



Supplement of

A machine learning method for estimating atmospheric trace gas concentration baselines

Kirstin Gerrand et al.

Correspondence to: Kirstin Gerrand (kigerrand@gmail.com) and Matthew Rigby (matt.rigby@bristol.ac.uk)

The copyright of individual parts of the supplement might differ from the article licence.

Supplementary Material

Here, we show additional figures and tables that elaborate on model choices and performance.

5 An example comparison of ECMWF and UK Met Office wind speed and direction at Mace Head, Ireland is shown in Figure S1, indicating that differences between the meteorology used to drive the NAME model (UK Met Office analysis) and that used in training our algorithm (ECMWF ERA5) are small and unlikely to contribute substantially to algorithm performance issues.

A summary of the meteorological parameters used as features in the machine learning model are provided in Table S1.

We show the relationship between number of training years and both model performance and training time in Figure S2.

Hyperparameter sets for the final MLP models are shown in Tables S2 and S3.

10 Plots showing the relationship between the coefficient of variation and model performance (as quantified by MAPE) for each site are shown in S3.

The outcome of the feature importance analysis using permutation importance for the MLP models are provided in Table S4.

Model summaries are provided for the two additional model architectures explored - random forest and gradient boosting.
15 Performance metrics are provided in Tables S5 and S8, based on hyperparameter sets in Tables S6, S7, S9 and S10, respectively. The confusion matrix maps and MAPE heatmaps are also provided for both model types; these are shown in Figs. S4, S5, S6 and S7.

Plots are provided showing model outcomes for the ten atmospheric trace species used in this study at all sites (where data is available) in Section S9. Three plots are shown per species: the first shows the high frequency observations categorised
20 by model outcome (true/false positive/negative); the second shows the model's predicted baseline probability across these observations; and the third shows predicted baseline monthly means, with anomalies highlighted for months exceeding one, three and five standard deviations from the InTEM-derived baseline monthly mean.

Contents

25	S1 Intercomparison of ECMWF and Met Office UM Meteorological Fields	4
	S2 Model Inputs	5
	S3 Training Set Length versus Performance and Training Time	6
	S4 Final MLP Hyperparameter Sets	7
	S4.1 scikit-learn MLPClassifier	7
30	S4.2 Custom Training Parameters	8
	S5 Coefficient of Variation and Model Performance	9
	S6 Feature Importance	10
	S7 Random Forest Summary	11
	S7.1 Model Metrics	11
35	S7.2 Final Hyperparameter Sets	12
	S7.2.1 scikit-learn RandomForestClassifier	12
	S7.2.2 Custom Training Parameters	13
	S7.3 Confusion Matrix Map	14
	S7.4 MAPE Heatmap	15
40	S8 Gradient Boosting Summary	16
	S8.1 Model Metrics	16
	S8.2 Final Hyperparameter Sets	17
	S8.2.1 scikit-learn GradientBoostingClassifier	17
	S8.2.2 Custom Training Parameters	18
45	S8.3 Confusion Matrix Map	19
	S8.4 MAPE Heatmap	20
	S9 MLP Plots	21
	S9.1 Kennaook/Cape Grim, Australia	21
	S9.2 Monte Cimone, Italy	36
50	S9.3 Gosan, South Korea	48
	S9.4 Jungfrauoch, Switzerland	60
	S9.5 Mace Head, Ireland	72

55

S9.6 Ragged Point, Barbados	87
S9.7 Cape Matatula, American Samoa	102
S9.8 Trinidad Head, USA	117
S9.9 Zeppelin, Svalbard	132

S1 Intercomparison of ECMWF and Met Office UM Meteorological Fields

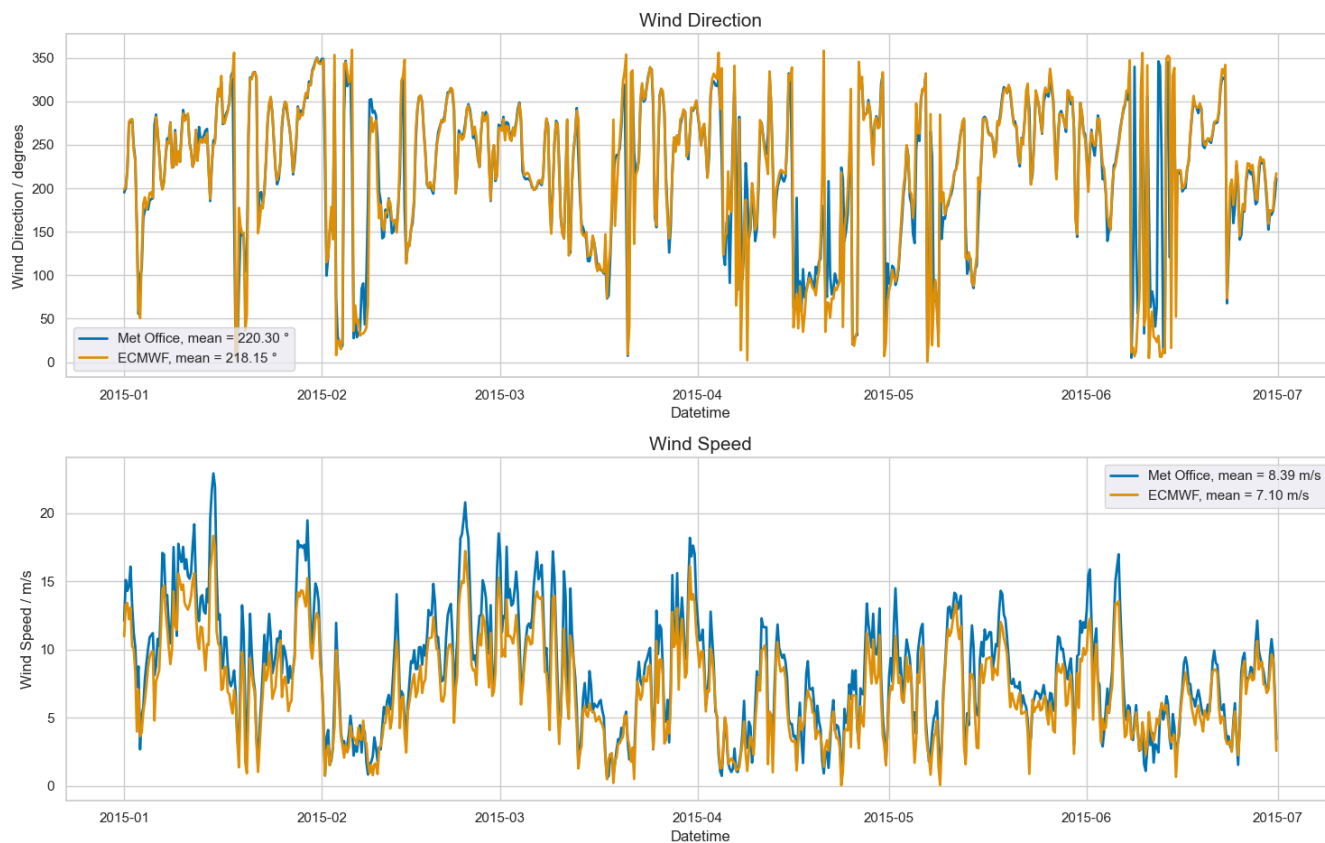


Figure S1. Subplots comparing ECMWF and Met Office UM 10-m winds across a six-month sample period (Jan-June 2015) at Mace Head, Ireland. Top figure compares wind directions, and bottom, wind speeds. Legend contains average values for additional quantitative comparison.

S2 **Model Inputs**

Table S1. Input feature categories used in the ML models. Each variable is extracted from 17 horizontally distributed points around the site; the data collection site itself and 16 from surrounding nearest grid points based on two 3x3 grids spanning $\pm 5^\circ$ and $\pm 10^\circ$ latitude and longitude.

<i>Category</i>	<i>Units</i>
Boundary layer height	m
Surface pressure	Pa
10 m u-wind	m s^{-1}
500 hPa u-wind	m s^{-1}
850 hPa u-wind	m s^{-1}
10 m v-wind	m s^{-1}
500 hPa v-wind	m s^{-1}
850 hPa v-wind	m s^{-1}
Time of Day	
Day of Year	

S3 Training Set Length versus Performance and Training Time

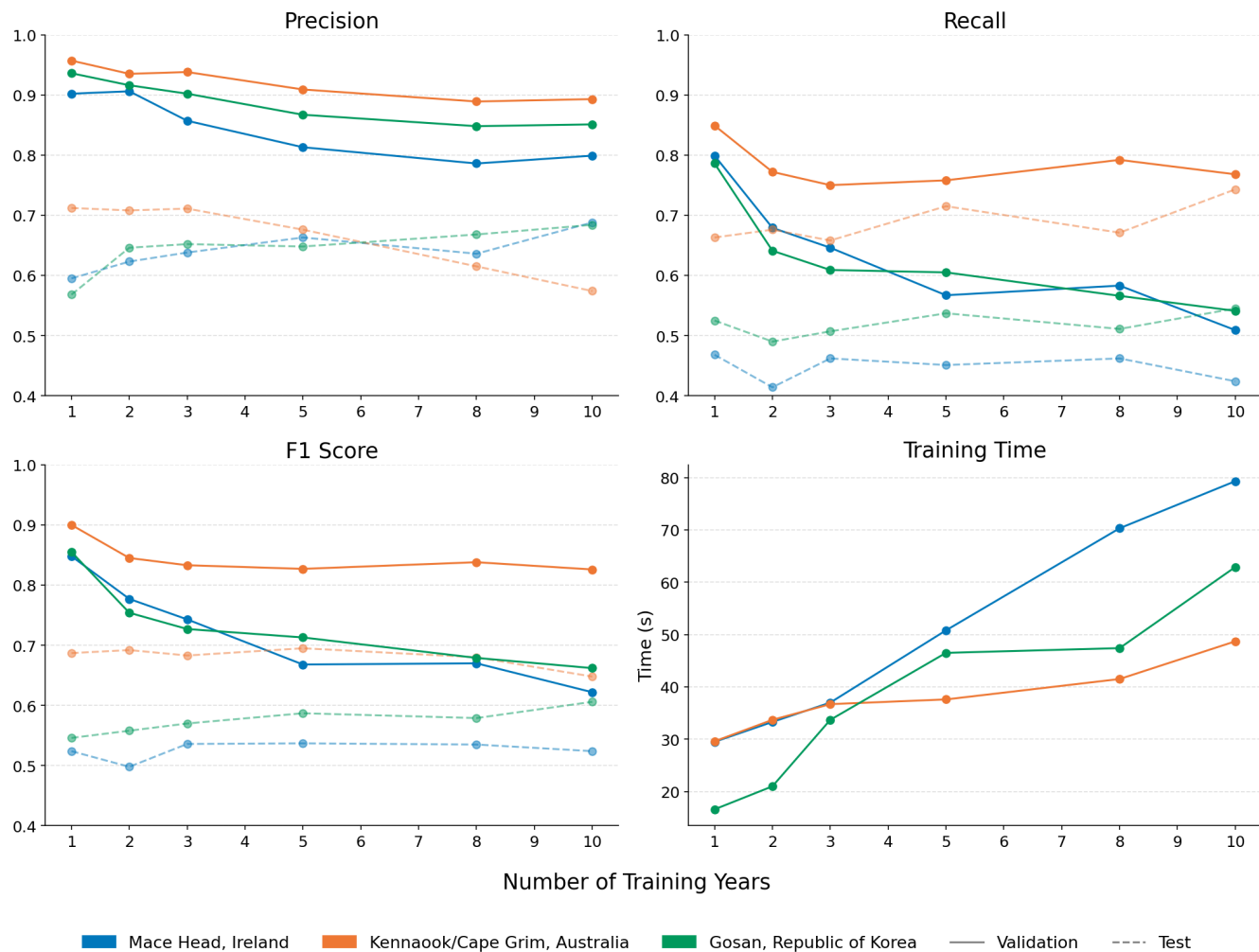


Figure S2. Subplots showing how precision, recall, F1 score and training time vary with number of training years. Metrics derived from both the validation and test set are shown. The time shown is the total time, including preprocessing time (includes data loading) and fit time. Note that this does not include the time for loading of the test set. Models were trained with 1, 2, 3, 5, 8 and 10 training years, with each setting run three times. The mean total time across these three runs is shown here.

S4.1 scikit-learn MLPClassifier

Note that hyperparameters not listed are as default in the documentation.

Table S2. Hyperparameter sets used in the final versions of the MLP models for AGAGE sites.

(a) Four AGAGE sites: Kennaoock/Cape Grim (CGO), Monte Cimone (CMN), Gosan (GSN), Jungfraujoch (JFJ).

<i>Parameter</i>	<i>CGO</i>	<i>CMN</i>	<i>GSN</i>	<i>JFJ</i>
hidden_layer_sizes	(64,)	(16,)	(64,)	(64,)
alpha	2.0	10.0	4.0	2.5
batch_size	32	32	32	32
learning_rate	'constant'	'constant'	'constant'	'constant'
learning_rate_init	0.0001	0.0001	0.0001	0.0001
shuffle	TRUE	TRUE	TRUE	TRUE
random_state	42	42	42	42
validation_fraction	0.10	0.15	0.15	0.15
n_iter_no_change	10	20	20	20

(b) Five AGAGE sites: Mace Head (MHD), Ragged Point (RPB), Cape Matatula (SMO), Trinidad Head (THD), Zeppelin (ZEP).

<i>Parameter</i>	<i>MHD</i>	<i>RPB</i>	<i>SMO</i>	<i>THD</i>	<i>ZEP</i>
hidden_layer_sizes	(64,)	(32,)	(32,)	(16,)	(64,)
alpha	2.5	5.0	5.0	3.0	2.0
batch_size	32	32	32	32	32
learning_rate	'constant'	'constant'	'constant'	'constant'	'constant'
learning_rate_init	0.0001	0.0001	0.0001	0.0001	0.0001
shuffle	TRUE	TRUE	TRUE	TRUE	TRUE
random_state	42	42	42	42	42
early_stopping	TRUE	TRUE	TRUE	TRUE	TRUE
validation_fraction	0.15	0.15	0.10	0.15	0.10
n_iter_no_change	20	20	10	20	10

S4.2 Custom Training Parameters

Table S3. Parameters defined in the training pipeline. `balance` sets the target proportion of baseline values in the training set. If '-' is shown for `balance`, there was no intervention and the native baseline proportion is used. `balance_method` defines the method used to balance the training dataset. `undersample` randomly undersamples the training set to the given fraction, if between 0 and 1. A value of '-' means the default value of 0 was used. `sample_weights` assigns the given weight to the baseline class. `normalise_inputs` defines whether to normalise the input features based on categories. `time_shift_hours` is a list of time shifts (in hours prior to measurement time) to create lagged features for. `prediction_threshold` is the minimum predicted probability required to classify a data point as baseline.

(a) Four AGAGE sites: Kennaoak/Cape Grim (CGO), Monte Cimone (CMN), Gosan (GSN), Jungfraujoch (JFJ).

<i>Parameter</i>	<i>CGO</i>	<i>CMN</i>	<i>GSN</i>	<i>JFJ</i>
<code>balance</code>	-	0.25	0.30	0.30
<code>balance_method</code>	'random'	'random'	'random'	'random'
<code>undersample</code>	-	-	-	-
<code>sample_weights</code>	1.5	1.0	1.5	1.5
<code>normalise_inputs</code>	TRUE	TRUE	TRUE	TRUE
<code>time_shift_hours</code>	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]
<code>prediction_threshold</code>	0.70	0.50	0.60	0.65

(b) Five AGAGE sites: Mace Head (MHD), Ragged Point (RPB), Cape Matatula (SMO), Trinidad Head (THD), Zeppelin (ZEP).

<i>Parameter</i>	<i>MHD</i>	<i>RPB</i>	<i>SMO</i>	<i>THD</i>	<i>ZEP</i>
<code>balance</code>	0.30	0.30	-	0.20	-
<code>balance_method</code>	'random'	'random'	'random'	'random'	'random'
<code>undersample</code>	-	-	-	-	-
<code>sample_weights</code>	1.5	1.0	2.0	1.0	1.5
<code>normalise_inputs</code>	TRUE	TRUE	TRUE	TRUE	TRUE
<code>time_shift_hours</code>	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]
<code>prediction_threshold</code>	0.65	0.55	0.60	0.60	0.70

S5 Coefficient of Variation and Model Performance

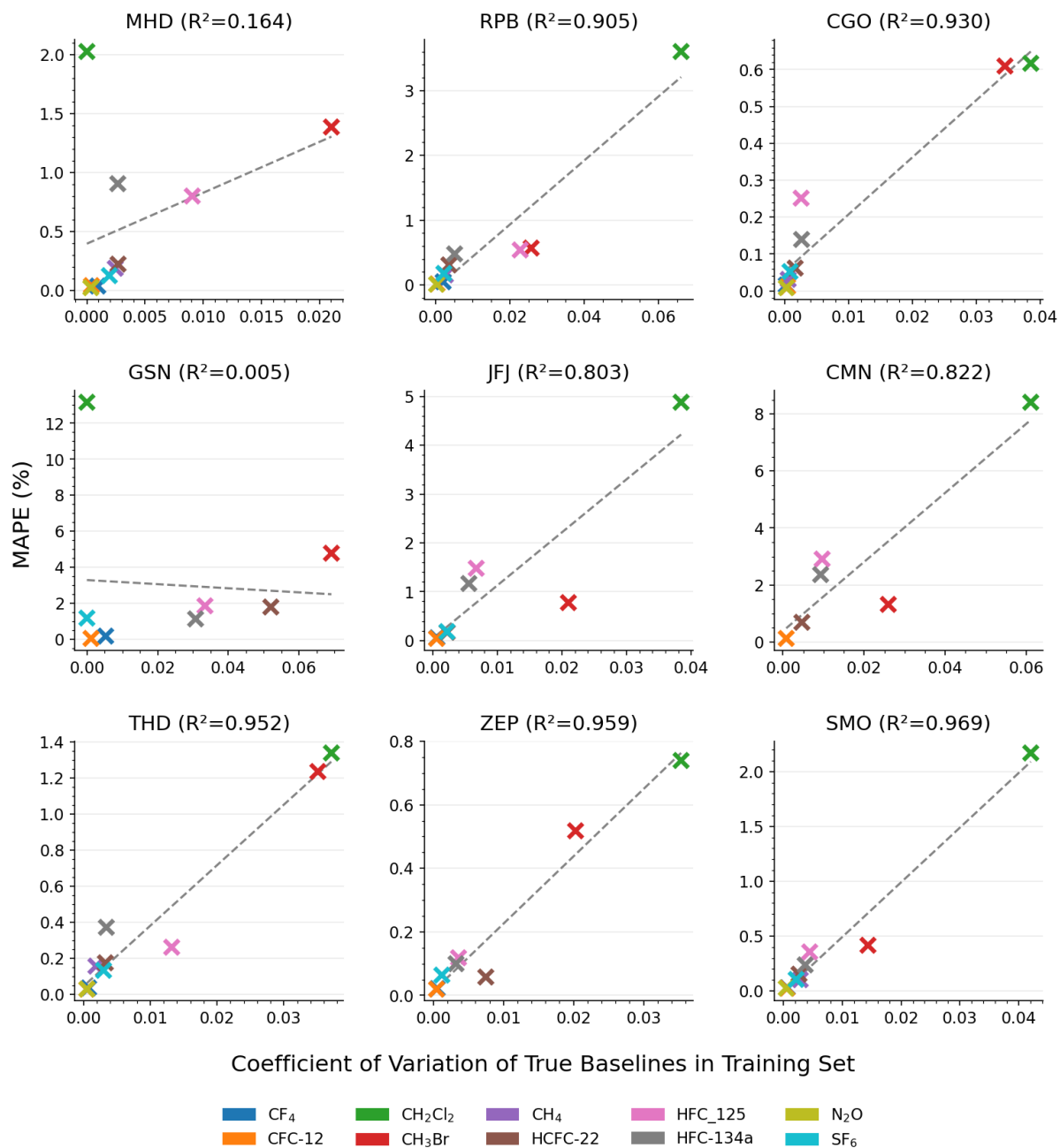


Figure S3. Each subplot shows the relationship between the coefficient of variation (CV) of true baselines and the mean absolute percentage error (MAPE) of baseline monthly means derived from the MLP model predictions for the nine AGAGE sites. A linear regression fit is shown (dashed red line) with the R^2 value reported in the subplot title. CV was computed on the training set.

Table S4. A tabular summary of the top three most influential feature groups when training the final MLP model for each site. u- and v- wind encompass all heights, locations and times. 'PBLH' represents planetary boundary layer height.

<i>Station Designation</i>	<i>Most Important</i>	<i>Second</i>	<i>Third</i>
CGO	u-wind	v-wind	PBLH
CMN	u-wind	v-wind	PBLH
GSN	PBLH	u-wind	v-wind
JFJ	v-wind	u-wind	PBLH
MHD	u-wind	PBLH	v-wind
RPB	u-wind	v-wind	PBLH
SMO	u-wind	v-wind	PBLH
THD	u-wind	PBLH	v-wind
ZEP	v-wind	u-wind	PBLH

S7 Random Forest Summary

S7.1 Model Metrics

Table S5. A tabular summary of the final random forest model outcomes, showing precision, recall and F1 score values for each of the AGAGE sites. Scores can range from 0 to 1, with higher scores indicating higher performance.

<i>Station Designation</i>	<i>Precision</i>	<i>Recall</i>	<i>F1 score</i>
CGO	0.669	0.818	0.736
CMN	0.284	0.406	0.334
GSN	0.643	0.501	0.563
JFJ	0.648	0.542	0.590
MHD	0.629	0.453	0.527
RPB	0.445	0.608	0.514
SMO	0.582	0.771	0.663
THD	0.689	0.336	0.452
ZEP	0.790	0.607	0.686

S7.2 Final Hyperparameter Sets

S7.2.1 scikit-learn RandomForestClassifier

70 Note that hyperparameters not listed are as default in the documentation.

Table S6. Hyperparameter sets used in the final versions of the random forest models for AGAGE sites.

(a) Four AGAGE sites: Kennaook/Cape Grim (CGO), Monte Cimone (CMN), Gosan (GSN), Jungfraujoch (JFJ).

<i>Parameter</i>	<i>CGO</i>	<i>CMN</i>	<i>GSN</i>	<i>JFJ</i>
n_estimators	100	200	100	100
max_depth	8	4	6	6
min_samples_split	10	15	15	15
min_samples_leaf	15	30	20	20
n_jobs	-1	-1	-1	-1
random_state	42	42	42	42
max_samples	0.9	0.7	0.8	0.8

(b) Five AGAGE sites: Mace Head (MHD), Ragged Point (RPB), Cape Matatula (SMO), Trinidad Head (THD), Zeppelin (ZEP).

<i>Parameter</i>	<i>MHD</i>	<i>RPB</i>	<i>SMO</i>	<i>THD</i>	<i>ZEP</i>
n_estimators	100	100	100	100	100
max_depth	6	6	8	5	8
min_samples_split	15	15	10	15	10
min_samples_leaf	20	20	15	25	15
n_jobs	-1	-1	-1	-1	-1
random_state	42	42	42	42	42
max_samples	0.8	0.8	0.9	0.8	0.9

S7.2.2 Custom Training Parameters

Table S7. Parameters defined in the training pipeline. `balance` sets the target proportion of baseline values in the training set. If '-' is shown for `balance`, there was no intervention and the native baseline proportion is used. `balance_method` defines the method used to balance the training dataset. `undersample` randomly undersamples the training set to the given fraction, if between 0 and 1. A value of '-' means the default value of 0 was used. `sample_weights` assigns the given weight to the baseline class. `normalise_inputs` defines whether to normalise the input features based on categories. `time_shift_hours` is a list of time shifts (in hours prior to measurement time) to create lagged features for. `prediction_threshold` is the minimum predicted probability required to classify a data point as baseline.

(a) Four AGAGE sites: Kennaoook/Cape Grim (CGO), Monte Cimone (CMN), Gosan (GSN), Jungfraujoch (JFJ).

<i>Parameter</i>	<i>CGO</i>	<i>CMN</i>	<i>GSN</i>	<i>JFJ</i>
<code>balance</code>	-	0.35	0.30	0.30
<code>balance_method</code>	'random'	'random'	'random'	'random'
<code>undersample</code>	-	-	-	-
<code>sample_weights</code>	1.5	1.0	1.5	1.0
<code>normalise_inputs</code>	FALSE	FALSE	FALSE	FALSE
<code>time_shift_hours</code>	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]
<code>prediction_threshold</code>	0.60	0.50	0.60	0.65

(b) Five AGAGE sites: Mace Head (MHD), Ragged Point (RPB), Cape Matatula (SMO), Trinidad Head (THD), Zeppelin (ZEP).

<i>Parameter</i>	<i>MHD</i>	<i>RPB</i>	<i>SMO</i>	<i>THD</i>	<i>ZEP</i>
<code>balance</code>	0.30	0.35	-	0.25	-
<code>balance_method</code>	'random'	'random'	'random'	'random'	'random'
<code>undersample</code>	-	-	-	-	-
<code>sample_weights</code>	1.0	2.0	3.0	1.5	1.5
<code>normalise_inputs</code>	FALSE	FALSE	FALSE	FALSE	FALSE
<code>time_shift_hours</code>	[6, 12, 18, 24]	[12, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]
<code>prediction_threshold</code>	0.50	0.50	0.60	0.60	0.60

S7.3 Confusion Matrix Map

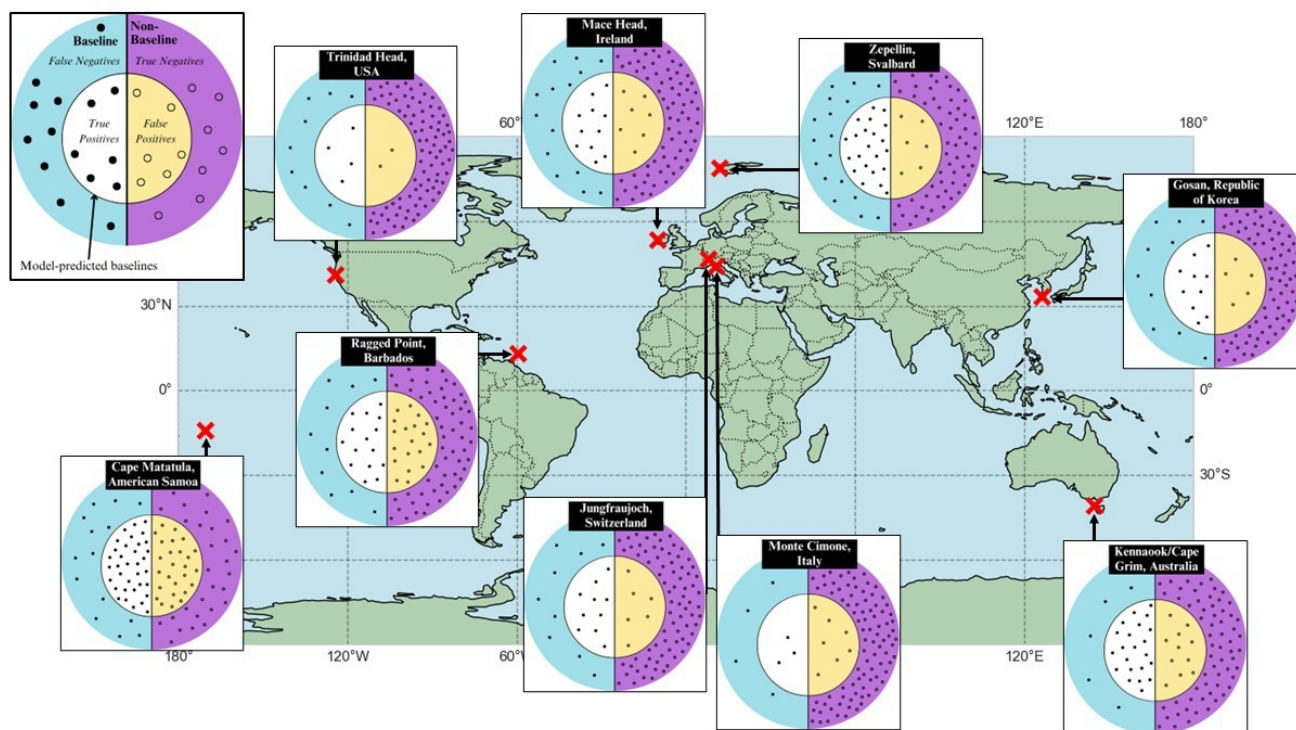


Figure S4. A map showing the locations of the nine AGAGE sites, with confusion matrix-derived plots at each location. Each confusion matrix was normalised, to remove visual differences due to testing set sizes; each point represents approximately 1% of the total test set (rounding means that the total number of points on each plot range from 99 to 101). The left half of each circle represents true baseline points, and the right half true non-baseline points. The inner circle shows the random forest model prediction of baseline points. The key in the top left indicates where true or false positives and negatives lie, as explained in the main text.

S7.4 MAPE Heatmap



Figure S5. Mean Absolute Percentage Errors (MAPE) for the random forest model for selected AGAGE species across the nine monitoring sites. White denotes species that were not available at a particular site.

S8 Gradient Boosting Summary

75 S8.1 Model Metrics

Table S8. A tabular summary of the final gradient boosting model outcomes, showing precision, recall and F1 score values for each of the AGAGE sites. Scores can range from 0 to 1, with higher scores indicating higher performance.

<i>Station Designation</i>	<i>Precision</i>	<i>Recall</i>	<i>F1 score</i>
CGO	0.693	0.765	0.727
CMN	0.402	0.291	0.338
GSN	0.669	0.516	0.583
JFJ	0.615	0.601	0.608
MHD	0.609	0.498	0.548
RPB	0.482	0.371	0.419
SMO	0.613	0.623	0.618
THD	0.615	0.449	0.519
ZEP	0.814	0.568	0.669

S8.2 Final Hyperparameter Sets

S8.2.1 scikit-learn GradientBoostingClassifier

Note that hyperparameters not listed are as default in the documentation.

Table S9. Hyperparameter sets used in the final versions of the gradient boosting models for AGAGE sites.

(a) Four AGAGE sites: Kennaook/Cape Grim (CGO), Monte Cimone (CMN), Gosan (GSN), Jungfraujoch (JFJ).

<i>Parameter</i>	<i>CGO</i>	<i>CMN</i>	<i>GSN</i>	<i>JFJ</i>
learning_rate	0.05	0.03	0.03	0.05
n_estimators	200	300	300	100
subsample	0.7	0.5	0.5	0.6
min_samples_split	5	20	20	10
min_samples_leaf	5	20	20	10
max_depth	5	3	3	4
random_state	42	42	42	42
max_features	'log2'	'log2'	'log2'	'log2'

(b) Five AGAGE sites: Mace Head (MHD), Ragged Point (RPB), Cape Matatula (SMO), Trinidad Head (THD), Zeppelin (ZEP).

<i>Parameter</i>	<i>MHD</i>	<i>RPB</i>	<i>SMO</i>	<i>THD</i>	<i>ZEP</i>
learning_rate	0.05	0.05	0.05	0.03	0.05
n_estimators	100	100	200	300	200
subsample	0.6	0.6	0.7	0.5	0.7
min_samples_split	10	10	5	20	5
min_samples_leaf	10	10	5	20	5
max_depth	4	4	5	3	5
random_state	42	42	42	42	0
max_features	'log2'	'log2'	'log2'	'log2'	'log2'

S8.2.2 Custom Training Parameters

Table S10. Parameters defined in the training pipeline. `balance` sets the target proportion of baseline values in the training set. If '-' is shown for `balance`, there was no intervention and the native baseline proportion is used. `balance_method` defines the method used to balance the training dataset. `undersample` randomly undersamples the training set to the given fraction, if between 0 and 1. A value of '-' means the default value of 0 was used. `sample_weights` assigns the given weight to the baseline class. `normalise_inputs` defines whether to normalise the input features based on categories. `time_shift_hours` is a list of time shifts (in hours prior to measurement time) to create lagged features for. `prediction_threshold` is the minimum predicted probability required to classify a data point as baseline.

(a) Four AGAGE sites: Kennaoook/Cape Grim (CGO), Monte Cimone (CMN), Gosan (GSN), Jungfraujoch (JFJ).

<i>Parameter</i>	<i>CGO</i>	<i>CMN</i>	<i>GSN</i>	<i>JFJ</i>
<code>balance</code>	-	0.25	0.30	0.30
<code>balance_method</code>	'random'	'random'	'random'	'random'
<code>undersample</code>	-	-	-	-
<code>sample_weights</code>	1.5	1.0	1.0	1.0
<code>normalise_inputs</code>	FALSE	FALSE	FALSE	FALSE
<code>time_shift_hours</code>	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]
<code>prediction_threshold</code>	0.70	0.60	0.50	0.50

(b) Five AGAGE sites: Mace Head (MHD), Ragged Point (RPB), Cape Matatula (SMO), Trinidad Head (THD), Zeppelin (ZEP).

<i>Parameter</i>	<i>MHD</i>	<i>RPB</i>	<i>SMO</i>	<i>THD</i>	<i>ZEP</i>
<code>balance</code>	0.30	0.30	-	0.25	-
<code>balance_method</code>	'random'	'random'	'random'	'random'	'random'
<code>undersample</code>	-	-	-	-	-
<code>sample_weights</code>	1.0	1.5	2.5	1.5	1.5
<code>normalise_inputs</code>	FALSE	FALSE	FALSE	FALSE	FALSE
<code>time_shift_hours</code>	[6, 12, 18, 24]	[12, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]	[6, 12, 18, 24]
<code>prediction_threshold</code>	0.50	0.50	0.60	0.60	0.70

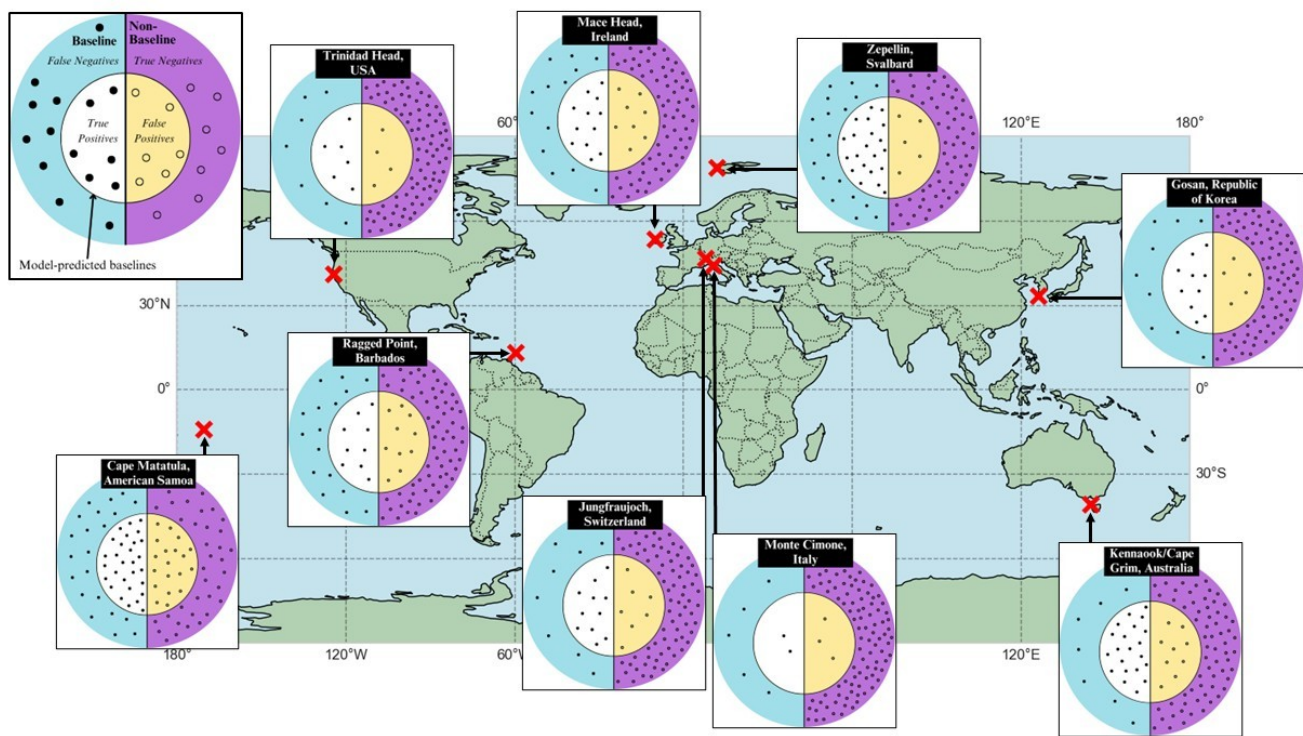


Figure S6. A map showing the locations of the nine AGAGE sites, with confusion matrix-derived plots at each location. Each confusion matrix was normalised, to remove visual differences due to testing set sizes; each point represents approximately 1% of the total test set (rounding means that the total number of points on each plot range from 99 to 101). The left half of each circle represents true baseline points, and the right half true non-baseline points. The inner circle shows the random forest model prediction of baseline points. The key in the top left indicates where true or false positives and negatives lie, as explained in the main text.

S8.4 MAPE Heatmap

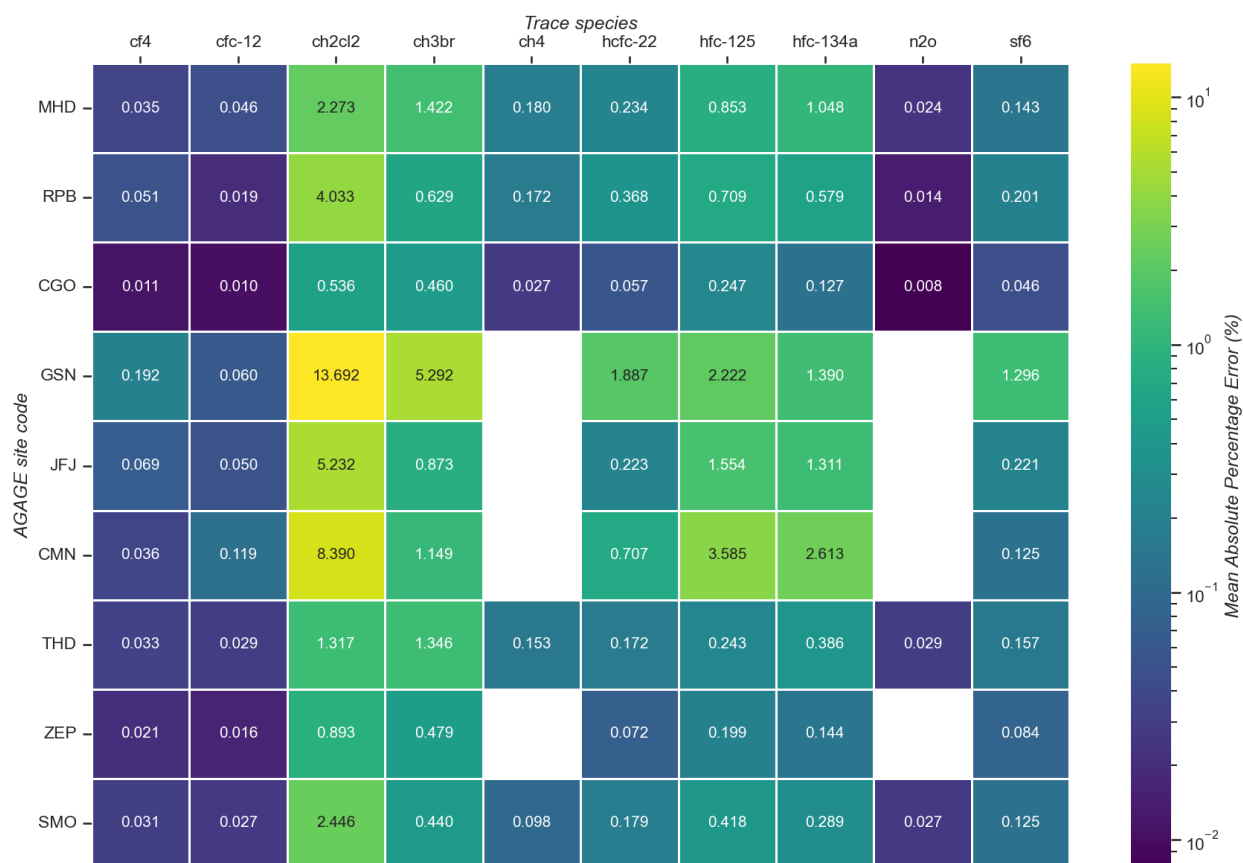


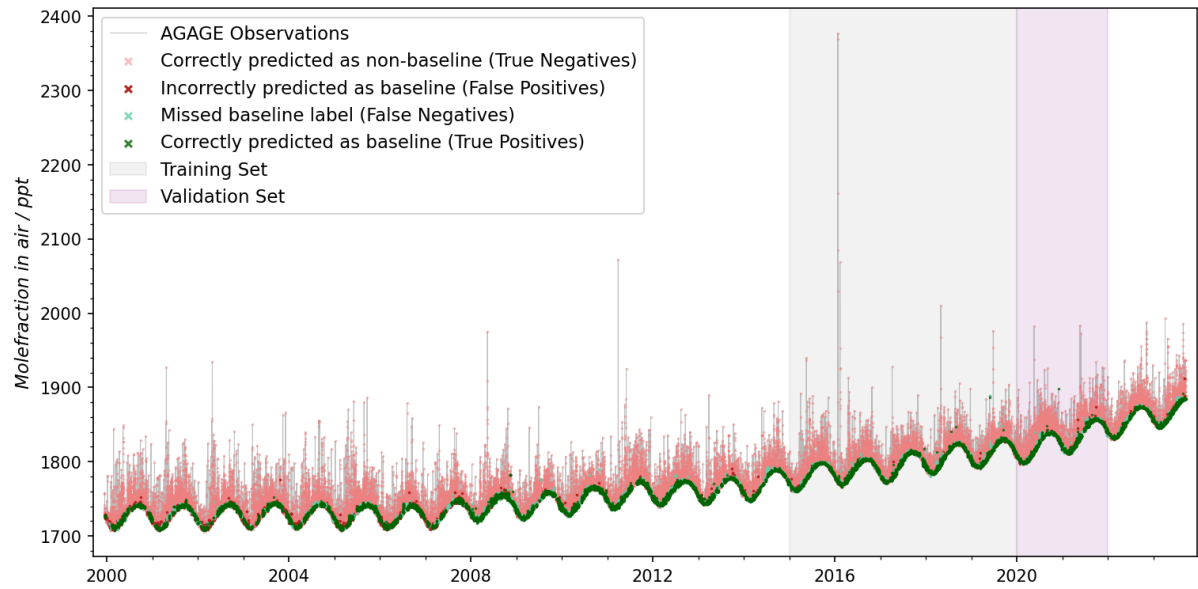
Figure S7. Mean Absolute Percentage Errors (MAPE) for the gradient boosting model for selected AGAGE species across the nine monitoring sites. White denotes species that were not available at a particular site.

S9 MLP Plots

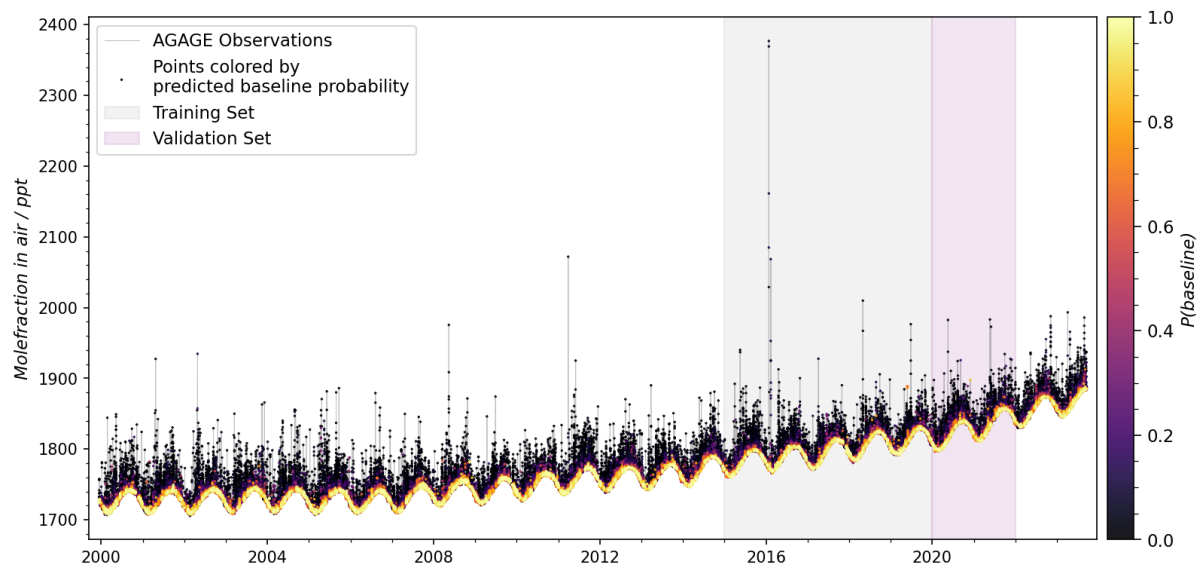
S9.1 Kennaook/Cape Grim, Australia

CH₄

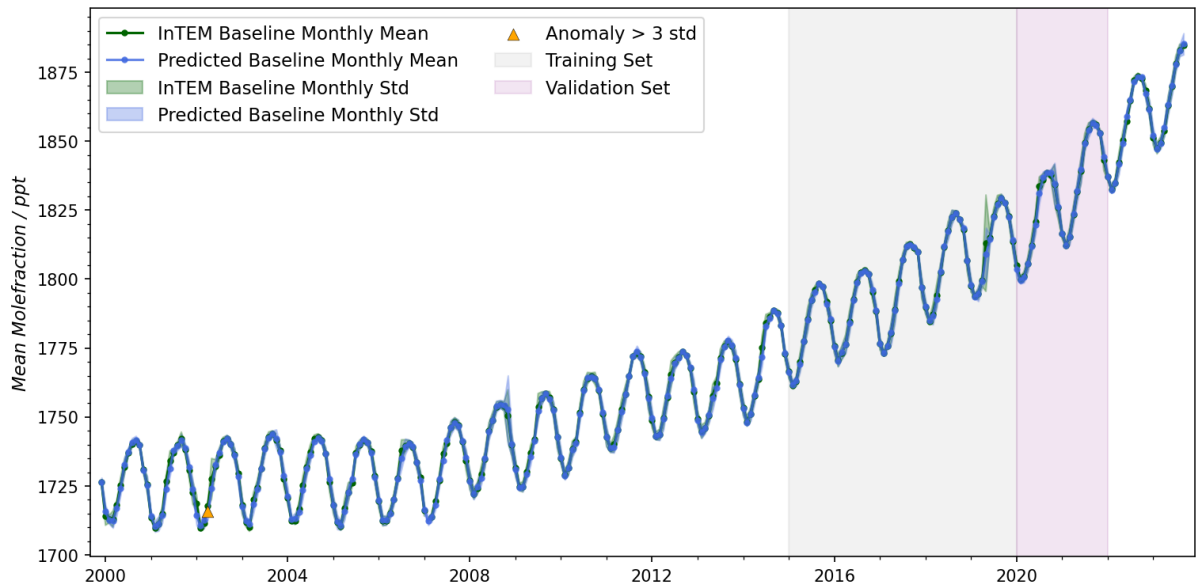
85 Molefraction time series (CH₄, CGO)



Model Confidence (CH₄, CGO)

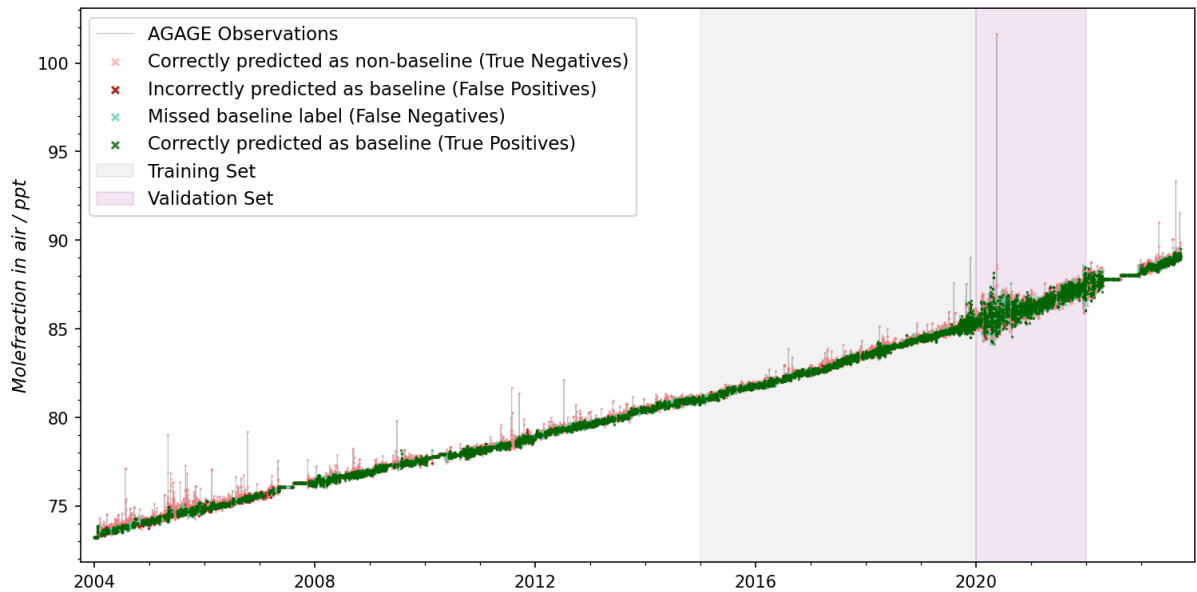


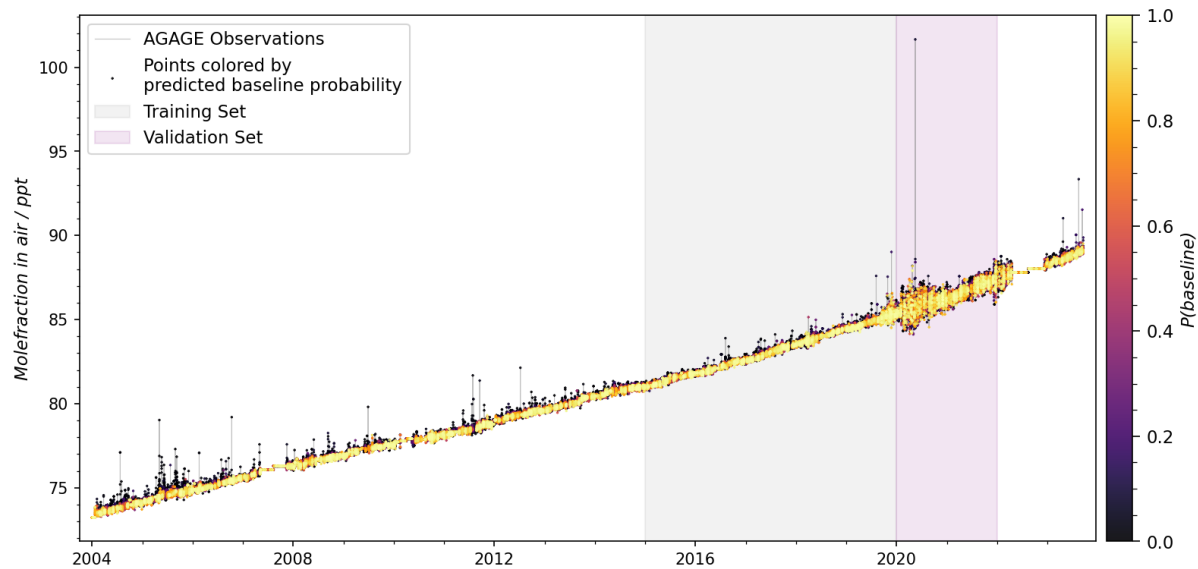
Monthly means (CH₄, CGO)



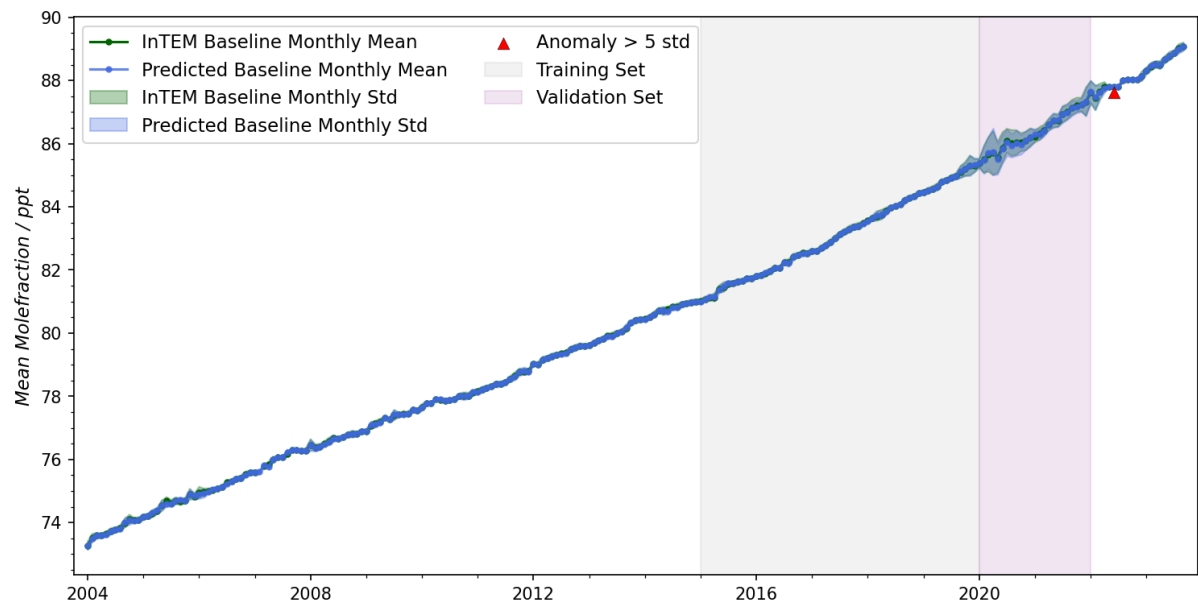
CF₄

Molefraction time series (CF₄, CGO)



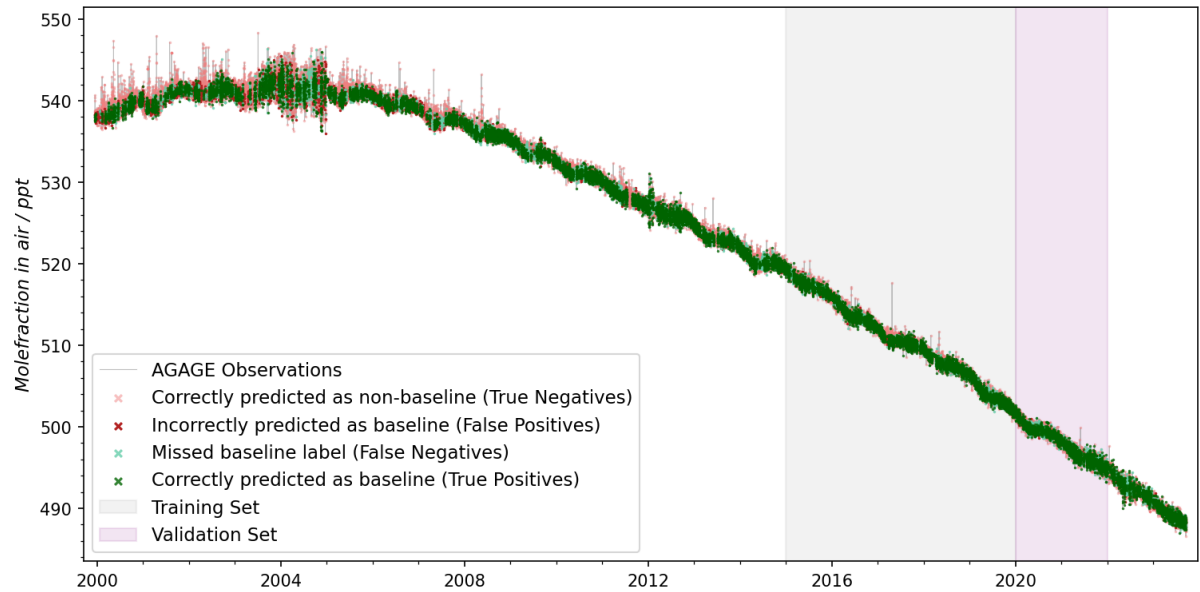


Monthly means (CF₄, CGO)

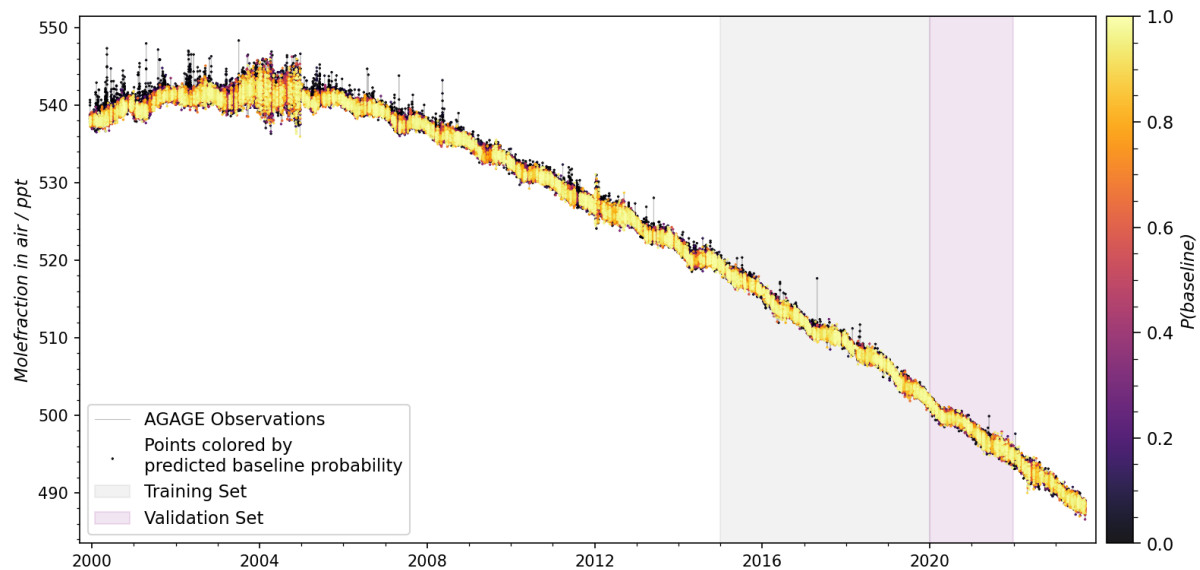


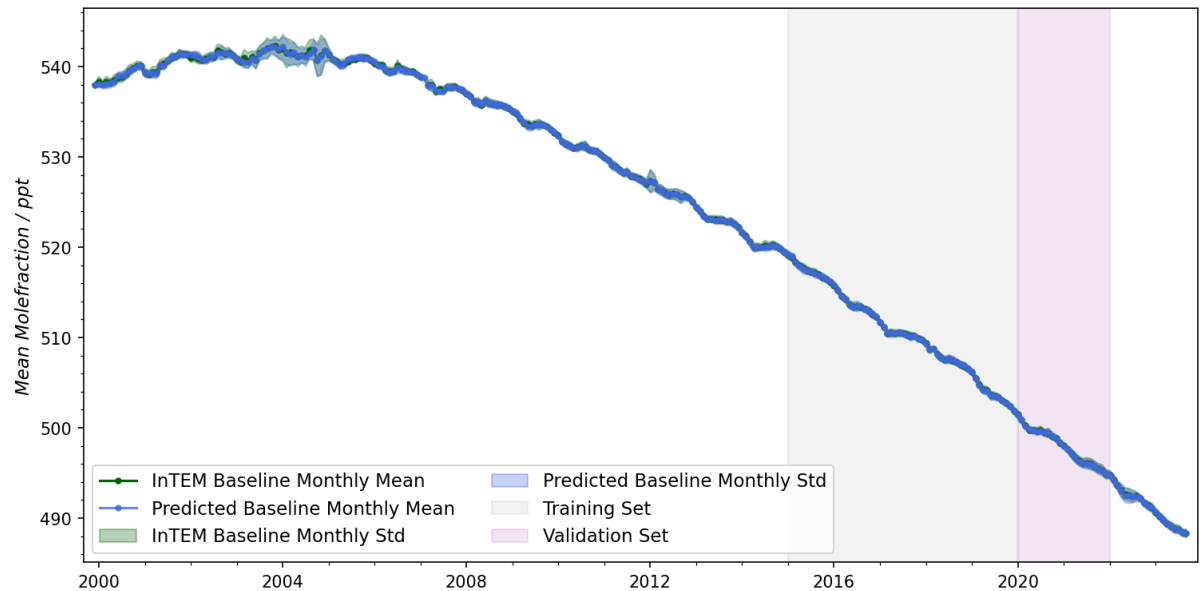
CFC-12

Molefraction time series (CFC-12, CGO)



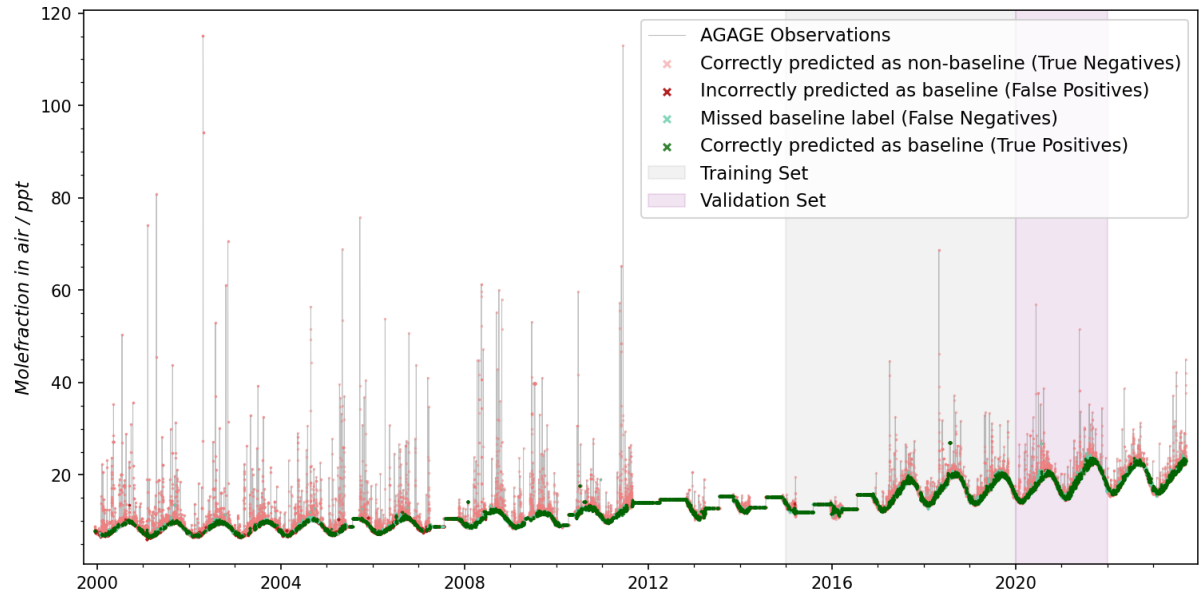
Model Confidence (CFC-12, CGO)



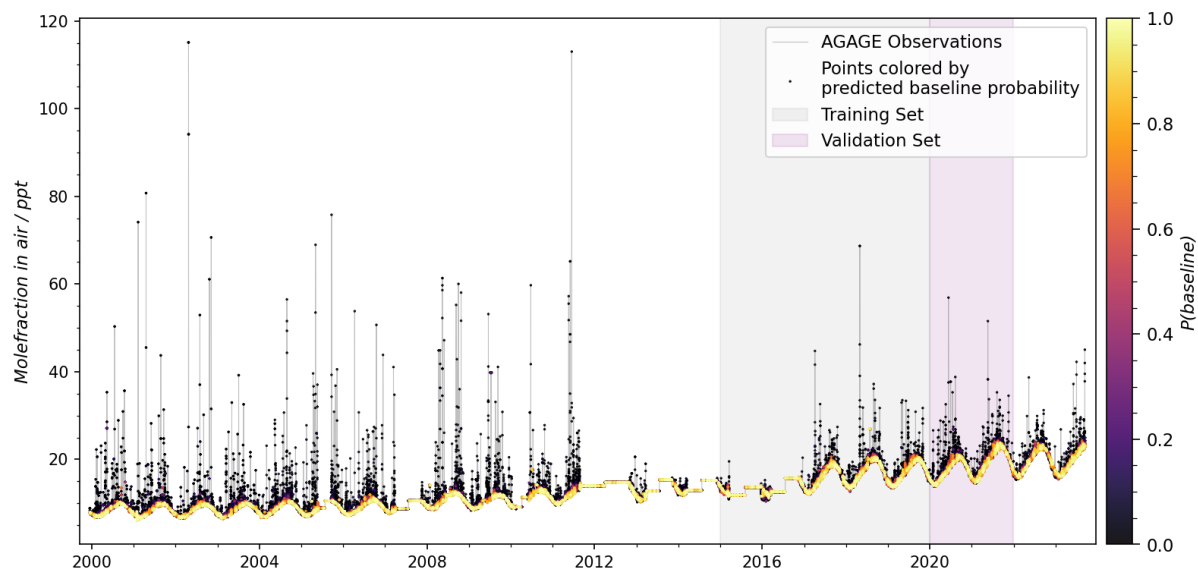


CH₂Cl₂

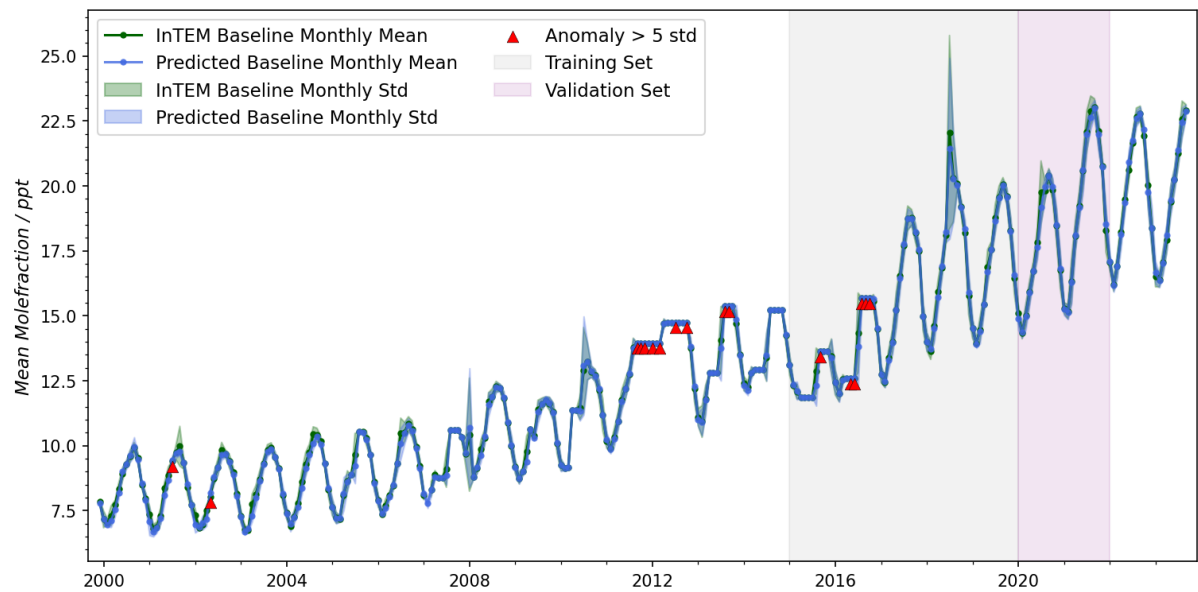
Molefraction time series (CH₂Cl₂, CGO)



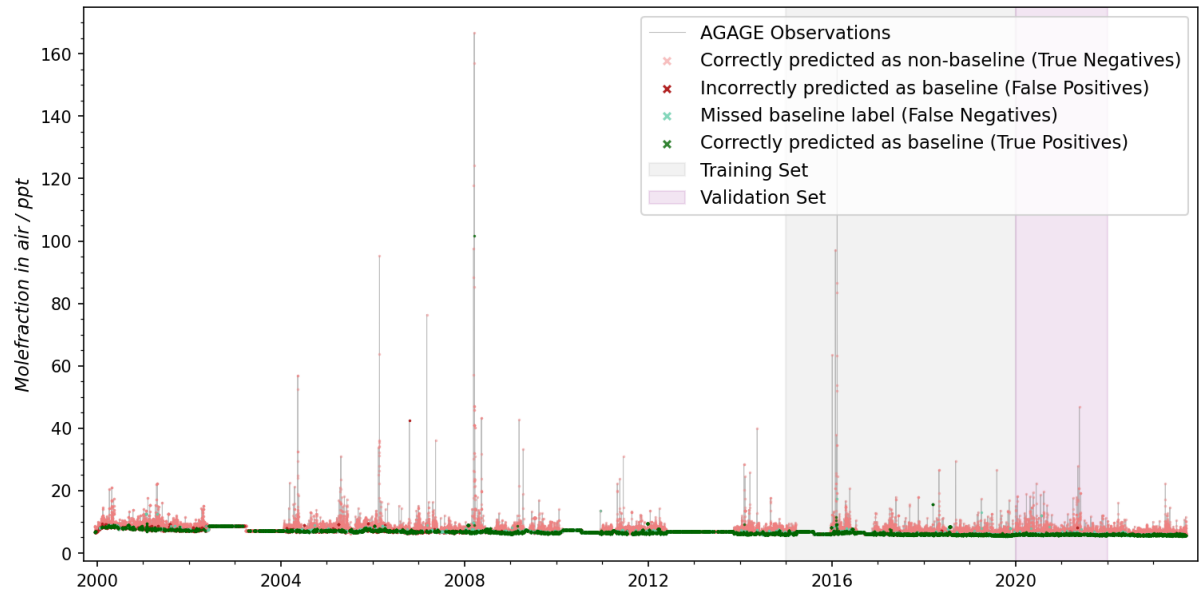
Model Confidence (CH₂Cl₂, CGO)



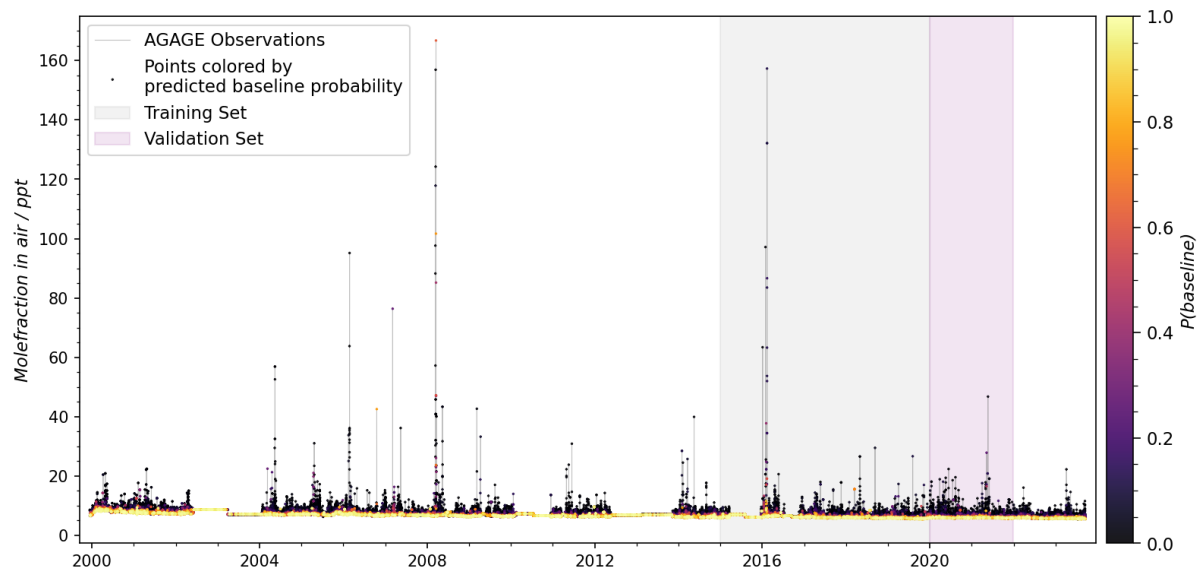
Monthly means (CH₂Cl₂, CGO)



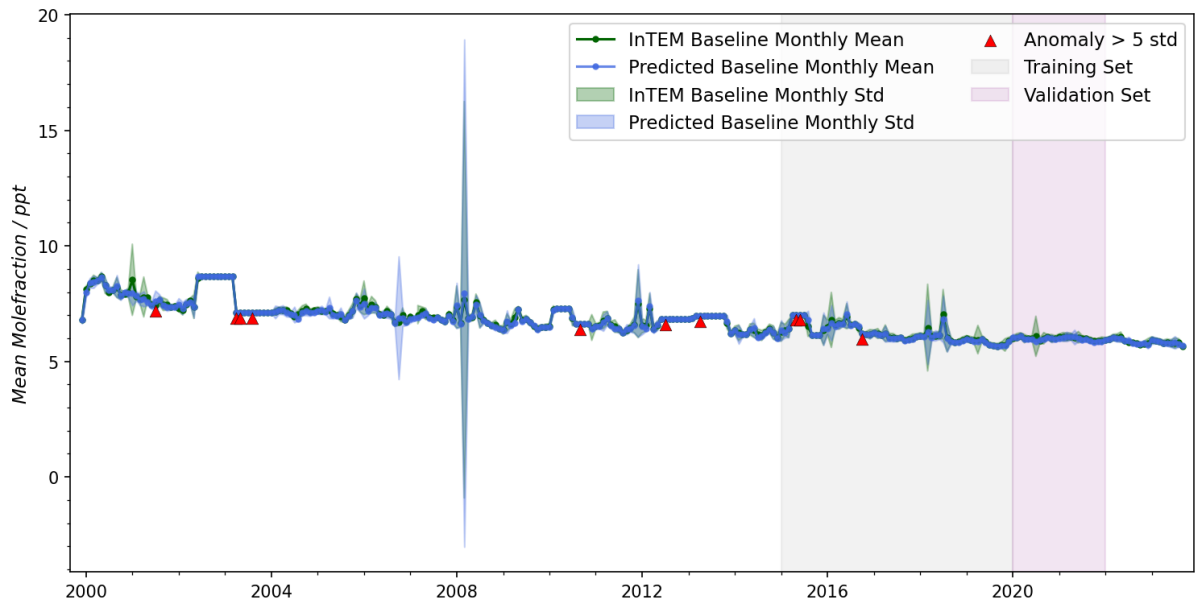
Molefraction time series (CH₃Br, CGO)



Model Confidence (CH₃Br, CGO)

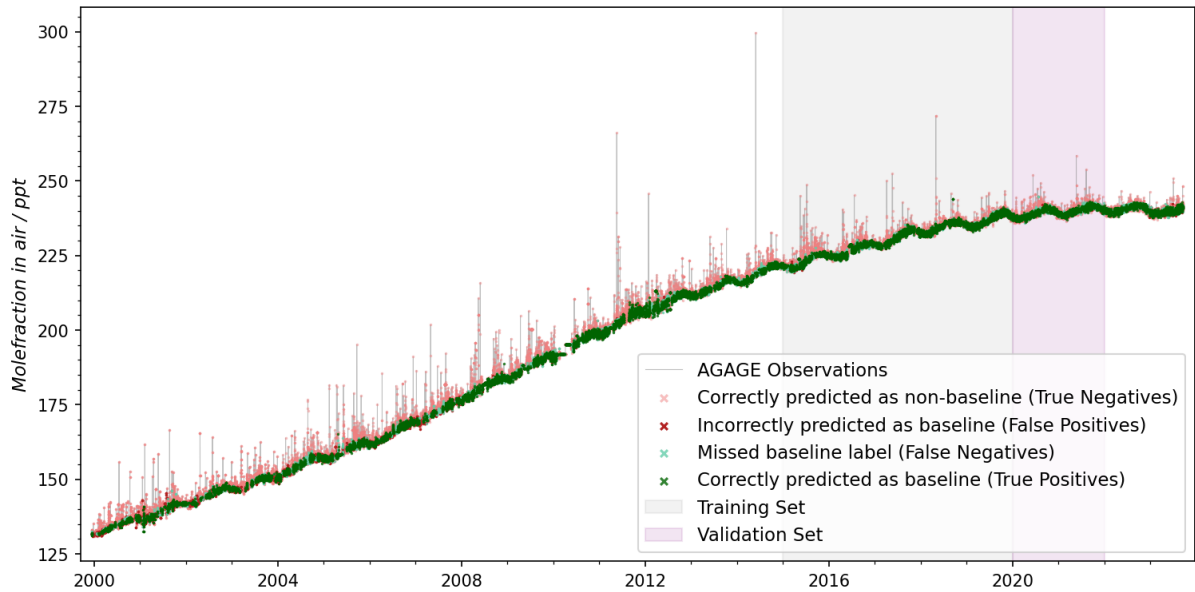


Monthly means (CH₃Br, CGO)

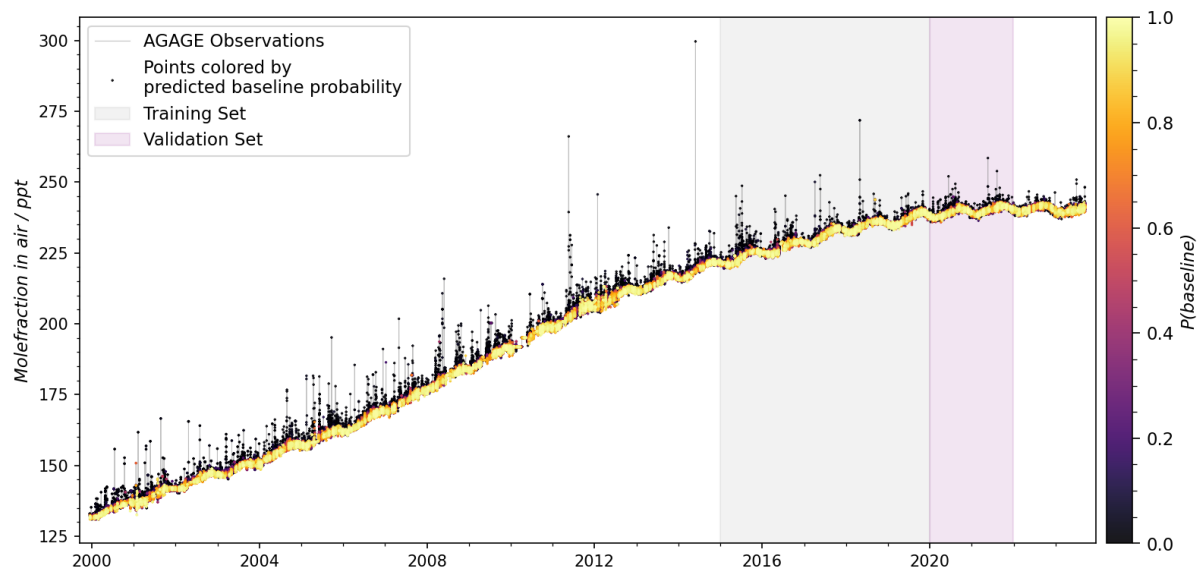


HCFC-22

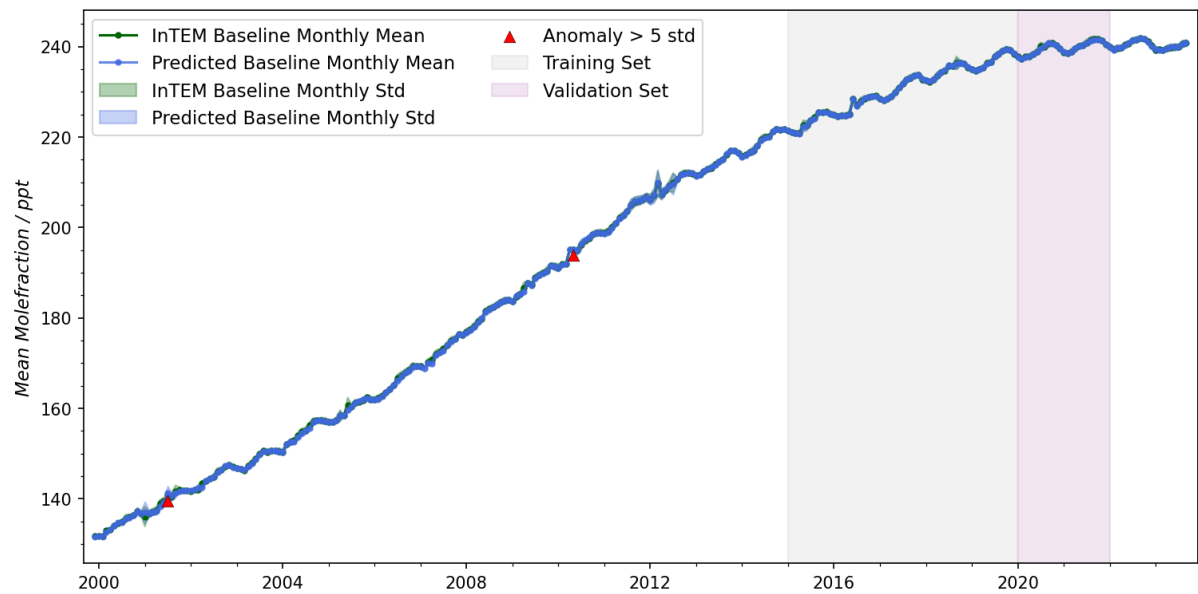
105 Molefraction time series (HCFC-22, CGO)



Model Confidence (HCFC-22, CGO)

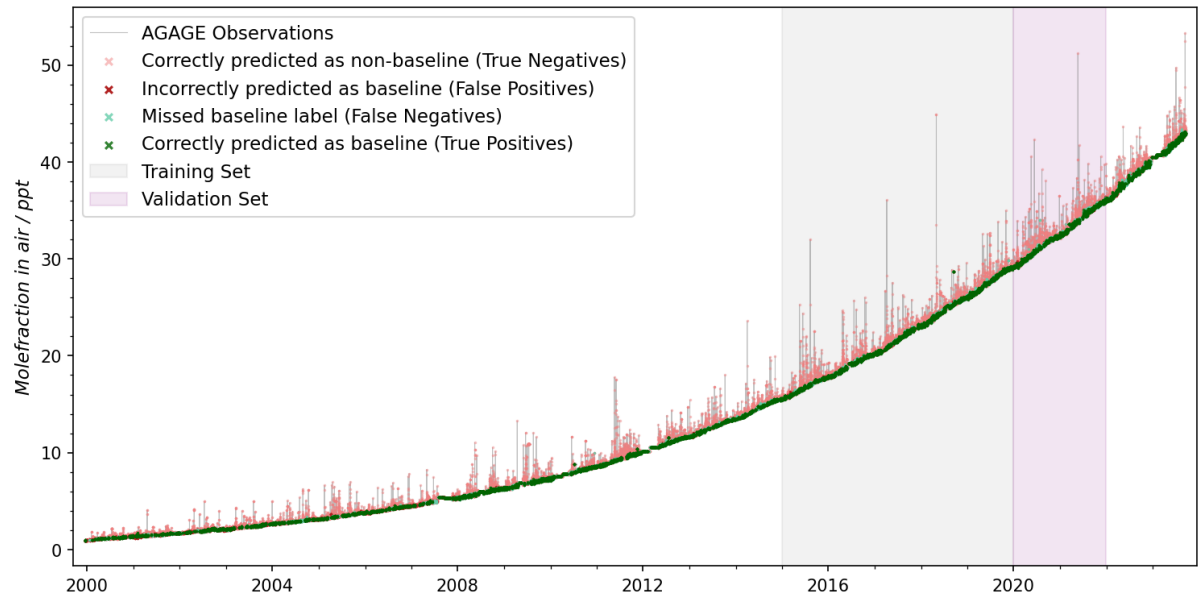


Monthly means (HCFC-22, CGO)

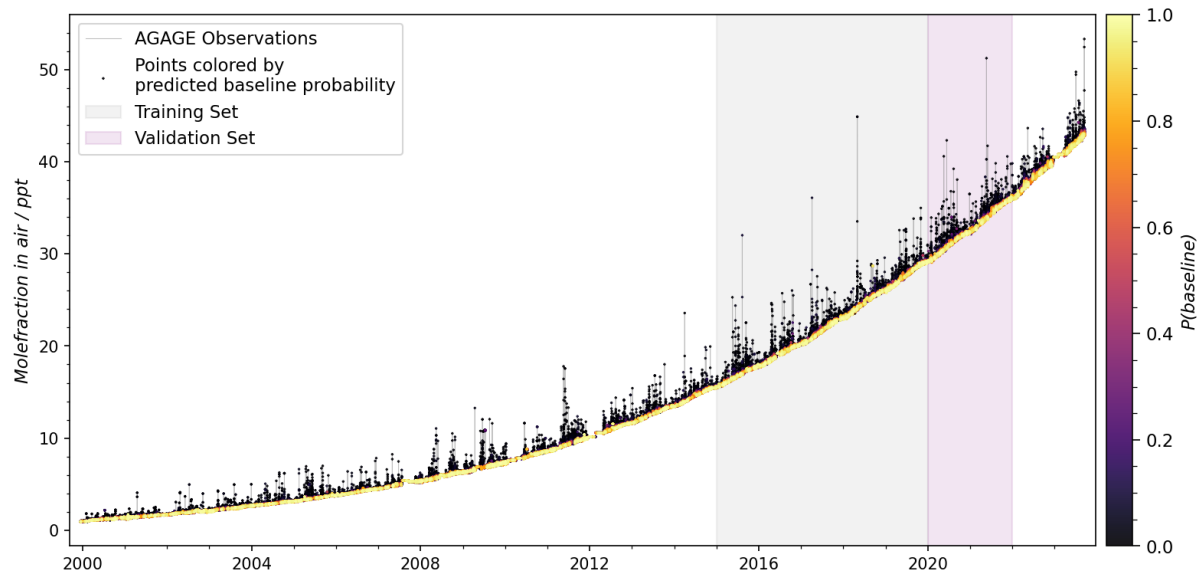


HFC-125

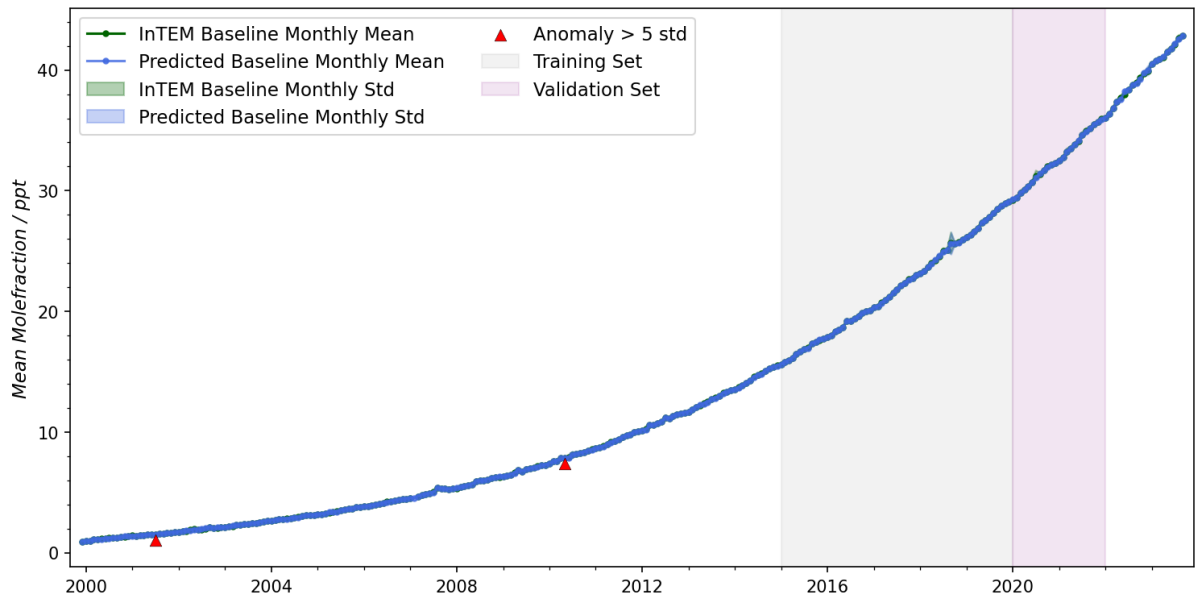
Molefraction time series (HFC-125, CGO)



110 Model Confidence (HFC-125, CGO)

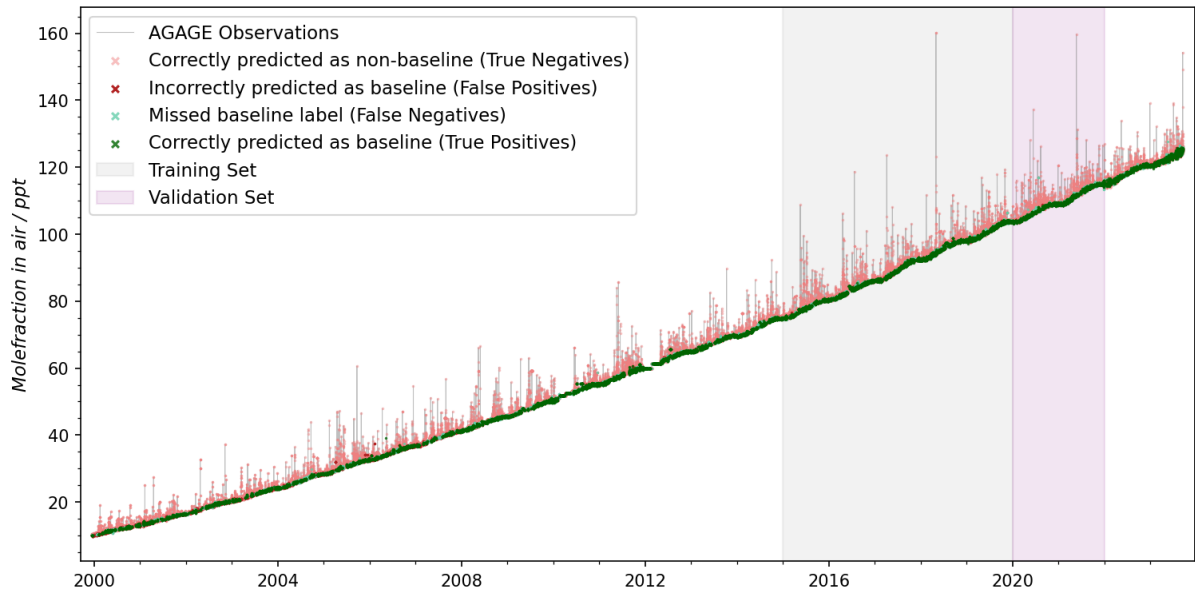


Monthly means (HFC-125, CGO)

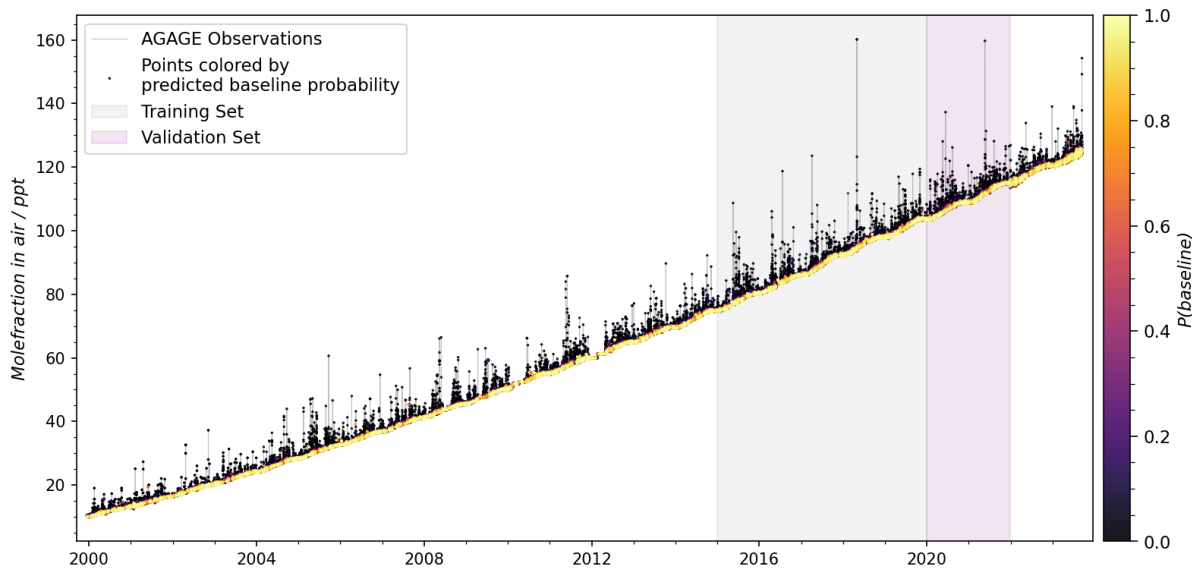


HFC-134a

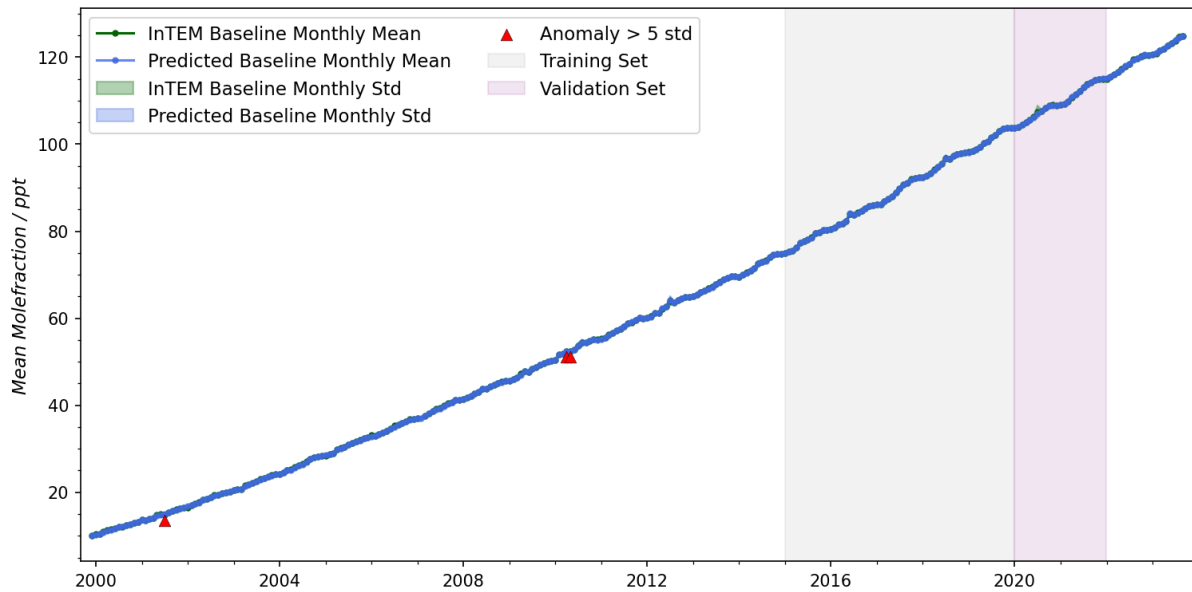
Molefraction time series (HFC-134a, CGO)



Model Confidence (HFC-134a, CGO)

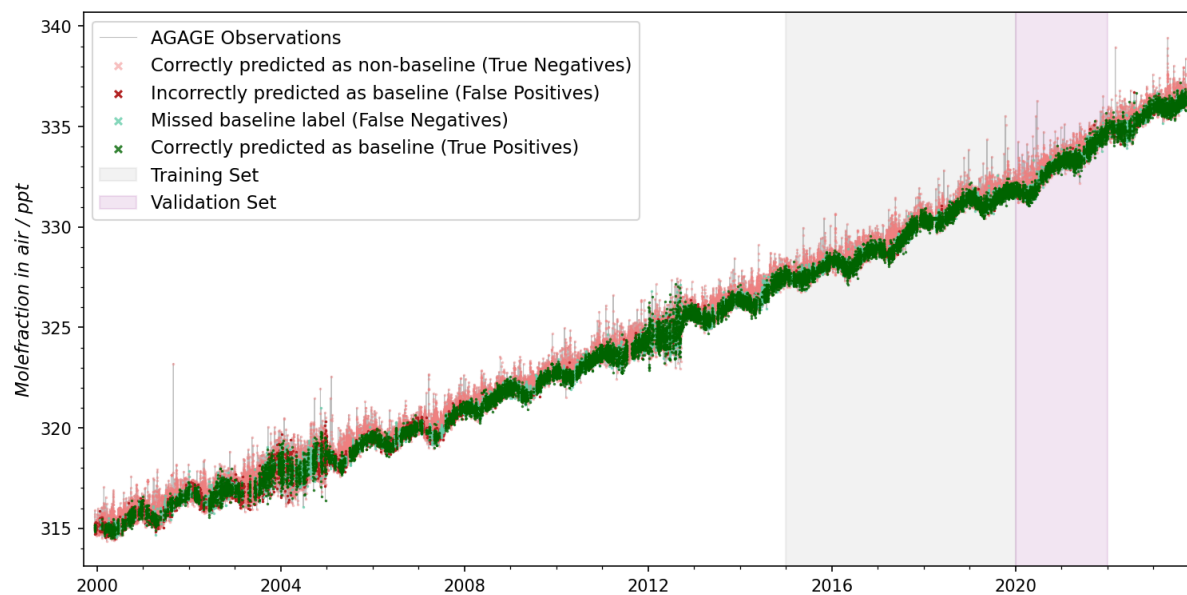


115 Monthly means (HFC-134a, CGO)

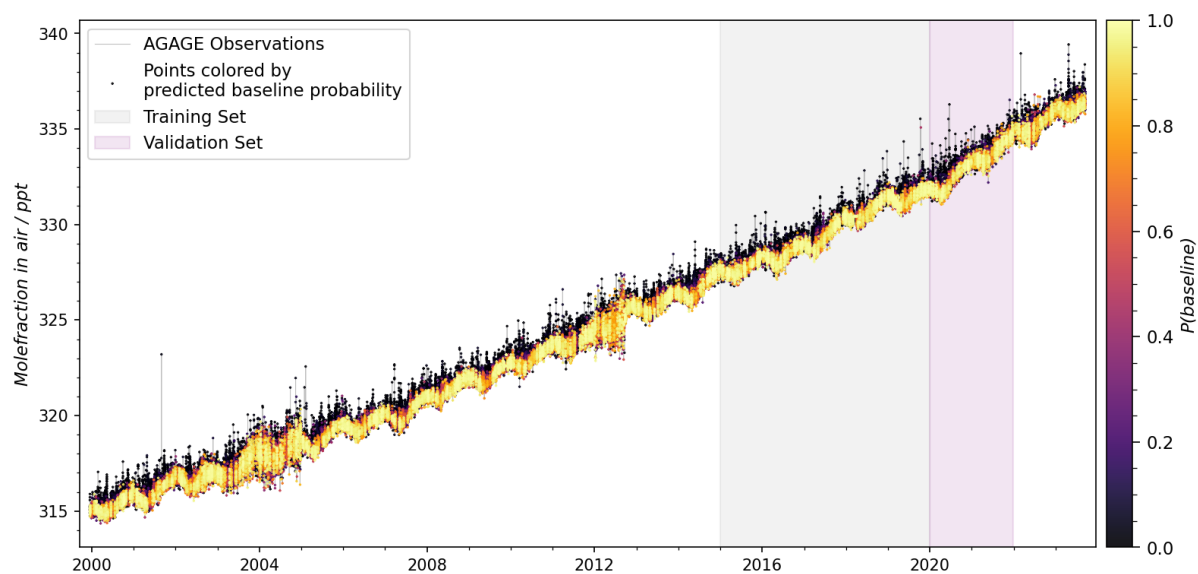


N₂O

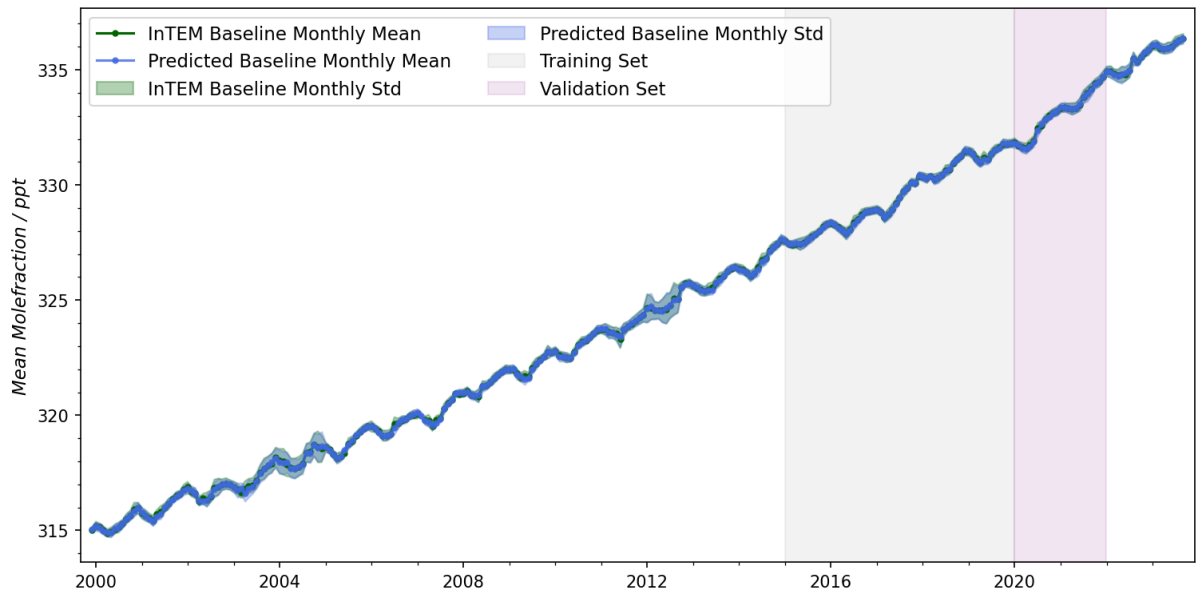
Molefraction time series (N₂O, CGO)



Model Confidence (N₂O, CGO)

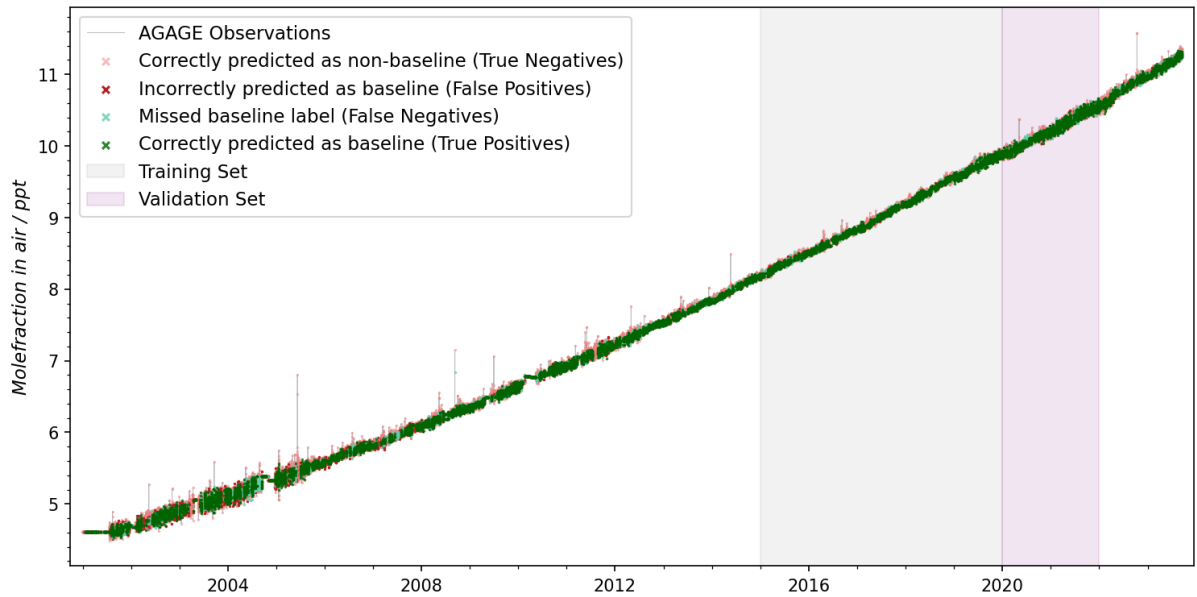


Monthly means (N₂O, CGO)

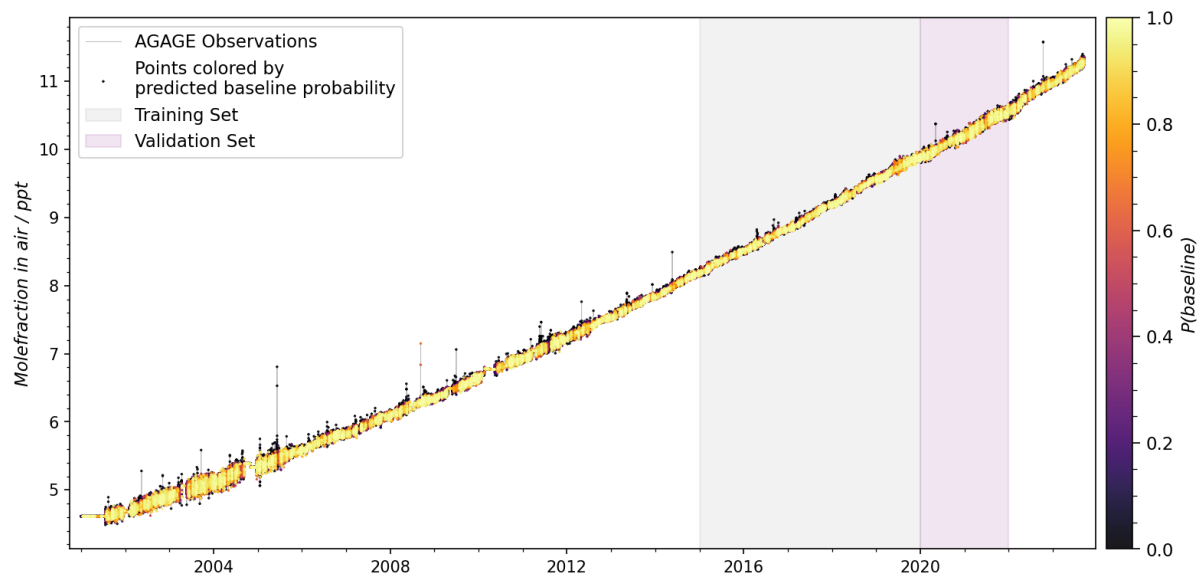


120 SF₆

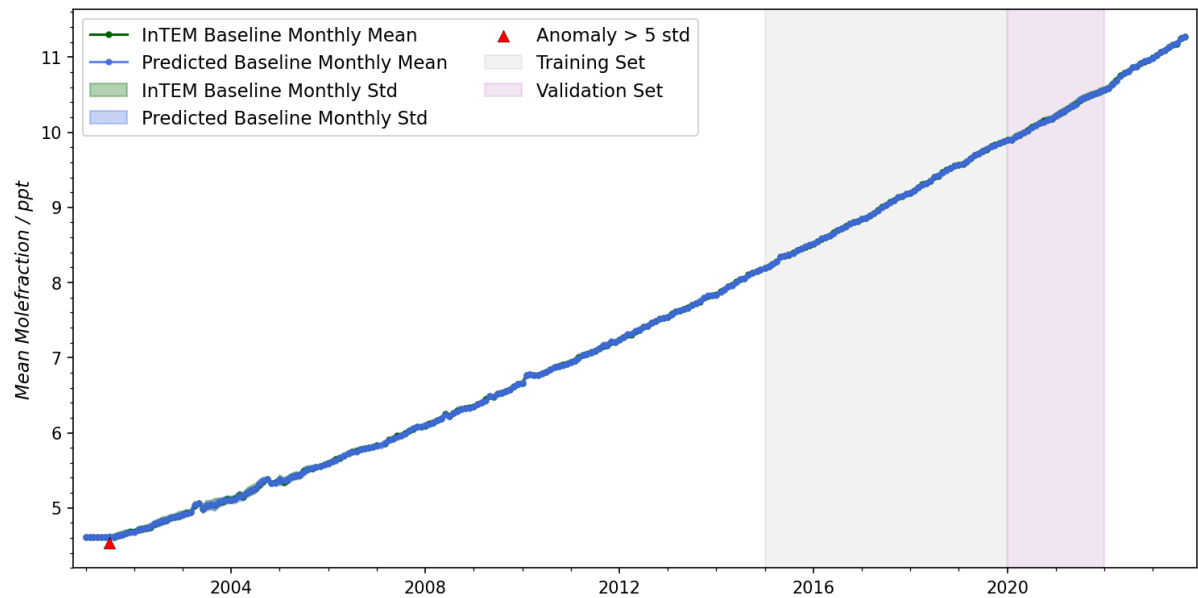
Molefraction time series (SF₆, CGO)



Model Confidence (SF₆, CGO)



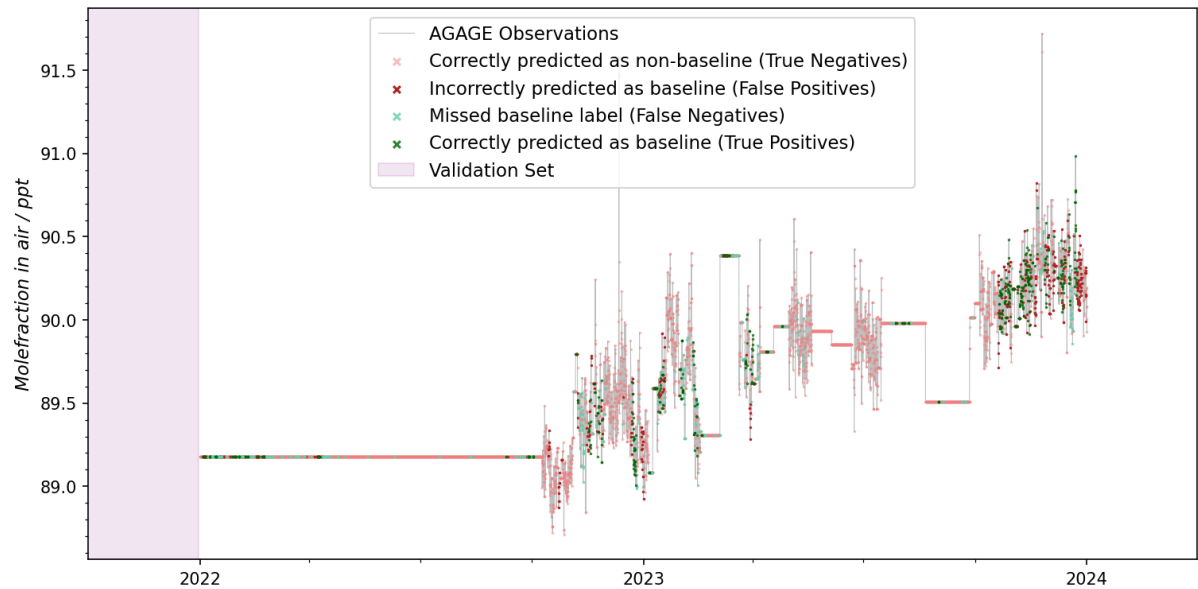
Monthly means (SF₆, CGO)



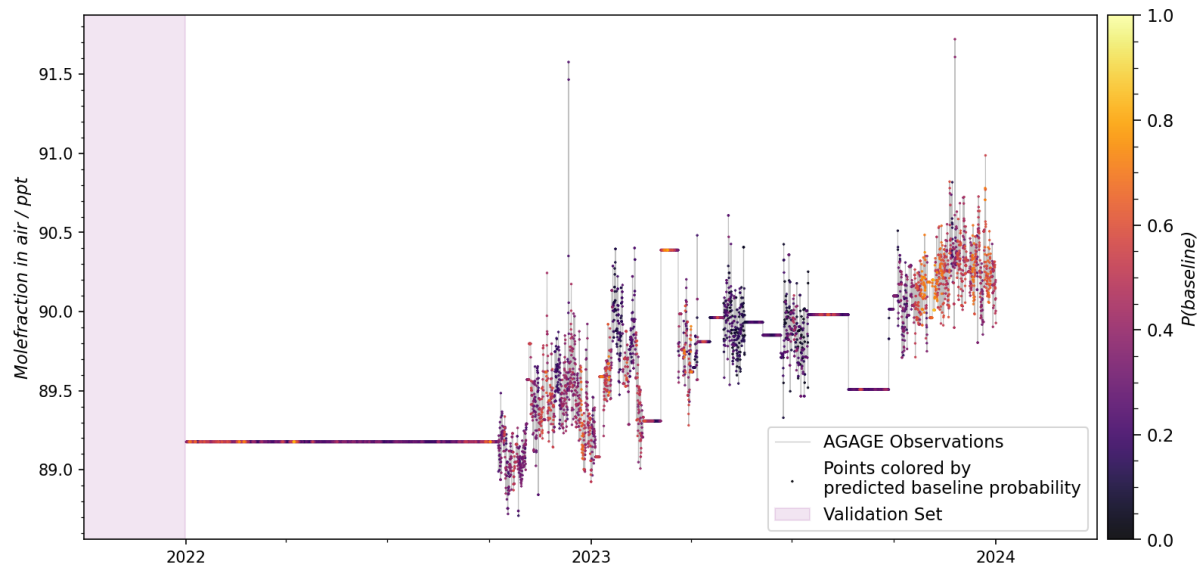
S9.2 Monte Cimone, Italy

125 CF₄

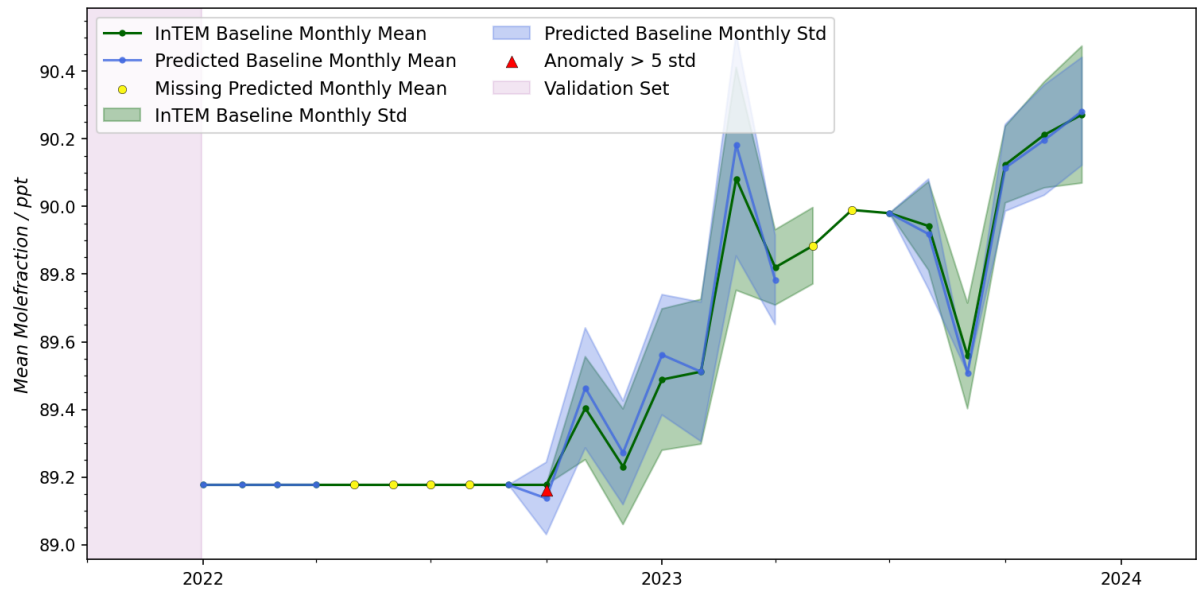
Molefraction time series (CF₄, CMN)



Model Confidence (CF₄, CMN)

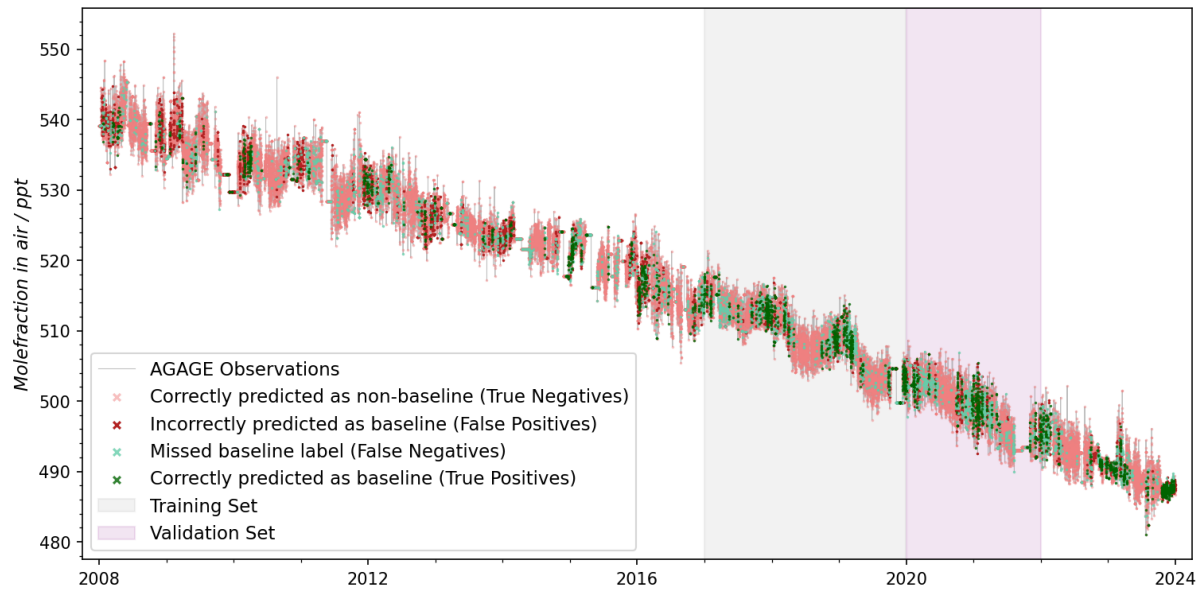


Monthly means (CF₄, CMN)

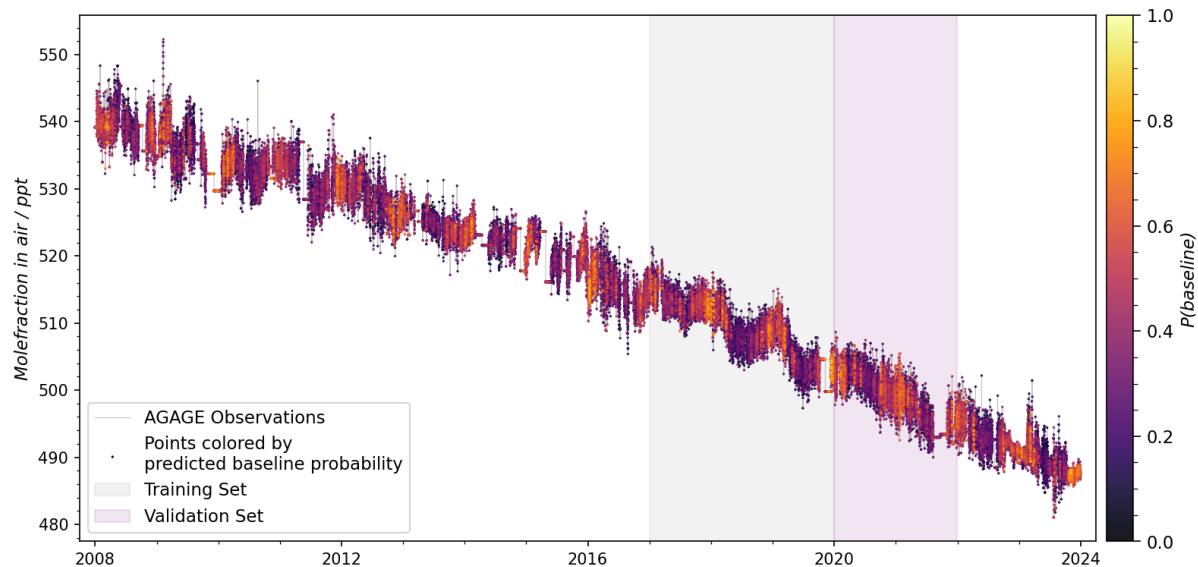


CFC-12

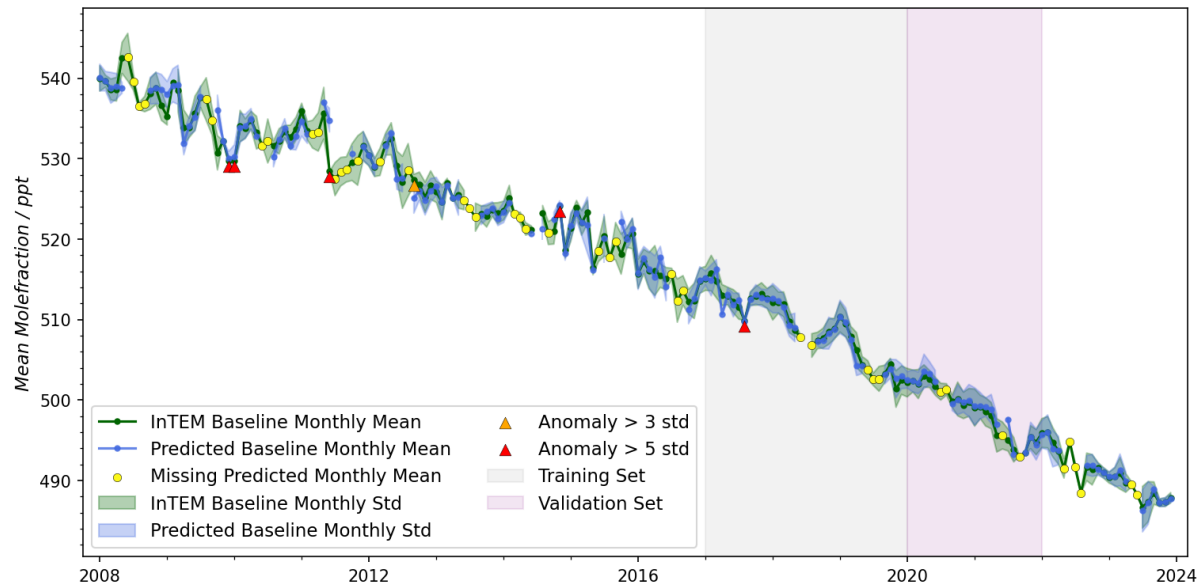
130 Molefraction time series (CFC-12, CMN)



Model Confidence (CFC-12, CMN)

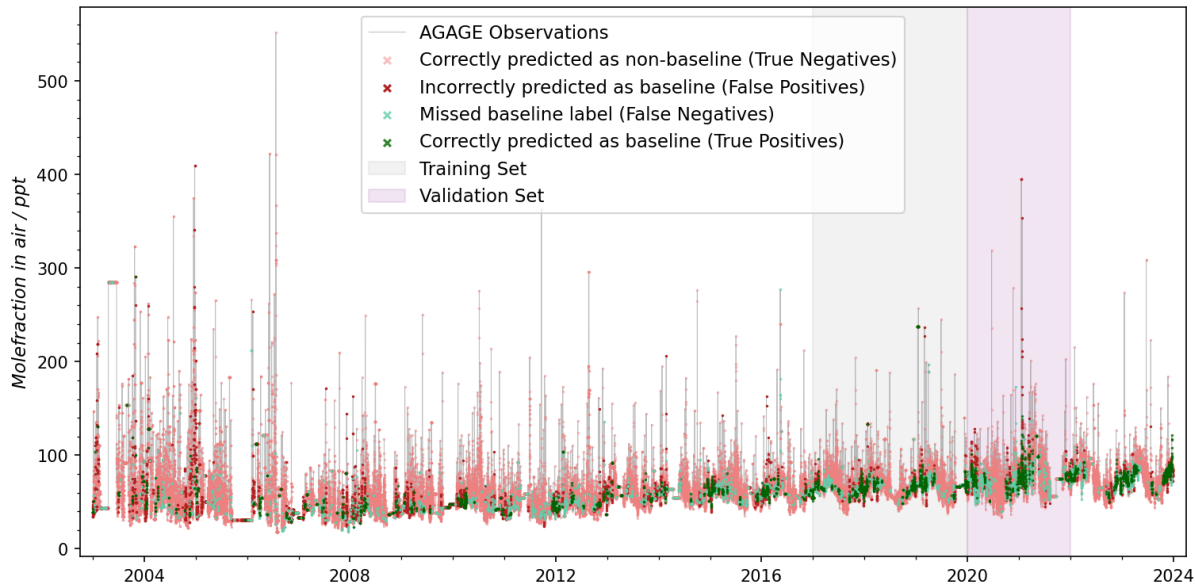


Monthly means (CFC-12, CMN)

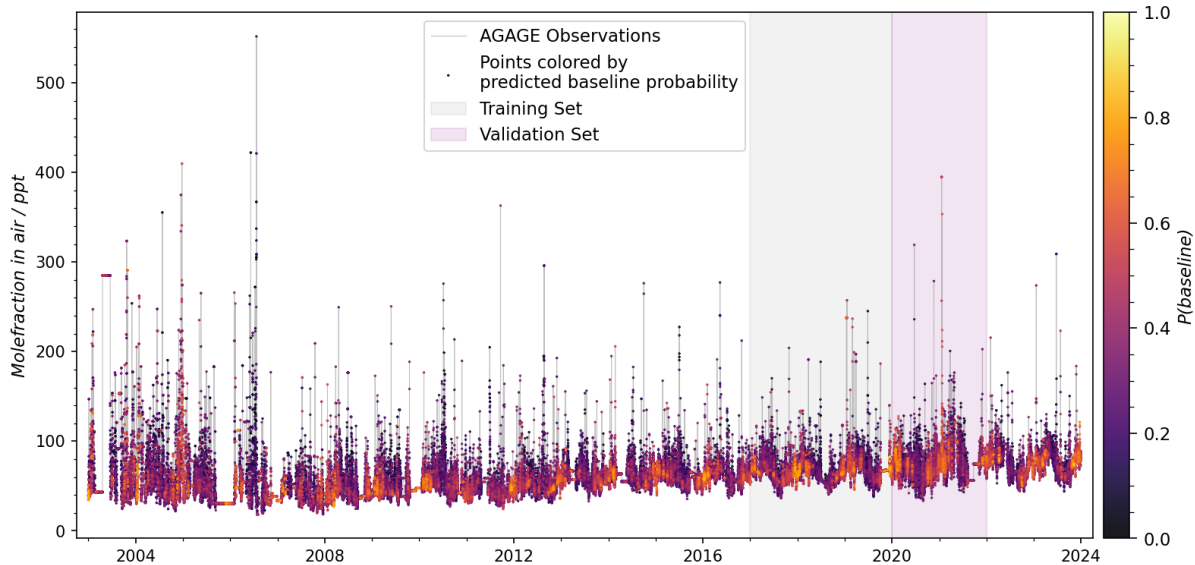


CH₂Cl₂

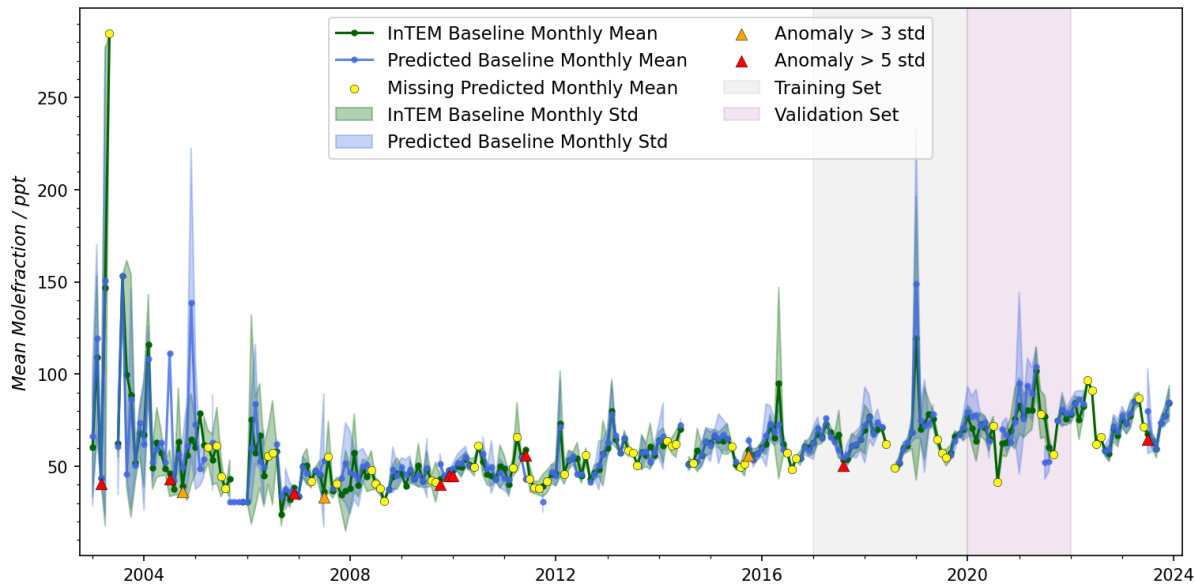
Molefraction time series (CH₂Cl₂, CMN)



135 Model Confidence (CH₂Cl₂, CMN)

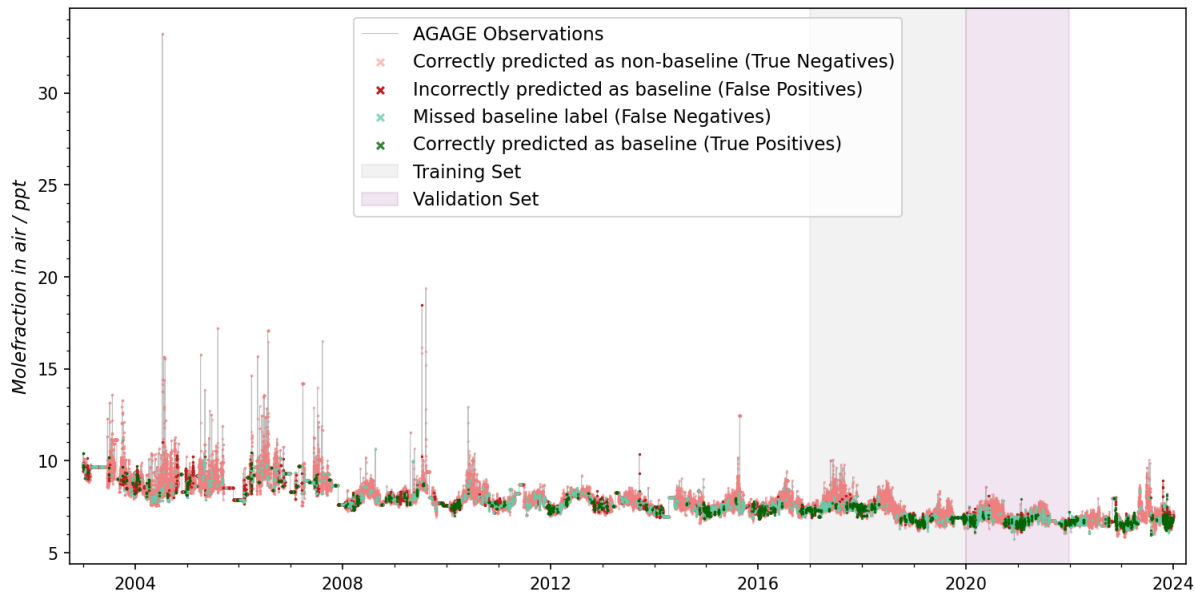


Monthly means (CH₂Cl₂, CMN)

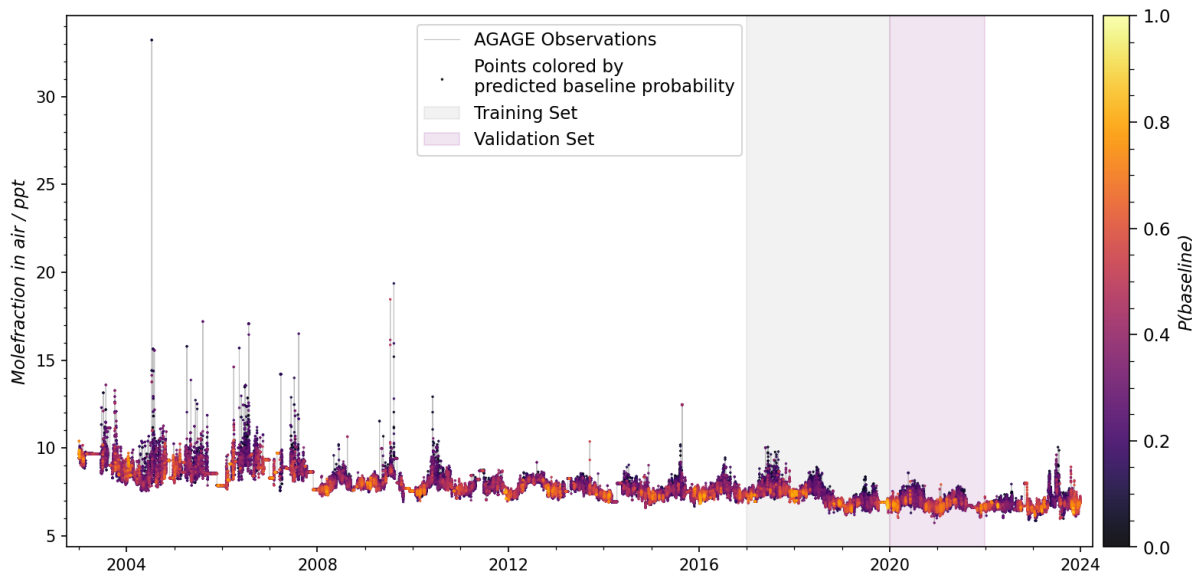


CH₃Br

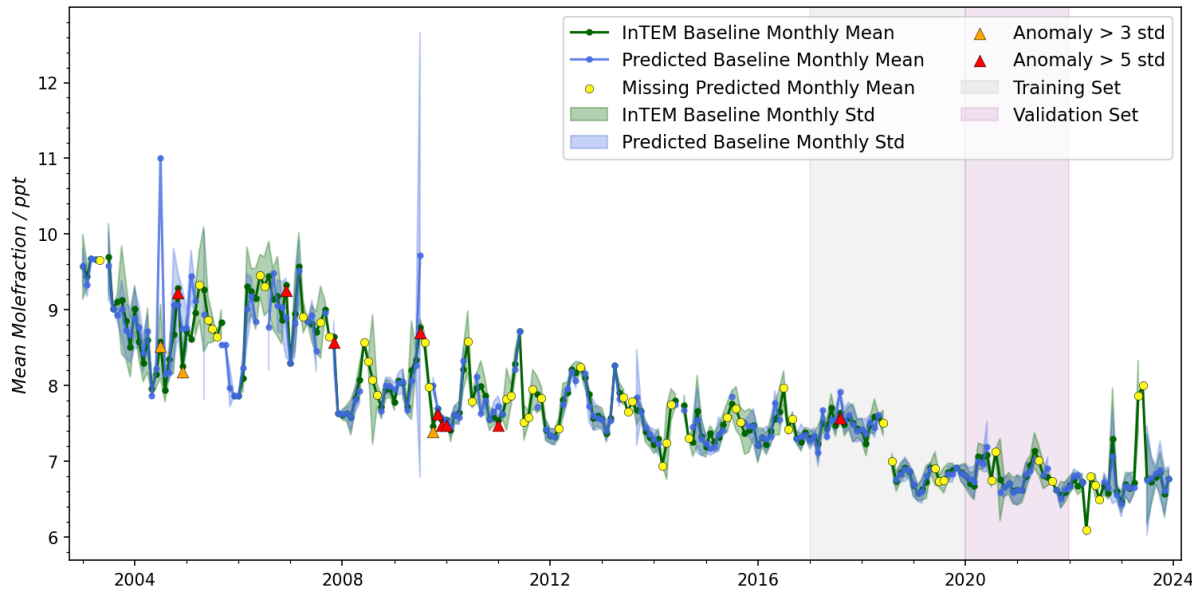
Molefraction time series (CH₃Br, CMN)



Model Confidence (CH₃Br, CMN)

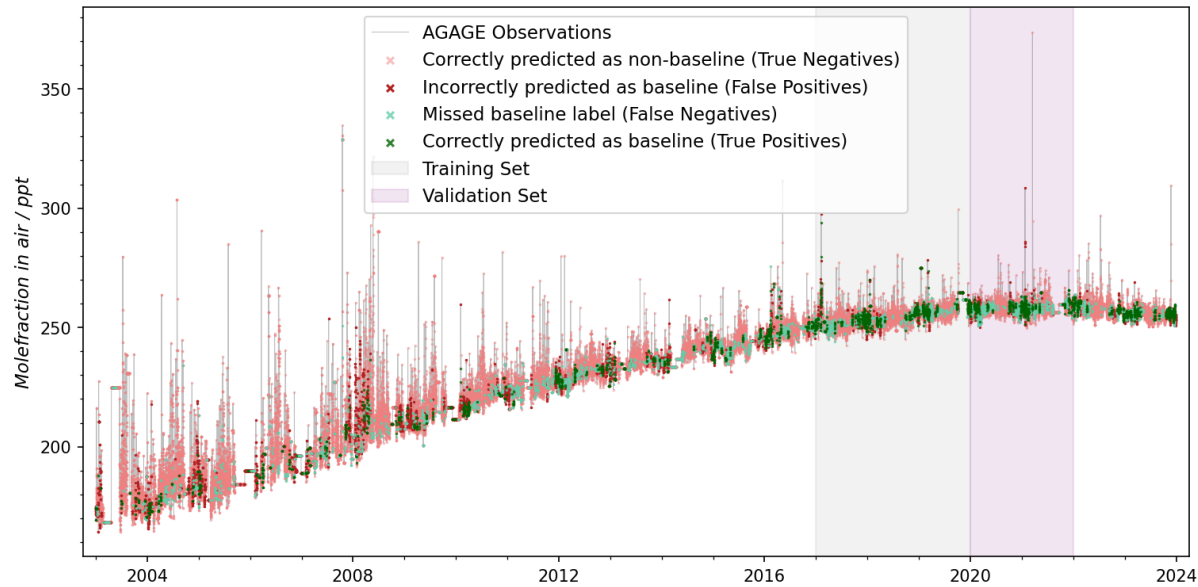


140 Monthly means (CH₃Br, CMN)

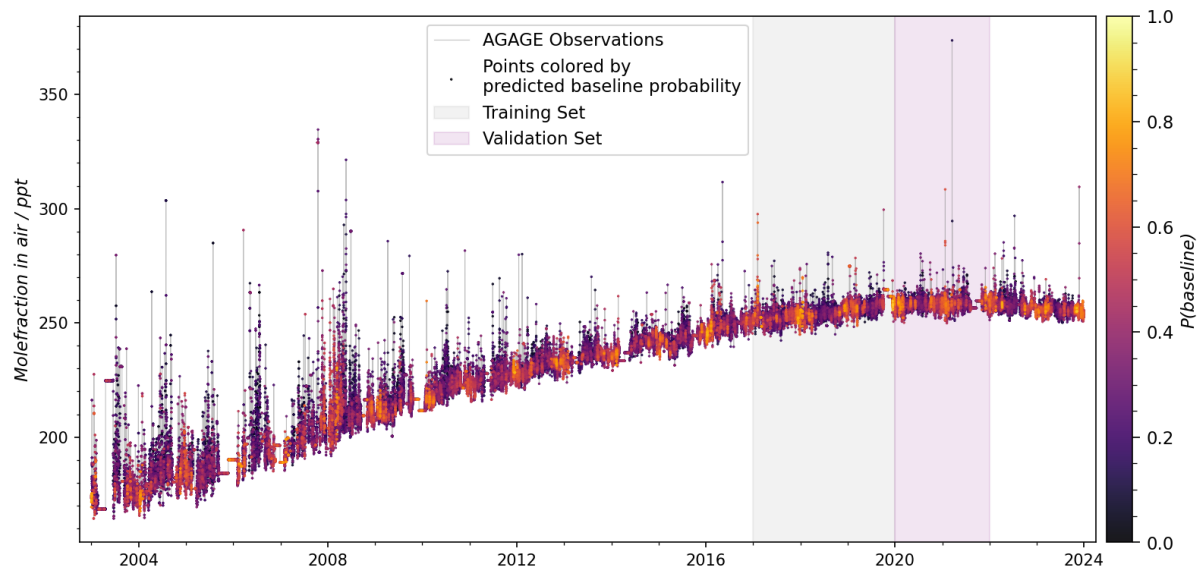


HCFC-22

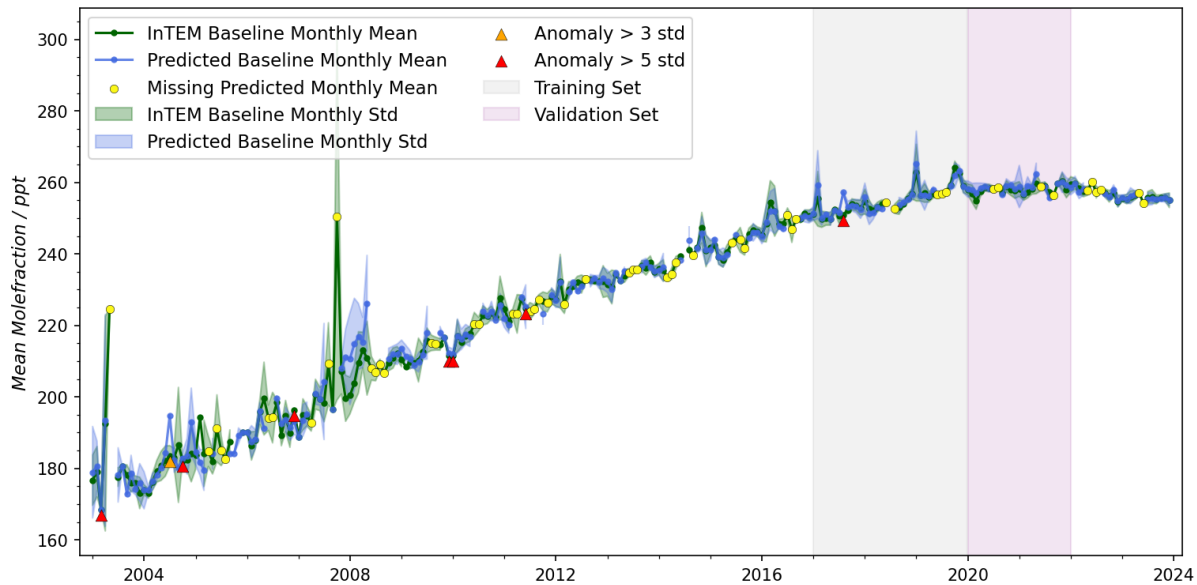
Molefraction time series (HCFC-22, CMN)



Model Confidence (HCFC-22, CMN)

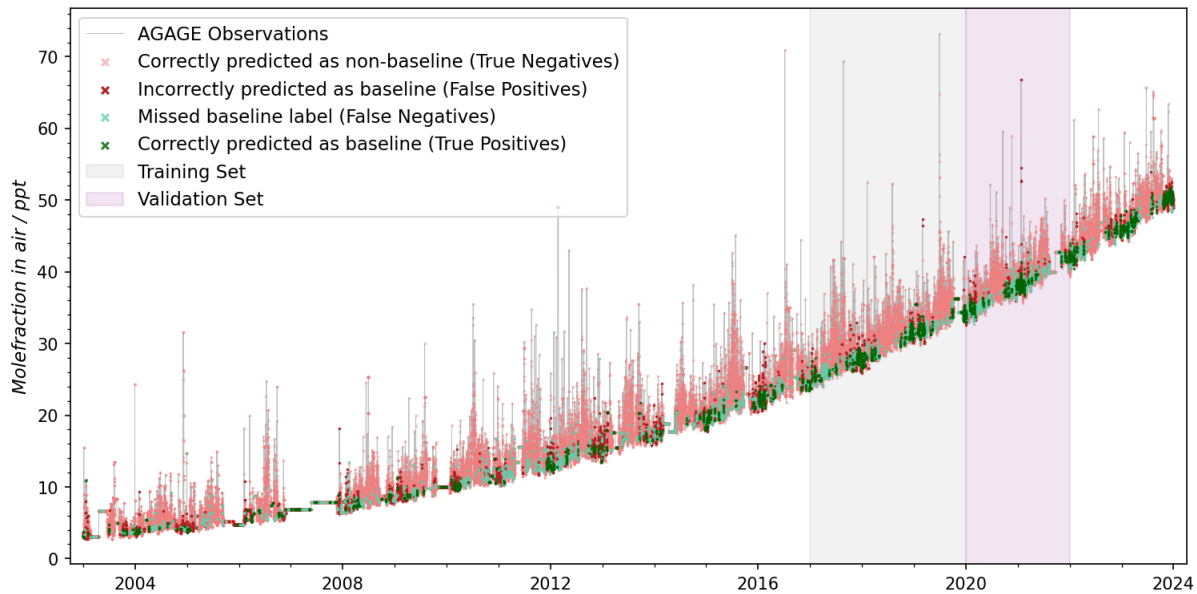


Monthly means (HCFC-22, CMN)

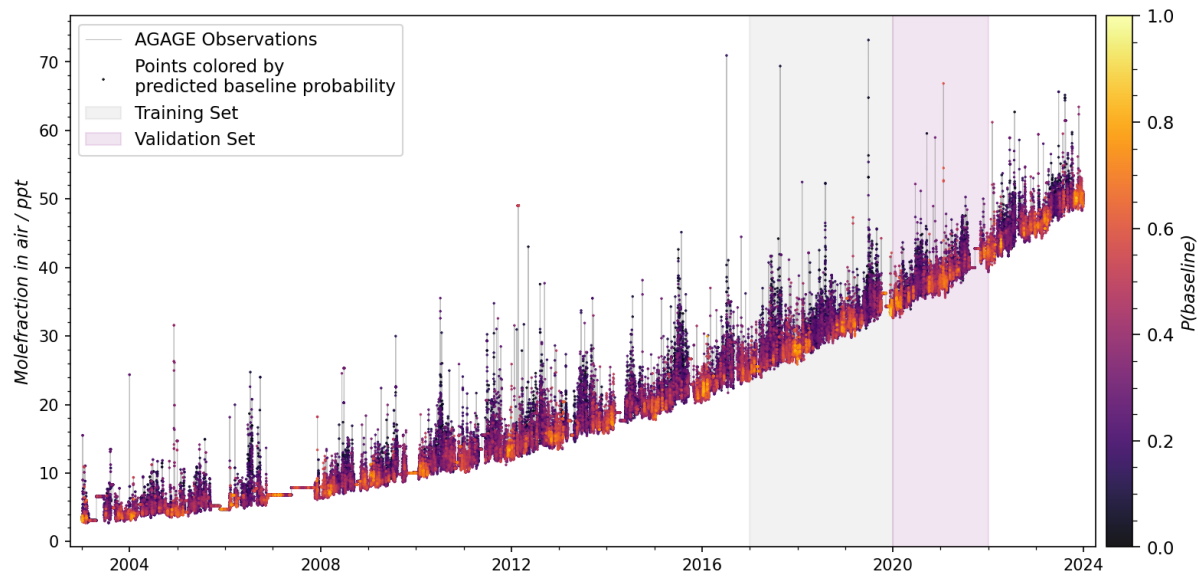


145 HFC-125

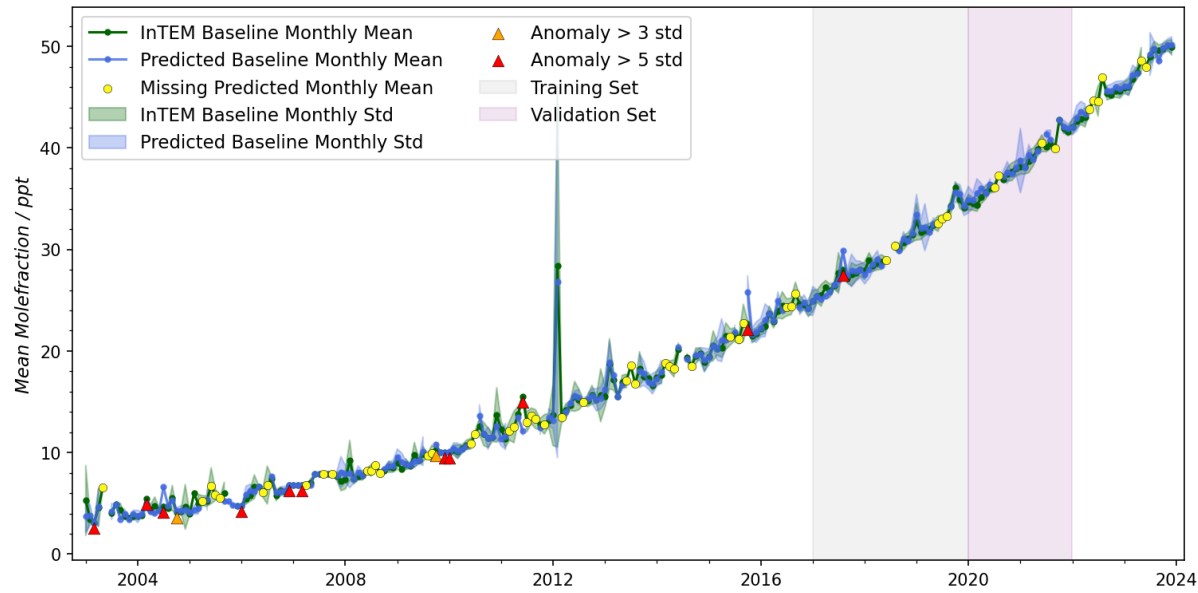
Molefraction time series (HFC-125, CMN)



Model Confidence (HFC-125, CMN)

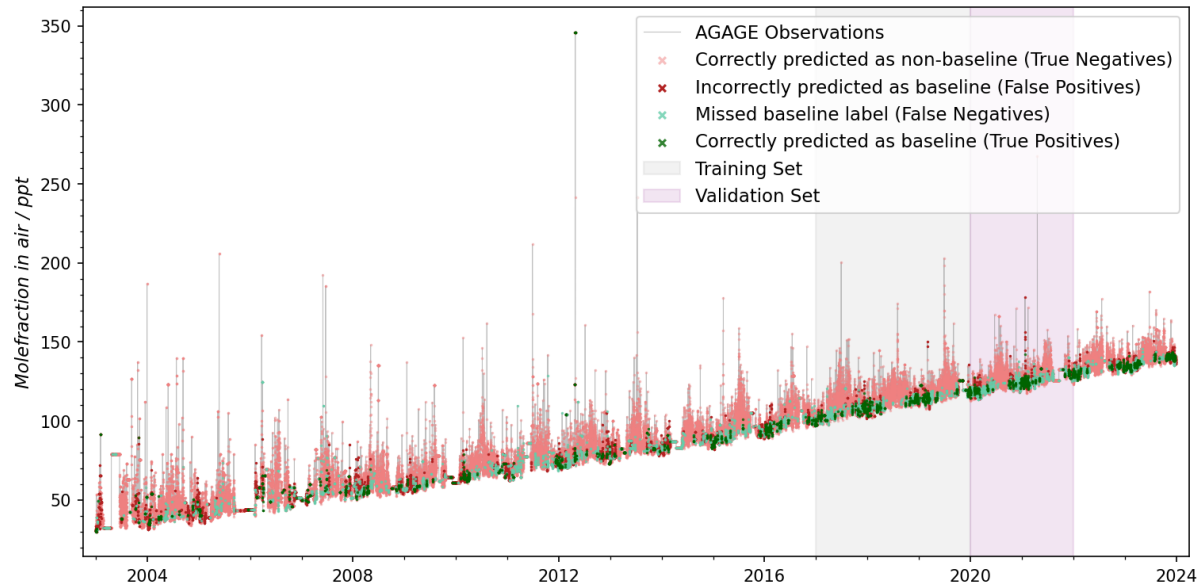


Monthly means (HFC-125, CMN)

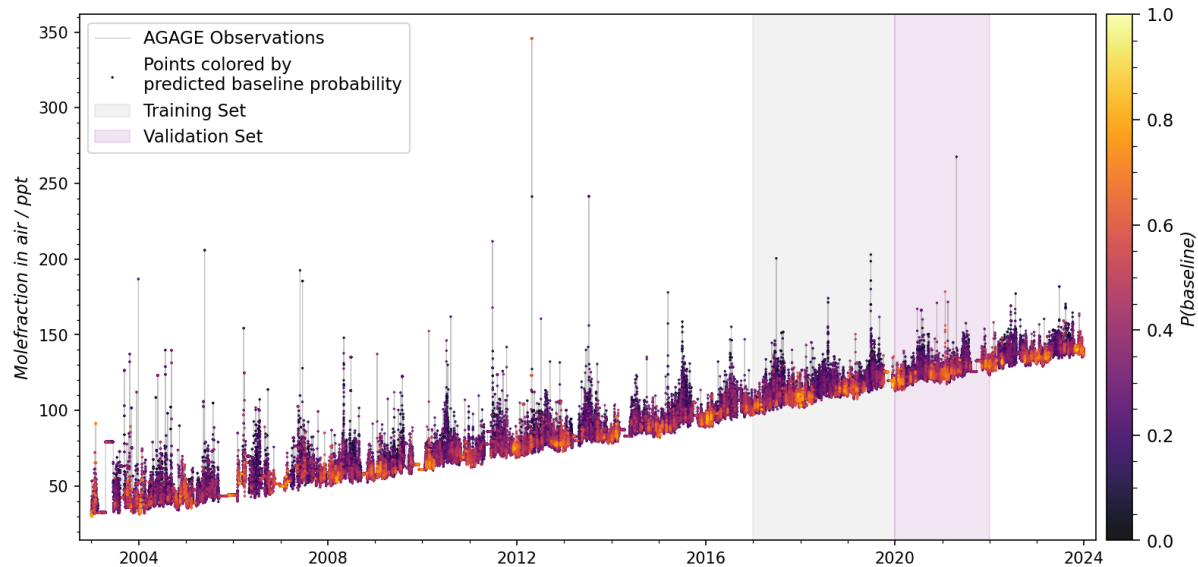


HFC-134a

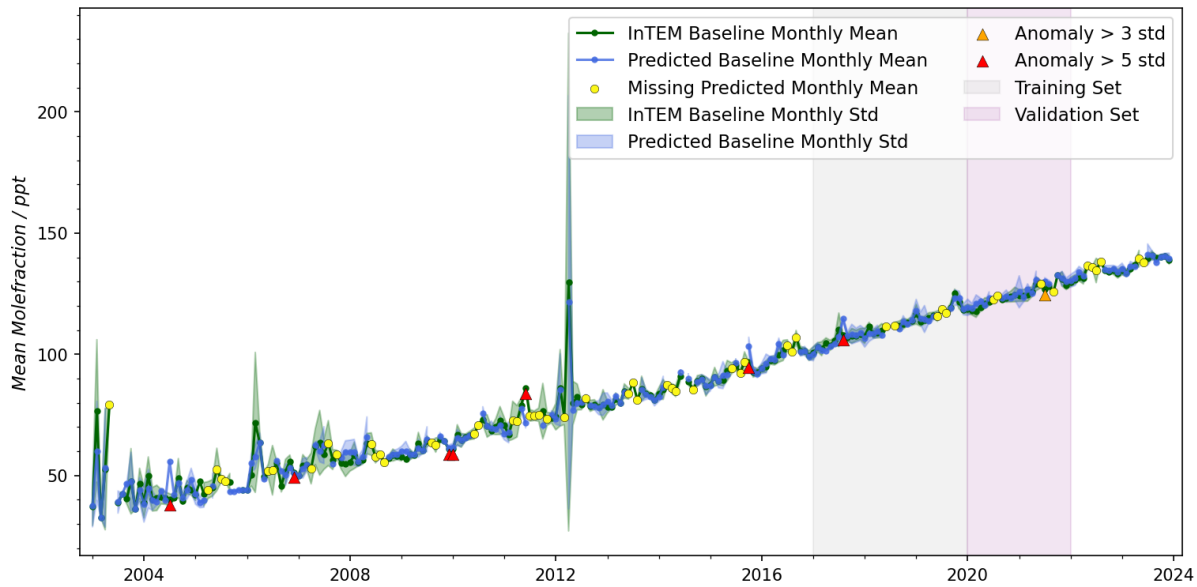
150 Molefraction time series (HFC-134a, CMN)



Model Confidence (HFC-134a, CMN)

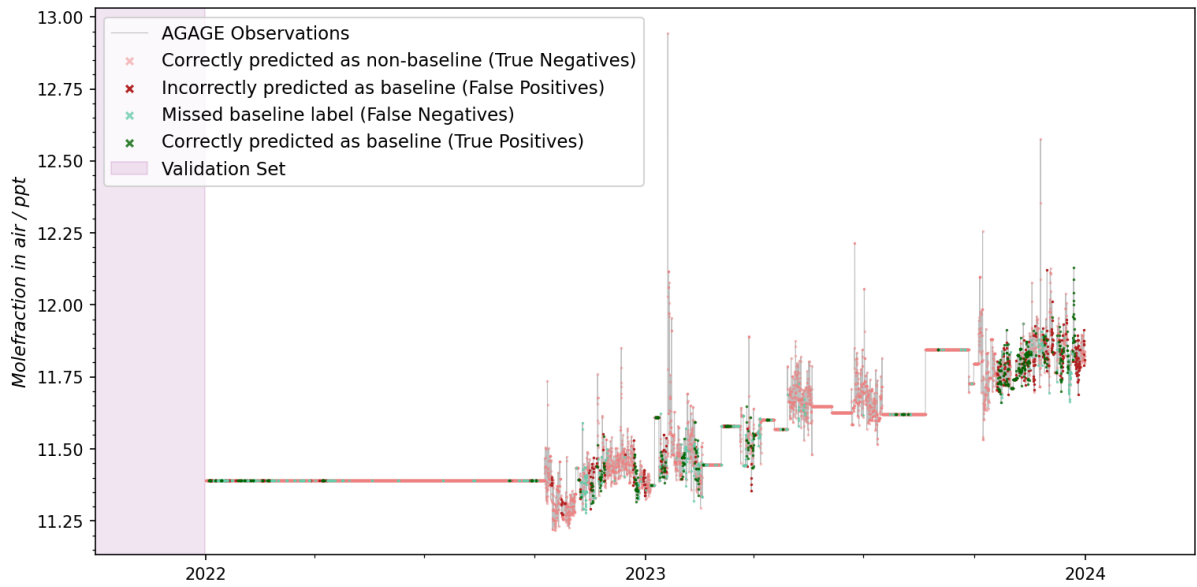


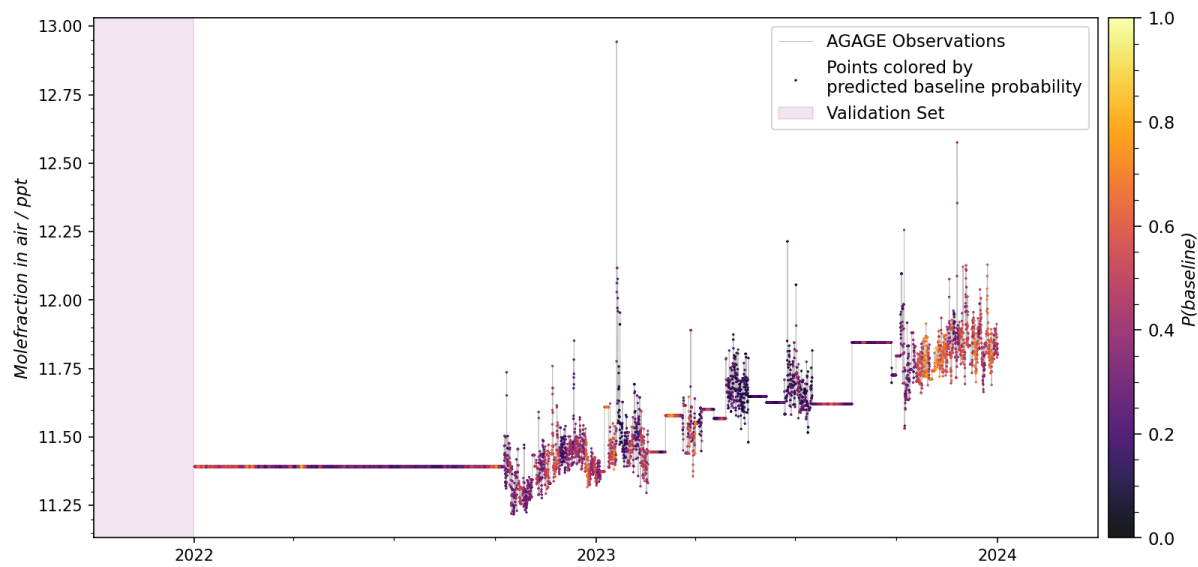
Monthly means (HFC-134a, CMN)



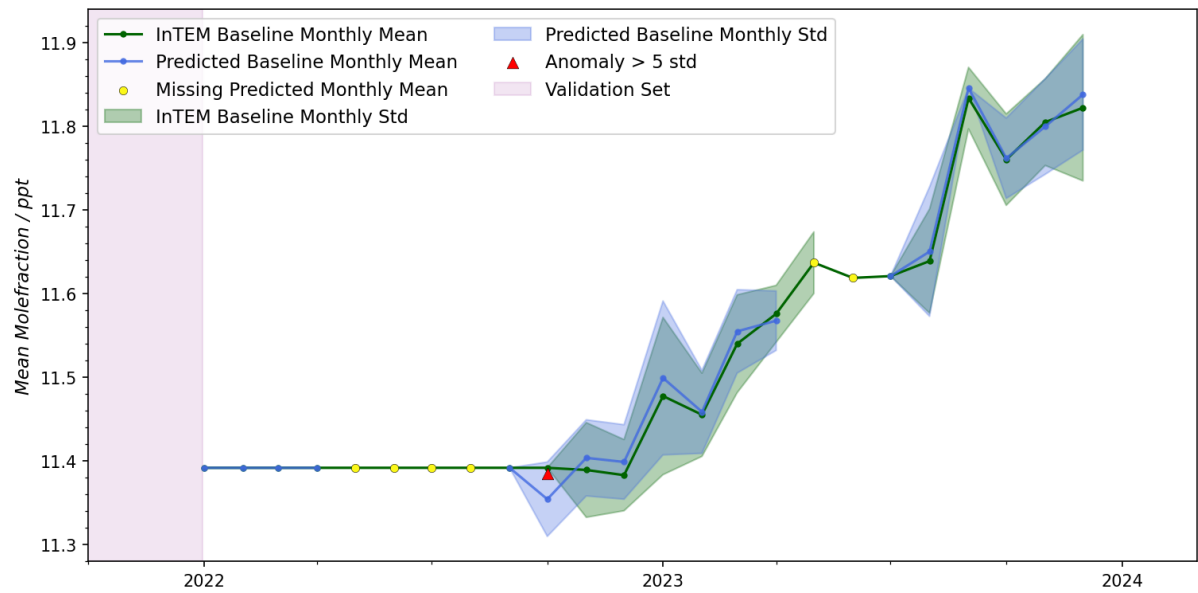
SF₆

Molefraction time series (SF₆, CMN)





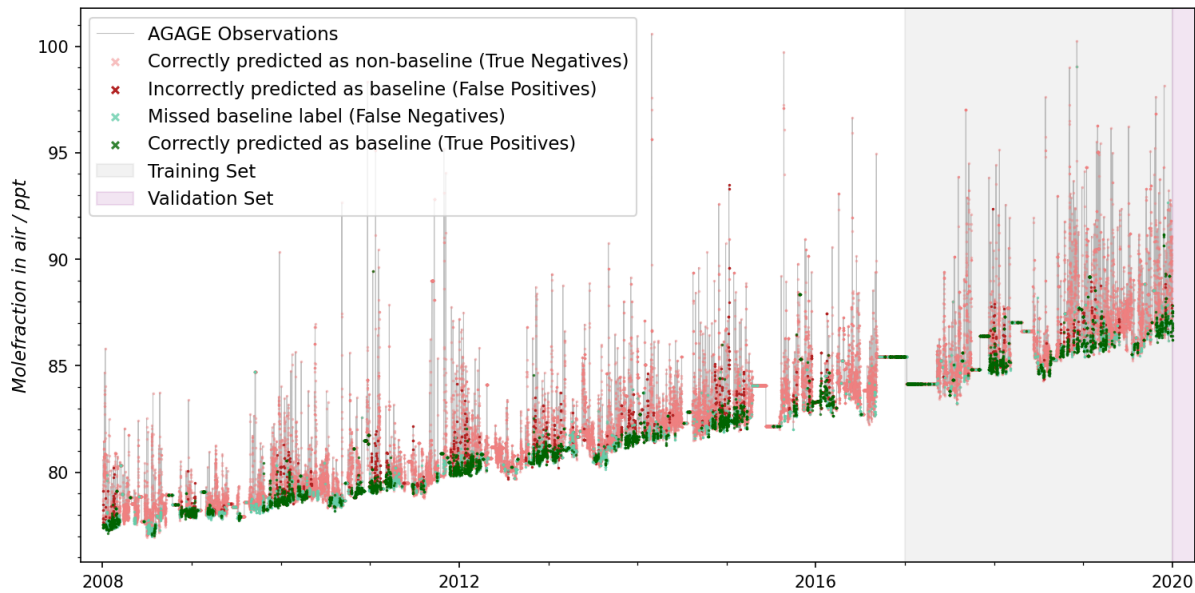
Monthly means (SF₆, CMN)



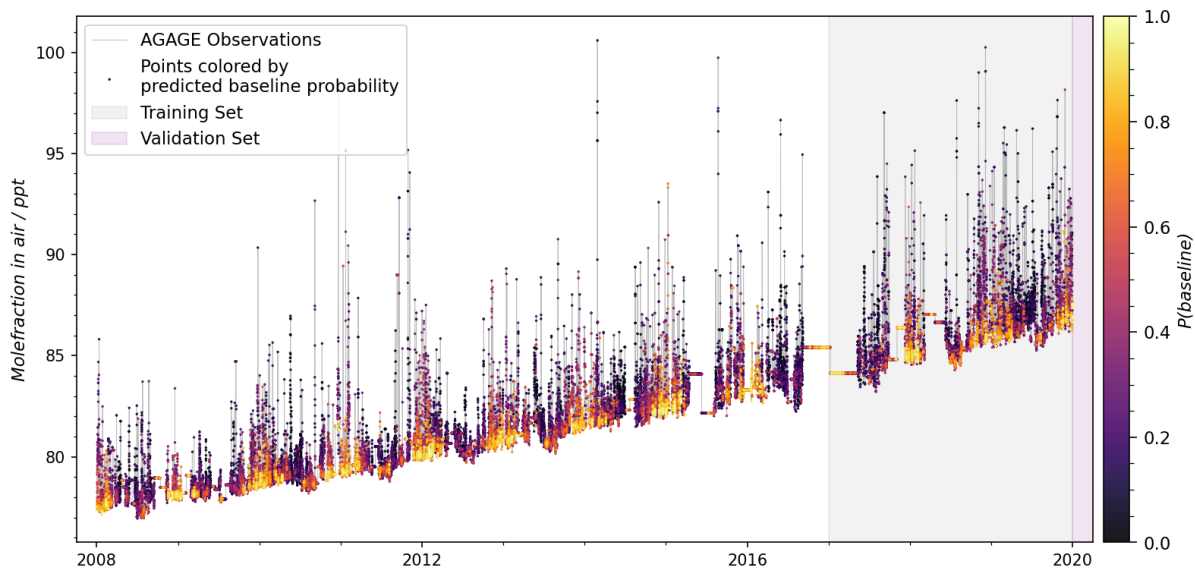
S9.3 Gosan, South Korea

CF₄

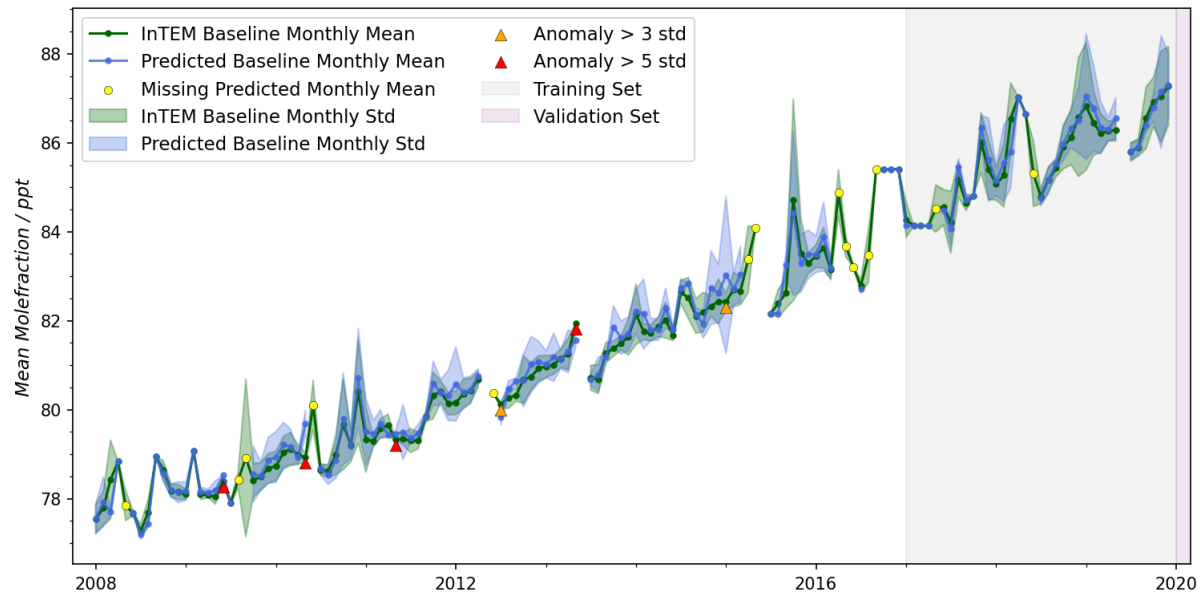
Molefraction time series (CF₄, GSN)



160 Model Confidence (CF₄, GSN)

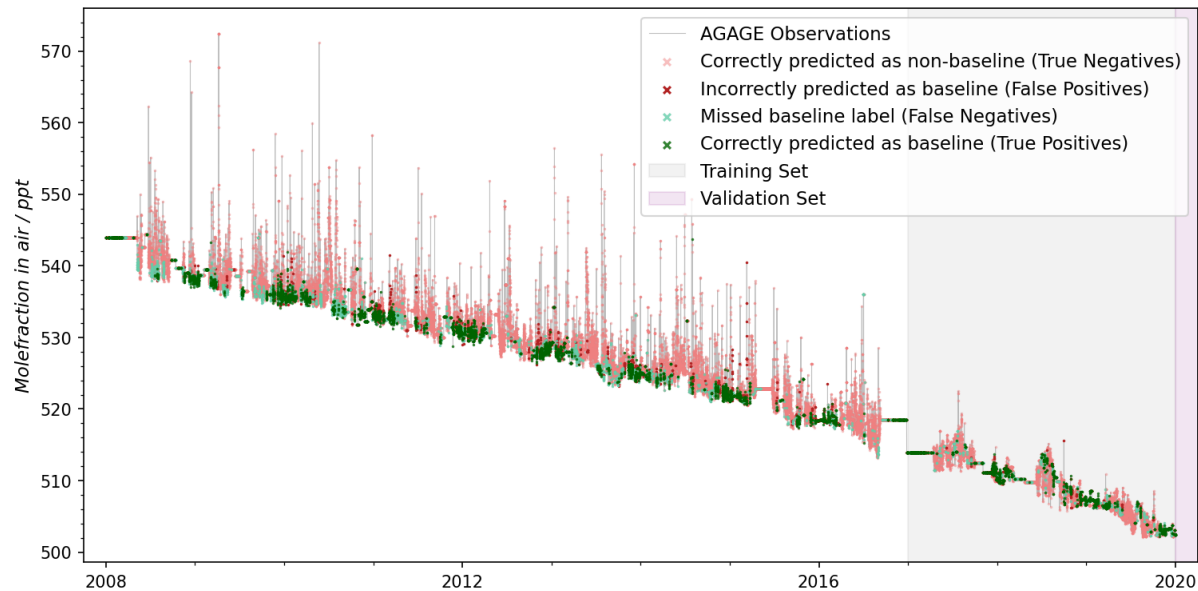


Monthly means (CF₄, GSN)

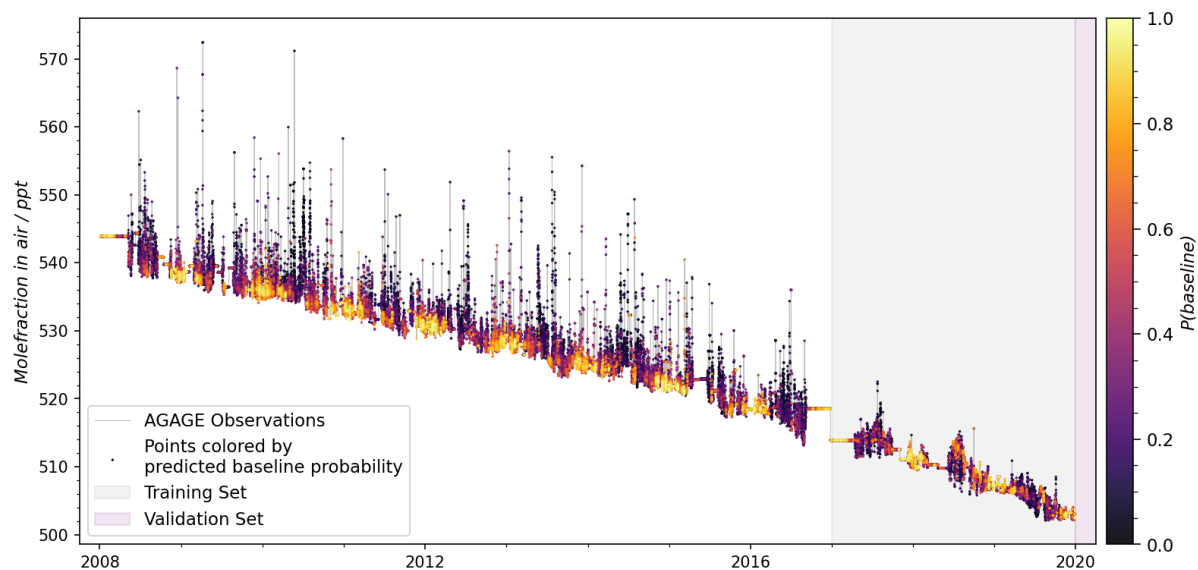


CFC-12

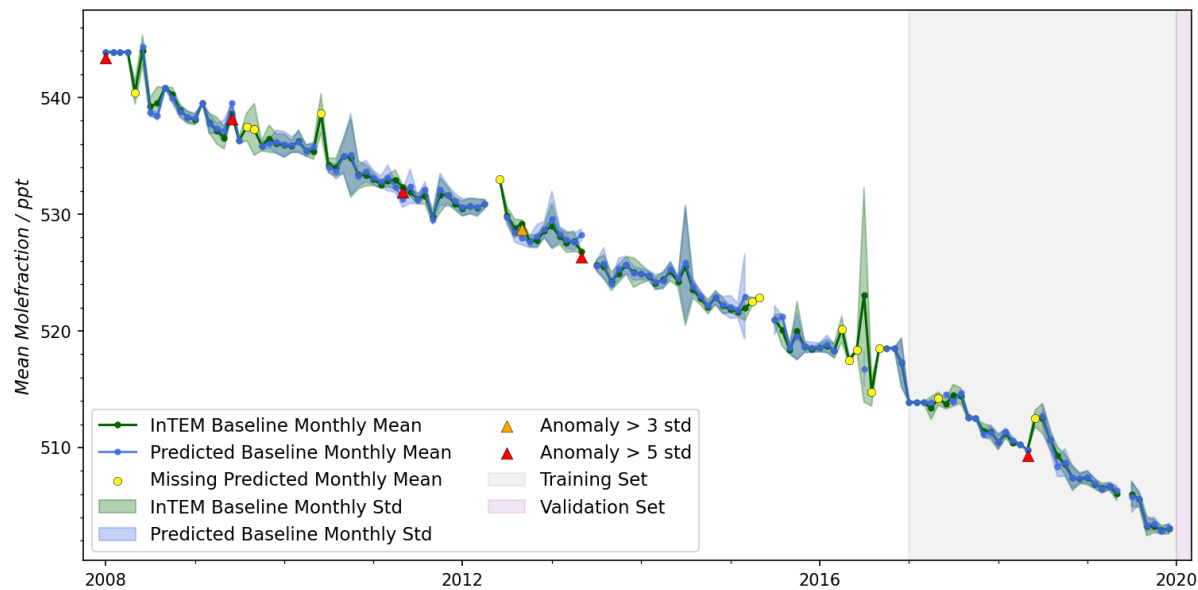
Molefraction time series (CFC-12, GSN)



Model Confidence (CFC-12, GSN)

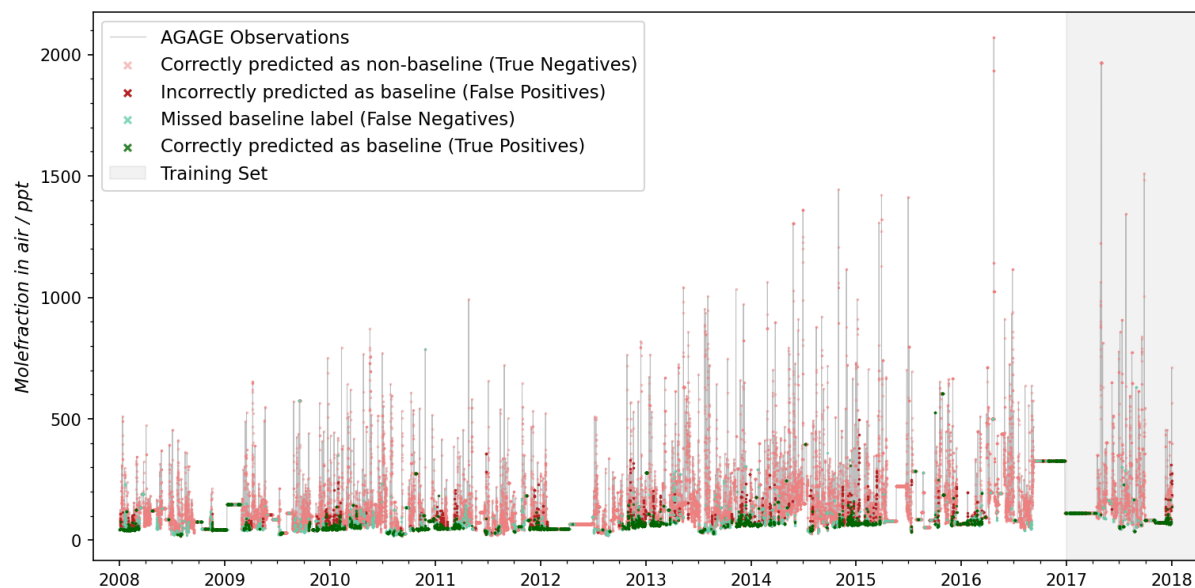


165 Monthly means (CFC-12, GSN)

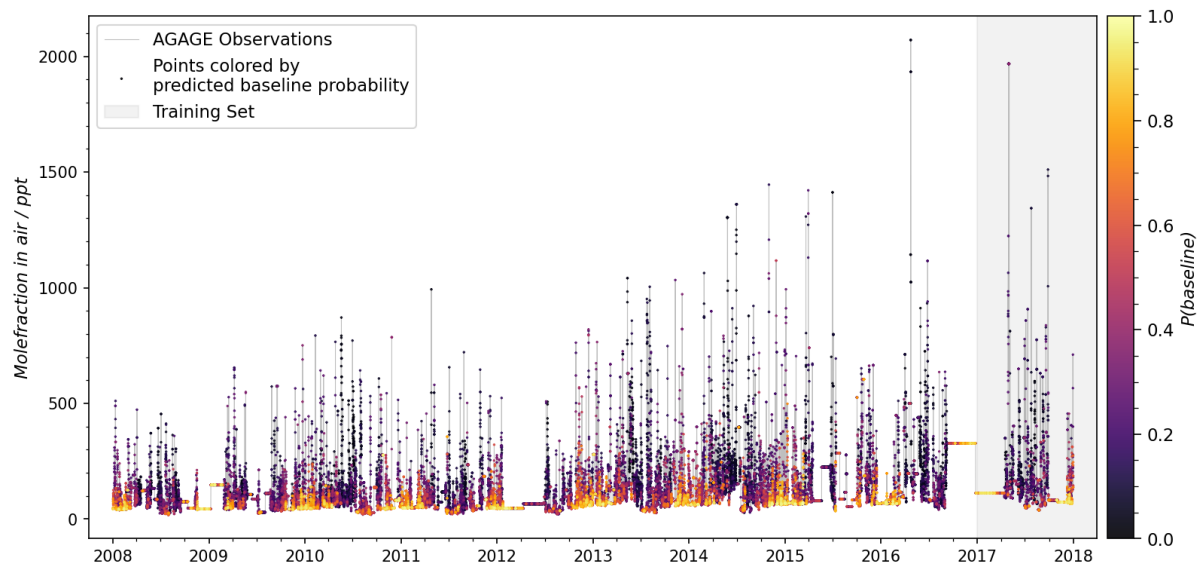




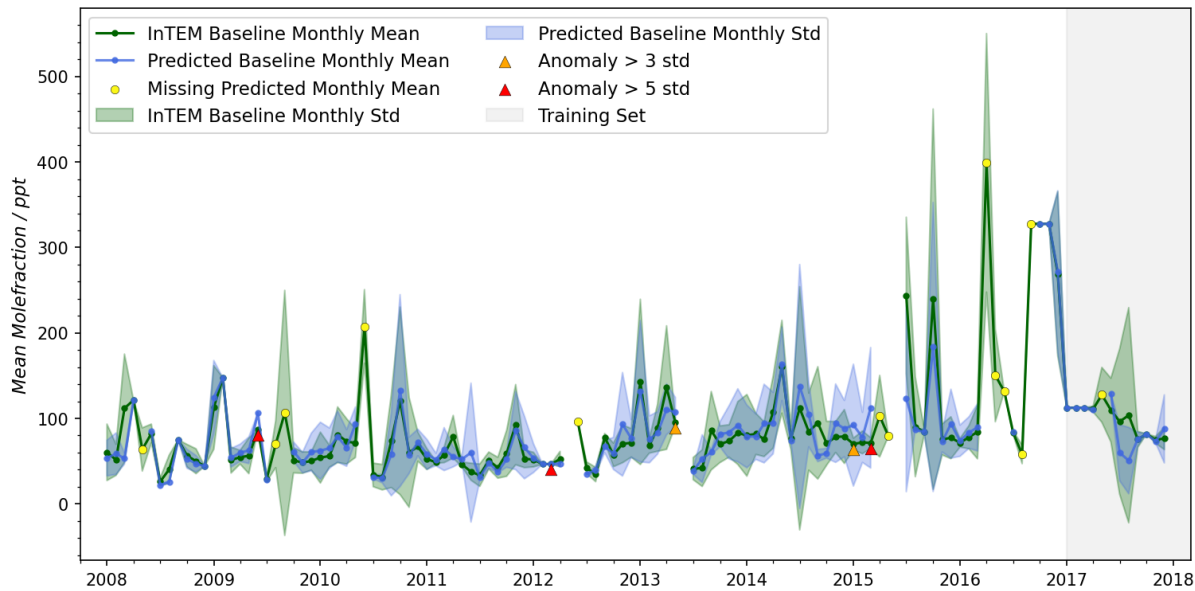
Molefraction time series (CH_2Cl_2 , GSN)



Model Confidence (CH_2Cl_2 , GSN)

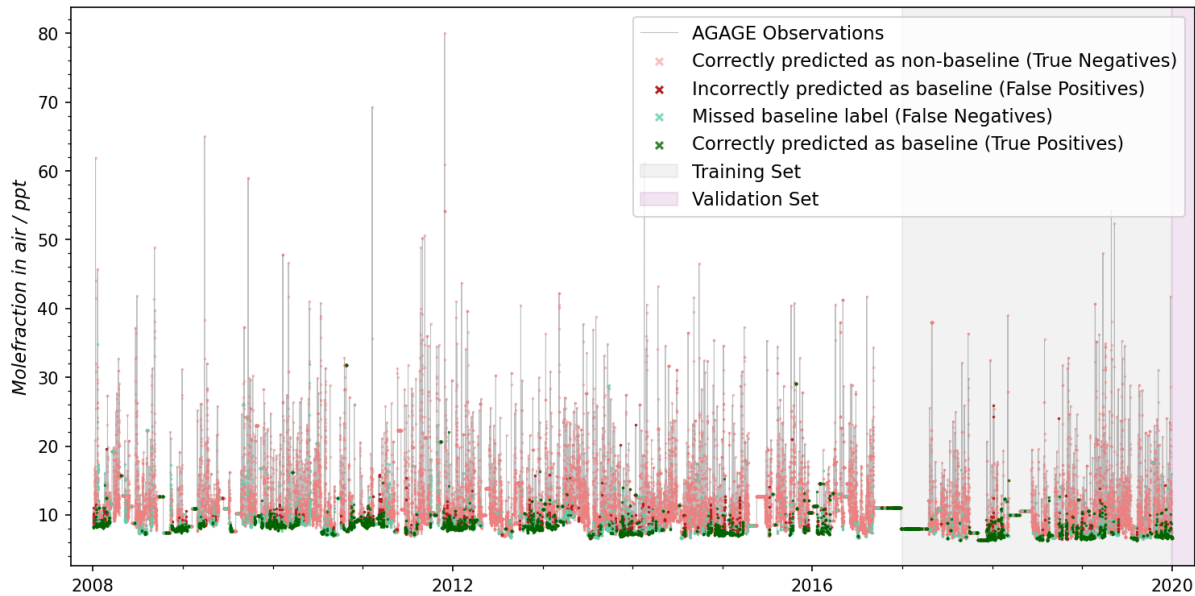


Monthly means (CH₂Cl₂, GSN)

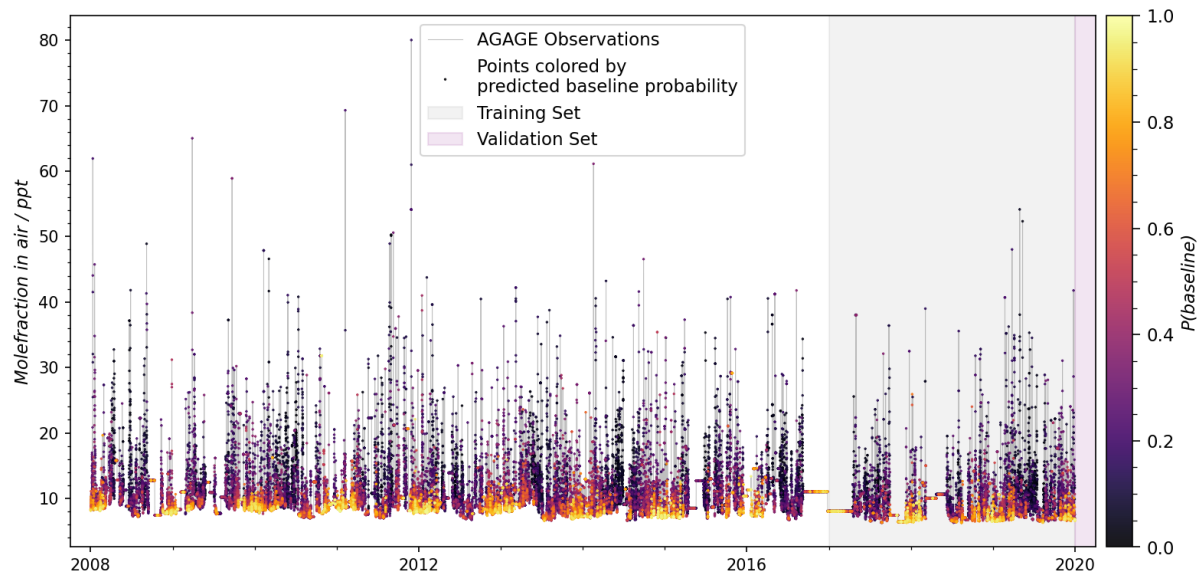


170 CH₃Br

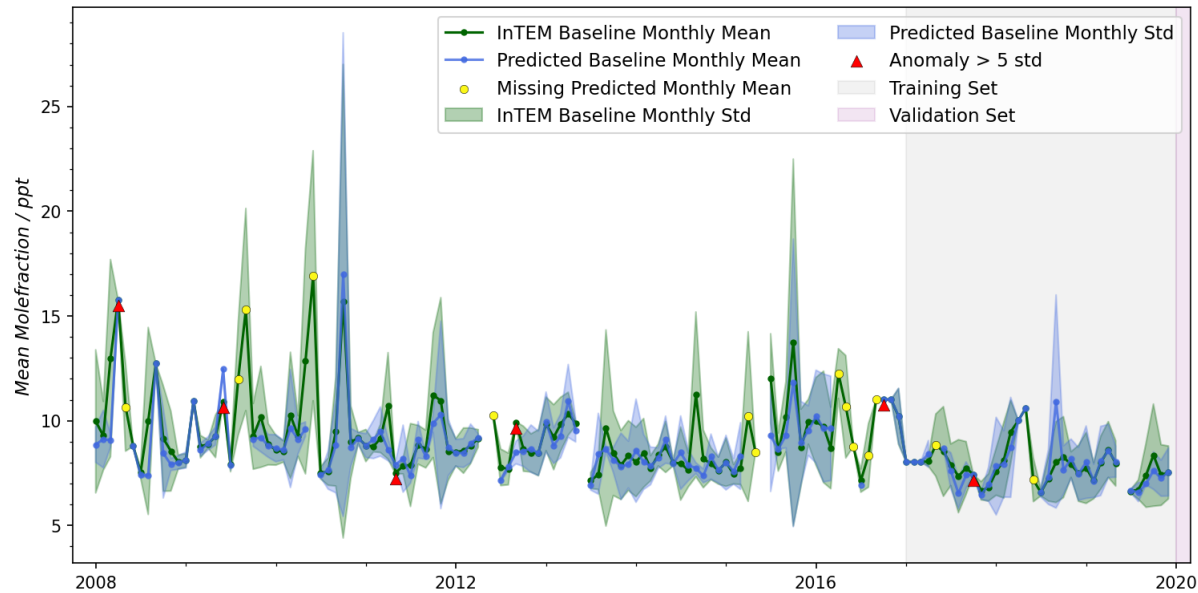
Molefraction time series (CH₃Br, GSN)

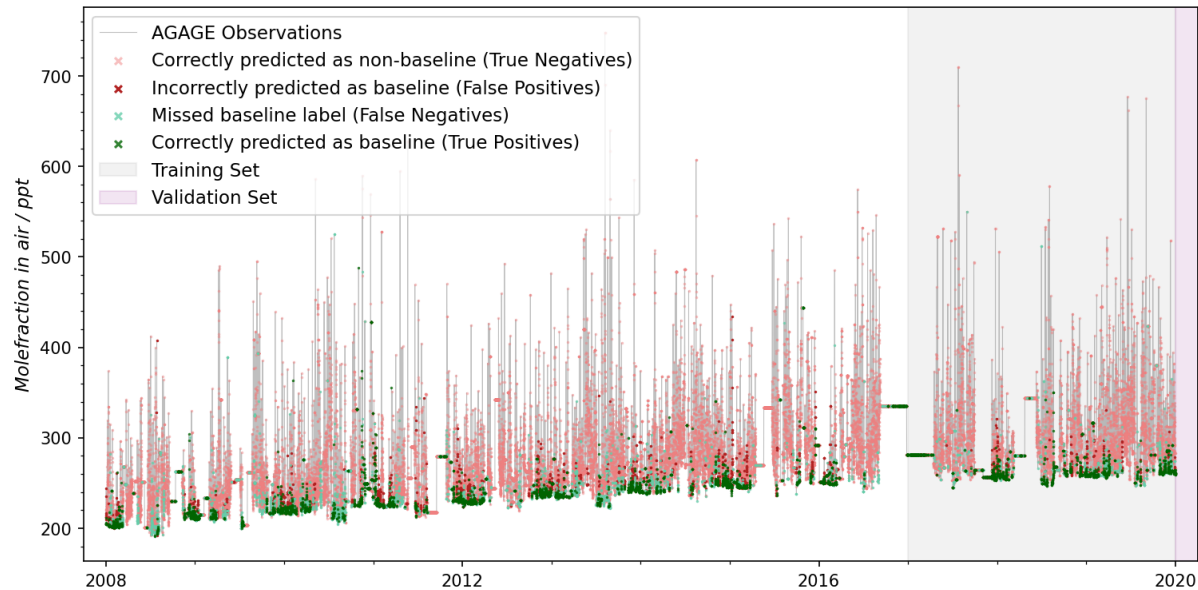


Model Confidence (CH₃Br, GSN)

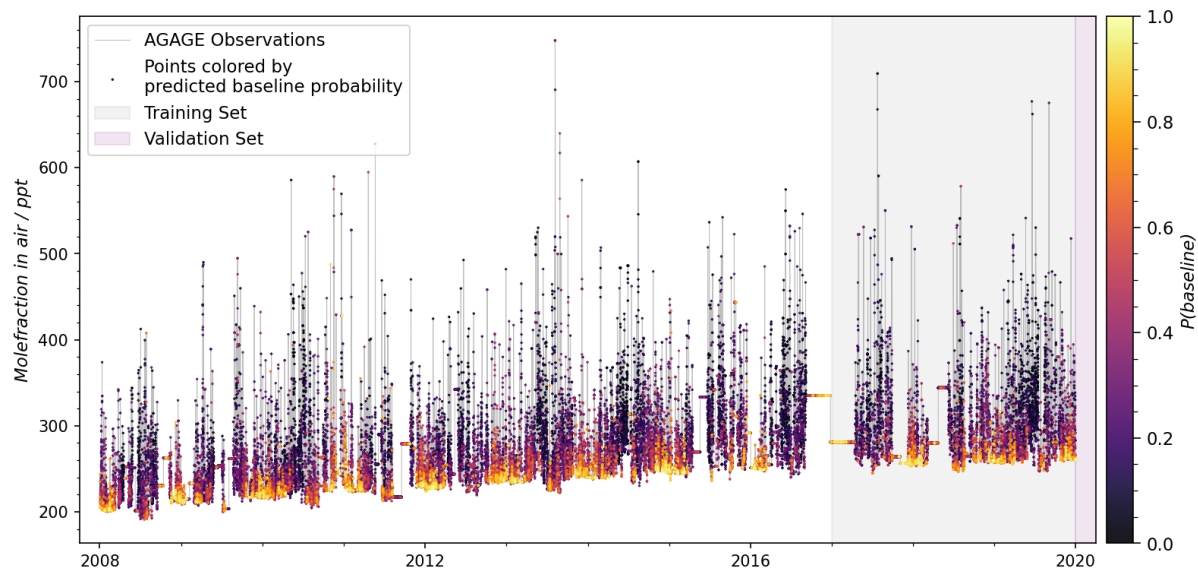


Monthly means (CH₃Br, GSN)

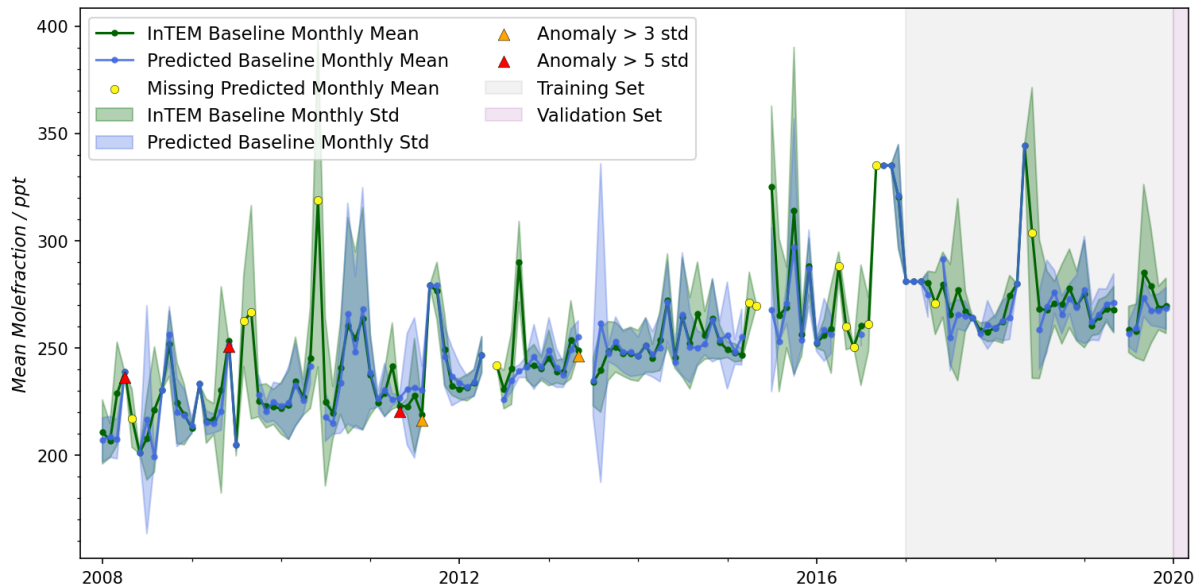




Model Confidence (HCFC-22, GSN)

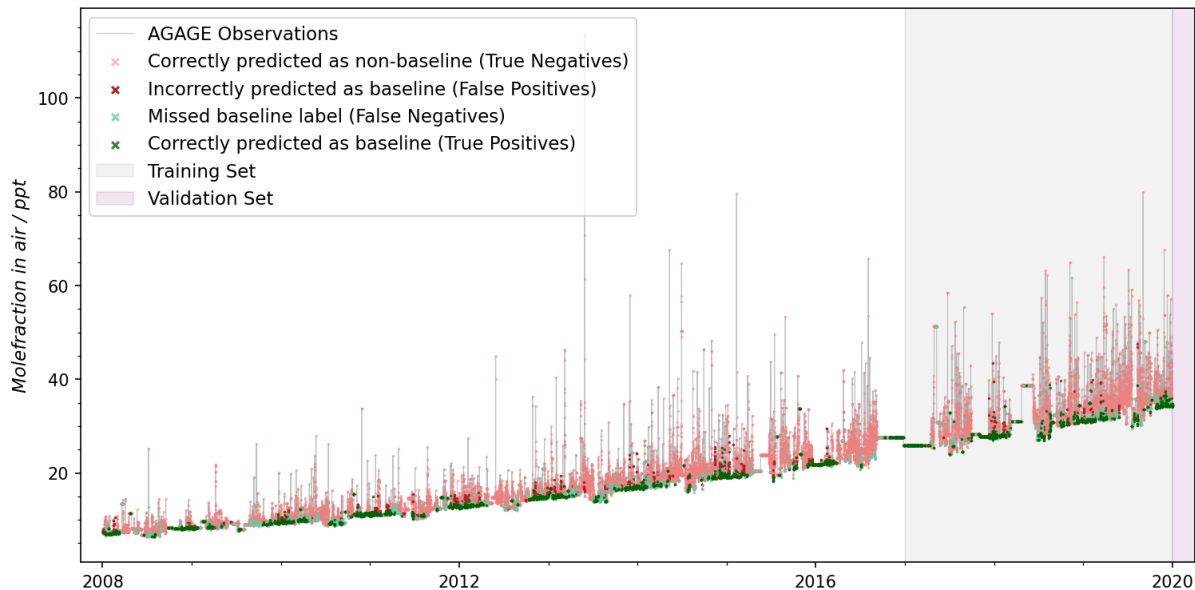


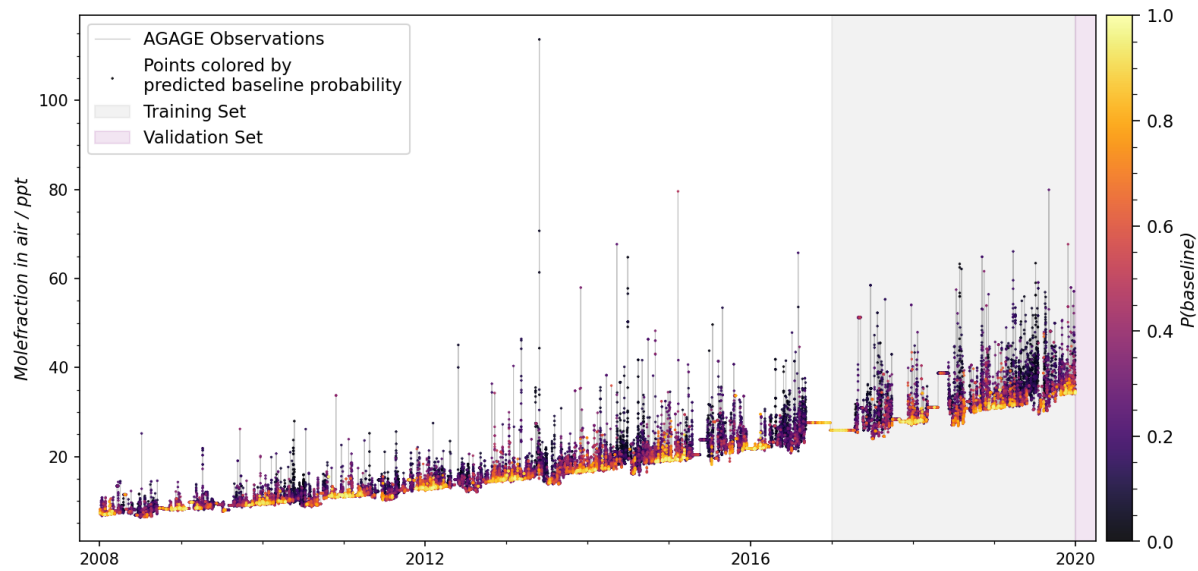
Monthly means (HCFC-22, GSN)



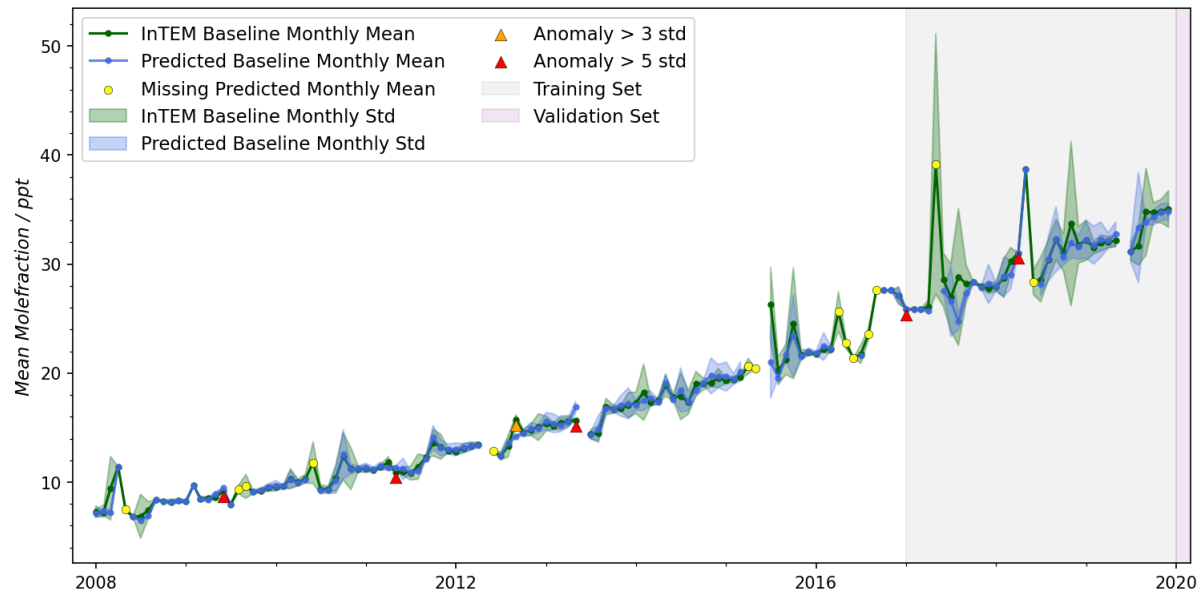
HFC-125

Molefraction time series (HFC-125, GSN)



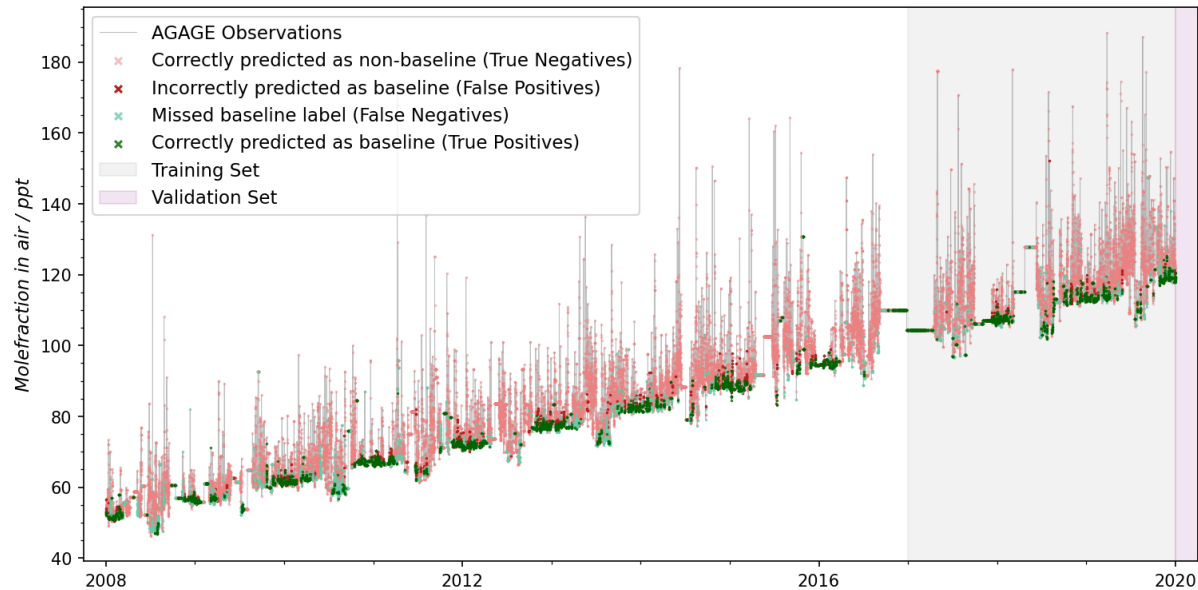


Monthly means (HFC-125, GSN)

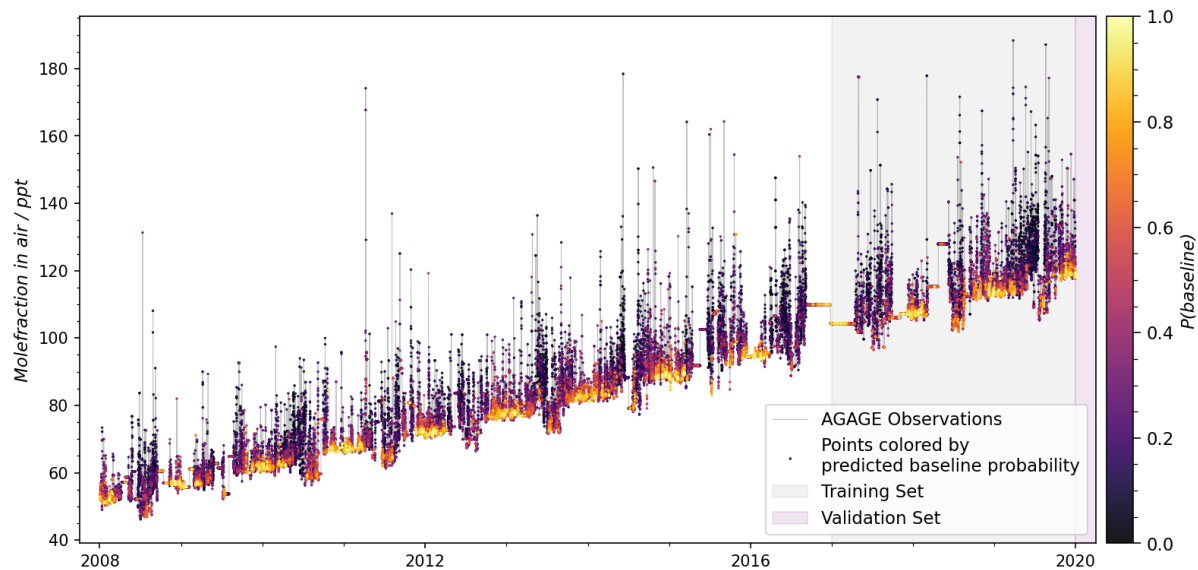


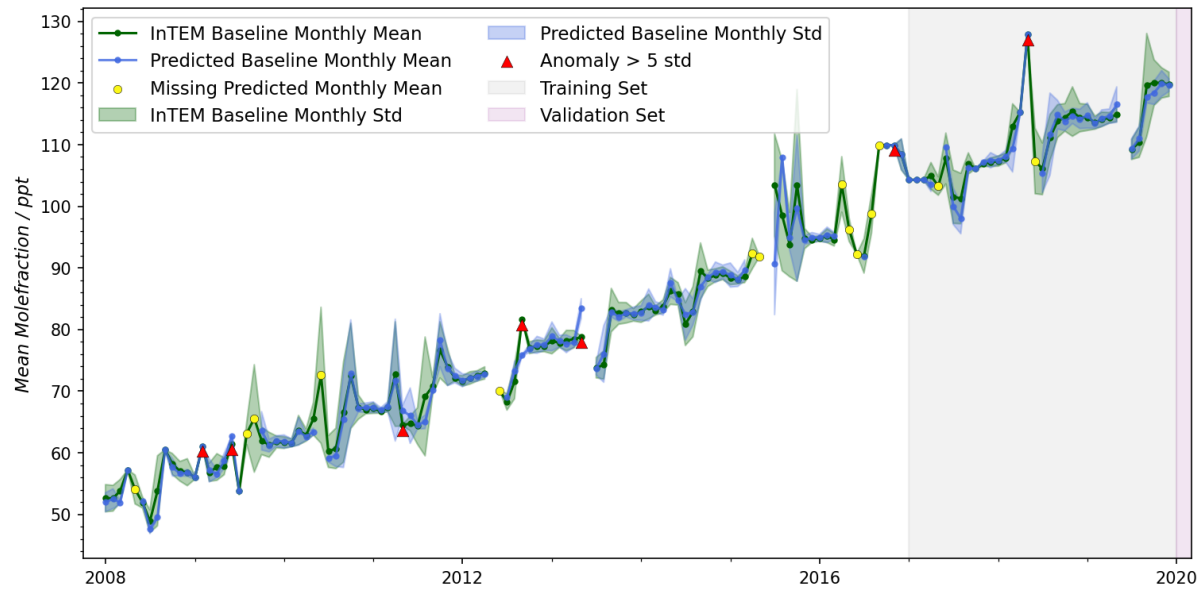
HFC-134a

Molefraction time series (HFC-134a, GSN)

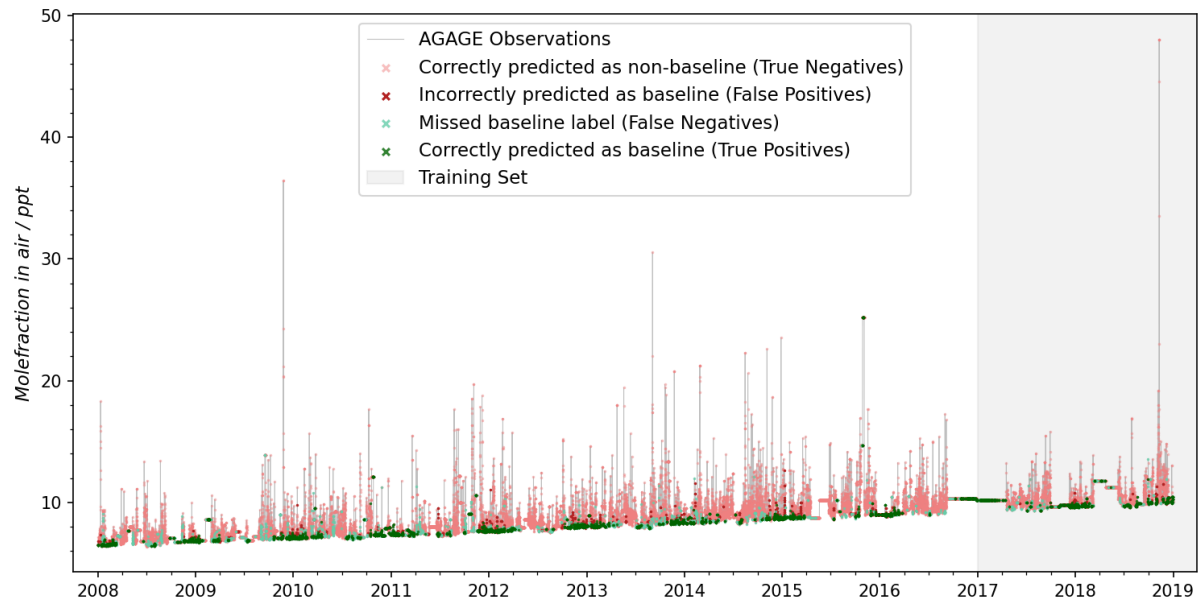


Model Confidence (HFC-134a, GSN)

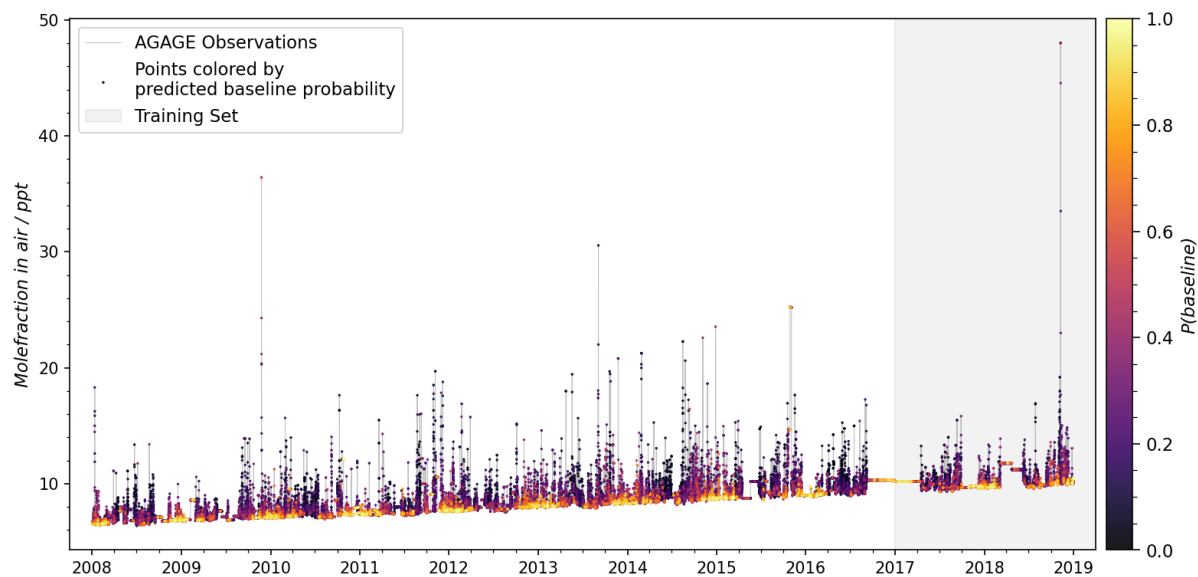




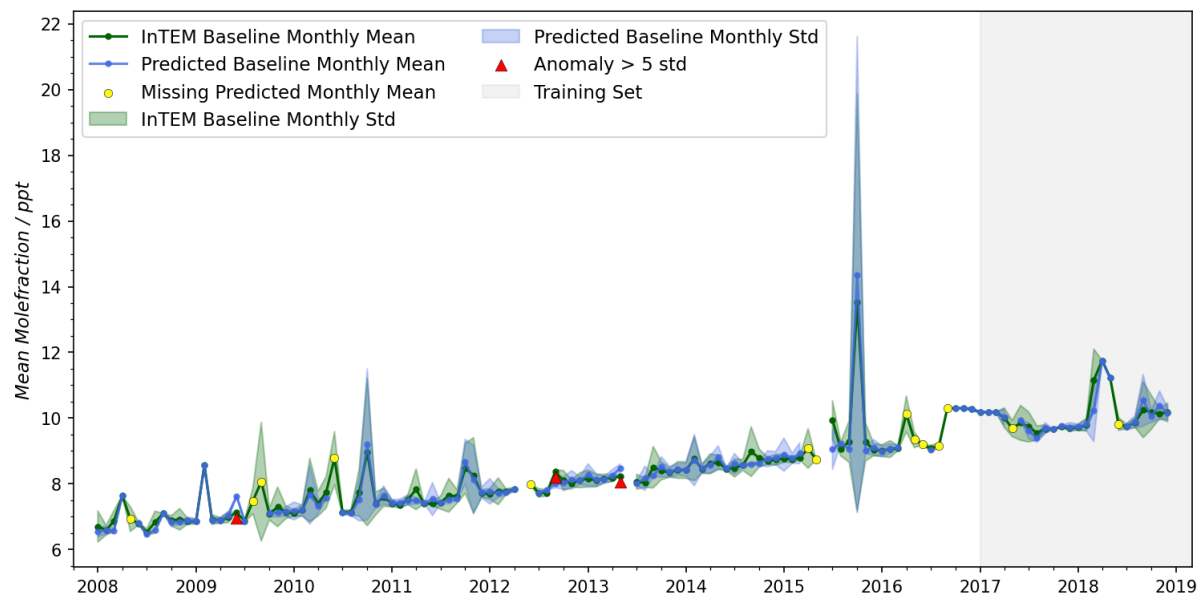
SF₆
Molefraction time series (SF₆, GSN)



Model Confidence (SF₆, GSN)

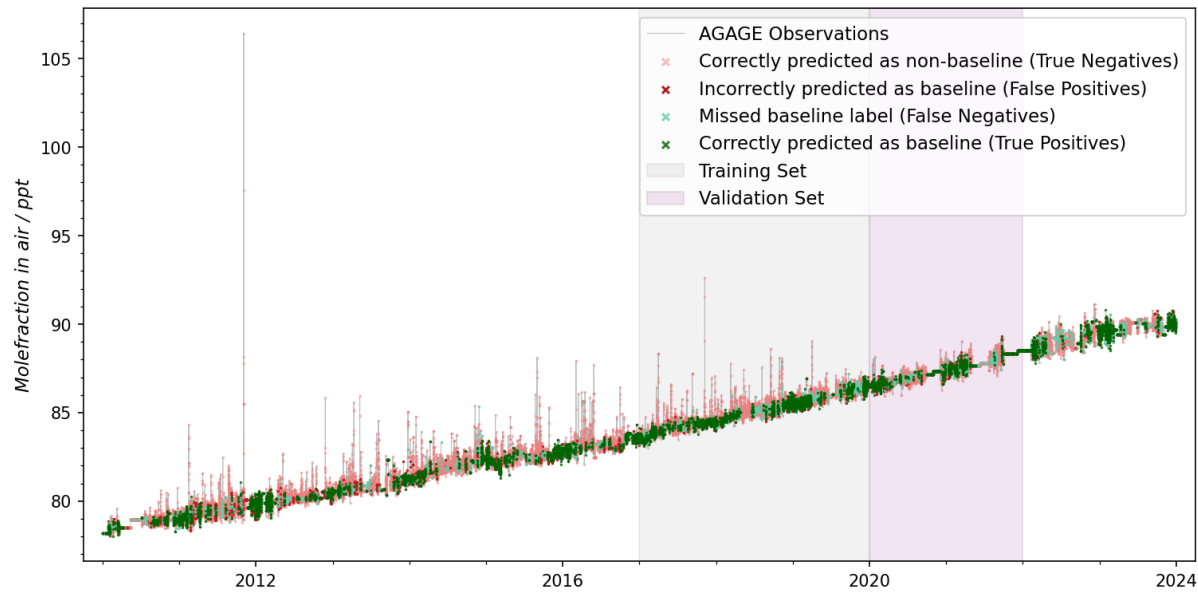


Monthly means (SF₆, GSN)

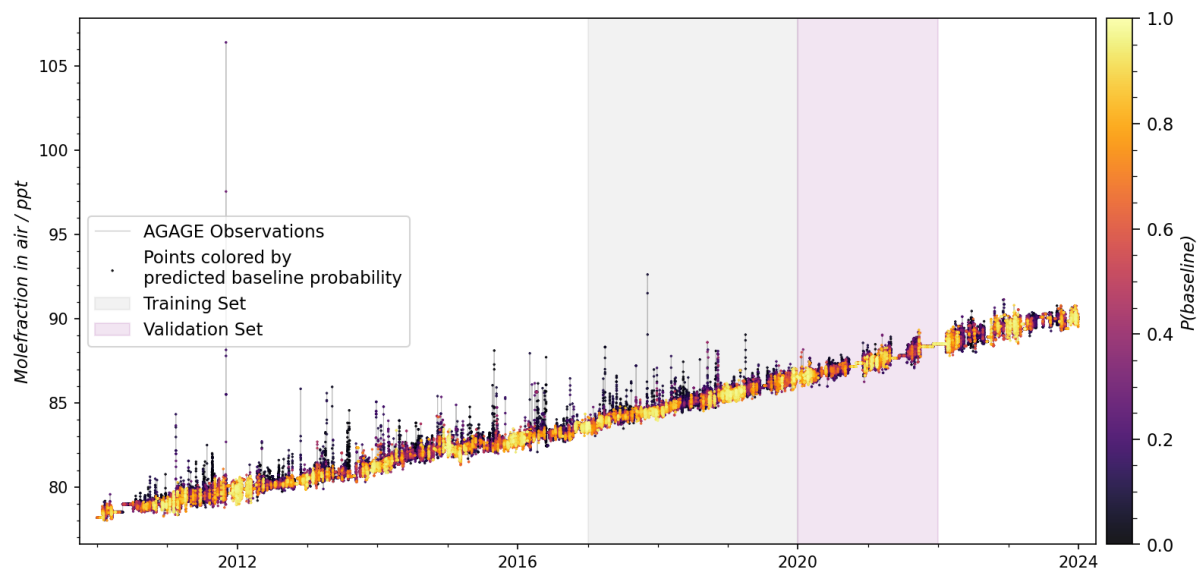


CF₄

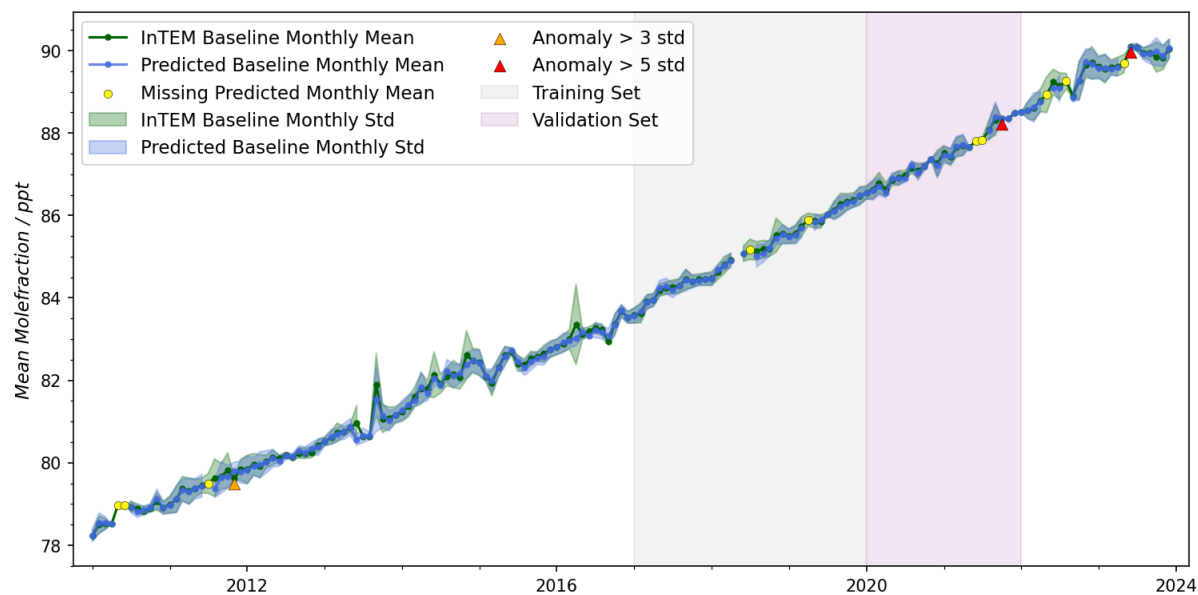
Molefraction time series (CF₄, JFJ)



Model Confidence (CF₄, JFJ)

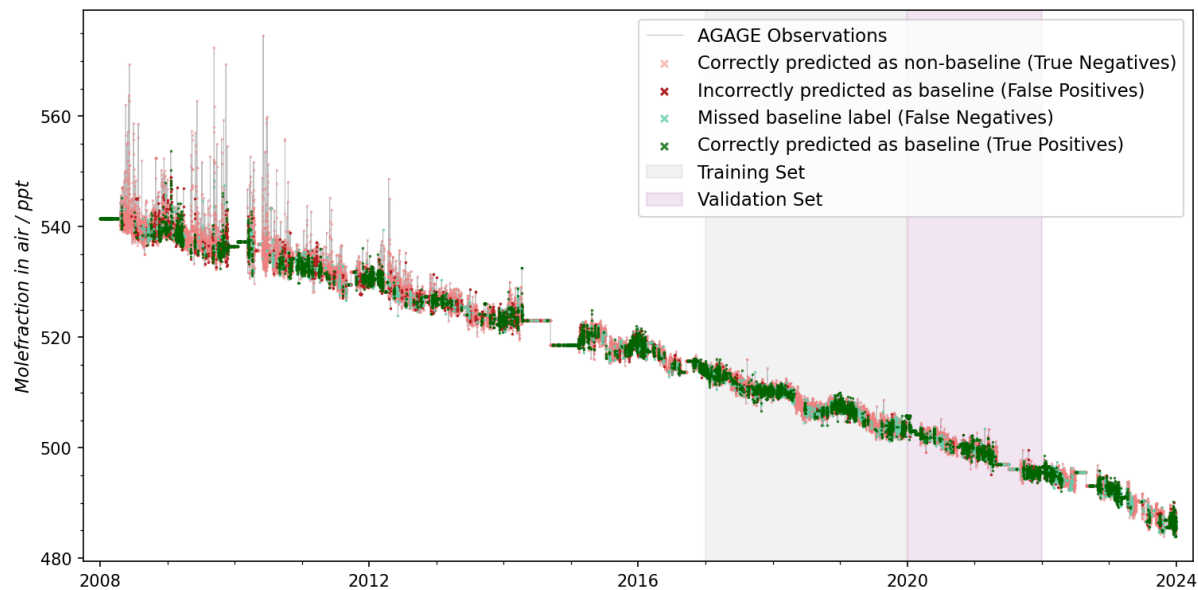


Monthly means (CF₄, JFJ)

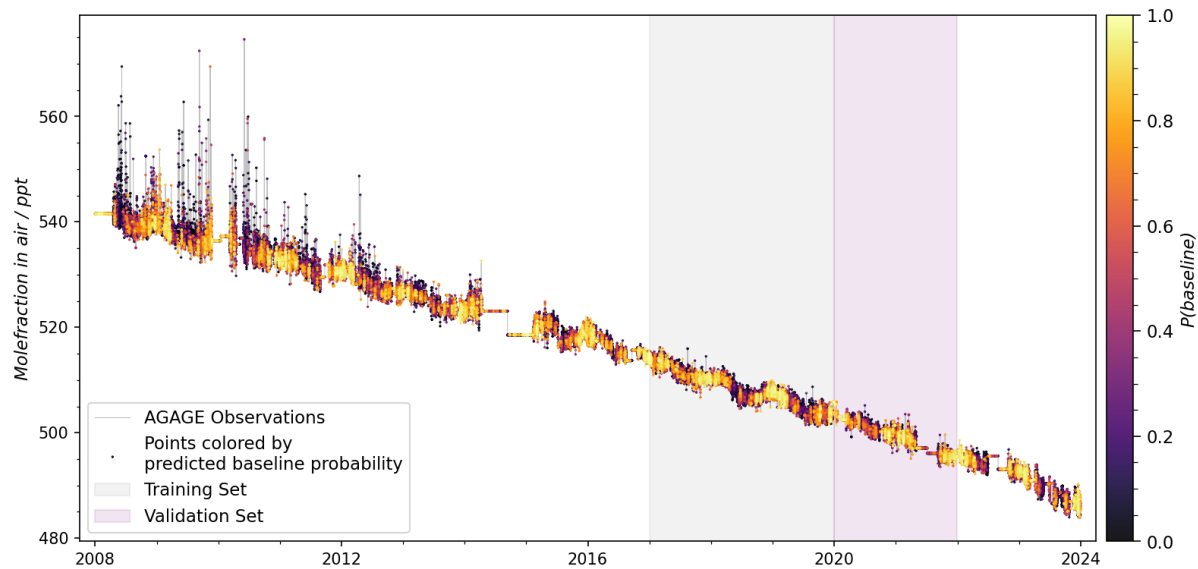


195 CFC-12

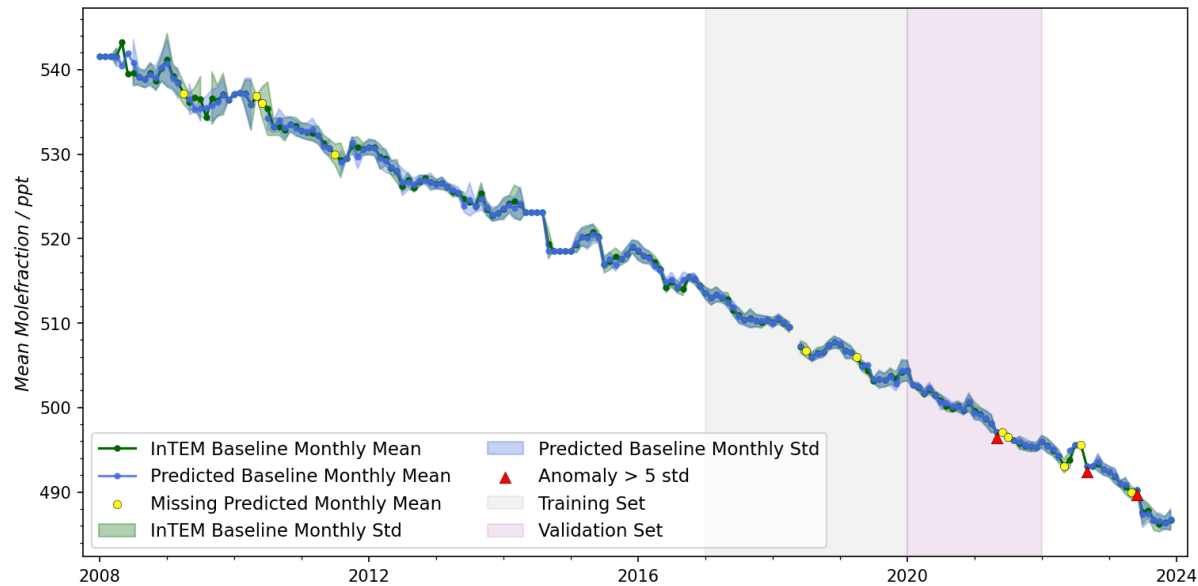
Molefraction time series (CFC-12, JFJ)

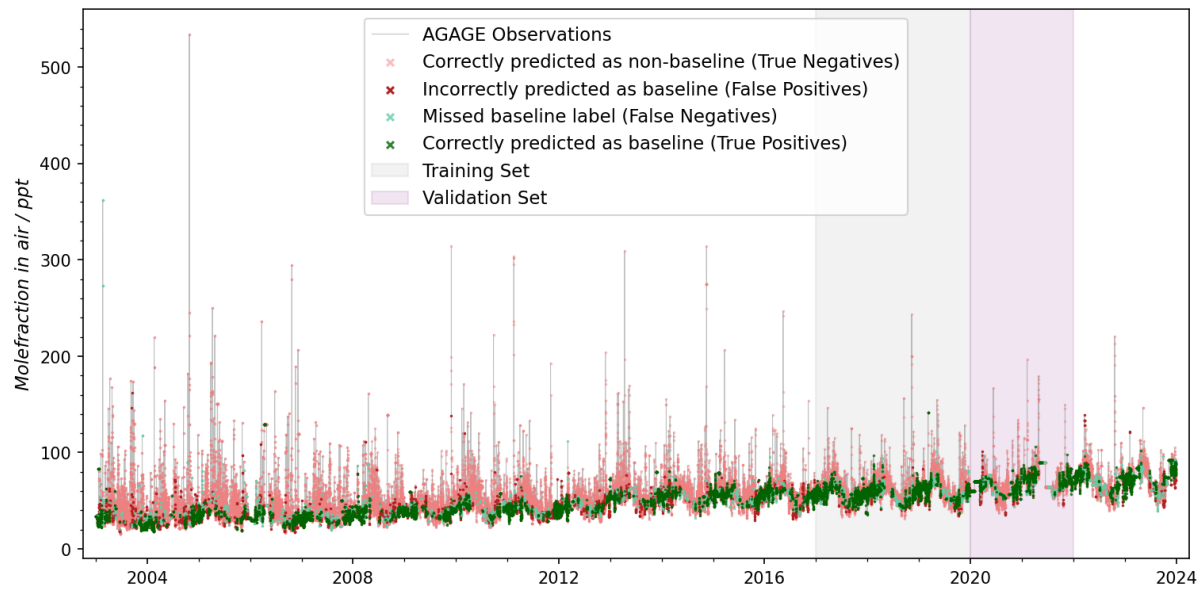


Model Confidence (CFC-12, JFJ)

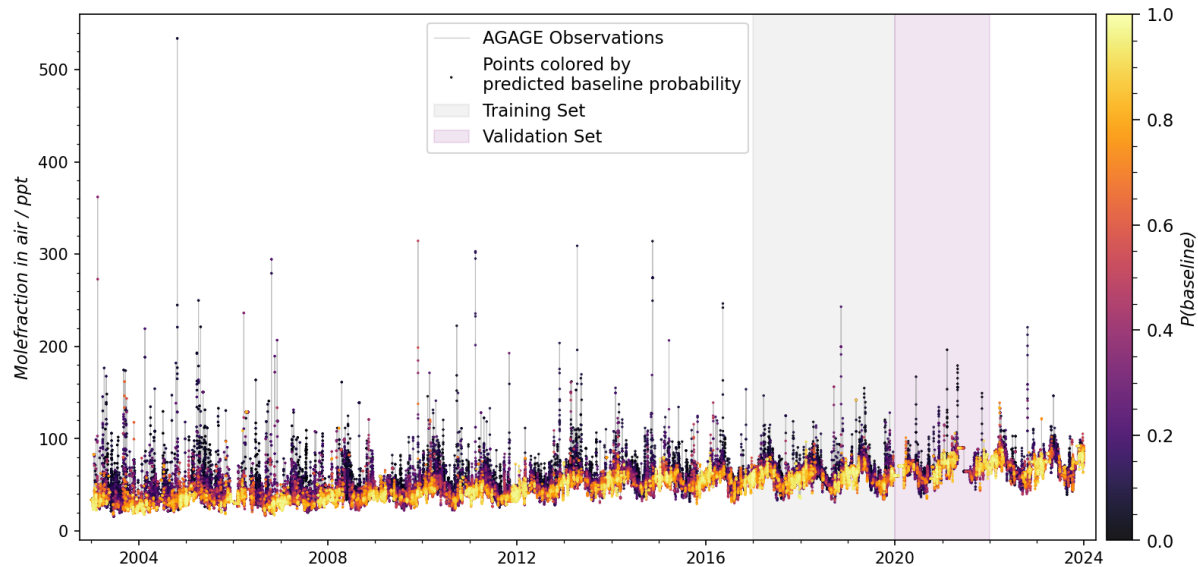


Monthly means (CFC-12, JFJ)

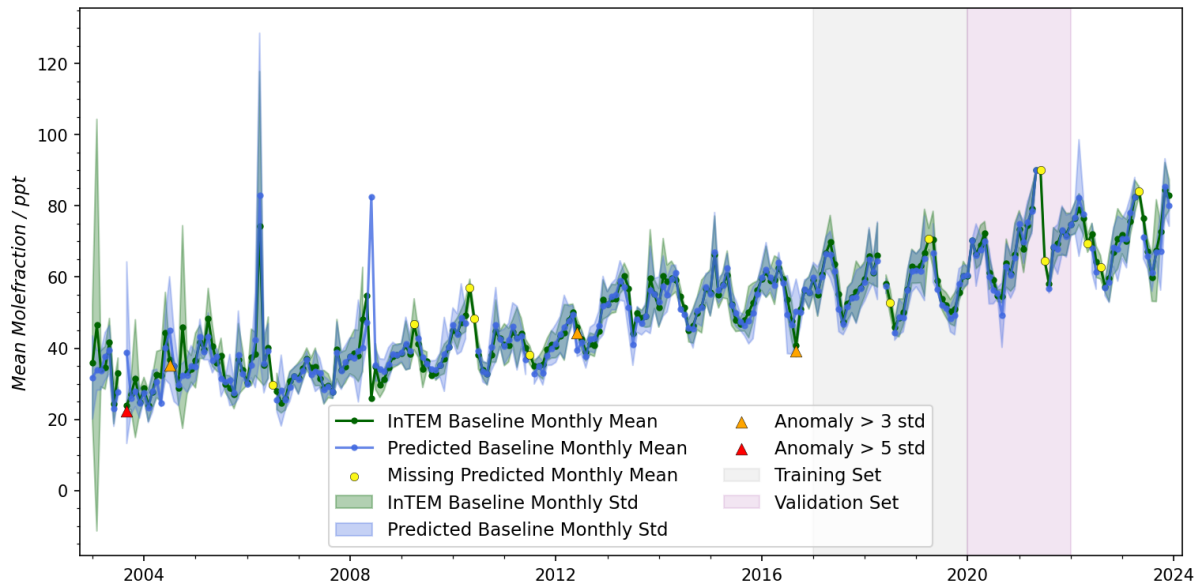




Model Confidence (CH₂Cl₂, JFJ)

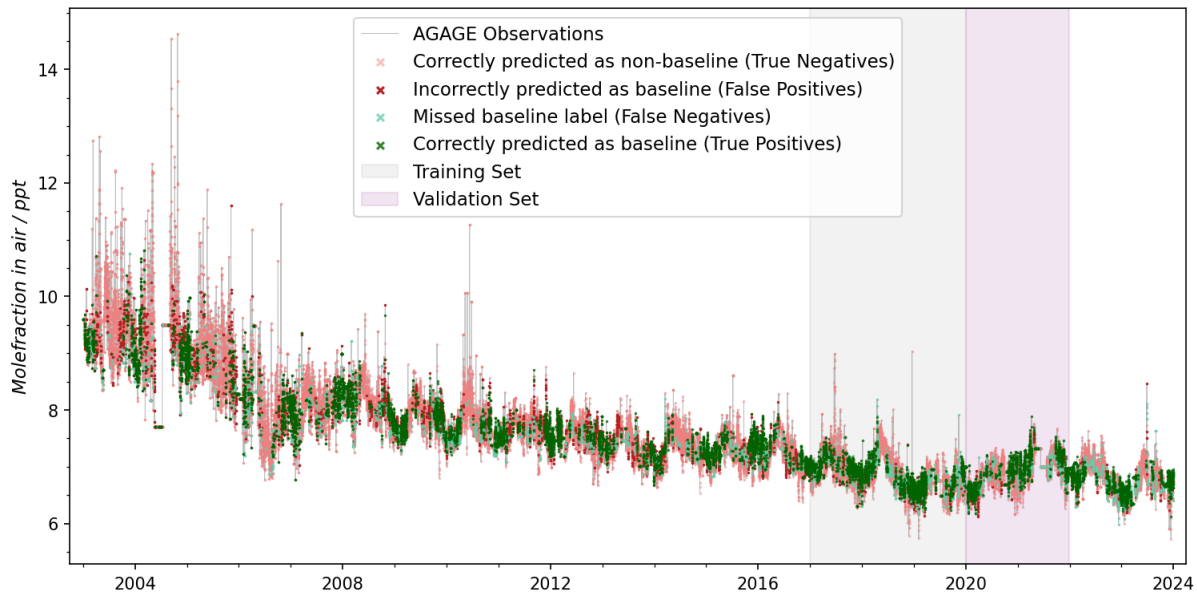


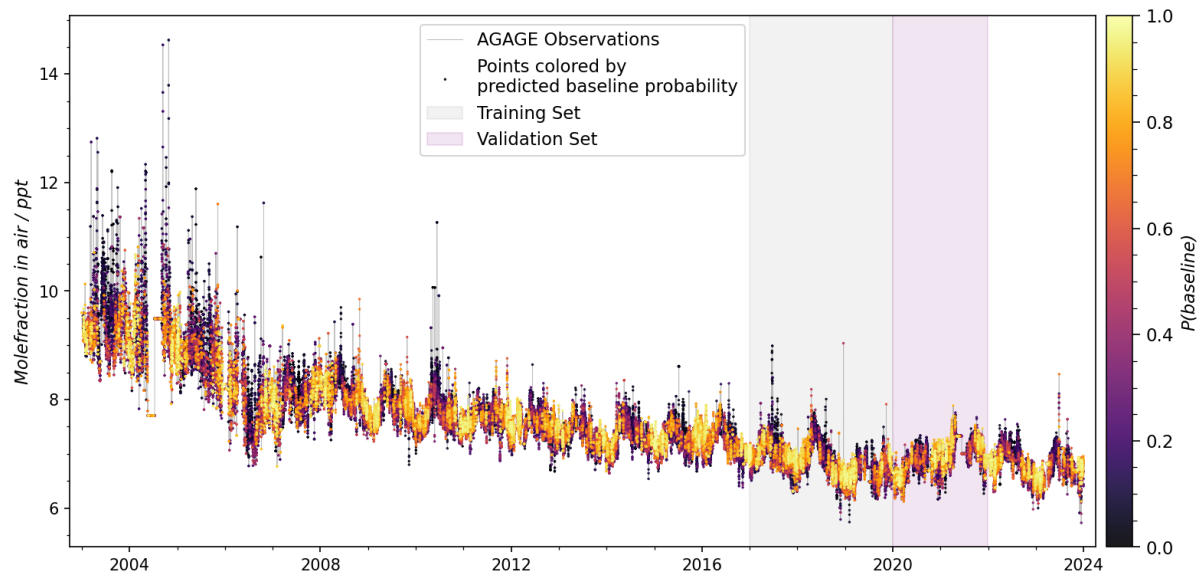
Monthly means (CH₂Cl₂, JFJ)



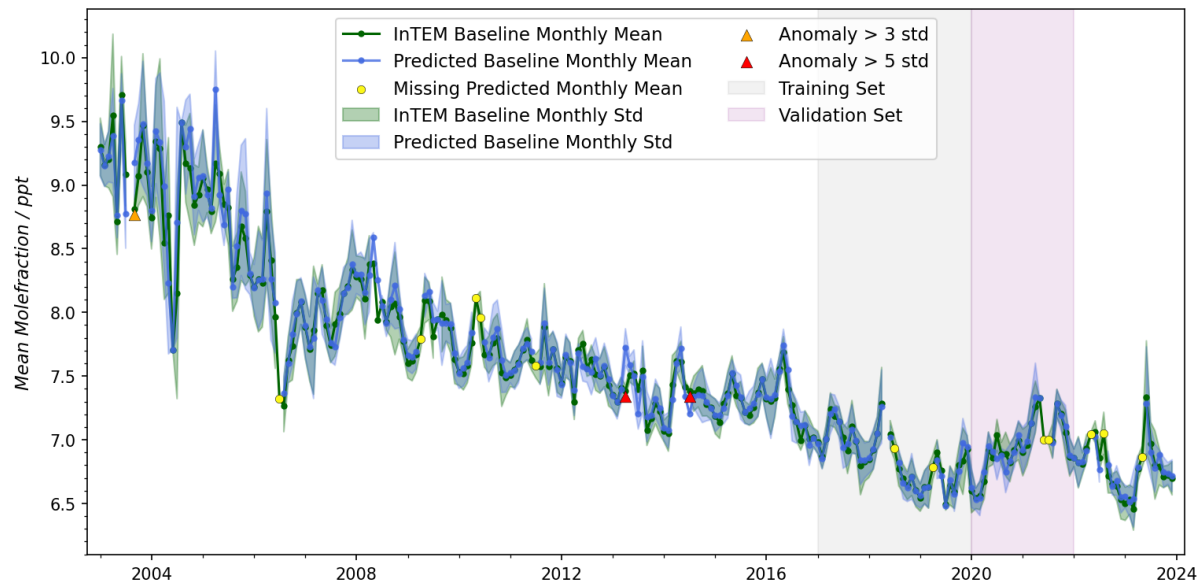
CH₃Br

Molefraction time series (CH₃Br, JFJ)



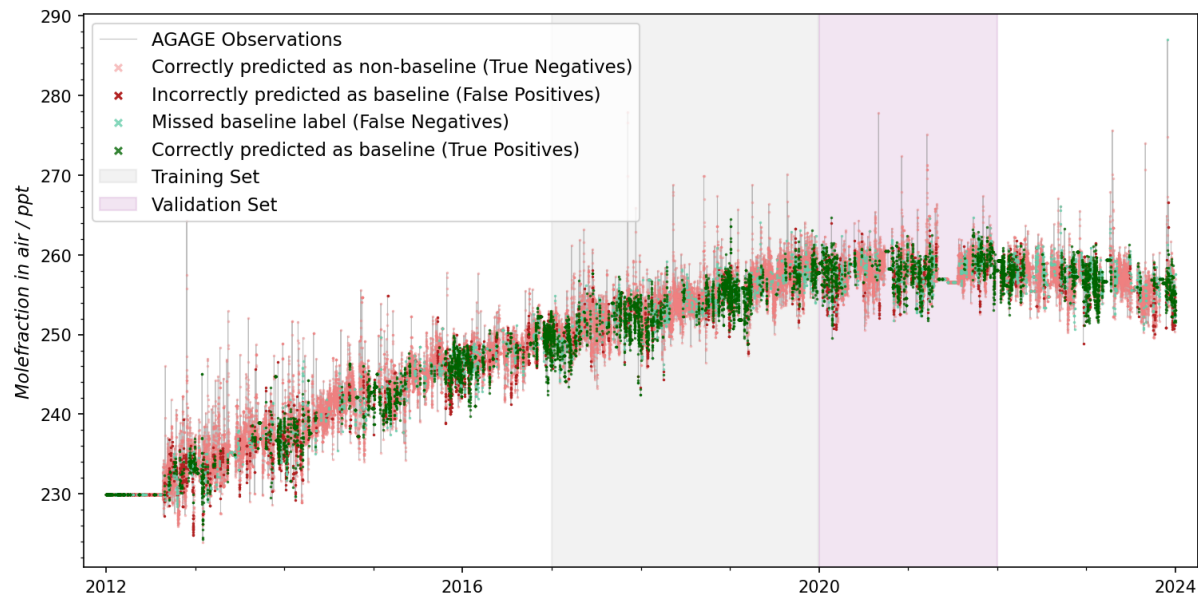


Monthly means (CH₃Br, JFJ)

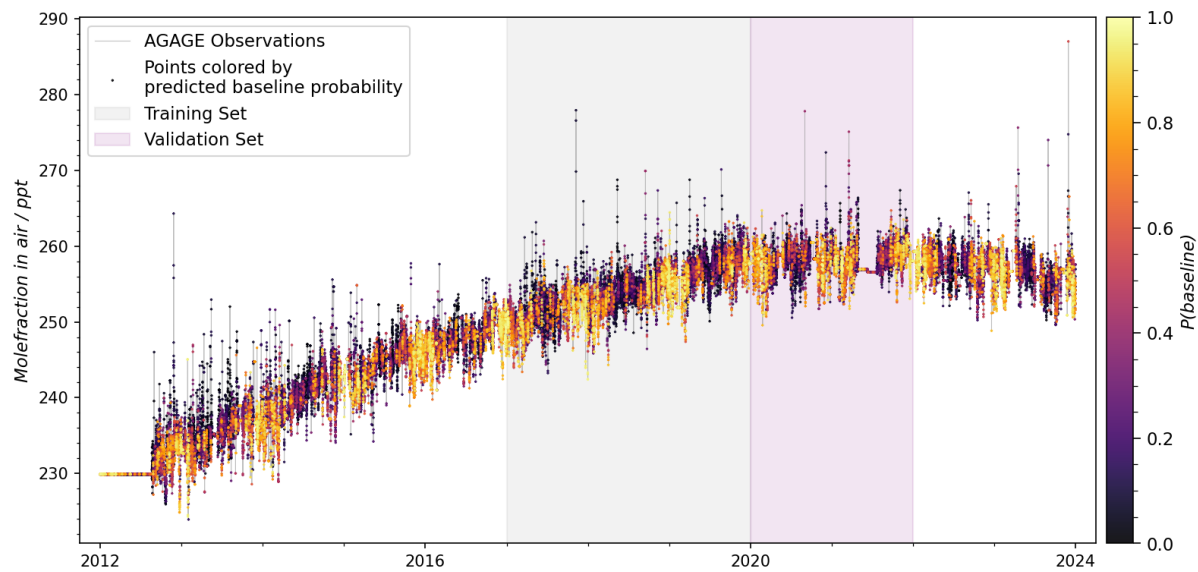


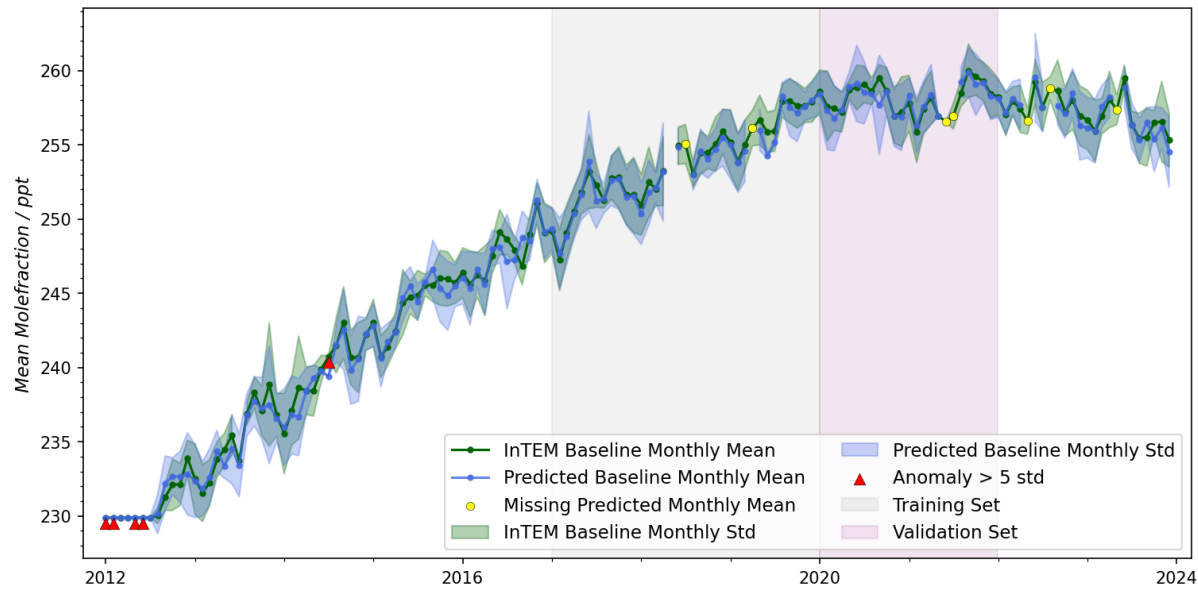
HCFC-22

Molefraction time series (HCFC-22, JFJ)



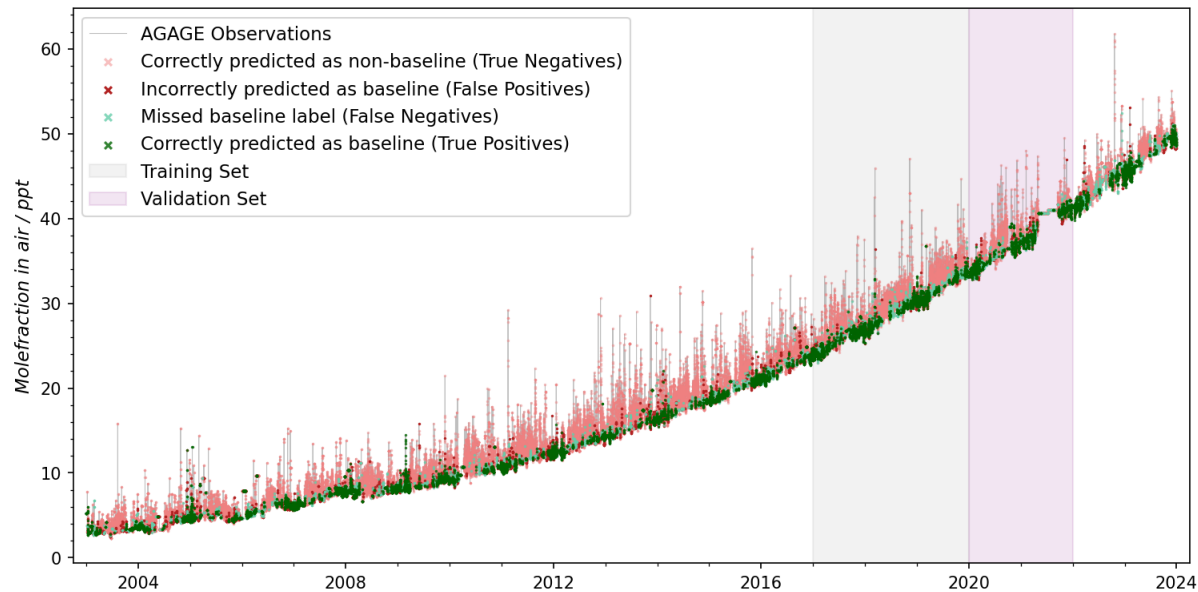
Model Confidence (HCFC-22, JFJ)



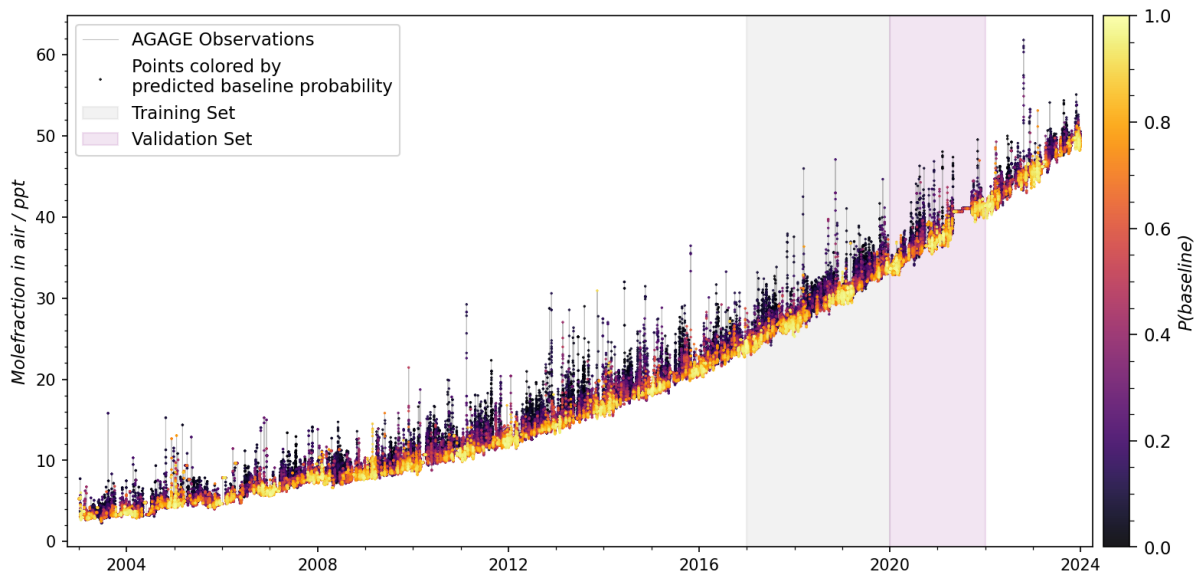


HFC-125

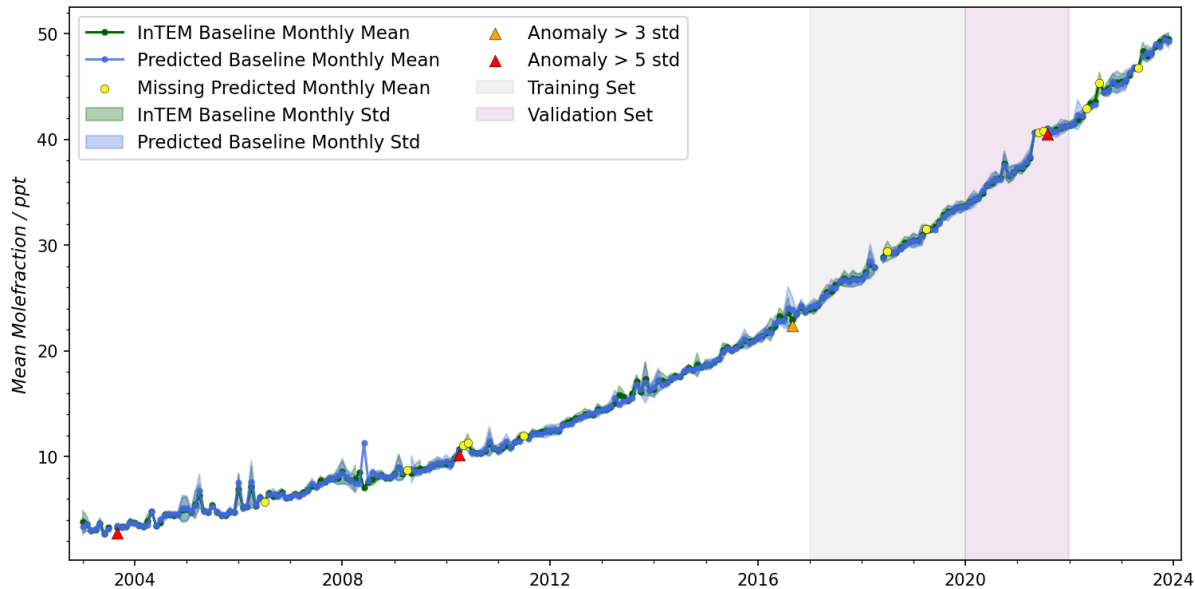
Molefraction time series (HFC-125, JFJ)



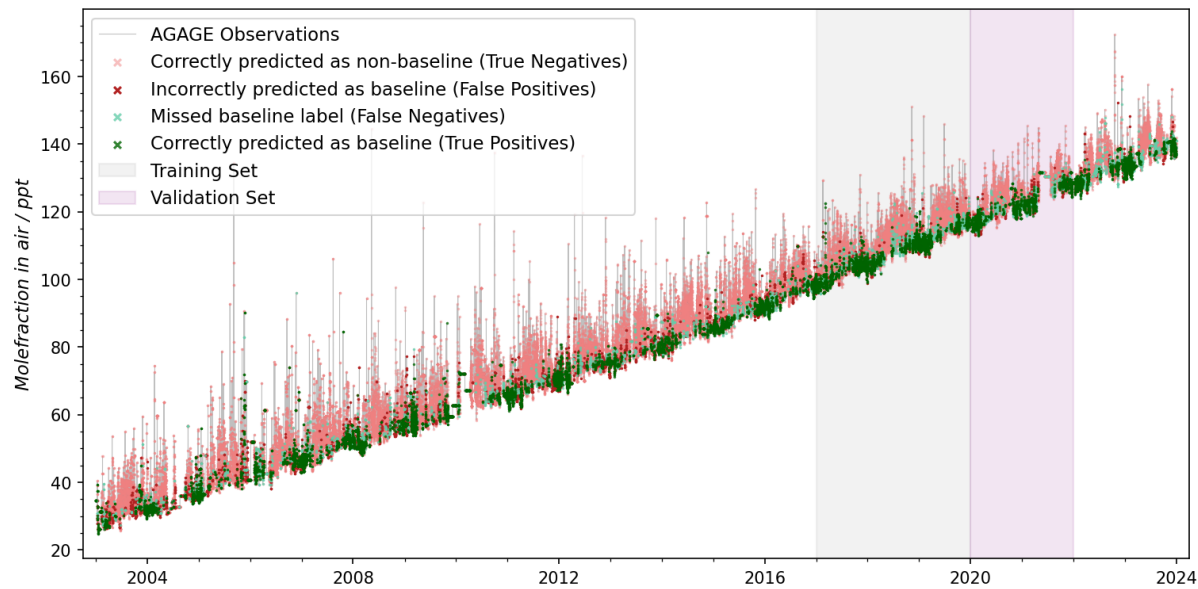
Model Confidence (HFC-125, JFJ)



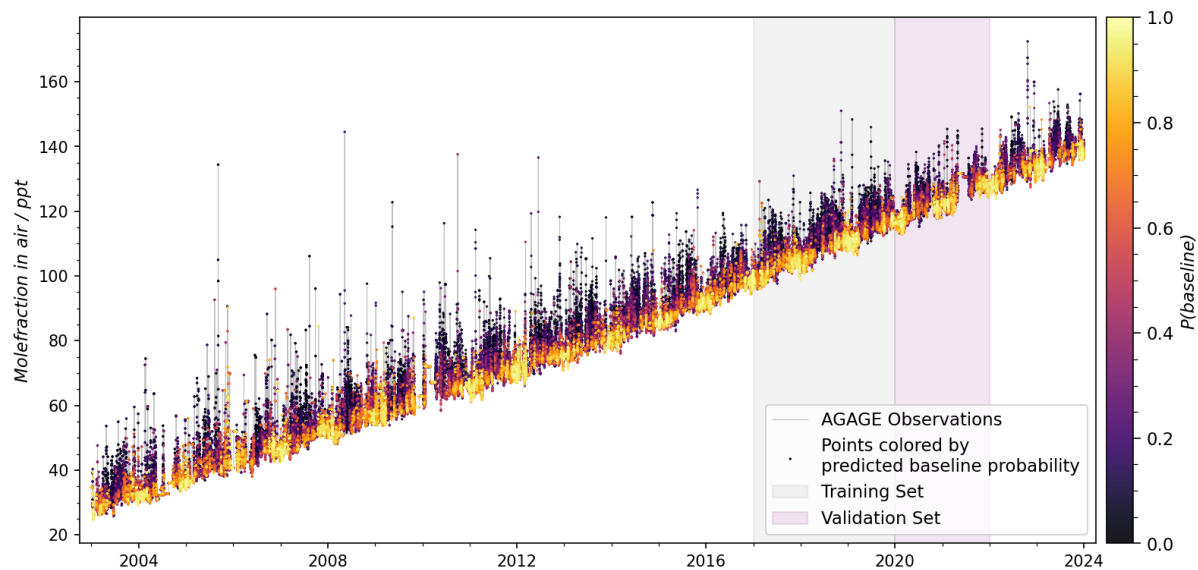
Monthly means (HFC-125, JFJ)



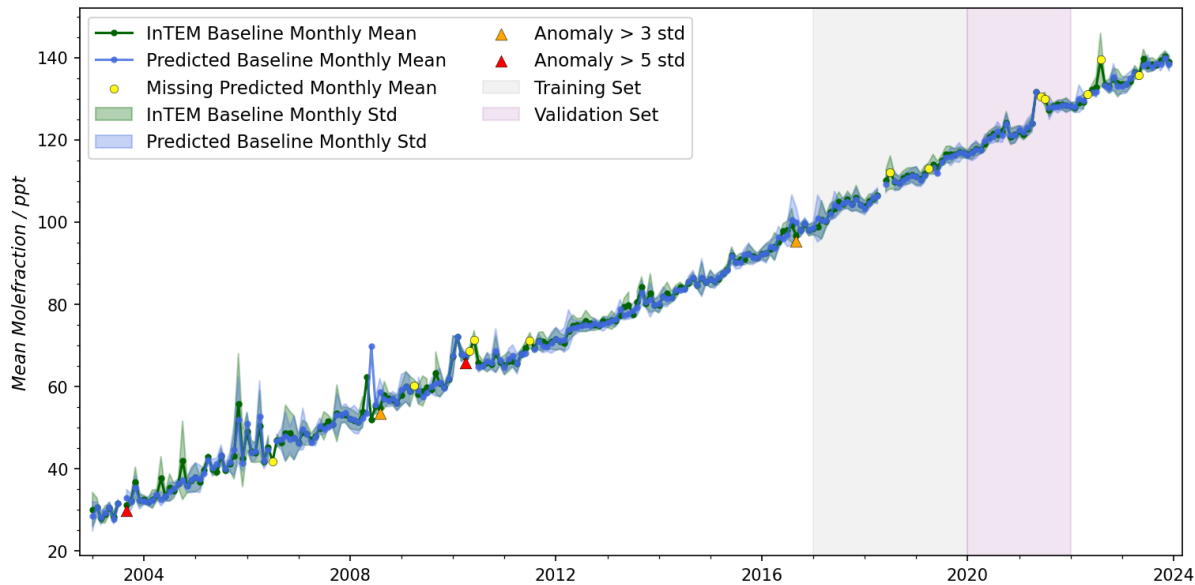
Molefraction time series (HFC-134a, JFJ)



Model Confidence (HFC-134a, JFJ)

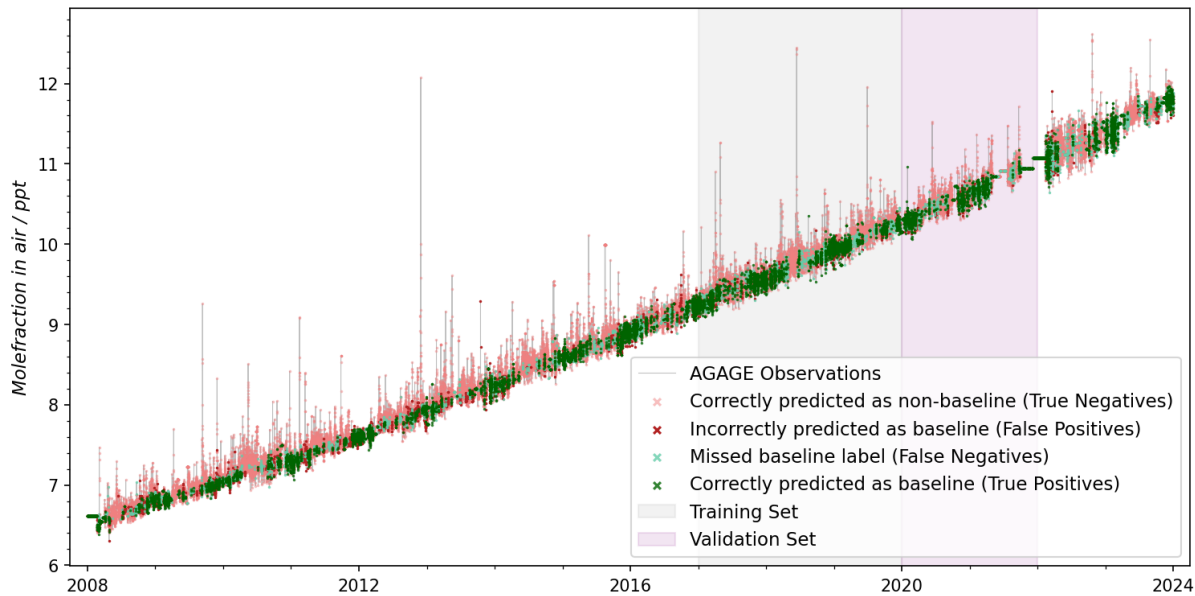


Monthly means (HFC-134a, JFJ)

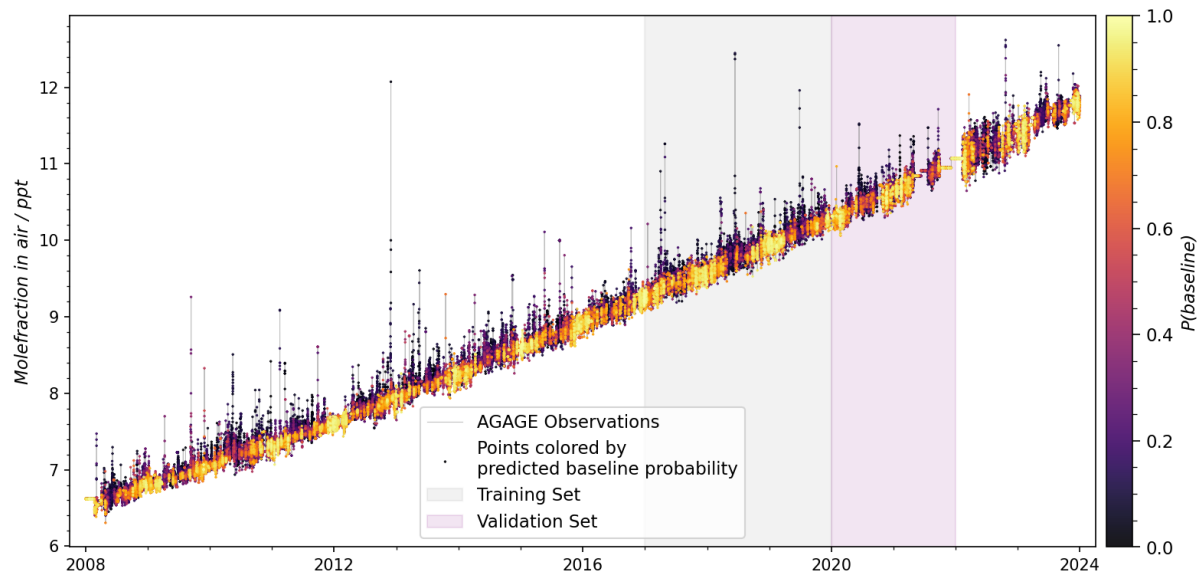


SF₆

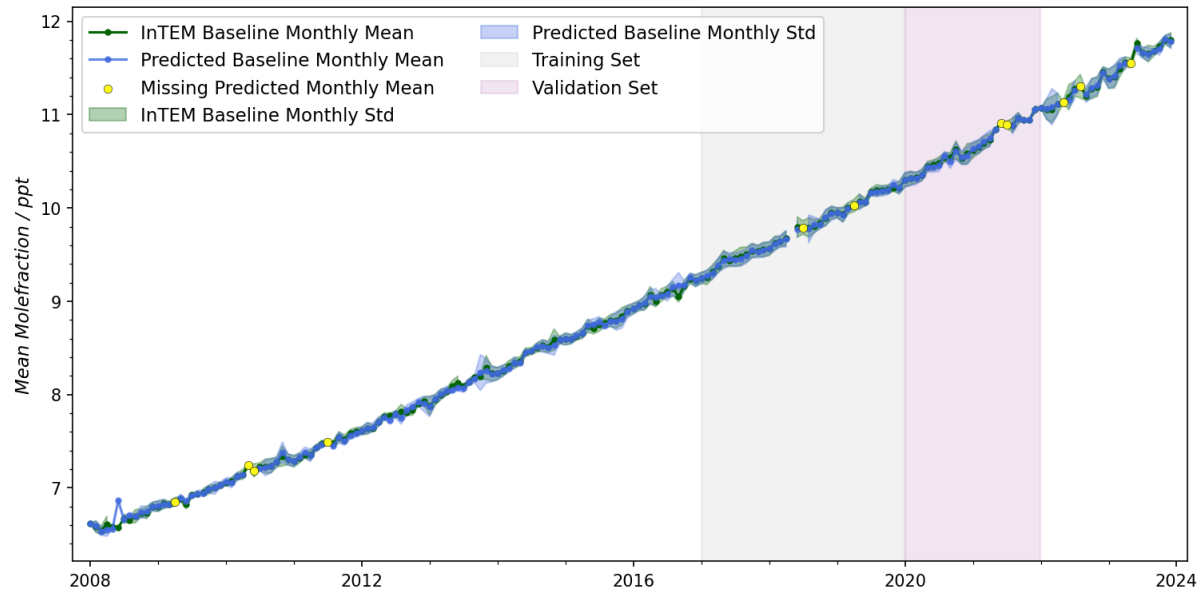
220 Molefraction time series (SF₆, JFJ)



Model Confidence (SF₆, JFJ)



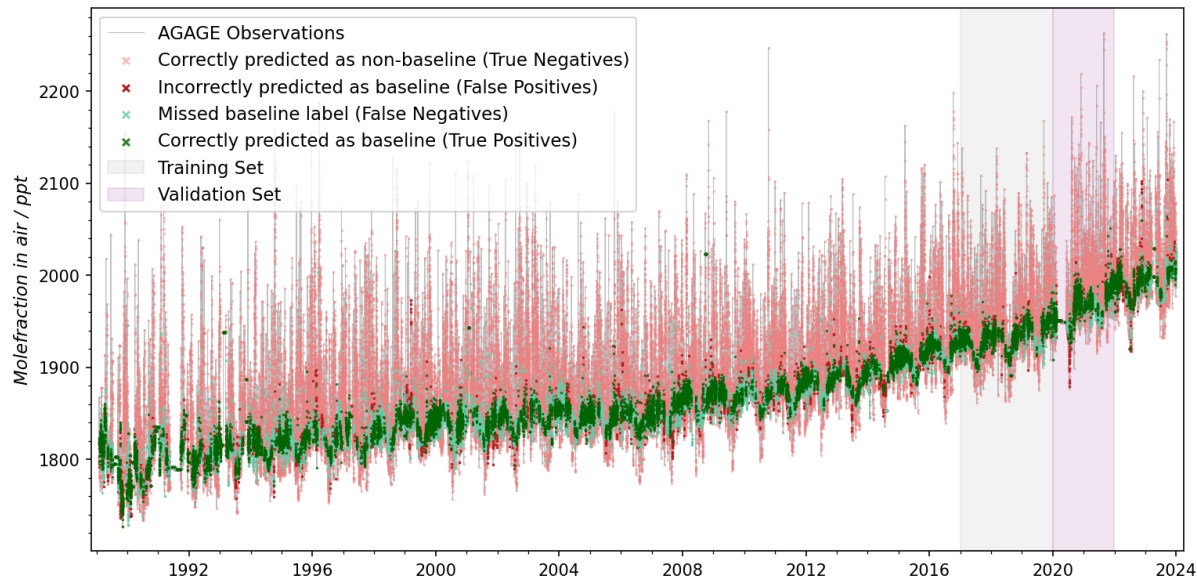
Monthly means (SF₆, JFJ)



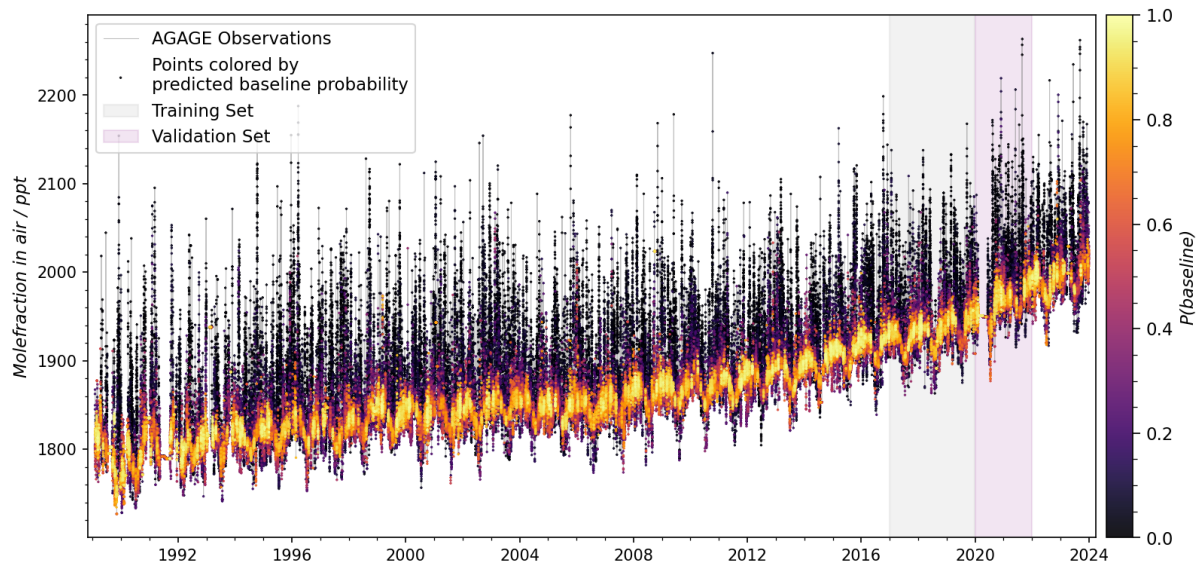
S9.5 Mace Head, Ireland

CH₄

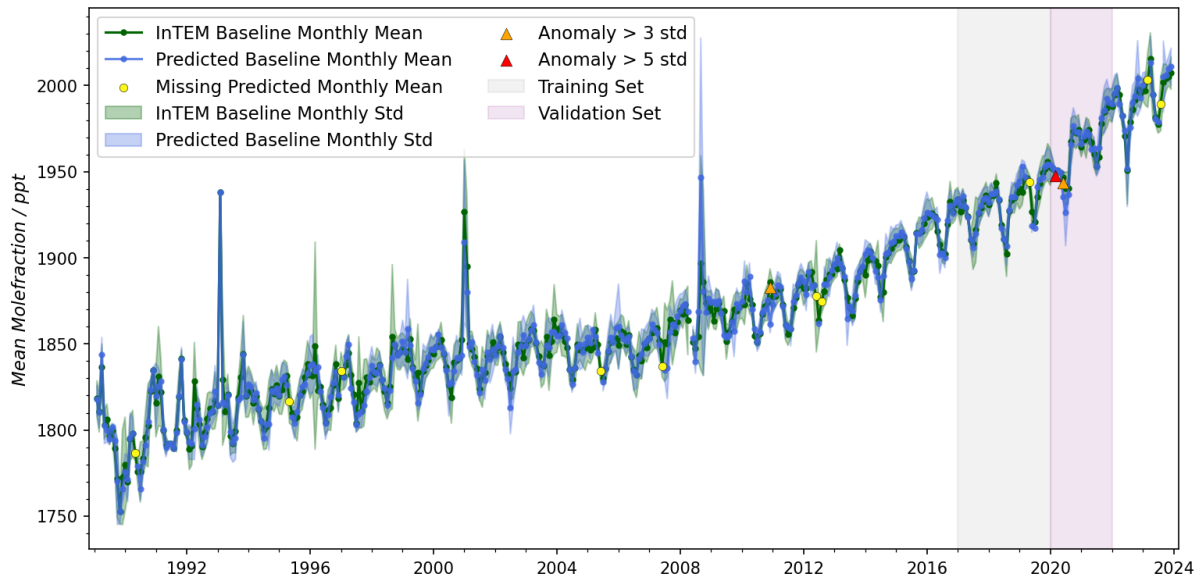
225 Molefraction time series (CH₄, MHD)



Model Confidence (CH₄, MHD)

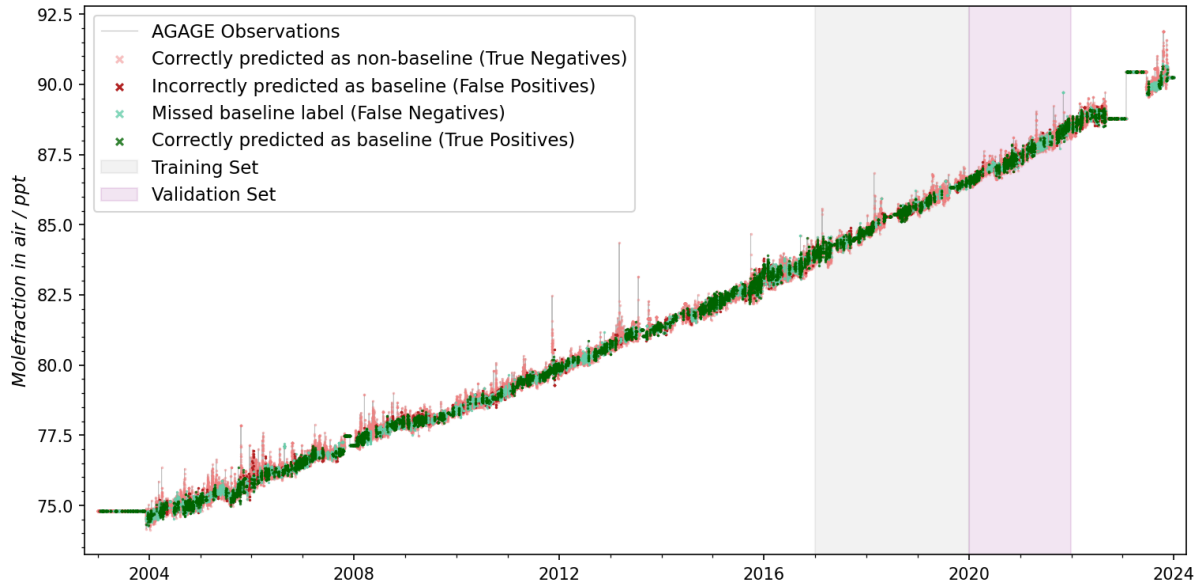


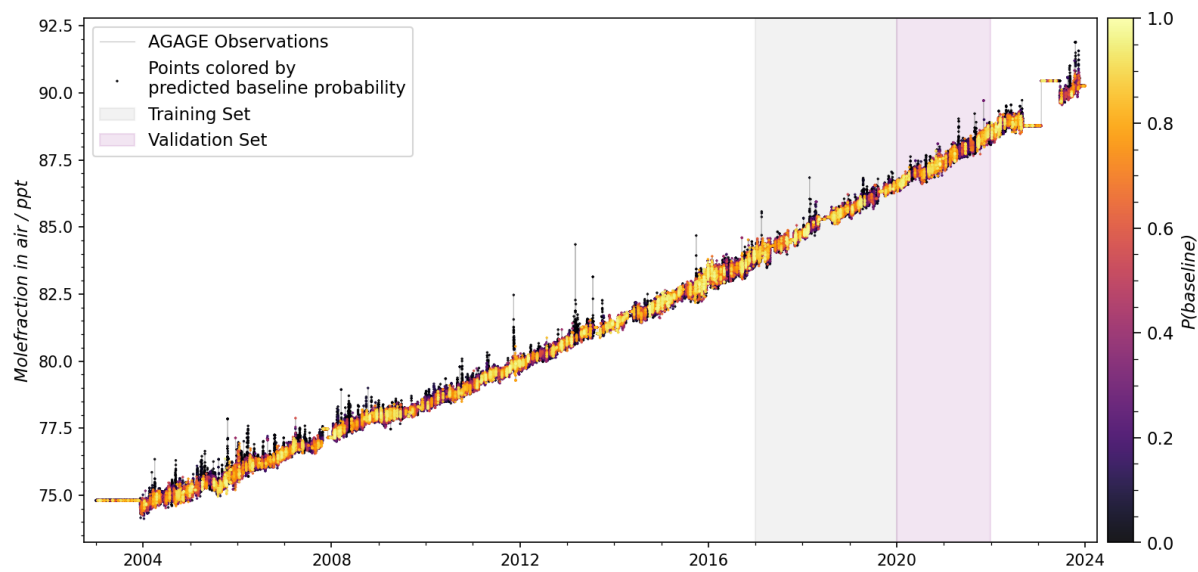
Monthly means (CH₄, MHD)



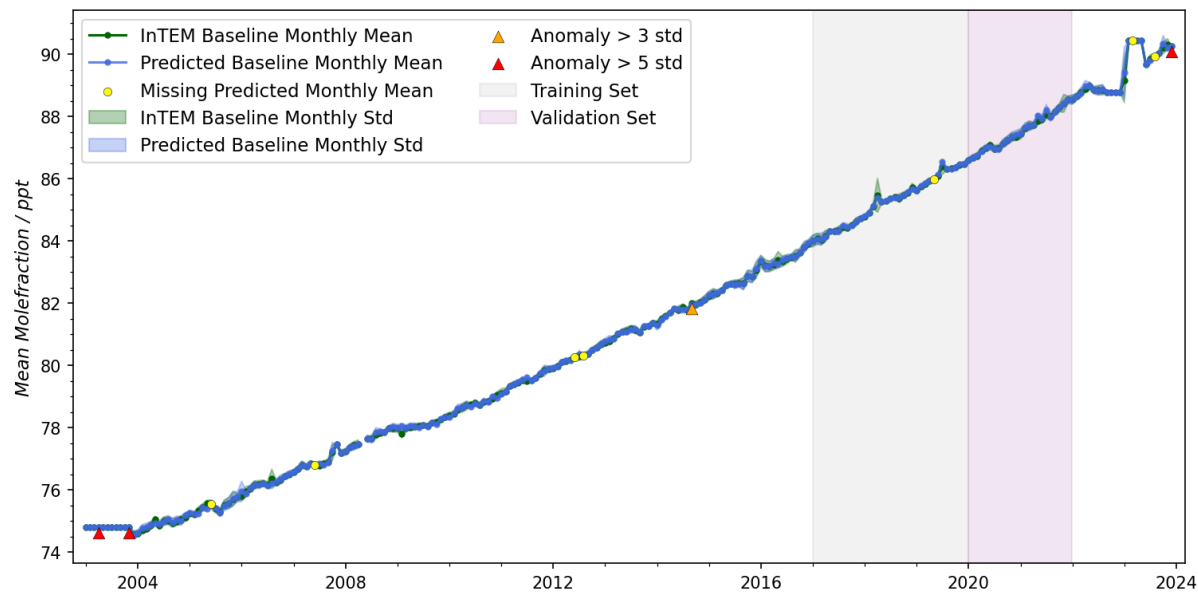
CF₄

Molefraction time series (CF₄, MHD)



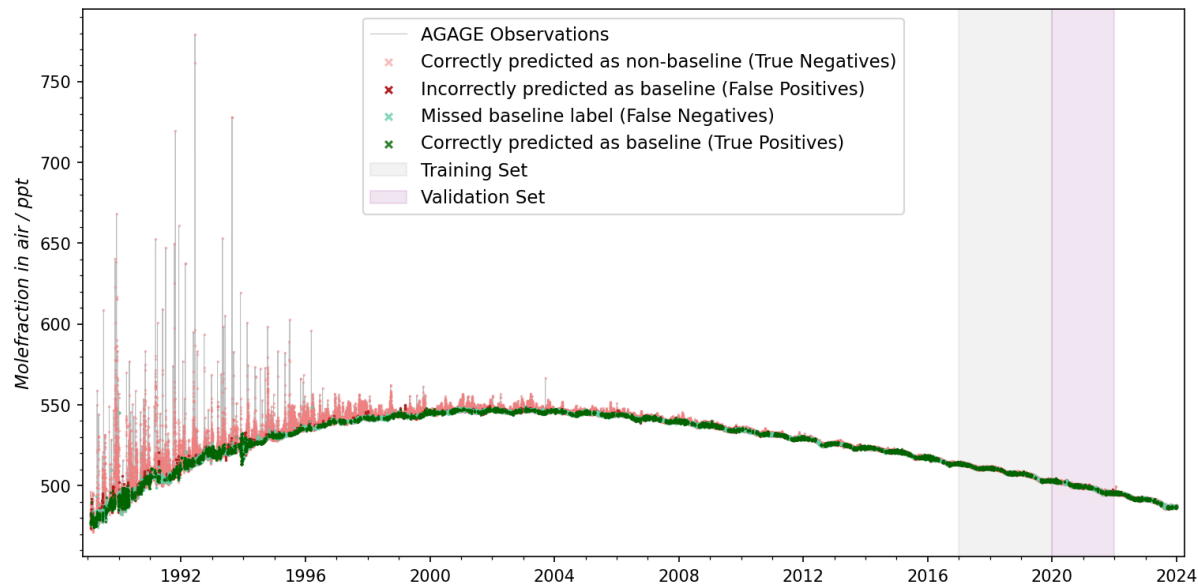


Monthly means (CF₄, MHD)

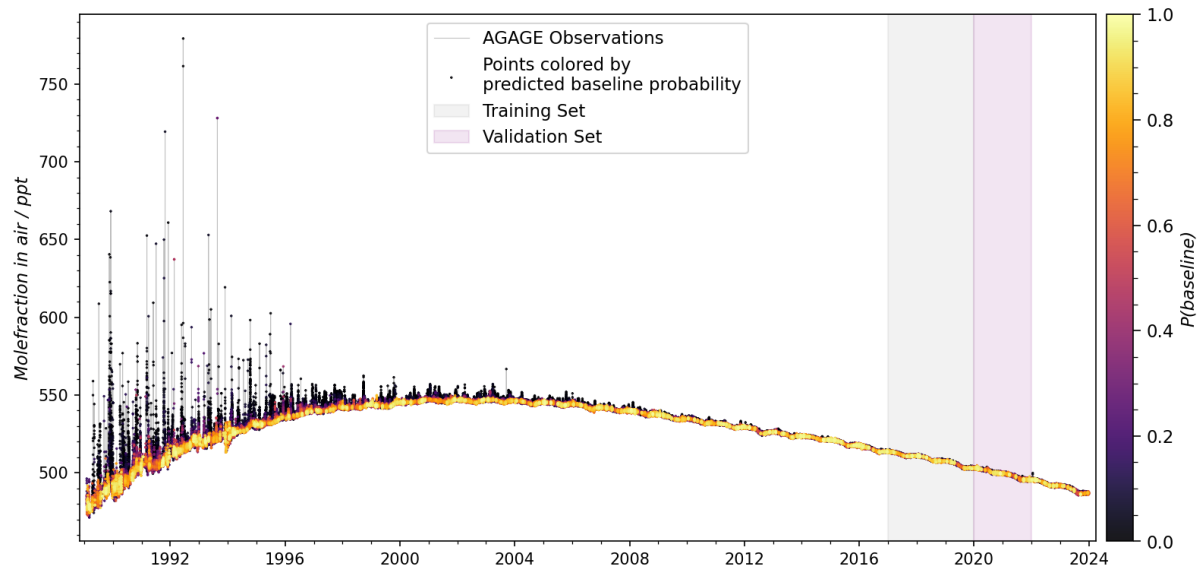


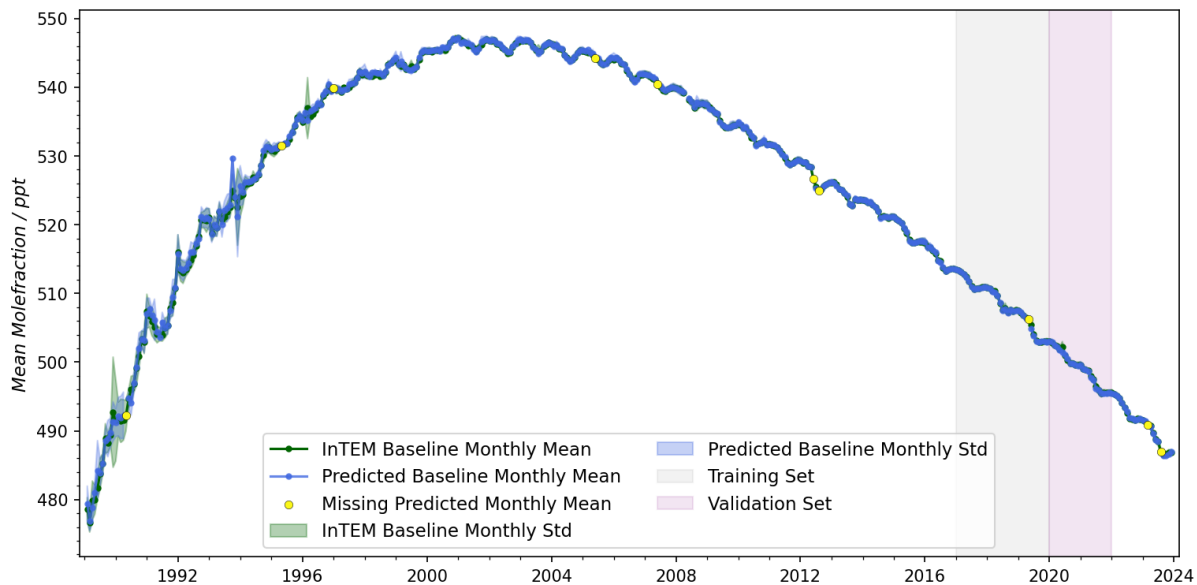
CFC-12

Molefraction time series (CFC-12, MHD)



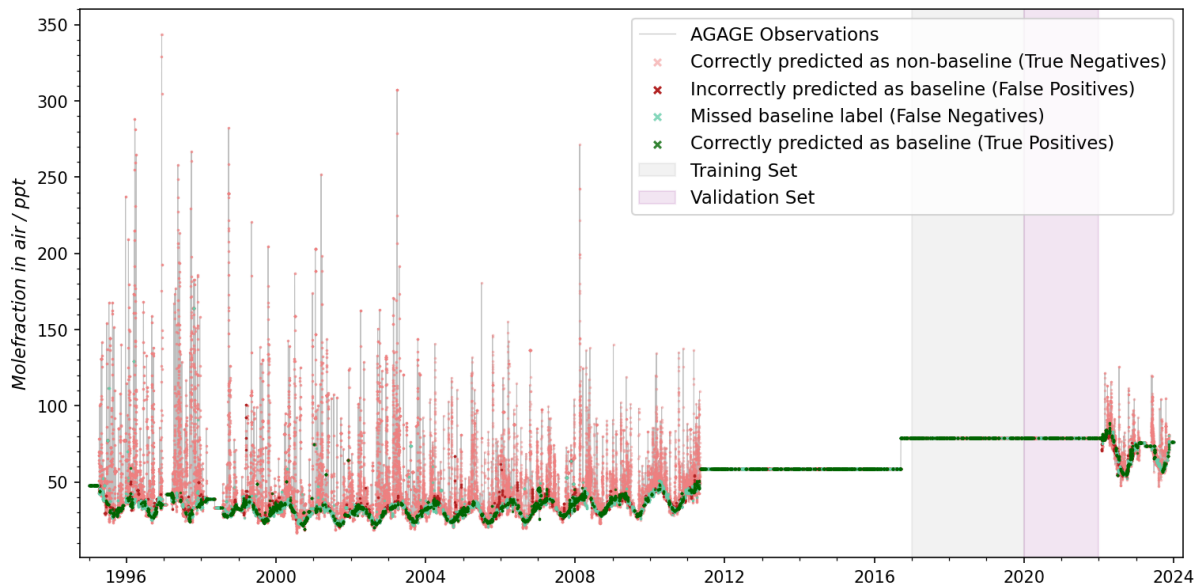
Model Confidence (CFC-12, MHD)



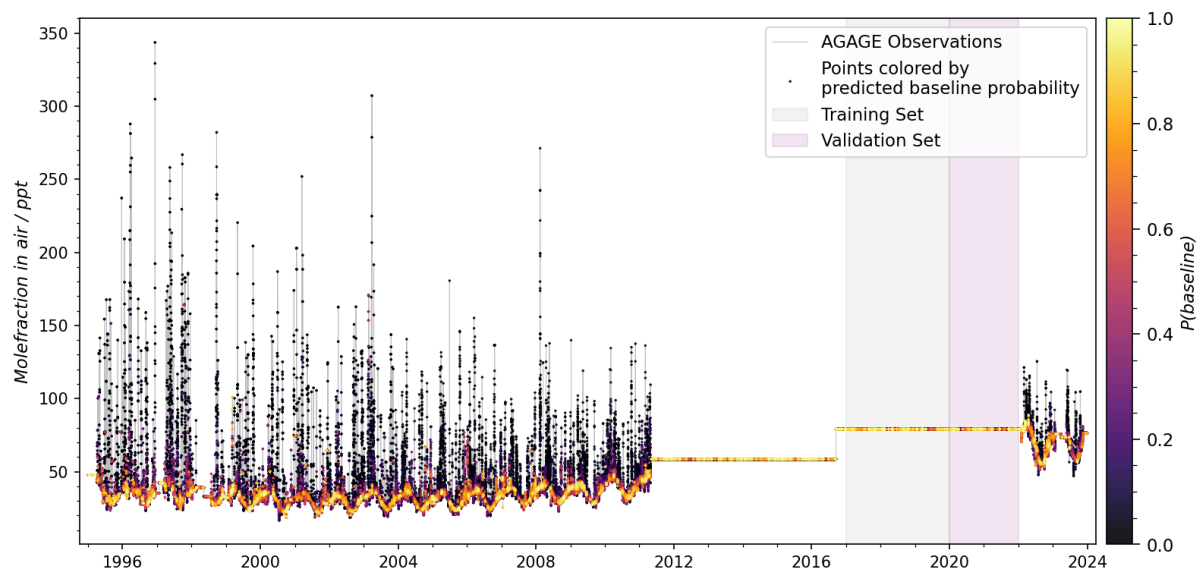


CH₂Cl₂

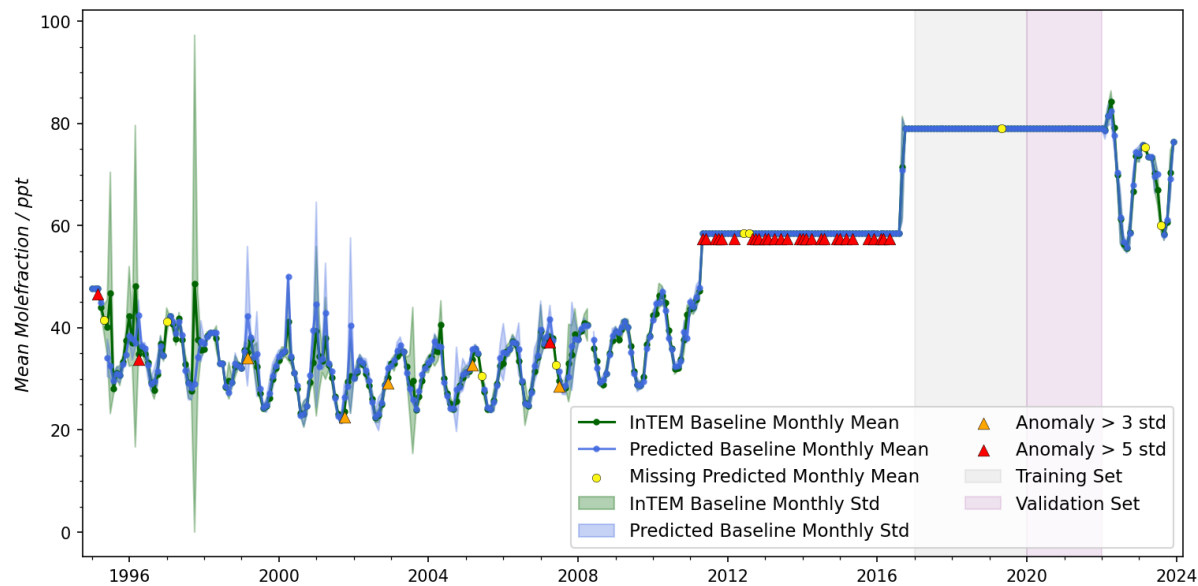
Molefraction time series (CH₂Cl₂, MHD)



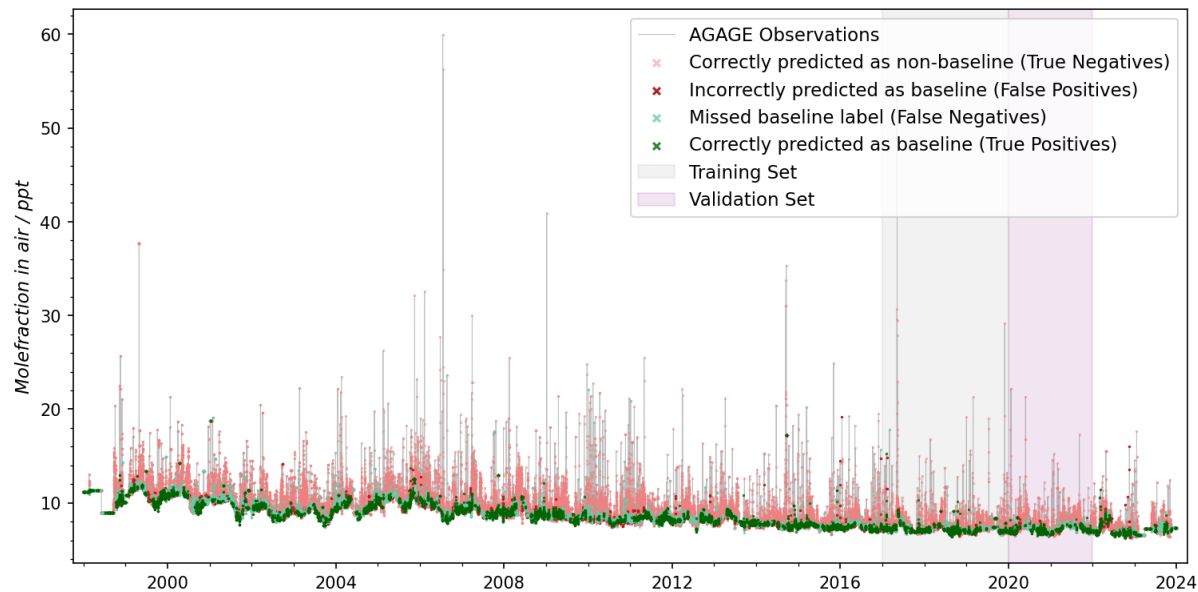
Model Confidence (CH₂Cl₂, MHD)



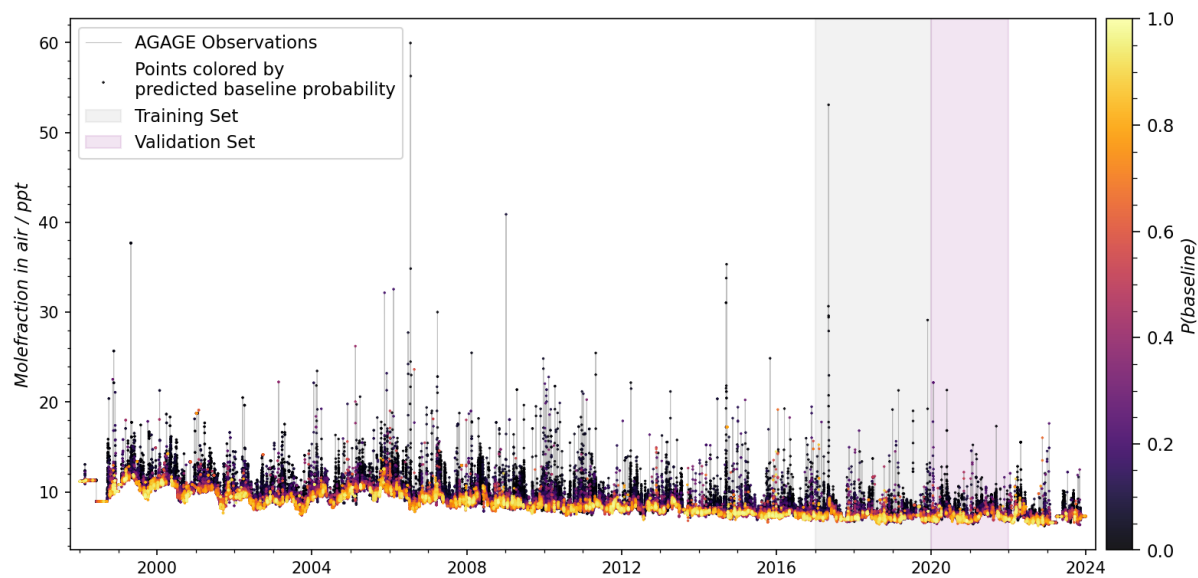
Monthly means (CH₂Cl₂, MHD)



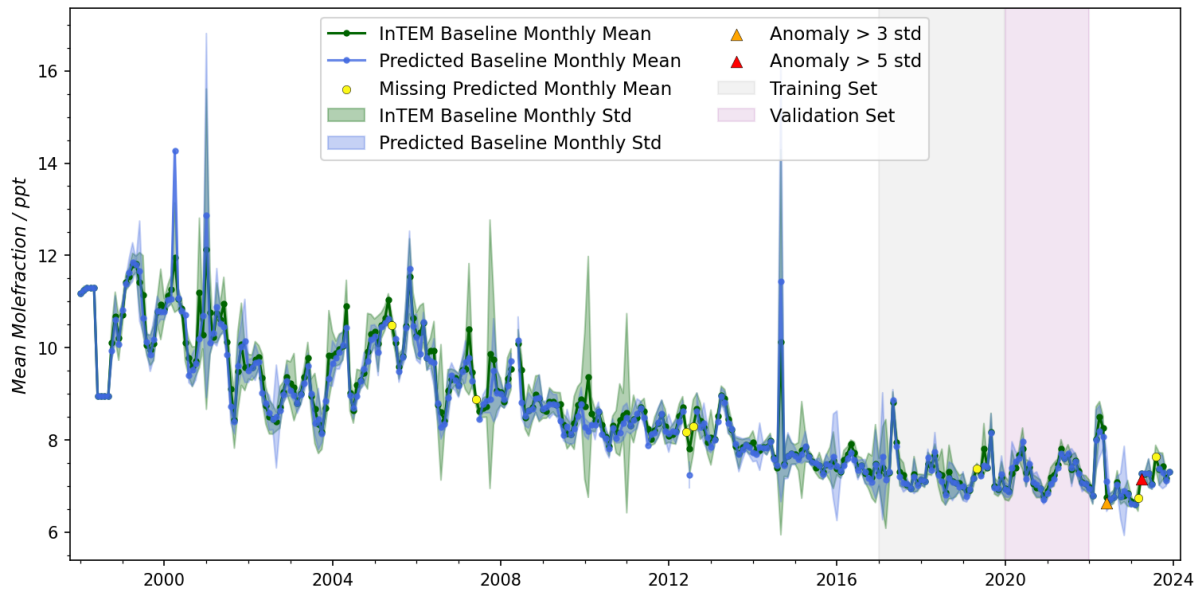
Molefraction time series (CH₃Br, MHD)



Model Confidence (CH₃Br, MHD)

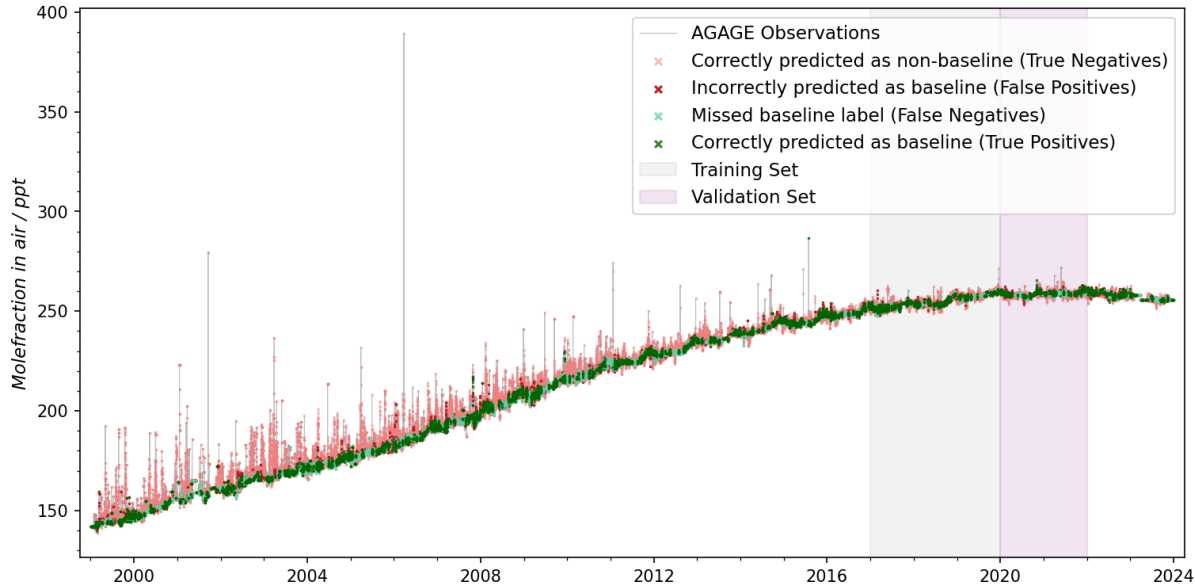


Monthly means (CH₃Br, MHD)

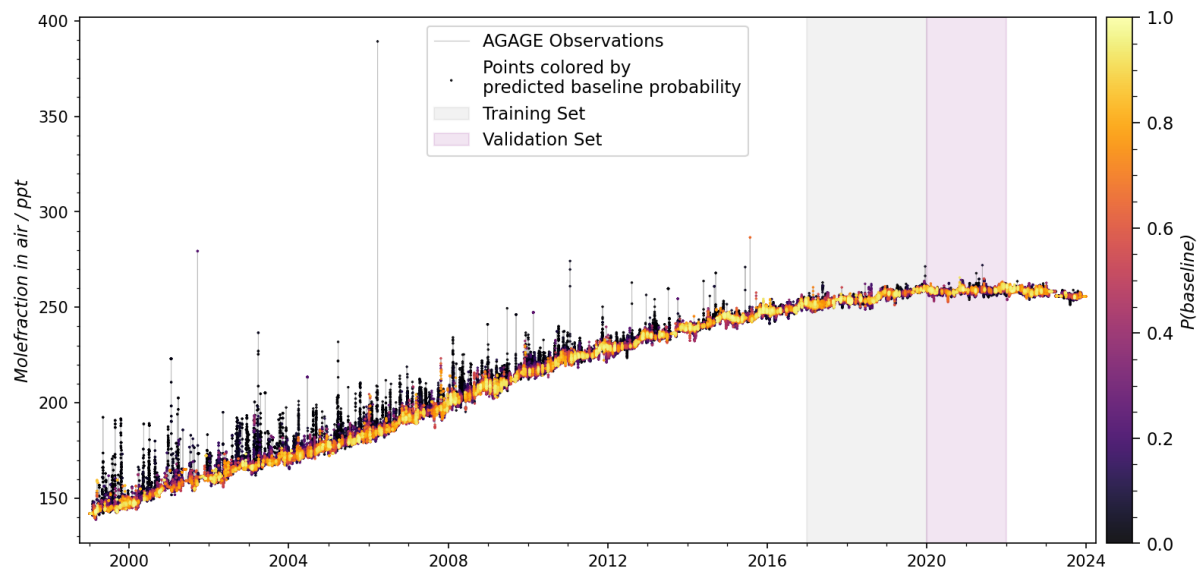


HCFC-22

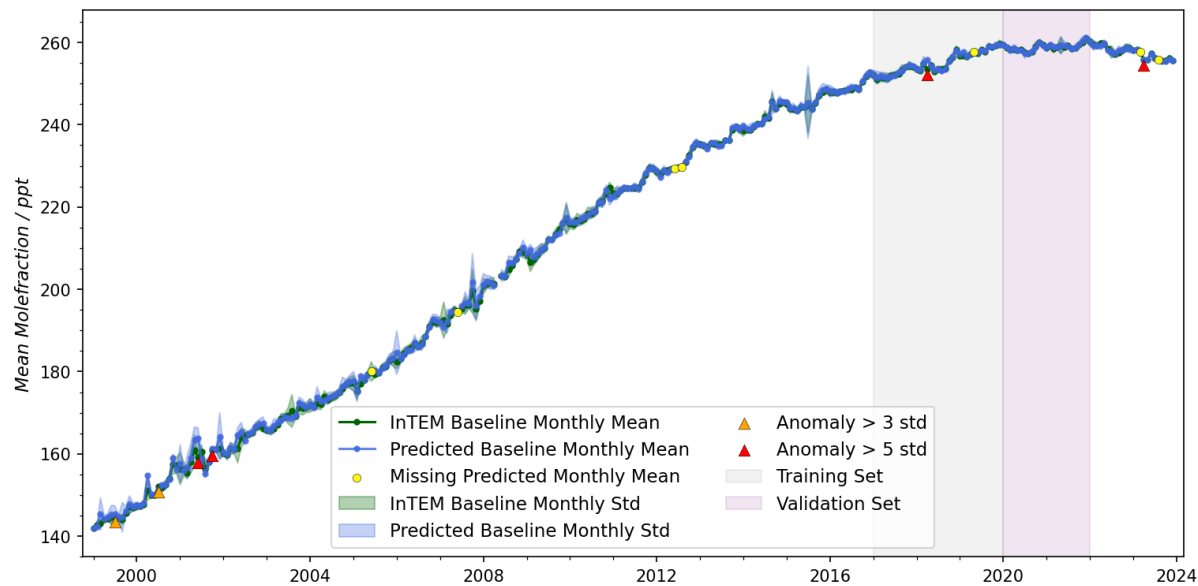
245 Molefraction time series (HCFC-22, MHD)



Model Confidence (HCFC-22, MHD)

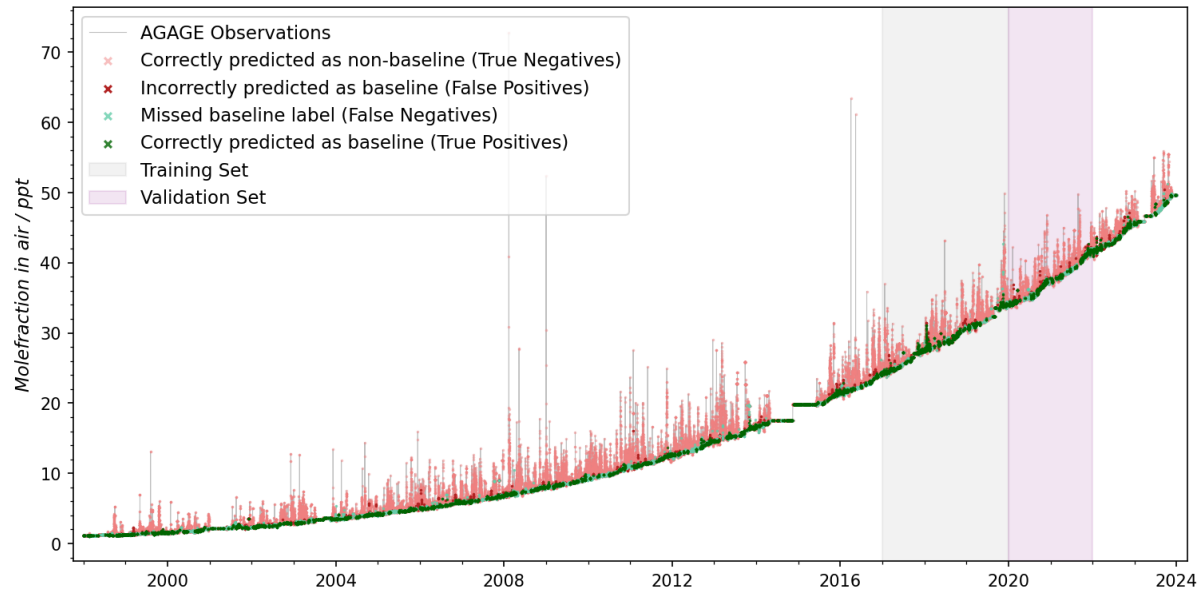


Monthly means (HCFC-22, MHD)

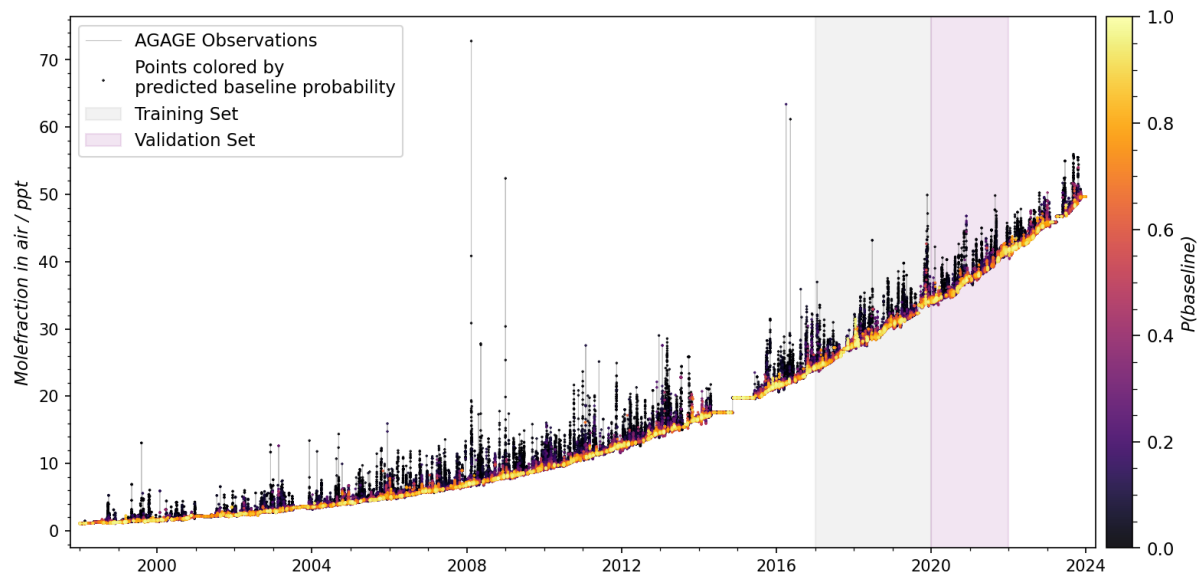


HFC-125

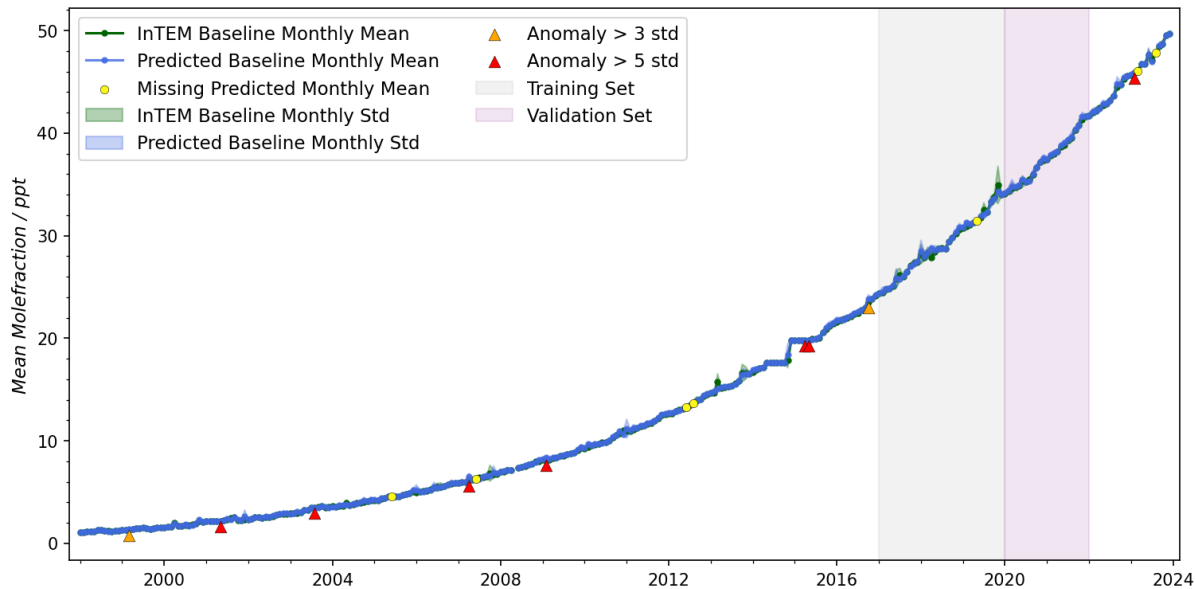
Molefraction time series (HFC-125, MHD)



250 Model Confidence (HFC-125, MHD)

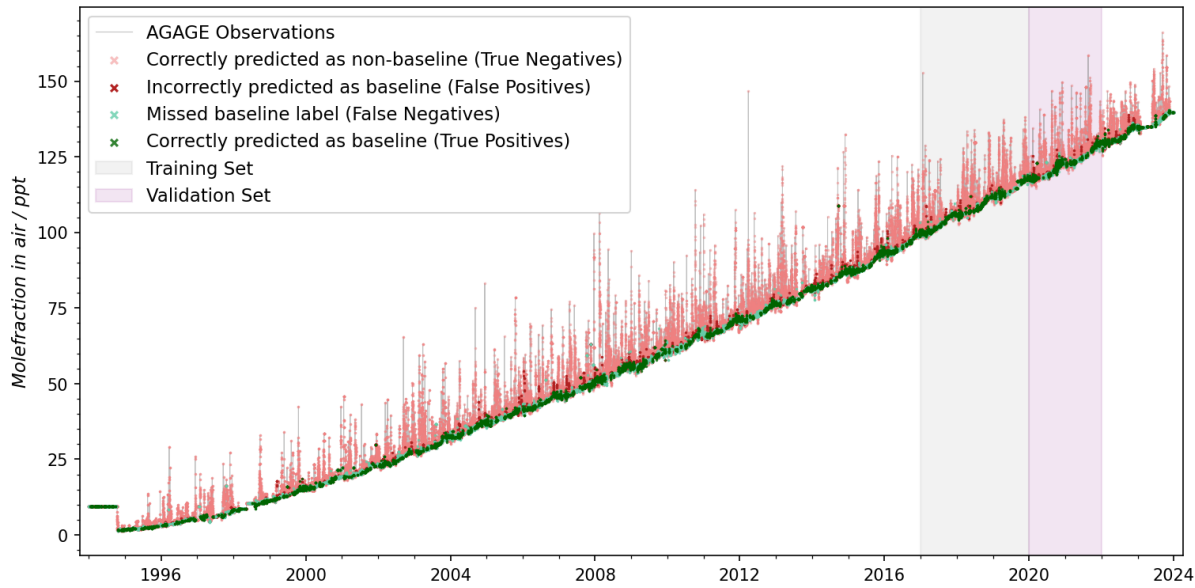


Monthly means (HFC-125, MHD)

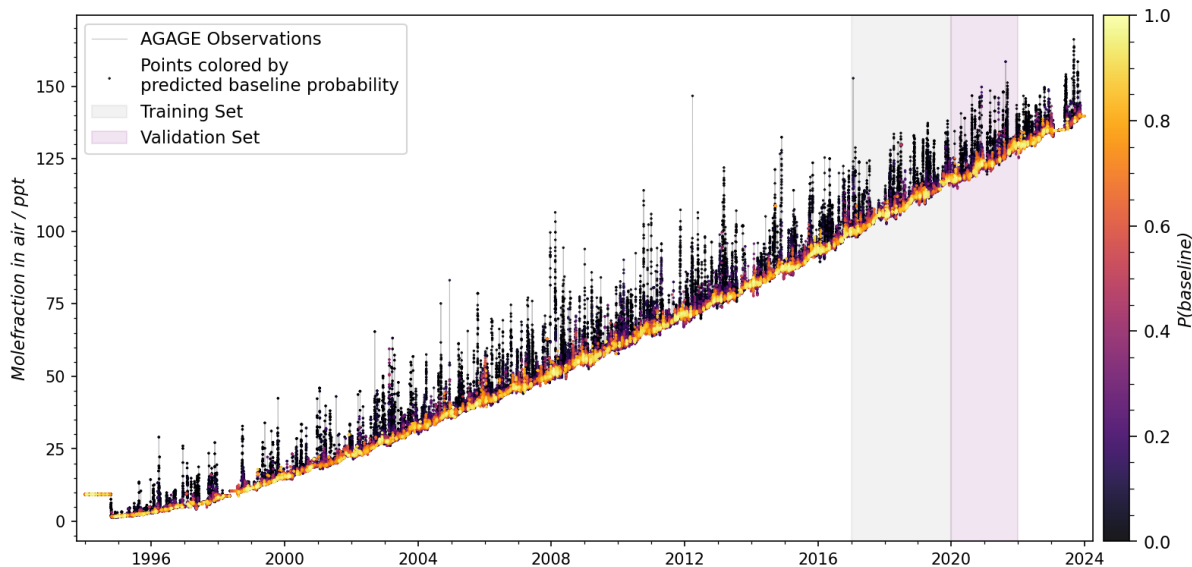


HFC-134a

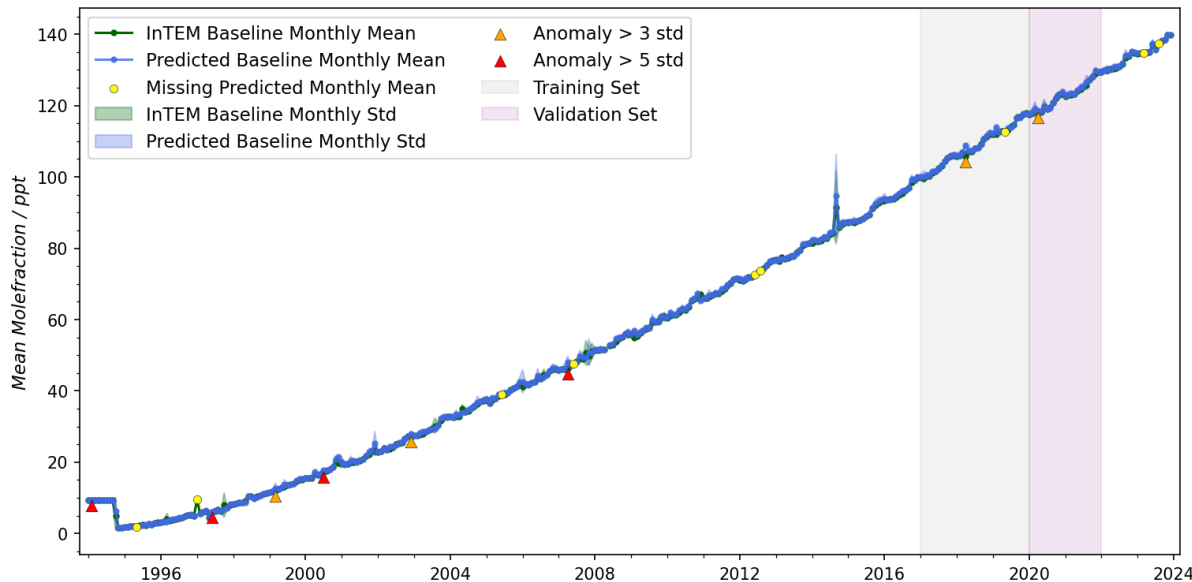
Molefraction time series (HFC-134a, MHD)



Model Confidence (HFC-134a, MHD)

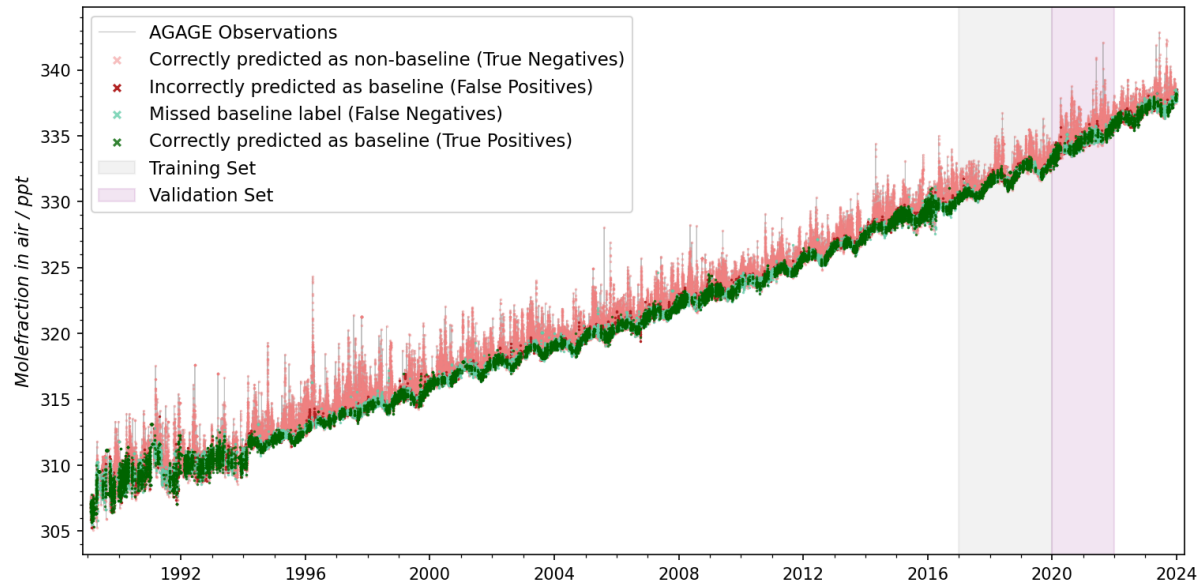


255 Monthly means (HFC-134a, MHD)

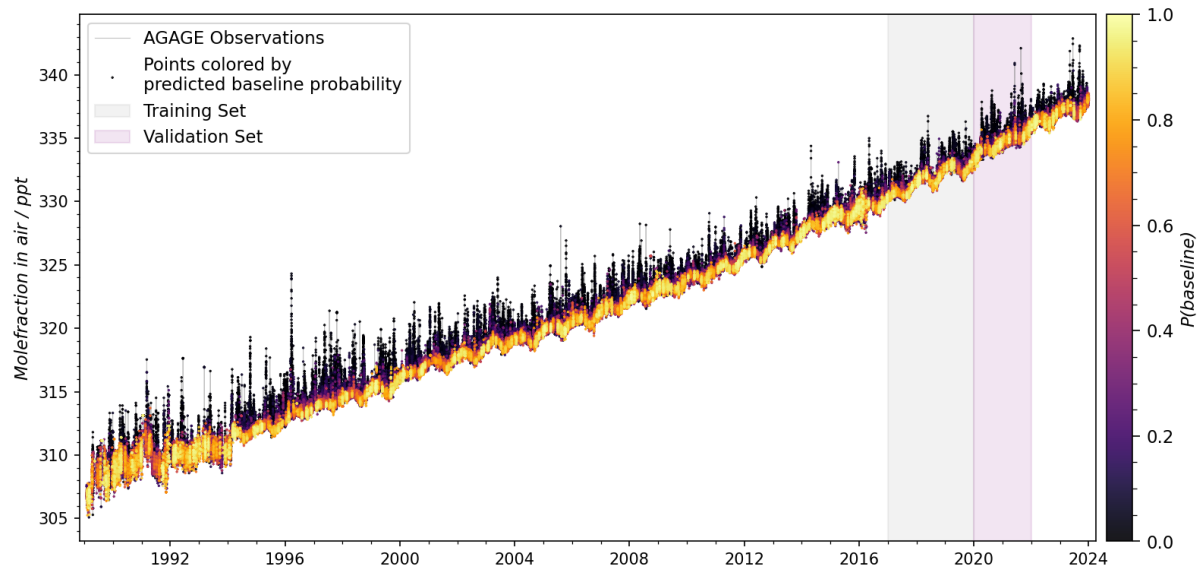


N₂O

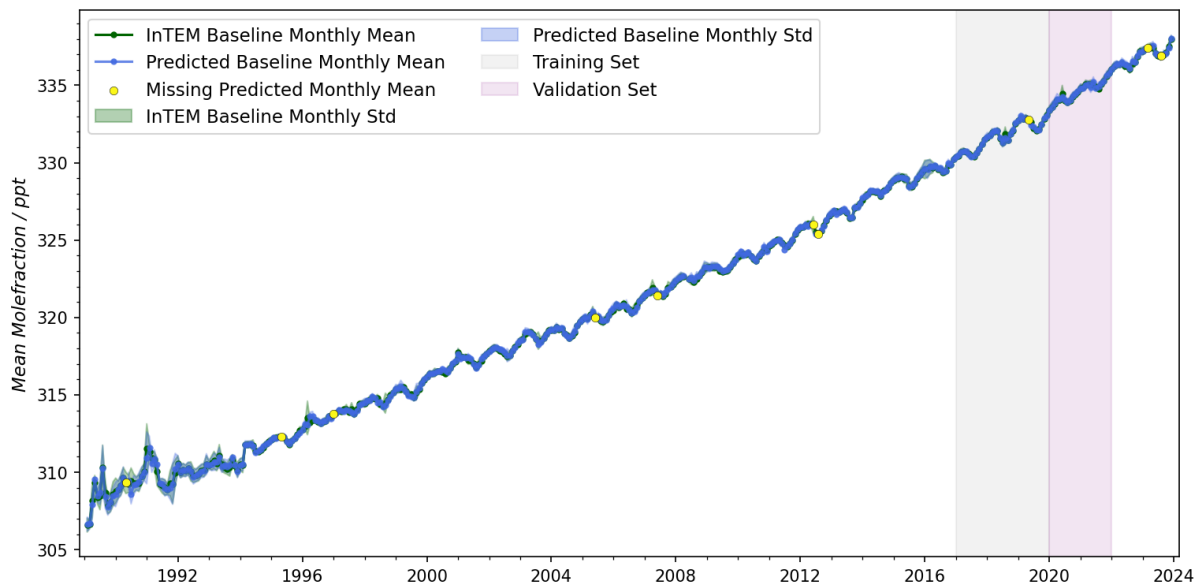
Molefraction time series (N₂O, MHD)



Model Confidence (N₂O, MHD)

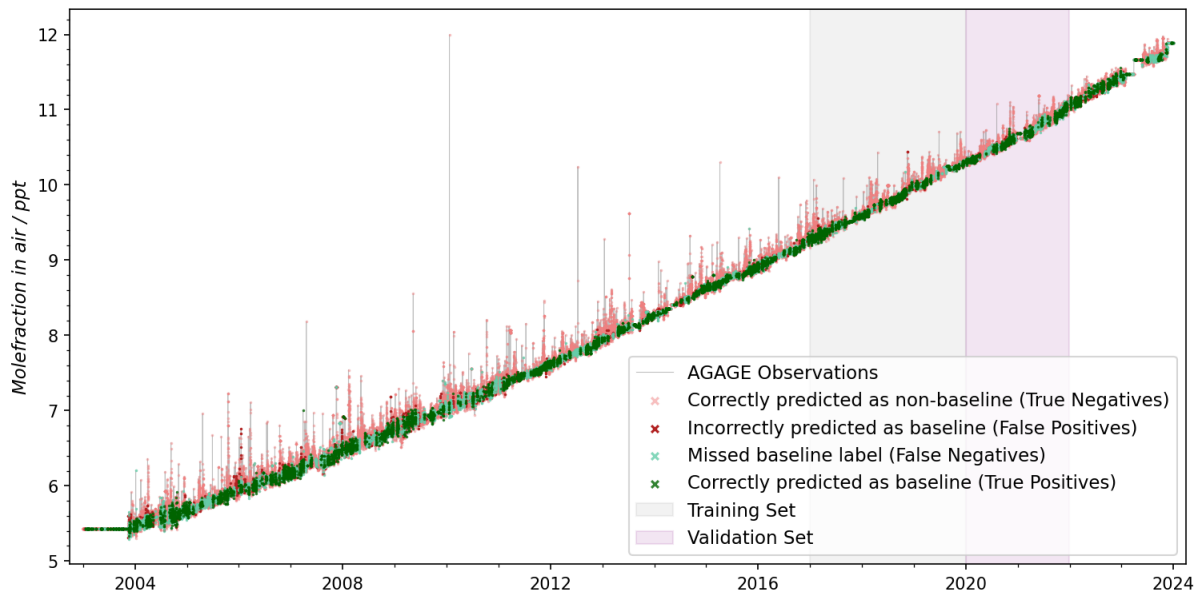


Monthly means (N₂O, MHD)

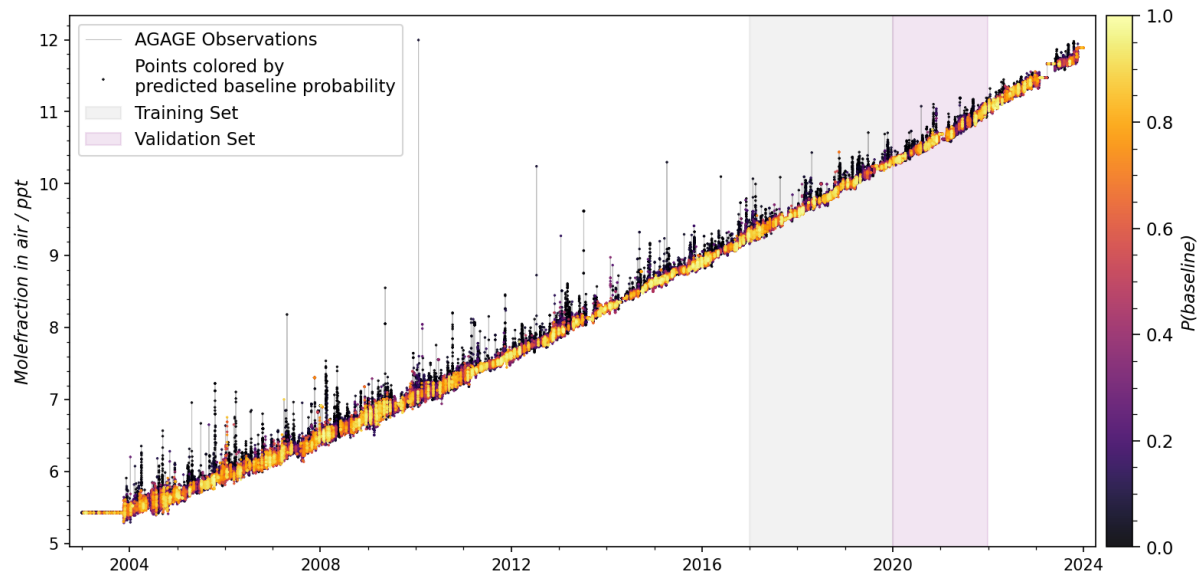


260 SF₆

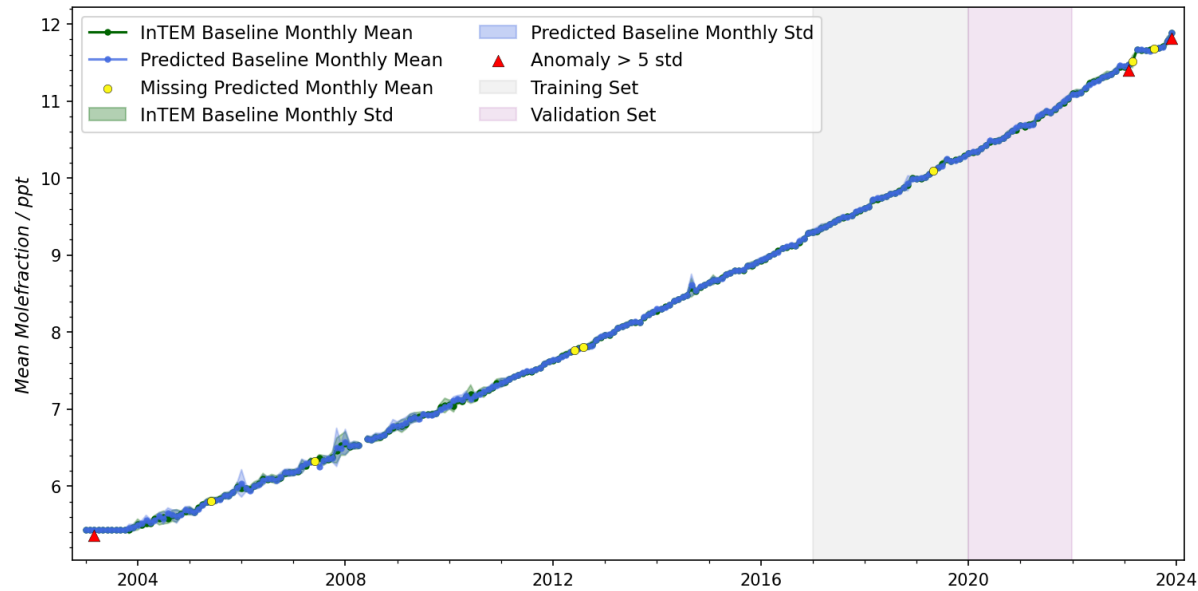
Molefraction time series (SF₆, MHD)



Model Confidence (SF₆, MHD)



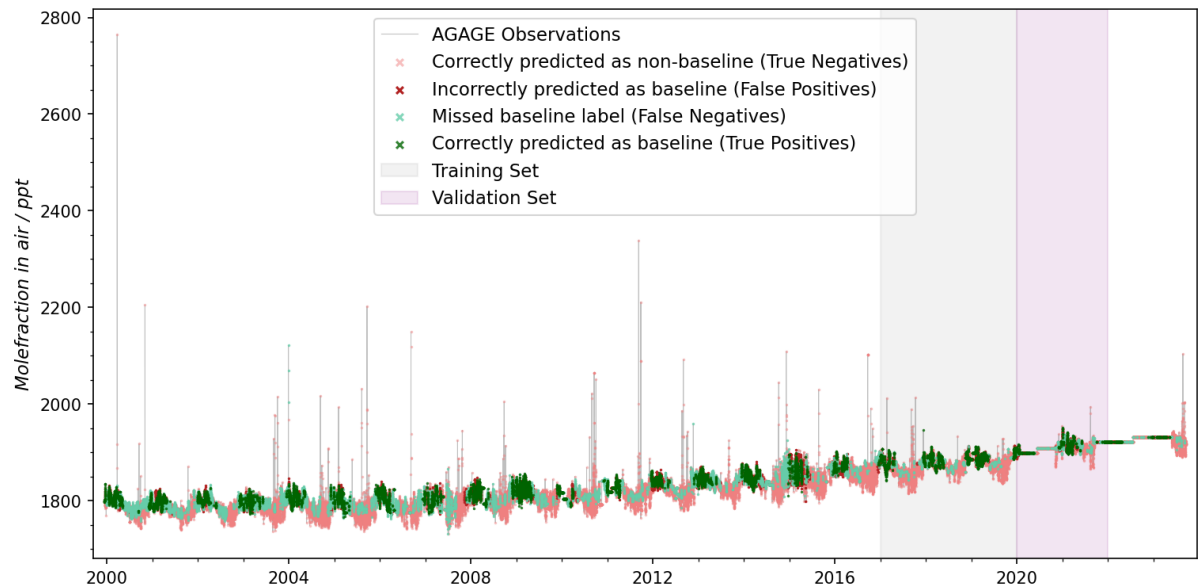
Monthly means (SF₆, MHD)



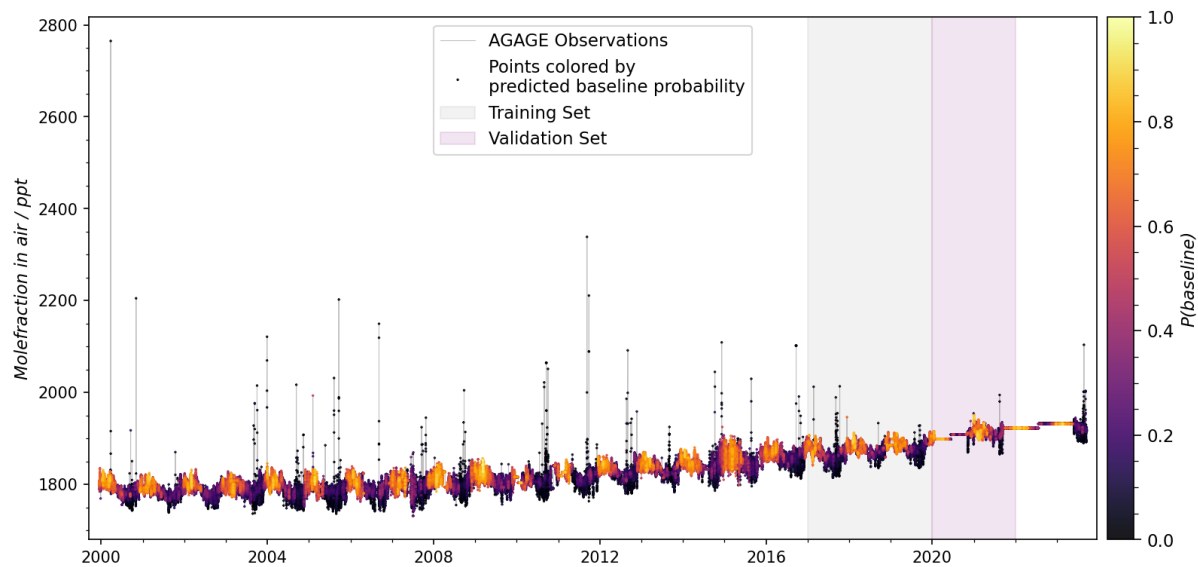
S9.6 Ragged Point, Barbados

265 CH₄

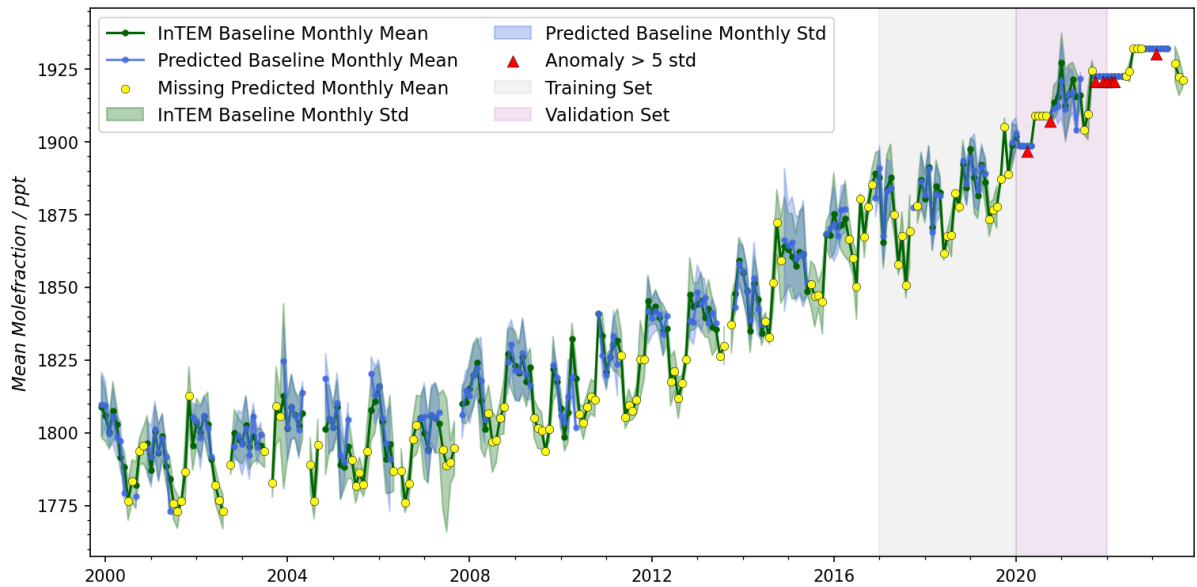
Molefraction time series (CH₄, RPB)



Model Confidence (CH₄, RPB)

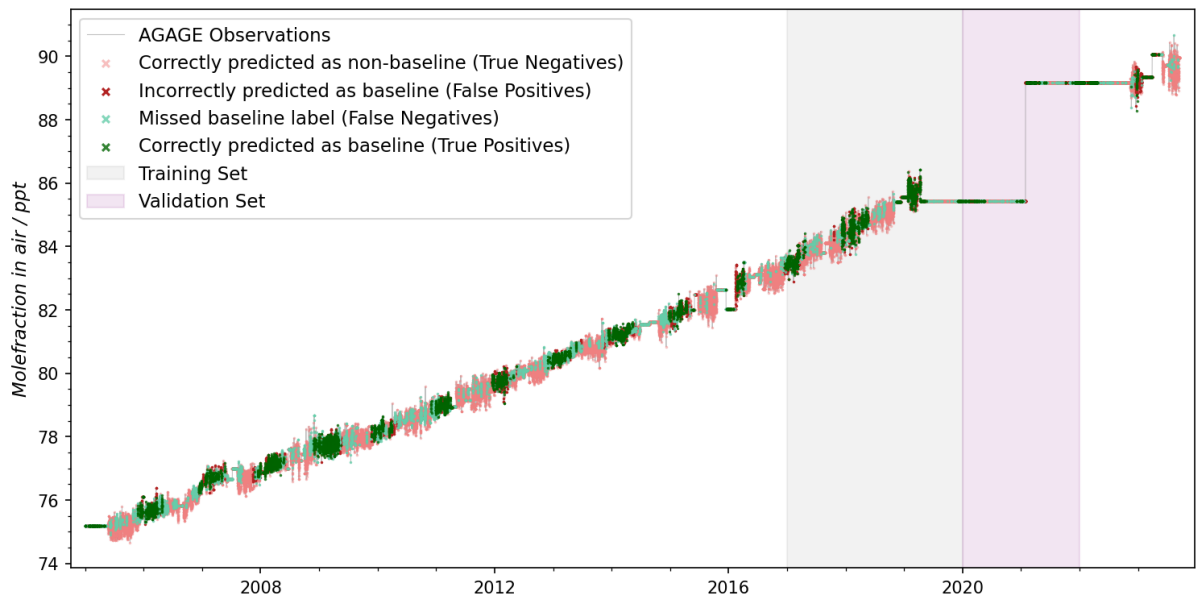


Monthly means (CH₄, RPB)

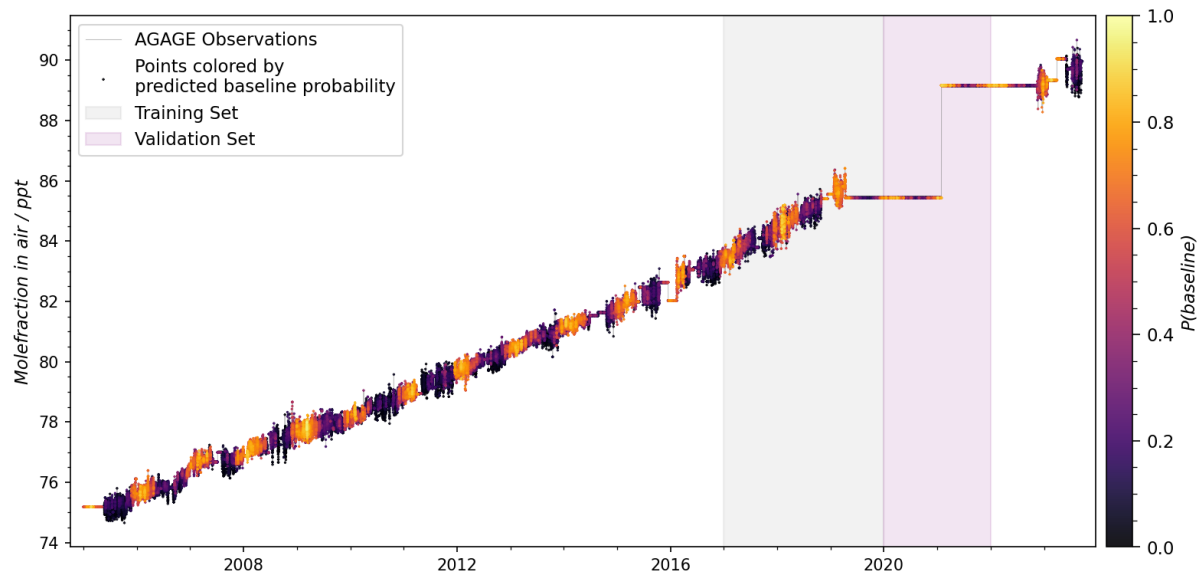


CF₄

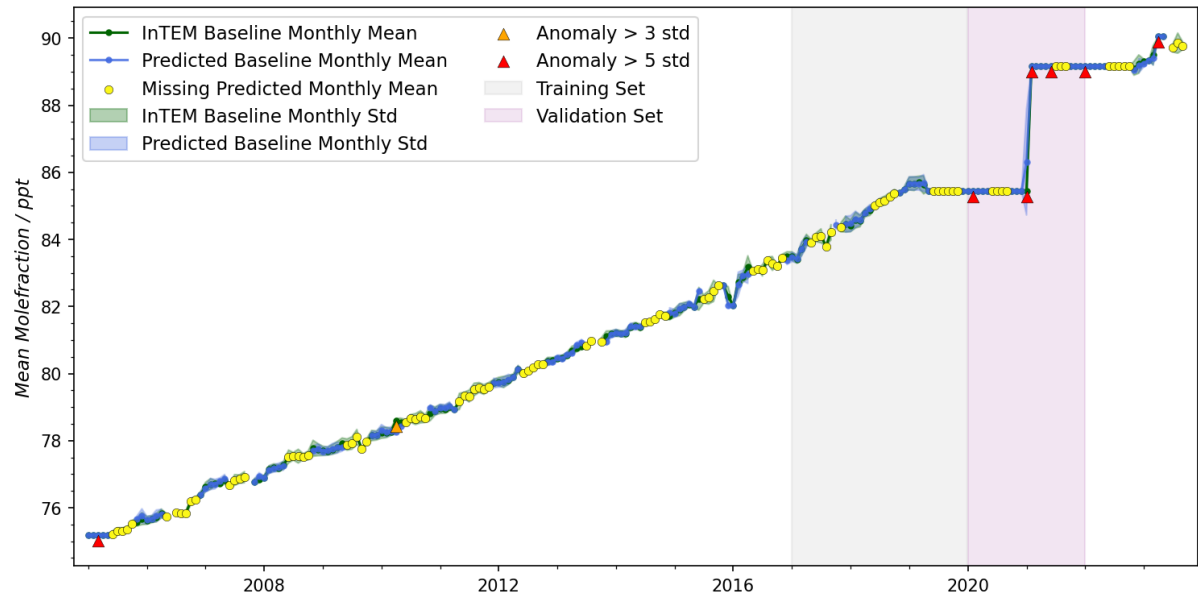
270 Molefraction time series (CF₄, RPB)



Model Confidence (CF₄, RPB)

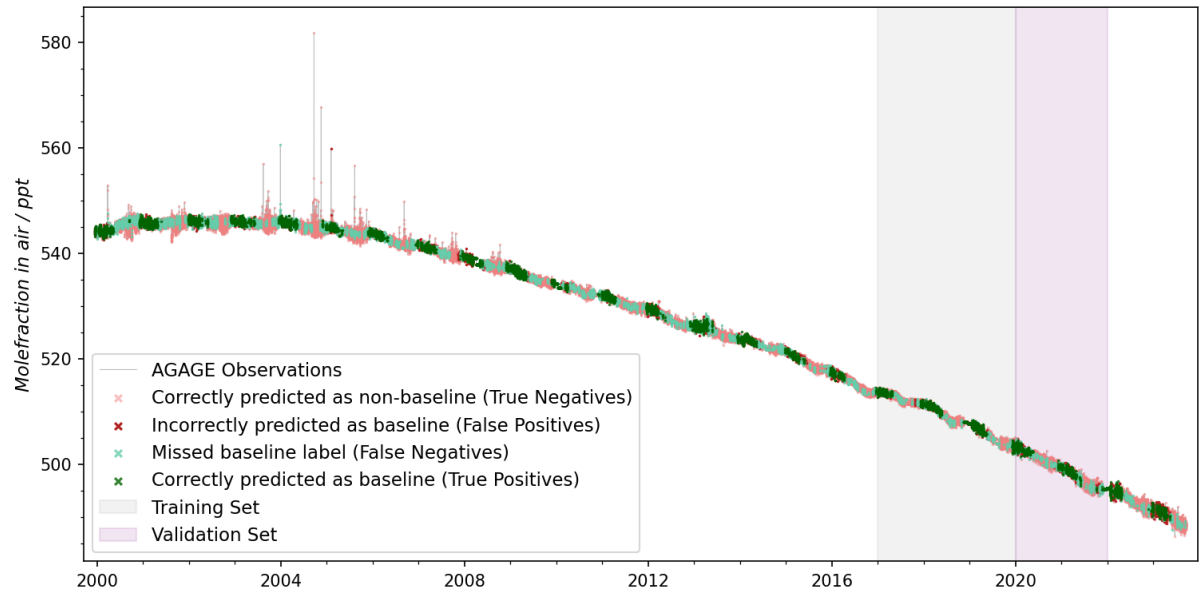


Monthly means (CF₄, RPB)



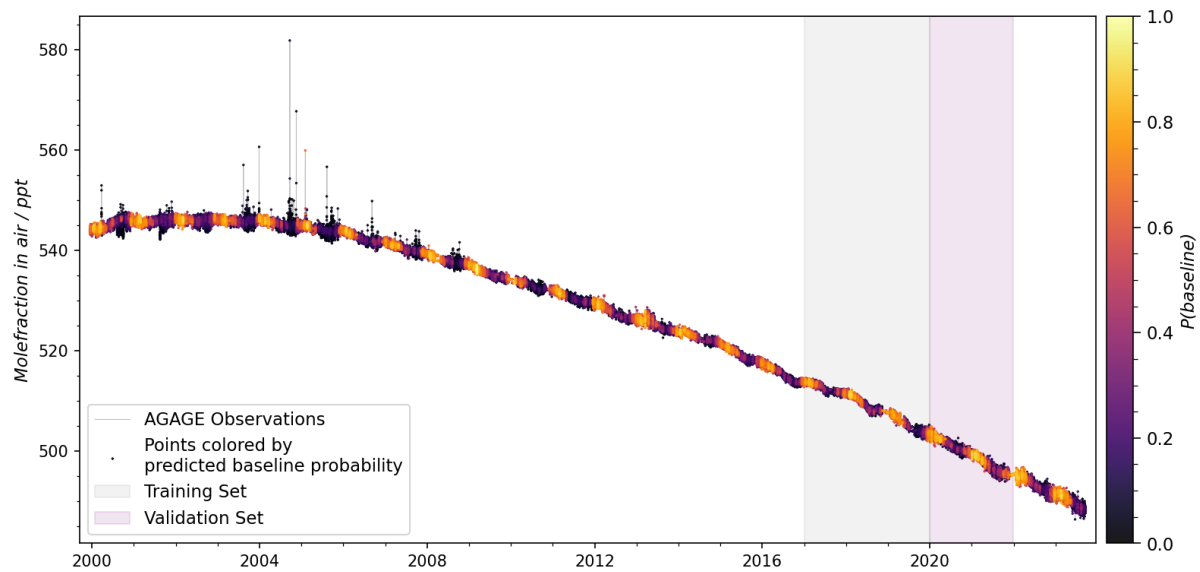
CFC-12

Molefraction time series (CFC-12, RPB)

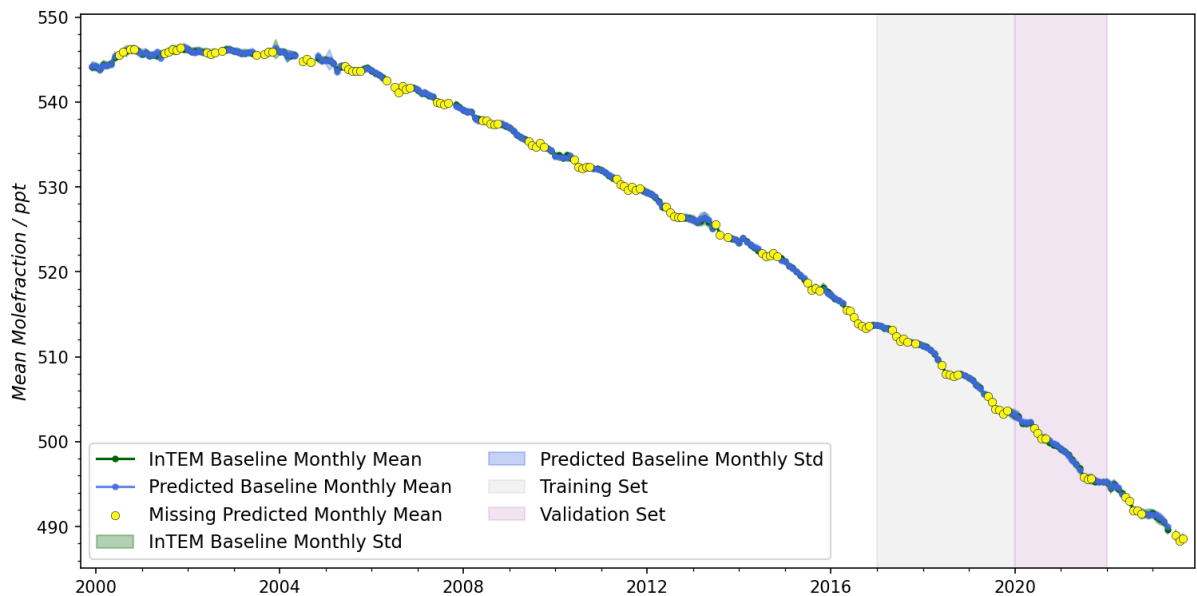


275

Model Confidence (CFC-12, RPB)

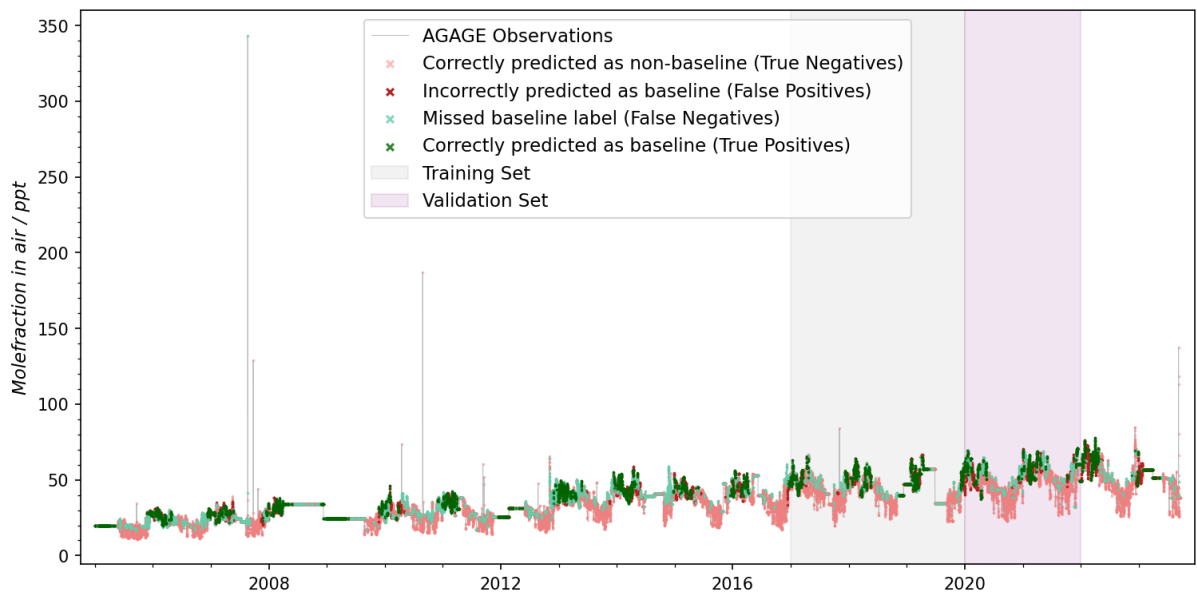


Monthly means (CFC-12, RPB)

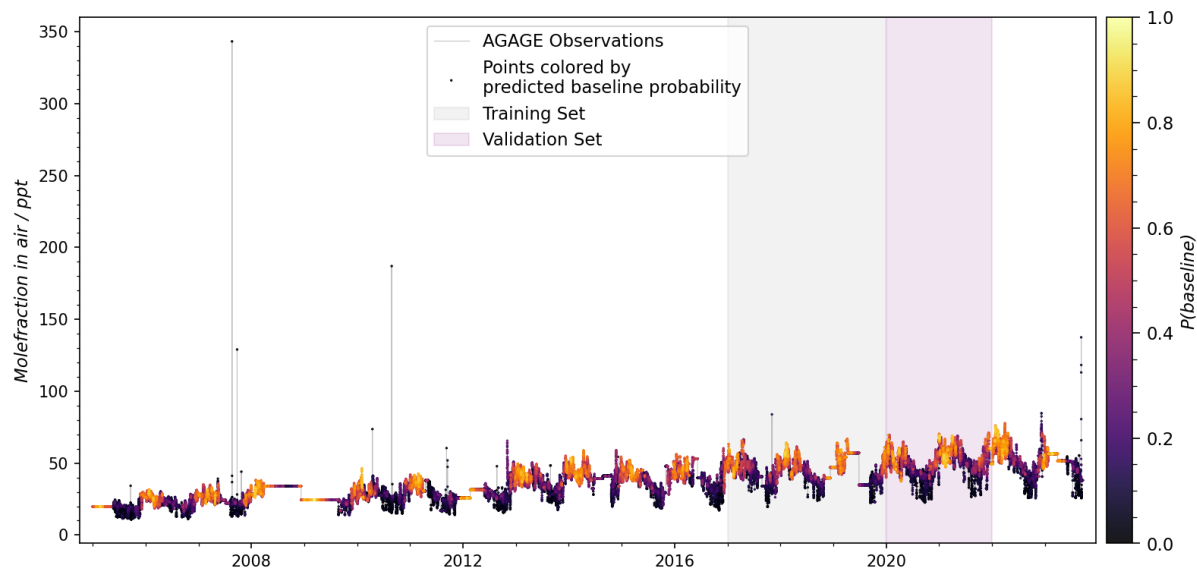


CH₂Cl₂

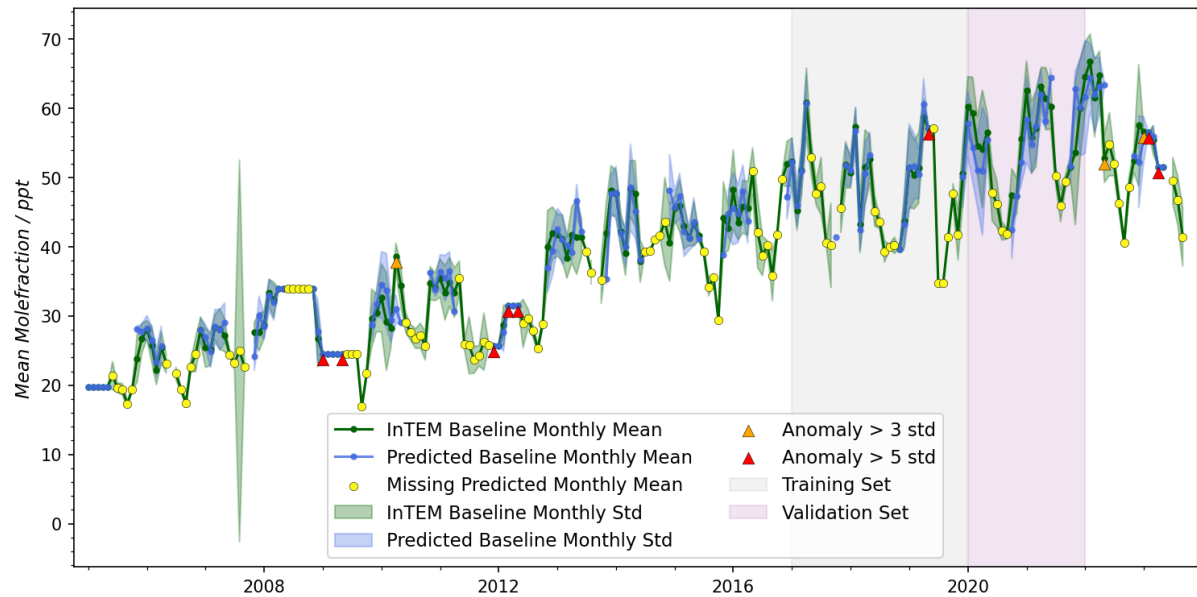
Molefraction time series (CH₂Cl₂, RPB)



Model Confidence (CH₂Cl₂, RPB)

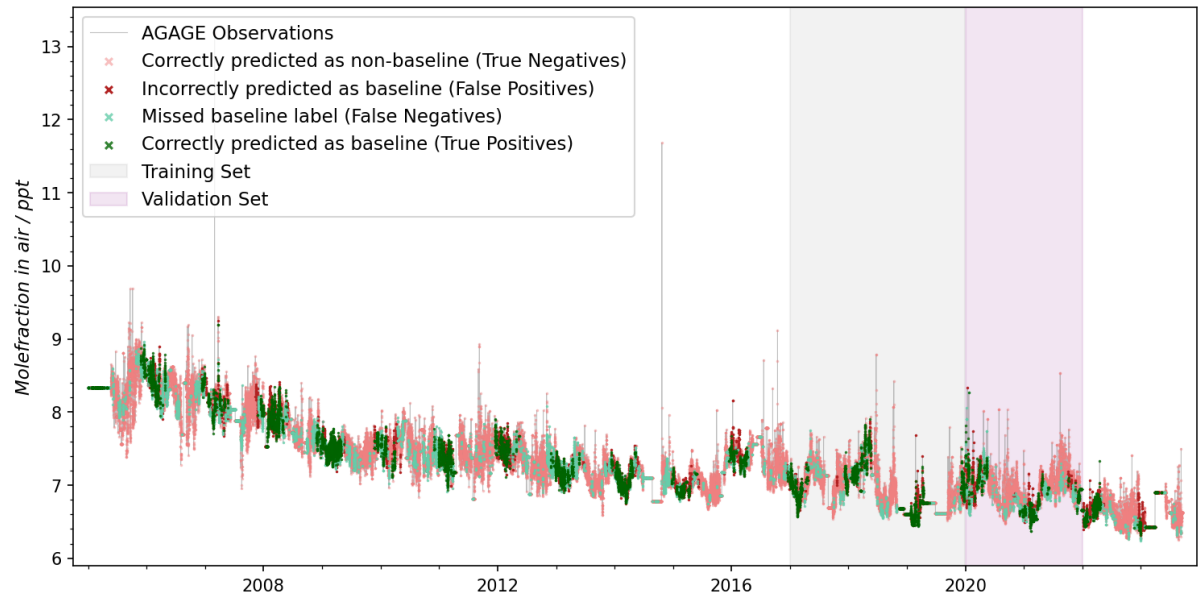


280 Monthly means (CH₂Cl₂, RPB)

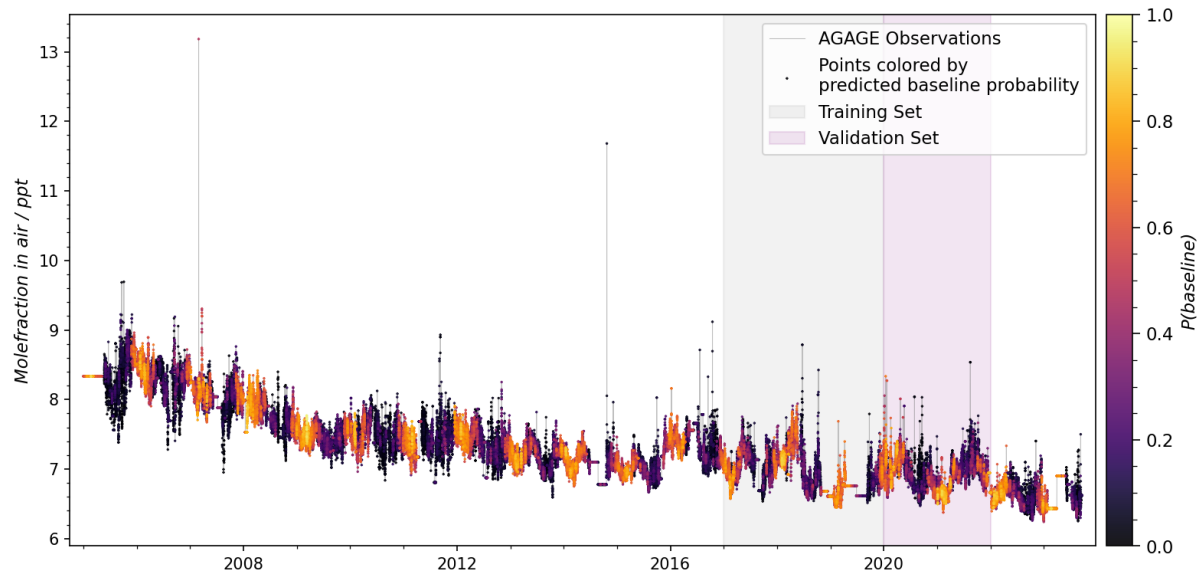


CH₃Br

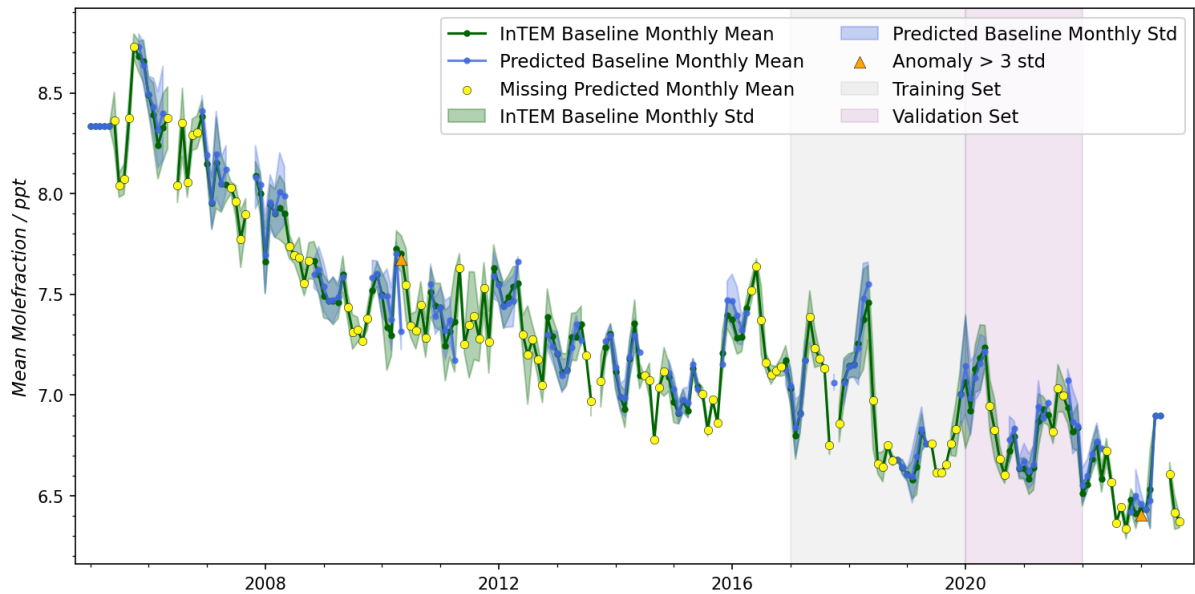
Molefraction time series (CH₃Br, RPB)



Model Confidence (CH₃Br, RPB)

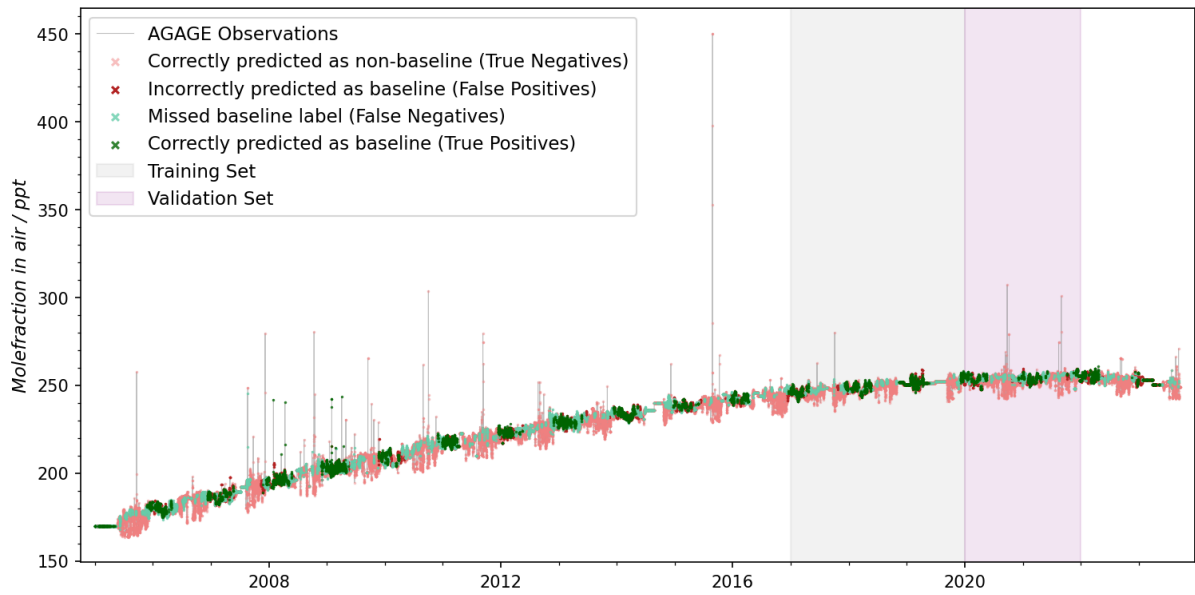


Monthly means (CH₃Br, RPB)

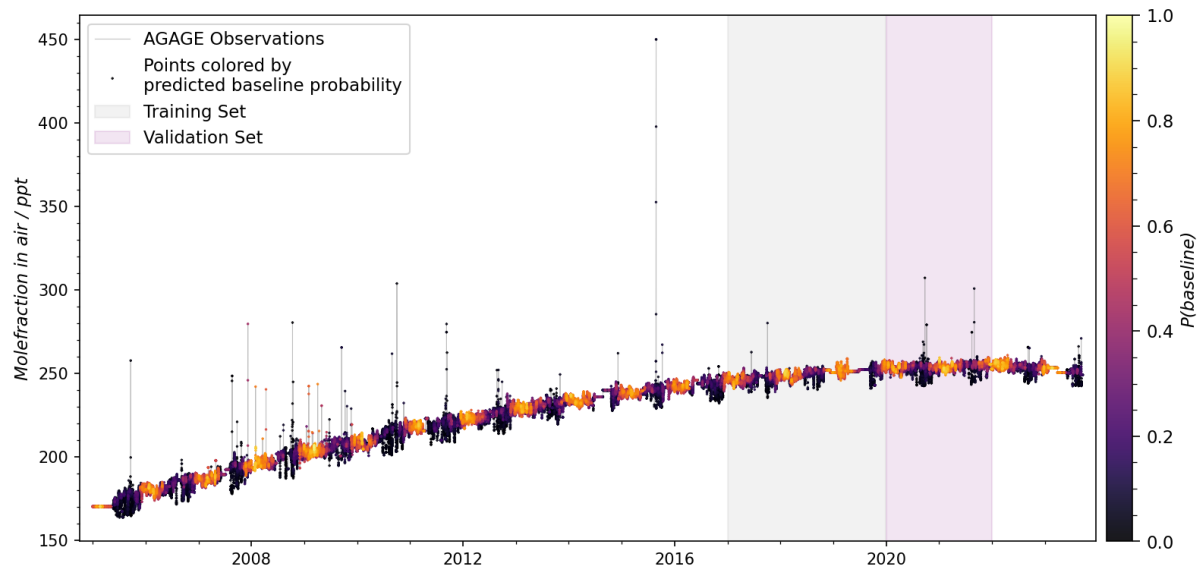


285 HCFC-22

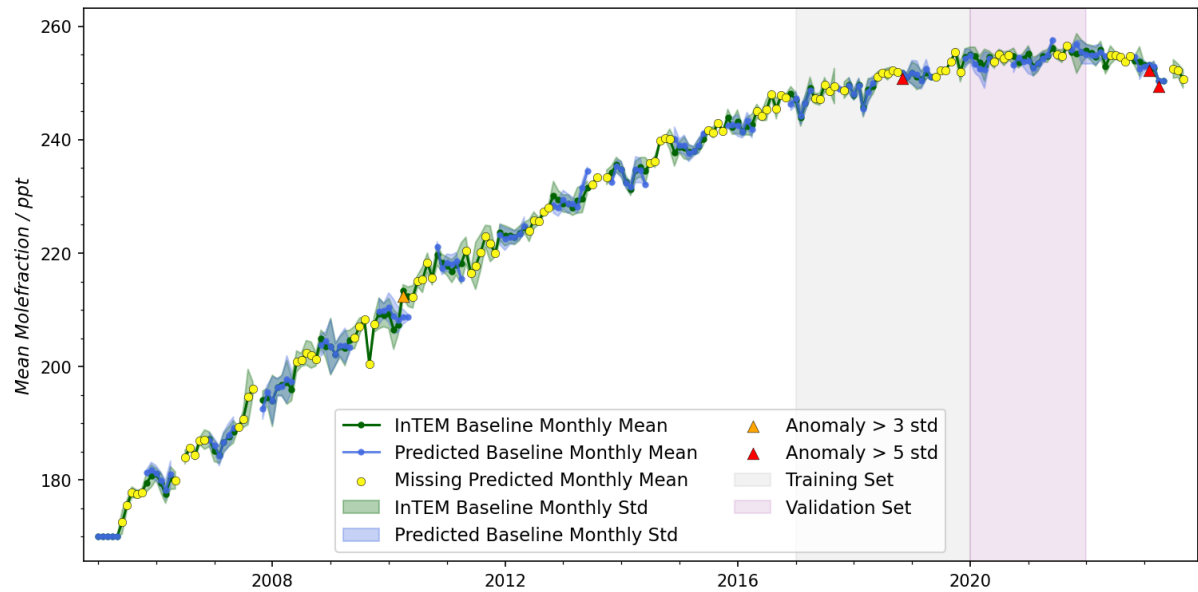
Molefraction time series (HCFC-22, RPB)



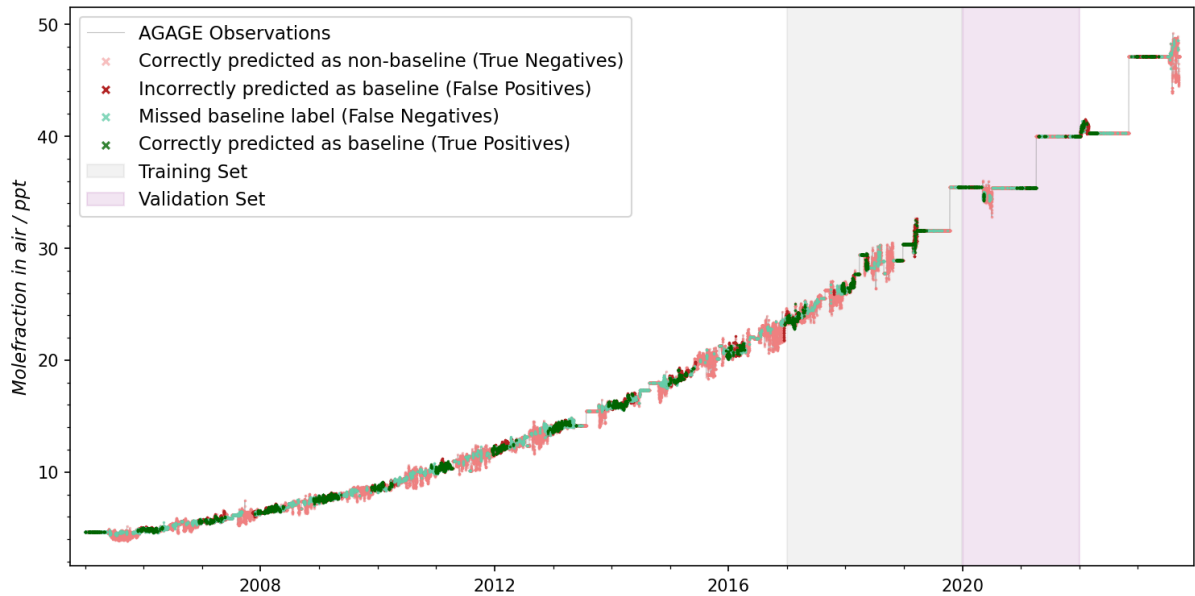
Model Confidence (HCFC-22, RPB)



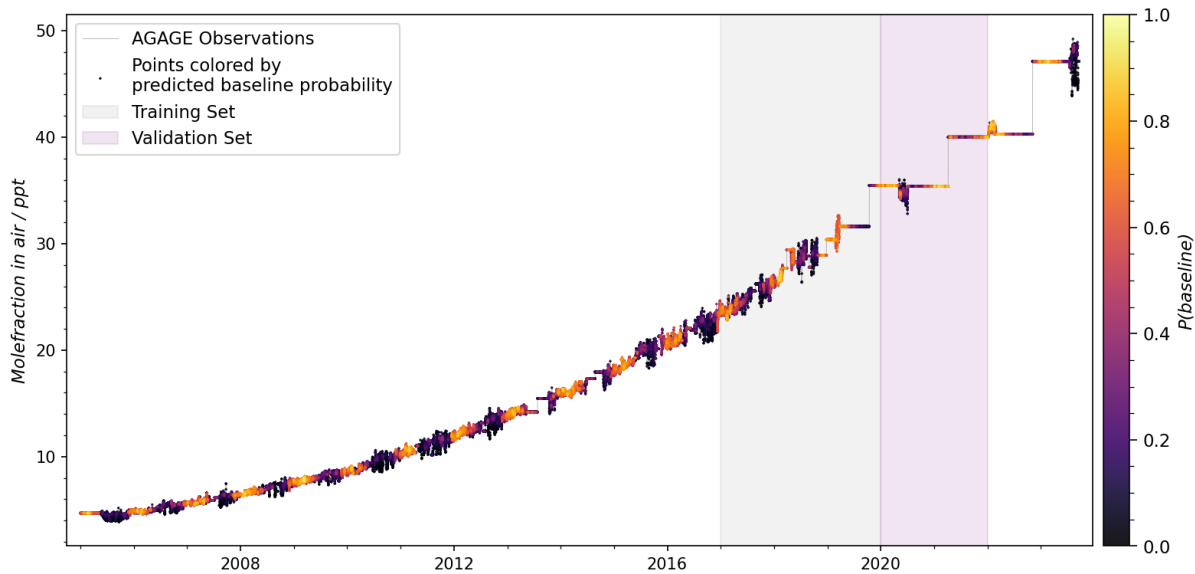
Monthly means (HCFC-22, RPB)



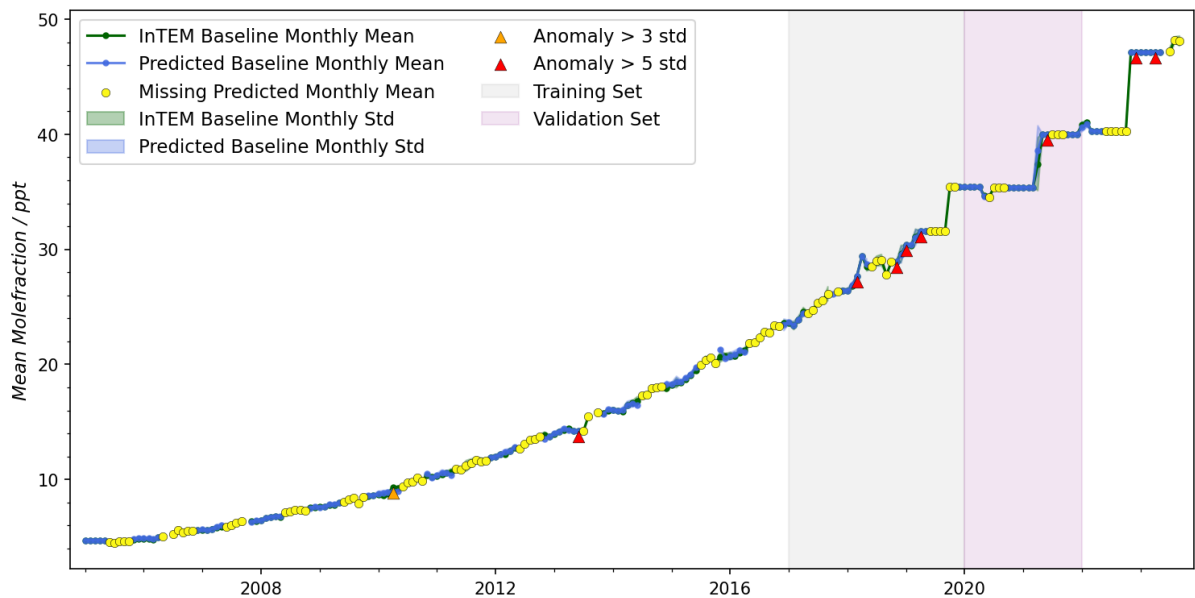
290 Molefraction time series (HFC-125, RPB)



Model Confidence (HFC-125, RPB)

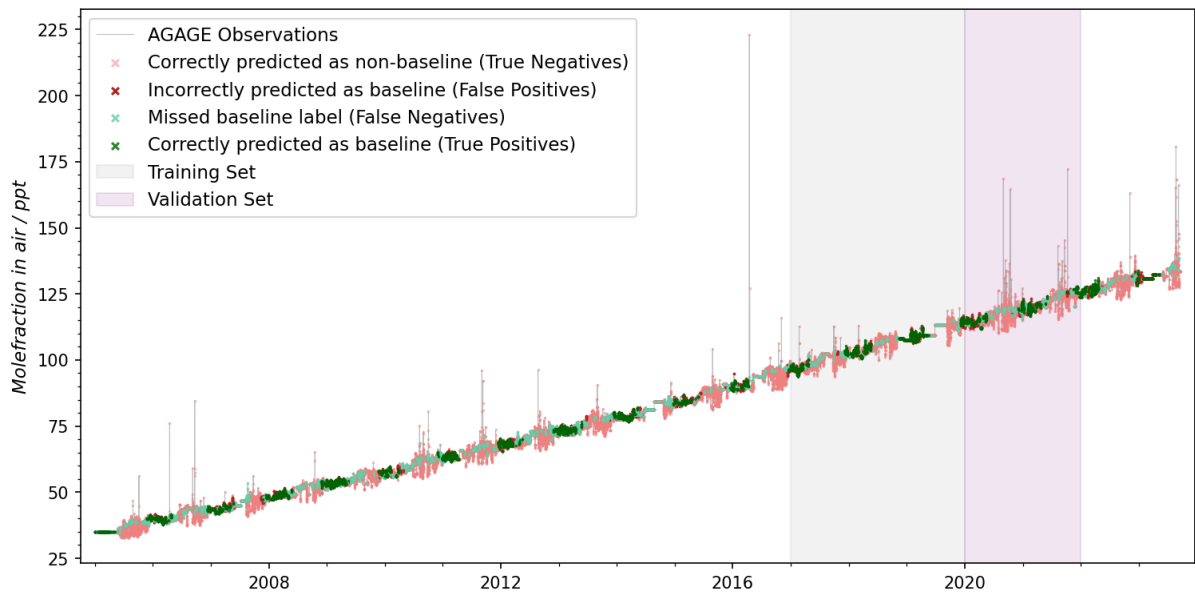


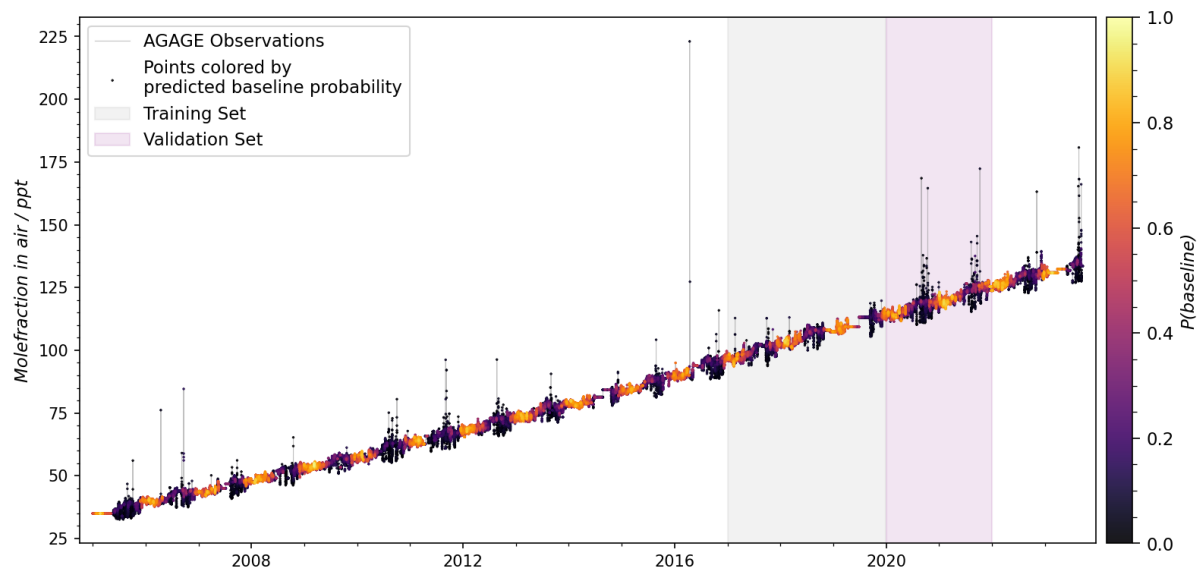
Monthly means (HFC-125, RPB)



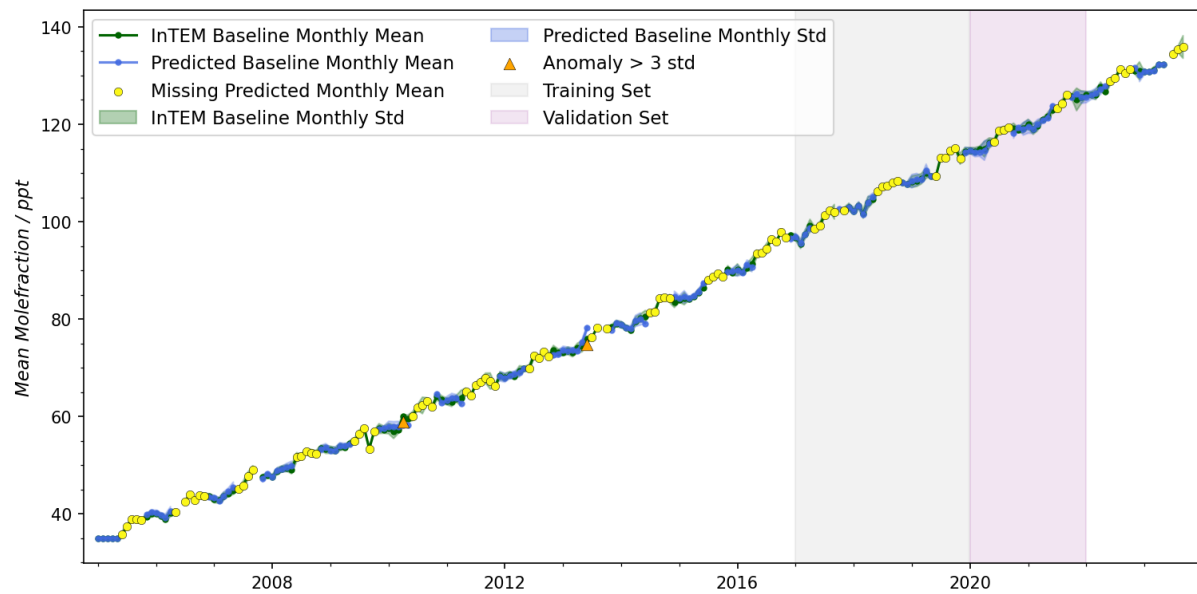
HFC-134a

Molefraction time series (HFC-134a, RPB)



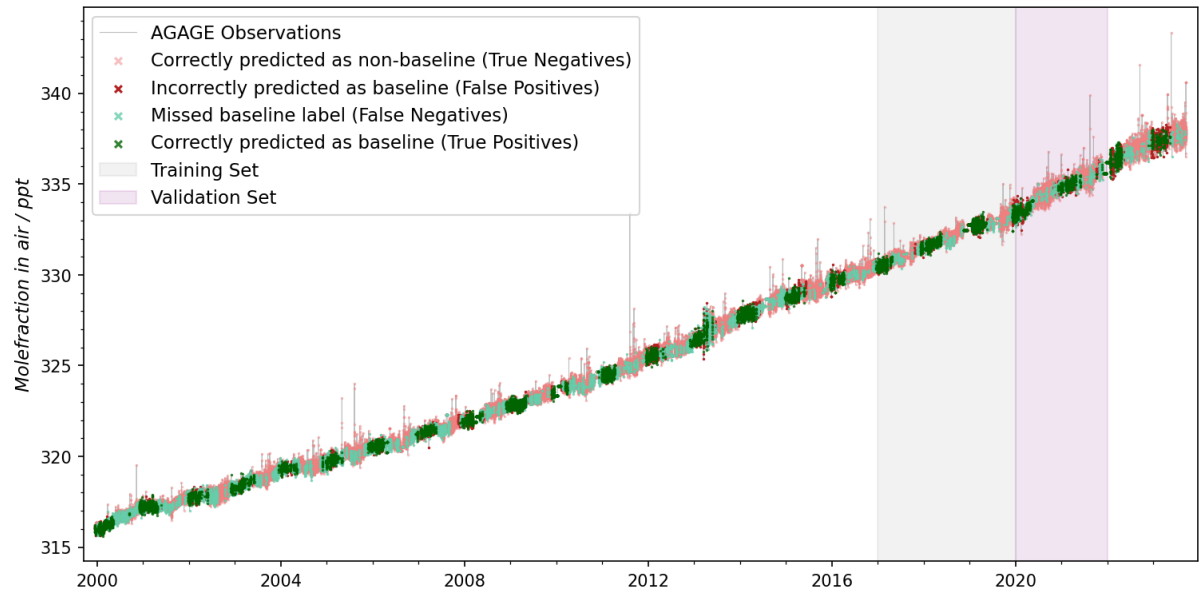


Monthly means (HFC-134a, RPB)

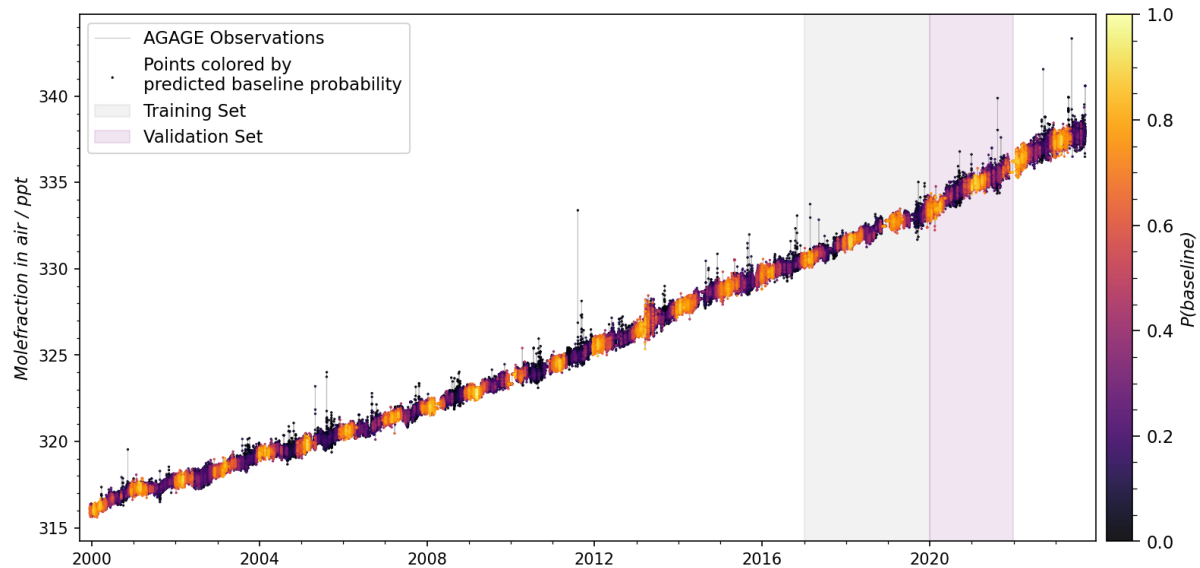


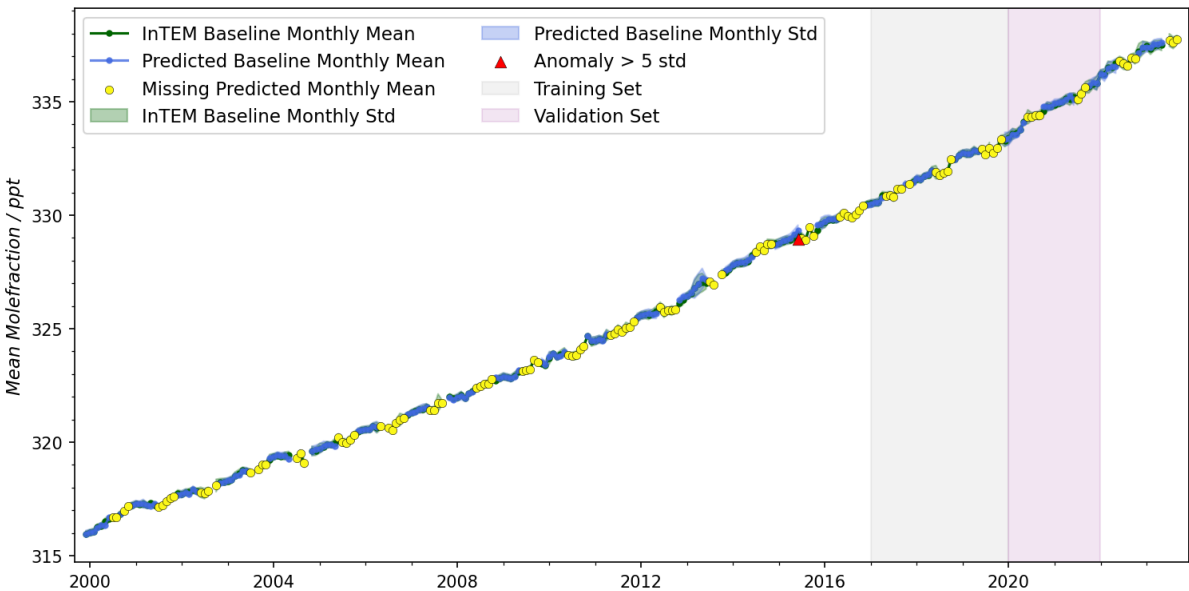
N₂O

Molefraction time series (N₂O, RPB)

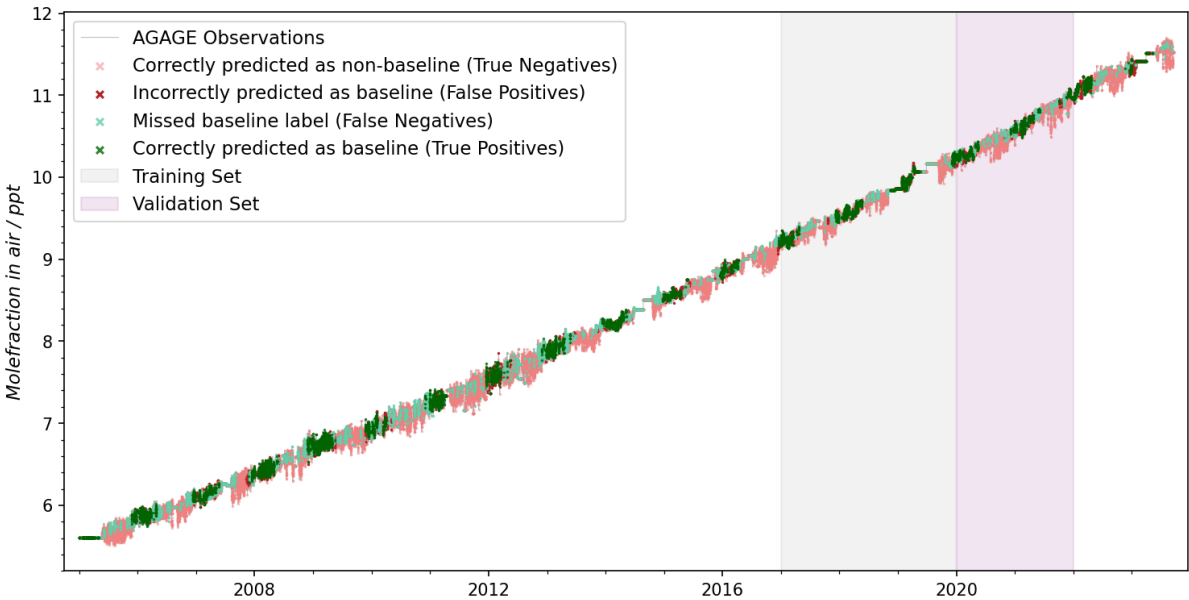


Model Confidence (N₂O, RPB)

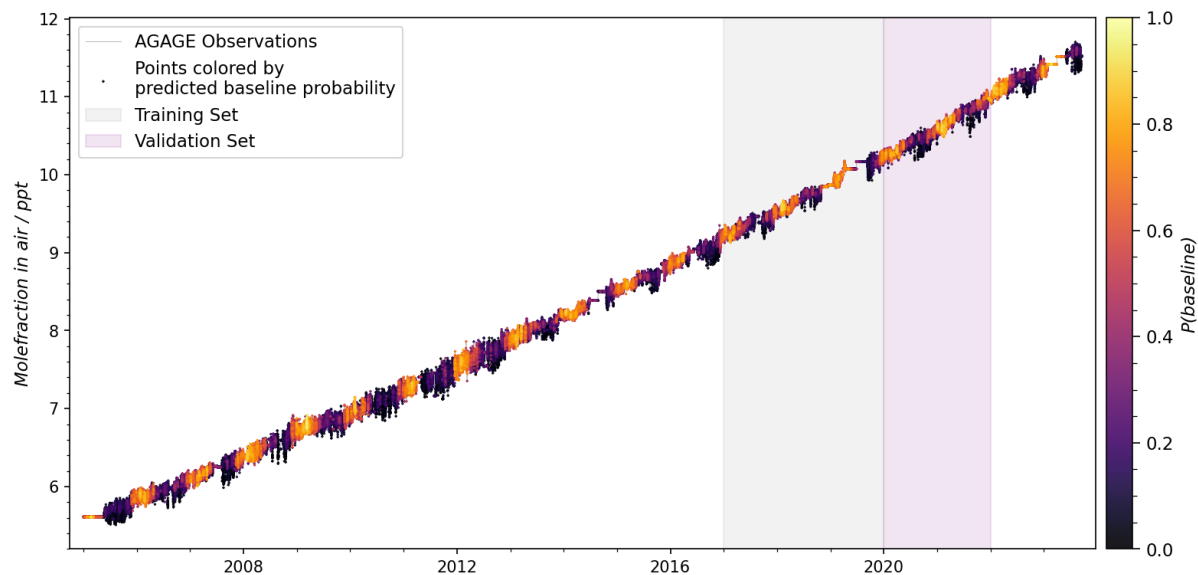




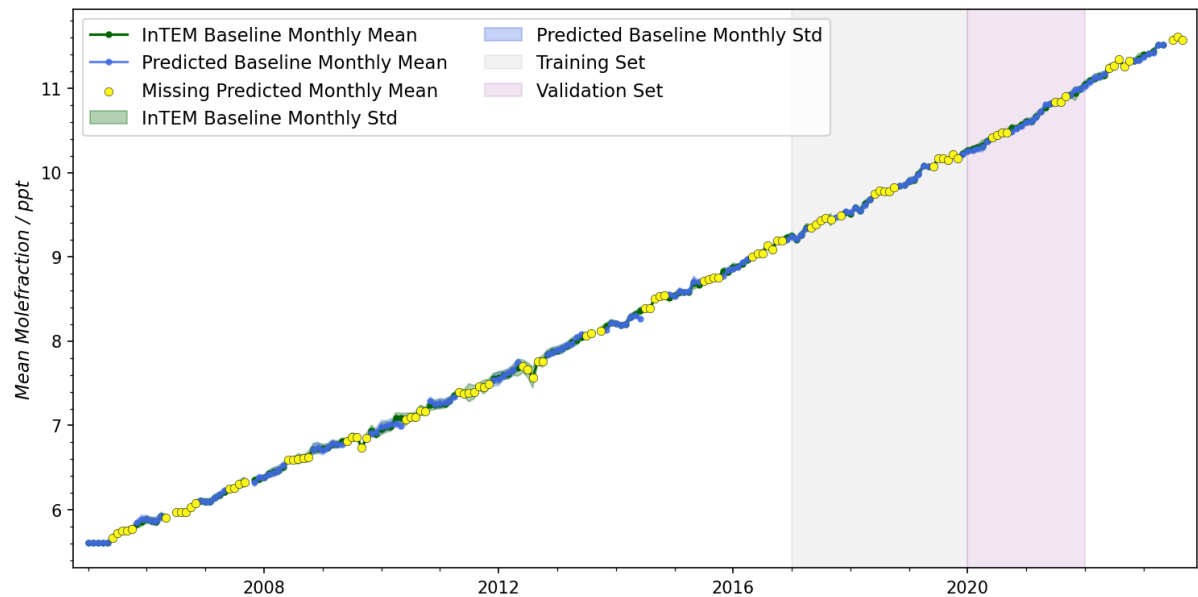
SF₆
Molefraction time series (SF₆, RPB)



Model Confidence (SF₆, RPB)

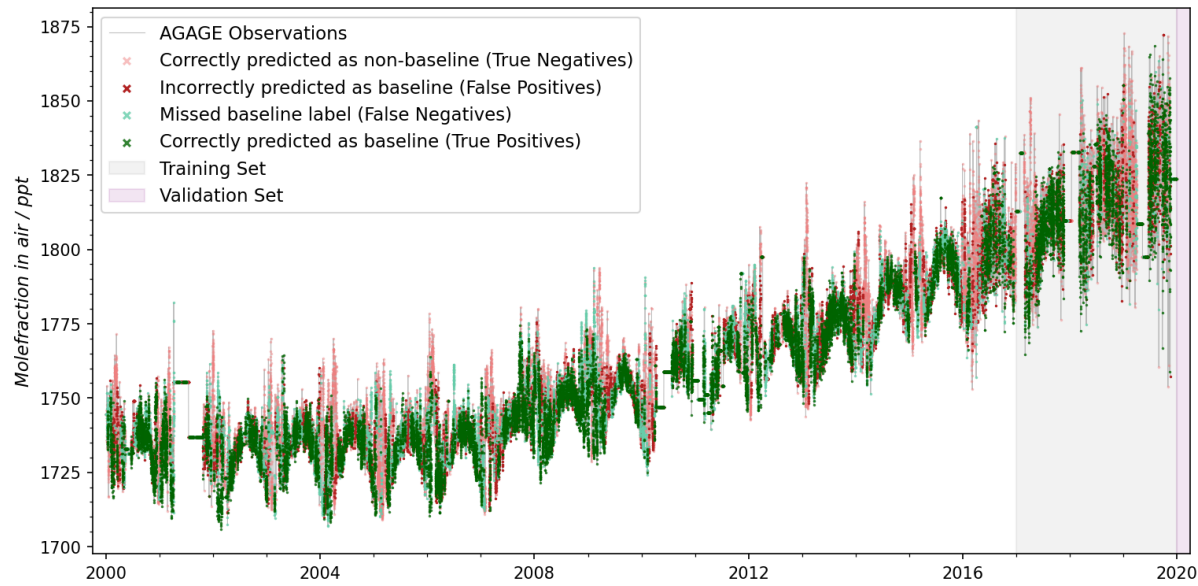


Monthly means (SF₆, RPB)

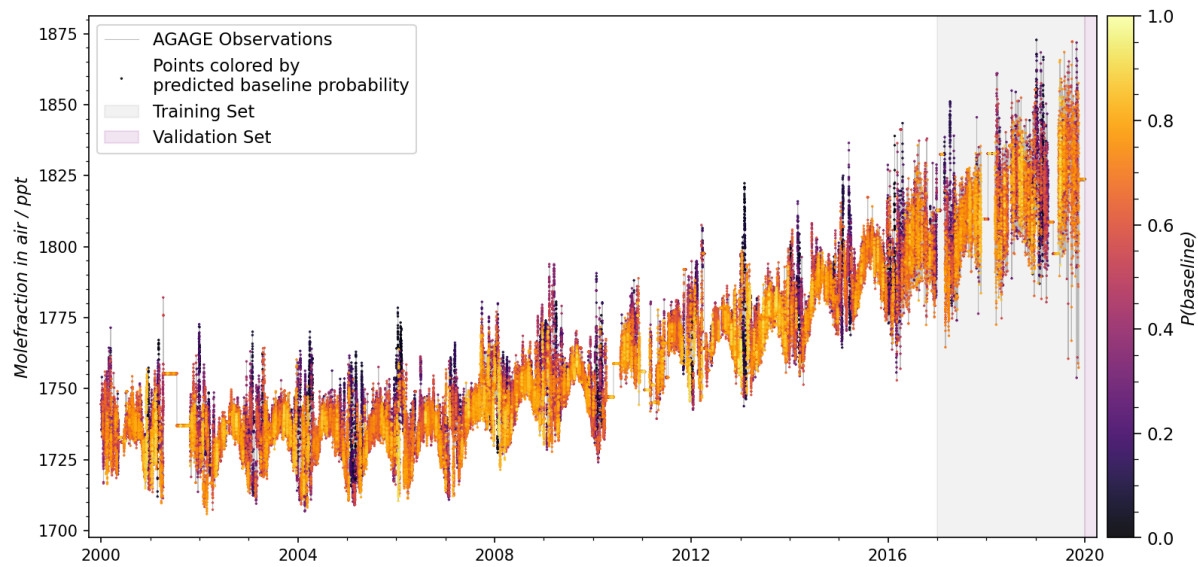


CH₄

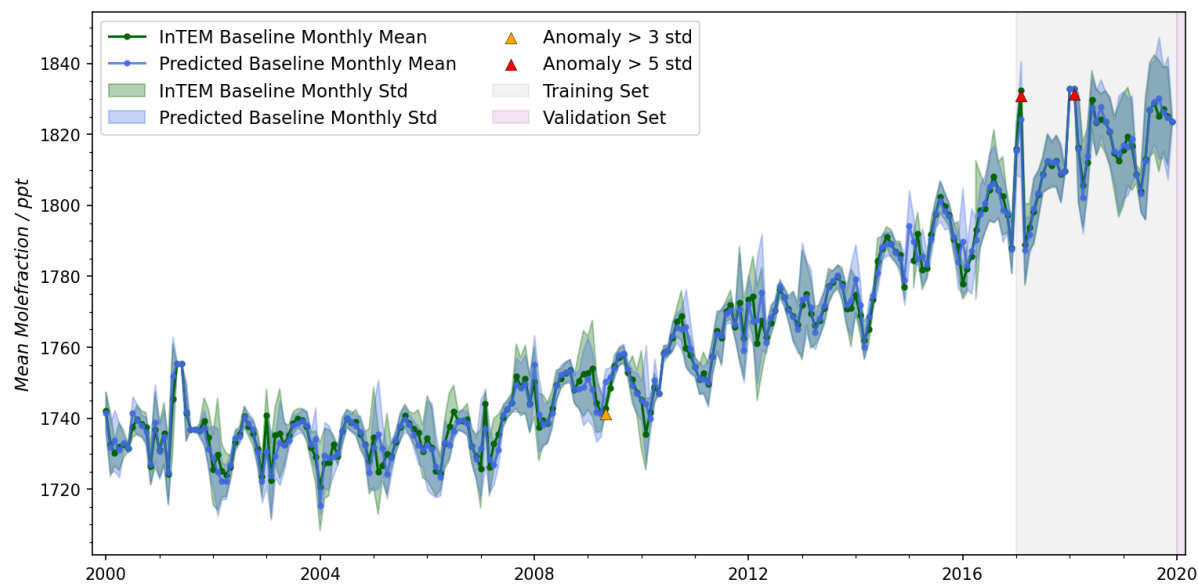
Molefraction time series (CH₄, SMO)



Model Confidence (CH₄, SMO)

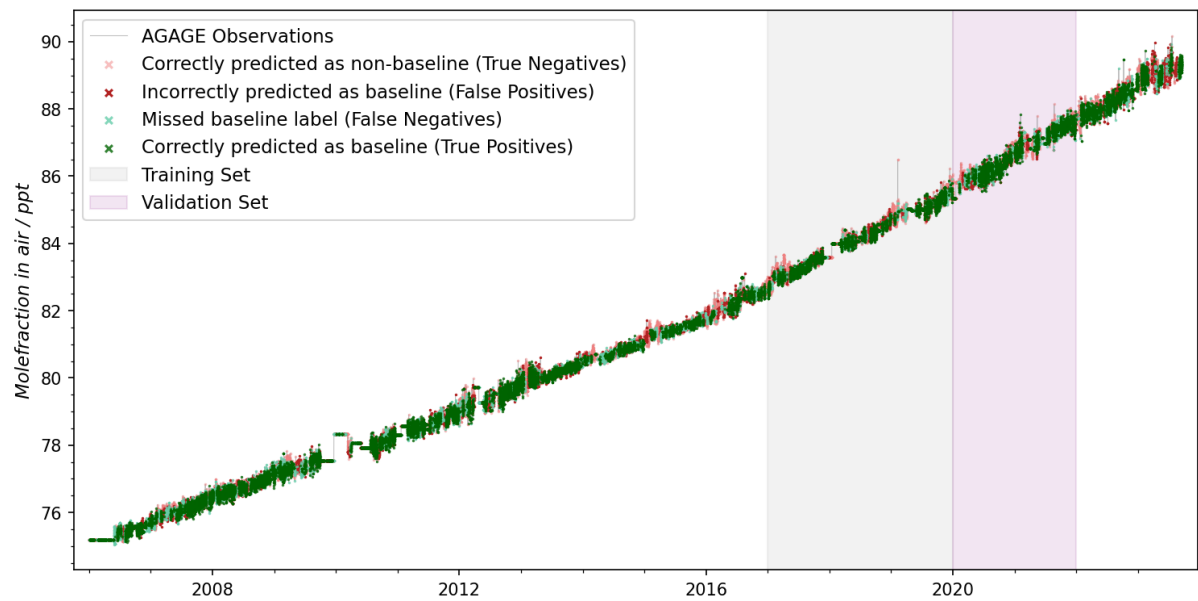


Monthly means (CH₄, SMO)

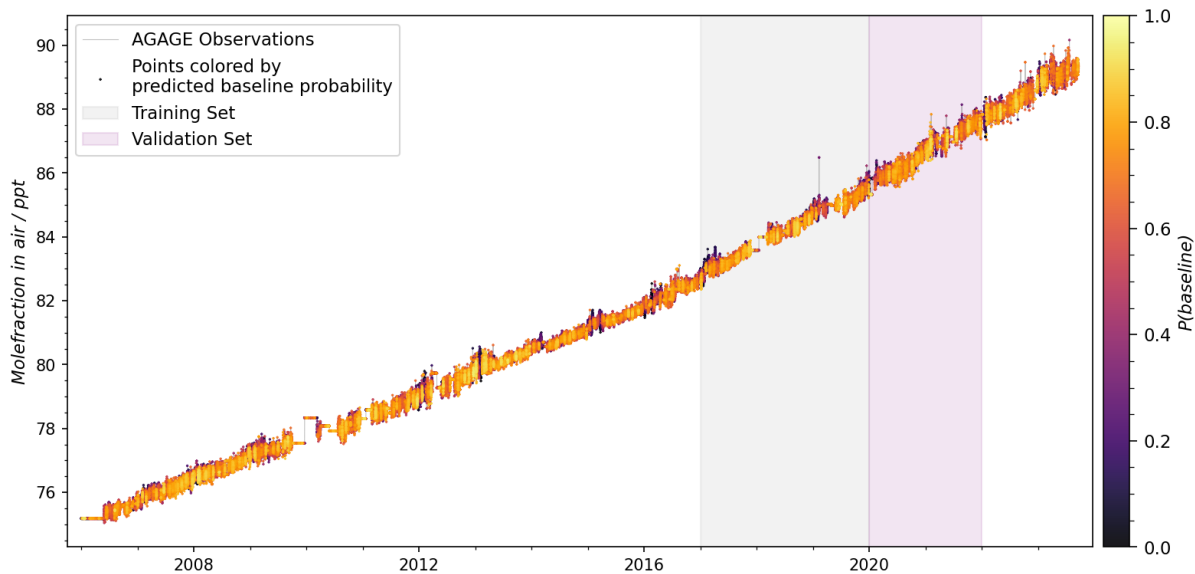


310 CF₄

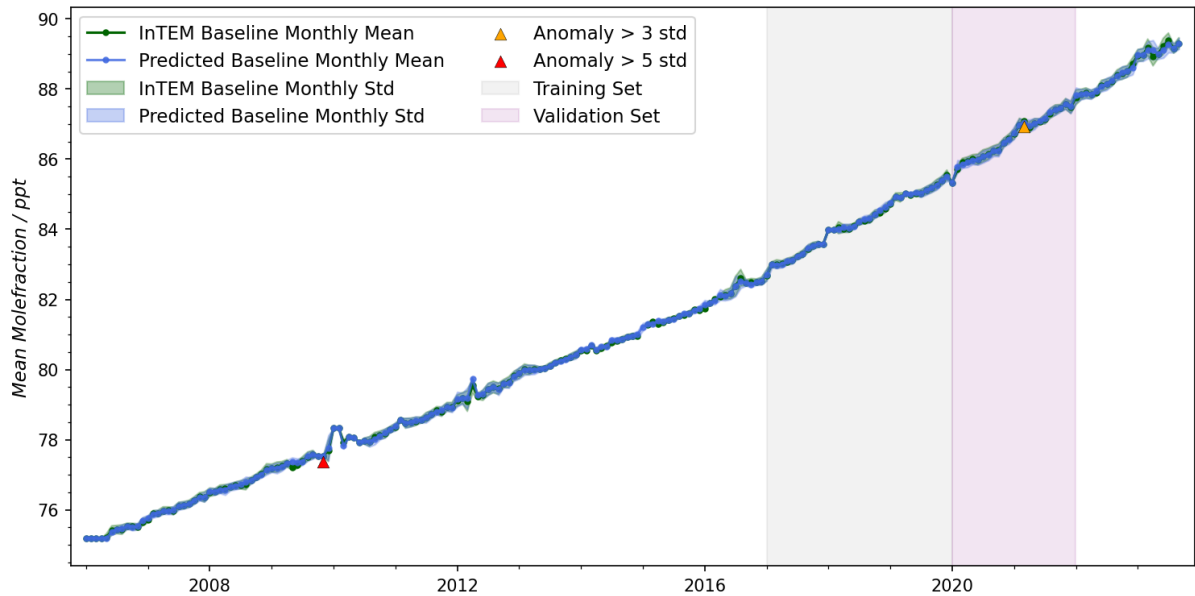
Molefraction time series (CF₄, SMO)



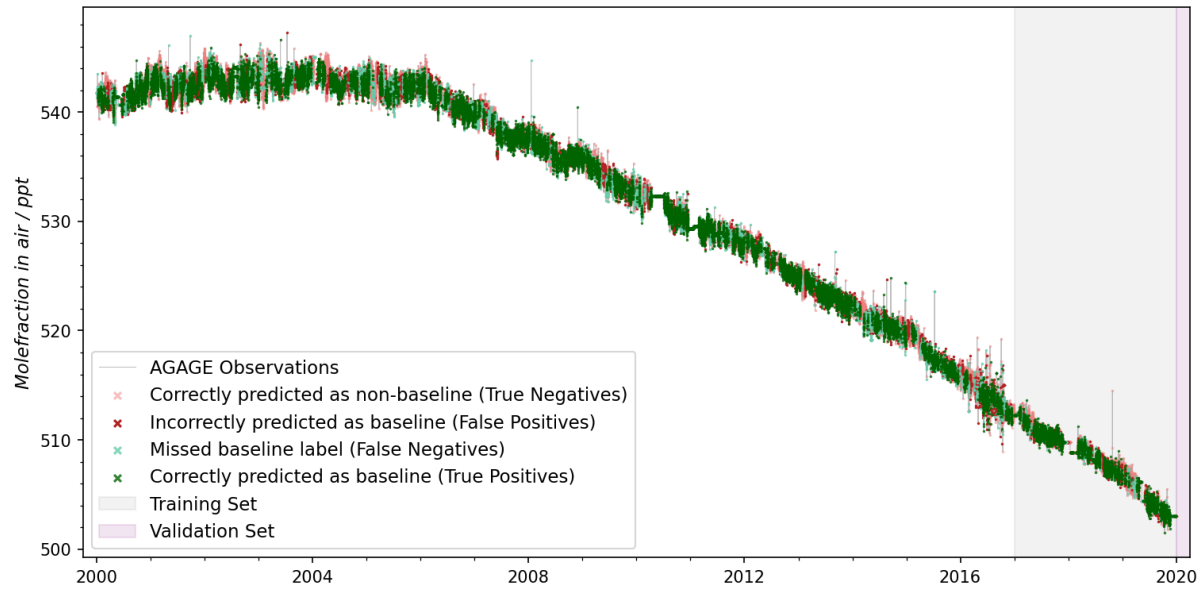
Model Confidence (CF₄, SMO)



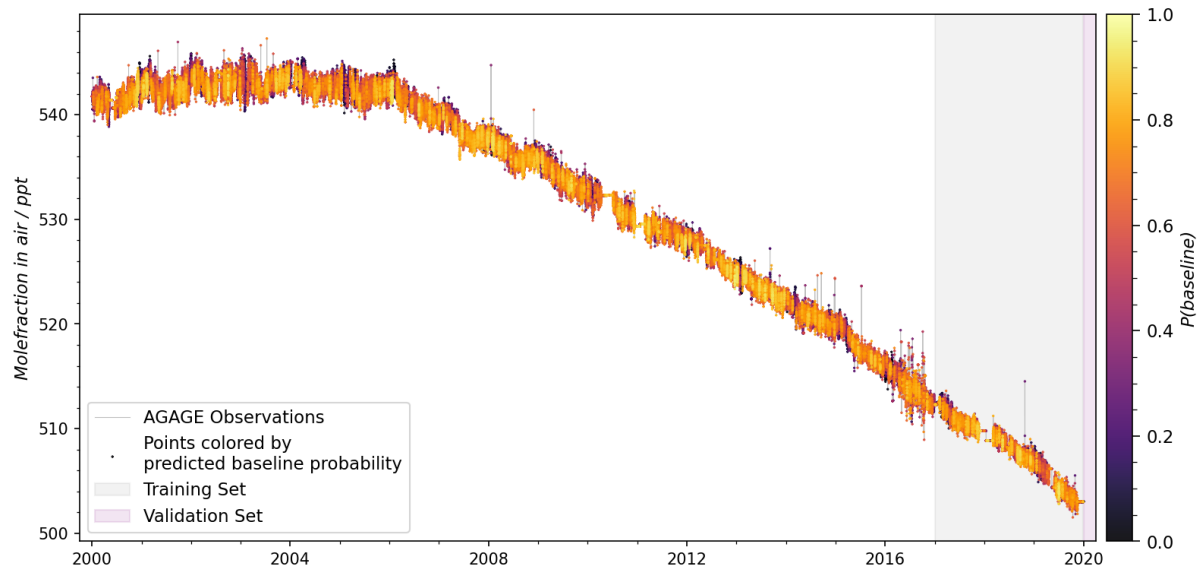
Monthly means (CF₄, SMO)



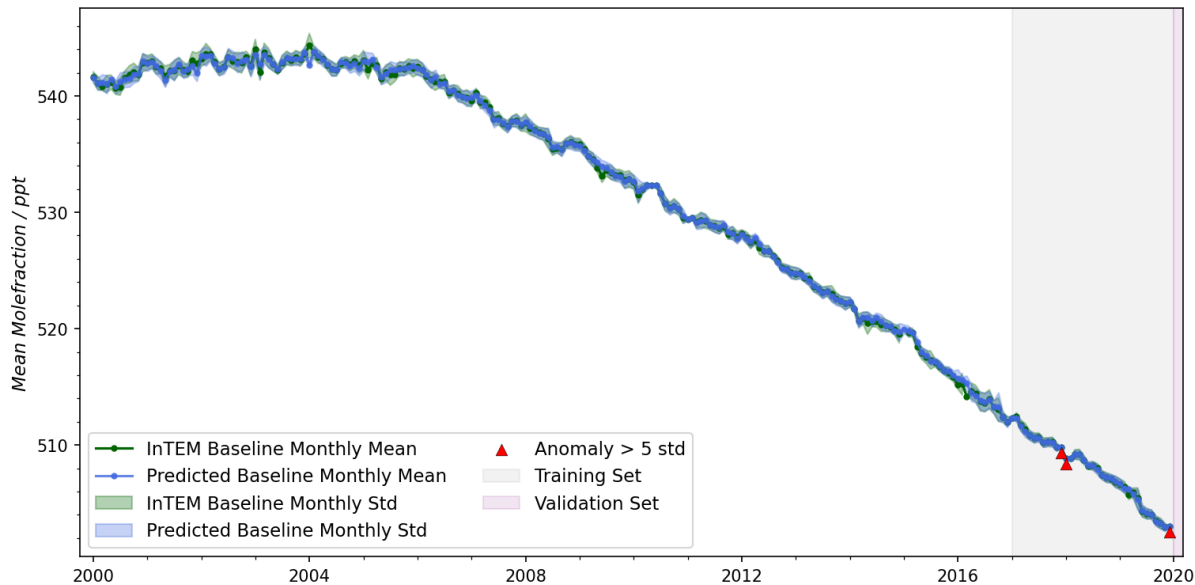
315 Molefraction time series (CFC-12, SMO)



Model Confidence (CFC-12, SMO)

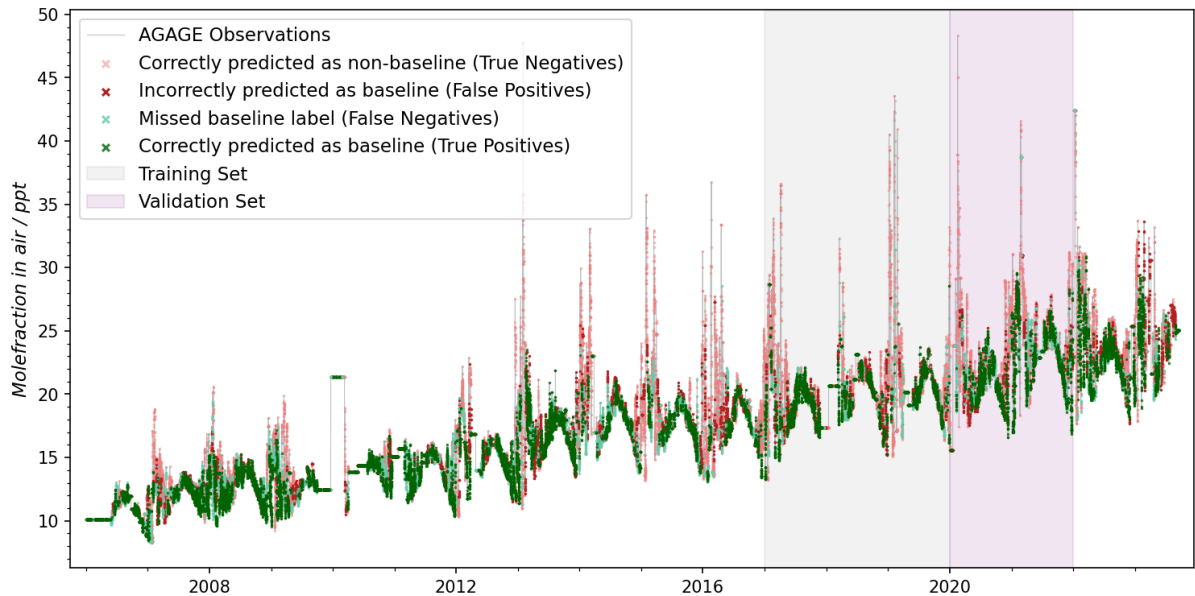


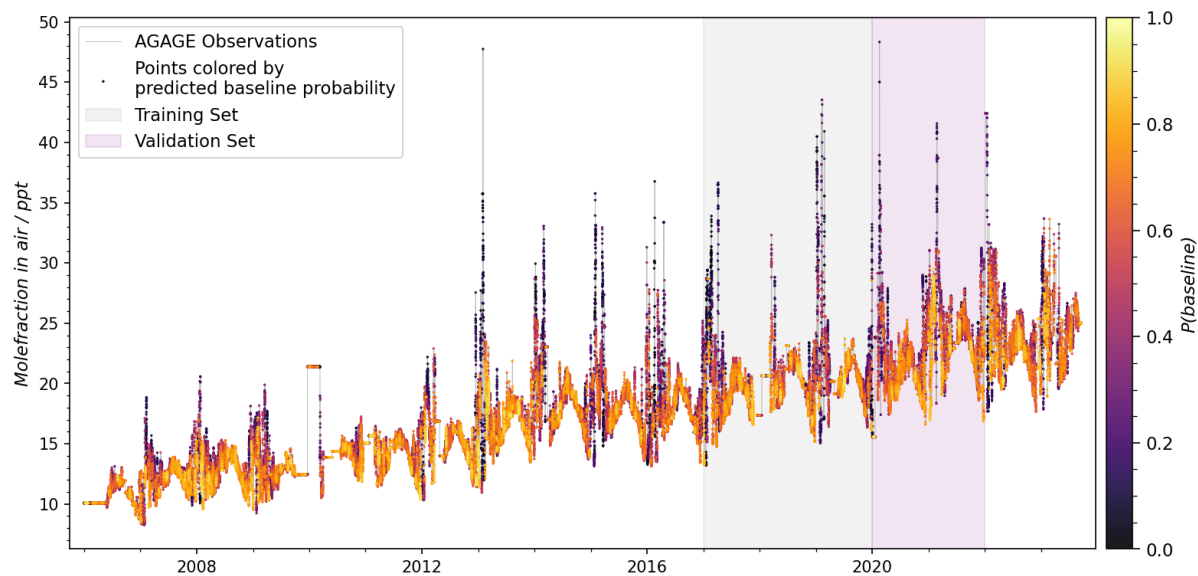
Monthly means (CFC-12, SMO)



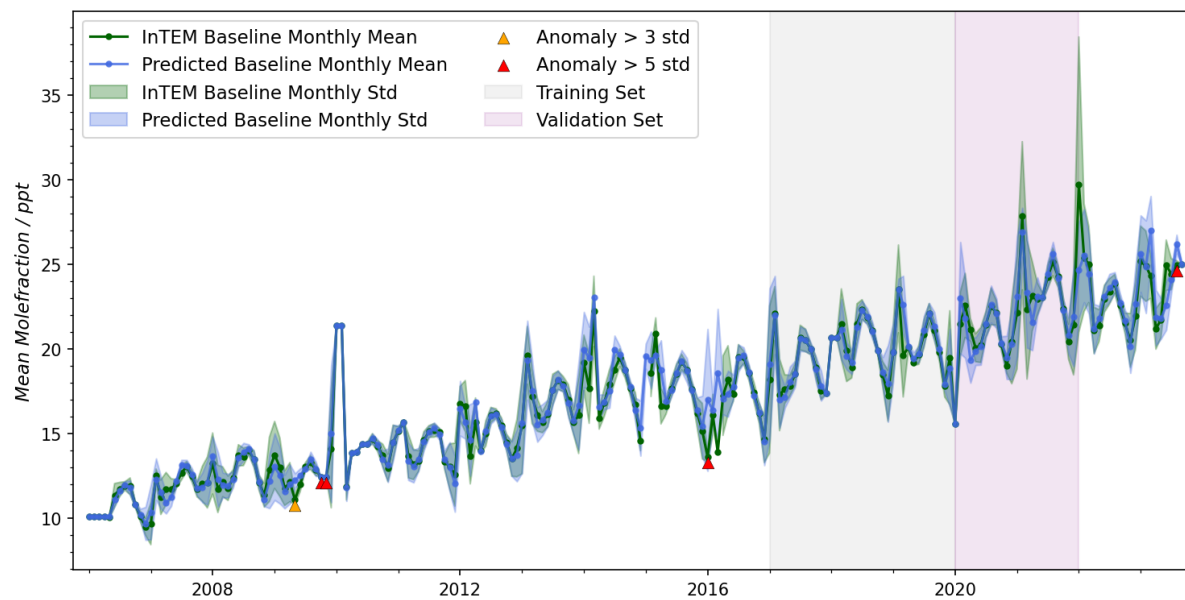
CH₂Cl₂

Molefraction time series (CH₂Cl₂, SMO)



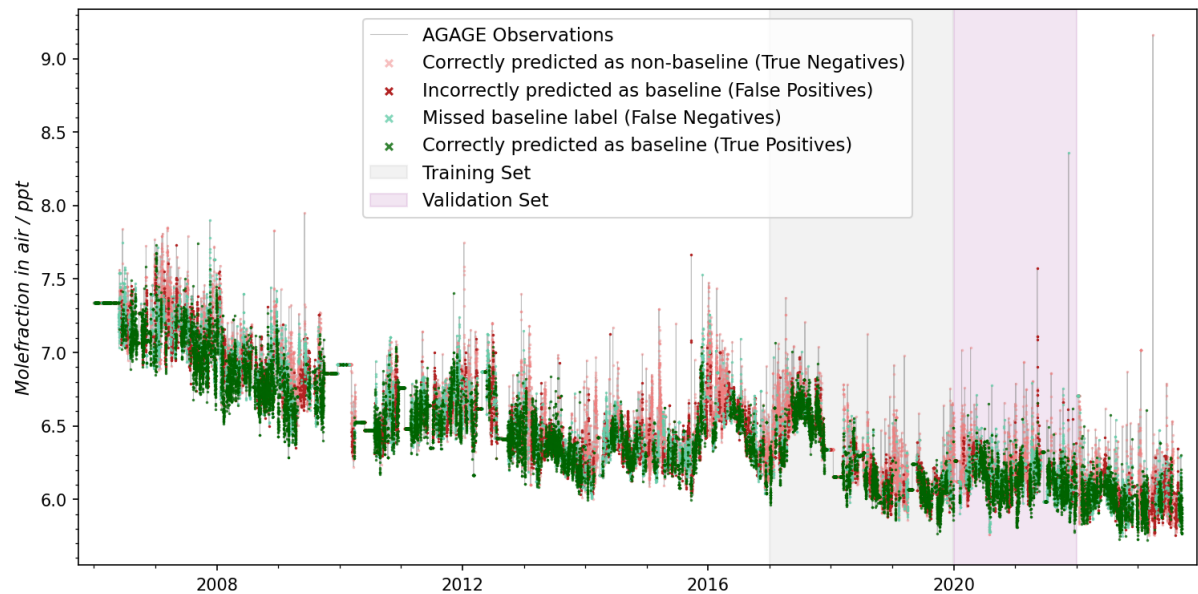


Monthly means (CH_2Cl_2 , SMO)

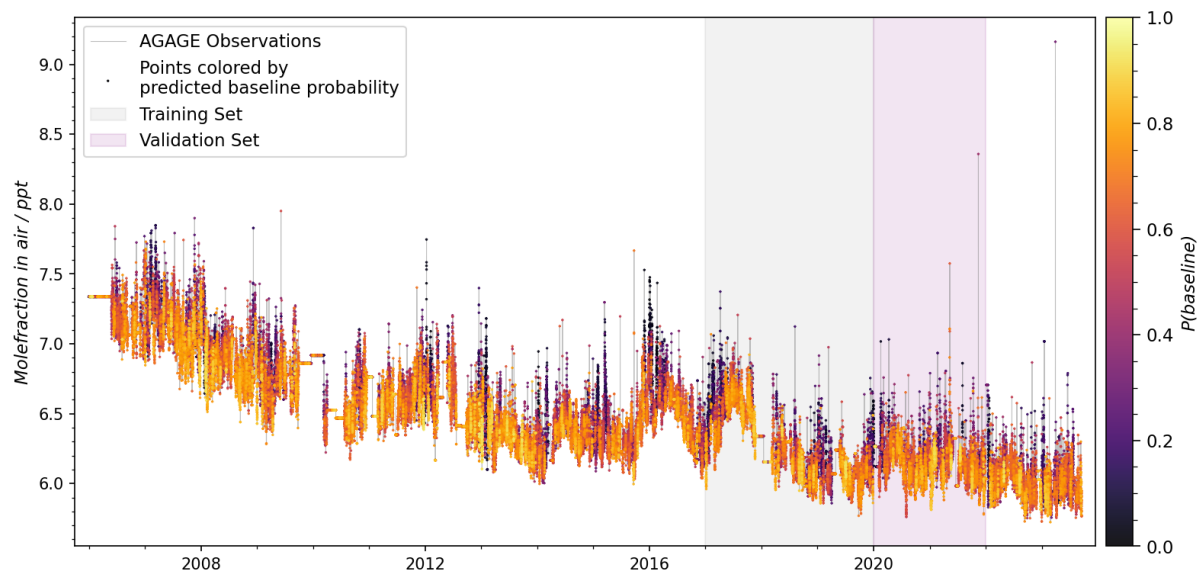


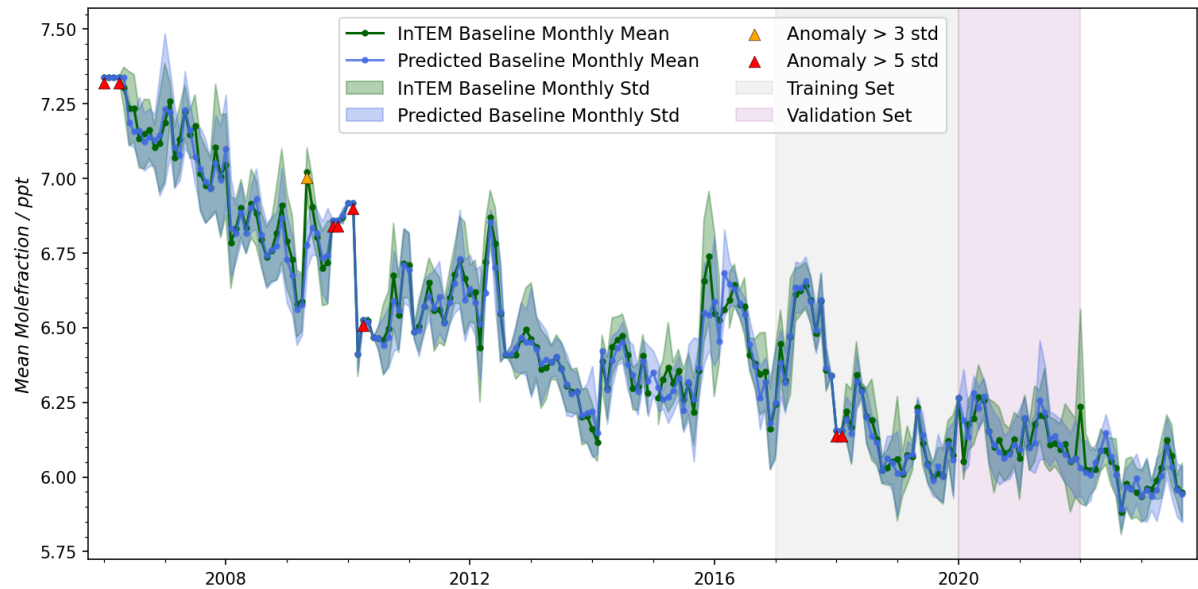
CH₃Br

Molefraction time series (CH₃Br, SMO)



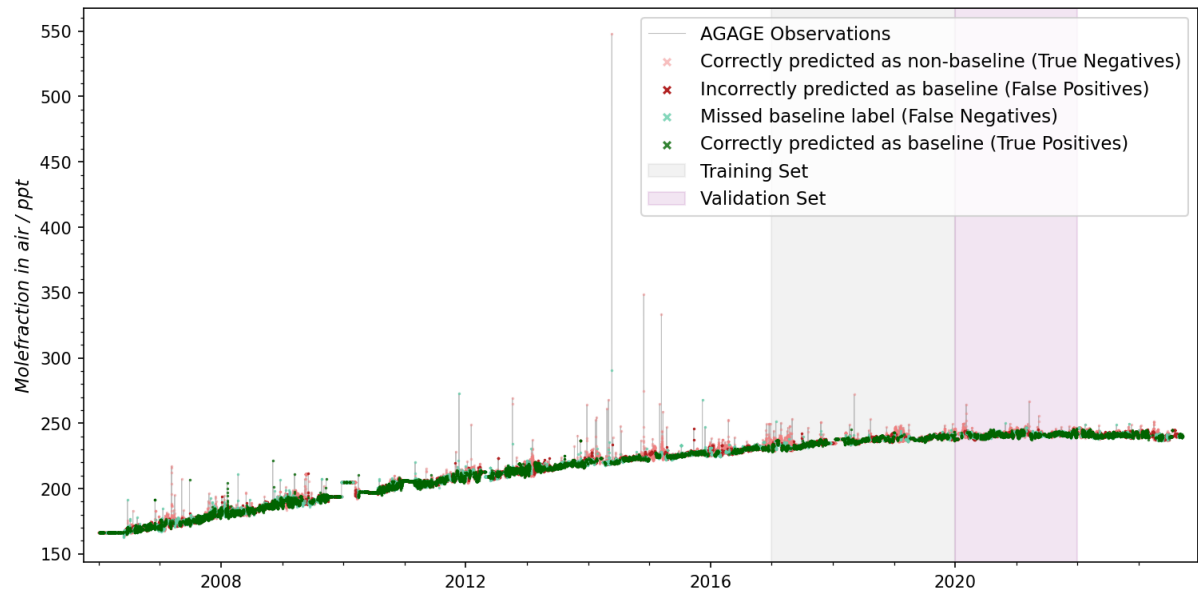
Model Confidence (CH₃Br, SMO)



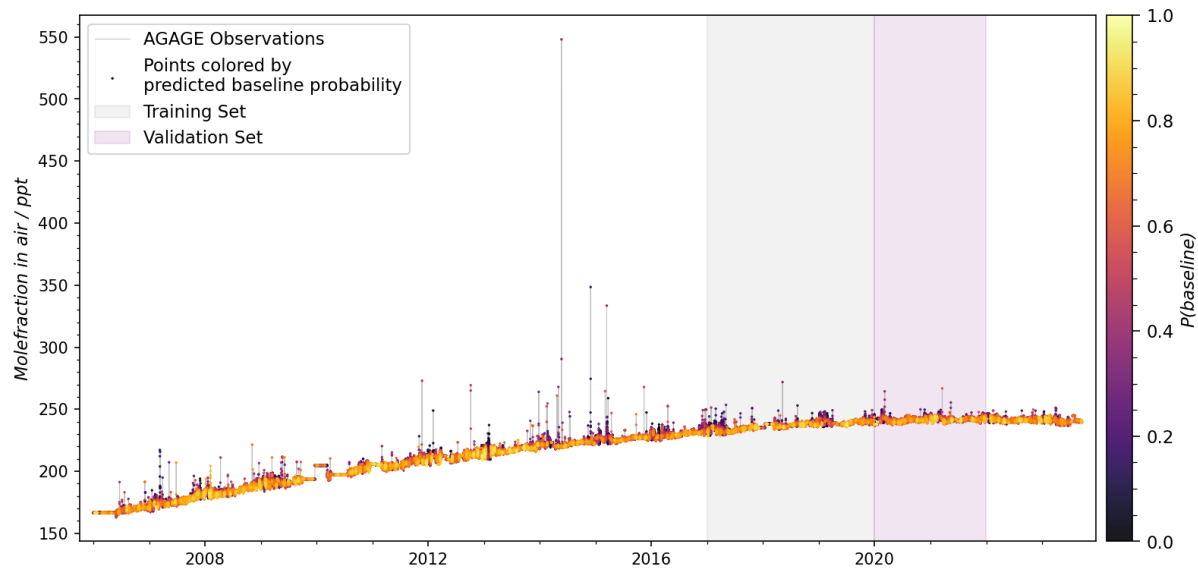


HCFC-22

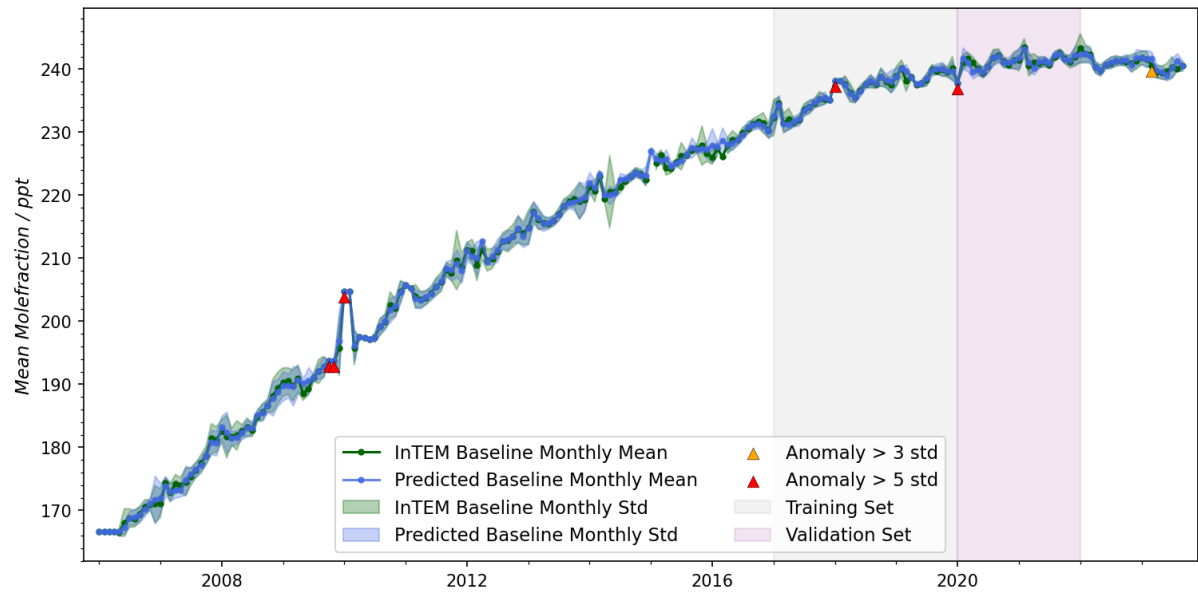
Molefraction time series (HCFC-22, SMO)



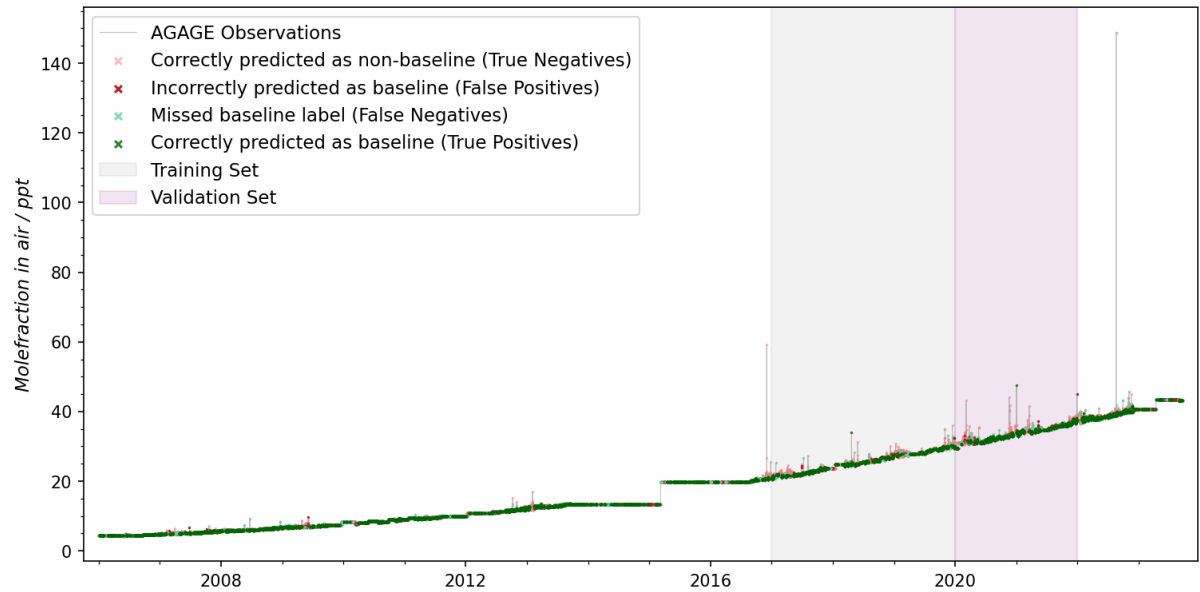
Model Confidence (HCFC-22, SMO)



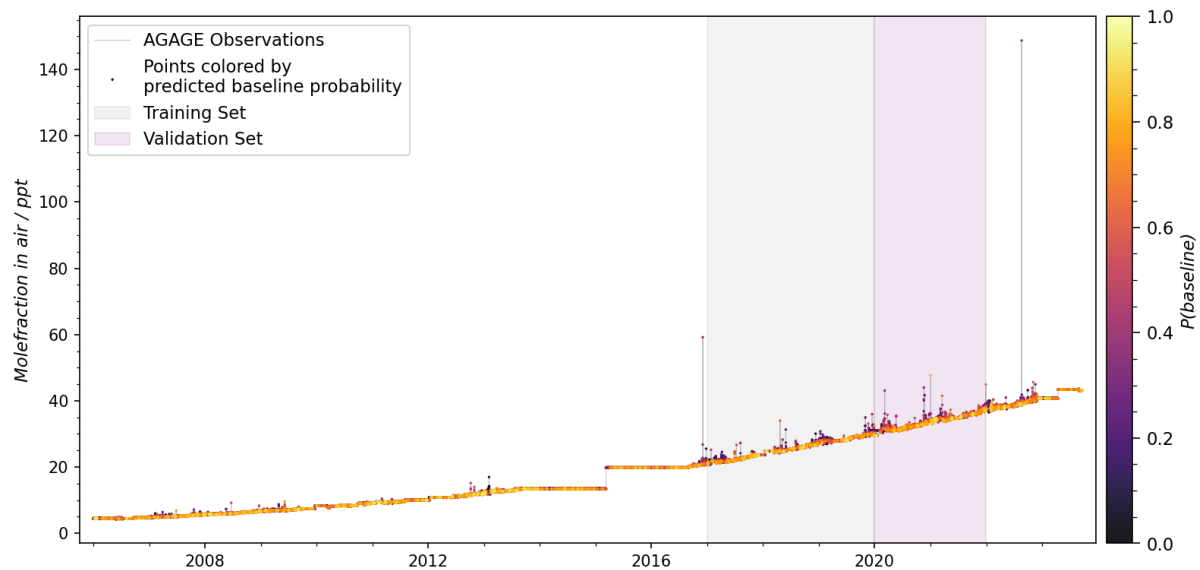
Monthly means (HCFC-22, SMO)



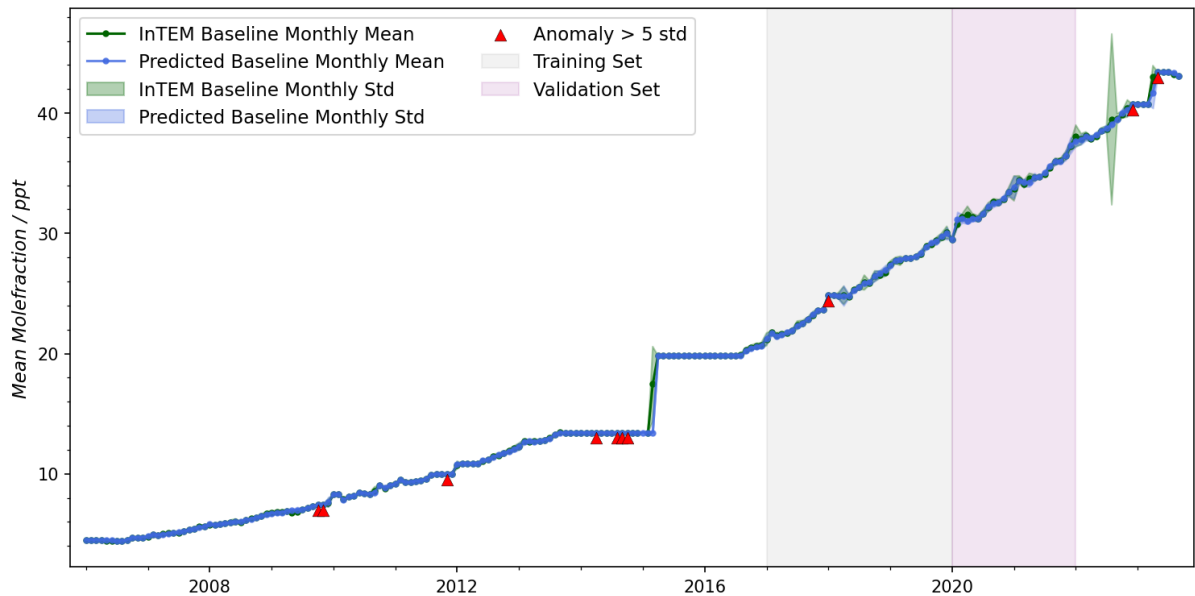
Molefraction time series (HFC-125, SMO)



Model Confidence (HFC-125, SMO)

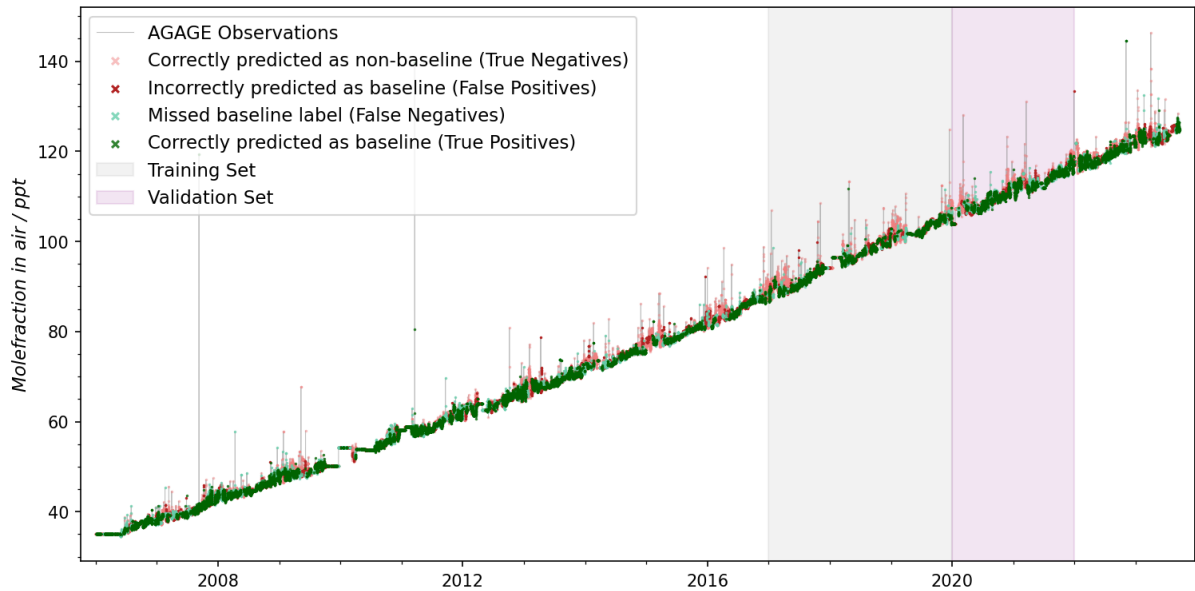


Monthly means (HFC-125, SMO)

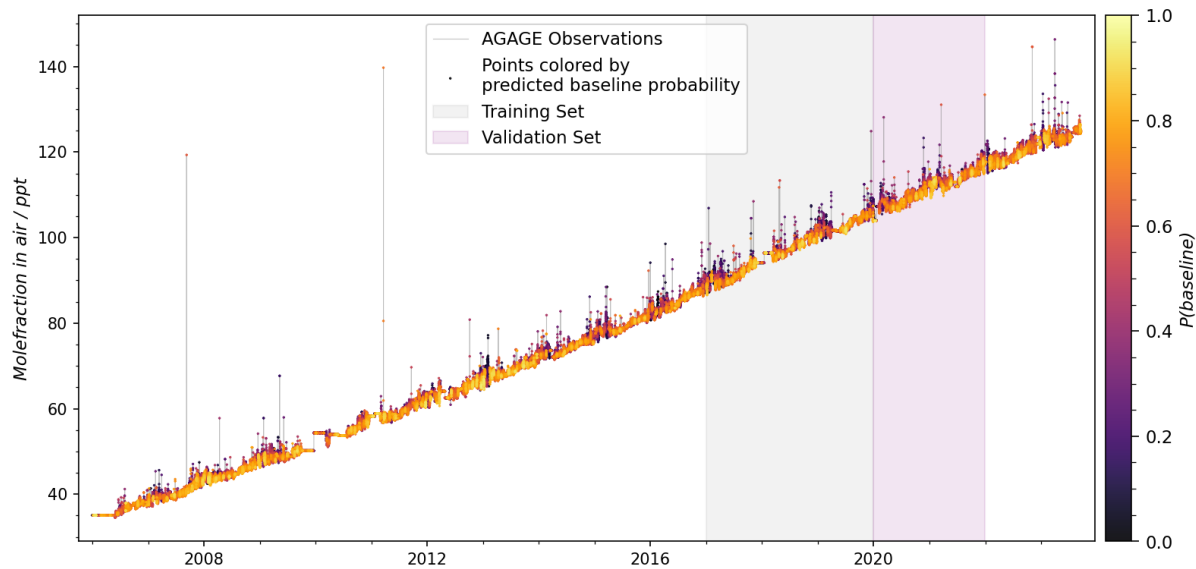


HFC-134a

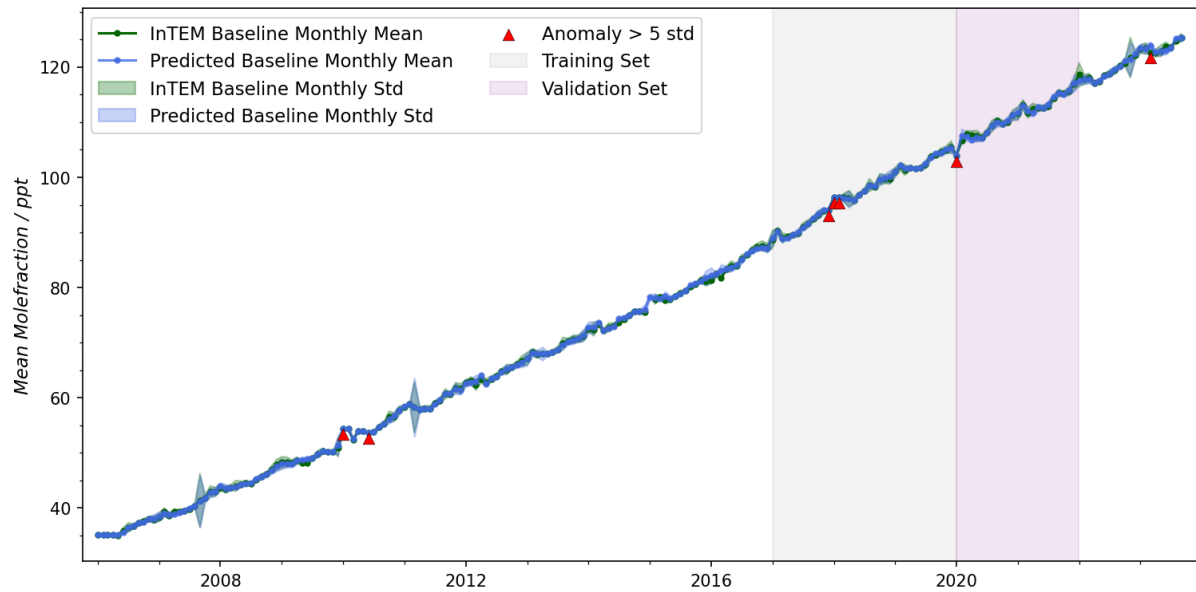
335 Molefraction time series (HFC-134a, SMO)



Model Confidence (HFC-134a, SMO)

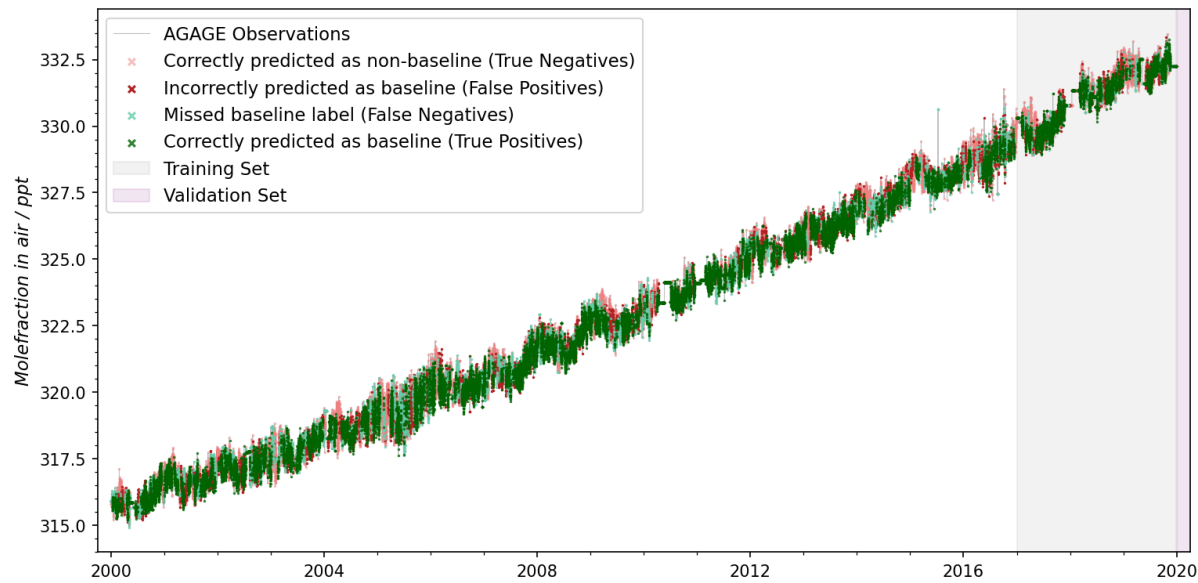


Monthly means (HFC-134a, SMO)

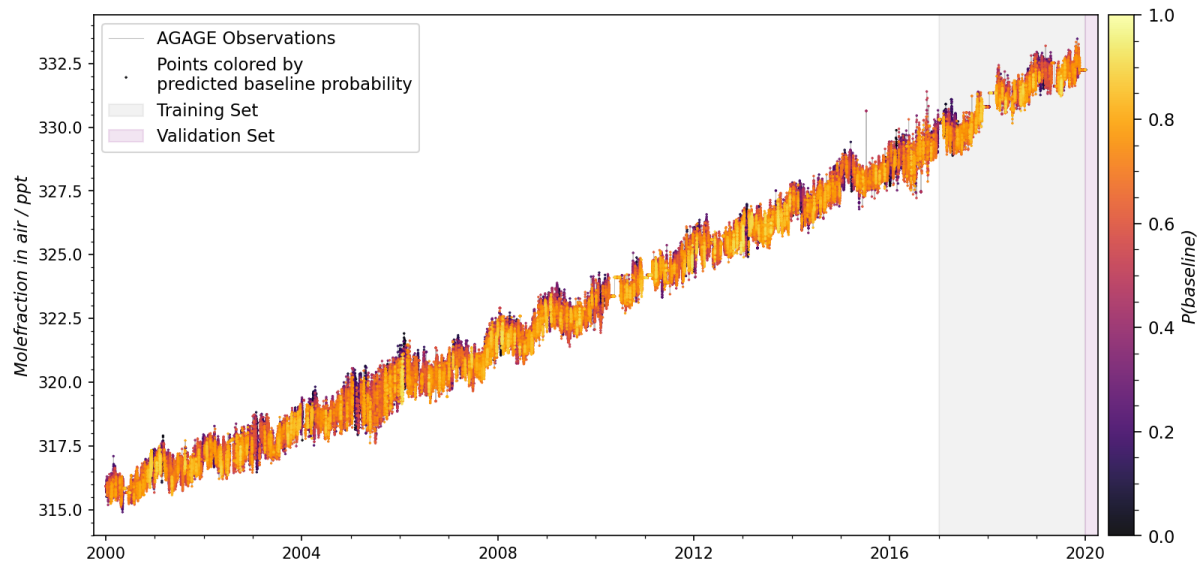


N₂O

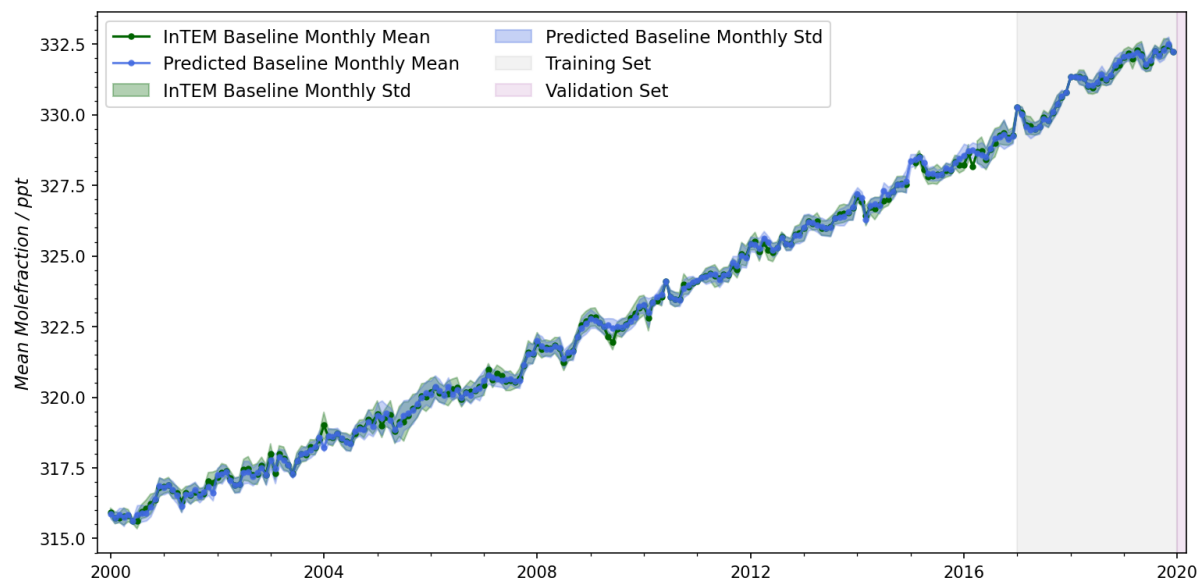
Molefraction time series (N₂O, SMO)



340 Model Confidence (N₂O, SMO)

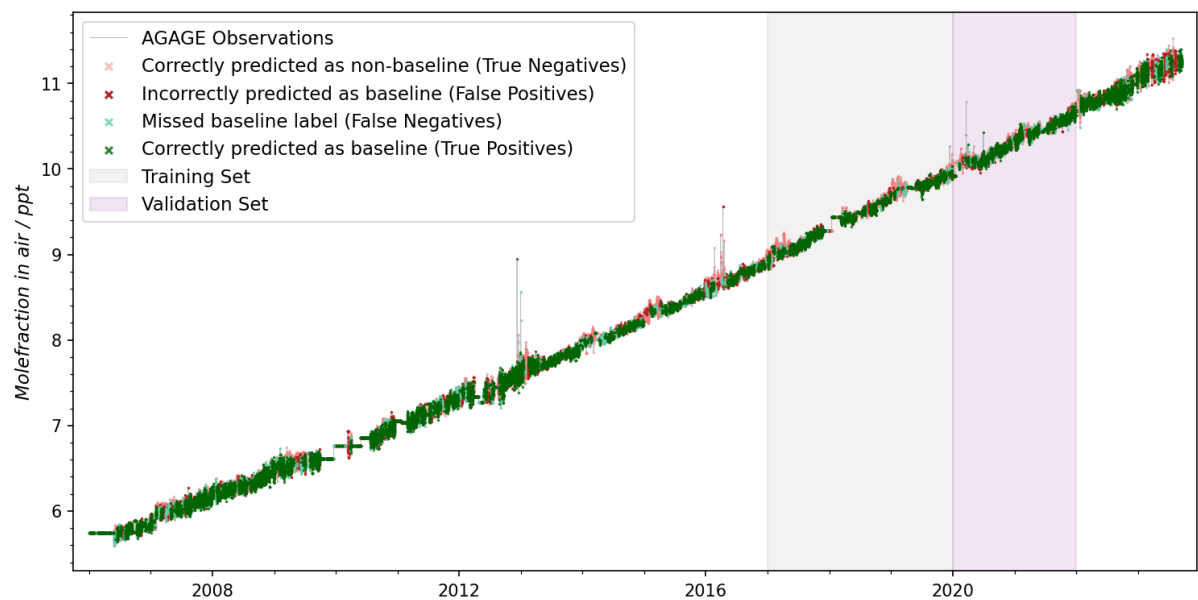


Monthly means (N₂O, SMO)

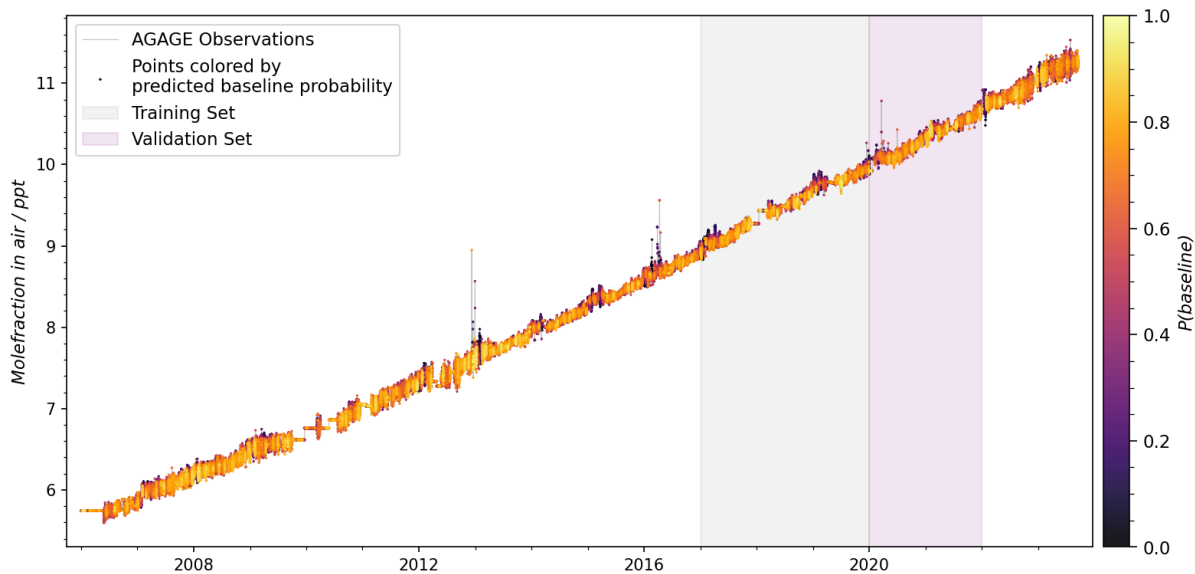


SF₆

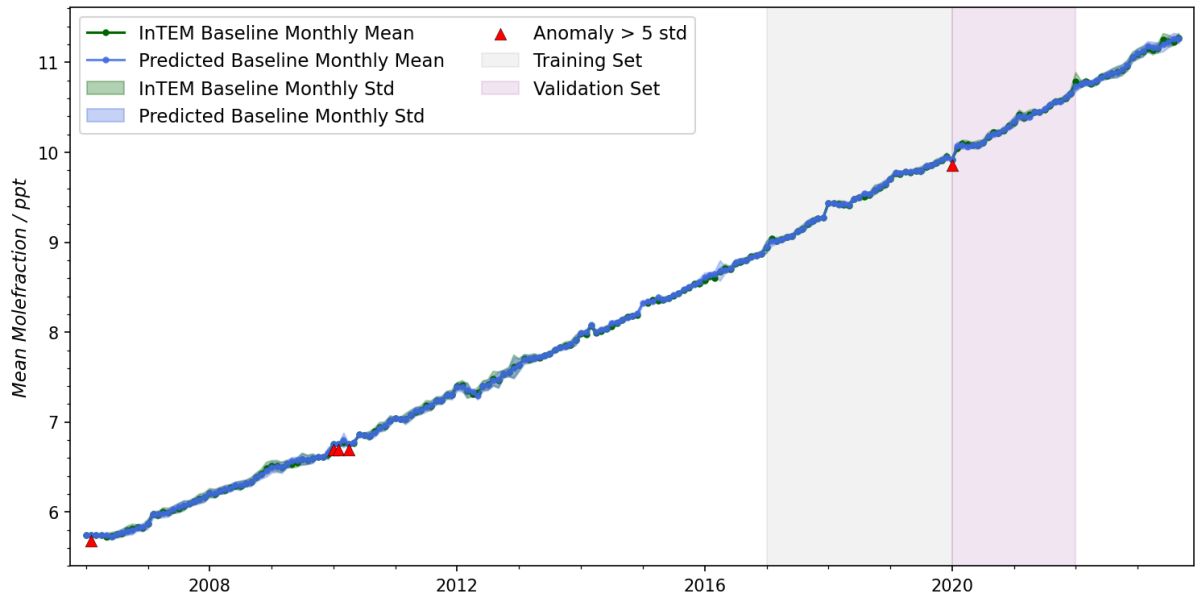
Molefraction time series (SF₆, SMO)



Model Confidence (SF₆, SMO)



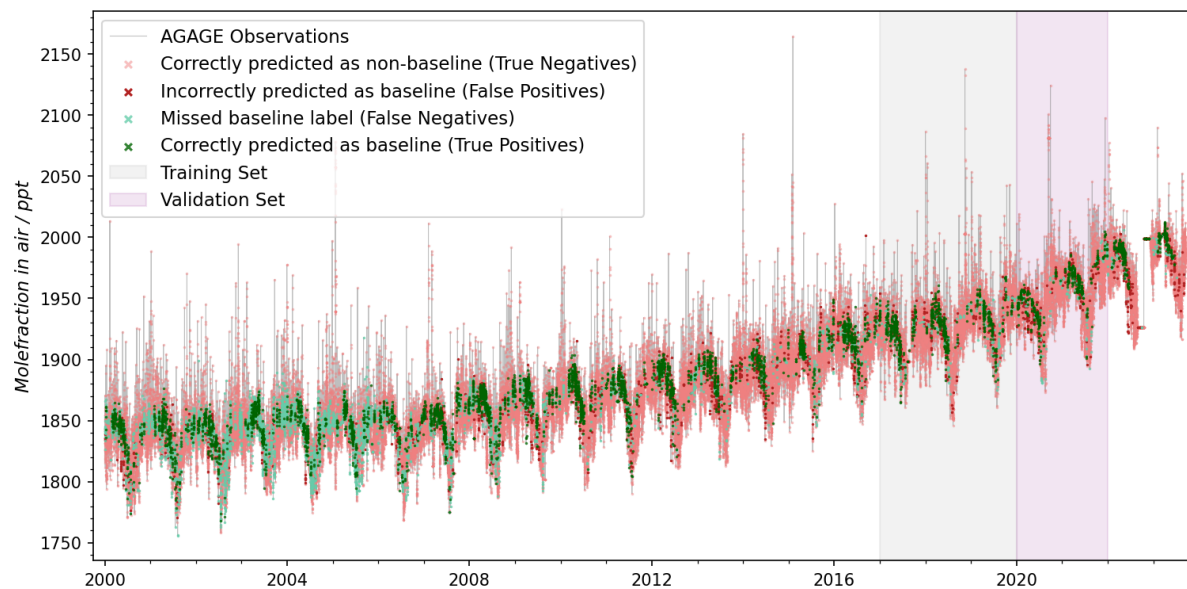
345 Monthly means (SF₆, SMO)



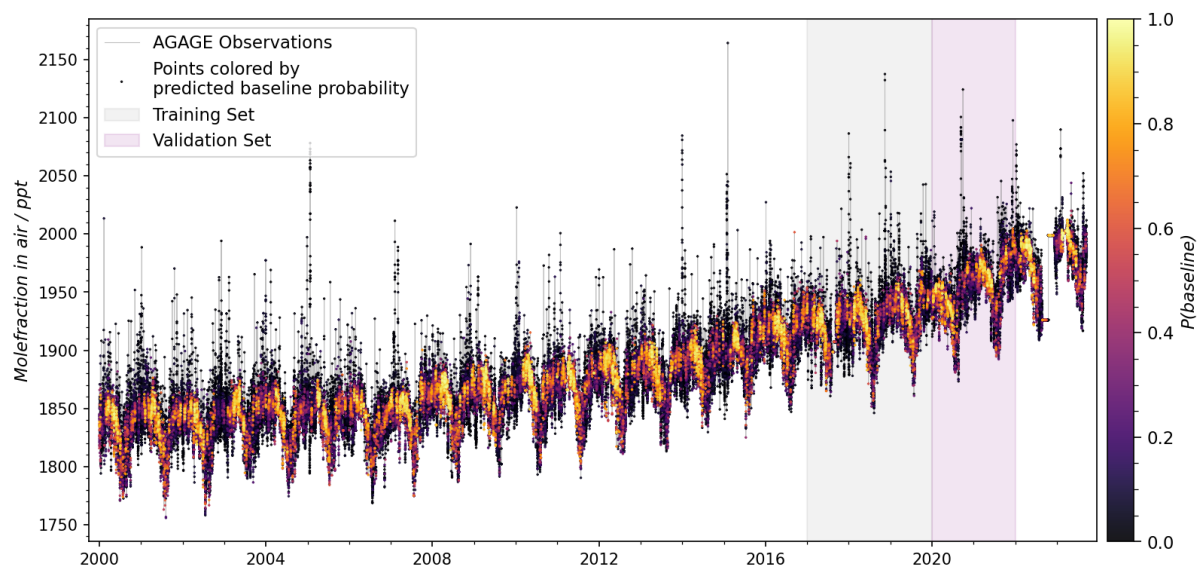
S9.8 Trinidad Head, USA

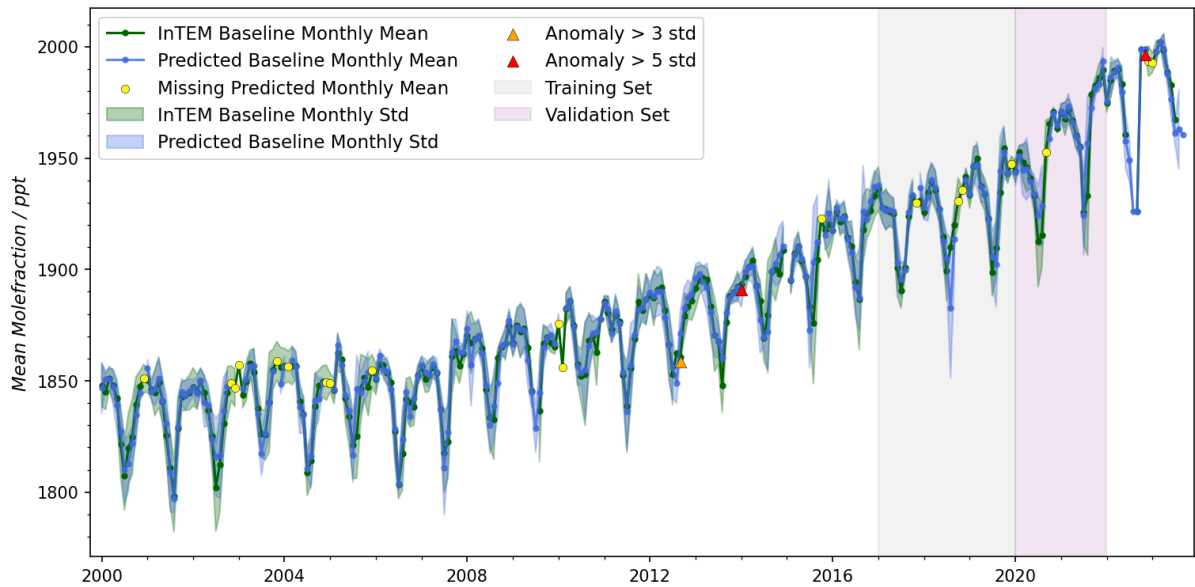
CH₄

Molefraction time series (CH₄, THD)



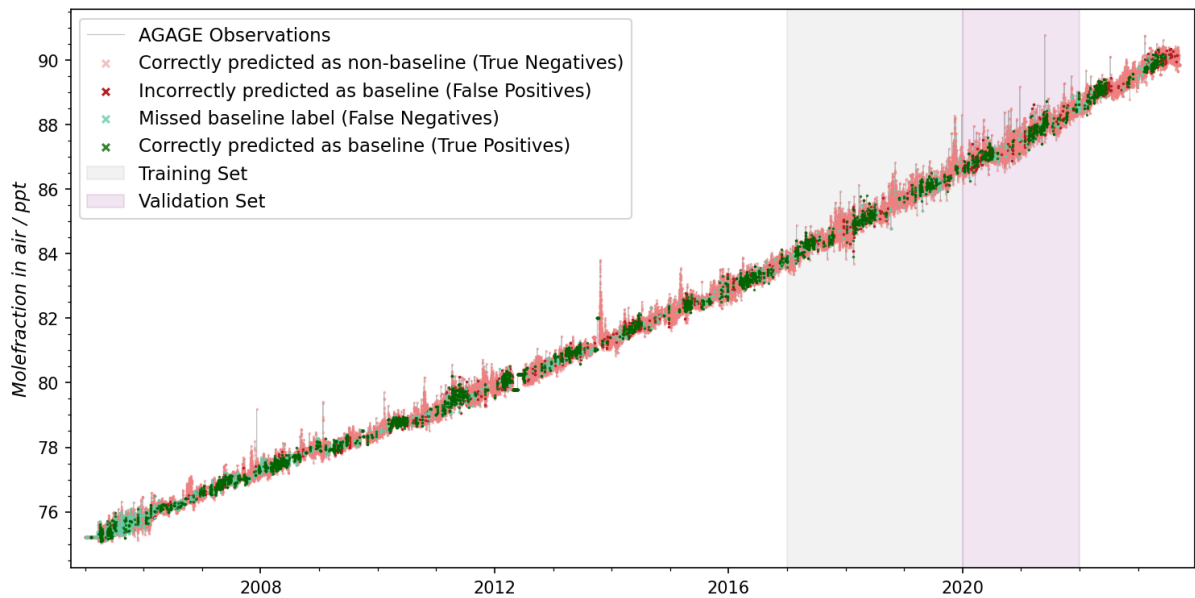
Model Confidence (CH₄, THD)



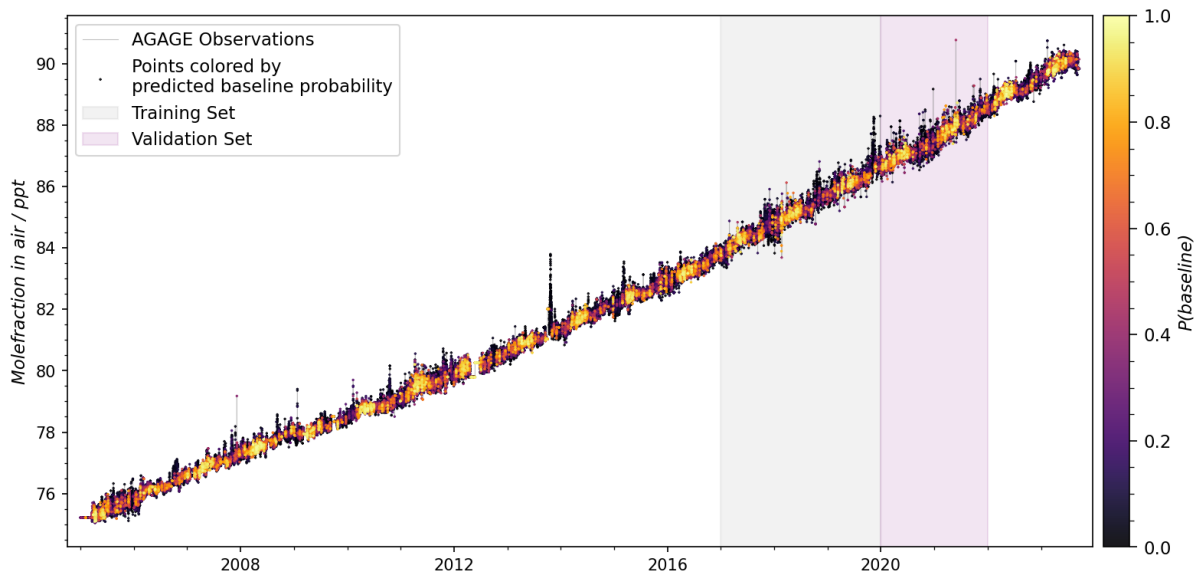


CF₄

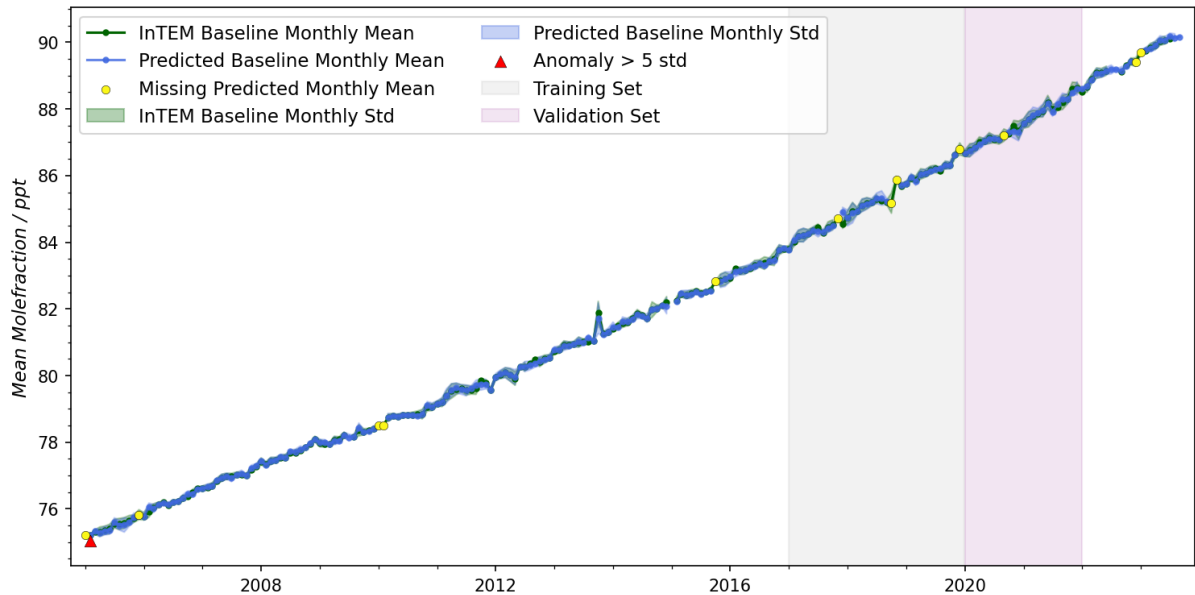
Molefraction time series (CF₄, THD)



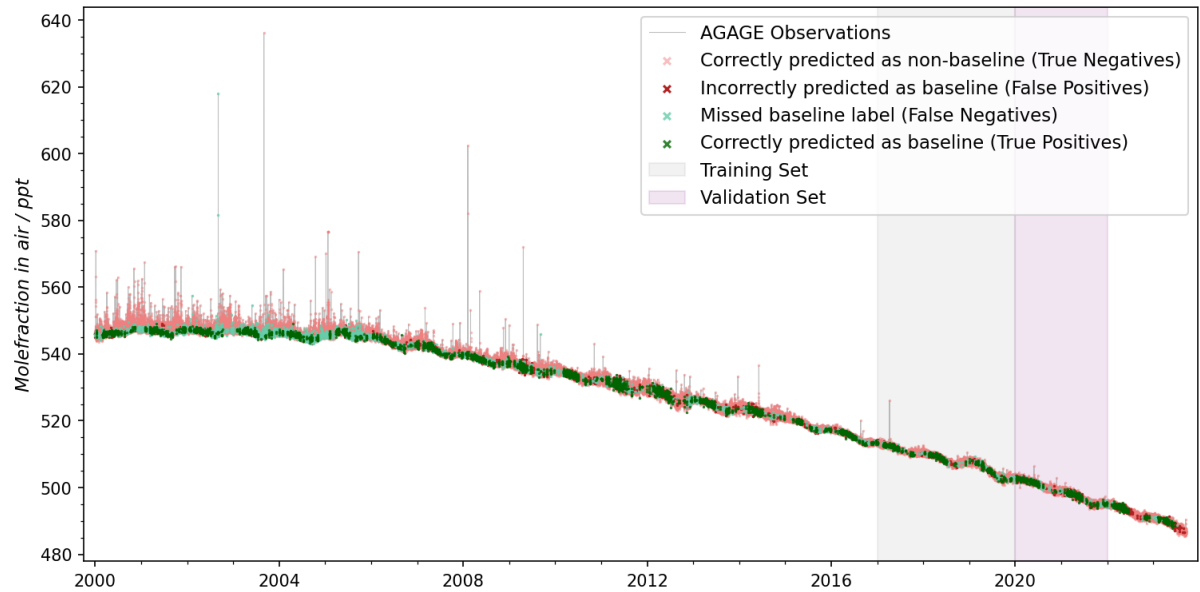
Model Confidence (CF₄, THD)



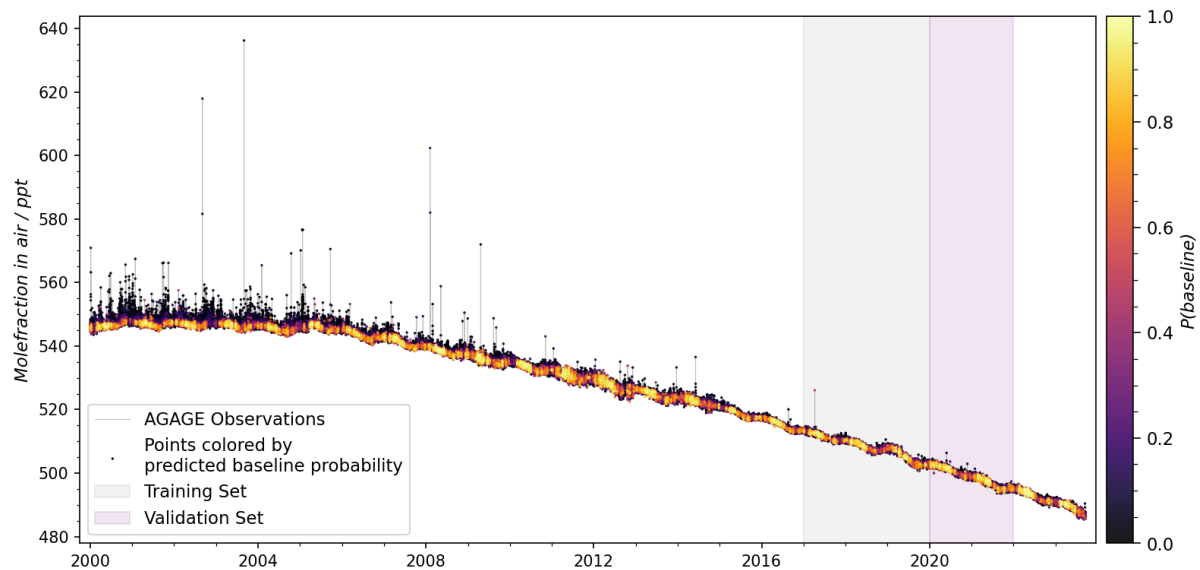
Monthly means (CF₄, THD)



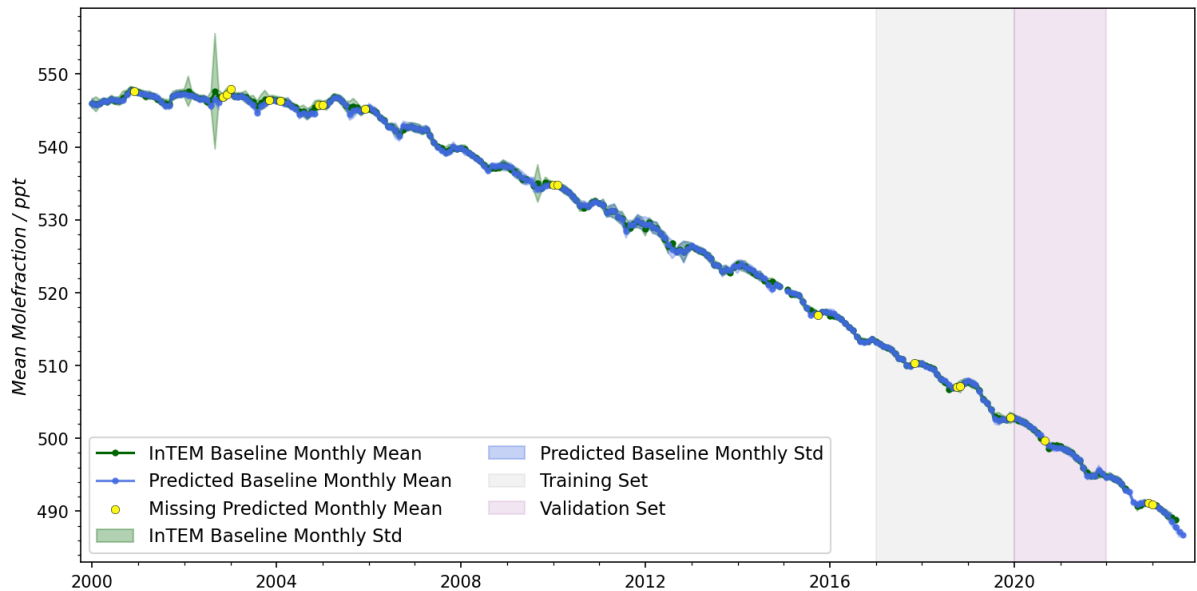
Molefraction time series (CFC-12, THD)



Model Confidence (CFC-12, THD)

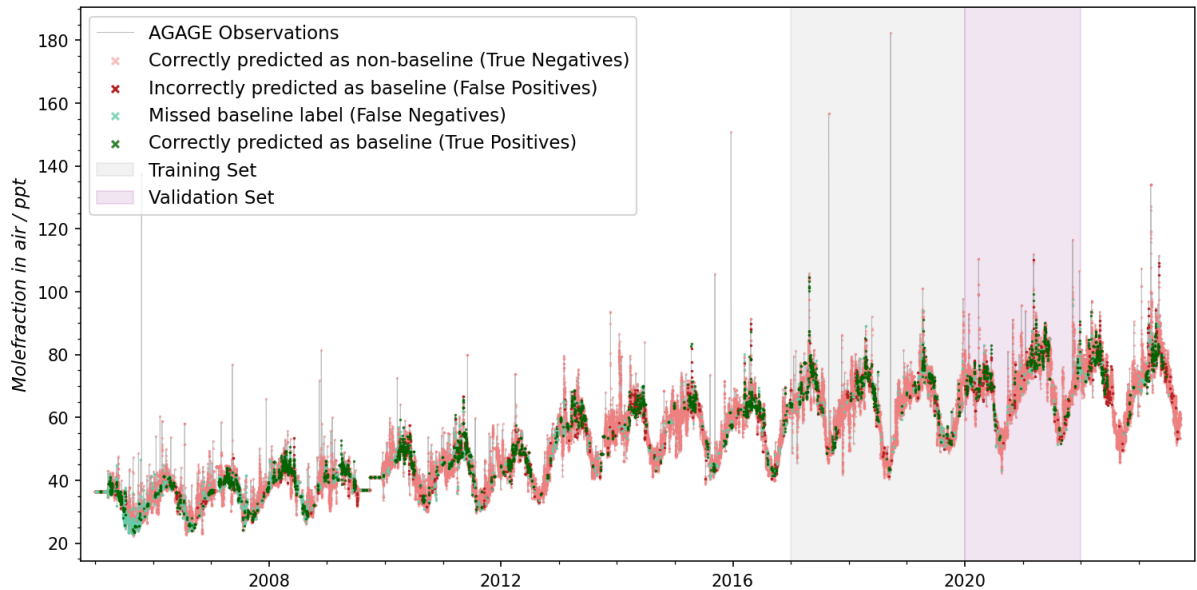


Monthly means (CFC-12, THD)

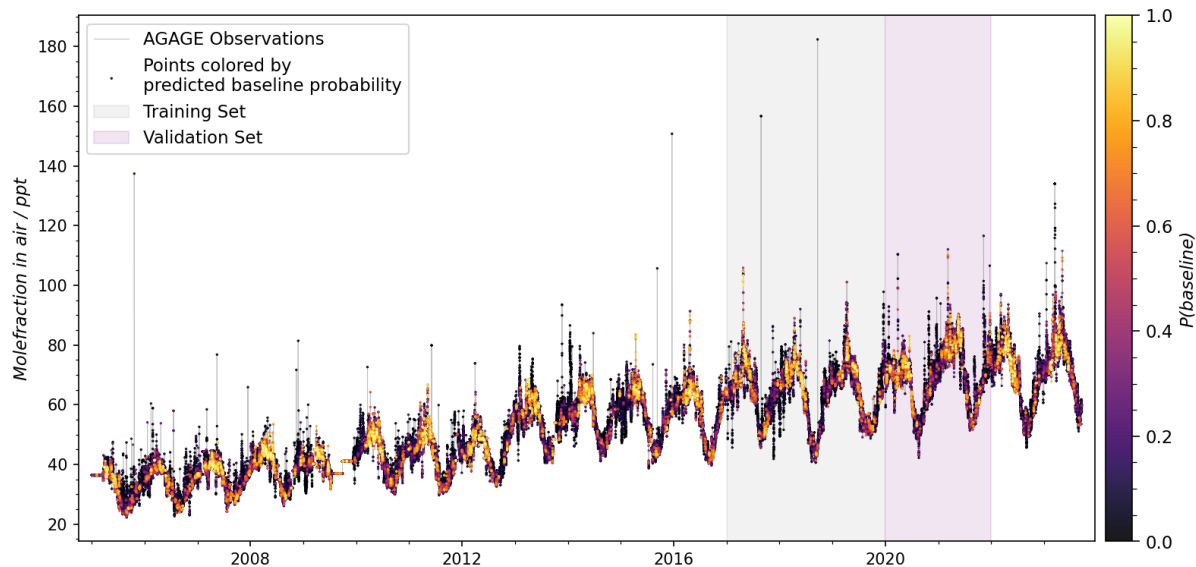


CH₂Cl₂

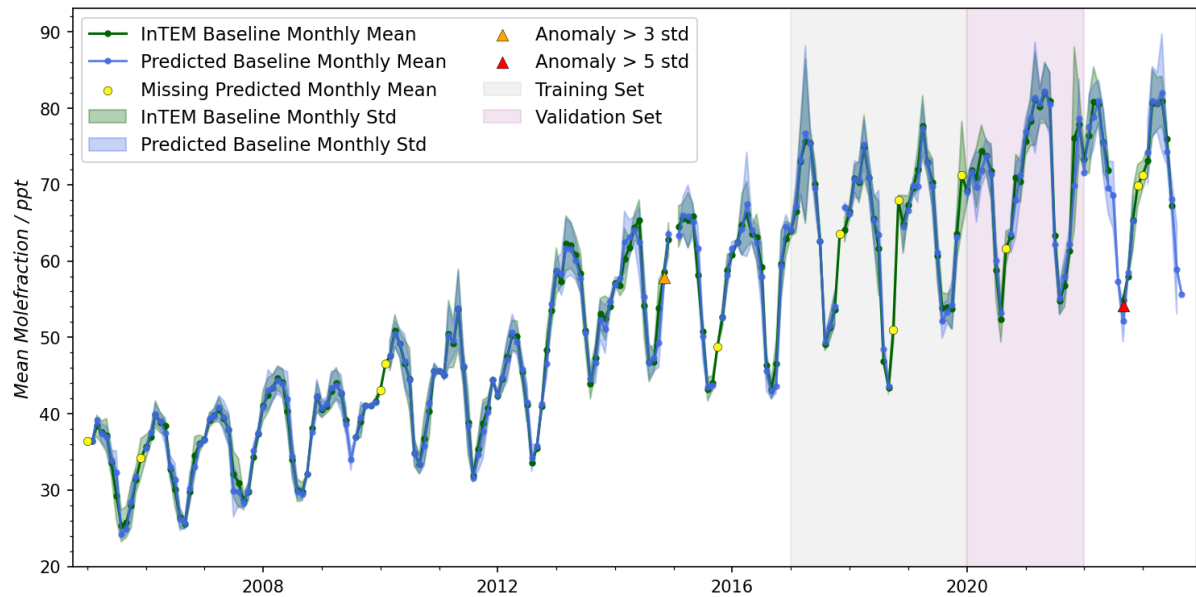
360 Molefraction time series (CH₂Cl₂, THD)



Model Confidence (CH₂Cl₂, THD)

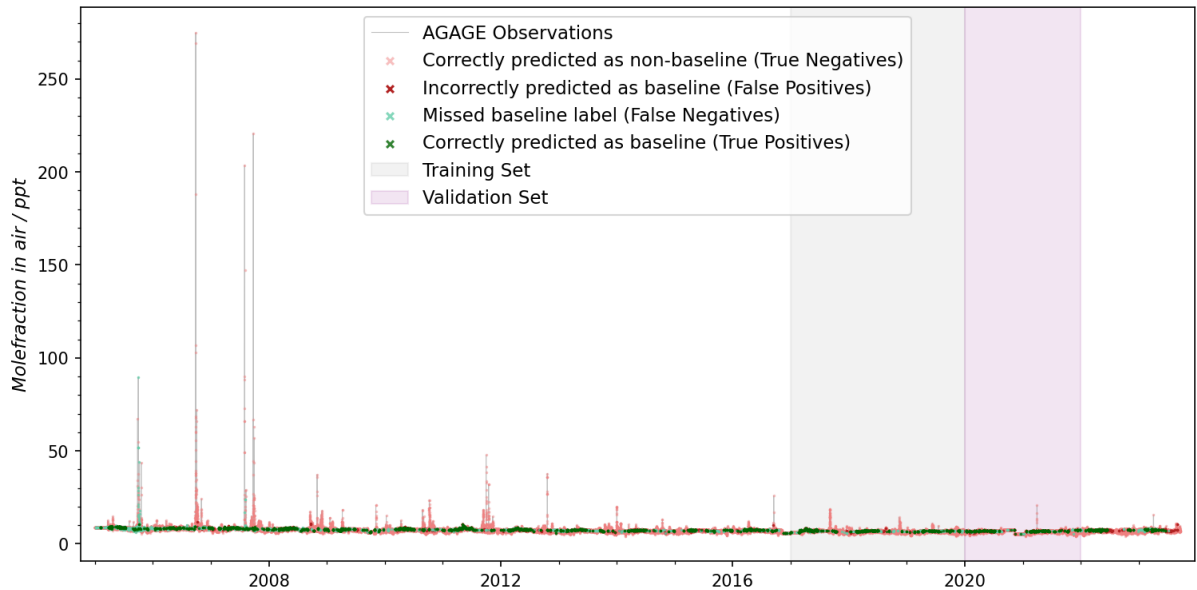


Monthly means (CH₂Cl₂, THD)

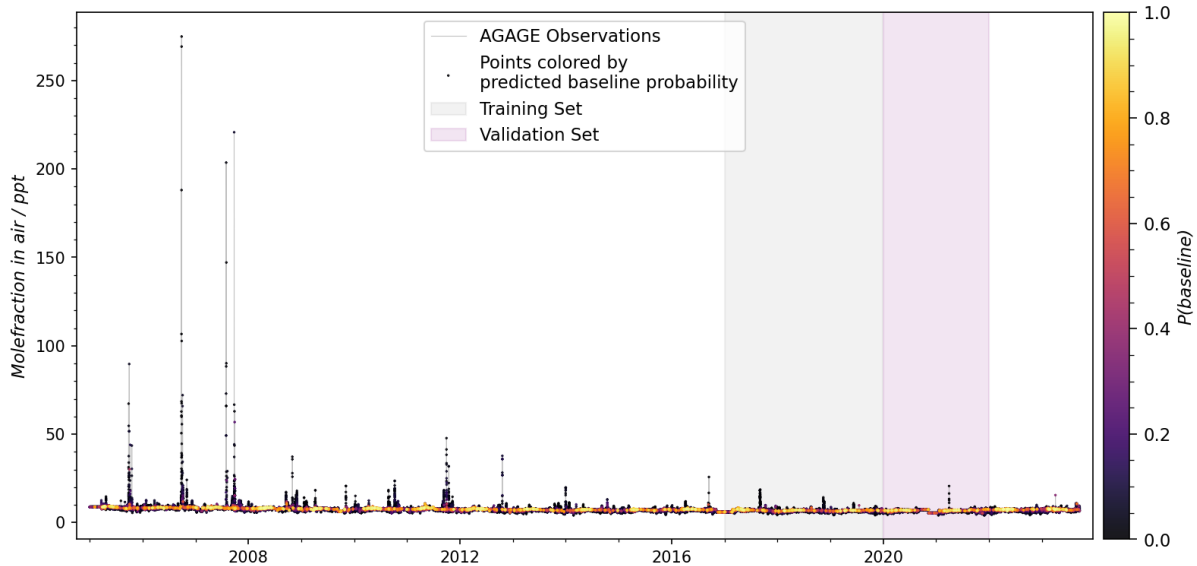


CH₃Br

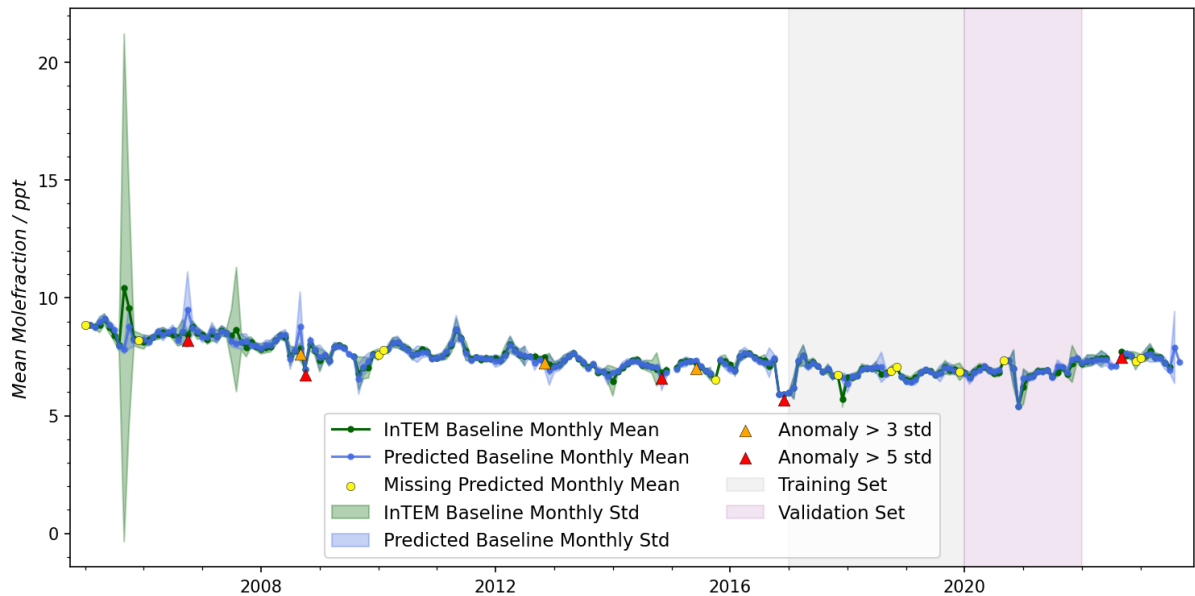
Molefraction time series (CH₃Br, THD)



365 Model Confidence (CH₃Br, THD)

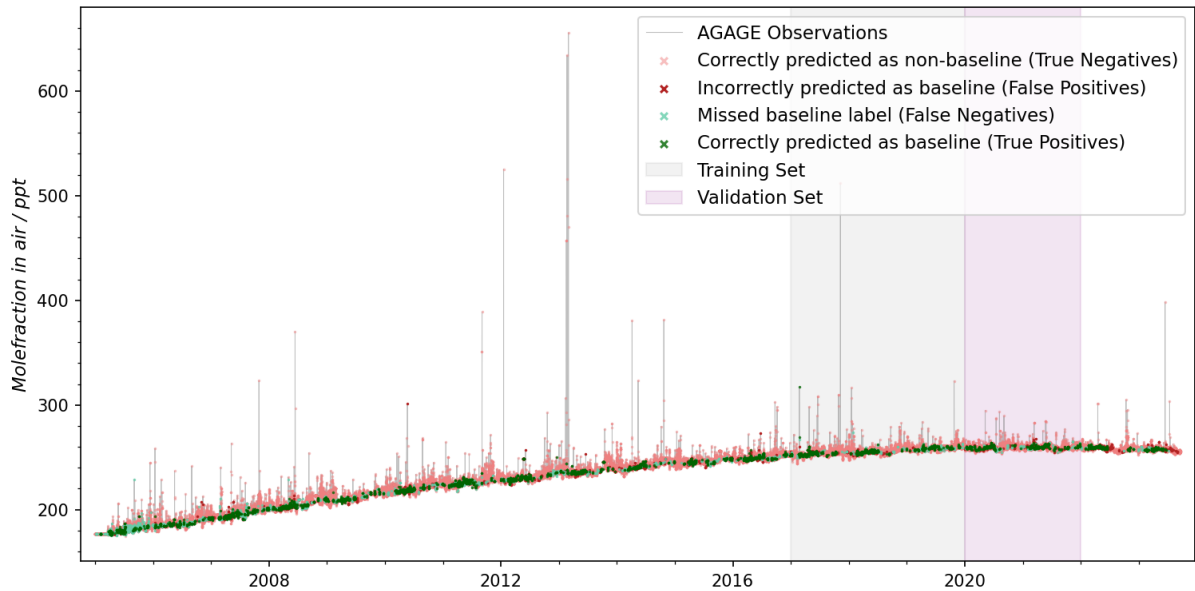


Monthly means (CH₃Br, THD)

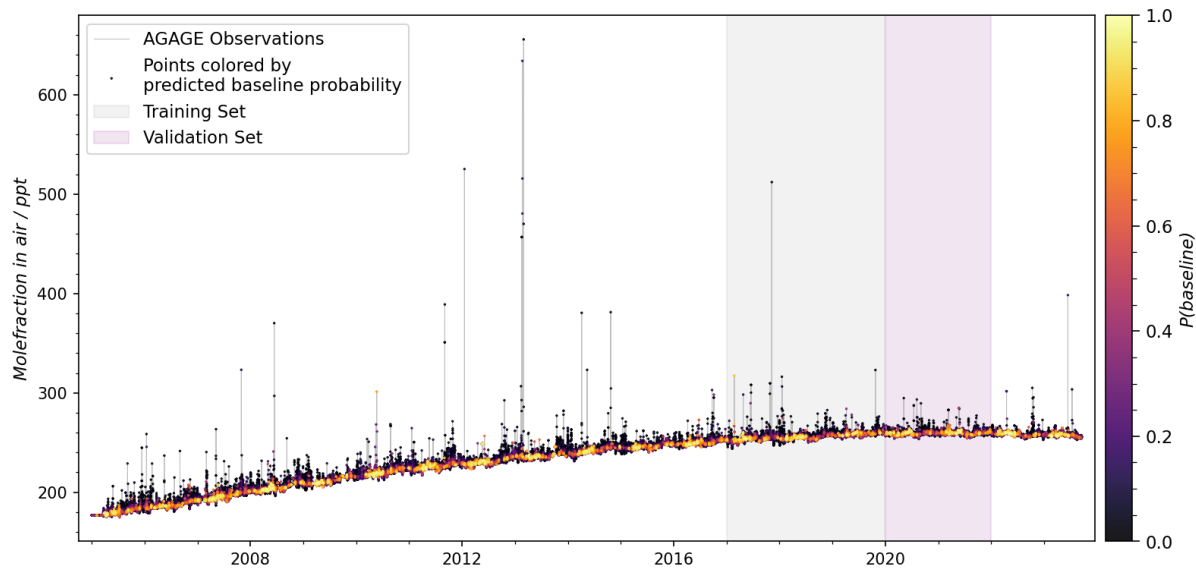


HCFC-22

Molefraction time series (HCFC-22, THD)



Model Confidence (HCFC-22, THD)

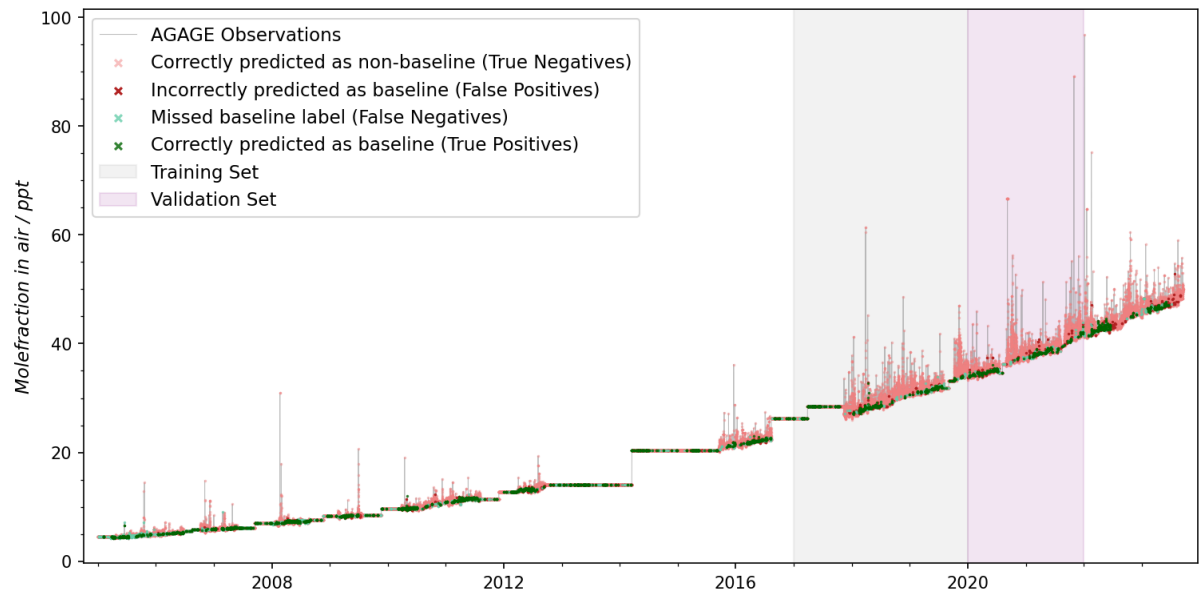


370 Monthly means (HCFC-22, THD)

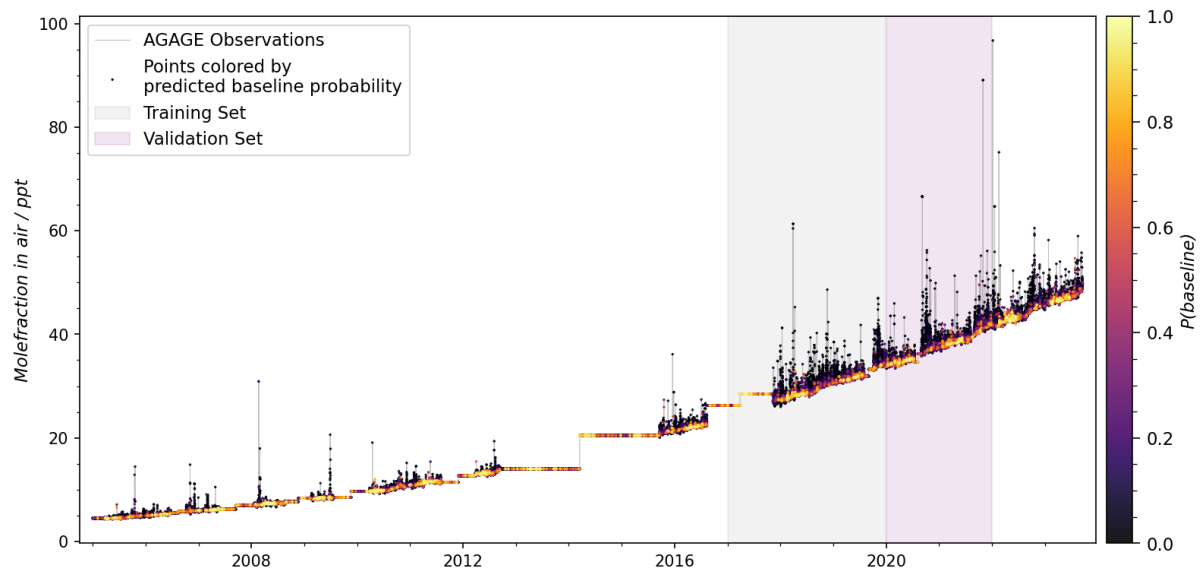


HFC-125

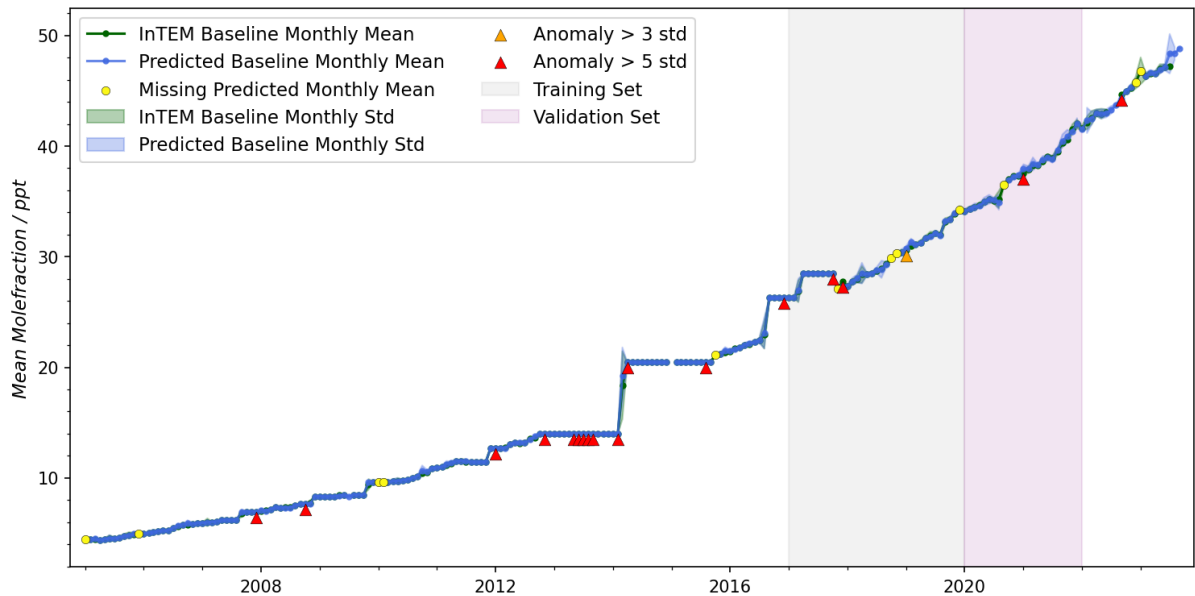
Molefraction time series (HFC-125, THD)



Model Confidence (HFC-125, THD)

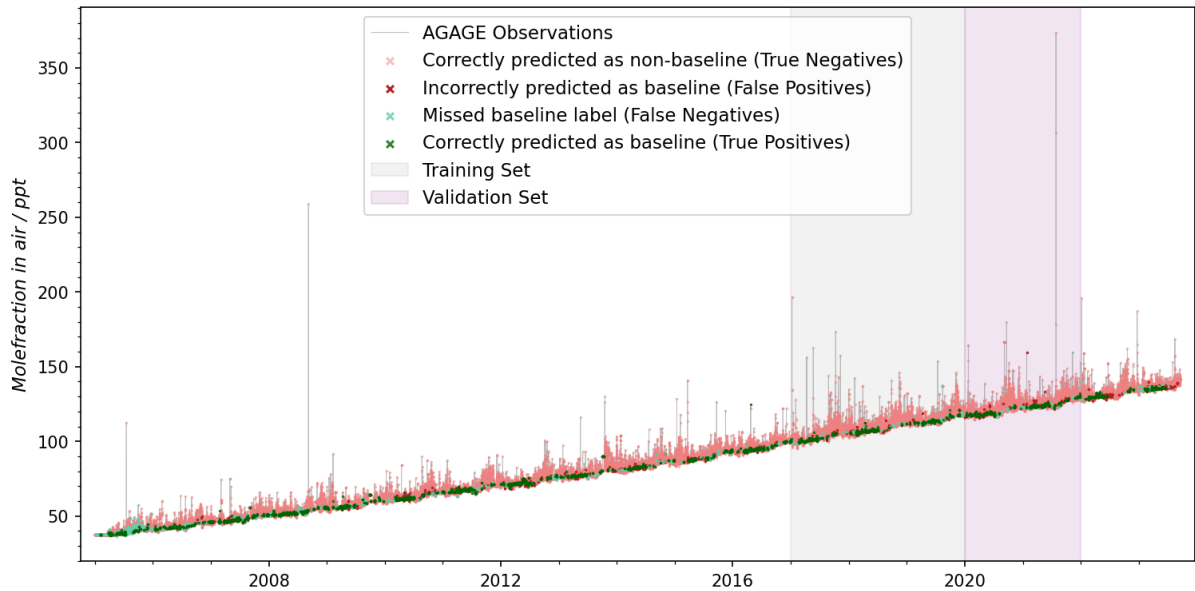


Monthly means (HFC-125, THD)

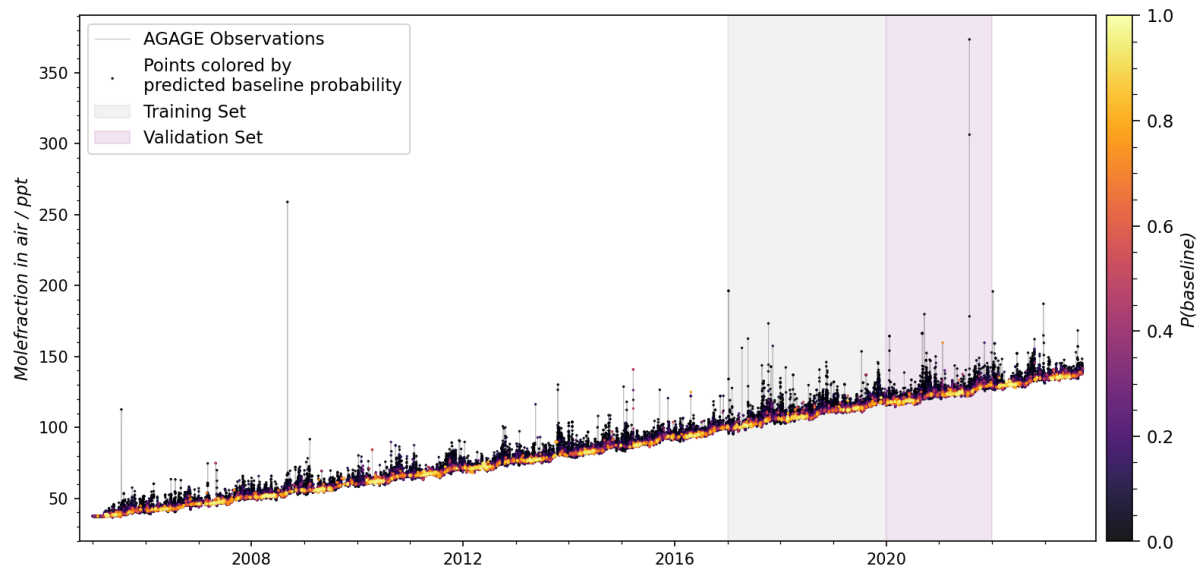


375 HFC-134a

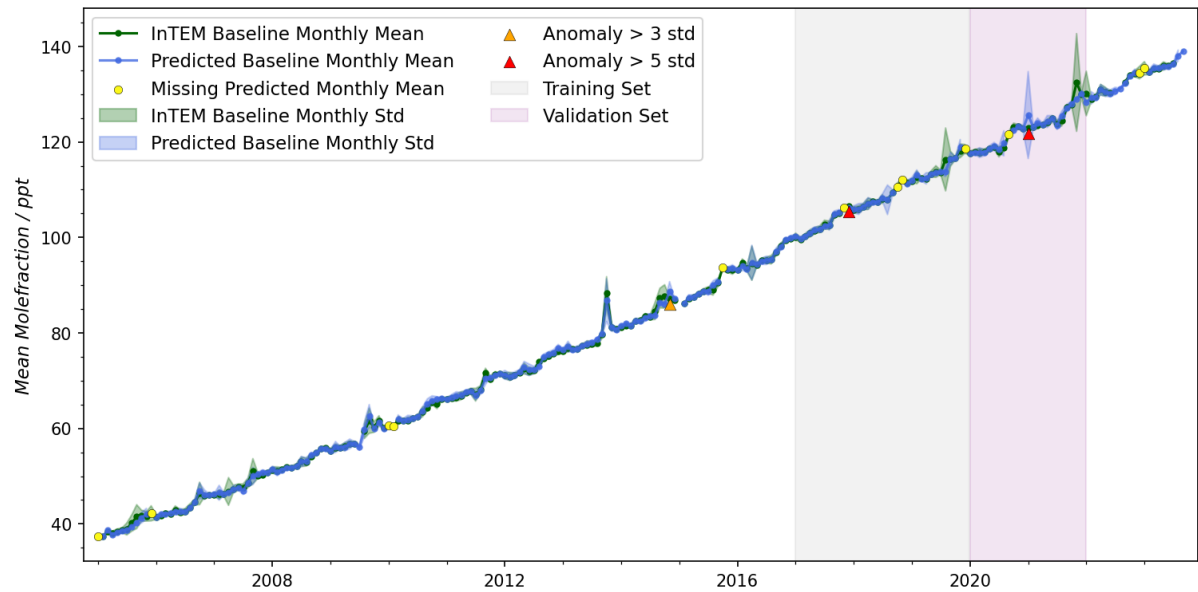
Molefraction time series (HFC-134a, THD)



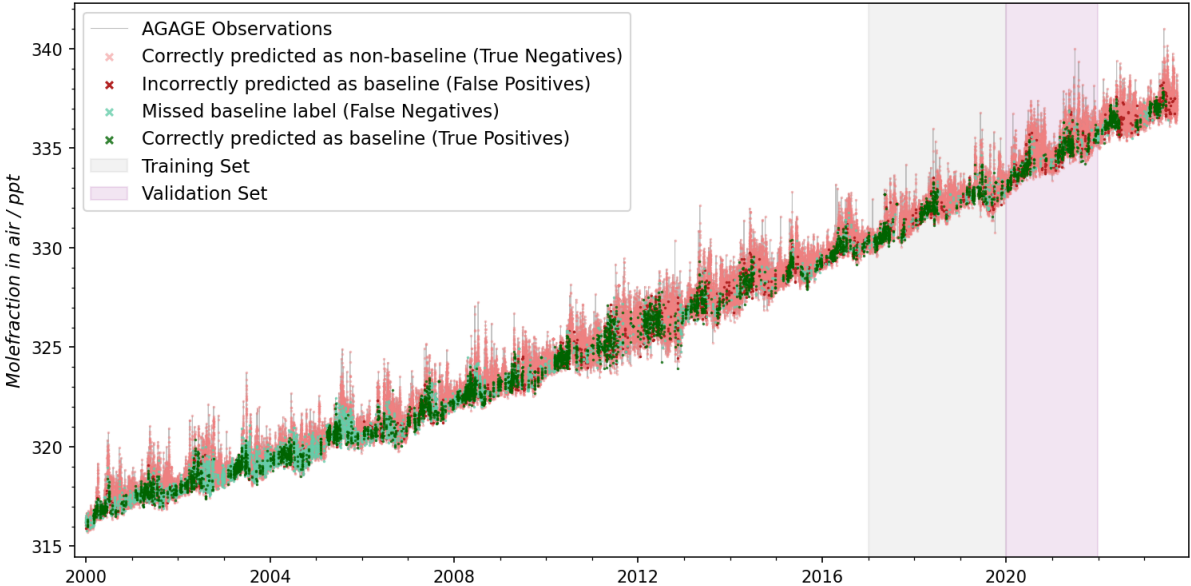
Model Confidence (HFC-134a, THD)



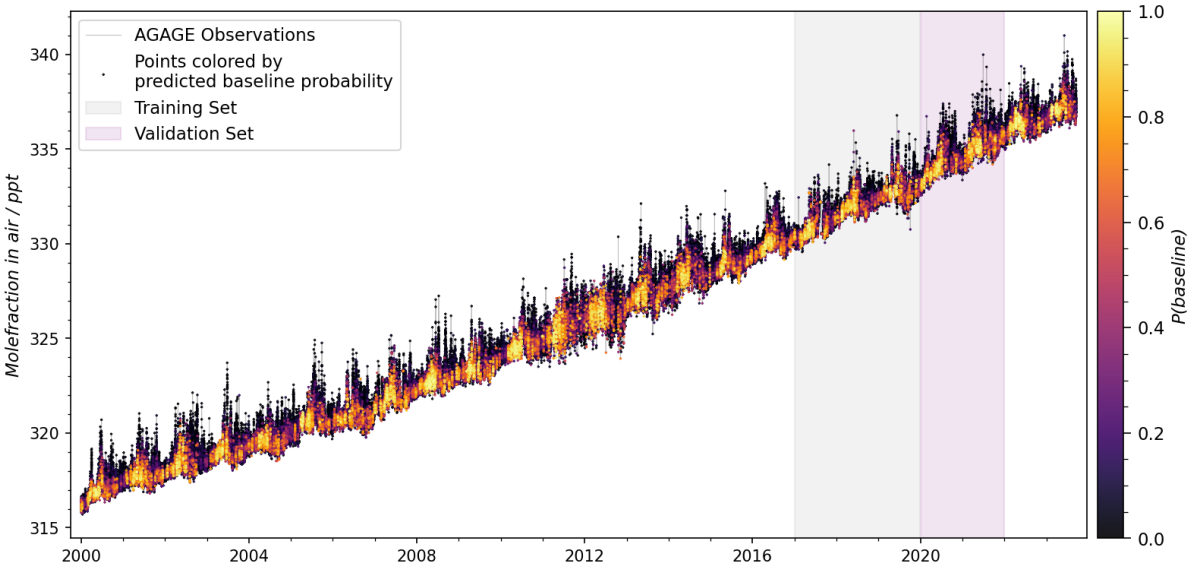
Monthly means (HFC-134a, THD)



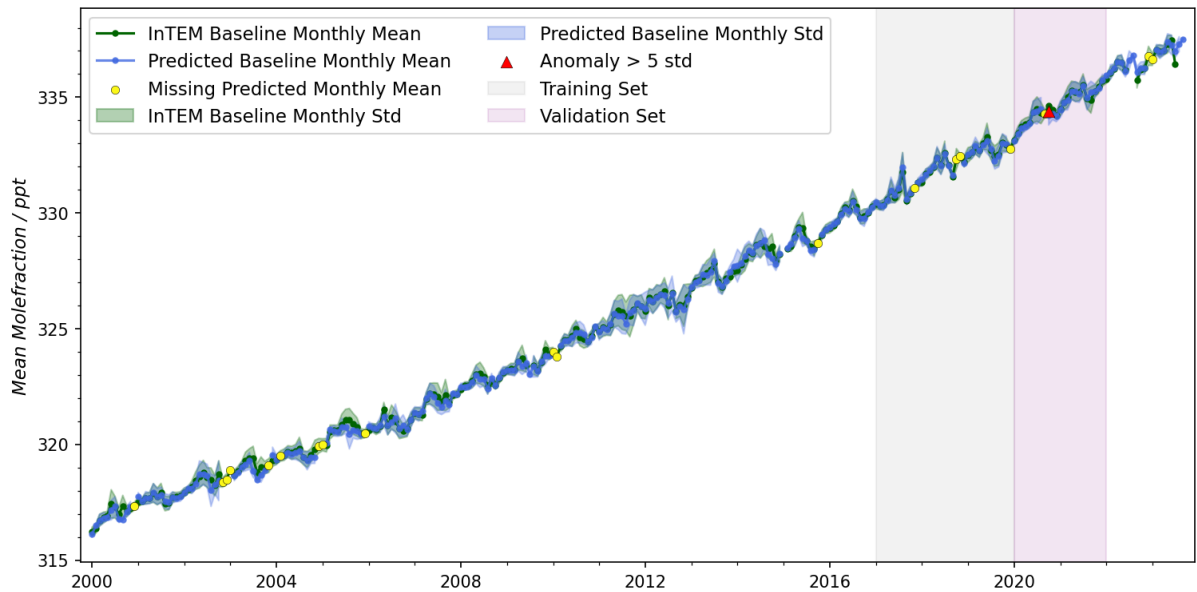
380 Molefraction time series (N₂O, THD)



Model Confidence (N₂O, THD)

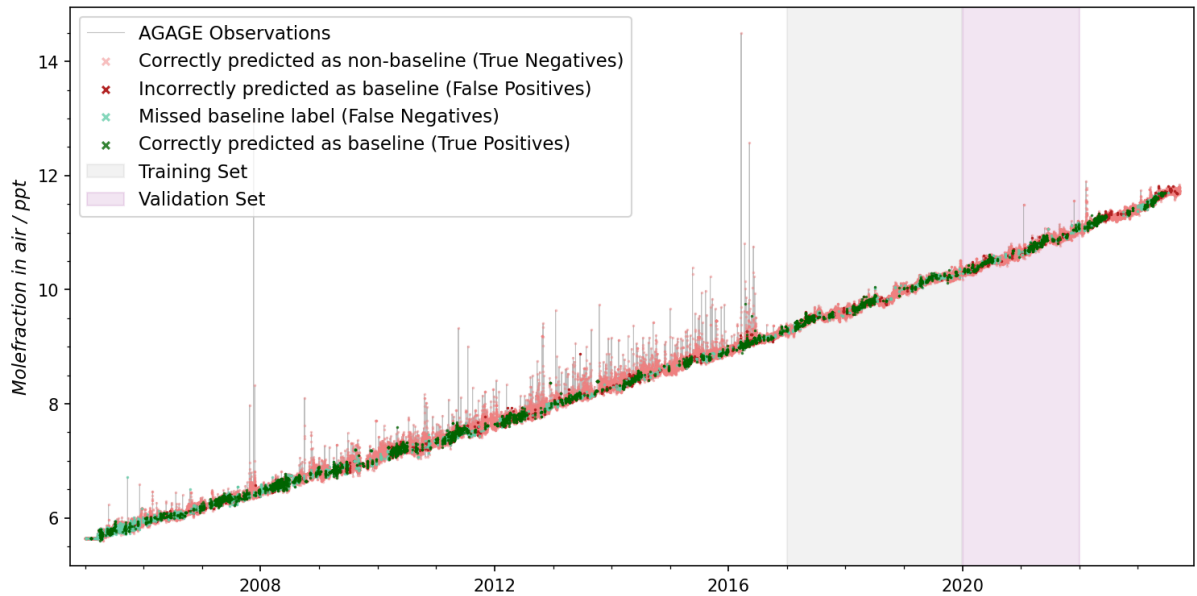


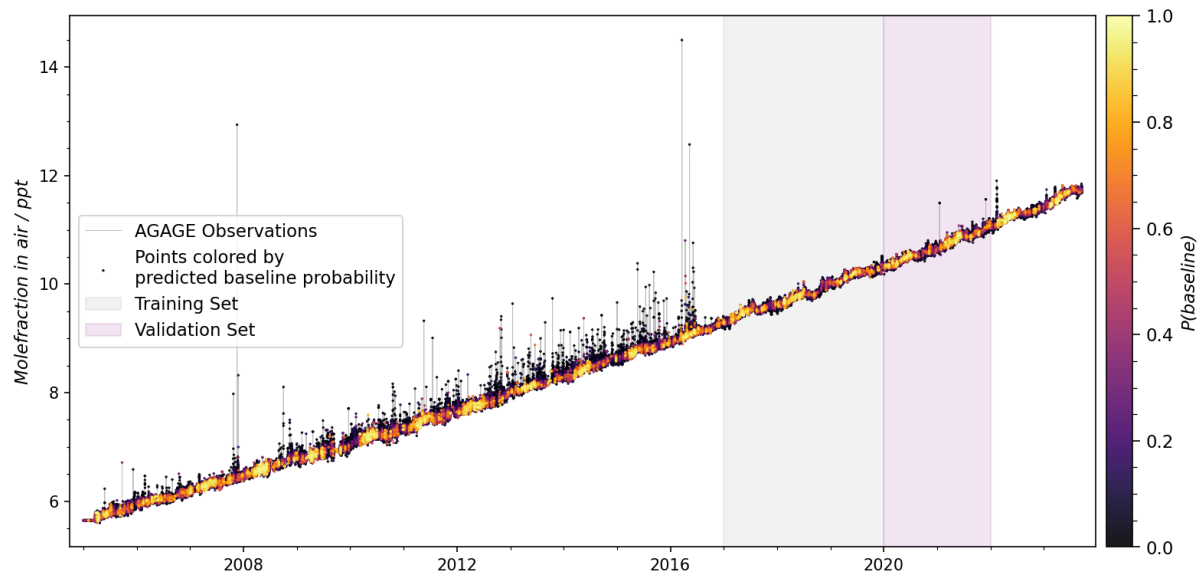
Monthly means (N₂O, THD)



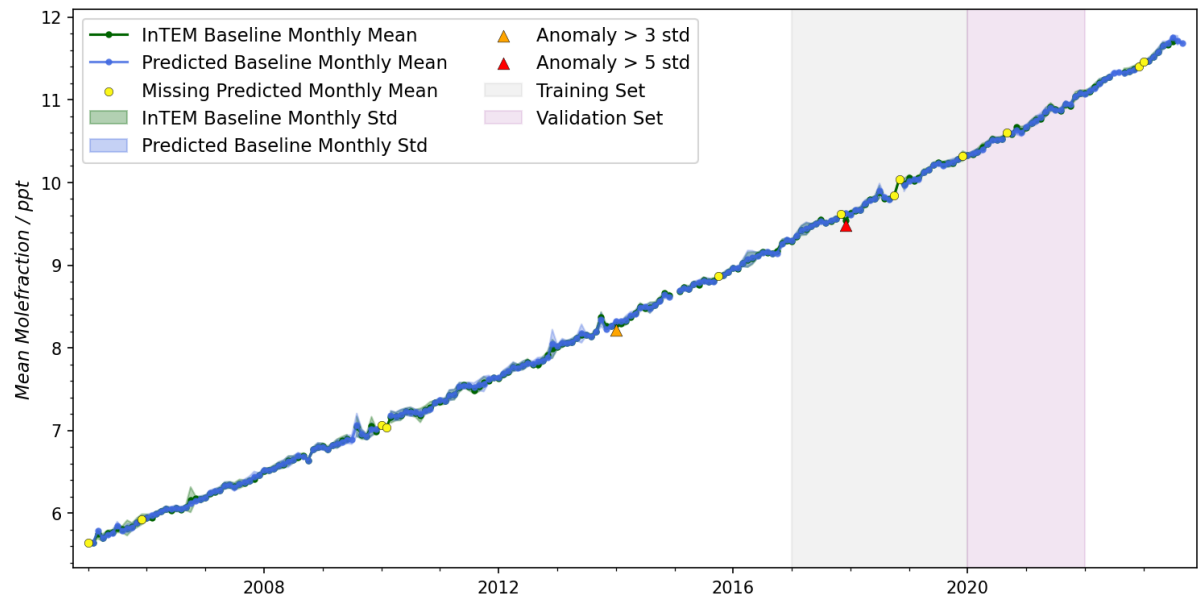
SF₆

Molefraction time series (SF₆, THD)





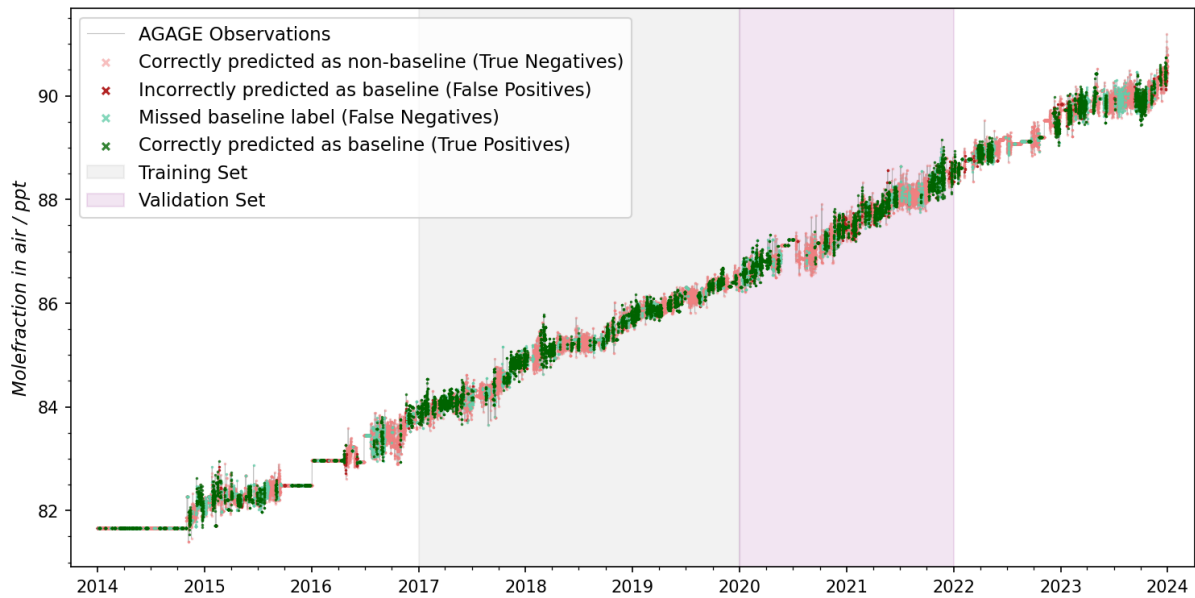
Monthly means (SF₆, THD)



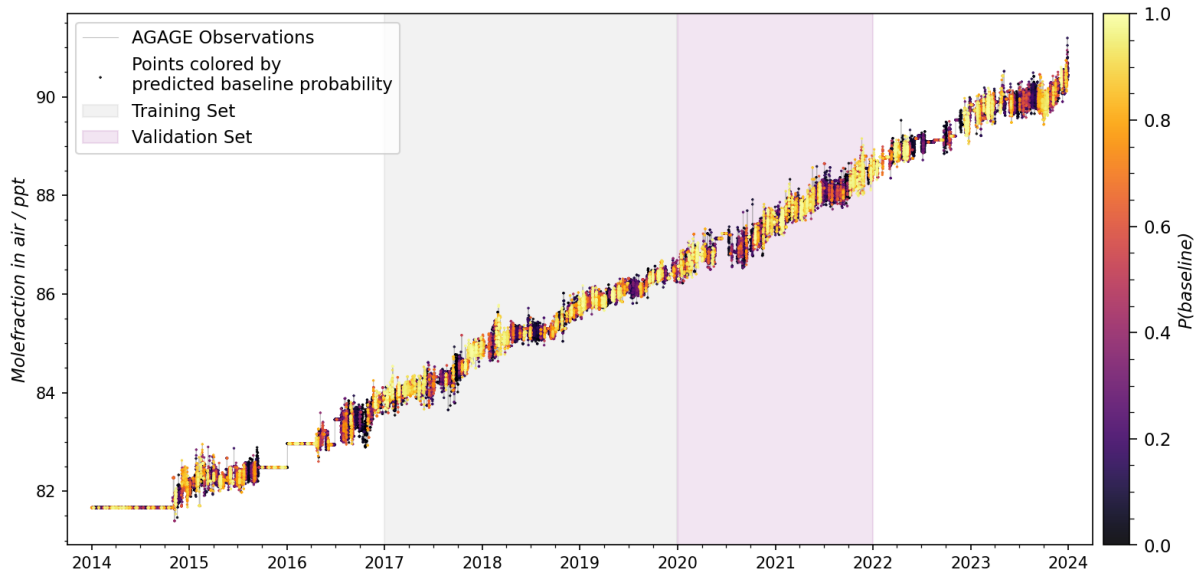
S9.9 Zeppelin, Svalbard

CF₄

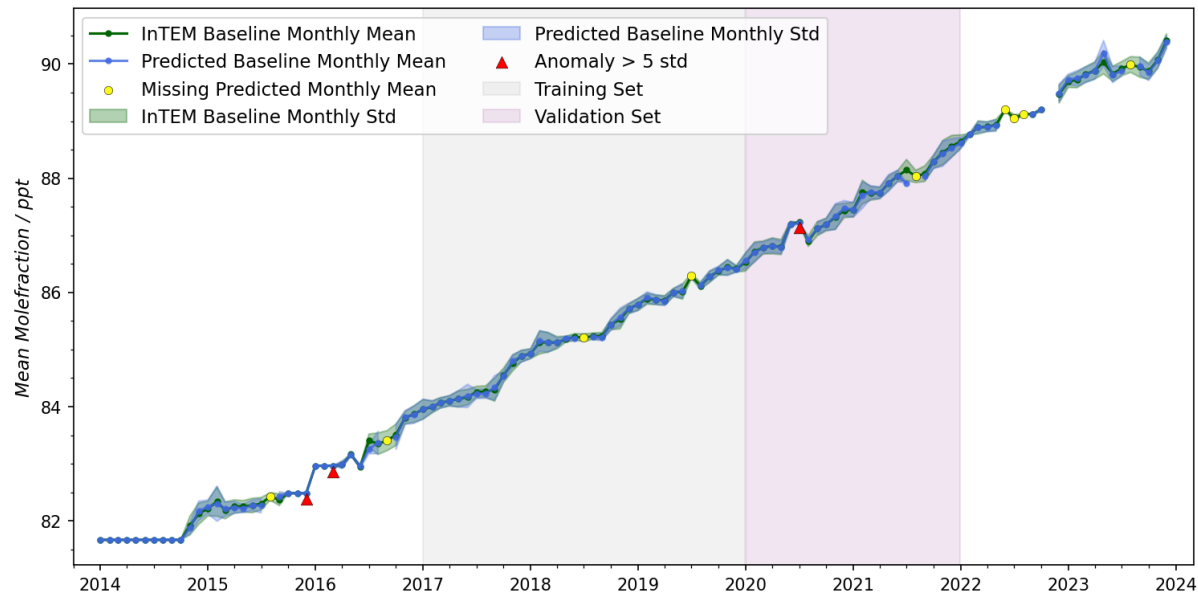
Molefraction time series (CF₄, ZEP)



390 Model Confidence (CF₄, ZEP)

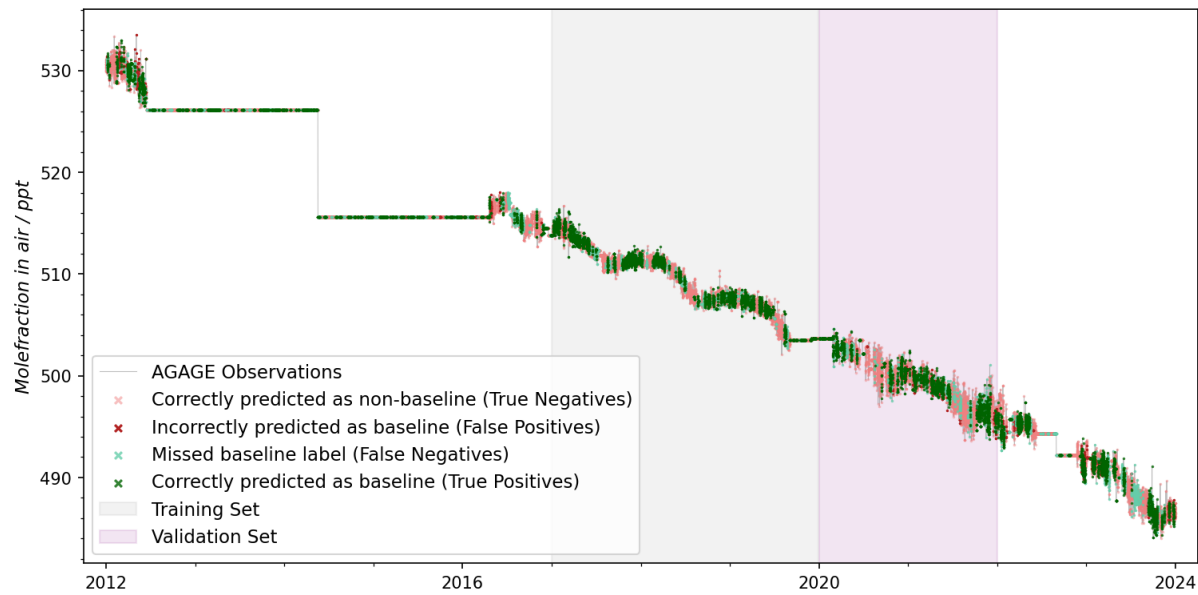


Monthly means (CF₄, ZEP)

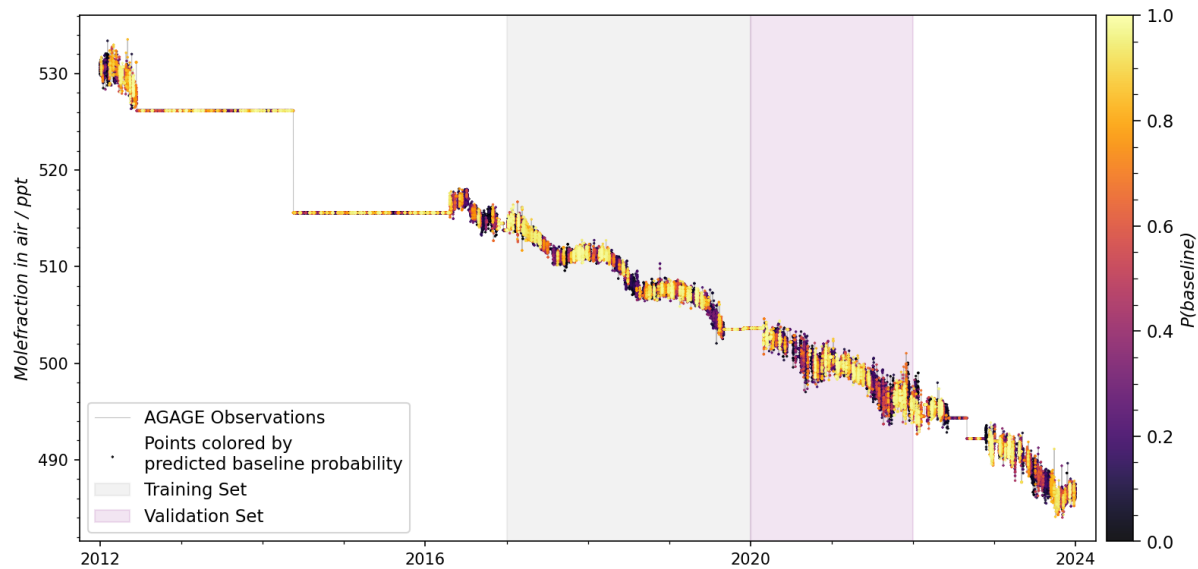


CFC-12

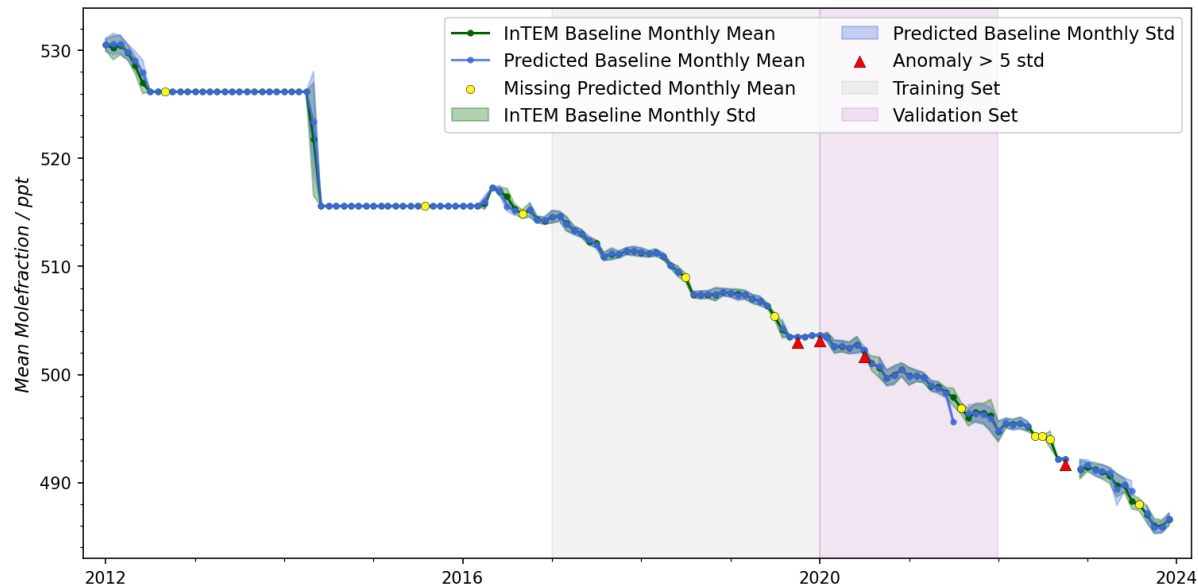
Molefraction time series (CFC-12, ZEP)



Model Confidence (CFC-12, ZEP)

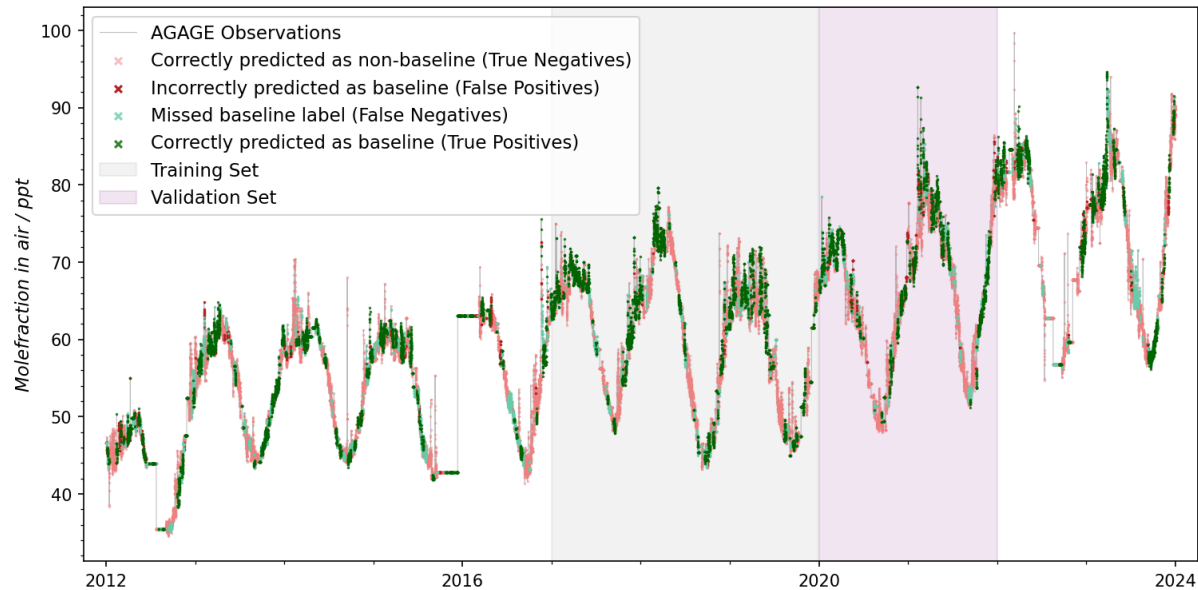


395 Monthly means (CFC-12, ZEP)

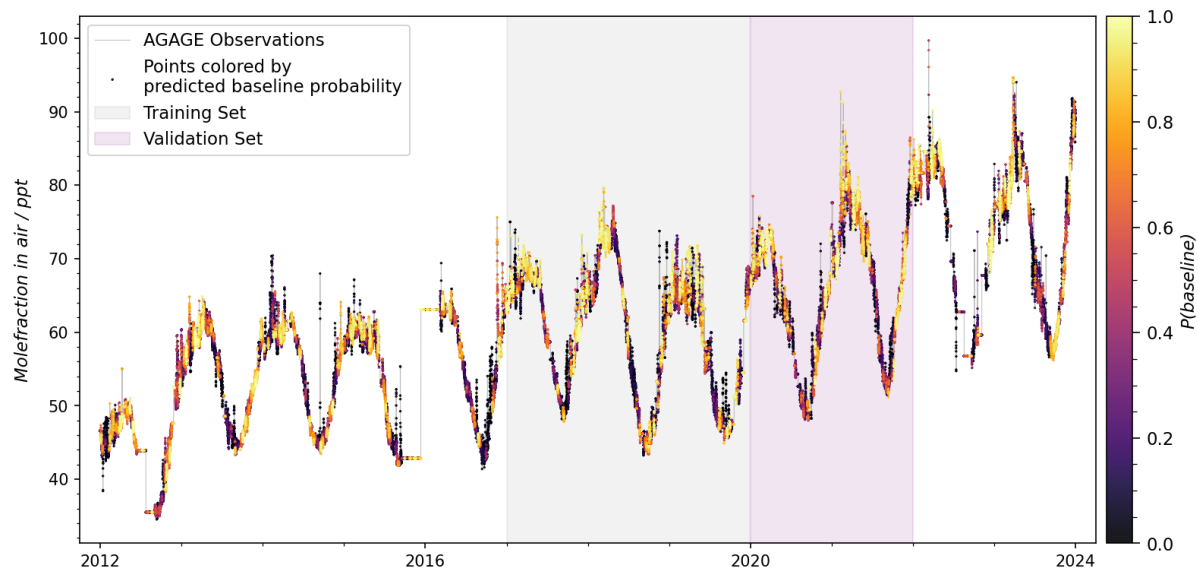


CH_2Cl_2

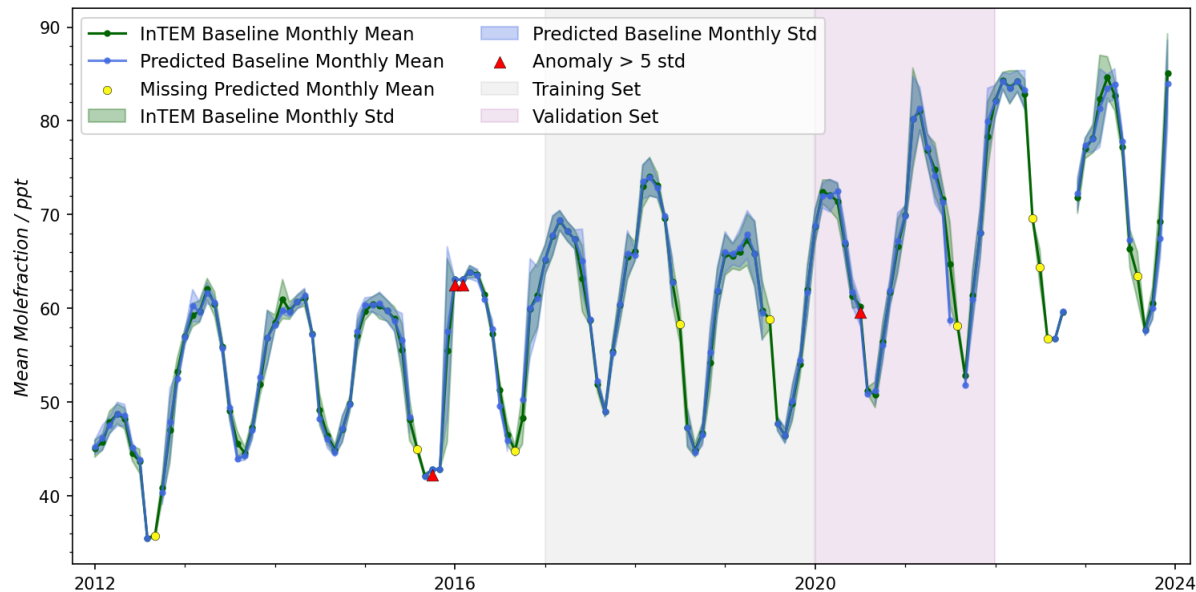
Molefraction time series (CH_2Cl_2 , ZEP)



Model Confidence (CH_2Cl_2 , ZEP)

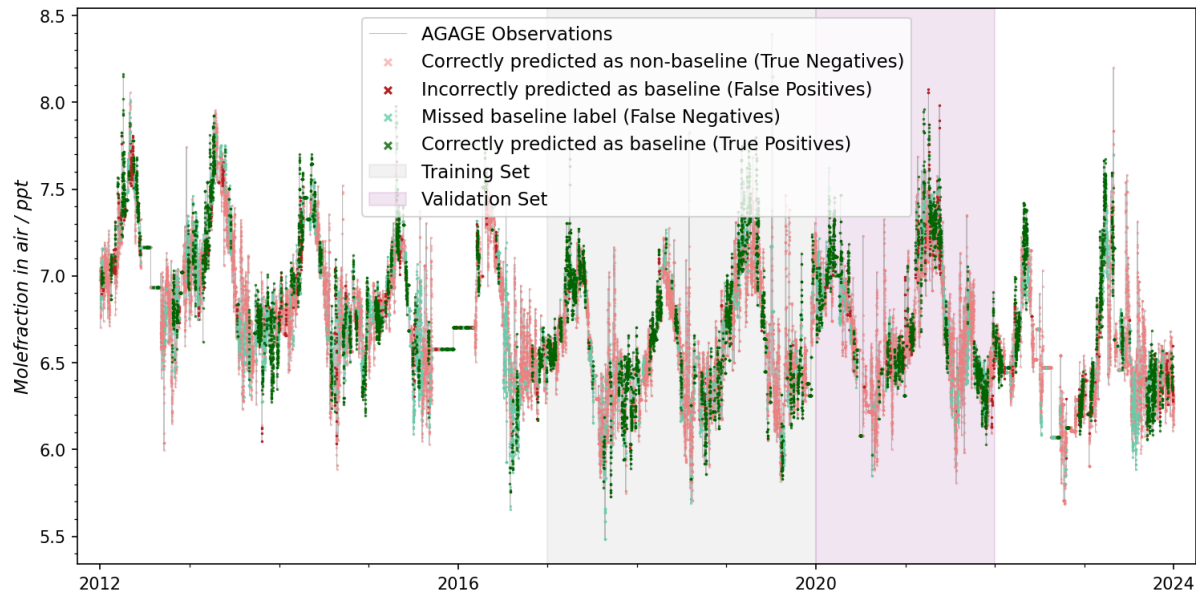


Monthly means (CH₂Cl₂, ZEP)

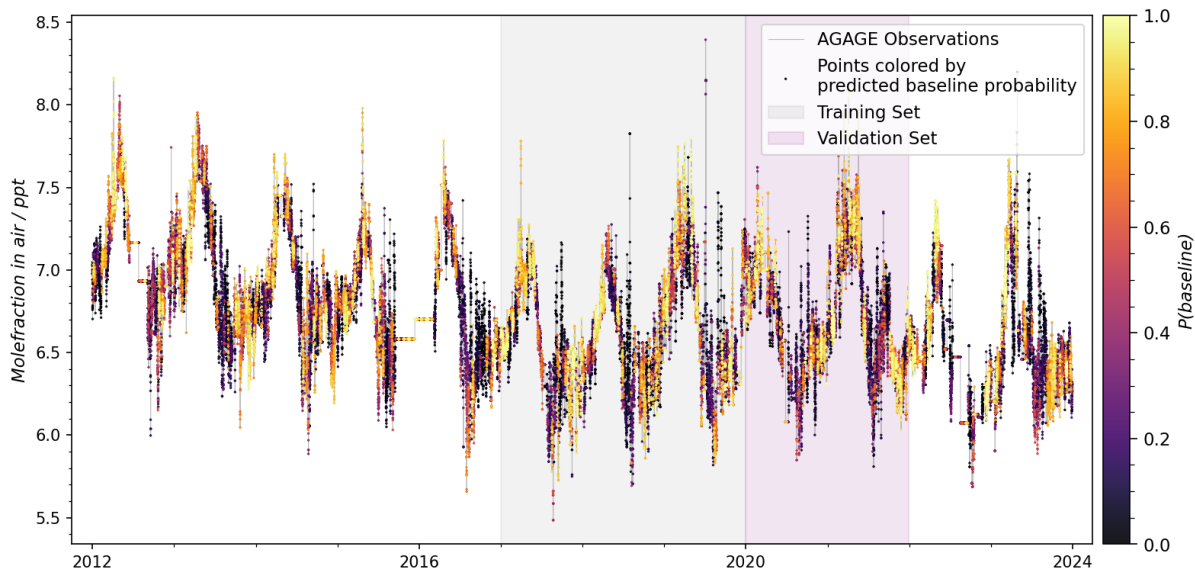


400 CH₃Br

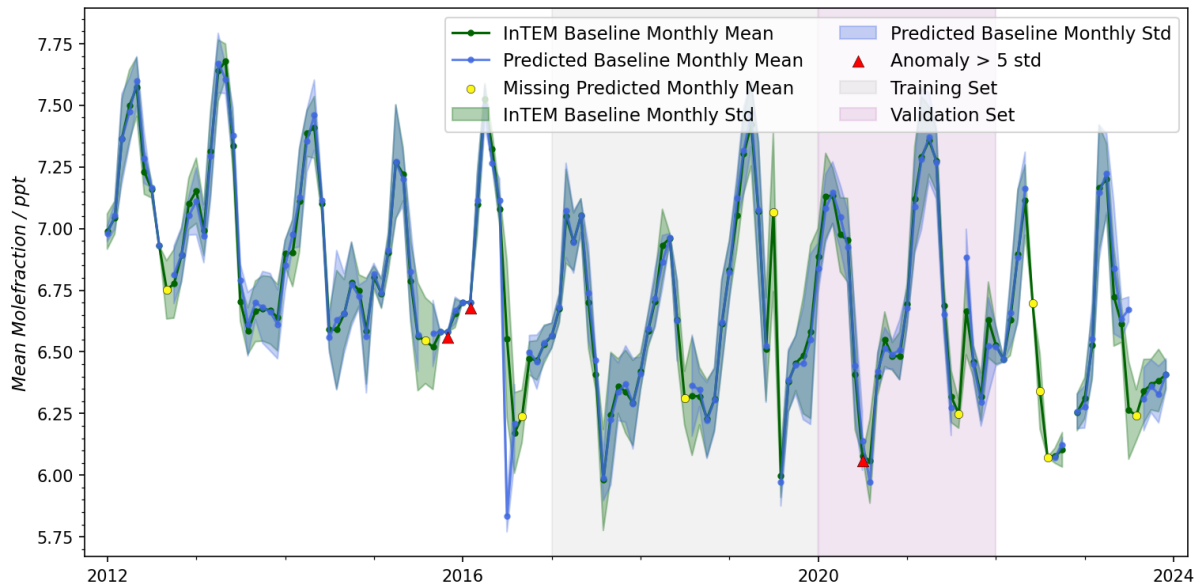
Molefraction time series (CH₃Br, ZEP)



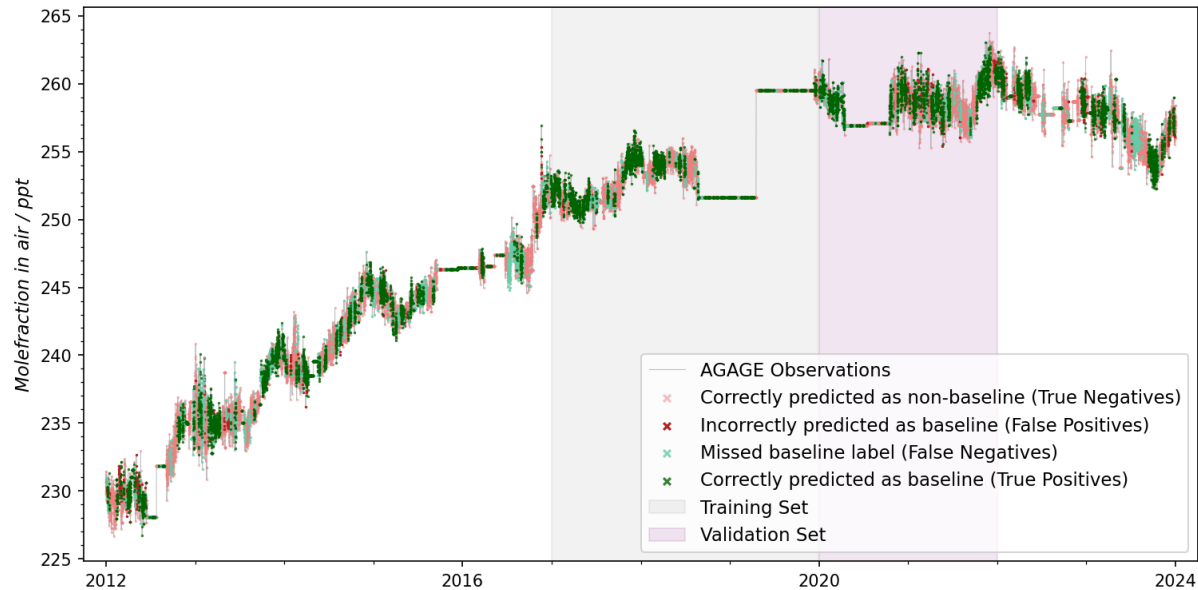
Model Confidence (CH₃Br, ZEP)



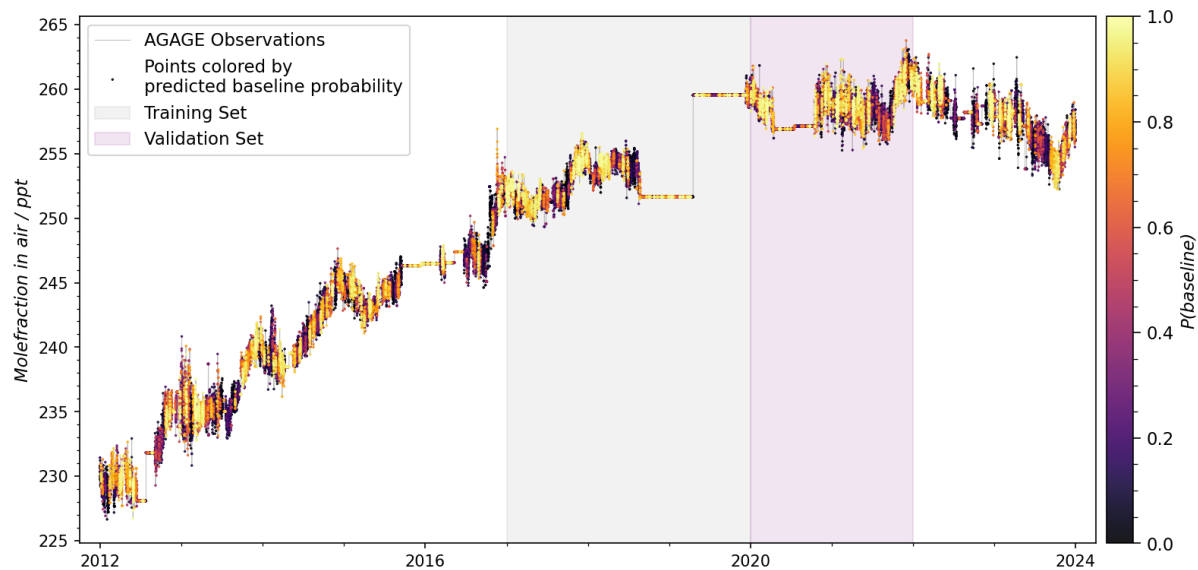
Monthly means (CH₃Br, ZEP)



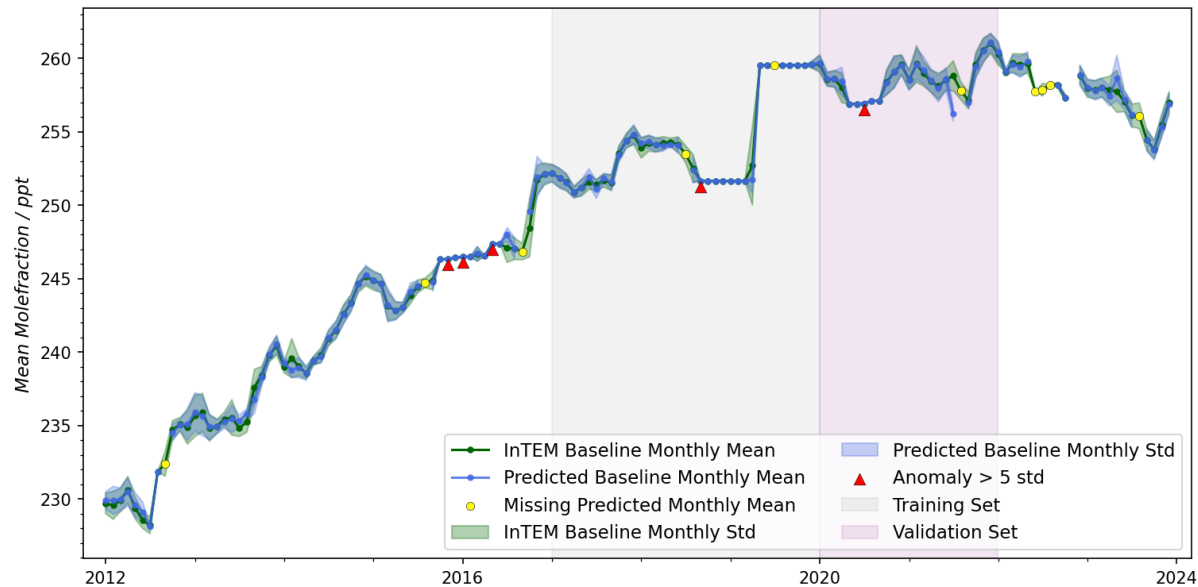
405 Molefraction time series (HCFC-22, ZEP)



Model Confidence (HCFC-22, ZEP)

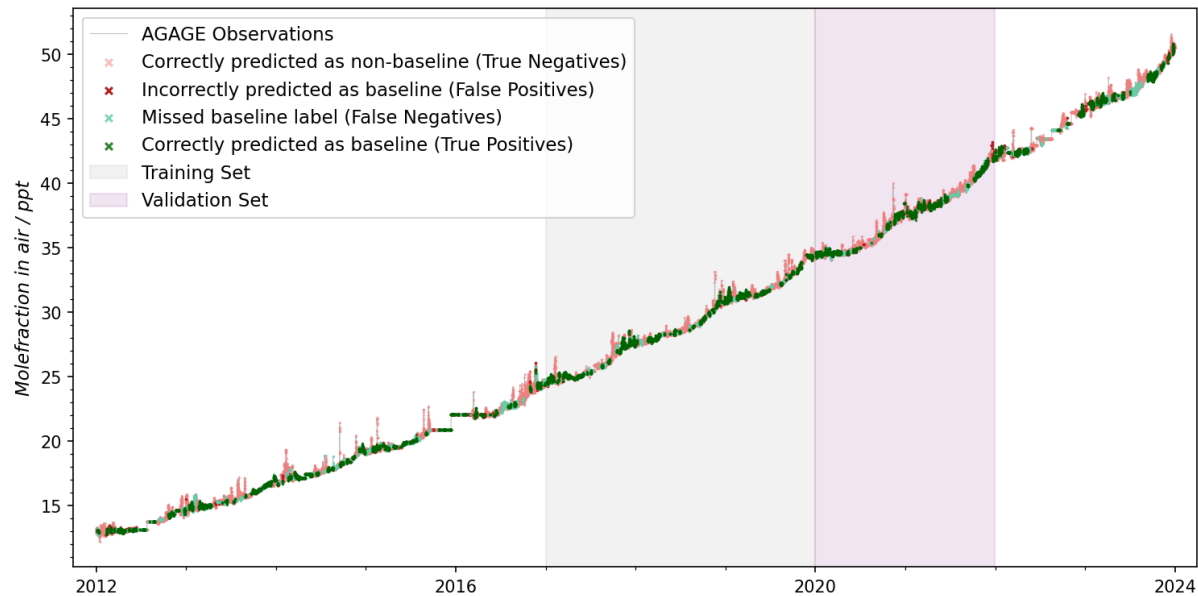


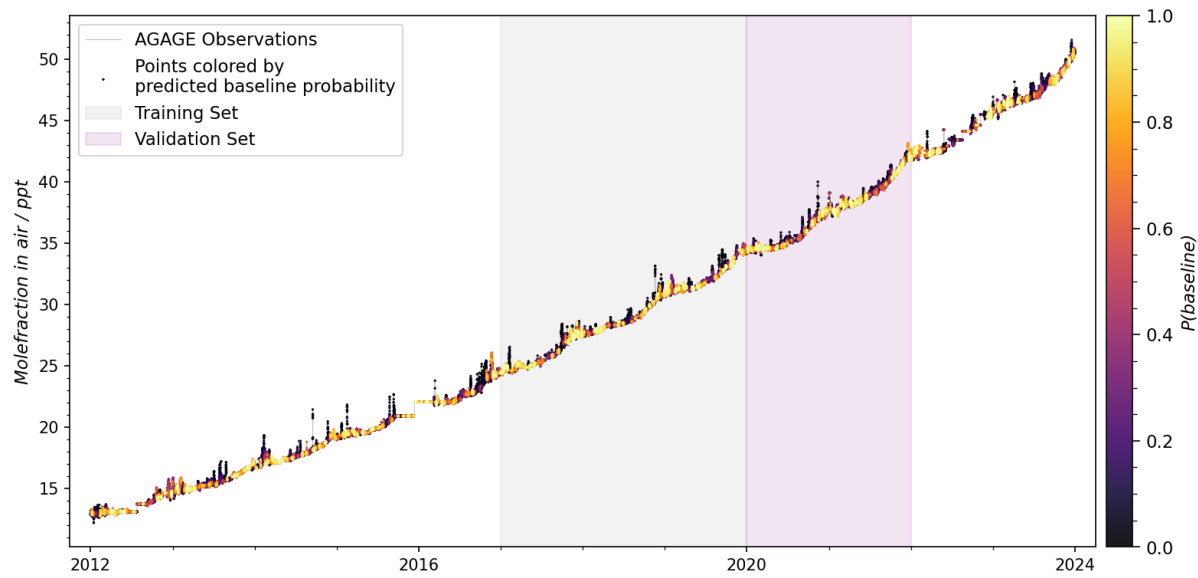
Monthly means (HCFC-22, ZEP)



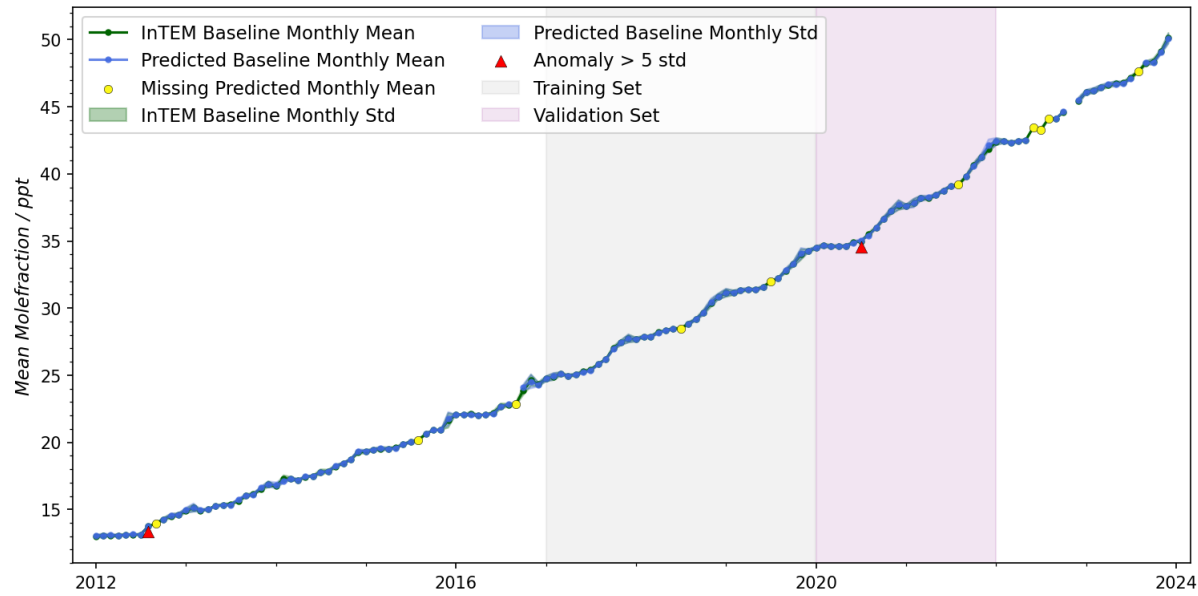
HFC-125

Molefraction time series (HFC-125, ZEP)



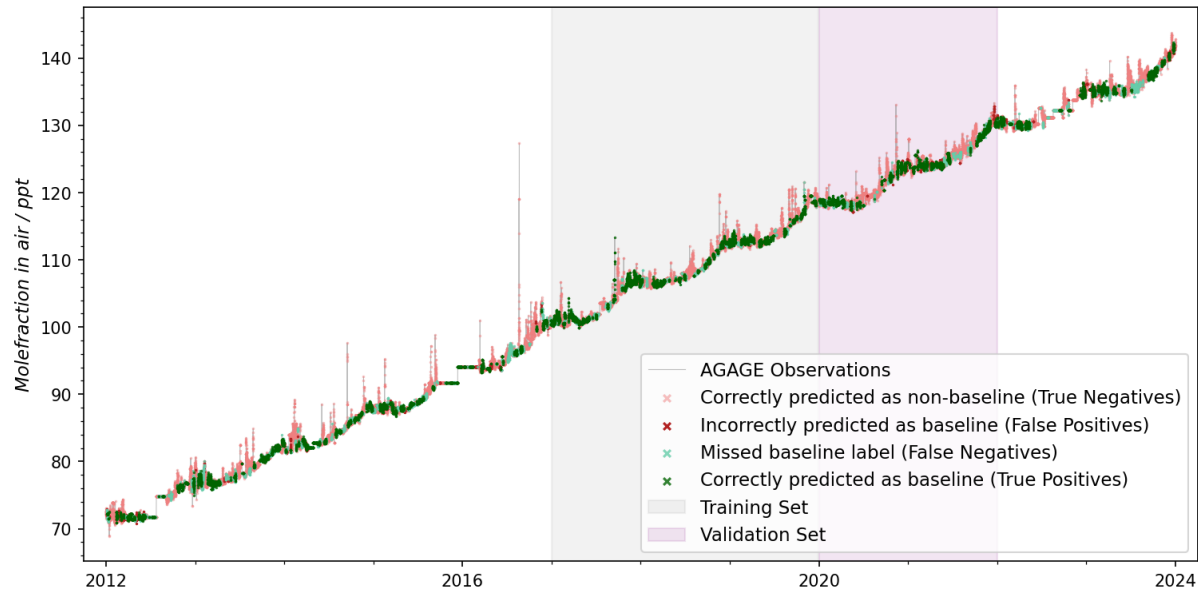


Monthly means (HFC-125, ZEP)

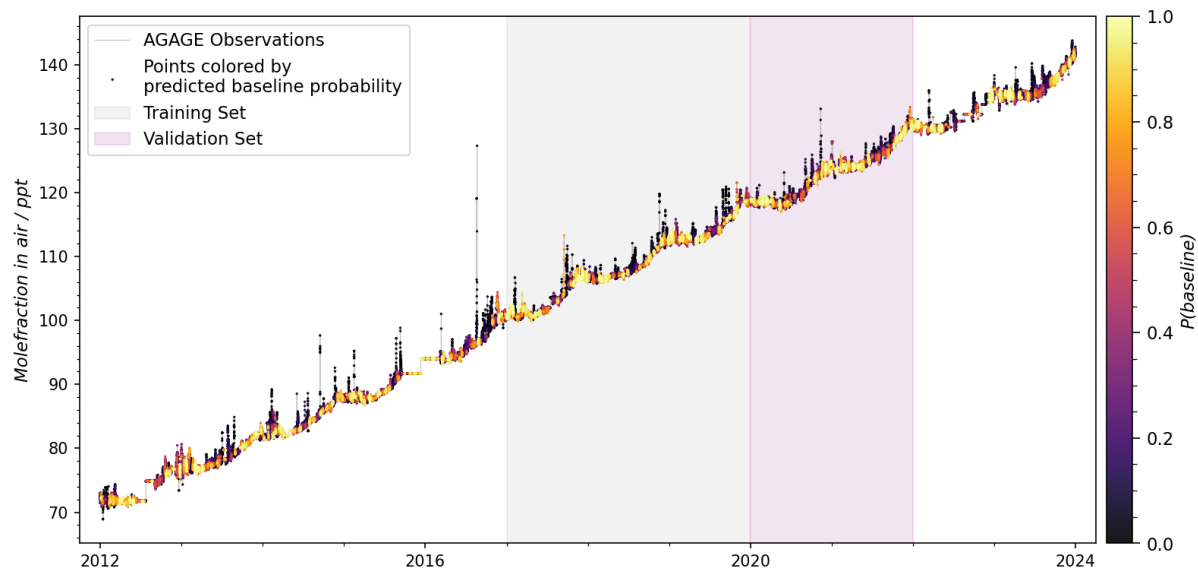


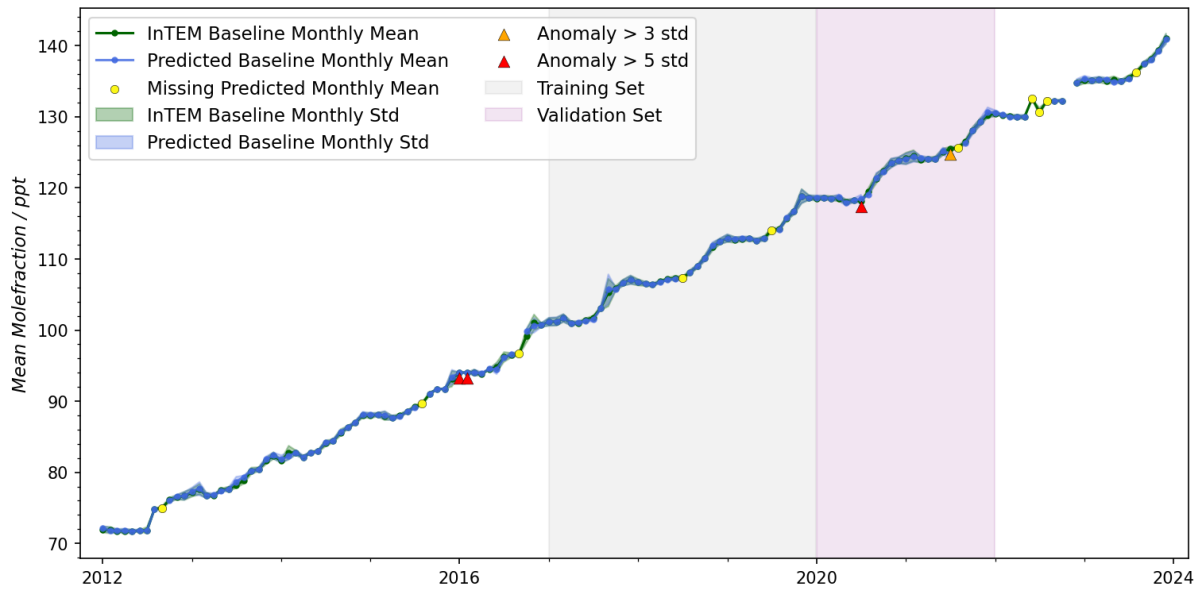
HFC-134a

Molefraction time series (HFC-134a, ZEP)

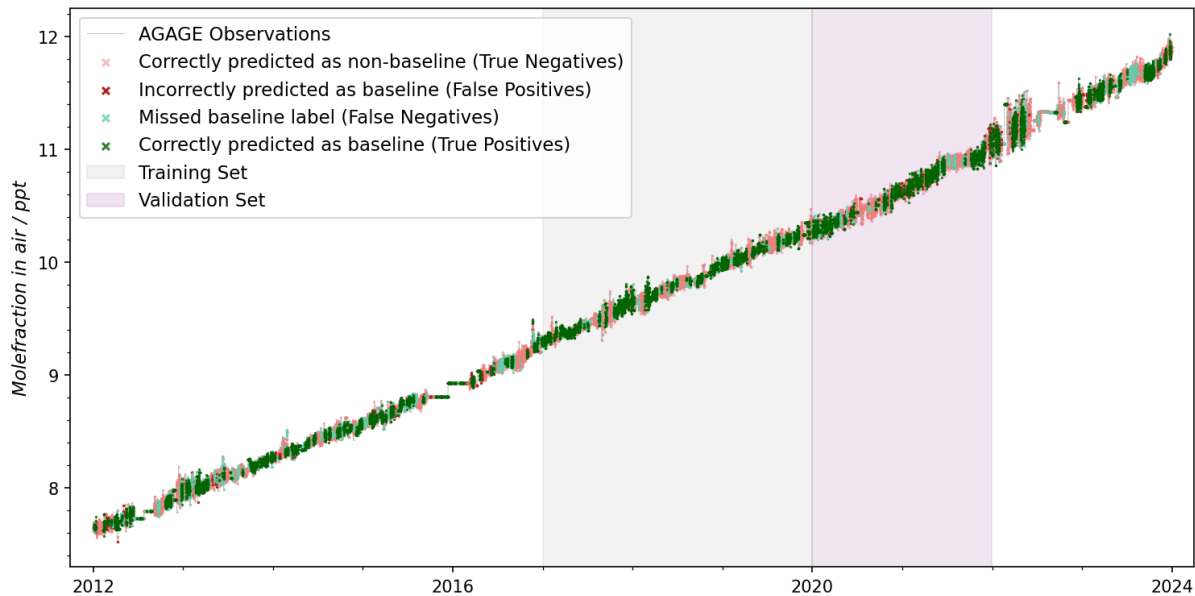


Model Confidence (HFC-134a, ZEP)

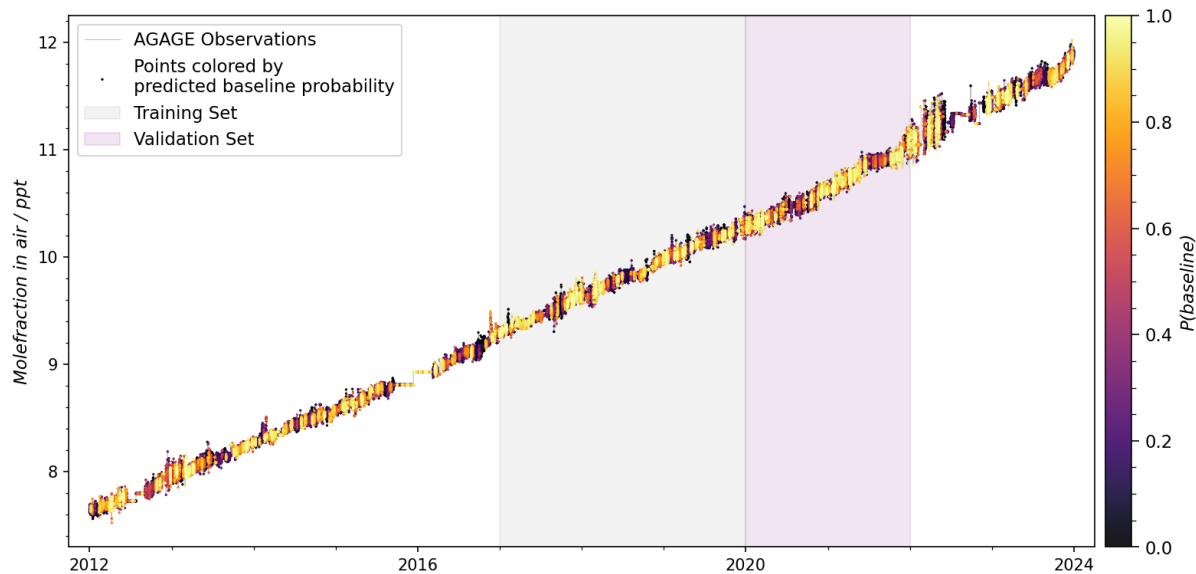




SF₆
Molefraction time series (SF₆, ZEP)



Model Confidence (SF₆, ZEP)



Monthly means (SF₆, ZEP)

