



Koninklijk Nederlands Meteorologisch Instituut Ministerie van Verkeer en Waterstaat

#### Assessment of the corrected CMOD6 GMF using scatterometer data

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## Outline

- C-band GMF's
  - Differences
- C-band scatterometers
  - ERS/AMI and Metop/ASCAT
  - Differences: resolution, accuracy, noise, etc.
- Comparison of scatterometer data and GMF's
- Correction of the GMF CMOD5n (by KNMI)
   CMOD5na and CMOD6
- Calibration of the scatterometer data to CMOD6

## Introduction

- Objective
  - Consistent C-band scatterometer data
  - Unified GMF for all C-band scatterometers
    - Applicable over full ERS/ASCAT incidence angle range [18°-66°]
- Issue
  - GMF's are empirical and instrument/dataset dependent
    - GMF's based on ERS data are not applicable to high incidence angles and GMF's based on only ASCAT data not to low incidence angles
- Strategy
  - Incidence-angle correction of the CMOD5n (developed for ERS) using ASCAT data (well calibrated)
    - Two versions of corrected model, called CMOD5na and CMOD6
  - Beam-dependent correction of residual biases of the scatterometer data to fit CMOD6

cf. Verspeek et al., 2012

# C-band GMF's state of the art

 C-band GMF's : similar general mathematical form (based on harmonic decomposition)

 $\sigma 0(\theta, v, \varphi) = B0(\theta, v) \left[1 + \sum_{k=1}^{N} (Bk \left(\theta, v\right) \cos k\varphi)\right]^{p}$ 

- Differ in B coefficients (determined empirically) which depend on the backscatter and wind dataset used
- Backscatter data
  - CMOD4, CMOD\_IFR2: ERS-1
  - CMOD5, CMOD5n: ERS-2
  - CMOD5na, CMOD6: ERS-2 (corrected with ASCAT-A)
  - CMOD\_RSS: ASCAT-A
- Wind data
  - CMOD4, CMOD5: ECMWF analysis/FGAT
  - CMOD\_IFR2: ECMWF analysis + NOAA buoys
  - CMOD\_RSS: SSMI/WindSat (speed), CCMP (direction)

# Differences between ERS and Metop scatterometers

- Depends on the product resolution used to construct the GMF (25 km, 12.5 km, etc.)
- Cumulated Spatial Response Function
  - Depends on filtering box (Vogelzang, Tuesday)





# Differences between ERS and Metop scatterometers

- Radiometric resolution
  - Noise: NESZ\_ASCAT < NESZ\_ERS
  - Accuracy: KP\_ASCAT < Kp\_ERS



#### Differences between scatterometers

- ERS-2 non-linearity
  - At low incidence angles (low backscatter)
  - Impact on the GMF



#### **GMF** comparison

- CMOD4, CMOD\_IFR2
- CMOD5, CMOD5n
- CMOD5na, CMOD6
- CMOD\_RSS
- Important differences





#### **GMF** comparison

- CMOD4 , CMOD\_IFR2
- CMOD5, CMOD5n
- CMOD5na, CMOD6
- CMOD\_RSS
- Asterisk: averaged backscatter





#### Difference between GMF and data

 The GMF's having the lowest difference; over all incidence angles, wind speed and directions; with ERS and ASCAT are CMOD5na and CMOD6



CMOD4, CMOD5, CMOD5n, CMOD5na, CMOD6, CMOD\_IFR2, CMOD\_RSS

### CMOD5n correction

- Assumption: ASCAT (well calibrated) reference
  - Absolute calibration (transponders)
- Incidence-angle dependent bias, attributed to the GMF
   CMOD5n developed for ERS, not validated at high incidence angles
- Beam-dependent bias, attributed to instrument calibration

Correction of CMOD5n

 $CMOD6 = CMOD5n + B0^{corr}(\theta)$ 

Note: To account for ERS incidences, CMOD5na as in Verspeek et al., 2012, is corrected to become CMOD6 See Stoffelen, Tuesday



#### NWP ocean calibration

- NWP ocean calibration (NOC)
  - Difference between measured and simulated backscatter, averaged over wind direction and speed
- Well established method to compute the bias between scatterometer data and a GMF
- Reference GMF: CMOD5n
- Reference wind: Era-interim forecasts

#### NOC bias w.r.t CMOD5n ERS-1 and ERS-2

- CMOD5na not appropriate to ERS
  - Large difference at low incidence angles
- CMOD6 is the closest GMF to ERS data
- Residual (small) biases to be corrected at each WVC



### Calibration result

- Correction of the beam-dependent and WVC dependent biases
- ERS and ASCAT data well calibrated to CMOD6



### Calibration result

- Same correction method applied to ERS-1, ERS-2, ASCAT-A and ASCAT-B
- All data follow the same model over all incidence angles
- Consistent C-band backscatter down to 0.1 dB



### Summary

- C-band GMF's comparison
  - Large differences particularly at low/high inc angles
  - CMOD5na and CMOD6: best candidates for C-band data given the current calibration
- CMOD6 fits ERS and ASCAT over all incidence angles, winds and directions
- Assumption: ASCAT (well calibrated) reference

Calibrate ERS-1 and ERS-2 to CMOD6

Correct ASCAT residual bias to CMOD6

Consistent C-band backscatter data

 Unified GMF -> Consistent wind vectors







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#### Thank you