

The Massive New Year 2020 pyroCb Event in Australia: Observations of Unprecedented Stratospheric Smoke

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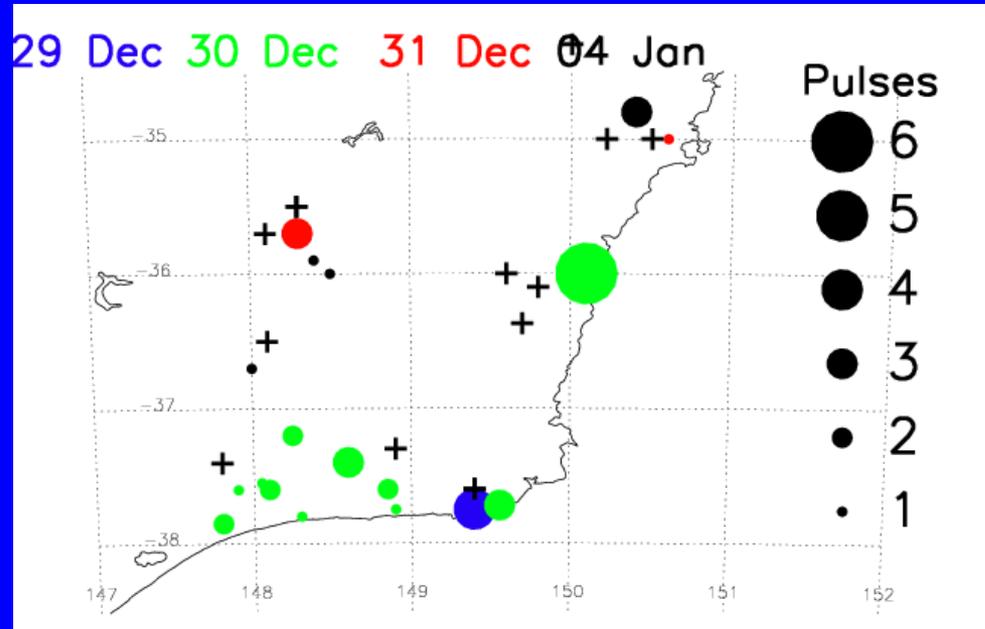
Dave Peterson, NRL

Gerald Nedoluha, NRL

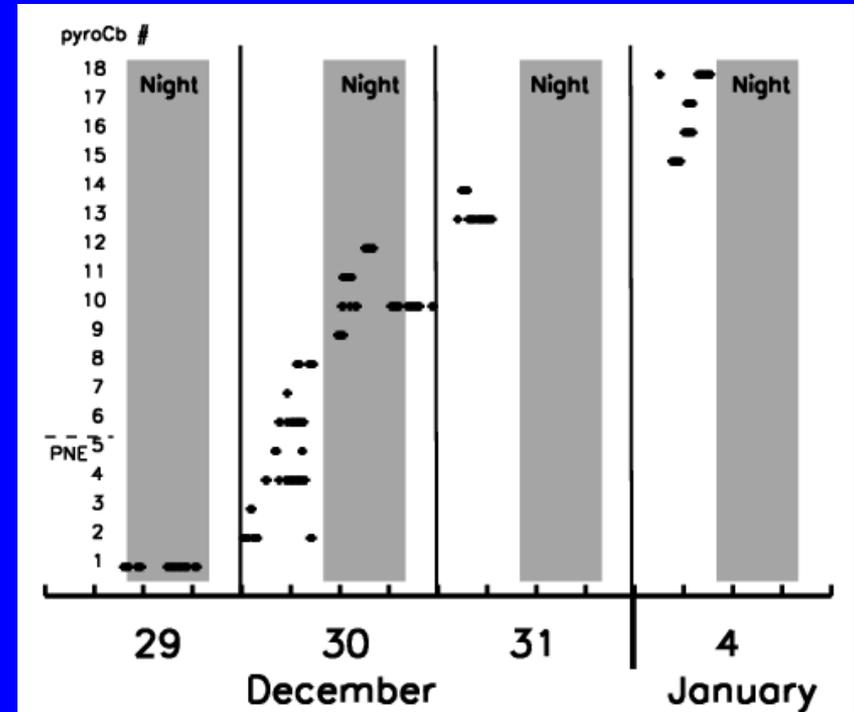
Rick McRae, ACT Emergency Services Authority

The Australia New Year (ANY) Event

4 days, 18 pyroCb, 38 total pyroCb pulses



+ Fire producing pyroconvection



Several of the most devastating firestorms occurred in the middle of the night.

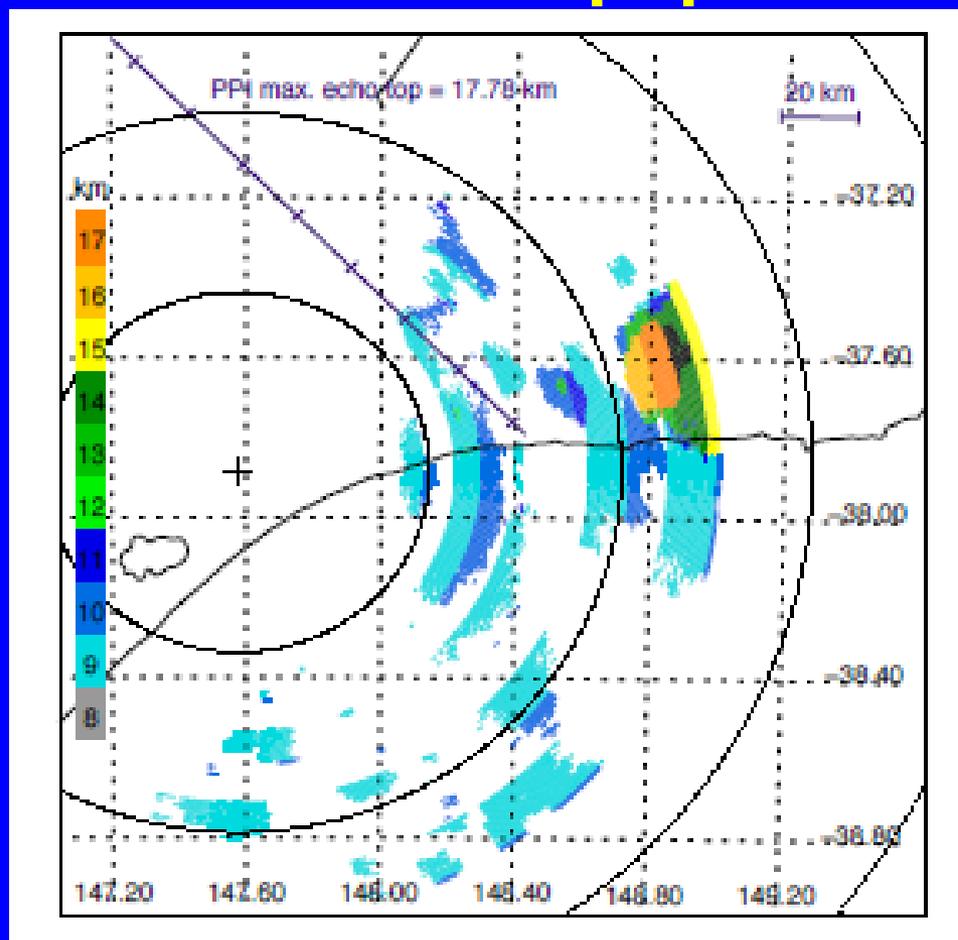
The Australia New Year (ANY) Event

PyroCb Echo Tops

Bairnsdale radar, 30 December 14:20 UTC

Example: 17.8 km Injection height

3 km above tropopause



Sorting Out the Australian Stratospheric PyroCb Smoke Plumes

- * **Two Prime Injection days**

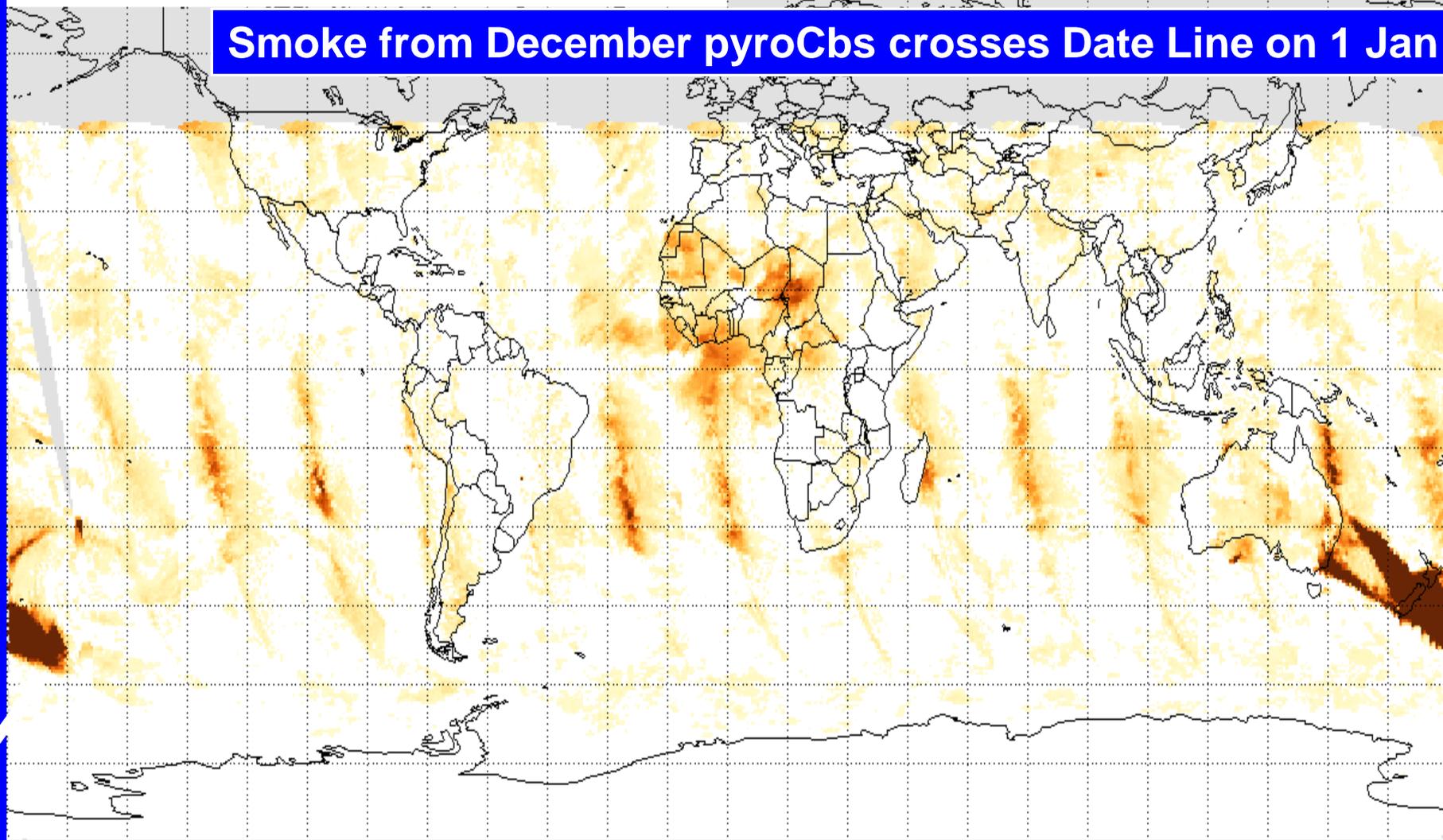
- * **30 December**

- * **4 January**

01 January 2020



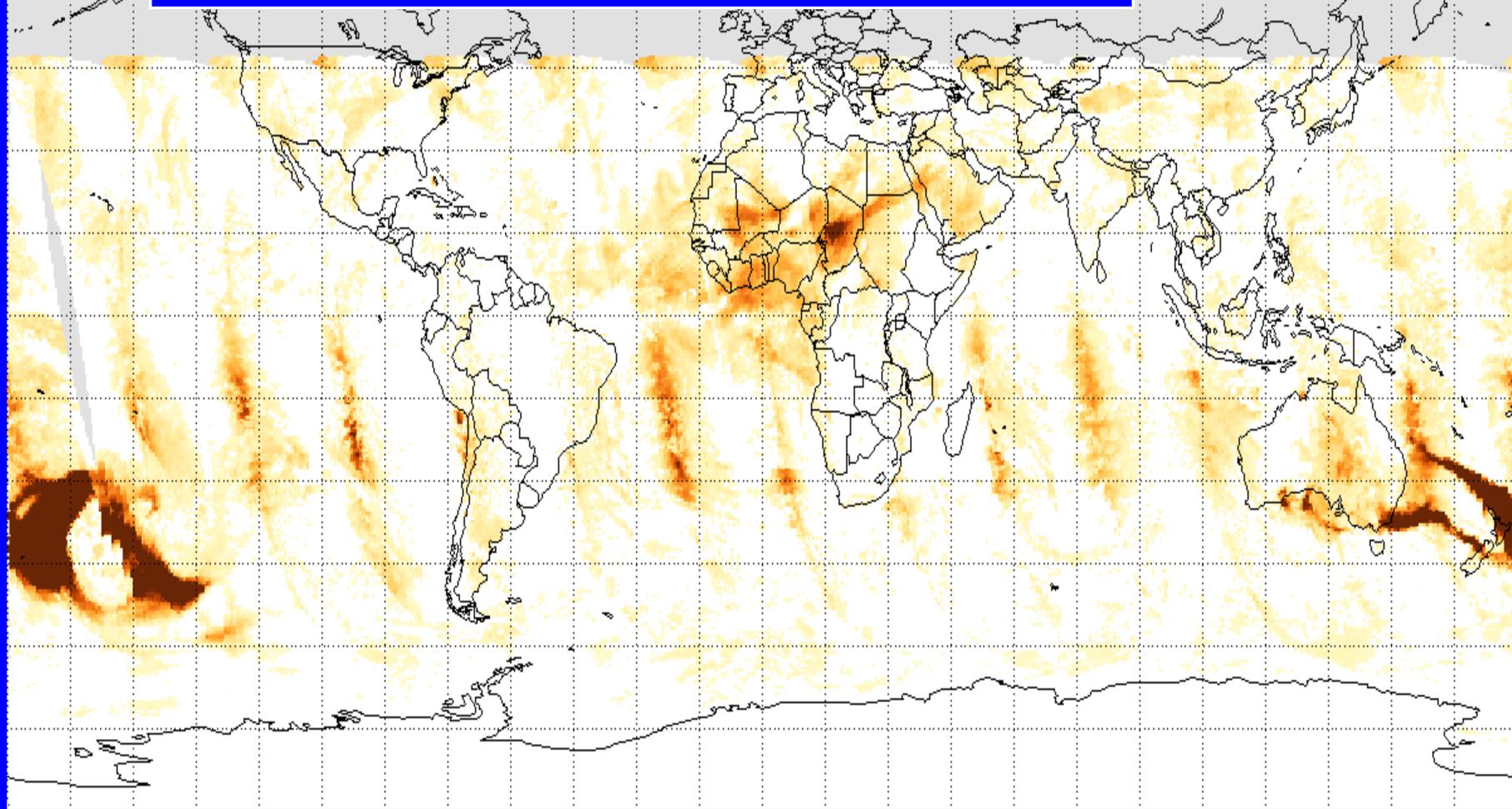
Smoke from December pyroCbs crosses Date Line on 1 Jan



02 January 2020



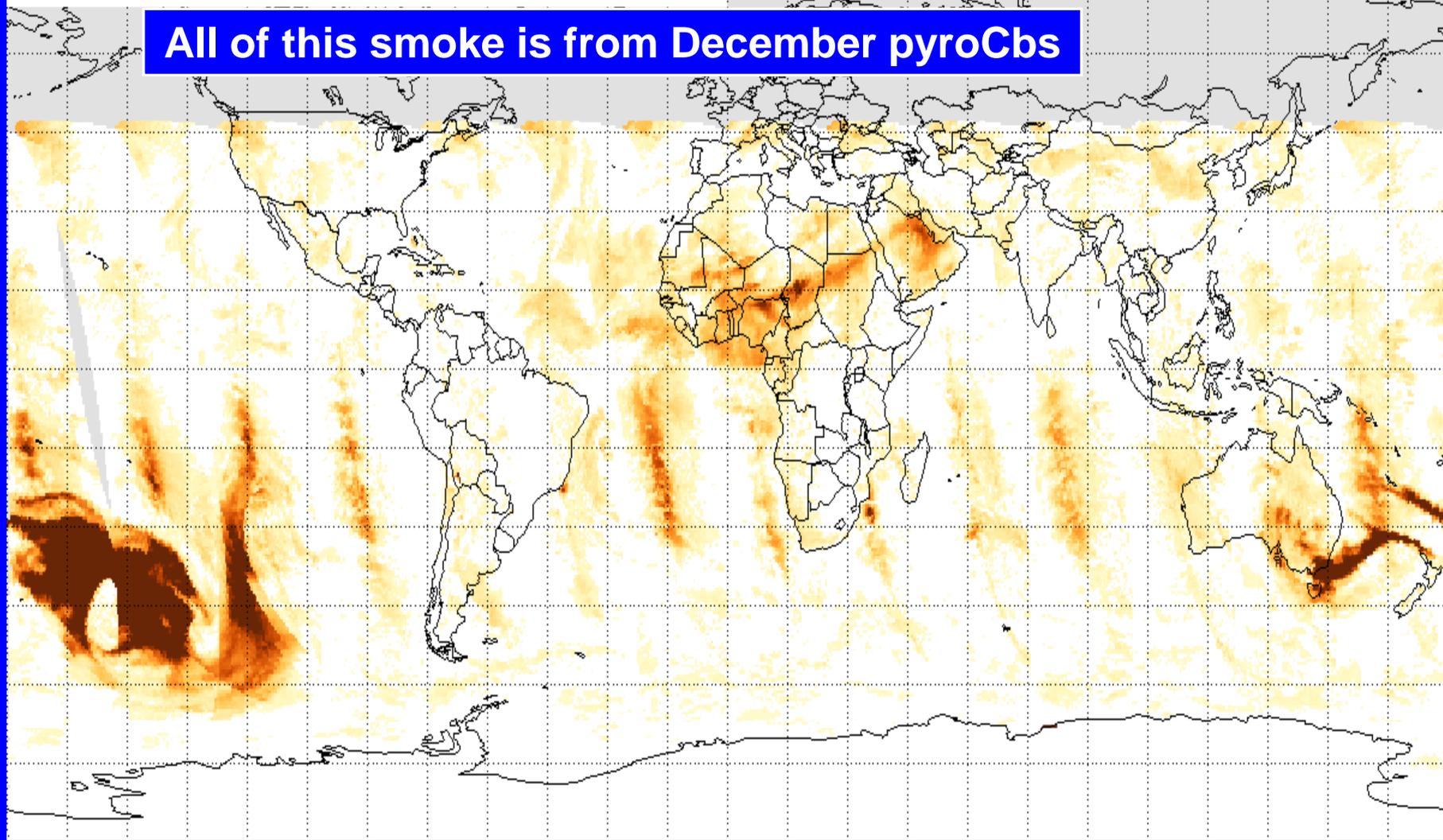
All of this smoke is from December pyroCbs



03 January 2020



All of this smoke is from December pyroCbs



04 January 2020

0.0 1.0 2.0 3.0 4.0

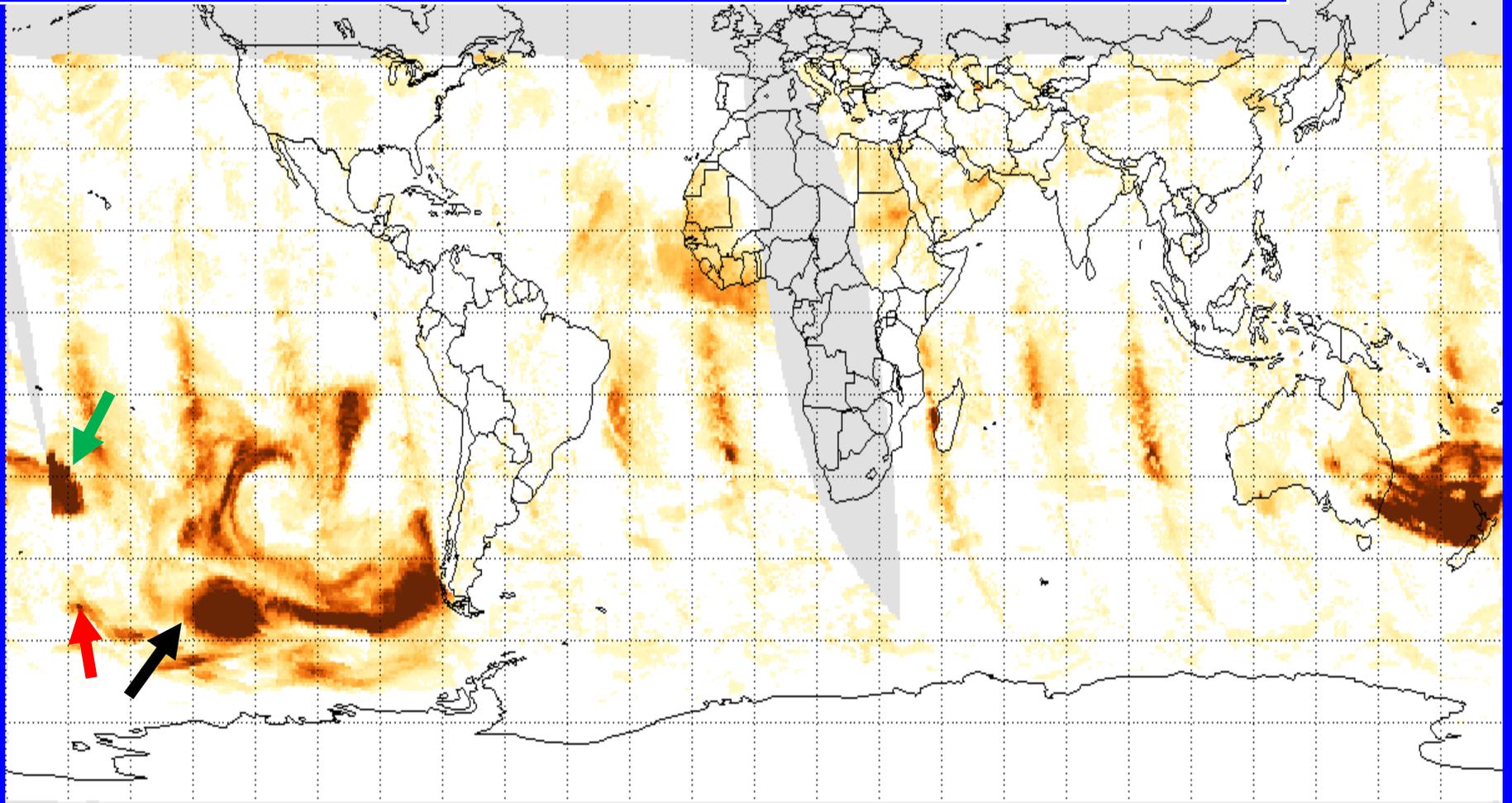
**All of this smoke is from December pyroCbs
A blob emerges (black arrow).**



05 January 2020



Smoke from 4 Jan pyroCbs crosses Date Line (green arrow)

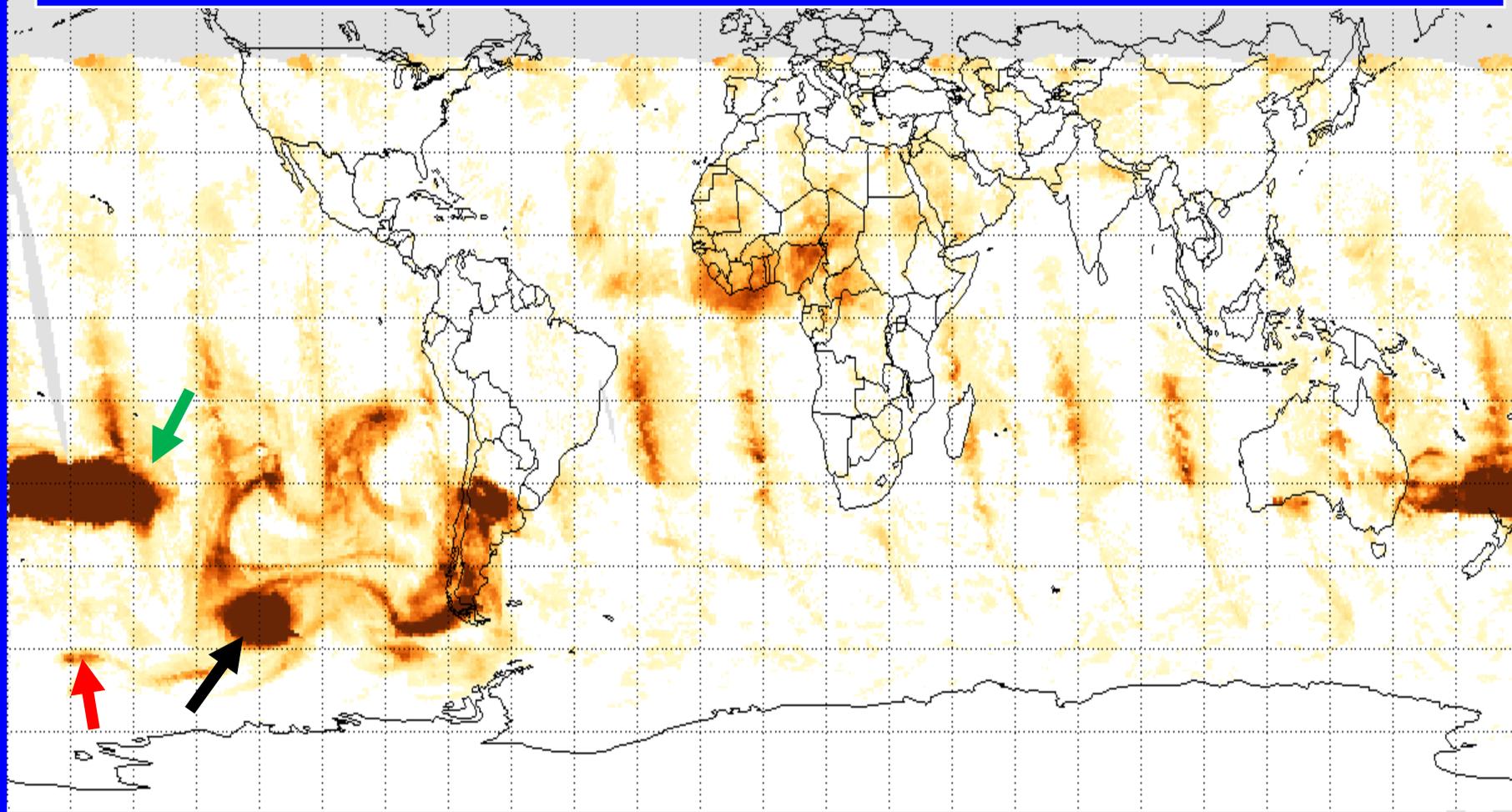


Penguin Plug (red arrow). This is the plug that drifts over Antarctic continent.

06 January 2020



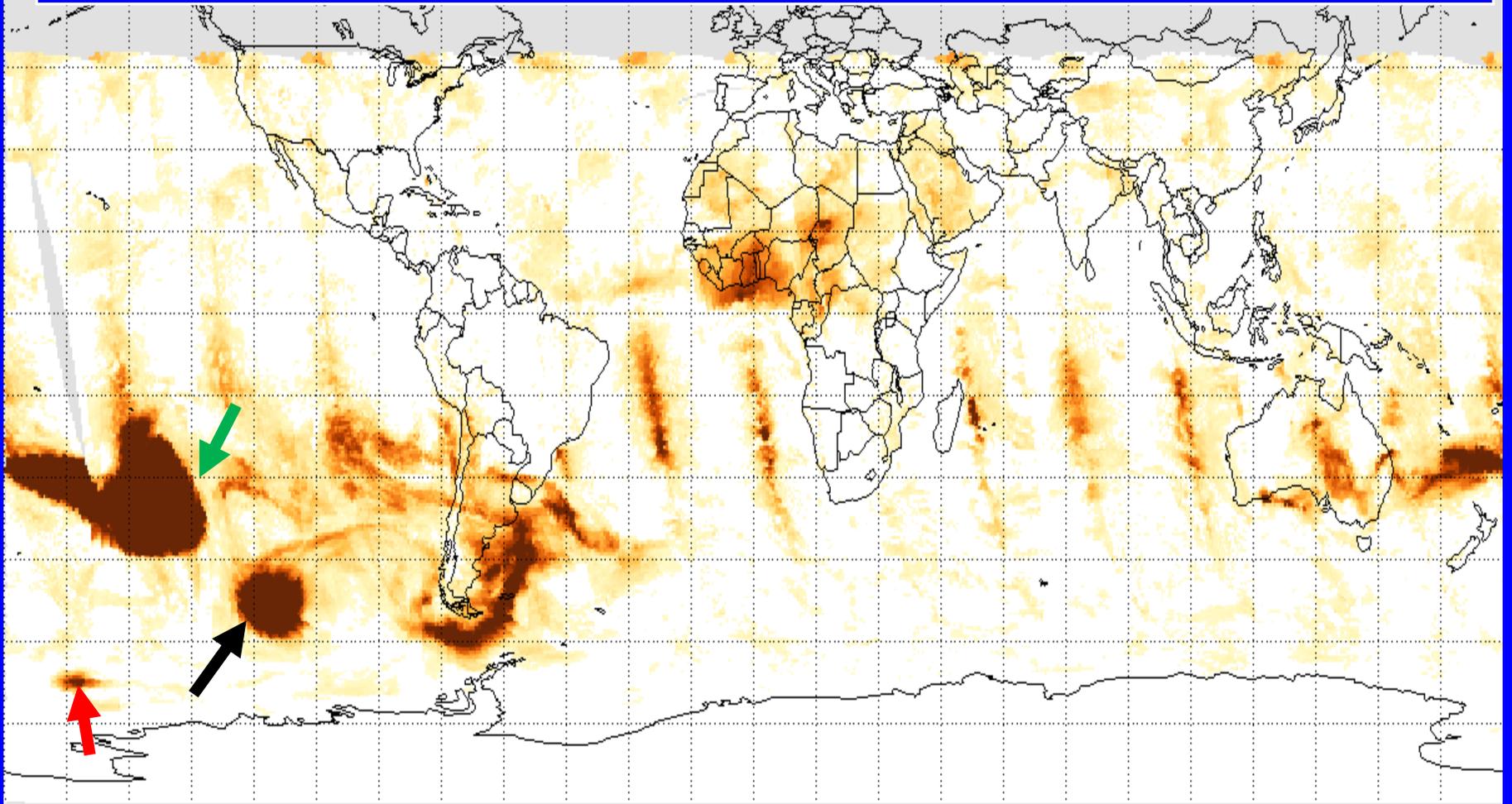
Smoke from 4 Jan pyroCbs advances on but is west of Dec smoke.



07 January 2020



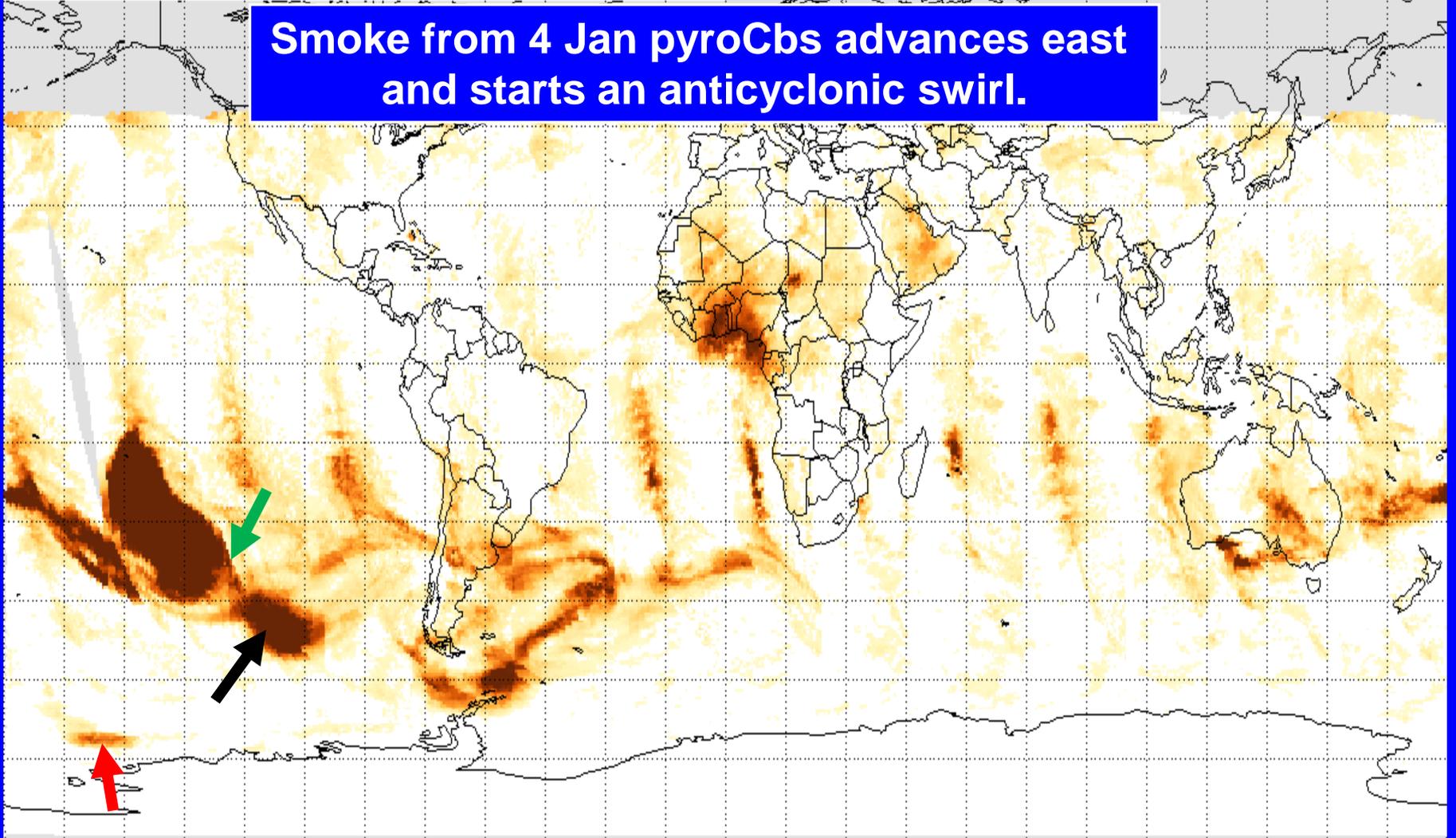
Smoke from 4 Jan pyroCbs advances on but is west of Dec smoke.



08 January 2020



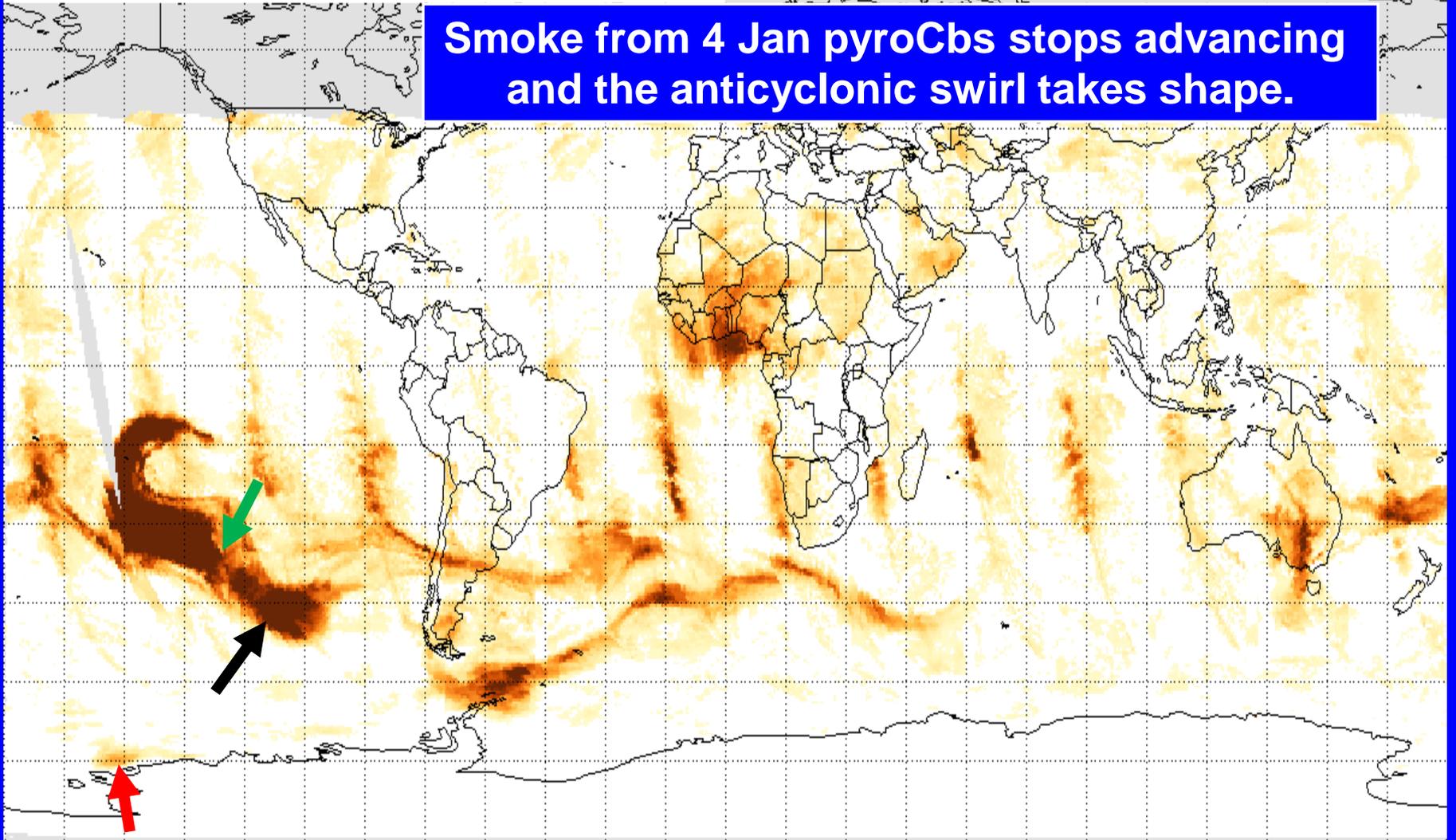
**Smoke from 4 Jan pyroCbs advances east
and starts an anticyclonic swirl.**



09 January 2020



Smoke from 4 Jan pyroCbs stops advancing and the anticyclonic swirl takes shape.



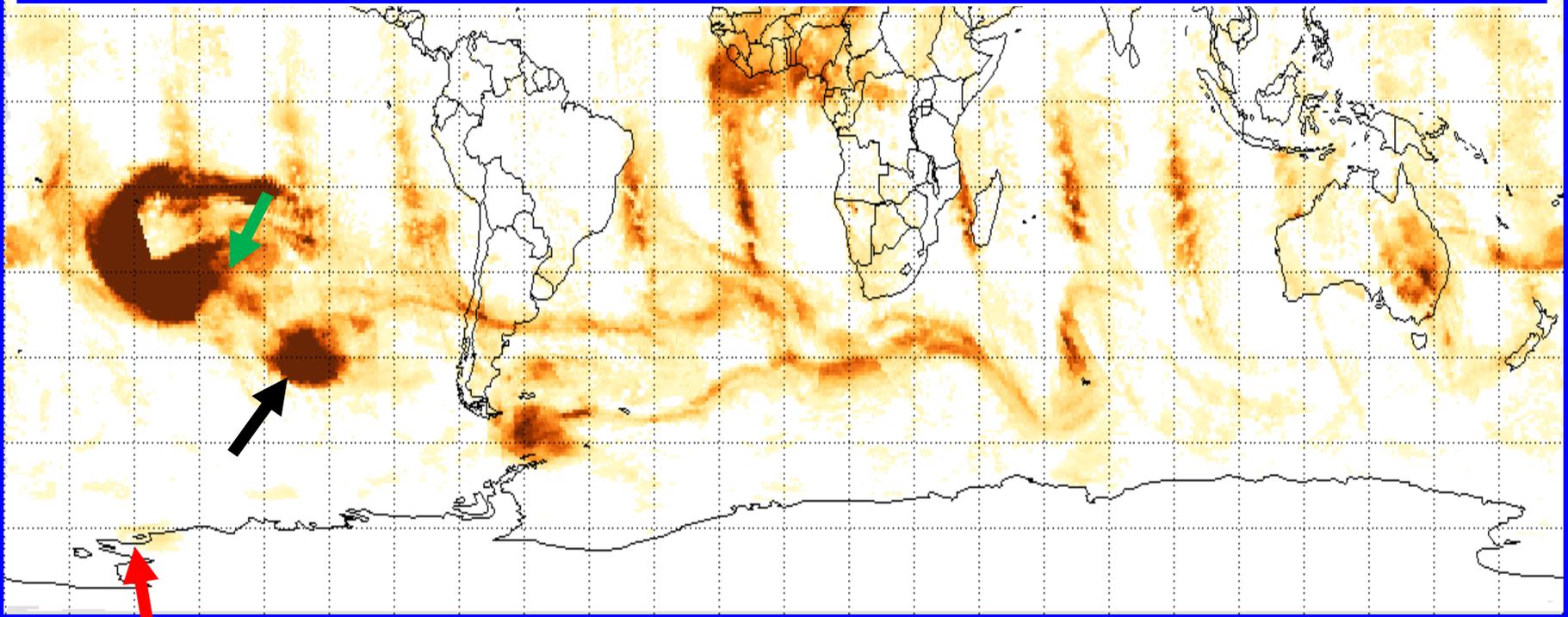
10 January 2020



Some retrograde movement in southern part of 4 Jan smoke plume.

Dec smoke blob is moving ever so slowly east.

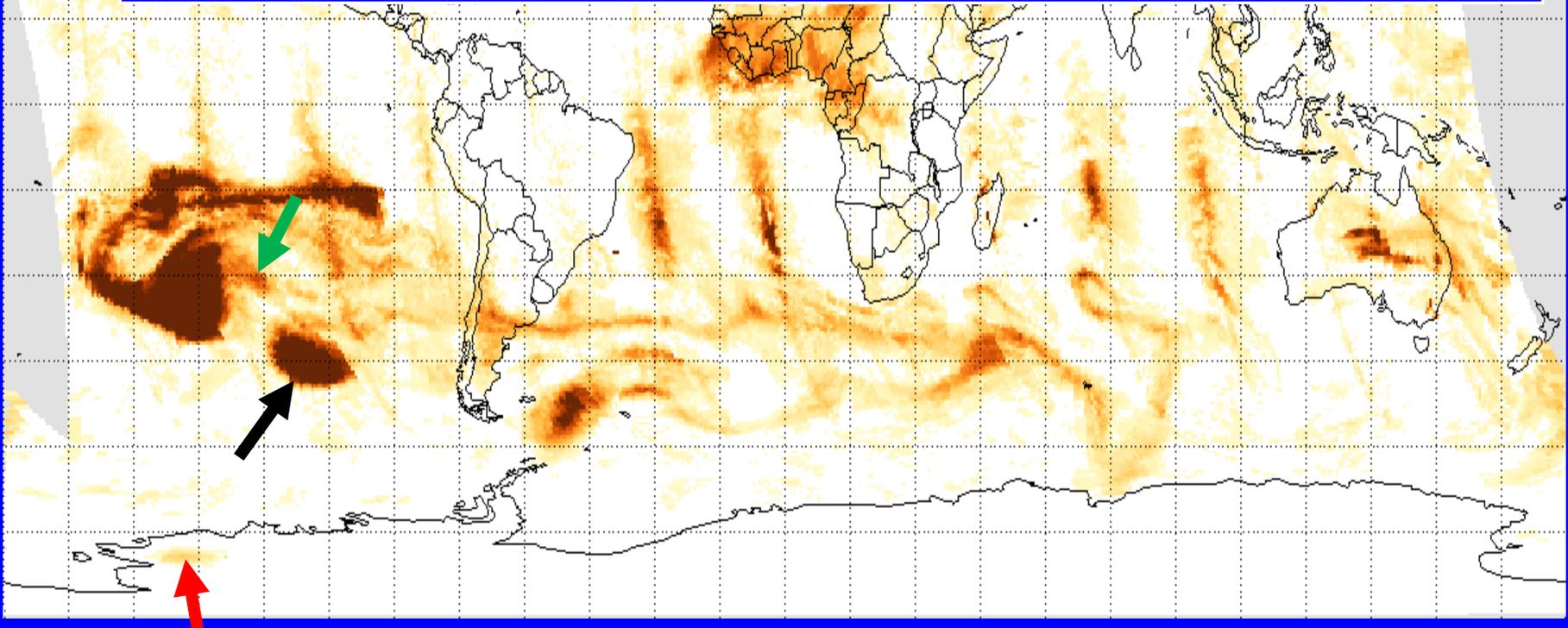
Other Dec smoke has spread all the way to Indian Ocean



11 January 2020



4 Jan smoke, southern portion, once again starts moving east.
Dec smoke blob is moving ever so slowly east.
Other Dec smoke has spread all the way to Indian Ocean



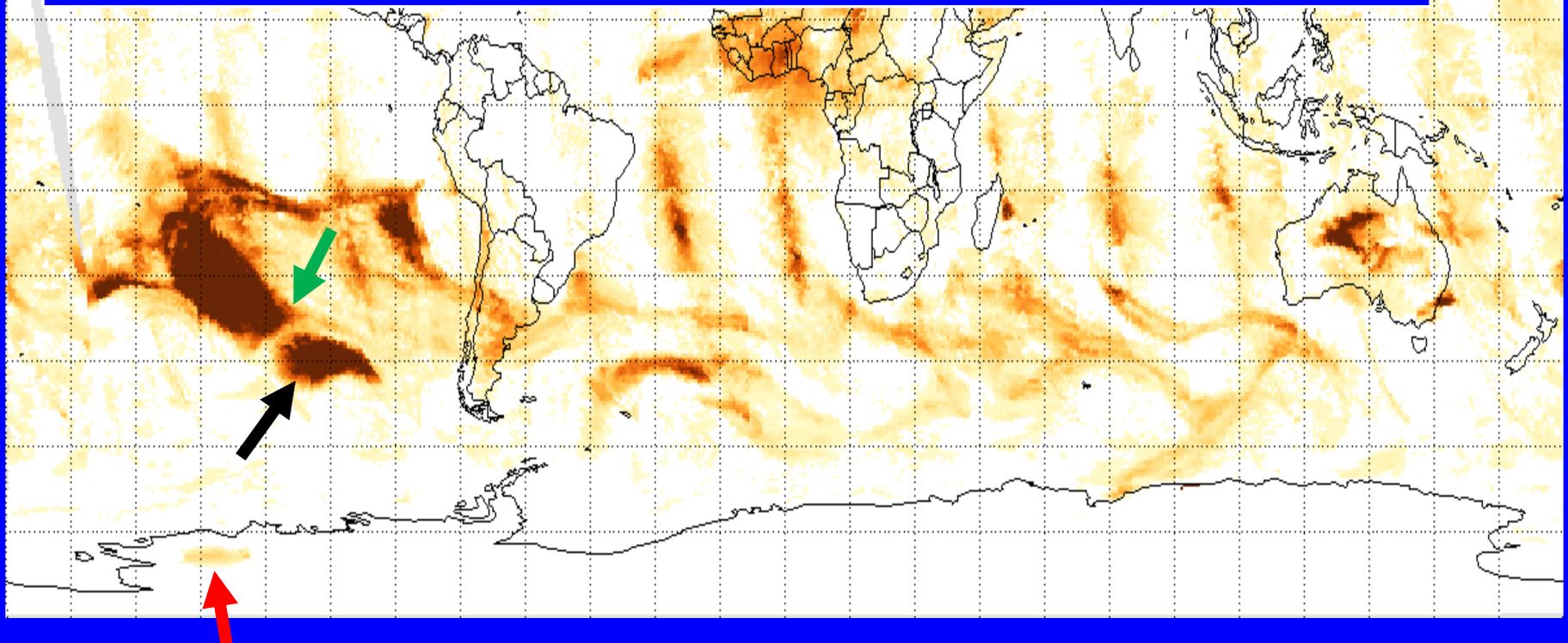
12 January 2020



4 Jan smoke, southern portion, approaching Dec smoke blob

Dec smoke blob is moving ever so slowly east.

Dec smoke leading edge at Australian longitudes.



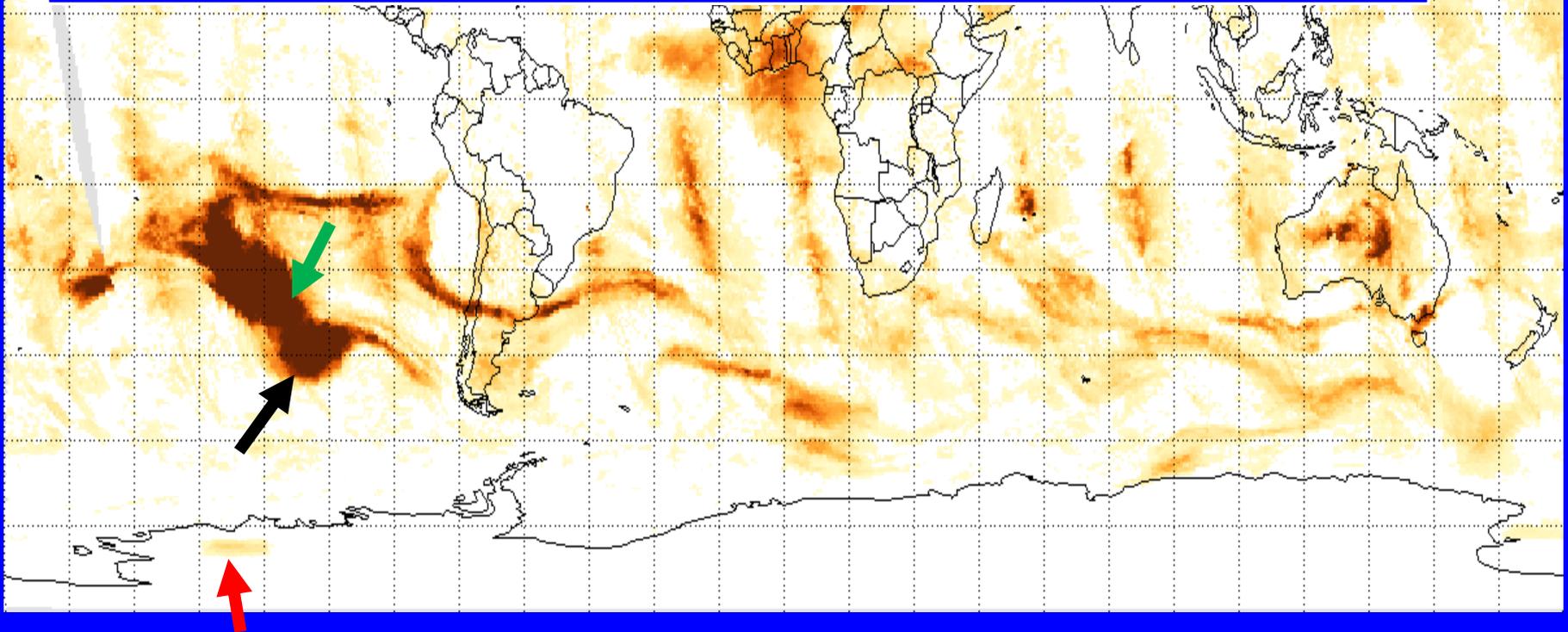
13 January 2020



4 Jan smoke, southern portion, merges with Dec smoke blob

Dec smoke blob is moving ever so slowly east.

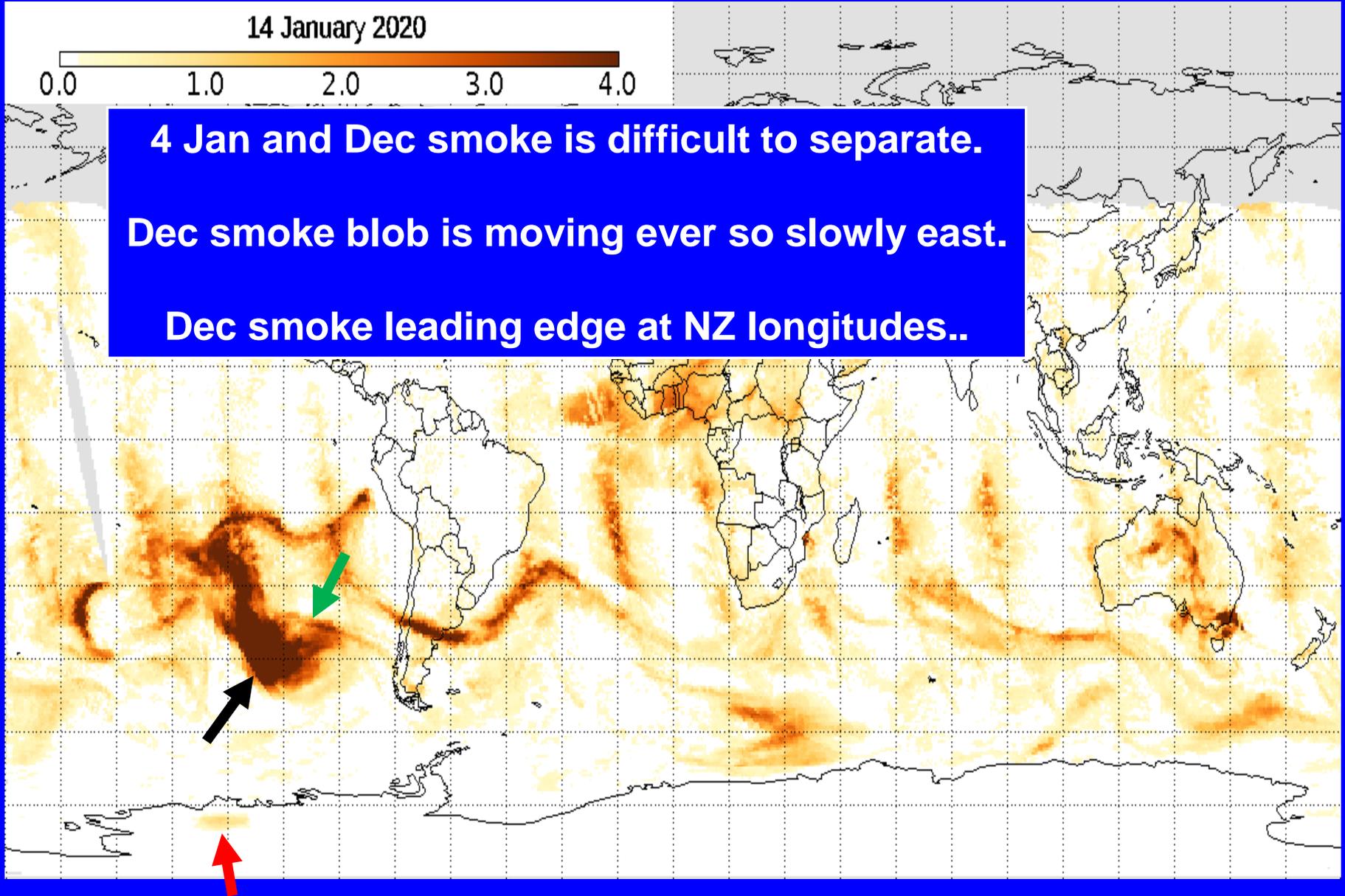
Dec smoke leading edge at Australian longitudes.



14 January 2020



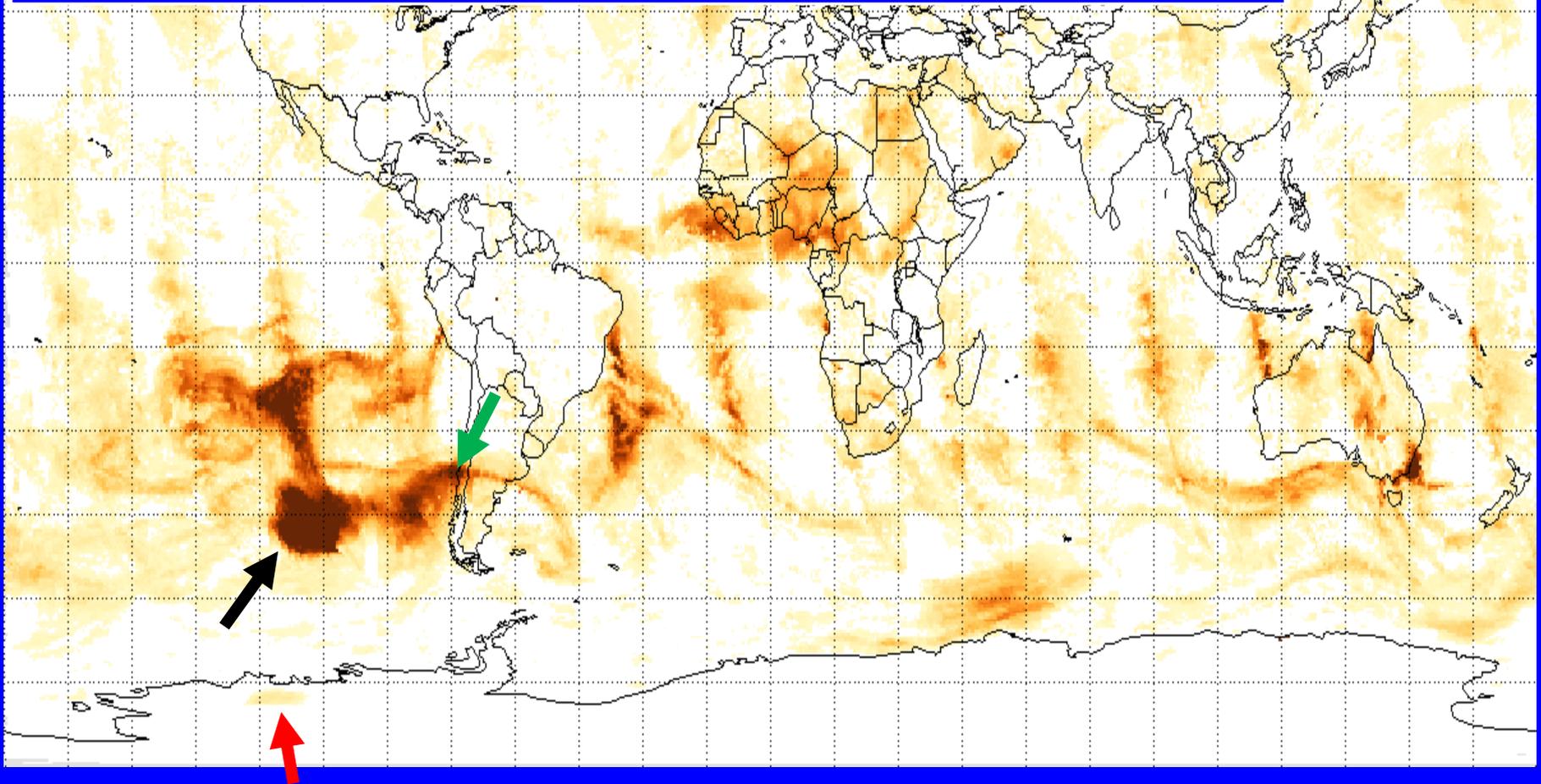
**4 Jan and Dec smoke is difficult to separate.
Dec smoke blob is moving ever so slowly east.
Dec smoke leading edge at NZ longitudes..**



15 January 2020



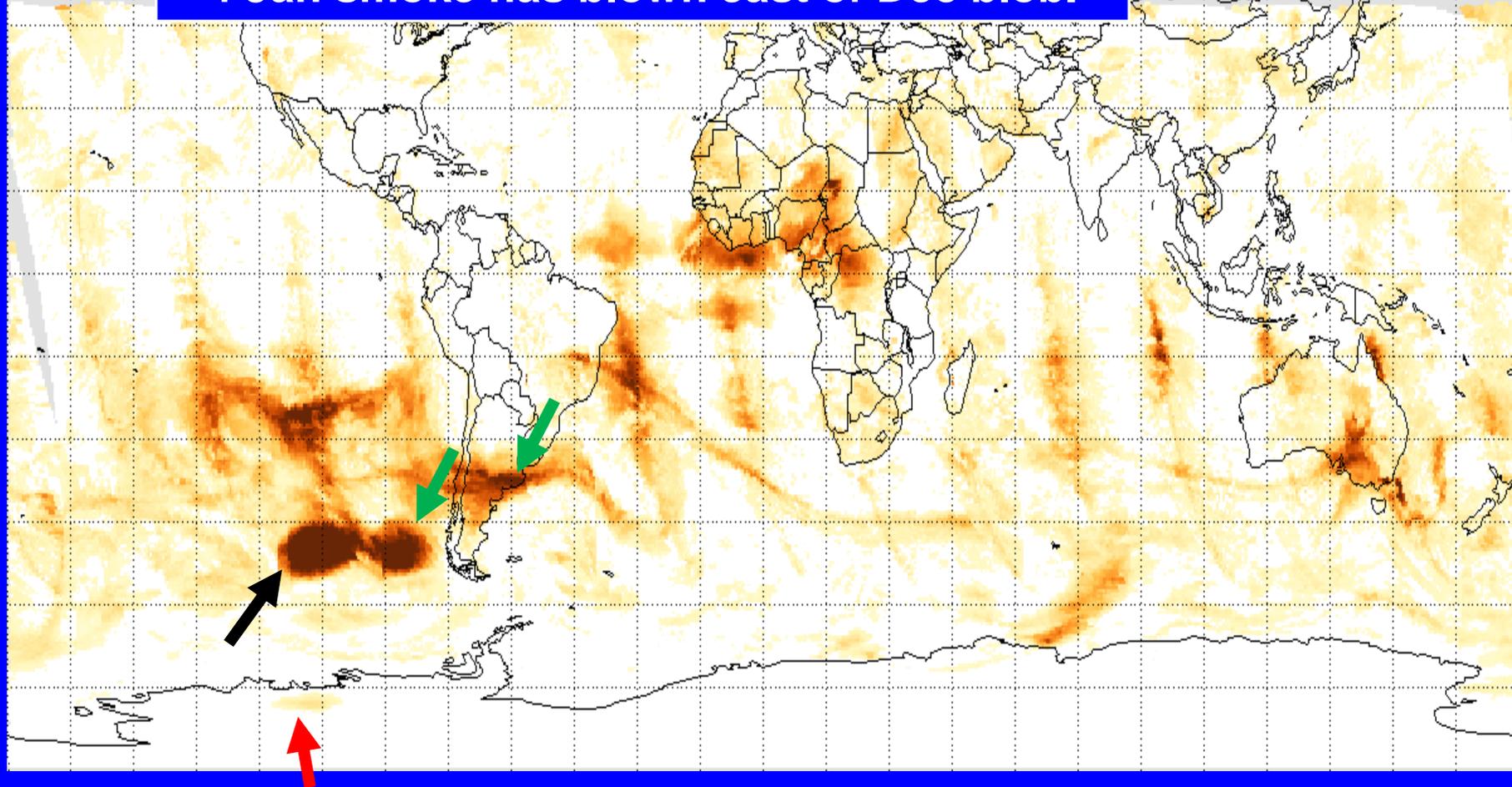
Dec smoke blob remains almost stationary. 4 Jan smoke has blown east of Dec blob.



16 January 2020



**Dec smoke blob remains almost stationary.
4 Jan smoke has blown east of Dec blob.**

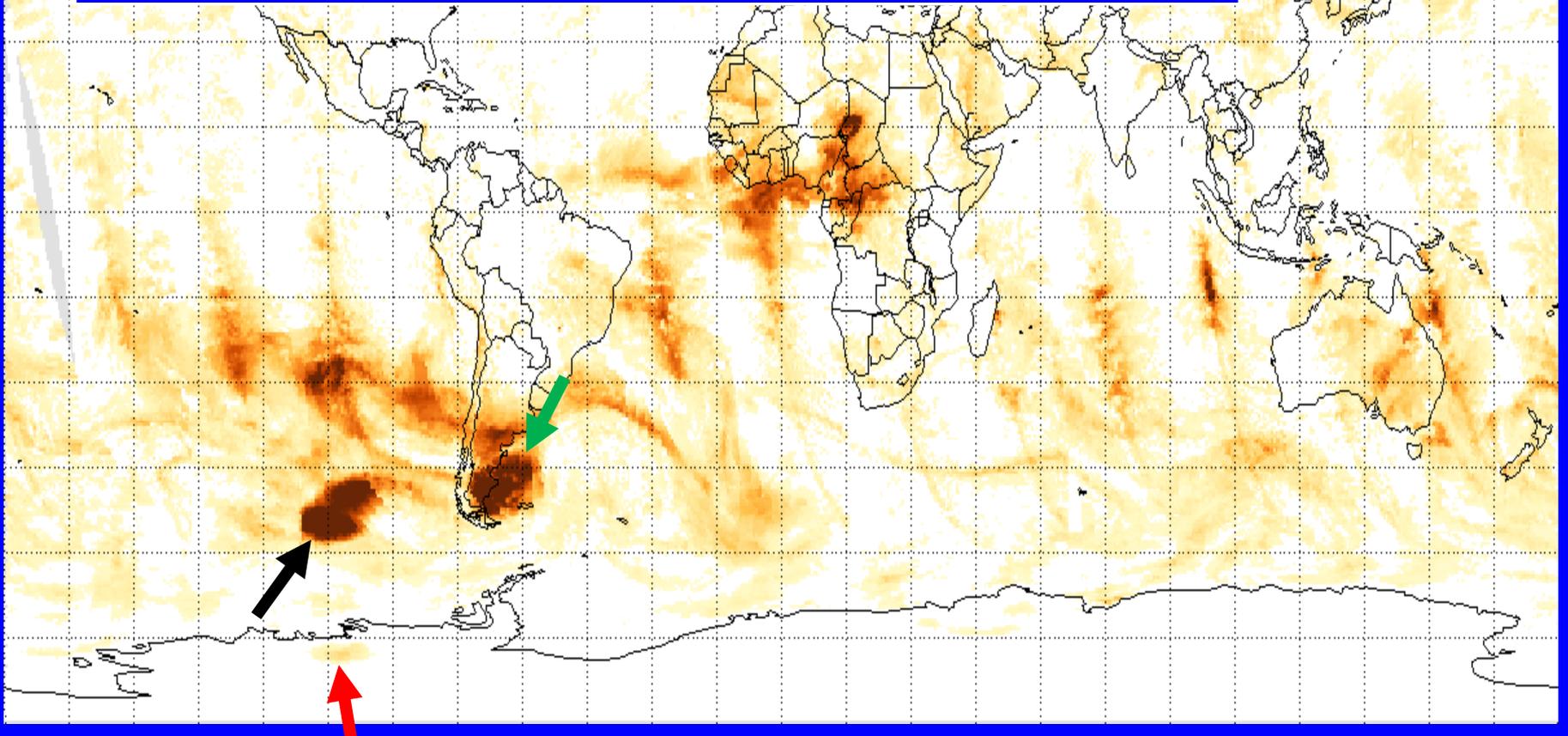


17 January 2020



Dec smoke blob remains almost stationary.

4 Jan smoke is north of Dec blob and also over SA.

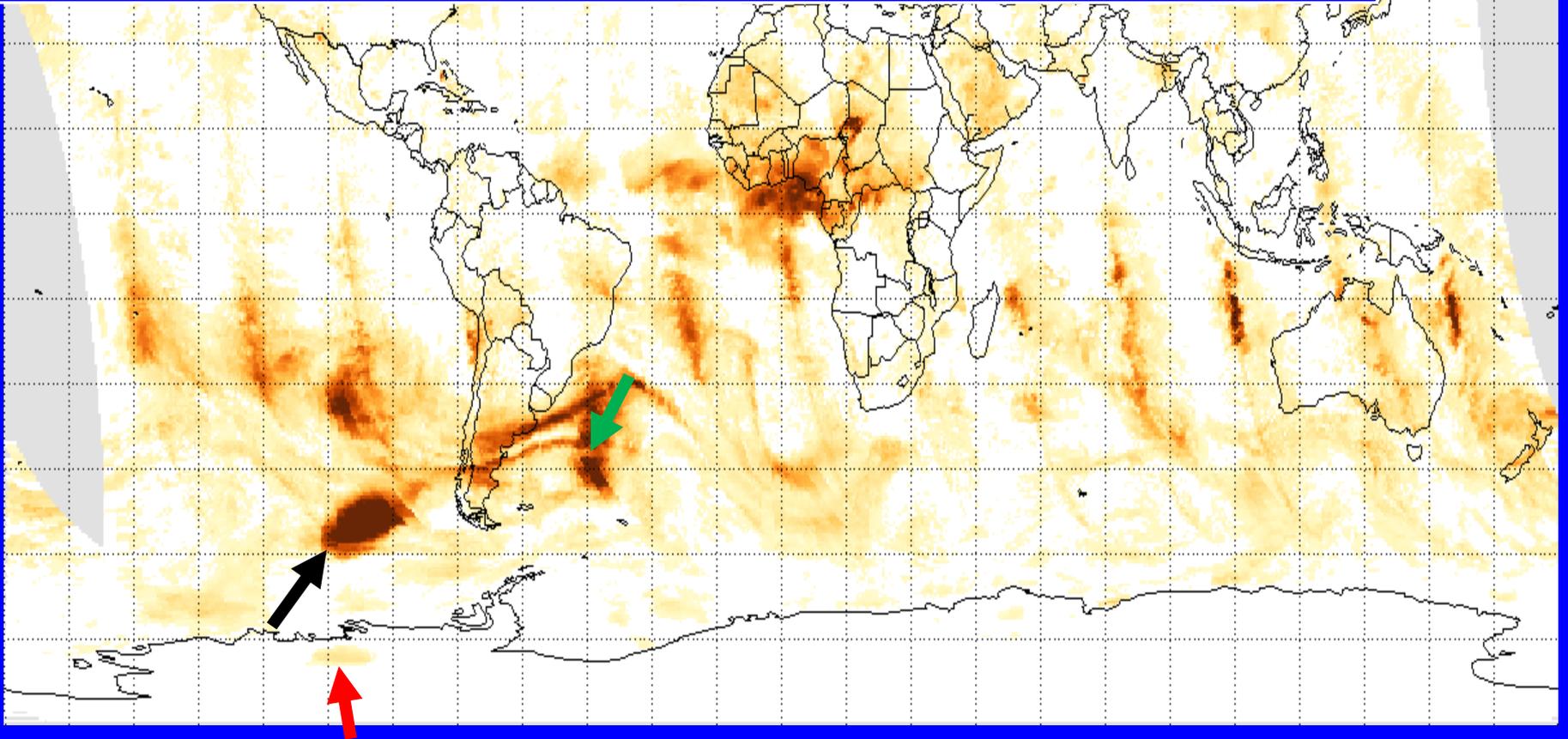


18 January 2020



Dec smoke blob remains almost stationary.

4 Jan smoke is north of Dec blob and also over SA and Atlantic.

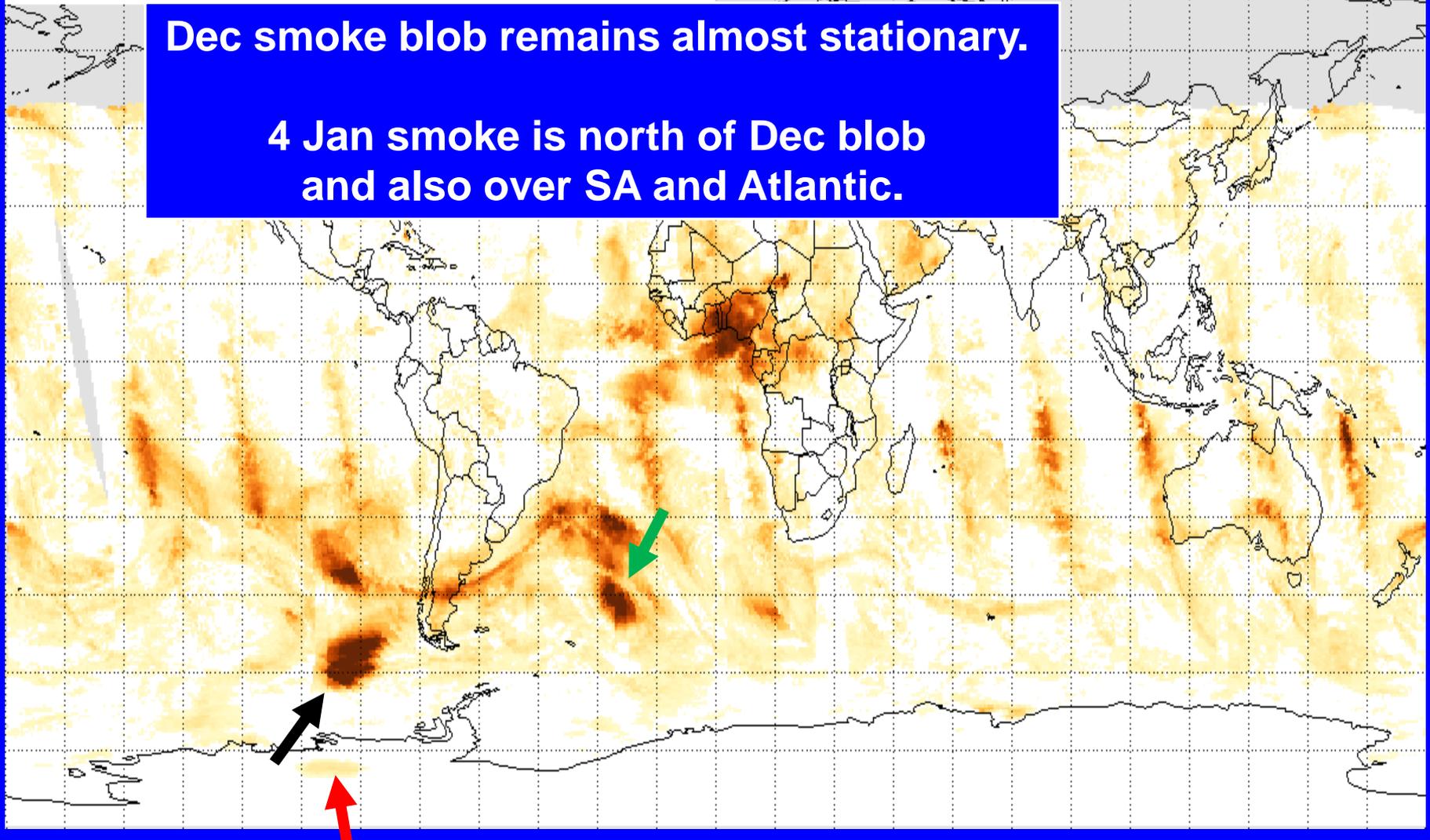


19 January 2020



Dec smoke blob remains almost stationary.

**4 Jan smoke is north of Dec blob
and also over SA and Atlantic.**

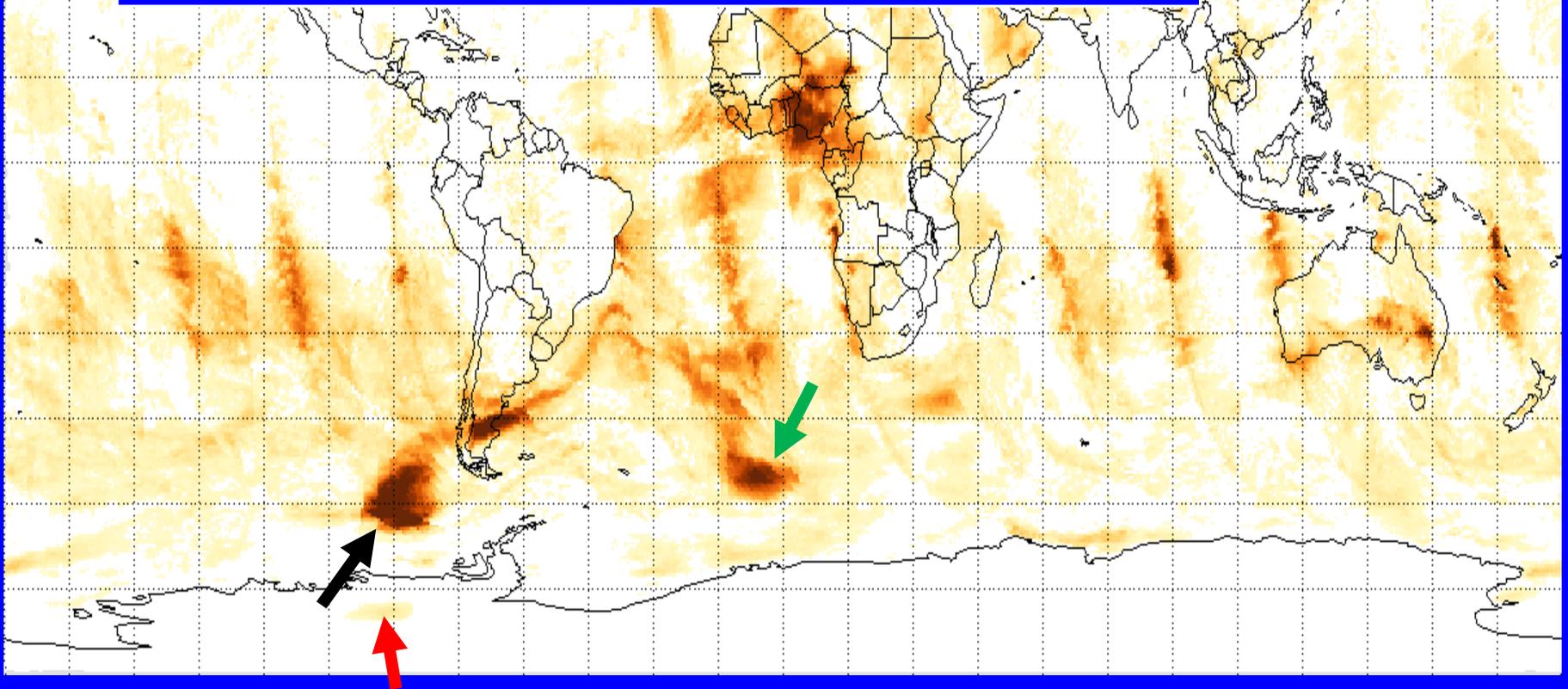


20 January 2020

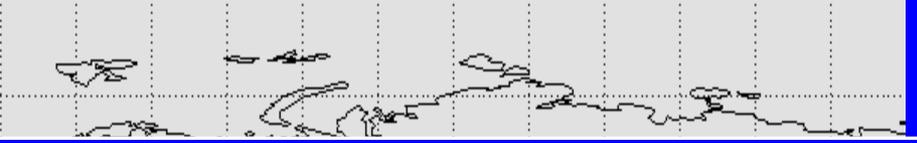


Dec smoke blob is still entirely over the Pacific.

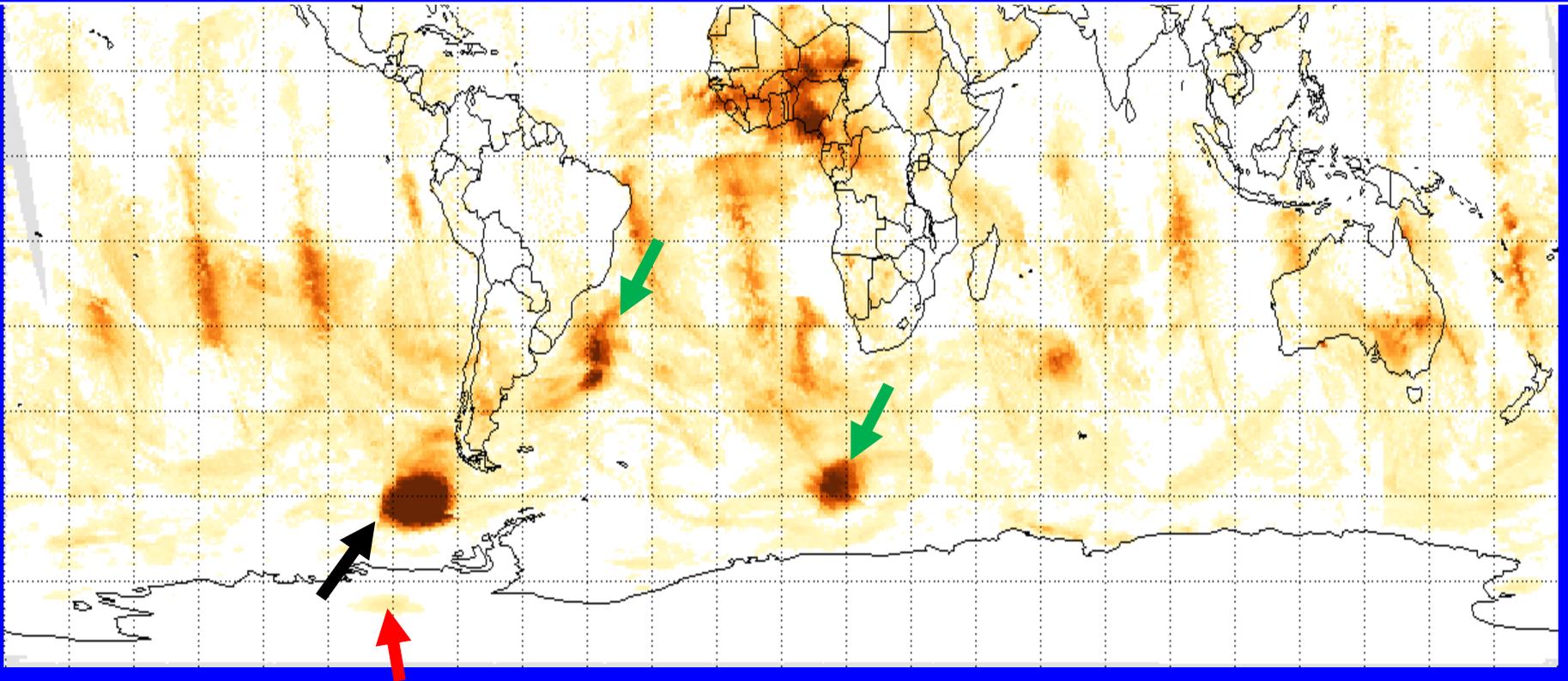
**4 Jan smoke is northeast of Dec blob
and also over SA and Atlantic.**



21 January 2020

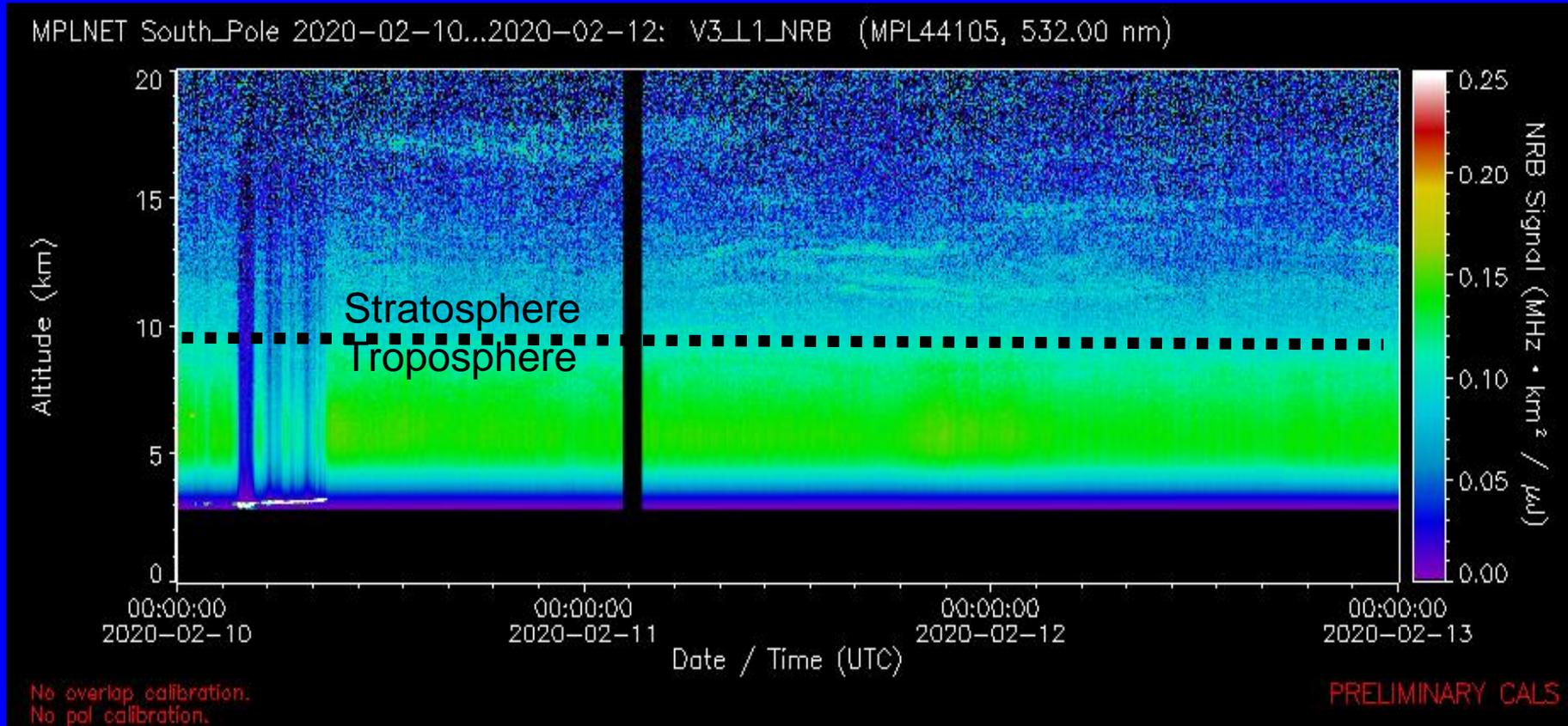


On 21 Jan the three most distinctive AI blobs consist of the Dec blob over the Pacific and two 4 Jan blobs over the Atlantic.



Stratospheric Smoke at the South Pole

MicroPulse Lidar Aerosol Backscatter - Credit, Judd Welton, NASA GSFC

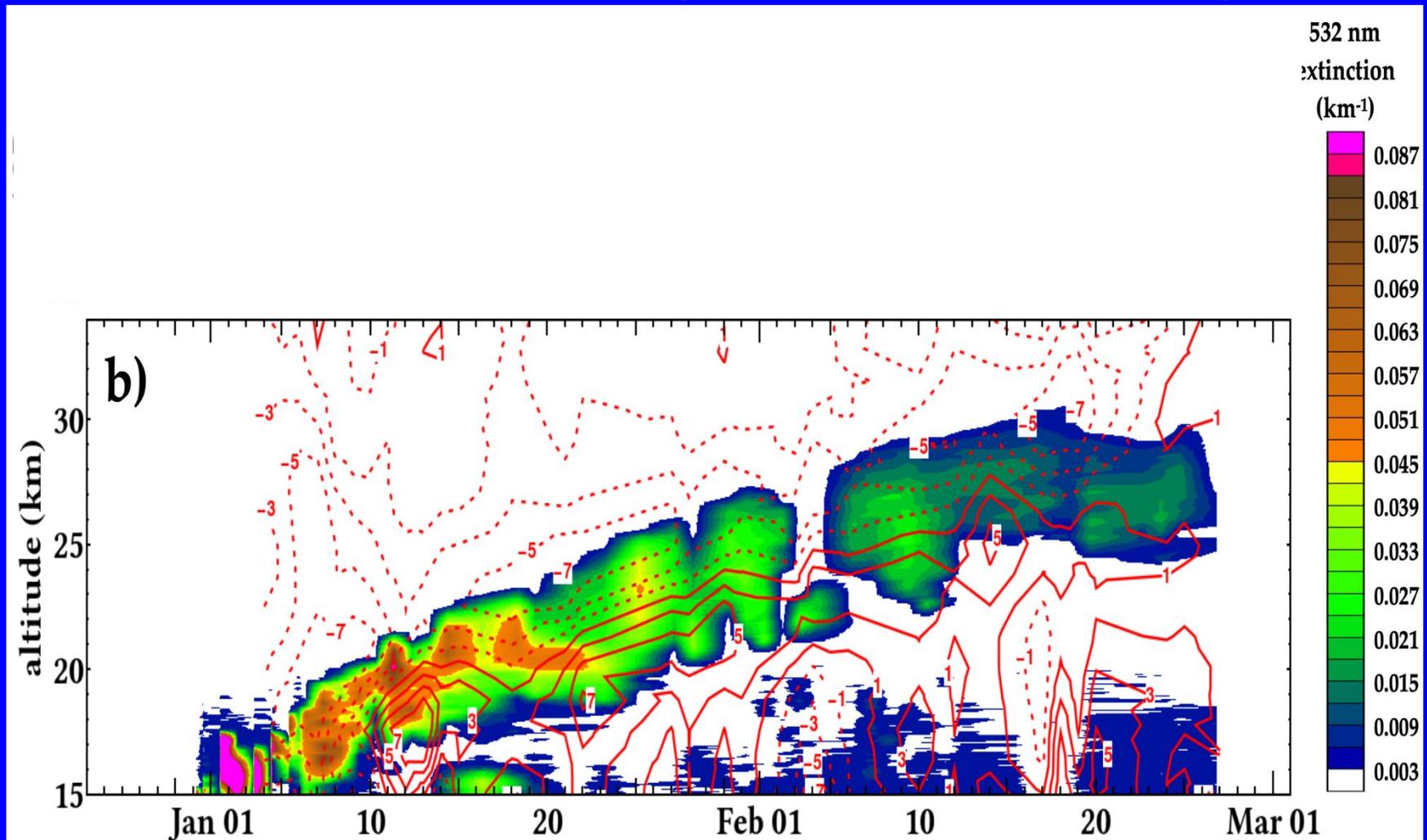


**Backscattering smoke layers for 3 days in February.
- up to 18 km**

CALIPSO lidar Aerosol Extinction

Altitude vs. Time

- red contours, Temperature anomaly



Conclusions:

- * ANY event had unprecedented, multi-day cluster of pyroCbs.**
- * Highest recorded injection heights**
- * Several pyroCbs occurred overnight**
- * Stratospheric smoke at the South Pole**
- * Unprecedented diabatic rise of smoke**