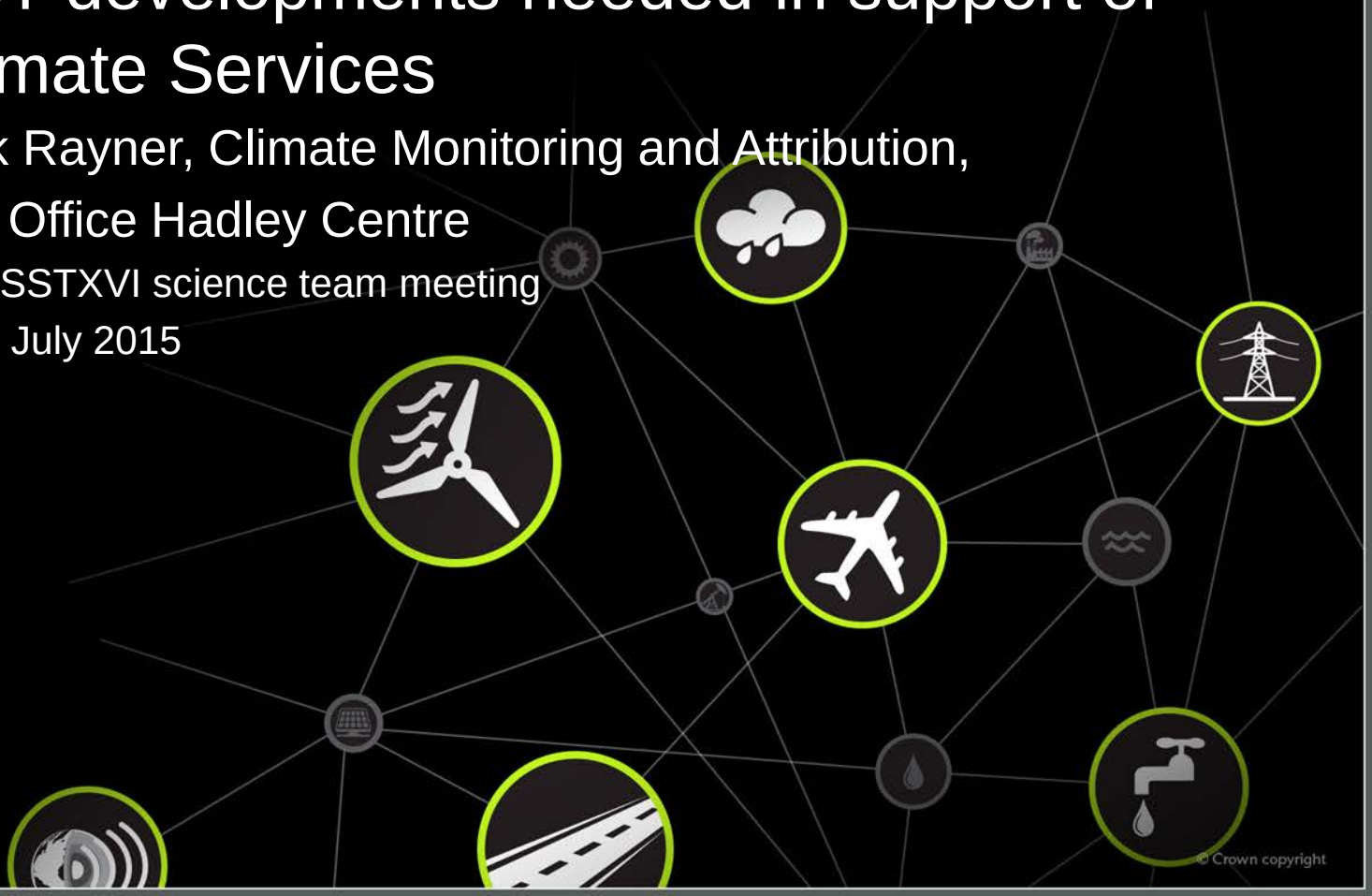
SST developments needed in support of Climate Services

Nick Rayner, Climate Monitoring and Attribution,

Met Office Hadley Centre

GHRSSTXVI science team meeting

22nd July 2015



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SST developments needed in support of climate services

Overview

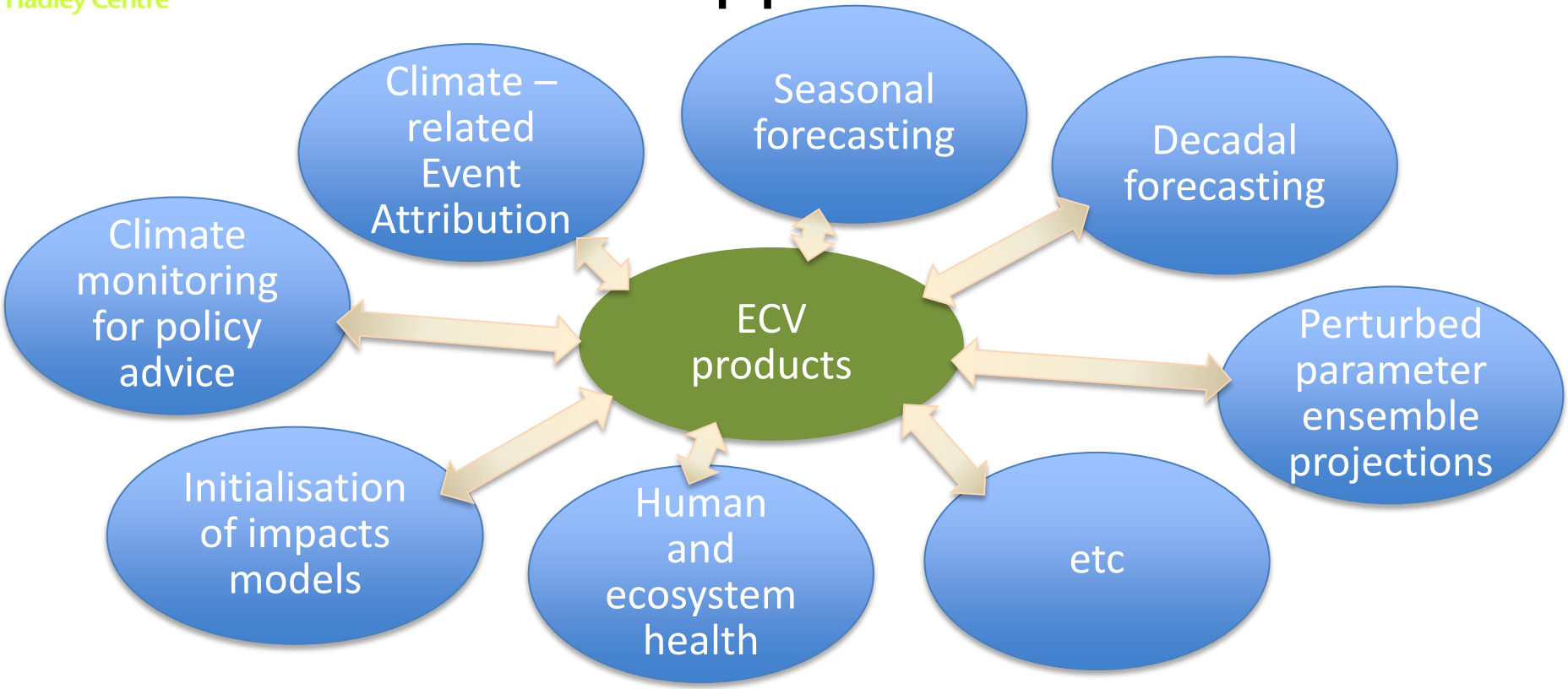
• How are SST products used in some examples of Climate Services and what does this mean for how they need to be produced?

Generic statements of needs

For the development of SST products to underpin Climate Services

- More data
  - more and ongoing measurements in sparsely observed regions
  - unlock the potential of past measurements (rescue of historical observations)
- More research into creating consistent records
  - understanding how data from different measurement platforms can be knitted together to create an homogeneous record for multiple decades/past 160 years
- More research into quantifying uncertainty components and their covariance structures
- Better statistical modelling techniques
  - develop new methods which use this richer uncertainty information

Requirements driven by the needs of different applications



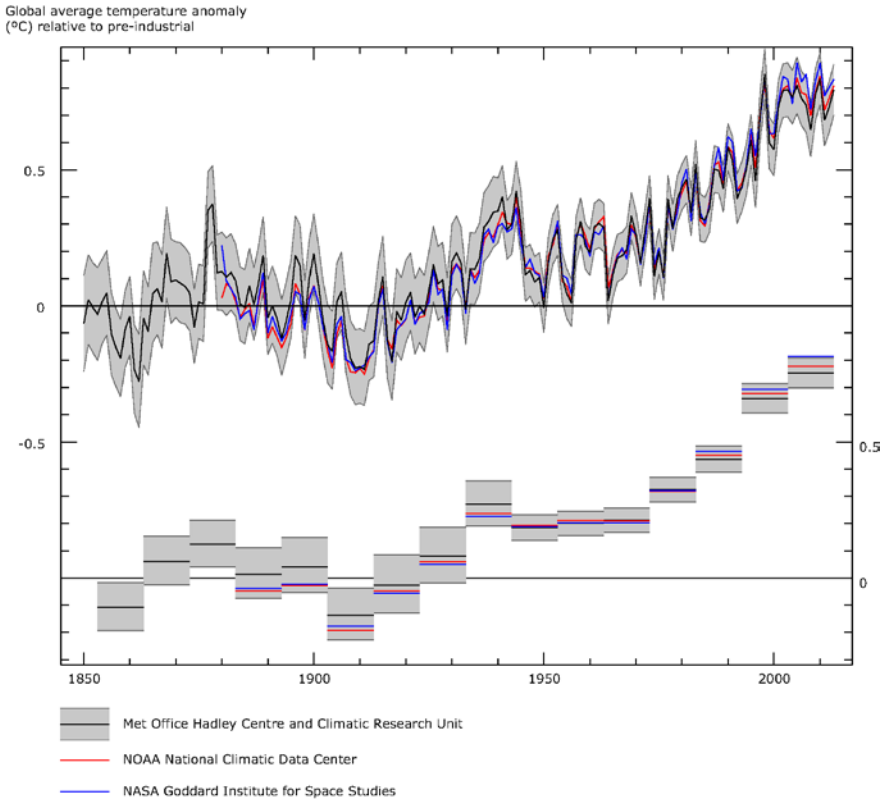
Climate monitoring for policy advice

Surface temperature

Part of EEA global and European temperature change indicator aimed at providing advice relevant to the questions:

- Will the global average temperature increase stay within the UNFCCC policy target of 2.0 degC above pre-industrial levels?

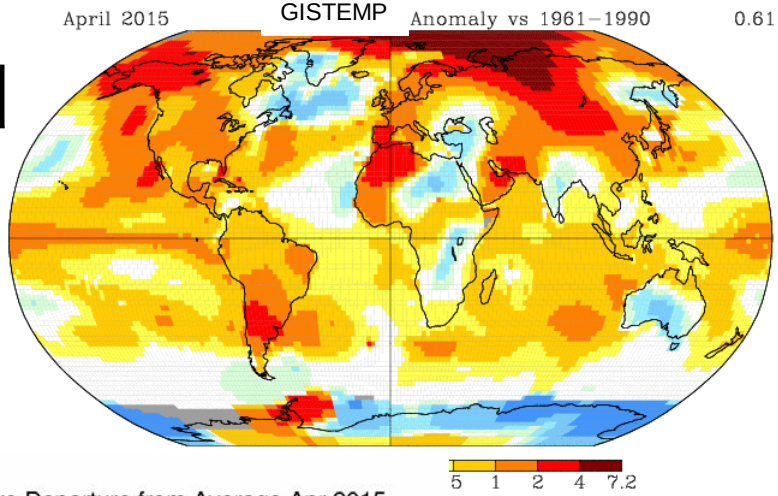
- Will the rate of global average temperature increase stay below the indicative proposed target of 0.2 degC increase per decade?

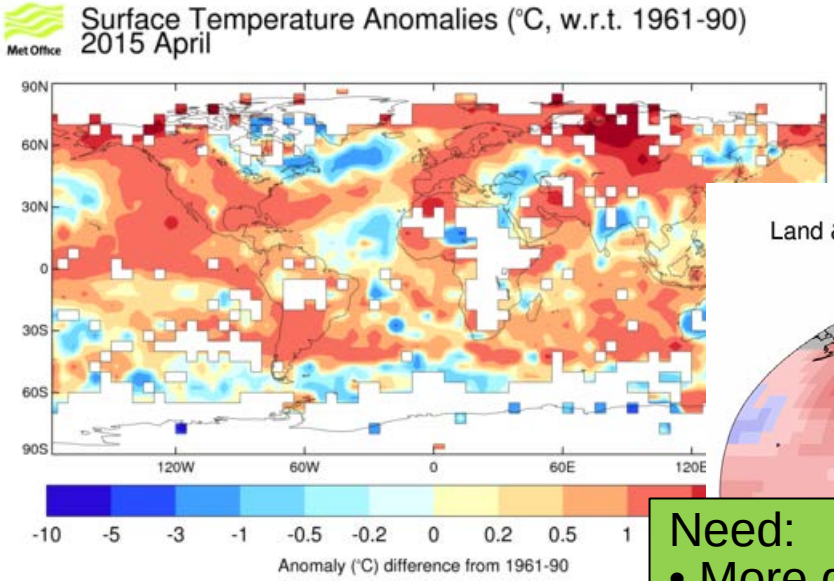


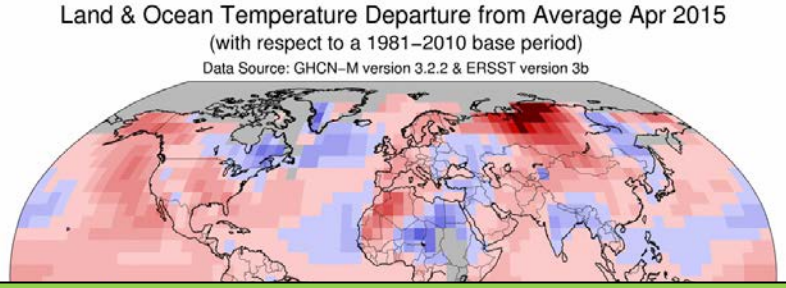
http://www.eea.europa.eu/data-and-maps/indicators/global-and-european-temperature/global-and-european-temperature-assessment-8

ECV products used

For EEA indicator







Need:

- More data
- Continued research into creating consistent records
- Better quantification of uncertainty components
- Research into new ways of statistical infilling

EUSTACE has received funding from the European Union Horizon 2020 Research and Innovation programme, under Grant Agreement number 640171

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DMI

Science & Technology Facilities Council

UNIVERSITY OF BATH

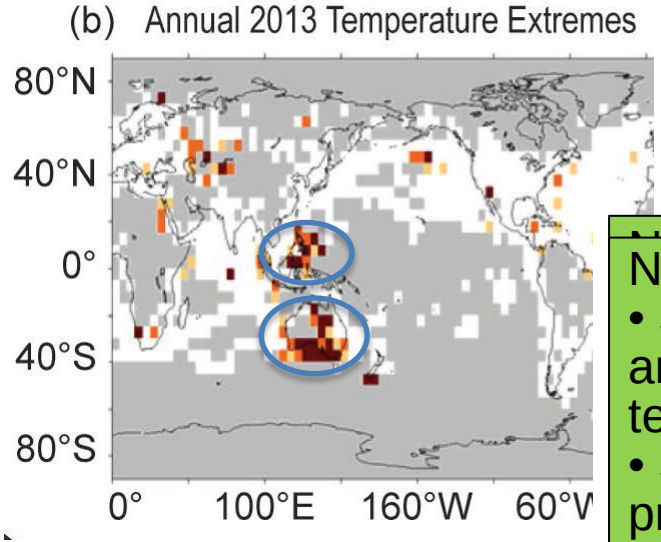
EUSTACE

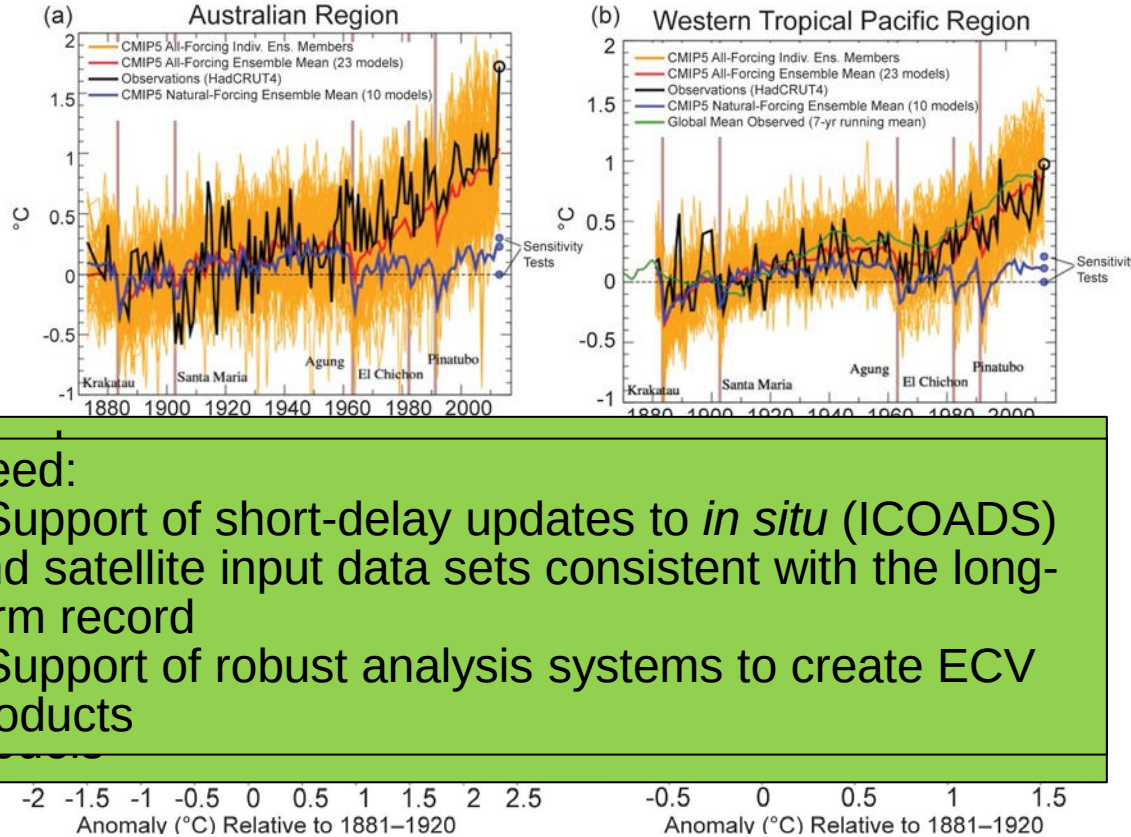
EUSTACE will give publicly available daily estimates of surface air temperature since 1850 across the globe for the first time by combining surface and satellite data using novel statistical techniques

Need:
- more data
- support for short-delay updates (including to underpinning *in situ* and satellite data)
- continued development of consistent long-term ECV products from *in situ* and satellite

Climate-related event attribution

Surface temperature





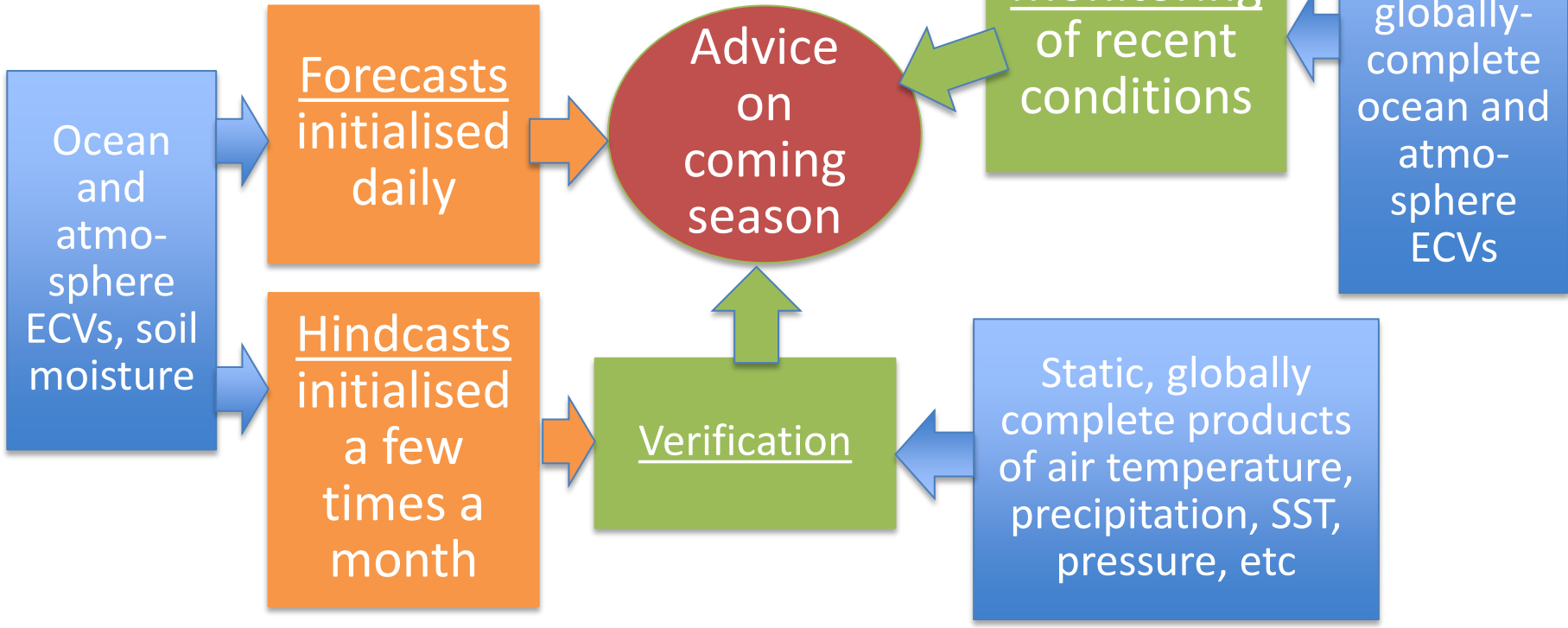
Need:

- Support of short-delay updates to *in situ* (ICOADS) and satellite input data sets consistent with the long-term record
- Support of robust analysis systems to create ECV products

Knutson et al., 2014, in Special Supplement to the *Bulletin of the American Meteorological Society,* 95, 9, 2014

Seasonal forecasting

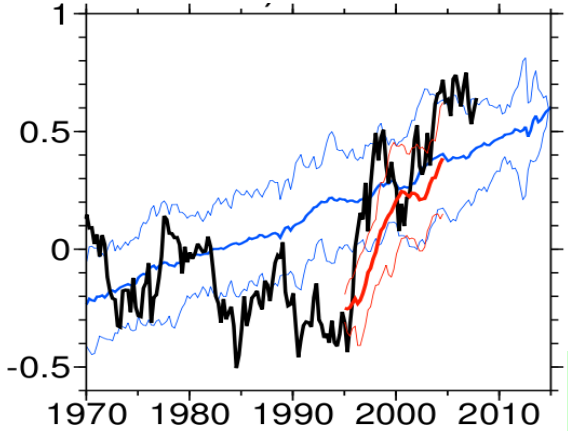
Need:
• Near-real time, short-delay and static ECV products to be more consistent



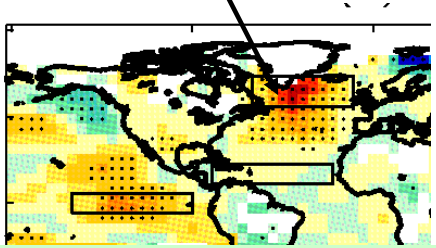
Decadal forecasting

Ocean temperature and salinity for initialisation

Initialisation with observed ocean temperature and salinity leads to better Atlantic ocean forecasts, e.g. 1990s sub-polar gyre warming, and hence realistic representation of rainfall and hurricane numbers



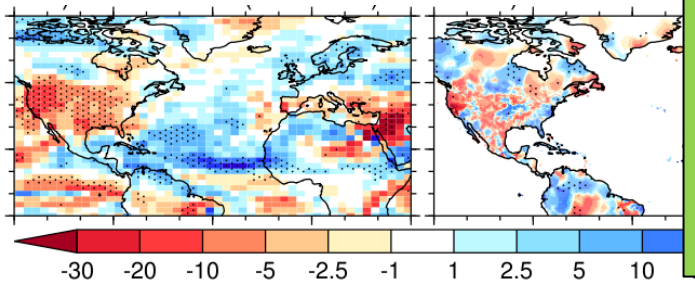
Sub-polar gyre



Increase in hurricane numbers well captured

Model

Observations



Need:

- Continued support of the Argo array
- ECV products need continued research into creating consistent historical records to support multi-decadal hindcasts
- Continued support of the RAPID array

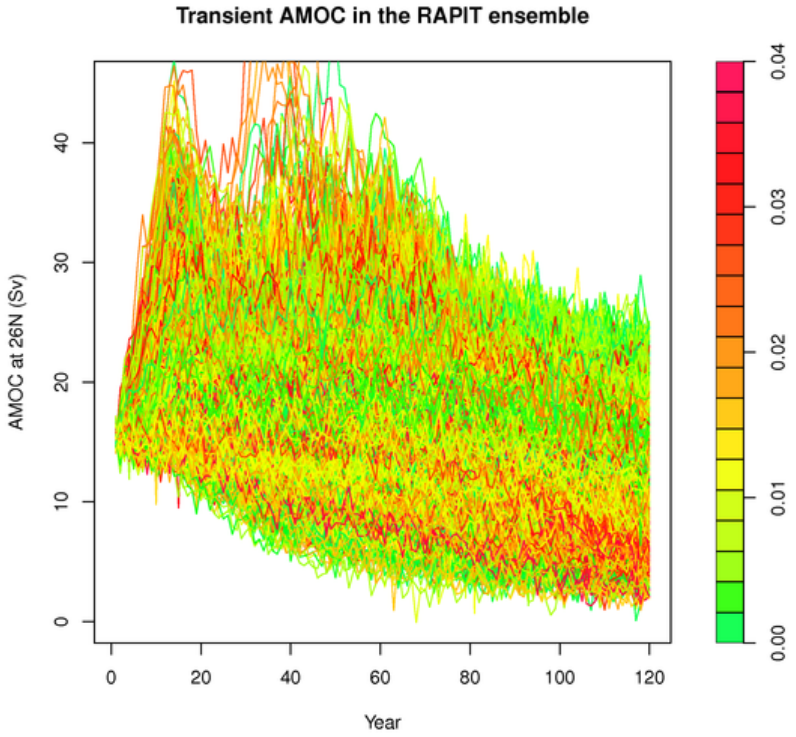
(Robson et al. 2012, 2013; Smith et al 2013)

Ensemble climate projection

Range of ECV products needed to select plausible models

- Different variants of the climate model can be as good, if not better than, the standard tuned version
- Their response can be different to that of the standard version
- Explore parameter space with a view to finding pockets of good quality and see what that implies for uncertainty
- Need to use observations to find these regions of plausible model variants

Example is Atlantic Meridional Overturning Circulation from the NERC RAPID project, but principle is used in UKCP09



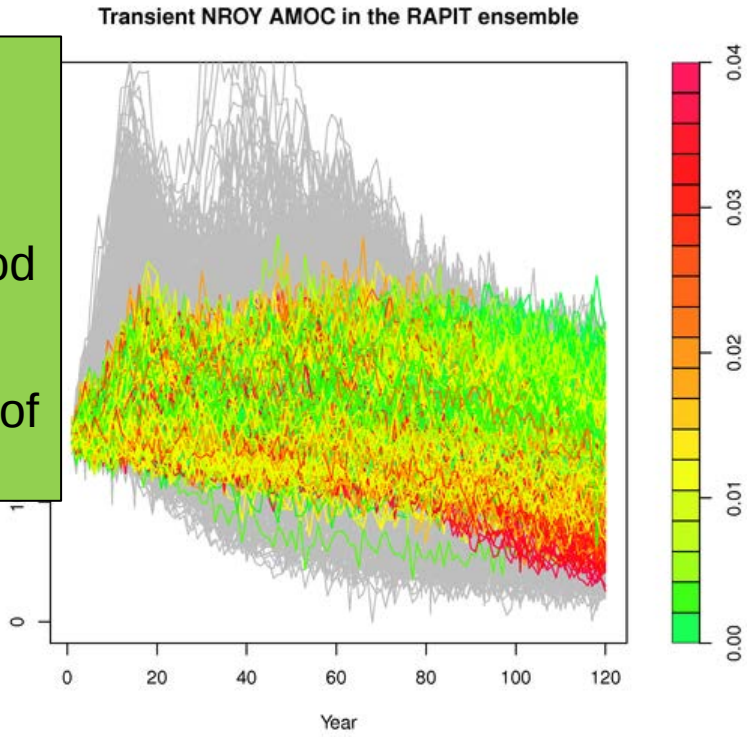
Ensemble climate projection

Range of ECV products needed to select plausible models

Need:
- products used for assessing surface temperature, pressure, precipitation, etc
- ECV products need to be developed with consistent coverage through time (in-filled) and good uncertainty estimates
- CF-standards need to be extended to allow description/communication of covariance structure of these uncertainties

- Need to use observations to find these regions of plausible model variants

Example is Atlantic Meridional Overturning Circulation from the NERC RAPID project, but principle is used in UKCP09



SST User Workshop: provision of ensembles

- Ensemble size 10-1000
  - A single central member, preferred by the data producer
  - A randomly-ordered set of ensemble members so that users can pick at random
- Start ensemble generation from Level 1 (radiances) in order to include the structural uncertainties
- Clearly stated underlying assumptions
- Ensemble produced on 0.05 degrees and coarser
- An operationally available ensemble **or**
- An operationally available best estimate with the ensemble later
- Updates must truly belong to the same ensemble member
- Clear, non-confusing terminology e.g. are members “equally likely”?

SST User Workshop: provision of covariance information

- Ensembles not always the best way to present uncertainty information
- Explicitly forming covariance matrix can be prohibitive
- Parameterize covariance instead
- Provide guidance and clear examples
- What shape are the error distributions?
  - “are they close enough to Gaussian?”
  - “is the distribution symmetric?”
  - For analysing extremes, the shape of the tails can be important.
- Parameterize the distribution shapes too
- Provide examples of the shapes of the distributions

Key messages

Making SST products that are useful for Climate Services

- More data (e.g. microwave retrievals) in data-sparse regions and rescue of old data to extend our ability to provide higher resolution information for longer
    - for many services at least 50-year records are needed, some need as long as possible (165 years+)
- Need continued efforts/research into creating consistent records. In particular, near-real-time needs to be consistent with short-delay mode and reprocessed, long-term data
    - all are needed for some climate services
- Good uncertainty estimates are needed, together with information on their covariance between observations
    - this information needs to be propagated into L4 analyses
    - covariance information could be captured in ensembles and/or descriptive distributions (for different users)