GEODESIE

Géodésie et phénomènes géophysiques périodiques

S. Nahmani

1 - Contexte

ANR Géodésie

- 2.3.5. Work Package 5 (WP5)
Exploitation and evaluation of the references

- T5.3. Periodic geophysical phenomena.

- Objectives. To assess the quality of the TRF by comparisons to loading models of the non-linear motion of the geocenter and of the non-linear motions of the stations.

Variations saisonnières des positions de station

Gravitationnelle

- Mouvement du pôle, variations UT1, Marée polaire.
- Déplacements liés aux marées:
  - Terrestre (OK)
  - océanique (FES2004)
  - Atmosphérique (faible)

-> effets soustraits des séries temporelles

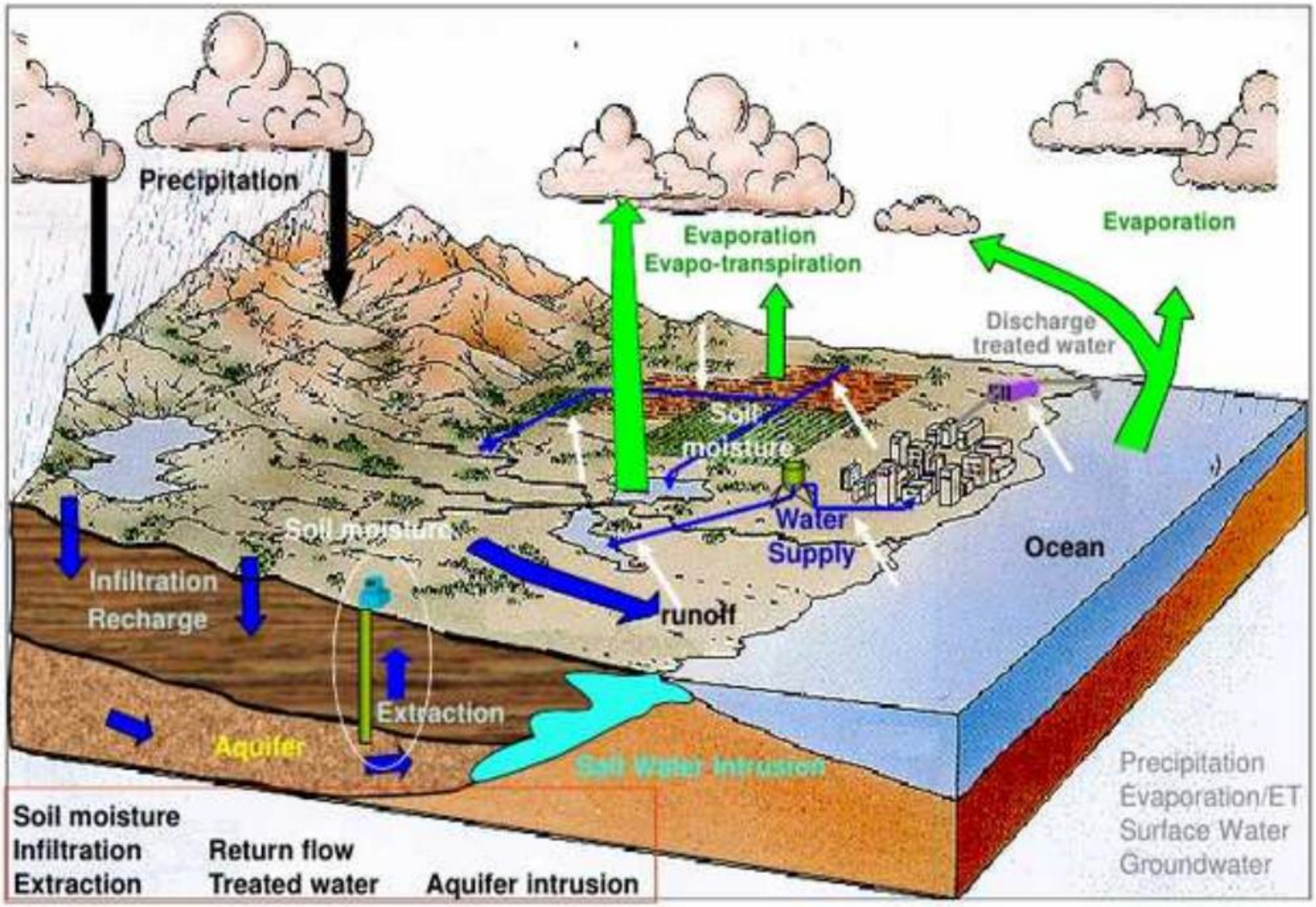
Hydro et thermodynamique

- Surcharges induites par:
  - Variations de pression atmosphérique : modèles météorologique
  - Fluctuations de la surface océanique
  - Hydrologie

-> effets conservés dans les séries temporelles

+ d'autres effets géophysiques et/ou liés aux erreurs

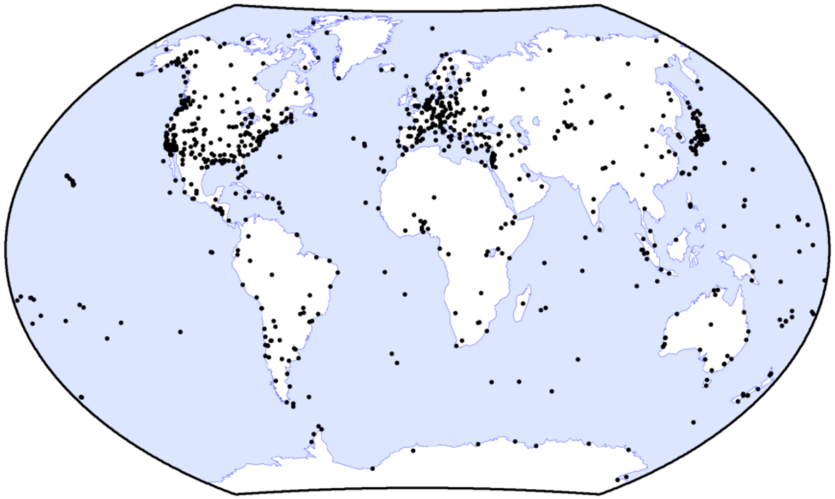
Cycle de l’eau



La complexité du cycle de l’eau (Kumar, 2006).

Méthodologie générale

- Séries temporelles sur plusieurs années
- Réseau de station étendu
- Comparaisons des modèles selon :



  - Tendance et impact sur les positions. → **Statistiques sur les tendances**
  - Caractéristiques spectrales → **Périodogrammes de Lomb-Scargle**
  - Peut-on évaluer les différences entre les modèles de surcharge ? → **Diagramme de Taylor normalisés**

2 – Surcharges atmosphériques

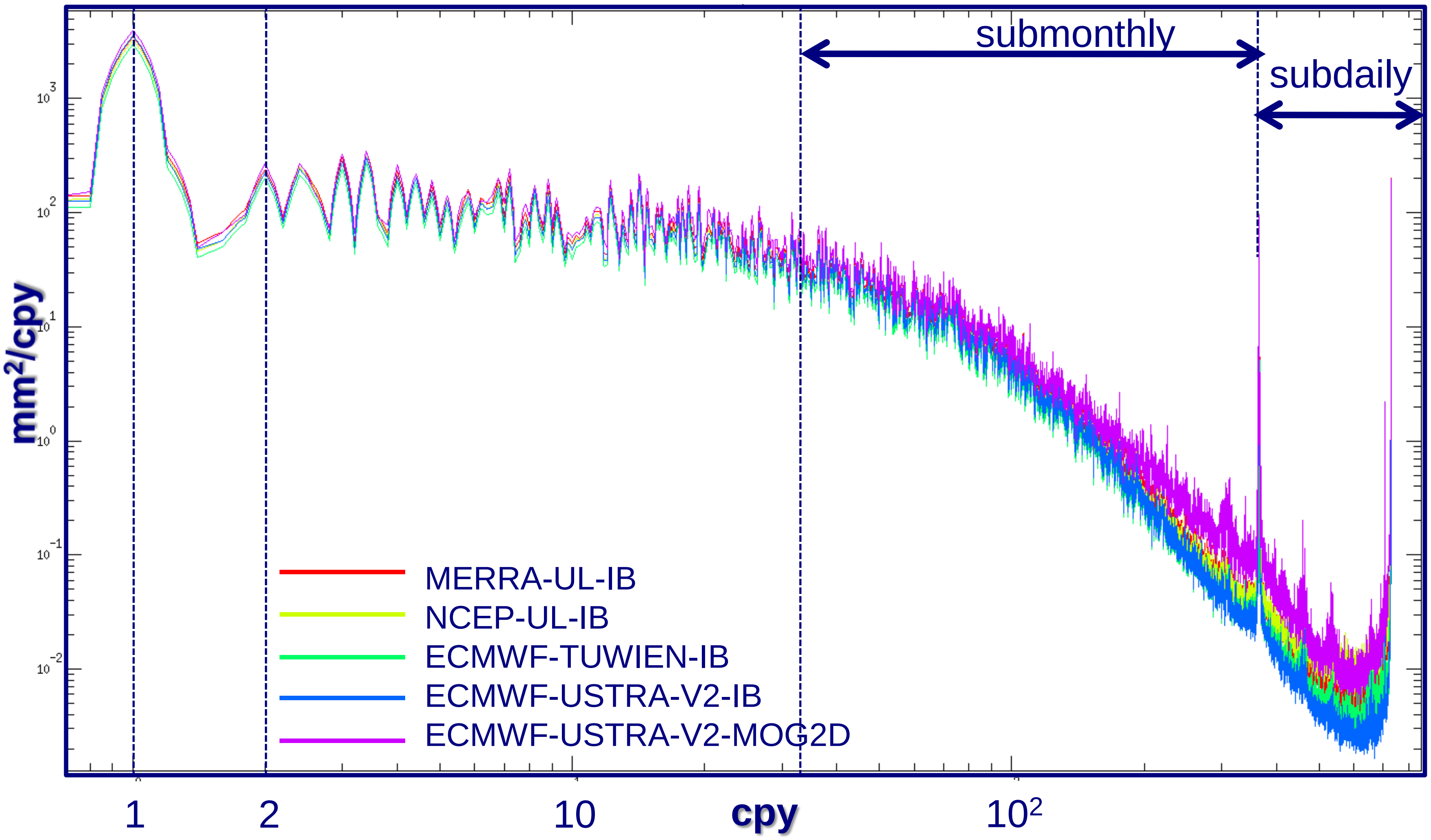
Modèles de surcharge atmosphérique

ID	Frame	Load	Nb stations	Res.	Period
ECMWF-TUWIEN-IB	CF	ECMWF/IB	-	6h	01/01/06 – 31/12/10
ECMWF-USTRA-V2-IB	CF	ECMWF/IB	887	3h	01/01/02 – 31/12/10
ECMWF-USTRA-V2-MOG2D	CF	ECMWF/MOG2D	887	3h	01/01/02 – 31/12/10
NCEP-UL-IB	CF	NCEP+topo/IB	1393	6h	01/01/06 – 31/12/11
MERRA-UL-IB	CF	MERRA/IB	887	6h	01/01/00 – 31/12/10

<u>Common Time-period:</u> 01/01/06 – 31/12/10
<u>Sampling rate for the comparison :</u> 6h
<u>Common stations :</u> 760

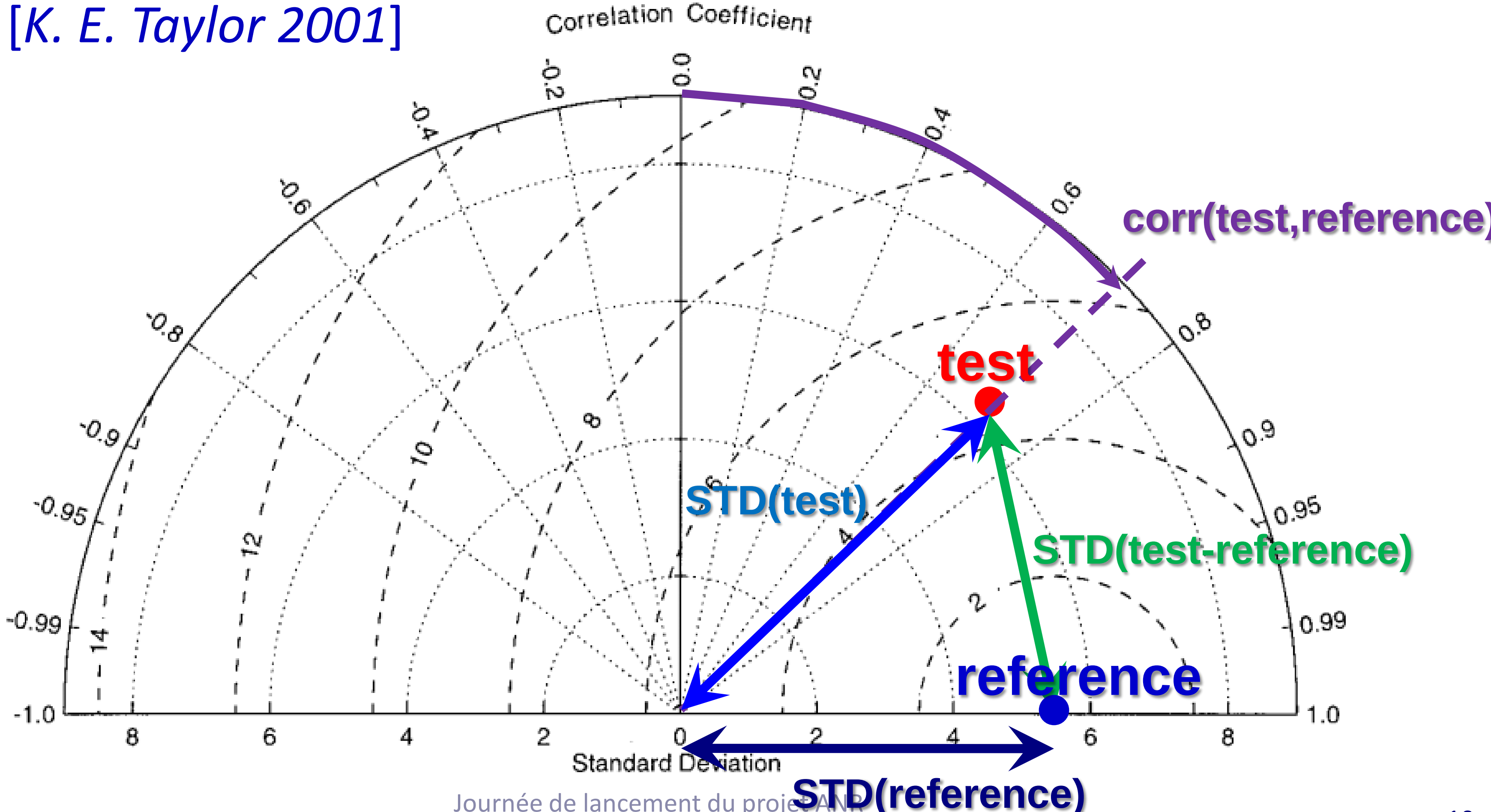
Analyse spectrale

Périodogramme de L.-S. moyenné sur les hauteurs de station



Taylor's diagram

- Given 2 series : “test” and “reference”
- Standard deviations, correlation and standard deviation of the difference can be represented on the same diagram [*K. E. Taylor 2001*]



Taylor's diagram

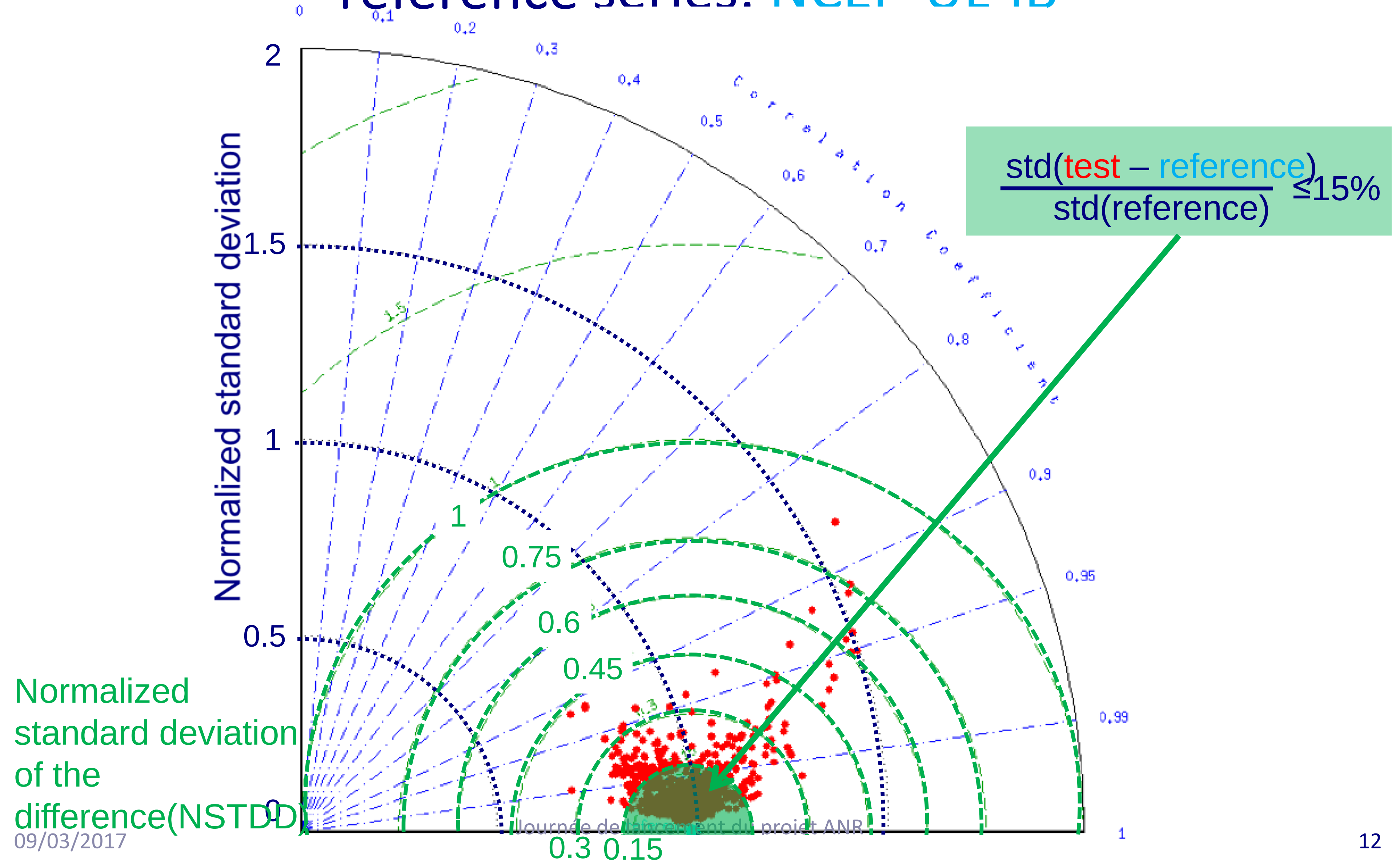
How to plot all statistics on the same diagram?

⇨ Normalize each test series by the standard deviation of the reference series.

⇨This leaves the correlation coefficient unchanged and yields a normalized diagram.

⇨Reference series all share the same point on the normalized Taylor’s diagram ([1 ; 0] coordinates)

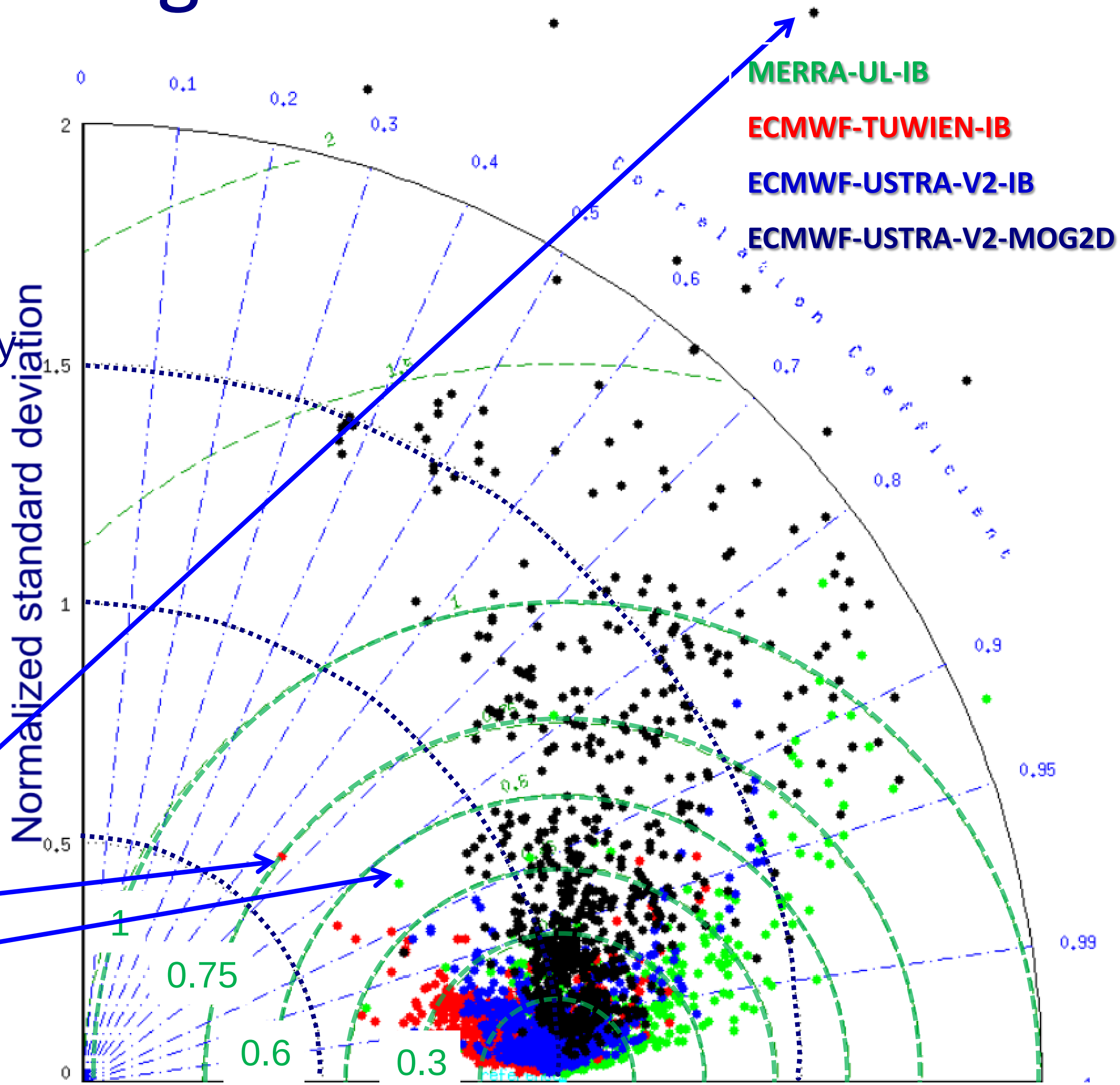
Example : Up daily average
test series: ECMWF-USTRA-V2-IB
reference series: NCEP-UL-IB



UP daily averaged w.r.t. NCEP-UL-IB

All models are well correlated with NCEP (> 0.8) except MOG2D (because model forced by winds in addition to pressure).

Differences between models
can be significantly larger
than 15 %.



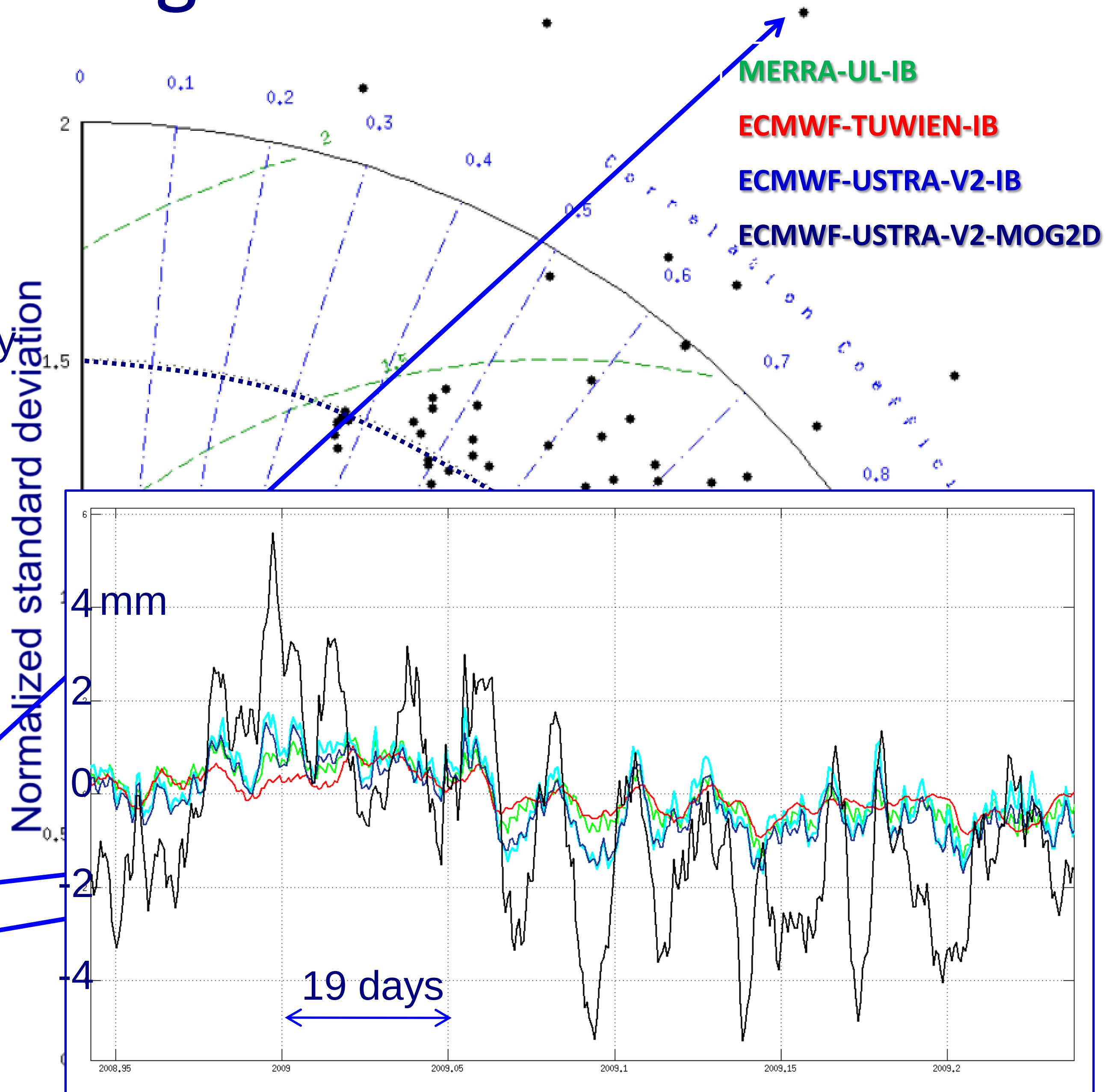
Example of a station with larger differences : **KERG**

UP daily averaged w.r.t. NCEP-UL-IB

All models are well correlated with NCEP (> 0.8) except MOG2D (because model forced by winds in addition to pressure).

Differences between models
can be significantly larger
than 15 %.

Example of a station with larger differences : **KERG**



UP daily averaged w.r.t. NCEP-UL-IB

Statistics of NSTDD = $\frac{\text{std(test – reference)}}{\text{std(reference)}}$

Model	% of stations where NSTDD ≤ 15 %			For 95 % of stations, NSTDD is less than		
	East	North	Up	East	North	Up
MERRA-UL-IB	22%	45%	**67%**	53%	62%	48%
ECMWF-TUWIEN-IB	11%	38%	53%	49%	**35%**	**31%**
ECMWF-USTRA-V2-IB	34%	**62%**	**67%**	**27%**	**35%**	**32%**
ECMWF-USTRA-V2-MOG2D	0%	0%	15%	98%	187%	130%

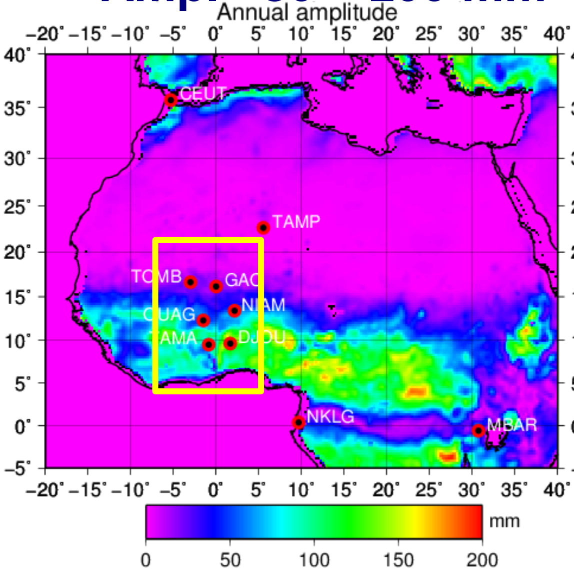
Error budget of atmospheric loading model is expected to be around 15% (Petrov and Boy, 2004)

Further discussions with authors of these models are required to understand if those figures reflect non-tidal loading model accuracy (physical assumption etc)

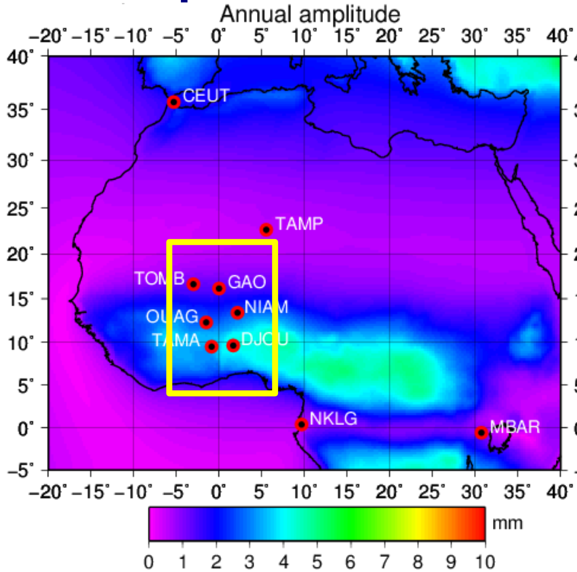
2 – Surcharges hydrologiques

Surcharges induites par la mousson ouest africaine

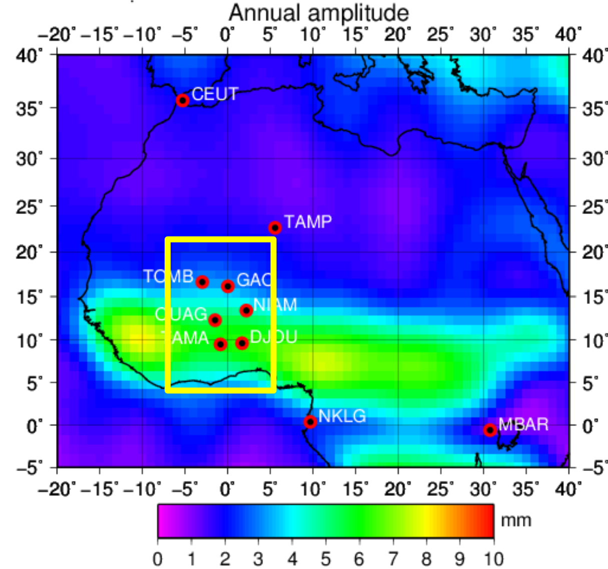
Humidité des sols (GLDAS)
Amp. ~50 – 100 mm



Surcharge hydrologique (GLDAS)
Amp. ~3 – 5 mm

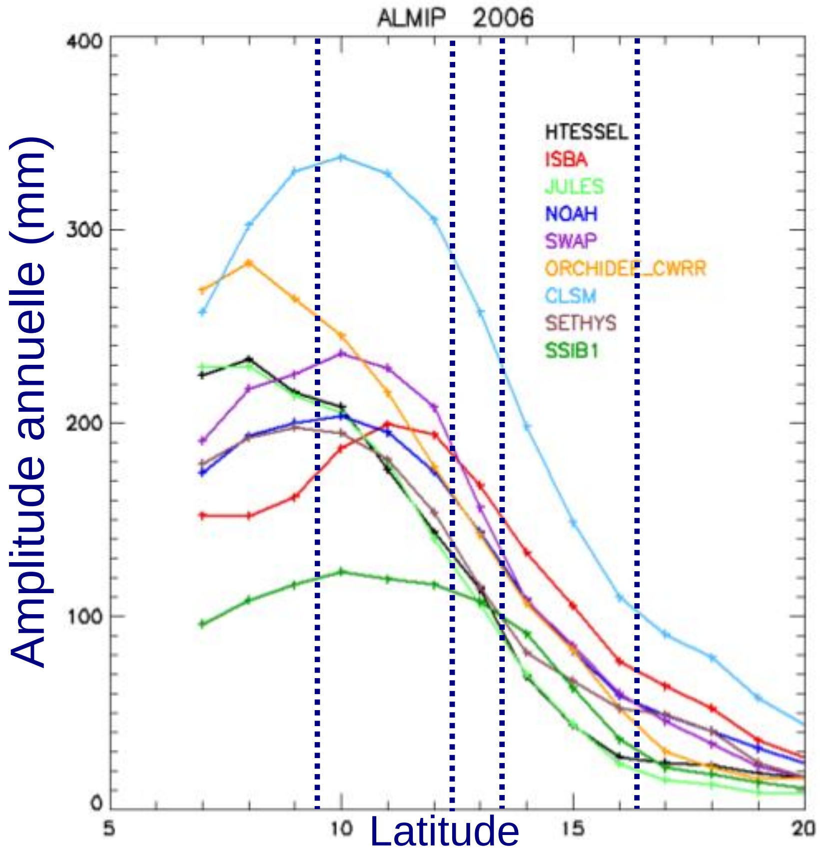


Surcharge hydrologique (GRACE)
Amp. ~ 4 – 6 mm

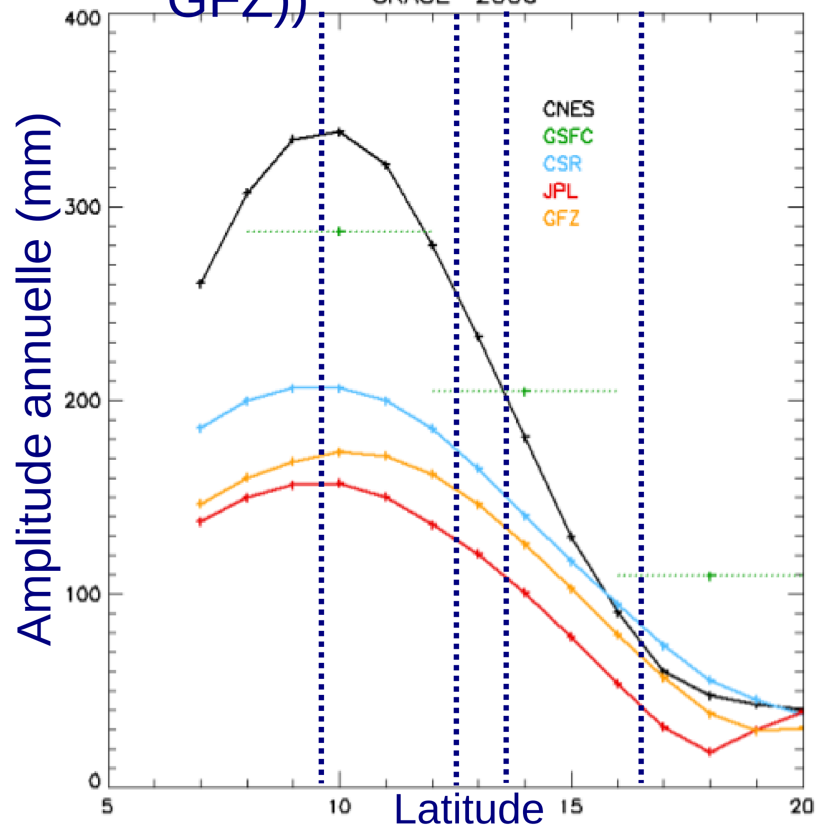


Incertitude des modèles hydrologiques et issus de GRACE levée par GPS ?

- ALMIP : 9 modèles régionaux
(AMMA LSM Intercomparison Project)



- GRACE: 5 global products
(CNES, GSFC, CSR, JPL, GFZ))

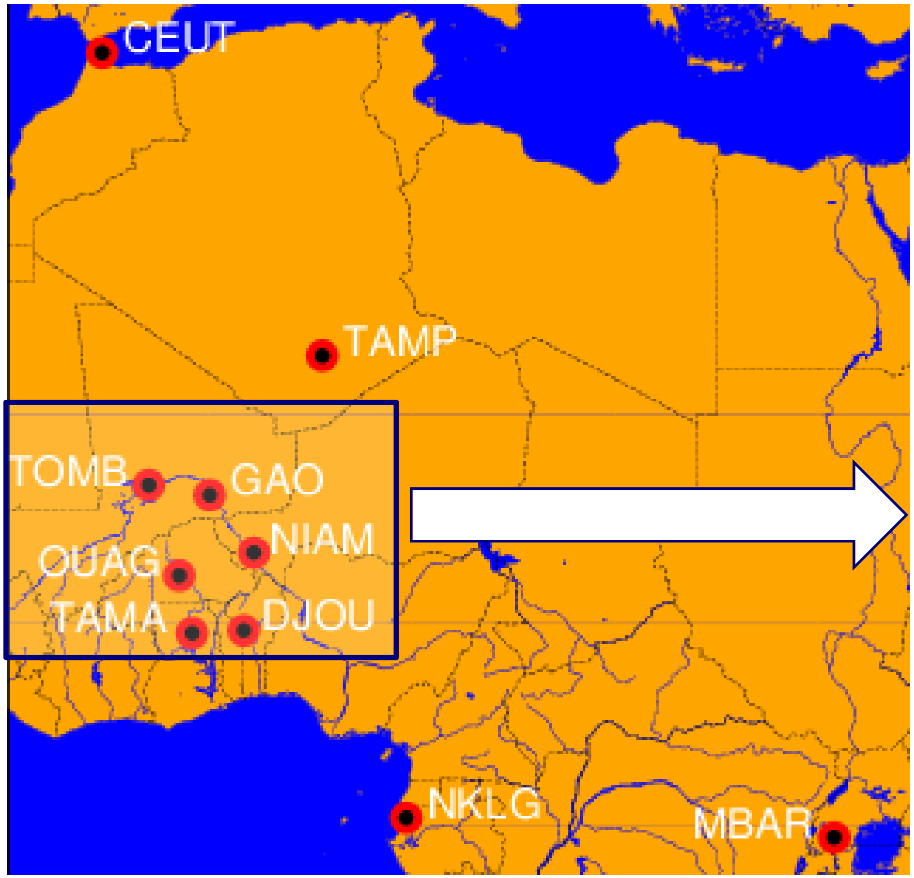


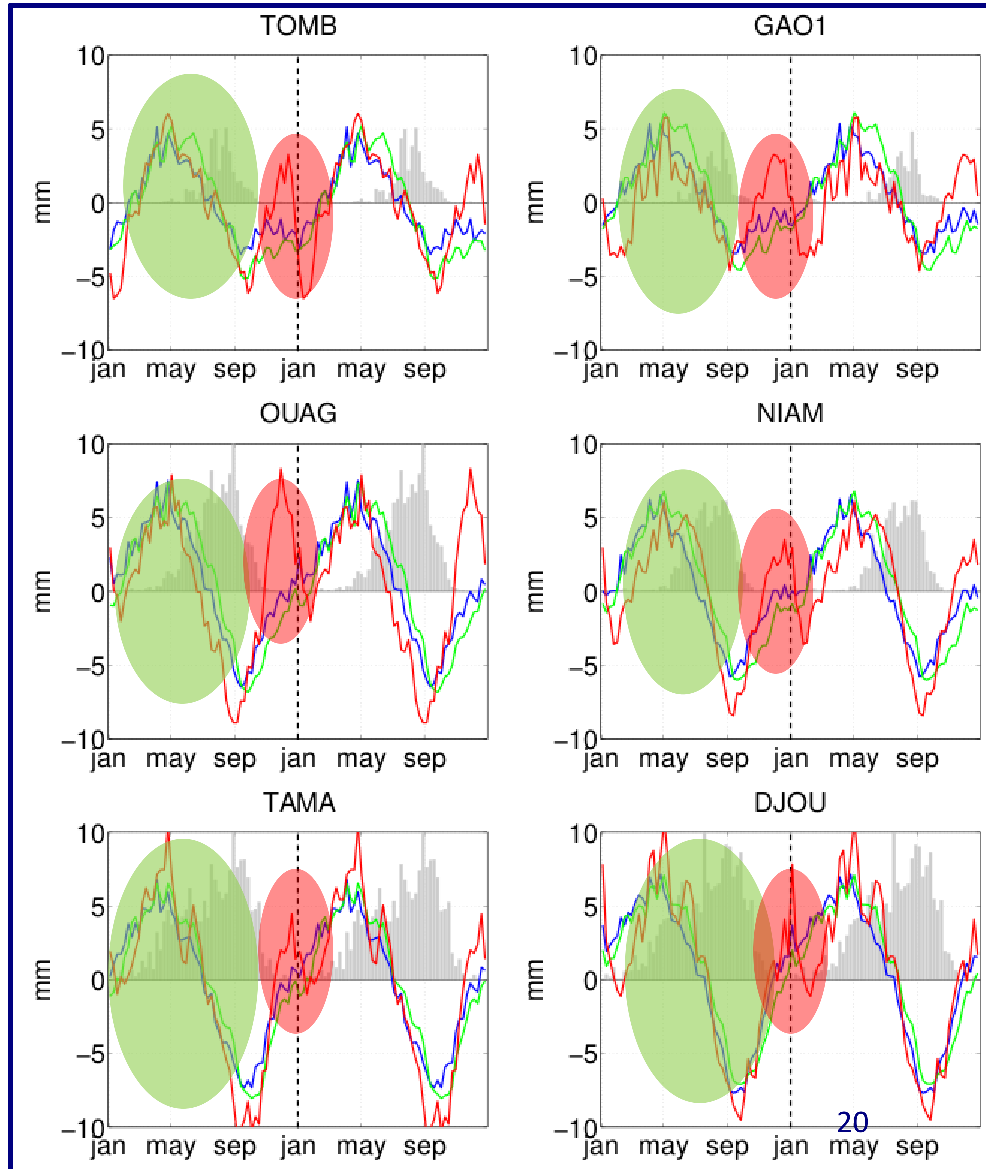
(Grippa et al., WRR, 2011)

Concrètement…

Résultats : déplacements verticaux : signaux annuels moyens (période 2005-2009 et répétés sur 2 ans)

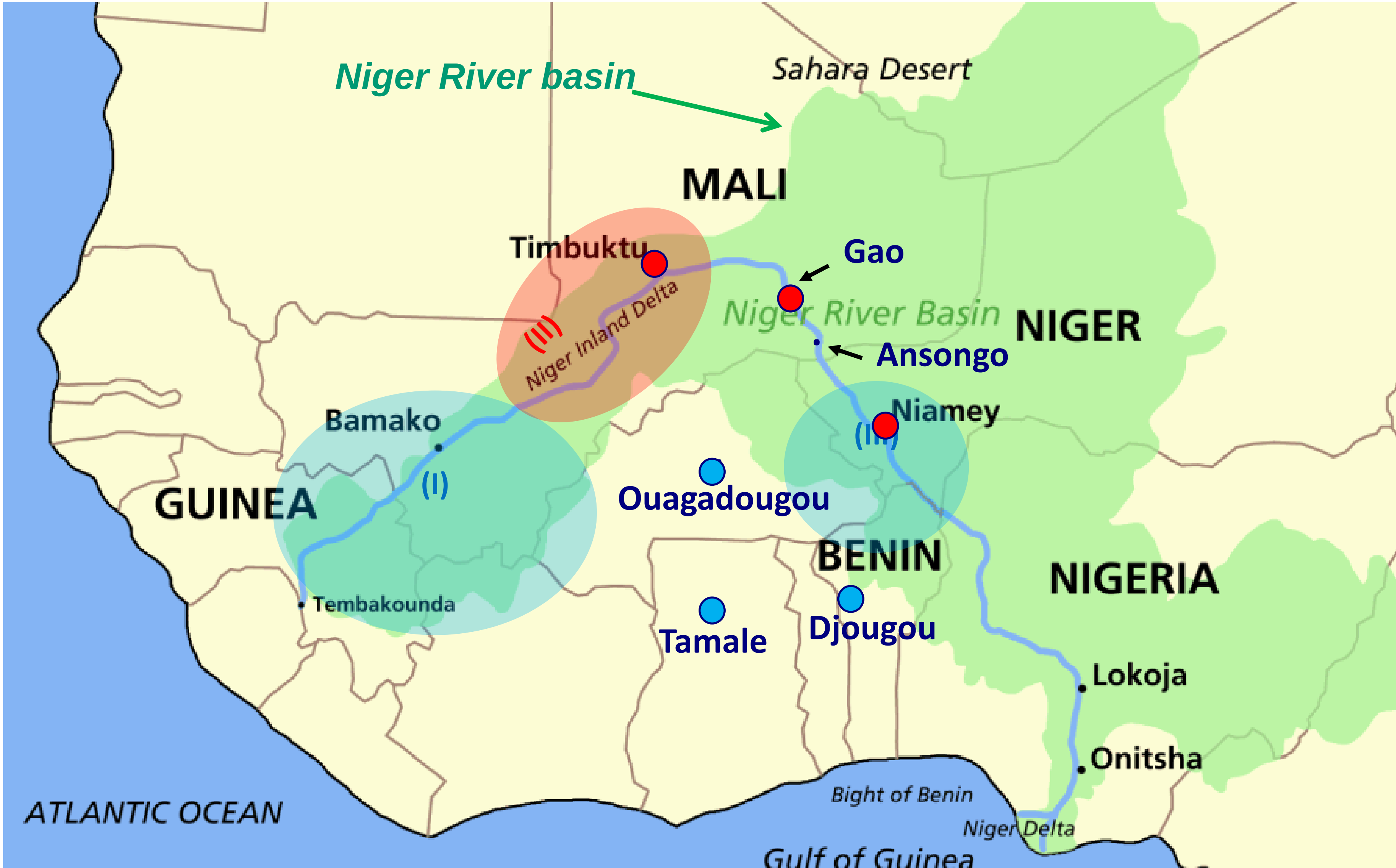
GPS, GRACE, Σmodels



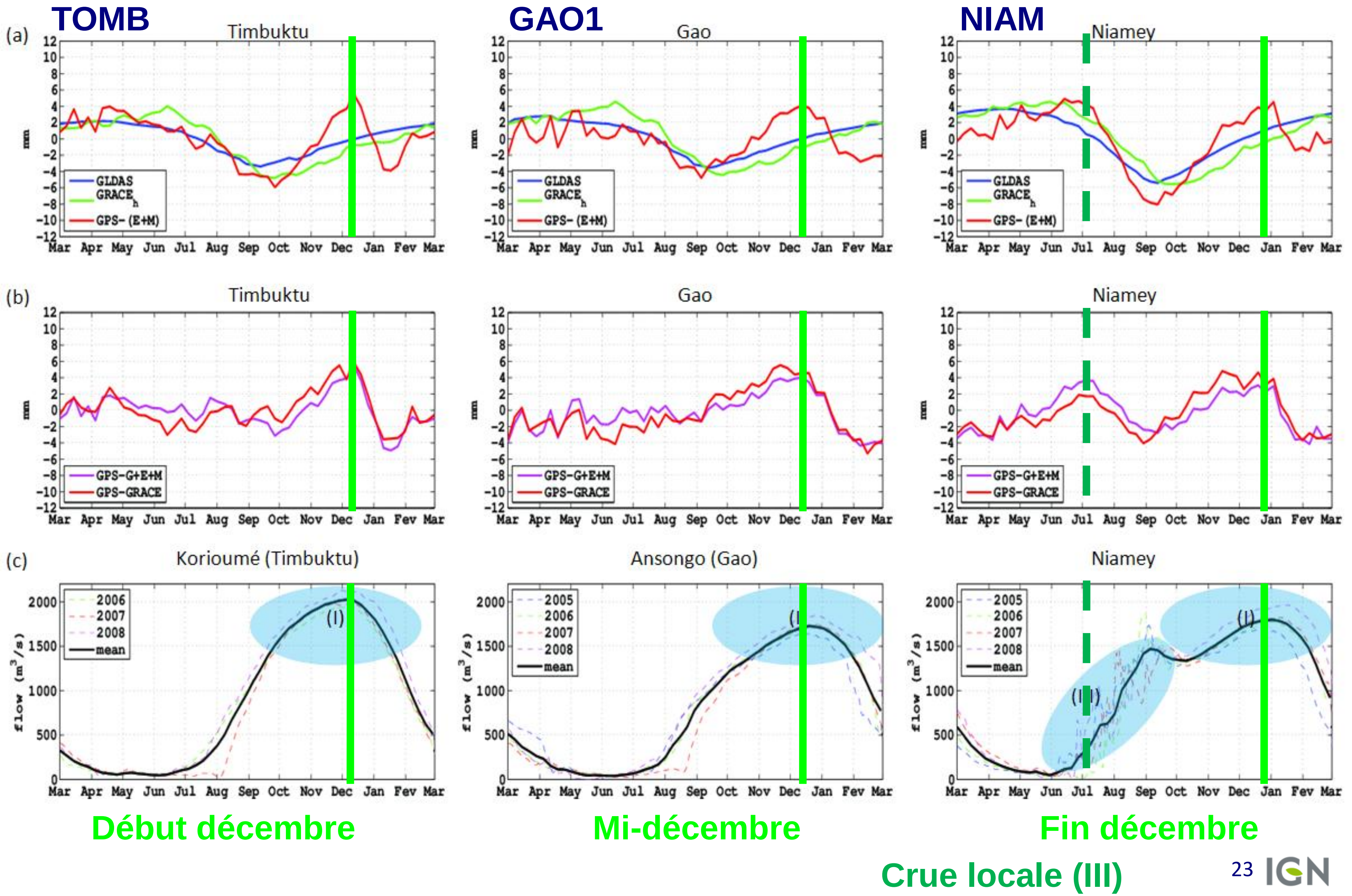


3 – Géotechnique

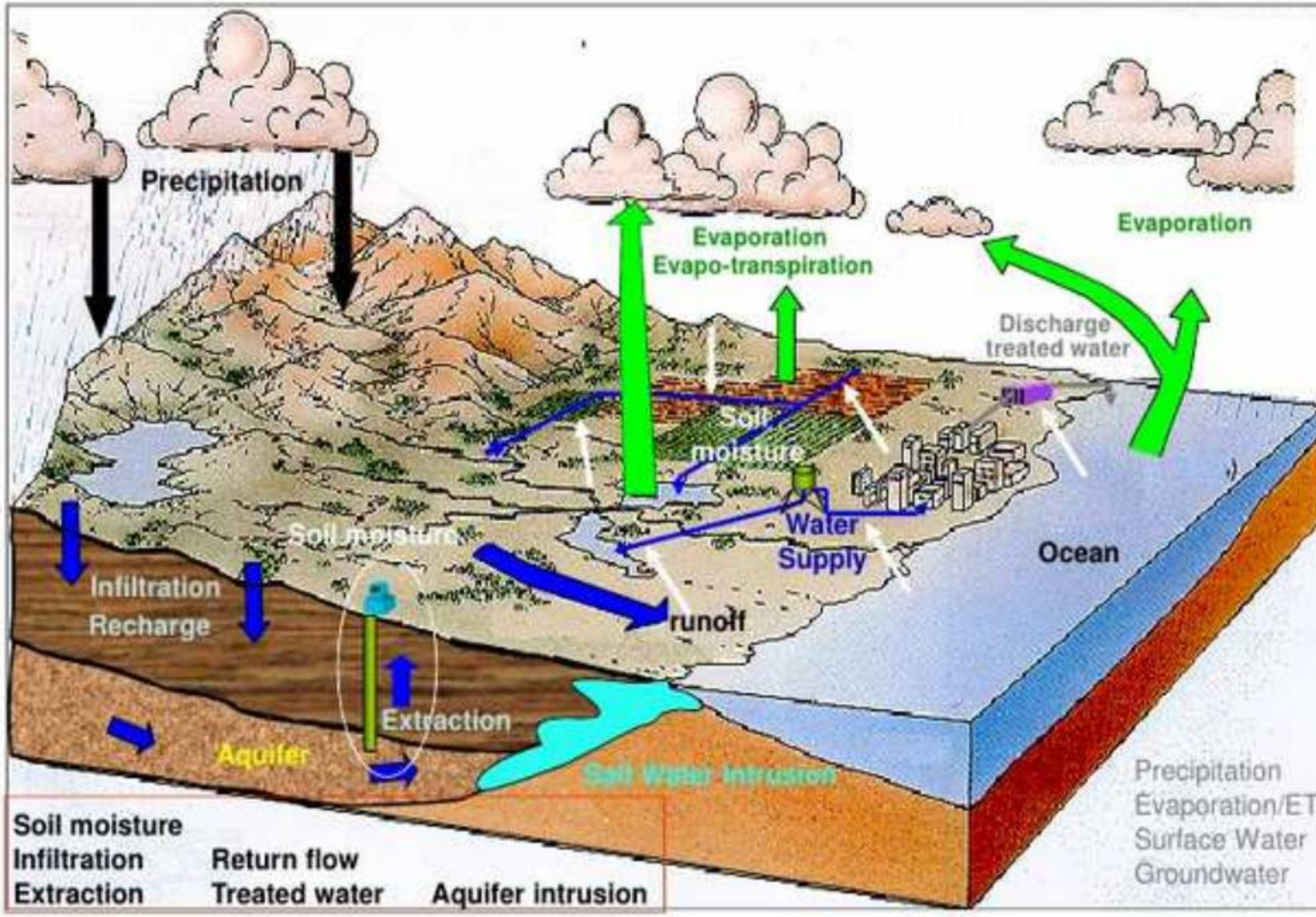
Le Niger, son bassin et ses crues



Déformations et crue du Niger

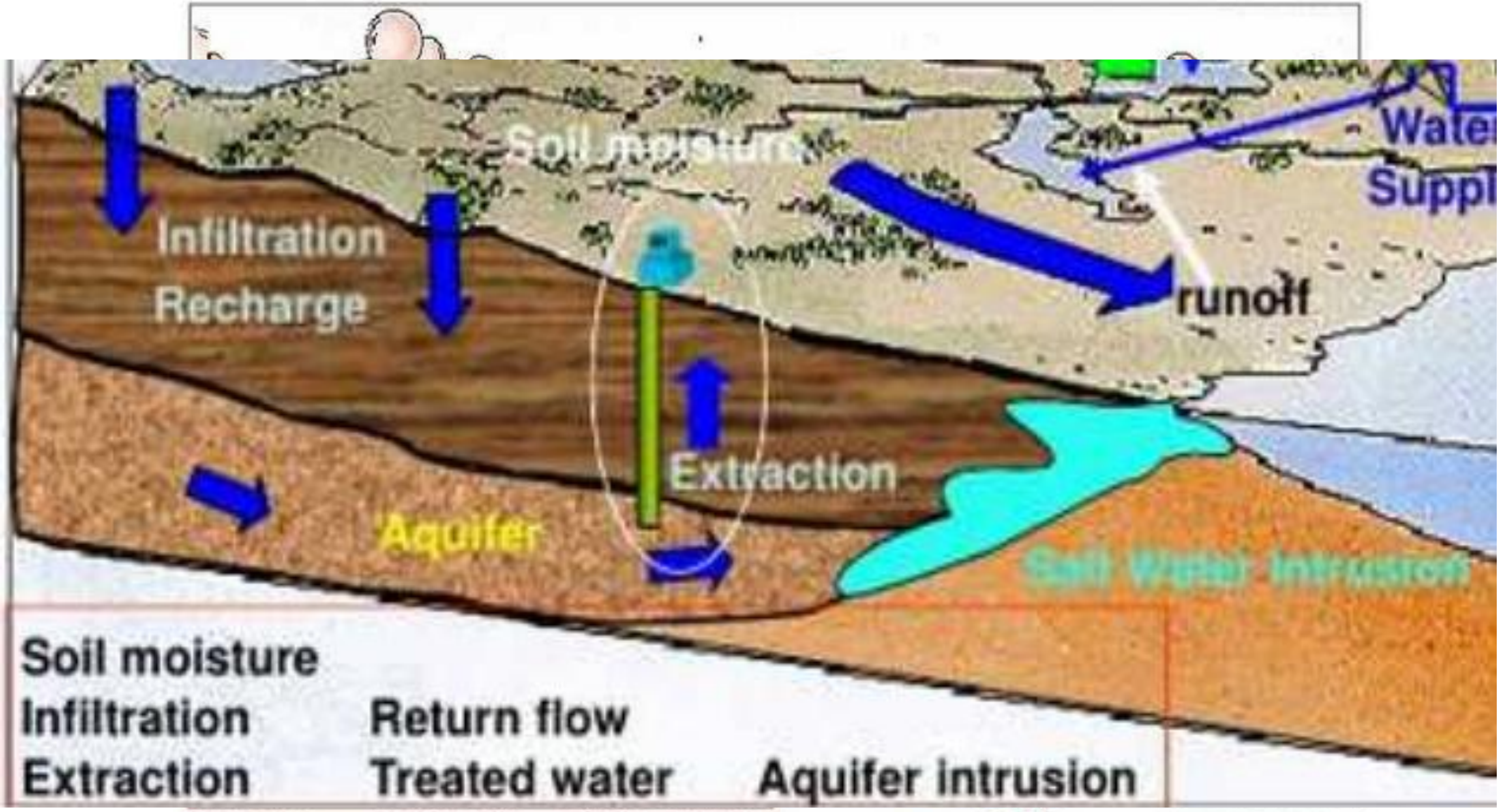


Cycle de l’eau



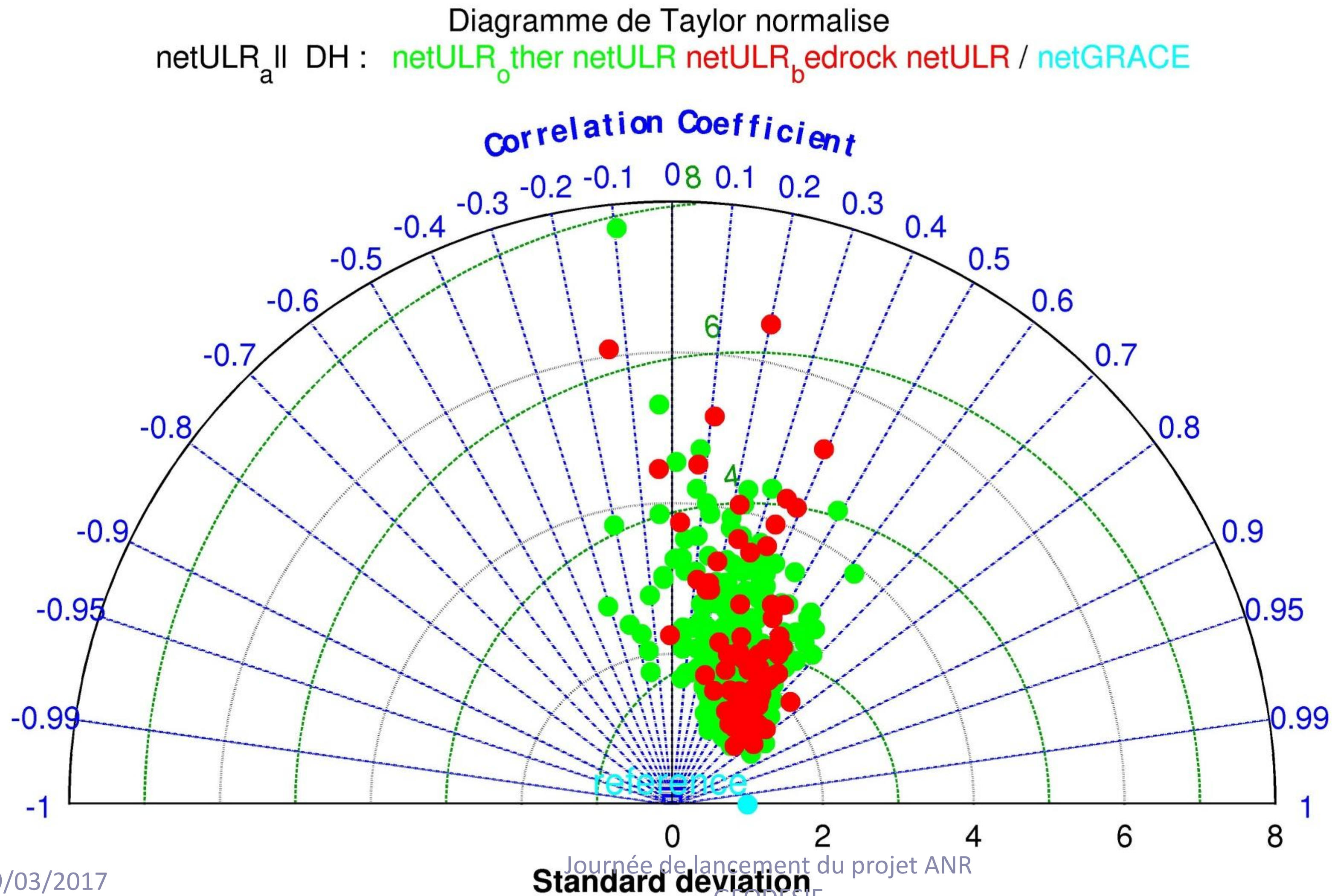
La complexité du cycle de l’eau (Kumar, 2006).

Cycle de l’eau



La complexité du cycle de l’eau (Kumar, 2006).

Influence de la géologie sur la comparaison GPS-GRACE



208 stations

69 stations

σ = 2.4

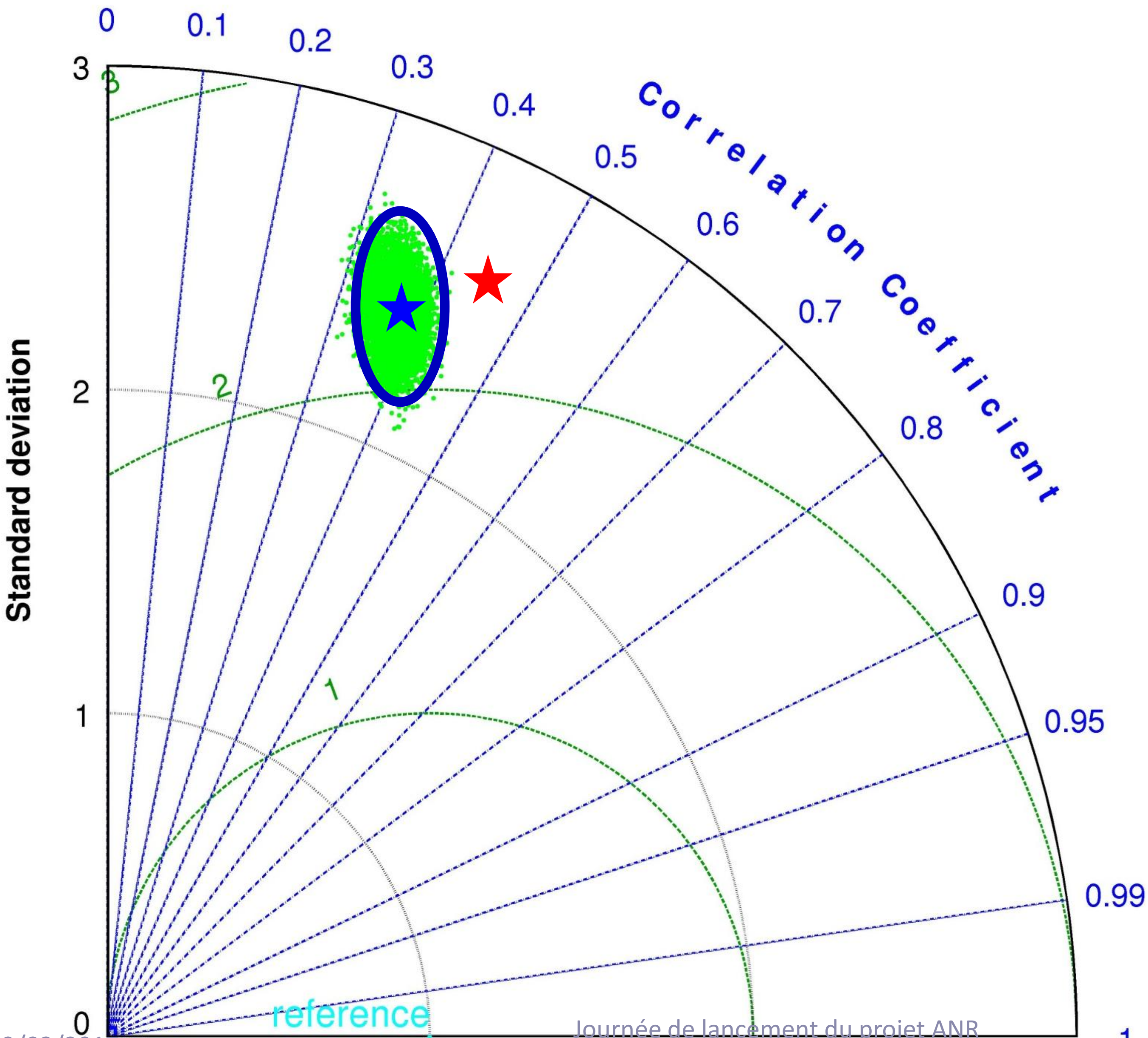
RMSΔ = 2.25

Corr = 0.37

σ = 2.56

RMSΔ = 2.33

Corr = 0.44



On tire aléatoirement 10000 sous réseaux de 69 stations parmi les stations « other »

Les stations sur le bedrock corrèlent mieux mais elles ont une variabilité plus forte.

Les autres stations ont une comportement statistiquement différent.

?