Cycles and Budgets Task Team

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This objective revolves around the continuity equation:

\[ \frac{\partial \rho}{\partial t} + \nabla \cdot f = \sigma \]

The first issue is to define a closed system over which the equation can be established.

Then identify all fluxes and reservoir changes which are part of the cycle. This often depends on our process understanding.

Except for some particular cases, the equality cannot be established. Thus everything hinges on the error estimation for the fluxes and reservoirs.
GEWEX’s experience

- GEWEX has performed many such studies for water from catchments to global and for energy mostly global.
- All previous closure studies done by the community have shown limitations in either:
  - Data availability or quality leading to large error bars.
  - Processes not properly taken into account and thus missing interactions or unmonitored boundary conditions.
- They have all lead to new process studies which have advanced our understanding.
- Cycle closure is an axiom for the community and serves to verify that our process knowledge or data are correct.
Latest estimates for the water and energy cycles

- This budget (in Wm$^{-2}$) was achieved using a ‘global’ optimization described in L’Ecuyer et al (2015).
- Uses more recent data that produce a more consistent set of fluxes.
- The global approach simplifies the problem.
Proposal from the Task Team

- Poll all core programs of WCRP to see where their knowledge of cycle & budget closure stands.
- Expected results:
  - Build an Earth system wide view on the energy and water cycle.
  - Assess observations and models available for all components.
  - Evaluate the possibility (relative to the errors) to detect and quantify imbalances of Earth’s energy and water cycles.
- This could lead to an Earth system wide vision of our ability to monitor the energy, water and biogeochemical cycles.
- Identify regions which are either easier to analyse or critical because of large trends.
- Identify the time and space scale which could be be covered with current observations and models.
A questionnaire for all core projects

For each study, within WCRP’s core projects which has attempted to close a budget equation, the questionnaire should be filled out. It will ask the following questions:

- Cycle analysed: energy, water, carbon or other biogeochemical species.
- Spatial & temporal scale of analysis
- Earth system component analysed
- Method used: 3 options and any combination of the 3:
  - Fully based on observed data
  - Data/model fusion
  - Statistically or AI based to derived unobserved quantities.
- Error characterisation for the fluxes and reservoir changes.
- Free text for: description of method and main conclusions of the study
Next steps

- Send the questionnaire to other core programs to see if it corresponds to their view on such studies.
- Send it to LHAs to see if it fulfils their needs.
- Evaluate the responses and organise a workshop to process the gathered information.
- The process should allow to draw some conclusions on what would be possible or where the road blocks are.