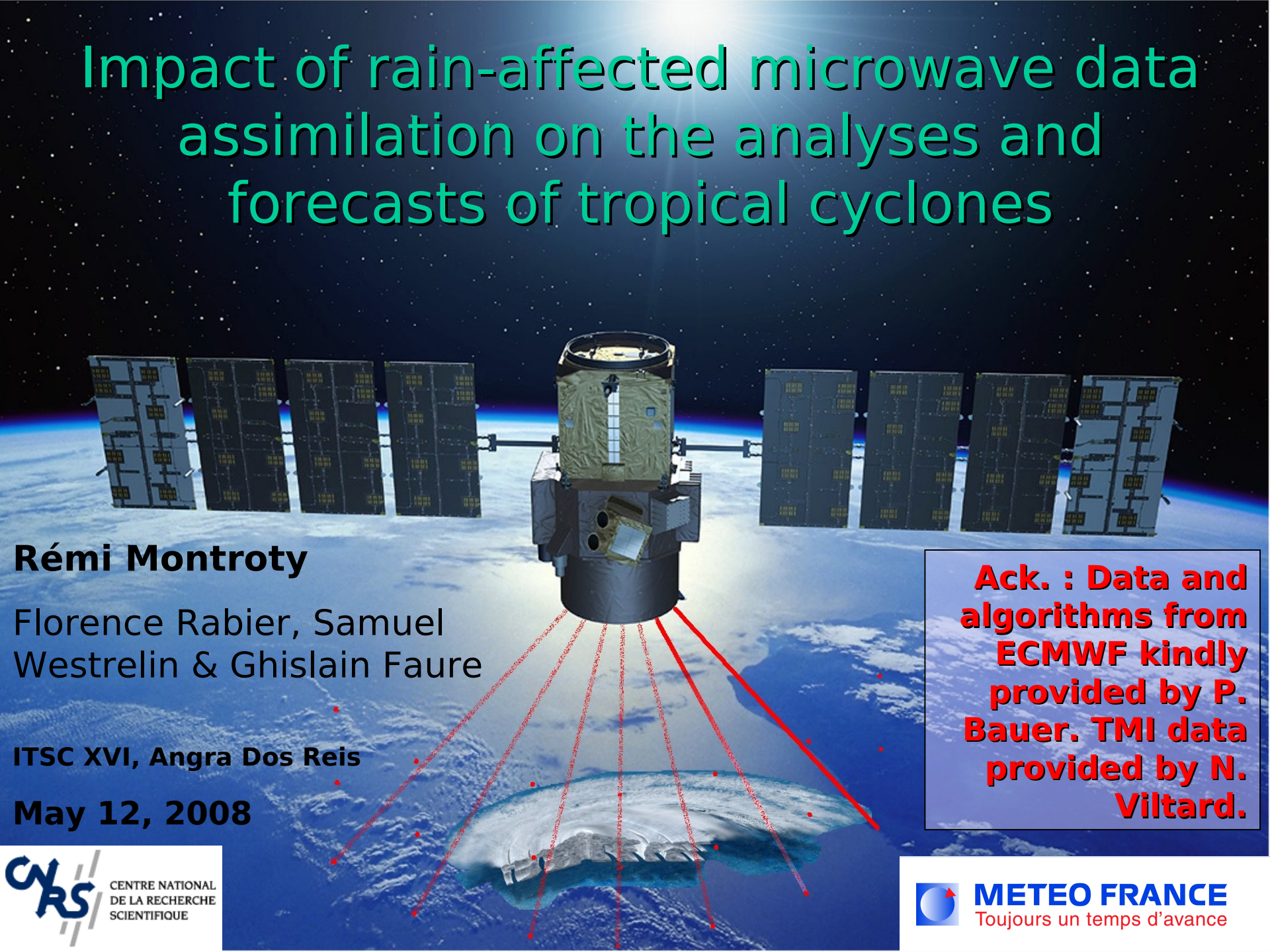
Impact of rain-affected microwave data assimilation on the analyses and forecasts of tropical cyclones



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Ack. : Data and algorithms from ECMWF kindly provided by P. Bauer. TMI data provided by N. Viltard.

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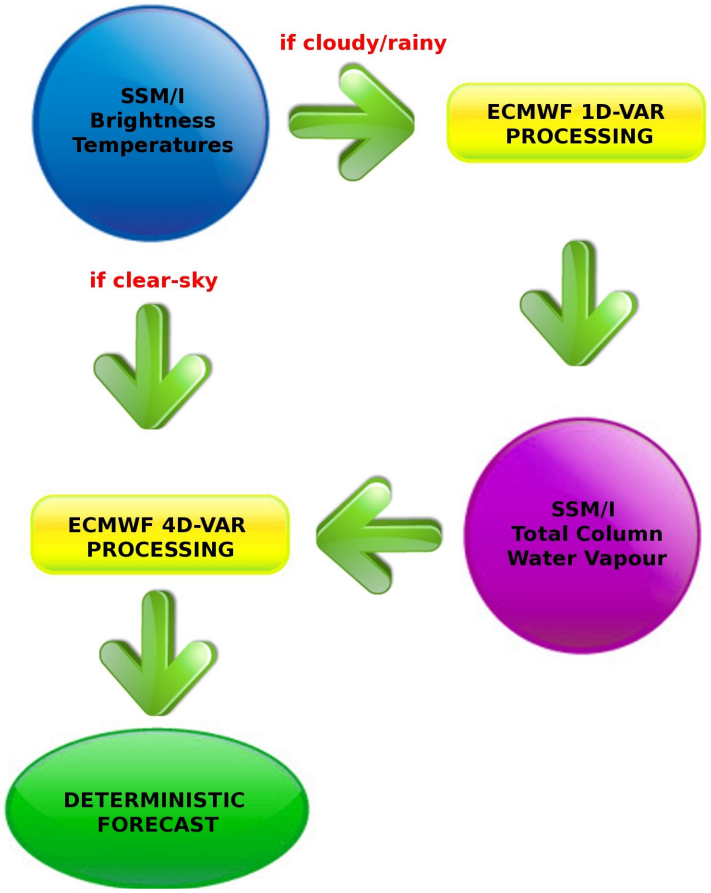
Motivation for this study

- NWP, and more specifically TC forecasting, is highly dependent on satellite observations
- These observations are usually not assimilated in cloudy and/or rainy conditions
- Assimilation of rainy satellite radiances proves very costly (complex obs operators)

Methodology (1/3): Rainy SSM/I at ECMWF

The characterization of the cloudy/rainy condition is purely observation-based. Namely:

- If TB_{37H}-TB_{37V} < 40 K, the pixel is considered rainy.
- If LWP> 0.01 kg.m^{-2} , the pixel is considered cloudy; with



$$LWP = A_0 + A_1 * \log(280-TB_{22V}) - A_2 * \log(280-TB_{37H})$$

where A_0=4.2993, A_1=0.399635 and A_2=-1.406920

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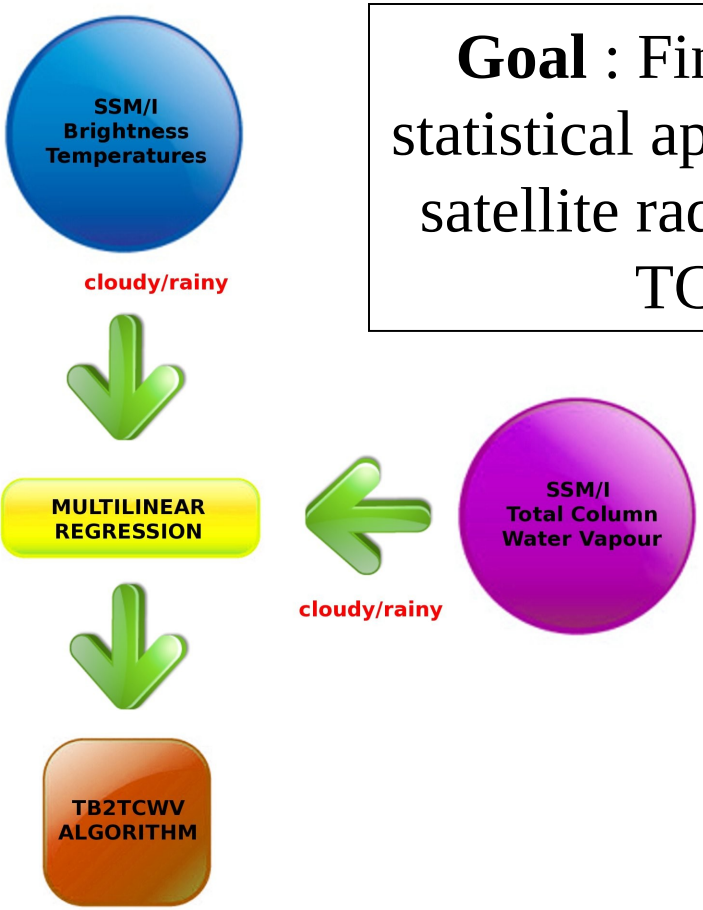
Methodology (2/3): Retrieving the algorithm

Goal : Find a simple, statistical approach to link satellite radiances to the TCWV

$$TCWV_{predicted} = \alpha_0 + \sum_{i=1}^{5} \alpha_i * \ln(290 - TB_i)$$



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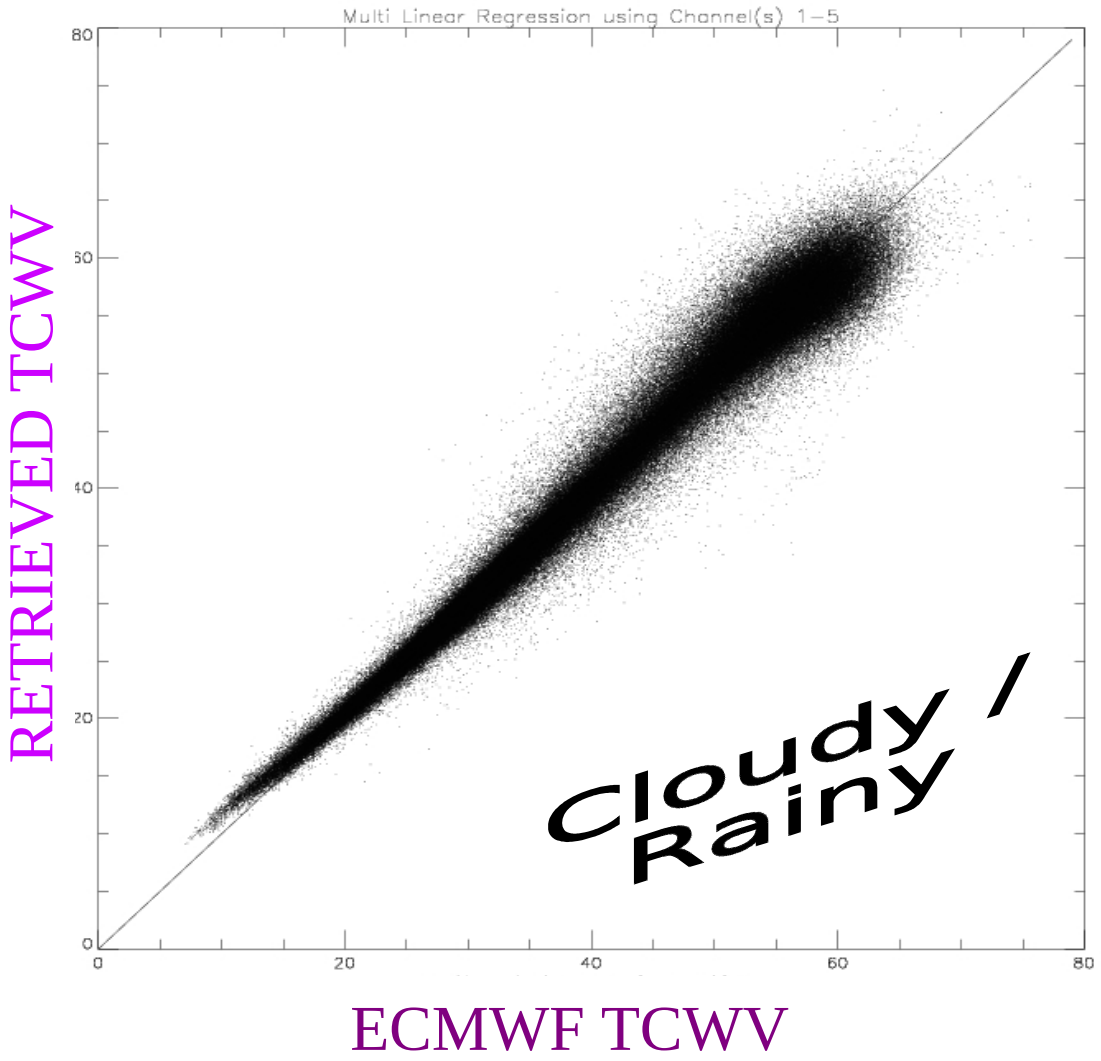
- One algorithm per SSM/I satellite
- Learning period from Nov 27, 2006 until Feb 11, 2007. Area is the SWIO.
- 250000 to 350000 points
- 3 TC and 1 Tropical Storm sampled



➢ Std dev < 2.2 kg/m² ; Correlation > 0.985

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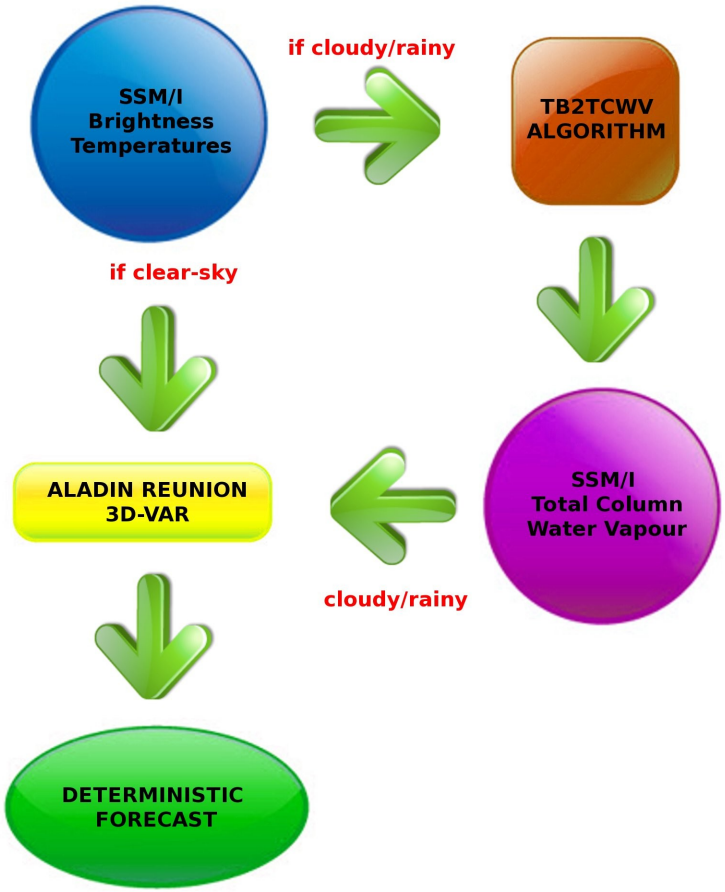
Methodology (3/3): Applying the algorithm

- The obtained TCWV is then assimilated in the ALADIN Reunion model (10km resolution, covers the SWIO)
- A 3D wind bogus following the UKMO technique (Heming, 1995) is used for cyclonic cases
- Several experiments were ran with the combination of TCWV and the 3D wind bogus



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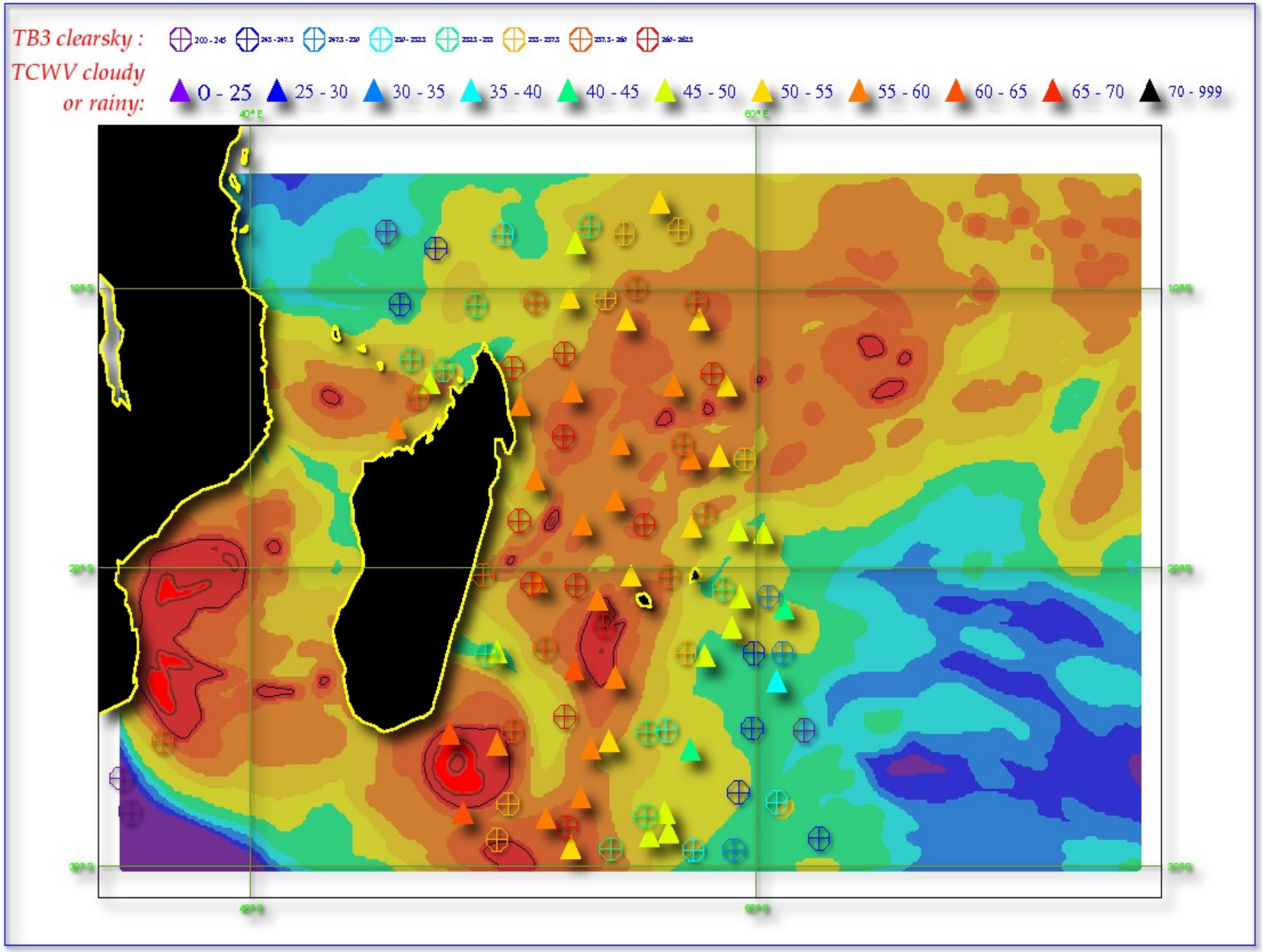
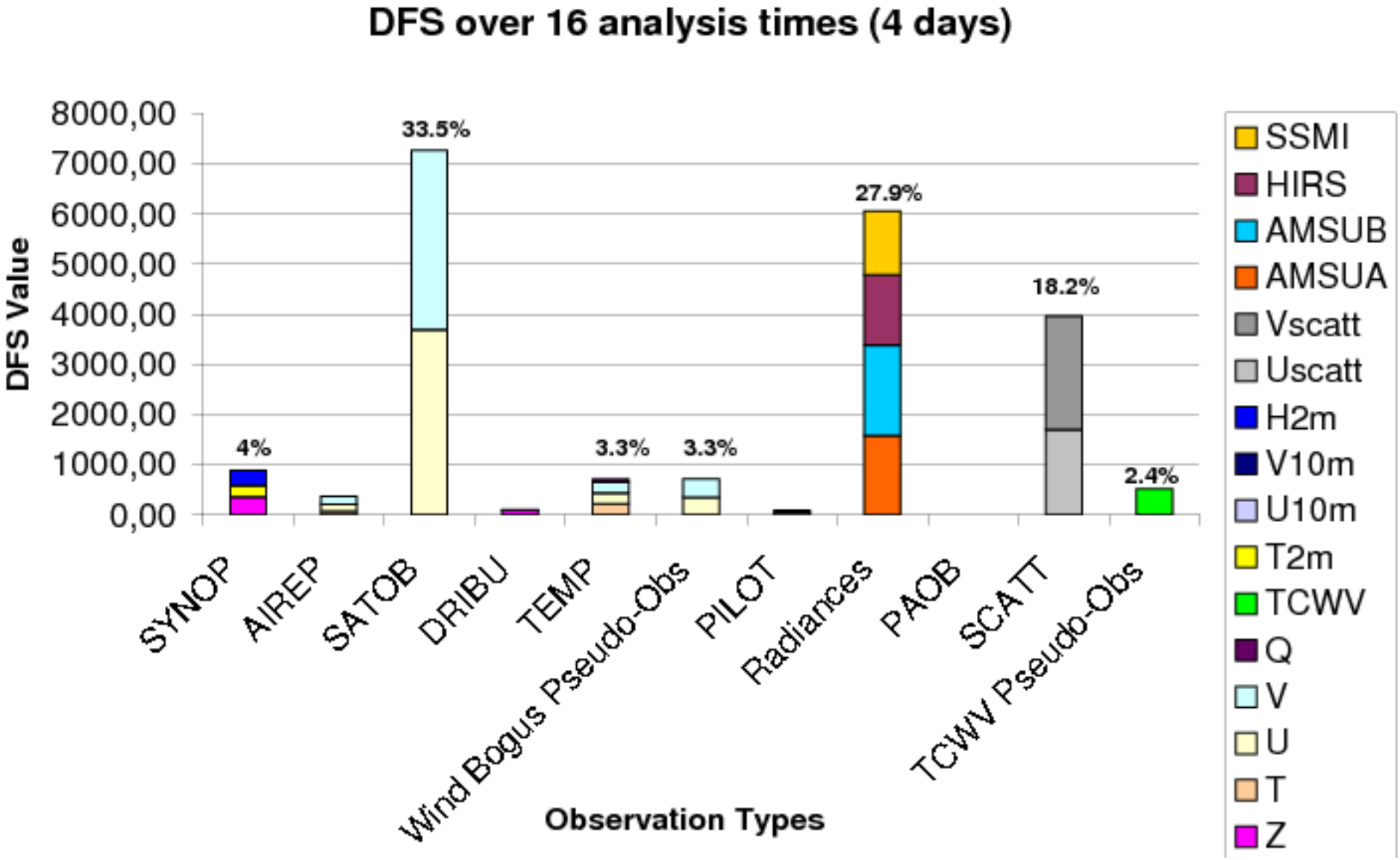
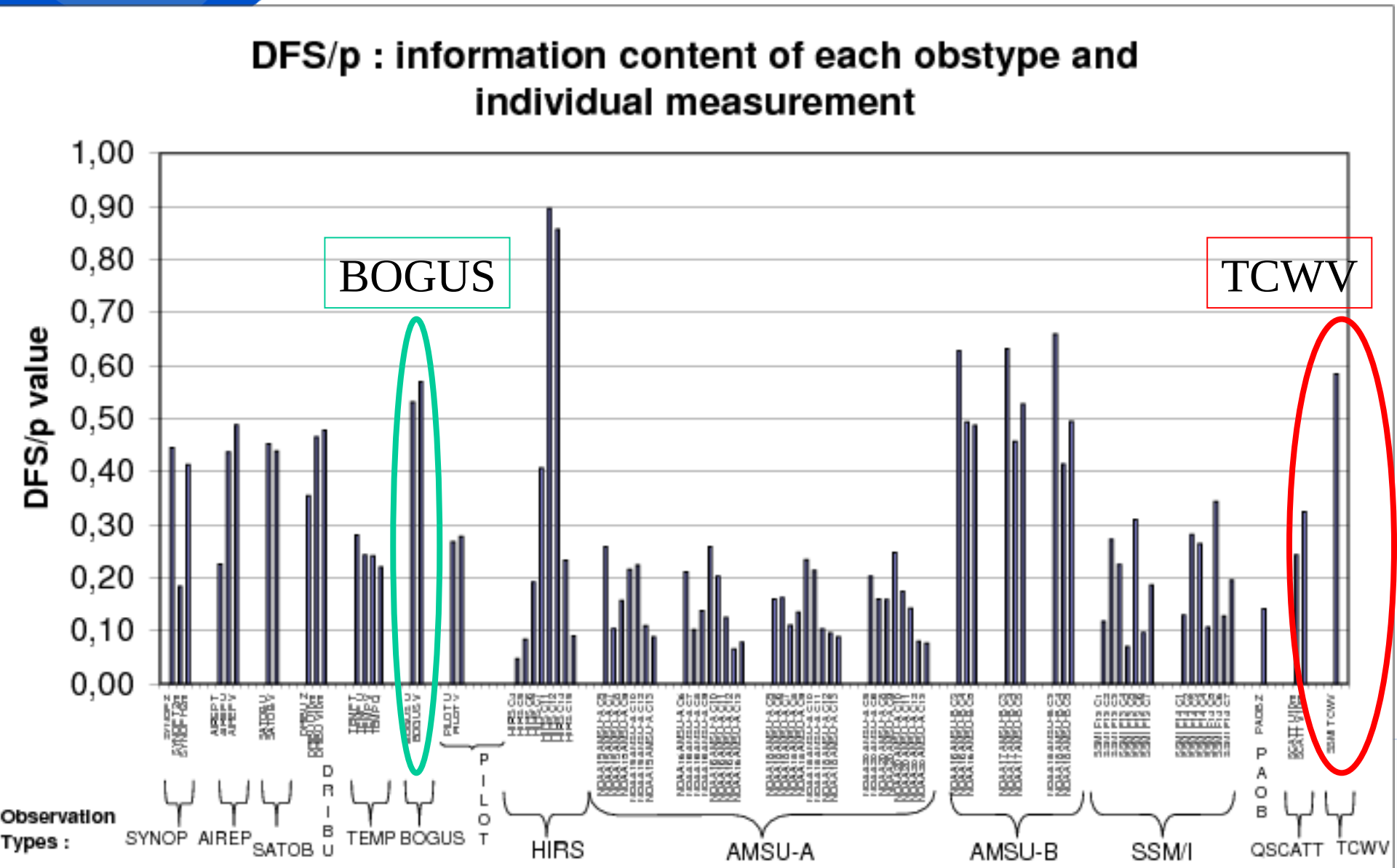
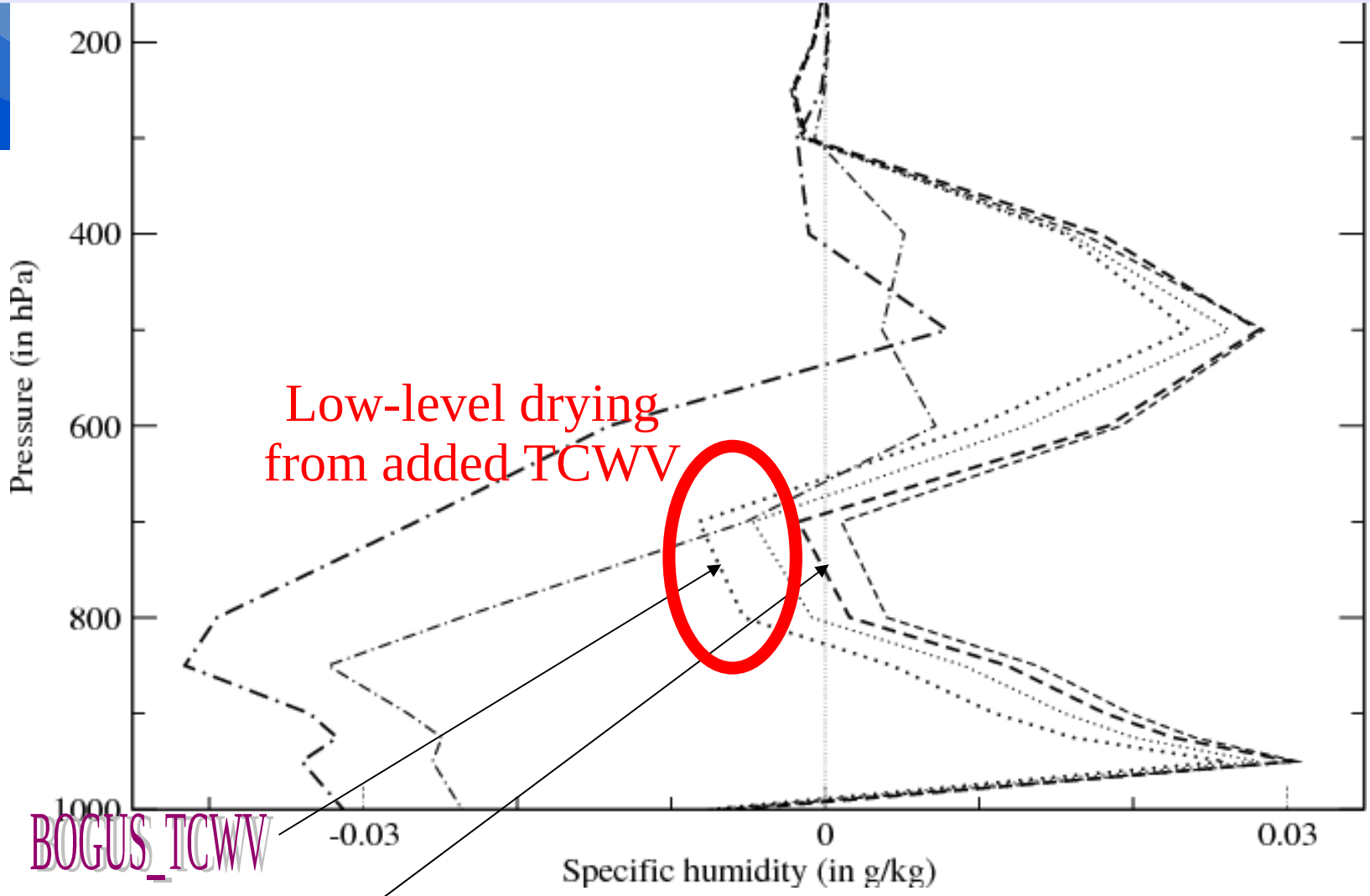

TB3 clearsky :
TCWV cloudy or rainy:
0 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 999
40° E
60° E


DFS over 16 analysis times (4 days)
DFS Value
8000,00
7000,00
6000,00
5000,00
4000,00
3000,00
2000,00
1000,00
0,00
4%
33.5%
3.3%
3.3%
27.9%
18.2%
2.4%
SYNOP
AIREP
SATOB
DRIBU
TEMP
Wind Bogus Pseudo-Obs
PILOT
Radiances
PAOB
SCATT
TCWV Pseudo-Obs
Observation Types
SSMI
HIRS
AMSUB
AMSUA
Vscatt
Uscatt
H2m
V10m
U10m
T2m
TCWV
Q
V
U
T
Z

OBSERVATIONAL IMPACTS ON THE 3DVar ANALYSES

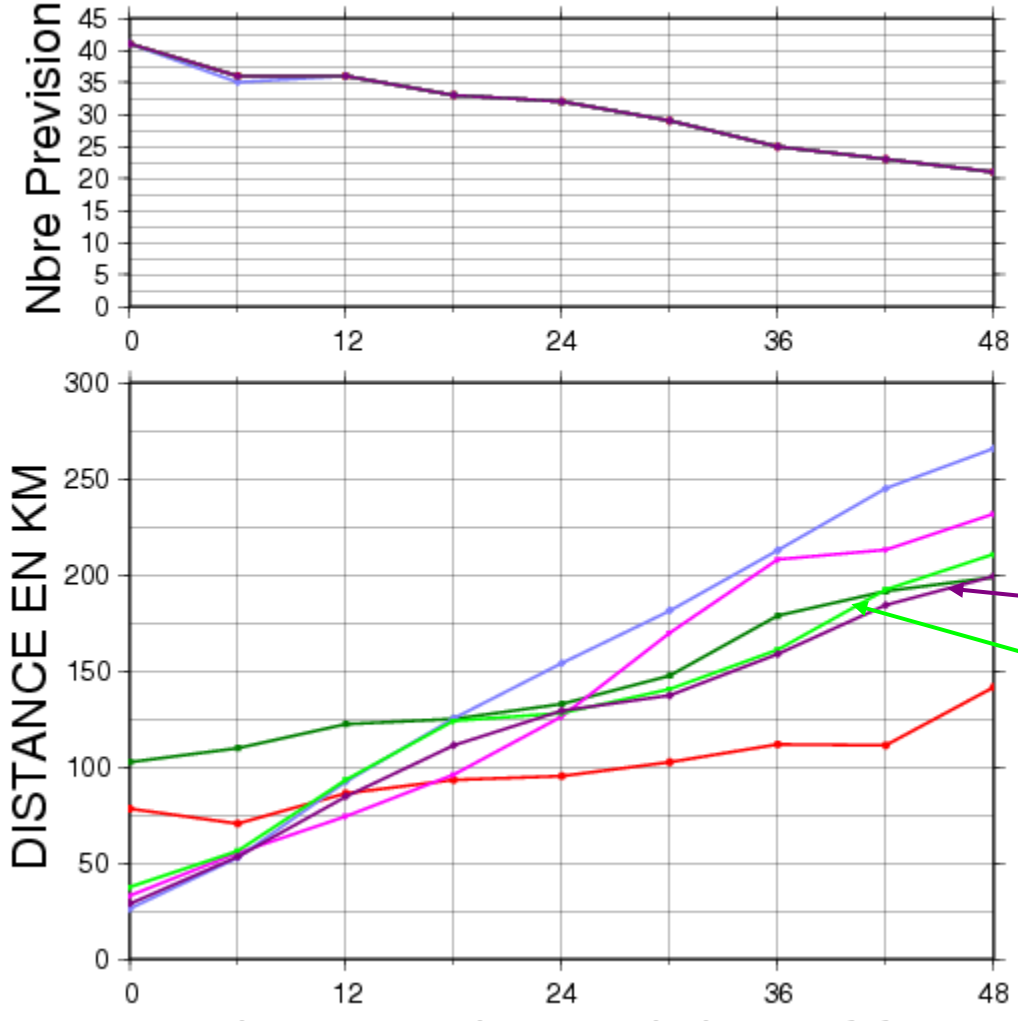


IMPACT ON HUMIDITY FIELDS



5-WEEK STATISTICS IN TERMS OF TRACK ERROR

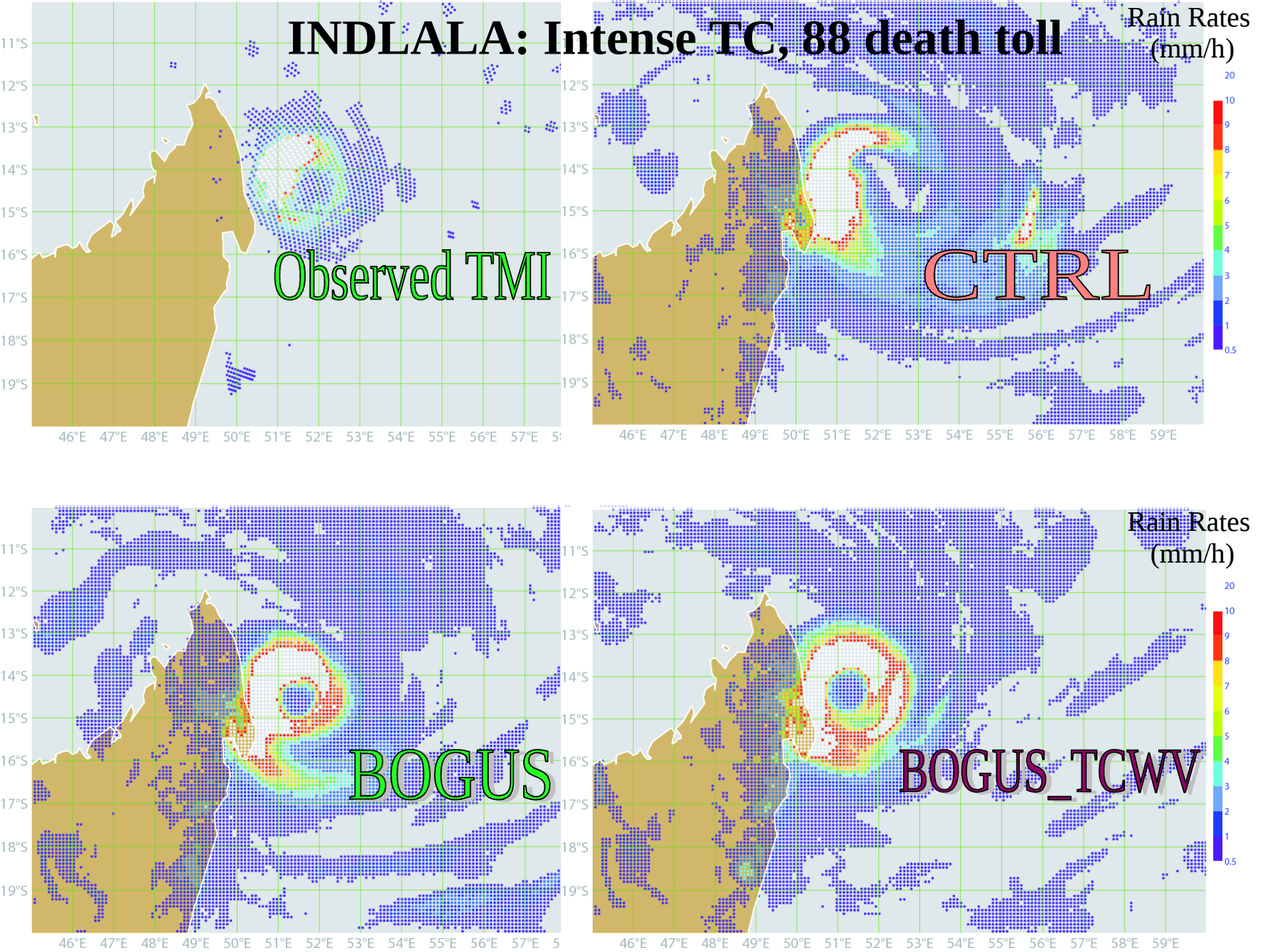
Between 2007/02/12 and 2007/03/17



Homogeneous statistics

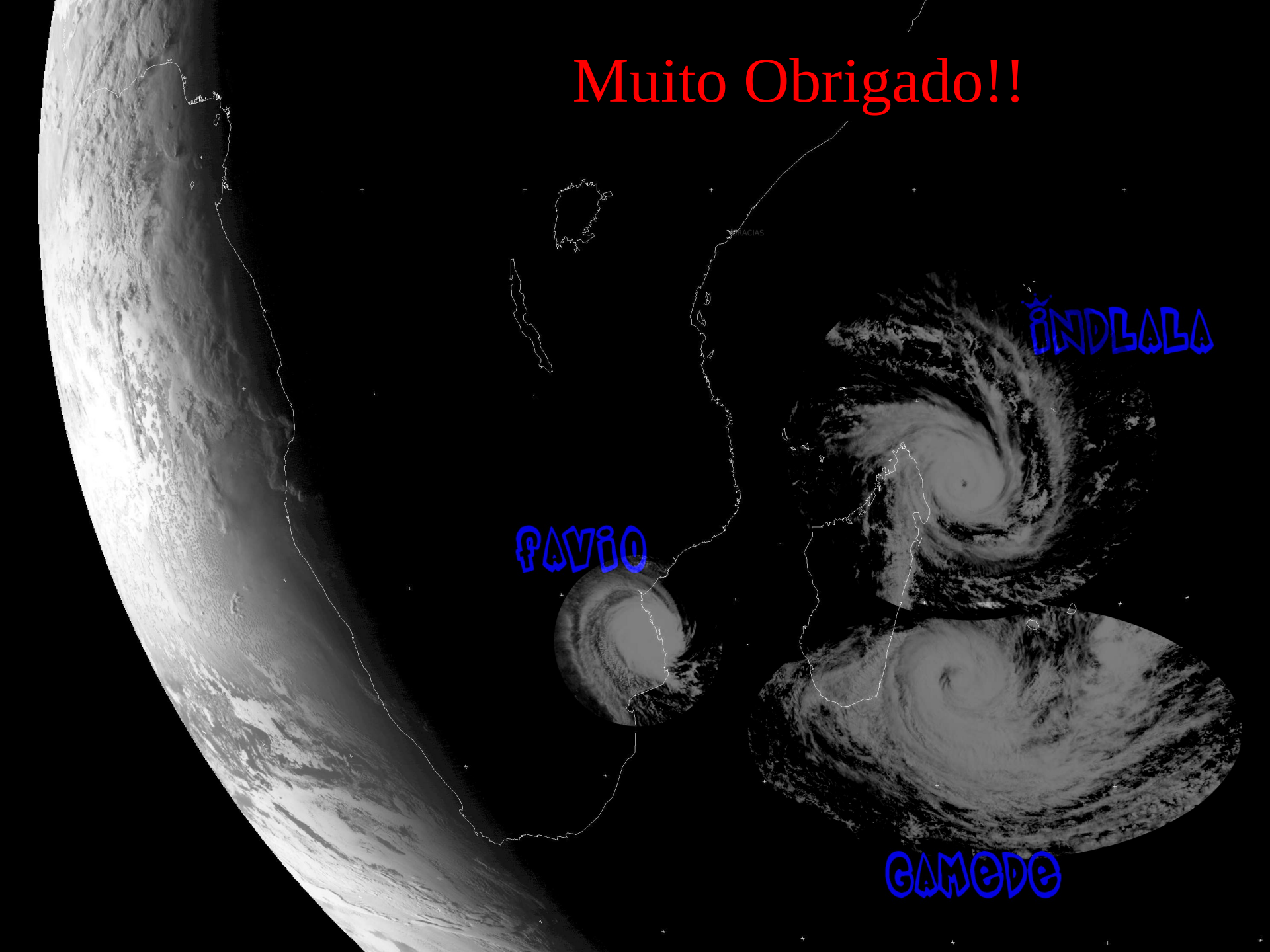
UKMO
ECMWF
GFDN
ARPEGE
BOGUS_TCWV
BOGUS

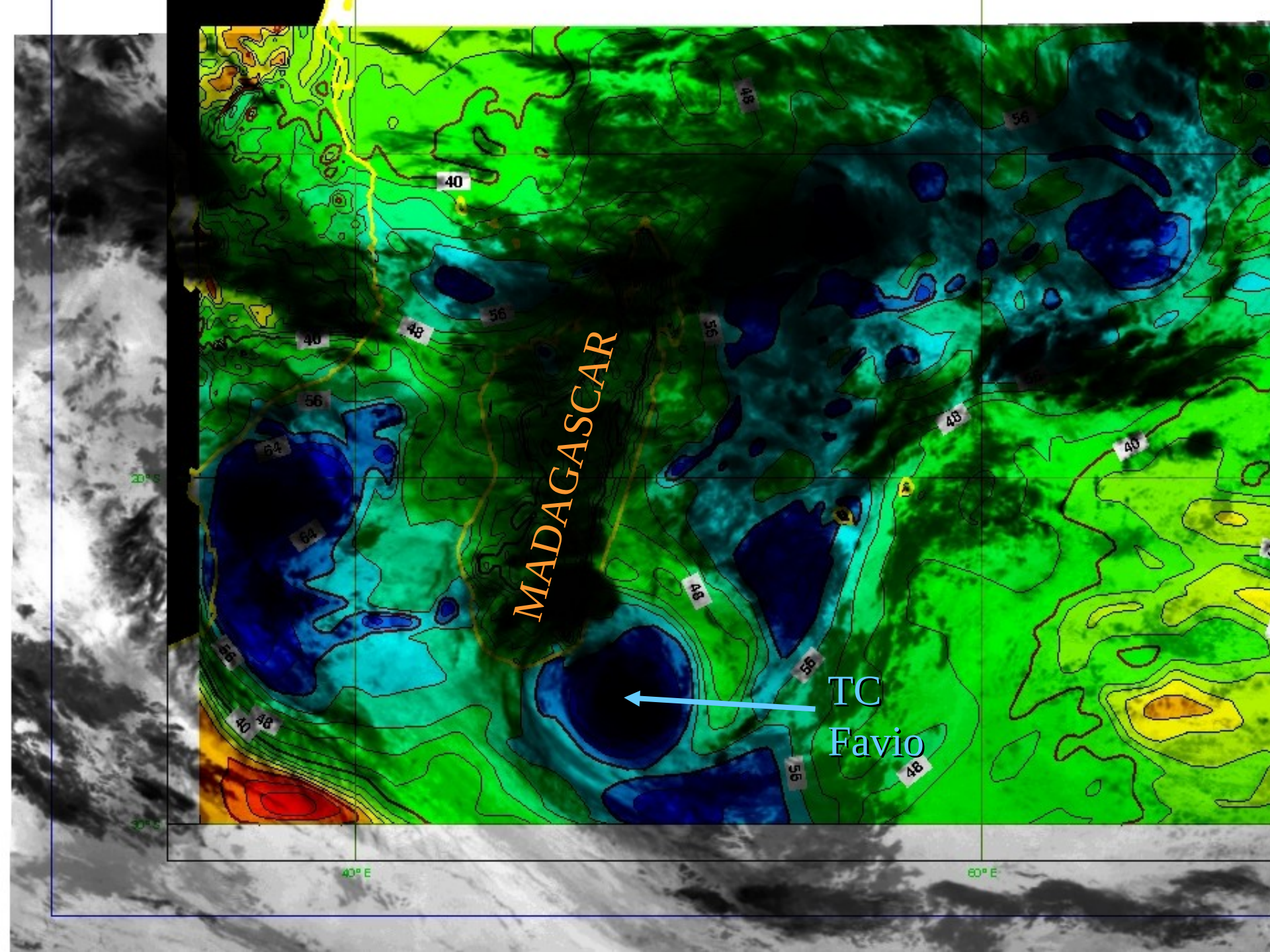
INDLALA: Intense TC, 88 death toll



Conclusion & Future work

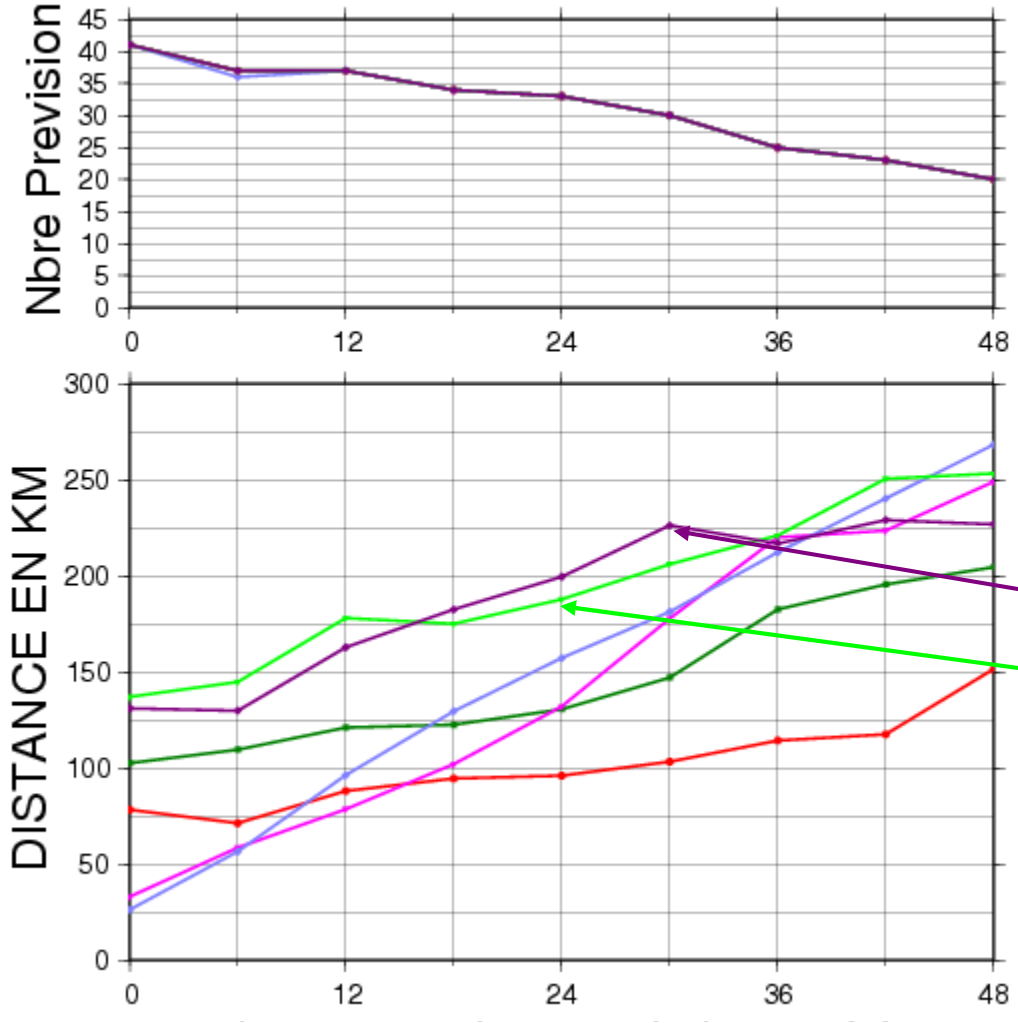
- This technique works and is definitely beneficial for the model: TCWV data assimilation helps constrain the analysis in cloudy/rainy conditions and leads to more realistic TC features, and to a better depiction of tropospheric humidity content (not shown).
- Possible expansion of the method to other satellites and other basins is to be investigated
- Up to 100% more SSM/I data points are gained in previously unsampled areas


Muito Obrigado!!
ÍNDLALA
FAVIO
GAMEDE


MADAGASCAR
TC
Favio
40
48
56
64
40° E
60° E

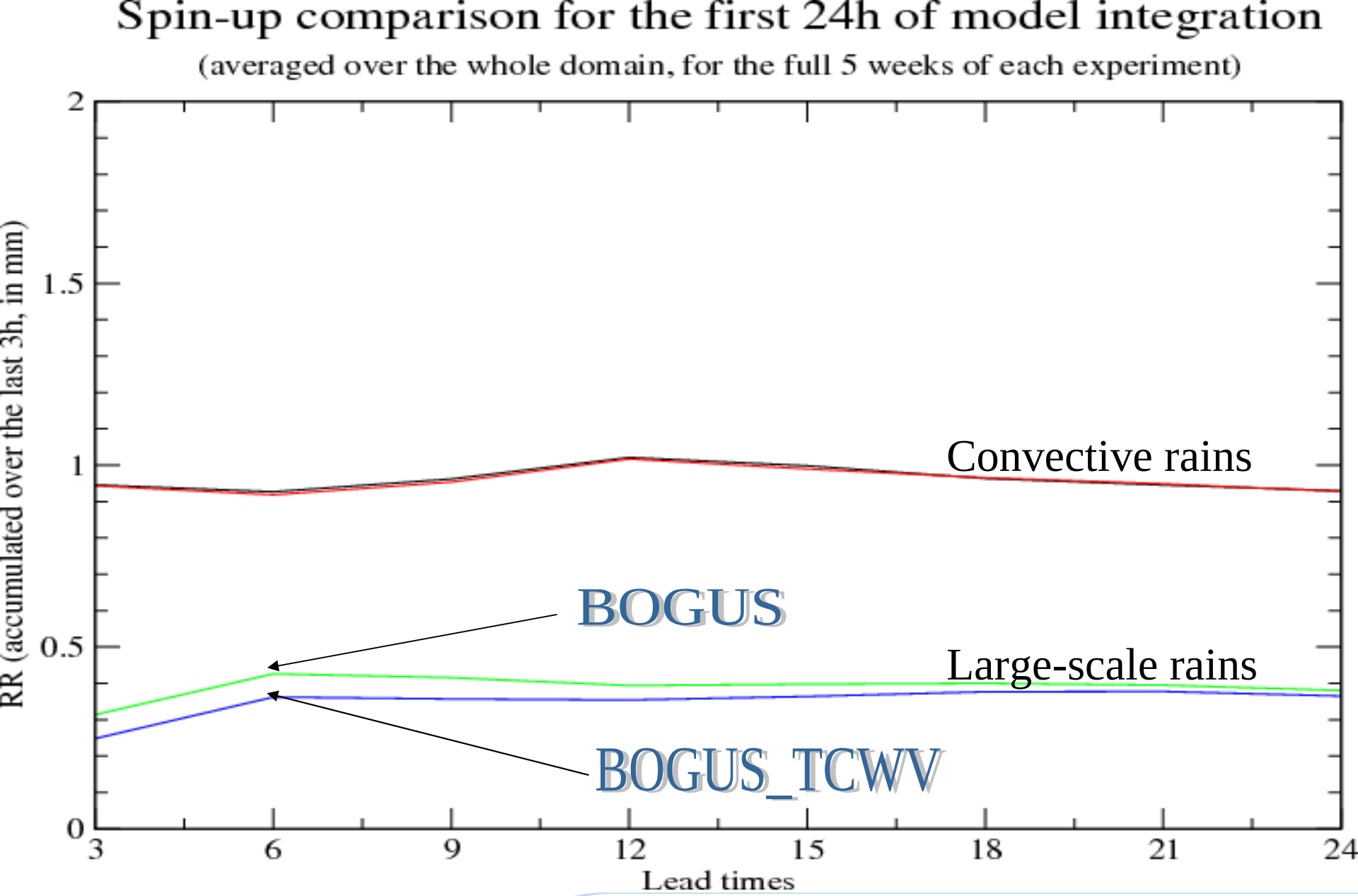
SEASON STATISTICS IN TERMS OF TRACK ERROR

Between 2007/02/12 and 2007/03/17



Homogeneous statistics

UKMO
ECMWF
GFDN
ARPEGE
TCWV
CTRL



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