ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Methane CarbonTracker Europe: influence of Pallas observations

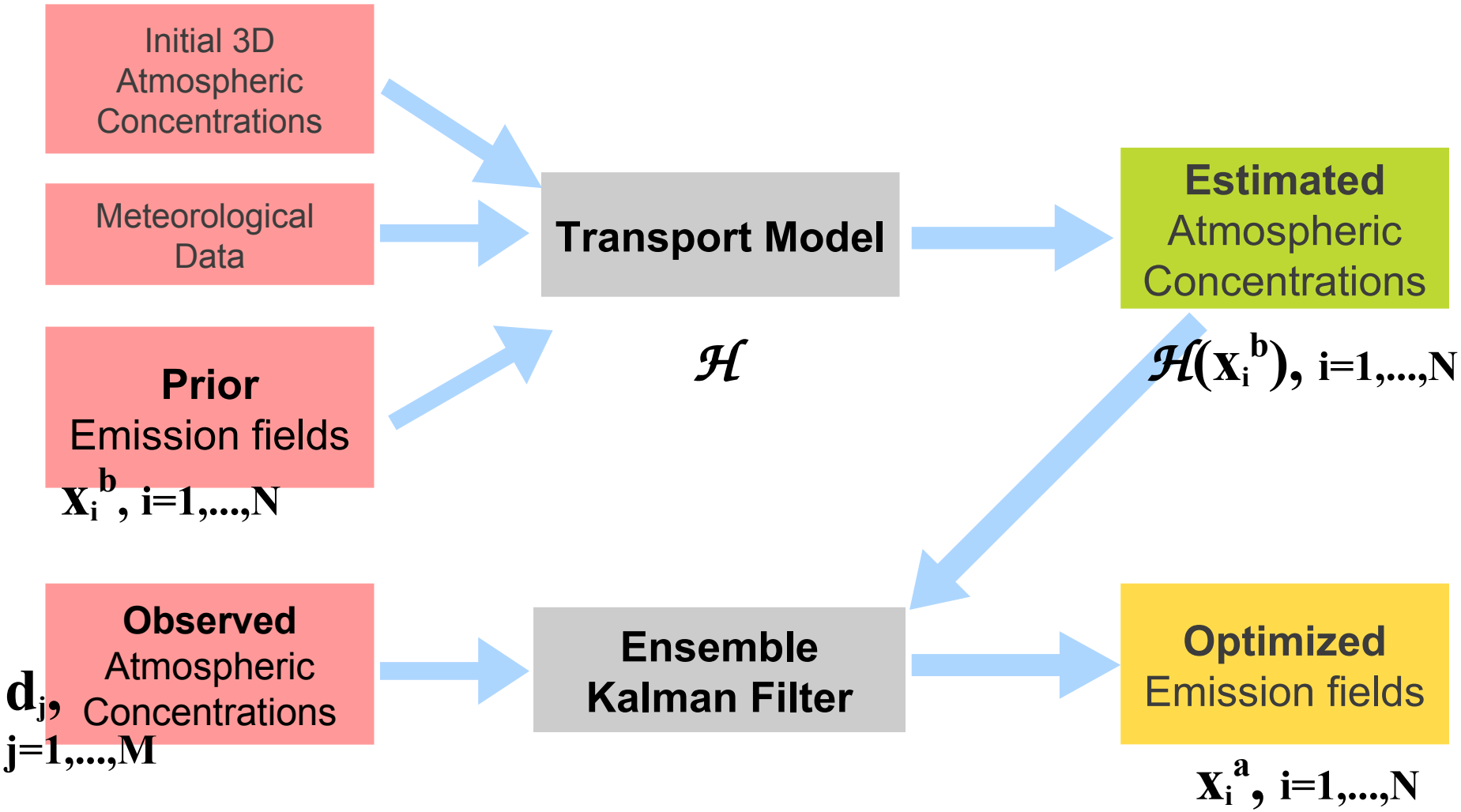
Aki Tsuruta, Tuula Aalto, Leif Backman & other developers

Aki.Tsuruta@fmi.fi

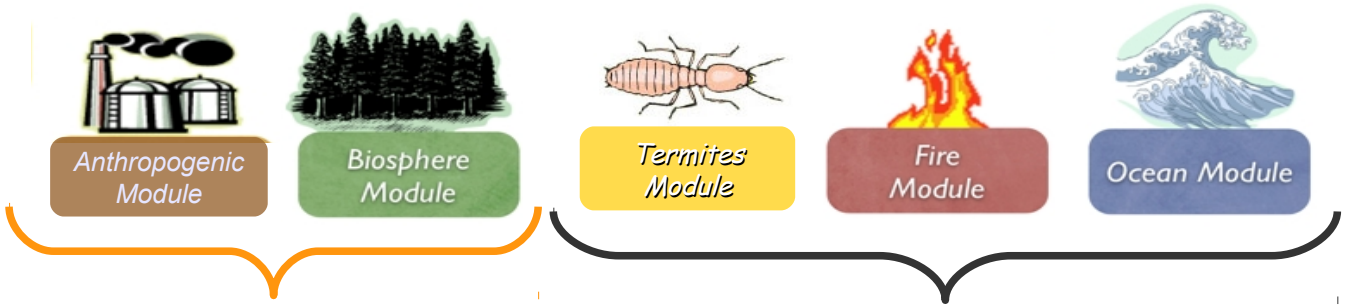
Methane CarbonTracker Europe model

- Basic structure is same as the original CarbonTracker (Peters et al. 2005).
- Optimises global **methane** surface fluxes.
- Scaling factor applied to **anthropogenic** and **biosphere** emissions.
- TM5 **zoom** grid **over Europe**, including Northern Europe.
- Region defined by **TransCom + land ecosystem map** based on soil types

CarbonTracker – Structure



Prior emission fields

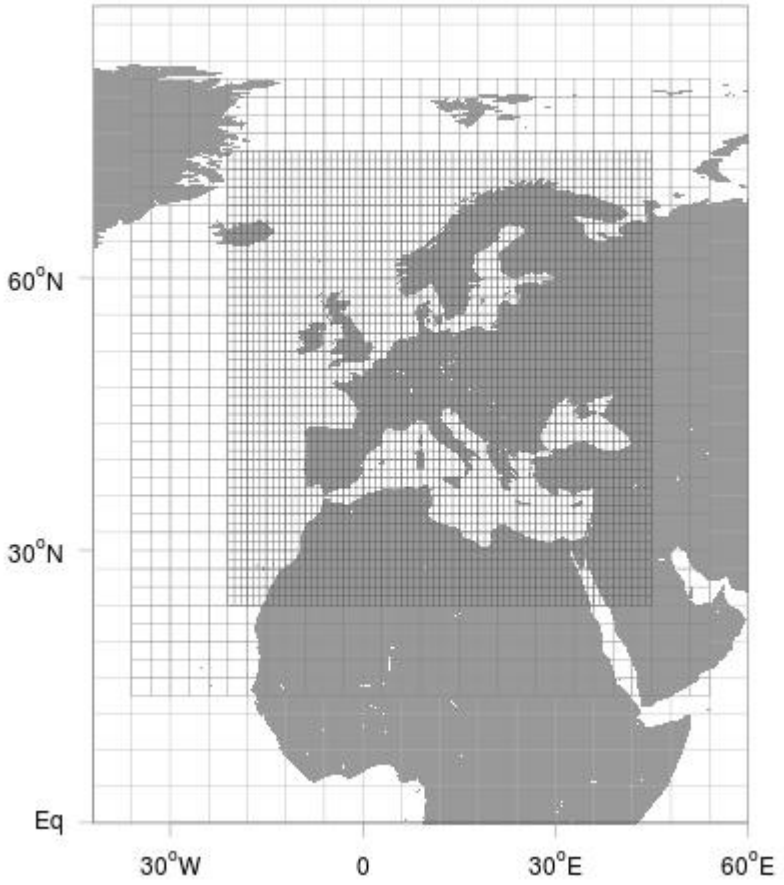


$$F_{total} = \lambda_{ff}(F_{ff}) + \lambda_{bio}(F_{bio}) + F_{term} + F_{fire} + F_{oce}$$

		Source	Grid	Temporal resolution
F_{ff}	Anthropogenic emission	EDGAR v4.2	0.1x0.1	annual
F_{bio}	Biosphere emission	LPJ-WhyMe (Spahni et al. 2011)	1x1	monthly
F_{term}	Termites emission	Ito et al. (2012)	1x1	annual
F_{fire}	Fire emission	GFED v3.2	0.5x0.5	monthly
F_{oce}	Ocean emission	δCH4(Bates et al. 1996)*Kl*L	1x1	monthly

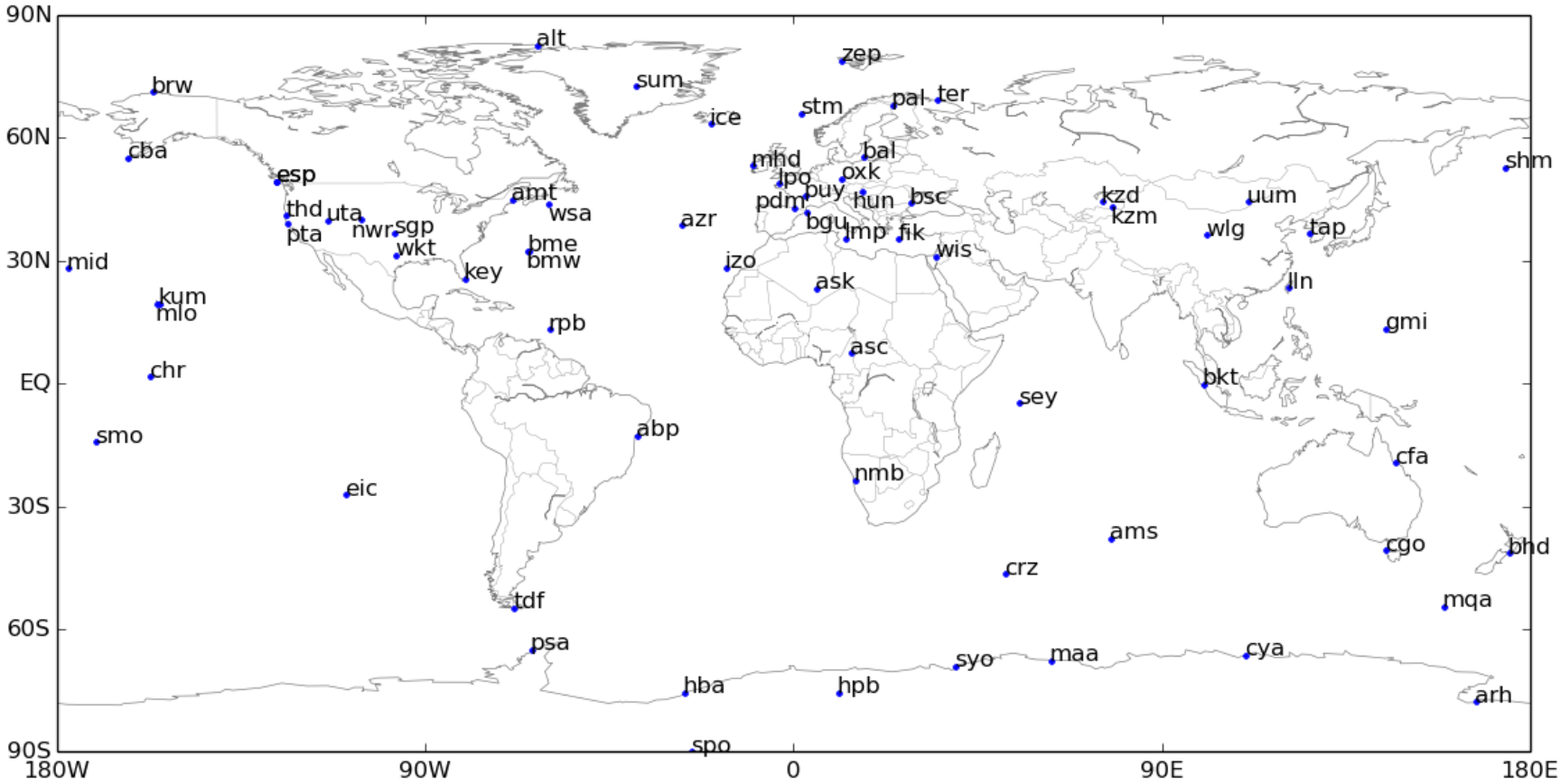
Transport model – TM5

- Driven by ECMWF ERA-Interim data
- European domain model grid:
  - **1ºx1º Europe (up to 74ºN)**
  - **3ºx2º Outer-Europe**
  - **6ºx4º Global**
- Time step: **3 hours**
- Vertical resolution: **25 levels**
- Off-line chemistry: **OH, O(^{1}D), Cl**
- Initial 3D from once optimized fields



Concentration measurements (flask) from WDCGG (Global):

- mainly NOAA samples, about 70 observations per week
- model-data-mismatch similar to Bruhwiler et al. (2014)

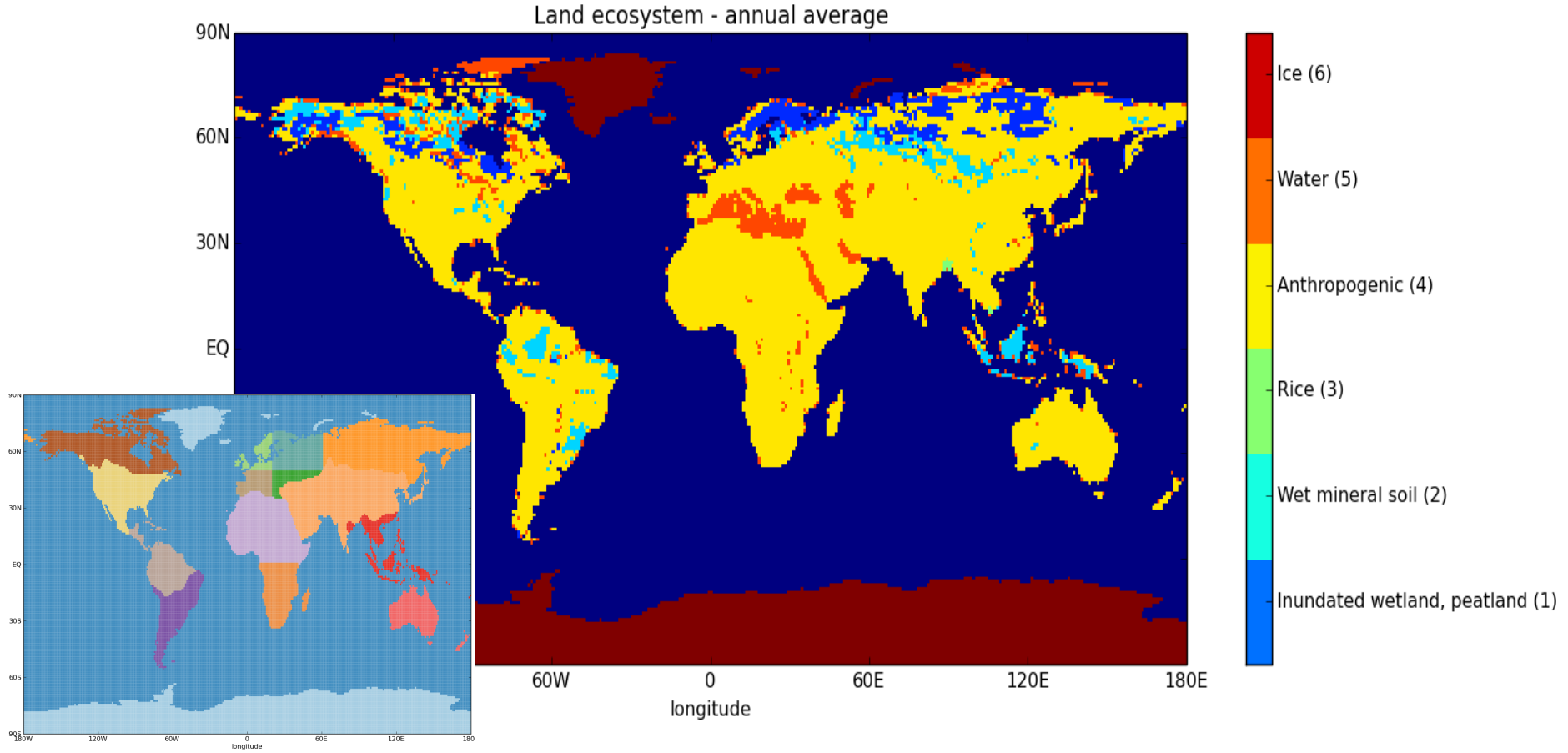


Observation network used for 2007 run

EnKF settings – Regions

Scaling factor λ is calculated region-wise, not grid-wise.

- Region definitions are combination of TransCom and land ecosystem. Total of about 50 regions.



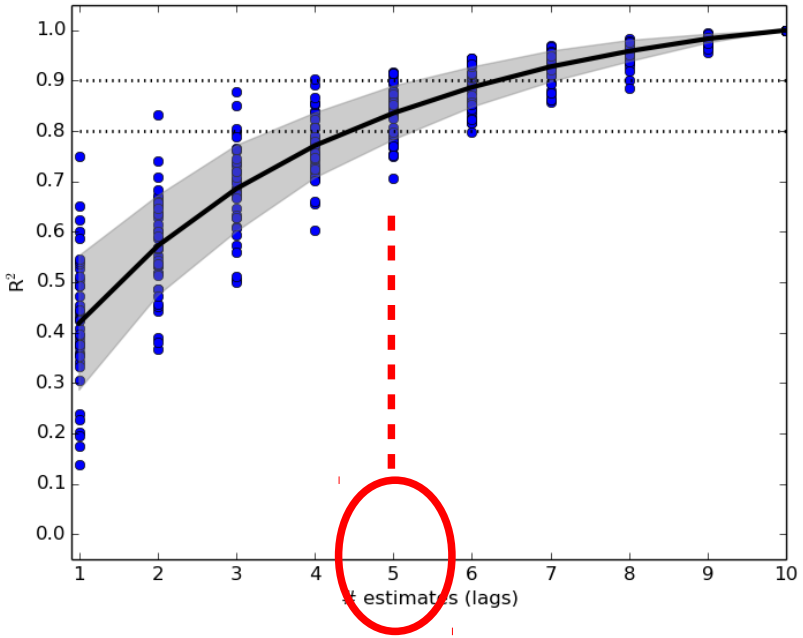
EnKF settings – EnKF parameters

After some tests, we chose...

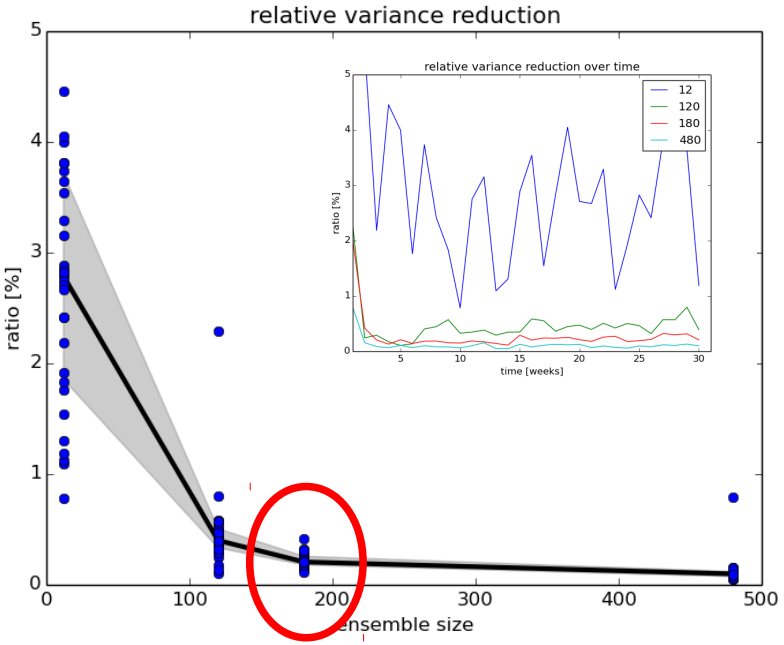
- Ensemble size: **180**
- Assimilation window size: **5 weeks**
- Optimization (cycle length): **1 week**

The tests were done with slightly different setup in emissions, so they might have to repeat for current settings!

Assimilation window size test



Ensemble size test

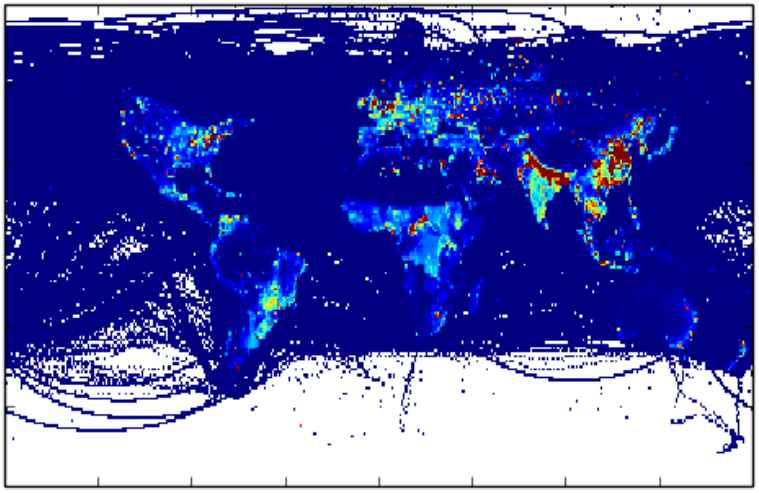


Model resutls - emissions
July 2007, 180 ensemble, lag 5

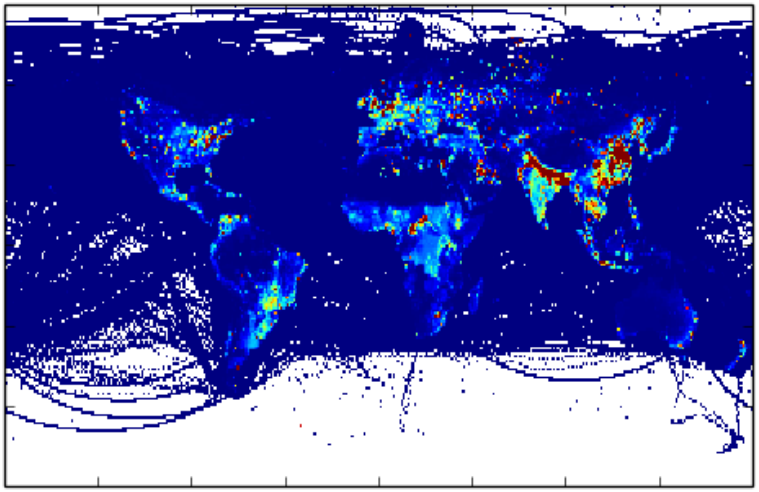
Anthropogenic Module

Global anthropogenic emissions (monthly average)

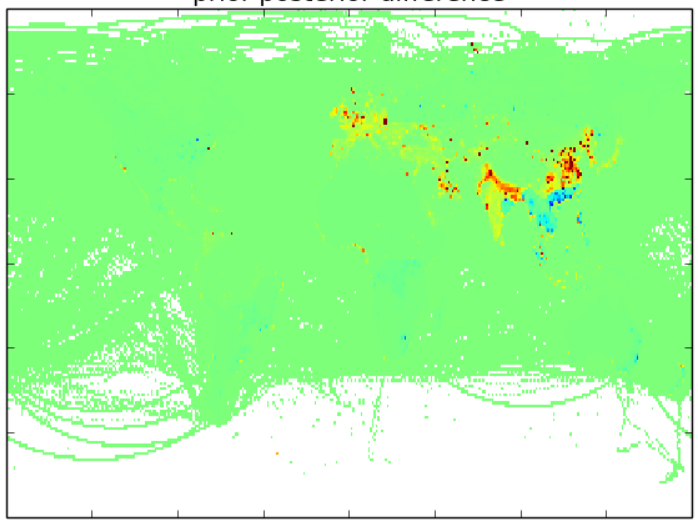
anth prior



anth posterior



prior-posterior difference



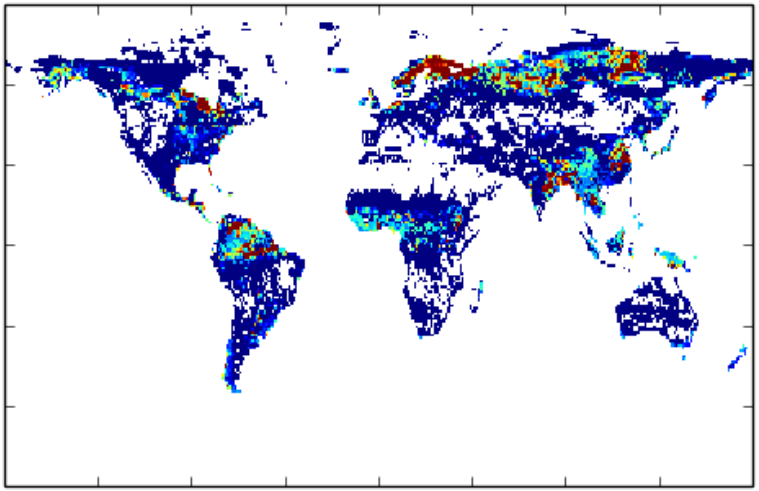
- Prior overestimates the emissions in: India, Europe, North part of China.
- Prior underestimates the emissions in: South part of China

Model resutls - emissions
July 2007, 180 ensemble, lag 5

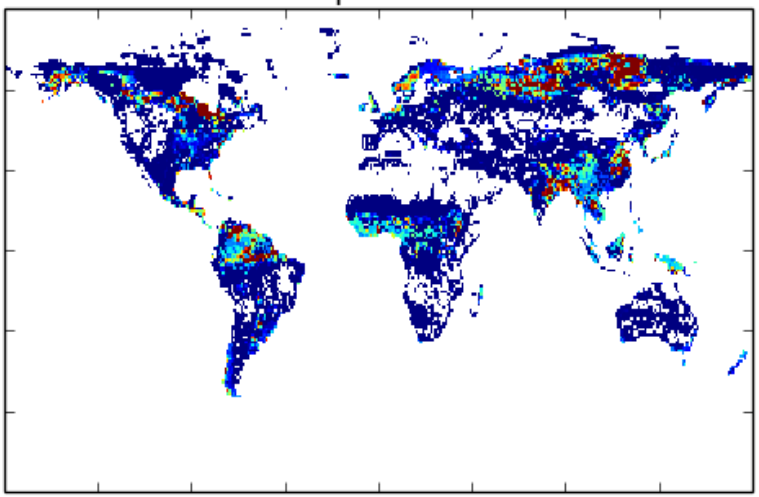
Biosphere Module

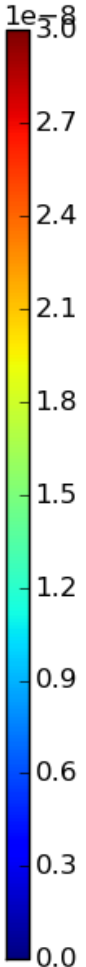
Global biosphere emissions (monthly average)

bio prior

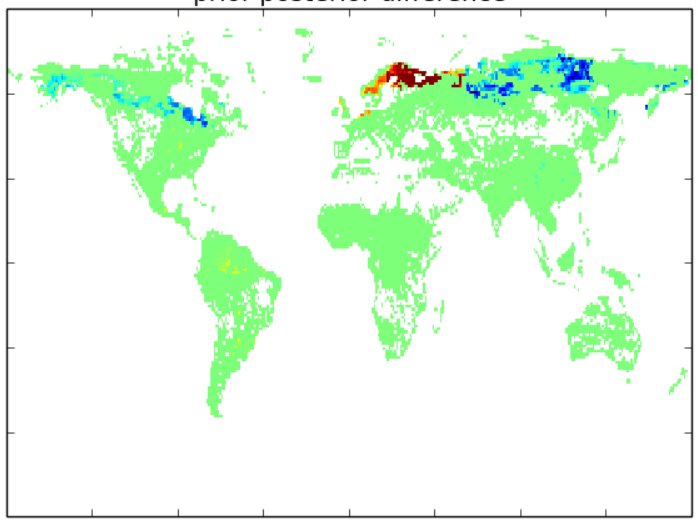


bio posterior





prior-posterior difference



- Prior overestimates the emissions in: Boreal Europe, including Finland
- Prior underestimates the emissions in: Boreal Russia, Boreal America

Comparison of two model runs

1. Pallas flask observations assimilated
2. Switch off Pallas observations

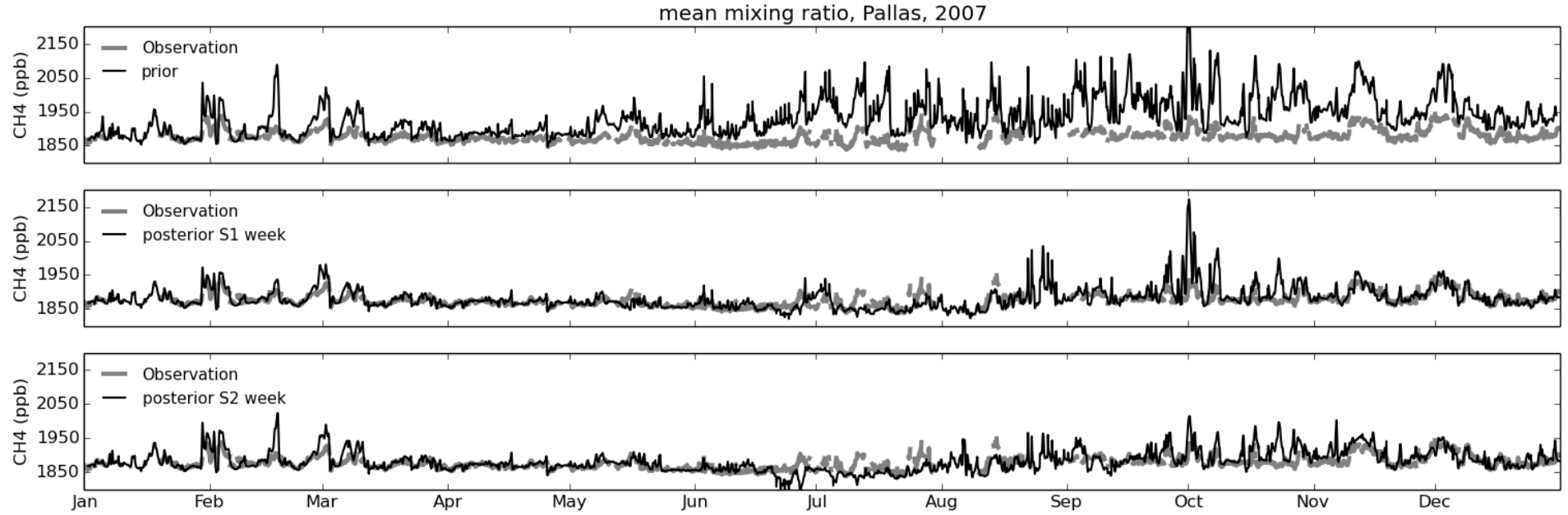
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

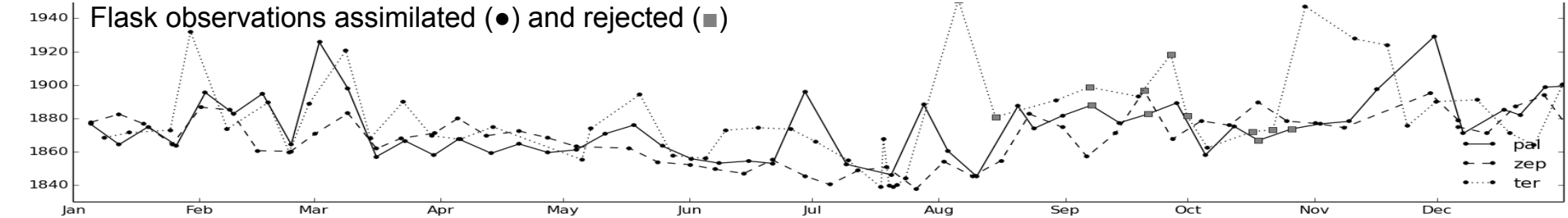
Model results – concentrations

Pallas 67°58'N, 24°07'E, 560m

Winter high concentration – anthropogenic emissions

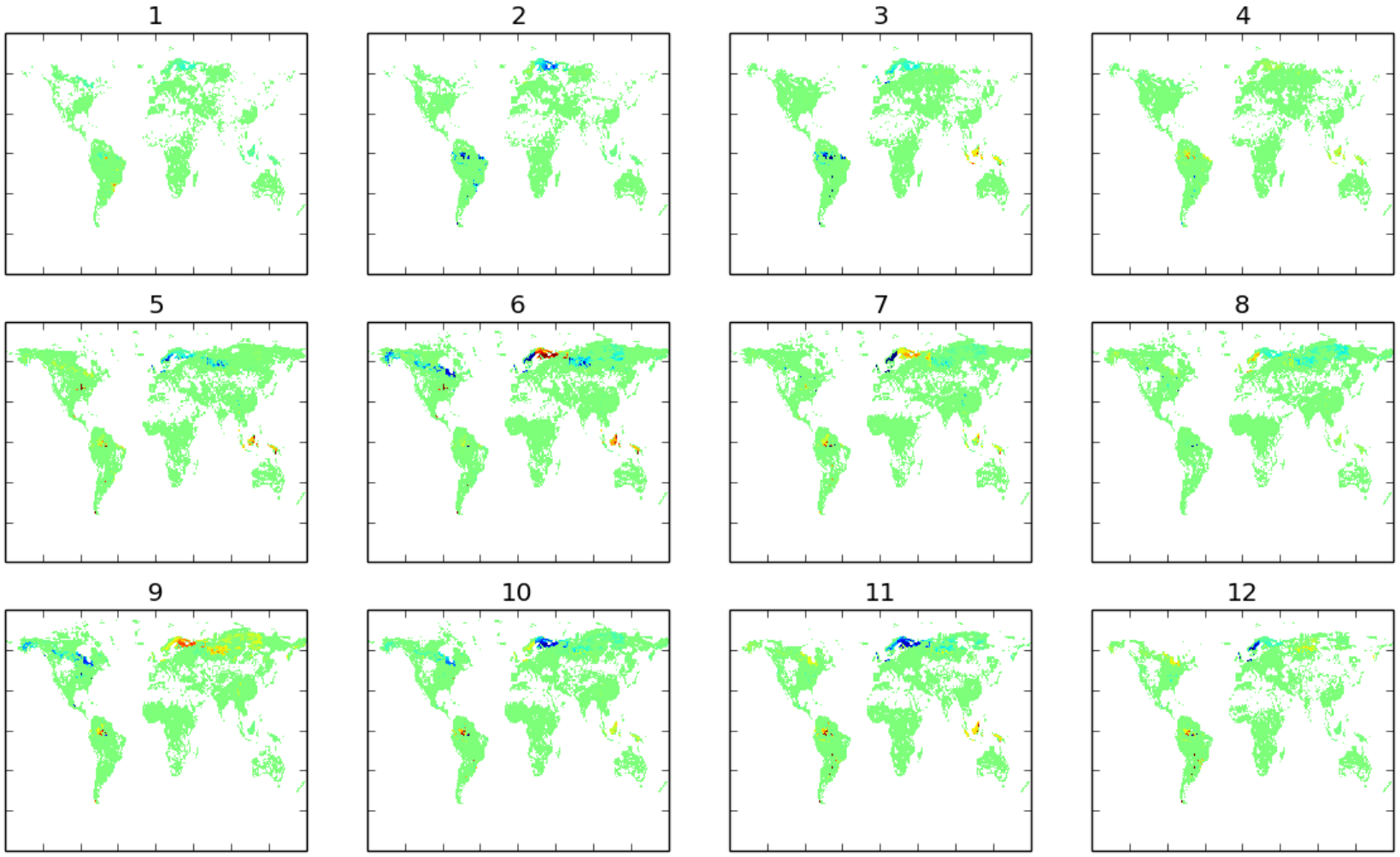
July, August high concentration – peatland emissions





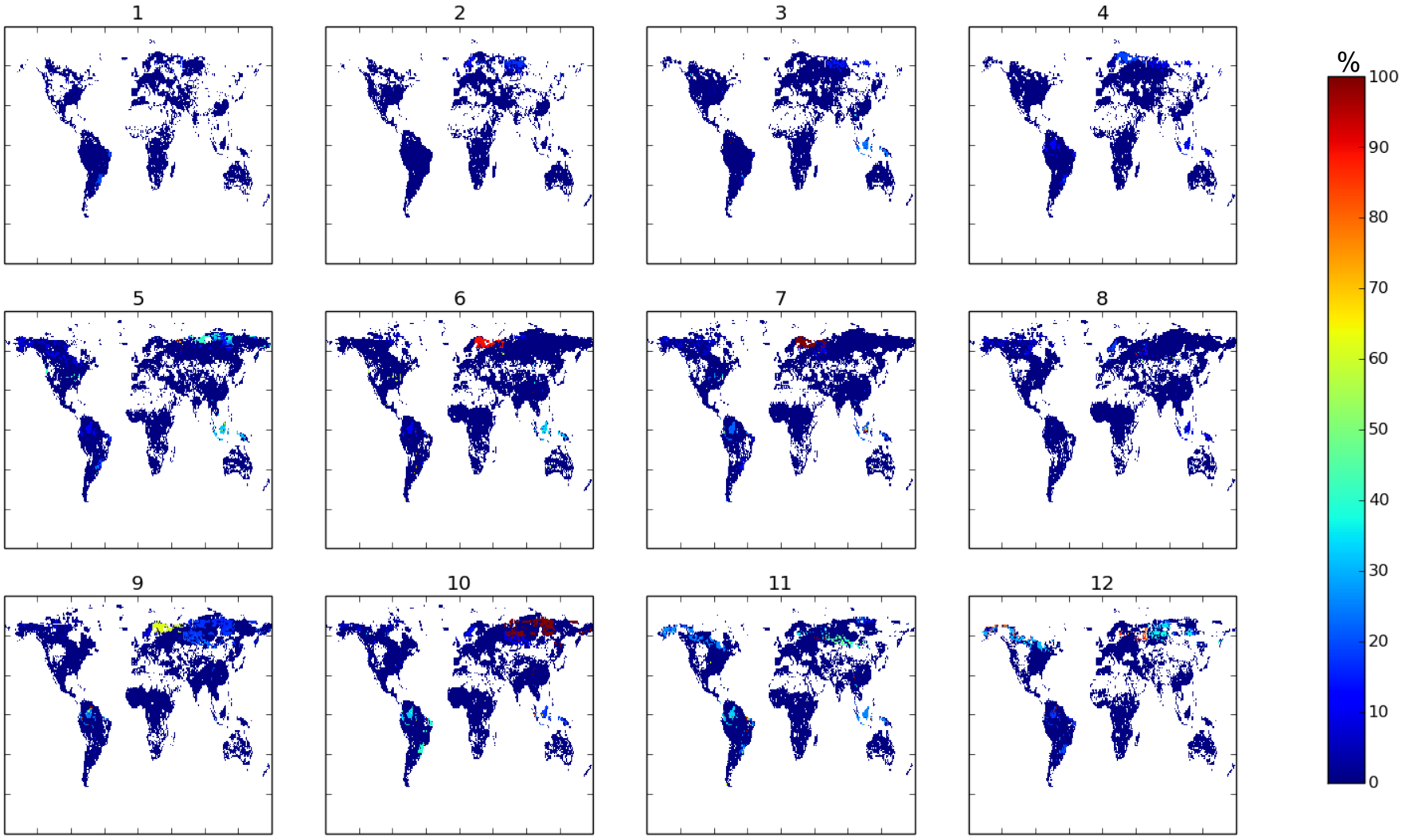
Model results – biosphere flux

with Pallas (S1) – without Pallas (S2), 2007



Model results – biosphere flux

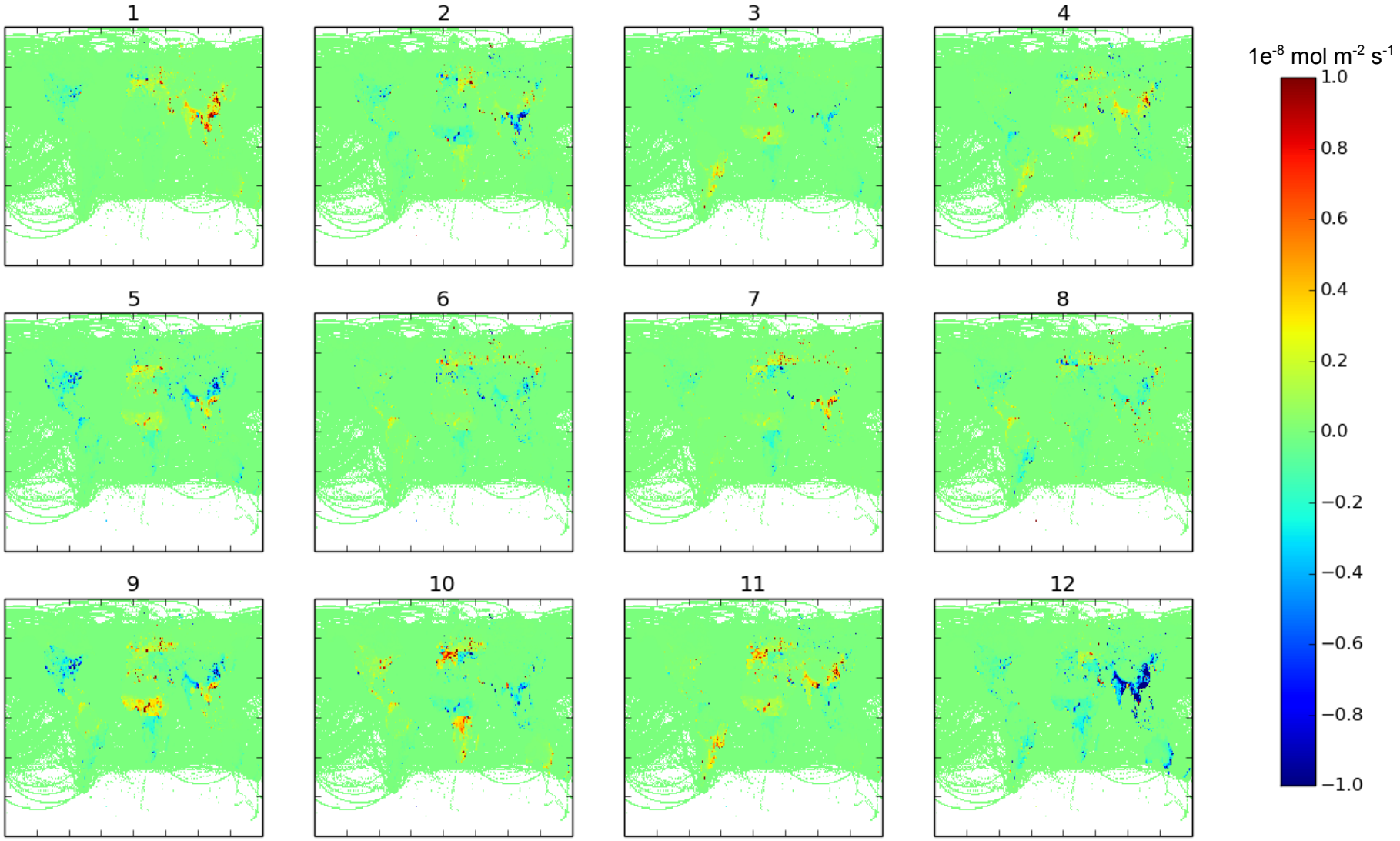
Ratio: 1 – with Pallas (S1) / without Pallas (S2), 2007



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

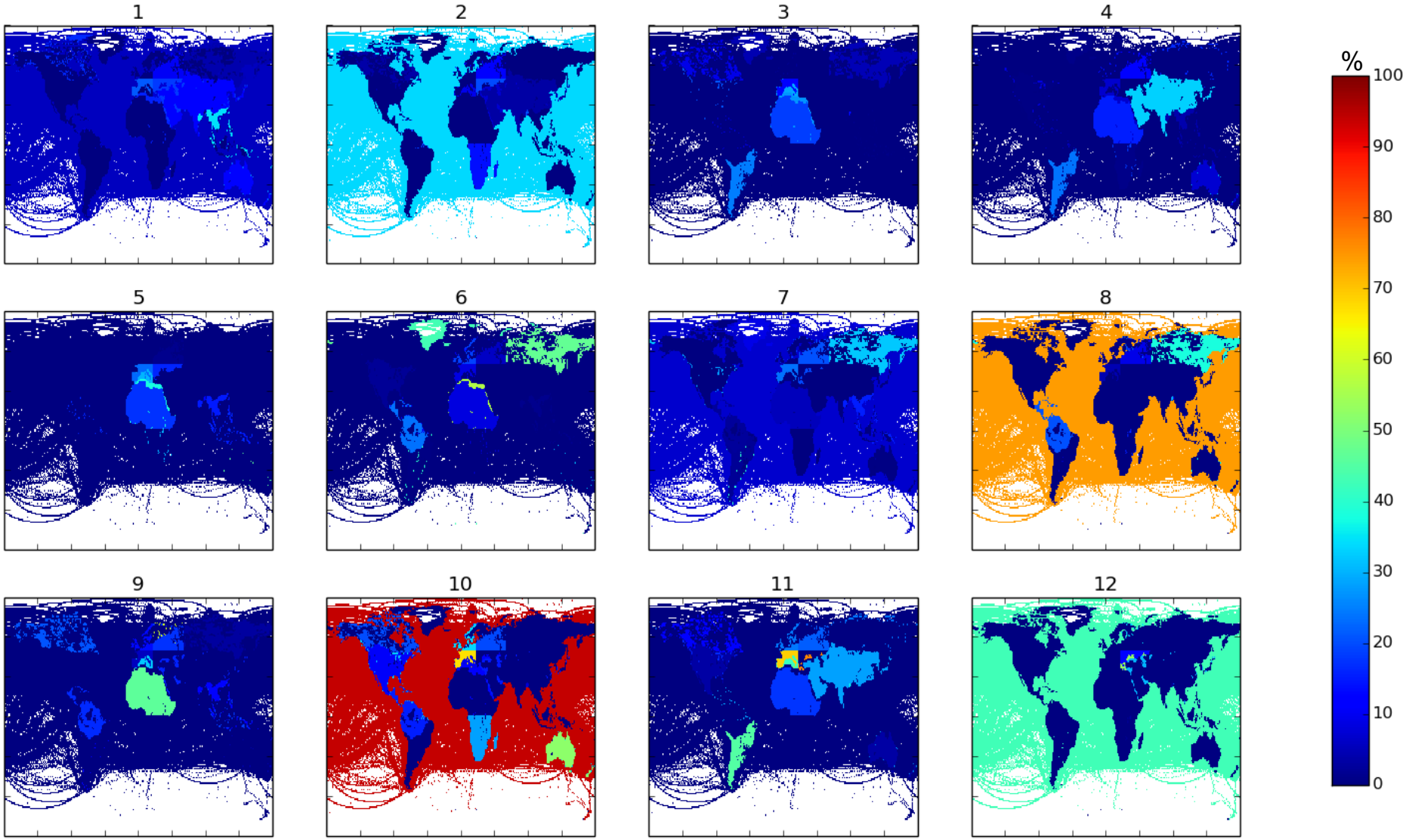
Model results – anthropogenic flux

with Pallas (S1) – without Pallas (S2), 2007



Model results – anthropogenic flux

Ratio: 1 – with Pallas (S1) / without Pallas (S2), 2007



Conclusions

- Emissions in boreal Europe was optimized well with methane CT Europe.

  – posterior concentrations better matched with the model independent continuous observations

- Influence of Pallas observations seems to be higher in biosphere emissions than in anthropogenic emissions

  – posterior concentrations did not change much during winter, whereas clear differences were seen during summer and autumn, when biosphere emissions dominates

  – the ratio of differences in anthropogenic emissions are generally small (<50%)

  – the ratio of differences in biosphere emissions are high in Boreal Europe, especially during summer and autumn