CYGNSS Sensitivities to Ocean Parameters and Geophysical Model Function Development

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Outline
GMF Development Algorithm Flow

Matchup Dataset

Evaluate Sensitivities:
• \( U_{10}, HS, \theta_{inc} \)
\[ \sigma_0 = F(U_{10}, HS, \theta_{inc}) \]

\[ \sigma_0^{MEAS} - \sigma_0^{MOD} = F(\text{Instrument Parameters}) \]

Calibration errors?

Develop \( \sigma_0^{MEAS} \) Correction

Fine Tune GMF
Evaluation Data Set

✧ Matchup Dataset:
✧ Satellite Data:
  ➢ Radiometer: SSMIF16, SSMIF17, WindSat, AMSR-2, GMI, SMAP (RSS)
  ➢ Scatterometers: ASCAT-A/B
  ➢ Altimeter: Jason-2, Jason-3, Altika, Cryosat, Sentinel-3a (NOAA)
✧ Model Data:
  ➢ ECMWF
  ➢ GDAS
  ➢ IFREMER Wave Watch 3
  ➢ Meteo France WAM
✧ Data: Feb 14th-May 1st, 2017
✧ Data Filters:
  ➢ Gain ≥10dB
  ➢ Position on delay peak = 7 or 8
  ➢ SNR ≥ 3dB
DDMA and Significant Wave Height

ASCAT

RSS Radiometers
Significant Wave Height Dependence

$\sigma_0 / GMF(U_{10})$

- Ifremer
- MWAF
- Altimeters: Altika, CryoSat, Jason2, Jason3, Sentinel-3a

$\text{NRCS} / GMF(U_{10})$

$HS [m]$

$0 \rightarrow 10$
Incidence Angle Dependence

\[ \sigma_0/GMF(U_{10}, HS) \]
NBRCs – GMF(U10, HS, INC)
Normalized NB RCS Bias

$(\text{NB RCS - GMF}) / \langle \text{NB RCS} \rangle$

SNR
NBRCs vs Radiometer Wind

After Correction

PRN and SNR Corrected NBRCs

Measured NBRCs

Radiometer Wind Speed [m/s]

Color Scale:

$10^6$

$10^7$

$10^8$

$10^9$
GMF Through Iterations

Final GMF

SNR and PRN Corrected NBRCS

Modelled NBRCS

Measured NBRCS

Bias: 0.01 dB
SD: 1.27 dB
#Pt: 21M
Final GMF

SNR, PRN and Antenna Azimuth Corrected NBRCS

Bias: 0.00 dB
SD: 1.23 dB
#Pt: 21M
Measured vs Modeled NBRCs

Non corrected NBRCs

UMICH GMF

NOAA GMF

SNR, PRN and Antenna Azimuth Corrected NBRCs

Bias: 0.40 dB
SD: 1.79 dB
#Pt: 21M

Bias: 0.00 dB
SD: 1.23 dB
#Pt: 21M
Measured vs Modeled NBRCs

Corrected NBRCs

UMICH GMF

Bias: 0.26 dB
SD: 1.57 dB
#Pt: 21M

NOAA GMF

SNR, PRN and Antenna Azimuth Corrected NBRCs

Bias: 0.00 dB
SD: 1.23 dB
#Pt: 21M
IIF appears to be on average exhibit a higher bias in the Atlantic and Western Indian Ocean than IIR and IIR-M.
 Developed initial CYGNSS NBRCs geophysical model function dependent on wind speed, significant wave height and incidence angle
  - 0.63dB between 20-50m/s

 Detected wind direction signal

 Developed NBRCs corrections based on SNR, antenna azimuth and PRN
  - SNR correction is nonlinear correction on the order of 1dB within valid range of 3-20dB
  - PRN simple bias correction developed for each PRN separately
  - ~1dB variations found across antenna azimuth angle
Some large errors with PRN blocks are still present and appear to have geographical dependence

- Suggest reevaluation PRN corrections applied to L1 data ver 2.0
- Reexamine antenna azimuth corrections
- CYGNSS wind retrievals released on PODAAC shouldn’t be used for scientific studies yet