



Recent Updates and Challenges in the Use of Sounders Data at ECCCC

7.08 (NWP center reports)

ITSC-XXIII

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50^e anniversaire d'Environnement et Changement climatique Canada
Environment and Climate Change Canada's 50th anniversary

150^e anniversaire du Service météorologique du Canada
Meteorological Service of Canada's 150th anniversary



Canada 

Outline

Status report on the use of Sounders

- Main observation data events
- Main scientific / technical innovations

Current challenges in our use of Sounders

- Research perspectives

Our models

GDPS: Global Deterministic (15 km)

GEPS: Global Ensemble (39 km)

RDPS: Regional Deterministic (10 km). Covers Northern/Central America.

HRDPS: High-Resolution Deterministic (2.5 km). Covers most of Canada (except northern islands) and Northern USA

Status Report on the use of Sounders

Main observation data events in GDPS and RDPS

December 1, 2020

- **AMSU-A AQUA** outage

December 7, 2020

- **AIRS AQUA** outage (NASA feed to be tested)

December 8, 2020

- **AMSU-A + MHS Metop-C** activation
- **CrIS-FSR S-NPP** activation
- **CSR GOES-17** activation

January 26, 2021

- **IASI Metop-C** activation (**Metop-A** removal)
- **MWHS-2 FY-3C** activation

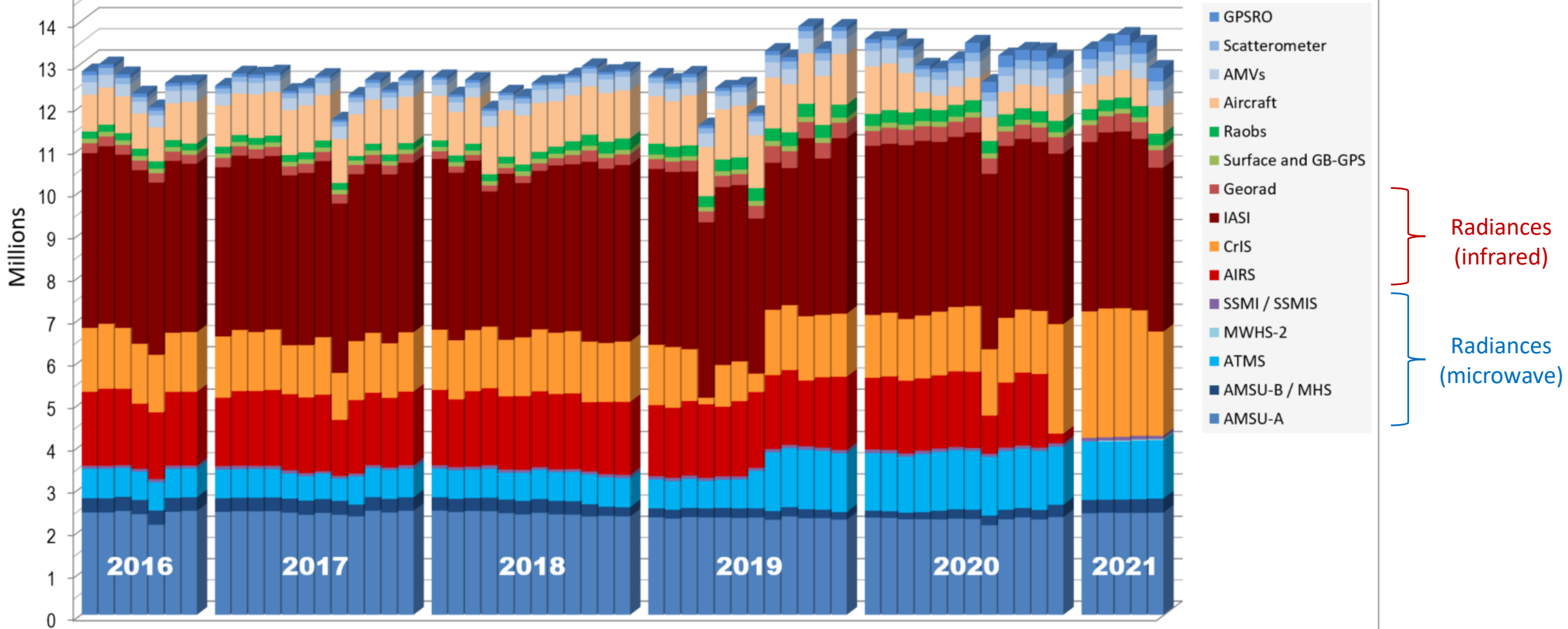
May 21, 2021

- **Cris-FSR S-NPP** outage (not reintegrated on June 2nd)



Monthly average number of observations assimilated per day in the ECCO global weather forecasting system

Period covered : Last 5 years



Status Report on the use of Sounders

Main scientific / technical innovations

« IC-3 » Innovation Cycle for operational implementation in Fall 2021.

IMPROVEMENTS TO OBSERVATION PROCESSING

Data assimilation in the HRDPS

- Bias correction from the GDPS. QC as done in GDPS and RDPS.

All-sky for AMSU-A channels 4 and 5 (GDPS) (Shahabadi and Buehner, 2021 MWR. To be submitted)

- Done over oceans and non-precipitating scenes
- CLW from a combination of observed (from AMSUA ch. 1 and 2) and modeled values
- Observation error as a function of CLW
- Global 5% - 12% increase in these observations
- Statistically significant 850hPa stddev temperature improvements up to 2 days

Status Report on the use of Sounders

Main scientific / technical innovations

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IMPROVEMENTS TO THE OBSERVATION OPERATOR (GDPS, RDPS and HRDPS)

RTTOV computations on native model levels

- Instead of interpolating to the predefined set of levels
- Has shown some significant forecast stddev temperature gain between 1hPa and 5hPa in southern hemisphere austral winter

Slant-path computations (Shahabadi et al., 2020 MWR)

- Improved and realistic representation accuracy using slanted line-of-sight geometry
- Numerically efficient scheme (new parallelization strategy)
- Noticeable stddev(OMB) improvements for temperature sensitive channels up to 4.5% (upper-troposphere jet streams and mid-stratosphere winter pole)

Status Report on the use of Sounders

Main scientific / technical innovations

« IC-3 » Innovation Cycle for operational implementation in Fall 2021.

INTEGRATION OF PROGNOSTIC OZONE AND ASSIMILATION (GDPS)

(Rochon and DeGrandpré; publications in 2022)

- Addition of an ozone prognostic variable based on linearized chemistry and implementation of ozone radiative coupling.
- Addition of diagnostic clear-sky and all-sky UV Index forecasting in the model relying on prognostic ozone and UV band surface fluxes.
- Assimilation of the MLS (Aura) limb profiles; OMI-TOMS (Aura), GOME-2 (MetOp-B), TropOMI (S5P) and OMPS-NM (NPP and NOAA-20) total column ozone; and SBUV/2 (NOAA-19) and OMPS-NP (NPP) partial column ozone profiles.

Status Report on the use of Sounders

Main scientific / technical innovations

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TECHNICAL IMPROVEMENTS

Integration of stand-alone programs for radiance processing into MIDAS

- The Modular and Integrated Data Assimilation System is a unified framework code tool aiming to facilitate the transition toward coupled data assimilation of different components of the earth system
- Bias correction, in addition to quality control and thinning of most instrument types
- GEPS model integration
- Better support and developement by the entire data assimilation community

Current challenges in our use of Sounders

Research perspectives for the « IC-4 » Innovation Cycle

INCREASING THE DENSITY OF ASSIMILATED OBSERVATIONS

- From current 150 km to 100 km globally for all radiances (60% quantity increase)
- Preliminary work presented at ITSC-XXII (Bédard)
 - Inflation factor of 2.0 applied to all observation errors during the analysis to account for spatial correlation.
 - Summer experiment showed small improvements on stddev temperature, statistically significant up to 72 hours in Southern extratropics low stratosphere.
 - No significant impact on humidity field
- Further refinement using reduced inflation factor of 1.4 on humidity sensitive channels observation errors improved stddev humidity. Statistical significance up to 48hr observed in Tropics.
 - But came with temperature degradation in Southern extratropics troposphere
- Further testing and adjustments to be done in the « IC-3 » environment

Current challenges in our use of Sounders

Research perspectives for the « IC-4 » Innovation Cycle

IMPROVING THE DEPENDENCIES BETWEEN GEPS AND GDPS

- Stronger coupling between the two models in « IC-3 » : purely flow-dependent background error covariances below 60 hPa (computed from 256 GEPS short-term forecasts)
 - Development of the GEPS observation processing (bias correction and QC) instead of relying on GDPS processed observation files for assimilation.
 - First steps at machine learning with the GEPS bias correction.
 - Investigation of humidity analysis increments in GEPS (threshold was put on humidity due to stratospheric degradation in GDPS).
- GEPS: Observation assimilation now cost-effective with the passage from EnKF to LETKF in « IC-3 »
 - Addition of CSR, CrIS-FSR (S-NPP) and more channels from hyperspectrals.
 - Addition of all-sky.
 - Use of inter-channel observation error correlations
 - Addition of ozone observations (in combination with added prognostic ozone)
 - Addition of hyperspectral channels sensible to ozone (also in GDPS)

Current challenges in our use of Sounders

Research perspectives for the « IC-4 » Innovation Cycle

ALL-SKY ASSIMILATION

- Extend to ATMS temperature sensitive channels.
- Extend to microwave humidity sounding channels using RTTOV-SCAT

SURFACE SENSITIVE OBSERVATION ASSIMILATION OVER LAND

- Work ongoing on an efficient atmospheric coupling with a land surface scheme and assimilation model, which will then allow to go further in this research avenue.

MONITORING

- Work towards real-time FSOI
- New observation database (SQLite) and need to develop visualisation tools

Thanks / Questions ?



Canadian Meteorological Center