

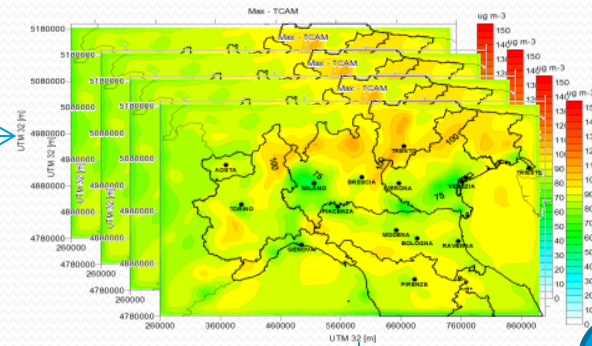
Models and Measurements for AQD: Application to Northern Italy

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- Introduction
 - Reanalysis/Optimal Interpolation
- Case Study
 - Validation of Re-analysed fields
 - Use of Re-analysed fields
- Discussion

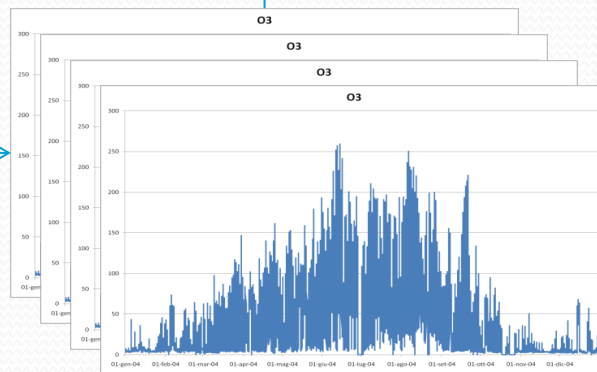
Re-analysys background

CTM
Model



Re-Analysis

Monitoring
Net



Best possible
Estimation of the atmosphere
state

Optimal Interpolation

- Optimal Interpolation is a Data Assimilation (DA) techniques
- The key to OI is the use of the discrepancies between measured and modeled data (residuals)
- In OI both the measurement and the model errors are taken into account

$$PM10_a(x) = PM10_M(x) + \mathbf{K} \left(y - H \left[PM10_M \right] \right)$$

$$\mathbf{K} = \mathbf{B} \mathbf{H}^T \left(\mathbf{H} \mathbf{B} \mathbf{H}^T + \mathbf{R} \right)^{-1}$$

y is the vector of observations (p)

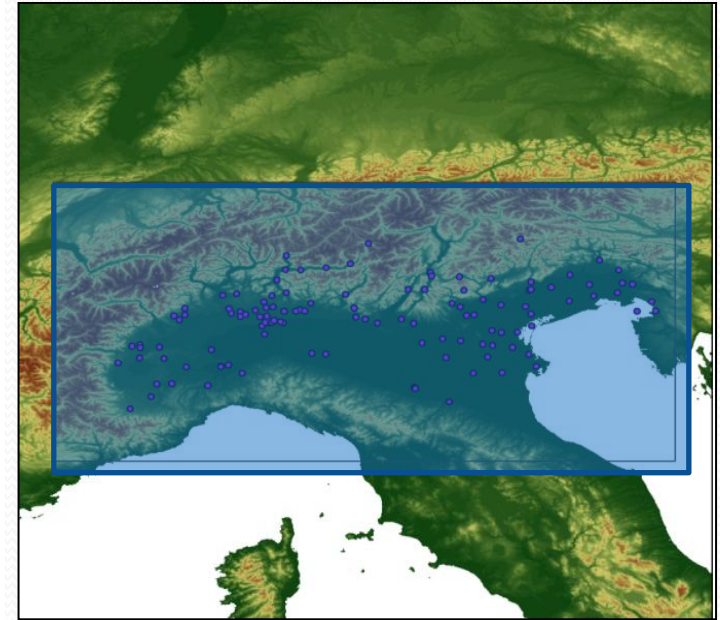
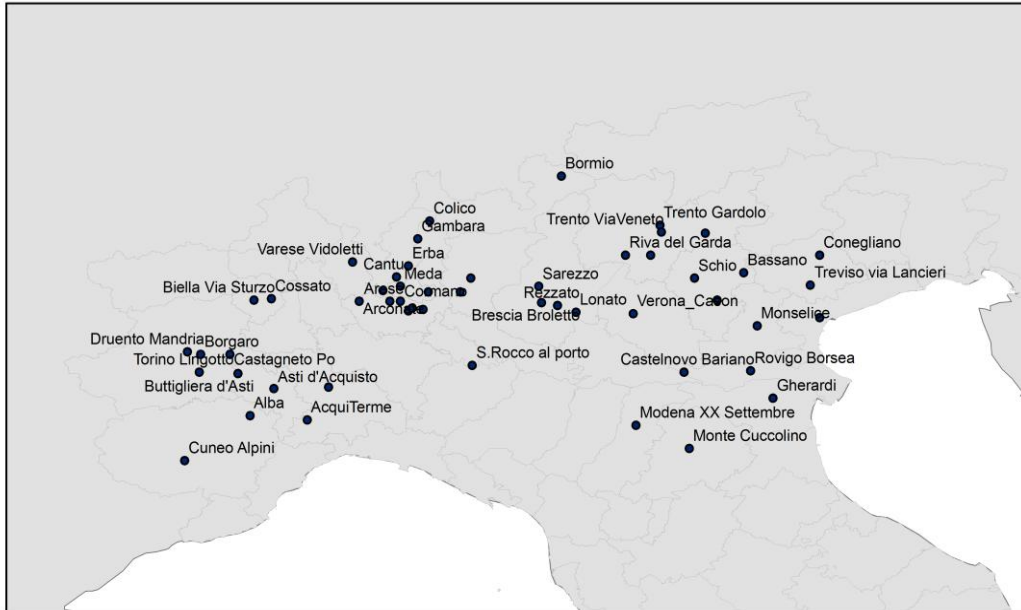
H is the observation operator (p × n)

B is the covariance matrix of ePM10_M (n × n)

R is the covariance matrix of eO (p × p)

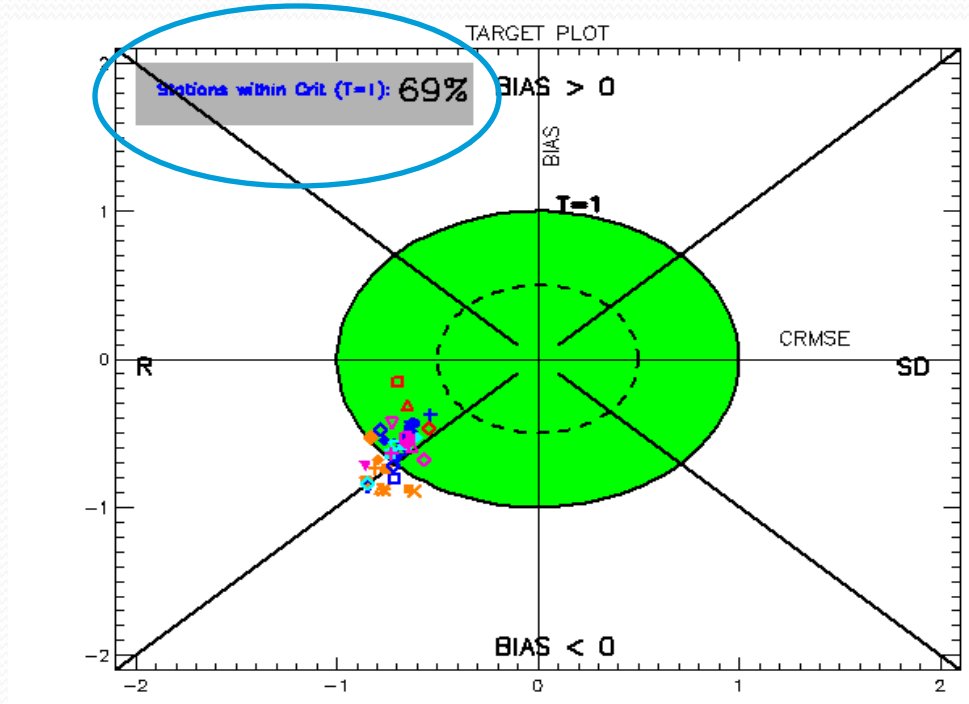
- Eulerian 3D model
- Terrain-following coordinate system
- Horizontal Transport Module: **Chapeau Function** + **Forester Filter**
- Vertical Transport Module: **Crank-Nicholson** hybrid solver based on the vertical diffusivity coefficient
- Deposition Module: Dry/Wet
- Gas Chemistry: **SAPRC 97 (Modified Version)**
- Aerosol:
 - Chemical Species: 21 (12 inorganics)
 - Size Classes: 10 (from 0.01 μm to 50 μm)
 - Thermodynamic module: **ISORROPIA**

Case study: Modeling Setup



- Measures: 50 monitoring sites (suburban, urban and rural background)
- Model: TCAM
- Year: 2005
- Domain resolution: $6 \times 6 \text{ km}^2$ (POMI exercise)
- Pollutants: PM₁₀

Target diagram: PM10 daily mean



- Systematic error: Bias < 0 (underestimation)
- 69% of sites respect the MPC_{RMSE}

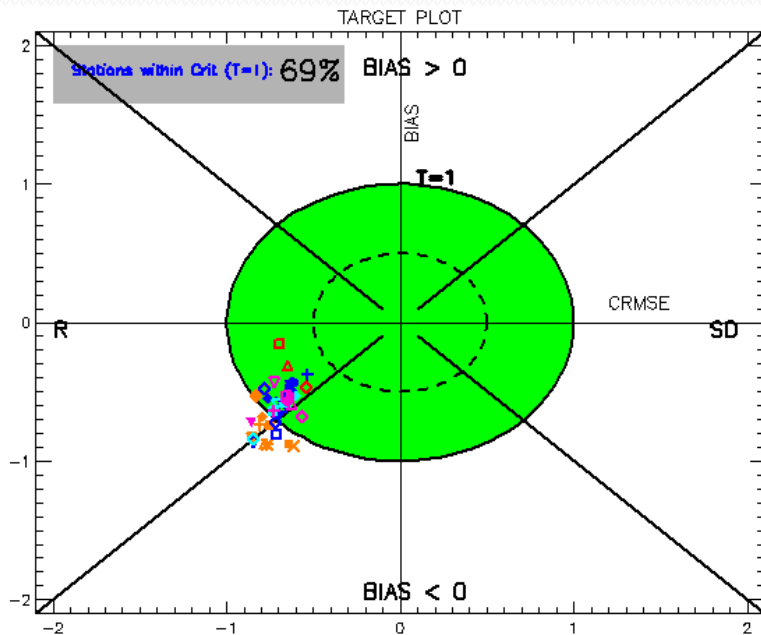
- Q1: Is the model “good enough”?
 - What means good enough?
- Q2: Is the delta tool a suitable tool to be used also for the evaluation of re-analysed fields?

Q1: The 90-90 criteria

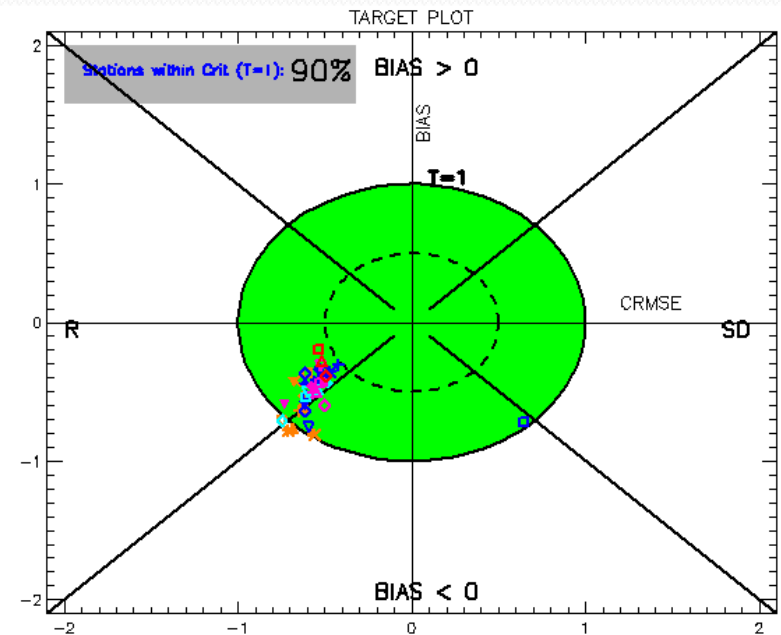
- For each stations, only the **90%** of the best data (X-th percentiles ?) is considered
 - If the **90%** of data are in the “**green zone**” of the target plot, the model is good enough...

Q1: The 90-90 criteria

Default



90% Data

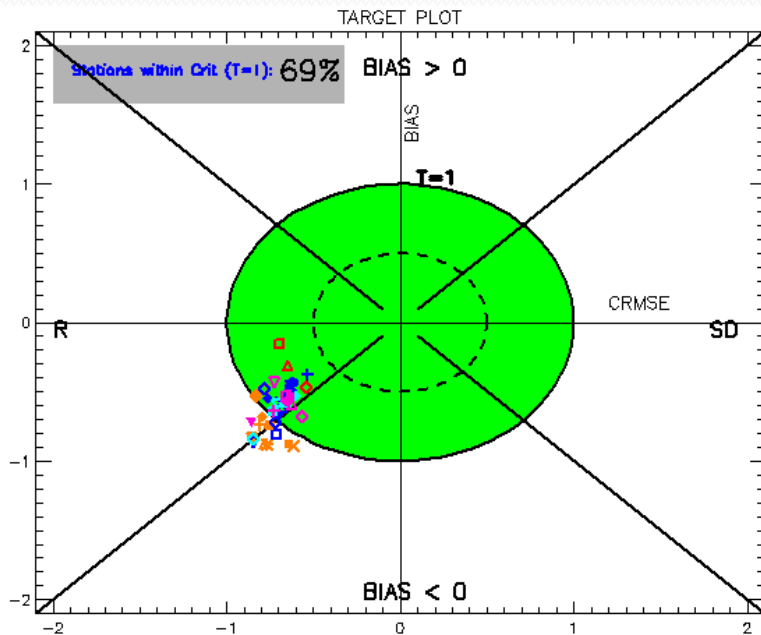


Q2: Re-analysed field Validation

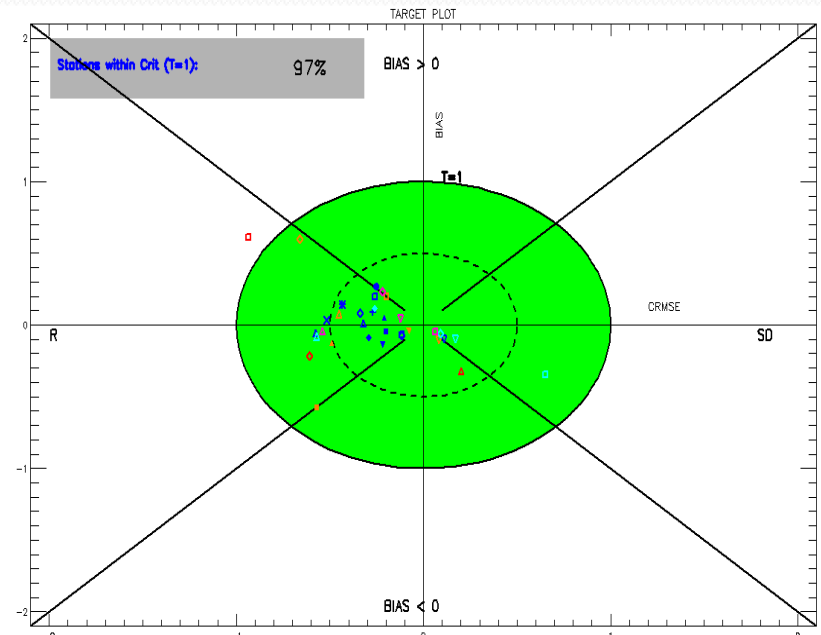
- Montecarlo approach
 - 100 re-analysis randomly selecting the 20% of the stations for the validation
 - How to aggregate the results of the 100 re-analysis?
 - Each station selected in the validation is considered in the worst case (**higher RMSE**)

Q2: Re-analysed field validation

TCAM



Re-analysed



◇ Castagagneto	✕ BIELLA_Sturzo	▼ Meda	□ Riva_delGard	■ Venezia_Saccoa	Strt/end Ind: 1-8760 Model (s): ISOTCAM Parameter: PM10 Scen: 2005 Extra Values: No Season: Year Day hours: All 24h Time Average: Preserve Daily stats: Mean
□ Torino_lingot	✕ COSSATO	+ Milano_Verzie	△ Rovereto_Larg	■ Rovigo_Borsea	
△ Bargarò	✕ Saronno_Santu	● VIMERCATE	▽ Trento_Gardol	■ Castelnovo_Ba	
▽ DruentoMandri	□ Erba	✕ OSIO_SOTTO	◇ Trento_ViaVen	◇ MODENA_XXLSET	
◇ ALESSANDRIA_N	△ Cantù	✕ Brescia_Brola	◇ Verona_Casan	◇ Monte_Cuccoli	
◇ ALESSANDRIA_L	△ Bormio	✕ REZZATO	◇ Schio	△ FELGHERARDI	
▽ Alba	◇ Arese	□ SAREZZO	◇ VICENZA_Quart		
+ ASTLDACQUIST	■ Milano_Juvana	△ S_ROCCO_ALPB	◇ Conegliano		
○ Buttiglierada	△ Limite_dLPia	◇ Borgo_Valsuga	◇ Treviso_viaLa		

- Q1: Is the model “good enough”?
 - What means good enough?
 - A1: the 90-90 criteria?
- Q2: Is the delta tool a suitable tool to be used also for the evaluation of re-analysed fields?
 - A2: Yes, but some work to compute the data...
 - Possibility to make it automatic (implemented in the tool?)
 - Other performance indicator for re-analysis, data fusion?
- Q3: Is it possible to use re-analysed field to for AQD/Delta tool development?

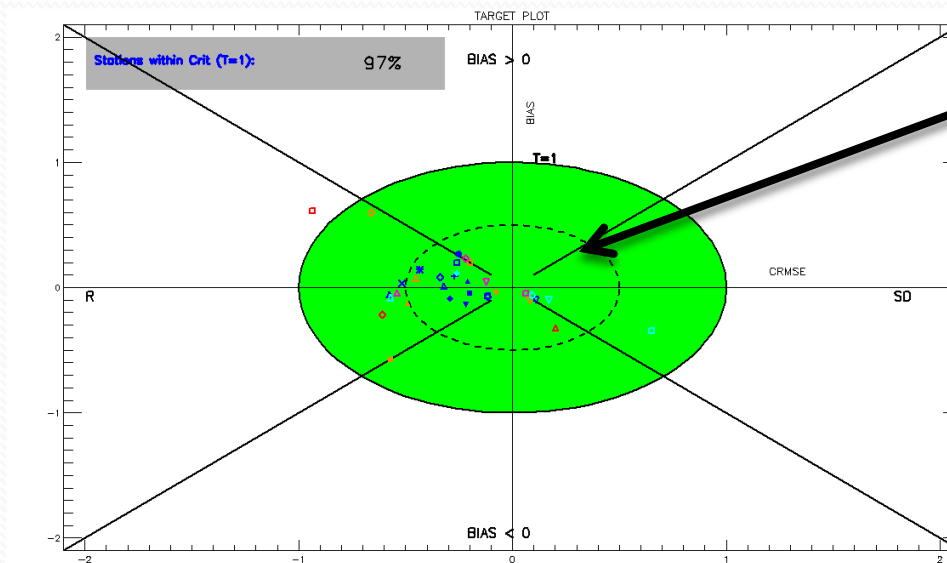
Q3: The scenario issue and MQO tuning

- Use for AQD: Integration Model-Measurement help in the definition of the AQ status in a certain region with high accuracy/precision
 - BUT: WHAT ABOUT SCENARIO EVALUATION?
- Other use of re-analysis?
 - MQO tuning...

$$|M_i - O_i| \leq 2ku_o = 2U_o$$

Q3: MQO tuning

1. The reanalysis field is the “Best possible estimation of the atmosphere state”.
2. In the (delta) target plot:



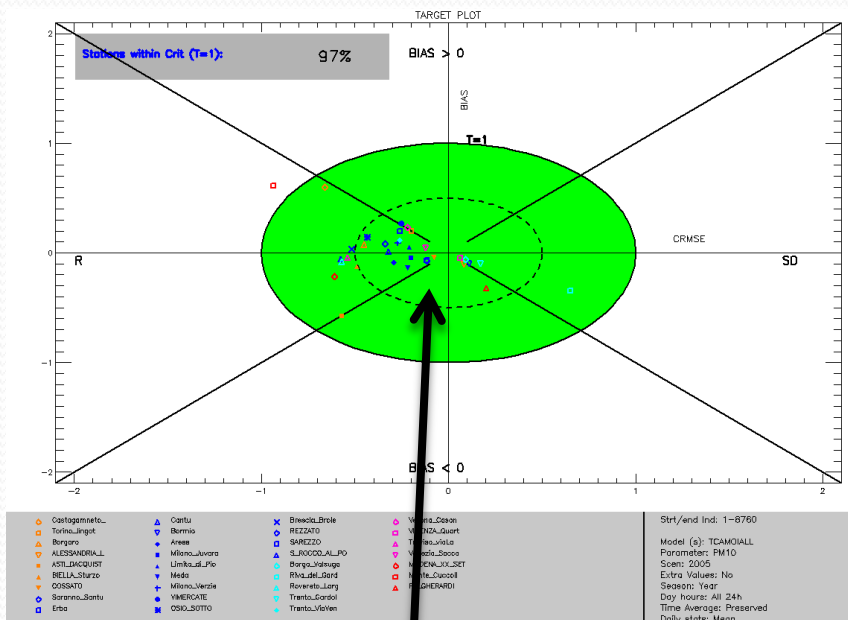
If a model has all the stations inside this circle so it is in the ideal situation



Can we state that the parametrization of the uncertainty has to ensure that (all) the stations stay inside the ideal circle (see (1)) if we consider the re-analysed fields?

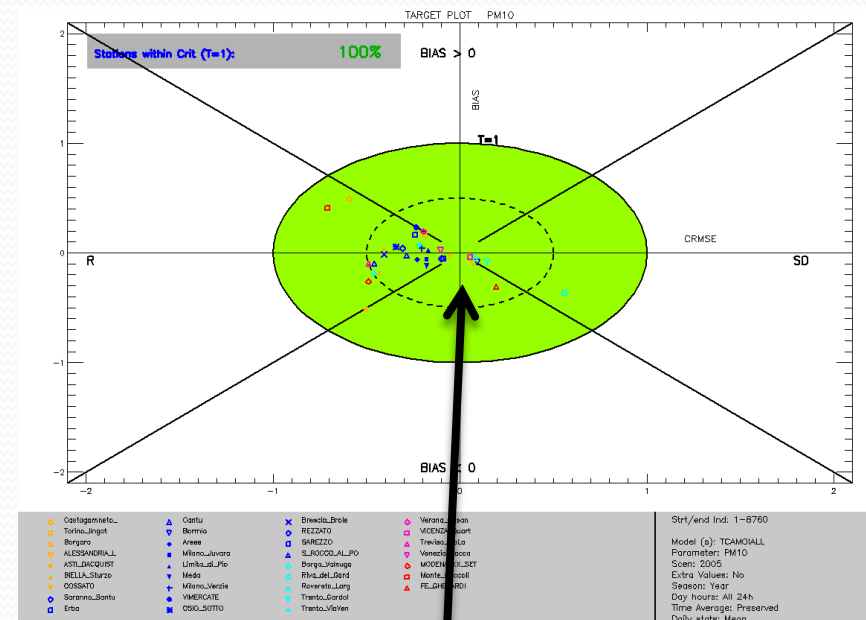
Q3: MQO tuning (k=2)

Default



67%

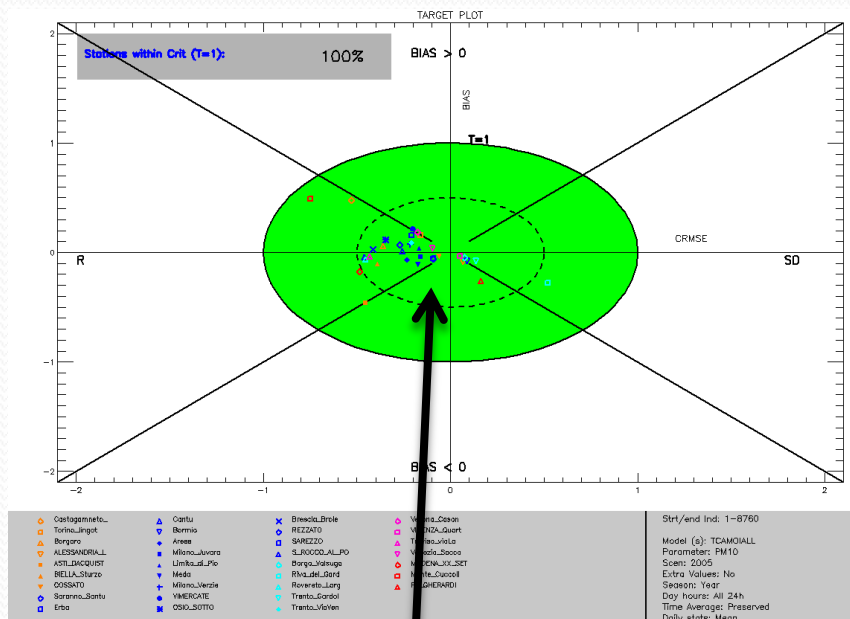
90% Data



82%

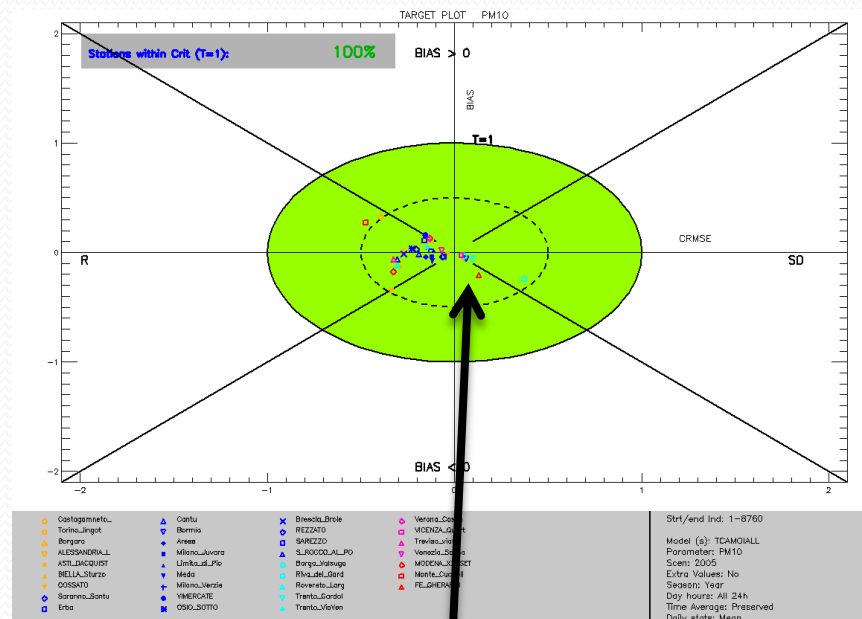
Q3: MQO tuning (k=2.5)

Default



89%

90% Data



95%

Conclusions & Discussions

- About Model&Measurement integration
 - Very valuable technique to compute the status of the AQ in a certain region.
 - Need for validation procedures **(OPEN)**
 - Integration on the delta tool (Philippe?)
 - AQD:
 - Use of re-analysed data?
 - Scenario issue...
- About the meaning of “model good enough”
 - The 90-90 criteria seems to be a good starting point **(OPEN)**
 - Could the re-analysed fields be used to tune MQO? **(OPEN)**

Thank you