International Use of S-NPP

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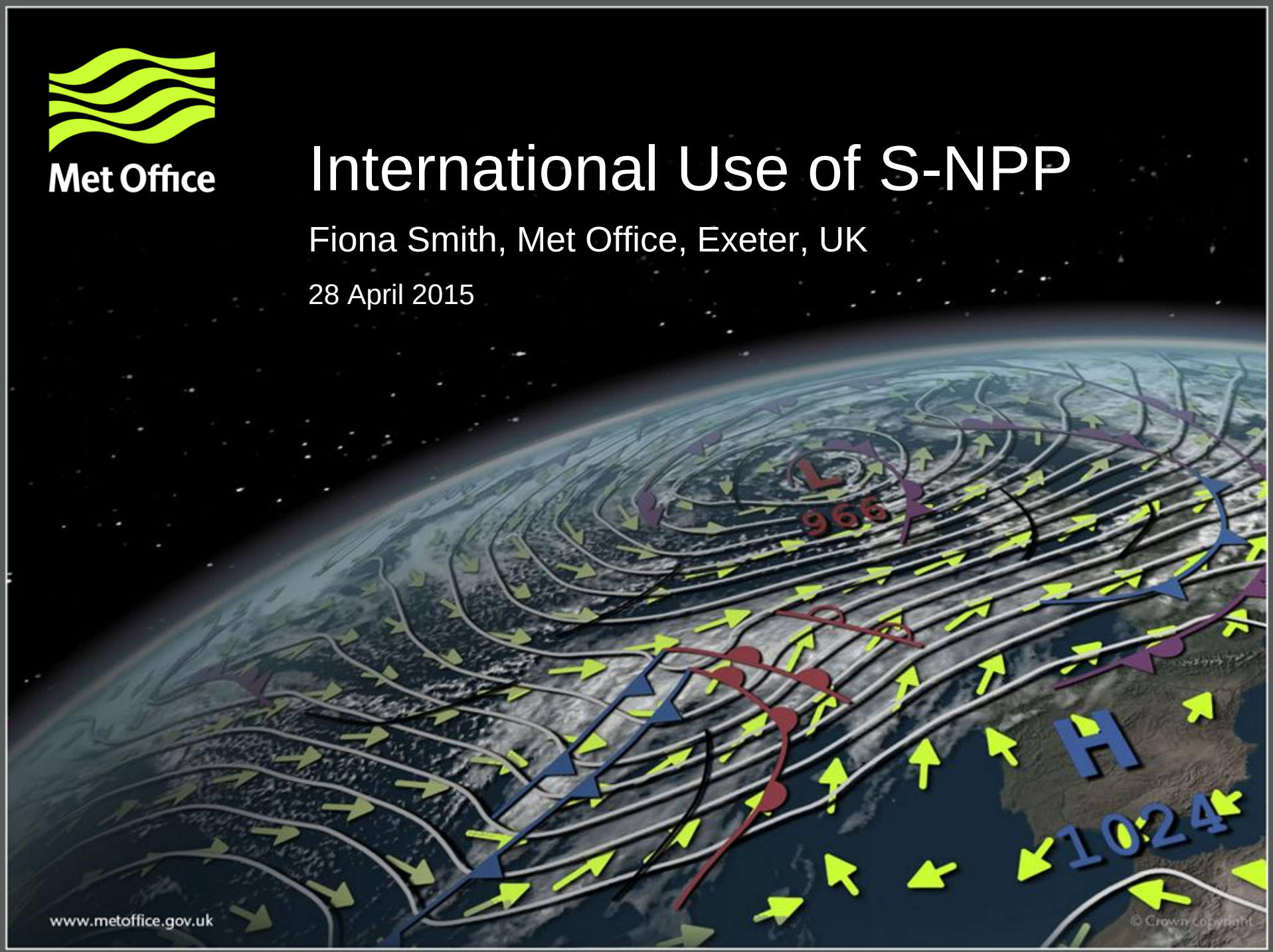

Thank you to all contributors

Met Office: James Cotton, Amy Doherty, Andrew Smith, Peter Weston, Bill Bell

BoM: Chris Tingwell

CMC: Louis Garand, Stephen MacPherson, Sylvain Heilliette

DMI: Bjarne Amstrup

DWD: Christina Koepken-Watts

ECMWF: Niels Bormann, Reima Eresmaa, Kirsti Salonen

Météo-France: Vincent Guidard, Louis-François Meunier

NCEP: Andrew Collard

NIWA: Michael Uddstrom

NRL: Bill Campbell, Ben Ruston

SSEC, University of Wisconsin: Jun Li

And also (who do not yet use S-NPP): Roger Randriamampianina (met.no), Magnus Lindskog (SMHI)

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Overview

How S-NPP is used by the international community for weather forecasting

- Sounder data
  - How ATMS is used
  - How CrIS is used
  - Impact assessment
  - Correlated Errors
  - What next?
- VIIRS

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S-NPP for Numerical Weather Prediction: ATMS

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Usage of ATMS

Met Office Processing

- Remapped and spatially averaged in AAPP* using Fourier techniques to improve noise performance and replicate AMSU footprint size (3.3° beamwidth)
- Treated like AMSU/MHS in operational assimilation, but observation errors are slightly increased because of striping
- No need to reject footprints at the edge of the scan (as is done with AMSU)
- Surface-sensitive channels and 183GHz channels are rejected over land and sea-ice

* ATOVS and AVHRR Pre-processing Package

International Usage of ATMS

	Status	Channels	Averaging	Remarks
Met Office	Operational	6-15, 18-22	3.3° Fourier	
BoM	Preparing	6-15, 18-22	3.3° Fourier	Parallel Now, Operational June
NIWA	Operational	6-15, 18-22	3.3° Fourier	
DMI	Operational		3.3° Fourier	Local only
ECMWF	Operational	6-15, 18-22	3 x 3 pixels	
Météo-France	Operational	6-14, 18-22	3 x 3 pixels	
CMC	Preparing	5-15, 17-22		Parallel Summer, Operational Fall
NRL	Operational	4-15, 17-22		
NCEP	Operational	1-15, 17-22		
DWD	Operational	T sounding		

S-NPP for Numerical Weather Prediction: CrIS

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Usage of CrIS

Met Office Processing

- Treated similarly to IASI but observation errors are lower
  - Operationally, IASI is assimilated with a full error covariance matrix, CrIS is still a diagonal matrix (see later slides)
- Start from NESDIS 399 channel set
  - Remove channels sensitive to trace gases, etc.
  - Remove adjacent channels in B2 to reduce inter-channel correlations
  - Reject all Band 3 channels
- Assimilate channels that peak above the cloud top
- Surface sensitive channels are rejected over land, all channels rejected over sea-ice

International Usage of CrIS

	Status	Channels	Remarks
Met Office	Operational	T: 76 Surf:13 WV: 45	
BoM	Preparing	T: 76 Surf:13 WV: 45	Parallel Now, Operational June
NIWA	Operational	T: 76 Surf:13 WV: 45	
DMI	-	-	-
ECMWF	Operational	T/Surf/O_3: 71 WV: 7	
Météo-France	Operational	T: 68	
CMC	Preparing	T: 35 Surf: 26 WV: 29 SW: 13	Parallel Summer, Operational Fall Also used for NH_3 retrievals
NRL	Preparing	B1: 84 B2: 49	Parallel Summer, Operational Fall
NCEP	Operational	T/Surf: 84	
DWD	Evaluating		

S-NPP for Numerical Weather Prediction: Impact Assessment

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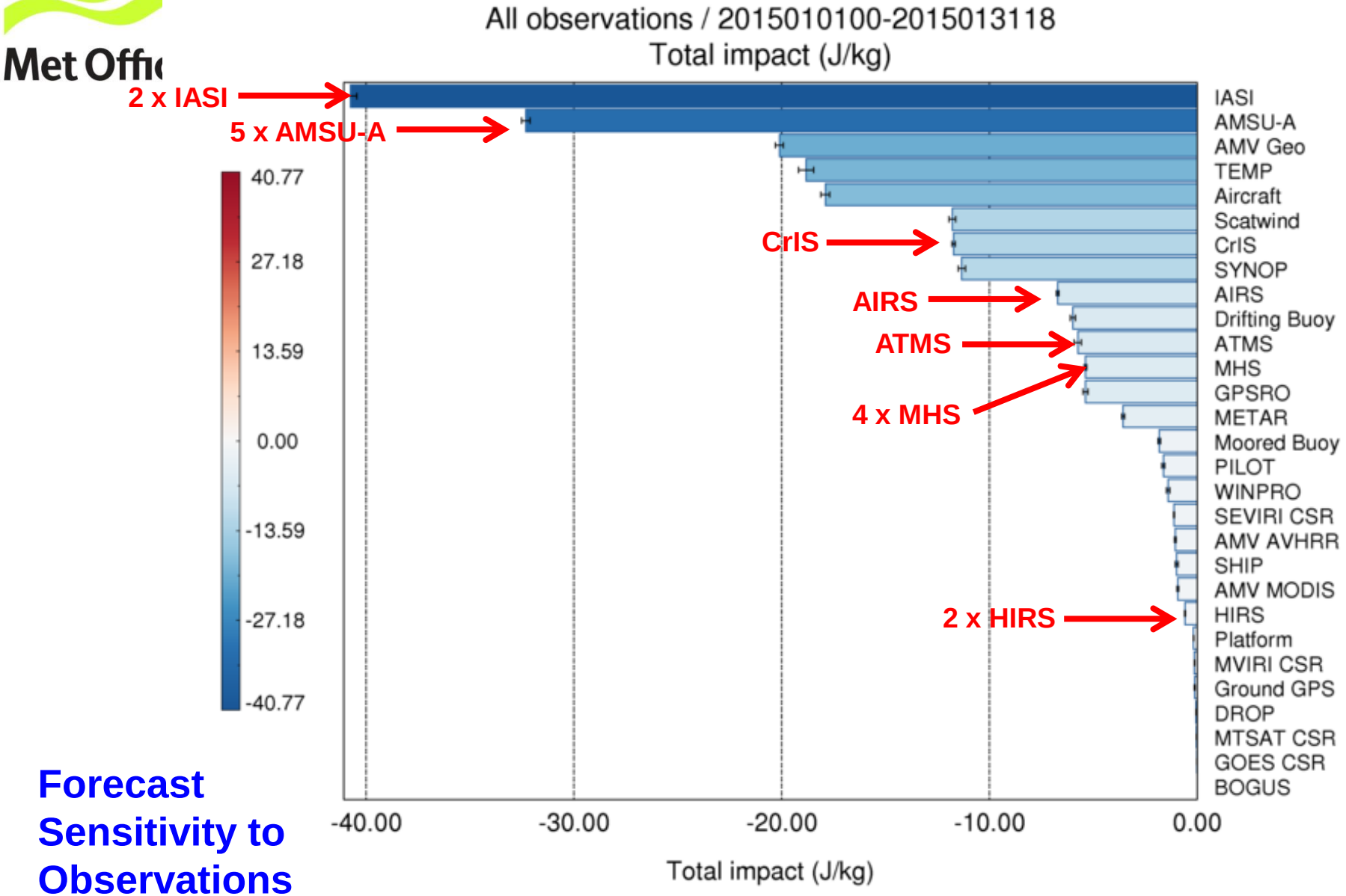
Impact of S-NPP: Observing System Experiments

- All centres report positive impact from assimilation of both ATMS and CrIS
- Met Office:
  - CrIS 1-2% improvement in RMS Error for PMSL* in NH and SH
  - ATMS 2% improvement in RMS Error for PMSL in SH; 1% improvement in RMS Error for 500hPa Geopotential in SH
- ECMWF:
  - ATMS 1% improvement in RMS Error for 500hPa Geopotential at 7-8 days in NH, 2% at 1-2 days in SH
  - CrIS beneficial in absence of AIRS

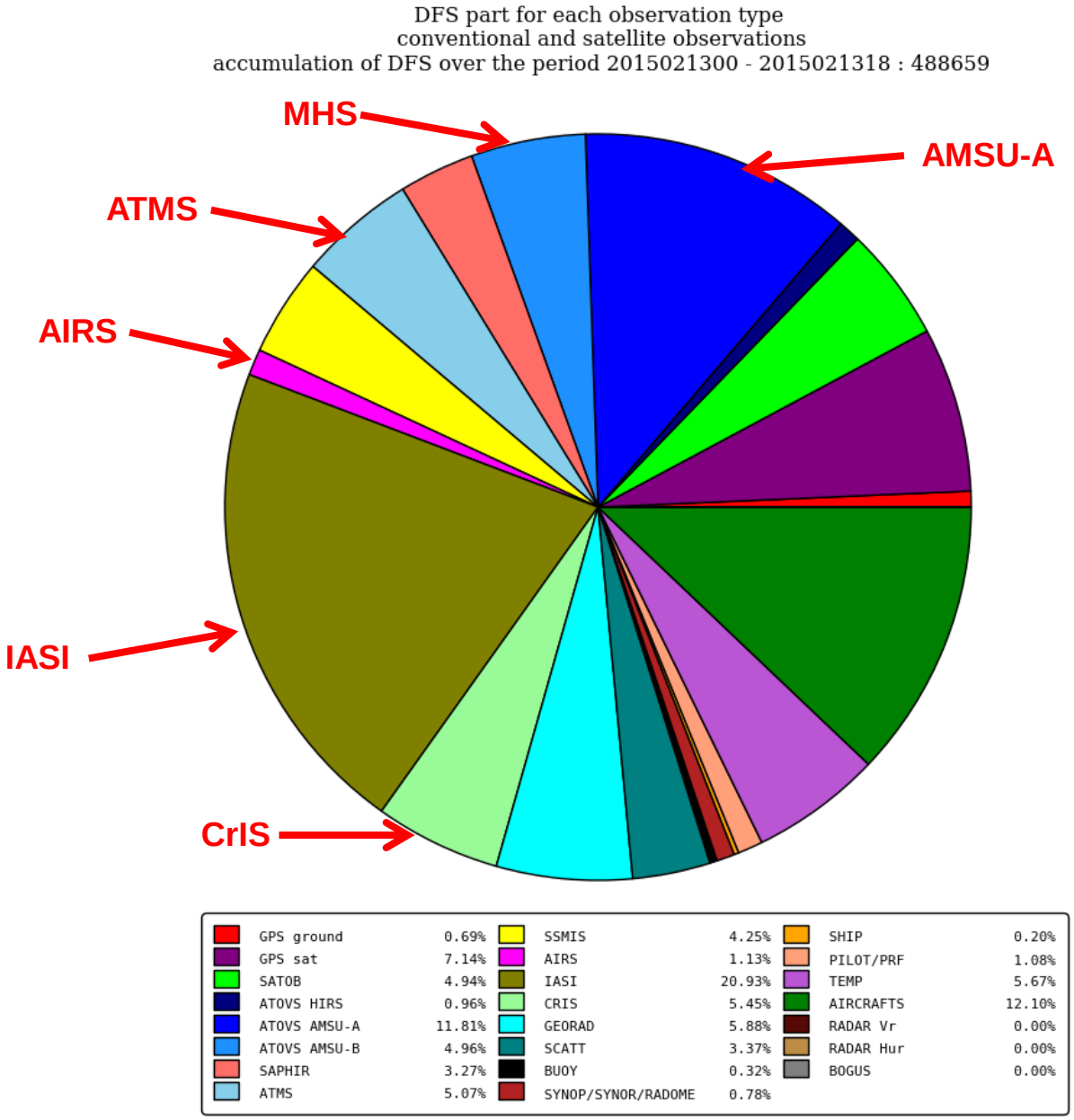
* Pressure at Mean Sea Level

Impact of S-NPP: Met Office



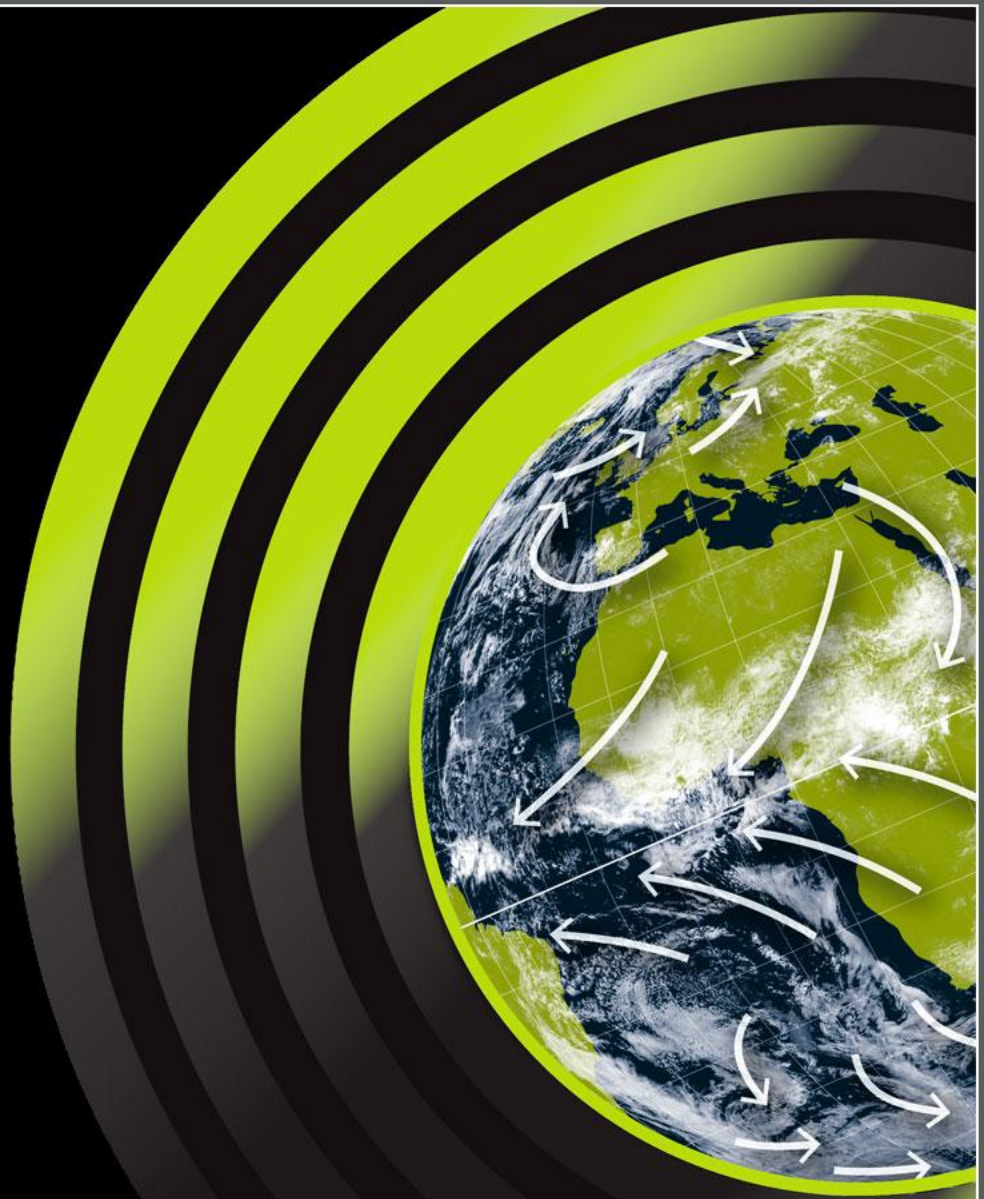
Forecast Sensitivity to Observations

Impact of S-NPP: Meteo-France



Degrees of Freedom for Signal

Correlated Errors



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Correlated Errors - CrIS

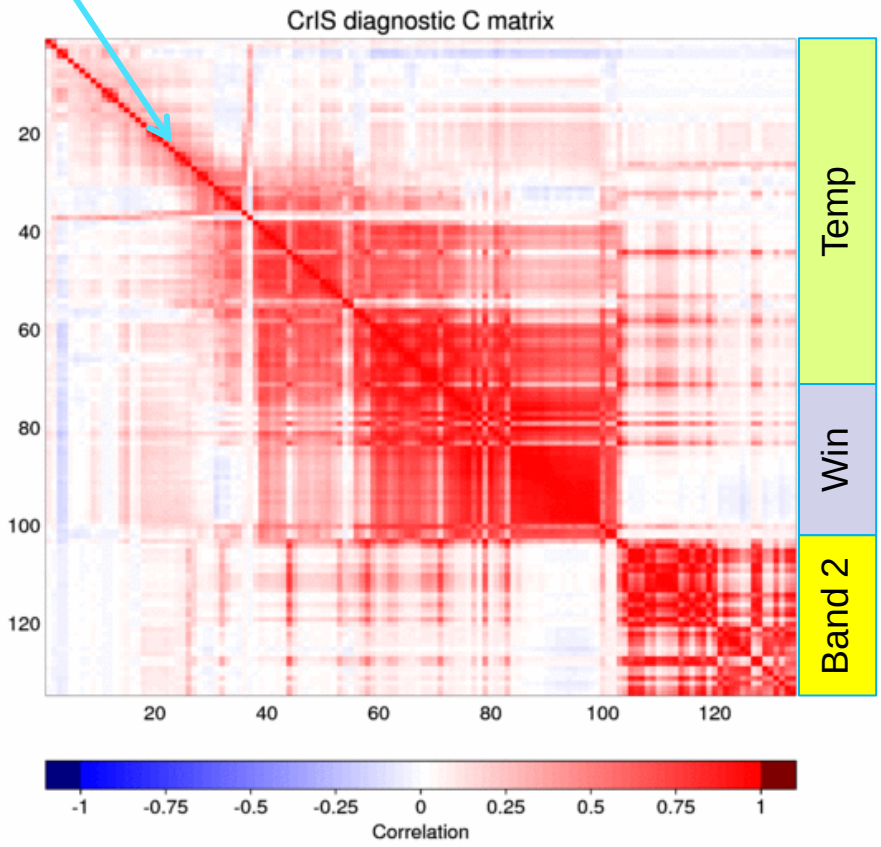
- Techniques such as that of Desroziers et al. (2005) can be used to estimate observation error covariances within an NWP system
  - Note that “observation error” includes forward model error and scale mismatch between the observation and grid of the assimilating model
- Recent trials at the Met Office of a diagnosed full error covariance matrix for CrIS give a positive impact
  - Significant improvements on forecasts of geopotential height in the Northern Hemisphere winter season
  - Small improvements in sea level pressure forecasts
  - Fit of the model to other observation types is improved by up to 2%
  - Similar impact seen when correlated errors were introduced for IASI

Correlated Errors – CrIS (2)

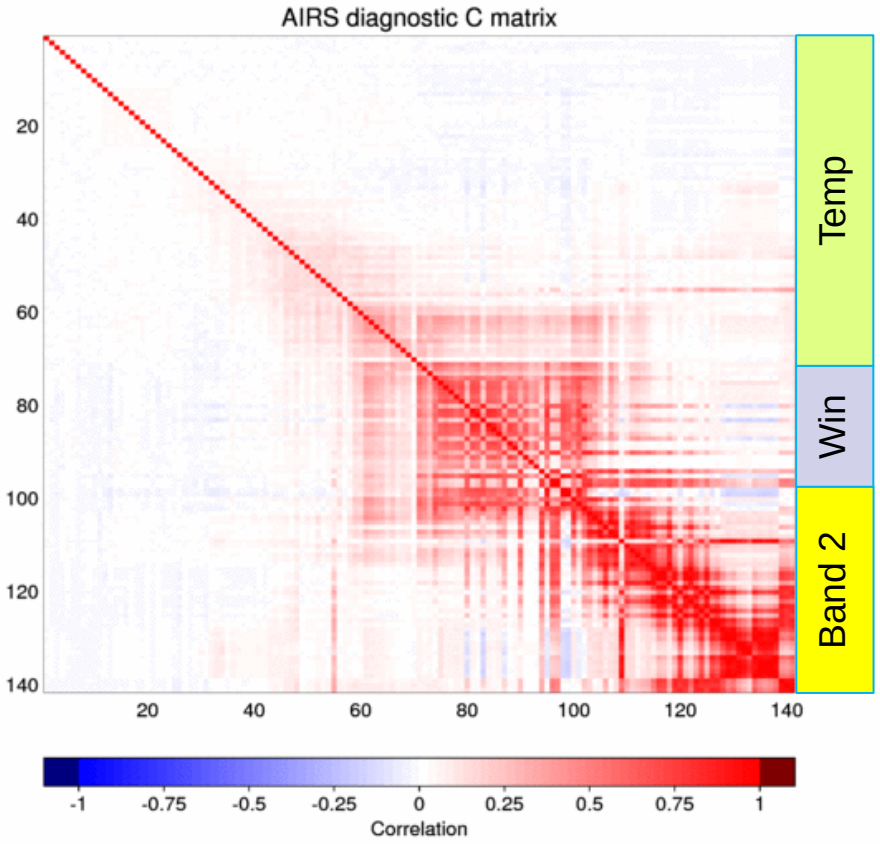
Met Office diagnosed Desroziers correlation matrix

Higher Correlations for Temp. Channels in CrIS than AIRS because other sources of error dominate over (diagonal) instrument noise

CrIS



AIRS



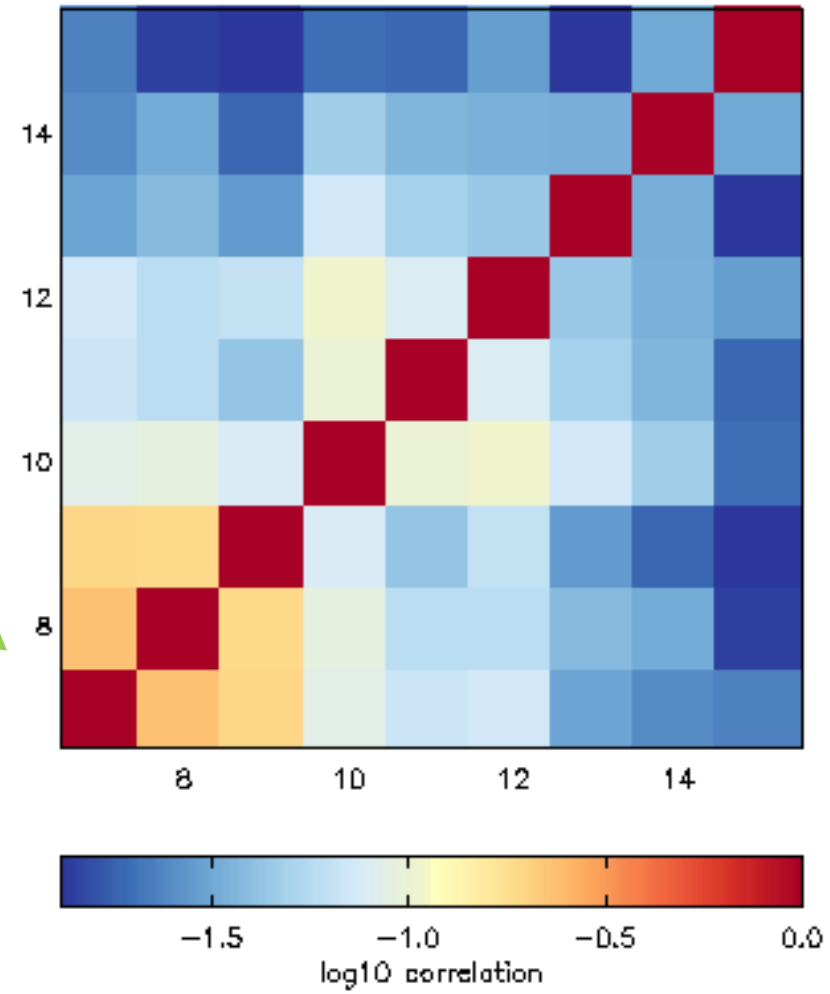
Correlated Errors - ATMS

- It's not just CrIS that may benefit from inclusion of correlations in the observation error term
- ATMS demonstrates correlations between adjacent channels
  - Related to striping
- NRL have been trialling a new Desroziers-derived error covariance for ATMS
  - Significant positive impact on 3-4 day forecasts of wind and height
  - Note experiment also includes adjustments to the diagonal term

Correlated Errors – ATMS (2)

Met Office diagnosed correlation using Desroziers technique

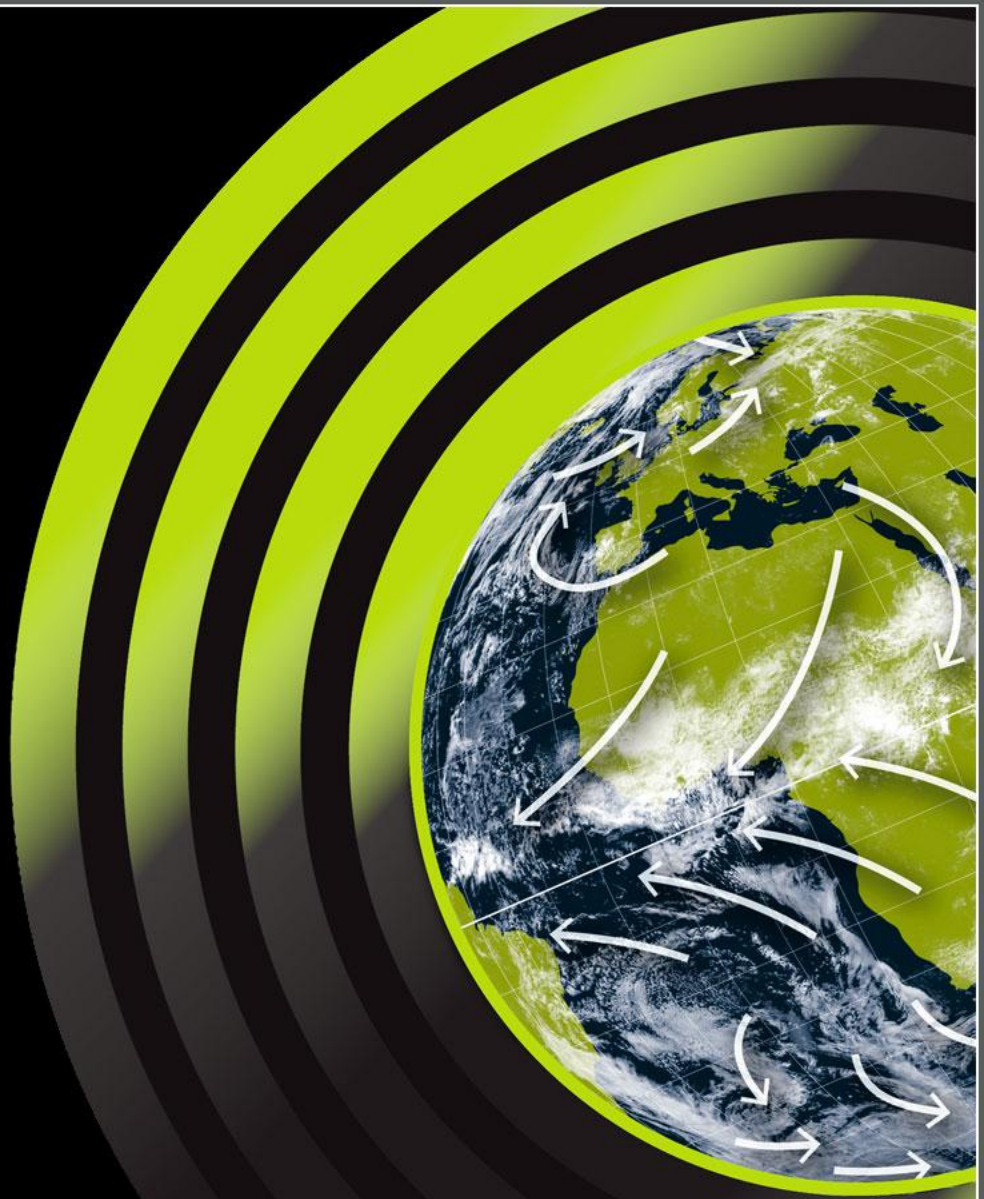
Note log scale! Correlations between ATMS 7/8/9 of about 0.4



Correlated Errors: In progress

- Met Office
  - CrIS ready for parallel suite
- NRL
  - ATMS ready for transition to operations
- CMC
  - CrIS/ATMS to go live this autumn

What next



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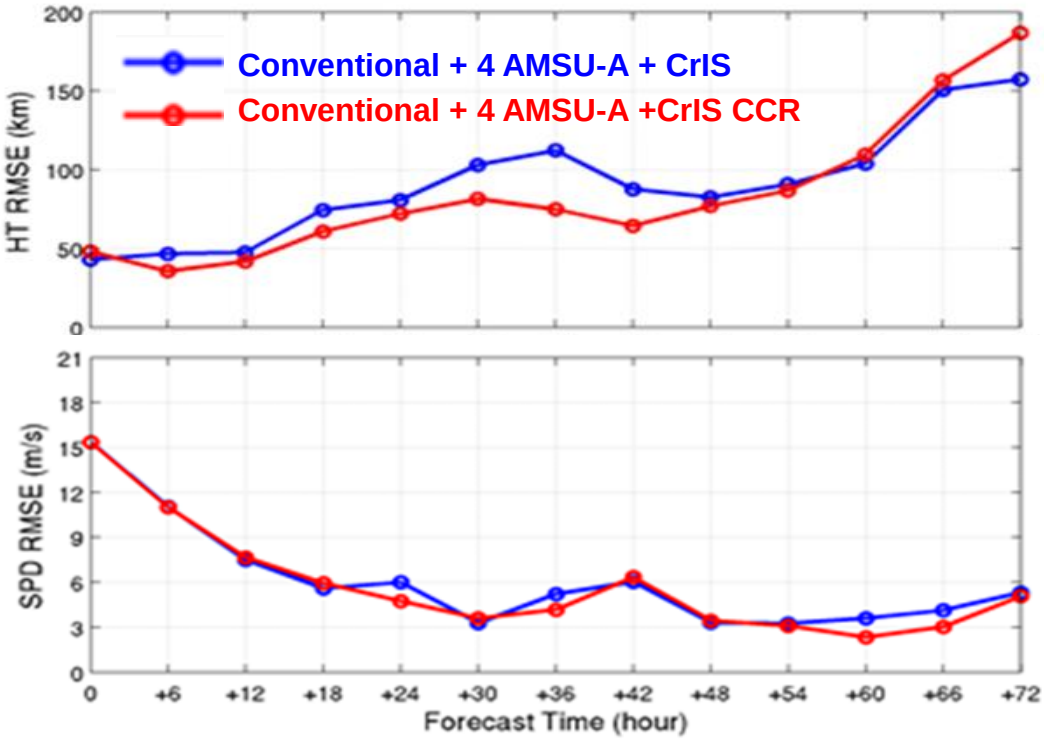
Most centres are aiming for increased usage

- For both CrIS and ATMS most centres report their plans include
  - Assimilation of water vapour channels
  - Use of land surface emissivity retrieval/atlas + assimilation of surface sensitive channels
  - General increase in the number of CrIS channels assimilated
  - Lower observation errors/ introduction of correlated errors
  - Investigations into cloud-cleared CrIS radiances

Cloud-cleared radiances

results from Jun Li (SSEC)

Impact of cloud-cleared radiances on Hurricane Sandy track and windspeed errors



Hurricane Sandy (2012) track and maximum wind speed (SPD) forecast RMSE from two experiments in WRF-ARW.

Data are assimilated every 6 hours with assimilation window of 3 hours from 2012-10-25-06 UTC to 2012-10-27-00 UTC, followed by 72 hour forecasts after each assimilation.

Met Office

VIIRS

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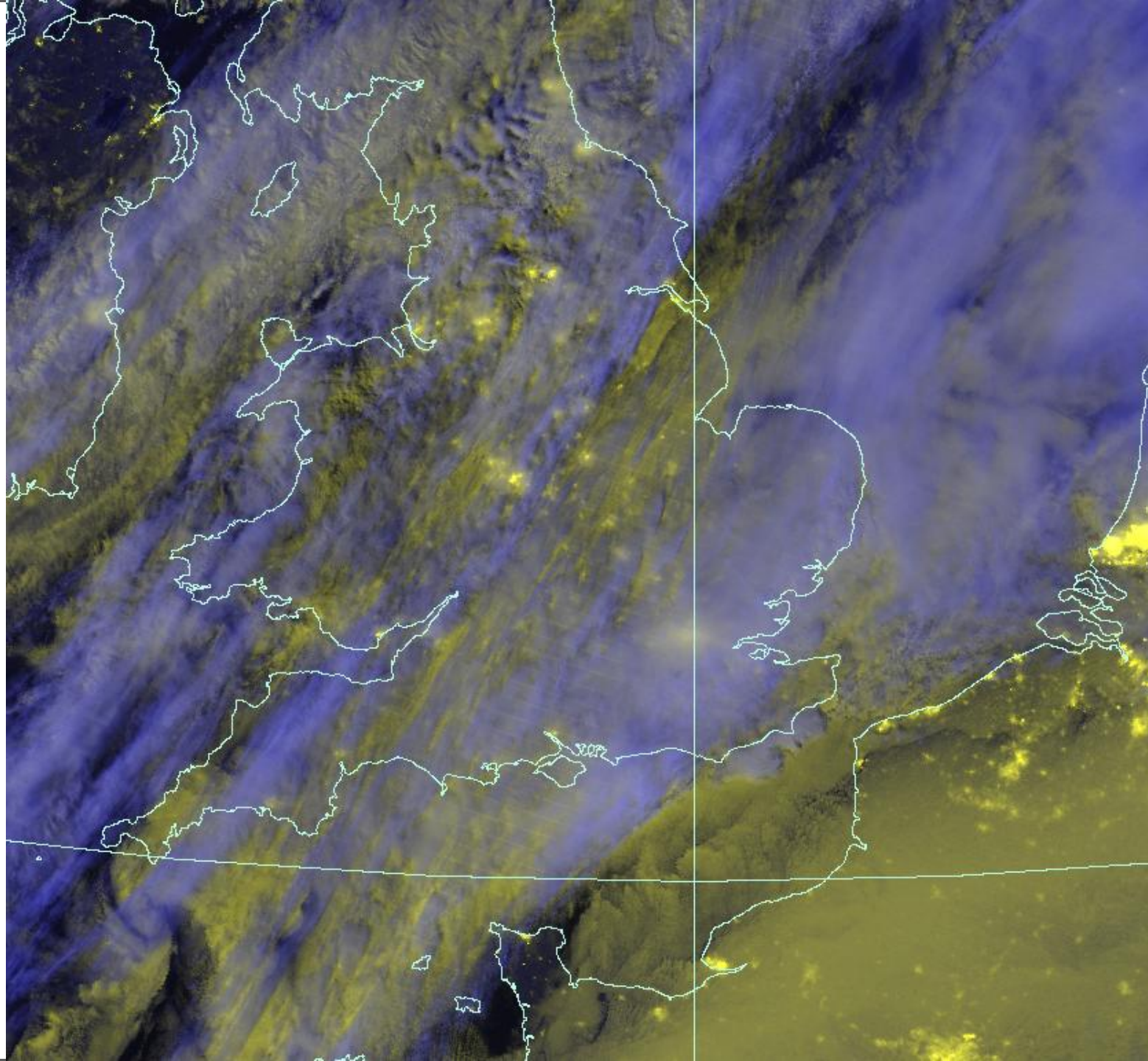
VIIRS AMVs / SSTs

- Atmospheric Motion Vectors
  - Better geographical coverage compared to MODIS AMVs from Aqua and AVHRR AMVs from NOAA-15,-18,-19.
  - Assimilated operationally at NRL
  - Monitored at ECMWF
  - Plans to evaluate at the Met Office
- Sea Surface Temperatures
  - Assimilated at CMC for SST analysis

VIIRS imagery

- VIIRS imagery forms part of the suite of data from polar orbiting satellites passed to forecasters to observe meteorological features
- Day/Night Band provides supplemental information that is not available elsewhere
  - Next slide shows a composite image at 2am
    - D/N Band (yellow) combined with
    - 10.8µm channel (blue)
  - D/N Band captures low cloud over France, not visible in 10.8µm image

Met Office



Met Office

Thank you for listening!

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Centre Names

- Met Office: UK
- BoM: Australian Bureau of Meteorology
- CMC: Canadian Meteorological Centre
- DMI: Danish Meteorological Institute
- DWD: Germany, Deutscher Wetterdienst
- ECMWF: European Centre for Medium-range Weather Forecasts
- Météo-France: France
- NCEP: USA, National Centres for Environmental Prediction
- NIWA: New Zealand, National Institute for Water and Atmospheric Research
- NRL: USA, Naval Research Laboratory
- SSEC: Space Science and Engineering Center, University of Wisconsin
- met.no: Norwegian Meteorological Institute
- SMHI: Swedish Meteorological and Hydrological Institute