Two Announcements

1) List of recent references with
   - submitted (archived online)
   - newly published papers
   - recommended papers
   → Harald will send a google doc link to be filled

Time	
13:45	**Atsushi Okazaki**: Development of MIROC5-iso and its comparison with isotopic climate proxies [Abstract] [Video][Email]
14:05	**Kanon Kino**: Contribution of the Southern Annular Mode to variations in water isotopes of daily precipitation at Dome Fuji, East Antarctica: A study with an isotope-enabled AGCM MIROC5-iso [Abstract] [Video][Email]
14:25	short break (15 min), offline or gather.town
14:40	**Christophe Leroy-Dos Santos**: From atmospheric water isotopes measurement to snow core interpretation in Adelie Land: A case study for GCMs with embedded isotopes in Antarctica [Abstract] [Video][Email]
15:00	**Sarah Worden**: Quantifying ET Over the Congo Basin Using a Combination of Remotely-sensed and Surface Measurements [Abstract] [Video][Email]
15:20	**Parallel discussion groups** (15:20 – 15:50 CET) T1: Stable water isotope observation-model intercomparisons (Mod2Obs) T2: Data sharing and formats for models and observations (DataShare) T3: Communicating about water isotopes with non-specialists (SWI2non-SWI) T4: Going from weather to climate with isotopes: how to close the gap? (Weather2Climate)
15:50	short break (15 min) offline or gather.town
16:00	**Poster introductions** on gather town
16:30	**Poster session** on gather.town
17:30	Closure remarks on gather.town (Harald, Franziska, Camille)

2) New break at 14:25 and shifted discussions to accommodate Sarah Worden's talk

Water Isotopes: From Weather to Climate

Recap on tropical clouds and outlook on coupled isotope-enabled modelling

Franziska Aemisegger

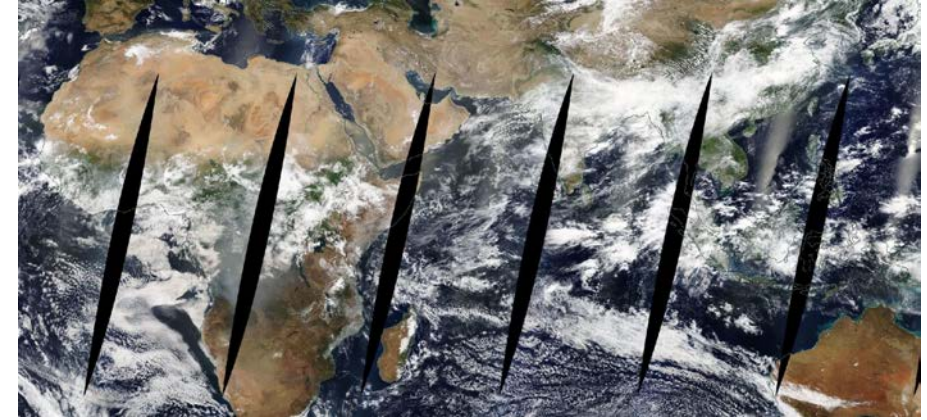with inputs from Camille, Harald, and the Zurich hub

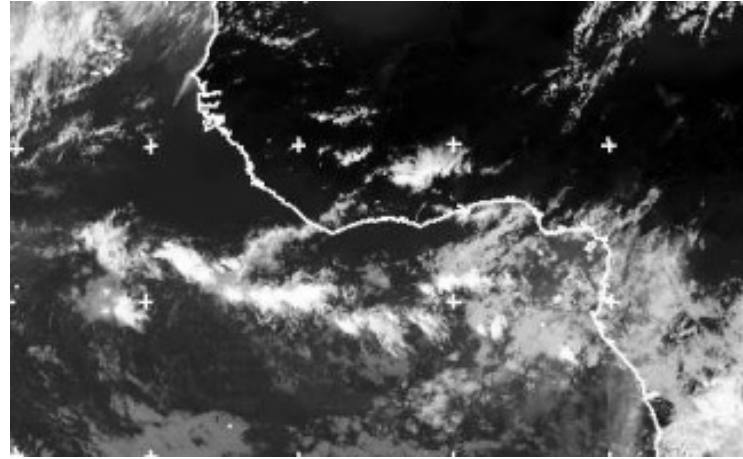17 November 2021

1) Data assimilation SWING

2) Circulation imprints in subtropical precipitation isotopes

3) Monsoon Systems with their moisture sources and dynamics

4) Continental moisture recycling

5) Deep convective organisation

6) Low clouds organisation

7) Do microphysical details matter?

Notes

- Contributions **on a wide range of scale**s from the global, hemispheric, continental scale, to the more regional, cloud organization scale, and finally the microphysical scale

- It once again became clear that we are **a community with diverse backgrounds**, with many people from meteorology this time, but also eco-hydrologists, groundwater dynamicists, paleoclimatologists.

- What was particularly **impressive for us to see that isotopes have the potential to become mainstream knowledge in various communities** such as tropical convection, cloud microphysics, dynamics community. Also isotope-people seem to be more and more involved in these communities, we use recent tools from our fields (e.g. the mesoscale cloud organisation patterns on Leonie's poster or the cold pool detection method on Estefania's poster) . We think that this is very good news if we want to bridge the gap between the isotope and our "home"/disciplinary communities!

- There are **gaps in theory** (everybody "complaining" about the d-excess) but we are confident that with the current experimental technologies these riddles can be solved by updated laboratory experiments (cloud chambers, wind tunnels) but also by adequate theoretical frameworks as we will see today.

Based on this we could seriously think **about ways forward to manifest isotopes as an integral tool** in microphysics, cloud circulation, in dynamics studies and as we will see today earth system modelling.

Big questions
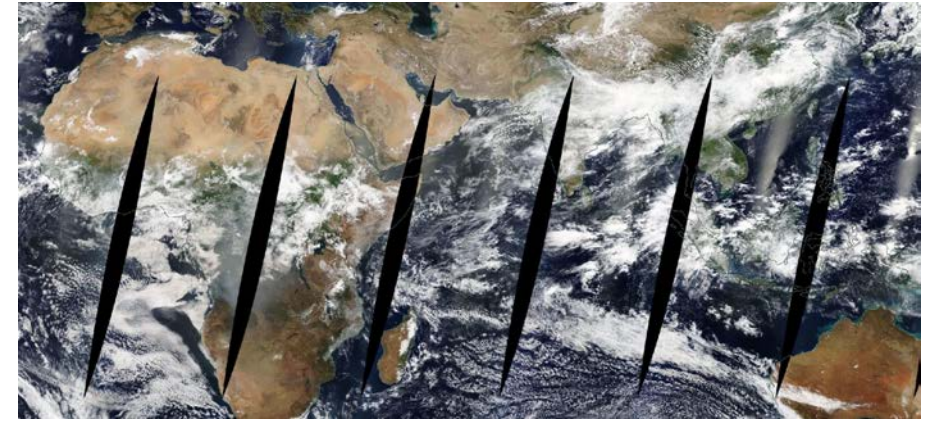
1) Data assimilation
SWING

2) Circulation imprints in subtropical
precipitation isotopes

3) Moisture sources and
dynamics of monsoon systems

1) Can isotopes be used in data assimilation to improve numerical weather forecasts?
(Kei Yoshimura, Farahnaz Khosrawi et al., Hayoung Bong et al.)

2) What is the impact of shifts in circulation patterns on the Earth's hydrological cycle?
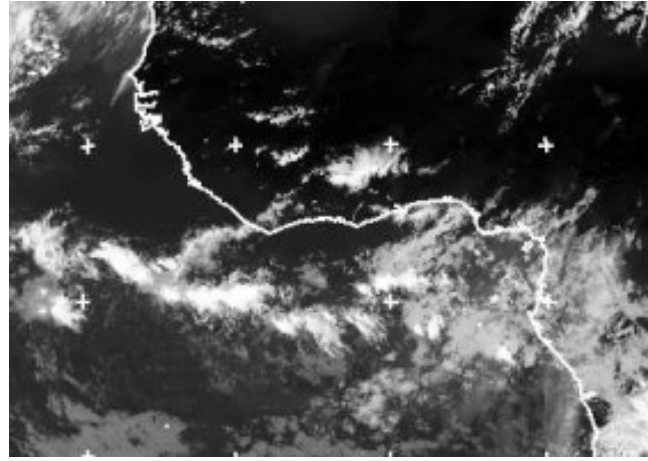(Giuseppe Torri et al., Yan Yang et al.)

3) Are isotopes good indicators of the regional characteristics of Earth's Monsoon systems?
(Xuejie Wang et al., Supriyo Chakraborty et al.)

Big questions

4) Continental moisture recycling

5) Deep convective organisation

6) Low clouds organisation

7) Cloud microphysical processes

4) What is the feedback of the land-atmosphere coupling on the regional water budget?
(Yafei Li et al., Sarah Worden et al., Mojtaba Heydarizad, Sidan Lyu et al.)

5) What are the mechanisms underlying the relationship between convective organisation and free tropospheric humidity? (Camille Risi et al., Jun Hu et al.)

6) Is there a coupling between low clouds organisation and the large-scale circulation in the trades? (Leonie Villiger et al., Estefania Quinones Melendez et al., Sebastian Los and Joe Galewsky)

7) Do microphysical details matter? (Dean Henze et al. and David Noone)

Impressions

- More and more observations from aircrafts in clouds & cloud free zones

- Modelling studies ahead in terms of detailed process analysis compared to obs (comparable situation to 15 years ago before vapour isotope measurement boom)

- Modelling studies are useful to formulate hypotheses but measurements urgently needed for validation

- Challenges to validate microphysical processes in deep convective clouds in environments with strong vertical motion

To wrap up our impressions
- More and more observations from aircrafts in clouds & cloud free zones are available. But it became clear yesterday that **modelling studies are still far ahead in terms of detailed process analysis compared to observations.**
Camille mentioned that this situation can be compared with the situation 15 years ago, when we had isotope-enabled GCMs ready to use but global water vapor isotope measurements were not yet available.
Such modelling studies are very **useful to formulate hypotheses about what water isotope measurements could tell us.**
For example: we saw that the combination of different modelling tools with isotopes such as water tagging and lagrangian diagnotics have a lot of potential to provide unprecendented insights into the dynamics of specific synoptic to mesoscale meteorological systems (also in today's programme -> Kyle Heyblum, Jun Hu and Yuzhen Yan).

It became also **clear how difficult it is to validate some modelling studies** like David's and Andries's on mesoscale convective clouds. We can hardly make Di Wang's drone fly into such an MCS, let alone a tropical cyclone.Remote sensing tools are blind in clouds and few aircrafts dare to adventure themselves into these regions with strong vertical motion either.

So despite very fast recent progress there **are still challenges in terms of obtaining observations** in regions were we think isotopes could be super useful at different altitudes in the troposphere especially also upper troposphere, inside and outside clouds, in the vapor and in the cloud water. We saw such measurements in a few talks: they are still in their infancy.

To conclude we can say that we may expect breakthroughs to come in the next few years **given the combination of many great experimental and modelling tools we have built up as a community in the last few years.**

And therefore this is a very exciting time to work in this field!

Outlook on coupled isotope-enabled modelling

- Parametrisation of non-equilibrium fractionation during ocean evaporation
  → Marina Dütsch et al., Daniele Zannoni et al.
- Global cloud resolving modelling
  → Masahiro Tanoue et al.
- Isotope-enabled earth system modelling
  → Xiaxu Shi et al., Alison McLaren et al., Merve Gorguner et al., Kyle Heyblom et al., Nao Kurita et al.
  over 2000 years
  → Alexandre Cauquoin et al.
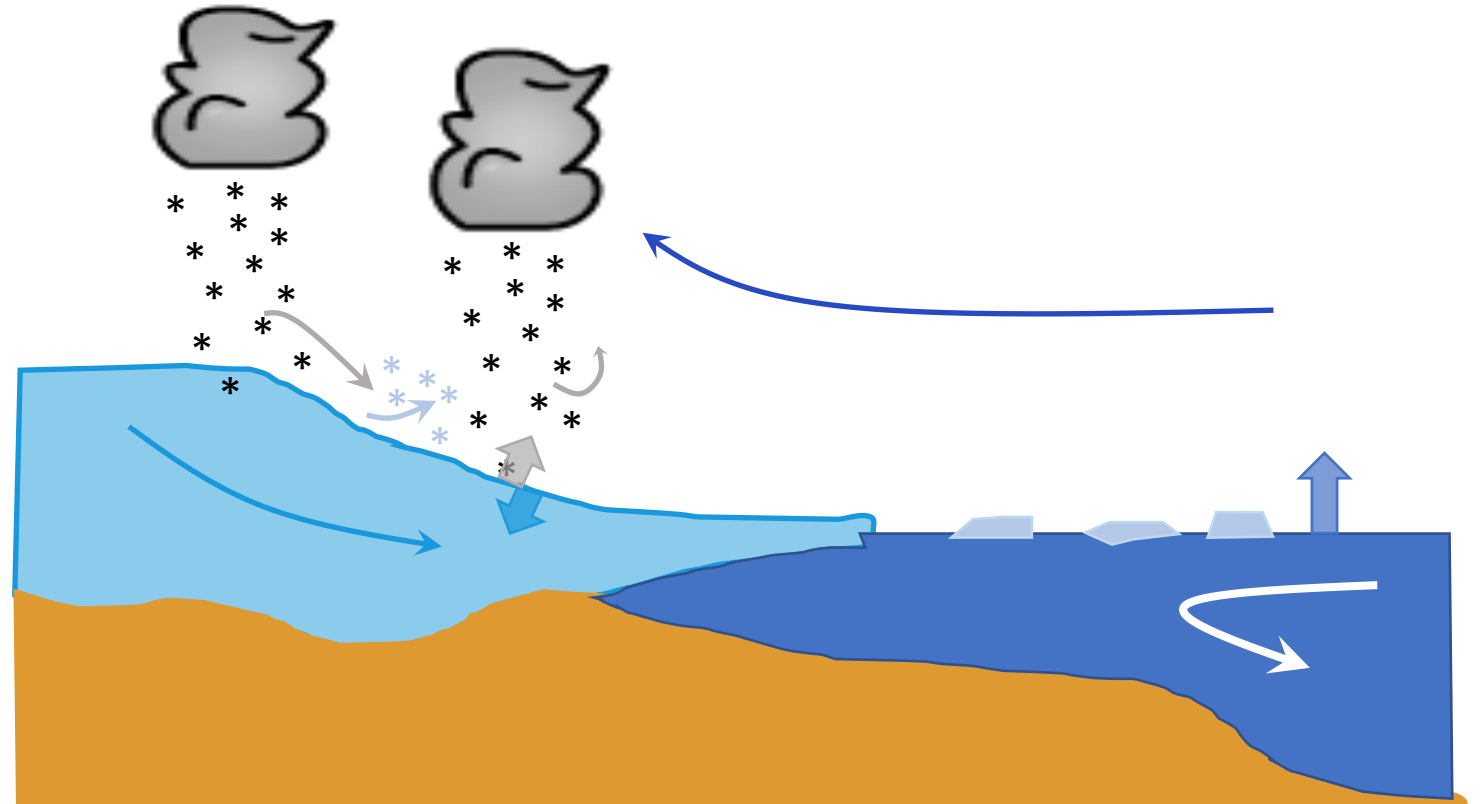
Outlook on coupled isotope-enabled modelling

- Combination with climate proxies
  → Atsushi Okazakhi et al., Satoru Shoji et al.
- Water vapour, precipitation, snow, and ice isotopes from Antarctica
  → Kanon Kino et al., Christophe Leroy-Dos Santos et al., Mathieu Casado et al., Yuzen Yan et al.
  and Greenland
  → Sonja Wahl et al., Chengfei He et al.