Increased use of microwave humidity sounding data from the FY-3 series in the ECMWF assimilation system

Keyi Chen[1], Stephen English[3] ,Niels Bormann[3], , Jiang Zhu[2]

[1]School of Atmospheric Sciences, Chengdu University of Information&Technology, Chengdu 610225, China
[2]ICCES, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China
[3]European Centre for Medium-Range Weather Forecasts (ECMWF)

Abstract

ECMWF has been assimilating the FY-3B MWHS (Microwave Humidity Sounders) data over sea in the operational forecasting system since September 24th, 2014 and the FY-3C MWHS-2 data since April 4th, 2016. Here we study the introduction of more microwave humidity sounding data from these two instruments, namely the introduction of MWHS data over land, and the addition of MWHS-2 data from DBNet.

For assimilating MWHS/FY-3B observations over land, we compare approaches in which the emissivity is retrieved dynamically from MWHS channel 1 (150GHz (V)) with the use of an evolving emissivity atlas from 89 GHz observations from the Microwave Humidity Sounders (MHS) on NOAA and EUMETSAT satellites. The assimilation of the additional data over land improves the fit of short-range forecasts to other observations, notably ATMS humidity channels, and the forecast impacts are mainly neutral to slightly positive over the first 5 days. The forecast impacts are better
in boreal summer and the Southern Hemisphere.

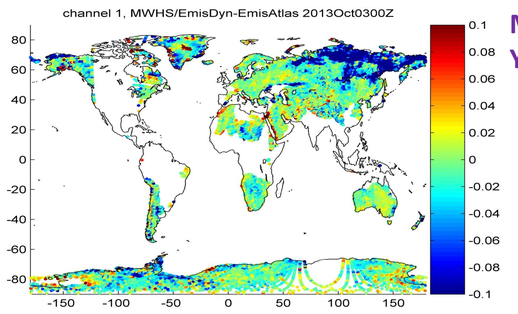
To improve the amount of available MWHS-2 data, we also consider the addition of DBNet data with much improved timeliness. This data is currently available from five stations around Europe. After excluding observations for the first and last few scan-lines of an overpass, the DBNet MWHS-2 data are overall consistent with the global data. Due to the improved timeliness, the data coverage is highly improved for the short cut-off assimilation window. It is therefore planned to add the FY-3C DBNet MWHS-2 observations to the ECMWF operational forecasting system from cycle 45r1.

Assimilation of MWHS Data over Land

Specification of surface emissivity and skin temperature more difficult over land.

Two methods are considered here for the surface emissivity:

1. **Emissivity atlas : averaged from retrieved emissivities at 89 GHz from different satellites, evolves slowly over time (Kalman filter)**
2. **Dynamic emissivity: updated instantly by retrieving emissivity from a window-channel observation of a specific instrument**



MWHS/FY3B-Oct

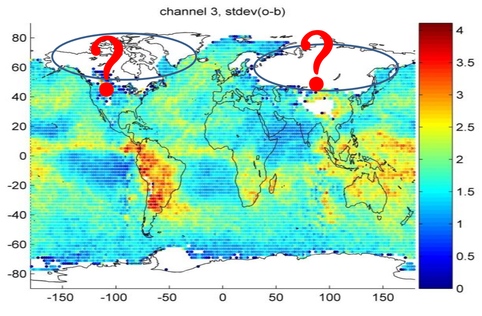
Positive

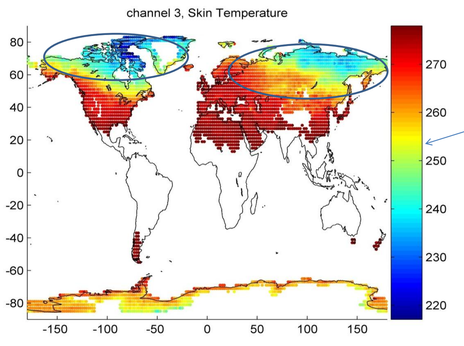
Tropics: 150GHz less sensitive to surface, emissivity retrieval is not reliable

Higher Latitudes: more sensitive; large differences over snow-covered surfaces due to stronger frequency dependence of snow emissivity

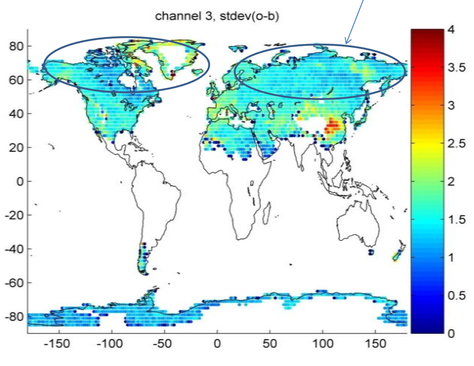
Snow-covered surfaces

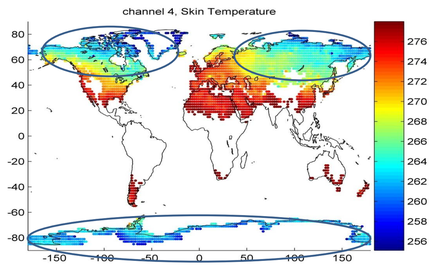
MWHS-CH3-Used data, SkinT>=278K, Orography<=1500m



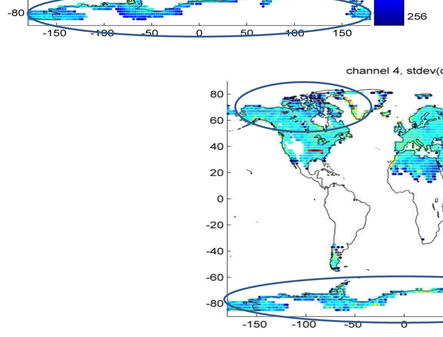


MWHS-CH3/clear data ,SkinT<=278K, Orography<=1500m





MWHS-CH4/clear data 255K=<SkinT<=278K, Orography<=1000m



Experiments set up

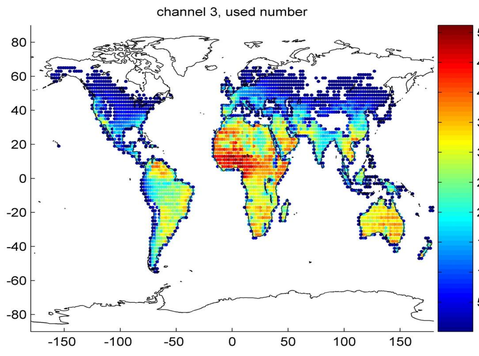
Control Run: Assimilating MWHS/FY-3B over sea only

BasicAtlas EXP: Assimilating MWHS/FY-3B over land by using emissivity atlas without adding data over snow-covered surfaces.

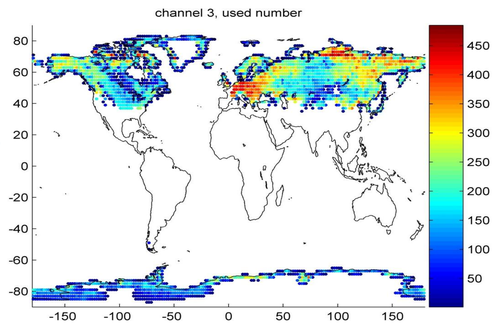
SnowAtlas EXP: Assimilating MWHS/FY-3B over land with adding data over snow-covered surfaces by using emissivity atlas. (SkinT >=255K)

SnowDynamic EXP: Assimilating MWHS/FY-3B over land with adding data over snow-covered surfaces by using dynamic emissivity retrieved from 150GHz(V) (SkinT >=255K)

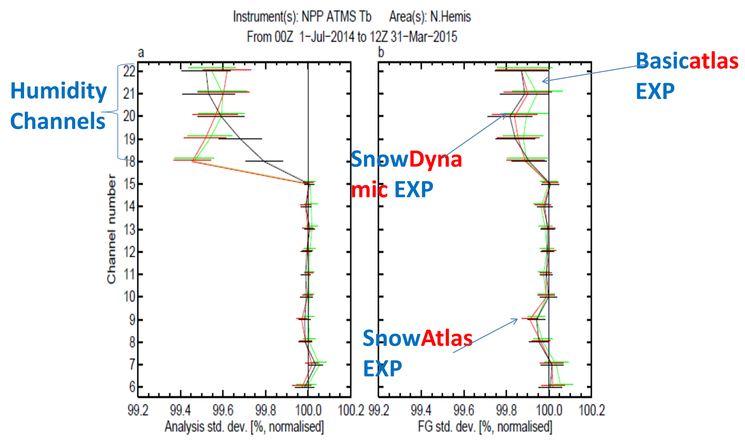
EXP period:1/1/2015-31/3/2015 + 1/7/2014-30/9/2014



MWHS-CH3 averaged used data coverage by using emissivity atlas without adding data over snow-covered surfaces.



Increased data use in snow-covered surfaces in SnowAtlas EXP.



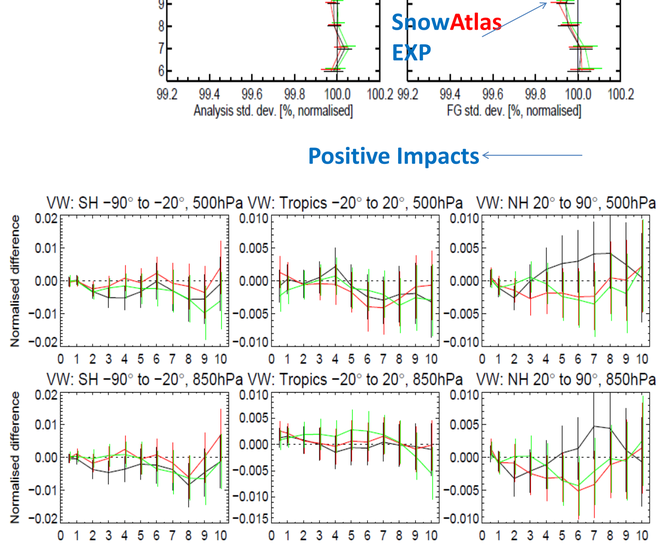
Humidity Channels

Basicatlas EXP

SnowDynamic EXP

SnowAtlas EXP

Positive Impacts



Positive Impacts

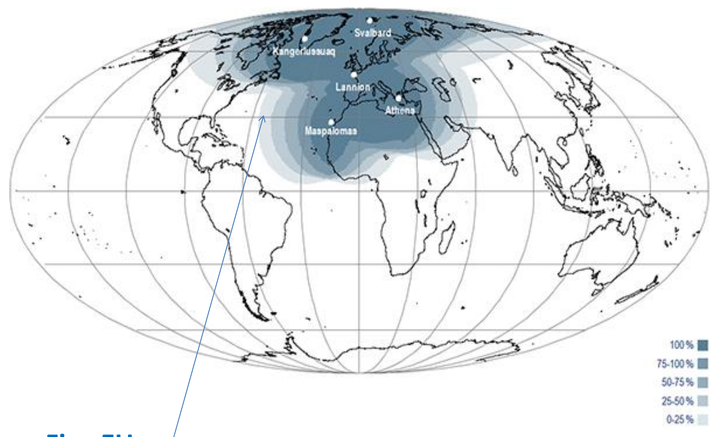
EXP period:2*3months

BasicAtlas EXP

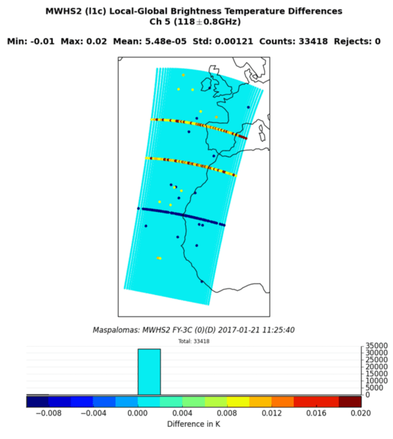
SnowAtlas EXP

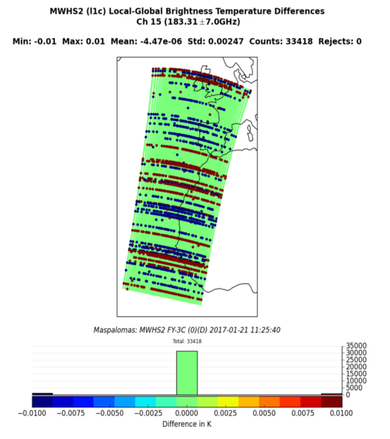
SnowDynamic EXP

EARS/DBNet Data for MWHS-2

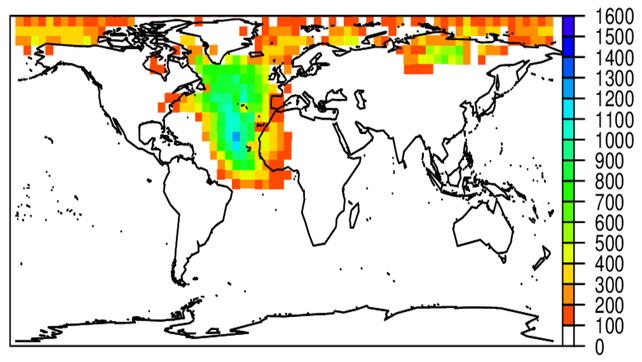


Five EU Stations to receive DBNet Data





Differences between DBNet and global data for channel 4 (left) and channel 14 (right) for an overpass on 21 January 2017 processed at Maspalomas



Additional coverage provided by DBNet for the early delivery cycle for November 2016.

Operationally use from ECMWF cycle 45r1 !!!

Conclusions:

1. **Assimilating MWHS/FY-3B data over land increases the used number of observations, and adding data over snow-covered surfaces with 150GHz(V) dynamic emissivity can further increase the data use.**
2. **Assimilating MWHS/FY-3B with adding data over snow-covered surfaces improves the fit of ATMS and SSMIS, especially over the Northern Hemisphere.**
3. **Forecast impacts are mainly neutral when using the emissivity atlas.**
4. **We do see slightly positive forecast impacts when using the 150GHz(V) dynamic emissivity with adding data over snow-covered surfaces, which suggests that the use of MWHS/FY-3B data could be further extended.**
5. **The DBNet initiative for MWHS-2 data enables a very significant increase in the number of observations that can be used for the early-delivery analysis for this instrument (70% for the Northern Hemisphere), with some improvements noticeable for the delayed cut-off analysis as well.**
6. **There is considerable scope for extending the DBNet service for MWHS-2. For AMSU-A and MHS from NOAA and Metop satellites, there is presently data available from up to around 40 stations covering large parts of the globe.**

Ref: 1. Chen,K., English,S., Bormann,N., Zhu,J., 2017. Assimilation of Feng-yun-3B Microwave Humidity Sounder Data over Land. *Adv Atmos Sci.* Vol. 35(3).

2. Chen. K., Bormann,N.,2017. EARS/DBNet data for MWHS-2. ECMWF Research Department Memorandum.