not work with many teams working on same code
  - Subversion (svn) server for version control.
  - Each team has code manager with access to server and latest developmental model versions thereon.
  - Code managers at NCEP merge individual contribution into “trunk” version of code.
    - Henrique, Arun, (Andre, Hendrik).
- Best practices guide for community model development of WAVEWATCH III as deliverable for NOPP project. NCEP intends to maintain this environment after project is finished.

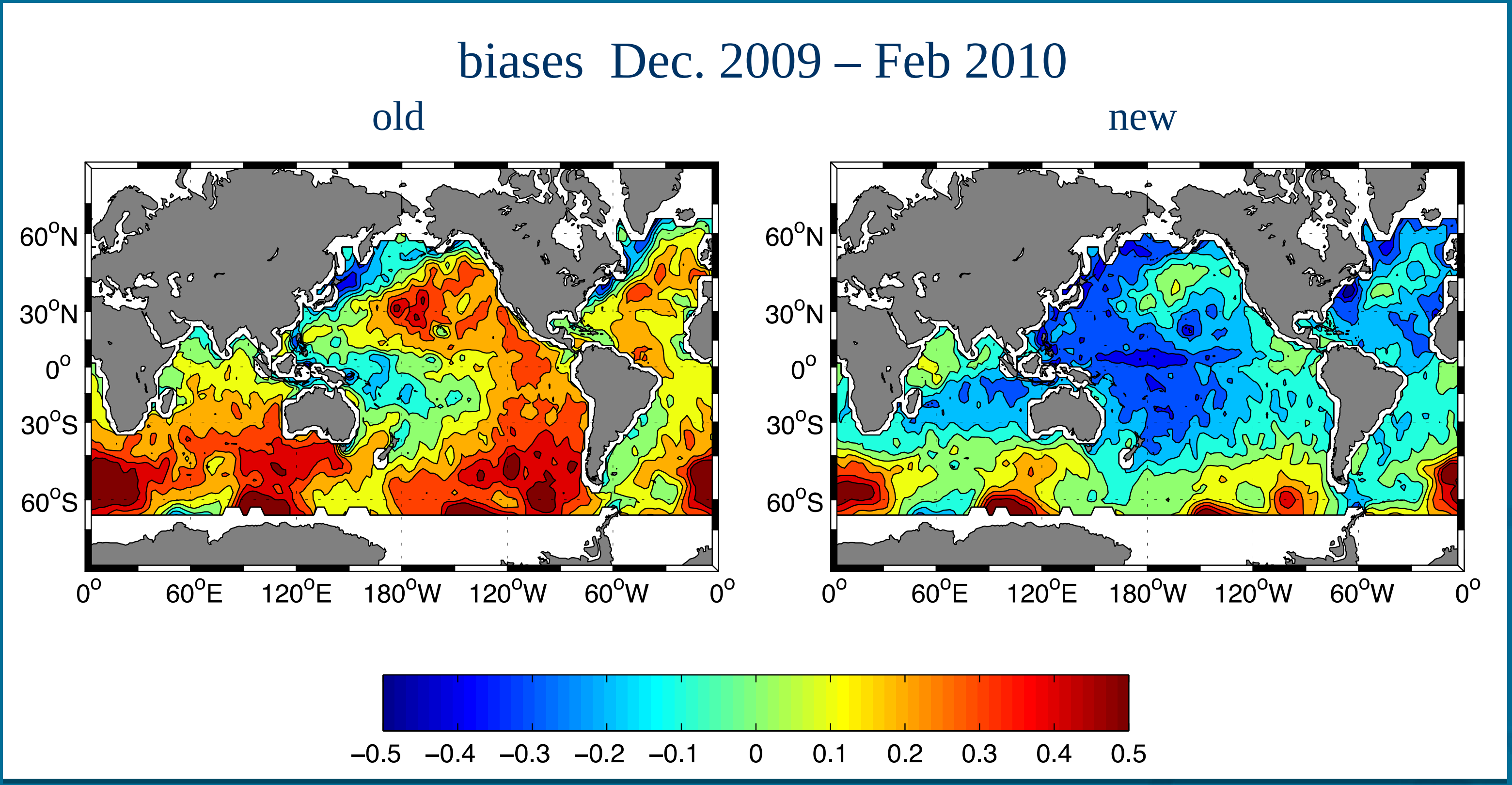
WAVEWACTH III added capabilities:

- Curvilinear and unstructured grids.
- Quasi-stationary model version.
- New source terms.
  - GMD and nonlinear filter.
  - Two moveable bed bottom friction terms.
  - Ifremer physics packages.
- Massively expanded output options (coupling).
- Post-processing tools:
  - Re-gridding.
  - NetCDF output.
- Coupling interfaces:
  - ESMF.
  - PALM.

In the pipeline:

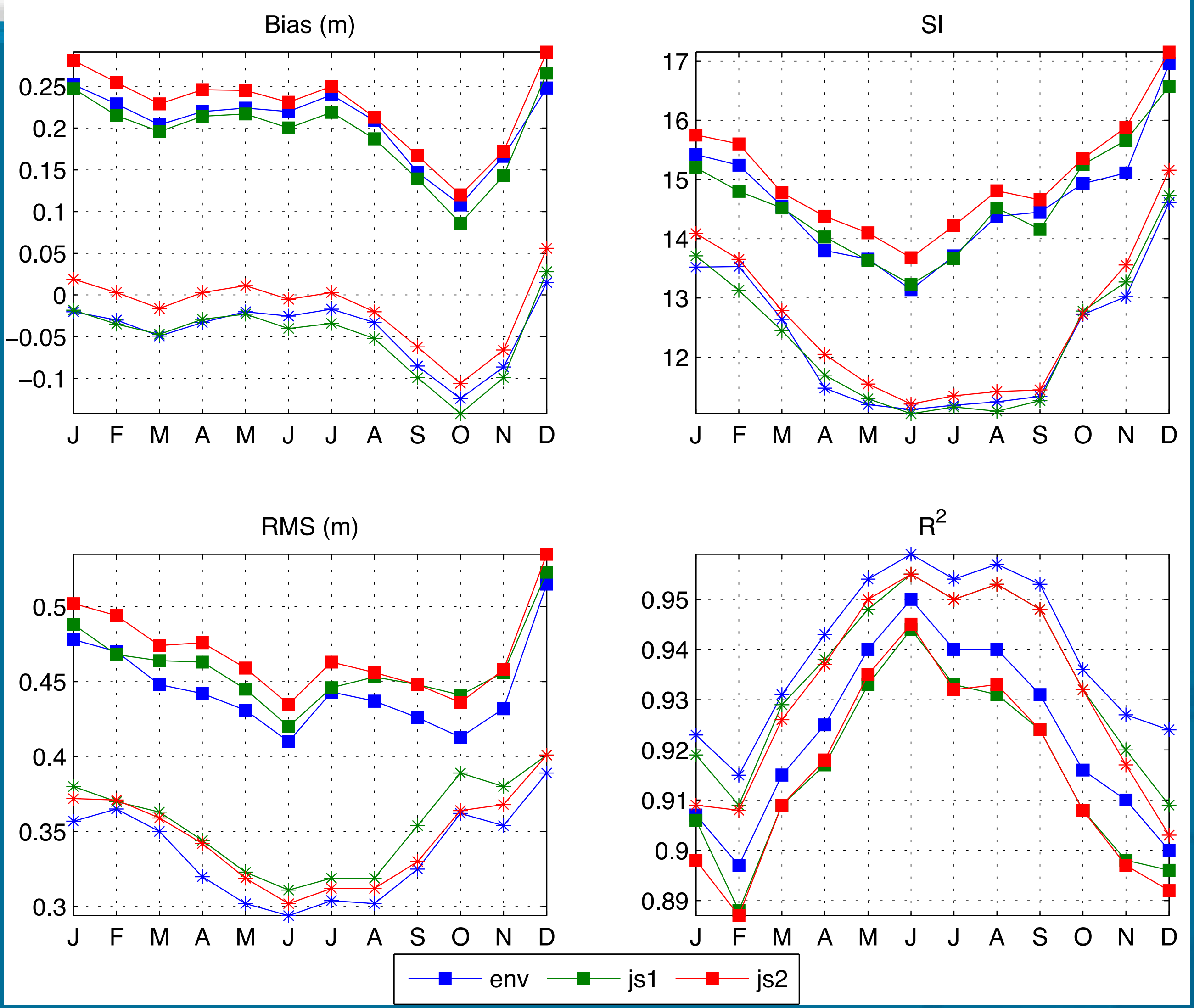
- Spatial and temporal tracking of wave fields:
  - Porting internal partitioning to SWAN.
  - Space-time tracking (external / internal).
- NCEP planning first physics upgrade in operational wave models based on NOPP project in 2012 (following slides).
- NCEP planning NOPP “consensus” upgrade in 2014/5.
  - Replacing DIA and other “deep” source terms.
  - New products for SOLAS, specifically wave breaking.
  - Full polar coverage (tri-polar / curvilinear Artic grid).
  - Unstructured coastal grids s(2-3 km resolution)
  - Upgrades shelf physics.
- Physics packages should be easily portable to SWAN, WAM, STWAVE if so desired.

NCEP physics upgrade based on Ifremer results, tested with NCEP global and Great Lakes winds.



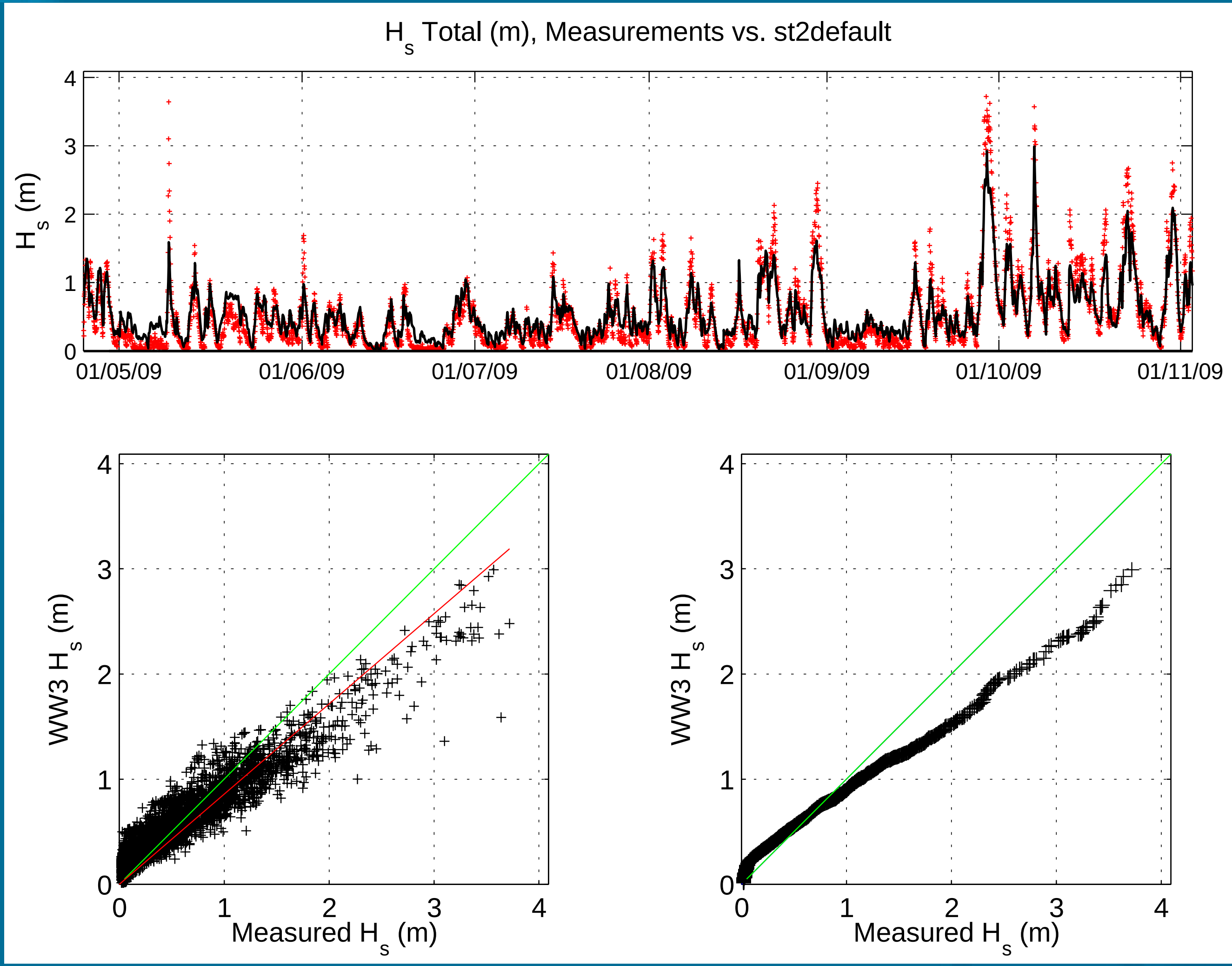
Outlook

Monthly global errors 2009



Outlook

Great Lakes buoy 45007, 2009
old physics



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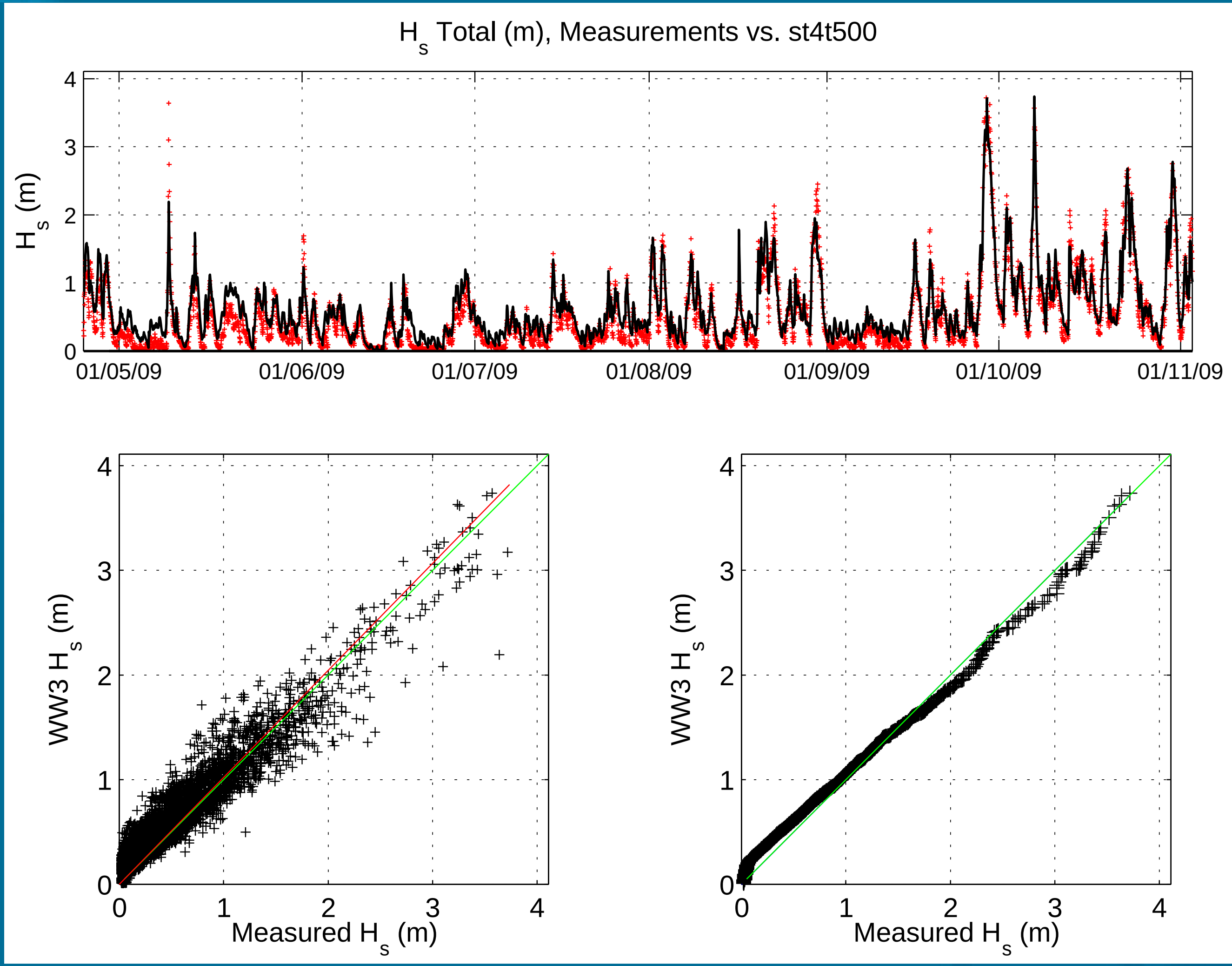
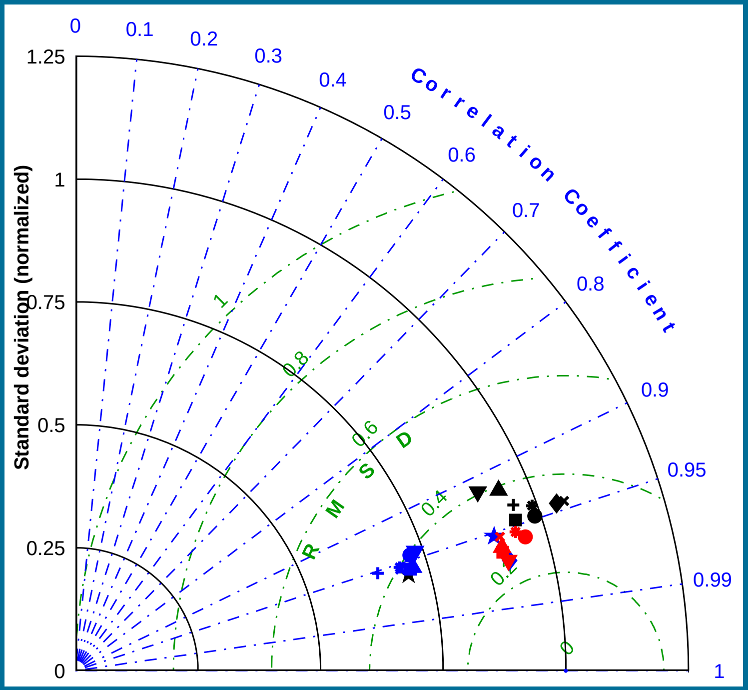
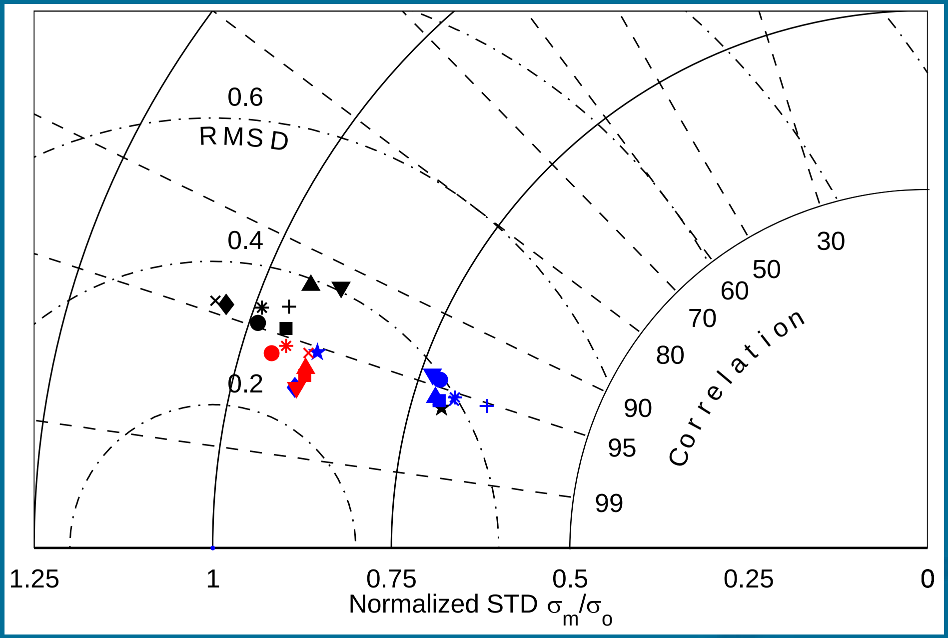


Outlook

Taylor diagram and alternative version for several GL buoys for 2009





GLERL-Donelan (2G)

WW III Tolman and Chalikov

WW III Ifremer

Conclusion

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Thank you!