ESA - MOST Dragon 2 Programme
2011 DRAGON 2 SYMPOSIUM

中国科技部-欧洲空间局合作 "龙计划"二期
"龙计划"二期2011年学术研讨会

Dragon 2 – id 5341

DROUGHT MONITORING, PREDICTION AND ADAPTATION UNDER CLIMATIC CHANGES

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The Dragon Drought Project team

Principle Investigators

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Dr. Li Jia, Alterra, The Netherlands

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Prof. Qinhuo Liu, Institute of Remote Sensing Applications (IRSA/CAS), Beijing
Prof. Qiang Yu, Institute of Geographical Sciences and Natural Resource Research (IGSNR/CAS), Beijing
Prof. Xin Li, CAREERI/CAS, Lanzhou

Young scientists & team members

- **Young scientists co-investigators**
- Dr. Rogier van der Velde (land surface processes, soil moisture, ASAR, drought monitoring)
- Laura Dente (PhD student) (Soil moisture, SMOS, drought prediction)
- Dr. Lei Zhong (PhD student) (land surface processes, monsoon climate)
- Yijian Zeng (PhD student) (land surface and unsaturated zone processes)
- Xin Tian (PhD student) (forest ecological processes and SAR, ALOS)
- Dr. Longhui Li (PhD student) (agroecological processes, crop water use)
- Changbo Qin (PhD student) (integrated water resources management)

- **ITC team members**
- Ir. Wim Timmermans (field experiments)
- MSc. Lichun Wang (software development)
- Eng. Murat Ucer (field experiments)
- Ir. Marcel van Helvoirt (numerical modeling & data assimilation)
- Dr. Christiaan van der Tol (PhD supervision – Longhui Li)
- Dr. Suhyb Salama (PhD supervision – Lei Zhong)
- Dr. Zoltan Vekerdy (PhD supervision – Laura Dente)
- Prof. W. Verhoef (radiative transfer, data assimilation, PhD supervision)
- Prof. Z. Bob Su (general coordination, land surface processes, PhD supervision)

Outline

- Rationale & objectives of the project
- Methods
- ESA & TPM EO data acquisition and ground data collection campaigns
- Preliminary results – soil moisture retrievals & cal/val, modeling & water balance
- Plans for 2011-2012
- Publications

What is the problem?

Why Drought Monitoring, Assessment, Prediction and Adaptation ?

- Drought disasters have often caused great hunger, social instability, large scale migration of the population and extinction of civilizations in the history, e.g. SW China Droughts 2010, Yangtze basin 2011
- The conflict between supply and demand of water resources constitutes the biggest problem for food security of a huge population in China, e.g. S-N water transfer projects.
- Under climate change, more frequent droughts are anticipated, predication will be necessary for preparedness and adaptation will be essential, e.g. how to adapt?

Desertification in Minqing county, China

emigration of 800 people caused by desertification in 2007

Project Objectives:

- Develop a quantitative and operational system for nation wide drought monitoring
- Conduct drought impact assessment
- Extend the system to drought prediction
- Develop adaptation strategies to climate change

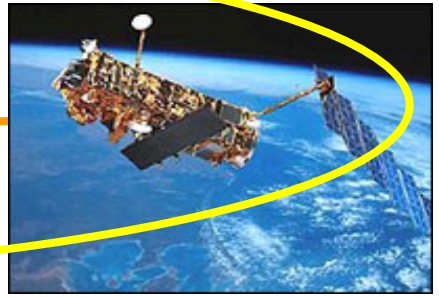
Approaches for Drought Monitoring, Assessment, Prediction and Adaptation

- 1: Quantify the available water content in the rooting zone
- 2: Deploy field experiments for process understanding and cal/val purposes
- 3: Early drought detection by time series analysis on vegetation response to water availability through integration of multiple sensor observations
- 4: Hydrometeorological modeling and data assimilation for drought simulation and prediction
- 5: Development of integrated water resources management for adaptation under climate change

Drought Monitoring, Assessment, Prediction and Adaptation under Climatic Changes

Atmospheric model or routine meteorological data

Climate & Satellite Information System

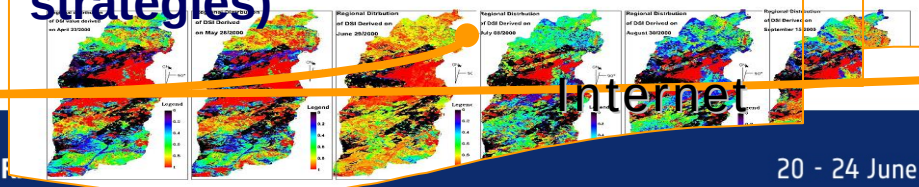


Surface Energy Balance System (SEBS)

Surface Soil Moisture

Data Assimilation

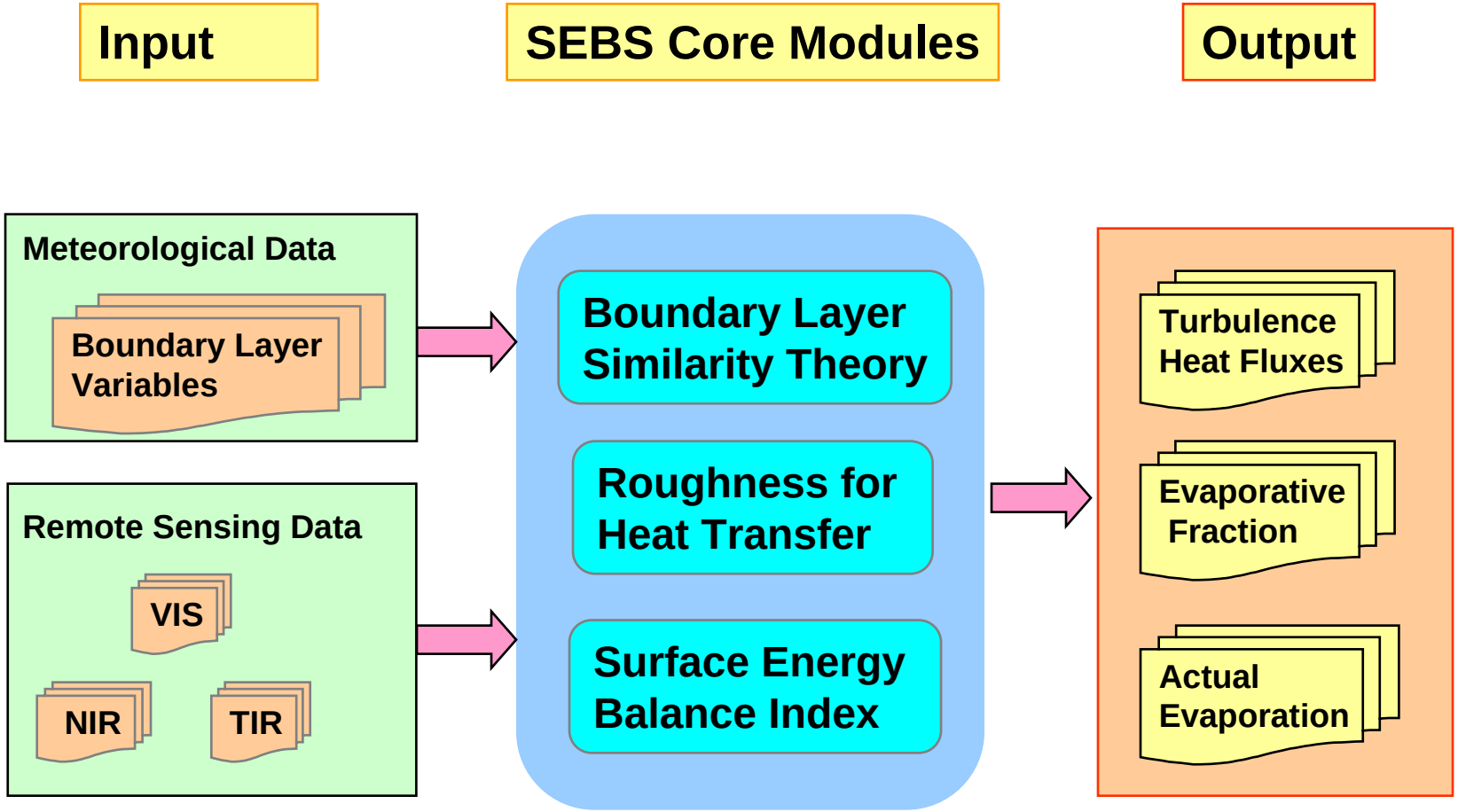
Drought Information System (Drought severity distribution, prediction and adaptation strategies)



Internet

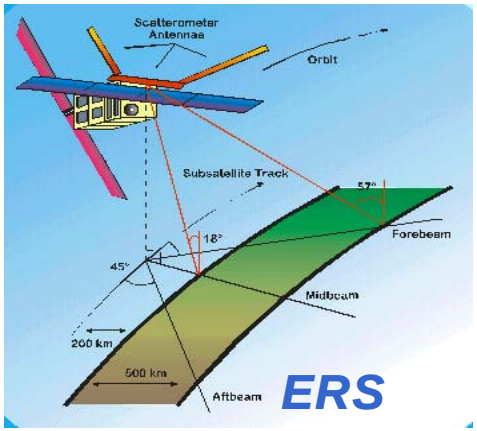
Decision Makers

SEBS - The Surface Energy Balance System (Optical/Thermal satellite data) (Fluxes)

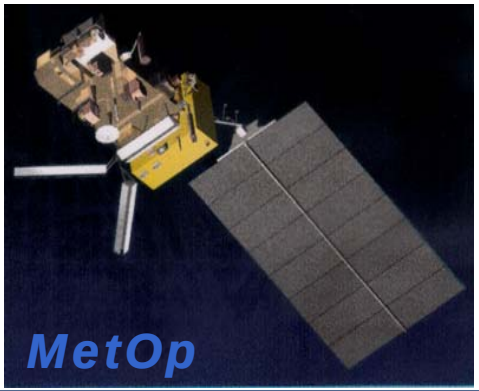


Z. Su, 2002, The Surface Energy Balance System (SEBS) for estimation of turbulent heat fluxes, *Hydrology and Earth System Sciences*, 6(1), 85-99.

Microwave remote sensing of soil moisture (storage change)



Chinese TPM Satellites



SMOS

GOCE

Ground Data Collection Sites

- 9 field experiment sites for the development and validation of algorithms.
  - 4 sites in Europe (Barrax in Spain, Cabauw, Speulderbos and Lattrop sites in the Netherlands)
  - 5 sites in China (TORP/CAMP/Tibet site, The Heihe Oasis-Desert Site, CAS Luancheng agro-ecological Observation Station (Hebei), CAS Xiaotangshan & Shunyi field experiment sites in Beijing, Maqu & the Yellow River Headwater Site, Ngri operational from 2010).
- 600 application demonstration sites with routine meteorological observations made by the China National Meteorological Center.

EO Data and Ground Data Collection Campaigns

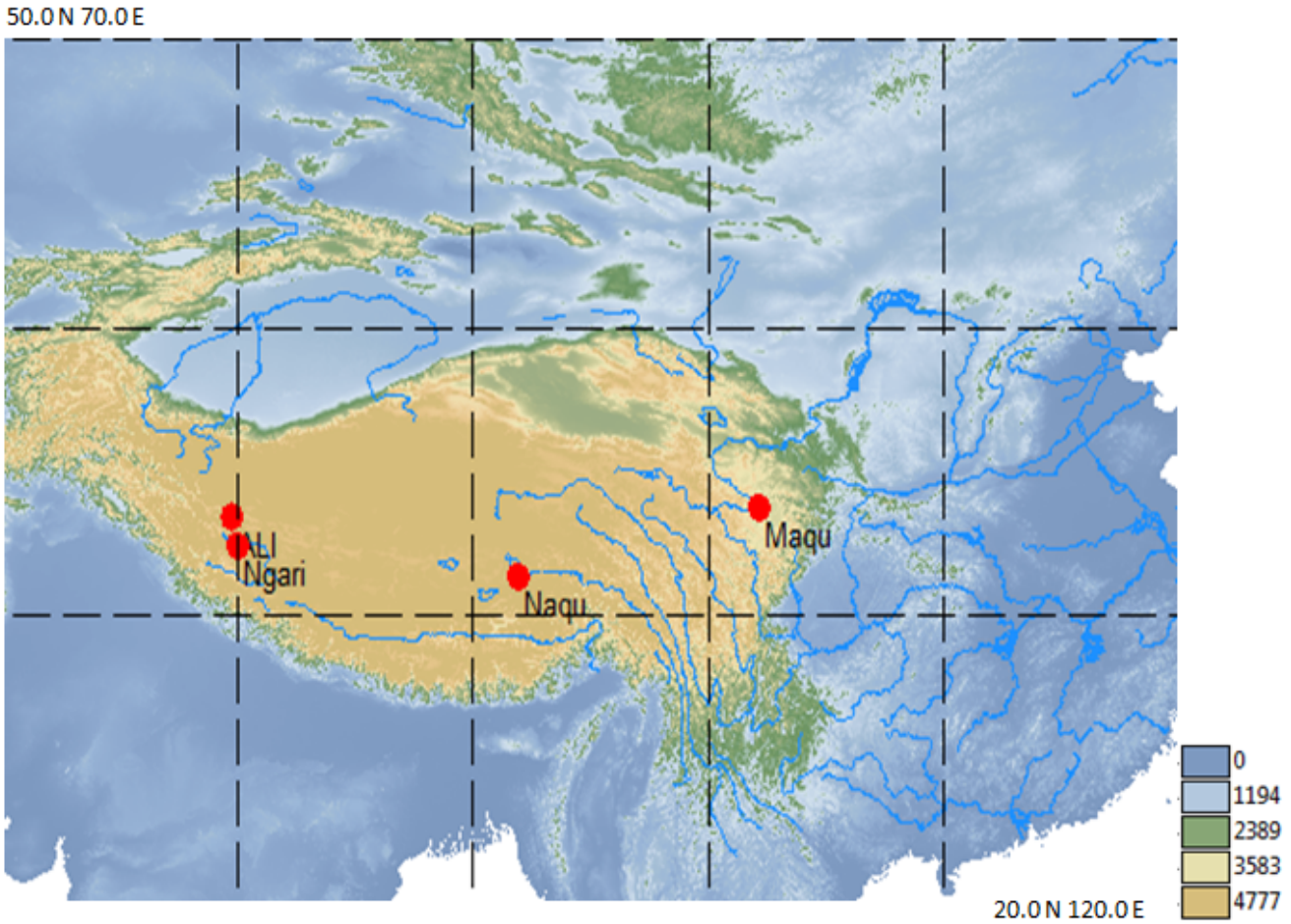
- EO data products requested:
  - ESA EO data (ERS, ENVISAT and Earth Explorer mission data)
  - Chinese EO data (FY)
  - ESA TPM data.
- Routine meteorological data and global/regional atmospheric model outputs
- General purpose field campaigns for algorithms development and validation

  (SPARC2004, SEN2FELX2005, CAMP/Tibet, EAGLE2006)
- Dedicated soil moisture field experiments (Tibetan soil moisture experiments and desert experiments).

Preliminary results

- Preliminary results – in situ & satellite observations, retrievals & cal/val, modeling
- Plans for 2011-2012
- Publications

ITC/CAS Soil Moisture Networks



ESA Dragon programme
EU FP7 CEOP-AEGIS project
ESA WACMOS

ITC Earth Observation Research and Education Sites – Naqu site

The Role of the Tibetan Plateau in Global Climate

(Collaboration with Chinese Academy of Sciences)

GEWEX Asian Monsoon Experiment (GAME) in the Tibet Plateau (GAME/Tibet,1996-2000)

CEOP (Coordinated Enhanced Observing Period) Asia-Australia Monsoon Project in the Tibetan Plateau (CAMP/Tibet, 2001-2005)

Tibetan Observation and Ressearch Platform (TORP, 2005 -2010)

Third Pole Environment (2009 -2019)

Coordinators: Y.Ma & T.Yao (China)

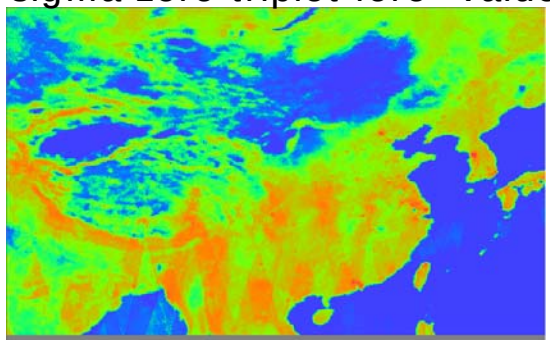
ITC Earth Observation Research and Education Sites – Maqu and Upper Yellow River site

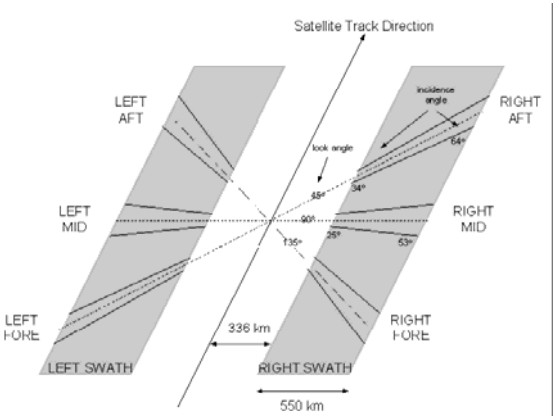
The Role of the Tibetan Plateau in Global Climate

(Collaboration with Chinese Academy of Sciences)

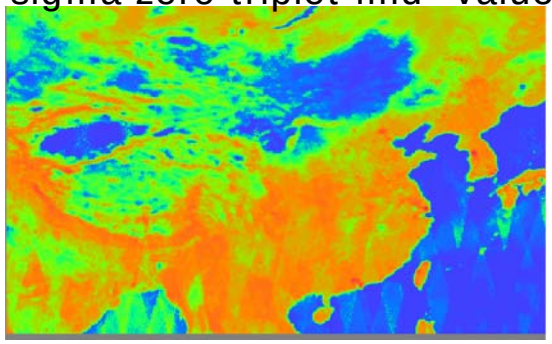
Part I – soil moisture retrievals, cal/val

sigma zero triplet fore- values

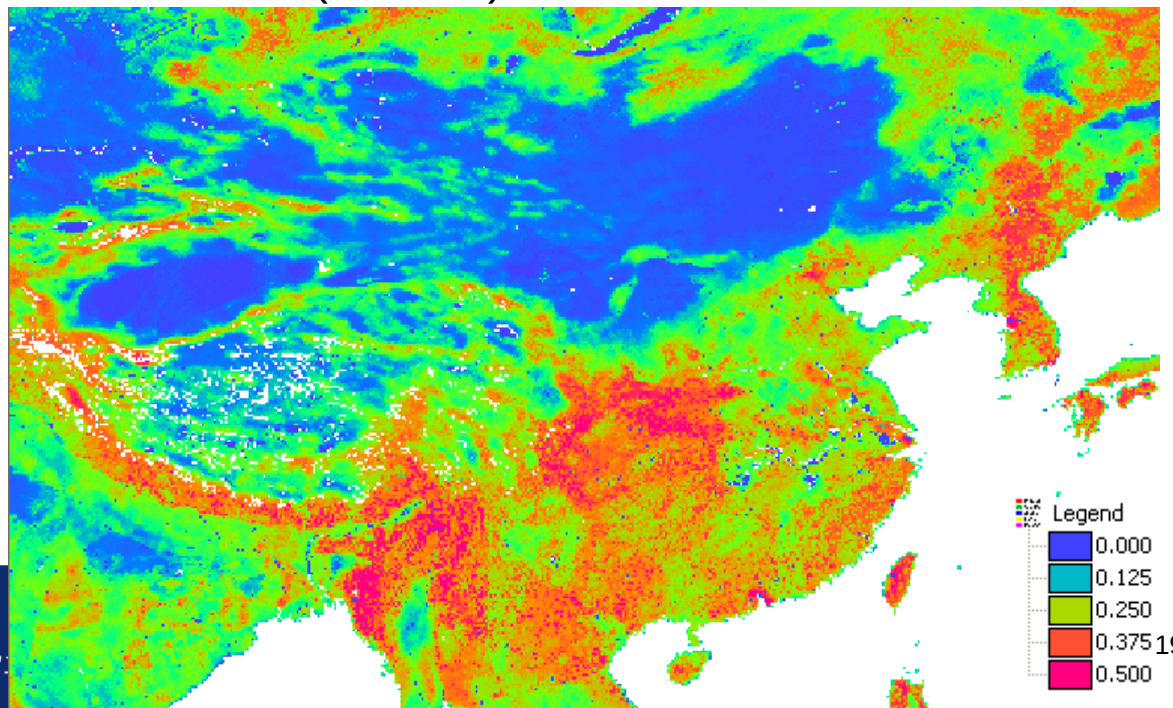




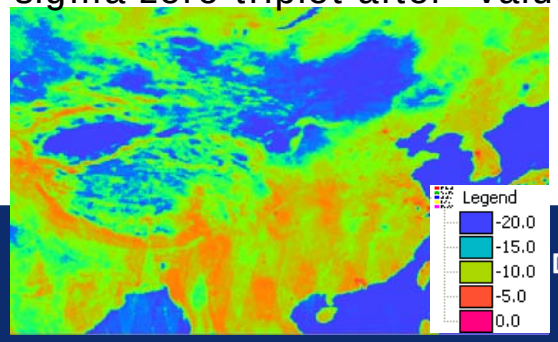
sigma zero triplet mid- values



Soil moisture (m^3/m^3)

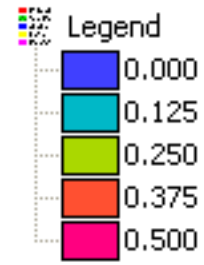


sigma zero triplet after- values

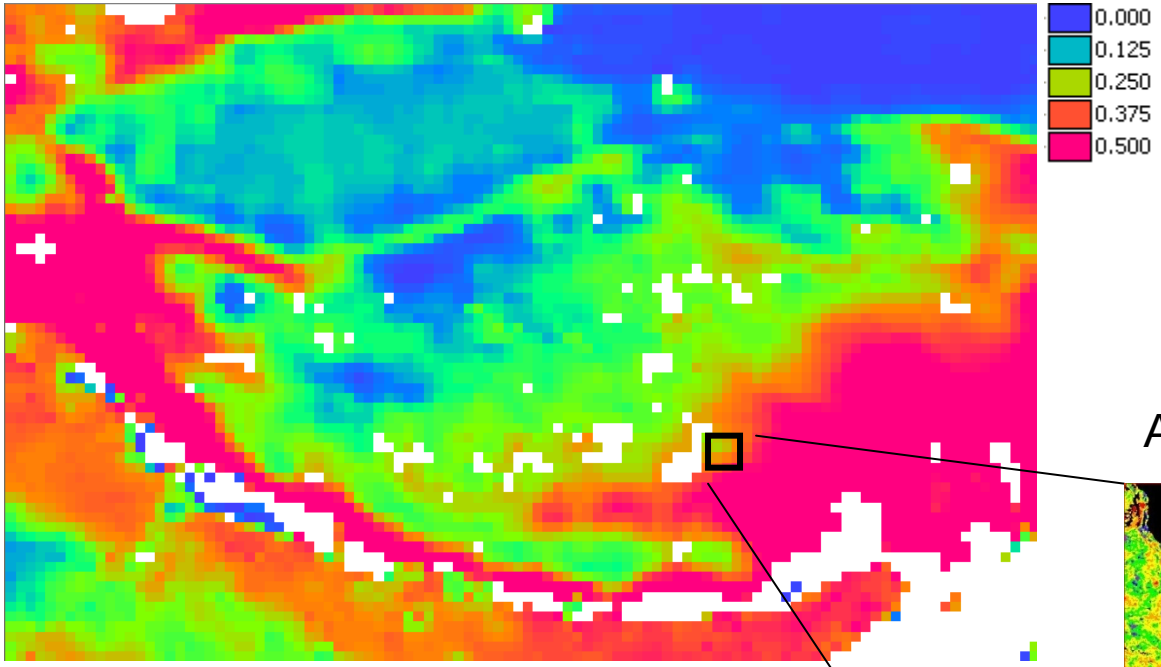


Volumetric soil moisture, ASCAT data (1-7 July 2007)

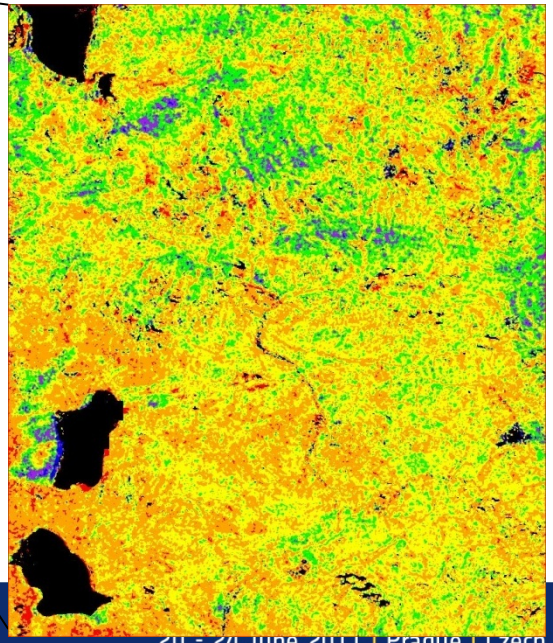
Volumetric soil moisture, AMSR-E VUA-NASA product (average, 1-7 July 2007)



Tibetan Plateau Average vol. soil moisture 1-7 July 2007 AMSR-E VUA-NASA

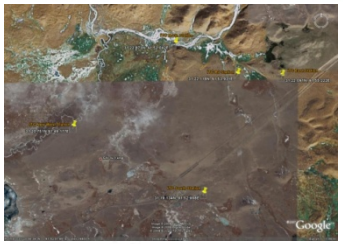


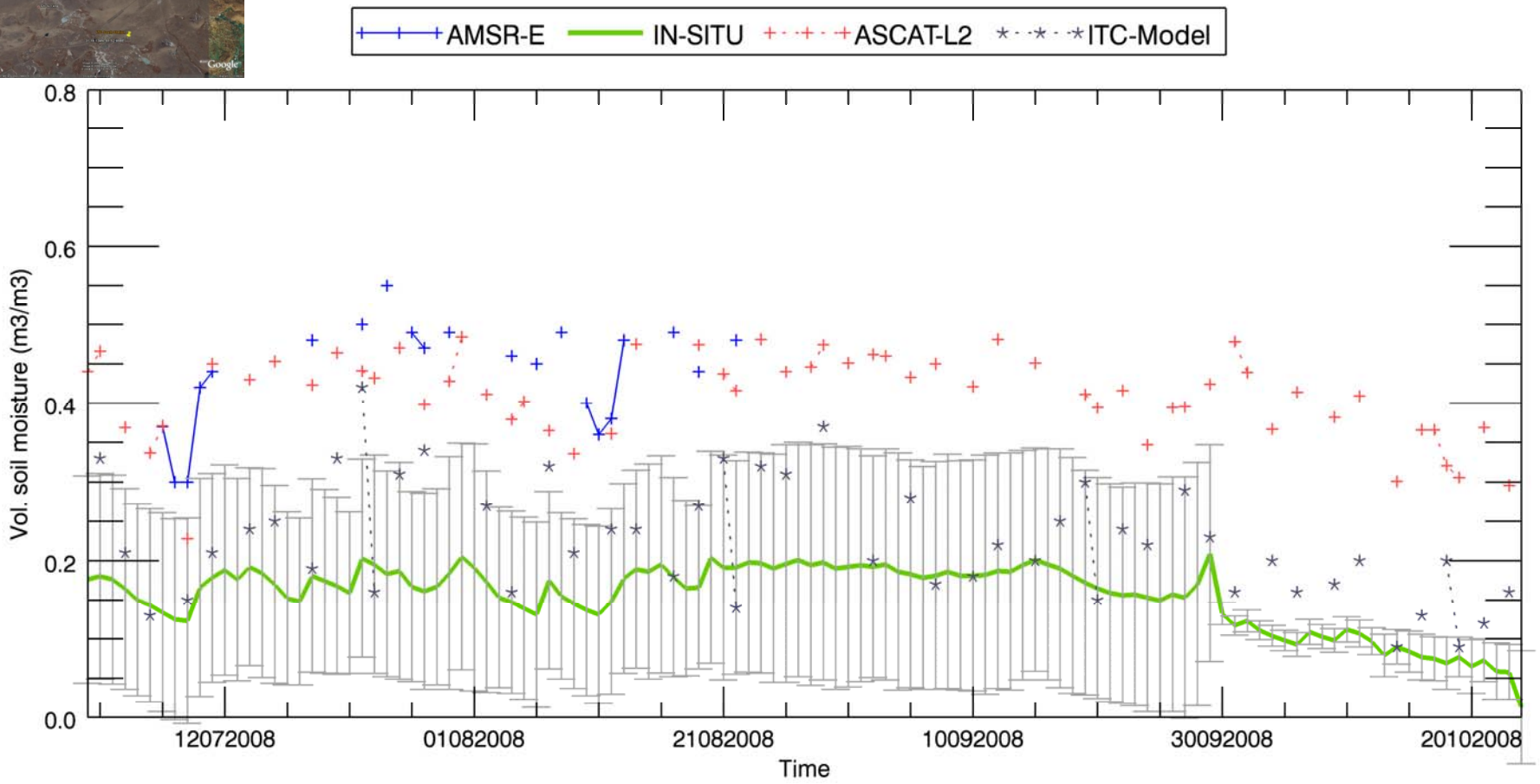
ASAR (ITC)



Naqu area Vol. soil moisture Jul 07, ASAR
(Details see Talk by Rogier van der Velde)

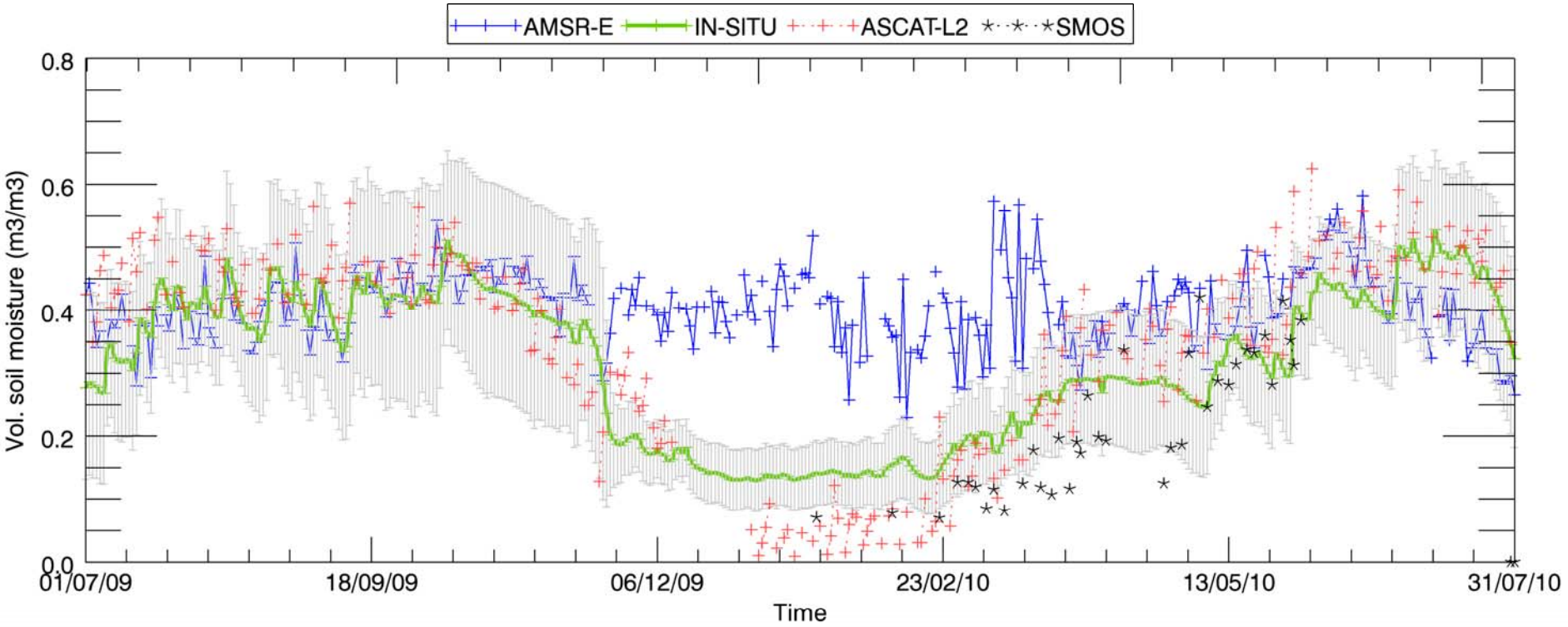
Validation of soil moisture retrievals at Naqu site (Cold & semi-arid), Tibetan plateau





Su et al., 2011, HESSD

Maqu site - Validation of soil moisture retrievals (Cold & humid site), Tibetan plateau

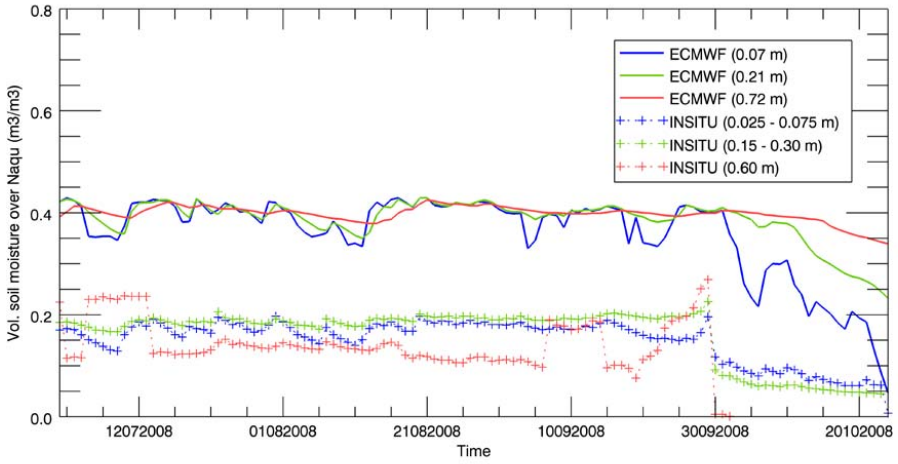


Part II - model outputs

- **Ability of the ECMWF model in simulating and analysis of root zone soil moisture on the Tibetan plateau**
- **(Su et al., 2011, JGR – in review)**

Figure 2a. Soil moisture from the ECMWF operational run (ECMWF-OI, where the SM analysis uses the Optimal Interpolation method) compared to in-situ measured soil moisture in the Naqu network area.

Figure 2b. Soil moisture from the ECMWF-EKF-ASCAT run (using the EKF soil moisture analysis with ASCAT data assimilation) compared to in-situ measured soil moisture (green) at the Naqu network area.



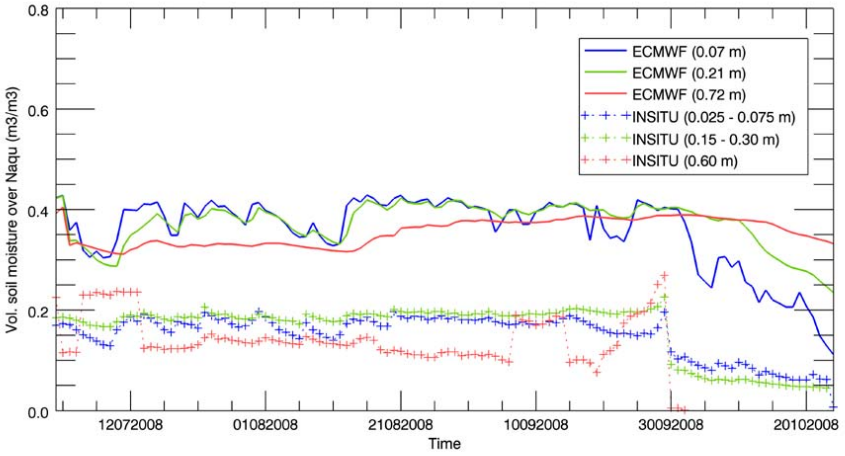
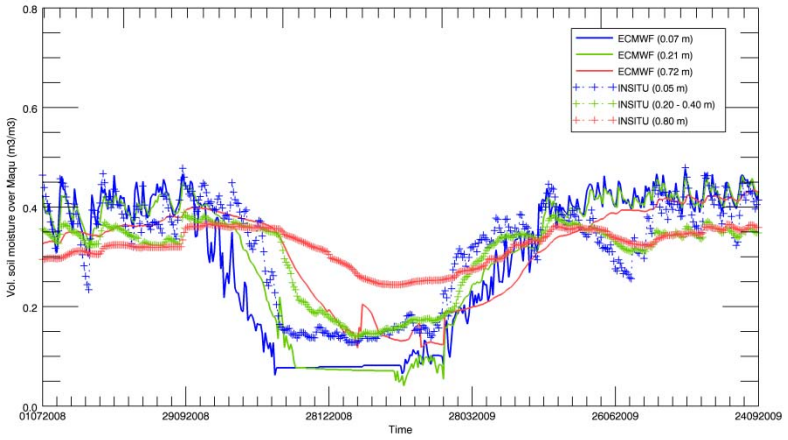
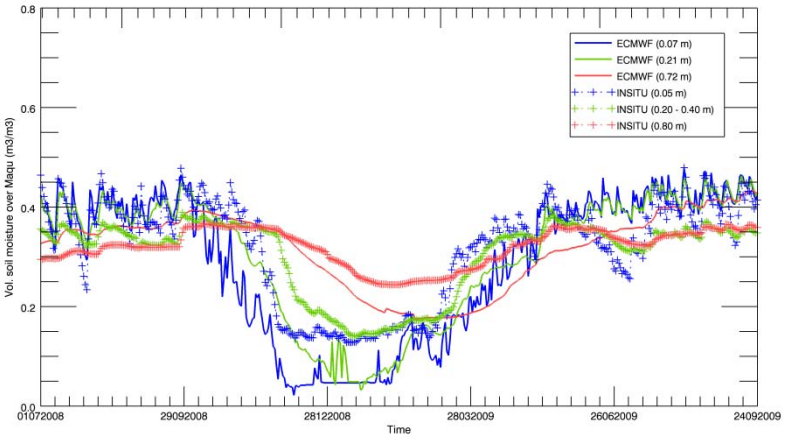


Figure 3a. Soil moisture from the ECMWF operational run (ECMWF-OI, where the SM analysis uses the OI) compared to in-situ measured soil moisture at the Maqu network area.

Figure 3b. Soil moisture from the ECMWF-EKF-ASCAT run (using the EKF soil moisture analysis with ASCAT data assimilation) compared to in-situ measured soil moisture at the Maqu network area.

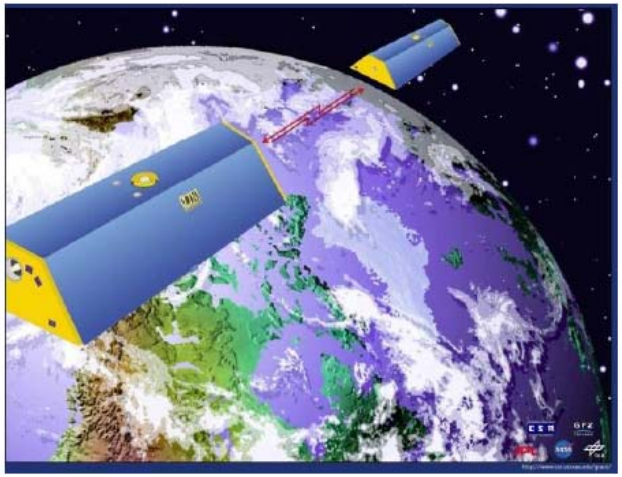


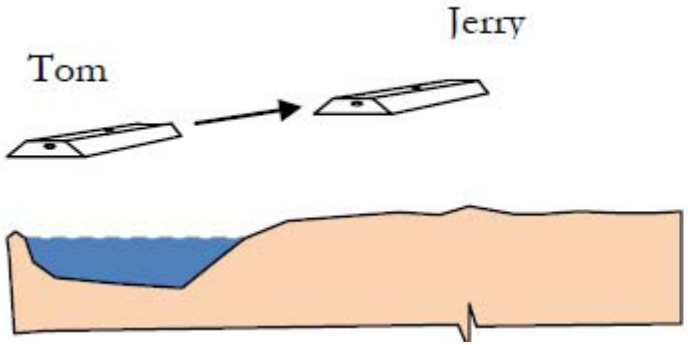


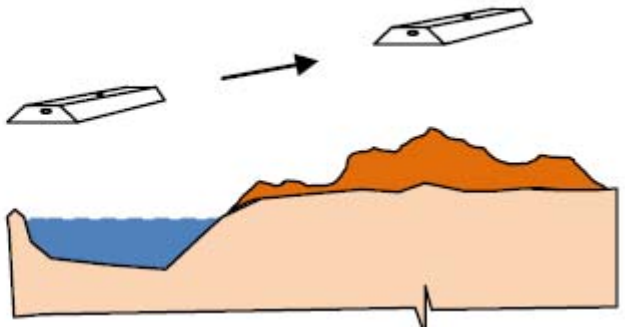
Part III –Terrestrial Water Storage

- An example in the Upper Yellow River
- (in prep. Su et al., 2011)

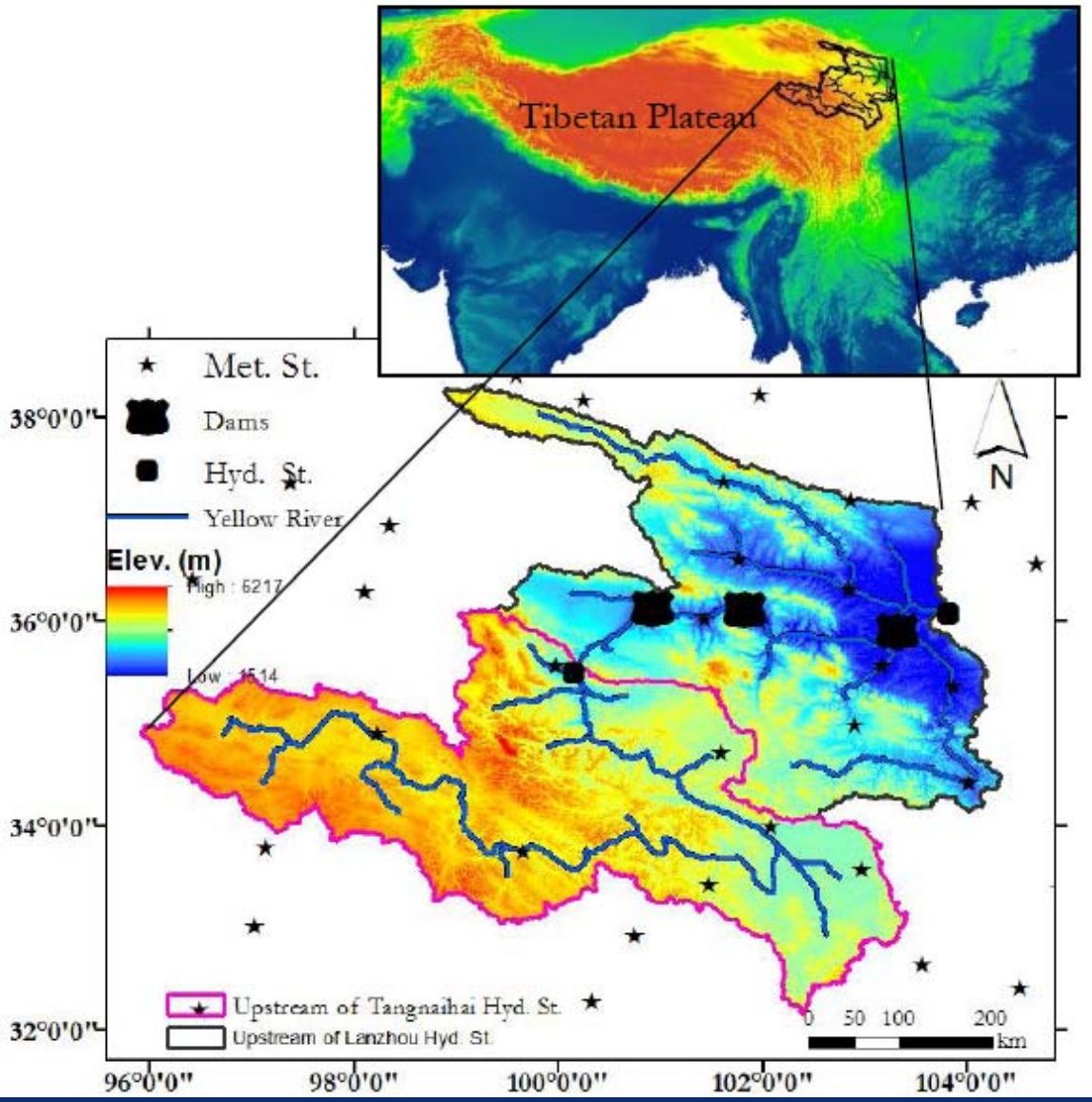
Space Gravimetry
(The Gravity Recovery and Climate Experiment (GRACE))



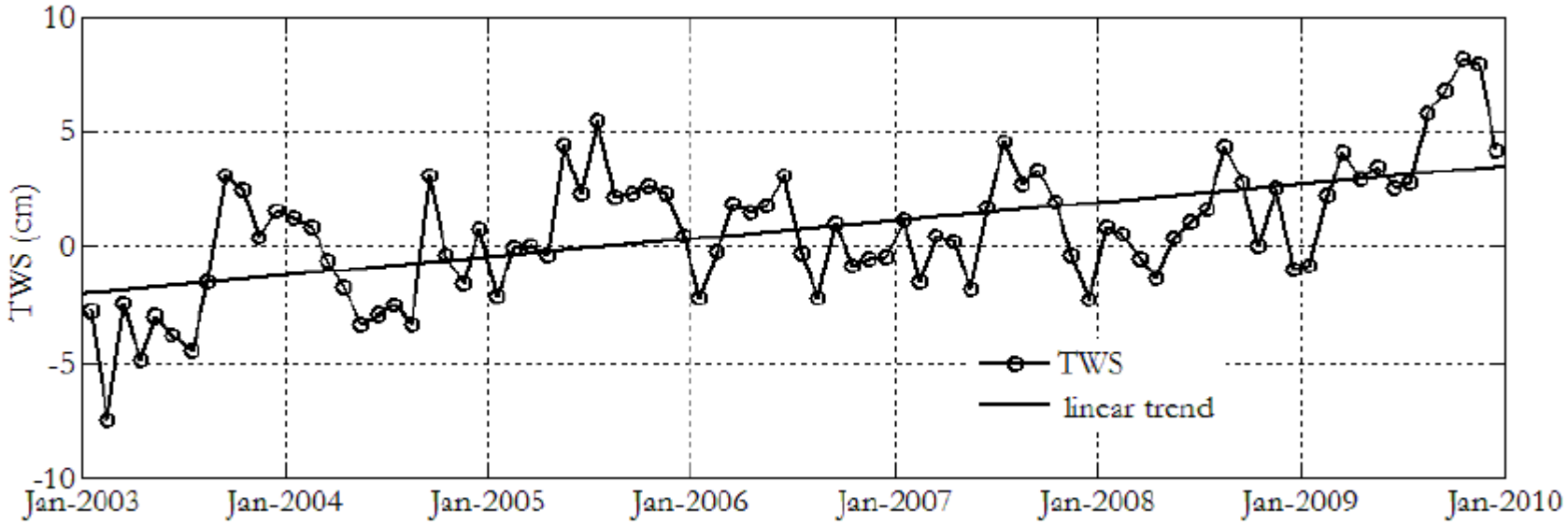


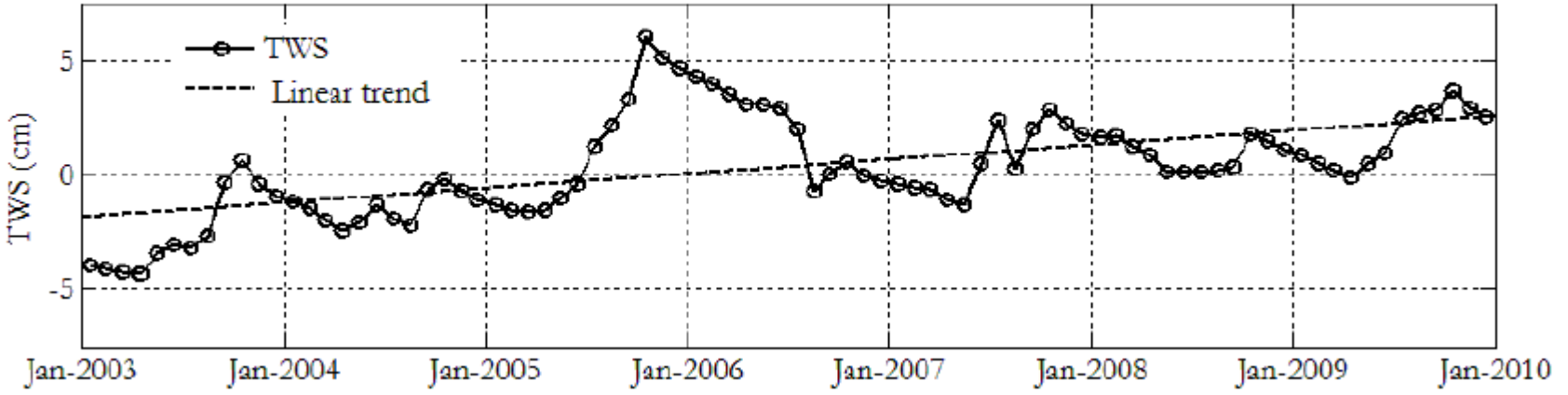


Upper Reach of Yellow River basin in northeast Qinghai-Tibetan plateau

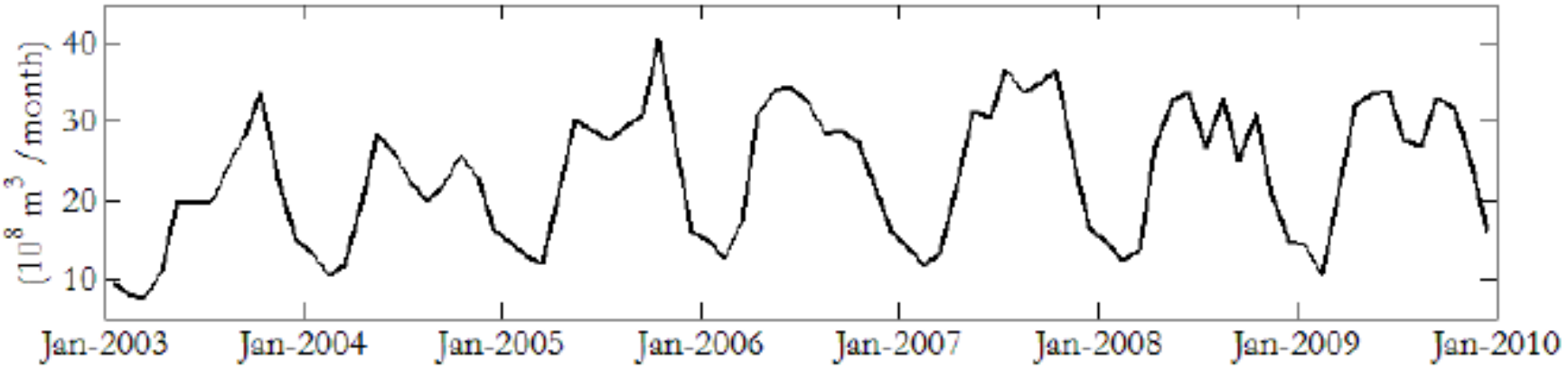


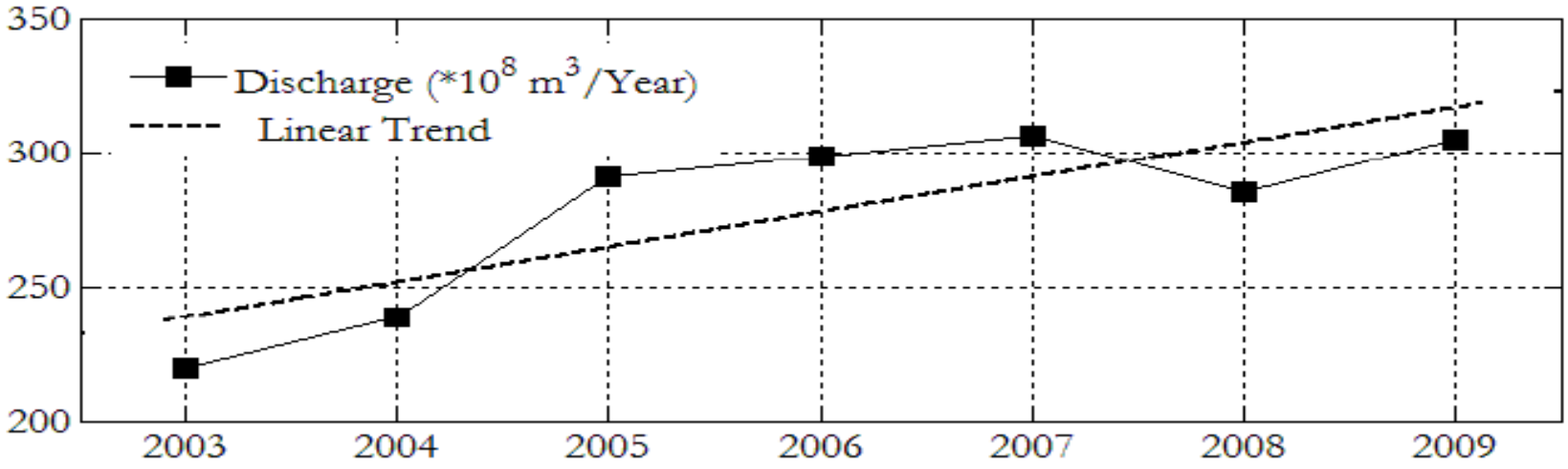
Time series of TWS of Upper Reach of Yellow River
(Top GRACE obs, bottom GLDAS output)



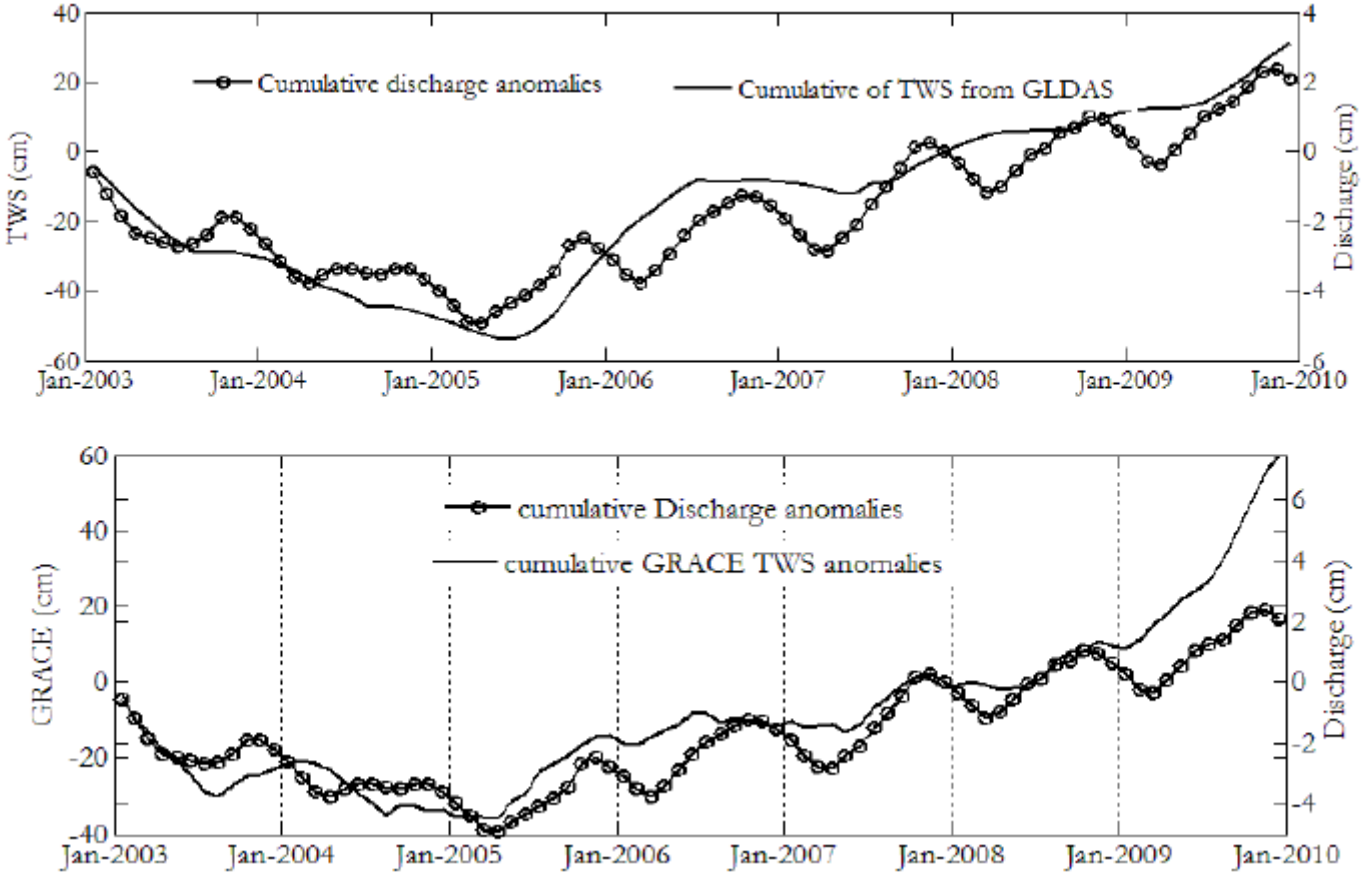


Monthly Yellow River discharge at Lanzhou hydrological station (Top). Annual discharge at Lanzhou hydrological station from 2003 to 2009 (Bottom)

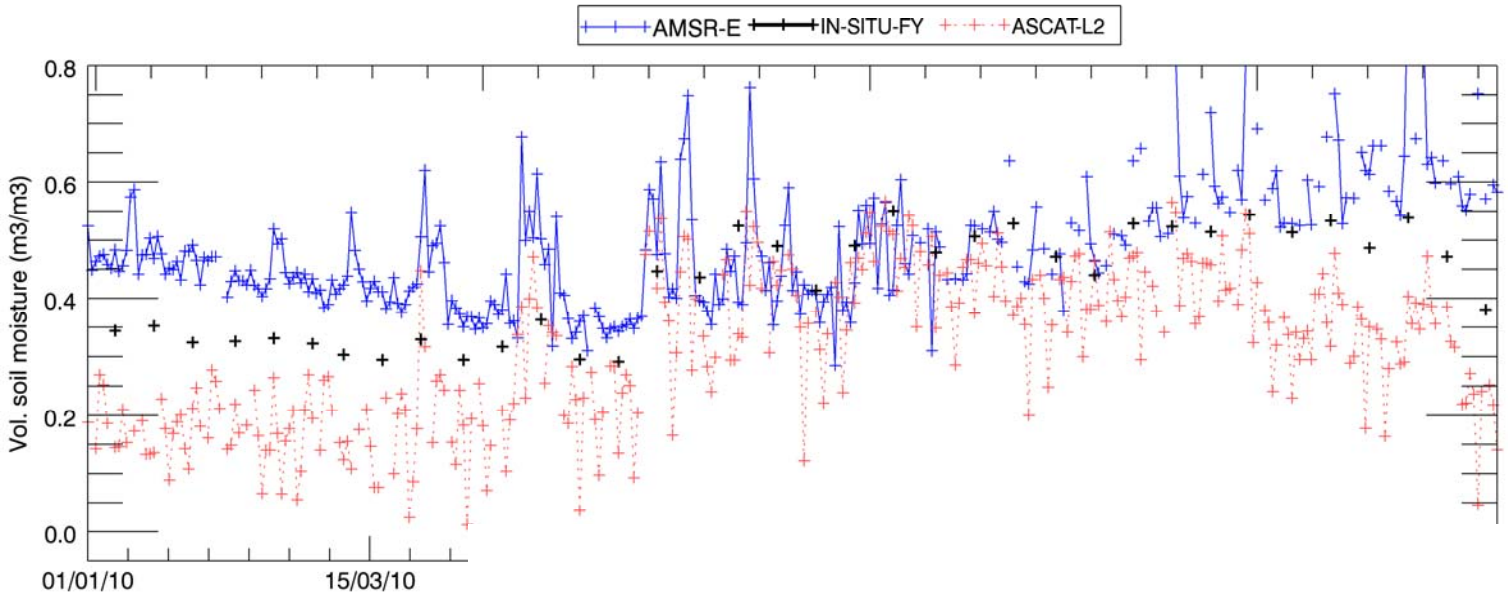




Cumulative discharge anomalies and TWS (right axis) estimated from GRACE observations and GLDAS state variables
(circles - the measured discharge at Lanzhou station, solid line - estimates by GRACE/GLDAS)

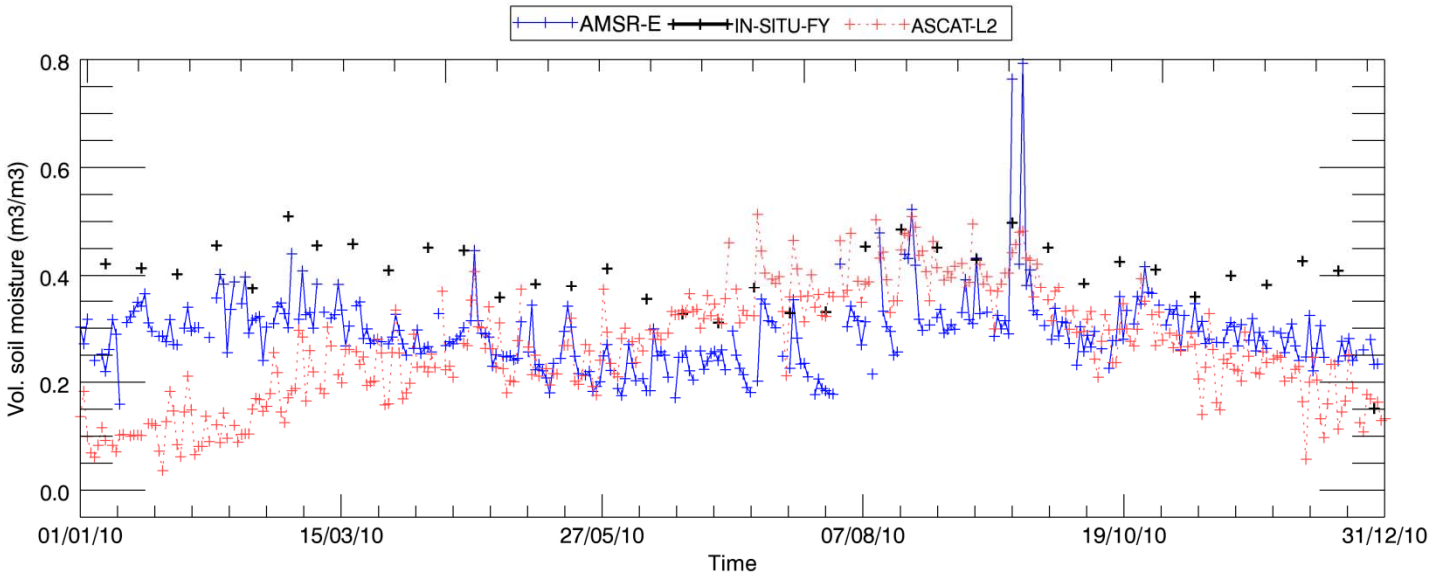


Towards an operational system - Can we detect droughts using surface soil moisture?

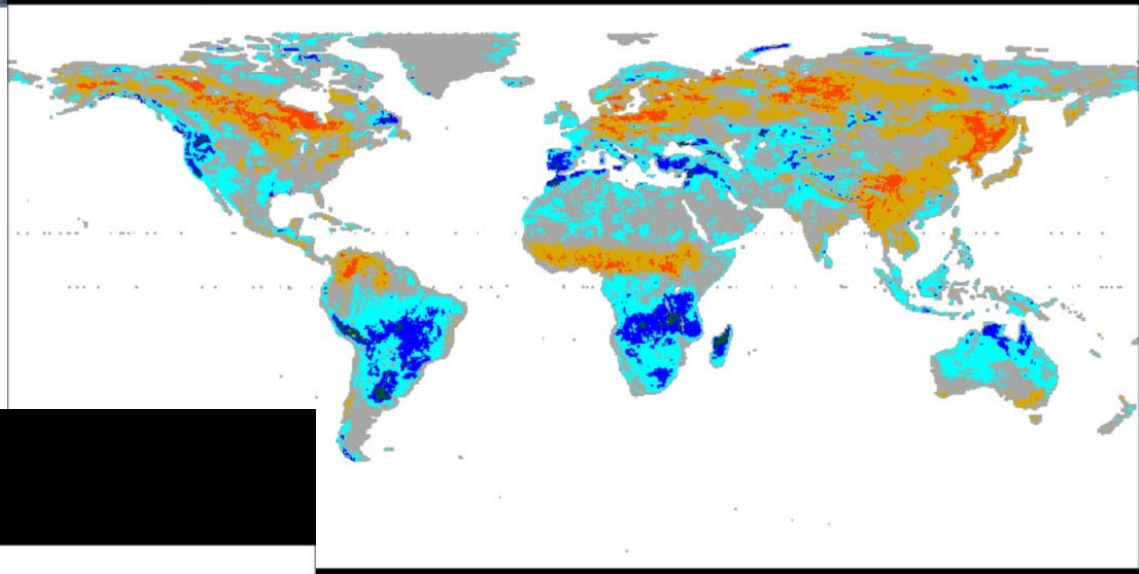


Kuenming area: (TL)

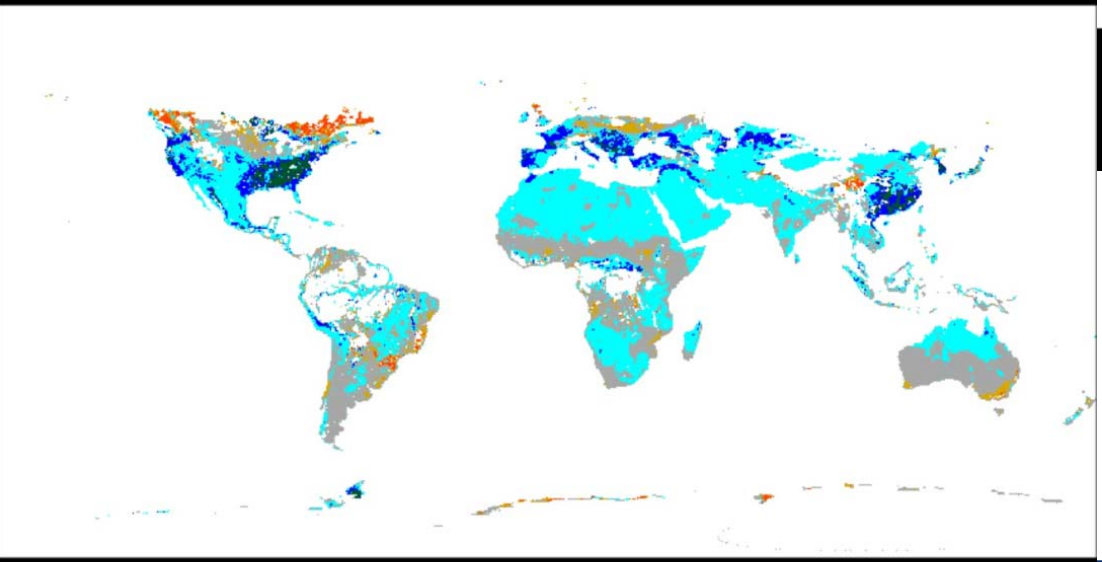
Shijiazhuang area (BR):



Towards a global system - Can we detect droughts?



2010-1



2010-01

BottomLeft: AMSR-E
TopRight: ASCAT

Plans for 2010-2012

- Continuous in-situ observations
- Continuous cal/val of EO data products
- Validation & improvements of model parameterization
- Assimilation of EO data into modeling system
- Setting-up of drought monitoring & prediction system
- Publications

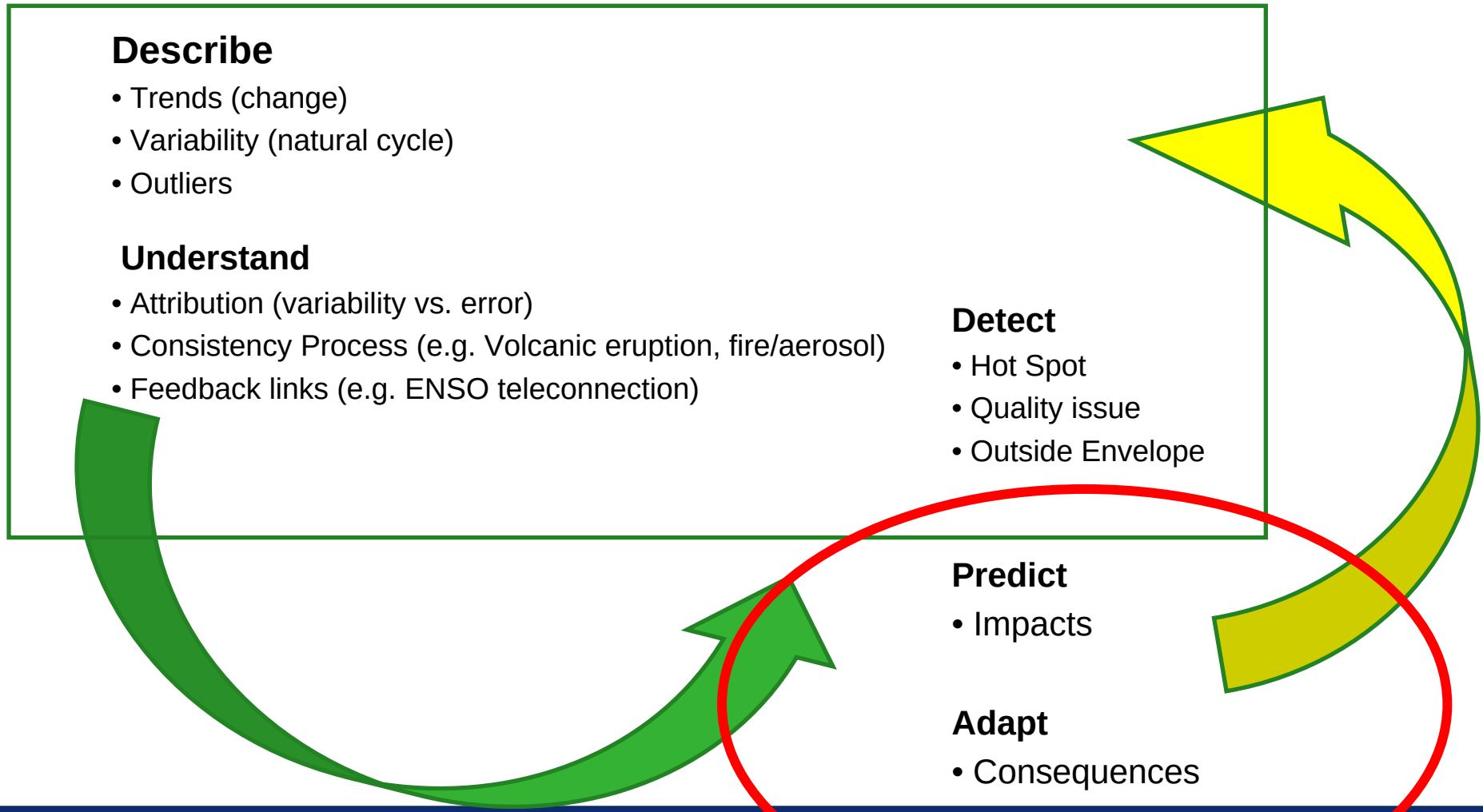
Recommendations

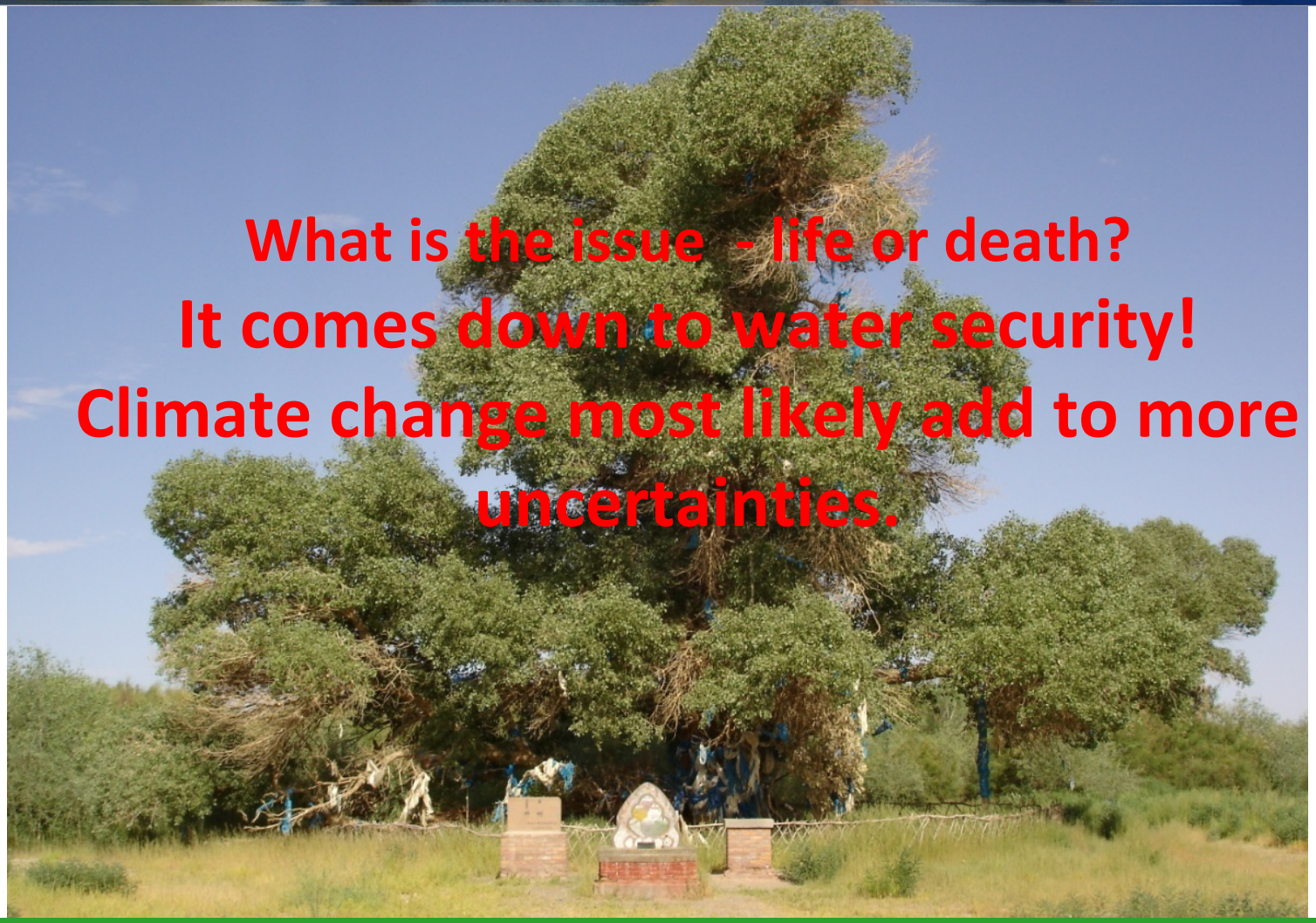
(Proposed action points for Dragon III)

- Satellite observations in data scarce environment are critical for quantifying climatic impacts – application agencies should develop dedicated capacities
- Uncertainties in satellite observations needed to be quantified with in-situ reference observations data – drought monitoring befits from advanced data retrievals
- Modeling results need to be verified before used in drawing conclusions about climatic change impacts – data assimilation necessary
- Concerted actions needed to aggregate and analyze climatic impacts in data scare environment – data sharing (e.g. in international collaboration) essential
- Existing studies need to be analyzed in detail – separating those based observation data with uncertainty certification from less rigorous studies
- Studies should be extended to adaptations!

A Roadmap From Process Understanding To Adaptation

Climate Change Adaptation In Water Resources




What is the issue - life or death?
It comes down to water security!
Climate change most likely add to more uncertainties.

Can we adapt?

Relevant Publications 2010-2011

http://www.itc.nl/about_itc/resumes/b_su.aspx

Chen, X.L., Ma, Y.M., Kelder, H., Su, Z., and Yang, K., 2011, On the behaviour of the tropopause folding events over the Tibetan Plateau' by X. L. Chen, et al, Atmospheric Chemistry and Physics (ACP), 11, 5113–5122, (www.atmos-chem-phys.net/11/5113/2011/)

Ma, W., Ma, Y., Hu, Z., Su, Z., Wang, J., and Ishikawa, H., 2011, Estimating surface fluxes over middle and upper streams of the Heihe River Basin with ASTER imagery, Hydrol. Earth Syst. Sci., 15, 1403-1413, doi:10.5194/hess-15-1403-2011.

Ma, W., Ma, Y., and Su, Z., 2011, Feasibility of Retrieving Land Surface Heat Fluxes from ASTER Data Using SEBS: a Case Study from the NamCo Area of the Tibetan Plateau, Arctic, Antarctic, and Alpine Research, 43(2): 239-245/DOI:10.1657/1938-4246-43.2.239

Romaguera, M., Hoekstra, A.Y., Su, Z., Krol, M.S. and Salama, M.S., 2010, Potential of using remote sensing techniques for global assessment of water footprint of crops. Remote Sensing: an international journal of the science and technology of remote sensing and the applications, 2(4), 117-1196.

Salama, M.S. and Su, Z., 2010, Bayesian model for matching the radiometric measurements of aerospace and field ocean color sensors. Sensors,10(8),7561-7575.

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