The 19th International TOVS Study Conference (ITSC-19)

Retrieval of atmospheric profiles and surface parameters from METEOR - 3M IR- and MW- sounders data

Polyakov, Alexander[1], Kostsov, Vladimir[1], Timofeyev, Yuri[1], and Uspensky, Alexander[2]

(1) Saint-Petersburg State University, Saint-Petersburg, Russia

(2) SRC "Planeta", Moscow, Russia

polyakov@troll.phys.spbu.ru

The instruments have not been lunched jet, therefore our presentation shows :

- **main bases of retrieval algorithms and code,**
- **some numerical modelling results**
- **and some attempt of conversion IASI spectral data to IRFS-2 parameters and retrieval of resulted spectra**

Satellite system for sounding of the atmosphere and surface at Meteor-3M №2 is designed for:

- the temperature-humidity sounding of the atmosphere;
- **determining of the surface temperature and emissivity;**
- **determining of the ozone and greenhouse gases content.**
- **wind velocity over water**
- **cloudiness parameters**

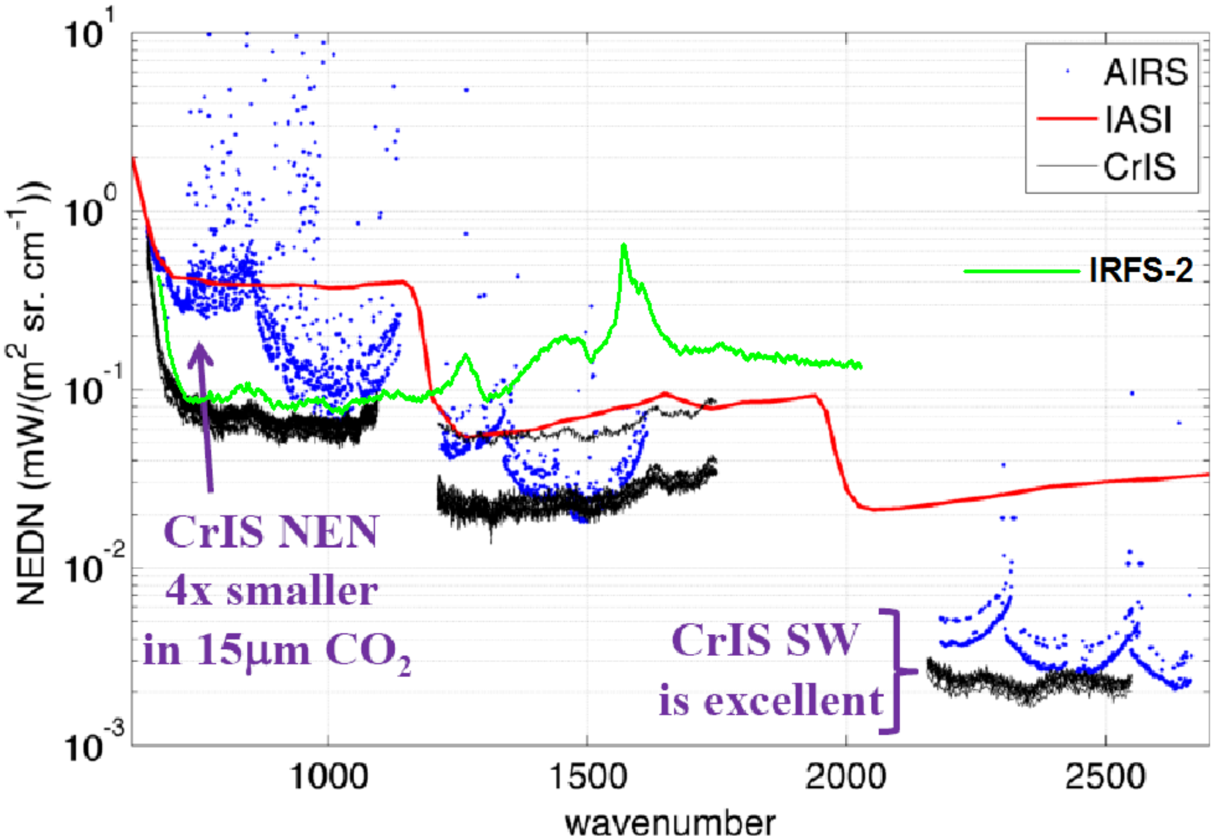
The system includes:
The IRFS-2 and MTVZA-GYa devices measuring the spectra of outgoing radiation in the IR and MW spectral ranges

Principal characteristics of devices onboard Meteor and some analogous

Instrument	Spectral Range /spectral resolution, N Cannels	Spatial Resolution (km)
	Microwave sounders	
MTVZA	**10.6 –183.3 GHz 29 channels**	**12–75**
ATMS	23-183 GHz 23 channels	
	IR Fourier Spectrometers	
IRFS-2	**660–1200/ 0.7, 1200-2000 /1.4 cm^{-1} 2701 channels**	**35**
CRiS,	655-1095/ 0.625, 1210-1750/ 1.25, 2155-2550/ 2.5 cm^{-1} 1305 channels	14
IASI	3.7 – 15.5 µm /0.35 – 0.50 cm^{-1} 8461 channels	12

Noise Comparison:

CrIS, AIRS L1B, IASI L1C and IRFS-2



Spectral resolution, cm^{-1}, in region 650-1000 cm^{-1}	
IRFS	**0.5**
IASI	**0.35**
CrIS	**0.625**
AIRS	**0.5 - 2**

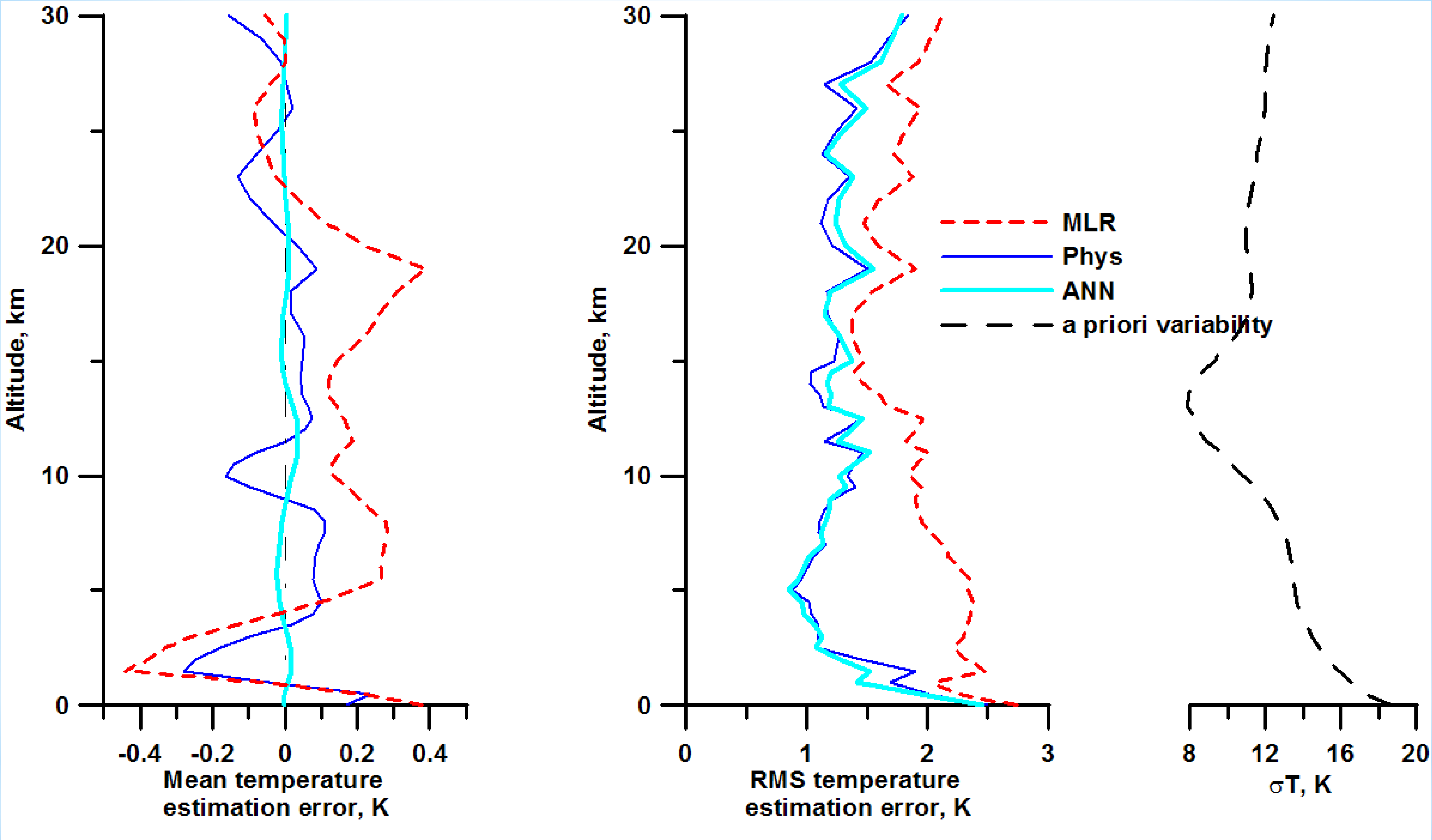
This figure was based (IRFS-2 was added) on a figure from: W. Smith, E. Weisz, et al Weather and Climate Applications of Ultraspectral IR Radiance Measurements, IRS 2012, 06-10 August 2012, Dahlem Cube, Berlin Germany

Algorithms for solving the inverse problem of retrieving the atmospheric and surface parameters from IRFS-2 and MTVZA spectral measurements have been developed using:

the *Multiple Linear Regression* (MLR) for determining the first guess**,**

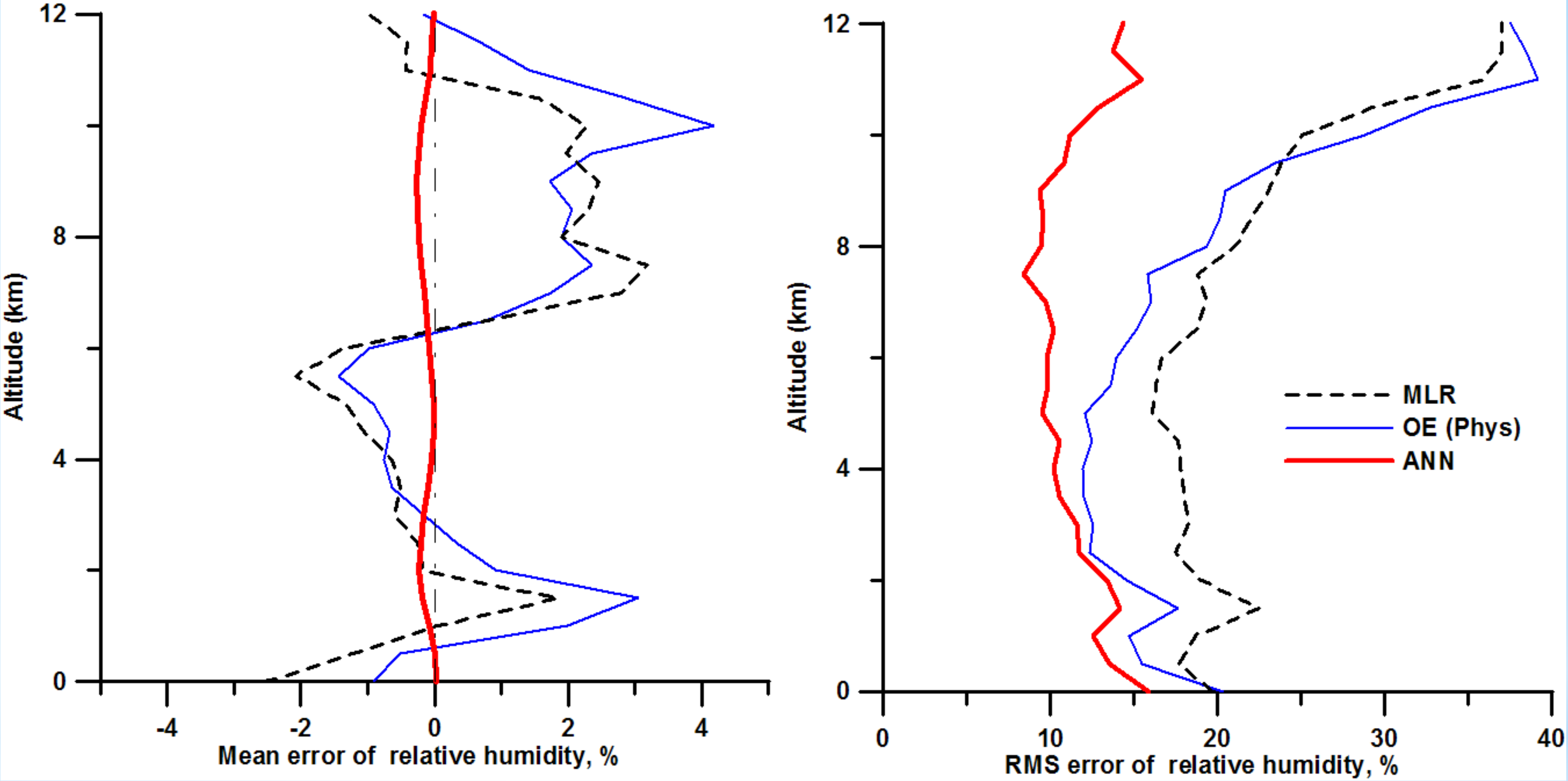
and the *Optimal Estimation* (OE) method, in some nonlinear extension, to improve the solution by iterations and based on **or *Physical radiation model***

and the ***Artificial Neural Networks* (ANN).**



Mean and RMS errors of temperature profile estimation, water surface, cloudless atmosphere.

The systematical errors of temperature profile by ANN are closed to zero, and by two other methods are less 0.4K. The RMS errors of MLR are greatest, in troposphere up to 2-3K. ANN and Ph. methods are more accurate then it and show near errors 1.0-1.5K on 2-30km heights. All of the methods show an errors rise in lower troposphere, up to 3K over land surface and 2.5K over water.



Mean and RMS errors of relative humidity profile estimation, water surface, cloudless atmosphere. Three methods.

An errors of relative humidity (RH) are not small quite, because the errors of spectral measurements in short-wave part of spectra is considerable. Mean errors by ANN method are close to zero, and by MLR and Ph. methods are 2-4% relative humidity. ANN method shows in the troposphere RMS error 10-15%. The Physical method shows the same errors lower 6km, but upper the errors rise with height, up to 40% in upper troposphere by Ph. and MLR methods.

Main result :
Inverse method, based on ANN, can be used successful instead of MLR method to get first guess on a first step of space measurements analyze, and in some cases instead of the Physical method cause it's high precision.

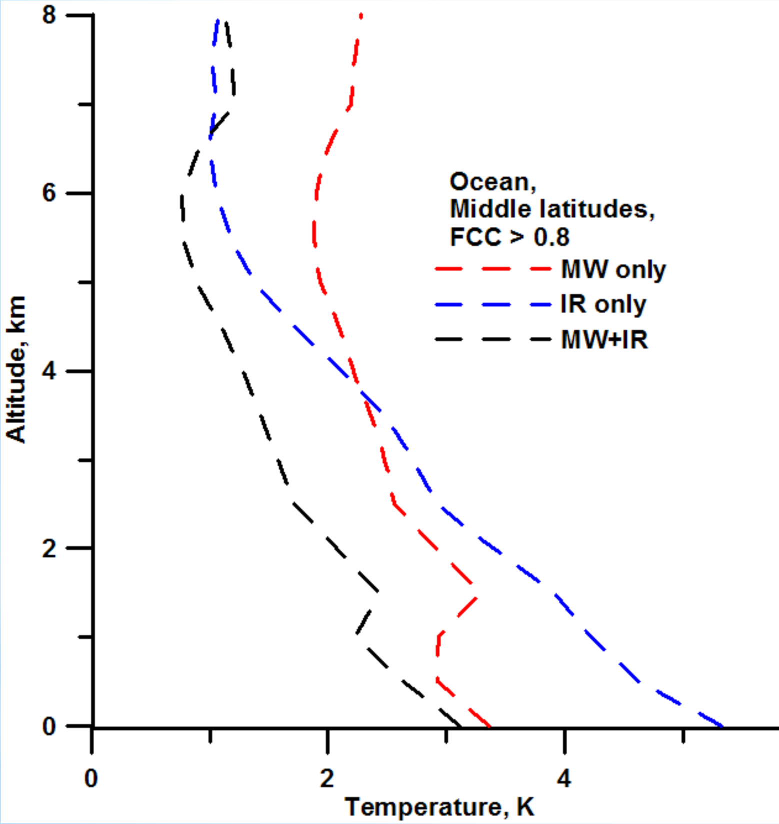
Integration of IR and MW measurements

On the basis of the algorithms pointed above, four code modifications were developed for spectral measurements interpreting:

- IRFS-2 measurements in the 273 preselected channels (IR only),
- MTVZA measurements (MW only),
- MTVZA measurements jointly with the data of 273 preselected channels of IRFS, to improve the retrieval precision in the cloudy atmosphere (MW + IR).

Modeling is shown that superposition of channels IR and MW spectral measurements allows to reduce errors of measurement of temperature profile in the conditions of the partial overcast **up to 2K** **(see slide below).**

Errors of retrieval the temperature profile from MW, IR, MW+IR measurements. Middle latitudes. Cloudy atmosphere, fractional cloud cover (FCC) > 0.8 (left hand) or FCC < 0.2 (right hand).



Summary

1). Different software for interpreting IRFS-2 and MTVZA measurements together and separately has been developed.
2). Potential accuracy of retrieval different atmospheric and surface parameters were determined by using numerical experiments

4) The concatenation of the 2 types of the spectral measurements may allow reduce error of temperature profile sounding up to 2 K.

3) The ANN method in comparison of the MLR method, for both our devices, reduces temperature profile errors up to 0.5 K, water vapor mixing ratio profile error up to 10-15%, and significantly for surface temperature and water vapor Total Column.

This study was supported by
Russian Foundation for Basic Research
(project no. 12-05-00445-a) and **Saint-Petersburg State University** **(**grant 11.31.547.2010)

THANK YOU
FOR YOUR ATTENTION