Water management in large scale models

- Agro-statistics – water usage
- Anthropogenic water dynamics:
  - Market-based water pricing models, locally and potential for global applicability
  - Water cost vs water value – understanding potential impact of additional water
  - Direct vs indirect vs non-use (e.g. cultural) value of water
- Local basin case studies, how different data sources provided different types of constraint in prediction / future management
- Range of existing modelling approaches:
  - Assimilation of satellite LAI, soil moisture, GRACE to try to constrain anthrop. water use at large scales
  - Some linking of human decision making to physical model
- Disconnect b/w ground water community and GW representation in global models

Observations of anthrop. intervention in water cycle

- Access to existing streamflow data (even centralised?) a problem
- Accurate constraining data on vertical fluxes (recharge, ET) difficult
- Access to any governing rules of centralised water management, water rights
  - Reservoir release, environmental flow regime, river and GW extraction regulations
  - Extremely heterogeneous – geopolitical
- Information on actual ecosystem demand vs. environmental flows
- Separation of water demand vs. water withdrawal vs actual use
- Water quality and useability
- Prioritisation of data collection similar to model development: for what purpose?
  - Societal impact?
  - Closing water budget?
  - Atmospheric flux, streamflow and feedback modification?
- DS of irrigation, reservoirs, LULCC, cropping information, inter-basin transfer, urbanisation, salinity, hydropower all relevant

Next steps:

- Definitions of what is included in different variables, naming conventions, ALMA/ CF/CMIP – ISIMIP?
- Focus on test-case basins where obs data allows model constraint

Modelling anthropogenic water processes

- Scale mismatch a recurring theme:
  - Lumped reservoirs at grid scale?
  - Incompatibility of grid scales / approach and hydrologic units
  - Need for ensemble simulations to remove internal variability vs benefits of high resolution in prediction (incl comparability with local obs)
- Water management as prognostic vs scenario based: "humans are logical"!
- Push for 'all important process' representation vs inclusion only where supported by observationally based data constraints?
  - if models already wildly disagree, how do we know that inclusion has helped for the right reasons?
- In either case, can we create out-of-sample validation?
- Dangers of ground water as an open boundary vs conserving system
- Should LSMs be coupled to existing hydrological models (expertise), or integrated?

Next steps:

- Are there regions where LSM uncertainties are smaller than the impact of human processes on fluxes and stocks?
- If we require conservation, then in order: reservoir, groundwater, irrigation, basin transfer…?
- Learn more fom AGMIP?

Potential feedbacks / interaction of human interventions (cross-cuts?)

- Increase in ET in irrigated crop tile sometimes leads to overall ET decrease in grid cell due to atmospheric feedback through increased humidity on other tiles
- Downstream effects in vicinity of irrigation, convection and rainfall near dry/wet soil boundaries
- Dissipation of convective systems over wet soils and water bodies
- Irrigation: not just local T changes, but local turbulence, more shallow convection and sea-breeze type phenomena., under certain circumstances it can trigger deep convection
- Impacts on sea level – increased reservoir storage offset by groundwater extraction
- Irrigation mitigates local and regional heat extremes (including TNN increases)