CMUG (Climate Modelling User Group)

Richard Jones

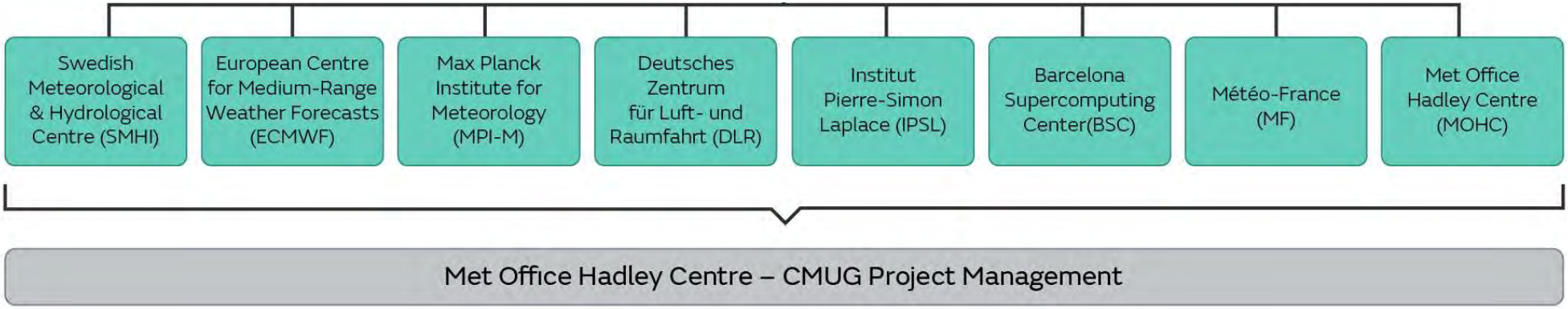
Overview

- Aims and objectives of the CMUG team
- Overview of CCI ECV datasets used in CMUG experiments and analysis
- Highlights of results, findings and uptake
- Use of ECV data in assimilation, reanalysis and forecasting
- CCI ECV-climate research gaps

The aim and objectives of CMUG and who is involved

Aim: to ensure state of the art climate datasets developed by ESA are accessible to and applied in the climate modelling and research community with the broadest possible range of applications by:

1. Supporting integration within the CCI programme
   - through ECV requirements and user assessment from a “climate system” perspective
2. Fostering the exploitation of Global Satellite Data Products
   - by promoting the use of CCI data sets to climate modellers and building links with relevant bodies.
3. Assessing quality and impact of individual/combined Global Satellite Data Products in Climate Model and Data Assimilation contexts
   - by assessing suitability and value of products to evaluate and improve climate predictions, reanalyses…

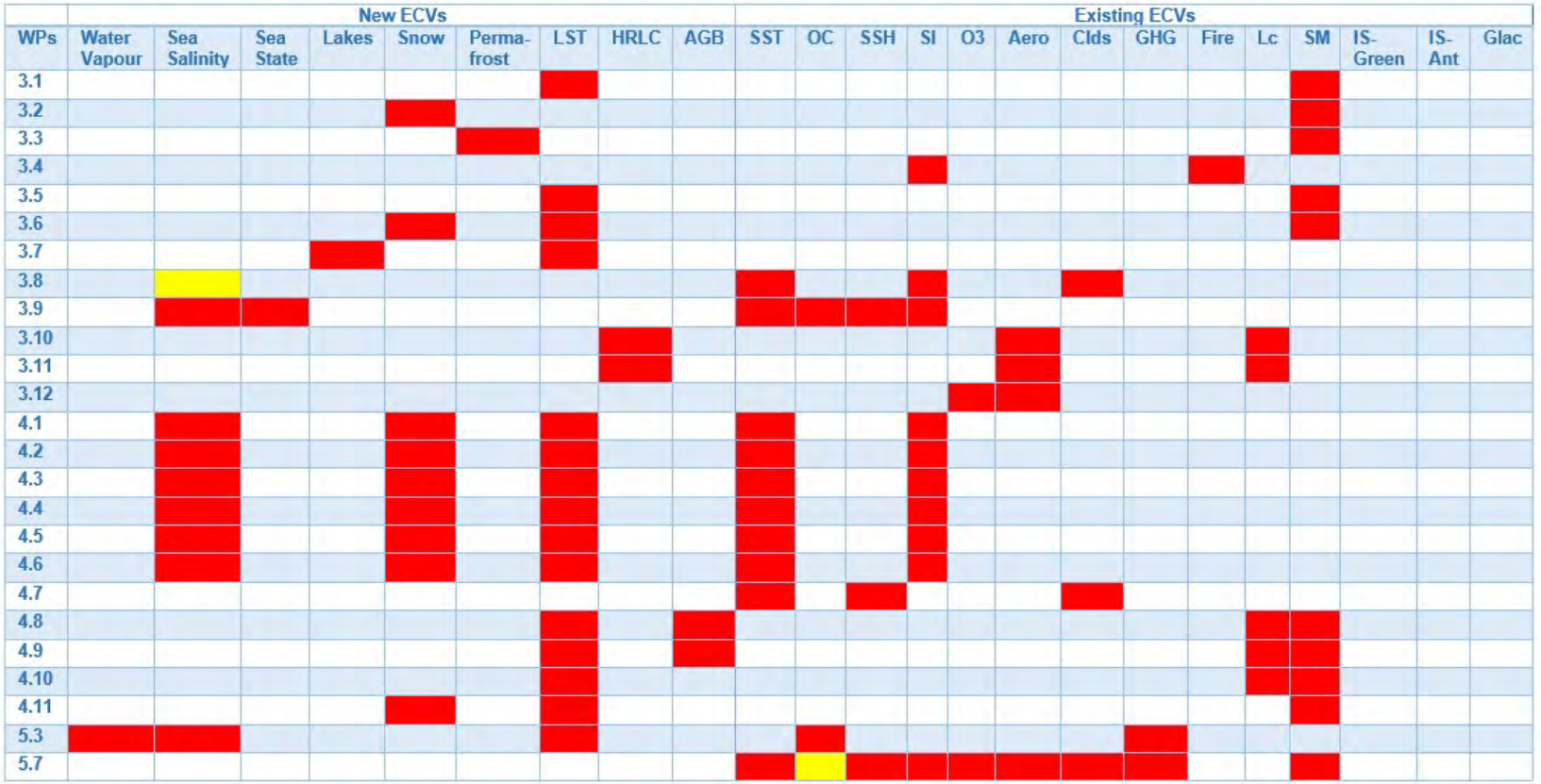


How are CCI data sets used by the modelling community

WP3: Assess consistency between ECVs and their applicability to understand the climate system and climate models

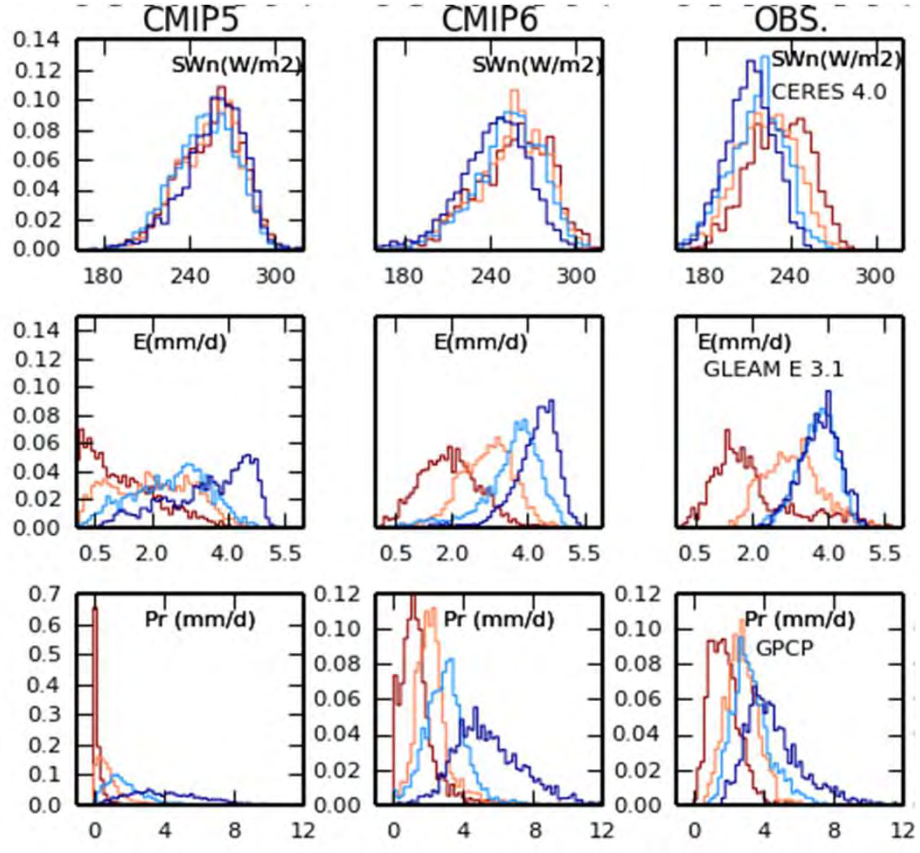
WP4:Assess/demonstrate how ECVs can be used to evaluate various aspects of large-scale simulations of climate models and analyse processes in MIP experiments

WP5: Adapt community climate evaluation tools for CCI needs



CCI ECV datasets in CMUG climate model experiments (WP3 and WP4) and evaluation (WP5). Red = in use, Yellow = May be used

Using ESA-CCI SSM allows to evaluate and improve GCM soil moisture-atmosphere coupling



From: Cheruy et al.,2020, JAMES

Use observations to calculate relationship between the quartiles of monthly SSM and distributions of evaporation, precipitation and solar flux.

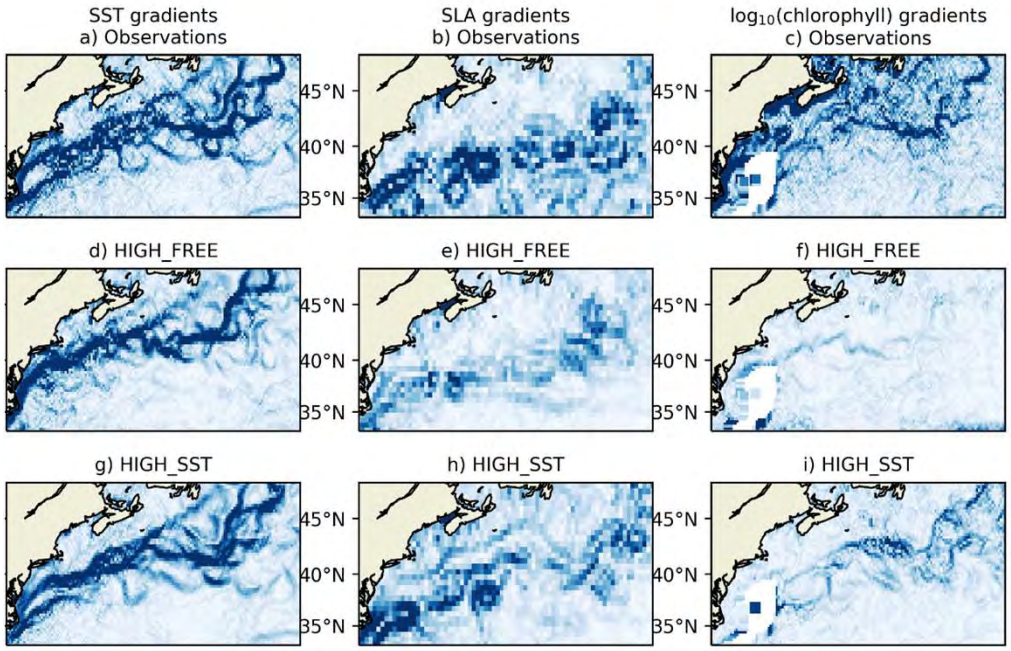
Comparison with CMIP5 GCM demonstrates biases in the relationship with all variables and provides evidence for required model improvement.

Updated atmospheric and land-surface representations in the CMIP6 GCM significantly improved the comparison with observations and thus the model's realism

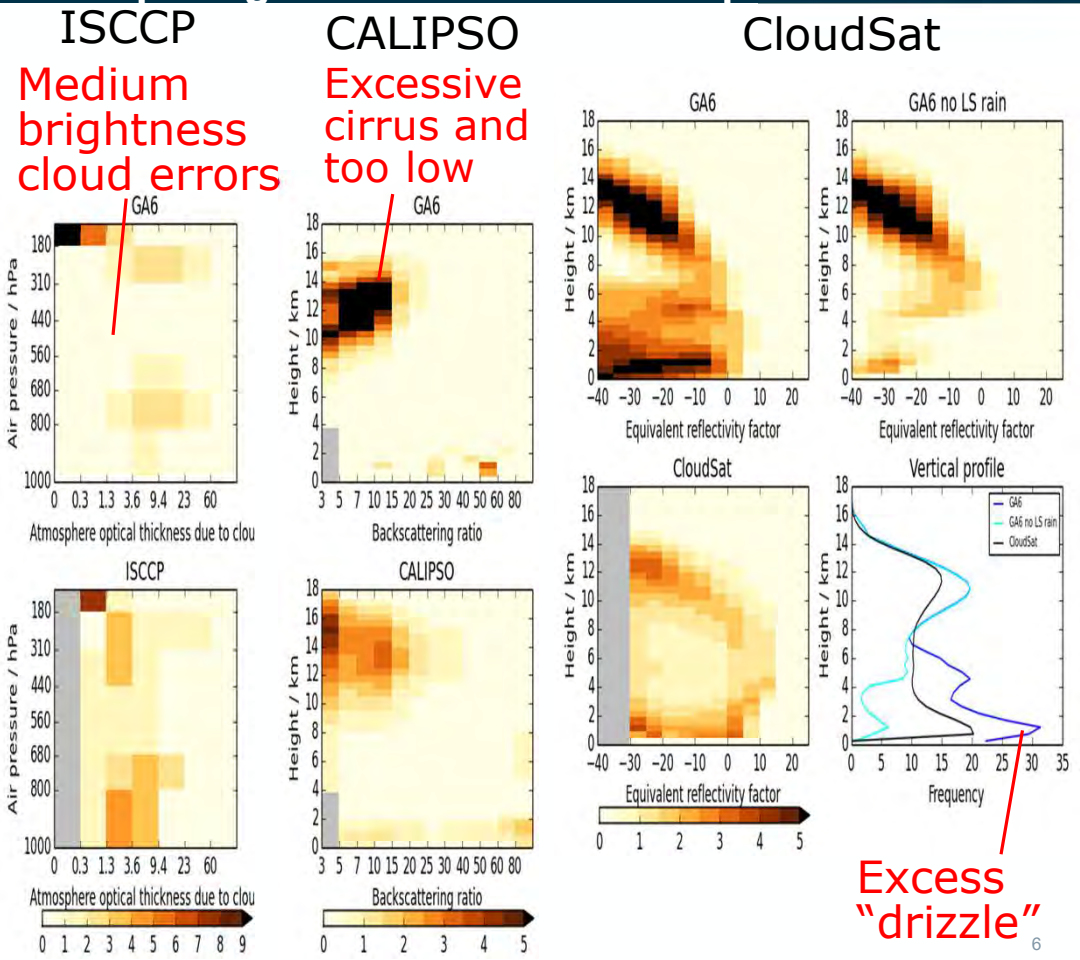
Results for Central North America in JJA. SSM quartiles 1-4 represented by dark red, pale orange, cyan, blue lines.

Diagnosing errors and assessing multi-variate consistency in climate models

Assimilating single and multiple ocean ECV data to assess sources of model errors and multi-variate consistency



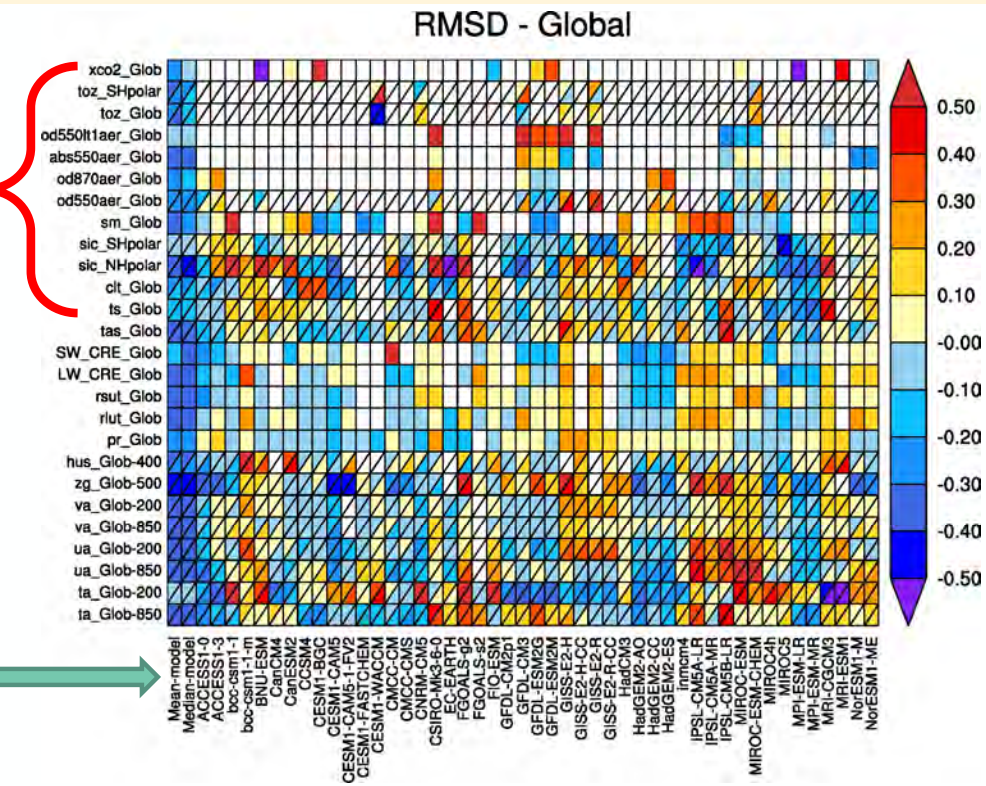
Comparing GCM and satellite tropical cloud data



Global (ESMVal tool) and regional model evaluation

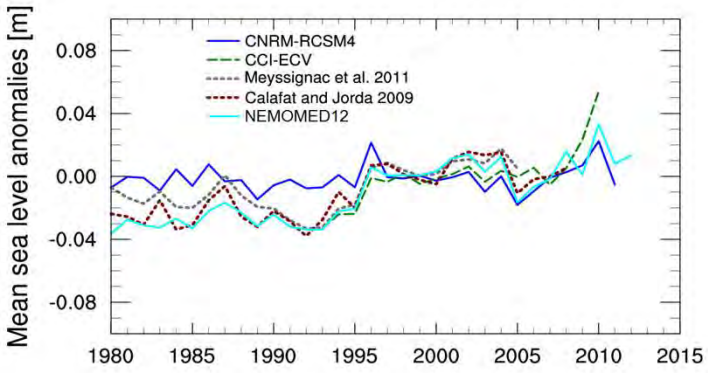
Assessment of climate models using multiple CCI datasets

CCI datasets
GHGs
ozone
aerosol
soil moisture
sea ice
cloud
SST



Climate models

Assessment of regional climate models



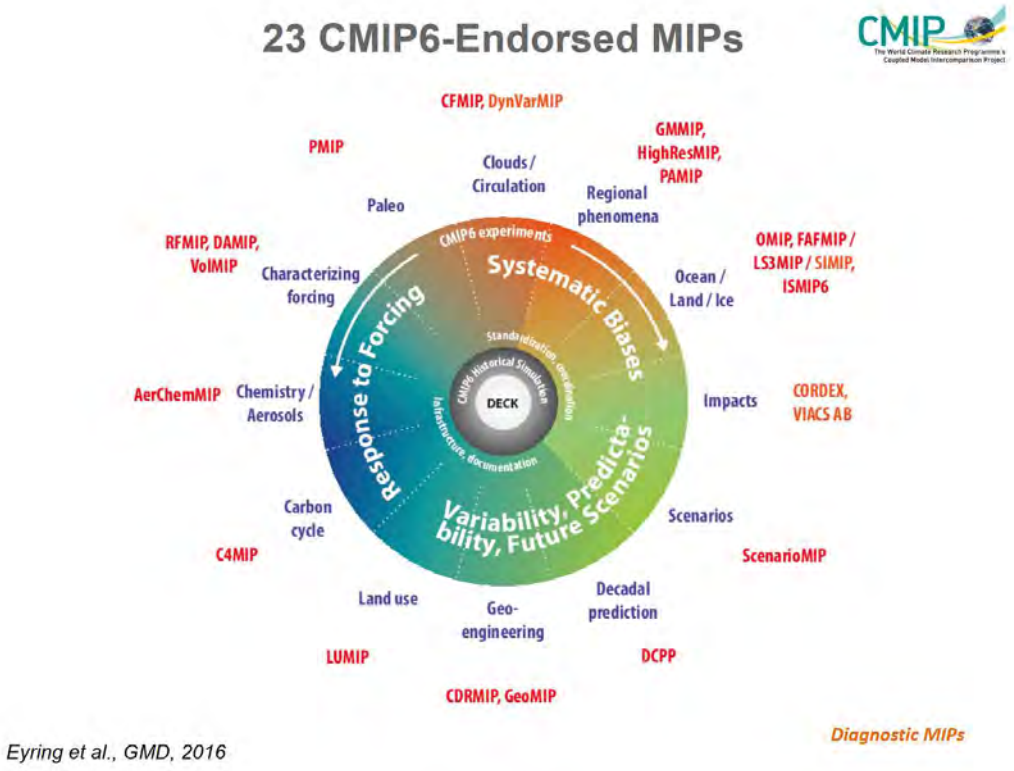
Sea level anomalies over the Mediterranean Sea for 1980-2013 for CCI sea level (dashed green), two tide gauge reconstructions (dotted grey and brown) for the coupled regional climate model CNRM-RCSM4 (dark blue) and the Nemomed12 Mediterranean sea model (light blue).

From: Lauer et al. (2016), Remote Sensing of Environment.
Now ESMVal tool V2: Righi et al. 2020 (T**echnical overview),** Eyring et al. 2020 (**Large-scale diagnostics),** Lauer et al. 2020 (**Diagnostics for emergent constraints and future projections),** Weigel et al. 2020 (**Diagnostics for extreme events, regional model and impact evaluation)**

Involvement in CMIP6 and data provision to Obs4MIPs

CMUG provides CCI ECV datasets to Obs4MIPS

CMUG partners are involved in all MIPs, lead several and several partners in the key projections MIPs (Scenario/HiRes) and process MIPs (CFMIP, LS3MIP, RFMIP)

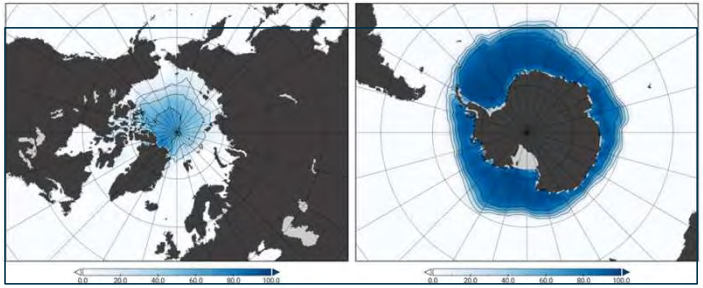


Eyring et al., GMD, 2016

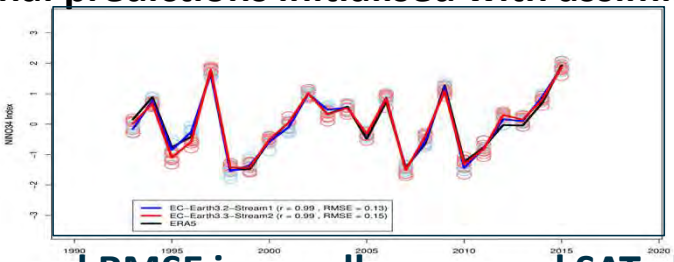
ECV	Project	Standards	Published
Land Cover	CCI	0%	0%
Ocean Colour	CCI	100%	0%
Ozone	CCI	22%	0%
Ozone	CCI	67%	0%
Sea Level	CCI	100%	0%
Soil Moisture	CCI	89%	0%
Salinity	**CCI+**	0%	0%
Sea state	**CCI+**	0%	0%
Snow	**CCI+**	0%	0%
Snow	**CCI+**	0%	0%
Glaciers	CCI	0%	0%
High resolution landcover	**CCI+**	0%	0%
Ice Sheets Antarctica	CCI	11%	0%
Ice Sheets Antarctica	CCI	11%	0%
Ice Sheets Greenland	CCI	11%	0%
Ice Sheets Greenland	CCI	11%	0%
Lakes	**CCI+**	0%	0%
Sea Ice	CCI	22%	0%
Sea Ice	CCI	22%	0%
Water vapour	**CCI+**	0%	0%
Water vapour	**CCI+**	0%	0%
Aerosol	CCI	100%	50%
Biomass	**CCI+**	0%	0%
Cloud	CCI	Prepared by provider	
Fire	CCI	22%	0%
GHG	CCI	100%	50%
GHG	CCI	100%	50%
Land Cover x 5	CCI	0%	0%
Land surface temperature	**CCI+**	0%	0%
Permafrost x 6	**CCI+**	0%	0%
Sea Surface Temp.	CCI	89%	25%

ECV-model data assimilation for reanalysis and forecasting

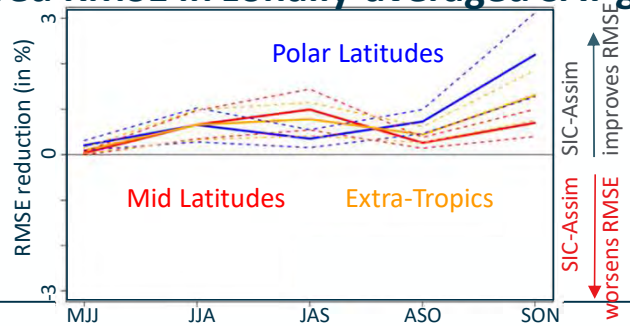
Reanalysis with Sea-ice ECV data



Seasonal predictions initialised with assimilated SIC

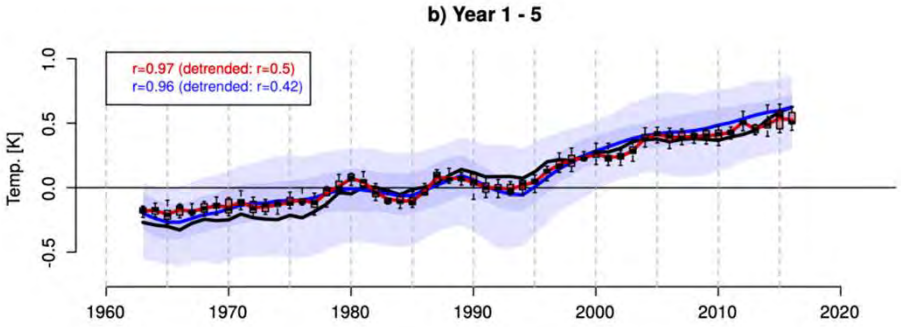


Improved RMSE in zonally-averaged SAT globally

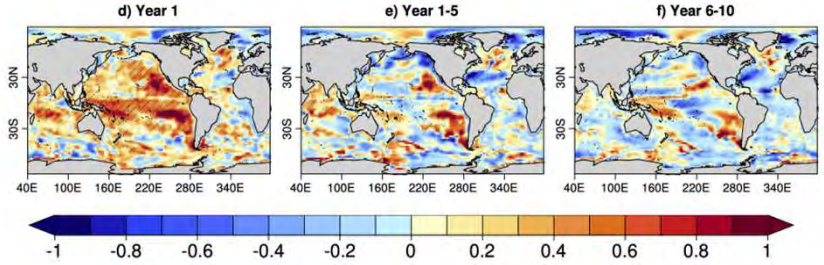


Skill assessment CMIP6 DCPP (Decadal Climate Predictions Project) initialised predictions using Sea Level, Cloud, SST ECVs

Predictions from 1963-2015, evaluated 1982-2015



Assessment of forecast skill for years 1, 1-5 and 6-10



Main focus on ocean subsurface as source of predictability

CCI ECV-climate research, opportunities & gaps

- CMUG (in collaboration with ECV teams) is facilitating wide-spread application of CCI ECV data for climate model improvement, model and forecast evaluation and understanding the climate system and climate change
  - Many new research ideas are emerging from the CMUG and ECV teams' research/applications
  - Significant value in enhancing provision, accessibility, usefulness of existing and new CCI ECV data
- Understanding and monitoring global and regional earth system cycles, energy, water, glaciers, ice-sheets etc, provides policy relevant climate information and combining ECVs and modelling can contribute significantly
  - Specifically on monitoring, generating reanalyses (reconstructions of the recent climate) from models of the full earth system will improve their consistency (current work focus on individual earth system components, e.g. land-surface, oceans).
  - There are also opportunities to improve reanalyses for each earth system component with new observations
- Detecting and attributing trends is a key input into climate policy and the robustness of these results is improved by quantifying errors in CCI ECV data - continued work on generating traceable error estimates is essential.
- Further improvement of global and regional climate models and evaluation of the skill of seasonal to decadal forecasts they generate will bring significant societal benefit and requires continuing work to bring together new and existing (and improved) CCI ECV datasets to evaluate and improve the models and their forecasts.