CEOP Cross Cut Studies

Isotope Cross Cut Studies (ICCS)

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&
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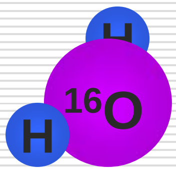
Stable Water Isotopes

- Proxy of integrated records of phase changes during hydrologic cycles.

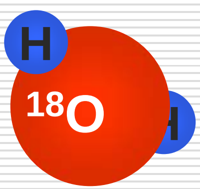


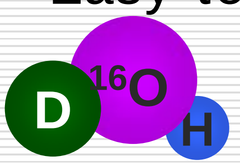
('Light' Water)
Easy to evaporate

H_2O

∧

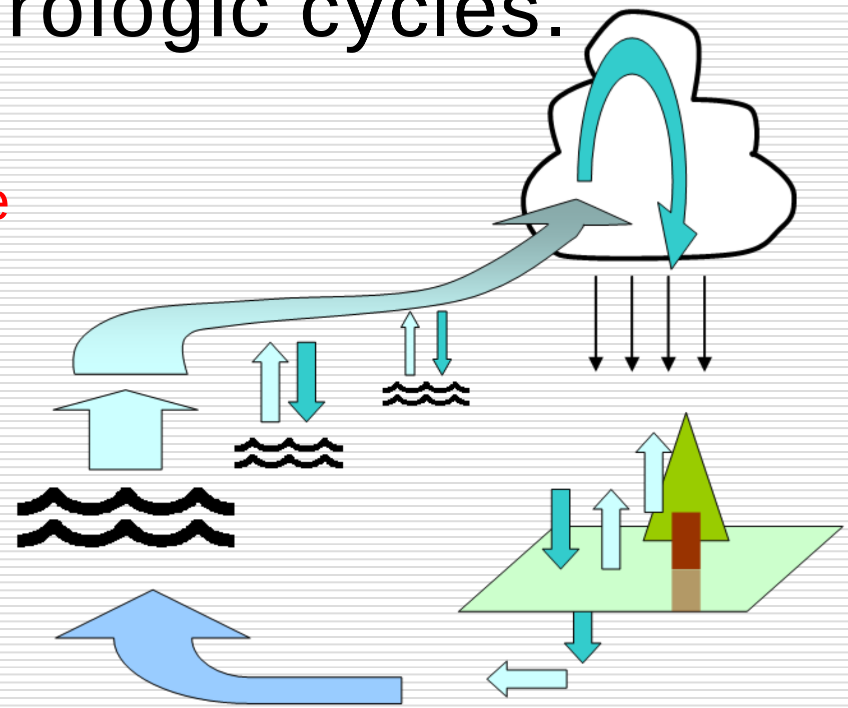
('Heavy' Water)
Easy to condense





$H_2{}^{18}O$ **0.20%**

HDO **0.016%**



"Fractionation" causes large spatial and temporal variability in isotope distribution.

ICCS Objectives:

- Facilitate isotope studies with modeling, in situ and remote sensed observations, and integration with other CEOP Elements.
- Understand isotopic processes in the hydrologic cycles and allow non isotope studies within GEWEX/CEOP to be enhanced by knowledge of isotopic constraints.
- Improve facilitation access to isotopic data (in-situ observations, and remote sensing data, and model simulation results) from other CEOP Elements.

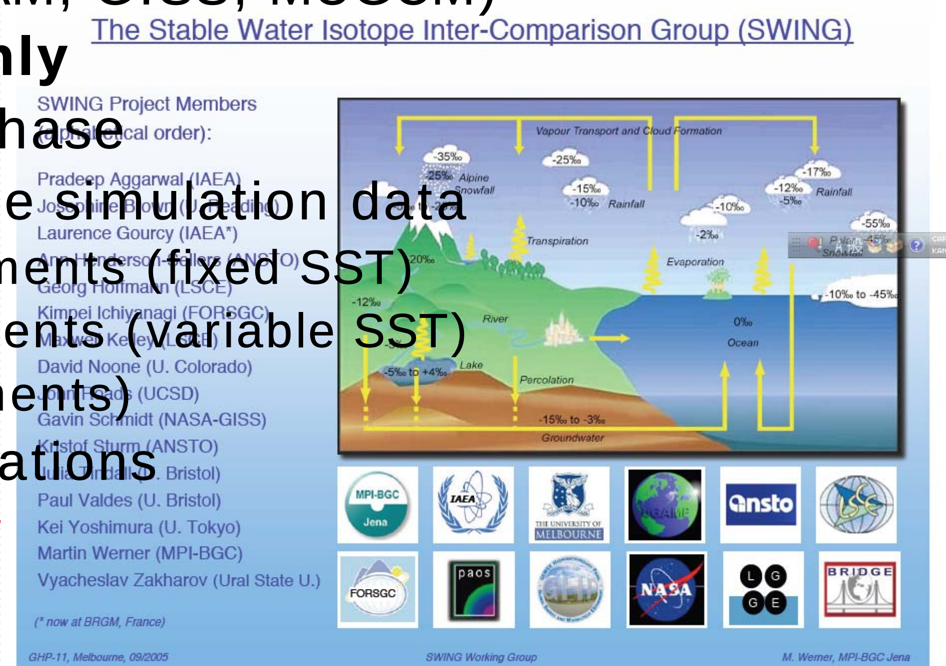
Implementations in 2007-08

- Continue to host and maintain model output database for SWING and community members
  - Proceeded to SWING-2.
- Analyze results in a summary paper
  - Yoshimura et al., 2008; Buenning and Noone, 2008
- Compile observational datasets for comparison
  - Monthly & sub-monthly data: Bowen, 2008.
- Develop satellite climatology of isotopes in atmospheric vapor
  - TES data: Worden et al., 2007; Brown et al., 2008
- Establish group Phase 2 experiment based on SWING member interest, and wider community interest
  - Kick-off meeting will be held in November.

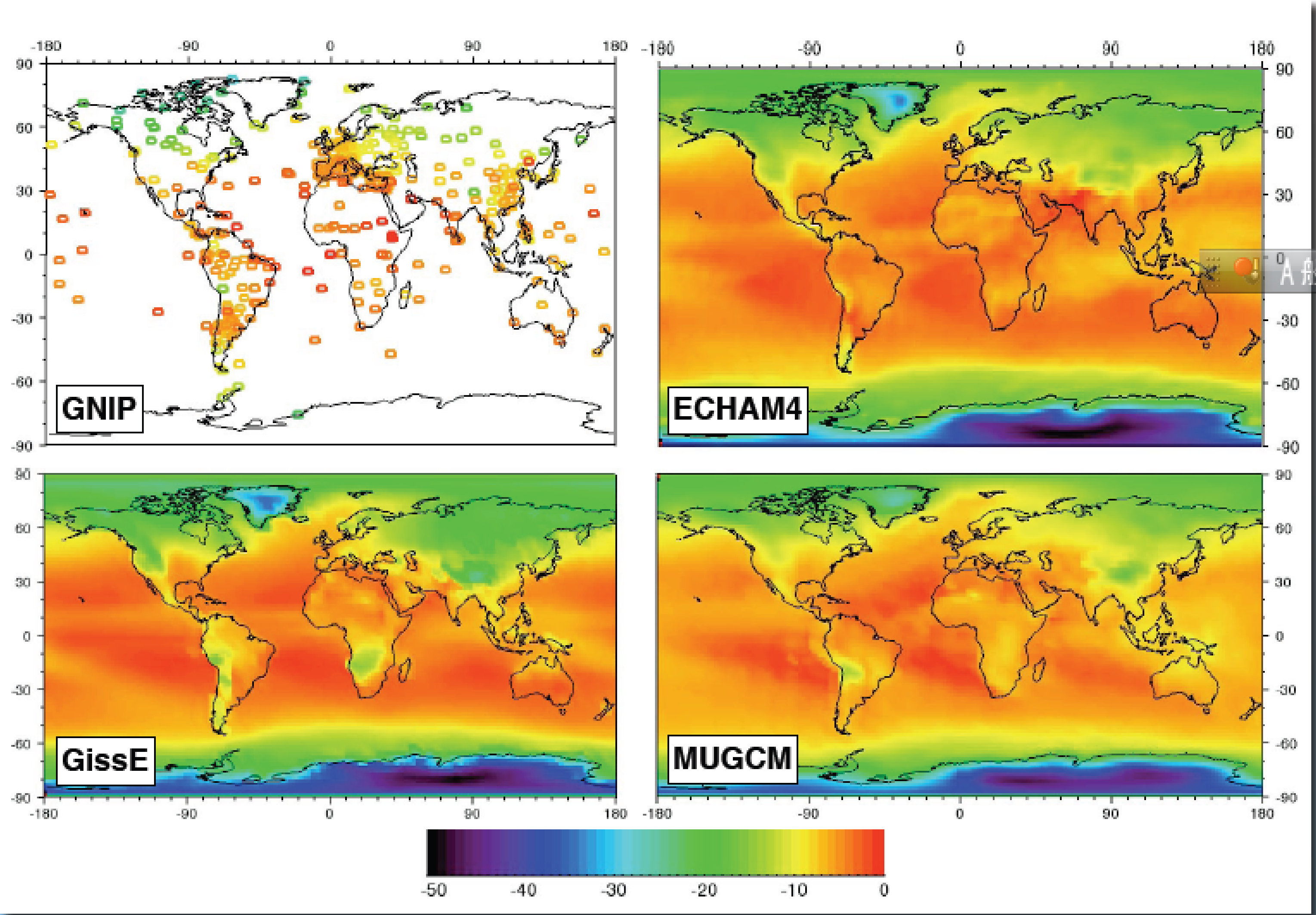
SWING

The Stable Water Isotope Inter-comparison Group

- SWING first phase
  - Active period: 2004-2007
  - Chair: M. Werner (MPI) to D. Noone (CU)
  - Authorized by IAEA
  - Took part of GHP/GEWEX
  - Three Iso-AGCMs (ECHAM, GISS, MUGCM)
  - **Institution funding only**
- Achievement of the first phase
  - Public data archive of the simulation data
    - 20-year control experiments (fixed SST)
    - Common 20^{th}c experiments (variable SST)
    - (Common LGM experiments)
  - 2 papers, many presentations



Simulated Global Pattern of $\delta^{18}O$ in Precipitation



Martin Werner
Max-Planck-Institute for Biogeochemistry

"Take Home Message"

- Stable water isotopes are a useful additional tracer for water cycle studies
- Hydrological Cycles of GCMs can be improved by the incorporation of stable water isotopes
- SWING experiments serve as a common standard to evaluate isotope GCMs
- SWING model data might help to improve the understanding of observed isotope values in precipitation (or other water pools)

Further Information:

SWING: www.bgc-jena.mpg.de/projects/SWING

GHP: http://ecpc.ucsd.edu/projects/ghp

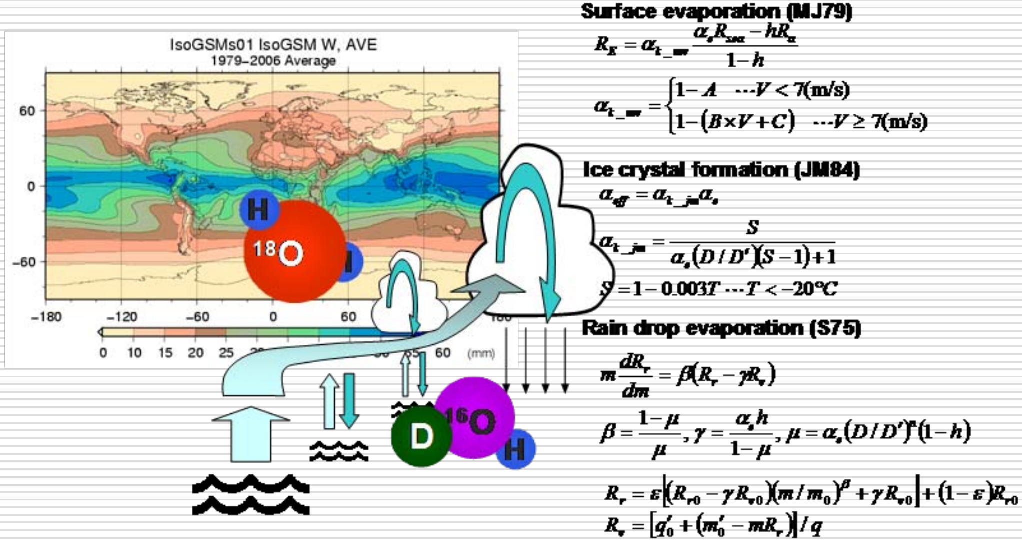
IPILPS: http://ipilps.ansto.gov.au

SWING-2

- Kick-off in 17-19 November in IAEA HQ; chaired by C. Sturm, K. Yoshimura & D. Noone.
- More isotopic AGCMs (at least 9) and 2 isotopic RCMs.
- Add nudging experiments to focus on only isotopic parameterizations and on more realistic reconstruction of isotopic variations.
- More focused on hydrologic cycle than climatology

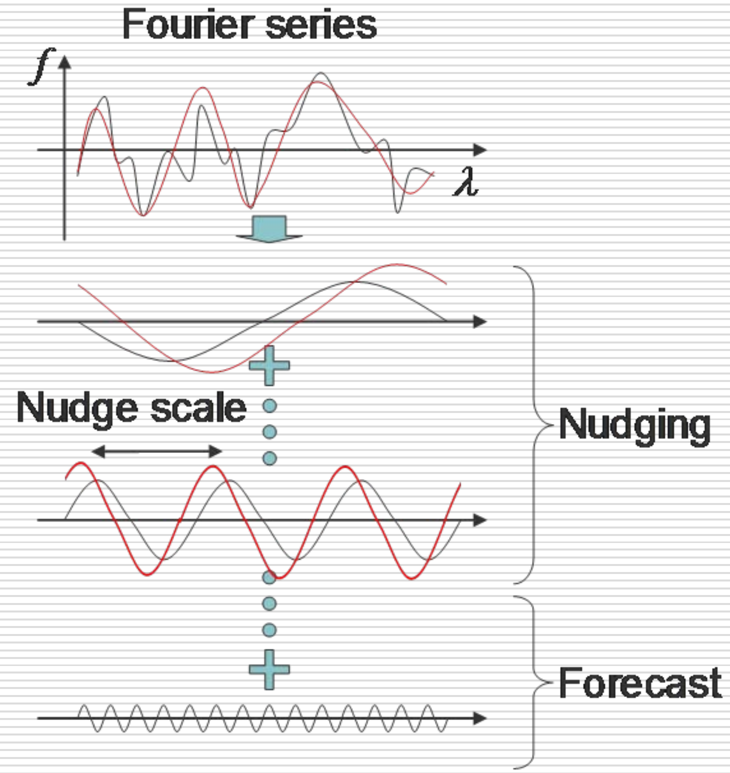
Nudging experiment with IsoAGCM

(http://meteora.ucsd.edu/~kyoshimura/IsoGSM1)



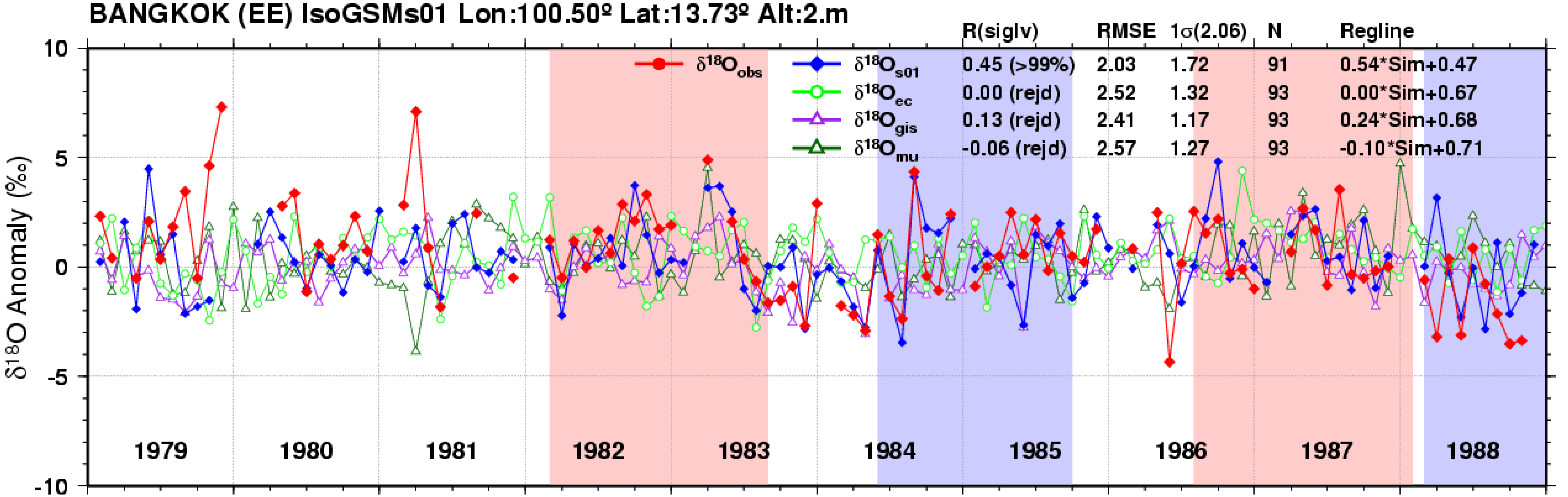
IsoGSM

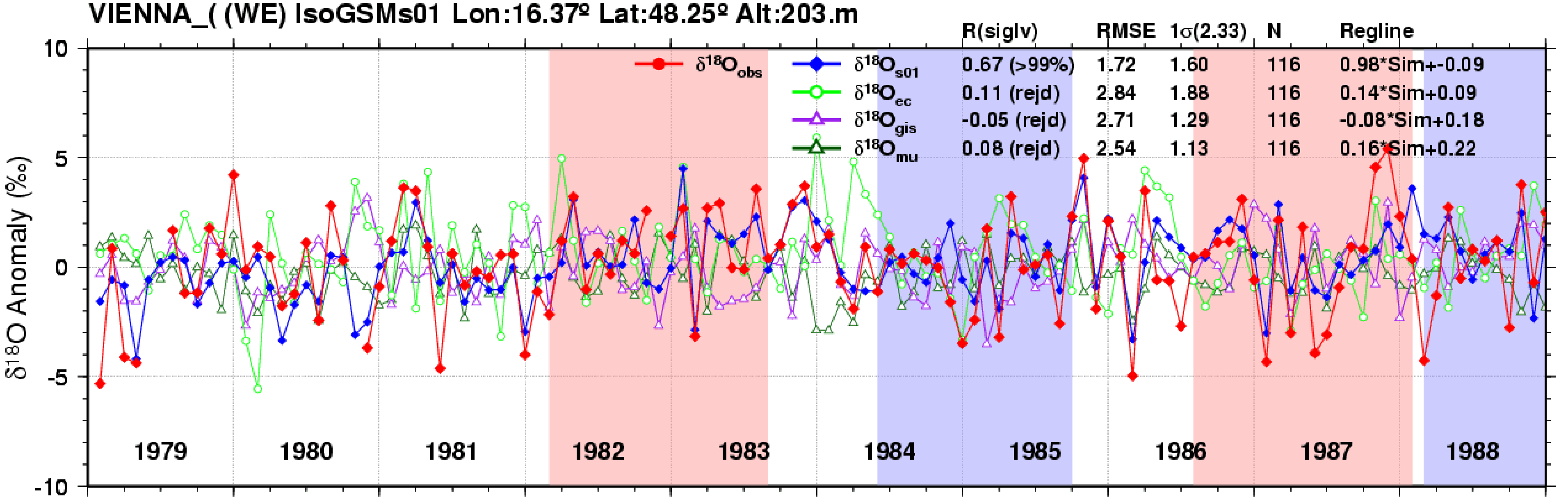
SIO/UT Isotopic Global Spectral Model



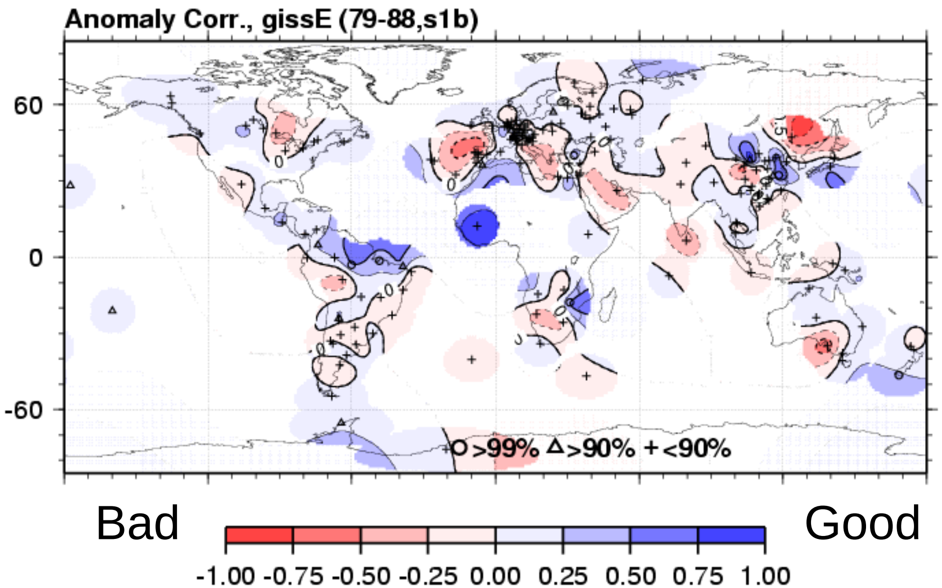
Use large scale (>1000km) winds to constrain dynamical field and
try to reproduce global isotope fields in daily to inter-annual time scales.

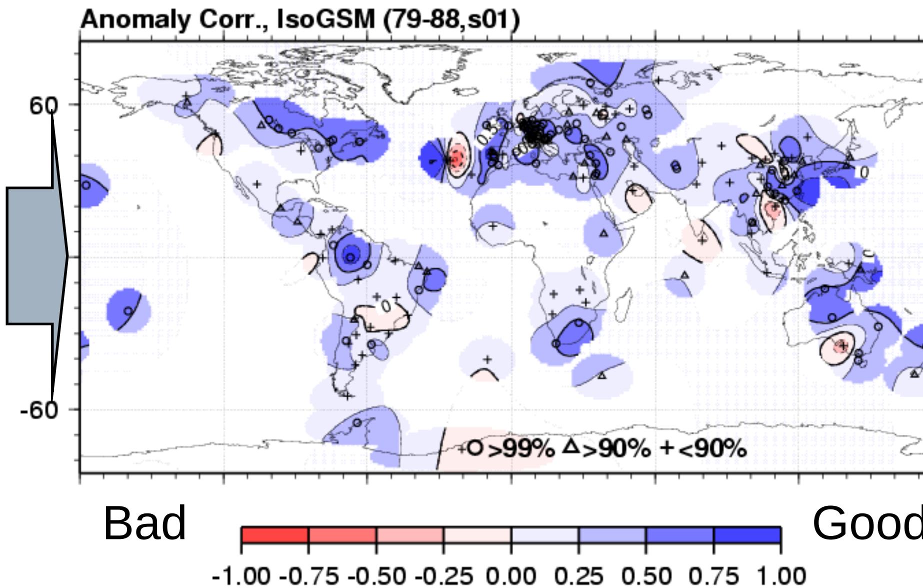
Performance of IsoAGCM+Nudging





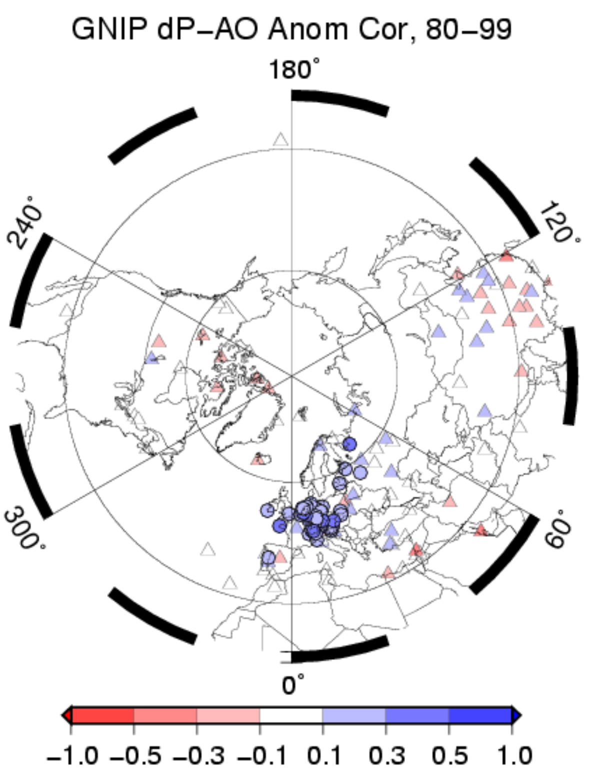
Performance of IsoAGCM+Nudging



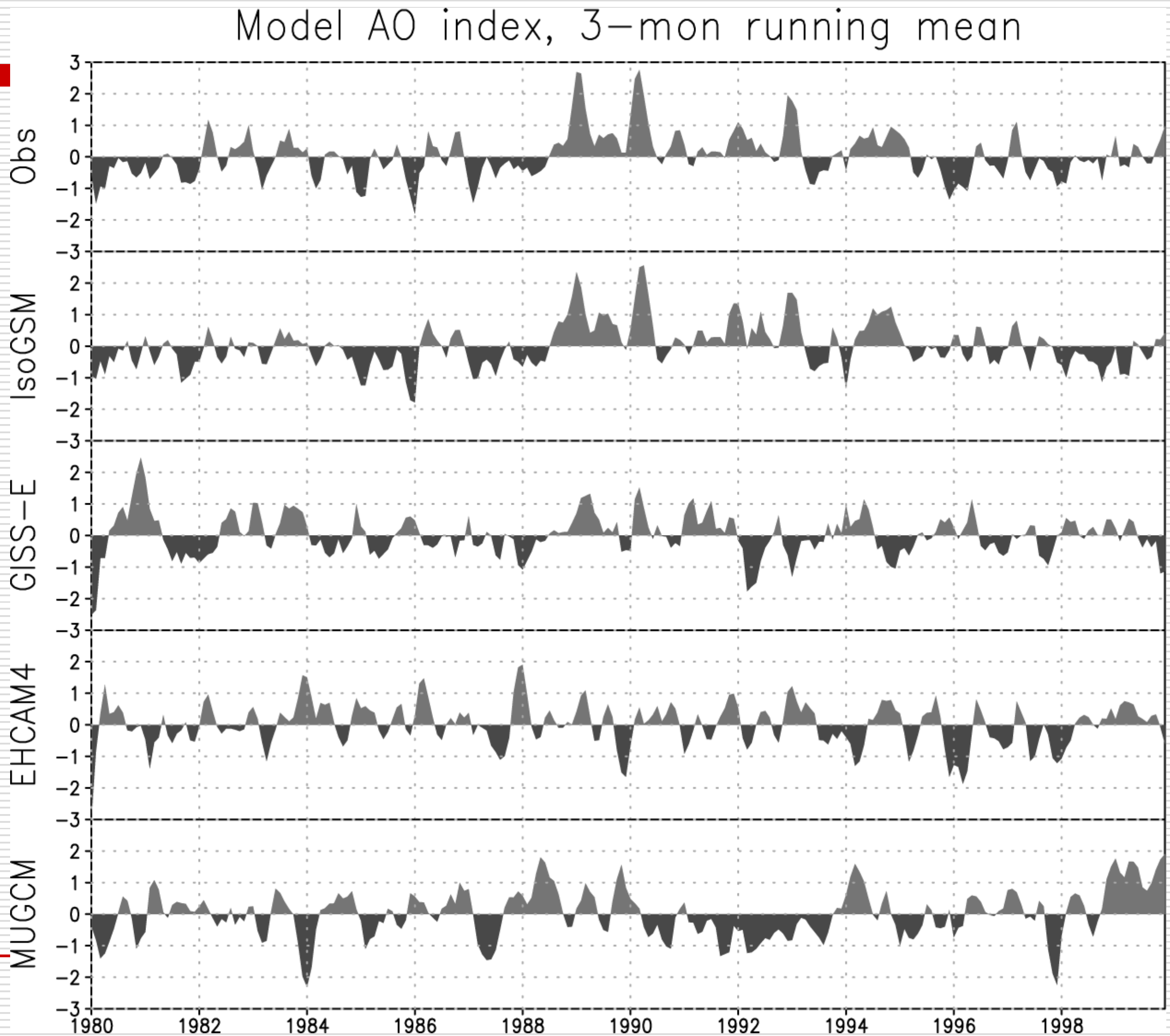


Comparison with GNIP for 1980-1999					
		ECHAM	GISS-E	MUGCM	IsoGSM
Correlation	NH (210)	147	171 (81%)	116	174 (83%)
	Tropics (142)	68	82 (58%)	46	96 (68%)
	SH (37)	22 (60%)	18	16	25 (68%)
Anomaly Correlation	NH (146)	13 (9%)	12	6	114 (78%)
	Tropics (67)	9	12 (18%)	6	32 (48%)
	SH (29)	1	3 (10%)	1	12 (41%)

AO is a key for isotopic distribution in NH



Obs. AO-Isotope correlation



Objectives of SWING-2

- Evaluate the capability of climate models to represent the spatial and temporal variability of water isotope composition in precipitation
- Spatially and temporally interpolate the GNIP (Global Network of Isotope in Precipitation, IEAE/WMO since 1960’s) dataset by applying the nudging technique or something else.
- Deliver an optimal reconstruction of monthly gridded maps of water isotopes in precipitation, by merging simulations and observations
- Assess the uncertainties and confidence intervals of the above gridded data-set (for all approved methods)

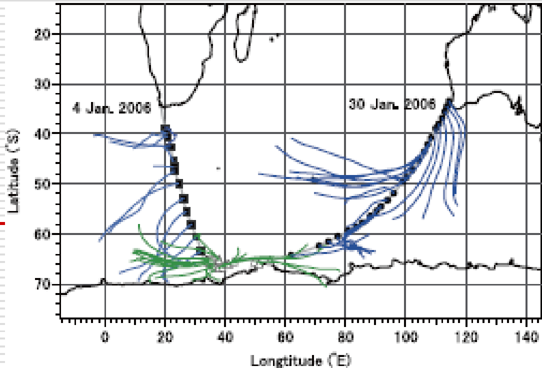
Lessons from SWING-1

- Not only from the isotopic community, but also wider interests from other scientific community should be included.
  - Usefulness of the isotopic datasets (“Quasi” isotope reanalysis, TES satellite observation data, in-situ data inventories) should be more advertized.
  - More involvement from CEOP elements is welcome.
- More wider isotopic interests needed: e.g., (land surface) hydrological processes, flood/drought records in lake/river sediments, eco-biological point of view (tree rings, coral, etc.).

- Should be officially (competitively) funded!

Observations

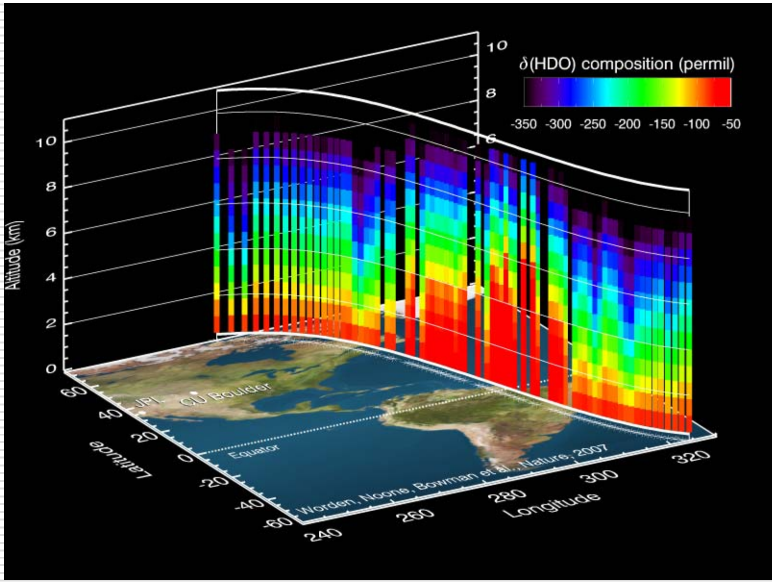
- In-situ observations
  - MAHASRI (Ichiyanagi et al.), Mongolia (Yamanaka et al.), Cold Region (Yang et al), Tibet(?), LBA(?), MDB(?), etc.
  - Biogeological foci (e.g. BASIN); isotopic ratio of ET flux is measurable by new vapor isotopic analyzer (portable and high frequency; e.g., Welp et al.). Carbon cycle is the primal interest.
  - Typhoon/Hurricane (e.g., Fudeyasu et al.), Storms (e.g., USGS/NOAA)
- Occasional ship measurements
  - Arctic Ocean (Uemura et al.), Indian/Pacific Ocean (Kurita et al.)
- TES/Aura vapor HDO observation



TES/Aura Vapor HDO observation

(Worden et al., 2007)

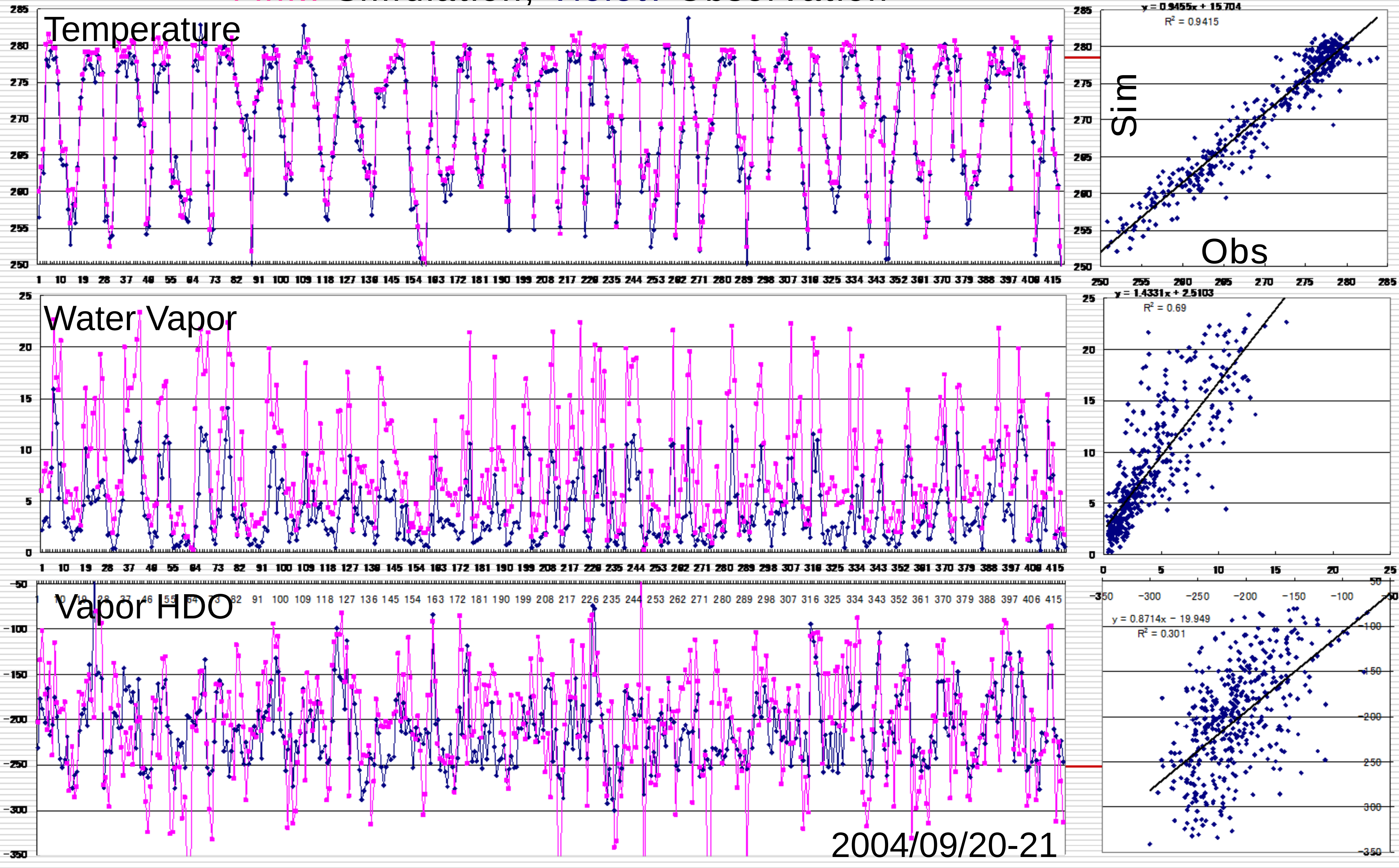
- Simultaneous profiles of HDO and H_2O from the thermal infrared radiances 1,200 ~ 1,350 cm^{-1}.
- Mean δD between 550 and 800 hPa.
- A typical precision of 10‰ in the tropics and 24‰ at the poles.
- Horizontal footprint of 5.3 km by 8.4 km and temporal interval of approx. 3 minutes.



Dramatic increase of observation data in high resolution.

TES HDO Obs compared with Nudging experiment (Y08)

Pink: Simulation, Violet: Observation



Relation to the special CEOP foci

- Relation to Monsoon:
  - Relationship between monsoonal hydrologic cycle and isotopes in precipitation in daily to inter-annual time scales.
- Relation to HE:
  - “Altitude effect” in a classical way
  - Detail of isotopic processes in snow/cold circumstance should be more studied.
- Relation to Extreme:
  - Isotopic records (variability from mean) are indeed information of extreme. The isotopic community intrinsically has interest in extremes.
  - Studies on proxy information in isotopic record (e.g. stalactite vs number of storm, tree ring, etc.) are independently under going.

Concluding remarks

- Implements of the modeling and observation components have been going well.
  - Deliverables from the nudged experiment results and/or the TES data are available online for further analyses of one's own in-situ isotopic observations.
- Collaboration and/or integration with other CEOP elements should be more effectively established.
  - Any idea/recommendation?

ICCS Objectives corresponded to the GEWEX's

- Objective 1: Data
  - Provide to the community isotope datasets from models and associated compiled observations.
- Objective 2: Understanding
  - Find an alternate view of model errors, and give insight to the mechanisms controlling variability.
- Objective 3: Prediction
  - The SWING contributes to understand the differences in model hydrology though the isotopic information, which might help to improve the prediction skill.
- Objective 4: Applications
  - Many opportunities to work with other groups, which are not presently being exploited. Studies on cloud processes and surface exchange are typical examples.

Simulation of the (local) "Temperature Effect"