EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE

ESF Exploratory Workshop on

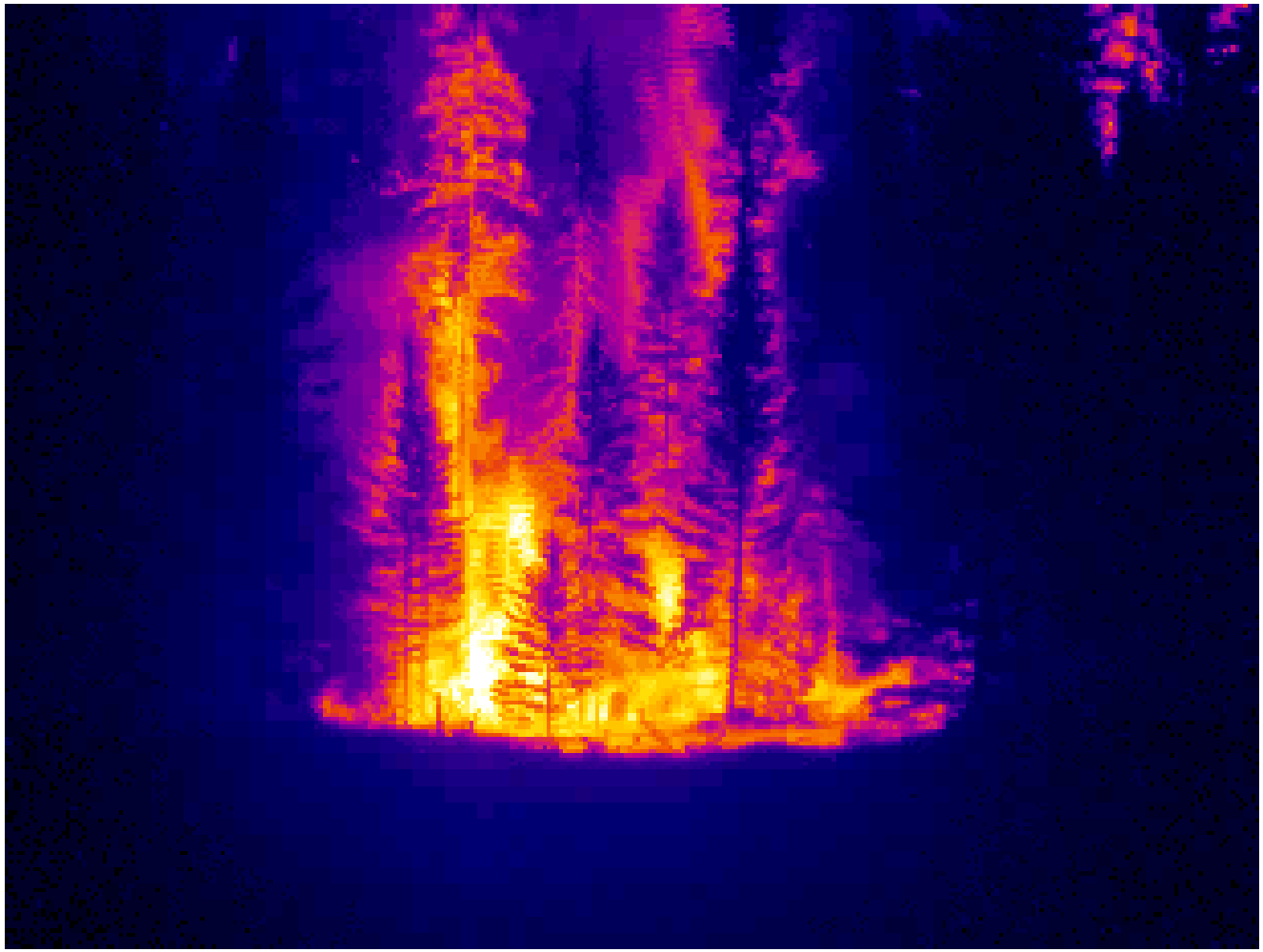
Improved Quantitative Fire Description With Multi-Species Inversions Of Observed Plumes

Farnham Castle (United Kingdom), 14-16 September 2009

Martin Wooster, Johannes Kaiser, Martin Schultz

Fire Observations **Fire Assimilation Systems** **Scientific Applications**

New Fire Observation Deployments



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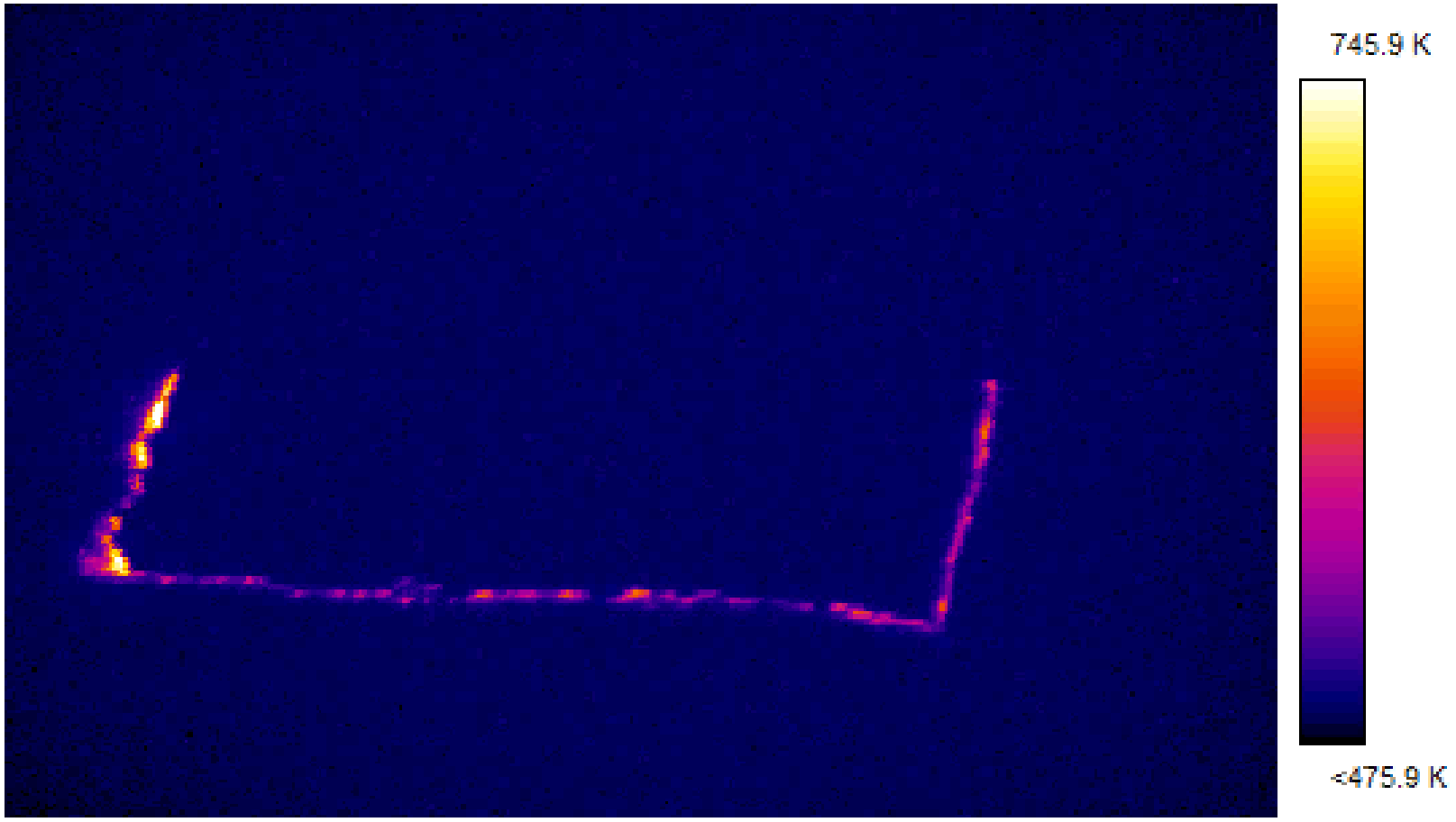
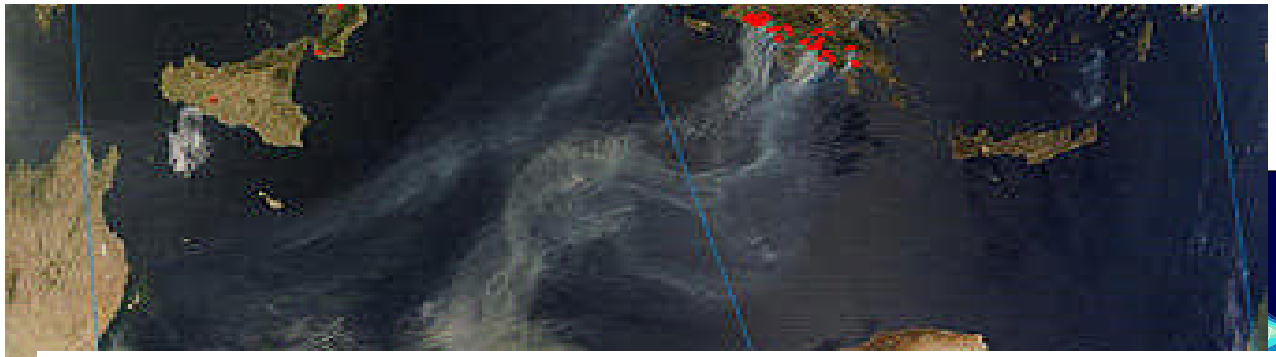
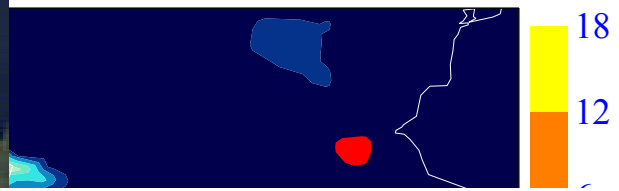
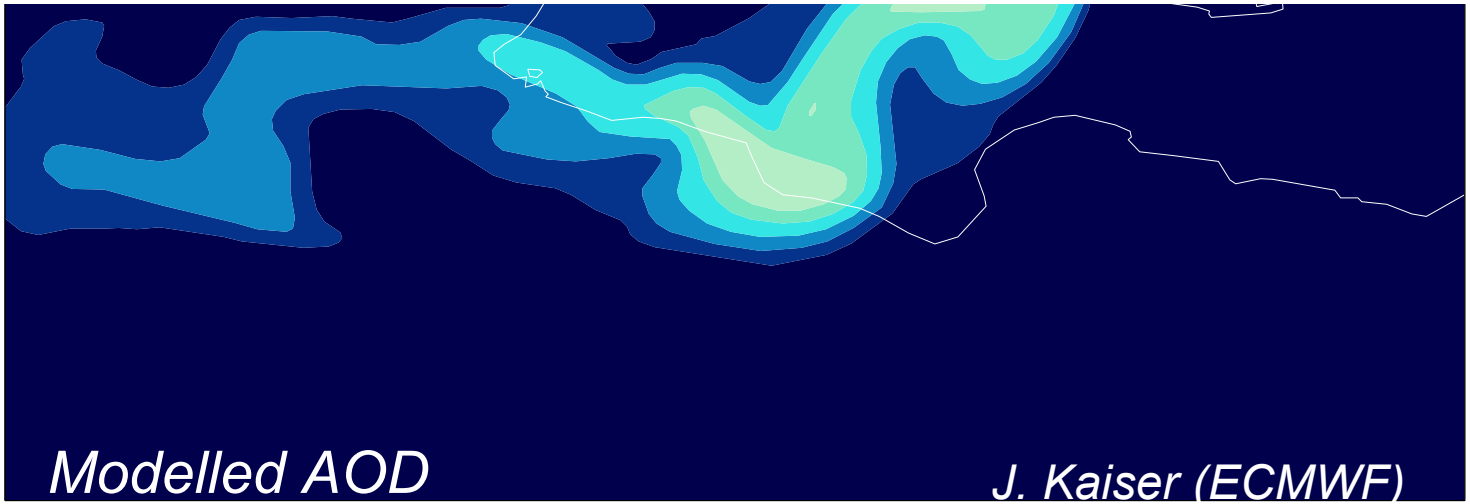


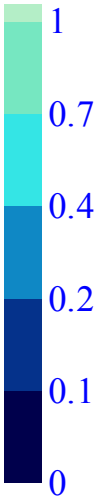
MODIS AOD and Simulated AOD Intercomparison: Greek Fires 2007





Question: Why do the aerosol emissions factors developed or used with satellite observations appear to differ substantially from lab values?





Traditional "Bottom-up" Inventory Approaches

Question: Can we find a sufficiently reliable approach to estimate combustion completeness (using satellite observations or modelling)

Photo's courtesy Sally Archibald, CSIR

Some Early History of Fire "Quantification"

Alexander von Danckelman

(1855 – 1919)

Geographer, Mathematician & Meteorologist. Travelled to Congo in 1870's with Stanley.

"*the sun appears in a dull light as during an eclipse or as a mat disc*"

Realised the climatic and environmental significance of African biomass burning

Weighed dry grass on sqr meter plots, and scaled up based on fraction of Africa covered by savannah.

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Calculated that ~ 20% of tropical African area burns each year, ~ 0.6 Gt biomass.

Global coal consumption ~ 0.3 Gt/yr – so this was huge and likely had great atmospheric & climatic consequences.

von Danckelman, A., 1884: Die Bewölkungsverhältnisse des stüdwestlichen Afrikas. – *Meteorol. Zeitschrift* 1, 301–311.

Brönnimann et al (2009) Biomass burning aerosols and climate – a 19th century Perspective, *Meteorol. Zeitschrift*, Vol. 18, 349-353.

History of fire monitoring

- Forest service “databases“ begin monitoring in 19th century
- Aerial observations (Canada, US, Russia) mid-20th century
- Landsat and NOAA POES satellites launched – 1970‘s.

- Early use and prepration for use of satellite data & product development (e.g. GTE TRACE-A, 1992; SCAR-B 95; SAFARI-96)
- Mid-1990s global nightime active fire detection from ATSR/AATSR
- Large scale burned area mapping since early 1990‘s

- MODIS 2000 – global day/night active fire detection & aerosols
- 1998: Global Fire Monitoring Centre Founded
- Early 2000‘s – much greater supply of trace gas species data from satellites, extending into the troposphere (e.g. AURA)
- Mid-2000‘s – continuous global burned area records commenced

- Recent operational monitoring systems emerge making use of fire observations for plume forecasting (e.g. BRAMS, NRL, GEMS etc)

Some Challenges for the future

- **Quality, quantity and consistency of fire observations**
  - (sensors, retrievals, coverage, longeivity …)
- **Parameterisation of fire emissions**
  - (from fire observation to model boundary condition)
- **Multi-sensor and multi-species integration**
  - Robustness, accuracy & consistency of integrated products
- **Joining of top down and bottom-up inventory approaches**
  - Obtain the most reliable and consistent emissions estimates

Structure of workshop

- Monday Afternoon:
- **Fire Assimilation Systems and Plume Inversions**

- Tuesday Morning:
- **Fire Observations**

- Tuesday Afternoon:
- **Scientific Applications**

- Wednesday Morning:
- **Synthesis & Conclusions**

Fire Assimilation Systems and Plume Inversions

- Inversion and other “top-down” studies:
  - Ichoku (aerosol)
  - Chevallier (CO_2)

- Operational-type systems based currently on bottom-up estimates of fire emissions:
  - INPE-CPTEC: Freitas
  - NRL: Hyer
  - FMI: Joana
  - ECMWF: Kaiser

- Future direction?

  More used of combined bottom-up and top-down emissions inventory approaches?

Fire Observations

- The “programmatics” of fire research
  - Goldammer
- Field and smoke observations
  - Andreae
- Satellite observations
  - Wooster (active fires)
  - San Miguel (burned areas)
  - Turquety (smoke plumes)
- Future directions: combine observations from multiple sensors and of multiple species
- Example Key Question:

How can we steer observations and instruments so they improve in the future and lead to maximum utility and benefit in combination?

Scientific Applications

- Fire Processes and Numerical Simulation
  - Simeoni
- Fires and Climate Change
  - Haywood
  - van der Werf
- Fires and Air quality
  - Schultz
- Fires and Ecosystems
  - Pereira
- Fires in Numerical Weather Prediction
  - de Rosnay
- Example Key Question:

Are current and planned observations & systems suitable for these applications? How might they be enhanced?

Synthesis and Conclusions