Development of a Neural-Network for the Retrieval of PWV and LWP from Measurements at 23.8 and 183.3 GHz

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Topics

- Background
- Development of NN retrieval
- Some results
- Conclusions and future work

Background

MWR: 23.8 & 31.4 GHz (NSA C1)

PWV rms ~ 0.4 mm
LWP rms ~ 0.025 mm
Better when PWV > 5 mm

GVR: 183.3±1, 3 ,7 ,14 GHz (NSA C1)

PWV 2-5% accuracy
LWP rms ~ 0.01 mm
Better when PWV <5mm

Current ARM products for MWR and GVR

MWR

Brightness temperatures
Real-time linear regression retrievals of PWV and LWP

GVR

Brightness temperatures

Physical retrieval for PWV and LWP from GVR:

- Computationally intensive
- Needs a radiative transfer model
- Needs real time temperature profiles

Objectives

1. Develop a retrieval that can provide real-time PWV and LWP from the GVR

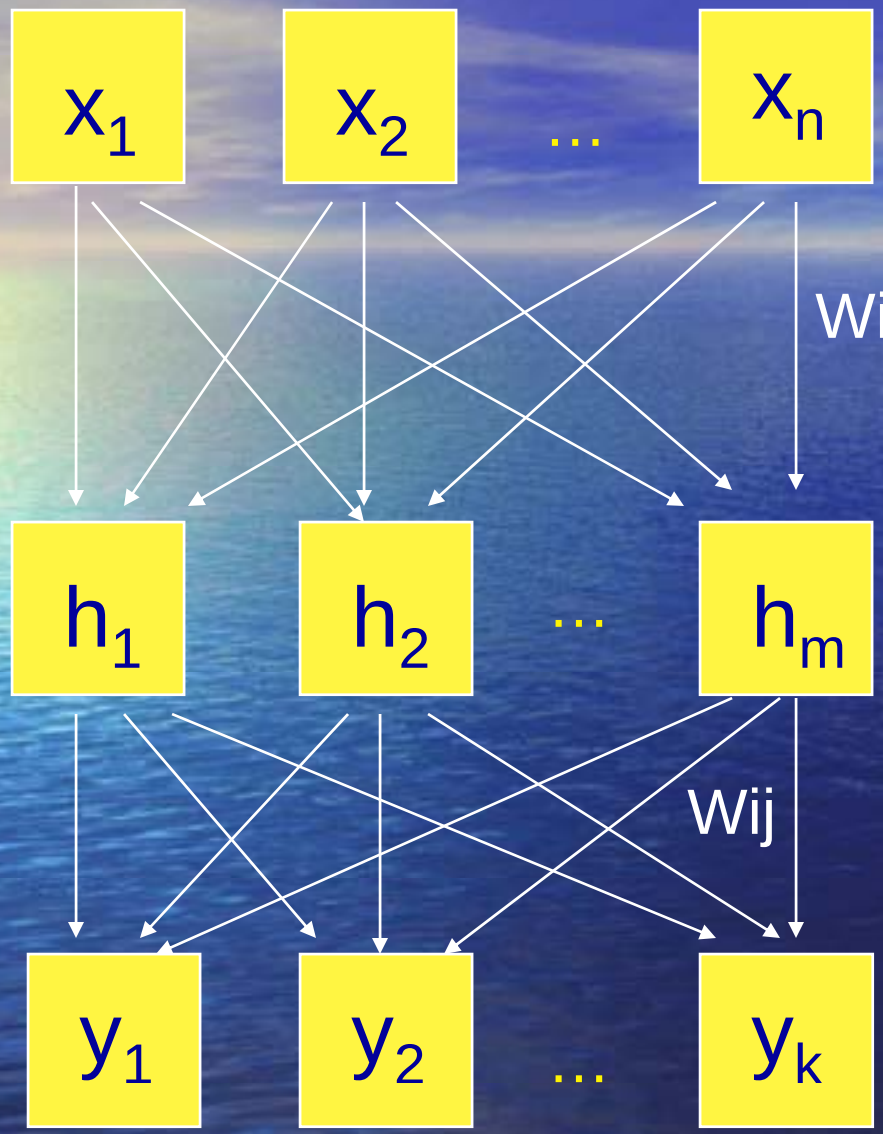
2. Investigate whether combination of GVR and MWR measurements improves retrievals

Development of NN retrieval

Advantages of NN:

- Possibility to account for non-linearity
- Inclusion of multiple sensors (IRT, MMCR)

$$Y = g(W, B, X)$$



Each unit is function of the weighted sum of the previous units

$$h_i = \frac{1}{1 + \exp(\sum_{j=1}^{n} w_{ji} x_j + b_i)}$$

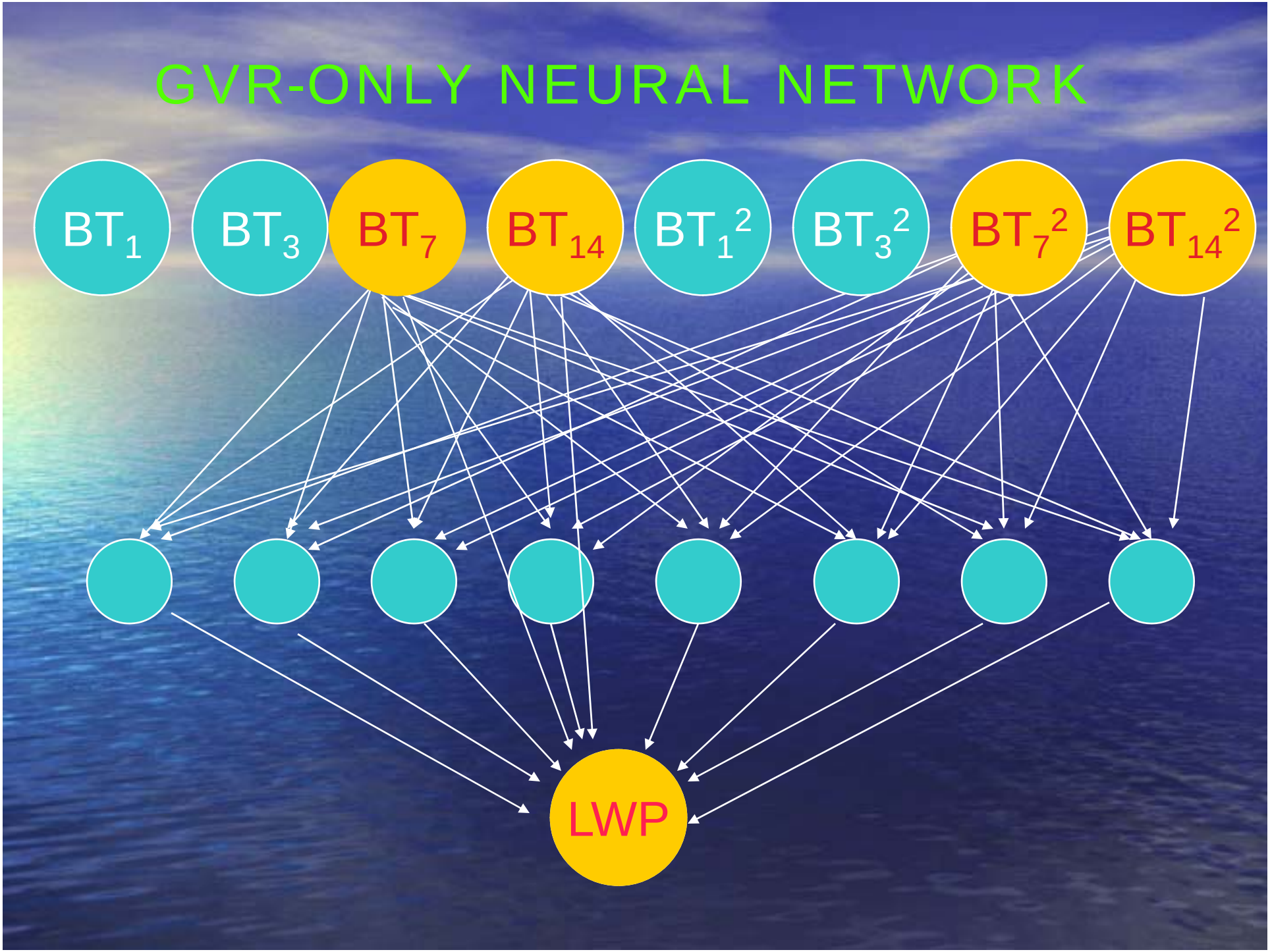
$$y_k = \sum_{i=1}^{m} w_{ik} h_i + b_k$$

Weights and biases are iteratively derived to minimize the sum of squared errors

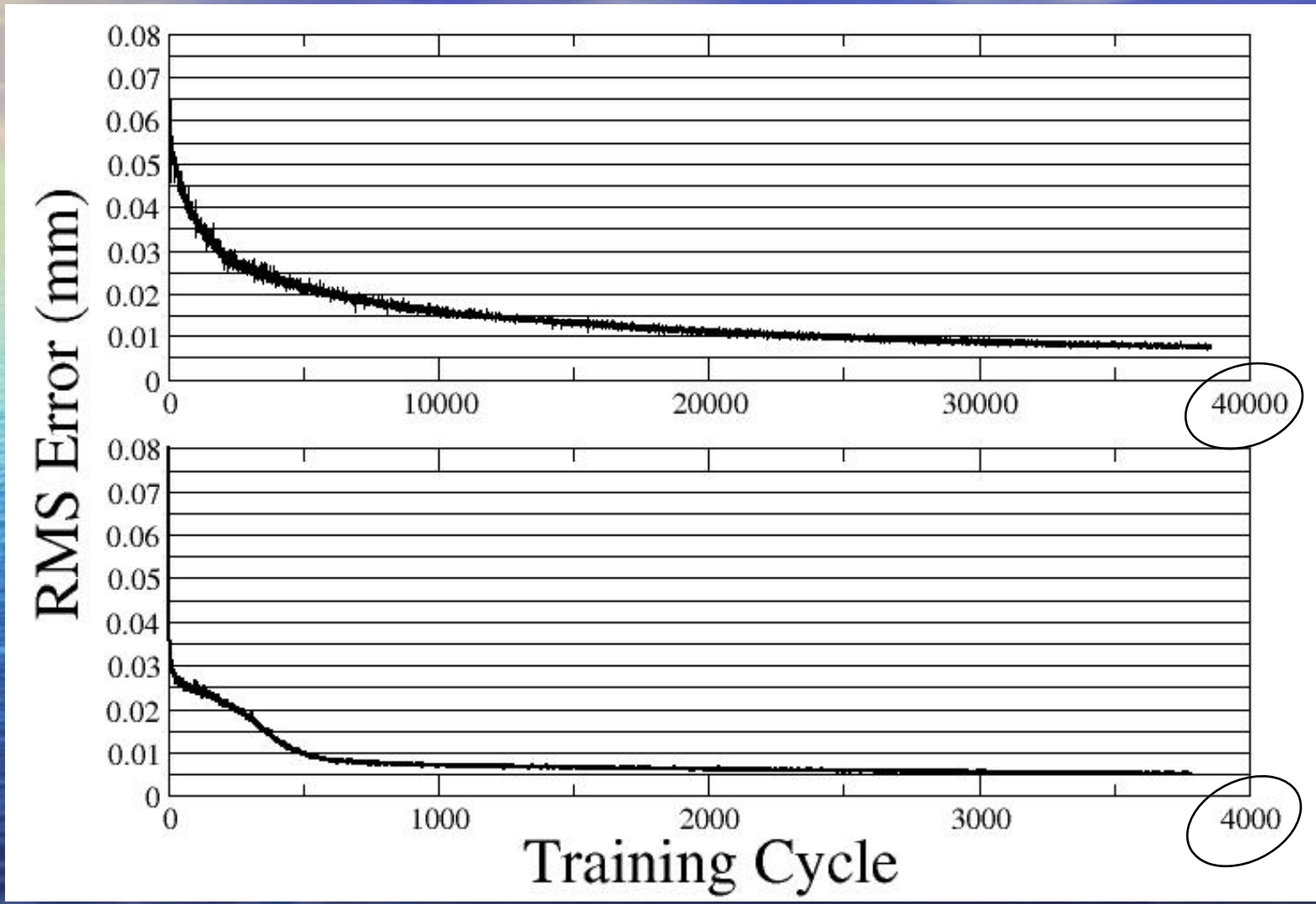
$$E = \sum_N \sum_r (T_r^N - O_r^N)^2$$

N = number of training patterns (N=1167)
T = training units (model PWV and LWP)
O = output unit (retrieved PWV and LWP)

Training set: 4 years of model calculations from winter NSA radiosonde.


GVR-ONLY NEURAL NETWORK
BT1
BT3
BT7
BT14
BT1 2
BT3 2
BT7 2
BT14 2
LWP

LWP TRAINING

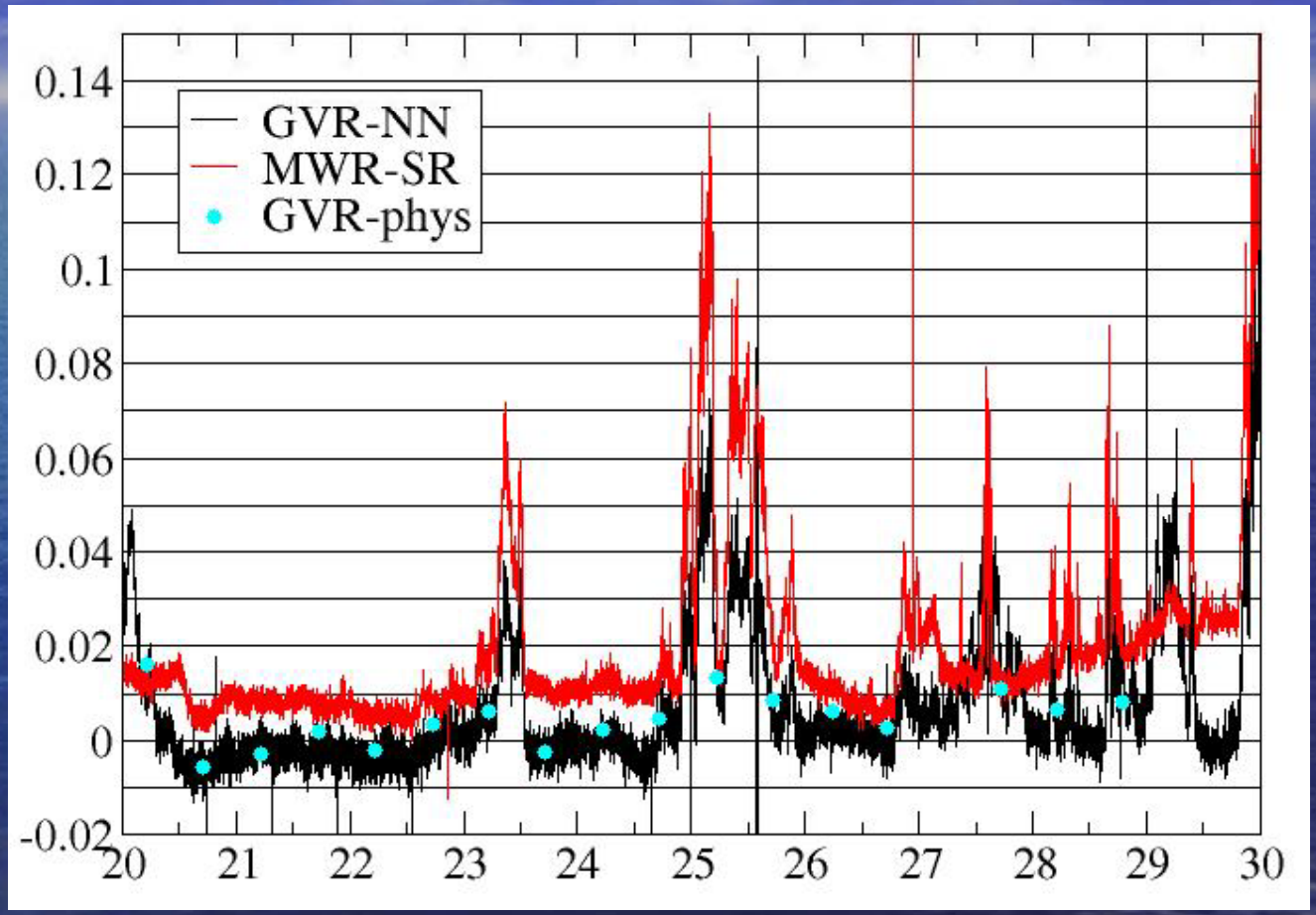


GVR

GVR
+
MWR

LWP RETRIEVAL

LWP
(mm)

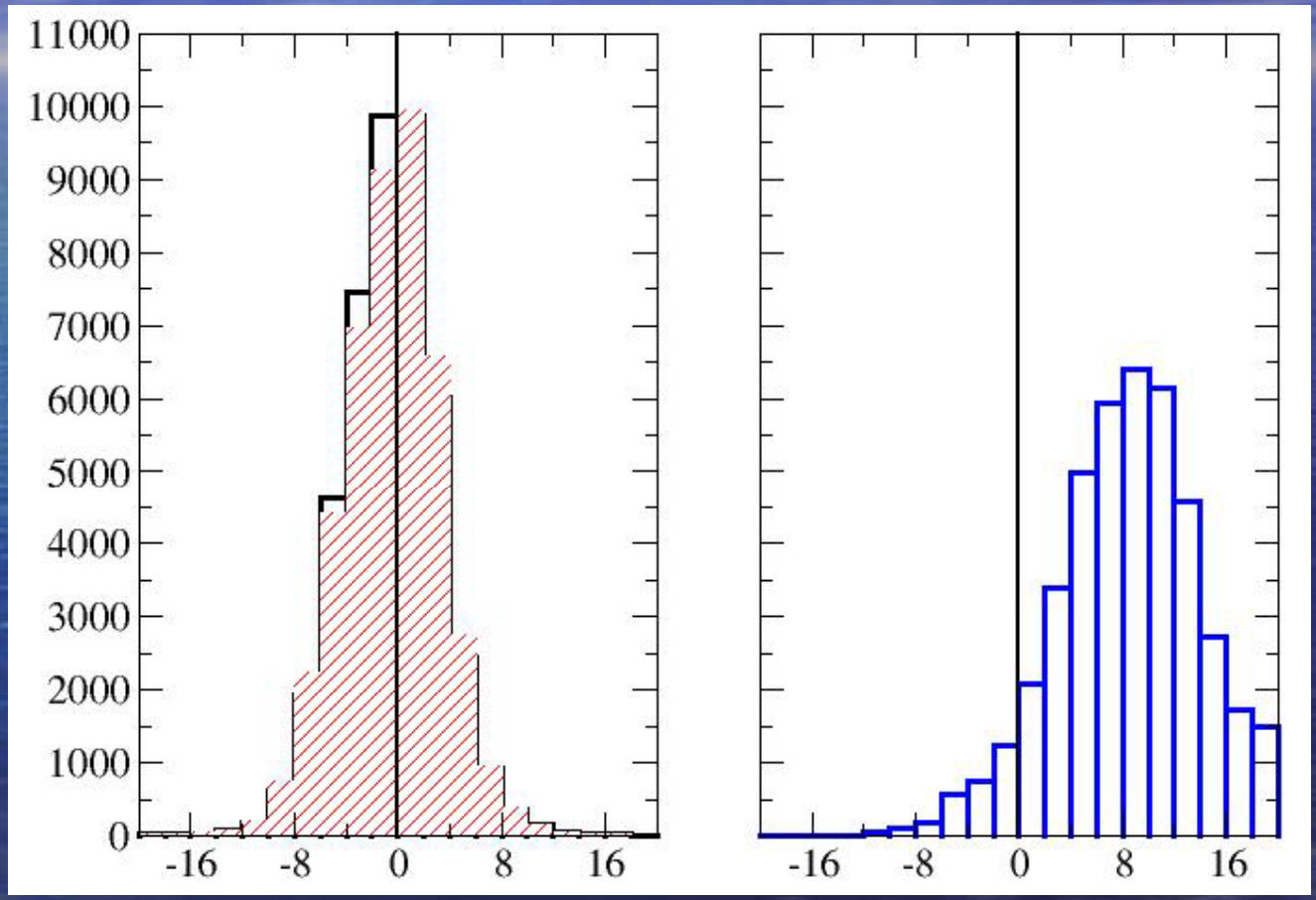


MWR-SR
GVR-NN
GVR-PHYS

Days in January, 2007

CLEAR SKY LWP DISTRIBUTIONS
Nov-Dec-Jan (N=45037)

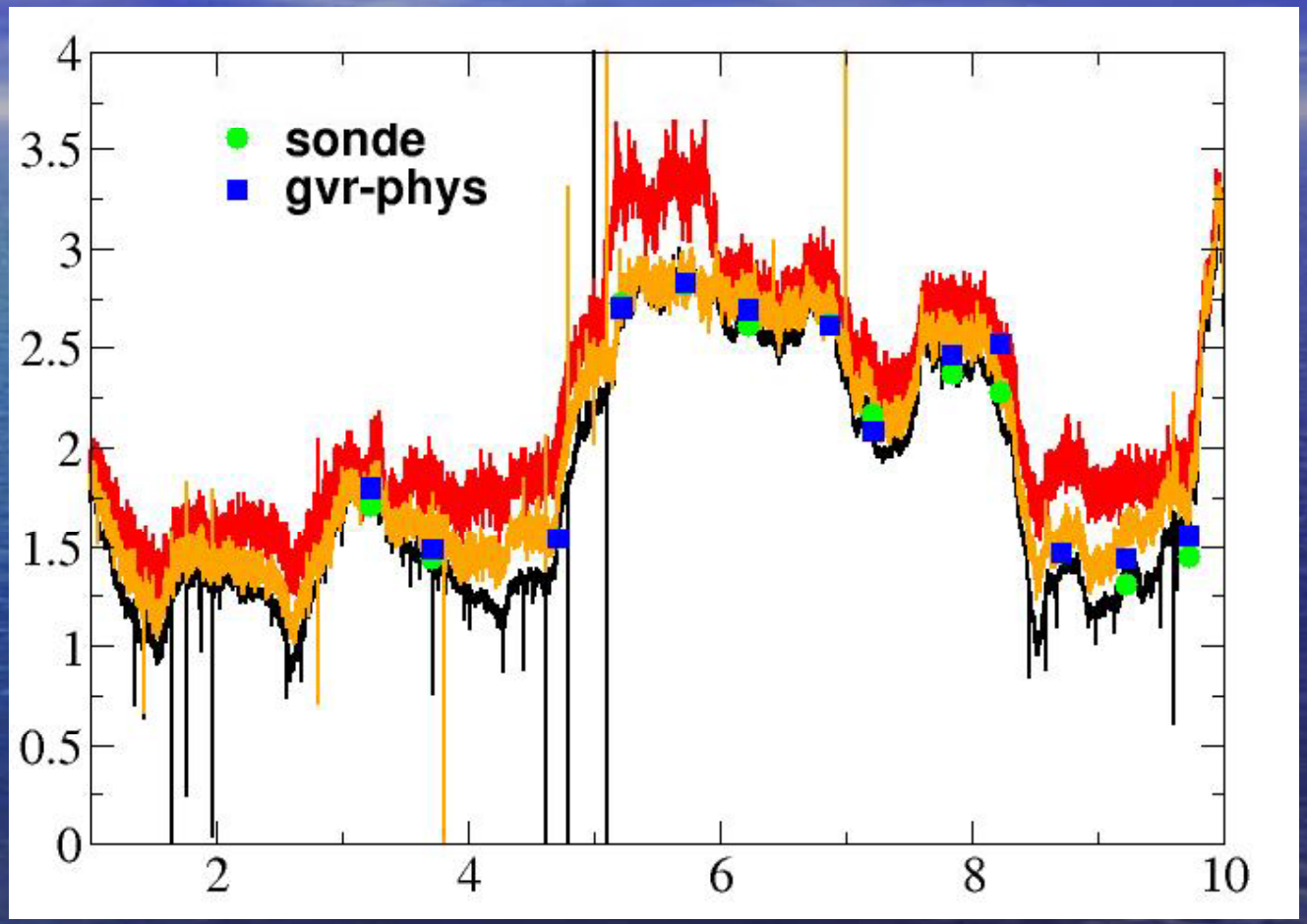
GVR
GVR+MWR
MWR



LWP (g/m^2)

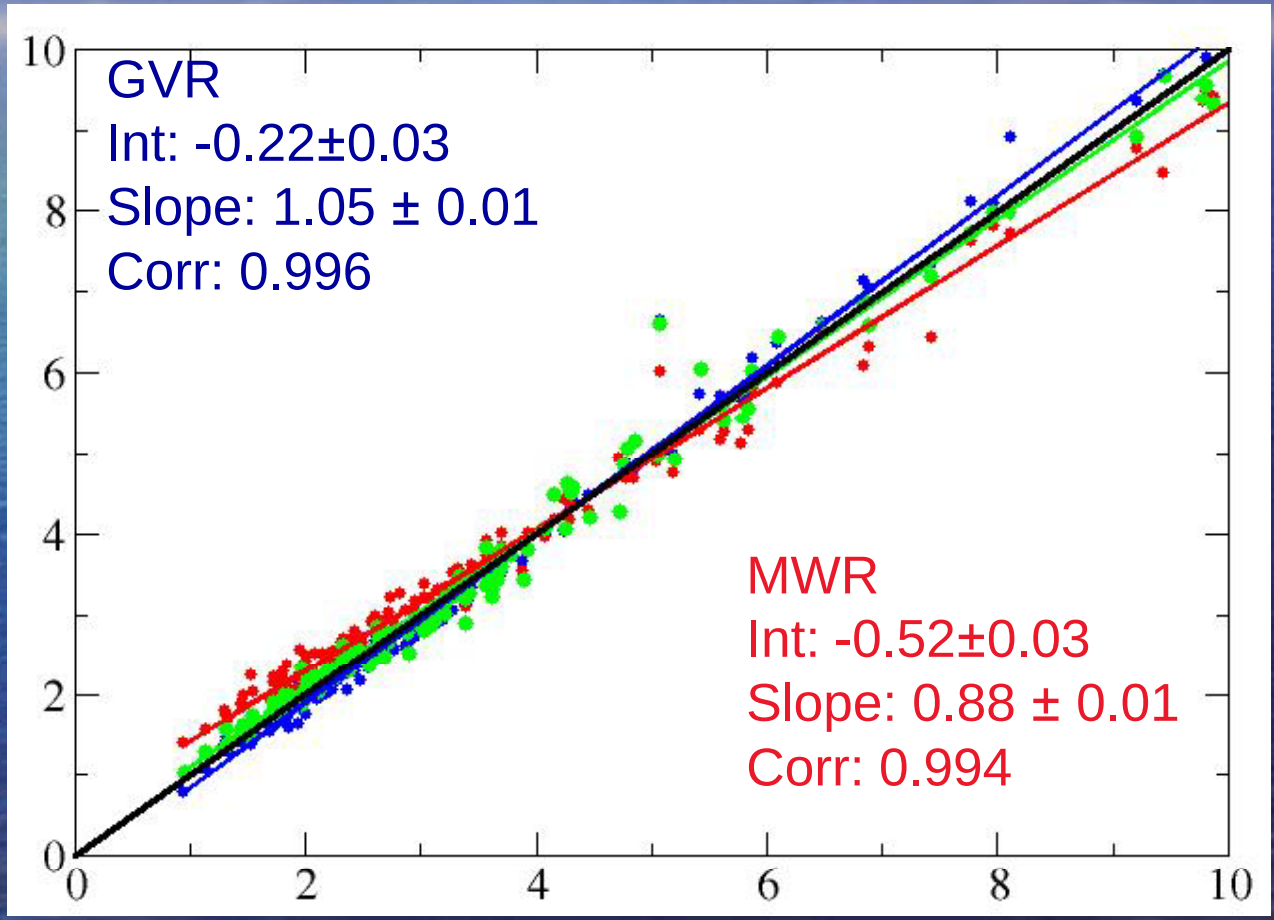
PWV
(mm)

GVR
GVR+MWR
MWR



Days in January 2007

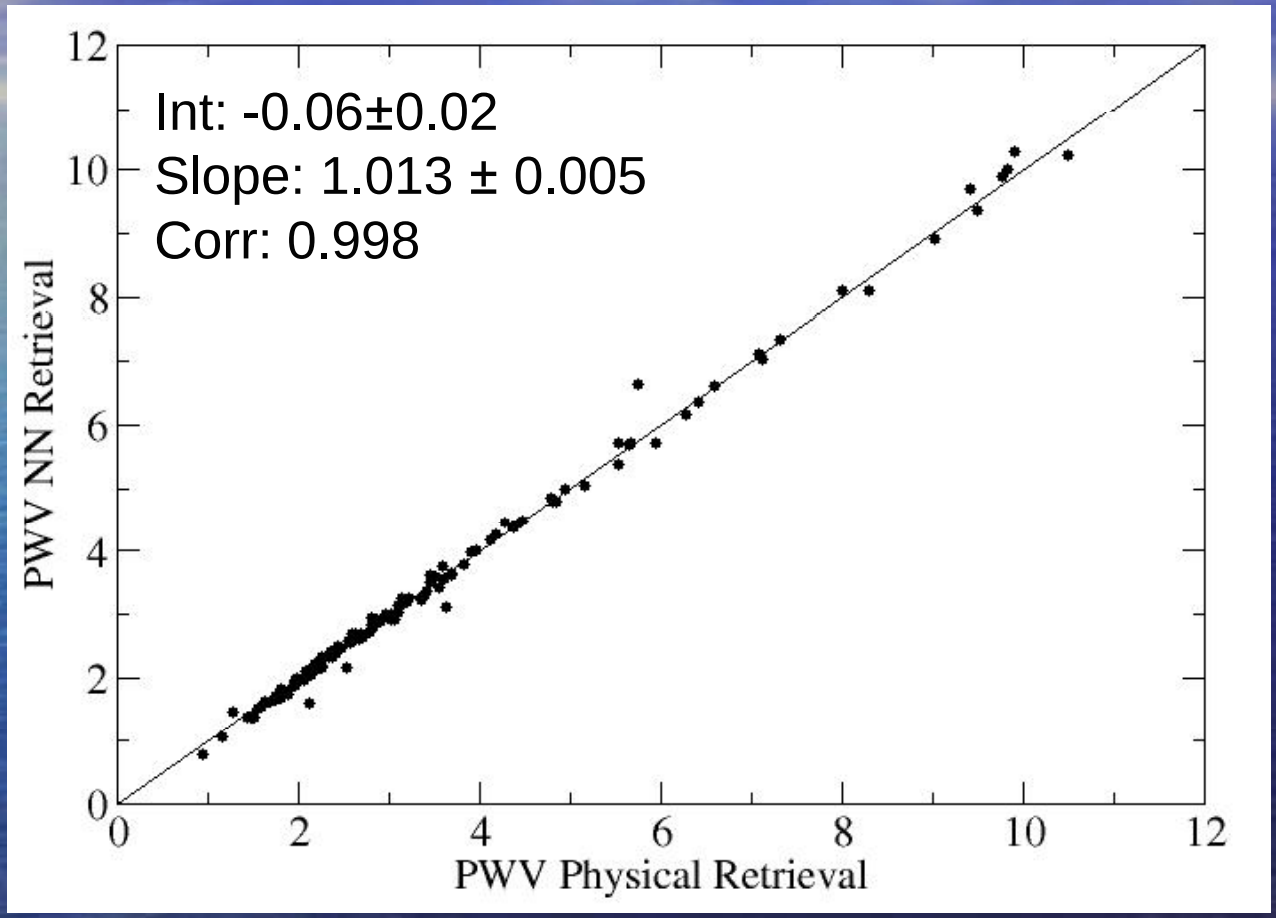
GVR
GVR+MWR
MWR



Retrieved PWV
N=133

PWV from RS

PWV retrieval comparison



NN retrieval

N=133

Physical retrieval

CONCLUSIONS

- NN can be used to derive real-time retrievals of PWV and LWP from GVR measurements
- It can be used to combine multiple sensors (IRT, radar, two or more radiometers…)
- First results are in good agreement with physical retrieval and radiosonde
- MWR data do not seem to contribute significantly

Future work…

- Repeat and optimize training
- Include 90/150-GHz measurements for LWP retrieval
- More in the poster…