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TECHNICAL NOTE

A NEW TRANSFER FUNCTION FOR SSM/I BASED ON AN EXPANDED NEURAL NETWORK ARCHITECTURE

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LIST OF ABBREVIATIONS

BT:	brightness temperature
C:	degrees Celsius
CC:	correlation coefficient
cal/val:	calibration/validation
FXX:	SSM/I instrument number XX
GHz:	10^9 cycles/second
GSW:	Goodberlet, Swift and Wilkerson (1989) - see References
H:	horizontal polarization
K:	degrees Kelvin
KBG:	Krasnopolsky, Breaker and Gemmilll (1995) - see References
***L*:**	columnar liquid water
LIMA:	European oceanic weather ship
MIKE:	European oceanic weather ship
NDBC:	National Data Buoy Center
NN:	neural network
NRL:	Naval Research Laboratory
OMBNNX:	Ocean Modeling Branch Neural Network number X
OWS:	oceanic weather ship
SBB:	Stogryn, Butler and Bartolac (1994) - see References
SD:	standard deviation
SSM/I:	Special Sensor Microwave / Imager
SST:	sea surface temperature
TAO:	tropical atmosphere ocean
TOGA:	tropical ocean global atmosphere
V:	vertical polarization
***V*:**	columnar water vapor

ABSTRACT

A new neural network (NN) SSM/I transfer function (OMBNN3) which retrieves wind speed (*W*), columnar water vapor (*V*), columnar liquid water (*L*), and *SST*, using only satellite data (five SSM/I brightness temperatures (BTs)) is introduced and compared with the current operational (GSW) algorithm and NN algorithms developed earlier (OMBNN1 and OMBNN2). The new NN algorithm systematically outperforms all algorithms considered for all SSM/I instruments (F8, F10, F11 and F13), under all weather conditions where retrievals are possible, and for all wind speeds. It also retrieves *V* and *L* with an accuracy close to that of cal/val (for *V*) and Weng and Grody (for *L*) algorithms, and produces low resolution SSTs with moderate accuracy. OMBNN3 demonstrates significantly better performance at higher wind speeds (and higher latitudes) than previous NN-based algorithms. It generates wind speeds up to ~23 m/s for the available test data, and has a theoretical upper limit of about 32 m/s. The retrieval accuracy for OMBNN3 does not depend significantly on the satellite and/or instrument.

1. INTRODUCTION

This report contains a description of a new neural network (NN) SSM/I transfer function (OMBNN3) which retrieves wind speed (*W*), columnar water vapor (*V*), columnar liquid water (*L*), and *SST*, using only satellite data (five SSM/I brightness temperatures (BTs)). Also contained is a detailed comparison of the new algorithm with the current operational (GSW) algorithm (Goodberlet, et al., 1989) and NN algorithms developed earlier (Krasnopolsky et al., 1995a, 1995b). It is shown that our new NN algorithm outperforms all other algorithms in terms of wind speed retrievals. It also retrieves *V* and *L* with an accuracy close to that of cal/val (Alishouse, 1990) and WG (Weng and Grody, 1994) algorithms, and produces low resolution SSTs with moderate accuracy.

SSM/I wind retrieval algorithms encounter two problems: (1) atmospheric moisture and (2) high wind speeds. It was shown (Stogryn et al., 1994; Krasnopolsky et al., 1994, 1995a), that an adaptive nonlinear approach such as NNs can successfully handle the nonlinearity of the SSM/I transfer function caused by atmospheric moisture, extending the retrieval capability under cloudy atmospheric conditions. However, it is not yet clear to what extent retrievals can be extended under cloudy conditions. Although an upper limit for retrievals (0.5 mm in terms of columnar liquid water) has been suggested, it is clear that in particular situations this limit may be significantly lower (e.g., in rain). Because high moisture events are relatively rare, they are poorly represented in development data sets which makes this problem even more difficult. The new OMBNN3 algorithm which estimates two moisture criteria, *V* and *L* together with the wind speed, provides an additional control on the level of moisture and on the accuracy of wind speed retrievals.

Several issues contribute to the problems at high wind speed (see Krasnopolsky et al., 1996a): (1) saturation of BT at high wind speeds due to saturation of the area of the ocean surface covered by the persistent fraction of whitecap foam, (2) increasing noise in BT from the transient part of whitecap foam fraction at high wind speeds, and (3) very few buoy observations for higher wind speeds ($W > 15$ m/s). The linear GSW retrieval algorithm can, in principle, generate high wind speeds; however, validation of this algorithm using buoy observations shows that it has high scatter at high wind speeds and generates high wind speeds in some cases even