THE SUMMER 2012 GREENLAND HEAT WAVE: isotopic fingerprint of an atmospheric river

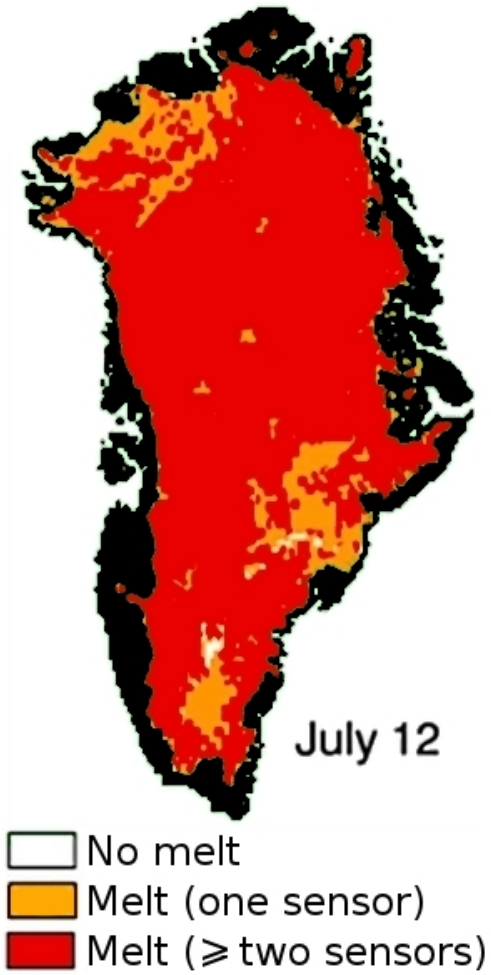
Jean-Louis BONNE (Ph.D. student) [1]

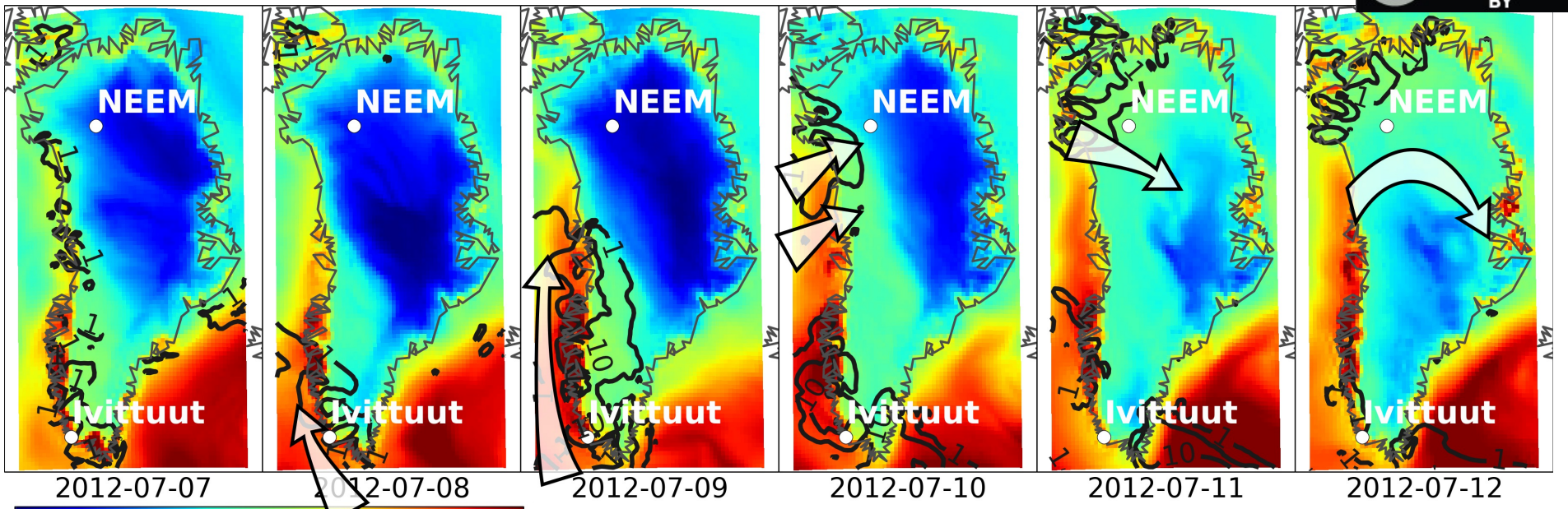
H.C. Steen-Larsen [1] H. Sodemann [2] C. Risi [3] J.-L. Lacour [4]
M. Werner [5] X. Fettweis [6] G. Cesana [3] C. Clerbaux [7]
M. Delmotte [1] V. Masson-Delmotte [1]

[1] *Laboratoire des Sciences du Climat et de l'Environnement, France* ; [2] *Institut for Atmospheric and Climate Science, ETH, Zurich, Switzerland* ; [3] *Laboratoire de Météorologie Dynamique, France* ; [4] *Spectroscopie de l'atmosphère, Service de Chimie Quantique et Photophysique, Université Libre de Bruxelles, Belgium* ; [5] *Alfred-Wegener-Institut für Polar und Meeresforschung, Bremerhaven, Germany* [6] *Laboratoire de Climatologie et Topoclimatologies, Université de Liège, Belgium* ; [7] *LATMOS, France* ;

Greenland surface snow melt on 12 July 2012

→ 97% of the ice sheet
[Nghiem et al. 2012]



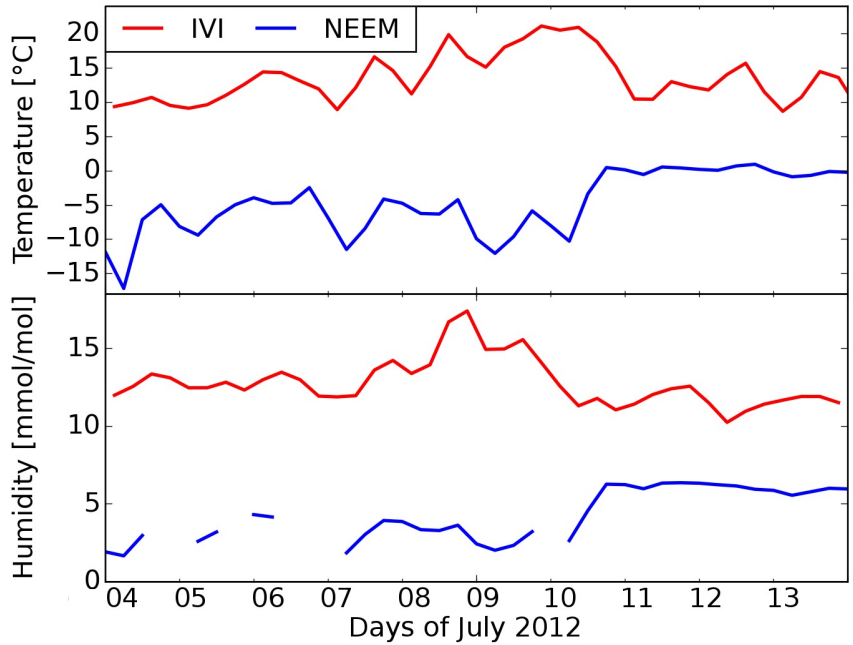


→ MAR Greenland regional model

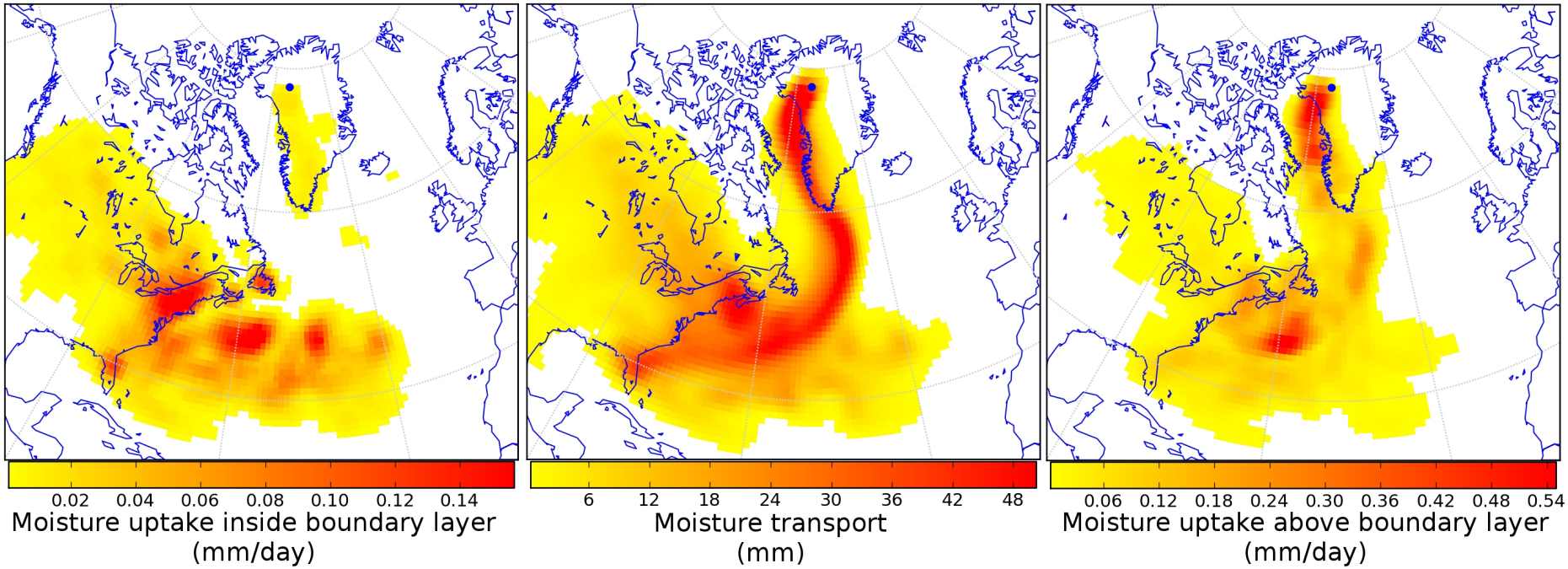
→ daily outputs

[Fettweis et al., TC 2013]

Ivittuut & NEEM observations



Water vapour sources for NEEM on July 11, 2012



Moisture source diagnostic

Lagrangian backtrajectory simulations (Flexpart)

→ Moisture uptake over Atlantic ocean 30-40°N

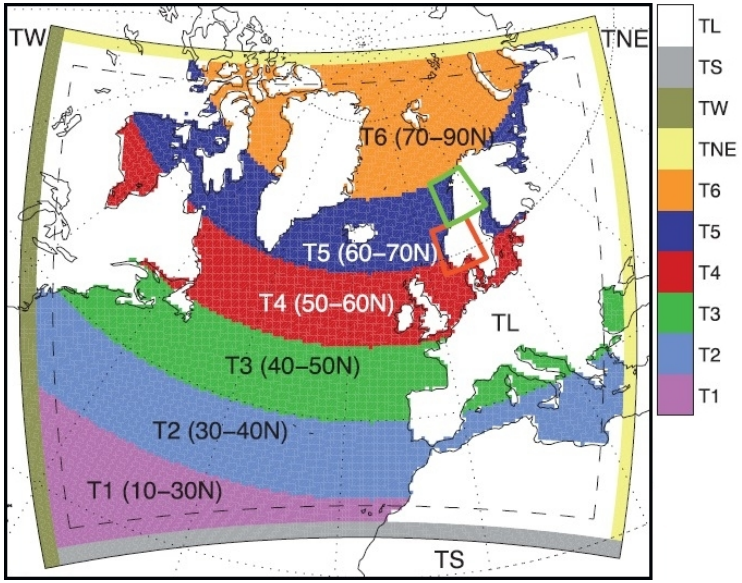
→ Northward transport : atmospheric river [Neff et al. 2014]

→ Uptake above boundary layer during northward transport (convection ? precipitation re-evaporation ?)

CHRM* Water tagging simulation

*Climate High Resolution Model

→ Model previously used for Scandinavian atmospheric rivers [Sodemann & Stohl, 2013]

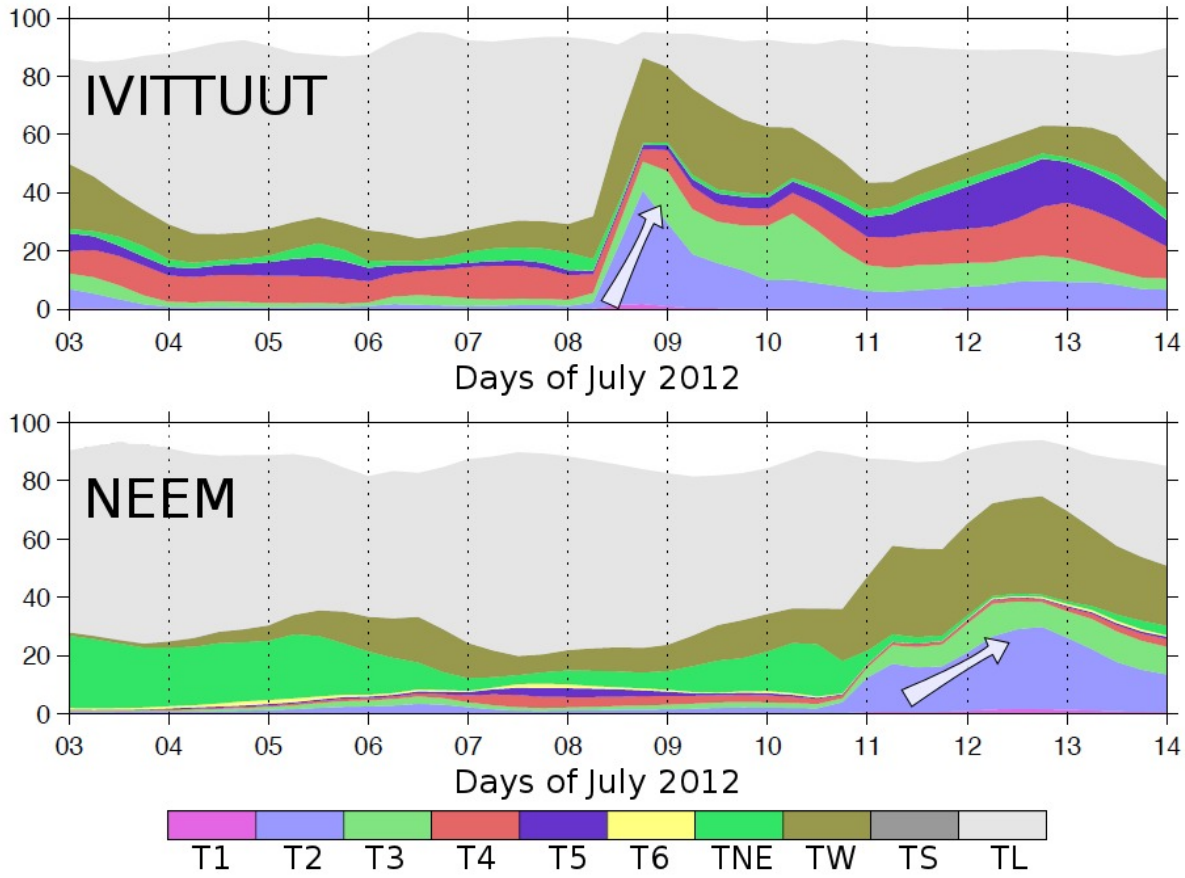


Tracers initialization zones
[Sodemann & Stohl, 2013]

⇒ Main summer contribution : continental recycling

⇒ During event :
strong increase of 30-40°N
(and 40-50°N) oceanic contribution

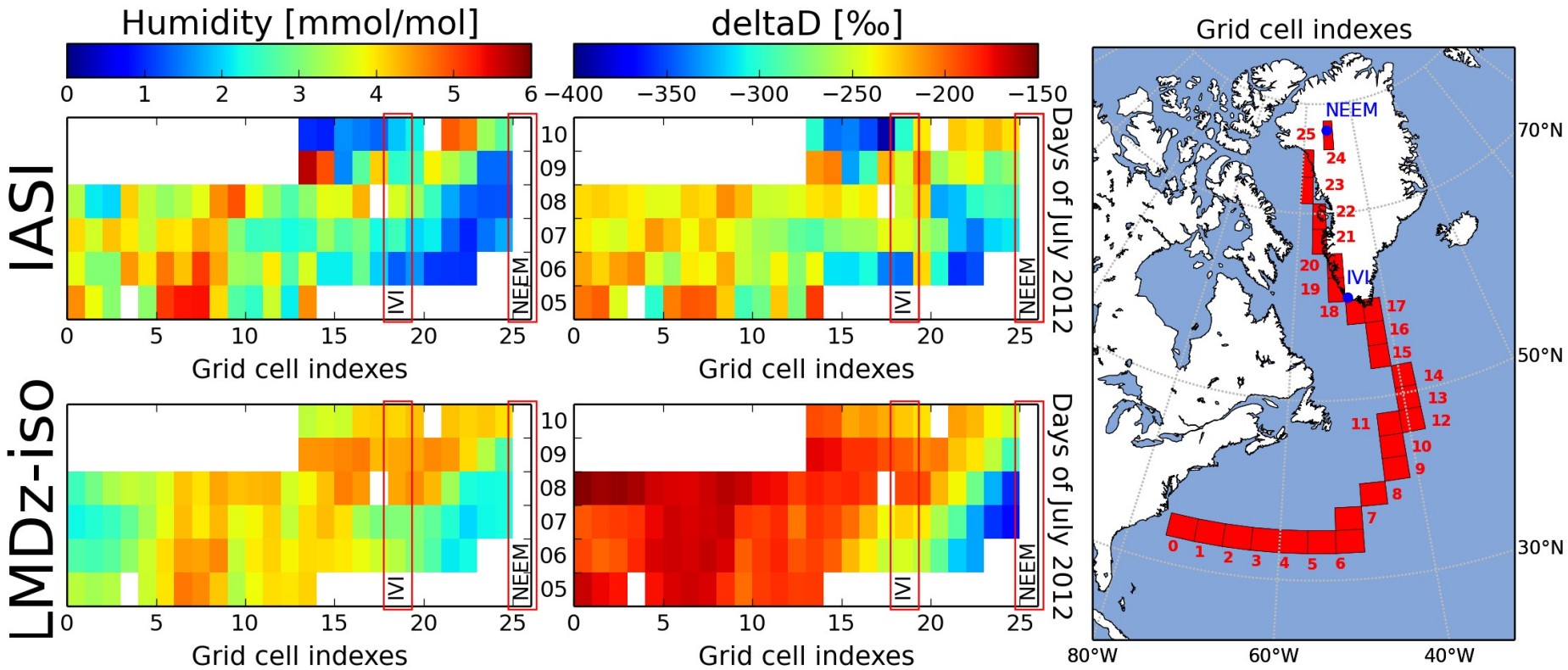
Daily evolution of humidity contributions for Ivittuut and NEEM



Tropospheric (3.5 to 6.5km) water vapour δD

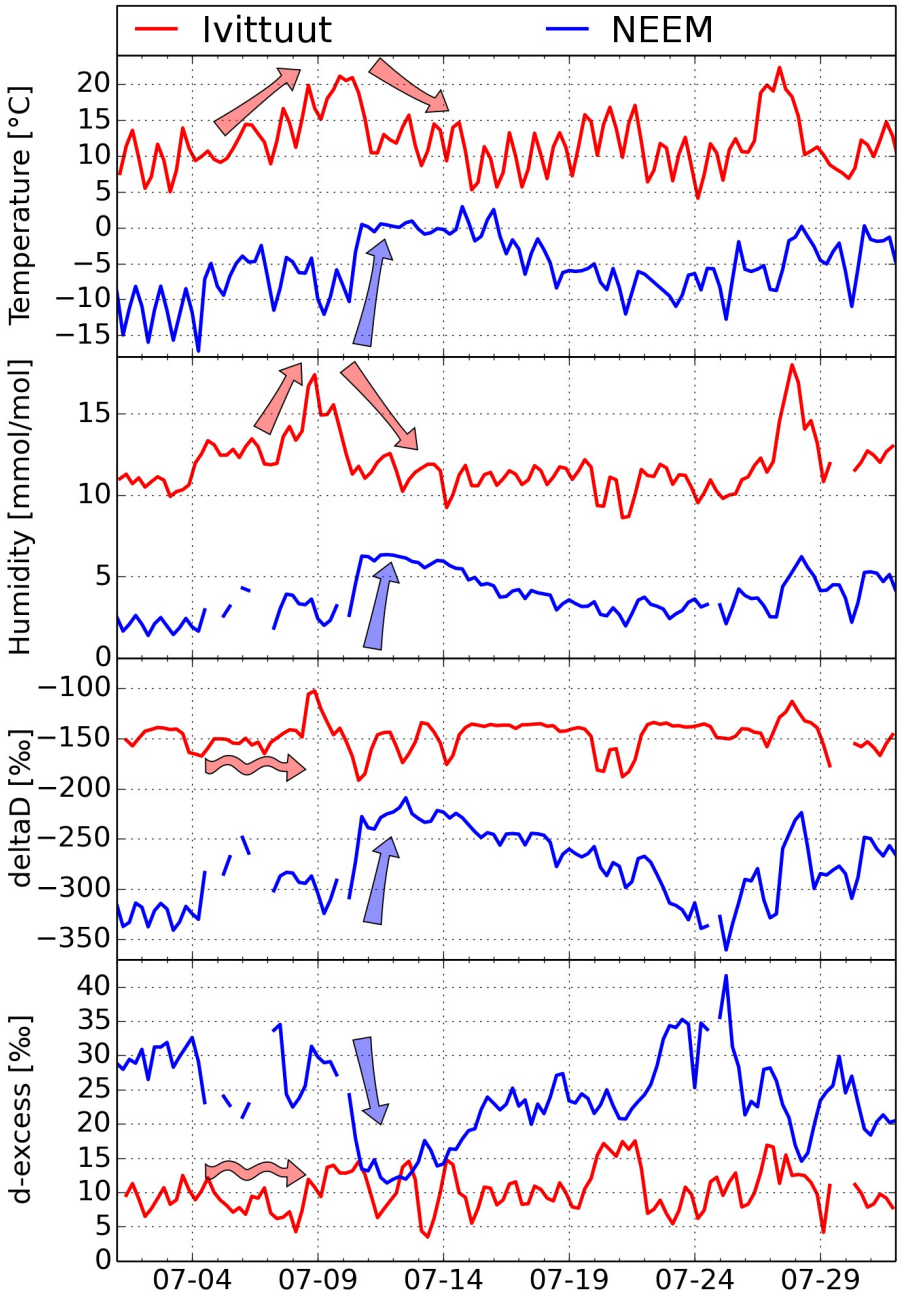
Remote sensing (IASI) vs. atmospheric model (LMDz-iso)

→ From July 5 to 10
→ Grid cells along moisture transport path



→ LMDz-iso smoothed with IASI retrieval kernels [Lacour et al., ACP 2012] for consistent H_2O & δD data

→ From July 1 to 31, 2012



Surface water vapour isotopic observations

→ CRDS analyzers

Ivittuut : [Bonne et al., ACP 2014]

NEEM : [Steen-Larsen et al., CP 2014]

Short lived δD variations

Large and long lasting δD enrichment

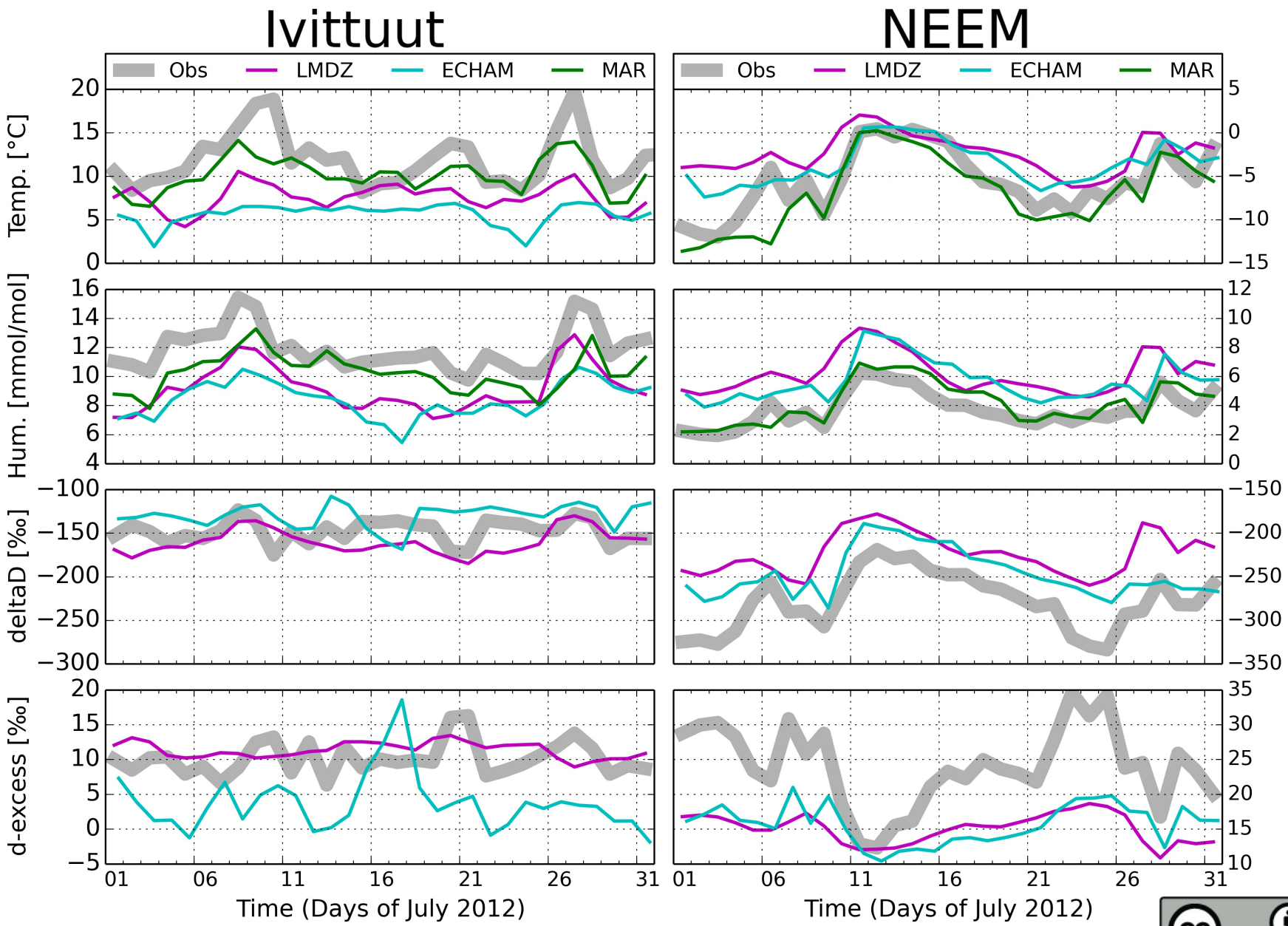
→ Half of δD decrease from Ivittuut to NEEM explained by Rayleigh distillation

Disappearing latitudinal d-excess gradient (common moisture source and distillation with positive temperatures)

d-excess $= \delta D - 8 \times \delta^{18}O$

Tracer of kinetic processes & moisture origin

Nudged atmospheric models : LMDz-iso, ECHAM5wiso, MAR



Conclusions

- Isotopic fingerprint : large anomaly at NEEM, small and shord lived changes at Ivittuut
- d-excess changes are coherent with water sources changes
- Counterintuitive with the usual d-excess interpretation in ice cores : low values for warmer moisture sources

Perspectives

- Implication for ice core data interpretations
- Motivation for coordinated Arctic monitoring
- Model sensitivity tests to resolution
- Feedbacks at the ice sheet surface (Summit-NEEM data)

$\longrightarrow$ Publication in preparation

Thank you for your attention