Intercomparison of operational wave forecasting systems against buoy data: time series of statistics data from ECMWF, FNMOC, NCEP, DWD, BoM, SHOM and JMA

Jean-Raymond Bidlot,
European Centre for Medium-range Weather Forecasts,
jean.bidlot@ecmwf.int

April 27, 2007

1 Forewords

Outputs from different operational forecasting centres are compared to buoy and platform data as broadcasted to the meteorological community via the Global Telecommunication System (GTS). On a monthly basis, data are gathered informally from operational weather services with an interest in wave forecasting (Bidlot and Holt, 2006). The different data sets are subsequently merged and made available to all participating partners for further evaluation. In this documents, examples, in graphical and tabular forms, are shown. These results have been processed at ECMWF and should served as an example to the kind of information that could be obtained from such comparison. No statement of quality, nor reasons why the different systems are performing differently will be given.

2 Data

Before using observations for verification, care has to be taken to process the data to remove any erroneous observations and also in order to match the scale of both model and observations. This scale matching is achieved by averaging the hourly data in ± 2 hour time windows centered on the four major synoptic times corresponding to the normal model output times. The original quality control and averaging procedure was discussed in Bidlot *et al.* (2002). It was extended to include platform data as described in Sætra and Bidlot (2004). Note that in this paper we refer to these data as buoy data since most of them are from moored buoys, except if stated otherwise.

The intercomparison relies on the exchange of model output at buoy locations. An agreed upon list of locations is used where observations are known to be available. Because buoy networks are changing with time, as witnessed by a rapid increase in the number of buoys available via the GTS since the mid-nineties, updates to the list have been necessary. Not all participating centres have been able to update their list however. Other participants are only running limited area model(s). Because of the limited number of buoys, a fair comparison between the different systems can only be achieved if the same number of buoys and the same number of buoy-model collocations are used.

In this document, data that are common to ECMWF, FNMOC, NCEP, DWD, BoM, SHOM and JMA are used. The other participants are left blank in the plots below.

References

Bidlot J.-R., D. J. Holmes, P. A. Wittmann, R. Lalbeharry, H. S. Chen, 2002: Intercomparison of the performance of operational ocean wave forecasting systems with buoy data. *Wea. Forecasting*, **17**, 287-310.

Bidlot J.-R. and M.W. Holt, 2006: Verification of operational global and regional wave forecasting systems against measurements from moored buoys. *JCOMM Technical Report*, **30**. WMO/TD-No. 1333.

Sætra, Ø. and J.-R. Bidlot, 2004: On the potential benefit of using probabilistic forecast for waves and marine winds based on the ECMWF ensemble prediction system. *Wea. Forecasting*, **19**, 673-689.

3   Results

In the remaining pages, time series of results of the comparison with buoys are presented for all common buoys and for common buoys within sub-areas. Three concecutive months of data are processed, and the corresponding statistics are plotted for the mid-month.

Only common data to ECMWF, FNMOC, NCEP, DWD, BoM, SHOM and JMA are used.

3.1 Comparison of wave height for all buoys

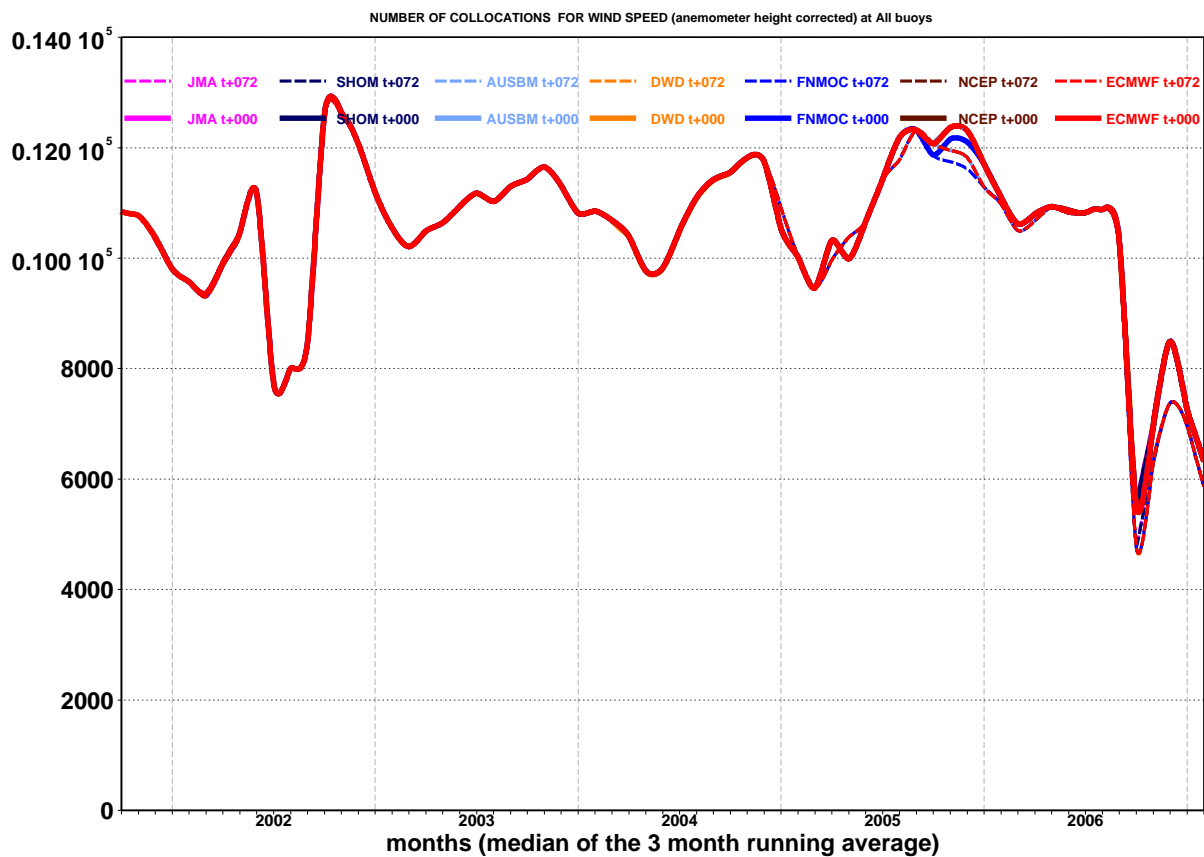The amount of data used is shown in Figure 1. Scatter index and bias are displayed next in Figure 2
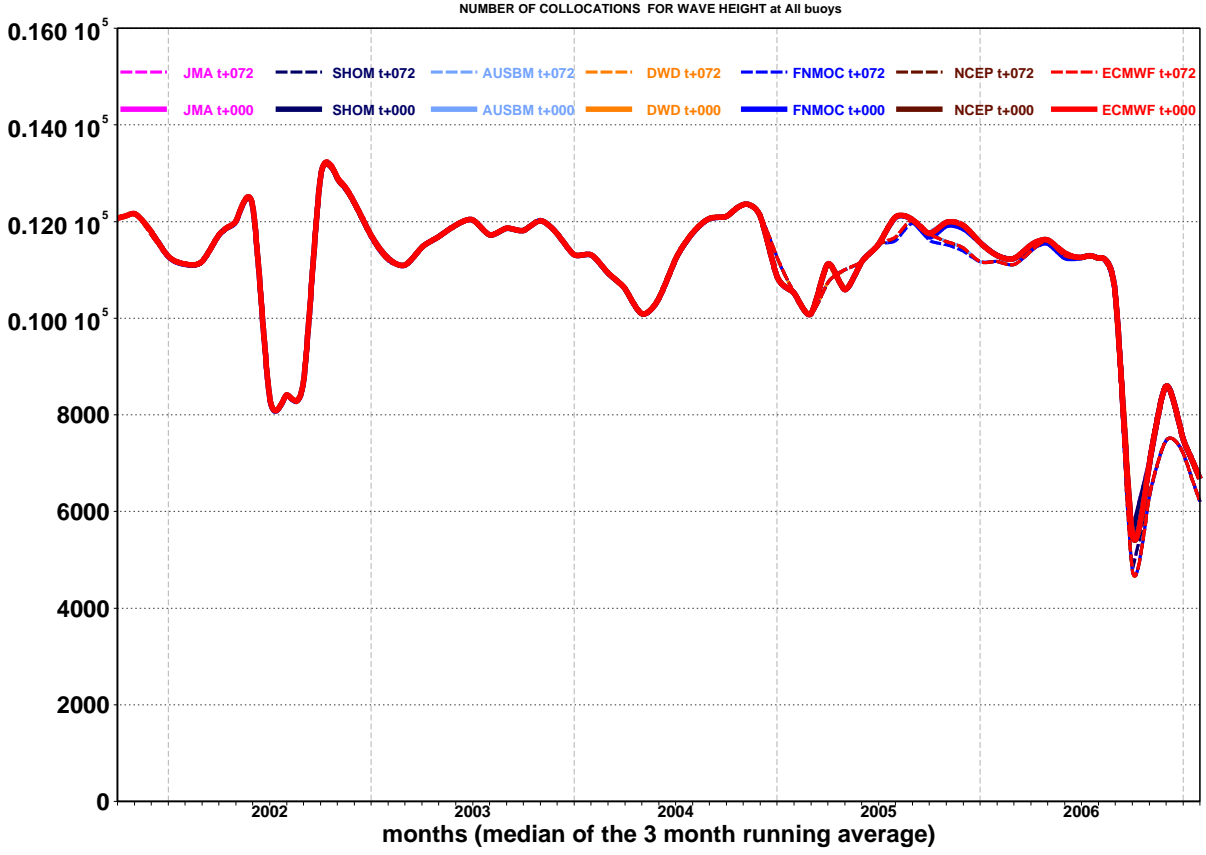
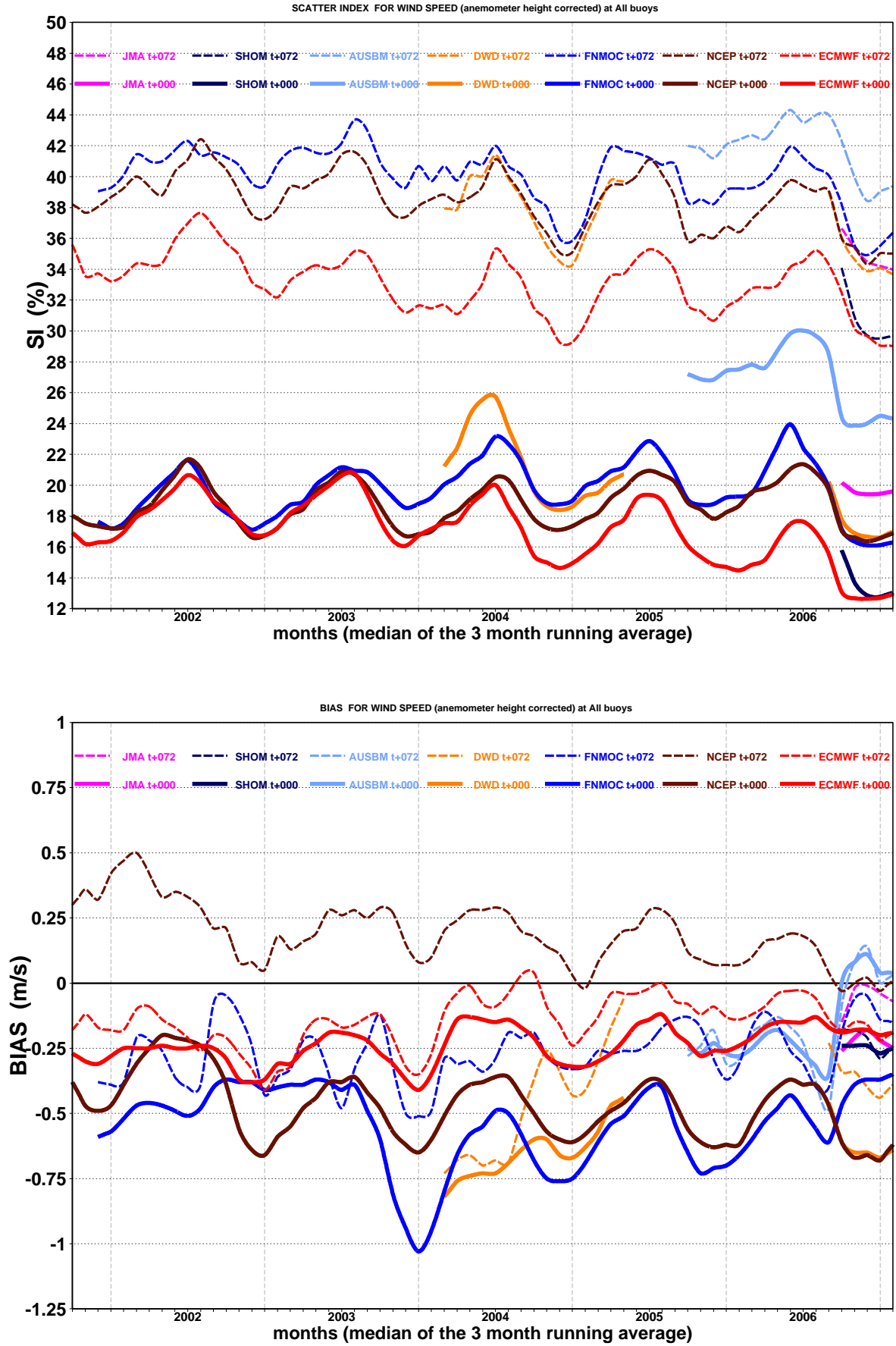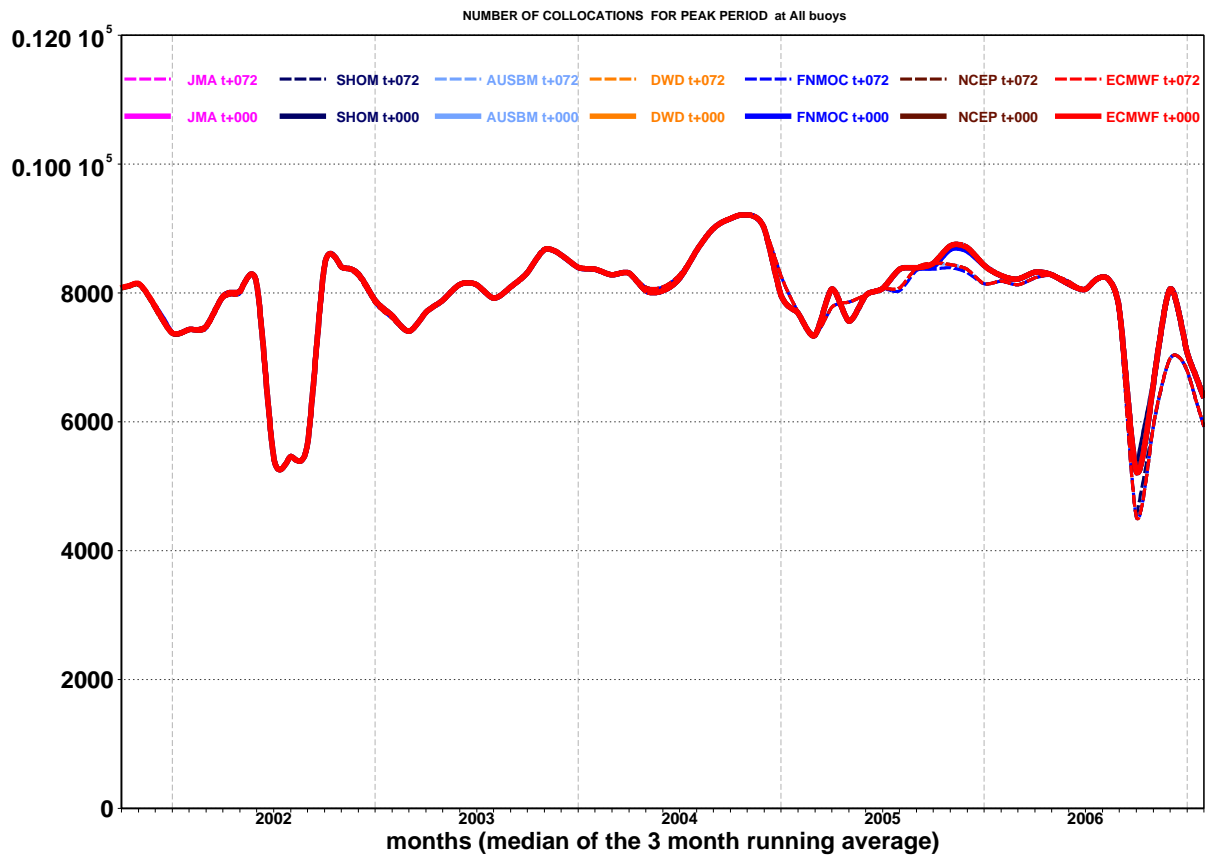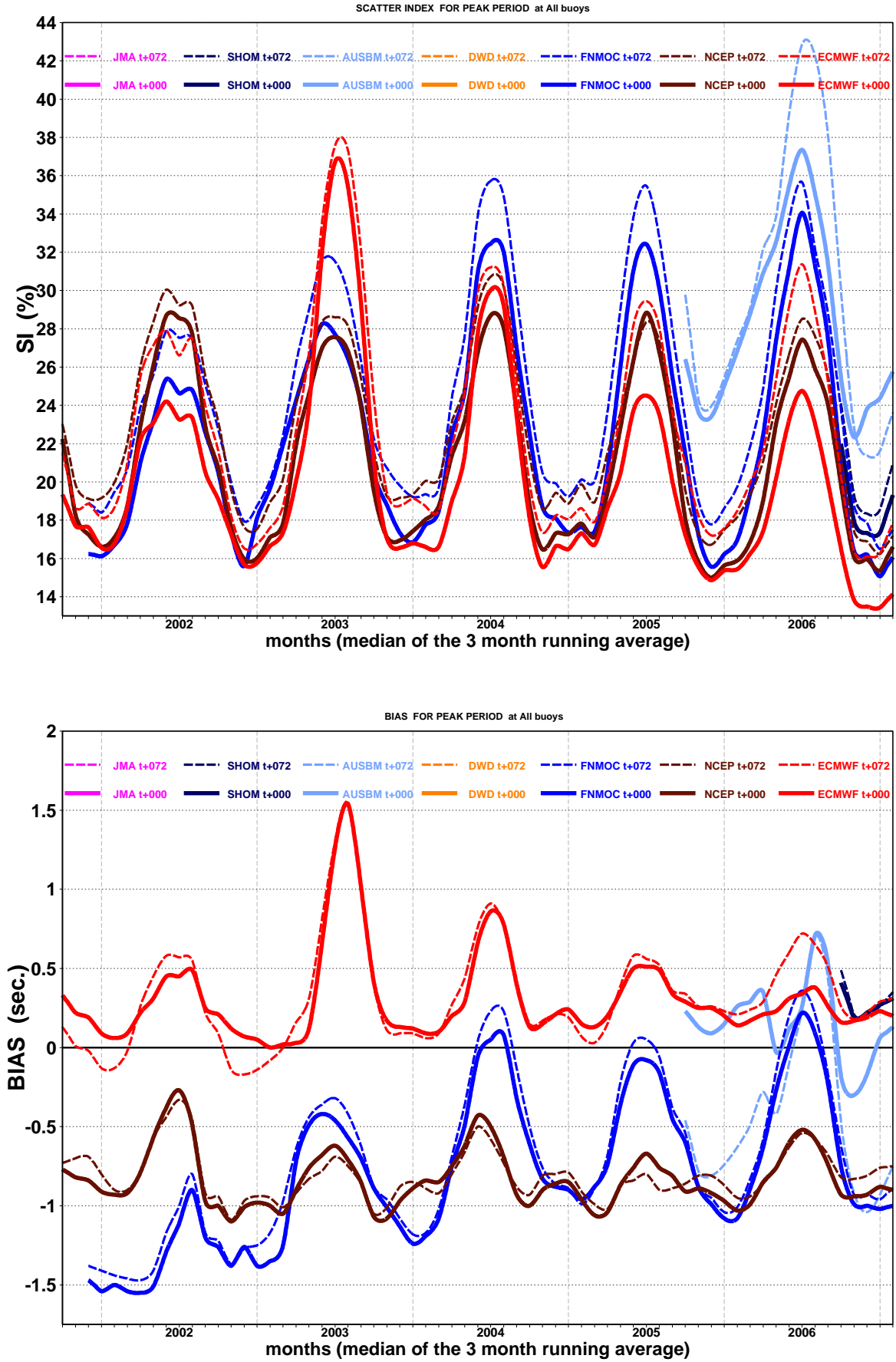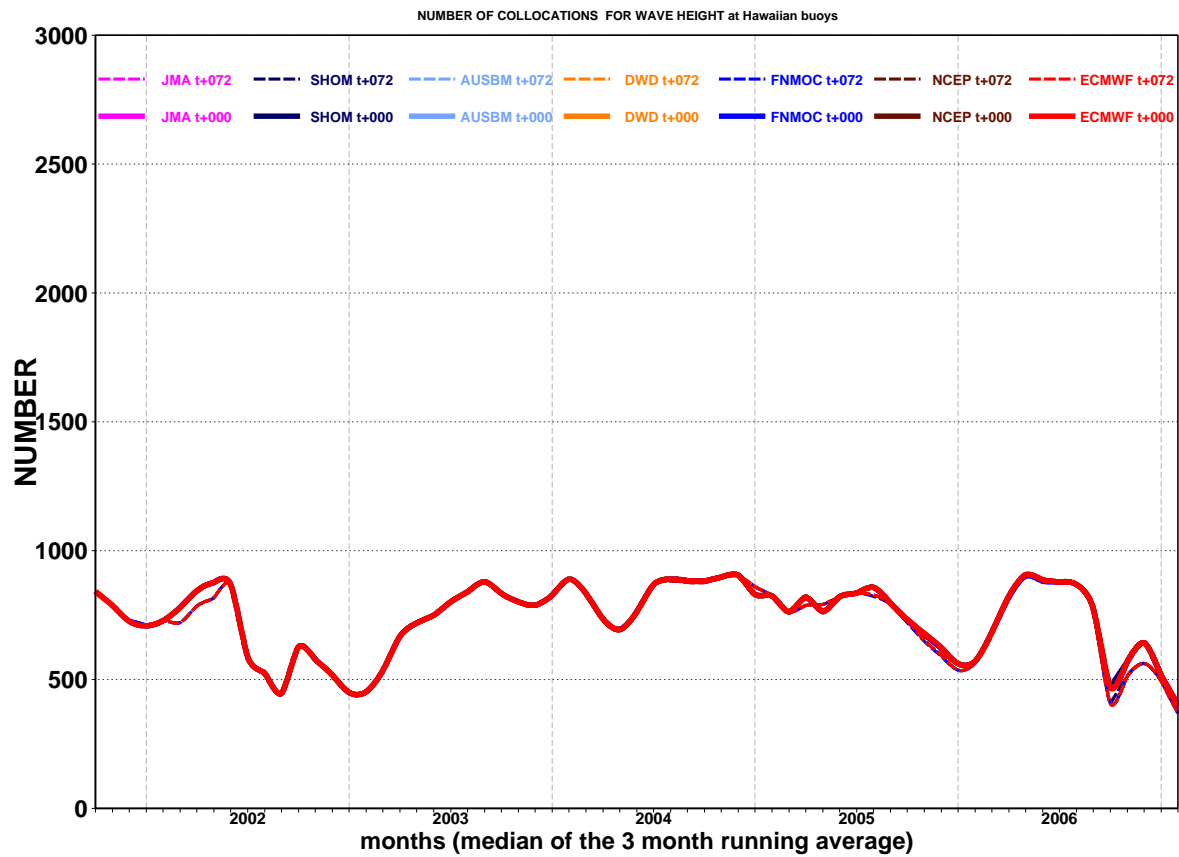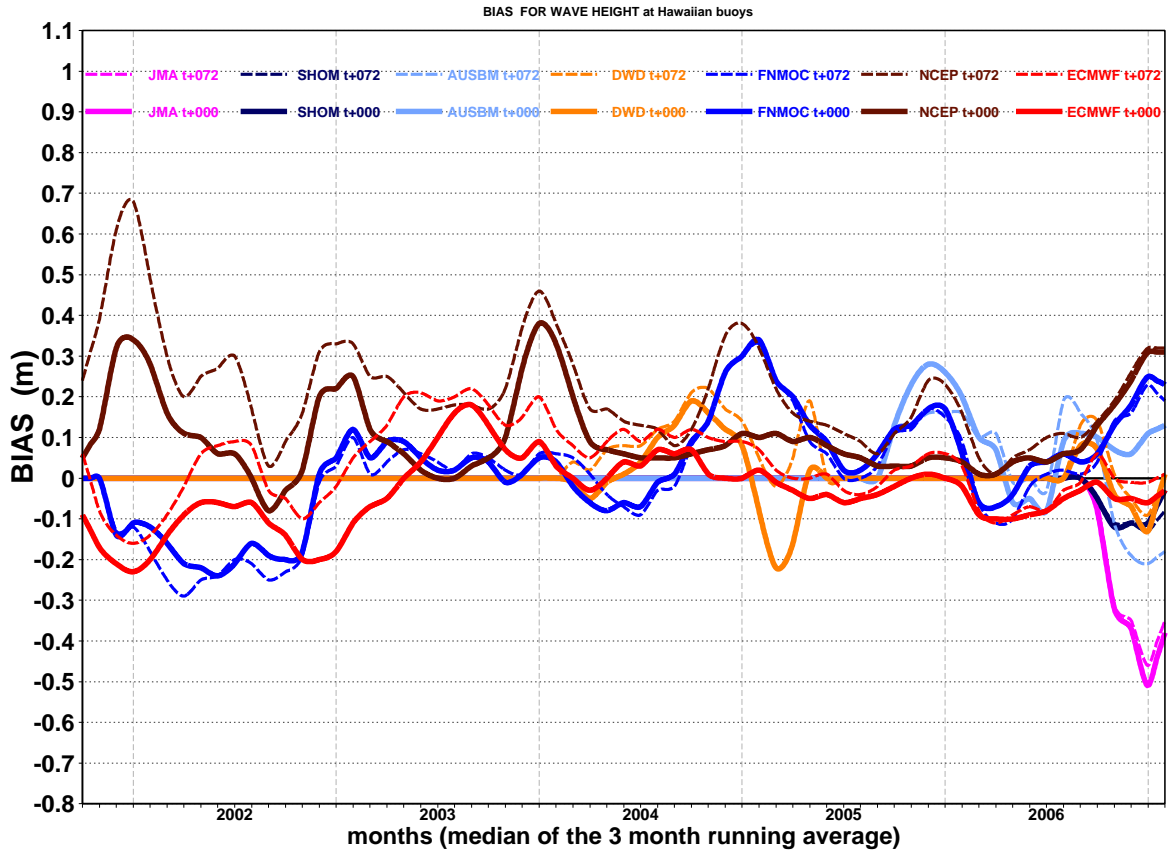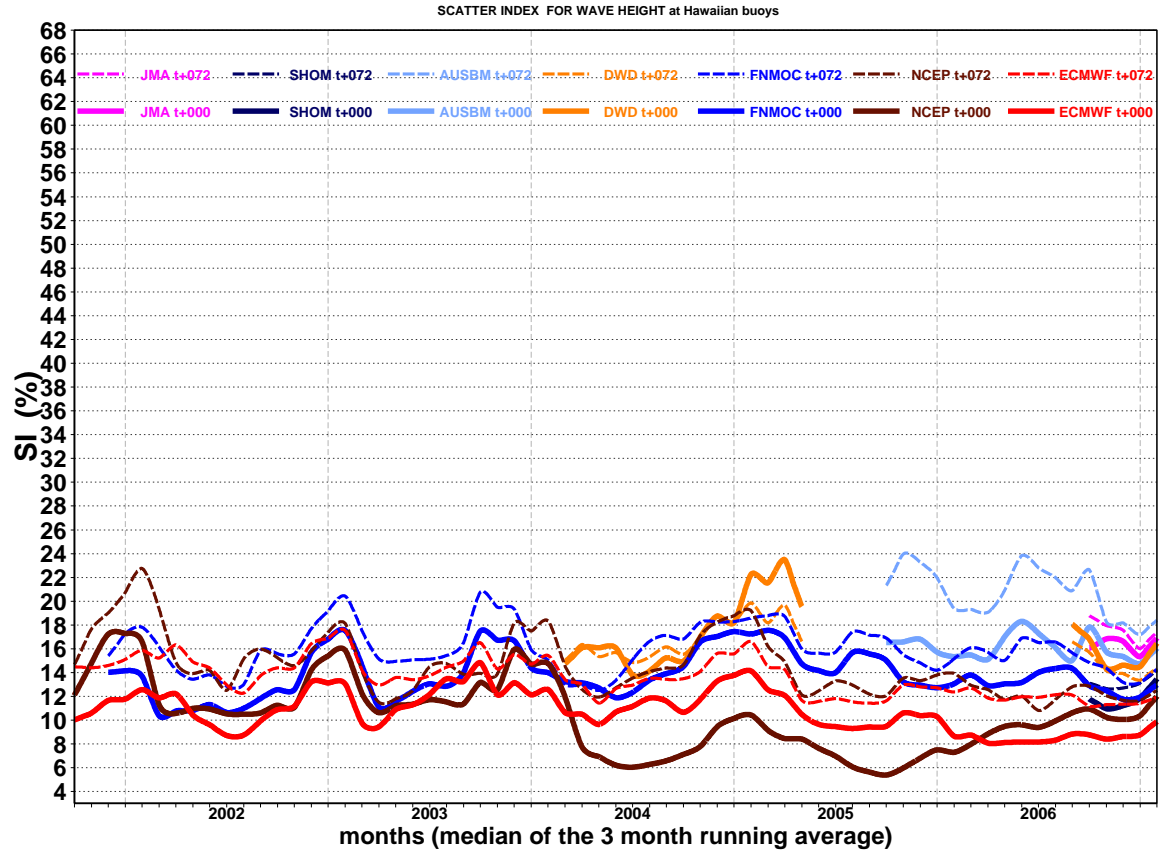Figure 1: Number of wave height collocations between models and all buoys.
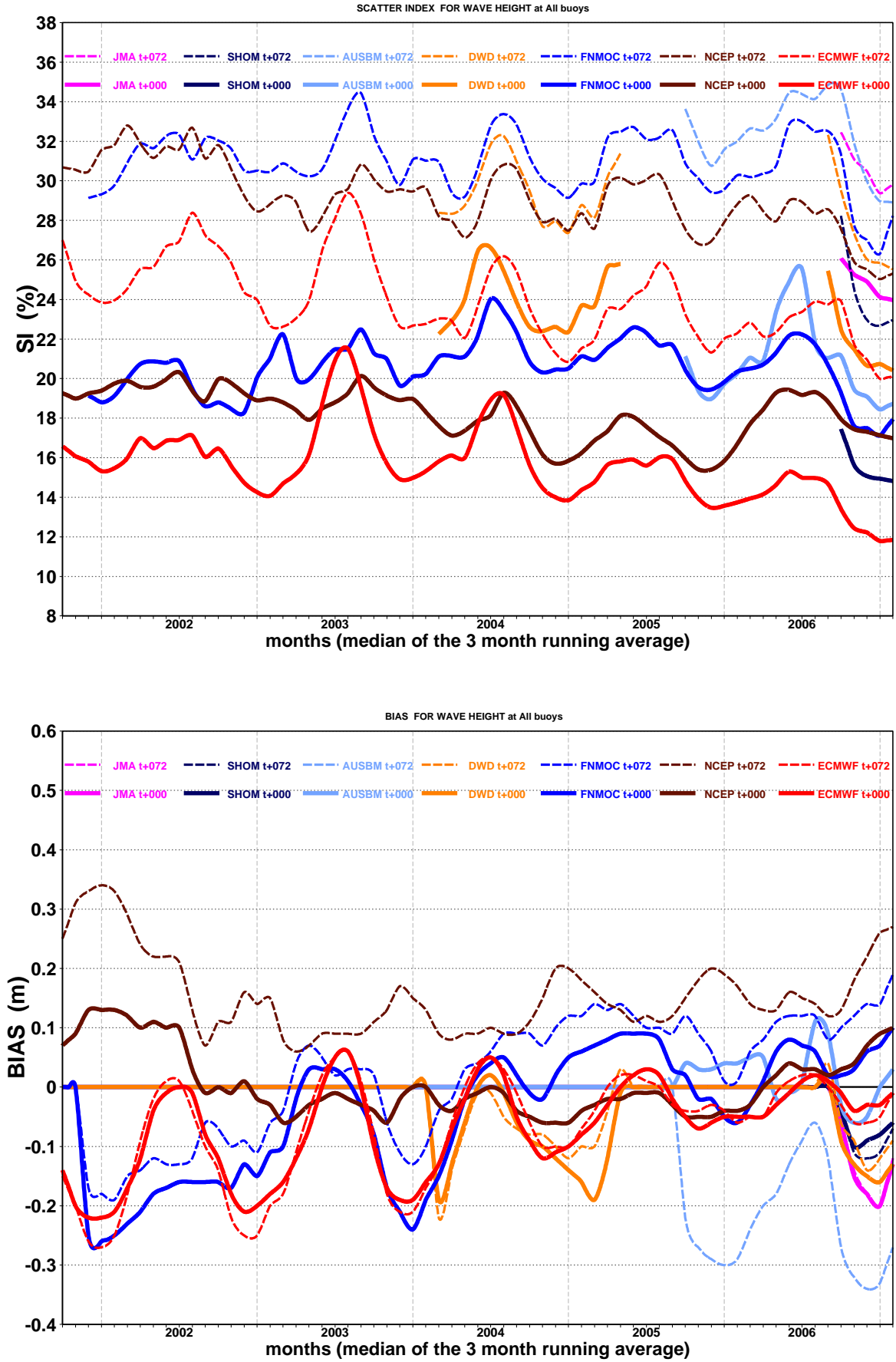
Figure 2: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common all buoys for forecast step 0 and day 3.

3.2 Comparison of wind speed for all buoys

The amount of data used is shown in Figure 3. Scatter index and bias are displayed next in Figure 4
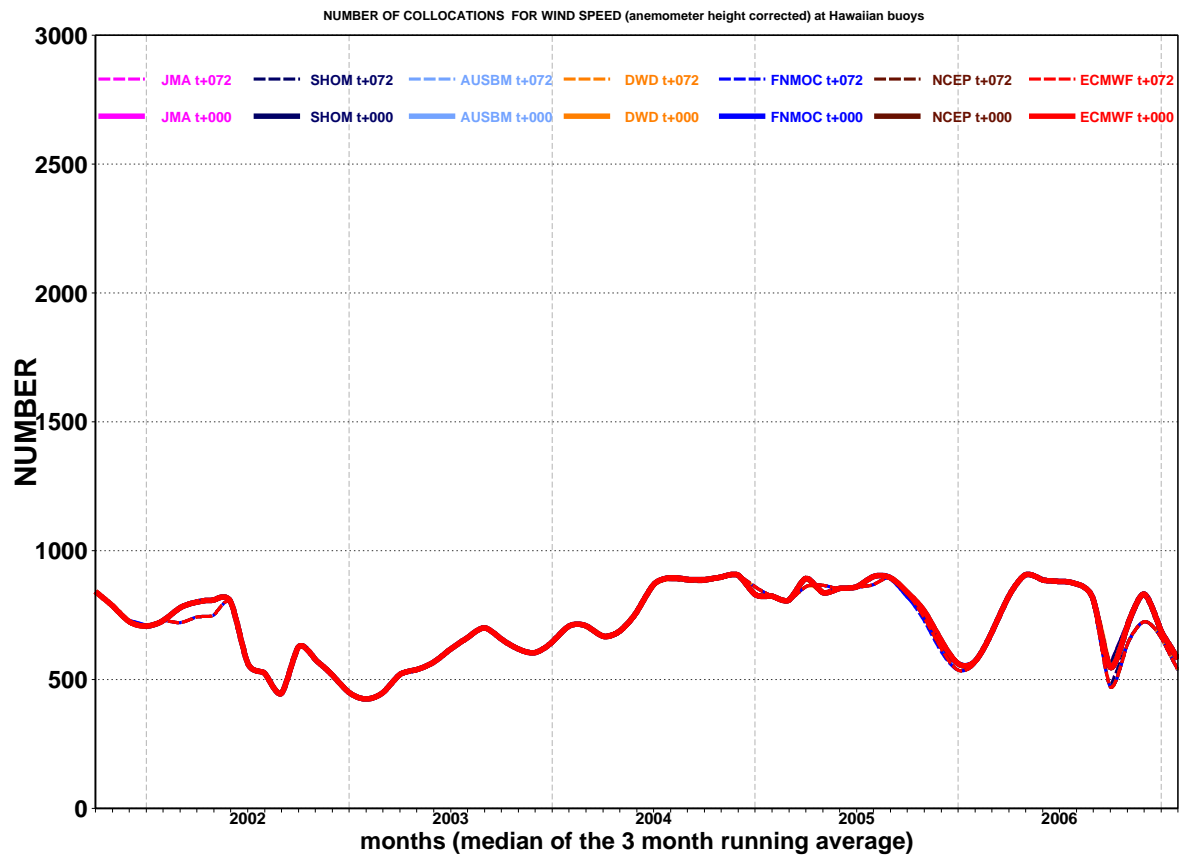

Figure 3: Number of wind speed collocations between models and all buoys.

Figure 4: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common all buoys for forecast step 0 and day 3.

3.3 Comparison of peak period for all buoys

The amount of data used is shown in Figure 5. Scatter index and bias are displayed next in Figure 6

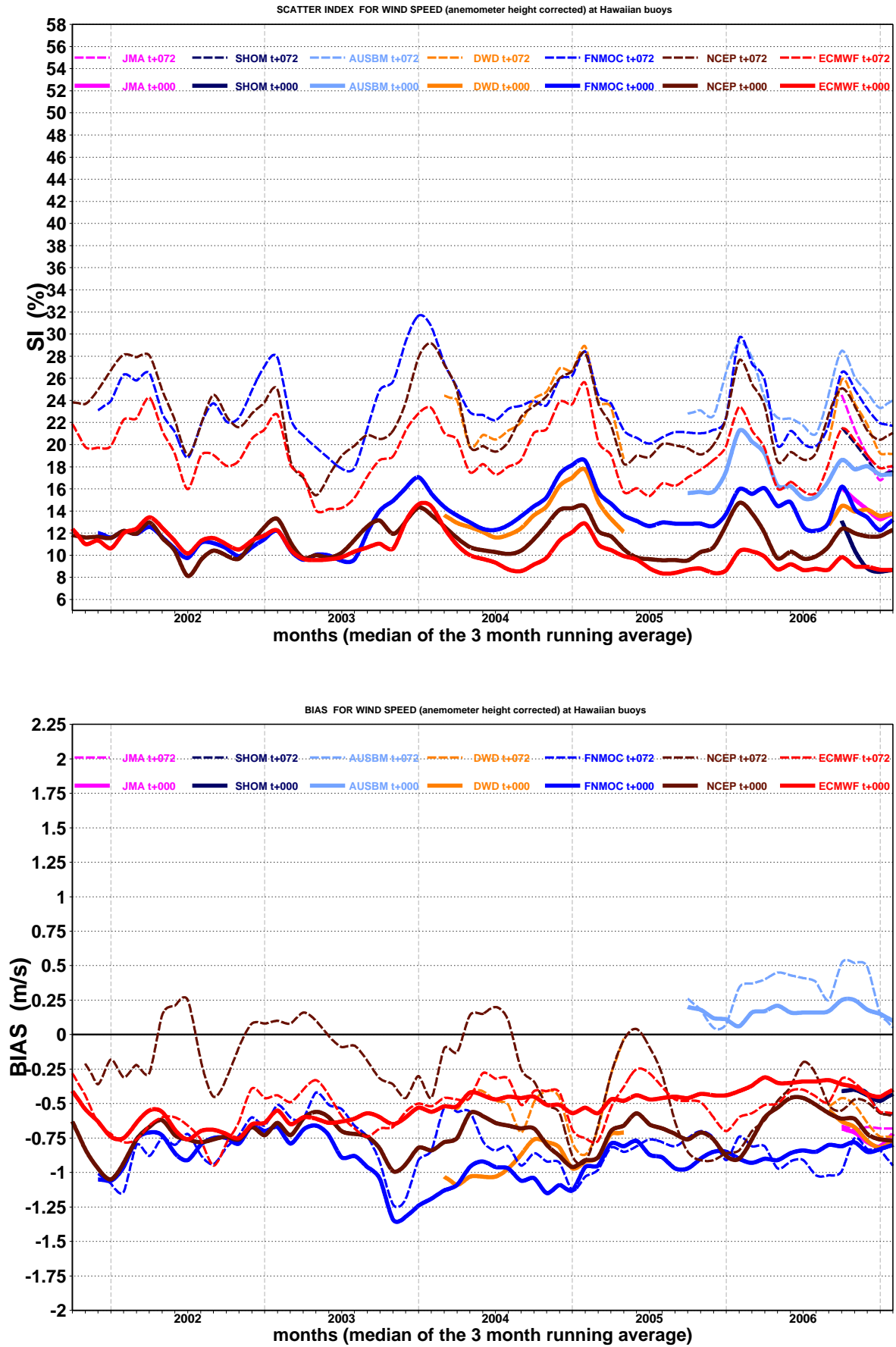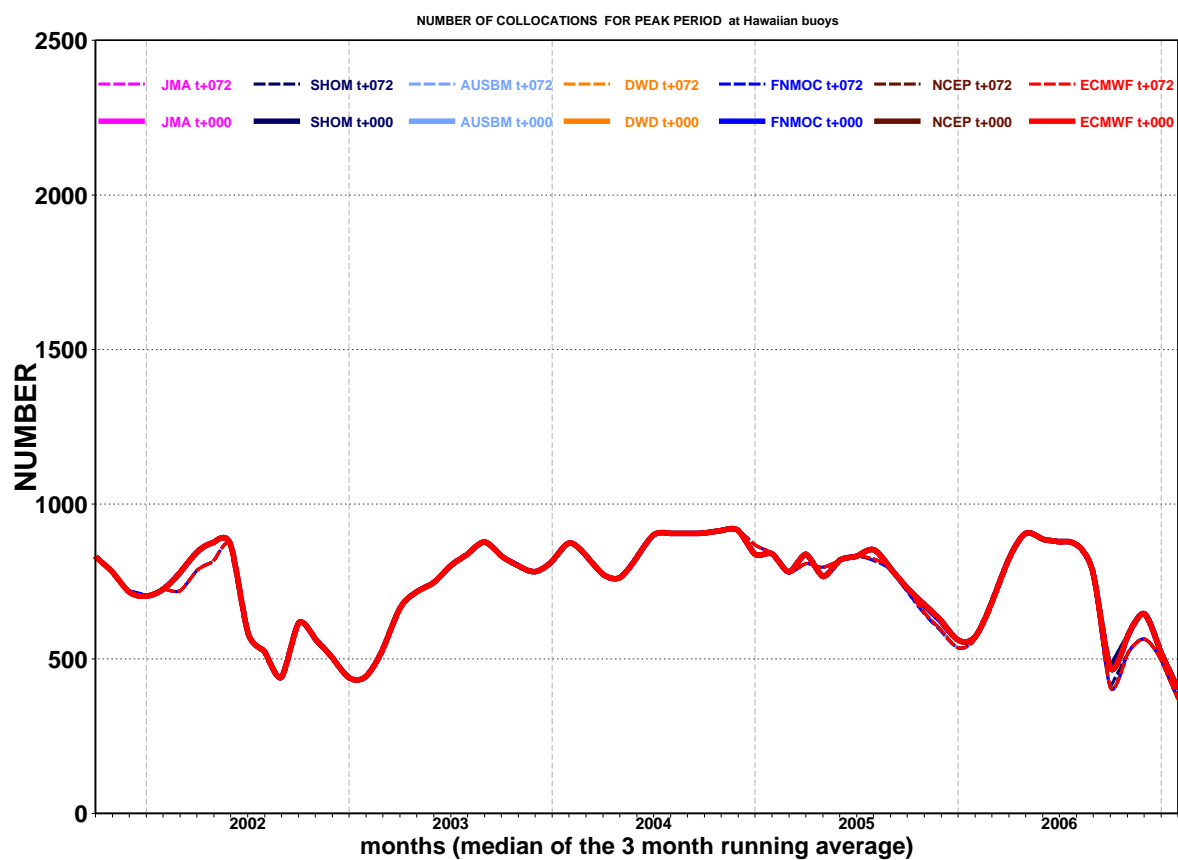Figure 5: Number of peak period collocations between models and all buoys.

Figure 6: Scatter index peak period (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common all buoys for forecast step 0 and day 3.

3.4 Comparison of wave height for Hawaiian buoys

The amount of data used is shown in Figure 7. Scatter index and bias are displayed next in Figure 8

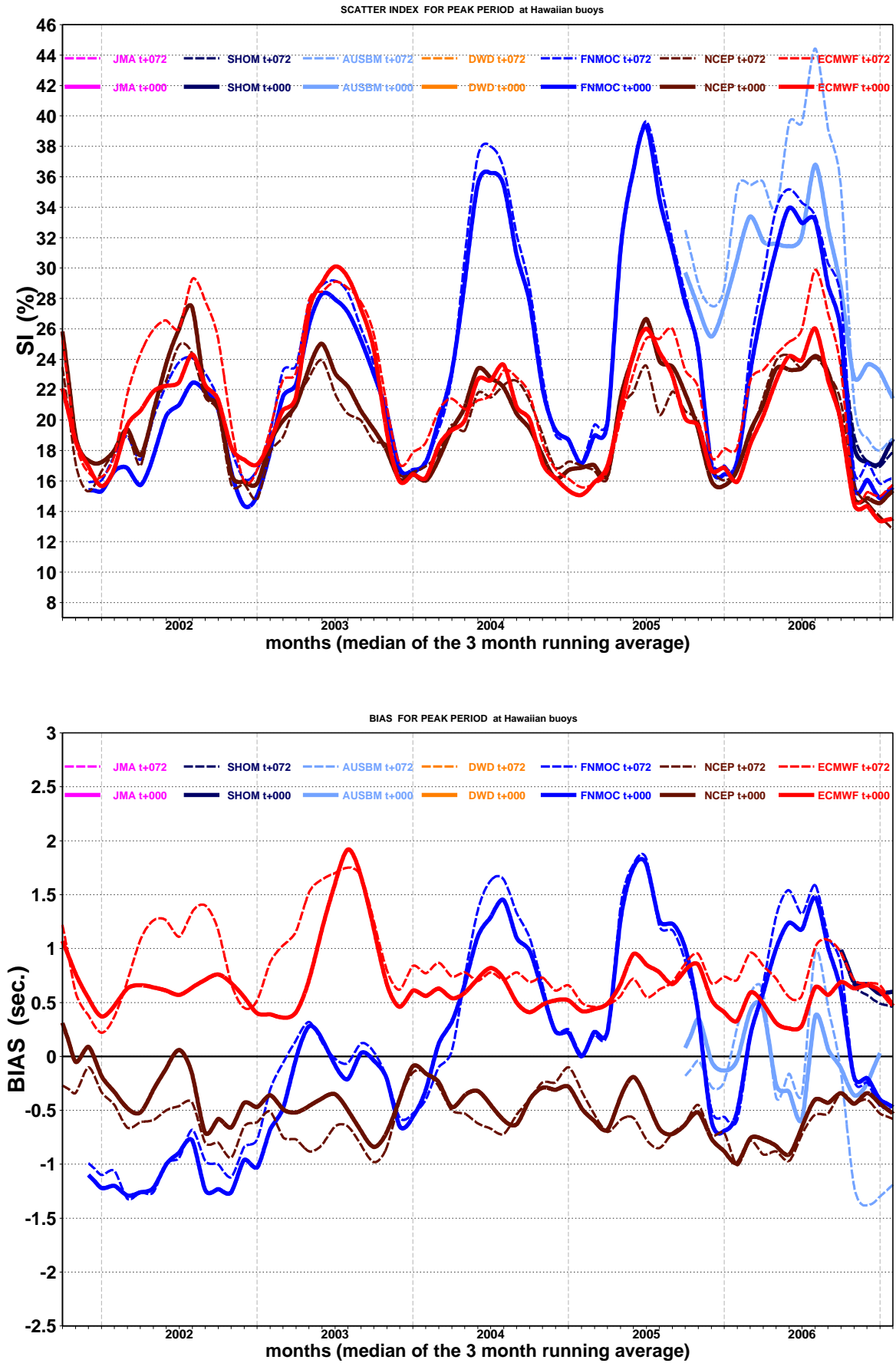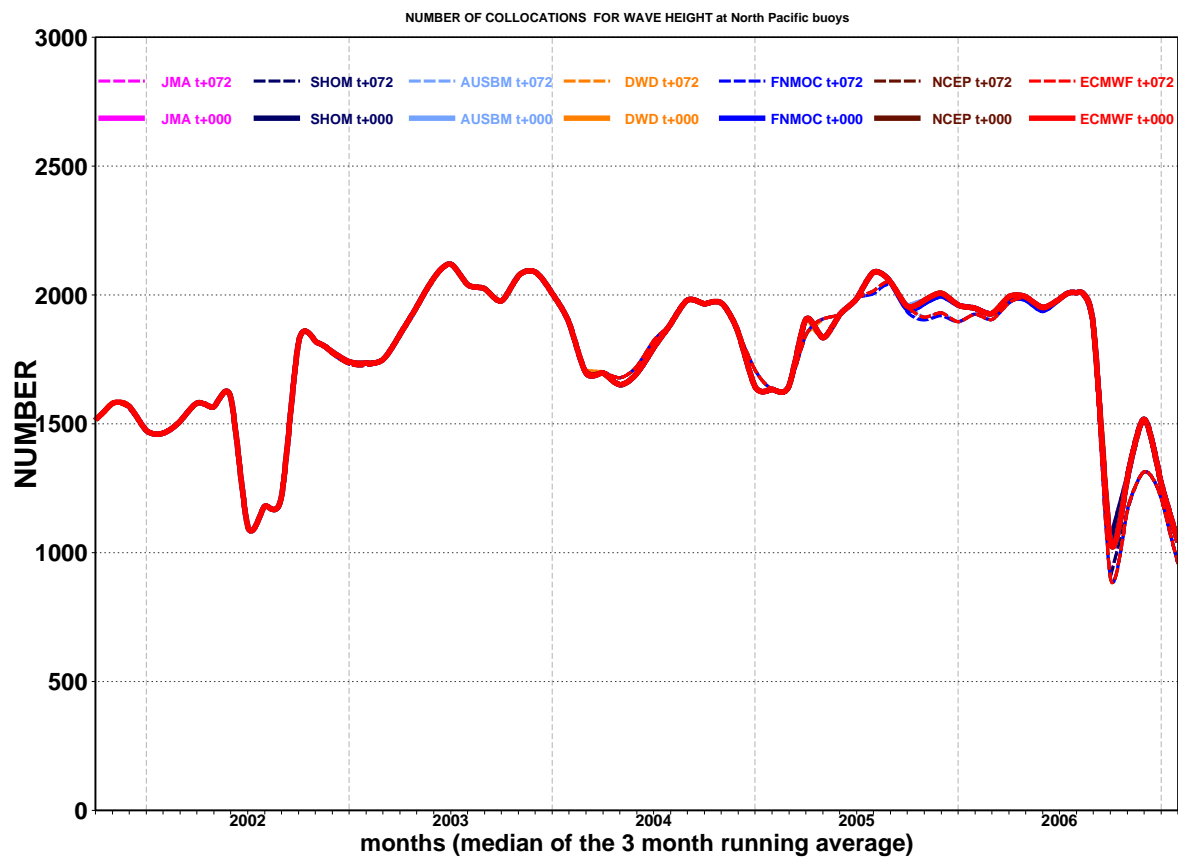Figure 7: Number of wave height collocations between models and Hawaiian buoys.

Figure 8: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Hawaiian buoys for forecast step 0 and day 3.

3.5 Comparison of wind speed for Hawaiian buoys

The amount of data used is shown in Figure 9. Scatter index and bias are displayed next in Figure 10

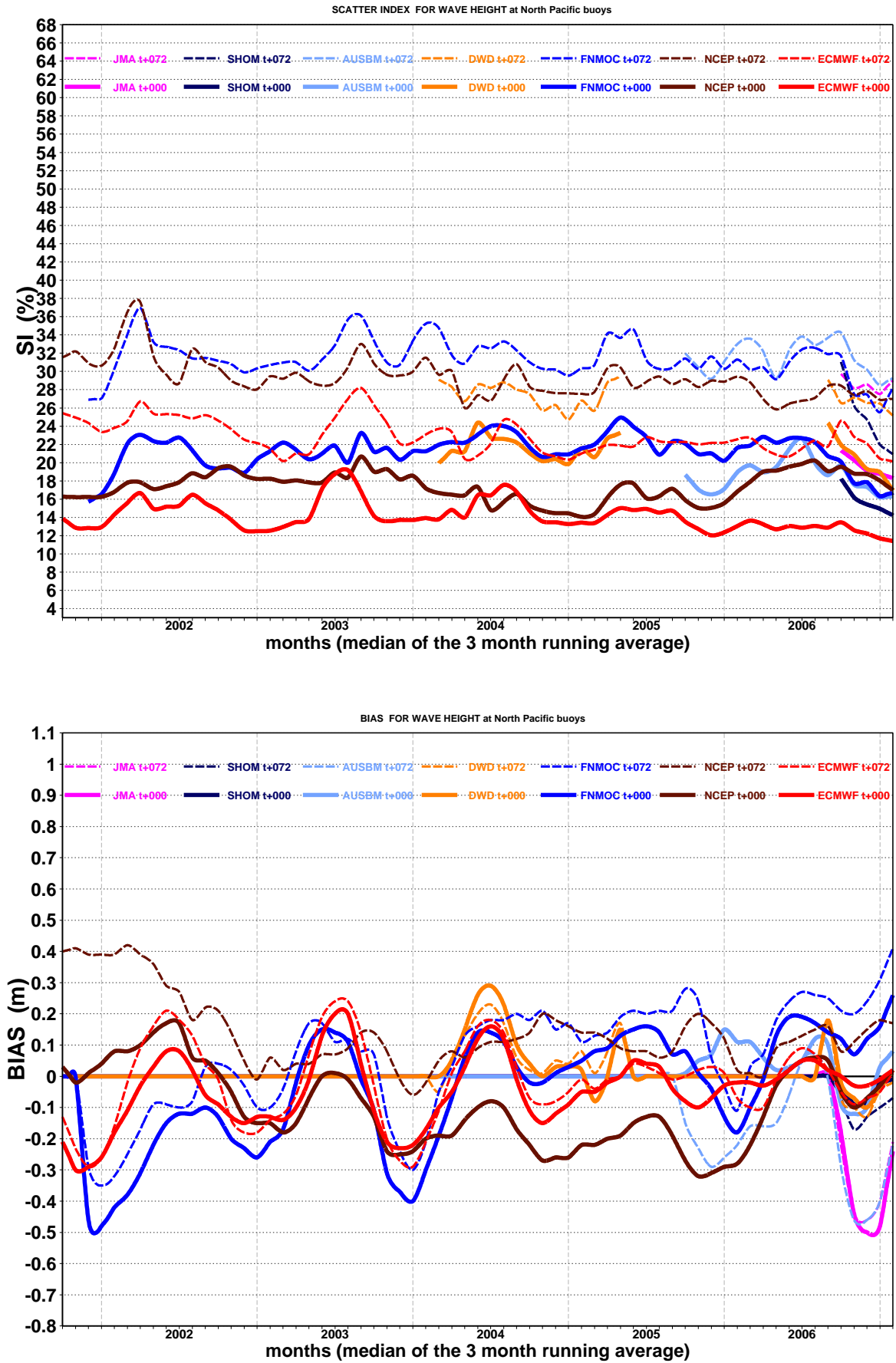Figure 9: Number of wind speed collocations between models and Hawaiian buoys.

Figure 10: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Hawaiian buoys for forecast step 0 and day 3.

3.6 Comparison of peak period for Hawaiian buoys

The amount of data used is shown in Figure 11. Scatter index and bias are displayed next in Figure 12

Figure 11: Number of peak period collocations between models and Hawaiian buoys.

Figure 12: Scatter index peak period (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Hawaiian buoys for forecast step 0 and day 3.

3.7 Comparison of wave height for North Pacific buoys

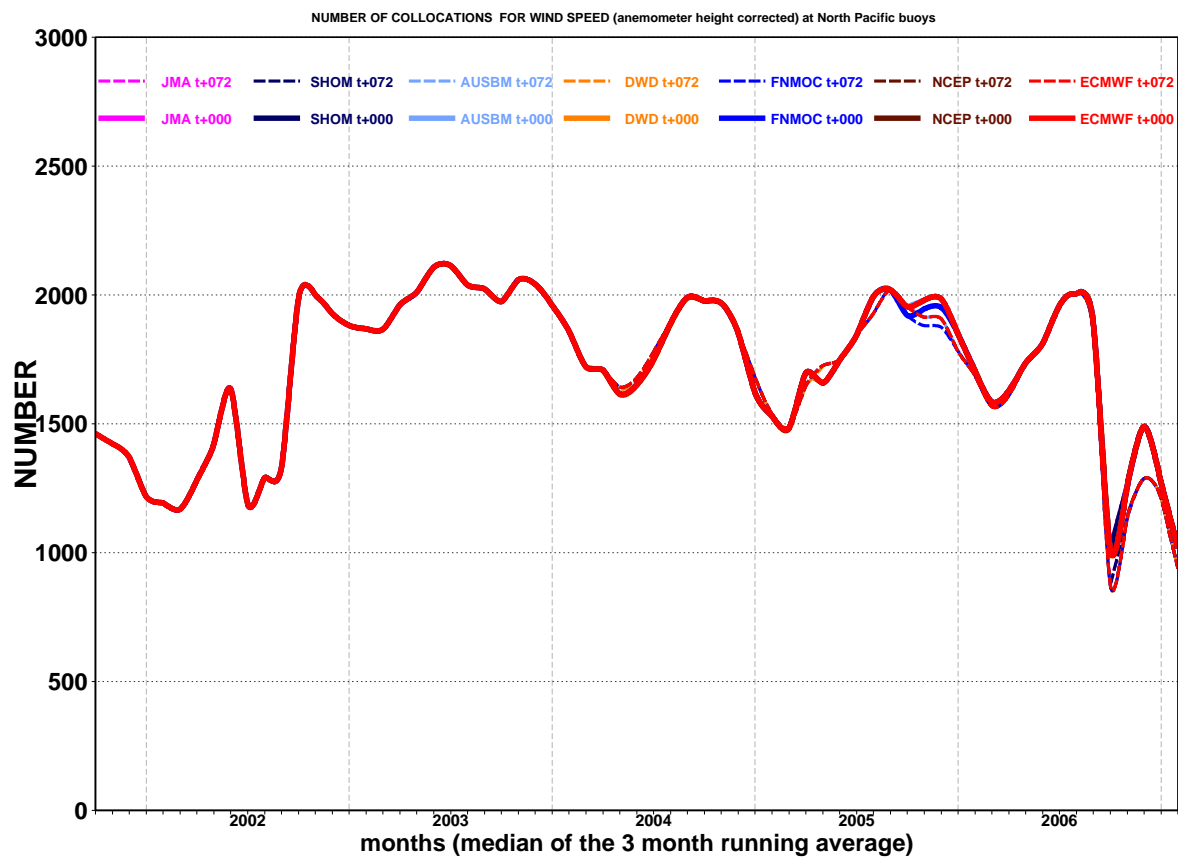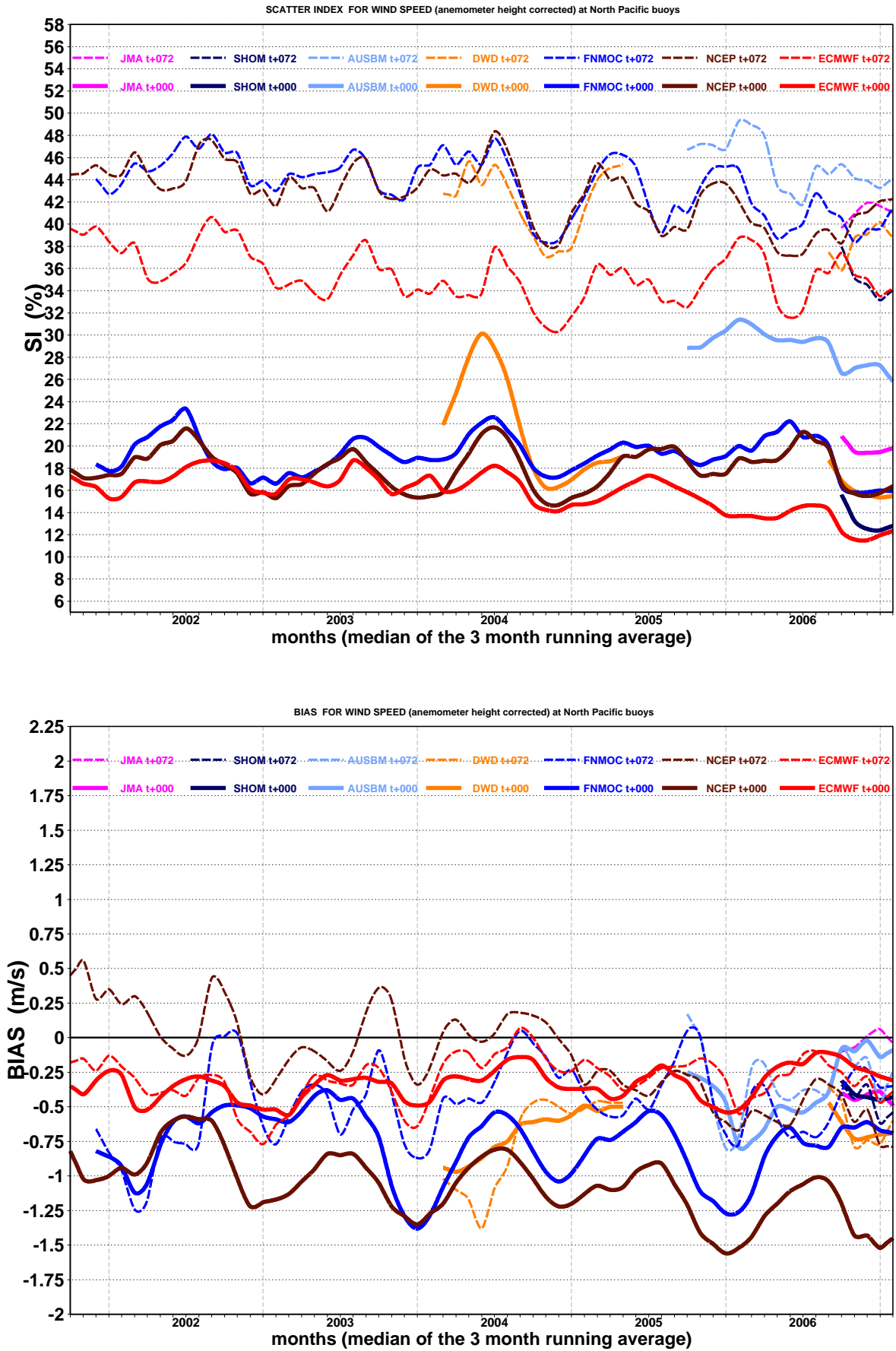The amount of data used is shown in Figure 13. Scatter index and bias are displayed next in Figure 14

Figure 13: Number of wave height collocations between models and North Pacific buoys .

Figure 14: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common North Pacific buoys for forecast step 0 and day 3.

3.8 Comparison of wind speed for North Pacific buoys

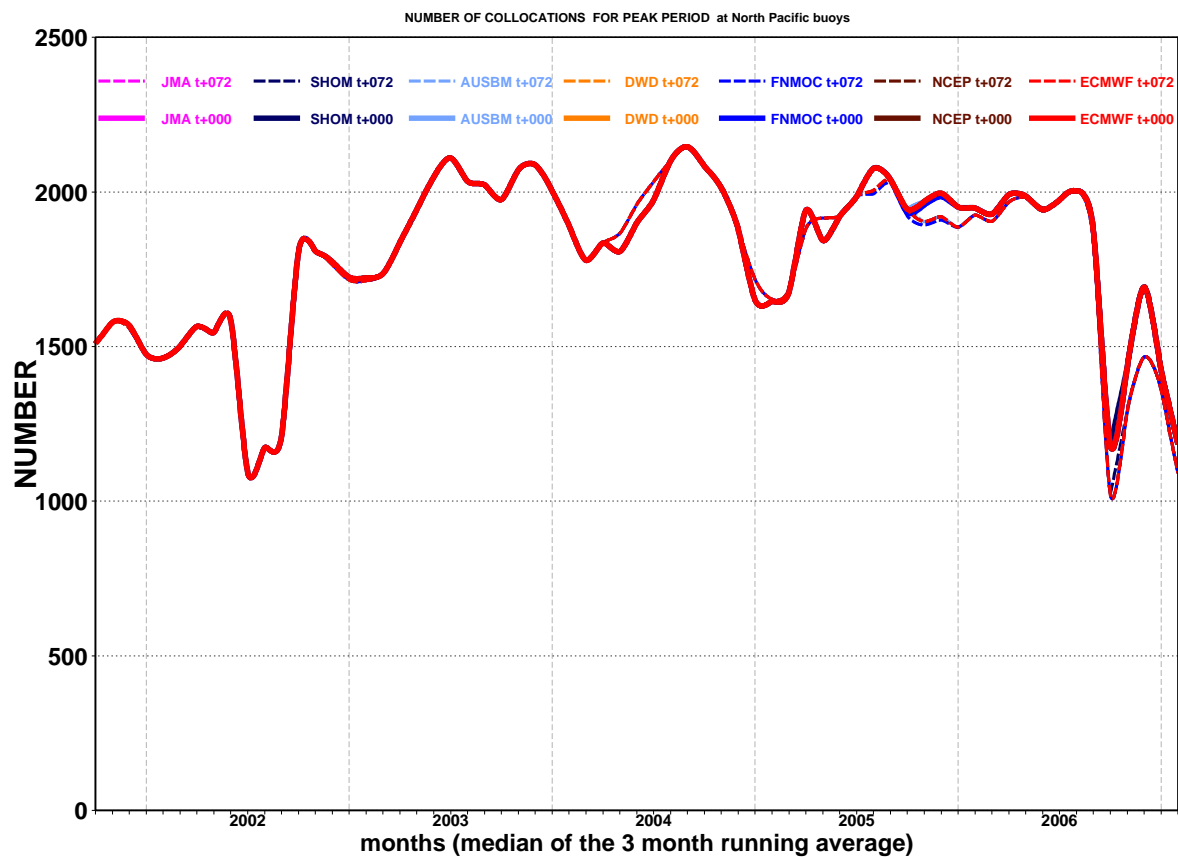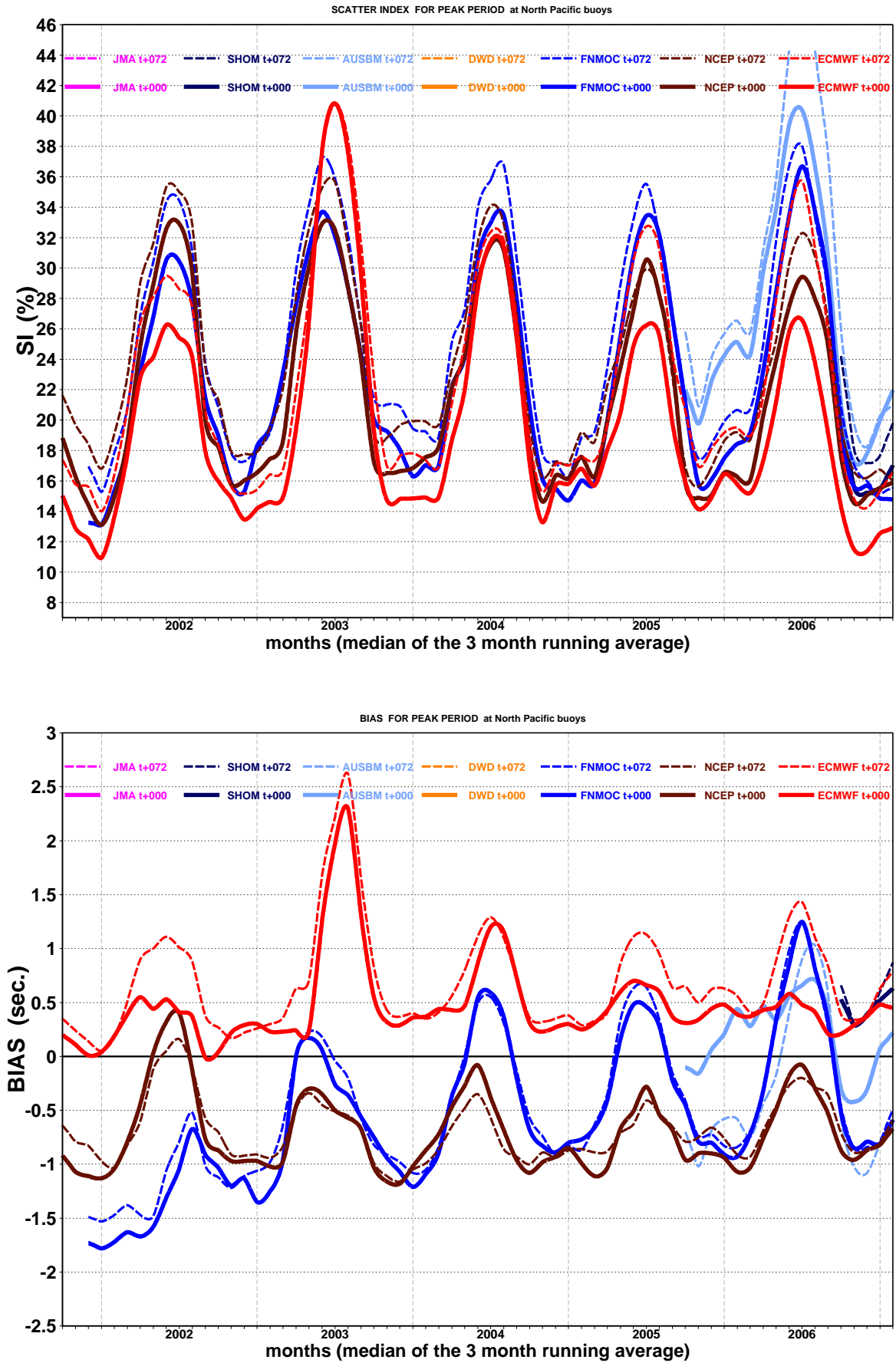The amount of data used is shown in Figure 15. Scatter index and bias are displayed next in
Figure 16

Figure 15: Number of wind speed collocations between models and North Pacific buoys .

Figure 16: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common North Pacific buoys for forecast step 0 and day 3.

3.9 Comparison of peak period for North Pacific buoys

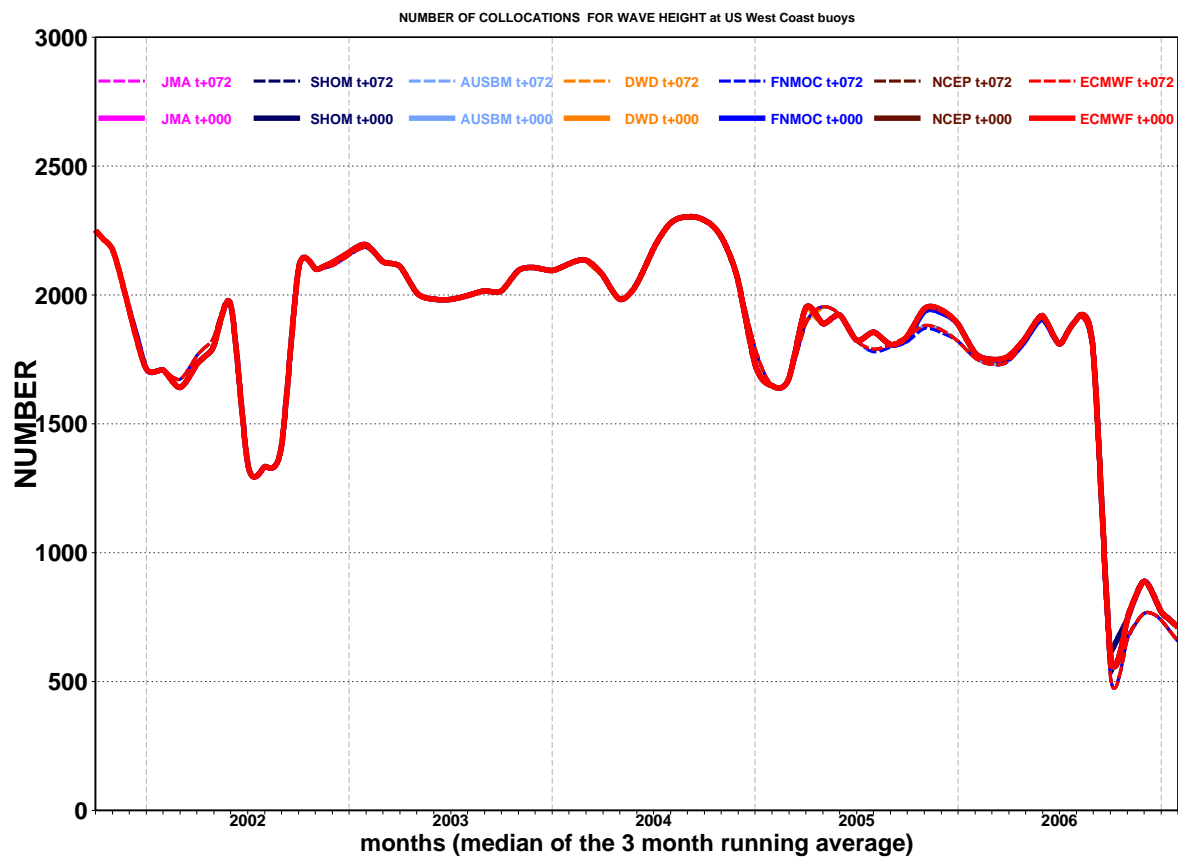The amount of data used is shown in Figure 17. Scatter index and bias are displayed next in Figure 18

Figure 17: Number of peak period collocations between models and North Pacific buoys .

Figure 18: Scatter index peak period (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common North Pacific buoys for forecast step 0 and day 3.

3.10 Comparison of wave height for US West Coast buoys

The amount of data used is shown in Figure 19. Scatter index and bias are displayed next in Figure 20

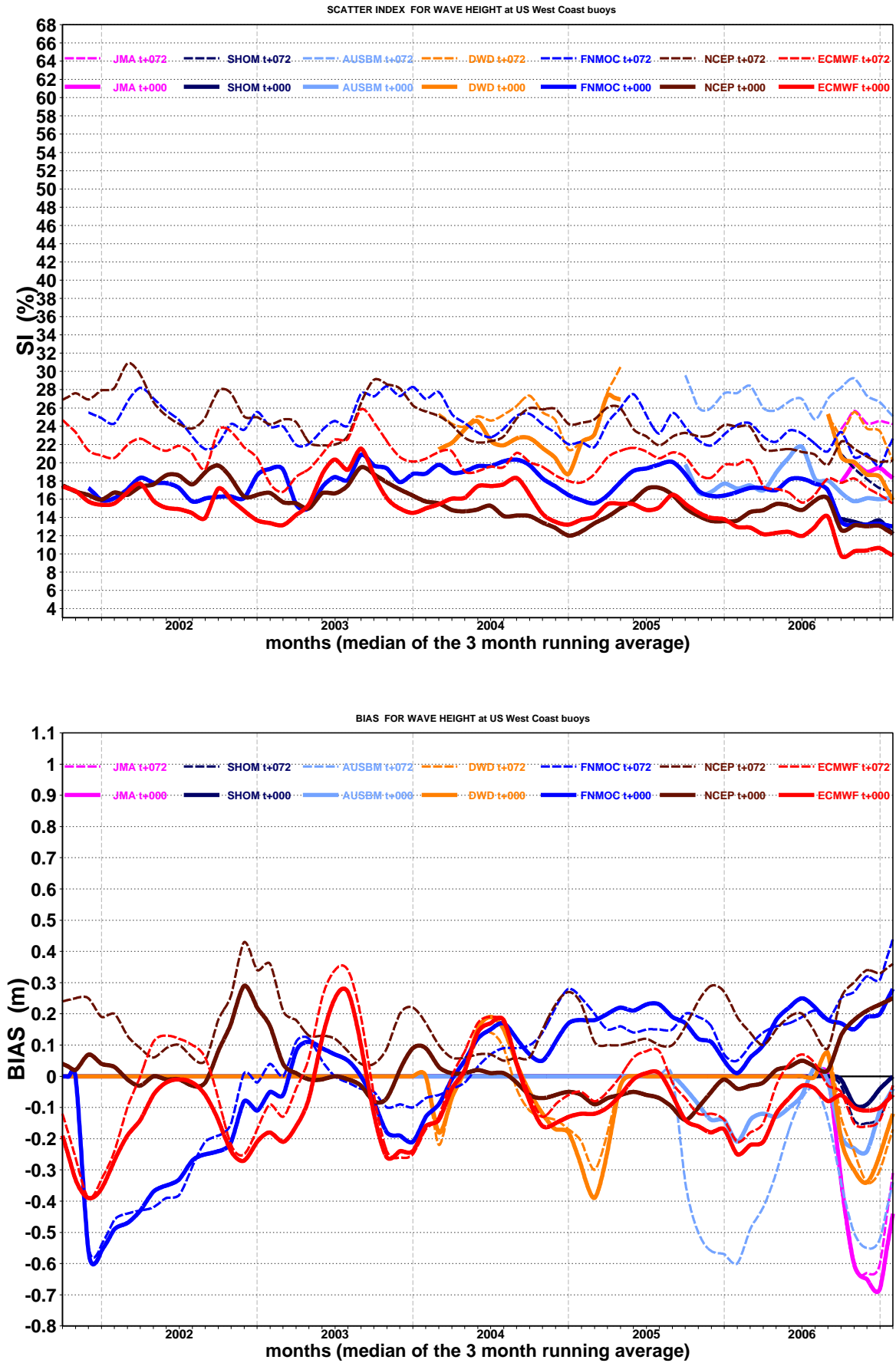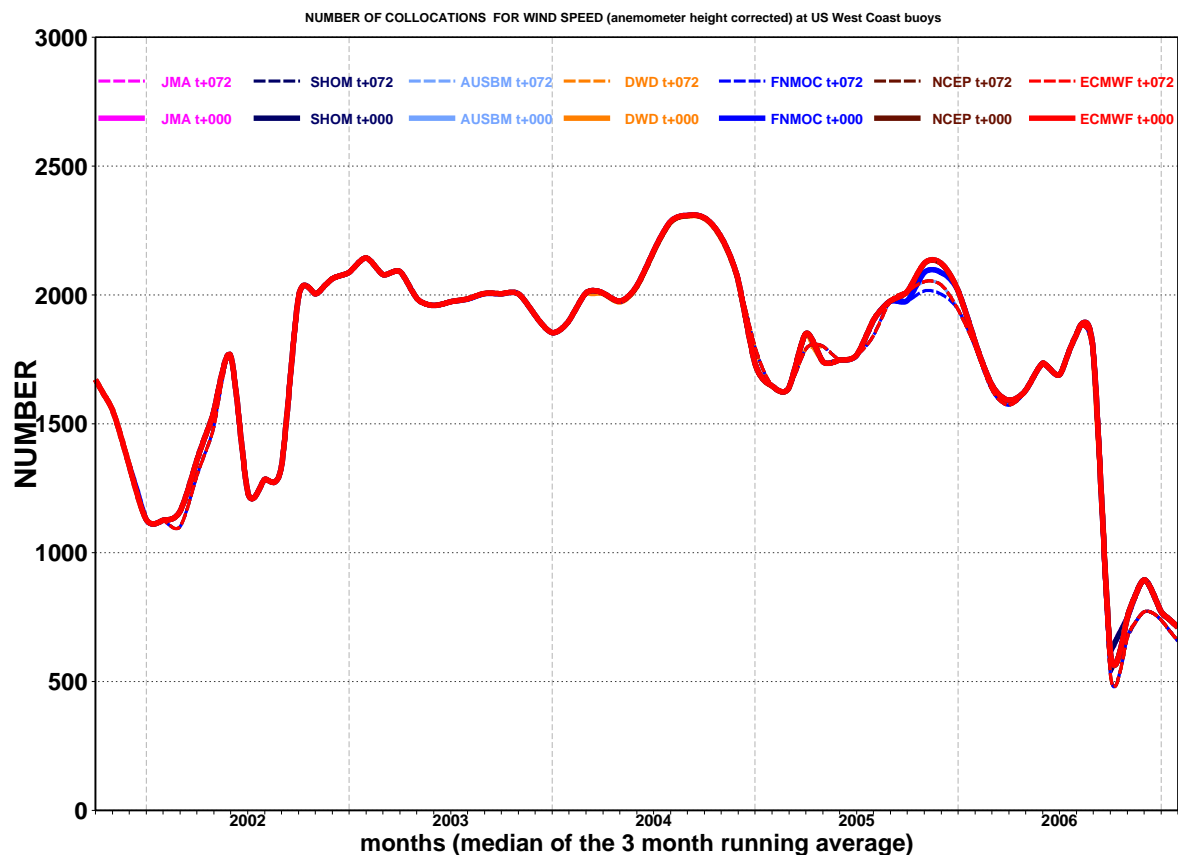Figure 19: Number of wave height collocations between models and US West Coast buoys .

Figure 20: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common US West Coast buoys for forecast step 0 and day 3.

3.11 Comparison of wind speed for US West Coast buoys

The amount of data used is shown in Figure 21. Scatter index and bias are displayed next in
Figure 22

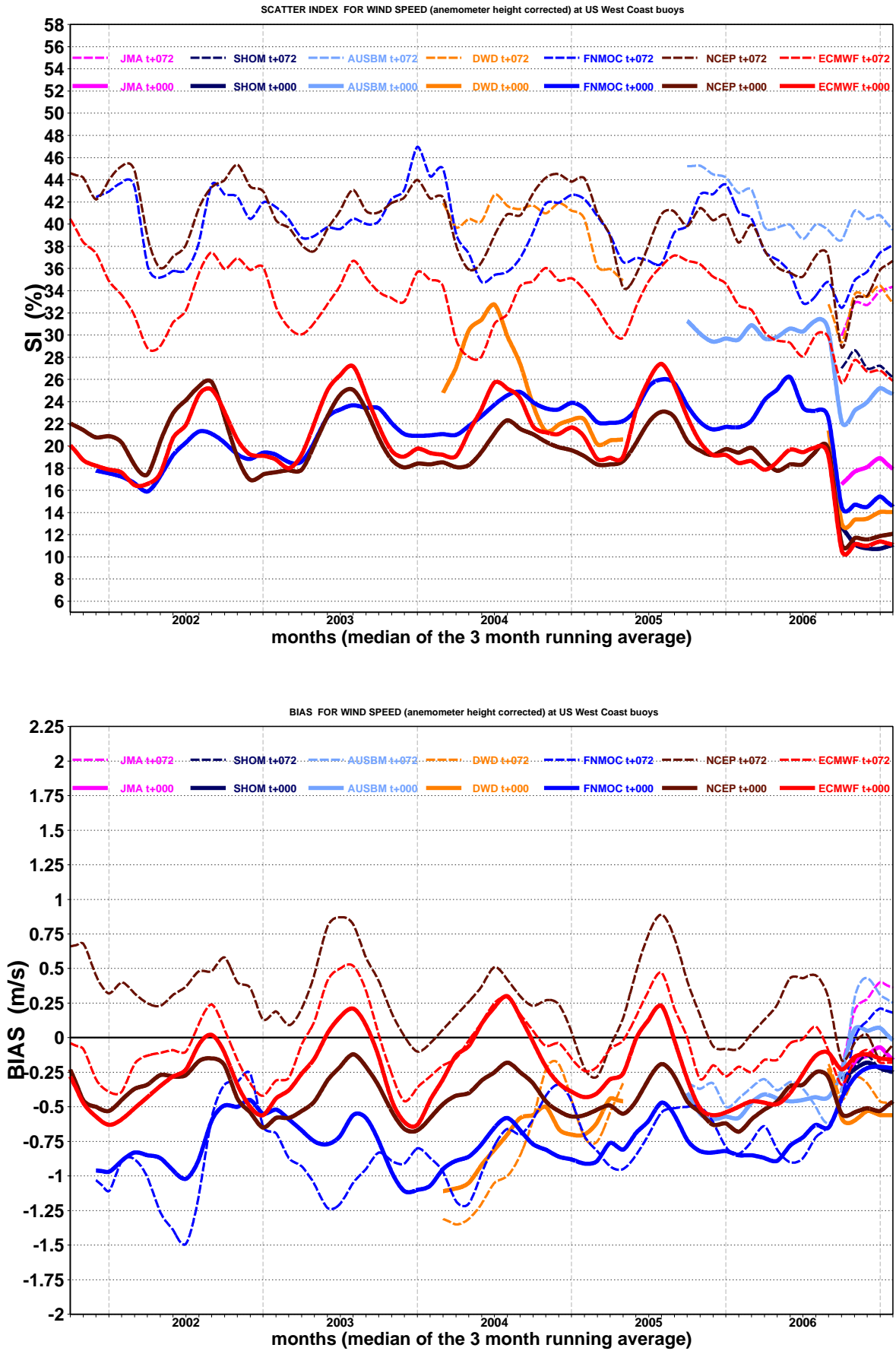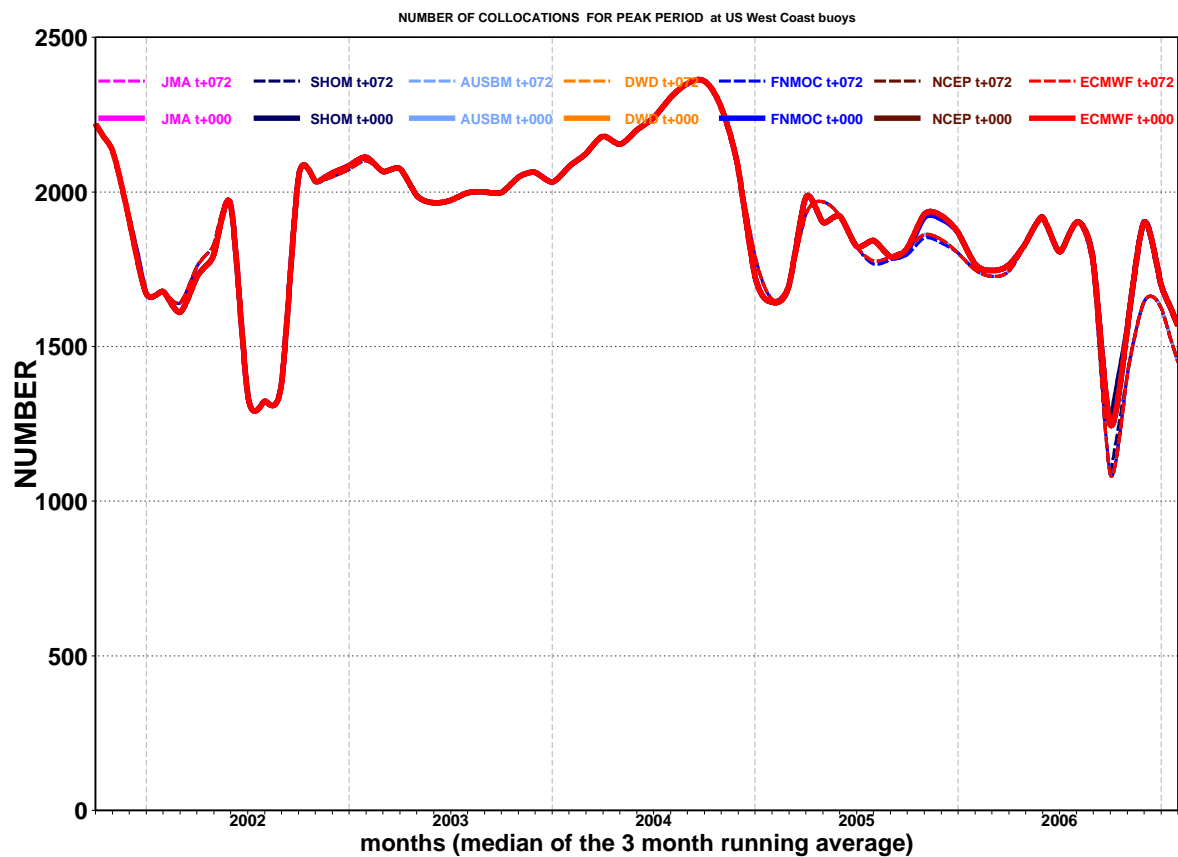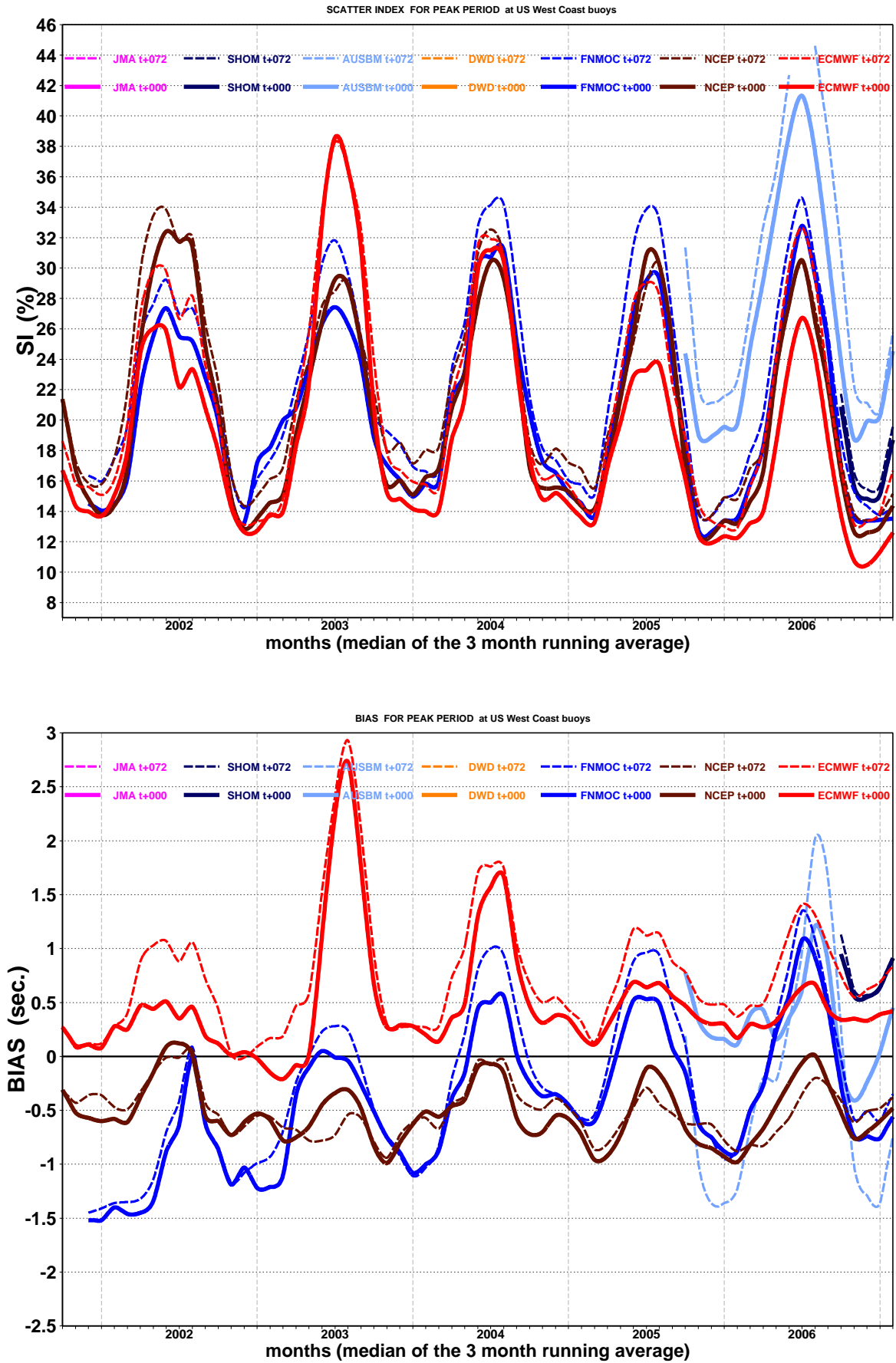Figure 21: Number of wind speed collocations between models and US West Coast buoys .

Figure 22: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common US West Coast buoys for forecast step 0 and day 3.

3.12 Comparison of peak period for US West Coast buoys

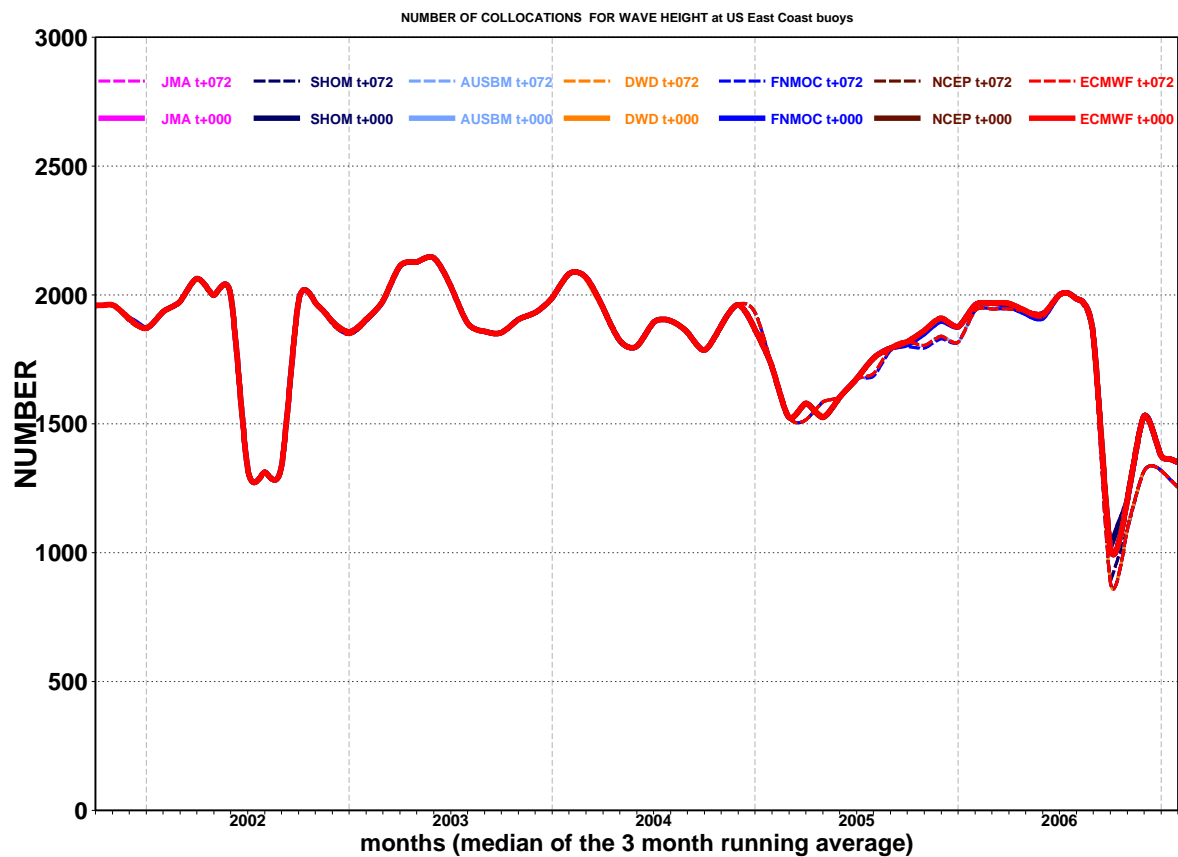The amount of data used is shown in Figure 23. Scatter index and bias are displayed next in Figure 24

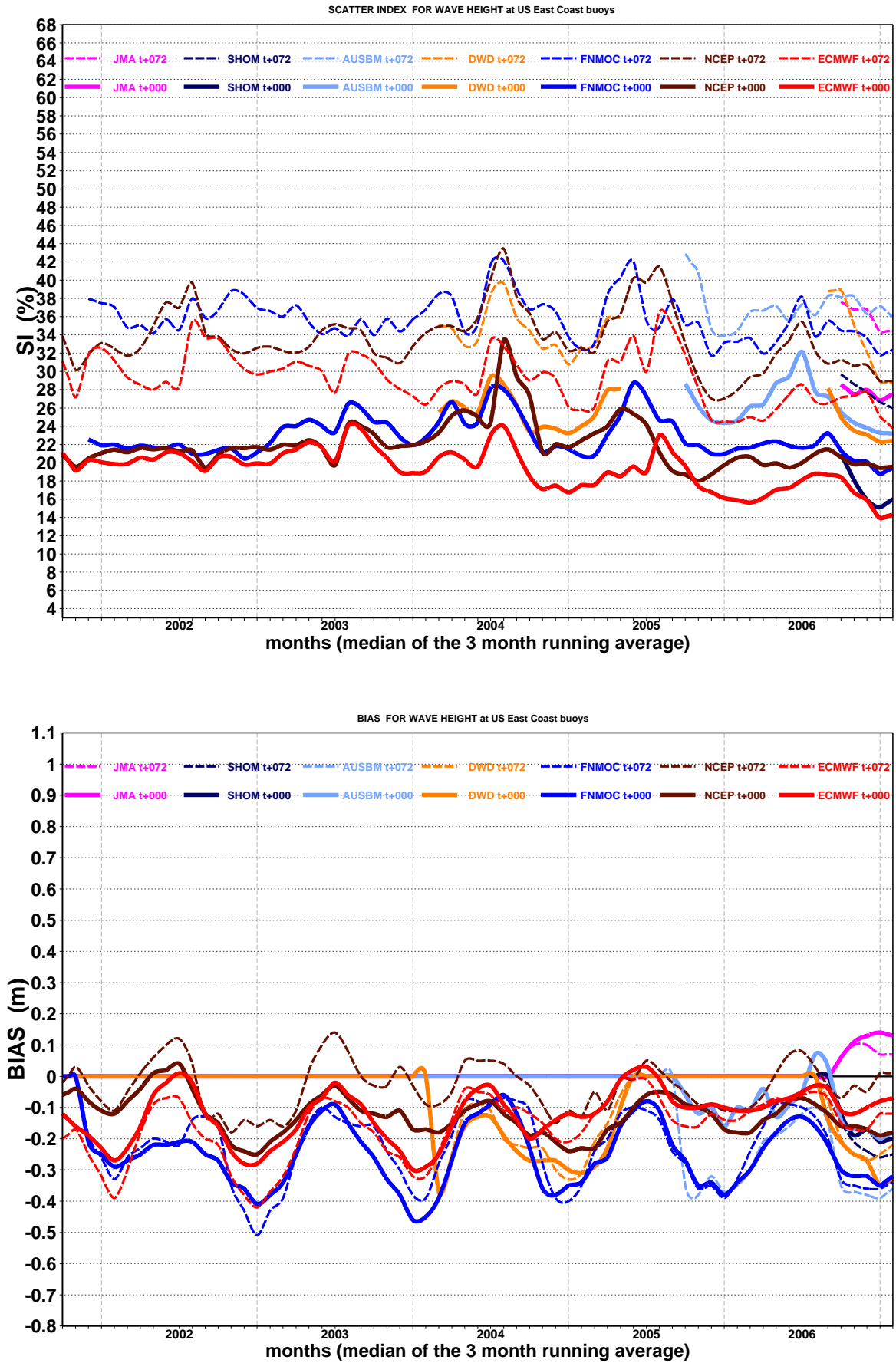Figure 23: Number of peak period collocations between models and US West Coast buoys .

Figure 24: Scatter index peak period (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common US West Coast buoys for forecast step 0 and day 3.

3.13 Comparison of wave height for US East Coast buoys

The amount of data used is shown in Figure 25. Scatter index and bias are displayed next in Figure 26

Figure 25: Number of wave height collocations between models and US East Coast buoys .

Figure 26: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common US East Coast buoys for forecast step 0 and day 3.

3.14 Comparison of wind speed for US East Coast buoys

The amount of data used is shown in Figure 27. Scatter index and bias are displayed next in Figure 28
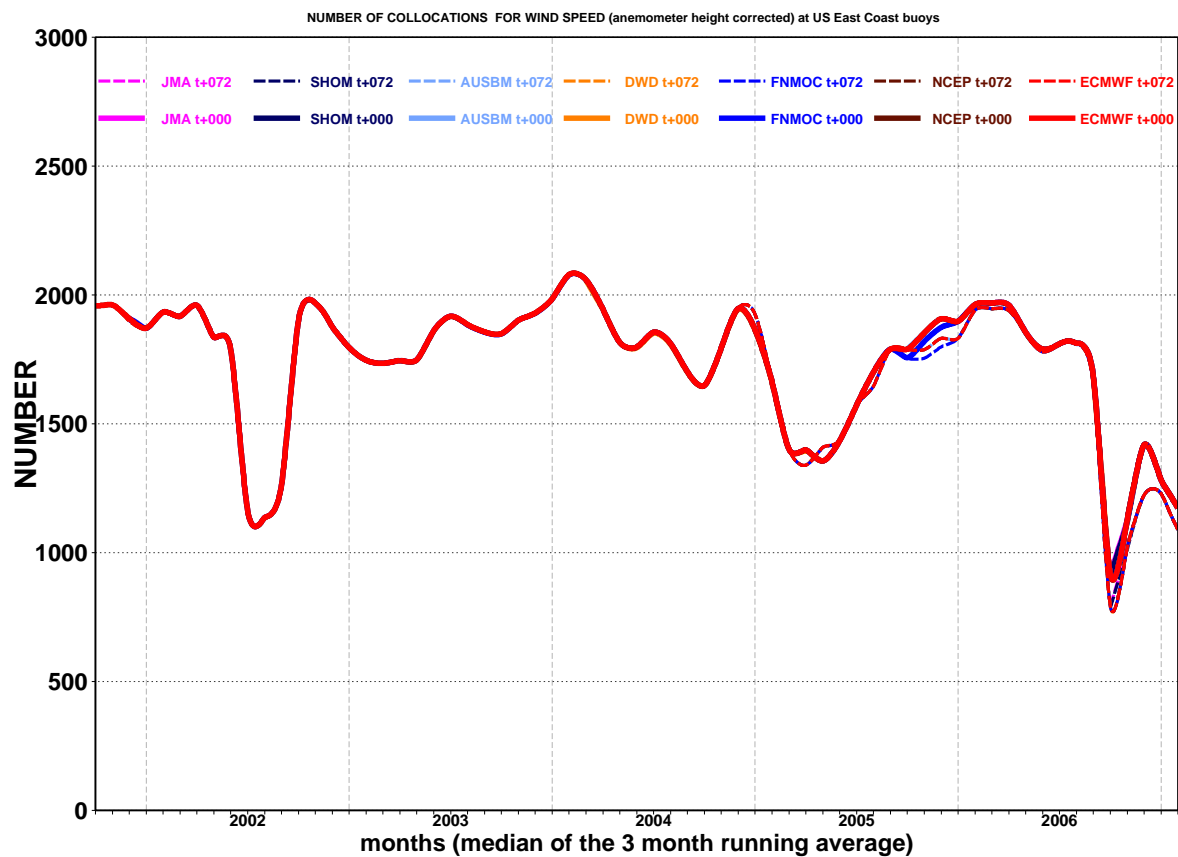

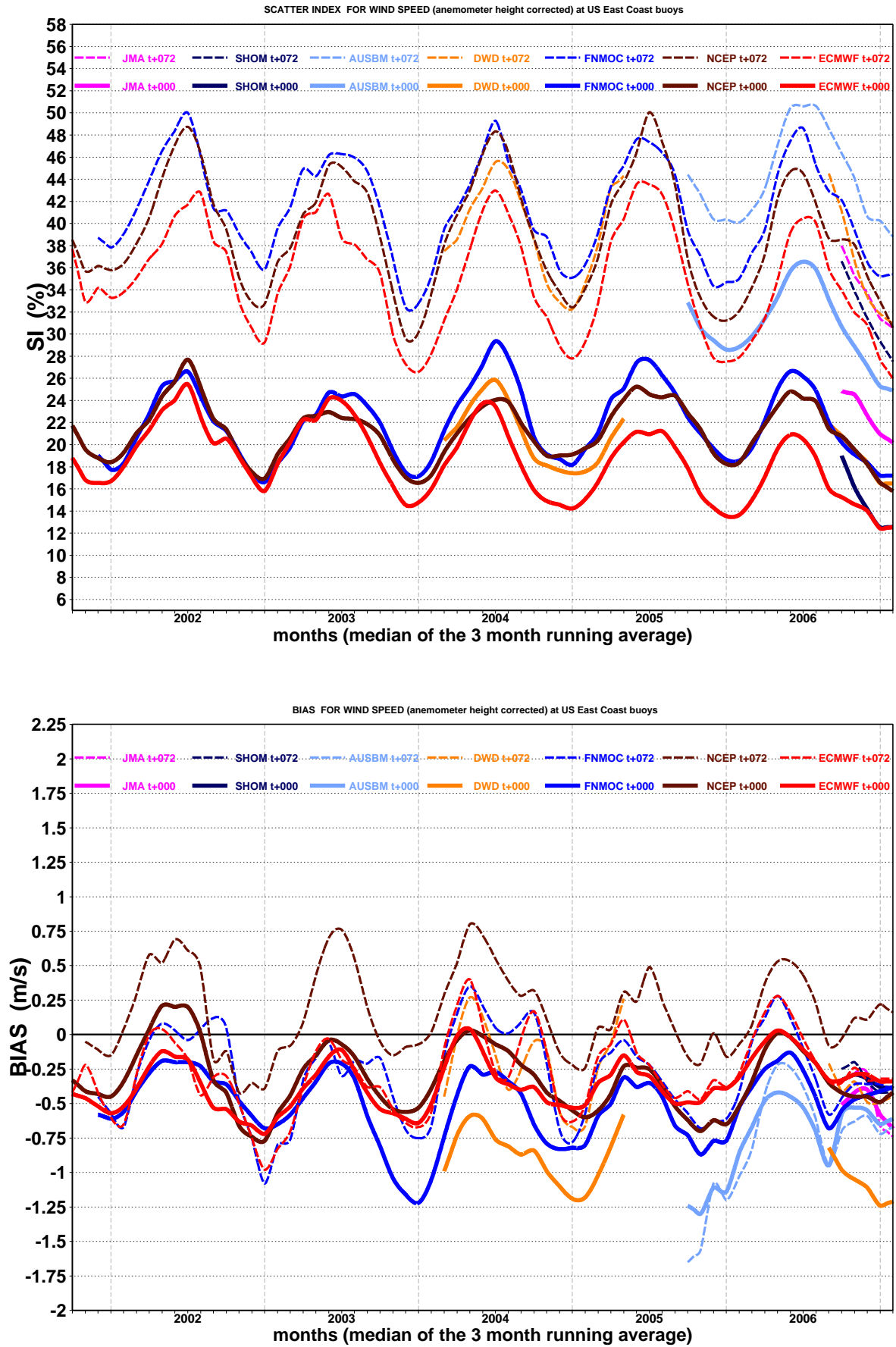Figure 27: Number of wind speed collocations between models and US East Coast buoys .

Figure 28: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common US East Coast buoys for forecast step 0 and day 3.

3.15   Comparison of peak period for US East Coast buoys

The amount of data used is shown in Figure 29. Scatter index and bias are displayed next in Figure 30
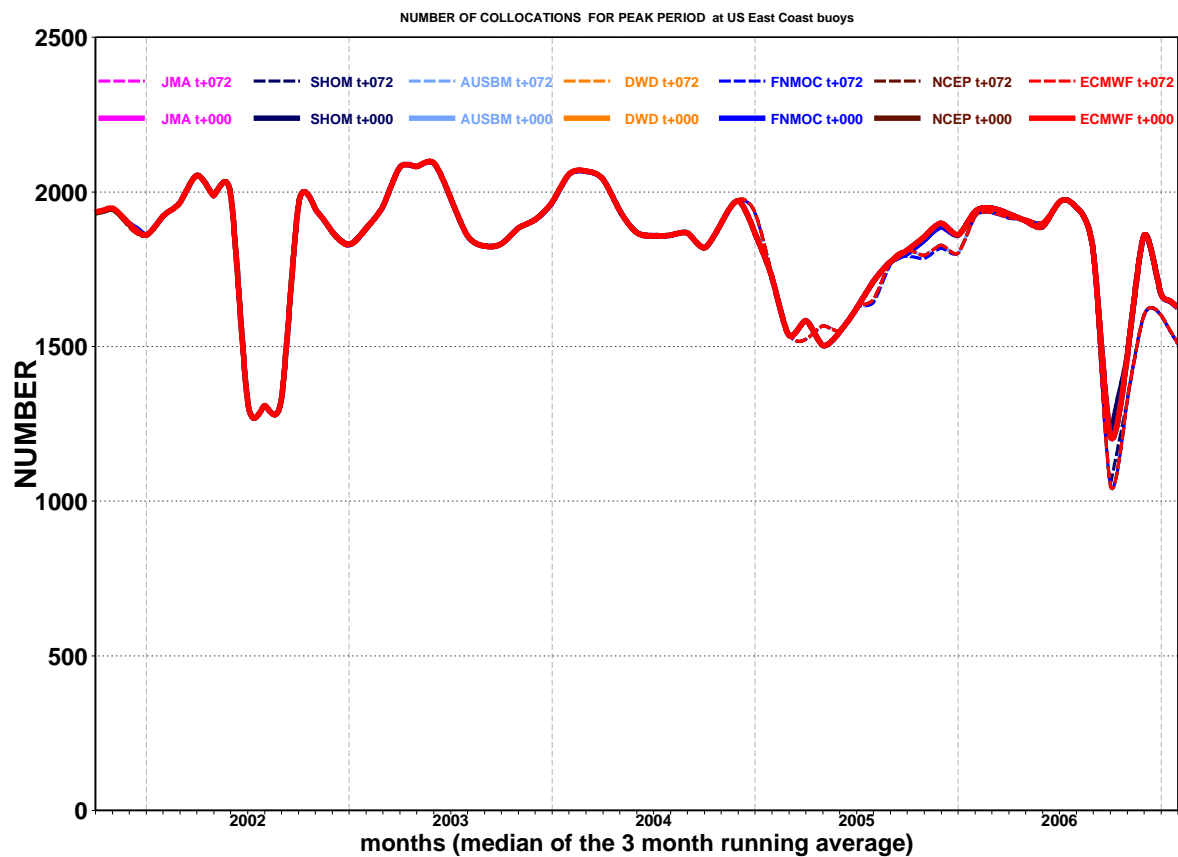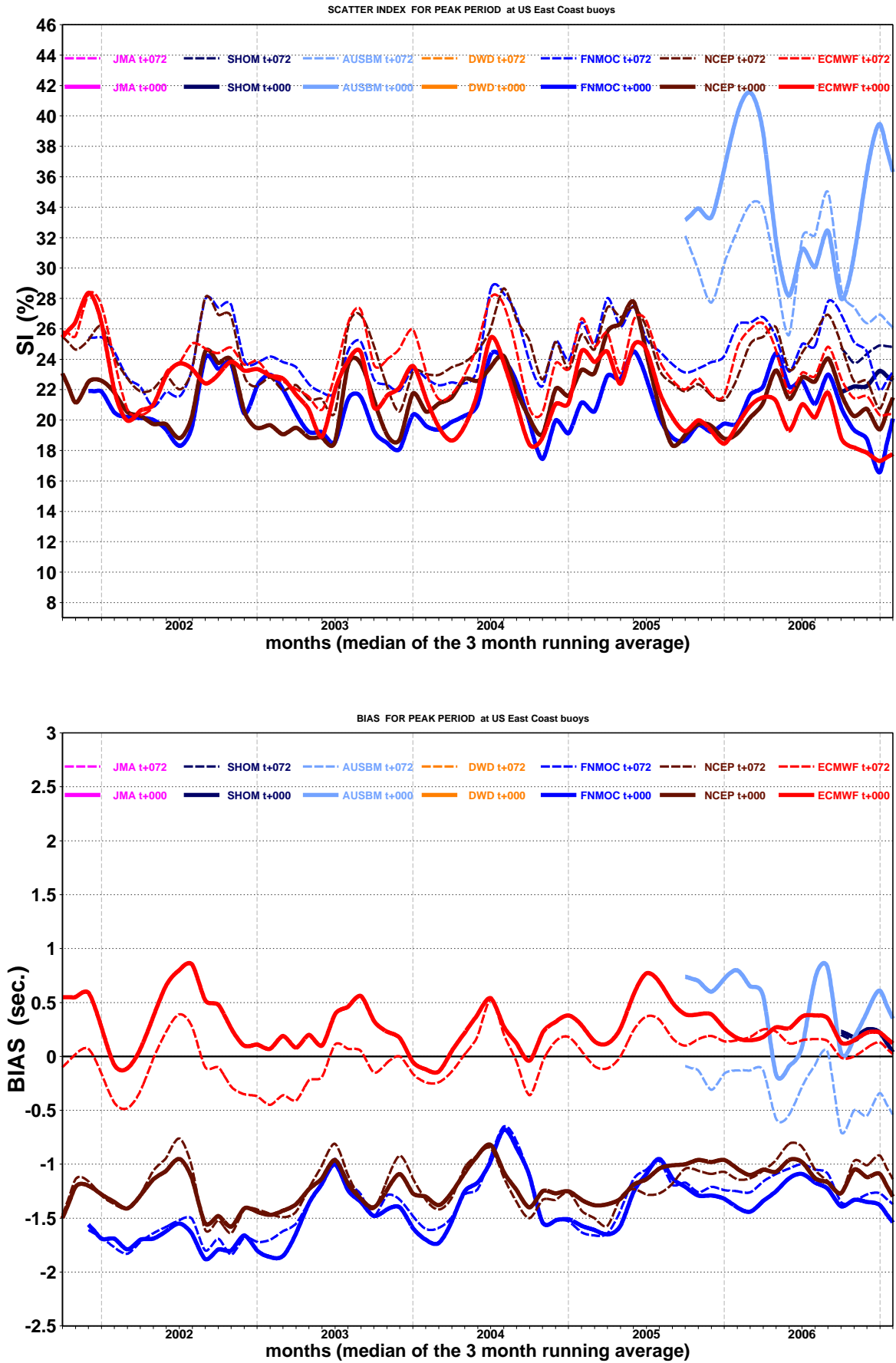

Figure 29: Number of peak period collocations between models and US East Coast buoys .

Figure 30: Scatter index peak period (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common US East Coast buoys for forecast step 0 and day 3.

3.16   Comparison of wave height for Gulf of Mexico buoys

The amount of data used is shown in Figure 31. Scatter index and bias are displayed next in Figure 32
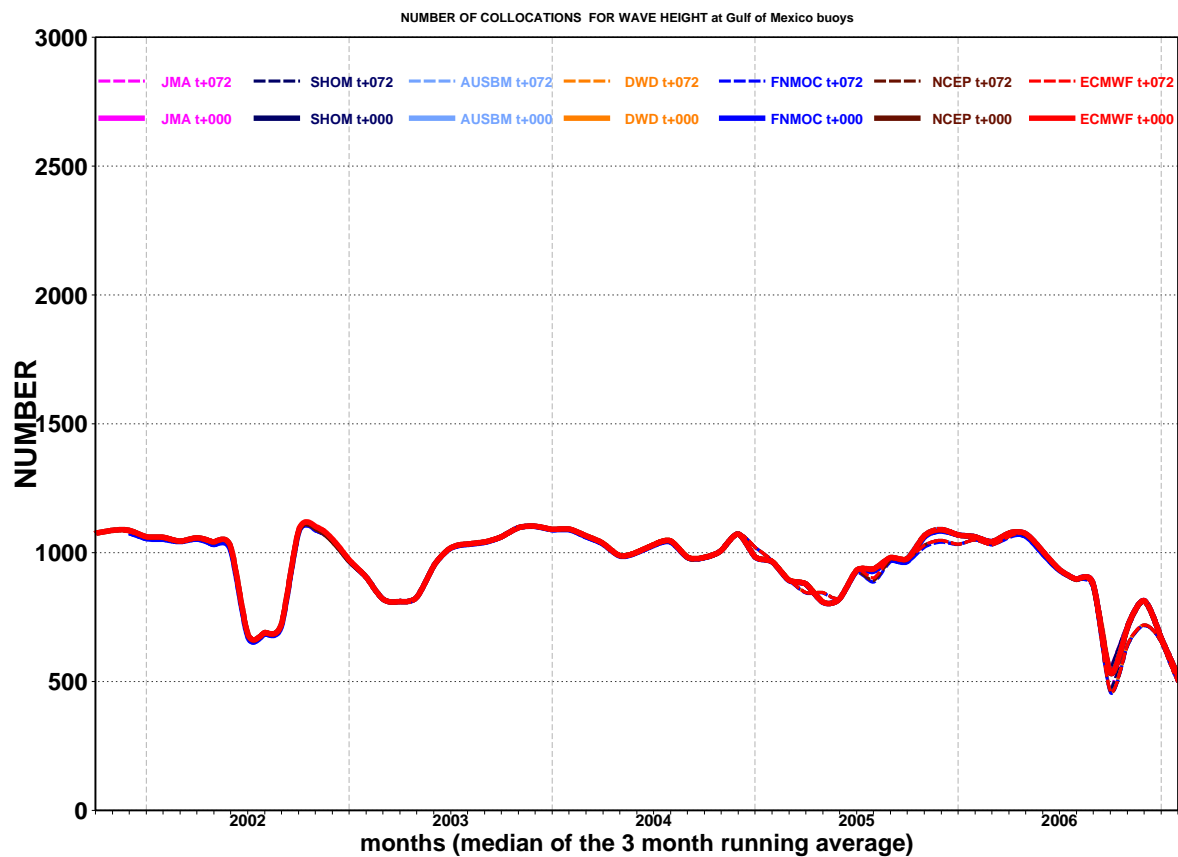

Figure 31: Number of wave height collocations between models and Gulf of Mexico buoys .
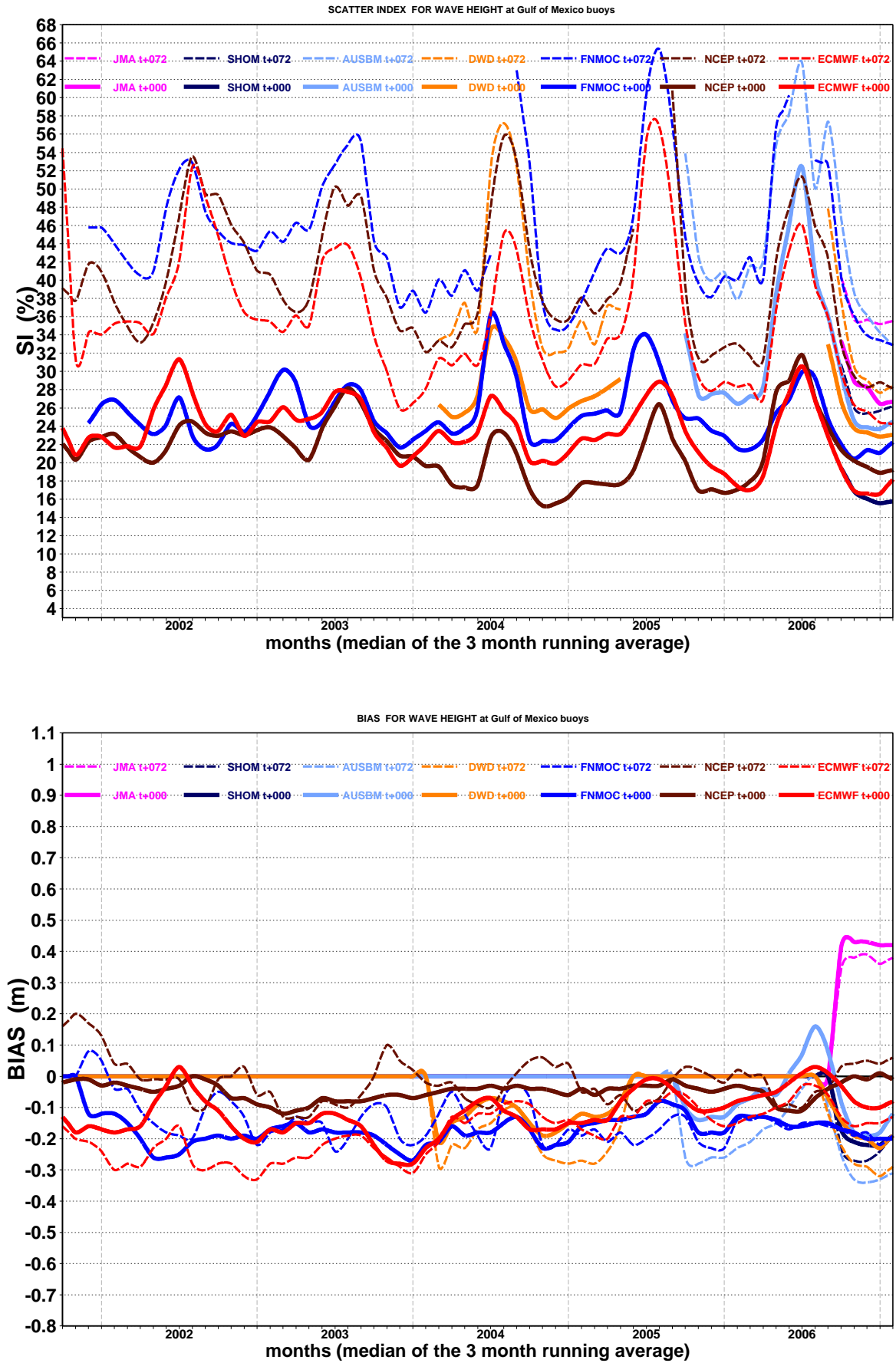
Figure 32: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Gulf of Mexico buoys for forecast step 0 and day 3.

3.17 Comparison of wind speed for Gulf of Mexico buoys

The amount of data used is shown in Figure 33. Scatter index and bias are displayed next in Figure 34
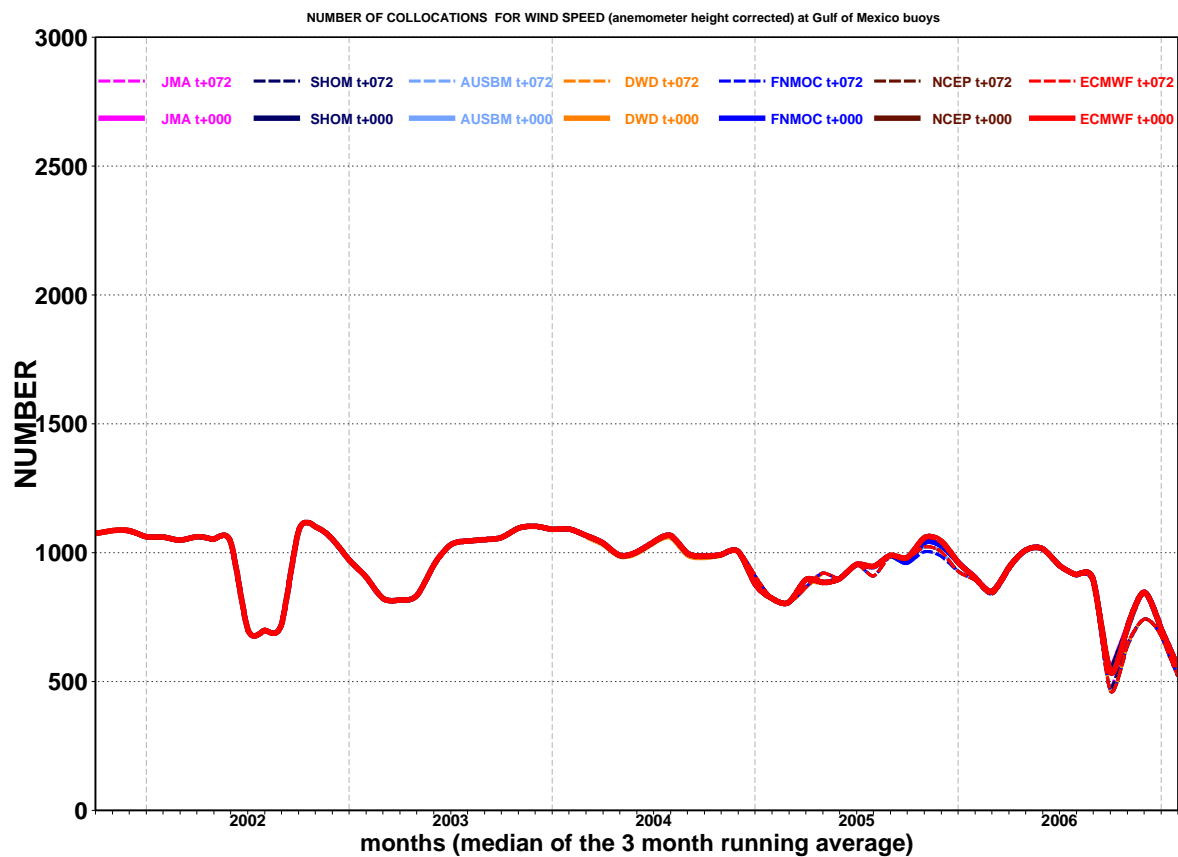

Figure 33: Number of wind speed collocations between models and Gulf of Mexico buoys .
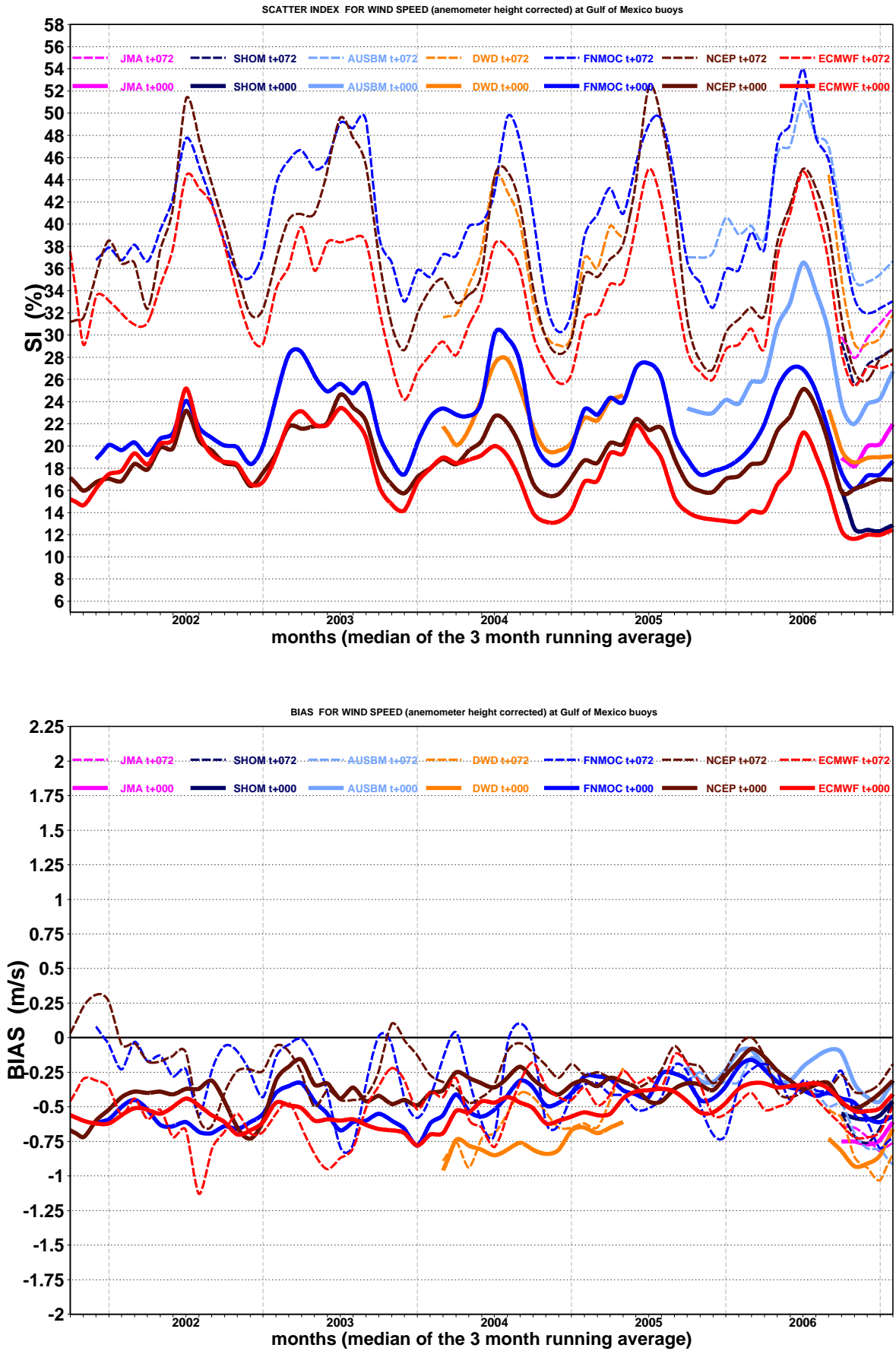
Figure 34: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Gulf of Mexico buoys for forecast step 0 and day 3.

3.18 Comparison of peak period for Gulf of Mexico buoys

The amount of data used is shown in Figure 35. Scatter index and bias are displayed next in Figure 36
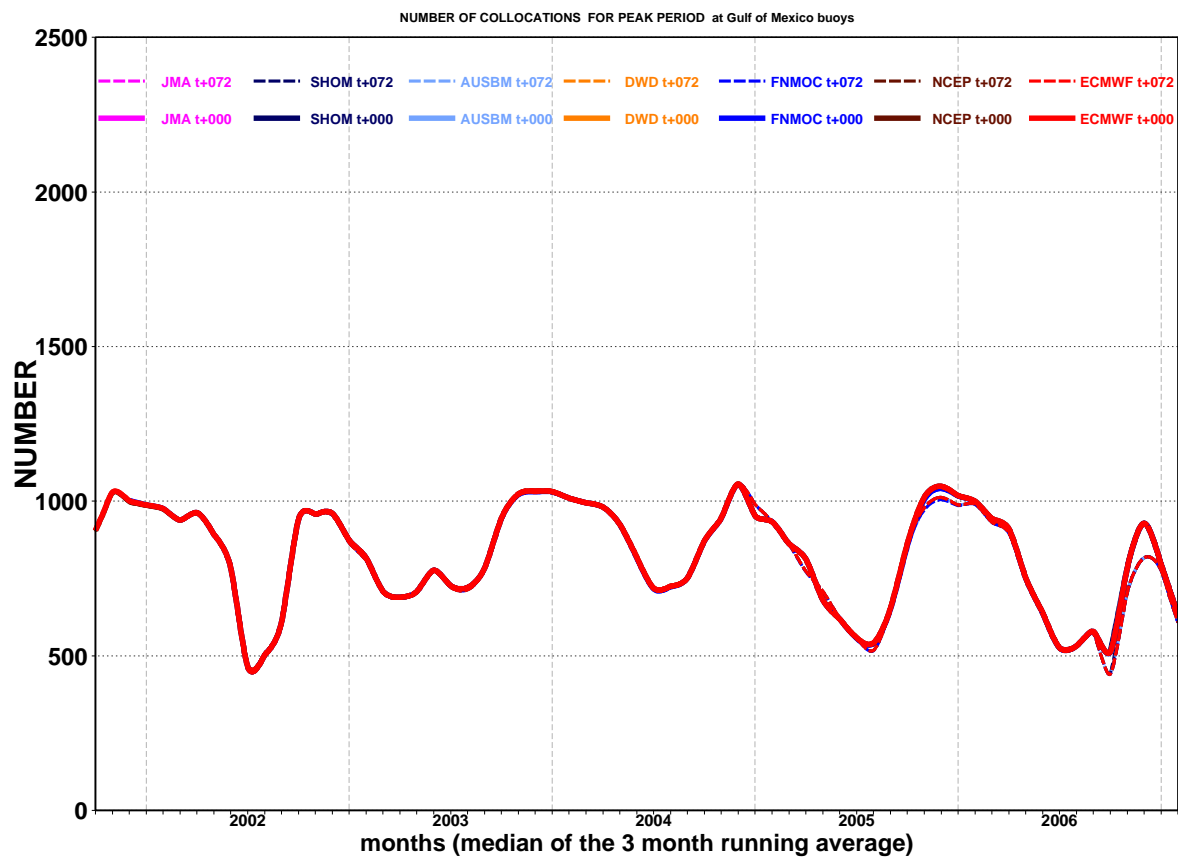

Figure 35: Number of peak period collocations between models and Gulf of Mexico buoys .
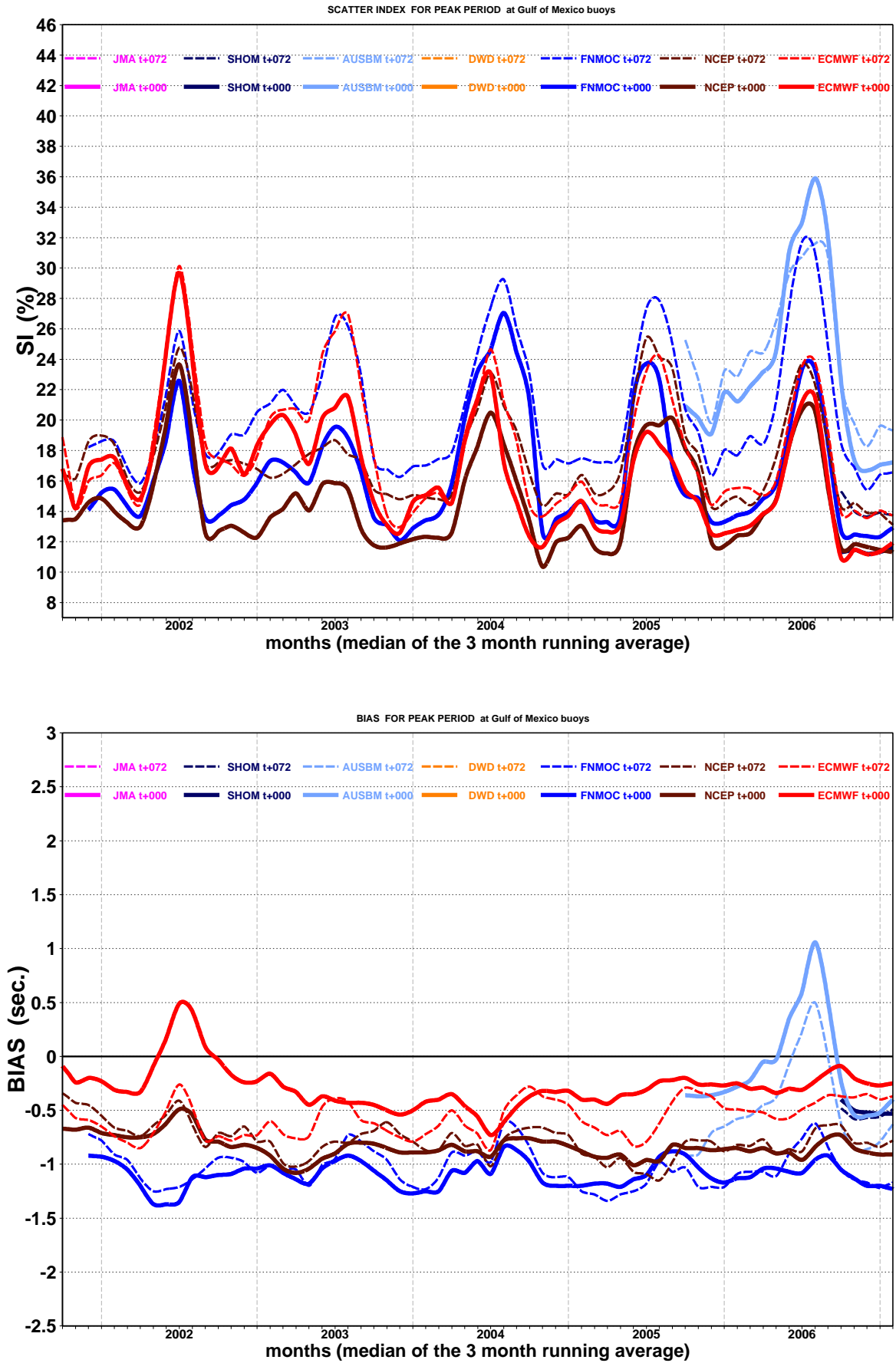
Figure 36: Scatter index peak period (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Gulf of Mexico buoys for forecast step 0 and day 3.

3.19 Comparison of wave height for Canadian East Coast buoys

The amount of data used is shown in Figure 37. Scatter index and bias are displayed next in Figure 38
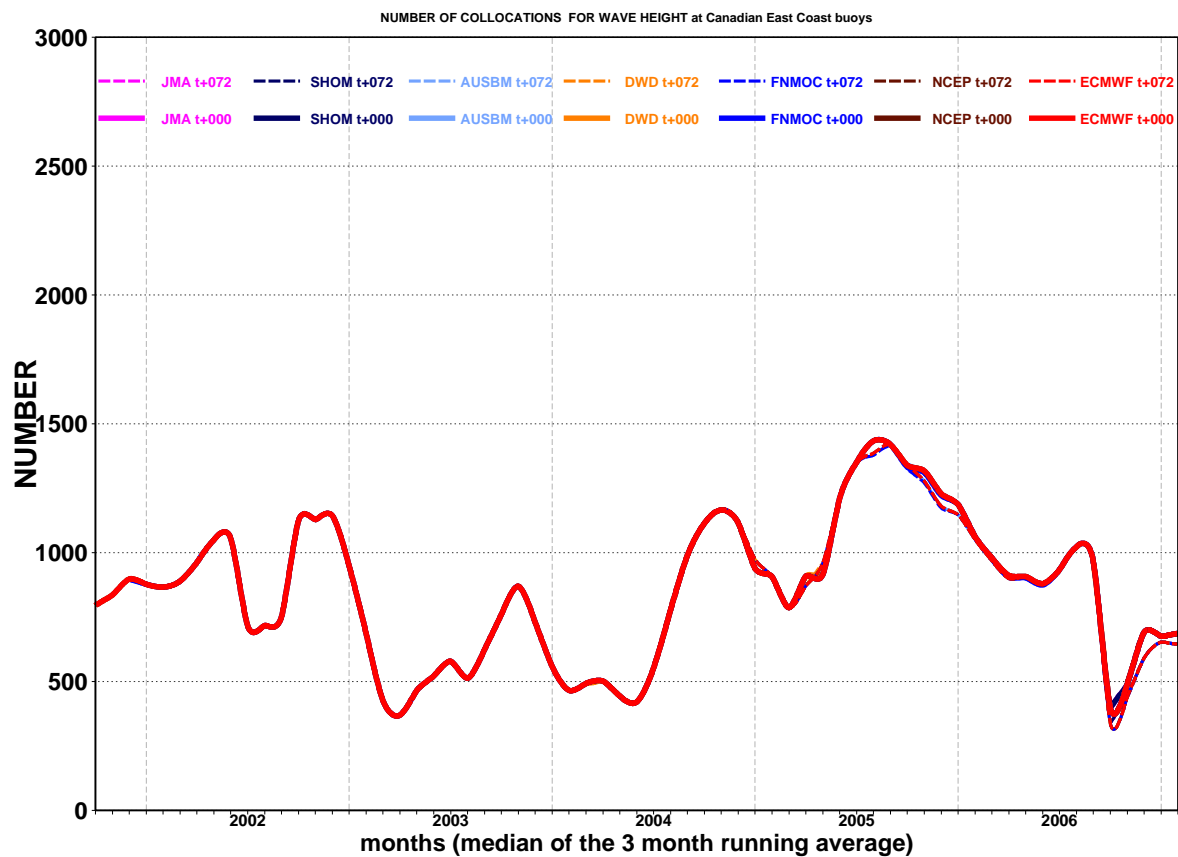

Figure 37: Number of wave height collocations between models and Canadian East Coast buoys .
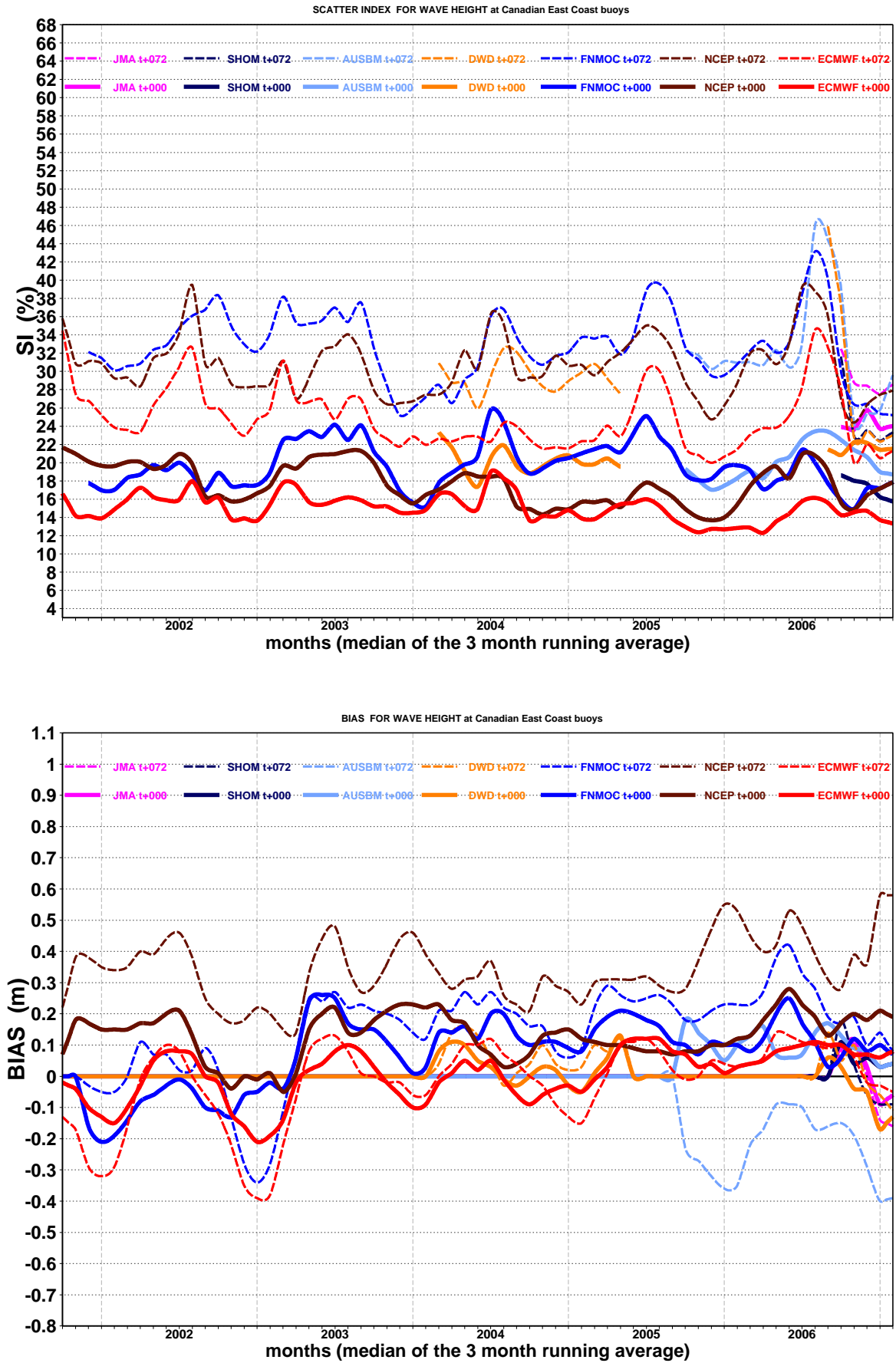
Figure 38: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Canadian East Coast buoys for forecast step 0 and day 3.

3.20   Comparison of wind speed for Canadian East Coast buoys

The amount of data used is shown in Figure 39. Scatter index and bias are displayed next in
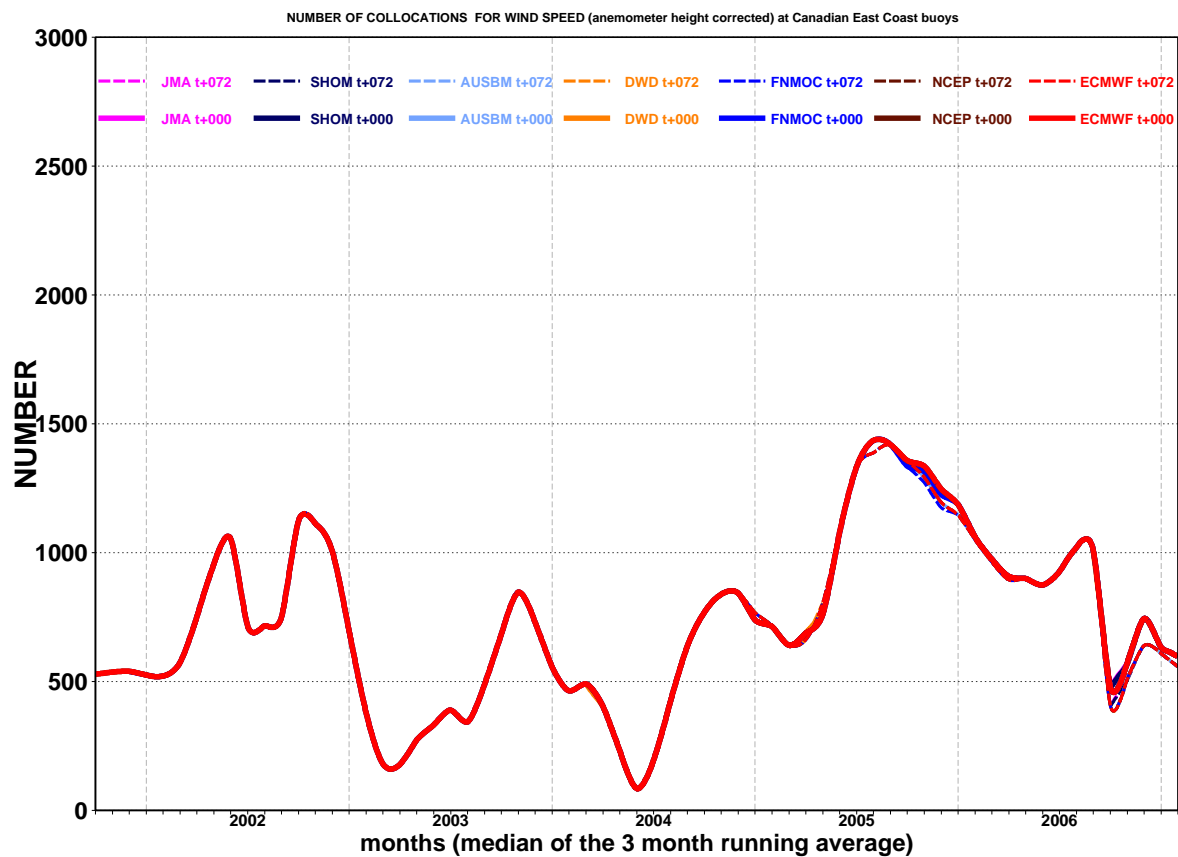Figure 40

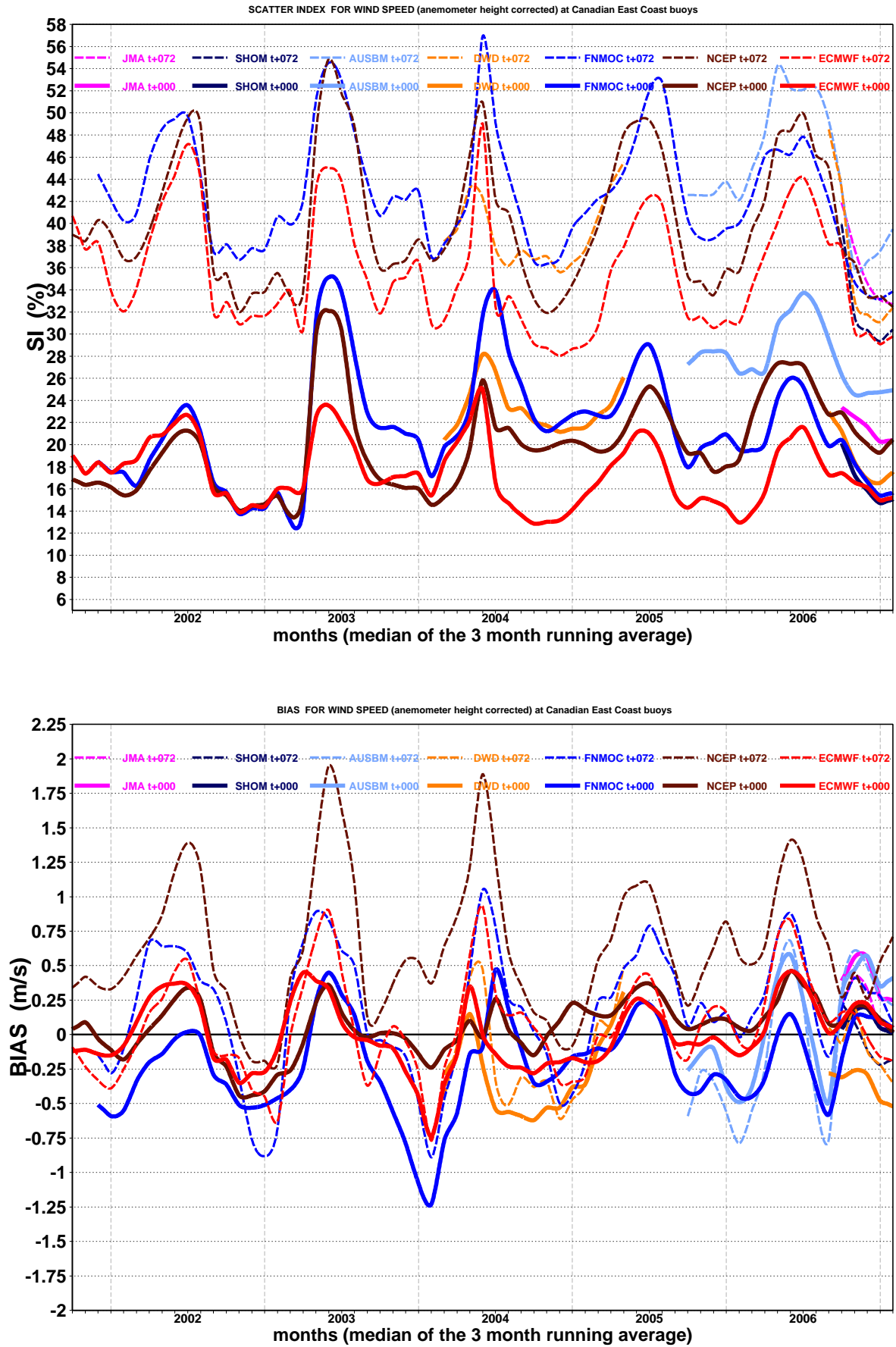Figure 39: Number of wind speed collocations between models and Canadian East Coast buoys .

Figure 40: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Canadian East Coast buoys for forecast step 0 and day 3.

3.21 Comparison of peak period for Canadian East Coast buoys

The amount of data used is shown in Figure 41. Scatter index and bias are displayed next in Figure 42
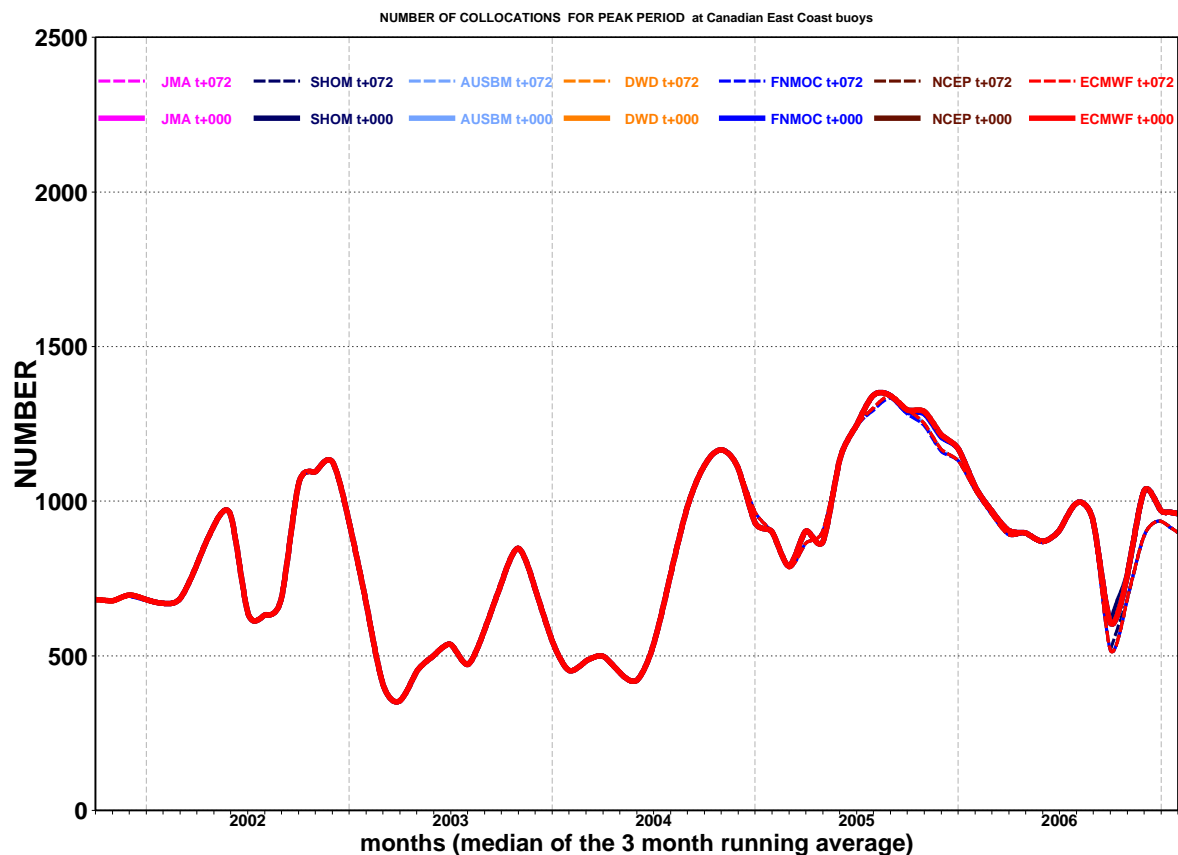

Figure 41: Number of peak period collocations between models and Canadian East Coast buoys .
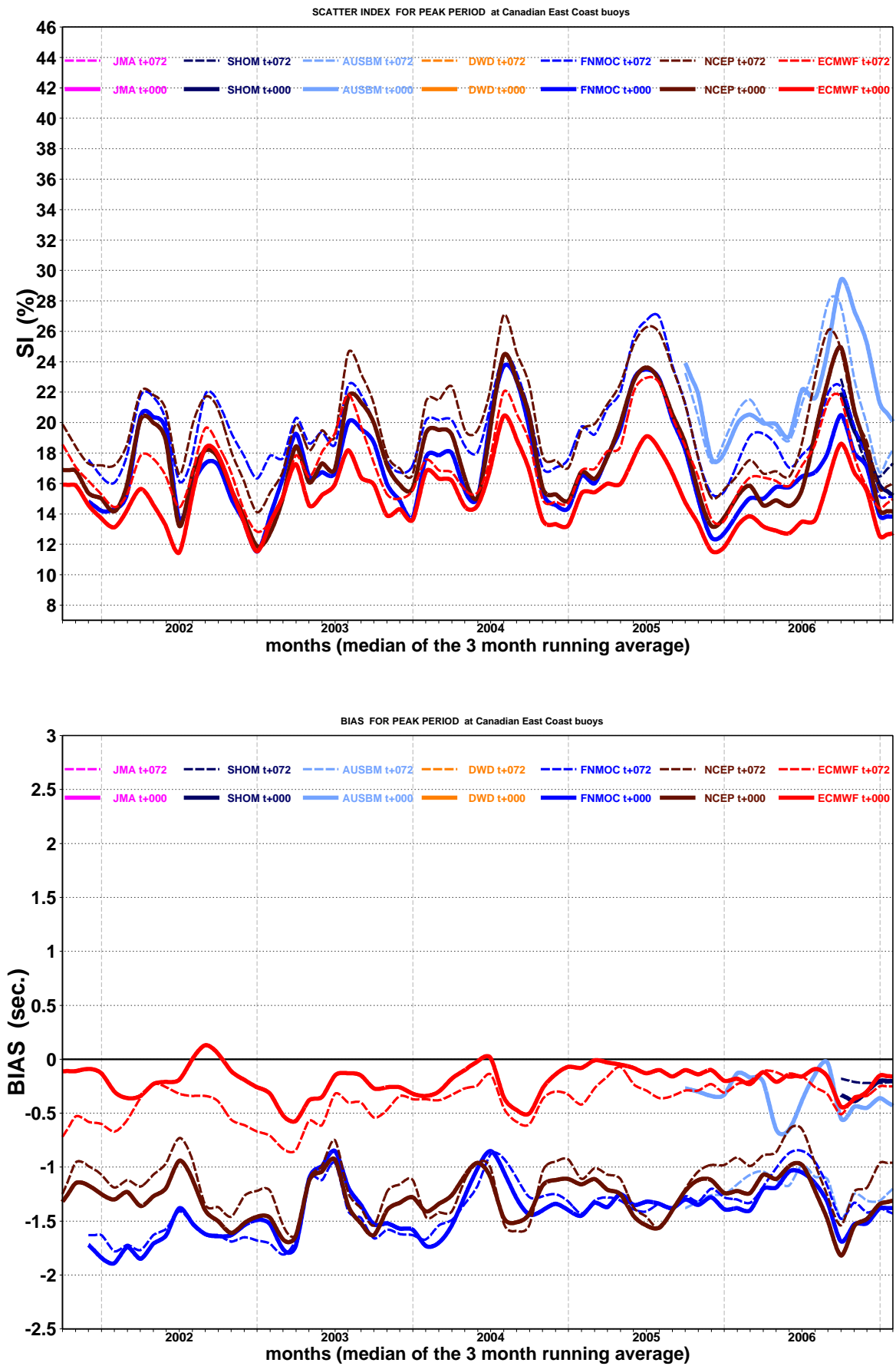
Figure 42: Scatter index peak period (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common Canadian East Coast buoys for forecast step 0 and day 3.

3.22 Comparison of wave height for North East Atlantic buoys

The amount of data used is shown in Figure 43. Scatter index and bias are displayed next in Figure 44
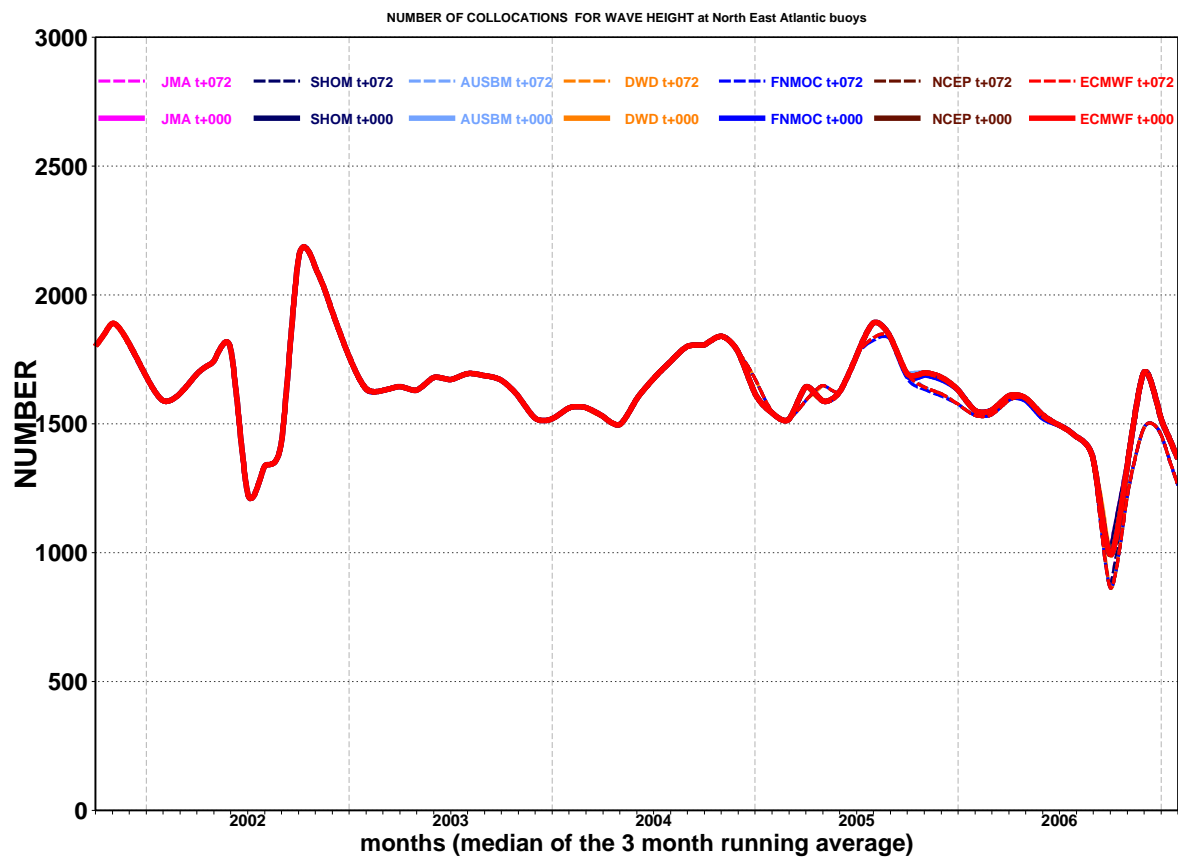

Figure 43: Number of wave height collocations between models and North East Atlantic buoys .
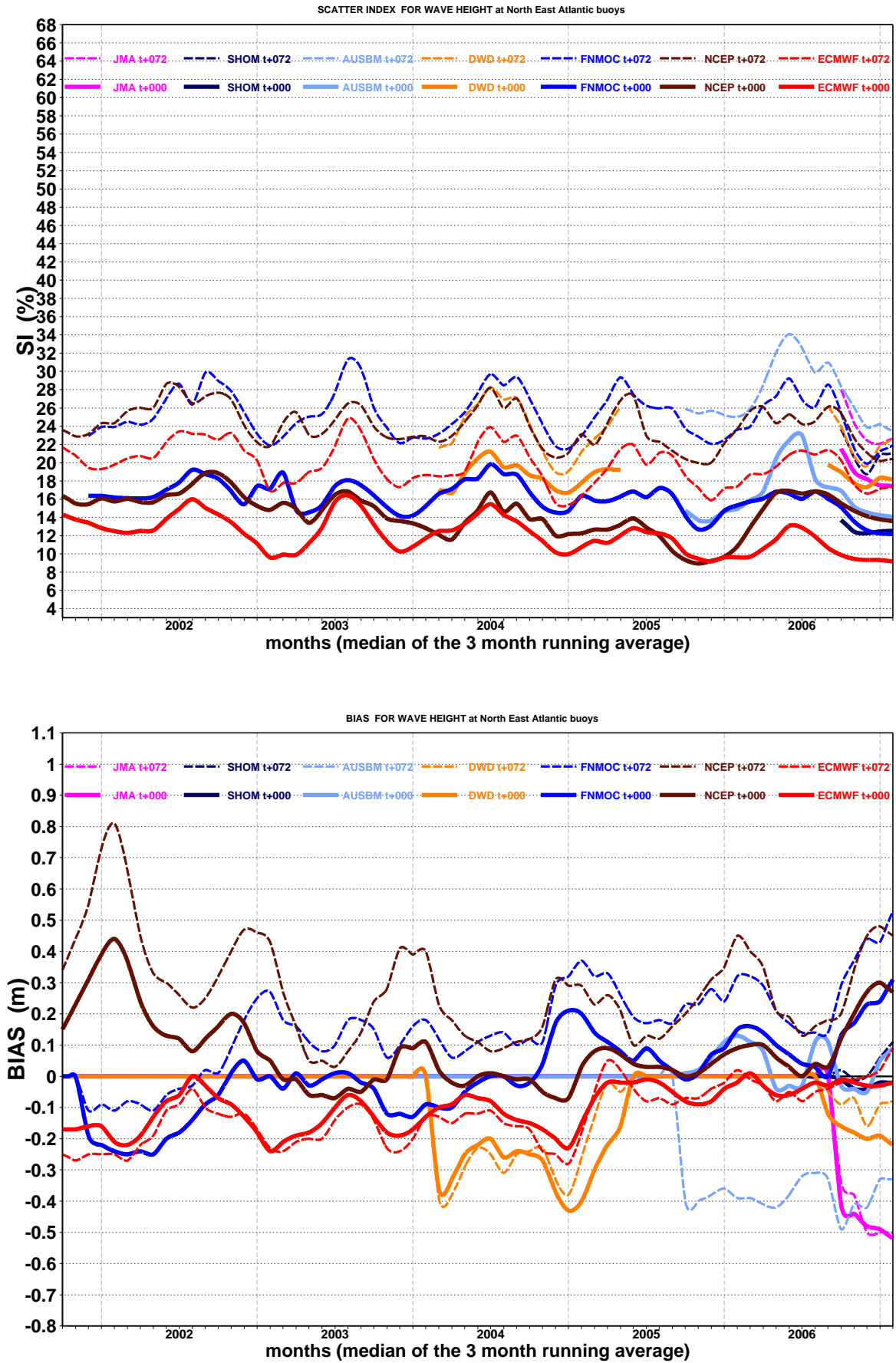
Figure 44: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common North East Atlantic buoys for forecast step 0 and day 3.

3.23 Comparison of wind speed for North East Atlantic buoys

The amount of data used is shown in Figure 45. Scatter index and bias are displayed next in Figure 46
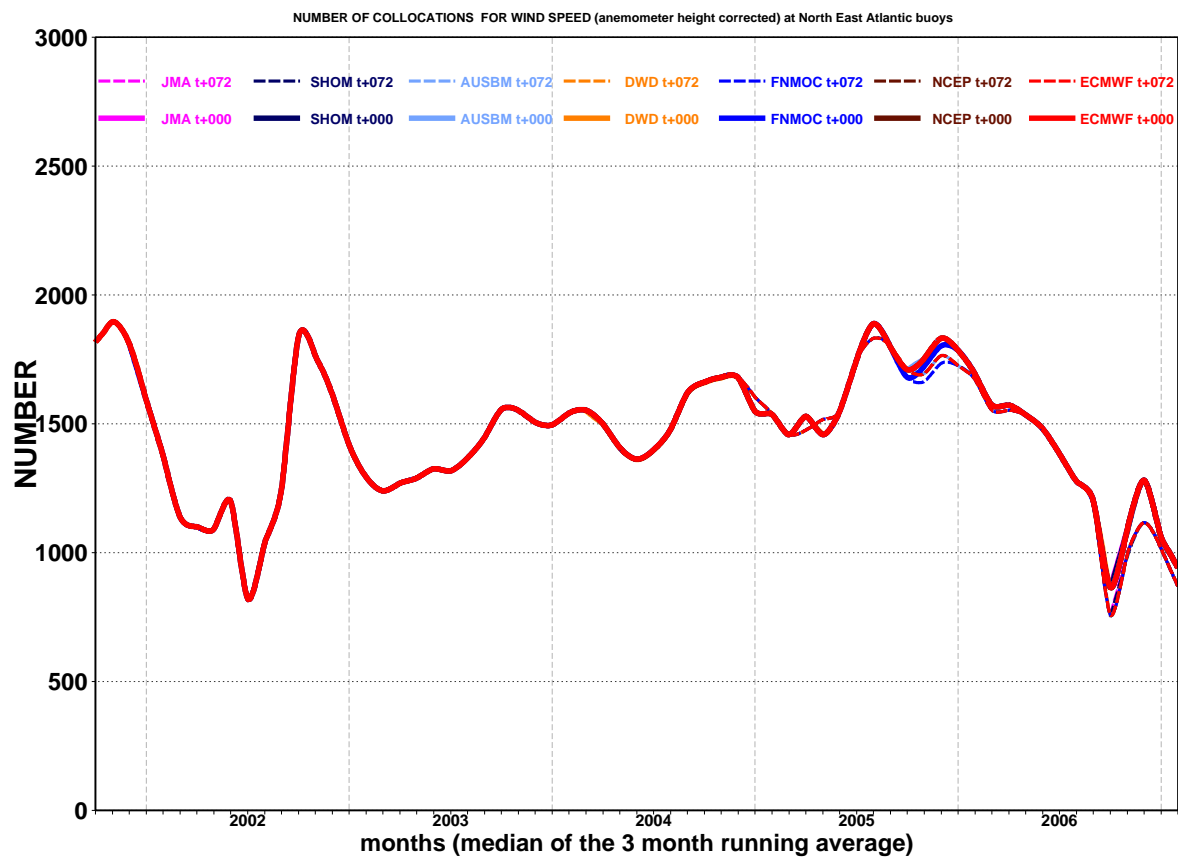

Figure 45: Number of wind speed collocations between models and North East Atlantic buoys .
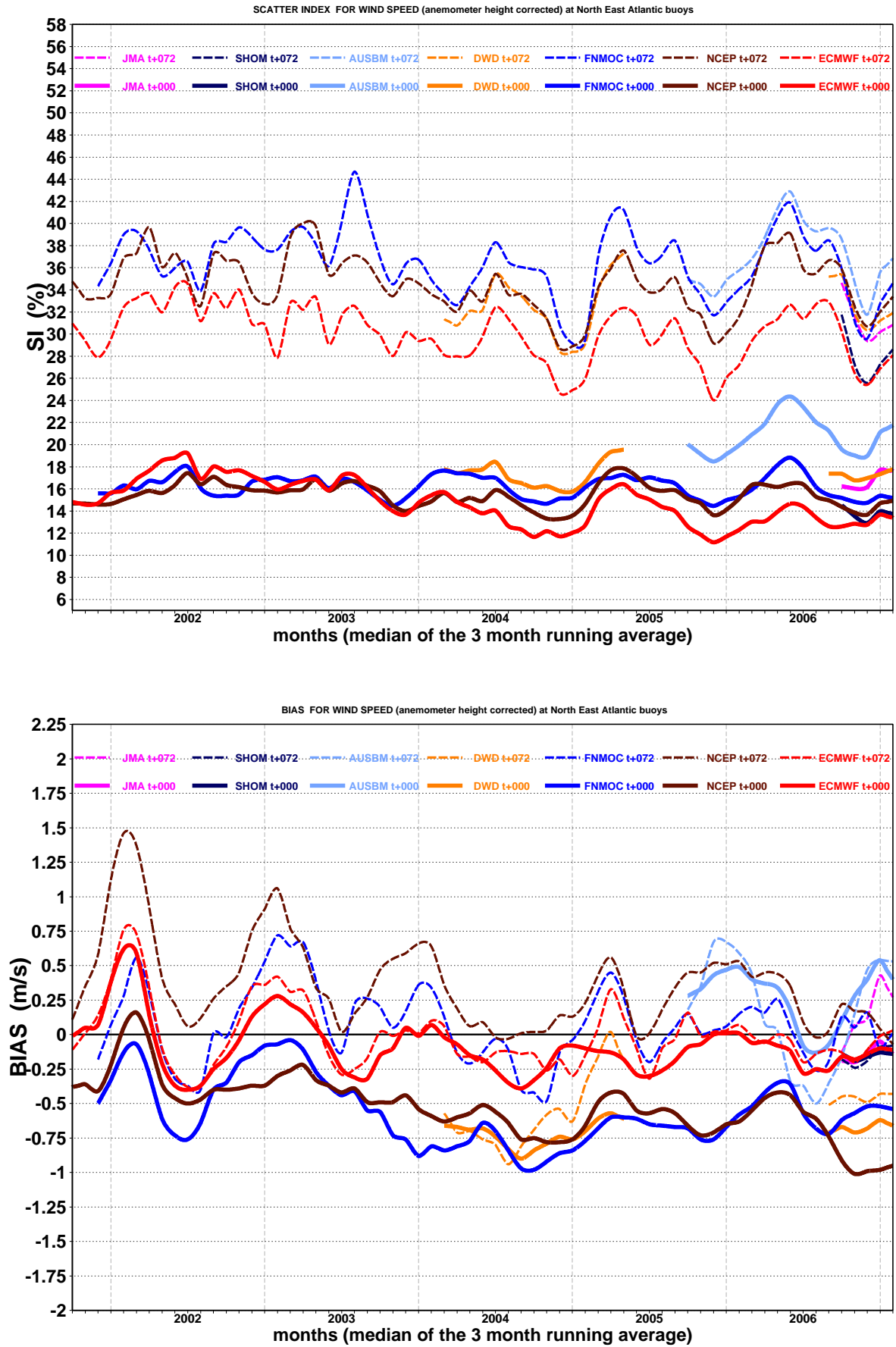
Figure 46: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common North East Atlantic buoys for forecast step 0 and day 3.

3.24 Comparison of wave height for North Sea platforms

The amount of data used is shown in Figure 47. Scatter index and bias are displayed next in
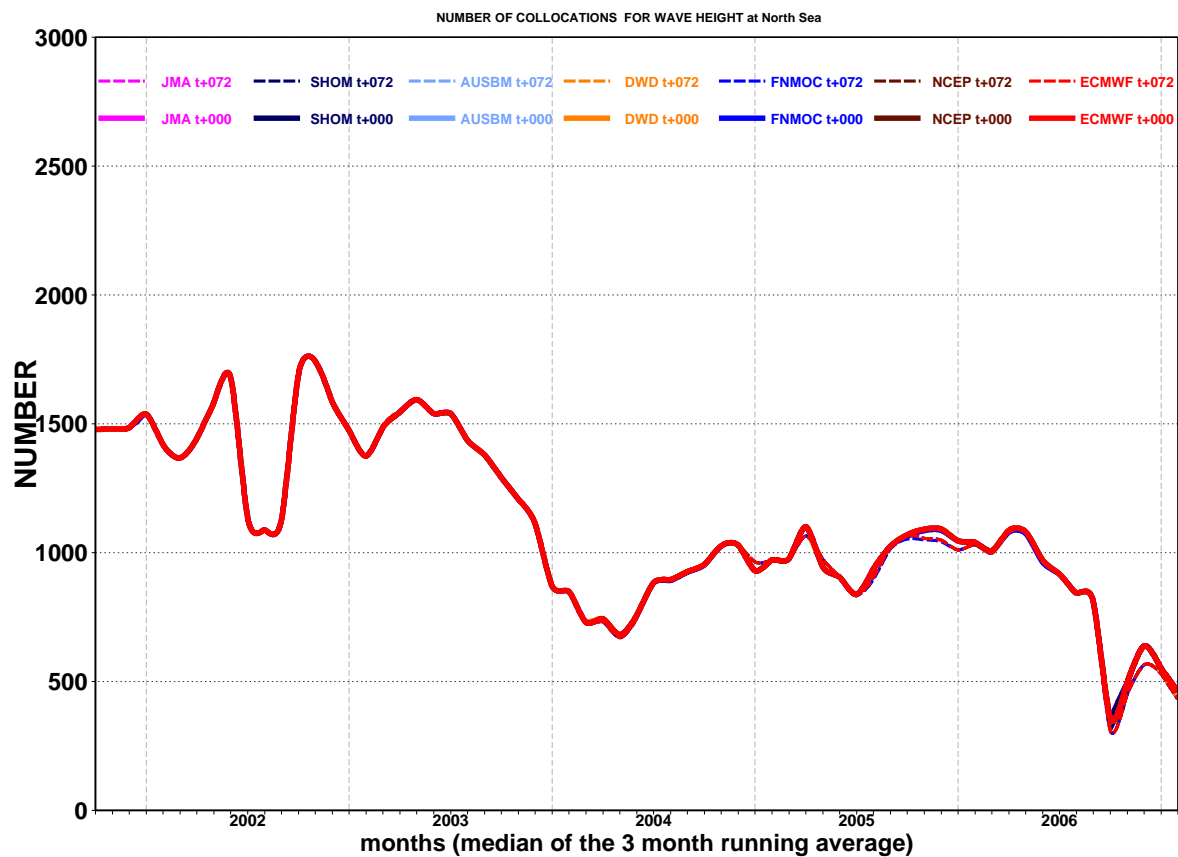Figure 48

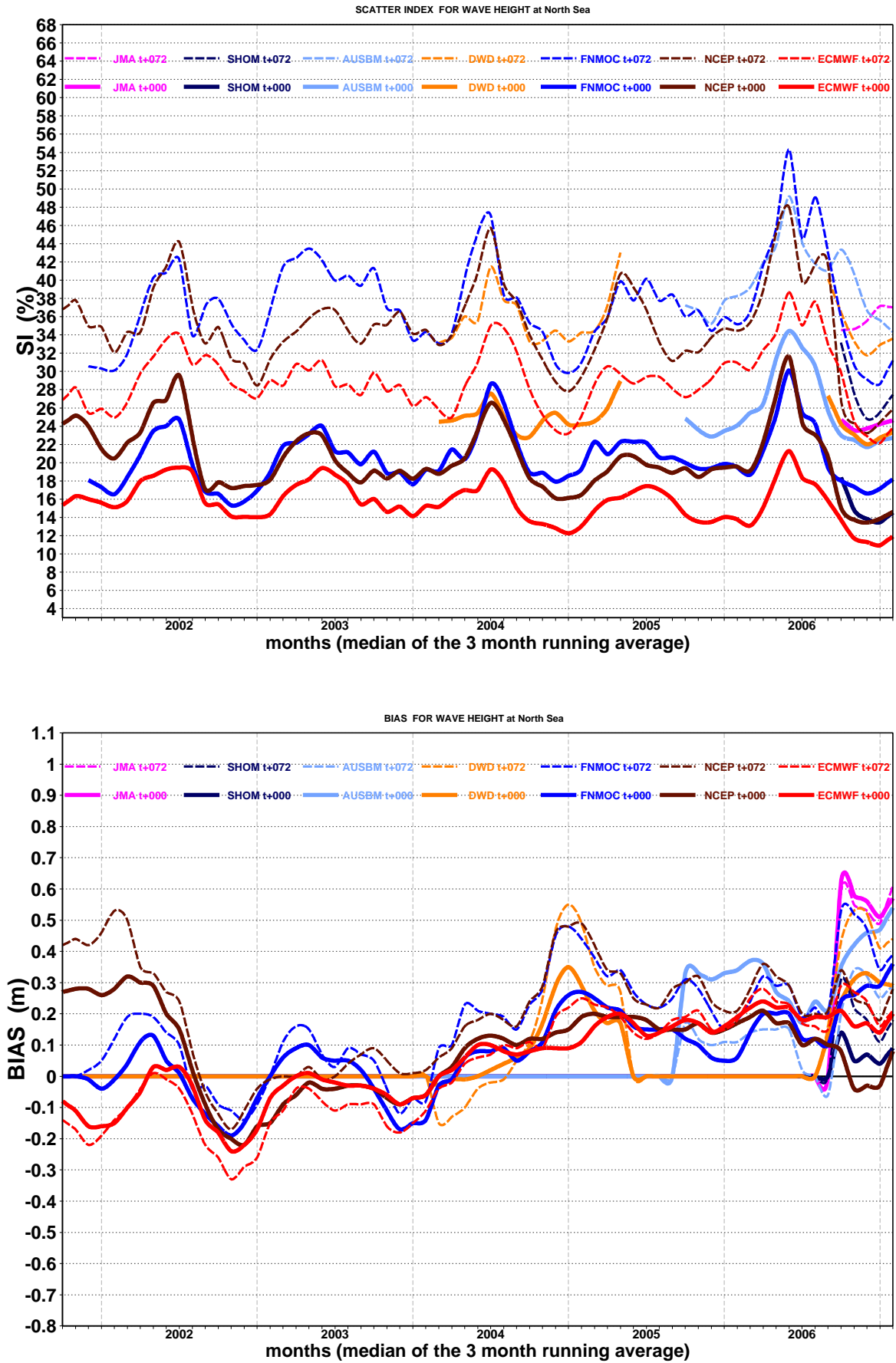Figure 47: Number of wave height collocations between models and North Sea platforms.

Figure 48: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common North Sea platforms for forecast step 0 and day 3.

3.25 Comparison of wind speed for North Sea platforms

The amount of data used is shown in Figure 49. Scatter index and bias are displayed next in Figure 50
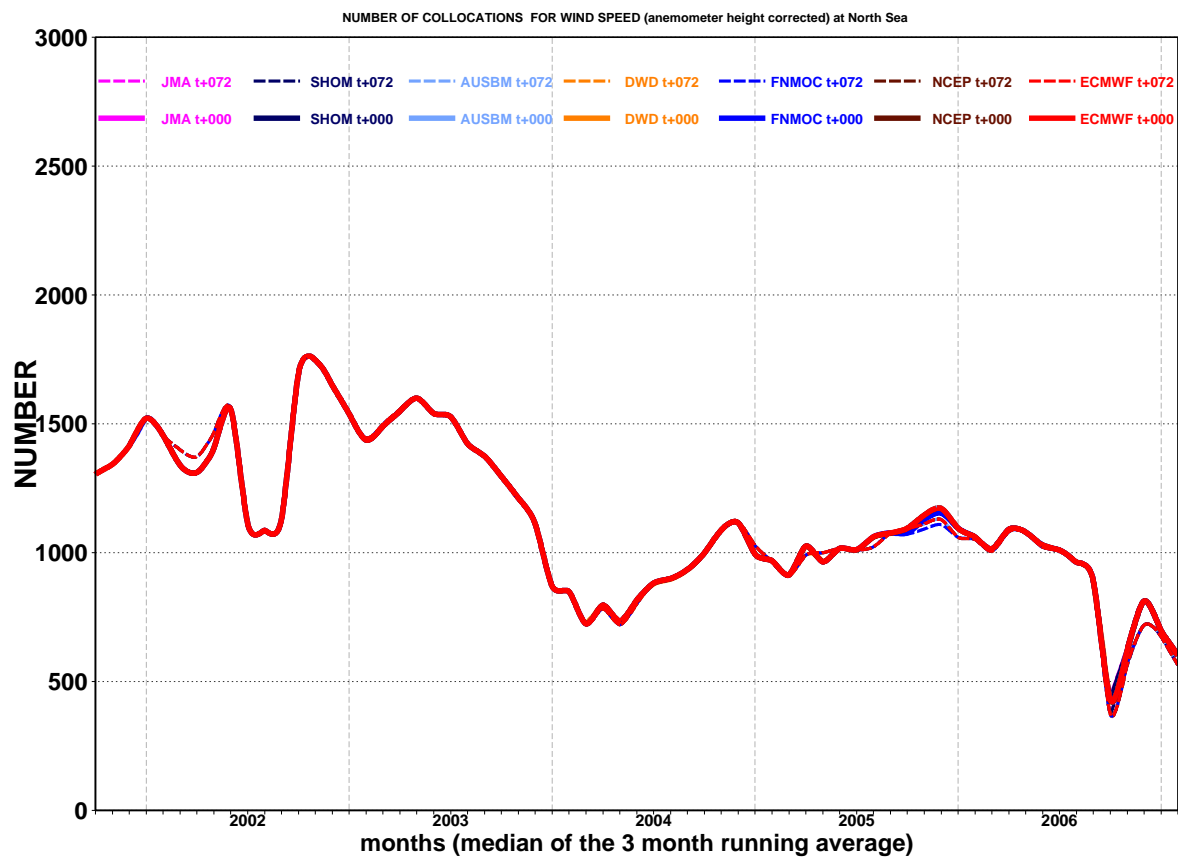

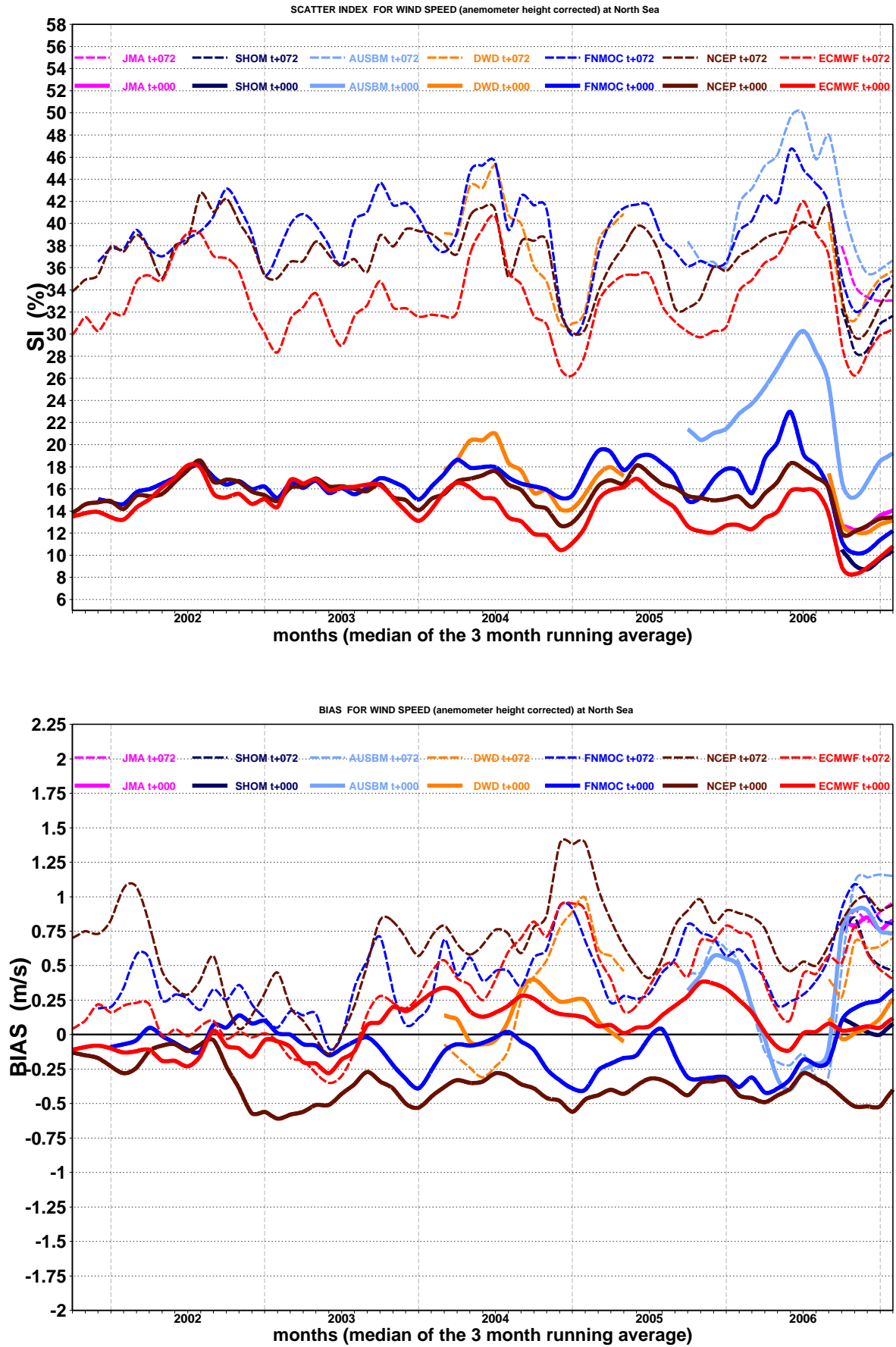Figure 49: Number of wind speed collocations between models and North Sea platforms.

Figure 50: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common North Sea platforms for forecast step 0 and day 3.

3.26 Comparison of wave height for South African platform

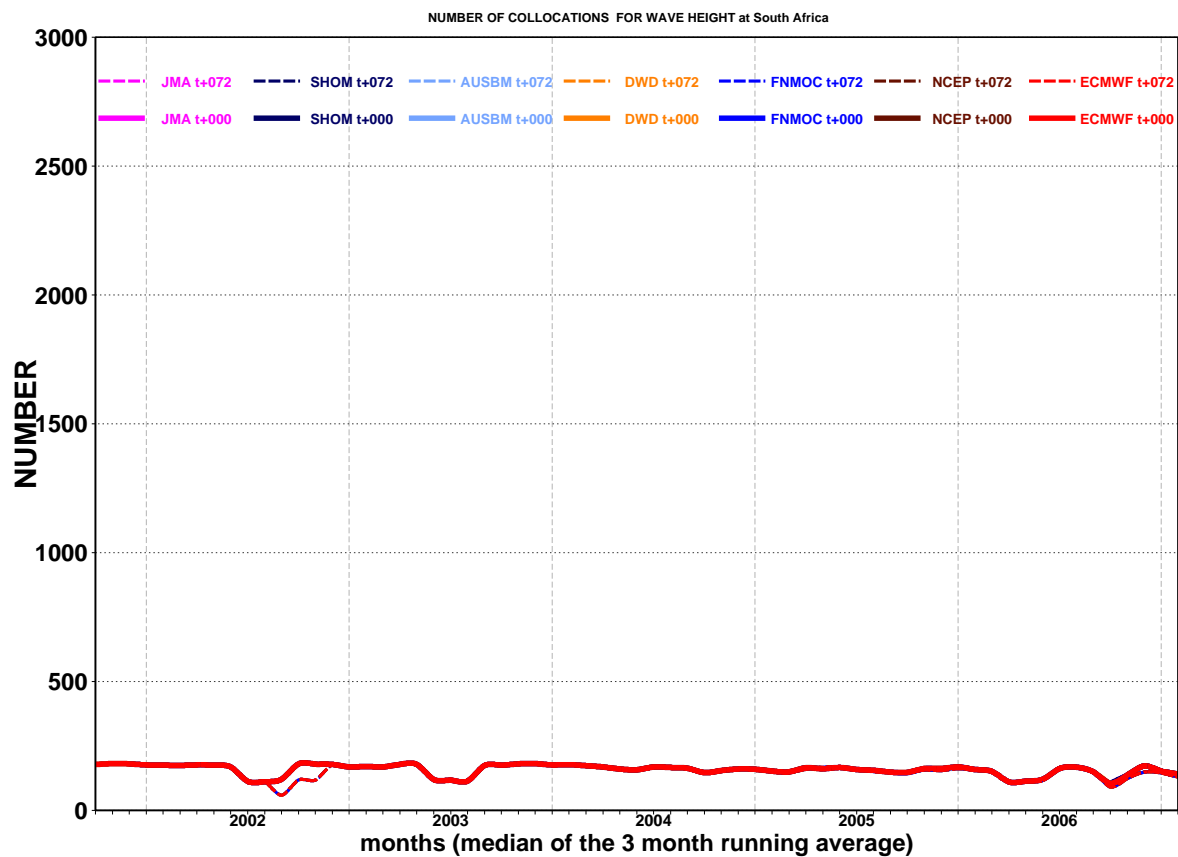The amount of data used is shown in Figure 51. Scatter index and bias are displayed next in Figure 52

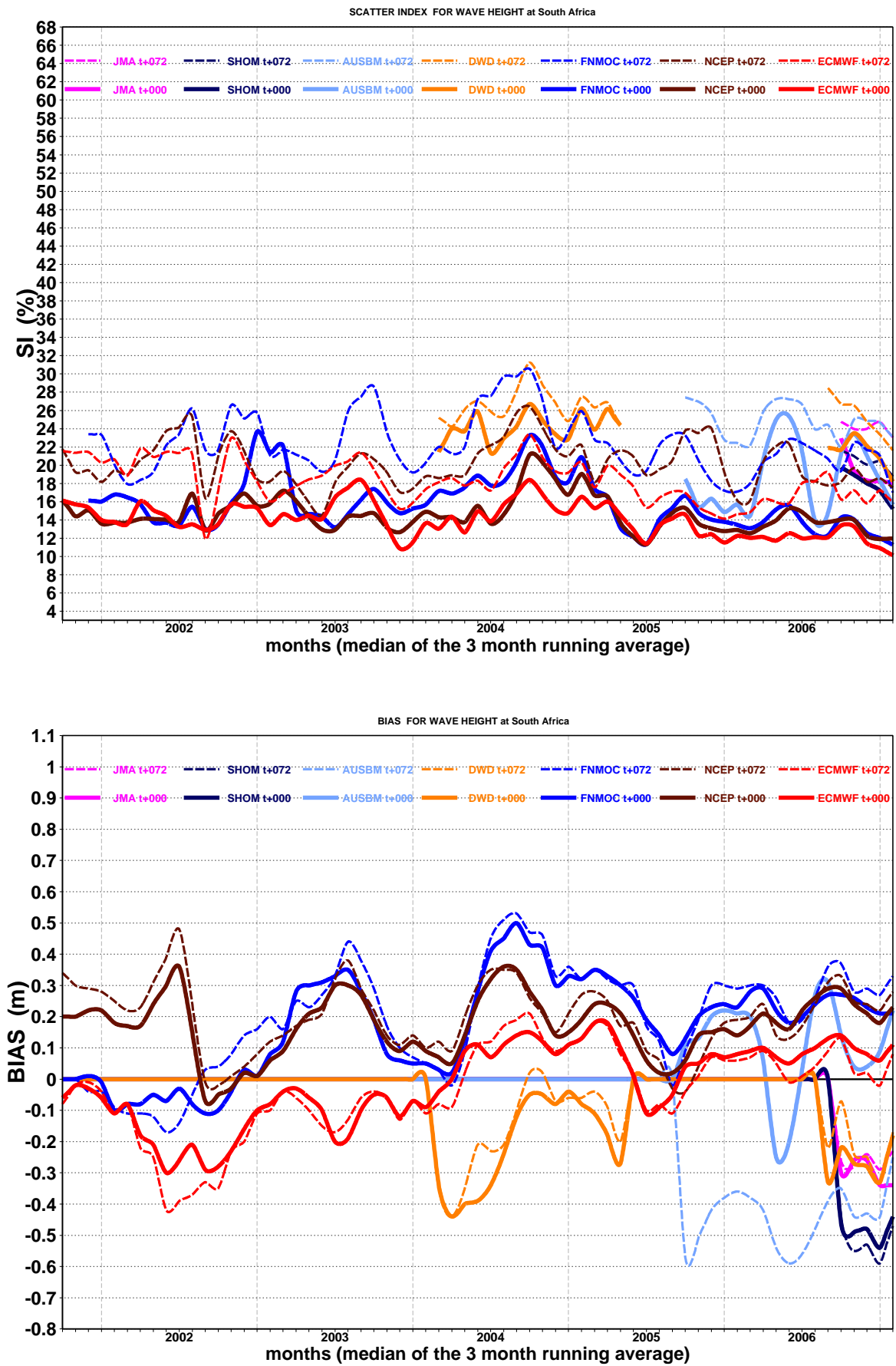Figure 51: Number of wave height collocations between models and South African platform.

Figure 52: Scatter index wave height (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common South African platform for forecast step 0 and day 3.

3.27 Comparison of wind speed for South African platform

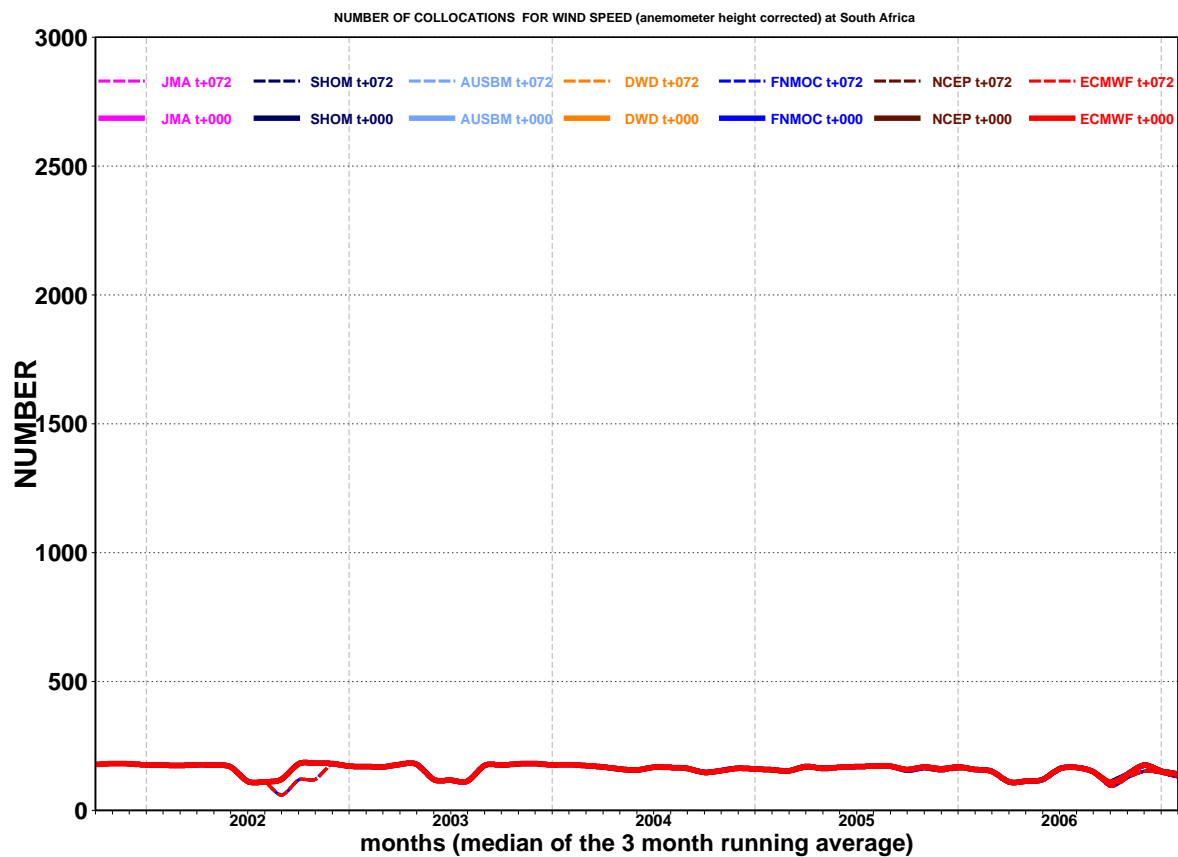The amount of data used is shown in Figure 53. Scatter index and bias are displayed next in Figure 54

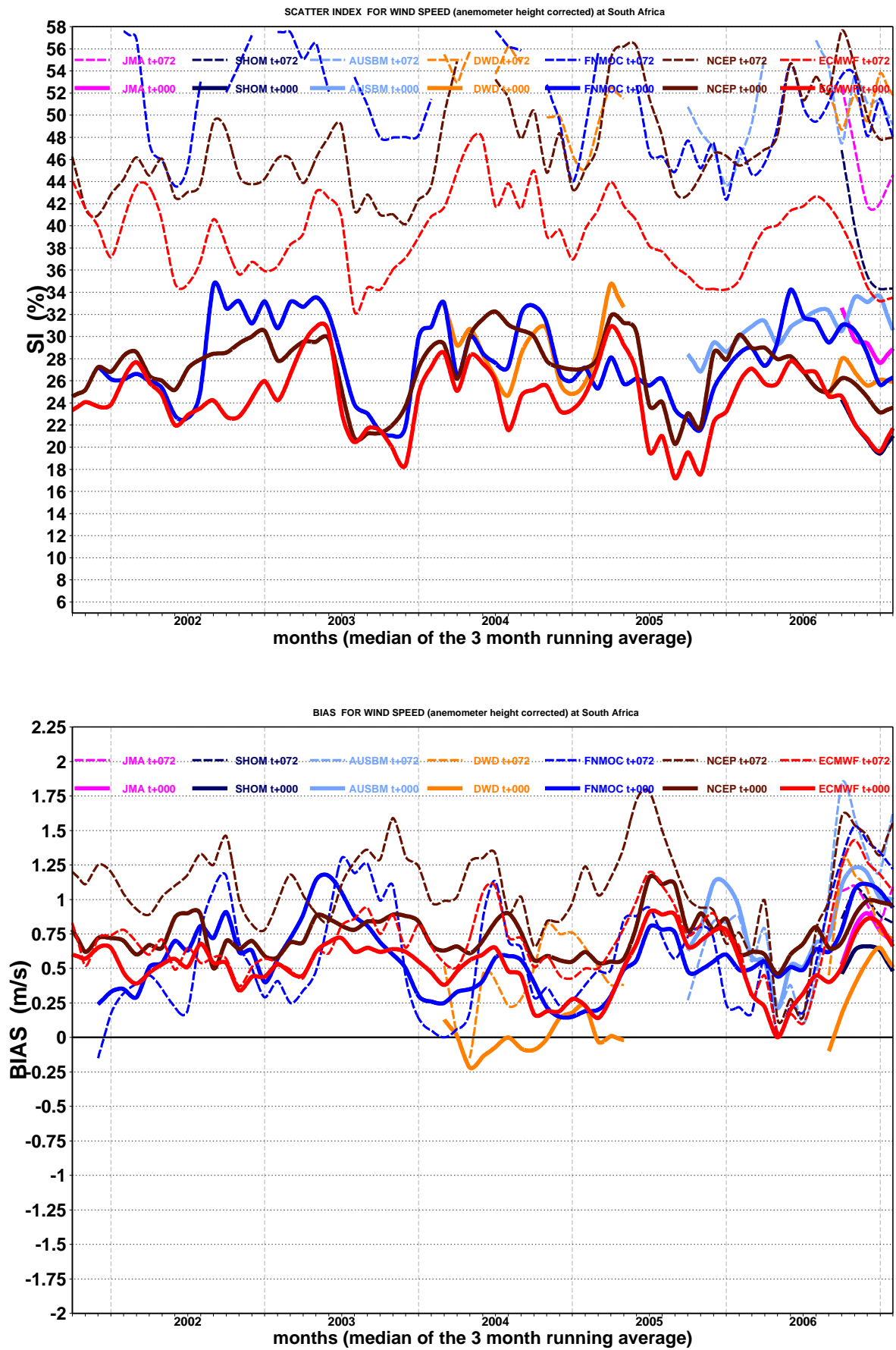Figure 53: Number of wind speed collocations between models and South African platform.

Figure 54: Scatter index wind speed (standard deviation of the difference normalised by the mean of the observations) (top) and bias (model-buoy) (bottom) at common South African platform for forecast step 0 and day 3.