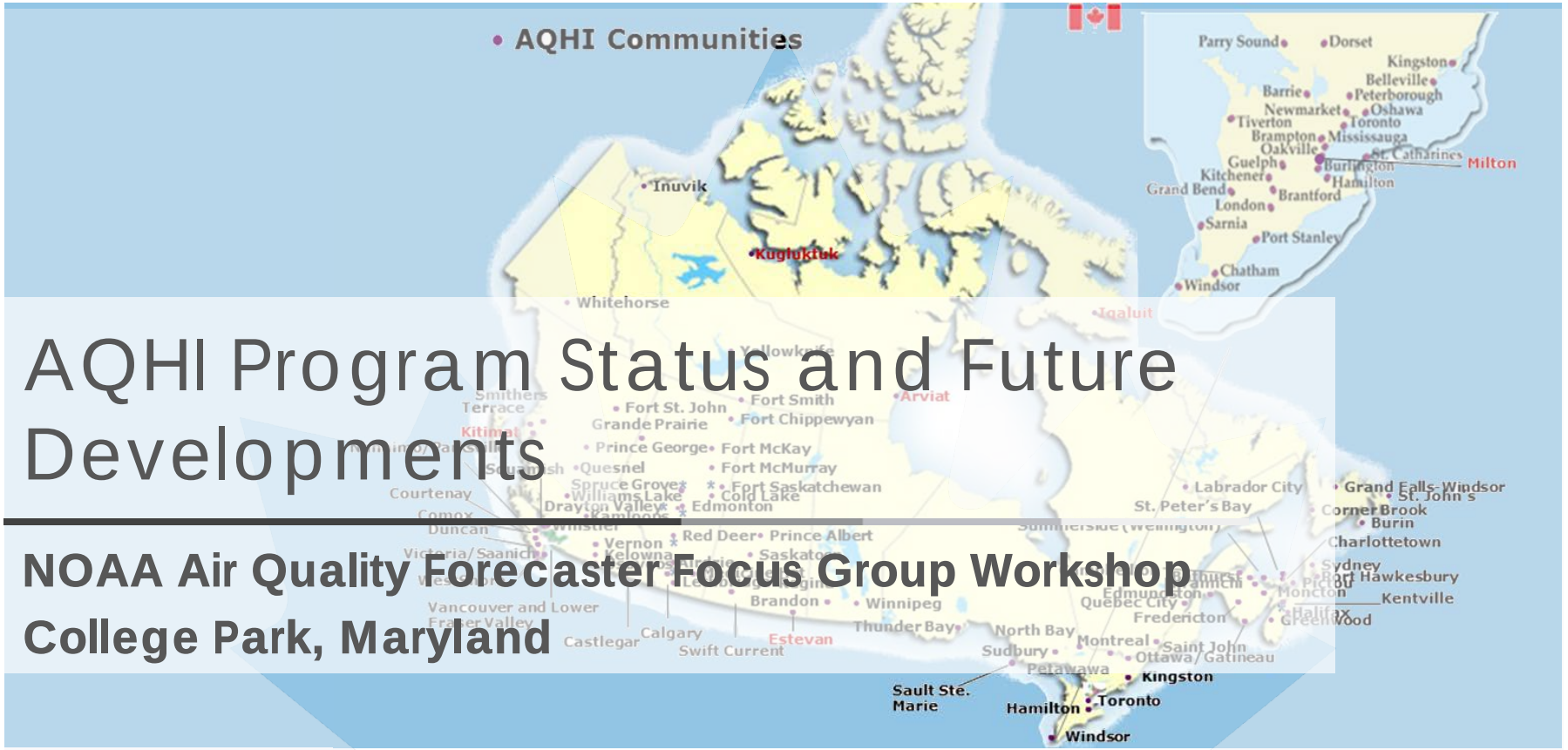


AQHI Program Status and Future Developments

NOAA Air Quality Forecaster Focus Group Workshop

College Park, Maryland

Daniel Jubainville, PSD – HAQS, Didier Davignon, CCMEP - CMCO
Meteorological Service of Canada, September 27-28, 2018

Canada

Part 1 - Overview

- AQHI Current Status
- AQHI+
- AQHI Advisory Program
- SO_2 Exceedances and Notes
- Future Developments

AQHI Current Status

- Multi-pollutant health based index (O_3, $PM_{2.5}$, NO_2)

$$AQHI_{PM\,2.5} = \frac{10}{10.4} * \left(100 * \left[\left(e^{(0.000871 * NO_2)} - 1\right) + \left(e^{(0.000537 * O_3)} - 1\right) + \left(e^{(0.000487 * PM\,2.5)} - 1\right)\right]\right)$$

- As of Sept 25th, 2018 AQHI forecasts available for:
  - 110 Communities across Canada
  - 11 additional station forecasts in larger cities
- This covers approximately 80% of the Canadian population
- **Special focus on sensitive population**
- Continue to support the Info-Smog program in Quebec

AQHI Communities

AQHI+

- Activates based on single pollutant thresholds
  - Set by province/territory
  - Single pollutant AQHI formulation used while above threshold
  - Threshold linked to high risk AQHI category (7 or more)
  - Exception for $PM_{2.5}$ in BC, activates based on formula when it exceeds regular AQHI value
  - Usually based on provincial regulations for specific pollutants
  - Can be used for non-AQHI pollutants (not ideal)
- Generally based on 1-hr average
  - More responsive to changing conditions
  - More vulnerable to bad data
- Acts as a support to health messaging during single pollutant events (e.g. Forest fires)

AQHI+ Pollutant Thresholds

AQHI+ Pollutant	Alberta	British Columbia	Ontario	Northwest Territories
CO (ppb)	13500		30501.5	
NO_2 (ppb)	159.5		201	
O_3 (ppb)	82.5		81	
$PM_{2.5}$ (µg/m^3)	80.5	Ceiling($PM_{2.5}$/10)		80.5
SO_2 (ppb)	172.5	36/71*	251	
H_2S (ppb)	1000.5			
TRS (ppb)	1000.5		28	

*proposed

Advisory Programs

- Ontario:
  - Smog and Air Health Advisory for AQHI 7 or more (incl. AQHI+)
- Alberta/Northwest Territories
  - Special AQ Statement for AQHI 7 or more (incl. AQHI+)
- British Columbia
  - Advisories issued by province
  - Provincial advisories disseminated by ECCC via Special AQ Statement
- Quebec
  - Smog Warning based on AQI
  - Triggered by:
    - O_3 (82 ppb) for at least 3 consecutive hours
    - $PM_{2.5}$ (35 µ/m^3) 3 hour rolling average

SO_2 Exceedances

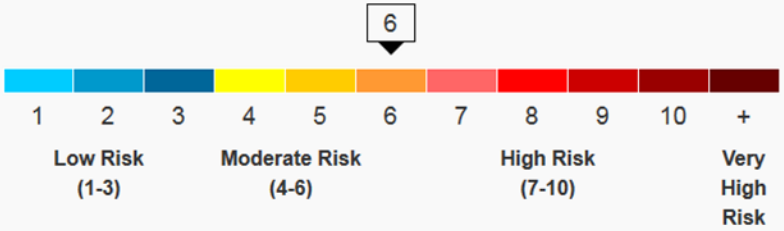
- SO_2 is not part of the AQHI formulation.
- British Columbia (and Ontario) wants additional messaging for SO_2
- Nature of the pollutant is such that exceedances occur with very little warning and are often short lived
- Pollutant is detectable by public due to pungent smell, but is not reflected in the AQHI
  - The observed AQHI does not reconcile with user experience
- Proposal:
  - Pre-defined SO_2 thresholds will trigger the appearance of a canned message that will be displayed on AQHI page
  - Message will be short, not too technical and direct users to another website for further information

Sample of AQHI Page with Note

Kitimat - Air Quality Health Index

Observed Conditions i Past 24 hr

Calculated at: 2:00 PM PDT Monday 10 September 2018



Please Note: 2:00 PM PDT Monday 10 September 2018

- Elevated levels of sulphur dioxide have been reported. For more information, visit B.C.'s Ministry of Environment and Climate Change Strategy.
- This is a second message to test special notes.
- This is a third message to test special notes.

At-Risk Population:

- Consider reducing or rescheduling strenuous activities

General Population:

- No need to modify your usual outdoor activities unless

Future Developments

- Note functionality was designed to be adaptable to use with any pollutants and/or hazards
- Note functionality may be used for forest fire smoke:
  - How to differentiate between forest fire smoke and other $PM_{2.5}$ events?
- As GEMMACH model run extends to 72-84 hours:
  - Forecast period can be expanded to include Day 3
- Customizable email alerts based on user defined AQHI thresholds
- Future version of Weather Office website will include customizable maps with selectable layers:
  - Planned layers will include AQHI Nationally, AQI in Quebec

Future Developments (cont.)

- Continuing to evaluate the feasibility of staffing a smoke desk that would monitor forest fire smoke
  - Regionally dependent, but coverage would be national
- Small sensor project:
  - Launched study to evaluate the reliability/feasibility of various sensors for potential integration into observation network, complementing existing monitors
  - Focus on rural and remote northern locations
  - Rapid deployment for emergency data collection (Forest Fires)
- Longer term: Integration into Weather App

Part 2 - Overview

- Status and recent updates to operational AQ systems
- Performance
- Next steps

2018 British Colombia Wildland Fires

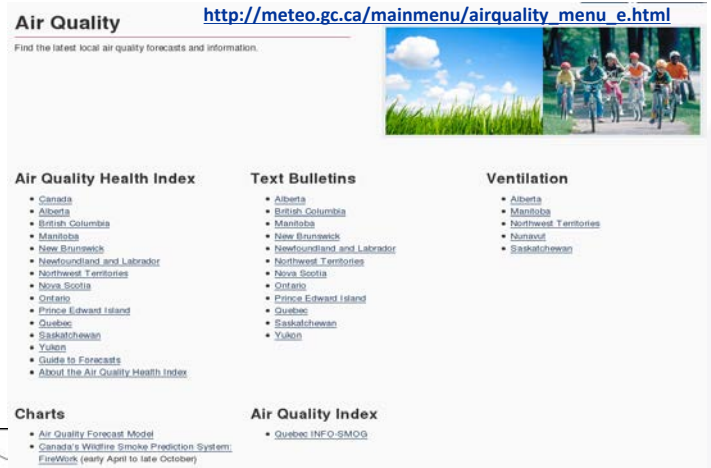
Fire season started late July only, but…
Record number of hectares have burned : estimated 1,252,000 hectares, previous record 1,216,000 hectares in … 2017

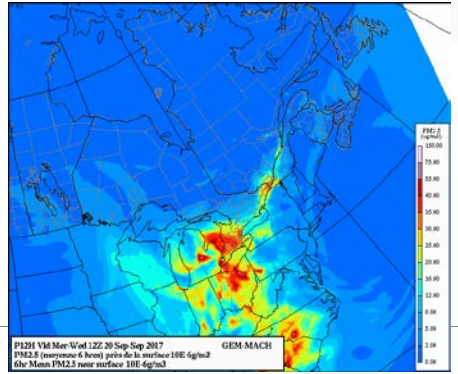
Since April 1, BC Wildfire has responded to **2,015 fires**
More than **4,500 personnel** fighting fires, including 850 out-of-province personnel, including 51 firefighters from Washington state
More than 1,400 contractors from the B.C. forestry industry assisting
230 aircrafts flying in support of ground crews
770 RCMP members or civilian members deployed in support of B.C. wildfires, including Alberta RCMP tactical officers

Canadian Operational Air Quality Forecast Systems

- **Systems run by ECCC Operations**

  1) RAQDPS (**R**egional **A**ir **Q**uality **D**eterministic **P**rediction **S**ystem)
  - GEM-MACH
  - Emissions & boundary conditions
  - Statistical model (UMOS-AQ)
  - Operational Products
  - Regional Deterministic Air Quality Analysis (RDAQA)





Different $PM_{2.5}$, PM_{10} and O_3 charts are available

Canadian Operational Air Quality Forecast Systems Con't

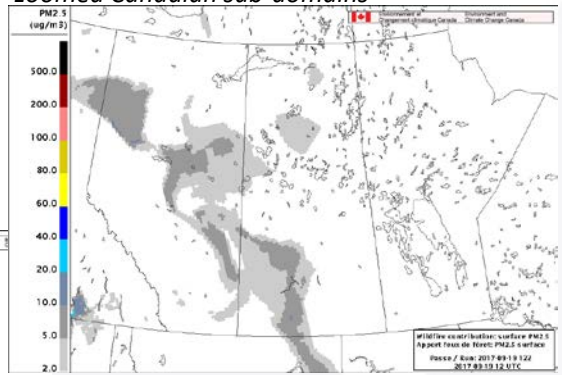
- **Systems run by ECCC Operations**

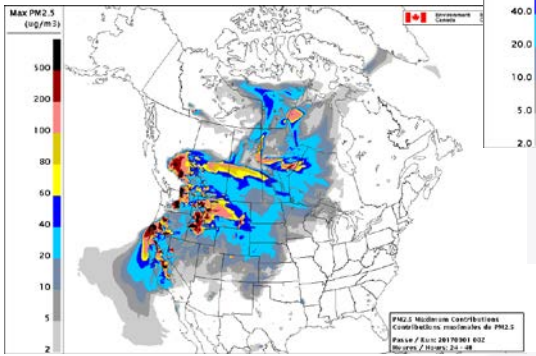
  2) FireWork (RAQDPS with wildfire emissions)

  - Emissions
  - Statistical model (UMOS-AQ)
  - Experimental Products
  - Regional Deterministic Air Quality Analysis connected to FireWork (RDAQA-FW)

http://weather.gc.ca/firework/index_e.html

Hourly, max and average fire-$PM_{2.5}$ concentrations over FireWork domain and/or zoomed Canadian sub-domains





Exemple: MAX hourly $PM_{2.5}$ (ug/m^3)
*Period covered: 2017 **Sept 2nd** 00-24UTC*

Canadian Operational Air Quality Forecast Systems

Con't

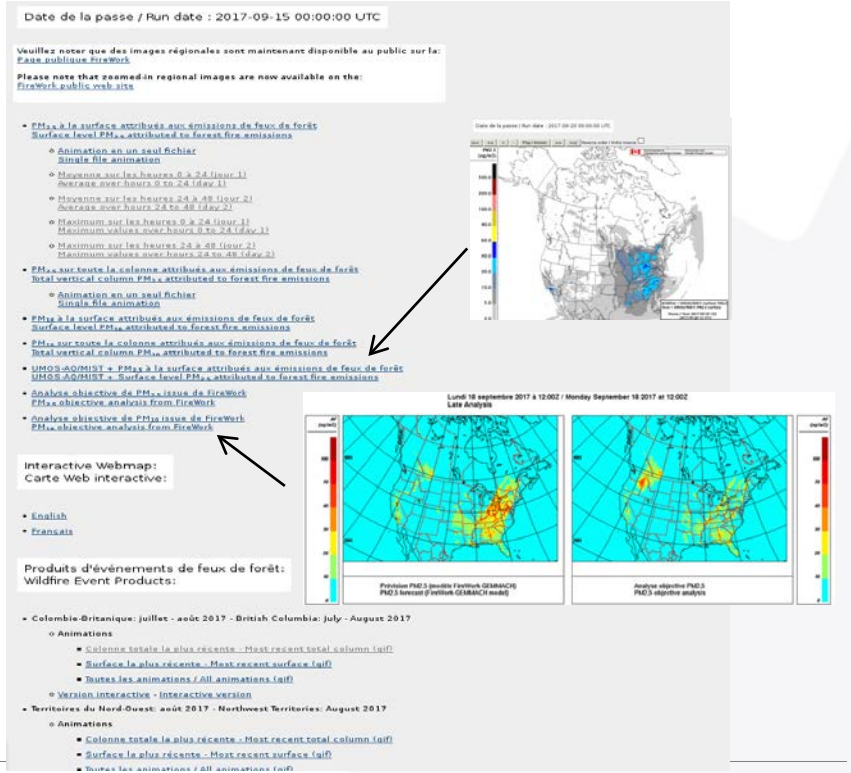
- **Systems run by ECCC Operations**

  2) FireWork (products available via password-protected web page)

  http://collaboration.cmc.ec.gc.ca/cmc/air/FireWork-GEMMACH/

  Many additional products and tools such as:

  - *Objective Analysis*
  - *Wildfire event related products*
  - *Client-specific products*
  - *Interactive Webmap*
  - *UMOS-AQ/MIST 2D fields*
  - *Etc.*



Recent updates to RAQDPS and FireWork

Operational as of September 18th 2018

- RAQDPS:
  - Inheriting updates to weather data assimilation in RDPS
  - Incremental Analysis Update (IAU)
  - Updated GEM-MACH core. Main features:
    - Improves dry deposition over snow/ice
    - Deactivation of aerosol chemistry in stratosphere
    - Code optimisation
  - New emissions
- FireWork:
  - Adjusted fire area estimates

	SRPDQA019	SRPDQA020
Canada	2010 →	**2013**
USA	2011 →	**2017***
Mexico	1999 →	**2008**

* Projected from 2011

New Performance Indicators – Mai 2018 AQPI

MAY 2018		O_3	NO_2	$PM_{2.5}$
SRPDQA	Current	86	68.7	59.3
	5 Year Average	86.1	71	59.2

Legend

Color	AQPI Difference
	[5; ∞
	[3; 5[
	[1; 3[
	[-1; 1[
	[-3; -1[
	[-5; -3[
	∞; -5[

AQPI formulation for each polluant :

AQPI[O_3,NO_2,$PM_{2.5}$]= 100*AVG [**FAC2** + **R** + (1-ABS(**MFB**/2))]

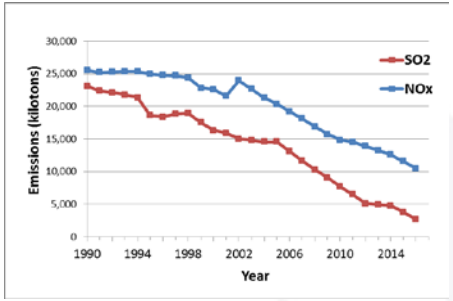
Conclusions for this month:
RAQDPS performance similar to 5 year average

O_3 – AQPI equivalent to the 5y average for this month. Slight improvement over Eastern Canada

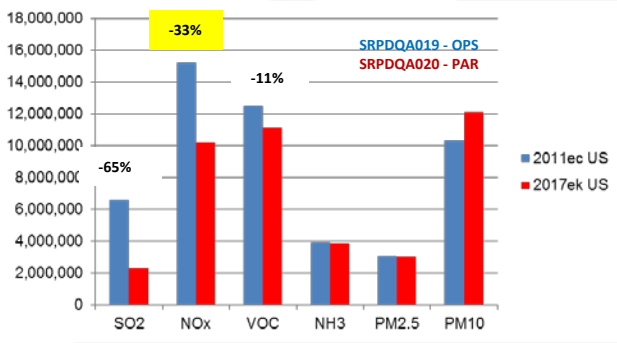
NO_2 – AQPI slightly degrading due to actual emissions decreasing while our emission inventories have not been updated yet.

$PM_{2.5}$ – AQPI equivalent to the 5y average for this month.

Trend (1996-2016) in annual SO_2 and No_x emissions in USA



USA

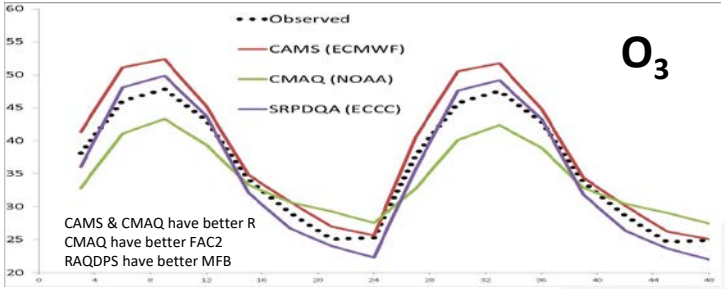


Note: SRPDQA is French for RAQDPS

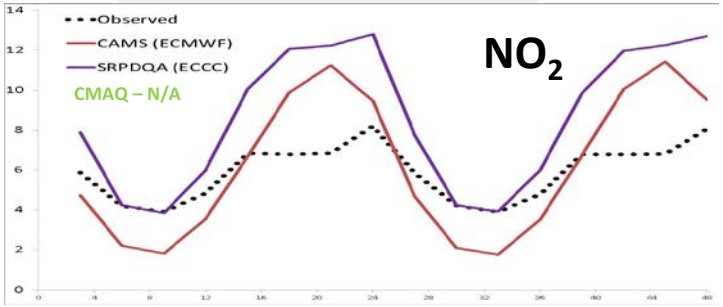
Multi-model analysis - May 2018 AQPI

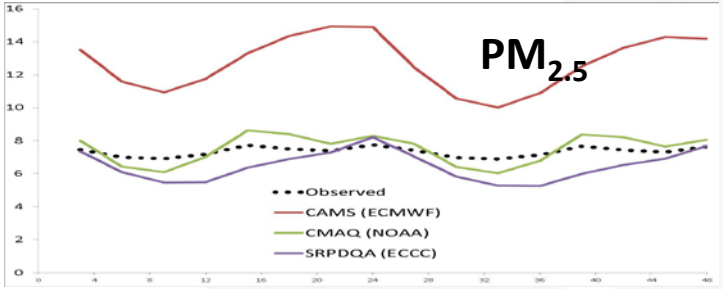
AQPI	O_3	NO_2	$PM_{2.5}$
CAMS **(ECMWF)**	**87.7**	**66.9**	53.5
CMAQ **(NOAA)**	**87.7**		**66.4**
SRPDQA **(ECCC)**	85.8	65.4	62.8

PI	Legend
90%-100%	Excellent
80%-90%	Very Good
70%-80%	Good
60%-70%	Acceptable
50%-60%	Poor
<50%	Very Poor



Concentrations per forecast hour





Conclusions:

The 3 models have similar performance as measured with AQPI, except for CAMS overpredicting PM.

To be adressed for the RAQDPS:

NO_2 – updated emissions (next update this fall)

$PM_{2.5}$ – Diurnal profile shifted in Eastern Canada – to be investigated

Next Steps

- RAQDPS
  - **72h forecasts** (late 2019)
  - New, improved GEM core dynamic library (late 2019)
  - Developing 2.5km subdomains (experimental)
- FireWork
  - Improved plume height and wildfire emissions estimates through the Canadian CFFEPS module (tested this year, delivery planned for 2019 wildfire season)
  - Experimental 2.5km runs over a western domain (supporting FireEx-AQ)

RDAQAv2 Planned Innovations (Spring 2019)

- Like current version 1, version 2 will produce off-line hourly surface analyses of O_3, NO_2, SO_2, $PM_{2.5}$, PM_{10}, and AQHI and will use the same Choleski solver to perform the analysis.

- v2 has important structural changes to:
  - improve the quality of the analyses
  - ease the transition towards data assimilation cycling

- RDAQA is an end product: GEM ⟹ GEM-MACH ⟹ RDAQAv2, and thus has no impact on other systems (reduced risk)

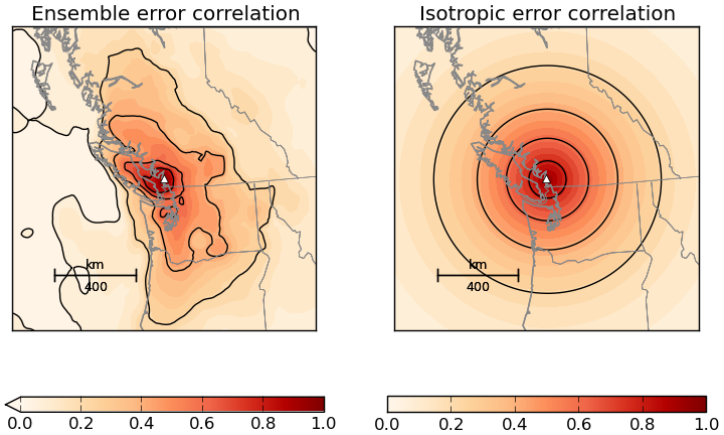
- Computational cost at execution time is about same as version 1

- Structural changes:
  - Analysis module, Error statistics (input), Improved verification

Error Statistics (Input)

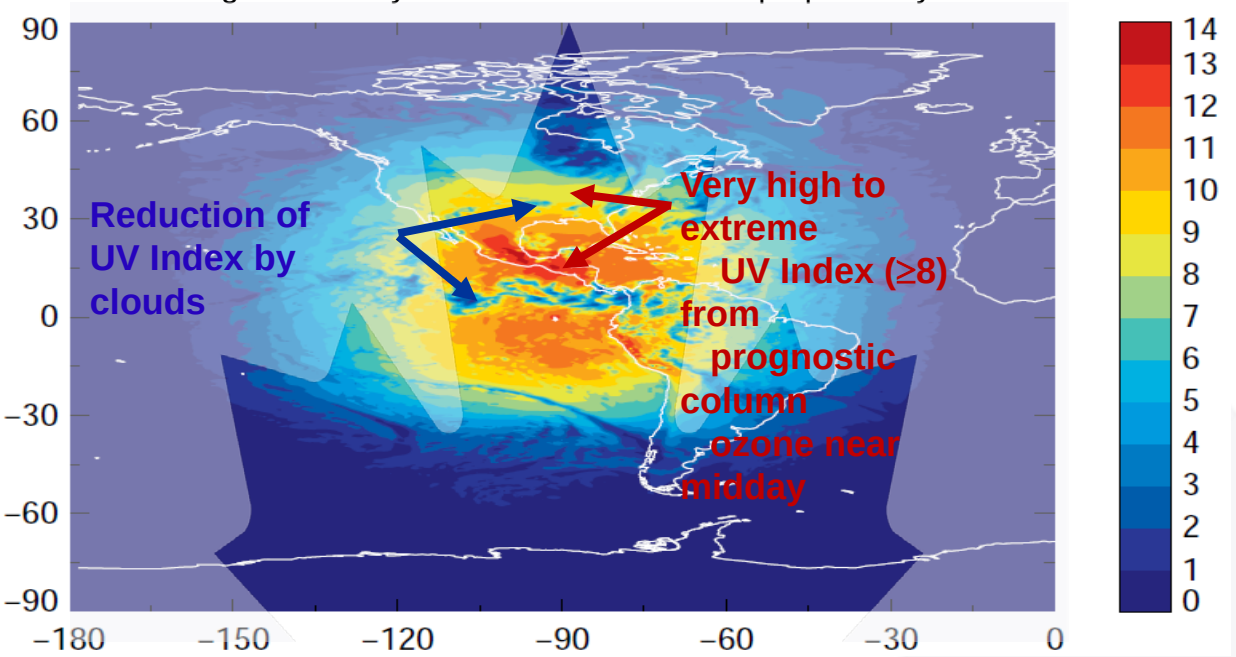
- Observation error variance to minimize the analysis error variance using cross-validation *(Ménard and Deshaies-Jacques, Atmosphere, 2018a,b)*
- Background error variance is state-dependent (2-month climatology) meeting the variance innovation consistency *(Ménard, QJRMS, 2016)*
- Anisotropic error correlations based on off-line ensembles (EnOI)

RDAQAv2



Global O_3 Assimilation and UV Forecasting (exp. 2019)

Sample summer time UV Index forecast image for 24 Aug, 2015, at 18 UTC generated by an earlier version of the proposed system.



Questions?