S2S Extreme Weather Science Plan

Below is a list of research elements that will form the basis of the work in the Extreme Weather subproject for the coming 5 years. This list is not meant to be exhaustive but rather highlight a small number of items that are best suited to the S2S project and more ready for immediate action.

Key resources for the S2S extreme Weather project include:

- **The S2S database** which is particularly suitable for predictability and application studies.

- **ISVHE** which is currently the best hindcast database targeting the sub-seasonal time scale

- **CHFP** which is a seasonal forecast hindcast

- **NMME** which may include daily data in its next phase

1. Predictive skill and predictability of extreme events (droughts, floodings, heat and cold wave) in operational sub-seasonal to seasonal forecasts. An index for each of these extreme events will be defined to fit the sub-seasonal to seasonal time scale in collaboration with the S2S verification sub-project and applied to the databases mentioned above to assess their predictability at various time ranges.This could include some of the indices defined by the Expert team on Climate Change Detection and Indices (ETCCDI). The advantage of multi-model combination on the prediction of the extreme events will be evaluated. The modulation of these extreme events by modes of variability such as the MJO, ENSO, land initial conditions, snow or sea ice cover will be assessed. This topic will help strengthen the links between S2S and the High Impact Weather (HIW) project. The result of this will show to what extent current operational sub-seasonal forecasts can provide an early warning to some extreme events and be part of a Ready-Set-Go system where sub-seasonal to seasonal forecast would the Ready and the medium-range and short range forecasts would provide respectively the Set and Go part of the seamless forecast.

Objective and Deliverables:

1) Assessment of the sub-seasonal to seasonal predictability and prediction skill of droughts, flooding, heat and cold events in various tropical and extra-tropical regions.

2) Assessment of the benefit of multi-model forecasting

3) Evaluation of the modulation of these extreme events by various sources of predictability.

4) Assess how this information could be used in a ready-set-go system in collaboration with HIW.

Calendar:

2014: Agree on a definition of extreme events and define an index which can be applied on a database. Test this concept on available models or databases (CHFP or ISVHE)

2015-2017: Apply the indices on the S2S database and evaluate the predictive skill of extreme events. The reliability of these forecasts will also be evaluated. The benefit of multi-model forecasting will be assessed.

2017-2018: Evaluate the modulation of the extreme events by various sources of sub-seasonal predictability.

Links with HIW,Joint Working Group on Forecast Verification Research, S2S verification sub-project and Africa sub-project.

2. Sub-seasonal prediction of tropical storms

Observations studies have shown that tropical storm activity is modulated by the Madden Julian Oscillation. Modelling studies have shown that the impact of the MJO on tropical cyclone activity can be simulated by numerical models. This suggests that sub-seasonal prediction of tropical storm is possible, and some operational centres are already issuing weekly outlooks of tropical cyclone activity, in addition to the medium-range and seasonal prediction of tropical storms.

The S2S database can be used to evaluate the skill of various models to predict sub-seasonal tropical cyclone activity and evaluate the benefit of multi-model prediction of tropical storm sub-seasonal activity. The modulation of tropical storms by the MJO in the various models can also be evaluated along with impact of ocean-atmosphere coupling.

Objectives and deliverables:

1) Assessment of the impact of the MJO on tropical storms in the operational sub-seasonal to seasonal forecasting systems.

2) Evaluation of the skill of a multi-model ensemble to predict sub-seasonal tropical cyclone activity

Calendar:

2015-2017: Tracking of tropical cyclones in the various models - Exchange of tropical cyclone tracks.

2018-2019: Skill assessment and impact of the MJO on tropical cyclones

Links: This activity will have strong links with the MJO sub-project and also with the MJO Task Force for the impact of the MJO on tropical cyclones. The evaluation of the forecast skill can be done as an extension of the work the TIGGE-GIFS and SWFDP working groups have done regarding the prediction of tropical cyclone tracks using the TIGGE database and follow the procedure and format for exchanging tropical cyclone track data. This activity will also link with HIW and WGNE which also works on the inter-comparison of tropical cyclone track forecasts.

3. Case studies

An important S2S activity as mentioned in the S2S implementation plan will be to study some cases of extreme events. Activity 1 will look more at the general skill of the models to predict some extreme events using the S2S or other databases, whereas Activity 3 (case studies) will aim to a more in depth study of several extreme events. The extreme events can be selected for their strong societal impacts (e.g. 2009 Pakistan floods) or for the physical processes that areinvolved (stratosphere, MJO, snow or sea-ice cover, SST anomalies, Rossby wave propagations..). A preference will be given for cases that will be covered by the S2S near real-time database.

The goal of the case studies will be to evaluate the skill of the operational models to predict specific events at various time scales. This is likely to provide useful information for applications and help to assess the potential use of sub-seasonal to seasonal forecasts in a Ready-Set-Go system. The goal of the case studies will also be to identify the mechanisms or sources of predictability responsible for the extreme event. For instance, The S2S extreme weather subproject already investigated the prediction of the extreme cold march 2013 over Europe and identified an MJO event as being likely responsible for the negative NAO which led to this event. The case studies should cover various regions and various phenomena.

Objectives and deliverables:

- Assess the predictability and forecast skill of a few high-profile events

- Investigate the mechanisms responsible for these cases of extreme events and possible identify weakness or issues in model predictions.

Calendar:

- At least a case study per year followed by a report. The choice of the case study will be decided as extreme events happen.