Observational Data Requirements for Earth system prediction

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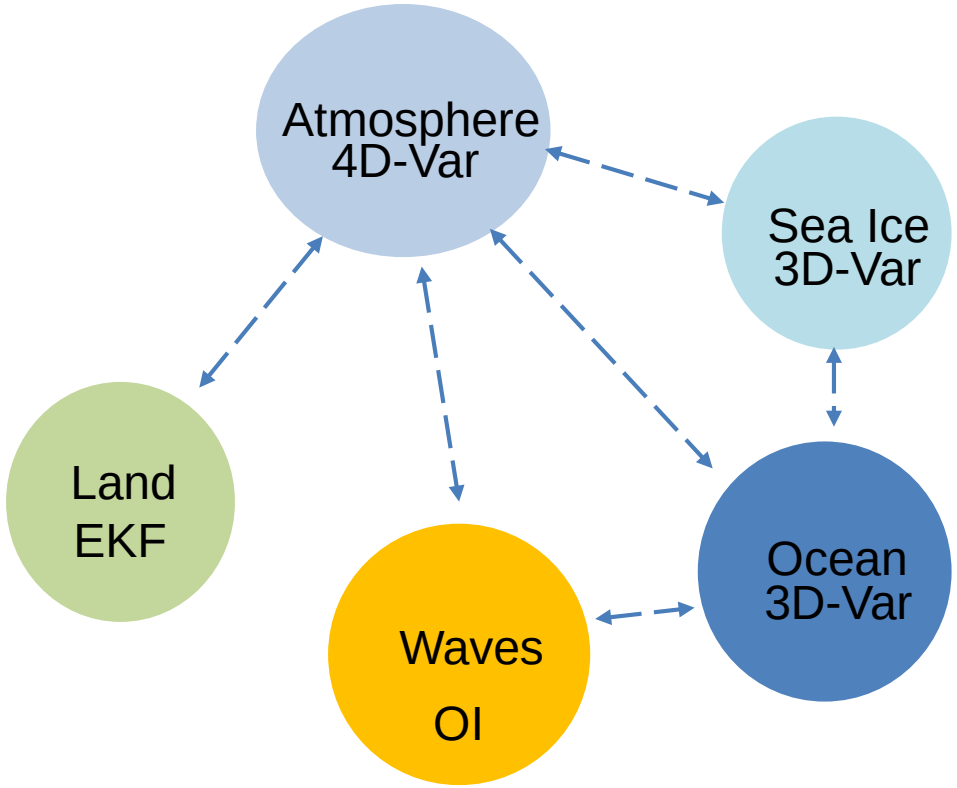
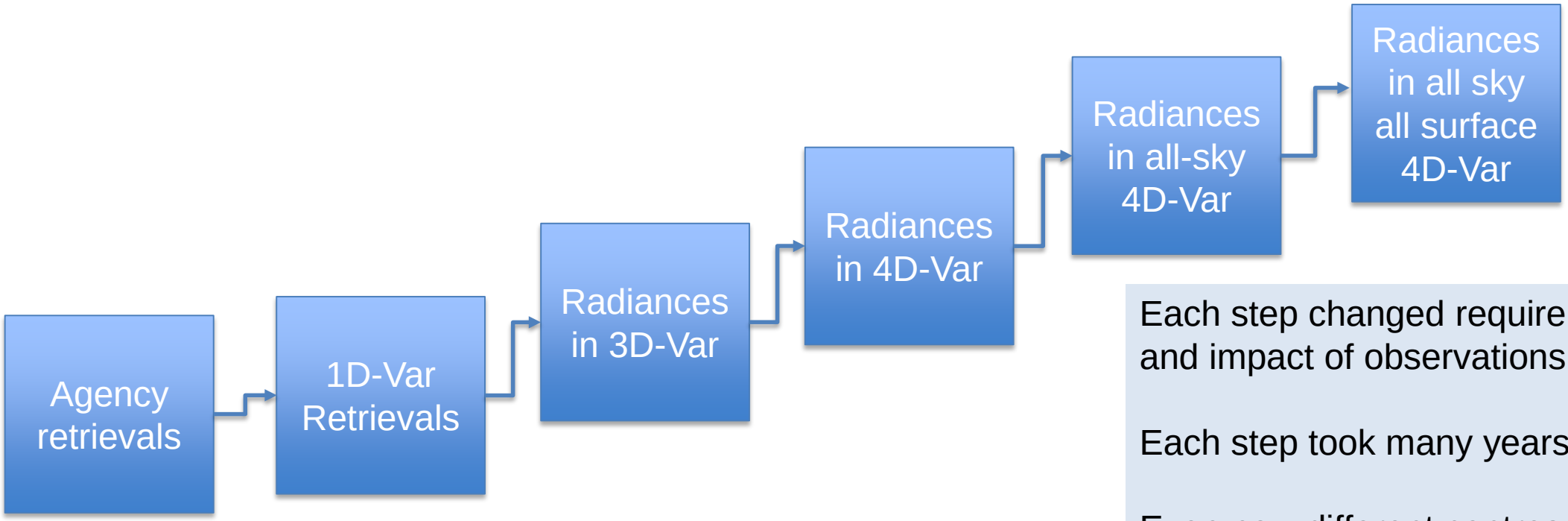


Thanks to many colleagues at ECMWF, notably Patricia de Rosnay, Tony McNally, Hao Zuo

ECMWF

What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?

- Moving from “weather”, “ocean”, “land” etc. to Earth System changes fundamentally the value of and hence requirement for observations
- Mature systems use sparse and incomplete observations better than less mature systems, are increasingly coupled and at higher resolution **e.g. recall satellite radiances for atmosphere:**



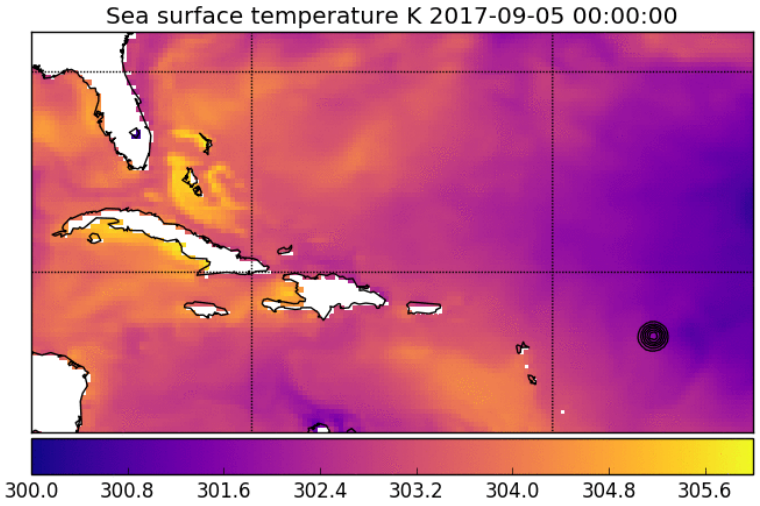
Each step changed requirement and impact of observations

Each step took many years!

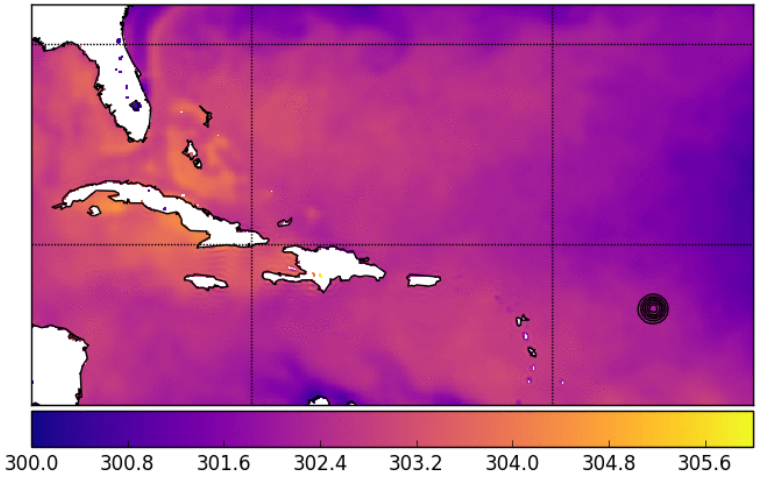
Even now different centres are at different stages

What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?

With ASCAT



Without ASCAT



What maturity will we have in 5, 10, 20 years in the future?

Many other examples:

- Winds from assimilating atmospheric composition observations as tracers
- Atmospheric composition from “weather” instruments e.g. IASI
- MW imagers coupling surface and atmosphere
- …

From Tony McNally, Phil Browne and Giovanna De Chiara, ECMWF

What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?

- **Examples of some important un-met requirements include,**
  - Ocean coverage, especially profile and in regions of boundary currents

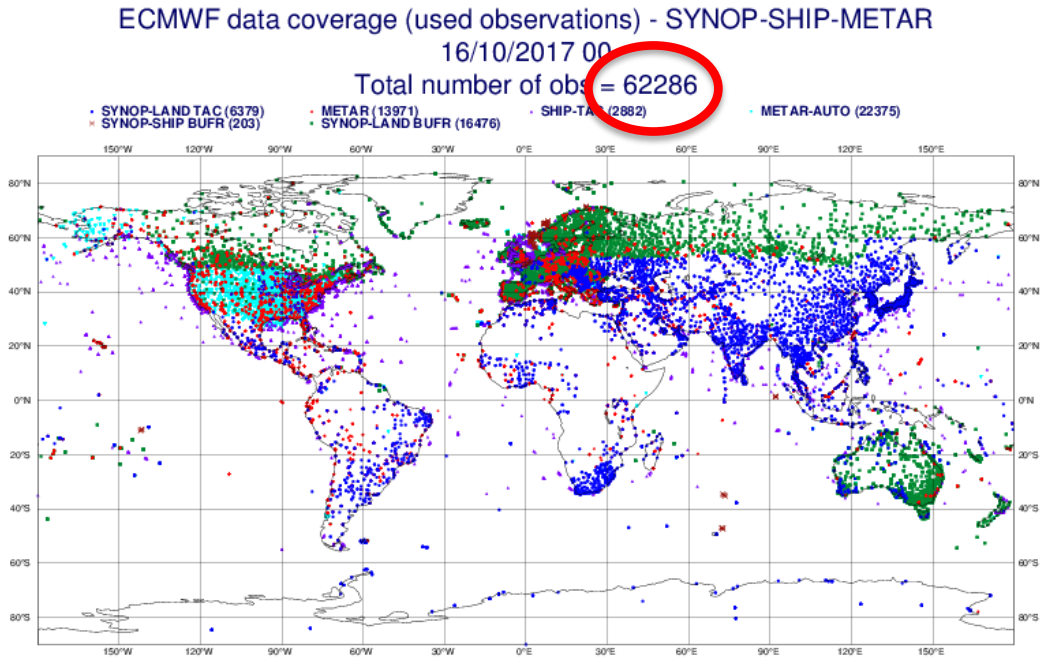
For a more detailed discussion on ocean gaps see:

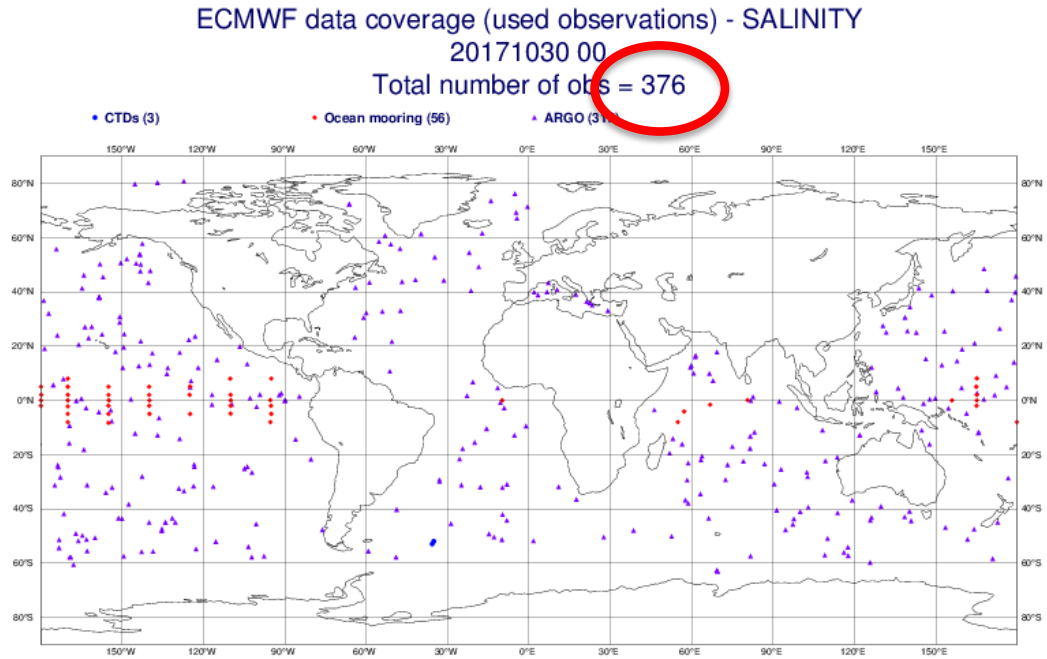
Statement of Guidance for Ocean Applications https://www.wmo.int/pages/prog/www/OSY/SOG/SoG-Ocean.pdf

Emma Heslop: "Challenges and opportunities towards improving data delivery for WMO Services", in Workshop on Theme 3 "Filling the gaps".

What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?

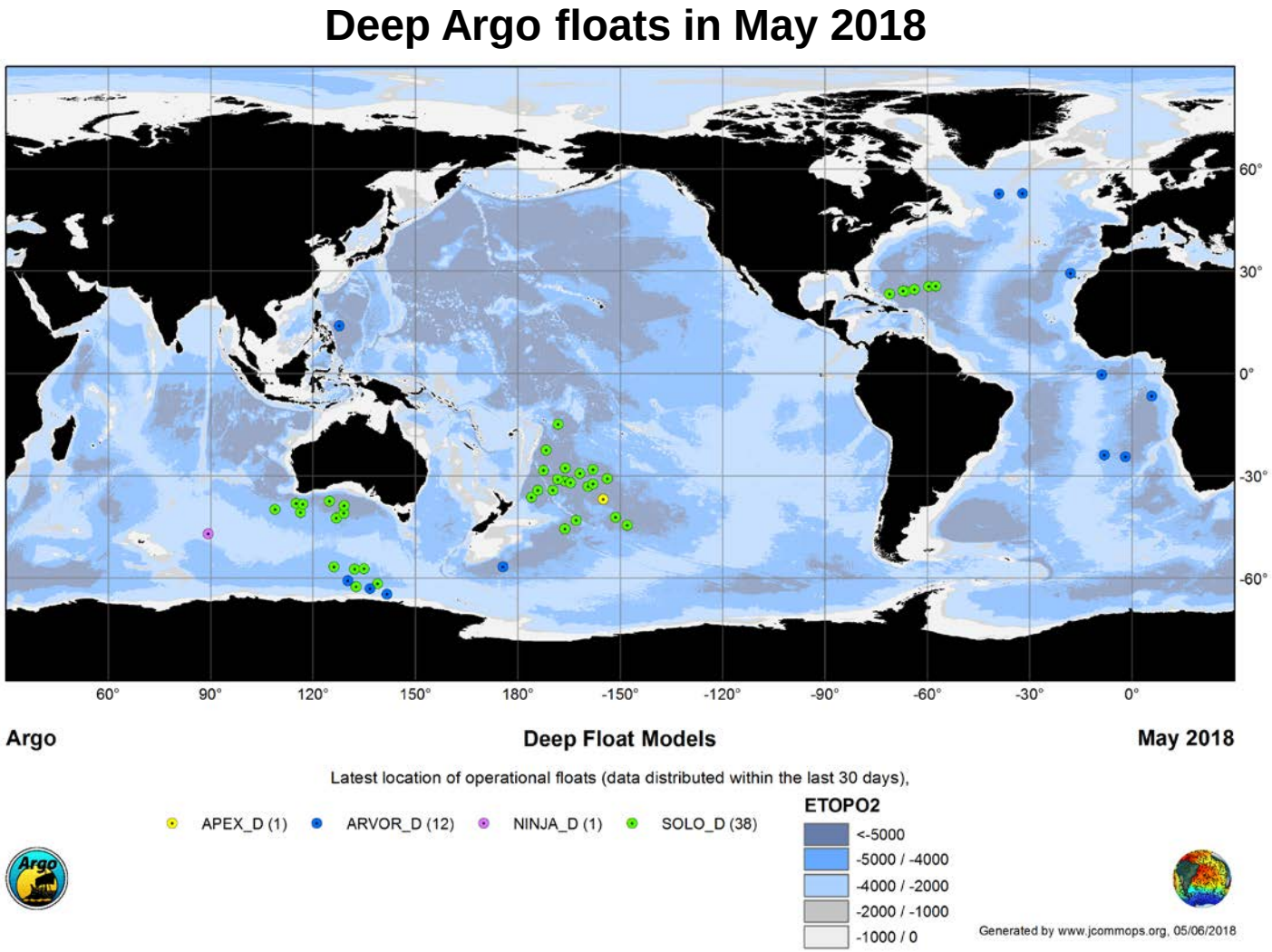
- Ocean obs plays a very important role in the Earth System approach of NWP
- The current global ocean obs network is still relatively sparse compared to atmosphere obs
  - e.g. Western Boundary Currents still un-sampled





From Hao Zuo, ECMWF

What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?



Depth range

Deep SOLO: 0-6000 m

Deep APEX: 0-6000 m

Deep ARVOR: 0-4000 m

Deep NINJA: 0-4000 m

Total number:

So far: **52** Deep Argo

Planned: **expansion** under ARGO2020 next 5-10 years

From Hao Zuo, ECMWF

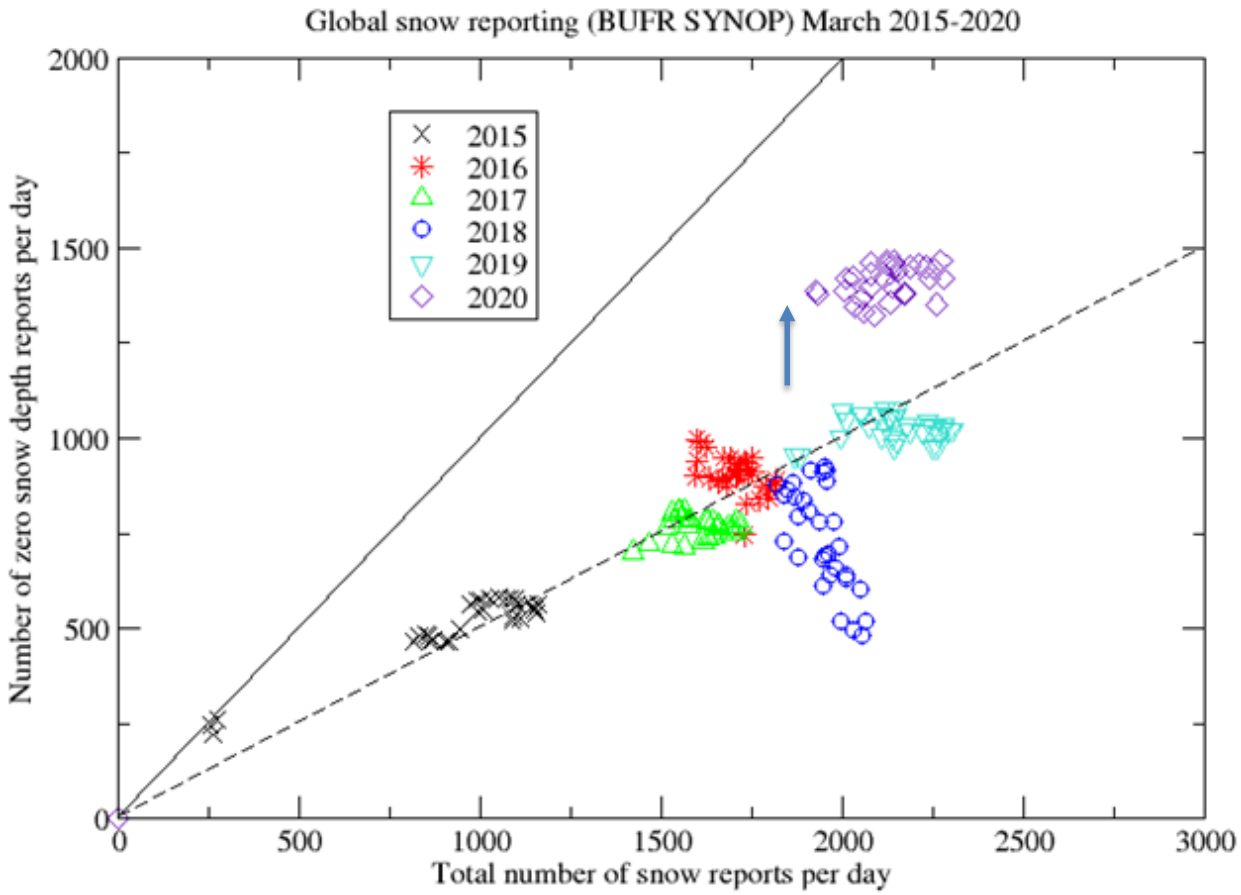
What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?

- **Examples of some important un-met requirements include,**
  - Ocean coverage, especially profile and in regions of boundary currents
  - Sharing of all existing observations (GBON effort)
  - Vertical wind profiles (post Aeolus) – demonstrated addressing atmospheric gaps still matters
  - Vertical atmospheric constituent profiles, including stratospheric water vapour (post MLS)
  - Land, especially Snowpack observations (including exchange of existing observations)
  - As maturity of other aspects increases, needs will become more pressing (e.g. hydrology)

How can we encourage data access and provision for multiple user needs?

6. Improvements in the reporting of 'zero' snow depth from SYNOP stations

(de Rosnay, Pullen, and Nitu)



- Confirm increase in available snow depth data from distinct SYNOP stations reporting in BUFR
- Recent increase in 'zero' snow depth reports

From Patricia de Rosnay, ECMWF

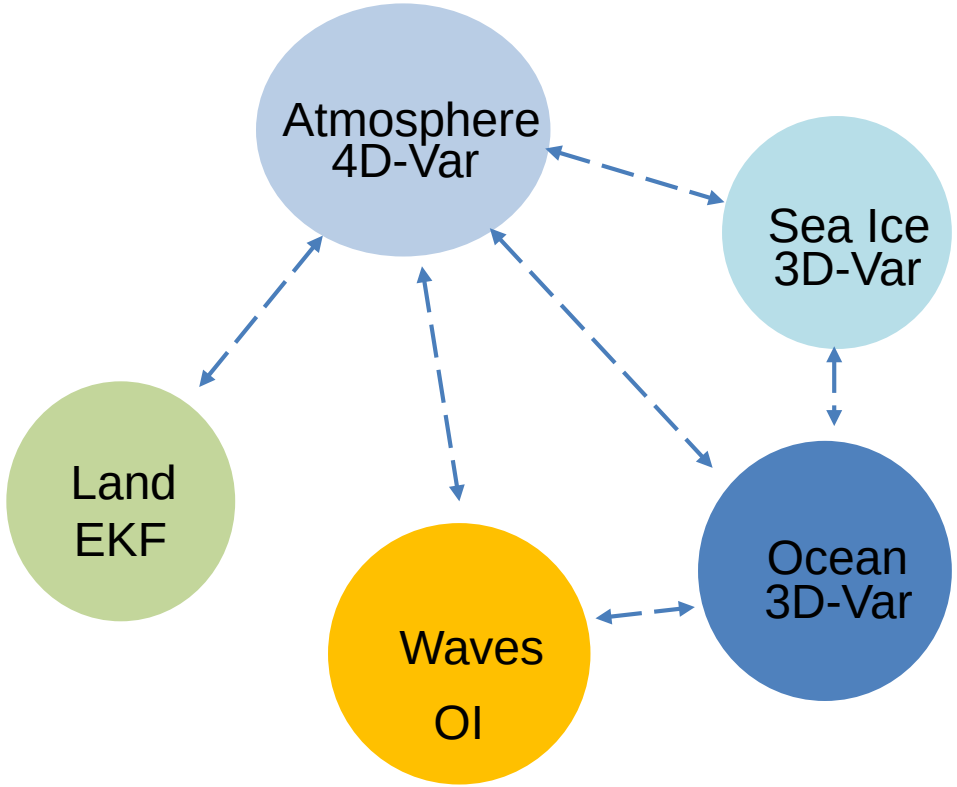
What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?

- **Examples of some important un-met requirements include,**
  - Sharing of all existing observations (GBON effort)
  - Ocean coverage, especially profile and in regions of boundary currents
  - Vertical wind profiles (post Aeolus) – demonstrated addressing atmospheric gaps still matters
  - Vertical atmospheric constituent profiles, including stratospheric water vapour (post MLS)
  - Cryosphere and land e.g. Snowpack observations (including exchange of existing observations)
  - As maturity of other aspects increases, needs will become more pressing (e.g. hydrology)

- **New considerations for Earth System NWP requirements**
  - Develop level of maturity of all Earth System capability
  - Recognition of “interface observations” sensitive to multiple Earth System components e.g. scatterometer
  - Observation quality, models, operational monitoring, error characterisation, timeliness (e.g. ocean – a few days or 2 hours???)
  - Level of observation processing (depends on maturity of system)
  - Governance issues, extension of GBON to other Earth System areas, to enable exchange of all observations

What are the data needs and requirements to move to a seamless Earth System Monitoring and Prediction?

Ocean, land, waves, sea ice tend to lag behind atmosphere



Message

There are observational gaps for Earth System especially in the ocean but it is as important to invest to increase maturity in use of observations and to share all observations to address Earth System Monitoring and Prediction

Development of a community of earth-observing system assessment/design

- Technical workshop* concluded impact assessment mature for ES components but called for more joined up studies across all ES to answer question: invest in ocean or atmosphere or land or … ?
  - Need to re-assess observation impact on coupled systems

Message

We know how to monitor ES observations based on NWP experience and how to assess impact: some good practise in individual areas but so far insufficient joined up studies to answer question on balance of investment

*** SCOPING WORKSHOP ON FUTURE ACTIVITIES TO ASSESS IMPACT OF VARIOUS OBSERVING SYSTEMS ON EARTH SYSTEM PREDICTION**

Development of a community of earth-observing system assessment/design

Current obs

OSE and FSOI: John Eyre talk
(also note ECMWF memo to CGMS guide on strengths and weaknesses)

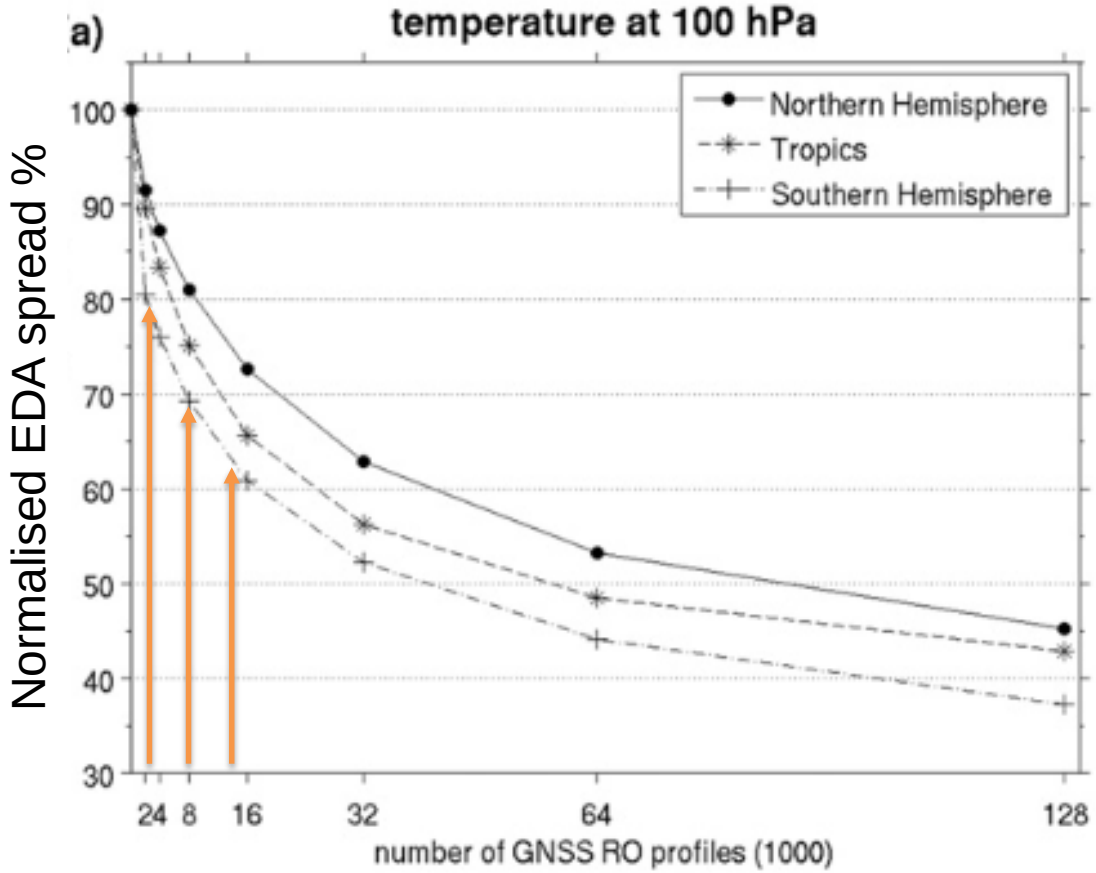
Future observations and network design

ECMWF pioneered use of the Ensemble of Data Assimilations as a cheap and effective way to predict impact of future observing systems

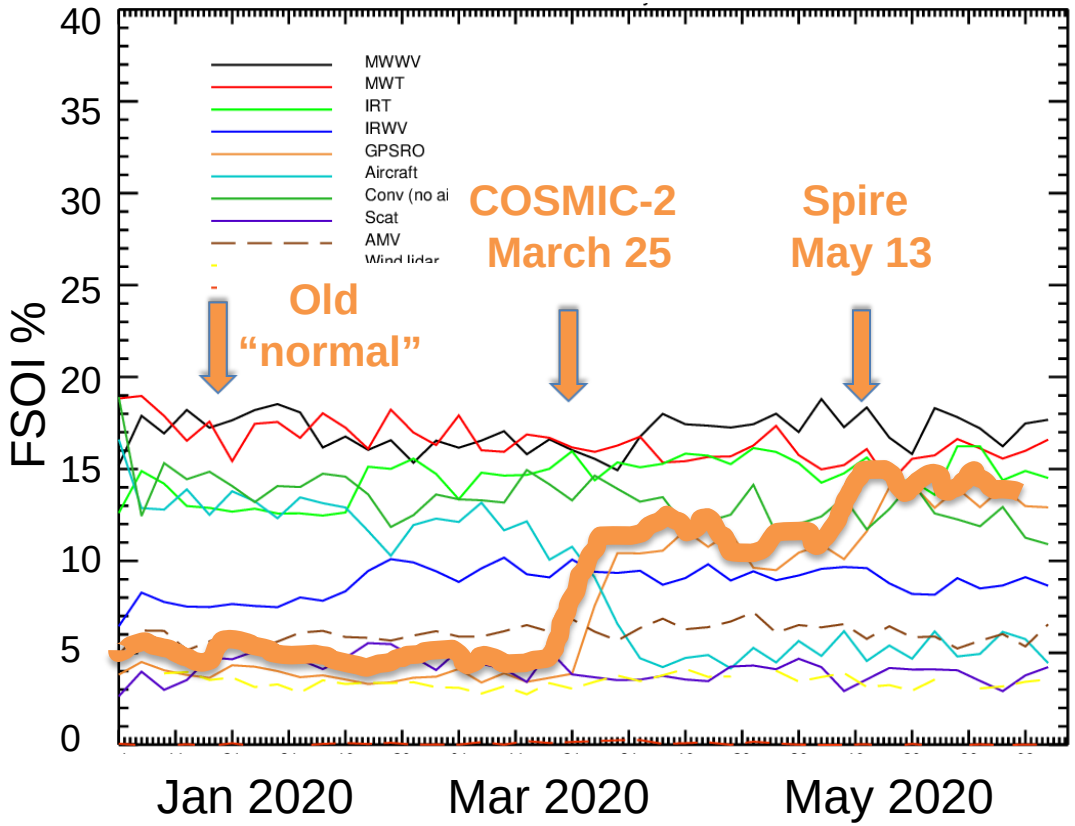
Proven with RO and being used for small satellite microwave constellations

Equally applicable to surface network design

Development of a community of earth-observing system assessment/design



EDA prediction in 2013 (Harnisch et al.)



Increased RO data in 2020

Adapted from Sean Healy and Florian Harnisch

Take home messages

As systems mature, gaps elsewhere e.g. cryosphere, hydrology….

There are observational gaps for ES especially in the ocean but it is as important to invest to increase maturity in use of observations and to share all observations to address Earth System Monitoring and Prediction

We know how to monitor ES observations based on NWP experience and how to assess impact: some good practise in individual areas but so far insufficient joined up studies to answer question on balance of investment

Earth System Ensemble of Data Assimilations enables us to assess impact of future systems and networks and can be used to inform decision making on where to invest resources