Science plan

S2S sub-project on extreme weather

Third draft:

4 February 2015

Objectives:

- Investigate predictability of extreme weather on sub-seasonal time-scale
- Promote the use of sub-seasonal to seasonal forecasts of extreme weather by application users
- Improve the prediction of extreme events in operational sub-seasonal to seasonal forecasts.

In order to successfully achieve these objectives, the sub-project will address a number of issues including:

I. Identification of current practises to define long-lasting extreme weather events such as heat waves, cold waves, drought and flooding. Indices defined by the Expert Team on Climate Change Detection could be used.

II. Verification of extreme events in a limited set of forecasts and re-forecasts.

III. Detection of tropical storms in a low-resolution and low-frequency database such as the S2S database (1.5 degree and 24-hourly data). Tropical storms tracked in the original grid could be exchanged between the centres, or tropical storm activity could

be diagnosed through large-scale indices such as Genesis Potential Index (Emmanuel and Nolan, 2004).

IV. Identification of weather regimes. Weather regimes can be a powerful tool to predict the probability of some extreme events, particularly when the models cannot represent extreme events realistically.

V. Promotion of new products based on sub-seasonal to seasonal forecasts of extreme weathers, which could lead to operational exchange.

VI. Identification of cases studies of extreme events with important societal impact. These case studies will cover various regions and various phenomena

Science questions:

- What is the predictive skill and predictability of heat waves, cold waves, flooding and drought at the sub-seasonal to seasonal time scale?
- What is the predictive skill of sub-seasonal to seasonal tropical cyclone activity in the S2S models? Observations studies have shown that tropical cyclone sub-seasonal activity is modulated by the Madden Julian Oscillation (e.g. Maloney et al, 2001), which can be reproduced by some models (e.g. Vitart, 2008).
- How are extreme event statistics modulated by modes of variability such as MJO, ENSO, land initial conditions, snow or sea ice? How do state-of-the-art numerical models represent this modulation?
- What is the predictability and predictive skill of weather regimes? How do model represent weather regime transitions?

- Can we attribute the occurrence of specific extreme events (case studies) to a specific mode of climate variability?
- What is the impact of resolution (atmosphere or ocean) on the representation and prediction of extreme events?
- How can the sub-seasonal to seasonal forecasts of extreme events be used in a ready-set-go system?
- What is the benefit of multi-model combination for the prediction of extreme events?

To address these questions, links with other groups will be established:

➢ High impact weather (HIW) for the predictability and prediction of some extreme events. Some of the 5 extreme events mentioned in the HIW implementation plan are also relevant to S2S: flooding, wildfire, heat &air pollution in blocking anticyclones. S2S and HIW could collaborate with S2S focusing on the extended-range predictability of the large scale conditions favoring these events and HIW focusing on the shorter forecast time scale.

➢ WMO Tropical Cyclone Panel and SWFDP for the sub-seasonal to seasonal prediction of tropical storms (work on tropical storm prediction using the TIGGE database could be extended to the sub-seasonal to seasonal time range)

➢ the MJO Task Force for the modulation of extreme events by the MJO; S2S verification sub-project for the verification of extreme event

➢ SERA for identifying case studies with important societal impact and promoting the use of S2S forecasts of extreme events in application.

➢ WGSIP and WWRP Grand Challenge on extremes prediction and attribution.

The key resource for the S2S extreme weather sub-project will the S2S database which, at the time of writing, will be available soon. This database will be particularly suitable for predictability and application

studies. Other databases may be used: ISVHE, which is a hindcast database targeting the sub-seasonal time scale; CHFP which is a seasonal forecast database and NMME which may include daily data in its next phase.

Proposed tasks/activities and tentative deliverables

2015-2016:

- Literature review on extreme event prediction and indices used to define droughts, flooding, heat and cold wave. Agree on a choice of indices and establish a list of past extreme events based on re-analysis.
- Diagnose weather regimes predictability in the S2S database and assess the skill of the S2S models to predict weather regimes, using for instance the methodology described in (Ferranti et al 2014).
- Link with the tropical storm panel to assess the sub-seasonal to seasonal prediction of tropical cyclones.
- Select a case of extreme event. Assess its predictability and investigate the mechanisms responsible. Identify potential weaknesses or issues in model prediction.

2017-2018

- Assess the skill of individual S2S models and multi-model to predict droughts, flooding, heat and cold wave.
- Investigate the modulation of extreme events by various sources of sub-seasonal predictability in the S2S models.
- Link with SERA on the potential use of S2S forecasts in applications
- Study other cases of extreme event.
- Organize a S2S workshop on extreme events

References:

Emanuel, K. A. and Nolan, D. S. 2004. Tropical cyclone activity and global climate. In: Proc. of 26th Conference on Hurricanes and Tropical Meteorology, pp. 240–241, American Meteorological Society , Miami, FL .

Ferranti, L. Corti, S. Janousek M. 2014. Flow-dependent verification of the ECMWF ensemble over the Euro-Atlantic sector. Q. J. Meteorol. Soc. DOI: 10.1002/qj.2411

Maloney, E. D., and D. L. Hartmann, 2000: Modulation of hurricane activity in the Gulf of Mexico by the Madden-Julian oscillation. Science, 287, 2002-2004

Vitart, F., 2009: Impact of the Madden Julian Oscillation on tropical storms and risk of landfall in the ECMWF forecast system. Geophys. Res. Lett., 36, L15802, doi:10.1029/2009GL039089