Understanding sources of predictability

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Overview

- Predictability - Lorenz's seminal work on chaos theory
- Climate predictability – challenges and opportunities
- Timescales of predictability
- Predictive signals
- Predicting drivers of predictability
- Sources of predictability and users
- Conclusions
- Follow-up

Predictability - Lorenz's seminal work on chaos theory

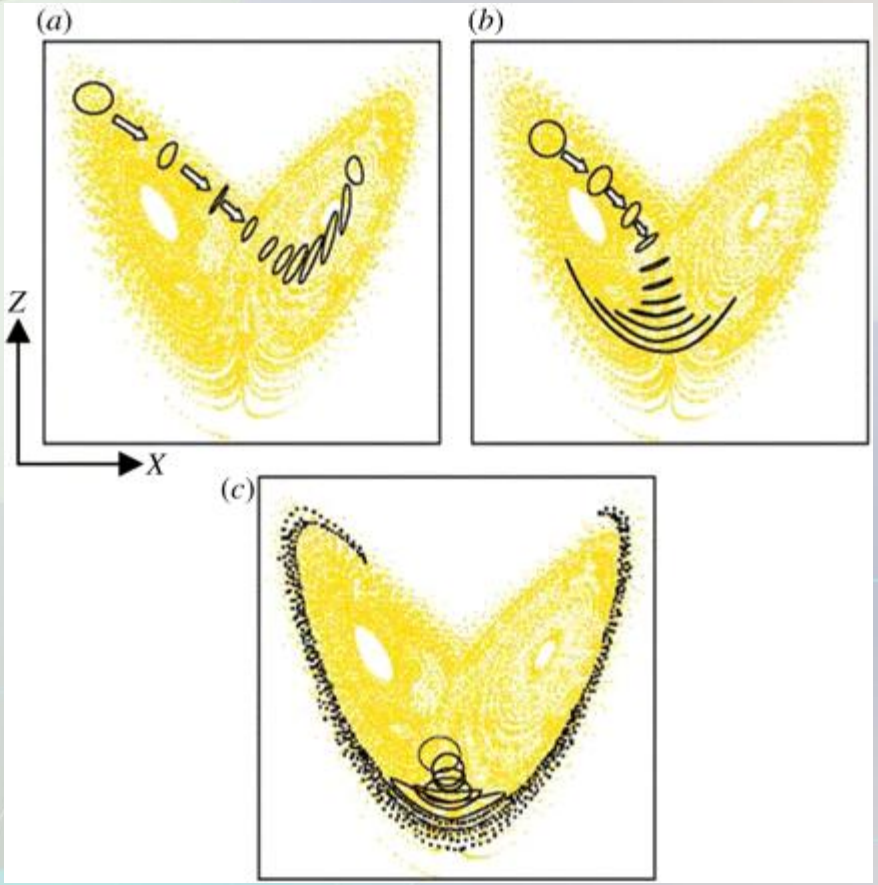


Fig. 1 Examples of finite-time error growth on the Lorenz attractor for three probabilistic predictions starting from different points on the attractor. (a) High predictability and therefore a high level of confidence in the transition to a different 'weather' regime. (b) A high level of predictability in the near term but then increasing uncertainty later in the forecast with a modest probability of a transition to a different 'weather' regime. (c) A forecast starting near the transition point between regimes is highly uncertain.

Source: Julia Slingo and Tim Palmer (2011)
http://rsta.royalsocietypublishing.org/content/369/1956/4751#F1

Predictability - Lorenz's seminal work on chaos theory

I. Deterministic predictability depending mostly on initial conditions applied to the system

II. Probabilistic predictability as an equilibrium response to slow evolving external perturbations or perturbations at the boundaries of the system

The system – atmosphere

Boundaries of the atmosphere:
- land, ocean
- lower stratosphere

Perturbations:
- SST anomalies, snow and ice cover extent
- stratospheric ozone concentration, stratospheric winds and temperature
- extrenal perturbations: greenhouse gases concentrations

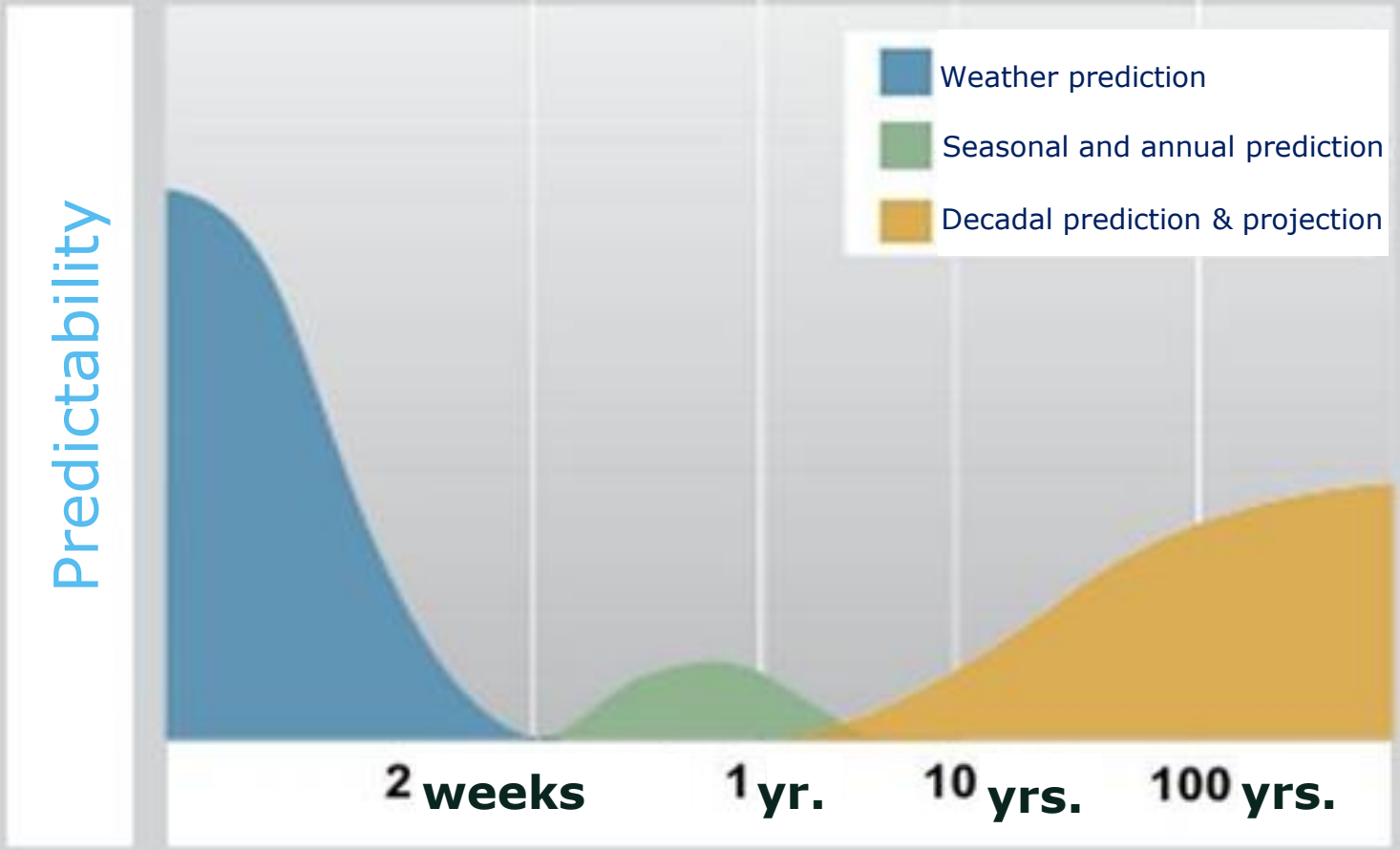
Climate predictability – challenges and opportunities

Challenges	Opportunities
Low skills over most of land at mid and high latitude regions	• Higher skills over tropics • Higher skills over oceans • Regional predictive signals: AMO, NAO/AO; ENSO; QBO, global warming signal etc.
Communicating probabilistic essence of climate prediction and related uncertainties	
Fast and strong impact on society	Fast and strong impact on society
Many different sources of predictability	

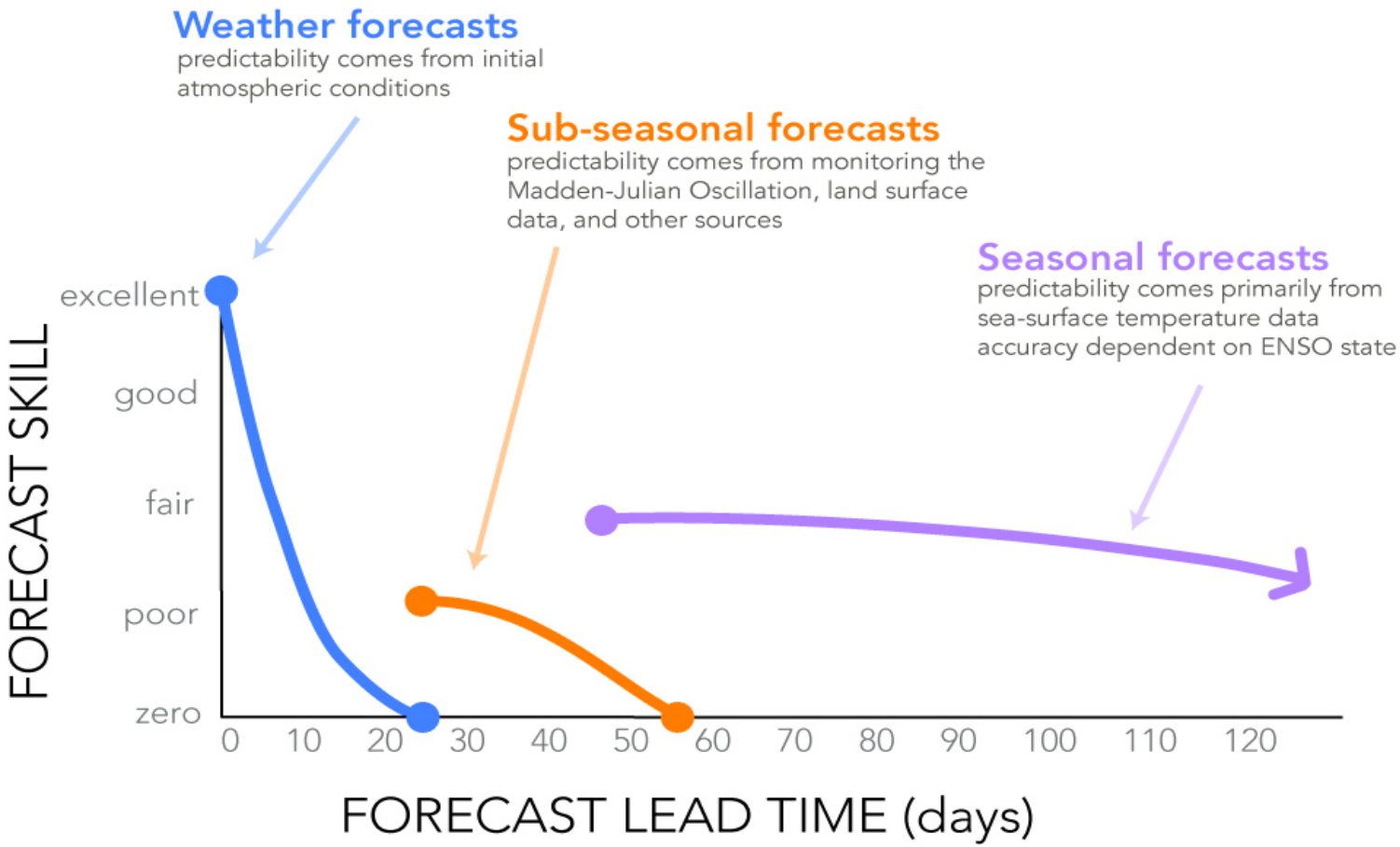
Why is it useful to know the sources of predictability?

- To assess 'predictability' of the specific forecast
- To qualify the level of confidence in the model predictions
- To anticipate the likely scale of the predictive signals (?)

Time scales of predictability

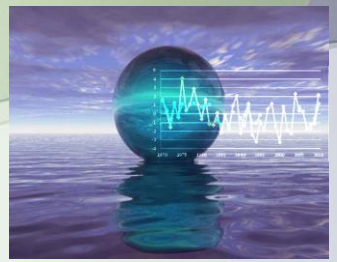


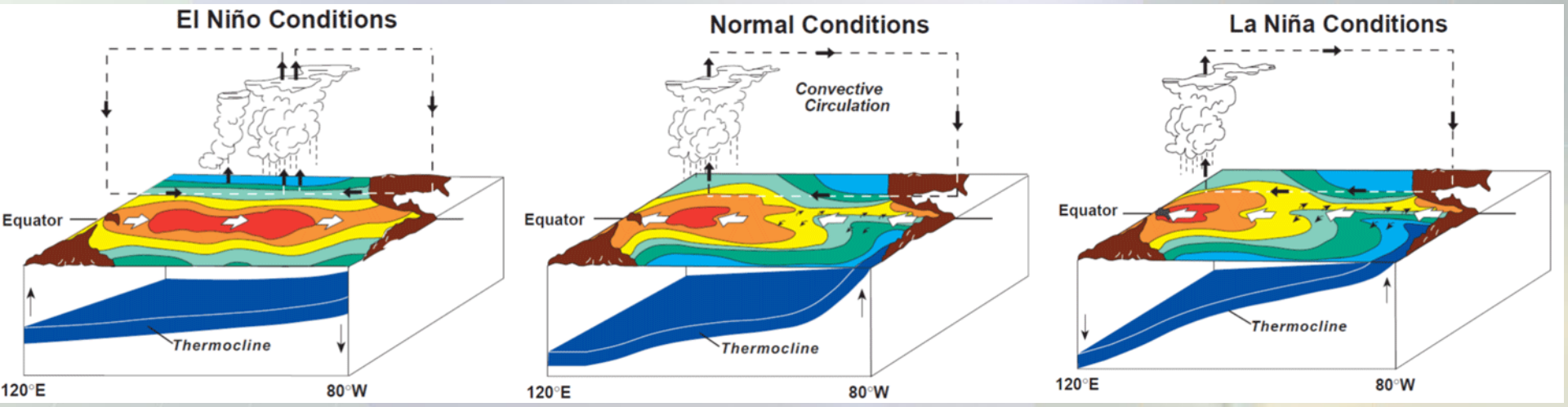
Time scales of predictability



Source:
Infographic adapted by Elisabeth Gawthrop from figure by Tony Barnston.
http://iri.columbia.edu/news/qa-subseasonal-prediction-project/

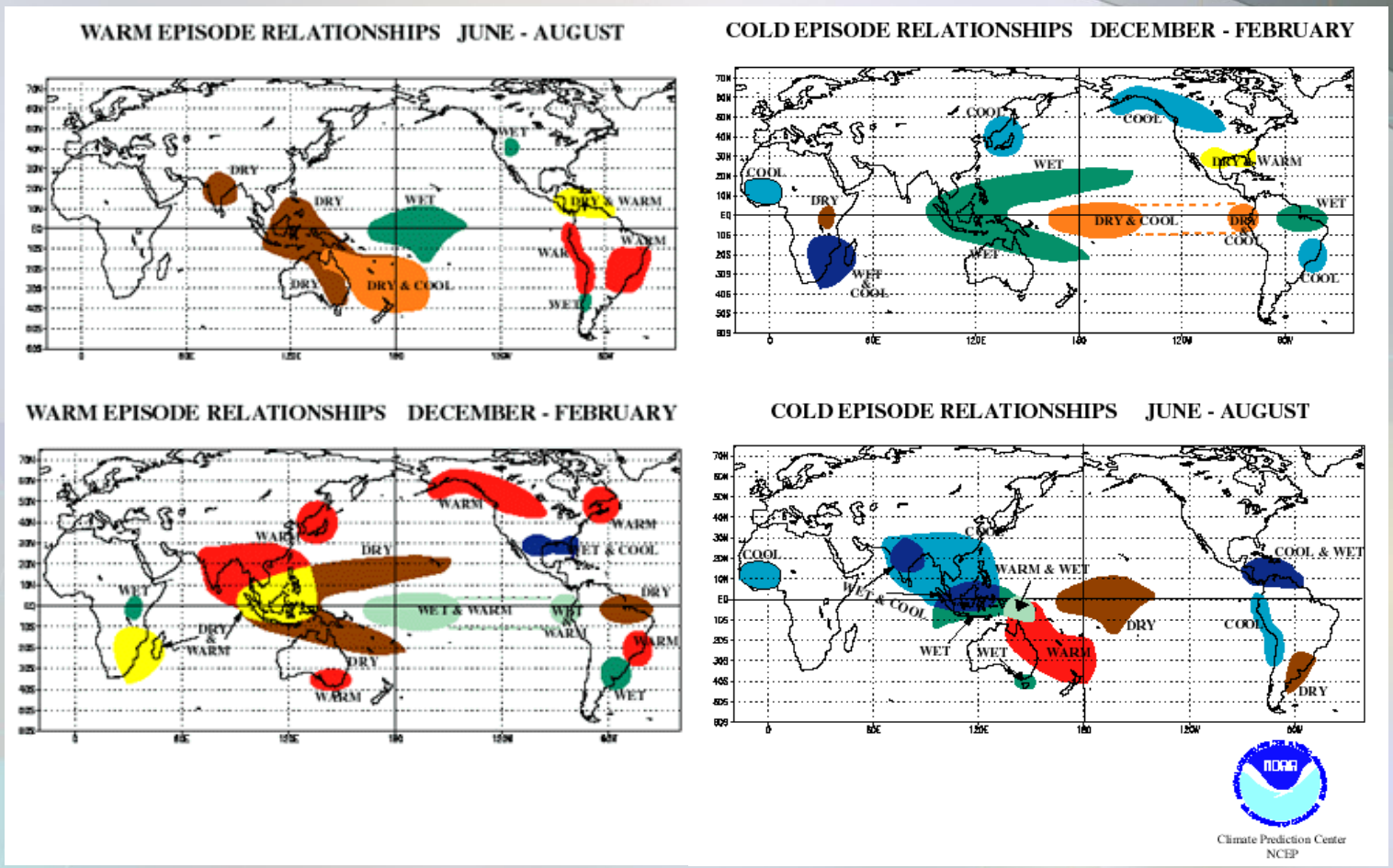
Predictive signals: ENSO delayed oscillator





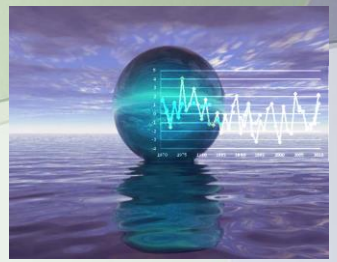
Source: NOAA/PMEL/TAO Project Office, Michael J. McPhaden

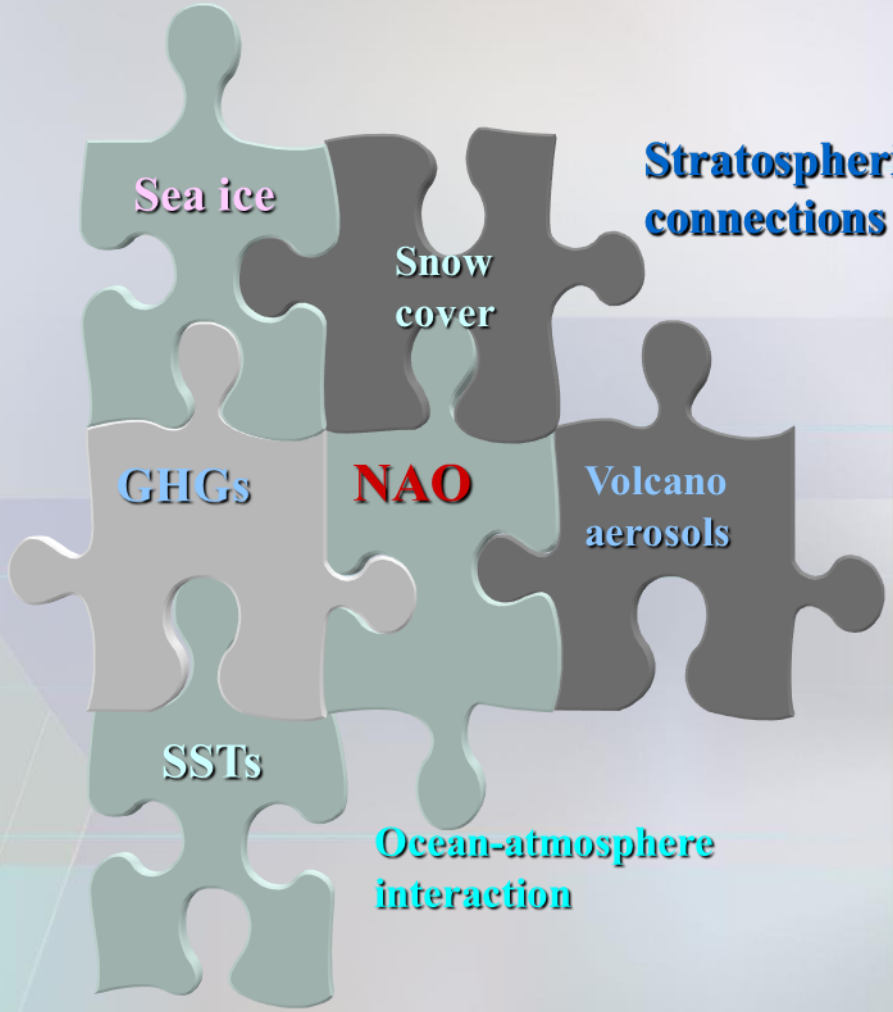
Predictive signals: ENSO delayed oscillator



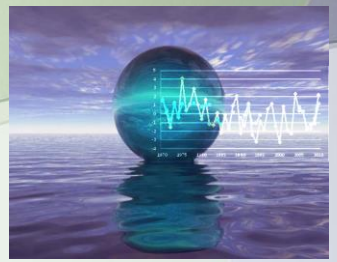
Source: Climate Prediction Center/NCEP/ NOOA

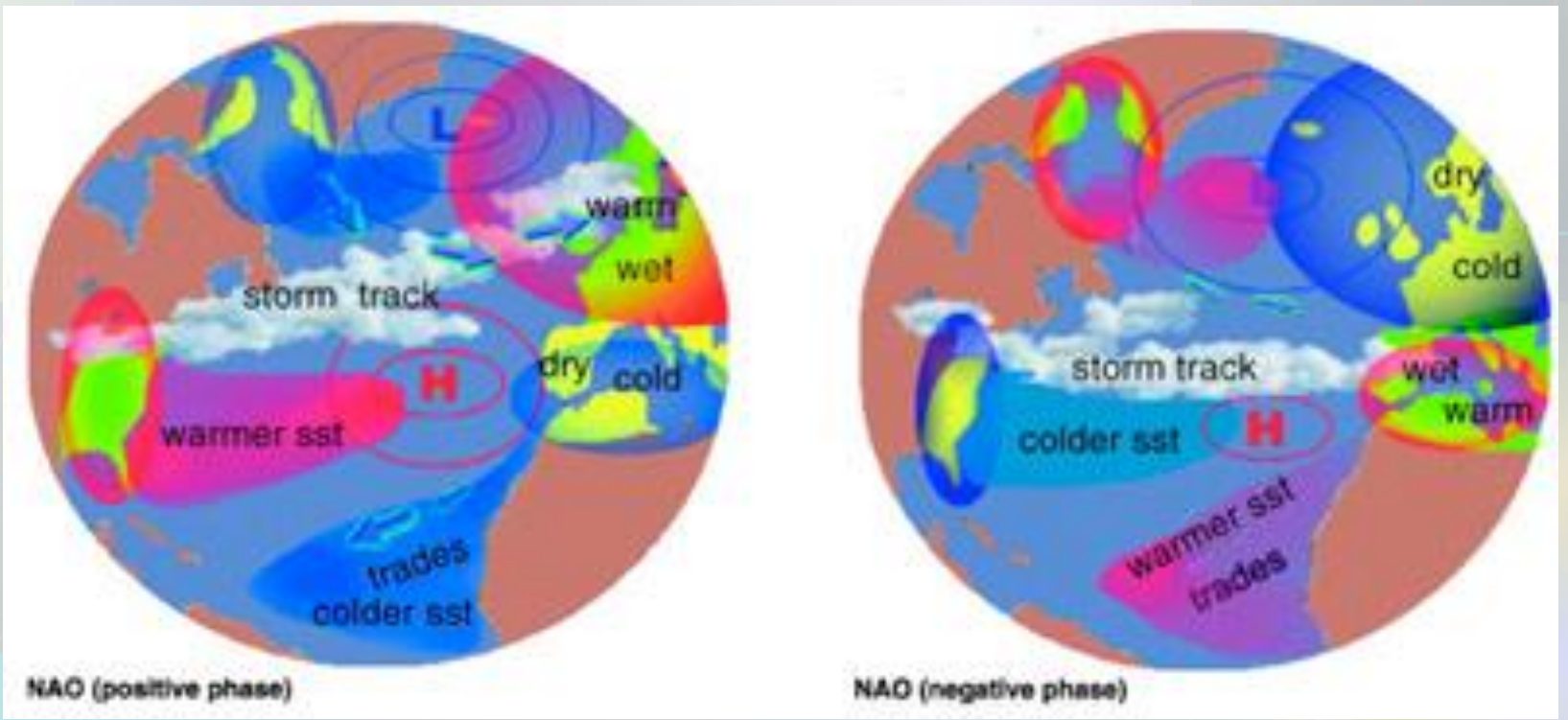
Predictive signals: AO/NAO puzzle



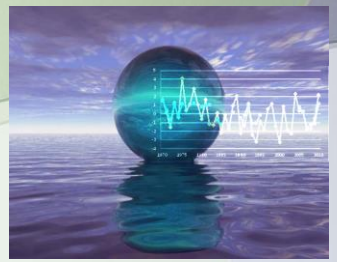


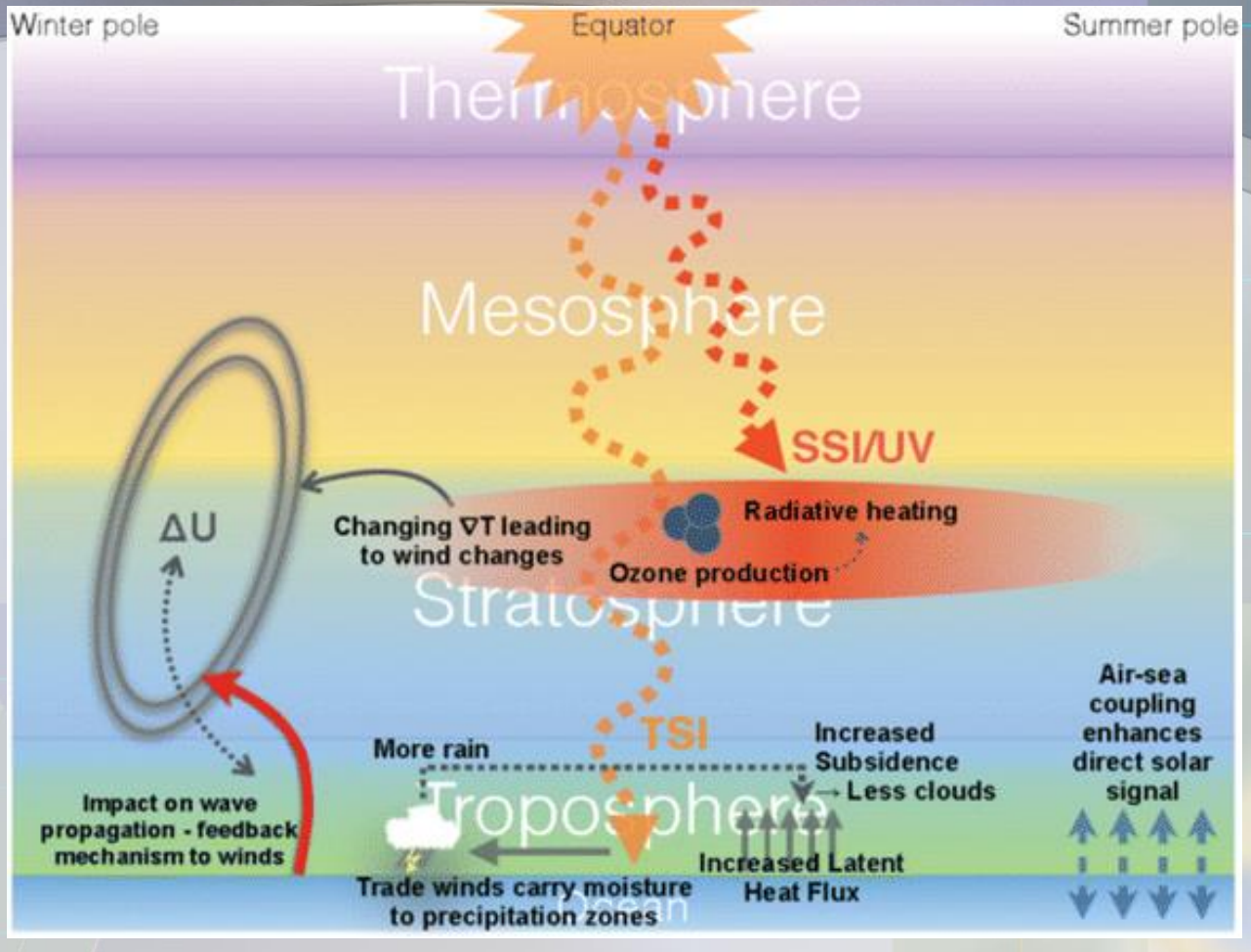
Predictive signals: AO/NAO puzzle





Predictive signals: stratosphere influences





Main features for both the bottom-up mechanism for total solar irradiance (TSI) and the top-down mechanism for solar spectral irradiance (SSI) (Seppälä et al. 2014) from Toshitaka TsudaEmail, Marianna Shepherd and Nat Gopalswamy (2015). https://progearthplanetsci.springeropen.com/articles/10.1186/s40645-015-0059-0

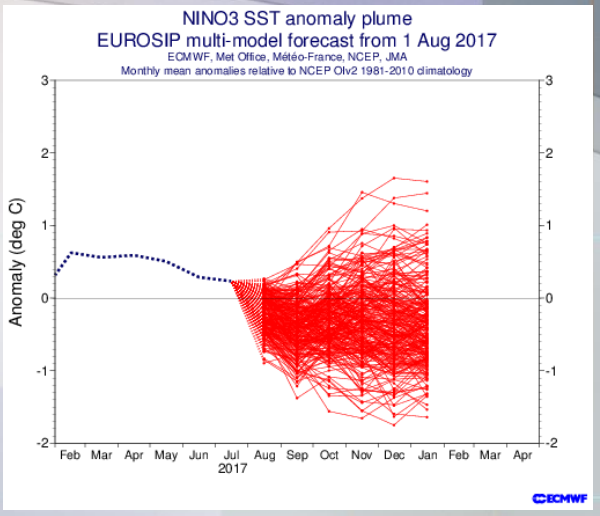
Predicted drivers of predictability

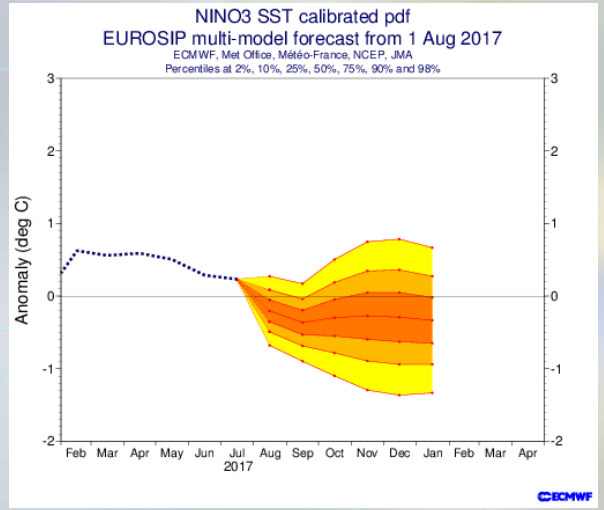
After Anca Brookshaw

Need to know skill of (all) models in predicting the modes of variability; the temptation is to take skill for granted.

Predictability of drivers of predictability may not operate in the model world on seasonal timescales (e.g. shorter lead time than desired, shorter influence than the period of interest) (e.g. stratospheric warmings)

Integrating information from several sources – multi-model combination for modes of variability



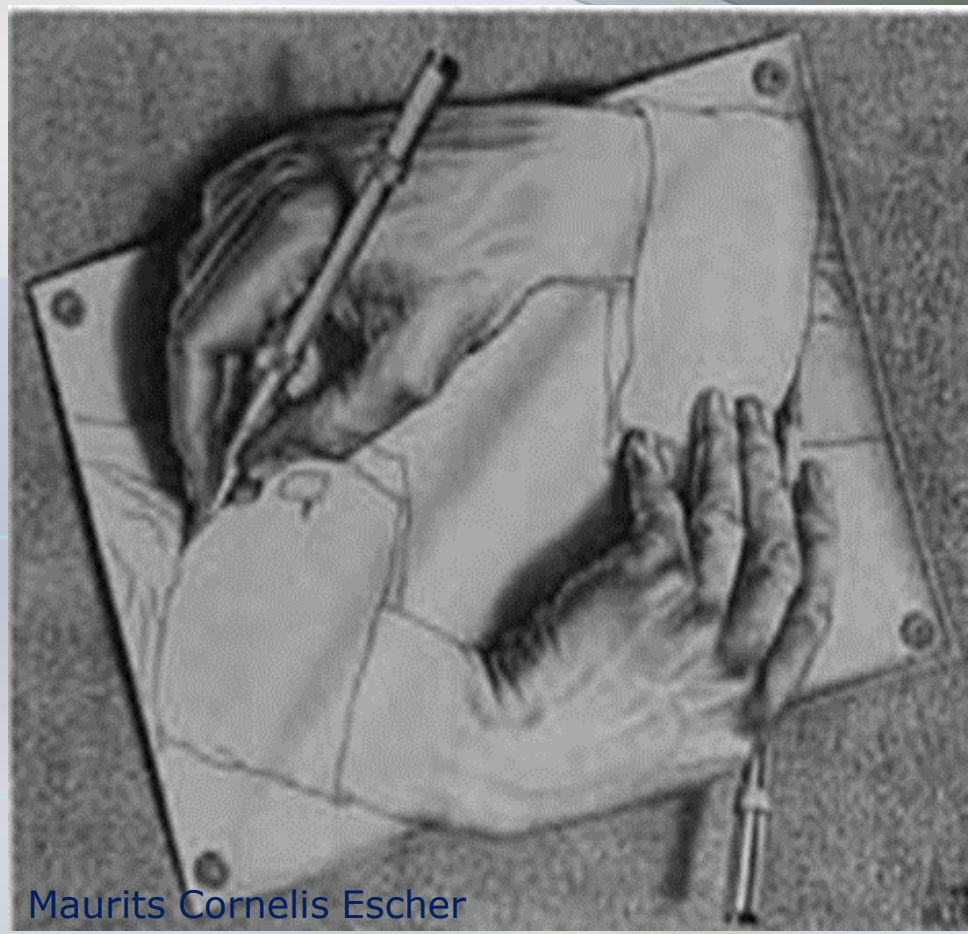


Sources of predictability and users

- Should information on predictability be incorporated in the probabilities of the definitive forecast?
- Is it helpful to convey the information on predictability in subjective terms to non-specialist users? Or better to tailor the products to take this into account?

Conclusions

- Seasonal predictions needs both approaches defined by Lorenz in relation to climate predictability.
- Probabilistic essence of climate prediction needs the assessment of related uncertainties to be taken into account and communicated.
- Regional and/or phenomena based approaches of seasonal prediction could add supplementary skill.
- The analysis of sources of predictability adds information of value to forecasters and to some users (predictability, scale of patterns).
- Integrating information from several sources – multi-model combination for modes of variability - is useful.



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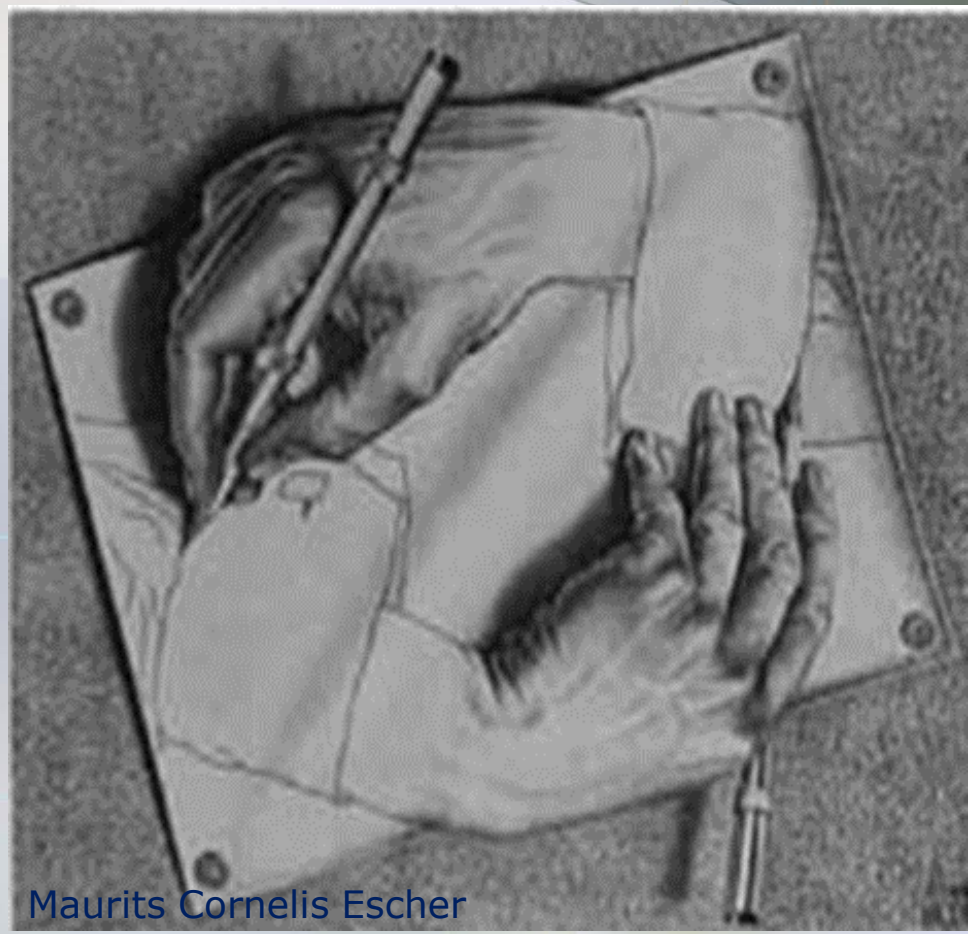
Follow-up

Understanding the sources of predictability is not the same as having a clear path to using them:

- how to use the GCM output?
- what use is the information on average skill?
- how do we deal with combined influences from several sources?



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